



Consistency between modeled gas exchange rates and observed radiocarbon inventories

S. A. Mueller, F. Joos, N. R. Edwards, T. F. Stocker

Climate and Environmental Physics, Physics Institute, University of Bern, Switzerland

Paleo simulations and the assessment of uncertainties in climate projections require computationally efficient climate models. Results from a suitable 3-dimensional ocean model (Bern3D) are presented. Various age tracers (CFC-11, CFC-12, ^{39}Ar , ^{40}Ar and ^{14}C) and biogeochemical tracers (anthropogenic CO_2 , DIC, DOC, Phosphate, Oxygen, Alkalinity, ^{13}C and ^{14}C) have been built in. The model consists of an extension of the frictional geostrophic ocean model component of Edwards et al. (1) with an improved formulation of sub-grid scale mixing processes. It is forced using monthly climatologies for temperature, salinity and wind-stress data. The model is coupled to a 4-box land-biosphere component via a well mixed atmosphere.

The model is tuned towards typical radiocarbon ratios observed for the deep Southern Ocean, North Atlantic and North Pacific and data-based CFC-11 inventories as suggested by Matsumoto et al. (2). The different targets probe the typical timescales of ocean transport from years to centuries. We show that, with the Bern3D model, these metrics can be matched within their uncertainties. The resulting temperature and salinity fields compare well with observations (root mean square differences are around 1.1°C for the temperature and around 0.19 psu for the salinity fields respectively).

The air-sea gas exchange rate governs the magnitude of basin-wide bomb radiocarbon inventories during the GEOSECS and WOCE era. We find that the Wanninkhof 92 (3) gas exchange formulation must be modified regionally to match the data-based inventories; GEOSECS and WOCE Pacific, Indian and South Atlantic data suggest a significant downward correction, whereas an upward revision of the exchange rates is required to match the North Atlantic GEOSECS inventory.

1. N. R. Edwards, R. Marsh, Uncertainties Due to Transport-Parameter Sensitivity

in an Efficient 3-D Ocean-Climate Model, *Climate Dynamics* (2004), (in press)

2. K. Matsumoto et al., Evaluation of Ocean Carbon Cycle Models with Data-based Metrics, *Geophysical Research Letters* (2004)
3. R. Wanninkhof, Relationship between wind speed and gas exchange over the ocean, *Journal of Geophysical Research* (1992)