Revisiting climatological Diurnal cycle of precipitation over Indian subcontinent using IMERG data

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Introduction

Diurnal oscillation in precipitation is one of the most fundamental modes which are multidimensional and highly influenced by regional characteristic. The simulation of diurnal cycle of rainfall, is a generic problem in most of the climate models. The detailed understanding of the diurnal cycle of rainfall from observations is limited.

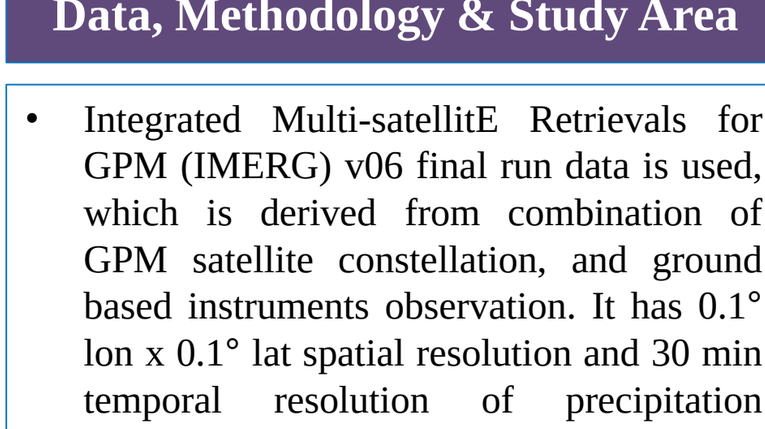
The IMERG data is well suited to study complex mix of mechanisms of diurnal peak within the same land form, separated by coastal area, low-laid hills, vast plain area and very high snow fed mountains. It will also, pinpoint the locations within the broad area where peaking times differ.

Objectives

- Utilizing very high spatial and temporal resolution data from IMERG GPM constellation of satellites for diurnal studies.
- Studying long term climatological diurnal oscillation characteristics of precipitation over Indian subcontinent and identifying the improvements and validate the previous studies using TRMM data (e.g. *Sahany et., al. 2010, Deshpande and Goswami 2013, Chen 2019 etc.*).

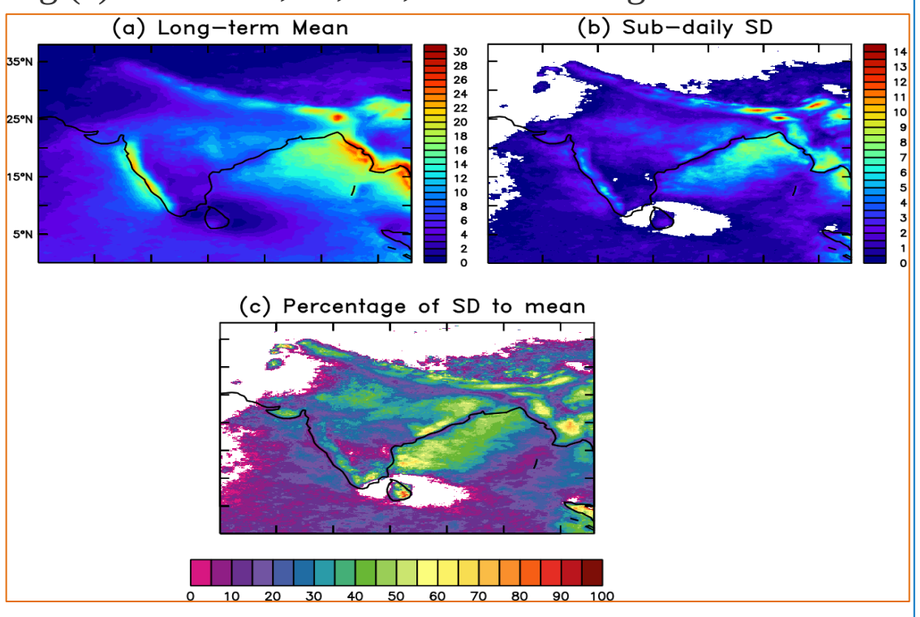
Data, Methodology & Study Area

- Integrated Multi-satellitE Retrievals for GPM (IMERG) v06 final run data is used, which is derived from combination of GPM satellite constellation, and ground based instruments observation. It has 0.1° lon x 0.1° lat spatial resolution and 30 min temporal resolution of precipitation globally.
- Study period is 21 years long climatological analysis for monsoon months (June, July, August and September), from year 2000 to 2020.
- Harmonic analysis was performed on IMERG data to construct amplitude and phase of diurnal precipitation
- Diurnal oscillation reconstructed at each grid point to study the oscillation in detail.
- The area of interest are shown with green polygon in the below Figure.

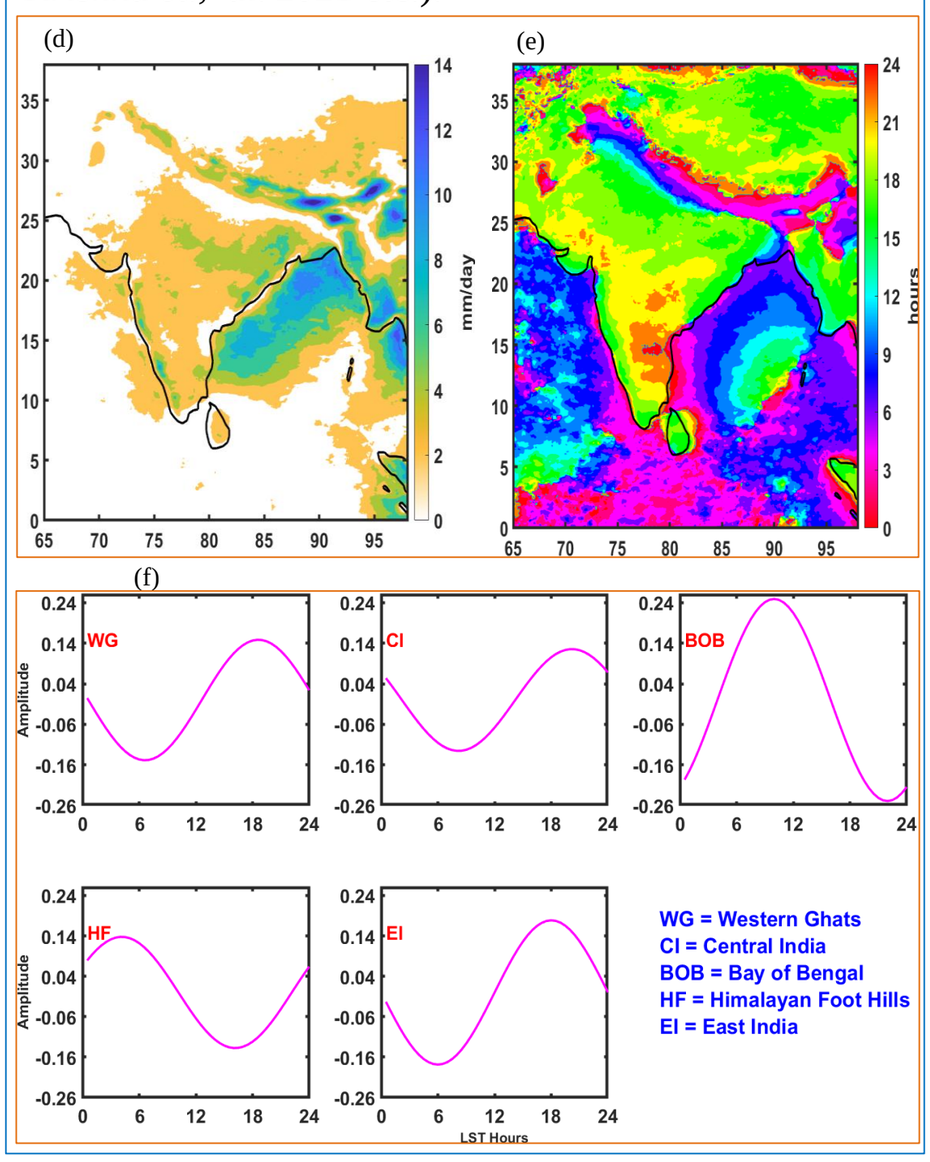


Results

The climatological mean in fig (a), shows large precipitation patches over head Bay of Bengal (BOB), windward side of western ghats (WG), and eastern part of Himalayan foothills (HF) while moderate rainfall patches could be seen over central India (CI) and eastern India (EI) but northwest and southeast part of India shows light rainfall patches. Diurnal rainfall standard deviation is shown in fig (b) and it shows significant contribution to the mean which is shown in fig (c) over BOB, EI, HF, HF and CI regions of India.



Using harmonic analysis on IMERG data, we have extracted amplitude and phase hours for diurnal mode as shown in fig (d) and (e). Fig (d) shows maximum amplitude over BOB, followed by eastern HF, EI, WG and CI. Fig (e) combining with fig (f), shows diurnal phase of rainfall maxima hours. WG, CI and EI shows similar pattern in time series graph but WG receives maximum rainfall during evening hours and peaks at 1800 LST while CI has less amplitude compare to WG and rainfall peaks around 1930 LST and EI shows rainfall peak similar to WG at 1800 LST but amplitude being on the higher side. BOB and HF shows during morning hours but BOB shows an interesting pattern of propagation and these results are supported by earlier studies (e.g. *Krishnamurty and Kishtwal 1999, Kikuchi and Wang 2007, Sahany et., al. 2010, Chen 2019, Murli Krishna et., al. 2021* etc.).



Conclusion

These are the preliminary results of our study on diurnal variation of precipitation over India region and summarized into following points.

- Diurnal component of precipitation has significant contribution to the long-term climatological mean over most of the Indian region (Fig a-c).
- Most prominent diurnally active region of precipitation is over BOB and eastern part of HF, followed by WG, EI and CI as shown in fig (c) & (d).
- Diurnal phase of rainfall (Fig e, f) shows rainfall peak during afternoon-evening hours over land region due to local convection as described by *Kikuchi and Wang, 2007* but orographic region like HF differs from WG because enhanced nocturnal monsoonal flow and Katabatic winds from Himalayas converges in morning hours (Chen 2019) while WG most of rainfall is due to orographic lifting (*Murli Krishna et., al. 2021*) on the windward side. Oceans show morning rainfall which could be due to land-ocean process, associated circulation and static stability (*Kikuchi and Wang, 2007*), also, propagation could be seen over BOB and according to *Yang and Slingo, 2001*, it is due to the diurnally generated gravity waves.

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