

Assimilation of clear-sky radiances from GOES-16 and 18 in the KIM data assimilation System

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Introduction

The Advanced Baseline Imager (ABI) sensor onboard the Geostationary Operational Environmental Satellite (GOES)-16, launched in 2016 at 136.9°W longitude, and GOES-18, launched in 2022 at 75.2°W longitude, provides radiance observations of the Western Hemisphere from 16 different (visible and infrared) channels. This study aims to incorporate clear-sky radiances (CSR) observed by this sensor into the Korean Integrated Model (KIM) data assimilation system, alongside CSR from other geostationary satellites (e.g., GK2A and Himawari)

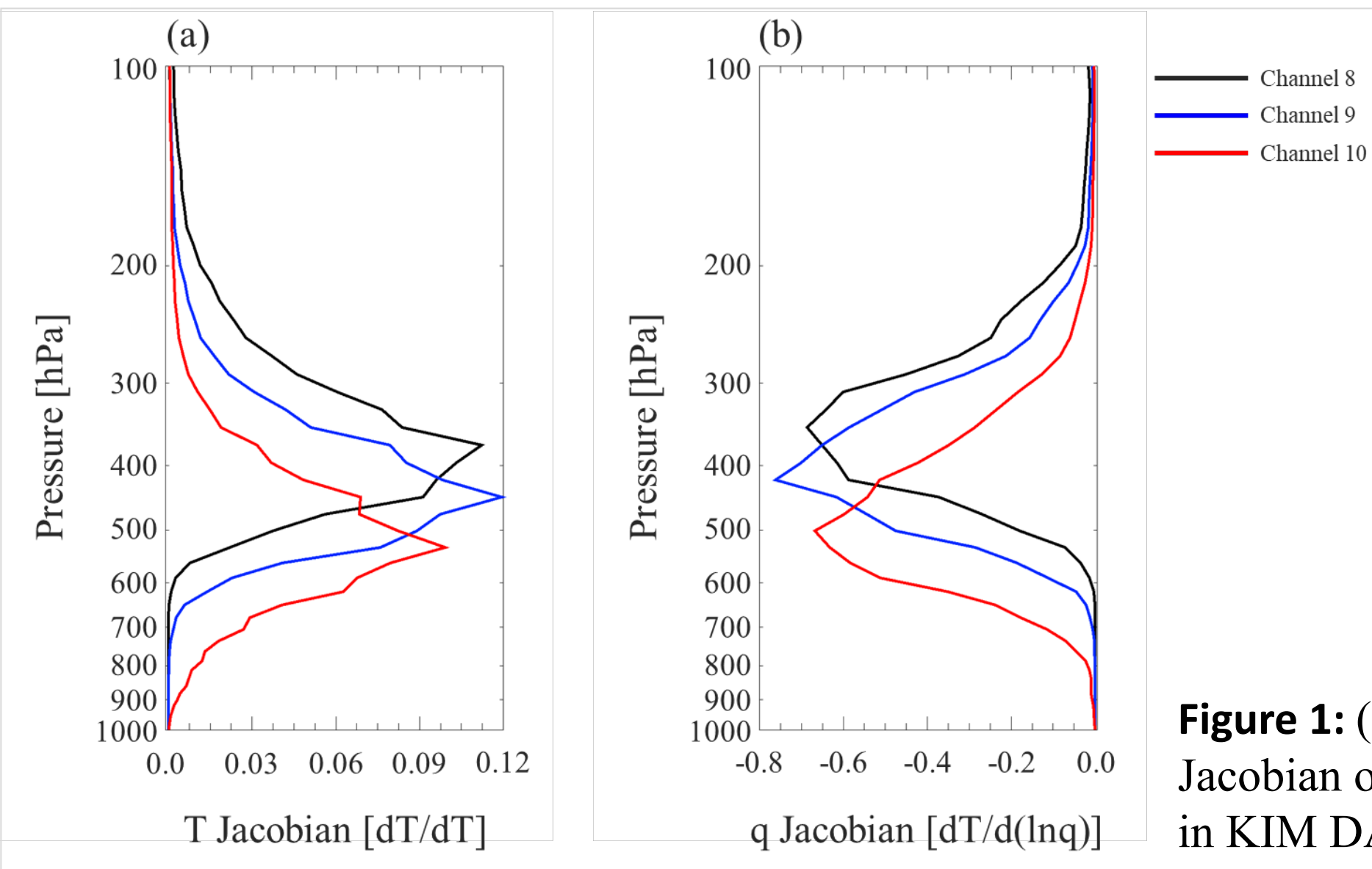


Figure 1: (a) Temperature and (b) humidity Jacobian of GOES-16/18 ABI channels used in KIM DA system.

Methodology

- Channels 8, 9, and 10 (sensitive to mid-tropospheric water vapor)
- Sensitivity experiments for quality control (QC) and bias correction (BC) processes within the KIM Package for Observation Processing (KPOP) framework
- Optimization experiments for observation error within the KIM Variational data assimilation system (KVAR) framework

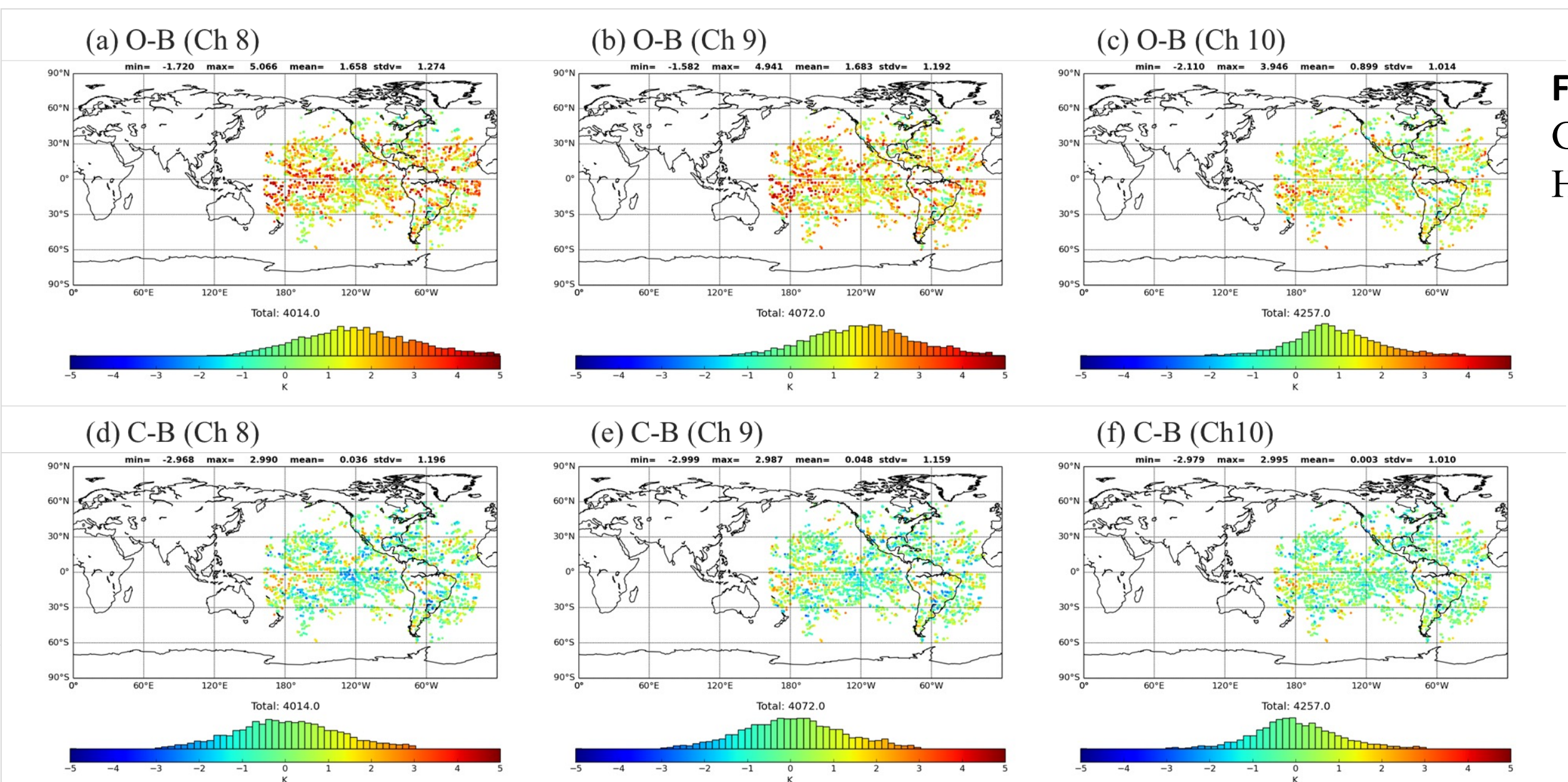


Figure 3: (Upper) O-B and (lower) C-B of (a),(d) GOES channel 8, (b),(e) GOES channel 9, and (c),(f) GOES channel 10 used in the KIM DA system. Histograms of each distribution are also shown at the bottom of the figures.

Table 1: Information of the used 3 ABI channels for GOES-16/18

Channel number	Wavelength(μm)	Observation Error(K)
8 (IR-WV)	6.15	4
9 (IR-WV)	7.00	4
10 (IR-WV)	7.40	4

Results

- (Analysis) Positive impact on mid-level water vapor near 30°S-30°N region, but some side-effect the other latitudinal region
- (Analysis) Overall positive impact on temperature and geopotential height
- (Forecast) Positive impact on mid-level water vapor, and neutral impact on temperature
- (Forecast) Significant positive impact on geopotential height near the tropopause

Impact on analysis fields

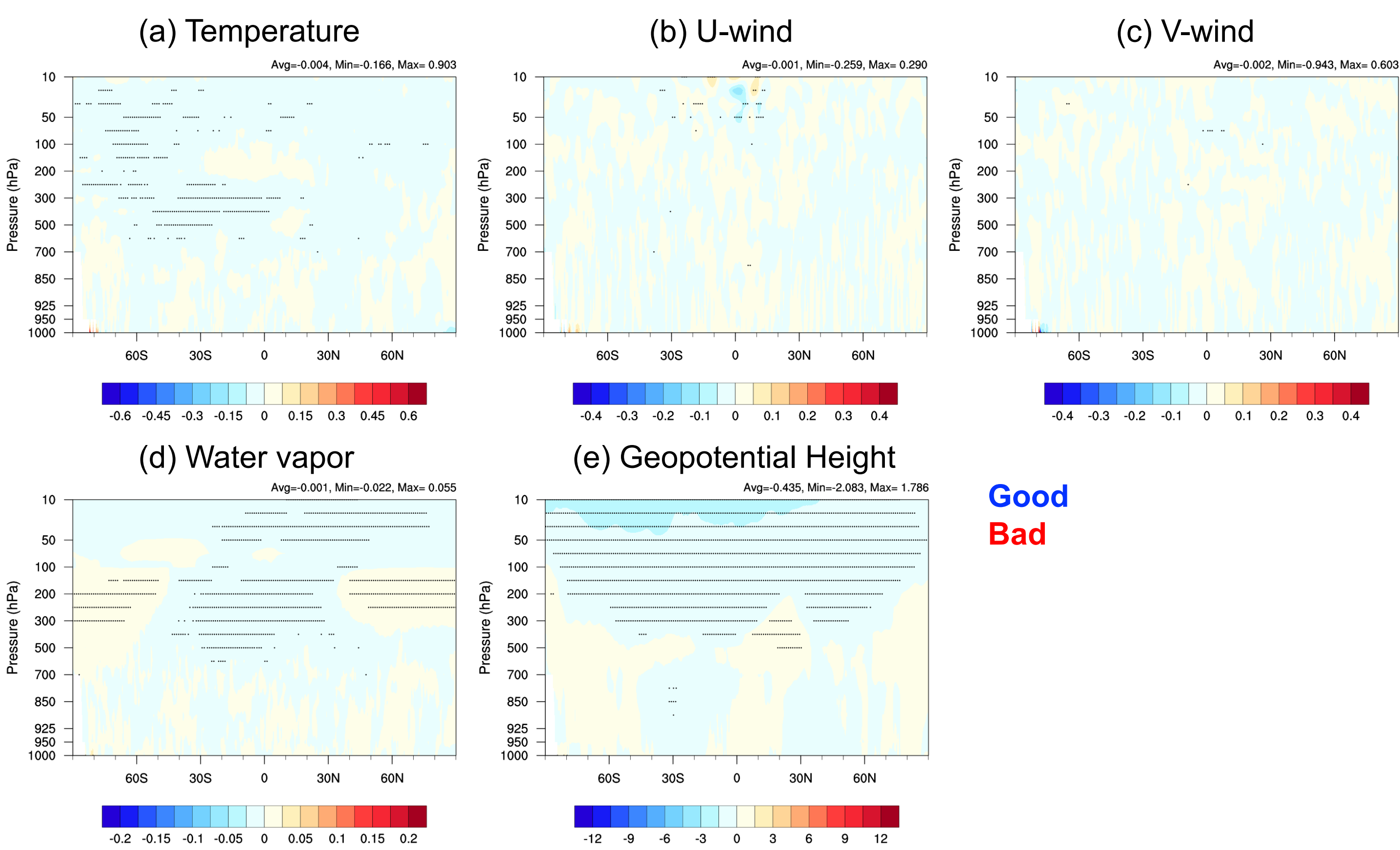


Figure 4: Zonal mean of (a) temperature, eastward wind, northward wind, specific humidity, and geopotential height RMSD between CTL and EXP experiments (CTL minus EXP). Black dots represent the 95% significant difference, verified by a *t*-test.

Future Work

- QC using CSR TB standard deviation and cloud amount
- BC using different *nrepeats*
- Sensitivity test for the OBS error and thresholds
- Impact of temporal and spatial thinning of the geostationary satellite in the KIM Hybrid 4DVar

Impact on forecast

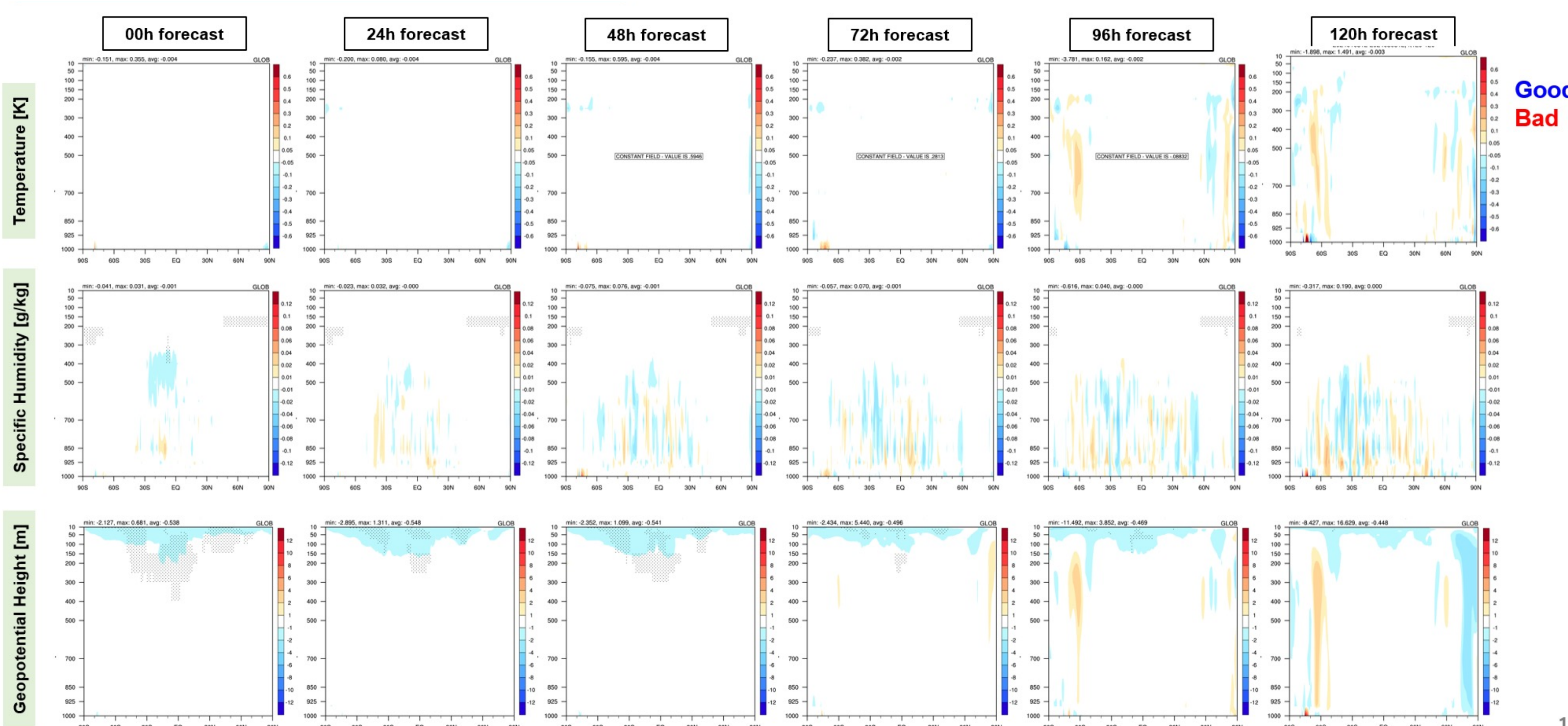


Figure 5: Zonal mean of (upper) temperature, (middle) specific humidity, and (lower) geopotential height RMSD between CTL and EXP experiments (EXP minus CTL). Shown are the 00h, 24h, 48h, 72h, 96h, 120h forecast times.

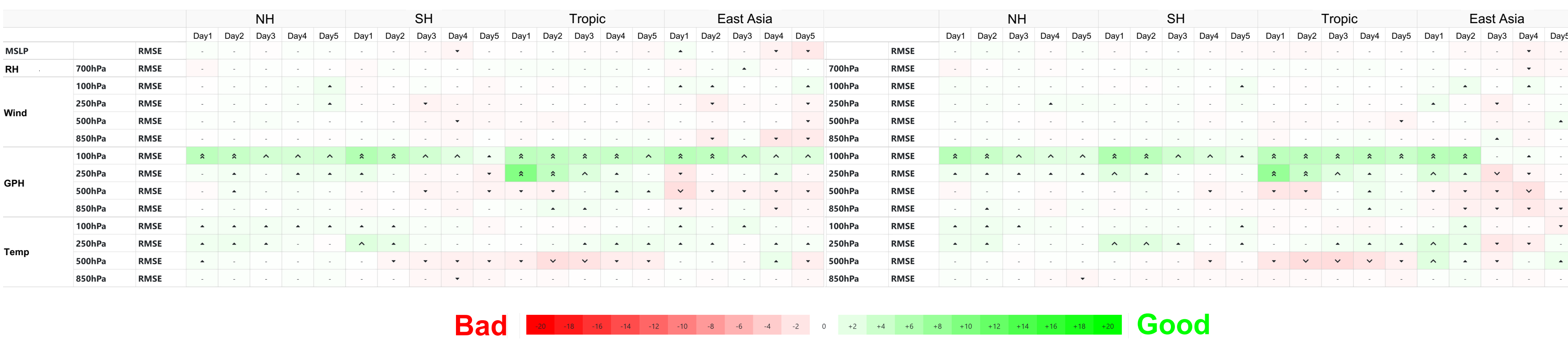


Figure 6: Scorecards RMSE improvement rate between the CTL and experiments ($RMSE_{CTL} - RMSE_{EXP} / RMSE_{CTL}$) for key atmospheric variables in the global (GLOB; 60°S-60°N), Northern Hemisphere (NH; 20°N-60°N), tropical (TR; 20°S-20°N), Southern Hemisphere (SH; 60°S-20°S), and East Asia (ASIA; 10°N-65°N, 80°E-160°E) regions at lead time 24-, 48-, and 72-hr forecast. Green (red) color indicates positive (negative) impact of GOES-16/18 CSR assimilation on the KIM forecast fields.

