INDIAN METEOROLOGICAL SOCIETY AHMEDABAD CHAPTER

Ahmedabad Chapter

November 2022

Monsoon Issue

E-MEGHA

Dr. Rashmi Sharma

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From the Chairman's desk

Change in our outlook, dedicated climate friendly efforts and climate resilience may be the only lifeline that our planet has.

It gives me great pleasure to connect with the IMSA members through this monsoon issue of E-Megha. As we all know, Monsoon- 2022 was a normal monsoon statistically, yet it exhibited many anomalies in terms of extreme behavior, heterogeneity and time period. The telltale signs of manifestations of global climate change are now out in the open, leaving unmistakable imprints in all spheres of the ecosystem. According to the recent provisional report on State of the Global Climate in 2022 by World Meteorological Organization, the past eight years are deemed to be the eight warmest on record. Change in our outlook, dedicated climate friendly efforts and climate resilience may be the only lifeline that our planet has.

In this context, many global leaders assembled at the 27th edition of the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (COP-27) to pledge adaptation for climate resilience. India has put forth the concept of the Mission LiFE, or Lifestyle for Environment, which advocates moving away from a consumptive lifestyle to more climate-friendly behaviour.

Thus, the role of scientific societies such as IMSA becomes all the more important in this scenario, which is to garner interest and empathy towards environment related issues. IMSA, through its outreach activities, photography contests, student participation strives towards better awareness, which will ultimately result in lifestyle changes for an environment friendly living. IMSA Newsletter E-Megha is also assimilating viewpoints and enriching the outreach base. I would like to applaud the efforts of the editorial team for their enthusiastic efforts in making E-Megha, the brand ambassador of IMSA.

I wholeheartedly invite all IMSA members to actively participate in a mission towards a better Earth: adaptive, inclusive and resilient. Together we can! Together we will!

Wishing you all a very healthy, happy and happening year ahead.

Secretary's Report

Dr. Sanjib Deb

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The Ahmedabad Chapter of Indian Meteorological Society (IMS) is a very active chapter, which, organizes various outreach programs on regular interval for creating awareness related to the field of Meteorology and allied sciences for school/college students, researchers and educators. The highly active members of this society are contributing immensely for conducting various events in the field of satellite meteorology and climatology in and around Ahmedabad. The society is also actively participating with various other local scientific societies like Indian Society of Remote Sensing (ISRS), Indian National Cartographic Association (INCA) and Indian Society of Geomatics (ISG) and thereby, is benefitted in conducting various activities where scientific and technical cooperation is required.

The Earth Day was celebrated online on April 22, 2022 by conducting a popular lecture on the topic "One Litre Water Plantation Technique". The lecture was delivered by Padma Shri awardee Shri S R Verma. A popular lecture on "Climate Change and Agriculture" was organized in collaboration with Anand Agriculture University on April 21, 2022. The lecture was delivered by a well-known Agro-Meteorologist Dr Santanu Kumar Bal, ICAR Hyderabad. Both the lectures were very informative and attended by many society members. The first offline events of this year was organized on July 01, 2022 by conducting two lectures: i) Satellite based nowcasting: Past experiences and Path ahead and ii) Safe travel under unsafe conditions. Two senior society members Dr Bipasha Paul Shukla and Shri Chakrapani Patnaik had delivered these talks. Both the talks were very informative for the members. One interesting outreach event was conducted on July 23, 2022 at Khambhat, Gujarat in collaboration with Cambay Education Society, Khambhat. Approximately 150 students from Class 7 -12 from five different schools had participated in this outreach program, which includes one motivational talk, poster and quiz competitions related to Indian Space Program. This program was a huge success. A documentary on the life of Dr Vikram A. Sarabhai was also screened. The society is planning to conduct such impactful programs in future as well. With active support of IMSA editorial team, the society is also publishing E-Megha newsletter in regular interval for the benefit of members. Annual General Body Meeting (AGBM) was conducted in online mode on July 28, 2022.

The society has planned many activities during the current year. This includes (1) to conduct Prof Satish Dhawan Lecture 2022, (2) to celebrate World Meteorological Day 2023, (3) to conduct educational excursion tour for members in co-ordination with other scientific societies, (4) to conduct Monsoon Lecture 2022. On behalf of IMSA executive committee, I thank each member for their active participation at various activities conducted by this chapter during this year. I am sure members would actively participate in various activities planned and fulfill the goals and objectives of the Society.

Editorial

Monsoon 2022 may remain in our memories as an outlier year or it may also turn out to be the tipping point for a NEW NORMAL, who knows??

The recently commenced COP-27 resounds with the same theme, where leaders from various countries put forth solutions for adaptation along with combating climate change. This monsoon issue of E-Megha is another step taken by the IMSA community through awareness and knowledge sharing towards a resilient and adaptive world.

In this issue, we have a wrap-up summary of the monsoon 2022, the challenges faced by forecasters in prediction of the not-so normally normal monsoon, the extreme rainfall events , especially over Gujarat region. In addition, we have thought-provoking articles on how the rising surface pressure over the Tibetan Plateau impacts monsoonal rain patterns and the projection of weather forecasting methods in the next 75 years. Further-more, this issue also looks at the innovative exploration of (Navigation with Indian Constellation) NAVIC signals for earth observation and weather studies.

To cater to the growing interest in the high-resolution crop specific agromet products, an article of the satellite sensing of agro-meteorological applications is also a part of the collection. Particularly for Ahmedabad city, we have informative articles on the persistent heat waves and reduction of blue cover over the city.

Upcoming satellite mission for Earth-Observations NASA–ISRO L and S band Synthetic Aperture Radar (NISAR) is another highlight of the current issue.

In addition to the technical content, this issue is metaphorically studded with dazzling jewels in form of experience sharing, book-review, IMSA activities, collage and most coveted ideas, viewpoints and beautiful creative expressions by the students and our IMSA future generations.

We, the E-Megha team, invite you all to embark on this beautiful journey of knowledge and aesthetics.

We eagerly look forward to your response , feedback , support and encouragement. !!!

E-Megha Team

E-Megha Team

Dr. Indrani Choudhury Singh

Dr. Bipasha Paul Shukla

Dr. Suchandra Aich Bhowmick

Dr. Abhineet Shyam

Mr. Sambit Kumar Panda

Quotable Rainy Quips

"Predicting rain doesn't count, building arcs does" - Warren Buffet

"Some people walk in rain, others just get wet" - Roger Miller

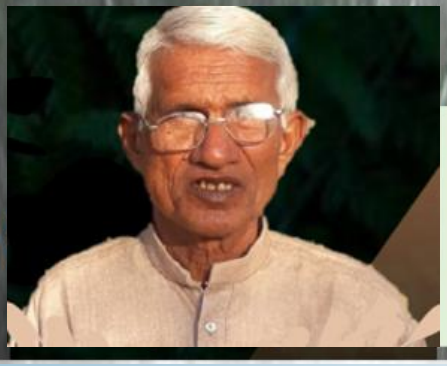
"The rain begins with a single drop" - Manal– al– Sharif

"I always like walking in the rain, so no one can see me crying" - Charlie Chaplin

IMSA Activity Log

World Ocean Day 2022
Lecture on "Biogeochemistry of Indian Ocean" by Prof. Sunil Singh, Director NIO Goa

Lecture on Nowcasting by Dr Bipasha Paul Shukla and experience sharing by Shri C.P Patnaik July 2022



Earth Day 2022
Lecture on "One litre water plantation technique" by Padmashri Shri S.R Verma

IMSA Activity Log

IMSA Cambay education society and VSSE-SAC organized an outreach event at Khambhat

IMSA and Centre for Agricultural Market Intelligence, NAHEP-CAAST organized an guest lecture on : Climate Change and Agriculture (April, 2022)

Prepared by Dr. Suchandra Aich Bhowmick

INSIDE THIS ISSUE:

PROGRESS OF MONSOON 2022

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The 2022 Southwest monsoon season comes to an end, with marginally above normal Seasonal rainfall, with extreme variation in its spatio-temporal distribution.

This year's Indian Monsoon Seasonal Rainfall (IMSR) (June to September) was predicted by IMD on 14 April as follows; "Rainfall is likely to be 99 % of the Long Period Average (LPA-87 cm) with a model error of ± 5%. This was updated on 31st May as rainfall is likely to be 103 % of the LPA with model error of ± 4%. IMD only counts the rainfall from 1 June to 30 September (IMSR), doesn't mean that the monsoon system ceases to pour rain over India from October 1. Withdrawal is a cessation of rainfall activity over Northwest India for five straight days, an anticyclone establishing itself in the lower troposphere and a marked reduction in the moisture content. The monsoon rains can continue up to a fortnight into October. IMD also predicted the onset of monsoon over Kerala will take place on May 27 (with an error margin of ± 4 days) on 14th May22. The private agency SKYMET made a prediction of onset over Kerala on May 26 (with an error margin of ± 2 days). However, the onset date as predicted by Satellite data **(on 11May22)** was on May 27(with an error margin of ± 4 days). **This year finally the onset was declared by IMD on 29th May.** However,

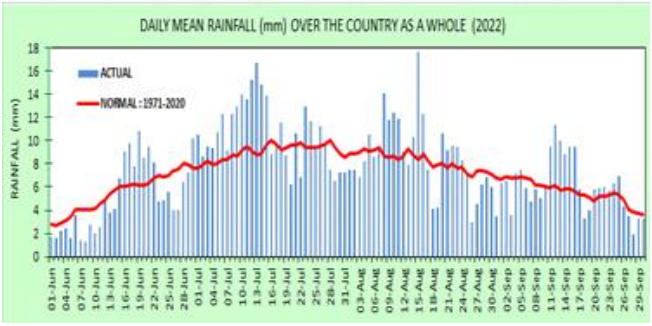

Fig 1. Daily mean rainfall (mm) time series over the country as a

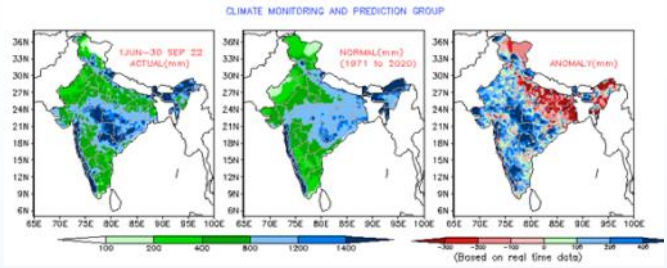

Fig 2. Actual seasonal rainfall (mm) over India, with normal and departure from normal (%) (Courtesy: IMD)

onset this year was weak, and progress was not like the typical pattern due to presence of anticyclonic circulation covering central and peninsular India extending from west Pacific. This year prior to onset, Total Precipitable Water Vapor (TPW) was high over Western Arabian Sea (>55 mm) on 9th May. The monsoon covered the entire country by 2nd July, six days earlier than normal. The daily mean rainfall time series (all India) is given in Fig-A and actual seasonal southwest monsoon rainfall (mm) over the country in 2022, with normal and % of departure from normal are given in Fig-B (Courtesy IMD). In the early June, Northeast India and Bangladesh were hit with devastating floods. Meghalaya's Mawsynram -worlds wettest place -recorded more than 1000 mm of rain on June 17, the highest June rainfall recorded by IMD. This year monsoon winds in the beginning were weak over Arabian Sea, however strong in Bay of Bengal (BoB). La-Nina (cooler than usual sea surface temperature conditions over Central and East Pacific Ocean) in combination with negative Indian Ocean Dipole (IOD) - (Cool Ocean temperature in West and warm in East Indian Ocean, strengthens the Southwesterly wind in Bay of Bengal.

This year Pakistan experienced worst flood in history due to unprecedented heat waves (Jacobabad experiencing 51 deg K). The intense heat also melted glaciers in the northern mountainous regions increasing the amount of water flowing into tributaries, that eventually made their way into the Indus river, combined with intense low pressure, in the Arabian Sea, which brought heavy rain to Pakistan's coastal provinces as early as June.

The 2022 Southwest monsoon season comes to an end, with marginally above normal Seasonal rainfall, with extreme variation in its spatio-temporal distribution. We also saw surge in August rainfall showing instances of flooding in Kerala, Karnataka and Madhya Pradesh, and on the other hand large part of UP, Bihar and Odisha have seen large rainfall deficit. Quantitatively monsoon seasonal rainfall was +6% (92.5cm) higher than its Long Period Average (87cm). In spite of monsoon onset on (29 May) the seasonal rainfall ended, just above normal. The monsoon rainfall is normal over Northwest India (96%) and Central India (104 %), below normal in East and Northeast India (88 %) and above normal in Southern Peninsula (111 %).

Experts have opinioned that the increase in rainfall is due to La Nina characterized by cooler than normal Sea Surface Temperature (SST) in Central Pacific. India is seeing an extended spell of La-Nina, called triple dip La-Nina, which is a phenomenon lasting across three winter seasons in the Northern hemisphere. This was only third time, since 1950 that a triple dip La-Nina has occurred. Monsoon patterns are showing a climatic shift since 1950. **Nowadays, instead of moderate rain spread through the monsoon season, we have long periods rainfall accompanied with short spells of heavy rains, since the moisture holding capacity of air increased with global warming,** best seen in the Pakistan floods.

The withdrawal of Southwest Monsoon has started on September 20 from Rajasthan. A low-pressure system formed in the Bay of Bengal, is since moving westwards in the coming days, rainfall is likely to occur over Odisha, Jharkhand, UP and Madhya Pradesh. The presence of this system will stall the monsoon withdrawal from parts of Central India till middle of October.

PREDICTION OF A UNIQUE MONSOON THAT IS STATISTICALLY NORMAL BUT NOT NORMALLY NORMAL

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Seasonal prediction of Indian summer monsoon rainfall (ISMR) during the recent times become more and more challenging due to several external factors both natural and manmade. Weather prediction improved manifold during last couple of decade; improved high resolution satellite and ground observations, better understanding of physical processes and high speed computational power play an important role in that. However, prediction skill of rainfall in medium to long-term time scale viz. 15 days to monthly, seasonal and decadal are not adequate. One of the biggest challenge is to model the fast changing climate and the manmade changes in land-use-land-cover. The fast growing infrastructure development activities in large scale over a landmass are significantly modify the respective land surface properties, heat and water budget, composition of atmospheric gases, aerosols etc. The state-of art climate models are not able to incorporate these changes while doing the long-term prediction.

Improved land surface parameterization in high resolution over extended Indian monsoon region is required to improve the prediction skill at the regional levels.

The monsoon season for the year 2022 was another example of unique and unusual rainfall variability during June to September. As per the Indian Meteorology Department (IMD) report, the country as a whole received 106% of rainfall of long period average. Thus, statistically, it was an above normal monsoon; however, the spatial distribution of the seasonal rainfall over Indian landmass (Fig. 1) does not suggest a normally normal monsoon. Almost, 40% of Indian landmass experienced below normal rainfall that includes some major rice growing states viz. Uttar Pradesh, Bihar and Jharkhand.

A seasonal prediction system has been setup at Space Applications Centre (SAC), Ahmedabad on experimental basis. The seasonal, monthly and weekly-accumulated rainfall prediction along with the forecast of onset and active -break phases have been successfully carried out during April

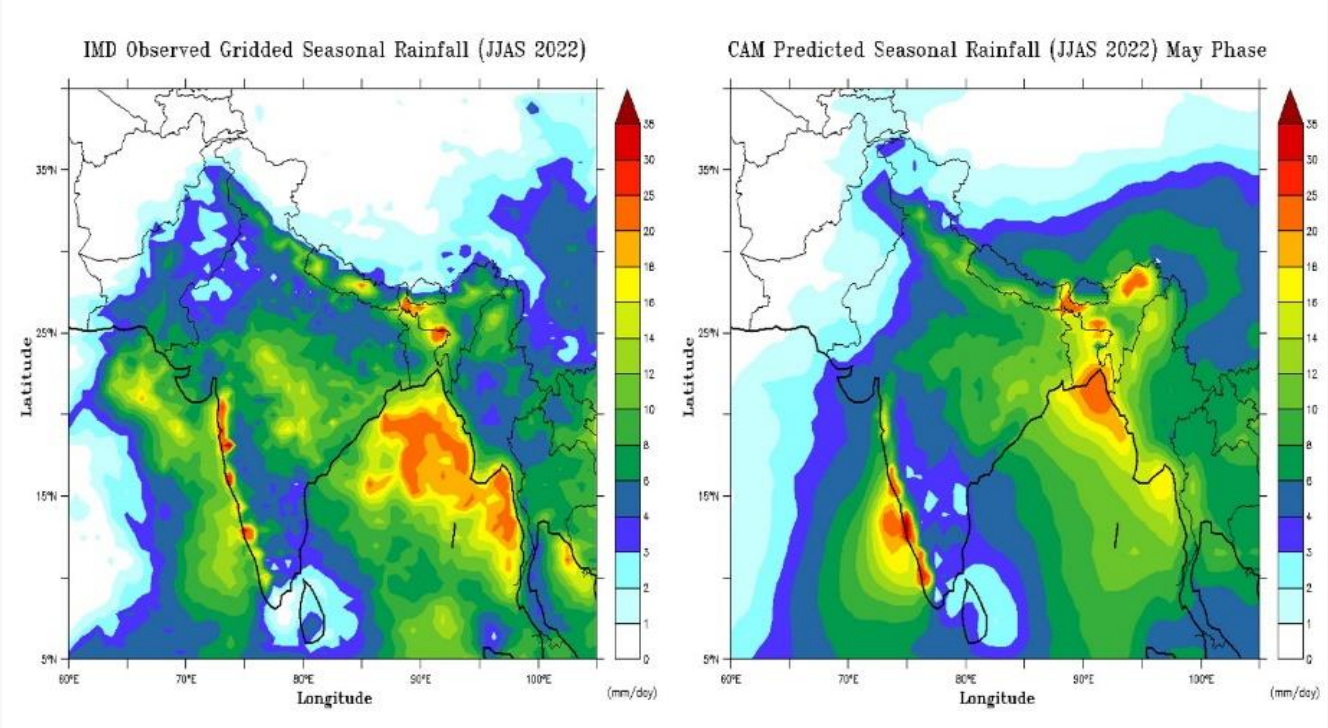

Fig 1. Comparison of seasonal predicted rainfall with IMD observed gridded rainfall

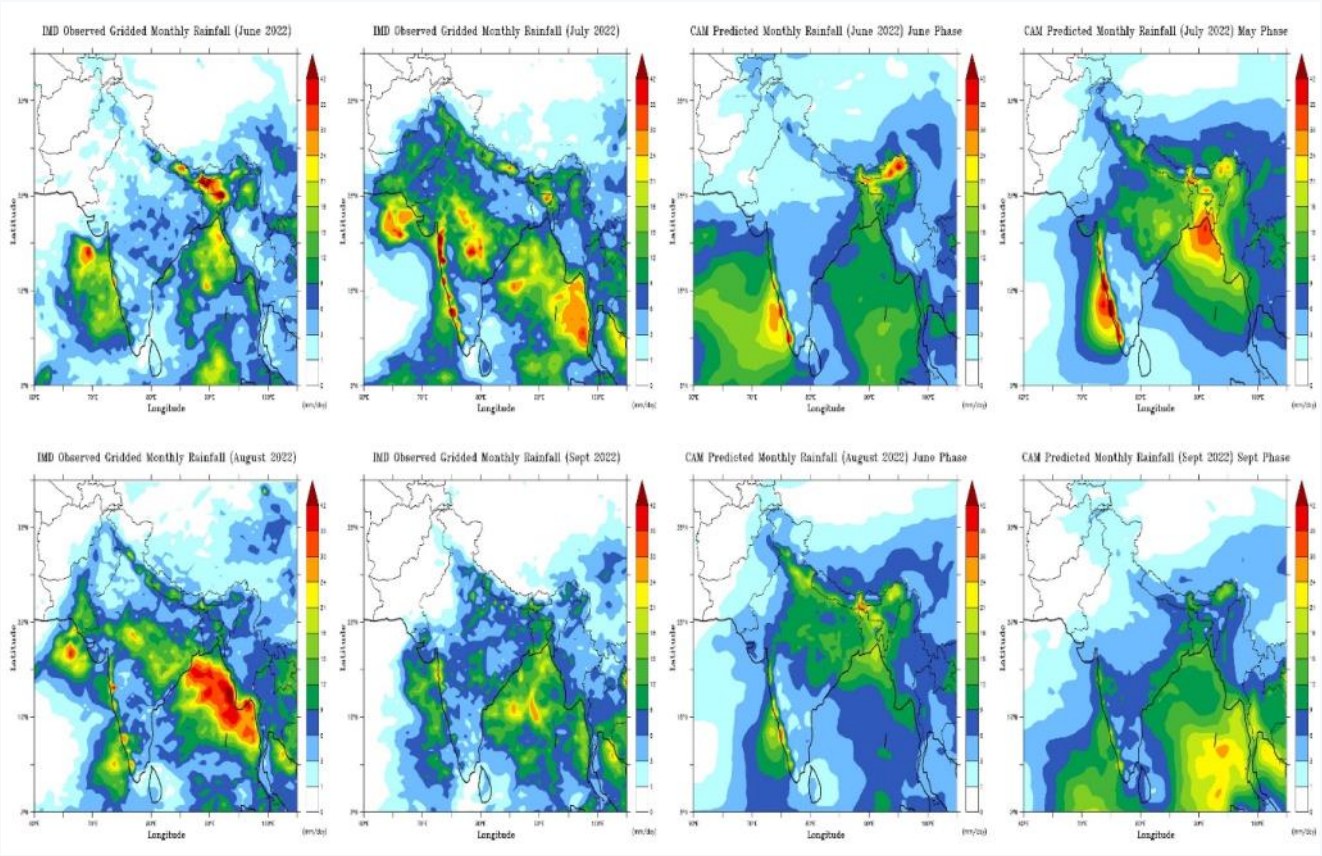

Fig 2. Comparison of monthly predicted (June to September 2022) rainfall with IMD observed gridded rainfall

to September 2022. Fig. 1 and 2 shows the comparison of the seasonal and monthly rainfall prediction with IMD observed gridded rainfall. ISMR over the country as a whole was predicted to be normal with 104% (92.5 cm) of All-India Rainfall (AIR) of long-term mean of 88.9 cm.

The prediction of ISMR has been generated through 50-member ensemble simulation of Community Atmosphere Model (CAM) version 4. CAM4 is the state-of-art AGCM that has been made available to the scientific community, originating from the National Center for Atmospheric Research (NCAR) Community Climate Model (CCM). It is also the atmospheric component of the Community Earth System Model version 1.2 (CESM), which is a fully coupled model. Each ensemble member of the model has been started with different initial conditions and sea-surface boundary conditions. An improved rain-bias correction technique has been applied to the model to eliminate the rainfall bias in the prediction system. Weighted ensemble mean has been computed to generate the ensemble prediction from the 50 members of identical model simulations. The first phase of prediction has been made during the first week of May named May-Phase. It has been updated during the first week of June called June-Phase. Subsequently the prediction has been updated on monthly basis till EOS i.e. September. Further, the weekly accumulated rainfall over Indian landmass has been predicted in four weeks of advance June through September. The predictions are disseminated through the MOSDAC web platform.

The prediction of ISMR generated by the 50 member ensemble CAM model is able to show the major seasonal and intra-seasonal variability on both seasonal and monthly scale. The rain minima over central-southern India can be seen in seasonal prediction (Fig 1), whereas, the deficiency of rainfall during June (15%) and excess rainfall all over the country during July (11%) are nicely picked up by the monthly prediction (Fig 2). The model failed to capture the excess rainfall over the west part of India throughout the season. Further, the deficit rainfall over the Gangetic plane during July-August is also unable to capture by the model. Overall, the All-India rainfall predicted during June to September 2022 was 104%, whereas, the seasonal rainfall of 106% was recorded by observations. However, the model is failed to capture many extreme events of rainfall and some regional monsoon breaks and active phases, especially over the West part of India. Improved land surface parameterization in high resolution over extended Indian monsoon region is required to improve the prediction skill at the regional levels.

AN ACTIVE WET SPELL OVER GUJARAT STATE DURING 10TH JULY TO 15TH JULY 2022: A BRIEF REPORT

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Gujarat state received an active wet spell during 10th July 2022 to 15th July 2022 with heavy to very heavy and extremely heavy rains. The active spell was mainly due to the interactions between monsoon trough, formation of depression over Gujarat coast, active offshore trough over south Gujarat coast and oscillation of shear zone between 19 to 20 deg N during the period.

The active spell was mainly due to the interactions between monsoon trough, formation of depression over Gujarat coast, active offshore trough over south Gujarat coast and oscillation of shear zone between 19 to 20 .deg N during the period.

Due to the above mentioned synoptic system monsoon was active over the region; during 10th and 11th July, vigorous over

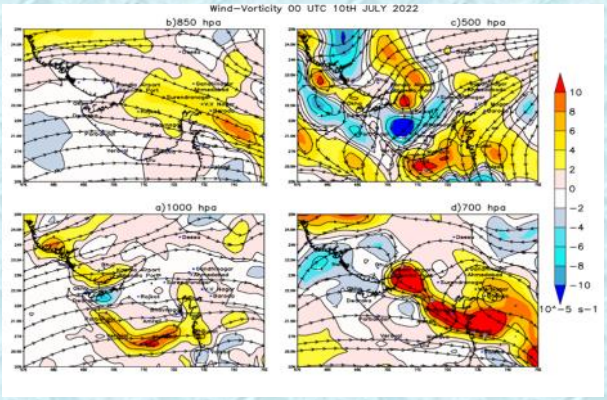

Fig 1: Vorticity and streamlines for levels a)1000hpa, b)850 hpa, c)500 hpa, d) 700 hpa, c)500 hpa 00 UTC 10th July

Fig1a : Isobars surface level 03 UTC 10/07/2022 Fig 1b: Highest rainfall recorded in the district.

Gujarat region during 13th July and active over Saurashtra-Kutch during 13th and 14th July, active over Gujarat region during 14th and 15th July 2022.

Exceptionally heavy rainfall occurred at isolated places in the districts of Gujarat region namely Chhota-Udaipur & Panchmahal during 10th July 2022; in the districts of Gujarat region namely Narmada & Surat during 11th July 2022. Extremely heavy rainfall occurred at isolated places in the districts of South Gujarat region namely Chhota Udaipur,

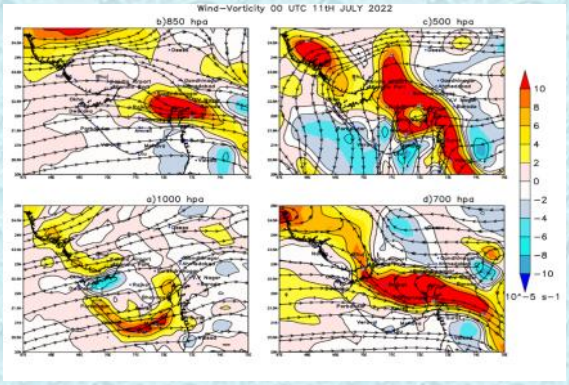

Fig2: Vorticity and streamlines a)1000hpa b)850 hpa c)500 hpa d) 700 hpa c)500 hpa 00 UTC 11th July

Fig 2a: Isobars surface level 03 UTC 11/07/2022 Fig 2b: Highest rainfall recorded in the district

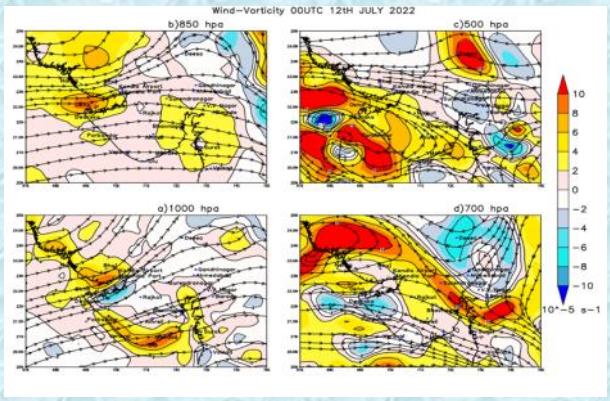

Fig3: Vorticity and streamlines a)1000hpa b)850 hpa c)500 hpa d) 700 hpa c)500 hpa 00 UTC 12th July

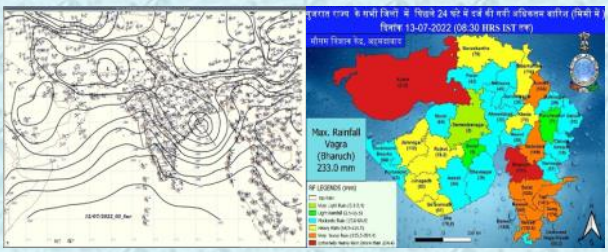

Fig 3a : Isobars surface level 03 UTC 12/07/2022. Fig 3b: Highest rainfall recorded in the district.

Dang, Navsari and Valsad during 10th July 2022; in the districts of Gujarat region namely Panchmahal, Valsad, Narmada, Dang, Surat, Tapi and in Daman, Dadra Nagar Haveli during 10th July 2022.;in the districts of South Gujarat region namely Navsari, Valsad, Dang & Daman, Dadra Nagar Haveli during 13th July 2022 ; in the district of South Gujarat region namely Navsari, Valsad and in Daman Dadra Nagar

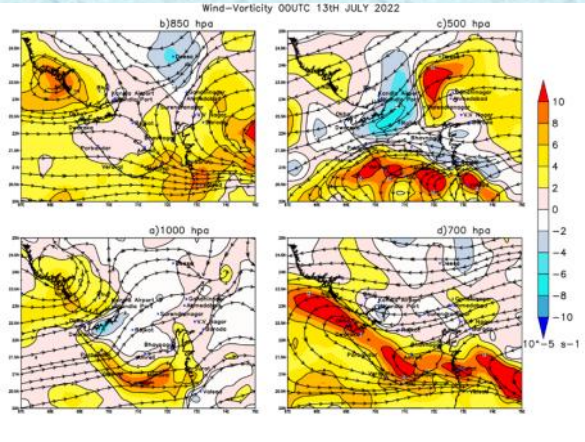

Fig4: Vorticity and streamlines a)1000hpa b)850 hpa c)500 hpa d) 700 hpa c)500 hpa 00 UTC 13th July

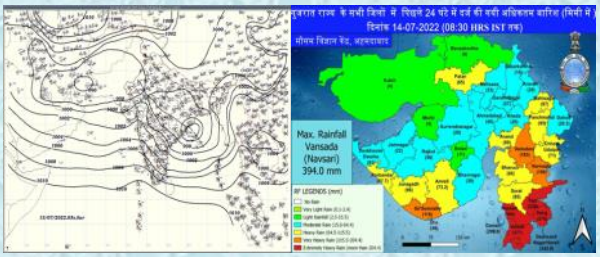

Fig4 a : Isobars surface level 03 UTC 13/07/2022 Fig 4b: Highest rainfall recorded in the district.

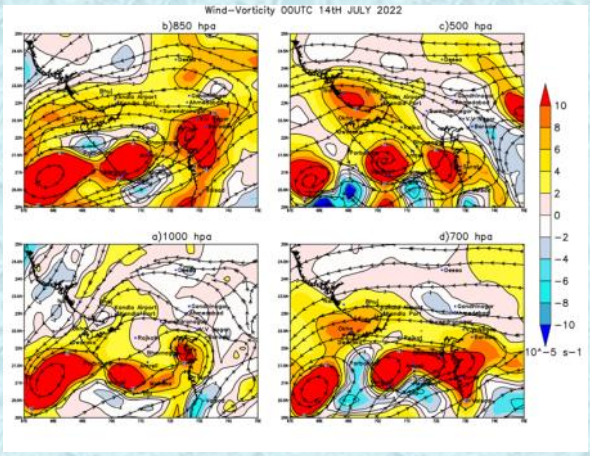

Fig5: Vorticity and streamlines a)1000hpa b)850 hpa c)500 hpa d) 700 hpa c)500 hpa 00 UTC 14th July.

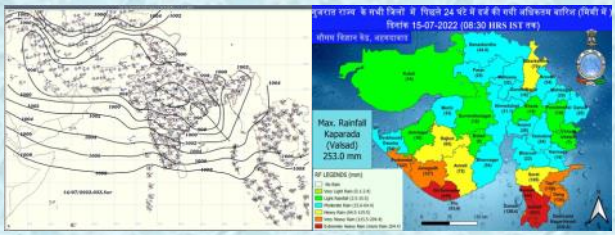

Fig 5a : Isobars surface level 03 UTC 14/07/2022 Fig 5b: Highest rainfall recorded in the district.

Haveli during 14th July 2022. Exceptionally heavy rainfall and extremely heavy rainfall occurred in the districts are coloured red in the district level map of Gujarat.

To study the characteristics of occurrences of heavy rainfall activity over Gujarat, IRA 5 reanalyzed 00 UTC data sets havebeen used to compute Vorticity and streamlines for 1000 hpa, 850 hpa, 500 hpa, 700 hpa and 500 hpa levels during the period 10th July to 15th July and plotted as shown in the Fig 1 to

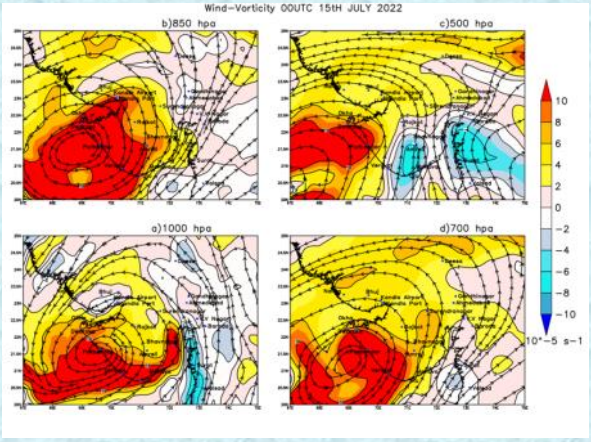

Fig6: Vorticity and streamlines a)1000hpa b)850 hpa c)500 hpa d) 700 hpa c)500 hpa 00 UTC 15th July

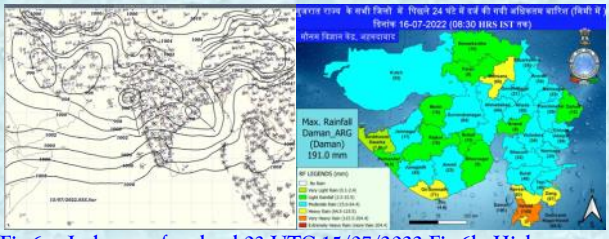

Fig 6a : Isobars surface level 03 UTC 15/07/2022 Fig 6b: Highest rainfall recorded in the district.

Fig 6. Surface chart also has been analysed for 10th July to 15th July as shown in the figure 1a to 6a respectively. It is found that the oscillation of shear zone from 18 °N latitude to 20 °N latitude and high value of positive vorticity at lower levels to upper levels in association with the low pressure system over Gujarat are highly correlated with the significant rainfall activity over the state(Fig 1b to Fig 6b). During the period, it is seen form fig 7(Vorticity Hovmöller diagram) that there was high values of positive relative vorticity over the Gujarat region as well as Saurashtra Kutch at lower layers(1000-850 hpa) as well as upper layers(700-500 hpa) of the atmosphere.

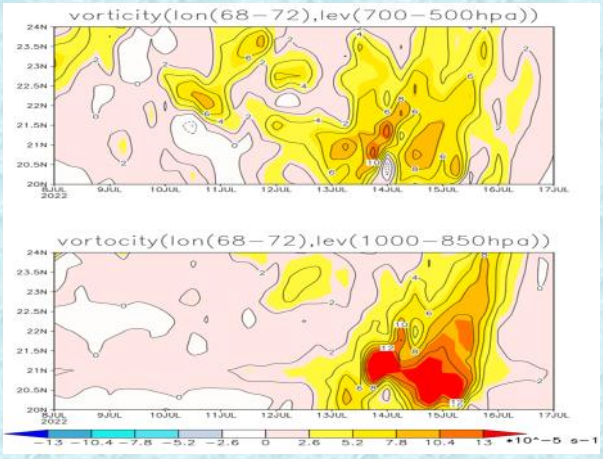

Fig 7: Vorticity Hovmöller diagram 1000-850 hpa and 700 -500 hpa 8th July 00 UTC to 17th July 00 UTC averaged for 68 to 72 .°N lon.

RISING SURFACE PRESSURE OVER TIBETAN PLATEAU STRENGTHENS INDIAN SUMMER MONSOON RAINFALL OVER NORTHWESTERN INDIA

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The Indian summer monsoon (ISM) is the strongest component of the global monsoon system, bringing 70-90% of India's yearly rainfall. The amount of ISM rainfall (ISMR) varies considerably from year to year, which significantly affects India's agriculture, socio-economic development, disaster management, and hydrological planning. The majority of studies have found that the ISMR has been relatively stable over the past half a century, especially on a national level, with significant spatial variability in the trends. A comprehensive examination of the geographical distribution of rainfall trends shows that, over the previous four decades, ISMR in northwest India and along the western ghat

As a result of rising surface pressure over the TP, lower level easterlies have intensified in northwestern India, while middle tropospheric north westerlies have decreased across East India.

increased while the ISMR over the Indo-Gangetic plains (IGP) and North East Indian regions significantly decreased (Fig. 1a). Several studies have reported the dipole pattern in the rainfall trends (wetting across northwestern India and drying over the Indo-Gangetic plains and northeast India). The real cause of the asymmetries in rainfall trends is still subject to debate. Previous studies revealed that low pressures/depressions in the Arabian

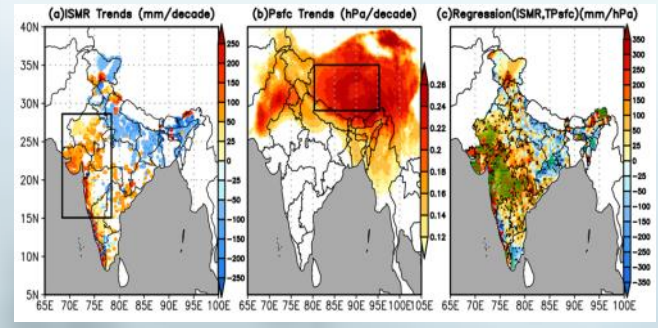

Fig 1 (a) linear trends of rainfall (mm/decade), (b) linear trends of surface pressure (hPa/decade), and (c) regression of the ISMR against the Tibetan surface pressure (TPsfc) (mm hPa-1).

Sea and an increase in moisture transport from the ocean towards the Indian land mass under the warming climate were the main causes of enhanced rainfall activity, particularly heavy rainfall events. The decrease in rainfall has also been linked to regional-scale anthropocentric forcing like aerosols, changes in land use/cover, and global-scale anthropocentric forcing like greenhouse gases (GHGs). The frequency of El-Nino, weakened monsoon circulation, and increased air pollution are some additional potential factors that could have impacted ISMR variability. In a very recent study, Singh et al. 2022a suggested that this dipole pattern in rainfall trends is linked to changes (due to global warming) in surface pressure across the Tibetan Plateau (TP). Only those trends that are significant above 95% confidence level are shown in (a) and (b). In (c), the green color circles show the regions where regression is significant above 95% confidence level and the black color triangles show the regions where regression is significant between 90 to 95% confidence levels. The entire analysis is for June-September, during 1979-2020. The rectangles in (a) and (b) depict northwest India (15°N-28°N, 68°E-78°E) and the Tibetan region (29°N-35°N, 80°E-95°E), respectively, which were considered in the analysis. Surface pressure data is from the recently released ERA5 reanalysis, while rainfall data is from the India Meteorological Department (IMD).

The TP, which has a mean elevation of about 4000 m and a surface area of about 3000000 km2, is the highest and largest Plateau in the world. It acts as a topographical barrier and influences the ISMR by obstructing cool, dry air from northwest Tibet, which has a substantial effect on regional weather and atmospheric circulation. Additionally, by serving as elevated heat sources, TP also promote the ISMR. It is apparent from the regression analysis (Fig. 1c) that rainfall increases across northwest India and decreases over the Indo-Gangetic Plains and northeast India as surface pressure above the TP rises. It is important to note that the rainfall regression with Tibetan surface pressure (TPsfc) in the Indo-Gangetic plains and northeast India is not uniform, in contrast to northwest India. Instead, only a small number of isolated locations exhibit a significant association, suggesting that factors other than TPsfc, which including local (such as changes in land use and cover) or remote (such as El-Niño) forcing, may be crucial. Surface pressure above the Tibetan Plateau controls the ISMR pattern by regulating both low and middle-level circulation. To show how zonal wind anomalies over northwestern India can influence the ISMR, the interannual variability of the area-averaged JJAS (June through September) 850 hPa zonal wind is compared with

TPsfc by Singh et al., 2022a. The strong link between surface pressure over the TP and zonal wind over northwest India (U850, 22°N-30°N, 68°E-78°E) is reflected in the interannual variability of U850 and TPsfc. A high negative correlation exists between the two time

series ($r = -0.55$, $p < 0.01$, Fig. 2a). Similarly, with a –0.81 ($p < 0.01$, Fig. 2a) correlation, NWIR (rainfall in northwest India) interannual variability is strongly linked to U850. In addition, U850 trends are examined, revealing a strong relationship between rising TPsfc and rising easterlies (-0.26 ms-1decade-1, $p < 0.01$, Fig. 2b). As a result of rising surface pressure over the TP, lower level easterlies have intensified in northwestern India, while middle tropospheric north westerlies have decreased across East India. Increased easterlies could transport more moisture from the Bay of

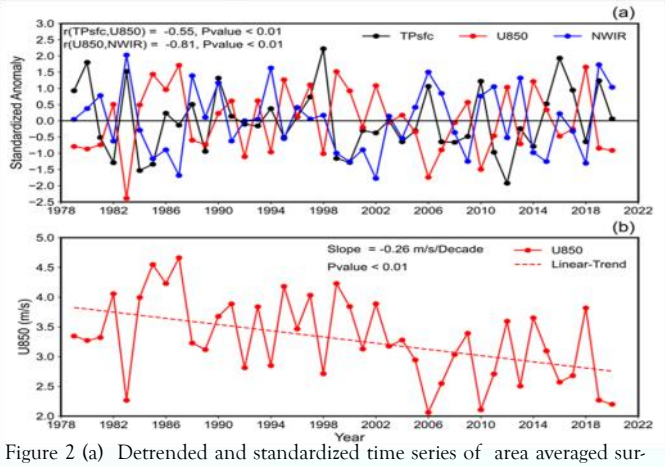

Figure 2 (a) Detrended and standardized time series of area averaged surface pressure over the Tibetan Plateau (TPsfc, 29°N-35°N, 80°E-95°E), 850 hPa zonal wind (U850, 20°N-30°N, 68°E-78°E), area averaged rainfall (NWIR, 15°N-28°N, 68°E-78°E), and (b) time series of 850 hPa zonal wind (U850, 20°N-30°N, 68°E-78°E). The entire analysis is for June-September, during 1979-2020. Wind data is from the recently released ERA5 reanalysis, while rainfall data is from the India Meteorological Department (IMD).

Bengal to the northwestern part of India, leading to increased rainfall activity.

The surface pressure above the TP increased significantly between 1979 and 2020. According to both observational and modeling studies, regional/hemispheric warming causes higher surface pressure over the TP in a hydrostatic atmosphere. Lower level easterlies over northwestern India and middle-level southerlies over East India show a rising tendency from 1979 through 2020, which is consistent with surface pressure patterns over the TP. Singh et al. 2020a also underlined that the influence of global warming on increasing surface pressure over the Tibetan Plateau was substantially greater than that of other causes of increases in the surface pressure over the Tibetan Plateau, such as water vapour loading and aerosols. Additionally, Singh et al. 2022a demonstrated that the interactions between ISMR and other significant climatic elements (e.g. ENSO, PDO, NP, NAO, AO etc.) have little impact on the association between TPsfc and ISMR. It is worth mentioning that, in addition to the increased surface pressure over Tibet, other causes are also contributing to the increased rainfall activity in northwest India. For example, according to a recent study, a rise in surface temperature as well as an intensification of the surface low-pressure area over Iran and anomalous cyclonic circulation over the Northern Arabian Sea is responsible for an increase in rainfall activity in northwest India (Yadav, 2016). The author further said that the surface temperature over Iran has been rising in recent decades. As a result, the south-west monsoon has shifted westward (for example, prolonged north-westward intrusion of low pressure systems (LPSs) form over the Bay of Bengal's head), bringing increased flooding in northwest India and drought in northeast India. Furthermore, the monsoon low-level jet (MLLJ), a strong cross-equatorial flow in the lower troposphere that originates from Mascarene High and flows across the east coast of Somalia to the Indian peninsula, is critical to the Indian summer monsoon rainfall. Rainfall in northwest India (NWIR) is significantly correlated with winds across MLLJ's core region (5°N-15°N, 50°E-70°E) over the Arabian Sea, shows a correlation of 0.62 (Pvalue < 0.01). Interestingly, the wind intensity in MLLJ has been increasing over the last four decades (0.22 $ms^{-1}decade^{-1}$, Pvalue < 0.01). Using data from 1950 to 2015, earlier study also reported a rise in low-level monsoon westerlies across the Arabian Sea (Roxy et al., 2017). Since strong cross-equatorial flow (i.e. MLLJ) is a manifestation of large thermal gradients between the Asian landmass and surrounding oceans, the intensification of MLLJ could be attributed to rising temperatures over Iran.

Similarly, there is evidence that human activities are influencing rainfall in the IGP region (Niyogi et al., 2010). Anthropogenic activities such as increased GHGs emissions, changes in radiative forcing due to aerosols and clouds, and changes in land surface physical properties due to land use changes such as urbanization and agricultural practices are some of the anthropogenic activities that may be playing a role, in addition to TPsfc changes. The IGP, India's largest irrigated region, is home to 40% of the country's population and 50% of its irrigated land, with groundwater irrigation serving as the primary source of water. Irrigated agriculture in India has expanded from less than 20% in the 1960s to more than 45% today. Increased irrigation, according to a recent modeling study, decreased the monsoon circulation, resulting in less precipitation (Mathur and AchutaRao 2020, Singh et al., 2022b). As a result, these various forcings may interact, leading to a complex change in monsoon rainfall patterns.

These findings are important in determining what is causing regional variations in the Indian summer monsoon rainfall pattern. Due to the fact that the surface pressure anomalies over the Tibetan Plateau are extremely sensitive to regional/hemispheric warming, these findings will also be helpful in understanding and forecasting summer monsoon rainfall on interannual time scales as well as in hydrological planning for the country under the backdrop of global warming. Furthermore, the significant synoptic-scale link between Tibetan surface pressure and ISMR can help with long-range monsoon forecasting.

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PREDICTION OF WEATHER FORECAST IN NEXT 75 YEARS

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As we are celebrating 75 years of Independence of India, let us look at how weather forecast is going to change in next 75 years. We shall be talking about the type of weather forecast by 2097

Whether this prediction of weather forecast becomes true or not, one thing is certainly true that change is the eternal and universal law of nature.

or by the end of this century. We are not talking about the change in weather, but about the change in weather forecast. We are witness of how weather forecast has changed during last 75 years. Based on the past trends, we shall try to project it in the future. One can not assume that the trends will remain same as in the past, and so it may not be possible to extend forecast behaviour linearly to future. So, the projection here will have inherent inaccuracy depending on the change in future trends.

First let us look at the causes which enable changes (improvement/ deterioration) in weather forecast. Briefly we shall describe how these causes change the weather forecast with time.

1. Understanding the physical process of weather system

Seven decades earlier weather parameters were measured only at a few observatories over land. These observations were used to understand the physical processes of weather system in a broad scale. Based on the understanding, weather forecast was made in synoptic scale by drawing weather charts extrapolating the streamlines to the places where there were no observation. The forecast accuracy was subject to the expertise of the meteorologist, who was drawing the charts. Understanding of physical processes causing weather is a continuous process and is gradually improving with time.

2. Understanding the dynamics of weather system and modelling

Considering the atmosphere as a fluid, the dynamics of weather system was formulated in terms of fluid dynamics equations. As these equations are evolutionary in nature, knowing the present weather conditions, it is possible to forecast how the weather will evolve in future. Only problem is that these equations are system of nonlinear partial differential equations and there is hardly any analytical solution. At the same time, these equations were the basis for better understanding the dynamics of the weather system and subsequently it helped to have improved forecast than synoptic forecast. This was also an objective method, which was not depending on the manual extension of synoptic weather charts. Though the dynamics is mostly understood, many physical processes causing weather have to be integrated with the dynamical system.

3. Development of numerical techniques for solving nonlinear hydrodynamics equations

As analytical solution was not available, numerical techniques were developed to solve these equations with the help of computer technology. Normally numerical techniques are implemented in a grid system representing an area where forecast is to be done. Considering the weather system as superposition of waves, spectral techniques were developed to replace the grid system and solve these equations in spectral domain of amplitude and frequencies of the waves. These were then transformed into grid point values of weather parameters. Numerical techniques have improved over time in the past and are still improving.

4. Observational accuracy of weather parameters

Development of instruments for measuring weather parameters played a crucial role in the forecast system. If one knows the current weather accurately, then one can expect to have accurate forecast. As the errors in the measurement grow with time evolution, while estimating their future state, the forecast will also have larger errors with time. Measuring instruments are getting better and better with time and the improved accuracy is having a positive impact on the forecast.

5. Density of observation of the present weather system

While solving the dynamical equations, one has to have knowledge of each weather parameter at each grid point of the area. If there is no observation at some of the grid points, then they have to be assigned some value by interpolation or extrapolation from neighbouring points. Earlier most observations were over land and vast area of ocean was not having any observation except over some islands and some commercial ships. With the era of satellites and development of remote sensing techniques, the number of observations is continuously increasing with time and consequently the current weather is known better.

6. Computational power for analysis of observations and forecasting weather

With the development of numerical techniques, simultaneous computer technology development helped to analyse the observation of weather parameters and to integrate the dynamical equations for making a forecast. Computational power is continuously increasing with time. With the increase of computational capability, data storage

capacity is also increasing with time and they together are changing the weather forecast system.

7. Communication technology for dissemination of weather observation and forecast

Though the number of observations is increasing at different locations, it has to be communicated to a central computer system for analysis in a reasonable time to make a proper forecast. The forecast also has to be disseminated in quick time to the users for whom it is relevant. With the help of satellites, communication technology is also improving with time. All these above causes have changed the weather forecast in the past.

Dynamical forecast has replaced synoptic forecast. The current weather is better known with the increase in observations. With the increase in computer power, the forecast is made in higher resolution, both in spatial and temporal domain. The same causes are supposed to change the forecast system in next 75 years. Let us explore how the rate of change in the past may be projected in the future.

In the past (1947 – 1970 approximately) the synoptic scale forecast was made for almost 100 Km in spatial domain. During next two decades (1970 – 1990) , with the help of dynamical models, the forecast was made for 25 – 50 Km. With the increase in number of observations, during next two decades (1970 – 2010) forecast resolution improved to 10 – 25 Km and now during the last decade, with fast computers having huge storage capacity, the forecast is made in 5 – 10 Km. Following the similar trend, by 2050 one can expect to have forecast in 1 – 5 Km resolution. Assuming the similar trend, by the end of this century, forecast will be available in 100 – 250 meters spatial resolution. With the advent of new technology for observation, every mobile phone may have a small chip for weather parameter measurements and transmission to a central computer with its location information. Though this is only a wild guess, this will definitely improve the quality of forecast in future. There will be advanced sensors in future geostationary satellites which will provide high resolution weather data in both spatial and temporal domain.

In contrast to the improvement in spatial domain, the improvement in temporal domain is rather slow with time. Earlier during synoptic forecast, forecast up to one day was made with the assumption of persistence forecast. With dynamical forecast, till now it has gone up to 3 – 5 days in tropics, and 5 – 7 days in mid-latitude with some reasonable accuracy. With similar trend, by the end of this century, forecast may go up to 5 – 7 days in tropics and 10 – 12 days in mid-latitude. One should remember, that weather system being a chaotic system (in which a small error in initial condition may result in a large error in forecast), it is already established that forecast of weather beyond 14 days (limit of weather predictability) will have no meaning.

For final verification of this prediction of weather forecast, one has to wait till the end of this century, but partial verification can be done with time whether the trend remains same. If there is drastic change in the trends, then that will also be only wild guess.

Whether this prediction of weather forecast becomes true or not, one thing is certainly true that change is the eternal and universal law of nature. So, by this law of nature, weather forecast is also definitely going to change with time and as in the past we can only hope that it is going to improve further.

Beauty of Monsoonal Clouds

Picture Courtesy : Dr. Ashish K Shukla

NAVIGATING WEATHER THROUGH NavIC

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GNSS is a very well-known term in navigation fraternity and generally stands for Global Navigation Satellite Systems. GNSS systems are meant for providing seamless Position, Navigation and Timing (PNT) services throughout the globe in all weather conditions. Generally, all Global Navigation satellite systems are in medium earth orbit (MEO). MEO is majorly a reasonable compromise between optimum resource, cost and coverage. However, now a days, satellites in Low Earth Orbit (LEO) are also gaining popularity due to the fact that the transmitted signals would be more jamming resistant than the signals received from the conventional MEO and GEO/GSO orbits. LEO orbits also offer a platform for hosting space-borne GNSS receivers to cater various cost-effective applications, especially weather and interplanetary navigation applications under Space Service Volume (SSV). Furthermore, opportunistic use of presently available Multi-GNSS signals from GPS, Glonass, Galileo, Beidou, NavIC and QZSS may prove to be valuable resource for the development of applications in numerous areas. Some of these potential application areas include Location Based applications, Remote Sensing applications, Science applications, tracking, disaster management, precision agriculture, Weather prediction, Construction, maritime, Unmanned Aerial Vehicle (UAV), survey and land records, robotics etc. This article attempts to provide stimulus about unique applications using NavIC with special emphasis on weather applications using NavIC S-band signals and multipsath classification with particular attention to NavIC GEO and GSO orbits.

There are very interesting applications and research areas which can be addressed especially using S-band NavIC signals or with a combination of NavIC and other GNSS signals such as GPS.

Weather Applications using NavIC S-Band Signals:

India has developed its own satellite navigation system NavIC (Navigation with Indian Constellation) which is a constellation of GEO and GSO satellites and is currently providing services over Indian land mass and 1500 km from its geo-political boundary. NavIC signals are currently being transmitted at two frequencies: L5 (1176.45 MHz) and S Band (2492.028 MHz). NavIC S band signal has wavelength of around 12 cm and this makes it very unique for weather monitoring applications. There are very interesting applications and research areas which can be addressed using especially S-band NavIC signals or with a combination of NavIC and other GNSS signals such as GPS.

Unique Applications using NavIC S-Band: Detection of Thunderstorm

NavIC S band uniquely provides opportunity to study weather system formation since S band is able to capture weather related signature such as cloud and thunderstorm formation. NavIC S Band signal strength (C/N0) parameter has been used to detect cloud system responsible for thunderstorm formation over a tropical station Kolkata, India (Das et al. 2020), since S band responds better for such applications in comparison to L Band.

Figure 1 illustrates detection of thunderstorm using NavIC S-band signals using Machine learning algorithm along with the validation using Radar data. Here a thunderstorm system developed on April 12, 2018, and gradually moved over the study location. Here two clear days April 10 and 11, 2018 along with the thunderstorm days have been considered for analysis of signal strength change. For a better understanding each day has been divided into three consecutive sessions of 8hr each and the same process has been applied for each individual session.

Dynamic Time Warping (DTW) is applied between signal strength of the L- and S-bands for every session of each day and the obtained Warping Lines (WLs) are compared between the same session of the two consecutive days (i.e., between two NR days (April 10 and 11, 2018)) and between rainy and its consecutive NR day (April 11 and 12, 2018). WL difference is plotted on vertical axis in Figure 1 for NavIC 1B, 1C and 1E. To understand the nature of this variation, IMD Doppler radar data of the event are also shown. It is clearly visible from the NavIC orbital constellation and Doppler radar cloud coverage picture that the cloud has moved from the direction of IRNSS 1C. This finds good agreement with the WL variation shown in Fig. 1. The starting time of such a deviation corresponded well with the cloud overcast as NavIC 1B and 1C are affected earlier than NavIC 1E. NavIC 1E has only been affected after the cloud moved over the study location.

GNSS Radio Occultation (GNSS-RO):

The main idea behind Radio Occultation is to use various GNSS systems such as GPS, GLONASS, GALLILEO, BEIDOU and regional systems such as NavIC and QZSS for atmospheric sounding. GNSS signals are abundantly available from these constellations in L and S band and are being used for remote sensing of Earth from LEO-based platforms using onboard GNSS receivers. The main advantage of GNSS remote sensing is that it provides high temporal resolution with acceptable spatial resolution in a cost-effective manner. Signals from GPS and other GNSS are already being exploited for the fully operational GNSS-Radio Occultation (GNSS-RO) satellites or constellations for atmospheric sounding. In this regard, NavIC S band generates great interest and scope to independently explore this field of remote-sensing for weather monitoring in particular because of the availability of S band signal which is more suitable for such studies.

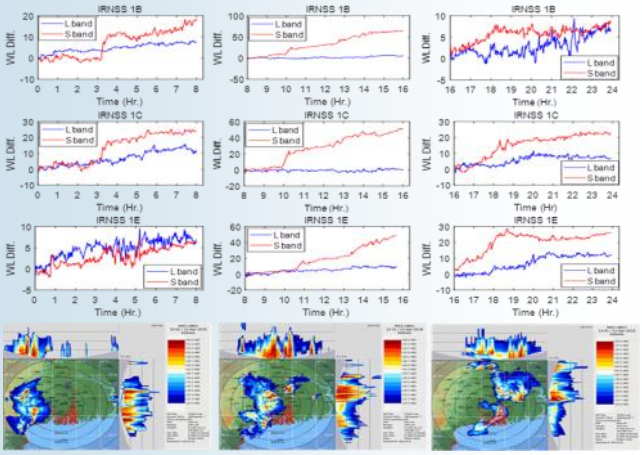

Fig1: Detection of Movement of a Thunderstorm System (Das et al.,2020)

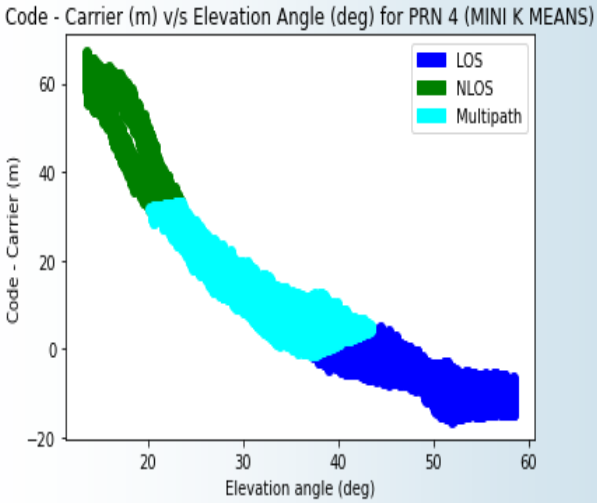

Fig 2: Multipath Classification of NavIC Signals

Detection of trajectories of Tropical Cyclones (TC) using GNSS-NavIC S-Band RO measurements:

Radio Occultation (RO) data using Space borne receivers at Low Earth Orbit (LEO) platforms provide valuable information about temperature, humidity and Water Vapour profiles which are being ingested in weather forecasting models by the researchers.

As per the earlier study by JPL/NASA NavIC S band adds significant information to COSMIC constellations with higher precision and provides ten times improvement in Signal to Noise Ratio (SNR) from the combination of L5 and S band of NavIC . It also provides greater temperature and altitude resolution with improved understanding of boundary layer processes. Studies by JPL/NASA [3] have shown that RO improves forecasts of tropical cyclone (TC) intensity and track location and with the inclusion of RO measurements from NavIC satellites will additionally provide excellent coverage near the TC tracks due to increase in the number of observations by 50%-100% near the TC tracks compared to COSMIC-2 alone. Therefore, it is expected that NavIC-RO measurements (especially S-Band) from LEO platforms will significantly improve forecasts of TC intensity and track location. NavIC-RO significantly increases occultation count in North Atlantic region relative to COSMIC-2, since, nearly all cyclones will spend sufficient time in this region.

Multipath Classification with signals received from NavIC GEO/GSO Orbits using Machine Learning Approach:

Unkike GPS which is a MEO orbit constellation, NavIC signals experience different multipath characteristics because of their GEO and GSO orbits. Multipath classification from GEO and GSO orbits are being explored using the machine learning algorithms and signals are classified as Line of Sight (LOS), Multipath and Non-Line of Sight (NLOS) (Shukla et al., 2022).

Figure 2 shows how explicitly machine learning algorithms are able to classify LOS, Multipath and NLOS signals using NavIC code minus carrier and Elevation angle as input parameters. This kind of intelligence to GNSS receiver will provide robust and accurate positioning for especially for safety of Life (SoL) applications. This classification of signals may also be useful for soil moisture estimation which is a very important inputs for flood prediction, weather forecast and climate monitoring.

GNSS Reflectometry (GNRR-R):

Another important technique which is gaining considerable momentum especially for weather applications now a days is GNSS reflectometry (GNSS-R). Tapping the reflected GNSS signals from the land and ocean surfaces using LHCP/RHCP antennae, ocean altimetry, and ice sensing (sea and glaciers) and near surface soil moisture studies are being done using space-borne and ground-based GNSS receivers respectively.

Conclusion:

S-band signals from Indian Satellite Navigation System, NavIC, provide unique opportunity to explore and develop weather applications to the researchers worldwide since S-band is unique to NavIC constellation and carries signatures to study cloud formation, thunderstorm detection and Cyclone Track prediction. Furthermore, characteristics of multipath is quite different from that of other GNSS systems in MEO orbits. Therefore, NavIC further provides opportunity to study and classify multipath signals from GEO and GSO orbits, Various other studies such as ionospheric Total Electron Content (TEC) and scintillation characteristics using S-band signals are also being explored. Future NavIC satellite is also proposed to transmit signals in L1 frequency band. Therefore, it would be further interesting to see researchers explore this additional frequency as well for addressing novel applications with single, dual and triple frequency combinations.

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SATELLITE SENSING FOR AGROMETEOROLOGICAL APPLICATIONS

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Agriculture and allied sector are an economic engine for India as more than 60% population livelihood directly and indirectly depend on it. After the era of green revolution, food security for all citizen is a prime focus for all government agricultural polices to feed the growing population. This require sustainable growth of agriculture to safeguard of our existing natural resources. The usage of growing technology to optimize farm resource efficiency for curtailing the cost of production and limit the expected losses is the need of farming community. The continuous rise in crop production is a result of adaptation of new technology by agricultural fraternity. But major apprehension for the farming community is increase in crop losses due to erratic and anomalous weather. Agrometeorology link the complex system of soil plant atmosphere continuum (SPAC). The coupled soil-plant-atmosphere system responsible for exchange of energy, mass, and momentum between land and atmosphere. The developed understanding of exchange processes provides reasonable operational applications and recommendations for farming community. The agrometeorological guidance for the timely farm operation and management can reduce the expected crop losses. Hence to strengthen the farmers' farm decision support mechanism bi-weekly Agrometeorological Advisory Services (AAS) is issued to farmers' through a network of 130 Agro-Met Field Units (AMFUs) by India Meteorological Department (IMD) under the umbrella of Gramin Krishi Mausam Seva (GKMS). The major objective of the AAS is translation of mesoscale medium range weather forecast for management strategies and required farm operations based on real ground situation of crop/livestock to increase crop production and reduce the losses due to unfavorable weather. The current advisory framework could reduce 5-10% cost of farming operations and increase in crop yield varying from 10-25% (Rathore and Maini, 2008). To improve the quality and coverage of present advisory framework require near real-time assessment of crop and soil condition at block and district scale. In the present scenario historical crop record and point scale crop condition with weather forecast are used for generation of advisory for a group of blocks and districts farmers'. The advances in the spectral sensing through polar and geostationary satellite provide an opportunity to capture the near real-time synoptic continuous coverage of crop condition throughout the crop season. This open up a new pathway to enhance the scope of agromet advisory services by integrating the satellite derived agromet products in the current framework to address block and district specific advisory. To encourage the usage of satellite data for the societal applications, Space Applications Centre (SAC), ISRO under Multi-Mission Data Reception and Processing System (MMDRPS) project providing many core agromet products from Indian geostationary satellites INSAT-3D and 3DR. These products further used to derive value added agromet products/indicators such as in-season crop sowing prospect, crop stress indicator, surface dryness index and assessment of agricultural drought etc.

> ***The agrometeorological guidance for the timely farm operation and management can reduce the expected crop losses.***

The SAC and IMD jointly initiated the usage of the core and value added agromet products in bi-weekly agromet advisory services for six Agro-Met Field Units (AFMUs) covering 672 blocks and 98 districts). At present agromet products such as Normalized Difference Vegetation Index (NDVI), Potential Evapotranspiration (PET), Surface Aridity Index (SAI), Minimum and Maximum Land Surface Temperature (LST) and Surface Soil Moisture (SSM) are provided to all six AFMUs in user friendly format since October 2019 through a dedicated web link from VEDAS (Visualization of Earth observation Data and Archival System) (https://vedas.sac.gov.in) geoportal.

Ground-based Agrometeorological Observational System

The AgroMet Station (AMS), Eddy Covariance (EC), Large Aperture Scintillometer (LAS) and four component radiation system were installed in different agroclimatic region by SAC team to measure the agrometeorological observation in different cropping system of India. AMS with INSAT communication link was having slow response sensors for air temperature, relative humidity, wind speed and direction at

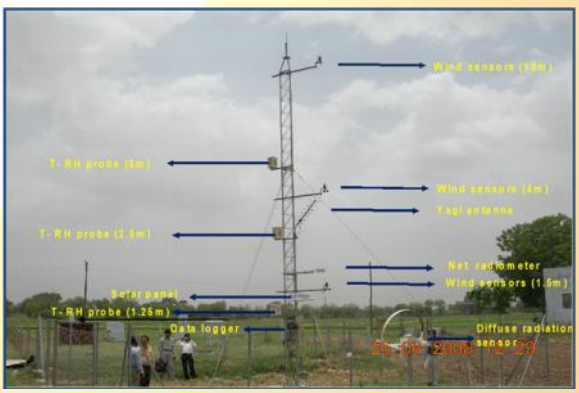

Fig 1. AgroMet Station (AMS)

Fig 2. Eddy Covaraince System

three heights along with four-component net radiometer, two-depth soil heat flux sensor, three-depth soil temperature sensors and rainfall sensor as shown in Figure 1. AMS used the bowen ratio-based methodology to provide surface latent and sensible heat fluxes. EC system possess fast response sensors and provide direct measurement of

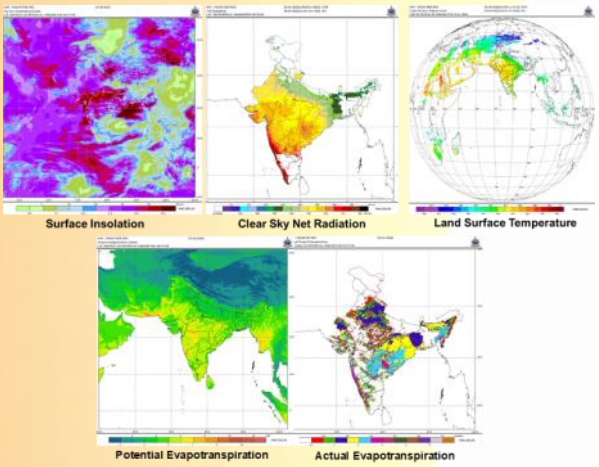

Fig 3. Examples of INSAT 3D/3DR derived Agromet Products

surface fluxes and net ecosystem exchange (NEE) as shown in Figure 2. These measurements were used to study field scale surface energy budgeting and CO2 fluxes for various cropping system and also helpful for evaluation of satellite derived agromet products.

Core Agromet Products

The algorithms were developed to generate core agromet products such as surface insolation (instantaneous and daily), net radiation (instantaneous and daily), potential evapotranspiration (daily), actual transpiration (daily) and land surface temperature (instantaneous and daily) from Indian geostationary satellite INSAT 3D and 3DR. The developed products were validated with the ground measured data in different agroclimatic zones of India. These regular products are generated through an operational and automated data processing chain at IMD,

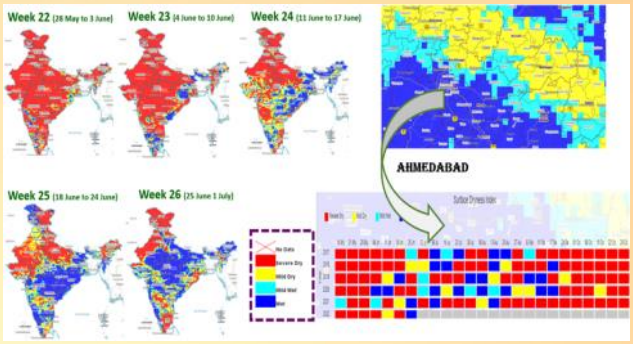

Fig 4. Operational Weekly Surface Dryness / aridity index from INSAT Derived Reference 2022

New Delhi and SAC's MOSDAC (Meteorological & Oceanographic Satellite Data Archival Centre) (www.mosdac.gov.in) geoportal.

Value-Added Agromet Products

The products such as Surface Dryness Index (SDI)/Aridity Index (AI) and forewarning of pest model also developed using the core agromet and additional ancillary data. SDI is used to quantify precipitation availability over atmospheric water demand over rainfed agricultural area. SDI represents adequacy of the precipitation to satisfy atmospheric vegetation water demand. A methodology has been developed to generate SDI using INSAT 3D derived daily reference ET and rainfall data. In the developed methodology, SDI is generated at weekly scale (standard meteorological week) and hosted at VEDAS geoportal. The generated SDI is categorized in four classes (a) severe dry, (b) mild dry (c) mild wet (d) wet as shown in Figure 4. The SDI able to capture the dryness and wetness over 'Rainfed' regions of India. The severity of infestation of pests and diseases differs across seasons, regions and crop types and crop stage in a given region. In the absence of stable,

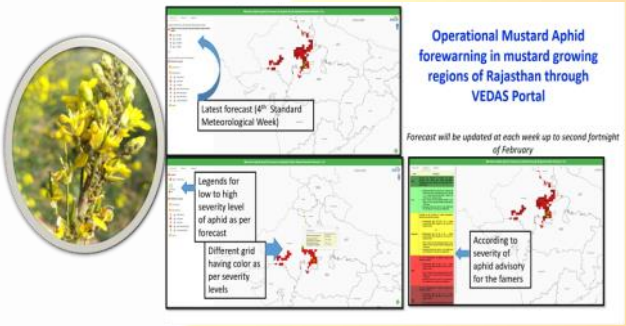

Fig 5. Web based dissemination forewarning for Mustard Aphid for Rajasthan state

desirable and diverse sources of resistance to the biotic menaces, timely and precise amount of spraying operation of specific chemical or bio-pesticides remain the primary effective means to manage them. Such exercise would be time consuming, labor -intensive in the country with difficult terrain and other constraints. Therefore, to overcome such limitations for agricultural crops, a pest forewarning model for mustard aphid has been developed

at spatial scale using long term systematic in situ mustard aphid population data, short-range weather forecast at high spatial resolution (5 km grid), satellite derived mustard crop mask and phenology over all mustard growing regions of Rajasthan, Haryana and West Bengal State. The pest forewarning information are divided into three categories (low, medium and high) represented by different colors which are obtained through objective analysis of aphid data based on historical records. For each category, various advisories are generated for farmers. These advisories were also stored into the database. The forewarning model output is automatically updated at each week from January 01 to second fortnight of February. The developed model is now operational and information is disseminated through VEDAS geoportal with weekly updates as per the standard Meteorological Week (SMW) as shown in Figure 5. The forewarning model are also developed for other targeted pest such as yellow stem borer and white fly for rice and cotton crop respectively.

Way forward for Digital Agrometeorology

In future as per the growing requirement the high-resolution crop specific agromet products and their near future (3-5 days) prediction will be generated at Gram Panchayat level advisory services. To further promote the judicious use of water in agriculture and water foot printing web-based geo-spatial tool and App will be developed to disseminate irrigation advisory for farming community. In future mission like TRISHNA, GISAT and NISAR will add more value-added products at much finer scale and higher precision through geo-spatial platform to guide farmers for optimizing the utilization of farm resources and save crop loss so that benefits can be promoted at farm-scale.

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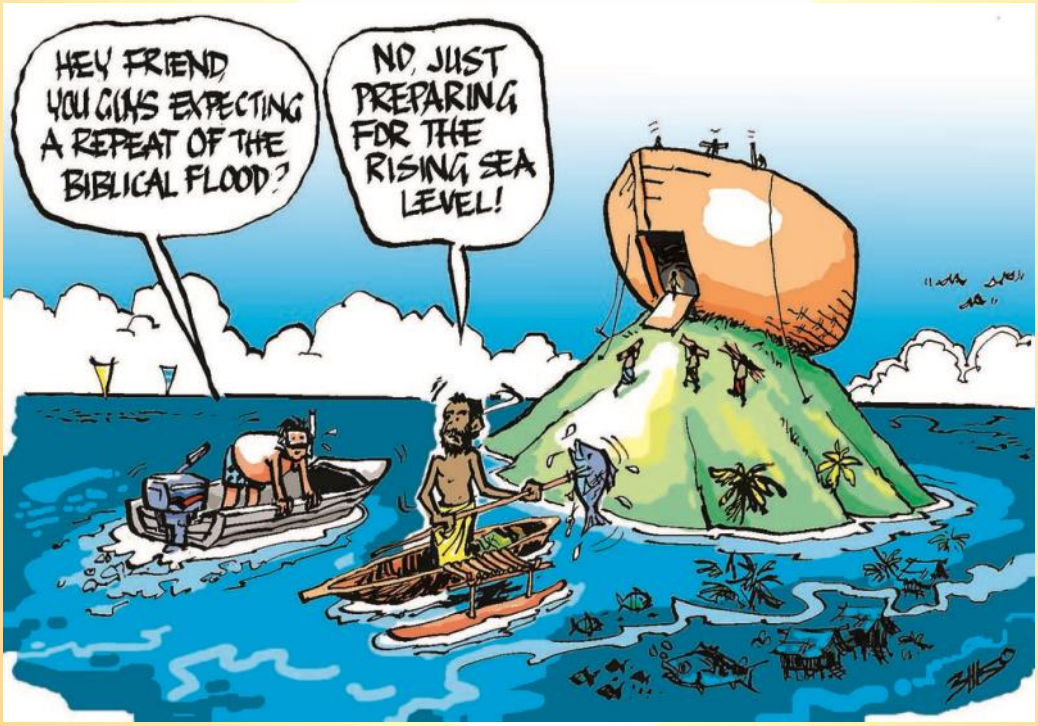

UNITED NATIONS DEVELOPMENT PROGRAMME's photostream Pacific 1st prize: Mr. Biliso Osake from Papua New Guinea

Many countries worldwide are affected by climate change. In the Pacific region, all the countries consist of small islands, and the effect of climate change is causing the sea level to rise. Soon many of these islands will be under water. The guy in the dinghy and the two sports sailboats on the horizon having fun and enjoying themselves depicts the lax and couldn't-care-less attitudes some developed countries have towards the issue of climate change. As for the poor people living on low level islands in the Pacific who are touched by the effect of climate change daily, it's a matter of life and survival

PROLONGED HEAT WAVES DURING 2022: A CASE STUDY OF AHMEDABAD

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The impact of human activities on the atmospheric chemical composition has become more evident since the industrial revolution. It is assumed that the human impact induced an increase of the global mean surface air temperature of approximately 0.74°C during the twentieth century. The temperature increase between 1950 and 2000 (+0.13°C/decade) nearly doubled compared to the previous 100 years. Hence, the global warming trend due to anthropogenic activities corresponds to an increase in energy flux of +1.6 Wm^{-2} since 1750 (IPCC, 2007). However, the human factor is not the only one, which changes and influences the energy balance of the earth system. In addition, natural forcing such as solar activity, volcanic eruptions or changes in orbital characteristics can cause climate change and climate variability. Besides increasing average temperatures, also more extreme events, modified wind patterns and sea level rise are consequences of the climate change. Temperature findings are sustained from instrumental observations over the last 150 years (IPCC, 2007). Overall, the IPCC (2007) predict hotter temperature extremes, more intensive heat waves, stronger precipitation events, a decrease in snow cover and a reduction in sea ice as potential consequences of climate change. This implies that we will be exposed to more extreme events with potential severe consequences on natural and anthropogenic ecosystems, health and economy (IPCC 2007).

Direct impact of climate change can be witnessed by increasing and prolonged occurrence of frequent heat waves all over the globe.

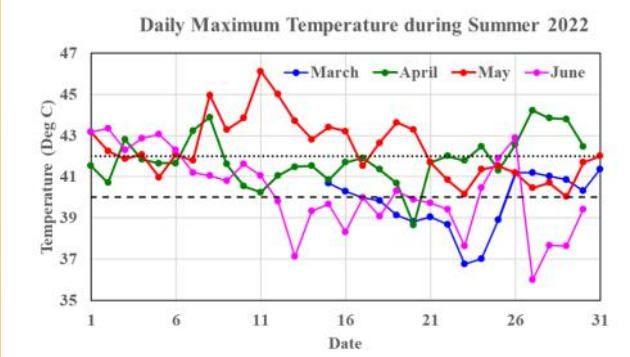

Fig 1: Daily maximum temperature recorded at SAC, Bopal campus Ahmedabad during March-June, 2022. The dashed and dotted horizontal lines shows the temperature limit of 40° C and 42°C.

Direct impact of climate change can be witnessed by increasing and prolonged occurrence of frequent heat waves all over the globe. Heat wave is a condition of air temperature, which becomes fatal to human body. Heat wave is abnormally high temperature condition, more than normal maximum temperature that occurs during the summer season. In India, it is experienced during March-June months. Heat wave occurs when temperature crosses 40°C in plains, 37°C in the coastal areas and 30°C in the hilly regions. As per the criterion given by India meteorological Department (IMD), when normal maximum temperature of a station is more (less) than 40°C, then heat wave departure from normal is 4-5°C(5-6°C) and severe heat wave departure from normal is >6°C (7°C). When actual maximum temperature remains >45°C, heat waves are declared.

In this year 2022, during summer months prolonged and widespread heat wave conditions were observed in the northwestern part of India affecting millions of population. Several cities across the country experienced high temperature (greater than 42°C). India experienced prolonged spells of heat eave during March and April 2022. In the year 2022, heat waves struck earlier, lasted longer and hit the high records. Many cities of India in Punjab, Uttarakhand, Gujarat, Rajasthan and Delhi experienced severe heat wave conditions during the year 2022. The daily maximum temperature of Ahmedabad city recorded at SAC Bopal campus is plotted in the Figure 1.

It can be noticed that that temperature exceeded 40°C threshold in March itself and persisted throughout April and May except 2-3 days. The continuous spells of extreme temperature (42° C) was observed during 27April-4 May and 8-20 May. The hottest day of the season was recorded on 11 May with the maximum temperature 46°C.

The unusual heatwave condition in March 2022 could be linked to global warming due to climate change. Climate change is a global phenomenon which affects not all areas to the same extend. The highest vulnerability is shown by polar to sub-polar zones and semi-arid areas (IPCC, 2007). Extreme events, such as heat waves are often accompanied by large damages and losses. These heatwaves are a major risk to health conditions and are termed as "silent disasters" as heat related deaths are often undercounted around the world. There is a need of an integrated nationwide program to study the change detection, impact assessment, and adaptation and mitigation.

MAPPING THE CHANGING BLUE COVER OF AHMEDABAD CITY DURING 1984-2020 USING HIGH RESOLUTION SATELLITE DATA

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The blue cover of a city (river, lakes, ponds and wetlands) is an important part of an urban ecosystem as it performs various significant environmental, social and economic functions *(Down to Earth, 2020)*. The blue cover acts as a source of drinking water, helps in recharging ground water, supports biodiversity and provides livelihoods. The location and persistence of the blue cover is affected by climate and human activity *(Vörösmarty et al., 2000)* and affects climate *(Subin et al., 2012; Holgerson and Raymond, 2016)* biological diversity *(Gardner et al., 2015)* and human well being *(Vörösmarty, C. J. et al., 2005; World Economic Forum, 2016)*. Thus it is very important for measuring long-term changes of the blue cover at a high spatial resolution. With this background the present study was undertaken for Ahmedabad city of Gujarat which is the 7th largest metropolis of India covering a geographical area of approximately 464 sq km. In this study a comprehensive accounting of the transitions in blue cover of Ahmedabad city has been done using Landsat data having a spatial resolution of 30 m for a period of **37 years (1984 – 2020).** A total of 10 types of water bodies were classified which are (i) Permanent (ii) New Permanent (iii) Lost Permanent (iv) Seasonal (v) Lost Seasonal (vi) New Seasonal (vii) Permanent to Seasonal (viii) Seasonal to Permanent (ix) Ephemeral Seasonal (x) Ephemeral Permanent *(Pekel et al., 2016)*.

One of the major reasons of the increase in the blue cover of the city is due to the implementation of the Sujlam Suflam scheme by Government of Gujarat which has the mandate of deepening the existing lakes and creating new lakes across the state.

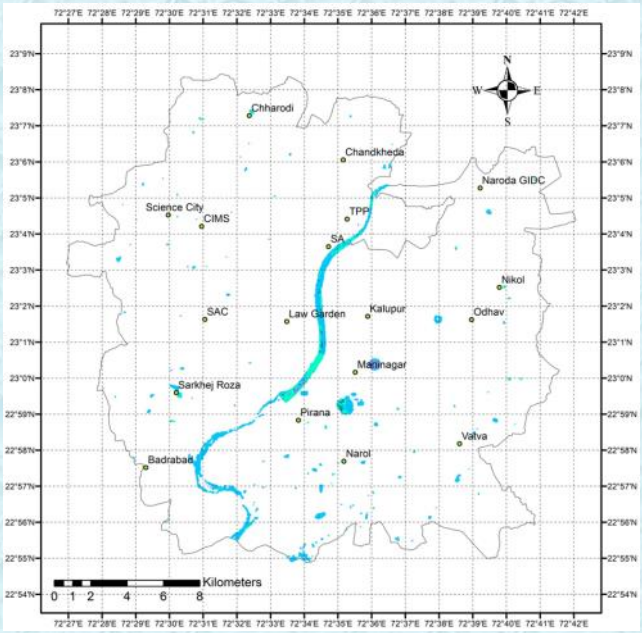

Fig. 1 The Total Blue cover of Ahmedabad city

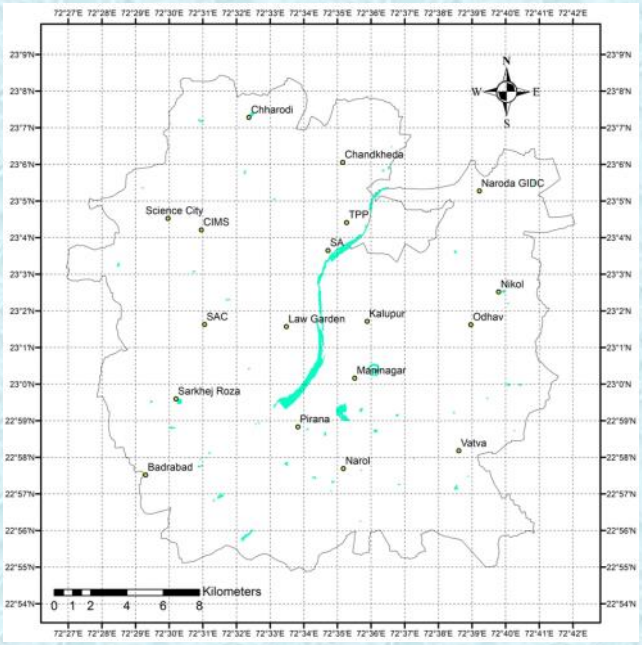

Fig. 2 The Permanent Blue cover of Ahmedabad

Fig. 1 shows the blue cover present in the city. The spatial quantification reveals that it is around **8,096,745 m²** which is **1.7450** % of the city's geographical area. Of this blue cover, **2,834,973 m²** (**0.6110**%) didn't register any change in its characteristics i.e. permanent water body remained permanent water body (which is 5889 m² (0.0013%)) while seasonal water body remained seasonal water body (which is 28,29,084 m² (0.6097%)) which is shown in **Fig. 2.** The city **gained 4,900,806 m²** (**1.0562**%) of blue cover as shown **in Fig. 3** (74,058 m² (0.0160%) is now the new permanent surface water body while 48,26,748 m² (1.0402%) is the new seasonal surface water body) while it **lost 2,289,248 m²** (**0.4934**%) of blue cover as depicted in **Fig. 4** (permanent water body 842 m² (0.0002%), ephemeral permanent water body 5,888 m² (0.0013%), seasonal water body 4,79,640 m² (0.1034%) and ephemeral seasonal water body 18,02,878 m² (0.3886%)). Around **360,966 m²** (**0.0778**%) of blue cover witnessed a transition - 270,097 m² (0.0582%) of permanent water body became seasonal water body while 90,869 m² (0.0196%) of seasonal water body became permanent water

body which is shown in **Fig. 5.**

The major reason of having relatively high area fraction in the category of new seasonal surface water body is the interlinking of

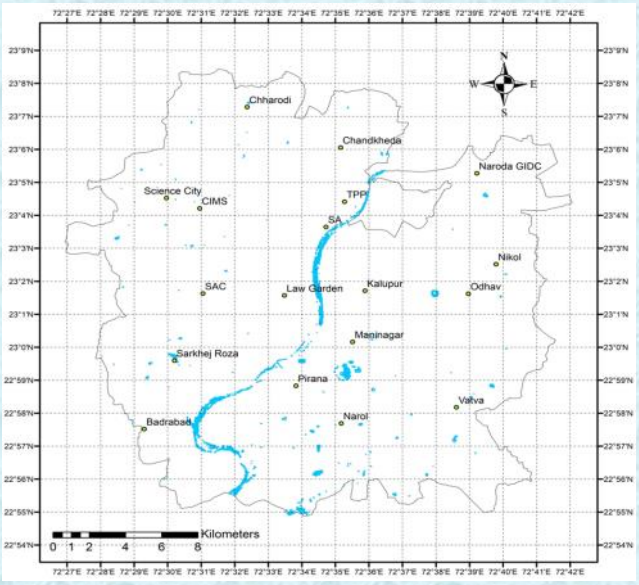

Fig. 3 The New Blue Cover of Ahmedabad city

the Sabarmati river with the Narmada river while that of ephemeral seasonal water body is because of the change in the path of the Sabarmati river within the city. In addition to this, one of the major reasons of the increase in the blue cover of the city is due to the implementation of the **Sujlam Suflam scheme** by Government of Gujarat which has the mandate of deepening the existing lakes and creating new lakes across the state. However, there is a significant need of further increasing the blue cover of the city so that the frequency and intensity of urban flooding decreases and the ground water recharging potential of the city increases

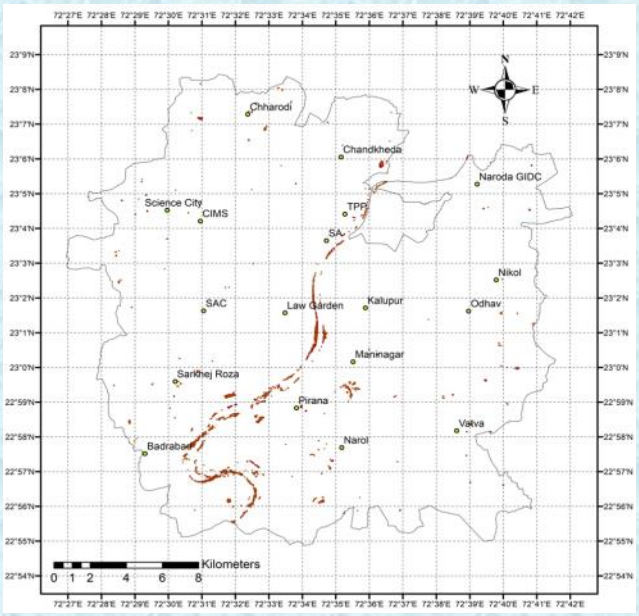

Fig 4. The Lost Blue cover of Ahmedabad city

The present study gives a detailed information regarding the surface water bodies of the Ahmedabad city which would be of crucial importance for the civic administration for strengthening the **'urban bluing'** activity which will have a significant impact on reducing the environmental stress along with **reducing the urban heat island effect and mitigating the urban air pollution.**

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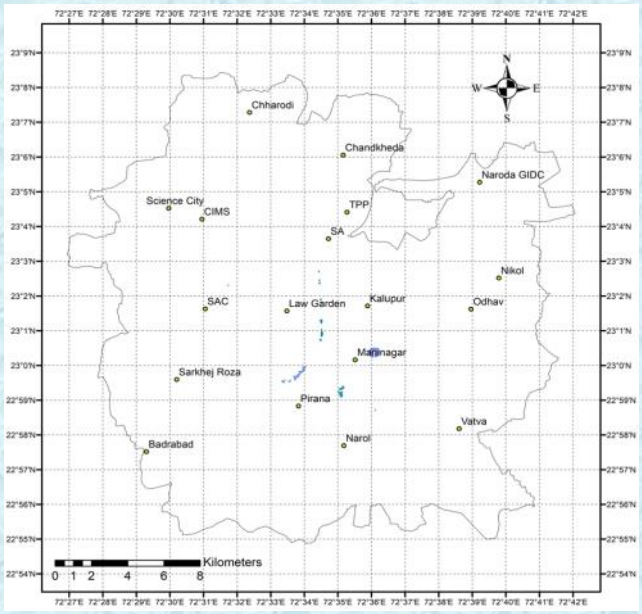

Fig. 5 Ahmedabad city's Blue cover in transition

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NISAR: MISSION OVERVIEW AND UTILIZATION PLAN

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Globally, the space agencies have joined hands by developing joint missions in order to maximize the utilisation of earth observation data and reduce the cost of missions by individual space agencies. The NASA–ISRO L & S band Synthetic Aperture Radar (NISAR) mission is a partnership between NASA and ISRO, currently scheduled to launch in January 2024 and to have a minimum mission lifetime of three years. The mission is optimized with high resolution imaging (3-10 meters), wide swath (240 km), high precision pointing and orbit control and short revisit period (12days) for studying hazards and global environmental change, specifically in support of its three core science disciplines: Ecosystems, Cryosphere, and Land Deformation (Figure 1). The satellite is designed to provide a detailed view of the Earth to observe and measure some of the planet's most complex processes, including ecosystem disturbances, glaciers and ice-sheet dynamics, coastal process dynamics and natural hazards. In addition to its science requirements, the mission has a requirement to be capable of supporting disaster response through expedited event-driven downlinking, processing, and delivery of relevant data.

The NISAR science observation plan is designed to tackle the science questions posed by persistent and consistent imaging of Earth's land and ice surfaces throughout the life of the mission, delivering time series of approximately 30 images per year from ascending and descending vantage points.

NISAR data products will be structured as raw radar signal data as level-0 product, Single Look Complex (SLC), Multi-Look Detected (MLD), phase unwrapped (UNW) and wrapped nearest-time interferograms (IFG), and polarimetric covariance images (COV) as level-1 products, geocoded level-1 products as leve-2 products, large area radiometric terrain corrected mosaic images as level-3 products and science products in physical units as level-4 products. NISAR has an open data policy where all levels of data products will be provided freely to the public in near real time through NASA (ASF DAAC) and ISRO (Bhoonidhi) portals.

The NISAR science observation plan is designed to tackle the science questions posed by persistent and consistent imaging of Earth's land and ice surfaces throughout the life of the mission, delivering time series of approximately 30 images per year from ascending and descending vantage points. NISAR will be operated with a predefined observation plan and the plan will be revisited every 6 months to review the successes of the observations to date and adjust as necessary to optimize. A typical observation scenario of NISAR over a 12-day observation cycle is shown in Figure 2. At present, the project is considering a left-only mode of operation to better optimize science return by uninterrupted coverage of Antarctica up to 87.5°S latitude and sacrificing the coverage of Arctic beyond 77.5°N latitude, with the expectation that other international missions can obtain science observations in the high Arctic regions.

NISAR Characteristic:	Enables...
L-band (24 cm wavelength)	Low temporal decorrelation and good foliage penetration
S-band (9 cm wavelength)	Sensitivity to light vegetation
SweepSAR technique with Imaging Swath > 240 km	Global data collection
Polarimetry (Single/Dual/Quad)	Surface characterization and biomass estimation
12-day exact repeat	Rapid Sampling
3 – 50 meters mode-dependent SAR resolution	Small-scale observations
3 years science operations (5 years consumables)	Time-series analysis
Pointing control < 273 arcseconds	Deformation interferometry (D-InSAR)
Orbit control < 500 meters	Short baseline D-InSAR
> 10% (S-band) & 50% (L-band) observation duty cycle	Complete land/ice coverage
Left-only pointing (Left/Right capability)	Uninterrupted time-series of Antarctic Rely on Sentinel-1 for Arctic

Figure 1. NISAR characteristics and capabilities

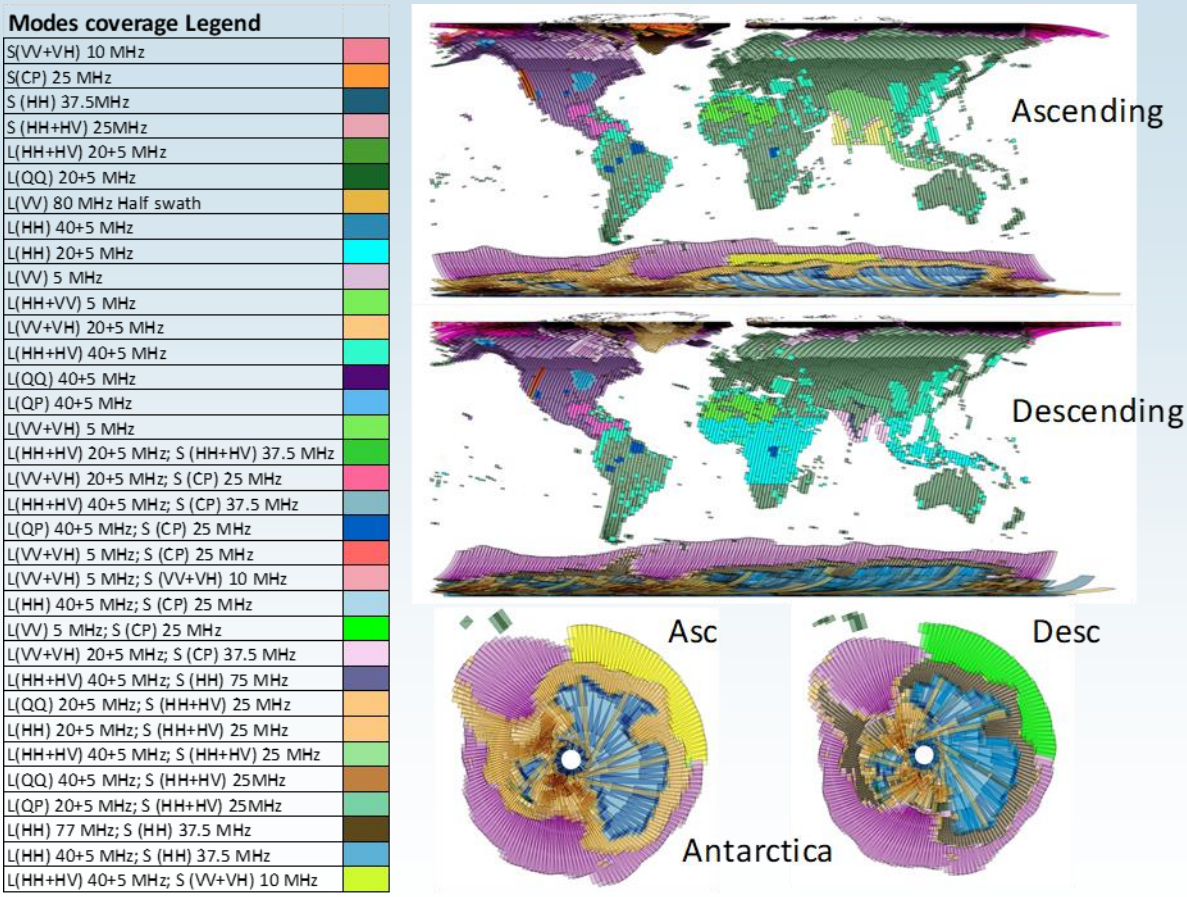

Figure 2. Typical observation scenario over a 12day observation cycle over Indian and global targets in left-looking NISAR ascending (Asc) and descending (Desc) orbits. Coverage over Antarctica is shown separately in polar stereographic projection at the bottom. The colour codes depicting various imaging modes are shown in the left.

While L-band data are planned over all regions, S-band data are planned over the South Asia, Antarctica, regions in the Arctic such as Greenland and Beaufort sea and a few global cal/val sites

From the Indian perspective, NISAR is considered a science mission with the potential to augment SAR-based applications in India and the countries in the South Asia, feeding data to several operational project activities. In addition, the blanket L-band coverage globally will support science and applications everywhere. The primary science objectives of NISAR are: 1) Characterize the global distribution and changes of vegetation above-ground biomass and ecosystem structure related to the global carbon cycle, climate and biodiversity; 2) Determine the likelihood of earthquakes, volcanic eruptions, and landslides through surface deformation monitoring; and 3) Predict the response of ice masses to climate change and impact on sea level. In addition, the NISAR mission plans observations to improve monitoring of crops, surface water bodies, root-zone soil moisture, oceans off the coasts of India and the US, coastal regions in general, groundwater, hydrocarbon, and sequestered CO_2 reservoirs.

Both ISRO and NASA have comprehensive plans for the utilization of NISAR data with common and shared objectives. The NISAR Utilization Plan intends to engage the stakeholder community and increase the utility and accessibility of NISAR data by a) demonstrating the value of the NISAR mission within a broad societal context; b) supporting activities that engage a diverse user community; c) educating a broader community on the utility of SAR data; d) working with interested end users to develop information products, and e) contributing to an observation plan and data delivery schedule that facilitates both science and applications within mission constraints. ISRO has made great efforts to engage the Indian academia and research community in the utilization of NISAR data through organization of NISAR science workshops, applications theme specific user's workshops, training and outreach programs and announcement of opportunity programs with NISAR prototype airborne L&S band SAR data. Soon, ISRO is going to announce NISAR Utilization Program inviting project proposals from Indian institutions on the applications of NISAR data.

COUNTERING ADVERSITIES WHILE ON A VACATION

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There are, on a majority basis, five travel destinations for the common person who goes with family/friends to enjoy a vacation. Hills/mountains, Coasts & sea, Deserts, Pilgrimage, Historical places. Seasons are slotted for some destinations, travel advisories are aplenty and with ease of transportation and accommodation, one generally takes things for granted and has positivity engulfing one's plan of action/travel. Perils are never planned and what-if scenarios are for the pessimist. The concepts over which the edifice of vacation are built leave no room for adversity planning for a majority of Indian vacationers, as God is our perpetual caretaker!

Cut to the hills/mountain vacationer. A case study where three families and a few solo travellers were subject to the harsh reality of travel under unsafe conditions. Hilly areas are unpredictable with their weather, come sun or rain. The case in point is for the tourists returning home from Bomdila in West Kameng District of Arunachal Pradesh in mid-June. The journey to Guwahati was approximately 260 km and would take 7 hours or so. Three hours into the journey and about 10 kilometers short of the plains, two landslides stopped the journey. The road had breached and for the next four days these tourists had to fend for themselves with limited relief coming in from the Sashastra Seema Bal (SSB) units spread across the traversed areas. There were of course a few SSB jawans travelling and stuck in the ordeal as well.

Getting stuck for a few hours due to a landslide can be in itself a claustrophobic experience, but when you are caught amidst live landslides occurring all around you and as you travel ahead in incessant downpour, trauma can set in. You see rocks falling all around you, trees sliding down the hill, roads cracking and caving and waterfalls pounding all around. Add to this the phenomenon of white-out where all around you is a sheet of clouds and fog rendering everything invisible and all that you get to see is a white blanket. One never knows what is going to fall from above and what is, say, 50 m ahead. Under such conditions when uncertainty looms large, survival becomes a challenge and you realise your body has begun to shut down, the only thing that pumps in, is the adrenalin. Hunger, thirst, cold etc. are no longer felt. The 23 survivors with indomitable spirit returned with some bruises and sprains after crossing 25 landslides, 17 of which they had to cross by foot over a distance of 8 km. Out of the 17 crossed by foot, 4 were death defying experiences. When one has to tread carefully on fragile roads, hang on to tree roots under breached road strips, cross knee-deep turbulent rivulets, have muddy waterfalls pounding on you and corroding the already fragile remnants of the road beneath you and at the same time watch out for exigencies both at family level as well as impending dangers, it is a pretty traumatic and bone chilling experience.

It is always advisable to follow a few safety precautions when one is caught unawares in such predicament. Knowledge of bare minimal survival tips can go a long way in coming out alive from such situations. Plus, thinking laterally so that your mind is not bogged down by threat but ready to think clearly and allow realities to sink in in a controlled way for one to seek alternate solutions. This article suggests some measures which one can plan and some tips which one can use at discretion. These tips, though drawn from the disaster caused by landslides, can also be looked in the perspective of general survival techniques in case of any other disaster. However, appropriate adoption and innovation may be required by the person.

Before one leaves for the vacation one should have a reasonably good idea of the place(s) regarding the best time to visit, extreme weather conditions, possible (historical) threats, local administrative/health department contact details along the places of visit. One should also be aware of the limitations of language, habits and nature of the locals. The following, learnt from the bitter experience in a hilly terrain, needs to be heeded to in case of any episodic event that mars your vacation, especially where one has to fend for oneself – no rescue teams to swing into action and no communication facilities, no way to seek help:

It is always advisable to follow a few safety precautions when one is caught unawares in such predicament. Knowledge of bare minimal survival tips can go a long way in coming out alive from such situations.

- Before you begin the vacation, make sure to carry a spare rucksack/over the shoulder bag so that you strap it on and keep hands free for movement/grasping.
- Download a detailed map of the areas you would be travelling date-wise and take a print-out of that. At least you can know your vicinity in case you are stranded.
- In a situation where you have to abandon your belongings, transfer the bare minimals like an extra pair of clothes, medicines, dry fruits, water, biscuits, house keys, towels (can be used in lieu of a rope), power banks, knife, into the rucksack/alternative.
- In most cases, your cellphone is a dead instrument. Seek local help if any, else work your way through, patiently and without panic.
- If you think rationally, maybe you will have more problems. Leave it to adrenaline.
- Move as a group and use crowd wisdom rather than bossing over (unless you know something more practical/useful).
- Do not panic. Try to lighten the gravity of the situation and boost up/help others who are weak,

Fig1. Low visibility in a landslide area with small rocks still hurling down the hill

Fig2. Broken roads and fallen trees blocking the way. Also, road edges giving way to any weight.

mentally or physically. Trauma should not set in, for anyone.

- Be patient with your vehicle driver. Remember he has been driving you for a few days, plus he knows the area much better than you. He should not be panicked.
- Be ready to move when rumblings are heard and trees begin shaking violently.
- In white-outs, preferably stay at areas without hilly outcrops or as far as possible from suspected danger.
- In case of high mud piles walk very fast to reduce contact time. If stuck, seek help from fellow travellers. Do not attempt to move out if you are knee deep in the liquefied mud.
- Where possible, use large leaves/stones/broken branches to use as stepping platforms. Work as a team.
- Where slippery/crumbling surfaces are there, catch hold of the nearby stable and rigid roots/branches/ rocks.
- Under pounding waterfalls, use a flat stone slab or weave a few leafy branches and hold over head to shield against pebbles falling through the waterfall.
- Whenever possible, check for signal on your cell phone, to call for external help.
- When the body shuts down, do not wake it up with heavy food or drinks on reaching safety. Normalise slowly by gradually hydrating and eating protein rich food.
- On reaching a village/locality, seek their help for any first-aid, food if necessary and more important to hire transport to leave the place.

These precautions should bring you back home, safely. Hope you never have to execute this, but forewarned is forearmed!!

Happy Vacationing !!!!!

Dark Raining Clouds

Picture Courtesy : Dr. Atul K Varma

REPORT ON IMSA OUTREACH PROGRAM 2022

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ઈસરોના ઉપક્રમે આયોજિત પોસ્ટર સ્પર્ધામાં અગ્રેસર

આણંદ, તા. ૨૫

ધી કેમ્બે, એજ્યુકેશન સોસાયટી, ખંભાત તથા ઈસરો અમદાવાદ ખાતે કાર્યરત ઈન્ડિયા મિતિયોરોલોજીકલ સોસાયટીના અમદાવાદ ચેપ્ટર અંતર્ગત સ્પેસ એપ્લિકેશન તથા હવામાન અંગેની જાગૃકતા માટે કેમ્બે એજ્યુકેશન સોસાયટીની વિવિધ શાળાઓના ધો. ૬ થી ૧૨ ના વિદ્યાર્થીઓ માટે ક્વિઝ તથા પોસ્ટર મેકિંગ સ્પર્ધાઓનું આયોજન કરવામાં આવ્યું હતું.

આ સ્પર્ધામાં માધવલાલ શાહ હાઈસ્કૂલના વિદ્યાર્થી રાણા કરણ અશોકભાઈએ પોસ્ટર મેકિંગ સ્પર્ધામાં પ્રથમ અને પ્રજાપતિ માહી શૈલેષભાઈએ તૃતીય સ્થાન મેળવ્યું હતું. ક્વિઝમાં શાળાની ટીમને તૃતીય સ્થાન મળ્યું હતું.

આ કાર્યક્રમમાં ઈસરોના વૈજ્ઞાનિક ડૉ. રામ રજક તથા ઈમસાના સેક્રેટરી ડૉ. સંજીબ કુમાર ડેબ ઉપસ્થિત રહી, વિદ્યાર્થીઓને પ્રેરણાત્મક ઉદ્બોધન કર્યું હતું, તથા તેમનામાં રહેલ સુષુપ્ત જિજ્ઞાસા તથા શક્તિઓને ઓળખીને ઉજ્જવળ ભવિષ્ય માટે આગળ વધી દેશ તથા સમાજને ઉપયોગી થવાની શીખ આપી હતી.

આ સમગ્ર કાર્યક્રમ માટે સંસ્થાના પ્રમુખ વિનેશભાઈ પટેલ, હેમેન્દ્રભાઈ શાહ તથા સમીરભાઈ શાહે માર્ગદર્શન આપી કાર્યક્રમને સફળ બનાવ્યો હતો. મંજરી ગોરડિયાએ શરૂઆતથી ઋચા દવે જેઓ ઈમસાના જોઈન્ટ સેક્રેટરી તથા શાળાના પૂર્વ વિદ્યાર્થિની રહેલ છે. તેઓની સાથે રહી આ કાર્યક્રમનું સંકલન કર્યું હતું. વિજેતાઓને શાળાના ઈન્ચાર્જ આચાર્ય અલ્પેશભાઈ પરમારે અભિનંદન પાઠવ્યા હતા.

Indian Meteorological Society – Ahmedabad chapter (IMSA) in association with Cambay Education Society (CES) organized a special outreach event on 23rd July 2022. More than 200 students from five different schools under CES, participated in the event including more than twenty school staffs.

A group of IMSA members and ISRO officials also attended the event and interacted with the students.

A Poster competition on the theme "*How to protect yourself from lightning and thunderstorm*" was organized for the students of 5 to 8. A school team-wise quiz competition on the theme "*Monsoon – Vagaries and Impacts*" was also organized for the students of 9 – 12. The event was graced by the motivational talks by Dr. D. Ram Rajak, Group Head PPEG, SAC and Dr. Sanjib Kumar Deb, Secretray IMSA. The entire event was well conducted by Mrs. Manjari Goradiya, Trustee of CES and Dr. Rucha Dave, Joint-Secretary IMSA. The event concluded by distributing awards to the winners.

BOOK-REVIEW: SATELLITE REMOTE SENSING AND COMMON MAN

Abhineet Shyam
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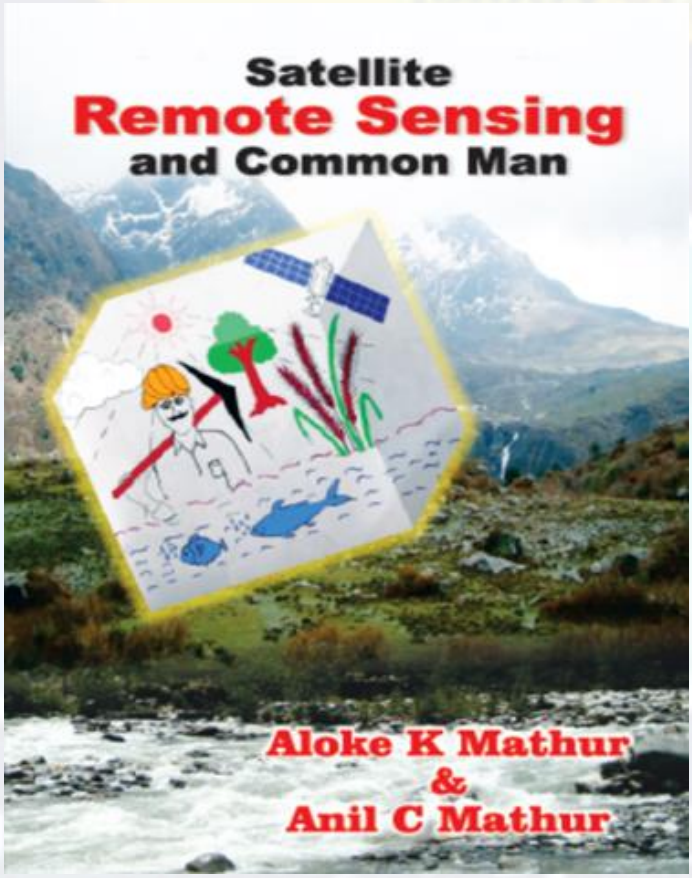

"Satellite Remote Sensing and Common Man", as the name reflects, has been an inspiring effort by two of the well-known veteran scientists- Dr. Aloke K Mathur and Shri. Anil C Mathur, who have served at Space Applications Centre in various capacities- both technically and managerially, in creating awareness on remote sensing by satellite instruments and their myriad applications for young school-level students. The field of satellite remote sensing itself is so vast and open-ended that there has been no dearth of technical books and periodicals, each catering to various micro applications. They have all catered to post-graduates and research students, and one rarely finds knowledge resources in terms of books, magazines etc. with lucid and non-technical explanation of this field for early knowledge-seekers at the secondary school level. The esteemed authors have precisely serviced, through this literary piece of work, to fill up this resource gap. As the authors put in their own words, "... a big challenge to explain the applications of satellite remote sensing in a vernacular language without using unnecessary technical words".

Summed up in about 51 pages, the book is a short narrative on remote sensing, satellite, satellite-based remote sensing, its history and contains vivid descriptions on applications beginning with weather and climate, oceans, agriculture, disaster management, renewable energy, water resources etc. It has thoughtfully inserted, under the sub-section "Some innovative applications", narratives on how satellite remote sensing has been serving to solve real-world problems such as Tax evasion assessment using remote sensing, delineation of archaeological sites for conservation, oil spill detection to name a few. A list of space science gallery/museums in India along with their locations serves to provide further awareness to the students. Towards the end, the book incorporates annexures on remote sensing instruments, list of Indian remote sensing satellite missions and the role of professional societies in awareness.

As I close, I am sure this book finds greater visibility among the chosen readers i.e. the school students through this newsletter and other media, and wish the authors continued success in bringing out many more such books on remote sensing for further awareness among the school students.

SCIENCE AND TECHNOLOGY NEWS

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World Space Week 2022: Space and Sustainability

World Space Week (WSW) 2022 celebrated space and sustainability, this year's theme, to address how space can help to achieve a cleaner, fairer and safer planet earth. Every year WSW is celebrated between October 4 and October 10 to commemorate the launch of Sputnik-1 (Oct 4, 1957) as well as to observe the signing of the treaty for peaceful use of space (Oct 10, 1967). The Unite Nations Organization declared the celebration of WSW all over the world in the year 1999 to create awareness in all the countries on the use of space for peace. ISRO has celebrated WSW this year at various locations in India to propagate the benefits of Indian Space programme to the scientific and academic communities and the common public.

Future emissions from Arctic permafrost in the changing climate scenario

By the end of this century, thawing permafrost in the rapidly warming Arctic will likely emit as much carbon dioxide and methane into the atmosphere as a large industrial nation, and potentially more than the U.S has emitted since the start of the industrial revolution. Arctic permafrost's expected gradual thawing and the associated release of greenhouse gases to the atmosphere may actually be sped by instances of abrupt thawing. Abrupt thawing takes place in thermokarst lake and the lake water speeds up the thaw of surrounding permafrost, freeing methane which bubbles up through the lakes and enters atmosphere much sooner than previously expected. Permafrost temperatures have been increasing over the past 40 years and now are at record high temperatures.

Over longer timescales, the greenhouse gas equivalent of additional CO2 and CH4 emissions from abrupt thaw can add another 40% to projections of carbon release by top-down gradual thaw. The recent appearance of methane craters, a new phenomenon associated with elevated CH4 concentrations, is a reminder that Arctic carbon cycle surprises are likely to emerge as the Earth warms. This study published in Annual Review of Environment and Resources forecasts the cumulative emission from permafrost through 2100 under low, medium, and high warming scenarios and stresses the significance of this factor to be considered into global climate targets.

Wind climate change alter desert dunes and threatens the disappearance of villages

Climate change could alter wind regimes so much by the end of this century that desert dunes and sand seas may impact human infrastructure, agriculture and homes - with the possibility of entire villages disappearing under sand. New study published in Nature Climate Change shows that wind patterns altered by climate change will speed up the migration of sand dunes, change the direction of the migration and morph the shape of the dunes, with the potential for desertification of some regions and the release of more dust emission globally. Desert dunes and sand seas cover approximately 20% of the world's arid zones. In many arid countries the impact of changing winds on desert dunes may be more important than other climate change indicators like sea level change.

Emissions Gap Report 2022 raise alarm on climate action

Emissions Gap Report 2022: The closing window – Climate crisis calls for rapid transformation of societies was released by the United Nations Environment Programmes (UNEP) on 27 October. According to the report, current pledges by countries for reducing greenhouse gas emissions would still the world warmer by 2.4 – 2.6 °C by the end of the century. Climate pledges since the Glasgow COP26 last year have shaved off only less than 1% of projected emissions till 2030.

This is when a 45 % reduction is required for the world to limit global warming to 1.5°C above pre-industrial level.

The report added that under the best case scenario there is a chance of limiting the warming to 1.8°C, still above 0.3°C above the ambitious Paris target. It has found that in India and six other top emitters, emissions have rebounded and increased after the pandemic. Urgent sector and system-wide transformations in the electricity supply, industry, transport and building sector and the food and financial systems would help to avoid climate disaster, the report found.

Stunning image of 'pillars of creation' from new James Webb Telescope

(Courtesy: NASA/ESA, Live Science)

The stunning image of pillars of creation taken by new James Webb Space Telescope (JWST) reveals the hidden beauty of cosmic creation of newly-formed stars in and around the gas clouds. The image of brightly growing tendrils of gas and dust within the Milky Way shows the signature three-finger form of the pillars in unprecedented detail. The red, lava-like squiggles at the tip of several pillars represent the supersonic jets of matter blasting out of still-forming clouds. This image is jointly released by NASA and ESA on 19 October 2022. According to NASA, this upgraded view of the iconic pillars will help astronomers to count the precise numbers of stars and quantities of gas in the region.

COP27: "Together for Implementation"

The 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) or COP27, themed "Together for Implementation", was held in Sharm el-Sheikh, Egypt from 6-18 November 2022 for the largest annual gathering on climate action. First report published at the ongoing COP27 criticizing greenwashing activities by corporate entities. UN Secretary General Antonio Guterres iterated that there shall be zero tolerance for net-zero greenwashing. Greenwashing is when a company or entity misleads the public to believe it is doing more to protect the environment than it is actually doing. India submitted its long-term strategy to achieve net zero emission by 2070 at COP27 on Monday, a declaration crucial for the country's climate action commitments. Developing countries, including India insists on action from rich countries in terms of climate finance, technology transfer and strengthening the capacity of poor and developing countries to combat climate change.

COMPARISON OF THREE MACHINE LEARNING ALGORITHMS FOR PREDICTING DAILY RAINFALL

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Three prediction algorithms namely Random Forest Classifier, Logistic Regression and Naive Bayes Classifier have been used to train the available rainfall dataset. This dataset contains about 10 years of daily weather observations from numerous Australian weather stations. RainTomorrow is the target variable to predict. There are various other attributes in the dataset like date, location, minTemp, maxTemp, rainfall (in mm), evaporation, sunshine, wind gust direction, wind gust speed and wind direction. The shape of the dataset was (145460, 23) . After preprocessing was carried out, the data was split into training and testing dataset having shape (85016, 24) and (21255, 24) respectively. For numerical data, we replaced all the null values with their respective column's median value and for categorical data, we used mode to replace null values. Then, the categorical variables were encoded . Before training the model, Min-max normalization was performed on the dataset. Then, the model was trained using Logistic Regression (LR), Naive Bayes Classifier (NBC) and Random Forest Classifier (RFC) available in sklearn library of Python.

The accuracy score for each are obtained as follows:

Logistic Regression Performance Score = 0.8711

Naive Bayes Performance Score = 0.6317

Random Forest Performance Score = 0.8673

Conclusions

As, observed LR and RFC gave similar scores and performed much better compared to NBC. Since, LR gave the best score, we calculated confusion matrix, sensitivity and specificity using it.

The confusion matrix was obtained as : [[17466 531] [2209 1049]]

The sensitivity and specificity scores were 0.8877 and 0.6639 respectively.

Though, here LR performed better than the other two, but the performance of any algorithm always entirely depends on the type of our dataset. Logistic regression is easier to implement, interpret, and very efficient to train, but if the number of observations is

lesser than the number of features, Logistic Regression should not be used, otherwise, it may lead to overfitting.

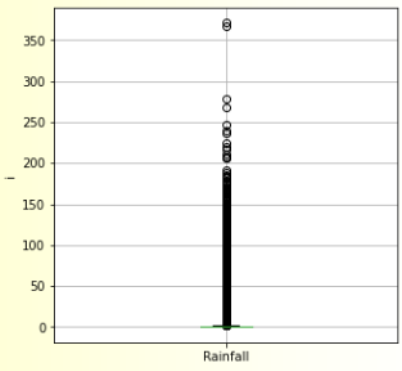
Courtesy:

https://www.kaggle.com/datasets/jsphyg/weather-dataset-rattlepackage

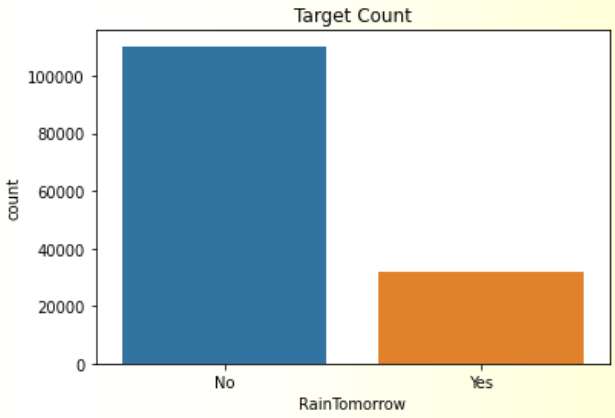
http://www.bom.gov.au/climate/dwo/

http://www.bom.gov.au/climate/data

https://www.kaggle.com/code/sghanvir/rain-in-australiaprediction- via-lrc-nbc-rfc



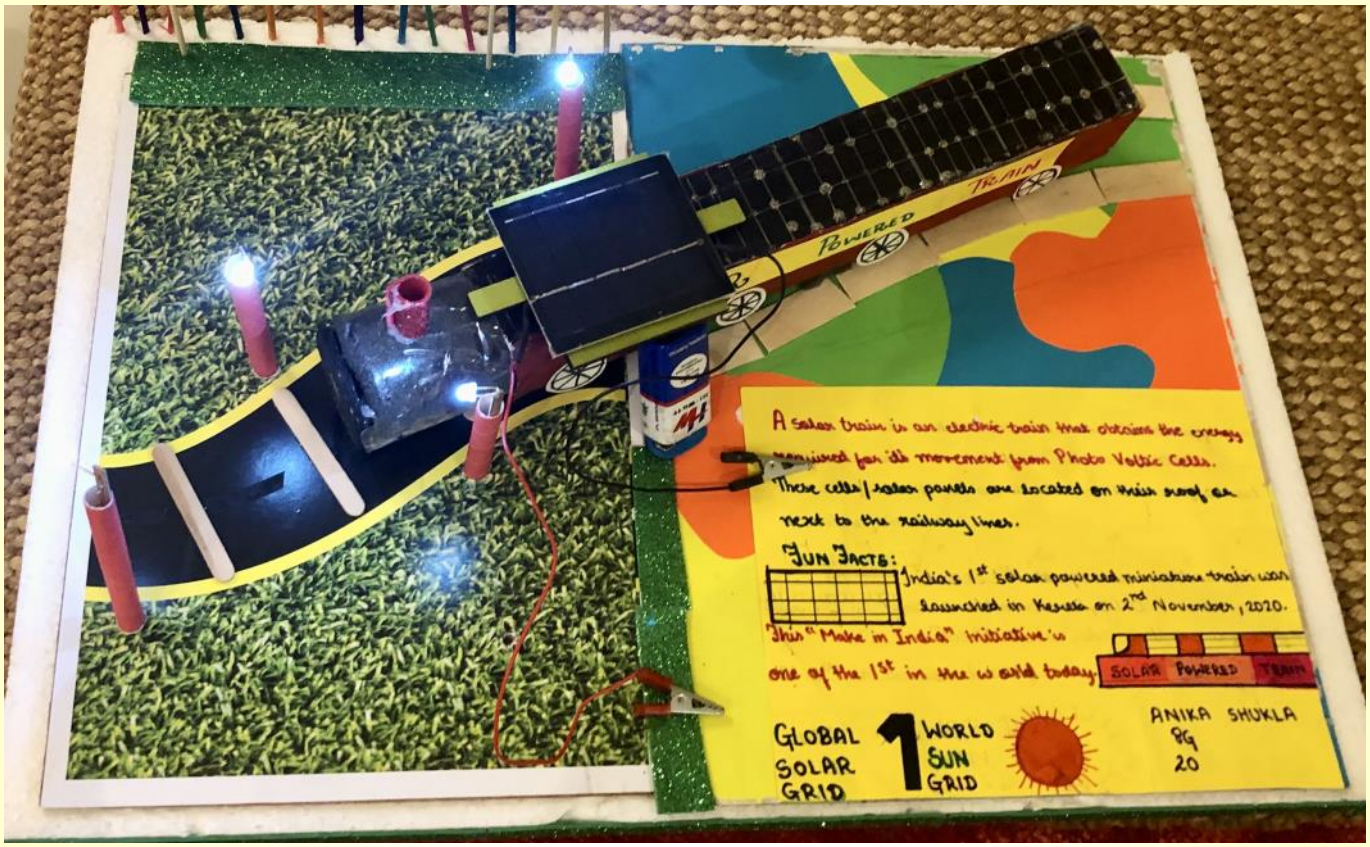
Box plot for Rainfall outliers



SOLAR POWERED TRAIN

ANIKA SHUKLA
CLASS : 8,
UDGAM SCHOOL FOR CHILDREN, Ahmedabad

A CONCEPTUAL / PARTIALLY PROTOTYPE MODEL FOR A SOLAR POWERED TRAIN WITH A PROVISION TO LIGHT UP A STATION ON THEIR ARRIVAL WAS BUILT AS A SCHOOL PROJECT.



SUN

NANDITA SAXENA
Class :2
DPS Ahmedabad

The Sun rises in the east,

And sets in the west.

The sun shines brightly,

Orange slightly.

The bird sings,

And spreads its little wings.

The day is sunny and bright,

What a wonderful sight!

The flowers blossom,

Looking so awesome.

The birds freely fly,

In the sky so high.

It's a new day with glowing Sun,

Let's all have a lot of fun

LOVE OF THE WATER FAIRY

ANANYA CHAURASIA
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International Relations and Governance Studies,
Shiv Nadar University, Delhi NCR Campus
Email: ac765@snu.edu.in

Why do I fear the water?
Is it because the fading waves of cool water make me think of you?

Of how you enter my life to bring me comfort while also leaving me behind?
Of, no matter how hard I try to run away from you, you still come back to me?

Is it the horizon of the sea?
The fact that I am so far away from you?
How I want to go to your deepest end?
But you simply look limitless!
Or perhaps it's the way the water gleams under the sun?
The same way you shone in the rain that night.

Ah, it's rain, water again?
Why do you always flow back into my heart?
Why do you remind me of the taste of ecstasy on my lips, Rain?
I never thought I could do this for anyone.
"It's cringey, old-fashioned" never crossed my thoughts,
Because it was your wish and my duty to fulfill it.

You clouded my heart, mind, and soul.
And now, I can't help but sob like the morning drizzles.
You are doing so much to me!

I can't even write about clouds without you in my thoughts!
How you used to come to a halt whenever you saw a gorgeous sky,
And how I used to stop every now and then to admire my Rain.

But I failed to see your love back then.
No, rather, I saw it, but there were too many storms inside me.
How could I make you wait for a person like me?
But you punish me way too hard, love!
Takes me back to those days when I used to do stupid things,
Like, forgetting my water bottle in your room?
Just for you to give me a call...
"Oyy, Puchu... Come and take your bottle, you wanna die or what?"
And now I yearn to hear your dewy voice.

God, why does it always come back to water?!?!
Why do you always condense on my foggy, warm heart?
Be careful! I might burn a bit,
But am I not worthy enough to melt the frost of your heart?

Maybe our love is too fluid to describe in words,
And you're anyways better at writing poems,
But I hope when this flower blooms in your garden this winter,
You give it a warm, dewy kiss,
And make this adoration blossom into passion.

Save environment : feel its beauty

By

ANANYA AGARWAL

CLASS: 5

Mount Carmel High School , Ahmedabad

THE FEEL OF RAIN

By

PRANITA LELE

Class : 4 ,

KV-SAC , Ahmedabad

PEACOCK SKIES

By

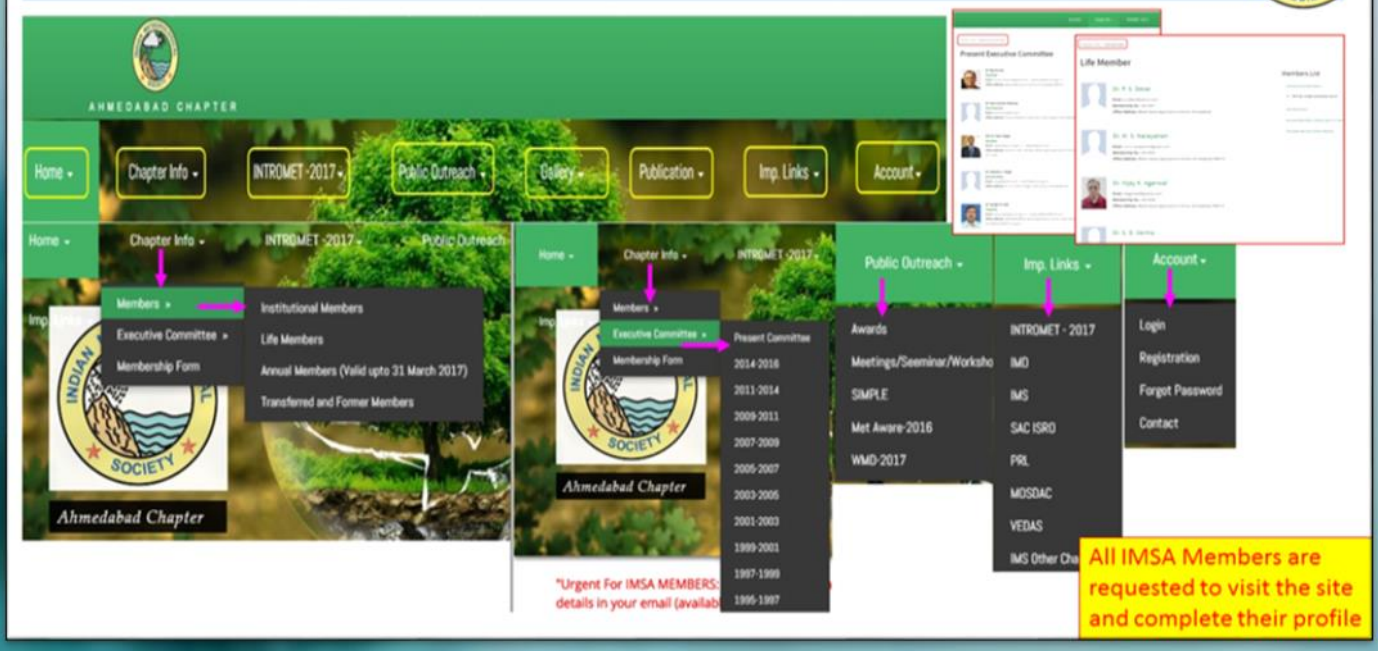
SOHAM DUTTA

Class: 5

DAV International School,

Ahmedabad

IMSA Website: www.imsa.net.in



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