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Editorial

Evaluation of Reanalysis Data in Meteorological and Climatological Applications: Spatial and Temporal Considerations

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Reanalysis datasets are among the most used gridded data for the study of weather and climate. Due to their homogenous nature and high spatial and temporal resolution (compared to raw observations), they are used for evaluating climate models, irrigation management decisions, soil water balance evolution, flooding predictions, and for many other purposes. With multiple reanalysis datasets now available, researchers must consider the strengths and weaknesses of each product by evaluating their quality in reproducing the variation of mean and variability—on a spatial and temporal basis—captured in observations [1]. Although efforts to improve reanalysis products have led to significant progress at a global level, reanalysis products at a regional level could not always reproduce characteristic climatological features. The estimates of the basic dynamic fields in modern reanalysis are increasingly similar, especially in the vicinity of abundant observations [2]. While this is true for temperature, physics fields (e.g., precipitation and longwave radiation) are more uncertain due to shortcomings in the assimilating model and its parameterizations [3]. The challenges become even more formidable when reanalysis data are used to assess climate change and extremes at high resolutions in time and in space.

In this context, this Special Issue (SI) entitled "Evaluation of Reanalysis Data in Meteorological and Climatological Applications: Spatial and Temporal Considerations", includes articles dedicated not only to the evaluation of reanalysis products against observations [4–7] but also to exploring the effects of uncertainties using reanalysis data in model outputs [8,9].

Pelosi et al. [8] compared ERA5-Land and UERRA MESCAN-SURFEX (UMS) reanalysis products with spatially interpolated weather observations, during the period from 2008–2018, for the assessment of reference evapotranspiration (ETo) for the Campania region in southern Italy. This study confirmed that reanalysis data can successfully (ERA5-Land outperformed UMS) surrogate the unavailability of observed weather data for the regional assessment of ETo.

Hamm et al. [4] evaluated nine different gridded precipitation products from different origins (ERA5, ERA5-Land, ERA-interim, HAR v2 10 km, HAR v2 2 km, JRA-55, MERRA-2, GPCC, and PRETIP) over a subregion of the Central Himalaya and the Southwest Tibetan Plateau from May to September 2017. They concluded that a higher grid resolution can better resolve extreme precipitation, leading to overall lower mean precipitation spatially, but higher extreme precipitation events. They suggest a careful choice of reanalysis based on the type of application and specific research question.

The skills of 12 bias-corrected CMIP6 (6th phase of the Coupled Model Intercomparison Project) models were evaluated against reanalysis and monthly observations by Alaminie at al. [5] for their abilities to reproduce past trends and project future trends over the upper Blue Nile Basin in Ethiopia for the period from 1981–2010. ERA5 for temperature and GPCC for precipitation showed better agreement with the basin's observational data.

The reliability of the ERA5 reanalysis product in replicating mean and extreme surface air temperatures from the E-OBS database and 196 meteorological stations across Europe was assessed by Velikou et al. [6]. In general, ERA5 captured the spatial distribution of the mean annual and seasonal temperature over Europe; however, in latitudes higher than 55° N, ERA5 presented some weaknesses in simulating the temperature values (especially over the Scandinavian region). Regarding extreme low temperatures, the weakest performance of ERA5 was noted over the northern and southern regions of Europe.

An assessment of the performance of four different precipitation databases of alternative sources (two from gridded analyses, MERGE and CHIRPS, and the other two from ECMWF reanalysis, ERA5 and ERA5Land) with respect to observations from seven weather stations located in a Brazilian region (SEALBA)—comprising three states and conducted during 2001–2020—was attempted by Ewurton et al. [7]. The study concluded that none of the data sources should be completely excluded and in the absence of information from one of them, the others can and should be consulted, retaining however the series of MERGE, CHIRPS, ERA5Land, and ERA5 as the order of priority.

My et al. [9] evaluated the performance of two long-term gridded datasets (E-OBS and CRU) for reproducing station-based precipitation and temperature data (with a particular focus on trends and aridity classification results) over the Apulia region in southern Italy for the period from 1956–2019. The main conclusion of this study was that gridded datasets, especially for complex topographic and/or climatic regions, should be used with caution or only after a preliminary evaluation against observational data before any climatological application to ensure their proper reliability.

In summary, the studies included in this SI cover many aspects of its main objectives, highlight the strengths and weaknesses of gridded products, and promote procedures and conditions that should be fulfilled to ensure their proper use. Regarding the future of these products, further refinement of these products is required for them to continue to be a critical resource for understanding the Earth's climate, variability, and change. Not only is reduction of uncertainty for any individual gridded dataset important, through improved algorithms and processing—but also these products—must be physically integrated and consistent in their use of ancillary information and in their assumptions [3].

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References

1. Mavromatis, T.; Voulanas, D. Evaluating ERA-Interim, Agri4Cast and E-OBS gridded products in reproducing spatiotemporal characteristics of precipitation and drought over a data poor region: The Case of Greece. *Int. J. Climatol.* **2020**, *41*, 2118–2136. [CrossRef]
2. Rienecker, M.R. NASA's Modern-Era Retrospective Analysis for Research and Applications. *MERRA J. Clim.* **2011**, *24*, 3624–3648. [CrossRef]
3. Bosilovich, M.G.; Kennedy, J.; Dee, D.; Allan, R.; O'Neill, A. On the Reprocessing and Reanalysis of Observations for Climate. In *Climate Science for Serving Society*; Asrar, G., Hurrell, J., Eds.; Springer: Dordrecht, The Netherlands, 2013. [CrossRef]
4. Hamm, A.; Arndt, A.; Kolbe, C.; Wang, X.; Thies, B.; Boyko, O.; Reggiani, P.; Scherer, D.; Bendix, J.; Schneider, C. Intercomparison of Gridded Precipitation Datasets over a Sub-Region of the Central Himalaya and the Southwestern Tibetan Plateau. *Water* **2020**, *12*, 3271. [CrossRef]
5. Alaminie, A.A.; Tilahun, S.A.; Legesse, S.A.; Zimale, F.A.; Tarkegn, G.B.; Jury, M.R. Evaluation of Past and Future Climate Trends under CMIP6 Scenarios for the UBNB (Abay), Ethiopia. *Water* **2021**, *13*, 2110. [CrossRef]
6. Velikou, K.; Lazoglou, G.; Tolika, K.; Anagnostopoulou, C. Reliability of the ERA5 in Replicating Mean and Extreme Temperatures across Europe. *Water* **2022**, *14*, 543. [CrossRef]
7. Silva, E.H.D.L.; Silva, F.D.D.S.; Junior, R.S.D.S.; Pinto, D.D.C.; Costa, R.L.; Gomes, H.B.; Júnior, J.B.C.; Freitas, I.G.F.D.; Herdies, D.L. Performance Assessment of Different Precipitation Databases (Gridded Analyses and Reanalyses) for the New Brazilian Agricultural Frontier: SEALBA. *Water* **2022**, *14*, 1473. [CrossRef]
8. Pelosi, A.; Terribile, F.; D'Urso, G.; Chirico, G.B. Comparison of ERA5-Land and UERRA MESCAN-SURFEX Reanalysis Data with Spatially Interpolated Weather Observations for the Regional Assessment of Reference Evapotranspiration. *Water* **2020**, *12*, 1669. [CrossRef]
9. My, L.; Di Bacco, M.; Scorzini, A.R. On the Use of Gridded Data Products for Trend Assessment and Aridity Classification in a Mediterranean Context: The Case of the Apulia Region. *Water* **2022**, *14*, 2203. [CrossRef]