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Hydrology and Earth System Sciences
Discussions

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

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The author would like to thank Referee #3 for his/her valuable and constructive comments. We have considered the comments of Reviewer 3, 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 #3 Received and published: 19 March 2016

The author explored the long-term trends in several hydro-climate variables, in a spatially distributed manner, based on two reanalysis datasets (ERA-Interim and ERAIn-

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terim/Land) in Turkey. This kind of research can provide information particularly for the researchers who are interested in the study area, and is therefore welcomed by the community. However, I have to point out this manuscript does not show very much a perspective that would attract the attention of the readers/researchers who are interested in other regions. Therefore, I would suggest that a major revision is required before it can be considered publication in HESS. My major concerns are listed as follows:

1. The author focused on the hydro-climate variables (i.e. air temperature, total precipitation, snowmelt, ET, surface runoff). I wonder why the author selected those variables and ignored others? Whether analyzing those variables is enough to help the author show his/her perspective? I am not very clear. For example, soil moisture is also an important variable, and why the author is not interested in it? Moreover, why the author ignores base flow, which is an important component of runoff?

Reply of the Author (1): There were mainly two consideration for selecting the hydroclimate variables for the trend analysis: Firstly, to keep the paper as short and simple as possible by considering only the major variables to represent the hydroclimate dynamics. Second, the variables should be present in both ERA-Interim and Interim/Land datasets so that a comparison can be made between the trends revealed by the two datasets. In this regards, although soil moisture is an important component of the water cycle, it could not be included in the analysis because Interim/Land dataset does not include the soil moisture variable. With respect to the base flow, it was not considered in the analysis due to limiting the analysis to the main components of a surface water balance.

2. The discussion is not deep enough. The author may explain the trends of the variables based on physics for instance. Are those trends of the variables reasonable? Is the phenomenon in Turkey unique? Is there any suggestion? For example, Figure 3b shows the distribution and the histogram of the average temperature increases (over study period) with respect to elevation. Why? Please discuss. I would suggest the

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author to have a more comprehensive discussion.

Reply of the Author (2): First of all, thanks to the additional temperature data provided by Dr. Faize Saris from Canakkale 18 Mart University, the comparison could be extended to around 100 stations distributed over the country. The revised Figure (attached Fig1) 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. In the revised Figure (attached Fig.2), the average yearly temperature of all stations was compared to the yearly average reanalysis data at the same station locations for the study period.

Similar to the previous Figure 3b, the revised Figure also indicate that the total temperature increase during the study period is higher in the lowlands and lower in the higher altitudes by both ERA-Interim and meteo-stations. As it can be seen in the topography map in Figure 1 (in the manuscript), East/North East part of Turkey constitute the mountainous and higher elevation region, where the increasing trend of temperature was less or non-significant. The average height corresponding to this area is about 1850 m.a.s.l. (the average of whole country is 1140 m). Therefore, the region has relatively intense terrestrial climate with shorter summers and longer & harsher winters. As shown in the satellite image (attached Fig.3), the snow also stays longer on the land. Considering that there has not been considerable change in the snow dynamics for the very Eastern region during the study period (Figures 6a and 6b in the manuscript), albedo effect could play a role for relatively less amount of increase in the temperature. Besides, the Eastern region has also significantly less population density in the country, with even considerable population migration to the other regions. So direct urban/land use change contribution to the temperature increase can be less effective. Lastly, the differences in the regional climate system due to the different controlling factors (e.g. the differences in the effective pressure systems, topography, etc) can play a role.

With respect to the observing the largest temperature in the Western coastal areas

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(which are also lowlands), as referred in lines 21-24 of page 5 (under section 3.1) of the manuscript, Sen et al. (2011) 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. Further details can be found in Sen et al. (2011).

Figure1. 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.

Figure2 a) The comparison of the average yearly T between the (all) stations and the corresponding grids from the ERA-I dataset for the study period b) The comparison of the total 32-years increase of T by meteo-stations and ERA-I with respect to elevation.

Figure3. True color Terra-Modis satellite image on a clear-sky day (April 1, 2016; source: worldview.earthdata.nasa.gov)

3. As pointed out by the Anonymous Referee #1 and # 2, the seasonal variations should be considered since it may strongly affects the intra-annual trends.

Reply of the Author (3): As suggested by the Reviewer #3 (and Reviewers #1, #2), the spatio-temporal trends in precipitation were analyzed at seasonal scale and the results will be included in the revised manuscript.

Figure4. The presence and the direction of Total Precipitation trends by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn.

Figure5. The magnitudes of the Total Precipitation trends (32-years total) by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn.

Figure6. The presence and the direction of Total Precipitation trends by Interim/Land for a) Winter, b) Spring, c) Summer and d) Autumn.

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Figure7. The magnitudes of the Total Precipitation trends by Interim/Land for a) Winter, b) Spring, c) Summer and d) Autumn.

On the other hand, to be selective on including the seasonal analyses of the variables, I assessed the correlations between the variables for both datasets. As the correlation maps reveal (attached Fig.8), all the hydrological variables (Runoff, SWE and ET over land) are positively correlated with Precipitation for the majority of the study area. Such high correlations also confirm the fact that, land surface models included in Reanalysis datasets (in this case ECMWF) are mainly driven by the atmospheric variables (i.e. Precipitation) rather than land use dynamics (e.g. irrigation). Therefore, I would rather limit the seasonal trend analysis to the Precipitation, as its seasonal trends would also be expressed especially in seasonal trends of Runoff and ET. With respect to Snow Water Equivalent, as the snow accumulation and melting is mostly taking place in Winter and Spring, a separate seasonal analysis of SWE was considered unnecessary.

Figure8. The correlation between (a) total Precipitation and Runoff, (b) total Precipitation and SWE, (c) total Precipitation and ET for Interim/Land dataset.

4. The author stated “while over land, ET is mainly water-limited (i.e. precipitation and soil moisture) especially for semiarid regions. ” This statement is not right since, in some humid regions, ET is energy-limited and there are many humid regions over land. For more information, please see the article “Seneviratne, S. I., T. Corti, E. L. Davin, M. Hirschi, E. B. Jaeger, I. Lehner, B. Orlowsky, and A. J. Teuling (2010), Investigating soil moisture–climate interactions in a changing climate: A review, Earth-Science Reviews, 99(3–4), 125-161.”

Reply of the Author (4): I think there is misunderstanding possibly caused by the formulation of the sentence, which was meant to refer not all land areas but only semi-arid regions. Otherwise, I totally agree with Referee #3 that for humid regions over land, ET is mainly energy-limited. To make it clearer, the related sentence will be revised as follows:

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: over sea, ET is generally energy-limited (i.e. temperature and incoming radiation), while over land, ET is mainly water-limited (i.e. precipitation and soil moisture) in semi-arid regions and energy-limited in humid regions.

To support the stament, (attached) Figure9 shows the long term average of the P/ET ratio and the correlation between P and ET for the region. As clearly shown in P/ET ratio map, except for the humid North-East region by the Black Sea, most of the study area has relatively semi-arid conditions with P/ET ratio less than 1. As a result, the correlation map reveals that, for non-humid parts of the country, there is a strong positive correlation between the Precipitation and ET, implying ET is mainly precipitation-controlled in these areas.

Figure9 a) The distribution of the average P/ET ratio during the study period (1979-2010), b) The correlation between the total Precipitation and ET for Interim/Land dataset.

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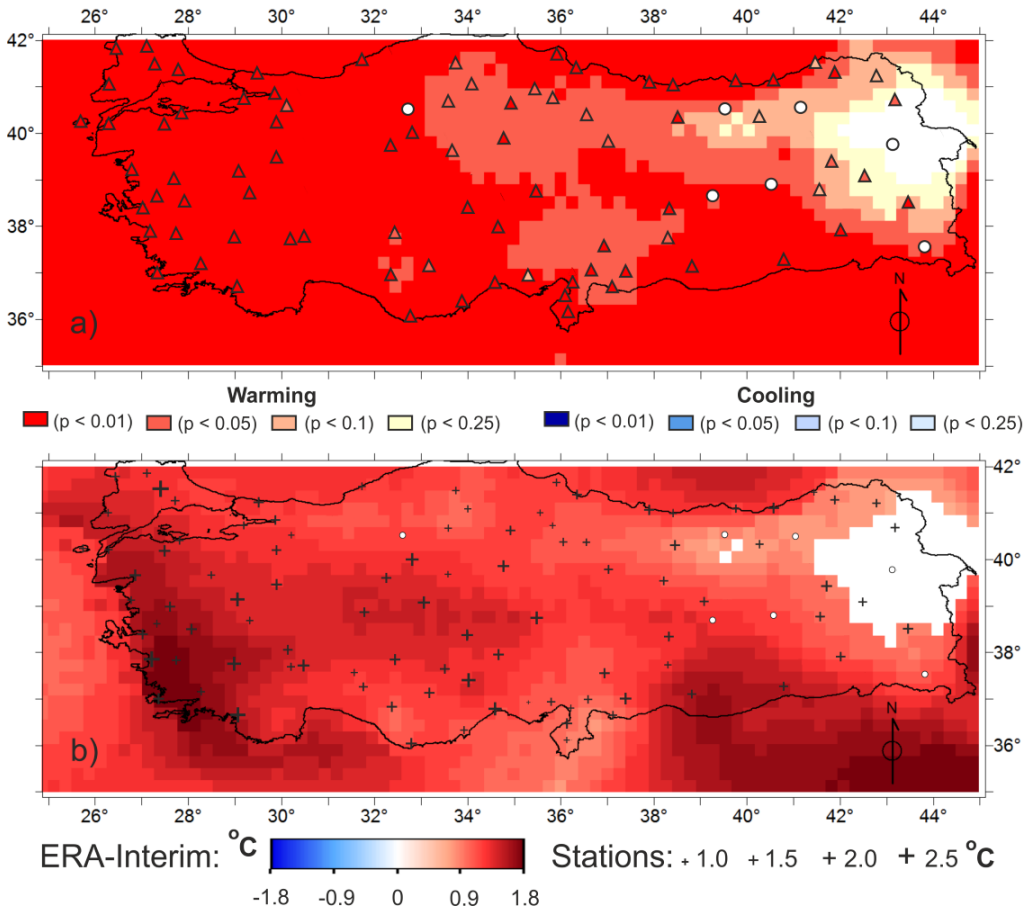

Fig. 1. The comparison of the (a) presence of the significant Air Temperature trends and (b) the magnitudes of 32-years total Air Temperature trends between the ERA-I dataset and the meteo-stations

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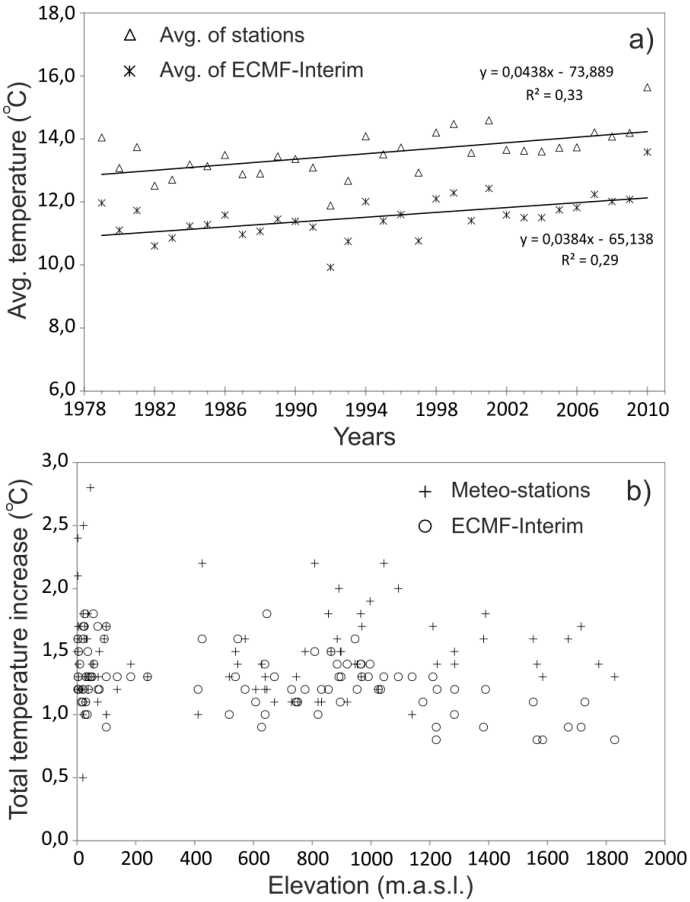

Fig. 2. Comparison of avg yearly T between the (all) stations and the corresponding grids from ERA-I for the study period b) The comparison of the total 32-years increase of T by stations and ERA-I

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Fig. 3. True color Terra-Modis satellite image on a clear-sky day (April 1, 2016 source world-view.earthdata.nasa.gov)

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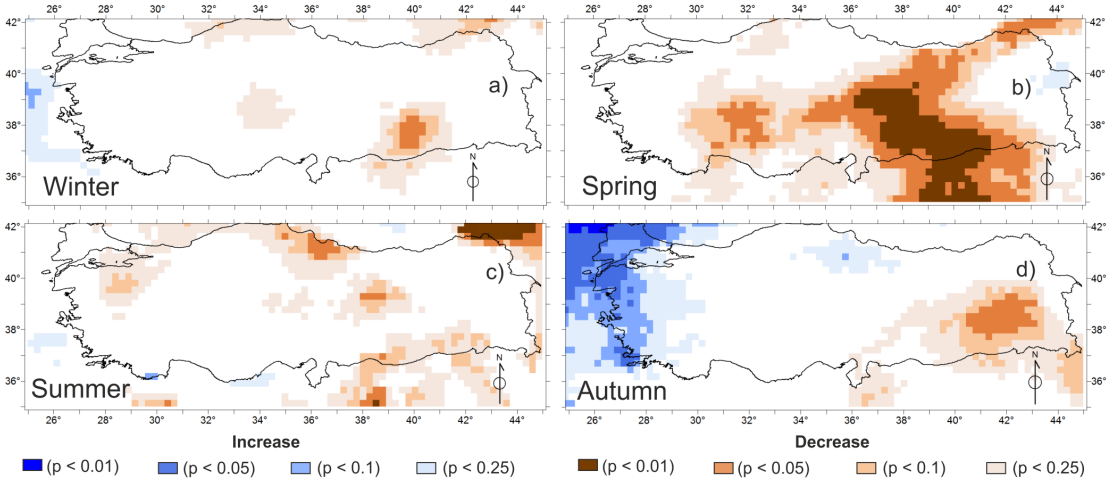

Fig. 4. The presence and the direction of Total Precipitation trends by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn

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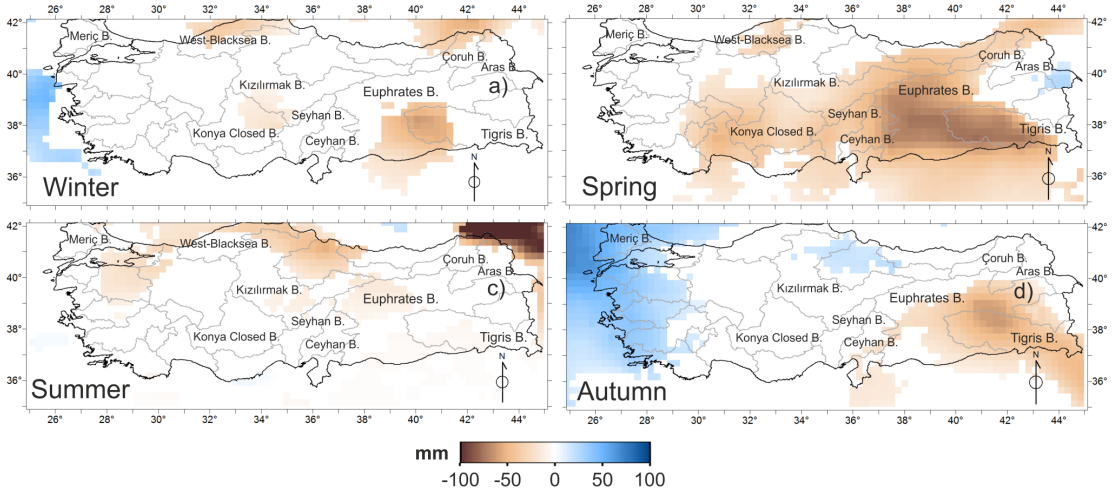

Fig. 5. The magnitudes of the Total Precipitation trends (32-years total) by ERA-Interim for a) Winter, b) Spring, c) Summer and d) Autumn

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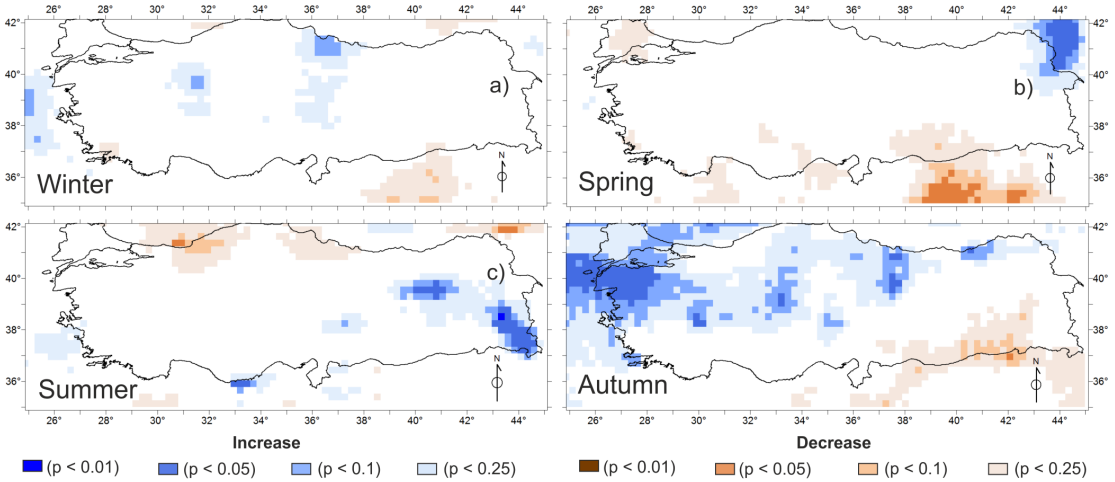

Fig. 6. The presence and the direction of Total Precipitation trends by InterimLand for a) Winter, b) Spring, c) Summer and d) Autumn

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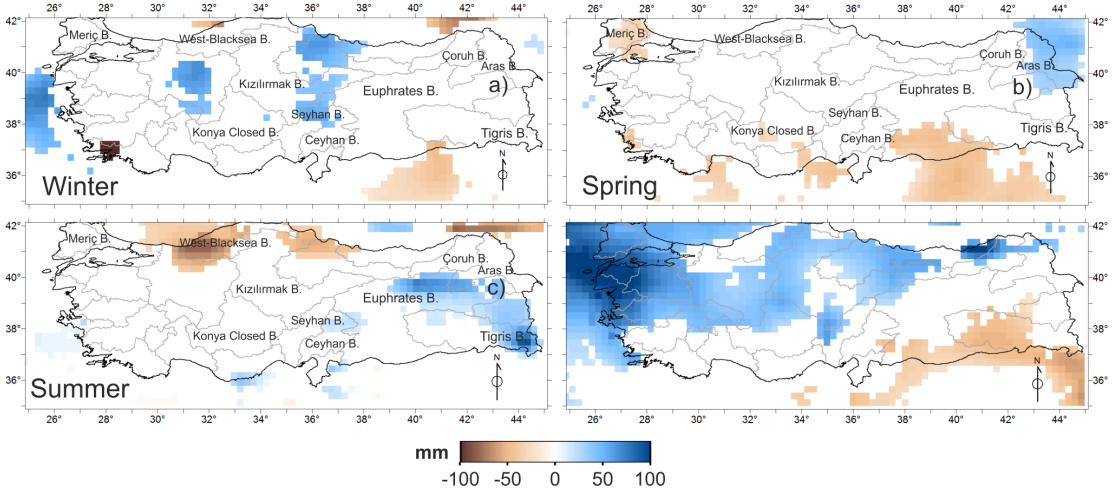

Fig. 7. The magnitudes of the Total Precipitation trends (32-years total) by InterimLand for a) Winter, b) Spring, c) Summer and d) Autumn)

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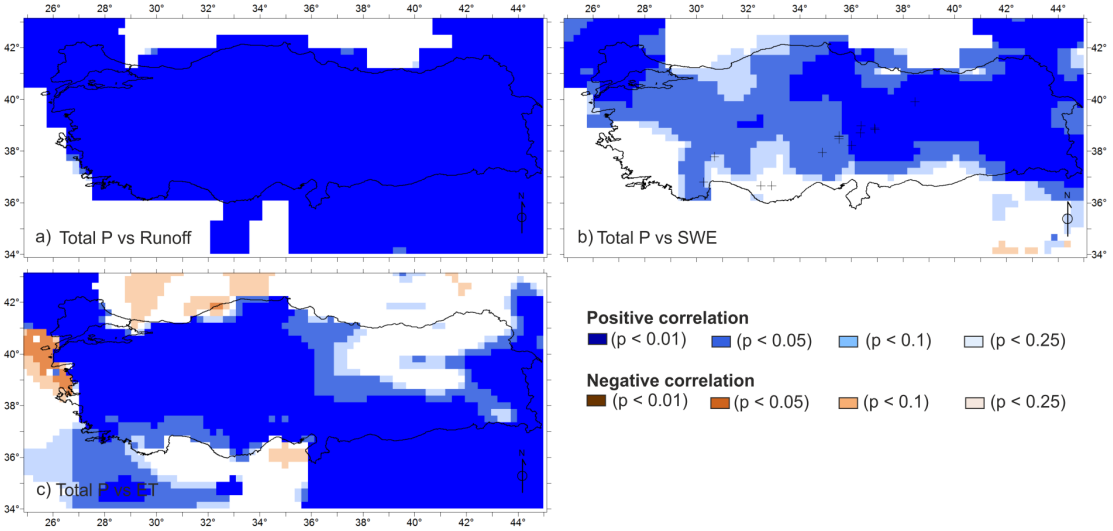

Fig. 8. The correlation between (a) total Precipitation and Runoff, (b) total Precipitation and SWE, (c) total Precipitation and ET for InterimLand dataset

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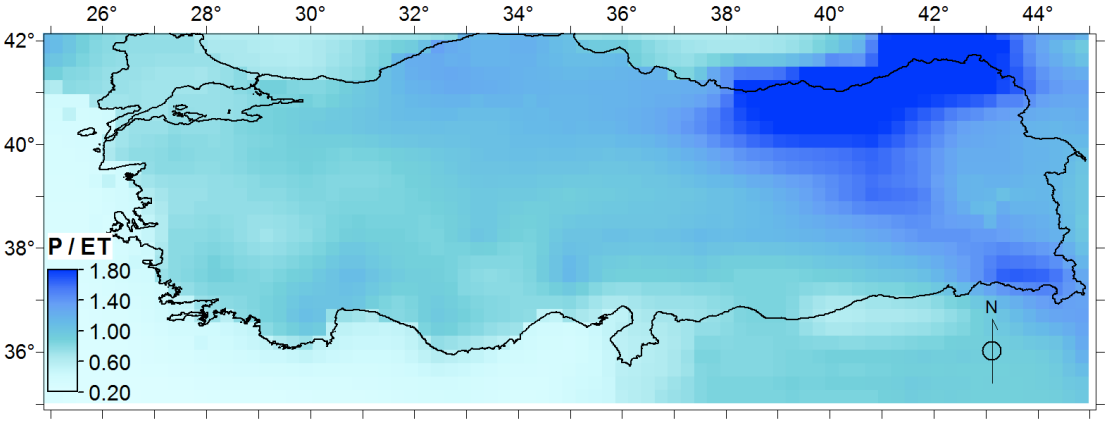

Fig. 9. Fig9a The distribution of the average P ET ratio during the study period (1979-2010)

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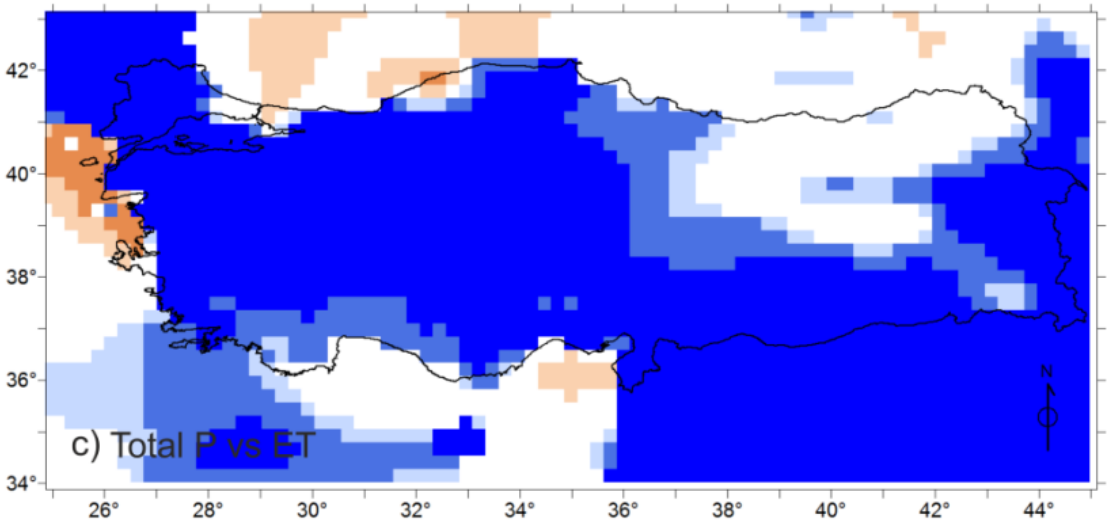

Fig. 10. Fig9b The correlationbetween totalP and ET

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