Indian Institute of Science Education & Research (IISER) Mohali

Department of Earth and Environmental Sciences

Foreword

The Indian Institutes of Science Education and Research (the IISERs) are a group of institutes set up by the Ministry of Human Resource Development (MHRD) of the Government of India (GOI), to facilitate high quality science education and research in the country. The first two IISERs were set up in Pune and Kolkata in 2006. The IISER at Mohali (IISER-M) began functioning in 2007. Two more IISERs were set up at Bhopal and Trivandrum in 2008. After functioning out of a transit campus located in Chandigarh for few years, IISER-M moved into its own permanent campus completely in 2013.

In June 2012, the institute organized itself into separate departments for administrative efficiency. In terms of research and teaching IISER Mohali continues to foster inter-disciplinary teaching and research across disciplines.

In its educational aspects, IISER-M is modelled on the highly successful Indian Institutes of Technology (the IITs). In its research-related aspects, IISER-M is modelled on the Indian Institute of Science (IISc) Bangalore.

All five IISERs were originally set up to bring together researchers who are pursuing cutting edge research in their individual disciplines and highly motivated graduate and undergraduate students.

The Department of Earth and Environmental Sciences is a new and vibrant department which seeks to pursue high profile research in the broad subject areas of Earth and Environmental Sciences, motivate undergraduates and graduates to undertake cutting edge research and provide them international exposure.

The Department has made a start with four regular faculty members and an honorary Professor and is constantly looking for extremely motivated scientists with a high-profile research agenda and a flair for teaching to join the faculty team.

The Department currently conducts a PhD program and participates in undergraduate teaching by offering core elective courses as well as advanced interdisciplinary elective courses open to 3rd, 4th and 5th year students from all the major disciplines.

Department of Earth and Environmental Sciences

Faculty Profiles

Joined August 2010

Vinayak Sinha

Associate Professor

M.Sc., Sri Sathya Sai Institute of Higher Learning, Prashantinilayam, 2002

M.Tech, Indian Institute of Technology Delhi, 2004

Ph.D., Johannes Gutenberg University & MPIC Mainz, 2007

Post Doc, Max Planck Institute for Chemistry, 2007-2010

Vinayak Sinha is guiding/has guided 6 Ph.D. and 9 M.Sc. thesis students

Selected Publications

Sarkar, C., **Sinha, V.,** Kumar, V., Rupakheti, M., Panday, A.K., Mahata, K., Rupakheti, D., Kathayat, B., Lawrence, M.G., Overview of VOC emissions and chemistry from PTR-TOF-MS measurements during the SusKat-ABC campaign: High acetaldehyde, isoprene and isocyanic acid in wintertime air of the Kathmandu Valley, **Atmos. Chem. Phys.**, 16, 3979- 4003, 2016. (Top 5% cited)

Chandra, B.P., **Sinha, V.,** Contribution of post-harvest agricultural paddy residue fires in the N.W. Indo-Gangetic Plain to ambient carcinogenic benzenoids, toxic isocyanic acid and carbon, **Environment International** 88, 187-197, 2016. (Top 10% cited)

Kumar, V., Sarkar, C., **Sinha, V.,** Influence of post-harvest crop residue fires on surface ozone mixing ratios in the N.W. IGP analyzed using 2 years of continuous in situ trace gas measurements, **JGR: Atmospheres** 121, 3619- 3633, 2016. (Top 20% cited)

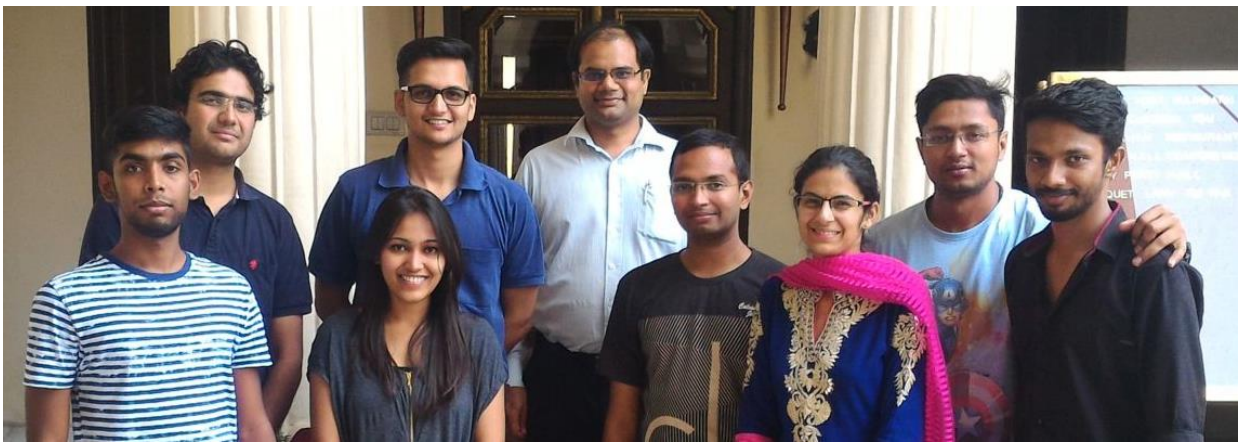
Sinha,V., Kumar,V., Sarkar,C., Chemical composition of pre-monsoon air in the Indo–Gangetic Plain measured using a new PTR-MS and air quality facility: high surface ozone and strong influence of biomass burning, **Atmos. Chem. Phys.**, 14, 5921-5941, 2014. (Top 5% cited)

Sinha, V., Williams, J., Diesch, J. M., Drewnick, F., Martinez, M., Harder, H., Regelin, E., Kubistin, D., Bozem, H., Hosaynali-Beygi, Z., Fischer, H., Andrés-Hernández, M. D., Kartal, D., Adame, J. A., Lelieveld, J., Constraints on instantaneous ozone production rates and regimes during DOMINO derived using in-situ OH reactivity measurements, **Atmos. Chem. Phys.**, 12, 7269-7283, 2012. (Top 15% cited)

Sinha, V., Williams, J., Lelieveld, J., Ruuskanen, T., Kajos, M., Patokoski, J., Hellen, H., Hakola, H, Morgensen, D., Boy, M., Rinne, J., Kulmala, M., OH reactivity measurements within a boreal forest: Evidence for unknown reactive emissions, **Environ. Sci. Tech.**, 44, 6614-6620, 2010. (Top 10% cited)

Sinha, V., Williams, J., Crowley, J., Lelieveld J., The Comparative Reactivity Method – A new tool to measure the total OH Reactivity of ambient air, **Atmos. Chem. Phys.**, 8, 2213-2227, 2008. (Top 10% cited)

Sinha, V., Williams, J., Meyerhofer, M., Riebesell, U., Paulino, A. I., Larsen, A., Air-sea fluxes of methanol, acetone, acetaldehyde, isoprene and DMS from a Norwegian fjord following a phytoplankton bloom in a mesocosm experiment, **Atmos. Chem. Phys.**, 7, 739-755, 2007. (Top 15% cited)

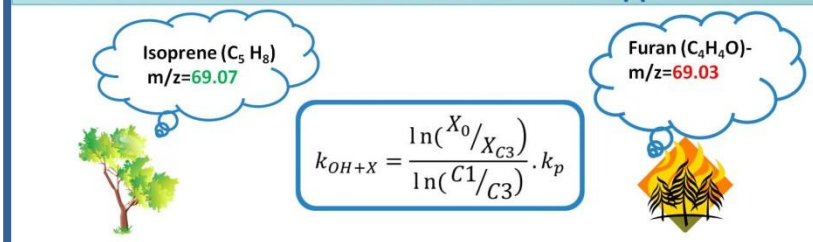


Research Interests

Our current research focus is centred on the real time atmospheric reactivity of hydroxyl radicals, emissions and chemistry of volatile organic compounds and the instantaneous ozone formation photochemistry, so as to develop a fundamental understanding of the processes that control the self cleansing (oxidizing) capacity of ambient air over the Indo Gangetic Plain. Towards this end, my group builds instruments (e.g. for quantifying OH reactivity) and deploys very sensitive online spectroscopic and mass spectrometric technqiues for quantifying the ultra trace atmospheric chemical constituents.

We are the only laboratory in India to have developed an instrument for quantifying atmospheric OH reactivity directly based on the innovative Comparative Reactivity Method (CRM) (Kumar and Sinha, 2014), that has been emulated by leading research groups worldwide (e.g. USA, France and Germany). OH reactivity is the key chemical parameter that constrains the total reactive pollutant loading of air masses and enables instantaneous ozone production rates and regimes to be quantified (Sinha et al. 2012). Our laboratory is also the first to deploy proton transfer reaction mass spectrometry (PTR-MS) technology within India and houses India's first PTR-MS. This instrument quantifies highly reactive volatile organic compounds (VOC's) in real-time at parts per trillion (ppt) level and has already been used to compile the first ambient dataset for reactive VOCs such as isoprene and acetaldehyde over the Indian region (Sinha et al. 2014).

VOC-OHM : A new analytical technique from IISER M's lab that can resolve nominal isobars in MS at ppt levels !



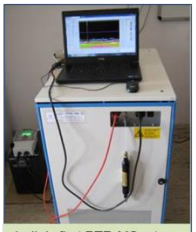
- Enables distinction between isoprene (m/z 69.07) and furan (m/z 69.03)
- Rate coefficient of the main contributor enables identification of primary isobaric contributor
- $k_{OH+isoprene} = 1.01E{-}10\ cm^3molecule^{-1}s^{-1}$
- $k_{OH+furan} = 4.01E{-}11\ cm^3molecule^{-1}s^{-}$

Calculated: $k_{OH+\frac{m}{z}69} = 1.18E{-}10\ cm^3molecule^{-1}s^{-1}$

V. Kumar, V. Sinha, VOC-OHM: A new technique for rapid measurements of ambient total OH reactivity and volatile organic compounds using a single proton transfer reaction mass spectrometer, International Journal of Mass Spectrometry, 2014, doi-10.1016/j.ijms.2014.10.012

Isoprene Acetonitrile

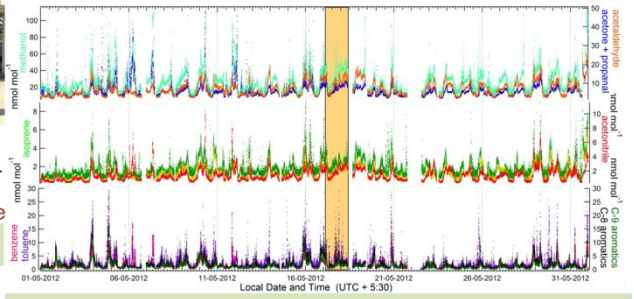
The 24 x 7 measurement facility (in blue) and team



India's first PTR-MS at IISER Mohali

Real time Volatile Organic Compound (VOC) speciation in ambient air of the IGP at parts per trillion (ppt) level :

India's first Proton Transfer Reaction Mass Spectrometer (PTR-MS) makes it possible

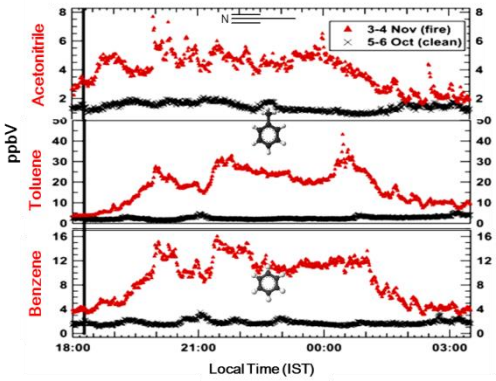


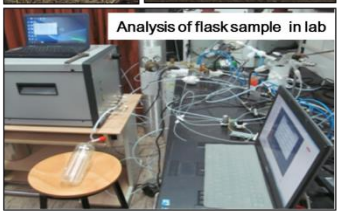
First ever in-situ ambient data of short lived reactive VOCs (methanol, acetone, acetaldehyde and isoprene) & acetonitrile (biomass burning marker) within India

- The Indo Gangetic Plain (IGP) grows much of South Asia's food crops but its ambient chemical composition is unknown for reactive VOCs that fuel ozone and aerosol formation. Note ozone levels exceeded the air quality standard 29/31 days in May 2012
- The in-situ chemical dataset reveals that the ozone production regime is sensitive to both VOCs & NOx, implying increase in either will increase future surface ozone levels
- The study will help policy makers plan effective mitigation strategies against pollutant build up that damages crops, affects human health and climate.

V. Sinha*,, V. Kumar and C. Sarkar , Atmos Chem Phys , 14, 5921-5941, 2014

Massive Emissions of Carcinogenic Benzenoids from Paddy Residue Burning





- Paddy residue burning is a widely prevalent post harvest activity in north India which occurs in Oct-Nov every year
- Chemical analysis of fire influenced air plumes (red data) versus non-fire influenced "control" air plumes

(black data) showed that the paddy residue fire influenced air masses had high levels of measured carcinogens (20 ppb toluene, 12 ppb benzene) even at a downwind site several km away. Levels of the carcinogens in air samples from the field were even higher (>2-3 times of these levels)

- Exposure to such high levels of carcinogenic chemicals exceeds permissible MOEF NAAQS limits for annual exposure to carcinogens (e.g. benzene) and poses grave cancer risks. Farmers and villagers are at highest risk from this activity

C. Sarkar *, V. Kumar and V. Sinha , Current Science , 104 (12), 1703-1706, 2013

Joined September 2011

Baerbel Sinha

Assistant Professor

M.Sc., TU-Bergakademie Freiberg, Germany, 2004

Ph.D., Johannes Gutenberg University & MPIC Mainz, 2007

Post Doc, Max Planck Institute for Chemistry, 2007-2011

Baerbel Sinha is guiding/has guided 5 Ph.D students and 14 M.Sc. thesis students

Selected Publications

Garg, S., Chandra, B.P., Sinha, V., Sarda-Esteve, R., Gros, V., **Sinha, B.,** Limitation of the Use of the Absorption Angstrom Exponent for Source Apportionment of Equivalent Black Carbon: A Case Study from the North West Indo-Gangetic Plain, **Environmental Science and Technology** 50, 814-824, 2016. (Top 10% cited)

Nandy, B., Sharma, G., Garg, S., Kumari, S., George, T., Sunanda, Y., **Sinha, B.,** Recovery of consumer waste in India - A mass flow analysis for paper, plastic and glass and the contribution of households and the informal sectors, **Resources, Conservation and Recycling** 101, 167-181, 2015. (Top 5% cited)

Pawar, H., Garg, S., Kumar, V., Sachan, H., Arya, R., Sarkar, C., Chandra, B.P., **Sinha, B.,** Quantifying the contribution of long-range transport to particulate matter (PM) mass loadings at a suburban site in the north-western Indo-Gangetic Plain (NW-IGP), **Atmospheric Chemistry and Physics** 15, 9501-9520, 2015. (Top 15% cited)

Harris, E., **Sinha, B.**, van Pinxteren, D., Tilgner, A., Fomba, K. W., Schneider, J., Roth, A., Gnauk, T., Fahlbusch, B., Mertes, S., Lee, T., Collett, J., Foley, S., Borrmann, S., Hoppe, P., Herrmann, H., Enhanced role of transition metal ion catalysis during in-cloud oxidation of SO_2. **Science** 340, 727-730, 2013. (Top 5% cited)

Pöhlker, C., Wiedemann, K., **Sinha, B.**, Shiraiwa, M., Gunthe, S. S., Smith M., Hang, S., Artaxo, P., Chen, Q., Cheng, Y., Elbert, W., Gilles, M.K., Kilcoyne, A. L. D., Moffet, R., Weigand, M., Martin, S. T., C., Pöschl, U., Andreae, M. O., Biogenic potassium salt particles as seeds for secondary organic aerosol in the Amazon, **Science** 337, 1075-1078, 2012. (Top 5% cited)

Pöschl, U., Martin, S. T., **Sinha, B.**, Chen, Q., Gunthe, S. S., Huffman, J. A., Borrmann, S., Farmer, D. K., Garland, R. M., Helas, G., Jimenez, J. L., King, S. M., Manzi, A., Mikhailov, E., Pauliquevis, T., Petters, M. D., Prenni, A. J., Roldin, P., Rose, D., Schneider, J., Su, H., Zorn, S. R., Artaxo, P., Andreae, M. O., Rainforest aerosols as biogenic nuclei of clouds and precipitation, **Science**, 329, 1513-1516, 2010. (Top 1% cited)

Winterholler, B., Hoppe, P., Foley, S., Andreae, M. O., Sulfur isotope measurements of individual sulfate particles by NanoSIMS. **International Journal of Mass Spectrometry**, 272, 63-77, 2008. (Top 25% cited)

Musat, N., Halm, H., **Winterholler, B.**, Hoppe, P., Peduzzi, S., Hillion, F., Horreard, F., Amann, R., Jørgensen, B. B., Kuypers, M. M.M., A single cell view on the ecophysiology of anaerobic phototrophic bacteria. **Proceedings of the National Academy of Science of the United States of America**, 105, 17861-17866, 2008. (Top 10% cited)

Research Interests

Our research focuses on investigating how the chemical properties and micro-physics of individual aerosol particles are affected by particle mixing state and ageing. We use a suite of sophisticated single particle techniques such as Scanning Electron Microscopy, Atomic Force Microscopy, Nano Secondary Ion Mass Spectrometry, Micro Raman Spectroscopy and Scanning Transmission X-ray Microscopy - Near Edge X-ray Absorption Fine - structure Spectroscopy as tools for investigating the mixing state, morphology and chemical composition of individual atmospheric aerosol particles.

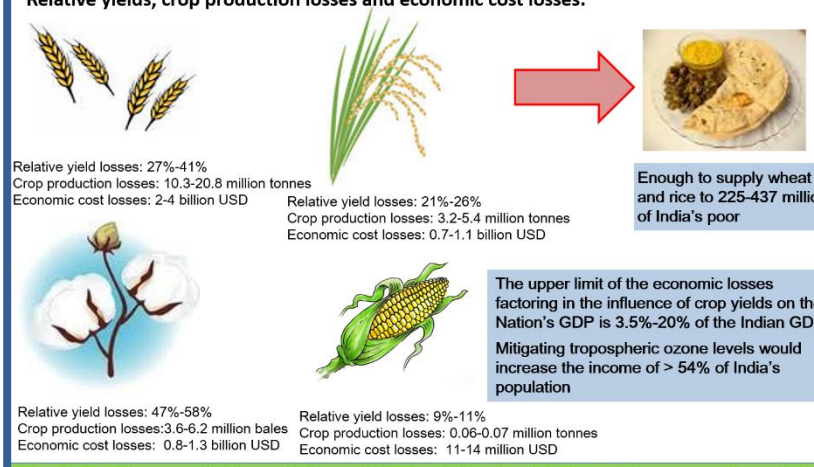
We aim to understand the effect of aerosol surface properties and mixing state on initiating and sustaining rainfall (Pöschl et al. 2010, Pöhlker et al. 2012) and on the direct climate forcing of aerosol. We investigate multiphase and heterogeneous reactions taking place on the surface of aerosol particles (Harris et al. 2013) with the purpose of improving global climate model predictions of secondary inorganic (Harris et al. 2013) and secondary organic particle formation (Pöschl et al. 2010).

We are also interested in source-receptor modelling of particulate matter, black carbon, ozone precursors and methane. We couple source identification with research on socially acceptable and economically viable approaches to couple mitigation climate change and air pollution with sustainable development.

Our research focuses on short lived climate forcers in particular ozone, black carbon, particulate matter and methane.

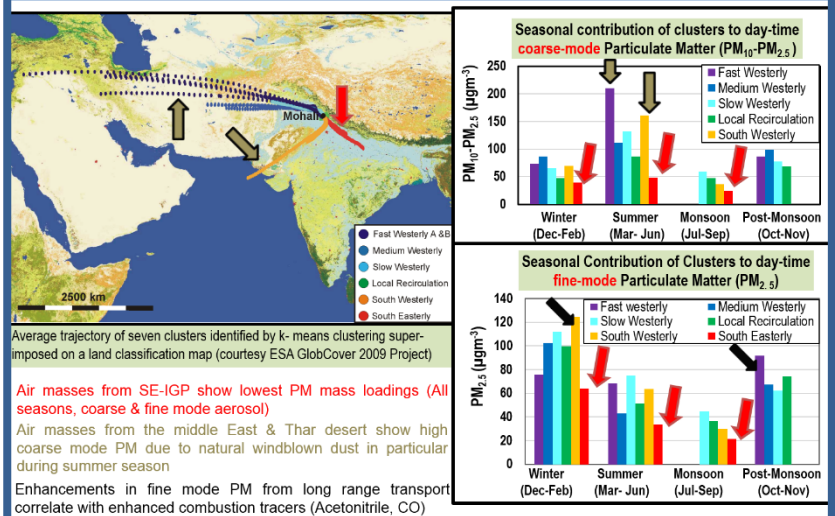
Assessment of crop yield losses in Punjab and Haryana using two years of continuous in-situ ozone measurements

Relative yields, crop production losses and economic cost losses:



Sinha, B., Singh Sangwan, K., Maurya, Y., Kumar, V., Sarkar, C., Chandra, B.P., Sinha, V. Assessment of crop yield losses in Punjab and Haryana using 2 years of continuous in situ ozone measurements, Atmos. Chem. Phys 15, 9555-9576, https://www.atmos-chem-phys.net/15/9555/2015/acp-15-9555-2015.pdf, 2015.

Long range transport of aerosol to the North West Indo-Gangetic Plain



Average trajectory of seven clusters identified by k- means clustering super-imposed on a land classification map (courtesy ESA GlobCover 2009 Project)

Air masses from SE-IGP show lowest PM mass loadings (All seasons, coarse & fine mode aerosol)

Air masses from the middle East & Thar desert show high coarse mode PM due to natural windblown dust in particular during summer season

Enhancements in fine mode PM from long range transport correlate with enhanced combustion tracers (Acetonitrile, CO)

Pawar, H., Garg, S., Kumar, V., Sachan, H., Arya, R., Sarkar, C., Chandra, B.P., Sinha, B., Quantifying the contribution of long-range transport to particulate matter (PM) mass loadings at a suburban site in the north-western Indo-Gangetic Plain (NW-IGP), Atmos. Chem. Phys 15, 9501-9520, 2015.

Enhanced role of transition metal ion catalysis during in-cloud oxidation of SO_2

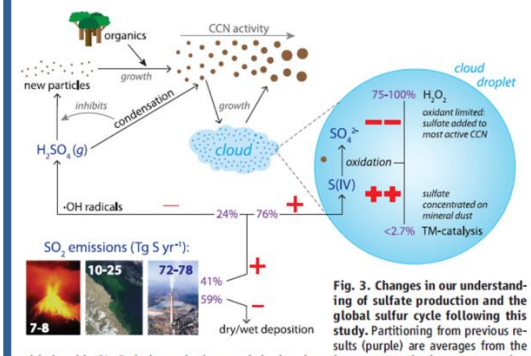


Fig. 3. Changes in our understanding of sulfate production and the global sulfur cycle following this study. Partitioning from previous results (purple) are averages from the models in table S1. Red plus and minus symbols show how the current study changes our understanding of the sulfur cycle; the number and size of plus and minus symbols represent the expected magnitude of the change and our confidence in it, respectively.

Major findings:

Transition metal ions play a substantial role in S(IV) to S(VI) conversion in the atmosphere.

The reaction occurs on coarse mode dust particles with short atmospheric residence times and results in rapid removal of sulphur from the atmosphere even at dust loadings of less than 2 µg/m³.

Globally 35% of the S(IV) to S(VI) conversion takes place due to this reaction.

Including it into atmospheric chemistry models reduces the global cooling due to fine mode sulphate

Harris, E.*, Sinha, B.*, van Pinxteren, D., Tilgner, A., Fomba, K. W., Schneider, J., Roth, A., Gnauk, T., Fahlbusch, B., Mertes, S., Lee, T., Collett, J., Foley, S., Borrmann, S., Hoppe, P., and Herrmann, H., Enhanced Role of Transition Metal Ion Catalysis During In-Cloud Oxidation of SO_2. *Science* 340, 727-730, 2013.

Joined March 2017

Anoop Ambili

Assistant Professor

M.Sc., Pondicherry Central University, Pondicherry, India, 2007

Ph.D., University of Potsdam, Potsdam, Germany, 2013

PostDoc, German Research Center for Geoscience (GFZ Potsdam), Germany, 2013-2014

PostDoc, Indian Institute of Science Education and Research Kolkata, 2014-2015

Inspire Faculty, Indian Institute of Science Education and Research Mohali, 2015-2017

Dr. Anoop Ambili is guiding/has guided 2 Ph.D students and 4 M.Sc. thesis students

Selected Publications

Pillai, A.A.S., **Anoop, A.**, Sankaran, M., Sanyal, P., Jha, D.K., Ratnam, J., 2017. Mid-late Holocene vegetation response to climatic drivers and biotic disturbances in the Banni grasslands of Western India. **Paleoclimatology Paleoecology Paleogeography** (in press). https://doi.org/10.1016/j.palaeo.2017.07.036

Ankit, Y., Mishra, Praveen K., Kumar, P., Jha, Deepak K., Kumar, Vivek V., Ambili, V., **Anoop, A.**, 2017. Molecular distribution and carbon isotope of n-alkanes from Ashtamudi Estuary, South India: Assessment of organic matter sources and paleoclimatic implications. **Marine Chemistry** (in press). https://doi.org/10.1016/j.marchem.2017.08.002.

Prasad, S., **Anoop, A.**, et al., Prolonged monsoon droughts and links to Indo-Pacific warm pool: a Holocene record from Lonar Lake, Central India. **Earth and Planetary Science Letters** 391, 171-182, 2014. (Top 2% cited)

Mishra, Praveen K, **Anoop, A.**, Jehangir, A., Prasad, S., Menzel, P., Schettler, G., Naumann, R., Weise, S., Yousuf, A.R., Gaye, B., Limnology and modern sedimentation patterns in high altitude Tso Moriri Lake, NW Himalaya – implications for proxy development. **Fundamental and Applied Limnology** 185 (3-4), 329-348, 2014.

Anoop, A., Prasad, S., Plessen, B., Naumann, R., Menzel, P., Basavaiah, N., Weise, S., Gaye, B., Brauer, A., Palaeoenvironmental implications of evaporative Gaylussite crystals from Lonar Lake, Central India. **Journal of Quaternary Science** 28 (4), 349-359, 2013. (Top 10% cited)

Anoop, A., Prasad, S., Krishnan, R., Naumann, R., Dulski, P., Intensified monsoon and spatiotemporal changes in precipitation patterns in the NW Himalaya during the early-mid Holocene. **Quaternary International** 313-314, 74-84, 2013.

Anoop, A., Prasad, S., Basavaiah, N., Brauer, A., Shahzad, F., Deenadayalan K., Tectonic versus climate influence on landscape evolution: a case study from the upper Spiti valley, NW Himalaya. **Geomorphology** 145-146, 32-44, 2012. (Top 25% cited)

Research Interests

Our research is aimed at multi-proxy paleoclimate reconstruction, with special focus on developing transfer functions for quantification of climate variability and understanding the impact of climate change on different components of the geo-ecosystems. We use lacustrine sediments from the Indian subcontinent as climate archives for deciphering past environmental changes. The developed paleoclimate dataset aims to improve the understanding of monsoon variability and the complex forcing mechanisms (solar insolation, internal teleconnections for e.g., El Niño-Southern Oscillation, tropical-midlatitude interactions).

Research Highlights

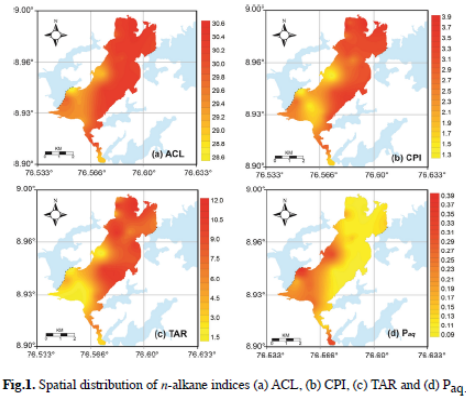


Fig.1. Spatial distribution of *n*-alkane indices (a) ACL, (b) CPI, (c) TAR and (d) P_{aq}.

- Baseline information on *n*-alkanes and carbon isotope in Ashtamudi Estuary sediments.
- Estimation of terrigenous versus recycled Organic Matter.
- Estimation of terrigenous versus aquatic productivity.

We evaluated the applicability of *n*-alkane indices to assess the relative contribution of terrestrial versus marine organic matter inputs to the estuarine environment.

- Quantitative apportion of organic matter sources in Ashtamudi sediments using End-member modelling of compound-specific carbon isotope values.
- The modern calibration from Ashtamudi Estuary provides potential in using *n*-alkane distribution in conjunction with carbon isotope as part of a high-resolution multi-proxy paleoclimate reconstruction from the region.

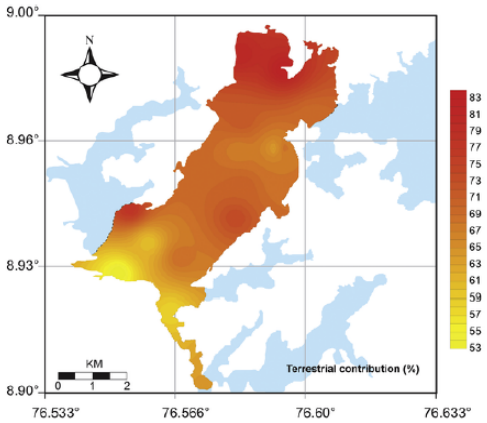


Fig.2. Spatial representation of terrigenous contribution in Ashtamudi Estuary based on the end member modelling of compound specific $\delta^{13}C$ values.

Ankit, Y., Prem, K., Mishra, P.K., **Anoop, A.**, 2017. Molecular distribution and carbon isotope of n-alkanes from Ashtamudi Estuary, South India: Assessment of organic matter source and paleoclimatic implications. Marine Chemistry. (doi.org/10.1016/j.marchem.2017.08.002)

A combination of geomorphic, sedimentological, geochemical, biomarker (*n*-alkane) in conjunction with isotopic data is used to understand the Holocene paleoclimate fluctuations. We are currently working on lacustrine sediments (e.g. Ahansar Lake, Kashmir valley; Ashtamudi Estuary, Kerala; Rushikulya continental shelf sediments; Ennamangalam Lake, Tamil Nadu) from various climate sensitive zones of Indian subcontinent. We perform modern calibration approach to identify proxies that are sensitive to environmental changes and use the identified proxies to generate long-term high-resolution palaeoclimate data.

Joined August 2017

Sunil Patil

Assistant Professor

M.Sc., Shivaji University, Kolhapur, 2005

Ph.D., University of Pune, 2011

DAAD scholar at TU Braunschweig, Germany, 2008-2010

Marie Skłodowska-Curie postdoc, Lund University, Sweden, 2011-2012

Marie Skłodowska-Curie fellow, Ghent University, Belgium, 2013-2016

Senior Humboldt fellow, TU Braunschweig, 2016-2017

Selected Publications

*Arends, J.B.A., ***Patil, S.A.**, Roume, H. and Rabaey, K., Continuous long-term electricity-driven bioproduction of carboxylates and isopropanol from CO_2 with a mixed microbial community. **Journal of CO_2 utilization**, 20, 141–149, 2017.

Pandey P., Shinde V. N., Deopurkar, R. L., Kale, S. P., **Patil, S.A.** and Pant, D., Recent advances in the use of different substrates in microbial fuel cells toward wastewater treatment and simultaneous energy recovery. **Applied Energy,** 168, 706-723, 2016. (Top 1% cited)

***Patil, S.A.**, *Arends, J.B.A., Vanwonterghem, I., van Meerbergen, J., Guo K., Tyson, G.W. and Rabaey, K., Selective enrichment establishes a stable performing community for microbial electrosynthesis of acetate from CO_2. **Environmental Science and Technology**, 49, 8833-8843, 2015. (Top 1% cited)

Patil, S.A., Gildemyn, S., Pant, D., Zengler, K., Logan, B.E. and Rabaey, K., A logical data representation framework for electricity-driven bioproduction processes. **Biotechnology Advances**, 33, 736-744, 2015. (Top 1% cited)

Patil, S.A., Górecki, K., Hägerhäll, C. and Gorton, L., Cisplatin-induced elongation of Shewanella oneidensis MR-1 cells improves microbe–electrode interactions for use in microbial fuel cells. **Energy and Environmental Science**, 6, 2626–2630, 2013. (Top 25% cited)

Patil, S.A., Hägerhäll, C. and Gorton, L., Electron transfer mechanisms between microorganisms and electrodes in bioelectrochemical systems. **Bioanalytical Reviews** 4, 159-192, 2012. (Top 20% cited)

Millo, D., Harnisch F., **Patil, S.A.**, Schröder, U. and Hildebrandt, P., In situ spectroelectrochemical investigation of electrocatalytic microbial biofilms by surface-enhanced resonance Raman spectroscopy. **Angewandte Chemie International Edition**, 50(11), 2625-2627, 2011. (Top 5% cited)

Chen, S., Hou, H., Harnisch, F., **Patil, S. A.**, Carmona-Martinez, A. A., Agarwal, S., Zhang, Y., Sinha-Ray S., Yarin, A. L., Schröder, U. and Greiner, A., Electrospun and solution blown three-dimensional carbon nanofiber nonwovens for application as electrodes in microbial fuel cells. **Energy and Environmental Science**, 4, 1417–1421, 2011. (Top 1% cited)

Patil, S., Harnisch, F. and Schröder, U., Toxicity response of electroactive microbial biofilms- a decisive feature for potential biosensor and power source applications. **ChemPhysChem**, 11, 2834–2837, 2010. (Top 20% cited)

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(*Equal contribution)

Research Interests

Our research focuses mainly on resource recovery from wastewaters, CO_2 conversion to biochemicals and biofuels, and bioremediation of pollutants with the goal of advancing environmental science and engineering towards value addition through to the development of sustainable biotechnologies. To achieve this, we use microbial electrocatalysis approach wherein microorganisms are used to catalyze the oxidation and/or reduction reactions at the electrodes in bioelectrochemical systems. In addition to the microbiology and electrochemistry toolkit, we employ techniques from environmental science, material science, energy science and engineering, bioengineering, microscopy and analytical chemistry disciplines to understand the fundamental aspects of microorganism-electrode interactions and to explore them for developing practically relevant applications (Fig.1).

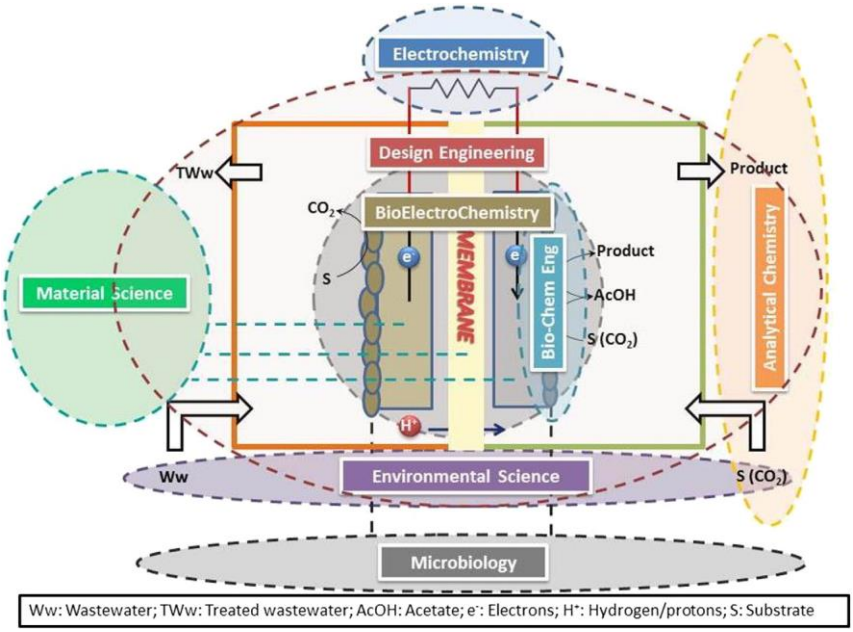

Fig. 1. An overview of the key aspects of microbial bioelectrochemical systems, spanning interdisciplinary approaches from various research fields *(Patil et al. Biotechnology Advances, 2015, 33, 736-744).*

Broadly, the research areas that we are interested in are summarized below.

I) Environmental Biotechnology: Electro-biotechnology

- Recovery of electricity or hydrogen, heavy metals & value-added chemicals from different wastewaters using microbial electrochemical technologies
- Carbon negative & energy neutral or positive wastewater treatment
- Electricity-driven production of biochemicals & biofuels from CO_2 using microbes
- Electro-assisted bioremediation

II) Environmental Microbiology: Electro--microbiology

- Exploration of different natural habitats for electroactive microorganisms
- Interactions between microorganisms & electrodes
- Microbial ecology of electroactive biofilms

Details and Indices

Honorary, Adjunct & Visiting Faculty

Professor Ashok Sahni

Ex Department of Earth Sciences, Punjab University, Chandigarh

Former Inspire Faculty

Dr. V. Lakshmi Narayanan

Faculty – Research Support

Dr. Vinayak Sinha

Max Planck Research Partner Group (2011-2016)	Rs 119.37 Lakh
DST Climate (2017-2019)	Rs 151 Lakh

Dr. Barbel Sinha

NCAP-COALESCE (2016-2021)	Rs 106 Lakh

Dr. Anoop Ambili

INSPIRE Faculty Grant (2015-2020)	Rs 35 Lakh

Dr. V. Lakshmi Narayanan

INSPIRE Faculty Grant (2014-2017)	Rs 17.5 Lakh

Faculty - Recognitions

Dr. Vinayak Sinha

- Received NASI-Scopus Young Scientist Award 2016
- Scientific Steering committee member of iLEAPS (Integrated Land Ecosystem-Atmosphere Processes Study) since 2015
- Co-chair of working group (WG 1) of the Atmospheric Composition in the Asian Monsoon (ACAM)
- Member of the Scientific Advisory Committee of the Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India since 2012
- Appointed Head of DST- Max Planck Partner Group on Tropospheric OH reactivity and VOC measurements in 2011
- Editor for the Journal “Earth System Science Data”
- Member of the Scientific Advisory Board of Sankar Foundation Research Institute, Vishakhapatnam, A.P., India since October, 2010.

Dr. Anoop Ambili

- Awarded INSPIRE Faculty position, India (2015 - 2020)

Student - Recognitions

Vinod Kumar (PhD scholar, EES, IISER Mohali)

- INSPIRE fellowship (2014-2018) for pursuing doctoral studies
- **International travel grant** from DST, to present a talk at iLEAPs Open Science Conference in Oxford, UK, 2017.
- **International travel grant** from Max Planck Institute for Chemistry, Mainz to take part in CINDI 2 field campaign in Cabauw, Netherlands, 2016.
- **First prize in poster presentation** in 7th national seminar on Synergistic Aspects of Chemistry and Other Sciences (SACOS) 2015, Punjabi University Patiala, India.
- **2014 IJMS Best Student Paper Award** from Elsevier and American Society of Mass spectrometry.
- **Member of the organising committee** for the International Integrated Land Ecosystem Atmosphere Processes Study (iLEAPS) Early-Career Scientist Workshop 10-12 May 2014, Nanjing, China.
- **International Travel Grant** from Integrated Land Ecosystem-Atmosphere Process Study to participate in 4th ILEAPS science conference in Nanjing, China. 2014.
- **International Travel Grant** from International Centre for Integrated Mountain Development (ICIMOD) to participate in WRF-CHEM workshop in Kathmandu, Nepal and to present a talk at SARAS workshop in Pokhran, Nepal. 2014.

B. Praphulla Chandra (PhD scholar, EES, IISER Mohali)

- IGAC **Early Career Travel Grant** to attend the IGAC Science Conference, 2016.
- **International Travel Grant** from Institute for Advanced Sustainability Studies (IASS), Potsdam to present a talk at European Geosciences Union (EGU) general assembly in Vienna, Austria, 2016.
- **International Travel Grant** from the German Federal Environment Agency and World Meteorological Organisation (WMO) to participate in the 29th GAWTEC Training Course, 2015.
- **Travel Grant** from Indian Institute of Science (IISc), Bangalore to present the poster at National Climate Science Conference" at IISc Bangalore, 2015.
- **International Travel Grant** from the Max Planck-DST project to present the poster at The Second Workshop on Atmospheric Composition and the Summer Monsoon (ACAM) and training school at Bangkok Thailand, 2015.

Abhishek Mishra (PhD scholar, EES, IISER Mohali)

- **International travel grant** from Atmospheric Composition and the Asian Monsoon (ACAM) to present a talk in The Third Workshop on Atmospheric Composition and the Asian Monsoon (ACAM) and Second ACAM Training School at Jinan University, Guangzhou, China, 2017.
- **International travel grant** from Max Planck Institute for chemistry, Mainz to take part in CINDI 2 field campaign in Cabauw, Netherlands, 2016.

Haseeb Hakkim (PhD scholar, EES, IISER Mohali)

- **First prize in poster presentation** in National Climate Science Conference, Divecha Centre for Climate Change, Indian Institute of Science (IISc), Bangalore, 2015

Harshitha Pawar (PhD scholar, EES, IISER Mohali)

- **Best poster presentation award** at National Climate Science Conference, IISC Bangalore, 2015
- **International travel grant** from International Centre for Integrated Mountain Development (ICIMOD) to participate and to present a talk at Second Workshop On Atmospheric Composition And The Asian Monsoon (ACAM)", Bangkok (July 08-10, 2015).

Alumni – Current Position

M.Sc. final year thesis students

Name	batch	(M.Sc. Thesis guide) and current position
Apurv Saxena	MS07	(Dr. Vinayak Sinha) Faculty at Allen Career Institute
Vinod Kumar	MS08	(Dr. Vinayak Sinha) Ph.D. scholar at IISER Mohali
Himanchu Sachan	MS08	(Dr. Baerbel Sinha) Assistant Branch Manager, Canara Bank
Prabhanjan Borwankar	MS08	(Dr. Baerbel Sinha) Data Analyst, Coriolis Technologies Pune
Yash Maurya	MS09	(Dr. Vinayak Sinha) Marketing officer, Gujarat Gas Limited
Harshita Pawar	MS10	(Dr. Vinayak Sinha) Ph.D. scholar at IISER Mohali
Haseeb Hakim	MS10	(Dr. Vinayak Sinha) Ph.D. scholar at IISER Mohali
Tess George	MS11	(Dr. Baerbel Sinha) Ph.D. scholar at IISER Mohali
Vaishali Vardhan	MS11	(Dr. Baerbel Sinha) Ph.D. scholar at Forschungszentrum Jülich, Germany
Bharti Sophaul	MS12	(Dr. Vinayak Sinha) Subject Matter Expert for Chemistry, Evelyn Learning Systems Pvt. Ltd.
Mohammmad Shabin	MS12	(Dr. Vinayak Sinha) Project Assistant at IISER Mohali
Ankit Yadav	MS12	(Dr. Anoop Ambili) Ph.D. scholar at IISER Mohali
Nimya S.S.	MS12	(Dr. Baerbel Sinha) Ph.D. scholar at IITM Pune

Ph.D. students

Name	year	(Ph.D. supervisor) and current position
Dr. Chinmoy Sarkar	2015	(Dr. Vinayak Sinha) Postdoctoral Fulbright-Kalam Climate Fellow at the University of California, Irvine.

Publications from the Department

IISER Mohali authors bold, Publications until August 2017 are listed

1. **Ankit, Y., Kumar, P., Anoop, A.,** Mishra, P.K., Varghese, S., Mid-late Holocene climate variability in the Indian monsoon: Evidence from continental shelf sediments adjacent to Rushikulya river, eastern India, Quaternary International 443, 155-163, http://dx.doi.org/ 10.1016/j.quaint.2016.12.023, 2017.
2. **Ankit, Y.,** Mishra, Praveen K., **Kumar, P.,** Jha, Deepak K., Kumar, Vivek V., Ambili, V., **Anoop, A.**, Molecular distribution and carbon isotope of n-alkanes from Ashtamudi Estuary, South India: Assessment of organic matter sources and paleoclimatic implications., Marine Chemistry (in press), http://dx.doi.org/10.1016/j.marchem.2017.08.002, 2017.
3. Pillai, A.A.S., **Anoop, A.**, Sankaran, M., Sanyal, P., Jha, D.K., Ratnam, J., Mid-late Holocene vegetation response to climatic drivers and biotic disturbances in the Banni grasslands of Western India. Paleoclimatology Paleoecology Paleogeography (in press). https://doi.org/10.1016/j.palaeo.2017.07.036, 2017.
4. **Garg, S., Sinha, B.,** Determining the contribution of long-range transport, regional and local source areas, to PM_{10} mass loading in Hessen, Germany using a novel multi-receptor based statistical approach Atmospheric Environment, https://doi.org/10.1016/j.atmosenv.2017.08.029, 2017.
5. **Chandra, B.P., Sinha, V., Hakkim, H., Sinha, B.,** Storage stability studies and field application of low cost glass flasks for analyses of thirteen ambient VOCs using proton transfer reaction mass spectrometry, International Journal of Mass Spectrometry 419, 11- 19, http://dx.doi.org/10.1016/j.ijms.2017.05.008, 2017.
6. **Sarkar, C., Sinha, V., Sinha, B.,** Panday, A. K.., Rupakheti, M., Lawrence, M.G., Source apportionment of NMVOCs in the Kathmandu Valley during the SusKat-ABC international field campaign using positive matrix factorization, Atmospheric Chemistry and Physics 17, 8129-8156, https://www.atmos-chem-phys.net/17/8129/2017/acp-17-8129-2017.pdf, 2017.
7. Ghude, S.D., Bhat, G.S., Prabhakaran, T., Jenamani, R.K., Chate, D.M., Safai, P.D., Karipot, A.K., Konwar, M., Pithani, P., **Sinha, V.,** Rao, P.S.P., Dixit, S.A., Tiwari, S., Todekar, K., Varpe, S., Srivastava, A.K., Bisht, D.S., Murugavel, P., Ali, K., Mina, U., Dharua, M., Jaya Rao, Y., Padmakumari, B., Hazra, A., Nigam, N., Shende, U., Lal, D.M., **Chandra, B.P., Mishra, A.K., Kumar, A., Hakkim, H., Pawar, H.,** Acharja, P., Kulkarni, R., Subharthi, C., Balaji, B., Varghese, M., Bera, S., Rajeevan, M., Winter fog experiment over the Indo-Gangetic plains of India, Current Science 112, 767-784, http://dx.doi.org/10.18520/cs/v112/i04/767-784, 2017.
8. Novelli, A., Hens, K., Ernest, C.T., Martinez, M., Nölscher, A.C., **Sinha, V.,** Paasonen, P., Petäjä, T., Sipilä, M., Elste, T., Plass-Dülmer, C., Phillips, G.J., Kubistin, D., Williams, J., Vereecken, L., Lelieveld, J., Harder, H., Estimating the atmospheric concentration of Criegee intermediates and their possible interference in a FAGE-LIF instrument, Atmos. Chem. Phys.17, 7807-7826, https://www.atmos-chem-phys.net/17/7807/2017/acp-17-7807-2017.pdf, 2017.
9. **Kumar, V., Sarkar, C., Sinha, V.,** Influence of post-harvest crop residue fires on surface ozone mixing ratios in the N.W. IGP analyzed using 2 years of continuous in situ trace gas measurements, Journal of Geophysical Research: Atmospheres 121, 3619- 3633, http://dx.doi.org/10.1002/2015JD024308, 2016.
10. **Chandra, B.P., Sinha, V.,** Contribution of post-harvest agricultural paddy residue fires in the N.W. Indo-Gangetic Plain to ambient carcinogenic benzenoids, toxic isocyanic acid and carbon, Environment International 88, 187-197, http://dx.doi.org/10.1016/j.envint.2015.12.025, 2016.
11. **Garg, S., Chandra, B.P., Sinha, V.,** Sarda-Esteve, R., Gros, V., **Sinha, B.,** Limitation of the Use of the Absorption Angstrom Exponent for Source Apportionment of Equivalent Black Carbon: A Case Study from the North West Indo-Gangetic Plain, Environmental Science and Technology 50, 814-824, http://dx.doi.org/10.1021/acs.est.5b03868, 2016.
12. **Sarkar, C., Sinha, V., Kumar, V.,** Rupakheti, M., Panday, A.K., Mahata, K., Rupakheti, D., Kathayat, B., Lawrence, M.G., Overview of VOC emissions and chemistry from PTR-TOF-MS measurements during the SusKat-ABC campaign: High acetaldehyde, isoprene and isocyanic acid in wintertime air of the Kathmandu Valley, Atmospheric Chemistry and Physics 16, 3979-4003, https://www.atmos-chem-phys.net/16/3979/2016/acp-16-3979-2016.pdf, 2016.
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18. **Nandy, B., Sharma, G., Garg, S., Kumari, S., George, T., Sunanda, Y., Sinha, B.,** Recovery of consumer waste in India - A mass flow analysis for paper, plastic and glass and the contribution of households and the informal sectors, Resources, Conservation and Recycling 101, 167-181, http://dx.doi.org/10.1016/j.resconrec.2015.05.012, 2015.
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20. **Pawar, H., Garg, S., Kumar, V., Sachan, H., Arya, R., Sarkar, C., Chandra, B.P., Sinha, B.,** Quantifying the contribution of long-range transport to particulate matter (PM) mass loadings at a suburban site in the north-western Indo-Gangetic Plain (NW-IGP), Atmos. Chem. Phys 15, 9501-9520, https://www.atmos-chem-phys.net/15/9501/2015/acp-15-9501-2015.pdf, 2015.
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22. Hansen, R.F., Blocquet, M., Schoemaecker, C., Léonardis, T., Locoge, N., Fittschen, C., Hanoune, B., Stevens, P.S., **Sinha, V.,** Dusanter, S., Intercomparison of the comparative reactivity method (CRM) and pump-probe technique for measuring total OH reactivity in an urban environment, Atmos. Meas. Tech., 8, 4234-4264, https://www.atmos-meas-tech.net/8/4243/2015/amt-8-4243-2015.pdf, 2015.
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Publications with undergraduate co-authors (bold)

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Sarkar C., **Kumar, V.**, Sinha, V: Massive Emissions of Carcinogenic Benzenoids from Paddy residue burning in North India, Current Science, Volume 104 (12) , pp. 1703-1709, 2013. http://www.currentscience.ac.in/Volumes/104/12/1703.pdf, 2013.

International Collaborations

Sustainable Atmosphere for the Kathmandu Valley (SusKat):

The IISER Mohali team (C. Sarkar, V. Kumar & Dr. V. Sinha) operated a PTR-TOF-MS during this international field campaign. The SusKat measurement campaign was conducted in December 2012 - January 2013 in Kathmandu, Nepal, provided a comprehensive assessment of various aspects of air pollution in the Kathmandu valley through a combination of intensive sampling and focused model simulations. The initiative was spearheaded by the Institute for Advanced Sustainability Studies (IASS) Potsdam, Germany and the International Centre for Integrated Mountain Development (ICIMOD). Eighteen research groups from nine countries participated in the SusKat field experiment.

Multi Axis Doas aerosols and trace gases intercomparison (MADCAT):

The IISER Mohali team (V. Kumar, V. Sinha) participated in the MADCAT campaign with their DOAS system. Thirteen international research groups participated in this intercomparsion campaign which was held at the Max Planck Institute (MPI) for Chemistry in Mainz, Germany, in June-July 2013.

Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments (CINDI-2):

In September 2016 the IISER Mohali team participated in the CINDI-2 campaign, held in Cabauw, the Netherlands. The campaing involves the comparison of a host of ground-based DOAS instruments for measuring atmospheric Nitrogen Dioxide (NO2) amounts. It is the second large scale international campaign addressing the intercalibration of remote sensing instruments using the DOAS technique to monitor air quality in support of satellites. More than 40 instruments operated by 30 groups participated to this field campaign.

International DST- Max Planck Research Partner Group on Tropospheric OH reactivity and VOC measurements:

The international Max Planck Research Partner Group is a collaboration between Dr. Vinayak Sinha (IISER Mohali) and Prof. Jos Lelieveld (Director Air Chemistry, MPI for Chemistry Mainz). The research group provides ample opportunity for student exchange. Vinod Kumar (MS08) and Biplob Nandi (MS10) visited the MPIC Mainz for a summer project and Hella Ride (PhD student, MPIC-Mainz) visited IISER Mohali. Six senior scientists from MPIC, Mainz also visited IISER Mohali. The group has been operating a DOAS jointly with Dr. Thomas Wagner MPIC for five years.

First direct measurements of chemical ozone production in India

The IISER Mohali Atmospheric Chemistry group in collaboration with TERI University Delhi hosted a research group from Birmingham University, UK, to perform the first direct measurements of atmospheric ozone production in India.

Admissions

Integrated BS-MS program admissions : Admissions to the integrated BS-MS program are handled centrally by a joint admissions committee consisting of members representing all five IISERs, and all admitted candidates are provided with a fellowship, subject to a minimum level of academic performance.
BS-MS students that have finished two years of coursework in all the science subjects are required to choose any one out of the four main science subjects (i.e., biology, chemistry, physics or mathematics) as a 'major' subject. The Department of Earth and Environmental Sciences does not currently offer a major.

MS thesis project: The Department of Earth and Environmental Sciences accepts MS-students from all major disciplines with research interests in earth and environmental sciences for MS-thesis projects. The department strongly recommends that prospective MS thesis project students undertake a summer project with their prospective advisor or take an elective course offered by the department prior to finalizing their choice for a 5th year MS-project.

Integrated MS-Ph.D program admissions : Admissions to this program are overseen by the respective departments. Eligibility criteria are routinely advertised on the institute's website, and the admissions are conducted in the summer of each year. The Department of Earth and Environmental Sciences does not currently offer an integrated MS-Ph.D program.

Ph.D admissions : Ph.D admissions are done at the beginning of each semester, twice a year, and advertisements appear on the website towards the end of each semester. Candidates who apply through an online application process are screened for eligibility and shortlisting criteria, and invited for examinations/interviews.

Summer Progams : The department participates in three kinds of summer research training programs : (i) IISER's own BS-MS students are required to do summer projects. Some do it at IISER-M; (ii) IISER participates in an inter-academy summer program co-ordinated by the Indian Academy of Sciences, Bangalore, which allots some summer students to research supervisors at IISER; (iii) IISER-M advertises a summer program open to students from around the country, in the month of February/March.

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