Geophysical Research Abstracts
Vol. 13, EGU2011-4373, 2011
EGU General Assembly 2011

Role of air-sea fluxes in the North Atlantic climate variability on interdecadal and interannual time scales

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We consider the response of the North Atlantic sea surface temperature (SST) to the variability of air-sea turbulent heat fluxes on different time scales using observational data. Air-sea surface flux time series were reconstructed for the period 1880-2008 using meteorological observations of Voluntary Observing Ships (VOS) available from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). Reconstruction included computation of turbulent heat fluxes from the VOS reports using simplified bulk formulae, homogenization of sampling density in VOS observations by the re-sampling of the original VOS reports and application of the Fisher-Tippett probability density functions for the derivation of gridded monthly air-sea heat flux anomalies. These long-term time series of surface fluxes in the North Atlantic were used to analyse the links between sea-air heat exchange and SST taken from the latest updates of HadSST. After the de-trending, both surface fluxes and SST time series were decomposed into long-term part associated with interdecadal variability (11 years and longer) and short-term component. Decomposition was performed using different filters and the results were generally insensitive to the choice of filtering procedure. On multidecadal time scale there is a clear positive correlation between surface heat fluxes southeast of Newfoundland (positive fluxes are directed from the ocean to the atmosphere) and the North Atlantic SST averaged over the latitudinal band from 35N to 50N (used as Atlantic Meridional Overturning Circulation, MOC index). This link is persistent during all seasons with the strongest manifestation in winter. At the same time, at interannual time scales there has been identified quite strong negative correlation between surface fluxes and SST over the mid latitudinal North Atlantic. Thus, on interdecadal time scale, increasing/decreasing SST results in the increase/decrease of the heat flux from the ocean to the atmosphere, implying the impact of MOC on the atmosphere through surface flux anomalies (the Bjerknes mechanism). However, on a shorter interannual time scale SST is likely to passively react to the changes in surface fluxes showing the decrease/increase under the influence of the positive/negative surface flux anomalies.