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Discussions

Interactive comment on "Building long-term and high spatio-temporal resolution precipitation and air temperature reanalyses by mixing local observations and global atmospheric reanalyses: the ANATEM method" *by* A. Kuentz et al.

Anonymous Referee #1

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General Comments:

The authors present a new method for reconstructing daily time series for both temperature and precipitation. This new method, which is referred to as ANATEM, combines a linear regression approach and an analogous downscaling approach in order to take advantage of local observations and globally available atmospheric fields (e.g., geopotential height from re-analyses). After describing each of the methods in brief, the authors show that the ANATEM method outperforms the underlying regression and

analogous methods when these are applied independently without combining them. In a subsequent evaluation, spatial patterns of model performance are studied. It is shown that the contribution of the regression model to ANATEM is most effective in the vicinity of the reference station, whereas the downscaling approach improves the model performance for remote locations. These findings clearly underline the added value achieved through combining both approaches in the ANATEM model making it a valuable contribution for all those who are interested in reconstructing time series for long-term analyses. Finally, ANATEM is validated against the HISTALP dataset exhibiting an independent validation of the proposed new method.

I enjoyed reading the paper, which is well written. The study is interesting and the results are very promising. However, in my opinion, the paper needs a few minor revisions and technical corrections. The paper would benefit from some additional explanations that might improve comprehensibility. Please find my suggestions below.

Specific comments:

P313, L7: Please rephrase: "time-series of different regions and climates."

P313, L10: Please rephrase: "...time-series that suffer from ..."

P313, L12: the correct term is "climatic information" (without s)

P314, L7: The "related uncertainties" refer to uncertainties related to multi-decadal variations? If so, please indicate the type of uncertainty.

P315, L1: "longer than 100 years" (plural)

P315, L 19: "streamflow variations" instead of "streamflows variations"?

P317, L3: Maybe "bounded" might be more appropriate in this context than "limited".

P318, L13: The correct longitude should be 8° W.

P318, L18-19: This statement is not clear: The methodologies you are discussing here

are based on the reconstruction site only?

P319, L19: $\hat{x}$ instead of x?

P321, L10: What do you mean exactly by this? If I understand that correctly, only the ANATEM approach incorporates uncertainty in terms of Eq. 4, whereas the local model itself is parameterized through neglecting e_d.

P322, L2: I expected k being the index variable, whereas n indicates the total number of days used for the similarity analyses. If so, I recommend replacing k by n since k is used for specific days later on in the manuscript.

P322, L6: Please indicate which archive is used here (SPAZM?).

P323, L1-7: It remains unclear how you have derived the ensembles using ANA and ANATEM. This is my point of criticism as described in the general comments section. It is clear that we can select among n days for which the spatial geo-potential height distribution is similar to that observed for the day of interest. Have the ensembles been achieved through drawing random numbers using the distributions (e.g., box plot in Fig. 2) derived for each day? Please provide some more details with respect to the ensembles.

P325, L12: Why does the local model yield a value of 9.0°C? From the figure, I would expect 9.8°C.

P326, Eq. 9: It remains unclear to me, why you have chosen this type of equation. Could you please provide some more information with respect to the theoretical background (e.g., appropriate shape for typical values of x_d and the parameters).

P326, Eq. 11: The first approximation for very small values of x_d is clear to me. However, I do not understand why

$$x_d \cdot \left(1 + \frac{a_d^k}{x_d}\right) \cdot \left(1 + \frac{b_d^k}{x_d}\right)^{-1} \tag{1}$$

yields $\approx x_d + (a_d^k - b_d^k)$ for $x_d \to \infty$. Even though it becomes evident from Fig. 4 that this approach represents an additive transformation for high precipitation intensities, I would like to ask you to explain this approximation more in detail.

P328, L11: What does SD mean? Is it the standard deviation of the time series? Please explain this abbreviation.

P328, Eq. 14: This equation is incomplete, as is it returns zero for an ideal model while the ideal value of the KGE criterion is 1 (as it is obvious from your results). The correct equation for the KGE criterion is (Gupta, 2009):

KGE = 1 - $\sqrt{(1-r)^2 + (1-\alpha)^2 + (1-\beta)^2}$.

P329, L9: "The ANATEM model does not capture..." instead of "do"

P330, L15-18: By definition, the local model has no mean bias. Please check the other values as well. When regarding the figure, the mentioned values are not clear to me.

P330, L25: intra-annual?

P332, L6: Do you mean α instead of β?

P332, L15-16: Please check these values carefully as they seem to differ from the values in the figure.

P333, L14-15: Do you mean "spatial robustness"?

P334, L11-16: Please add a brief description how to relate your statements in the text to the findings achieved through evaluating the figure (e.g., ANATEM-ANA is suitable to investigate the contribution of LM,...). This might improve the comprehensibility of the model inter-comparison.

P334, L. 23: 0.69 to 0.89

P335, L5: This statement is somewhat confusing, as I would expect the spatial distribution to be dependent on the distance to the Gap meteorological station.

P336, L9-12: Please define “annual precipitation multiplicative anomaly” plotted in Fig. 15 (0.5 = 150% precipitation depth with respect to the mean value?).

P350, Fig. 4: In my opinion, the term “observed precipitation” is confusing as these values represent the analogue days (which have been derived from observations).

P358, Fig. 12, P359, Fig. 13: These figures are difficult to read. The numbers on the map are too small in my opinion. I would suggest rearranging the panels of both figures and adjust their size. Would it make sense to create a new figure that includes the panels d and e of Fig. 12 and 13, respectively? You could increase the size of each panel, which would greatly improve readability.

References

Gupta, H. V., Kling, H., Yilmaz, K. K., and Martinez, G. F.: Decomposition of the mean squared error and NSE performance criteria: implications for improving hydrological modelling, J. Hydrol., 377, 80–91, doi:10.1016/j.jhydrol.2009

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