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Supporting Information for

Top-of-atmosphere, surface and atmospheric cloud radiative kernels based on ISCCP-H datasets: Method and Evaluation

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Introduction

Text S1 is the list of non-cloud, input parameters for the ISCCP-FH CRK calculation for each grid box.

In the ISCCP-FH flux calculation, the cloud thickness (therefore cloud base) is a cubic polynomial function of CTP with its coefficients as a function of cloud optical thickness, longitude, latitude, ocean/land, and month, based on linear least square fitting for a combination of the 20-year rawinsonde climatology and 5-year climatology from the CloudSat and CALIPSO data products (see the main text). As examples, Figures S1 and S2 show the cloud base (in hPa) for the seven CTPs for thin, medium and thick τ on global map, used in ISCCP-FH cloud radiative kernel calculation, for January and July, respectively. This climatology is relatively simpler than that used in the ISCCP-FH flux calculation because all the 49 bins have invariant CTP while the ISCCP-FH calculation deals with numerous CTPs.

Table 2 in the main text is based on the statistical comparison for six pairs of all possible combinations of the four cloud radiative kernel (CRK) datasets, FH, CS, MZ and OZ. However, the MZ and OZ are calculated using the same Fu-Liou radiation code (but with different input of mean climate states) so that the four CRK datasets may not be completely independent. To address this issue, we remove OZ CRK datasets and then make the same comparison but for three pairs of all possible combinations of the three CRK datasets (FH, CS and MZ). Table S1 shows that RMS values are increased by ~20% based on the new comparison, which should be more objective than those from Table 2 in the main text since the three CRK datasets are now completely independent of each other.

Using the same statistical comparison as Table S1 (or Table 2 in the main text), we have also made a comparison for (normalized) cloud fraction changes (CFC) for 45 pairs of all possible combinations of the 10 CFMP1 models for 1 x CO_2 to 2 x CO_2 experiments. The results are shown in Table S2, which is too large to be presented in the main text. For convenience, we have copied Table 3 in the main text as Table S3 here for a list of all the 10 models.

Text S1.

All the input parameters are physical quantities of atmospheric and surface properties. The main variables (besides CTP and τ) are as follows:

(1) Atmospheric Gases: Climatology from NASA GISS radiation code of ModelE;
(2) Atmospheric temperature/humidity Profile from nnHIRS (in ISCCP HGG);
(3) Atmospheric aerosol climatology: MACv2 (Kinne, et al. 2019);
(5) Particle size of liquid/ice clouds based on Han et al. (1994; 1999)) climatology
(6) Surface air temperature (from ISCCP-HGG based on nnHIRS) with cloud-caused, diurnal adjustment on it for land areas (> 1/3 fraction) using climatology from NCEP & NMC Surface Weather station reports;
(7) Surface skin temperature (from ISCCP-HGG) also with cloud-caused, diurnal-adjustment (for land);
(8) Surface albedo: MACv2-aerosol-corrected reflectance for 0.55 μm from non-aerosol-corrected reflectance (based on ISCCP-HXG), modulated using VIS/NIR ratio of ModelE to have broadband albedo (for six wavebands)
(9) O_3, Snow/Ice, vegetation and other surface characteristic (type, topography, land ice, etc.) data (from ISCCP-H Ancillary data);
(11) TSI (total solar irradiance): self-consistent daily time series based on SORCE V-15, Davos WRC composite and RMIB (from Dr. Shashi Gupta).