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 $\Delta t$.

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

Assimilate observations used in operational forecasting:

$\rightarrow$ U, V, and T from radiosondes, ACARS, and aircraft,

$\rightarrow$ 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.”

Ensemble Mean V at 266 hPa at 6 hours

80 member mean
00Z 25 September 2006
Suspicions turned to the polar filter
Using a continuous polar filter does not show this effect.
The differences are minimal except at the transition region of the default polar filter.
Three adjacent E-W cross-sections from the region of the discontinuity reveal more detail.
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

$2 \Delta y$ noise in ens. avg. V

Meridional Wind Speed from ALT

Ensemble Mean V @ 266hPa  CAM FV core 00Z 25 September 2006
North-South cross sections

46° East

206° East

Meridional Wind Speed

Polar filter noise (fixed)

Doh!

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
Same time, after assimilating the observations
Close-up after assimilating:

Assimilation reduces the noise, implicating the model.
Noise not restricted to V winds ...

Temperature °K (Prior)

suspicious
Assimilation with finer dynamics time splitting:
\[ nsplit = 8 = 2^{*}\text{default} \]

Ens. Mean V, 266 hPa, 00Z 25 Sep 2006
Doubling the dynamical time splitting reduced the noise; implicates model as opposed to assimilation.
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.