# Construction of a krigged precipitation field based on surface observations and remote sensing tools

**Peio Oria(*), Xavier Calbet, Pilar Rípodas, Llorenç Lliso (AEMET, Spain)**

GOBIERNO DE ESPAÑA · MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA · AEMet Agencia Estatal de Meteorología

**Quantitative precipitation estimation (QPE) fields can be obtained by merging rain gauge data from Automatic Weather Stations (AWS) with spatial continuous information from remote sensing observations or NWP model outputs. Several radar/satellite-gauge merging methods have been proposed and are mainly based on two different approaches: Field bias correction and geostatistical techniques. Here we focus on Kriging with External Drift (KED) as a non-stationary geostatistical method. Fields obtained from radar, satellite and model are used for the auxiliary information. The semivariogram model for the KED is taken from the spatial autocorrelation of the remote sensing fields.**

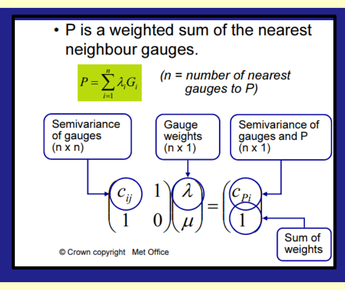
**The procedure is applied to the construction of the precipitation field which produced the flash-flood event of October 9, 2018, over the east part of Majorca.**

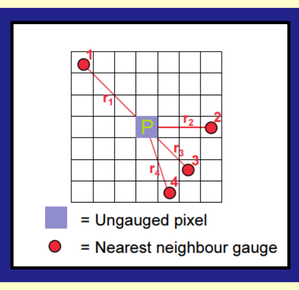
## Kriging with External Drift

**Kriging is a geospatial prediction method which uses a weighted average of a variable in neighbouring points to estimate the 'unknown' value at a given location.**

**Weights are optimized using:**

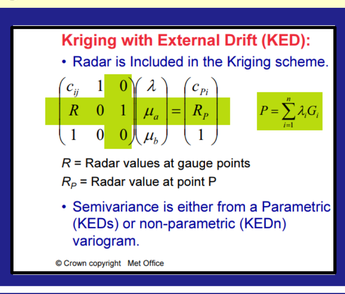
- **A semivariogram model**
- **The location of the neighbouring points**
- **The relevant interrelationships between known and unknown values**




### Kriging with External Drift

**Auxiliary information of the spatial variability (i.e. from radar data) is included in the kriging scheme.**




**Ordinary Kriging constraints:**

- Semivariance is included.
- The sum of the weighting factors for P equals 1.

**In addition for KED:**

- Applying the weighting factors to the radar values at the points 1-4 must give the radar value measured at P.

## Flash-flood event

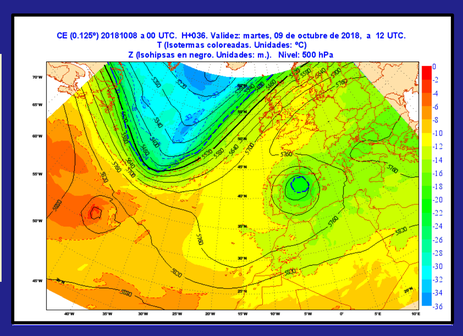
### Synopsis

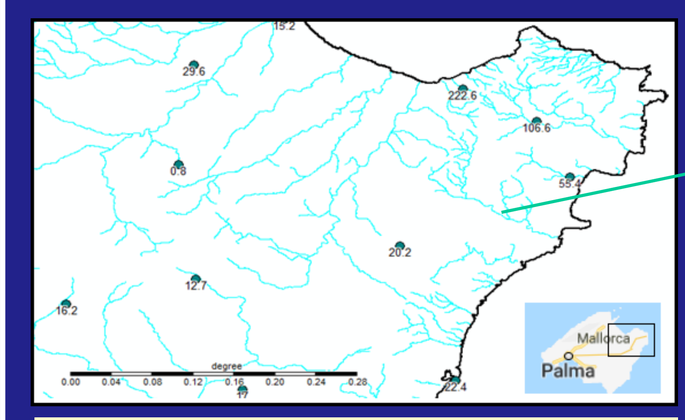
**Intense and persistent thunderstorms over northeast of Spain and Balearic islands produced by:**

**Cut-off low located over the Iberian System mountain range.**

**Strong instability in low levels.**

**Very humid and warm subtropical flow over Balearic islands.**




**Precipitation amounts registered by rain gauges of AWS from AEMET between 13 and 18 UTC of October 9, 2018.**

**The main torrents and rivers are displayed.**

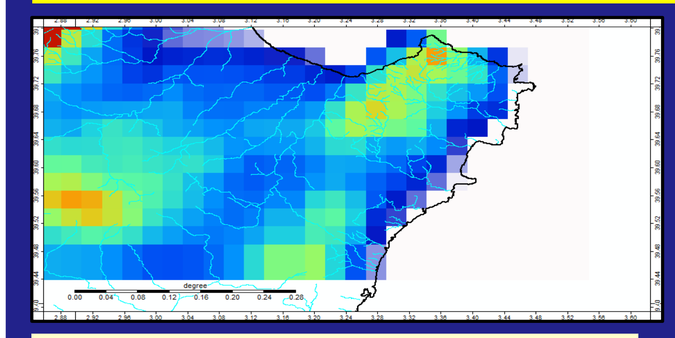
**Source: el diariodemallorca.es**

**Impacts**

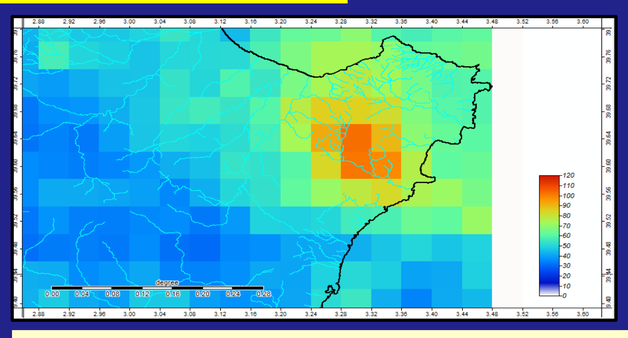
**13 fatalities**

**Extensive material and economic damage.**

## Fields used as ancillary information for Kriging

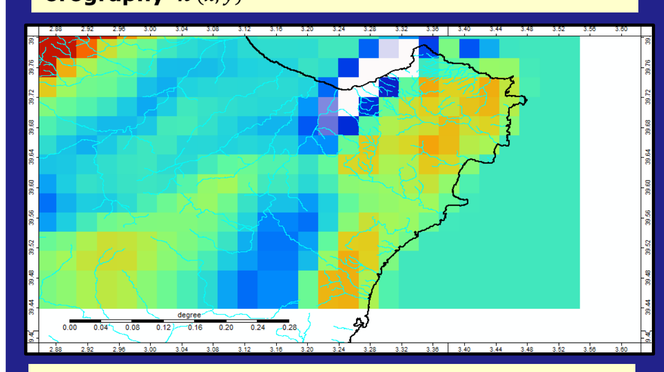



***oro:* 2,5 km resolution Harmonie – Arome model orography** $h\,(x,y)$



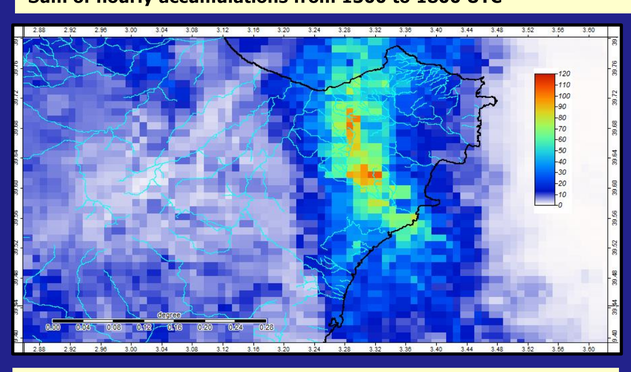

***crr*: Convective Rate Rainfall product from NWC SAF**

**Sum of hourly accumulations from 1300 to 1800 UTC**




***adv:* Wet advection relative to model orography**
$\overrightarrow{\nabla h}(x,y) \cdot q \cdot \vec{v}\,(x,y)$

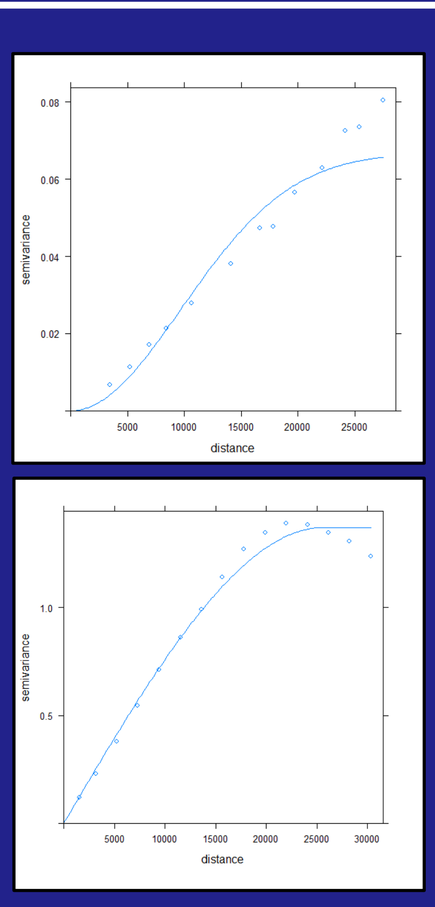
$q$ **and** $\vec{v}$ **are obtained from 12 UTC run of Harmonie - Arome (AEMET Convective-Scale operational model) for 15 UTC.**




***rad:* Rain-Radar product from AEMET (SRI + Rain gauge adjustment).**

**Sum of hourly accumulations from 1300 to 1800 UTC**

**The semivariograms for KED are obtained taking the spatial variation of the remote sensing fields (*crr* and *rad)***




**Gaussian fit to the semivariogram data**




**Spherical fit to the semivariogram data**

## Results and conclusions

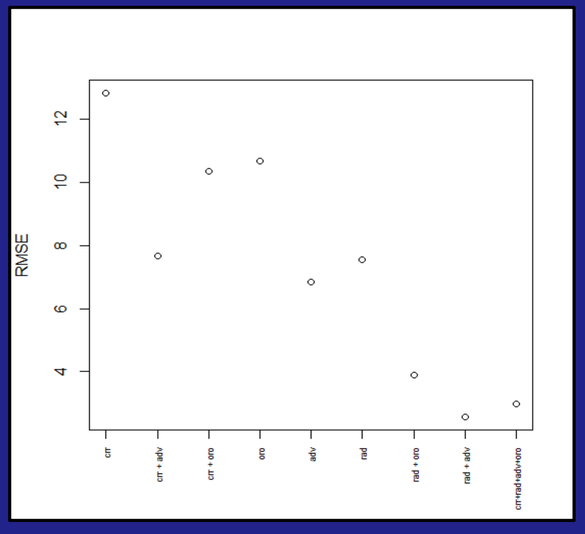
**Before applying KED the following preparatory steps over all fields are carried out:**

**1) Projection transformation to UTM (distances are required for KED scheme). Transformation to LONLAT datum WGS84 for data display.**

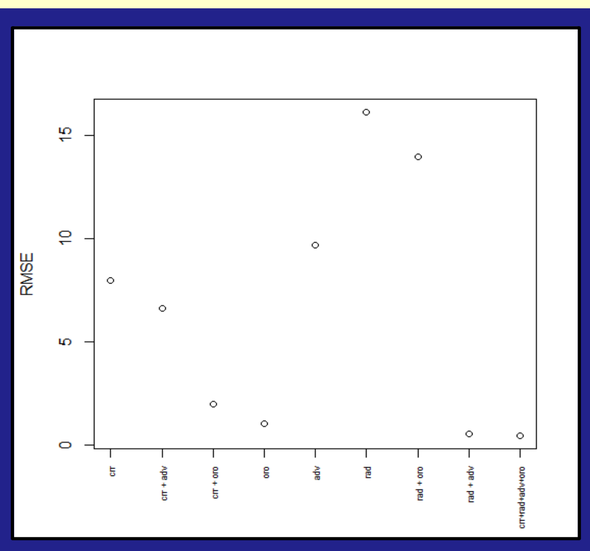
**2) Selection of a domain which includes the AWS.**

**3) Interpolation of the fields in a regular grid covering the previous domain.**

**4) Degradation of *crr, adv* and *oro* resolutions to 1 km in order to match *rad* resolution.**


**RMSE computed through cross-validation over the rain-gauge points data set using different ancillary fields (single or combined). The semivariogram model is obtained from *rad* field.**




**RMSE computed through cross-validation over the rain-gauge points data set using different ancillary fields (single or combined). The semivariogram model is obtained from *crr* field.**


**Precipitation field over two domains where torrential precipitations took place. The field is constructed by means of KED with ancillary fields *crr* + *oro* and semivariogram model obtained from *crr* field. Pixel size is 1 km.**

**The shape of the river network is also displayed and blue points indicate the observed precipitations at the rain-gauges of AWS.**

**All the information is shown over a relief map from Google-Earth.**

### Conclusions

**Precipitation fields obtained merging surface and remote sensing observations can contribute to improve nowcasting tools in torrential rain events.**

**Kriging with External Drift provides good results when satellite- or radar-based precipitation products are included as auxiliary fields.**

**If few rain-gauge data are available remote sensing fields can be used to generate the semivariogram model for the kriging scheme.**

(*) **Corresponding author: poriai@aemet.es**