Changes in pan and visible evaporation over European Russia territory

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Definitions and Data

Pan evaporation observations in the USSR began in the middle of 1950s. At the peak of the network extent (in the middle of 1960s, more than 150 stations performed these observations, spanning over European Russia). From 1960s the number of stations was significantly reduced, and now the network only includes the majority of the region for 20 stations. Mean pan evaporation, \( \bar{E}_w \), is defined as the mean annual value of pan evaporation for the actual period of observation. It is used as a tool to assess interannual variability of pan evaporation changes in the land-atmosphere column. Positive values indicate “dry” conditions signaling that the regional moistening is insufficient. When precipitation predominates above evaporation, \( \bar{E}_w \) is negative (“humid” conditions). The more positive \( \bar{E}_w \), the more pronounced is the evaporation process in the land-atmosphere column. Visible evaporation, \( \bar{Vi} \), is defined as the difference between pan evaporation (\( \bar{E}_w \)) and precipitation (P). It characterizes actual evaporation from the water surface and serves as an indirect index of losses of energetic resources on evaporation processes in the land-atmosphere column. Positive \( \bar{Vi} \) values indicate “dry” conditions, signaling that the regional moistening is insufficient. When precipitation predominates above evaporation, \( \bar{Vi} \) is negative (“humid” conditions). The more positive \( \bar{Vi} \), the more pronounced is the evaporation process in the land-atmosphere column.

Results

Over the entire European Russia, a decrease in pan evaporation is observed. However, in the taiga zone, the changes become more apparent except for region 8, where we do not have observations since 1956. Pan evaporation changes in the dry steppe zone and in its surroundings are non-linear. Up to the 1990s, pan evaporation decreased here, but since the end of the 20th century tendencies of increase were documented.

Changes in visible evaporation during the past 40 years show a tendency towards more humid conditions practically over the entire European Russia. In the west of the taiga zone systematic changes in \( \bar{Vi} \) are not very clear, and \( \bar{Vi} \) (pan evaporation is more than precipitation) periods become more prolonged than in the past. In region 8, the number of “dry” years since the middle of 1970s up to 1995 (when our last pan evaporation data are available for analysis). Within the taiga zone, pan evaporation exceeds precipitation, and the conditions of liquid-based moisturizing are typical for this zone. However, differences in \( \bar{Vi} \) are decreasing here, thus indicating an improvement in the zone moisturizing. \( \bar{Vi} \) changes in the dry steppe zone and semi-desert (region 12) differ from the common tendency of changes. Since 1990s, we observe in this region drier conditions and \( \bar{Vi} \) has increased.

Interannual variability of both pan evaporation and visible evaporation in the last 10 years becomes less than in the previous decades. It can be an indication that local and continental exchanges within the surface-atmosphere system in the European Russia is becoming weaker. Only the west of the taiga zone (Region 1) is an exception and interannual fluctuations of \( \bar{Vi} \) here become more apparent.

Location of pan-evaporation stations

Pan evaporation changes within selected regions

Mean visible evaporation for 1966(61) - 1977

Mean visible evaporation since 1978

Visible evaporation changes within selected regions

Estimates for the 1978-1992 period are in grey; estimates for the 1978-2000 period are in italics.