

friend and colleague from early days when Rad was at CSIRO, talked about him at an evening function on behalf of John Brooks, as Brooks could not attend the workshop. Goss and Brooks have been with Radhakrishnan on sailing expeditions too!

In addition to having headed RRI and carrying out cutting-edge research, Radhakrishnan continues to pursue his interests in sailing and gliding. His presence in the institute can be sensed with the 'Double Trouble' glider and boat models that reside in the RRI workshop.

He is a source of inspiration for the young and old alike.

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MEETING REPORT

Frontiers in atmospheric sciences*

The dissemination of contemporary developments in atmospheric science, meteorology and climatology is important in decision-making with regard to climate change and natural hazards, and to meet the information requirements of personnel in related institutions. In this background, a refresher course on 'Frontiers in Atmospheric Sciences' was organized.

Its main objectives were to: (i) bring together individuals and organizations interested in teaching climatology, atmospheric science and meteorology, (ii) dissipate knowledge on some important frontline topics such as climate and climatic change, palaeoclimate, global warming, atmospheric pollution, weather forecasting, climate forecasting, weather modification, physics and dynamics of tropical clouds, thunderstorms and global electric circuit, and (iii) introduce atmospheric science in the graduate/post graduate curriculum in research and development institutes in India.

The course was inaugurated by Madhav Gadgil (Indian Institute of Science (IISc), Bangalore) who delivered a lecture on 'up above the world so high!'. He focused upon the evolution of living beings with regard to climate change. Sulochana Gadgil (IISc, Bangalore) gave four talks on understanding and predicting the Indian monsoon. She explained the biotic responses on the eve of monsoon,

physical mechanisms behind the initiation of monsoon, intraseasonal and inter-annual variations in monsoon rainfall and associated phenomena, factors related to large-scale and large-area coverage of monsoon rainfall through the phenomenon of the Inter Tropical Convergence Zone (ITCZ) and drought related to human impact. Processes responsible for interannual variations in rainfall such as the El Niño Southern Oscillation (ENSO) and the Equatorial Indian Ocean Oscillation (EQUINOO) were described in detail. She also highlighted the importance of monsoon with regard to the gross domestic product and agriculture.

B. N. Goswami (Indian Institute of Tropical Meteorology (IITM), Pune) delivered talks on 'our climate' and 'present and future of Indian monsoon in a changing climate'. In the first lecture, he spoke on how to distinguish between weather and climate, and the principles of global weather parameters. This was followed by an explanation of the principles of monsoon system and the complexities in monsoon prediction including human induced forces. He said that the recent change in climate (particularly since the 1980s) is attributed to human impact as a consequence of increase in greenhouse gases such as carbon dioxide, nitrous oxide and methane. Climate modelling studies support these observations.

R. Krishnan (IITM, Pune) spoke on the 'dynamics of atmospheric general circulation models (GCM) and modelling'. He first explained the principles of GCM and boundary conditions. Other parameters required for GCM are atmospheric circulation and dynamics in tropics, temperate and polar regions including

monsoon system. In the second part, he discussed the different approaches for modelling.

Krishna Kumar (IITM, Pune) lectured on 'ENSO–monsoon linkages' and 'impact of climate change on India's monsoonal climate'. He gave an overview of the developments with respect to the ENSO phenomenon, from the initial contributions made by Sir Gilbert Walker in the 1920s till recent years. He then focused on the ENSO–Indian monsoon linkages – stronger El Niño events tend to decrease monsoon rains, causing droughts in India; however, not all El Niño events result in droughts.

The fundamental principles which change the radiation balance of the earth, that in turn change climate, were explained by G. Pandithurai (IITM, Pune). He outlined the effect of atmospheric aerosols on incoming solar flux to the earth's surface (through scattering and absorption), which would alter the water budget for the hydrological cycle. Pandithurai also emphasized the importance of anthropogenic aerosols with regard to size, life time and rain yielding capacity.

J. R. Kulkarni (IITM, Pune) talked about 'the cloud aerosol interactions and precipitation enhancement experiment (CAIPEEX)'. He highlighted the significance of air-borne monitoring in the troposphere for understanding the nature of aerosols and their microphysical properties, and clouds over different parts of India. This type of investigation would be useful for cloud seeding, particularly during drought conditions.

A series of lectures in different fields of atmospheric electricity, viz. 'global electric circuit – the classical concept', 'physics of lightning, electrical structure

*A report on the two-week refresher course on 'Frontiers in Atmospheric Sciences' organized at the Indian Institute of Tropical Meteorology, Pune, during 14–25 June 2010. The course was jointly funded by the Indian Academy of Sciences, Bangalore, the Indian National Science Academy, New Delhi and the National Academy of Sciences, Allahabad.

of the earth's atmosphere and thunder storms', 'evolution of electrification in thunderstorm', 'cloud electrification mechanisms' and 'weather modification' were given by A. K. Kamra (IITM, Pune), who was the chief coordinator of the refresher course. He also emphasized upon the efforts made to mitigate meteorological hazards such as cyclones and hail storms, and the clearance of smog and fog over airports.

Understanding the dispersal of atmospheric pollutants was another aspect of training programme during the refresher course. On this topic, G. Beig from IITM delivered two lectures on principles of atmospheric chemical transport modelling and its applications down-scale to local/city level. The model can be temporally updated by uploading various environmental parameters to take preventive measures against extreme pollution. From this, it would be possible to pre-

pare air quality indices maps. This approach is also useful for developing new-generation integrated meso-meteorological and atmospheric chemical transport models.

G. B. Pant (IITM, Pune) spoke on the evolution of planet earth, its atmosphere and palaeoclimatology. He outlined the different stages of development in the earth's climate, since its origin. The utility of palaeo-proxies preserved in the natural records of the earth was also highlighted; meteorological data are available for only about 150 years. Therefore, measurements of proxies in natural records or natural archives such as ice cores, tree rings, lake and marine sediments, and speleothems are particularly useful in understanding the palaeoclimate over millions of years.

On the extension of the importance of proxies and records of climate, S. Chakraborty (IITM, Pune) delivered a talk on

the applications of isotopes. Measurement of stable isotopes such as oxygen isotopes in natural archives of the earth is particularly useful for understanding quantum rainfall and its pattern in the past.

The refresher course not only exposed the participants to a wide variety of expert lectures but also included the screening of documentaries on weather and climate, and visits to different laboratories at IITM and IMD, Pune. They were also taken to visit the largest windmill farm in Asia, located at Satara, to understand the importance of wind energy.

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