

# Marine Atmospheric Observations vs. ERA-40 in the North Sea - Limitations & Challenges

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## Departmental Research Programme

- National Meteorological Service in Germany (DWD)
- German Maritime and Hydrographic Agency (BSH)
- German Federal Institute of Hydrology (BfG)
- German Federal Waterways Engineering and Research Institute (BAW)

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## Summary

For the validation of regional climate models, high quality observations and/or reanalyses (i.e. ERA-40) data are needed as reference of the actual climate state.

Comparisons of marine atmospheric in-situ observations (DWD-Archive) with ERA-40 show a systematic bias for the small-scale parameter air temperature near the coasts in the reanalysis data for the winter months. This apparent land-influenced bias does not appear in the analysis for sea level pressure, probably due to its larger scale and land-sea insensitivity. The bias may be caused by the ERA-40<sup>th</sup> interpolating process from the spherical calculations to the final grid.

A higher resolution of the reanalyses data set might therefore reduce the land-influenced bias and improve its quality near the coasts. This would provide a better reference for subsequent high resolution modelling, coastal engineering, etc., which will become more and more important in the future.

## Limitations & Challenges

- Existing climate models are not able to reproduce the spatial variability in the North Sea area. Especially, no regional coupled atmosphere-ocean models (RCAOMs) exist to describe the complex interactions properly. Within the KLIWAS research programme, three RCAOMs will be implemented.
- Reference data are needed for validation purposes, i.e. high quality controlled surface marine in-situ observations and/or reanalyses.
- The problem:** Marine in-situ observations are unevenly distributed in space and time, while the resolution of the reanalysis data is coarse.

## Observations vs. ERA-40: Air Temperature

To compare the different data sets, suitable grid boxes have to be identified. Two grid boxes without obvious land influence in the North Sea area appear to be statistically consistent and of sufficient quality for further investigations (Fig.1).

Fig.1: Mean ERA-40 2 m air temperatures in °C in the North Sea area for the period 1961-2000

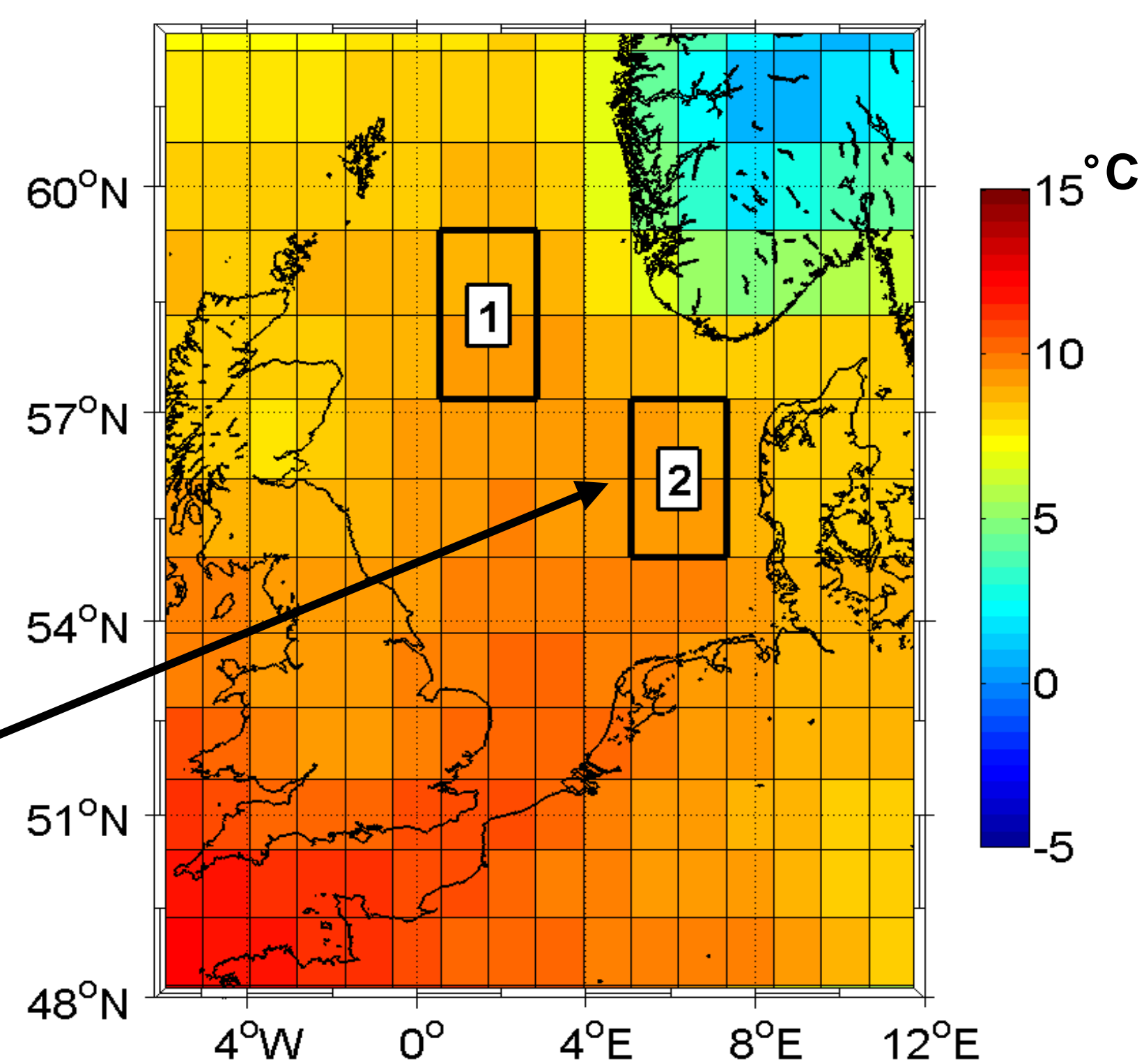


Figure 2 shows the distribution of air temperatures of observations and ERA-40 reanalysis in those boxes. Box 2 shows differences in the winter months, even in the median value, and predominantly near the coast (2b / 2d).

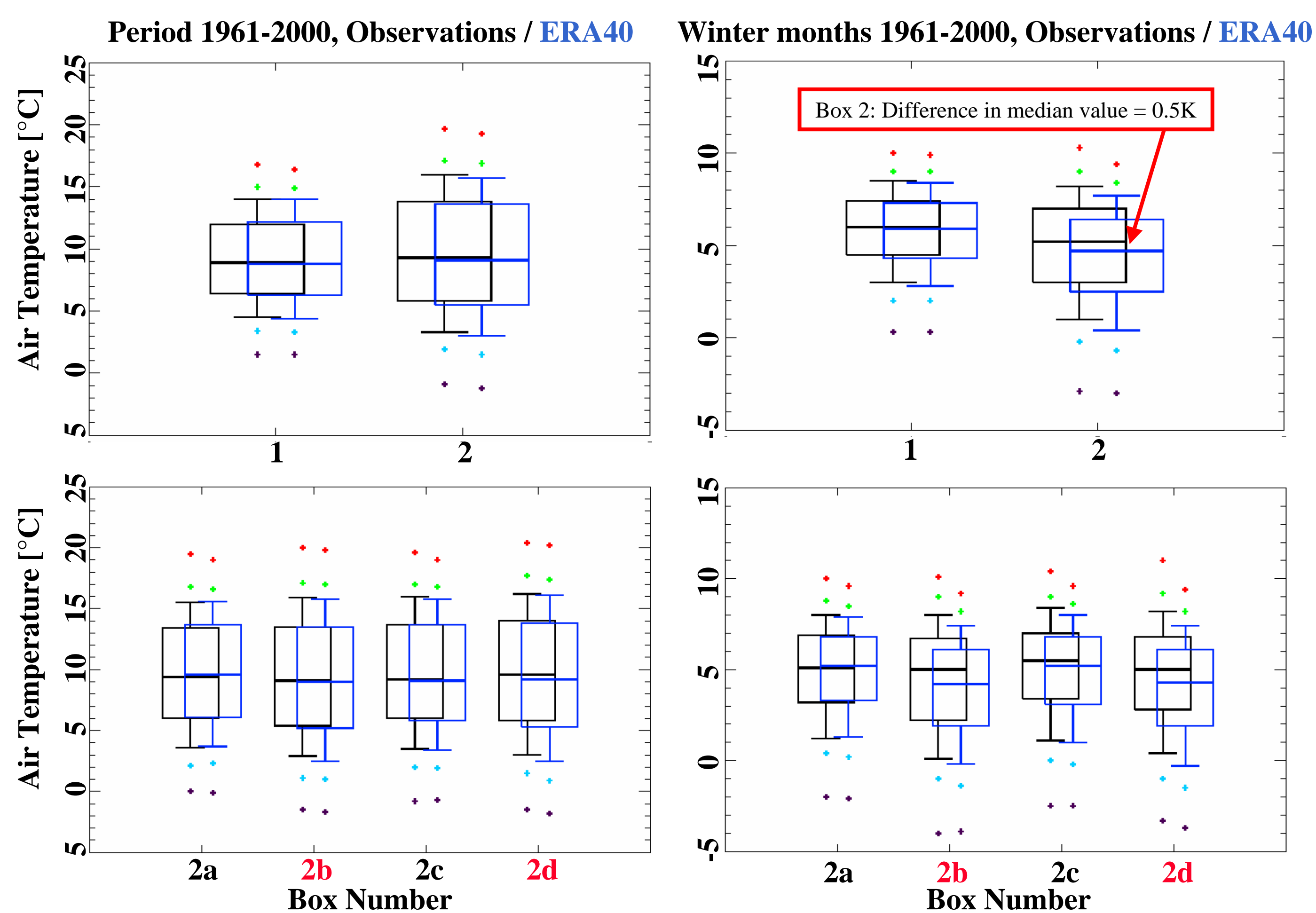


Fig 2: Air temperature from observations (black) and ERA-40 (blue) for the period 1961-2000 (left side annual values, right side winter months DJF) for box 1 and 2 (above). The sub grid boxes of box 2 are shown below. Median values and the 25 and 75 percentiles are marked by the box, the whiskers show the 10 and 90 percentiles, the plus the percentiles 1, 5, 95, 99

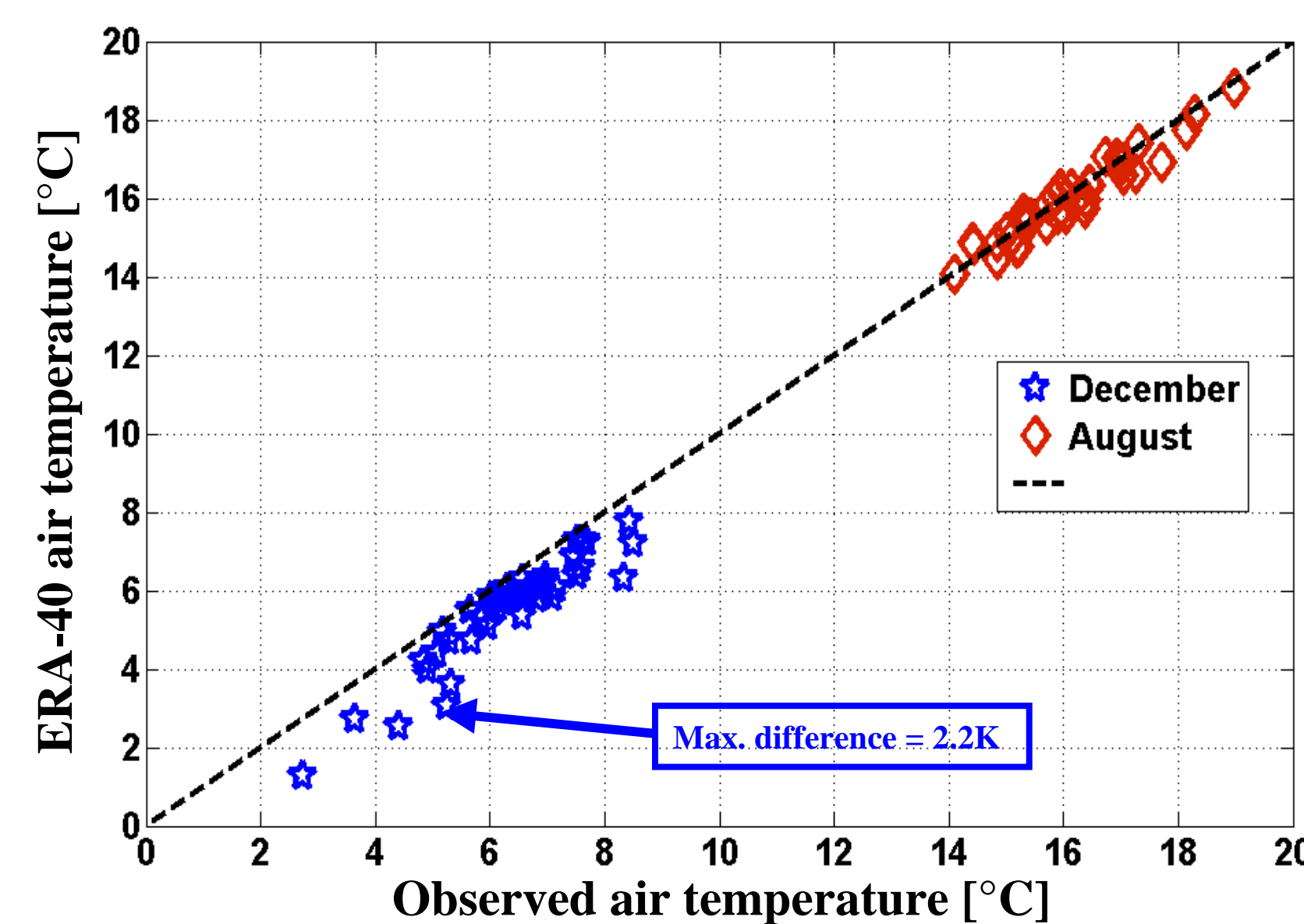


Figure 3 shows monthly mean air temperatures for December and August for grid box 2 of the 40yr period. Apparently, all ERA-40 December means are colder than the corresponding observed values.

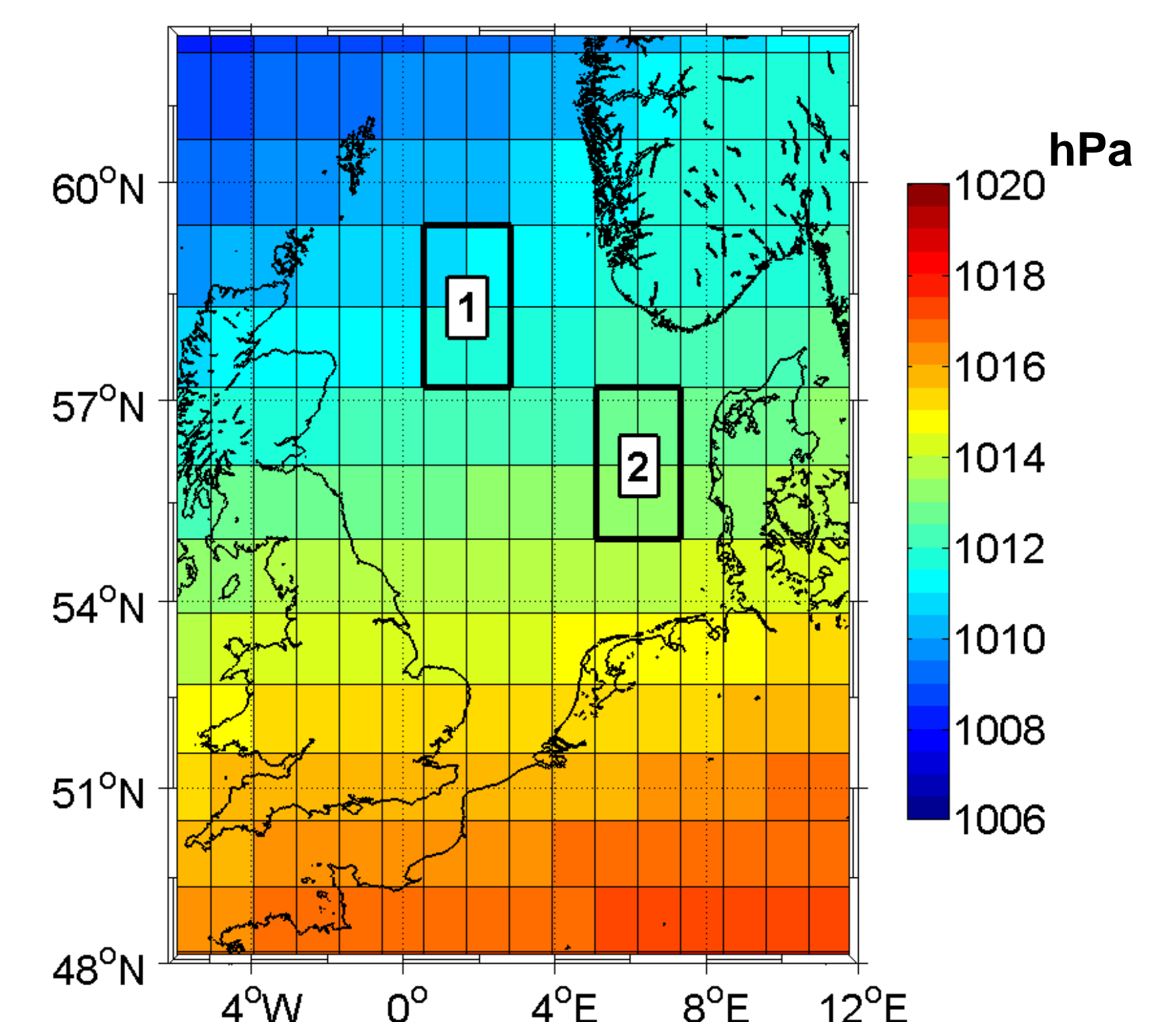
Fig.3: Mean air temperature for observations and ERA-40 data, Box 2, December and August 1961-2000

The transition from “good” to “bad” fitting happens in October and vice versa in April (not shown). The ERA-40 temperature data seem to be biased to colder values during the whole winter half year, caused by the land-influence of grid points closer to the coast. It should be noted, that all boxes with obvious land influence show positive biases in the summer and negative in the winter months, while box 1 shows only marginal differences during the whole year.

## Observations vs. ERA-40: Sea Level Pressure

No systematic differences can be found between ERA-40 sea level pressure and the observations in any of the grid boxes, neither in the mean nor in the percentiles (not shown). The reason may be the larger scale of the pressure patterns and the insensitivity from land-sea distribution.

Fig.4: Mean ERA-40 sea level pressure in hPa in the North Sea area for the period 1961-2000



Finally, Figure 5 shows the scatter plot of the same months as in Figure 3, but for the sea level pressure. No bias is apparent. The spread is larger with an increased low pressure occurrence during December, since more low pressure system paths lead through this area, especially during NAO+ phases. This significantly effects the wintertime circulation in Europe.

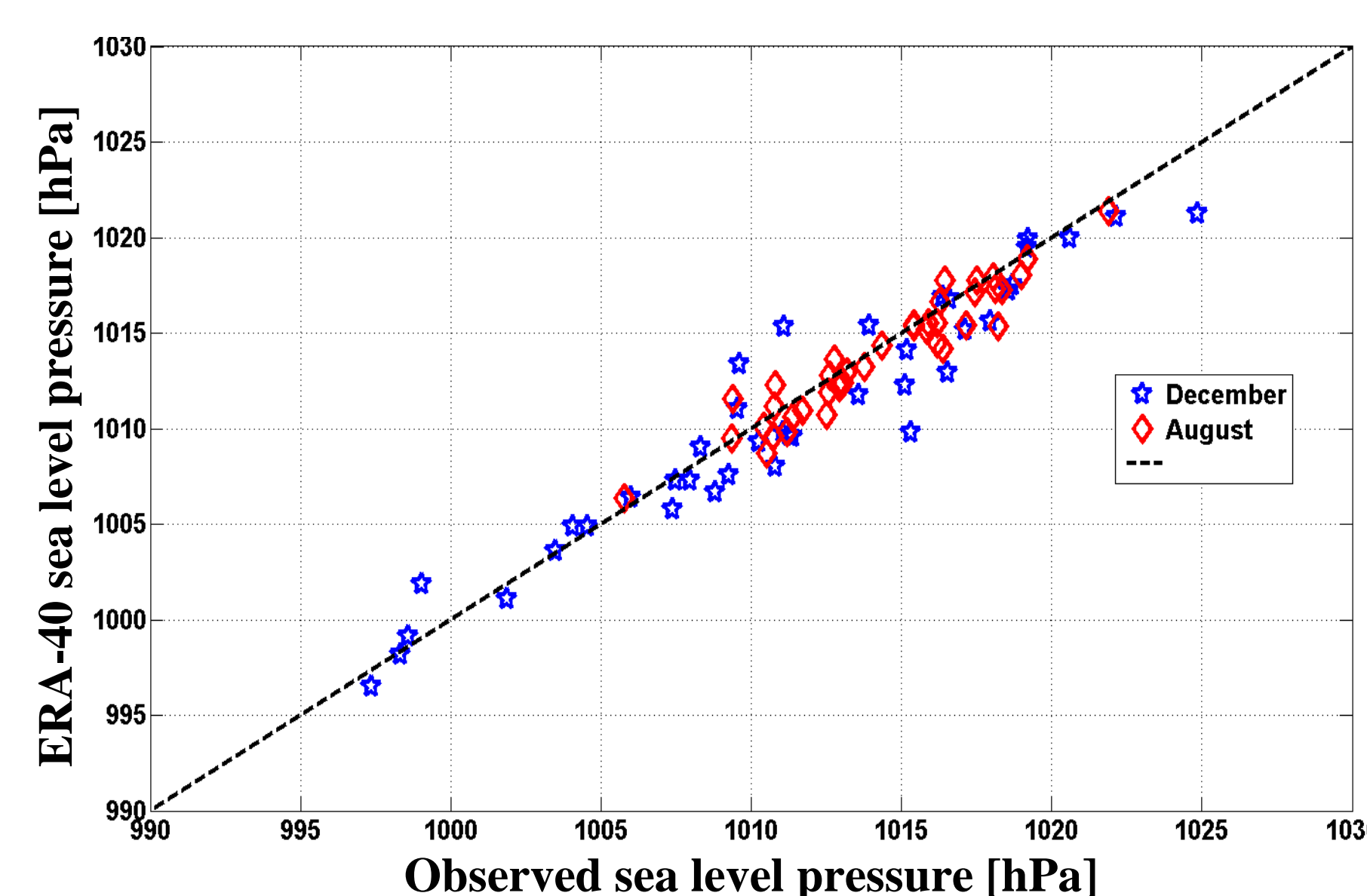


Fig.5: Mean sea level pressure for observations and ERA-40 data, Box 2, December and August 1961-2000

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