Effects of spring Earth surface temperature anomalies on summer 2-m air temperature

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Background and objectives

Much of the research addressing the linkages between the Arctic and mid-latitude weather and climate has focused on the effects of changes in sea ice, sea surface temperature or terrestrial snow pack on the air temperature. There is, however, a need for a systematic study on the atmospheric response to Earth surface temperature anomalies, irrespective of the surface type and the cause of the anomalies. For this purpose, we studied the relationships between anomalies in the Earth surface temperature (Ts) and 2-m air temperature (T2m) in the Northern Hemisphere, focusing on lagged correlations between spring Ts and summer T2m.

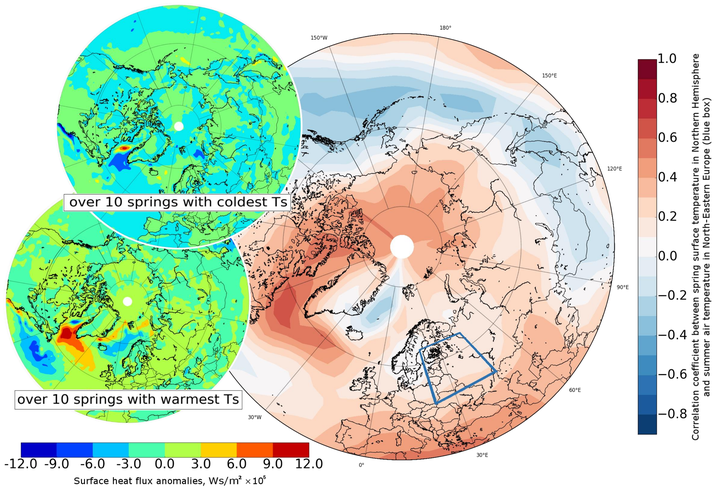
Material and methods

- ERA-Interim reanalysis 1979-2014
- The globe divided in grid cells with size 1.25º x 1.25º
- Calculation of the correlation coefficient between Ts in all the grid cells and T2m over land in 13 different study regions in Europe, Greenland, and parts of Asia and North Africa.
- The study regions were selected based on similar physiographic conditions.
- Temperature linkages were analysed with focus on lagged spring – summer relationships

Results for North-Eastern Europe

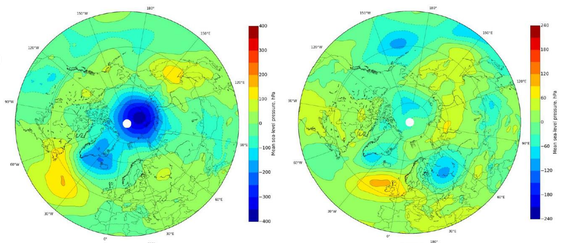
Positive correlation was detected between spring (MAM) Ts over the Canadian Arctic, Labrador Sea and North Atlantic and summer (JJA) T2m in north-eastern Europe.

The surface sensible + latent heat flux was small in springs with lowest Ts and high in springs with highest Ts in the Labrador Sea. Differences in sea ice cover were small.



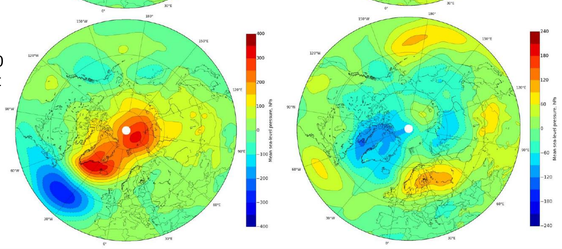
The springtime Ts anomalies were associated with very diffreent MSLP fields in spring and summer.

Spring MSLP for 10 years with coldest spring Ts in the Labrador Sea



Summer MSLP for 10 years with coldest spring Ts in the Labrador Sea

Spring MSLP for 10 years with warmest spring Ts in the Labrador Sea

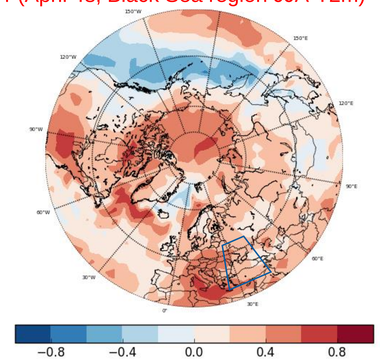


Summer MSLP for 10 years with warmest spring Ts in the Labrador Sea

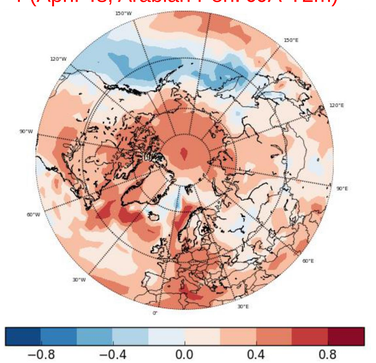
Selected results for other regions

- Global spring Ts and regional summer T2m are most strongly correlated in the Black Sea region and Arabian Peninsula. The results resemble those for the North-Eastern Europe. The spring-summer relationships are weakest for the British Isles and Northern Central Asia.

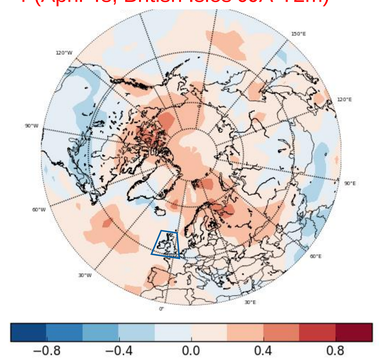
r (April-Ts, Black Sea region JJA-T2m)



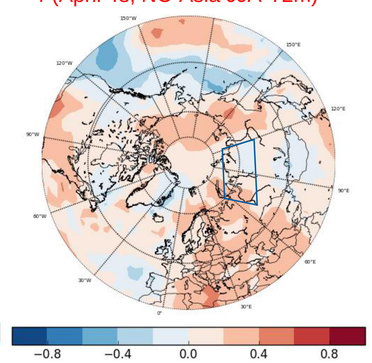
r (April-Ts, Arabian Pen. JJA-T2m)



r (April-Ts, British Isles JJA-T2m)

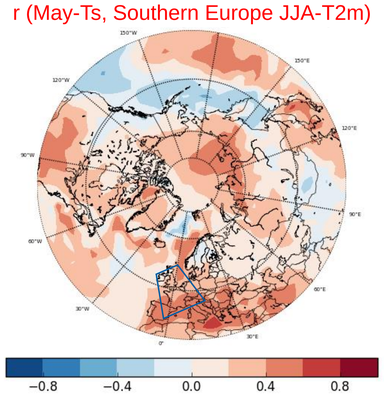


r (April-Ts, NC-Asia JJA-T2m)

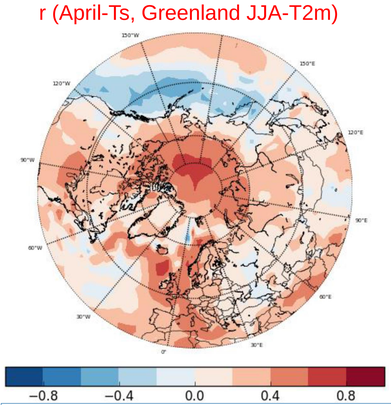


- Regional summer T2m is usually poorly correlated with spring Ts of the same region. This suggests that the inter-seasonal relationships are mostly due to teleconnections instead of local processes related to the heat capacity of Earth surface layers or to inter-seasonal persistency of weather.
- There were, however, more positive than negative correlations (roughly 60-80% positive), suggesting that the heat stored in the Earth surface in spring plays a role, but mostly via teleconnections.
- Among the few regions, where the local correlations were higher than the inter-regional ones, was the Southern Europe, particularly for May Ts – JJA T2m relationship. Positive local correlations suggest the dominance of the surface heat capacity over teleconnections.

r (May-Ts, Southern Europe JJA-T2m)



r (April-Ts, Greenland JJA-T2m)



- Warm central Arctic in April and May is often followed by a warm summer in Greenland. Only since May, Greenland Ts correlates with Greenland summer T2m.
- Negative correlation occurs between spring Ts in northernmost Pacific and summer T2m in large parts of Eurasia.
- Work is needed to understand the physical mechanisms responsible for the statistical relationship

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