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Lagged correlation between soil water content and evapotranspiration along recent decades and across different land cover types of Europe

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The link between soil water content (SWC) and evapotranspiration (ET) is of great importance in ecohydrology, agroecosystem management, and land-atmosphere interaction of earth-system analysis. There is still a need to understand the key processes linking SWC and ET in different vegetated ecosystems, especially at larger scales. Therefore, in this work, we used wavelet coherence analysis to explore the long-term relationship between SWC and ET among the predominant land use types (cropland, evergreen needleleaf forest, mixed forest, open shrubland, wooden tundra, grassland, and mixed tundra) in Europe during the last four decades (1980-2020). To this end, first a principal component analysis was performed among the SWC and ET data from GLDAS, GLEAM, and ERA5-land, and the first component was then used for further analyses when the target variable was in demand. Using the first component, then, we averaged SWC and ET data over the pixels covered by each land use type. Then, for each land-use types, we averaged the data daily for each decade to account for a representative decadal year of daily data. Then, wavelet coherence analysis was conducted between those averaged data of SWC and ET for each land-use type. The results showed a negative correlation between ET and SWC for all land use types, with ET lagging behind SWC, with an average phase shift value of 134 days for grassland (the minimum) and 168 days for mixed tundra (the maximum). Converting the phase shift values to a time lag [*lag* = n/2 - *phase shift* for the case *phase shift* < -n/4 where *n* represents the period (1/frequency) of the signals] shows (Fig. 1) that ET controls SWC with a lag of 15 days in mixed tundra (the minimum) and 48 days in grassland (the maximum). Moreover, we applied Mann-Kendall trend analysis test and found that the lag between SWC and ET decreases in mixed and wooden tundras with a slope value of -2.4 days/year, while it increases in cropland and grassland with a slope value of 1.6 days/year. Although there is a significant downward trend in evergreen needleleaf forests (with a slope value of -0.3 days/year) and an increasing trend in mixed forests and open shrublands (with a slope value of 0.4 days/year), the lower slope values in these land use types indicate that the change is slower compared to grasslands, croplands, and tundras.

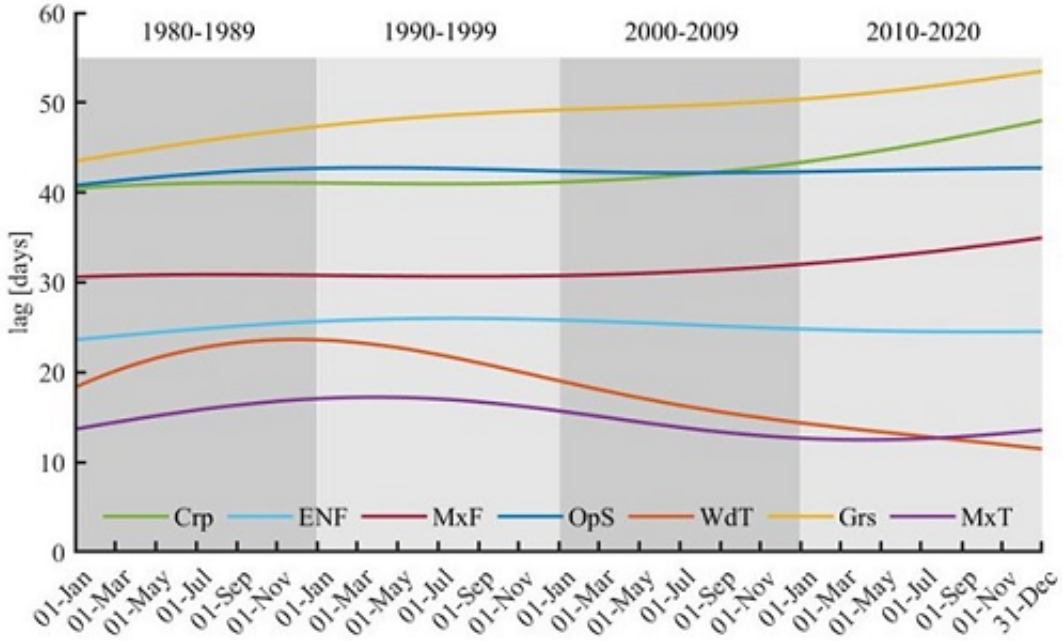

Figure Temporal evolution of the lag between soil water content and evapotranspiration in the annual cycle in different land use types in Europe