A comparison of three surface flux datasets for use in standalone ocean climate models

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Abstract:

The National Oceanography Centre, Southampton, (NOCS) has recently (2003) developed an ocean heat flux climatology which is globally, annually balanced to within 2W/m^2. This climatology is based on the COADS dataset, corrected for biases in the ship reports. The resulting fluxes have been variationally adjusted to improve their match to various hydrographic estimates of ocean heat transport.

This poster describes the use of these fluxes in the standalone version of the NEMO ocean climate model, a tripolar ocean model developed at LODYC, Paris. It describes the preliminary results of driving a low resolution (2°) global model with the NOCS fluxes. It also compares these results to those produced when the same model is driven by surface fluxes from two other climatologies: an AGCM and NWP reanalyses. This allows the accuracy of each climatology to be investigated, as well as providing an estimating of the sensitivity of ocean model integrations to the uncertainty in surface forcings. This will help to distinguish between model systematic errors arising from deficiencies in the model's physics and numerics schemes and those coming from the data used to drive the model.

The ultimate goal is to derive a well defined set of fluxes for parameterization developments within NEMO.

Three flux datasets:

- **SOC** — based on COADS ship reports, adjusted to give better match to observed heat transports and net ocean heat input. (Grist & Josey, 2003)
- **GFDL** — based on NCAR reanalyses, satellite data and other observations. Fluxes via bulk formulae and SST. Adjusted to give better net heat and freshwater input. (Large & Yeager, 2004)
- **HadGAM1** — taken from averaged AMIP2 simulation with specified SSTs. No adjustments. (Martin et al 2004)

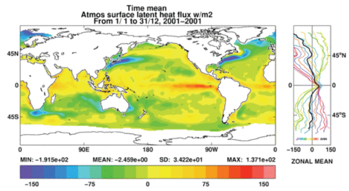


Figure 1: *The annual mean total (SW+LW+SH+LH) heat flux for the SOC dataset. Zonal means of monthly fluxes indicate seasonal variability*

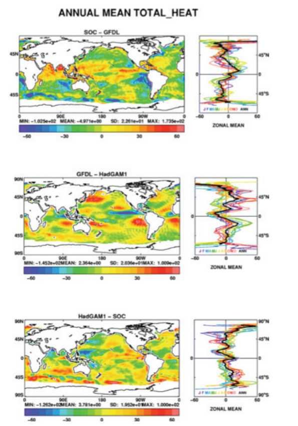


Figure 2: *Differences in the annual mean total heat for the three datasets. Top panel: SOC-GFDL; middle panel: GFDL-HadGAM1; bottom panel: HadGAM1-SOC. Note the large (+/- 50 W/m^2) local differences*

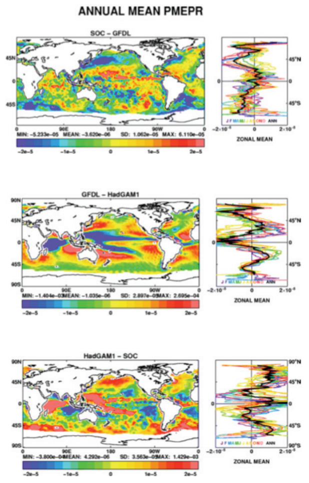


Figure 3: *Differences in the annual mean total freshwater (precipitation-evaporation+runoff) for the three datasets. Top panel: SOC-GFDL; middle panel: GFDL-HadGAM1; bottom panel: HadGAM1-SOC. Note the large (+/- 50 mg/m^2/s) local differences*

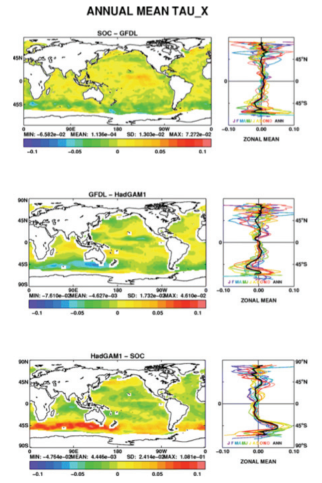


Figure 4: *Differences in the annual mean zonal windstress (τ_λ) for the three datasets. Top panel: SOC-GFDL; middle panel: GFDL-HadGAM1; bottom panel: HadGAM1-SOC. Note the large (+/- 50 mN/m^2) local differences*

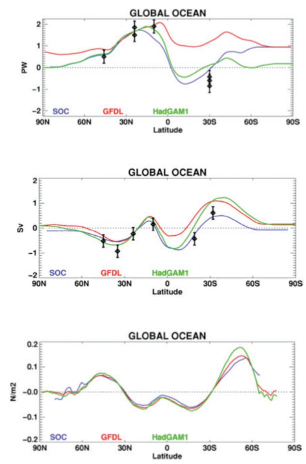


Figure 5: *Global transports from all 3 datasets compared to observational estimates (Bryden & Imawaki, 2001; Wijffels 2001). Top panel: heat; middle panel: freshwater; lower panel: zonal windstress. Heat and freshwater normalised to match observations at 24°N. Precipitation rescaled to give zero net global freshwater flux*

Comparison of surface flux datasets:

- Large local differences are apparent even in global, annual averages
- *Three* diverse datasets allow likely source of differences to be inferred, eg: 'beads' of cooling in S. Ocean come from SOC; less cooling in Sc regions in GFDL; higher tropical ppn in HadGAM1; higher zonal windstress in S. Ocean in HadGAM1
- Transports have biggest differences in Southern Hemisphere, especially in Pacific (not shown)
- SOC net heat flux after adjustment, -2.5W/m^2, still implies a large global heat transport (~1PW)
- Adjusting latent heating without adjusting precipitation can destroy the freshwater balance

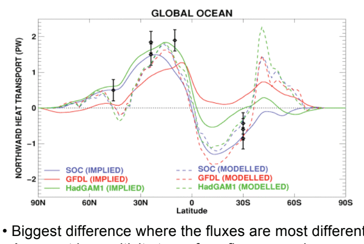
SUMMARY: GLOBAL, ANNUAL MEANS

	TOTAL HEAT (W/m^2)	FRESH WATER (mg/m^2/s)	ZONAL STRESS (mN/m^2)
SOC (adjusted)	-2.5	-6.7	5.4
GFDL (adjusted)	1.3	-2.7	6.0
HadGAM1 (AMIP2)	0.2	-2.3	11.3

Preliminary results:

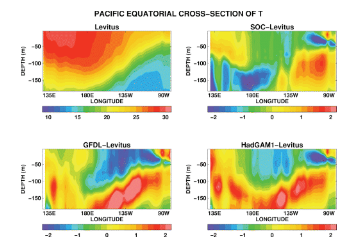
- All three flux datasets have been interpolated to the ORCA2 configuration of the NEMO ocean model (Madec et al 1998). This uses a tripolar 2° resolution grid (reducing to 1/2° at the equator). Compare results after 50 years.

Modelled and implied global heat transports



- Biggest difference where the fluxes are most different
- Apparent insensitivity to surface fluxes may be a consequence of Haney relaxation (40 W/m^2/K)

Pacific thermocline depth



- Different tendencies: thermocline becomes shallower in SOC; deeper in GFDL and HadGAM1

Conclusions:

- We've compared three surface flux datasets derived from diverse sources
- Closely-matched global averages (after adjustment) hide large local differences
- We've run them through NEMO ocean model for 50 years
- Early results suggest little difference in resulting heat transport, but interesting differences in equatorial thermocline depths

Further work:

- Run models with different forcings for 100 years; analyse time-dependence of results
- Try removing Haney relaxation
- Repeat on higher resolution (1°) grid
- Derive a well defined set of fluxes for parameterization development in NEMO

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We would like to thank Chris Gordon for his guidance and advice. Simon Josey (NOCS), Michael Winton (GFDL) and Gill Martin (Met Office) gave very helpful advice on the use of their respective datasets.

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