



CPC Review: Ensemble Utilized Products, Forecast Skill and Development Work

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NOAA / NWS / Climate Prediction Center

9th NOAA Ensemble Users Workshop
August 22-24, 2023



Outline



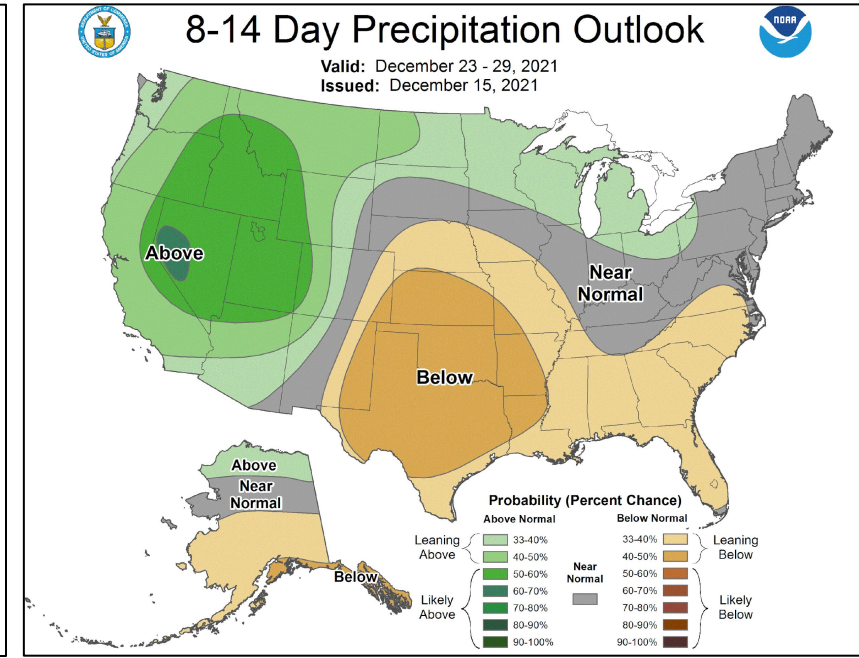
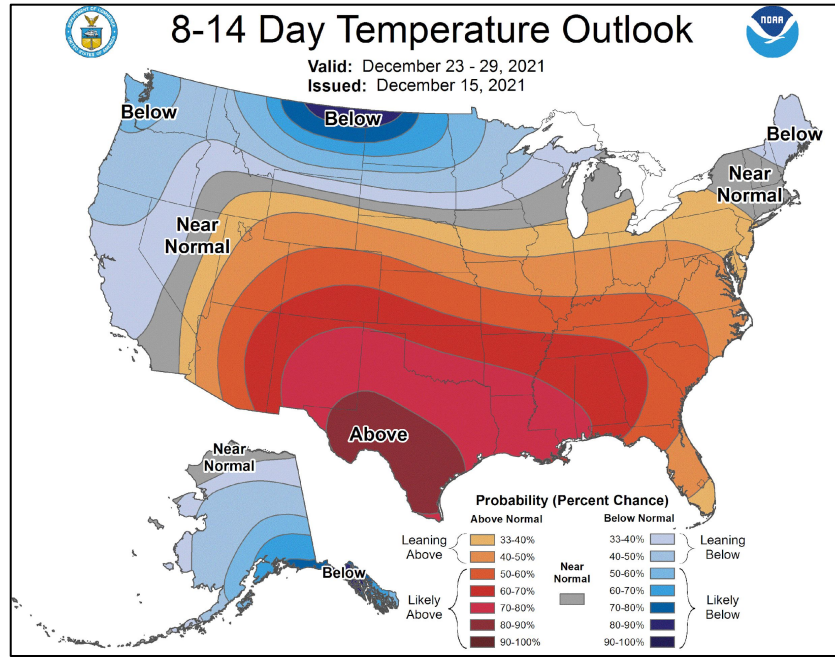
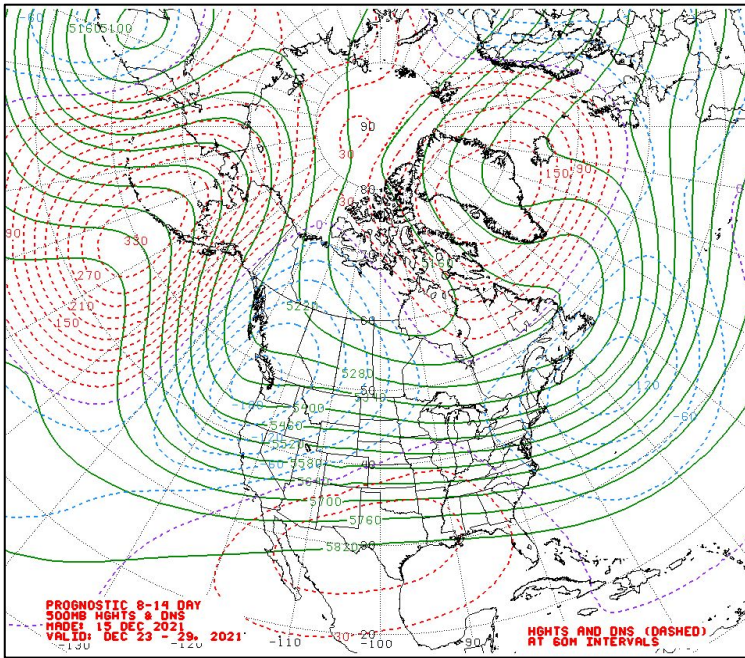
- ✓ CPC ensemble supported operational outlooks with examples of recent model forecast skill
 - Week 2 and Week 3-4 H/T/P outlooks
 - Week 2-3 Global Tropics Hazards (GTH) outlook (TCs)
 - Seasonal T/P and ENSO outlooks

- ✓ Ongoing ensemble supported CPC development projects

- ✓ Forthcoming CPC talks at meeting

CPC Ensemble Supported Products – Week 2

- Targets the Days 8-14 period, probabilistic in nature
- Mean weekly temperature or weekly total precipitation
- Displays the most favored category (above-, below- or near-normal)



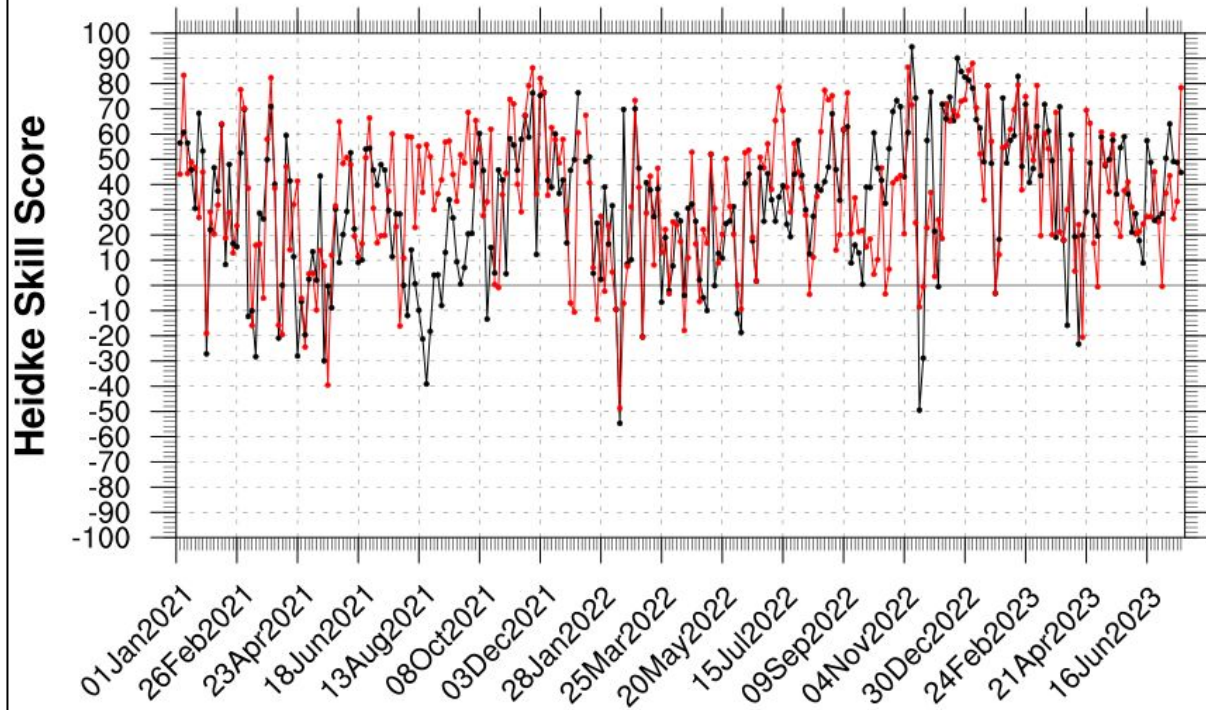
- Utilizes NCEP GEFSv12, ECMWF IFS and ECCO GEPS daily model ensemble data
- Supports T, P, H500
- Bias-correction, calibration and objective, historical (reforecast) skill based consolidation
- Natural analogs and teleconnections also derived from ensemble model data



CPC Ensemble Supported Products – Week 2



Temperature: Week 2 Verification

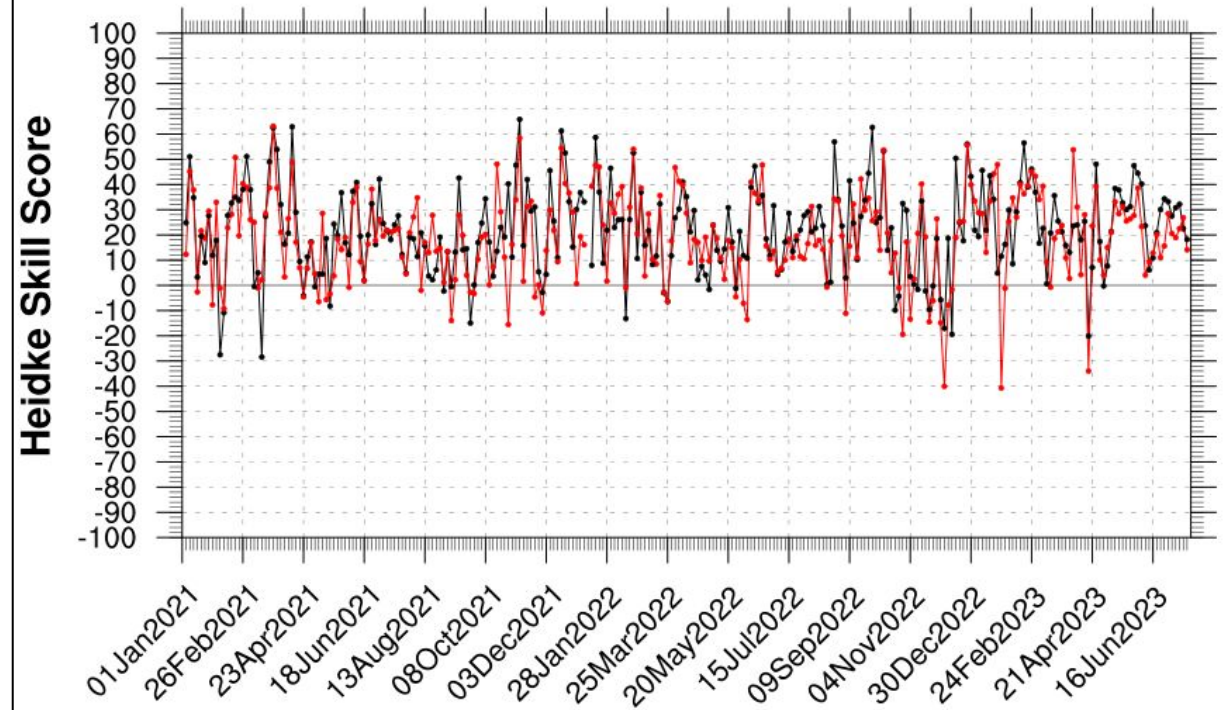


Forecast Issuance Date

ECMWF **GEFSv12**
(avg: 32.5) (avg: 34.8)

Domain: CONUS/AK; # of Forecasts: 265

Precipitation: Week 2 Verification



Forecast Issuance Date

ECMWF **GEFSv12**
(avg: 21.7) (avg: 18.9)

Domain: CONUS/AK; # of Forecasts: 265

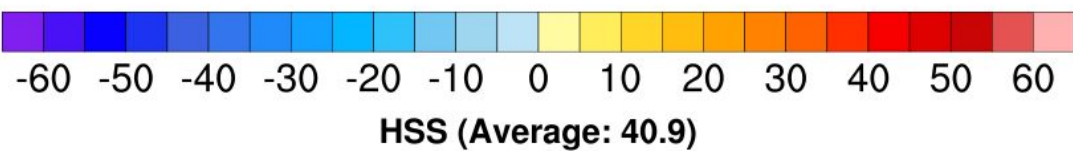
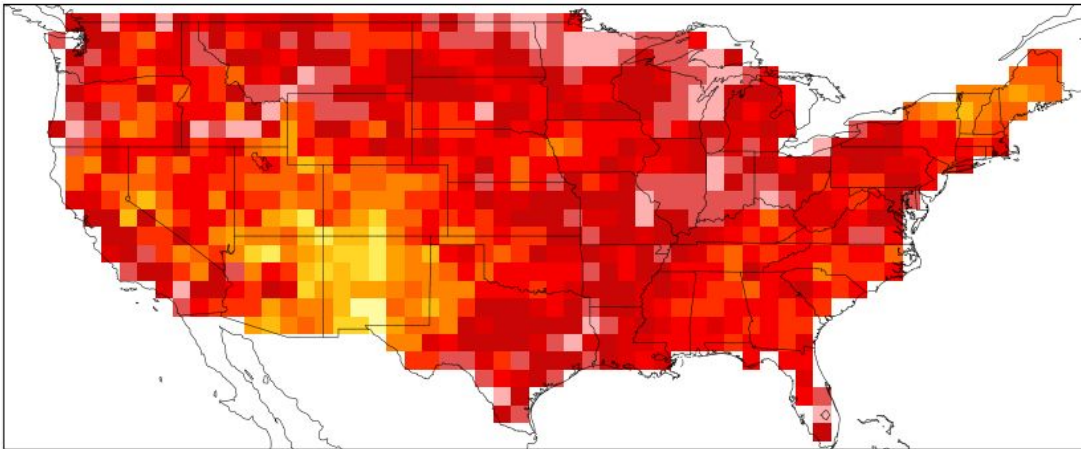
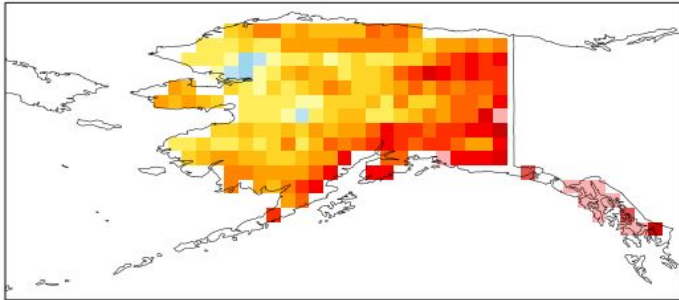


CPC Ensemble Supported Products – Week 2



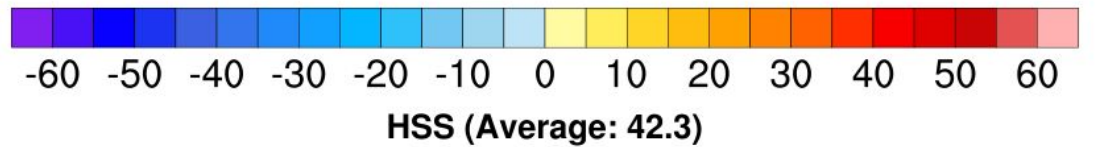
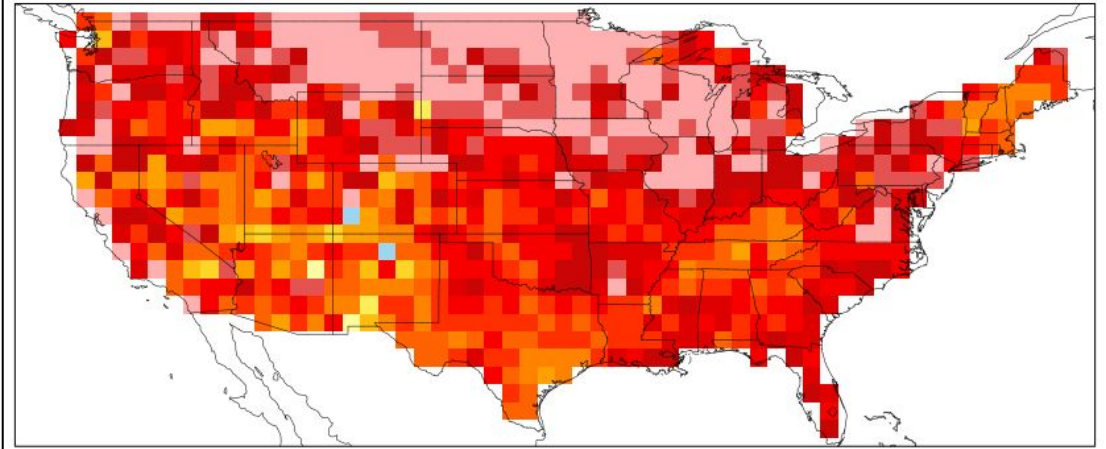
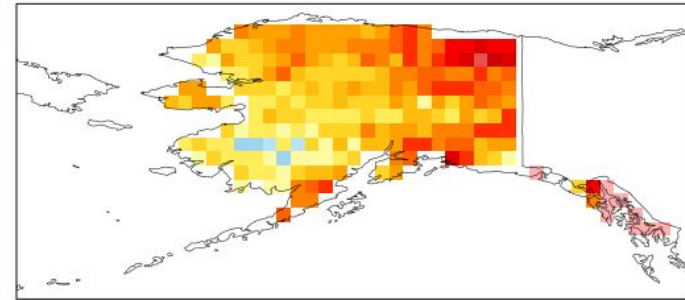
GEFSv12 Temperature: Week 2 Verification

DJF: 01Dec2020 to 28Feb2023



ECMWF Temperature: Week 2 Verification

DJF: 01Dec2020 to 28Feb2023



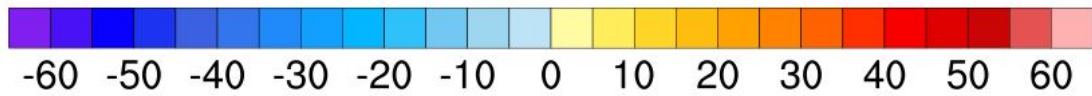
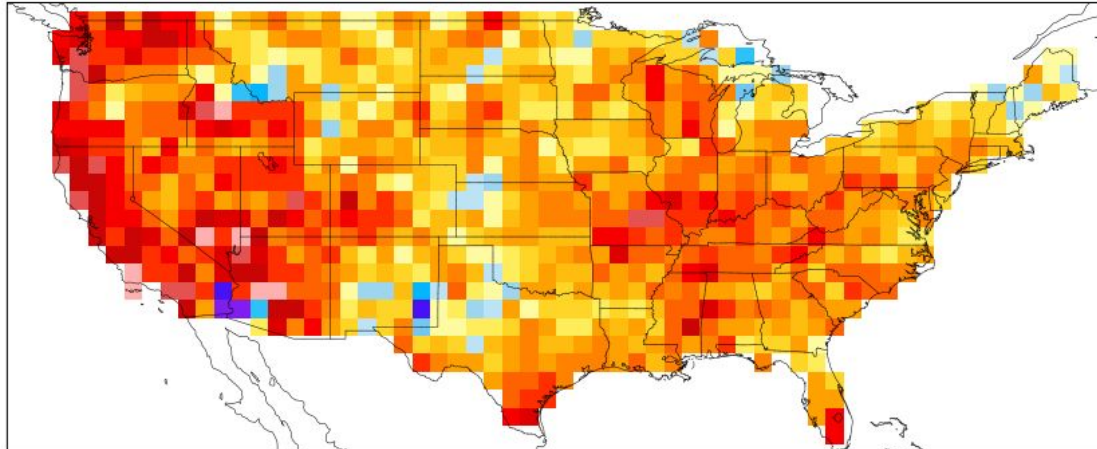
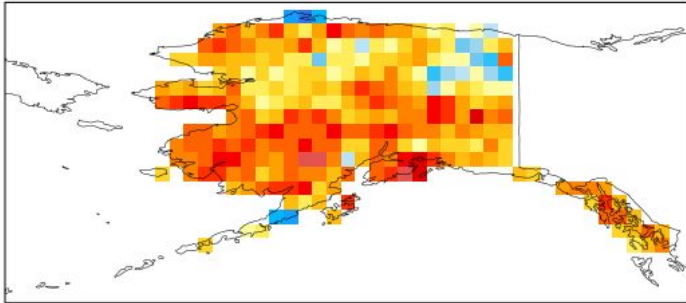


CPC Ensemble Supported Products – Week 2



GEFSv12 Precipitation: Week 2 Verification

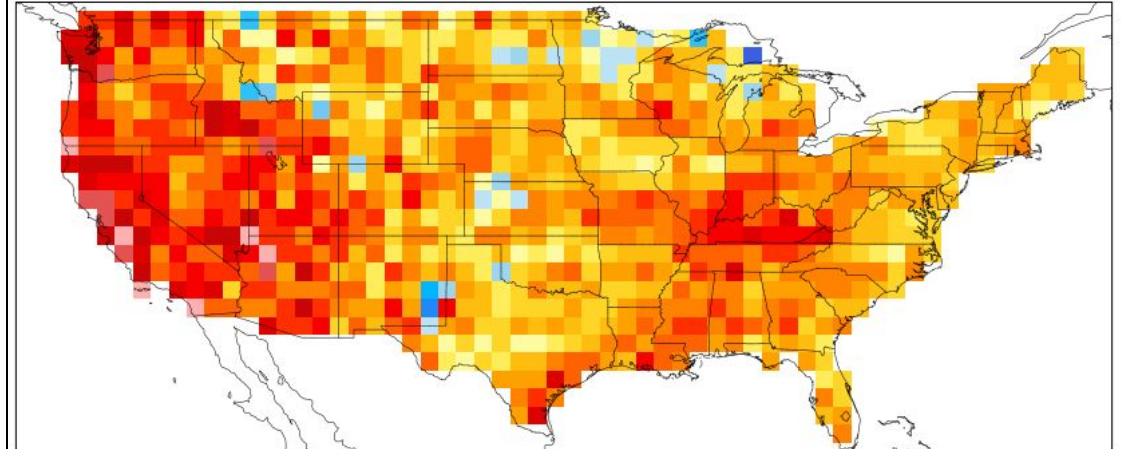
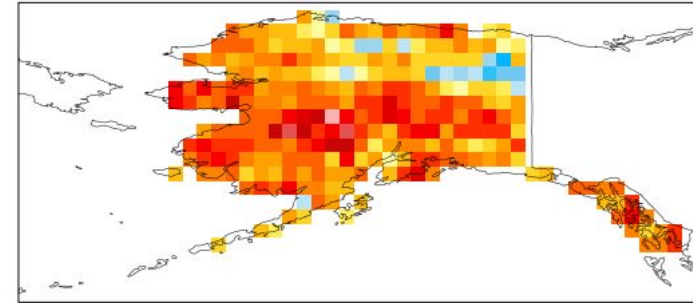
DJF: 01Dec2020 to 28Feb2023



HSS (Average: 23.3)

ECMWF Precipitation: Week 2 Verification

DJF: 01Dec2020 to 28Feb2023



HSS (Average: 24.3)



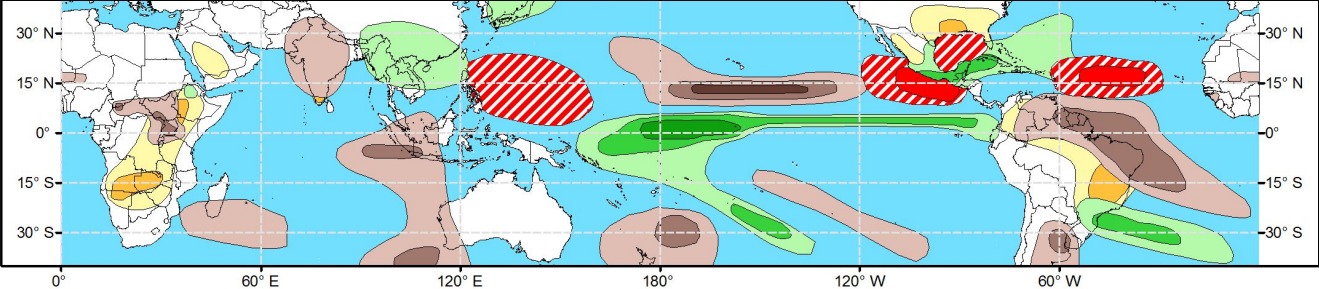
CPC Ensemble Supported Products – Week 2-3



Global Tropics Hazards Outlook

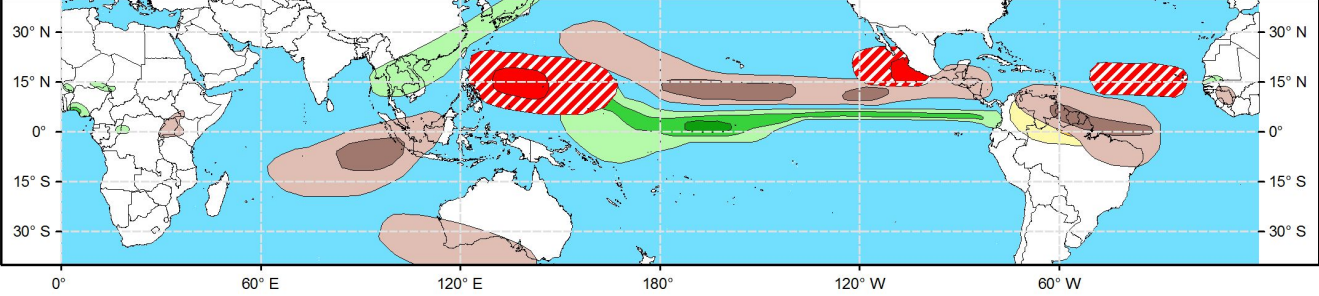
Climate Prediction Center

Week 2 - Valid: Aug 23, 2023 - Aug 29, 2023



Week 3 - Valid: Aug 30, 2023 - Sep 05, 2023

**** Experimental ****



Tropical Cyclone (TC) Formation Probability



Tropical Depression (TD) or greater strength

Above-Average Rainfall Probability



Weekly total rainfall in the Upper third of the historical range

Below-Average Rainfall Probability



Weekly total rainfall in the Lower third of the historical range

Above-Average Temperatures Probability



7-day max temperatures in the Upper third of the historical range

Below-Average Temperatures Probability



7-day min temperatures in the Lower third of the historical range

Issued: 08/15/2023

Forecaster: Barandiaran

This product is updated once per week and targets broad scale conditions integrated over a 7-day period for US interests only. Consult your local responsible forecast agency.

Outlook Discussion

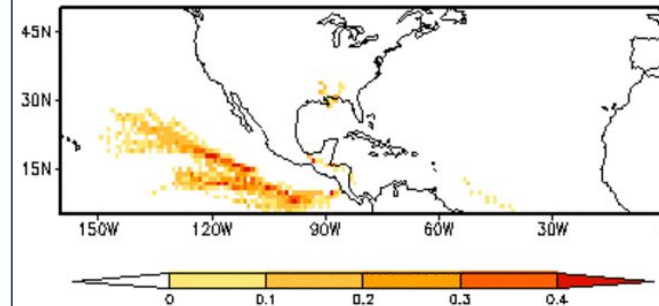
Last Updated - 11/29/22

Valid - 12/07/22 - 12/20/22

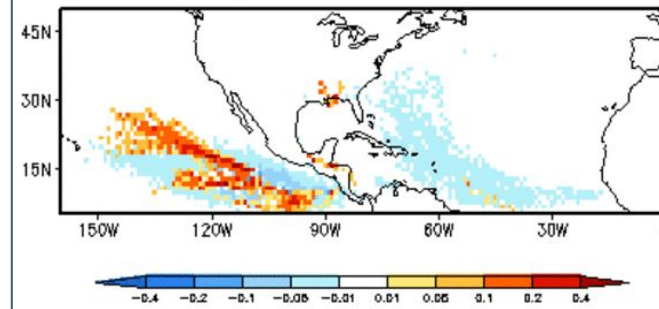
La Nina continues to be a dominant player in the global tropical convection pattern, but MJO activity has increased recently and is favored to continue for the next several weeks. Currently the enhanced convective envelope is situated over the Americas, with a strong suppressed phase over the western Indian Ocean (IO). Looking ahead, the majority of model guidance favors the MJO to remain coherent but weaken as it moves across the Western Hemisphere and into the Indian Ocean during week 2. Model solutions diverge

- ✓ Utilizes GEFSv12, CFS, ECMWF and ECCO ensemble model data
- ✓ Explicit TC identification and tracking

a) Forecast Tracks



c) Track Anomaly





CPC Ensemble Supported Products – Week 2-3

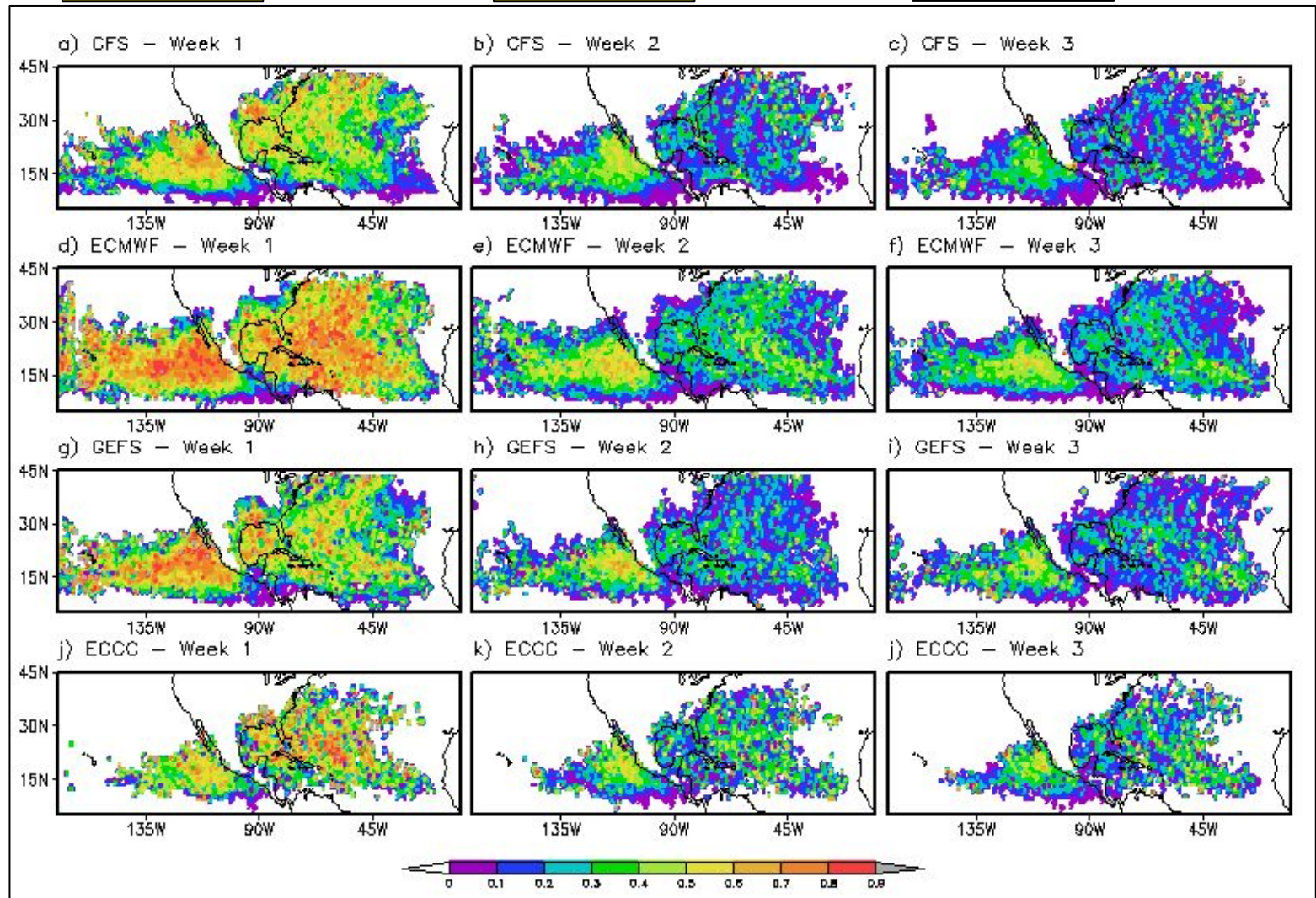


Week 1

Week 2

Week 3

- ✓ Critical Success Index (CSI):
 $CSI = a / (a+b+c)$
 a = Hits **CFS**
 b = False Alarms **ECMWF**
 c = Misses **GEFS**
- ✓ Reforecast overlap period:
 2000-2012
- ✓ Expected drop in skill from
 Week 1 to Week 2, but skill
 remains in main EPAC
 cyclogenesis region and
 some areas of the NATL
 basin for Week 3 **ECCC**

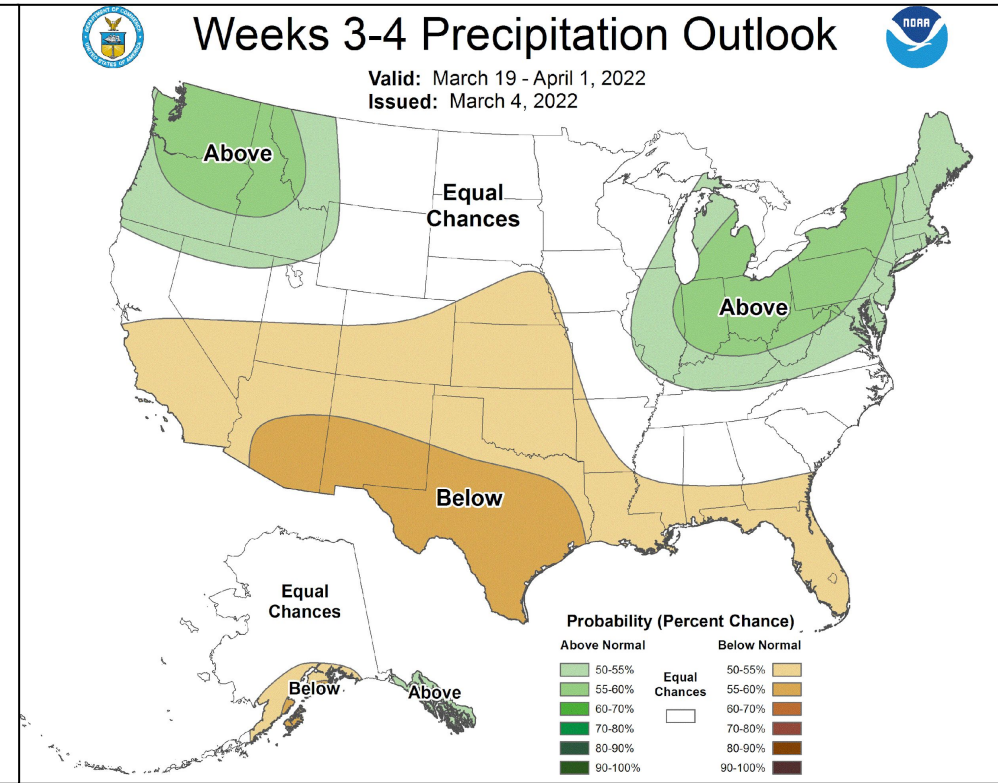
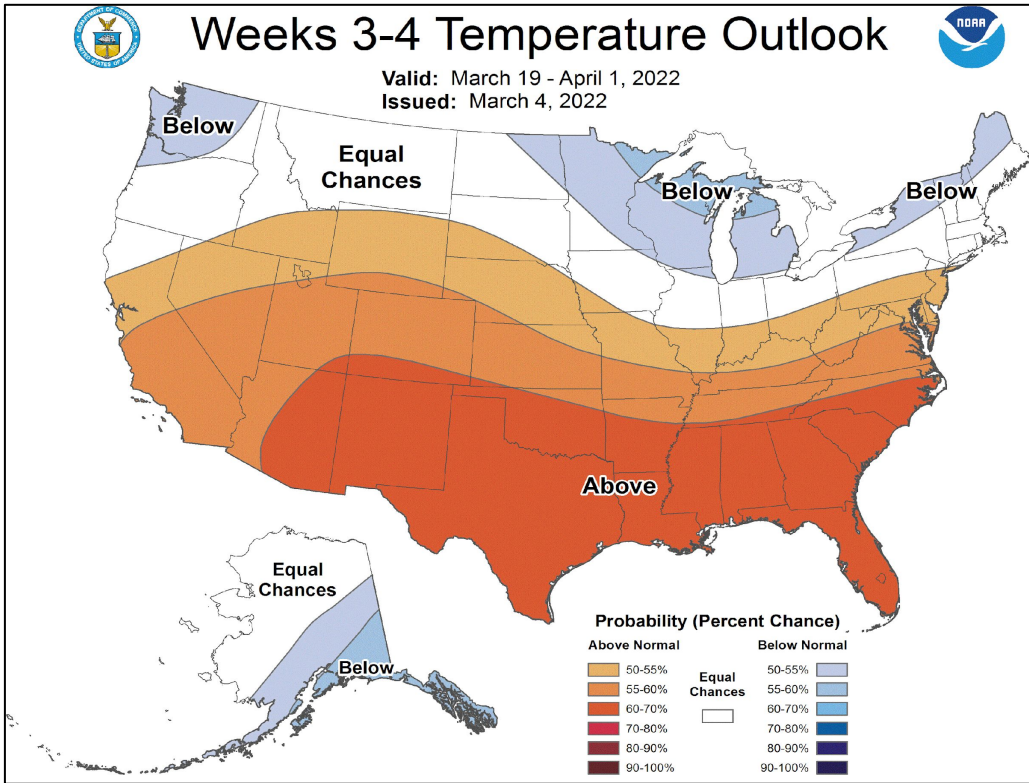




CPC Ensemble Supported Products – Week 3-4



- Two category outlook for above- or below-normal 2-week mean temperature and total precipitation
- “EC” areas indicate 50% probability for each category



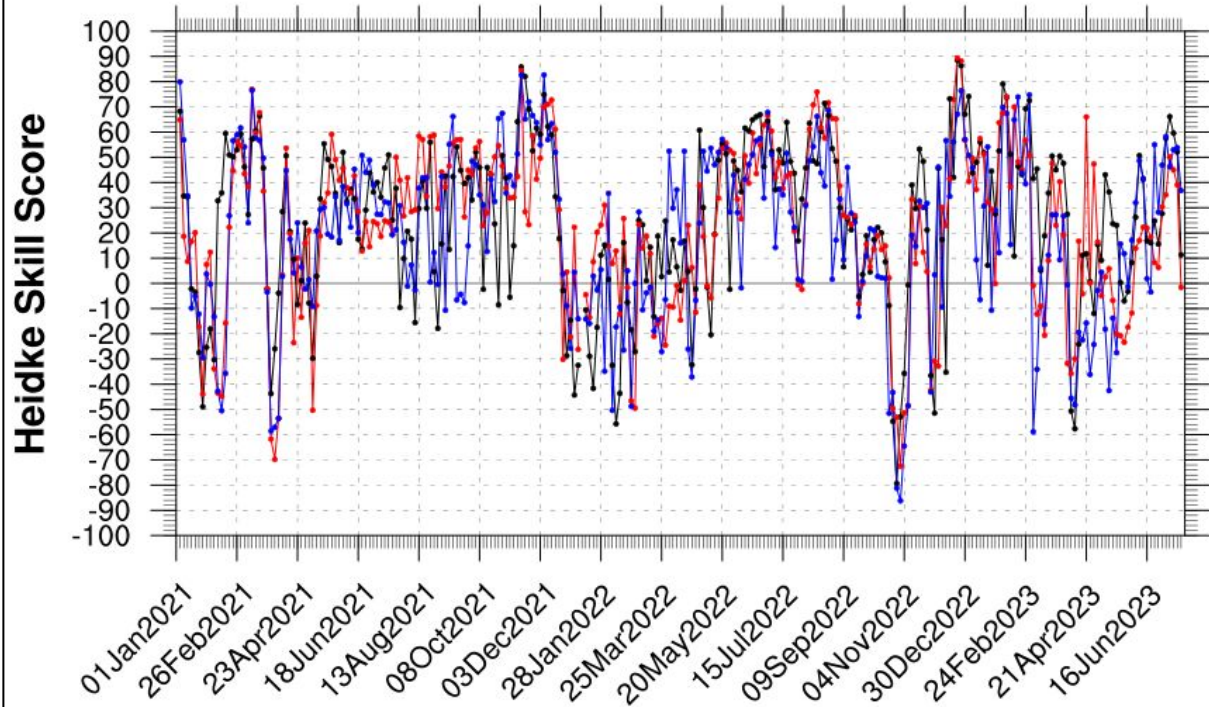
- Utilizes NCEP CFSv2, GFSv12, ECMWF IFS, ECCO GEPS and JMA GEPS ensemble model data
- Supports T, P, H500
- Bias-correction, calibration and objective, historical (reforecast) skill based consolidation



CPC Ensemble Supported Products – Week 3-4



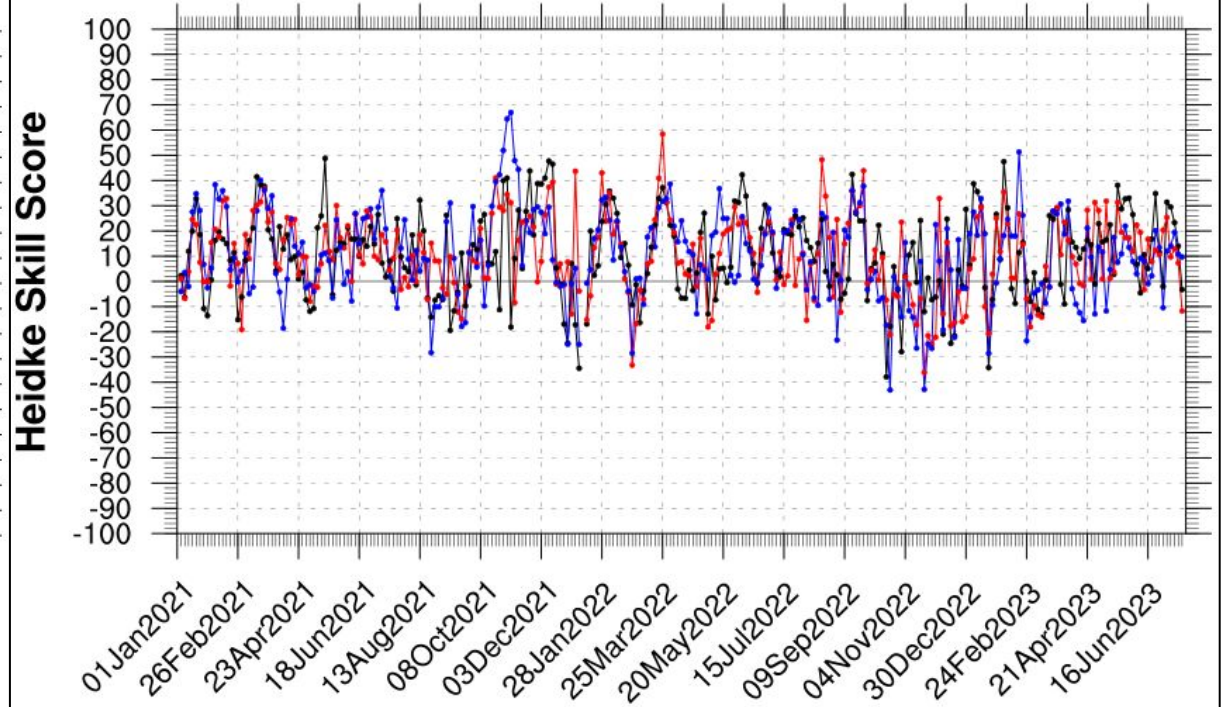
Temperature: Week 3-4 Verification



Forecast Issuance Date

ECMWF GEFSv12 CFSv2
(avg: 24.8) (avg: 22.6) (avg: 19.5)
Domain: CONUS/AK; # of Forecasts: 265

Precipitation: Week 3-4 Verification



Forecast Issuance Date

ECMWF GEFSv12 CFSv2
(avg: 10.8) (avg: 10.3) (avg: 10.2)
Domain: CONUS/AK; # of Forecasts: 265

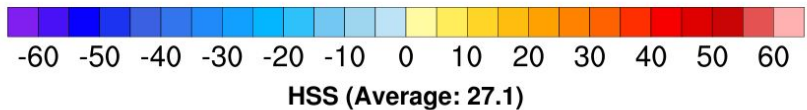
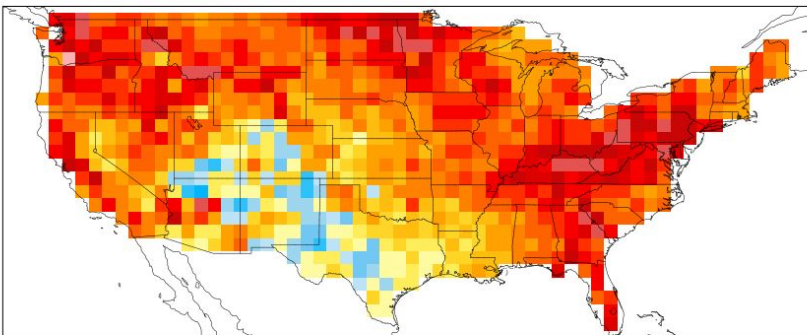
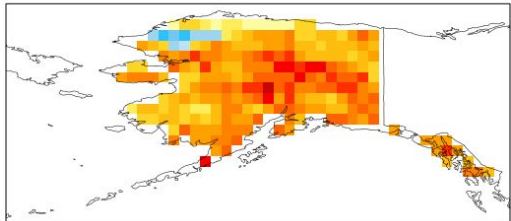


CPC Ensemble Supported Products – Week 3-4



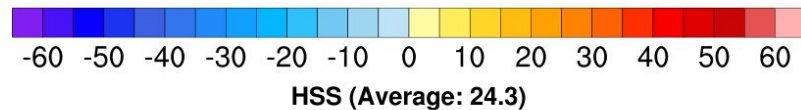
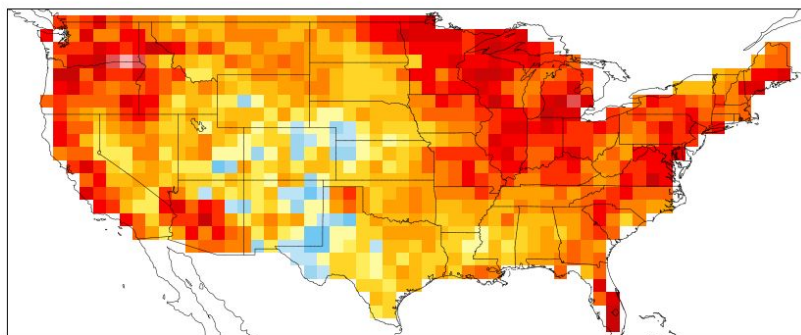
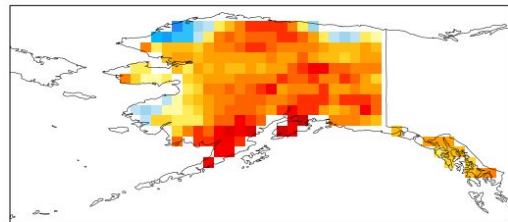
GEFSv12 Temperature: Week 3-4 Verification

DJF: 01Dec2020 to 28Feb2023



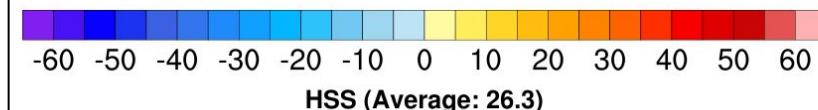
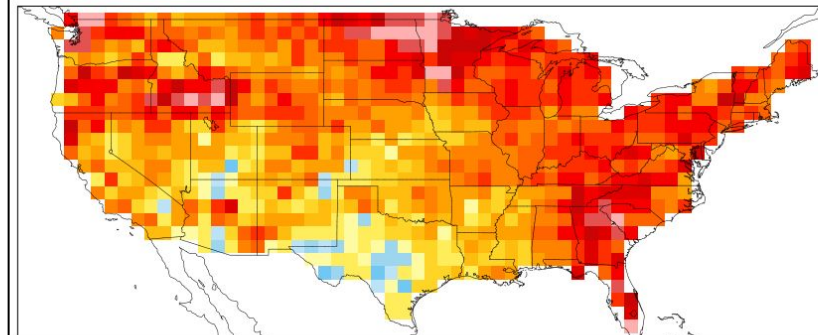
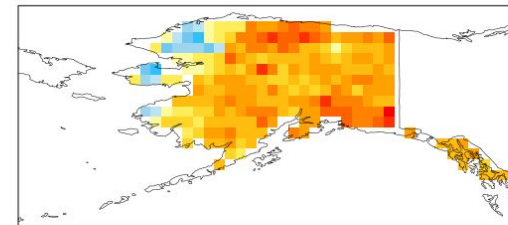
CFSv2 Temperature: Week 3-4 Verification

DJF: 01Dec2020 to 28Feb2023



ECMWF Temperature: Week 3-4 Verification

DJF: 01Dec2020 to 28Feb2023



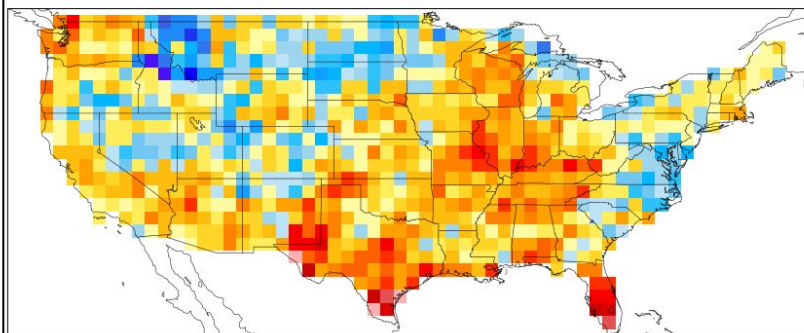
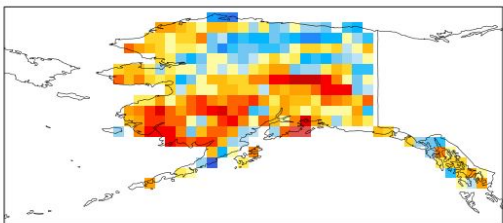


CPC Ensemble Supported Products – Week 3-4



GEFSv12 Precipitation: Week 3-4 Verification

DJF: 01Dec2020 to 28Feb2023

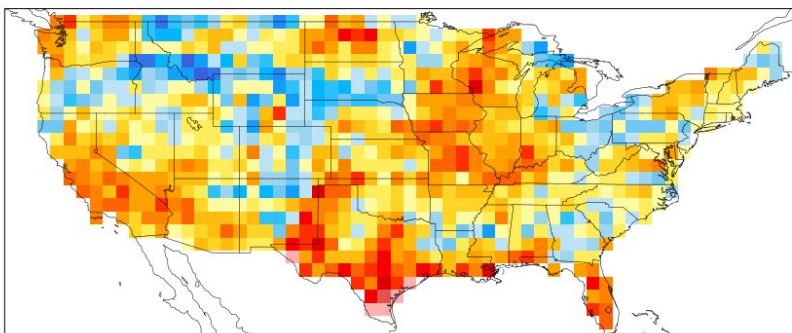
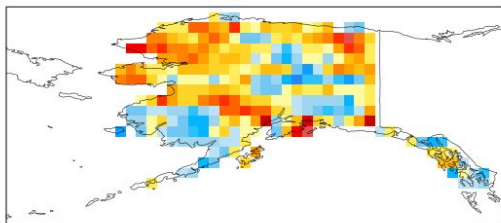


-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60

HSS (Average: 9.2)

CFSv2 Precipitation: Week 3-4 Verification

DJF: 01Dec2020 to 28Feb2023

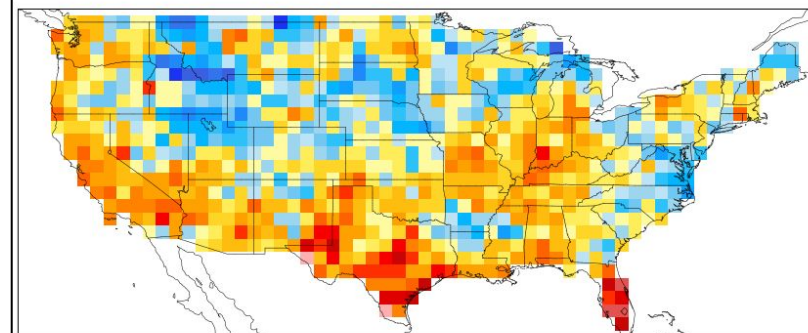
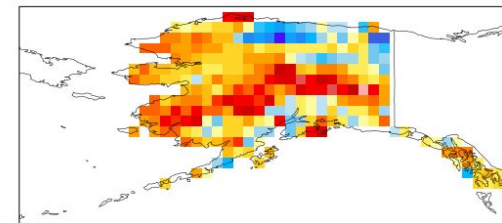


-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60

HSS (Average: 9.2)

ECMWF Precipitation: Week 3-4 Verification

DJF: 01Dec2020 to 28Feb2023

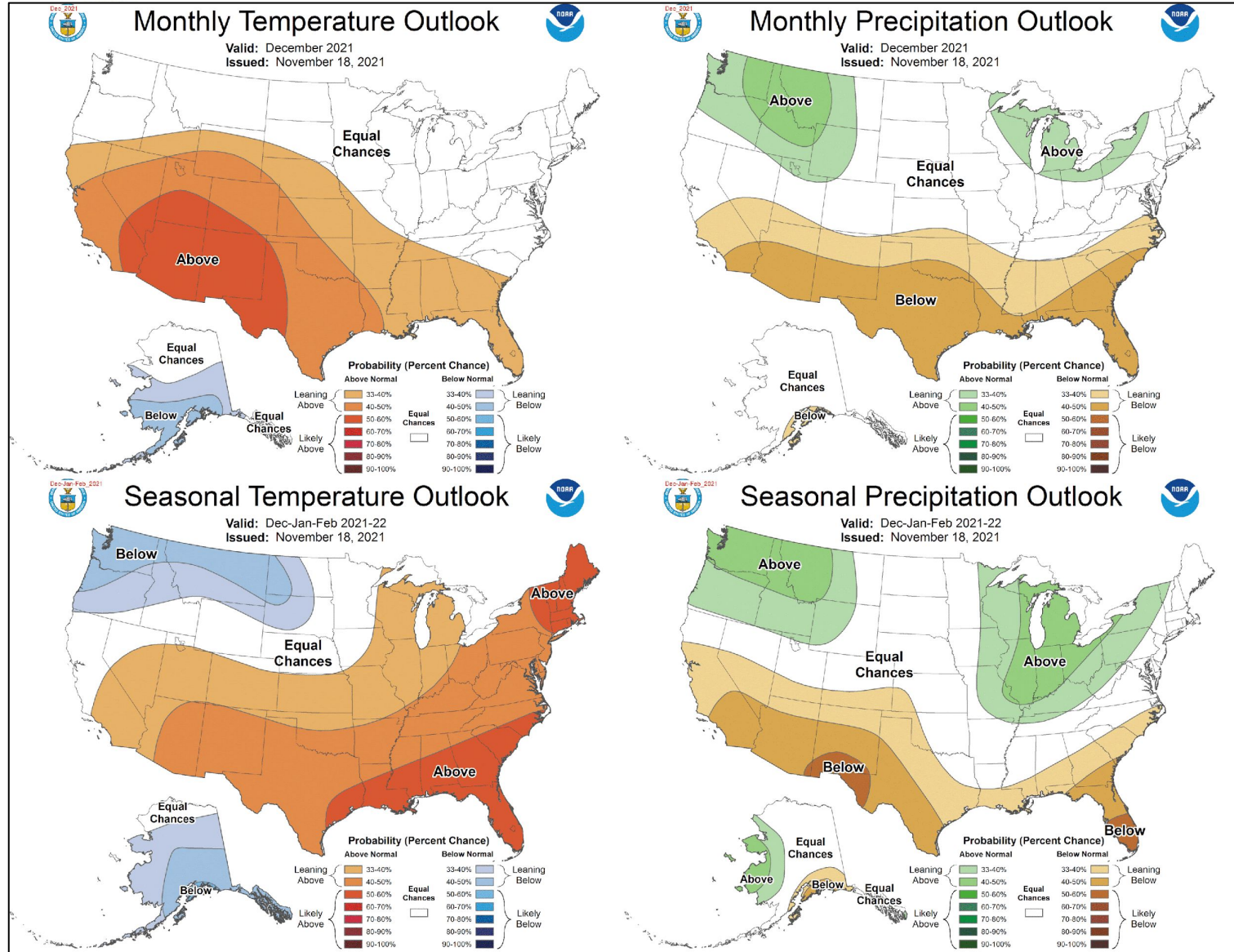


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HSS (Average: 7.8)



CPC Ensemble Supported Products – Monthly/Seasonal

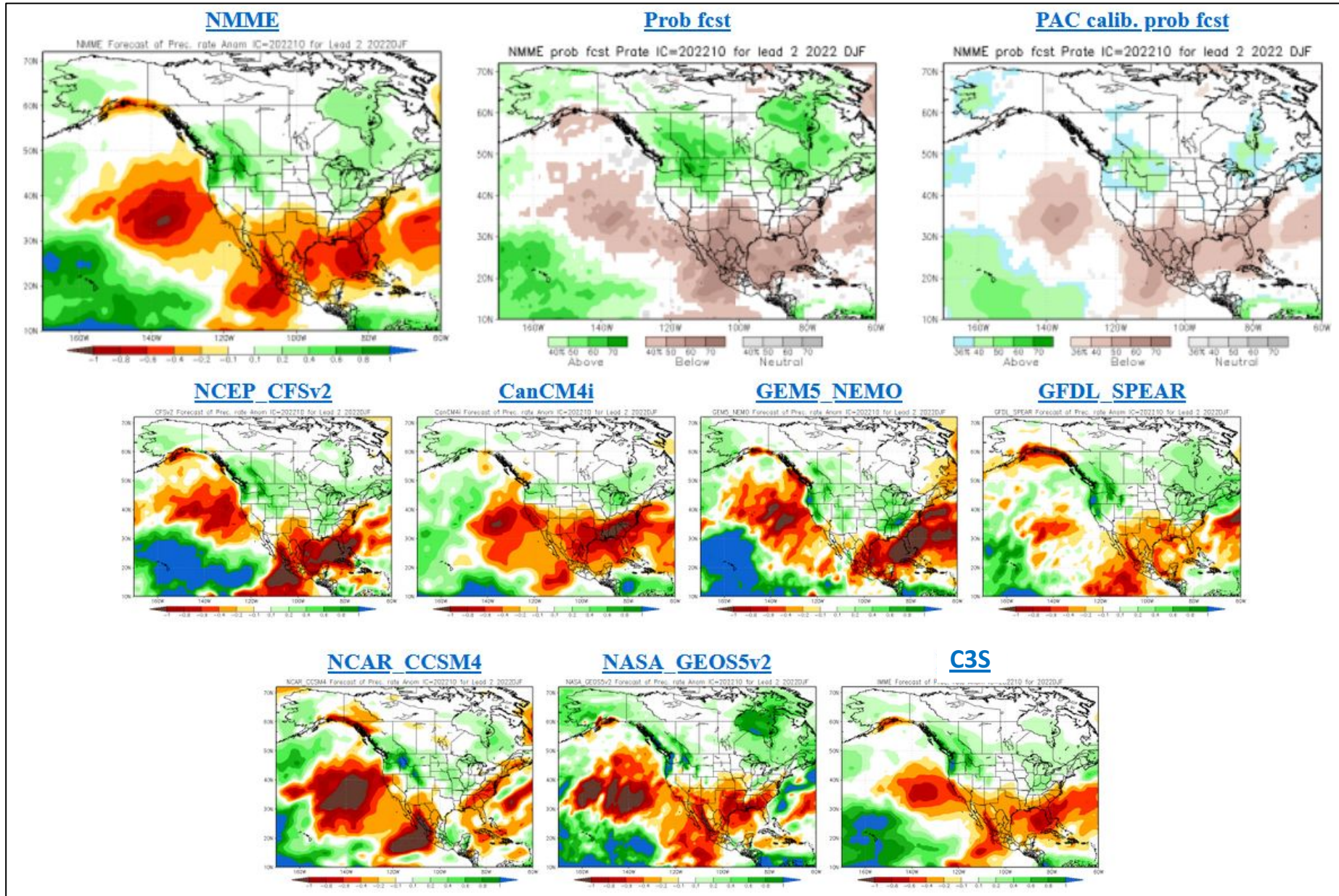


- Three category outlook for above-, near- or below-normal monthly mean temperature and monthly total precipitation amounts
- “EC” areas indicate 33% probability for each category

- ✓ Utilizes NCEP CFSv2, North American Multi-Model (NMME) and Copernicus (C3S) model ensemble data
- ✓ Supports T, P, NOAA Hurricane Outlook
- ✓ Bias-correction, calibration and equal-weight based consolidation



CPC Ensemble Supported Products – Seasonal

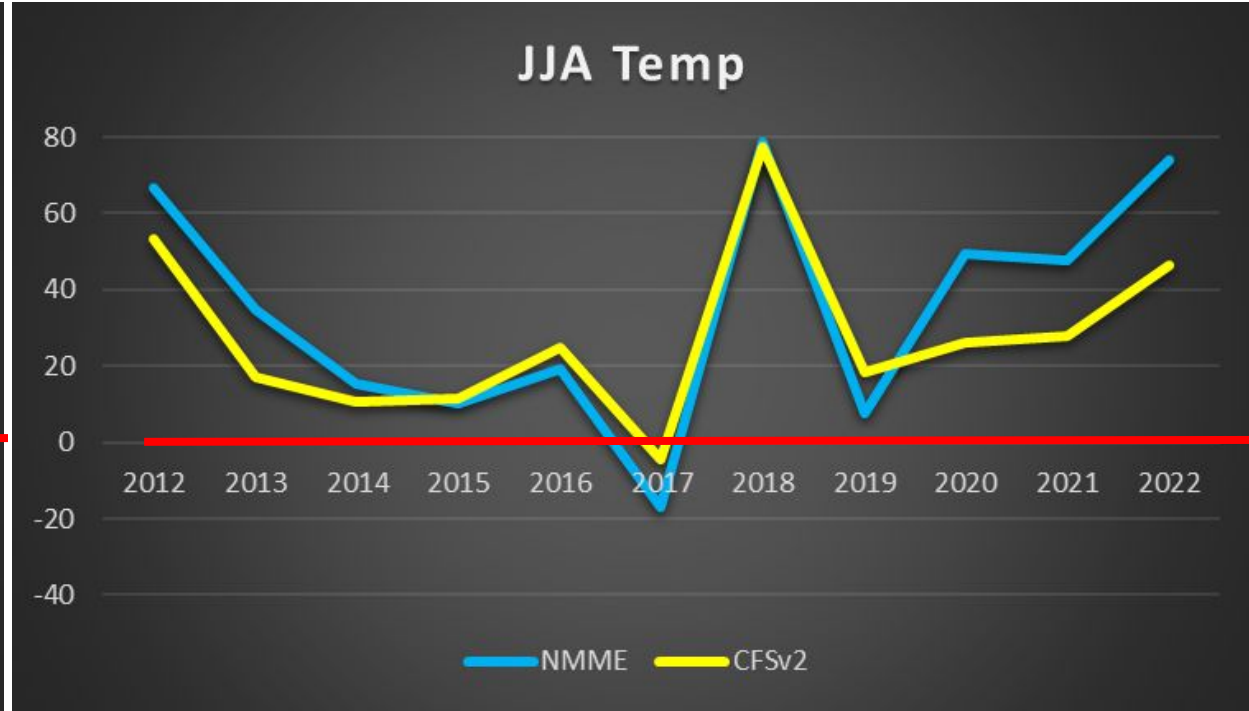
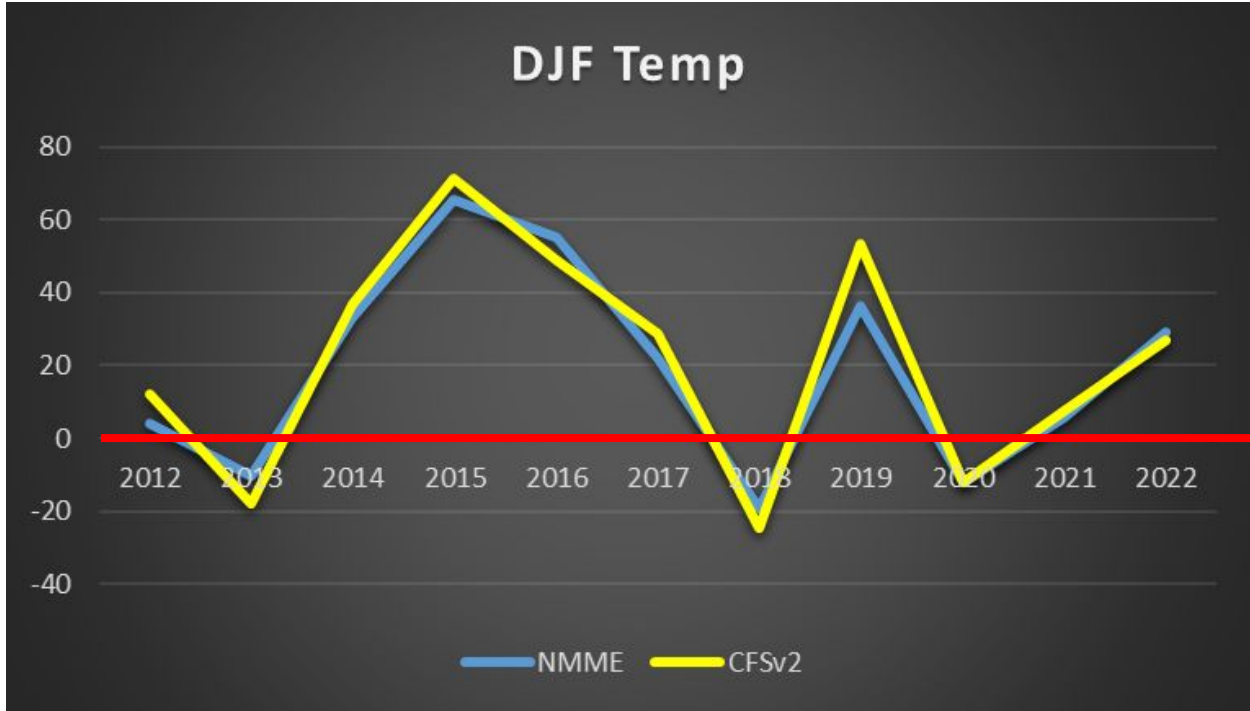




CPC Ensemble Supported Products – Seasonal



Temperature – CONUS mean (2012-2022)

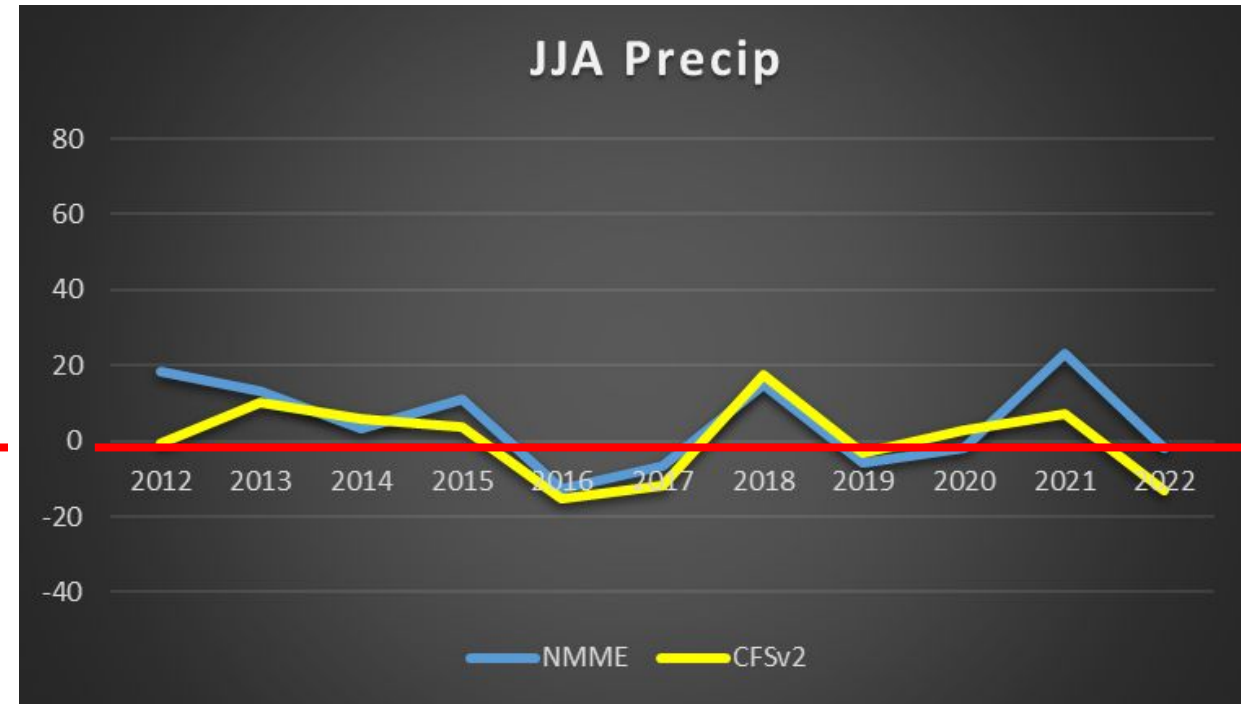
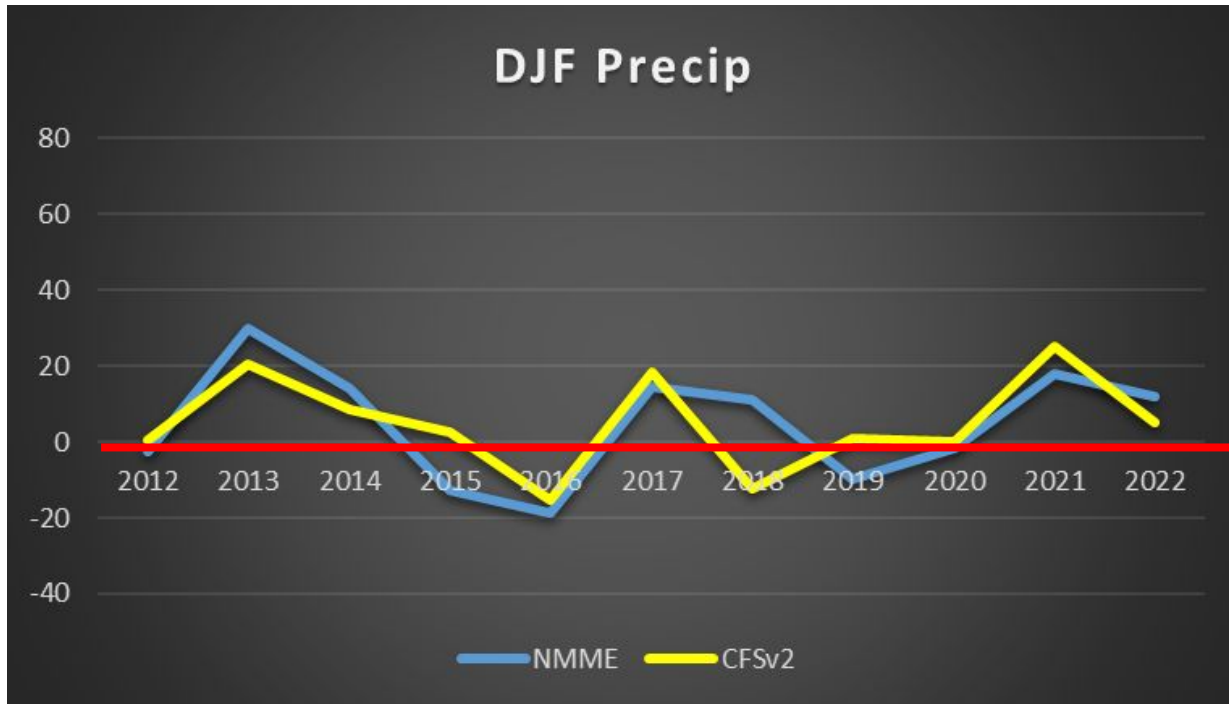




CPC Ensemble Supported Products – Seasonal



Precipitation – CONUS mean (2012-2022)





CPC Ensemble Supported Products – Seasonal



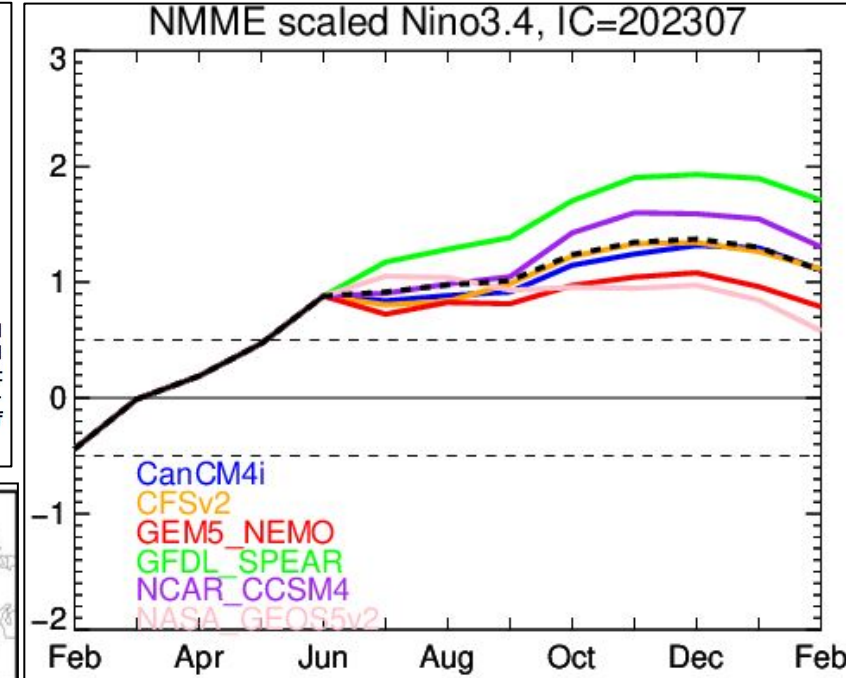
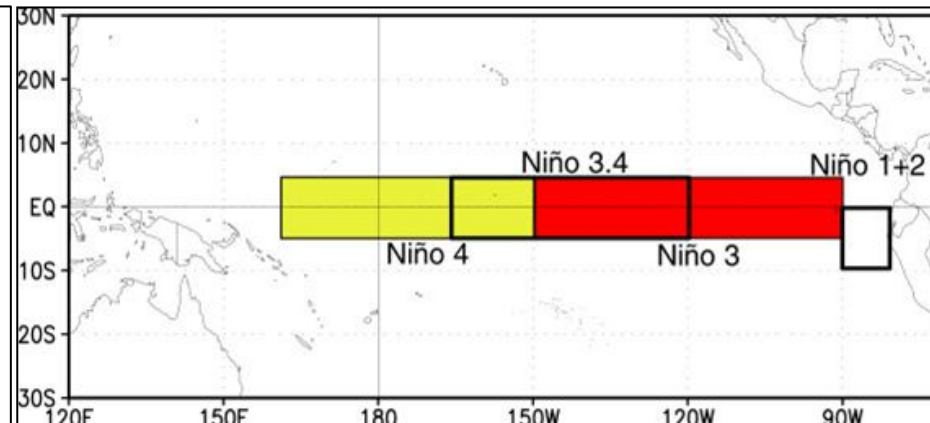
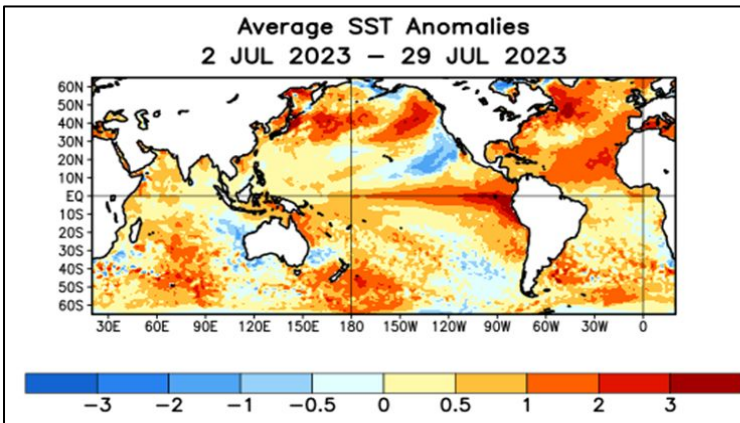
EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by
CLIMATE PREDICTION CENTER/NCEP/NWS
10 August 2023

ENSO Alert System Status: El Niño Advisory

Synopsis: El Niño is anticipated to continue through the Northern Hemisphere winter (with greater than 95% chance through December 2023 -February 2024).

In July, El Niño continued as indicated by above-average sea surface temperatures (SSTs) across the equatorial Pacific Ocean [Fig. 1]. Nearly all of the weekly Niño indices in the central and eastern Pacific were in excess of +1.0°C: Niño-3.4 was +1.1°C, Niño-3 was +1.8°C, and Niño1+2 was +3.4°C [Fig. 2]. Area-averaged subsurface temperatures anomalies decreased compared to June [Fig. 3], but remained positive, in association with anomalous warmth across the equatorial Pacific Ocean [Fig. 4]. Tropical atmospheric anomalies were also consistent with El Niño. Starting in mid-July, low-level winds were anomalously westerly over the western equatorial Pacific, while anomalous easterlies prevailed over the eastern Pacific. Upper-level wind anomalies were westerly over the eastern Pacific. Convection continued to be enhanced around the International Date Line and was weakly suppressed in the vicinity of Indonesia [Fig. 5]. The equatorial Southern Oscillation Index (SOI) and the traditional SOI were both negative. Collectively, the coupled ocean-atmosphere system reflected El Niño.





Other CPC Operational and Developmental Products



- Development of **probabilistic drought outlooks** to complement deterministic monthly and seasonal drought outlooks (Hailan Wang et al.)
- Weeks 2-4 **extreme heat** probabilistic predictions (Evan Oswald et al.)
- **Hydrological applications**: Downscaling - GFSv12 to create hi-res Week-2 outlooks via ML methods (BCSDwMSSL, ConvNeuralNet) (Matt Rosencrans et al.)
- Operational support for the **Week 2 U.S. Hazards Outlook** for threats associated with extremes related to temperature, precipitation and wind, among others (Melissa Ou et al.)
 - ✓ Utilizes GFSv12, ECMWF, ECCO ensemble data daily
 - Extreme heat/cold
 - Heavy precipitation (rain/snow)
 - High winds
 - Flash drought / extended periods of flooding



Forthcoming CPC Talks



This session

“Week 2 Probabilistic Fire Danger Outlook Tool Based on NCEP Ensemble Forecast System”

[[Mingyue Chen](#)]

“Week 3-4 Multi-Model Ensemble Subsampling: A Real-time Verification” [[Cory Baggett](#)]

“CPC’s post-processed ensemble Probabilistic week-2 Extremes Tool (PET)” [[Melissa Ou](#)]

“Separation of Interannual signals into decadal and shorter time scales in dynamical ensembles for seasonal forecast” [[Dan Collins](#)]

Thursday morning

“S2S opening remarks” [[David DeWitt](#)]

“A Large FV3GFS Ensemble in an Reanalysis System” [[Wesley Ebisuzaki](#)]

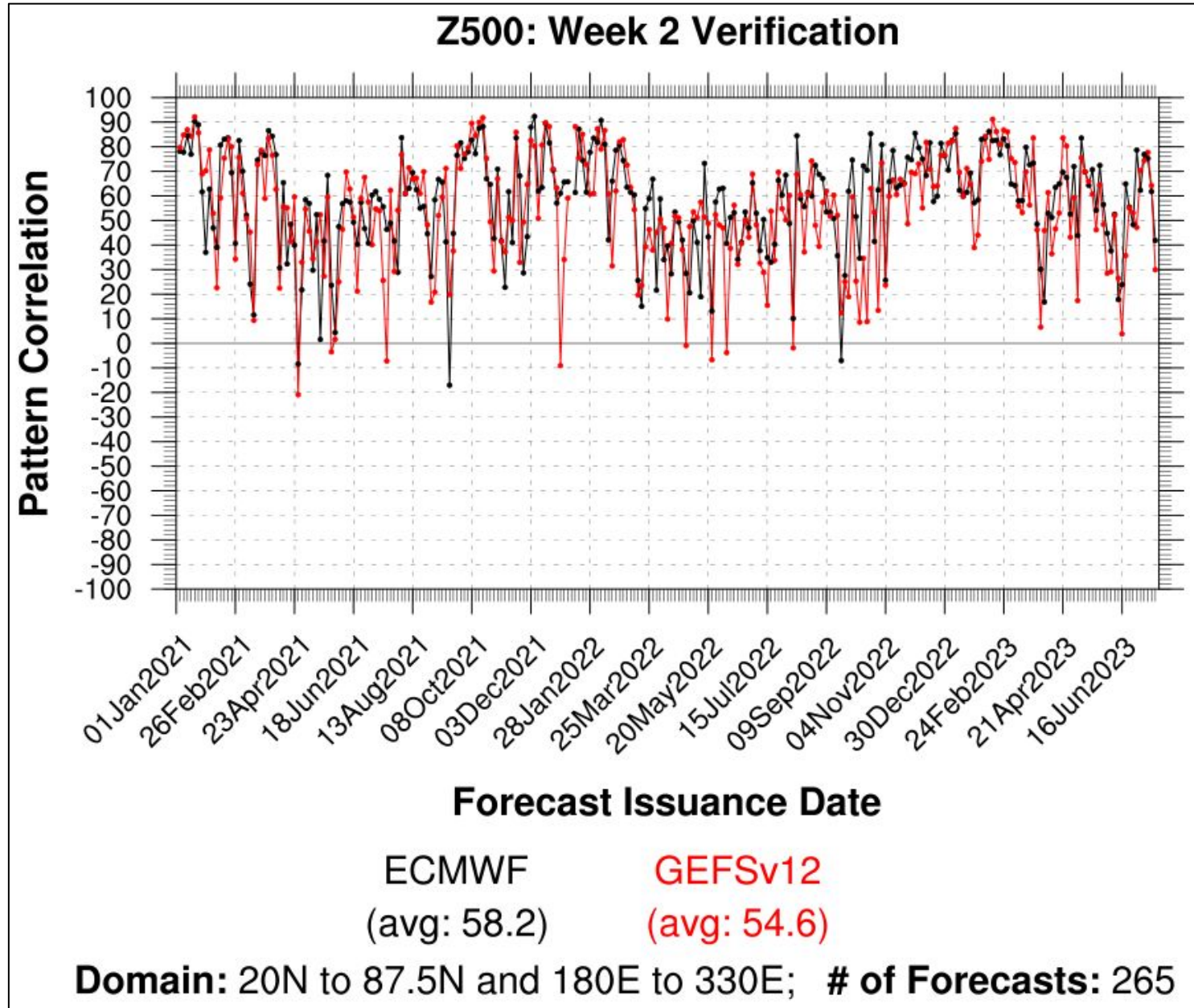
“Application of Subseasonal and Seasonal Ensemble Forecasts for the Development of NOAA CPC Probabilistic Drought Outlook” [[Hailan Wang](#)]



Thank you for your time and attention
Jon.Gottschalck@noaa.gov

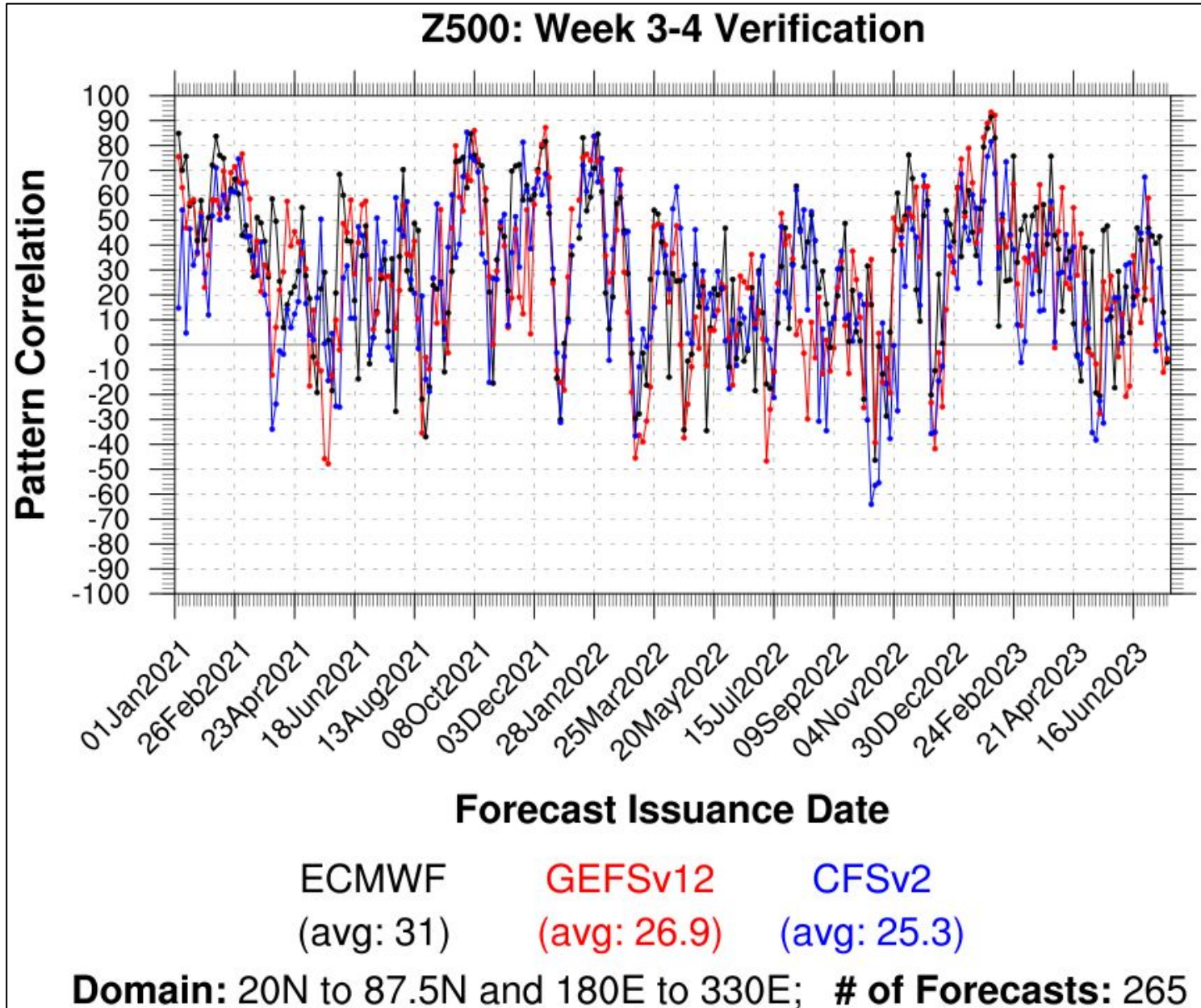


CPC Ensemble Supported Products – Week 2





CPC Ensemble Supported Products – Week 3-4





Forecast Skill Metric – HSS



Modified Heidke Skill Score (HSS):
% Improvement over Random Forecasts

$$\text{HSS (\%)} = 100 * \frac{(H - E)}{(T - E)}$$

H = Number of correct forecasts

E = Expected number of correct forecasts (1/3 of total)

T = Total number of valid forecast-observation pairs

$$\text{HSS (\%)} = 100 * \frac{(\text{Hits} - \text{Expected})}{(\text{Total} - \text{Expected})}$$