International Conference on the Asian Summer Monsoon Anticyclone: Gateway of Surface Pollutants to the stratosphere

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Date:
10-11 February 2020

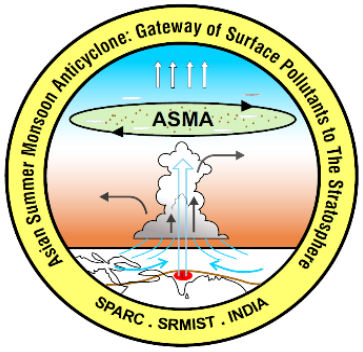
Number Of Participants: **45**

Organisers:
Sanjay Kumar Mehta (SRM Inst. of Science and Technology); Masatomo Fujiwara (Hokkaido Univ., Japan); Susann Tegtmeier (Univ. of Saskatchewan, Canada)

Scientific Organisisng Committee:
Sanjay Mehta, Masatomo Fujiwara, Susann Tegtmeier, M. Venkat Ratnam, Suvarna Fadnavis, V. Rakesh, D. Narayana Rao, K. Ramasamy, C. Muthamizhchelvan, K. Mohan Kumar, B.V. Krishna Murthy, S.R.S. Prabhaharan, B. Neppolian and D. John Thiruvadigal

Local Organising Committee:
Arijit Sen, Ritesh Kumar Dube, Bhalchandra Kakde, S. Venkat Prasad Bhat, S. Anandkumar, Paromita Chakraborty, P. Malar, K. M. Ramkumar, M. Sasidharan, A. Jesuarockiaraj, S. Harinipriya, T.V. Lakshmi Kumar, and K. Namitharan

Host Institution:
SRM Institute of Science and Technology, Chennai, India



To promote the better understanding towards the increasing emission and its transport to the upper troposphere and lower stratosphere (UTLS) the International Conference on Asian Summer Monsoon Anticyclone (ASMA): Gateway of surface pollutants to the stratosphere was organized at SRM Institute of Science and Technology (SRMIST) in association with Hokkaido University, Japan and University of Saskatchewan (USask) Canada as the part of the Scheme for Promotion of Academic and Research Collaboration (SPARC) project funded by Ministry of Human Resource and Development (MHRD), Govt. of India. SPARC provides a platform to facilitate academic and research collaborations between Indian institutions and the best institutions in the world so that Indian scientists and students can interact with the finest minds in the world. SRM IST has recently initiated activities on atmospheric observations and modelling works with micropulse lidar and radiosonde experimental facilities. International ASMA Conference was provided with an excellent opportunity for scientists and students to demonstrate their research results.

The first International ASMA Conference was held on 10-11 February 2020 at SRMIST, Chennai, India, with 45 participants from 5 countries, mostly from India. Scientific presentations and discussions covered a focused and thematic topic on the transport of the surface pollutants to UTLS via ASMA region, its transport pathways, deep convection, the tropical easterly jet, cirrus clouds and their nucleation, the Asian tropopause aerosol layer (ATAL), and long-term changes and climatology of the ASMA. The ASMA is an important component of the circulation system that enables direct transport of surface pollutants and climate-active gases to the UTLS. Observational and modelling studies confirm that the ASMA confines maximum concentrations of surface trace gases such as CH_4, CO, and HCN. The strong anticyclonic circulation couples their convective transport during the Asian summer monsoon with their entrainment deep into the stratosphere. This unique dynamical situation is characterized by warm tropospheric air overlaid by cold stratospheric temperature anomalies, and frequent occurrence of cirrus clouds. The ASMA has recently drawn much attention within the scientific communities and unprecedented campaigns using ground-based instruments and research aircraft are being carried out to understand associated sources and transport pathways.

Sponsors:

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Background:

Asian Summer Monsoon Anticyclone (ASMA) is a joint project between SRM, IST, India, CSIR 4PI, Bangalore, India, Hokkaido University, Japan and University of Saskatchewan, Canada sponsored by MHRD, Govt of India under its SPARC initiative started in the year 2018. The aim is to establish a strong research collaboration to peruse the sources and pathways of the atmospheric compositions in the Asian monsoon region which has global impact.

Workshop webpage:

https://www.srmist.edu.in/asma-2020/

The International ASMA Conference program was structured according to the four ASMA sub-themes which will highlight the current status of how the ASMA variability and dynamical mechanisms link to the stratospheric entrainment of surface trace gases.

1. Variability and Long-term changes of the trace gases in the ASMA
2. Transport pathways: relative roles of TEJ and deep convection
3. Cirrus cloud nucleation process and thermodynamical structure of the ASMA
4. Transport of ABL pollutant to free troposphere

The international ASMA conference included 30 oral and 10 poster presentations. This includes 9 keynote speakers, 6 invited talks and about 40% of the presentations from early carrier scientists and students. The presentations from early carrier scientists and students were examined by expert panels. The best two oral and poster presentations were awarded, each with a memento and cash prize. Due to the novel coronavirus outbreak in China just a week before the conference, international participants opted to deliver their presentations remotely. The conference was started with a formal inaugural function including lighting lamp followed by the welcome address by **Sanjay Mehta** (SRMIST, India) and the release of the abstract book and proceeding of the conference. The conference was divided into four oral sessions and one poster session. Each oral session began with a keynote presentation followed by invited talks and presentations from early carrier scientists and students. During this conference, a 3-day radiosonde campaign was also conducted to train the master degree students from SRM IST. The radiosonde system was recently purchased from InterMet, USA, who sponsored five radiosonde payloads for this conference.

Variability and long-term changes of the trace gases in the ASMA

The Aura Microwave Limb Sounder (MLS) has provided unprecedented measurements of trace gas species of tropospheric origin: CO, CH_3Cl, CH_3CN, HCN, CH_3OH, H_2O and stratospheric origin: O_3, HNO_3 and HCl. Of the 3500 daily profiles from MLS, ~300 falls within the general ASM region enclosed by the 10°-50°N latitude × 0°-140°E longitude. MLS is well suited to characterize UTLS composition in the ASM region and quantify its considerable spatial, seasonal, and interannual variations. Based on 15 years of MLS observations, **Michelle Santee** (JPL, California Institute of Technology, USA) presented a comprehensive overview of the climatological composition of the ASMA and interannual variations in the UTLS response to the monsoon as well as trends. **M. Venkat Ratnam** (NARL, Gadanki, India) described that the ASMA is strongly affected by long-period oscillations such as QBO, ENSO and Solar Cycle.

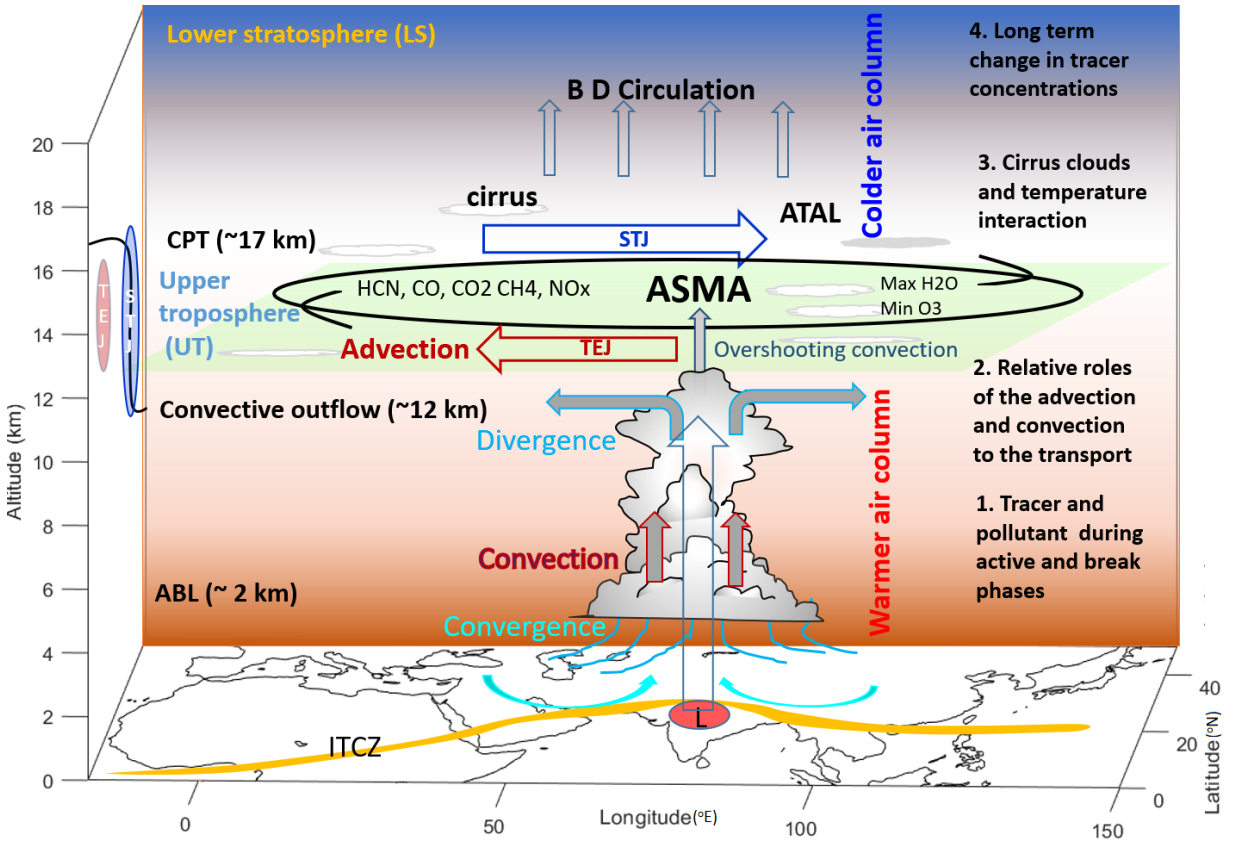

Figure 8: *Schematics of the vertical structure of the troposphere (red) and lower stratosphere (blue) showing the transport of the surface pollutant over the Indian monsoon region. The Asian summer monsoon anticyclone (ASMA, green) horizontally confined within subtropical jet (STJ) in the northern flank and tropical easterly jet (TEJ) in equatorial side and vertically confine within top of the convective outflow level and cold point tropopause (CPT). During ASM inter tropical convergence zone (ITCZ) shifts towards the northward create low pressure in central India. The deep convection transports the surface pollutants from the South Asian atmospheric boundary layer (ABL). ASMA contains chemically active gases and surface pollutants which is slowly enters to the deep stratosphere possibly by Brewer-Dobson circulation. Four main subthemes of the conference are listed in the diagram.*

The SPARC Reanalysis Intercomparison Project (S-RIP) is a coordinated activity to compare key diagnostics that are important for stratospheric processes and their tropospheric connections among available reanalyses. **Susann Tegtmeier** (Univ. of Saskatchewan, Canada) presented the bimodality of the ASMA, cold point tropopause temperature, vertical velocity and diabatic heating proxy for convective transport, residence times based on diabatic Lagrangian transport calculations and cloud properties in ASMA and their differences amongst reanalysis. All reanalyses generally agree on the climatological mean position of the ASMA core with smaller differences. Detailed understanding of Upper tropospheric ozone transport from the sub-tropics to tropics was discussed by **Siddarth Das** (SPL, Trivandrum, India). **Sabin T.P.** (IITM, Pune, India) using CMIP5 output, MRI-20 km model simulations and global climate model presented the intensity of the boreal summer monsoon overturning circulation and the weakening of associated south-westerly monsoon flow during the past 50-years. **Ghouse Basha** (NARL, Gadanki, India) presented variability of ASMA in association with active monsoon and La Niña years. Other presentations focussed on the water vapor distribution with increasing concentrations in the UTLS over ASM region El-Niño years (**K. V. Suneeth**; SPL, Trivandrum, India), ASMA variability during active break phases of monsoon (**Aneesh S.**; SRM IST, Kattankulathur, India) and a review on climatological feature of the ASMA and trace gases in the UTLS (**Sanjay Mehta**).

Transport pathways: relative roles of TEJ and deep convection

Airborne measurements such as during the OMO and StratoClim campaigns have been carried out to understand the chemical compositions of the ASMA. Based on these campaigns, **Hans Schlager** (DLR, Istitut für Physik der Atmosphäre, DLR, Germany) described that Southeast Asia (India/Nepal/Pakistan and China) are the main source regions to contribute the air in the ASMA, sharp gradients of traces gases across the edge of the ASMA, convective transport indicating enhanced SO_2 and NO observation above the CPT in the ASMA, observed mixed particles, nitrates and organics in the ASMA and nucleation of HNO_3 in ice clouds.

Figure 9: *Participants at the International Conference on the Asian Summer Monsoon Anticyclone held in Chennai, India, during February 10-11, 2020. International participants attended online due to the then emerging COVID-19 issue.*

Suvarna Fadnavis (IITM Pune, India) presented transport of trace gases via eddy shedding from ASMA to the extratropical upper troposphere and lower stratosphere using MIPAS satellite, ECHAM5–HAMMOZ global chemistry-climate model. The simulations show persistent maxima in black carbon, organic carbon, sulphate, and mineral dust aerosols within the ASMA throughout the ASM season (June to September). Effects of Asian monsoon convection on the tropical tropopause layer (TTL) based on observations from StratoClim campaign was presented by **K. Mohankumar** (ACAAR, Cochin, India). The StratoClim aircraft campaign under Indo-French joint research program took place from 27 July to 10 August 2017 and provided an extensive dataset of observations of air composition inside the ASMA region. Analysis of campaign data indicates the origin of convective air mainly from local sources, like North India, Nepal and Tibetan Plateau, injected at heights between 14 and 15 km. **Revathy S. Ajayakumar** (SPL, Trivandrum, India) presented the results on the tropospheric ozone measurements by balloon-borne ozonesondes during 2011 to 2014. **Akhil Raj S.T.** (NARL, Gadanki, India) described the results on trace gases measurements under ISRO-NASA BATAL Campaigns which includes Radiosonde, ozonesonde, Cryogenic frost Point Hygrometer (CFH), Compact optical Backscatter Aerosol Detector (COBALD) and optical particle counters measurements. The Influence of the bimodality in the ASMA on the UTLS chemical composition was shown by **A. Hemanth Kumar** (NARL, Gadanki India). **N. Kowshika** (TNAU, Coimbatore, India) presented the overview on TEJ over Indian monsoon region and **Sanjay Mehta** discussed the Relationship between the tropical tropopause and TEJ streams over Indian monsoon region. **Selvaraj Dharmalingam** (Ecole Polytechnique, France/ University of Central Florida, Orlando, USA) presented the accuracy of super-pressure balloon trajectory forecasts in the lower stratosphere. The observed trajectories were made during the (tropical) Pre-Concordiasi and (polar) Concordiasi campaigns in 2010, while the simulated trajectories are computed using analyses and forecasts from the European Centre for Medium-Range Weather Forecasts (ECMWF) Integrated Forecast System model. **Satheesh Chandran P R** (SPL, Trivandrum, India) presented the results on the effect of monsoon dynamics on the variability and distributions of ozone in the tropical UTLS using radiosonde/ozonesonde observations.

Cirrus cloud nucleation process and thermodynamical structure of the ASMA

ASMA transport processes with proposed simultaneous measurement of balloons, Lidars, and aircraft under proposed Asian Summer Monsoon Chemical and Climate Impact Project (ACCLIP) was presented by **Masatomo Fujiwara** (Hokkaido University, Sapporo, Japan). The primary goal of this program is to investigate the impacts of Asian gas and aerosol emissions on global chemistry and climate via the linkage of ASM convection and associated large-scale dynamics. A case study of lidar aerosol measurements in Japan during July-August-September 2018 was conducted to understand the capability of measuring UTLS aerosol particles coming from ASMA region. **Karanam Kishore Kumar** (SPL, Trivandrum, India) presented vertical distributions of multi-layered cloud and their types, the spatial distribution of convectively active regions, and associated dynamics from the five years (2006–2010) of CloudSat observations over the Indian summer monsoon region.

The frequency of occurrence of various cloud types their vertical structure was used to identify the preferential regions for particular cloud types. A possible role of the large-scale circulation in the formation of multi-layered clouds was suggested. The role of latent heat released in the clouds in driving the mesoscale to synoptic-scale circulation needs to be explored. **Mushin M** (NIT, Calicut, India) presented heterogeneity in diurnal variation of tropospheric convection over Indian region, **Sunil Kumar SV** (SPL, Trivandrum, India) described the deep convection, inter-tropical convergence zone and ASM. He used balloon-borne cryogenic frost-point hygrometer (CFH) observations during the period 2014-2017 over Hyderabad and Trivandrum to determine the amount of water vapor transport into UTLS and its role in the formation of cirrus clouds. These observations reveal the persistence of thin cirrus overlying a thick cirrus associated with the deep convective outflows mainly hydrate the region while the thin cirrus layer can cause hydration or dehydration in the TTL depending upon the temperature anomalies. **Ajil Kottayil** (ACARR, Cochin, India) presented the factors behind the variability of cirrus clouds using TRACZILLA model over the ASM region. It is suggested that an increase in the cirrus frequency (~ 60%) towards the westward direction from north Bay of Bengal over the regions lying within 72-90°E and 0-12°E during ASM season. **Saleem Ali** (SRMIST, Chennai, India) nvestigated the occurrence of cirrus clouds and its seasonal variability using micro-pulse lidar (MPL) observations for the period 2016-2018 over Chennai.

Transport of ABL pollutant to free troposphere

The atmospheric boundary layer is the source region for the transport of pollutants into the UTLS via monsoon convection process. Organic species are ubiquitous and often found to be a dominant component of atmospheric fine particles. **Neeraj Rastogi** (PRL, Ahmedabad, India) discussed the atmospheric ageing of Organic aerosol (OA) during horizontal and vertical transport and their effects on air quality and climate. **Vinoj V** (IIT Bhuvneshwar, India) presented the simulation simulate the observed changes in dust aerosol loading over the Indian region using regional climate model and attributed the role of large scale dynamics. The exchange process and aerosol properties from the boundary layer to free troposphere was the focus of **Aravindhavel A**'s (SRMIST, India) presentation and **Balasubramanian** (SRM IST, India) presented important emission regions for atmospheric industrial persistent organic pollutants (iPOPs) and its implications for atmospheric transport using HYSPLIT trajectory model. **Ramesh Reddy** (SRM IST, India) presented the performance of different PBL parameterization schemes available in weather research and forecasting (WRF) to simulate the observed characteristics of atmospheric boundary layer height over Chennai.

Acknowledgements

We acknowledge support for the conference by MHRD, Govt of India under SPARC Program and SRM IST.

Figure 10: *Conference activities left to right release of the Abstract book and conference proceeding, Participants during inaugural day, poster presentations by participants and Radiosonde balloon launch during the International ASMA Conference.*