Low-frequency SST and upper-ocean heat content variability in the North Atlantic

Martha W. Buckley

Observations indicate that Atlantic sea surface temperatures (SSTs) exhibit significant low-frequency variability. The goal of this work is to quantify the relative roles of atmospheric forcing and ocean dynamics in creating SST/upper-ocean heat content anomalies in the North Atlantic. For this purpose, I utilize a state estimate (covering the period 1992 to 2010) produced by Estimating the Circulation and Climate of the Ocean (ECCO) to quantify the upper ocean heat budget in the North Atlantic on monthly to interannual timescales. Three novel techniques are introduced: (1) the heat budget is integrated over the maximum climatological mixed layer depth (integral denoted as H), which gives results that are relevant for explaining SST while avoiding strong contributions from vertical diffusion and entrainment; (2) advective convergences are separated into Ekman and geostrophic parts, a technique that is successful away from ocean boundaries; (3) air-sea heat fluxes and heat transport convergences due to anomalous Ekman advection are combined into one local forcing term. The central results of the analysis are as follows: (1) In the interior of subtropical gyre, local forcing explains the majority of H variance on all timescales resolved by the ECCO estimate. (2) In the Gulf Stream region, low-frequency H anomalies are forced by geostrophic convergences and damped by air-sea heat fluxes. (3) In the interior of the subpolar gyre, diffusion and bolus transports play a leading order role in H variability, and these transports are correlated with low-frequency variability in wintertime mixed layer depths.