Integration of satellite products of radiative fluxes in support of hydrological modeling

Rachel T. Pinker Team

Department of Atmospheric and Oceanic Science
University of Maryland College Park, MD

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Context of Activity - NEWS aims

- Integrate model, satellite and in-situ datasets that are needed to *quantify* the *rate* and *variation* of *water* and *energy cycling* throughout the globe.

- Make *progress* toward *improved, observationally based predictions* of water and energy cycle consequences of Earth system variability and change.
Project Objectives

- Perform *in depth* evaluation of current satellite radiative fluxes against ground observations and other products; *determine error statistics globally and regionally*
- *Identify regions* where satellite product *disagree most*, and where models have problems
- *Determine extreme statistics* in fluxes and *relate* them to episodes of *extreme conditions* such as droughts
- *Develop pathways* that will allow integration of data to address scientific issues.
Major data sources to be used:
Radiative fluxes (SW and LW) from:
• UMD_ISCCP DX, 0.5°, 3 hr (from MEaSURES Project), July 1983 to Dec 2009 (Ma and Pinker, 2012).
• GEWEX 3.0; ISCCP-FD; CERES
• UMD_MODIS Terra and Aqua, daily at 1°, 2002 to 2010 (Wang and Pinker, 2009).
• ERA Interim; CFSR; NCEP/Reanalysis II
• BSRN, PIRATA, TAO, ARM
Turbulent Fluxes:
Integration activity facilitated by participation in several NEWS WGs:

- Contribution to Ocean Flux issues
- Droughts
- Radiation/Clouds
- Providing data to users
Contribution to Flux Activities over oceans:

At issue: What is the cause of current difference in net flux estimates over oceans?

Turbulent fluxes in the two approaches:
1. An updated version of the IFREMER turbulent flux estimates (Bentamy et al., 2013) daily time scale at a spatial resolution of 0.25° - a prototype of a satellite estimation method (QuikSCAT; SSM/I)
2. Woods Hole Oceanographic Institution (WHOI) (OAFlux) (Yu et al., 2008) fluxes – a prototype of a blended approach.

Radiative fluxes – independent approaches from satellites:
Various ISCCP products; UMD/MODIS

Paper published:
Conclusion: Differences in the turbulent fluxes among two widely used approaches are overshadowed by those in radiative fluxes.

Upper: Difference ($Q_{\text{net}}$) over the Atlantic from UMD_MODIS + IFREMER minus OAFLUX ($Q_{\text{net}}$) during 2003-2005:
   a) January b) July;

Lower: Histogram of differences for above.
Observations used for evaluation of MODIS based surface fluxes
Why MODIS?

Evaluation of **daily** mean SW from **UMD/SRB_MODIS** (2003-2005) against PIRATA and TAO/TRITON

Contribution to Drought Activities:

Following investigated:

• What happens to radiative fluxes during drought?

• How well do numerical models predict radiative forcing during drought conditions?
CPC Precipitation anomaly (top) vs. UMD/SRB DSWR at the surface (bottom), July 1983—December 2009 (here SW is from UMD/DX MEaSURES product. Both data sets are averaged over 95° W-88° W; 36° N-46° N. Dashed lines represent the standard deviations (1, 2, 3 sd). Red circles - months when two or more standard deviations are exceeded.
Departure from Normal: Seasonal Precipitation (mm) and SW down W/m² - JJAS 2012

CPC Precipitation anomaly

SW from satellites: UMD/MODIS

NCEP/Reanal II
Evaluation of MODIS based surface radiative fluxes against ground observations

Daily and monthly mean SW flux estimated by UMD/SRB_MODIS against BSRN measurements over land Jan 2003-Dec 2005

Land/BSRN (Daily)
N=11439
Mean of Obs.= 201

Land/BSRN (Monthly)
N= 381
Mean of Obs.= 198

Corr. Coef. = 0.98
RMSE = 21 (11%)
BIAS = -3 (2%)

Corr. Coef. = 0.99
RMSE = 10 (5%)
BIAS = -3 (2%)
Contribution to Radiation/Clouds Activities:

At Issue: Energy Budget Closure.

First step: Derive best Surface Energy Budget Estimates

The total net flux ($Q_{\text{net}}$) across the air-sea interface includes turbulent and radiative fluxes.
Comparisons of IFREMER and TAO daily turbulent fluxes. TAO buoys located between 120° W and 80° W, and south of equator are used (after A. Bentamy).
In depth evaluation of current satellite *radiative fluxes* against observations and other products.
Approach for LW: Use Neural Network based on passive and active satellite data

The cloud based temperature is derived using an artificial neural network trained using spatially and temporally collocated MODIS and Cloudsat Cloud Profiling Radar (CPR) and Calipso Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) observations. This information coupled with parameterizations is used to derive surface LW.


Analysis in progress.