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Winter NAO significantly influences Baltic SST values throughout spring and summer

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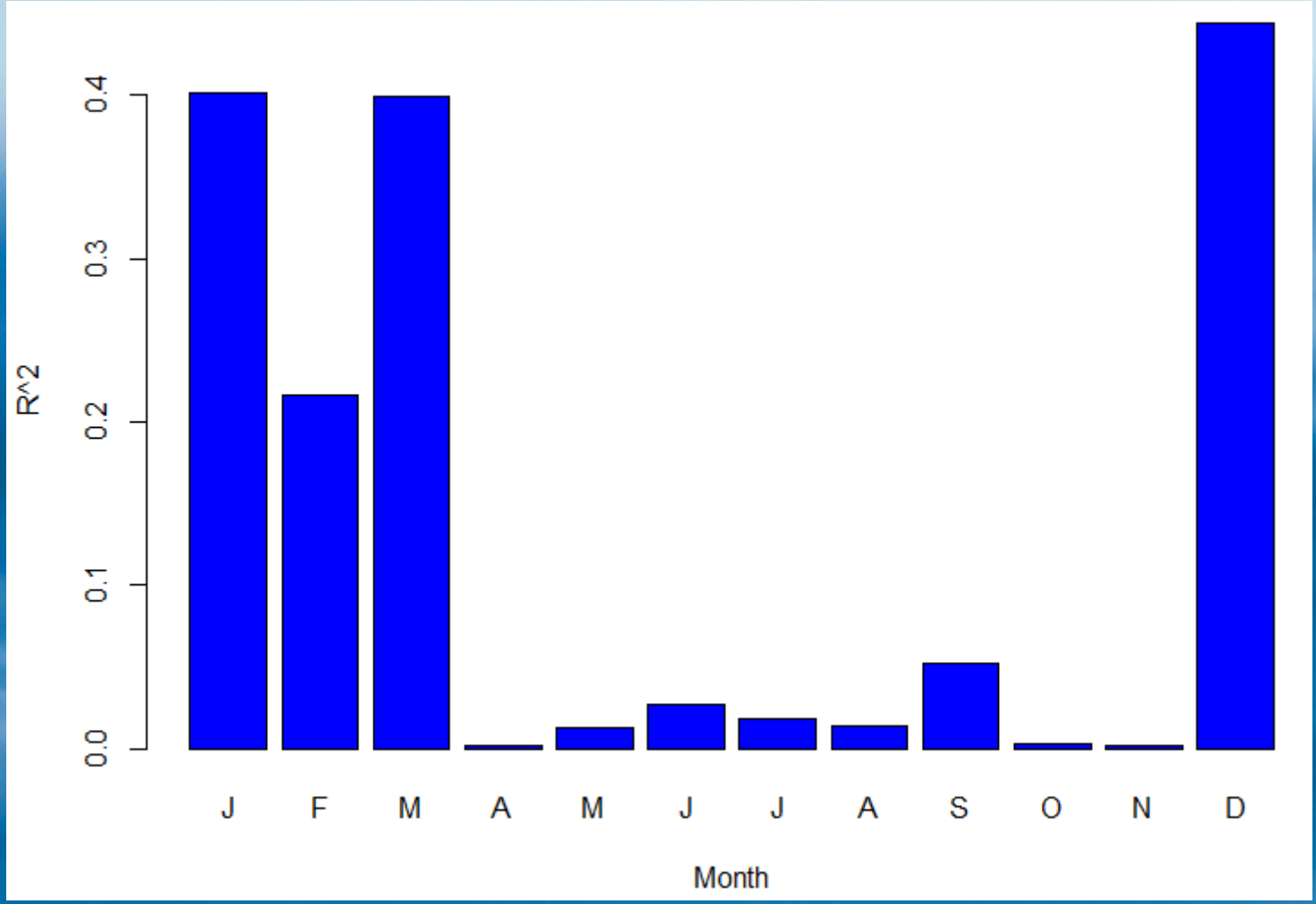
Motivation and methods

The aim of the study was to test the possibility of improving prediction skills of Baltic SST values throughout the year using past NAO index value. This could be possible due to the strong effect of NAO on Central and North European winter (DJFM) temperatures and the large thermal capacity of a sea, even as shallow as the Baltic.

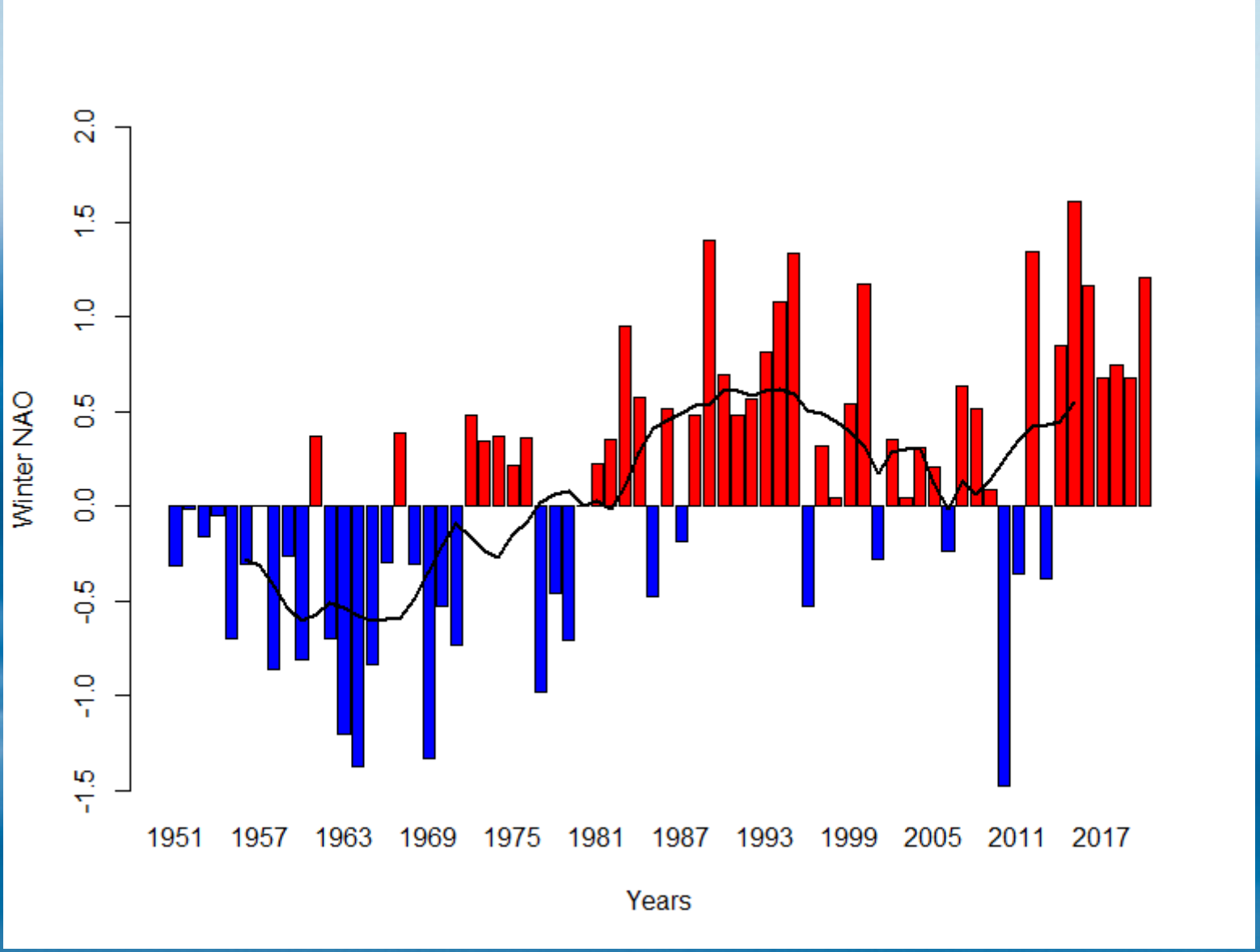
In order to do that, I used the NOAA NAO index, based on rotated principal component analysis of the 500 hPa geopotential height anomalies calculated for the North Atlantic sector (20º do 90º N) from 1950 up do date, as well as the Hadley Centre sea surface temperature (SST) series HadISS1 as the only one covering all the period since 1950 with enough resolution to have at least several; pixels in the Baltic. The calculations were done using R language and the online Climate Explorer application.

Why winter NAO?



Correlation index squared (determination index) of 1950-2019 NOAA (Hurrell) NAO index and monthly average temperature in Poland (POLTEMP) showing DJFM as the only period with NAO influencing the temperature.

Winter DJFM NAO



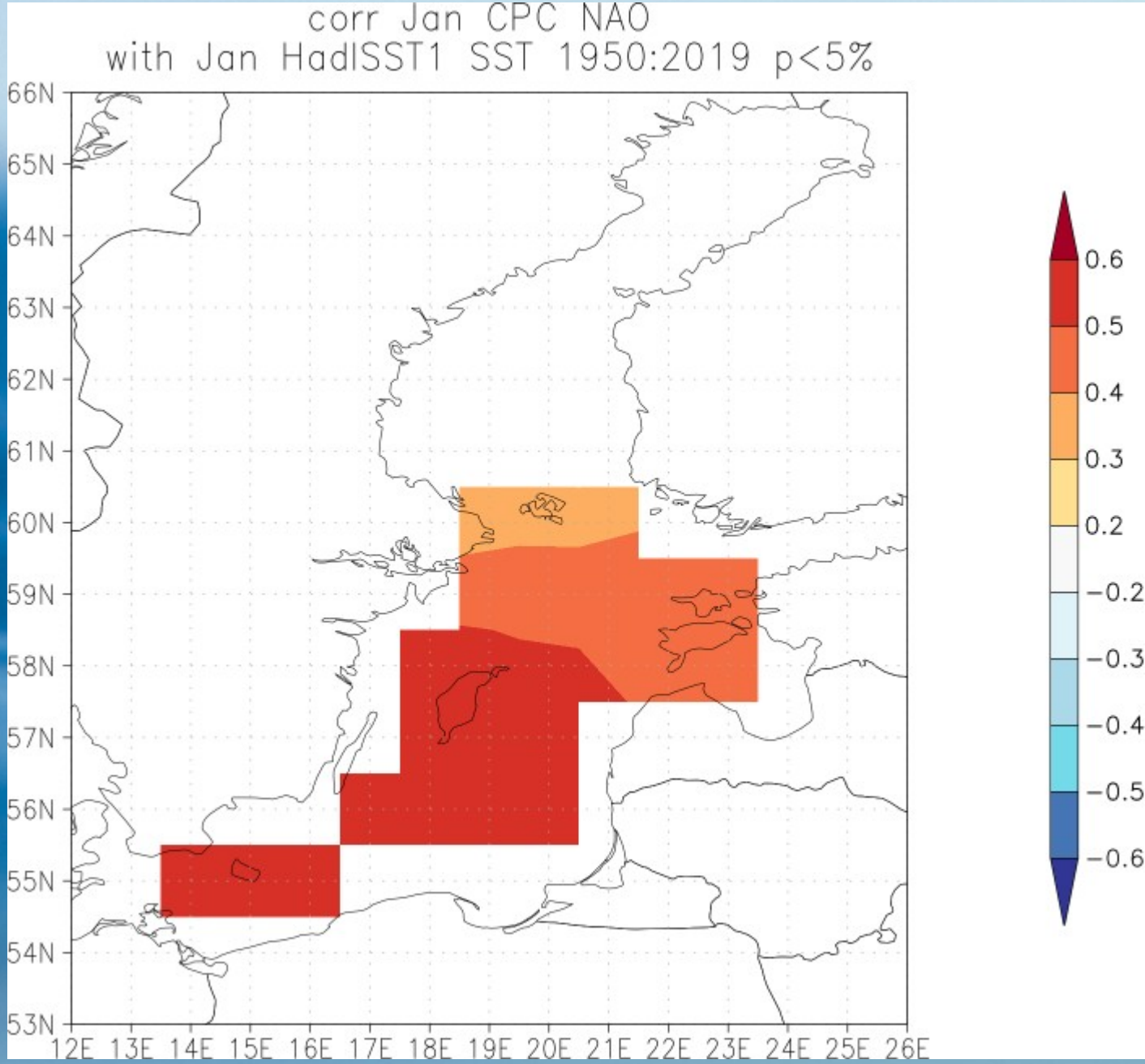
Winter DFJM 1950-2020 NOAA NAO index with the 11-year running mean.

Results 1/2

First, the correlations of monthly NAO index and SST fields have been calculated. Significant ($p<0.05$) correlations were noted only in the central and southern Baltic in January, February and March, unlike in the air temperature - not shown – when significant correlations last from December to March. This may suggest one month delay in NAO affecting SST. To test this delay directly correlations with one month delay were performed showing significant values for five months of the year (from December to April SST temperatures).

Correlations with no lag

Example of correlation map between NAO and SST for one of the moths (January) where it was significant with no lag for southern and central Baltic. The months were January, February and March.

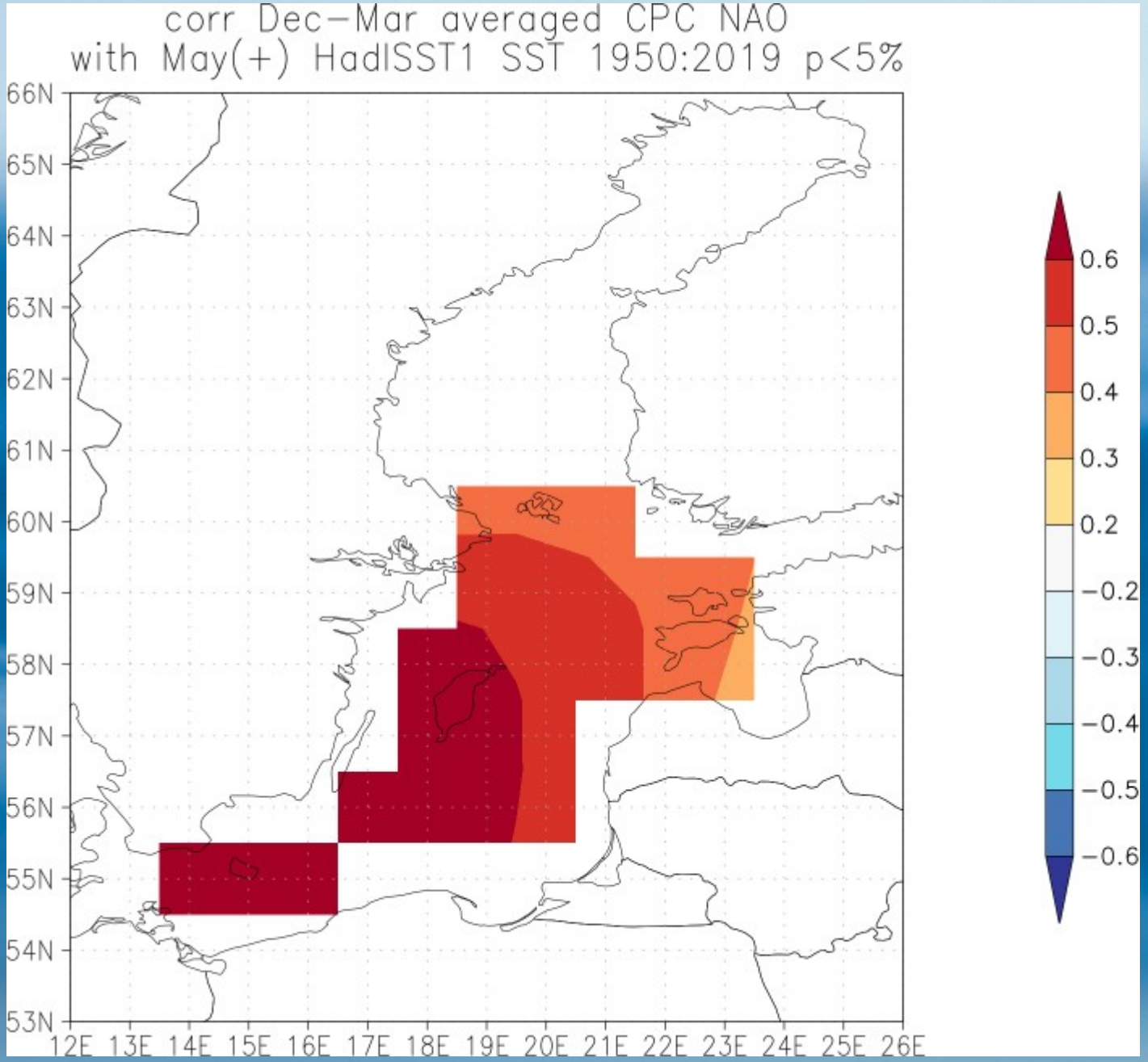


Results 2/2

Next, the main test of the study was performed by calculating the lagged correlations of average winter (DJFM) NAO values with SST fields. The results show that winter NAO significantly affects SST first in the central and southern basins (April to June) and later (July-September) also in the Bothnian Bay in the north. In some regions (mainly close to the Gulf of Riga) the influence of winter NAO is significant even in October, seven months after the end of the DJFM period when NAO influences the air temperatures. This shows that the effect must be caused by changes of heat content of the sea water. Also the fact that the effect of winter NAO spreads northwards during the summer can be explained with advection due to sea currents. It is interesting the that correlations of winter NAO with SST in April and May are similar ($r>0.6$) to the lag-less correlations of NAO and SST in winter. It needs to be noted that summer SST Baltic temperatures do not correlate significantly with any months outside the winter DJFM period including the summer ones (the strongest correlation is with February NAO values).

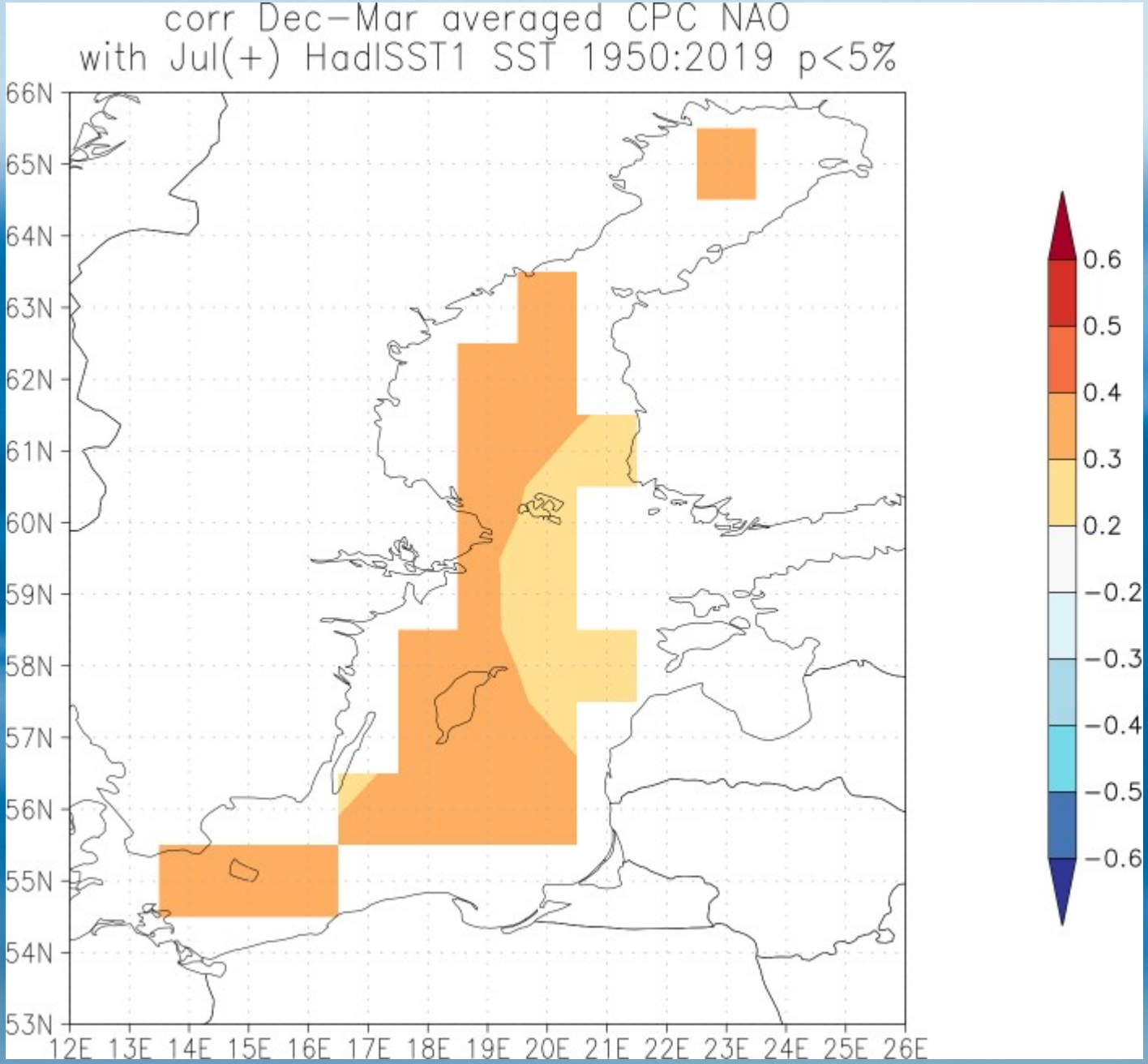
Lagged DJFM NAO correlation with May SST

Example 1 of lagged correlation map between DJFM NAO and May SST.



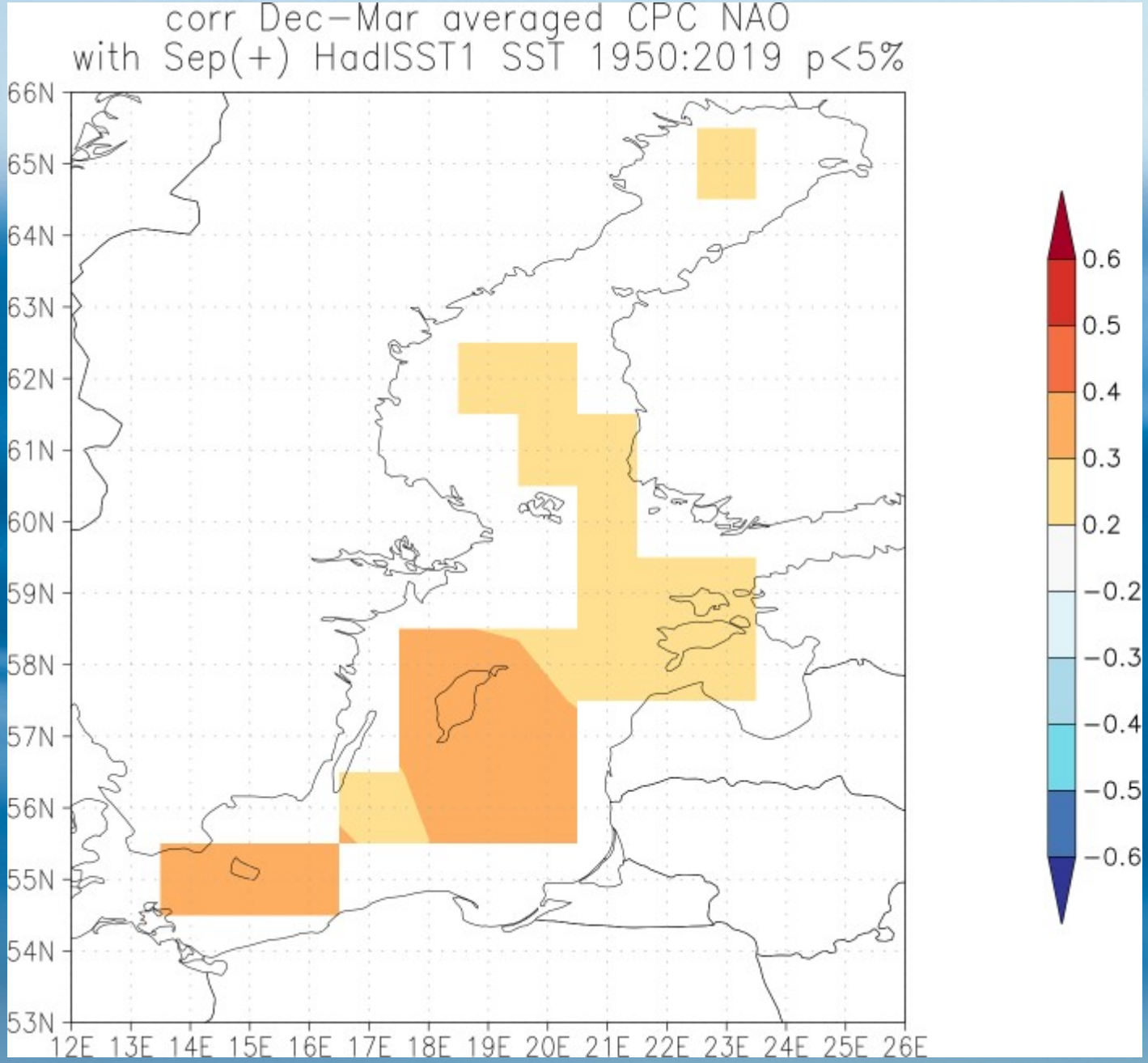
Lagged DJFM NAO correlation with July SST

Example 2 of lagged correlation map between DJFM NAO and July SST.

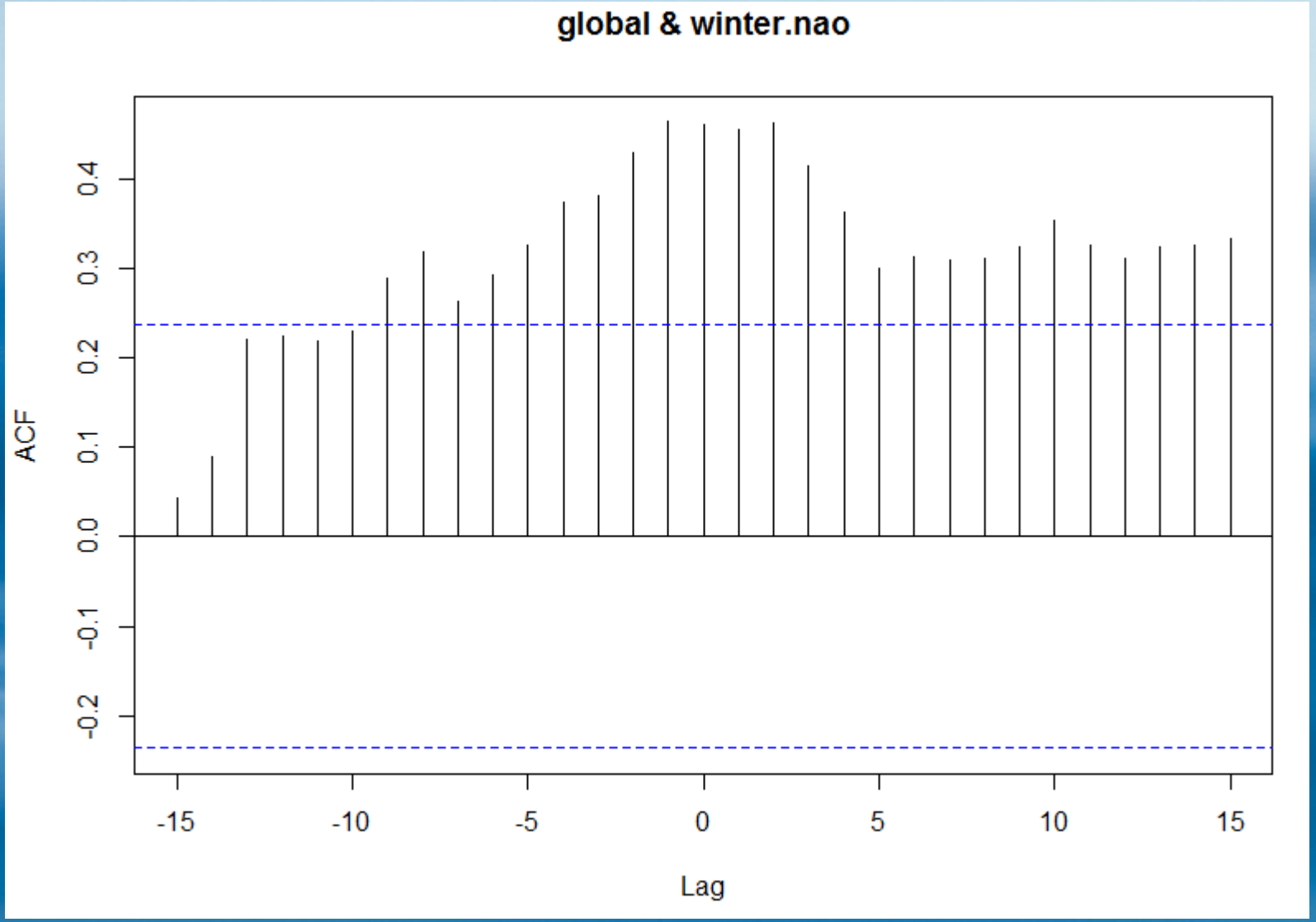


Lagged DJFM NAO correlation with September SST

Example 3 of lagged correlation map between DJFM NAO and September SST.



Lagged correlation of NAO and global temperature



Lagged correlation between 1950-2019 global temperature and winter DJFM NAO showing signifiant correlations for zero lag and positive (NAO lagging temperature) lags up to 15 years and negative up to 9.

Conclusions

The results show that winter NAO, influencing Baltic SST values throughout the spring and summer can be used to improve the skill of seasonal predictions of Baltic SST values in spring and summer. They also imply that if the observed significant correlation of the winter NAO values with global temperature will continue in the next decades, the prevailing positive winter NAO values should result in the spring and summer Baltic SST warming at a faster rate than the adjacent land.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