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Influence of ocean and atmosphere coupling in a regional climate simulation:

Case study on typhoons over CORDEX Southeast Asia

Motivation

- Regional climatic biases in global circulation models (GCMs) exist (Sein, et. al., 2015) especially over areas with strong ocean and atmosphere interactions
- GCMs have a tendency to overestimate the tropical cyclone frequency in the Northwest Pacific (NWP) Basin (e.g. Manganello et. al., 2012)
- Contribute to the WCRP Initiative on Coordinated Regional Downscaling Experiments (CORDEX; www.cordex.org), with focus on the Southeast Asian (SEA) Domain

Coupling of the ocean to the atmosphere can potentially improve climate simulations and their cyclonic activity. In this study, the regional atmosphere model REMO is coupled with the Max Planck Institute Ocean Model to produce a regional atmosphere, global ocean coupled model system (ROM). The aim is to identify the regions where the ocean-atmosphere coupling can improve climate simulations in the CORDEX-SEA domain.

Preliminary results

- Wet biases over the ocean in the uncoupled simulations (REMO) are reduced in the coupled simulation (ROM) e.g. summer of 1980-2012 in Fig. 2.
- Some regions with cold or warm biases (e.g. between Philippines and Japan) still remain or are enhanced

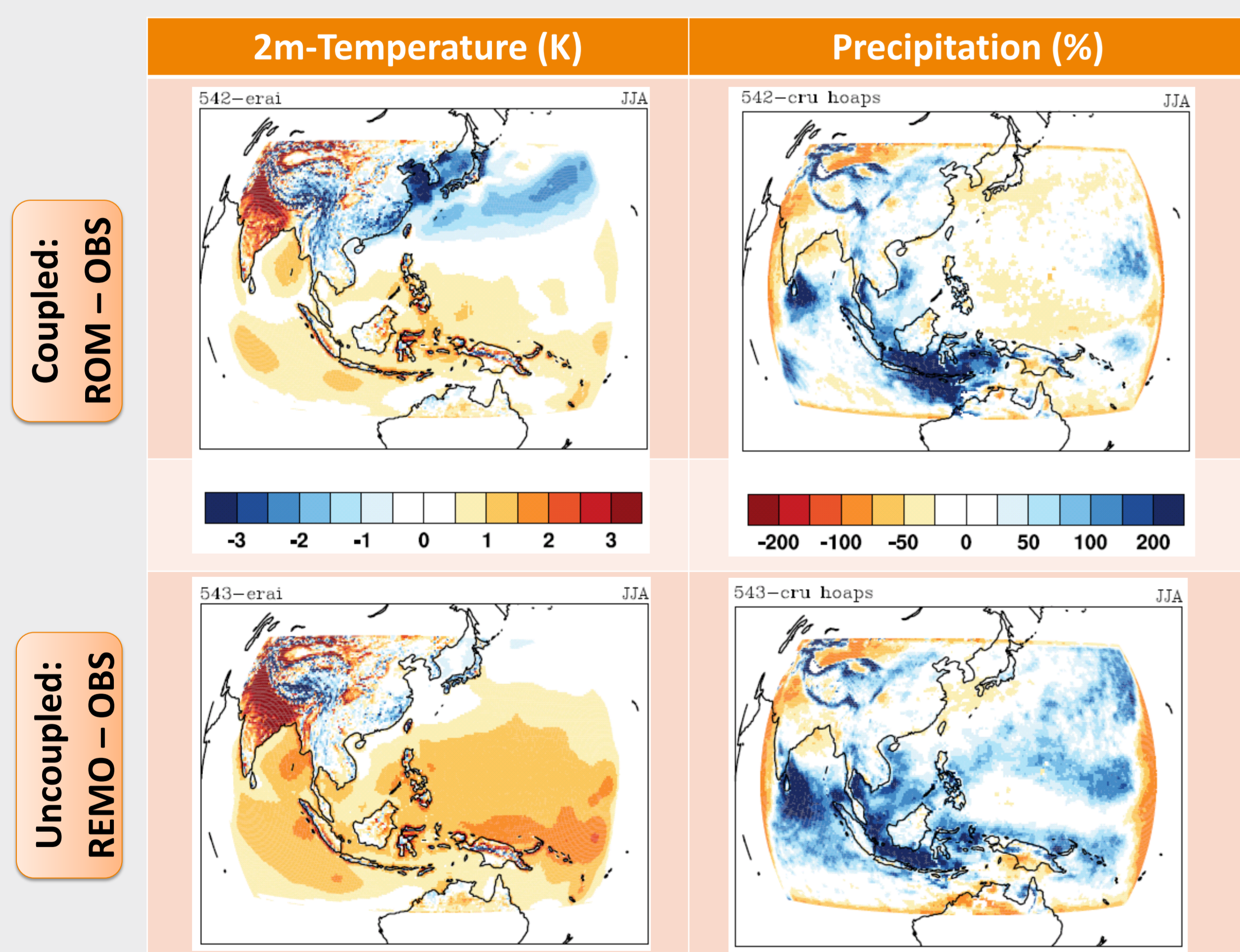


Fig. 2. Temperature and precipitation mean biases from observational datasets for the JJA season from 1980 to 2012.

References:

- Jacob, D.; Elizalde, A.; Haensler, A.; Hagemann, S.; Kumar, P.; Podzun, R.; Rechid, D.; Remedio, A.R.; Saeed, F.; Sieck, K.; et al. (2012) Assessing the transferability of the regional climate model REMO to different coordinated regional climate downscaling experiment (CORDEX) regions. *Atmosphere*, 3, 181–199.
- Hodges, K. (1994), A General Method for Tracking Analysis and its Application to Meteorological Data, *Mon. Weather Rev.*, V122, 2573-2586.
- Manganello, J., Hodges, K., Dirmeyer, B., Kinter, J. III, Cash, B., Marx, L., Jung, T., Achuthavarier, D., Adams, J., Altshuler, E., Huang, B., Jin, E., Towers, P., Wedi, N. (2014) Future Changes in the Western North Pacific Tropical Cyclone Activity Projected by a Multidecadal Simulation with a 16-km Global Atmospheric GCM. *Journal of Climate* 27:20, 7622-7646.
- Sein, DV, Mikolajewicz, U, Gröger, M, Fast, I, Cabos, W, Pinto, JG, Hagemann, S, Semmler, T, Izquierdo, A and Jacob, D (2015): Regionally coupled atmosphere-ocean- sea ice-marine biogeochemistry model ROM: 1. Description and validation, *Journal of Advances in Modeling Earth Systems*. doi: 10.1002/2014MS000357.

Data and methods

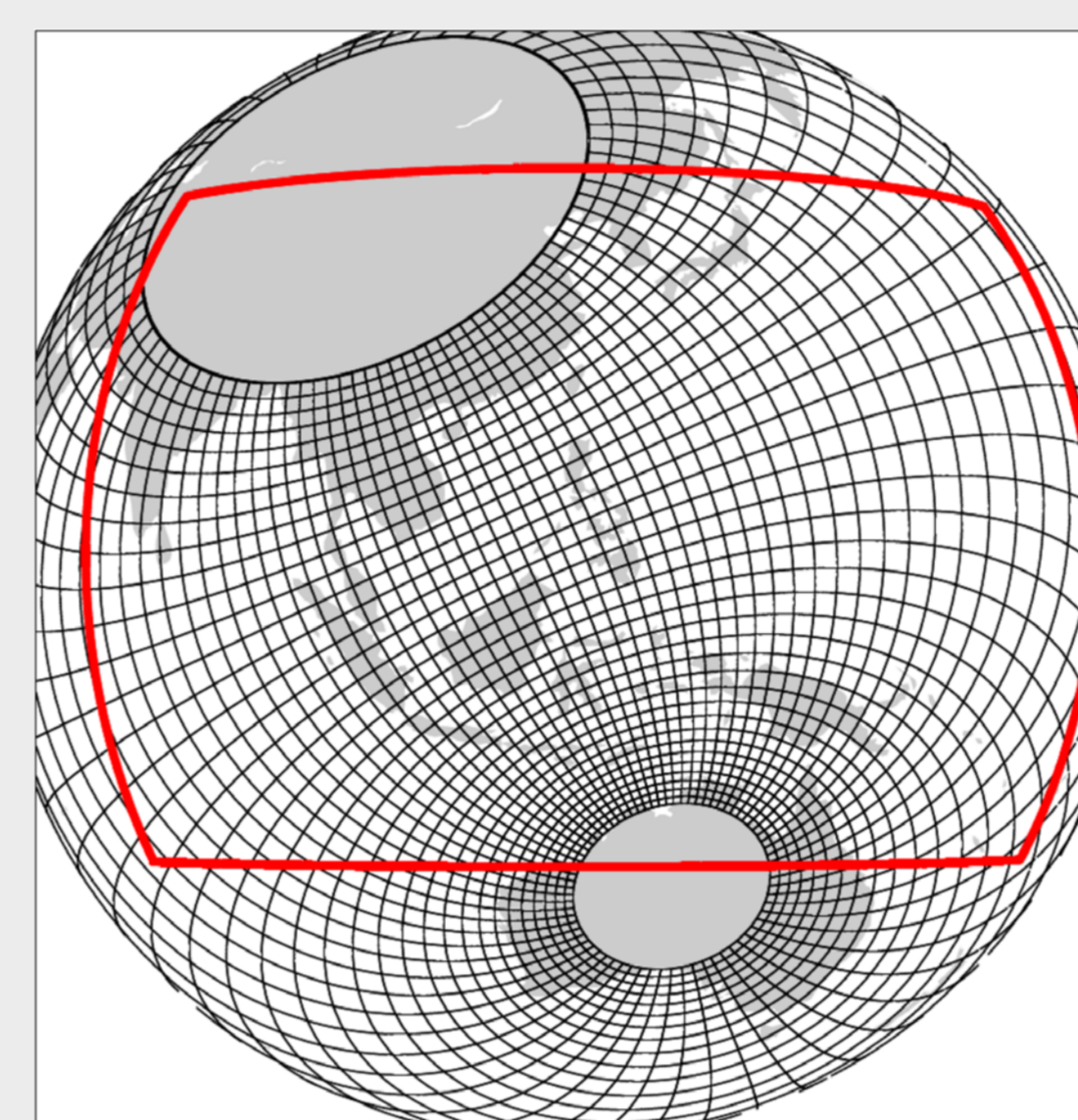


Fig. 1. Extended CORDEX-SEA domain to include the cyclogenesis region. Red box, REMO coupled or uncoupled with ocean model region. Black lines, MPIOM grid lines (every 12th grid is shown).

The model domain (Fig. 1) spans 80 E to 180 E and -15 S to 40 N

- Horizontal resolution of about 50 km and 27 hybrid vertical levels.
- Models were driven by the ERA-Interim reanalysis for the period of 1980 to 2012

Tropical cyclones (TCs) are detected using TRACK (Hodges, 1994), which is an objective feature tracking system

Observational datasets used to compare the simulations are obtained from:

- CRU (<http://www.cru.uea.ac.uk/>)
- HOAPS (<http://www.hoaps.zmaw.de/>), and
- HURDAT(<http://www.aoml.noaa.gov/>)

Table 1. List of experiments.

| Experiment | Description | References |
|------------|--|----------------------|
| REMO | Uncoupled simulation, prescribed sea surface temperature | Jacob, et. al., 2012 |
| ROM | Coupled global ocean and regional atmosphere simulation | Sein, et. al., 2015 |

- The frequency of tropical cyclone occurrences in ROM is lower compared to REMO and the mean number of TCs during a 23-year period is comparable to the observed mean (Fig. 3).

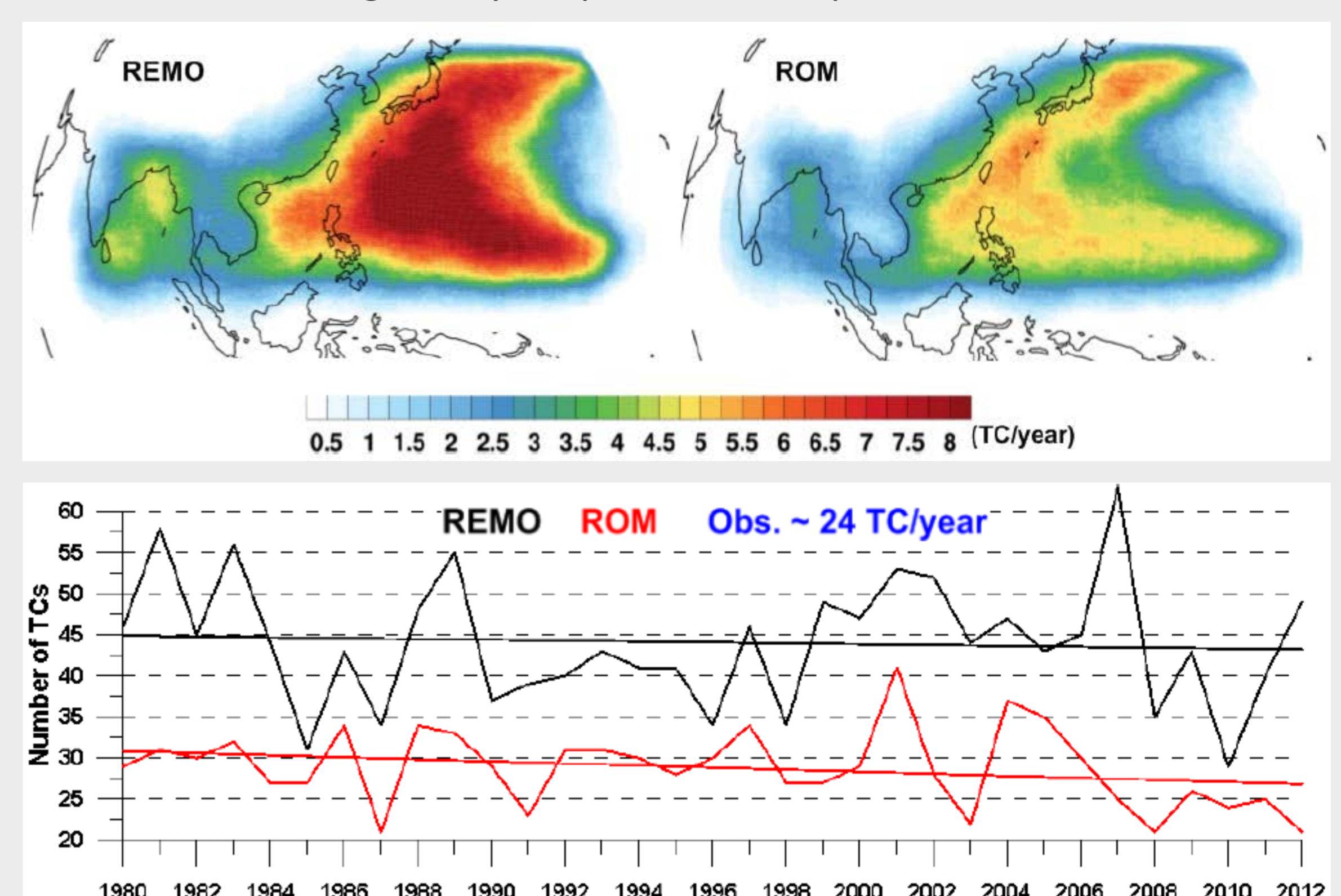


Fig. 3. Track density distribution and number of tropical cyclones detected using TRACK for the period of 1980-2012.

- Wet biases over the ocean are reduced in the coupled simulation compared to the uncoupled simulation
- Simulated frequency of tropical cyclones in the coupled model are closer to observed values than in the uncoupled model
- Outlook: Potential for ROM in investigating the changes in tropical cyclones in a global warming scenario

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