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Memo: 2024 Jul-Oct Wind Speed and Solar Radiation Differences from the ERA5T-ERA5 Alps-Region Snow Depth Issue

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Summary

An issue with non-representative snow depth observations over the Alps region has triggered a correction of snow data followed by a re-run of the ERA5/ERA5T reanalysis models by ECMWF. The updated dataset will differ for the months of July-October 2024. Our findings show, that the final ERA5 100m wind data typically differs less than 0.1 m/s as monthly average – with largest differences in the tropics. Differences in individual, instantaneous timestamps are larger, even up to 10 m/s. Update data will be included in windPRO when available from ECMWF and processed by EMD, see [1].

1. Introduction

In early October 2024, ECMWF informed that the final, validated ERA5 data will differ from the preliminary ERA5T for the months of July, August, September and October 2024. This is caused by an area in the Alps, where snow data needed correction due to an issue with the quality control and use of non-representative snow depth observations. As a result of this, for July to October 2024, final ERA5 data differs from ERA5T. Due to the nature of the 4D-Var data-assimilation system, changing observation at one location will also lead to changes in other parts of the world also, however these changes are within the uncertainty of the ERA5 data. ECMWF reports that the affected area is small and affects mainly surface parameters [2]. This memo provides an input on the impact on parameters used in renewable energy modelling.

2. Analysis

The following gives a closer investigation of differences in wind speeds and other climate variables - 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 July 2024 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 visible are in Central Asia and within the tropics (where wind speeds are small).

2.2 Individual Time Step Wind Speeds

Differences at individual time steps can be significant. Figures 3 and 4 show three sample sites from the Alps and globally, respectively. These figures highlight the daily absolute maximum differences between ERA5 and ERA5T across seven climate parameters, including wind speed and solar radiation. Most parameters show notable differences for individual timestamps, even in areas far from where erroneous snow depths were assimilated into the model. Table 1 confirms these trends and findings from 1765 samples.

3. Conclusion

In summary, differences in wind speed (and other variables) between the ERA5T and ERA5 datasets can be substantial in individual time series samples, sometimes exceeding 10 m/s for wind. However, these differences typically average out to approximately 0.1 m/s for wind on a monthly basis. For analyses dependent on individual time samples, these discrepancies are significant. It is important to assess whether a specific location is affected and to validate or rectify any conclusions drawn from the ERA5T data. The observed differences may not be directly attributable to erroneous snow depth data but could also result from the numerical nature of an assimilation model and the data sources employed. The differences found in this study are consistent with our previous study from 2021, see [3].

4. Data Update

The preliminary ERA5T dataset for July-October 2024 will be superseded by the final version of ERA5. Consequently, EMD-derived services and datasets that utilize ERA5 and ERA5T data as boundary conditions are also undergoing updates.

5. References

- [1] Thøgersen et al: *windPRO knowledgebase on ERA5T*, available [here](#).
- [2] Copernicus Support Announcement: "ERA5T issue in snow depth – July-October 2024", available [here](#).
- [3] Ahsbahs et al: "2021 Sep-Nov Wind Speed Differences from the ERA5T-ERA5 Anomalous Snow Depth Assimilation Issue", available [here](#) and [here](#).

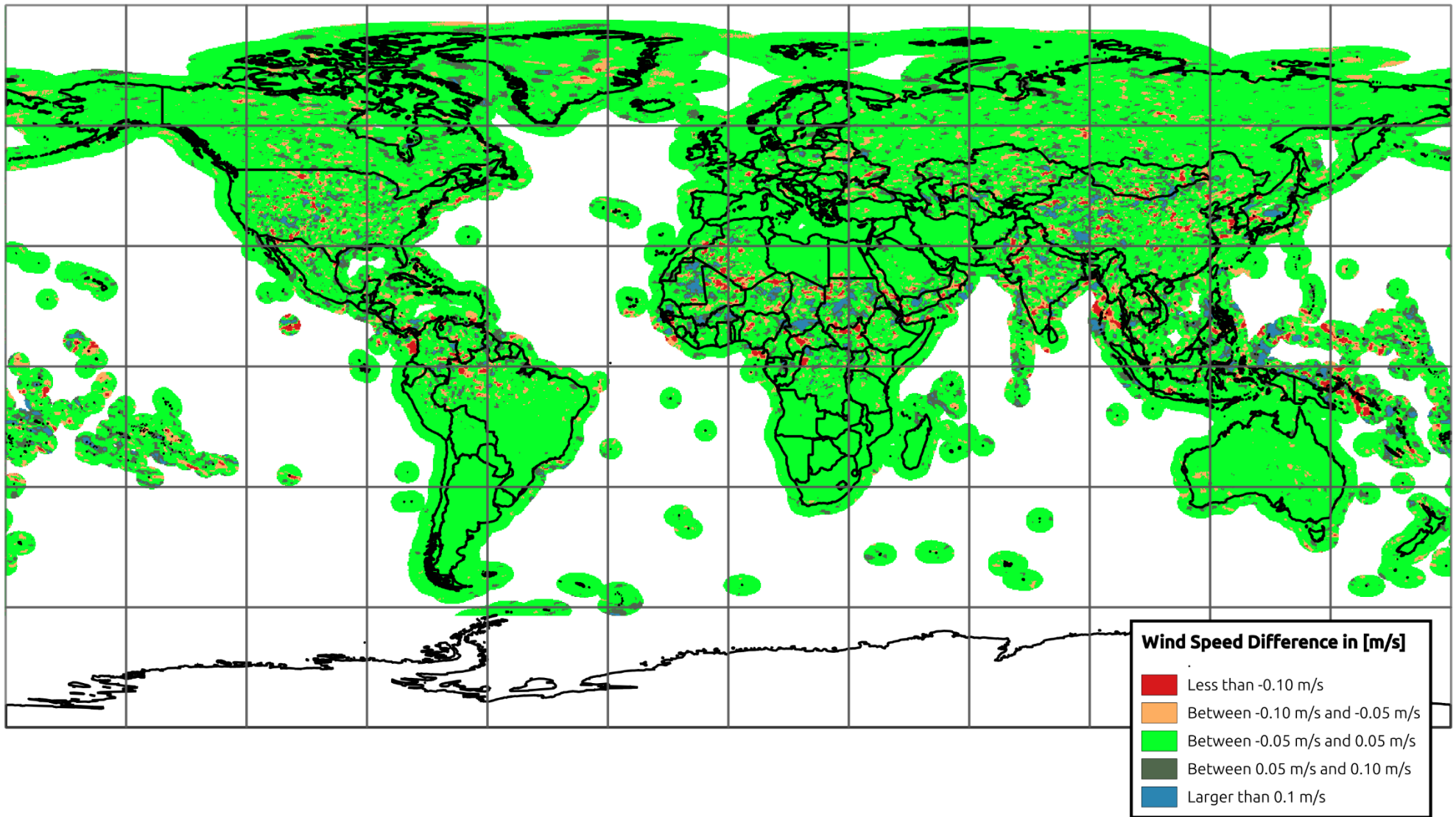


Figure 1: Absolute deviation [m/s] between ERA5 and ERA5T for monthly average wind speeds at 100m (July 2024).

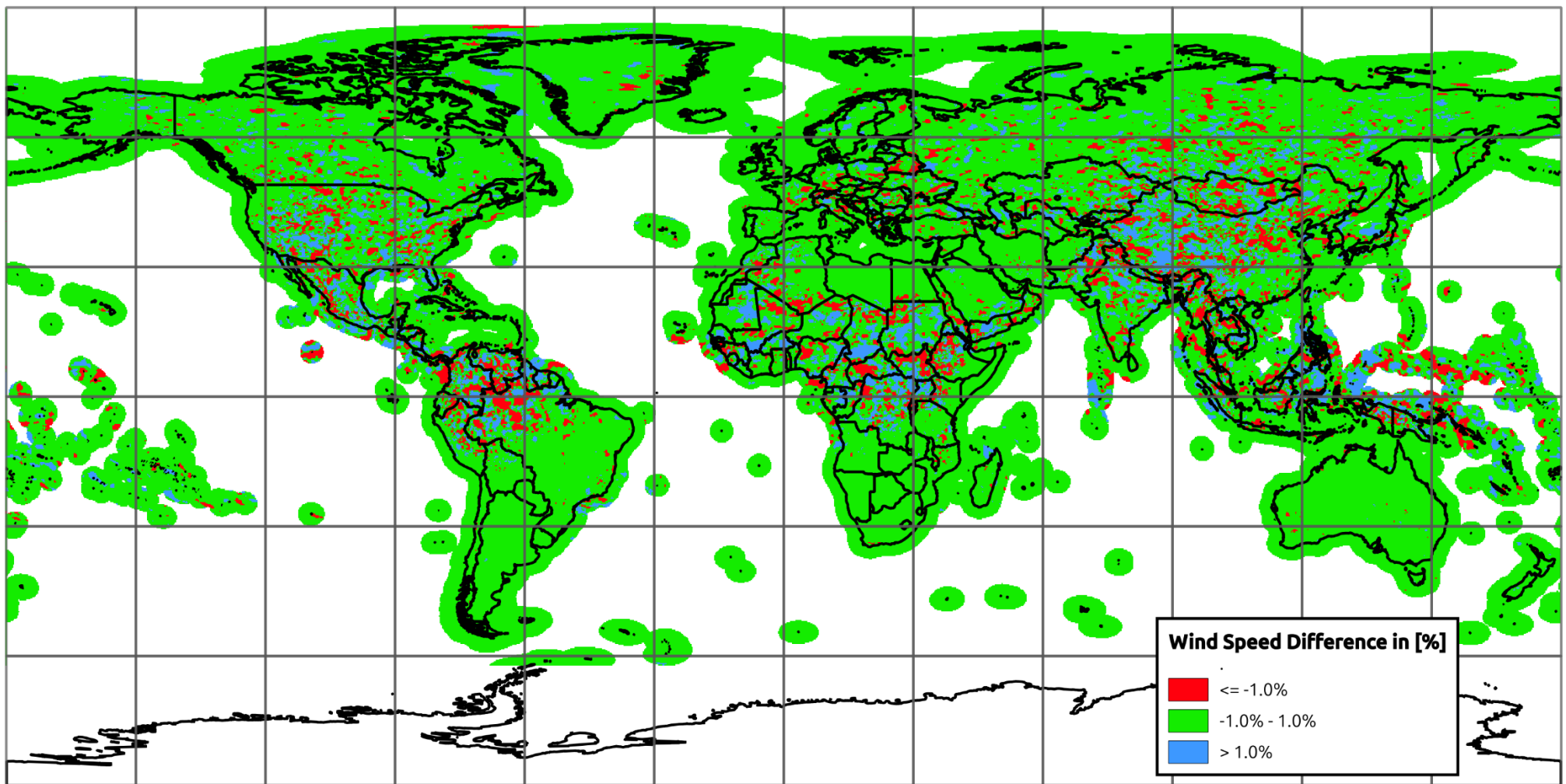


Figure 2: Relative deviation [%] between ERA5 and ERA5T for monthly average wind speeds at 100m (July 2024).

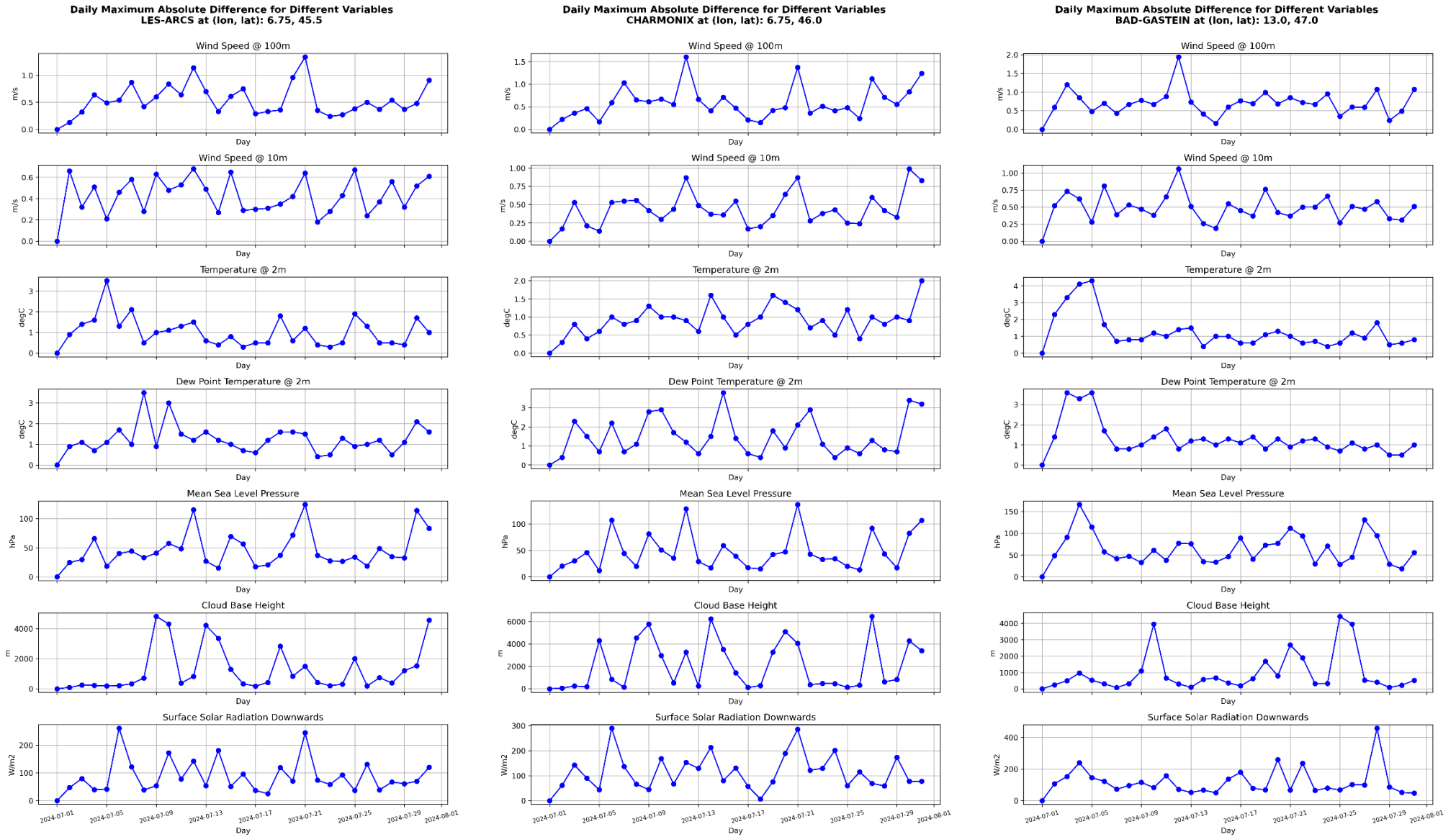


Figure 3: Three example sites within the Alps region: LES-ARCS (left), CHARMONIX (center) and BAD-GASTEIN (right). Time series shows the daily absolute maximum difference between the “final” ERA5 and “preliminary” ERA5T.

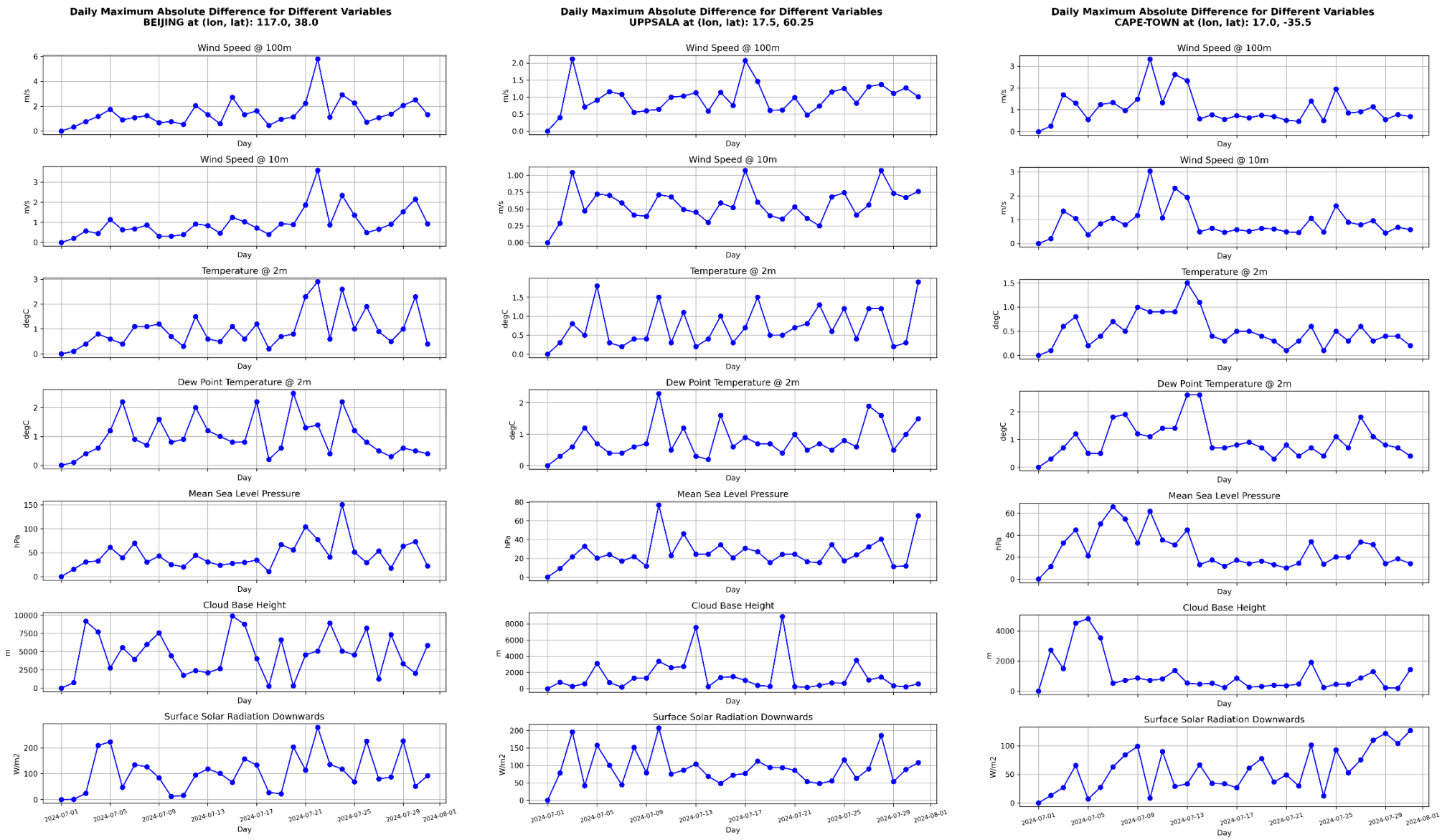


Figure 4: Three example sites from around the globe: BEIJING (left), UPPSALA (center) and CAPE-TOWN (right). Time series shows the daily absolute maximum difference between the “final” ERA5 and “preliminary” ERA5T.

Sample Statistics – 765 Samples within Alps Region and 1000 Random Samples Around the Globe

The differences between ERA5T and ERA5 have been analyzed using 765 samples from the Alps region and 1000 random samples globally, as illustrated in the two figures below. The analysis encompasses four climate parameters: wind speeds at 10m and 100m, 2m temperature, and downward solar radiation. The results are summarized based on three metrics for each climate parameter: monthly bias, maximum absolute difference across all samples, and sample correlation. As indicated in Table 1, the monthly average wind speed differences typically remain within 0.1 m/s but can exceed 10 m/s in individual samples. For the Alps region, there is a noticeable temperature bias even in the monthly average data.

Climate Parameter	Metric	Unit	Alps Region 765 samples				Globe 1000 random samples			
			Mean	StDev	Min	Max	Mean	StDev	Min	Max
Wind Speed @ 100m	Average Bias - Monthly	m/s	0.00	0.03	-0.11	0.14	0.00	0.04	-0.28	0.28
	Absolute Maximal Difference	m/s	2.70	1.07	0.93	7.62	2.69	0.05	0.50	13.3
	Correlation Instantaneous Winds	-	0.93	0.04	0.77	0.99	0.97	0.05	0.50	0.99
Wind Speed @ 10m	Average Bias - Monthly	m/s	0.00	0.03	-0.15	0.17	0.00	0.03	-0.23	0.18
	Absolute Maximal Difference	m/s	1.78	0.86	0.68	7.17	1.96	1.27	0.24	11.1
	Correlation Instantaneous Winds	-	0.92	0.05	0.64	0.99	0.96	0.05	0.52	0.99
Temperature @ 2m	Average Bias - Monthly	°C	-0.1	0.4	-4.0	0.6	0.0	0.05	-0.4	0.43
	Absolute Maximal Difference	°C	2.5	1.5	0.5	12.1	1.9	1.1	0.2	6.5
	Correlation Instantaneous Winds	-	0.99	0.02	0.81	1.00	0.97	0.05	0.63	0.99
Solar Radiation	Average Bias - Monthly	W/m ²	0.5	3.0	-6.8	18.1	0.0	2.1	-10.0	9.9
	Absolute Maximal Difference	W/m ²	264	75	104	524	221	121	1	633
	Correlation Instantaneous Samples	-	0.99	0.00	0.97	1.00	0.99	0.01	0.91	1.00

Table 1: Sample Statistics - Alps Region and Globe.

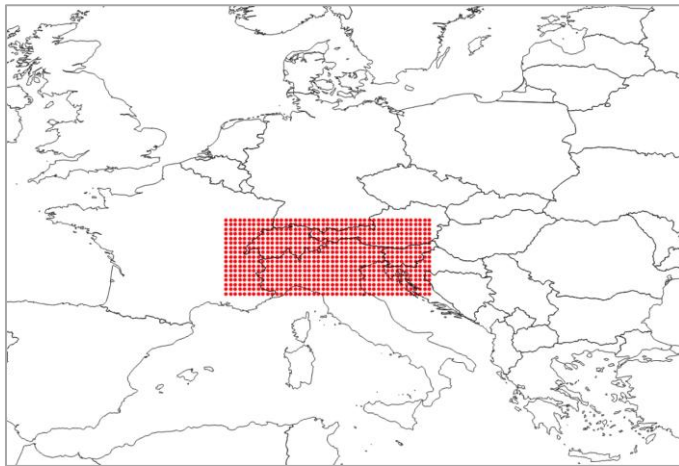


Figure 5: Location of 765 Analysis Samples in Alps Region.

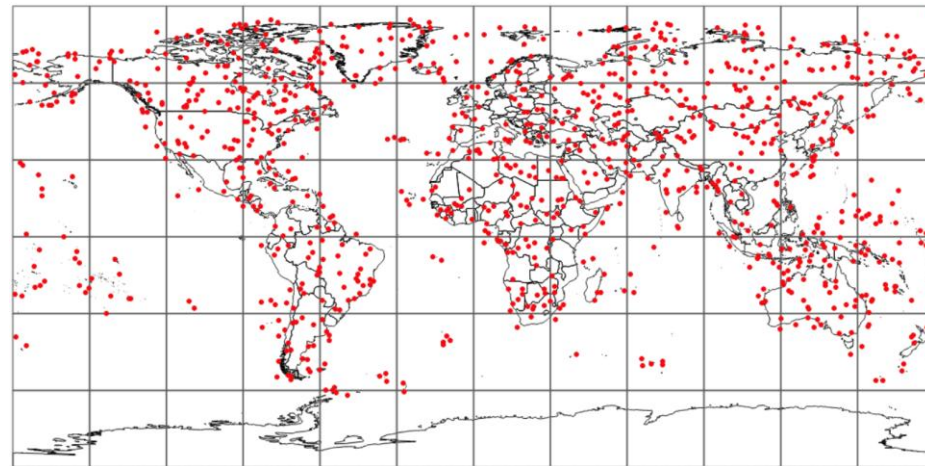


Figure 6: Location of 1000 Random Samples - Globe.