



**The Abdus Salam  
International Centre for Theoretical Physics**



**2160-12**

**Conference on Decadal Predictability**

*16 - 20 August 2010*

**Decadal prediction activities at CMCC**

BELLUCCI Alessio

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Conference on Decadal Predictability, August 16-20 2010, ICTP, Trieste.

# Decadal Predictions at CMCC

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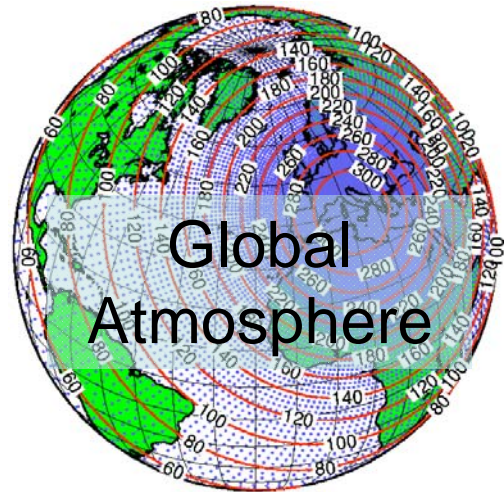


## Comprehensive Modelling of the Earth System for Better Climate Prediction and Projection

Decadal Prediction activities are under way at CMCC, under the frame of the EU FP7 **COMBINE** (Comprehensive Modelling of the Earth System for Better Climate Prediction and Projection) Project – WP6.

# Decadal Predictions at CMCC

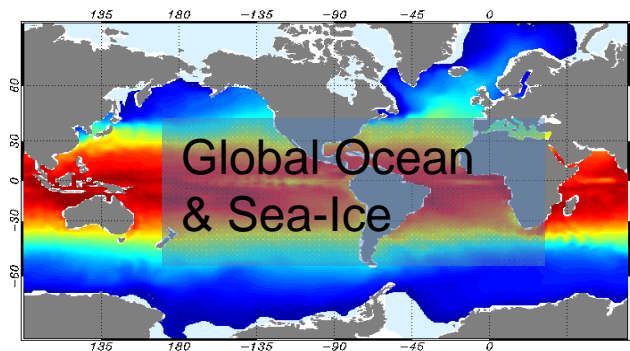
## The CMCC HRT159 model



ATMOSPHERE

ECHAM5 T159 (~ 80 Km)

COUPLER Oasis 3

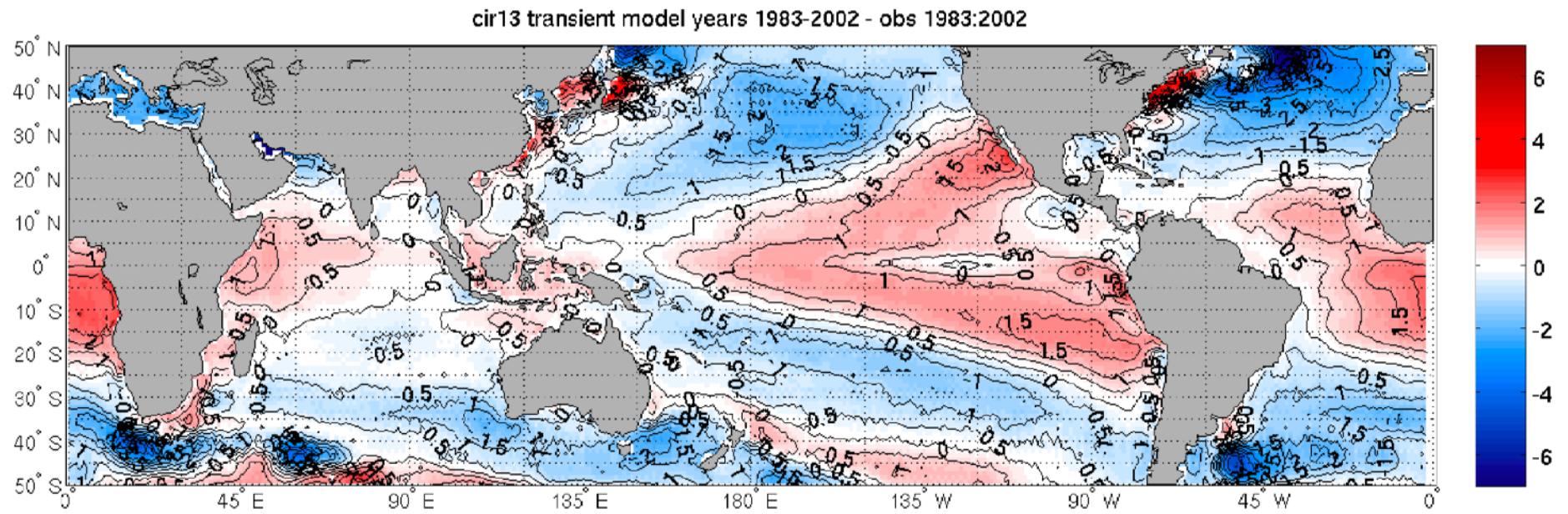


OCEAN:

OPA 8.2/ORCA2 (2°-1/4°)

SEA-ICE: LIM

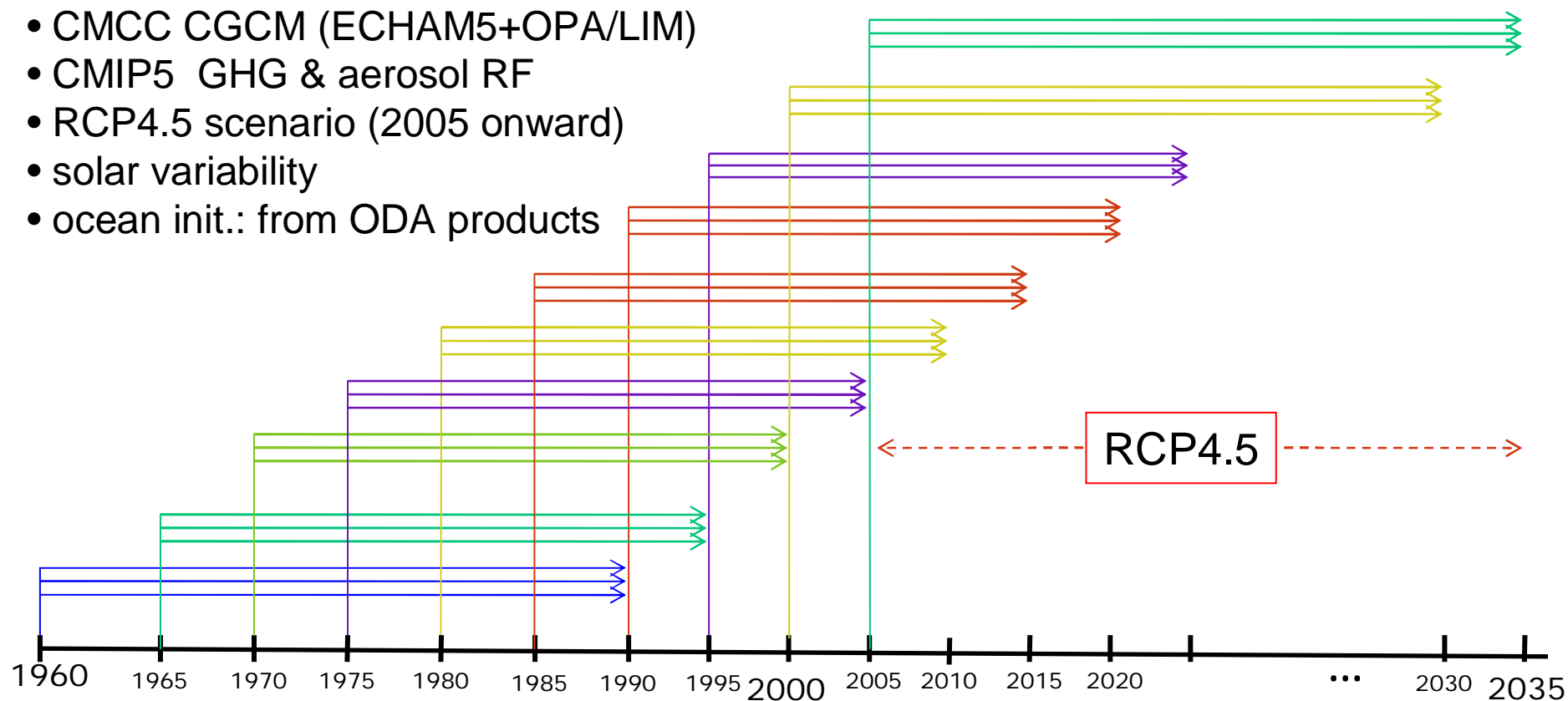
# SST bias



# Decadal Predictions: experiment setup

◆ 30-year hindcast/forecast simulations grouped into 3-members ensembles, for different start dates.

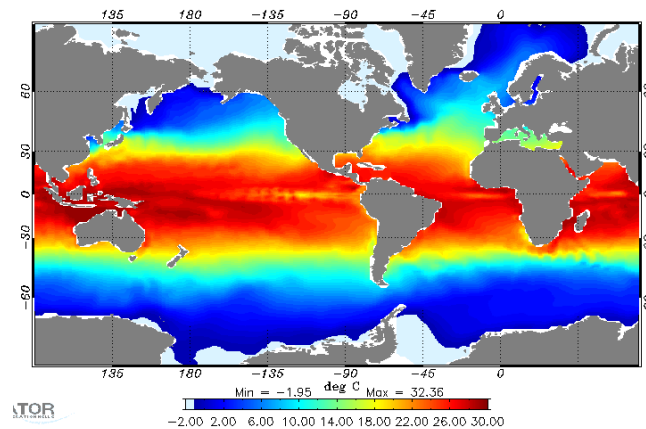
- CMCC CGCM (ECHAM5+OPA/LIM)
- CMIP5 GHG & aerosol RF
- RCP4.5 scenario (2005 onward)
- solar variability
- ocean init.: from ODA products



# Initialization

- ◆ Ocean Initialization: Full fields from ODA products
- ◆ Sea-ice: model climatology

**Sea-Ice & Snow thickness**  
init.: model climatology



**OCEAN:** different analyses  
(strategy adopted to generate  
the ensemble spread)

CMCC - OI

CMCC – 3DVAR

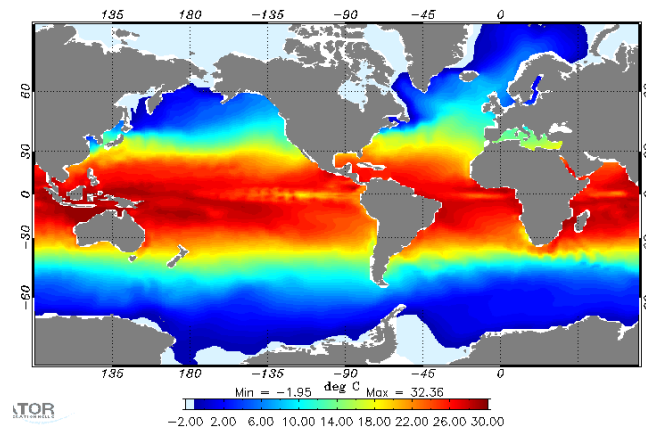
NEMOVAR

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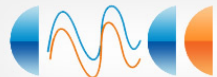
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CMCC - OI

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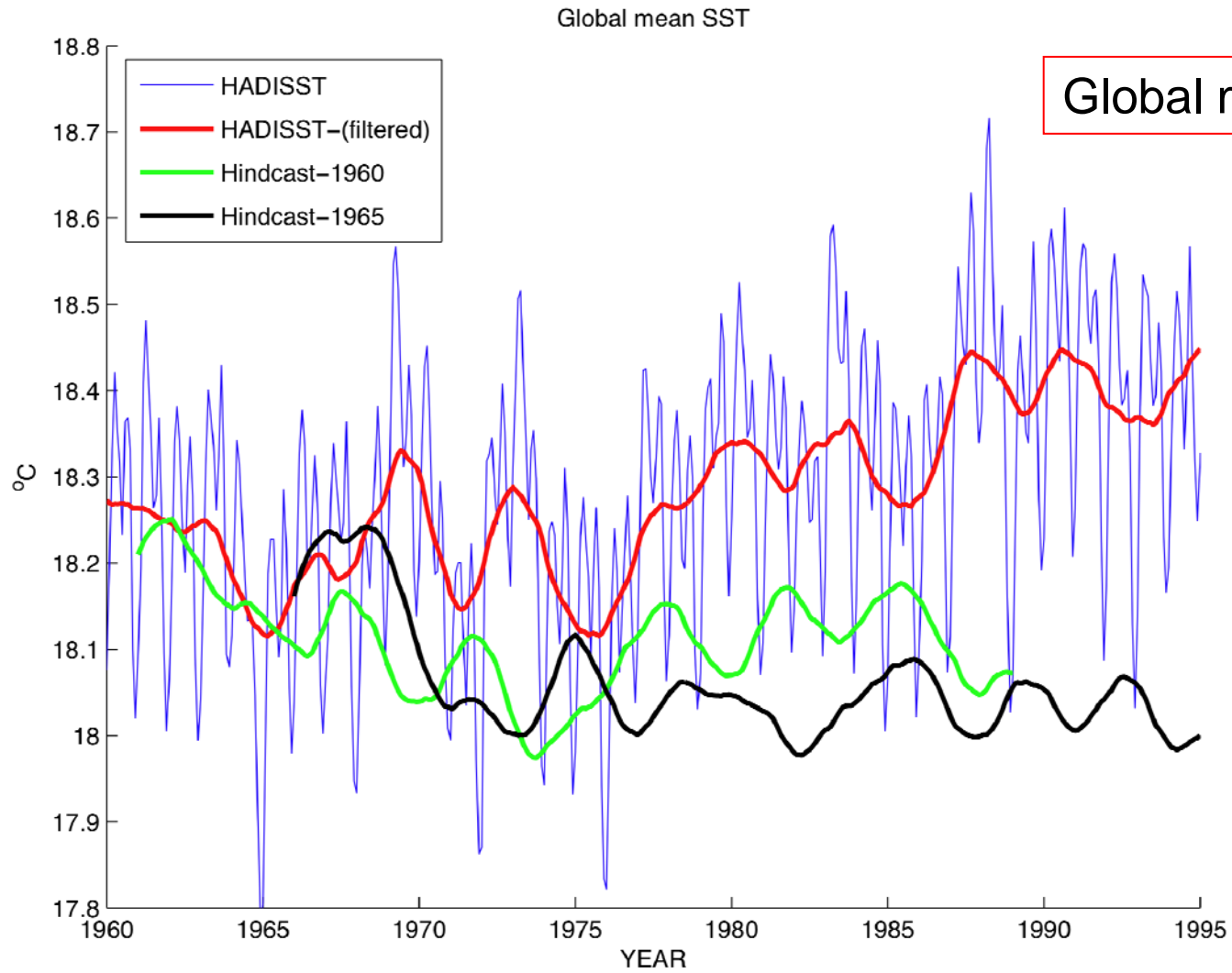
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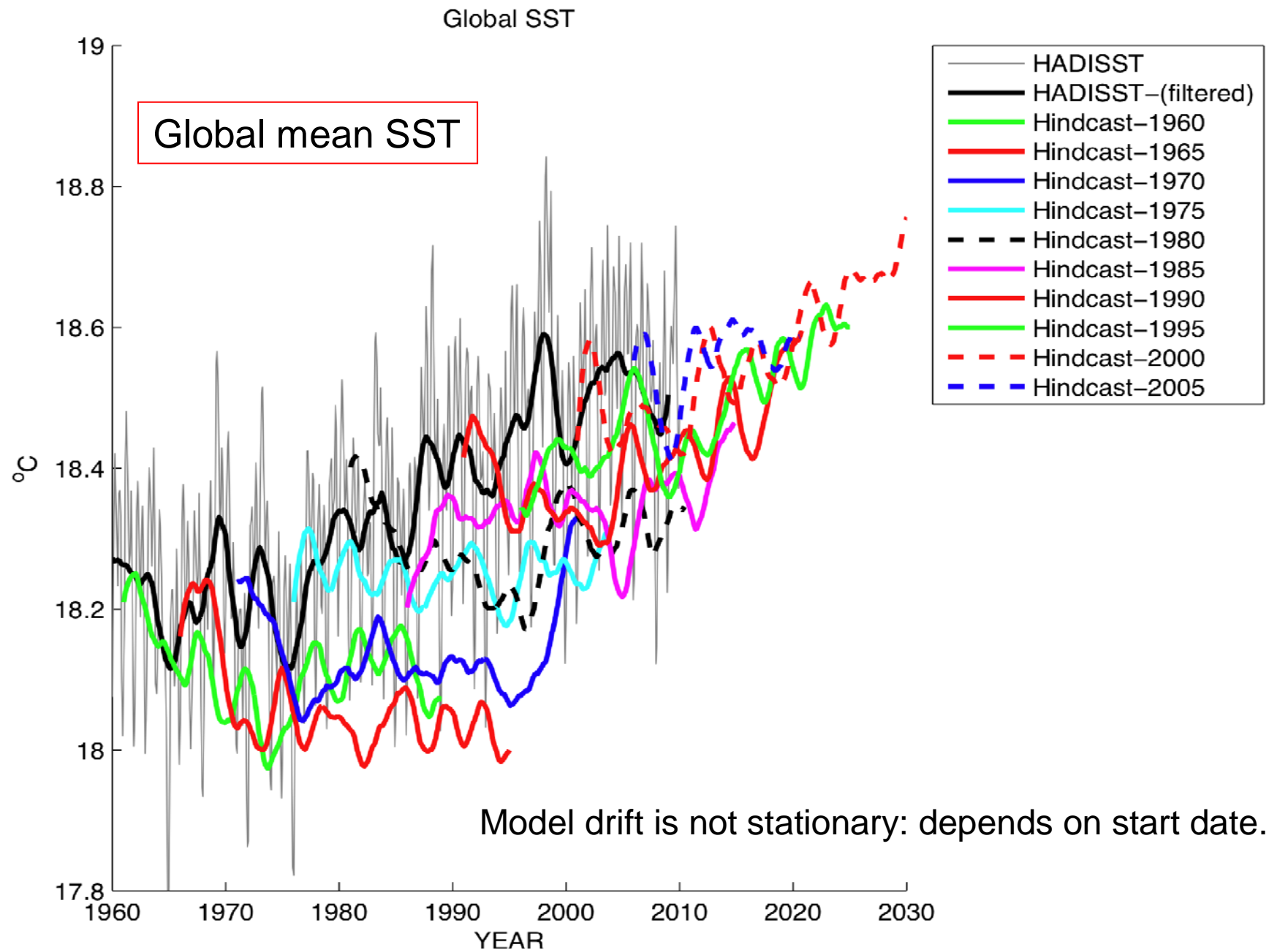




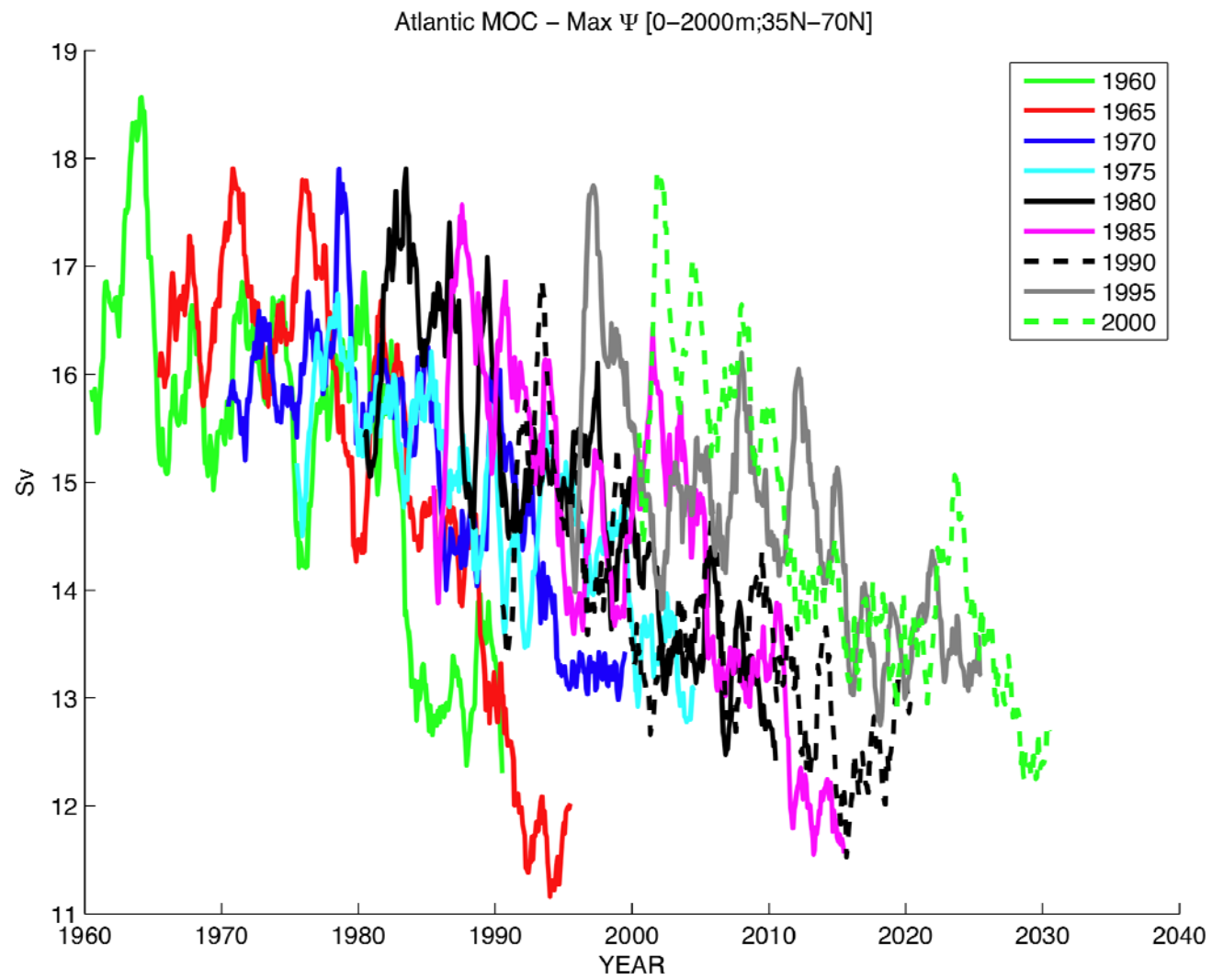
# Full initialization: drift



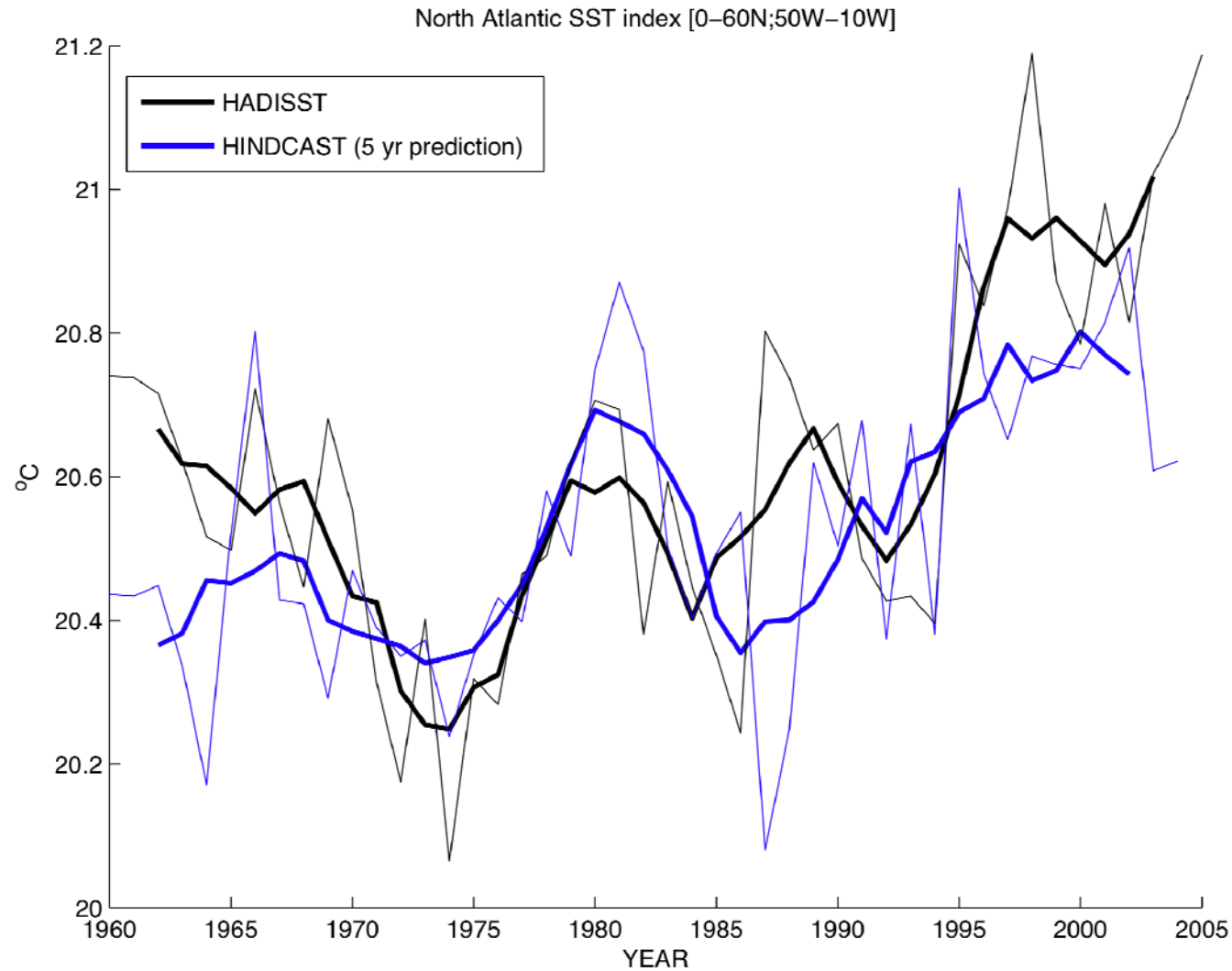
The model converges towards its cooler climate!



# Atlantic MOC

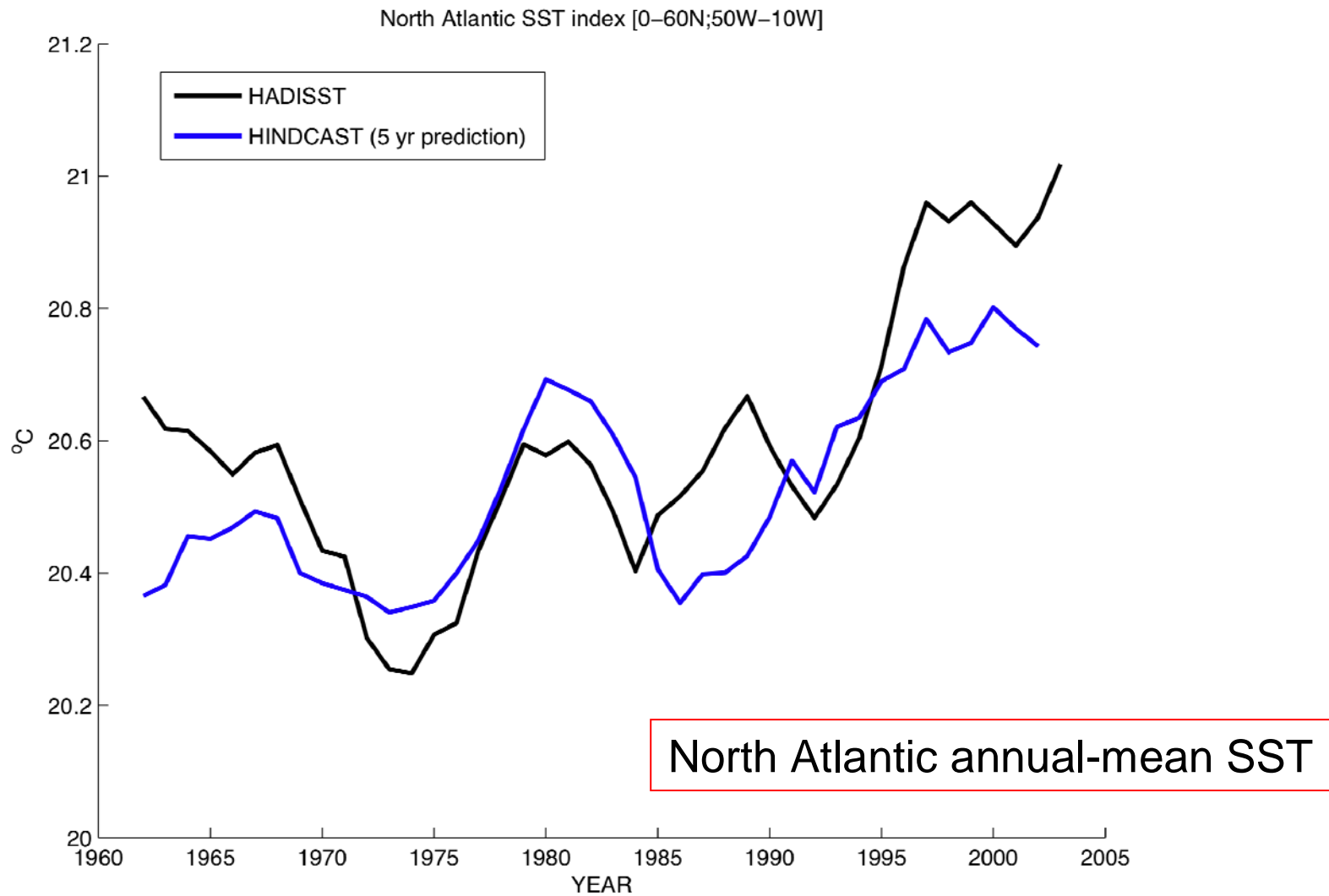


# Time series of annual-mean SST in the North Atlantic [0-60N;50W-10W] Hindcast for 5-prediction years (2 °C bias was removed) vs HADISST



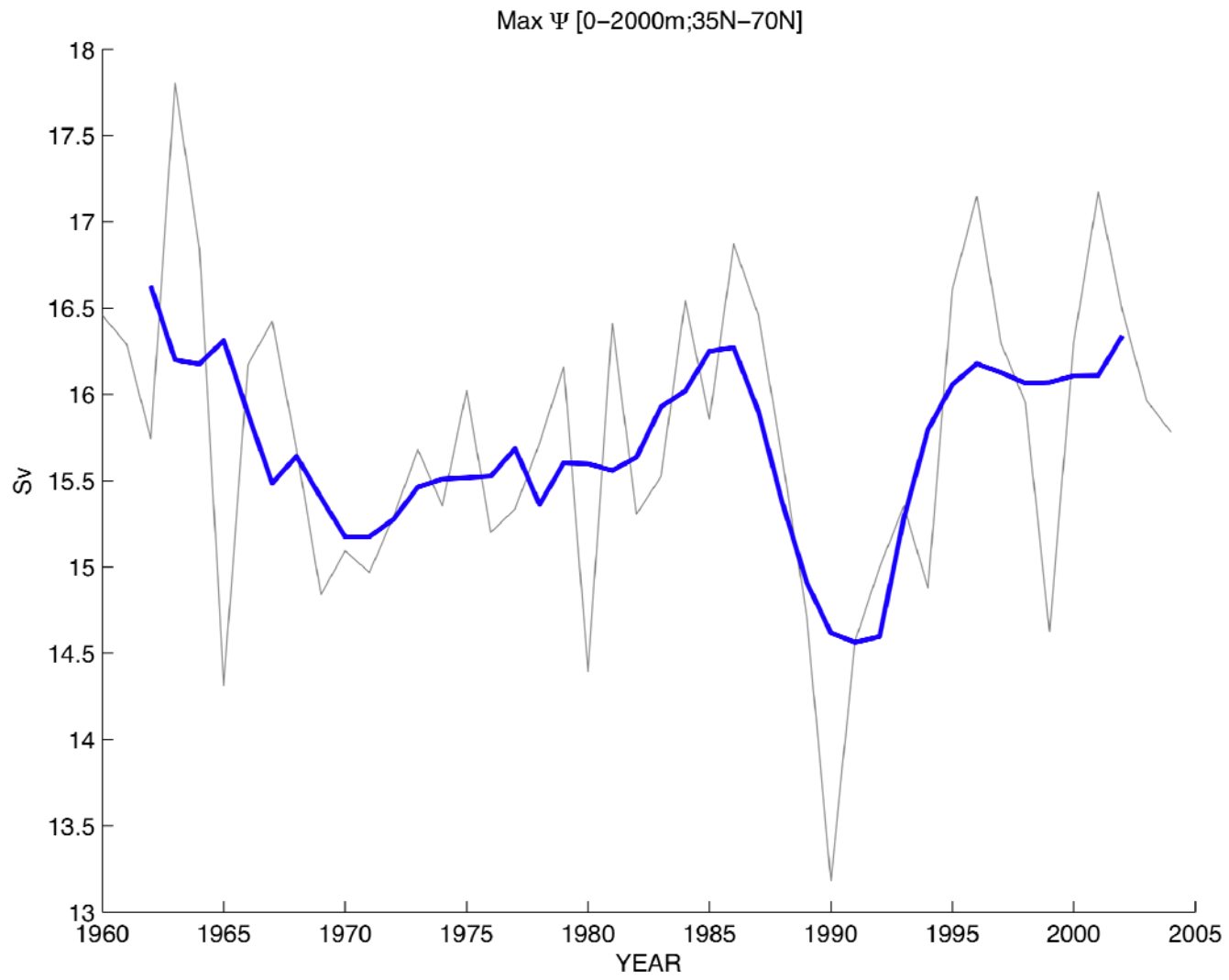
North Atlantic annual-mean SST

# Time series of annual-mean SST in the North Atlantic [0-60N;50W-10W] Hindcast for 5-prediction years (2 °C bias was removed) vs HADISST



Some predictive skill is evident in the North Atlantic, when 5-yr slices out of each hindcast simulation are retained.

# Atlantic MOC

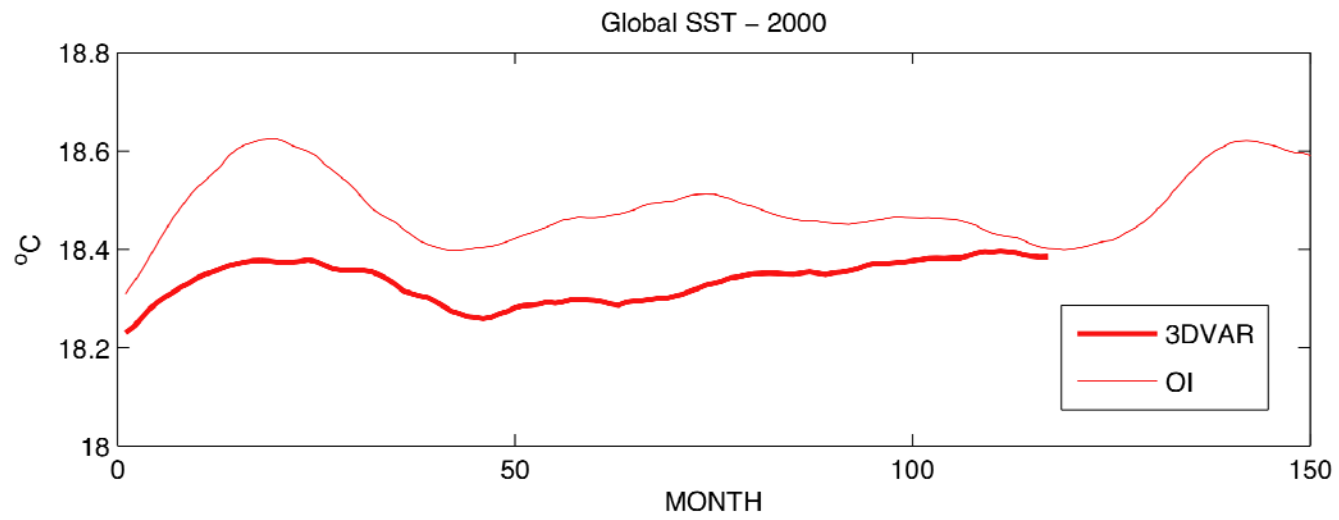
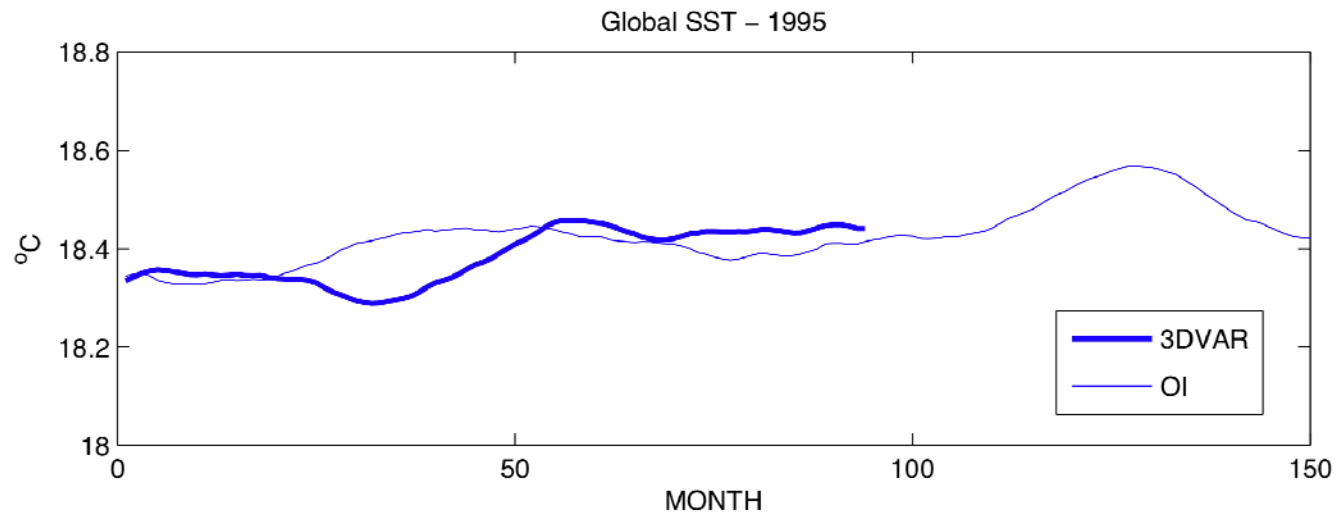


# Perturbing the ocean initial conditions using different analyses

- ◆ **CMCC OI** (Bellucci et al. 2007): Assimilating in-situ T,S observations (ENSEMBLES EN3 dataset) using an Optimal Interpolator assimilation system.
- ◆ **CMCC 3DVAR** (Storto et al., 2010): Assimilating EN3 in-situ T,S data (as OI) + along-track sea-level anomaly observations using a three-dimensional variational data assimilation system.

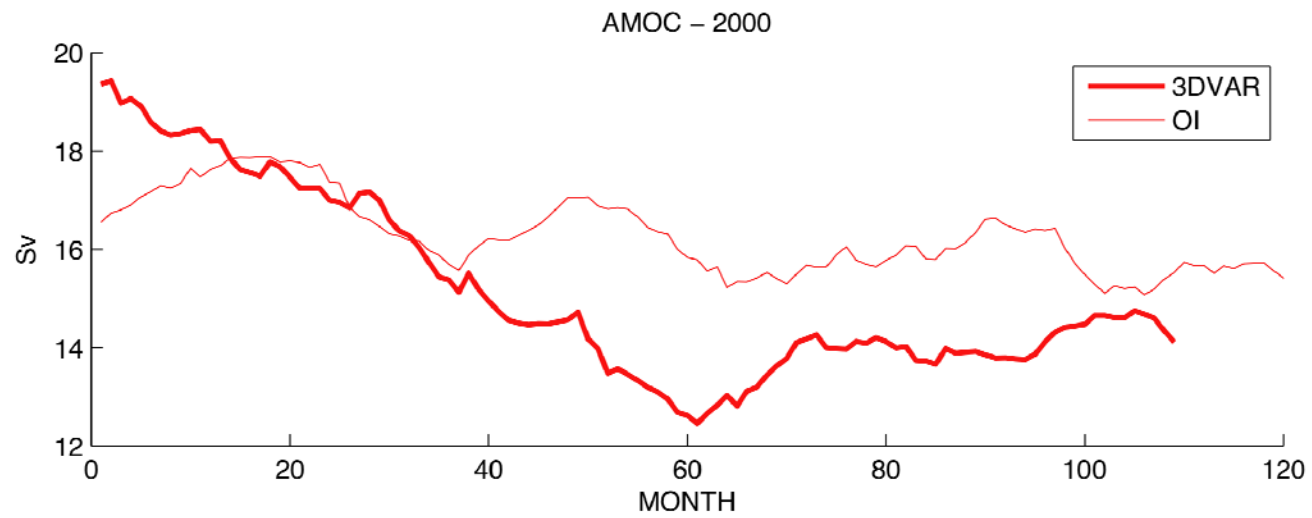
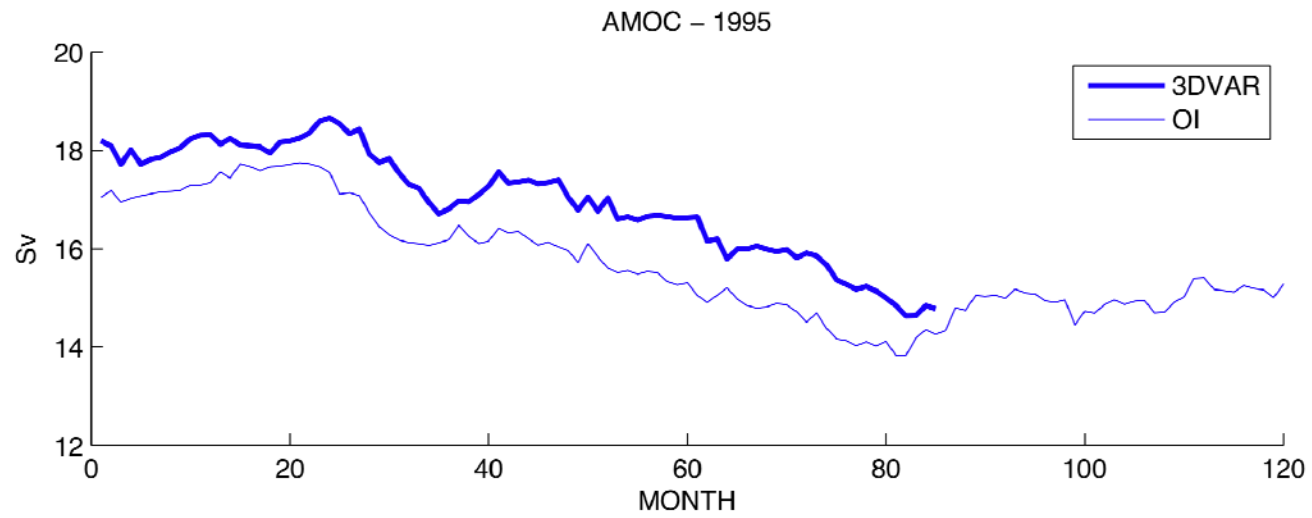
**Two “perturbing” elements: the assimilation methodology (OI vs 3DVAR) and the amount of assimilated data (additional effect of altimetry data on ocean state from 1992 onward).**

# Impact of initialization on global SST

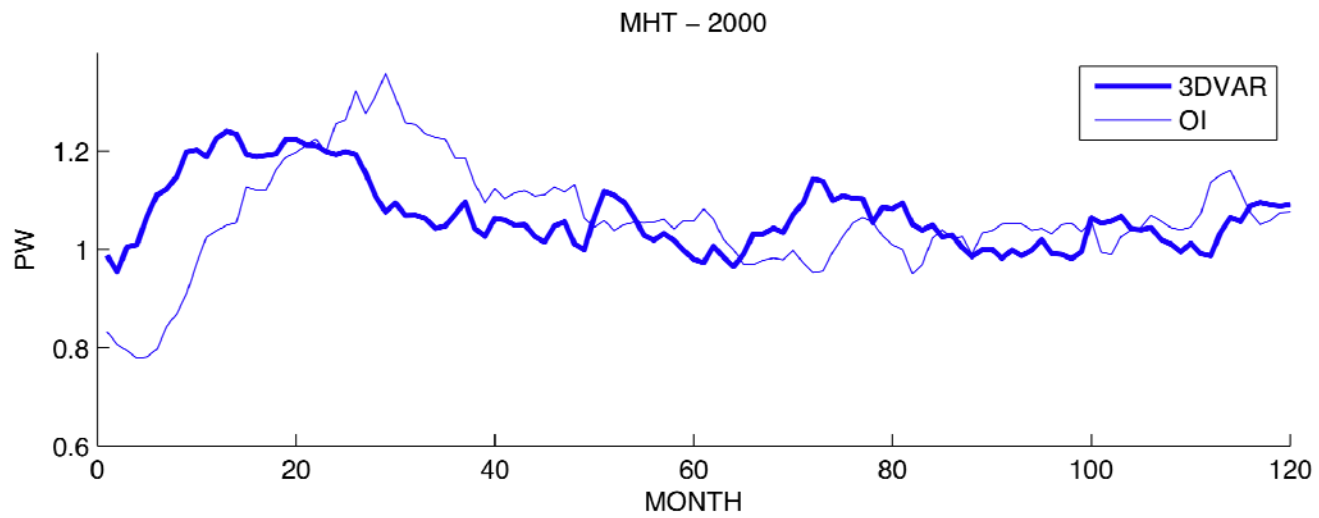
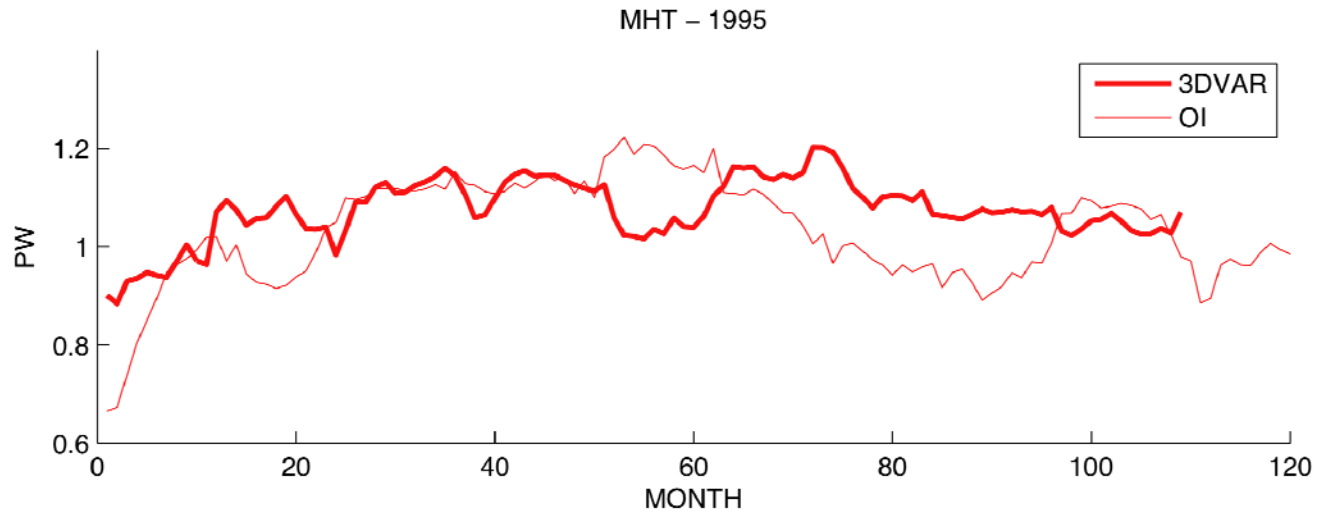




# Impact of initialization on AMOC



# Impact of initialization on Atlantic MHT



North Atlantic MHT at 17N

# Summary

- Decadal Prediction activities have just started at CMCC
- Ensemble spread is generated using different ocean analyses to initialize the ocean state
- Full initialization causes strong drift towards model attractor but it is highly non-stationary (adjustment depends on the start date)
- SST and THC display different adjustment time-scales (fast/slow)
- Prediction skill in the North Atlantic over 5-years
- Effect of altimetry data (SLA) assimilation (and assimilation methodology) on ensemble spread is being investigated

# CMCC Decadal Prediction Exp.

- ◆ Decadal prediction simulations are under way
- ◆ Delays in the availability of CMIP5 forcings led to a change of ocean initialization strategy (see below).
- ◆ Change of ocean initialization strategy: **Full initial state is currently being used, instead of model attractor**, as initially planned.
- ◆ For model attractor a long control simulation performed with CMIP5 forcings was required to build a model climatology in equilibrium with the new radiative forcing fields. Since CMIP5 data have only recently become available, it was decided to start Dec Pred. experiments using full fields from ocean analyses (no model climatology required)