EGU2017-17833

Evolution of Indian land surface biases in seasonal hindcasts from the Met Office Global Seasonal Forecasting System GloSea5

Amulya Chevuturi | Andrew G. Turner | Steven J. Woolnough | Gill Martin

University of Reading

Met Office

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

1. Introduction

- We investigate the development of biases over the Indian sub-continent in summer hindcasts of the UK Met Office coupled initialised global seasonal forecasting system, GloSea5-GC2, which include precipitation errors over India persisting during monsoon season (Fig. 1, Ref. 1).

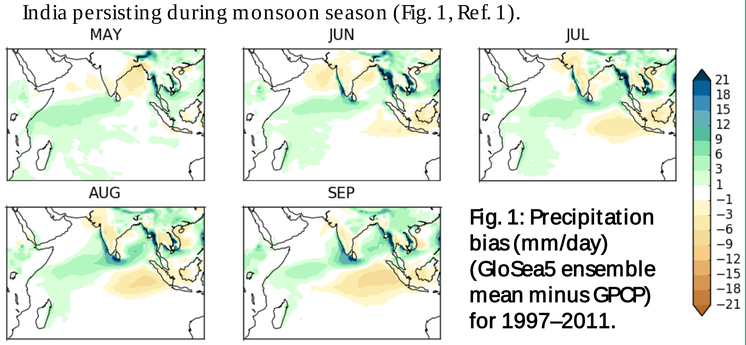

Fig. 1: Precipitation bias (mm/day) (GloSea5 ensemble mean minus GPCP) for 1997–2011.

- Even in pre-monsoon, surface heat fluxes show strong biases (higher sensible / lower latent heat flux) compared to observed estimates (Fig. 2a) and point towards soil moisture bias present from the early days of the seasonal forecasts (Fig. 2b) which may exacerbate precipitation forecast errors.
- This soil moisture bias during the beginning of the hindcasts may originate in the GloSea5 initialization, using climatological soil moisture.
- Significant changes in seasonal climate simulations have been observed with models initialized with accurate soil moisture conditions (Ref. 2).
- On this premise, for the current study a sensitivity experiment is designed using an atmosphere-only version of the model with increased soil moisture forcing to assess the response of heat fluxes and subsequently precipitation.

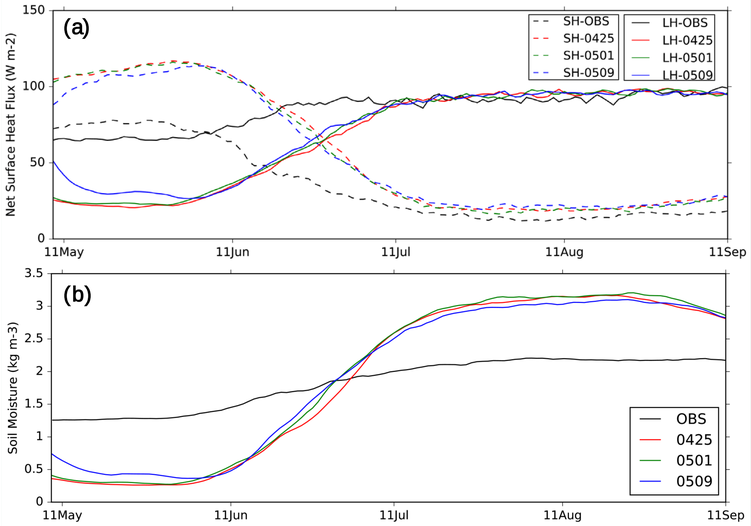

Fig. 2: (a) Surface sensible & latent heat (SH & LH) flux, (b) soil moisture (bottom) averaged over 73–83°E, 16–28°N for the GloSea5 ensemble means of 3 start dates (MMDD) & ERA-Interim observation for 1992–2011.

2. Objective

- Sensitivity experiments with atmosphere only model with a considerable initial soil moisture perturbation to judge its impact on surface heat flux budget and overall Indian summer monsoon simulation.

3. Experimental Design

- Global Atmosphere (GA6.0) model coupled with Global Land (GL6.0) model at N96 resolution (~135km) is used for the sensitivity experiments for control (CTR) and experiment (EXP) over 20 years (1992-2011) initialized at 01May each year with180 days of integration.
- EXP is similar to CTR but with maximum soil moisture over Indian landmass, with soil moisture input maximized over 12 months on each grid point at all four soil levels. Model simulations have the same initial conditions as the GloSea5-GC2 seasonal hindcast set.

4. Results

- Due to the pre-monsoon heating over the Indian land surface, the EXP loses most of the extra moisture added to the soil within 30 days of initialization (Fig. 3a).
- The surface latent heat flux increases and sensible heat flux reduces with the additional moisture added to the soil as expected but this change does not persist beyond 30-40 days (Fig. 3b).

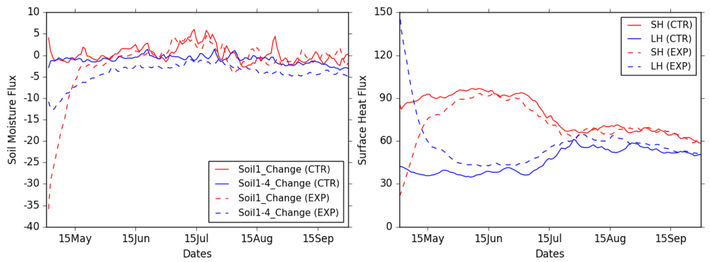

Fig. 3: Daily (a) soil moisture flux (mm/day) and (b) surface SH flux and surface LH flux for 1997–2011 averaged over Indian land points. with CTR and EXP.

- Most of the extra moisture added in the EXP simulation is lost due to high evapotranspiration over India (Fig. 4) and part of it is lost to oceans due to sub-surface runoff.
- Consequently the precipitable water in EXP is higher and surface temperature is lower than CTR.
- Resulting weaker south-westerly circulation in EXP due to altered stability conditions over India leads to enhanced moisture convergence and precipitation over southern Indian and Arabian Sea.
- Little to no impact is observed on the Indian monsoon precipitation.

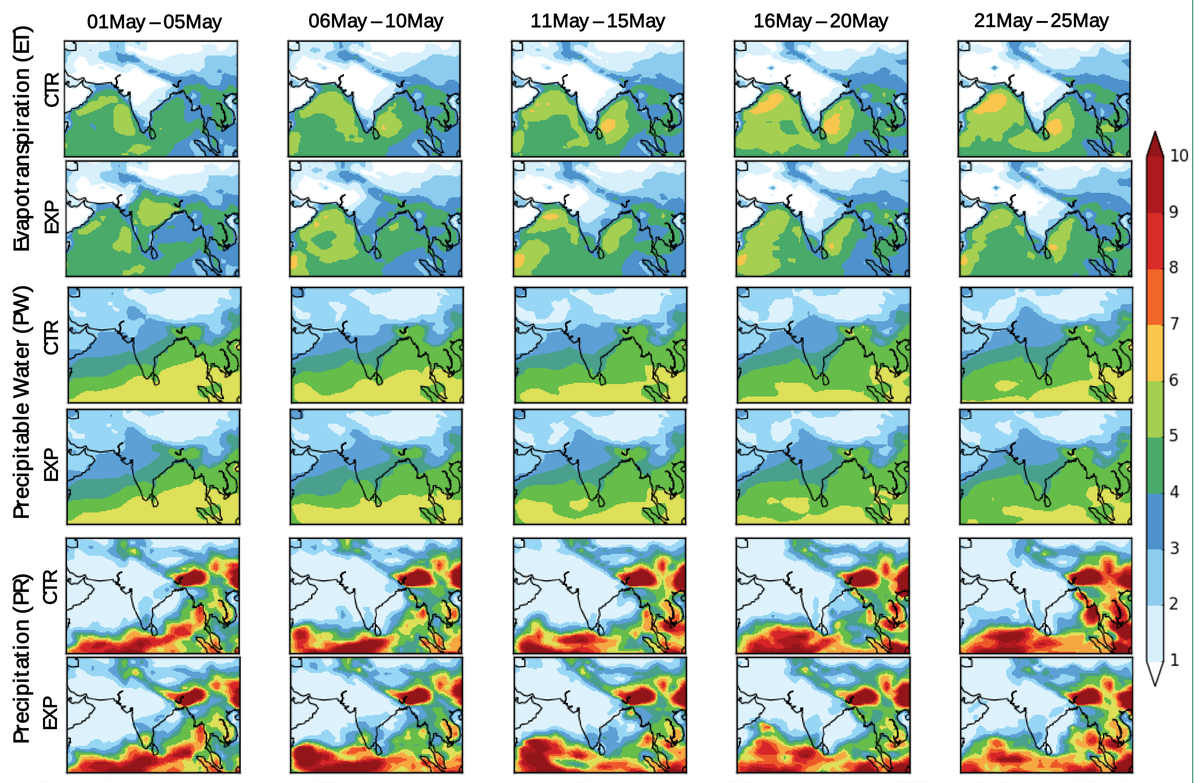

Fig. 4: Climatological pentad ET (mm/day), total column PW (kg/kg) and PR (mm/day) for CTR and EXP for 1997–2011.

5. Conclusions

- The evolution of surface heat flux biases, prior to the monsoon, suggests that there may be a problem with GA6.0/GL6.0 model's simulation of land surface features.
- Our experimental (sensitivity) analysis shows that:
  - A change in soil moisture, of all the four soil levels, introduced during the pre-monsoon season, only persists for about a month.
  - Most of top soil level moisture is lost to evapotranspiration and all four soil levels lose soil moisture through sub-surface runoff, with the lowest soil level retaining some of the excess moisture.
  - Resulting changes in heat fluxes, precipitation and atmospheric humidity show a similar signal to the soil moisture change (which also persist for a month) .
  - Too early addition of the excess soil moisture in all four soil levels does not have any significant impact on the monsoon circulation or the monsoon precipitation over India.
- Future experiments planned are: sensitivity experiments with enhanced soil moisture forcing introduced later into the season (15May or 01Jun) to evaluate its response on monsoon climatology.

6. References

1. Johnson et al. (2016) *Climate Dynamics*, **48**, 1447–1465.
2. Dirmeyer (2000) *Journal of Climate*, **13**, 2900-2922.

E: a.chevuturi@reading.ac.uk | T: +44 (0) 118 378 6016 | A: NCAS Climate, Department of Meteorology, University of Reading, RG6 6BB, United Kingdom | orcid.org/0000-0003-2815-7221