A New *In Situ* Surface Flux Dataset from NOCS

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A new ocean surface flux dataset has been developed at the National Oceanography Centre Southampton (NOCS). It is based on the International Comprehensive Ocean-Atmosphere Data Set (ICOADS, Worley et al. 2005) and initially covers the period 1970 to 2006.

The new dataset is a major update to the NOCS Flux Climatology (Josey et al. 1999) and contains gridded estimates of turbulent and radiative fluxes along with the meteorological variables used in the flux calculation. Random and systematic uncertainty estimates are also available.

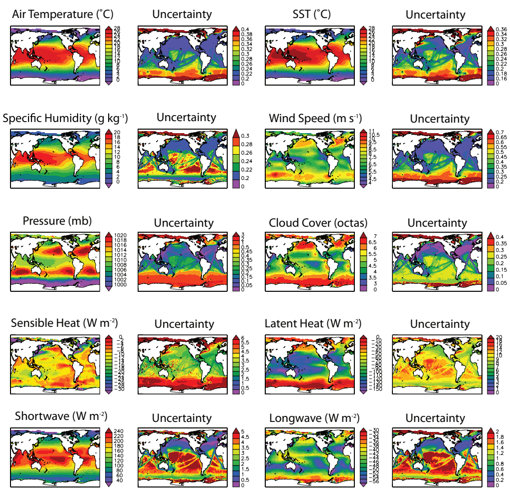
NOCS2.0 will be available for download from:

http://www.noc.soton.ac.uk/ooc/CLIMATOLOGY/noc2.php

Introduction

ICOADS contains the routine weather reports from ships, buoys, drifters and fixed platforms. These measurements of sea surface temperature (SST), air temperature, near surface humidity, winds and pressure can be used with parameterisations known as "bulk formulae" to estimate the surface turbulent exchange of heat and moisture, the sensible and latent heat fluxes.

A different approach is being taken to previous *in situ* datasets (e.g. da Silva et al. 1994, Josey et al. 1999). We are using optimal interpolation (e.g. Reynolds 1988) to produce daily fields of SST, air temperature, near surface humidity, winds and pressure on a 1˚x1˚ area grid. Random error estimates for the ship data were taken from Kent and Berry (2005). The previous day's analysis, incremented to allow for a seasonal cycle, has been used for the background field. The background error field is the previous day's analysis error relaxed towards the climatological intra-monthly standard deviation using a 3 day time scale. The spatial scale chosen was 300 km. In the absence of data, anomalies are allowed to persist, but the uncertainty increases toward the climatological variability.



Climatological mean of each variable used in the calculation of NOCSv2.0 fluxes. Alongside the plot for each variable is the accompanying climatological monthly mean uncertainty estimate, in the same units. Uncertainty estimates include both random and bias components.

The method of flux calculation

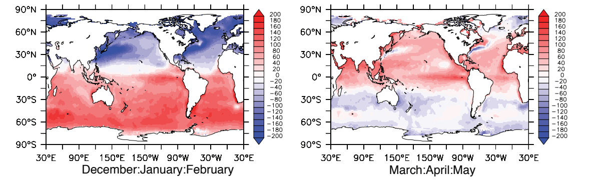
Daily fields for the basic variables are calculated along with their uncertainty (see above). These fields are then input to the bulk formulae and daily fluxes calculated. Accompanying uncertainties are estimated following Gleckler and Weare (1997). The daily flux fields and uncertainties are then combined to give monthly mean sensible and latent flux and uncertainty estimates.

There are several advantages to this approach. Firstly calculation of fluxes from mean meteorological fields avoids bias due to the random errors in individual observations resulting from the non-linearity of the bulk flux formulae (Smith 1980, 1988). Secondly the use of fields which can capture much of the synoptic-scale variability avoids biases caused by correlations between the basic meteorological variables (e.g. large air-sea temperature differences and high winds in cold air outbreaks) which can be lost if longer-period averages are used. And finally the daily fields allow us to avoid sampling bias and make better estimates of the uncertainty in monthly mean fields.

Acknowledgements

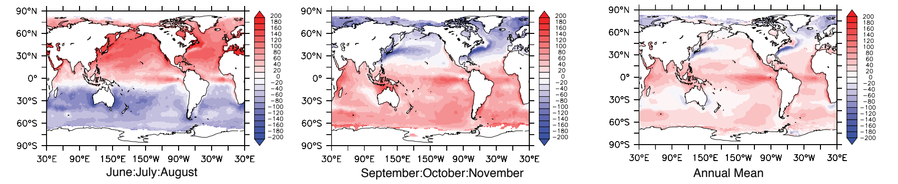
The OAFlux dataset (Yu et al. 2004) was downloaded from the Objectively Analyzed air-sea Fluxes Project (OAFlux) website: http://oaflux.whoi.edu/.
The HOAPS3 dataset was downloaded from the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS) website: http://www.hoaps.zmaw.de/.
ECMWF ERA-40 data (Uppala et al. 2005) have been obtained from the ECMWF data server.
NCEP Reanalysis data (Kistler et al. 2001) provided by the NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, USA, from their Web site at http://www.cdc.noaa.gov/.
The buoy data were downloaded from the WHOI Upper Ocean Processes Website.

Seasonal Mean Net Heat Flux (Wm^{-2}), 1973-2002, -ve is heat loss from the ocean



The seasonal cycle of heat gain and loss is clear, along with the major heat loss over the Gulf Stream and Kuroshio regions which persists throughout most of the year.

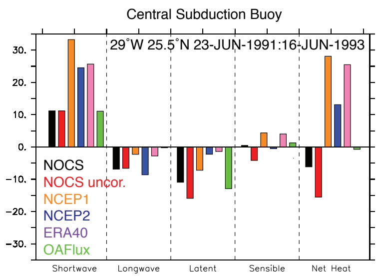
The annual mean plot shows the global mean imbalance in the dataset:, 26 Wm^{-2} additional heat gain by the ocean. This is slightly smaller than the 30 Wm^{-2} in the unadjusted NOCV1.1a.



Comparison with Existing Flux Estimates

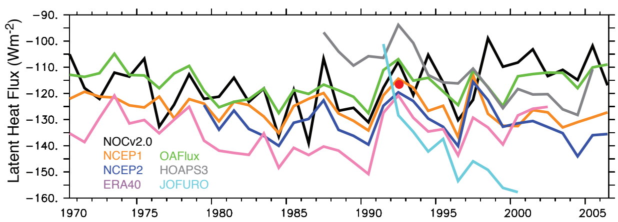
Probably the best surface flux estimates we have over the ocean are from dedicated research quality moored buoys. Wood's Hole Oceanographic Institution (WHOI) have made the data from many deployments available. The bar chart shows the differences between the fluxes from the central buoy in the "Subduction Array", a 2-year deployment in the Northeast Atlantic.

The NOCSv2.0 fluxes (black bars) agree with the buoy to within 10 Wm^{-2} for each component and for the net heat flux. Comparison with the fluxes with no data adjustments applied (red bars) shows that the adjustment has improved the agreement with the buoy. Various reanalysis products (orange, blue and pink bars) show some poor agreement with the buoy data with biases in the net heat flux between 10 and 30 Wm^{-2}. The best agreement is with the WHOI OAFlux product (green bars) although this product has been tuned using the buoy data so the agreement is perhaps unsurprising.



The time series shows annual averages of latent heat flux at the same Northeast Atlantic location. The red dot shows the buoy latent heat flux for 1992, the only full year of deployment.

Also plotted are the latent heat fluxes from two satellite datasets, HOAPS3 (grey) and JOFURO (light blue). There is considerable scatter between the annual means from the different data sources, typically the estimates differ by around 30Wm^{-2}.



Conclusions and Future Work

- A new approach to the calculation of surface turbulent heat fluxes from *in situ* data has been developed which allows uncertainty estimates to be made for the fluxes.
- The new method calculates fluxes from daily fields of the basic meteorological variables which should reduce biases in the flux compared with previous methods.
- The flux uncertainty, as expected, is strongly dependent on the sampling of the ship data in ICOADS, outside the main shipping lanes the errors can be very large.
- However in well-sampled regions (largely the Northern mid-latitudes) there are enough data to make high-quality daily estimates of sensible and latent heat flux.
- Adjustments applied to the data typically act to improve comparisons with fluxes from moored buoys.
- More work is required to improve the bias adjustments, the characterisation of random uncertainty, the method of weighting data within the OI scheme and the time and space scales used.
- Future developments should include adding other data sources, such as buoys and eventually satellite data, and the extension of the datset to cover a 50-year period.

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The new dataset should be available later this year. Although initially the main product will be the monthly fields, we will be making the daily values for well-sampled regions available on request.

More information:

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