

Supplement S2: Comparison of trends on differing pressure levels (500 hPa, 700 hPa, 850 hPa) for specific humidity (q), relative humidity (RH), and wind speed (WS). These figures are related to Figure 6 in the manuscript as well as Appendix A.

5 **S2.1 Specific humidity (q) at 700 hPa and 850 hPa**

For this supplement we used the same thresholds as initially identified for the 700 hPa level. As specific humidity is decreasing with height, we were not able to count enough values above 0.004 kg kg^{-1} at 500 hPa to be able to plot or compare them. At 850 hPa, the positive trend found at 700 hPa remains (Figure S2.1 e, g). It is, however, less strong in the East of the study area, where it is moreover insignificant (Figure S2.1 f).

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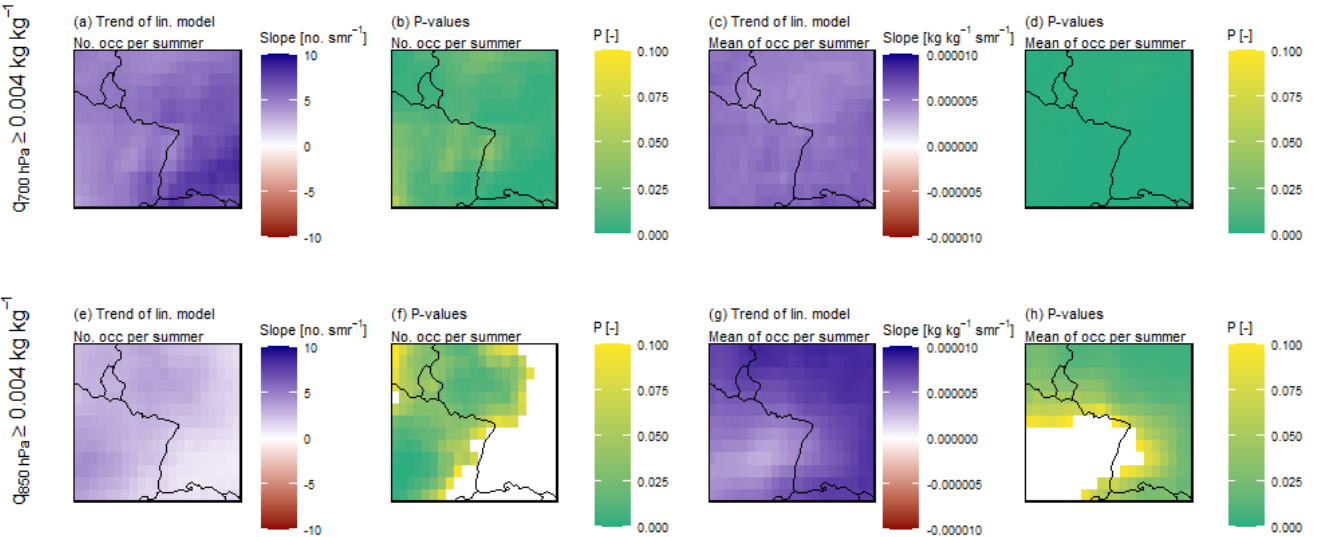


Figure S2.1: Trend analysis of the specific humidity (q) above the identified threshold of $0.004 \text{ kg kg}^{-1} \text{ smr}^{-1}$ at two differing pressure levels: 700 hPa and 850 hPa. The first column (a, e) shows the trends of the numbers of hourly occurrences of values above the threshold, including their significance-levels p in the second column (b, f). The third column (c, g) shows the trends of the mean values of all hourly occurrences above the threshold and the last column (d, h) their respective significance-levels. White areas mark insignificance.

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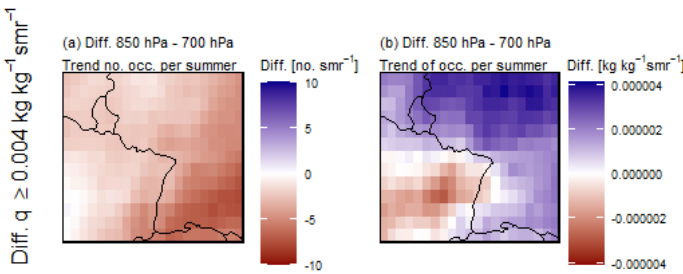


Figure S2.2: The difference of trends in specific humidity (q) above $0.004 \text{ kg kg}^{-1} \text{ smr}^{-1}$ between the pressure levels 850 hPa and 700 hPa regarding the annual number of occurrences (a) and the actual values (b).

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S2.2 Relative humidity (RH) at 500 hPa, 700 hPa, 850 hPa

The decrease in relative humidity (RH) is stronger at lower levels of the atmosphere (850 hPa) (Figure S2.3 i, k), where especially the mean of high RH_{850 hPa} is decreasing at a significant level (Figure S2.3 l). At the 500 hPa pressure level, the decrease in the number of occurrences of RH_{500hPa} > 59.4% is also stronger (Figure S2.3 a, b), than at 700 hPa. The actual values above the threshold increased at a very low rate, which was also insignificant (Figure S2.3 c, d). Concluding, these results show that the 700 hPa level turns out to be a good proxy for RH in the middle of the troposphere.

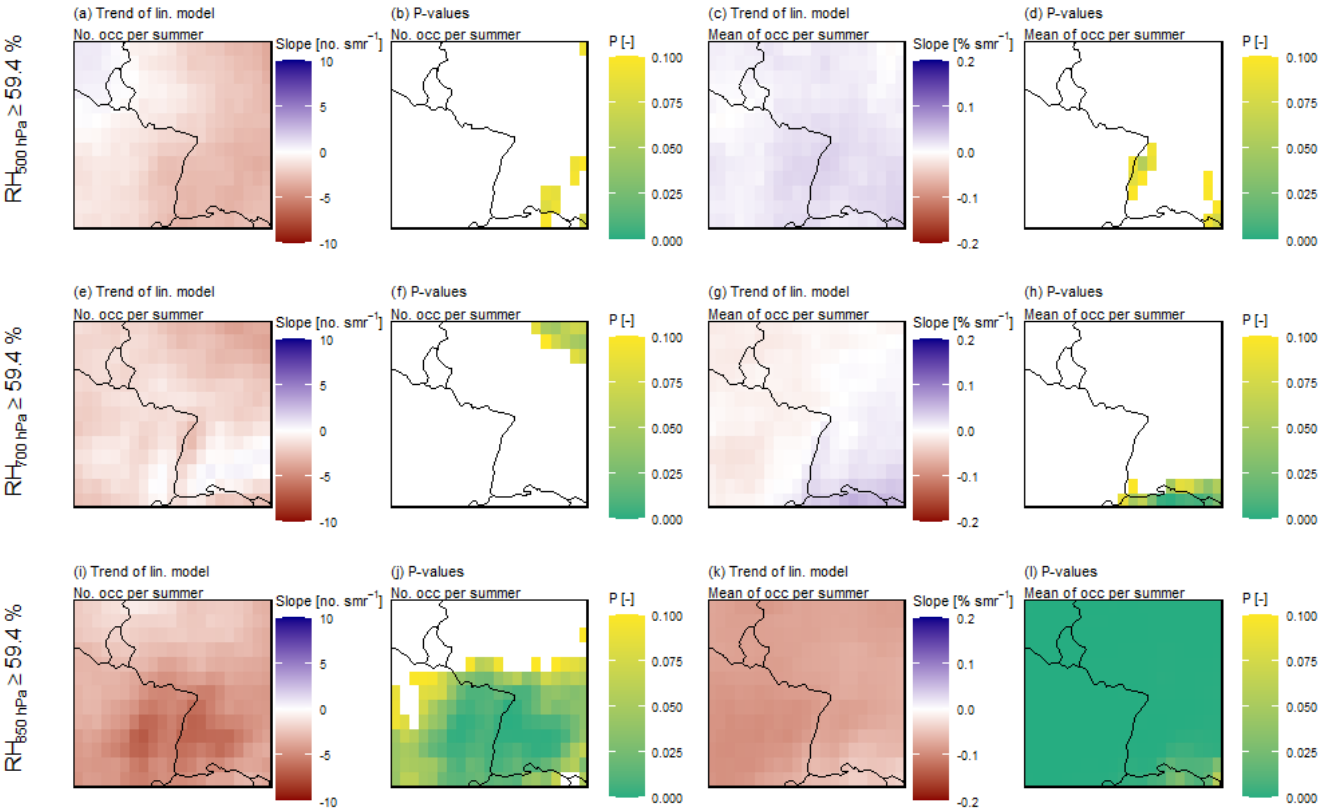


Figure S2.3: Trend analysis of the relative humidity (RH) above the identified threshold of 59.4% at three differing pressure levels: 500 hPa, 700 hPa and 850 hPa. The first column (a, e, i) shows the trends of the numbers of hourly occurrences of values above the threshold, including their significance-levels in the second column (b, f, j). The third column (c, g, k) shows the trends of the mean values of all hourly occurrences above the threshold and the last column (d, h, l) their respective significance-levels p. White areas mark insignificance.

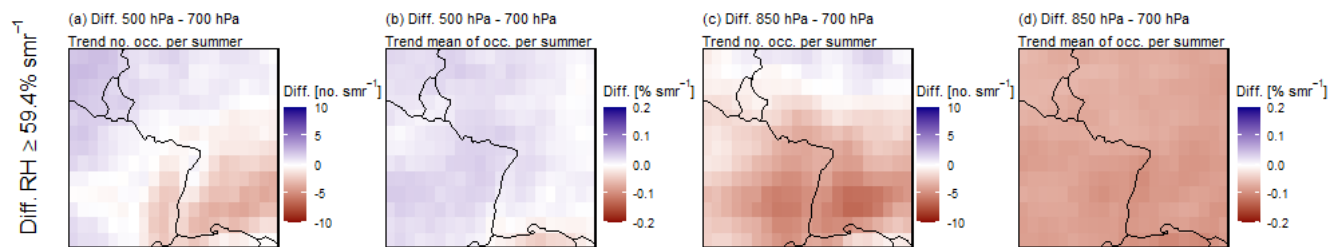


Figure S2.4: The difference of trends in relative humidity (RH) above 50% between the pressure levels 500 hPa and 700 hPa (a, b), as well as 850 hPa and 700 hPa (c, d).

S2.3 Windspeed (WS) at 500 hPa, 700 hPa, 850 hPa, and mean between 10 m and 500 hPa

At 500 hPa trends in $WS_{500hPa} \leq 6.2 \text{ m s}^{-1}$ are showing a stronger, but insignificant decrease compared to the mean of 10 m above the ground level and the pressure level of 500 hPa ($WS_{10m-500hPa}$) (Figure S2.5 a-d & m-p, Figure S2.6 a, b). The WS_{700hPa} at 700 hPa splits the study area in two, where in the north-west, WS_{700hPa} occurrences below the threshold are decreasing and increasing in the south-west. The decreases in the mean $WS_{850hPa} \leq 6.2 \text{ m s}^{-1}$ at the pressure level 850 hPa are even partly significant (Figure S2.5 k, l) and occur more often (Figure S2.5 i, j). $WS_{10m-500hPa}$ shows a strong but insignificant decrease in the number of occurrences of low WS, as well as its mean (Figure S2.5 m-p). Generally low WS occurs more frequently throughout different levels of the atmosphere and the values at these occurrences are slightly decreasing.

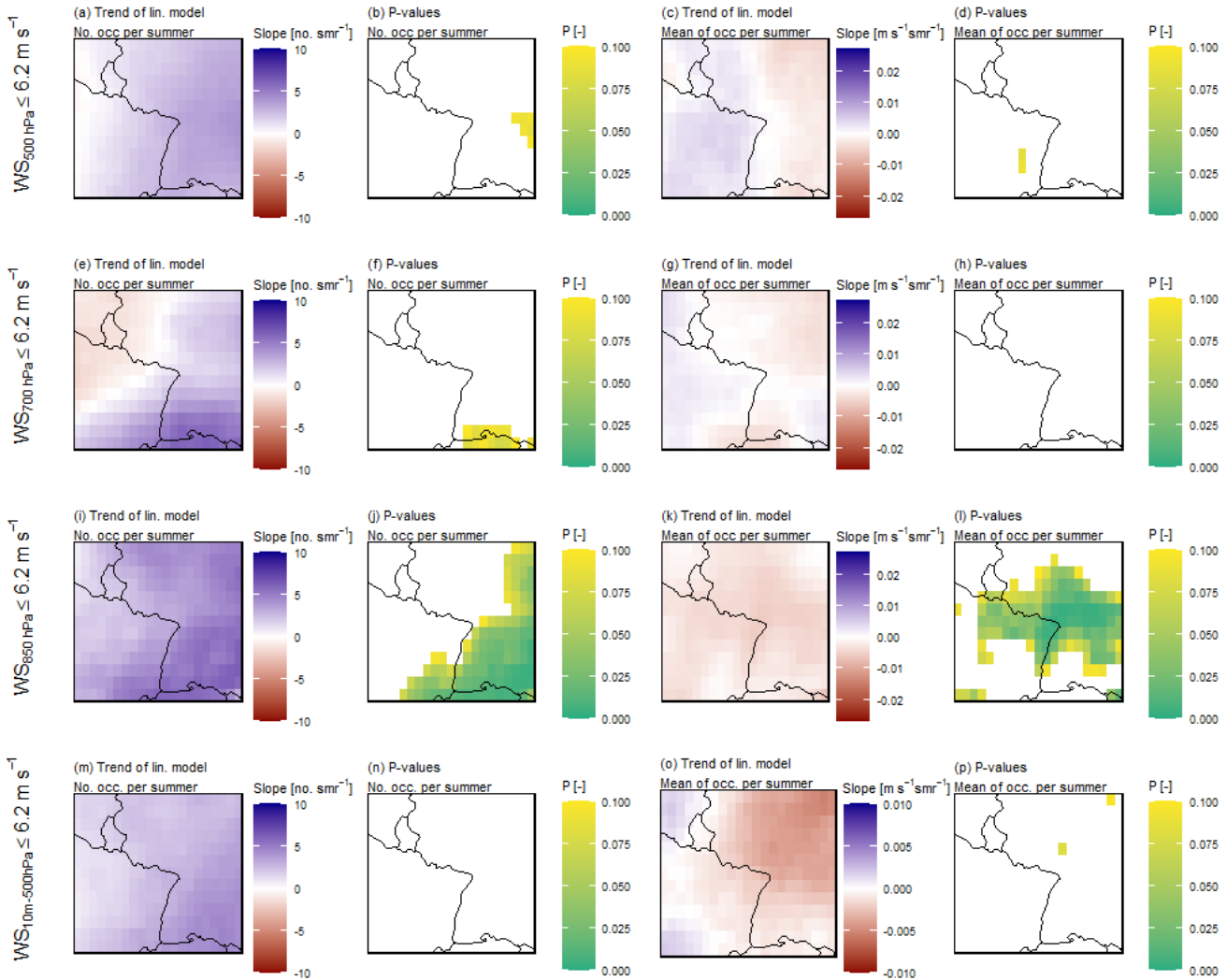


Figure S2.5: Trend analysis of the wind speed (WS) above the identified threshold of 7 m s^{-1} at three differing pressure levels (500 hPa, 700 hPa and 850 hPa) as well as considering the mean between the surface (10 m) and the pressure level at 500 hPa. The first

column (a, e, i, m) shows the trends of the numbers of hourly occurrences of values above the threshold, including their significance-levels p in the second column (b, f, j, n). The third column (c, g, k, o) shows the trends of the mean values of all hourly occurrences above the threshold and the last column (d, h, l, p) their respective significance-levels p . White areas mark insignificance.

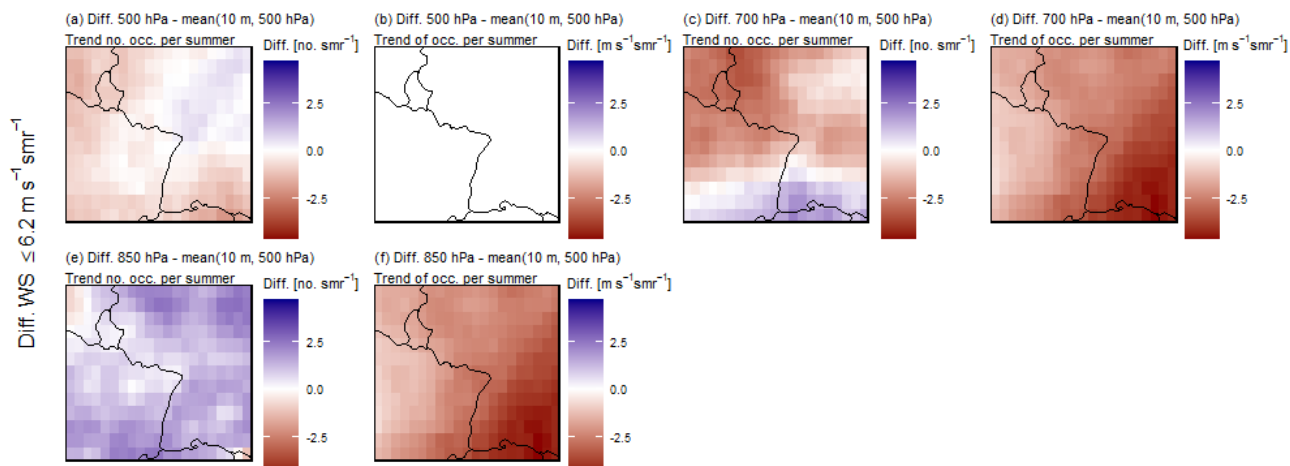


Figure S2.6: The difference of trends in wind speed (WS) below 6.2 m s^{-1} between the pressure levels 500 hPa and the mean of 10 m and 500 hPa (a, b), as well as 700 hPa and the mean of 10 m and 500 hPa (c, d), and 850 hPa and the mean of 10 m and 500 hPa (e, f).