Centre for Atmospheric Sciences
Indian Institute of Technology Delhi

A Report for Internal Review

March 2014

Executive Summary

The **Centre for Atmospheric Sciences** (CAS) is a premier centre for education and research in atmospheric and oceanic sciences in India. CAS was set up in 1979 to undertake modelling studies to improve the prediction of the monsoon and its variability. Initially sponsored by the India Meteorological Department, CAS was later upgraded in 1981 by the Planning Commission to an advanced centre for **interdisciplinary research**. To complement its research activities, CAS started the **Ph. D. programme** in atmospheric sciences that was **the first of its kind in the country**. In 2008, CAS started the M.Tech programme in "Atmospheric and Oceanic Sciences & Technology" with the support of the Ministry of Earth Sciences and Indian Space Research Organization. In 2011, we initiated the UG Minor Area Programme in "Atmospheric and Oceanic Sciences", also the **only one of its kind in the country**. Currently, CAS has a **faculty strength of 14** and has awarded **17 Ph. D. and 35 M.Tech** degrees in the last five years. During the same period, the Centre received ~ Rs. **2** Crore in 'Plan' and ~ Rs. **0.39** Crore in 'Non-Plan' grants and generated ~ Rs. **19.1** Crore in Sponsored Research and Consultancy projects. Based on the **number of research publications, degrees awarded, courses offered and student/faculty strength** criteria, we estimate that CAS is nationally ranked among the top two centres/departments in the field. According to the **2011 US National Academy of Sciences benchmarking criteria**, we also compare favourably with all US centres/departments in our discipline. The following sections summarize the key aspects of the Centre's activity.

1. Curriculum

The Centre's curriculum is designed to provide rigorous training in the fundamentals of atmospheric and oceanic sciences in order to meet the nation's requirements of skilled manpower in this expanding field. What sets us apart from similar institutions abroad is that most of our incoming students have no formal training in weather, climate or oceans, but through the training received in the CAS, they develop into full-fledged atmospheric and oceanic scientists capable of conducting **independent research**. In addition to the fundamentals, we also teach state-of-the-art modeling and operational techniques to our M.Tech and Ph. D. graduates who can then cater to the special needs of agencies such as IMD, NCMRWF, INCOIS, ISRO, Indian Navy, Indian Air Force, etc. The curriculum of the UG Minor Area programme is geared towards generating interest among UG students for **advanced study in this emerging area** of national importance.

The sanctioned strength for M.Tech admission per year is 25 (**14** with Institute Assistantship and the rest with external funding**)** and the average **enrolment** was **13** students**.** In the last five years, on an average **8** students were admitted to the Ph. D. programme per year. Even though only **2 UG** students completed Minor Area in Atmospheric & Oceanic Sciences in the last 3 years, **the 3 UG courses had an average enrolment of 246.4**. Of the total credit requirements, **60**% at the UG level (towards fulfilling Minor Area requirements) and **40**% at the PG level are elective. The Ph. D. program has a **12**-credit requirement for students with M.Sc and a **6-**credit requirement for students entering with an M.Tech degree. The **2 core** courses at the UG level (Minor

Area) have **entirely** been introduced in the last three years. **94.7**% of the **57** courses at the PG level, were introduced in the last five years while the rest were updated.

2. Teaching Environment

The average **class size** for UG and PG courses were **112** and **19.6**, respectively. In the last 5 years, the average class size across all the courses has gone up from **13** in 2008-2009 to **43.1** in 2012-13. The average **contact hour** of the faculty is **13** hrs per week of UG and **3.5** hrs per week of PG teaching. Three **new laboratories** have been established with **all the** experiments in the PG courses being created in the last five years. Average student-teacher ratio of the courses floated by the Centre in the last five years was 23.6. The total space available for teaching is 1318.8 ft^2 as M.Tech/Ph. D. teaching laboratories. We use the research High-Performance Computing (HPC) system for instructional purposes because we do not have any HPC system exclusively for teaching. The Centre's library contains almost all the important textbooks in the field of weather and climate to facilitate student learning and research.

3. Research

The goal of CAS is to conduct cutting-edge interdisciplinary research and create highly skilled manpower in 4 core areas: **atmospheric modelling, oceanic modelling, air pollution and climate science**. In the last five years, CAS faculty published **a total of 154 publications in peer-reviewed SCOPUS journals**. Regular seminars by distinguished speakers of international repute are arranged in the Centre so that our faculty and students can keep abreast of the latest scientific developments in the field.

Averaged over the last five years, **43.8**% of the M.Tech students and **58.3**% of the research scholars were supported by **external funding**. In the last five years, approximately **21%** of the students have enrolled for a Ph. D in the Centre after completing the M.Tech degree. During this period, the average number of **Ph. Ds graduated per faculty per year** was **1.2** and the average **journal publication per faculty** per year was **11**. The externally funded projects trained about **70** technical and scientific personnel. Over the last five years, CAS received Rs. 2.39 Crores as plan and non-plan budget from the Institute. During the same period, CAS faculty generated ~ Rs. 19.1 Crore from research and consultancy projects. **Thus, 89% of the Centre's funds were generated from externally funded projects.** The average number of research and consultancy projects per faculty was **1.8** and **0.28**, respectively, generating **Rs. 1.53 Crores per faculty**. In **60**% of the projects, investigators from outside CAS were collaborators, out of which **50%** were from outside the country.

4. Innovation, Design and Development

The Centre has made significant contributions to the improvement of operational capabilities in the country. The IIT Storm Surge Model is a state-of-the-art tool for predicting storm surges due to tropical cyclones along the Indian coast. It has been transferred to IMD as well as to the Indian Ocean rim countries for operational storm surge forecasting. Our Centre is also recognised by the WMO as a nodal centre for imparting training on storm surge modelling. Every year, WMO sponsors two meteorologists from different countries for undergoing training at the Centre. Faculty

members have undertaken several collaborative projects for goal-oriented benefits of organizations such as IMD, INCOIS, ISRO, NCMRWF, NEERI, C-DAC and CPCB.

5. R&D Environment

The Centre has developed several laboratories for carrying out its research programmes, and routinely acquires large-volume datasets for instructional and research applications. Computing facilities have been established through sponsored projects funded by organizations such as MoES, ISRO and DST. Currently, the Centre has two parallel computing clusters with ~2.3 Teraflops of computing power. The existing computing infrastructure is not adequate to meet the computing challenges of the 21st century such as running fully-coupled climate models or conducting large ensemble simulations. CAS faculty are developing innovative hybrid computing technology to solve this problem. Moreover, we are seeking external funding to build a HPC system in the Centre as well as driving the establishment of an institute-wide HPC infrastructure. In addition to the computing labs, the Centre has enhanced observational facilities by acquiring image processing software (ERDAS Imagine) and instruments such as Microtops Radiometer, Aethalometer, Albedometer and Gas Analyzers.

The Centre occupies ~ **8611 ft^2** of physical space, of which 26% is faculty office space and, 38% is research and teaching laboratories. **Average space available** for a Ph. D. student is **48.57 ft^2** and **23.46 ft^2** is available for an M.Tech student. On average, faculty members attended **6** national and **3** international conferences/workshops and a Ph. D. student attended **2** national and **1** international conferences/workshops. Over the last five years, **3** M.Tech and **2** Ph. D. theses were completed under joint supervision with researchers from outside the Institute. In the last five years, **10 conferences/workshops were organized** at the Centre.

6. Outreach

CAS faculty are actively engaged in reaching out to the academic community and the general public. In the last five years, faculty organized **16** workshops and training programmes and **1** NPTEL course for students and scientists for capacity building in atmospheric and oceanic sciences. CAS faculty authored/edited 12 books/chapters in the last five years and served as guest editors of international and national journals, external examiners and invited speakers. Our faculty also provide technical expertise to various academic institutions and ministry committees at state and national levels. Faculty have given public lectures, and have undertaken projects at schools and local governments to create awareness about climate change and its impacts on the society.

7. Governance

The Centre is led by the Head who functions in close coordination with the Centre Research Committee, the Professorial Committee and the Centre's Faculty Board. The Faculty Search Committee is actively engaged in recruiting new faculty in thrust areas to expand the scope of activities of CAS. We also provide leadership and otherwise contribute to institute-level activities through faculty representatives to the Senate, Board of Academic Programmes, Task Force on HPC, and Committee on Training & Placement.

Averaged over the last five years, **8 faculty board meetings** (80% average attendance)**, 14.2 CRC meetings and 7.2 Professorial Committee meetings** were held every year. **Faculty time utilization** was **20**% in teaching, **5**% in meetings, **20**% in project management, **35**% in research & thesis guidance and **20**% in administrative work. Staff time utilization was **20**% in laboratory and **80**% in supporting research.

8. Benchmarking

Over the last three decades, CAS has established itself as a reputed Centre in India in the field of atmospheric and oceanic sciences through its research and curriculum. In the strictest sense, there is no peer for CAS within the Institute because we are a uniquely interdisciplinary entity. The Centre for Atmosphere and Oceanic Science (CAOS), Indian Institute of Science, Bangalore, is identified as a peer because of our similarities in history, curriculum and research. Public domain data suggests that our performance is competitive with regards to CAOS. For example, our publications per faculty and Ph. Ds per year are **2.2 and 3.2** respectively**,** while the corresponding numbers in CAOS are **1.4** and **2.0**, respectively.

Moreover, information from "A Data-Based Assessment of Research-Doctorate Programs in the United States", a 2011 study on 52 US centres/departments in Oceanography, Atmospheric Sciences and Marine Sciences conducted by the National Research Council of the US National Academies show that we compare favourably with US institutions. For example, our publications per faculty per year is **2.2** while that in the US is **1.51**.

In terms of student intake into the Centre, the **GATE cut-off** for short-listing at M.Tech level was **300** for General/OBC and **200** for SC/ST in this academic year.

9. Feedback

Feedback is obtained regularly from students through class-committee meetings held at the middle of every semester and the concerns of the students are then followed up. Online feedback from the students at the end of the semester is also obtained to take corrective measures. A conference was organized in December 2012 to interact with the alumni and get feedback from them and other research and operational organizations. At individual level, faculty members interact and take timely feedback from their counterparts in operational organizations, so that their efforts in CAS will help the growth of this important area country. On-campus placement for M.Tech and off-campus placement for Ph. D. students were **70**% and **100**%, respectively, in this academic year.

10. Vision

The vision of the Centre for Atmospheric Sciences is to be the best in innovative research and education and develop the future leaders in atmospheric sciences. This vision shall be realized within the context of a premier technological research institute through achieving excellence in both Research and Education.

Our target in the next five years is to generate **6 Crore** per year from external funding and publish **3 peer-reviewed publications** per faculty per year. CAS seeks to establish at least one nationally-recognized interdisciplinary research programme related to climate change. In order to achieve the above, we plan to **recruit 10 new faculty** members leading to a **projected faculty strength** of **20.** When operating at full capacity, we expect to graduate **8** Ph. D., **25** M.Tech and **20** B.Tech (Minor Area) students per year. We aim to improve the quality of student intake by attracting applicants from the top national colleges and universities. **The Centre aspires to be upgraded to a full-fledged Department in the Institute, where a five year integrated M.Tech program is envisaged to replace the existing two-year M.Tech programme.**

11. Public Domain

Faculty profile, courses of study, publication records, research activities, infrastructure facility, student profiles, information about past events and upcoming events, sponsored and consultancy projects, collaboration with institutions within the country and abroad and alumni information displayed in the Centre's webpage is available in public domain. All CAS meeting minutes are available in the Centre's office. All M.Tech and Ph. D. theses are archived in the library. The outreach activities organized by the Centre are announced in advance on the Centre and Institute webpages and sent to all potential stakeholders.

Summary of actions

The major changes planned within the Centre to address the strategy of building excellence in Research, Education and Outreach are given below.

1. Recruit new faculty in the following thrust areas: Multi-scale modeling of monsoon; geophysical fluid dynamics; land-atmosphere-ocean modeling; NWP and data assimilation; regional and global climate change, adaptation and mitigation; air pollution and chemical modelling; Earth System observations.
2. Enhance the profile of our students in the national and international arena.
3. Conduct outreach activities amongst undergraduates majoring in physical sciences disciplines to recruit better quality students.
4. Strengthen the computing facilities by acquiring an HPC in the 20 Teraflops range.
5. Streamline administrative work by using high-value assistantships and hiring efficient and skilled manpower for HPC systems administration by creative utilization of the funding resources at our disposal.

The Institute has been generous in providing support through plan and non-plan budgets whenever sought. CAS seeks an allocation of **Rs. 3.5 Crore of plan support and Rs. 0.75 Crore of non-plan support** for the next five years. CAS also hopes to work with the Institute hand-in-hand to seek innovative solutions such as flexible hiring mechanisms and automation of administrative functions wherever possible. With appropriate institutional support, CAS is confident of achieving its projected goals within the next five years. We strongly feel that the conversion of the Centre to a Department will significantly advance the scope of teaching atmospheric and oceanic sciences at the B.Tech level in the Institute.

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Highlights of the Centre

1. Highlights of the Centre

The Centre for Atmospheric Sciences (CAS) was set up in the year 1979 at the Indian Institute of Technology Delhi. Subsequently, the Ministry of Education, Government of India funded the Centre under the Sixth Five Year Plan. The Centre was also co-sponsored by the India Meteorological Department (IMD). It has 14 core faculty members and about 50 research scientists/assistants/scholars: a multi-disciplinary team of meteorologists, oceanographers, applied mathematicians, physicists, chemists and engineers working in the areas of atmospheric and oceanic sciences.

The major activities are: Research & Development, Teaching and Continuing Education. These activities are oriented towards achieving fundamental understanding of the atmospheric and oceanic processes. The key research topics of the Centre have great relevance to weather and climate, especially the Indian summer monsoon, tropical cyclones & associated surges and air quality modelling. The Centre provides an ideal environment for higher studies in the fascinating and emerging sciences of the earth system.

A Memorandum of Understanding was signed between the Ministry of Earth Sciences (MoES) and IIT Delhi, which has facilitated in launching of the M. Tech programme in Atmospheric-Oceanic Science and Technology and enriching the fundamental and applied research in the Centre and iii) Establishing the Sir Gilbert Walker MoES Distinguished Chair Professorship and three Dr. Sudhansu Kumar Banerji MoES Outstanding Young New Faculty Fellowships in the Centre.

The highlights of the Centre are summarized below.

Number of Ph. D. Students

Completed:	**106**
Ongoing:	**36**

Number of M.Tech Students (since 2008-2009)

Completed:	**35**
Ongoing:	**21**

Number of B.Tech students registered this semester in Atmospheric Science electives:
~**507** (350 in the last semester)
(Minor Area started in 2011-12)

Number of papers published in Journals: **753**

Number of sponsored projects to date: **164**

Total budget of projects to date: **Rs 43 Crore**

Faculty Profile

2. Faculty Profile

Currently there are 14 faculty members in the Centre. Their contact information, research interest, honours and awards and three selected publications (in the last five years) are given below.

Professor and Head

A.D. Rao, Ph. D. (IIT Delhi)
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Research Interests: *Developing numerical models for coastal ocean state prediction system; Modelling of storm surges and associated inundation, internal waves and wind waves.*

Selected publications:

1. Muraleedharan G, Mourani Sinha, A D Rao, N Unnikrishnan, Nair and P G Kurup," Estimation of wave period statistics using numerical coastal wave model" , Natural Hazards, 49, 2, 165-186, 2009.
2. Rao A D, Madhu Joshi, Indu Jain and Ravichandran M, "Response of subsurface waters in the eastern Arabian Sea to tropical cyclones", Estuarine, Coastal and Shelf Science, 2010, 89: 267-276.
3. Madhu Joshi and Rao A D, "Response of southwest monsoon winds on shelf circulation off Kerala Coast, India", Continental Shelf Research, 2012, 32: 62-70.

Professors

S. K. Dash, Ph. D. (PRL, Ahmedabad)
skdash@cas.iitd.ac.in

Research Interests: *Monsoon Studies, Climate Modelling and Meteorological Computing*

Selected publications:

1. Dash, S. K., M. A. Kulkarni, U. C. Mohanty and K. Prasad (2009), Changes in the characteristics of rain events in India, J. Geophys. Res.,114.
2. Dash, S. K. and A. Mamgain (2011), Changes in the frequency of different categories of temperature extremes in India, J. Appl. Metorol. Clim., 50, 50, 1842-1858.
3. Dash, S. K., N. Sharma, K. C. Pattnayak, X. J. Gao and Y. Shi (2012), Temperature and precipitation changes in the north-east India and their future projections, Global and Planetary Change, 98-99, 31-44.

P. Goyal, Ph. D. (Roorkee)
pramila@cas.iitd.ac.in

Research Interests: *Air Pollution Modelling, Environmental management system, EIA of industries and power plants, vehicular pollution of urban cities, assimilative capacity of urban cities, development of source inventories, air quality management and risk assessment techniques*

Selected publications:

1. P. Goyal, A. Kumar Mishra, D., "The impact of air pollutants and meteorological variables on visibility in Delhi" Environmental Modeling and Assessment, DOI: 10.1007/S10666-013-9380-4 (2013).
2. Anikender Kumar and P. Goyal, "Forecasting of air quality index in Delhi using neural network based on principal component analysis" Pure and Applied Geophysics, 170, 711-722 (2013).
3. P.Goyal, Dhirendra Misra and Anikender Kumar, "Vehicular emission inventory of criteria pollutants in Delhi" SpringerPlus 2, 216 (2012).

M. Mohan, Ph. D. (IIT Delhi)
mmanju@cas.iitd.ac.in

Research Interests: *Atmospheric Boundary Layer Modelling, Chemical Transport Modelling and Atmospheric Pollution, Urban Meteorology: Heat Island and Thermal Stress Studies, Fog Prediction with models and Measurements.*

Selected publications:

1. Medhavi Gupta and Manju Mohan: Assessment of contribution to PM_{10} concentrations from long range transport of pollutants using WRF/Chem over a subtropical urban airshed, Atmospheric Pollution Research, 2013, volume 4, Issue 4, Pages 405-410, DOI: 10.5094/APR.2013.046.
2. Manju Mohan, Yukihiro Kikegawa, B.R. Gurjar, Shweta Bhati and Narendra Reddy Kolli: Assessment of Urban Heat Island Effect for Different Landuse -Landcover from Micrometeorological Measurements and Remote Sensing Data: A Case Study for Megacity Delhi. Theoretical and Applied Climatology, Volume 112, Issue 3-4, May 2013, DOI: 10.1007/s00704-012-0758-z.
3. Manju Mohan, Shweta Bhati, Archana Sreenivas, Pallavi Marrapu: Performance Evaluation of AERMOD and ADMS-Urban for Total Suspended Particulate Matter Concentrations in Megacity Delhi, Aerosol and Air Quality Research, 2011, Volume 11, pages 883–894, DOI: 10.4209/aaqr.2011.05.0065.

M. Sharan, Ph. D. (IIT Delhi)
mathilis@cas.iitd.ac.in

Research Interests: *Air Pollution Modelling, Atmospheric Boundary Layer, Computational and Mathematical Methods, physiological fluid dynamics*

Selected publications:

1. Maithili Sharan, J.P. Issartel, Sarvesh K. Singh and Pramod Kumar, An inversion technique for the retrieval of single-point emissions from atmospheric concentration measurements. Proc Royal Society A, 465, 2069-2088 (2009).
2. Pramod Kumar and Maithili Sharan, An analysis for the applicability of Monin-Obukhov similarity theory in stable conditions. J.Atmos.Sci., 69, 1910-15 (2012) .
3. Maithili Sharan, J.P.Issartel and S.K.Singh, A point-source reconstruction from concentration measurements in low wind stable conditions, Q.J.Roy. Meteorol. Soc., 138: 1884- 1894 (2012).

O. P. Sharma, Ph. D. (IIT Bombay)
opsharma@cas.iitd.ac.in

Research Interests: *Ocean Atmospheric Circulation Modelling, Aerosols and Atmospheric Chemistry, Methods of Applied Mathematics*

Selected publications:

1. Fatima Hashmi, H.C. Upadhyaya, S. N. Tripathi, O.P. Sharma, Fangqun Yu, 2011: On radiative forcing of sulphate aerosol produced from ion-promoted nucleation mechanisms in an atmospheric global model. Meteorology and Atmospheric Physics, Vol. 112, pp. 101-115.
2. Verma S., O. Boucher, M. Shekar Reddy, H. C. Upadhyaya, P. Le Van, F. S. Binkowski, and O.P. Sharma, 2012: Tropospheric distribution of sulphate aerosols mass and number concentration during INDOEX-IFP and its transport over the Indian Ocean: a GCM study. Atmos. Chem. Phys., 12, 6185–6196, doi:10.5194/acp-12-6185-2012.
3. Verma S., O. Boucher, H. C. Upadhyaya and O.P. Sharma, 2013: Variations in sulphate aerosols concentration during winter monsoon season for two consecutive years using a general circulation model. Atmosfera, 26 (3), pp. 360-367.

Associate Professors

Krishna AchutaRao, Ph. D. (Tulane, USA)
akrishna@cas.iitd.ac.in

Research Interests: *Climate modelling, climate model validation, climate variability, climate change detection and attribution, ocean heat content, sea-level rise, air-sea heat transfer and climate data analysis tools*

Selected publications:

1. Collins, M. et al. (2013), Observational challenges in evaluating climate models, *Nature Climate Change, 3*(11), 940-941.
2. Gleckler, P. J. et al., (2012), Human-induced global ocean warming on multidecadal timescales, *Nature Climate Change, 2*, 524-529.
3. Bindoff, N. L., P. A. Stott, K. M. AchutaRao, et al., 2013: "Detection and Attribution of Climate Change: from Global to Regional." In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T. F. et al., (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Somnath Baidya Roy, Ph. D. (Rutgers, USA)
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Research Interests: *Land cover change, Wind energy, Boundary layer processes*

Selected Publications:

1. Zhou, L., Tian, Y., Baidya Roy, S., Thorncroft, C., Bosart, L. and Hu, Y (2012), Impacts of wind farms on land surface temperature, *Nature Clim. Change, 2*, 539-543.
2. Baidya Roy, S. and J. Traiteur, Impact of wind farms on surface temperatures (2010), *Proceedings of the National Academies of Sciences, 107*, 17899-17904.
3. Baidya Roy, S. Mesoscale deforestation climate feedback in Amazonia (2009), J. Geophys. Res., 114, D20111.

H. C. Upadhyaya, Ph. D. (IIT Delhi)
hcdhyaya@cas.iitd.ac.in

Research Interests: *General Circulation Modelling, Data Assimilation, Adjoint Modelling*

Selected publications:

1. Hashmi Fatima , H.C. Upadhyaya and O P. Sharma 2011: Sensitivity of radiative forcing to global carbonaceous emissions. Tellus B 2012, 64, 17157, DOI: 10.3402/tellusb.v64i0.17157
2. Hashmi Fatima, H. C. Upadhyaya, S. N. Tripathi, O. P. Sharma and Fangqun Yu 2011: On radiative forcing of sulphate aerosol produced from ion-promoted nucleation mechanisms in an atmospheric global model. Meteorology and Atmospheric Physics, 2011, Volume 112, Numbers 3-4, Pages 101-11
3. S. Verma, O. Boucher, M. Shekar Reddy, H. C. Upadhyaya, P. Le Van, F. S. Binkowski, and O. P. Sharma 2012: Tropospheric distribution of sulphate aerosols mass and number concentration during INDOEX-IFP and its transport over the Indian Ocean: a GCM study. Atmos. Chem. Phys., 12, 6185-196, 2012.

Assistant Professors

Sagnik Dey, Ph. D. (IIT Kanpur)
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Research Interests: *Aerosol-cloud-precipitation Interaction, Impacts of Aerosols and clouds on climate, Characterization of aerosols and clouds using 'remote sensing' and 'in-situ observations', Climate change and health*

Selected publications:

1. S. Dey, L. Di Girolamo, A. van Donkelaar, S. N. Tripathi, T. Gupta and M. Mohan (2012), Variability of outdoor fine particulate ($PM_{2.5}$) concentration in the Indian subcontinent: a remote sensing approach, *Rem. Sens. Environ., 127*, 153-161.
2. S. Dey, L. Di Girolamo, G. Zhao, A. L. Jones and G. M. McFarqahar (2011), Satellite-observed relationships between aerosol and trade-wind cumulus cloud properties over the Indian Ocean, *Geophys. Res. Lett., 38*, L01804.
3. S. Dey and L. Di Girolamo (2010), A climatology of aerosol optical and microphysical properties over the Indian subcontinent from 9 years (2000-2008) of MISR data, *J. Geophys. Res.*, 115, D15204.

Dilip Ganguly, Ph. D. (PRL, Ahmedabad)
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Research Interests: *Aerosol-cloud-precipitation interaction, Cloud parameterization, Radiative Forcing and Climate Change, climate sensitivity and feedback processes, Climate diagnostics using model output and observations, Monsoon Dynamics*

Selected publications:

1. Ganguly, D., Philip J. Rasch, Hailong Wang, and Jin-ho Yoon (2012), Climate response of the South Asian monsoon system to anthropogenic aerosols, Journal of Geophysical Research, 117, D13209, doi:10.1029/2012JD017508.
2. Ganguly, D., P. Ginoux, V. Ramaswamy, D.M. Winker, B.N. Holben, and S.N. Tripathi (2009), Retrieving the composition and concentration of aerosols over the Indo-Gangetic basin using CALIOP and AERONET data, Geophysical Research Letters, 36, L13806, doi:10.1029/2009GL038315.
3. Ganguly, D., Philip J. Rasch, Hailong Wang, and Jin-ho Yoon (2012), Fast and slow responses of the South Asian monsoon system to anthropogenic aerosols, Geophysical Research Letters, 39, L18804, doi:10.1029/2012GL053043.

Saroj K. Mishra, Ph. D. (IISc. Bangalore)
skm@cas.iitd.ac.in

Research Interests: *Numerical Modelling of the Atmosphere, Hierarchical Climate Modelling, Indian Monsoon, Interaction between Dynamic and Physical Processes, Modelling of Climate Change*

Selected publications:

1. Evans, K. J., P. H. Lauritzen, S. K. Mishra, R. B. Neale, M. A. Taylor, J. J. Tribbia, 2013: AMIP Simulation with the CAM4 Spectral Element Dynamical Core, *J. Climate*, 26, 689–709.
2. Mishra. S. K., M. A. Taylor, R. D. Nair, P. H. Lauritzen, H. M. Tufo, and J. J. Tribbia, 2011: Evaluation of the HOMME Dynamical Core in the Aqua-Planet Configuration of NCAR CAM4: Rainfall, *J. Climate*, 24, 4037-4055.
3. Mishra. S. K., J. Srinivasan, and R. S. Nanjundiah, 2008: The Impact of Time Step on the Intensity of ITCZ in Aquaplanet GCM, *Monthly Weather Review*, 136, 4077 – 4091, DOI: 10.1175/2008MWR2478.1.

Vimlesh Pant, Ph. D. (IITM, Pune)
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Research Interests: *Physical Oceanography, Ocean Modelling, Atmospheric Aerosols, Meteorological and Oceanographic Observations*

Selected publications:

1. Pant Vimlesh, Devendraa Singh, A. K. Kamra 'Concentrations and size distribution of aerosol particles at Maitri, during the passage of cyclonic storms revolving around the continent of Antarctica' Journal of Geophysical Research, 115, D17202, doi: 10.1029/2009JD013481, 2010.
2. Pant Vimlesh, C. G. Deshpande, A. K. Kamra 'The concentration and number size distribution measurements of the Marine Boundary Layer aerosols over the Indian Ocean' Atmospheric Research, doi:10.1016/j.atmosres.2008.12.004, Vol. 92, 381 – 393, 2009.
3. Pant Vimlesh, C. G. Deshpande, A. K. Kamra 'On the aerosol number concentration–wind speed relationship during a severe cyclonic storm over south Indian Ocean' Journal of Geophysical Research, Vol. 113, D02206, doi:10.1029/2006JD008035, 1-10, 2008.

Senior Scientific Officer-I

Poornima Agarwal, Ph. D. (Srinagar, J&K)
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Research Interests: *Environmental Chemistry, Mathematical Techniques*

Selected publications:

1. Agarwal P and Srivastava P. (2012) Estimation of the atmospheric surface Layer parameters over Gujarat during Laspex-97, Our Earth, 9(2), 1-13.
2. Agarwal P and Kumar A. (2010) Short range atmospheric dispersion measurements from ground level source under tropical conditions, Our Earth,7(3), 3-11.

Adjunct Faculty (since 2013):

Sai Ravela (MIT, USA)
sairavela@mit.edu

Research Interests: *Estimation, control and information theory, Statistical pattern recognition, Statistical inference and learning*

Sir Gilbert Walker MoES Distinguished Chair Professor (2009-2013):

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tkrishnamurti@fsu.edu

Research Interests: *Tropical meteorology, High resolution hurricane forecast, Monsoon forecast, Interseasonal and intraseasonal variability of the tropical atmosphere*

Recently Retired Faculty

Professors

U. C. Mohanty (till 2013)
mohanty@cas.iitd.ac.in

Research Interests: *Tropical meteorology, Numerical weather prediction, Monsoon dynamics, Regional climate studies and Meso-scale modelling*

S. K. Dube (till 2012)
skdube@cas.iitd.ac.in

Research Interests: *Numerical storm surge prediction, Ocean wave modeling, Coastal marine hazards, Regional ocean state forecasting models*

Girija Jayaraman (till 2012)
jgirija@cas.iitd.ac.in

Research Interests: *Applied Mathematics, Physiological Fluid Dynamics, Aquatic Ecosystems*

Senior Scientific Officer-I

R. C. Raghava (**till 2013**)
rameshcr@cas.iitd.ac.in

Research Interests: *Numerical Modelling of Atmospheric and Land Surface processes, Atmospheric general circulation modelling*

Honours & Awards

Faculty members of the Centre are recipients of various awards, chairs and fellowships. Notable honors and awards are:

Shanti Swaroop Bhatnagar Prize
Fellow, Indian National Science Academy
Fellow, Indian Academy of Sciences
Fellow, National Academy of Sciences, India
Fellow, National Academy of Engineering
Fellow, Royal Meteorological Society
Fellow, Indian Meteorological Society
Fellow, Indian Institute of Environmental Engineers
Fellow, Andhra Pradesh Akademi of Sciences (FAPAS)
Young Scientist Award, INSA
National Award in Atmospheric Science & Technology, Ministry of Earth Sciences
VASVIK Award in Environmental Science & Technology
Sir Gilbert Walker Gold Medal
Mausam Award
AR & DB Silver Jubilee Award
Samanta Chandra Sekhar Award
Prof. M.G. Deshpande Award
Indira Gandhi Priyadarshini Award
Meghnad Saha Award in Theoretical Sciences
Dr. A. D. Vernekar Award of Indian Meteorological Society
NASI-SCOPUS Young Scientist Award
Nawab Zain Yar Jung Bahadur Memorial Medal of Institution of Engineers
Senior Associate, Abdus Salam ICTP, Trieste
Sofia Kovalevskaiya Chair, University of Kaiserslautern, Germany

Curriculum

3. Curriculum

a. Degree Programmes

Currently CAS has three vibrant teaching programmes, namely:

- B. Tech Minor Area in Atmospheric Sciences
- M. Tech in Atmospheric-Oceanic Science & Technology
- Ph. D.

Undergraduate Programme:

The Centre has initiated a Minor Area Programme in Atmospheric Sciences since 2011-12. In this minor area programme there are two core courses which deal with the Fundamentals of Atmosphere & Ocean and Climate Change. The students also have options for 16 elective courses where they have a wide range of choice from offerings such as Atmospheric Chemistry, Aerosols, Air-Sea Interaction and High Performance Computing. In order to complete the Minor Area programme in Atmospheric Sciences, students need to earn 20 credits from among these courses.

Core Courses in Minor Area Programme:

Course Code, Credit (L-T-P Structure)	**Course Name**
ASL 310, 4 (3-0-2)	Fundamentals of Atmosphere and Ocean
ASL 320, 4 (3-0-2)	Climate Change: Impacts, Adaptation and Mitigation

The elective courses in B.Tech Minor Area Programme include ASL410.

Course Code, Credit (L-T-P Structure)	**Course Name**
ASL 410, 4 (3-0-2)	Numerical Simulation of Atmospheric and Oceanic Phenomena

Other Minor Area electives such as ASL701, ASL703, ASL705, ASL706, ASL707, ASL710, ASL712, ASL715, ASL718, ASL720, ASL722, ASL724, ASL804, ASL808 and ASL819 are listed along with other M.Tech electives below.

Other than the above UG courses offered by the Centre, our faculty participate in a UG course, CYP100 (L-T-P structure of 0-0-4) outside the centre.

Post Graduate Programmes

i) M.Tech in Atmospheric-Oceanic Science & Technology

The M.Tech Programme in Atmospheric-Oceanic Science & Technology was introduced in the year 2008-2009. The courses under this programme are designed in such a way that

students with engineering and science background will be able to get interested in the exciting field of Weather and Climate. The courses are also oriented to help the graduated students get employed in Government Organizations, public and private sectors or continue in a doctoral program within the country and abroad. There are 10 core courses which include the Dynamics and Physics of Atmosphere & Ocean, Boundary Layer Meteorology, Atmospheric Chemistry and few practical courses and the Major Project. In addition to these core courses, there are a number of electives which include the Science of Climate Change, Air Quality Monitoring, Marine & Water Pollution and Remote Sensing. Some special modules for one credit are also floated every semester which are usually timed with the visits of distinguished scientists from inside the country and abroad. Detailed course content is provided in. The semester-wise credit requirement for M.Tech in Atmospheric and Oceanic Sciences & Technology is given in the Table below:

	Credits				
	Core	**Program Elective**	**Open Elective**	**Project (Core)**	**Total**
I – Semester	11	3	3	-	17
II – Semester	9	6	-	-	15
III - Semester	4	3	3	6	16
IV - Semester	-	-	-	12	12
Total	24	12	6	18	60

In India, until recently there has been no atmospheric and oceanic sciences degree programme at UG level. Hence, M.Tech students with background of basic science and engineering are introduced to the atmospheric and oceanic sciences at M.Tech for the first time. To strengthen their fundamental knowledge in the subject, the proportion (70%) of core courses is kept larger relative to the conventional departments where the PG programme is generally the advanced level of UG courses. The core and elective courses that are floated by the Centre are listed below.

Core Courses in M.Tech:

Course Code, Credit (L-T-P structure)	**Course Name**
ASL701, 3 (3-0-0)	Dynamics of Atmosphere and Ocean
ASL703, 3 (3-0-0)	Physics of Atmosphere and Ocean
ASL705, 3 (3-0-0)	Boundary Layer Meteorology and Air Pollution
ASL706, 3 (3-0-0)	Parameterization of Physical Processes
ASP751, 2 (0-0-4)	Simulation Lab -I: Weather Analysis & Forecasting
ASP752, 3 (0-0-6)	Simulation Lab -II: Obj. Analysis & Data Assimilation
ASP801, 3 (0-1-4)	Simulation Lab -III: Ocean-Atmosphere Forecast Methodology
ASL808, 3 (3-0-0)	Atmospheric Chemistry & Aerosols
ASD891, 6 (0-0-12)	Major Project Part -1
ASD892, 12 (0-0-24)	Major Project Part -2
ASC861, 1 (0-1-0)	Atmospheric Science Colloquium

Electives in M.Tech & B.Tech Minor Area:

Course Code, Credit (L-T-P Structure)	Course Name
ASL707, 3 (3-0-0)	Mathematical and Statistical Methods in Atmospheric Sciences
ASL712, 3 (3-0-0)	Air-Sea Interaction
ASL715, 4 (3-0-2)	Science of Climate Change
ASL718, 3 (3-0-0)	Tropical Meteorology
ASL720, 3 (3-0-0)	Satellite Meteorology and Remote Sensing
ASL722, 3 (3-0-0)	Biological Oceanography
ASL724, 3 (3-0-0)	Atmospheric Diffusion and Air Pollution
ASL 803, 3 (3-0-0)	Advance Ocean Dynamics
ASL804, 3 (2-0-2)	Air Quality Monitoring & Health Risk Assessment
ASL 813, 3 (3-0-0)	Climate Variability
ASL 814, 3 (3-0-0)	Modelling of Dynamic Processes of Oceans & Atmosphere
ASL 815, 3 (3-0-0)	Marine Pollution and Coastal Zone Management
ASL 816, 3 (3-0-0)	Advance Dynamic Meteorology
ASL 817, 3 (3-0-0)	Mesoscale Meteorology
ASL 819, 3 (2-0-2)	High Performance Computing in Atmospheric Science
ASL 871, 3 (3-0-0)	Special Topics in Storm Surges
ASV 872, 1 (1-0-0)	Special Module in Storm Surges
ASV 873, 1 (1-0-0)	Special Module in Indian Ocean Studies and Its Relevance to the Monsoon
ASV 874, 1 (1-0-0)	Special Modules in Climate Change and Disaster Management
ASL 875, 3 (3-0-0)	Special Topics in Air Pollution
ASV 876, 1 (1-0-0)	Special Module in Air Pollution
ASL 877, 3 (3-0-0)	Special Topics in Marine and Water Pollution
ASV 878, 1 (1-0-0)	Special Module in Marine and Water Pollution
ASL 879, 3 (3-0-0)	Special Topics in Remote Sensing
ASV 880, 1 (1-0-0)	Special Module in Remote Sensing
ASL 881, 3 (3-0-0)	Special Topics in Objective Analysis
ASV 882, 1 (1-0-0)	Special Module in Objective Analysis
ASL 883, 3 (3-0-0)	Special Topics in Clouds and Aerosols
ASV 884, 1 (1-0-0)	Special Module in Clouds and Aerosols
ASL 885, 3 (3-0-0)	Special Topics in Lake Circulation Modelling
ASL 886, 1 (1-0-0)	Special Module in Lake Circulation Modelling
ASV 887, 1 (1-0-0)	Special module in Numerical Weather Prediction
ASL 888, 3 (3-0-0)	Special Topics in Atmospheric Sciences
ASV 889, 1 (1-0-0)	Special module in Tropical meteorology
ASS 800, 3 (3-0-0)	Independent Study

In addition to the above M.Tech and minor area courses, for the benefit of students pursuing their M.Sc. in Mathematics, Physics and Chemistry, a special course on Atmospheric Physics has been designed and offered in alternate semesters for the last several years.

M.Sc. Elective:

ASL 710, 3 (3-0-0)	Atmospheric Physics

Till date 35 students have been awarded the M.Tech degree. Out of the 35, 6 were given to part-time students - 4 deputed from IMD, one from IGCAR, Kalpakkam and one from IAF. 10 students (28.5% of the total M.Tech degrees awarded) are continuing Ph. D. either in the Centre or outside. The titles of all the M.Tech dissertations and names of supervisor(s) are given below.

Year	Student	Supervisor(s)	M. Tech Dissertation
2010	A Bagavath Singh	Prof. Manju Mohan	Atmospheric dispersion simulation in a coastal terrain using coupled mesoscale and dispersion model
	Amit Bhardwaj	Prof. S. K. Dash and Prof. O. P. Sharma	Study of convective processes in the simulation of thunderstorm using a mesoscale model
	Anil Kumar Devrani	Prof. O. P. Sharma and Dr. H. C. Upadhyaya	Impact of data assimilation on thunderstorm simulation with WRF model
2011	Tarkeshwar Singh	Prof. U. C. Mohanty and Dr. G. Schadler (Germany)	Impact of spatial and temporal resolution on simulated precipitation using COSMO-CLM model
	Sushant Das	Prof. G. Jayaraman and Dr. B. Kumari (ISRO)	Remote sensing and coastal marine ecology
	Aniket Chakravorty	Dr. K. AchutaRao and Dr. N. Kalthoff (Germany)	Analysis of soil moisture distribution of satellite retrievals
	Medhavi Gupta	Prof. Manju Mohan	Atmospheric chemical modelling for air quality assessment of megacity Delhi
	Amit Kumar Gupta	Prof. O. P. Sharma and Prof. G. Jayaraman	Modelling the transport processes in the upper ocean
	Hetalben Prafulbhai Patel	Prof. S. K. Dash	Regional climate modelling with grid computing

	Surendra P. Singh	Prof. A. D. Rao	Numerical modelling of surface circulation and associated thermohaline features of North Indian Ocean
	Kamlesh Kumar Meena	Prof. S. K. Dash and Prof. Manju Mohan	Change in frequency of extreme temperature events over north-east India
	Ram Singh	Dr. K. AchutaRao and Prof. A. D. Rao	Climate change performing time slice experiment using AGOCM
	Pushp Raj Tiwari	Prof. U. C. Mohanty	Simulation of winter circulation over north-west India using Regional Climate Model
2012	Nidhi	Dr. Sagnik Dey	Variability of cloud cover in India
	Sarjeet Singh	Prof. S. K. Dash	Impact of climate change on heat stress
	Swati Singh	Prof. U. C. Mohanty	Simulation of extreme weather events with high-resolution mesoscale models
	Alok Kumar	Dr. K. AchutaRao	Developing and implementing diagnostics for intra-seasonal oscillations for the NCMRWF global forecast model
	Ashwani Kumar	Prof. O. P. Sharma	Retrieval of temperature profile from satellite radiance using radiative transfer RTTOV
	Sumer Budhiraja	Prof. P. Goyal	Impact of air pollutants on climate change
	Ajit Singh	Dr. Sagnik Dey	Climatic trends in visibility and its relation to aerosols in India
	Pranav Kumar	Dr. H. C. Upadhyaya	Numerical experiments with the dynamical core of a global model of circulation on a GPU cluster
	Sanchit Mehta	Prof. Manju Mohan	Performance Evaluation of Different Air Quality Models
	Kapil Kumar	Prof. P. Goyal	Environment impact assessment of power plants using air quality models

2013	Ayan Kumar Banerjee	Dr. Sagnik Dey and Prof. S. K. Dash	Cloud radiative feedback on surface temperature trends in India
	Rizwan Ahmed	Prof. Manju Mohan and Dr. Sagnik Dey	Application of satellite remote sensing in detection fog over Indo-Gangetic Plain
	Amitoj Singh	Prof. S. K. Dash and Dr. Y. Sabharwal (IBM)	Fine grained accurate wind forecasting for wind farms
	Rahul Saini	Prof. P. Goyal	Impact of phasing out diesel by CNG vehicles on air quality in Delhi
	Pawan Pal	Prof. Manju Mohan	Air quality analysis using remote sensing data
	S. V. K. Murthi	Prof. A. D. Rao	Numerical modeling of storm surges in the Bay of Bengal
	Subodh Kumar	Dr. R. C. Raghava	Deterministic state of art atmospheric flow fields on global scale
	Amrendra Kumar	Prof. O. P. Sharma	Numerical simulations for the monsoon rainfall using various parameterization of precipitation process
	Karanjit Singh	Dr. R. C. Raghava	Deterministic biosphere atmosphere interfacing for an atmospheric general circulation modeling
	Rajeev Kumar Singh	Prof. O. P. Sharma	Parameterization of cirrus in a numerical model
	Nimish Singh	Prof. P. Goyal	Impact of power plant on air quality due to phasing out coal by cleaner gas
	Manish Bhardwaj	Dr. Vimlesh Pant	Characterization of cloud condensation nuclei over a high altitude site

ii) Ph. D. Courses:

There are 10 Ph. D. courses in CAS for the benefit of students registered for Ph. D. in CAS. These courses include Tropical Meteorology, General Meteorology, Dynamic & Synoptic Meteorology, Dynamic and Physical Oceanography, Numerical Modelling and some other advanced level courses. In addition to the Ph. D. students registered in CAS, students from other disciplines also register for these courses.

Course Code, Credit (L-T-P Structure)	Course Name
ASL 830, 3 (3-0-0)	General Meteorology
ASL 831, 3 (3-0-0)	Introduction to Micro-Meteorology
ASL 832,3 (3-0-0)	An Advanced Course in Micro-Meteorology and Risk Assessment Techniques
ASL 840, 3 (3-0-0)	Dynamic Meteorology
ASL 850, 3 (3-0-0)	Numerical Modelling of the Atmospheric Processes
ASL 860, 3 (3-0-0)	Synoptic Meteorology
ASL 870, 3 (3-0-0)	Physical Oceanography
ASL 880, 3 (3-0-0)	Dynamic Oceanography
ASL 890, 3 (3-0-0)	Special Topics in Geophysical Fluid Dynamics

In the last five years, 17 students were awarded Ph. D. Their thesis title and names of the supervisor(s) are provided below.

Ph. D. Degree Awarded:

Year	Student	Supervisor(s)	Thesis
2009	Ashish Routray	Prof. U. C. Mohanty and Dr. Someshwar Das (NCMRWF)	Mesoscale data assimilation for simulation of heavy rainfall events associated with south-west monsoon
	Sankalp Anand	Prof. P. Goyal	Estimation of assimilative capacity environment of Gangtok, Sikkim
	Jagabandhu Panda	Prof. Maithili Sharan	Atmospheric boundary layer characteristics over north India using WRF modeling system
2010	Pramod Kumar	Prof. Maithili Sharan	Analytical models for dispersion of pollutants in the atmospheric boundary layer
	Hashmi Fatima	Prof. O. P. Sharma and Dr. H. C. Upadhyaya	Impact of aerosols on the hydrology of Indian monsoon

	Subrat Kumar Panda	Prof. S. K. Dash	Some aspects of climate change in India based on observed data and modeling studies
2011	G. Senthil	Prof. G. Jayaraman and Prof. A. Keshari (Civil)	Modelling bank inundation and contaminant dispersion in open channel flows
	Sarvesh Kumar Singh	Prof. Maithili Sharan	Inverse modeling for identification of point-source emissions in atmosphere
2012	D.K. Mahapatra	Prof. A. D. Rao	Modelling of coastal ocean processes along the Indian coasts
	Palash Sinha	Prof. U. C. Mohanty and Prof. S. K. Dash	Extended range prediction of summer monsoon rainfall over the Indian region using downscaling approaches
	Sujata Pattanayak	Prof. U. C. Mohanty and Prof. A. D. Rao	Simulation of track and intensity of tropical cyclones over north Indian ocean and associated storm surges
	Swagata Payra	Prof. Manju Mohan	Fog prediction using numerical and statistical models
2013	Anikender Kumar	Prof. P. Goyal	Air quality forecasting using mathematical models for Delhi
	Liby Thomas	Prof. U. C. Mohanty and Prof. S. K. Dash	Influence of land surface processes on simulation of western disturbances
	Mourani Sinha	Prof. A. D. Rao and Prof. S. K. Dube	Parametric estimation and real-time forecast of wind waves
	Somnath Jha	Dr. R. C. Raghava	Diagnostics of biosphere-atmosphere interfacing in Indian agro-climate regime
	Lalit Kumar	Prof. Manju Mohan	Atmospheric Chemical Modelling of Tropospheric Ozone and Nitrogen dioxide using a Chemical Transport Model over Delhi

b. Consistency of curricula with the academic vision of the Centre

The Centre's curriculum has evolved in recent years from a set of pre-Ph. D. courses to include new academic programmes such as the M. Tech and UG Minor Area programme. The M. Tech curriculum was designed with a potential intake of students from a broad range of disciplines in mind. This has been successful to some extent and with nearly six years of experience with the curriculum, we are in a position to analyze the curriculum (and its effectiveness for our student intake). The curriculum is now due to be revised in consultation with all stakeholders including the Institute level curriculum revision effort currently underway.

The more recent introduction of the UG minor area programme has also been a step towards the Centre's stated vision of becoming a department offering an integrated 5-year M. Tech. programme. The curriculum for the Minor Area borrows heavily from the M. Tech programme for the electives on offer and will have to be revisited in order to provide a better mix of foundation and advanced courses which will be necessary to function as an integrated M.Tech programme.

c. Quality of Programme

(a) Periodicity of curriculum review

So far, four batches of M.Tech students have graduated. The curriculum review will be carried out after five years (which is due after the present final year batch completes). This will be done following the new guidelines of the Institute on the structure of M.Tech programmes.

(b) Mechanism for review

The review of the courses floated by the Centre is undertaken in two ways:

(i) Class-committee meetings are held in the middle of every semester to discuss the concerns of the students. Subsequently, corrective measures are taken based on the discussion in the class committee meeting.

(ii) Online feedback forms filled by the students at the end of the semester for each course is discussed by the Head, Course coordinators and the Program coordinator.

(c) New advanced Master's/Pre-PhD courses introduced in the last 5 years

As the M.Tech program of the centre started in the academic year 2008-2009, all the courses listed under M.Tech programme in section 3.1 are new.

(d) Overlap between courses

All PG level courses are of advanced level compared to the three UG level courses (section 3.1). However, these courses are open to UG students as open electives as part of the Minor Area Programme. ASL710 (Atmospheric Physics), which is generally floated

for M.Sc students across the Institute has 40% overlap with ASL703 (Physics of Atmosphere and Ocean).

(e) Seminar Series

In the last four years, 60 seminars were given at the Centre by visitors from Institutions in India and abroad, CAS students and faculty. Other than these, every PhD student gives a seminar every semester as part of the evaluation of their progress. This practice as initiated by the CRC in the academic year 2011-2012 as an additional requirement of the Centre to enhance oral communication skills and monitor the progress of each student in a structured way. Second year M.Tech students also give seminar twice every semester following the Institute practice for evaluation of their dissertation work. In addition to this, there is a one-credit course (ASC861), which evaluates the understanding of the seminars organized in each semester by M.Tech students. A detailed list of the seminars is provided in Annexure I.

(f) Placement

Over the last 5 years, 17 students were awarded PhD and all of them are placed at various research and operational organizations in the country and abroad. Out of 35 M.Tech students, 7 students joined the Ph. D. programme at the centre, while 4 other have joined Ph. D. programmes in other places. Other students are working at various private and government organizations. Detailed placement record is listed in section 10.4.

(g) Relevance of PG Programmes to recruiters, potential and on-campus recruiters

The M.Tech. and Ph. D. programmes at the Centre include highly specialized courses in atmospheric and oceanic sciences with adequate training in numerical and statistical methods, programming and HPC. Hence, industries, research organizations and academic institutions find our students competent enough for recruitment. The rising global importance of weather and climate issues has led to rapid expansion of private sector companies where our alumni are making significant contributions. Most of the important government organizations (MOES, DST), operational and research organizations (IMD, INCOIS, NCMRWF, SAC, IITM, NEERI) as well as leading academic institutions such as IITs and Universities have several of our alumni at key positions.

Teaching Environment

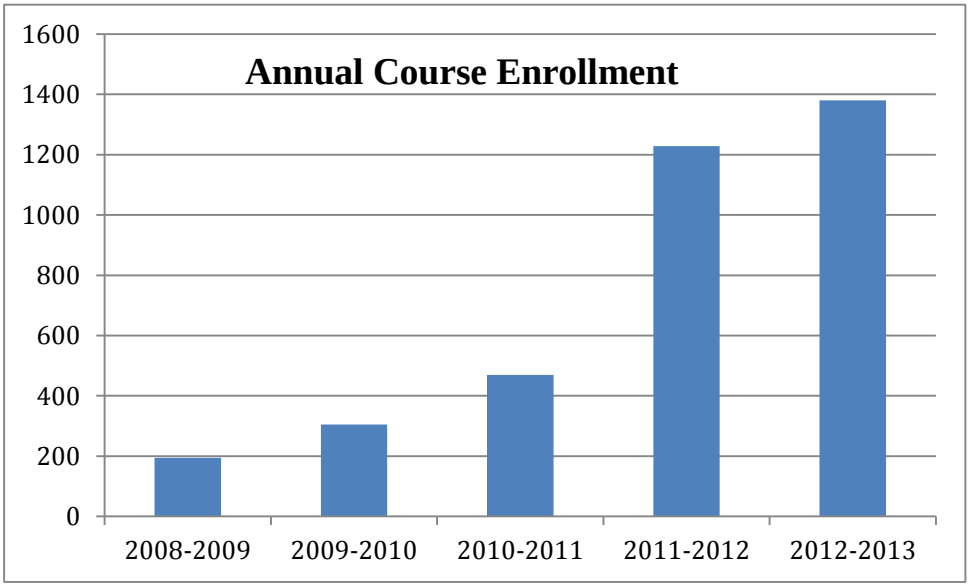
4. Teaching Environment

4.1 Student-teacher ratio

Average student-teacher ratio per course is 23.65 as estimated based on the registration records of all the courses floated by the Centre in last five years (including the summer semester). The detailed registration record in each course is summarized in Annexure II. The total number of courses floated in the regular semesters and number of registered students are summarized in the following Table.

Academic Year	Number of Courses		Number of Students	
	Semester I	Semester II	Semester I	Semester II
2008-2009	8	7	104	91
2009-2010	11	11	159	146
2010-2011	14	11	264	205
2011-2012	14	14	402	826
2012-2013	16	16	470	910

The student strength has increased (as shown in the figure below) nearly 7 times from 200 in the academic year 2008-2009 to 1380 in the academic year 2012-2013. This increase is primarily due to the introduction of B.Tech Minor Area programme in the year 2010-2011. UG students constitute approximately 80% of the classes, while remaining 20% are the PG students (both M.Tech and Ph. D.).



4.2 Number of students graduated from each programme

A total of 52 students were awarded degrees in the last five years, out of which 35 students were awarded M.Tech and 17 students received the Ph. D. degree. Also, 2 UG students completed the required 20 credits and received the mention of “Minor Area in Atmospheric Sciences” in their B.Tech degree.

Academic Year	B.Tech Minor Area	M.Tech	Ph. D.
2009	-	-	3
2010	-	3	3
2011	-	10	2
2012	2	10	4
2013	-	12	5
TOTAL	2	35	17

4.3 Student-TA ratio

All M.Tech and Ph. D students with Institute Assistantships are assigned to faculty or labs for TA work. The number of TAs in various courses is determined based on the number of registered students by the Program Coordinator in consultation with the respective course coordinator(s). Students are expected to work 8 hours per week for the assigned Lab/TA work as per the norms laid by the Institute.

Due to shortage of available TAs to fulfill the requirements in the Centre, Ph. D. students with external funding resources (e.g. CSIR/UGC/Project) are also given TA duty, if required.

4.4 Number of skilled technical staff

Currently, CAS has three technical staff whose job is to help the students and faculty in research activities. Departmental Technical Assistant – 2; Senior Technical Superintendent – 1.

4.5 Gross laboratory space

The Centre has a total 8611.65 sq. ft area, out of which 2280 sq. ft is used for faculty space, 1933.85 sq. ft for research labs, 1360 sq. ft. for Ph. D. lab, 657 sq. ft. for M.Tech lab, 1062 sq. ft for utility space (that includes Store, library, office, PA room and UPS room) and 1318.8 sq. ft for teaching labs. The detailed break up is given in Annexure III.

4.6 Laboratory modernization performed in the last 5 years

The two M.Tech labs were created with the grant from Ministry of Earth Sciences and ISRO, while all the computing laboratories were upgraded over the years with internal and external financial support from time to time.

4.7 Course files

Course content for the list of courses listed in section 3.1 are summarized below. The frequency of each course, coordinator and other relevant information are provided in the Annexure II.

PG	Course Title and Details
ASL701	**Dynamics of Atmosphere and Ocean:** Basic hydrodynamic equations in a rotating frame of reference, geostrophic balance; basic laws of conservation, hydrostatic balance, gradient and thermal winds, dimensional analysis, simplified equations for ocean and atmosphere in motion; shallow water equations, potential vorticity conservation; barotropic and baroclinic instabilities; acoustic, gravity, Rossby and Kelvin waves; horizontal and transverse waves, vertically propagating waves; large-scale atmospheric circulations, available potential energy; equatorial dynamics, heat-induced tropical circulations, Gill's solution; mid-latitude circulations; planetary waves and stratosphere. Ocean Dynamics: thermohaline and wind-driven ocean circulations; Ekman layers, Sverdrup transport, western boundary currents; ocean Circulation variability; oceanic mixed layer; response of ocean to a moving storm or hurricane.
ASL703	**Physics of Atmosphere and Ocean:** Thermodynamics of dry and moist air: atmospheric stability and dry adiabatic lapse rate, Clausius-Clapeyron (C-C) equation, moist processes in the atmosphere, saturated and unsaturated accent, moist adiabatic and saturated adiabatic processes in the atmosphere, saturated adiabatic lapse rate, pseudo adiabatic processes and equivalent potential temperature, conditional instability of second kind, thermodynamic diagrams; moist convection, condensation processes, formation of cloud droplets, precipitation. Ocean physics: thermodynamics of seawater, observed temperature, salinity, and density in the ocean; density stratification, water mass distribution, coastal currents and upwelling; thermohaline circulation, The Gulf Stream and its rings; ocean currents, The Great Ocean Conveyor Belt, coupling of surface and deep ocean waters; basic foundation of turbulence, turbulent flows, turbulent vorticity, turbulent pressure, eddy diffusivity, and coherent structures; surface fluxes, air-sea interaction, mixing processes in the ocean. Radiative transfer in atmosphere and ocean: Sun and climate, Planck function, black-body radiance, local thermodynamic equilibrium, radiometric quantities, absorption and emission, Schwarzchild's equation, radiative equilibrium in a grey atmosphere, balance between incoming solar and outgoing thermal radiation; More complex radiative transfer: integration over frequency, single lines, average transmission over a spectral interval, absorption by atmospheric gases, Heating rates, net radiative heating; a simple model of scattering in the atmosphere; Radiative transfer in atmosphere-ocean system.

ASL705	**Boundary Layer Meteorology and Air Pollution:** Boundary layer processes, atmospheric boundary layers, bulk and gradient Richardson numbers, shear and buoyant production of turbulence, organized large eddies, boundary layer wind and thermodynamic profiles, convective and stably stratified boundary layers; surface layer; similarity theory, conservation equations for covariance, Reynolds stresses; turbulent fluxes; equations of atmospheric turbulence and closure assumption, TKE budget equation, observational techniques; Ekman boundary theory, oceanic boundary layers; parameterization and models of turbulent transport. Air pollution meteorology: sources of air pollution, Gaussian plume models, diffusion from point, line and area sources; urban air pollution
ASL706	**Parameterization of Physical Processes:** Parameterization of subgrid-scale processes; one-dimensional PBL model; parameterization of subgrid orographic processes, gravity-wave (GW) drag; parameterization of dry adiabatic and moist convective processes, cloudiness parameterization in numerical models; cloud microphysics in numerical models; radiative transfer, band and emissivity models, multi-level longwave and shortwave radiation computations; surface and atmosphere interaction, land surface parameterizations, surface hydrology modelling, energy balance at the surface, surface albedo and vegetation cover.
ASL707	**Mathematical and Statistical Methods in Atmospheric Sciences:** Initial and boundary value problems, ordinary differential equations, orthogonal functions; partial differential equations: solving them through variational and numerical methods. Review of probability, discrete and continuous distributions, multivariate probability distributions, assessing goodness of fit, hypothesis testing, regression, time-series analysis, principal component/ empirical orthogonal function analysis.
ASL710	**Atmospheric Physics:** Structure and thermodynamics of atmosphere: composition of air, stratification of the atmosphere, moist adiabatic processes, stability of the atmosphere, thermodynamics of dry and moist air. Atmospheric radiation: the radiation balance of the earth: Atmospheric system. Basic equations governing atmospheric circulations: effects of rotation of the earth, scale analysis, hydrostatic and geostrophic approximations; circulation and vorticity. Waves in the atmosphere: sound waves and gravity waves, inertial oscillations, Rossby gravity waves. Planetary boundary layer: influence of obstacles on wind, mixing length theory, Ekman layer equations, the inversion layer. Weather prediction and climate studies: general circulation of the atmospheric, introducing different numerical techniques and physical parameterization schemes, the monsoon and its simulation by numerical models

ASL712	**Air-Sea Interaction:** Ocean-atmosphere system, transfer properties between atmosphere and ocean, oceanic absorption of solar energy, fluxes in the surface boundary layer over the sea, marine boundary layer, ENSO, variability of the ocean parameters in relation to Indian monsoon, physical parameterizations of the air-sea interaction, coupled ocean-atmosphere modeling.
ASL715	**Science of Climate Change:** Description of the climate system, natural greenhouse effect and the effect of trace gases and aerosols, feedbacks in the climate system, climate change in the past, ice ages, proxy records, abrupt climate change, Instrumental record of climate, climate variability on various time-scales, simple models of climate, General Circulation Models, natural and anthropogenic climate change: detection and attribution, impacts and mitigation of climate change.
ASL720	**Satellite Meteorology and Remote Sensing:** Satellite meteorology, observing system, retrieval of clouds, winds, temperature, humidity, trace gases and aerosols, and rain; image interpretation and analysis; ocean colours, SST, scatterometer studies, microwave sounding, radar equation, severe storm detection, lidar, radar and its principles, remote sensing of vegetation
ASL803	**Advanced Ocean Dynamics:** Western boundary intensification, barotropic currents, baroclinic transport over topography. Mesoscale eddies and variability. Indian Ocean dipole circulation, linear waves, wave spectra, wave propagation. Wave energy equation, breaking waves, reflection and dissipation, theory of tides, tidal currents. Tidal processes in embayment and estuaries, wind and buoyancy driven currents, Near-shore circulation, alongshore and rip currents, littoral drift, sediment transport, coastal ocean response to wind forcing, storm surges, coastal upwelling and fronts, Kelvin, Rossby, inertia-gravity waves.
ASL808	**Atmospheric Chemistry and Aerosols:** General characteristics of atmospheric composition, ozone layer, stratospheric and tropospheric chemistry; principles of chemical kinetics; gas-phase and aqueous-phase reactions in the atmosphere; chemistry and physics of the polluted atmospheres, photochemical reactions and smog; monitoring techniques, organic pollutants in the atmosphere; atmospheric aerosols, impact of aerosols and clouds on climate; Montreal and Kyoto protocols, major fire emissions, greenhouse effect, climate change and green chemistry.
ASL816	**Advance Dynamic Meteorology:** Quasi-geostrophic analysis, circulation and vorticity theorems, Ertel-Rossby invariants, Ertel's PV conservation theorem, Thomson's and Bjerkness baroclinic circulation theorem, barotropic and baroclinic instabilities, symmetric instabilities; quasi-geostrophic motion in equatorial area, heat

	induced tropical circulations; Rossby waves, internal gravity waves, vertically propagating waves, Rossby adjustment theory; middle atmospheric dynamics, sudden stratospheric warming, QBO; general circulation of the atmosphere. Turbulence in the atmosphere: ensemble-averaged equations, space averaged equations, conservation equations for covariances, large-eddy simulations, atmospheric surface layer, convective boundary layer, stable atmospheric boundary, statistical representation of turbulence, quasi-geostrophic turbulence
ASL819	**High performance Computing in Atmospheric Science:** Basic ideas on multitasking and massively parallel processing, different architectures, application of HPC in global and regional models, parallelism in weather and climate models, domain decomposition method, 1D, 2D and 3D parallelization of GCMs, MPI, PVM, SHMEM, message passing libraries, high performance compilers, load balancing, inter-processor communication, network communication, graphical user interface, data formats, local and wide area networking, data flow and data mining.
ASL830	**General Meteorology:** Basic concepts, thermodynamics of dry and moist air, thermodynamic diagrams, hydrostatic equilibrium, hydrostatic stability and convection, clouds and precipitation; Physics of radiation: solar and terrestrial radiation, mean annual heat balance.
ASL840	**Dynamic Meteorology:** Fundamental forces, equations of motion in rotating and non-rotating coordinate frames, scale analysis, basic conservation laws, spherical coordinates, thermodynamic equation, geostrophic approximation, hydrostatic balance, static stability, circulation and vorticity, conservation of potential vorticity; Rossby adjustment theory, atmospheric waves, quasi-geostrophic equations, omega equation, hydrodynamic instability, available
ASP751	**Simulation Lab - I: Weather Analysis and Forecasting:** Programming languages, Unix & shell programming, data formats: ASCI, GRIB, NetCDF. Introduction to Fortran 95, programming in Fortran 95; Examples for converting and reading ASCI, GRIB, NetCDF data files; graphical display of meteorological fields. Visits to observation facilities of IMD: meteorological instruments workshop; radiosonde and radar installations; forecasting for aviation and air pollution, meteorological parameters, GTS, weather codes and decoding of weather observations; visits to IMD for map discussion participation; thermodynamic diagrams, tropical weather systems, tropical cyclones; synoptic features during different seasons, western disturbances, monsoon circulation and its climatology at surface, 850 hPa and 200 hPa; sea-level pressure distribution on the globe; ø and ÷ fields. Mass and wind field balance, synoptic forecasting from analysis of weather maps; satellite image interpretation, cloud classifications ERDAS software, Introduction to numerical methods used in weather prediction, quasi-geostrophic and balance models, omega equation.

ASP752	**Simulation Lab – II: Objective Analysis and Data Assimilation:** Observed meteorological / oceanographic parameters and their interpretation; Numerical mathematics of weather prediction: space discretizations, Arakawa's staggered and non-staggered schemes, Arakawa Jacobians; time integration schemes. Objective analysis: interpolating polynomials and function fitting for a triangular, rectangular and polygonal geometry; preparation of initial conditions from observations using method of successive correction and spline interpolations; Initialization: mass and wind field balance, Rossby adjustment theory, introductory dynamic and normal-mode initialization; initial model grid data preparation and forecast / hindcast experiments with a limited area model. Variational data assimilation: variational methods, variational assimilation basics; Examples of 3D-/4D-VAR with shallow water model and its adjoint; Experience with meteorological / satellite data assimilation; Simple oceanographic data assimilation at mesoscale and assimilation of altimetry data and ARGO data.
ASP801	**Simulation Lab – III: Ocean, Atmosphere Forecast Methodology:** Design of horizontal and time differencing schemes, discrete analogues of basic governing equations, discrete formulations of horizontal and vertical mixing; preparation of model initial and boundary conditions from meteorological analyses and climatological data; Limited-area modelling, short-range forecast experiments with limited area model; medium and long range weather prediction experiments with a GCM; experience with different convection schemes in thunderstorm/ cyclone modelling with a fine resolution hydrostatic/ non-hydrostatic model. Image analysis of simulated fields with ERDAS. Data studies: Madden-Julian oscillation, El niño and Southern Oscillation, Gill's barotropic model, computation of heat-induced tropical circulations; ocean analysis from ARGO data; ocean circulation models, computation of air-sea fluxes using meteorological and oceanographic data.
ASS800	**Independent Study**:- To be given by the interested faculty
ASD891	**Major Project –I**
ASD892	**Major Project-II**

UG	Course Title and Details
ASL310	**Fundamentals of Atmosphere and Ocean:** Composition of atmosphere and ocean; thermodynamic state; distribution of temperature, density, pressure, water vapour, salinity etc., equation of state; fundamental forces in the atmosphere and ocean; Pressure gradient, Coriolis and frictional force, atmospheric chemistry; laws of motion in the rotating Erath; Thermodynamic laws and energy cycle; thermodynamic diagrams; Radiation, conduction, advection and convection; general circulation in the atmosphere; monsoon; global ocean currents; wave propagation; atmosphere-ocean interaction, gravity waves, oceanic tides, surges and tsunamis, examples of air-sea interaction
ASL320	**Climate Change: Impacts, Adaptation and Mitigation:** Elements of physical climatology; climate variability; anthropogenic causes of climate change; concepts of radiative forcing, climate feedback and climate sensitivity; observed climate records and reconstruction of paleo-climate; carbon emission pathways; scenario development; observed and projected changes in weather, monsoons, teleconnection, sea level rise; climate hot spots, sector wise vulnerability and adaptation; geoengineering options
ASL410	**Numerical Simulation of Atmospheric and Oceanic Phenomena:** Density stratification in atmosphere and ocean, static stability, equations of motions of a rotating fluid, scale analysis, hydrostatic approximations, vorticity and divergence, a coordinate system for planetary scale motion, Saint-Venant (shallow water) equations, meteorologically important waves, Rossby and vertically propagating waves, basic concepts of barotropic and baroclininc instability, Numerical methods: finite difference methods – advection equation, stability analysis, oscillation equation and Galerkin method – transform method, application of spectral and finite element methods to barotropic vorticity equation, Time integration schemes for the advection equation, Introduction to consequences of sound waves, surface gravity waves, internal gravity waves in weather prediction models, boundary layers, Ekman layer, Monin-obukhov similarity theory, closure assumption Objective analysis and initialization, data preparation, numerical models, variational and 4-dimensional data assimilation

4.8 Study materials

Study materials used in the UG and PG courses include lecture slides and notes, reference books, research articles and scientific videos.

4.9 Research and innovation in teaching-learning processes

CAS faculty have used the following strategies in teaching-learning processes.

1. Field trips to IMD, NCMRWF, Hindon Air Force station

2. Simulation experiments using numerical models
3. Review of recent research papers
4. Use of state-of-art meteorological and satellite data
5. Project component is presented as posters
6. Term papers and class presentations
7. Development of software/algorithm

4.10 Number of students who have spent at least a semester at another university (overseas or abroad) in the last 5 years

(i) 2 M.Tech students have spent two semesters in Germany under DAAD program to carry out their dissertation works (as mentioned in section 3.1)
(ii) One PhD student is on ex-India leave to carry out his PhD work at Florida State University, USA

4.11 Industry experts who have delivered lecture(s), seminars, discussion as part of core/elective courses

The list of industry experts who gave lectures/seminars in the Centre is available in Annexure I.

4.12 Industry exposure to students

(i) Field visit is to IMD, NCMRWF, Air Force
(ii) Projects undertaken with organization with NCMRWF, IMD, IBM etc.

Research Activities

5. Research Activities

5.1 Number of UG and PG students supported from various sources

The Centre has a UG Minor Area program. Currently, the number of students (across all categories) supported from Institute Assistantship and outside sources in the PG (M.Tech and PhD) programmes are listed below.

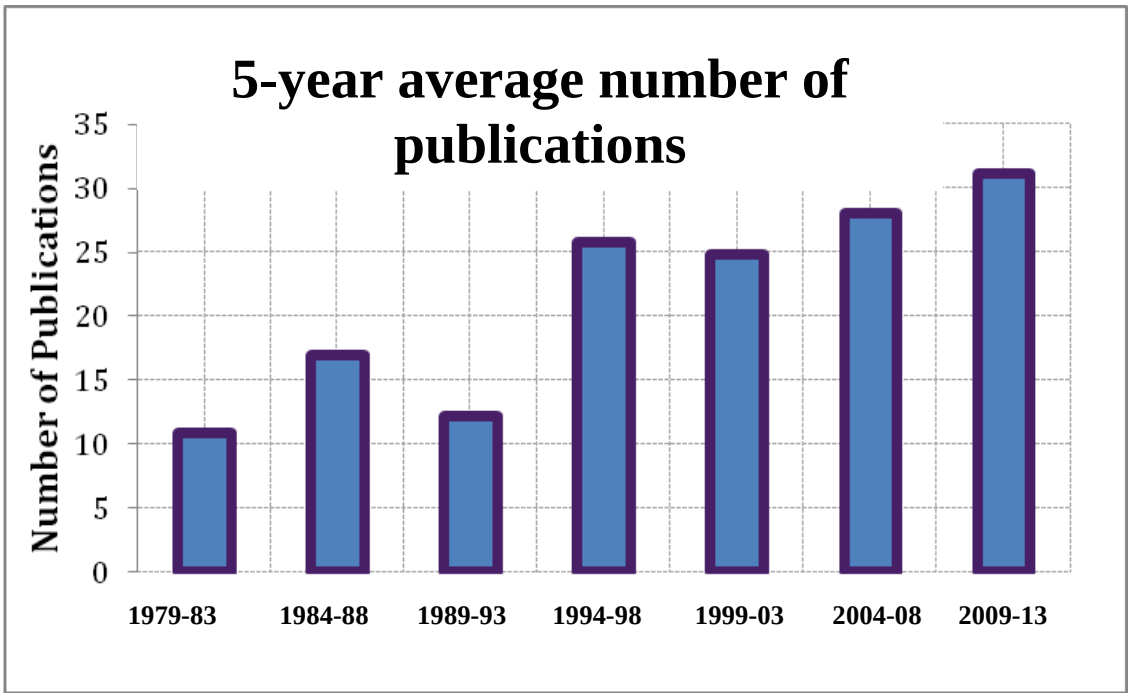
Category	**Sanctioned Strength for Ph. D.**	**Ph. D. in place**	**Sanctioned strength for M.Tech (two years combined)**	**M.Tech in place**
Institute Assistantship	24	15	28	13
MoES	5	1	10	5
Others	21	20	12	3
Total	50	36	50	21

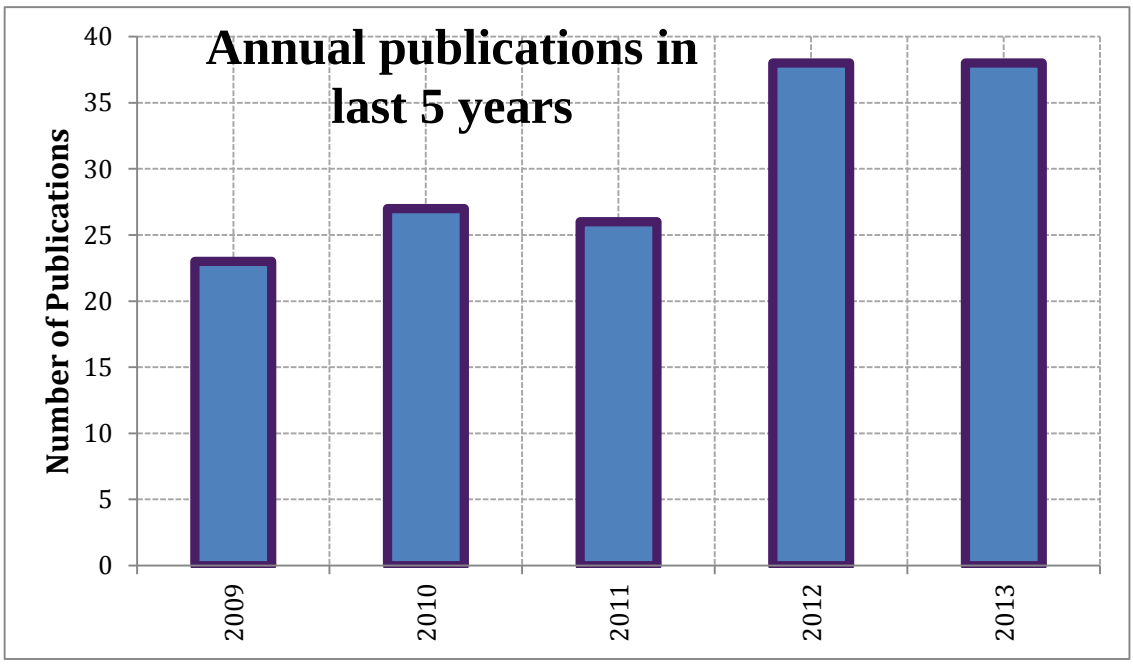
5.2 Areas of research

The R&D activities of CAS are broadly grouped under the four major contemporary topics - Atmospheric Modeling, Ocean Modeling, Air Pollution, and Climate Science. While the first three areas were identified as thrust areas during the inception of the Centre, the last one was added in recent times due to its relevance in the present time. This area was expanded with the induction of new faculty in the last six years. The faculty members are involved in research in collaboration across the groups that can be gauged by joint research projects and supervision of M.Tech and PhD students.

5.3 Publications

CAS faculty has published more than 750 papers in peer-reviewed journals since its inception. The growth rate of scientific publications for each five-year period from the inception of the Centre can be seen in the following figure. In the last five years 156 peer-reviewed papers were published in SCOPUS cited journals (2.2 publications per faculty per year). In addition, faculty has also published in other national peer-reviewed journals (e.g. Mausam, Vayumandal etc.). List of research papers published in SCOPUS cited journals in the last five years is given in Annexure IV.


5-year average number of publications
Number of Publications
35
30
25
20
15
10
5
0
1979-83
1984-88
1989-93
1994-98
1999-03
2004-08
2009-13


Annual publications in last 5 years
Number of Publications
40
35
30
25
20
15
10
5
0
2009
2010
2011
2012
2013

5.4 Some of the best publications from the Centre

Our faculty has published more than 150 papers in peer-reviewed journals in the last five years. There are multiple criteria through which best papers may be chosen. Some of the best research papers published by our faculty is listed below and are chosen based on the impact factor of the journals. There are also many important contributions by our faculty in specialized fields, which do not appear in this list.

- P. J. Gleckler, B. D. Santer, C. M. Domingues, D. W. Pierce, T. P. Barnett, J. A. Church, K. E. Taylor, **K. M. AchutaRao**, T. P. Boyer, M. Ishii and P. M. Caldwell, 2012: Human-induced global ocean warming on multidecadal timescales, Nature Climate Change, 2, 524–529, doi:10.1038/nclimate1553 [IF:14.472].

- M. Collins, **K. AchutaRao**, K. Ashok, S. Bhandari, A. K. Mitra, S. Prakash, R. Srivastava and A. Turner, 2013: Observational challenges in evaluating climate models, Nature Climate Change, 3, 940-941, doi:10.1038/nclimate2012 [IF:14.472].

- **S. Dey**, L. Di Girolamo, A. van Donkelaar, S. N. Tripathi, T. Gupta and **M. Mohan**, 2012: Variability of outdoor fine particulate ($PM_{2.5}$) concentration in the Indian subcontinent: a remote sensing approach, Remote Sensing of Environment, 127, 153-161 [IF: 6.144].

- S. Verma, O. Boucher, M. Shekar Reddy, **H. C. Upadhyaya**, P. Le Van, F. S. Binkowski, and **O. P. Sharma**, 2012: Tropospheric distribution of sulphate aerosols mass and number concentration during INDOEX-IFP and its transport over the Indian Ocean: a GCM study, Atmospheric Chemistry and Physics, 12, 6185–6196, doi:10.5194/acp-12-6185-2012 [IF:5.556].

- K. J. Evans, P. H. Lauritzen, **S. K. Mishra**, R. B. Neale, M. A. Taylor and J. J. Tribbia, 2013: AMIP Simulation with the CAM4 Spectral Element Dynamical Core, J. Climate, 26, 689–709 [IF: 5.19].

- **S. K. Dash**, N. Sharma, K. C. Pattnayak, X. J. Gao and Y. Shi, 2012: Temperature and precipitation changes in the north-east India and their future projections, Global and Planetary Change, 98-99, 31-44 [IF:4.476].

- **S. K. Dash**, V. Saraswat, S. K. Panda and N. Sharma, 2013: A study of changes in rainfall and temperature patterns at four cities and corresponding meteorological subdivisions over coastal regions of India, Global and Planetary Change, 108, 175–194 [IF:4.476].

- **A. D. Rao**, M. Joshi and M Ravichandran, 2009: Observed low-salinity plume off Gulf of Khambhat, India during post-monsoon period, Geophysical Research Letters, 36, L03605, doi: 10.1029/2008GL036091 [IF:3.982].

- K. Sengupta, **S. Dey** and M. Sarkar, 2013: Structural evolution of monsoon clouds in the Indian CTCZ region, Geophysical Research Letters, 40, 5295-5299 [IF: 3.982].

- Anikender Kumar and **P. Goyal**, 2011: Forecasting of daily air quality index in Delhi, Science of the Total Environment, 409, 5517-5523 [IF: 3.789].

- **Maithili Sharan**, J.P.Issartel and S.K.Singh, 2012: A point-source reconstruction from concentration measurements in low wind stable conditions, Quarterly Journal of the Royal Meteorological Society, 138, 1884-1894 [IF: 3.327].

5.5 Some important publications by New Faculty

Faculty who have recently joined the Centre have also published excellent papers in peer-reviewed journals. Though these works were not carried out in the Centre, they reflect the quality of the new faculty. Some of the high-impact publications are listed below.

- Zhou, L., Tian, Y., **Baidya Roy, S.**, Thorncroft, C., Bosart, L. and Hu, Y, 2012: Impacts of wind farms on land surface temperature, Nature Climate Change, 2, 539-543 [IF: 14.472].

- **Baidya Roy, S.** and J. Traiteur, Impact of wind farms on surface temperatures, 2010, Proc. Natl. Acad. Sci., 107, 17899-17904 [IF: 9.737].

- **Mishra, S. K.**, M. A. Taylor, R. D. Nair, P. H. Lauritzen, H. M. Tufo, and J. J. Tribbia, 2011: Evaluation of the HOMME Dynamical Core in the Aqua-Planet Configuration of NCAR CAM4: Rainfall, Journal of Climate, 24, 4037-4055, doi: 10.1175/2011JCLI3860.1 [IF: 5.19].

- **Mishra, S. K.**, and S. Sahany, 2011: Effects of Time Step Size on the Simulation of Tropical Climate in NCAR-CAM3, Climate Dynamics, 37, 689-704, DOI 10.1007/s00382-011-0994-4 [IF: 4.231].

- **Ganguly, D.**, Philip J. Rasch, Hailong Wang, and Jin-ho Yoon (2012), Fast and slow responses of the South Asian monsoon system to anthropogenic aerosols, Geophysical Research Letters, 39, L18804, doi:10.1029/2012GL053043 [IF: 3.982].

- **Ganguly, D.**, P. Ginoux, V. Ramaswamy, D.M. Winker, B.N. Holben, and S.N. Tripathi (2009), Retrieving the composition and concentration of aerosols over the Indo-Gangetic basin using CALIOP and AERONET data, Geophysical Research Letters, 36, L13806, doi:10.1029/2009GL038315 [IF:3.982].

- **Pant, V.**, Devendra Singh, A. K. Kamra, 2011: Size distribution of atmospheric aerosols at Maitri, Antarctica, Atmospheric Environment, 45, 5138 – 5149 [IF: 3.787].

5.6 Changes/modification done to improve the quality of M.Tech and Ph. D. students

1. Ph. D. students are required to give an oral presentation on their research activities every semester. This is considered to be a part of the evaluation of the progress of the Ph. D. students
2. M.Tech students are taken to various operational agencies as field trips to make them familiar with the meteorological operations and requirements in the country.
3. Students are given class projects in many courses, where they are trained to handle data analysis, model simulations and visualization, so that after graduation, they can pursue independent research.

5.7 Sponsored and Consultancy projects

The statistics of the research and consultancy projects in the four core areas for the last five years are summarized below. The details of the externally funded research projects are given in Annexure V.

The year-wise break-up of the externally-funded research and consultancy projects of the Centre and the budget is as follows:

Year	Research Projects	Total Budget (INR in lac)	Consultancy Projects	Total Budget (INR in lac)	Total Budget (INR in lac)
2009	5	245.92	-	-	245.92
2010	6	148.29	1	165.55	313.84
2011	10	1008.18	1	0.75	1008.93
2012	2	116.12	1	16.91	133.03
2013	3	179.45	1	24.0	203.45
Total	26	1697.96	4	207.21	1905.17

During the same period, CAS received Rs. 200 lac as Plan and Rs. 39 lac as Non-Plan budget. Thus, ~89% of the funds have been generated externally through the research projects.

5.8 Some high budget projects

Brief description of some of the high budget projects operational in the last five years is given below.

1. Development and Application of Extended Range Forecast System for Climate Risk Management in Agriculture (ERFS):

A coordinated national project involving IMD, NCMRWF, ICAR, DAC, SAC and IIT Delhi with IITD as coordinator has just completed. This project with additional partnership from 9 Agricultural Universities and IRI, Columbia University, USA is sponsored by the Department of Agriculture and Cooperation, Government of India with a total budget of Rs 17.25 Crore. Following are the objectives of the project:

- Development of deterministic and probabilistic extended range forecast systems (monthly to seasonal time scale) for rainfall and temperature at meteorological subdivisions level of India.
- End to end application of the ERFS products for use by prospective farming community through suitable agro-meteorological advisory for climate risk management in agriculture.

Following are some major achievements in this research project:

- For the first time in India monthly and seasonal scale deterministic as well as probabilistic experimental forecast are generated round the year since 2009 with use of coupled GCMs products and statistical downscaling methods. These products are experimentally operationalized through IMD.
- In the project 8 global coupled GCMs with 150 members are used to generate monthly with seasonal forecast of rainfall and temperature (mean, maximum and minimum) round the year for 34 meteorological subdivisions of India for better utilization by 9 Agricultural Universities across the country.

2. Design and Development of a Unified Modelling System for Seamless Weather and Climate Predictions of Monsoons:

It is a project sponsored by MoES, Govt. of India for a total budget of Rs 457.82 lac. This project is being implemented jointly by several Centres/Departments of IIT Delhi such as CAS, Mechanical, CSE, Mathematics, Civil and Chemical. The specific objectives of this project are:

- Formulation and design of a new forecasting system on icosahedral-hexagonal grid for seamless predictions
- Development of an efficient code for exploiting GPU computing potential for a unified model designed on icosahedral-hexagonal grids
- Code development of exiting “physics” modules for GPU computing
- Development of cloud resolving governing equations with coding on GPUs
- Validation of the new model with benchmark cases
- Evaluation of high-resolution hindcast of episodic monsoon rainfall events and other features of monsoon circulation produced from the unified model
- Production of a new generation of young modellers with higher computing skills

Results obtained so far demonstrate an order of speed up in computation with GPU.

3. South Asian PRecIpitaton: A SEamless Assessment (SAPRISE):

It is an international project consisting of Univ. Exeter, UK**;** ICCSIR, Gujarat; IITM, Pune; IIT, Kanpur; IIT, Kharagpur; IMD, New Delhi; Met Office Hadley Centre, UK; NCMRWF, Noida; Univ. Reading, UK and CAS, IIT Delhi. It is funded by MoES (India)/NERC (UK) as part of the Changing Water Cycle Initiative. Total funding of this project is Rs 347.39 lac (46.12 lac IITD component) for the Indian component. It is approximately 1 million GBP for UK researchers.

This project aims to investigate driving processes, variability, predictability and forced changes in South Asian precipitation on multiple time scales. A key focus is on interactions with the Indian and remote ocean basins and on the local and remote interactions with the dynamic and radiative effects of aerosol, addressing gaps in previous studies. Specific Objectives are to:

- Investigate process responsible for present day mean, variability and change in South Asia precipitation and test the ability of state-of-the-art climate models to simulate this.
- Evaluate the skill of initialized experiments in predicting South Asia precipitation variability and investigate mechanisms for predictability.
- Investigate changes in South Asia precipitation and its drivers and interactions in a changing climate.
- Provide a seamless assessment and syntheses of results to advance our understanding of precipitation variability, predictability and change in precipitation in South Asia.

4. Impact of Storm Surges, Wind Waves and Seiches on the proposed Kalpasar Dam.

This consultancy project has been funded by the Government of Gujarat with a total funding of Rs 189.07 lac. The Gujarat Government plans to build a 64-km long dam in the Gulf of Khambhat region, between Ghogha, in Bhavanagar district, and Hansot in Bharauch district. This project is to study on the assessment of impact of Probable Maximum Storm Surge (PMSS), Maximum Total Water Level Elevation (MTWLE; as a result of combined effect of storm surge, high tides, wave setup, continental shelf waves, edge waves, topographic Rossby waves, meso-scale forcing and remote forcing), extreme wind wave conditions and seiches on the proposed Kalpasar Dam. This information would be helpful for determining the required freeboard of the dam and the actual height of the crest of the dam.

5. Asian Cities Adapt: Impacts of Climate Change in Target Cities in India and the Philippines and Local Adaptation Strategies:

It is an international project funded by the German Federal Ministry for the Environment, Nature Protection and Nuclear Safety (BMU) with a budget of about Rs 1.23 Crore (189,795.67 Euro). The partners are ICLEI European Secretariat, ICLEI South Asia and

ICLEI South East Asia, and Potsdam Institute for Climate Impact Research (PIK), Germany. Four Indian cities such as Howrah, Visakhapatnam, Kochi and Madurai and four Philippines Cities Baguio, Dagupan, San Fernando and Tuguegarao are selected for this study. The main aim of the project is to identify generic climate change parameters in four selected cities in India and Phillipines and to scientifically contribute in the local climate adaptation plans in those cities in India as well as in Philippines. The specific objectives are given below:

- To analyze the regional climate of four selected cities in India and identify key climate changes based on observations and model results.
- To work in collaboration with PIK to develop a climate change impact database for the regions of the above selected four cities.
- To support the four cities in India in developing climate change impact scenarios and vulnerability assessments.
- To collaborate with PIK in developing a Decision_Support_Framework for local adaptation.
- To contribute to training and other capacity building activities in four cities in India.

5.9 New areas of research outside the Ph. D. topic of the faculty

Most of the faculty members recruited earlier have their Ph. D.s in basic and applied sciences. They have expanded their horizons in research through inter-disciplinary collaborations at national and international levels. Even though the recent recruits have interdisciplinary Ph. D. topics, they are also branching out in to new areas of enquiry. Some of the emerging interdisciplinary and superspecialized topics include renewable energy, climate change and health, advanced computing, geoengineering, aerosol-cloud-precipitation interaction, earth system modelling, etc.

5.10 Collaboration

The Centre has strong research collaboration with various leading national and international Institutions.

International Organizations:

- University of Reading, Reading, UK.
- Imperial College, London, UK.
- University of Cambridge, Cambridge, UK.
- University of East Anglia, Norwich, UK.
- University of Exeter, Exeter, UK.
- UK Met Office Hadley Centre, Exeter, UK.
- Institut National Recherche en Informatique et Automatique (INRIA), Le Chesnay, France.
- Laboratoire de Meteorologie Dynamique (LMD), ENS, Paris, France.
- Abdus Salam International Center for Theoretical Physics, Trieste, Italy.

- Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany.
- North Carolina State University, (NCSU), Raleigh, USA.
- Florida State University (FSU), Tallahassee, USA.
- University of Maryland at College Park, Maryland, USA.
- Naval Research Laboratory, Washington, USA.
- National Institute of Resources and Environment (NIRE), Tsukuba, Japan.
- Laboratoire de Meteorologie Dynamique (LMD), ENS, Paris, France.
- Abdus Salam International Centre for Theoretical Physics, Trieste.
- Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany.
- North Carolina State University, (NCSU), Raleigh, USA.
- Florida State University (FSU), Tallahassee, USA.
- University of Maryland at College Park, Maryland, USA.
- Naval Research Laboratory, USA.
- National Institute of Resources and Environment (NIRE), Tsukuba, Japan.
- Russian Academy of Sciences, Moscow, Russia.
- Pukyong National University, Busan, South Korea.
- Meisei University, Tokyo, Japan
- University of Albany-SUNY, USA
- Technical University, Delft, Netherlands
- University of Birmingham, UK
- University of Colorado, USA
- UCLA, USA
- NCAR, USA
- Sandia National Lab, USA
- Oak Ridge National Lab, USA
- JPL, USA
- University of Illinois Urbana-Champaign, USA
- Pacific Northwest National Lab, USA
- Lawrence Livermore National Lab, USA
- Princeton University, USA
- Geophysical Fluid Dynamics Lab, USA
- Environmental Protection Agency, USA

National Organizations:

- India Meteorological Department
- National Centre for Medium Range Weather Forecasting
- Indian Institute of Tropical Meteorology
- Indian National Centre for Ocean Information Systems
- Indian Space Research Organization
- Space Applications Centre
- Central Pollution Control Board
- National Environmental Engineering Research Institute
- National Institute of Oceanography
- Centre for Mathematical Modelling And Computer Simulation

- Centre for Development of Advanced Computing
- National Aerospace Laboratories
- Indian Air Force
- Indian Navy
- Indira Gandhi Centre for Atomic Research
- IIT Kanpur
- IIT Kharagpur
- IIT Bhubaneswar

Innovation, Design and Development

6. Innovation, Design and Development

Over the years, the Centre has made significant contributions to the improvement of operational capabilities in the country. The IIT Storm Surge Model is a state-of-the-art tool for predicting storm surges due to tropical cyclones along the Indian coasts that is continuously improved through research. The model has been transferred to the IMD as well as meteorological departments of the Indian Ocean rim countries for operational storm surge forecasting. Our Centre is also recognised by the WMO as a nodal centre for imparting training in program on storm surge modelling. Every year, WMO sponsors two meteorologists from different countries for undergoing training at the Centre. In addition, collaborative research projects have been undertaken for goal oriented benefits of organizations such as IMD, NCMRWF, INCOIS, SAC, C-DAC and CPCB.

R & D Environment

7. R & D Environment

7.1 No. of post-doctoral scholars

The provision to recruit post-doctoral researchers through Institute fund was made in October 2013, where 2 positions were sanctioned for the Centre. Besides this, the faculty members have employed 10 research scientists with PhD degree in the externally funded projects in the last five years.

7.2 No. of foreign students enrolled in PG program

None

7.3 No. of Indian/foreign faculty who spent a sabbatical in the Centre

- Prof. Kirk Smith (University of California, Berkeley) has spent five months (Sep 2013-Jan 2014) at the Centre on Fulbright Distinguished Professorship.
- Dr. Abdelrazig Mohomod Abdelbagi (Omdurman Sudan) has spent three months in the Centre (Jan-Mar 2011) as a CV Raman International Fellow of DST, Govt. of India.
- Dr. K. M. Mphale (Botswana University) has spent three months (Aug-Nov 2011) as a CV Raman International Fellow of DST, Govt. of India

7.4 Sabbatical taken by CAS faculty

Dr. H. C. Upadhyaya (Jan 2010-Dec 2010).

7.5 Number of seminars

All PhD students give a seminar every semester as part of the evaluation of their progress of work. M.Tech final year students also give a seminar in the middle of the 3rd and 4th semesters as mid-term progress. They give another seminar at the end of 3rd semester for end-semester progress and another one at the end of 4th semester for final evaluations. Other than these seminars, the Centre arranges 59 seminars in the seven semesters by eminent scientists/faculty from Institutions in the country and abroad as well as by the students. The number of seminars in the last few years is summarized below with the details of the speakers, title of the talks and dates are given in Annexure I.

Academic Year	Semester	Number of Seminars
2009-10	II	7
2010-11	I	13
2010-11	II	14
2011-12	I	5
2011-12	II	11
2012-13	I	7
2012-13	II	2

7.6 Adequacy of research infrastructure

The main research infrastructure required is for computing because the research focus of the Centre is numerical modelling. At present, the Centre has two parallel computing clusters with ~2.3 Teraflops of computing power. This is complemented by storage servers of ~100 Terabytes capacity, and workstations. The software to utilize the available systems includes Intel and PGI compliers, libraries such as NetCDF & JPEG, visualization software (GrAds, Ferret, UVCDAT) and installed models (WRF/WRF-Chem, RegCM4.0, and CAM5.0). The details of in-house computing infrastructure are as follows:

Compute Clusters

1. AjayMeru: SUNFIRE X2270 with 8 nodes (128 processors) and 16TB Archival System (RAID) - SUN Storage 34200.
2. Chandra: Fujitsu Primergy RX300 S7 with 10 nodes (120 processors) and 16TB RAID storage.

Storage Servers

1. Opslag-FS2: 24TB raw capacity NAS storage server
2. Storage: 72 TB raw storage capacity Linux based RAID server.
3. Samudra: 10 TB raw storage capacity l\Linux based RAID server.

Visualization and Analysis Software

1. GrADS: The Grid Analysis and Display System (GrADS) is an interactive desktop tool that is used for easy access, manipulation, and visualization of earth science data. GrADS has two data models for handling gridded and station data. GrADS supports many data file formats, including binary (stream or sequential), GRIB (version 1 and 2), NetCDF, HDF (version 4 and 5), and BUFR (for station data). GrADS has been implemented worldwide on a variety of commonly used operating systems and is freely distributed over the Internet.
2. Ferret: Ferret is an interactive computer visualization and analysis environment designed to meet the needs of oceanographers and meteorologists analyzing large and complex gridded data sets. Ferret offers a Mathematica-like approach to analysis; new variables may be defined interactively as mathematical expressions involving data set variables. Calculations may be applied over arbitrarily shaped regions. Fully documented graphics are produced with a single command. It runs on most Unix and Linux systems using X Window for display, and on Windows XP/NT/9x.
3. Uvcdat: Ultrascale Visualization Climate Data Analysis Tools and Visual Data Exploration and Analysis of Ultra-large Climate Data, plan to deliver new capabilities to the climate-science community. Funded by the DOE Office of Science through its Earth System Modeling Program, these two projects share a joint vision for large-scale visualization and analysis for both observational and model-generated climate data, with the goal of delivering new capabilities into the hands of the climate scientists. The integrated software product, the Ultrascale Visualization Climate Data Analysis Tools (UV-CDAT), is a powerful and complete front-end to a

rich set of visual-data exploration and analysis capabilities well suited for climate-data analysis problems.

In addition to these, efforts are on to procure IDL software for visualization.

Models Installed on the clusters:

1. WRF: The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed to serve both atmospheric research and operational forecasting needs. It features two dynamical cores, a data assimilation system, and a software architecture allowing for parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales ranging from meters to thousands of kilometers.
2. REGCM: The Regional Climate Model system RegCM, originally developed at the National Center for Atmospheric Research (NCAR), is maintained in the Earth System Physics (ESP) section of the ICTP. The first version of the model, RegCM1, was developed in 1989 and since then it has undergone major updates in 1993 (RegCM2), 1999 (RegCM2.5), 2006 (RegCM3) and most recently 2010 (RegCM4). The latest version of the model, RegCM4, is now fully supported by the ESP, while previous versions are no longer available. This version includes major upgrades in the structure of the code and its pre- and post- processors, along with the inclusion of some new physics parameterizations. The model is flexible, portable and easy to use. It can be applied to any region of the World, with grid spacing of up to about 10 km (hydrostatic limit), and for a wide range of studies, from process studies to paleo-climate and future climate simulation.
3. CAM: The Community Atmosphere Model (CAM) is the latest in a series of global atmosphere models developed at NCAR for the weather and climate research communities. CAM also serves as the atmospheric component of the Community Earth System Model (CESM).

This facility has to serve the requirements of not just the research activity but also teaching labs. At the Institute level, the computing availability is restricted to a cloud computing server (Baadal) and a new Nvidia GPU cluster that has been recently commissioned. There is a process underway to create a High Performance Computing infrastructure with about 130 Teraflops capacity to serve the computing needs across different departments and Centres. However, this is still in the tendering stage and hopefully this facility will come up soon. For the long-term, the Institute is committed to creating a Petaflop scale facility at the new campus in Sonepat.

The existing computing infrastructure is ***not adequate*** to meet the computing challenges of the 21st century such as running Atmosphere-Ocean General Circulation Models (AOGCM) coupled with Dynamic Vegetation Growth Models (DVGM) and conducting large ensemble simulations. Our faculty members are trying to develop innovative hybrid computing systems to solve this problem. Moreover, we are seeking external funding to build a High-Performance Computing (HPC) infrastructure at the Centre to meet our upcoming needs as well as driving the establishment of the institute-wide computing infrastructure.

7.7 Adequacy of technical staff

The Centre's focus in modeling and the availability of reasonably cheap computing power has meant that the computational facility has grown over the years. The current number of technical staff is highly inadequate to manage the computing labs and courses both technically and administratively. This is a serious problem, which has resulted in enormous amount of administrative load for the faculty serving as in-charge of various labs hampering their research activities.

In line with the improvements in computing infrastructure required, there is also a need for increased supporting technical staff primarily as Systems Administrators. We envisage ***at least 2 experienced personnel*** to support these activities. The difficulty in recruiting experienced systems administrators under current recruitment constraints implies that creative solutions are needed to be able to pay these personnel competitive salaries.

7.8 Student activities

Ph. D. students, on an average, attend one international conference and two national conferences/workshops in five-year duration. M.Tech students are also encouraged to attend conferences/workshops at national level. In the last five years, out of 33 M.Tech students, 6 have joined the Ph. D. programme of the Centre, 3 have joined Ph. D. programmes elsewhere in India and 2 students have joined doctoral programme abroad.

Outreach Engagement

8 Outreach Engagement

8.1 Workshops/Short-term courses/Training programs

In the last five years, the Centre has organized several short-term courses, training programs and workshops to train skilled manpower in the field of atmospheric and oceanic sciences and create awareness among the students and society. The list of these programmes is given below year-wise.

Year 2009

1. International Training cum workshop on "Climate risk management in agriculture" sponsored by DAC, Min. of Agriculture, Govt. of India (Prof. U. C. Mohanty and Prof. S. K. Dash).
2. Annual review meeting and Training workshop programme on "Use of Crop simulation modelling for climate risk Management" sponsored by DAC, Min. of Agriculture, Govt. of India (Prof. U. C. Mohanty).

Year 2010

3. Training programme on "WRF-ARW modelling system" from 24th November to 4th December, 2010 sponsored by Weather Modification Technical Services Unit, Jakarta (Prof. U. C. Mohanty).
4. Training on Use of Crop Simulation Models and DSS in ERFS project During 26 Oct – 03 Nov 2009 at Centre for Atmospheric Science, IIT Delhi (Prof. U. C. Mohanty and Prof. S. K. Dash).
5. Workshop on Climate Risk management in Agriculture (O.U.A.&T. Bhubaneswar) during April 12-17, 2010 at OUA&T, Bhubaneswar (Prof. U. C. Mohanty).
6. International EU-IndiaGrid2 Workshop with special focus on Material Science and Climate Change at IIT Delhi during 13-16 December 2010 (Prof. S. K. Dash)
7. WMO sponsored Training on Storm Surge Prediction at IIT Delhi during 11-14 February 2010 (Prof. S. K. Dube and A. D. Rao)

Year 2011

8. SERC School on "Dynamics and Forecasting of the Indian Summer Monsoon 27th June to 20th July, 2011 sponsored by Department of Science and Technology, Govt. of India.
9. 2ndNational Conference on Climate Change Date: 5-6 November, 2011(Dr. K. AchutaRao).
10. Brain Storming Workshop on Impact of Extreme Weather Events and Climate Change on Human Health. 21-22 November, 2011 (Prof. S. K. Dash and Dr. Sagnik Dey).

Year 2012

11. Brain storming meeting for Establishing Network Program on "Climate Modelling & Human Health in the context of Climate Change" Date: 24-25 May- June 1, 2012 (Prof. S.K. Dash and Dr. Sagnik Dey)
12. Advanced Indo-US Training Workshop and Colloquium on "Modelling and Data Assimilation for Tropical Cyclone Predictions" during 9-14 July, 2012, at Bhubaneswar, Odisha (Prof. U. C. Mohanty).
13. Workshop on "Establishing network program on Climate change and health" sponsored by DST, Govt. of India during July 2012 (Prof. S. K. Dash and Dr. Sagnik Dey).
14. Workshop on "Future Directions for Weather and Climate Research in the Tropics" Date: 3-5 December, 2012 (Prof. S.K. Dash)

Year 2013

15. SERB School on Weather and Climate in the Tropics, during June 2013 at CAS, IIT Delhi (Dr. Sagnik Dey and Prof. U. C. Mohanty)
16. Training Workshop on 'Climate Modelling: Simulations and Analysis", during Dec 2013 as part of sponsored research project from DST, Govt. of India (Prof. S. K. Dash, Dr. K. AchutaRao, Dr. Sagnik Dey and Prof. U. C. Mohanty)

8.2 Courses taught via NPTEL

Prof. O. P. Sharma has taught one course, Physics of atmosphere and ocean' via NPTEL.

8.3 Books and book chapters

CAS faculty members have published the following books and contributed chapters in books in the last five years.

Authored Books

1. G. Jayaraman, *Mathematical Modelling*, 2009: published by Indira Gandhi Open University.

Edited Books

1. Challenges and Opportunities in Agrometeorology, Attri, S. D., L. S. Rathore, M. V. K. Sivakumar and **S. K. Dash** (Eds.), 2011, 560 pp, Springer.

Chapters in Books

1. Dash, SK, S Rai, UC Mohanty, SK Panda, 2011: Monthly and Seasonal Indian Summer Monsoon Simulated by RegCM3 at High Resolutions, in *Challenges and Opportunities in Agrometeorology*, Springer, 13-34.

2. Dash, S. K., Weather and Climate in High Latitudes with Special Reference to the Himalayas; in *Climate Change and its Ecological Implications for the Western Himalaya*, Scientific Publishers

3. Dash, S. K., The present context of climate change, projections and scenarios; **in** *Agricultural Drought: Climate Change and Rainfed Agriculture*, Eds. By V. U. M. Rao et al., CRIDA.

4. Litta, AJ, UC Mohanty, SC Bhan, M Mohapatra, 2011: Simulation of Tornadoes over India Using WRF-NMM Model, in *Challenges and Opportunities in Agrometeorology*, Springer, 173-186.

5. Mohanty, UC, S Pattanayak, AJ Litta, A Routray, OK Kishore, 2011: Simulation of Heavy Rainfall in Association with Extreme Weather Events: Impact on Agriculture, in *Challenges and Opportunities in Agrometeorology*, Springer, 35-59.

6. Osuri, KK, A Routray, UC Mohanty, MA Kulkarni, 2013: Simulation of Tropical Cyclones Over Indian Seas: Data Impact Study Using WRF-Var Assimilation System, in *Indian Ocean Tropical Cyclones and Climate Change*, Springer, 115.

7. S Pattanayak, UC Mohanty, 2013: Simulation of Track and Intensity of Gonu and Sidr with WRF-NMM Modeling System, in *Indian Ocean Tropical Cyclones and Climate Change*, Springer, 83.

8. Pramod Kumar and Maithili Sharan, Analytical models for the dispersion of pollutants in low wind conditions. In: *Air Pollution and Turulence: Modelling and Applications*. Eds D Moreira and M. Vilhena, CRC Press Boca Raton, 157-178 (2009).

9. Srivastava, A., Dey, S. and S. N. Tripathi, "Aerosol Characteristics over the Indo-Gangetic Basin: Implications to Regional Climate", in "*Atmospheric Aerosols - Regional Characteristics - Chemistry and Physics*", (Ed.) Intech Publishers.

10. Dey, S. and S. N. Tripathi, "Remote Sensing of Atmospheric Aerosols", in "*Aerosol Science: technology and Applications*", (Ed.) by Ian Colbeck and Mihalis Lazardis, 2014 John Wiley & Sons, Ltd.

8.4 Service as thesis examiners, board members, positions outside IITD, technical committee

8.4.1 Thesis examiners

- Prof. S. K. Dash – Gujarat University, Utkal University, North Orissa University, Mohanlal SukhadiaUniversity, Udaipur, Fakir Mohan University, Orissa, University of Pune, IISc Bangalore, PRL Ahmedabad, Cairo University, Egypt, BIT Mesra, University of Allahabad, Pondicherry University, SAC Ahmedabad

- Prof. Manju Mohan – Delhi University, B.R. Ambedkar University, Madurai Kamraj University, JNU

- Prof. Maithili Sharan – IIT Roorkee, University of Rajasthan Jaipur, JNCASR Bangalore

- Prof. Pramila Goyal – IIT Roorkee, Institute of Technology Lucknow

- Prof. G. Jayaraman – IIT Madras, IIT Kanpur, IIT Guwahati, NIT Warangal, ISM Dhanbad, Bangalore University, Christ University Bangalore

- Dr. H. C. Upadhyaya – IIT Kharagpur

- Prof. S. K. Dube - Pune University, JNU, Lucknow University, Cairo University, Egypt

- Dr. Dilip Ganguly - IIRS, Dehradun

8.4.2 Board members

- Prof. Maithili Sharan –
  (a) Member, Selection Committee - IISER Mohali; University of Rajasthan, Jaipur; MNIT Jaipur; University of Allahabad; BHU
  (b) Visitor nominee in Physical Sciences, HNB Central University, Srinagar Garwal, 2012
  (c) Member, Court, Kurukshetra University 2010-2012
  (d) Member, Executive Council, Central University Kashmir, 2013 onwards
  (e) Member, University Court, Central University, 2013 onwards
  (f) Member, Search Committee for VASVIK Industrial Research Awards (2007-2011)
  (g) Member, Committee for NASI-SCOPUS Young Scientist Award in Mathematical Sciences (Elsevier), 2009

- Prof. S. K. Dash –
  (a) Director, Seventh ICTP Workshop on the Theory and Use of Regional Climate Model

- Prof. Manju Mohan –
  (a) Elected Member, National Academy of Sciences, Allahabad
  (b) Member, Managing Committee, Indian Air Pollution Control Association (Delhi Chapter) 1999-2004; 2008-2010

- Prof. Pramila Goyal –
  (a) Advisory Board of JIIT, Noida and BITS, Mesra

- Prof. U. C. Mohanty –
  (a) Member, Academic Advisory Committee (AAC) of School of Environmental and Natural Resources (SENR), Doon University, Dehradun, 2012-
  (b) Member, Governing Council, Indian Institute of Tropical Meteorology (IITM), Pune 2006-2017.
  (c) Member, Governing Body, Wadia Institute of Himalayan Geology (WIHG), Dehradun, 2011-

- Prof. A. D. Rao –
  (a) Elected member, national Academy of Sciences, Allahabad
  (b) Member, Indian Meteorological Society

- Dr. K. AchutaRao –
  (a) Lead author, Working group I, Intergovernmental panel on Climate Change (IPCC)
  (b) Member, Board of Studies, School of Human Ecology at Ambedkar University, Delhi

- Prof. S. K. Dube –
  (a) Member, Earth Commission, Govt. of India
  (b) Member, Advisory Board, National Disaster Management Authority, Govt. of India
  (c) Member, Board of Management, GBTU, Greater Noida

8.4.3 Technical Experts on Committee

- Prof. Manju Mohan –
  (a) Member, DST Subject Expert Committee for Technical Evaluation of Proposals of Earth and Atmospheric Sciences for Women Scientist Scheme (WOS-A) [2005 -2012]
  (b) Member, Environmental Appraisal Committee (Industry-I) of Ministry of Environment and Forests (MOEF), GOI [2009 - 2012]

- Prof. S. K. Dash –
  (a) Member, PAMC, Himalayan Glaciology Program, DST, Govt. of India
  (b) Member, PAMC, PROBE, DST, Govt. of India
  (c) Member, Subject Expert Committee, Women Scientist Scheme, DST, Govt. of India
  (d) Member, Reviewers Panel of Climate Change Program, DST, Govt. of India

- Prof. Maithili Sharan –
  (a) Member, Research Council, CSIR-NEERI Nagpur 2009-15
  (b) Member, Selection Committee for SRF/RA, CSIR, New Delhi 1992-till date

(c) Member, Advisory Committee for SS Bhatnagar Prize in Mathematical Sciences, CSIR 2009,2012.
(d) Member, as UGC Nominee, Advisory Committee for SAP program in Mathematics, University of Rajasthan Jaipur 2011-till date
(e) Member Science Promotion Committee, Indian National Science Academy 2013 onwards
(f) Member, Sectional Committee I, Mathematical Sciences, Indian National Science Academy, 2009-11
(g) Member, Sectional Committee X, (Multi-disciplinary), Indian National Academy of Engineering, 2009-10; 2014
(h) Member, Expert/Advisory Committee for Fast Track Young Scientists in Mathematical and Physical Sciences, DST 2009-till date
(i) Member, Swarna Jayanti Fellowship Award in Mathematical Sciences, DST 2010-2011.
(j) Member, Screening Committee, Climate Change Program, Dept of Biotechnology, Govt of India. 2008-09.
(k) Member, Charpak Fellowship 2012, Mathematics, French Embassy, New Delhi

- Prof. U. C. Mohanty –
  (d) Chairman, Programme Advisory Committee on Atmospheric Sciences (PAC-AS), Scientific and Engineering Research Board (SERB), Dept. of Science and Technology (DST), Govt. of India, 2012-
  (e) Chairman, Fund for Improvement of S&T Infrastructure (FIST) in Earth and Atmospheric Sciences, DST, 2009-
  (f) Chairman, Programme Implementation Committee (PIC) for Severe Thunderstorms Observations and Regional Modelling (STORM) programme, Ministry of Earth Sciences (MoES), Govt. of India, 2008-
  (g) Member, International Advisory Panel (IAP) for Weather and Climate, MoES, Govt. of India, 2008-2015
  (h) Member, International Programme Committee (IPC), SAARC, Storm Programme, SAARC
  (i) Meteorological Research Centre (SMRC), Dhaka, Bangladesh, 2009-
  (j) Member, Project Appraisal and Monitoring Committee (PAMC) on Atmospheric Sciences including Climate Science, MoES, 2012-2017.
  (k) Member, FIST Board, DST, Govt. of India,
  (l) Member, Scientific Review and Monitoring Committee (SRMC), Monsoon Mission Programme, 2012-2017.
  (m) Member, Research Council of Snow and Avalanche Study Establishment (SASE), Govt. of India,2012-
  (n) Member, Research Advisory committee (RAC), NCMRWF, 2011
  (o) Member, Programme Advisory Committee (PAC) for International Cooperation in the area of Earth, Atmospheric and Environmental Sciences, DST, 2012-2015.
  (p) Member, Partial Financial Assistant Committee (PFAC), Council of Scientific and Industrial Research (CSIR), 2011-
  (q) Member, High Power Committee for Review of India Meteorological Department (IMD) Projects during 11th 5-year plan, MoES, 2012-

(r) Member, Sectional Committee-X (Interdisciplinary Engineering and Special Fields), Indian National Academy of Engineering (INAE), 2012
(s) Member, Sectoral Monitoring Committee on Physical Science Cluster Group II- Innovative Physics and Advanced Electronics, CSIR, 2010-
(t) Member, International Coordinating Committee (ICC), UN-CECAR, UNU, Tokyo, Japan, 2009-
(u) Member, Forecast Demonstration Project on "Bay of Bengal Tropical Cyclones", IMD, 2008-

- Prof. A. D. Rao –
  (a) Member, Expert committee for Pilot Experiment in Coastal Sea State Forecast, INCOIS, Department of Ocean Development, Govt. of India
  (b) Member Cyclone Early Warning System, National Disaster Management Authority, Govt. of India
  (c) Peer reviewer for Storm Surge Guide, WMO

- Prof. P. Goyal –
  (a) Member, Selection Committee for Deputy Director, Ministry of Environment and Forest, Govt. of India in 2009.
  (b) Member, Selection Committee for Scientist C and D, Central Pollution Control Board, Delhi in 2009- 2010.
  (c) Member, Selection Committee for Research Scientist/SRA, Department of Environment, Govt. of Delhi. in 2009.

- Prof. G. Jayaraman –
  (a) Member, Staff Selection Committee, IIT Roorkee, IIT Mandi, IIT Rajasthan, NIT Durgapur
  (b) Member, Research Development Committee (Math), UPTU, Lucknow

- Prof. S. K. Dube –
  (a) Member, O&M Programme Committee, National Agricultural Innovation Project, ICAR, New Delhi
  (b) Chairman, Expert Committee on Climate Change Programme, DST, Govt of India
  (c) Member, Steering Committee of Climate Change Programme, DST, Govt of India
  (d) Member, Executive Council, Bundelkhand University, Jhansi
  (e) Member, Academic Council, Central University of Kerala, Kasargod
  (f) Member, Search cum Selection Committee for National Earth System Science Awards, MoES, Govt of India
  (g) Member, Working Group of MoES for the formulation of 12^{th} five year plan., MoES, Govt of India
  (h) Member, 13^{th} Judging Committee for the "Biennial Award & MAUSAM Sodh Purraskar", IMD, New Delhi

8.4.4 Editorial Board Members

- Prof. A. D. Rao –
  (a) Editorial Board, Natural Hazards
  (b) Associate Editor, The International Journal of Ocean and Climate Systems

- Prof. S. K. Dash –
  (a) Vayu Mandal

- Prof. Maithili Sharan –
  (a) Editorial board of Proc. Indian National Academy, Ganit Sandesh, Boundary Layer Meteorology, Atmospheric Environment
  (b) Guest Editor for –
    1. Pageoph topical volume on "Data Assimilation and its Applications" Birkhauser Verlag 2012 (Eds: Maithili Sharan and J.P. Issartel).
    2. Special issue on "Mesoscale Processes and Natural Hazards" of the journal of Natural Hazards, Springer 2008 (Eds: Maithili Sharan and S. Raman).

- Prof. U. C. Mohanty –
  (a) Guest editor, Special issue on "Tropical Cyclones of 21st Century" of "Journal of International Society for the Prevention and Mitigation of Natural Hazards (Natural Hazards)", Vol. 63, 3, 1281-1620, 2012.
  (b) Member, Editorial Board for the Quarterly Journal, Proceedings of the National Academy of Sciences, India (Section A-Physical Sciences), Journal Vayu Mandal (Proceeding of Indian Meteorological Society), Mausam

- Prof. P. Goyal –
  (a) Member of Editorial Board, Indian Journal of Air Pollution Control (IJPAC), 2007-2010.

- Prof. G. Jayaraman –
  (a) Editorial board member of International Journal of Emerging Multidisciplinary Fluid Sciences, UK

- Prof. S. K. Dube –
  (a) Advisory Board, Pakistan Journal of Meteorology, Islamabad, Pakistan
  (b) Member, Editorial Board of MAUSAM, IMD, New Delhi
  (c) Editorial Board, Natural Hazards, Lower Academic Publishers, The Netherlands
  (d) Member Advisory Editorial Board, International Journal of Mathematical Modelling & Analysis of Complex Systems, Kanpur, India

- Dr. Somnath Baidya Roy –
  (a) Editor of Earth Systems Dynamics (EGU),
  (b) Associate Deputy Editor - Climatic Change

- Dr. Saroj Kenta Mishra –
  (a) Associate Editor, Asia-Pacific Journal of Atmospheric Sciences

- Dr. Sagnik Dey –
  (a) Review Editor, Frontiers in Earth Sciences

8.4.5 Mentoring of other Institutions

- Prof. Maithili Sharan – Member, Curricular development, M.Sc (Mathematics), Central University of Rajasthan

- Prof. G. Jayaraman – Technical Education Quality Improvement Program of Govt. of India

- Prof. S. K. Dube – Member, Board of Studies, Mahamaya Technical University, Uttar Pradesh

- Prof. S. K. Dash - National Coordinator – Climate Change & Health and Climate Modelling, DST, Govt. of India

Governance

9 Governance

9.1 Organization structure

The Centre is led by the Head who functions in close coordination with the Centre Research Committee, the Professorial Committee and the Centre's Faculty Board. The Faculty Search Committee is actively engaged in recruiting new faculty in thrust areas to expand the scope of CAS. We also provide leadership and otherwise contribute to institute-level activities through faculty representatives to the Faculty Senate, Board of Academic Programs and committees on Training & Placement, etc.

Averaged over the last five years, annually 8 faculty board meetings, 14.2 CRC meetings and 7.2 Professorial Committee meetings are held and these have been on the average attended by 80% of the faculty. Faculty time utilization has been 20% in teaching activities, 5% in meetings, 20% in project management, 35% research & thesis guidance and 20% in administrative work. Staff time utilization has been 20% in laboratory and 80% in supporting research.

9.2 Planning documents prepared by the Centre – space, faculty, staff related

The following documents are prepared by the Centre in the last five years:
(i) Report presented to the Board of Governors, IIT Delhi
(ii) Centre's vision document – submitted to the DD S&P
(iii)Consolidated Table to quantify the space usage in the Centre

9.3 Internal documents

The minutes of the CRC, CFB and Professorial Committee meetings are available at the Centre's office. The vision document was prepared based on the discussion in the CFB.

9.4 Financial Resources

i. Funds provided to the Centre

The Centre received a total of Rs.2.39 Crore from the Institute, while the funds generated from sponsored research and consultancy projects is Rs. 19.1 Crore during the same period. Thus, the Centre generated 89% of the fund from the external funding sources.

Year	Plan (INR in lac)	Non-plan (in INR lac)	Total fund (from the Institute)	External fund	% of external fund
2009	32.35	6.54	38.89	245.92	86.3
2010	43.64	7.32	50.96	313.84	86
2011	28.45	6.58	35.03	1008.93	96.6
2012	60.13	9.51	69.64	133.03	65.6
2013	35.64	8.82	44.46	203.45	82
Total	200.21	38.77	238.98	1905.17	89

ii. Processes of distribution

Funds are requested from the Institute based on a review of the requirement for each financial year in the Centre's Faculty Board. The funds are distributed to the faculty members according to the requirement.

iii. Funding for focus area

The funding is sought for the upgradation of the research and teaching laboratories and other day-to-day activities of the Centre.

iv. Funding for UG and PG teaching laboratories

Since there are no exclusive teaching laboratories in the Centre, it is difficult to separate the funding used for teaching and research laboratories. All the laboratories that are used for teaching are also utilized for research purposes.

9.5 Faculty short-listing

Applications are accepted throughout the year across the Institute for Assistant Professor in addition to the advertisements posted in national media. Positions of Associate Professor and Professor are advertised as per the requirement. In addition to the call for Assistant Professor posted in the Centre's website, CAS faculty members interact with potential candidates during their visit to various national and international conferences. The Centre's faculty members are also in contact with their national and international collaborators and alumni to find suitable candidates in the thrust areas.

There is a faculty search committee, which shortlists the candidates applying for various positions. The faculty short-listing criteria is given below.

Institute-level short-listing criteria for faculty positions

Minimum short-listing criteria for Assistant Professor:

- Ph. D. with 3 years experience (excluding the experience gained while pursuing Ph. D.),
- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record,
- Potential for very good teaching
- Maximum age is 35 years for male and 38 years for female candidates (to be relaxed by 5 years in case of persons with physical disability, SC and ST), and
- And at least 4 refereed conference/journal papers (of which at least 2 should be in reputed journals).

Minimum short-listing criteria for Associate Professor:

- Ph. D. with 6 years experience (excluding the experience gained while pursuing Ph. D.) of which at least 3 years should be as Assistant Professor or equivalent,
- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record,
- Should have demonstrated capability for good teaching,
- And at least 10 refereed conference/journal papers (of which at least 4 should be in reputed journals out of which at least 2 in last 3 years), and
- Completed at least one sponsored R&D or consulting project as a PI, or completed two sponsored R&D or consulting projects as a co-PI.

Minimum short-listing criteria for Professor:

- Ph. D. with 10 years experience (excluding the experience gained while pursuing Ph. D.) of which either.
  a. At least 4 years should be as Associate Professor or equivalent, or
  b. At least 8 years should be as Assistant Professor or equivalent (in case of Institutions where the post of Associate Professor or equivalent does not exist),
- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record,
- Should have demonstrated excellence in teaching,
- At least 20 refereed conference/journal papers (of which at least 8 should be in reputed journals, out of which at least 3 in last 4 years),
- Should have guided independently at least one Ph. D. student, or have guided at least two Ph. D. students jointly with other faculty/researchers, and
- Completed
  a. One sponsored R&D or consulting projects as a PI, and
  b. One more sponsored R&D or consulting project as a PI, or two sponsored R&D or consulting projects as a Co-PI.

Additional short-listing criteria for CAS:

Assistant Professor:

- Throughout first class academic career
- At least 4 refereed papers relevant to CAS published in reputed journals with positive impact factor.

Associate Professor:

- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record (more than 55% at graduation level),
- At least 3 years experience at the level of Assistant Professor excluding the period of contract appointment.

- Candidate from outside IITs, IISc Bangalore, IIMs, NITIE Mumbai and IISERs shall have period of 3 years in the equivalent level with a grade pay of at least Rs.8000/-
- At least 10 refereed papers relevant to CAS published in reputed journals with positive impact factor (out of which at least 2 in last 3 years).
- Completed at least one sponsored R&D or consulting project as a PI, or completed two sponsored R&D or consulting projects as a co-PI/CI (funded by the agency outside the parent organization)

Professor:

- First class or equivalent grade in preceding degree in respective discipline, with a consistently good academic record (more than 55% at graduation level),
- At least 20 refereed papers relevant to CAS published in reputed journals with positive impact factor (out of which at least 3 in last 4 years).

Recruitment in the last five years:

The statistics of faculty recruitment for the last five years is given below.

Position	Number of Applicants	Number of Shortlisted Candidates	Number of candidates recruited
Assistant Professor	84	8	4
Associate Professor	13	2	1
Professor	5	0	0

9.6 Diversity in Faculty profile

CAS has 14 faculty in regular positions with the following break-up:

Professor – six
Associate Professor – three
Assistant Professor – four
SSO I – one

In addition to the regular positions, the Centre has one adjunct faculty and one Chair Professor. In the last two years, four faculty members have retired. The sanctioned strength of the faculty is 19, which if filled, can be increased to 22. The diversity in the existing faculty profile in various categories is summarized below:

Sr. No.	Item	Description
1	Gender	Female = 3 Male = 11
2	Category	All faculty belong to General category

3	Region	North = 4 East = 5 South = 2 West India = 3
4	PhD Institution	IIT Delhi = 4 IIT Kanpur = 1 IIT Bombay = 1 PRL Ahmedabad = 2 IISc Bangalore = 1 IITM Pune = 1 Roorkee University = 1 Jammu University = 1 Rutgers University, USA = 1 Tulane University, USA = 1
5	Employment prior to IIT Delhi	ARIES (DST), Nainital = 1 IIST Trivandrum = 1 Pacific Northwest National Laboratory, USA = 1 University of Illinois = 2 Utkal University = 1 Lawrence Livermore National Laboratory, USA = 1

9.7 Faculty time utilization

On an average, faculty time utilization (in %) of the Centre's faculty is as follows:

Class	Meeting	Project Management	Thesis Supervision	Administrative Work
20	5	20	35	20

Due to shortage of efficient technical and support staff, CAS faculty has to devote significant time in administrative works related to store purchase, maintenance of laboratories etc., especially those who are in-charges of various labs. This is hampering the pace of research activities in the Centre.

9.8 Level of harmony amongst Centre's faculty

There is an excellent level of harmony amongst faculty of CAS, which can be gauged from the large number of joint research projects and joint thesis supervisions.

9.9 Student Selection

The total sanctioned strength for M.Tech and PhD students in the Centre for Institute Assistantship and other support in various categories are summarized below:

	Institute Assistantship				Others (including Part-time)	Total
	General	**OBC**	**SC**	**ST**		
M.Tech	7	4	2	1	11	25
PhD	12	6	4	2	26	50

A. Selection for PhD Admission

Applications are received generally twice a year for the admission to the PhD programme. CRC scrutinizes the applications based on the short-listing criteria (see below) and fix a date for the shortlisted candidates for interview. The list of shortlisted candidates is displayed in the Institute websites. The candidates who are not shortlisted are also informed along with the reason through Institute website. Shortlisted candidates are personally contacted by the Centre's office through e-mail, post and phone (if required) and call letters for the interview are issued. After the interview, each candidate is given marks by the faculty members present in the interview board. Result is displayed on the evening of the interview.

S. No.	Qualifying Degree	Minimum performance in Qualifying degree	Qualification through national level examination requirements	Additional requirements at CAS
1	M.Tech/M.E or equivalent	60% marks or 6.75 CGPA on a 10 point scale for general/OBC (non-creamy layer) category students (relaxed to 55% marks or 6.25 on a 10 point scale for SC/ST/PH category students)	Nil	If the previous degrees are M.Sc and B.Sc, candidates should have taken both Physics and Mathematics at the undergraduate level
2	M.Sc. or equivalent	60% marks or 6.75 CGPA on a 10 point scale for general/OBC (non-creamy layer) category students (relaxed to 55% marks or 6.25 on a 10 point scale for SC/ST/PH category students)	(i) A valid GATE Qualified score ≥ 300 for general and OBC (non-creamy layer) category students (relaxed to 200 for SC/ST/PH category students) or qualifying score whichever is higher, CSIR/ UGC-NET/ICAR/ICMR/DST INSPIRE fellowship	Candidates should have taken both Physics and Mathematics at the undergraduate level.

			(ii) M.Sc from IITs graduating with a CGPA of 8.0 or above, requirement of qualification through national examination is waived off	
3	B.E/B.Tech or equivalent	70% marks or 7.5 CGPA on a 10 point scale for general/OBC (non-creamy layer) category students (relaxed to 65% marks or 7.0 on a 10 point scale for SC/ST/PH category students)	(i) Qualified GATE/ CSIR/UGC NET/ ICAR/DST INSPIRE fellowship (ii) B.Tech from IITs graduating with a CGPA of 8.0 or above, requirement of qualification through national examination is waived off (iii) B.Tech from Centrally Funded Technical institutions having CGPA 7.0 or above on a 10 point scale at the end of third year, requirement of qualification through national examination is waived off	Nil

B. Selection for M.Tech. Admission

Applications are received once a year for the admission to the M.Tech program, in summer. CRC scrutinizes the applications based on the short-listing criteria (see below) and fix a date for the shortlisted candidates for interview. The list of shortlisted candidates is displayed in the Institute websites. The candidates who are not shortlisted are also informed along with the reason through Institute website. Shortlisted candidates are personally contacted by the Centre's office through e-mail, post and phone (if required) and call letters for the interview are issued. After the interview, each candidate is given marks by the faculty members present in the interview board. Result is displayed on the evening of the final date of the interview.

S. No	Qualifying Degree	Minimum performance in Qualifying degree	Qualification through national level examination requirements	Additional requirements at CAS
1	M.Sc. or equivalent	60% marks or 6.75 CGPA on a 10 point scale for general/OBC (non-creamy layer) category students (relaxed to 55% marks or 6.25 on a 10 point scale for SC/ST/PH category students)	(i)A valid GATE Qualified score ≥ 300 for general and OBC (non-creamy layer) category students (relaxed to 200 for SC/ST/PH category students) or qualifying score whichever is higher, CSIR/ UGC-NET/ ICAR/ ICMR/INSPIRE fellowship (ii) M.Sc from IITs graduating with a CGPA of 8.0 or above, requirement of qualification through national examination is waived off	(i) M.Sc in Physics/ Chemistry/ Mathematics/ Oceanography/ Computer Sc.&Applications/ Geology/Geophysics / Environmental Sciences/ Earth Sci. (ii) Candidates should have taken both Physics and Mathematics at the undergraduate level.
2	B.E/B.Tech or equivalent	60% marks or 6.75 CGPA on a 10 point scale for general/OBC (non-creamy layer) category students (relaxed to 55% marks or 6.25 on a 10 point scale for SC/ST/PH category students)	(i) A valid GATE Qualified score ≥ 300 for general and OBC (non-creamy layer) category students (relaxed to 200 for SC/ST/PH category students) or qualifying score whichever is higher, CSIR/ UGC-NET /ICAR /ICMR/INSPIRE fellowship (ii) B.Tech from IITs graduating with a CGPA of 8.0 or above, requirement of qualification through national examination is waived off	B.Tech/ B.E. in Civil/ Mechanical/ Chemical/ Agriculture/Environmental/Marine Engineering. Candidates from other branches of engineering will be considered only if they have appropriate experience in related areas of atmospheric and oceanic sciences and meteorology

Feedback System and Results

10 Feedback System and Results

10.1 System for feedback from UG and PG students

CAS has UG Minor Area program. However, feedback is obtained from the UG students registered in various courses offered by the Centre through class-committee meeting in the middle of the semester and online feedback at the end of the semester. The program coordinator and Head discuss the feedback with the course coordinators and if required, the corrective measures are taken by the course coordinator.

10.2 System for feedback from recruiters

We do not have any formal system of getting feedback from the recruiters; however, we do get informal feedback from various employers who appreciate the performance of our graduates. We are planning to develop a formal mechanism for obtaining the feedback from the recruiter in the future.

10.3 Alumni feedback

All of our PhD alumni are placed in various research and academic Institutes. A workshop was organized entitled "Future Directions for Weather and Climate Research in the Tropics" during December 2012 to interact with our alumni, discuss the potential thrust areas and obtaining their feedback about the Centre's curriculum. They were very happy with this kind of interaction and expressed their desire to participate in such events more frequently on a regular basis.

10.4 Placement Records

Placement record of the PhD graduates in the last 5 years is given below.

S. No.	Student	Year of Graduation	Placement
1	Ashish Routray	2009	Scientist-C, NCMRWF
2	Sankalp Anand	2009	Scientist in Private sector
3	Jagabandhu Panda	2009	Assistant Professor, NIT Rourkella
4	Pramod Kumar	2010	Research Sci., Univ. of Evry, France
5	Hashmi Fatima	2010	Scientist-C, NCMRWF
6	Subrat Kumar Panda	2010	Project Scientist, CAS
7	G Senthil	2011	Scientist in Singapore
8	Sarvesh Kumar Singh	2011	Research Eng. Univ. of Evry, France
9	D. K. Mahapatra	2012	Scientist-C, NCMRWF
10	Palash Sinha	2012	Post-doc, Penn State Univ., USA
11	Sujata Pattanayak	2012	Project Scientist, IIT Bhubaneswar
12	Swagata Payra	2012	Assistant Professor, BIT Jaipur

13	Anikender Kumar	2013	Post-doc, Colombia
14	Liby Thomas	2013	NA
15	Mourani Sinha	2013	Assistant Professor, NIIT
16	Somnath Jha	2013	State Administrative Services
17	Lalit Kumar	2013	Research Scientist, Univ. of Brunei

Placement record of M.Tech students in the last 5 years is given below.

S. No.	Student	Year of Graduation	Present Status
1	A Bagavath Singh	2010	IGCAR, Kalpakkam
2	Amit Bhardwaj	2010	Continuing PhD at the Centre
3	Anil Kumar Devrani	2010	Wing Commander, Indian Air Force
4	Tarkeshwar Singh	2011	Continuing PhD at the Centre
5	Sushant Das	2011	Continuing PhD at the Centre
6	Aniket Chakravorty	2011	Continuing PhD at IITD (Civil)
7	Medhavi Gupta	2011	Continuing PhD at the Centre
8	Amit Kumar Gupta	2011	Lecturer in private college
9	Hetalben P. Patel	2011	NA
10	Surendra P. Singh	2011	Asst. Prof. in Deshbandhu College
11	Kamlesh Meena	2011	Engineer, CPWD
12	Ram Singh	2011	Continuing PhD at the Centre
13	Pushp Raj Tiwari	2011	Continuing PhD at the Centre
14	Nidhi	2012	PhD student at UNSW, Australia
15	Sarjeet Singh	2012	IMD
16	Swati Singh	2012	PhD student at IIT Bombay
17	Alok Kumar	2012	Analyst at e-Value
18	Ashwani Kumar	2012	DRDO
19	Sumer Budhiraja	2012	IMD
20	Ajit Singh	2012	PhD at Univ. of Birmingham, UK
21	Pranav Kumar	2012	IBM
22	Sanchit Mehta	2012	Asst. Prof., Manipal Univ., Jaipur
23	Kapil Kumar	2012	Asst. Prof. at private engg. college
24	Ayan K. Banerjee	2013	Project Associate at IIT Bombay
25	Rizwan Ahmed	2013	IMD
26	Amitoj Singh	2013	NA
27	Rahul Saini	2013	NA
28	Pawan Pal	2013	Teaching at private engg. college
29	S V K Murthi	2013	IMD
30	Subodh Kumar	2013	NA
31	Manish Bhardwaj	2013	Engineer, Chhatisgarh Govt.
32	Karanjit Singh	2013	NA
33	Amrendra Kumar	2013	NA
34	Rajeev Kumar	2013	NA
35	Nimish Singh	2013	NA

Benchmarking

11. Benchmarking

Performance of the Centre is compared with that of the CAOS, IISc Bangalore, a peer to the CAS. Both the centres were established around the same time with similar objectives and have evolved in parallel. The objective of this benchmarking is to estimate the relative performance and identify the strengths and weaknesses of the Centre. Goals and priorities will accordingly be set or redefined based on this benchmarking. It may be noted that we followed the "internet survey" method using information available on CAOS website and Google Scholar.

This benchmarking is made based on 4 parameters - publication per faculty, Ph. D. degrees awarded per year, number of faculty members and the number of Ph. D. students enrolled - which are shown in the following table.

	Publication per Faculty Member per year	**Ph. D./ Year**	**Number of Faculty Members**	**Number of Ph. D. Students enrolled**
CAOS, IISc	1.4	2	10	18
CAS, IITD	2.2	3.4	14	36

It can be seen that CAS is at par with CAOS in all categories. We are trying to collect additional information e.g., citation records, research grants, faculty awards, etc. to conduct a more thorough benchmarking.

Similarly, we benchmarked against the US universities and observed that CAS is at par with the leading universities/centres as far as publication/faculty per year and Ph. D. degrees awarded per year statistics are concerned. This information is obtained from "A Data-Based Assessment of Research-Doctorate Programs in the United States", a 2011 study conducted by the US National Academies to evaluate 52 US universities/centres offering doctoral degrees in Oceanography, Atmospheric Sciences and Meteorology. The data is available on the website of the National Research Council of the US National Academies. Results show that the number of peer-reviewed publication per faculty per year is 2.2 for CAS, while the average for the US universities is 1.51.

Centre/Dept.	**Institution**	**Papers per faculty per year**	**Ph. D. per Year**
CAS	**IIT Delhi**	**2.2**	**3.4**
	Average US University	**1.51**	**4.95**
Marine Science	College of William and Mary	0.99	10.6
Atm. Sc.	Colorado State Univ.	2.93	7.2
Meteorology	Florida State Univ.	1.92	4.2
Oceanography	Florida State Univ.	1.74	5.4
Oceano. & Coastal Sc.	Louisiana State Univ.	1.2	6.0

Atm., Ocean & Climate	MIT	1.6	11.6
Marine, Earth & Atm. Sc.	North Carolina State Univ.	0.8	5.8
Atm. Sc.	Ohio State Univ.	2.58	1.4
Oceanography	Old Dominion Univ.	1.27	3.2
Oceanography	Oregon State Univ.	1.59	3.8
Meteorology	Penn State Univ.	2.4	6.0
Atm. & Ocean Sc.	Princeton Univ.	1.53	2.0
Atm. Sc.	Purdue Univ.	1.47	1.0
Oceanography	Rutgers Univ.	1.58	2.6
Atm. Sc.	SUNY at Albany	1.66	2.4
Marine & Atm. Sc.	SUNY at Stony Brook	1.45	7.0
Atm. Sc.	Texas A & M Univ.	1.49	3.6
Oceanography	Texas A & M Univ.	0.89	5.2
Atm. Sc.	Univ. of Alabama Huntsville	0.58	2.8
Oceanography	Univ. of Alaska Fairbanks	0.66	2.2
Atm. Sc.	Univ. of Arizona	1.62	1.6
Atm. & Oceanic Sc.	UC – Los Angeles	2.71	4.2
Scripps Inst.	UC – San Diego	1.66	23.6
Marine Sc.	UC – Santa Barbara	1.87	3.4
Ocean Sc.	UC – Santa Cruz	1.27	2.6
Atm. & Ocean Sc.	Univ. of Colorado, Bolder	2.09	3.8
Oceanography	Univ. of Connecticut	0.97	1.4
Marine Studies	Univ. of Delaware	1.01	6.2
Oceanography	Univ. of Delaware	1.01	2.0
Marine Sc.	Univ. of Georgia	1.17	3.0
Meteorology	Univ. of Hawaii at Manoa	1.83	2.4
Oceanography	Univ. of Hawaii at Manoa	1.45	4.2
Atm. Sc.	UIUC	1.84	2.8
Marine, Estuary & Env. Sc.	UMBC	0.66	18.6
Atm. & Oceanic Sc.	Univ. of Maryland College Park	1.7	4.0
Marine & Atm. Sc.	Univ. of Miami	1.38	11.6
Atm., Oceanic & Space Sc.	Univ. of Michigan-Ann Arbor	2.76	3.4
Water Resources Sc.	Univ. of Minnesota	1.09	4.8
Atm. Sc.	Univ. of Nevada Reno	0.74	1.4
Marine Sc.	UNC at Chapel Hill	1.34	2.0
Meteorology	Univ. of Oklahoma	1.27	4.4
Oceanography	Univ. of Rhode Island	1.36	7.8
Marine Sc.	Univ. of South Florida	1.58	5.6
Marine Sc.	Univ. of Southern Mississippi	0.81	1.4
Marine Sc.	Univ. of Texas Austin	1.31	2.8
Meteorology	Univ. of Utah	1.12	2.4
Atm. Sc.	Univ. of Washington	2.2	6.6
Oceanography	Univ. of Washington	1.37	8.8
Atm. & Oceanic Sc.	Univ. of Wisconsin-Madison	1.33	4.2
Limnology & Marine Sc.	Univ. of Wisconsin-Madison	2.45	2.6
	Average US University	**1.51**	**4.95**

Vision for the next 5 years

1. Vision for the next 5 years

The vision of the Centre for Atmospheric Sciences is to lead in innovative research and educate the future leaders in atmospheric sciences for the 21st century, within the context of a premier technological research university.

Some of the questions to which the Centre seeks answers from the Review Committee are:

i. Does the vision reflect the opportunities and challenges faced by the Centre?
ii. Are the areas for growth in line with the broader trends internationally and likely to address the needs of the country?
iii. Are the goals and targets achievable?
iv. Are the benchmarking criteria adopted by us appropriate?

The Centre envisages the following mechanisms for effective changes based on feedback received for development and implementation of corrective measures: The vision document will be revamped based on the feedback from the external review process. We also plan to continue annual benchmarking based on suggested criteria.

Mission Statement

The mission of the Centre for Atmospheric Sciences is to realize the vision through building pillars of excellence in the following areas:

A. Research
B. Education and Outreach

Strategic Advantages

The strategic advantages for CAS are determined by external opportunities, strengths within IITD, and strengths internal to CAS.

External strengths include:

- High public visibility of weather, climate and air pollution issues
- A national imperative to address the issue of anthropogenic climate change through the NAPCC
- Increasing concern over management of the environment and its key renewable and non-renewable resources
- Increasing job opportunities in the atmospheric sciences, particularly in the private sector

The strengths of IITD include:

- An excellent student body, an exceptional faculty and staff, committed alumni, and others who have a vital interest in the future of the Institute

- Vigorous, dynamic research programs that produce technology and innovation, helping to drive national, and international growth
- A focused mission with a historical commitment to innovative technology and science

Internal strengths within CAS include:

- Established history of broad and relatively large external research funding
- Programmatic strengths in numerical modeling for atmospheric science and oceanography, air pollution, and climate.

Strategic Challenges

The strategic challenges for CAS are determined by external challenges, challenges within IITD, and challenges and weaknesses internal to CAS.

External challenges for atmospheric sciences include:

- Small number of high-quality graduate students
- Converting interest of high school students in environmental issues into scientific interest

Challenges within IITD include:

- Increasing competition to share inadequate Institute resources
- Need to integrate strengths in science and technology with the humanities and social sciences

Challenges within CAS:

- Faculty demographics with many professors retiring and recently recruited Assistant Professors

Goals and Strategies

In order to build excellence in the twin areas of Research and Education & Outreach, we have specific goals and strategies in order to accomplish them.

A. <u>Research:</u>

Specific goals to enhance research at the Centre are:

Goal A1: Conduct research that expands the frontiers of knowledge in atmospheric and oceanic sciences and promotes interdisciplinarity.

Goal A2: Recruit and nurture an outstanding faculty engaged in scientific research that is recognized worldwide for its excellence and impact.

Strategies to accomplish Goal A1:

1. Identify and enable *Thrust Areas* for fundamental research (*Broad application for coupled modeling to be the basis for research activity*)
   i. Mathematical & numerical formulation of models for applications in areas such as Indian monsoons, air pollution and climate.
   ii. Furthering basic understanding by using existing observing systems, planning new observations and field programs.
   iii. Understanding of processes & phenomena (For e.g. Clouds-Aerosols-Radiation-Precipitation)
   iv. Variability & Uncertainty in the context of weather and climate
   v. High-performance Computing

2. Enhance Applied Research
   i. In order to make an impact in the application of research, the prime focus needs to be in meeting societal needs. As these needs change with time, there will have to be frequent assessments of where the CAS can play a unique role. Based on current trends, the following areas have been identified:
      a. Climate change and its impacts on agriculture, water, energy and health in order to inform policy making for adaptation and mitigation research.
      b. Air quality and its relations to weather & climate
      c. Severe/Extreme weather, coastal hazards and risk
   ii. Initiate development activities and pursue excellence in key areas by
      a. Enhancing cross-disciplinary research with related areas such as computing, biological/ecological modeling, policy research, hydrology, health, etc.
      b. Strengthening collaboration with other organizations including exchange of students and researchers.

3. Establish nationally recognized research centers to foster interdisciplinary research and improve program visibility and to improve our ability to attract and direct resources.
   i. Actively pursue opportunities to establish centers funded by national funding agencies.

4. Develop the appropriate collaborations within IIT and beyond needed to respond to opportunities to establish centers. Actively encourage participation of CAS faculty in major interdisciplinary research initiatives at IIT.
   i. Target participation in developing Institute-wide initiatives in areas including energy, sustainability, scientific computing.

5. Stimulate interdisciplinary research collaborations within CAS and with other Departments/Centres/Schools.
   i. CAS faculty members give seminars to other Departments/Centres.
   ii. CAS faculty members more frequently give seminars in the Centre's Seminar series.
   iii. Invite faculty members from other Departments/Centres to give seminars in CAS.
   iv. Co-teach interdisciplinary courses.
   v. Co-advise undergraduate and graduate students.

6. Continue to raise the international profile of CAS and individual faculty members.
   i. Actively encourage organizing and participation in national and international workshops, conferences, and symposia.
   ii. Increase participation in national/international panels, advisory boards.
   iii. Increase participation in major national and international research efforts (e.g. field programs, etc.).

Targets:

1. *Establish at least one nationally recognized interdisciplinary research programme relating to climate change.*
2. *Increase external funding for sponsored research to 6 Crore per year.*
3. *Increase publication number to 3 per faculty per year.*

Strategies to accomplish Goal A2:

1. Faculty
   i. Identify areas where new faculty will be needed based on research and teaching requirements. Currently identified areas for recruitment include Geophysical Fluid Dynamics, statistical climatology, scientific computing / numerical analyst, ocean modelers, land-surface, vegetation/biological, meteorology / NWP
   ii. Establish additional named professorships for faculty

2. Postdoctoral Researchers
   i. Attract and support postdocs recruited from the top Ph. D. programs
   ii. Establish a named postdoc program
   iii. Identify funding sources for postdocs outside individual grants, through development activities and the establishment of research centers.

3. Provide State-of-Art Facilities
   i. HPC capability must be enhanced to provide computing power of the order of Petaflops.
   ii. Laboratories for research needs must be enhanced

Targets:

1. *Increase faculty strength to 20 over next five years (and 30 over the next ten years)*
2. *Attract 1 additional named Chair to the Centre.*
3. *Attract 2 additional professorships for faculty.*
4. *Establish a named postdoc program funding at least 2 postdoctoral scholars annually.*
5. *Improve computing facilities in-house and through external funding.*

B. Education and Outreach

The specific goals to achieve excellence in education and outreach activities of the Centre are:

Goal B1: To become a Department and creating an integrated M. Tech program that takes in students at the undergraduate level.

Goal B2: Enhance the profile of our M.Tech & Ph. D. students so that they are competitive with the top students from international universities.

Strategies to accomplish Goal B1:

1. Revamp Ph. D, M. Tech & minor area curricula
   i. Reflect a better mix of fundamental and advanced courses
2. Strengthen the Minor Area program by attracting more students into it early in their IIT stay.

Target:

i. Have 10 students complete Minor-Area Program in the next 2 years and 20 per year in 5 years time.

Strategies to accomplish Goal B2:

1. Increase the overall quality of the applicant pool
   i. Identify top institutions from which we would like more applicants.
   ii. Visit the identified institutions and give seminars, talk to faculty & students about programmes, and make information available.
   iii. Work towards inclusion of Atmospheric / Oceanic sciences as a separate subject in GATE.
2. Increase the selectivity of the Ph. D. program through
   i. The admissions process
   ii. The Ph. D. comprehensive exam.
3. Enhance the profile of our Ph. D. students
   i. Establish expectations of Ph. D. students
   ii. Expand the international educational and research experiences
      a. Build relationships with international universities.
      b. Encourage students to go to international meetings and summer schools
      c. Help them obtained the needed funding.
4. Implement a program to help students develop necessary skills
   i. Improve student technical writing skills
   ii. Strengthen the colloquium/seminar course
   iii. Internships for M.Tech students
5. Increase Outreach activities by
   i. Holding Conferences & Workshops
   ii. Planned Continuing Education Sessions

iii. Improving Industry interaction through
    a. Internships for students especially at the M. Tech level
    b. Placements for graduating students
    c. Associateship for people from Industry
    d. Pursuing and carrying out Industry funded research
iv. Taking on Problems of National importance

Targets:

1. *Number of Ph. D.s graduated to be increased to 8 per year in 5 years.*
2. *Applicant pool with at least half from the top national colleges and universities.*
3. *All Ph. D. students participate in some international experience.*
4. *Each Ph. D. student presents a paper at a national or international conference by the end of the 3rd year.*
5. *Each Ph. D. student submits a paper for publication in a journal by the end of the 4th year.*
6. *Establish a tie up with at least one international institution of repute to enhance experience for students.*

Annexures

Annexure I

List of Seminars (in the last five years)

Semester	Date	Speaker	Title
2012-13 – II Semester	Mar12, 2013	Prof. S. Ramachandran (PRL)	Aerosols, clouds, rainfall
	Feb 5, 2013	Dr. Pankaj Kumar (MPI)	Regional climate modeling over South Asia
2012-13 – I Semester	Dec 20, 2012	Dr. Dilip Ganguly (IITM)	Climate response of the South Asian Monsoon system to anthropogenic aerosols
	Nov 5, 2012	Dr. Toshio Yamagata (Japan)	Indian Ocean dipole and Indian Ocean modoki
	Oct 29, 2012	Dr. Anup K. Prasad	Impact of Amazonian deforestation on local hydrometeorology
	Oct 5, 2012	Dr. Pramod Kumar	Dispersion and receptor modelling of air pollutants in the atmospheric boundary layer
	Aug 22, 2012	Dr. Sai Ravela (MIT, USA	The planet in a bottle and other experiments in fluids
	Jul 26, 2012	Prof. T. N. Krishnamurti (FSU, USA)	Now casting and one-day forecast of high impact weather
	Jul 26, 2012	Dr. Kirpa Ram (Japan)	Carbonaceous aerosols: atmospheric chemistry and absorption properties over northern India
2011-12 – II Semester	Jul 13, 2012	Dr. Vasu Misra (FSU, USA)	A perspective on reanalysis
	Jun 8, 2012	Prof. V. Polnikov (Russia)	Spectral theory of wind wave dissipation
	Apr 24, 2012	Prof. Manju Mohan (IITD)	Assessment of urban heat island effect from micrometeorological observations and remote sensing data
	Apr 12, 2012	Dr. Swadhin K. Behera (Japan)	Climate predictions using SINTEX-F
	Mar 23, 2012	Dr. Tomoki Tozuka (Univ. of Tokyo, Japan)	Simulated seasonal and interannual variations of the Seychelles Dome
	Mar 16, 2012	Prof. G. J. Evans (Canada)	Every breath you take: the impacts of aerosol on air

			quality and health
	Mar 12, 2012	Prof. U. C. Mohanty (IITD)	Impact of DWR reflectivity and radial velocity on the simulation of track and intensity of tropical cyclones over Bay of Bengal
	Feb 22, 2012	Prof. S. K. Dash (IITD)	Changes in the characteristics of temperature and precipitation in India
	Feb 16, 2012	Dr. Ziad Haddad (JPL)	Combining active and passive microwave measurements from space to observe the environment
	Feb 2, 2012	Dr. K. AchutaRao (IITD)	Building a framework for weather model diagnostic
	Jan 19, 2012	Dr. S. K. Mishra (IISST)	Design and development of a unified model on Icoshedral-hexagonal grids
2011-12 – I Semester	Dec 14, 2011	Dr. F. Hourdin (France)	Numerical simulations with climate models: monsoons, convection and climate change projections
	Nov 29, 2011	Dr. Harshvardhan (Purdue Univ, USA)	Air quality in the future (and in the past)
	Nov 11, 2011	Dr. K. Mphale (Botswana)	Rainfall regime changes and trends in Kalahari transect late summer precipitation
	Nov 4, 2011	Dr. Sagnik Dey (IITD)	Decadal variability of aerosol properties over the Indian subcontinent: implications for regional climate and human health
	Oct 5, 2011	Dr. C. Gnanaseelan (IITM)	Processes of intra-seasonal sea surface temperature variability in the north Indian ocean during boreal summer
2010-11 – II Semester	July27, 2011	Dr. C. Gnanaseelan, (IITM)	Processes of intra-seasonal sea surface temperature variability in the north Indian Ocean during boreal summer
	May11, 2011	Mr. A. M. Abdelbagi (Sudan)	Assessment of pollution and source identification and apportionment in Sudan Mint company and Khartoum state aerosol
	May10, 2011	Prof. O. P. Sharma (IITD)	Modeling of aerosols in large-scale atmospheric

			flows
	Feb 23, 2011	Dr. C-J. Tsai (Taiwan)	Characterization of environmental and workplace Nano-particles
	Feb 18, 2011	Dr. S. K. Dhaka (DU)	Influence of solar cycle variation and dynamically controlled seasonal and annual variations on temperature in the tropopause region (~100 mb) during 1980-2006 over India
	Feb18, 2011	Dr. Chuen-Jinn Tsai, National Chiao Tung University	Characterization of Environmental and Workplace Nano-particles
	Feb 9, 2011	Dr. S. Ramachandran (Univ. Massachusetts, USA)	Subgrid modeling in LES: gaining insights from the subgrid conservation equations
	Feb 7, 2011	Dr. G. Bala (IISc)	Geo-engineering for climate stabilization
	Feb 7, 2011	Dr. Sanjiv Ramachandran, Dartmouth, USA	Subgrid modeling in LES: Gaining insights from the subgrid conservation equations
	Feb 2,2011	Dr. G. Bala, Divecha Centre for Climate Change	Geo-engineering for Climate Stablization, IISc
	Jan 28, 2011	Dr. Sudip Sen (UK)	On inhomogeneous flows in the atmosphere
	Jan 19, 2011	Dr. Akhilesh K. Mishra (USA)	Mixed layer ocean modeling of north Indian Ocean FSU multi-model weather research
	Jan 19,2011	Dr. Sudip Sen, Lancaster University, UK	On Inhomogeneous Flows in the Atmosphere
	Jan 12,2011	Dr. Akhilesh K Mishra, Dept. of Earth, Ocean and Atmospheric Science, Florida State University, USA	Mixed Layer Ocean Modelling of North Indian Ocean FSU Multimodel Weather Research
2010-11 – I Semester	Dec 22, 2010	Prof. T. J. Pedley (UK)	Collective behavior of swimming micro-organisms
	Dec 6, 2010	Dr. Vijaya R. Ambati (Netherlands)	Space-time discontinuous Galerkin method for water waves and currents: applications to geophysical

			flows
	Nov 10, 2010	Prof. A. D. Rao (IITD)	Prediction of water levels and extent of coastal inundation due to cyclonic storms along the Indian coast
	Nov 3, 2010	Dr. Sagnik Dey (IITD)	Aerosol characteristics over the Indian subcontinent: climatology, hot spots and implications to human health
	Oct 27, 2010	Dr. Sagnik Dey (IITD)	Aerosol-cloud interaction: a remote sensing approach
	Oct 20, 2010	Dr. M.S. Narayanan (SAC)	A training method to improve the satellite derived rainfall over Indian land mass - in the context of INSAT-3D and Megha Tropiques
	May 12, 2010	Prof. T. N. Krishnamurti, Florida State University	Seasonal Precipitation Forecast for Asia
	Mar 25, 2010	Prof. Anurag Sharma, Department of Physics	A method for Numerical Solution of Wave (Helmholtz Equation)
	Mar 23, 2010	Dr. J. P. Issartel, Centre d'Etudes du Bouchet	Multi-Point Source Identification
	Feb 25, 2010	Prof. Chandra Venkataraman, (IITB)	Aerosol source-receptor relationships in the climate context: An Indian region perspective
	Feb 25, 2010	Dr. Vinayak Sinha, Max Planck Institute for Chemistry, Germany	Measurements of Volatile Organic Compounds and OH Reactivity: Necessary Tools for Quantifying Organic Pollutants and Ozone Production Regimes
	Jan 29, 2010	Jan Polcher, LMD Paris	African Monsoon Multidisciplinary Analyses (AMMA)
	Jan 7, 2010	Dr. R. Saravanan, Texas A&M University	Hurricanes and Air-Sea Interaction
2009-10- I Semester	Aug 26, 2009	Dr. Y. Kikegawa, Meisei University, Japan	Studies on Urban Heat Island Countermeasures in Japan
	Aug 19, 2009	Dr. S. K. Dash (IIT D)	i) Eurasian snow, mid-latitude circulation and Indian summer monsoon

			(ii) Climatic changes in the Siachen glacier
	Apr 16, 2009	Dr. B. Bhaskaran, Hadley Centre, UKMO	Role of Hadley Centre in Informing Policy Making
	Mar 27, 2009	Prof. V. Ramanathan, Scripps Institution of Oceanography, UCSD	On the Scientific Understanding of the Retreat of the Himalayan Glaciers Role of Hadley Centre in Informing Policy Making
	Mar 13, 2009	Dr. George Philander, KTPG, Princeton University	How paleo-climate studies can improve global warming forecasts?
	Feb 19, 2009	Dr. S. Venkatesh, AQRD, Environment Canada, Toronto	Air Quality Modelling Research at Environment Canada: An Overview
	Jan 16, 2009	Dr. Jai Sukhatme, University of Wisconsin, Madison	Vortical and Wave Modes in Rotating and Stratified Turbulence

Annexure II

Course and Student Registration Statistics (2008-2009 onwards)

Academic Year	Semester	Courses Floated (Coordinator*)	# Students	Student/Teacher Ratio
2008-2009	I	ASL703 (SKD) ASL850 (HCU) ASL705 (UCM) ASL701 (GJ) ASL707 (MS) ASL410 (KAR) ASL710 (RCR) ASP751 (RCR)	6 1 3 8 7 52 24 3	14.8
2008-2009	II	ASL830 (PG) ASL715 (KAR) ASL706 (OPS) ASL712 (ADR) ASL808 (MM) ASL840 (UCM) ASP752 (HCU)	15 29 8 20 7 9 3	13
2008-2009	SUMMER	ASL715 (SKD)	1	1
2009-2010	I	ASL703 (SKD) ASL705 (PG) ASL701 (HCU) ASL715 (KAR) ASL803 (ADR) ASC861 (MS) ASD891 (MM) ASD892 (MM) ASL710 (RCR) ASL808 (KAR) ASP751 (RCR) ASP801 (HCU)	18 15 17 30 3 4 3 0 52 1 13 3	19.88
2009-2010	II	ASL706 (UCM) ASL830 (PG) ASL712 (ADR) ASL707 (KAR) ASL808 (MM) ASL840 (SKDu) ASD891 (MM) ASD892 (MM) ASL410 (SKD) ASP752 (OPS)	19 8 14 18 14 6 4 3 28 16	16.25
2009-2010	SUMMER	ASL803(ADR)	2	2
2010-2011	I	ASL703 (OPS) ASL705 (UCM)	19 16	18.8

		ASL701 (MS) ASL715 (KAR) ASL803 (ADR) ASL707 (GJ) ASL724 (MM) ASC861 (SKD) ASD891 (MM) ASL410 (SKD) ASL710 (RCR) ASP751 (PA & SD) ASP801 (SKDu) ASS800	17 11 13 23 14 2 15 71 37 14 10 2	
2010-2011	II	ASL706 (OPS) ASL830 (PG) ASL814 (HCU) ASL808 (MM) ASL712 (ADR) ASL813 (KAR) ASL720 (SD) ASL840 (MS) ASD891 (ADR) ASD892 (ADR) ASL410 (SKD) ASP752 (HCU) ASV887 (SKD)	14 15 0 11 12 0 12 1 5 10 77 11 37	22.78
2011-2012	I	ASL703 (OPS) ASL705 (PG & MM) ASP751 (SD) ASP801 (HCU) ASL701 (MS) ASL715 (KAR) ASL803 (ADR) ASL707 (GJ) ASL310 (SD) ASL410 (SKD) ASL710 (UCM) ASC861 (OPS) ASD891 (ADR) ASV889 (SKD)	19 15 14 11 16 25 7 19 91 99 22 12 11 41	36.55
2011-2012	II	ASL830 (UCM) ASL706 (OPS) ASL808 (MM) ASL712 (ADR) ASL840 (MS) ASL720 (SD) ASL320 (KAR) ASL410 (SKD) ASL710 (RCR)	23 15 14 29 5 234 80 239 66	59

		ASD892 (ADR) ASP752 (HCU) ASV873 (ADR) ASV887 (SKD) ASL721 (PG)	10 12 45 41 13	
2012-2013	I	ASL703 (OPS) ASL705 (MM & PG) ASP751 (PA) ASP801 (HCU) ASL701 (MS) ASL715 (KAR) ASL803 (ADR) ASL707 (RCR) ASL310 (SD & SKM) ASL819 (SKD) ASL710 (UCM) ASC861 (SKD) ASD891 (ADR) ASV874 (SKD) ASV889 (SKD) ASL879 (SD)	29 19 16 11 17 27 4 49 186 14 34 11 11 24 15 3	29.4
2012-2013	II	ASL830 (PG) ASL706 (OPS) ASL808 (MM) ASL712 (ADR) ASL720 (SD) ASL410 (SKD & SKM) ASL840 (MS) ASL320 (KAR) ASL816 (RCR) ASL710 (VP) ASD891 (ADR) ASD892 (ADR) ASP752 (HCU) ASS800 (SD) ASV875 (SKD) ASV889 (SKD)	10 20 16 41 234 243 3 66 34 91 1 11 15 2 65 58	69
2012-2013	SUMMER	ASL883 (DG)	5	5
2013-2014	I	ASL701 (MS) ASL703 (OPS) ASL705 (PG & MM) ASL707 (DG) ASL715 (KAR) ASL803 (ADR) ASL310 (SD & DG) ASL410 (SKM & SKD)	25 28 25 57 17 7 122 92 83	37

		ASL710 (VP) ASC861 (SKD) ASD891 (ADR) ASD892 (ADR) ASL751 (PA & VP) ASP801 (HCU)	19 13 1 16 13	
2013-2014	II (Ongoing)	ASL706 (OPS & DG) ASL808 (MM) ASL830 (PG) ASL712 (ADR) ASL720 (SD) ASL410 (SKM & SKD) ASL320 (KAR) ASL710 (VP) ASD892 (KAR) ASP752 (HCU)	17 20 48 99 96 102 97 99 12 13	60.3

**Coordinators:*
Prof. O. P. Sharma (OPS)
Prof. S. K. Dash (SKD)
Prof. MaithiliSharan (MS)
Prof. S. K. Dube (SKDu)
Prof. G. Jayaraman (GJ)
Prof. U. C. Mohanty (UCM)
Prof. A. D. Rao (ADR)
Prof. Pramila Goyal (PG)
Prof. Manju Mohan (MM)
Dr. H. C. Upadhyaya (HCU)
Dr. K. AchutaRao (KAR)
Dr. Sagnik Dey (SD)
Dr. Saroj K. Mishra (SKM)
Dr. Vimlesh Pant (VP)
Dr. Dilip Ganguly (DG)
Dr. P. Agarwal (PA)
Dr. R. C. Raghava (RCR)

Annexure III

Sr. No.	Name	Area (sq. ft)
1	Faculty Space	2280.00
2	Research Lab	1933.85
3	PG Teaching Lab	1318.80
4	Utility Space	1062.00
5	Ph. D. Student Space	1360.00
6	M.Tech Student Space	657.00
	Total	8611.65

Annexure IV

Research Publication by CAS faculty and Students

Year 2014

1. Tiwari, P., S. C. Kar, U. C. Mohanty, S. Kumari, P. Sinha, A. Nair and S. Dey, 2013: Skill of precipitation prediction with GCMs over North India during winter season, International Journal of Climatology, (accepted).

2. Verdhen Anand., Bhagu Ram Chahar, and O.P. Sharma, 2013: Spring Time Snowmelt and Streamflow Predictions in the Himalayan Mountain. ASCE's Journal of Hydrologic Engineering (Accepted for publication).

3. Anikender Kumar and P.Goyal, 2014: "Air Quality Prediction of PM10 thorough Analytical Dispersion Model for Delhi", Aerosol and Air Quality Research, (Accepted for publication)

4. Manju Mohan, Anuj Gupta and Shweta Bhati, 2014: A Modified Approach to Analyse Thermal Comfort Classification, Atmospheric and Climate Sciences, Issue 4, pages 7-19.

5. S. Das, S. Dey and S. K. Dash, 2014: Inter-annual variations in natural and anthropogenic aerosol loadings over the seas adjoining India using a hybrid approach, Atmospheric Science Letters. 15: 58–64.

Year 2013

6. S. K. Dash, Vaishali Saraswat, S. K. Panda and Neha Sharma, 2013: A study of changes in rainfall and temperature patterns at four cities and corresponding meteorological subdivisions over coastal regions of India, Global and Planetary Change, 108, 175–194.

7. S.K.Singh and Maithili Sharan, 2013: Simulation of Plume Dispersion from Single release in Fusion Field Trial-07 Experiment. Atmospheric Environment, 47, 50-57.

8. S.K.Singh, Maithili Sharan and J.P Issartel, 2013: Inverse Modelling for Identification of Multiple-Point Releases from Atmospheric Concentration Measurements, Boundary Layer Meteorology 146, 277-295.

9. K. M. Mphale, S. K. Dash, A. Adedoyin and S. K. Panda, 2013: Rainfall regime changes and trends in Botswana Kalahari Transects late summer precipitation, Theoretical and Applied Climatology, DOI 10.1007/s00704-013-0907-z.

10. Stefano Cozzini, Deepika Vaddi, Savita Goel, Francesco De Giorgi and S. K. Dash, 2013: Regional Climate Simulations on EU-INDIA Grid Infrastructures:

Methodologies and Performance, J. Grid Computing, DOI 10.1007/s10723-013-9286-z.

11. K. C. Pattnayak, S. K. Panda and S. K. Dash, 2013: Comparative study of regional rainfall characteristics simulated by RegCM3 and recorded by IMD, Global and Planetary Change, 106, 111–122.

12. A. Gupta, S. K. Dhaka, V. Panwar, R. Bhatnagar, V. Kumar, Savita M. Datta and S. K. Dash, 2013: AIRS satellite observations of seasonal variability in meridional temperature gradient over Indian region at 100hPa, Journal of Earth System Science, 122(1), 285-213.

13. S. K. Dash, Dipak K. Sahu and S. C. Sahu, 2013: Impact of AWS observations in WRF-3 DVAR data assimilation system: A case study on abnormal warming condition in Odisha, Natural Hazards, 65(1), 767-798.

14. A D Rao, Mourani Sinha, Sujit Basu, 2013: Bay of Bengal wave forecast based on genetic algorithm: a comparison of univariate and multivariate approaches, Applied Mathematical Modelling, DOI.org/10.1016/j.apm.09.001.37, 4232-4244.

15. P.Goyal, Anikender Kumar and Dhirendra Mishra, 2013: "The impact of air pollutants and meteorological variables on visibility in Delhi" Environmental Modeling and Assessment, DOI: 10.1007/S10666-013-9380-4.

16. Anikender Kumar and Pramila Goyal, 2013: Forecasting of air quality index in Delhi using neural network based on principal component analysis, Pure and Applied Geophysics, 170, 711-722.

17. Pramila Goyal, Dhirendra Mishra and Anikender Kumar, 2013: Emissions of criteria pollutants from vehicular traffic in Delhi, Journal of Environmental Research and Development 7 (4A), 1693-1702.

18. Pramila Goyal, Dhirendra Mishra and Anikender Kumar, 2013: Vehicular emission inventory of criteria pollutants in Delhi, SpringerPlus 2, 216.

19. Collins, M., AchutaRao, K., Ashok, K., Bhandari, S., Mitra, A. K., Prakash, S., Srivastava, R., Turner, A., 2013: Observational challenges in evaluating climate models, Nature Clim. Change 3 (11), 940-941, doi:10.1038/nclimate2012

20. Manju Mohan, Yukihiro Kikegawa, B.R. Gurjar, Shweta Bhati and Narendra Reddy Kolli, 2013: Assessment of Urban Heat Island Effect for Different Landuse - Landcover from Micrometeorological Measurements and Remote Sensing Data: A Case Study for Megacity Delhi. Theoretical and Applied Climatology, Volume 112, Issue 3-4, DOI: 10.1007/s00704-012-0758-z.

21. Medhavi Gupta and Manju Mohan, 2013: Assessment of contribution to PM10 concentrations from long range transport of pollutants using WRF/Chem over a subtropical urban airshed, Atmospheric Pollution Research, volume 4, Issue 4, Pages 405-410, doi: 10.5094/APR.2013.046.

22. Sengupta, K., S. Dey and M. Sarkar, 2013: Structural evolution of monsoon clouds in the Indian CTCZ region, Geophysical Research Letters, 40, 5295–5299.

23. S. Das, S. Dey, S. K. Dash and G. Basil, 2013: Examining mineral dust transport over the Indian subcontinent using the regional climate model, RegCM 4.1, Atmospheric Research, 134, 64-76.

24. Singh Devendra, Vimlesh Pant, A. K. Kamra, 2013: Temperature-dependence of the positive intermediate ion concentrations at Maitri, Antarctica, Journal of Atmospheric and Solar-Terrestrial Physics, 104, 67-74.

25. K. Evans, P. Lauritzen, S. K. Mishra, R. Neale, M. A. Taylor, and J. J. Tribbia, 2013: AMIP Simulation with the CAM4 Spectral Element Dynamical Core. Journal of Climate, 26, 689 – 709.

26. S. Verma, O. Boucher, H. C. Upadhyaya, and O. P. Sharma, 2013: Variations in sulphate aerosols concentration during winter monsoon season for two consecutive years using a general circulation model. Atmosfera, Vol. 26, 3, 359-367.

27. Routray A.,U. C. Mohanty, Krishna K. Osuri, and S. Kiran Prasad (2013): Improvement of Monsoon Depressions Forecast with Assimilation of Indian DWR Data Using WRF-3DVAR Analysis System, Pure Appl. Geophys, DOI 10.1007/s00024-013-0648-z.

28. Acharya, N., S Chattopadhyay, U C Mohanty, S K Dash and L N Sahoo, 2013: On the bias correction of general circulation model output for Indian summer monsoon, Meteorol. Appl., 20, 349-356.

29. Sinha P., Mohanty U. C., Kar S. C., Dash S. K., and S Kumari (2013): Sensitivity of the GCM driven summer monsoon simulations to cumulus parameterization schemes in nested RegCM3, Theoretical and Applied Climatology, 112:285-306.

30. Acharya, N, Singh A., Nair A, Mohanty U.C., Chattopadhayay S (2013): Performance of General Circulation Models and their ensembles for prediction of drought indices over India during summer monsoon, *Natural Hazard* Volume 66(2): 851-871.

31. Nair A, Acharya, N, Singh A., Mohanty U.C. and Panda T.C. (2013): On the predictability of northeast monsoon rainfall over south peninsular India in General Circulation Models, *Pure and applied Geophysics,* DOI 10.1007/s00024-012-0633-y.

32. Mohanty U.C, N Acharya, Ankita Singh, Archana Nair, M.A. Kulkarni, S.K. Dash, S.C. Kar, A.W. Robertson, A.K. Mitra, L.S. Rathore, K.K. Singh, D.R. Pattanaik, Dalip Singh , SurajitChattopadhyay, R.K. Rai, M.M.N Rao, P.Sinha, A.K. Mishra and R.K. Pal. (2013): Real-time Experimental Extended Range Forecast System (ERFS) for Indian summer Monsoon Rainfall: A case study for Monsoon 2011. *Current Science 104(7),* 856-870.

33. Acharya, N, Mohanty U.C, Sahoo L.N. (2013): Probabilistic Multi-Model Ensemble Prediction of Indian Summer Monsoon Rainfall using General Circulation Models: A non-parametric approach, *Comptes Rendus Geoscience*, 345, 126–135.

34. Acharya N , Kulkarni M.A., Mohanty U.C. and Singh A (2013): Performance of two version of NCEP Climate Forecast System for predicting Indian summer monsoon rainfall: comparison study, *Acta Geophysica*, Vol. 62 Issue 1, p199.

35. Nair A., U.C.Mohanty and AW Robertson (2013): An analytical study of hindcasts from General Circulation Models for Indian Summer Monsoon Rainfall, *Meteorological Applications*, DOI: 10.1002/met.1395.

36. Acharya, N., S.Chattopadhyay, U.C. Mohanty and K.Ghosh (2013): Prediction of Indian Summer Monsoon Rainfall: a weighted multi-model ensemble to enhance probabilistic forecast skills, *Meteorological Applications,* DOI:10.1002/met.1400.

37. Thomas L., S.K. Dash, U.C. Mohanty (2013): Influence of various land surface parameterization schemes on the simulation of Western Disturbances. *Meteorological Applications*. DOI: 10.1002/met.1386.

38. Sinha P., Mohanty U. C., Kar S. C. and S. Kumari (2013): Role of the Himalayan Orography in Simulation of the Indian Summer Monsoon using RegCM3, Pure Appl. Geophys. Springer Basel, DOI 10.1007/s00024-013-0675-9.

39. Nair, A., U C Mohanty, and N. Acharya, 2013: Monthly prediction of rainfall over India and its homogeneous zones during monsoon season: a supervised principal component regression approach on general circulation model products, Theor. Appl. Clim., 111, 327-339.

40. P. Sinha, U. C. Mohanty, S. C. Kar, S. K. Dash, A. W. Robertson and M. K. Tippett (2013): Seasonal prediction of the Indian summer monsoon rainfall using canonical correlation analysis of the NCMRWF global model products, Int. J. Climatol. 33: 1601–1614.

Year 2012

41. P. Parth Sarthi, S. K. Dash & Ashu Mamgain, 2012: Possible changes in the characteristics of Indian Summer Monsoon under warmer climate, Global and Planetary Change, (92-93), 17-29.

42. Manish Modani and Maithili Sharan, 2012: A Model for the simulation of crosswind integrated concentrations in the surface-based inversion layer. Int. J. Model. Simul. and Sci Comput 3, doi: 10.1142/S1793962312500171.

43. A. P. Dimri and S. K. Dash, 2012: Wintertime climatic trends in western Himalayas, Climatic Change, 111(3), 775-800.

44. S. K. Dash, Neha Sharma, K. C. Pattnayak, X. J. Gao and Y. Shi, 2012: Temperature and precipitation changes in the north-east India and their future projections, Global and Planetary Change, 98-99, 31-44.

45. A.K. Srivastava, S. N. Tripathi, S Dey, V. P. Kanawade and S. Tiwari, 2012: "Inferring aerosol types over the Indo-Gangetic Basin from ground based sunphotometer measurements", Atmospheric Research, 109-110, 64-75.

46. P. J. Gleckler, B. D. Santer, C. M. Domingues, D. W. Pierce, T. P. Barnett, J. A. Church, K. E. Taylor, K. M. AchutaRao, T. P. Boyer, M. Ishii & P. M. Caldwell 2012: "Human-induced global ocean warming on multidecadal timescales" Nature Climate Change 2, 524-529, doi:10.1038/nclimate1553.

47. Madhu Joshi, Rao, A. D. 2012: "Response of southwest monsoon winds on shelf circulation off Kerala coast, India ",Continental Shelf Research, doi: 10.1016/j.csr.2011.10.015

48. Manju Mohan and Shweta Bhati, 2012: Wind Flow Conditions as an Indicator to Assimilative Capacities of Urban Airsheds towards Atmospheric Pollution Potential. J. Civil Environ. Eng. 2012, S:1003. Doi: 10.4172/2165-784X.S1-003

49. Kikegawa,Y., Y. Ishizaka, K. Hokari, Manju Mohan, B. R. Gurjar, 2012: Study on the structure of surface air temperature distribution and potential of heat island countermeasures in Delhi under dry climate, Journal of the Japan Society of Civil Engineers Division G: Environmental Systems and Engineering, 67, pp.II_315-II_326.

50. Manju Mohan, Yukihiro Kikegawa, B.R. Gurjar, Shweta Bhati, Anurag Kandya and Koichi Ogawa, 2012: Urban Heat Island Assessment for a Tropical Urban Airshed in India, Atmospheric and Climate Sciences, 2012, Volume 2, pages 127-138. doi:10.4236/acs.2012.22014.

51. Ajit Singh and S. Dey, 2012: Influence of aerosol composition on visibility in megacity Delhi, Atmospheric Environment, 62, 367-373.

52. Pramod Kumar and Maithili Sharan, 2012: Parameterization of the eddy diffusivity in a dispersion model over homogeneous terrain in the atmospheric boundary layer. Atmospheric Research, 106, 30-43.

53. J.P.Issartel, Maithili Sharan and S.K.Singh, 2012: Identification of a point release by use of optimally weighted least squares, Pure and Applied Geophysics, 169, 467-482.

54. Maithili Sharan, S.K.Singh and J.P.Issartel, 2012: Least square data assimilation for identification of the point-source emissions, Pure and Applied Geophysics, 169, 483-497.

55. Panda J., and Maithili Sharan, 2012: Influence of land-surface and turbulent parameterization schemes on regional-scale boundary layer characteristics over northern India. Atmospheric Research, 112, 89-11.

56. Pramod Kumar and Maithili Sharan, 2012: An analysis for the applicability of Monin-Obukhov similarity theory in stable conditions. J.Atmos.Sci., 69, 1910-15.

57. Maithili Sharan, J.P.Issartel and S.K.Singh, 2012: A point-source reconstruction from concentration measurements in low wind stable conditions, Q.J.Roy. Meteorol. Soc., 138:000-000.DOI:10.1002/qj.1921.

58. Dey, S., L. Di Girolamo, A. van Donkelaar, S. N. Tripathi, T. Gupta and M. Mohan, Variability of outdoor fine particulate matters (PM2.5) in the Indian Subcontinent: a remote sensing approach", 2012: Remote Sensing of Environment, 127, 153–161.

59. Singh, A., M A Kulkarni, U. C. Mohanty, S. C. Kar, A. W. Robertson, and G. Mishra, 2012: Prediction of Indian summer monsoon rainfall (ISMR) using canonical correlation analysis of global circulation model products, Meteorol. Appl., 19, 179–188. doi: 10.1002/met.1333179-188.

60. Krishna K. Osuri, Mohanty U.C., Routray A., Makarand A. Kulkarni, Mohapatra M., 2012: Customization of WRF-ARW model with physical parameterization schemes for the simulation of tropical cyclones over North Indian Ocean; Natural Hazards, 63, 1337-1359, DOI 10.1007/s11069-011-9862-0.

61. Litta, A. J., U. C. Mohanty, S. Das and S. M. Idicula, 2012, Numerical simulation of severe local storms over east India using WRF-NMM mesoscale model, Atmos. Res., 116, 161-184.

62. Litta, A. J., U. C. Mohanty and S. M. Idicula, 2012: The diagnosis of severe thunderstorms with high resolution WRF model, J. Earth Sys. Sc., 121, 297-316.

63. Osuri, K K, U C Mohanty, A Routray and M Mohapatra, 2012: The impact of satellite-derived wind data assimilation on track, intensity and structure of tropical cyclones over the north Indian Ocean, Int. J. Rem. Sens., 33 (5), 1627-1652.

64. Kar, S C, N. Acharya, U C Mohanty and M A Kulkarni, 2012: Skill of monthly rainfall forecasts over India using multi-model ensemble schemes, Int. J. Clim., 32(8), 1271-1286.

65. Pattanayak, S., U C Mohanty and K Kosuri, 2012: Impact of parameterization of physical processes on simulation of track and intensity of tropical cyclone Nargis (2008) with WRF-NMM Model, The Scientific World Journal. 2012, Article ID 671437,18 pages doi: 10.1100/2012/671437

66. Acharya, N., S Chattopadhyay, M A Kulkarni and U C Mohanty, 2012: A neurocomputing approach to predict monsoon rainfall in monthly scale using SST anomaly as a predictor, Acta Geophys., 60, 260-279.

67. Mohapatra, M, GS Mandal, BK Bandyopadhyay, A Tyagi, UC Mohanty, 2012: Classification of cyclone hazard prone districts of India, Natural Hazards, 63, 1601-1620.

68. Litta, A. J., S M Idicula, U C Mohanty and S K Prasad, 2012: Comparison of thunderstorm simulations from WRF-NMM and WRF-ARW models over East Indian region, The Scientific World Journal, 2012 Article ID 951870, 20 pages http://dx.doi.org/10.1100/2012/951870

69. Mohanty, U C, K K Osuri, S Pattanayak and P. Singha, 2012: An observational perspective on tropical cyclone activity over Indian seas in a warming environment, Natural hazards, 63, 1319-1335.

70. Raju, PVS, J Potty, UC Mohanty, 2012: Simulations of Severe Tropical Cyclone Nargis over the Bay of Bengal Using RIMES Operational System, Pure and Applied Geophysics, 169, 1909-1920, DOI: 10.1007/s00024-011-0426-8.

71. Mohanty, U C, A Routray, K Kosuri and S Kiran Prasad, 2012: A study on simulation of heavy rainfall events over Indian region with ARW 3DVAR modelling system, Pure and Appl. Geophys., 169(3), 381-399.

72. Kulkarni, M A, N Acharya, S C Kar, U C Mohanty, M K Tippett, A W Robertson, J-J Luo and T. Yamagata, 2012: Probabilistic prediction of Indian summer monsoon rainfall using global climate models, Theor. Appl. Clim., 107, 441-450.

73. Kulkarni, A Singh and U C Mohanty, 2012: Effect of spatial correlation on regional trends in rain events over India, Theor Appl. Clim., 109, 497-505.

74. Mohanty, U C, D Niyogi and K V J Potty, 2012: Recent developments in tropical cyclone analysis using observations and high resolution models, Natural Hazards, 63, 1281-1283.

75. Anikender Kumar and P.Goyal, 2012: "Analytical Models for pollutants dispersion released from point, line and area sources in atmospheric boundary layer", Journal of Environmental Research And Development 7, 131-139.

76. Rao A D, D. K. Mahapatra, S. V. Babu and Smita Pandey, 2012: Spatial-temporal variation and mechanism associated with mini-cold pool off the southern tip of India during summer and winter monsoon season, Water Quality Research Journal of Canada, 47.3-4.

77. Sinha Mourani, A D Rao, Sujit Basu, 2012: Forecasting space–time variability of wave heights in the Bay of Bengal: a genetic algorithm approach, Journal of OceanographyDOI.org/10.1007/s10872-012-0154-4,68,5.

78. Rao A D, P. L. N. Murty, Indu Jain , R. S. Kankara, S K Dube, T. S. Murty, 2012: Simulation of water levels and extent of coastal inundation due to a cyclonic storm along the east coast of India", Nat Hazards, DOI 10.1007/s11069-012-0193-6.

Year 2011

79. S. K. Dash and Ashu Mamgain, 2011: Changes in the Frequency of Different Categories of Temperature Extremes in India, Journal of Applied Meteorology and Climatology, 50, 1842-1858, DOI: 10.1175/2011JAMC2687.1.

80. S. K. Dash and T. Kjellstrom, 2011: Workplace heat stress in the context of rising temperature in India, Current Science, 101(4), 496-503.

81. Fatima, Hashmi; Upadhyaya, H. C.; Tripathi, S. N.; Sharma, O. P.; Yu, Fangqun, 2011: On radiative forcing of sulphate aerosol produced from ion-promoted nucleation mechanisms in an atmospheric global model: Meteorology and Atmospheric Physics, Volume 112, Issue 3-4, pp. 101-115.

82. Babu, S. and Rao, A. D., 2011: Mixing in the surface layers in association with internal waves during the winter in the northwestern Bay of Bengal, Nat. Hazards, 57, 557-595.

83. S. L. Waters, J Alastruey , D A. Beard , P H.M. Bovendeerd , P. F. Davies ,Girija Jayaraman, O. E. Jensen , J. Lee , K.H.Parker, A S. Popel, Timothy W. Secomb , M. Siebes, Spencer N.P. Smith, F.N.van de Vosse, 2011: Theoretical models for coronary vascular biomechanics: progress and challenges, Progress in Biophysics and Molecular Biology,104, 49-76

84. Raju P.V.S., Potty K.V.J. and Mohanty U.C., 2011: Sensitivity of physical parameterizations on prediction of tropical cyclone Nargis over the Bay of Bengal using WRF model, Meteorology and Atmospheric Physics, DOI 10.1007/s00703-011-0151-y.

85. Pattanayak S., Mohanty U.C. and Gopalakrishnan S.G., 2011: Simulation of very severe cyclone Mala over Bay of Bengal with HWRF modeling System, Natural Hazards, DOI 10.1007/s11069-011-9863-z.

86. N. Acharya, S. C. Kar, M. A. Kulkarni, U. C. Mohanty and L N Sahoo, 2011: Multi-model ensemble schemes for predicting northeast monsoon rainfall over peninsular India, J. Earth Sys. Sci., 120, 795-805.

87. Maithili Sharan and Pramod Kumar, 2011: Estimation of Upper Bounds for the Applicability of Nonlinear Similarity Functions in the Atmospheric Surface Layer in Very Stable Conditions. Proc Royal Society A 467, 473-494 (Royal Society London).

88. Upadhyaya, H. C., Sharma, O. P., Mittal, R. and Fatima, H., (2011), Icosahedral-hexagonal grids on a sphere for CFD applications. Asia-Pacific Journal of Chemical Engineering, 6(1), Jan/Feb 2011, pp.110 - 119, DOI:10.1002/apj.479.

89. Acharya Nachiketa, Kar S.C., Mohanty U.C., Kulkarni Makarand A. and Dash S.K., 2011: Performance of GCMs for seasonal prediction over India - a case study for 2009 monsoon, Theor. Appl. Climatol, 105, pp.505-520.

90. Manju Mohan, Shweta Bhati, Archana Sreenivas, Pallavi Marrapu: 2011: Performance Evaluation of AERMOD and ADMS-Urban for Total Suspended Particulate Matter Concentrations in Megacity Delhi, 2011: Aerosols and Air Quality Research, Volume 11, Pages 883-894, doi: 10.4209/aaqr.2011.05.0065

91. Manju Mohan, S. K. Pathan, Narendrareddy K., Anurag Kandya and Suchita Pandey, 2011: Dynamics of Urbanization and its Impact on Land-Use/Land-Cover: A Case Study, of Megacity Delhi, Journal of Environmental Protection, Vol. 2 No. 9, pp. 1274-1283. doi: 10.4236/jep.2011.29147.

92. Manju Mohan, Anurag Kandya and B. Arunachalam, 2011: Urban Heat Island Effect over National Capital Region of India: A Study using the Temperature Trends, Journal of Environmental Protection, 2, doi:10.4236/jep.2011.24054

93. Manju Mohan and Shweta Bhati, 2011: Analysis of WRF model performance over subtropical region of Delhi, India. Advances in Meteorology, Volume 2011, Article ID 621235, 13 pages (doi:10.1155/2011/621235)

94. Suresh Tiwari, Swagata Payra, Manju Mohan, Sunita Verma, Deewan Singh Bisht, 2010: Visibility Degradation during Foggy Period due to Anthropogenic Urban Aerosol at Delhi, India. Atmospheric Pollution Research, 2011, Volume 2, Pages 116-120, doi: 10.5094/APR.2011.014.

95. Anikender Kumar and P.Goyal. 2011: Forecasting of air quality index in Delhi using principal component regression technique. Atmospheric Pollution Research, 2 436-444.

96. Anikender Kumar and P.Goyal, 2011: "Forecasting of daily air quality index in Delhi", Science of the Total Environment 409, 5517-5523 (2011).

97. Bhatla R., Raju P.V.S., Mohanty U.C., Madan O.P. and Mall R.K., 2011: Study of Energy Fluxes over the Indian Ocean Prior and During the Summer Monsoon, Marine Geodesy, 34, pp.119-137

98. Dey, S. and L. Di Girolamo (2011), A decade of change in aerosol properties over the Indian Subcontinent, Geophysical Research Letters, 38, L14811, doi:10.1029/2011GL048153.

99. Dey, S., L. DI Girolamo, G. Zhao, A. L. Jones and G. McFarquhar (2011), Satellite-derived observed relationships between aerosol and trade-wind cumulus cloud properties over the Indian Ocean, Geophysical Research Letters, 38, L01804, doi:10.1029/2010GL045588.

100. Jai Devi, J. S. N. Tripathi, T. Gupta, B. Singh, V. Gopalakrishnan and Sagnik Dey (2011), Observation-based 3-D view of aerosol radiative properties over Indian Continental Tropical Convergence Zone: Implications to regional climate, Tellus, 63B, 971-989.

101. Idicula, SM, AJ Litta, UC Mohanty, 2011: A Comparative Study of Convective Parameterization Schemes in WRF-NMM Model , International Journal of Computer Applications 33 (6), 32-40

102. Dash, SK, AA Nair, MA Kulkarni, UC Mohanty, 2011: Characteristic changes in the long and short spells of different rain intensities in India, Theoretical and Applied Climatology 105 (3), 563-570

103. Raju, PVS, R Bhatla, UC Mohanty, 2011: A study on certain aspects of kinetic energy associated with western disturbances over northwest India, Atmósfera 24 (4), 375-384.

104. Kulkarni, MA, N Acharya, SC Kar, UC Mohanty, MK Tippett, AW Robertson, JJ Luo, 2012: Probabilistic prediction of Indian summer monsoon rainfall using global climate models, Theoretical and Applied Climatology, 107, 441-450.

Year 2010

105. Raj Rani and Girija Jayaraman, 2010, A minimal model for plankton dynamics in Shallow Coastal Lagoons Chilika Lagoon, A Case Study, Int. Journal of Emerging Multidisciplinary Fluid Sciences, 2, 123-141.

106. Rao, AD, Madhu Joshi, Indu Jain and M Ravichandran, 2010, Response of surface water in the eastern Arabian Sea to tropical cyclones, Estuarine, Coastal and Shelf Science, 89, 267-276.

107. Rao, AD, 2010, Variability of Coastal ocean process along the west coast of India, Indian Journal of Marine Sciences, 39, 475-484.

108. Girija Jayaraman, 2010, Mathematical Challenges in modeling the cardiovascular flows and associated clinical procedures, The Mathematics Student, 79, 61-76.

109. Indu Jain, A D Rao and K J Ramesh, 2010, Vulnerability Assessment at Village Level due to Tides, Surges and Wave Setup, Marine Geodesy, 33, 245-260.

110. Jain Indu, A D Rao, V Jitendra and S K Dube, 2010, Computation of Expected total water levels along the east coast of India, Journal of Coastal Research, 26, 681-687

111. Ashu Mamgain, S. K. Dash and P. Parth Sarthi, 2010, Characteristics of Eurasian snow depth with respect to Indian Summer Monsoon Rainfall, Meteorol Atmos Phys, 110, DOI 10.1007/s00703-010-0100-1, 71-83.

112. Mandal M. and Mohanty U.C., 2010, Simulation of Severe Land-Falling Bay of Bengal Cyclones During 1995-1999 Using Mesoscale Model MM5, Marine Geodesy, 33, 315-337

113. Mohanty U.C., Krishna K. Osuri, Routray A., Mohapatra M. and Pattanayak Sujata, 2010: Simulation of Bay of Bengal Tropical Cyclones with WRF Model: Impact of Initial and Boundary Conditions, Marine Geodesy, 33, pp.294-314

114. Mohanty U.C., Pattanayak Sujata and Krishna K. Osuri, 2010: Changes in Frequency and Intensity of Tropical Cyclones over Indian Seas in a Warming Environment, Disaster & Development, Vol. 4, pp.53-77

115. Manju Mohan, Shweta Bhati and Archana Rao, 2010: Application of Air Dispersion Modelling for Exposure Assessment from Particulate Matter Pollution in Megacity Delhi, Asia Pacific Journal of Chemical Engineering, 6(1), DOI:10.1002/apj.468.

116. Manju Mohan and B.R. Gurjar, 2010: Sensitivity Analysis of Probits with respect to Quantitative Risk Assessment of Airborne Toxic Chemicals using IITD-QRA Model. International J. of Environment and Waste Management, Volume 6, Nos 3/4 pp 345-355, DOI: 10.1504/IJEWM.2010.035067.

117. Manju Mohan, A. Kandya, and M. Yadav, 2010: Air Quality Index Estimations From Measurements and Statistical Modelling Techniques Over Delhi. International J. of Environmental Protection, 2011, Volume 44. Numbers 1-2, pp. 96-105(10).

118. P.Goyal, Neeru Jaiswal, Anikender Kumar, J.K. Dadoo and M. Dwarakanath. 2010: Air quality assessment of NOx and PM due to diesel vehicles in Delhi. Transport. Res. Part D, 15, 298- 303.

119. P.Goyal, and Neeru Jaiswal, 2010: "Effects of meteorological parameters on RSPM concentration in urban Delhi", Int. J. of Environment and Waste Management 5 (3/4), 237-251.

120. Poornima Agarwal and Avnish Kumar, 2010: Short range atmospheric dispersion measurements from ground level source under tropical conditions, Our-Earth, 7, 3-7.

121. Pramod Kumar and Maithili Sharan. 2010: An analytical model for dispersion of pollutants from a continuous source in the atmospheric boundary layer. Proc Royal Society A, 466, 383-406.

122. Prasad K., Dash S.K. and Mohanty U.C., 2010: A logistic regression approach for monthly rainfall forecasts in meteorological subdivisions of India based on DEMETER retrospective forecasts, Int. J. Climatol. 30, pp.1577-1588

123. Raju P.V.S., Mohanty U.C., Hsu H.H., 2010: A Study on drought features of the Indian summer monsoon 2002, Meteorology and Applied Physics 108, 43-55.

124. Routray A., Mohanty U.C., Rizvi S.R.H., Niyogi Dev, Krishna K. Osuri and Pradhan D., 2010: Impact of Doppler weather radar data on numerical forecast of Indian monsoon depressions, Q.J.R.Meteorol. Soc, DOI:10.1002/qj.678

125. Litta, AJ, UC Mohanty, SC Bhan, 2010: Numerical simulation of a tornado over Ludhiana (India) using WRF-NMM model, Meteorological Applications 17, 64-75.

126. Routray, A, UC Mohanty, D Niyogi, SRH Rizvi, KK Osuri, 2010: Simulation of heavy rainfall events over Indian monsoon region using WRF-3DVAR data assimilation system, Meteorology and Atmospheric Physics 106 (1), 107-125.

127. Senthil, G., G. Jayaraman and A. D. Rao, 2010: A variable boundary method for modeling two dimensional free surface flows with moving boundaries, Appl. Mathematics and Computation, 216, 2544-2558.

128. Rao A D, Babu S. V., K V S R Prasad, T V Ramana Murty, Y Sadhuram and D K Mahapatra, 2010: Investigation of generation and propagation of low frequency internal waves: A case study for the east coast of India, Estuarine, Coastal and Shelf Science, 88, 143-152.

129. Hareesh Kumar P V, S Lekshmi, P S V Jagadeesh, K Anil Kumar, G V Krishna Kumar and A D Rao, 2010: Internal Tides in the CoastalWaters of NE Arabian Sea: Observations and Simulations" Marine Geodesy, 33: 232–244.

130. Sinha P C, G K Jena, Indu Jain, **A D Rao** and Mohd Lokman Husain, "Numerical modelling of tidal circulation and sediment transport in the Gulf of Khambhat and Narmada Estuary, west coast of India", Pertanika Journal of Sci. & Technology, 18, 2, 293-302.

131. Rao A D, Indu Jain and R Venkatesan, "Estimation of extreme water levels due to cyclonic storms: a case study for Kalpakkam coast", International Journal of Ocean and Climate Systems, Vol 1, 1-14.

Year 2009

132. Jayaraman, G., P. Nagarani and G. Sarojamma, 2009, Effect of boundary absorption on dispersion in Casson fluid flow in an annulus – Application to catheterized artery, doi:/10.1007/s00707-008-0013-y Acta Mechanica 202, 47-52.

133. Dash, S. K., M. A. Kulkarni, U. C. Mohanty and K. Prasad, 2009: Changes in the characteristics of rain events in India, J. Geophys. Res. 114, D10109, doi:10.1029/2008JD010572.

134. Saji, M., S. K. Dash and P. K. Mohanty, 2009: Indian summer monsoon simulation studies with different orographic representations in a spectral GCM, Int. J. Climatol. 29, 269-288.

135. Manju Mohan, Shweta Bhati and Pallavi Marrapu, 2009: Performance Evaluation of AERMOD and ADMS Urban Models in a Tropical Urban Environment. Indian J. of Air Pollution Control, Volume IX, No.1, pp 47-62.

136. Manju Mohan and Swagata Payra, 2009: Influence of Aerosol Spectrum and Air Pollutants on Fog Formation in Urban Environment of Megacity Delhi, India. Environmental Monitoring and Assessment, 2009, vol 151, pages 265-277

137. Rao A D, Madhu Joshi and M Ravichandran, 2009: "Observed low-salinity plume off Gulf of Khambhat, India during post-monsoon period", Geophysical Research Letters, doi: 10.1029/2008GL036091.

138. Rajesh Kumar, R, B Prasad Kumar, A N V Satyanarayana, D Bala Subrahamanyam, A D Rao and S K Dube, 2009: "Parameterization of sea surface drag under varying sea state and its dependence on wave age", Natural Hazards, 49, 2, 187-197, 2009.

139. Rajesh Kumar, R, B Prasad Kumar, A N V Satyanarayana, D Bala Subrahamanyam, A D Rao and S K Dube, 2009: "Effect of varied atmospheric stability on sea surface drag in shallow seas and its impact on wind-wave growth", Natural Hazards, 49, 2, 213-224.

140. Hareesh Kumar P V, Madhu Joshi, K V Sanilkumar, A D Rao, P Anand, K Anil Kumar and C V K Prasada Rao, 2009: "Growth and decay of the Arabian Sea mini warm pool during May 2000: observations and simulations", Deep-Sea Research, Part 1, 56, 528-540.

141. Rao A D, Indu Jain, M V Ramana Murthy, T S Murty, and S K Dube, 2009: "Impact of cyclonic wind field on interaction of surge-wave computations using finite-element and finite-difference models", Natural Hazards, 49, 2, 225-239.

142. Muraleedharan G, Mourani Sinha, A D Rao, G Latha and S K Dube, 2009: "Modified weibull derived spectrum for deep water significant wave height estimation", Natural Hazards, 49, 2, 199-211.

143. Muraleedharan G, Mourani Sinha, A D Rao, N Unnikrishnan Nair and P G Kurup, 2009: "Estimation of wave period statistics using numerical coastal wave model", Natural Hazards, 49, 2, 165-186.

144. Dube S K, Indu Jain, A D Rao and T S Murty, 2009: "Storm surge modeling for the Bay of Bengal and Arabian Sea", DOI 10.1007/s11069-009-9397-9, Natural Hazards, 51: 3–27.

145. Maithili Sharan and Pramod Kumar, 2009: An analytical model for cross wind integrated concentrations released from a continuous source in a finite atmospheric boundary layer. Atmospheric Environment, 43, 2268-2277.

146. Maithili Sharan, J.P. Issartel, Sarvesh K. Singh and Pramod Kumar, 2009: An inversion technique for the retrieval of single-point emissions from atmospheric concentration measurements. Proc Royal Society A, 465, 2069-2088.

147. Panda J., Maithili Sharan and S.G. Gopalakrishnan, 2009: Study of regional-scale boundary layer characteristics over northern India with a special reference to the role of Thar Desert in regional-scale transport. J Applied Meteorology and Climatology, 48, 2377-2402.

148. Maithili Sharan and Aditi, 2009: Performance of various similarity functions for non-dimensional wind and temperature profiles in the surface layer in stable conditions. Atmospheric Research, 94, 246-253.

149. Dimri, AP, UC Mohanty 2009: Simulation of mesoscale features associated with intense western disturbances over western Himalayas, Meteorological Applications 16 (3), 289-308

150. Chang, HI, D Niyogi, A Kumar, CM Kishtawal, J Dudhia, F Chen, UC Mohanty, 2009: Possible relation between land surface feedback and the post-landfall structure of monsoon depressions, Geophys. Res. Lett 36, L15826

151. Chang, HI, A Kumar, D Niyogi, UC Mohanty, F Chen, J Dudhia, 2009: The role of land surface processes on the mesoscale simulation of the July 26, 2005 heavy rain event over Mumbai, India, , Global and Planetary Change 67 (1-2), 87-103

152. Dutta, SK, S Das, SC Kar, UC Mohanty, PC Joshi, 2009: Impact of Downscaling on the Simulation of Seasonal Monsoon Rainfall Over the Indian Region Using a Global and Mesoscale Model, The Open Atmospheric Science Journal 3, 104-123

153. Raju, PVS, R Bhatla, UC Mohanty, 2009: The evolution of mean conditions of surface meteorological fields during active/break phases of the Indian summer monsoon, Theoretical and Applied Climatology 95 (1), 135-149

154. Dutta, SK, S Das, SC Kar, UC Mohanty, PC Joshi, 2009: Impact of vegetation on the simulation of seasonal monsoon rainfall over the Indian subcontinent using a regional model, Journal of Earth System Science 118 (5), 413-440.

Annexure V

Externally funded Research Projects undertaken by CAS Faculty in the last 5 years

Year	Title	PI	Sponsoring Agency	Amount (in INR lac)
2013	Impact of Air Quality and Heat stress on Health: Future Projections for India	Dr. Sagnik Dey	DST, Govt. of India	39.38
	Development of a Improved Prediction System for Storm Surges and its Inland Inundation along the Indian Coasts	Prof. A. D. Rao	INCOIS, MoES, Govt. of India	91.99
	Understanding the Response of Indian Monsoon to Variations in CO2 and Solar Radiation Using Ocean Atmosphere Modeling in a Geoengineering Context	Dr. Saroj K. Mishra	DST, Govt. of India	48.08
2012	Modelling Regional Climate Change: Addressing Scientific Uncertainties and Capacity Building needs	Prof. S. K. Dash	DST, Govt. of India	78.78
	Local Scale Assessment of Tropical Cyclone induced Coastal Storm Surge Inundation over the Coastal Zones of India in a probabilistic Climate Risk Assessment Scenario	Prof. A. D. Rao	DST, Govt. of India	37.33
2011	Understanding Microphysical Evolution of Clouds in the Indian CTCZ: Variability and Impacts of Aerosols	Dr. Sagnik Dey	CTCZ Programme, MoES, Govt. of India	16.92
	Simulation and Prediction of Intense Convective Systems associated with Indian Summer Monsoon: Role of Land Surface Processes	Prof. U. C. Mohanty	CTCZ Programme, MoES, Govt. of India	42.69
	Boundary Layer Characteristics over Surface representative of CTCZ region in India	Prof. Maithili Sharan	CTCZ Programme, MoES, Govt. of India	34.2
	Understanding the Evolution of Aerosol Properties over India in a 3-D observational framework using multi-sensor remote sensing data	Dr. Sagnik Dey	FAST-TRACK Programme, DST, Govt. of India	19.3

	Assimilation of INSAT 3D Radiances and retrieved products in a high resolution Global Model for Monsoon Forecasts	Prof. O. P. Sharma	Space Application Centre, ISRO	8.5
	South Asian Precipitation: A Seamless Assessment – SAPRISE	Dr. K. AchutaRao	Indo-UK Programme, MoES, Govt. of India	347.4
	Design and development of a Unified Modelling System for Seamless Weather and Climate Prediction of Monsoon	Prof. O. P. Sharma	MoES, Govt. of India	383.47
	A Comprehensive study on Internal Waves from Observations and Non-hydrostatic Modelling	Prof. A. D. Rao	Ministry of Defence, Govt. of India	28.3
	Mathematical Modelling of Dispersion of Air Pollutions in the atmospheric boundary layer	Prof. Maithili Sharan	DST, Govt. of India	32.45
	Collaboration study on the potential linkage of the Monsoon Variability of Korea and India by Impact of Eurasian Snow, Pacific and Indian Ocean	Prof. S. K. Dash	DST, Govt. of India	20.95
2010	Tuna Habitat and Forage Distribution in the Indian EEZ using Biophysical Models	Prof. G. Jayaraman	Space Application Centre, ISRO	26.97
	Sustainable e-Infrastructures Across Europe and India (EU-IndiaGrid2)	Prof. S. K. Dash	European union	12.0
	Regional Climate Scenario in Sikkim and Western Arunachal Pradesh using RegCM3	Prof. S. K. Dash	WWF India	5.64
	Climate Variability over India using a Regional Climate Model	Prof. S. K. Dash	DST, Govt. of India	34.98
	Regional Climate Change in Global Climate Simulations	Prof. U. C. Mohanty	CMMACS	19.2
	Precipitation and Temperature Variability and Extended Range Seasonal Prediction during Winter over Western Himalayas	Prof. U. C. Mohanty	SASE HQ, DRDO	49.5
2009	Development of a Non-Hydrostatic Finite Volume Icosahedral Model for Regional/Global Climate simulation and Weather Forecast	Dr. H. C. Upadhyaya	Indo-French centre for the Promotion of Advanced Research (IFCPAR)	10.42

	Simulation of Heavy Rainfall Events associated with Indian Summer Monsoon using High-Resolution Mesoscale Modelling and Data Assimilation Systems	Prof. U. C. Mohanty	ISRO	36.8
	Asian Cities Adapt: Impacts of Climate Change in Target Cities in India and the Philippines and Local Adaption Strategies	Prof. S. K. Dash	German federal Ministry for the Environment, Nature Protection and Nuclear Safety	123
	Development of a framework for Systematic Model Diagnosis	Dr. K. AchutaRao	MoES, Govt. of India	53.7
	Ocean Heat Uptake and Thermosteric Sea-Level rise in the Northern Indian Ocean	Dr. K. AchutaRao	Space Application Centre, ISRO	22