

GEFSv12 and CFSv2 Based Sub-seasonal Storminess Outlook

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1. Background

To support the NWS Alaska and other regional centers for storm track monitoring and long-lead forecast products, a suite of sub-seasonal (week-2 and week 3-4) storm track forecast products is being developed at CPC based on the combined dynamical forecast of GEFSv12 and CFSv2. The two models are merged with equal weight for each ensemble member. The week-2 and week 3-4 outlooks consist of storm activities, which are accumulated within 500-km radius, precipitation, mean SLP, 10-m winds, day-to-day variance of SLP over N. Pacific, N. America, and N. Atlantic. The forecast skill is assessed using 21-year (1999–2019) GEFSv12 and CFSv2 hindcast data. Verifications for the real-time sub-seasonal forecasts are also provided using CFSR. The storminess outlooks are updated daily.

2. Data and Methods

2.1 Data

- Model forecasts/hindcasts (6-hourly):
 - GEFSv12 operational 16-day and 35-day forecasts
 - CFSv2 operational 45-day forecast
 - GEFSv12 16-day and 35-day hindcasts (1999–2019, 21 years)
 - CFSv2 45-day hindcast (1999–2019, 21 years)
- Observations:
 - CFSR real-time data
 - CFSR archive data: 1999–2019 (21 years)

2.2 Outlook product and CFSR verification

- Storm track detected based on the algorithm developed by Mark Serreze (1995), with a criteria of storm center SLP ≤ 1000 hPa
- Storm track density, storm intensity (center SLP), and duration
- Precipitation, mean SLP, 10-m winds, day-to-day variance of SLP
- Probability forecasts of precipitation, 10-m wind speed ($>75^{\text{th}}$ and 90^{th} percentiles), and storm intensity ($< 990, 980, 970$ and 960 hPa)
- Regional storminess index forecasts over N. Pacific and Alaska

2.3 Evaluation of the sub-seasonal storm track forecasts

- Anomaly correlation between GEFSv12+CFSv2 21-yr hindcast and CFSR

3. Results

3.1 Sub-seasonal storminess forecast

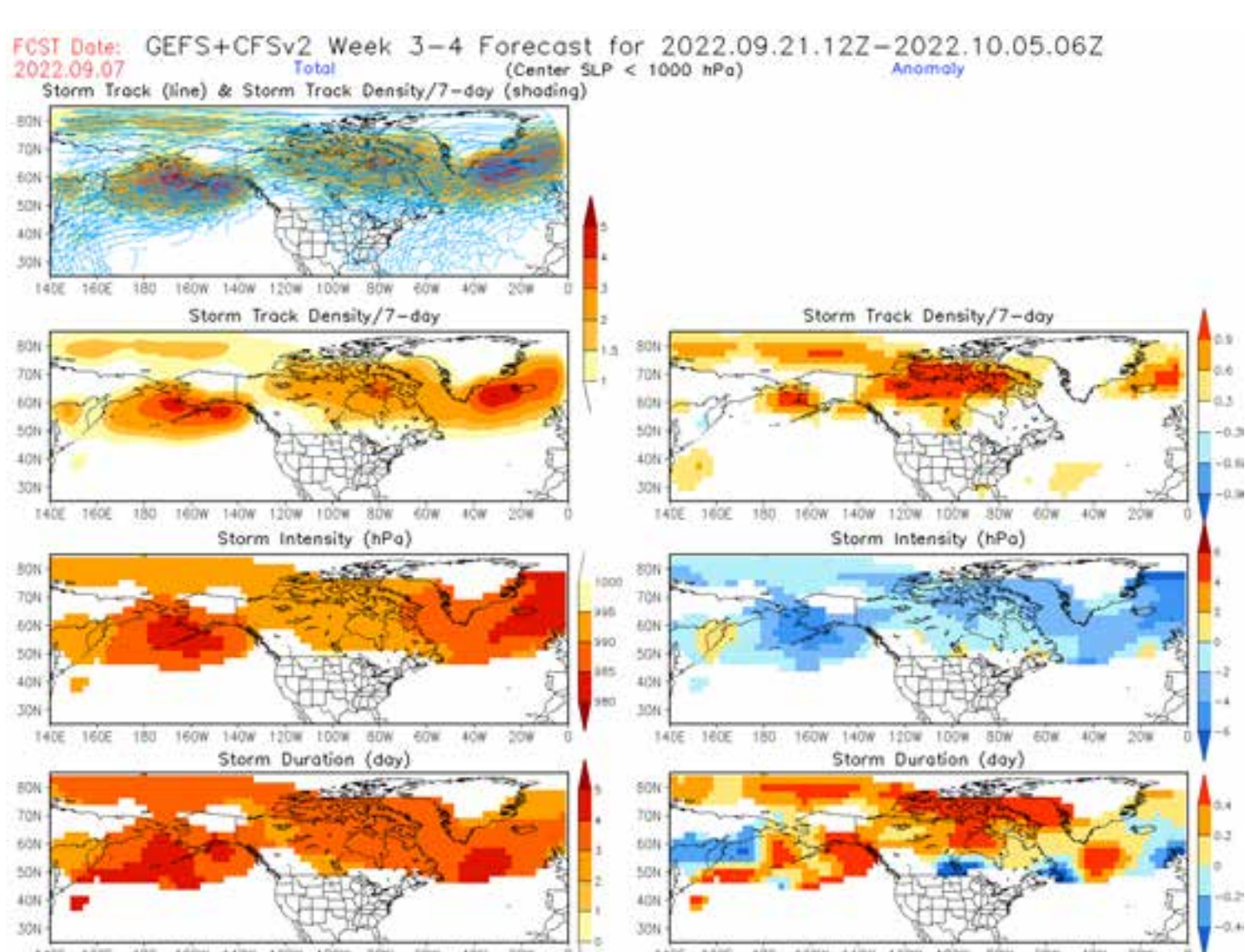
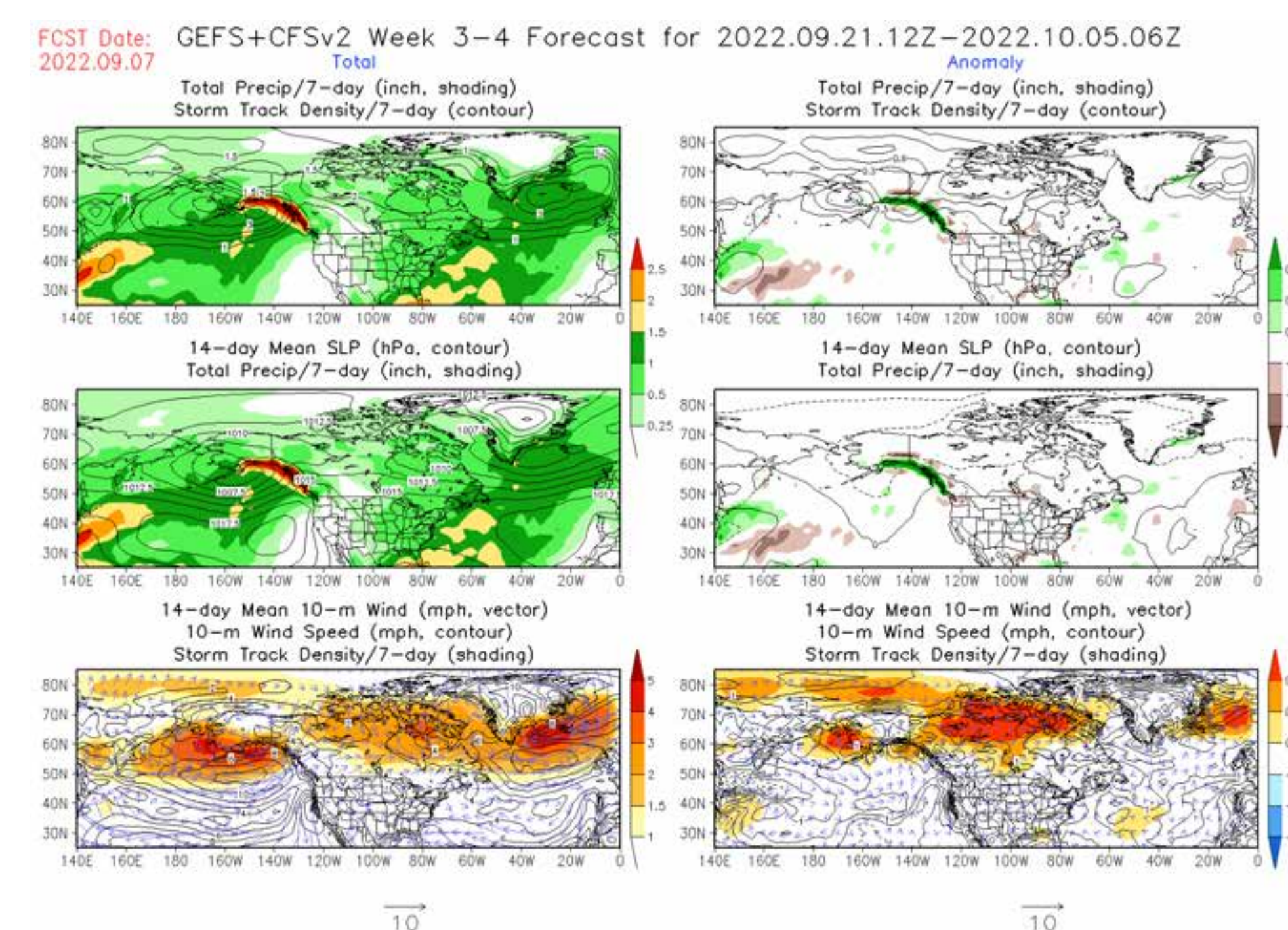


Fig. 1 Example of GEFSv12+CFSv2 combined week 3-4 forecast for storm tracks, track density, storm intensity and duration for both total (left) and anomaly fields (right). The forecast date is 2022.09.07.

- Relatively large uncertainty in week 3-4 storm tracks.

Fig. 2 GEFSv12+CFSv2 combined week 3-4 forecast for precipitation, mean SLP, 10-m wind vector and 10-m wind speed for both total (left) and anomaly fields (right). The forecast date is 2022.09.07.



- Regions of large precipitation and low SLP are consistent with the regions of high storm track density.

3.2 Verification of the sub-seasonal storminess forecast

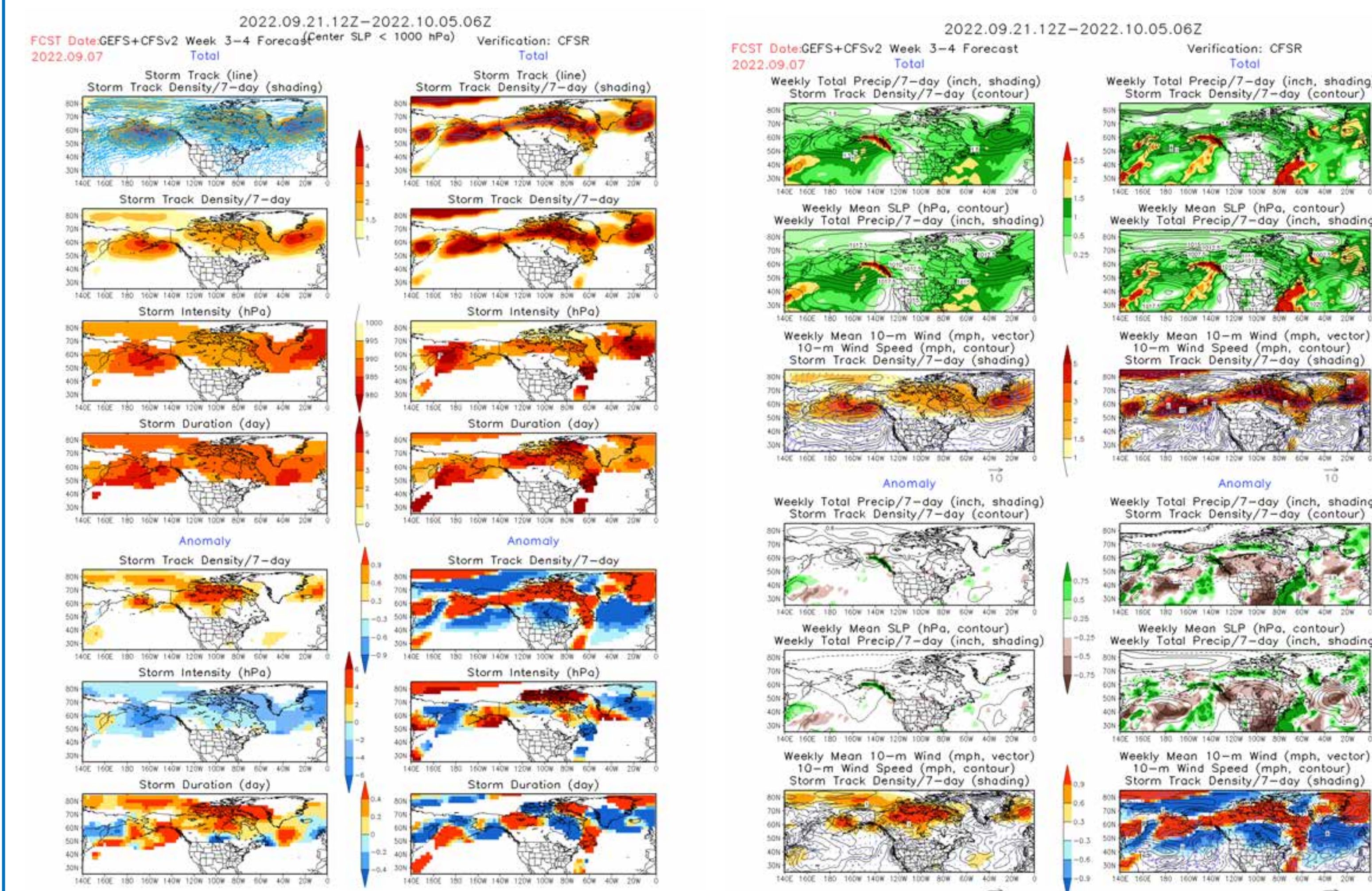


Fig. 3 Verification (right) of GEFSv12+CFSv2 combined week 3-4 forecast (left) for storm tracks, track density, storm intensity and duration with total fields in top panels and anomaly fields in bottom panels. (Forecast date: 2022.09.07)

- The verifications indicate certain degree of agreement between the week 3-4 outlook and CFSR.

Sub-seasonal forecasts of day-to-day variance of SLP and CFSR verification, probability forecasts of precipitation, 10-m wind speed, and storm intensity, as well as the regional storminess index forecast are available on the real-time forecast webpage.

3.3 AC skill of the sub-seasonal forecast

Fig. 5 Anomaly correlation (AC) of week 3-4 storm track density between GEFSv12+CFSv2 combined hindcast and CFSR over the 1999–2019 hindcast period for January and July.

- A certain level of skill is found for week 3-4 storm track density over the mid- and high-latitudes.
- Winter month (January) has a higher skill than summer month (July).

Fig. 4 Verification (right) of GEFSv12+CFSv2 combined week 3-4 forecast (left) for precipitation, mean sea-level pressure, 10-m wind vector and 10-m wind speed with total fields in top panels and anomaly fields in bottom panels. (Forecast date: 2022.09.07)

- The verifications indicate certain degree of agreement between the week 3-4 outlook and CFSR.

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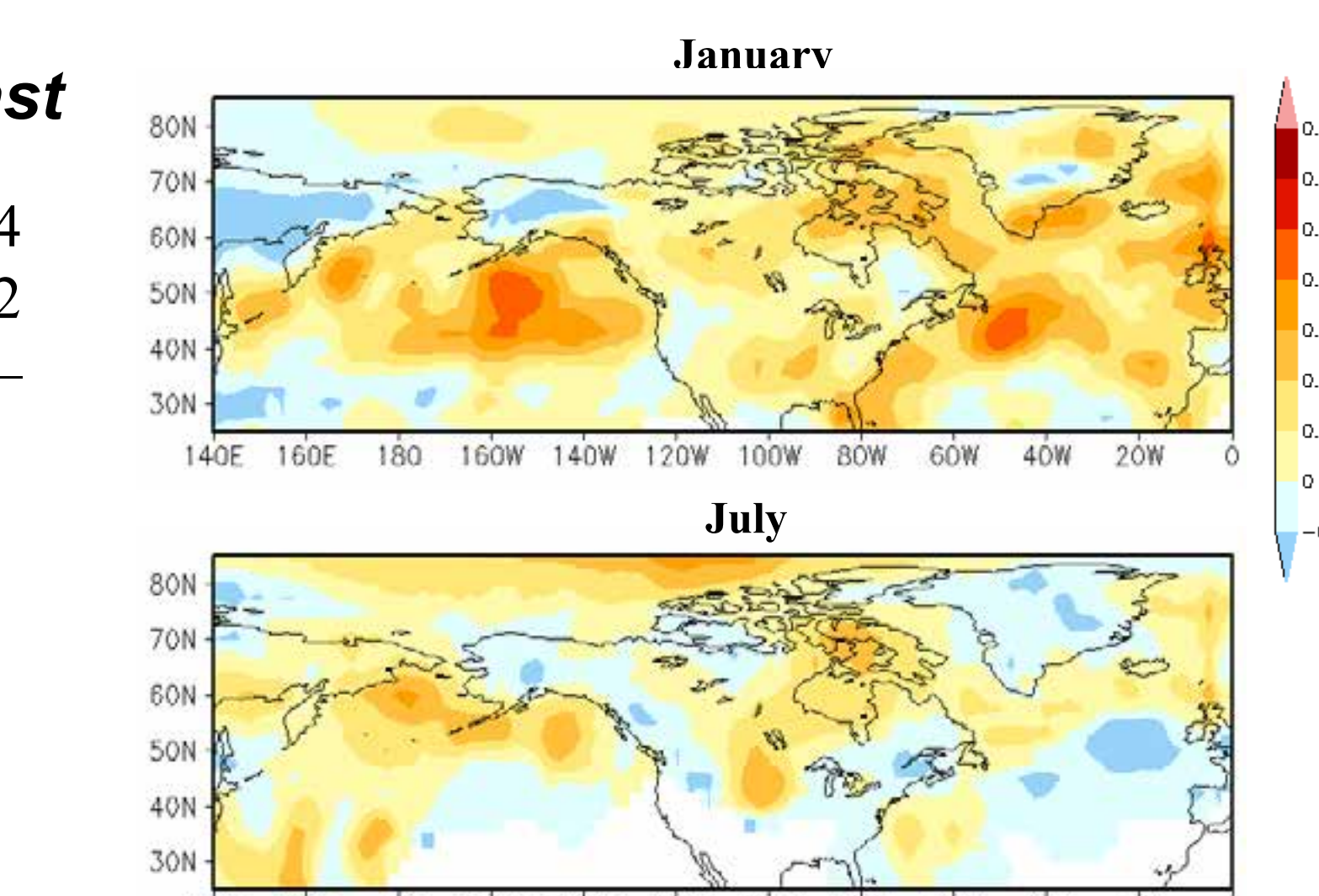


Fig. 6 Anomaly correlation of week 3-4 day-to-day variance of SLP between GEFSv12+CFSv2 combined hindcast and CFSR over the 21-year hindcast period for January and July.

- AC skill of day-to-day SLP variance is higher than that of storm track density.
- The SLP variance has more areas with positive AC values than storm track density and smoother spatial distributions.

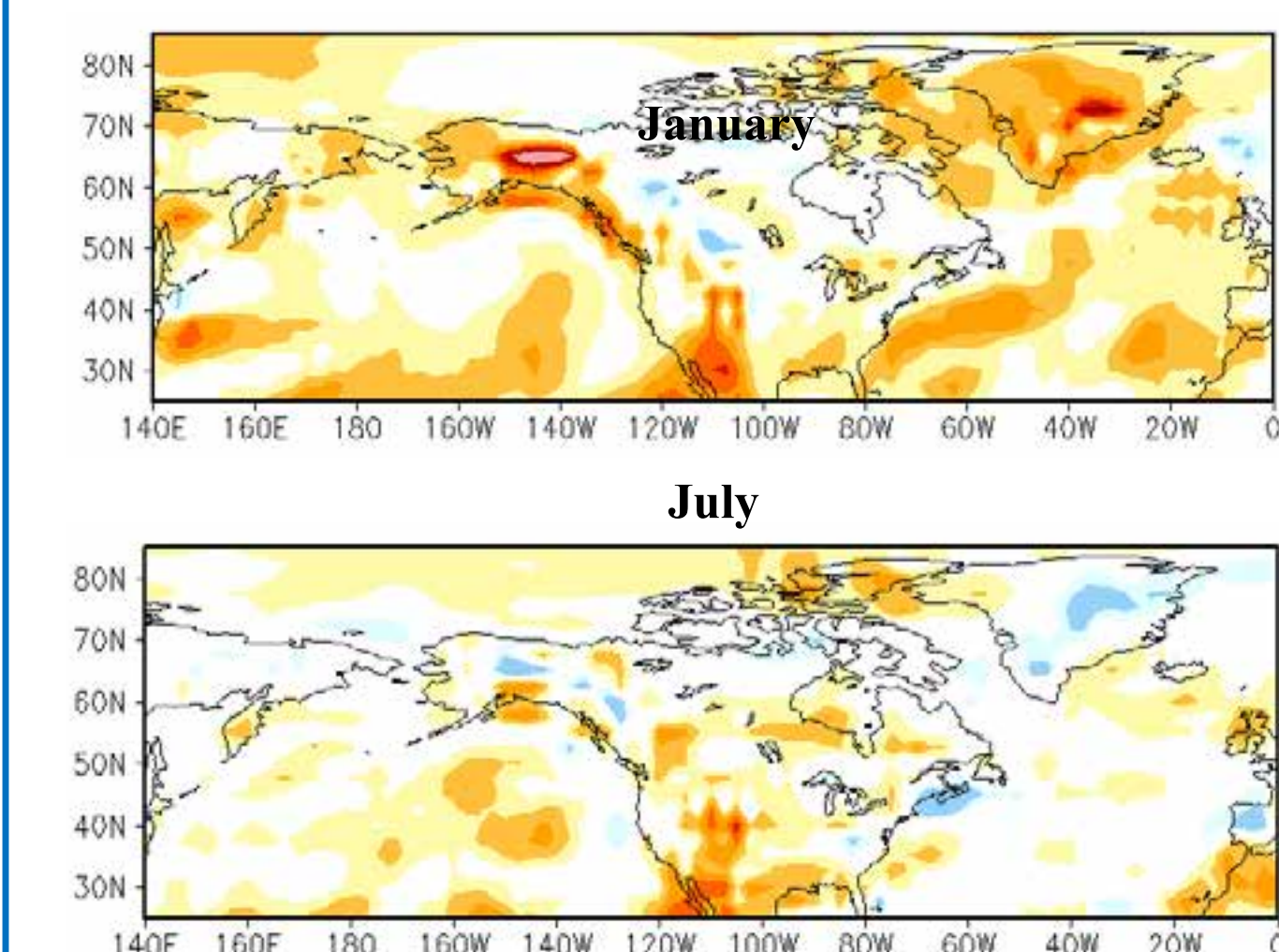


Fig. 8 Anomaly correlation of week 3-4 mean SLP between GEFSv12+CFSv2 combined hindcast and CFSR over the 21-year hindcast period for January and July.

- High skill for large-scale circulation (SLP).

Week-2 forecast has much better skill (not shown).

4. Summary

- A real-time GEFSv12 and CFSv2 based sub-seasonal (week-2 and week 3-4) storminess outlooks were developed at NOAA CPC, with a daily update and verification using CFSR.
- Both real-time sub-seasonal storm track outlook and CFSR verification are available at: <https://ftp.cpc.ncep.noaa.gov/hwang/YP/week2/>
- Assessment of sub-seasonal forecast skill shows a certain level of skill for storm track density over the mid- and high-latitudes and better skills for day-to-day variance of SLP, and mean SLP.
- Combining the GEFSv12 operational forecast with the CFSv2 leads to an overall higher sub-seasonal storminess forecast skill than the two individual model forecasts.

Reference

Chang, E. K. M., Y. Pan, W. Wang, and C. Zheng, 2022: Developing and evaluating week 2 and weeks 3 – 4 outlook tools for extratropical storminess. *Frontiers in Earth Science*, DOI 10.3389/feart.2022.963779