CMIP Subproject.
Energetics of coupled models: role of oceanic heat transport on climate and climate change.

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1 Background

Ocean and atmosphere transport the excess of energy received at low latitudes to high latitudes where there is an energy deficit. The ocean heat transport is comparable in magnitude to the atmosphere heat transport but its characteristics are only crudely known because of a broad uncertainty band among observationally based estimates (e.g. Gleckler et al. 1995). Therefore a strict evaluation of the realism of ocean heat transport simulated by coupled model is not possible. However, one may want to know if this uncertain process is of importance in the simulation of climate by coupled models as it has been put into evidence in simplified frames (Cohen-Solal and Le Treut 1997; Covey and Thompson 1989). Comparison of ocean heat transports that are computed by the models participating to CMIP can give informations on the impact of this term on model-to-model variability and for climate scenarios.

2 Objectives/Methods

The present project responds to several objectives:

1. Document the energetics of coupled models by putting into comparable representation the ocean heat transport simulated by coupled models participating to CMIP. Use of other energy terms available in CMIP database to deduce indirect diagnosis (interbasin heat transport...). Evaluation of the contribution of flux adjustment when applicable. Comparison with available observationally based data (Carissimo et al. 1985; Esbensen and Kushnir 1981; Hsiung 1985; Oberhuber 1988; Savijarvi 1988; Trenberth and Solomon 1994). Large intermodel variability is expected for this term (Covey and Cohen-Solal 1998). (CMIP1, CMIP2.)

2. Study of the relationship in models between ocean heat transport and meridian gradient of temperature. Attempt to relate the evolution of

the gradient with the ocean heat transport: role of ocean heat transport on model climate drift (Cohen-Solal et Le Treut 1998), when occuring. (CMIP1, CMIP2.)

3. Analysis of ocean heat transport change when co2 increases and evaluation of the average response of coupled models. Ratio between the magnitude of heat transport change and flux correction, or variability in control simulations (model interannual variability and/or drift). Focus on the relationship between ocean heat transport change and sea ice extent. Role of ocean mass transport, ocean temperatures and salinity changes on ocean heat transport evolution when co2 increases. (CMIP2.)

3 Fields required

3.1 CMIP1

3.1.1 Time series

Monthly mean surface air temperature.

3.1.2 Ocean annual mean

- global and by basin, meridional overturning streamfunction: zonal mean cross sections.
- global horizontal vertically integrated mass transport streamfunction.
- global and by basin, zonal mean heat transport.

3.2 CMIP2: control and perturbed cases

3.2.1 Time series

Monthly mean surface air temperature.

3.2.2 Sets of four 20-years means

Atmospheric geographic distributions:

- net surface heat flux
- net surface freshwater flux
- flux adjustments (if any)

Oceanic fields:

- ocean transports:
  - global and by basin, meridional overturning streamfunction: zonal mean cross sections.
  - zonal mean heat transport global and by basin.
  - global geographic vertically integrated mass transport streamfunction
- 3D global fields
  - temperature
  - salinity
- bathymetry
- sea ice thickness and concentration

3.3 Possible extensions

It would be very interesting to compare the ocean heat transport with the global heat transport. Therefore, we would appreciate to have the atmospheric heat transport or at least the total (ocean and atmosphere) heat transport (as the net radiative fluxes at the top of the atmosphere, for example). Modeling groups may be invited to furnish these supplementary fields.

4 References

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