Multiyear predictability of extratropical North Atlantic sea surface temperatures (SST) in hindcasts initialized with wind stress anomalies

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Can we use observed wind stress anomalies to push the model into a state close enough to reality to make skilful SST predictions?



"Initialization runs" with prescribed wind stress <u>anomalies</u> (from ERA-interim)



Initialized hindcasts (predictions)

– no prescribed wind stress

Initial conditions





Kiel Climate Model (Park et al. 2009)

- Atmospheric component: ECHAM5, T42 (~2.8°) horizontally, 19 vertical levels
- Ocean-sea ice component: NEMO, ~2° horizontally, 31 vertical levels

Initialization runs with prescribed wind stress



Initial conditions

Initialized hindcasts



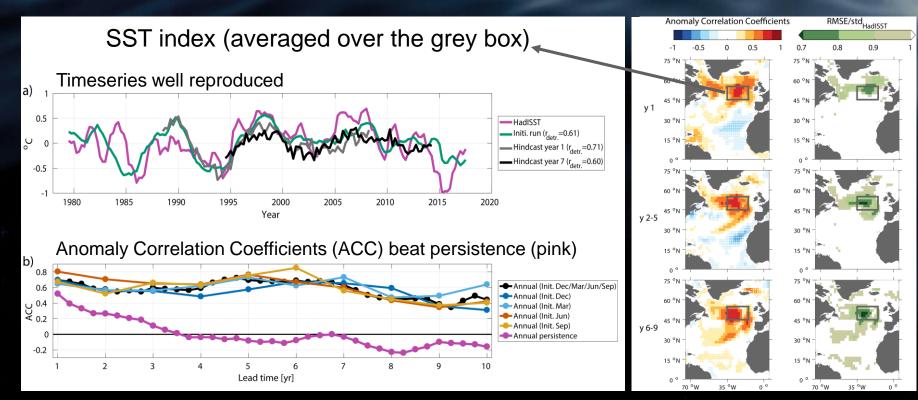
- Daily ERA-interim wind-stress anomalies
- +Added to the model climatology
- Apart from wind-stress fully coupled
- Runs cover the period 1970-2017
- 10 ensemble members (differing in initial conditions)
- Historical CO₂ forcing

- Apart from historical CO₂
 forcing, no prescribed variables
- Initialized every 3 months starting 31 Dec 1987 till 30 Sep
 2007 (80 different start dates)
- Integrated for 10 years
- 10 ensemble members
- In total 800 hindcasts



Data detrended prior to analysis to reduce the effects of global warming.

Significant skill of the hindcast ensemble-mean to predict annual SST anomalies in the extratropical North Atlantic several years ahead

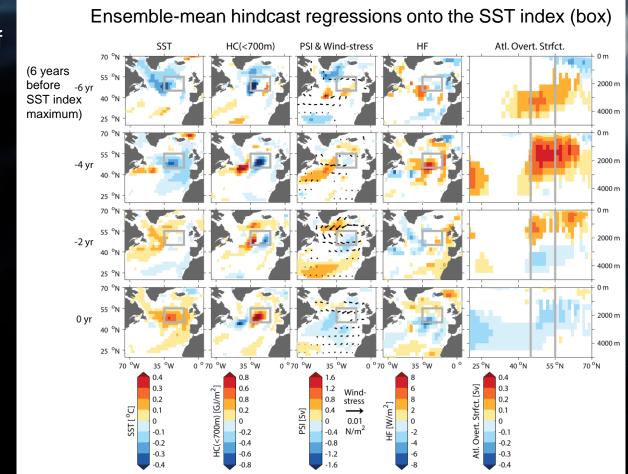






Wind-driven ocean dynamics are the source for this predictive skill

- Wind-driven response of PSI (barotropic streamfunction) causes subsurface heat (HC<700m) build-up
- Heat further maintained by circulation and moving eastward over several years
- HF (heat flux, defined downward) is only+ damping SST anomalies +

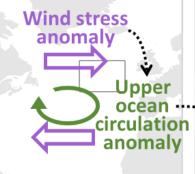




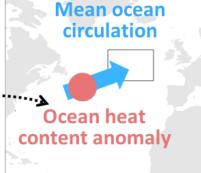


Schematic mechanism

Initialization year



Forecast year 2



Forecast year 4



Forecast year 6

Sea surface warming





