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Memo: 2021 September Wind Speed Differences from the ERA5T-ERA5 Anomalous Snow Depth Assimilation Issue

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Summary

Assimilation of anomalous snow depths over Asia has triggered a re-run of the ERA5/ERA5T models by ECMWF. The two datasets now differ for months of Sep-Dec 2021. The final ERA5 100m wind data differs about 0.1 m/s as monthly average – with largest differences in the tropics. Differences in individual timestamps can be as large as 10-15 m/s.

1. Introduction

In early December 2021, ECMWF informed that the final, validated ERA5 data will differ from the preliminary ERA5T for the months of September to December 2021. This is caused by the assimilation of anomalous snow depth observations over Central Asia in the ERA5T dataset – which has been corrected in the ERA5 dataset. While ECMWF reports that the affected area is small and affects mainly surface parameters [1], this memo provides a brief input on the impact on modelled wind speeds in 100m height - as this parameter and height is of main interest for most wind-energy applications.

2. Analysis

The following gives a closer investigation of differences in wind speeds between the preliminary ERA5T and the validated ERA5 data. The analysis is done for the global dataset and for specific, selected data-nodes by comparing ERA5T and ERA5 for September 2021 recently made available from ECMWF.

2.1 Monthly Averaged Wind Speeds

Figure 1 and Figure 2 show the difference on the monthly average wind speeds between the datasets of ERA5T and ERA5: These differences are below 0.1 m/s for most of the world. When normalized with the wind speed, the largest deviations are in the tropics where wind speeds are small.

2.2 Individual Time Step Wind Speeds

For individual time steps differences can be much larger. Figure 3 shows two time-stamps as example of differences between ERA5 and ERA5T. The top plot shows large differences in the wind fields in the Western Mediterranean Sea. Differences between the model runs are exceeding 10 m/s. For the same case pressure differences up to 300 Pa on the mean sea level pressure are observed (not shown). At the same time the wind fields in the North Sea are quite similar. The bottom of Figure 3 shows a case where large differences are observed in the North Sea. These differences are caused by a slight shift in the position of the fronts together with small differences in magnitude. At the same time, differences in the Mediterranean are minimal.

Figure 4 shows time series of differences in the Western Mediterranean Sea. We can see that differences between exceeding 5 m/s are commonly present that region. Figure 5 shows a point in the North Sea where differences in the wind speed are much smaller. A large spike occurs at the same time as for the example from Figure 3 bottom. Figure 6 shows a global map of the absolute difference in instantaneous wind speed, with the largest difference observed is above 15 m/s.

3. Conclusion

In conclusion, wind speed differences between the ERA5T and ERA5 datasets can be very large when looking at individual time series samples (>10m/s), but mostly average out to acceptable levels on a monthly basis (~0.1m/s). For analyses that rely on individual time samples, these differences are concerning – and appropriate action must be taken to analyse if a particular location is affected – and to validate or rectify any conclusions drawn based on ERA5T data. The differences seen here are likely not directly caused by the erroneous snow depth data – but likely also driven by the (numerical) nature of an assimilation model and the data sources used.

4. Data Update

Affected months (September to December 2021) in the preliminary ERA5T dataset will be updated with the final version of ERA5 when these are released from ECMWF (typically with a lag of about 3 months).

5. References

[1] Copernicus Support Announcement: "*IMPORTANT: Final validated ERA5 product differ from ERA5T for Sep-Dec 2021*", available here.

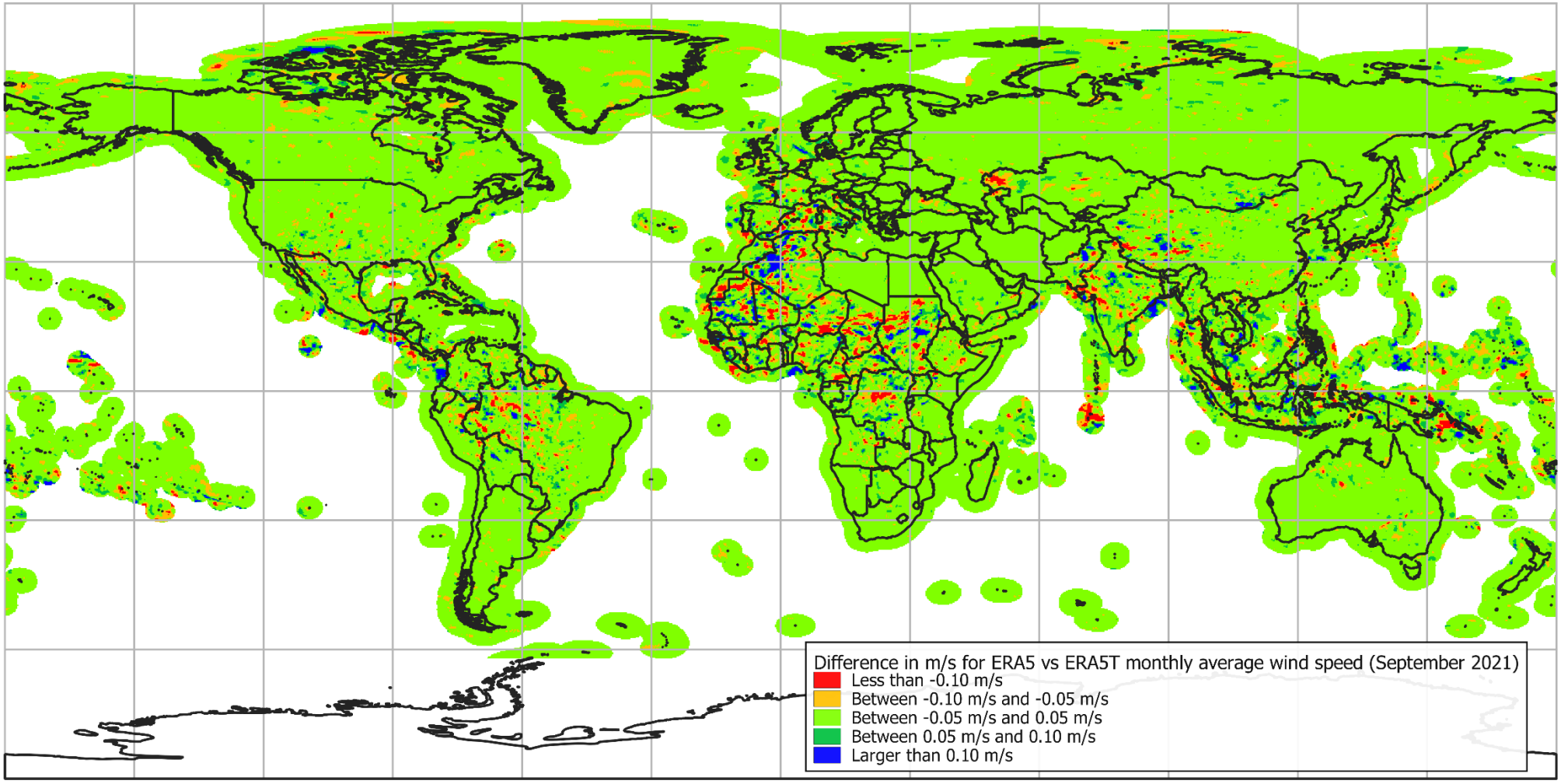

Figure 1: Absolute deviation [m/s] between ERA5 and ERA5T for monthly average wind speeds at 100m (September 2021).

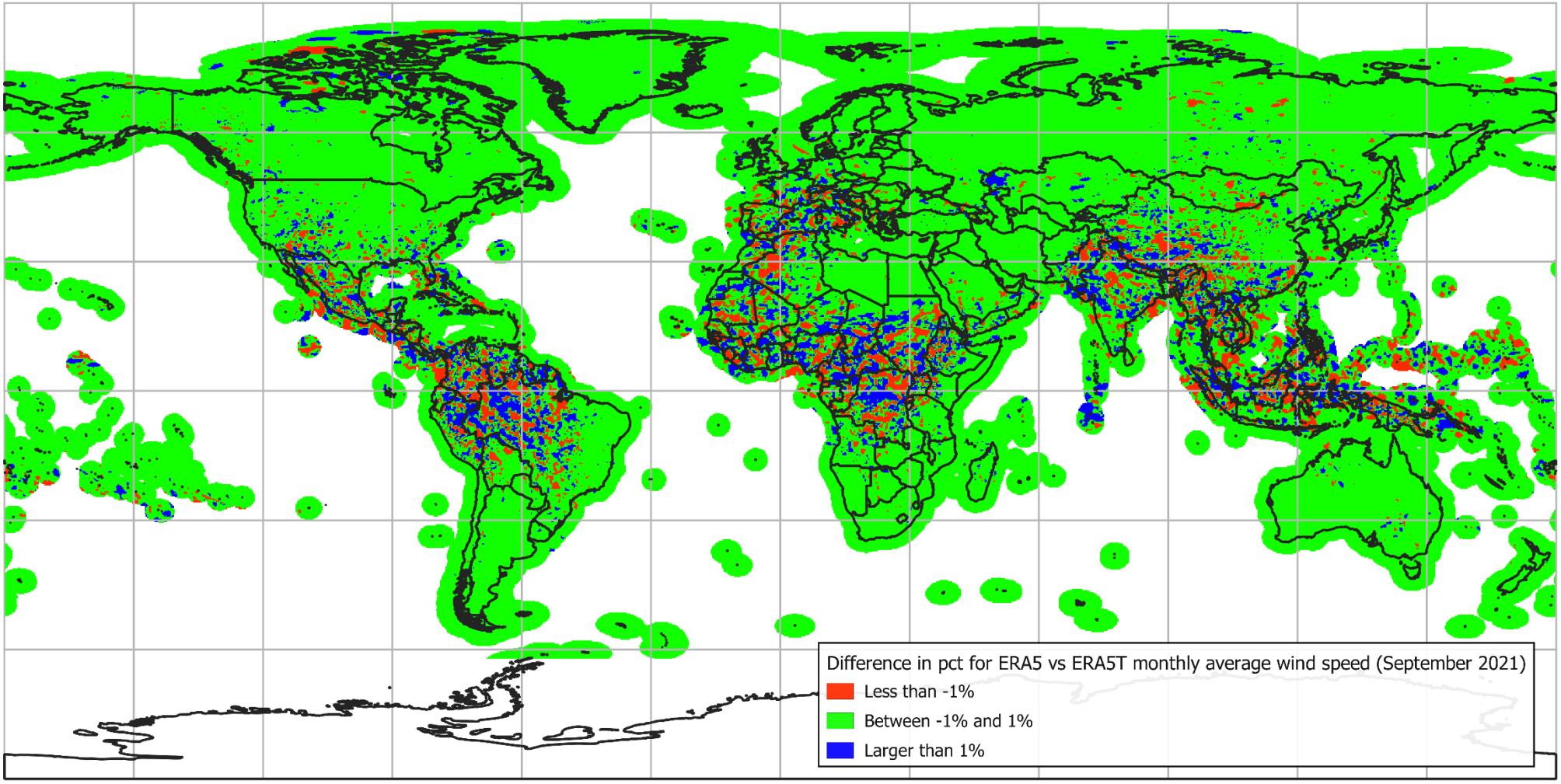

Figure 2: Relative deviation [%] between ERA5 and ERA5T for monthly average wind speeds at 100m (September 2021).

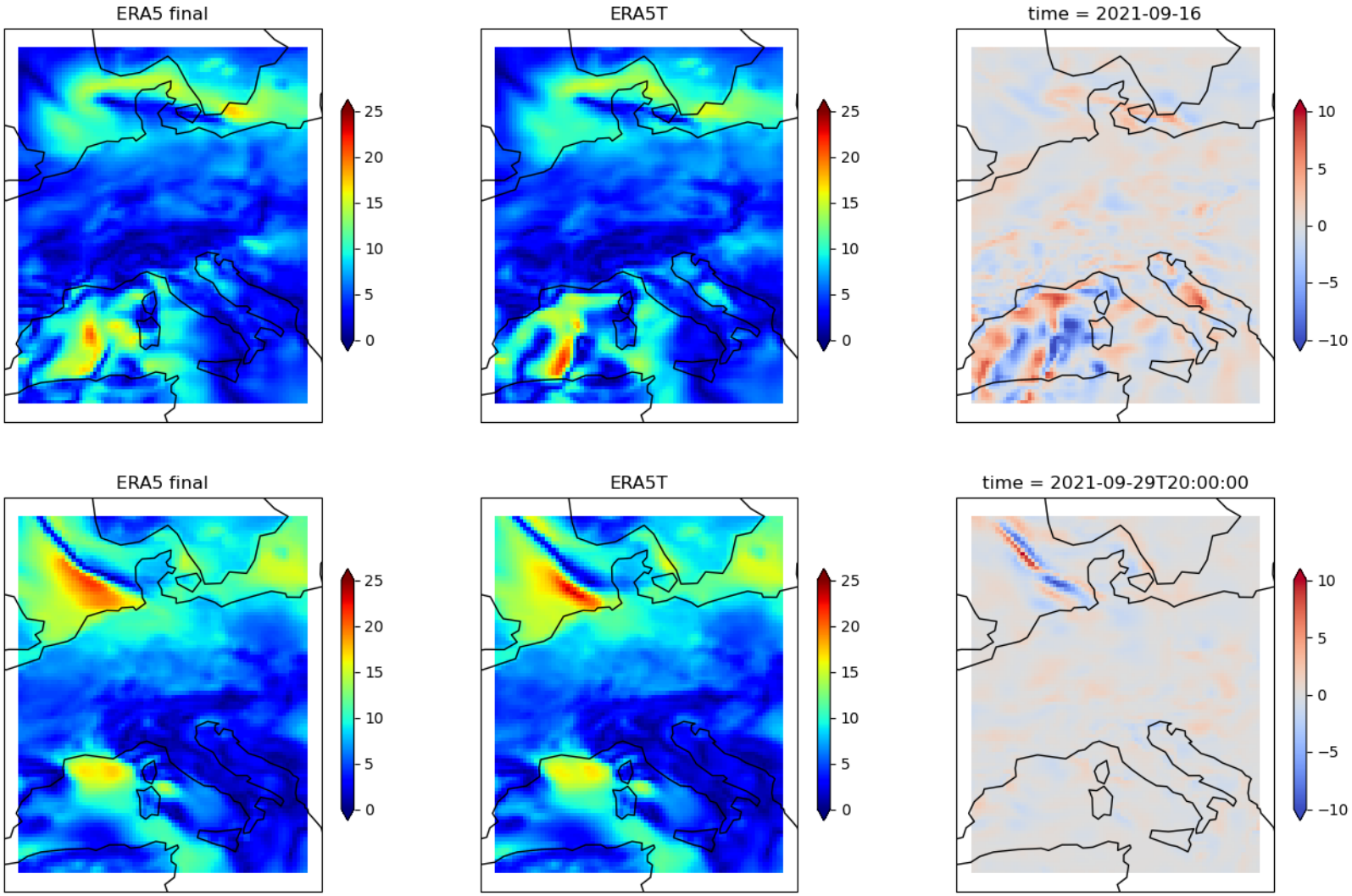

Figure 3: Two example time stamps (each row represents a time stamp) showing the validated final ERA5 data (left), the preliminary ERA5T (mid) and their difference (right). Parameter: 100m wind speeds.

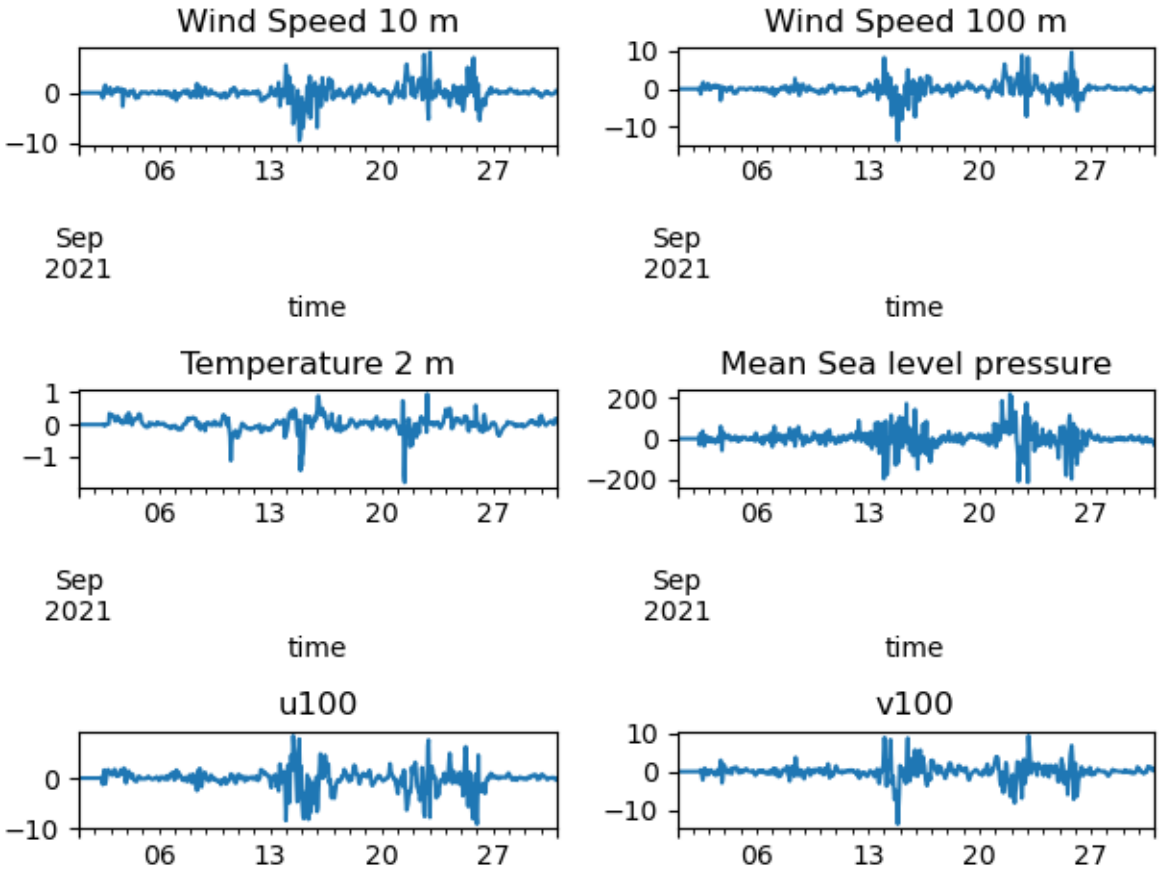

Figure 4: Time series of differences between ERA5T and ERA5 for a location in the Western Mediterranean Sea (latitude=38, longitude=4). Wind speed differences in m/s, pressure differences in Pa, temperature differences in C.

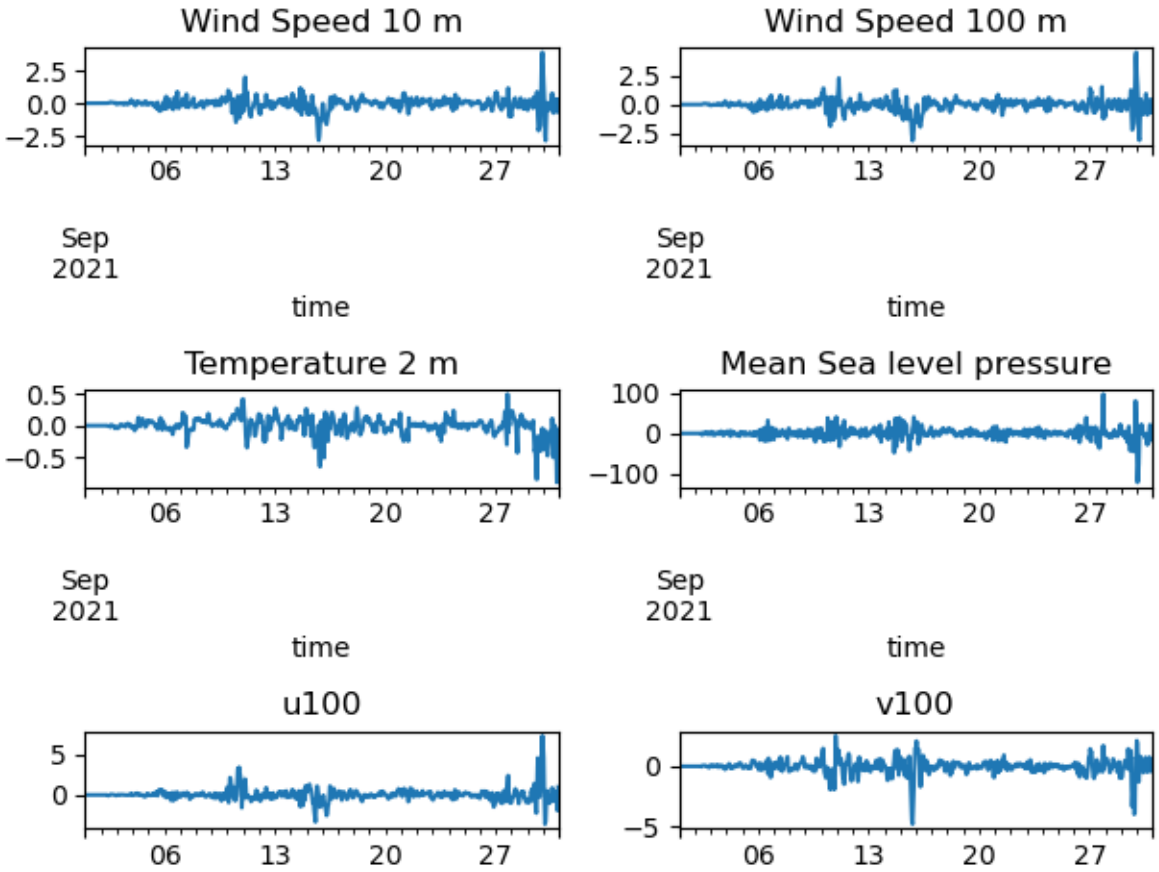

Figure 5: Time series of differences between ERA5T and ERA5 for a location in the North Sea (latitude=55, longitude=8). Wind speed differences in m/s, pressure differences in Pa, temperature differences in C.

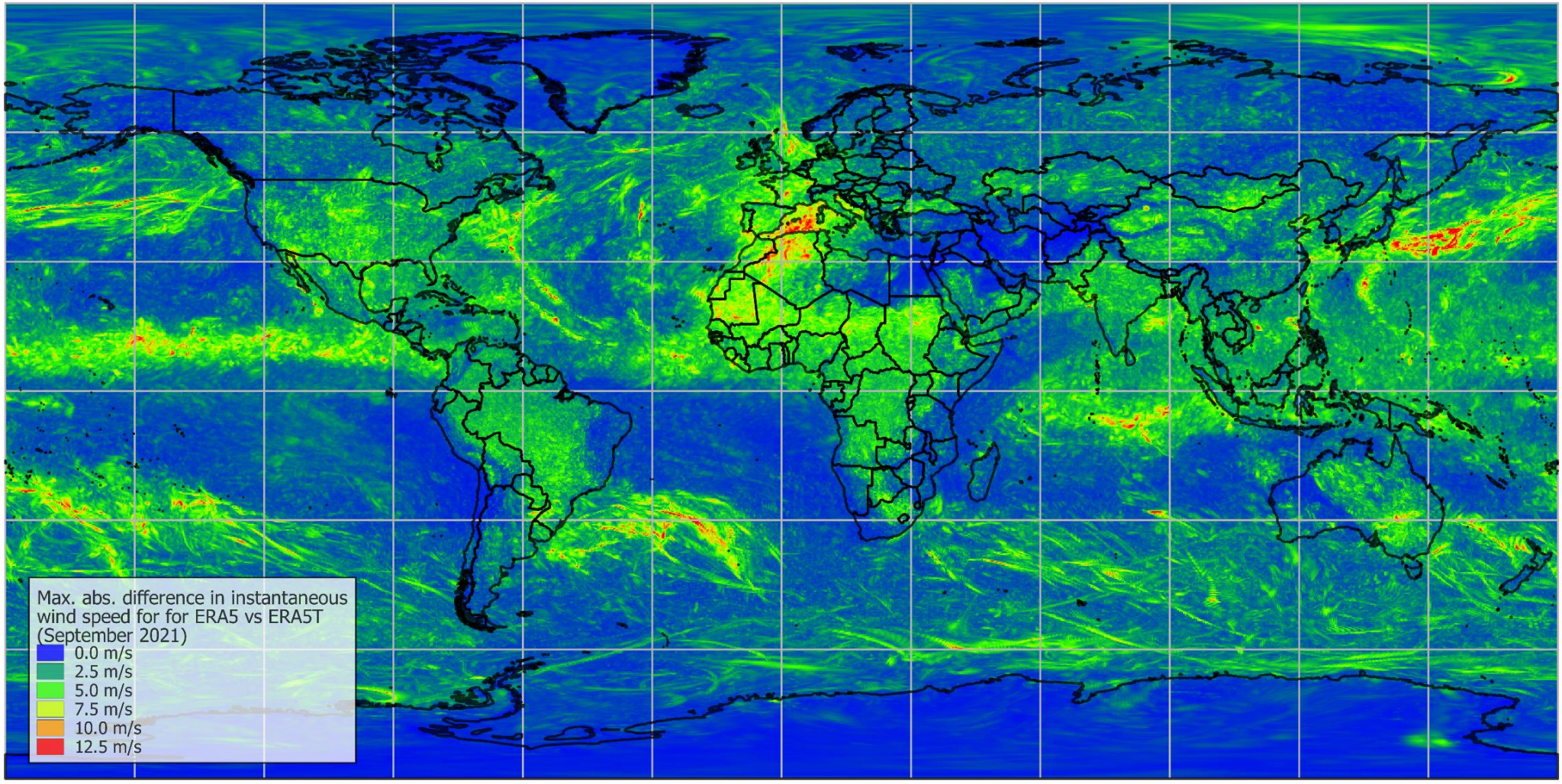

Figure 6: Maximum absolute difference in instantaneous wind speed (individual hourly time-series samples) for ERA5 vs ERA5T for September 2021. Parameter: 100m wind speeds.,