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A Model Study on the Role of Ocean-Atmosphere Coupling for the 11-year Solar Signal in the Troposphere

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The 11-year solar cycle is known to influence the stratospheric circulation and even tropospheric conditions on a hemispheric and seasonal scale. However, large uncertainties exist with respect to the top-down influence of radiative-chemical interactions as well as bottom-up ocean-atmosphere interactions for the tropospheric signal.

Here, effects of the 11-year solar cycle on the tropospheric climate are studied by analyzing integrations of the chemistry climate model EMAC that has been coupled to the MPIOM ocean model. A series of experiments has been tailored to investigate the role of atmosphere-ocean coupling for the formation of the near-surface response to the 11-year solar irradiance variability. The focus is on the north Atlantic region in the northern winter season. The model output is analyzed with a multiple linear regression technique.

It is found that there is a tendency towards a positive phase of the North-Atlantic Oscillation (NAO) at maxima of the Sunspot cycle. The signal is enhanced when the atmosphere-ocean interaction is suppressed by prescribed sea surface temperatures. Additional sensitivity simulations with either the sea surface temperatures or the middle atmosphere being free from 11-year solar influence reveal a key role for the stratospheric forcing in shaping the tropospheric response in the North Atlantic-European region. The robustness of the signals is tested by varying the length of the analyzed time series as well as by varying the set of basis functions used in the regression. The NAO response shows substantial variation of magnitude and even sign when subsets of the analysis period are examined.