EGU2020-18454
https://doi.org/10.5194/egusphere-egu2020-18454
EGU General Assembly 2020

A simulator for the CLARA-A2 cloud climate data record and its application to assess EC-Earth polar cloudiness

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One of the primary purposes of satellite simulators is to emulate the inability of retrievals, based on visible and infrared sensors, to detect subvisible clouds from space by removing them from the model. The current simulators in the COSP rely on a single visible cloud optical depth (τ)-threshold (τ=0.3) applied globally to delineate cloudy and cloud-free conditions. However, in reality, the cloud sensitivity of a retrieval varies regionally.

This presentation describes the satellite simulator for the CLARA-A2 climate data record (CDR). The CLARA simulator takes into account the variable
skill in cloud detection of the CLARA-A2 CDR using long/lat-gridded values separated by daytime and nighttime, which enable it to filter out clouds from
climate models that would be undetectable by observations. We introduce two methods of cloud mask simulation, one that depends on a spatially variable
τ-threshold and one that uses the cloud probability of detection (POD) as a function of the model τ and long/lat. The gridded POD values are from the
CLARA-A2 validation study by Karlsson and Hakansson (2018).

Both methods replicate the relative ease or difficulty for cloud retrievals, depending on the region and illumination. They increase the cloud sensitivity where the cloud retrievals are relatively straightforward, such as over mid-latitude oceans, and they decrease the sensitivity where cloud retrievals are
notoriously tricky, such as where thick clouds may be inseparable from cold, snow-covered surfaces, as well as in areas with an abundance of broken and
small-scale cumulus clouds such as the atmospheric subsidence regions over the ocean.

The CLARA simulator, together with the International Satellite Cloud Climatology Project (ISCCP) simulator of the COSP, is used to assess Arctic clouds in the EC-Earth climate model compared to the CLARA-A2 and ISCCP H-Series CDRs. Compared to CLARA-A2, EC-Earth generally underestimates cloudiness in the Arctic. However, compared to ISCCP and its simulator, the opposite conclusion is reached. Based on EC-Earth, this paper shows that the simulated cloud mask of CLARA-A2 is more representative of the CDR than using a global optical depth threshold, such as used by the ISCCP simulator.
The simulator substantially improves the simulation of the CLARA-A2-detected clouds compared to

a global optical depth threshold, especially in the polar regions, by accounting for the variable cloud detection skill over the year.