METEO-RO contribution to INDECIS D6.2

European Reanalysis ERA5, UERRA MESCAN-SURFEX, COSMO_REA6 compared to station-based data

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Summary
We present the results of validation of the European reanalysis datasets ERA5, UERRA MESCAN-SURFEX, COSMO_REA6 against the observation-based data available from the Horizon 2020 EUSTACE Project, with respect to daily minimum, maximum and average air temperature, for the period 1995-2017. Furthermore, we investigate the changes in the regime of 4 extreme temperature indices relevant for agro-meteorological studies, from the list of indices adopted in INDECIS project.

Methodology

The European reanalysis datasets ERA5, UERRA MESCAN-SURFEX, COSMO_REA6 have been validated against the homogenized temperature series obtained in the Horizon 2020 EUSTACE Project, with respect to daily minimum, maximum and average air temperature. The UERRA MESCAN-SURFEX dataset is available from Copernicus Climate Data Store (https://cds.climate.copernicus.eu/). Although the UERRA-HARMONIE/V1 dataset was selected for the intercomparison exercise and described in D6.1, in this study the MESCAN- SURFEX dataset was used as it presents the finest spatial resolution for near-surface air temperature among the UERRA reanalysis datasets.

The study employed data from 2163 stations (Fig.1), covering the period 1995-2017, which represents the common period for the three datasets. The comparison made use of common accuracy indicators (ME, MAE, RMSE, Pearson correlation coefficient), seasonal scatterplots and Taylor diagrams. The analysis was performed using the INDECIS software for intercomparison of reanalysis datasets (interdecis) (https://github.com/alexdum/interdecis) developed in WP6.

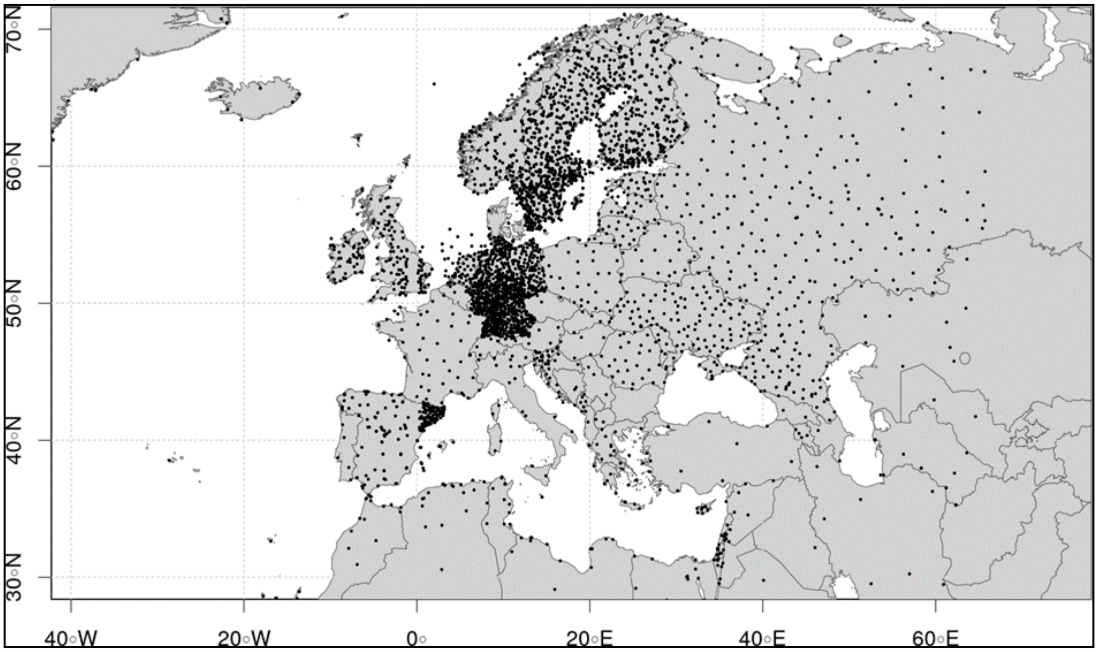


Fig. 1 Spatial distribution of the stations used in the study.

For the investigation of the changes in the regime of extreme temperature indices for the analyzed area (Europe), we used a core set of 4 indices as defined in Table 1. The indices have been computed using R-dedicated packages, starting from daily and hourly results of the reanalysis data (COSMO, UERRA) and observations data (E-OBS) for the interval 1955 – 2017.

Meteorological variables used as input for computing the extreme indices are daily mean, maximum and minimum values of 2m air temperature.

The statistical analyzes performed for the four climate indices aim at a comparative approach regarding the three data sets.

Table 1. The definition of indices.

Indices	**Indices Name**
D32	Number of consecutive days with maximum temperature ≥32˚C from June to August
PTG	Sums of positive average temperatures calculated for the 1st of February to the 10th April interval
STN15	Sums of minimum air temperatures ≤-15˚C recorded in December-February interval
STX32	Sums of maximum temperatures ≥32˚C in JJA

Results

Intercomparison in terms of variables

The ERA5 and COSMO-REA6 datasets have a very similar behavior with regard to the reference data, while UERRA MESCAN-SURFEX presents the best accuracy scores, for all variables and all seasons as shown also by the scatter plots (Fig. 2-4), possibly due to the improved representation of physical processes in the SURFEX land surface platform (Masson et al, 2013).

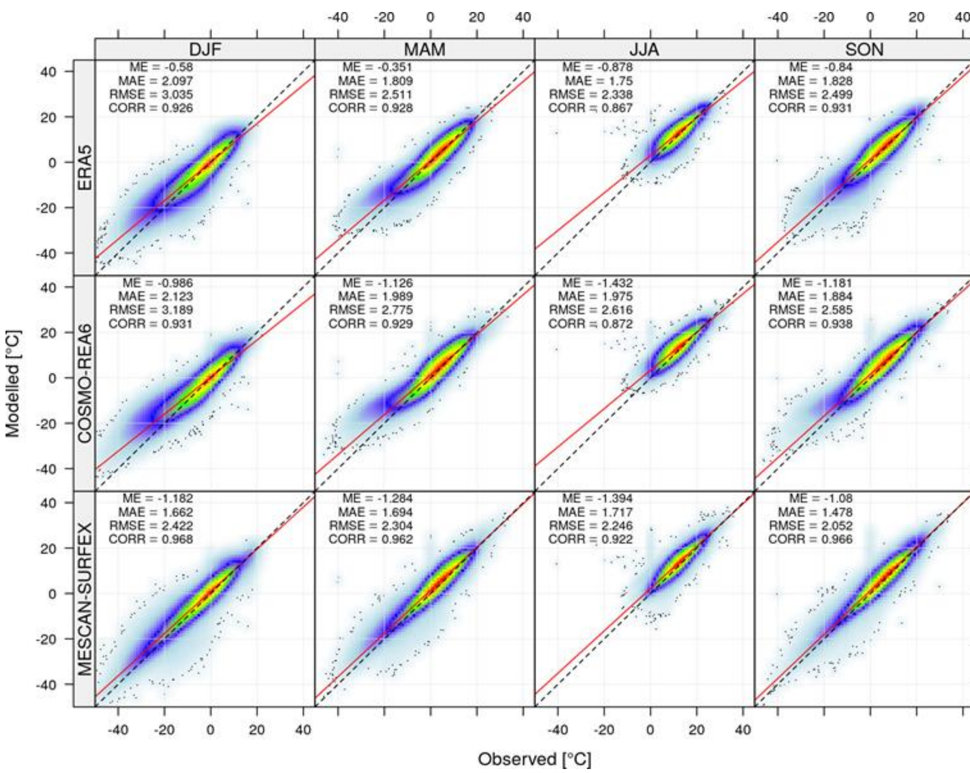


Fig. 2 Observed daily minimum air temperature vs. modelled daily minimum air temperature.

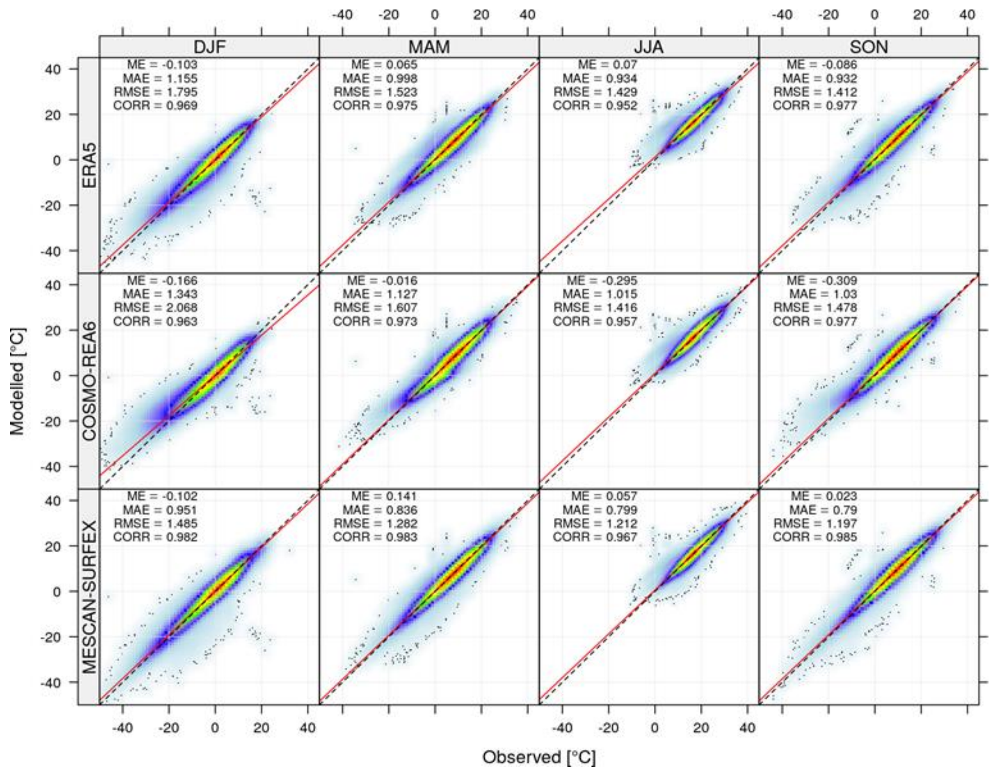


Fig. 2 Observed daily average air temperature vs. daily average modelled minimum air temperature.

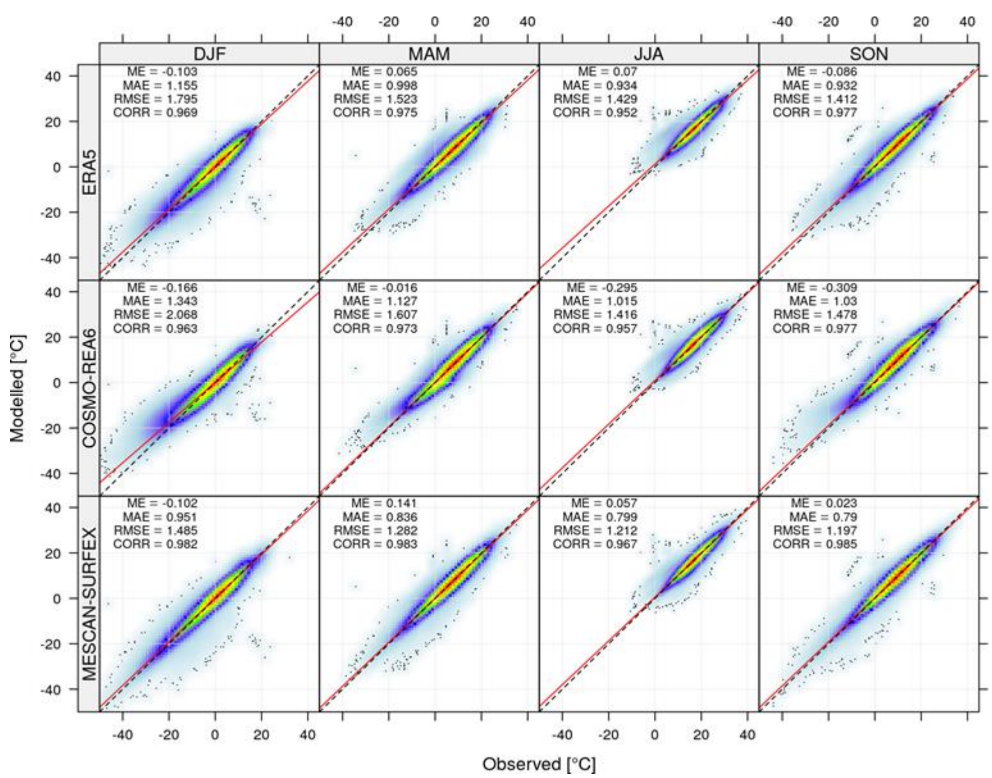
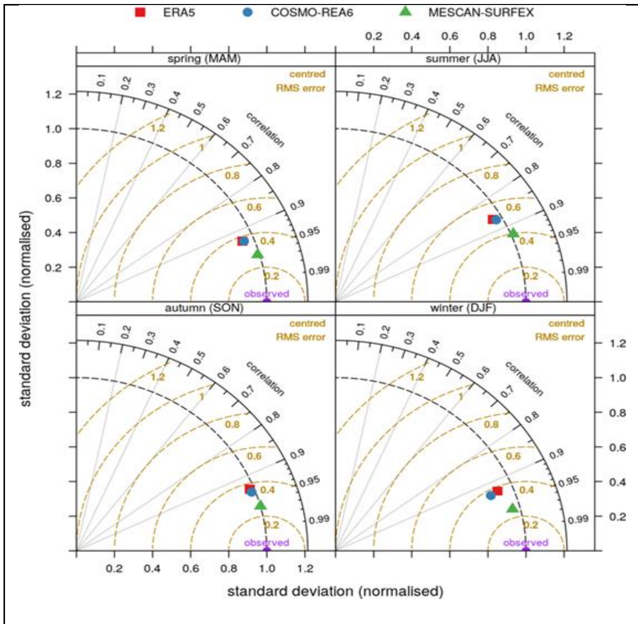
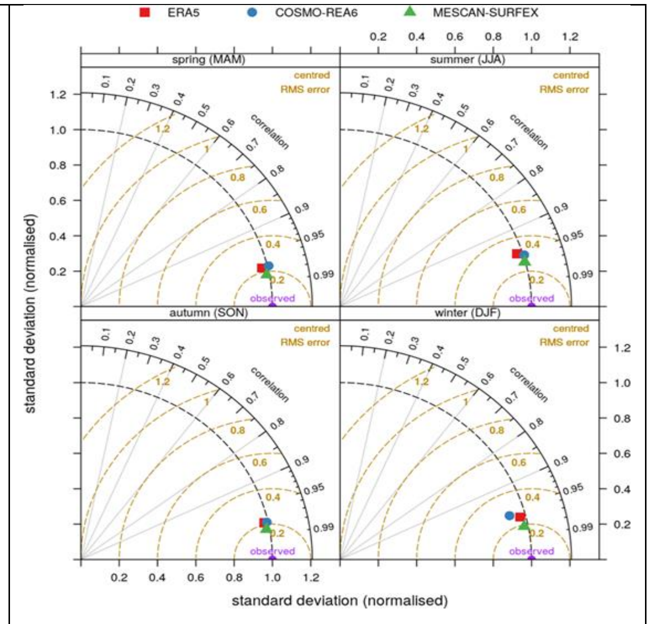


Fig. 3 Observed daily maximum air temperature vs. modelled daily maximum air temperature.

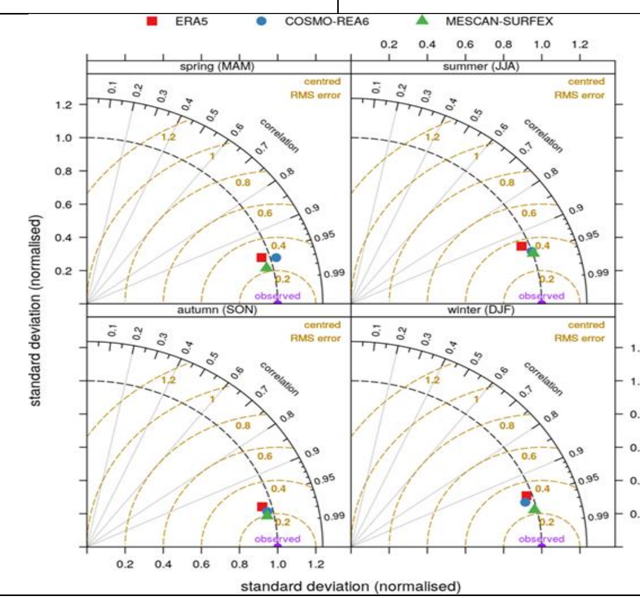
The results of the intercomparison between the three datasets and the reference data for the 2m air temperature show a high correlation (above 0.85) between each reanalysis dataset and the reference data, for each variable and season, averaged over the entire European area (Fig. 5).



a)



b)



c)

Fig. 5 Taylor diagram of the pairwise observed and reanalysis for (a) daily minimum air temperature, (b) daily average air temperature and (c) daily maximum air temperature.

Intercomparison in terms of indices

The comparative analysis of the spatial distributions representing the temporal average calculated in each grid (1955-2017) for the three data sets studied reveals, for each index, a similar pattern produced by each dataset.

For indices D32 and STX32, the highest mean values are found in the southern Mediterranean area, gradually decreasing towards the north of the European continent. For these indices, both reanalysis datasets are slightly colder than the observations (Fig 6 and 8) and they are closely correlated (Fig. 7 and 9), the spatial correlation with the reference data suddenly decreasing after 2005.

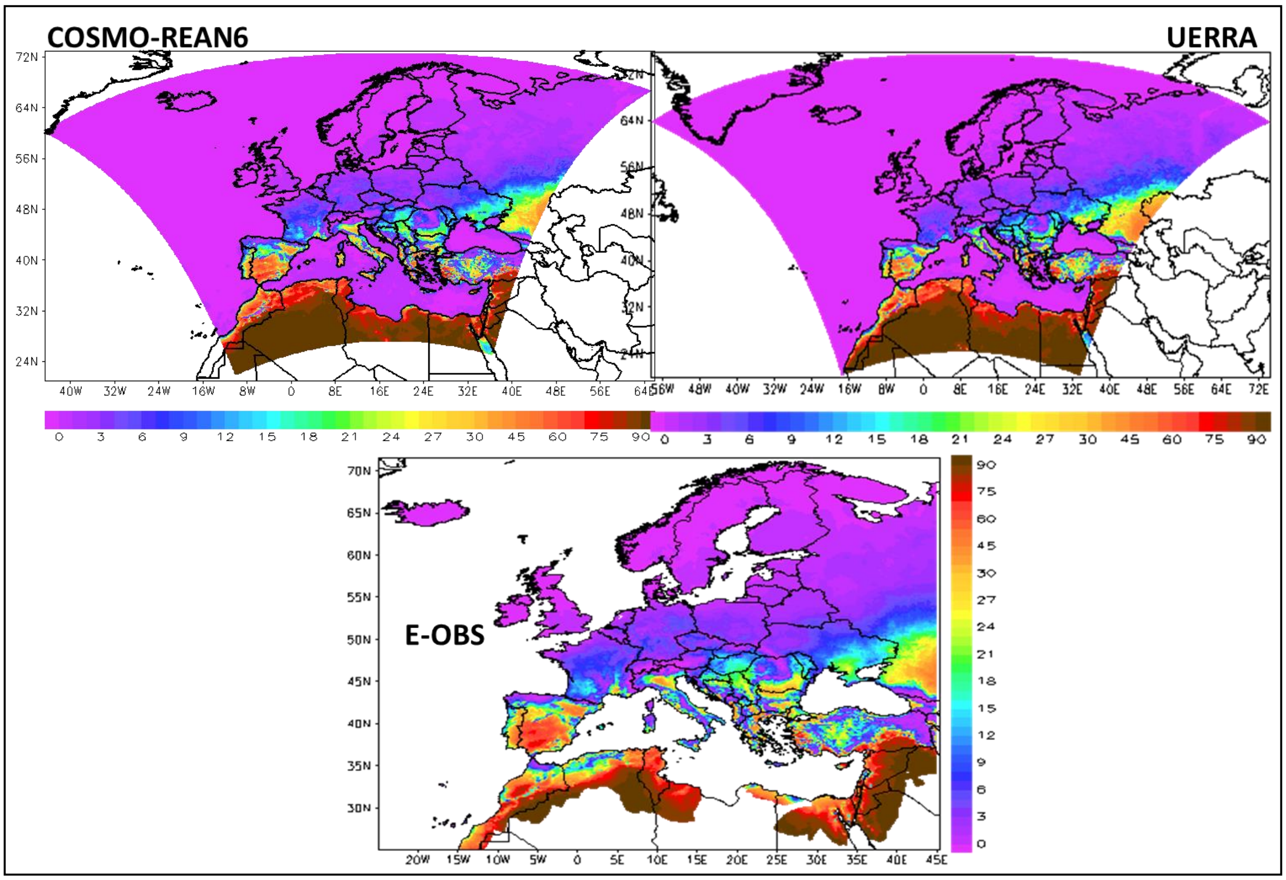


Fig. 6 Spatial distribution of mean values for D32 index from COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

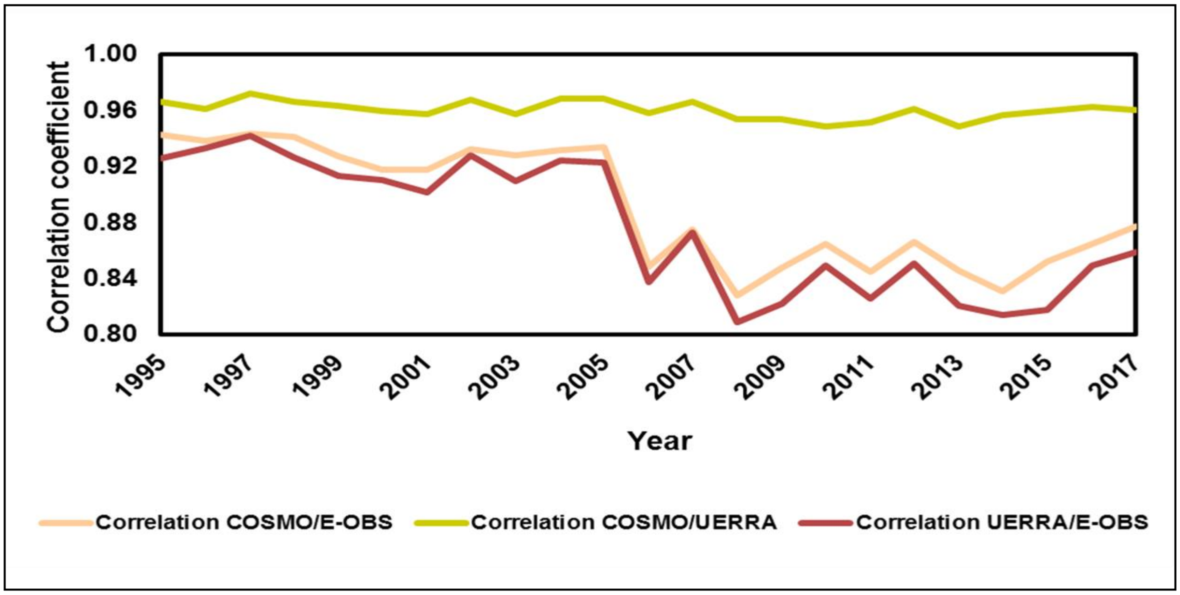


Fig. 7 Spatial correlation coefficient for D32 index between COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

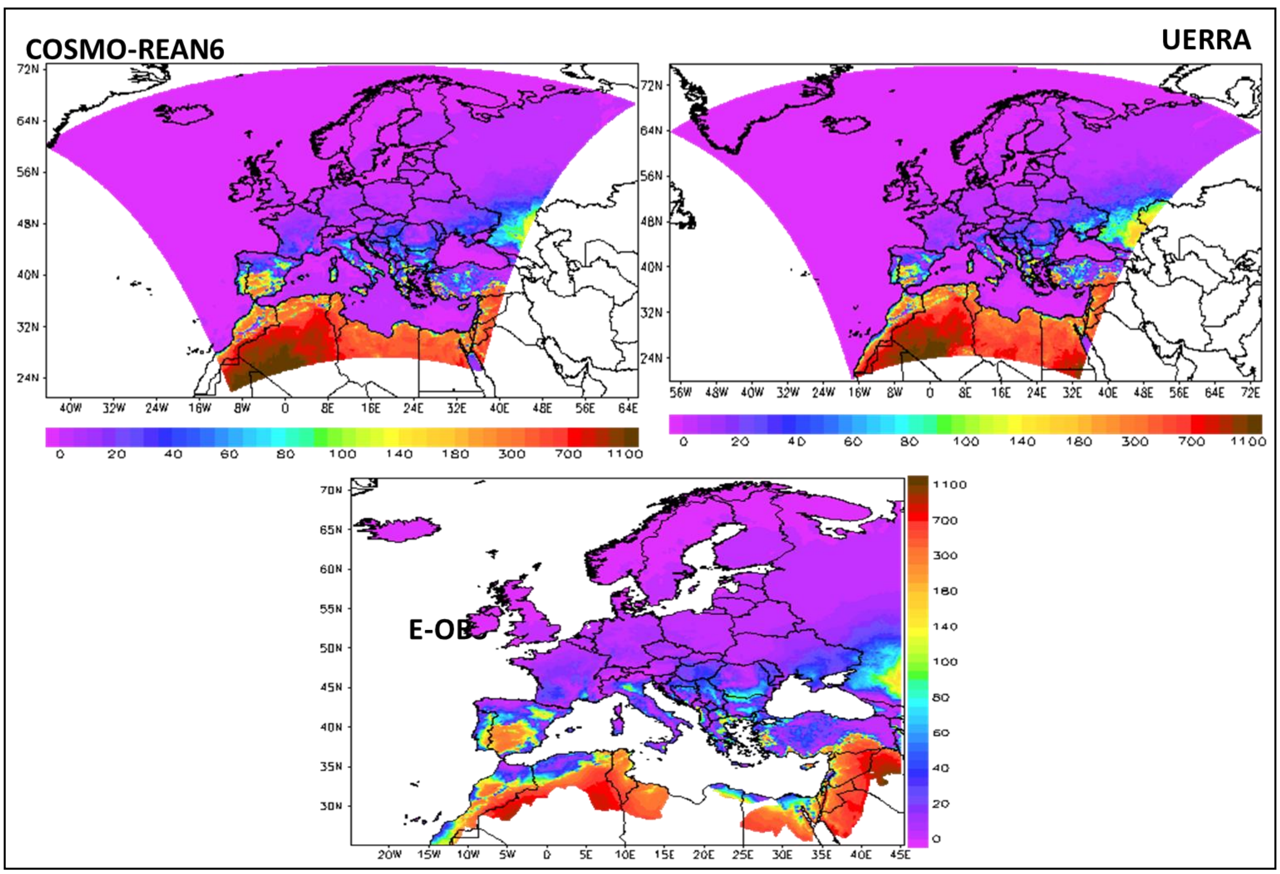


Fig. 8 Spatial distribution of mean values for STX32 index from COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

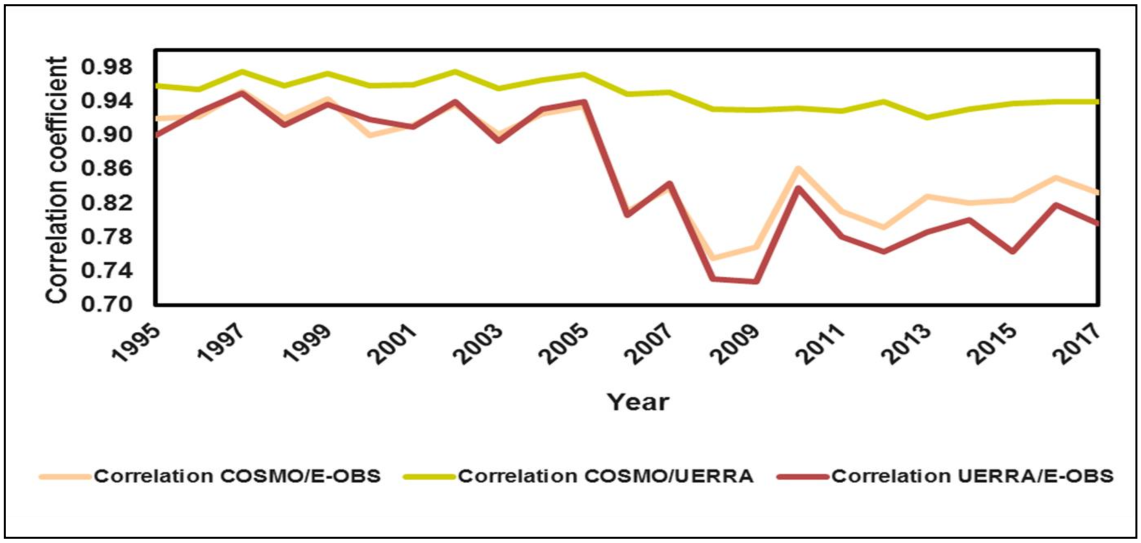


Fig. 9 Spatial correlation coefficient for STX32 index between COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

In the case of the PTG index, the spatial distribution looks like a dipole (NE / SV) with higher values in southwestern Europe and lower values in northeastern Europe (Fig.10). A better agreement in terms of spatial distribution is found between COSMO-REAN6 and the reference dataset, while the spatial correlation is high for both reanalysis data (Fig.11).

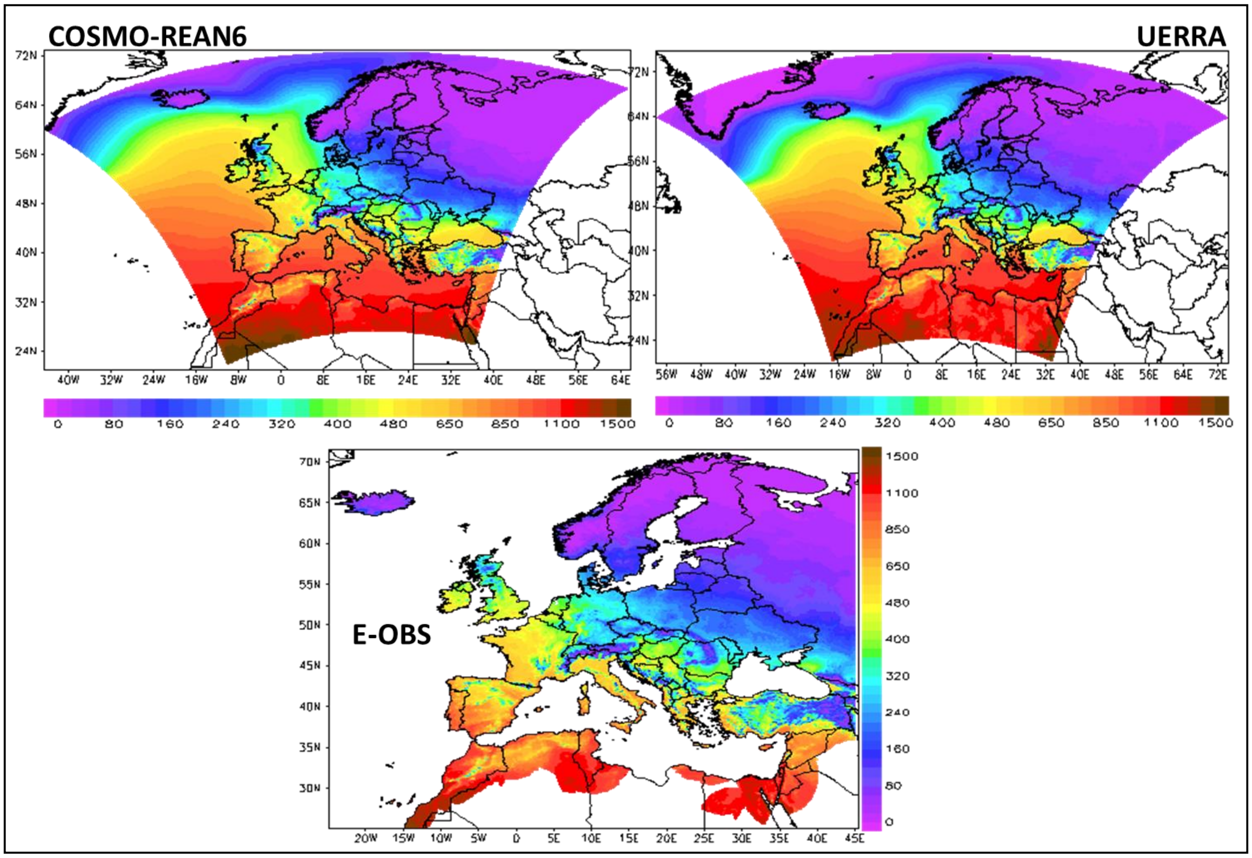


Fig. 10. Spatial distribution of mean values for PTG index from COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

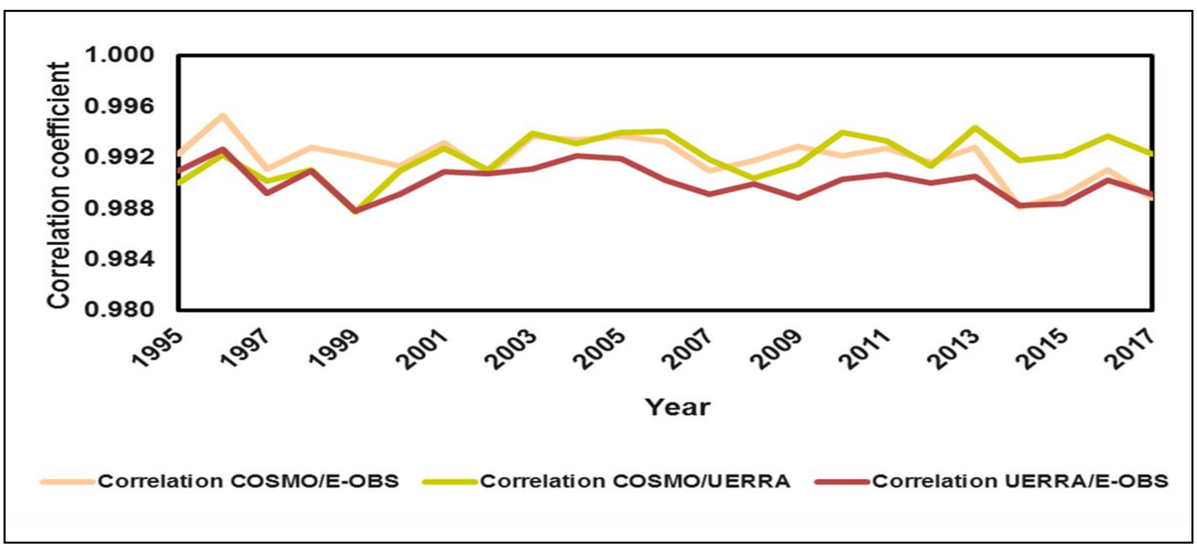


Fig. 11 Spatial correlation coefficient for PTG index between COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

The STN15 index shows the highest values of the average in the north of Europe gradually increasing towards the northeast of Europe (Fig.12). For both reanalysis the spatial distribution of STN15 mean values show a good agreement with the reference dataset, but in terms of spatial correlation, UERRA MESCAN SURFEX is closer to the E-OBS data (Fig. 13).

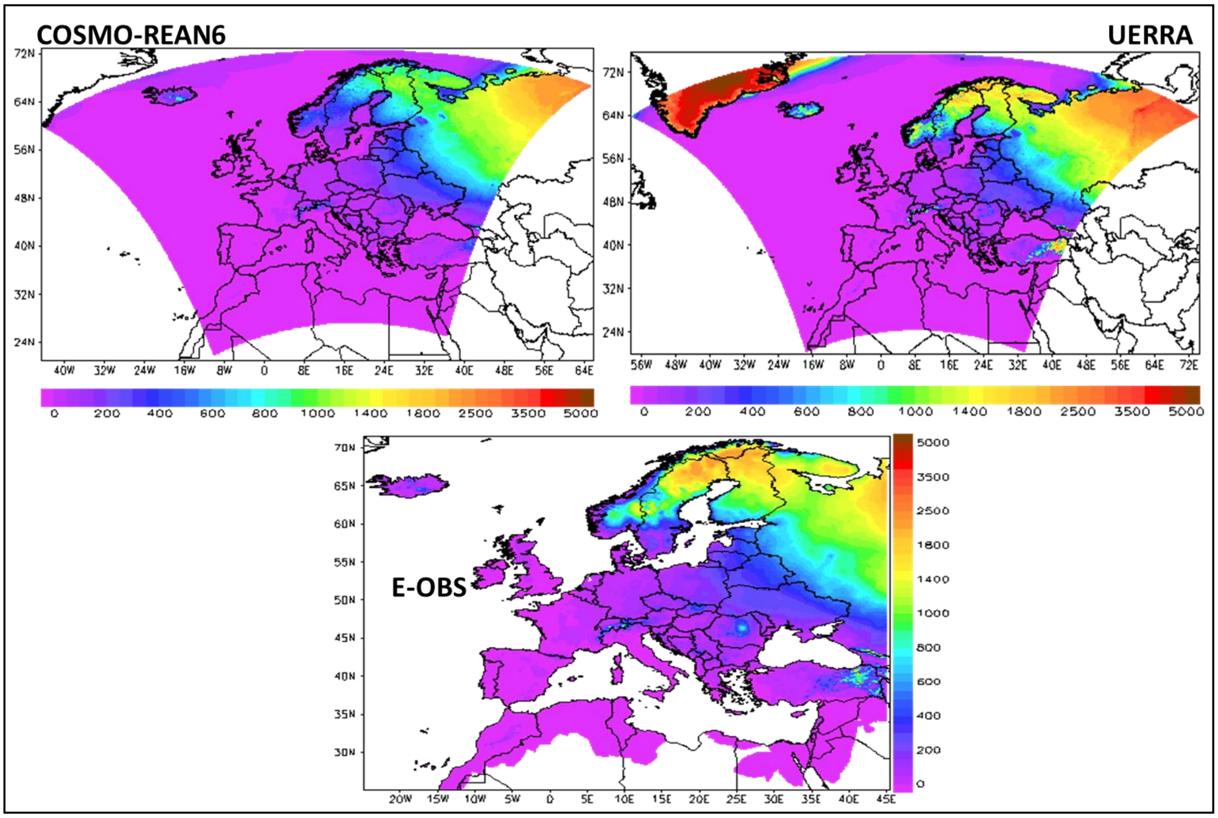


Fig. 12. Spatial distribution of mean values for STN15 index from COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017

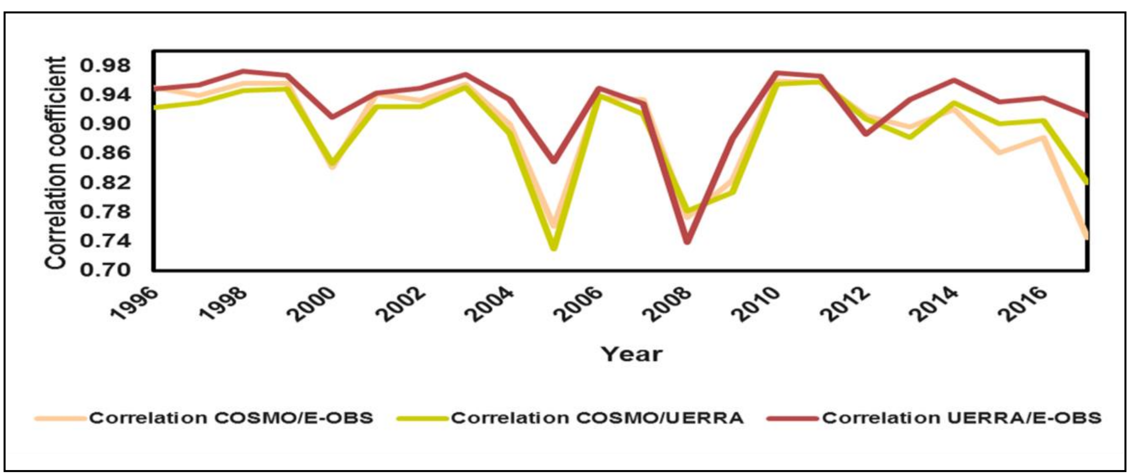


Fig. 11 Spatial correlation coefficient for STN15 index between COSMO-REAN6, UERRA-MESCAN SURFEX and E-OBS datasets for the period 1995-2017.

Conclusions

- Reanalysis datasets are good candidates as alternative data sources with respect to parameters analyzed, at European level.
- In particular, the UERRA MESCAN-SURFEX dataset presents, overall, the best performance for both atmospheric variables and climate indices considered.
- For indices: correlation between the reanalysis datasets and observations is high; for D32 and STX32, the correlation higher in the first part of the interval, while after 2005 it decreases significantly.
- The COSMO-REA6 reanalysis set correlates better with the observation data for the D32, STX32 and PTG indices.
- In the case of the STN15 climate index, the set of UERRA reanalysis is better correlated with the observational data, more pronounced in the last years of the interval.

References

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