Probabilistic multi-model sub-seasonal climate forecasts using skill-based model weighting

Bohar Singh, Andrew Robertson, Michael Tippett and Nachiketa Acharya
International Research Institute for Climate and Society (IRI),
Columbia University, Palisades, NY

Problem Statement

- Can differential model weighting MME improve probabilistic forecast skill as compared to equally weighted MME?

- In this study, we examine this question based on historical forecast performance at sub-seasonal time-scales from SubX hindcasts of precipitation over North America.

Model and data description

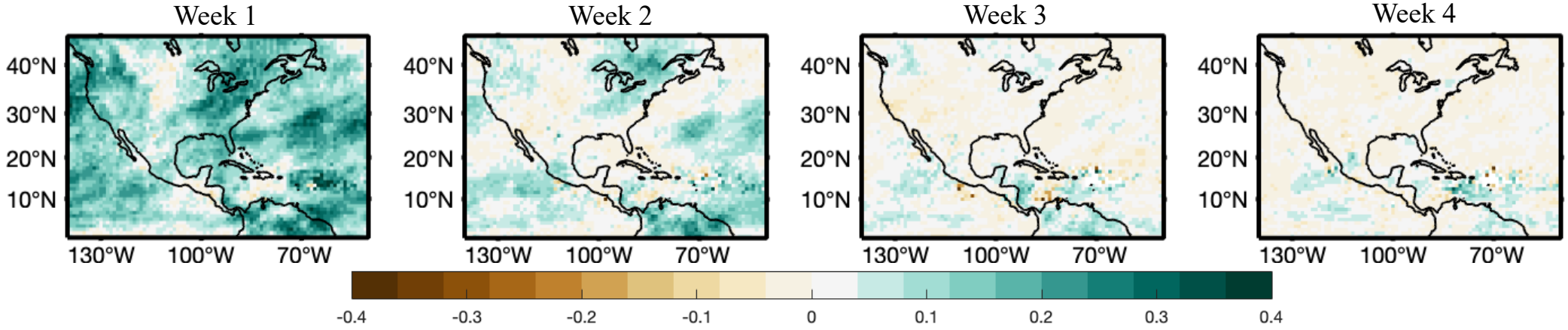
Models: CFSv2 , GEFS, ESRL
Data period: Hindcast from 1999-2014
Method: Weights based on existing cross-validated RPSS

- RPSS<=0 are set equal to zero
- Now at each grid point weight are calculated by weighted mean of RPSS and weighted mean of √RPSS as follows:

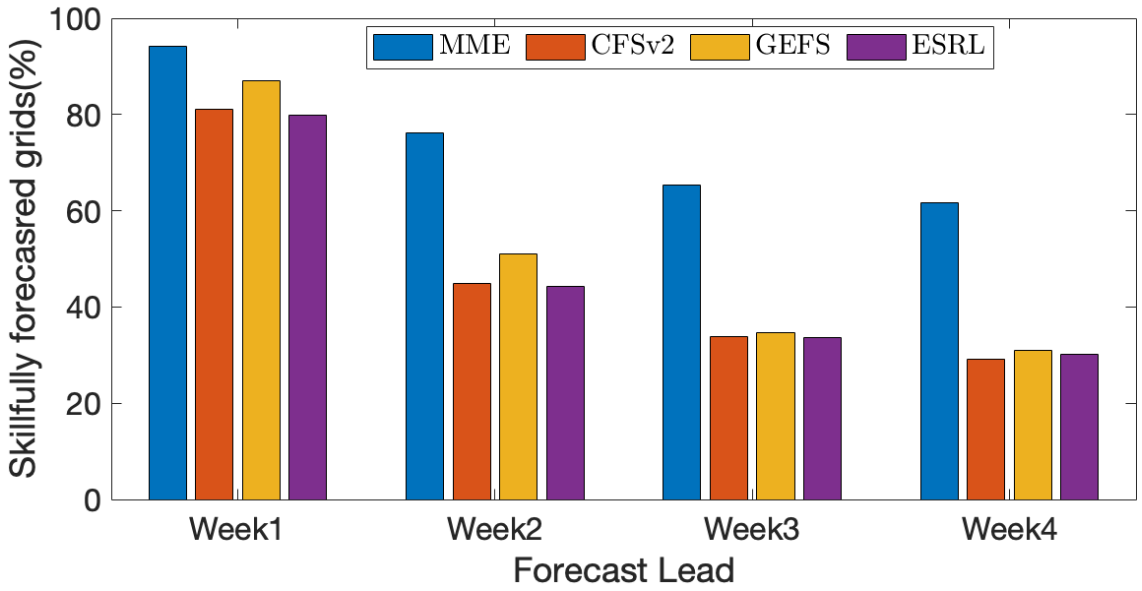
$$w1_{i,j,k,m} = \frac{RPSS_{i,j,k,m}}{\sum_i^n RPSS_{i,j,k,m}} \quad \text{and } w2_{i,j,k,m} = \frac{\sqrt{RPSS_{i,j,k,m}}}{\sum_i^n \sqrt{RPSS_{i,j,k,m}}}$$

here i represent model, j and k represent grid position and m stand for month. $w1$ *and* $w2$ *are weights claculated from both methods*

Rank Probability Skill Score (RPSS) for January (1999-2014)

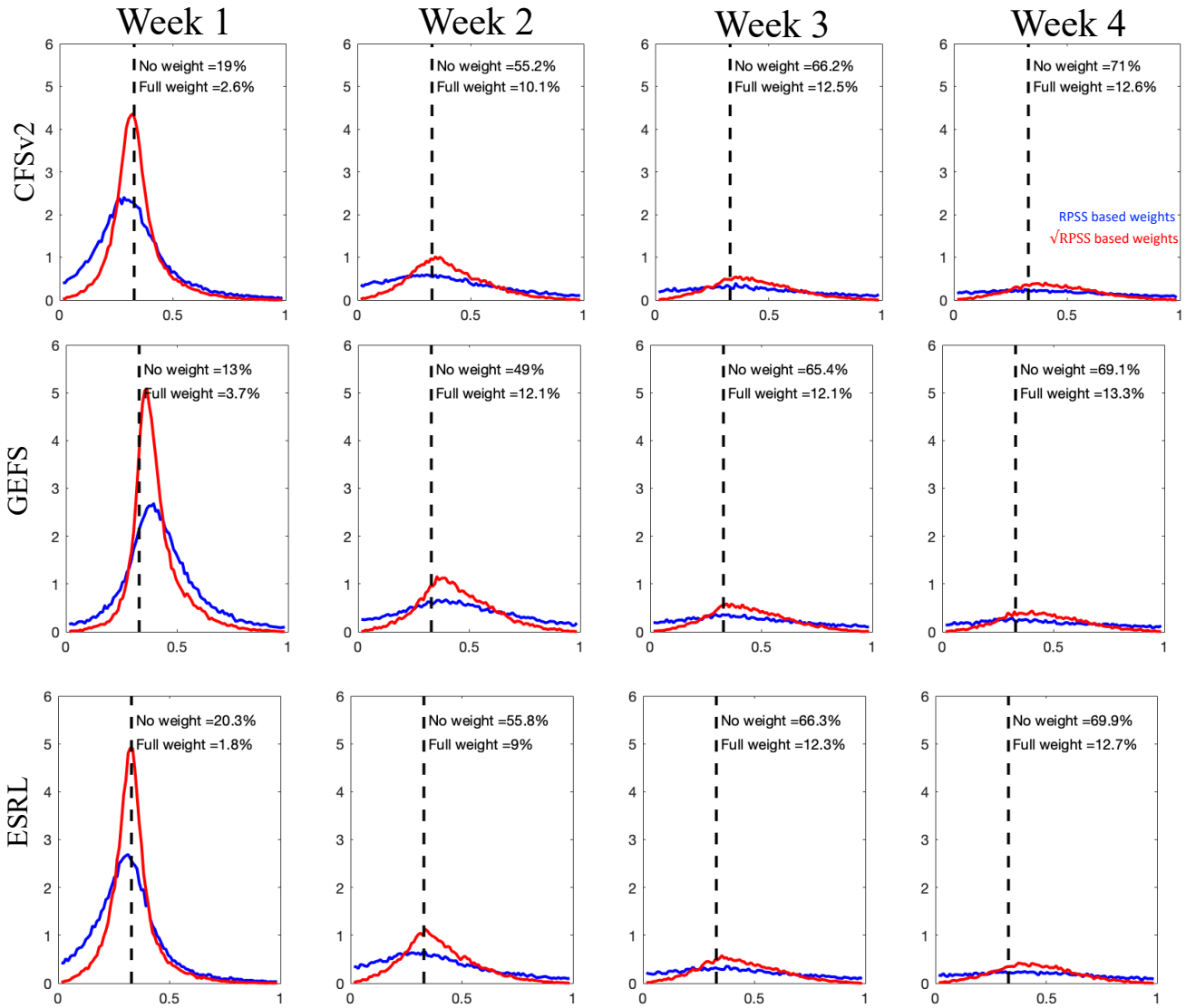


Fraction of skillful grid-points (RPSS>0)

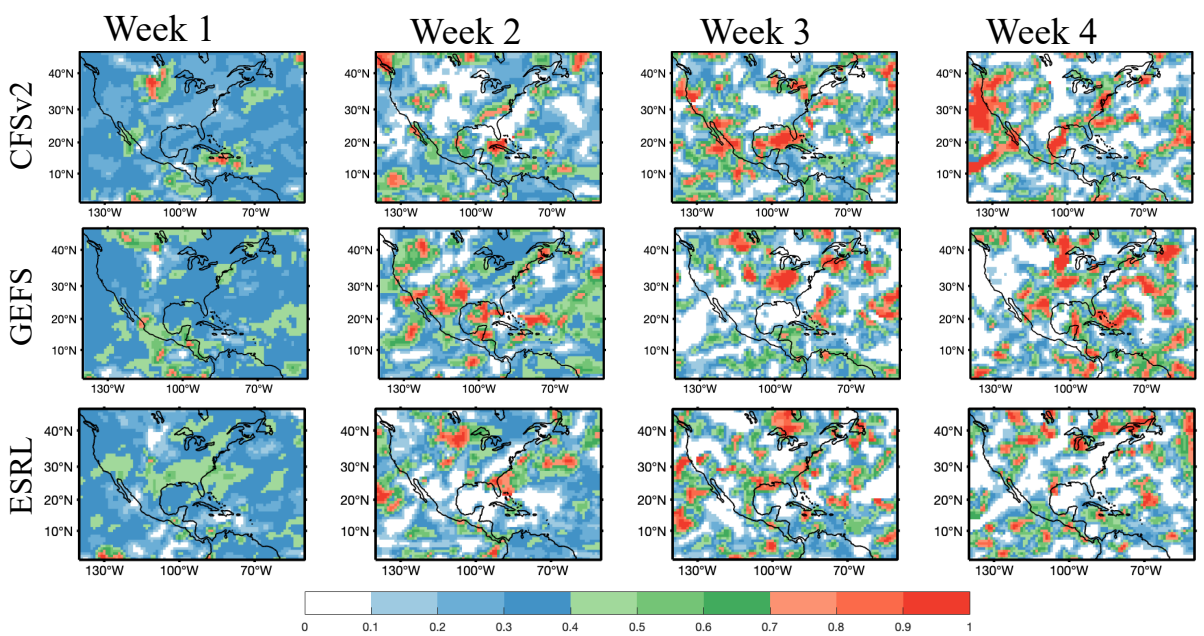


- Fraction of skillfully predicted area deceases rapidly after week 1 for individual models
- GEFS getting slightly higher weights in first week
- √RPSS based weights less strict and favor democracy as compared RPSS based weights
- At week 4, Individual model remain skillful only over ~30% region, while MME is skillful at ~60% of region
- Adding more models into forecast system may increase coverage of skillfull prediction

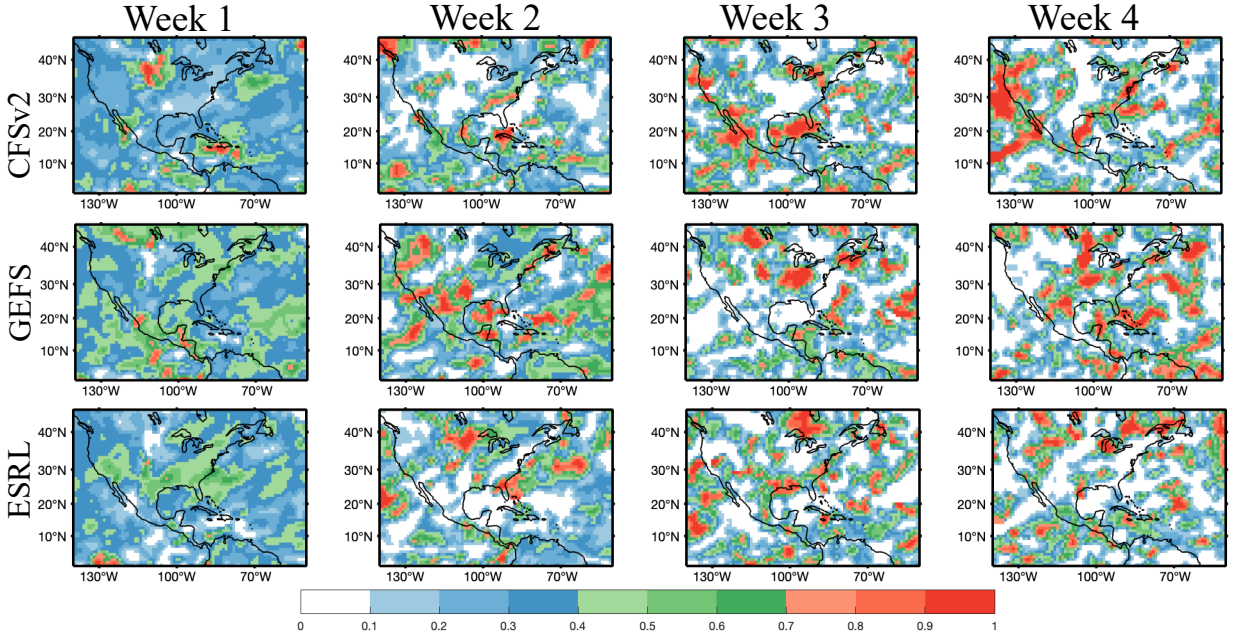
Model weights distribution over (0° − 55N°, 230°E − 320E°)



RPSS based weights (January)

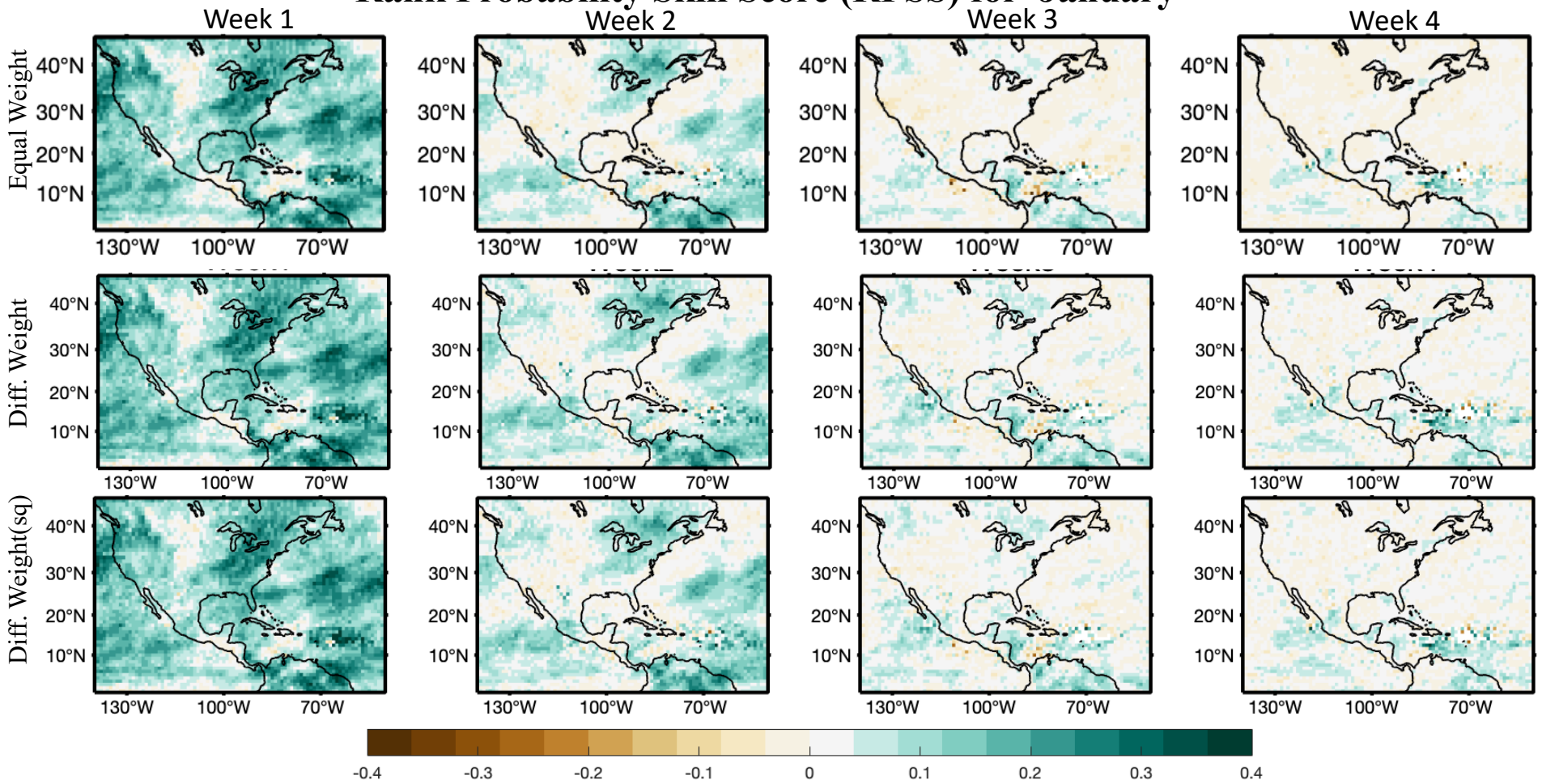


√RPSS based weights (January)



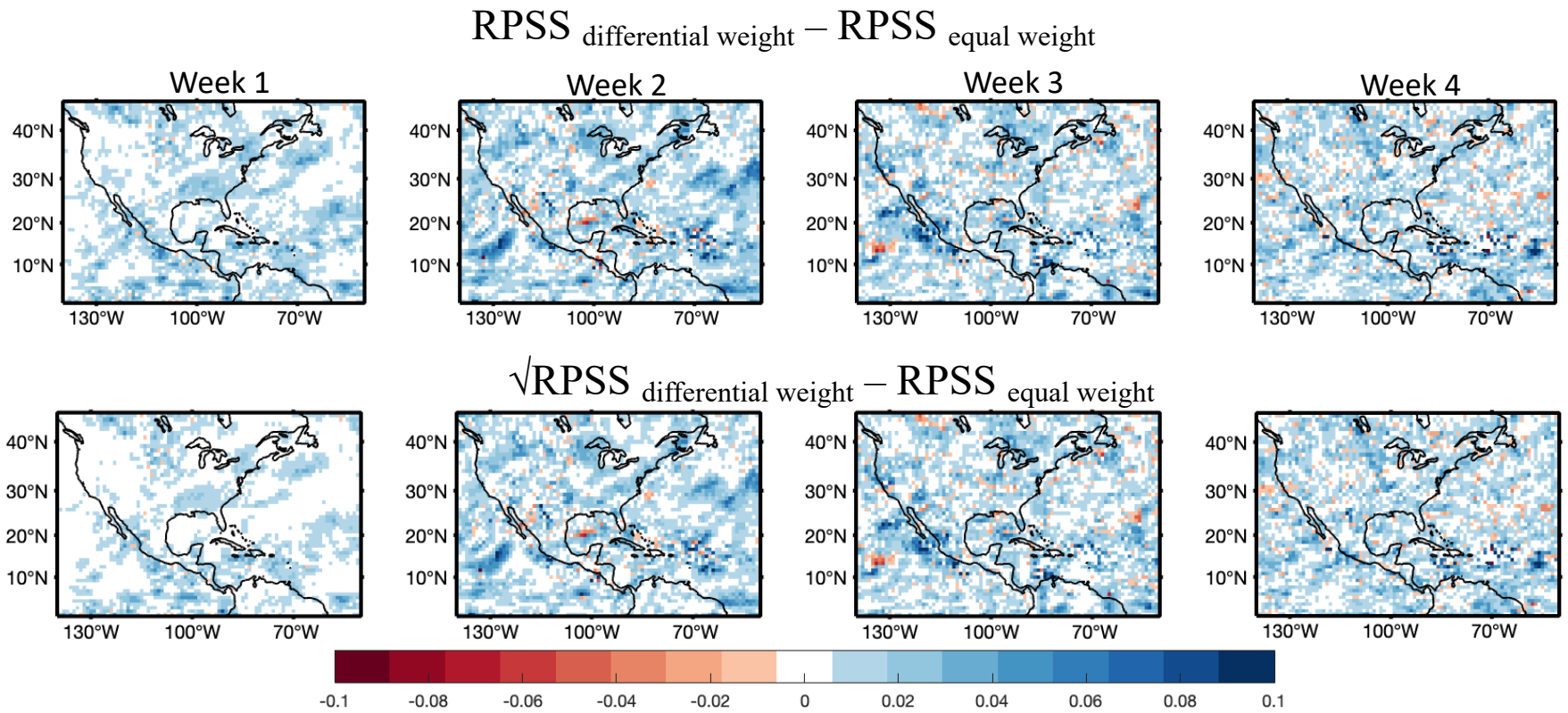
- Weights were noisy and Gaussian smoothing of one standard deviation is applied
- Weights from both of the methods are very similar
- During week 1, all model weights remain close 0.33 (equal weight)
- Single model weights contribution to MME increased after week 1

Rank Probability Skill Score (RPSS) for January



In sample, probabilistic skill slightly increased in differential model weighing based MME as compared to equally weighted MME RPSS looks identical in both of skill basses MME methods.

However models are getting higher weights on week 3 and 4 but individual models are less skillful at longer leads.



Conclusions:

- RPSS are slightly improved by combining forecast information on the basis of individual model performance
- MME on the basis RPSS and √RPSS based method perform equally well.
- Adding more models into MME may increase coverage of skill area but lack of skill at longer leads is challenging
- Improvement in RPSS will tested on independent forecast over the period of 2017-Present
- Bi-weekly averaged forecast at longer leads will be explored in future