Convective-Scale Testing of MPAS with CAM6 Physics

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Test Case 1: Squall Line in the Central US

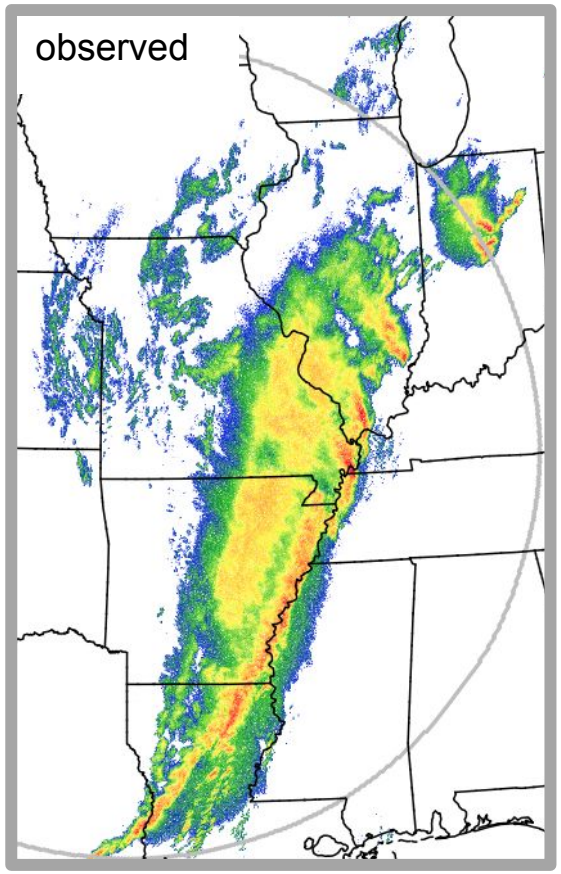
Simulations use the 60-3 km MPAS mesh, 58 levels, 3 km region placed over area of interest.

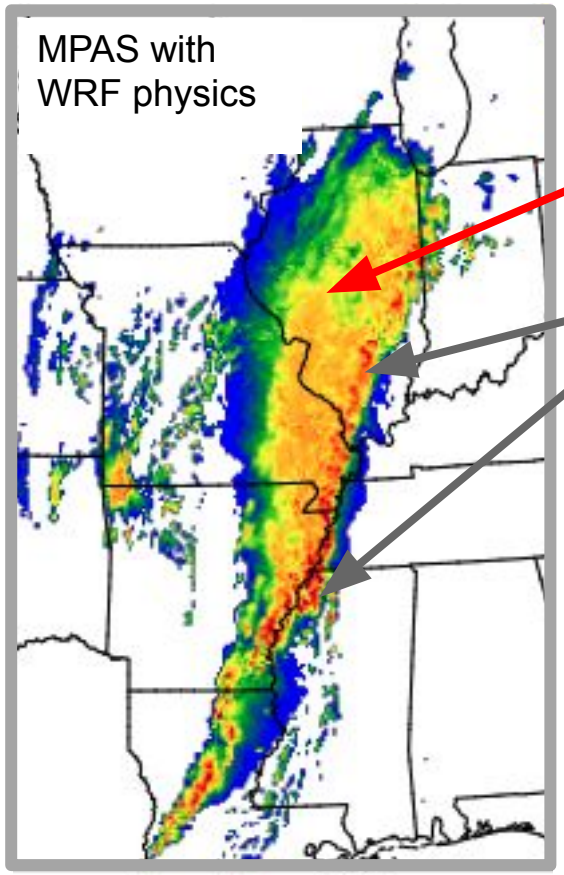
Case 1:
Central US spring test case, 24 hour forecast valid 00 UTC 27 April 2017

Squall line in the warm sector of a baroclinic wave over the central US.

Initialized using GFS analysis

Test Case 1: Squall Line in the Central US

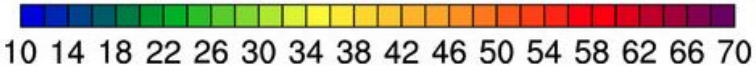




trailing stratiform

leading line convective cells

Reflectivity (dBZ)

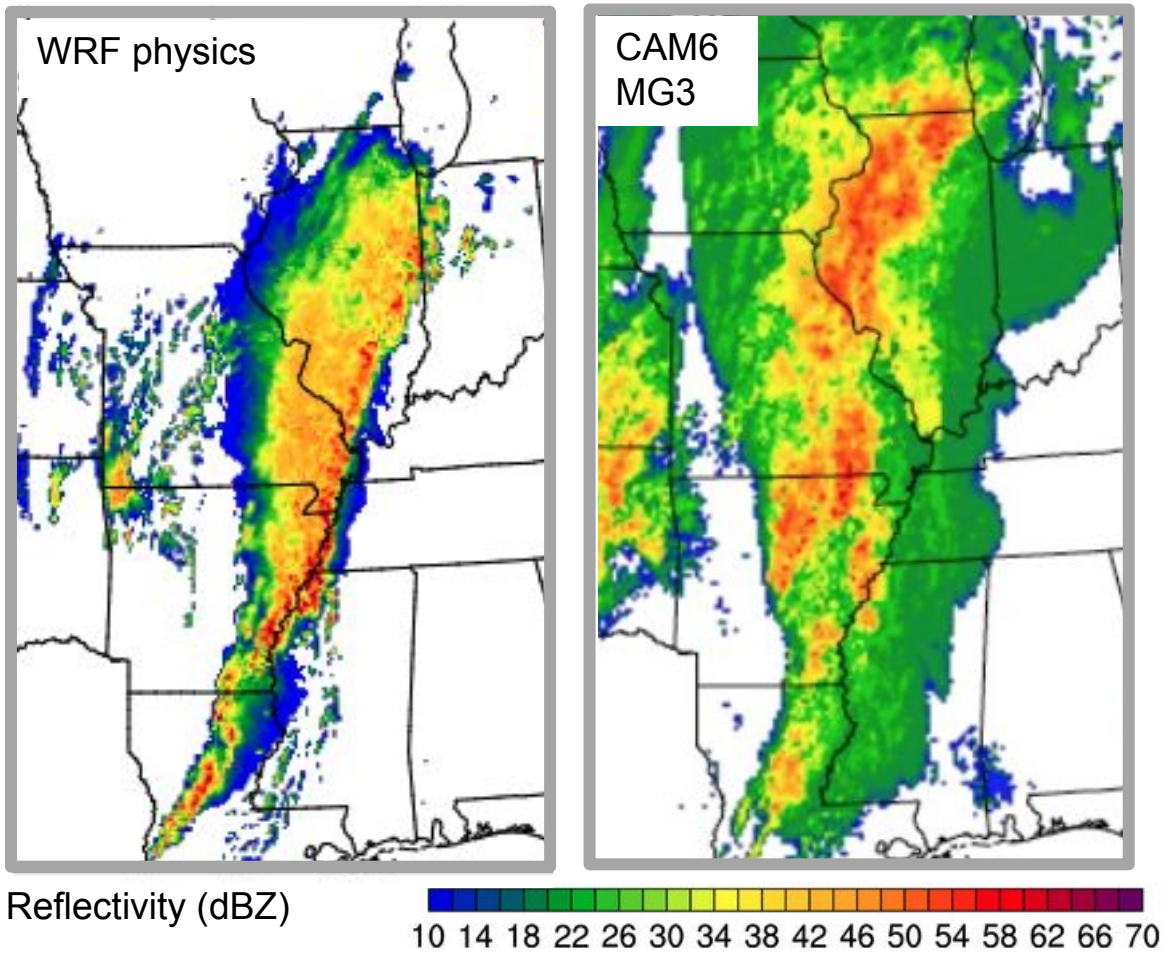


- System extends farther north than observed.
- Leading line and stratiform region dBZ higher than observed.
- No distinct weak echo region between leading line and stratiform region.

Good 1-day forecast, differences from obs are typical for 3 km deep-convection simulations.

Test Case 1: Squall Line in the Central US

CAM6 physics with
MG3 instead of MG2

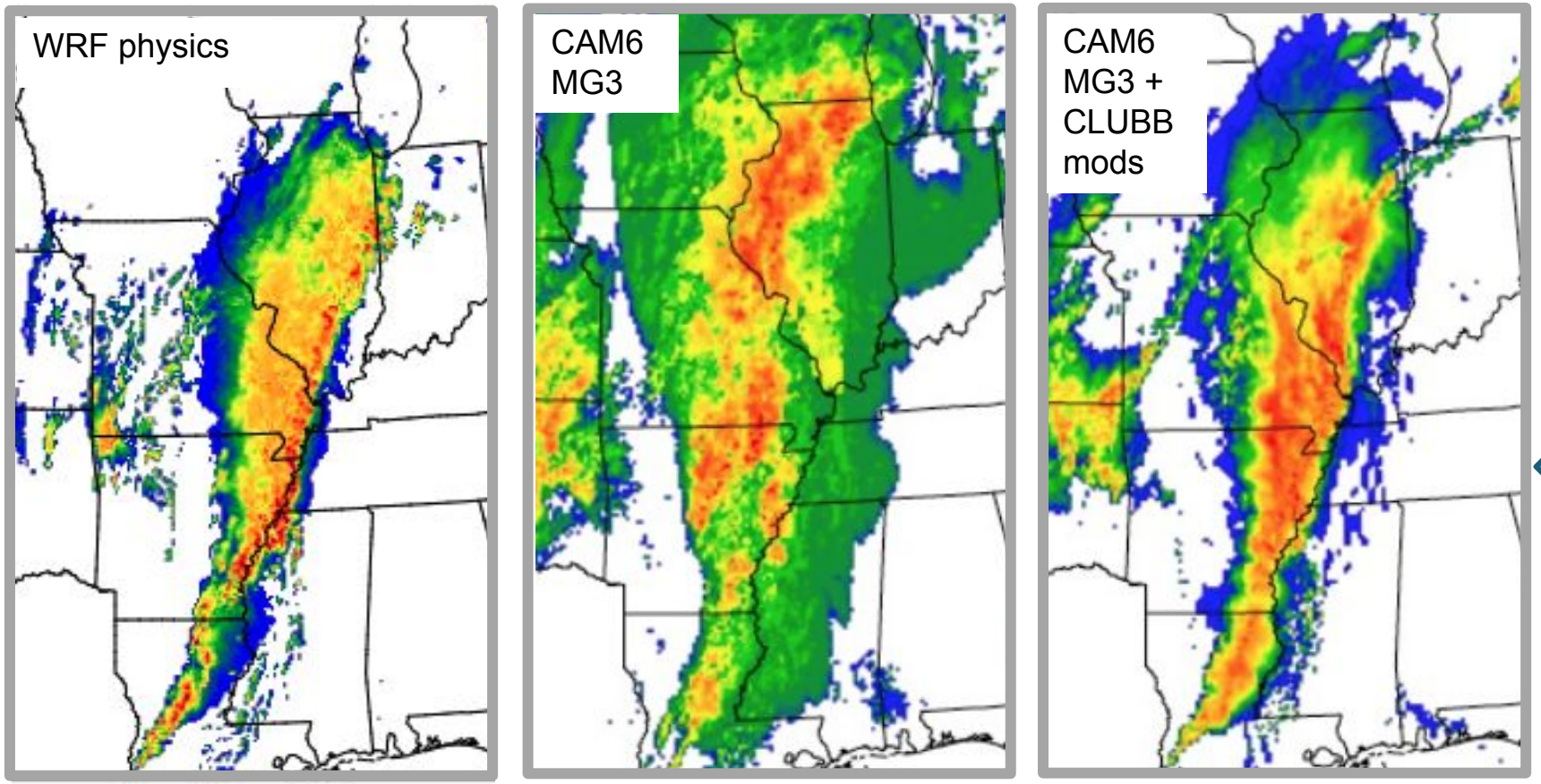


With CAM6 and MG3 the active convection is tied to the cold front.

Stratiform region is much too large.

Test Case 1: Squall Line in the Central US

CAM6 physics with
MG3 instead of MG2



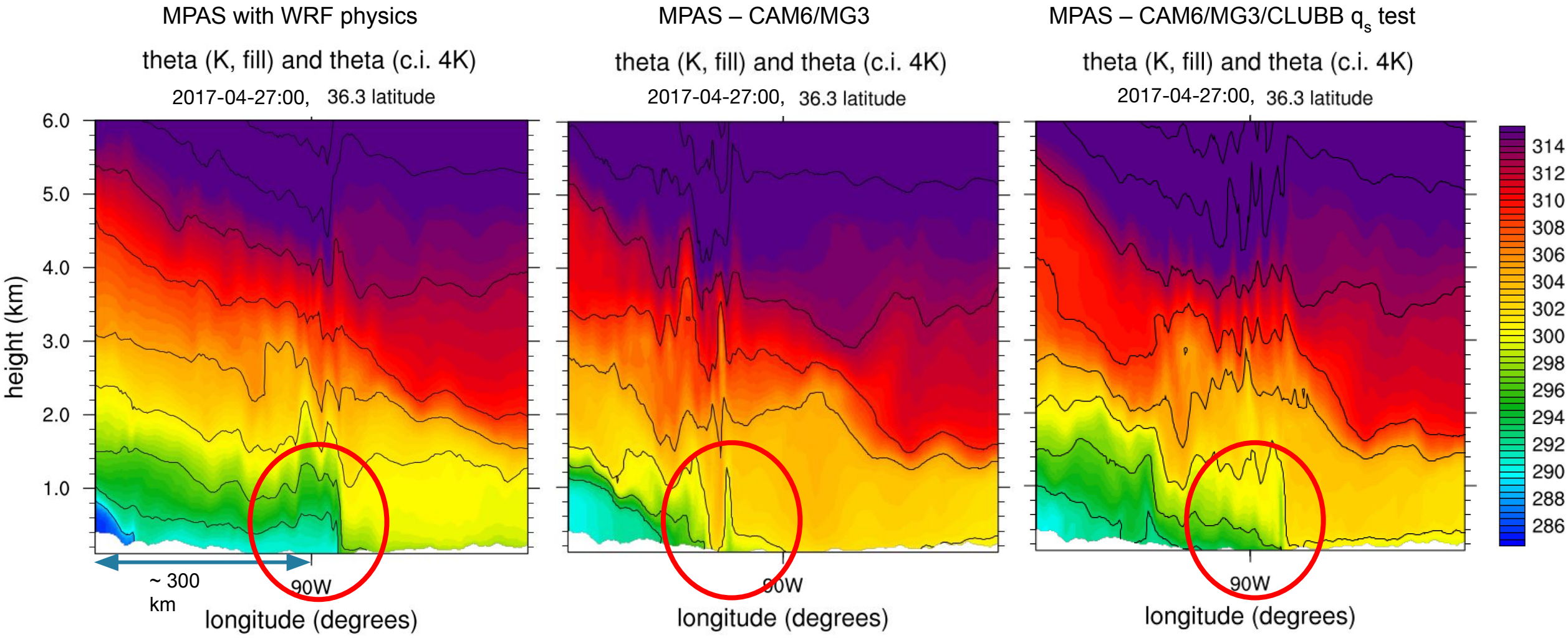
Reflectivity (dBZ)

10 14 18 22 26 30 34 38 42 46 50 54 58 62 66 70

CAM6 physics with MG3 instead of MG2 and with PDFs in CLUBB's saturation adjustment collapsed to delta functions by setting their std. dev. to zero.

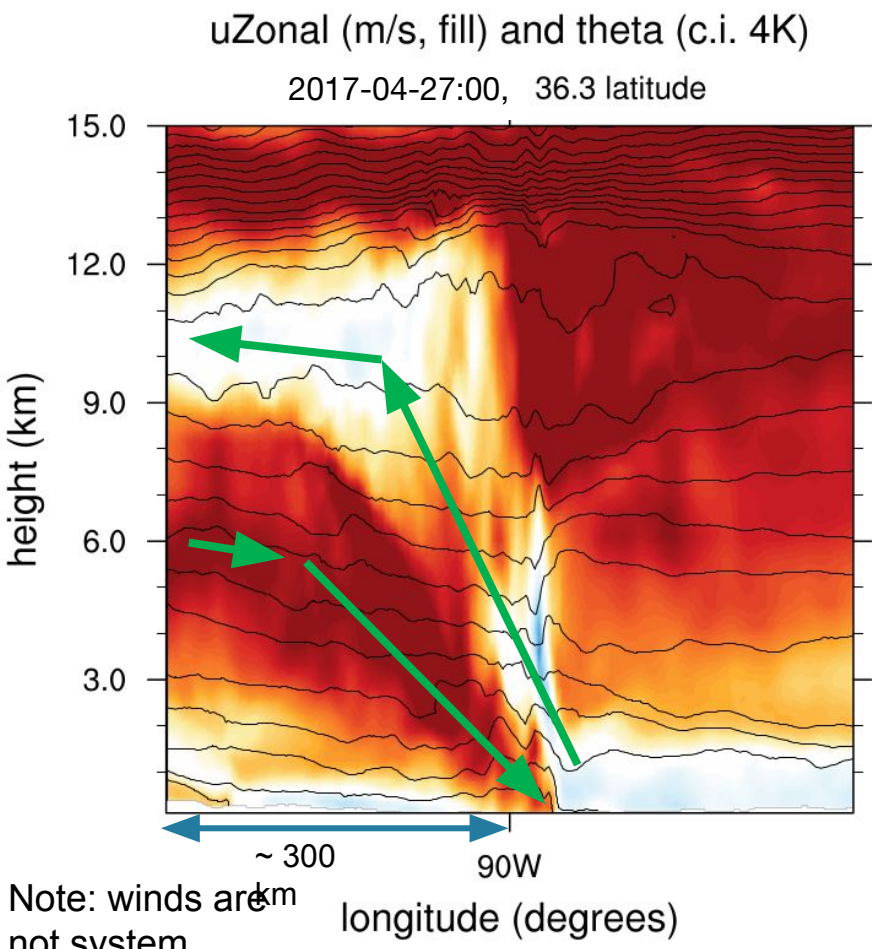
Collapsing the PDFs in the saturation adjustment is a major improvement.
But…
still no clear leading-line trailing-stratiform line structure.

Test Case 1: Squall Line in the Central US

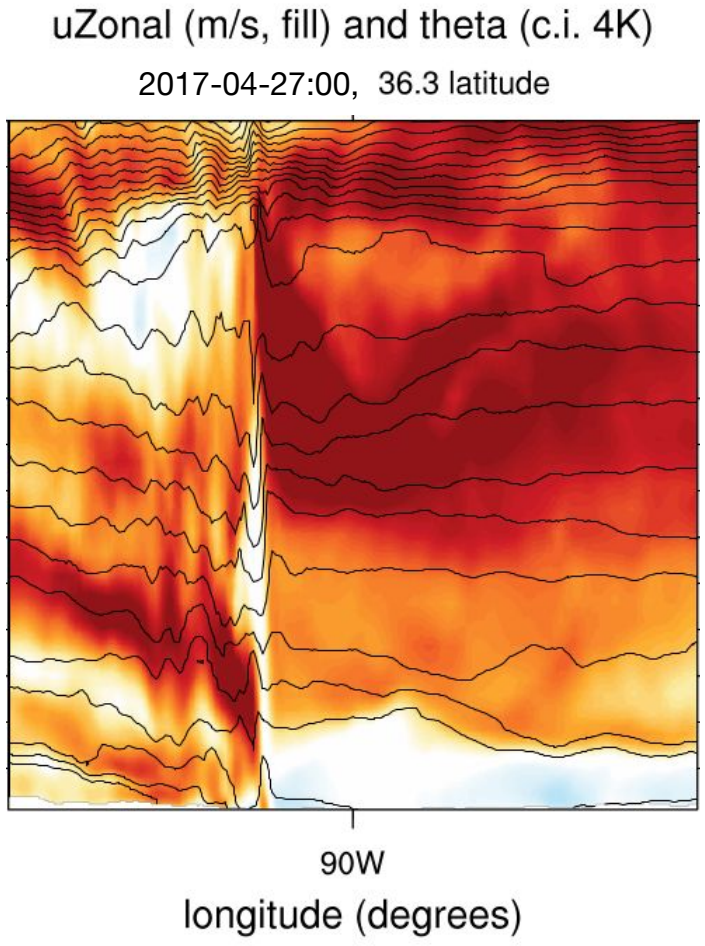


Test Case 1: Squall Line in the Central US

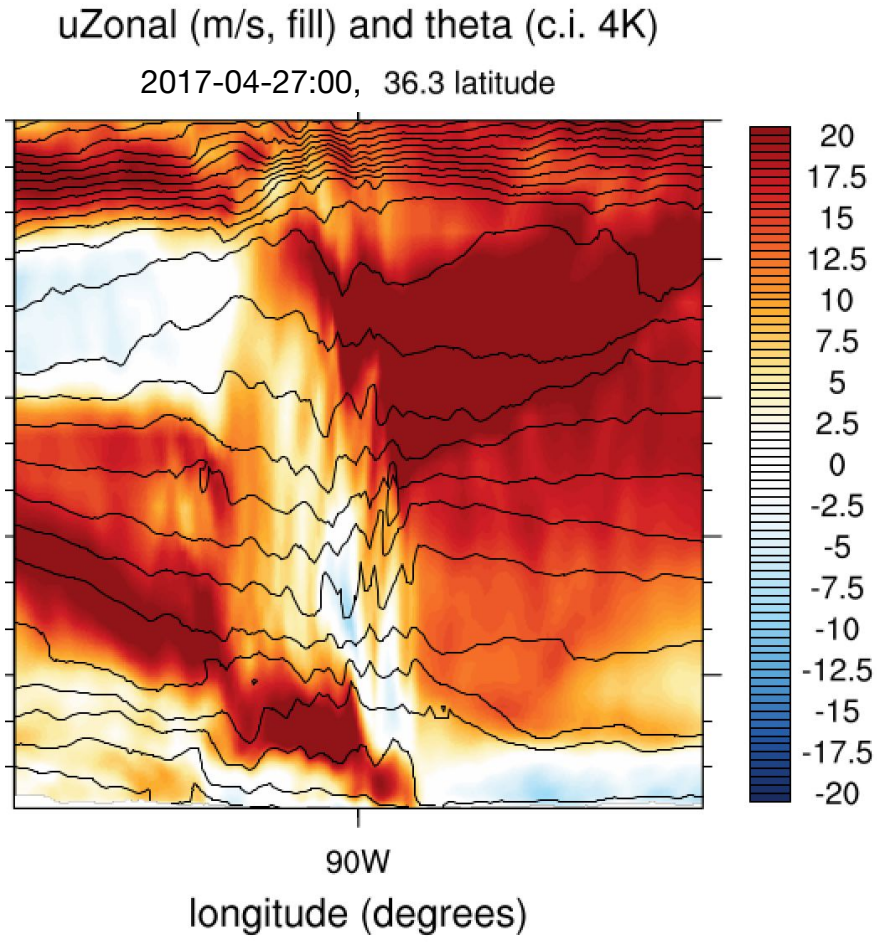
MPAS with WRF physics



MPAS – CAM6/MG3



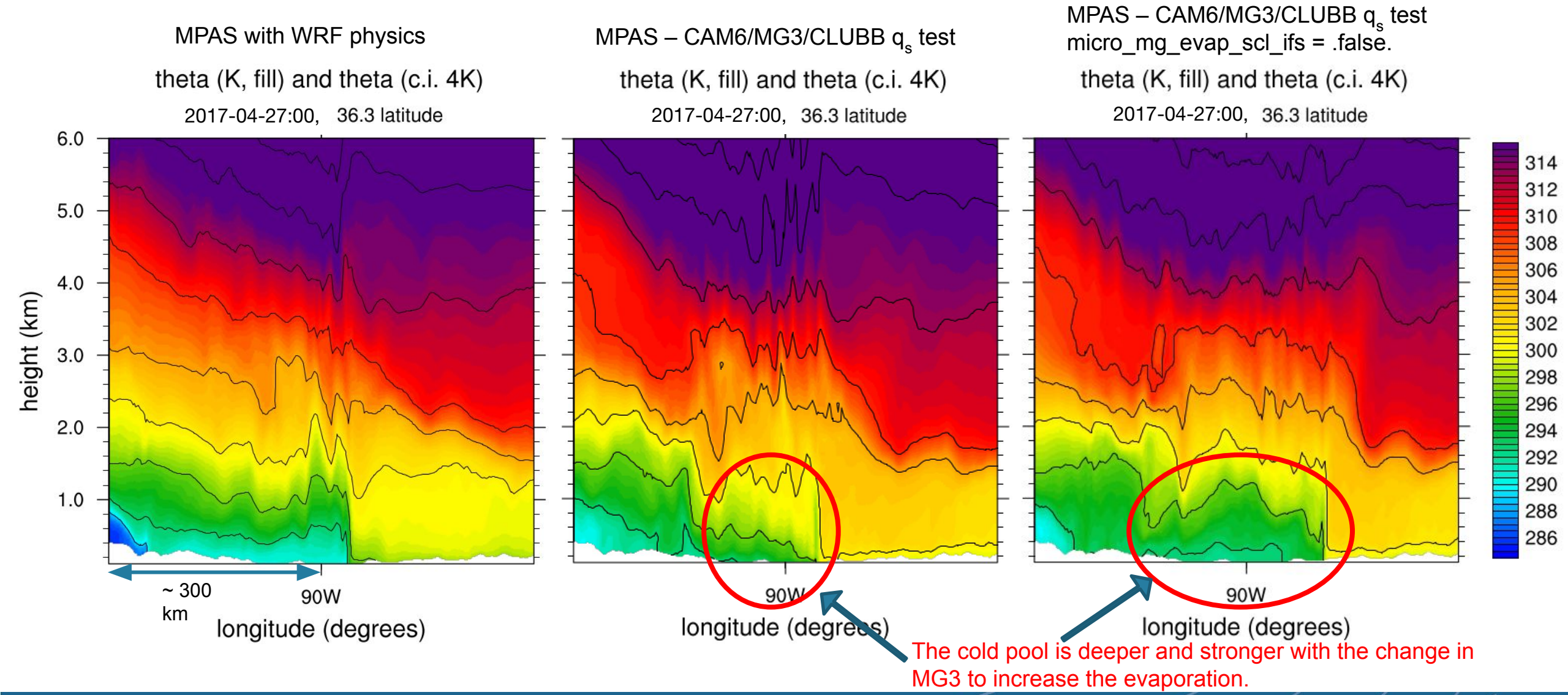
MPAS – CAM6/MG3/CLUBB q_s test



Note: winds are not system relative.

The ascending front-to-rear and descending rear-to-front flows are a classic feature of these types of squall lines.

Test Case 1: Squall Line in the Central US



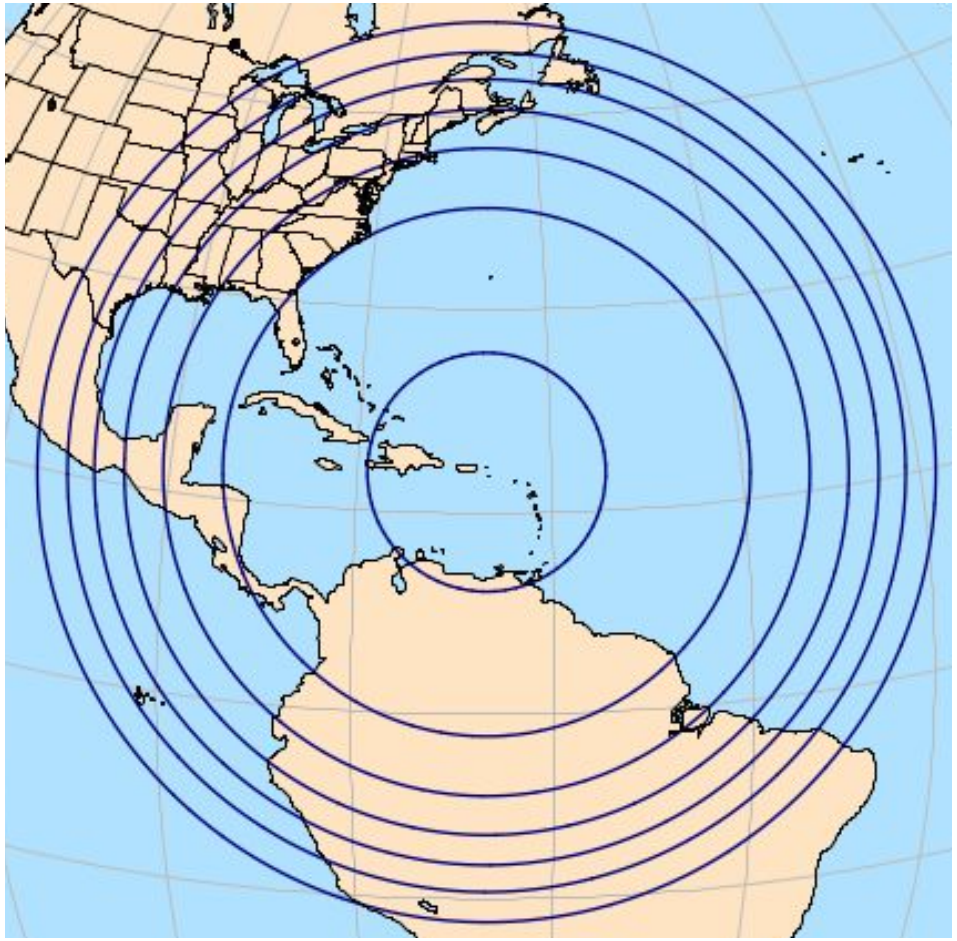
Test Case 2: Tropical Cyclone Maria

Simulations use the 60-3 km MPAS mesh, 58 levels, 3 km region placed over area of interest.

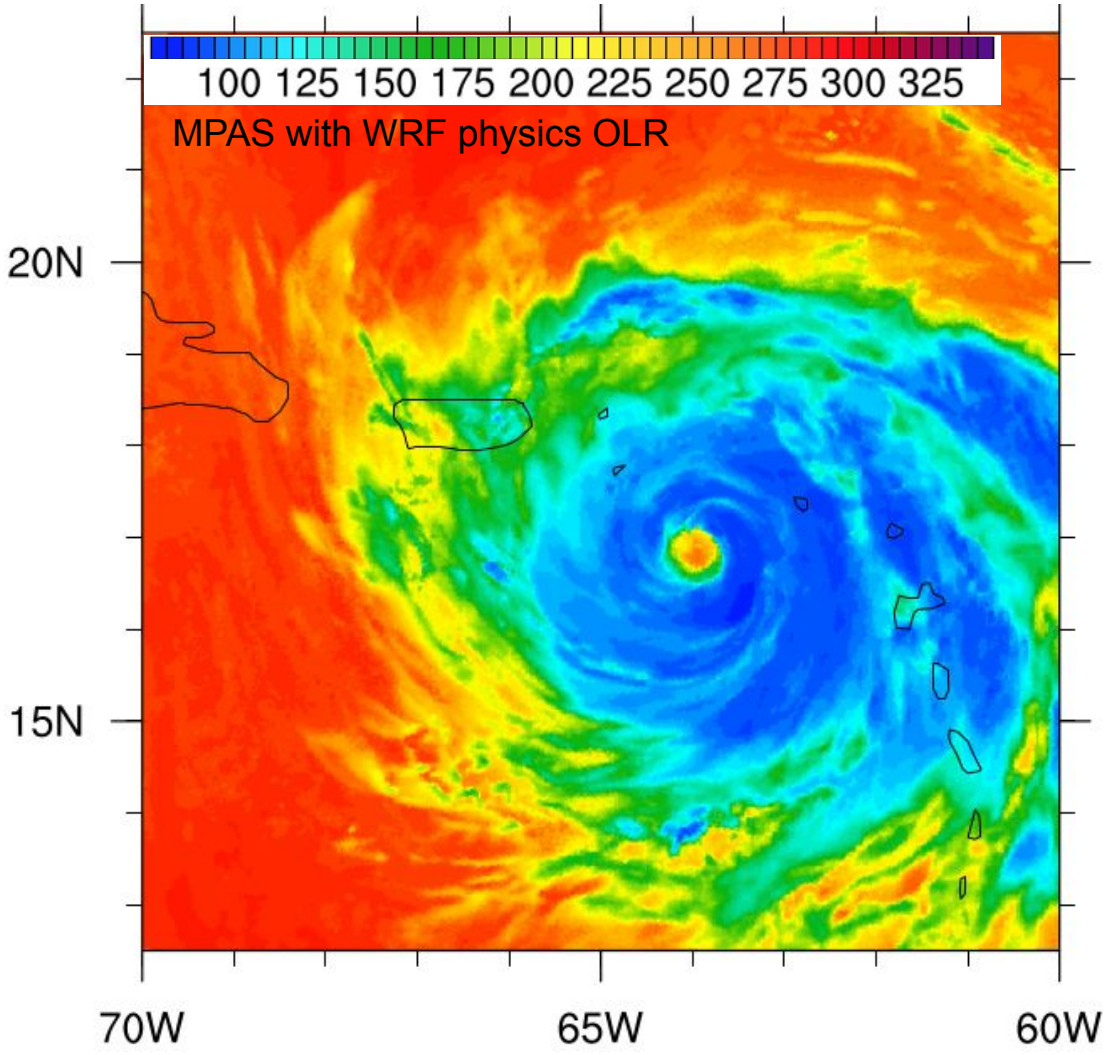
Case 2:
Hurricane Maria, 48 hour forecast
Initialized 00 UTC 18 September 2017

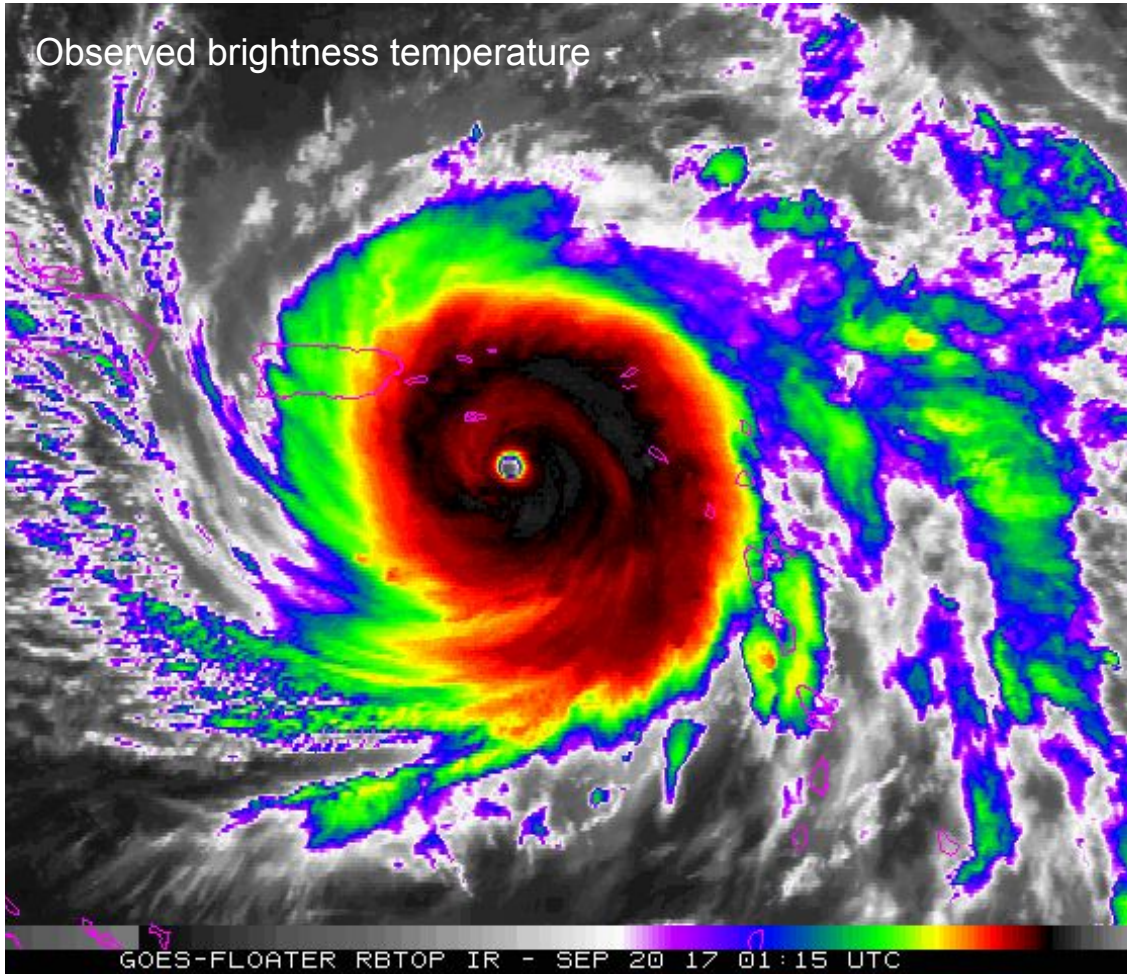
Very strong hurricane (Cat 4-5) during this period

Initialized using ERA5 analysis



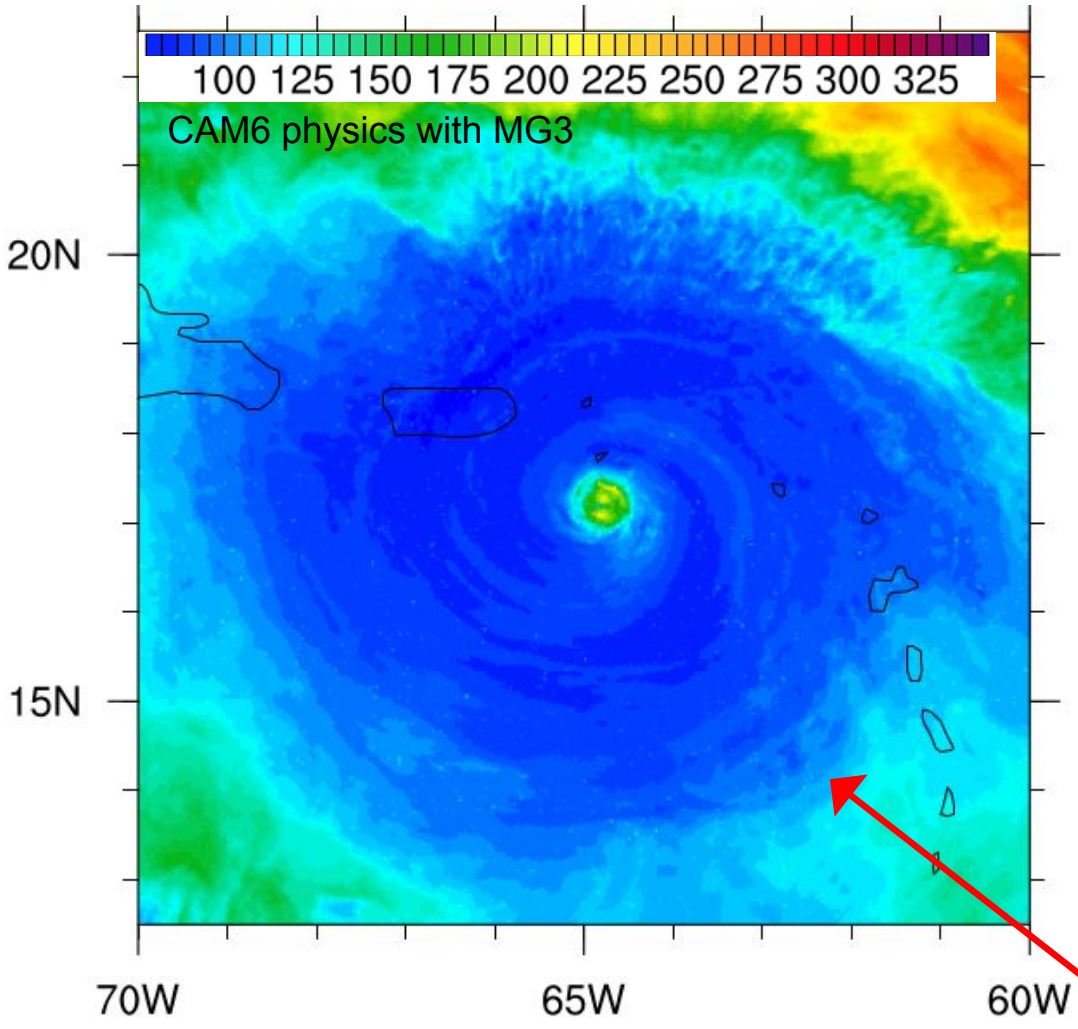
Test Case 2: Tropical Cyclone Maria

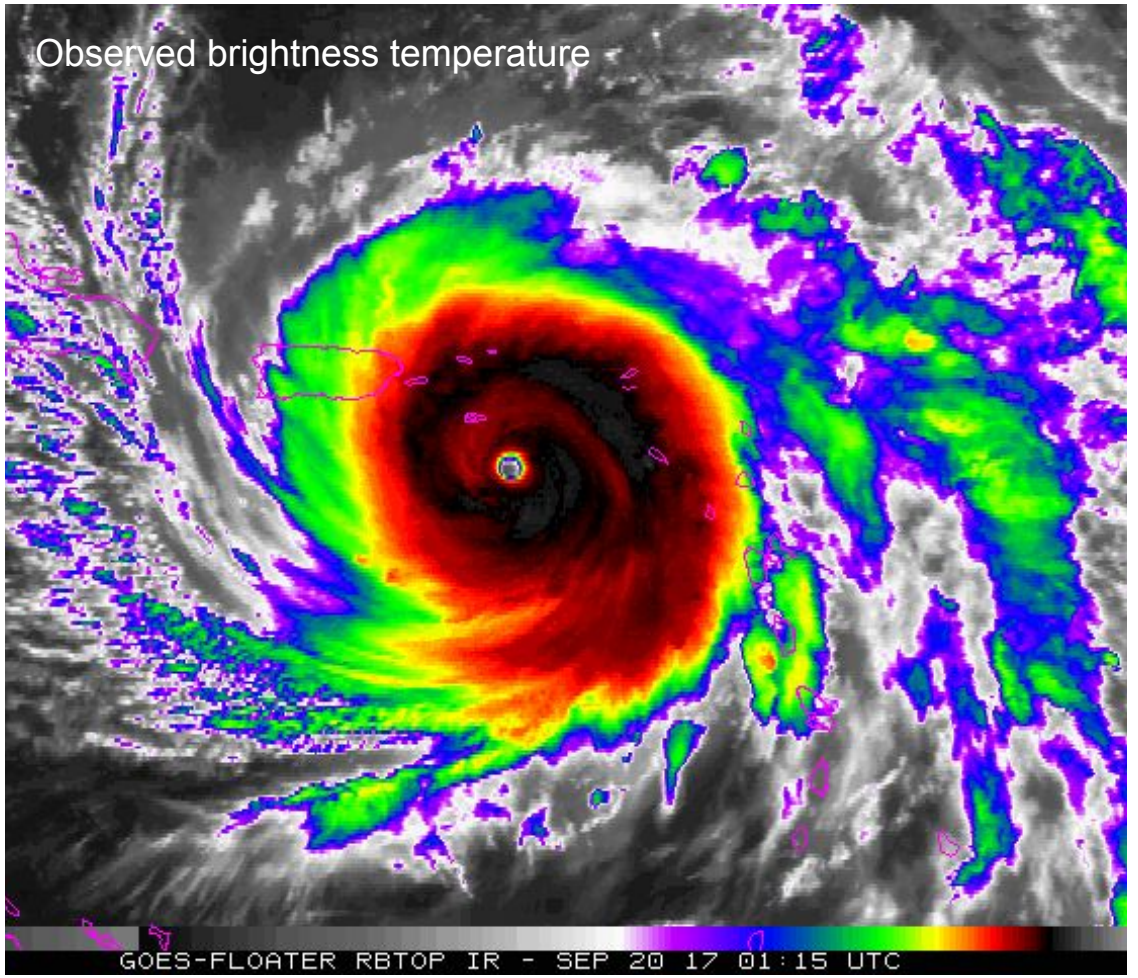




The plots are approximately the same scale. MPAS with WRF physics produces a TC of similar size. Banding is evident.

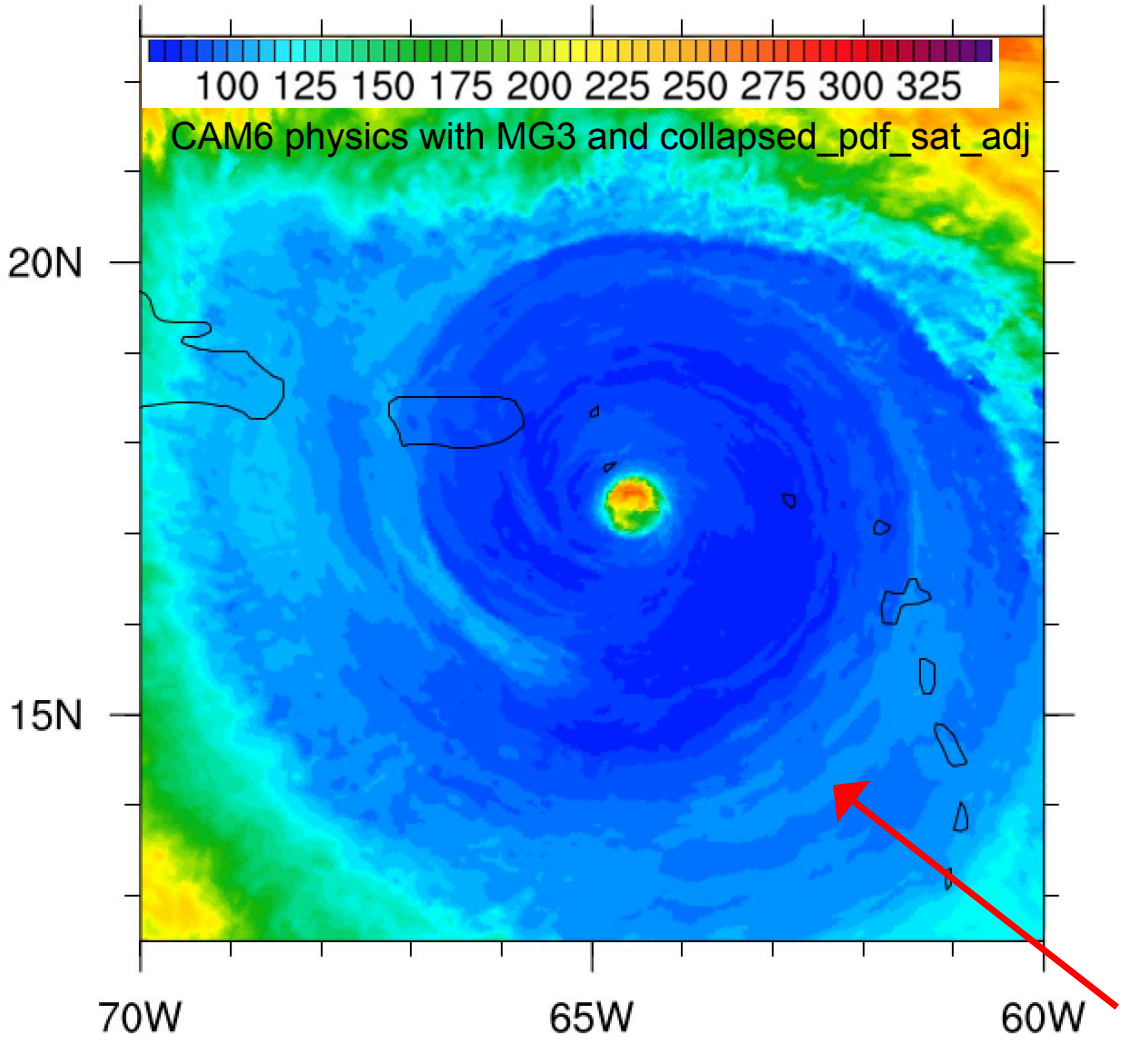
Test Case 2: Tropical Cyclone Maria

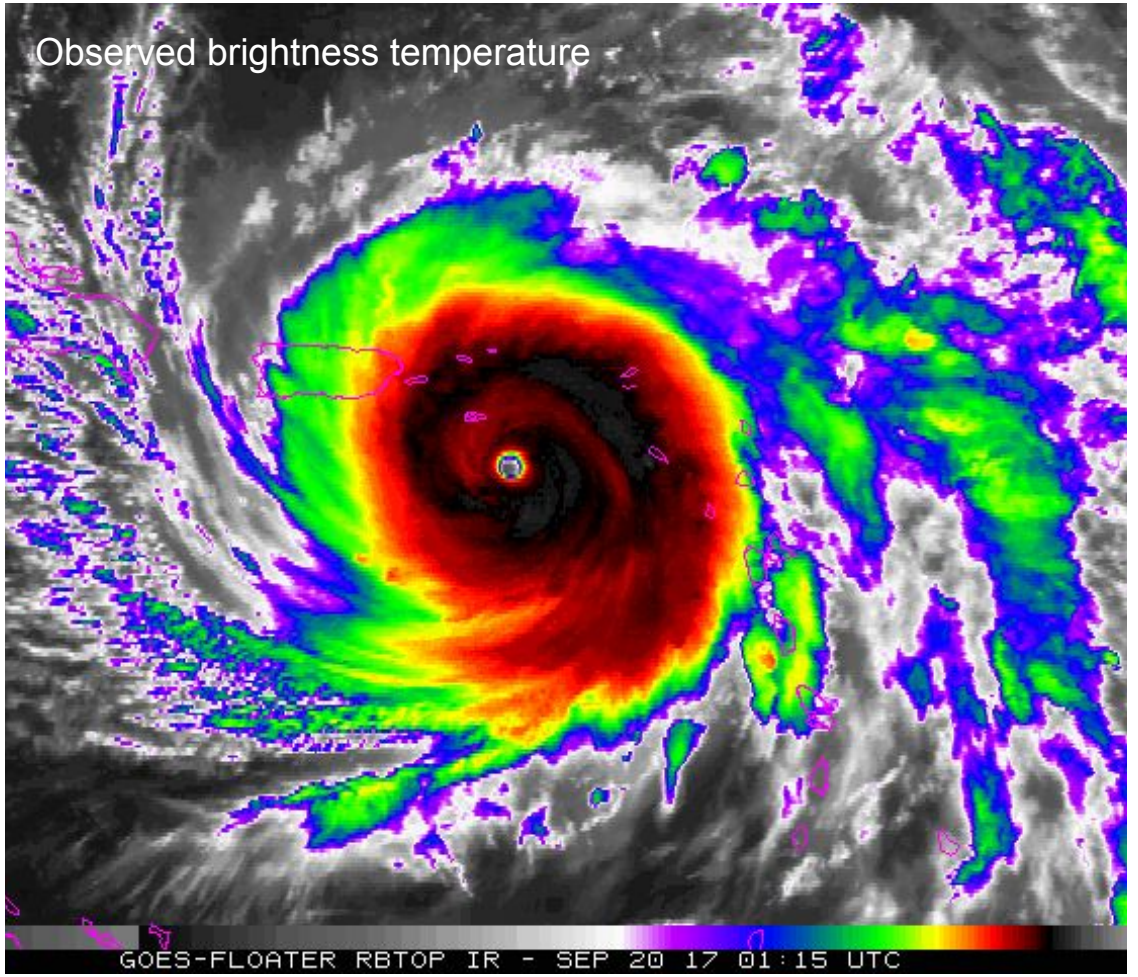




Indistinct bands, much larger cloud shield than observed.

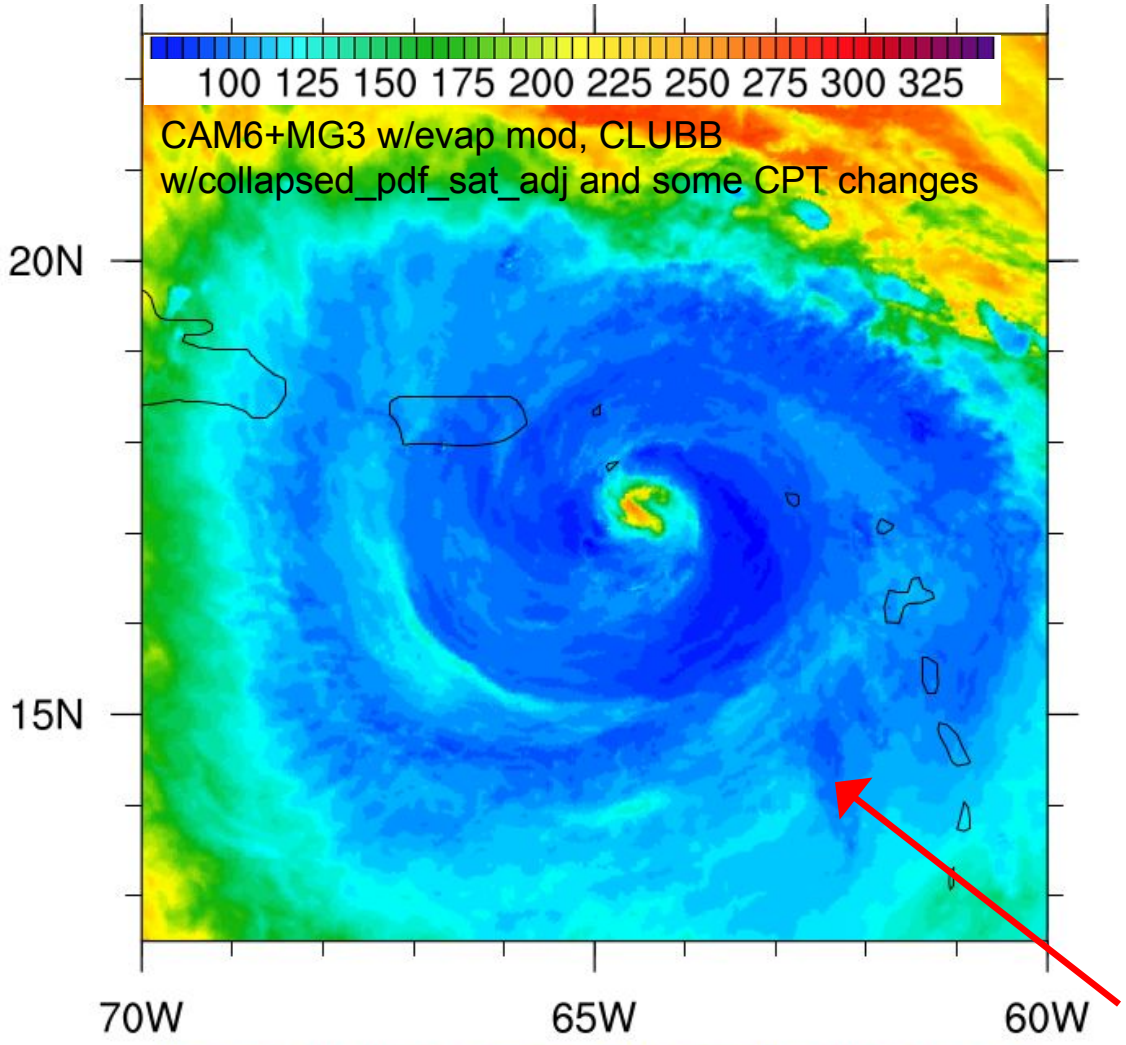
Test Case 2: Tropical Cyclone Maria

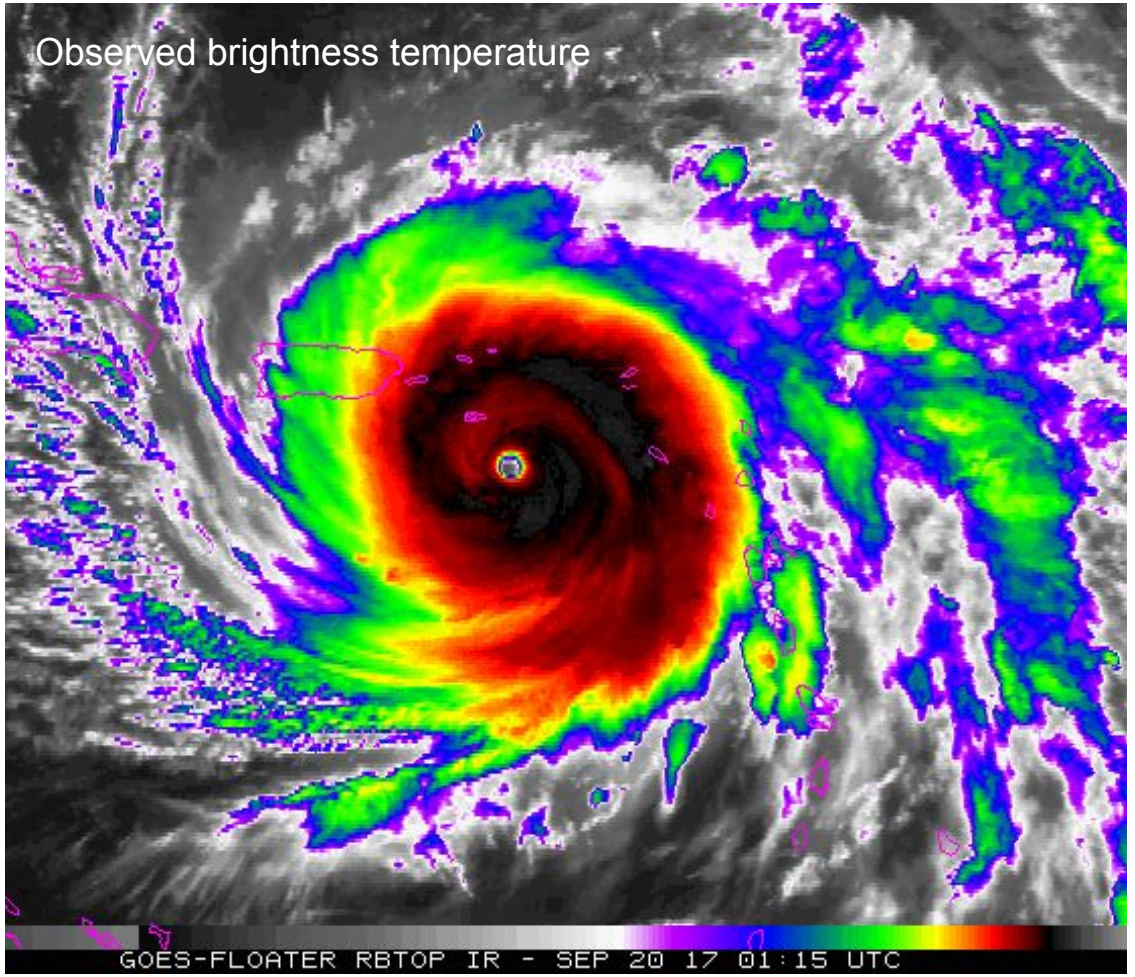




Banding structure starting to appear, still a larger cloud shield than observed.

Test Case 2: Tropical Cyclone Maria





Banding structure much better, still a larger cloud shield than observed.
Importantly, this also includes increased evap option in MG3.

Convective-Scale Testing of MPAS with CAM6 Physics

Status:

- Collapsing the PDFs in CLUBB in the saturation adjustment resulted in much better simulations for both the squall line and TC case
- Cold pools are too weak with the CAM6-MG3 physics, even when the CLUBB saturation adjustment PDFs are collapsed. Tweaking MG3 to enhance the evaporation helps
- The changes to CLUBB being developed by the CPT helped in the TC case, but only after collapsing the PDF in the saturation adjustment.

Next steps:

- We expected to have to tune the microphysics (MG3). Further tuning is necessary.
- How do we address the PDFs in CLUBB?
- ZM on a variable-resolution mesh – scale-awareness?