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

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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

Reduction of large T2m errors

Day 3
Europe N Africa

12 month running mean
3 month running mean
Addressing systematic errors, i.e. underestimation of diurnal cycle of 2m temperature

Summer biases: **diurnal cycle** is **underestimated** with 00 UTC too warm, 12 UTC too cold
Other models have biases in their 2m temperature as well.

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

Falkenberg

Sodankyla

Cabauw

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

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

http://www.cesar-observatory.nl/
Supersite observations enable in-depth analysis of surface process

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

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

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.

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