Linking Atmospheric Moisture Transport to Extreme Precipitation Events Associated with Floods over India

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Background

- Extreme precipitation events causing significant floods have intensified over last few decades across the world.
- Anomalous High Moisture Transport (AHMT) is largely attributed to this intensification[1,2]
- Investigating AHMT linkages to extreme precipitation unravels the drivers and mechanisms that may have a potential role in causing unusually large floods.

Data and Method

- Disastrous Floods in India:
  - ➢Uttarakhand Floods: June 16 -17, 2013
  - ➢Chennai (Tamil Nadu) Floods: December 1-2, 2015
- High-resolution (0.25° x 0.25°) daily rainfall data developed by India Meteorological Department[3].
- ERA5 reanalysis data with a horizontal resolution of 0.25° x 0.25° at 6-hour temporal scale are used in this analysis[4].
- ERA5 reanalysis hourly data are averaged to daily temporal scale
- Quantifying AHMT: Integrated Water Vapor Transport (IVT)

$$IVT = \sqrt{\left(\frac{1}{g}\int_{1000}^{300} qu\, dp\right)^2 + \left(\frac{1}{g}\int_{1000}^{300} qv\, dp\right)^2}$$

where, q, u, and v are specific humidity (kg kg^{-1}) and zonal and meridional wind components (ms^{-1}), respectively; g is the acceleration due to gravity (equal to 9.81 ms^{-2}); and p is pressure (pa).

- Assessing spatiotemporal patterns in daily MSLP anomalies, 850 hPa wind, moisture divergence and daily precipitation during flood events.

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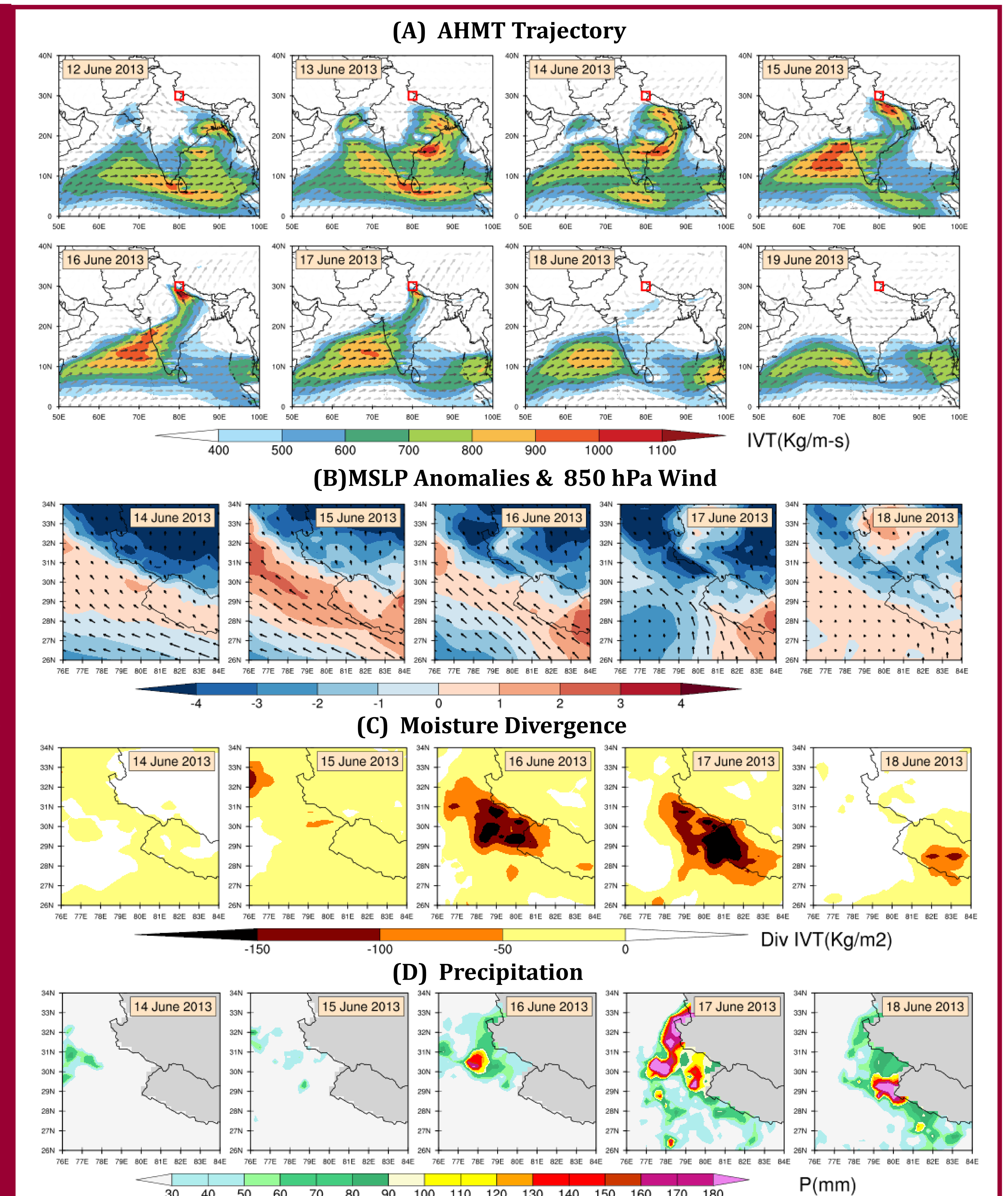
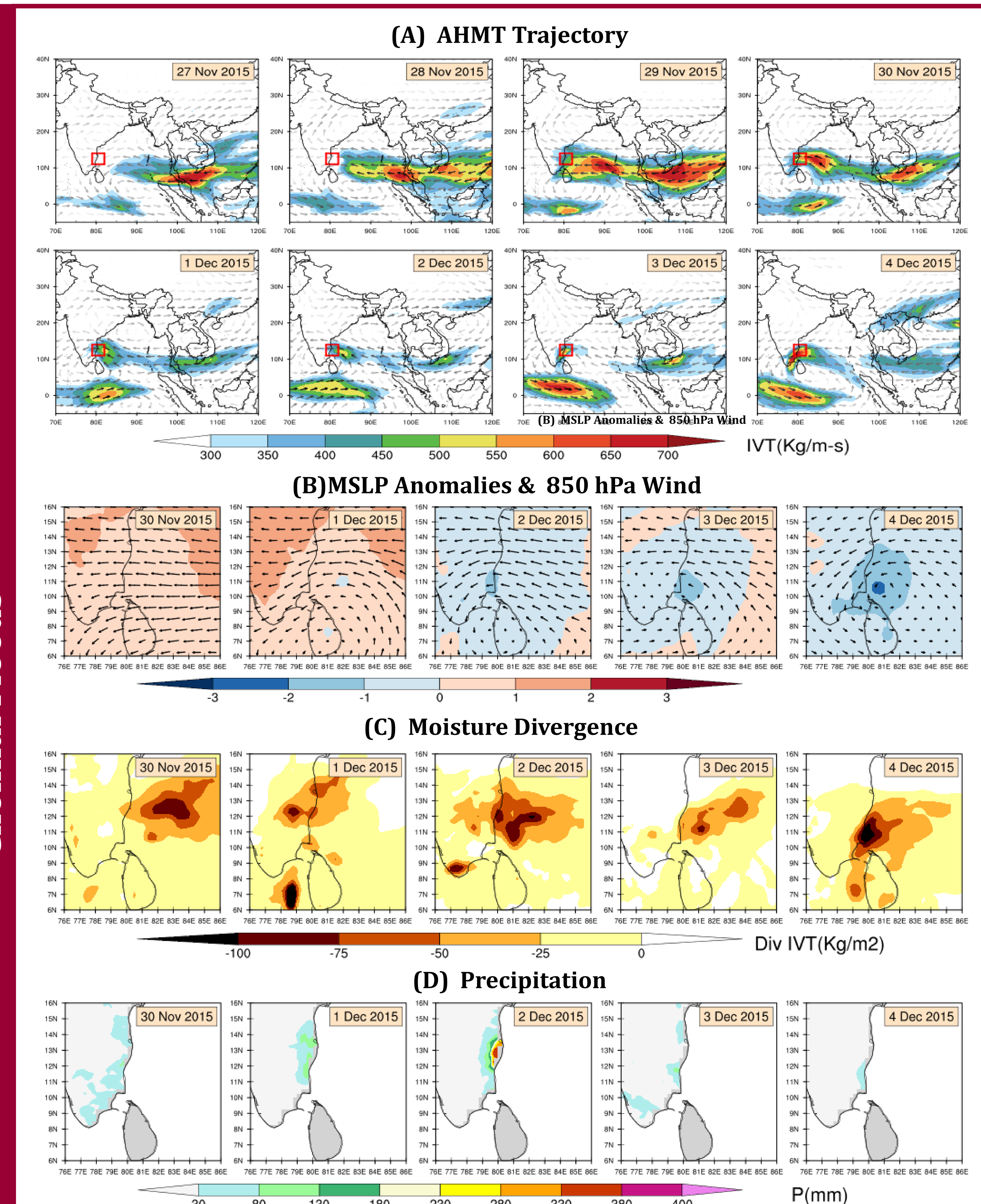
Uttarakhand Floods



- AHMT persisted for 2 days with IVT values ranging from 1100 to 800 kg m^{-1} s^{-1}
- A low-pressure area was formed over the north Indian region that extended further north till 17 June 2013
- Existence of asymmetry in the moisture convergence and associated rainfall, which is a characteristic of the monsoon low-pressure systems.
- Extreme Precipitation event of magnitude >125 mm persisted for >2 days causing disastrous floods over Uttarakhand region

Chennai Floods



- AHMT persisted for > 2 days with IVT values ranging from 700 to 500 kg m^{-1} s^{-1}
- Low pressure system over Bay of Bengal concentrated over Indian east coast and Sri Lanka brought huge moisture over Chennai region.
- Constant source of moisture with strong wind fields from Pacific side for >3 days are the main reason to form persistent AHMT
- Extreme Precipitation event of magnitude >230 mm caused disastrous floods over Chennai region.

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Highlights

- Extreme precipitation events are strongly influenced by the strong moisture convergence that are also associated with the low-level pressure systems.
- Monsoon low-pressure systems are characterized by asymmetry in the moisture convergence and associated rainfall.
- Persistent AHMT for 2 day or more could lead to heavy precipitation and associated floods over a region.