Diagnosis of Noise in the FV core using DART

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CAM & DART

CAM = 3.5.xx, FV core, 1.9x2.5, 30 min Δt.

DART = Data Assimilation Research Testbed, an ensemble Kalman filter data assimilation system.

Assimilate observations used in operational forecasting:

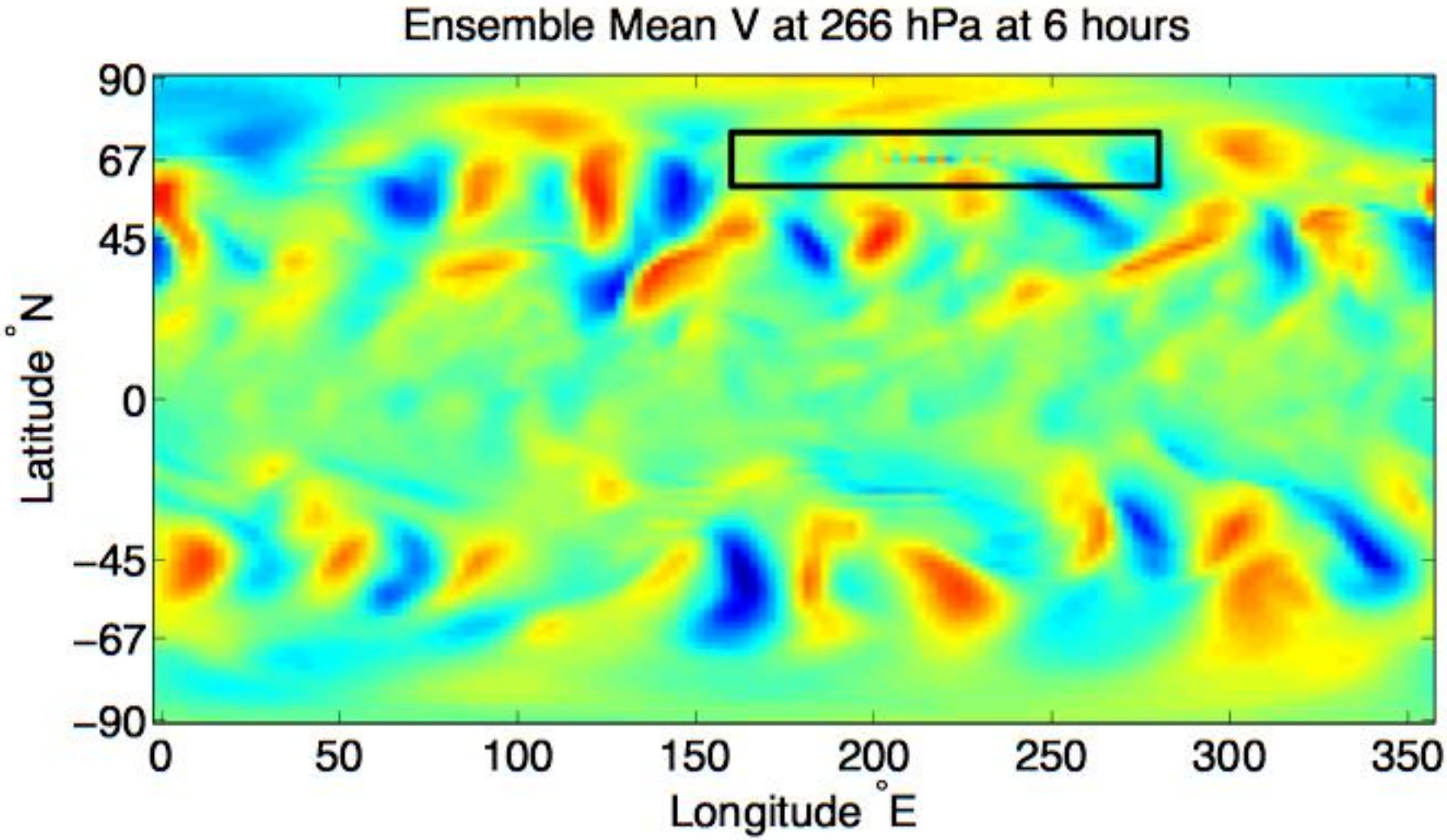
→ U, V, and T from radiosondes, ACARS, and aircraft,

→ U and V from satellite wind scatterometers,

every 6 hours to bring CAM as close to the atmosphere as possible, balancing the obs and model errors.

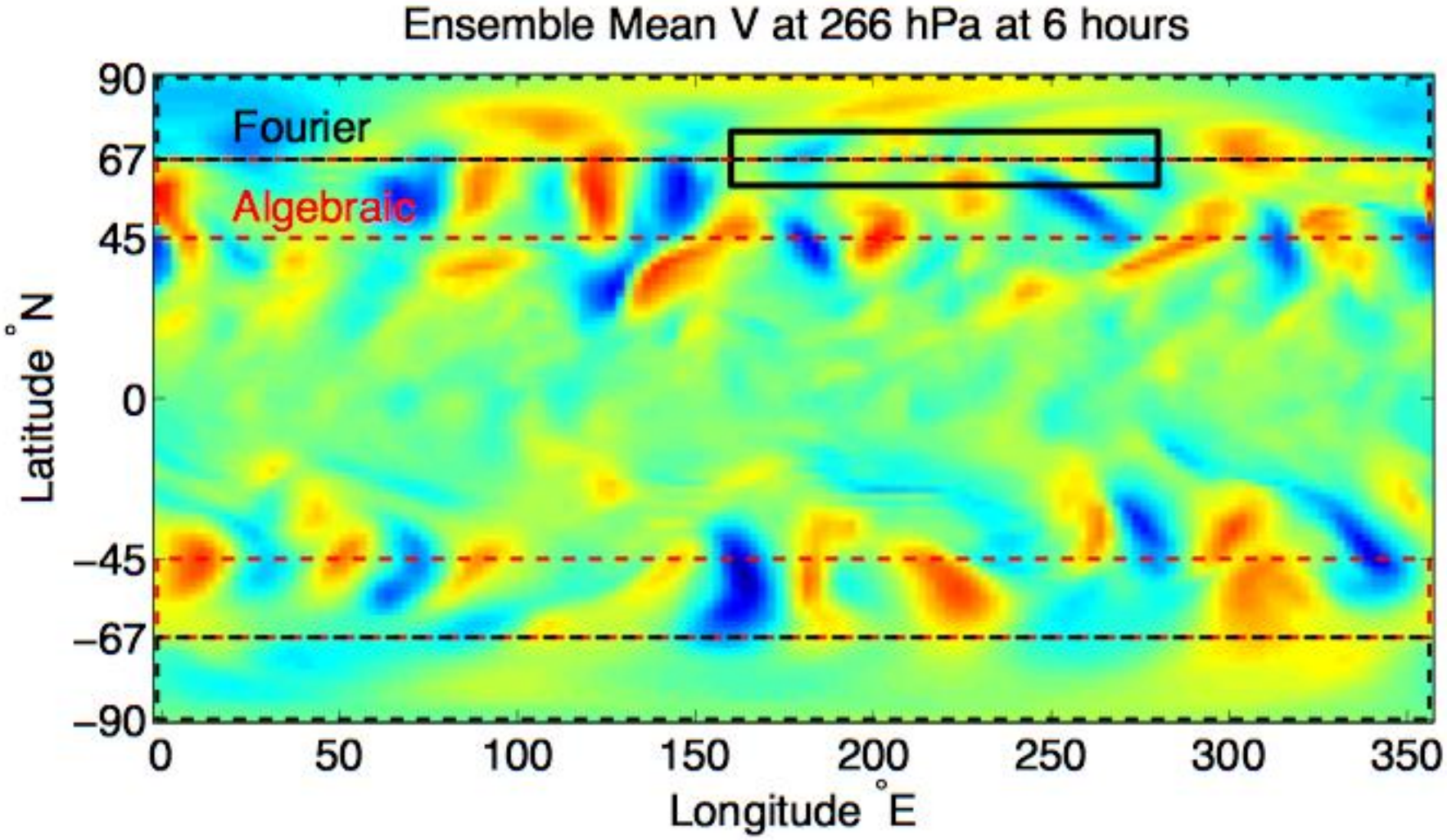
This system is competitive with operational weather centers' data assimilation systems.

“Houston, we have a Problem.”



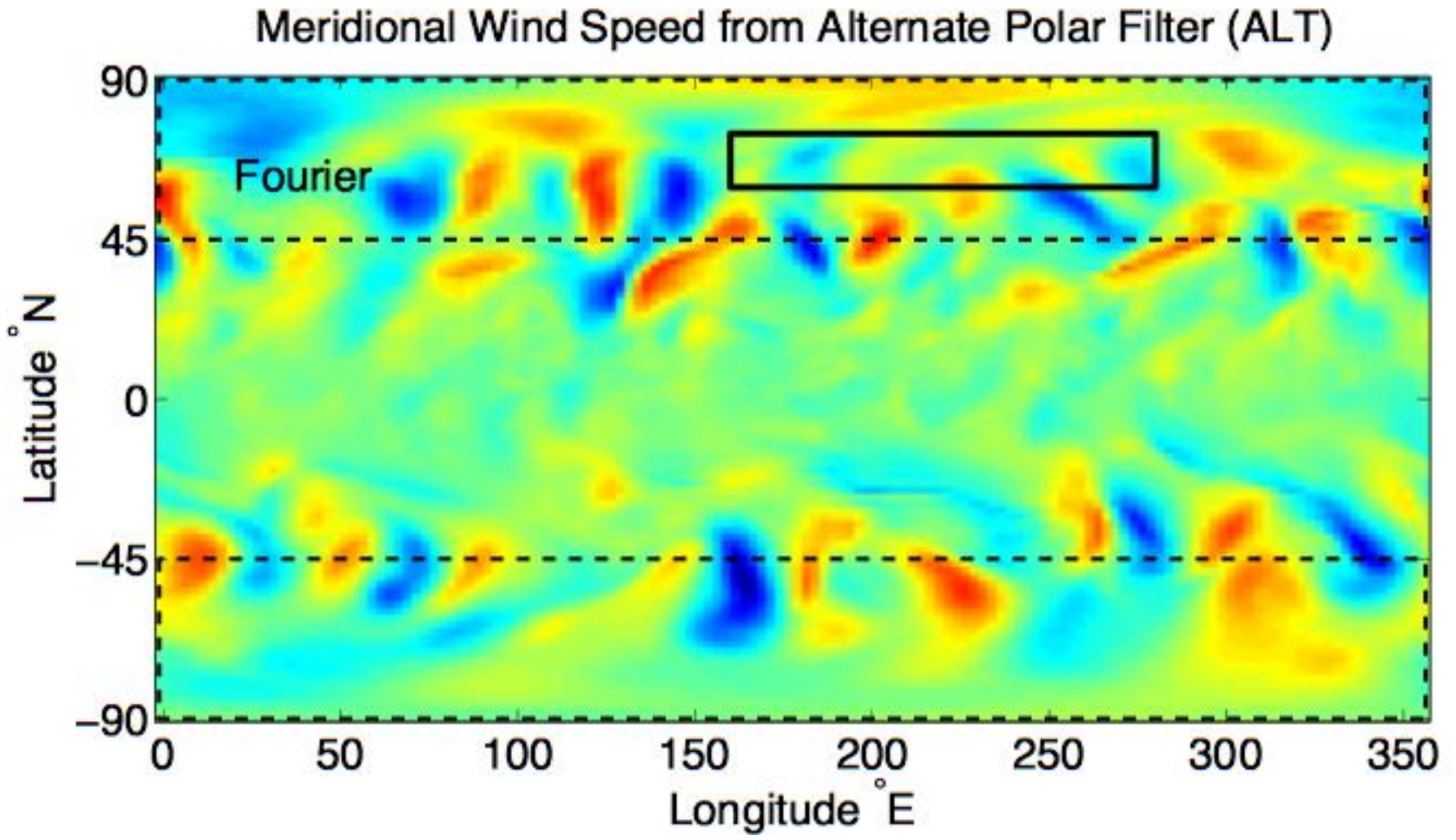
80 member mean
00Z 25 September 2006

Suspicions turned to the polar filter



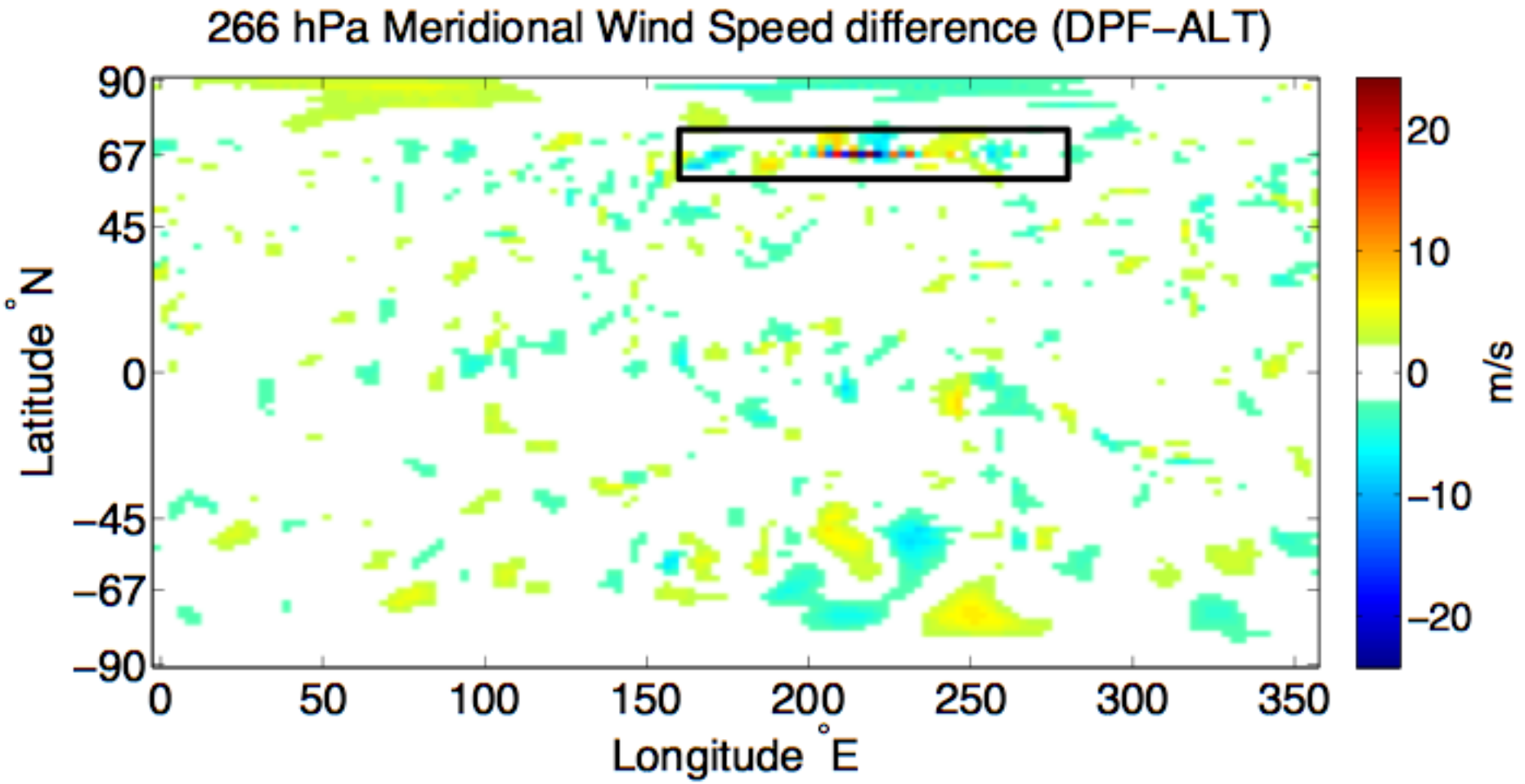
CAM FV core 00Z 25 September 2006

Using a continuous polar filter
does not show this effect.



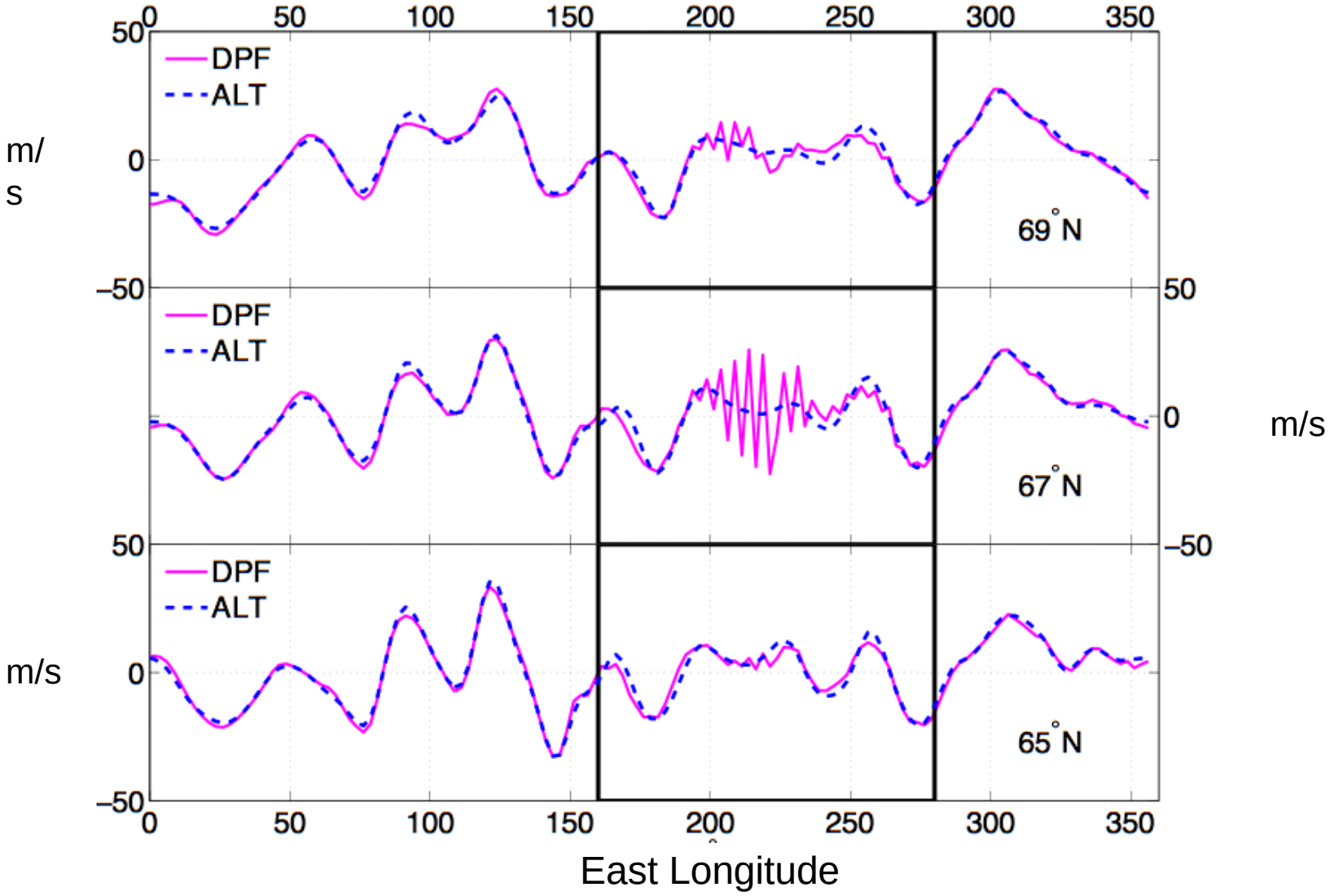
Ensemble Mean V @ 266hPa CAM FV core 00Z 25 September 2006

The differences are minimal except at the transition region of the default polar filter.



Ensemble Mean V @ 266hPa CAM FV core 00Z 25 September 2006

Three adjacent E-W cross-sections from the region of the discontinuity reveal more detail.



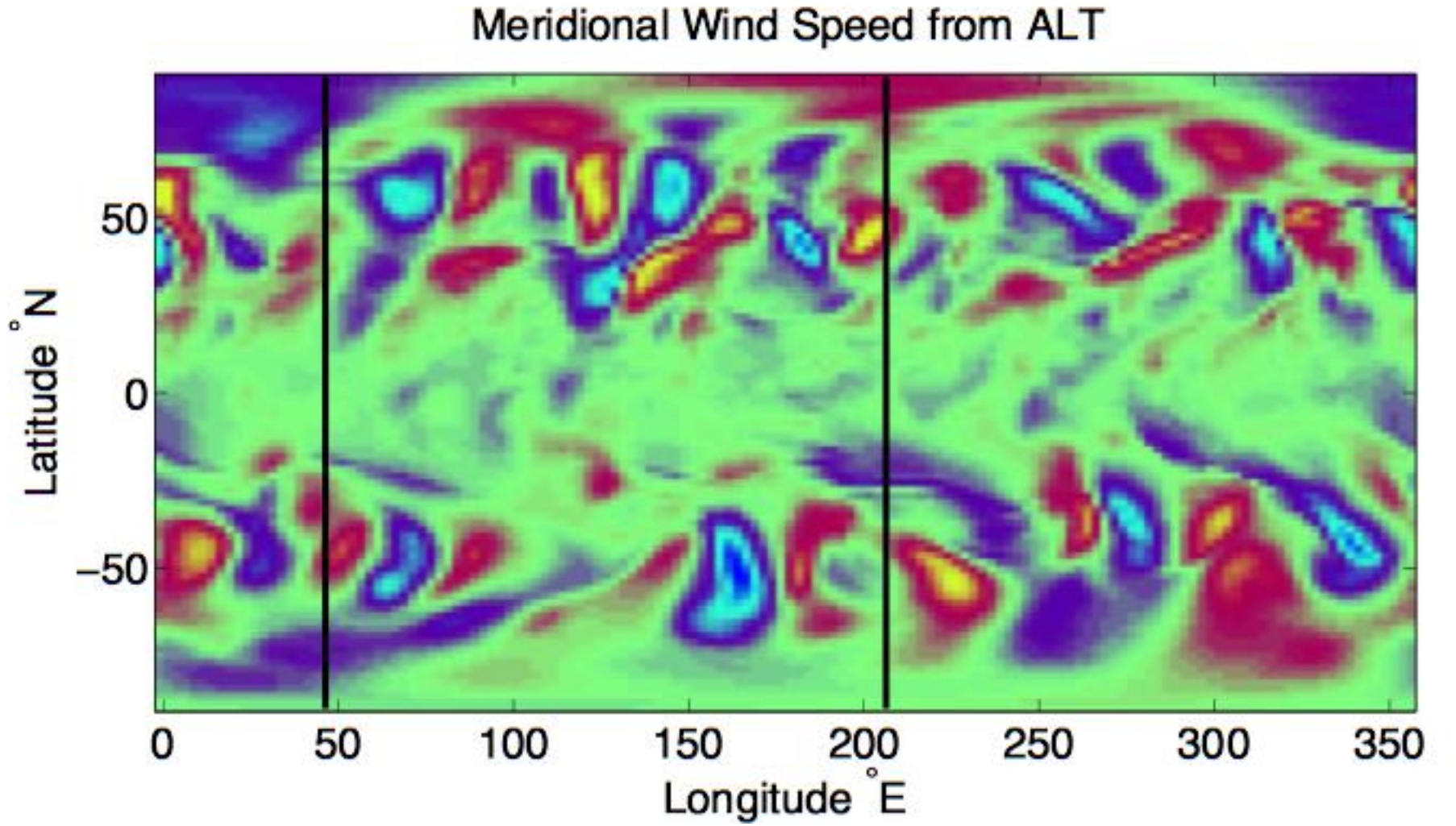
Ensemble Mean V @ 266hPa CAM FV core 00Z 25 September 2006

That wasn’t so bad!

- The use of DART diagnosed a problem that had been unrecognized (or at least undocumented).
- The problem can be seen in ‘free runs’ - it is not a data assimilation artifact.
- Could have an important effect on any physics in which meridional mixing is important.
- The alternate polar filter ‘fixes’ this problem, but . . .

More suspicious patterns, not fixed by ALT_PFT

2 Δy noise in ens. avg. V



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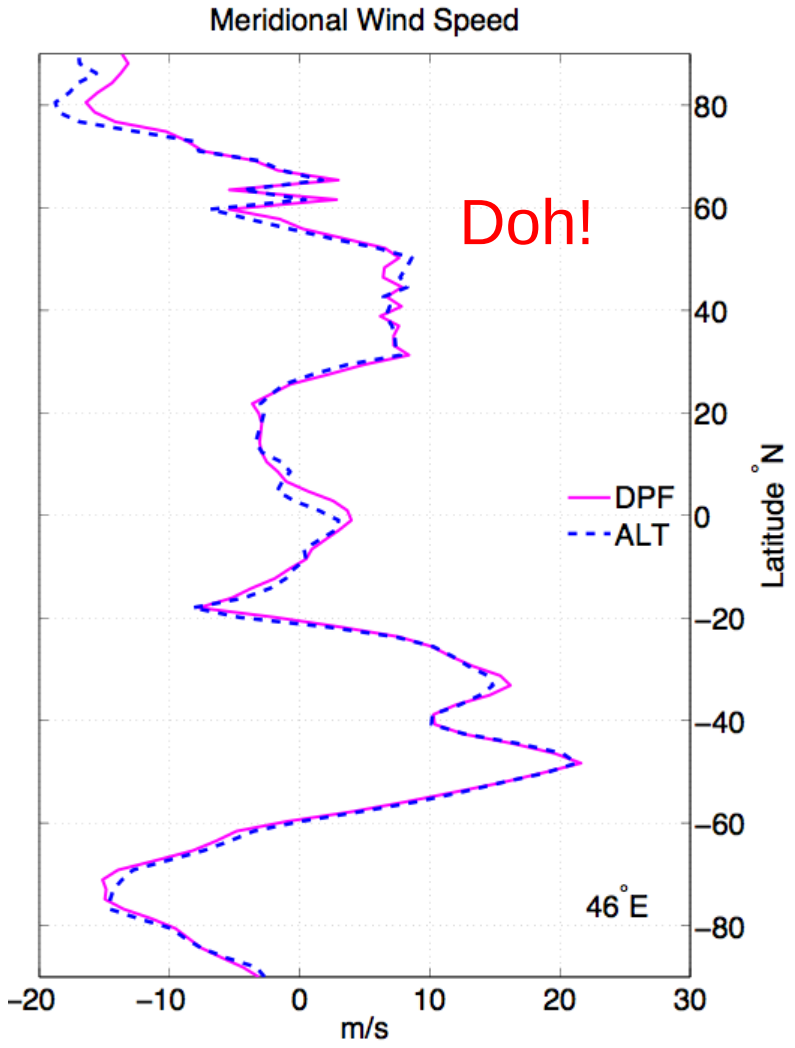
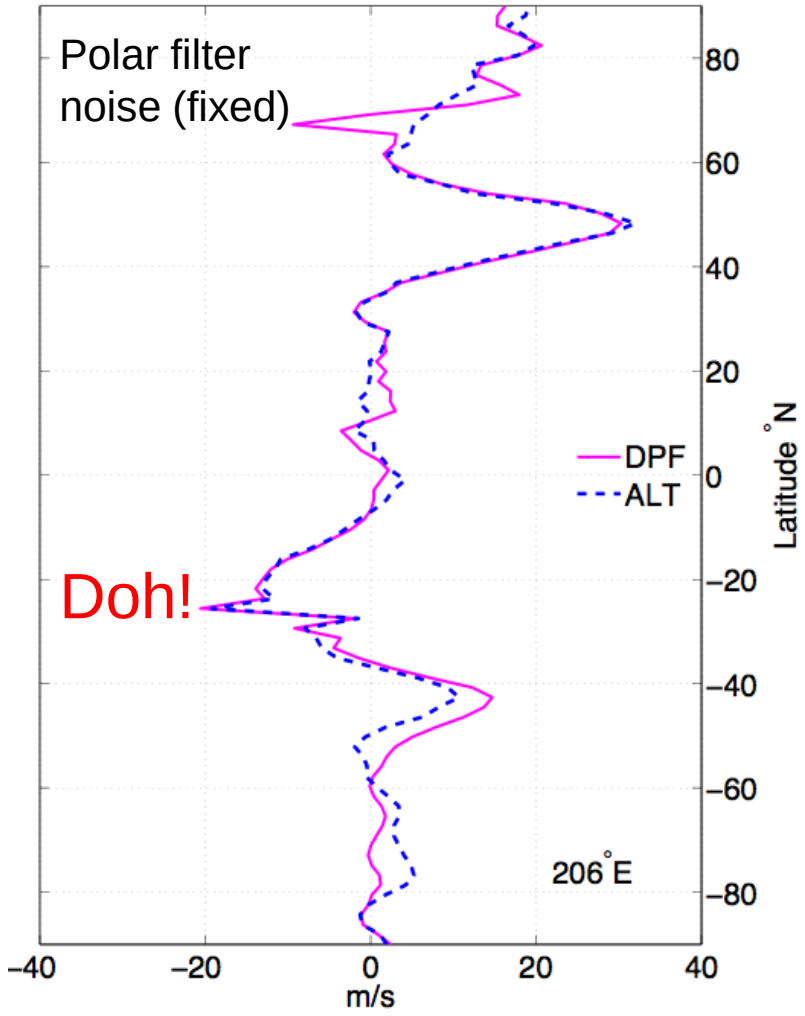
North-South cross sections

46º East



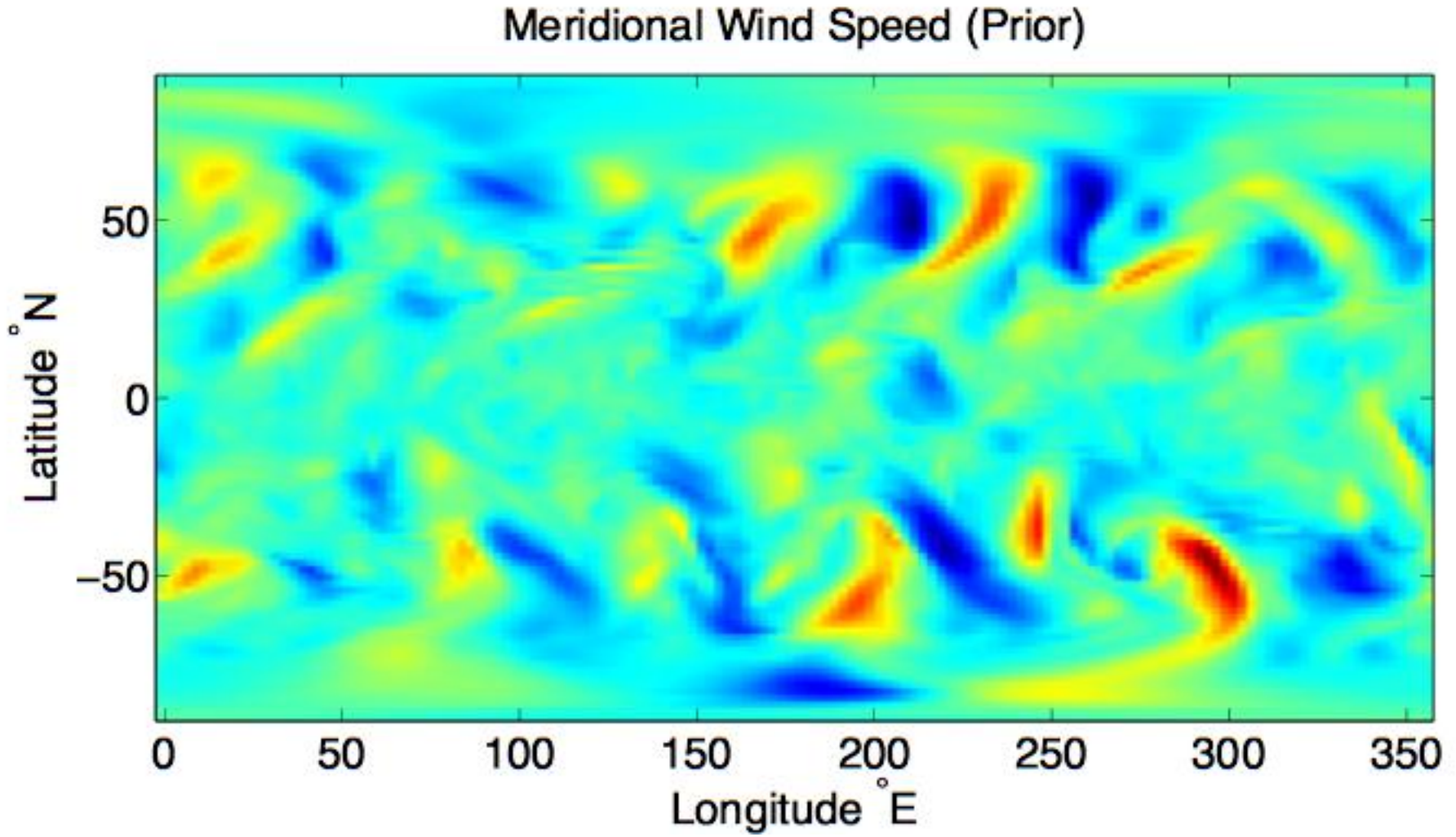
206º East



Ensemble Mean V @ 266hPa CAM FV core 00Z 25 September 2006

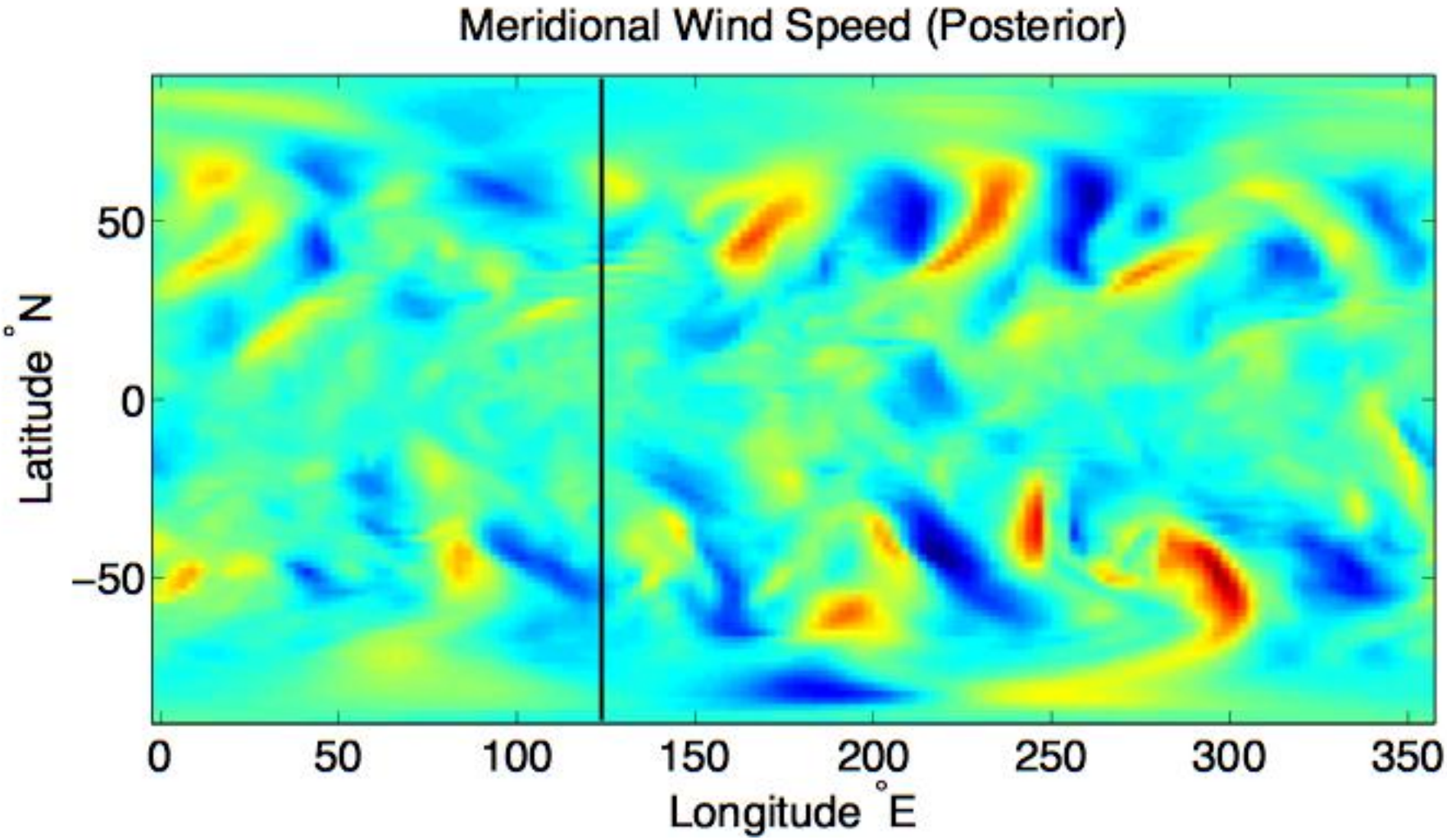
Another instance from real-time use of DART-CAM in a chemistry field campaign

6 hour forecast of a single ensemble member



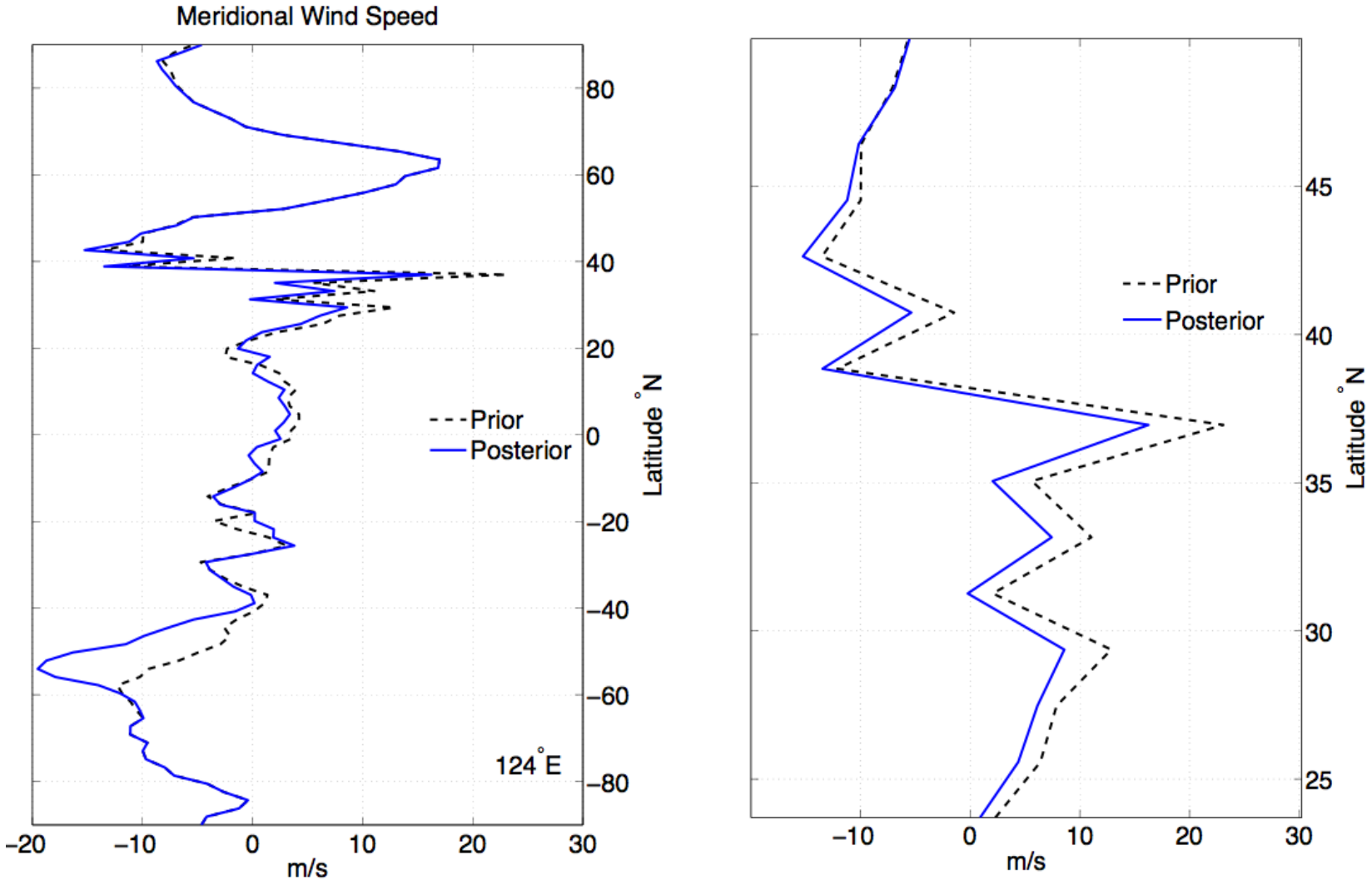
Ensemble Member 10 V @ 266hPa CAM FV core 06Z 13 April 2008

Same time, after assimilating the observations



Ensemble Member 10 V @ 266hPa CAM FV core 06Z 13 April 2008

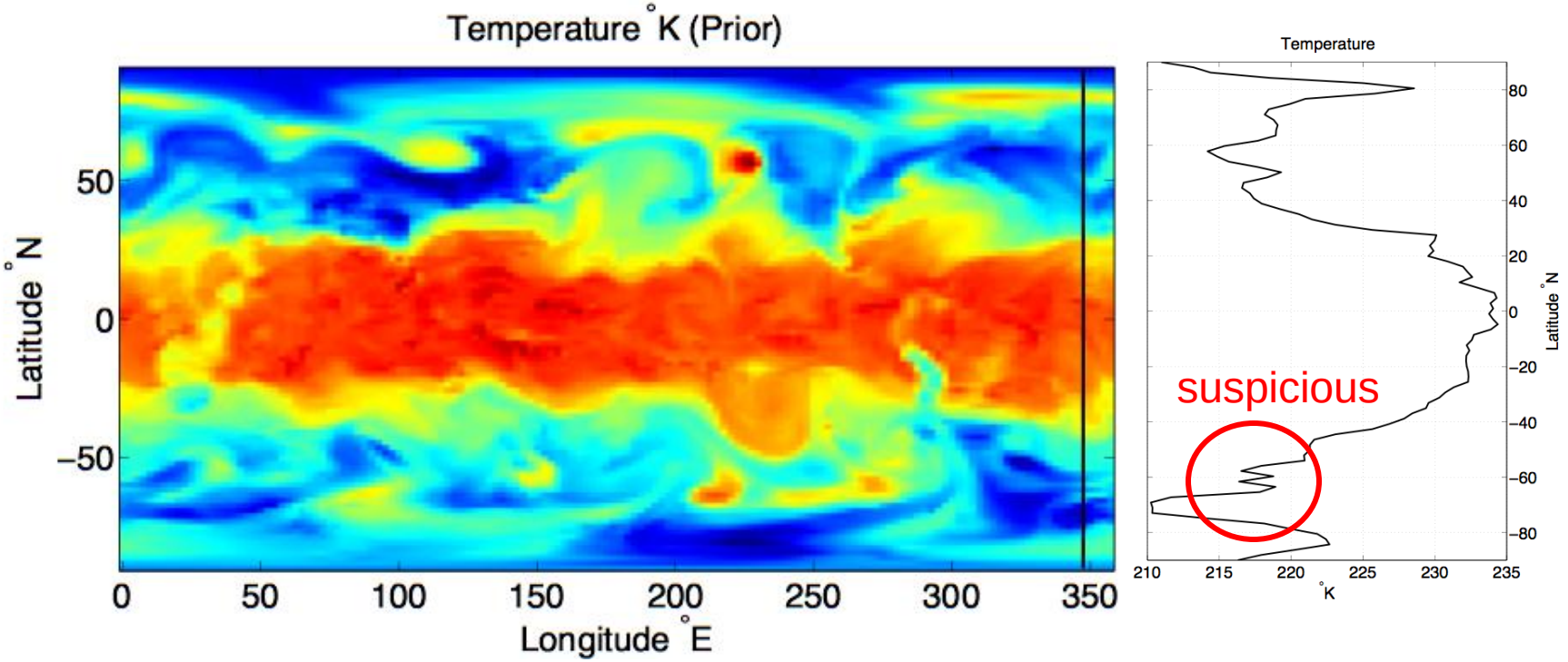
Close-up after assimilating:



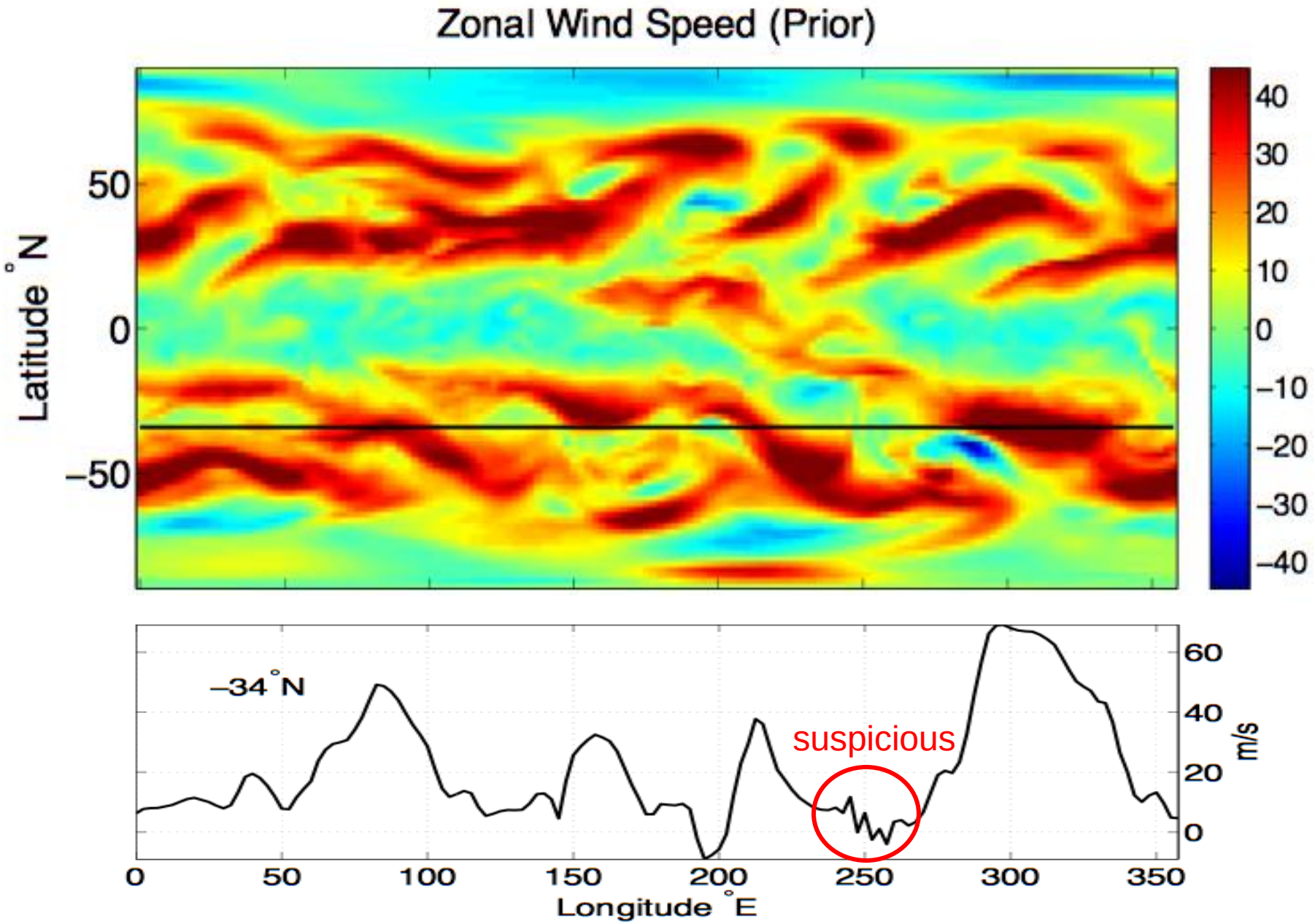
Assimilation reduces the noise, implicating the model.

Ensemble Member 10, V @ 266hPa 06Z 13 April 2008

Noise not restricted to V winds …



Ensemble Member 10 T @ 266hPa CAM FV core 06Z 13 April 2008

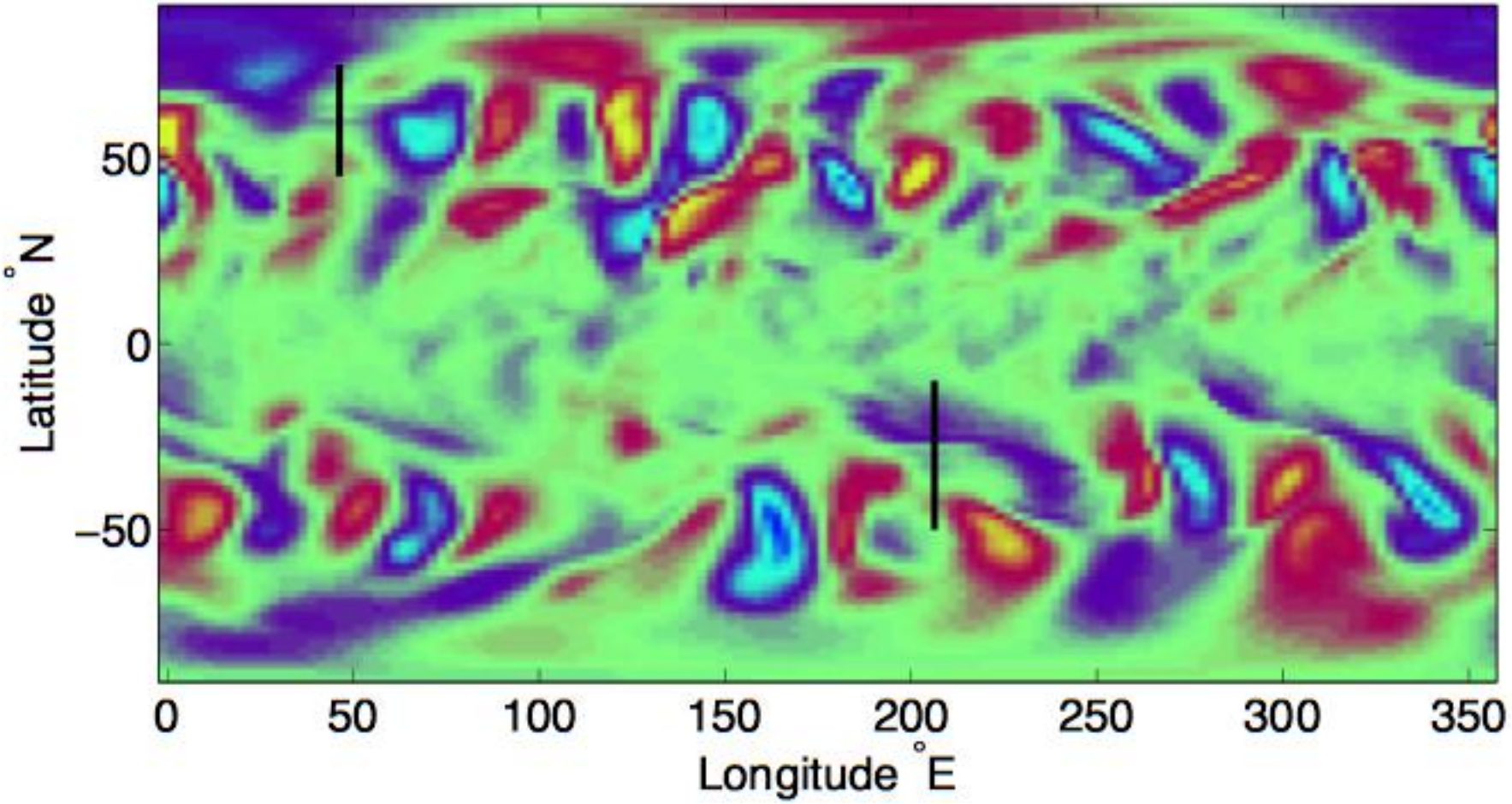


Ensemble Member 10 U @ 266hPa CAM FV core 06Z 13 April 2008

Assimilation with finer dynamics time splitting:

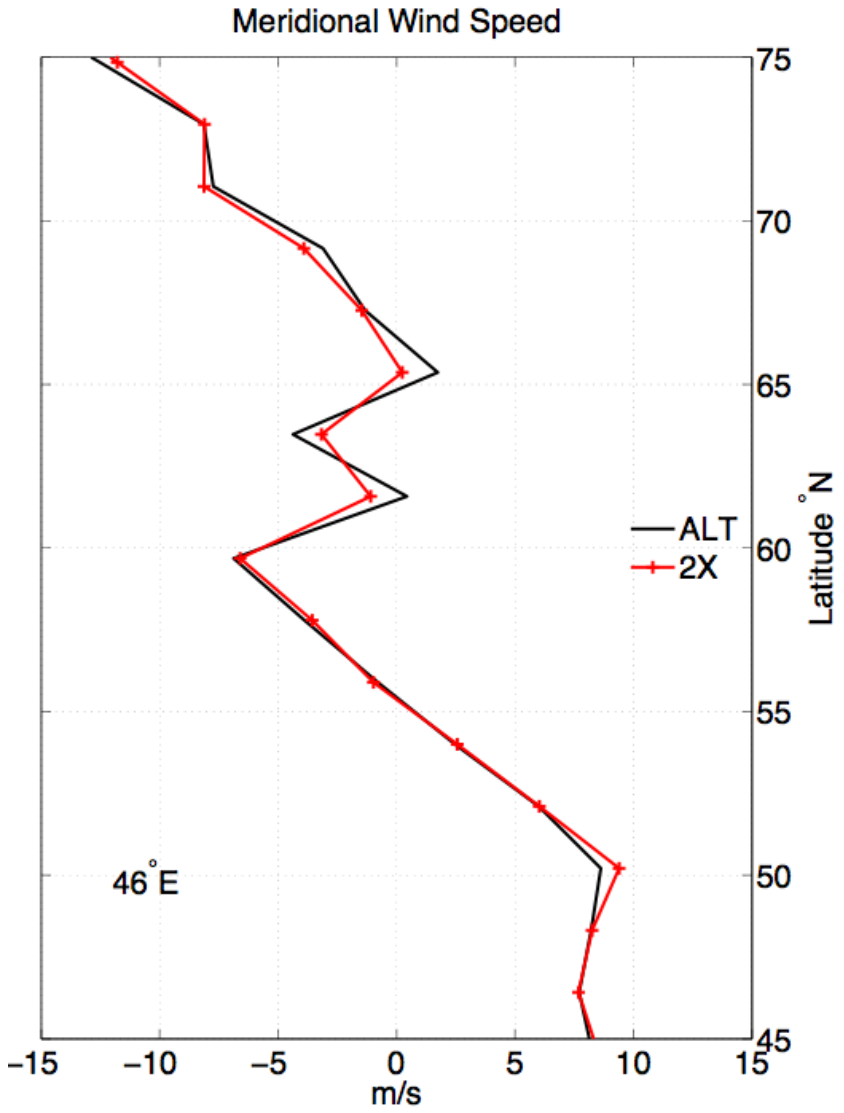
nsplit = 8 = 2*default

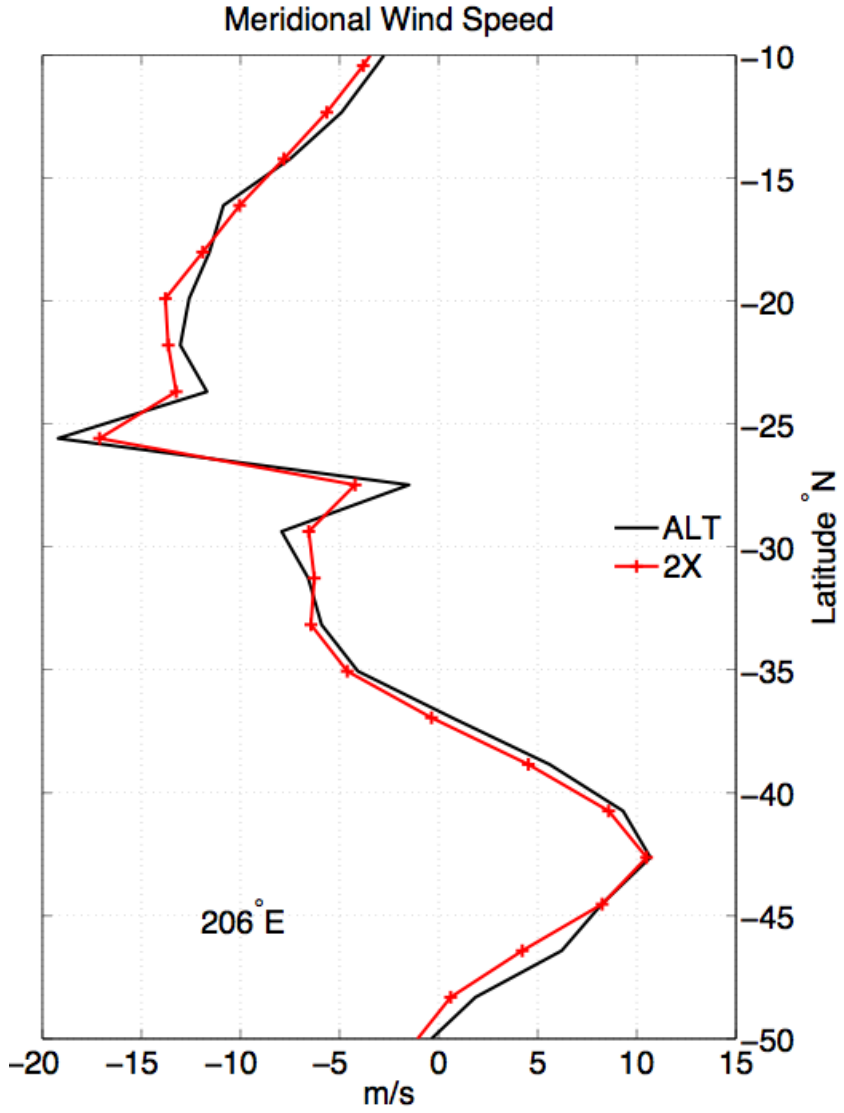
Ens. Mean V, 266 hPa, 00Z 25 Sep 2006



Ensemble Mean V @ 266hPa CAM FV core 00Z 25 September 2006

Doubling the dynamical time splitting reduced the noise; implicates model as opposed to assimilation.





Ensemble Mean V @ 266hPa CAM FV core 00Z 25 September 2006

Notes and Conclusions

The noises here may seem small and transient,
but since they had not been recognized by any of the labs which are using this FV core, their effects on climate runs have not been explored.

- Spurious mixing is happening.
- Parameterizations may have been mistuned.
- More time may need to be spent fixing the remaining noise and looking at other unexamined pieces of the code.

Notes and Conclusions

In the polar filter case the assimilation exaggerated the noise,
In the other case it reduced the noise.

Work is continuing, but DART has identified
unrecognized problems in the CAM FV core,
and contributed to quick solutions.