Atlantic Ocean Freshwater Transport in a Global Ocean Eddy-Permitting Reanalysis

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Meridional ocean freshwater transports in the Atlantic between Bering Straits and 32°S have been calculated from a global ocean reanalysis (based on the Met Office operational FOAM assimilation) and compared with air-sea freshwater fluxes (evaporation, precipitation and runoff) and prior transport estimates based on independent hydrographic section data. The reanalysis, spanning the period 1989 to 2010, assimilates ocean profiles from EN3_v2a data set including from Argo, in situ and satellite based SSTs, altimeter sea level from AVISO and satellite-based sea ice concentrations from the EUMETSAT Ocean Sea Ice Satellite Application Facility (OSI-SAF). Total freshwater transports based on reanalysis velocities and salinities are presented for a 14-year period from 1997 to 2010 as a function of latitude for comparison with the model's air-sea fluxes, from ECMWF ERA-Interim atmospheric reanalysis (Dee et al., 2011) with bulk fluxes calculated as in Large and Yeager (2004, 2009) and climatological runoff estimates from Dai and Trenberth (2002). Transports are also broken down between the model's overturning and horizontal gyre circulations, a contribution from the Bering Strait throughflow, and a "eddy transport" term which includes all variability from the mean on all temporal scales of less than 14 years, not just mesoscale perturbations.

In this ocean reanalysis, freshwater is transferred from the Arctic and subpolar North Atlantic to the mid-latitude North Atlantic. Using annual means for the period 1997-2010, the transport at 32S compared with Bering straits implies a net evaporation of -0.26 ± 0.01 Sv for the entire region north of 32S. This compares favorably with the section-based estimates from Talley (2008), who found a net loss of freshwater of -0.28 ± 0.04 Sv for the combined Arctic/Atlantic region north of 32S, using Reid (1994, 1997, 2003) absolute geostrophic velocity analyses with Ekman transports from NCEP reanalysis winds for 1979–2005 (Kalnay et al., 1996) and Levitus et al. (1994) climatological near-surface salinities. However when we assess the total freshwater transport at 32S the contribution of transient eddies is an additional 0.08 Sv northward, which is ~30% of the total, to give a total net evaporation closer to 0.34Sv. The freshwater transport associated with the meridional overturning circulation however, is 0.1 Sv of freshwater southward, consistent with several other recently published model analyses (e.g., Hawkins et al., 2011) and with possible implications for AMOC stability, e.g., Dijkstra (2007). We also look at 3 other hydrographic sections in the Atlantic at 47N, 24N, and 24S with similar freshwater budget comparisons to observations.