



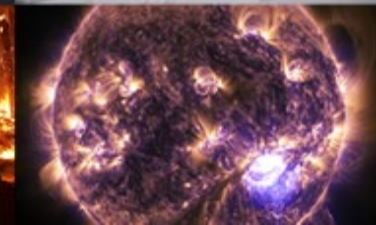
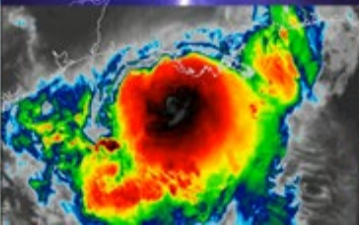
Conversion of Week 3-4 Temperature & Precipitation Outlooks from 2-class to 3-class Systems

Cory Baggett

Jon Gottschalck, Johnna Infanti, Greg Jennrich, Dan Collins, Justin Hicks, Mike Charles, Melissa Ou, Adam Allgood, Daniel Harnos, Laura Ciasto, Peitao Peng, Emerson LaJoie, Ginger Zhang, and Michael Halpert

20th Annual Climate Prediction Applications Science Workshop

Asheville, NC · May 9-11, 2023



Project Background

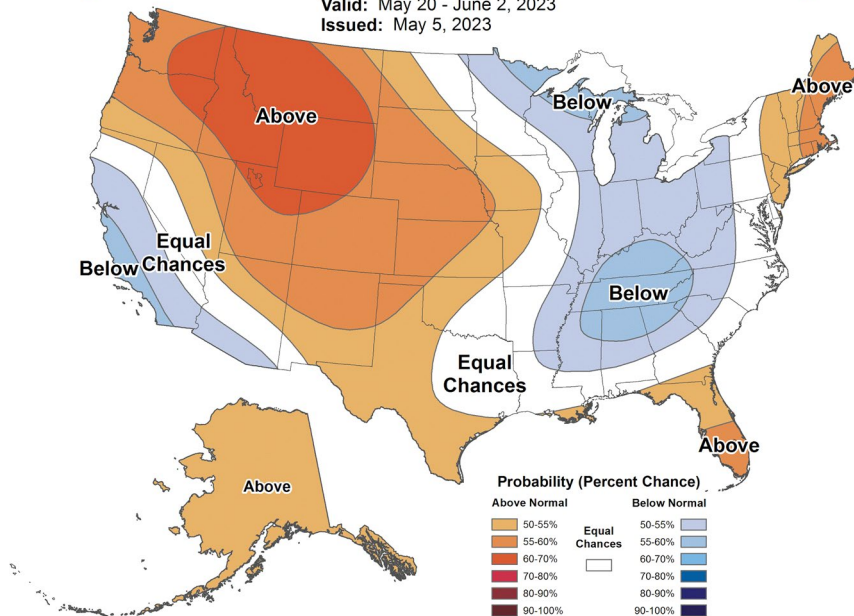
Current Week 3-4 2-Class Product



Weeks 3-4 Temperature Outlook



Valid: May 20 - June 2, 2023
Issued: May 5, 2023



2 classes: Below or Above Normal

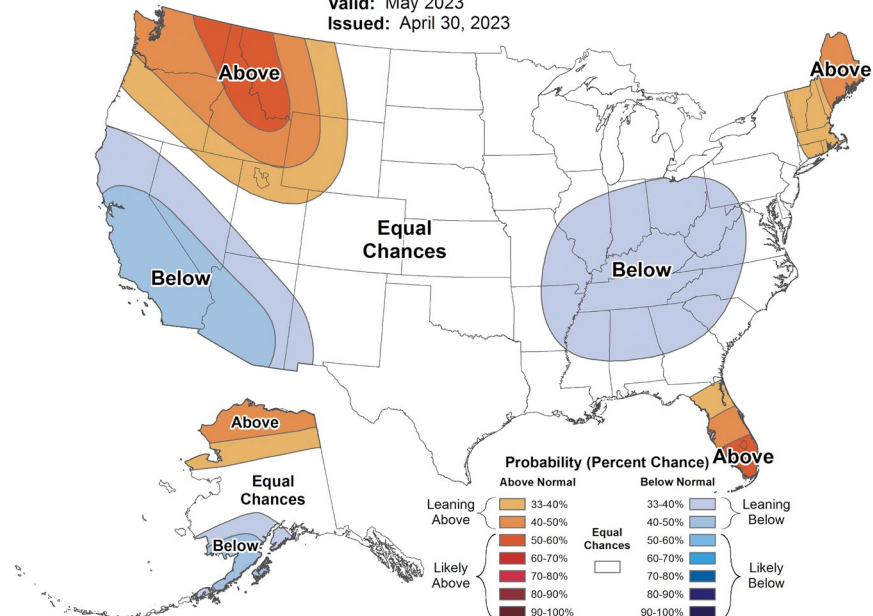
Example of Monthly 3-Class Product



Monthly Temperature Outlook



Valid: May 2023
Issued: April 30, 2023



3 classes: Below, Near, or Above Normal



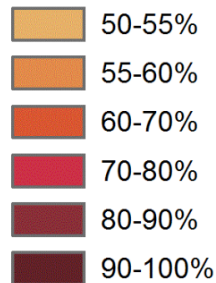
Project Background

Current Week 3-4 2-Class Product

Example of Monthly 3-Class Product

Probability (Percent Chance)

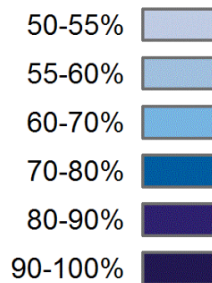
Above Normal



Equal
Chances



Below Normal



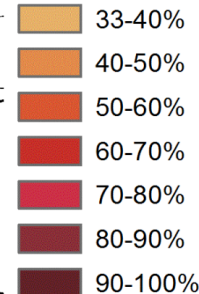
2 classes: Below or Above Normal

Probability (Percent Chance)

Above Normal

Leaning
Above

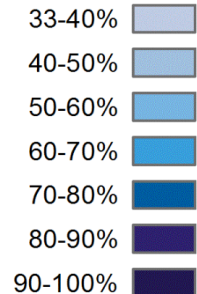
Likely
Above



Equal
Chances



Below Normal



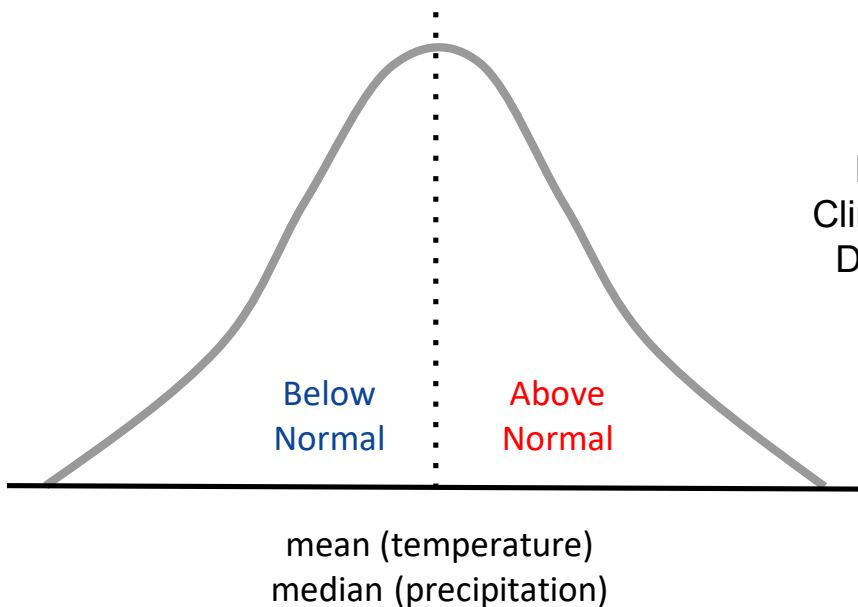
Leaning
Below

Likely
Below

3 classes: Below, Near, or Above Normal

Project Background

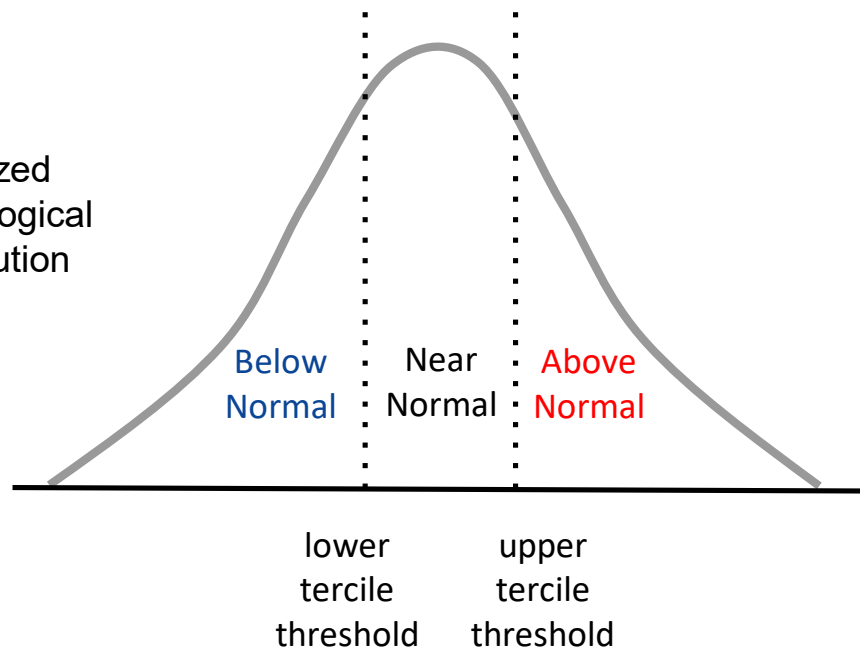
Current Week 3-4 2-Class Product



2 classes: Below or Above Normal

Example of Monthly 3-Class Product

Idealized
Climatological
Distribution



3 classes: Below, Near, or Above Normal

Project Background

- **Goal:** To convert the Week 3-4 Temperature and Precipitation Outlooks from 2-class to 3-class systems
 - FY22: Development
 - Develop lower and upper tercile climatologies
 - Convert statistical forecast tools
 - Convert dynamical model forecast tools
 - Convert dynamical/statistical model consolidations
 - Perform retrospective verifications
 - FY23: Evaluation
 - FY24: Transition to Operations



Project Background



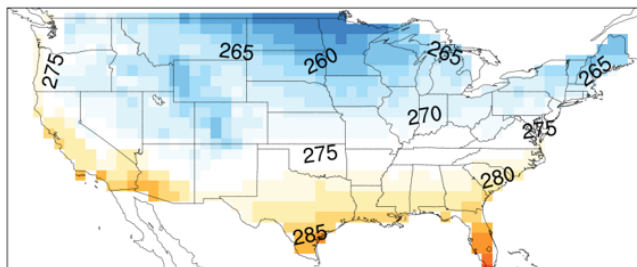
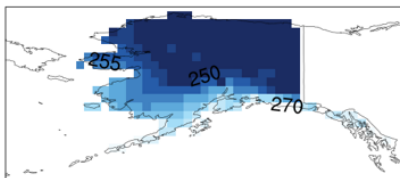
- **Target audience/stakeholders:** NWS Field Structure (NCEP, NWC, Regional Operating Centers, Weather Forecast Offices, decision makers in several sectors of the U.S. economy, general public and media.
- **Collaborators:** Social science team – ultimately found that having inconsistencies across official forecast products was confusing to the public.



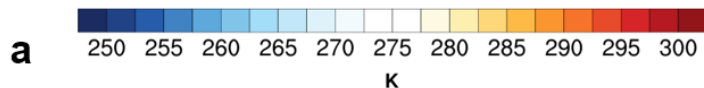
Temperature Climatologies

Temperature: Lower Tercile Threshold (33%)

2-week period beginning January 1

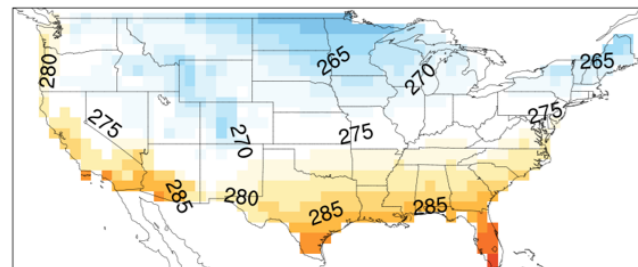
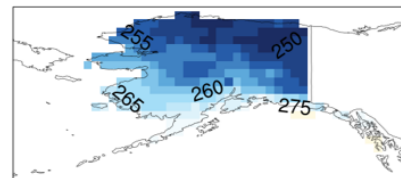


climate normal: 1991-2020

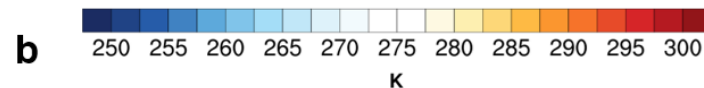


Temperature: Upper Tercile Threshold (67%)

2-week period beginning January 1



climate normal: 1991-2020



- We defined lower and upper tercile thresholds for 2-week periods for each calendar day.
- The near normal range is just a few degrees celsius or less, making it a small target.

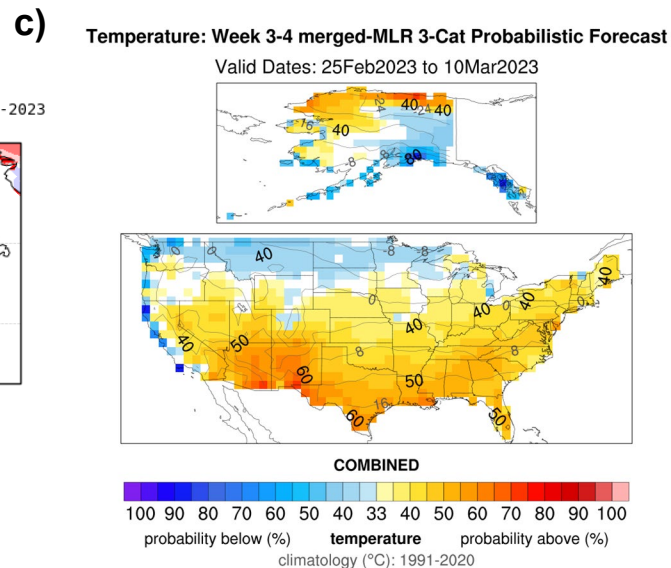
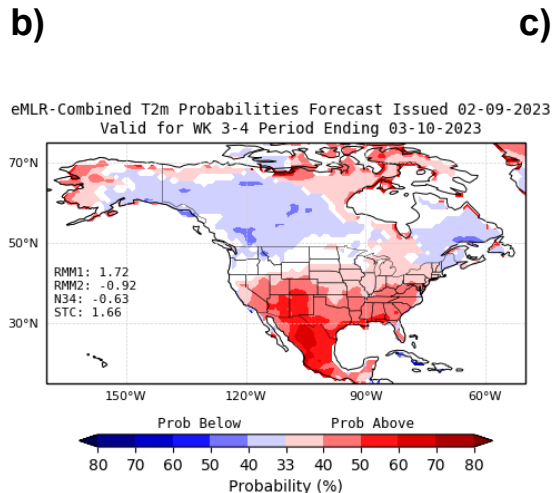
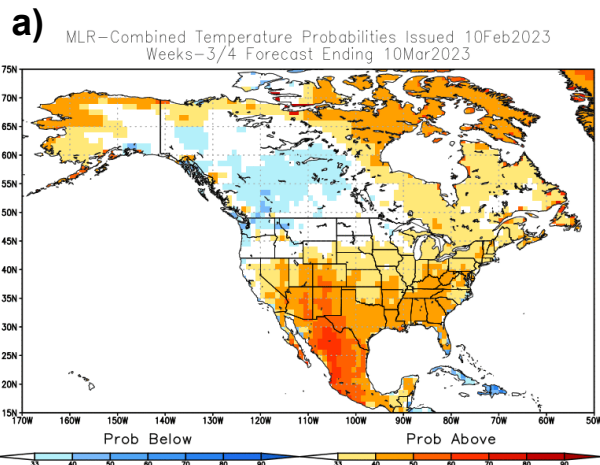
3-Class Statistical Models

Issued: February 10, 2023; Valid: February 25 – March 10, 2023

MLR

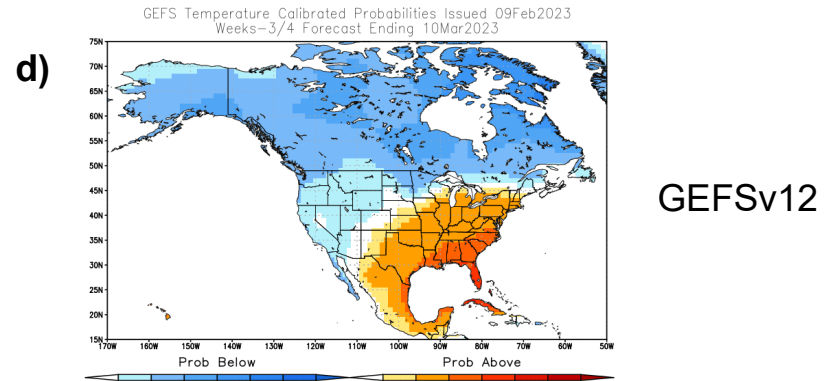
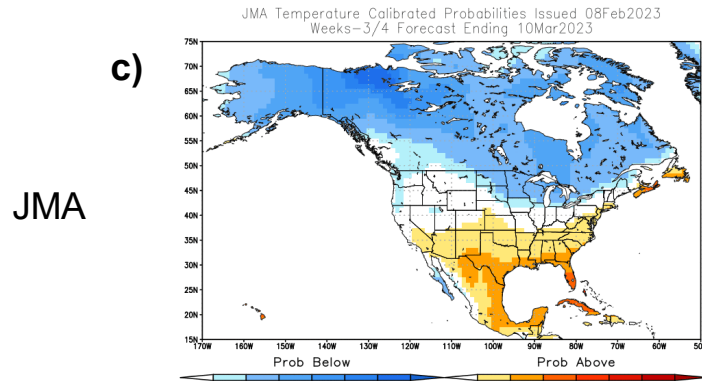
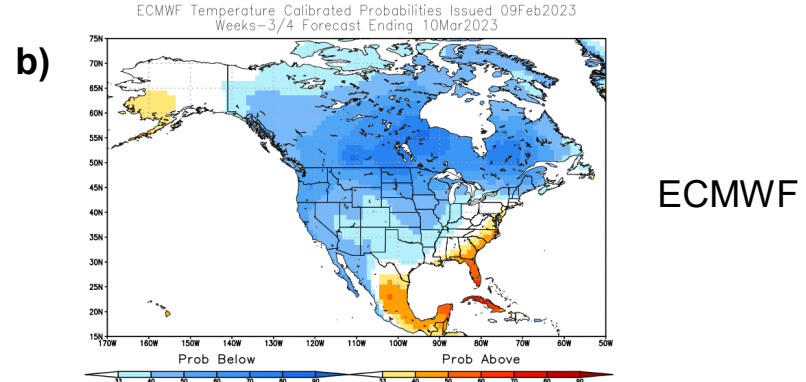
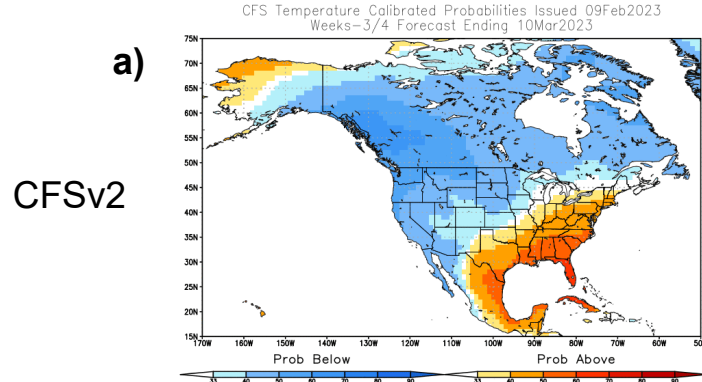
Enhanced-MLR

Merged-MLR



3-class probabilistic temperature forecasts from a selection of statistical models: **a)** the operational multiple-linear regression (MLR) model, **b)** the enhanced-MLR, which incorporates the stratosphere as a predictor, and **c)** the merged-MLR, which incorporates blocking as a predictor

3-Class Dynamical Models

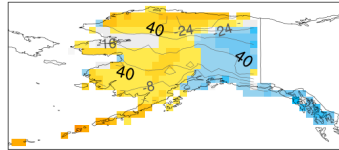


3-class probabilistic temperature forecasts from operational dynamical models calibrated by the model post-processing (MPP) driver: **a)** CFSv2, **b)** ECMWF, **c)** JMA, and **d)** GEFSv12

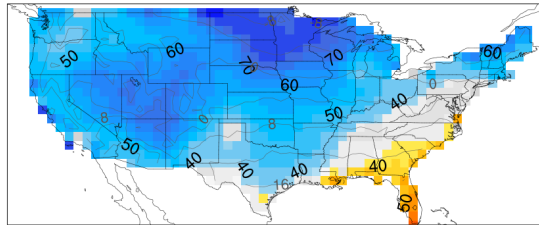
3-Class Dynamical Models

a) Temperature: Week 3-4 ECMWF 3-Cat Probabilistic Forecast

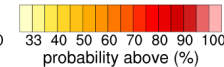
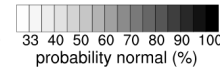
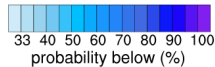
Valid Dates: 25Feb2023 to 10Mar2023



ECMWF



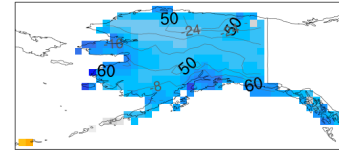
n = 51 members



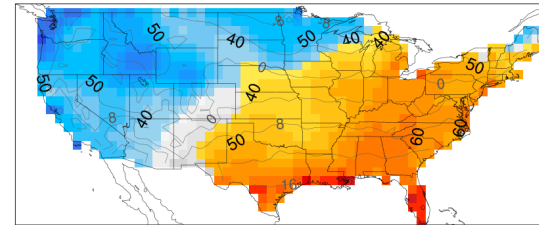
temperature
climatology (°C): 1991-2020

b) Temperature: Week 3-4 GEFSv12 3-Cat Probabilistic Forecast

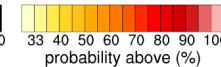
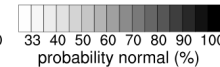
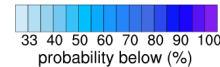
Valid Dates: 25Feb2023 to 10Mar2023



GEFS



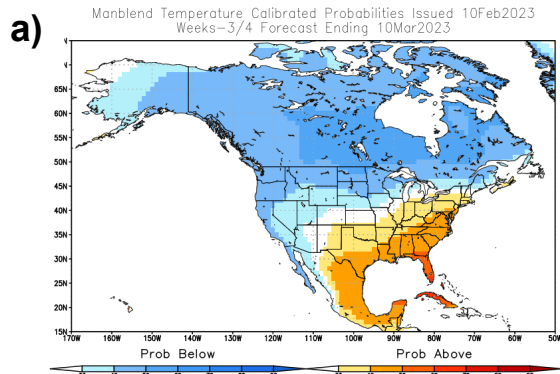
n = 31 members



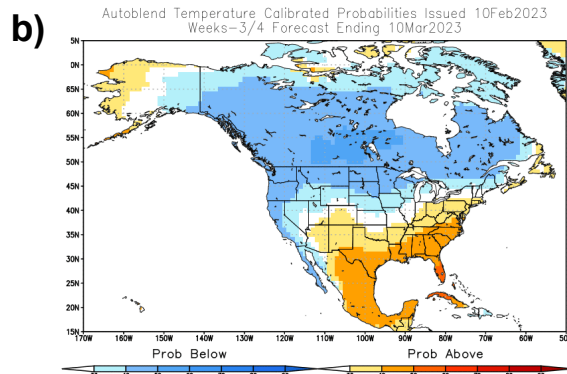
temperature
climatology (°C): 1991-2020

Examples of 3-class probabilistic temperature forecasts from the dynamical models post-processed on the Ensemble Subsampling Page: **a) ECMWF** and **b) GEFSv12**

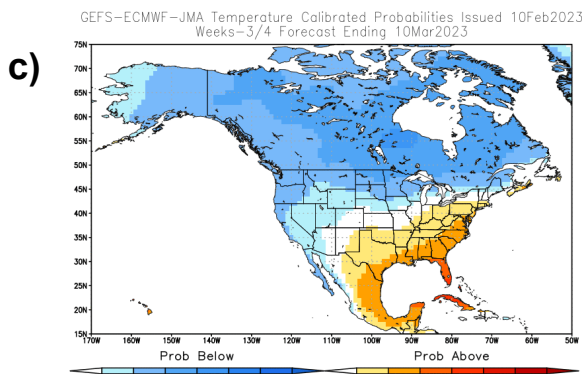
3-Class Consolidation Products



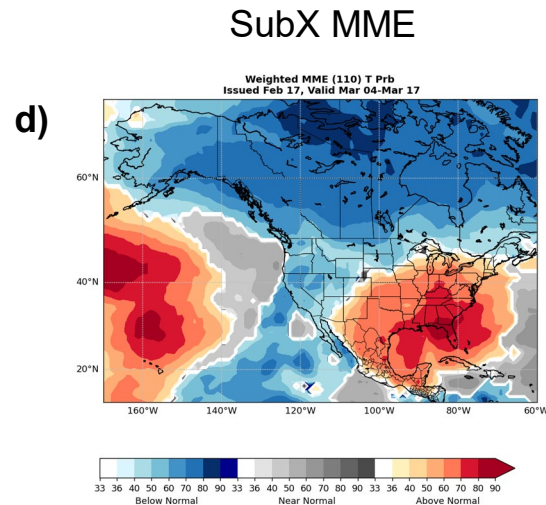
Manual
Blend



Auto
Blend



Equal-weighted Blend

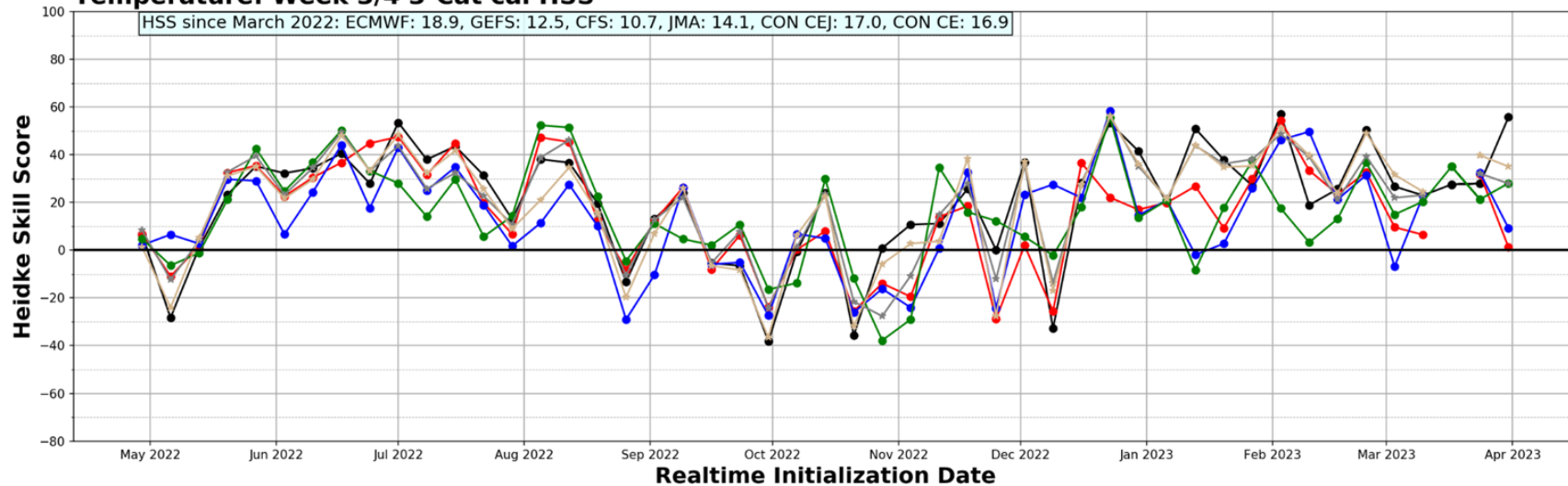


Examples of consolidated 3-class probabilistic temperature forecasts: **a)** manual blend, **b)** autoblend, **c)** equal-weighted, and **d)** SubX multi-model ensemble

Dynamical Model Verifications

ECMWF: 21.4, GEFS: 15.8, CFS: 13.7, JMA: 16.8

Temperature: Week 3/4 3-Cat cal HSS



- 3-class Heidke Skill Scores (HSS) for probabilistic temperature forecasts from the dynamical models
 - ~60% of their 2-class HSS counterparts
- Lower skill scores are partly attributable to near normal being forecasted much less than it is observed.

FY2023 Project Activities

- Continue to evaluate and quality control the 3-class products
 - Identify methods to produce more near normal forecasts in both the dynamical and statistical models
- Transition the experimental Week 3-4 Ensemble Subsampling tool to operations
- FY23 Milestone: *Development of an improved Week 3-4 temperature consolidation first guess*

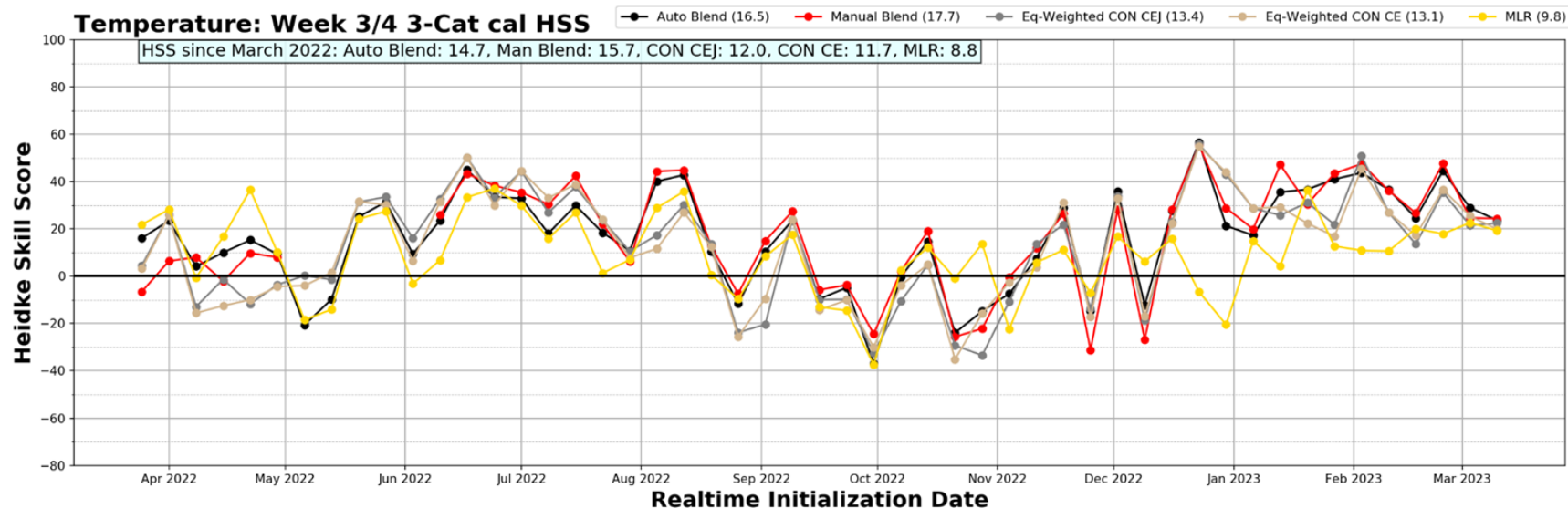
Summary

- Lower and upper tercile climatologies have been derived from both observations and models.
- Statistical, dynamical, and consolidation forecast tools have been converted to 3-class.
- A retrospective verification has revealed that 3-class skill scores are approximately 60% of their 2-class counterparts. Some of this decline in skill is attributable to near normal being forecasted less than observed.
- The 3-class tools are running experimentally during FY23 with an expected transition to operations in FY24.



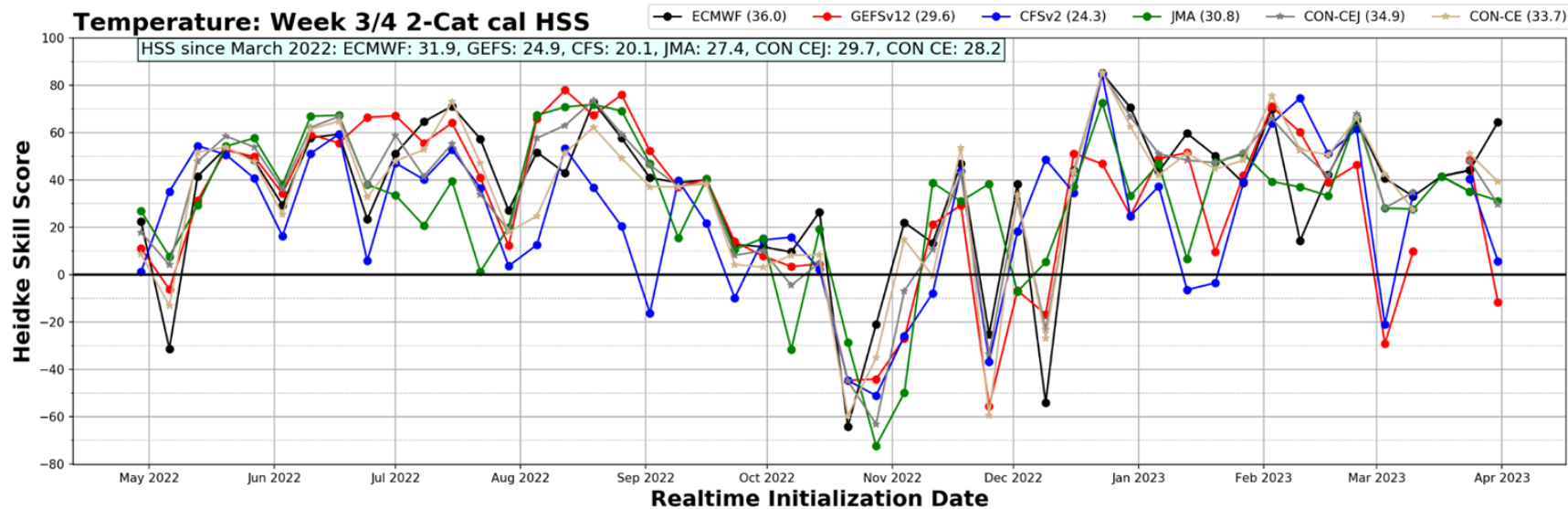
Extra Slides

Consolidation and MLR Verifications



- 3-class HSS for probabilistic temperature forecasts from the consolidations and the operational MLR

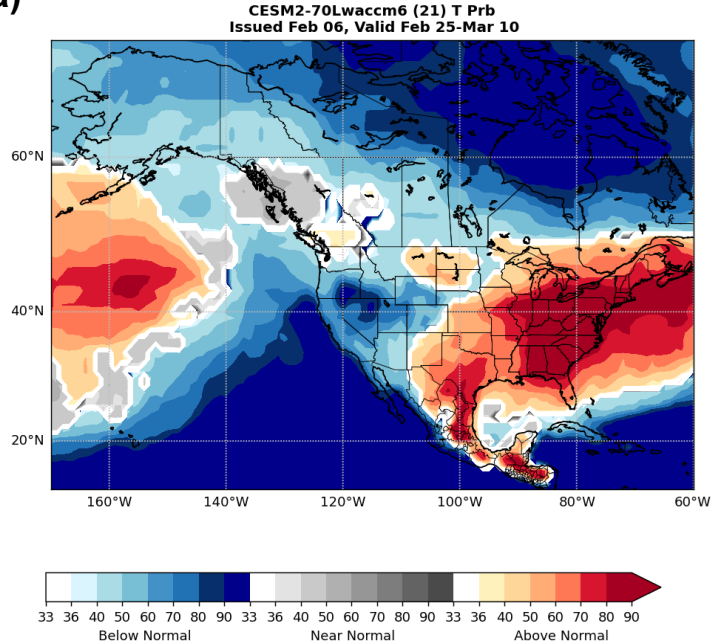
Dynamical Model Verifications (2-cat)



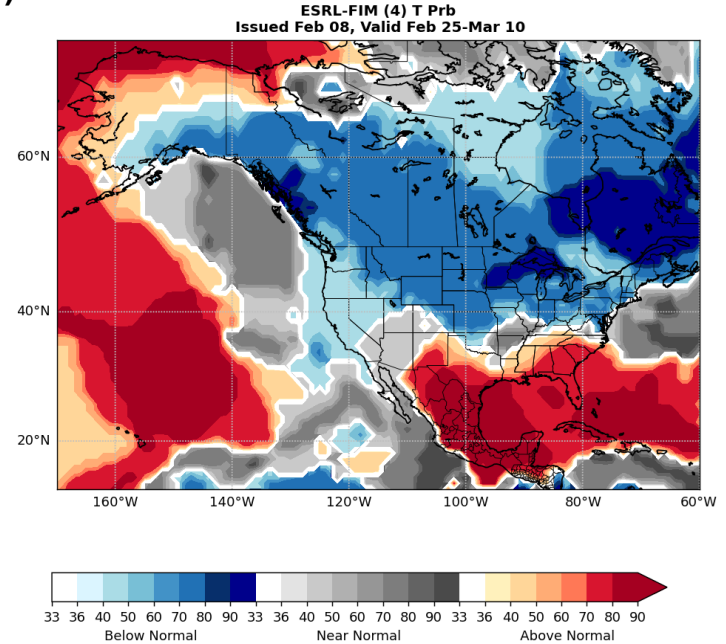
- 2-class Heidke Skill Scores (HSS) for probabilistic temperature forecasts from the dynamical models
 - ~150% of their 3-class HSS counterparts

3-Class Dynamical Models

a)



b)



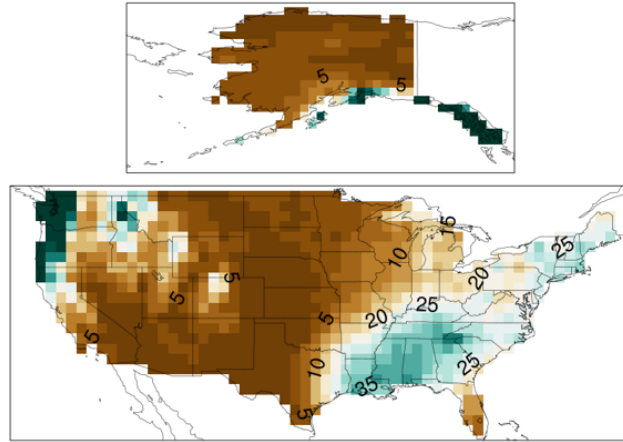
Examples of 3-class probabilistic temperature forecasts from experimental dynamical models participating in SubX: **a)** CESM2-70Lwaccm6 and **b)** ESRL-FIM



Precipitation Climatologies

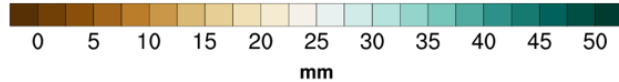
Precipitation: Lower Tercile Threshold (33%)

2-week period beginning January 1



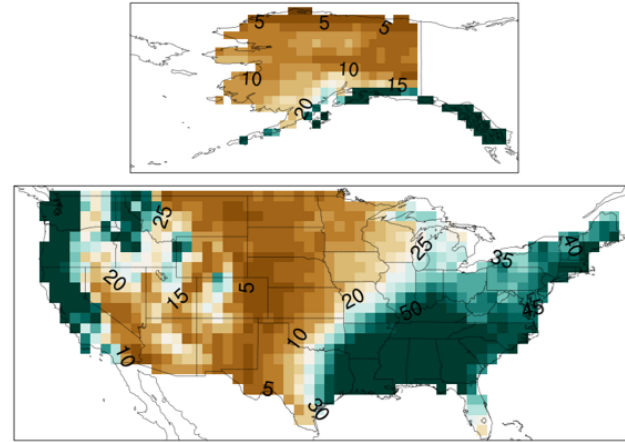
climate normal: 1991-2020

a



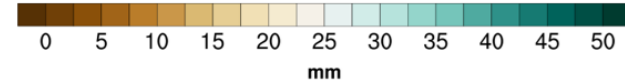
Precipitation: Upper Tercile Threshold (67%)

2-week period beginning January 1



climate normal: 1991-2020

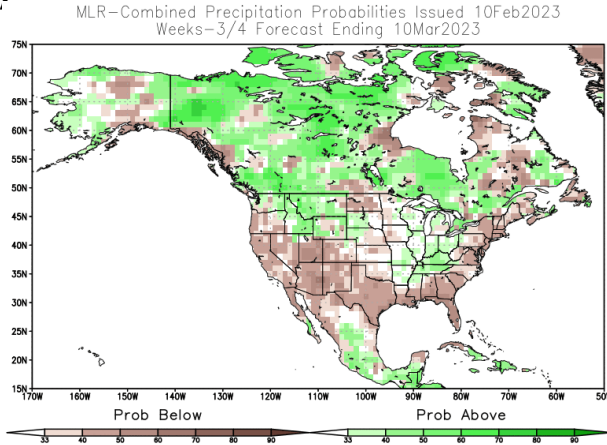
b



- We defined lower and upper tercile thresholds for 2-week periods for each calendar day.
- The lower tercile threshold is often zero in arid areas, making the below normal category ill-defined.

3-Class Statistical Models

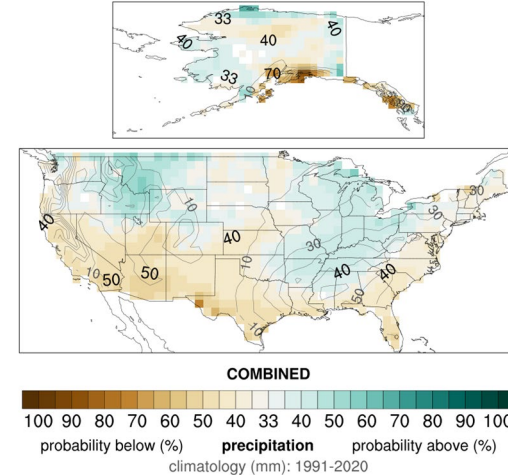
a)



b)

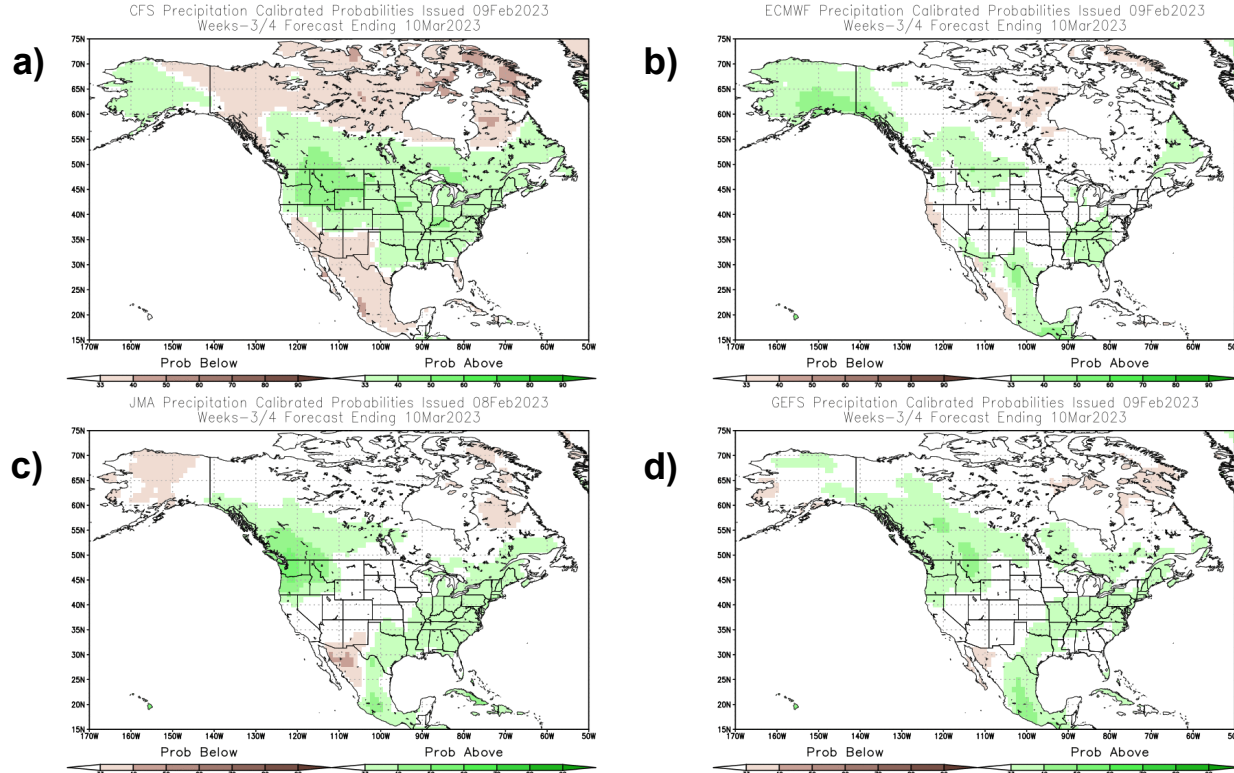
Precipitation: Week 3-4 merged-MLR 3-Cat Probabilistic Forecast

Valid Dates: 03Mar2023 to 16Mar2023



3-class probabilistic precipitation forecasts from a selection of statistical models: **a)** the operational multiple-linear regression (MLR) model and **b)** the merged-MLR, which incorporates blocking as a predictor

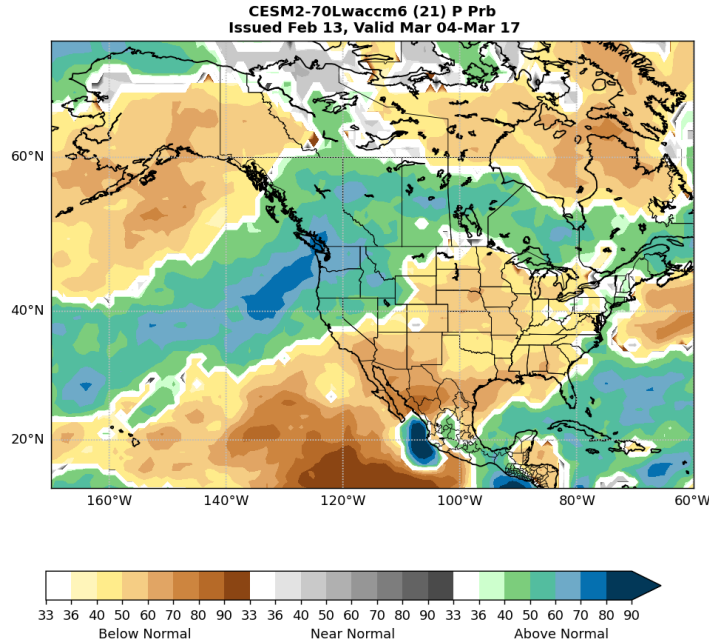
3-Class Dynamical Models



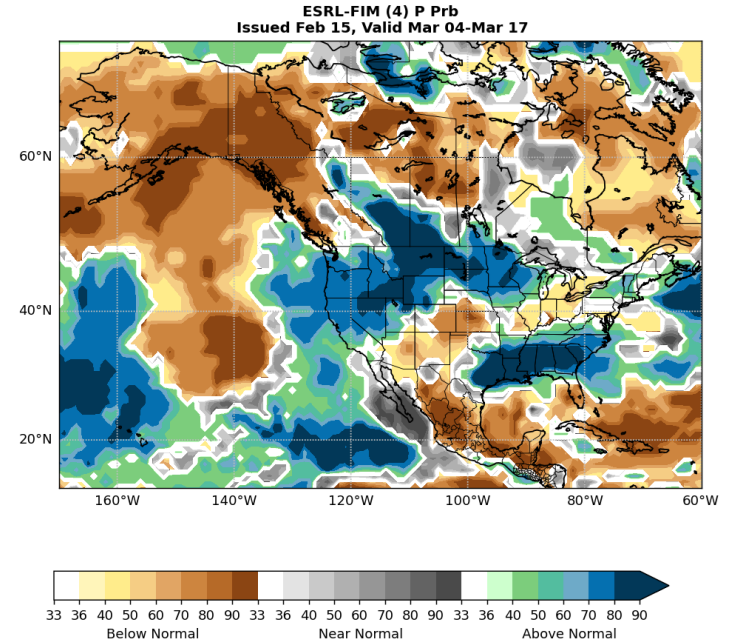
3-class probabilistic precipitation forecasts from operational dynamical models calibrated by the model post-processing (MPP) driver: **a) CFSv2**, **b) ECMWF**, **c) JMA**, and **d) GEFSv12**

3-Class Dynamical Models

a)

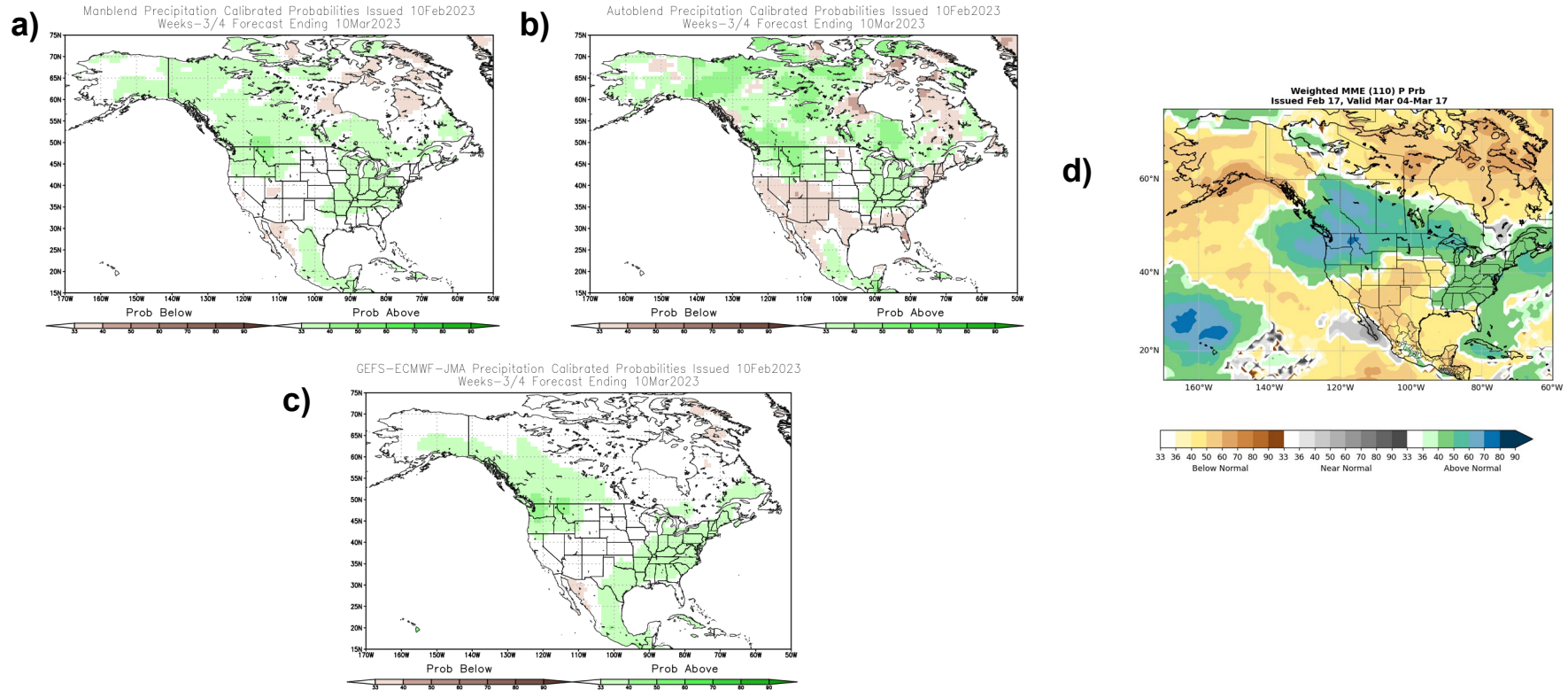


b)



Examples of 3-class probabilistic precipitation forecasts from experimental dynamical models participating in SubX: **a)** CESM2-70Lwaccm6 and **b)** ESRL-FIM

3-Class Consolidations



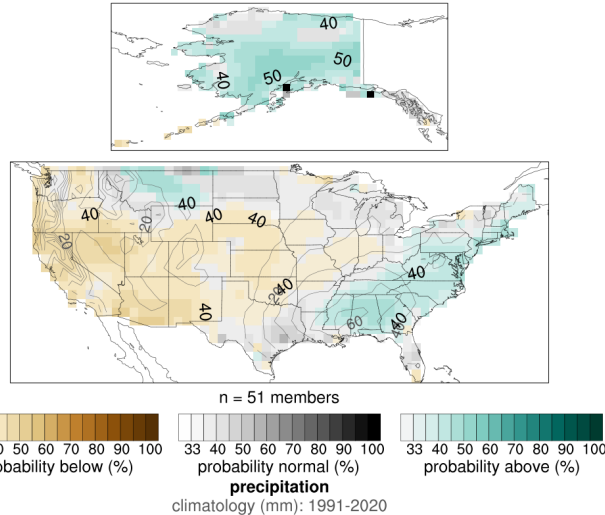
Examples of consolidated 3-class probabilistic precipitation forecasts: **a)** manual blend, **b)** autoblend, **c)** equal-weighted, and **d)** SubX multi-model ensemble

3-Class Dynamical Models

a)

Precipitation: Week 3-4 ECMWF 3-Cat Probabilistic Forecast

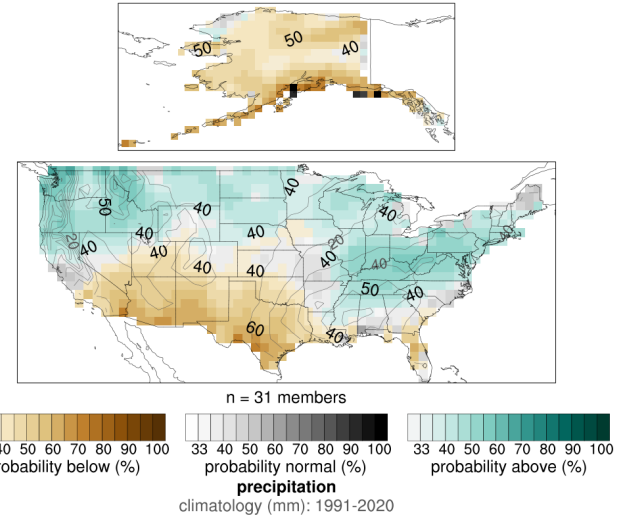
Valid Dates: 25Feb2023 to 10Mar2023



b)

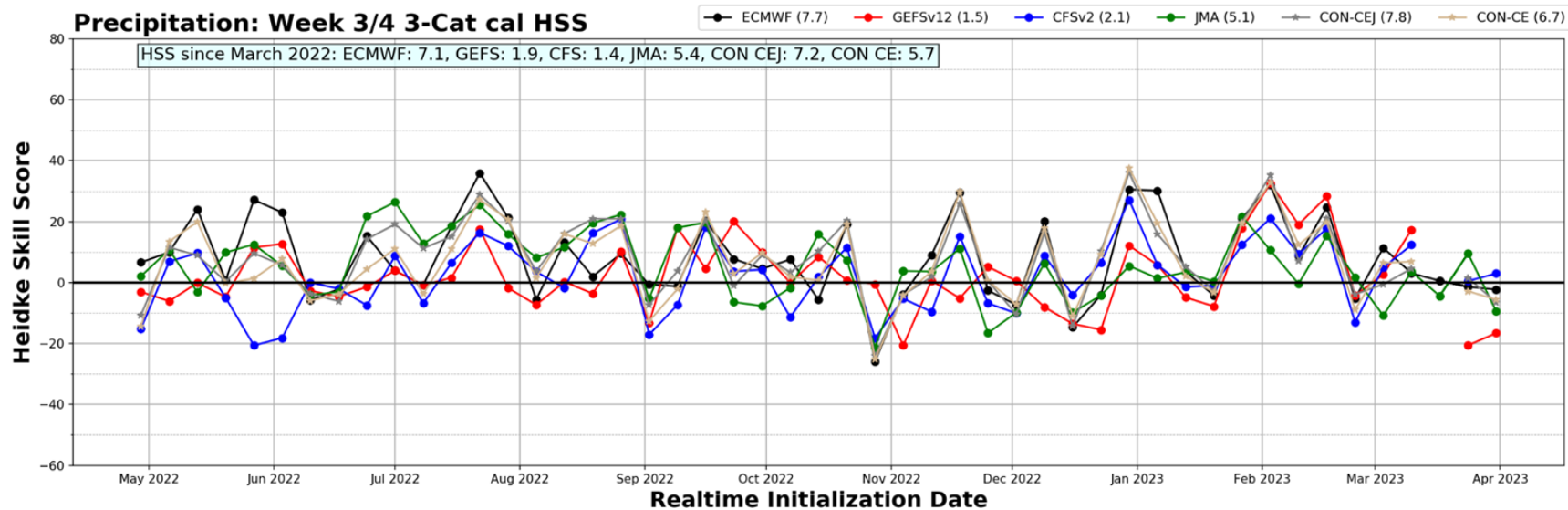
Precipitation: Week 3-4 GEFSv12 3-Cat Probabilistic Forecast

Valid Dates: 04Mar2023 to 17Mar2023



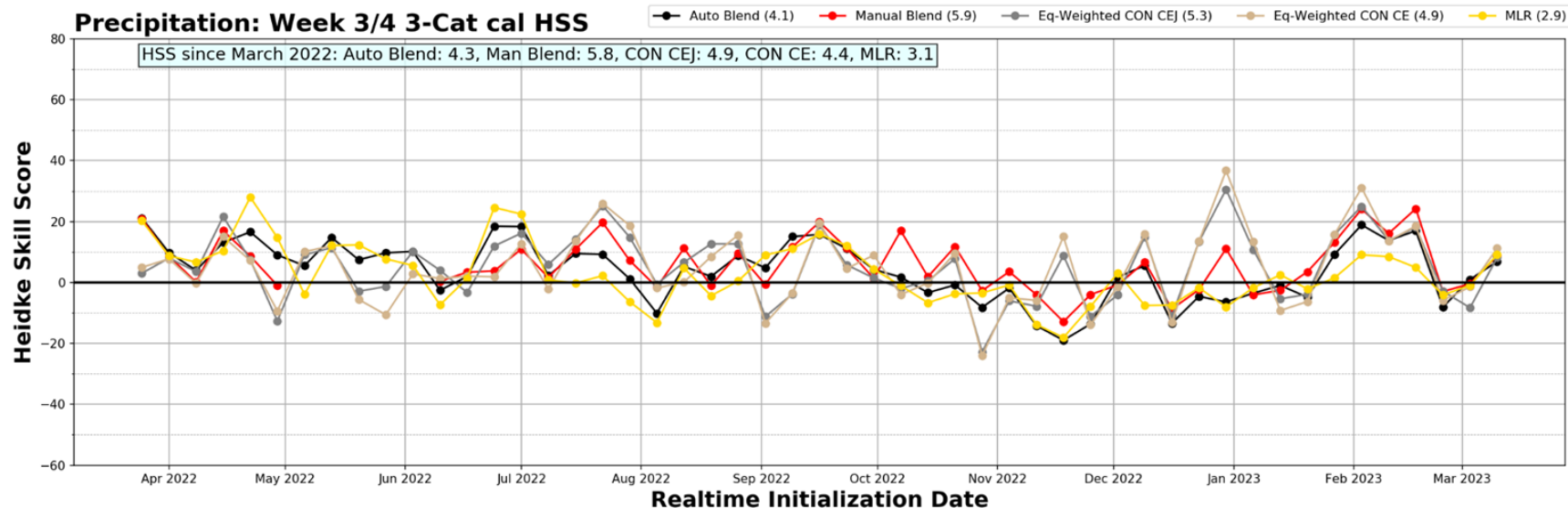
Examples of 3-class probabilistic temperature forecasts from the dynamical models post-processed on the Ensemble Subsampling Page: **a) ECMWF** and **b) GEFSv12**

Dynamical Model Verifications



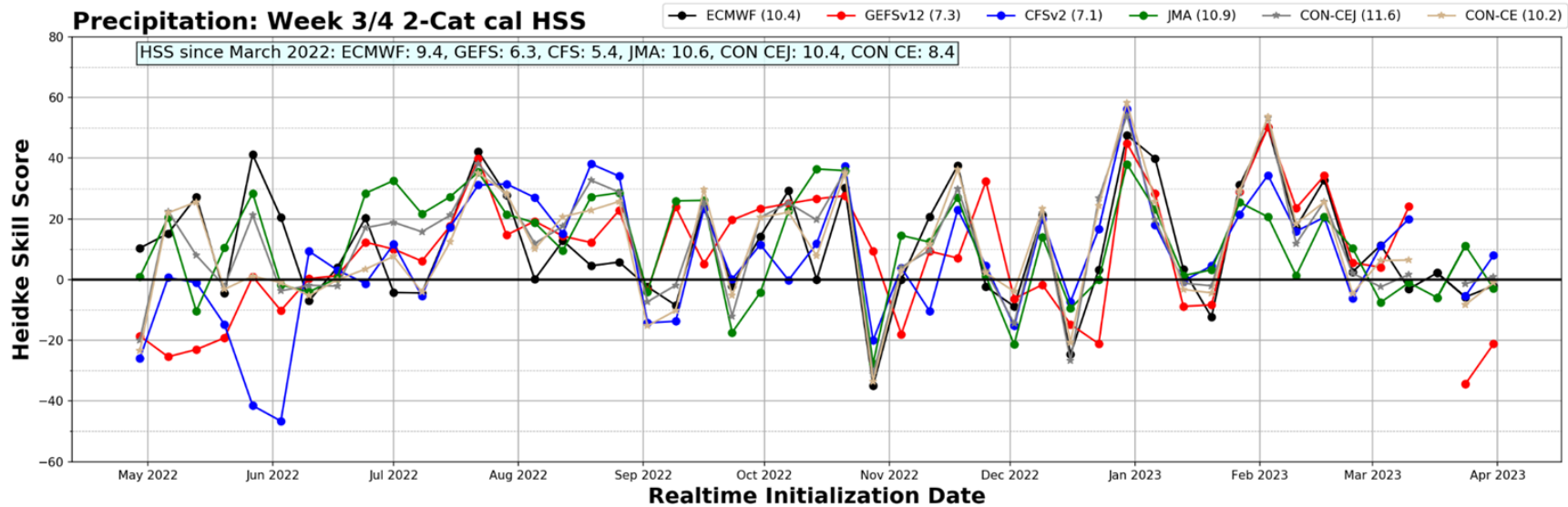
- 3-class Heidke Skill Scores (HSS) for probabilistic precipitation forecasts from the dynamical models
 - ~50% of their 2-class HSS counterparts
- Lower skill scores are partly attributable to near normal being forecasted much less than it is observed.

Consolidation and MLR Verifications



- 3-class HSS for probabilistic precipitation forecasts from the consolidations and the operational MLR
 - ~50% of their 2-class HSS counterparts

Dynamical Model Verifications (2-cat)



- 2-class Heidke Skill Scores (HSS) for probabilistic temperature forecasts from the dynamical models
 - ~160% of their 3-class HSS counterparts

Outline

- Project Background
 - 2-class versus 3-class products
- Key project results to date
 - Temperature Results
 - Updated climatological limits
 - Statistical models in 3-class system
 - Dynamical models in 3-class system
 - Consolidation products in 3-class system
- Current activities
- Summary