NEWS Annual Progress Report:
Studies on Integrated Satellite Global Energy Climatology

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We have made significant progress on several aspects of the climate energy cycle, including:

1) Global energy climatology and data set

The most significant accomplishment is the completion of our NEWS global energy balance data obtained from satellite observations covering 1988-2004. Both land and ocean components are considered. The technique used for the global energy cycle analysis is based on our previous official report on the assessment of global energy balance. We have posted results of annual mean TOA, surface and atmospheric heat balances and their variations to the NEWS Project-3 group and its Google web site. Good discussion has been generated. This is the effort connected with the whole NEWS Integrated Project-3 working group members and general NEWS program.

2) Dust aerosol effect on radiation and precipitation

Multi-platform and multi-sensor observations are employed to investigate the impact of mineral dust aerosols on cloud microphysical and precipitation processes in mesoscale convective systems. Normally, stratiform rain is largely determined by the updraft intensity of its related convective core. Relatively stronger stratiform rain should be associated with relatively stronger convective rain. However, for a given convective strength, stronger stratiform rain was found in dusty convection areas than that of dust-free convection areas. Also, small hydrometeors were more prevalent in the stratiform rain regions with dust than in those regions that were dust free. Evidence of abundant cloud ice particles in the dust areas, particularly at altitudes where heterogeneous nucleation of mineral dust prevails, further supports the observed changes of precipitation. The consequences of the microphysical effects of the dust aerosols were to shift the precipitation size spectrum from heavy precipitation to light precipitation and ultimately suppressing precipitation. This result is critical for the aerosols on global radiation and hydrological cycle. We have published these results on the journal of *Atmos. Chem. Phys*.

3) Remote sensing aerosol water uptake

Aerosol water content is an important component of aerosol radiative forcing, but the effect of water uptake on aerosols throughout the atmospheric column is not monitored at the present time. We present a technique for retrieving the volume fraction of water in atmospheric aerosols, and apply the technique to the AERONET database. We estimate that the volume fraction of water and the geometric hygroscopic growth factor (gHGF) can be retrieved to within 0.3 using this retrieval. The growth factors we obtain are consistent with published measurements, and

indicate that aerosol water uptake is high in humid continental regions (gHGF ~1.3 along the U.S. East Coast in August) and low in regions dominated by desert dust (gHGF ~1.04 in Saudi Arabia). The results are published in the *Geophysical Research Letters*.

4) Assessment of global annual atmospheric energy balance

Global atmospheric energy balance is one of the fundamental processes for the earth's climate system. As a part of our product development and evaluation of global atmospheric energy balance, we have been studying global energy data sets with their associated accuracies and uncertainties. This study uses currently available satellite data sets of radiative energy at the top of atmosphere (TOA) and surface as well as latent and sensible heat over the oceans for the year 2000 as an example to assess the global annual energy budget. Over land, surface radiation data are used to constrain assimilated results and to force the radiation, turbulent heat, and heat storage into balance due to a lack of observation-based turbulent heat flux estimates. Global annual means of the TOA net radiation obtained from both satellite direct measurements and calculations are close to zero. The net radiative energy fluxes into the surface and the surface latent heat transported into the atmosphere are about 113 and 86 W/m^2, respectively. The estimated atmospheric and surface heat imbalances are about -8 and 9 W/m^2, respectively, values that are within the uncertainties of surface radiation and sea surface turbulent flux estimates and the likely systematic biases in the analyzed observations. The potential significant additional absorption of solar radiation within the atmosphere suggested by previous studies does not appear to be required to balance the energy budget: the spurious heat imbalances in the current data are much smaller (about half) than those obtained previously and debated about a decade ago. Progress in surface radiation and oceanic turbulent heat flux estimations from satellite measurements has significantly reduced the bias errors in the observed global energy budgets of the climate system.
We have officially reported these results on *Journal of Geophysical Research*.

5) Collaboration with NEWS investigators

In order to properly address the global energy and water cycles, we have strong connections with major investigators of NEWS Integraged Projects 2 and 3 for energy cycle climatology and analysis.

References mentioned in this report:

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