# Evaluation of near-surface temperature forecasts against super-site observations

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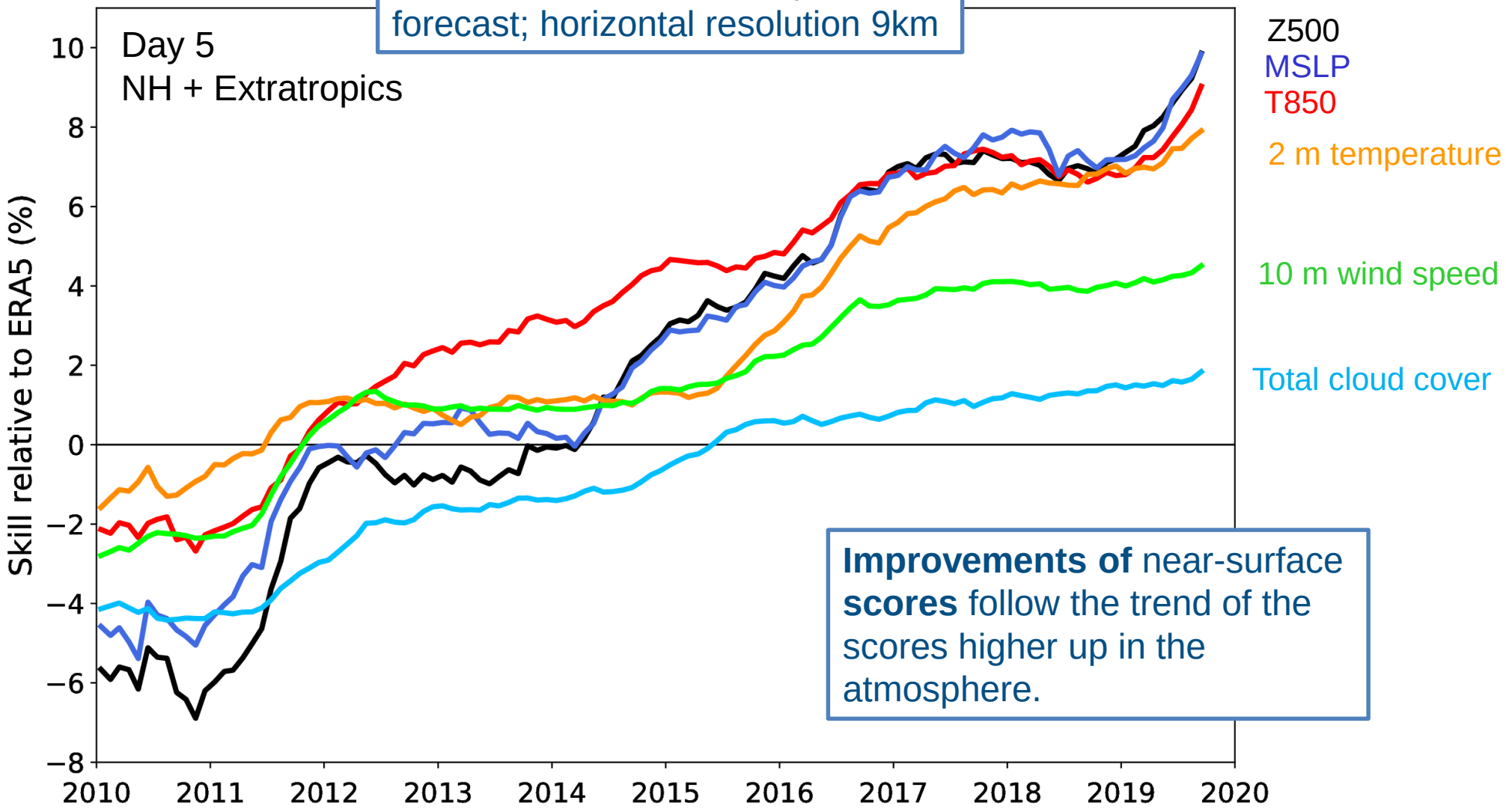
ECMWF

# Continuous improvements in predictions of near-surface weather parameters – HRES

**HRES** – ECMWF's 10 day forecast; horizontal resolution 9km

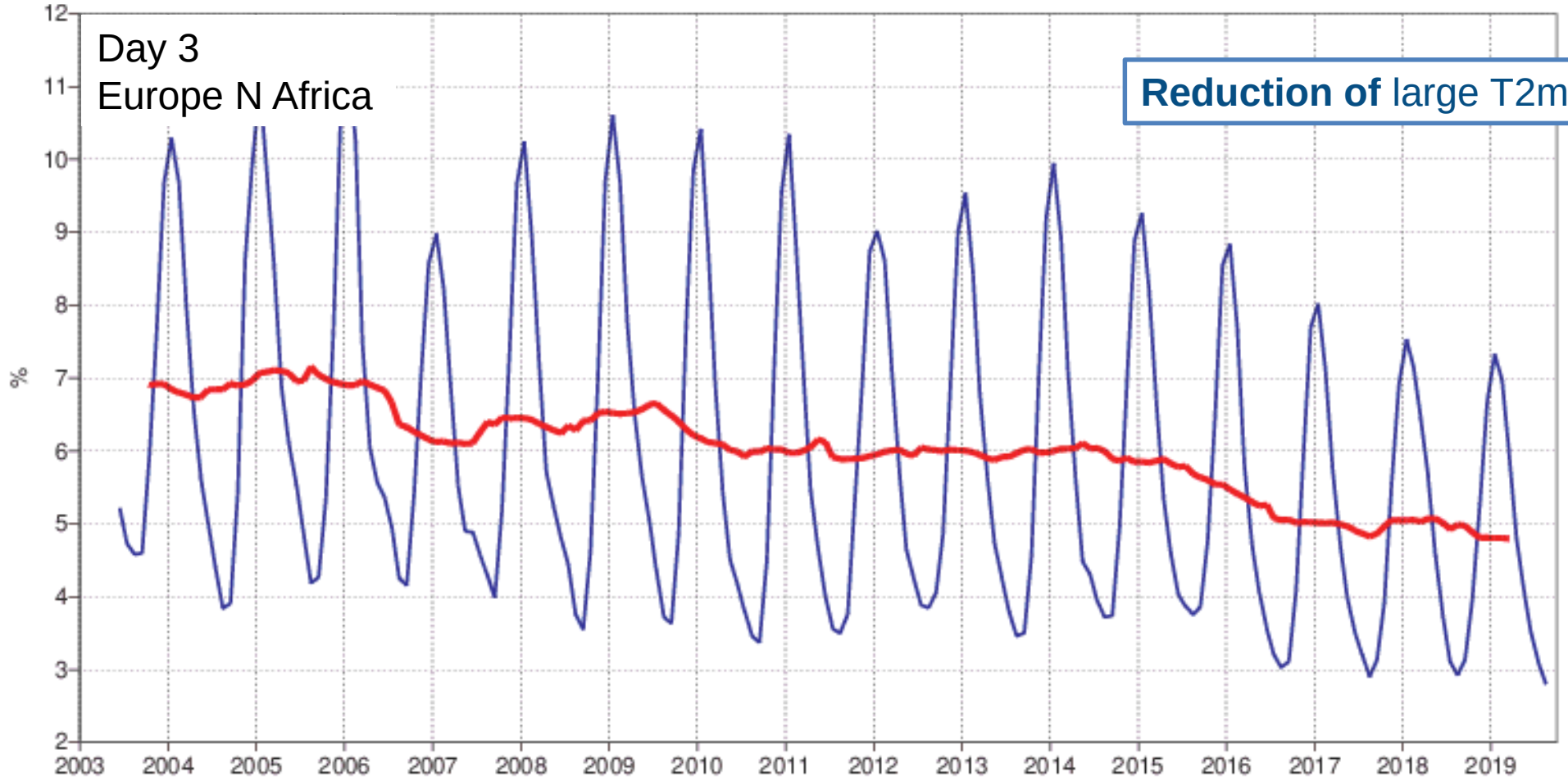



**Improvements of** near-surface **scores** follow the trend of the scores higher up in the atmosphere.

# Continuous improvements in predictions of near-surface weather parameters – ENS

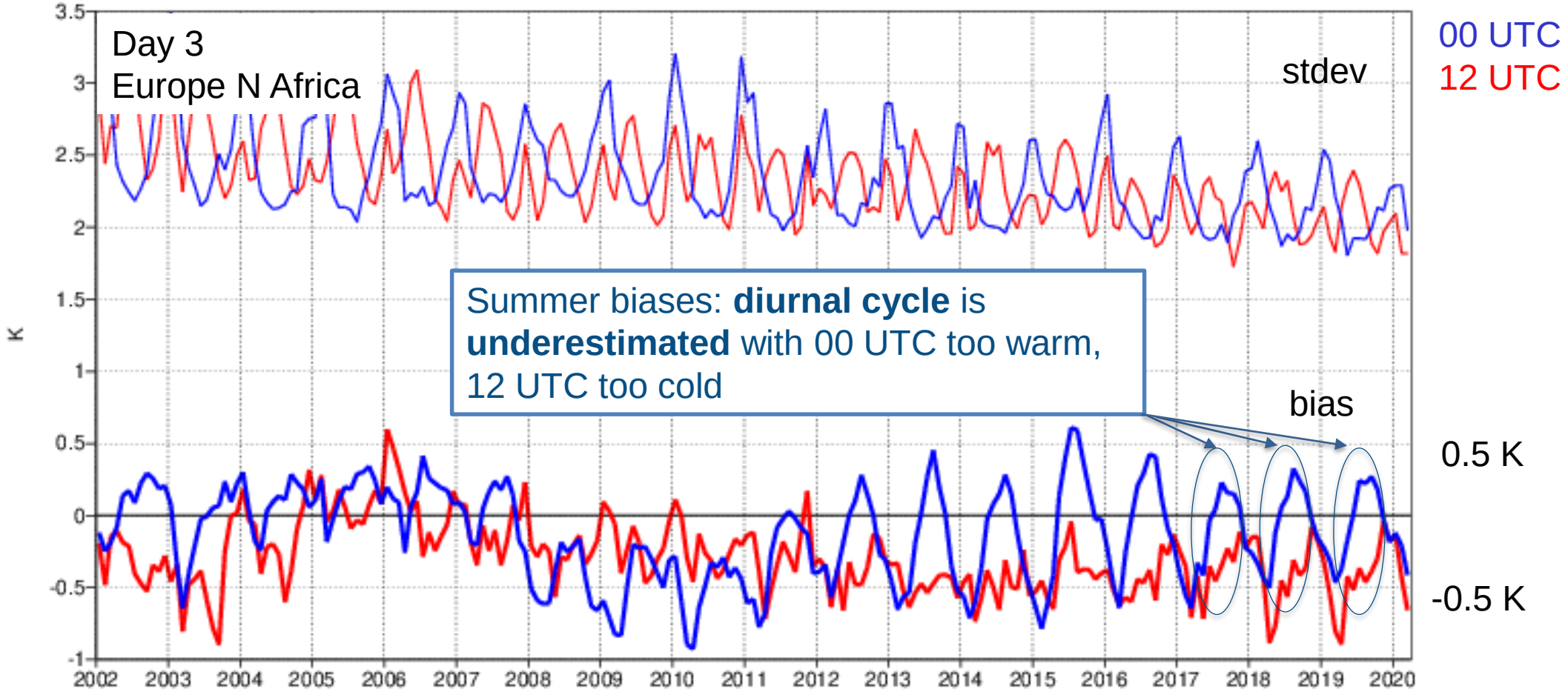
**ENS** – ECMWF's ensemble (50+1 member); horizontal resolution 18km

12 month running mean
3 month running mean




**Reduction of** large T2m **errors**

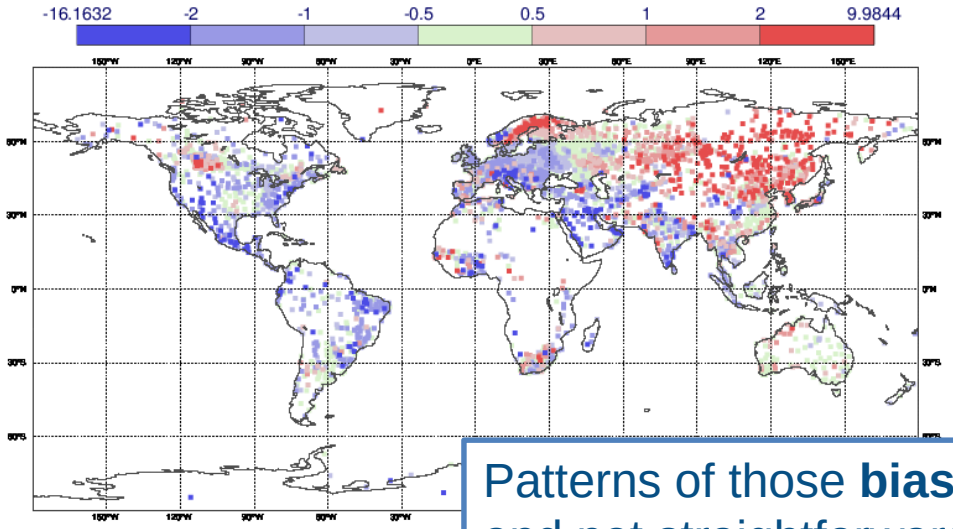
# Addressing systematic errors, i.e. underestimation of diurnal cycle of **2m temperature**



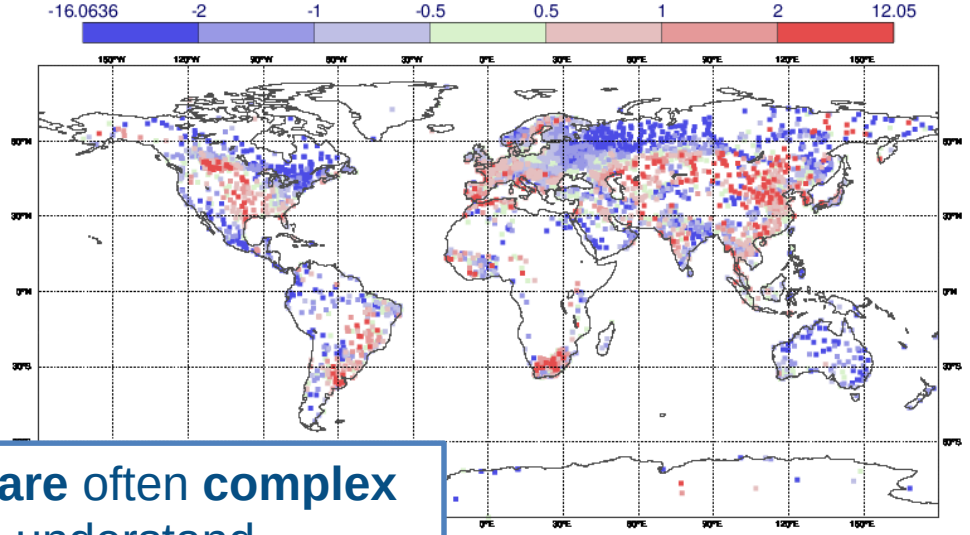
# Other models have biases in their 2m temperature as well

Day 3, 00 UTC T2m bias DJF 2018-19

ECMWF

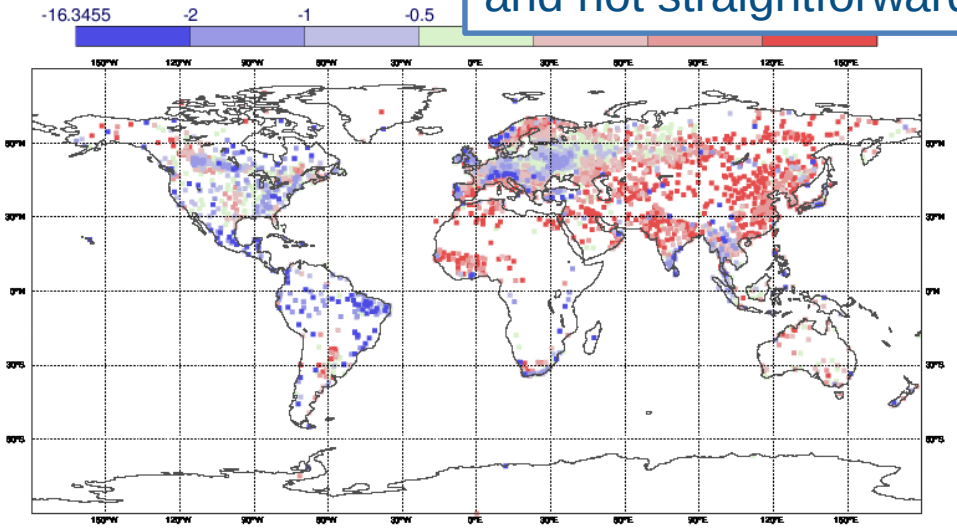



JMA

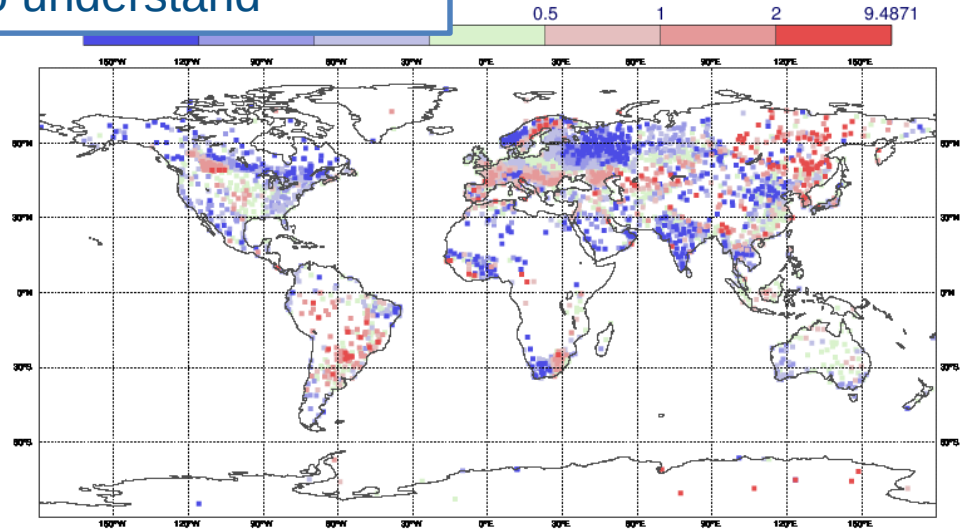



Patterns of those **biases are** often **complex** and not straightforward to understand

NCEP

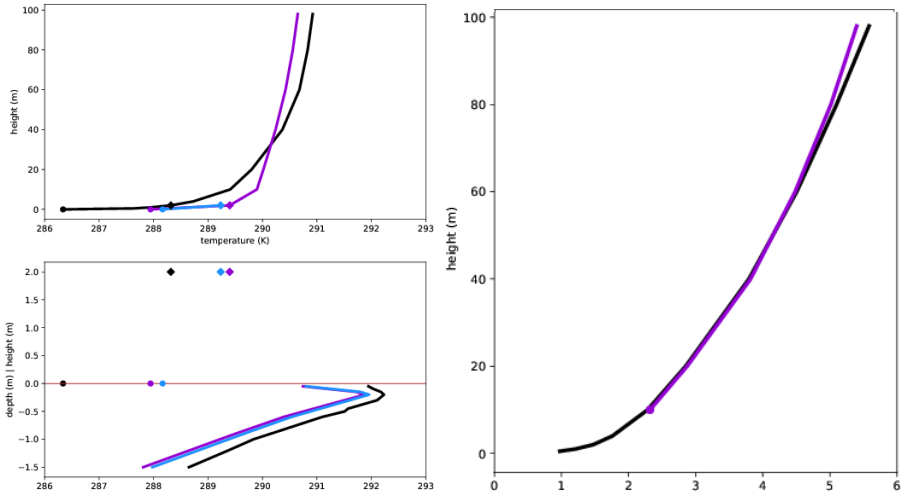



UKMO



# Supersite observations enable in-depth analysis of surface process

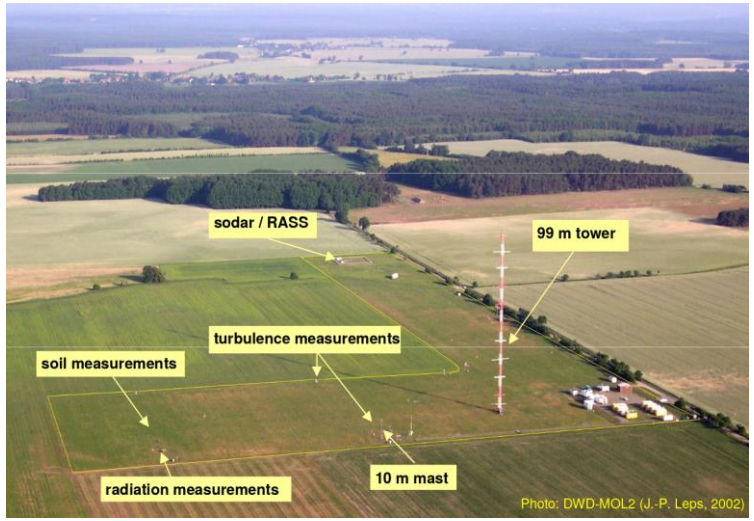
Supersites provide **high-resolution observations** of meteorological parameters in a number of heights of the near-surface atmosphere, as well as the soil.




temperature (K)

wind speed (m/s)

## Falkenberg

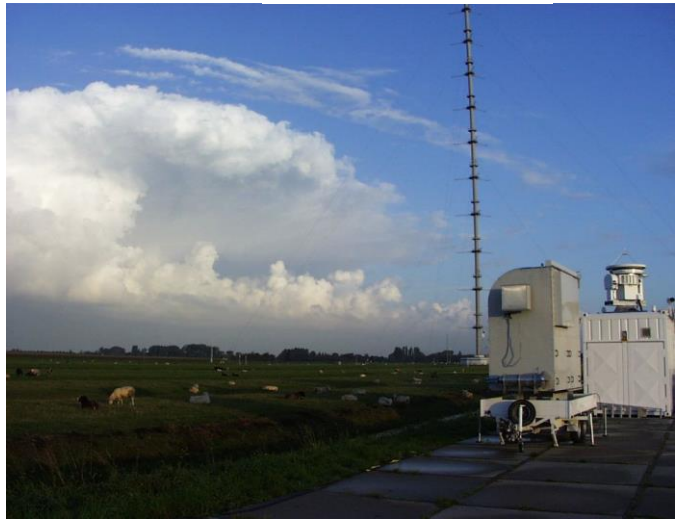



https://www.dwd.de/EN/research/observing_atmosphere/lindenberg_column/boundery_layer/gmfalkenberg_node.html

## Sodankyla

https://litdb.fmi.fi/ioa0003_data.php

## Cabauw



http://www.cesar-observatory.nl/

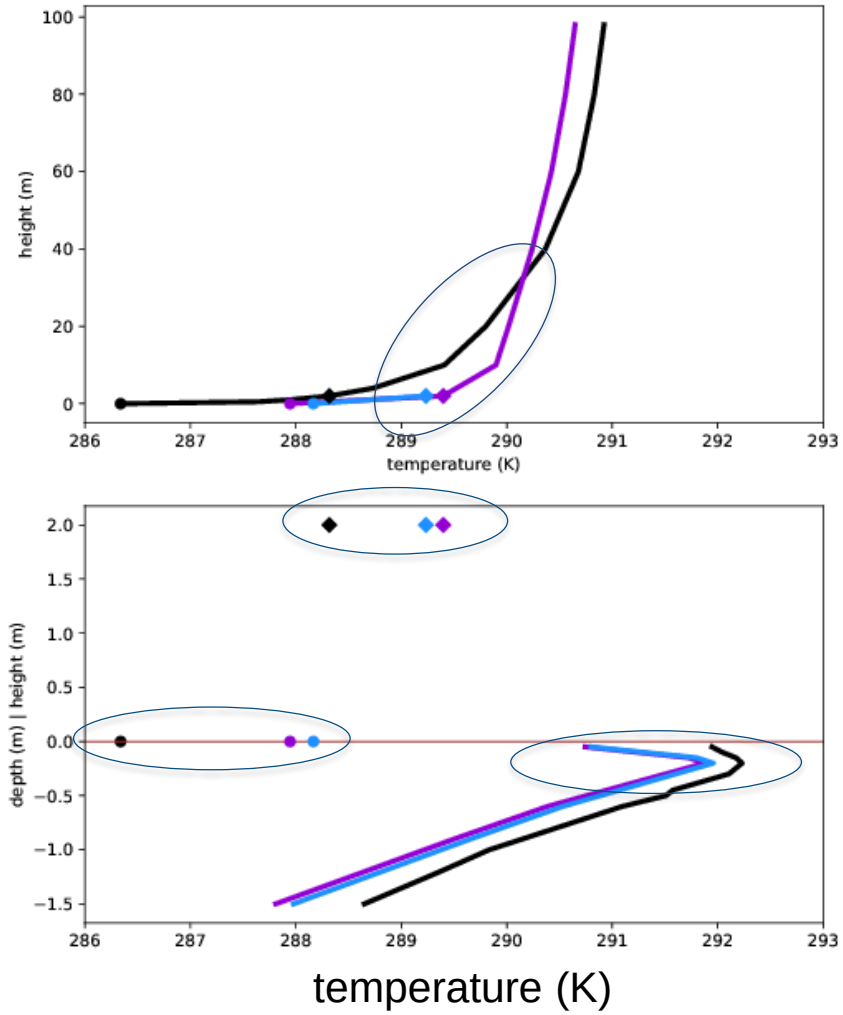
# Supersite observations enable in-depth analysis of surface process

Step 96
(0 UTC)

Falkenberg

JJA
2017

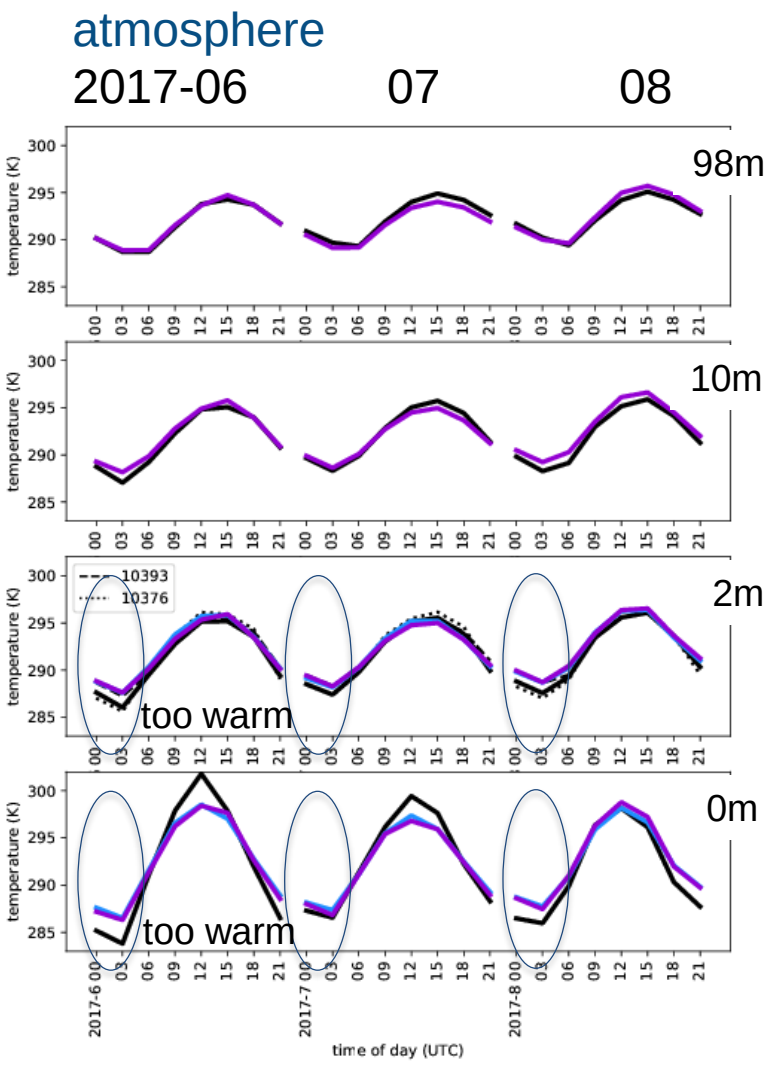
HRES
ENS mean
OBS

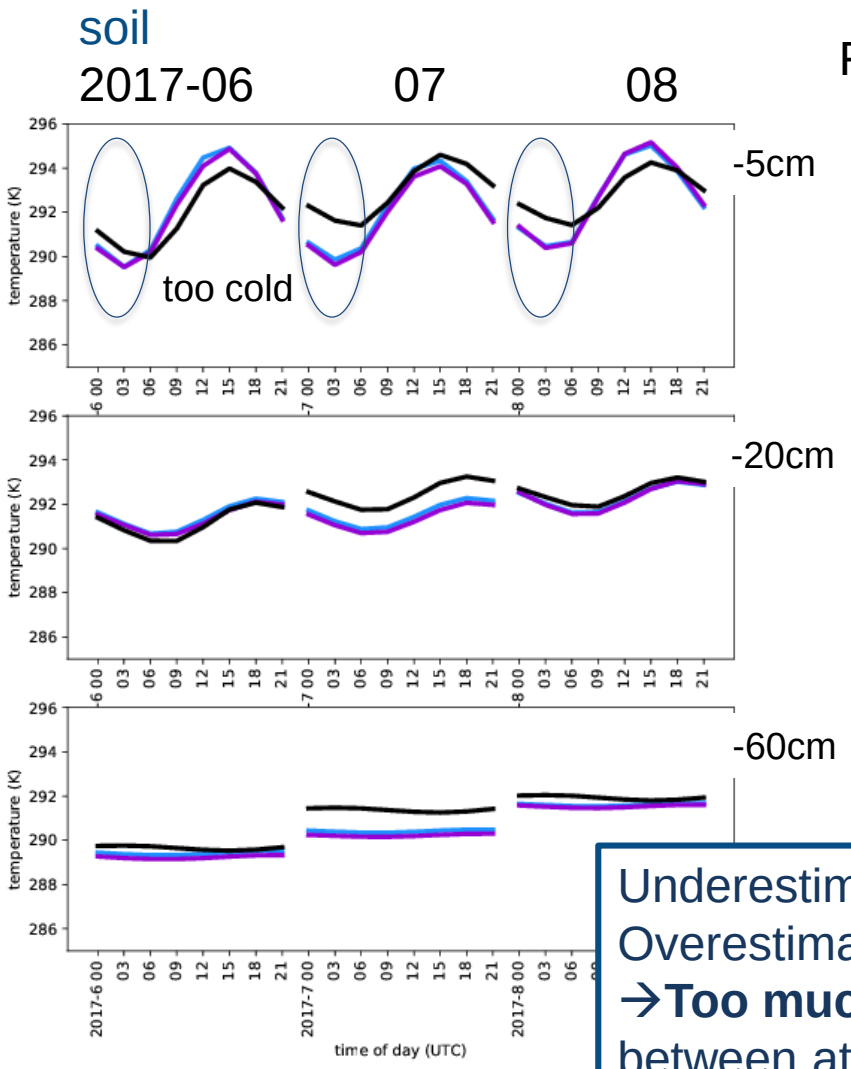



HRES:
- lowest part of atmosphere too warm
- 2m temperature too warm
- skin temperature too warm
- soil temperature too cold

ENS mean:
Same systematic error

# Supersite observations enable in-depth analysis of surface process



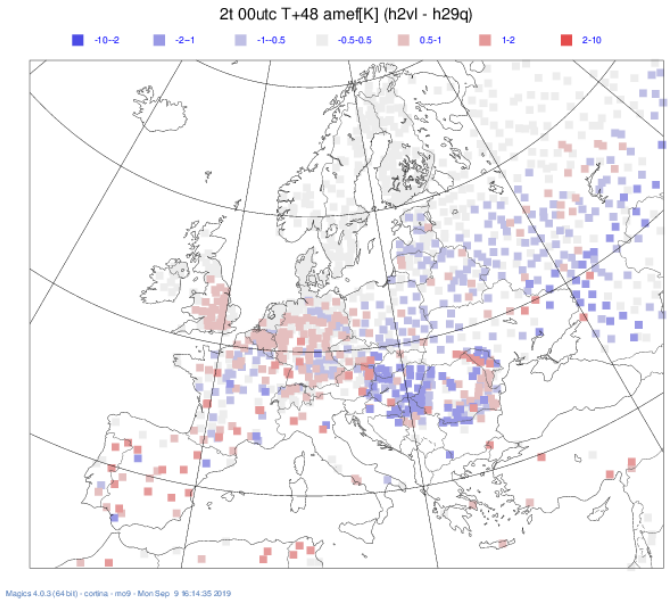

Falkenberg

HRES
ENS mean
OBS

Underestimation of T2m, Tskin;
Overestimation of first soil layer;
→**Too much energy exchange** between atmosphere and soil cools at night first soil layer and warms near-surface atmosphere

# Sensitivity to land-atmosphere coupling

Impact of reduced coupling: better | worse




T2m

00 UTC

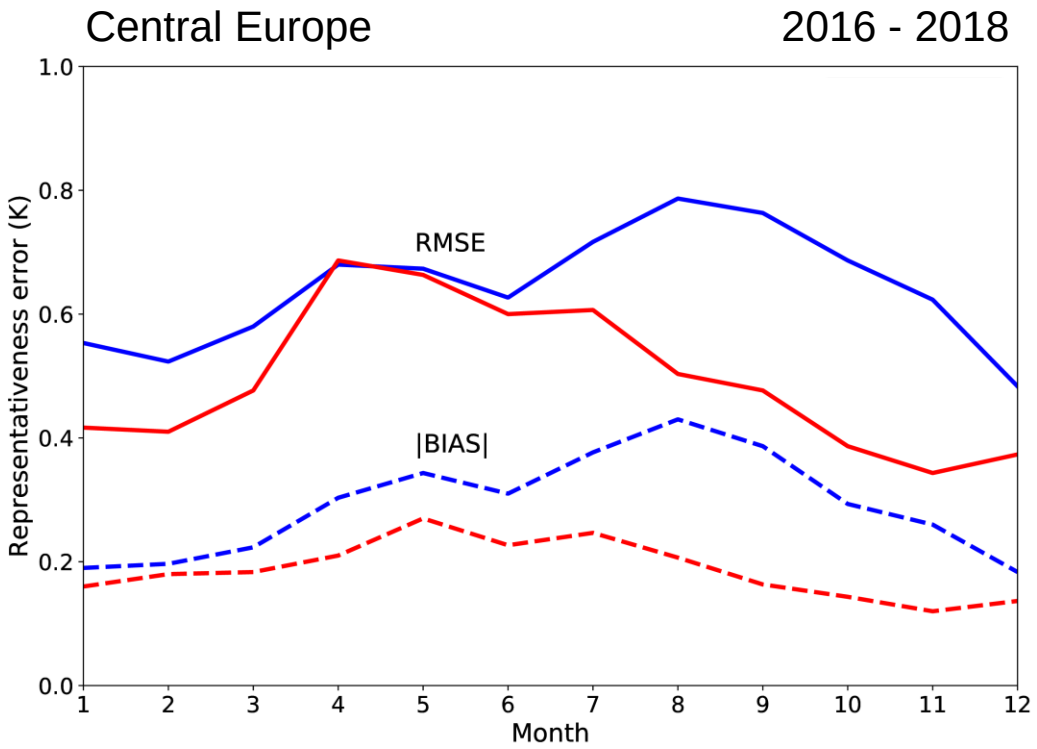
Reduction of land-atmosphere coupling confirms expectation:
Cooling of T2m at night, and warming of T2m at daytime.
BUT only improvement in some regions, and degradation in others

→ Due to heterogeneity,
→ representation of vegetation in semi-arid areas, and
→ others sources of biases e.g. vegetation, soil type, land use.

→ **How representative** are point observations for a grid box?

# Representativeness error derived for Central Europe

**Representativeness error** = Difference of a grid box mean (average of all SYNOP stations within a grid box; radius = 20 km) and the point observation.




00 UTC
12 UTC

Representativeness error smallest in winter. Due to higher wind speeds in that season.

**Provides benchmark** for weather models. **Minimum level of forecast error** that can be expected at a given horizontal resolution.

HRES T2m RMSE for Central Europe currently about 2 K.

# Summary

- **Super-site observations** are **valuable additional source** for further developing parametrizations of boundary layer processes and surface-atmosphere exchange.
- Help to **gain deeper insight** into possible causes of biases in near-surface weather parameters.
- **Limitations** must be kept in mind when using **point observations**.
- **Representativeness error** indicates the minimum level of forecast error that can be expected at the given horizontal resolution.

areas for **further investigations of T2m bias**:

- more up-to-date mapping of vegetation, land use, soil properties
- heat transfer within the soil