

Interactive comment on “Season-Ahead Forecasting of Water Storage and Irrigation Requirements – An Application to the Southwest Monsoon in India” by Arun Ravindranath et al.

Arun Ravindranath et al.

arunravi86@gmail.com

Received and published: 14 July 2018

We thank the three referees for their valuable comments. Here are our point-by-point responses. Some comments that had similar concerns were grouped together for the response. Note the following conventions: RC = referee comments, AC = author comments (replies)

Referee 1 General response. This is a well-written paper that develops and demonstrates a framework for season-ahead forecasts of an irrigation-relevant index, the CDI. Although there have been other studies examining season-ahead forecasting for the agricultural sector, the significance of this paper is the demonstration of the forecast-

[Printer-friendly version](#)

[Discussion paper](#)



ing of a decision-relevant index, rather than routinely forecasted products, such as precipitation. I recommend the paper for publication, with a few minor revisions for consideration by the authors:

Thank you.

RC1. General comment for Section 4. This section is well written, but is quite dense, making it hard to follow each step. I suggest adding a flow chart detailing the main steps (along with the associated section #), to help the reader follow along.

RC1.a. Related to this point, in section 4.2.1. "Predictor Selection" I was not clear if there was any consideration for having more versus less predictors, especially since these would likely be co-linear; i.e., your best model includes Niño 12 MAM-DJF, Niño 34 MAM-DJF, and ITF. It would seem like these would have similar information, though I recognize that this is a data-driven approach (i.e., is ultimately used in the feature vector in the knn, not linear regression). Was there any penalty calculated in your metrics (i.e., RMSE and RPSS) for including additional predictors?

AC1: We have created the flowchart suggested by the reviewer, outlining the main steps in section 4 and labelling each step with the paper section and subsection numbers in which those steps appear.

The following flowchart is added as Figure 2 in the revised manuscript (see first attachment).

AC1a: The final set of predictors we obtained from the exhaustive search method turned out to be oceanic tele-connections that are from different spatial regions over the equatorial Pacific and Indian Oceans. In this regard, Nino 34 and Nino 12 trends and ITC are not correlated in space, as Nino 34 and Nino 12 are located in unconnected regions of the Pacific, and ITC is a different phenomenon best described as a pathway for warm freshwater to move from the Pacific to the Indian Ocean. However, they may be correlated in time subject to a lag.

[Printer-friendly version](#)

[Discussion paper](#)



The reason that we used all three of the predictors is that we wanted to incorporate all of the spatial features. We demonstrate concurrent time correlations across the predictors by showing a scatterplot matrix between any and every two of the three chosen predictors. There does not appear to be any significant correlation between Nino 12 MAMMDJF and ITC. There appears to be some degree of correlation between Nino 34 MAMMDJF and ITC. Although Nino 34 and Nino 12 are in disconnected regions of the Pacific, they appear to have some correlation, at least over time. We did not add any penalty to the metrics (RPSS and RMSE). See second attachment for scatterplot matrix alluded to earlier.

RC2. General comment for section 5.1. Your evaluation of the forecasts is effective (e.g., Figure 4, and Tables 1 & 2), especially when you compare with the precip forecasts (Table 3).

RC2.a. Minor comment related to this point: Figure 4 & Line 562. If possible, maybe have a color coding or symbol of the triangles to indicate the directional similarity? And add a legend to that effect? Otherwise this is hard to see. At first glance, I was looking to see if the observation was captured by the IQR.

RC2.b. Table 3 and lines 611. Agreed that it is important to note that your forecasts are tailored to the location, which is quite resource intensive to do for every crop, and every location. I agree that this is where a framework (such as what you have put forth) is helpful, but it may be worth highlighting that there is a rich literature on opportunities and barriers to using seasonal forecasts (see next comment: 3. General comment for section 5.2).

AC2a: We have elected to color-code boxplots corresponding to identical directionality as gray and the boxplots corresponding to dissimilar directionality as white. A legend to that effect has been included in the plot. Thank you for this suggestion.

Figure 4 in the paper shows this change has been implemented. See third attachment.

[Printer-friendly version](#)

[Discussion paper](#)



AC2b: The literature on opportunities and barriers to using seasonal forecasts is integrated into the manuscript in the relevant section(s). The following paragraph is added as the concluding paragraph of section 5.2.

“An interesting and excellent discussion concerning the usability of such science is found in Dilling and Lemos (2011) and several papers cited therein. In the context of that discussion, we find that our forecasting procedure combines the “science push” and “demand pull” approaches to creating scientific usability. The impetus for crafting the CDI and, prior to that, independently developing the k-NN algorithm, was scientific. However, the decision to combine them and apply them as we have to seasonal forecasting was made with agricultural stakeholder interests in mind. As discussed in Dilling and Lemos (2011), the problem of overcoming informal institutional barriers to availing of such seasonal forecasts, namely the idea that current methods of forecasting through weather and climate prediction centers are the only reliable methods, is one potentially faced by our methodology. If this is the case, this is unfortunate, as we feel that our targeted forecasting system is potentially very useful to stakeholders and decision-makers in relevant sectors.”

RC3. General comment for section 5.2. It is useful to provide a discussion of the utility of such forecasts. Targeted forecasts, such as those presented here, can help to increase the utility of the forecasts since they intersect with actual decision contexts (e.g., irrigation needs for particular crops). It would also be worth mentioning (briefly) that there have been studies on developing useable climate information, and mention how this study fits into that bigger picture. Dilling and Lemos (2011) have a good overview of some of the opportunities and barriers to the use of seasonal climate forecast information (but there are other studies), which might be of interest to that end. Dilling, L., & Lemos, M. C. (2011). Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change*, 21(2), 680–689. <http://doi.org/10.1016/j.gloenvcha.2010.11.006>

AC3: The literature suggested here (Dilling and Lemos, 2011, etc.) has been re-

Printer-friendly version

Discussion paper



viewed and incorporated in the revised manuscript. More discussion on the utility of these forecasts is also added. Please see AC2 for a reference to the change in the manuscript.

Other Minor comments:

RC: Line 208: Any prior studies/experience/justification for this selection?

AC: We have used $\alpha = 0.7$ in our previous studies of water stress in India [Devineni et al. 2013]. The selection was based on discussions with local agricultural experts from India and some corroborative tests for similar rainfall and temperature conditions in the USA [Devineni et al. 2015]. The reference was added in section 3 to the sentence declaring the value of $\alpha = 0.7$, as shown below: In our study, we set $\alpha = 0.7$ (Devineni et al, 2013). Here are the references Devineni, N., Perveen, S., & Lall, U. (2013). Assessing chronic and climate-induced water risk through spatially distributed cumulative deficit measures: A new picture of water sustainability in India. *Water Resources Research*, 49(4), 2135–2145. doi:10.1002/wrcr.20184

Devineni, N., Lall, U., Etienne, E., Shi, D., & Xi, C. (2015). America's water risk: Current demand and climate variability. *Geophysical Research Letters*, 1–9. doi:10.1002/2015GL063487.

RC: Next time, please put the captions beneath each figure for ease of reading. AC: We will follow this in the corrected/updated manuscript.

RC: Figure 2 – What is CWSI (plot title)? Also, the x-axis does not seem to line up properly.

AC: The CWSI plot title is a mistake – changed it to CDI. The x-axis label has also been modified to cover the entire horizontal plotting area. The revised Figure is shown below (see fourth attachment):

RC: I see the local smoother trends indicating the variability. Did you test to see if there is any monotonic trend over the time series? From the figure it seems like recent

Printer-friendly version

Discussion paper



years may be pulling it down towards a negative trend (but perhaps not stat significant). Just curious, as this might be relevant to calculating the anomalies (e.g., line 539, the anomalies being estimated from the 1901-2013 mean).

AC: Mann-Kendall test indicates a likely monotonic decreasing trend, with a p-value of 0.013. Trend analysis typically involves carefully understanding the causes for the trend. We wish to explore these in a later work.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2018-183>, 2018.

Printer-friendly version

Discussion paper



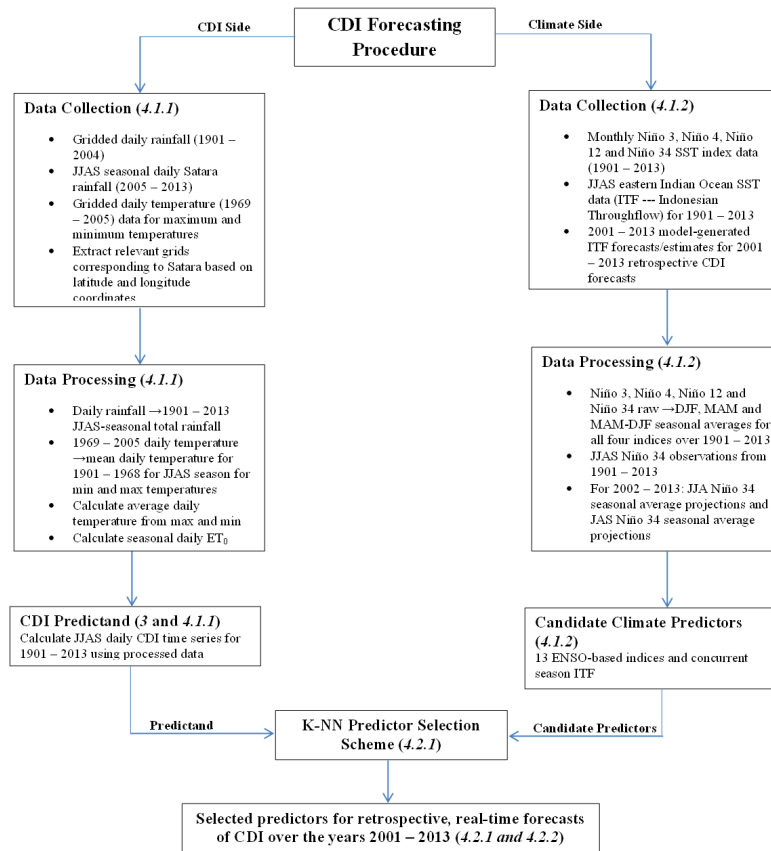


Fig. 1.

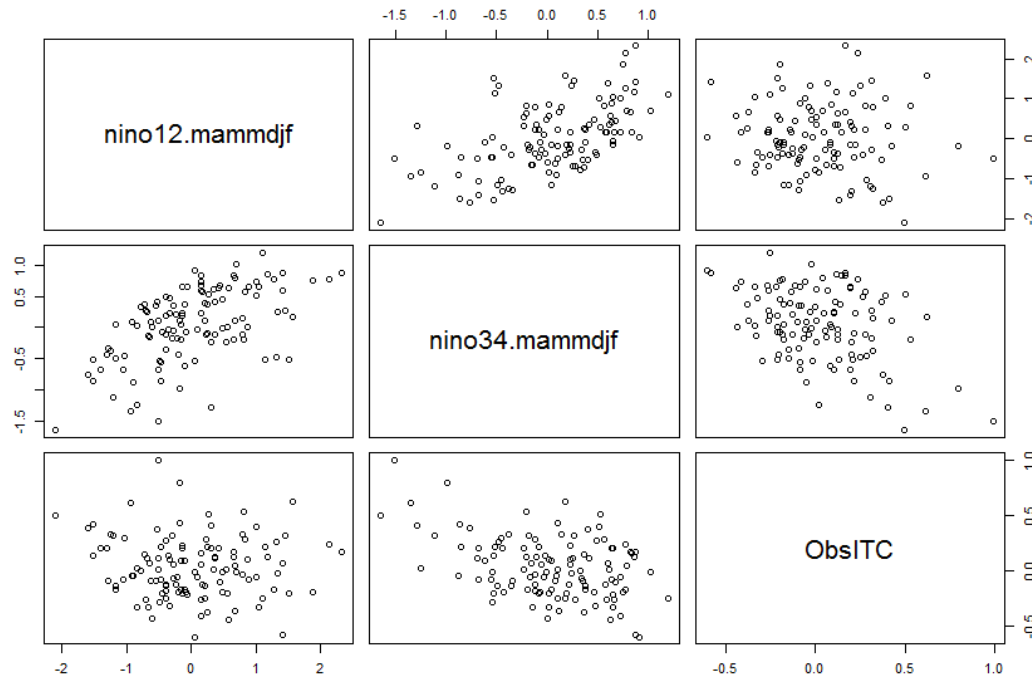


Fig. 2.

Printer-friendly version

Discussion paper



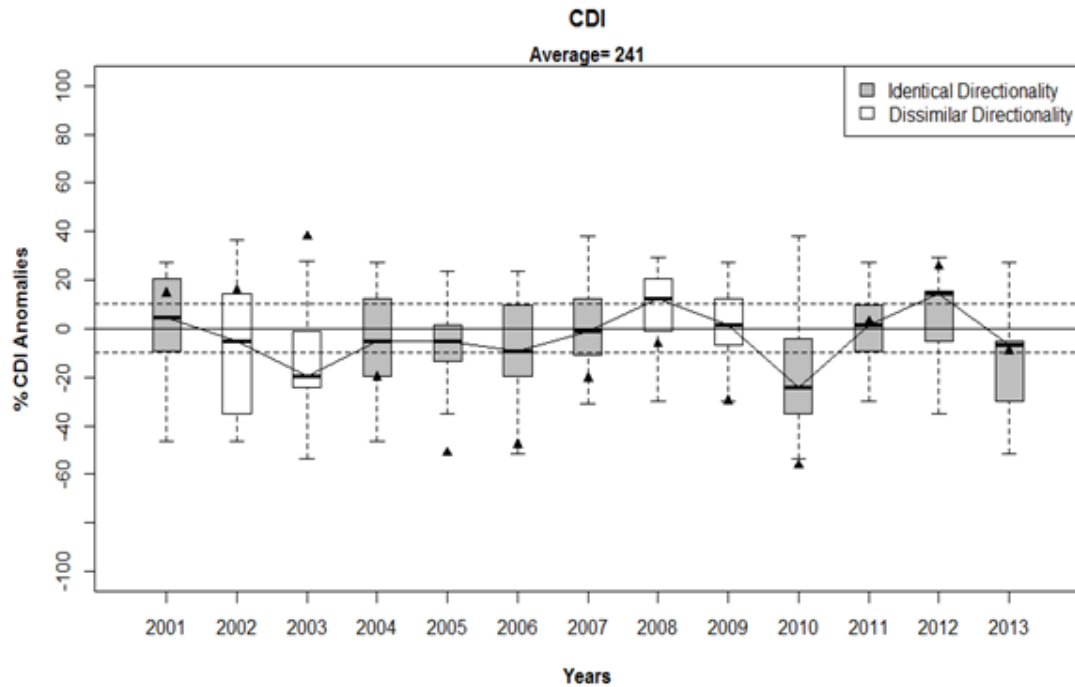


Fig. 3.

[Printer-friendly version](#)

[Discussion paper](#)



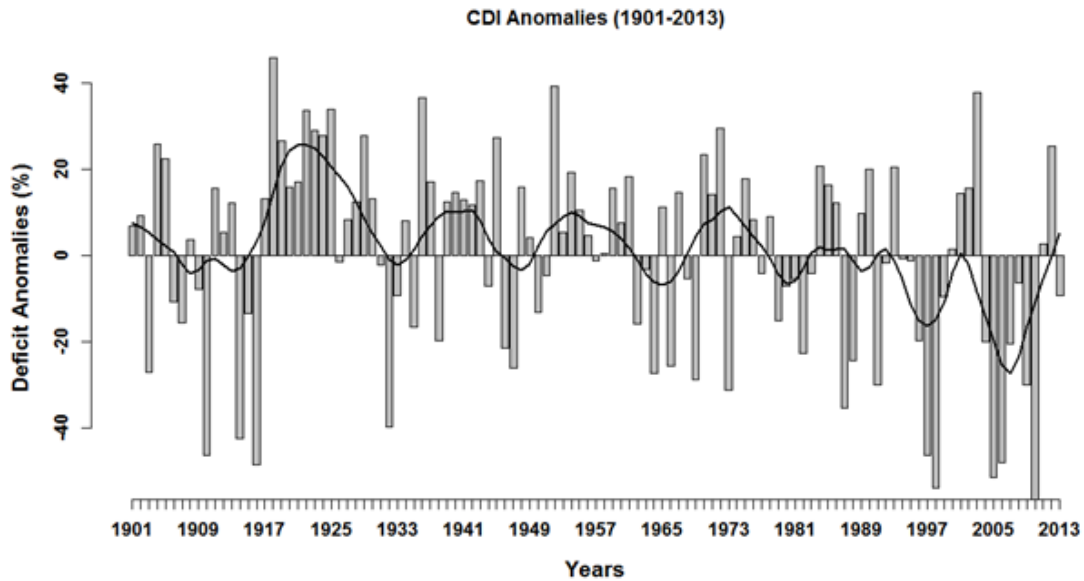


Fig. 4.

[Printer-friendly version](#)

[Discussion paper](#)

