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Evaluation of inter-calibration approaches for the GEMS Level 1B product

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To meet the growing demand for diurnal information on trace gases and aerosols in the atmosphere, a series of satellite programs consisting of the GEO-ring (GEO-constellation) has been initiated. The series started off with the launch of the Geostationary Korean Multi-Purpose Satellite-2B (GK-2B) in 2020, followed by the Tropospheric Emissions: Monitoring of Pollution (TEMPO) in 2023 and the expected launch of Sentinel-4 in 2024. Onboard GK-2B, the Geostationary Environment Monitoring Spectrometer (GEMS) is dedicated to observing the Asia-Pacific region, providing spectral radiance in the 300-500 nm range to obtain specific spectral information on absorption and scattering lines. To evaluate the post-launch data quality of GEMS, especially for Level 1B products, this study utilizes inter-calibration approaches with the measurements from geostationary as well as polar orbit satellite sensors. The evaluation comprises two parts to address current and potential calibration issues of GEMS: 1) applying the ray-matching approach with the Advanced Meteorological Imager (AMI) onboard the twin satellite, GK-2A; and 2) employing vicarious calibration with polar orbit satellite sensors, Tropospheric Monitoring Instrument (TROPOMI) and Ozone Mapping and Profiler Suite (OMPS), targeting stable scenes on Earth. In the first approach, AMI and GEMS demonstrate a strong agreement, showing a high correlation coefficient exceeding 0.9 regardless of measurement time and season. However, the GEMS Level 1B product reveals a positive bias when compared to AMI, 10% and 5% for radiance and reflectance, respectively. The GEMS measurements also display distinct seasonal and diurnal variations compared to AMI, which needs further investigation considering that the variations could influence the Level 2 retrieval products of GEMS. In the second approach, GEMS shows residual stray light effect especially at the shorter wavelengths (below 320 nm) and quantitatively, GEMS shows a consistent bias with the first approach, when compared to TROPOMI and OMPS. The paper aims to provide valuable insights for the efficient monitoring of sensors under comparable conditions with GEMS, along with remaining challenges emphasizing the need for refined approaches to address the radiometric calibration accuracy of the GEMS Level 1B product.