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Plain Language Summary: Detailed comparisons with rainfall products by Global Satellite Mapping of Precipitation (GSMaP) were conducted using summer precipitation over Mongolia and a heavy rainfall event near Ulaanbaatar. The measurement by the core-satellite of the Global Precipitation Measurement mission (GPM) and the regional atmospheric modeling also cooperated the comparison for the rainfall event. As a result, the gauge-calibrated GSMaP effectively moderates the enormous error of the ungauged ones. However, the gauge-calibrated GSMaP over mountainous areas may be affected by a potential underestimation of gauge analysis due to the missing localized precipitation occurring in the significant gaps of the routine observation network.

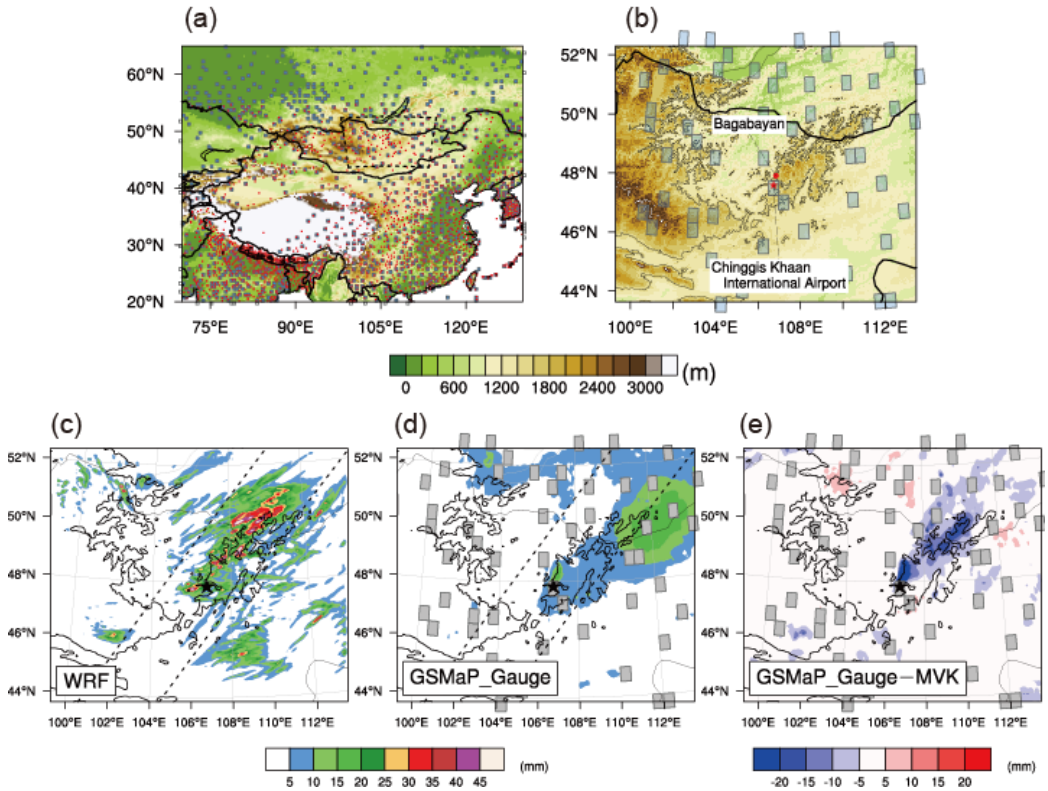

Figure 1. Geographical maps of the study area for (a) Mongolian Territory and (b) Ulaanbaar with grid cells of rain gauge networks. (c), (d) and (e) represent 24-hour accumulated precipitation (mm) of the heavy rainfall event in July 2016 estimated by WRF, GSMaP_Gauge, and the anomaly of GSMaP_Gauge vs. GSMaP_MVK, respectively.

- For national scale precipitation, the use of rain gauge calibration can effectively correct the tendency of satellite-only GSMaP products to overestimate precipitation.
- As for the case study, the GSMaP_Gauge may overcorrect rainfall over a mountain region with a far less surface observation station.
- As Mongolia has a complex terrain with a sparse observation network, the uncertainty of rain-gauge-based analysis resulting from the sparse network is likely to limit the accuracy of satellite-based precipitation estimates.