Estimation of Analysis Error Characteristics Using an OSSE

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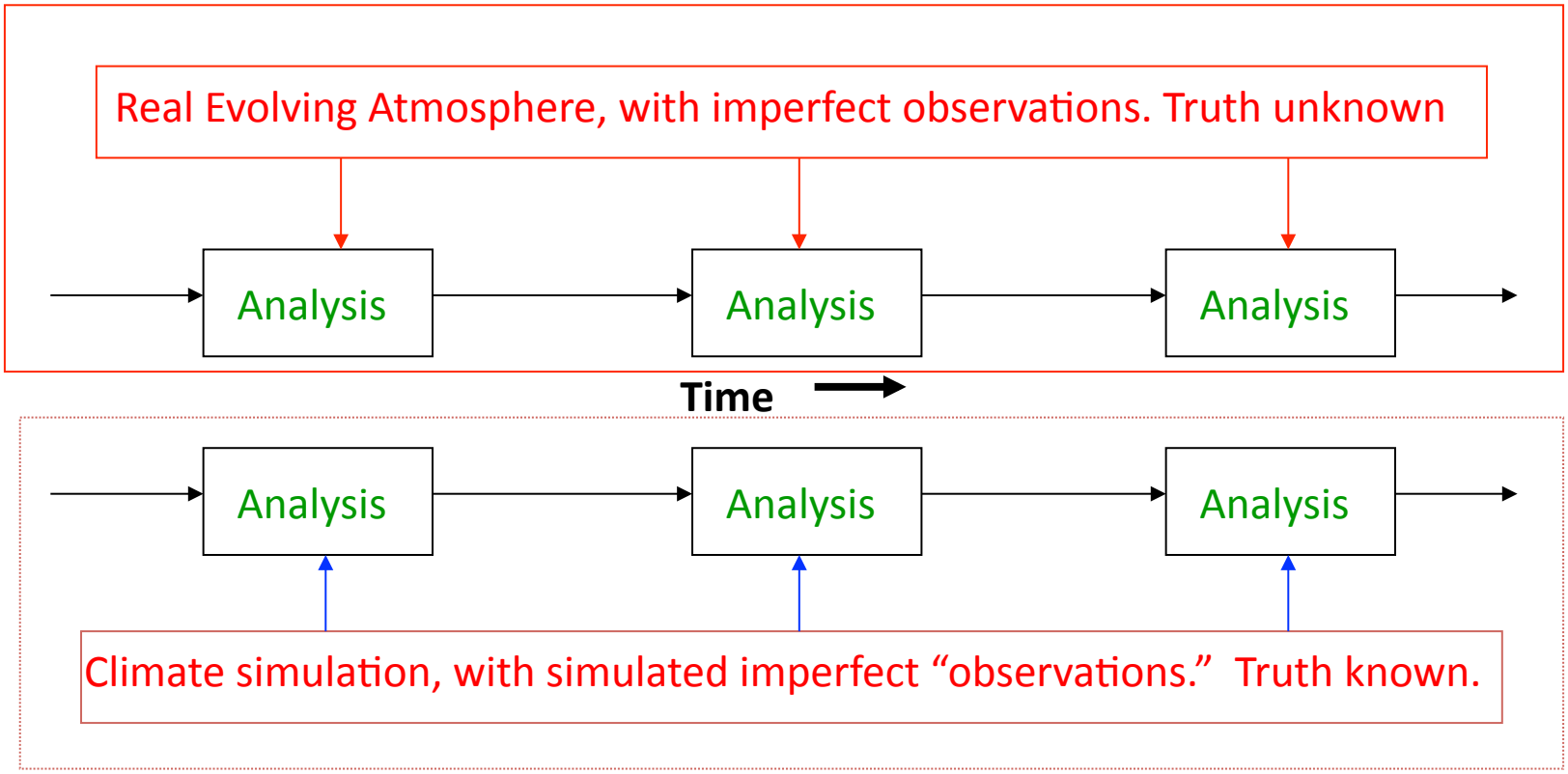
Data Assimilation of Real Data



Observing System Simulation Experiment

Applications of OSSEs

1. Estimate effects of **proposed instruments** (and their competing designs)on analysis skill by exploiting simulated environment.

2. Evaluate present and **proposed techniques** for data assimilation by exploiting known truth.

ECMWF Nature Run

1. Free-running “forecast”
2. Operational model from 2006
3. T511L91 reduced linear Gaussian grid (approx 35km)
4. 10 May 2005 through 31 May 2006
5. 3 hourly output
6. SST and sea ice cover is real analysis for that period

Assimilation System

NCEP/GMAO GSI (3DVAR) scheme (GMAO version 5.7.2)

Resolution: approx. ½ degree, 72 levels

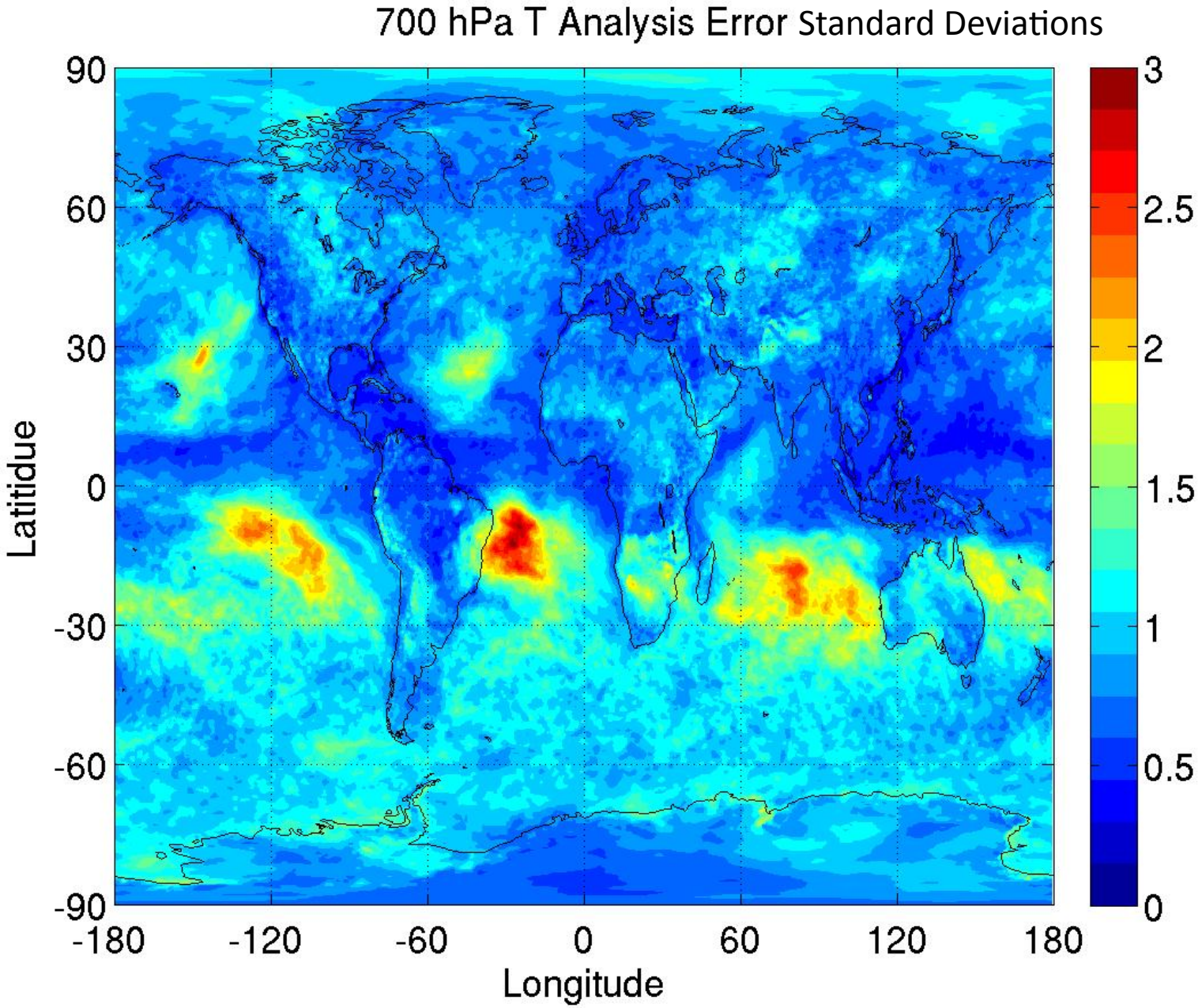
Evaluation for 1 July – 31 Aug, with prior 2 weeks for spin-up.

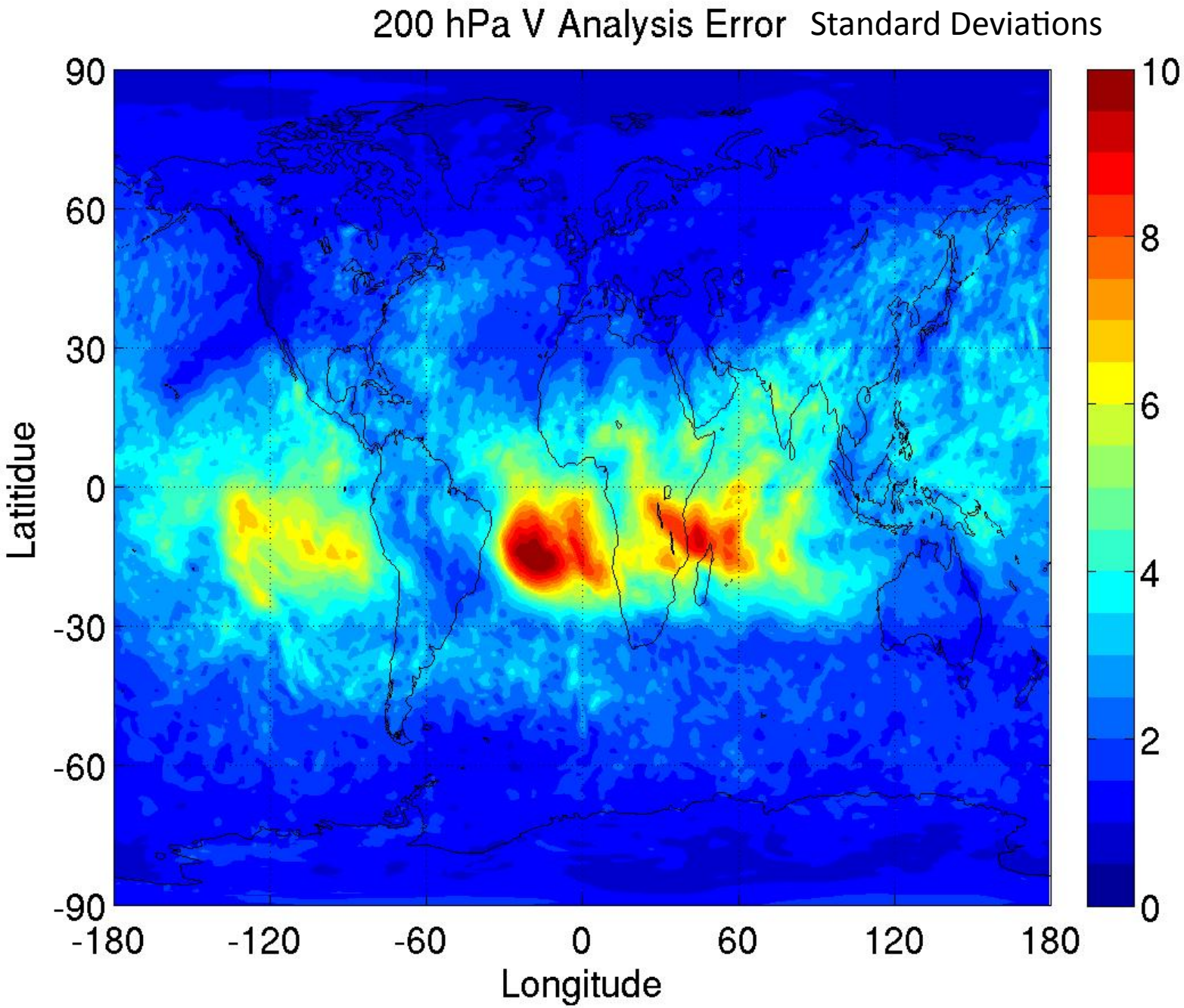
Observations include all "conventional" observations available during those calendar days in 2011 (except for precipitation rates) and radiances from all available MHS, AMSU-A, HIRS-3/4, AIRS, and IASI.

Tuning parameters for simulated observation errors taken from previously tuned experiments as described in papers to appear in Q.J.R.Met. Soc.

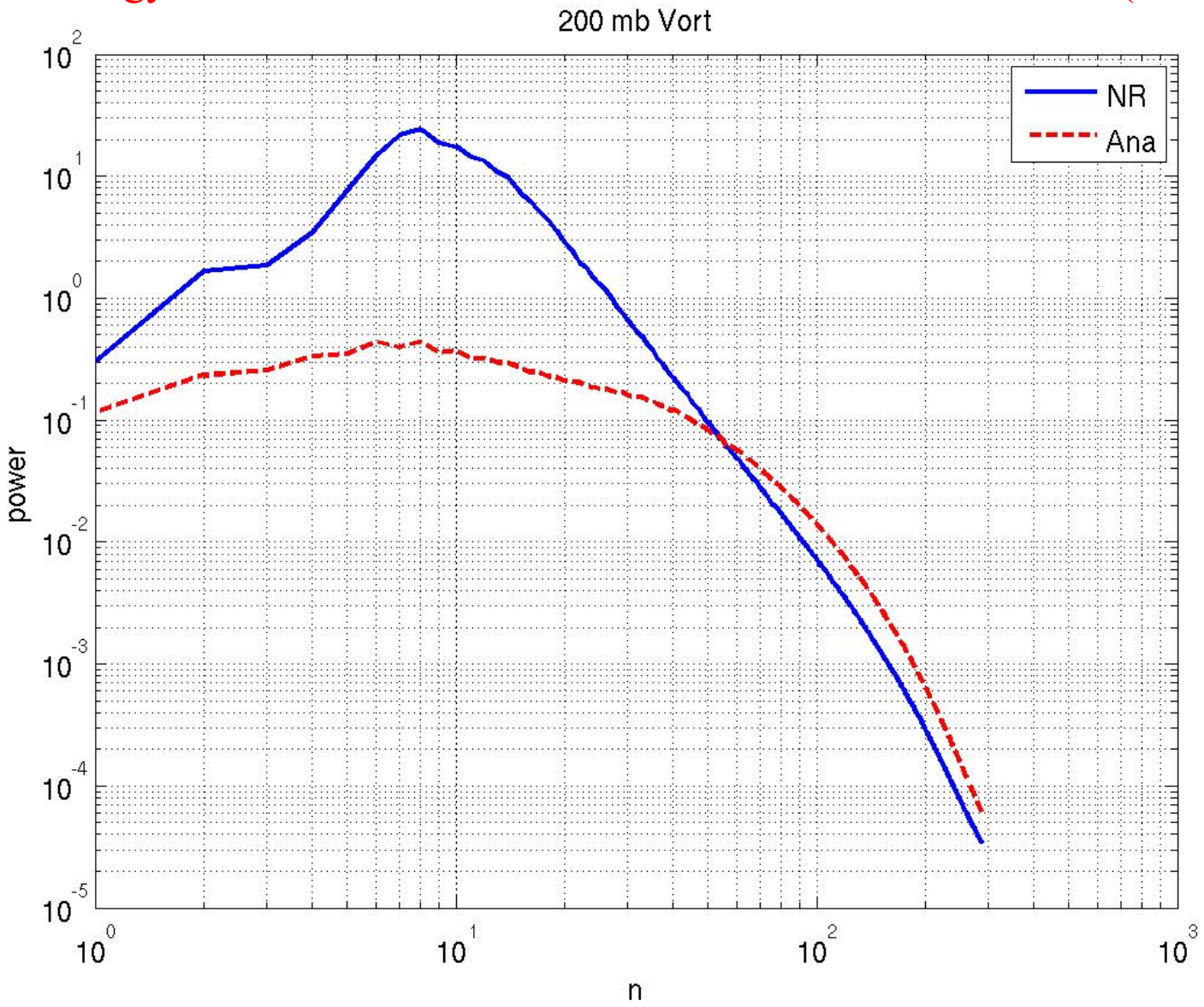
What is different about the GMAO OSSE?

1. More-thorough validation includes examinations of innovation variances and correlations, analysis increment means and variances, observation impact estimates, and forecast skill metrics.
2. Attention focused on modeling observation errors rather than on simulating observations as realistically as possible.
3. Modeled observation errors includes spatially or channel correlated components.
4. Observation impacts estimated using adjoints of forecast and assimilation systems.

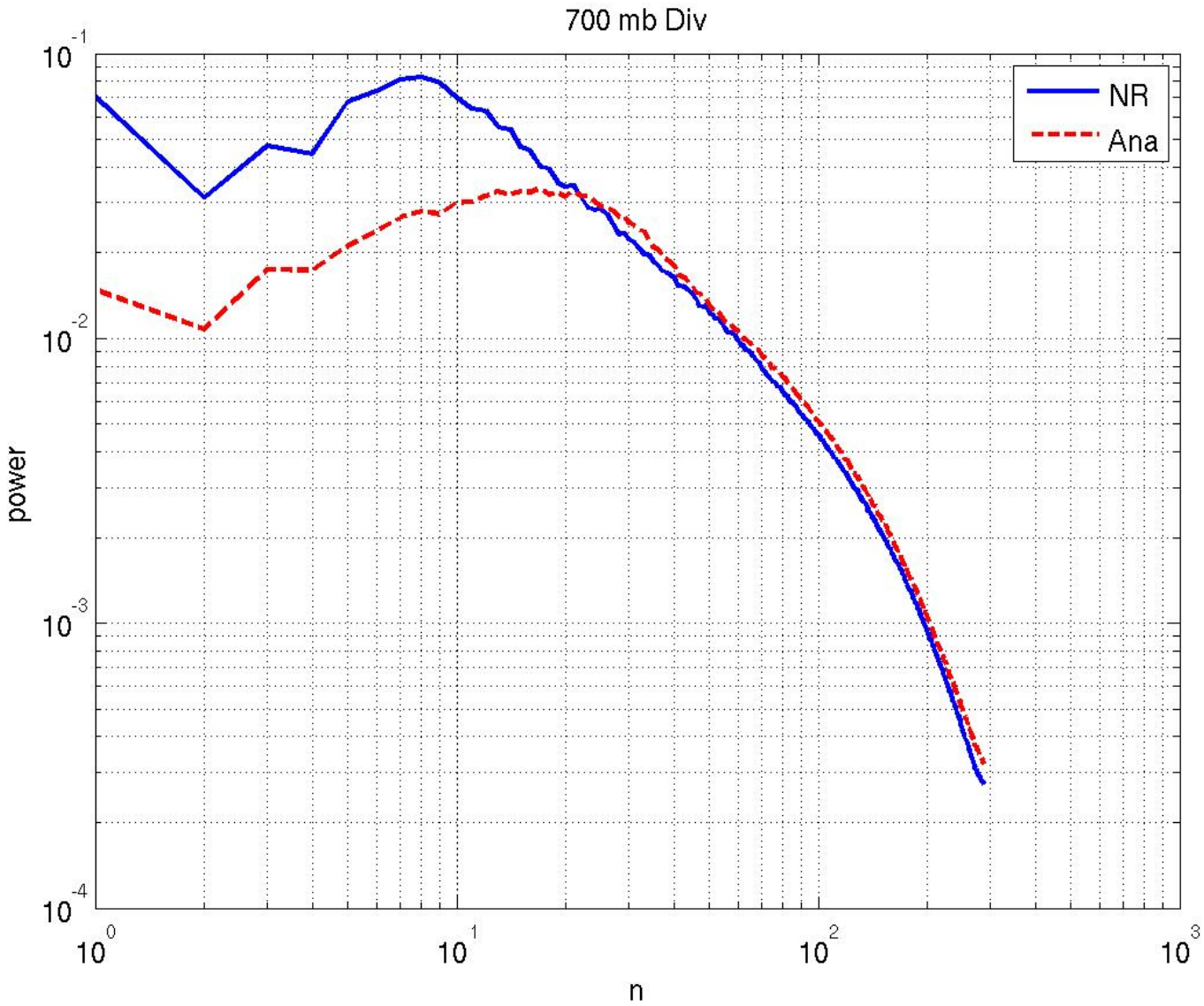

700 hPa T Analysis Error Standard Deviations
90
60
30
0
-30
-60
-90
Latitidue
-180
-120
-60
0
60
120
180
Longitude
3
2.5
2
1.5
1
0.5
0


200 hPa V Analysis Error Standard Deviations
90
60
30
0
-30
-60
-90
Latitidue
-180
-120
-60
0
60
120
180
Longitude
10
8
6
4
2
0

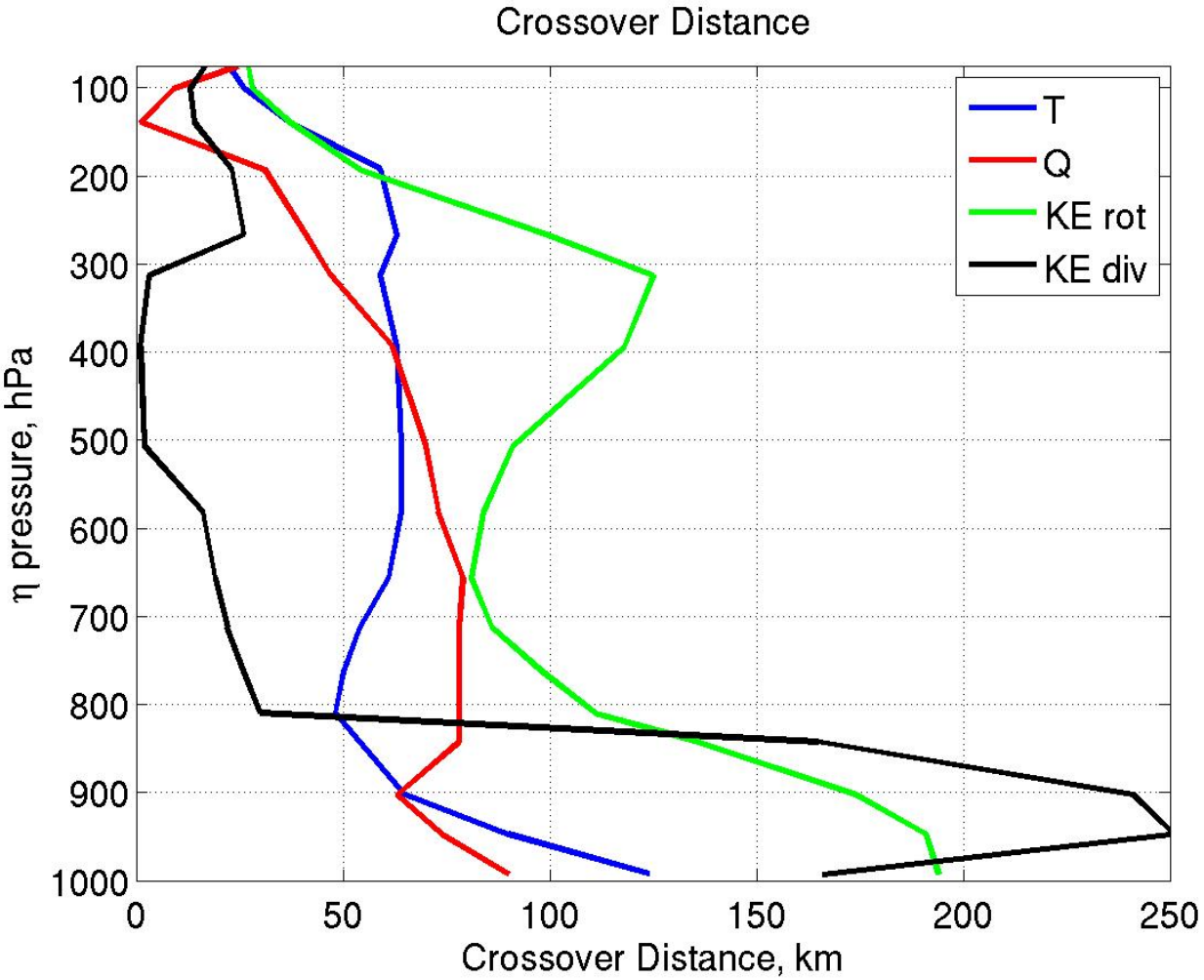
Kinetic Energy of Transient Rotational Wind for Truth and Ana Err (200hPa)



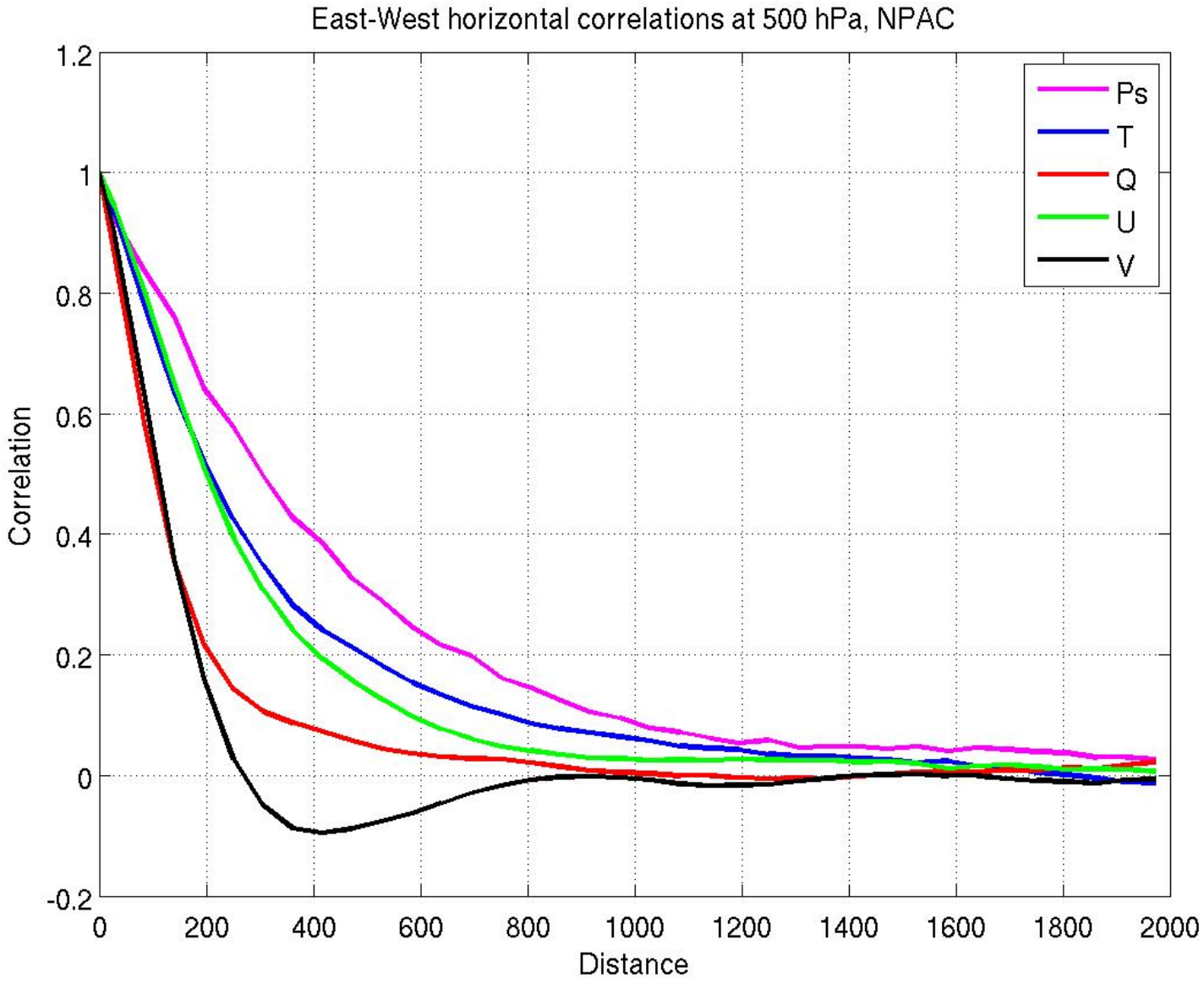
Kinetic Energy of Transient Divergent Wind for Truth and Ana Err (700hPa)



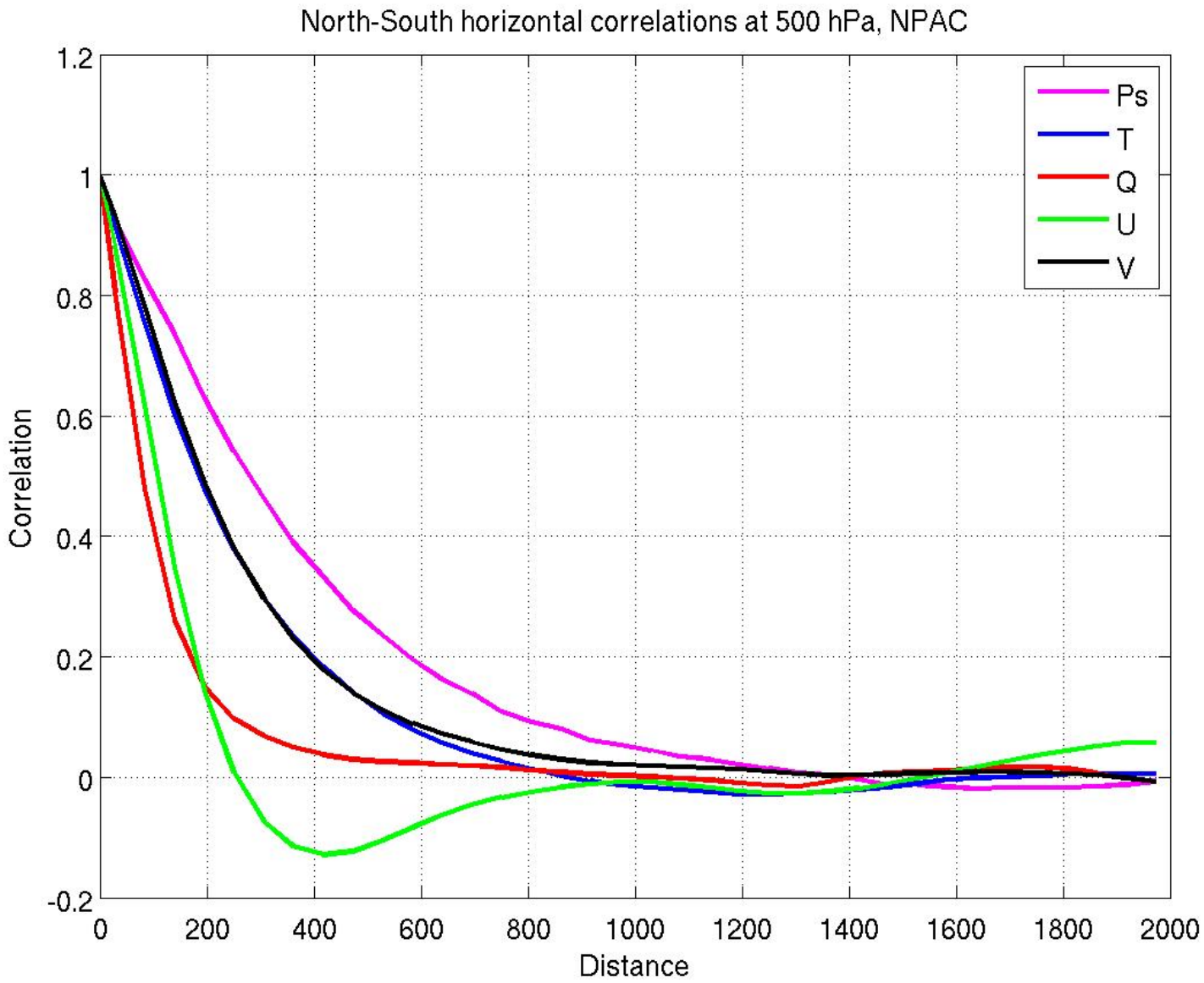
Wavenumbers where Variances of Analysis Error and Truth Are Equal

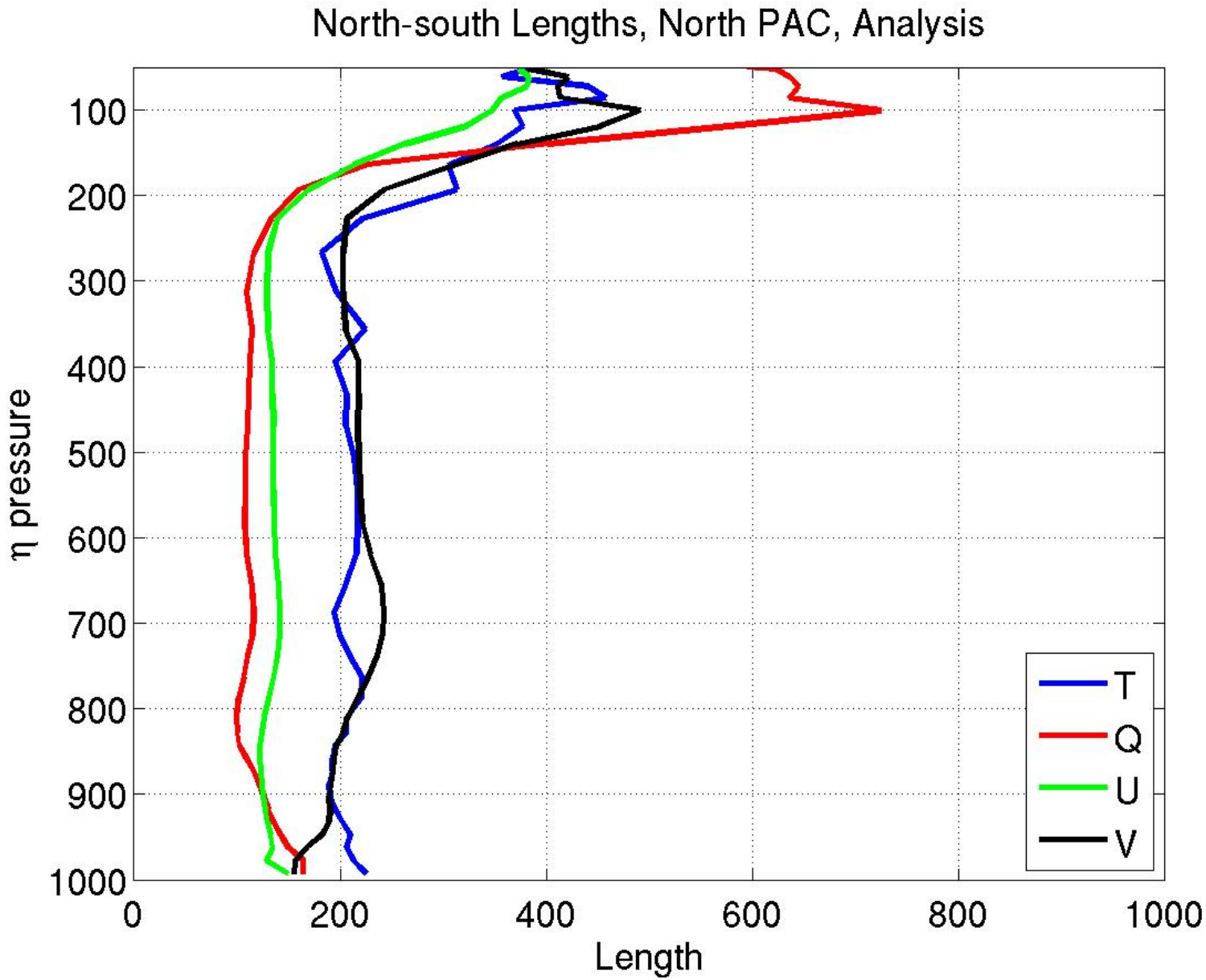


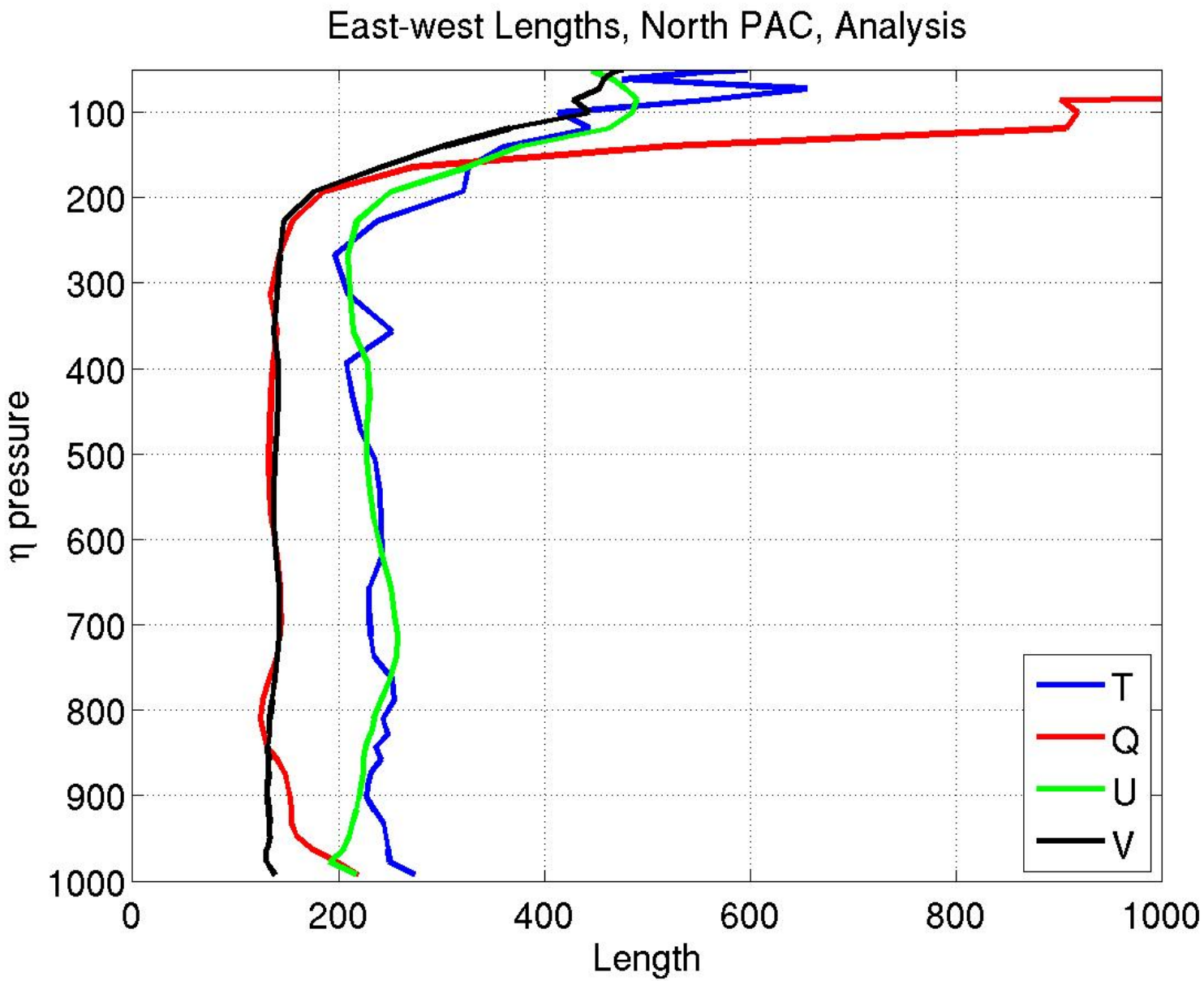
E-W Correlations of Analysis Error in N. Pacific Region (500hPa)



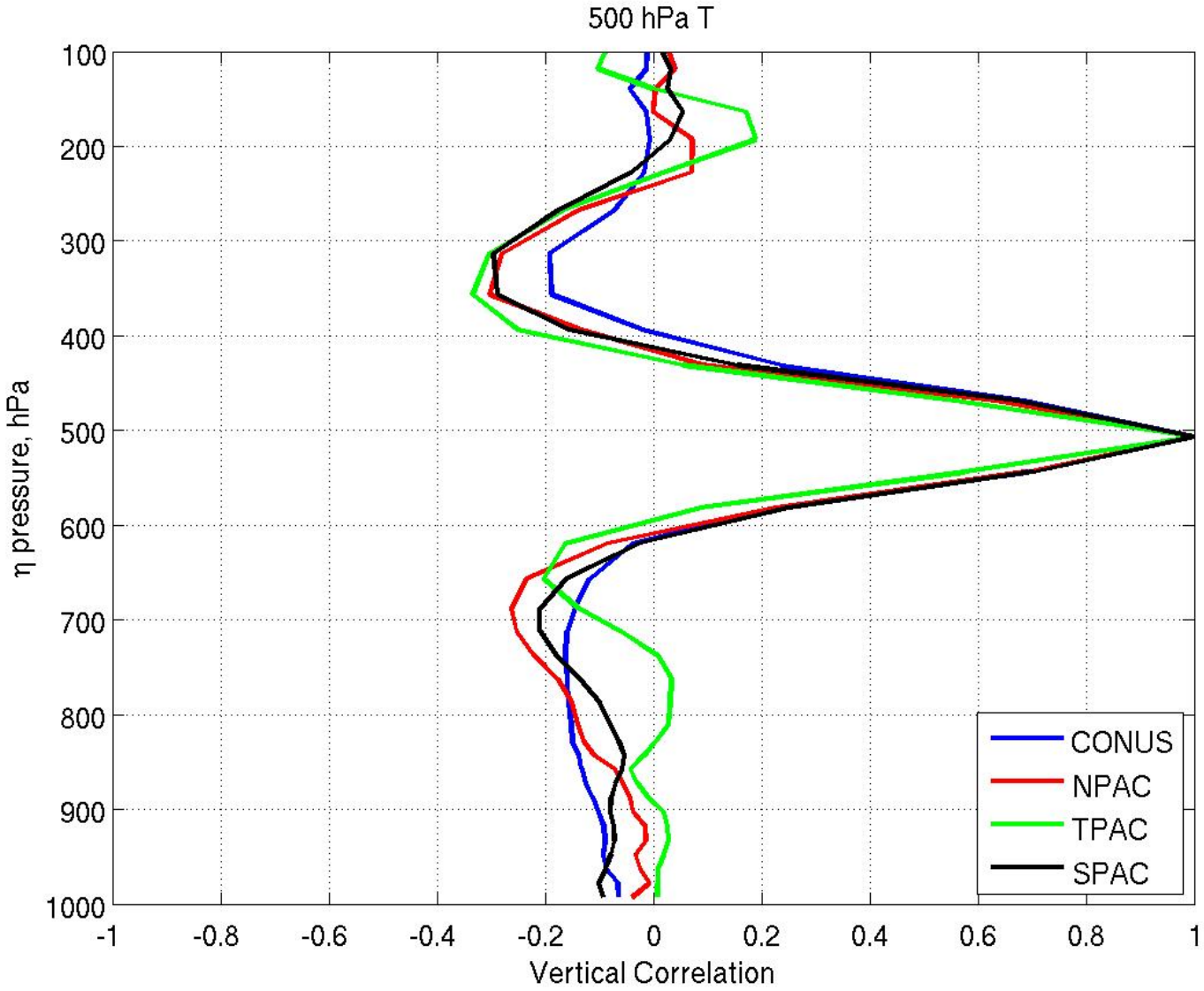
N-S Correlations of Analysis Error in N. Pacific Region (500hPa)



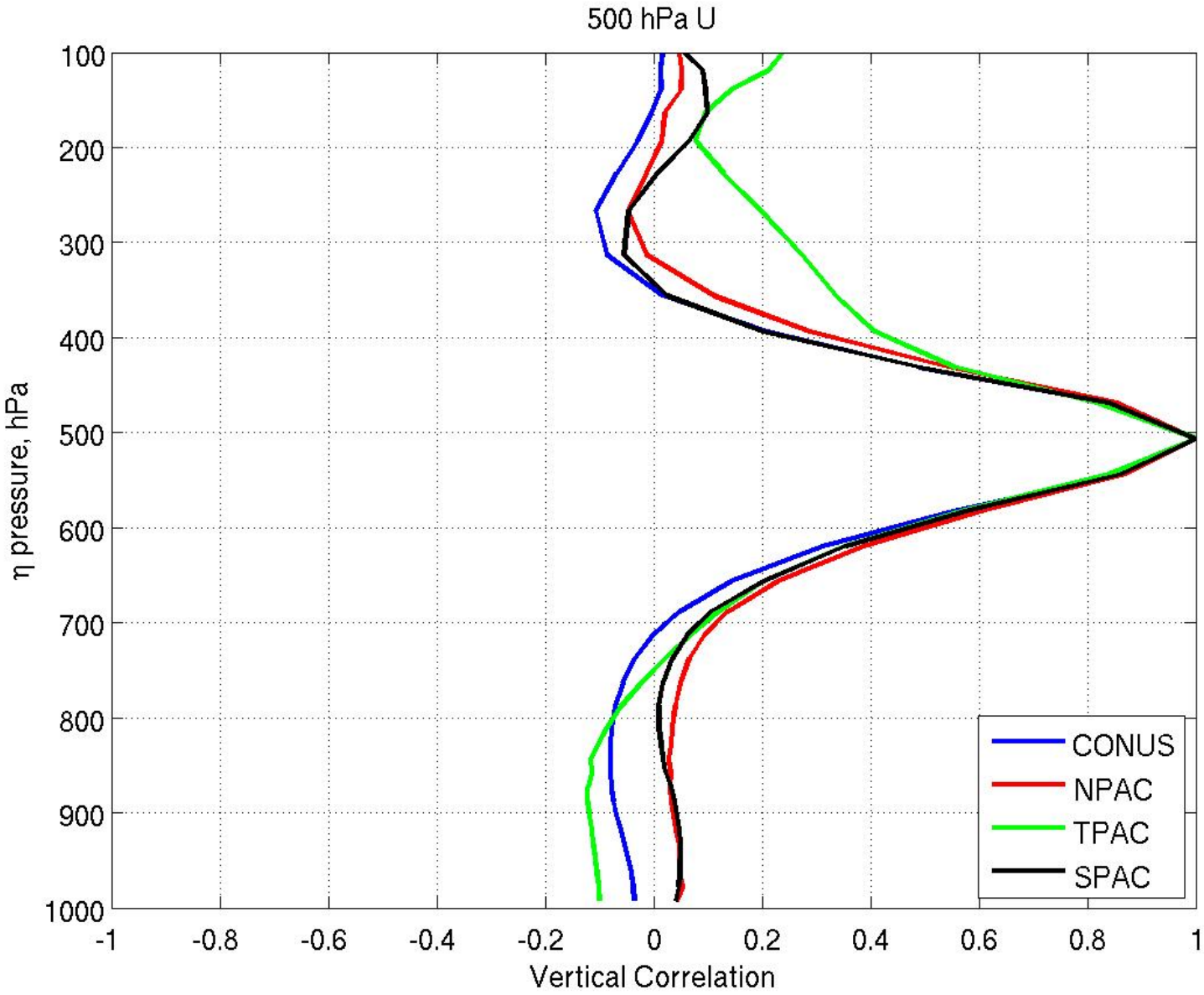

North-south Lengths, North PAC, Analysis
η pressure
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
Length
T
Q
U
V

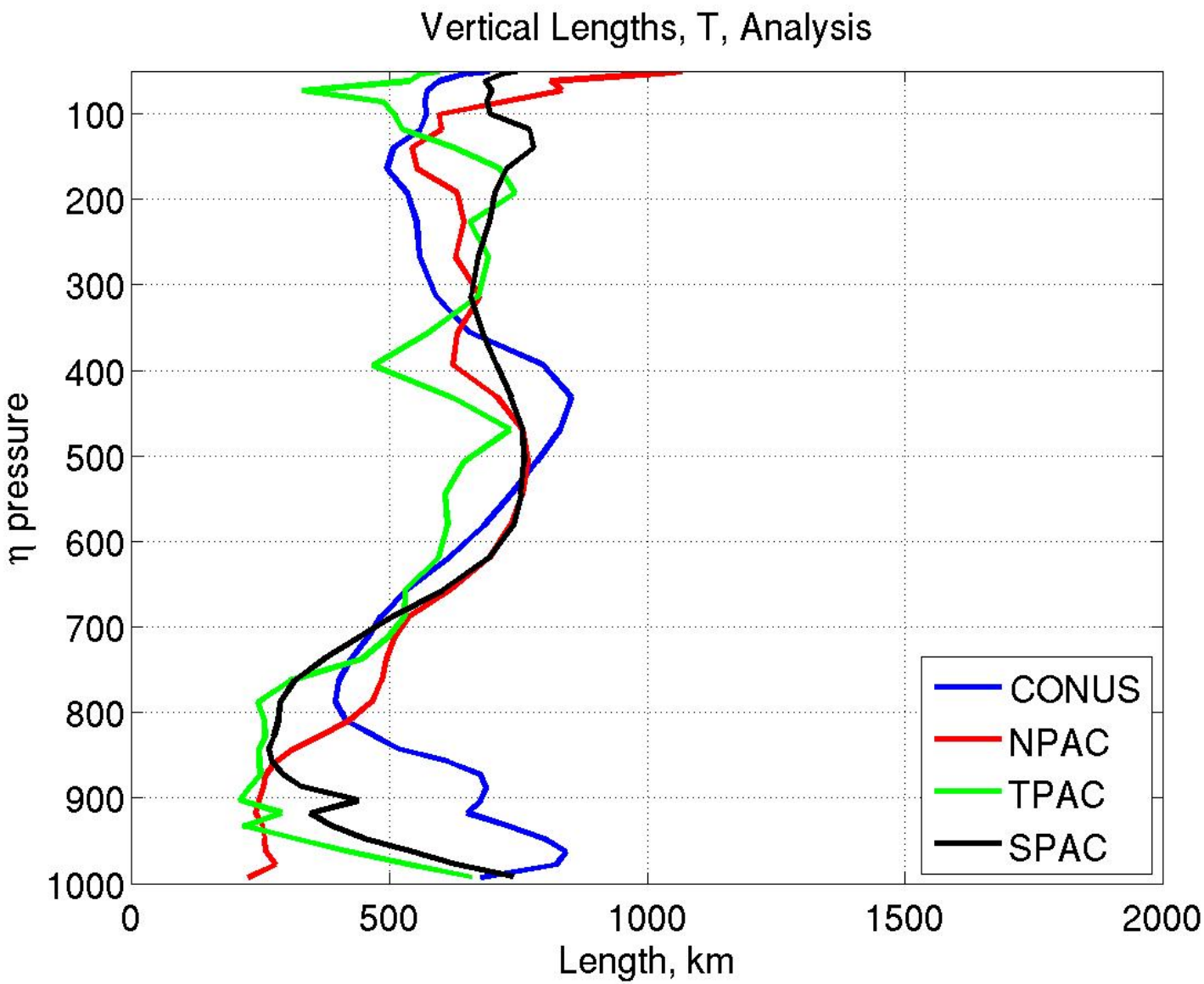

East-west Lengths, North PAC, Analysis
η pressure
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
Length
T
Q
U
V

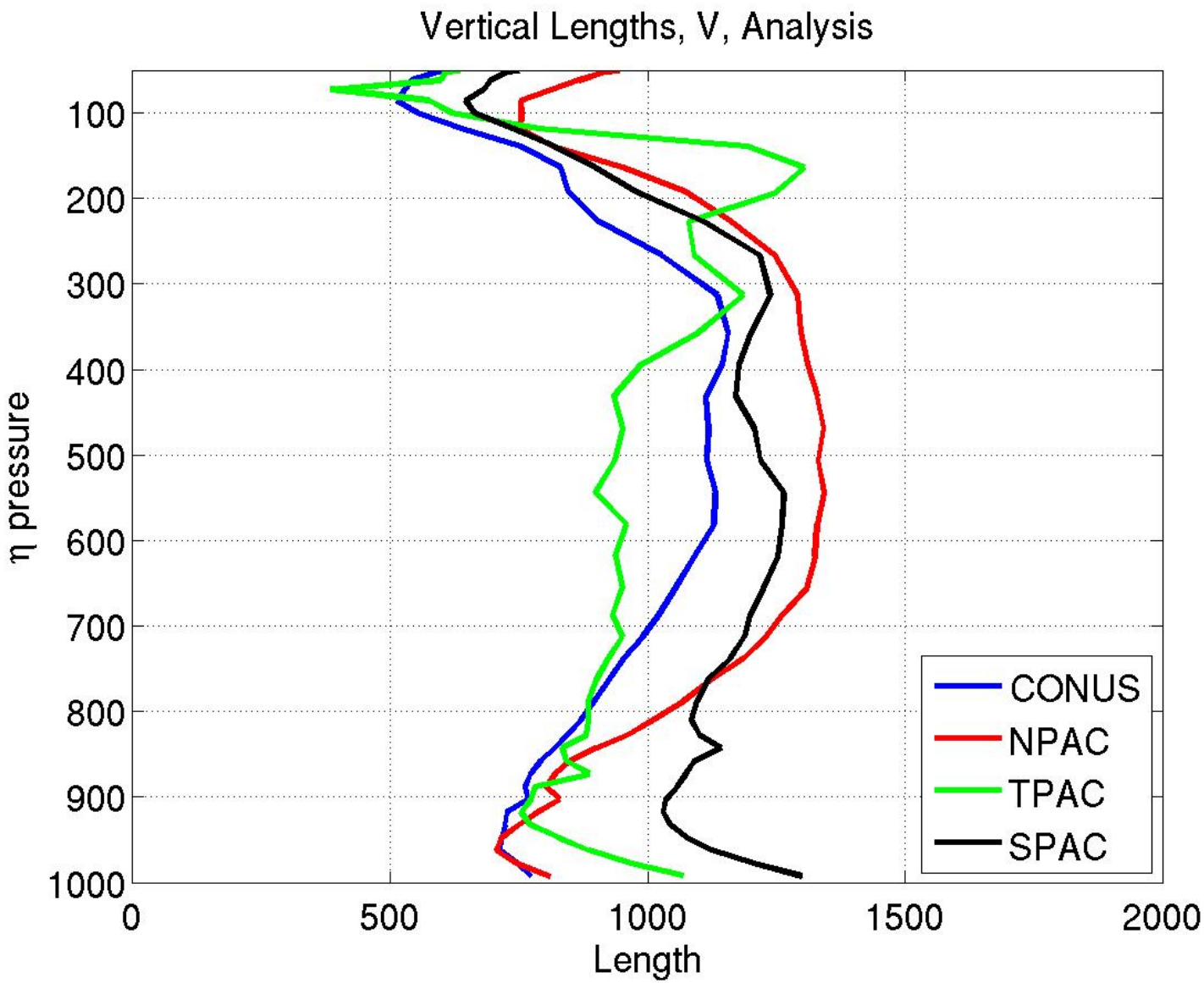
Vertical Correlations of Analysis Errors of T with T at 500hPa



Vertical Correlations of Analysis Errors of u with u at 500hPa

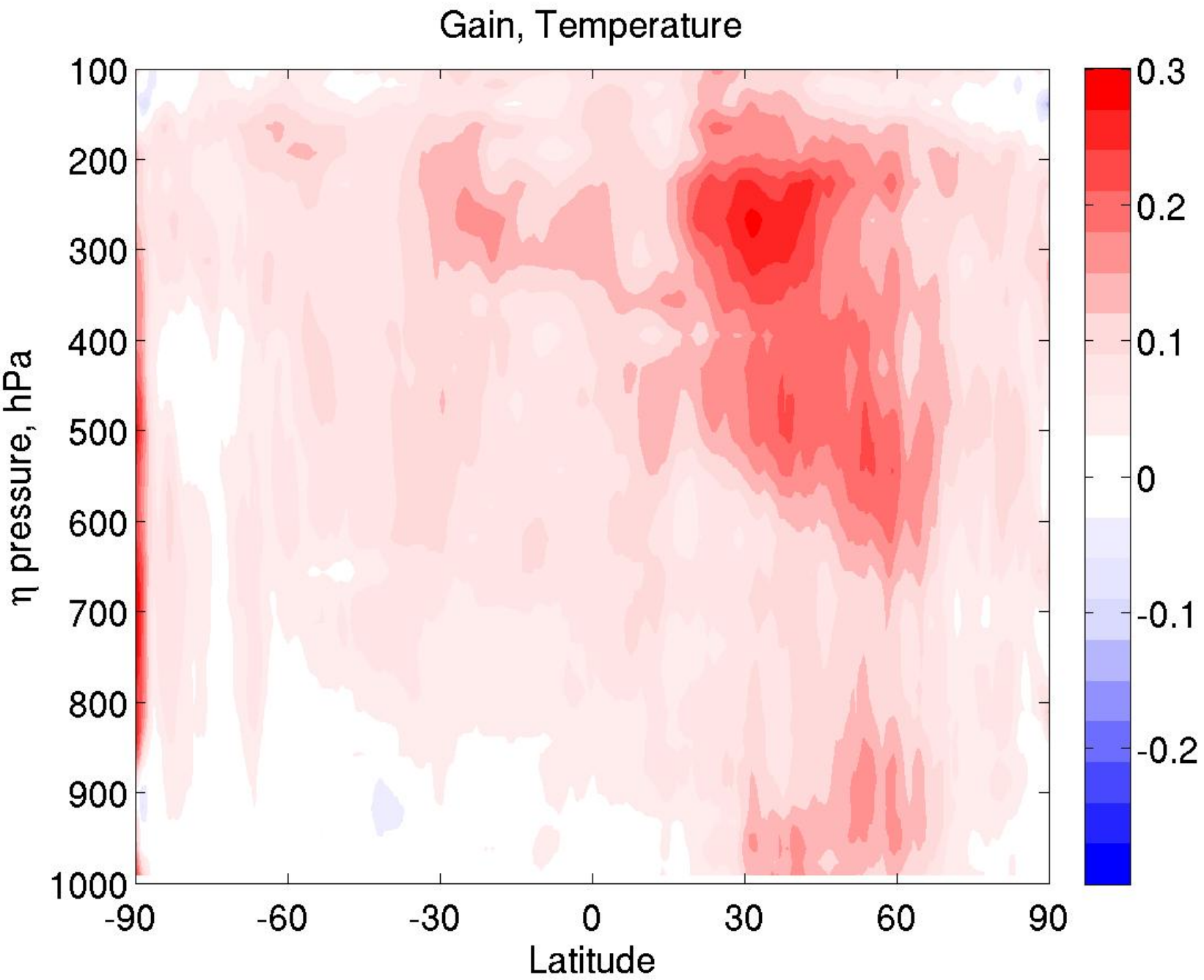


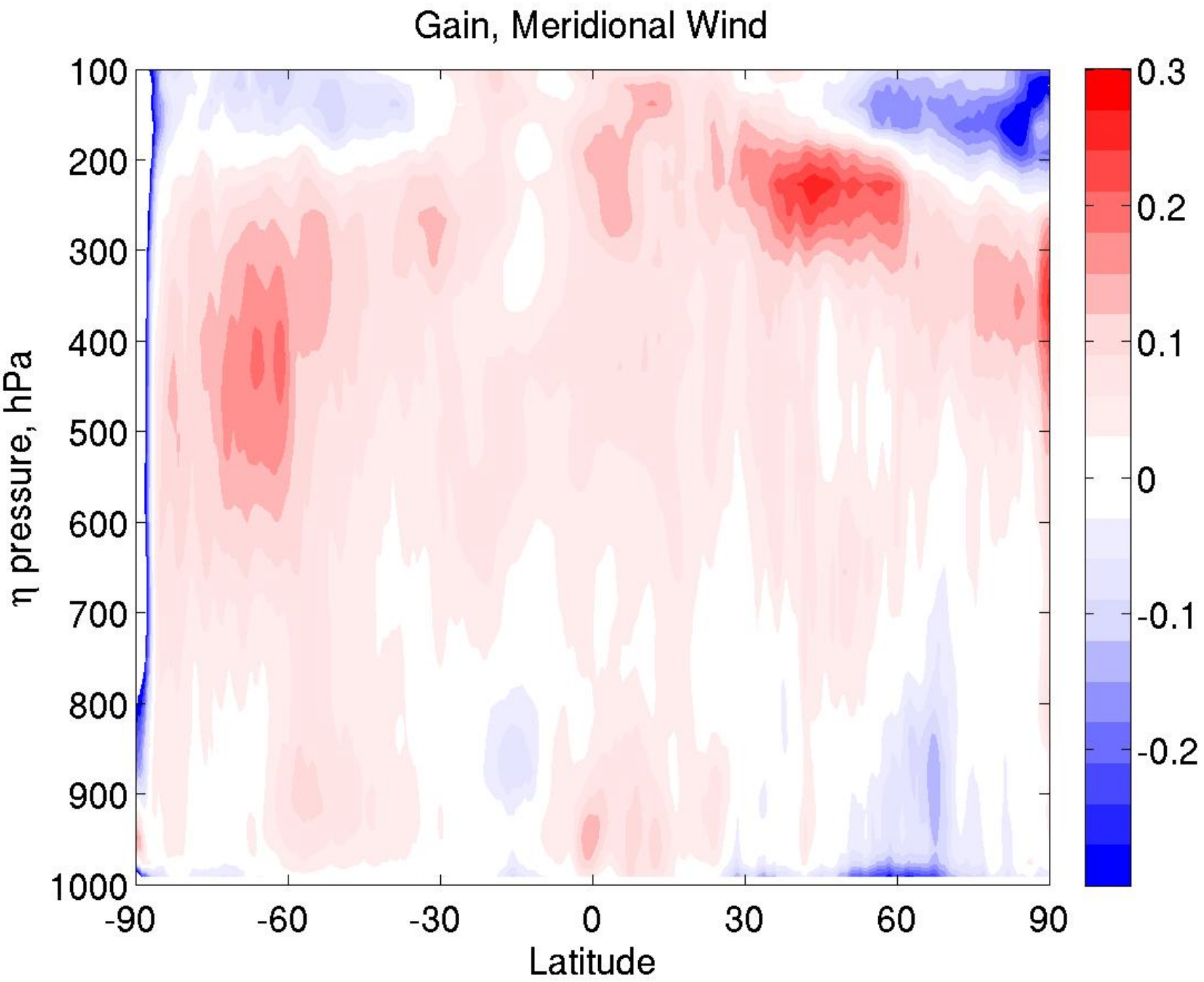

Vertical Lengths, T, Analysis
η pressure
100
200
300
400
500
600
700
800
900
1000
0
500
1000
1500
2000
Length, km
CONUS
NPAC
TPAC
SPAC

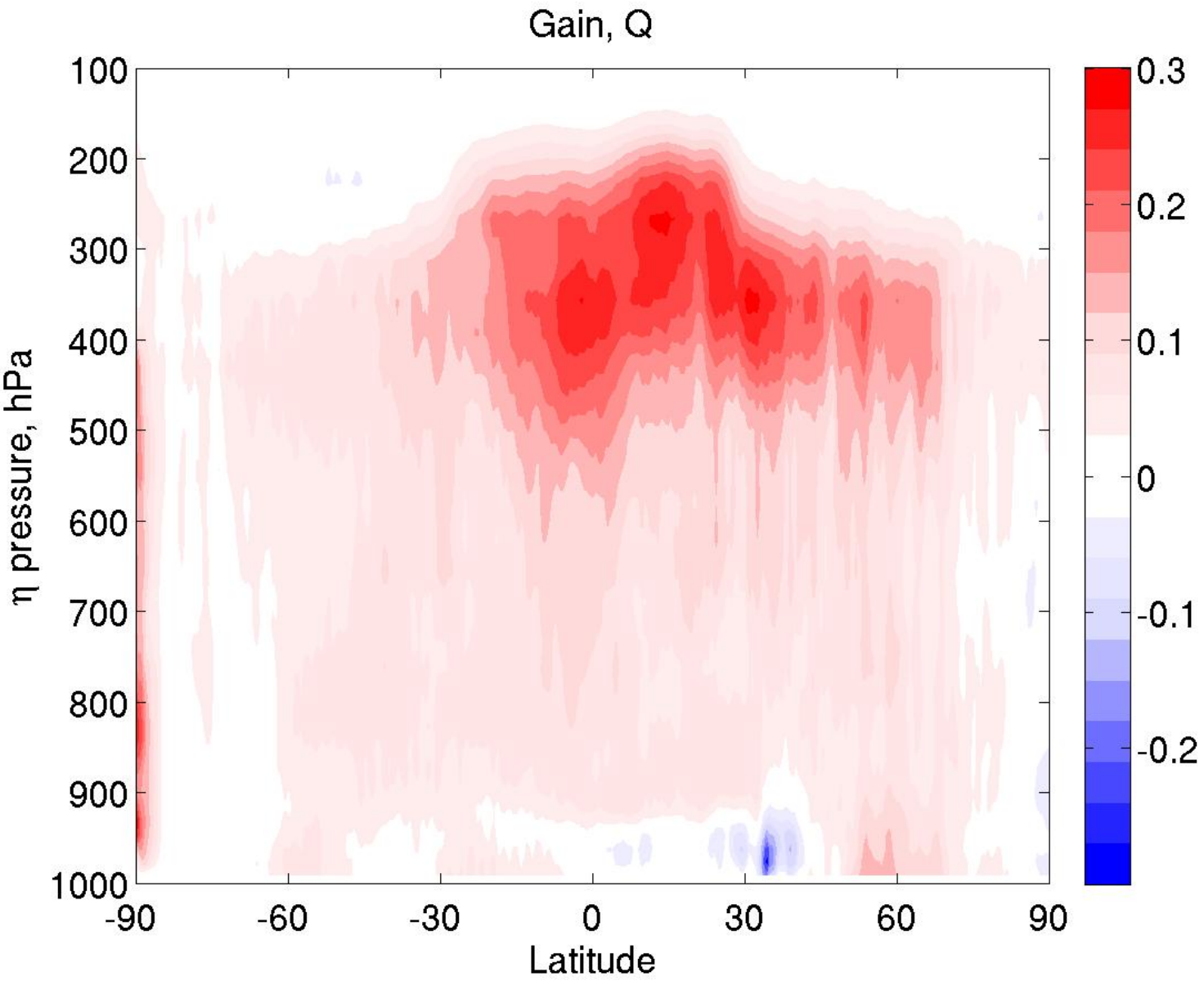

Vertical Lengths, V, Analysis
η pressure
100
200
300
400
500
600
700
800
900
1000
0
500
1000
1500
2000
Length
CONUS
NPAC
TPAC
SPAC

Kalman Gain $\approx$ Fractional Reduction of Error Variance

$$\frac{\text{Background Error Variance} - \text{Analysis Error Variance}}{\text{Background Error Variance}}$$


Gain, Temperature
100
200
300
400
500
600
700
800
900
1000
η pressure, hPa
-90
-60
-30
0
30
60
90
Latitude
0.3
0.2
0.1
0
-0.1
-0.2


Gain, Meridional Wind
η pressure, hPa
100
200
300
400
500
600
700
800
900
1000
-90
-60
-30
0
30
60
90
Latitude
0.3
0.2
0.1
0
-0.1
-0.2


Gain, Q
η pressure, hPa
100
200
300
400
500
600
700
800
900
1000
-90
-60
-30
0
30
60
90
Latitude
0.3
0.2
0.1
0
-0.1
-0.2

Other Metrics

1. Balance
2. Non-Separable correlations
3. Gain in terms of spectra
4. Flow dependent metrics

Applications

1. Estimate accuracy of analysis system
2. Estimate Kalman gain
3. Evaluate models of background error statistics
4. Evaluate spreads of ensemble analysis and forecasts