Final Report
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Anthropogenically-Induced Climate Change
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Work performed under this grant is summarized in the following publications:

1. Sun MG, Cess RD, mprovements in cloud identification over snow/ice surfaces from ERBE to CERES, GEOPHYSICAL RESEARCH LETTERS, Volume: 32, Issue: 5, Article Number: L05801, 2005.

2. Cess RD, Water vapor feedback in climate models, SCIENCE, Volume: 310, Issue: 5749, Pages: 795-796, 2005.

3. Zhou YP, Kratz DP, Wilber AC, Gupta SK, Cess RD, An improved algorithm for retrieving surface downwelling longwave radiation from satellite measurements, JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES, Volume: 112, Issue: D15, Article Number: D15102, 2007.

Paper number 1 addresses the fact that the procedure used in the Earth Radiation Budget Experiment for identifying the presence of clouds over snow/ice surfaces is known to have shortcomings, and this is corroborated through use of surface insolation measurements at the South Pole as an independent means of identifying clouds. These surface insolation measurements are then used to validate the more detailed cloud identification scheme used in the follow-up Clouds and the Earth's Radiant Energy System (CERES), and this validation is extended to the polar night through use of CERES measurements of the outgoing longwave radiation.

General circulation models (GCMs) are highly sophisticated computer tools for modeling climate change, and they incorporate a large number of physical processes and variables. One of the most important challenges is to properly account for water vapor (clouds and humidity) in climate warming. In this Perspective, Cess discusses results reported in the same issue by Soden et al. in which water vapor feedback effects are tested by studying moistening trends in the upper troposphere. Satellite observations of atmospheric water vapor are found to agree well with moisture predictions generated by one of the key GCMs, showing that these feedback effects are being properly handled in the model, which eliminates a major potential source of uncertainty.

Zhou and Cess [2001] developed an algorithm for retrieving surface downwelling longwave radiation (SDLW) based upon detailed studies using radiative transfer model calculations and surface radiometric measurements. Their algorithm linked clear sky SDLW with surface upwelling longwave flux and column precipitable water vapor. For cloudy sky cases, they used cloud liquid water path as an additional parameter to account for the effects of clouds. Despite the simplicity of their algorithm, it performed very well for most geographical regions except for those regions where the atmospheric conditions near the surface tends to be extremely cold and dry. Systematic errors were also found for scenes that were covered with ice clouds. Paper Number 2 provides an improved version of the algorithm that prevents the large errors in the SDLW at low water vapor amounts by taking into account that under such conditions the SDLW and water vapor amount are nearly linear in their relationship. The new algorithm also utilizes cloud fraction and cloud liquid and ice water paths available from the Cloud and the Earth's Radiant Energy System (CERES) single scanner footprint (SSF) product to separately compute the clear and cloudy portions of the fluxes. The new algorithm has been validated against surface measurements at 29 stations around the globe for Terra and Aqua satellite. The results show significant improvement over the original version. The revised Zhou-Cess algorithm is also slightly better or comparable to more sophisticated algorithms currently implemented in the CERES processing and will be incorporated as one of the CERES empirical surface radiation algorithms.

Reference

Zhou, Y. P., and R. D. Cess, 2001:Algorithm development strategies for retrieving the downwelling longwave flux at the Earth's surface. J. Geophys. Res., 106, 12,477-12,488.