Sub-Seasonal Prediction skill of GEFSv12 for Atmospheric Rivers and Associated Precipitation Forecasts over the U.S. West Coast

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Background and Motivation:

- Accurate predictions of Atmospheric Rivers on an extended range/sub-seasonal time scale can be beneficial for various risk management sectors and for planning hydrometeorological applications.

- Global Ensemble Forecast System version 12 (GEFSv12) was made operational at NCEP in September 2020 to provide stakeholders with sub-seasonal forecasts for hydrological applications.

- GEFSv12 comes with 20-year reforecast data for 2000-2019, with 5 ensembles for up to 16 days, except on Wednesdays when the integration is extended to 35 days with 11 members.

- AR Prediction Skill of GEFSv12 Reforecasts is examined for Weeks 1, 2, 3 to 4, and Monthly scale along with inter-annual variability.

Data Used

Model : GEFSv12 (Zhou et al. 2019; 2021)

Period used : 2000-2019

**Horizontal Resolution** : 0.25° X 0.25° for Day-1 to 10 and 0.5° X 0.5° for Day-11 to 35.

Members used : 11 members ever wednsday 00 UTC initial conditions.

Reference data set : CMORPH Precipitation and ERA5 Reanalysis.

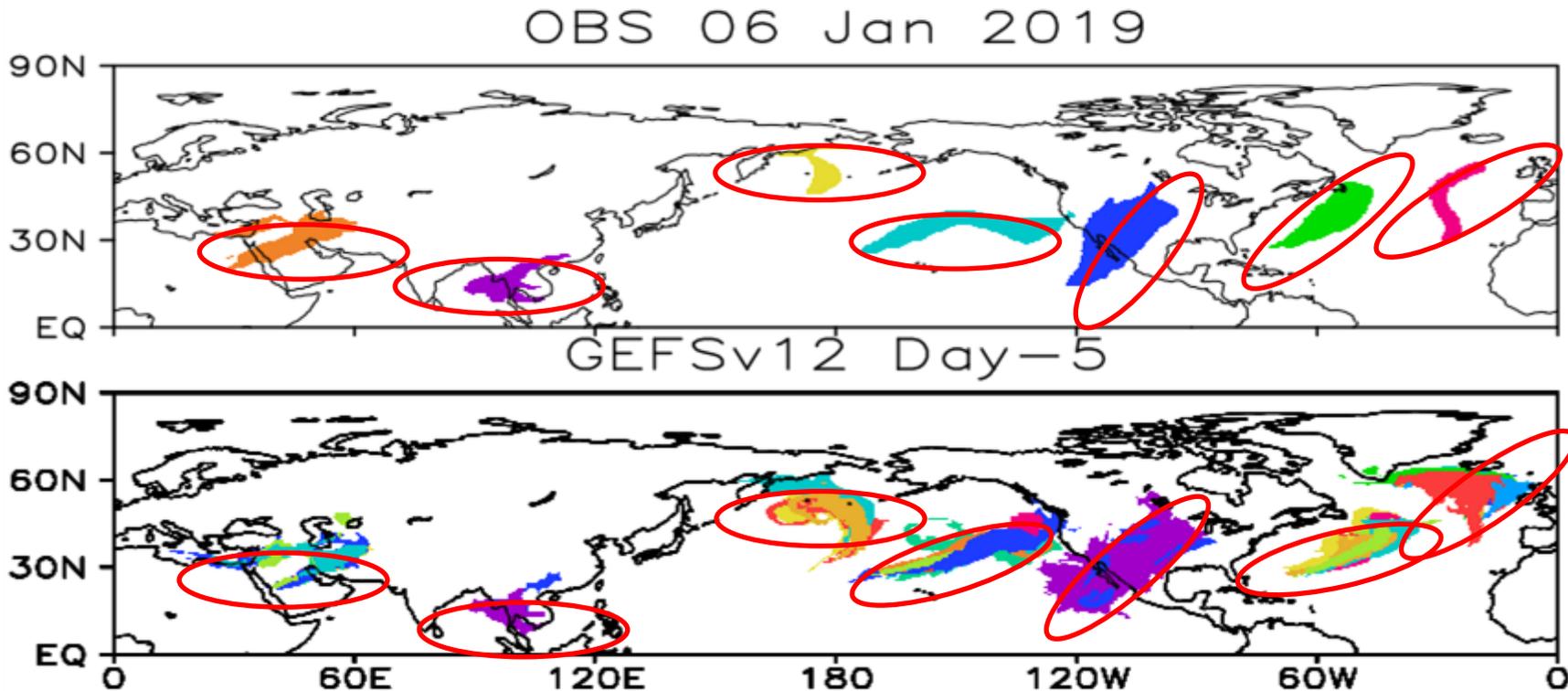**AR Detection Criteria:** Guan and Waliser 2019.

Performance of GEFSv12 in depicting AR over Northern Hemisphere with 11 members based on 02 Jan 2019 00UTC initial conditions
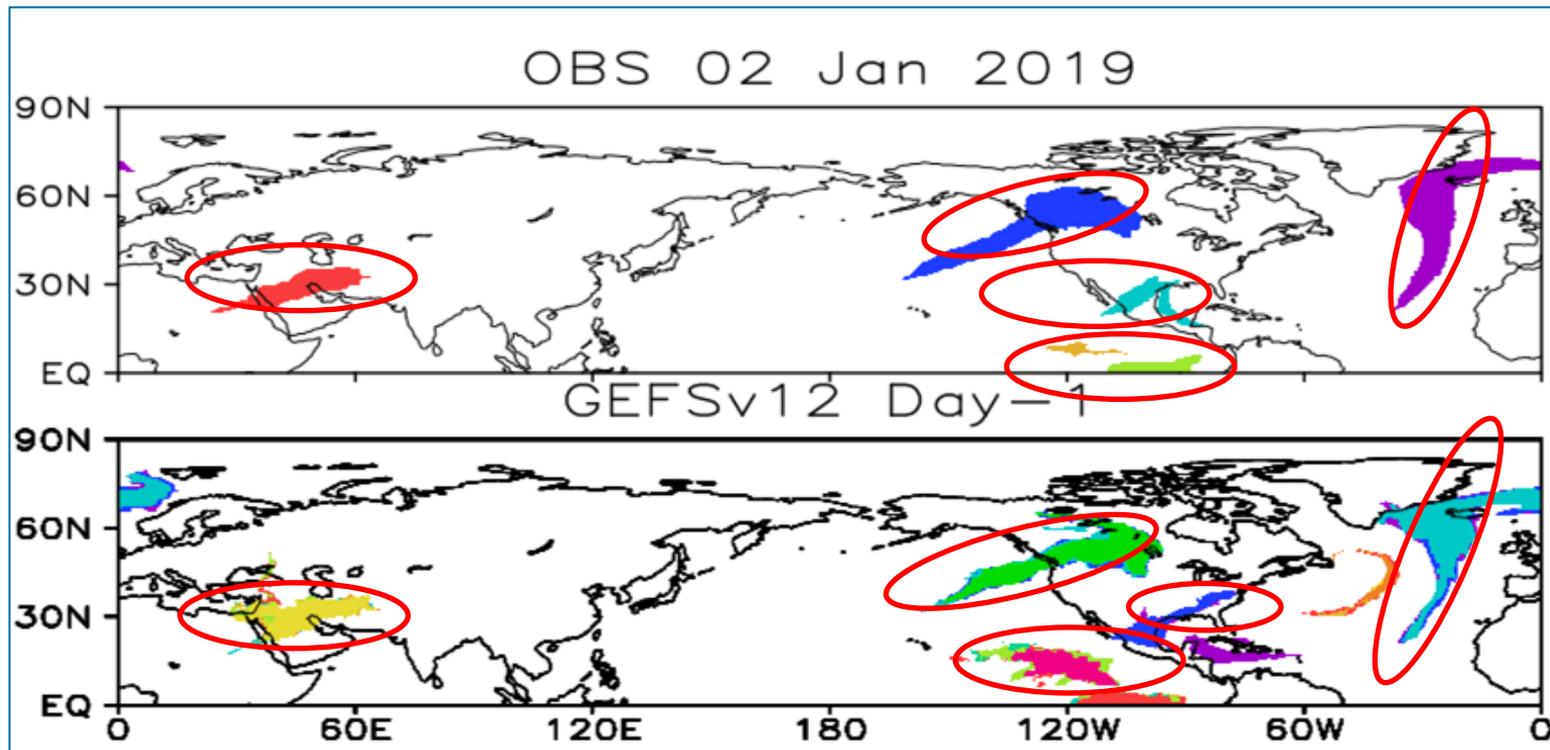
- **All members of GEFSv12 are good in detecting AR with Day-1 forecast lead time. The AR from all the members coincide.**

Performance of GEFSv12 in depicting AR over Northern Hemisphere for Day-1 to 35 lead time forecast with 11 members based on 02 Jan 2019 00UTC initial conditions


OBS 06 Jan 2019

GEFSv12 Day-5

- All members of GEFSv12 are good in detecting AR with Day-5 forecast lead time. The AR from all the members are coincide.

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Performance of GEFSv12 in depicting AR over Northern Hemisphere for Day-1 to 35 lead time forecast with 11 members based on 02 Jan 2019 00UTC initial conditions
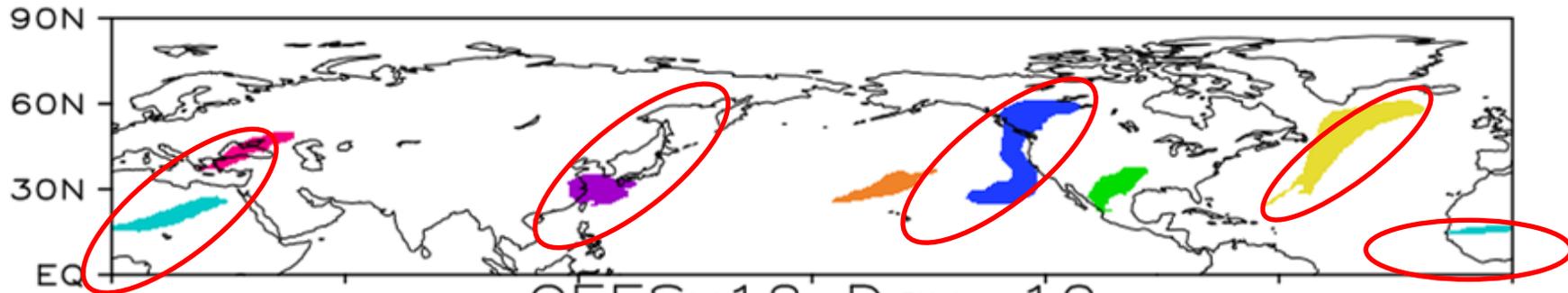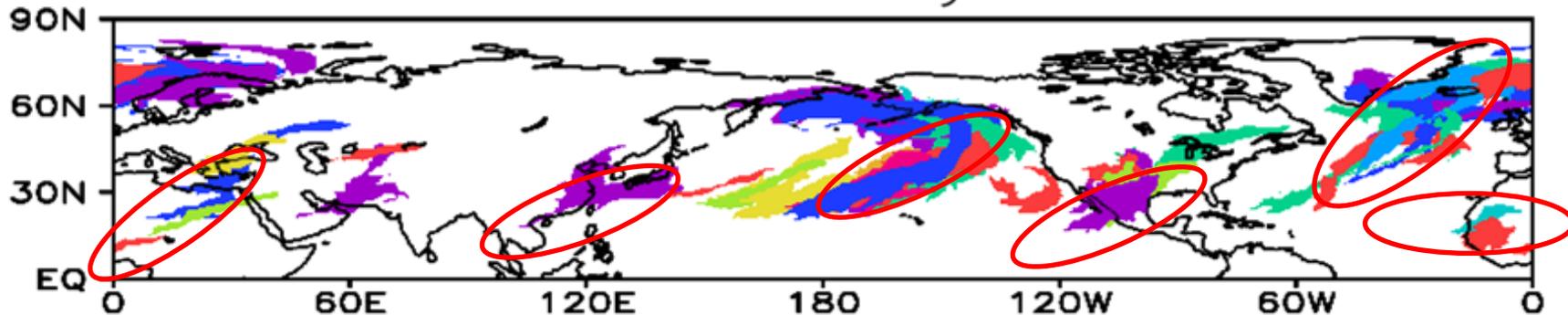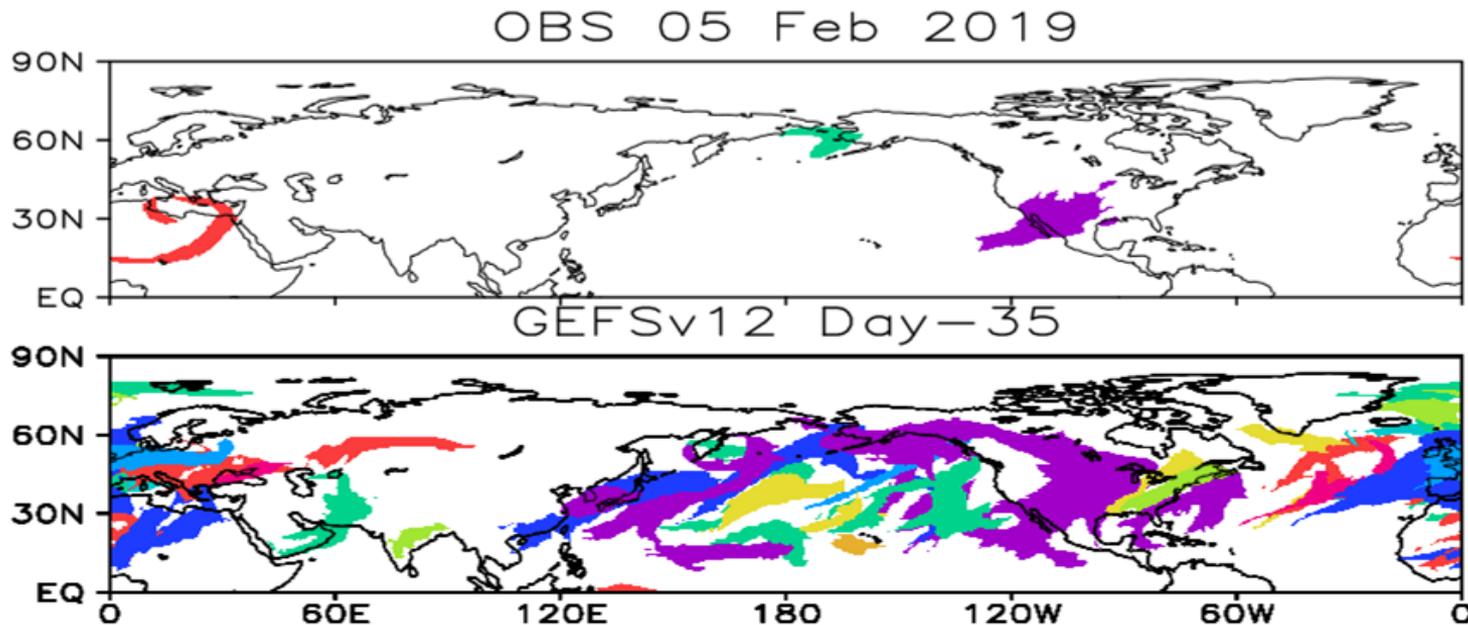

- **All members of GEFSv12 are good in detecting AR with Day-10 forecast lead time. The spread of AR region from ensemble members (the coincidence is decrease) increased with lead time.**

Performance of GEFSv12 in depicting AR over Northern Hemisphere for Day-1 to 35 lead time forecast with 11 members based on 02 Jan 2019 00UTC initial conditions

- **AR spread region from all members of GEFSv12 is increased with forecast lead time and it leads to low probability AR in large area and causes to overestimation of AR.**
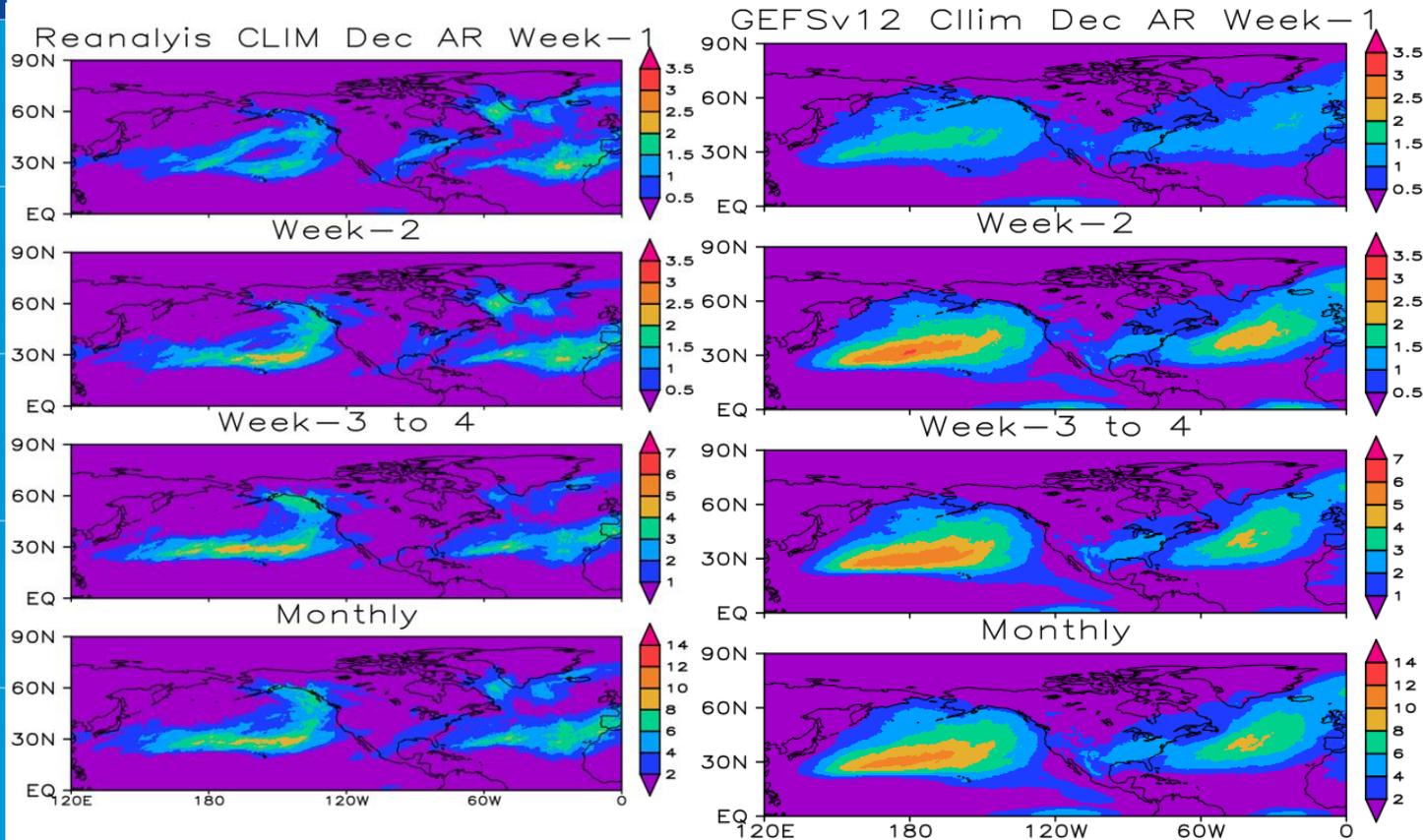
Spatial distribution of ARs during October from ERA5 Reanalysis and GEFSv12 (2000-2019)
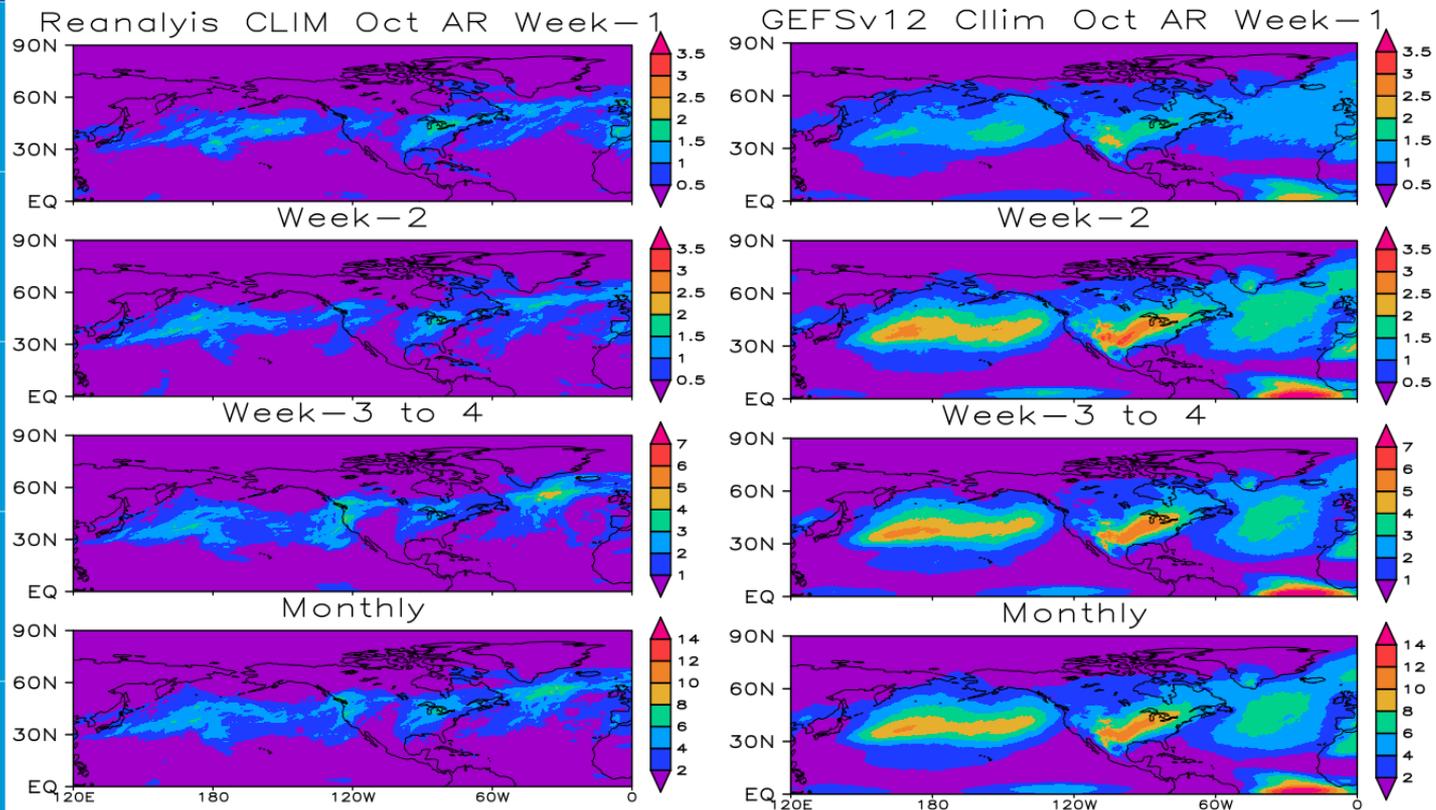
- **GEFSv12 well captured AR patterns compared to ERA5**
- **There is a large overestimation of AR from GEFSv12.**

- **The large AR region from GEFSv12 is due to the spread between the ensemble members.**

Spatial distribution of ARs during December from ERA5 Reanalysis and GEFSv12 (2000-2019)

- **GEFSv12 well captured AR patterns compared to ERA5**

- **There is a large overestimation of AR and increases with forecast lead times.**
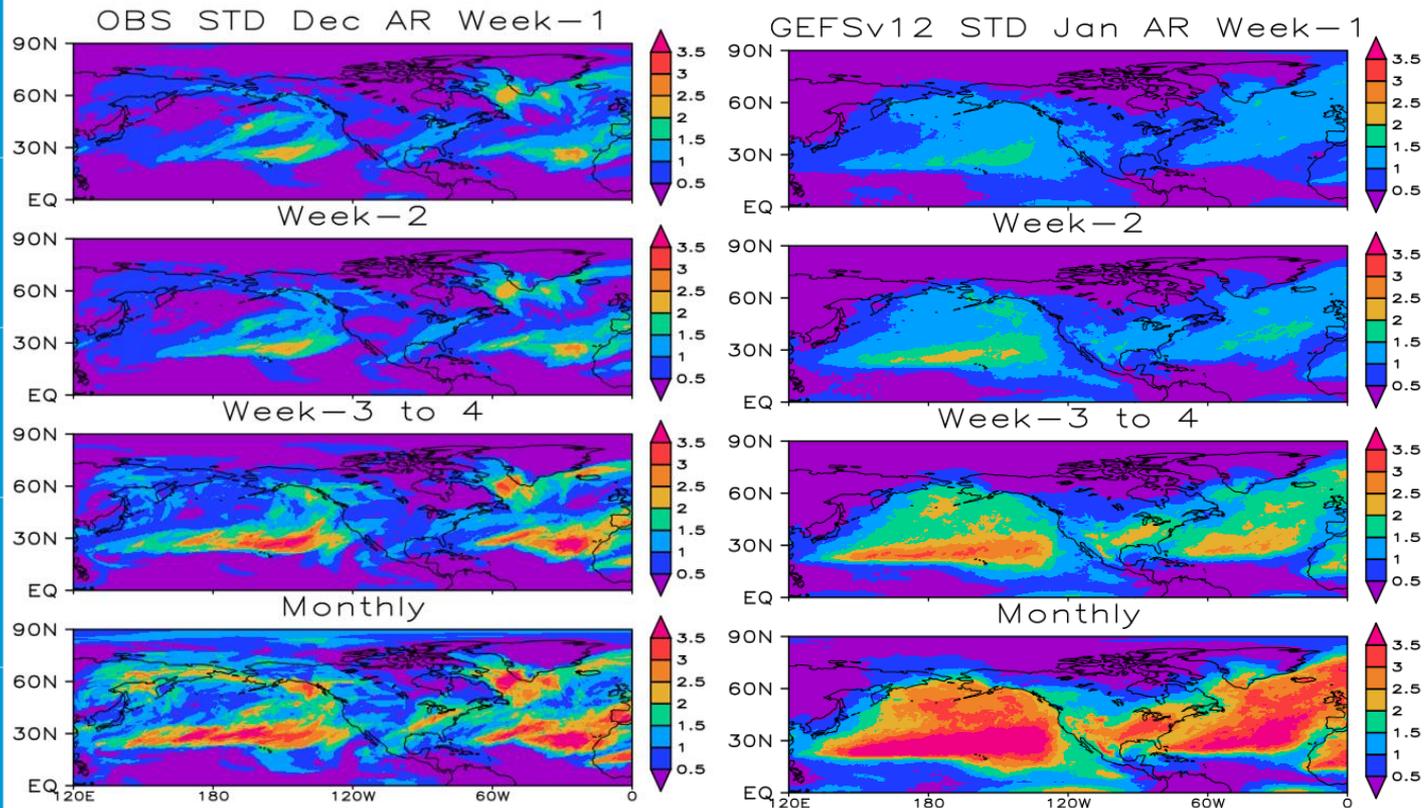
Spatial distribution of ARs during January from ERA5 Reanalysis and GEFSv12 (2000-2019)
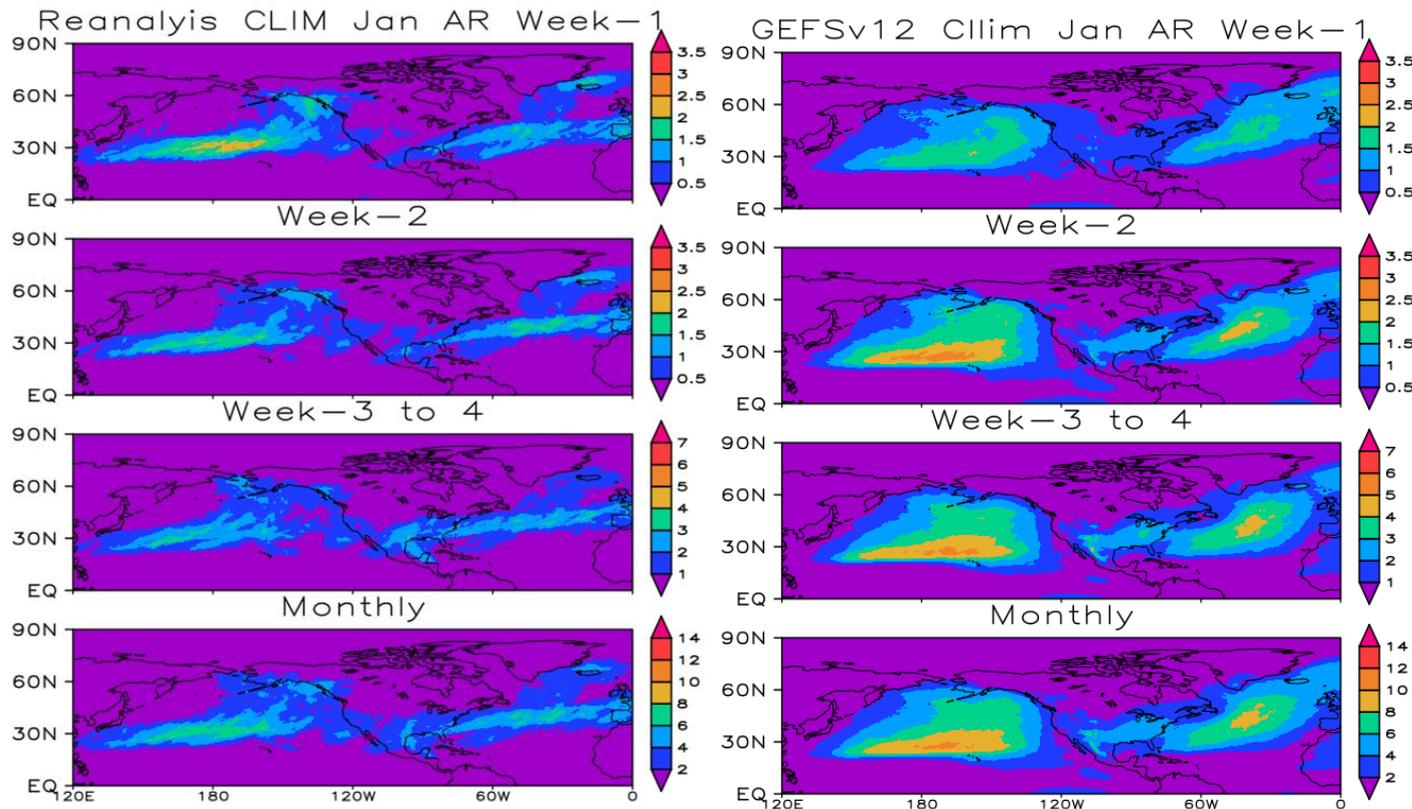
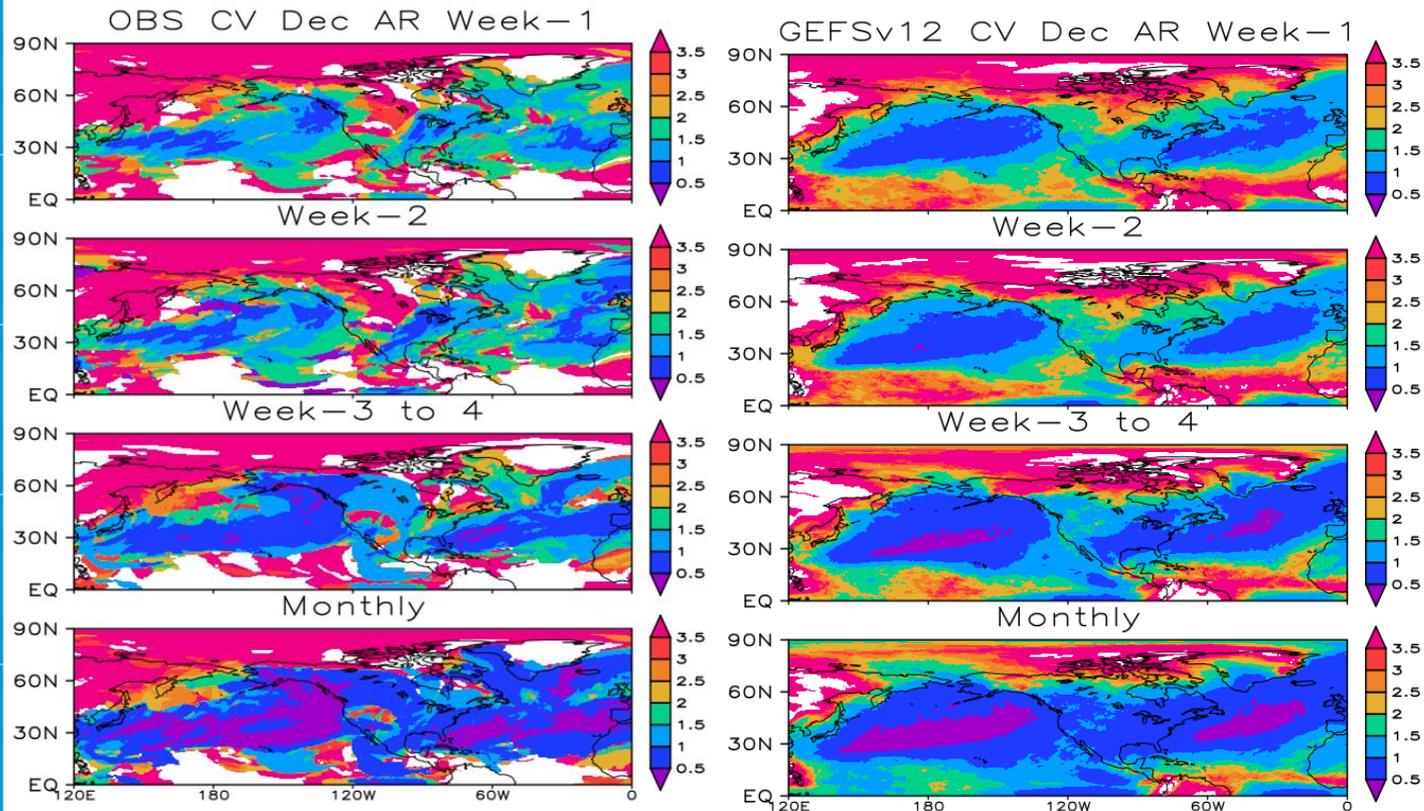- **GEFSv12 well captured AR patterns compared to ERA5**

- **Large overestimation of AR for forecast lead times.**

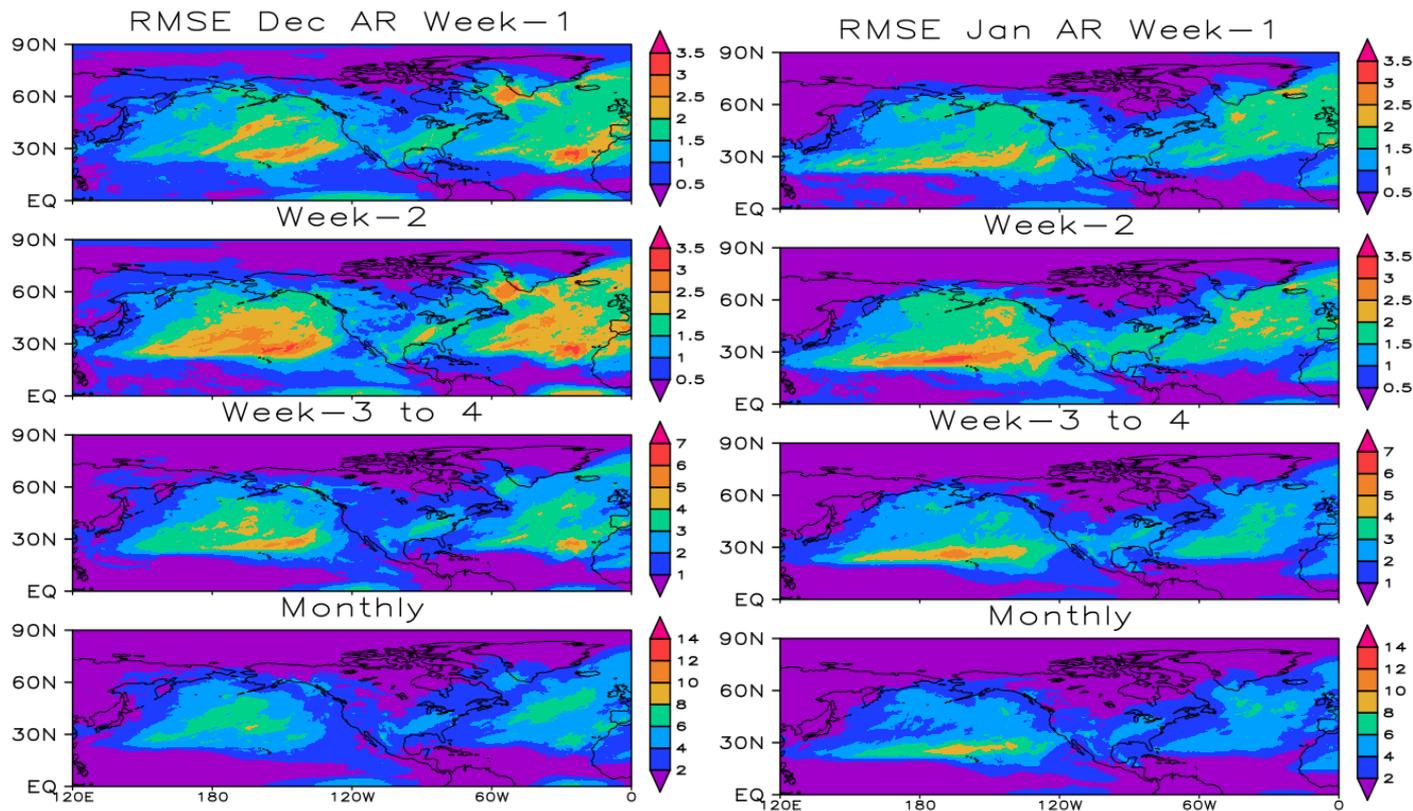# Inter-annual Variability (IAV) of ARs during December (2000-2019)

- **The IAV of AR increases with forecast length.**

# Coefficient of Variation (CV) ARs during December (2000-2019)

- **The CV pattern is opposite to the mean and IAV of AR patterns. The CV is decreases with forecast length.**

RMSE of GEFSv12 in depicting AR with December and January initial conditions
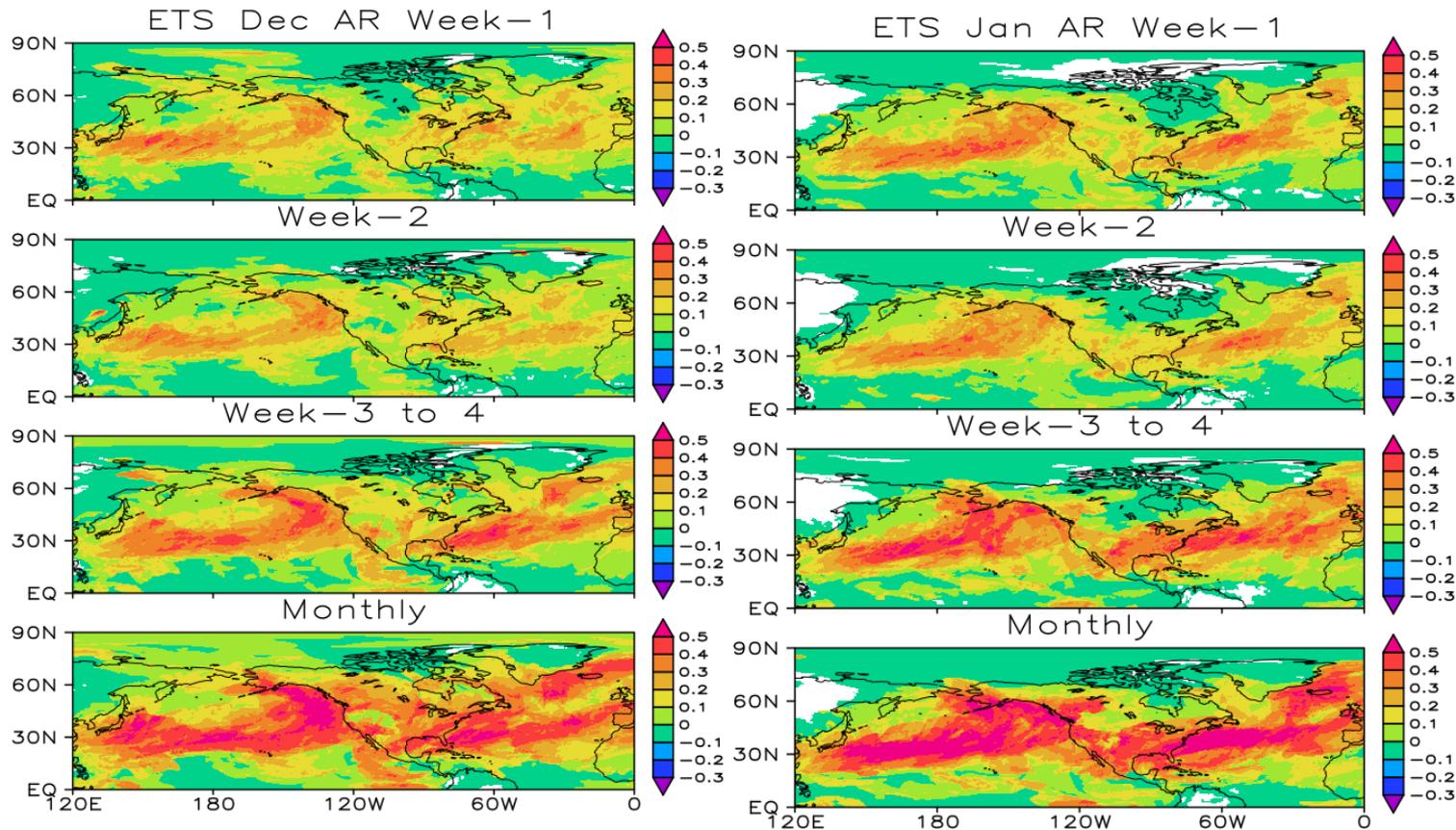

- **Large RMSE increasing with lead time and decrease with length of forecast scale.**

Index of Agreement of GEFSv12 in depicting AR with December and January initial conditions
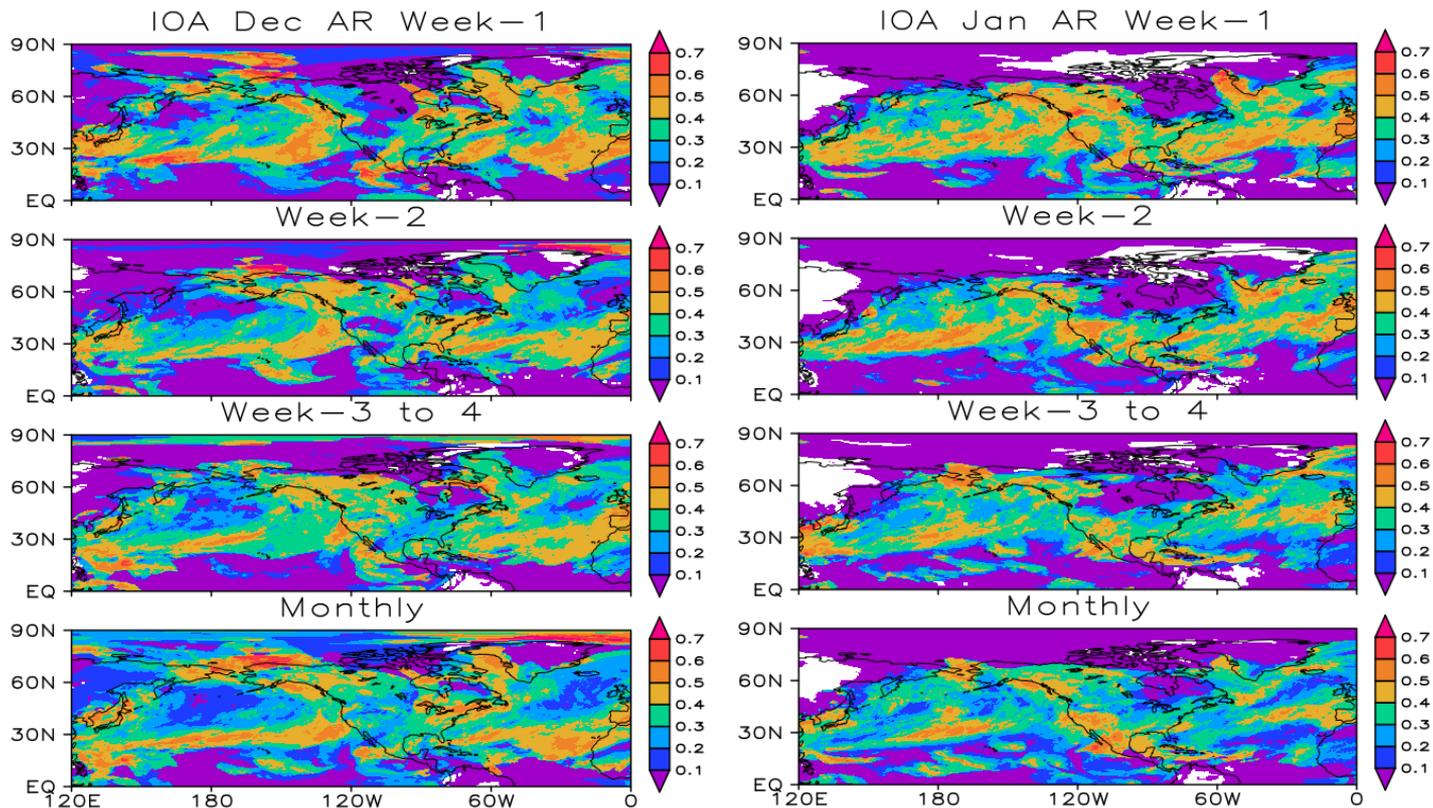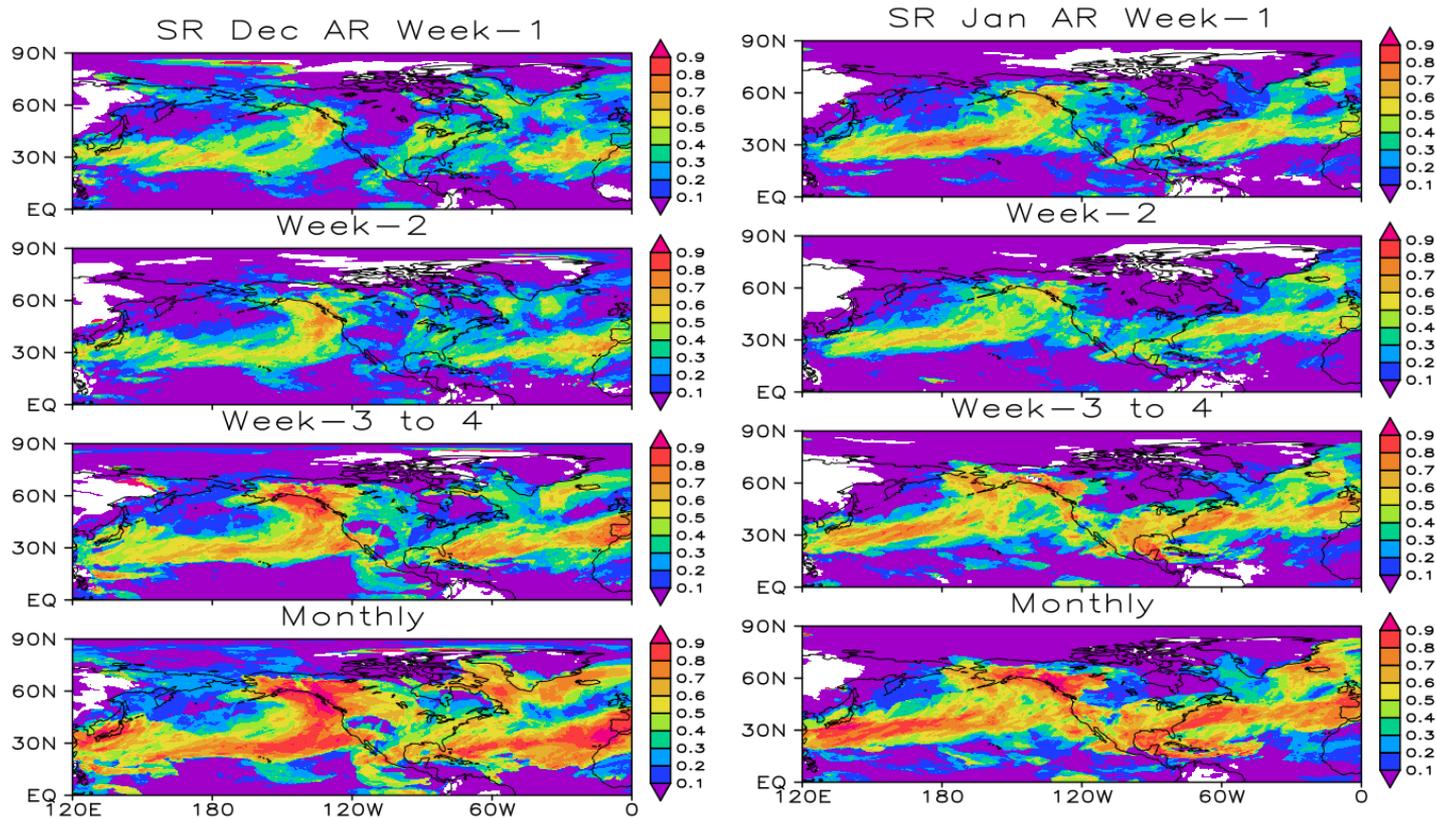

- **IOA is higher over prominent AR regions for all forecast lead times, decreasing with lead time.**

ETS of GEFSv12 in depicting AR with December and January initial conditions

- **ETS is higher over prominent AR regions for all forecast lead times. The ETS of AR increases with length of forecast scale.**

SR of GEFSv12 in depicting AR with December and January initial conditions
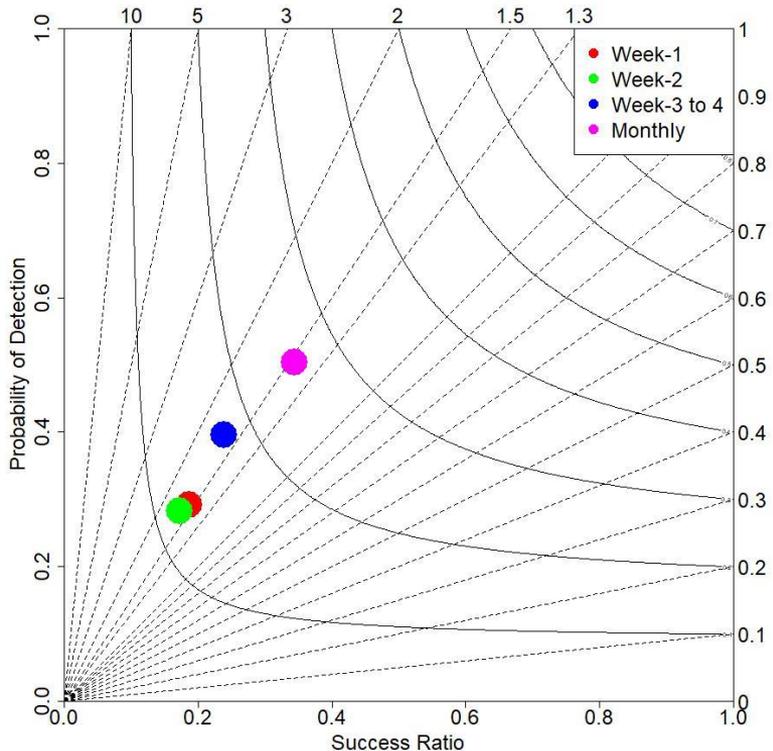

- **SR is higher over prominent AR regions for all forecast lead times. The SR of AR increases with length of forecast scale.**
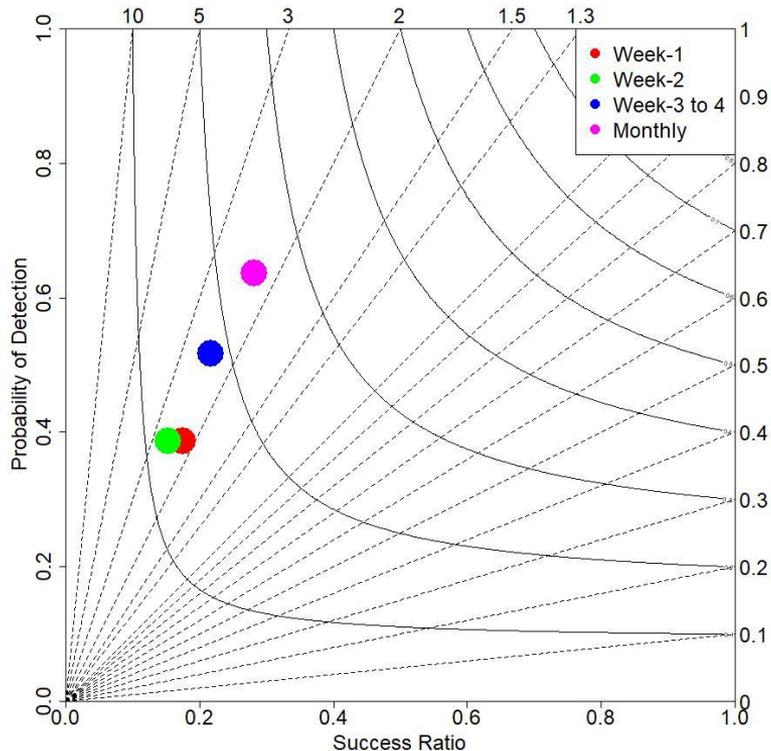
Categorical skill Scores of GEFSv12 in depicting AR with December and January initial conditions

Perf. Diagram for Dec AR on Week-1,2,3 to 4 and Monthly scale

Perf. Diagram for Jan AR on Week-1,2,3 to 4 and Monthly scale

- **Most of Categorical skill Scores are relatively higher over prominent AR regions for all forecast lead times. These skill score are increases with length of forecast scale.**

Composite AR precipitation mean (mm) for Week-1, 2, 3 to 4 and Monthly scale from CMORPH and GEFSv12 in with January conditions based on ERA5 AR.
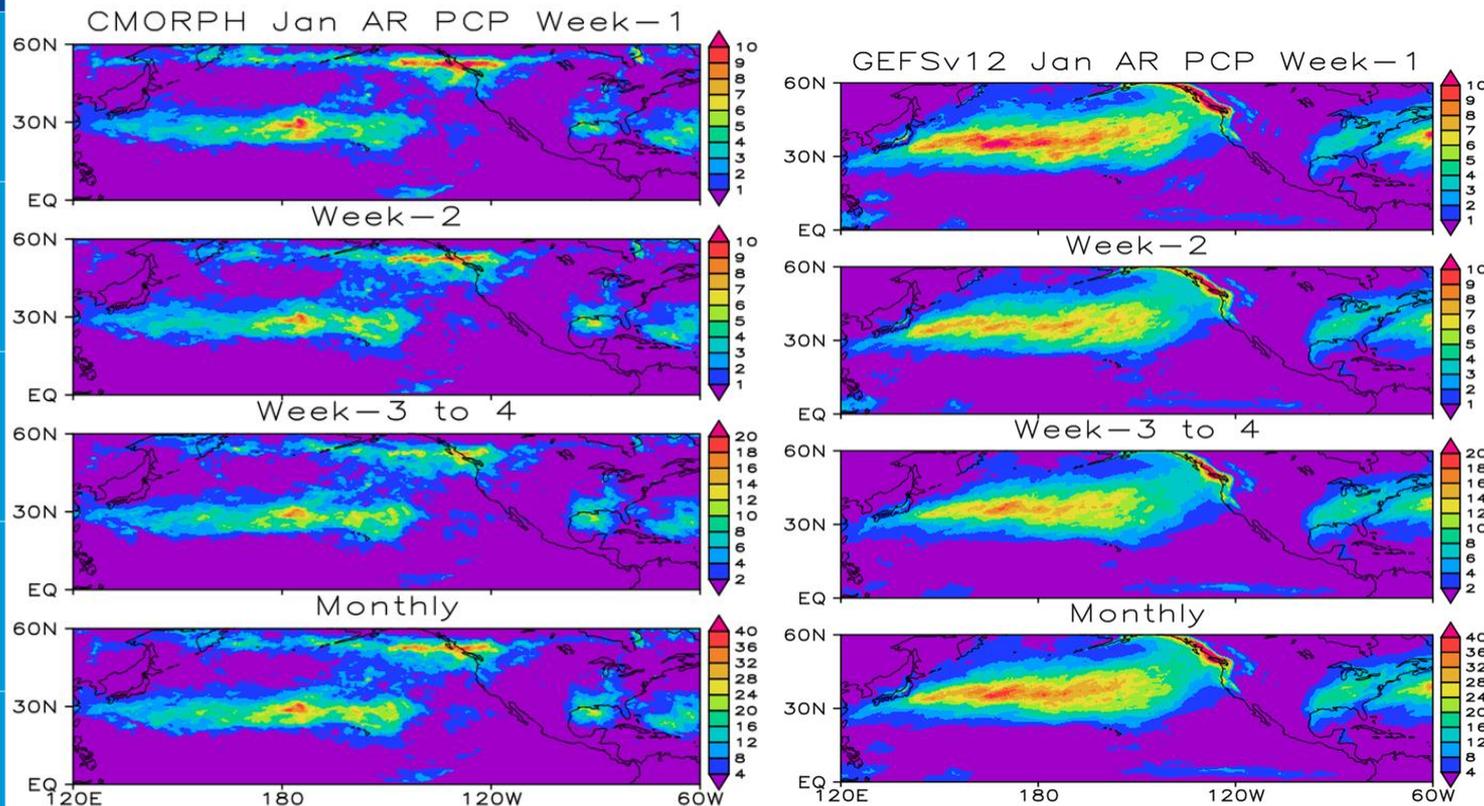
- **The composite AR precipitation patterns is similar to CMORPH.**

- **Overestimation of precipitation and larger area of AR precipitation occurrence.**

Summary & Conclusions

➢ **GEFsv12 was able to capture the spatial patterns of ARs over the North Pacific for Week-1, 2, 3 to 4, and Monthly time scales. Interannual Variability (IAV) is overestimated for longer lead times and Coefficient of Variation decreased with lead time.**

➢ **GEFSv12 has good prediction skills (CC and IOA) for Weekly ARs, particularly in regions where ARs are prominent.**

➢ **Hit rate/ POD (>0.8), ETS, SR, FAR, and TS are all higher over prominent AR regions with low false alarm rate and a high success rate (SR > 0.6) in prominent AR regions.**

➢ **The accuracy of weekly/monthly ARs can be improved by implementing an appropriate calibration technique.**

Thank You