Report for the year 2016 and future activities

SOLAS *'INDIA'*
compiled by: 'VVSS Sarma'

This report has two parts:

- Part 1: *reporting of activities in the period of January 2016 – Mar-Apr 2017*
- Part 2: *reporting on planned activities for 2017 and 2019.*

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan.

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups, cities)!*

PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

Describe one scientific highlight with a title, text (max. 200 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in international collaboration. (If you wish to put more than one, feel free to do so).

Orography and meteorological factors facilitate increase in finer particles over Visakhapatnam 'bowl' area

Amount of fine particles in air is of concern because of its potential hazard to human health. It is not yet mandatory to monitor $PM_{2.5}$ (particles<2.5 µm) levels in our country and therefore very limited information is available on its amounts and distributions. It is also important to study air particles of other sizes and the role of meteorological and other topographic conditions in determining the particle concentrations and variations. We report here abundances and changes in $PM_{2.5}$, PM_{10} (particles<10 µm) and PM>10 (particles >10 µm) sized particles during winter and transition to summer periods in the Visakhapatnam city to examine the potential sources and influence of unique orographic features of the city. Our results suggest the occurrence of alarming levels of $PM_{2.5}$, and PM_{10} that will have serious implications to respiratory issues and lung diseases. Despite less populated and low industrial activities in Visakhapatnam, the concentration of $PM_{2.5}$ and PM_{10} were higher than other major Indian coastal cities (eg: Mumbai, Kolkata and Chennai), which are heavily populated as well as industrially active cities. Visakhapatnam city has a unique orography (bowl shape, surrounded by hill ranges) and atmospheric temperature inversion during winter limits the transport of particles, therefore, increases the particle residence time over the city. Relations of particles abundances with meteorological properties revealed that increase in temperature and winds blowing from southwest facilitate transport of particles from the industrialized hub to the 'bowl' area and the prevalence of finer particles aided by poor flushing due to orography. This study highlights the dominant effect of orography over other factors and potential impacts of fine particles on human health of the city.

Table 1 — Ratio of $PM_{2.5}$ and PM_{10} at different geographical locations

Location	$PM_{2.5}$(µgm^{-3})	PM_{10}(µgm^{-3})	$PM_{2.5}/PM_{10}$
World			
Switzerland	25	40	0.61
Spain	17	28	0.63

United States			0.3-0.27
Manila	45		0.45
South Korea			0.38-0.89
China	57	73	0.78
Saudi Arabia	28	87	0.33
Greece	40	76	0.53
Turkey	64	80	0.80
Lahore		900	
Nepal	225		
Colombo		60	
Egypt	59	136	0.43
Italy			0.61
Taiwan	22	40	
India			
Punjab	66	157	0.42
Delhi	99	113	0.86
Mumbai	52	83	0.62
Chennai	73	135	0.54
Calcutta	313	445	0.70
Lucknow	113	171	0.65
Anantpur	17	10	0.9
Kanpur	165	225	0.74
Agra	98	163	0.6
Udaipur	8-111	28-350	0.3
Chhattisgarh	125	189	0.66
Hyderabad	50	135	0.4
Patiala	57	97	0.59
Visakhapatnam (present study)	93	227	0.66

17, Current Science, in review

tmospheric dry deposition of inorganic nutrients on phytoplankton biomass in the Bengal

rom continents contain relatively higher amounts of inorganic nutrients than those of marine make a notable contribution to the coastal biological productivity. To test this hypothesis, on of aerosols over the city of Visakhapatnam (central east coast of India) were studied ntal flow was dominant and its impact on phytoplankton biomass was estimated through periments between September 2013 and November 2014. Higher nitrate (NO_3^-) and NH_4^+) concentrations were observed in the aerosols collected in January while higher $)_4^{3-}$) was observed in September. Simultaneous observations of aerosols over the city and oastal waters revealed that the concentrations of nitrate in ambient aerosols ranged from g m^{-3} and 0.09 to 0.86 µg m^{-3}, respectively. Our results suggest that 52-89% of city's aerosols n deposited over waters within 10 km from the coastline. Microcosm experiments were spiking the surface water samples, collected from the coastal Bay of Bengal (BoB), with the trients. Upon spiking, dissolved inorganic nitrogen (NO_3^- + NH_4^+) increased from 0.3 to $^{-1}$ and the N:P ratio increased from 2 to 97. This led to enhanced phytoplankton to 4 times) upon spiking. The increase in phytoplankton biomass was linearly related to ratios in water as aerosol deposition increased the N: P ratios in the microcosms, leading to growth. Though aerosols did not contribute to bioavailable silicate, our microcosm showed linear relationships between ambient silicate phytoplankton biomass, and of Fucoxanthin (a marker pigment for diatoms). This indicates that the availability of silicate ers facilitated dominant diatom growth in the presence of higher N: P ratios due to aerosol e deposition of soluble aerosol nitrogen appears to support ~3 to 33% of the biological the coastal waters off Visakhapatnam with higher contribution in winter (~33%) than in). This study suggests that atmospheric deposition of nutrients enhances phytoplankton aters along the central east coast of India during the winter monsoon period, in particular, he hypothesis stated above.

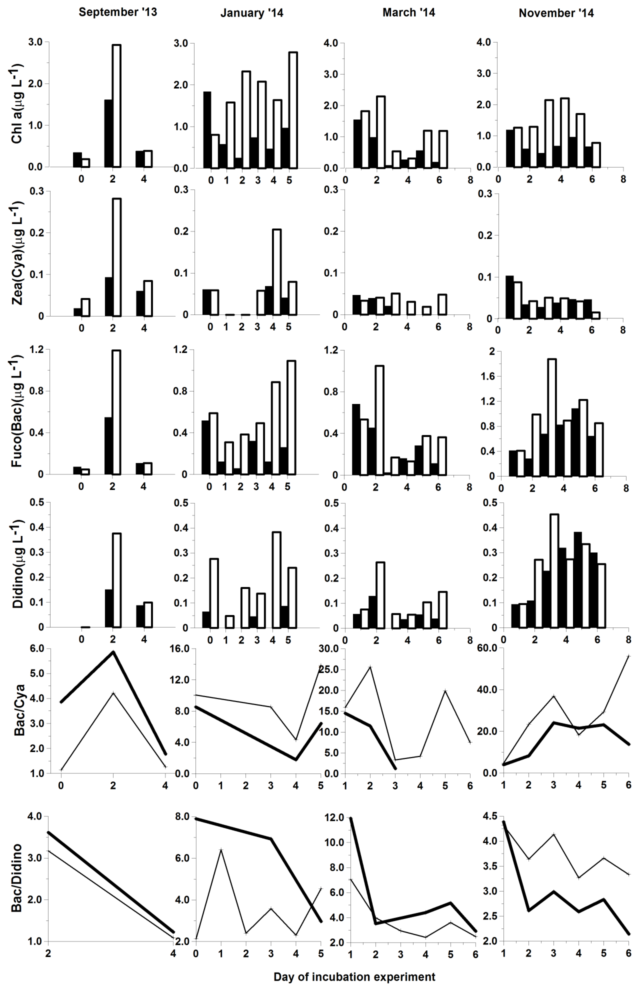

Figure: Variations in the concentrations of pigments in water observed during the incubation experiments after spiking with the dust collected for each season. Filled bars/ thick line show results from control experiments while hollow bars/ thin lines show data from the spiked microcosms.

Yadav et al., 2016, Marine Chemistry, 187, 25-34.

Atmospheric dust acidifies coastal Bay of Bengal and enhances CO_2 flux to the atmosphere

Enhanced atmospheric deposition of nitrogen and sulphur due to anthropogenic activities may acidify coastal waters and change direction of CO_2 exchange at air-sea interface.In order to test this hypothesis, simultaneous observations of atmospheric dust and coastal water pH was measured over two years at weekly and monthly intervals respectively to examine the impact of atmospheric deposition on surface water pH. The composition of atmospheric dust over study region suggests significant contribution of acidic aerosols, such as sulphates and nitrates and their concentrations were relatively higher during winter followed by spring and summer. The mean $[NO_3^-/SO_4^{2-}]$ ratio in the study region (0.8±0.2)suggests greater contribution of $SO_4^{2-}$from stationary sources (industrial activities) over vehicular activity. The acidity of the anions was not balanced by cations during winter while closer balance occurred during other seasons. The atmospheric deposition of aerosols relatively decreased more pH of surface seawater during winter (0.020±0.003) than summer (0.011±0.003) and spring (0.007±0.002) and it is consistent with the concentrations of sulphate and nitrate in the dust deposited. The decrease in pH due to atmospheric deposition of dust elevated pCO_2 levels by 5.1 to 19.7 µatm resulting in enhanced CO_2 flux (by 0.12 to 0.54 mmol m^{-2} d^{-1}) to the atmosphere from the coastal Bay of Bengal. This study suggests that atmospheric deposition has significant impact on acidification of coastal Bay of Bengal, however, its impact on ecosystem needs integrated studies.

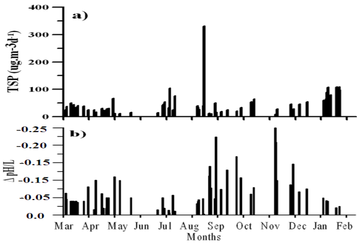

Figure: Weekly variations in concentrations of TSP (μg/m^3/d) (top panel) and change in pH due to dissolution of 1 μg/m^3/d of atmospheric dust to one liter of filtered (0.2 μm) surface seawater.

Kumari et al., 2017. Tellus-B, submitted

Carbon isotope-constrained seasonality of carbonaceous aerosol sources from an urban location (Kanpur) in the Indo-Gangetic Plain: 14Capportionment of carbonaceous aerosol

The Indo-Gangetic Plain (IGP) in northern India, Pakistan and Bangladsh is a major source of carbonaceous aerosols in South Asia. However, poorly constrained seasonality of their sources over the IGP leads to large uncertainty in climate and health effects. Here, we present a first dataset for year-round radiocarbon (^{14}C) and stable carbon (δ^{13}C) based source apportionment of total carbon (TC) in ambient PM10 collected from an urban site (Kanpur: 26.5N, 80.3E) in the IGP during January 2007-January 2008. The year-round 14C based fraction biomass (fbio-TC) estimate at Kanpur averages ~77±7%, emphasize an impact of biomass burning emissions (BBEs). The highest fbio-TC (%) is observed in fall season (October-November: 85%±6%) followed by winter (December-February: 80±8%) and spring (March-May: 75±8%), while lowest values found in summer (June-September: 69±2%). Since biomass/coal combustion and vehicular emissions mostly contribute to carbonaceous aerosols over the IGB, we predict δ13CTC (δ13TCpred) over Kanpur using nown δ13C source signatures and the measured Δ14C value of each sample. The seasonal variability of δ13Cobs- δ13Cpred versus Δ14CTC together with air mass back trajectories and MODIS fire count data reveal that carbonaceous aerosols in winter/fall are significantly influenced by atmospheric aging (downwind transport of crop-residue burning/wood combustion emissions in the northern IGP), while local sources (wheat residue combustion/vehicular emissions) dominate in spring/summer. Given the large temporal and seasonal variability in sources and emission strength of TC over the IGP, 14C-based constraints are, thus, crucial for reducing their uncertainties in carbonaceous aerosol budgets in climate models.

Srinivas et al., 2017. Journal of Geophysical Research (Atmosphere) Doi:10.1002/2016JD025634.

2. Activities/main accomplishments in 2016 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

Two projects (GEOTRACES and Ocean finder) have been completed. However, we are anticipating extension of GEOTRACES project for another 5 years.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Yadav K., Sarma VVSS, and Kumar MD. 2016. Influence of atmospheric dry deposition of inorganic nutrients on phytoplankton biomass in the coastal Bay of Bengal, *Marine Chemistry*,187, 25-34 .

Srinivas B, Andersson A, Ram K, Gustafsson, O, Sarin MM, Sheesley RJ, Kirillova E, Rengarajan, R, Sudheer AK, Gustafsson O. 2017. Carbon isotope-constrained seasonality of carbonaceous aerosol sources from an urban location (Kanpur) in the Indo-Gangetic Plain: 14Capportionment of carbonaceous aerosol. Journal of Geophysical Research (Atmosphere) Doi:10.1002/2016JD025634.

Srinivas B, Kawamura K, Sarin MM. 2017. Secondary organic aerosol formation over coastal ocean: Inferences from atmospheric water soluble low molecular weight organic compounds. Environmental Science and Technology, Doi: 10.1021/acs.est.6b05986.

Baker AR, Kanakidou M, Altieri KE, et al. 2017. Observation and model based estimates of particulate dry nitrogen deposition to the oceans, Atmospheric Chemistry and Physics, doi: 10.5194/acp-2016-1123.
Jickells TD, Buitenhuis E, Altieri KE et al. 2017. A re-evaluation of the magnitude and impacts of

anthropogenic atmospheric nitrogen inputs on the ocean: Duce et al revisited, Global Biogeochemical cycles, doi: 10.1002/2016GB005586

Srinivas B, Kawamura K, Sarin MM, 2016. Stable carbon and nitrogen isotopic composition of fine mode aerosols (PM2.5) over the Bay of Bengal: Impact of continental sources, Tellus B, 68, doi: 10.3402/Tellusb.v68.31518.

Srinivas B, Andersson A, Sarin MM et al. 2016. Dual-carbon-Isotope characterization of total organic carbon in wintertime carbonaceous aerosols from northern India. Journal of Geophysical Research (Atmosphere), doi:10.1002/2016JD024880.

Ram K, Singh S, Sarin MM et al. 2016. Variability in aerosol optical properties over an urban site, Kanpur, in the Indo-Gangetic Plain: A case study of fog and haze events. Atmospheric Research, doi: 10.1016/j.atmosres.2016.01.014.

Boreddy SKR, Kawamura, K, Srinivas B, Sarin MM, 2016. Hygroscopic growth of particles nebulized from water-soluble extracts of PM2.5 aerosols over the Bay of Bengal: Influence of heterogeneity in air masses and formation pathways, Science of the total environment, 544: 661-669, doi: 10.1016/j.scitotenv.2015.11.164.

Rastogi N, Singh A, Sarin MM, Singh D. 2016. Temporal variability of primary and secondary aerosols over Northern India: Impact of biomass burning emissions, Atmospheric Environment, 125, 396-403, doi: 10.1016/j.atmosenv.2015.06.010.

For journal articles please follow the proposed format:
Author list (surname and initials, one space but no full stops between initials), year of publication, article title, full title of journal (italics), volume, page numbers, DOI.

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

No

PART 2 - Planned activities from 2017/2018 and 2019

1. Planned major field studies and collaborative laboratory and modelling studies, national and international (incl. all information possible, dates, locations, teams, work, etc.)

No

2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible)

No

3. Funded national and international projects / activities underway (if possible please list in order of importance and indicate to which part(s) of the SOLAS 2015-2025 Science Plan and Organisation (downloadable from the SOLAS website) the activity topics relate – including the core themes and the cross cutting ones)

In India, we are at the end of five year plan (2012-2017) and all existing projects have been closed and new proposals are under review.

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please precise to which funding agencies and a timing for submission is any)

A proposal entitled “Impact of atmospheric dust on coastal ecosystem” is proposed to Council of Scientific and Industrial Research (CSIR) for possible funding. This proposal is under review.

5. Engagements with other international projects, organisations, programmes etc.

No

Comments