

Progress Report for 2008-9 for
The NASA Energy and Water Cycle Study Science Integration Team (NSIT)
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Three specific projects are underway, in addition to participation in NSIT activities: (1) analysis of diurnally-resolved land surface skin and air temperatures, together with surface meteorology to determine surface fluxes (radiative fluxes already available), (2) analysis of multi-satellite data to estimate the extent and causes of variation of land surface inundation events, and (3) a first attempt at a multi-year, global energy and water cycle analysis focusing first on the atmospheric energy cycle. The additional NSIT tasks include participation in two of the three integration questions by providing data products that result from the above tasks. Progress in the past year on each of these tasks is described below.

Task 1

Since the available surface temperature datasets are incomplete in their space-time coverage or sampling (as compared with an objective of obtaining global, multi-decadal coverage with sampling intervals of 25 km and 3 hr), a complete global description of the variations of surface skin and air temperature must be constructed from the many available datasets. The first version of such a surface temperature and meteorology data was created for calculation of surface radiative fluxes. Further evaluations of this reconstruction of the diurnal cycle of surface skin and air temperatures have been completed by comparing the satellite-based results with surface measurements of longwave fluxes, showing that this first scheme represents these variations very well (amplitude within about 1K), even capturing most of the change in amplitude going from clear to cloudy conditions (Zhang *et al.* 2009). However, the agreement of mean values is still affected by poor quality atmospheric temperature-humidity data used in the surface temperature retrievals; a replacement dataset is being worked on. Another analysis combined IR and microwave satellite observations, together with several other datasets to retrieve land surface skin temperatures under cloudy conditions. Comparison of the first reconstruction with the microwave-based cloudy-sky retrievals are now underway. The changes in surface longwave fluxes produced by using the new diurnally resolved SST product, being produced for SeaFlux under NEWS funding, were evaluated.

Task 2

The 12-yr (1993-2004) global datasets of land surface emissivities and inundation (Prigent *et al.* 2007, Papa *et al.* 2007, Papa *et al.* 2008a,b) are now being extended into more recent years based on SSM/I as well as AMSR-E. Studies are also underway to prepare for re-processing the inundation dataset at finer time resolution. The most striking result from the current product is a strong decline in the inundated areas over numerous (but not all) portions of the globe, especially coastal regions where significant population growth has occurred over the past decade. This

result is still being investigated; however the annual variations of wetland extent have been used to refine the (land surface and biosphere) model-based determination of global methane emissions. Using the inundation dataset provided a better match with observed changes of atmospheric methane concentrations (Papa – methane). The inundation dataset was combined in two studies with altimetry (water level) and water mass data from GRACE to estimate water volume changes in part of the Amazon river system (Papa *et al.* 2008a, Frappart *et al.* 2008), showing encouraging results for being able to estimate river basin discharges from satellite measurements. More detailed hydrological studies of the Amazon and Congo river systems are now underway. Work is also underway to extend this result to all river basins by using topography datasets when altimeter data are not available; the results are also being compared with discharge models (Guntner *et al.* 2009). Studies of Arctic region rivers have shown close quantitative correspondence of the annual variations of basin-average snow amounts and flood extents (Papa *et al.* 2007, 2008b); a more general survey of changes of the flooding behavior in permafrost regions is now being prepared for publication (Papa *et al.* 2009a).

Task 3

Efforts are underway to get the completed Roads *et al.* (2009) study published; this study examined what information can be obtained about global (although focused on continental areas) estimates of energy and water exchanges to form a closed budget (similar to work now on-going under Integration Question 3 – because of different criteria and constraints, the resulting data collection is complementary to that by the NSIT). Another collection of global datasets has been assembled (with help from NEWS team members) to determine the day-to-day variations of the generation of zonal mean and eddy available potential energy in the atmosphere from the complete diabatic heating (Romanski and Rossow 2009a). The separate evaluations of the contributions by radiation, precipitation and surface sensible heat flux have revealed that the surface sensible heat flux is more important than might have been expected from the magnitude of the fluxes and that although radiation and precipitation act in concert to force the mean atmospheric circulation, they act in opposition in storms. These results are now being compared with those from a number of the IPCC models to see whether there is any relationship between the fidelity of their representation of these diabatic heating processes and their climate sensitivity (Romanski and Rossow 2009b)..

Team Activities

Ongoing collaborations with other NEWS team members are: (1) with J. Curry/C.A. Clayson to test new SeaFlux products, (2) with J. Famiglietti on estimation of river basin water volume changes, (3) supplying land surface emissivity data product to B. Lin and E. Wood, (4) supplying inundation data product to M. Rodell. F. Papa also participated in space mission planning workshops for Jason2, SMAP and SWOT.

Publications (Chronological)

- Zhang, Y-C., W.B. Rossow and P.W. Stackhouse, 2007a: Comparison of different global information sources used in surface radiative flux calculation: Radiative properties of the surface. *J. Geophys. Res.*, **112**, D01102, doi: 10.1029/2005JD007008, (1-20).
- Rossow, W.B., J.J. Bates, Y-C. Zhang, K. Knapp, E. Duenas, J. Romanski, 2007: Analyzing the variations of the global ocean energy cycle. *U.S. CLIVAR Variations*, **5**, 13-15.

- Prigent, C., F. Papa, F. Aires, W.B. Rossow and E. Matthews, 2007: Global inundation dynamics inferred from multiple satellite observations, 1993-2000. *J. Geophys. Res.*, **112**, D12107, doi: 10.1029/2006JD007847, (1-13).
- Romanou, A., B. Liepert, G. Schmidt, W. Rossow and Y-C. Zhang, 2007: 20th century reduction in surface solar irradiance in simulations and observations. *Geophys. Res. Lett.*, **34**, L05713, doi: 10.1029/2006GL028356, (1-5).
- Papa, F., C. Prigent and W.B. Rossow, 2007: Ob' river inundations from satellite observations: A relationship with winter snow parameters and river runoff. *J. Geophys. Res.*, **112**, D18103, doi 10.1029/2007JD008451, (1-11).
- Zhang, Y-C., W.B. Rossow, P. Stackhouse, A. Romanou and B.A. Wielicki, 2007b: Decadal variations of global energy and ocean heat budget and meridional energy transports inferred from recent global data sets. *J. Geophys. Res.*, **112**, D22101, doi 10.1029/2007JD008435, (1-8).
- Glatt, P., 2008: Variability of polar surface and atmospheric radiation budget inferred from ISCCP FD data. PhD Thesis submitted to ETH, Zurich, Switzerland.
- Papa, F., A. Guntner, F. Frappart, C. Prigent and W.B. Rossow, 2008a: Variations of surface water extent and water storage in large river basins: A comparison of different global data sources, *Geophys. Res. Lett.*, **35**, L11401, doi: 10.1029/2008GL033857 (1-5).
- Zhang, Y., W.B. Rossow, P. Stackhouse, A. Romanou and B.A. Wielicki, 2008: Implication from recent global datasets about decadal variations of global energy and ocean heat budget and meridional energy transports, *Flux News*, **5**, 16-18.
- Papa, F., C. Prigent and W.B. Rossow, 2008b: Monitoring flood and discharge variations in the large Siberian rivers from a multi-satellite technique. *Surv. Geophys.*, doi: 10.1007/s10712-008-9036-0, (1-21).
- Frappart, F., F. Papa, J.S. Famiglietti, C. Prigent, W.B. Rossow and F. Seyler, 2008: Interannual variations of river water storage from a multiple satellite approach: A case study for the Rio Negro river basin. *J. Geophys. Res.*, **113**, D21104, doi: 10.1029/2007JD009438 (1-12).

Submitted Publications

- Zhang, Y-C., W.B. Rossow, C.N. Long and E.G. Dutton, 2009: Exploiting diurnal variations to evaluate the ISCCP-FD flux calculations and Radiative-Flux-Analysis-Processed Surface Observations from BSRN, ARM and SURFRAD. *J. Geophys. Res.*, (submitted).
- Roads, J., E. Bainto, K. Masuda, M. Rodell and W.B. Rossow, 2009: GEWEX water and energy budget study. *Earth Interactions*, (submitted).
- Papa, F., C. Prigent, W.B. Rossow and E. Matthews, 2009: Interannual variability of surface water extent at global scale, 1993-2004. *J. Geophys. Res.*, (submitted).

Publications in Preparation

- Romanski, J., and W.B. Rossow, 2008: Diabatic heating and the generation of available potential energy. *J. Climate*, (in preparation).
- Romanski, J., and W.B. Rossow, 2009: Generation of available potential energy and climate sensitivity in IPCC models. *J. Climate*, (in preparation).
- Guntner, A., S. Werth, F. Papa and F. Frappart, 2009: Retrieval of surface water storage in large

river basins from multi-satellite and topographic data. *J. Geophys. Res.*, (in preparation).
Papa – methane
Papa – permafrost