Julie Carreau
julie.carreau@univ-montp2.fr

CNRS IRD UM1 UM2

Spatial Kernel Interpolation of Annual Rainfall Maxima

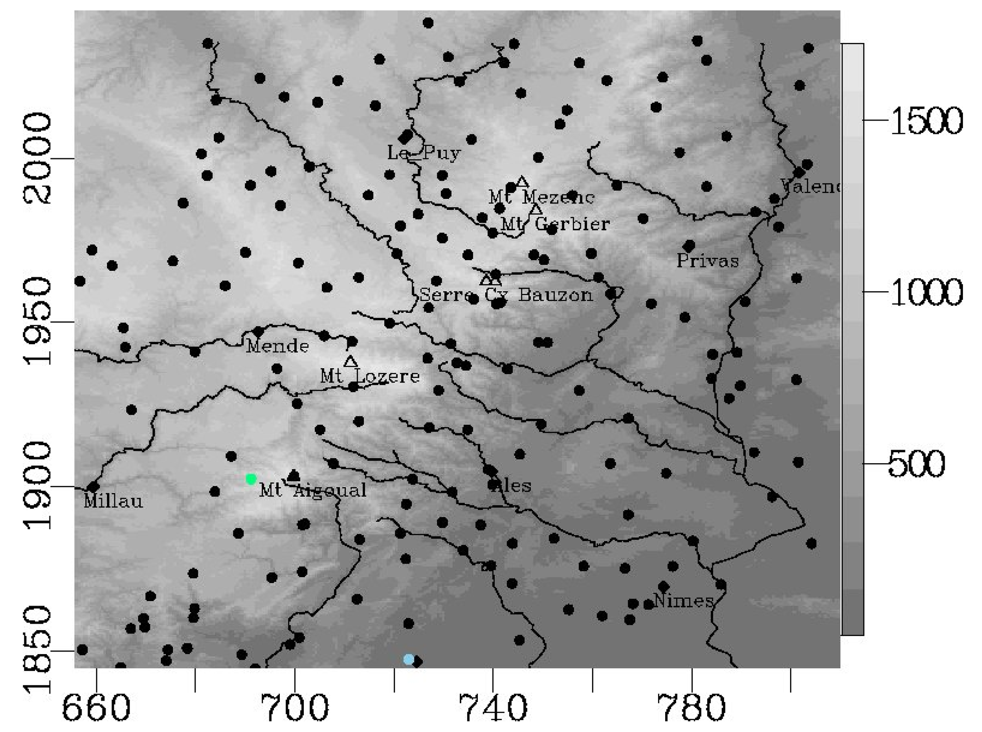
Stéphane Girard, Eugen Ursu
Mistis team

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Workshop on metrics and methodologies of estimation of extreme climate events
27-29 September 2010, UNESCO headquarters, Paris, France

This work was partially supported by the Agence Nationale de la Recherche (french research agency) through its VMC program (Vulnérabilité : Milieux, Climats)

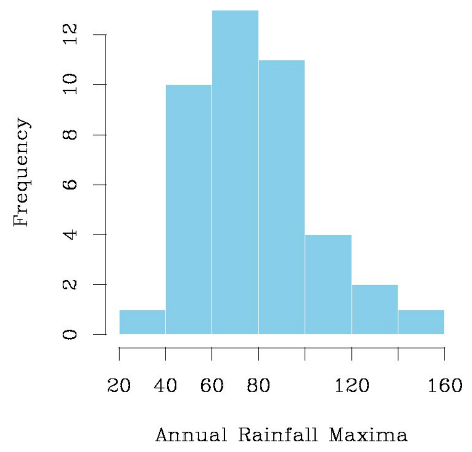
Cévennes-Vivarais Precipitation Data



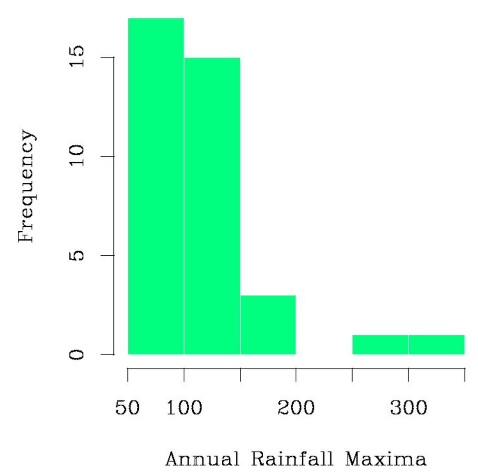
- daily rainfall measurements
- 43 years
- 198 stations

Distribution of Annual Maxima

Montpellier: Plain



Mont Aigoual: Mountain range



Interpolate Extreme Rainfall

1. Assume Generalized Extreme-Value (GEV) distribution at sites
2. Interpolate GEV parameters at ungauged sites
3. Estimate return levels across the area

Latent Space Formulation

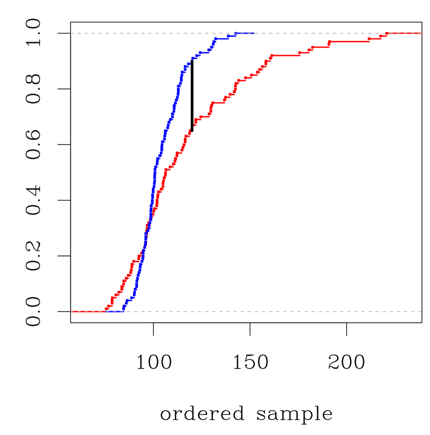
Let S_1, S_2, two sites with observed annual maxima $\mathbf{Y}_1 = \{Y_{1,1}, \ldots Y_{1,n}\}$ and $\mathbf{Y}_2 = \{Y_{2,1}, \ldots Y_{2,n}\}$

Assume there is a latent variable $Z \in \mathbb{R}^p$ which takes values $Z(S_1)$ and $Z(S_2)$ such that

$$d(Z(S_1), Z(S_2)) \text{ is small } \iff \mathbf{Y}_1 \text{ and } \mathbf{Y}_2 \textit{ are similar in distribution}$$

Similarity in distribution

Empirical distribution function



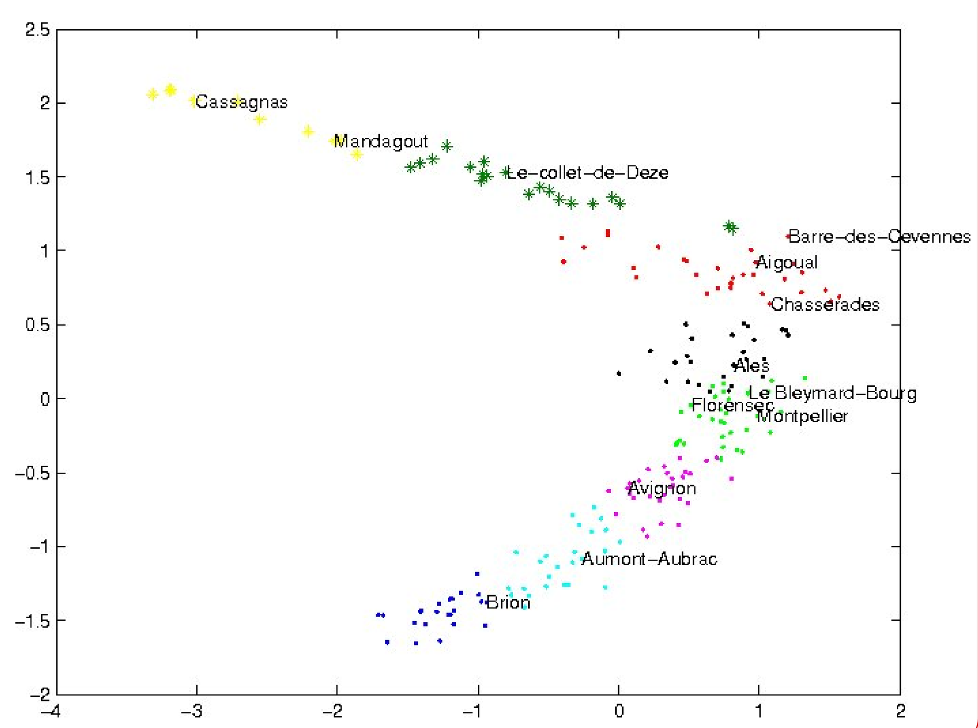
Kolmogorov-Smirnov statistic $\mathcal{KS}(S_1, S_2) \in [0, 1]$: *largest vertical distance between empirical distribution functions of* $\mathbf{Y}_1$ *and* $\mathbf{Y}_2$

Assume :

$$d(Z(S_1), Z(S_2)) = \mathcal{KS}(S_1, S_2)$$

Inference of latent space

1. Infer $Z(S_i)$ at gauged sites with **Multi-Dimensional Scaling** (MDS)
2. Interpolate $Z(S)$ at ungauged sites by training a neural network



Spatial Interpolation in Cévennes-Vivarais

Spatial Kernel Interpolation

For an ungauged site S :

- Define weights w_i with each stations in the latent space so that

$$w_i \propto \left(1 - \frac{d(Z(S), Z(S_i))^2}{h^2}\right)^2 \mathbf{I}_{\{d(Z(S),Z(S_i))<h\}}$$

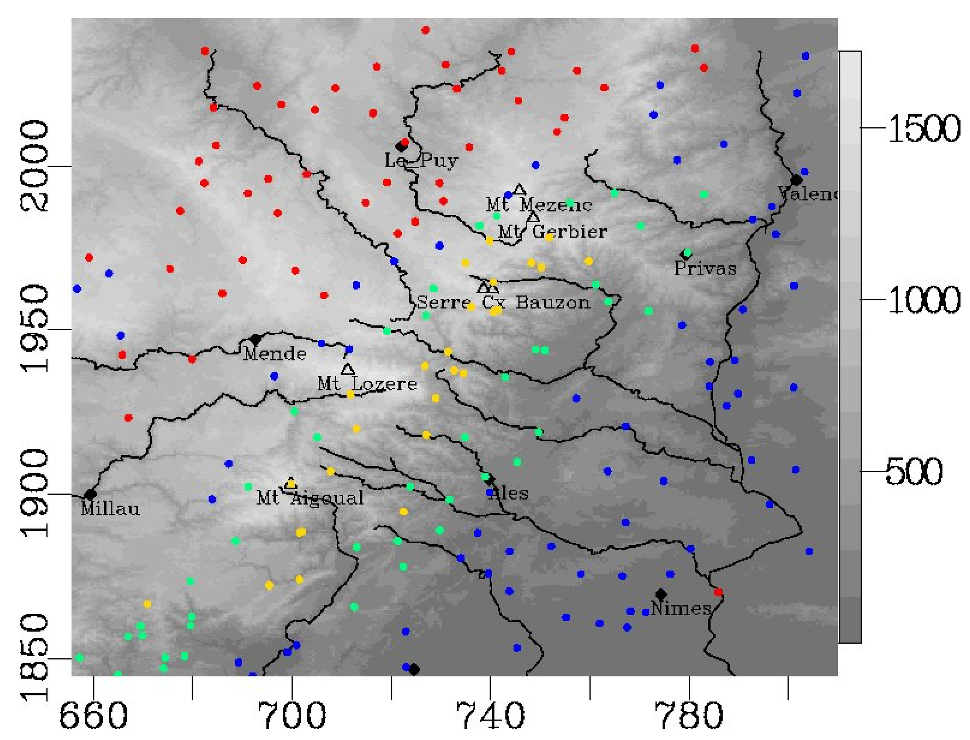
w_i is large $\iff S_i$ is similar in distribution to S

- Infer GEV parameters by minimizing the negative log-likelihood :

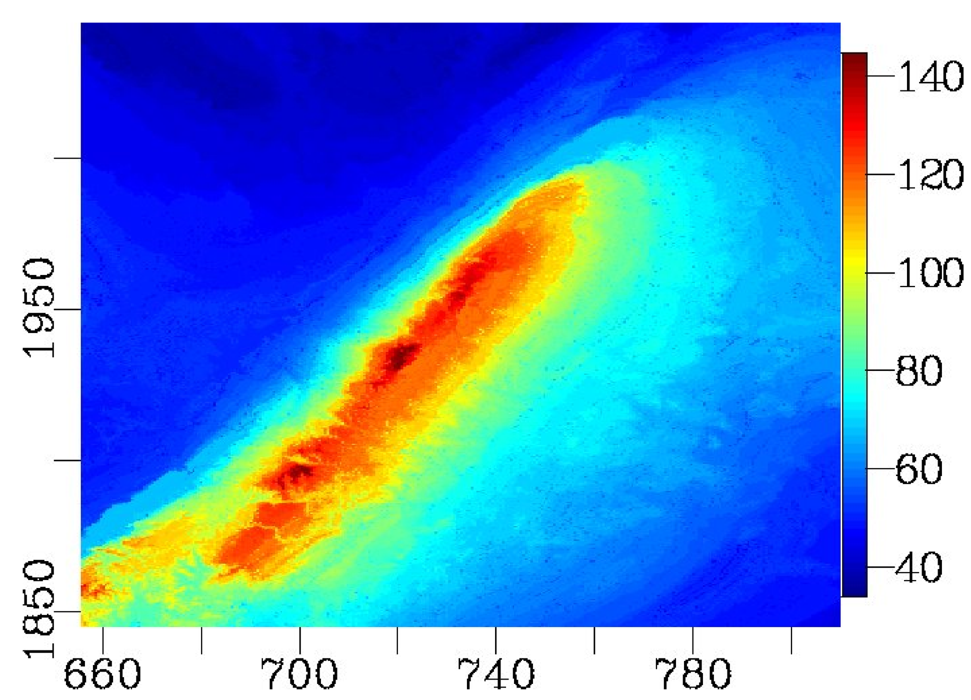
$$l(\mu, \sigma, \xi) = -\sum_{i=1}^{n} w_i \log\left(f(Y_i; \mu, \sigma, \xi)\right)$$

with respect to μ, σ and ξ where f is the GEV pdf

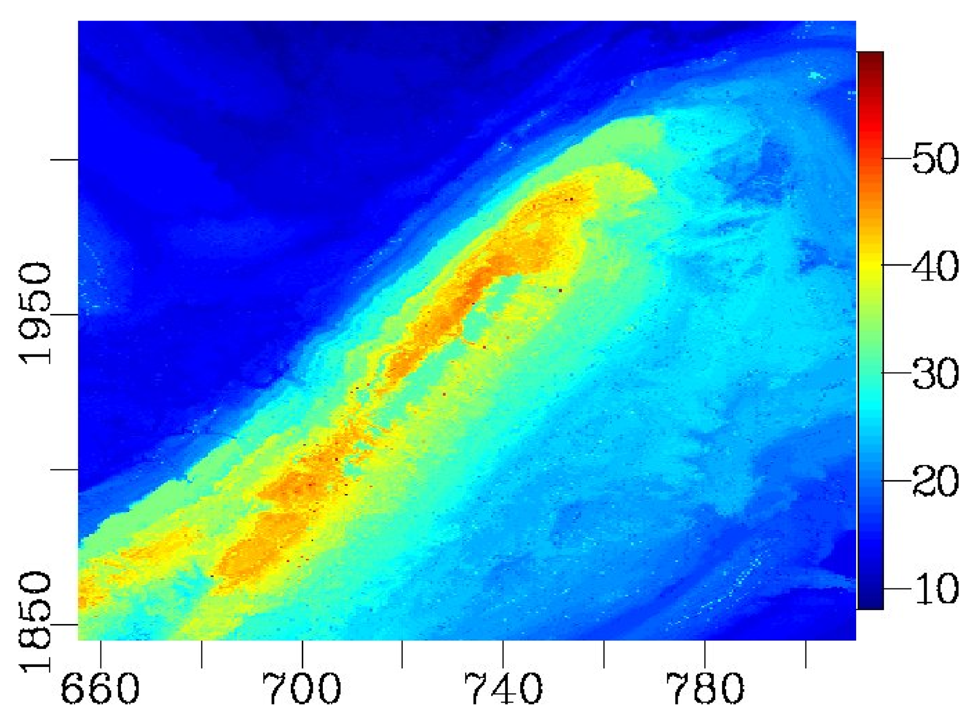
Clustering in the latent space



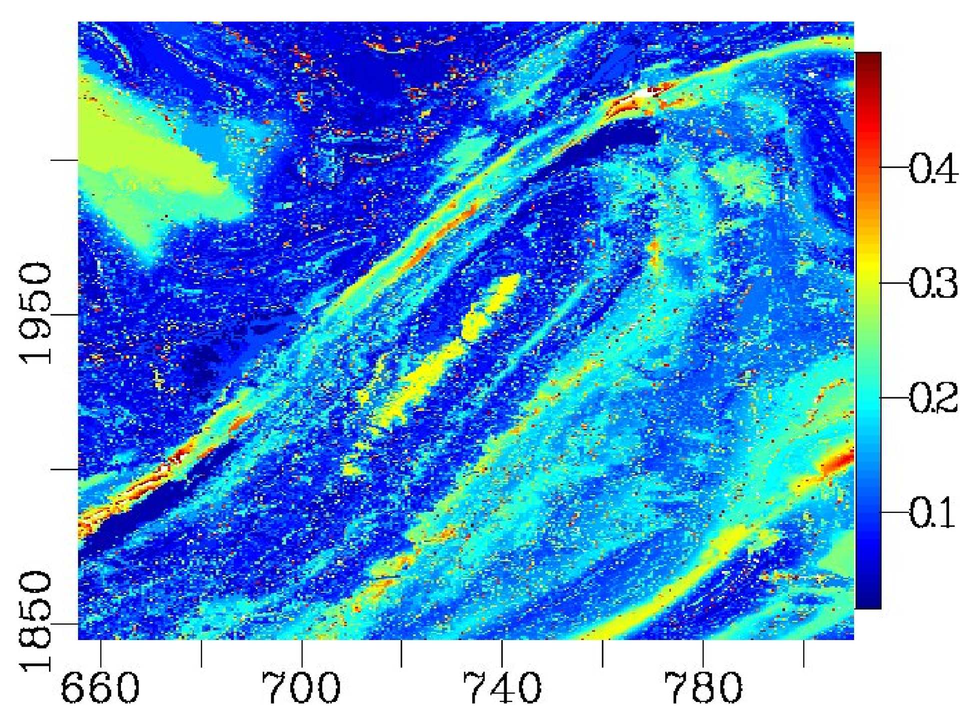
Interpolated location parameter μ



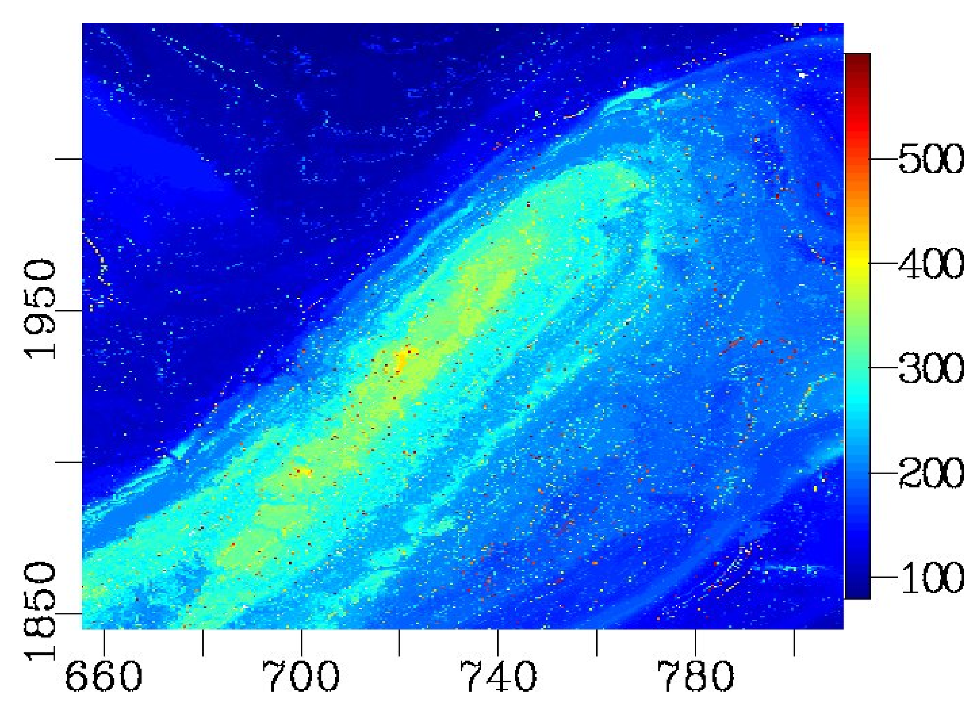
Interpolated scale parameter σ



Interpolated tail index parameter ξ



Interpolated return level 50 years



References

- An Introduction to Statistical Modeling of Extreme Values, S. Coles, Springer 2001
- SpatialExtremes Package: An R package to model spatial extremes, M. Ribatet
- Weighted Likelihood Copula Modeling, X. Wang, M. Gebremichael, J. Yan, submitted
- Sammon's mapping using neural networks: A comparison, D. de RIdder, R. P. W. Duin, Pattern Recognition Letters 18 , 1997