Sensitivity of Longwave Fluxes to Clouds and Meteorology: Establishing Uncertainties for GEWEX SRB Longwave

1. Introduction

The necessity of improved energy and water budget models is crucial for preventing global climate change. The aerospace community has made significant efforts to improve the accuracy of these models. The GEWEX Surface Radiation Budget (SRB) project produces the Global Aerosol and Clouds (GAC) Data and Information System (GDIS) cloud and climate products. These products provide critical information for understanding the Earth's energy balance and climate change. The SRB project has developed a comprehensive set of climate and atmospheric science products, including cloud and aerosol retrievals, to support climate modeling and prediction.

2. Data Sources

The cloud data are the MODIS temperature and water vapor retrievals (Shi et al., 2021) that are further processed by the NASA CSSS to produce global MODIS-derived cloud products. The cloud products are beta products from the next version of ISCCP data (beta version) that provide retrievals of cloud and aerosol properties for all visible and infrared (IR) channels. The cloud and aerosol products are collected and updated and an additional cloud-type of high water clouds has been added to the properties. The products are calibrated using satellite and ground-based observations.

3. Flux Comparisons as a Result of Altering Cloud Inputs

Here we consider the flux differences that result from changing the cloud properties that are input into the ISCCP flux algorithm. First, we present maps of differences of ISCCP-O and ISCCP-H cloud properties, and then flux differences. The same profile and surface meteorology are used in each case for the flux differences shown in the bottom. The longwave algorithm uses only cloud properties, so we plot only cloud and surface properties. The differences shown are for all 8-10 km pixels included in ISCCP-B1 products. The longwave algorithm uses IR-only cloud properties. In addition to comparing different meteorological data sets, we also compare different cloud types of high water clouds to the proper es.

4. Flux Comparisons as a Result of Differing Meteorological Inputs

In this section we evaluate the flux differences that result from changing meteorological profiles. The flux differences show the largest sensitivity for downward flux at the surface for near surface atmospheric water vapor. The patterns of flux differences show that the differences are driven by changes in the water vapor flux. The modeled longwave algorithm uses IR-only cloud properties. In addition to comparing different meteorological data sets, we also compare different cloud types.

5. Summary and Validation of Fluxes from Various Inputs

Table 1: Global and ISCCP-O fluxes for annual averages of 2007-2009. The ISCCP-O fluxes are calculated using a 10 km spatial resolution. The ISCCP-O fluxes are compared to the ISCCP-H fluxes for the annual average of 2007. For both datasets, the differences between the ISCCP-O and ISCCP-H fluxes are also presented.

6. Flux Comparisons as a Result of Differing Both Clouds and Meteorological Conditions

Table 2: Global and ISCCP-O fluxes for annual averages of 2007-2009. The ISCCP-O fluxes are calculated using a 10 km spatial resolution. The ISCCP-O fluxes are compared to the ISCCP-H fluxes for the annual average of 2007. For both datasets, the differences between the ISCCP-O and ISCCP-H fluxes are also presented.

7. Conclusions

This paper highlights the ongoing assessments made in the development of ISCCP/OBS03-constrained radiation transfer algorithms to changes in top inputs including updated ISCCP clouds and MODIS HIRS analyses. In looking at how meteorological changes affect fluxes, the largest sensitivity is for downward flux at the surface for near surface atmospheric water vapor. The patterns of flux differences show that the differences are driven by changes in the water vapor flux. The modeled longwave algorithm uses IR-only cloud properties. In addition to comparing different meteorological data sets, we also compare different cloud types.

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