Evaluating the skill of European large scale gridded datasets in detecting trends in Southern Italy

Carmelo Cammalleri[1], Brunella Bonaccorso [2] and Alfonso Senatore[3]

(1) *Joint Research Centre (JRC), European Commission, Ispra, Italy*
(2) *Department of Engineering, University of Messina, Messina, Italy*
(3) *Department of Environmental Engineering, University of Calabria, Arcavacata di Rende (CS)*

Observational gridded datasets from station data or model-derived reanalysis products at global or continental spatial scales are widely used for many hydroclimatic applications, as they provide long and spatially homogeneous records. At the European level, the Copernicus Climate Change Service (C3S) Climate Data Store (CDS) includes several of these datasets, such as the E-OBS daily gridded observational dataset for precipitation, temperature, sea level pressure and global radiation, and ERA5 and ERA5-Land reanalysis gridded datasets, which are commonly used to characterize the past weather conditions since the 1950s. One of the main limitations of such datasets is the coarse spatial resolution (never less than 10km), which hinders applications at relevant hydrological scales, especially in areas of complex topography.

Another main issue for E-OBS is that the underlying stations time series used as input to the interpolation are usually not corrected for inhomogeneities (except for E-OBSv19.0eHOM). Also, the station density is not constant neither through time nor space. This latter drawback also affects ERA5 and ERA5-Land products, which are built upon data assimilation of historical observations provided by different and unevenly distributed sources within a numerical weather prediction model. Therefore, trend analyses based on E-OBS or ERA5 and ERA5-Land should be treated with caution.

We compare the spatio-temporal evolution of rainfall trends derived from E-OBS and ERA5 to those detected using long historical rainfall series recorded by ground-based monitoring networks in Southern Italy. These networks, operated by the former Regional Hydrographic Offices, have density considerably greater than the observational gridded datasets. In particular, the study is applied to Sicily and Calabria regions on a seasonal and annual scale. Gradual trends are studied using Sen's slope and Mann-Kendall tests on gridded rainfall data from 1951 to 2019, whereas abrupt change points are detected using Pettitt's test. In addition, the progressive form of the Mann Kendall test (Sneyers, 1990), is carried out to identify where a significant trend starts and follow its time evolution from then on. In particular, the following protocol is implemented:

1. At first, grid cells including at least one rain gauge are selected.
2. Among the selected grid cells, priority is given to the ones including multiple stations to better match the coarse spatial resolution of gridded data and to minimize data gaps.
3. Trend analyses are carried out both on the selected gridded and ground-based data at annual and seasonal scale.
4. Only grid cells where at least one trend analysis either on gridded or ground-based data reveals a statistically significant trend are retained. Grid cells with no significant trend in contrast to the corresponding station data are marked as "anomalous".
5. For the remaining grid cells, trends are compared in terms of starting point, sign, magnitude, and p-values, and results are summarized through similarity indices and contingency tables.

Finally, an expanding-sliding window trend analysis based on Kendall's τ_b (Yeh and Wu, 2018) is conducted for cell grids with the highest level of agreement with station data to understand the sensitivity of trends to varying data periods and data length.

References

Sneyers, S. (1990). On the statistical analysis of series of observations; Technical note 782 no. 143, WMO No. 725 415. Secretariat of the World Meteorological Organization, 783 Geneva, Switzerland.

Yeh, P. J.-F., and Wu, C. (2018). Recent acceleration of the terrestrial hydrologic 794 cycle in the U.S. Midwest. Journal of Geophysical Research: Atmospheres, 123, 795 2993–3008. doi: 10.1002/2017JD027706