Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-23-AC5, 2016

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Spatio-temporal trends in the hydroclimate of Turkey for the last decades based on two reanalysis datasets" *by* Mustafa Gokmen

PhD Gokmen

mustaf.gokmen@gmail.com

Received and published: 6 May 2016

The author would like to thank Referee #5 for his/her valuable and constructive comments. We have considered the comments of Referee #5, and hereby try to correspond to them within our knowledge. Based on the comments, we will make the necessary revisions, which will contribute improving the quality of the manuscript. We hope that our replies will satisfy the Referee.

Anonymous Referee #5 Received and published: 24 March 2016 General Comments: This manuscript analyzes the trends of hydro-climatic variables (annual precipitation, air temperature, snow water equivalent, runoff and ET) from two reanalyses data (ERA Interim and ERA Interim/land) over Turkey from 1979 to 2010. The magnitude of

the variables between these years, direction and different significance levels of the changes are evaluated spatially over the map of Turkey with a particular focus on several important watersheds. Seeing the contradiction and agreement of two reanalyses data for different variables are important as the study potentially provides a good reference for future applications in this semi-arid country where the climate change impacts become vulnerable. The following issues should be considered to make the manuscript in better quality before its publication:

Some Issues: 1. As I agree with other referrers, Turkey shows strong seasonality and therefore it is better to include seasonal changes particularly for precipitation. Other studies show that some important trends are available seasonally but such trend is lost when it is evaluated annually (offsetting).

Reply of the Author (1): As suggested by the Referee #5 (and the other Reviewers), the spatio-temporal trends in precipitation were analyzed at seasonal scale and the results will be included in the revised manuscript.

Figure1. The presence and the direction of Total Precipitation trends by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn.

Figure2. The magnitudes of the Total Precipitation trends (32-years total) by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn.

Figure3. The presence and the direction of Total Precipitation trends by Interim/Land for a) Winter, b) Spring, c) Summer and d) Autumn.

Figure4. The magnitudes of the Total Precipitation trends (32-years total) by Interim/Land for a) Winter, b) Spring, c) Summer and d) Autumn.

2. A more in depth explanations with other findings available in the literature should be given. For example, it is very obvious that there is strong warming and it is very significant on some regions (west, south west), so it should have some impacts on the type and intensity of precipitation. Snow becomes rain and their frequency and

intensity are changing. Seasonality analyses can help identfy these results but at least some literature supports can be incorporated to your results.

Reply of the Author (2): In lines 21-24 of page 5 (under section 3.1) of the manuscript, Sen et al. (2011) is referred from the literature, who indicated that the largest warming (over 2 oC) occurred over the Aegean Sea and Western Turkey, due to the propagation of warmer air from the Balkans and Aegean Sea toward eastern Anatolia after about 25 February. In addition, the following studies will be mentioned to explain the spatial distribution of the warming in the revised manuscript: 1. Önol B., Bozkurt D., Turuncoglu U.U., Sen O.L., Dalfes H.N., "Evaluation of the twenty-first century RCM simulations driven by multiple GCMs over the Eastern Mediterranean–Black Sea region", Climate Dynamics, Vol. 42, 2014, s. 1949-1965 2. Önol B. , F.H.M Semazzi, "Regionalization of Climate Change Simulations over the Eastern Mediterranean", Journal of Climate, No. 22, 2009, s. 1944-1961

Besides, the seasonal precipitation trends (both by ERA-Interim and Interim/Land) indicate considerable increase of seasonal precipitation especially in Autumn (and partly in Winter) in the western coastal areas. Moreover, a correlation analysis between the yearly Temperature and total Precipitation (attached Fig.5) indicate a significant positive correlation between temperature and precipitation in the western/southwestern coastal areas (both over land and sea). Based on these findings we can suggest that, the strong warming in the western coastal areas is reflected as increased Autumn (and partly Winter) precipitation in the western coastal areas through intensified evapotranspiration and changes in the type and intensity of precipitation.

Figure5. The distribution of the correlation between the total Precipitation and the Temperature during the study period

3. Figure 3a, are the station values compared with yearly country-averaged values from ERA Interim data set? You should have compared averaged of observations with averaged of corresponding pixels from dataset (not all country). Make the plots more

visible. Why just used temperature data at that location (inland part). As you used precipitation observation from different location across the country you can use the same for temperature to make it more representative spatially. The reason for using these stations should be given (maybe this is the area where very significant increase in temperature but it should be explained).

Reply of the Author (3): Previously, the stations temperature data was only available for an in-land basin because that basin was the study area for my (completed) PhD research and the data was available from that. Thanks to the temperature data provided by Dr. Faize Saris from Canakkale 18 Mart University, the comparison now extended to around 100 stations distributed over the country. The revised Figure (attached Fig.6) presents an overlaid comparison of the significance and magnitude of the temperature trends by the ERA-Interim and meteo-stations.

With the availability of more stations data, Figure 3 (in the manuscript) was also revised to compare the observational and reanalysis data in a more systematic manner. As suggested by the Reviewer #5, in the revised Fig. 3a (attached Fig.7a), the average yearly temperature of all stations was compared with the average of corresponding pixels from the reanalysis dataset for the study period. While, in the revised Figure 3b (attached Fig.7b), the total 32-years increase of temperatures indicated by meteo-stations and Reanalysis were compared for different elevations.

The (attached) Fig.7a generally reveals a systematically higher average temperatures and total increasing trends by the meteo-stations compared to Reanalysis data. The systematically higher yearly average temperature by the stations can generally be attributed to the intrinsic problems of point-based vs. grid comparisons: the meteo-station measurements not only represent the local environment (compared to the 80 km resolution original Reanalysis data), they are also usually located in the lower altitudes around the cities due to ease of maintenance. Therefore, for a particular grid, it can be expected that the point measurement of temperature by the station is systematically higher than the overall average of the grid represented by the Reanalysis data. In addition, the growth of urban areas and the related urban heating effect possibly explains the higher increasing trend of temperature indicated by the meteo-stations compared to the Reanalysis data (attached Fig.7b). The revised figures and the updated results and discussions will be included in the revised manuscript.

Figure6. The comparison of the (a) presence of the significant Air Temperature trends and (b) the magnitudes of 32-years total Air Temperature trends between the ERA-Interim dataset and the meteo-stations. In Figure (a) upward triangles/circles indicate the presence/absence of increasing trends, while the colors indicate the degree of the significance.

Fig. 7a) The comparison of the average yearly temperature between the (all) stations and the corresponding grids from the ERA-Interim dataset for the study period, 7b) The comparison of the total 32-years increase of temperatures by meteo-stations and ERA-Interim with respect to elevation.

4. Make the plots showing the performance of datasets with observations more visible. Use different legends.

Reply of the Author (4): Thanks to the availability of extended observations data (for temperature, total precipitation and SWE), all the related trend maps from the Reanalysis datasets were overlaid with the trends of the observations for a better visibility of the comparisons. Besides the revised comparison of the temperature trends (attached Fig.6), Precipitation & SWE trend comparisons were also revised (attached Figs.8, 9 and 10).

Figure8. The presence of the significant total Precipitation trends by (a) ERA-Interim vs. rain gauges, (b) Interim/Land vs. rain gauges. The magnitudes of 32-years total Precipitation trends by (c) ERA-Interim vs. rain gauges, (d) Interim/Land vs. rain gauges. In figures a-b, the upward/downward triangles indicate the significant increasing/decreasing trends, circles indicate no trend and the colors indicate the degree of the significance. In figures c-d, the numbers indicate the total increasing/decreasing

trends at the stations with significant trends.

Figure9. The presence of the significant SWE trends by (a) ERA-Interim, (b) Interim/Land. The magnitudes of 32-years total SWE trends by (c) ERA-Interim, (d) Interim/Land.

Figure10.The plots 1-6 indicate the comparison of the yearly SWE from the snow-gauges with the corresponding grids from ERA-I and I-L. The locations of the stations are shown in figures 9a-b.

5. All figure captions describing the trend direction and magnitude (except temperature) are wrong. they should be corrected according to figure panels.

Reply of the Author (5): All the figure captions will be checked and corrected in the revised manuscript.

6. As contradictory results for some areas are obtained for ET, runoff and SWE, a suggestion to readers should be given to which dataset to be used in a possible future studies. Whether the author suggests using ERA Interim Land is more preferable because it uses an updated land surface model.

Reply of the Author (6): Based on the extended comparisons with observations data (for precipitation and SWE), now it is safer to suggest that Interim/Land dataset reveals hydrological trends closer to the observations. Although no direct comparisons (with observations) were made for Runoff and ET, a correlation analysis revealed (attached Fig.11) that there were strong positive correlations between Precipitation and Runoff, & Precipitation and ET (except the humid North-east). Therefore, improved time-series of Precipitation and SWE by the updated Interim/Land dataset also imply improved Runoff and ET distributions by the Interim/Land. Such an explanation will be added in the Discussion and Conclusions section of the revised manuscript.

Figure11. The correlation between (a) total Precipitation and Runoff, (b) total Precipitation and SWE, (c) total Precipitation and ET for Interim/Land dataset.

7. Derivation of surface runoff should be given. Does it include contribution from subsurface flow or just an excess water on surface after infiltration? I dont think streamflow on river channels are considered.

Reply of the Author (7): In the ERA-Interim dataset, which uses TESSEL land surface model, Runoff is estimated based on a single global soil texture, which does not characterize different soil moisture regimes, and a Hortonian runoff scheme which produces hardly any surface runoff (Balsamo et al., 2015). On the other hand, the Interim/Land with the updated HTESSEL model (described in detail in Balsamo et al., 2009), integrates a spatially variable soil hydrological conductivity and diffusivity according to a global soil texture map and the surface runoff is calculated based on the variable infiltration capacity approach. The explanation will be added in the revised manuscript. In this regard, streamflow on river channels are not considered in the surface runoff by ECMWF models.

8. In text or in figure captions, the basins whose borders are shown in Figures should be explained.

Reply of the Author (8): An explanation will be added regarding the basins in the revised manuscript.

9. It is explained that ERA Interim is available at 80 km resolution but the author used them at 25 km (0.25) resolution. Have you done a re-scaling (downscaling)? Give explanations

Reply of the Author (9): In Balsamo et al. (2015), it is mentioned that ERA-Interim is produced at T255 spectral resolution (about 80 km). On the other hand, in the data delivery website of ECMWF (http://apps.ecmwf.int/datasets/), the variables are possible to download from 0.125X0.125 (apprx. 12.5 km) grid to 3X3 degrees grid. In this regard, I directly retrieved 0.25X0.25 grid data from ECMWF and did not apply any re-scaling myself. How ECMWF applies the re-scaling is not unfortunately provided in ECMWF's website (http://www.ecmwf.int/en/what-horizontal-resolution-data)

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-23, 2016.

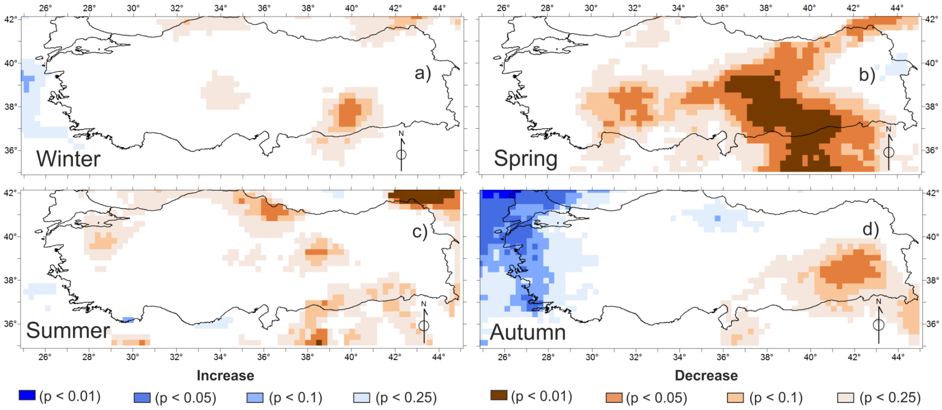

Fig. 1. The presence and the direction of Total Precipitation trends by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn

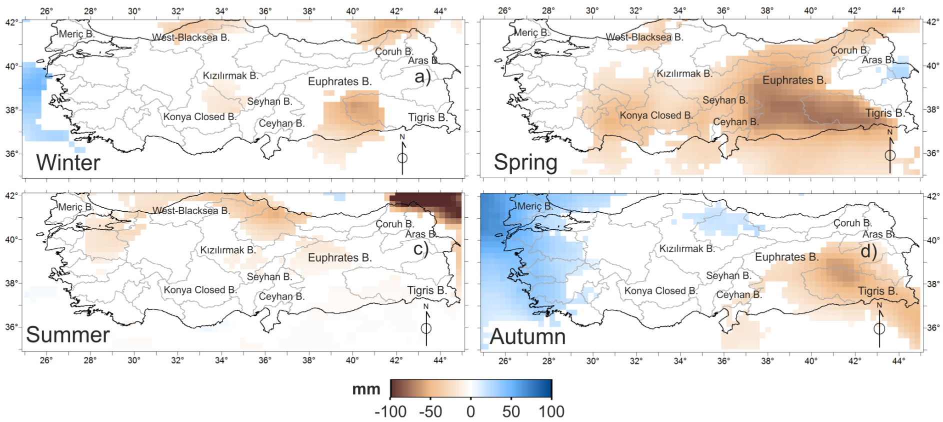

Fig. 2. The magnitudes of the Total Precipitation trends (32-years total) by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn

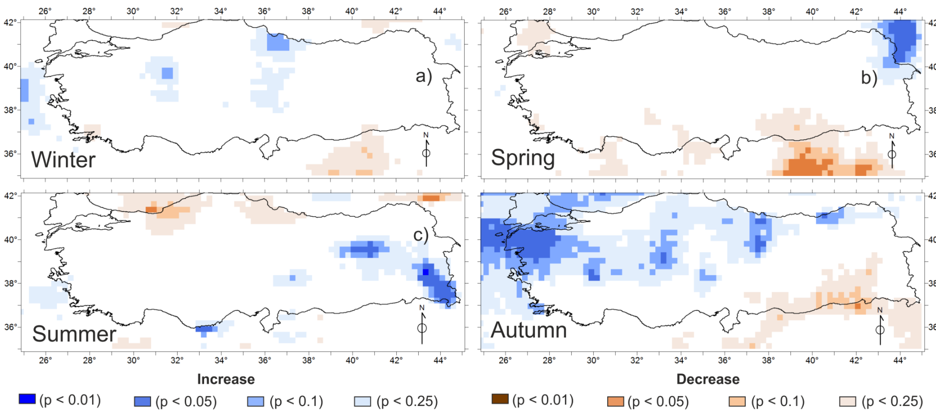

Fig. 3. The presence and the direction of Total Precipitation trends by InterimLand for a) Winter, b) Spring, c) Summer and d) Autumn

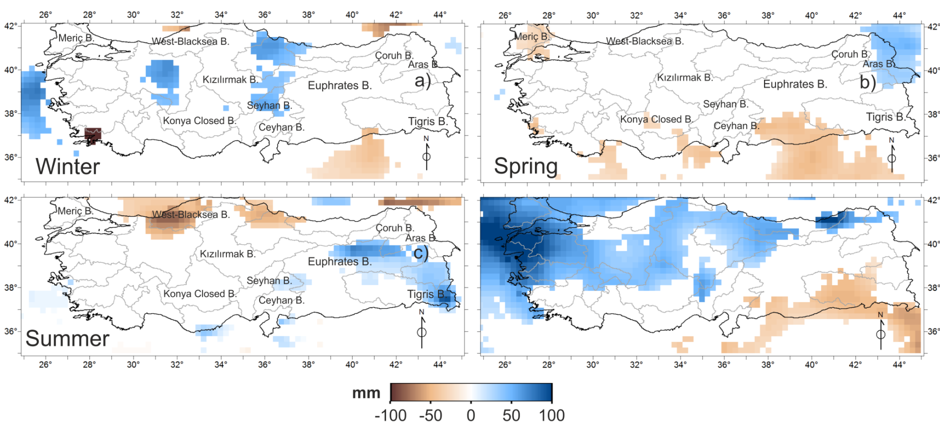

Fig. 4. The magnitudes of the Total Precipitation trends (32-years total) by InterimLand for a) Winter, b) Spring, c) Summer and d) Autumn)

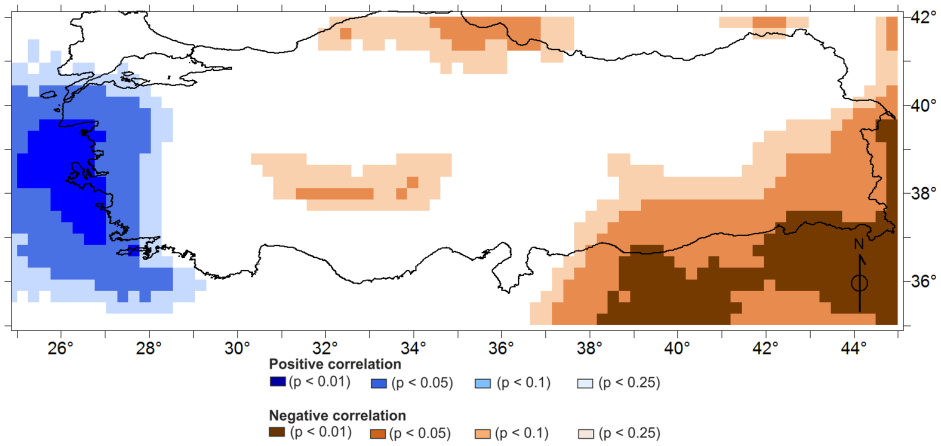

Fig. 5. Correlations of totalP with Temperature

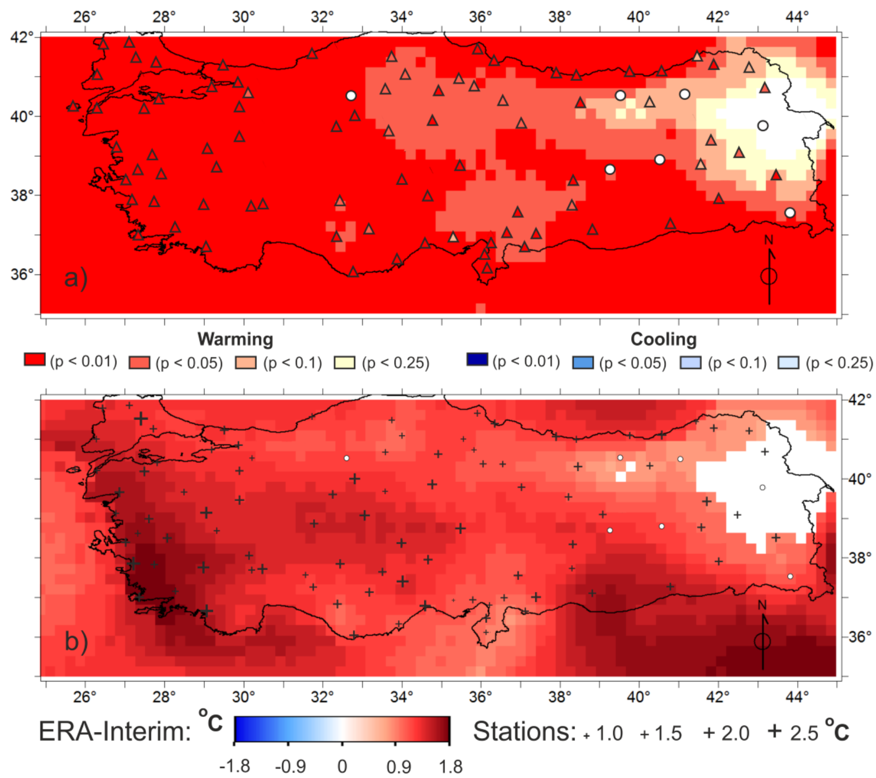

Fig. 6. The comparison of the (a) presence of the significant Air Temperature trends and (b) the magnitudes of 32-years total Air Temperature trends between the ERA-I dataset and the meteo-stations

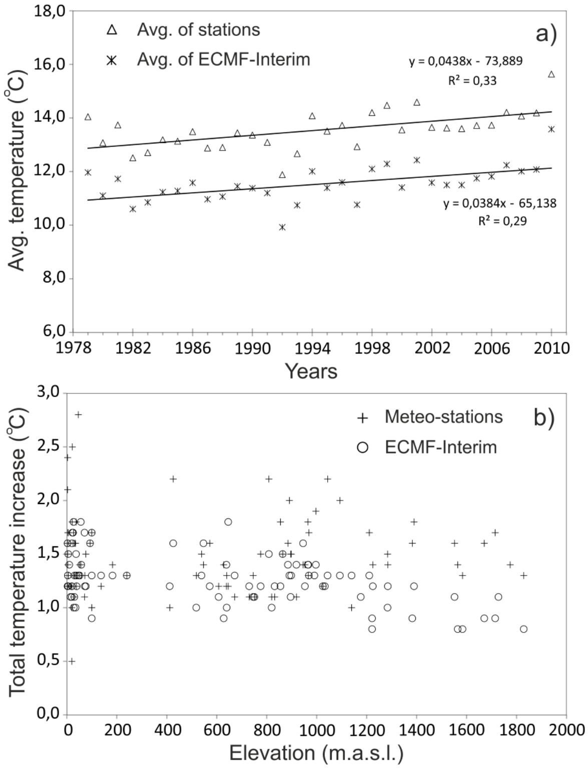

Fig. 7. Comparison of avg yearly T between the (all) stations and the corresponding grids from ERA-I for the study period b) The comparison of the total 32-years increase of T by stations and ERA-I

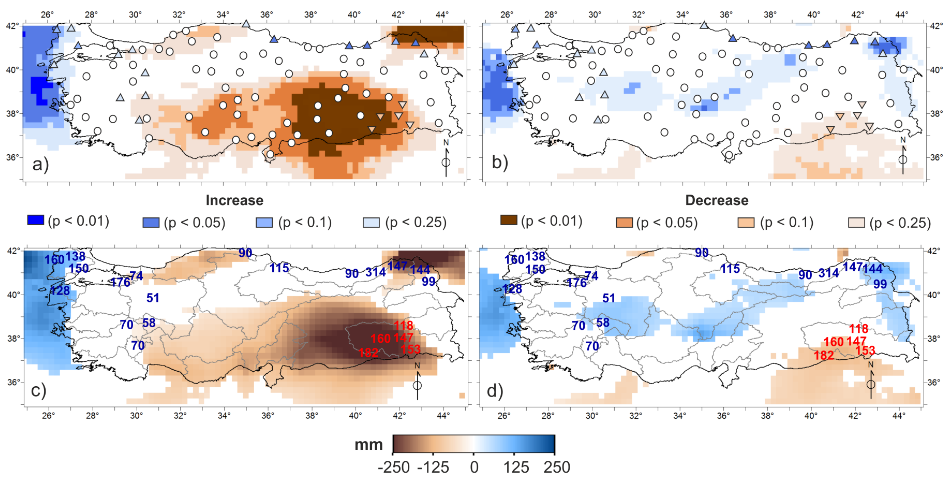

Fig. 8. The presence of the significant totalP trends by (a) ERA-I vs. rain gauges, (b) I-L vs. rain gauges. The magnitudes of 32-years totalP trends by (c) ERA-I vs. gauges, (d) I-L vs gauges

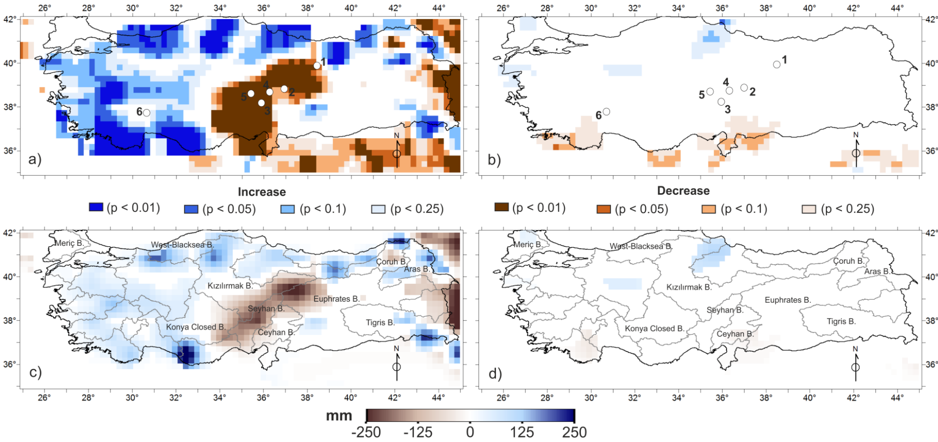

Fig. 9. The presence of the significant SWE trends by (a) ERA-I, (b) I-L. The magnitudes of 32-years total SWE trends by (c) ERA-I, (d) I-L

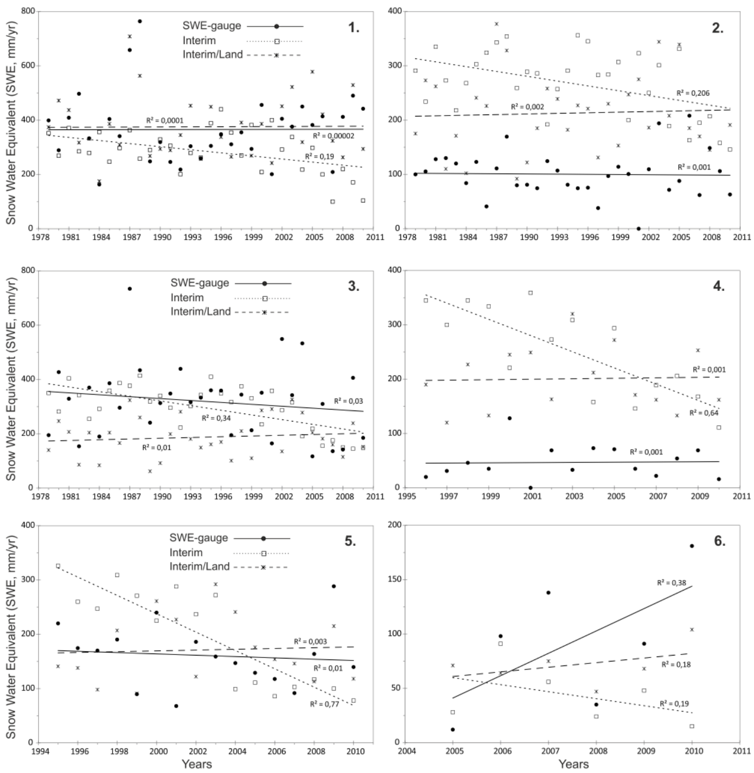

Fig. 10. The plots 1-6 indicate the comparison of the yearly SWE from the snow-gauges with the corresponding grids from ERA-I and I-L

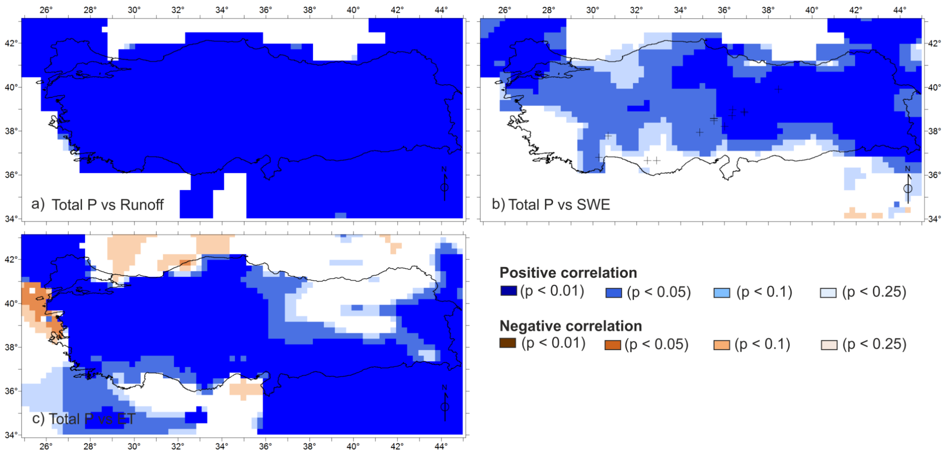

Fig. 11. The correlation between (a) total Precipitation and Runoff, (b) total Precipitation and SWE, (c) total Precipitation and ET for InterimLand dataset