The Role of Ocean Heat Transport for the Time-Dependency of Decadal Surface Temperature Prediction Skill in the North Atlantic Region

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Recent studies found that estimates of decadal surface temperature prediction skill in the North Atlantic region changed over time in the 20th century. Due to this time-dependency, estimates of decadal hindcast skill, commonly constructed for a time period of 60 years and therefore representing a statistical mean over 60 years, do not necessarily reflect skill variations found for sub-periods of the hindcast interval. These estimates therefore underachieve when transferred to the credibility of decadal climate forecasts.

Here, we present an approach to make hindcast skill estimates transferable to forecast credibility by connecting a physical mechanism to variations in hindcast skill. As a case study, we analyze North Atlantic sea surface temperature (SST) in an initialized prediction system based on the MPI-ESM-LR for the period 1901-2010. By varying the length of the analyzed time window, we illustrate the impact of time-averaging on hindcast skill estimates. Depending on the analyzed period, a time-average of hindcast skill can over- or underestimate the hindcast skill of its sub-periods. This shows that time-averaging does not only have a systematic effect on the hindcast skill estimate, but there is also another – physical – factor influencing skill.

We show that the skill of individual SST hindcasts is to a large degree determined by the strength of ocean heat transport (OHT) in the subpolar North Atlantic at the beginning of these hindcasts: We find high skill when OHT is strong at hindcast initialization, but almost no skill when OHT is average at hindcast initialization. Slowly southward propagating OHT phases in the North Atlantic provide a physical explanation for this connection between OHT strength and SST hindcast skill. Variations of OHT strength thus explain much of the time-dependency of SST hindcast skill in the twentieth century, indicating that the strength of OHT at initialization needs to be taken into account when assessing the credibility of individual decadal surface temperature forecasts in the North Atlantic region.