Arctic response to changing Atmospheric Blocking

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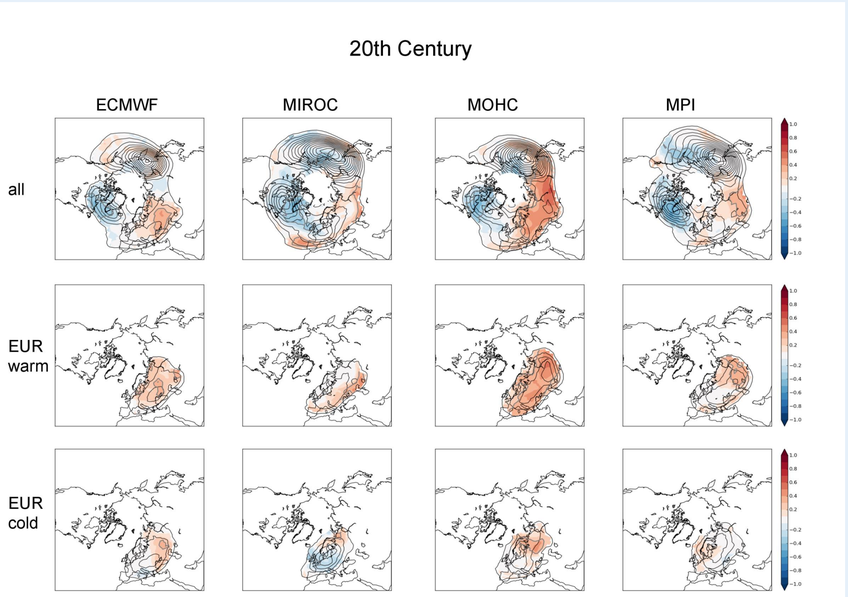


Correlation maps of winter (DJF) blocking with time series of seasonal mean temperatures over the Barents–Kara Sea region. Correlation values are shown in colour with contour lines showing the climatology of DJF blocking in each respective model (drawn every 0.05 from 0.05 for the first row and every 0.01 from 0.01 for the other rows). All blocking events are shown in the first row, while the second and third rows are for warm and cold European blocking, respectively.

1. 20th Century, blocking and Arctic temperature links

The 44 years detrended time-series of the surface temperature for the Barents-Kara Sea region are compared with the time-series of blocking frequency, to explore the existence of possible links.

The correlations values for Greenland blocking are generally negative. This is in accordance with positive NAO phases, which are associated with episodes of warm air advections over the B-K region. There exist positive correlations between the B-K region and east European blocking, particularly for HadGEM2-CC. However, the values are quite low and not centred on the peak of blocking frequency.

If European blocking is divided into warm and cold events, the positive correlations hold true for the first, while they disappear for the second. In particular, the positive values increase for EC-EARTH and HadGEM2-CC and tend to extend upstream over Central Europe. MIROC5 and MPI-ESM-MR also show positive correlations, however these are small and confined to the eastern and southern region of blocking.

The warm air advection associated with the strong anticyclone (see section 0) might provide the link between warm European blocking and the surface temperature over the B-K region.

REFERENCES

Masato, Giacomo, B. J. Hoskins, and Tim J. Woollings. "Wave-breaking characteristics of midlatitude blocking." *Quarterly Journal of the Royal Meteorological Society* 138.666 (2012): 1285-1296.

Masato, G., T. Woollings, and B. J. Hoskins. "Structure and impact of atmospheric blocking over the Euro-Atlantic region in present day and future simulations." *Geophysical Research Letters* (2014).

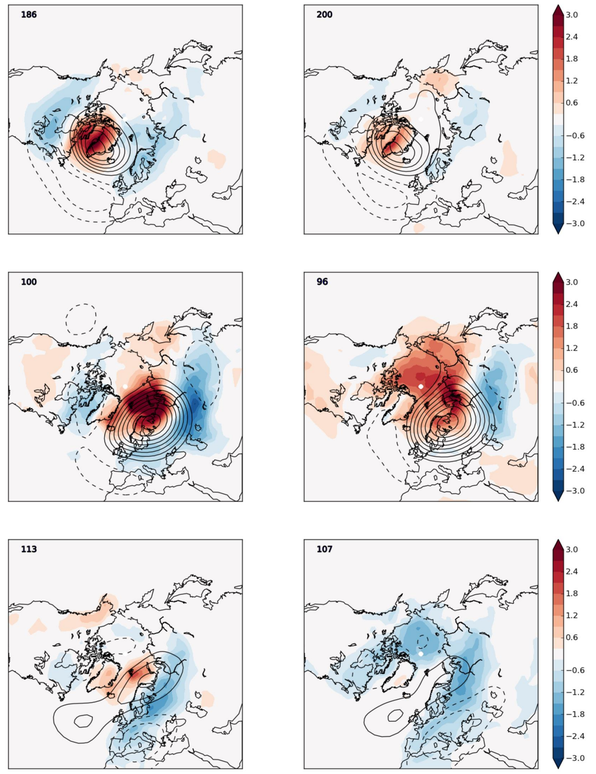
0. The structure and impact of blocking

Four fully coupled CMIP5 models are considered. The present day climate and the RCP8.5 scenarios are analysed. The periods considered are 1958-2001 and 2056-2099. Blocking occurrence is calculated using the diagnostic tools as in *Masato et al. (2012)*. The anomalies in geopotential (at 500 hPa) and temperature (at the surface) associated with blocking are used to observe its structure and impact .

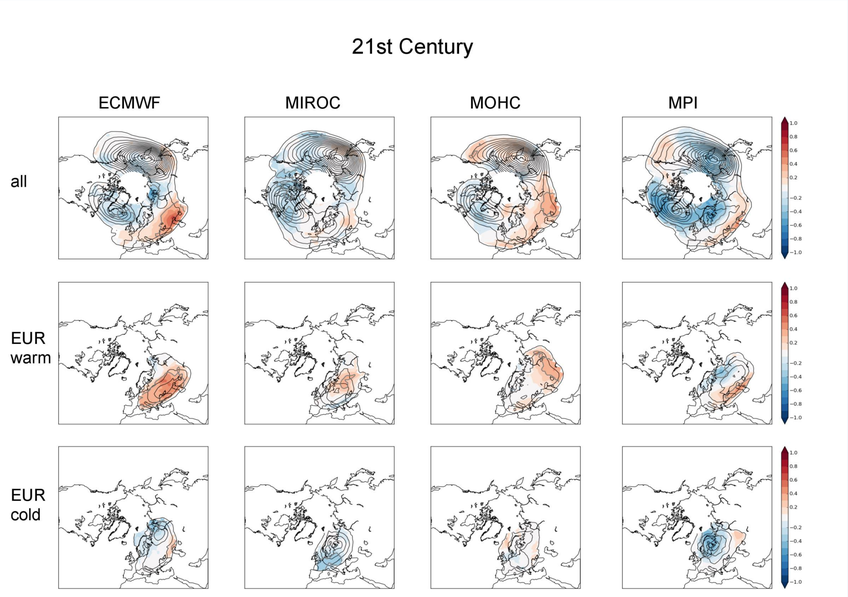
Three "blocking types" are identified, the Greenland blocking and two European blocking types, driven respectively by warm and cold air mass extrusions (see *Masato et al. 2014* for the details). Their frequency in the future projections does not change substantially.

The geopotential anomalies associated with *Greenland blocking* are very similar for the two climate scenarios, while the anomalies for surface temperature decrease in the 21st Century by a factor of ~2.

The two *European blocking* types exhibit changes in the geopotential anomalies, both in their amplitude and location. In particular for the warm events, the anticyclone strengthens and extends downstream. This can be potentially linked to the strong response in the surface temperature over the Arctic. Negative anomalies in the surface temperature by the end of the 21st Century are only linked to the occurrence of cold European blocking.



Left. Geopotential height at 500 hPa (contours) and surface temperature anomalies (colour shading) for the Atlantic (top), European warm (middle) and cold (bottom) blocking types in the multi-model mean for the 20th Century. Right. Same, but for the 21st Century. The number of events considered for each composite is on the top left corner of each panel. Contours are every 15 metres, the zero-line is omitted.



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2. 21st Century, blocking and Arctic temperature links

The 44 years detrended time-series of the surface temperature for the Barents-Kara Sea region are compared with the time-series of blocking frequency, to explore the existence of possible links.

The correlations values for Greenland blocking are again negative (see section 1), although smaller than their 20th Century counterpart. The positive correlations between the B-K region and east European blocking are also smaller and not significant except for the eastern tip of the blocking region (in ECMWF, HadGEM2-CC and MPI-ESM-MR).

Such positive correlations increase if only the warm European blocking events are considered (see for example ECMWF and MIROC5), but not all the models exhibit such a behaviour. Some negative correlations appear instead for the cold European blocking events (all models except HadGEM2-CC).

The opposite behaviour for the two European blocking types might be linked with the increase in sensitivity of Arctic temperature to blocking in the future (see section 0).

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