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Interannual-to-decadal variability of the ocean heat and salinity content from different global analyses

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Despite recent advances in the state of the global ocean observing system and numerical modeling, the estimate of oceanic variability over the last several decades remains difficult. In particular, subsurface ocean data scarcity and uneven distribution over large ocean extents have limited the understanding of interannual-to-decadal variability in the ocean. Only recently data assimilation has been recognized as a possible tool needed to synthesize basin and global climate data sets. Ocean analyses providing dynamically consistent three-dimensional time series of ocean properties can indeed be used as the basis for climate dynamics studies. The analyses produced by ocean data assimilation systems can also be used to evaluate time and space variability of the heat and salinity content for the global ocean and separate basins. The ocean heat content trend and changes over the 1960-2000 period has been analyzed for separate regions and at different depths. In order to give an estimate of the uncertainties associated with ocean trends and variability, we have used two independently developed global data assimilation systems. The first approach is based on a reduced order multivariate optimal interpolator that has been implemented to an ocean general circulation model. The scheme assimilates in situ temperature and salinity data with uniform quality control produced and made available in the context of the ENACT project. The second is a global ocean analysis based on a 3D-VAR assimilation scheme developed at the Geophysical Fluid Dynamics Laboratory. The results show that both analyses indicate a warming trend for the upper ocean heat content in the global ocean with the maximum trend in the North Atlantic, confirming the results previously obtained by Levitus.