Hydrol. Earth Syst. Sci. Discuss., 12, C440–C446, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C440/2015/

Hydrology and Earth System Sciences
Open Access
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.

A. Kuentz et al.

anna.kuentz@gmail.com

Received and published: 5 March 2015

The authors would first like to thank Referee #2 for his positive evaluation and for his interesting questions and suggestions. The answers to the general comments are detailed below

It might be important to tell why those 2 geopotential heights were chosen.

For our domain, these geopotential fields were found to be the most informative predictors by Bontron (2004). We can add this sentence p322, line 18.

According to the spatial grid upon which the ANA model is based, it would be worth precising that large-scale information refers here to meso-scale circulation (rather than large synoptic scale).

That is right, we will correct this in the revised version.

p.320 : The authors mention a general, stochastic form of the local model and then state they would only consider uncertainty using the ANA model turned probabilistic by taking 50 analog days instead of the only nearest one. But what would have been the value-added of using a stochastic LM instead of a pure deterministic model ?

We decided not to present the use of a stochastic LM mainly because of the statistical distribution of precipitation residuals which is not straightforward to model. This would have also introduced some additional complexity level in the ANATEM formulation, which we wanted to avoid. We however agree that introducing a stochastic LM is obviously one of the points that would be worth to explore as a perspective of our work. This would however potentially require some other approach for combining ANA and LM estimates. A major advantage of using different combination methods as suggested in the conclusion (p338 l.21-27) would be actually the possibility to combine two probabilistic models. Another advantage of a stochastic LM would be also to that it would allow an extended comparison of the three LM, ANA and ANATEM reconstruction with probabilistic scores (This probabilistic evaluation was for instance carried out for both the ANA and ANATEM approaches in Kuentz 2013).

Upon which criteria was the spatial domain chosen in order to implement the analog model ?

The predictor spatial domain was optimized by maximizing the mean performance of the prediction for a number of precipitation stations over south-eastern France. The performance was estimated from the mean over the simulation period 1953-1993 of the Ranked Probability Score (RPS) (Epstein, 1969; Murphy, 1971). The spatial domain optimization results from the exploration of different growing rectangular analogy domain, as explained by Obled et al. (2002).

I would recommend presenting the ANATEM model for precip of section 3.3.2 another way : as is, it is not clear what the rationale was that eventually lead to such a formulation, although the results and mathematical formulation show the model is definitely appropriate for dealing with both low and high values issues. For instance, the Dufour and Garçon (1997) reference is very difficult to obtain whereas it is needed to understand how parameters a(k,d) and b(k,d) were defined. I would suggest adding a short description of it.

As explained in our response to referee 1, we acknowledge that the reference, which

is an EDF internal report, is not published. We made nevertheless this choice because we already had an experience with this formulation in the field of data assimilation for operational streamflow forecasts. This formulation is used to post-process streamflow forecasts based on the analysis of Rainfall-Runoff model past residuals. Despite its rather empirical nature, the formulation proved to give satisfactory results for this post-processing application. Depending on the current hydrological processes, we may prefer to make a "multiplicative" post-processing of the forecast (typically during drought events) or an "additive" post-processing of the forecast (typically during floods). Due to these two basic properties, we decided to use this formulation for ANATEM, suitable with the problems encountered with rainfall. Another formulation could be obviously tested (as suggested by one of the examiner of Anna Kuentz PhD). Note however that this would not change the principle of the ANATEM combination. We also expect it would not drastically change the conclusions of our work.

a_d^k and b_d^k coefficients are deduced from two conditions proposed by Dufour and Garçon (1997) :

- The slope of the tangent to the curve in $x = 0$ should be $\left(\frac{P_{ANA_d^k}}{P_{LM,ANA_d^k}}\right)^2$
- When $P_{ANA_d^k} = P_{LM,ANA_d^k}$, the following should be obtained : $\widehat{P}_d^k = P_{LM,d}$

The first condition has been imposed empirically and selected because it gave satisfactory results, while the second condition is logically deduced from the idea of the correction model.

The first condition gives the equality :

$\frac{a_d^k}{b_d^k} = \left(\frac{P_{ANA_d^k}}{P_{LM,ANA_d^k}}\right)^2$

The second condition gives the equivalence relation :

$P_{ANA_d^k} = P_{LM,ANA_d^k} \Leftrightarrow x_d = \frac{x_d^2 + a_d^k \cdot x_d}{x_d + b_d^k} \Leftrightarrow a_d^k = b_d^k$

From these two relations the coefficients can be defined as :

$a_d^k = P_{ANA_d^k}$ and $b_d^k = \frac{\left(P_{LM,ANA_d^k}\right)^2}{P_{ANA_d^k}}$

Note that in the paper there are some notation mistakes that will be corrected: the value of the local model for day d is sometimes noted LM_d instead of $P_{LM,d}$.

Do you think it would be worth adding the description of these two conditions in the paper ?

Also, explain eq.11 (just mention it comes from Taylor expansion)

We will add the mention of Taylor expansion in the revised version. You can find the details of the calculations below.

Using the usual first order Taylor expansion $(1+y)^{-1} = 1 + y + o(y)$ when y is close to 0 for the variable $y = \frac{b_d^k}{x_d}$:

$x_d \cdot \left(1 + \frac{a_d^k}{x_d}\right) \cdot \left(1 + \frac{b_d^k}{x_d}\right)^{-1} \quad \sim \quad x_d \cdot \left(1 + \frac{a_d^k}{x_d}\right) \cdot \left(1 - \frac{b_d^k}{x_d}\right)$ when $x_d \rightarrow +\infty$

After expansion,

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

The last term tends to 0 when x tends to infinity.

Minor comments and suggestions

Thank you for these detailed suggestions and corrections that will be integrated in the revised version.

Figure 10 should have been (and will be) deleted, since it is the same as Figure 9 with a larger scale (but ANA results are not seen in Fig. 9 because they are very poor). This sentence will be added in the caption of figure 9 : *"For the annual time step, ANA results are smaller than 0.6; they therefore do not appear on the figure."*

References

Bontron, G.: Prevision quantitative des precipitations: adaptation probabiliste par recherche d'analogues ; utilisation des reanalyses NCEP-NCAR et application aux precipitations du sud-est de la France, Thèse doctorat, Institut national polytechnique, Grenoble, France, 2004.

Dufour, C. and Garçon, R.: Méthode statistique de recalage du modèle de prévision au pas journalier MORDOR dans le cadre du projet Vienne, Rapport technique, Electricité de France, Grenoble, France, 1997.

Epstein, E. S.: A Scoring System for Probability Forecasts of Ranked Categories, Journal of Applied Meteorology, 8, 985–987, doi:10.1175/1520-0450(1969)008<0985:ASSFPF>2.0.CO;2, 1969.

Kuentz, A.: Un siècle de variabilité hydro-climatique sur le bassin de la Durance : recherches historiques et reconstitutions., Thèse de Doctorat, AgroParisTech, Paris, France, 2013.

Murphy, A. H.: A Note on the Ranked Probability Score, Journal of Applied Meteorology, 10, 155–156, doi:10.1175/1520-0450(1971)010<0155:ANOTRP>2.0.CO;2, 1971.

Obled, C., Bontron, G., and Garçon, R.: Quantitative precipitation forecasts: a statistical adaptation of model outputs through an analogues sorting approach, Atmospheric Research, 63, 303–324, doi:10.1016/S0169-8095(02)00038-8, 2002.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 311, 2015.