Model-data differences over the Indo-Asian monsoon region using high-resolution modeling

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Abstract: In order to simulate more precise downscaled boundary conditions for regional climate models, it is critical to resolve model-data mismatch between global models and observations. This study looks at how general circulation models (GCMs) over estimate precipitation rates over the Indo-Asian monsoon (IAM) region or more specifically how GCMs produces excessive orographic precipitation near the Himalayan Mountains. Here we used a range of high to low-resolution simulations (~0.25 to ~ 2.0) using Community Climate System Model (CCSM4) with Atmospheric GCM, Community Atmospheric Model version 4 (CAM4) and compared our results to observational data set GPCP. We show that precipitation distribution are better resolved as we increase model resolution. However, despite model improvements, some of these biases continually persist. Comparisons between reanalysis products (MERRA and JRA55) suggest that strong orographic precipitation over this region suffers from excessive total diabatic heating (Q) forming near topography. We find that enhancing model grid-resolution has the potential to mitigate the Q bias.

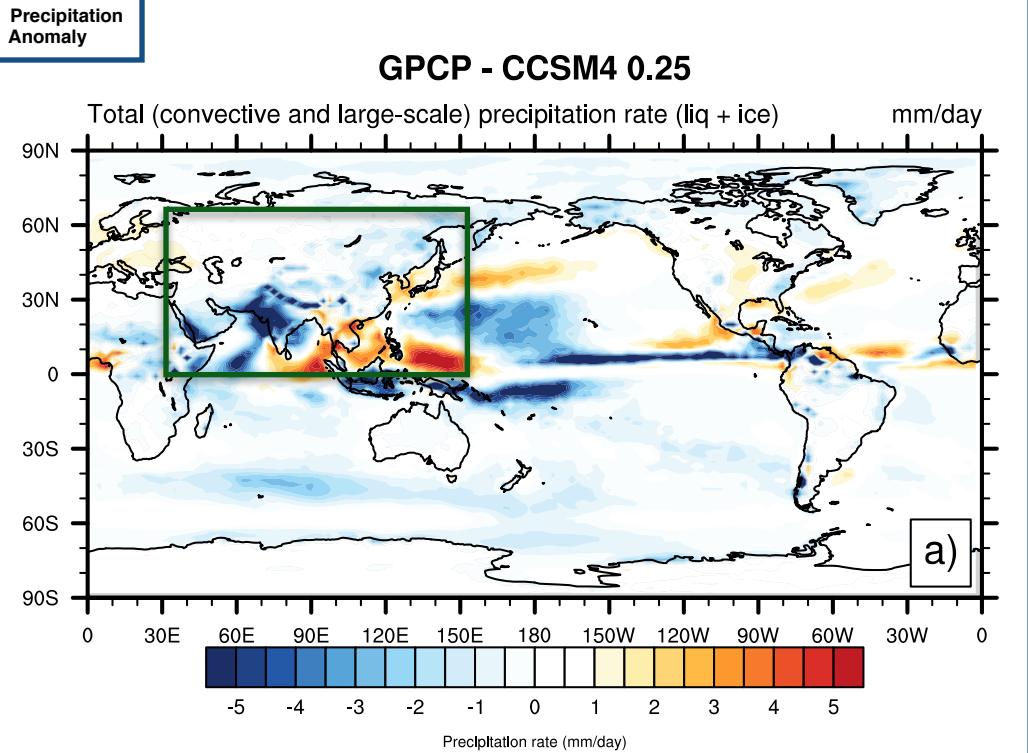**Precipitation Anomaly**

GPCP - CCSM4 0.25

Figure 1: Modern climate simulations, illustrating anomaly of summer (June, July and August) global precipitation between Global Precipitation Climatology Project (GPCP) and Community Climate System version 4 (CCSM4) with black outlines representing continents. The green box represent the Asian Monsoon region which we focus on the green panel above.
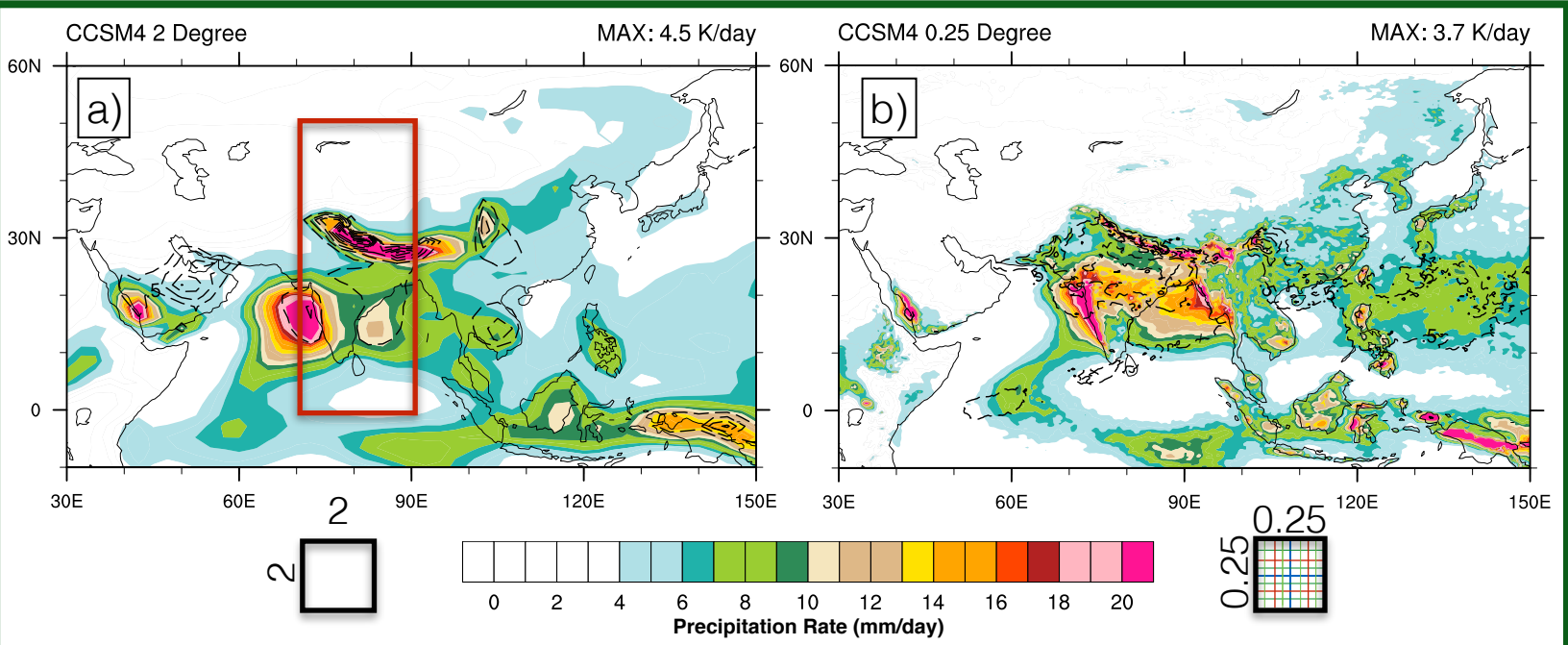
Precipitation Diabatic Heating

Figure 2: Color contour map of JJA precipitation rate distribution over Asia, overlain with dashed contour lines of vertically integrated (1000-100 mb) diabatic heating. Dashed contour is from 0.5-5.0 in increments of 0.5. **a** represents our 2 degree simulation and **b** is our 0.25 degree simulation. The red box on plot **a** represents the area we focus on below.
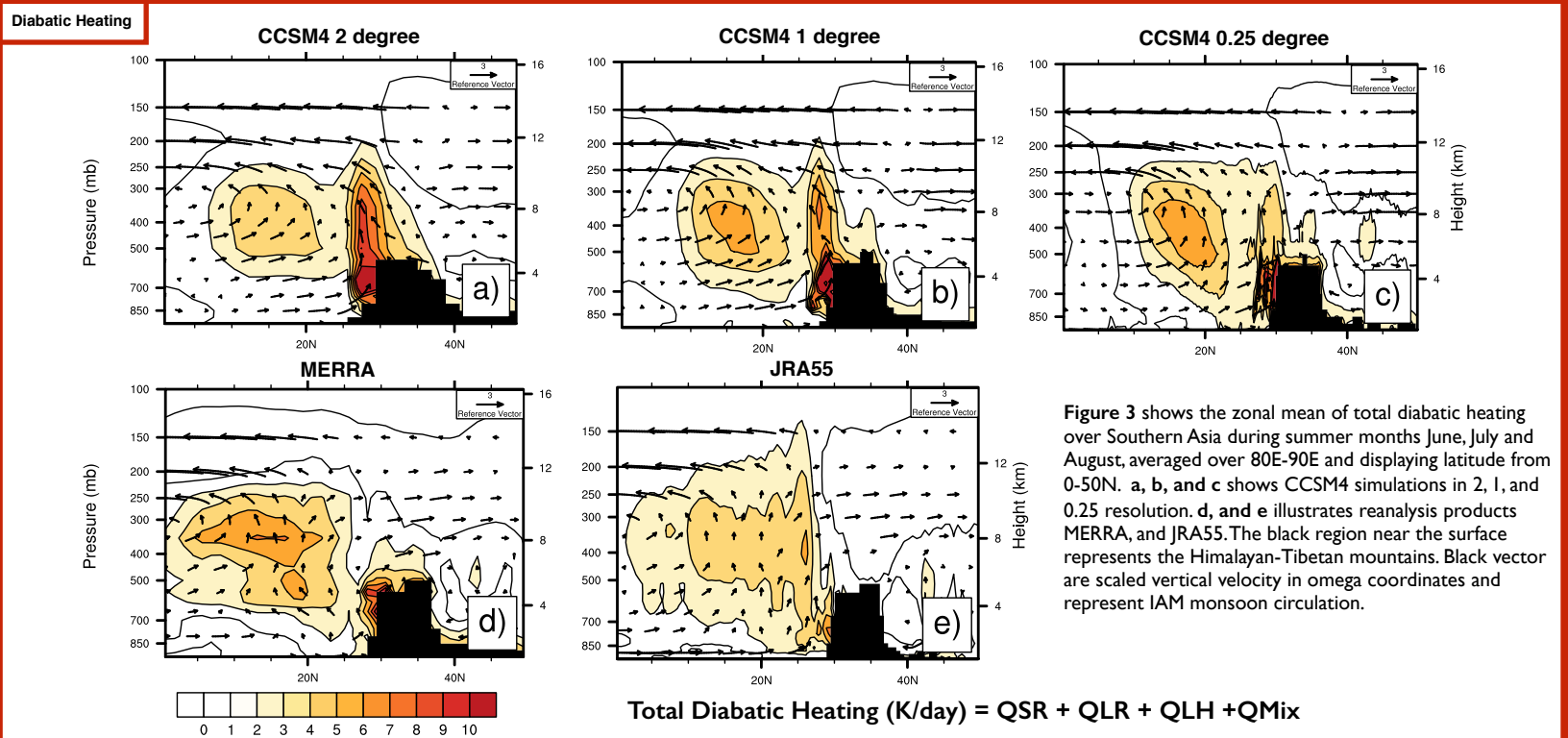
Diabatic Heating

Figure 3 shows the zonal mean of total diabatic heating over Southern Asia during summer months June, July and August, averaged over 80E-90E and displaying latitude from 0-50N. **a, b, and c** shows CCSM4 simulations in 2, 1, and 0.25 resolution. **d, and e** illustrates reanalysis products MERRA, and JRA55. The black region near the surface represents the Himalayan-Tibetan mountains. Black vector are scaled vertical velocity in omega coordinates and represent IAM monsoon circulation.

Total Diabatic Heating (K/day) = QSR + QLR + QLH + QMix