Variability and Teleconnections in Wind-Driven Hindcasts with the Kiel Climate Model

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Wind stress is an important driver of ocean and sea ice variability, and in some cases with a key feedback to the atmosphere. A prominent example for this is the El Nino Southern Oscillation (ENSO). Modulations of the wind stress are an important component of the Bjerknes feedback that links anomalies in the atmosphere, and the surface and sub-subsurface ocean. ENSO illustrates how wind stress can act as a crucial element of recurring climate modes, particularly on the interannual timescales. Similar processes operate on the decadal timescales, as, for example, during the recent global warming hiatus, which was shown to be reproduced by a coupled model when forced by observed wind stress in the tropical Pacific. Thus, wind stress forcing of the ocean circulation is important to understand climate predictability on a wide range of timescales, from seasonal to decadal.

We perform ensemble hindcast simulations with the Kiel Climate Model (KCM) driven by daily wind stress anomalies from the ERA-20C reanalysis covering the period 1900-2010. The variability of the ensemble mean is compared to observations, and those components of variability which are forced by wind stress are identified. Both, local and remote effects are considered. The latter can be established through teleconnections either via the ocean circulation or an atmospheric bridge. Most influence of the wind stress on sea surface temperature and sea level pressure is found in the tropics. In the extratropics, the wind stress explains more than half of the monthly variability in the Atlantic Meridional Overturning Circulation (AMOC) index at 26°N.

Additional simulations where the wind forcing is restricted to certain ocean basins are also analyzed. It is shown, for example, that the wind stress over the tropical Pacific is most important in explaining the observed variability not only over the tropical Pacific but also over the tropical Indian Ocean where no wind stress forcing was applied.