The manuscript presents observational gridded datasets over Greece, covering daily total precipitation and daily mean, maximum, and minimum temperatures. The authors have applied quality control and homogenization procedures to the input data. They also examined the use of different statistical methods for spatial interpolation. In addition, they incorporated numerical model output to address gaps in the observational network, which is relevant given the complex topography of the region. The datasets have been evaluated through cross-validation using independent observations and compared with existing gridded products available for the same area. The figures included in the paper are informative and clearly presented. The results support the conclusions drawn by the authors.

There are a few points that may require clarification or expansion. First, the manuscript does not include a sensitivity analysis regarding the use of WRF model output for a year other than 1999. While this analysis may not be essential, the authors could expand the discussion around lines 139–141. For example, they might consider whether a regional reanalysis product, such as CERRA, could have been used, or if WRF simulations were tested for other years. Second, certain methodological choices could be described in more detail. This is outlined in the comments below.

Overall recommendation: The study provides a useful dataset and analysis for the region. I recommend publication after the authors have addressed the comments that follow.

Answer:

We sincerely appreciate the reviewer's thoughtful comments and valuable suggestions. We have carefully considered all the points raised and have addressed each of them thoroughly in the revised manuscript. We believe that these revisions have significantly improved the clarity, rigor, and overall quality of the work. A detailed point-by-point response is provided below, highlighting how each comment was incorporated or clarified.

Regarding the selection of the year for the WRF simulation. The specific selection of the simulation year is not of primary importance in this study, as the WRF model is used primarily as a physically based spatial interpolator. The model output is adjusted using observational data to account for seasonal and interannual variability. Therefore, the key requirement is that the WRF model provides a continuous and physically consistent representation of the temperature field across the region's complex terrain, a capability supported by the studies referenced in Section 2.3 of the revised manuscript. Thus the following lines have been added in section 2.3.

In particular, the **following lines** include studies that have implemented WRF in Greece as well as areas with similar topographic and climatic characteristics.

"WRF is widely used in both operational forecasting (Sofia et al., 2024; Patlakas et al., 2023) and scientific research (Pantillon et al., 2024; Patlakas et al., 2024; Politi et al., 2021; Stathopoulos et al., 2023; Otero-Casal et al., 2019). These studies provide comprehensive evaluations of the model's performance not only over the present study area but also in regions with similar topographic and climatic characteristics, demonstrating its reliability in representing climatological fields."

Moreover, the following lines have been added at the end of section 2.3.

"It should be noted here that the selection of the year of the WRF simulation is not of primary importance in this study, since it is used as a physically based spatial interpolator, as described in Section 3.2. Therefore, the key requirement is that the WRF model provides a continuous and physically consistent representation of the temperature field across the region's complex terrain, a capability supported by the aforementioned studies."

Regarding the comment on whether a regional reanalysis product such as CERRA could have been used, the methodology presented in this study indeed allows for that possibility, in several ways and for different purposes. For instance, if the goal is to develop a gridded dataset with a resolution similar to that of CERRA (5.5 km × 5.5 km), the WRF output could be directly replaced by CERRA. Alternatively, CERRA could be combined with WRF output to produce a statistically downscaled CERRA dataset, which can subsequently be bias-adjusted using observational data.

Specifically, in Step 1 of the methodology, the observations could be replaced by CERRA values at the closest grid points to the station locations. These values could then be used to perturb the WRF output, followed by applying the final step of the methodology to a 1 km regridded version of the CERRA dataset. Finally, the resulting dataset could be bias-adjusted by adding the interpolated mean monthly differences between the observations and the 1 km CERRA dataset (again, based on the closest grid points to the stations' locations).

To highlight the flexibility of the methodology the following lines have been added in the end of section **3.2 Spatiotemporal modeling for temperatures**

"The methodology presented in this study regarding the gridding of temperature data is flexible and allows for the integration of other regional datasets (e.g. the Copernicus regional reanalysis for Europe, CERRA) in multiple ways, depending on the objective. For example, if the aim is to develop a gridded dataset at a resolution similar to that of CERRA (5.5 km × 5.5 km), the WRF output could be replaced entirely with CERRA data. Alternatively, a combined approach could be employed, whereby CERRA is used in conjunction with WRF output to produce a statistically downscaled CERRA dataset, which can then be bias-adjusted using observational data.
More specifically, in the first step of the methodology, observational data could be substituted with CERRA values at the nearest grid points to the stations locations. These values would be used to perturb the WRF output, followed by application of the final step of the methodology to a 1 km regridded version of the CERRA dataset. The resulting high-resolution dataset could then be bias-adjusted by adding the interpolated mean monthly differences between the station observations and the corresponding values from the 1 km CERRA dataset."

Comments:

1) Regarding the gridding of temperature data: It is likely that the station locations, your grid, and the CHELSA grid differ in elevation for the same geographic points. This is expected, but it is unclear how these differences were handled during the spatial analysis and subsequent comparisons. Did you interpolate all datasets onto a common grid before comparison? This

point could be clarified in Sections 3.3 and 3.4. Also, discussing elevation differences may help with the interpretation of results in Section 4.2.1. Please consider revising that section accordingly.

Answer:

Both our gridded dataset (CLIMADAT-GRid) and the CHELSA dataset use the same underlying Digital Elevation Model (DEM), GMTED2010, as described in section 3.4. This ensures that elevation values in corresponding grid points are constant throughout the two gridded datasets. As a result, any systematic elevation differences exist exclusively between the station data and the gridded datasets, as station elevations may differ from the DEM-derived heights at the nearest grid points. As a result, we choose not to correct for elevation variations using a typical lapse-rate method. Nevertheless to further clarify that both gridded datasets are on the same grid the relative lines in section 3.4 have been modified **from:**

" CHELSA is a 1 km daily global land dataset for air temperatures, precipitation rates, and downwelling shortwave solar radiation for the period 1979–2016 and has been produced by spatially downscaling the 0.5° W5E5 dataset on an identical resolution grid as the one used in this study (GMTED2010)."

to :

" CHELSA is a global land dataset providing daily air temperature, precipitation, and downwelling shortwave solar radiation at a 1 km resolution for the period 1979–2016. It is produced by spatially downscaling the 0.5° W5E5 dataset onto a grid based on the GMTED2010 Digital Elevation Model, which is also used in this study. Notably, both the CLIMADAT-GRid and CHELSA are constructed using the same digital elevation model thus sharing the same grid while the shared elevation model ensures consistency in elevation values across corresponding grid points in the two datasets."

2) The choice of FRK as the final spatial analysis method is only briefly mentioned in lines 289–291. This decision is important and could be stated earlier and more clearly. For example, it could be introduced in the abstract (e.g., after "against withheld observational data," add a sentence about the method used). Additionally, you could move the relevant lines to the beginning of Section 4.1, rather than introducing FRK in the section discussing temperature results. Consider also whether the conclusion should briefly mention that FRK performed best among the methods evaluated. It may also be useful to explain why a single method (FRK) was chosen for both temperature and precipitation, despite indications that SVM performed well for precipitation. A short explanation of the reasoning behind this choice could be helpful.

Answer:

Following the reviewer's suggestion, the abstract has been modified to include the method selected.

In particular, the abstract has been modified **from:**

"Abstract. We introduce the development of CLIMADAT-GRid, the first publicly available daily air temperature and precipitation gridded climate dataset for Greece at a high resolution of 1 km x 1 km, covering the period 1981–2019. The dataset is derived from quality-controlled and homogenized daily measurements from an extensive network of meteorological stations: 122 for temperature and 312 for precipitation. Several approaches are evaluated for generating the daily gridded datasets, and their accuracy is assessed against withheld observational data. To address the lack of observations in high-elevation areas, high-resolution simulations from the WRF model are blended with the observational data to provide the gridded temperature data. CLIMADAT-GRid is benchmarked against the CHELSA-W5E5, a global climate product with a similar resolution, for the overlapping period 1981–2016. While both datasets show comparable results for temperature, CLIMADAT-GRid demonstrates superior spatial variability and closer agreement with observational data for both the mean and for the extreme values. Regarding precipitation, CLIMADAT-GRid consistency indicates higher values than CHELSA, especially during the rainy season, but exhibits better agreement with observations. In terms of the number of wet days, both datasets overestimate spatial means relative to observations, with CLIMADAT-GRid showing a more pronounced orographic pattern than CHELSA. Both datasets show similar results for the number of days with precipitation amounts equal to or higher than 10 mm, with CLIMADAT-GRid indicating better overall agreement with the observations. The CLIMADAT-GRid dataset is publicly available at https://doi.org/10.5281/zenodo.14637536 and can be cited as Varotsos et al. (2025)."

to :

"Abstract. We introduce the development of CLIMADAT-GRid, the first publicly available daily air temperature and precipitation gridded climate dataset for Greece at a high resolution of 1 km x 1 km, covering the period 1981–2019. The dataset is derived from quality-controlled and homogenized daily measurements from an extensive network of meteorological stations: 122 for temperature and 312 for precipitation. Several approaches are evaluated for generating daily gridded datasets, including Fixed Random Kriging, Generalized Additive Models, K-Nearest Neighbors, and Support Vector Machines. Based on the evaluation analysis against withheld observational data, Fixed Random Kriging is selected as the method for the CLIMADAT-GRid construction. To address the lack of a dense temperature observational network, high-resolution simulations from the WRF model are blended with observational data to produce the gridded temperature datasets. CLIMADAT-GRid is benchmarked against the CHELSA-W5E5, a global climate product with a similar resolution, for the overlapping period 1981–2016. While both datasets show comparable results for temperature, CLIMADAT-GRid demonstrates enhanced spatial performance and closer agreement with observational data for both the mean and for the extreme values. Regarding precipitation, CLIMADAT-GRid consistency indicates higher values than CHELSA-W5E5, especially during the rainy season, but exhibits better agreement with observations. In terms of the number of wet days, both datasets overestimate spatial means relative to observations, with CLIMADAT-GRid showing a more pronounced orographic pattern than CHELSA-W5E5. Both datasets show similar results for the number of days with precipitation amounts equal to or higher than 10 mm, with CLIMADAT-GRid indicating better overall agreement with the observations. The CLIMADAT-GRid dataset is publicly available at https://doi.org/10.5281/zenodo.14637536 and can be cited as Varotsos et al. (2025)."

In addition, the following lines have been added in the conclusions section:

"To produce the gridded fields, we evaluated four interpolation methods, Fixed Rank Kriging (FRK), Generalized Additive Models (GAM), Support Vector Machines (SVM), and K-Nearest Neighbors (KNN), using independent station data for validation. FRK emerged as the most reliable method, demonstrating consistent performance across variables and time scales, particularly for precipitation. It also best captured spatial patterns, especially over the complex terrain of Greece. For temperatures, SVM and KNN performed well for maximum temperatures, while FRK was more consistent for mean and minimum temperatures. FRK was ultimately chosen as the method for constructing the CLIMADAT-GRid."

We also moved the lines regarding the selected method from the end of section 4.1.2 to the beginning of section 4.2. In particular the following lines have been added in the revised manuscript:

"**4.2 Results of the comparison between CLIMADAT-GRid against CHELSA-W5E5 for the period 1981–2016**

This section presents the results of the comparison between CLIMADAT-GRid and CHELSA for both temperatures and precipitation. It is important to note that, based on the findings in Section 4.1, FRK was selected as the method used to construct the CLIMADAT-GRid for both variables."

3. Lines 42–44: The phrase "model-generated" could be clarified by adding that these were generated using statistical methods, to distinguish them from output from dynamical models.

<u>Answer:</u>

Following the reviewer's suggestion, the sentence has been rephrased from:

"However, it is crucial for users of gridded observational datasets to recognize that these products are model-generated rather than direct observations, and as such have a number of limitations (Hofstra et al., 2010)."

to:

"It is important for users to recognize that these gridded observational products are geostatistically generated, rather than direct observations. Consequently, they are subject to several limitations and the accuracy of these datasets largely depends on the quality and spatial density of the underlying meteorological station network. In particular, interpolation methods tend to perform poorly in regions with sparse station coverage or complex topography (Hofstra et al., 2010; Beguería et al., 2016; Herrera et al., 2019)."

4. Section 2.1: Please specify the definition of a "day" for each variable (e.g., whether it spans from 00 UTC to 24 UTC). Even if this follows a standard convention, it should be stated explicitly.

<u>Answer:</u>

Following the reviewer's suggestion Section 2.1 has been modified **from:**

"This study utilizes daily air temperature observations from two main sources. The first is the National Observatory of Athens Automatic Network (NOAAN, Lagouvardos et al., 2017), which provides records from 48 stations for the period 2010–2019, and the second source is Hellenic National Meteorological Service (HNMS), which provides temperature records from 73 stations

spanning 1981–2019. In addition, we incorporate daily observations from the historical weather station of the National Observatory of Athens in Thissio (NOA) for the same period. In total, daily data from 122 meteorological stations across Greece were collected (Fig. 1a), with station altitude ranging from 1 to 960 m above sea level (a.s.l.).
In addition to the data from the stations mentioned above, we also collected daily precipitation data for 190 stations provided by the General Secretariat for Natural Environment and Water of the Ministry of Environment and Energy for the period 1981–2019. In total, daily precipitation from 312 stations are obtained (Fig. 1b), with altitudes from sea level to 1130 m a.s.l. The selected stations were included based on the criterion of having less than 10 % missing data on an annual basis."

to:

"This study utilizes daily air temperature observations from two main sources. The first is the National Observatory of Athens Automatic Network (NOAAN, Lagouvardos et al., 2017), which provides records from 48 stations for the period 2010–2019. The second source is the Hellenic National Meteorological Service (HNMS), providing temperature records from 73 stations spanning 1981–2019. Additionally, we incorporate daily observations from the historical weather station of the National Observatory of Athens in Thissio (NOA, Founda et al., 2022) for the same period. In total, daily data from 122 meteorological stations across Greece were collected (Fig. 1a), with station altitudes ranging from 1 to 960 m above sea level (a.s.l.). Temperature data were aggregated over a 24-hour period from 00:00 to 24:00 UTC.
In addition to the above temperature data, daily precipitation observations were collected from 190 stations operated by the General Secretariat for Natural Environment and Water of the Ministry of Environment and Energy, covering the period 1981–2019. Combined with precipitation records from HNMS and NOAAN, this results in a total of 312 stations (Fig. 1b), with station altitudes ranging from sea level to 1130 m a.s.l. Only stations with less than 10% missing data annually were considered. According to the data providers, daily precipitation data were collected over a 24-period from 08:00 to 08:00 UTC for the HNMS, NOA and the stations provided by the General Secretariat for Natural Environment and Water of the Ministry of Environment and Energy. Regarding the NOAAN stations, daily precipitation data were collected over a 24-period from 00:00 to 24:00 UTC."

5. Line 165: Consider whether this line should be part of the previous paragraph, as the new line may not be necessary.

<u>Answer:</u>

The reviewer's suggestion has been implemented.

New references included in the revised version of the manuscript and in the response letter.

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