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Hydrology and Earth System Sciences Discussions

Interactive comment on "An operational hydrological ensemble prediction system for the city of Zurich (Switzerland): skill, case studies and scenarios" *by* N. Addor et al.

N. Addor et al.

massimiliano.zappa@wsl.ch

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We would like to thank the referee for his valuable comments which clearly contributed to improve both the structure and the content of this manuscript.

Several remarks from the three referees concerned two important aspects of the manuscript: the under-sampling and the assessment of the uncertainty sources. We propose to dedicate two new Sections (2.3 and 3.1) as well as a few new paragraphs to address these concerns. They are presented in first part of the reply to referee H. Cloke.

We submit in continuation our answers to each point raised by the referee. When necessary, we invite the referee to refer to the aforementioned submitted modifications.

1 - Page 719: It may be good to elaborate a little more on how the Sihl passes underneath the station. I would mention explicitly that there are five culverts, two of which are closed during construction. To be honest I am not sure if "tide" gates does not confuse – perhaps better just mention that the culverts are closed by gates.

We propose to replace lines 12-16 of page 719 as follows:

Floods are especially threatening during the construction period of a new underground railway station, located below the Sihl river bed (Bruen et al., 2010). The Sihl passes through the construction site by five culverts, two of which are sealed alternately for the duration of the project (2008–2011, see Fig. 2). This provides dry construction areas, but therefore reduces the cross-section available for the river by around 40%.

2 - Page 720: It may also help to be more explicit on how water is normally diverted from the lake to Lake Zurich to pass through the hydropower station. Also – if a drawdown is required – is this then done through the penstock thus generating additional power due to increased flow, or is this always released into the Sihl towards Zurich? I can imagine this would influence the cost/loss ratio of the decision.

We propose to modify the lines 21-24 of page 719 as follows:

A first mitigation measure is the preventive controlled water release (drawdown) from the Lake Sihl, which collects the waters from a 156 km2 large headwater. This reservoir is operated by a private company for hydropower production. The water used therefore is not released into the Sihl River, but is diverted through a penstock to a hydropower station and flows into the Lake Zurich (Fig. 1). In contrast, for a preventive drawdown, three gates located at the top of the dam are gradually lowered and water is directly released into the Sihl River, without passing through the power plant, i.e. without producing electrical energy. The water is thus lost from the point of view of the dam operators, but this enables to increase the buffering capacity of the lake. Secondly, should the Sihl...

3 - Page 722: In the discussion on the use of the COSMO-LEPS model, the first 12 hours of the model run are disregarded. This it is mentioned is close to what happens operationally. For the COSMO-7 model, however, the model run initiated at 00:00 is used directly. Under normal operational conditions this would not have been the case, as that run would not yet be available, and the 12:00 run would be used. Would it not have been more logical to apply the same reasoning to the selection of which of the two COSMO-7 models to use. This may warrant some comment as to how much difference this could make.

We propose to complete the line 22 page 722 as follows:

However, only the forecasts from the 00:00 UTC run are here considered because, as mentioned for COSMO-LEPS, PREVAH requires initialisation at 00:00. This favours COSMO-7, as the first 12 h of COSMO-LEPS are disregarded but the full COSMO-7 forecast is considered. Note nevertheless that COSMO-7 driven forecasts are faster computed than the ones relying on COSMO-LEPS and are available as early as 04 UTC. Furthermore, despite truncating the first 12 h of COSMO-LEPS, this model performs better than COSMO-7 for the large majority of the metrics considered, as shown in continuation.

4 - Page 724: The significance of large driftwood reaching Zurich is a little unclear to me. Perhaps this could be reformulated in some way.

The concerned paragraph as been reformulated and the reference to driftwood has been suppressed (see new Section 3.1 in the reply to referee H. Cloke).

5 - Page 724: An approach that is often used to resolve the issue of undersampling due to the limited number of events is to use thresholds derived as exceedence quantiles in the hindcast period. Whilst these may be significantly lower than real warning

thresholds and raise the question on how well skill at these lower levels extrapolates to higher levels, the issue of too few events is reduced in this way. Again, it may be good for the authors to comment on approaches taken by others (applied in work referred to), and why they chose to take the approach they have (estimating quantiles from a much longer period of record).

The approaches selected to handle the issue of under-sampling for the present dataset are detailed in the new 3.2 Section (see the reply to referee H. Cloke). We nevertheless do not pretend that they permit to solve the issue, which in our view would require a longer reforecast, as discussed in the new Section 3.1.

6 - Page 731-732: The discussion shows that flows are generally overpredicted by the model (as shown in the rank historgrams). Perhaps it would be interesting to understand if the authors considered any methods to correct for this bias. As I understand it, this may be achieved by recalibrating the model, but this may also be detrimental (as noted). Have any statistical postprocessing methods for reducing bias been considered, such as quantile regression?

We propose to replace lines 11-14 of page 741 by:

Possible future developments include using calibrated COSMO-LEPS rainfall forecasts (Fundel et al., 2010) to drive the hydrological and hydraulic model. As this calibration method based on quantile mapping improves the reliability of precipitation forecasts, it is expected to improve the discharge forecasts as well. Note that alternative calibration methods for limited-area ensemble precipitation forecasts are currently investigated (Diomede et al., 2011).

7 - Page 734: In the discussion of the ROC diagrams, it is interesting to note that for the high thresholds Q=0.99 the skill is quite low. I think that besides the issue of FAR and Misses, that this is quite relevant for the users – in any case that depends at which threshold the decision is taken to evacuate the two closed channels and give the underpass under the station the full capacity. If this is at the lower threshold, then

maybe the poor skill of the higher threshold is not that relevant (for that particular user). I guess that this exercise also is quite cheap when compared to the possible loss – this leading to the conclusion that falser alarms are more acceptable to misses.

The highest quantile considered for Fig. 6 is Q0.9 which corresponds to a discharge of about 21m3/sec. The skills for this threshold in terms of FAR and H are indeed quite low and it is preoccupying. However, as this threshold is one order of magnitude smaller than that considered to evacuate the railway station construction site, no conclusion can be drawn about model performance for these high thresholds. This is now mentioned in the last paragraph of the reworded Section 4.3 (see our reply to referee H. Cloke's fourth comment).

It is true that although the cost of an unnecessary drawdown should not be underestimated, a flooding of the construction site or of the down-town of Zurich is significantly more expensive. But as we mention - also in the reworded Section 4.3: "Although end-users are usually more concerned about missed events than by false alarms, these high FAR should not be neglected or trivialized. Unnecessary preventive drawdowns represent significant monetary losses for the dam operators, and successive false alarms could undermine end-users' confidence in the flood forecasting system".

Once again, we would like to thank the referee for his inspiring comments. The typos he mentioned will be corrected and a new linguistic revision of the whole manuscript will be performed.

On behalf of all co-authors | N. Addor

Reference

Fundel, F., Walser, A., Liniger, M. A., Frei, C., and Appenzeller, C.: Calibrated precipitation forecasts for a limited-area ensemble forecast system using reforecasts, Mon. Weather Rev., 138, 176–189, doi:10.1175/2009MWR2977.1, 2010.

Diomede, T., Marsigli, C., Montani, A., and Paccagnella, T.: Comparison of calibration

techniques for a limited-area ensemble precipitation forecast using reforecasts, Geophysical Research Abstracts Vol. 13, EGU2011-7261, 2011 EGU General Assembly 2011,

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