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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Modeling regional evaporation through ANFIS incorporated solely with remote sensing data" *by* F.-J. Chang and W. Sun

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The manuscript addresses the practically important question how regional evaporation (ET) can be estimated from remote sensing data. The authors make use of a highly sophisticated machine learning technique to estimate evaporation from aggregated Landsat images. The authors argue that other remote sensing based ET approaches may fail in heterogeneous terrain such as in Taiwan. While I personally believe that remote sensing based data can actually improve regional ET estimation, the authors got hit by several issues with this approach. So here is a list of scientific concerns which should be addressed by the authors:



1. Pan vs actual ET: it remains vague what exact evaporation measurements are used to train the model and hence what type of evaporation is being predicted. I guess pan evaporation is observed, but I believe that actual evaporation should be predicted. So the authors should make at least make clear that they are extrapolating potential (pan) evaporation and that this is different from actual ET.
2. Skill: the results analysis does not allow to judge if ANFIS is actually better than simpler tools
3. Improve discussion (see below)

## Detailed comments

**Skill** The authors should assess the performance of the proposed model more rigorously, such as the ability to discern the temporal and spatial variability. Further, the authors introduced a skill score in the methods. Here I would wish that the authors look for an independent reference to predict ET. This could be a naive model (mean ET over Taiwan) or a more sophisticated model which produces some climatology of ET from available data (maybe a standard ET model from the meteorological data presented). The results should also be compared with the prior paper of Chung et al. (2012), who use ANFIS and meteorological station data to predict pan evaporation. Further, a RMSE of 1mm/d at an average of 4mm/d (Table 2) refers to a uncertainty of about 25% which is quite large. Also the correlation of LST to ET is in the range of the model predictions (Fig. 9a). Hence, so far I am skeptical with the conclusions of the authors, that an acceptable product has been derived.

**Improve discussion**

The authors should discuss their methodology and results wrt. to :

- enable the reader to judge the potential of ANFIS + Landsat images; e.g. for now I can not compare the model results with respect to standard models

- what can be learnt from the ANFIS model selection results? Explain and show formulae in the methods section related to the input radius and the rules. I think that these explanations should enable the reader, who is not familar with machine learning (like me), to understand the model output. One question to solve is for example, why is an RMSE difference of 0.04 critical to decide for a model with 6 rules than an model with less rules? Or can ANFIS compute some uncertainty of the estimates?
- Daily vs. temporal data: LST and ET have a dominant diurnal cycle, which is altered by the seasons. But in this case the remote sensing data only provides a snapshot which could be influenced by current cloudiness etc. The authors thus link this temporal snapshot with the cumulative sum of ET over a full day. I think this should be discussed, Delogu et al. (2012) might be a good reference for that.
- Useability; there are about 5 irregular remote sensing images a year at 10 AM local time in Taiwan; who could actually use this information?
- Spatial resolution: its argued that the heterogeneous terrain of Taiwan challenges other ET estimation tools, so I think the aggregating the Landsat data from 30m to 1000m for evaluating the model skill might counteract this argument.

**Minor comments**:

- "Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?" The ANFIS method requires complex supervised learning tools and the specification of fuzzy rules, which is not sufficiently described.
- "Is the language fluent and precise?" Mostly yes, but there is some room for improvement in the introduction.



- "Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?" Generally, improve the readability (text size) of labels and text in figures! Table 1, Fig 2, Fig 6 into Appendix or supplement. Fig. 10 what location is shown, add borderlines.

**References**

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