Lagged Effects of North Atlantic SST Anomalies on Weather in Remote Areas

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Polar climate has experienced dramatic changes during observed global warming. These changes in turn have, as hypothesised, strong influences on the mid-latitude weather. Many proposed linkages focus on the effects of changes in sea ice, sea surface temperature or terrestrial snow pack on the air temperature in selected mid-latitude areas. Our hypothesis is that from the point of view of the atmosphere, it does not matter whether the thermal forcing from the surface originates from sea ice melt, terrestrial snow melt, or changes in SST. Most important is to quantify how the atmosphere responds to anomalies in surface temperature, and how the local/regional responses may affect weather patterns in remote areas. By analysing these responses systematically in global scale, we can identify the regions and seasons where/when the response is strongest. Comparing these regions/seasons to observed changes in sea ice, terrestrial snow, and open ocean SST, we will obtain information on the relative importance of forcing from these three factors. For this purpose, we studied the relationships between anomalies in the surface temperature (Ts) in the Northern Hemisphere (on grid 1.5^{o}-1.5^{o}) and 2-m air temperature (T2m) in selected 13 study regions in Europe, Greenland, and parts of Asia and North Africa for the period 1979-2018 based on the ERA-Interim reanalysis. Applying also detrended data, we eliminated spurious correlations resulting from similar trends in the two variables.

We detected significant correlations between the surface temperature over the Labrador Sea, Canadian archipelago and North Atlantic and 2-m air temperature in different study regions for inter-seasonal spring - summer (MAM-JJA) and autumn - winter (SON-DJF) relationships. Among the strongest correlations between the spring Ts and summer T2m were the positive correlations found between Ts in the North Atlantic and T2m in Scandinavia, Ts in the Labrador Sea and T2m in Northeast Europe, and Ts in Norther Sahara and T2m in Urals. As well, among the strongest correlations between the autumn Ts and winter T2m were the positive correlations found between Ts in the North Atlantic and the Labrador Sea and T2m in Scandinavia and Northwest Africa; and the negative correlations found between Ts in the Labrador Sea and the North Atlantic and T2m in Scandinavia, Northeast Europe, Urals, Black Sea region and Northcentral Asia.

In order to identify thermal forcing factors and to assess their relative importance, we analysed the multiyear averages and anomalies of sea-ice concentration, snow cover and surface heat fluxes. According to the results, in all identified cases, changes in SST mostly were an influencing factor.

Another big challenge was to understand the physical mechanisms responsible for the obtained statistical results. For this purpose, we analysed surface pressure, geopotential heights, wind components, air-mass trajectories, incoming solar radiation, cloud cover, and total precipitation for sub-sets of 10 coldest and 10 warmest seasons in the period 1979-2018. There is a detectable effect on anomalies in the atmospheric pressure field and wind components in these regions.

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