Spatial pattern of the isotopic composition of bird feathers from India

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Stable isotopic composition of the bird feathers have been studied extensively to explore dietary patterns and to track migration. However, such studies have not been carried out in the Indian region. This work generates the base-line data of the isotopic signatures of birds from different geographical regions within India. The feathers of twelve species distributed across India were analyzed for carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), sulfur ($\delta^{34}S$) and oxygen ($\delta^{8}O$) isotopic compositions. Museum specimens of Bombay Natural History Society, Mumbai were mostly used towards this. The isotopic variability of different feathers within a specimen showed consistent values indicating isotopic composition of a few feathers from a specimen is sufficient to establish spatial patterns. Trophic level control on $\delta^{15}N$ of different species was clearly observed. $\delta^{13}C$ values were dependent on C-3 and C-4 plant sources in the diet. $\delta^{34}S$ values of feathers from the close proximity showed similar values suggesting geographical variation. Pelagic and coastal species showed a higher $\delta^{34}S$ around 20‰. $\delta^{18}O$ and $\delta^{34}S$ of bird feathers appears to have a spatial control and hence could be useful in studying migration of birds in the Indian region.

Abstract Title: Calibration and Validation of a Process-based Model to Simulate the Ecosystem-Atmosphere Carbon, Water and Energy Fluxes at a Subtropical Forest in India

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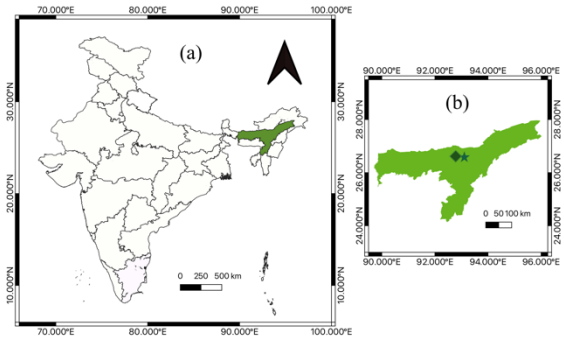
Location map of Kaziranga National Park (KNP)



Climate-carbon feedback is essential to be studied for identifying the sources and sinks of atmospheric CO_2, their strength, pattern and spatio-temporal variabilities for to devise the climate change mitigation strategies[1]. The ecosystem-atmosphere exchanges of terrestrial ecosystems are key drivers of global carbon, water and energy cycles, and with a global strength of 3.4±0.9 GtC yr^{-1}, the terrestrial ecosystems constituted the largest sink in the global carbon budget in the last decade[2]. These exchanges are crucial to be measured accurately and, additionally represented in bottom-up biogeochemically and biogeophysically coupled ecosystem, Earth system and climate models for improving the model predictions and impact assessment of climate change on these ecosystems. The diverse natural ecosystems in India are poorly represented in these models due to the absence any of integrated data-model framework and intercomparison study so far[3]. To partially address this knowledge gap we have used flux-tower measurements in our study to simulate the gross photosynthetic carbon uptake (gross primary productivity or GPP), sensible (H) and latent heat fluxes (LE) of a moist semi-evergreen deciduous forest in the Kaziranga National Park (marked on the adjoining figure) in subtropical Northeast India[4] using a process-based model namely Integrated Science Assessment Model (ISAM)[5]. The model is calibrated using two years of measurement which improves its performance when subsequently run to simulate these fluxes for a year. The model produced annual GPP, mean maximum H and LE are 2432.26 gC m^{-2} y^{-1}, 29 and 82 W m^{-2} respectively as compared to their measured values i.e. 2398.47 gC m^{-2} y^{-1}, 26 and 73 W m^{-2} correspondingly. Additionally, we report the calibrated model biogeochemical and biogeophysical parameters which will be useful in simulating the fluxes at this forest using similar process-based modelling approaches.

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Anomalous $\delta^{18}O$ signal in the shell of a giant clam (*Tridacna maxima*) from the Lakshadweep Archipelago, India: Signatures of thermal stress during a coral bleaching event

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Abstract

A shell of the giant clam *Tridacna maxima* from the lagoon of Minicoy Island in the southern Lakshadweep Archipelago, India, was used for a high-resolution stable isotope ($\delta^{18}O$, $\delta^{13}C$) analysis. Results show a cyclic pattern in $\delta^{18}O_{shell}$ values, interpreted as a combined signature of seasonal temperature and salinity fluctuations over the period of 2004 to 2014. These $\delta^{18}O_{shell}$ cycles are characterized by a slight background scatter proposed to be caused by rainfall events leading to short-term and limited freshening of the water in the partly restricted lagoon. The most striking feature of the stable isotope data is exceptionally negative outliers in $\delta^{18}O_{shell}$ values beginning in mid-2010. This first anomalous isotope excursion is followed by a phase of lowered growth rates lasting until the beginning of 2011. It is observed that this sudden change in stable isotope composition and shell precipitation is caused by anomalous sea surface warming, which was previously documented for the region in 2010 and caused widespread coral bleaching throughout the Lakshadweep Archipelago. Even though several other negative excursions in $\delta^{18}O_{shell}$ values follow, the cyclicity in the stable isotope signal and the growth rates become more regular in the later part of shell growth, which indicates a gradual recovery of the bivalve after the initial thermal stress event. The results reveal that even short high temperature events could significantly perturb the biology of giant clams and require long recovery phases. This information is particularly significant for conservation efforts for this endangered bivalve group in a world with on-going global warming.

Keywords. *Tridacna maxima*, seasonal variability, Indian Ocean, thermal stress, stable isotope records, Minicoy Island

Seasonal radiocarbon record from a coral of the Andaman Sea

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Corals growing in shallow ocean waters record the radiocarbon changes of dissolved inorganic carbon (DIC) of the surface ocean in its aragonitic skeleton. High-resolution radiocarbon records from corals provide essential insight into surface ocean processes. In this regard, a *Porites* coral from the Andaman Sea was investigated for its high-resolution stable oxygen isotope ($\delta^{18}O$) and radiocarbon ($\Delta^{14}C$) records. The coral record spanned between 2007-2014. The $\delta^{18}O$ values of the coral showed a significant correlation with the SST of the region. Seasonal variations in the coral radiocarbon record were observed to be superimposed over a secular decreasing trend. A positive correlation was observed between the seasonal radiocarbon changes and the $\delta^{18}O$ values of the coral. These observations suggest that the coral records the mixed layer depth and sea surface temperature change during the monsoon and non-monsoon periods. It is also noted that recent surface radiocarbon values of the Andaman Sea surface water are higher compared to the atmosphere. It indicates that a significant fraction of bomb radiocarbon has moved into the ocean reservoir from the atmosphere.

Endolithic cyanobacterium *Chroococcidiopsis sp.* JS7 from Mawsmai Limestone cave, Meghalaya, India

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Cyanobacteria primarily molded the Earth's atmosphere and play an indispensable role in the global carbon, oxygen and nitrogen cycles. These oxyphotobacteria have endured drastic geochemical and climate changes during their evolution and exhibit the most-wide range of distribution in habitats from moderate to extremes. Karst caves are considered as a specific case of extreme environment. Epiliths and Endoliths are assumed to be the main sources of primary production in hyper-arid/cave environments where plants are rare or infrequently encountered. Despite the ecological importance, the lithobiontic cyanobacteria occurring on rock surfaces remain largely unexplored and uncharacterized.

In this study, lithobiontic cyanobacteria growing on the surface/fissures/pores of the rock surfaces were sampled from Mawsmai Limestone cave, Meghalaya, India. Samples were used as inoculums for isolating cyanobacteria capable of thriving in extreme conditions of light, pH, temperature and inorganic carbon. Mineralogical characterization of rock samples collected from the cave showed calcite as the dominant mineral. An endolithic strain from the dark/low light zones of the cave, was thus isolated, identified and characterized. The isolate was identified as *Chroococcidiopsis sp.* JS7, favored low light intensities, pH (6-9), high salinity (5%) and high DIC (0.2- 0.5M L^{-1}). *Chroococcidiopsis sp.* JS7 grew very well in Artificial Seawater Medium at salinity 25 g/L NaCl with biomass productivity of 747 mg/L/d. *Chroococcidiopsis sp.* are reported to flourish in Dry Valleys in Antarctica, the Atacama Desert in Chile, the Mojave Desert in California, and low light zones of caves. Their tolerance to desiccation, extreme irradiation and temperature surpasses any of the other photosynthetic cyanobacteria and has gained them the attention from astrobiologists due to their potential as analogs for possible life on Mars. Nevertheless, the isolate also came out to be a promising candidate for production of sustainable

biomass through efficient CO_2 capture and recycling for its remarkable capacity to sustain in high salinity and high DIC with minimal nutritional requirements.

Concentration and average chain lengths of leaf wax n-alkanes in tropical deciduous and evergreen species

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Abstract

Understanding of time of synthesis of leaf wax compounds has bearing on assessing seasonality in reconstructed paleoclimate variability. Although the primary leaf wax synthesis occurs during leaf flush, its synthesis in mature leaves is not well understood. To address this issue, three tropical deciduous (*Tectona grandis*, *Haldina cordifolia*, *Sterculia urens*) and four evergreen (*Syzygium cumini*, *Callophylum inophyllum*, *Memecylon umbellatum* and *Diospyros malabarica*) species were grown under similar conditions. Leaves were periodically sampled and characterized for n-alkane concentration. The n-alkane concentrations varied among the species. Among deciduous species, the maximum concentration was observed in *Tectona grandis* (~250 μg/g) and least in *Haldina cordifolia* (26 μg/g). Values of all evergreen species varied from 46 to 143.8 μg/g with *Memecylon umbellatum* having maximum (105μg/g) value. Various species showed different seasonal variations in total n-alkane concentrations. The average chain length (ACL) of n-alkanes varied among different species: *Tectona grandis* (32.9±0.2), *Haldina cordifolia* (30.8±0.5), *Sterculia urens* (30.9±0.6), *Syzygium cumini* (30.2±0.2), *Callophylum inophyllum* (30.2±0.2), *Memecylon umbellatum* (30.9±0.2), and *Diospyros malabarica* (31.8±0.2).Deciduous species' ACLs were almost constant with a significant drop observed towards the end of the growing season. Evergreen species' ACLs did not show a trend during the experiment.

Seasonality of particulate REEs in the estuarine water column of the Gulf of Cambay

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Spatio-temporal distributions of rare earth elements (REEs) have been widely utilized to understand various earth surface processes including provenance and sedimentary processes [1–3]. In this study, we present the concentrations of REEs in the suspended sediments (>0.45μm) collected from surface and sub-surface waters of the Narmada and Tapi estuaries during four different seasons in 2016–2017. The major goal is to explore seasonally varying sediment sources and sediment-water interactions in governing the REEs abundances in these estuaries. The ΣREE in surface and subsurface suspended sediments are comparable in each estuary indicating negligible grain size variations. The absence of Ce anomaly suggests aluminosilicates as a major carrier of the particulate REEs rather than Fe–Mn coatings. The distribution patterns of Chondrite normalized REEs (LREE>MREE>HREE) reveal a similar drained lithology in the watersheds irrespective of seasons. Interestingly, non-monsoonal samples show a significant depletion of HREE in both the estuaries indicating HREE removal in heavy minerals. The ternary plot of La–Th–Zr also reveals heavy mineral sorting effects in these estuarine sediments.

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Assessment of spatial distribution of metal contamination in shallow groundwater of Udyavara river basin, Southwest India

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Abstract

The present study assessed the spatial distribution of heavy metal contamination and human health risk of a shallow groundwater in Udyavara river basin, Udupi district, Southwest India. Twenty five groundwater samples were collected from the open wells (N=50) during the post-monsoon season. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was used to analyse heavy metals present in the samples. Spatial distribution analysis of the heavy metals and human health risk were conducted using geo-statistical interpolation tool in ArcGIS. Human health risk and pollution index were calculated based on United States Environmental Protection Agency (USEPA) method. The results of the study revealed the presence of the heavy metals in the groundwater with mean dominance in the order Mn > Al > Fe > Zn > Cu > Ni >Co > Cr > Pb. North-west region of the study area have an increased concentration of heavy metals due to intensive agricultural activity. Nickel and zinc were high in the open wells present in densely populated area due to sewage treatment plant effluents. Manganese and iron have similar geochemical behavior and derived from geogenic sources. Based on the classification, heavy metal valuation index (HEI) and heavy metal pollution index (HPI) values in all the samples fall into the low category. Human health risk evaluation findings revealed children are more prone to potential carcinogenic and non-carcinogenic health risks than adults and infants. The study concludes that heavy metals present in groundwater were derived from both geogenic and anthropogenic factors. The study recommends regular monitoring of groundwater to control heavy metal contamination from anthropogenic activities.

Effect of semidiurnal tides on dissolved inorganic carbon (DIC) and $\delta^{13}C_{DIC}$ in a tropical estuary (Mahanadi river estuary)

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Abstract

Tidal influence on dissolved inorganic carbon (DIC) and its isotopic composition ($\delta^{13}C_{DIC}$) were investigated in tropical estuary, Mahanadi, eastern India. DIC concentration and $\delta^{13}C_{DIC}$ varied between a wide range of 1537.70 to 710.15 µmol Kg^{-1} and −1.7 ‰ to −11.2 ‰ across the salinity gradient. Results indicated that carbonate and/or silicate weathering by possible biogenic CO_2 is the probable DIC source in the freshwater end of the estuary. However, the observed DIC concentration and $\delta^{13}C_{DIC}$ in the mixing regime greatly deviate from the compositions calculated from mixing model. The results suggest that biogeochemical processes such as; primary productivity, organic matter degradation, calcite dissolution and precipitation in addition to physical processes such as; CO_2 outgassing, individually or combination of two and more such processes are simultaneously active in the mixing regime. Our analysis also indicates calcite dissolution during low tide and calcite precipitation during high tide might have been dominant processes affecting DIC dynamics in the mixing zone. The presence of organic matter degradation at the cost of oxygen was observed in the mixing zone, which was more prominent during low tide compared to high tide. The estimated average DIC export flux from the estuary to the Bay of Bengal was ~ 0.89 Tg y^{-1} and the average annual DIC yield was ~ 6.4 g m^{-2} y^{-1}. Our results highlight the complex nature of the estuarine ecosystem where tides can have significant influence in shaping the carbon budget, which may be relevant globally.

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Biogeochemistry of Nutrient, dissolved Silica along the salinity gradients of three estuaries, Southwest coast of India

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Keywords: Estuary, dissolved silica, Salinity, net flux, and non-conservative behaviour

Abstract

Spatiotemporal behaviour of dissolved silica (DSi) along the salinity gradients of Kali, Sharavati and Sita-Swarna estuaries was studied. Surface seawater samples were collected with a pre cleaned transparent white bucket and bottom water samples using Niskin sampler. Analysis of the DSi was carried out using DR5000 UV spectrophotometer by heteropoly blue method with a wavelength of 815 nm. The study revealed that, irrespective of the seasons, DSi showed non-conservative behaviour in all the three estuaries. Significant variations were not observed depth-wise, in the concentrations of DSi. Approximately 80 to 85% of removal of DSi was observed along the salinity gradients. This removal was mainly because of the processes like, changes in the ionic strength during the mixing of river water and seawater and biological uptake (diatoms). Therefore, estuary acts as a net sink for dissolved silica. Finally, the gross flux and the net flux from the three west flowing rivers to the Arabian Sea was estimated. Together, Kali, Sharavati and Sita-Swarna accounts for gross flux of 0.08Tg/yr and net flux of 0.01Tg/yr respectively.

STUDIES ON WATER POLLUTION OF NORTH KOEL RIVER IN AND AROUND KECHKI AND DALTONGANJ, JHARKHAND.

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ABSTRACT

The Study area falls within the latitude 23°45'N to 37°30'N(part) and longitude 83°50' to 84°23'E (part) Latehar and Palamu district (Jharkhand). Nearly, 70% of all the water available in study area is polluted. The major causes of water pollution are dumping of untreated domestic materials, increased use of Fertilizers, Pesticides and Chemicals. Water quality deterioration can be also caused by geogenic contamination occuring due to natural causes through rock- water interaction. Geogenic Sources are leaching and weathering of rocks,(kumar et al. 2015). While anthropogenic are those caused by man made activities like Industries, Fertilizers, waste landfills and mining.While samples were collected from North koel, Auranga river, Amanat river and their confluences during pre and post monsoon period and analysed. The values obtained were compared with the Indian Standard specifications as well as W.H.O guidelines. The effect of various contaminants and now availability of water resources. Rainfall is the main sources of water in the study area and recieves an annual rainfall 750 mm – 1100 mm as per central groundwater board. Most of the people depend on agricultural activities mainly depends on rainfall since the availability of surface water resource is scanty.

The case study indicate the sources from which pollutants and leaching out to the water and causing high concentration in water.

An urgent need is to educate the people on the cause and effects of pollution and also cause fluorosis, encouraging rainwater harvesting and providing safewater to the people.

Keywords: Geogenic, Anthropogenic, Leaching, Contaminants.

Spatial variability and residence time of beryllium isotopes in the Indian Ocean: Role of oceanic processes

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The cosmogenic produced beryllium-10 (^{10}Be, half-life - 1.39 Ma) has proven to be an essential tool for building chronology and understanding millennial-scale earth surface processes. Prior to application of beryllium isotopes for deciphering the past processes, it needs understanding of processes controlling the present distribution of ^{10}Be/^{9}Be in global oceans. Multiple attempts have been made to understand beryllium isotopic distribution in the global ocean based on water column measurements and authigenic fractions derived from various archives (such as surface sediments and Fe-Mn nodules), though Indian Ocean remains poorly explored. This study based on beryllium isotopic measurements by AMS attempts to address the processes controlling beryllium isotopic distribution in surface sediments from the central and northern Indian Ocean.

In the Bay of Bengal, the sediments show higher ^{9}Be concentration and lower ^{10}Be/^{9}Be ratio because of higher terrestrial flux. Whereas for the open ocean locations, a negative correlation observed between $CaCO_3$ concentration and the beryllium isotopes suggests processes such as scavenging by particles affects both isotopes in well-mixed open ocean waters. The residence time of beryllium estimated for the Indian Ocean shows large basin-wise variation. The higher residence time of beryllium was observed in the central Indian Ocean, indicating lower scavenging of beryllium in the water column due to limited scavenging particles such as clay in the open oceans. Significantly lower residence time was observed in the Bay of Bengal implies enhanced scavenging of beryllium due to large terrestrial flux.

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Evaluation of the role of carbon and sulfur bio-geochemical cycles on the seasonal arsenic mobilization process in the shallow groundwater of the Bengal aquifer

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Abstract

Bacterial reduction of As-coated Fe(III)-OOH and SO_4^{2-} plays an important yet complex role in releasing arsenic (As) into the groundwater by utilizing available dissolved organic carbon in the sub-surface aquatic system[1,2,3]. The intensity of such a process varies seasonally. The present study documents seasonal variability (between dry pre-monsoon and post-monsoon period) of these processes based on the selected shallow and a few deep groundwater samples from West Bengal, India (Nadia district), with the data from multiple geochemical tracers including dissolved total As, Fe, SO_4^{2-}, dissolved inorganic carbon (DIC) content, and stable isotope ratios in the dissolved inorganic carbon (δ^{13}C-DIC) and sulfate (δ^{34}S-SO_4^{2-}) phases. Seasonal observations from multiple years of the present study show evidence of microbially-mediated reduction of As-coated Fe(III)-OOH and methanogenesis occuring at seasonal time intervals actively participate on high As mobilization in the groundwater with low initial sulfate

contents and therefore with limited bacterial sulfate reduction (BSR) state. This process is dominant during the dry pre-monsoon period compared to the post-monsoon period, documented based on the selected groundwater samples monitored during the present study. However, few seasonal shallow groundwater samples with abundant sulfate contents show active BSR state and resultant lower dissolved As contents, however independent of the BSR intensity. We show Rayleigh fractionation model can simulate the intensity of BSR in the groundwater at seasonal time intervals using the dissolved SO_4^{2-} concentration and $\delta^{34}S$-SO_4^{2-} isotope enrichment factor.

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Fresh and recirculated submarine groundwater discharge through Indian coastline: A review

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Abstract

Submarine groundwater discharge studies along the Indian coastline are very scarce, with only 0.2% of the coastline accounted for discharge so far. Here we present the status of the studies done in India and evaluate probable SGD zones along the Indian coastline using other published data. Reported estimates point out that the west coast of India, especially Kerala, Karnataka and Goa coasts, discharge more fresh groundwater to the sea than the east coast. This is due to the elevated topography of coastal alluvial aquifers, low electrical conductivity in coastal groundwater, high rainfall (>3000mm) and a higher number of rainfall days. Thermal images could be able to better identify discharge on the west coast than the east due to higher temperature differences between the groundwater and seawater. The discharge of recirculated seawater to the sea could be more Gujarat and West Bengal due to the high tidal range (~3-5m) and large intertidal zones in these areas. Based on the synthesis of literature and published data, probable SGD zones along the Indian coastline are marked and presented in this work. The implications of the population to the coastal ecosystem through the discharging groundwater is also discussed.