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Hydrology and Earth System Sciences Discussions

Interactive comment on "Space-time variability of hydrological drought and wetness in Iran using NCEP/NCAR and GPCC datasets" *by* T. Raziei et al.

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Reviewer #1 "The manuscript is a good contribution for the studies of drought variability. It provides very new information about the possibilities and precautions of using gridded precipitation and reanalysis datasets to analyse spatial and temporal patterns of droughts. The objectives of the manuscript are stated very clearly. The manuscript is very well organised, introduction is informative and the methods are very suitable according to the objectives of the research. The manuscript deserves to be published in Hyd. and Earth System Science including very few clarifications."

Reply: We thank Prof. Sergio M. Vicente-Serrano for his positive opinion on the paper; he properly captured the aim of the study. We have appreciated his useful suggestions that are useful insights for improving the presentation of the work and planning further analyses.

1. "Authors used two gridded precipitation datasets. Given the climatic diversity of the region, I would like to see the agreement between precipitation observations and GPCC in Iran. The data provided by Raziei et al. (2010) could be used for this purpose. If a good agreement is found, then the differences between GPCC and NCEP/NCAR can be directly related to some problems of the reanalysed dataset."

Reply: In the present study we have not presented the comparison between observations and GPCC gridded data because: 1) We have already compared observations and GPCC dataset in a recent paper (see Raziei et al., 2010 quoted in the manuscript and published on Water Resources Management Journal) by applying the Principal Component Analysis to the SPI on 12-month time scale. In particular, in that paper the performance of both GPCC and NCEP/NCAR datasets in assessing drought variability within Iran has been checked against observations at 32 rain gauge stations for the common period 1951–2005. Results showed a very good agreement between GPCC and observations, while several discrepancies were noted with NCEP/NCAR data, especially in central Iran for periods before the mid seventies. Thus, GPCC dataset appeared to be a useful tool to complement the information provided by rain-gauge observations and seemed suitable to be used in place of the observations for further studies; 2) The main objective of the present study was to analyse recent trend changes in dry/wet periods, as provided by Bordi et al. (2009) for the large-scale. The available dataset for observations in Iran is shorter (1951–2005) with respect to the one used in the present study (1948–2007). Thus, based on the results obtained by Raziei et al. (2010) we decided to use GPCC dataset as representative of observations. Summarizing, the aim of the present analysis is to complement the two previous studies and check the reliability of NCEP reanalysis against gridded data (these motivations are discussed in the Introduction).

Coming back to the comparison between the reanalysis and gridded data, for sure the agreement between GPCC product and observations is due to the incorporation of rain gauge data into the gridded GPCC analysis system (see Raziei et al., 2010). The interpretation of the discrepancies between NCEP/NCAR and GPCC datasets, instead, remain a very difficult task. On one hand, GPCC monthly precipitation analysis products (including Reanalysis Product Version 4) are based on anomalies from climatological normals at the stations, or where no station normal is available, from GPCC's high resolution gridded climatology. The anomalies are spatially interpolated and the gridded anomalies are then superimposed on GPCC's background climatology. Moreover, (i) the data global coverage per month varies from less than 10.000 to more than 45.000 stations along the time section (see Fig. 7 in Schneider et al., 2008); (ii) the spatial distribution of Iranian stations is quite uniform with the exception of central Iran (see Fig. 8 in Schneider et al., 2008). In principle, besides the several quality checks applied, all these features might introduce in the final precipitation product some shortcomings in time and space. On the other hand, NCEP/NCAR reanalysis precipitation data are numerical model forecasts and no precipitation observations are assimilated into the reanalysis system. The observing system used in the reanalysis changed along the years (mainly during 1948–1957, when the upper-air network was established, and in 1979 when the global operational use of satellite soundings was introduced). Thus, as claimed by Janowiak et al. (1998) the "absolute truth" with regard to precipitation does not exist. It is hard to objectively assess which dataset (gridded data or reanalysis) is closer to the reality, may be gridded data but further analyses are needed using different sources of data to better understand the discrepancies found in central Iran, as recommended in the concluding section.

2. "Why a 24-SPI is selected for analysis? Authors should justify better the selection of this time scale. Thus, the spatial patterns are much complex at long time scales, like 24-months, than shorther time-scales (see Vicente-Serrano, 2006 Wat. Res. Manag.

20: 37-60). This behaviour is consequence of the local short-duration but intense precipitation events. If the index is agreggated at long time-scales the role of the intense precipitation events is propogated during a long time, and given the local character of the events, large differences in the SPI series among neighbor observatories can be observed for several months (low correlations). This is a common and unsolved problem in the drought indices, which even makes more difficult the spatial comparability among different datasets."

Reply: The motivations that led us to use 24-month time scale in the present study are twofold: (i) We have analysed space and time variability of the SPI-12 in Raziei et al. (2010) and identified four sub-regions characterized by independent climate variability. In studying the hydrological aspects of drought and being enough different with the previous study, the SPI on 24-month time scale has been considered; (ii) The SPI-24 is suitable for analyzing the low-frequency variability of drought and wetness due to its smoothed time behaviour. Also, using SPI-24 in the present study, results of trend analysis are easily comparable with those obtained by Bordi et al. (2009) at large-scale (European sector). In the revised version of the manuscript we will discuss these motivations more clearly.

About the increasing complexity of the spatial modes of the SPI for long time scales as observed in Spain by Vicente-Serrano (2006), in our case we have not found a similar feature. A visual comparison between the four identified spatial modes of the SPI-24 in the present study and those of the SP-12 (Raziei et al., 2010) reveals a very high coherence, suggesting that the spatial patterns of the SPI are almost stable moving from 12 to 24-month time scale (see the end of Sect. 3.2). However, before drawing any conclusive statement for Iran a more complete analysis should be carried out by considering other time scales, such as 3, 6 and 36-months. For this purpose, it should be interesting to study the stability of the SPI spatial modes by considering datasets with higher spatial resolution (for example GPCC or APHRODITE gridded precipitation datasets of 1×1 degree resolution). Perhaps a finer resolution allows better capturing the variations in the spatial patterns of drought when the SPI time scale is varied. This will be the topic of a future study. In the revised version of the paper, we will provide a brief discussion on this topic.

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