

GFS (T126L28) experiments for different horizontal diffusions

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Motivations

- To try to answer questions.
 - Why T190 is much better than T126?
 - Is it really resolution affecting (only)?
 - Both deterministic and ensemble
- To find out GFS horizontal diffusion set up as:
 - T62 – 2nd order
 - T126 – 4th order
 - T170 and beyond – 8th order
- Simply play around the diffusion setting up
 - T126L28 – 4th order (default – operation)
 - T126L28 – 6th order (experiment)
 - T126L28 – 8th order (experiment)

Old statement for diffusion set up

The major reason (historical) for incorporating horizontal diffusion in the spectral model is to control small scale noise caused by:

1. The spectral truncation at a finite wave number, which prohibits nonlinear energy cascade toward the smaller scales (wave blocking), and
2. The creation of small scale gravity waves by the parameterization of physical processes.

2nd and 4th order horizontal diffusions have strong scale dependence, which mainly dumping all the small scales in order to control the noise without affecting large scale of motion.

From basic equations (e.g. vorticity)

$$\frac{\partial \eta}{\partial t} = \dots\dots\dots + F_{\eta H}$$

$$F_{\eta H} = K_n \left(\nabla^n \eta + \dots\dots\dots \right)$$

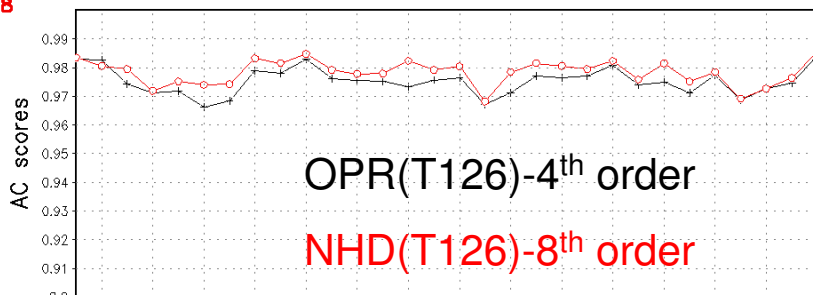
n is the order

T126 for 4th and 8th orders

(May and November 2007)

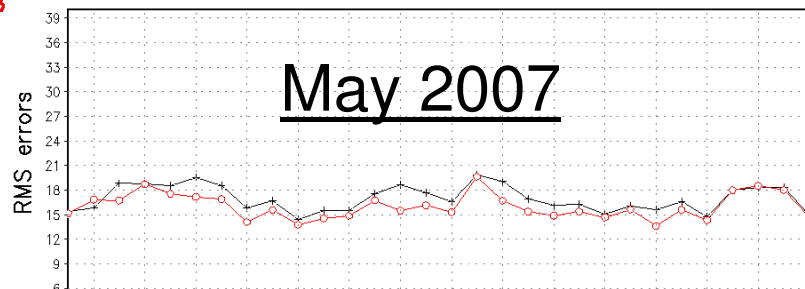
OPR=0.975
NHD=0.978

NH 500 hPa Geopotential Height at day 2
for 00Z02MAY2007 - 00Z31MAY2007



OPR(T126)-4th order
NHD(T126)-8th order

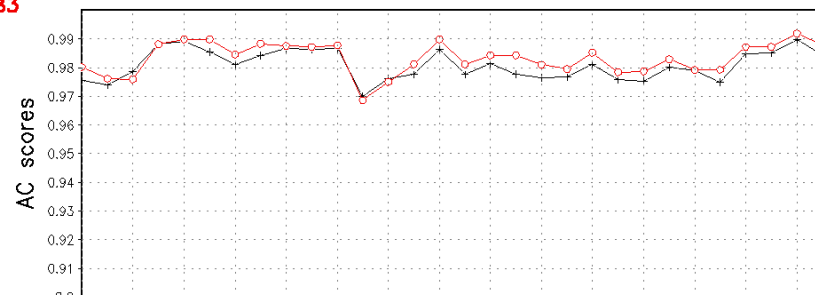
OPR=17.014
NHD=16.03



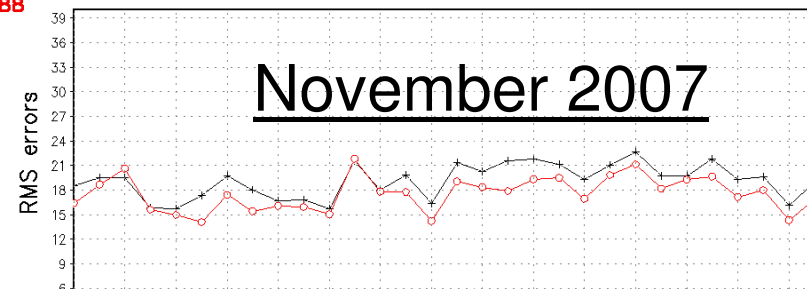
May 2007

OPR=0.980
NHD=0.983

NH 500 hPa Geopotential Height at day 2
for 00Z01NOV2007 - 00Z30NOV2007



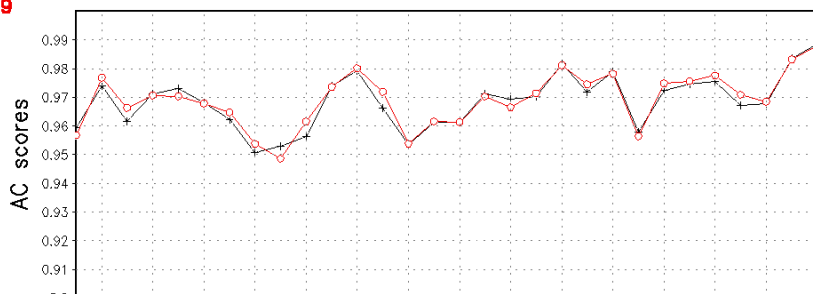
OPR=19.131
NHD=17.588



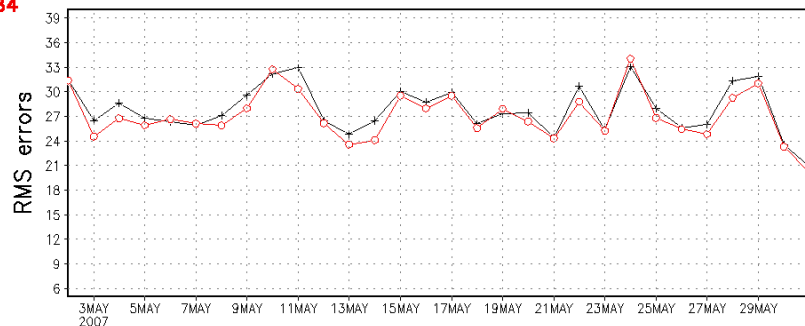
November 2007

OPR=0.968
NHD=0.969

SH 500 hPa Geopotential Height at day 2
for 00Z02MAY2007 - 00Z31MAY2007

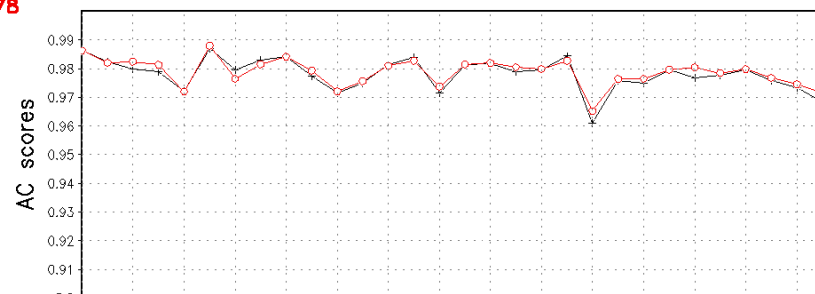


OPR=27.864
NHD=27.084

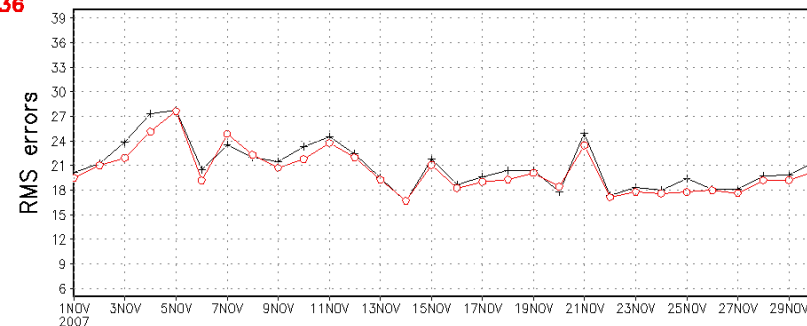


OPR=0.978
NHD=0.978

SH 500 hPa Geopotential Height at day 2
for 00Z01NOV2007 - 00Z30NOV2007



OPR=20.943
NHD=20.336

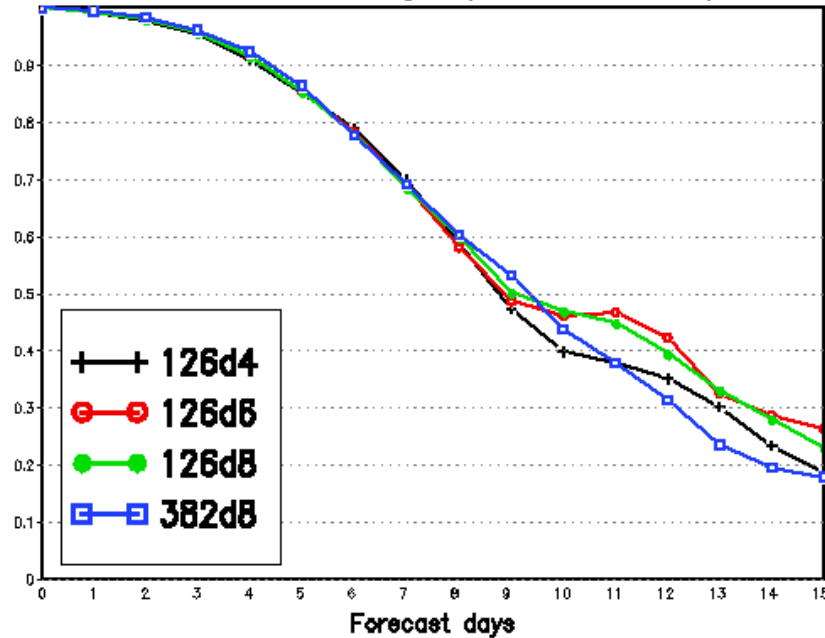


T126 for 4th, 6th and 8th orders

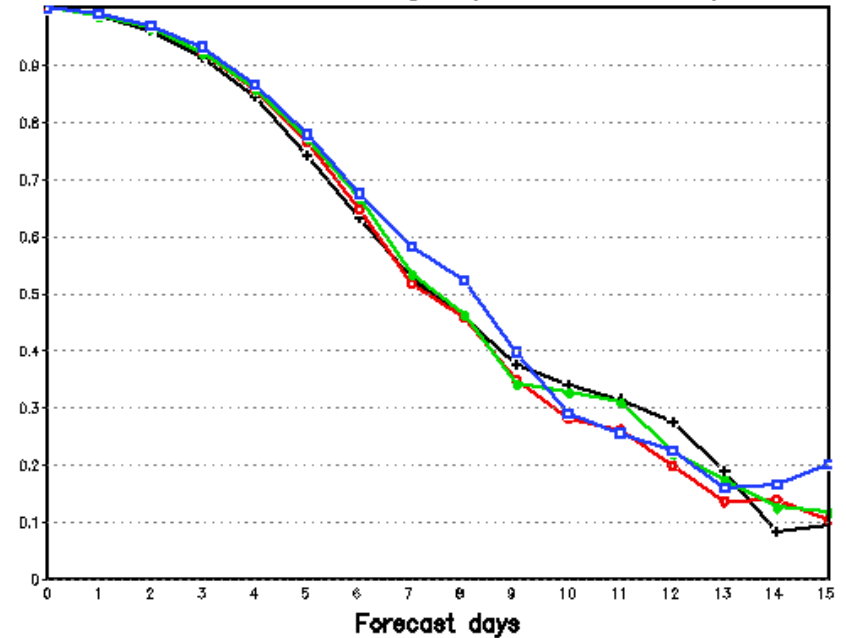
(December 2007)

AVERAGE FOR 00Z01DEC2007 – 00Z31DEC2007

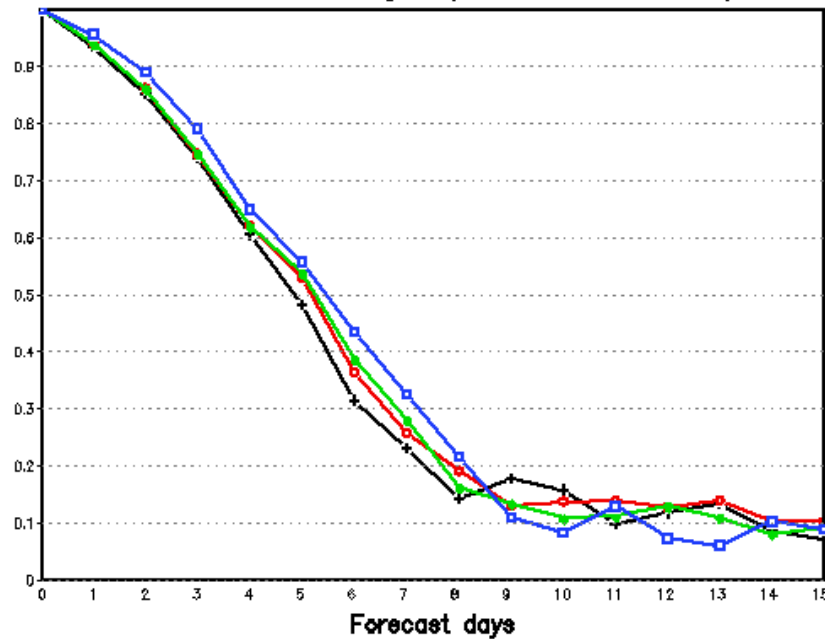
NH 1000 mb Height (wave 1-3 AC)



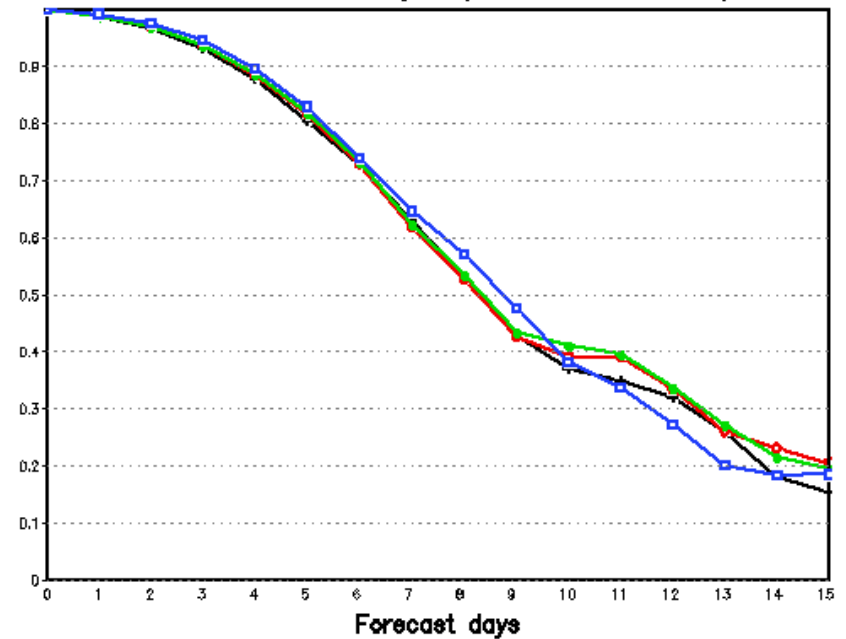
NH 1000 mb Height (wave 4-9 AC)



NH 1000 mb Height (wave 10-20 AC)

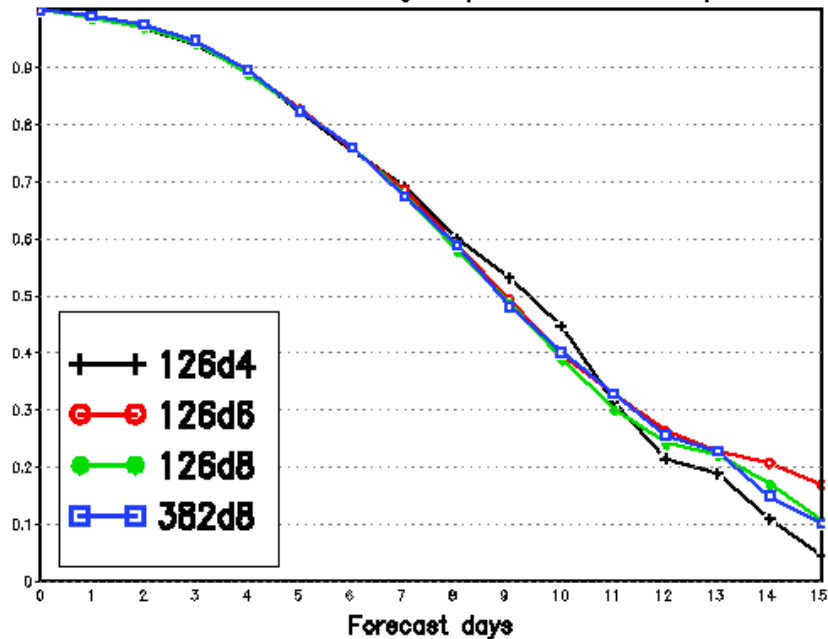


NH 1000 mb Height (wave 1-20 AC)

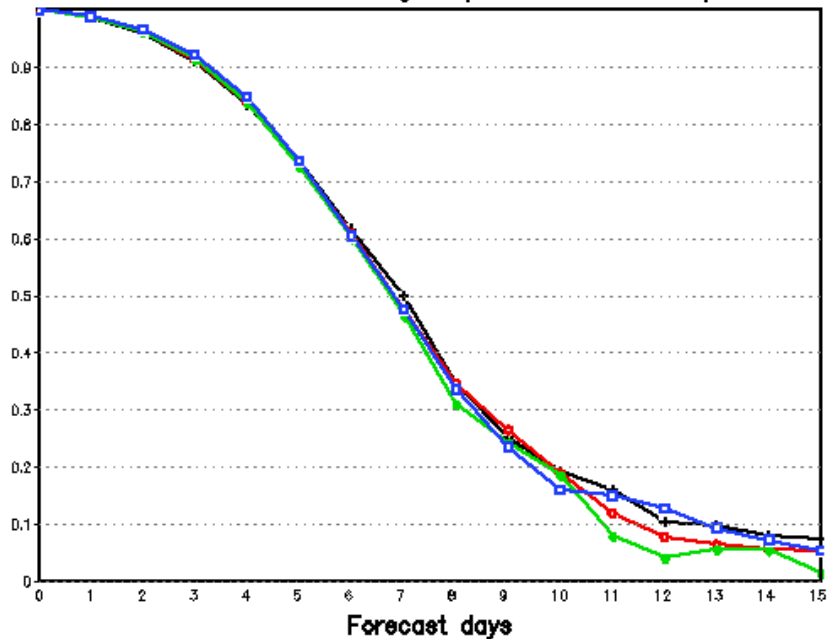


AVERAGE FOR 00Z01DEC2007 – 00Z31DEC2007

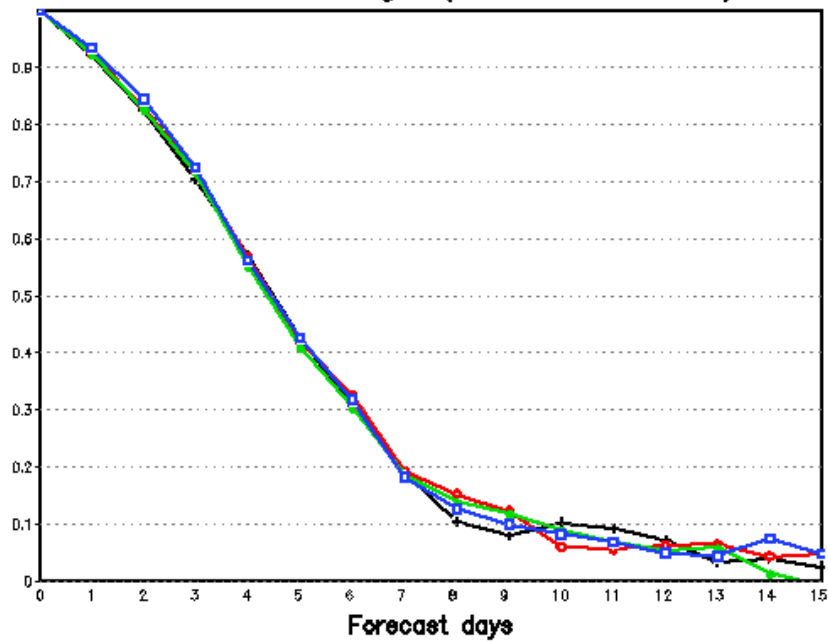
SH 1000 mb Height (wave 1–3 AC)



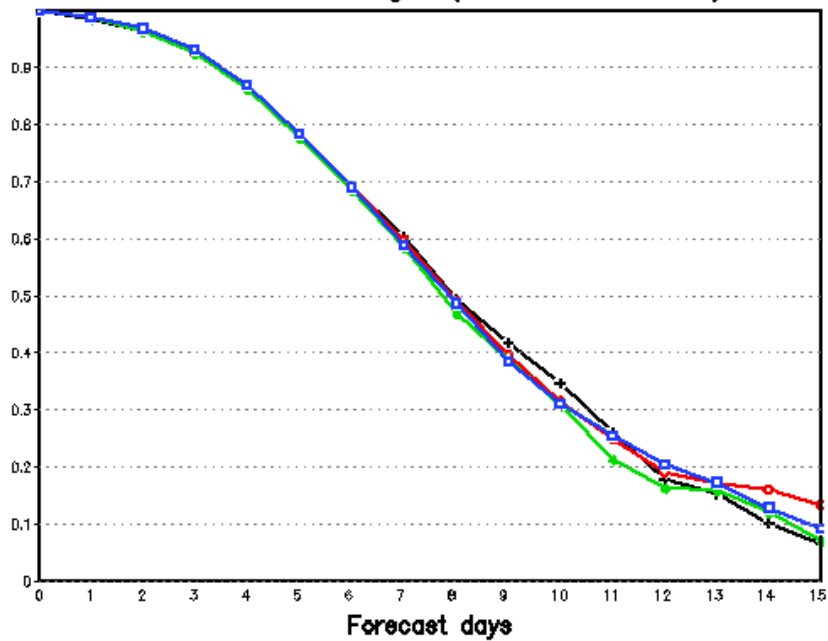
SH 1000 mb Height (wave 4–9 AC)



SH 1000 mb Height (wave 10–20 AC)

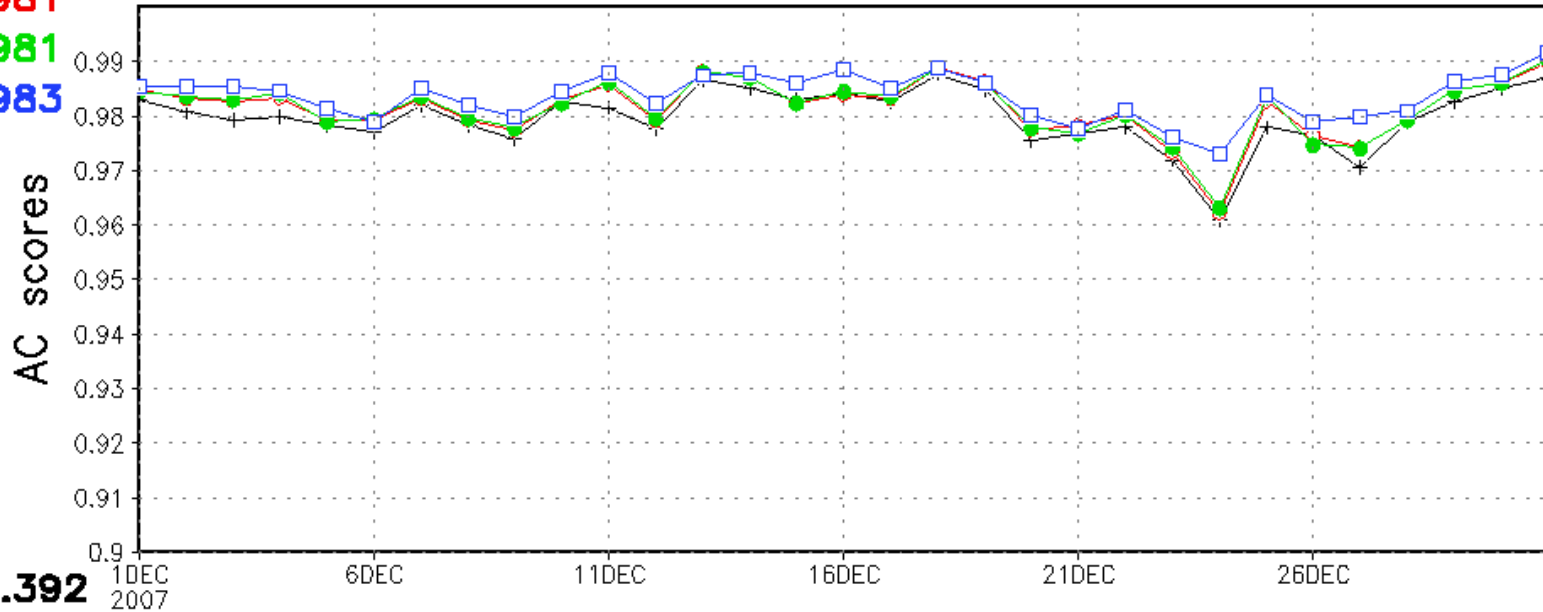


SH 1000 mb Height (wave 1–20 AC)

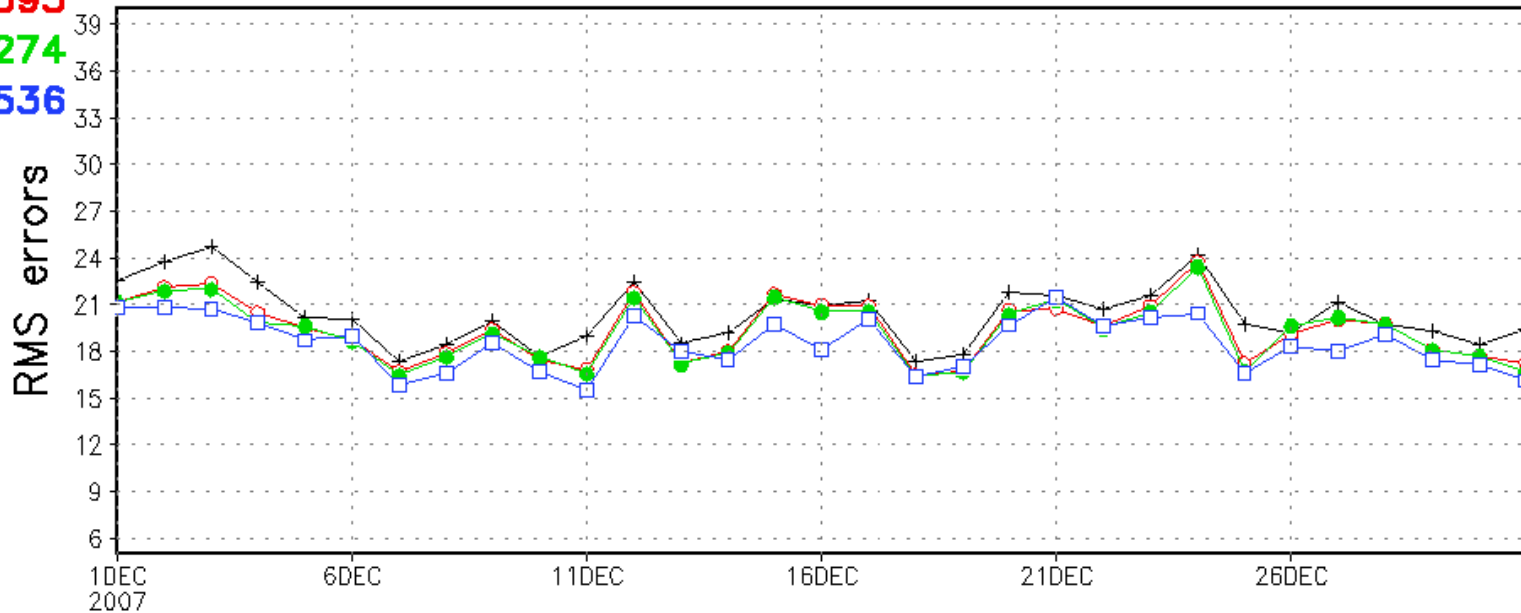


NH 500 hPa Geopotential Height at day 2 for 00Z01DEC2007 – 00Z31DEC2007

126d4=0.979
126d6=0.981
126d8=0.981
382d8=0.983



126d4=20.392
126d6=19.393
126d8=19.274
382d8=18.536



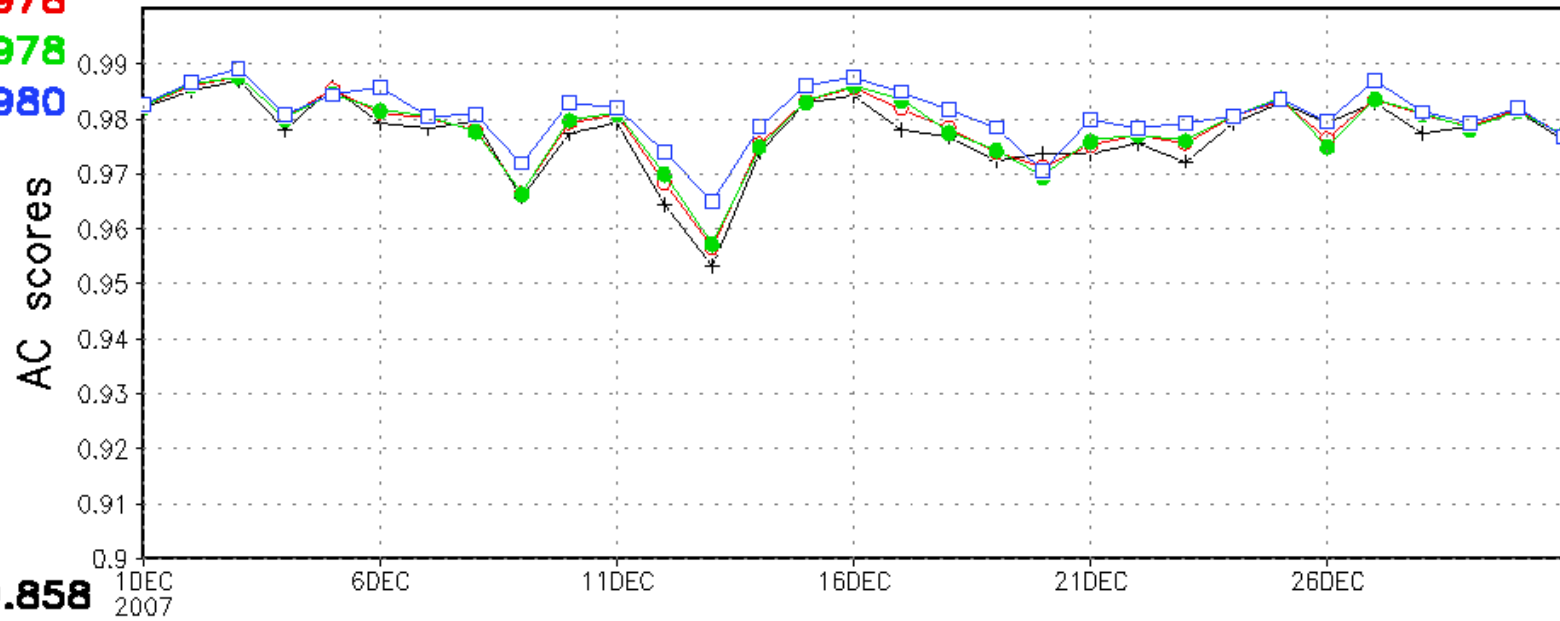
SH 500 hPa Geopotential Height at day 2 for 00Z01DEC2007 – 00Z31DEC2007

126d4=0.977

126d6=0.978

126d8=0.978

382d8=0.980

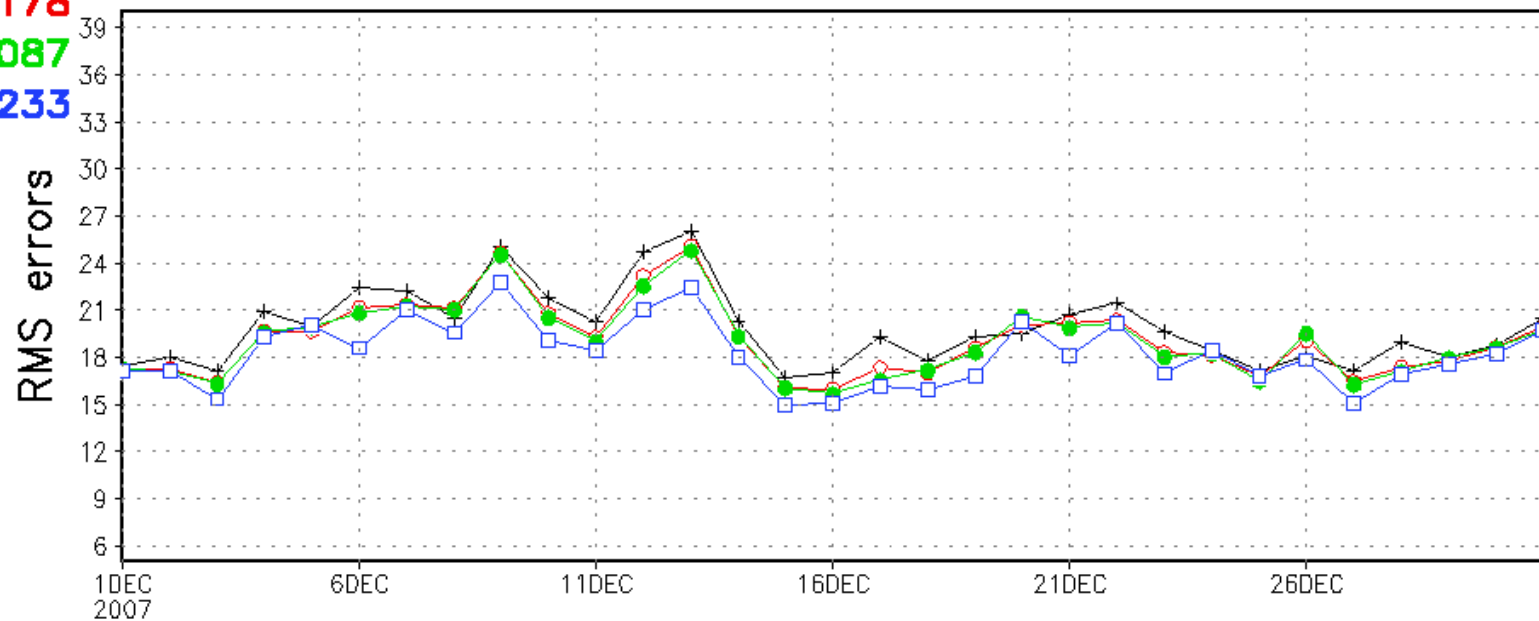


126d4=19.858

126d6=19.178

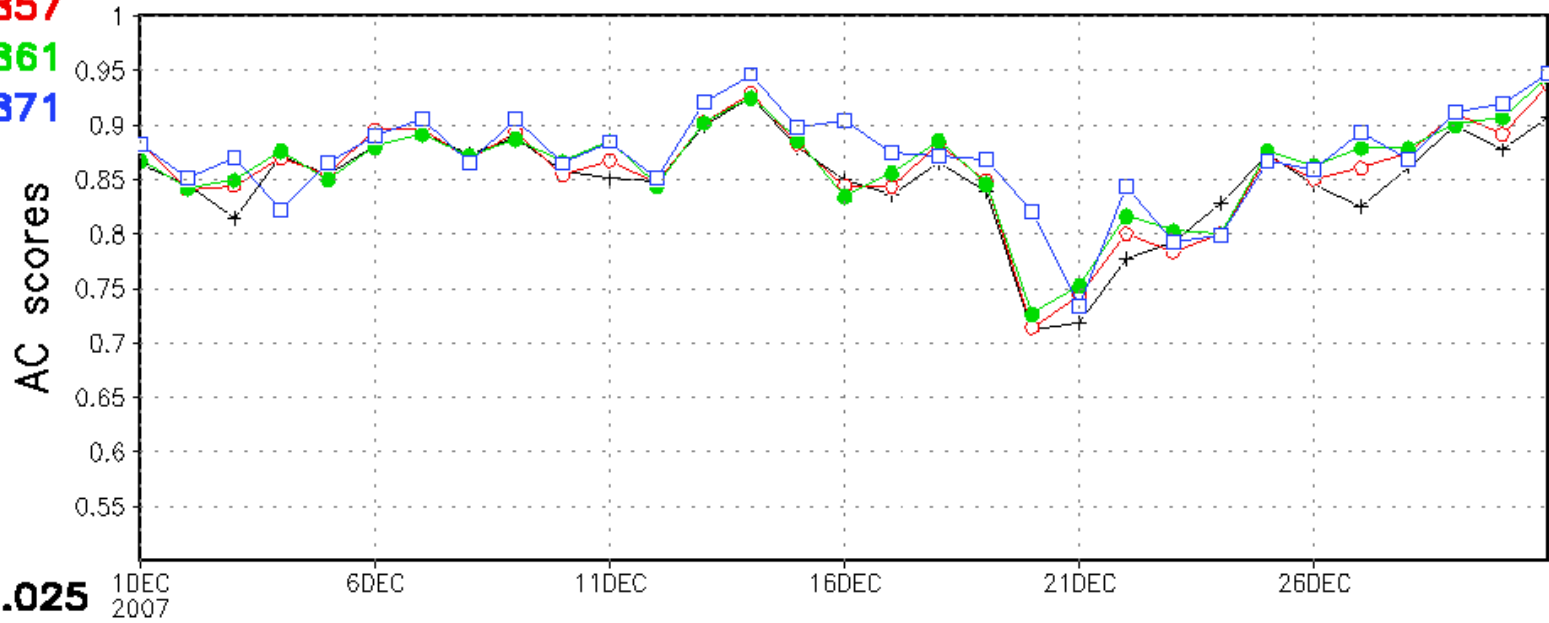
126d8=19.087

382d8=18.233

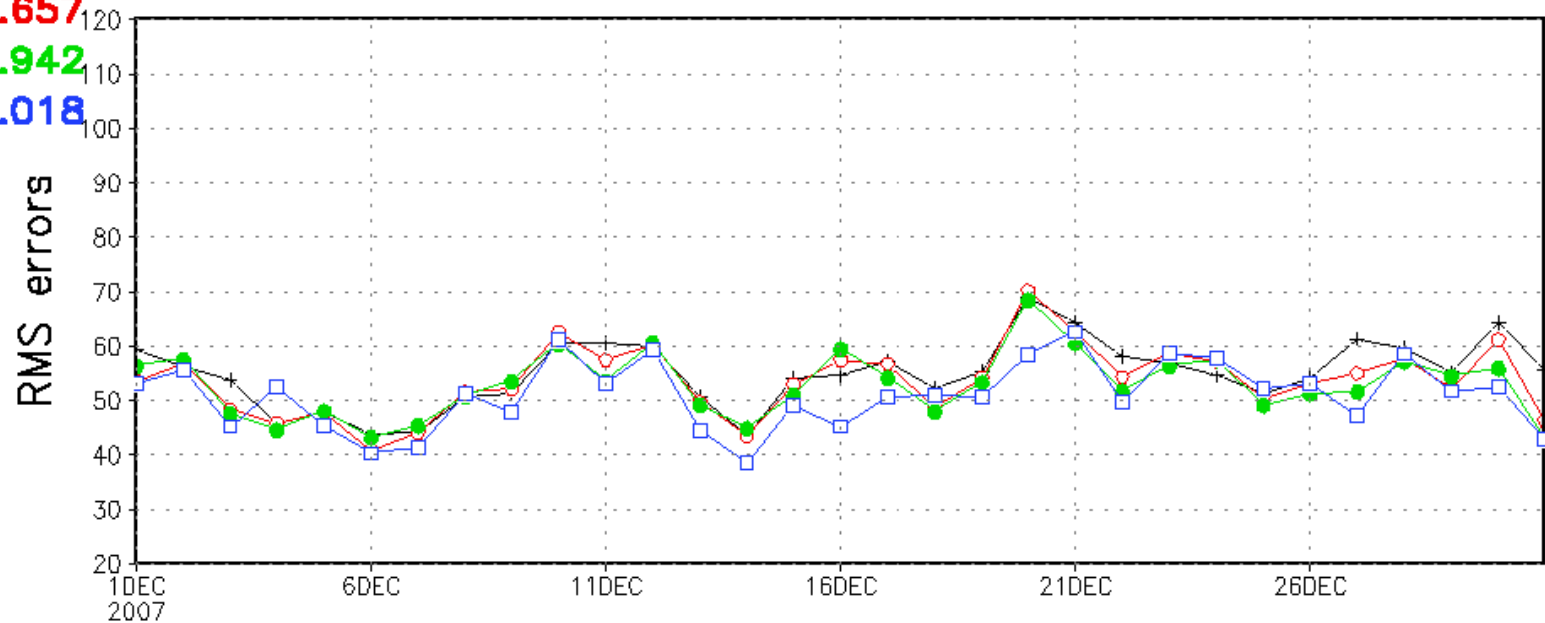


NH 500 hPa Geopotential Height at day 5 for 00Z01DEC2007 – 00Z31DEC2007

126d4=0.850
 126d6=0.857
 126d8=0.861
 382d8=0.871

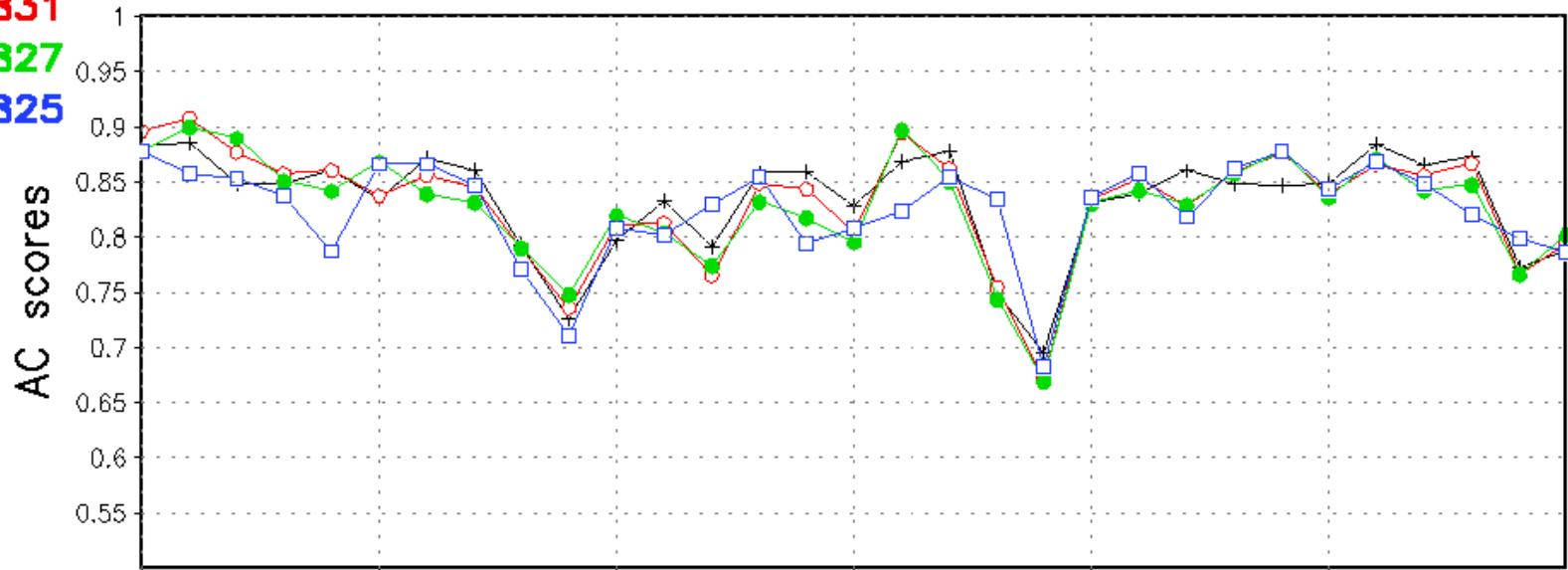


126d4=55.025
 126d6=53.657
 126d8=52.942
 382d8=51.018

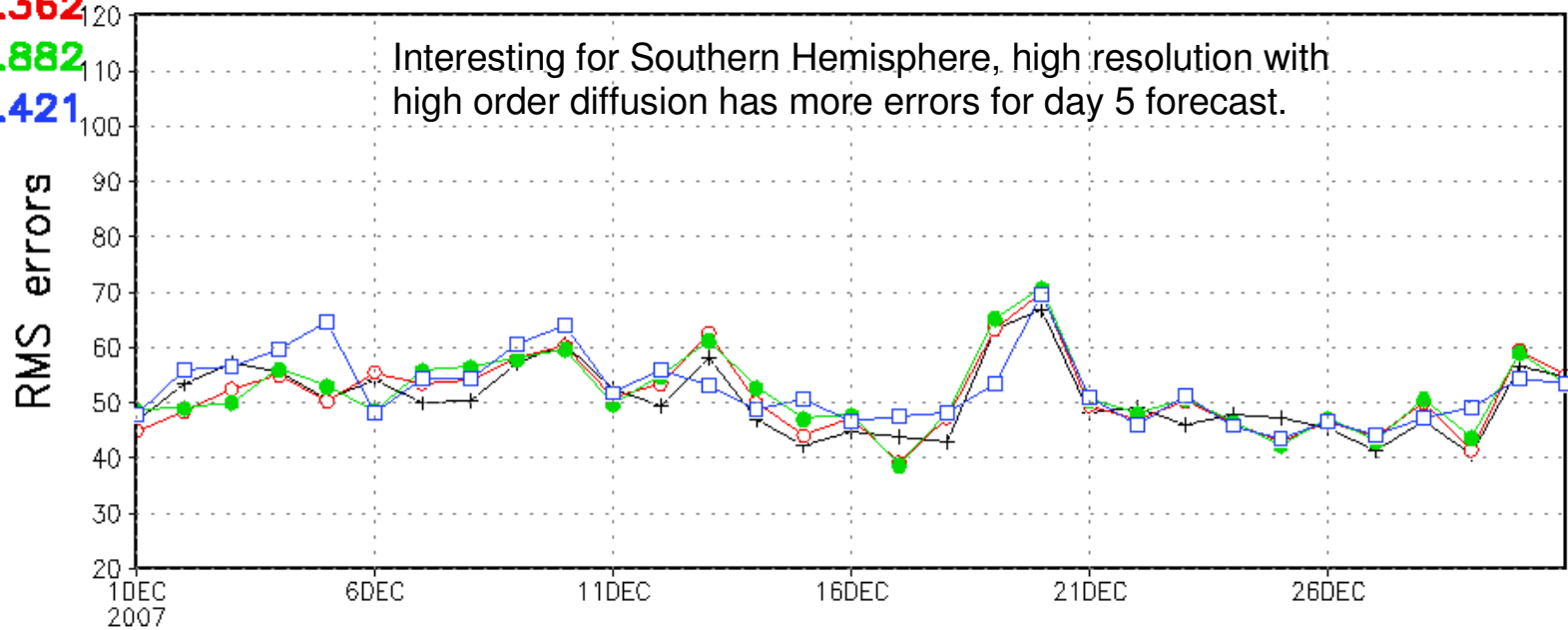


SH 500 hPa Geopotential Height at day 5 for 00Z01DEC2007 – 00Z31DEC2007

126d4=0.833
126d6=0.831
126d8=0.827
382d8=0.825

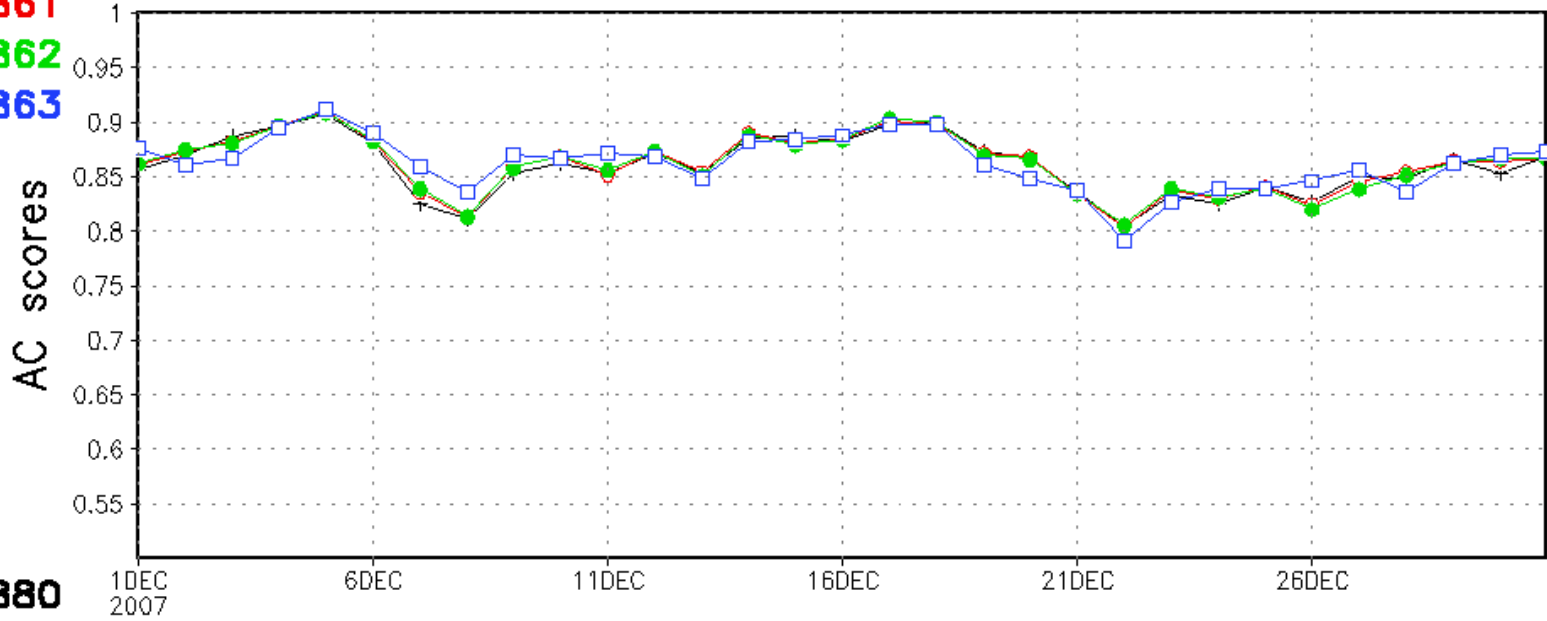


126d4=50.676
126d6=51.362
126d8=51.882
382d8=52.421

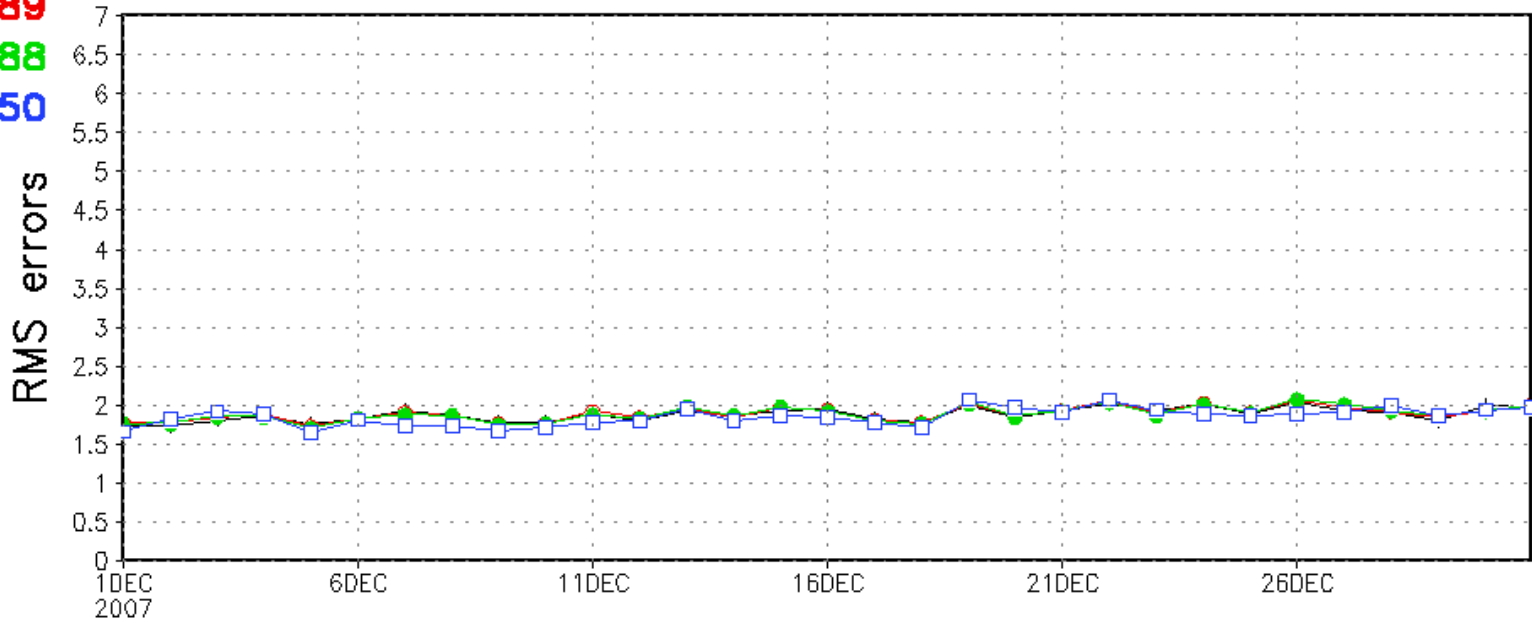


TROPICAL 850 hPa Wind-Speed at day 2 for 00Z01DEC2007 – 00Z31DEC2007

126d4=0.860
126d6=0.861
126d8=0.862
382d8=0.863



126d4=1.880
126d6=1.889
126d8=1.888
382d8=1.850



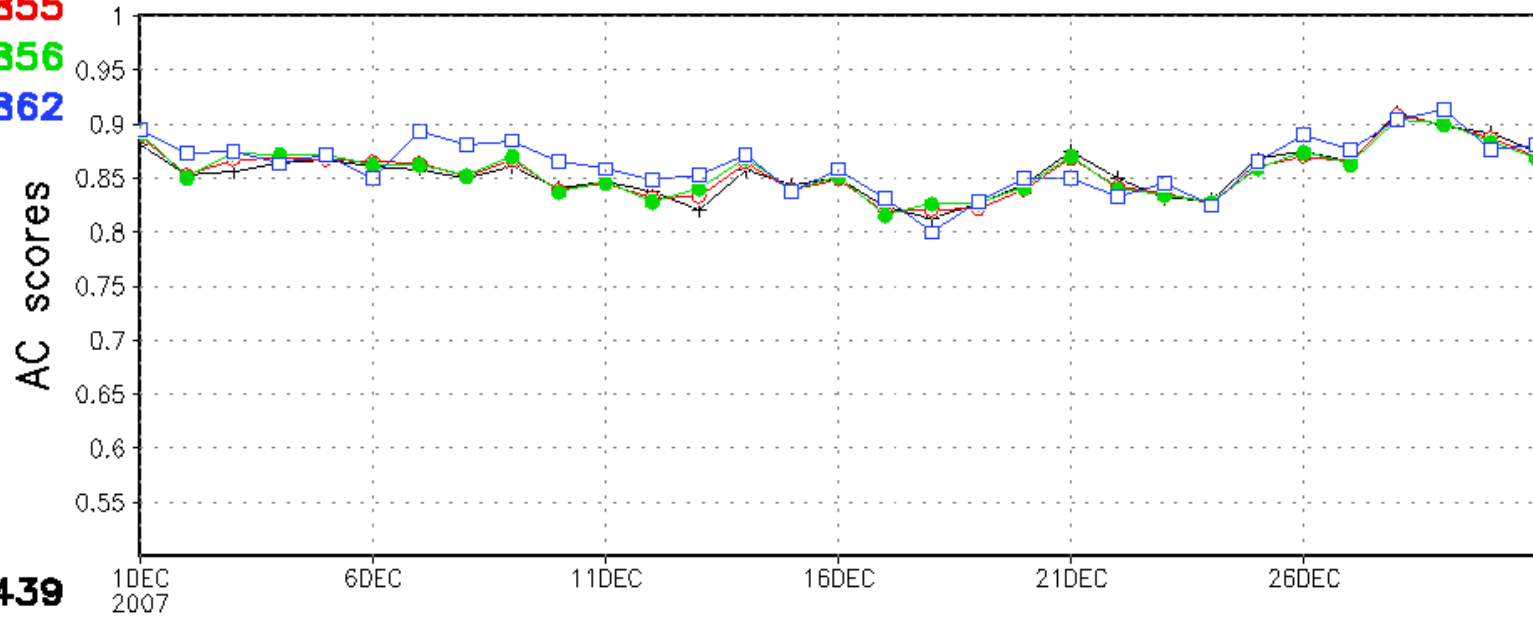
TROPICAL 200 hPa Wind-Speed at day 2
for 00Z01DEC2007 – 00Z31DEC2007

126d4=0.855

126d6=0.855

126d8=0.856

382d8=0.862

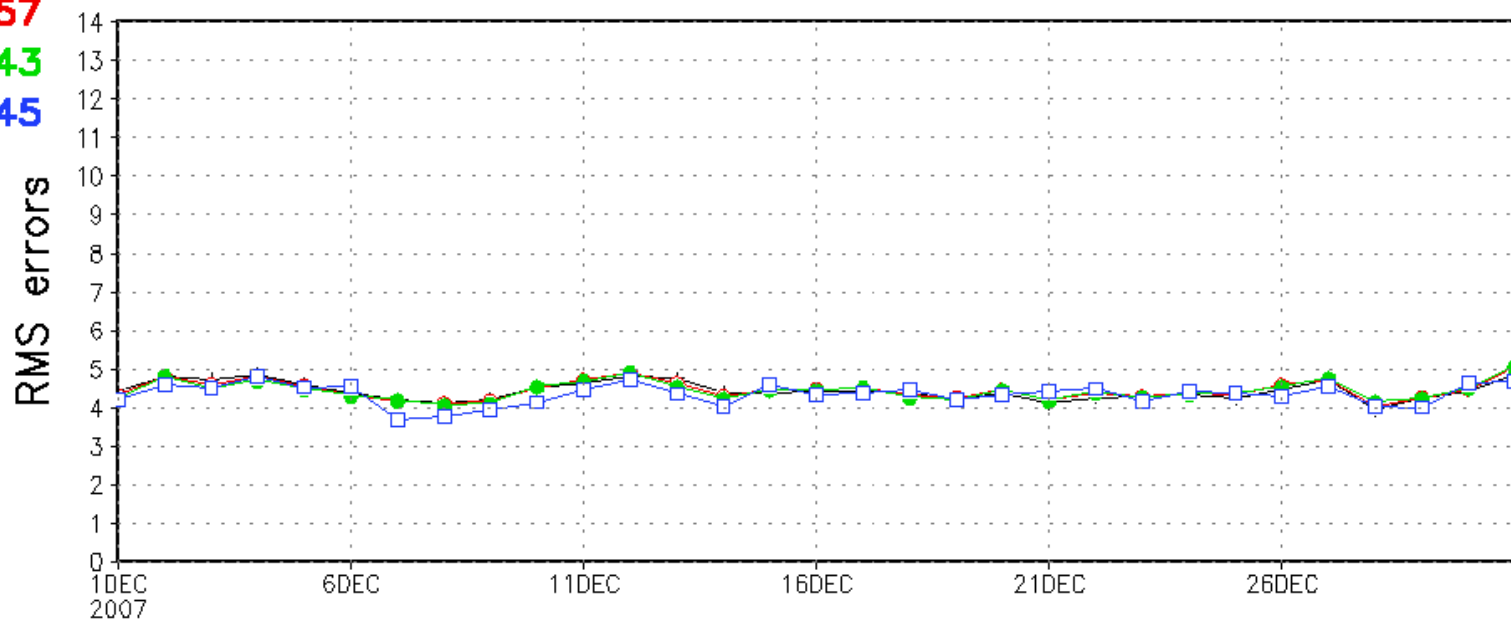


126d4=4.439

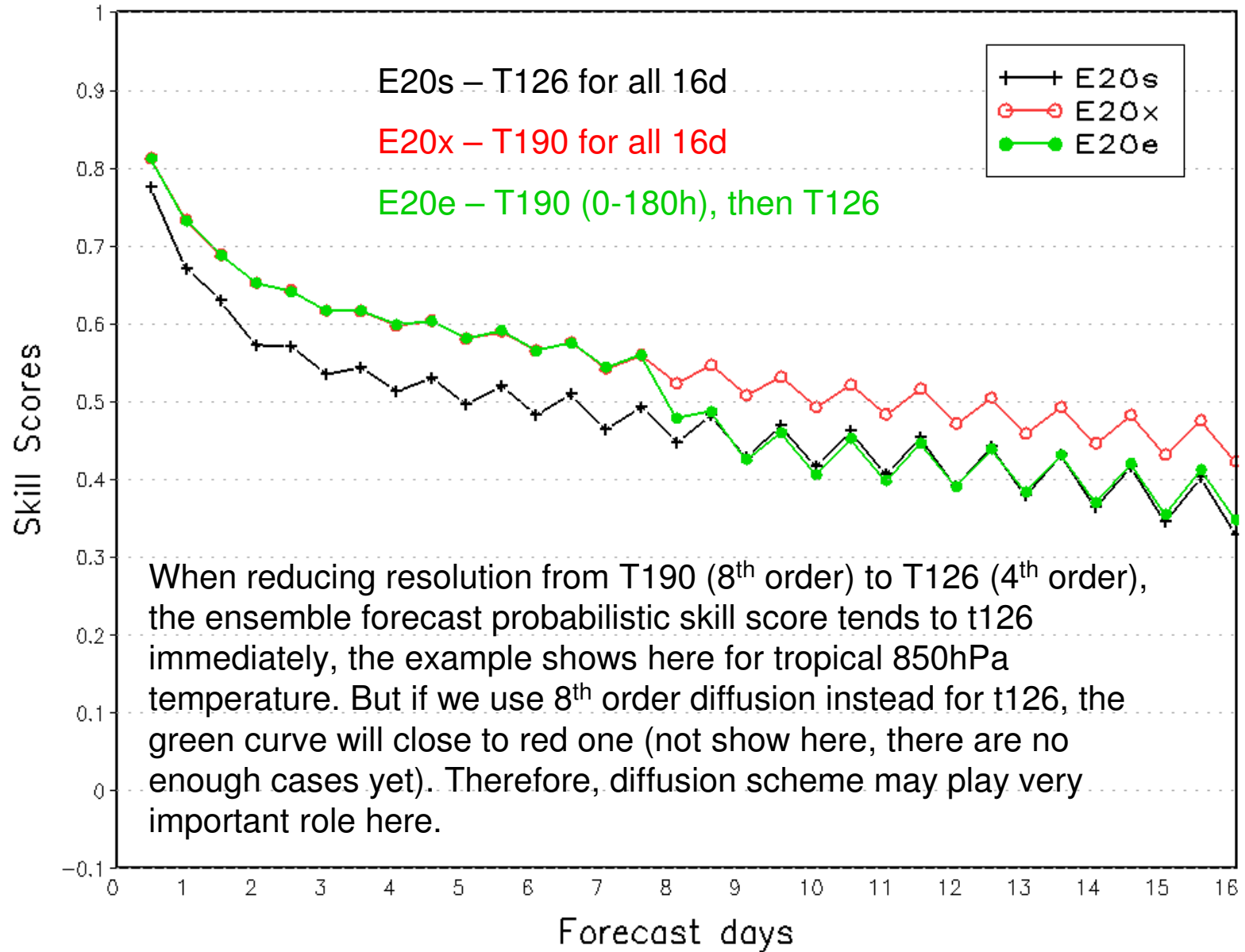
126d6=4.457

126d8=4.443

382d8=4.345



Tropical 850hPa Temp.
 ROC area (0-1)
 Average For 20071101 - 20071212



Conclusions

- Overall, 8th order horizontal diffusion is much better than current 4th order for T126 resolution, because:
 - There is much improved global analysis with fine resolution for past years
 - Small scale information is not noise anymore
 - Allow interaction between all scales, especially for global ensemble system
- Plan to use 8th order horizontal diffusion for GEFS T126 resolution
 - T190 (8th order: 0-180hrs), then T126 (8th order: 180hrs-384hrs)