Evaluation of initial condition blending within MPAS to inform RRFSv2

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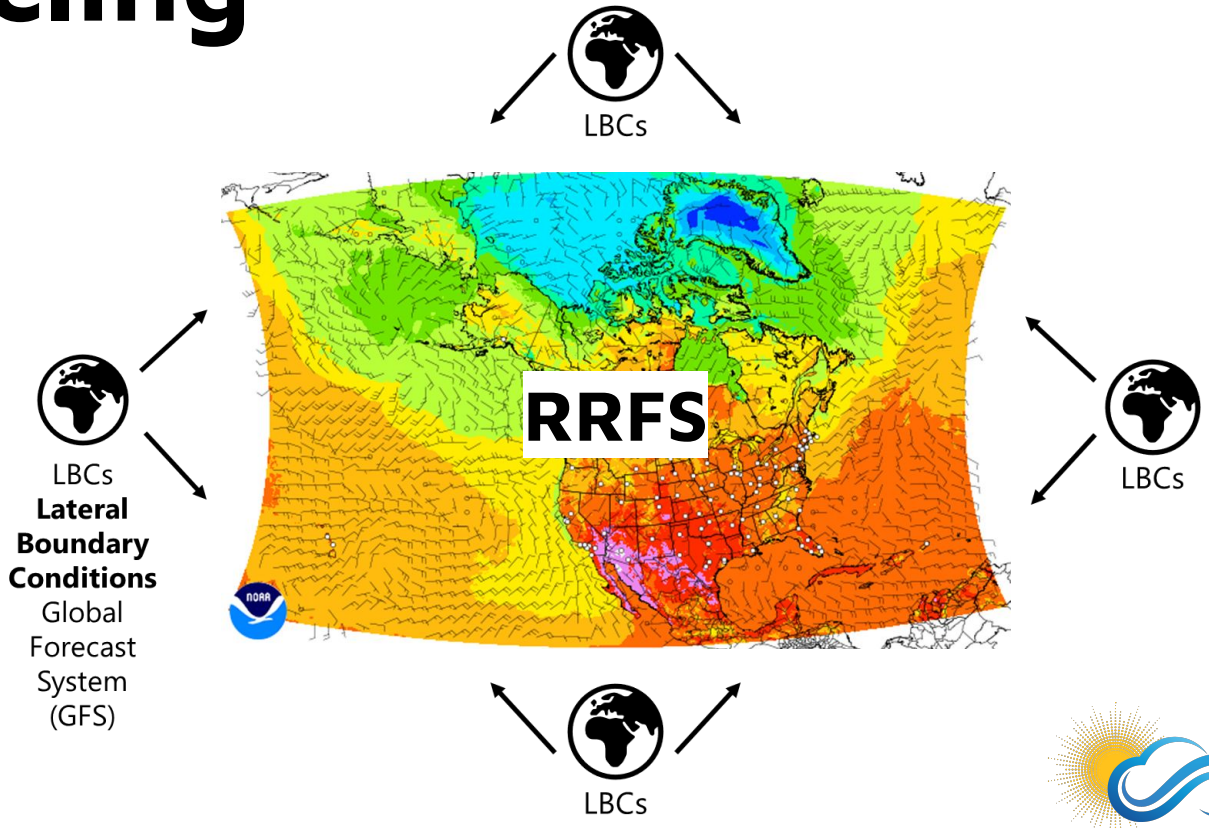
Partial Cycling

The **interruption of continuous cycling** to restart and force regional simulations with global data to **prevent model drift**



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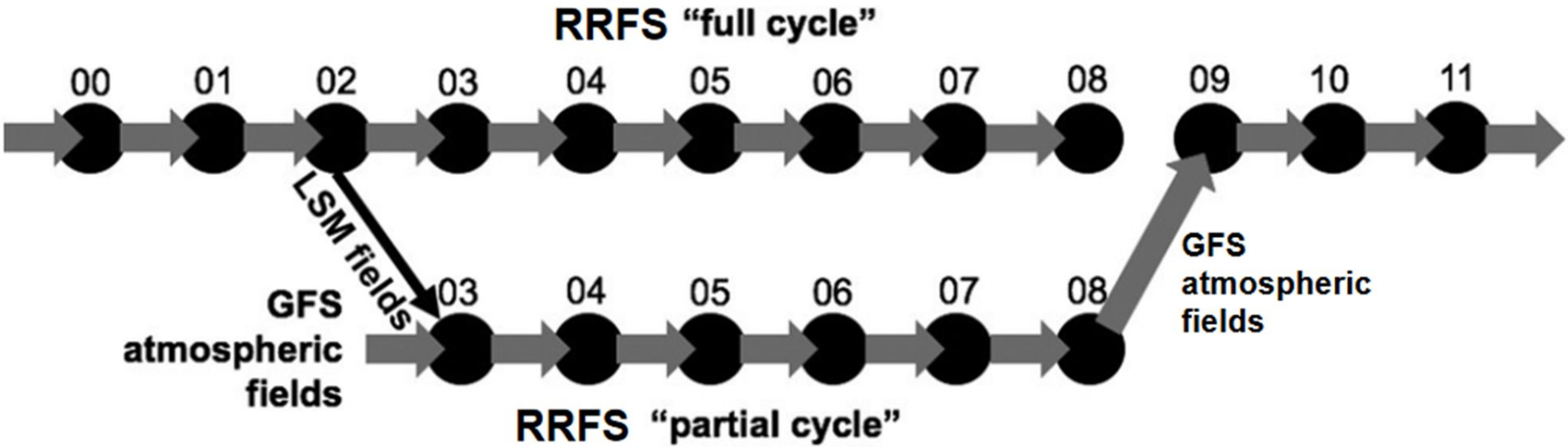
Partial Cycling



Computationally expensive and complex

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Initial Condition (IC) Blending

Blend higher resolution **regional ICs** with coarser resolution **global ICs**

- 3km Ensemble Kalman Filter (**EnKF**) Analyses → $\mathbf{S_1}$
- 0.25° (28km) Global Forecast System (**GFS**) → $\mathbf{L_1}$

3km GFS

3km EnKF

Native Highest Resolution Mesh

1) Interpolate global ICs (L_1) to MPAS native 3km mesh; the regional ICs (S_1) are already on the native mesh

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Initial Condition (IC) Blending

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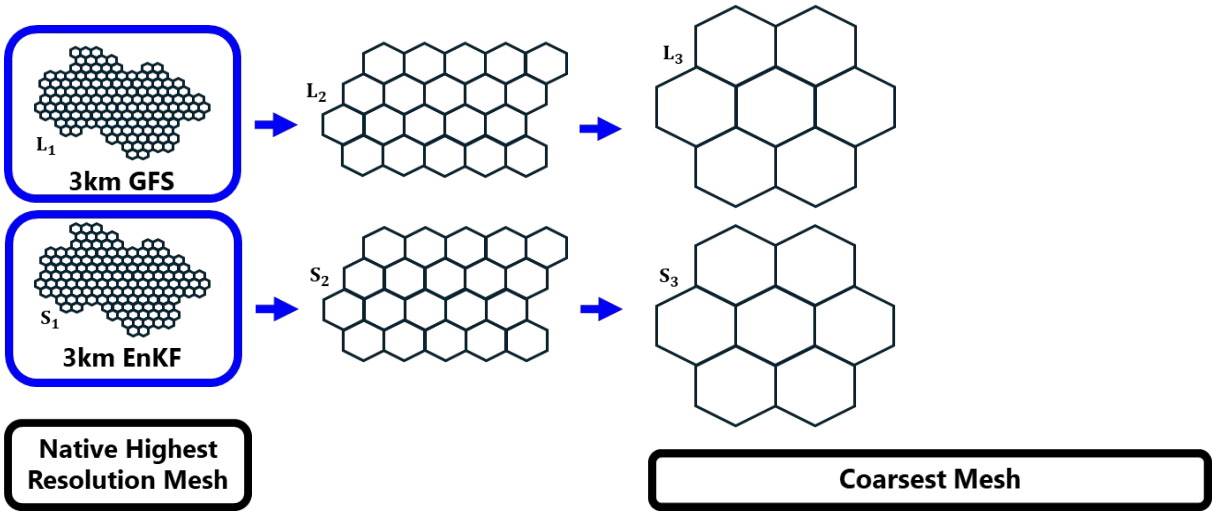

2) Upscale the small-scale (S) & large-scale (L) data

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Initial Condition (IC) Blending

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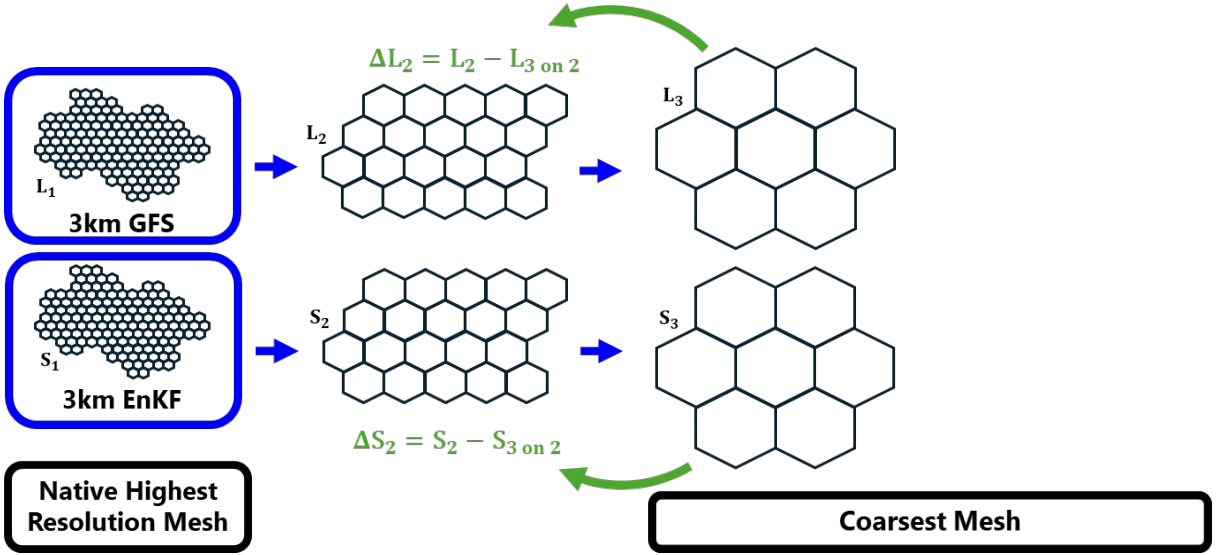
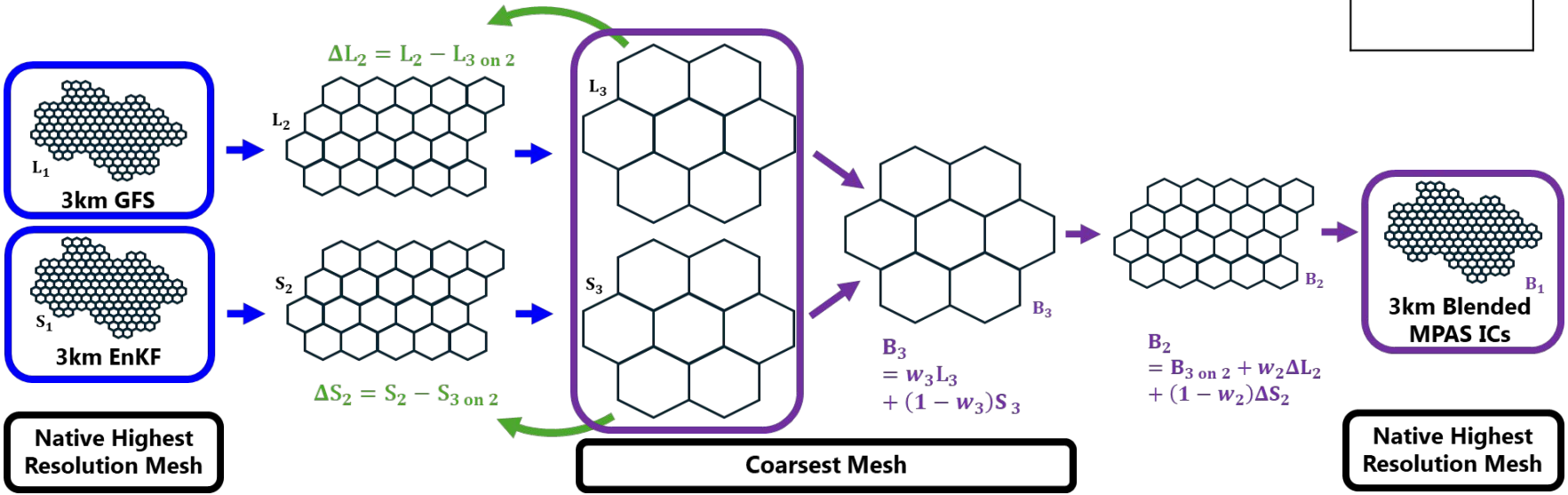


3) Calculate perturbations (Δ)

Initial Condition (IC) Blending

Blend higher resolution **regional ICs** with coarser resolution **global ICs**

Control Weights	
Mesh	Weights ← w
3km	0
7.5km	0
15km	0
30km	**0.05**
60km	**0.1**
120km	**0.25**
140km	**0.5**
384km	**0.75**
480km	**1**



4) Downscale & blend data with specified weights (w; Table)

Why does IC blending work?

Blending **perturbations (Δ) store scale-dependent information** and are **weighted (*w*)** to **tailor contributions** from larger- and smaller-scale information.

Larger weights are assigned to the datasets that provide the large-scale fields for a given mesh and wavelength.

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Goal of this Study

To **inform the development of RRFSv2** about using IC blending instead of partial cycling

Is there a benefit in using IC blending in our regional simulations that would allow us to **forgo partial cycling**?

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Research Questions

Are regional MPAS simulations
sensitive to different
blending weight distributions?

Is there a **“best”** weighting distribution?

Simulation Setup - Regional MPAS

- **Model**: MPAS Atmosphere; regional over CONUS
- **Initialization times**: 0000 UTC 01/03/05/07/12 May 2022 (5 days)
- **Regional ICs**: 3km partially cycled Ensemble Kalman Filter (EnKF) analyses from the RRFS DA system
- **Global ICs**: 0.25° (28km) Global Forecast System (GFS)

Control Weights		Weights 6		Weights 9		Weights 13		Weights 14	
Mesh	**Weights**	**Mesh**	**Weights**	**Mesh**	**Weights**	**Mesh**	**Weights**	**Mesh**	**Weights**
3km	0	3km	0	3km	0	3km	0	3km	0
7.5km	0	7.5km	0	7.5km	0	7.5km	0	7.5km	**0.1**
15km	0	15km	0	15km	0	15km	**0.1**	15km	**0.2**
30km	**0.05**	30km	0	30km	0	30km	**0.2**	30km	**0.4**
60km	**0.1**	60km	0	60km	0	60km	**0.4**	60km	**0.5**
120km	**0.25**	120km	**0.1**	120km	0	120km	**0.5**	120km	**0.6**
140km	**0.5**	140km	**0.25**	140km	**0.1**	140km	**0.6**	140km	**0.75**
384km	**0.75**	384km	**0.5**	384km	**0.25**	384km	**0.75**	384km	**1**
480km	**1**	480km	**0.75**	480km	**0.5**	480km	**1**	480km	**1**
		960km	**1**	960km	**1**	960km	**1**	960km	**1**
						1920km	**1**	1920km	**1**

Less global information → **More** global information

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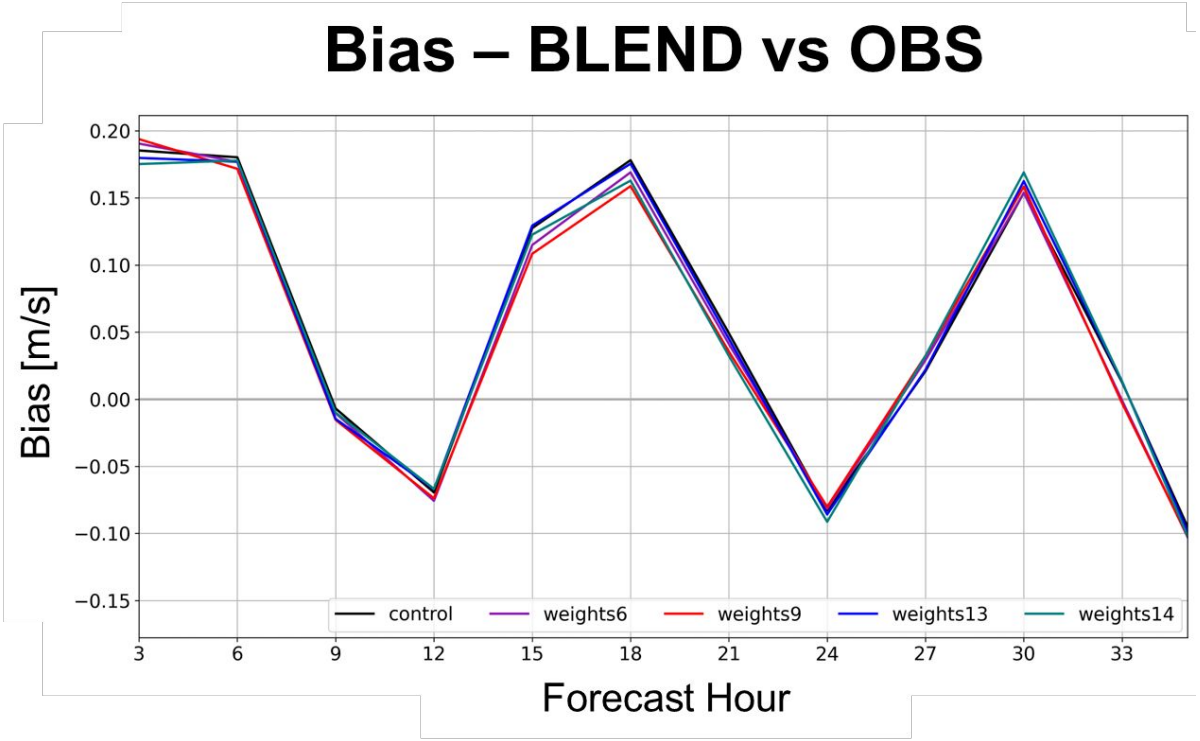
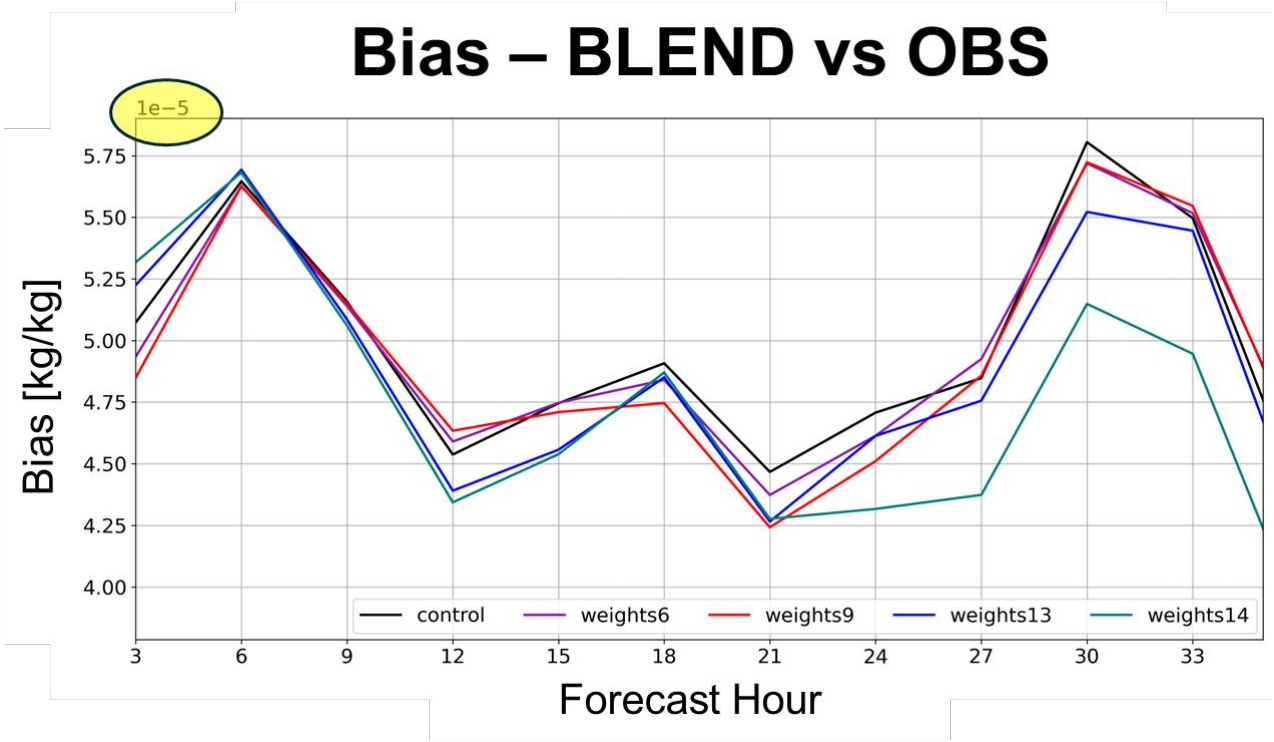
Mid-Level: 500-hPa U-Wind over CONUS



Slight differences when using different weighting distributions

OBS: RTMA

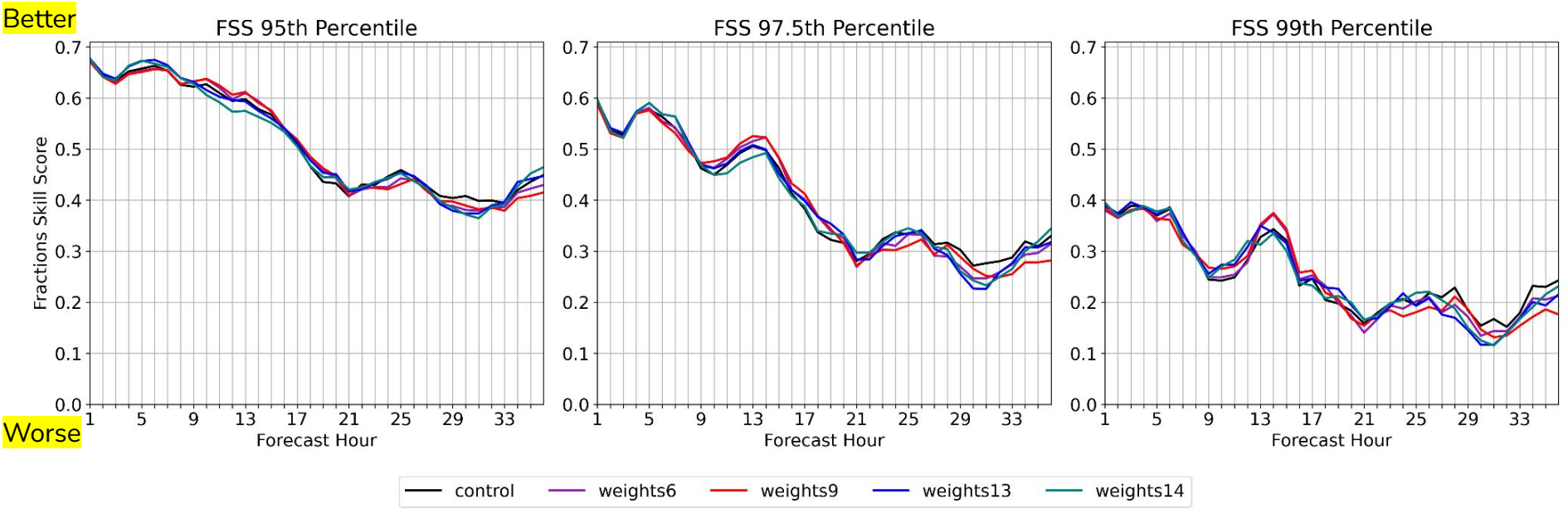
Mid-Level: 500-hPa Specific Humidity over CONUS



After 21 hrs, **weights14** has the lowest bias likely because it includes the most global information

OBS: RTMA

Low-Level: Reflectivity East of the Rockies



Again, we see sensitivity to different weighting distributions

weights9 and **weights14** show the biggest impact due to varying amounts of global information

OBS: MRMS

Research Questions

Are regional MPAS simulations
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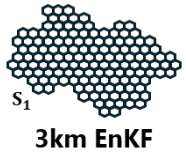
blending weight distributions?

Yes!

Is there a **“best”** weighting distribution?

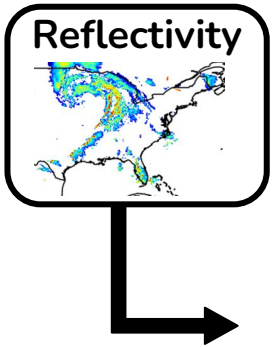
More research is necessary to determine which weights distribution leads to the best model performance.

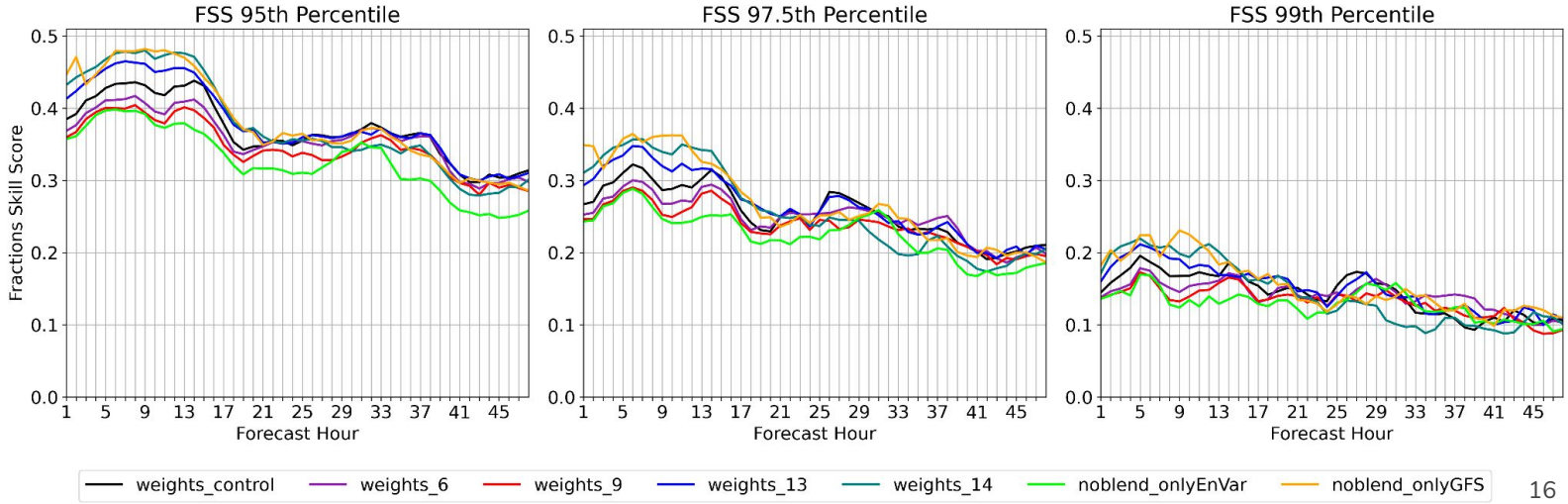
Current/Future Work



Findings indicate that the introduction of global information from the GFS twice daily through partial cycling in the EnKF analyses **limits the ability of IC blending to improve results**

We ran **continuously-cycled global** MPAS v7.0 simulations that use regional 3DEnVar and global GFS blended ICs





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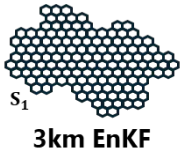
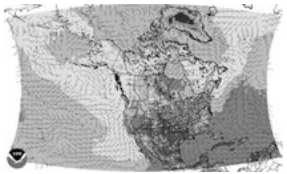


Findings indicate that the introduction of global information from the GFS twice daily through partial cycling in the EnKF analyses **limits the ability of IC blending to improve results**

We ran **continuously-cycled global** MPAS v7.0 simulations that use regional 3DEnVar and global GFS blended ICs

We see **greater sensitivity with continuously-cycled ICs,** and we are investigating whether this sensitivity is variable dependent.



The larger goal of this research is to **inform the development of RRFSv2** via the replacement of IC partial cycling with IC blending

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Thank you! Questions?

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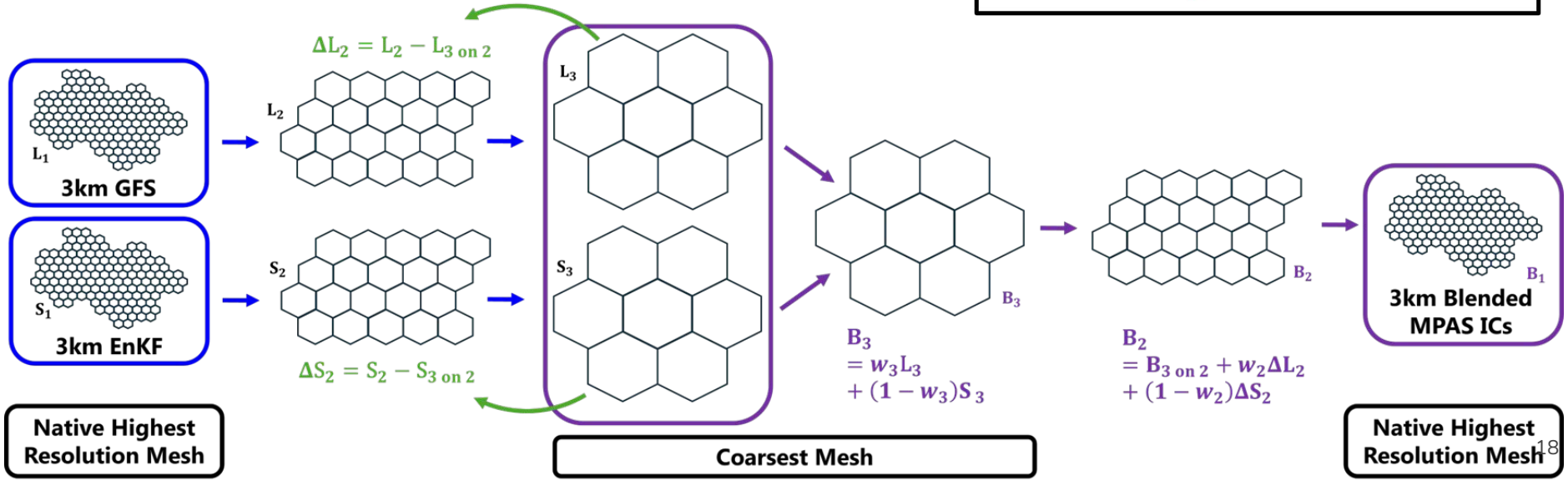

Simulation Setup - Global MPAS

- **Model**: MPAS Atmosphere; global
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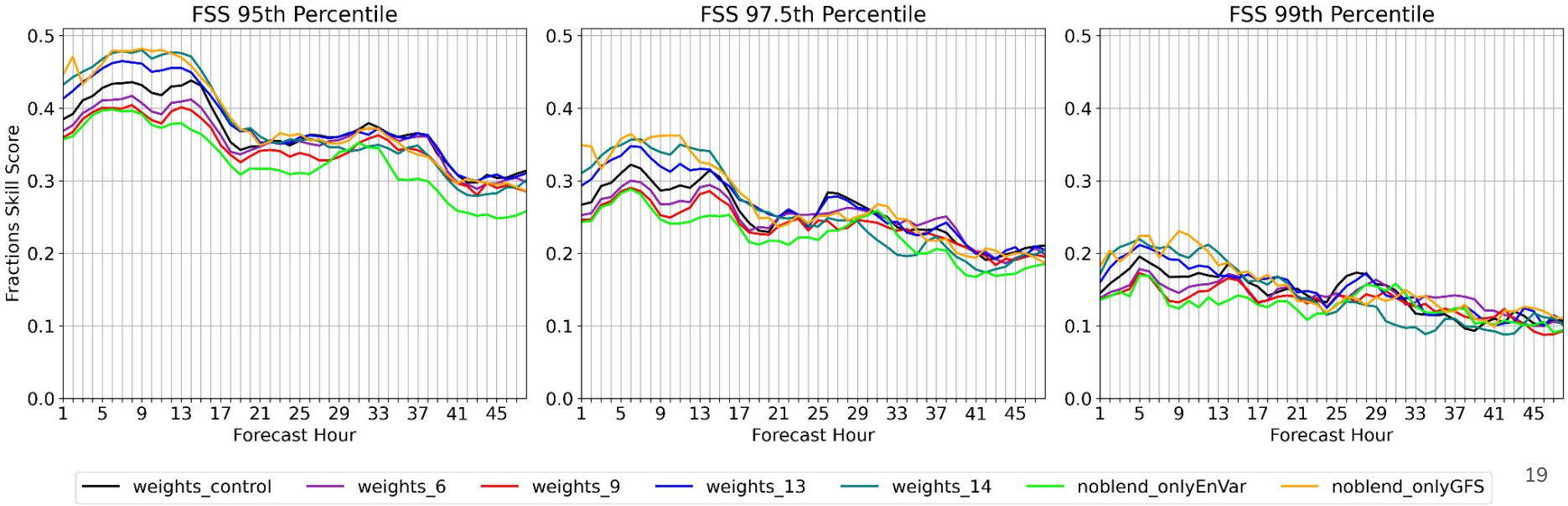
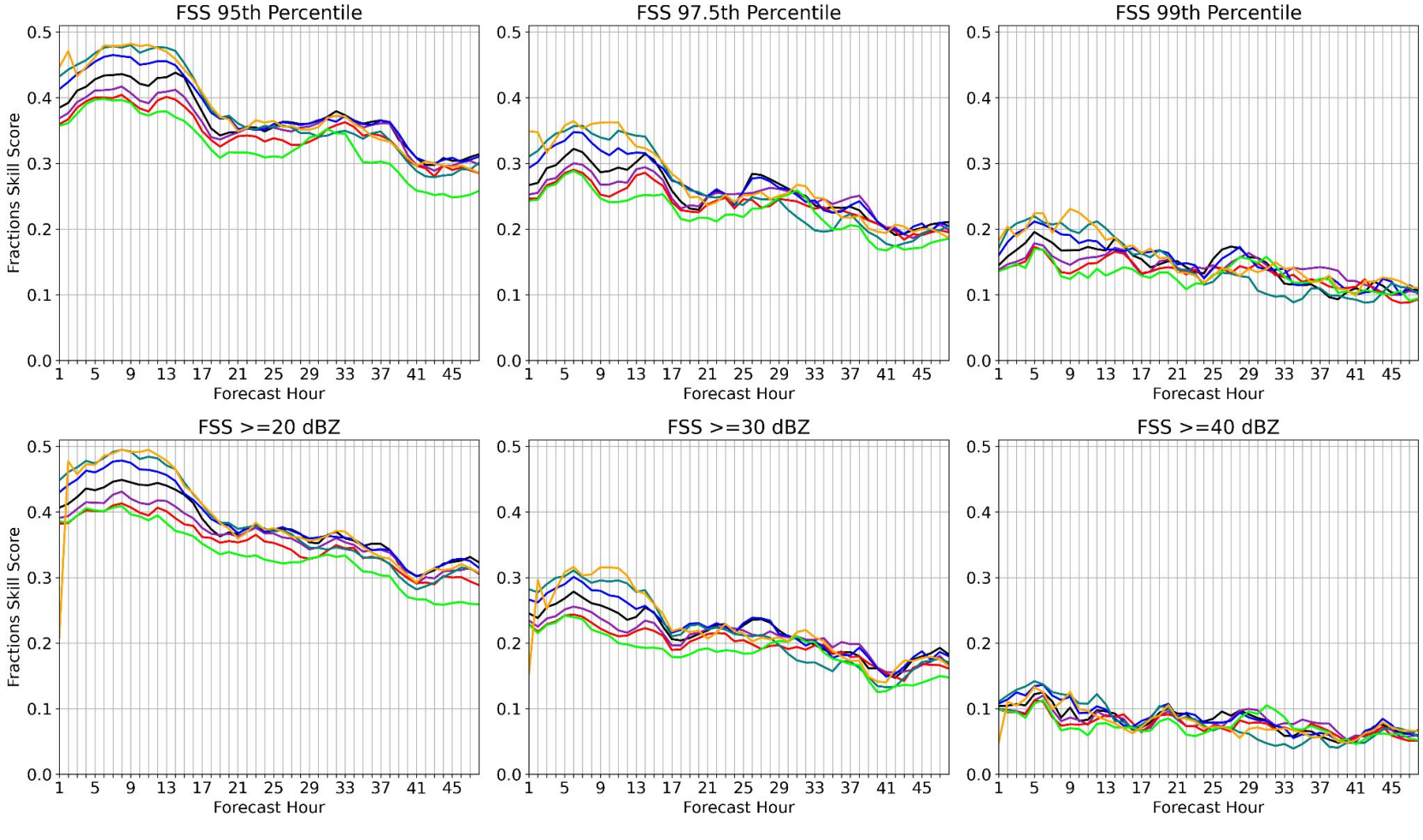
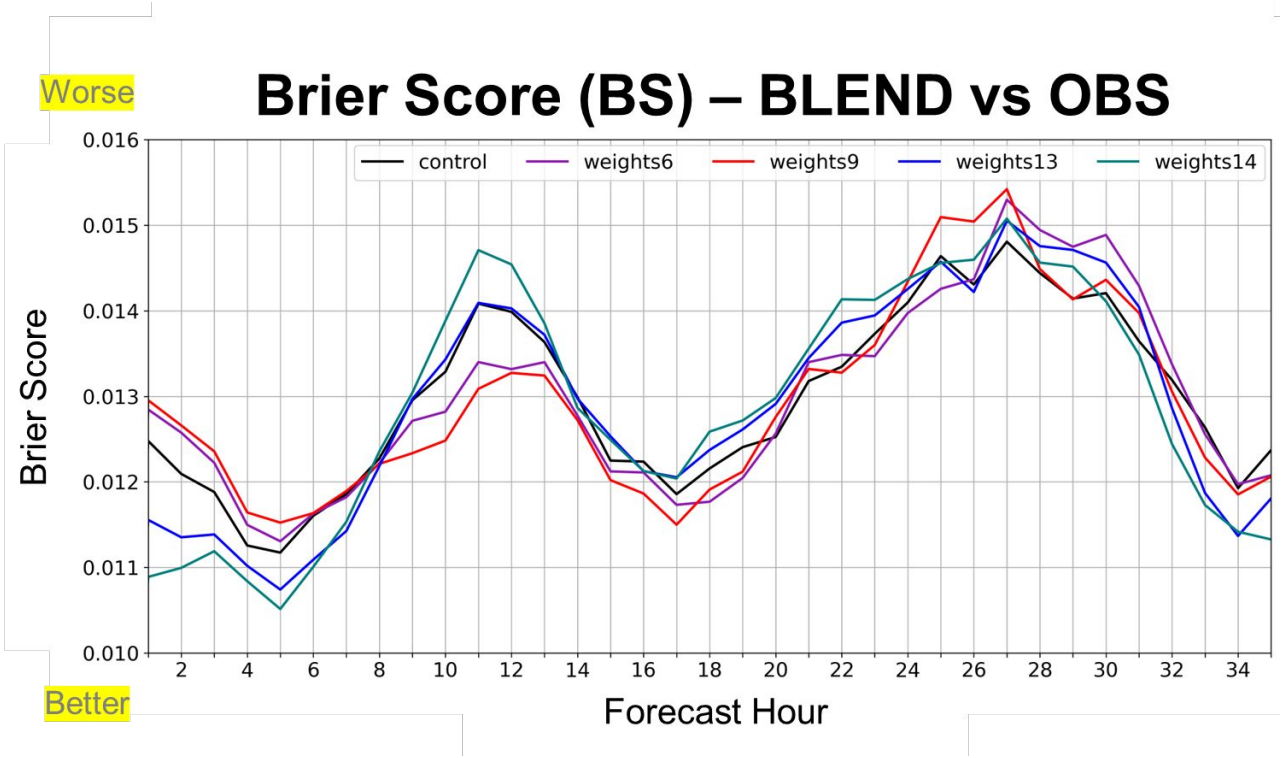



FSS 95th Percentile
FSS 97.5th Percentile
FSS 99th Percentile
FSS >=20 dBZ
FSS >=30 dBZ
FSS >=40 dBZ
Fractions Skill Score
Forecast Hour
weights_control
weights_6
weights_9
weights_13
weights_14
noblend_onlyEnVar
noblend_onlyGFS

Mid-Level: 500-hPa Specific Humidity



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