Comparing the interaction of dry air incursion with monsoon depression using ERA-5 and IMDAA datasets

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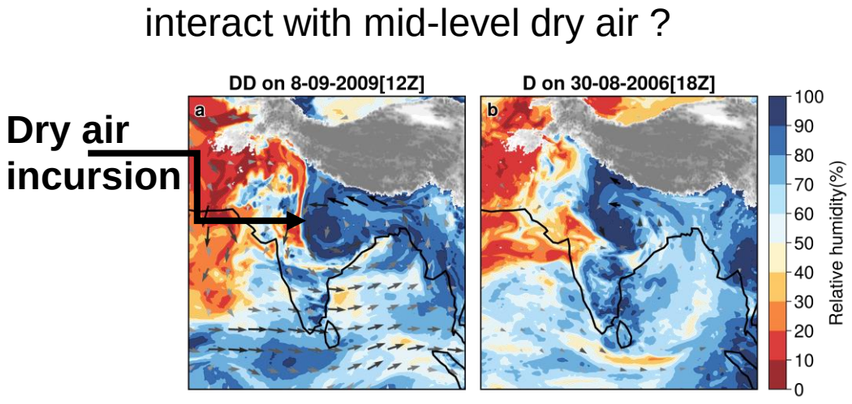
Introduction

- Monsoon depressions (MDs) that originate over the Bay of Bengal travel northwest and bring substantial rainfall over northern and central India during the summer monsoon.
- Mid-level **(700–400 hPa**) dry air masses often interact with the MDs and **significantly modify the space-time rainfall intensity and distribution.**
- Previous studies have emphasized the need for higher resolution data to understand such interactions.

Key Objectives

1. Compare the composite structure of Monsoon depression (MD) and its interaction with mid-level dry air incursion (700–400 hPa).
2. Is there any considerable difference in the features observed with **depression (D) and deep depression (DD) events** when they interact with mid-level dry air ?



Data and Methodology

Datasets : IMDAA , ERA-5 and IMD gridded rainfall product (1982 - 2012)

Events and Methods used :

1. 42 (D events) and 35 (DD events) over BOB compiled used IMD cyclone track database.
2. Dry air incursion data added to the above chosen events following the work by *Fletcher et.al (2018)*
3. Spatially averaged composite maps are constructed for the events with emphasis on some selected sub-domains (R1, R2, R3 and R4) as shown in Fig.1

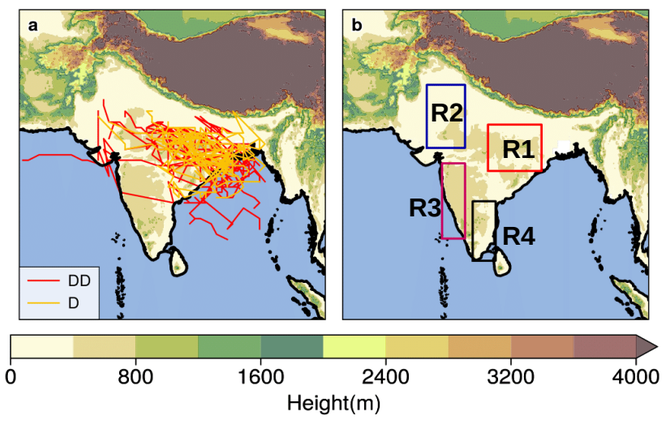
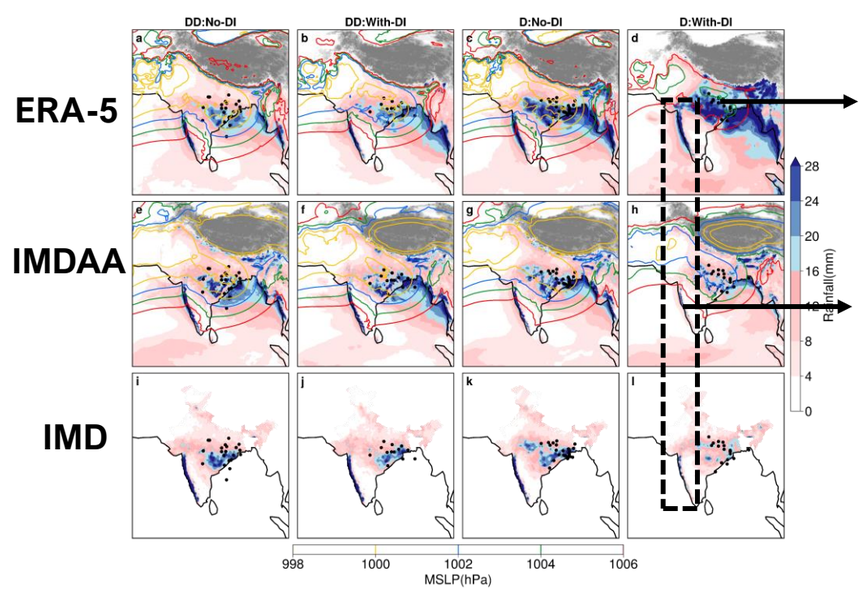


Fig 1 :(a) Tracks of D and DD events considered in this study with orography as the background; (b) Region of interest over the Indian sub-continent where the area averages are computed.

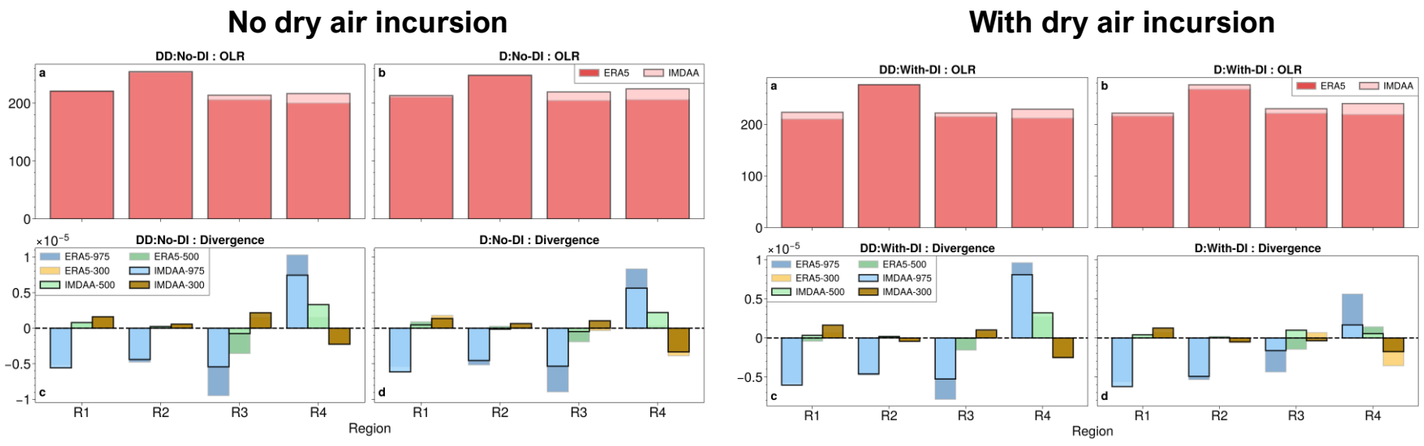
Results and Discussion

1. Spatial distribution of accumulated precipitation



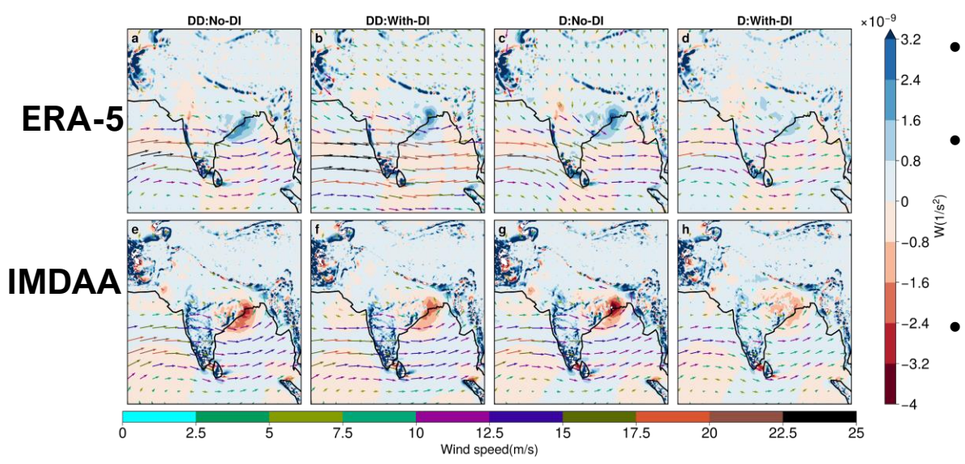
- Wet-bias in ERA-5 for D:With-DI events.
- Drying of western ghats for D:With-DI events captured well by IMDAA and IMD
- MSLP at the centre of monsoon trough is 5 hPa higher for D than DD during dry-air incursion.

2. Thermodynamic parameters – OLR and horizontal wind divergence



- Relation between divergence at various levels with OLR is demonstrated in this figure.
- R3 and R4 exhibits a strong dipolar nature in its divergence structure.
- Nearly **75% drop in low-level convergence over R3** (western ghats) as noted in IMDAA for D with-DI events.

3. Resolving mesoscale eddies : Okubo-Weiss (W) parameter @ 850 hPa



- W=(Normal strain)² +(shear strain)² -(relative vorticity)²
- IMDAA captures the vorticity dominated (W < 0) flow structure over MD while ERA-5 could not.
- Larger drop in vorticity for D-With DI well represented in IMDAA.

Conclusion

1. **IMDAA realistically represents** the monsoon features whereas **ERA-5 exaggerates** the characteristics associated with vigorous monsoon circulation.
2. **Over R3 (western ghats),** the accumulated precipitation **almost reduces to half in D-With DI** as observed in IMDAA and IMD.
3. The differences between ERA-5 and IMDAA are **very prominent for D events as compared to DD events** when they interact with DI.
4. Overall, **IMDAA picks up the fine scale structure embedded within the cyclonic systems which ERA5 could not capture**

References

Fletcher, J. K., Parker, D. J., Hunt, K. M., Vishwanathan, G. and Govindankutty, M. (2018) **The interaction of indian monsoon depressions with northwesterly midlevel dry intrusions**. *MonthlyWeather Review*, **146**, 679–693

Ashrit, R., Indira Rani, S., Kumar, S., Karunasagar, S., Arulalan, T., Francis, T., Routray, A., Laskar, S.,Mahmood, S., Jermey, P. et al. (2020) **Imdaa regional reanalysis: Performance evaluation during indian summer monsoon season**. *Journal of Geophysical Research: Atmospheres*, **125**, e2019JD030973