# Comparison of parametric and non-parametric drift correction approaches

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## 1. Introduction

- Analysis of decadal prediction skill of temperature and Northern Hemisphere (NH) winter windstorms
- Using initialized decadal hindcasts
- Performing drift correction approaches
  - non-parametric
  - parametric (polynomial model)
- comparison of methods

## 2. Data

1. Near surface temperature (tas)
2. NH windstorm frequency [Leckebusch et al., 2008] for extended winter (Oct-Mar)
   - coherent exceedance of local 98th percentile of near surface wind speed

- observation/reanalysis:
  - for (1) **HadCRUT4** [Jones et al., 2012]
  - for (2) **ERA-Mix**
  - ERA40 (1961/1962-1989/90) and ERA-Interim (1990/91-2009/2010)
  - ERA40 corrected, in order that mean and variance correspond for overlapping years of ERA40 and ERA-Interim
- model simulations with **MPI-ESM** [Kruschke et al., 2015], 10 member
  - **decadal hindcasts**: full-field initialized with ORA S4
  - **uninitialized historical simulations**

## 3. Method

- correction of hincast $H$ considering lead-time $\tau$ dependent bias, i.e. drift $D$
- non-parametric (**NP**) approach calculates $D_\tau$ for each $\tau$ separately [ICPO, 2011]
- parametric method uses a polynomial of **different order on lead-time** $\tau$ to estimate drift. Polynomial also depends on initialization-time $t$ [Kruschke et al., 2015]

$$D(\tau,t) = (b_0 + b_1 t) + (b_2 + b_3 t)\tau + (b_4 + b_5 t)\tau^2 + (b_6 + b_7 t)\tau^3$$

- using mean square error skill score (MSESS) comparing forecast (FC) and reference (REF) [Illing et al., 2014]

$$\text{MSE} = \frac{1}{n}\sum_j (H_j - O_j)^2, \quad \text{MSESS} = 1 - \frac{\text{MSE}_{FC}}{\text{MSE}_{REF}}$$

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FONA Decadal Climate Prediction BMBF
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## 4. Results

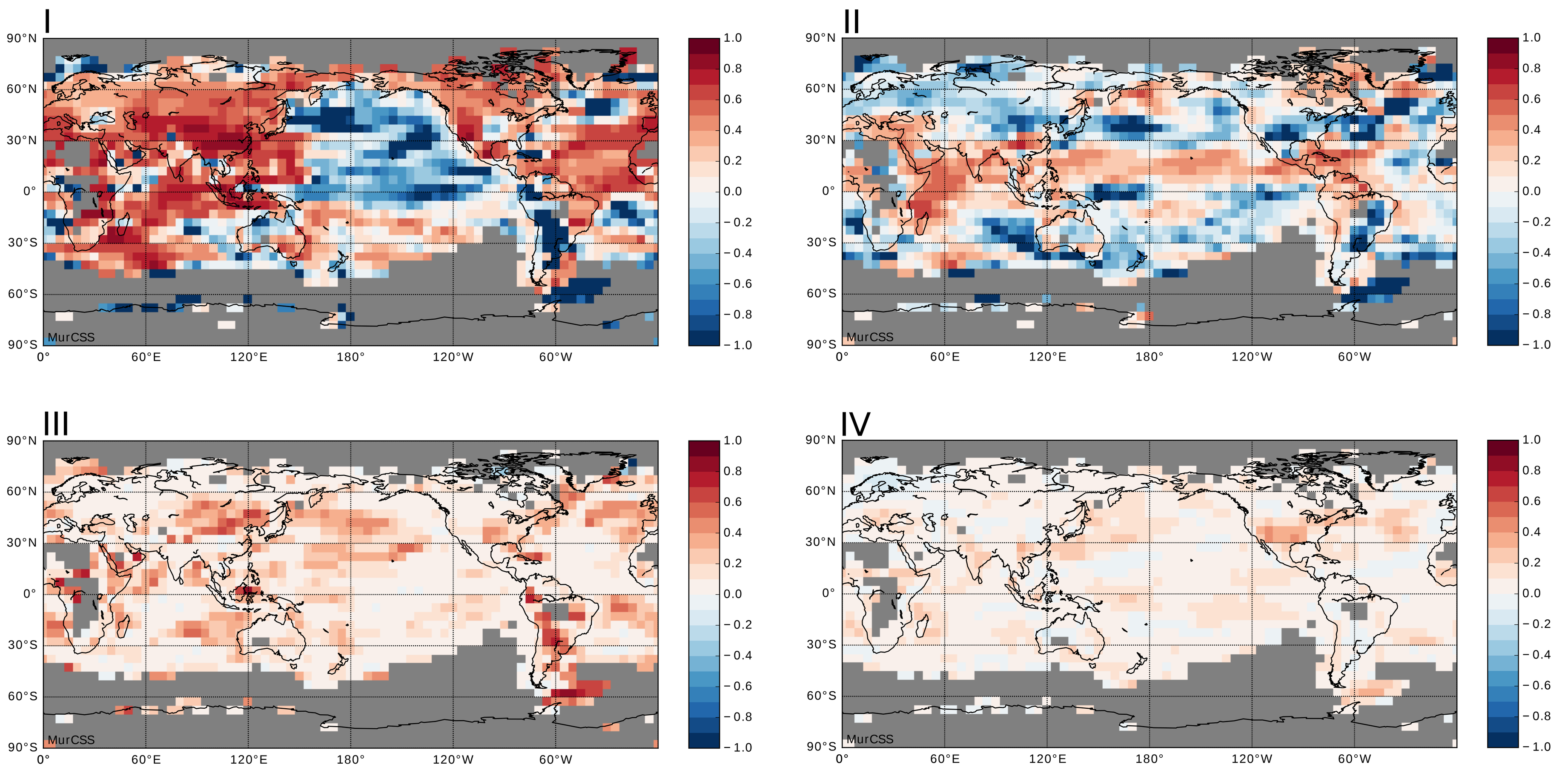
| Drift ID | Drift correction |
|---|---|
| A | NP |
| B | $\tau^0$+NP |
| C | $\tau^3$ |

Table 1: Overview of drift-correction combinations (non-parametric and polynomial of different order) using for the comparison (cf. Tab. 2)

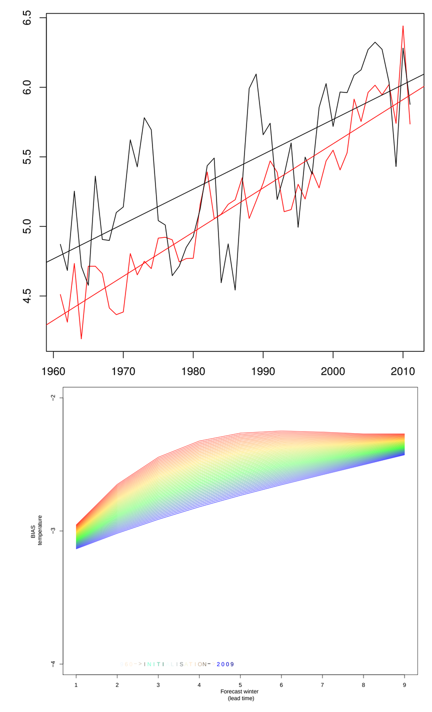
| MSESS ID | FC | REF |
|---|---|---|
| I | A | climatology |
| II | A | uninitialized |
| III | C | A |
| IV | C | B |

Table 2: Overview of MSESS combinations for the comparison of drift correction approaches. MSESS IDs refer to the panel plot below.

### 1. Near surface temperature (tas)

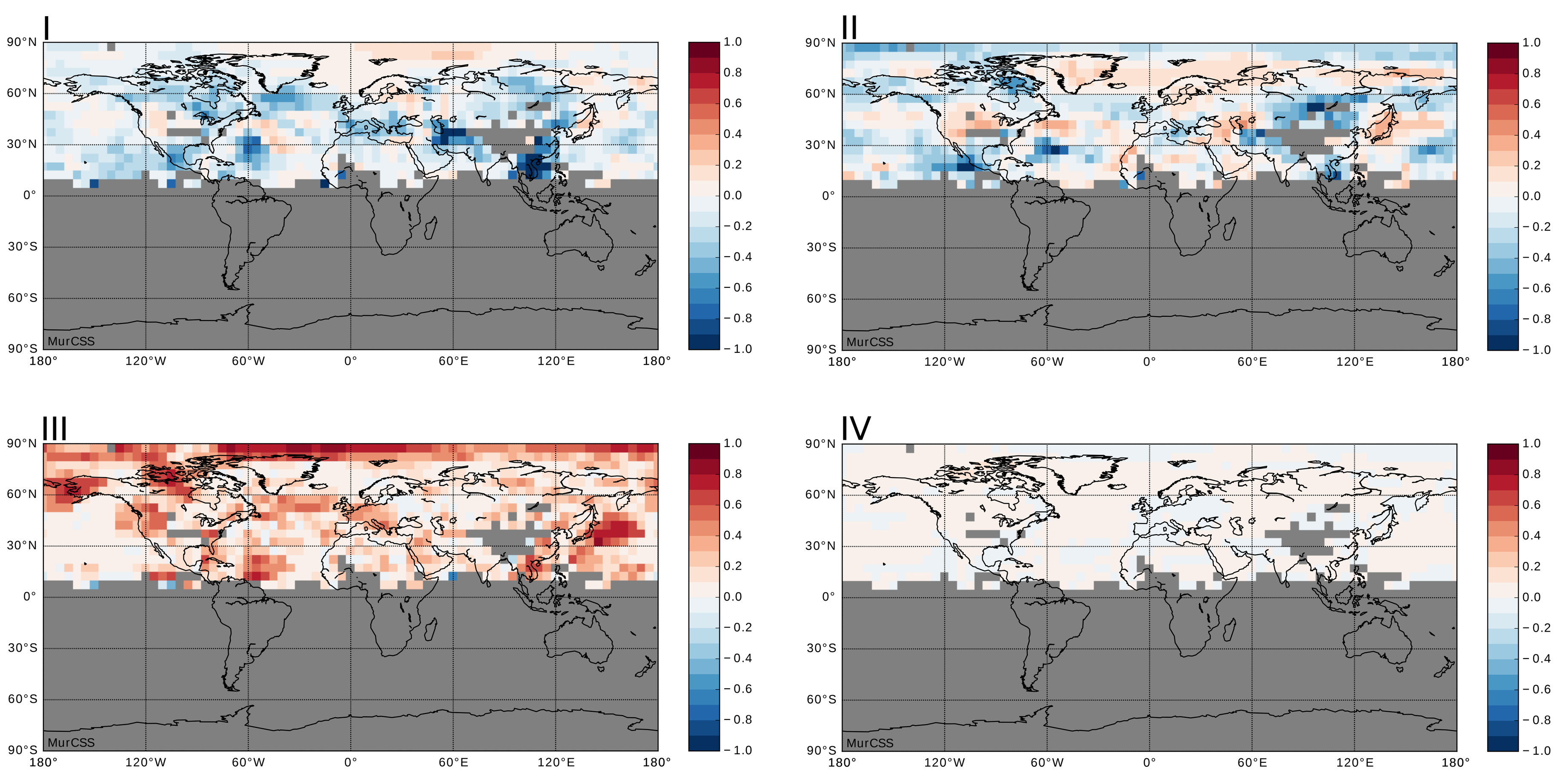



MSESS of near surface temperature for the different combinations of forecast (FC) and reference (REF) shown in Tab. 2

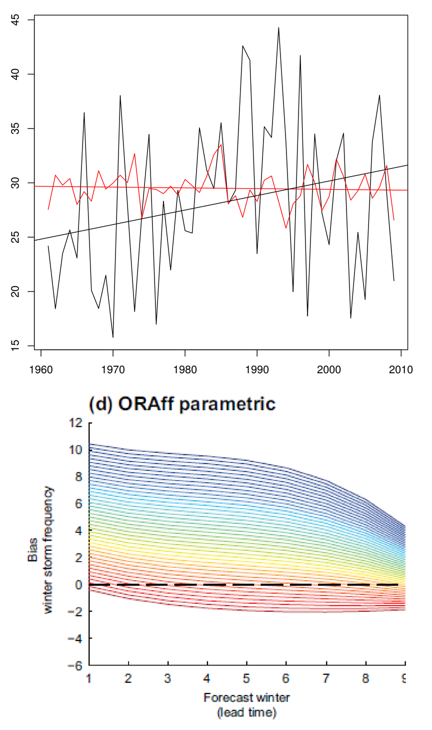



Temperature in the Northern European region defined within the IPCC SREX [IPCC, 2012]. (Upper) Time series of (black) observed and (red) modeled (uninitialized simulations) temperature. (Lower) Drift $D(\tau, t)$ whereas color denote initialization-time $t$.

### 2. Winter wind storms




MSESS of NH wind storm track density for the different combinations of forecast (FC) and reference (REF) shown in Tab. 2




Storm track density in the North Atlantic (-30°E, 48.75°N). (Upper) Time series of (black) observed and (red) modeled (uninitialized simulations) track density. (Lower) Drift $D(\tau, t)$ whereas color denote initialization-time $t$ (Fig. taken from Kruschke et al. [2015]).

## 5. Conclusions

- Decadal hindcasts show positive skill for temperature compared to the climatological forecast
- Skill is reduced for uninitialized simulations as reference
- Skill for winter wind storms is small using the non-parametric approach
- Hindcasts show positive skill for winter storms compared to climatological forecast as well as uninitialized simulations in certain regions using the parametric approach (not shown)
- Parametric correction approach leads to large increase of skill for both temperature and wind storms
- **Third order polynomial is beneficial for temperature**
  - due to **large drift** and **small deviation of trend**
- **Trend correction (zero order polynomial) has largest effect on wind storms**
  - due to **small drift** and **large deviation of trend**

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