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The impact of drift correction and detrending on the skill of ENSEMBLES decadal predictions

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1 Introduction

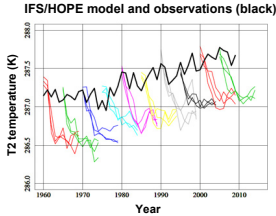
Decadal predictions bridge the gap between seasonal forecasts and climate change projections, and their time scale is of high relevance for stakeholders and decision makers in many sectors. However, several challenges are linked to the prediction on decadal time scale, and we here address two of them.

1. Drift correction: With increasing forecast lead-time, some models develop large systematic errors that make them drift away from the observed state. We apply methods for correcting this drift and discuss their effects on the predications.
2. Detrending: In order to differentiate the capabilities of the models in predicting natural variability from predicting anthropogenic climate change, the anthropogenic forcing can be modelled as a trend and be removed from the forecast and observational data. We evaluate how a trend removal may influence the quality and skill of decadal predictions.

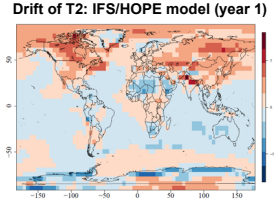
The questions are addressed by using the decadal predictions of the ENSEMBLES project (Doblas-Reyes et al. (2010)). Near-surface temperature predicted by four coupled ocean-atmosphere models (IFS/HOPE (ECMWF), HadGEM2 (UKMO), ECHAM5/OM1 (IFM-GEOMAR) and ARPEGE4/OPA (CERFACS)) is compared to ERA-40/Interim reanalysis data.

2 Drift

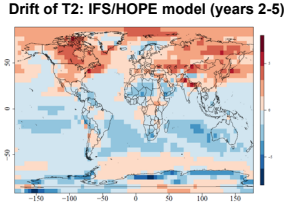
Global mean T2 temperature:
BEFORE drift correction
IFS/HOPE model and observations (black)



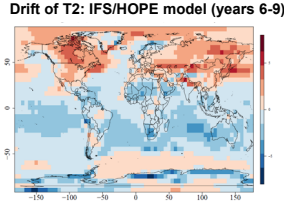
Drift of T2: IFS/HOPE model (year 1)



Drift of T2: IFS/HOPE model (years 2-5)



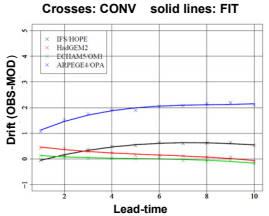
Drift of T2: IFS/HOPE model (years 6-9)



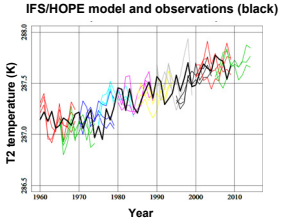
The ENSEMBLES decadal model forecasts show substantial drift, as seen in the figures above (example from the IFS/HOPE model). We remove this drift in two ways (in leave-one-out cross-validation):

1. **the "conventional" way, i.e. by subtracting the lead-time dependent bias (CONV)**
2. **by fitting a 3rd degree polynomial to the lead-time dependent bias estimates (FIT)**

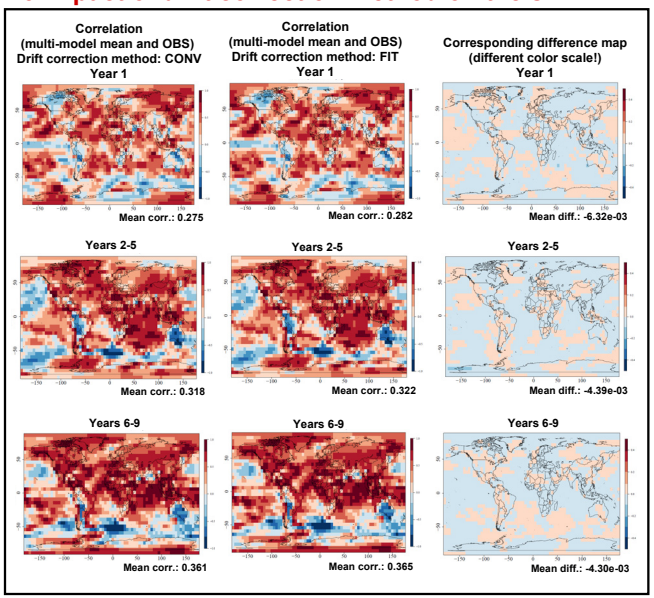
Evolution of drift with lead-time
Crosses: CONV solid lines: FIT



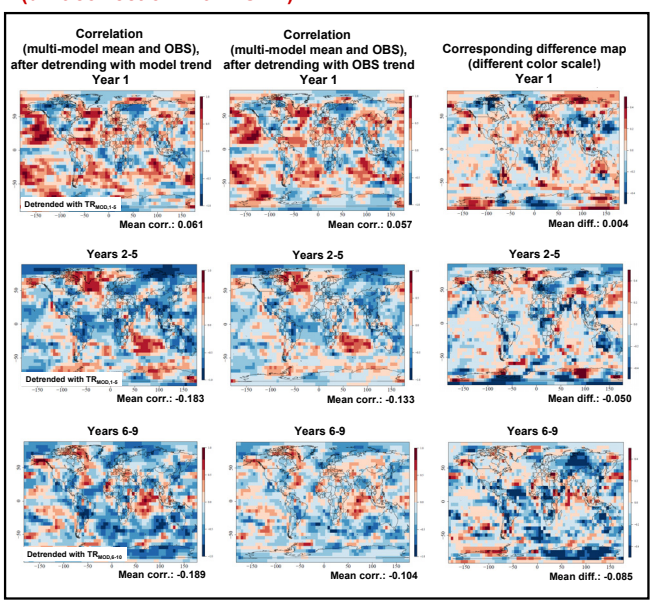
Global mean T2 temperature:
AFTER drift correction (CONV)
IFS/HOPE model and observations (black)



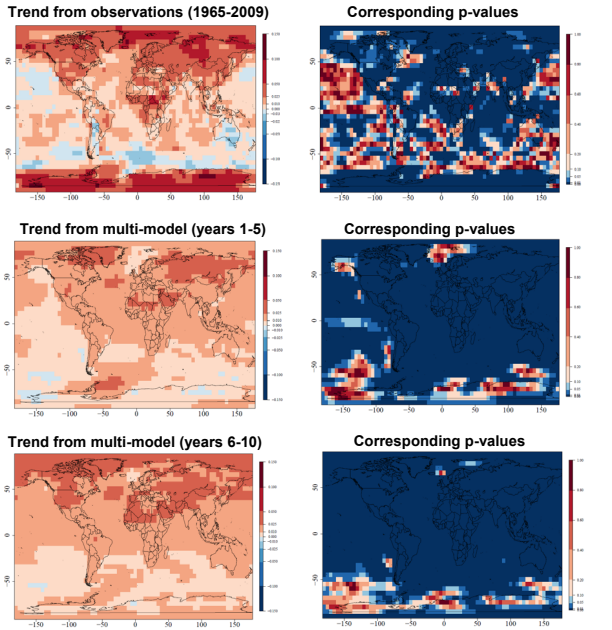
3 Impact of drift correction method on the skill



5 Impact of detrending method on the skill
(drift correction with CONV)



4 Trends



The trend estimated from the observations differs from the trends estimated from the multi-model (see figures above and corresponding statistical significances (p-values)). We detrend the model hindcasts in three ways:

1. **removing the trends estimated from the multi-model mean, using model data for lead-times 1-5 years ($TR_{MOD,1-5}$)**
2. **removing the trends estimated from the multi-model mean, using model data for lead-times 6-10 years ($TR_{MOD,6-10}$)**
3. **removing the trend estimated from observations (TR_{OBS})**

6 Conclusions

- **Prediction skill (2m temperature) has been analyzed for a 4-model 12-member ensemble of 10-yr hindcasts of the ENSEMBLES data-base**
- **The models are subject to substantial drift**
- **After drift-correction, the multi-model has significant positive skill, with skill depending on averaging period and lead-time**
- **Most of the skill of the multi-model is related to the trend**
- **After detrending, positive skill is only more evident over some ocean regions (especially the North Atlantic)**
- **The choice of drift correction method has only a minor impact on skill**
- **The choice of detrending method can locally have a significant impact**

Reference

Doblas-Reyes, F. J., Weisheimer, A., Palmer, T. N., Murphy, J. M., and Smith, D. (2010) Forecast quality assessment of the ENSEMBLES seasonal-to-decadal stream 2 hindcasts. Tech Memo 619, ECMWF, www.ecmwf.int/publications/

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