



Space Physics Laboratory

SCIENTIFIC ACCOMPLISHMENTS 2011-2012

VIKRAM SARABHAI SPACE CENTRE

Thiruvananthapuram - 695022

From the Director

It gives me immense pleasure and satisfaction in summarizing the scientific, technical and programmatic accomplishments of SPL during 2011-12 to the 29th meeting of its Scientific Advisory Committee (SAC). Surging ahead from its rightful position amongst the top laboratories, SPL has made an impact in all the scientific disciplines being pursued, and is emerging as a centre of academic excellence. The ongoing activities continue to fructify, while new projects and programs progress steadily along the timelines. SPL has not only bettered all its academic credentials, but has taken them to newer peaks, to be scaled.

Publications in peer-reviewed, impact factor journals of repute are the ultimate benchmark of the scientific accomplishments of a science laboratory. In this discipline, SPL has excelled all its previous performances with a new record of 78 publications during the current year. In a **novel way of showing brilliance**, the young scientists and Research Fellows of SPL have clinched the **best paper awards in all the themes that covered SPL's scientific disciplines** in the National Space Sciences Symposium of 2012; besides bagging best paper and poster awards in other national and international symposia. The middle-level and senior scientists have received **Awards and Honours at national and international levels** and bestowed with **academic responsibilities** and recognitions in scientific pursuits. SPL scientists being selected/ elected as members of the **INSA-ICSU committee for COSPAR, URSI and SCOSTEP for 2012-2015**; the **INSA National Committee** for International Geosphere Biosphere Program & World Climate Research Program (**IGBP-WCRP**) and the **vice-president of COSPAR scientific commission B**, are some of the marks of excellence.

Among the chief accomplishments, the **shortlisting of SPL's payload MENCA** (Mars Exospheric Neutral Composition Analyser) for Mars-2013 mission, and after evaluation of the **EM, developed in-house** by a team from SPL and the entities of VSSC, its successful demonstration within the stipulated timeframe, and **selecting it for the Mars Orbiter Mission slated for 2013**, stands out. New scientific results keep emerging from Chandrayaan -1. The SARA data has been used for the development of an **empirical model for the angular scattering function** of energetic neutral atoms from the lunar surface. This model has been applied successfully to quantify the shielding efficiency of lunar magnetic anomalies. These are *first of their kind* accomplishments in lunar science.

In the discipline of **aeronomy and space sciences**, SPL has gone far into the scientific utilization of the **RaBIT data from YouthSat** (the only ISRO satellite dedicated for aeronomy studies). A two-day national workshop was conducted with extensive participation from academic and research institutions to provide hands-on training in data utilization. A **Payload Operation Centre** has been set up in SPL and the up-linking of RaBIT data to ISSDC and generation of quick-look tomograms have been automated. Scientific analysis of RaBIT data have revealed several interesting features; including the dynamical nature of the **equatorial ionization anomaly**, the **'plasma bubbles' leading to generation of Spread F** and also the changes in the ionospheric structure in response to a **severe solar flare**; all of them providing first experimental evidences of the electrodynamical and aeronomical processes taking place in the equatorial ionosphere. An ionospheric model has been developed from the first principles and applied successfully to explain the **F region oscillations** during the sunrise and also the role of **seed perturbations** in the generation of Spread F.

Coming to the science of **Aerosol Regional Radiative Forcing and Climate Impact** studies under the ISRO-GBP projects **ARFI, ICARB and RAWEX**, the current year witnessed extensive accomplishments. The **much needed modeling studies to assess the climate impact** of aerosols have been initiated using state-of-the-art **Regional Climate Model (RegCM)** and chemical transport models such as **CHIMERE and GOCART**. A synthesis of RegCM and the measurement from the network has brought out, for the first time, the deficiencies in the model w.r.t to tropical boundary layer parameterization schemes leading to an overestimation of the dispersion under stable ABL conditions. The ARFINET was expanded and augmented, technological developments were carried out for **seamless network activity, automatic data acquisition and dissemination** to the nodal station, and **payload development for high-altitude balloon experiment**. The collaborative efforts in **polar and high-altitude** research have been strengthened, and for the first time, one year continuous data on **Arctic aerosols**

have been generated in India. The ARFI observatory at **Hanle**, besides completing two years of continuous operation, has provided, again for the first time, insights in to the **new particle formation process** that take place in the free-tropospheric environments from the pre-cursor gases leading to a dynamical aerosol size spectrum, as well as the **strong solar control** on it. Extensive and interdisciplinary research have been carried out using the **W-ICARB** data on aerosols and marine boundary layer fluxes to quantify the role of long-range transport in modifying the aerosol properties over Bay of Bengal.

Initiating a new sphere of activity in the discipline of **aerosol chemistry**, extensive molecular level characterization of **organic aerosols** from distinct environments has been carried out as part of a sabbatical fellowship under the JSPS (Japan Society for Promotion of Science). The study brought out the seasonally changing dominance of **natural biogenic precursors** as well as anthropogenic emissions in contributing to the organic aerosol species; a very important input from environmental and climate perspective.

Satellite data have been extensively used for characterizing the spatial distribution of the **trace gases such as CO, O₃, NO_x and OH** at the surface and in the tropospheric column and their temporal features. The roles of distinct photochemical and transport processes responsible for the above have been delineated. For the first time, satellite-derived vertical profiles of CO were examined over BoB, which revealed the presence of a strong CO layer at ~9km, with water vapour playing a major role at the lower altitudes.

In the emerging area of **clouds and convection, extensive use of satellite data, and ground based microwave profiler along with modeling have used to explain the genesis and dynamics of tropical mesoscale convective systems**, one of the complex phenomena **over the tropics**. A methodology has been developed for the validation of data from the microwave payloads (**MADRAS and SAPHIR**) of **Megha-Tropiques** satellite. Based on the analysis of data on December 09, 2011 (9 passes) preliminary inferences on the **thermodynamics** of the atmosphere and **deep convective clouds** were made and the inferences were compared with independent ground-based and satellite microwave sounding measurements. Satellite data have been used to quantify **frequency of occurrence of different types of clouds** over the Indian summer monsoon region.

In the area of middle atmosphere, the inter-relationship between the Quasi Biennial Oscillations (**QBO**) and Semi Annual Oscillations (**SAO**) in the stratosphere and mesosphere has been brought out by synthesizing **simultaneous data from balloon, rockets and radar**. Investigations of the **Tropical Tropopause Layer (TTL)** over the Indian regions using 18-years of balloon data have shown a **steady decrease in the TTL thickness, primarily due to the larger decrease in CPT (cold point tropopause) altitude**; a probable indicator of global warming impact.

A quantification of the **land-sea breeze circulations** under clear and cloudy sky conditions, based on lidar and radiosonde observations and numerical modeling has been the main accomplishment of the boundary layer and modelling activities. A **thought experiment** was conducted to simulate the effect of an anomalous heating in the lower atmosphere on the regional weather and onset of monsoon as prelude to model the effect of warming due to elevated aerosol layers. From an extensive study of **cloudiness using satellite data and sea-surface temperature**, the non-universality of the relation between the two has been exemplified. Studies on the distinctiveness of the boundary layer processes at different environments have been **initiated using the NOBLE data**, while the lidar has been used to investigate the descending cirrus clouds. **This group also provided weather forecast support to all the three PSLV launches during the year.**

Making a **quantum shift** from the role of a support provider, the Atmosphere Technology Division has accomplished several laurels during the current year and is gearing up to take up greater challenges in **scientific instrumentation**. The **successful in-house development** of the **MENCA electronics** within a short time-span has been a major achievement. The development and proliferation of a **standalone controller and data acquisition system** (for the in-house developed MWRs in ARFINET) that got rid of the long-standing impediments; the development of **automatic data disseminator and archival system for the ARFINET; the development of balloon payloads and GSM based real-time data transmission** and display system have been creditably accomplished. In a **major effort of indigenization**, the ATD has made significant advancement in the **in-house development of an advanced FPGA-based radar controller, data acquisition and processing system for the HF radar**. This has great promise for the revival of the radar systems of SPL, which were the backbone tools for upper atmospheric and ionospheric research. ATD is also making strides in the development of advanced **beacon receivers, and transmitters** for opportunity satellite missions.

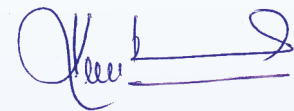
In establishing **new facilities, development of space-borne instrumentation** and infrastructure, the reporting period has excelled. A new 1-meter class **High Vacuum Space Simulation Facility**, an essential need for all space-borne instrument developments, has been commissioned. The development of a new payload, **Plasma Energy Explorer**, has been taken up with the support of the AVN of VSSC aiming at developing an advanced plasma payload for future planetary missions. For the study of ionosphere, development of **improved ENWi payload** and ground based photometers are underway. Initial spadework has started for the development of **topside sounder and spatial heterodyne receivers** for space borne studies. In the area of infrastructure, the new building for SPL is nearing completion.

Interactions, collaboration, exchange programs and visits of academicians are the key elements in the progress of any science Laboratory. During the current year, 7 scientists and 6 research fellows have been deputed for foreign symposia, meetings, workshops and schools. SPL continued its extensive collaborations with other departments and institutions and continued to contribute to national programs, such as the **CTCZ and the CAIPEEX of MoES, and the Polar Research program of the National Centre for Antarctic and Ocean Research, as well as the National Carbonaceous Aerosol Program (NCAP) of the MoEF**. SPL also very effectively co-ordinated the joint Indo-US project **RAWEX-GVAX**.

SPL pursues a strong and vibrant academic program leading to doctoral and post-doctoral degrees, as well as provides guidance in dissertations and project works of the students leading to capacity building in the relevant disciplines as a part of societal commitments. While the former is a program supported through the ISRO research fellowship (RF) and Research Associate (RA) schemes, the latter basically are part of the curricular needs of universities and also under the summer research fellowship programs of the science academies of India. The RF and RA schemes are overviewed by the **SPL academic committee** consisting of senior scientists of the various disciplines of SPL and also by the **Centre Level Monitoring Committee (CLMC)** comprising of senior scientists drawn from different entities of VSSC. These committees regularly conduct thorough reviews of the progress of each RF and RA and provide useful suggestions, identify pitfalls if any and provide the broad direction to maintain the high standards of research and publications. The academic project works are carried out under the guidance of senior scientists and engineers and supports the needs of students of B Tech, M Tech, M Sc and M Phil courses.

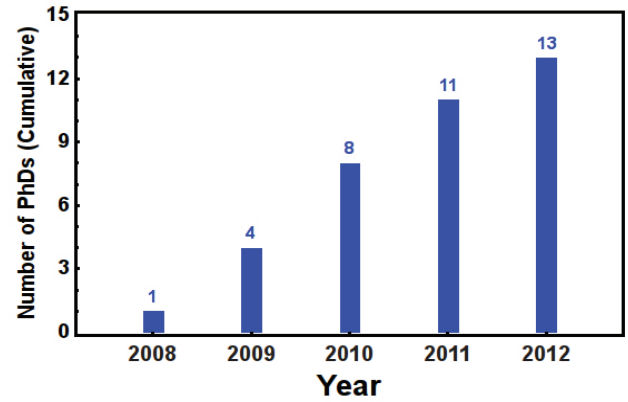
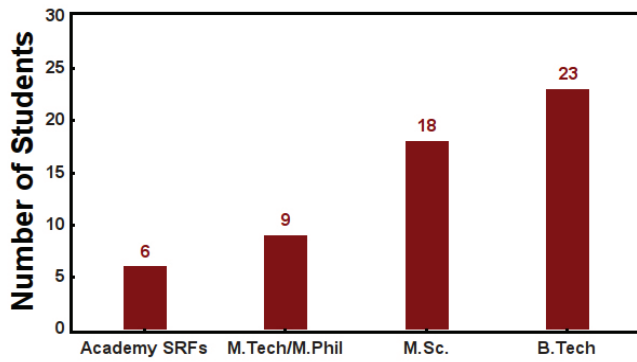
Given the strength, potential and enthusiasm of the scientific and technical groups, the type of support SPL is receiving from VSSC, and the recommendations of the SAC of SPL for the 12th FYP and beyond, the coming years are poised for major expansions in the experimental capabilities and infrastructure development of SPL, that would cater its scientific needs for several years to come. I have great pleasure in presenting this report of SPL's accomplishments during 2011-12.

August 16, 2012

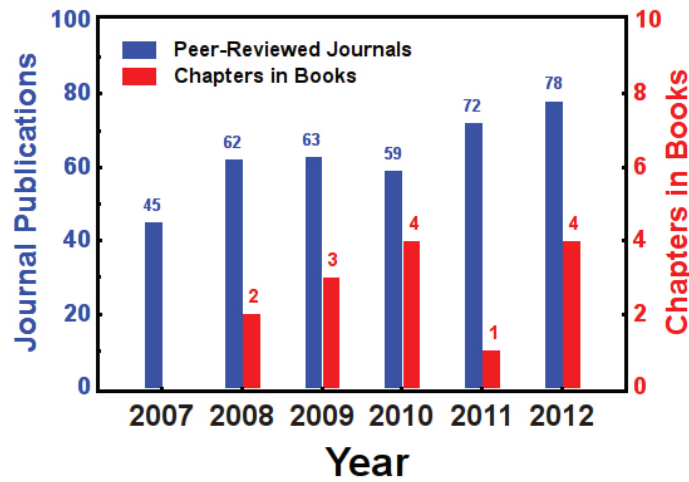


K. Krishnamoorthy

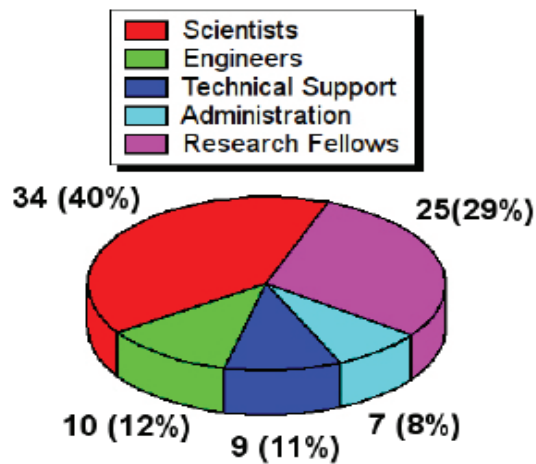
Academic Activities



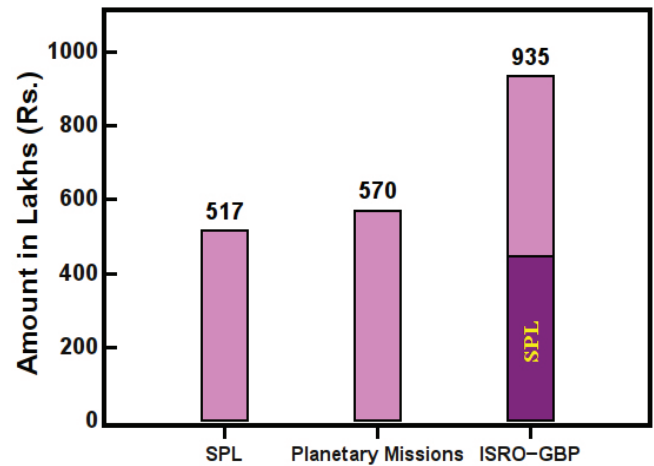
Publications



Human Resources



Budget



AWARDS, HONOURS & RECOGNITION

Anil Bhardwaj

Nominated Member, **INSA-ICSU Committee for COSPAR, SCOSTEP and URSI**, for 2012-2015.

Elected Member, **Executive Council of Indian Geophysical Union**, 2011-2013.

Elected Vice-Chair, **COSPAR Commission B**.

C. Vineeth

IGA Young Scientist Award from International Association for Geomagnetism and Aeronomy, March 2012.

URSI Young Scientist Award from Union Radio-Scientifique Internationale, August 2011.

Karanam Kishore Kumar

IETE Young Scientist Award from International Radar Symposium, India (IRSI-83) Institute of Electronics and Telecommunication Engineers

Siddarth Shankar Das

INSA Young Scientist Medal from Indian National Science Academy for the Year 2012

S. Suresh Babu

Member, **Joint National Committee of International Geosphere Biosphere Program-World Climate Research Program constituted by INSA**.

Member, **National committee for the selection of scientific instruments in C-130J aircraft to be procured by Ministry of Earth Science (MoES) for atmospheric research**.

ACADEMIC EXCELLENCE

BEST PAPER AWARDS IN SYMPOSIA

Asha Babu: "Mean structure and variability of Tropical Tropopause over the Indian Longitude sector and its Role in Particulate Transport", (Co-Authors: S. V. Sunilkumar and K. Parameswaran) under Ocean and Atmospheric Processes Session, Meteorology for Socio-economic Development, **TROPMET 2011**, December 14 - 16, 2011. Hyderabad

D. Bala Subrahmanyam: "Short-Range Weather Predictions in support of PSLV and GSLV launch activities: Role of High-resolution Regional Model" (Co-Author: T. J. Anurose) under Numerical Weather Prediction Session, Meteorology for Socio-economic Development, **TROPMET 2011**, Hyderabad, December 14 - 16, 2011.

Jai Prakash Chaubey: "Fine and Ultra Fine Particles at Near Free Tropospheric Environment in Trans-Himalayas: Results from RAWEX", (Co-Authors: S. Suresh Babu, V. Sreekanth, Sobhan K. Kompalli, Mukunda M. Gogoi and K. Krishna Moorthy), Space based meteorology, Oceanography and Geosphere-biosphere interactions, National Space Science Symposium (**NSSS-2012**), Tirupati, February 14-17, 2012.

K. N. Uma: "Studies on the characteristics of tropical convection and its associated dynamics during the Indian summer monsoon", (Co-Authors: T. Narayana Rao, K. Kishore Kumar and S. S. Das) in **OCHAMP**, Indian Institute of Tropical Meteorology (IITM), Pune, from 21-25 February 2012.

Nizy Mathew: "Retrieval of Land Surface Emissivities at 89 and 150 GHz from AMSU Data", (Co-Authors: Tinu Antony, C. Suresh Raju and K. Krishna Moorthy), under satellite observations and meteorology Session, Meteorology for Socio-economic Development, **TROPMET 2011**, Hyderabad, December 14 - 16, 2011.

R. Renju: "Thermodynamics of Convective Cloud System during a Waterspout Studied using Microwave Radiometer Observations at Thiruvananthapuram", (Co-Authors: C. Suresh Raju, Uma K. N., Tinu Antony and K Krishna Moorthy), under Emerging Trends in Observation Systems, Meteorology for Socio-economic Development, **TROPMET 2011**, Hyderabad, December 14 - 16, 2011.

Sherine Rachel John: "Interannual variability of global gravity wave activity and signatures of Quasi-Biennial (QBO), Annual (AO) and Semi-Annual (SAO) Oscillations", (Co-Author: K. Kishore Kumar), National Space Science Symposium (**NSSS-2012**), Tirupati, February 14-17, 2012.

Sonal Kumar Jain: "Study of N2 Vegard-Kaplan band emission in the dayglow of Mars, Venus and Titan", (Co-Author: Anil Bhardwaj), National Space Science Symposium (**NSSS-2012**), Tirupati, February 14-17, 2012.

S. G. Sumod: "On the variability of the Thermospheric 630.0 nm Dayglow owing to the simultaneous forcing due to Strong Neutral heating in the mesopause and a noontime penetration of interplanetary electric field", (Co-Author: Tarun Kumar Pant), National Space Science Symposium (**NSSS-2012**), Tirupati, February 14-17, 2012.

Vijayakumar S Nair: "Simulation of Black Carbon Aerosols over the South Asian Region using the Regional Climate Model (RegCM4.0): Comparison with Measurements". (Co-Authors: S Suresh Babu and K Krishna Moorthy), National Space Science Symposium (**NSSS-2012**), Tirupati, February 14-17, 2012.

BEST ARTICLE AWARDS IN JOURNALS

Anil Bhardwaj: The paper "Solar system X-rays from charge exchange processes", coauthored by A. Bhardwaj, published in 2012 in *Astronomische Nachrichten (Astronomical Notes)* is selected as Editor's Choice of the journal.

Mukunda M Gogoi: The paper "An investigation of aerosol size distribution characteristics at Dibrugarh", (Co-authors: Pradip K. Bhuyan and K. Krishna Moorthy), received best article award in *Terrestrial, Atmospheric and Oceanic sciences* 2010.