cle size) presents a similar spatial pattern to the correlation coefficient between these two variables, with the maximum number of co-occurring events close to 100.

For Q and S (Fig. 7b), the highest correlations are of around 0.3–0.4 when both drivers are dominant, mainly along the southern Atlantic coasts of the Iberian Peninsula, north of Africa and the Gibraltar Strait. The dependency is slightly higher when Q is the main variable in the identification of compound events, even the only correlation along most of the northern coasts of the Mediterranean Sea. Higher joint occurrences are detected in locations with higher correlation, with around 50–60 of co-occurring events. However, similar numbers of joint occurrences are found in locations along the eastern coast of Italy and the eastern north Mediterranean coasts with lower correlation.

For Q and W (Fig. 7c), the spatial distribution is quite similar to Q–S, with slightly smaller correlation along the most southern Atlantic coast and higher along the west coast of the Iberian Peninsula. Correlation only when Q is the dominant variable is even more pronounced in locations along the Mediterranean Sea (e.g. eastern coast of Spain). These spatial patterns are also reflected in the distribution of the correlation coefficient between Q and SW as a combination of both (Fig. 7d).

Spatial distribution of the dependence between P and S, W, or SW (Fig. S5 in the Supplement) is relatively similar to the spatial distribution between Q and the three oceanographic variables. The highest correlation between P–S or P–W (with values around 0.3–0.4) is concentrated on the southern coast of the North Atlantic Ocean. In the case of the Mediterranean Sea, similar areas with high dependence are detected including the western coast of the Black Sea and excluding many locations along the Greek coast. Correlation is higher when the conditional sampling is conditioned to oceanographic variables. S and W (Fig. S5d) are the drivers with the highest correlation, with coefficients of around 0.6–0.7 in the north Atlantic Ocean to minimum values of 0.2 in some regions in the Mediterranean Sea.

4.2.2 Severity index

Here we define an index, based on driver severity, to be included in the characterization of the spatial patterns of compound flooding potential. The driver severity is calculated as the sum of normalized thresholds of each driver, applied in the conditional sampling (multiplied by 0.2 in the case of W). Q thresholds, which cover a wide range of values, have been categorized into 10 intervals [0–10–25–50–100–250–500–750–1000–5000 → 25 000 $\mathrm{m^3\,s^{-1}}$] to avoid skewing the driver severity due to very high discharge magnitude in several locations. Driver severity is divided into 11 scores from 0 to 1. Figure 8d shows the spatial distribution of the severity index (SI). Areas with the highest SI are concentrated in the North Sea, the northwest of the Iberian Peninsula, the eastern coast of the Adriatic Sea, the eastern coast of the Black Sea, and a few locations that represent large rivers. Coastal areas with the lowest SI are mainly concentrated along the southern coast of the Mediterranean Sea and the most southern coast of the Atlantic Ocean of our study domain. The SI spatial distribution indicates that an identical SI ranking can be determined by different combinations of driver extremes. To facilitate this analysis, we classify the thresholds of the four drivers (shown in Fig. S6 in the Supplement) into 10 clusters to define the main combinations of driver extremeness (Fig. 8a). The probability of occurrence of each cluster (number of locations of the study domain represented by each cluster) associated with each SI rank (Fig. 8b) provides which combinations of the four driver thresholds have an equal SI rank. For example, locations with SI equal to 0 are associated with only one cluster (represented in light green), which is defined by a combination of the lowest thresholds of Q, P, and S and low W severity. On the other hand, locations with SI equal to 1 are associated with clusters 1 and 2 (in yellow and orange, respectively) which are characterized mainly by the severity of one driver (Q or S, respectively) but also associated with clusters 3, 7, and 8 (in red and dark and light blue, respectively) with high severity of two or three drivers (Q, P, and W; or Q and P; or Q and S, respectively). The spatial distribution of these clusters (Fig. 8c) allows identification of the representative combination of the four driver thresholds for each location.

4.2.3 Spatial patterns of compound flooding potential

The characterization of compound flooding potential can be summarized using the combination of two metrics: the Kendall correlation (τ) and the joint occurrence (JO) for the pairs Q–P, Q–SW, and P–SW and the number of co-occurring events when all three variables are extreme JO(Q–P–SW). The two-step cascade classification method is applied to the 11-dimensional array $X_i = [\tau1(Q\text{–}P)_i$, $\tau2(P\text{–}Q)_i$, $\mathrm{JO}(Q\text{–}P)_i$, $\tau1(Q\text{–}SW)_i$, $\tau2(SW\text{–}Q)_i$, $\mathrm{JO}(Q\text{–}SW)_i$, $\tau1(P\text{–}SW)_i$, $\tau2(SW\text{–}P)_i$, $\mathrm{JO}(P\text{–}SW)_i$, $\mathrm{JO}(Q\text{–}P\text{–}SW)_i$, $\mathrm{SI}_i]$, where the subscript represents the ith grid point. Each parameter is normalized to avoid assigning different weights in the classification process. We first use the SOM algorithm to obtain a large collection of centroids ($20 \times 20 = 400$) projected onto a 2D organized lattice that helps to analyse the dependence between the 11 parameters. The hexagonal SOM of 20×20 size of the compound flooding potential derived from the 11 metrics outlined above for the study sites is shown in Fig. 9. Results are shown in individual panels (Fig. 9a–k) over the same 2D lattice for the different metrics defining the SOM centroids (the hexagons in a certain position correspond to the same map unit in each figure). Note that each figure has a different scale. For example, we can observe that the three parameters related with the pair Q–P TS3 ($\rho1$, $\rho2$, JO; see Fig. 9a–c) present a similar distribution in the lattice, which means that there is a high dependence between them. Locations with the highest correlation between