

## Exercises series 8 – Internal Variability

Due 14 June 2017

The Arctic Oscillation (AO) refers to an opposing pattern of pressure between the Arctic and the middle latitudes: If the atmospheric pressure is high in the Arctic, it tends to be low in the middle latitudes. In such cases the AO is in its negative phase. In the positive phase, the pattern is reversed. The phase has an important effect on weather in northern locations.

Your task is to identify the AO teleconnection pattern in the atmospheric pressure field. In order to do so you need to use Empirical Orthogonal Function (EOF). EOF is a statistical method used to emphasize variation and bring out strong patterns in a datasets. It is often used in climate studies to study spatial patterns of variability and how they change with time.

1. The AO is most pronounced in the 1000 mb geopotential height. Re-analysis of the 1000mb geopotential (not geopotential height!) for the winter months (DJFM) of the years 1979-2015 is available for you<sup>1</sup>. Average the data for each year and then apply the EOF method on the data north of 20N. In order to ensure an equal area weighting it is recommended that the gridded data will be weighted by the square root of the cosine of the latitude. Don't forget that it is the anomaly that goes into the EOF function. Plot the first EOF (the EOF has the same dimensions as the geographical dimensions of the input data) and think, e.g., how wind direction, storm tracks, jet stream curvature and strength in the upper atmosphere behave given the pattern that you see.
2. Show the yearly AO index by plotting the first principal component (PC) that comes out of the EOF analysis (i.e., the first PC that matches the first EOF). Use scaling of 1. Based on your conclusions from question 1, under which AO phase (positive/negative) you would expect to have warmer/colder winters in northern Europe and the US?
3. Use the 1000mb global temperature reanalysis data<sup>2</sup> and plot the difference in the temperature between positive and negative AO index years, for every data point on the globe north of 20N. Explain the geographical patterns that you see with respect to the AO phase.

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1 1000mb geopotential ECMWF reanalysis: /home\_local/tgoren/ex5/geop\_1000\_DJFM.nc

2 1000mb temperature ECMWF reanalysis: /home\_local/tgoren/ex5/temp\_1000\_DJFM.nc