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Heat content and sea-surface height variability in a North Atlantic model: Mechanical versus thermal forcing

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Interannual to sub-decadal variability of the upper ocean heat content and sea surface height from 1950 to 2000 is investigated using a 1 degree resolution ocean GCM. Experiments performed with different components of the monthly forcing fields show that the effects of heat flux and wind stress forcing on heat content anomalies (top 1000m) add in an almost linear way. They are equally important in mid-latitudes while stress anomalies dominate at lower latitudes via wind stress curl driven long Rossby waves. Heat flux anomalies play a dominant role at higher latitudes through their control on deep convective processes. EOF patterns of sea surface height are similar to those of heat content. In particular, monthly sea surface height variability in the 1990's shows a decline of the subpolar gyre circulation from 1995 to 1998, as suggested by other observational studies. The weakening trend is primarily related to the local surface heat flux forcing, not the wind stress. Results from an experiment with higher frequency (daily) forcing generally exhibit similar patterns to those of the monthly forcing experiments, although some interesting differences exist at higher latitudes.