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Supplement of

How an uncertain short-wave perturbation on the North Atlantic wave guide affects the forecast of an intense Mediterranean cyclone (Medicane Zorbas)

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S1 Backward trajectories from cyclogenesis region and importance of surface latent heat fluxes

This section provides an analysis of the history of the air parcels in the 850-950 hPa layer within a radius of 250 km around the cyclone centre at genesis. Figures S1 and S2 show that the air parcels were advected over the Aagean Sea where they picked up a lot of moisture by surface latent heat fluxes which contributed substantially to their high equivalent potential temperature at cyclogenesis. Figure S3 shows the averaged latent heat flux during the 48 hours before cyclogenesis. A comparison to instantaneaous latent heat fluxes in Fig. 13 in Miglietta and Rotunno (2019) shows that these values (note: they are 48 h averages) are well comparable to latent heat fluxes of the October 1996 case. Hence this analysis shows that latent heat fluxes before cyclogenesis are important for medicane formation, not only afterwards. This analysis also clarifies the link between cyclogenesis position and low-level θ_e values: θ_e in the cyclogenesis region could only reach high values because cyclogenesis occurred at the southern coast of the Mediterranean and the air could pick up moisture over the Mediterranean on its way to the cyclogenesis region. If cyclogenesis occurs at the northern coast of the Mediterranean (as in cluster E), this moisture pick up can not, or not as strongly, occur.

S2 Lightning maps

To confirm convective activity during cyclone formation and intensification lightning maps are shown for the 12 h period from 1200 UTC 27 Sep - 0000 UTC 28 Sep in Figure S4.

S3 Statistical significance for Figure 11

Figure S5 shows statistically significant grid points for mean sea level pressure in Figure 11. For this Figure, the test area was slightly extended to the east and south in order to avoid abrupt cut-off of significant regions in the eastern and southern Mediterranean, resulting in a 25-70 °N and 80°E - 40°W box and 5400 tests.

S4 Anomaly correlation coefficient

The anomaly correlation coefficient (ACC) is a widely used measure to quantify forecast skill and computed as (see e.g. Wilks, 2011):

$$ACC = \frac{\sum_{i=1}^{n}(f_i - c_i)(a_i - c_i)\cos\phi_i}{\sqrt{\sum_{i=1}^{n}(f_i - c_i)^2\cos\phi_i \sum_{i=1}^{n}((a_i - c_i)^2\cos\phi_i}} \quad (1)$$

where ϕ is latitude, $\sum_{i=1}^{n}$ the sum over all grid points in the considered box and f_i the forecasted value, a_i the observed value and c_i the climatological value at grid point i.

References

Miglietta, M.M. and Rotunno, R.: Development mechanisms for Mediterranean tropical-like cyclones (medicanes), Q. J. Royal Meteorol. Soc., 145, 1444-1460, https://doi.org/10.1002/qj.3503, 2019

Wilks, D.S., 2011: Statistical methods in the atmospheric sciences, Third Edition. Elsevier ltd. ISBN: 978-0-12-385022-5, 704p.

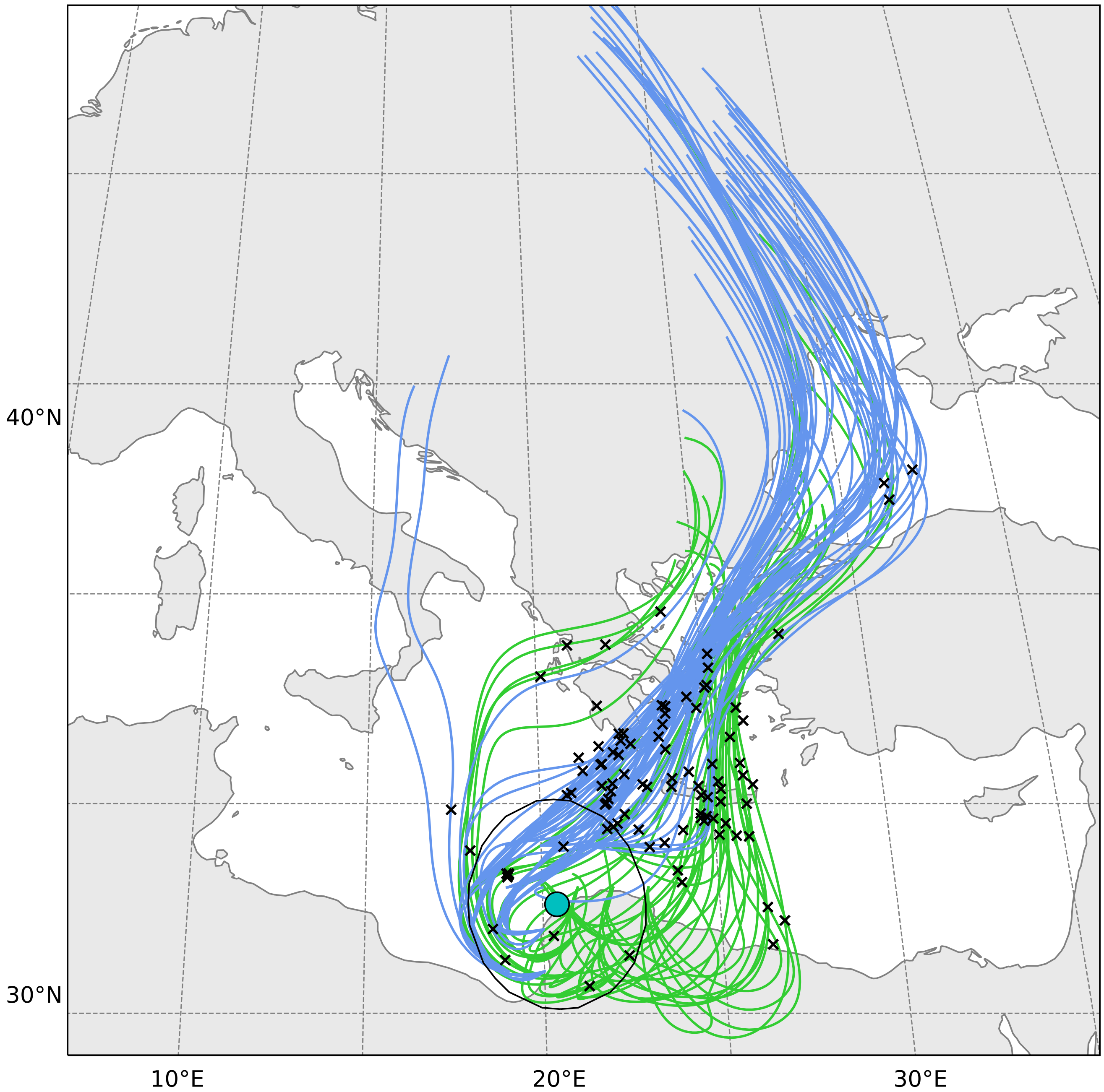

Figure S 1. 48 h backward trajectories from the layer between 850 and 950 hPa within a radius of 250 km around the cyclone center started at cyclogenesis (1200 UTC 27 Sep 2018), separated into trajectories with final equivalent potential temperature larger (green) and lower (blue) than 330 K. Crosses mark the average position of the air parcels within the 6-hourly interval during which they experienced the largest increase in specific humidity.

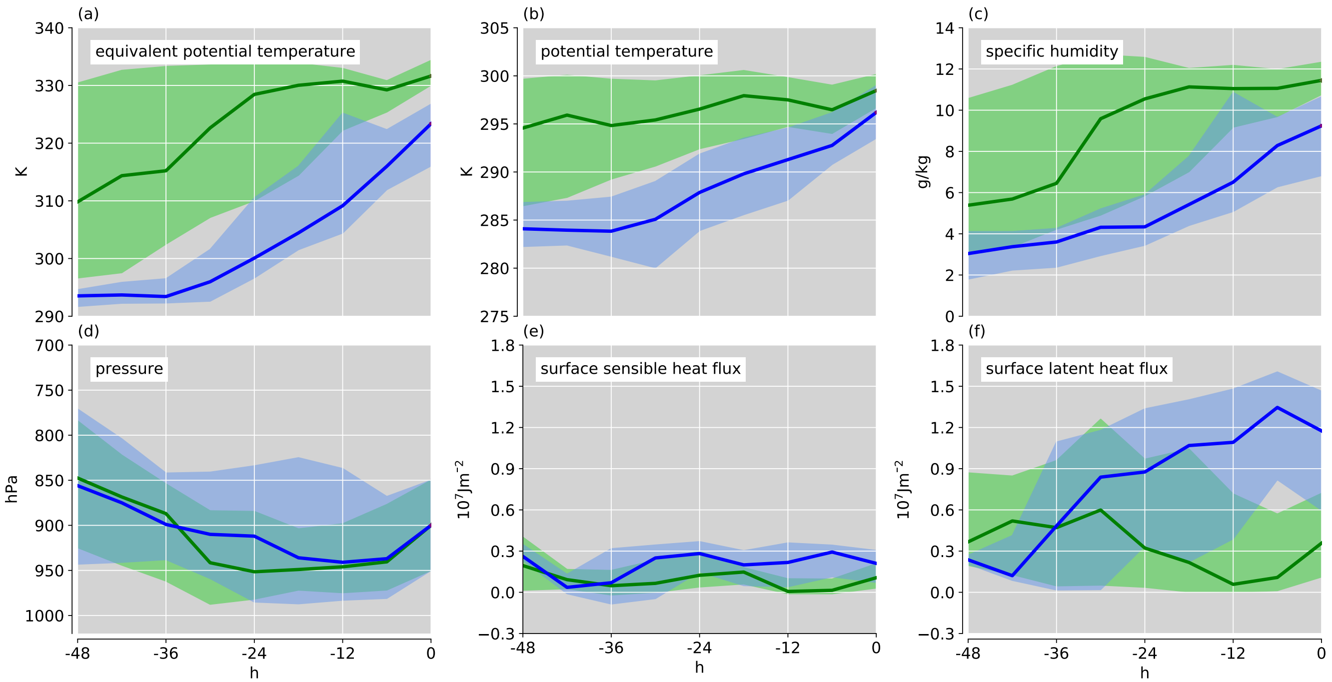

Figure S 2. Temporal evolution of (a) equivalent potential temperature, (b) potential temperature, (c) specific humidity, (d) pressure, (e) surface sensible heat flux, and (f) surface latent heat flux for the trajectories shown in Fig. S1.

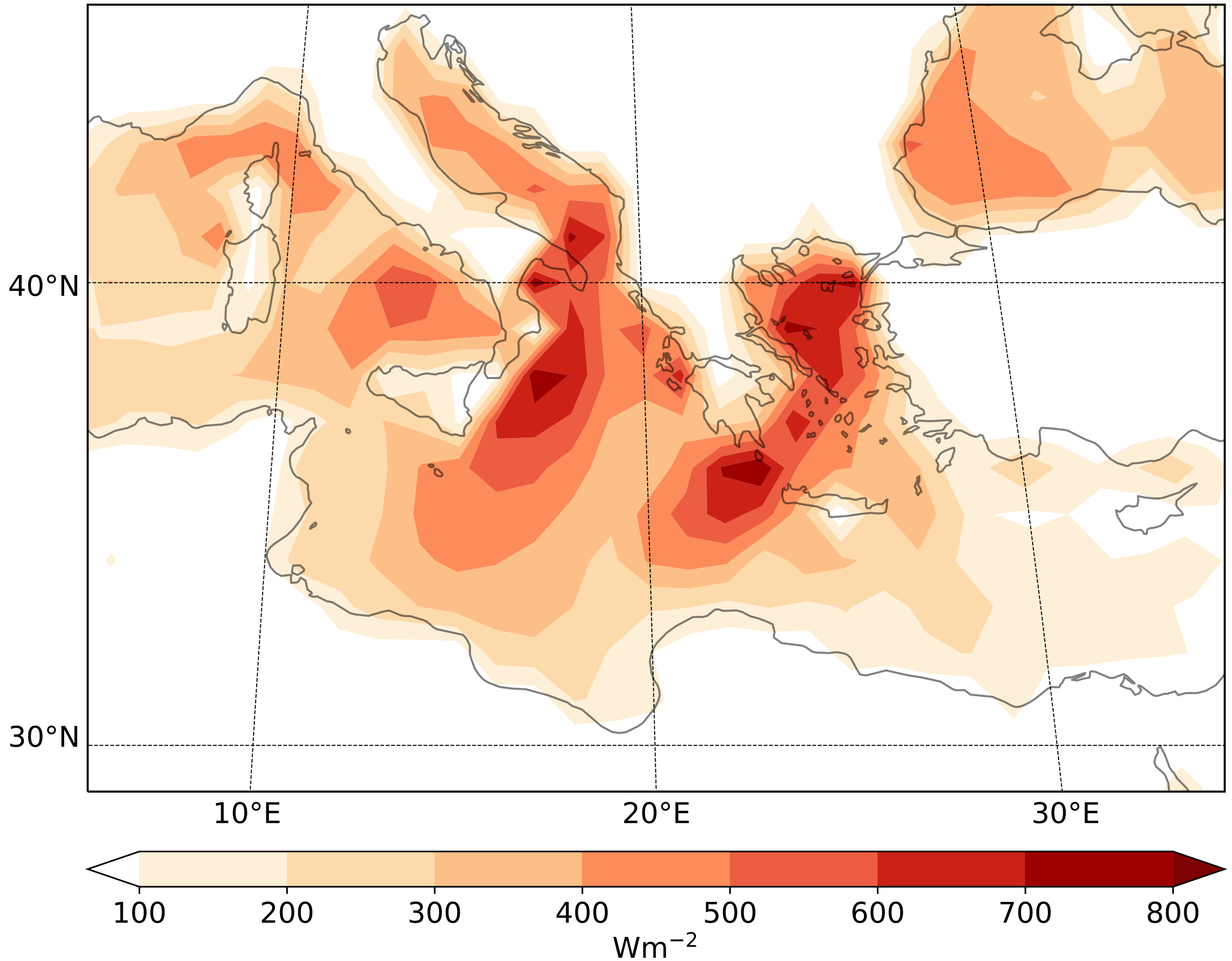

Figure S 3. Surface latent heat flux averaged over the 48 h prior to cyclogenesis of Zorbas (1200 UTC 25 Sep - 1200 UTC 27 Sep 2018).

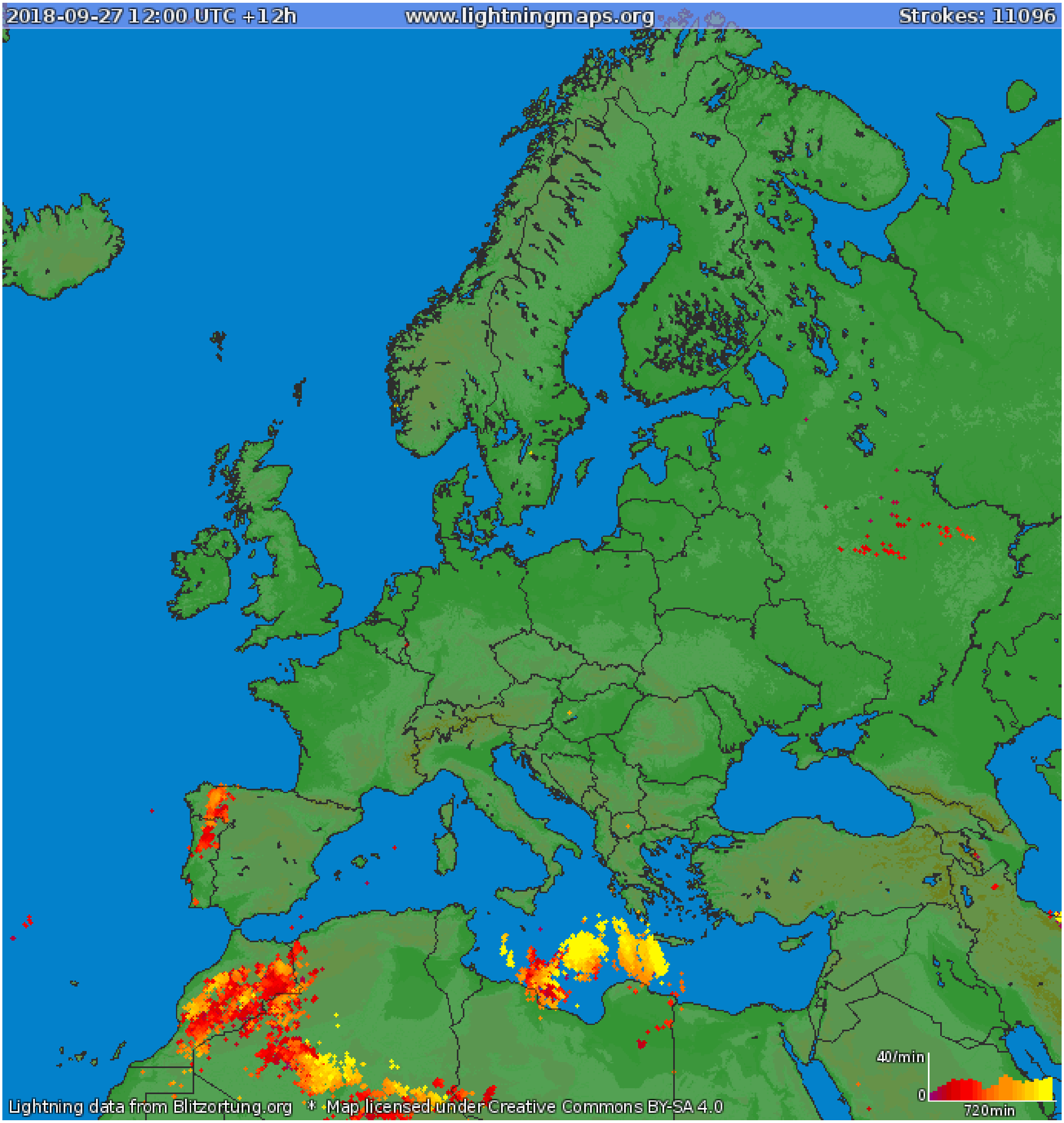

Figure S 4. Lightning strikes (coloured dots) for the 12 h period from 1200 UTC 27 Sep - 0000 UTC 28 Sep. Figure is from the archive on LightningMaps.org CC BY-SA 4.0 / Lightning data by Blitzortung.org and contributors.

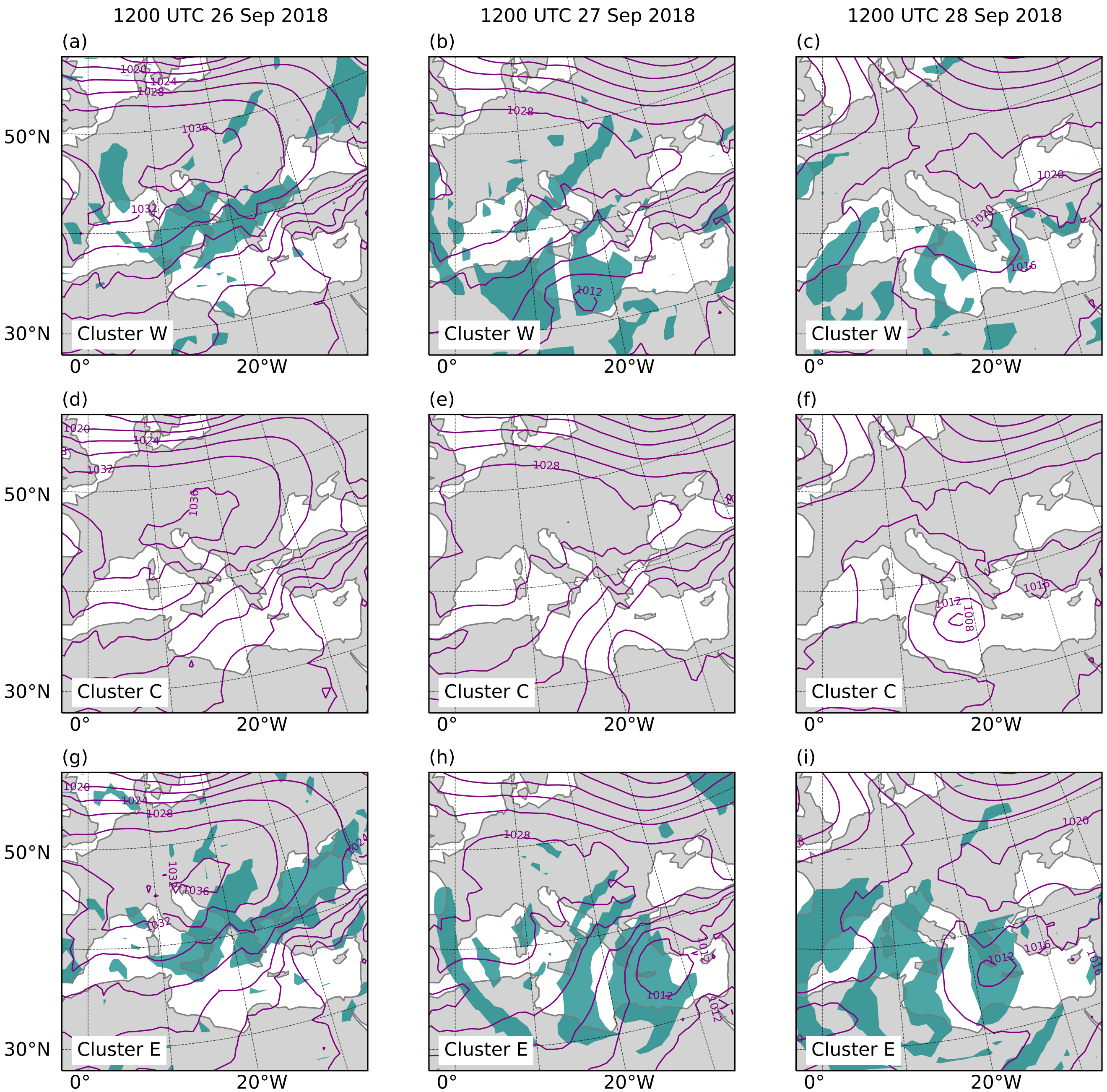

Figure S 5. Regions where differences of mean sea level pressure in each cluster to values in cluster C are significant on the $\alpha_{fdr} = 0.1$ level (teal patches) and cluster-mean mean sea level pressure (purple) for the same times and regions as Fig. 11.