Impact of air-sea interactions on subseasonal prediction in the 2016 Indian summer monsoon

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1. Introduction

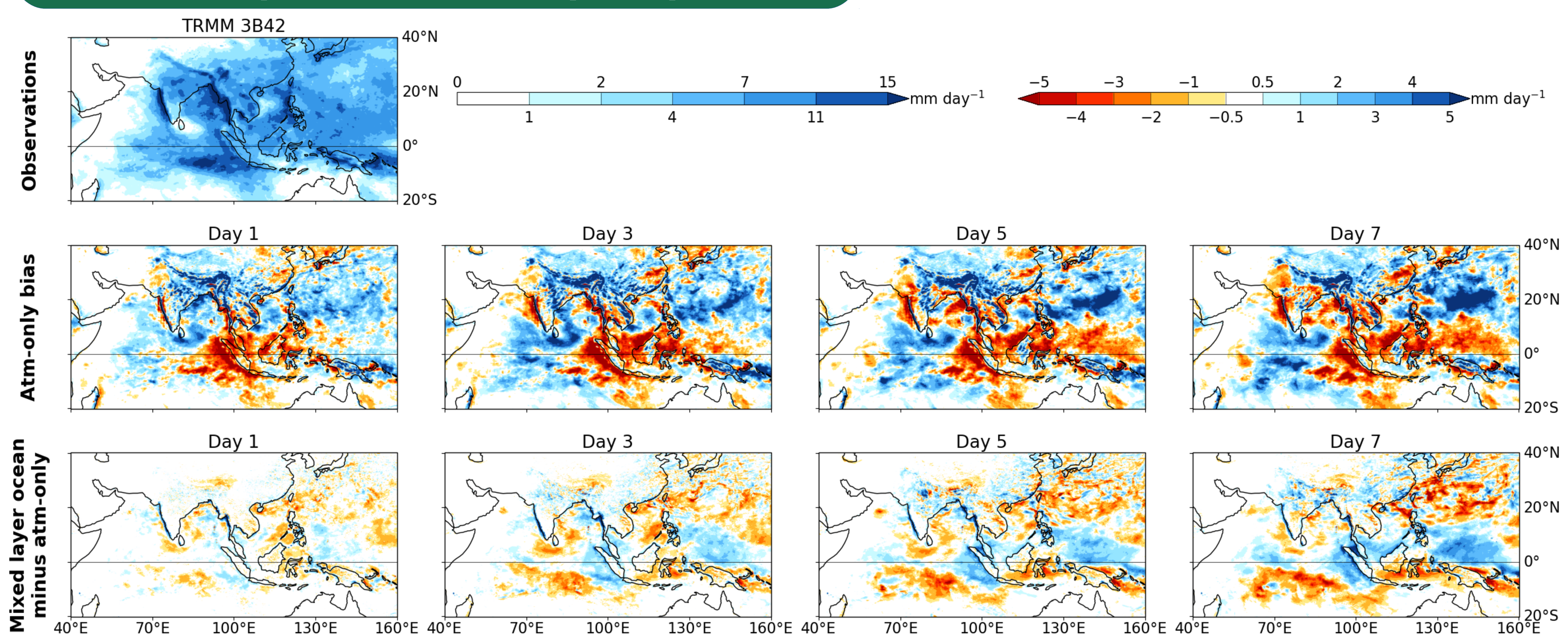
- The Bay of Bengal Boundary Layer Experiment (BoBBLE) investigates the effect of air-sea interactions on the Indian Summer Monsoon, including intraseasonal variability (ISV)
- The chief source of ISV is the Boreal Summer IntraSeasonal Oscillation (BSISO), the northward-propagating summer component of the MJO
- BoBBLE ship-based field campaign took place in June-July 2016 (Vinayachandran et al, 2018)

We use forecasts of the 2016 season, initialized daily at 00Z at ~25km grid spacing:

- **Atmosphere-only (➔7 days):** UK Met Office Unified Model (MetUM) global operational forecasts
- **Mixed layer ocean (➔15 days):** MetUM-GOML2.0 – the MetUM coupled to a KPP ocean (vertical mixing but no advection)
- **Dynamical ocean (➔15 days):** the MetUM coupled to NEMO

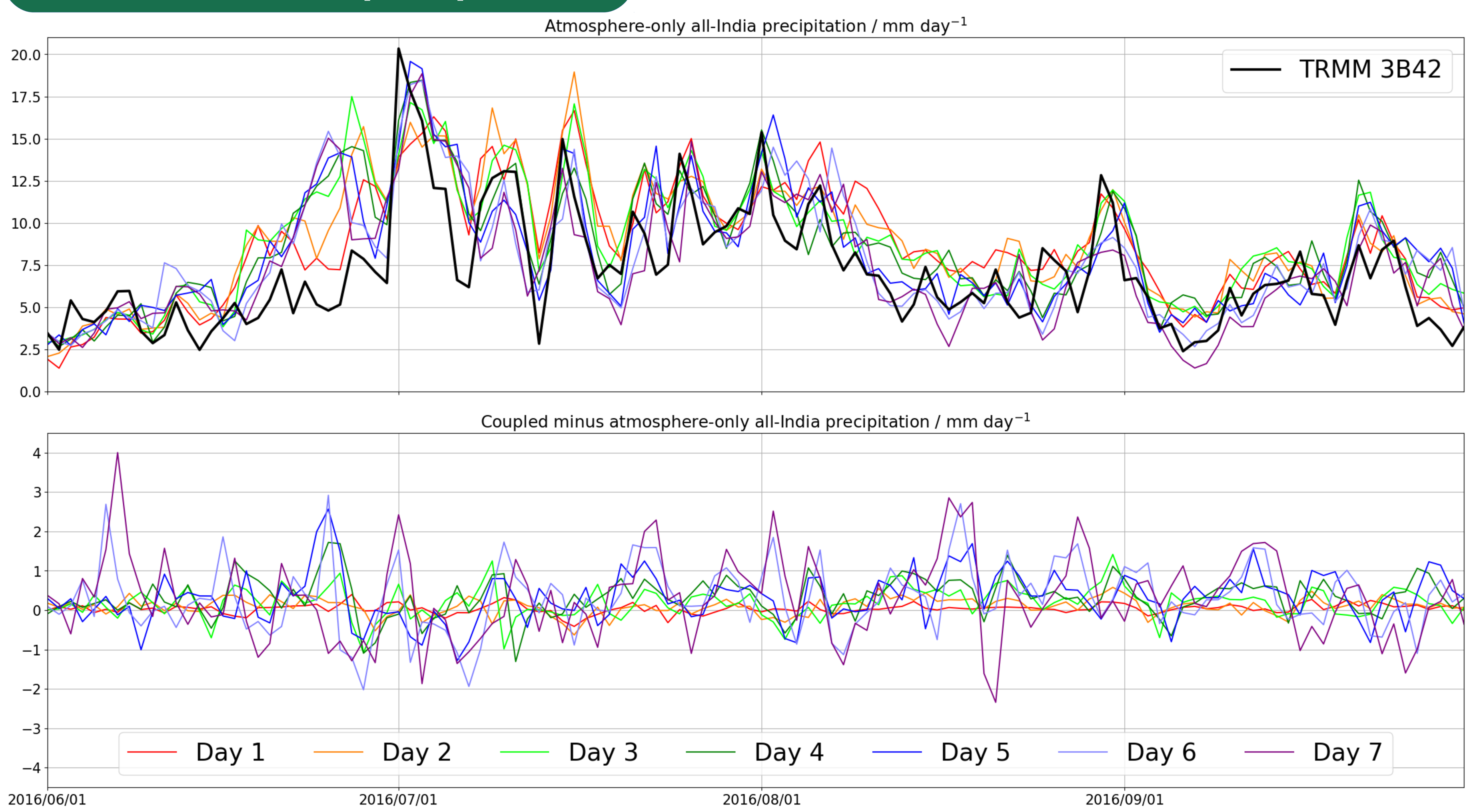
Results from the dynamical ocean forecasts (not shown) are very similar to the mixed layer ocean results, indicating that ocean dynamics have no significant role on this temporal scale

2. June–September mean precipitation



- Significant wet bias over India at early lead times (whereas in climate configurations the MetUM has a summer dry bias; e.g., Peatman and Klingaman, 2018), drying with lead time
- Coupling has only a minor impact over land; over ocean, it reduces the biases in most areas

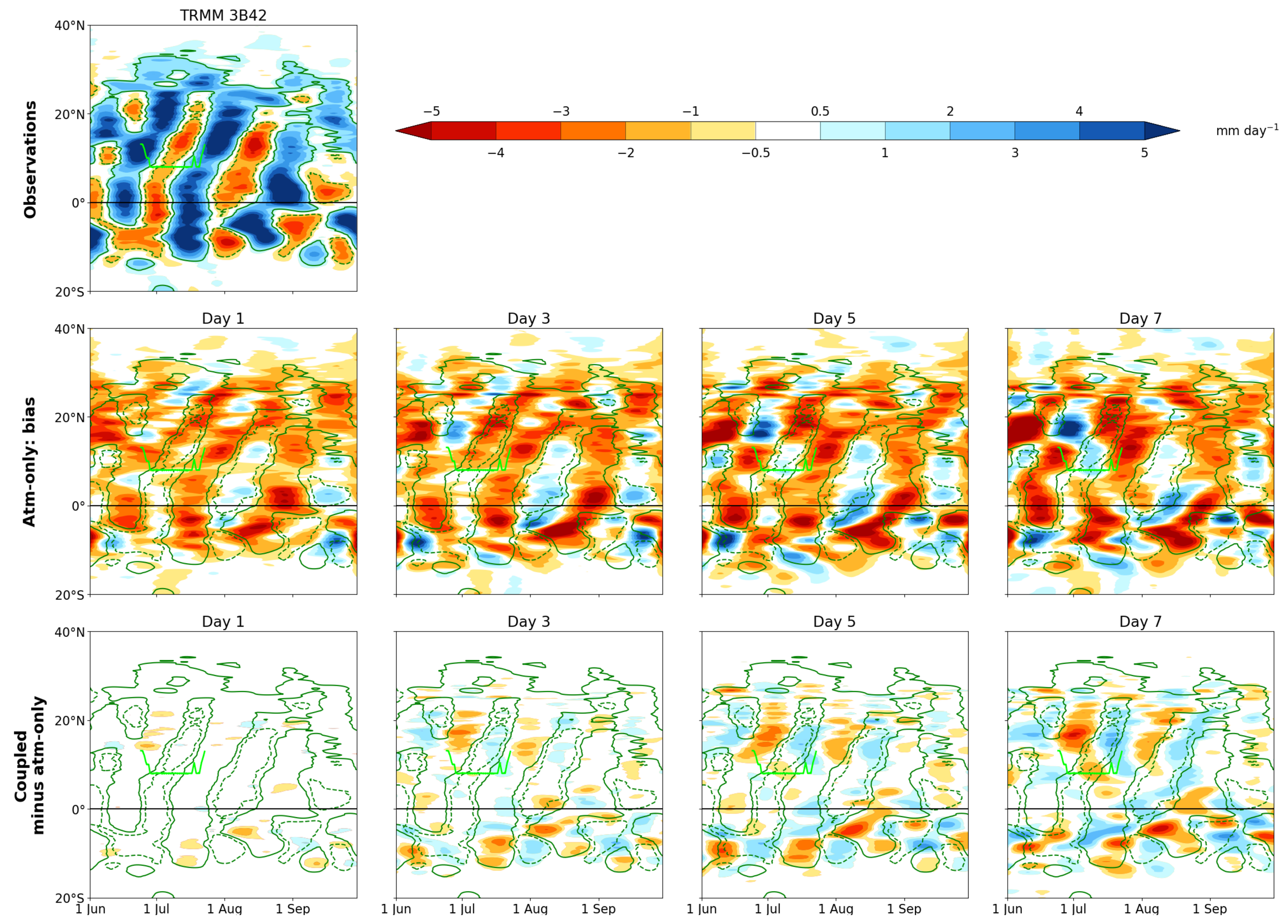
3. All-India mean precipitation



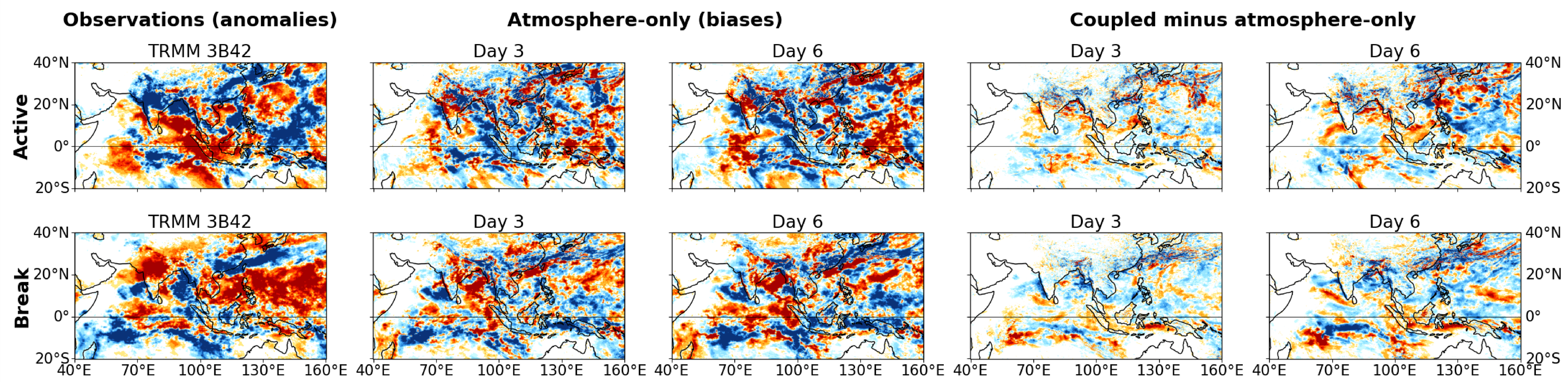
- Strong wet bias emerges in late June; for late lead times, bias then remains roughly constant
- Generally too wet during transition from dry to wet (late June) or wet to dry (early August)
- As seen in Box 2, atmosphere-only forecast tends to be drier at longer lead times
- The coupled forecasts are generally wetter than atmosphere-only at later lead times

4. Intraseasonal variability

- Plots show latitude-time diagrams of precipitation, averaged over 70–100°E and bandpass Lanczos filtered between 24 and 70 days
- Dark green lines: 1 mm day^{-1} contour from TRMM observations
- Bright green lines: Latitude of BoBBLE ship on field campaign, which sampled a break phase and transition to next active phase
- There were three clear active propagation events in the summer of 2016
- The active phases are very weak in the atmosphere-only forecasts, especially in the second and third events
- Effect of adding coupling is again small compared with the magnitude of the biases
- At later lead times, coupled model can start and end active events too early (e.g., 10–20°N in the second active event of the summer)



5. Composites of active and break events



- Active and break phases defined in terms of area-mean observed precipitation in the Core Monsoon Zone (CMZ) of India (Rajeevan et al., 2010)
- Three successive days with CMZ precipitation:
  - 1σ above climatology ⇒ active phase
  - 1σ below climatology ⇒ suppressed phase
- Plots show composites of precipitation in each phase (using the same colour bar as in Box 4)

- Active and break phases defined in terms of the CMZ over India have opposite-signed precipitation anomalies over much of the domain plotted here
- Forecast biases have similar magnitudes for active and break phases, and have similar magnitudes over land and sea
- There is an approximate east-west split over India in the forecast biases, with east India and the BoB being too wet (dry) in active (break) phases, and vice versa for west India, with little change over lead time
- Coupling has no coherent effect over Indian land, although it makes active (break) phases wetter (drier) over the Maritime Continent islands, especially at later lead times

6. Conclusions and further work

- Operational forecasts from the UK Met Office of the Indian Summer Monsoon of 2016 are evaluated, and compared against mixed layer ocean-coupled forecasts to investigate the role of air-sea coupling
- Significant mean biases exist at all lead times up to 7 days – for example, a wet bias over India which dries with lead time; at later lead times this is mainly due to incorrect forecasting of an active event in the second half of June
- Air-sea coupling has little effect over India in the seasonal mean, or during active or suppressed events
- Further work will measure the predictability of the propagation of the BSISO using indices of Lee et al. (2013; similar to the RMM indices of the MJO)
- The cause of the wet bias in late June is to be investigated
- Sensitivity experiments will be run for case studies; for example, during a monsoon depression which existed in early July. For example, the role of the diurnal forcing will be investigated by removing the diurnal cycle of solar radiation

References

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