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Supplement of

The role of large-scale dynamics in an exceptional sequence of severe thunderstorms in Europe May–June 2018

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Supplement

1 North Atlantic-European weather regimes in May and June

A meteorological perspective on the seven weather regimes during May and June (1979 – 2015) is given in Figure S1.

2 Sensibility of the buffer zone regarding lightning activity

Figure S2 includes the chosen buffer zone of 500 km. Additionally, Table S1 illustrates the sensitivity by choosing the buffer radius for the matching between PV information and lightning activity. Note that a deformation radius of 400 km can be related to a scale height of approximately 4 km. This is already a very low value for the vertical extent of a cut-off low. We therefore argue that radii below 400 km are not appropriate from a meteorological perspective. Furthermore, the lightning strikes per day are shown in Figure S3 for two different buffer radii (400 km and 600 km). The percentage of overall matched lightning increases from 42.2 % to 64.3 %, showing sensitivity to the chosen radius. However, the changes do not affect the qualitative interpretation of our results.

Table S1. Percentage of lightning that can be linked to a nearby PV cut-off or PV filament depending on the choice of the buffer radius.

Buffer radius	Lightning linked to PV cut-off
100 km:	Matching of 10.5 %
200 km:	Matching of 18.4 %
300 km:	Matching of 27.5 %
400 km:	Matching of 42.2 %
500 km:	Matching of 54.3 %
600 km:	Matching of 64.3 %
700 km:	Matching of 71.5 %
800 km:	Matching of 76.7 %
900 km:	Matching of 81.1 %

3 Spatial distribution of thunderstorm days

Figure S4 shows the number of thunderstorm days with a horizontal resolution of $10 \times 10\,\text{km}^2$ during the study period (22 May – 12 June). A thunderstorm day is defined as a day when at least five flashes (all lightning types considered) were registered within a detection area of $10 \times 10\,\text{km}^2$ between 00 and 00 UTC on the following day.

4 Rain statistic: Rain rate & duration

To estimate the rain rate and duration of the events in Table 1, we use radar-based precipitation data (RADOLAN), which enables us to perform the analyses with the necessary high temporal resolution. The online calibration of RADOLAN is a routine process of DWD that uses measurements of automatic ombrometers in order to create area-wide, spatially as well as temporally highly resolved quantitative precipitation analyses (Winterrath et al., 2012; DWD, 2019). The reprocessed product that is used in the study has a temporal resolution of 5 minutes. The RADOLAN grid consists of $1 \times 1\,\text{km}^2$ boxes covering entire Germany (as well as parts of the neighbouring countries).

Figure S5 shows exemplarily two events in Germany from Table 1, for which the high-resolved RADOLAN data are available: (a) Bruchweiler weather station with a 24 h rainfall total of 145.0 mm (27 May 2018) and (b) Dietenhofen with a 1 h rainfall total of 85.7 mm or 3 h rainfall total of 86.2 mm, respectively (31 May 2018). In addition to the RADOLAN grid point closest to the station, other reference areas (9 grid points and a radius of 5 km around the station) were considered to show the variability of rain event.

5 Video supplement related to this paper

Animated images of 2D radar reflectivity of the German Weather Service (DWD) for two representative days during the thunderstorm episode (27 and 31 May 2018; from 06 UTc to 06 UTC on the next day) are available from the Repository KITopen at: https://doi.org/10.5445/IR/1000118571 (27 May 2018) and https://doi.org/10.5445/IR/1000118574 (31 May 2018). The two cases were selected because of the extraordinary rainfall and the high number of ESWD reports and lightning detections associated with these days (see Sect. 3).

References

DWD: RADOLAN/RADVOR: Hoch aufgelöste Niederschlagsanalyse und -vorhersage auf der Basis quantitativer Radar-und Ombrometerdaten für grenzüberschreitende Fluss-Einzugsgebiete von Deutschland im Echtzeitbetrieb – Beschreibung des Kompositformats Version 2.5, Tech. rep., Deutscher Wetterdienst (DWD): Abteilung Hydrometeorologie, Offenbach, Germany. Available from: https://www.dwd.de/DE/leistungen/radolan/radolan.html (Accessed 6 March 2020), 2019.

Grams, C. M., Beerli, R., Pfenninger, S., Staffell, I., and Wernli, H.: Balancing Europe's wind-power output through spatial deployment informed by weather regimes, Nat. Clim. Change, 7, 557–562, https://doi.org/10.1038/nclimate3338, 2017.

Winterrath, T., Rosenow, W., and Weigl, E.: On the DWD quantitative precipitation analysis and nowcasting system for real-time application in German flood risk management, Weather Radar and Hydrology (Proceedings of a symposium held in Exeter, UK, April 2011), IAHS Publ, 351, 323–329, 2012.

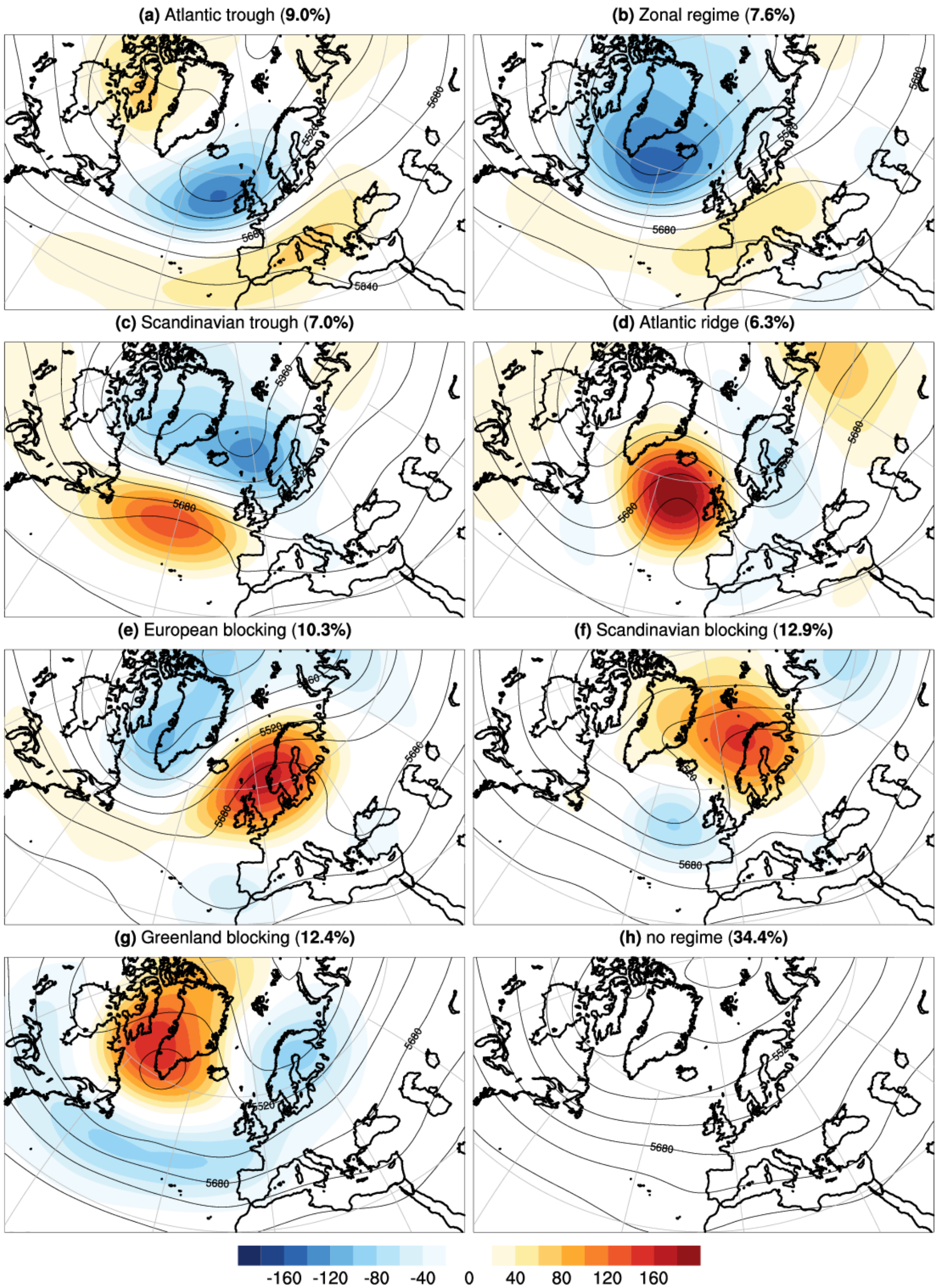

Figure S1. Mean low-pass filtered (10 days) 500 hPa geopotential height anomaly (Z500', shading, every 20 gpm), and mean absolute 500 hPa geopotential height (Z500, black contours, every 80 gpm) in May/June for all days attributed to one of the seven weather regimes (a – g) and to no regime (h). Regime name and relative frequency (in percent) indicated in the sub-figure caption (see Grams et al., 2017, for details). Data taken from ERA-Interim (1979 – 2015).

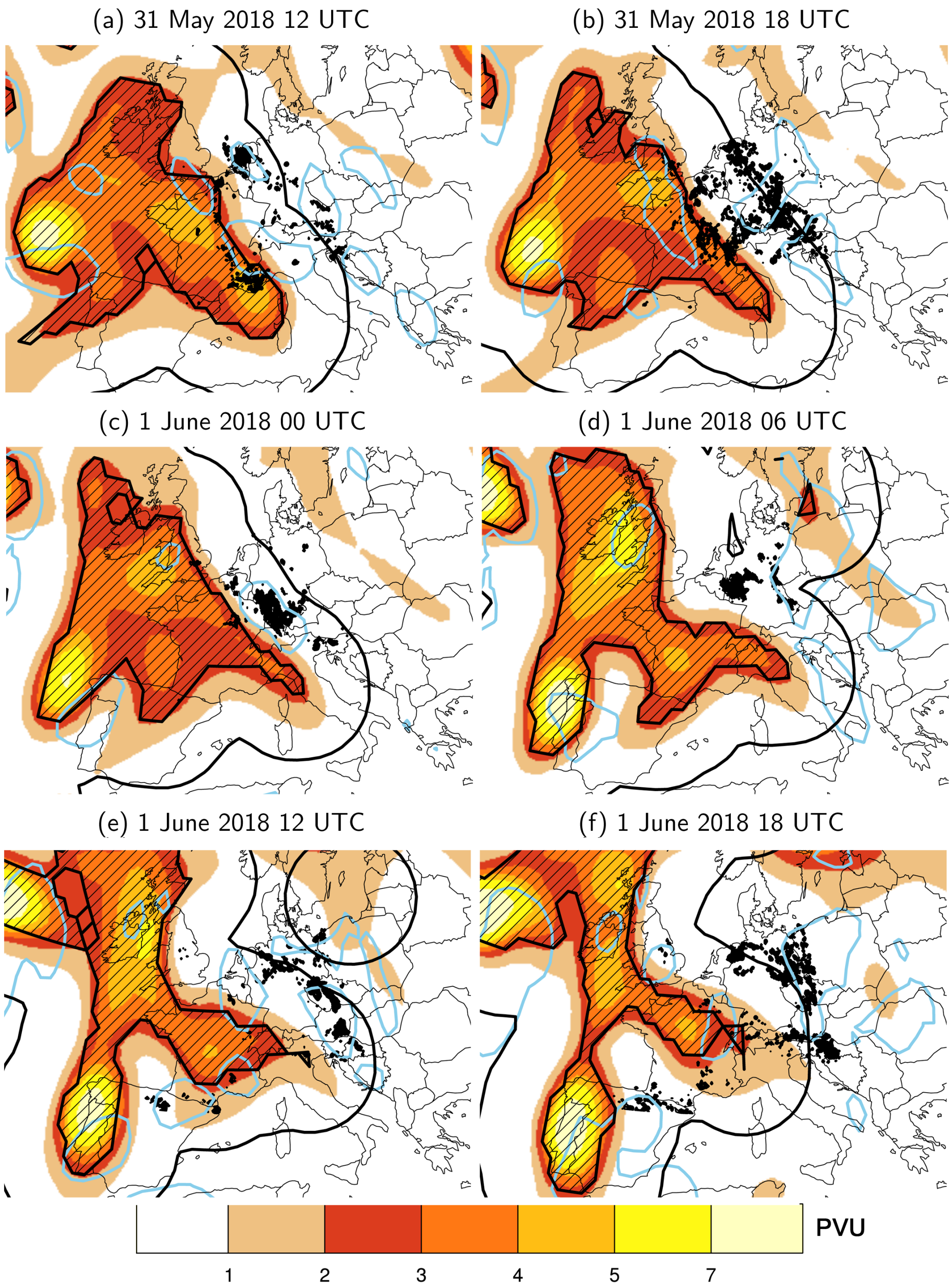

Figure S2. As Figure 11, but including the buffer zone of about 500 km (thick black contour).

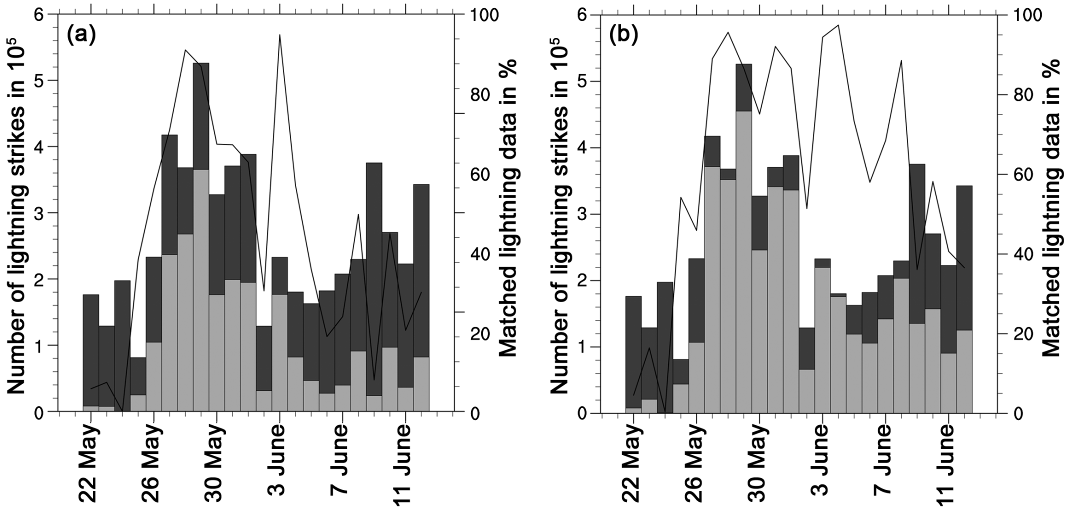

Figure S3. As Figure 10, but for a buffer of about (a) 400 km and (b) 600 km.

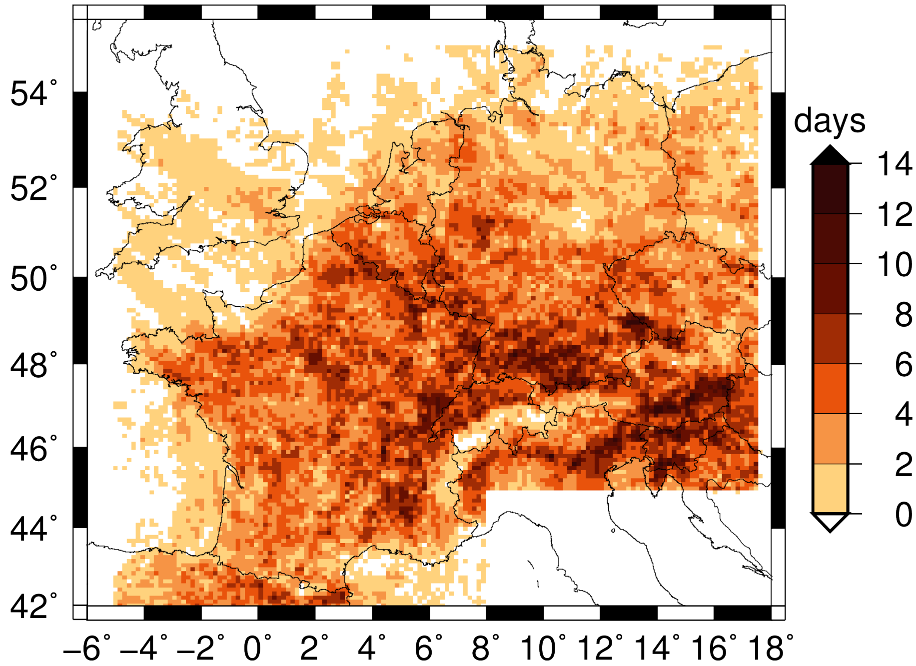

Figure S4. Number of thunderstorm days (all lightning types considered) during the study period from 22 May to 12 June (EUCLID).

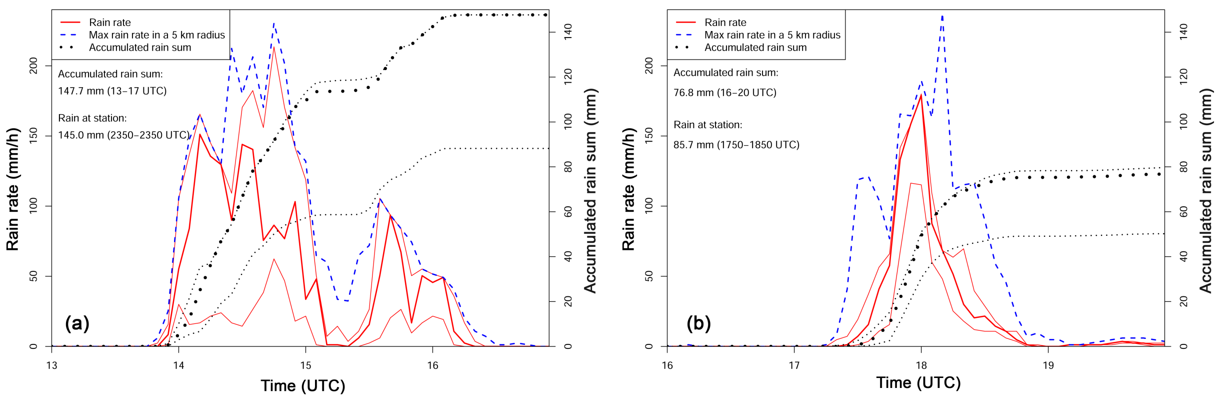

Figure S5. Precipitation time series for two cases from Table 1 based on 5-minutes RADOLAN data: (a) Bruchweiler weather station with a 24 h rainfall total of 145.0 mm (27 May 2018) and (b) Dietenhofen with a 1 h rainfall total of 85.7 mm or 3 h rainfall total of 86.2 mm (31 May 2018). Shown is the rain rate for the nearest grid point to the weather station (bold red line) and the minimum/maximum values for the nine grid points nearest to the station (thin red lines), the maximum rain rate (dashed in blue) in a radius of 5 km around the location, and the accumulated rain sum calculated for the nearest grid point (thick dotted line in black) and the minimum/maximum values for the nine grid points nearest to the station (thin dotted lines in black).