

Post-Onset Heavy Rainfall Events and Their Impacts in Southwestern Sri Lanka: A

Comparative Analysis of Atmospheric Conditions in 2021 and 2024

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Introduction

The study examines post-onset heavy rainfall events in 2021 and 2024 that occurred shortly after the onset of the Southwest Monsoon. These extreme weather conditions resulted in widespread flooding, loss of life, and severe socio-economic impacts in southwestern Sri Lanka. Understanding the meteorological causes and consequences of these events is essential for improving climate resilience and disaster preparedness.

Objectives

- Analyze and compare post-onset heavy rainfall patterns in 2021 and 2024.
- Identify atmospheric conditions contributing to extreme rainfall events.
- Assess the socio-economic and environmental impacts of these events.
- Provide recommendations for improved forecasting and disaster management.

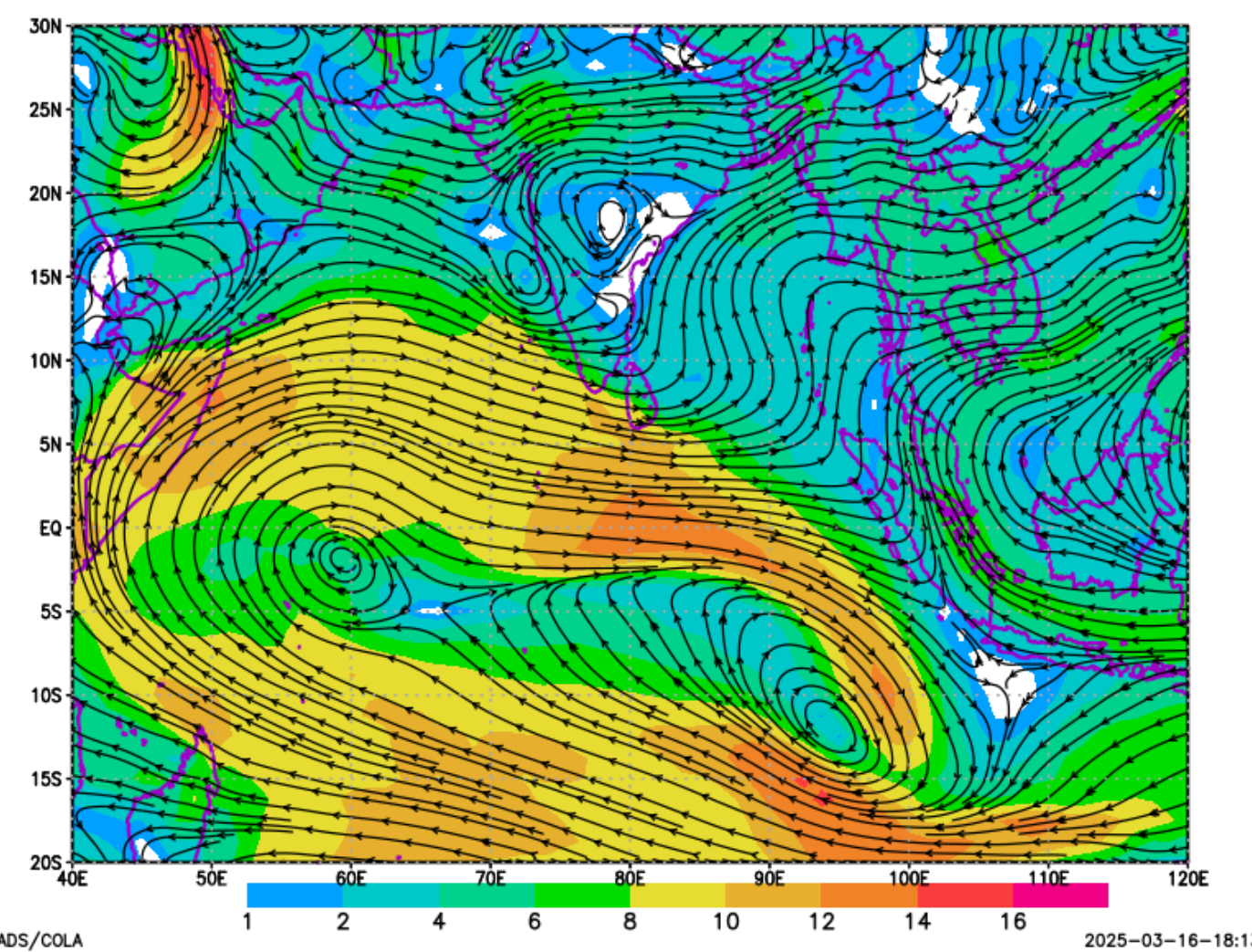
Data and Methodology

- **Data Sources:** JRA3Q reanalysis data, Meteorological data from the Sri Lanka Department of Meteorology, automatic rain gauge readings.
- **Analysis Techniques:** Comparative study of atmospheric circulation patterns and rainfall distribution.
- **Event Periods:** Focus on the onset and peak heavy rainfall periods from June 1st to June 4th in both years.

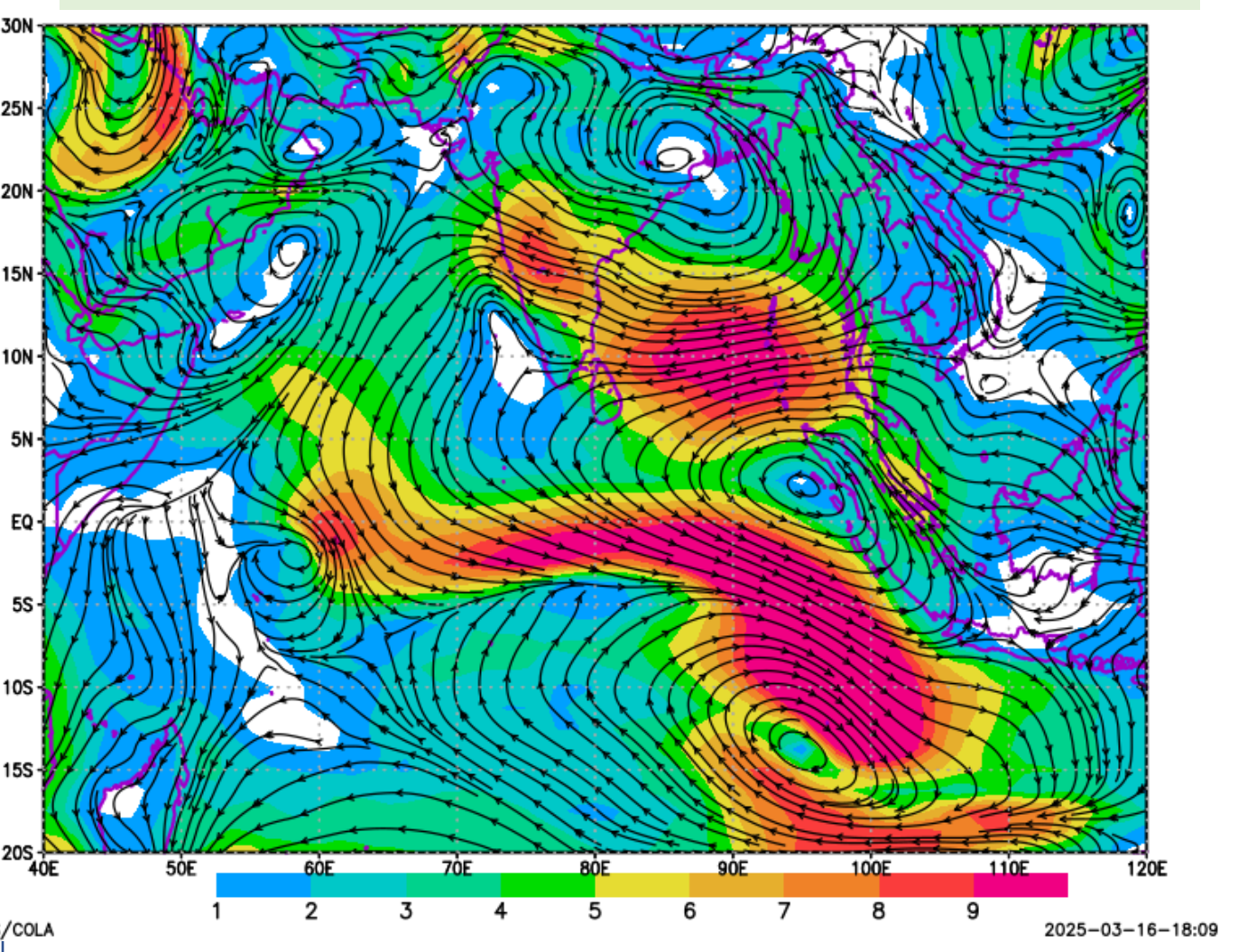
Results

2021

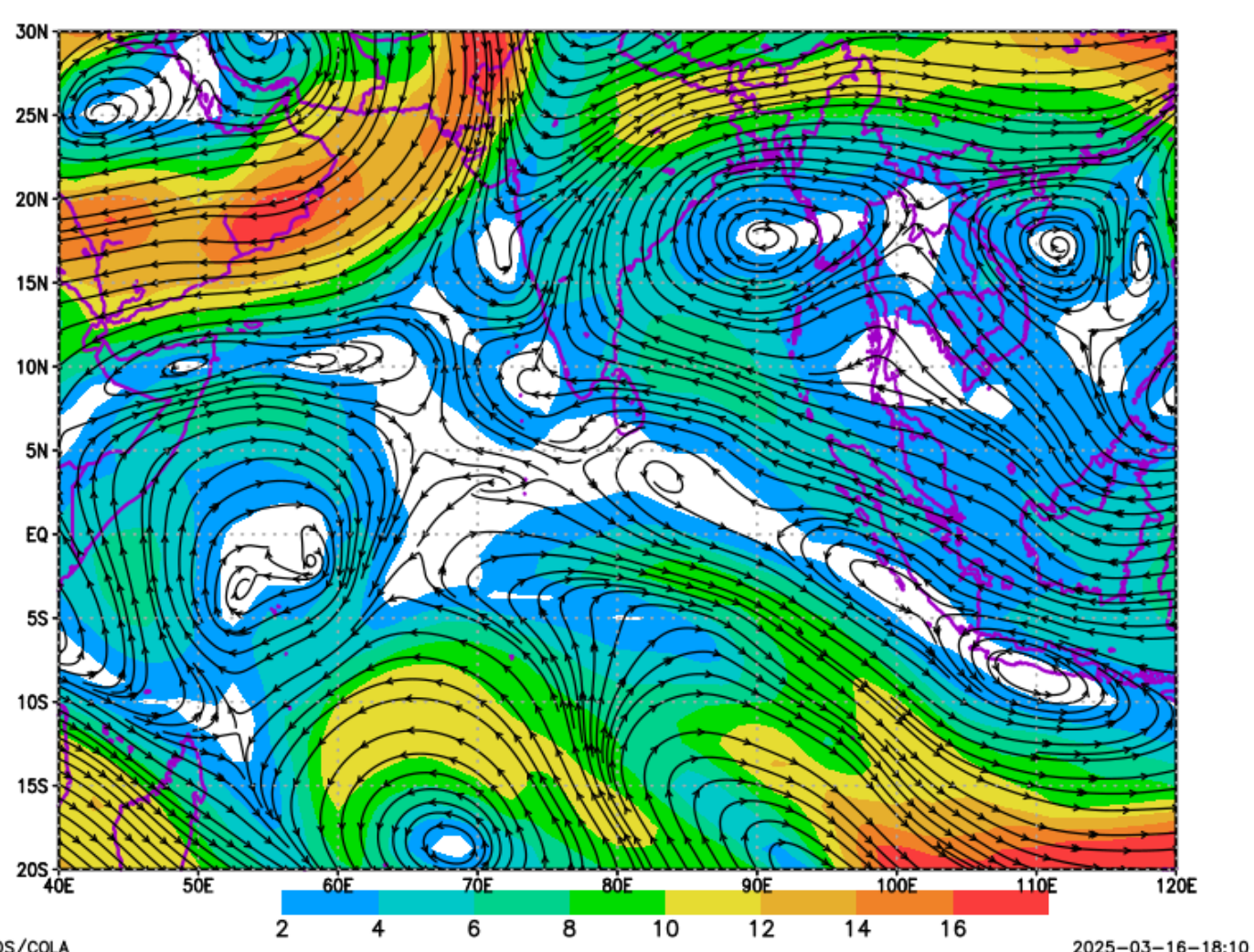
850 mb mean wind



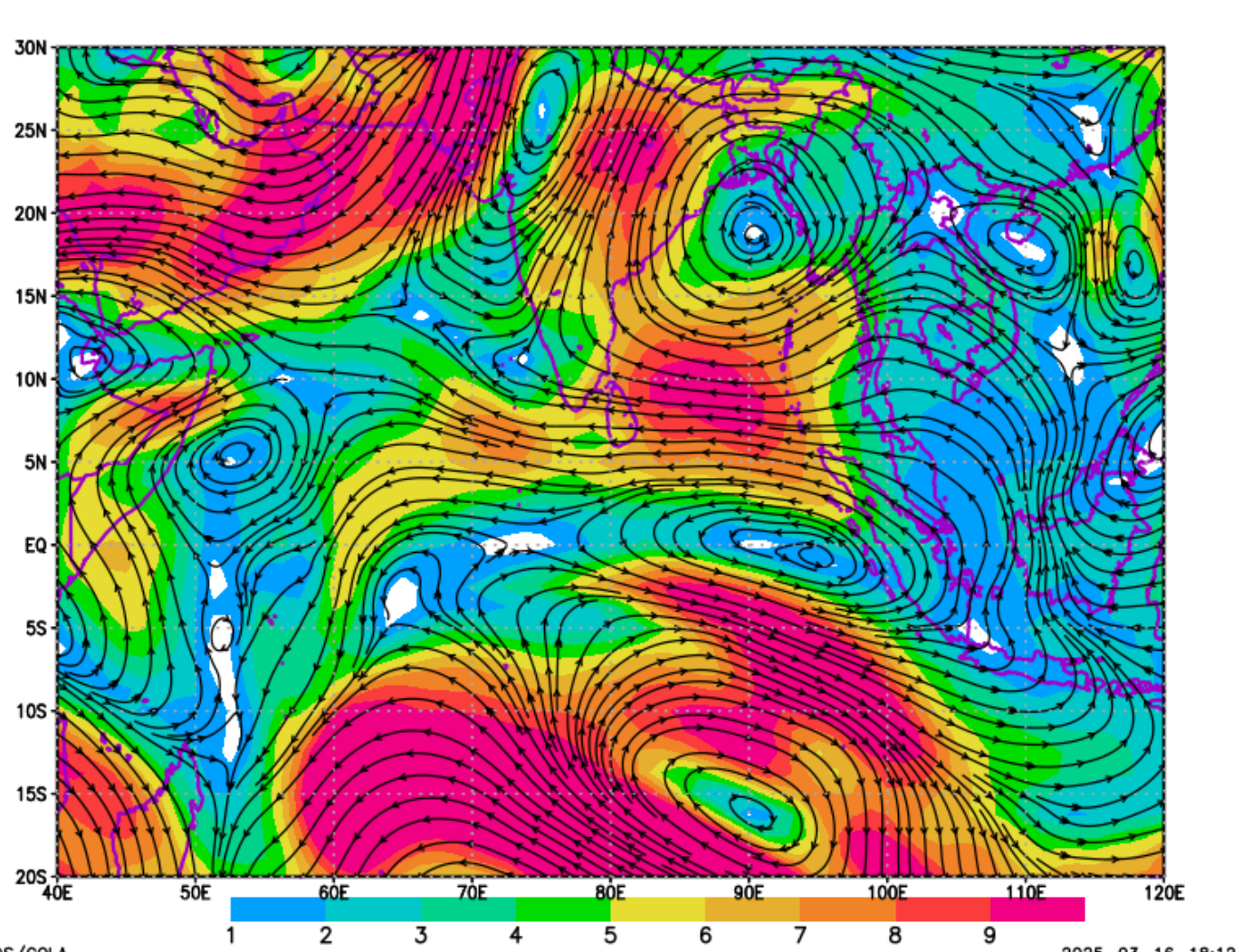
850 mb wind anomaly



500 mb mean wind

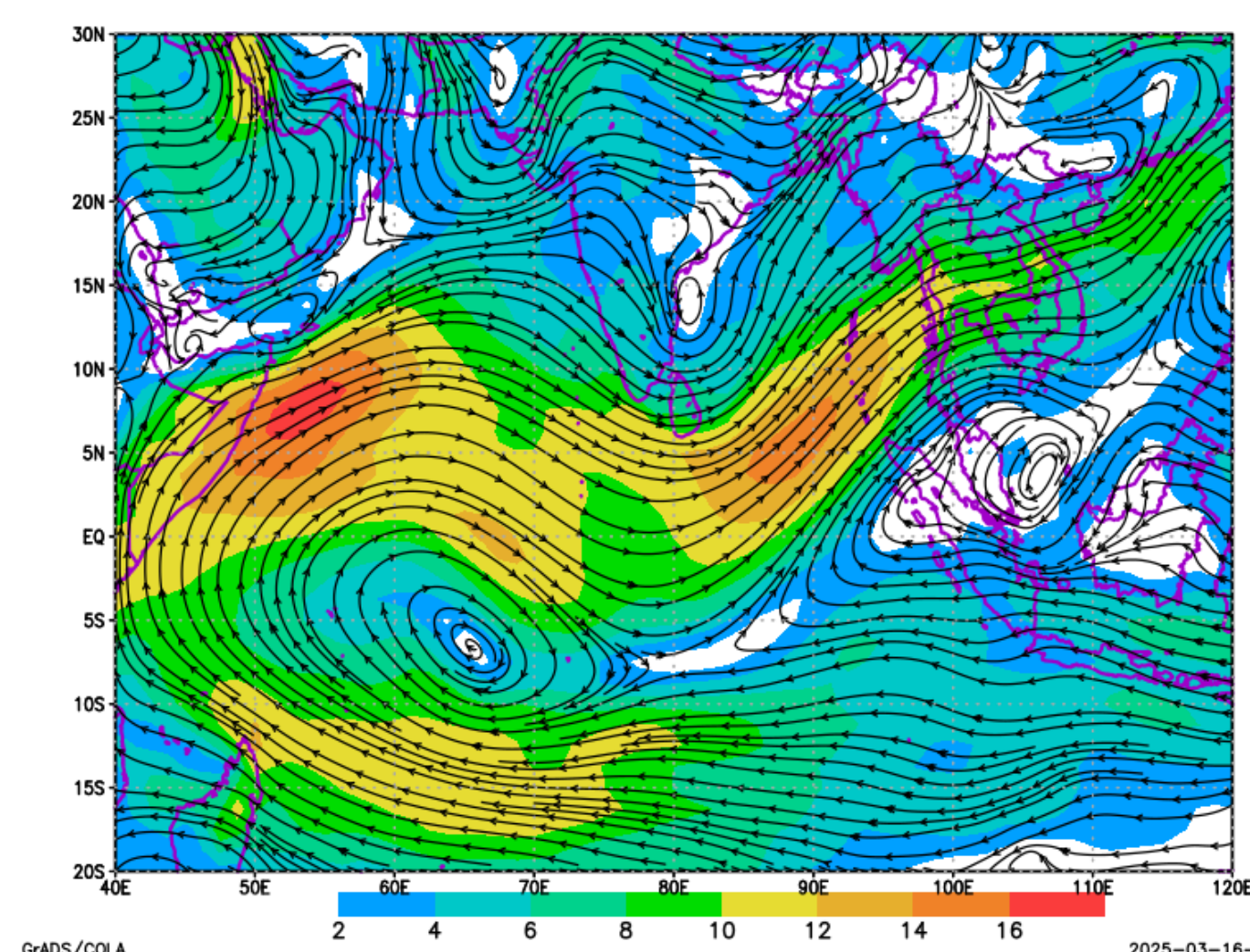


500 mb wind anomaly

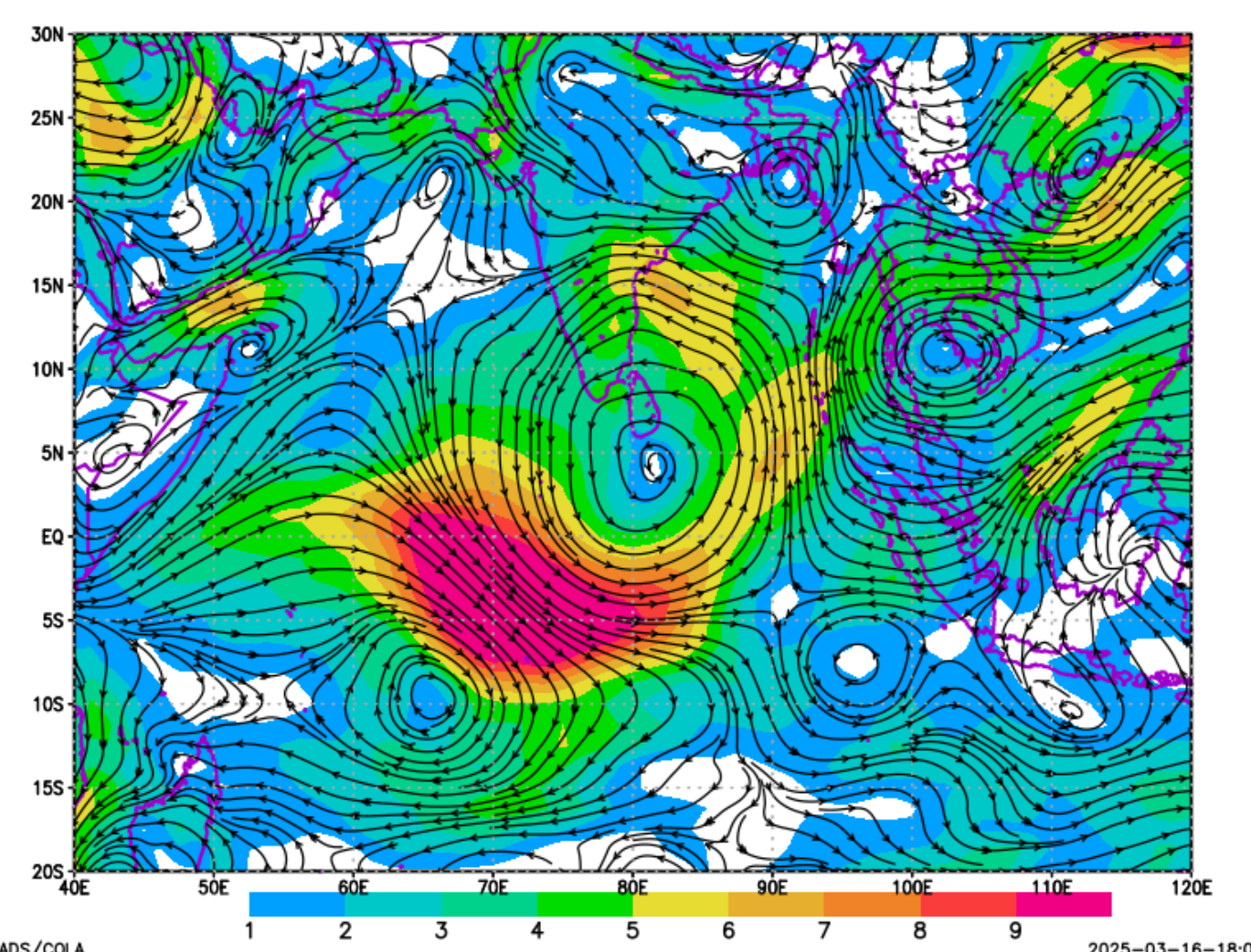


2024

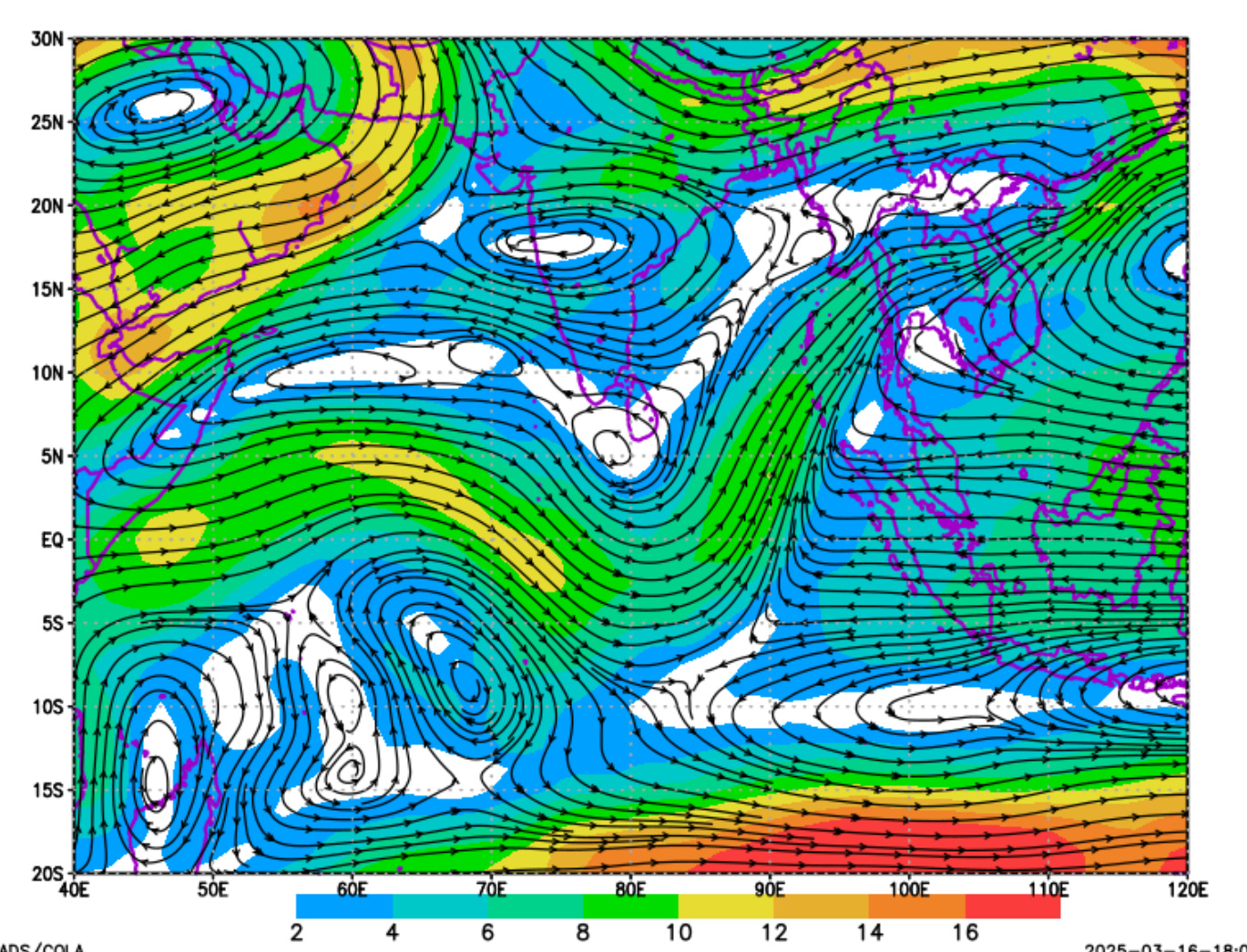
850 mb mean wind



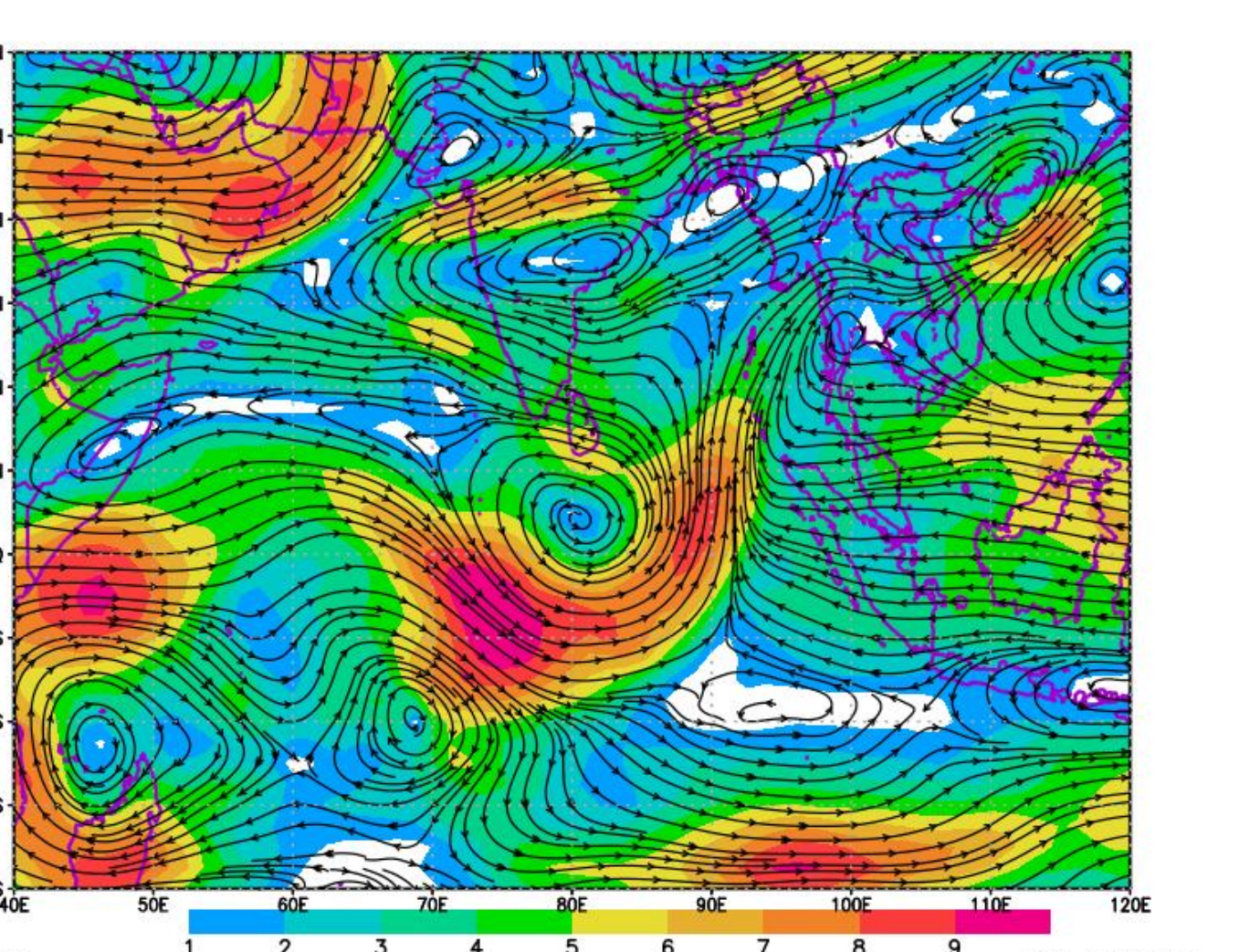
850 mb wind anomaly



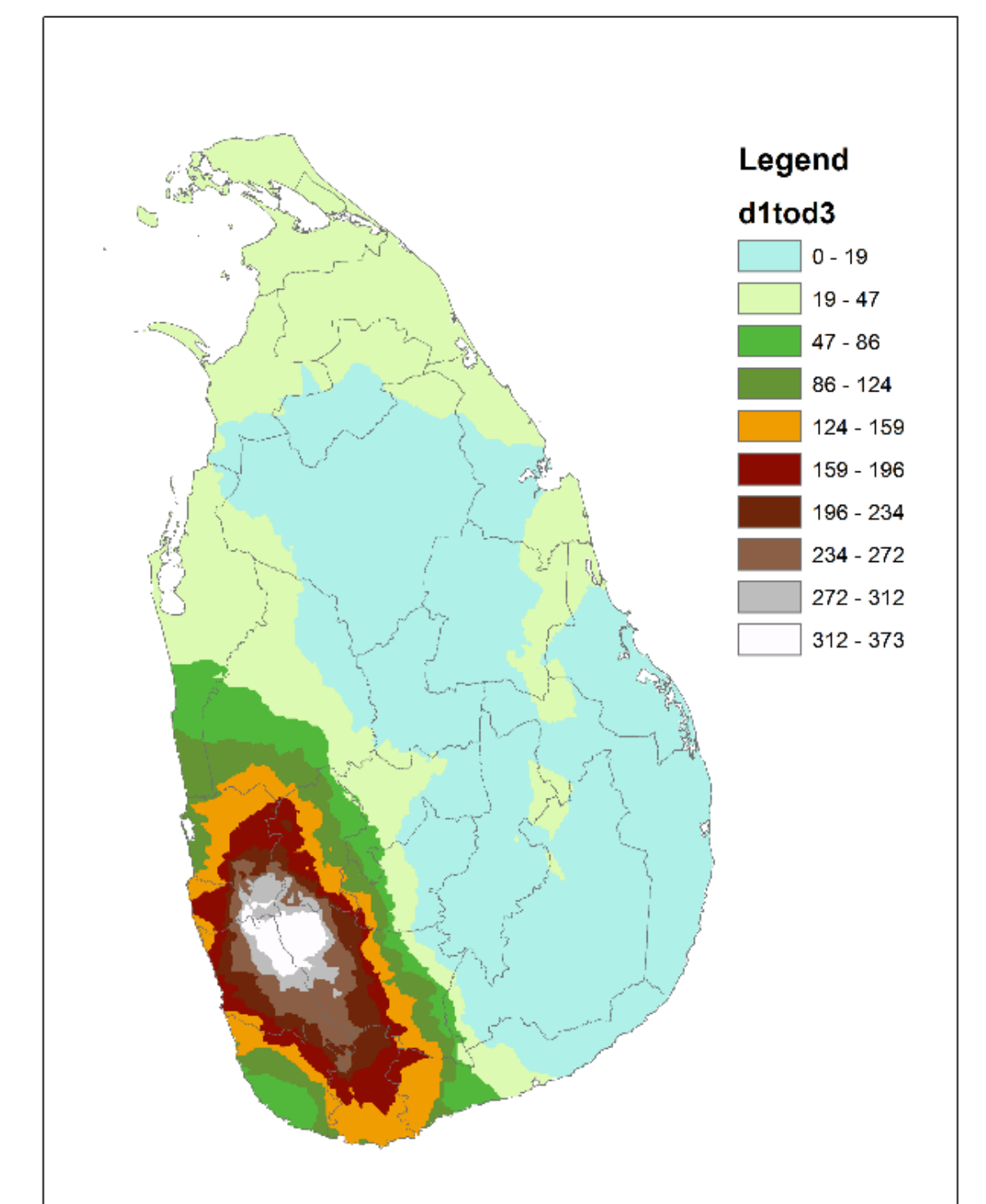
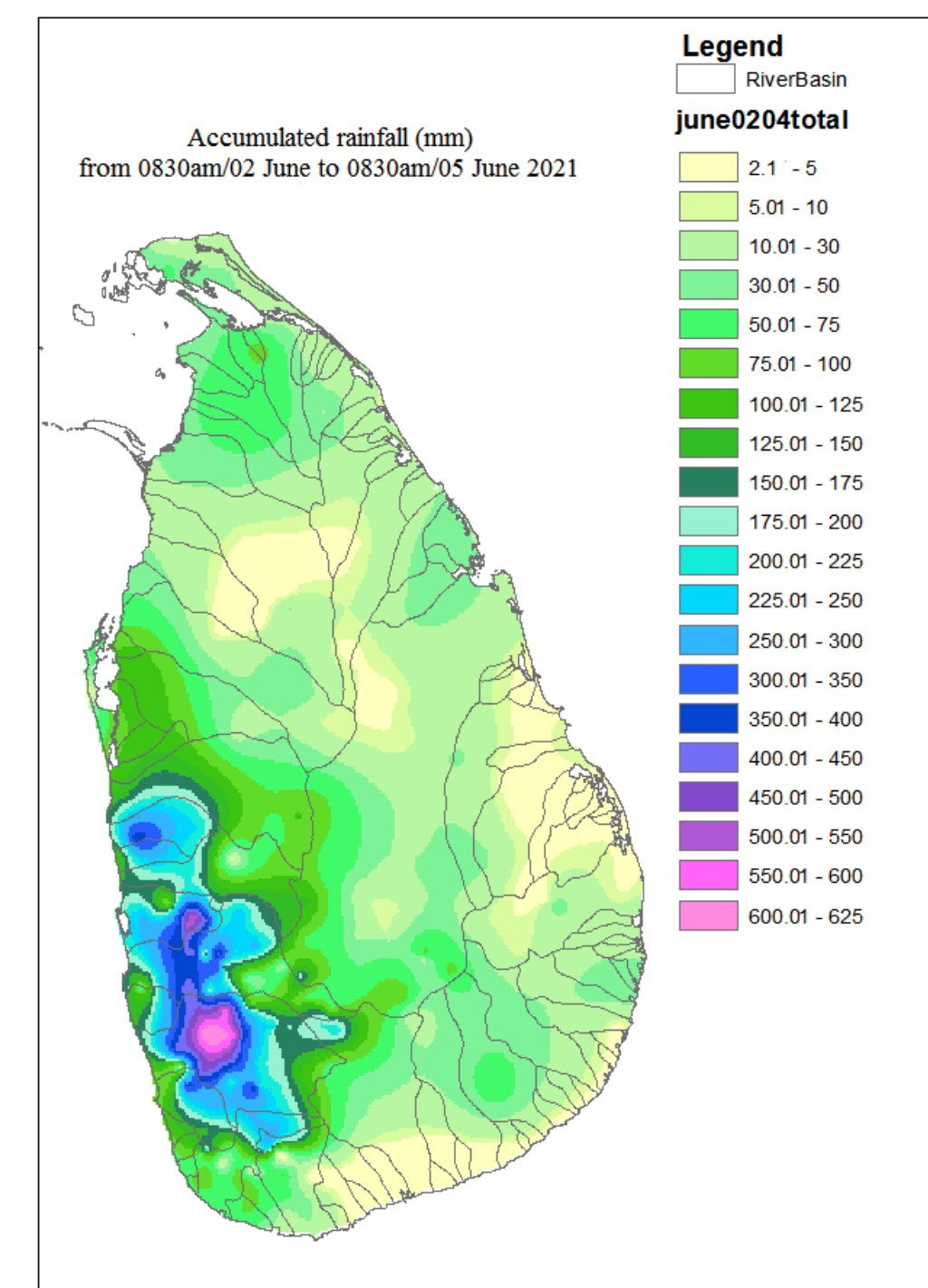
500 mb mean wind



500 mb wind anomaly

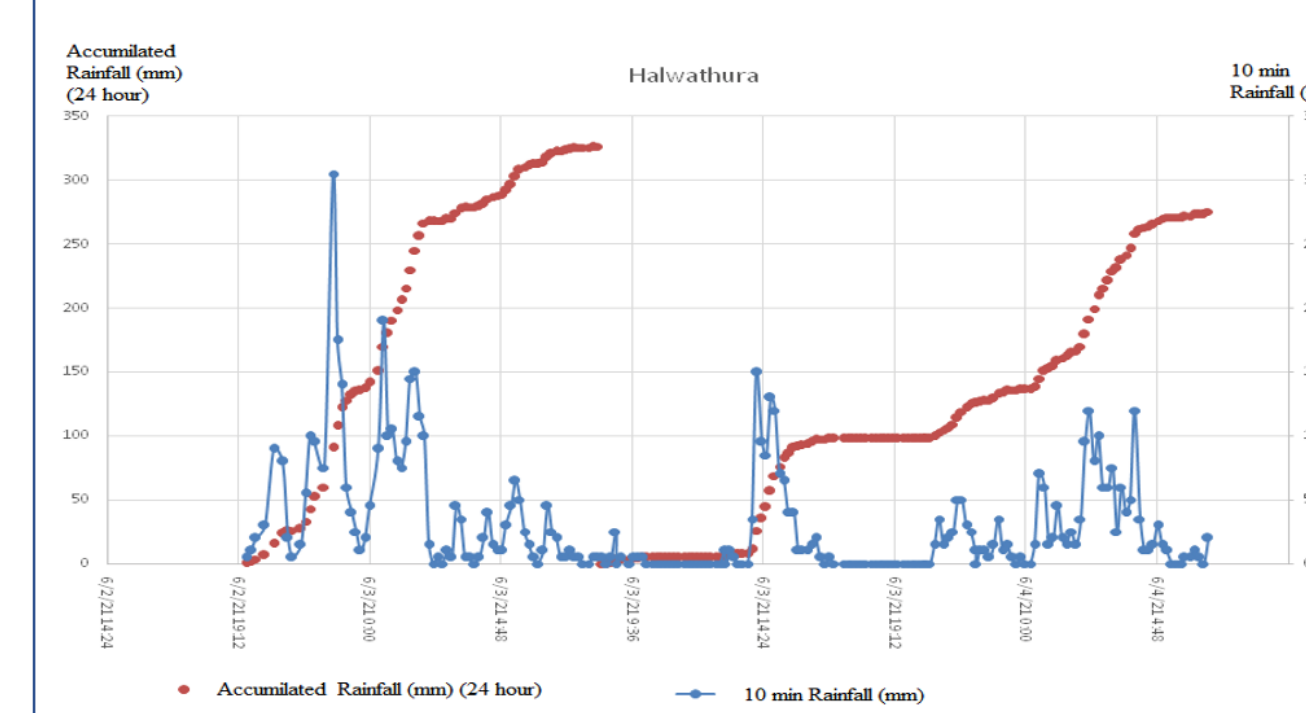


Results

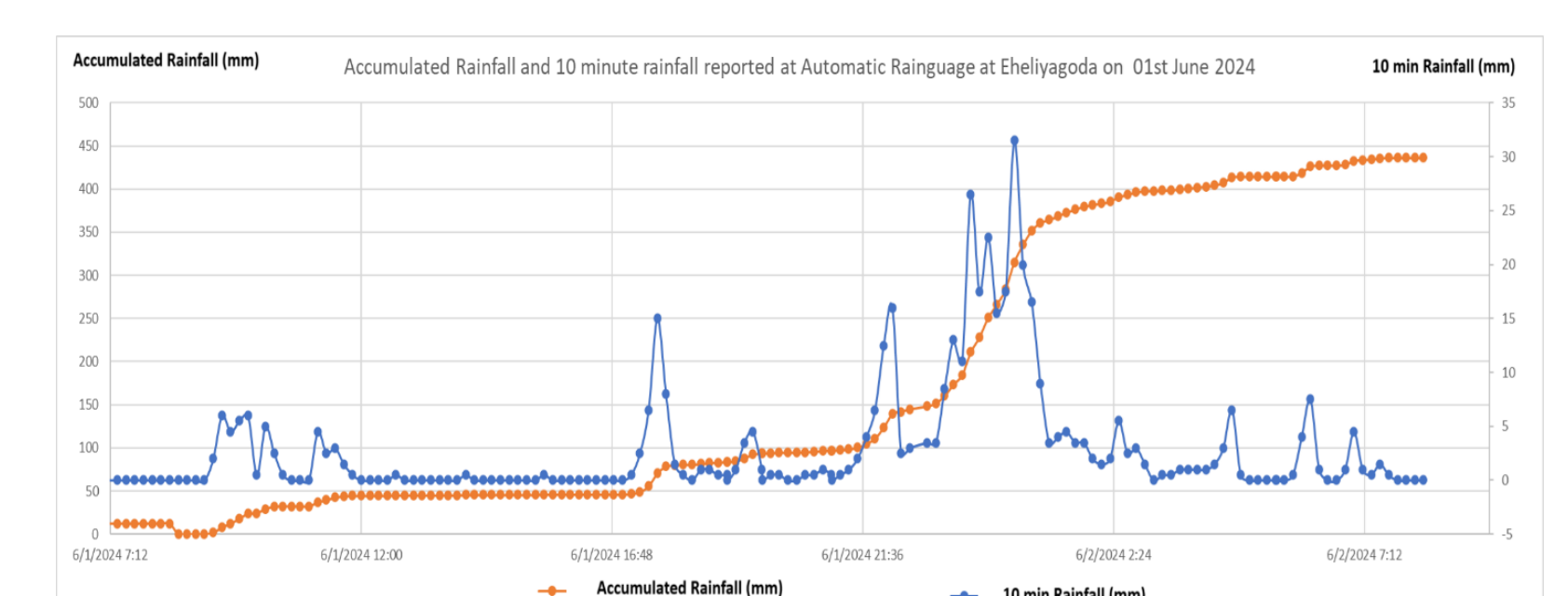


Accumulated rainfall (mm) from 0830am 02nd June to 0830am 05 June 2021 (left) and from 0830am 01 to 0830am 04 June 2024 (Right).

- **Rainfall Patterns:** Heavy rainfall exceeding 200mm was recorded in both 2021 and 2024 within the first week of June
- **Prediction Challenges:** These extreme rainfall events were not predicted by the models, indicating limitations in current forecasting techniques. The lack of accurate model-based early warnings highlights the need for improved predictive capabilities, particularly in capturing localized convective systems and monsoon variability.
- **Impact Assessment:**
 - 2021: 16 deaths, 270,912 people affected across 10 districts.
 - 2024: 25 deaths, 253,581 people impacted by floods and landslides.
- **Comparative Insights:** The 2024 event exhibited stronger atmospheric instability and higher rainfall intensity compared to 2021.
- **Monsoonal Flow Analysis:** Weakening of the southwesterly monsoonal flow across Sri Lanka was observed in both cases. The southward shift of the monsoon jet from Sri Lanka created an anomalous cyclonic vortex in 2024 at both 850mb and 500mb levels. A trough appeared over Sri Lanka at 850mb in both cases, further enhancing convective activity and contributing to the heavy rainfall events.



Accumulated Rainfall and 10 minute rainfall reported at Automatic Rainguage at Halwathura 03rd and 04th June 2021.



Accumulated Rainfall and 10 minute rainfall reported at Automatic Rainguage at Eliyagoda on 01st June 2024.

Conclusion

- Strong cyclonic circulations and vertical wind shear contribute to the formation of extreme rainfall events.
- Current meteorological models fail to accurately predict these extreme events, necessitating improvements in forecasting methods.
- The atmospheric conditions contributing to these events included a deep northwest-southeast oriented trough over Sri Lanka at both the surface and 850 mb levels, coupled with mild cyclonic circulations embedded in the trough at 500 mb.
- Strong vertical wind shear, both in speed and direction, created favourable conditions for the formation of multicell thunderstorms, which resulted in torrential rainfall over the southwestern regions and adjacent areas from June 1st to June 4th in both 2021 and 2024.