Can decadal climate predictions be improved by ocean ensemble dispersion filtering?
Any impact on seasonal predictions?
Motivation

MiKlip project

Initialisation

Decadal prediction and evaluation system

Evaluation

Processes

Regionalisation

Exchange of results during project development stages
Question: How good is a forecast? Answer: Evaluate the hindcast!

Global Mean Temperature

“Global mean temperature is a key metric for measuring how our climate is changing.” (NCAS)

1979 to 2013 Yearly

MPI-ESM-LR [Atm: T63L49 Ini: ERA-40/Int; Oce: 1.5°/L40 Ini: ORAS4]

Global mean temperature is a key metric for measuring how our climate is changing.” (NCAS)

Mean Squared Error Skill Score (MSESS)

Forecast vs Reference compared to Observations
Baseline1 vs Climatology compared to HadCRUT4
Question: What are we trying to do? Answer: Improve the forecast!

The Ocean

2.

The Ensemble

Climate Science Facts

- large-scale mixing occurs on time scales from years to decades
- The ocean has a much larger heat capacity than the atmosphere
  *Vuille and Garreaud*
- the ocean provides the important memory for climate variations
  *Trenberth*

- ... the ensemble average is closer to the truth [...] due to non-linear filtering of errors ...
  *Kalnay, Hunt, Ott, Szunyogh*
- ... skill of a [...] prediction based on the ensemble mean is shown to be always greater than that based on a single realization
  *Kumar and Hoerling*
**Question:** What are we trying to do?  
**Answer:** Improve the forecast!

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<tr>
<th>Hindcast Setup</th>
<th>MiKlip-REF</th>
<th>zoom-in example</th>
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**MiKlip-REF**

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<td>Stop forecast</td>
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**Question:** What are we trying to do? **Answer:** Improve the forecast!

The Ocean

+ The Ensemble

**Runtime Adjustments via**

*Ensemble Dispersion Filter*

MiKlip-EDF

**Stop forecast**

Ensemble Mean of Ocean Temperatures

**Restart forecast**

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**zoom-in example**

MiKlip-REF
**Question:** Is the EDF system better?  **Answer:** Compare evaluations!

Temporal Evolution of Temperature

+ Deceleration of the loss of skill over lead years
+ Significant skill improvement in LY2-5

**MSESS - Global Mean Temperature**

+ Strongest effect in the North Atlantic
  + Deceleration of the loss of skill over lead years
  + Significant skill improvement in LY2-5

**MSESS - Regional Mean Temperature**

- Lead Year 2-5

**Mean Squared Error Skill Score**

- Forecast vs Reference compared to Observations
- **MiKlip-EDF vs MiKlip-REF** compared to HadCRUT4
**Question:** Is the EDF system better?  **Answer:** Compare evaluations!

Correlation Coefficient LY2-5 - 1979 to 2013

- **Temperatur**
  - MiKlip-REF compared to HadCRUT4
  - MiKlip-EDF compared to HadCRUT4

- **Precipitation**
  - Compared to GPCC

- **Cyclones (DJF)**
  - Compared to ERA-Interim
Question: Seasonal effect of the EDF? Answer: Check first months!

Decadal system starts in November to be synchronized with the Seasonal system
- New MiKlip Prediction system -
  Check first Winter - Correlation

Lead Month 1
Nov

Lead Month 2
Dec

Lead Months 2-4
Jan DJF

Lead Month 4
Feb

Ref

EDF
Summary

Question:
What is the main idea behind this novel approach?

Answer:
Using the ensemble mean (non-linear error filter) of the ocean temperatures (decadal memory) within a forecast, keeps the forecast on track

Is the temperature forecast closer to the observations?

Yes, the prediction is better, due to deceleration of the loss of skill over lead years and a significant skill improvement in LY2-5 (global and regional)

What about other important variables than temperature?

MiKlip-EDF shows large areas of significant positive correlation coefficients from precipitation and winter cyclone track density


TAKE HOME MESSAGE:
The ensemble dispersion filter via the ensemble mean of ocean temperatures improves the accuracy of the decadal prediction system of MiKlip on the important time-scale LY2-5.
Ensemble Spread and Reliability – Near-Surface Air Temperature

MiKlip-REF

MiKlip-EDF

LESS

Reliability

-1.5  -0.75  0  0.75  1.5

perfect  still useful  marginally useful  not useful
Ensemble Spread and Reliability – Precipitation

MiKlip-REF

MiKlip-EDF

LESS

Reliability

- perfect
- still useful
- marginally useful
- not useful