Final report: The development of a 20-year data base of ocean surface and near-surface properties suitable for climate analysis

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Purchase Order P010-262

SEAFLUX data set

Under a previous NASA NEWS grant "Global analysis of ocean surface fluxes of heat and freshwater: satellite products, NWP analyses, and CMIP simulations," a new satellite – derived ocean surface turbulent flux data set was developed. This data set, referred to as SEAFLUX, provides latent and sensible heat fluxes as well as surface and near-surface parameters on a spatial scale of 0.25 degree and a temporal scale of 6 hours. The SEAFLUX data set has been processed for the years 1998-2007, and the period is being extended under a NOAA Climate Data Records grant (PI: Clayson), under which I am a collaborator.

Clayson, C.A. J. B. Roberts, A. Andersson, A. Bentamy, J.A. Curry, D. Jackson, C. Klepp, M. Kubota, W.B. Rossow, J. Schulz, C.-L. Shie, Tomita, G.A. Wick, 2011: Results of the SeaFlux Intercomparison Project. *Bull. Amer. Meteorol. Soc.*, submitted.

Impact of hurricanes on ocean surface turbulent fluxes

One paper has been published:

Liu, J, JA Curry, CA Clayson, MA Bourassa: High-resolution satellite surface latent heat fluxes in North Atlantic Hurricanes. *Mon. Weather Rev.*, 139, 2735-2747.

Abstract: This study presents a new high-resolution satellite-derived ocean surface flux product, XSeaFlux, which is evaluated for its potential use in hurricane studies. The XSeaFlux employs new satellite data sets using improved retrieval methods, and uses a new bulk flux algorithm formulated for high wind conditions. The XSeaFlux latent heat flux (LHF) performs much better than the existing numerical weather prediction reanalysis and satellite-derived flux products in a comparison with measurements from the Coupled Boundary Layer Air-Sea Transfer (CBLAST) field experiment. Also, the XSeaFlux shows well-organized LHF structure and large LHF values in response to hurricane conditions relative to the other flux products. The XSeaFlux data set is used to interpret details of the ocean surface LHF for selected North Atlantic hurricanes. Analysis of the XSeaFlux data set suggests that ocean waves, sea spray, and cold wake have substantial impacts on LHF associated with the hurricanes.

The following figure demonstrates that the high resolution XSeaFlux data set enables resolution of the cold wake behind the hurricane. This figure shows the spatial distribution of the XSeaFlux SST and LHF at 18 UTC on 13 and 17 September for Hurricane Isabel. Latent heat fluxes are seen to exceed 1000 W m^{-2} in the center of the hurricane. In the wake of the hurricane, the SST is cooled by up to ~2-3°C with the largest cooling occurring in a narrow band in the back quadrant of the storm and trailing effects of the cold wake can be seen along the previous track of the hurricane. The cold wake has substantial impacts on air-sea fluxes. Pre-storm (undisturbed) LHF has a range of ~100-200 W/m², which is reduced to ~20-80 W/m² after the passage of the storm.

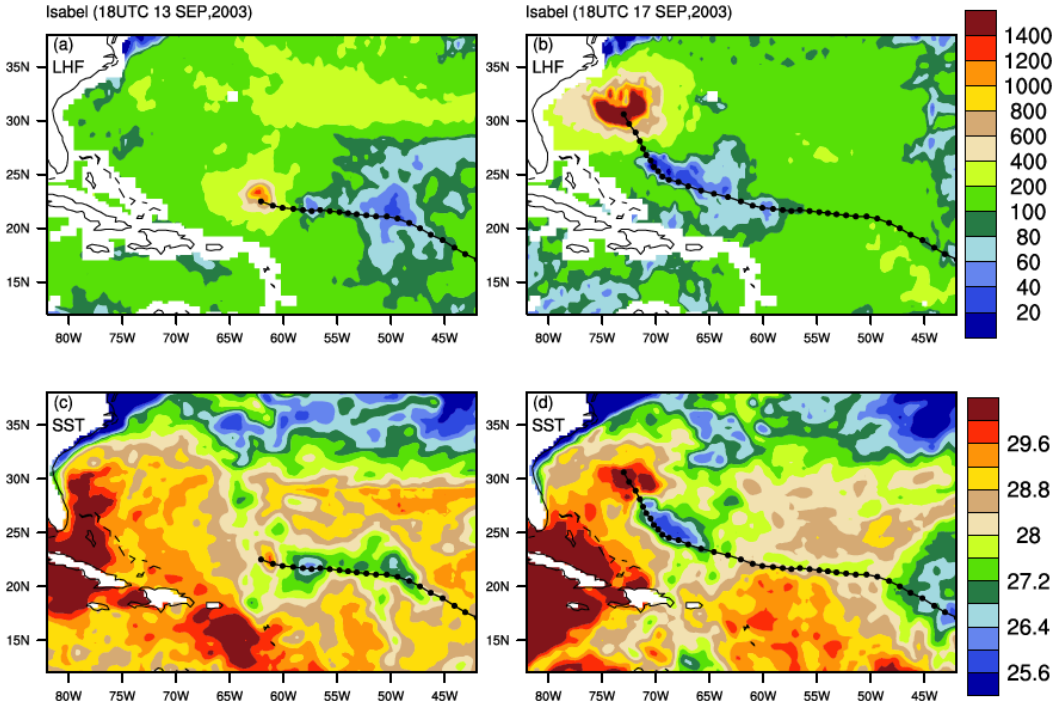

Figure 8. Spatial distribution of (a, b) LHF (W/m²) and (c, d) SST (° C) for Hurricane Isabel (18 UTC, 13 September, left panel; 18 UTC, 17 September, right panel)

The greatest challenge with analyzing surface latent heat fluxes in hurricanes is the determination of surface wind speeds. Satellite retrievals (active and passive) are hampered in the conditions of heavy precipitation and disturbed sea state. To address this issue, we plan to blend several different wind data sets to take advantage of the best features of each: the NCDC blended sea winds data set, the NASA cross-calibrated, multi-platform, multi-instrument ocean surface wind data set (CCMP) and H*winds (from Hurricane Hunter aircraft). Compared to the NCDC data set, the CCMP shows less missing data in the interior of hurricanes. For speed of winds in hurricanes, the CCMP is substantially weaker than the observation based on the H*wind analysis, whereas the NCDC is comparable to the observation. For hurricane wind structure, compared to the observations (H*wind analysis), the CCMP shows better wind structure (i.e., hurricane

eye's structure) than the NCDC. We plan to combine 1) a radial wind speed model (Holland et al. 2010) and 2) satellite analyses (CCMP and NCDC) to improve the estimation of winds (speed and structure) in the interior of hurricanes. This will improve the estimation of surface evaporative flux in hurricanes.

Reasoning about climate uncertainty

I have initiated a new research line on reasoning about climate uncertainty that I believe has relevance not only to this particular project, but to the broader NOAA climate research program and climate science more generally. Over the past year, the following three papers have been submitted and accepted for publication, for which this grant is acknowledged (and from which I have paid page charges.) Copies of these papers are available upon request.

Curry, J.A. (2011) Reasoning about climate uncertainty. *Climatic Change*, 108, 723-732.

Curry, J.A. and P.J. Webster (2011) Climate science and the uncertainty monster. *Bull. Amer. Meteorol. Soc.*, 92, 1667-1682.

Curry J.A. (2011) Nullifying the climate null hypothesis. *WIRES Climate Change*, 2, 919-924.

Berkeley Earth Temperature Project

For the past year, I have been member of the Berkeley Surface Temperature Project http://berkeleyearth.org/ that is developing a new land surface temperature data base and analysis methods. The Berkeley Earth Surface Temperature study is using over 39,000 unique stations, which is more than five times the 7,280 stations found in the Global Historical Climatology Network Monthly data set (GHCN-M). Whereas the other team members have funding from private donations through Novim, my participation is unfunded and has been supported by this grant. To date, three papers have been written from this project on which I am coauthor.

Muller, RA, D. Brillinger, JA Curry, et al. (2011) Decadal Variations in the Global Land Temperatures. *J. Geophys. Res.*, in press.

Wickam, C., D. Brillinger, JA Curry, et al. (2011) Influence of Urban Heating on Global Land Temperature Average Based on MODIS Classifications. *J. Geophys. Res.*, under revision.

Rohde, R, D. Brillinger, JA Curry, et al. (2011) Berkeley Earth Temperature Averaging Process. *J. Geophys. Res.*, under revision.