VALIDATION OF THE CFSv2 MODEL TECHNOLOGIES FOR LONG RANGE WEATHER FORECASTS: LITHUANIA'S CASE

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Photography encouraged

Introduction.
The need for reliable long-range forecasts of air temperature and precipitation anomalies has recently been growing around the world. Such forecasts are necessary both for planning work and making decisions in most economic sectors. The objective of this paper is to assess the validation of long-range forecasts generated for the territory of Lithuania using the NOAA National Centers for Environmental Prediction's (NCEP's) Climate Forecast System, version 2 (CFSv2), and to determine the atmospheric circulation conditions present at the time of conclusion of the respective long-range forecasts.

Data and methods.
This study covers the air temperature (measured at the height of 2 metres) and precipitation data collected in Lithuania from 18 meteorological stations (Fig. 1) during the period between 2012 and 2018, as well as long-range forecast data generated using the CFSv2 model. The article analyses the air temperature and precipitation data obtained from two forecasts with different mean spatial – three-month mean and monthly mean – anomalies. Air temperature and precipitation anomalies are calculated with respect to climatological data for the period between 1981and 2010.
The validation of weather forecasts for Lithuania was performed in accordance with three criteria: (1) the correspondence between the ranges of predicted anomalies and those actually observed within the territory of Lithuania; (2) the state (plus/minus) of the predicted anomalies; (3) the absolute error of the respective predicted anomaly.
Atmospheric circulation conditions present at the time of conclusion of the long-range forecasts were studied by analysing the standardised NAO and AO indexes, as well as circulation types in accordance with the Hess-Brezowsky classification.
The study used digital data and maps related to the monthly and 3-month air temperature and precipitation amount anomalies with lead times of 0-170 days contained in the data base of the CFSv2. The precipitation forecast units, expressed in millimetres per day in the CFSv2 model, were converted into precipitation amount in millimetres over the span of 1 or 3 months.
The CFSv2 model uses 1° × 1° grid cells (the edge of the grid of the Lithuanian territory is approximately 84 km long and has an area of 7,100 km2). Based on the model grid, the Lithuanian territory was found to be present in 16 individual cells (Fig. 2).

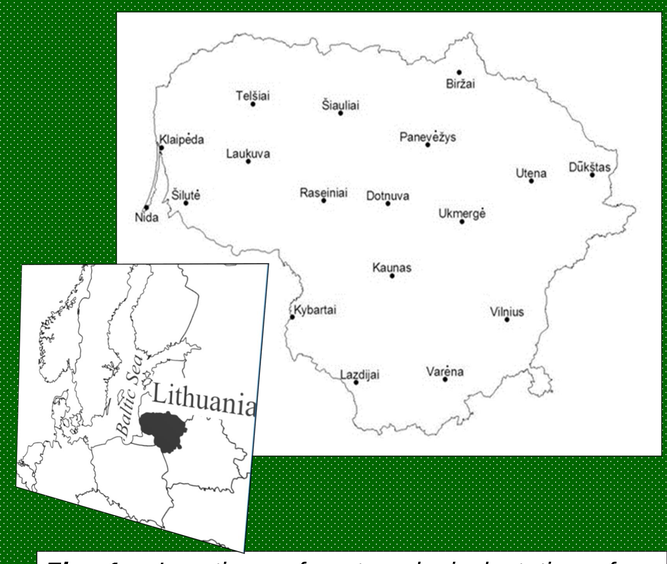

Fig. 1. *Locations of meteorological stations from which the air temperature were used in the present study*

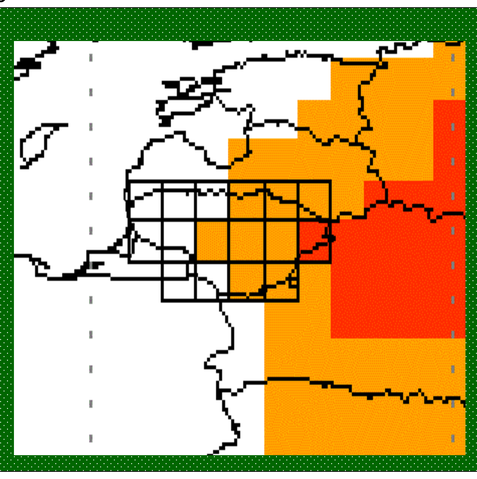

Fig. 2. *CFSv2 model cells which represent the territory of Lithuania*

Results.
As can be seen in the Figure 3, the most reliable monthly-mean air temperature and monthly precipitation amount spatial anomalies forecasts were obtained with 0-10 days left until the beginning of the forecasted month (according 1 and 2 criteria).
The smallest absolute error (the mean error module was seen in forecasts concluded right before the forecasted month (lead time 0 days) respectively 0.5 °C and 7.9 millimetre per month.
In case of three-month (seasonal) air temperature spatial anomaly the most reliable monthly-mean air temperature forecasts were obtained with lead time 0-10 days (Fig. 4a.), the mean absolute error was 0.34 °C.
The most reliable three-month precipitation amount forecasts were generated with lead time 0, 10, 90, 120 and 160 days (Fig. 4b), the mean error was 11.6-12.9 mm per season.

An analysis of atmospheric circulation present during the conclusion of the monthly air temperature forecasts has shown that the most reliable forecasts were concluded when the NAO index was >1 (Fig. 5), leading to 58% reliability, and the AO index was between -0.5 and 0 (Fig. 6), leading to 42-53% reliability (1 criteria of the reliability). Unfavourable conditions were present when the NAO index was between -0.5 and 0, leading to only 29% reliability, and the AO index was <-0.5, leading to 32-33% reliability.
According to the Hess-Brezowski classification, favourable conditions for generating forecasts are created by the west major types, whereas unfavourable conditions arise given the dominance of the meriodonal major types (North, Northeast, East, South, and Southeast).
Favourable and unfavourable atmospheric circulation for generating of the long-range forecasts were also found for other types of forecasts.

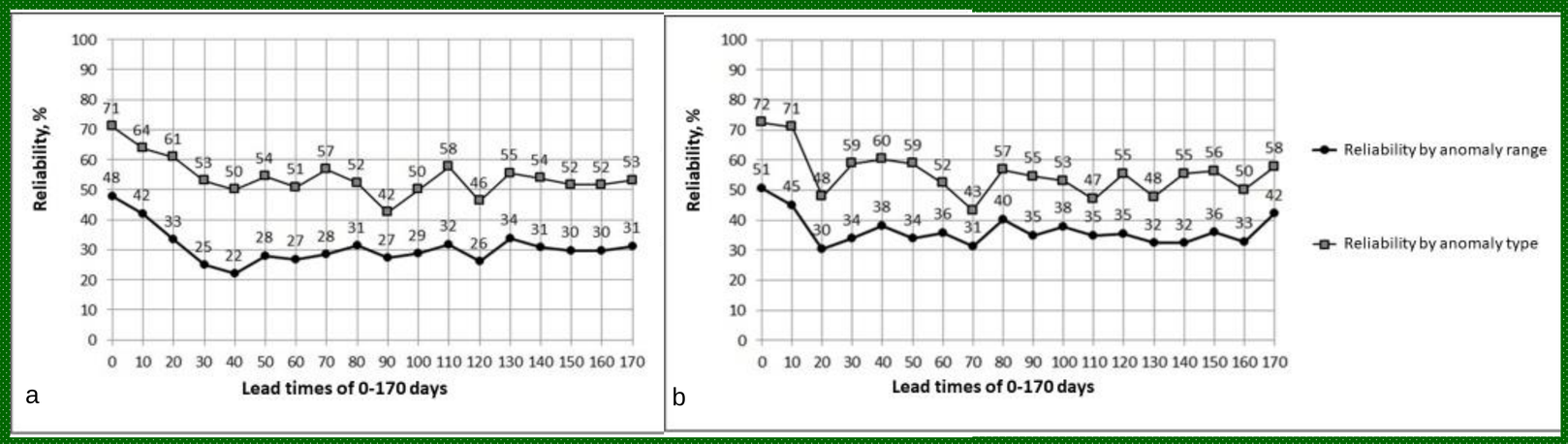

Fig. 3. *The reliability of monthly-mean air temperature spatial anomaly (a) and monthly precipitation amount anomaly (b) forecasts with different lead times generated using the CFSv2 for the territory of Lithuania*

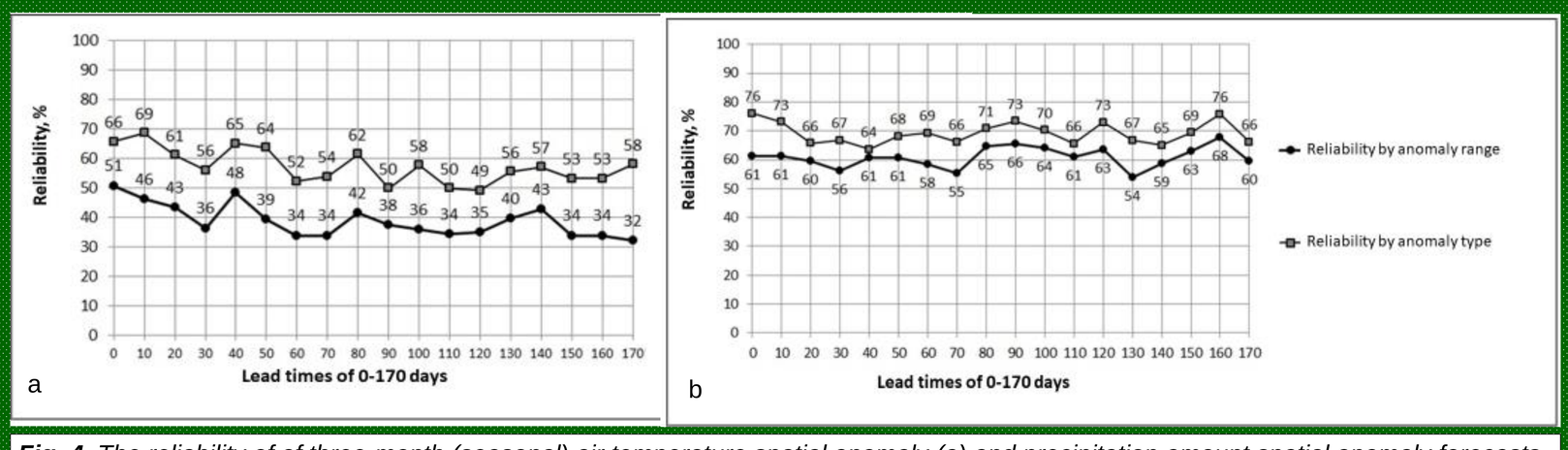

Fig. 4. *The reliability of of three-month (seasonal) air temperature spatial anomaly (a) and precipitation amount spatial anomaly forecasts (b) with different lead times generated using the CFSv2 for the territory of Lithuania*

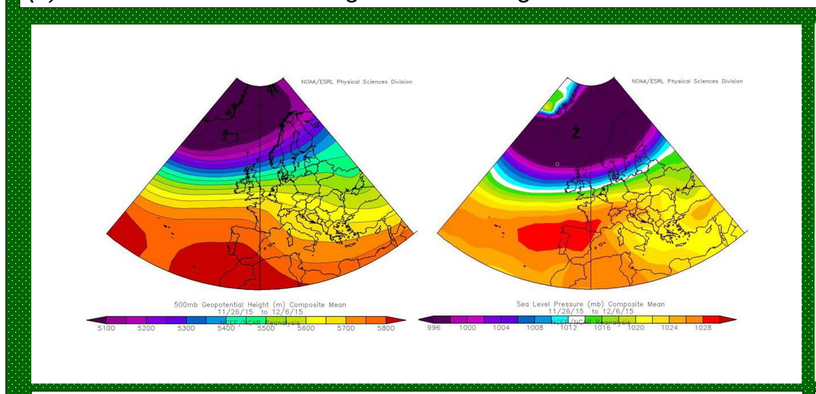

Fig. 5. *Typical atmospheric circulation in the presence of strongly positive (>1) NAO and AO indices: on the left – 500 mb geopotential height (m) composite mean, on the right – sea level pressure (mb) composite mean.*

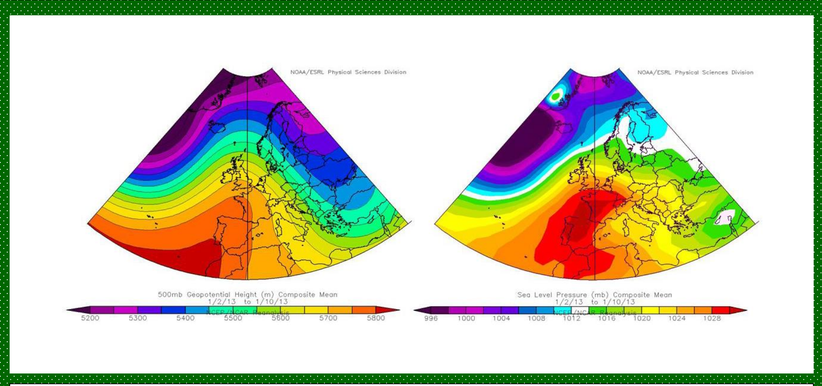

Fig. 6. *Typical atmospheric circulation in the presence of neutral (-0.5 to +0.5) NAO and AO indices: on the left – 500 mb geopotential height (m) composite mean, on the right – sea level pressure (mb) composite mean.*

Conclusion
In summary, it may be argued that the most accurate forecasts generated for the territory of Lithuania using the CFSv2 were concerned with precipitation amount anomalies (both monthly and seasonal), followed by forecasts of seasonal and monthly air temperature. Of all the examined forecasted parameters, seasonal precipitation amount forecasts were the most notable, because their reliability was the highest by all assessment criteria. Results of the present study confirm the well-known truth about long-range forecasts with lead times of over 20 day, namely – the reliability of such forecasts is not yet sufficient, which means they should probably not be relied upon for any practical purposes. The most reliable are not the specific forecasted anomaly intervals, but their types – positive anomalies, negative anomalies, or situations close to the climatic norm.

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