Geophysical Research Abstracts
Vol. 20, EGU2018-10159, 2018
EGU General Assembly 2018

Is it possible to built accurate long-term forecasts of the North Atlantic Oscillation (NAO) index based solely on sea level changes?

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The combination of current knowledge about NAO and the ocean-atmosphere interactions becomes a basis for elaborating a simple long-term (up to three months) weather and climate forecasting system, based on sea level anomaly (SLA) data. It is believed that such predictions are doable through the use of the existing relationship between the NAO index and SLA time series (Esselborn and Eden, 2001).

The long-term predictions of the SLA data, which are computed using the integrated altimetric satellite weekly data obtained from AVISO+, are computed in real time within the comprehensive system Prognocean Plus available now as a new generation service in Polish grid infrastructure.

The procedure allows us to convert the long-term SLA predictions for the North Atlantic (0ºN - 65ºN, basin-wide) to the SSH forecasts, and subsequently to the predictions of the NAO index.

In our study we considered seasonal (three months period, 4 seasons per year), monthly, weekly and daily data of Hurrell NAO index, between 1993 and 2017. We built an empirical model describing the relationship between the SSH data and the NAO index. The model is based on the calculated correlation between the first principal component of sea surface height (SSH) data (using Principal Component Analysis, known as PCA) and the NAO index, following the method of Esselborn and Eden (2001). The highest Pearson correlation coefficient was obtained for the seasonal data (0.69) and winter months (December/January/February) – 0.59. This led us to the computation of the NAO index prognoses solely based on the already predicted sea surface topography using statistical, linear model.

We also proposed a new solution which differs from the procedure proposed by Esselborn and Eden. We have taken referenced database of SSH data (20 years, from 1993 to 2013) and used it as a database for calculating PCA1 of SSH data to built an empirical model describing relationship between SSH data and NAO index. The main objective is to recalculate referenced model when new prognoses of NAO index are needed. Therefore, a new set of PCA1 SSH data is produced at every time step. To compute forecasts of the NAO index, in contrast to the previous procedure, the empirical model coefficients are used on database of PCA1 SSH, extended by a set of long-term forecasts of SSH.
The results show that forecasts accuracy gained by the new method for determining the NAO index is comparable with forecasts produced on a basis of the relationship between the NAO index and the heat content dipole strength.

The results support investigations carried out in a frame of the research project no. 2016/21/N/ST10/03231, financed by the National Science Centre of Poland.