Project: **1144**

Project title: **Impact of climate change on South Asia extremes: A high-resolution regional Earth System Model assessment**

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Report period: **2020-11-01 to 2021-08-31**

The overall aim of the project is to setup a high-resolution Regional Earth System Model (RESM) for South Asia and the northern Indian Ocean (CORDEX South Asia domain) and to study climate change consequences and extreme events in the present and future climate.

During the second stage of the Project, a detailed atmospheric, ocean physical and biogeochemical characteristics for the period 2015-2100 within the South Asia CORDEX domain have been obtained from simulations of the Regional Earth System Model ROM [Sein et al., 2015]. Comparative analysis of average climatic characteristics for the past (1975–2004) and future (2070–2099) climates has been carried out. It shows significant future SST increase, reaching 3 ºC on average over the considered area (Fig. 1). The salinity of the ocean's upper layer will decrease by 1 ‰ on average, which indicates a change in the precipitation–evaporation balance in the future climate (Fig. 1). The simulated annual MLD will decrease by 5 m in the future. However, this MLD change will be strongly irregular, both in time and space. Simulations also show a widespread decrease of the chlorophyll-a concentration in the surface layer (up to 2 mg Chl m^{-3}) in the future, especially pronounced in the northern and western parts of the Arabian Sea. It is a significant change, given that absolute chlorophyll-a concentration in these areas is typically 3–4 mg Chl m^{-3} in spring and 5–8 mg Chl m^{-3} in summer, as was obtained for the 1975-2004 model run. The model also shows that the chlorophyll-a concentration at the surface will decrease by 1–2 mg Chl m^{-3} along the western coast of the Bay of Bengal in the future. The relative decrease in the surface chlorophyll-a concentration will be about 40% in the future climate in the Arabian Sea and the Bay of Bengal.

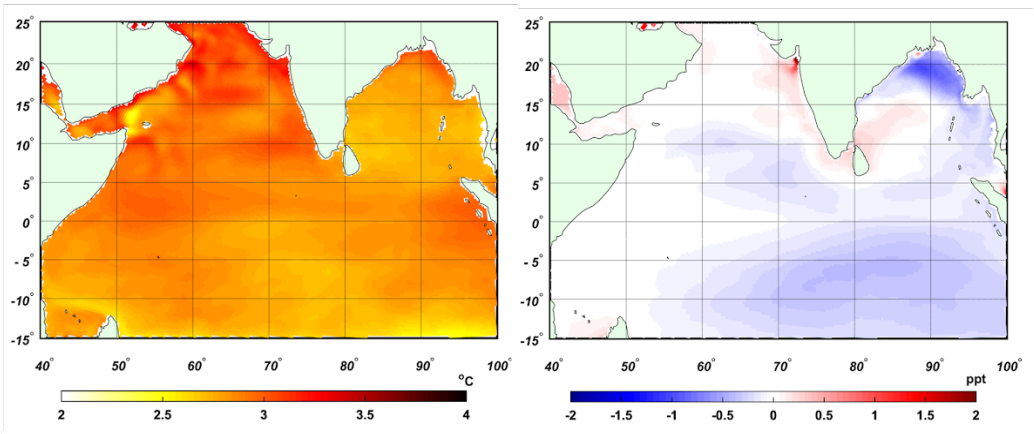

Fig. 1. Difference between simulated future (2070-2099) and past (1975-2005) climatic SST (left) and SSS (right).

The model solution according to the SSP5-8.5 scenario shows a decrease in the amount of precipitation in the future climate (up to 3–4 mm/day) over the northeastern part of India and over Nepal in summer (Fig. 2). But there will be an increase in the amount of precipitation over the central part of India, in the Andaman Sea, over Thailand and Myanmar. The total continental runoff into the Bay of Bengal will increase, but the runoff in the Ganges delta will be greatly weakened. Thus, despite the decrease in the runoff of the Ganges and Brahmaputra rivers, the total continental runoff into the Bay of Bengal turns out to be higher in the future climate (2070–2099) relative to retrospective calculations (1975–2004) due to the runoff of smaller rivers.

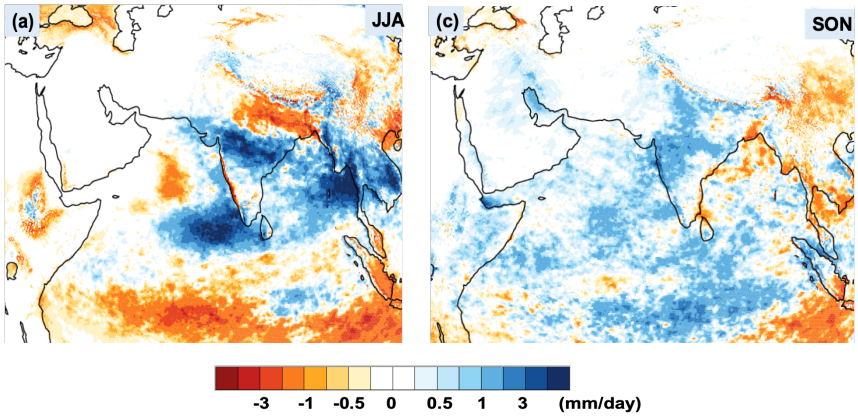

Fig. 2. Difference between simulated future (2070-2099) and past (1975-2005) total precipitation based on the SSP5-8.5 scenario. Seasons: JJA - summer, SON - autumn.

For the first time for CORDEX-South Asia, a high-resolution regional earth system model (ROM) is adopted to assess the impact of horizontal resolution (0.22◦ and 0.11◦) in simulating the Indian summer monsoon rainfall (ISMR) and the underlying spatiotemporal variability. ROM at both resolutions bears a close resemblance to observations in simulating the mean precipitation climatology compared to other regional climate models (RCMs) participated in CORDEX- South Asia. ROM shows substantial improvement relative to the ensemble mean of the RCMs included in CORDEX-South Asia. While comparing both simulations with observations, some systematic wet and dry bias over Central India (CI) and Northern Western Ghats is noticed. In general, the wet/dry bias over India is mainly associated with the overestimation/underestimation of the large-scale/convective component. Increasing horizontal resolution from 0.22◦ to 0.11◦ significantly adds value in simulating the JJAS mean precipitation by reducing the wet bias over western central India (WCI) and southern peninsular India and dry bias over eastern CI. The reduction in wet/dry bias is mainly associated with suppression/enhancement of the large scale/convective precipitation. This improvement in mean precipitation is partially due to the improved representation of the propagation of mesoscale systems such as boreal summer intraseasonal oscillation (eastward and northward). Despite the above improvements, the wet precipitation bias, particularly over WCI, persists. The weaker Findlater Jet associated with weaker land-ocean thermal contrast caused by the warm sea surface temperature (SST) bias over the western Arabian Sea (AS) suggests that AS moisture transport does not contribute to the wet bias over India. The wet bias is possibly associated with favourable atmospheric conditions (atmospheric instability).

Publications of the Project, 2021:

Mishra A.K., Kumar P., Dubey A.K., Javed A., Saharwardi M.S., Sein D.V., Martyanov S.D., Jacob D. (2021) Impact of horizontal resolution on monsoon precipitation for CORDEX-South Asia: A regional earth system model assessment, Atm. Res., Vol. 259, 105681, https://doi.org/10.1016/j.atmosres.2021.105681.

Aditya Kumar Dubey, Preet Lal, Pankaj Kumar, Amit Kumar, Anton Y. Dvornikov (2021). Present and future projections of heatwave hazard-risk over India: A regional earth system model assessment, Environmental Research, Volume 201, 111573, https://doi.org/10.1016/j.envres.2021.111573.

Saharwardi, M. S., Dubey, A. K., Kumar, P., and Sein, D. V.: Drought dynamics and variability over Bundelkhand region of central India: Past, Present and Future, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-15248, https://doi.org/10.5194/egusphere-egu21-15248, 2021.