Validation of SGLI/GCOM-C cloud and radiation budget products using various data from satellite and ground measurements

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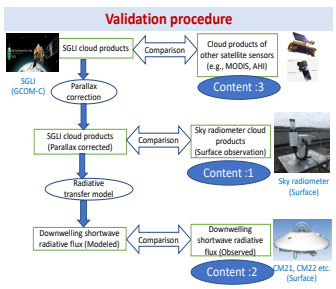
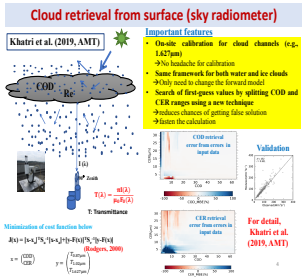
1. Background/Motivation

The Global Change Observation Mission – Climate (GCOM-C) satellite (or "Shikisai" in Japanese) is a polar-orbiting satellite that was launched on December 23, 2017. Onboard is the Second-generation Global Imager (SGLI), which has 16 channels covering the spectrum from ultraviolet to thermal infrared. Of these 16 channels, the 1.05-, 1.63-, and 2.21-μm channels in the shortwave infrared region and the 10.8-μm channel in the thermal region are used to infer the properties of both water and ice clouds (Nakajima et al., 2019). Having entered operation relatively recently, very little is known about the quality of the cloud products generated from the SGLI satellite sensor as well as their capabilities to generate surface radiation, thereby emphasizing the need and urgency for assessing the quality of SGLI cloud products. In addition, SGLI is a powerful sensor for observing aerosols because of the inclusion of polarization and bidirectional channels, thereby making it very useful for studying aerosol–cloud interaction with qualitative aerosol data. Therefore, studies related to assessing the quality of SGLI cloud products can also contribute to aerosol–cloud interaction studies performed using SGLI data.

2. Study method





- **Sites for validation using surface observations**

Location	Longitude (°E)	Latitude (°N)
Chiba	140.104	35.625
Hedo-misaki	128.248	26.867
Fukue-jima	128.682	32.752
Miyako-jima*	125.327	24.737
Sendai	140.839	38.259

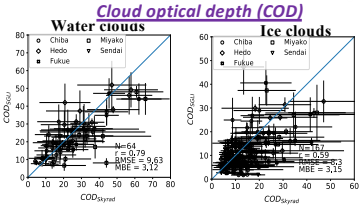
*Missing of surface radiative flux data

- **Period for validation using surface observation**
  2018-2020
- **Region for validation using space observations**
  20ºN-40ºN; 96ºE-156ºE
  (Tiles: T0527,T0528, T0529, T0627,T0628, T0629)
- **Period for validation using surface observation**
  May 2020 – July 2020

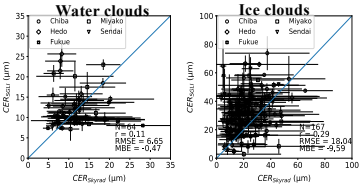
3. Validation using surface-observation data

(a) Comparison between sky radiometer and SGLI cloud properties (Overall)

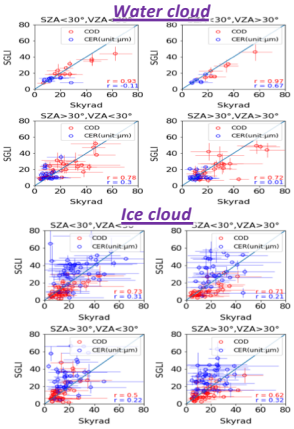
Cloud optical depth (COD)



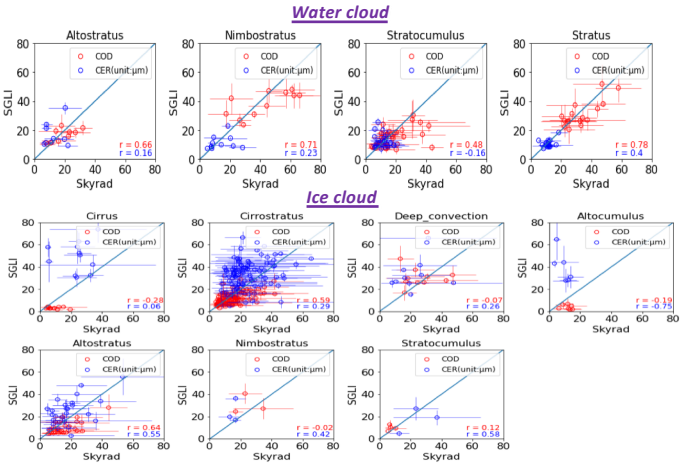
Cloud-particle effective radius(CER)



(b) Comparison based on solar and satellite viewing zenith angles



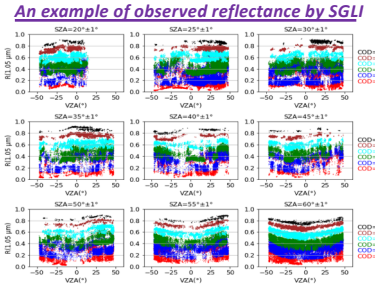
(c) Comparison based on cloud type



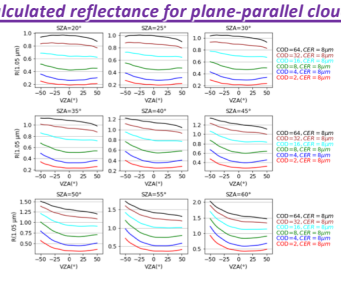
Note: Average values of +/- 30 minutes from sky radiometer are compared with average values for 5x5 pixels from SGLI in above figures

(d) Dependencies of observed reflectance on solar and satellite viewing geometries

An example of observed reflectance by SGLI

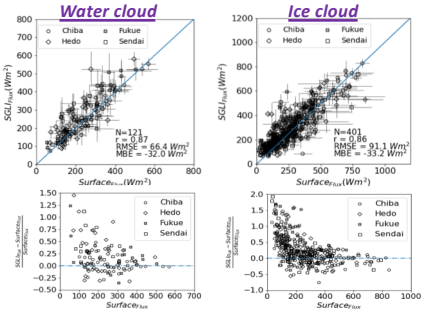


Calculated reflectance for plane-parallel clouds



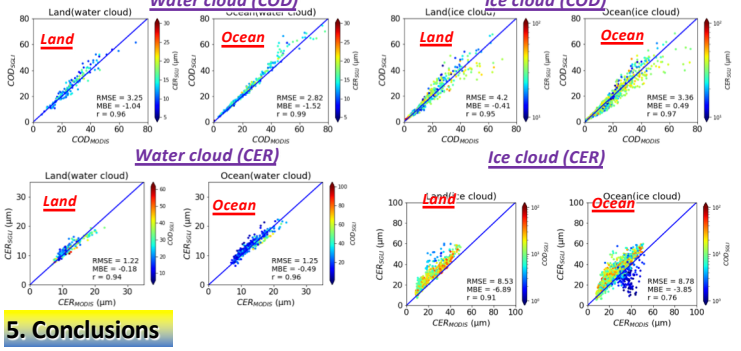
Note: SZA: Solar zenith angle; VZA: Viewing zenith angle;
Observation data shown in the left hand figure are for 500 pixels centered on the Chiba observation site in 2020

(e) Comparison between observed and modeled global irradiances

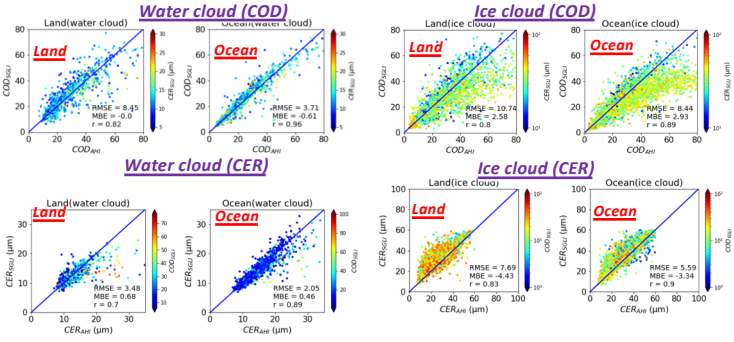


4. Validation using space-observation data

(a) Comparison between SGLI and MODIS cloud properties



(b) Comparison between SGLI and AHI cloud properties



5. Conclusions

- The SGLI-observed COD agrees well with values observed from the surface, although it agrees better for water clouds than for ice clouds, while the SGLI-observed CER exhibits poorer agreement than does the COD, with the SGLI values being generally higher than the sky radiometer values.
- These comparisons between the SGLI and sky radiometer cloud properties are found to differ for different cloud types of both the water and ice cloud phases and different solar and satellite viewing angles by agreeing better for relatively uniform and flat cloud type and for relatively low solar zenith angle.
- SGLI-observed cloud properties reproduce global irradiances quite satisfactorily for both water and ice clouds by resembling several important features of the COD comparison.
- SGLI-observed cloud properties show very good agreement with MODIS-observed values, and fairly good agreement with AHI-observed cloud properties.
- SGLI showed better agreement over ocean than over land and for water cloud than for ice cloud when compared with results of MODIS and AHI observations.

6. References

1. Khatri, P., Hayasaka, T., Irie, H., Letu, H., Nakajima, T. Y., Ishimoto, H., and Takamura, T.: Quality assessment of Second-generation Global Imager (SGLI)-observed cloud properties using SKYNET surface observation data, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2021-418, in review, 2021.

2. Khatri, P., Iwabuchi, H., Hayasaka, T., Irie, H., Takamura, T., Yamazaki, A., Damiani, A., Letu, H., and Kai, Q.: Retrieval of cloud properties from spectral zenith radiances observed by sky radiometers, Atmos. Meas. Tech., 12, 6037–6047, https://doi.org/10.5194/amt-12-6037-2019, 2019.