Climate science*

The First National Climate Science Conference was held recently in Bengaluru. The main goal of the conference was to facilitate interaction and collaborations among Indian scientists working in the area of climate science in various Indian institutions. Scientists, research scholars and students from various institutions across the country were invited to participate in this conference.

About 250 abstracts were submitted on a range of topics in climate sciences: atmospheric physics and dynamics, ocean dynamics, monsoon dynamics, global and regional carbon cycle, land-use change, hydrological cycle, aerosols, Himalayan glaciers, palaeoclimate, detection and attribution of climate change and geoengineering. About 135 abstracts were selected for poster presentations and close to 100 applicants attended the conference.

The conference featured invited talks by 14 experts. Overall, about 150 participants from 57 institutions attended the conference. The conference was organized in four half-day sessions. As the aim of the conference was to bring together researchers working in different areas of climate science and to facilitate interaction, parallel sessions were avoided. The sessions were not organized by themes. This enabled researchers from different disciplines to interact with people working on different themes. Each session started with 3–4 invited presentations followed by short 2-min poster presentations. These short presentations were followed by formal poster-viewing for about 2 h.

On the first day, M. Rajeevan (Indian Institute of Tropical Meteorology (IITM), Pune) spoke on the challenges in predicting the seasonal Indian monsoon rainfall. He noted that the seasonal forecast skill of monsoon rainfall by dynamical models has dropped significantly in the recent decades because models are not able to capture the recent weakening of the monsoon–El Niño relationship. He showed that a statistical model that links monsoon rainfall to Eastern Pacific El Niño, Central Pacific El Niño, Pacific sub-tropical highs and anomalous Asian low has a relatively higher skill in recent decades. R. Ramesh (Physical Research Laboratory, Ahmedabad) discussed the Holocene monsoon variability as inferred from oxygen isotopes in speleothems. He presented evidences to show that the Indian monsoon rainfall has increased steadily in the last 10,000 years. V. K. Dadhwal (National Remote Sensing Centre, Hyderabad) discussed the National Carbon Project that measures net carbon fluxes and atmospheric CO_2, land-use changes, deforestation rates, fires, forest biomass, net primary productivity and soil carbon pools in India. He showed that the forest cover, biomass and soil carbon pools were increasing in the recent years. The first session ended with the viewing of 28 poster presentations.

The afternoon session on the first day featured 3 invited talks by experts and 18 2-min poster presentations followed by formal poster viewing. R. Krishnan (IITM) discussed the status of earth system model (ESM) development at IITM. He described the evolution and improvements from the coupled forecasting system (CFSv2) to ESMv1 and from ESMv1 to ESMv12. He showed that major improvements in the seasonal cycle of monsoon, SST biases and global energy balance were achieved through improvements in parameterization of various physical processes. He indicated that the latest version of IITM ESM would participate in the next coupled model intercomparison project (CMIP6). Vimal Mishra (Indian Institute of Technology (IIT), Gandhinagar), spoke on the temperature and precipitation extremes in a changing climate. He noted that there has been a significant increase in the number of heat wave events and decrease in cold wave events in urban areas around the world during the period 1973–2012, with large regional variations. In the case of precipitation, there was large spatial variability in trends in observational records and agreement among global and regional model projections that precipitation extremes will increase in the 21st century. C. Balaji (IIT-Madras, Chennai) presented a technique that can be useful to derive the vertical profile of hydrometeors by combining space-borne observations of radar reflectivity from Tropical Rainfall Measuring Mission (TRMM) precipitation radar and brightness temperatures from TRMM Microwave Imager (TMI) and a high-resolution regional weather forecasting model.

On the second day, Ashok Karmuri (University of Hyderabad) spoke about the correlations between the El Niño and the Indian monsoon. He indicated that the correlation between the two has weakened since 1950s, irrespective of the choice of an index for tropical Pacific variability. He showed that the tropical Pacific is changing and in addition to the natural variability, background changes associated with human activities could play a role. Subimal Ghosh (IIT-Bombay, Mumbai) discussed the effects of urbanization on climate extremes and the role of local evapotranspiration on monsoon rainfall. He showed that there was a significant impact of urbanization on extreme rainfall in the central and western regions of India, and a high precipitation recycling ratio (~25%) in North East India. V. Vinoj (IIT, Bhubaneswar) showed using model simulations that absorption by dust aerosols west of India during the summer season strengthens the monsoon circulation and leads to enhanced rainfall. However, sea-salt aerosols over the Arabian Sea scatter solar radiation and weaken the monsoon circulation. On future projections, K. Rajendran (CSIR-Fourth Paradigm Institute, Bengaluru) showed that model projections of future increase in surface temperature over India is certain, whereas the changes in summer monsoon rainfall are uncertain due to the disparity in the simulation of mean and variability by the models. However, by screening the models based on their ability to simulate seasonal cycle and interannual variability, more reliable projections can be obtained. The average from the subset of

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models with higher reliability shows an increase of 0.75 mm/day in rainfall and around 3.0°C in summer temperature over India for a high CO_2 emission scenario by the end of this century. The third session of the conference ended with 25 2-min poster presentations followed by formal poster-viewing.

During the last session of the conference, Thamban Meloth (National Centre for Antarctic and Ocean Research) discussed a high-resolution study of dust fluxes, stable isotope and glaciochemical composition in ice cores corresponding to the last 100 years from the coastal East Antarctica. He showed that the estimated surface air temperatures using the $\delta^{18}O$ profiles of two ice cores revealed a significant warming of 0.6–1°C per century, with enhanced warming during the recent decades (~0.4°C per decade). Using observations of TMI SST for the years 1998–2010, R. R. Rao (IITM) showed that the near-surface layers in the Arabian Sea progressively warm from February to early May, resulting in the formation of the Arabian Sea Warm Pool (ASWP), with core warming exceeding 30.5°C. He suggested that the mechanisms that govern the observed interannual variability of the ASWP are Sea Surface Temperature/heat content during October–January, near-surface vertical salinity stratification during November–February, surface net heat flux forcing during February–May and El Niño/La Nina. Krishna Achuta Rao (IIT Delhi) highlighted the various sources of uncertainty in climate projections: scenario uncertainty, internal variability and model uncertainty. He used the model projections of precipitation over NE India to illustrate that while the model uncertainty increases with time, uncertainty related to internal variability decreases. He also showed that weighting models based on various performance metrics result in little improvement. In this session, poster presentations were made by 22 students and research scholars from the Indian Institute of Science (IISc), Bengaluru.

The last talk of the conference on climate policy was delivered by T. Jayaraman (Tata Institute of Social Sciences). Based on the recently identified proportionality between cumulative carbon emissions and global mean warming, he argued that climate negotiations should use 'emission units' on the basis of entitlements to countries. He suggested that India should claim access to its legitimate 'carbon space' in global negotiations. The conference ended with closing remarks by G. Bala (IISc) and J. Srinivasan (IISc) and presentation of best poster awards.

G. Bala and **J. Srinivasan*,** Divecha Centre for Climate Change, Centre for Atmospheric and Oceanic Sciences, Indian Institute of Science, Bengaluru 560 012, India.
*e-mail: jayes@caos.iisc.ernet.in

MEETING REPORT

Palaeogene of the Indian subcontinent*

The Palaeogene period, spanning about 42 million years (from approx. 65 to 23 million years BP), commenced with one of the most destructive volcanic eruptions on Earth (Deccan Traps volcanism) which led to the mass extinction of organisms, including dinosaurs, at the so-called Cretaceous–Palaeogene or the K–Pg boundary. Later, the early Palaeogene interval, between 56 and 50 Ma, witnessed several global warming (hyperthermal) events that include the Palaeocene–Eocene Thermal Maximum (PETM) at ~55.5 Ma and the Second Eocene Thermal Maximum (ETM2) at 53.7 Ma. Also during this interval, one of the most profound tectonic events on Earth, the continent-to-continent collision between India and Asia took place, resulting in the closure of the Sea of Tethys and the rise of the mighty Himalaya. The collision is believed to have caused climatic changes on a global scale, and the Indian monsoon system was established during the Palaeogene period. The development of seasonality during Palaeogene allowed deciduous flora (particularly grasses) to dominate the Earth's surface. Fossil records also suggest the sudden appearance of a number of modern mammal orders, particularly Artiodactyls, Perissodactyls and Primates (APP taxa) at the Paleocene–Eocene transition that is popularly known as the Mammalian Origination Event (MOE). India's present-day demand of fossil fuels (natural gas, oil and lignite) is also met from the Palaeogene sedimentary sequences which were deposited along its western and north-eastern margins.

To highlight the geological importance of the Palaeogene period, especially its Indian context, a two-day national conference was held recently. The diverse themes of the conference included issues related to stratigraphic correlation of the Palaeogene sequences of the Indian subcontinent, fossil records (both flora and fauna) in an evolutionary, palaeobiogeographic and the paleoclimatic context, rise of the Himalaya and related events, and also the exploration of energy resources from the Palaeogene sedimentary basins of the India.

K. S. Valdiya (Chief guest), Harbans Singh (Geological Survey of India (GSI)), Sunil Bajpai (Birbal Sahni Institute of Palaebotany (BSIP), Lucknow), Siddharth Swaroop (GSI, Lucknow), D. M. Banerjee (INSA-IUGS) and S. C. Tripathi (CRDHG, GSI-Northern Region, Lucknow) were present at the inaugural session.

Scientists, academicians and research scholars from 7 national institutes, 14 universities (including Tribhuvan University, Nepal) and 5 Central Government Organizations participated. Forty-four oral presentations were made and 24 posters were displayed.

In his keynote lecture, O. P. Pandey (CSIR-National Geophysical Research Institute (CSIR-NGRI), Hyderabad) stressed

*A report on the two-day national conference on 'Palaeogene of the Indian Subcontinent' held on 23 and 24 April 2015. The conference was jointly organized by the Birbal Sahni Institute of Palaeobotany, Lucknow and the Geological Survey of India, Lucknow.