Developing an Experimental Week-2 Storm Track Outlook over North Western Hemisphere
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1. Introduction

Extratropical storm activities have strong societal and economic impacts on mid- and high-latitude regions, including Alaska. To support the NWS Alaska and other regional centers for storm track monitoring and forecast products, a suite of week-2 storm track forecast products has been developed at the NOAA Climate Prediction Center (CPC) based on the dynamical forecast of the NCEP Global Ensemble Forecast System (GEFS).

In this project, extratropical storms are detected and tracked using 6-hourly sea level pressure (SLP) data from the real-time GEFS 16-day forecasts and a storm-tracking algorithm developed by Serreze (1995). The week-2 outlooks include storm tracks and track density, storm intensity and duration, and corresponding precipitation, SLP and 10-m wind over North Western-Hemisphere including Alaska/Arctic, North Pacific, North America, and North Atlantic, derived from the GEFS week-2 forecasts for both total and anomaly fields. In addition, GEFS week-2 probabilistic forecasts of precipitation and 10-m wind exceeding 75% and 90% percentiles, and storm intensity lower than 990, 980, 970, and 960 hPa are also provided. Verifications for the real-time week-2 forecasts are also conducted using the NCEP Climate Forecast System Reanalysis (CFSR). The week-2 storminess outlook is updated on a daily basis.

2. Data and methodology

2.1 Data

The week-2 storm track outlook is based on the GEFS 16-day, 6-hourly dynamic forecast on a 2.5° × 2.5° (lat × lon) grid. The outlook was upgraded from the GEFSv11 based (80 ensemble members) to the GEFSv12 based (124 ensemble members) in September 2020. The variables used include SLP, precipitation, and 10-m wind. The 21-year (1999-2019) GEFS hindcast dataset was utilized to derive model climatology and assess the forecast skill. The CFSR data are used as observations for the forecast verification and skill assessment.

2.2 Methodology

The week-2 storm detecting and tracking are based on the algorithm developed by Serreze (1995), with the following criteria:

- Using 6-hourly SLP data on the 2.5° × 2.5° grid
- Storm center SLP ≤ 1000 hPa
- Storm center SLP at least 1 hPa lower than surrounding grid points
- Maximum distance a storm can move is 800 km/6 hour

Storm track density is defined as total number of storm centers in a 2.5° × 2.5° grid box divided by total ensemble members. Storm intensity (center SLP) denotes the mean center pressure of storm centers in a 2.5° × 2.5° grid box. Storm duration is the mean lifetime of storms passing through a 2.5° × 2.5° grid box. The forecast tool is assessed using the 21-year (1999-2019) GEFS hindcast data. The forecast skill is determined by the anomaly correlation (AC) between the forecasts and the CFSR during the GEFS hindcast period.
3. Week-2 storm track outlook, CFSR verification and evaluation

The week-2 forecast products consist of storm tracks, storm track density, storm intensity and duration, weekly total precipitation, mean SLP and 10-m wind, for both total and anomaly fields. The week-2 outlook also includes probabilistic forecasts for precipitation and 10-m wind exceeding 75% and 90% percentiles, and storm intensity lower than 990, 980, 970, and 960 hPa. Sub-regional maps for Alaska/Arctic, North Pacific, North America, and North Atlantic are also provided. The week-2 forecast products are available on the real-time forecast website, with a daily update: https://ftp.cpc.ncep.noaa.gov/hwang/YP/week2/

Figure 1 shows an example of the week-2 forecast issued on January 20, 2021, for the 7 days from January 27 to February 3, 2021, including storm tracks, storm track density, storm intensity and duration. The left panels in Fig. 1a are the total fields and that in Fig. 1b the anomaly fields. Forecasts for other variables, as well as the sub-regional maps can be found in the forecast webpage.

The verification of the week-2 forecast against the CFSR is done when the CFSR data are available for the forecast target week. Therefore, there is a 16-day delay for the real-time verification. Figures 1a and 1b in right panels show the verification of the model forecasts in the left panels.

Figures 2–3 display the AC skills of week-2 storm track density, precipitation, and sea-level pressure, between the GEFSv12 hindcasts and CFSR over the 21-year (1999–2019) hindcast period, respectively, for

![Example of week-2 forecast](image)

**Fig. 1a** Verification (right) of GEFSv12 week-2 forecast (left) for storm tracks, track density, storm intensity and duration with total fields. The forecasts were issued on January 20, 2021 for week-2 from January 27 to February 3, 2021.
Fig. 1b  Same as Fig. 2a but with anomaly fields.

Fig. 2. Anomaly correlation of week-2 storm track density between the GEFSv12 hindcasts and CFSR over the 21-year (1999–2019) hindcast period for May (left) and October (right).

Fig. 3  Anomaly correlation of week-2 sea level pressure (top row) and precipitation (bottom row) between the GEFSv12 hindcasts and CFSR over the 21-year hindcast period for May (left) and October (right).
May and October. The results indicate a certain level of skills for the week-2 storm track density over the mid- and high-latitudes (Fig. 2). The week-2 forecasts of precipitation and SLP (Fig. 3) show higher AC skills than the week-2 storm track forecasts in both May and October.

**Conclusion**

A real-time GEFS-based week-2 storminess outlook tool was developed at the NOAA CPC, with a daily update and the CFSR verification. Anomaly correlations of week-2 storm track density, precipitation and SLP between GEFSv12 21-year hindcast and CFSR data indicate a certain level of skills for week-2 storm track density over the mid- and high-latitudes and better skills for week-2 precipitation and SLP. A mean bias correction method is being developed to improve the week-2 forecast. Future work includes extending the target period to week 3/4 and exploring use of a multi-model ensemble with GEFS and the Climate Forecast System (CFS).

**References**