Review of the HYDROL21431 paper:

Using genetic algorithms to optimize the analogue method for precipitation downscaling in the Swiss Alps
by Horton P., Jaboyedoff J., and Obled C.

Summary

The authors present a methodology to optimize the parameters of an analogue-based precipitation downscaling system using genetic algorithms (GA). The GA is not only an optimization technique but allows discovering parameter inter-dependencies and possibly give a better understanding of the dynamics that lead to high precipitation accumulations in Canton Valais, Switzerland.

The paper is well written and a pleasure to read. I believe that the use of genetic algorithms within analogue-based forecasting techniques is an interesting idea. In fact, it increases the objectivity of current "rule-of-thumb" decisions that are done to drive the selection of analogue situations. Consequently, I recommend the publication of the paper after having addressed the remarks that I list hereafter.

Major comments

Page 4, Line 66	I would rather put the equation just after mentioning the Teweless-Wobus criterion S1.
Page 5, line 97	Here I would also mention that the skill of analogue forecasts that include as predictor variable the moisture index depends on the skill of the NWP model in predicting moisture fields (when used in real-time).
Page 5, line 8-9	Does the AM perform well also when looking for analogues for a single rain gauge? What is the consequence of computing a local average given the high spatial variability and intermittency of precipitation, e.g. for convective cases? There is no need to do analysis to answer this question
Page 6, line 122	Is the climatological distribution of precipitation over a single day sufficiently stable as reference to account for seasonality? Have you tried to include a temporal smoothing or pool the data over days before and after the given day? A harder reference to beat could be the Eulerian persistence forecast (the precipitation observed on the previous day).
Page 9, line 200-202	What is the overlapping constraint? The expression "what the sequential calibration cannot do" is not clear to me.
Page 10, line 226	It would be very interesting to show a plot with the CP and VP error as a function of number of predictors to illustrate that the VP error reaches an optimum around 4 predictors while the CP error keeps decreasing for increasing number of predictors (overfitting).
Page 13, line 316	You could add that there are multiple local optima in very different regions of the parameter space that provide sufficiently good performance. Instead of using only one single optimal solution for the selection of analogues, you could use an ensemble of optimal solutions. This way you could both account for the parameter uncertainty of the analogue technique and increase the number of samples contributing to the empirical distribution of precipitation at the rain gauge (ensemble size). This could be considered for future studies.
Page 14, lines 351-356	When optimizing an error function depending on precipitation totals, the

	large precipitation values (and errors) will contribute more to the total error. Thus, using GA allows to minimize the forecast error in particular for days with high precipitation accumulations. Therefore, it is quite reasonable that you beat the reference method, which has no optimization of an error function.
Page 17, line 435-438	Could the over-parametrization of the regions be due to the larger spatial variability of moisture fields? Pressure fields are known to be smoother and could be expected to generalize more to close regions than moisture fields.
Page 17, line 450	It would be interesting to mention that there is an interdependence between the location (or size) of the spatial window and the temporal window. In fact, if we follow Taylor's hypothesis, space and time could be easily related if we consider a moving precipitation system (or other) that has no significant growth and decay processes. More we go backwards in time more we have to move upstream the analogy window.
Page 20, line 536	I wonder whether it would be useful to compute and show a correlation matrix between the different predictors.
Figures and Tables	The number of figures and tables in the paper is quite high, but I do not know which ones could be removed, perhaps those that are not discussed in detail in text or that are giving redundant conclusions.

Minor comments

Abstract, line 2	"provided by global models" is a bit too general. I would rather use general circulation models or numerical weather prediction models.
Abstract, par 2, line 2	"strong limitations". You could complete the sentence by listing a couple of them.
Page 2, line 9	"Other predictands are also often considered". Here I would also add which ones, e.g. …
Page 2, Line 15	"get down" → resolve, compute, forecast. I would use a more appropriate term.
Page 2, Line 21	"made" → "designed"?
Page 3, Line 26	"criterion itself" or "criteria themselves"
Page 3, lines 27-29	Here you could also mention that ad-hoc techniques for the selection of predictors were also used by Panziera et al. (2011) and Foresti et al. (2015) for ensemble radar rainfall nowcasting. The GA technique could also be adapted for these applications.
Page 3, Line 30	I would find a better term for "reconsidering"
Page 3, Line 31	"pressure levels" → "optimal pressure levels"
Page 3, Line 44	"on precipitation predicting" → "for precipitation prediction"
Page 4, Line 74	"of the geopotential height". I would add ", which represent better the upper level flow direction"
Page 5, Line 81	"both North and East directions"
Page 5, line 102	"Predictors are generally extracted from reanalysis datasets"

Page 6, line 111	It would be interesting to mention that you are trying to verify the performance of an ensemble-probabilistic forecast technique.
Page 7, line 133	"complex surface". You could add that you are trying to find the global optimum of a complex high-dimensional error function having multiple local optima.
Page 8, line 165	Here you could add that the high spatial variability of precipitation is due to complex orography.
Page 9, line 196	"are not provided in this paper"
Page 9, line 204	"respectively, w.r.t. the reference method based on Z500 and Z1000"
Page 9, 205	"tremendous" → "very significant", "large"
Page 9, line 209	"other parameters (…)"
Page 9, line 211	"and may" → "but may"
Page 10, line 225	"but always more to a smaller extent" could be rephrased
Page 10, line 229	"another region than Valais" to clarify that it is not another region within your domain.
Page 10, line 239	"name" → "named"
Page 11, line 263	"cross-compatibility and spatial coherence of the optimized parameters"
Page 11, line 276	"significant preference in the AM" is not clear.
Page 14, lines 360-365	Does this mean that the two levels of analogy bring complementary information (not independent)? This is a good finding.
Page 15, line 382	"spatial shift"?
Page 18, line 481	"does not"
Page 20, line 522	"what the sequential calibration" is a strange expression to me.
Page 21, line 544	"dependence in the selected parameters"
Page 21, line 555	"significantly more improved" → "improved further" or other
Figure 2 and 7	Would it be better to put the actual pressure levels (Z500, Z1000, etc) instead of the four levels (Z1, …, Z4)?
Table 1-3	It is not clear if the provided hour (12h, 24h) is for the day before the target day that we want to forecast.
Table 6	In the caption I would make clear whether the improvement is w.r.t. climatology or the reference method.

References

- Panziera L, Germann U, Gabella M, Mandapaka PV (2011) NORA -nowcasting of orographic rainfall by means of analogues. Q. J. R.Meteorol. Soc.137(661): 2106–2123.
- Foresti, L., Panziera, L., Mandapaka, P. V., Germann, U., and Seed, A. (2015) Retrieval of analogue radar images for ensemble nowcasting of orographic rainfall, Meteorol. Appl., 22, 141–155.