Validation of T and q in AIRS V6 and V6.2, Neural Network, and ECMWF against Dedicated Radiosondes

Sun Wong, Eric Fetzer, Joao Teixeira, Bjorn Lambrigtsen, Evan Manning, Evan Fishbein,
Van Dang, and Fredrick Irion
Jet Propulsion Laboratory, California Institute of Technology, CA

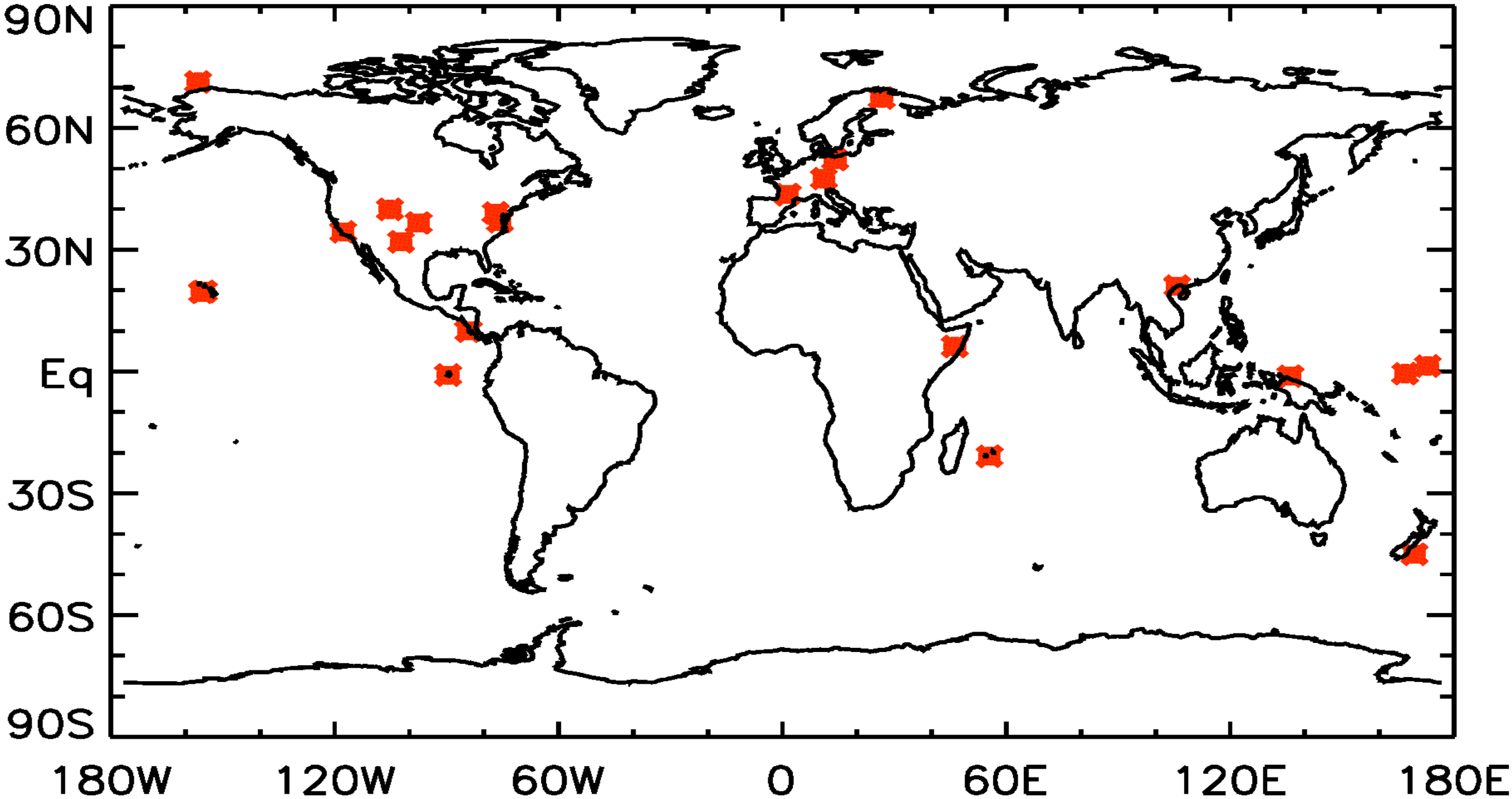
Sounder Science Team Meeting (March, 2016 Caltech.)

©2016 California Institute of Technology.
Government sponsorship acknowledged.

Objectives

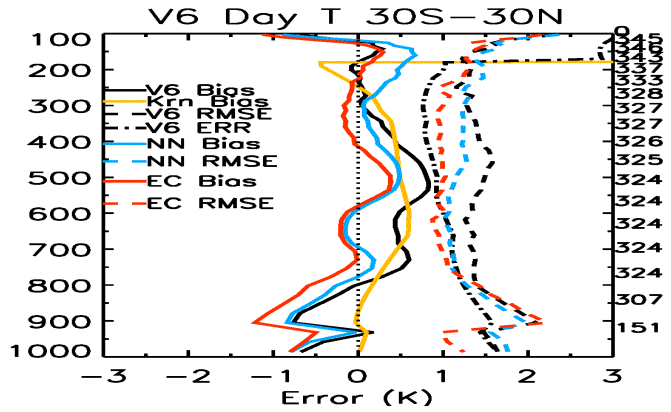
- T and q biases and RMSEs against Dedicated radiosondes
- AIRS V6, V6.19, V6.22, NN, ECMWF
- Changes in averaging kernels among V6, V6.19, and V6.22
- Degree of freedom (trace of an averaging kernel)
  Verticality profile (sum of rows of an averaging kernel)

Dedicated Sonde Sites

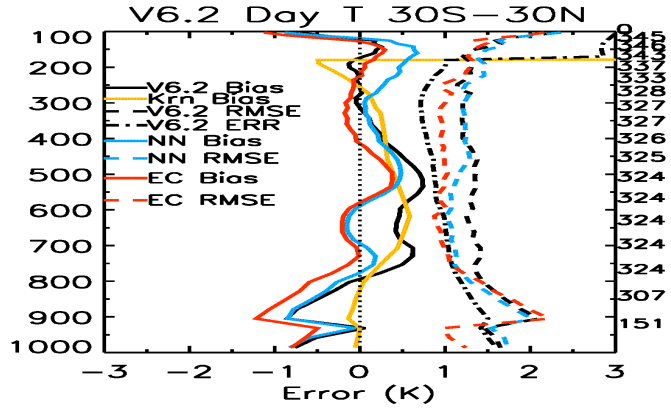


Good Daytime 30S-30N Degree of Freedom and Verticality

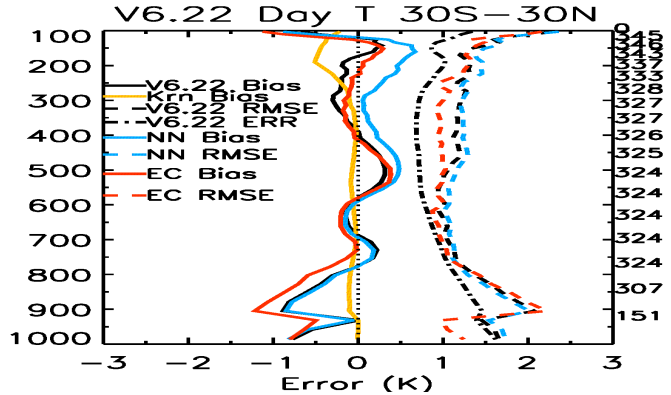
30S-30N



V6



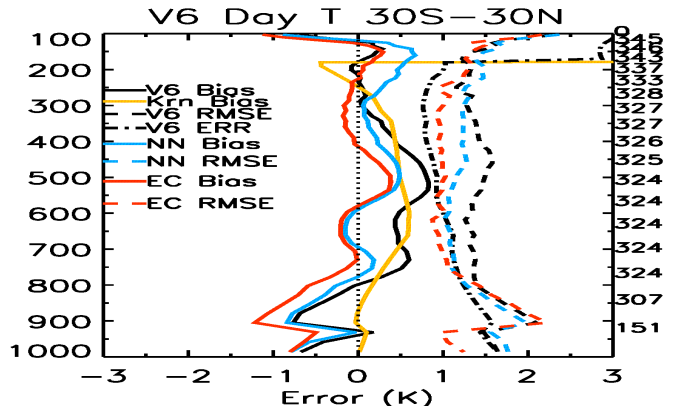
V6.2

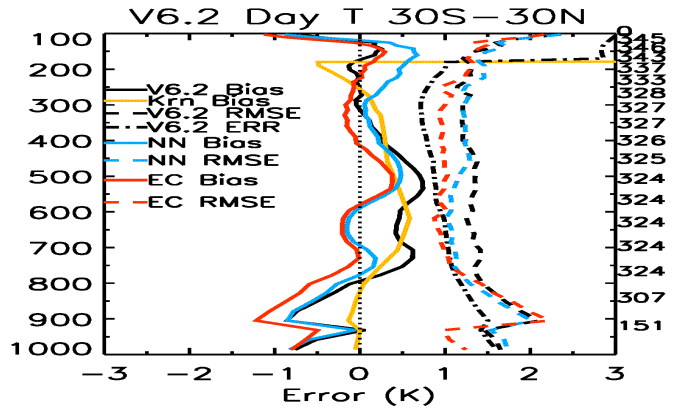


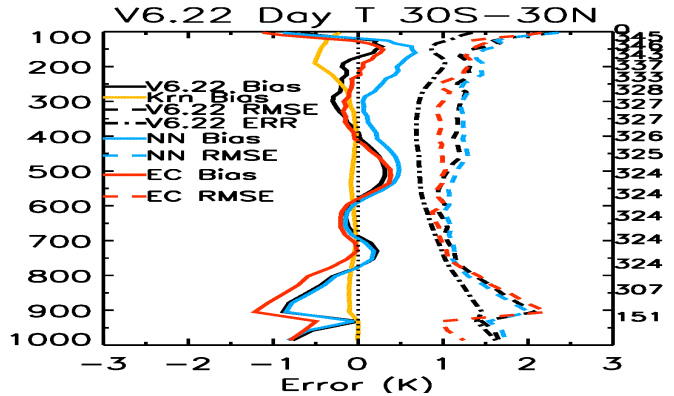
V6.22

Good Daytime 30S-30N Degree of Freedom and Verticality

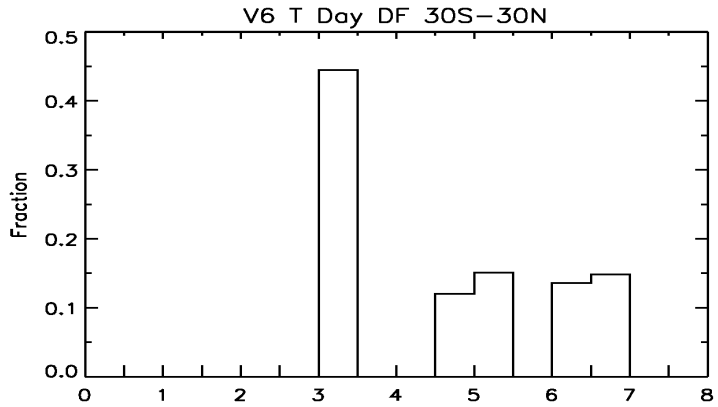
30S-30N

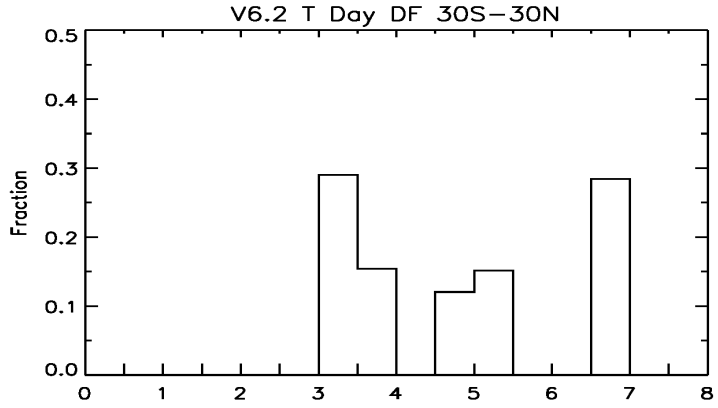


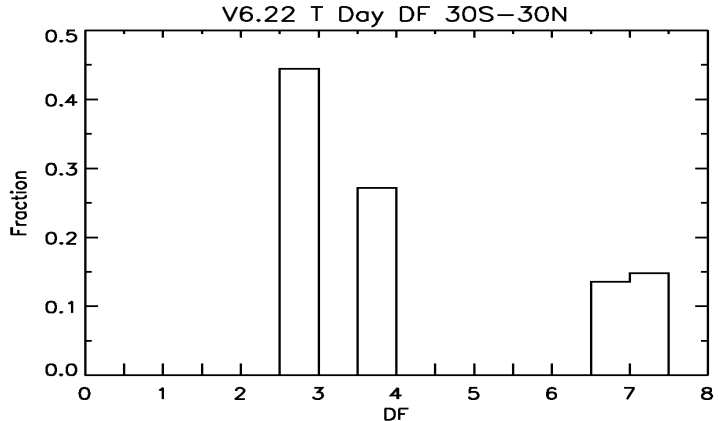




Degree of Freedom







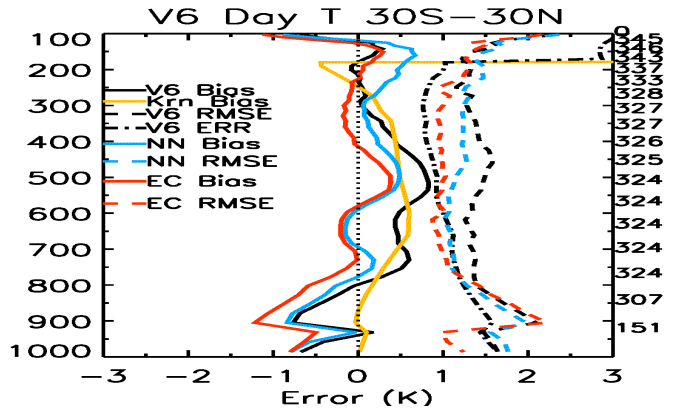
V6

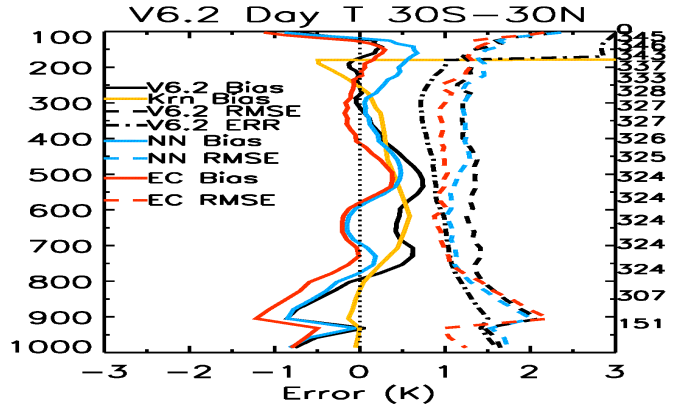
V6.2

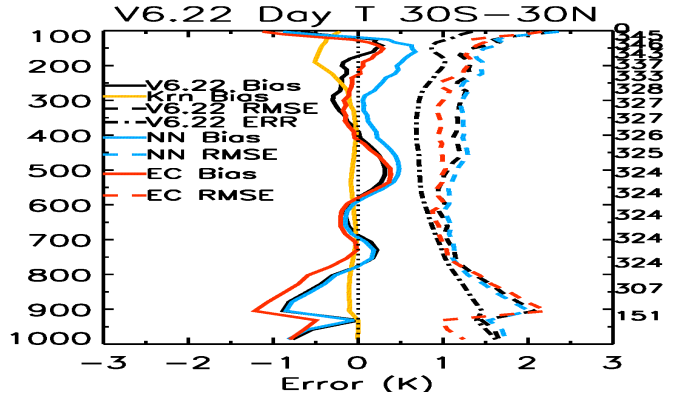
V6.22

Good Daytime 30S-30N Degree of Freedom and Verticality

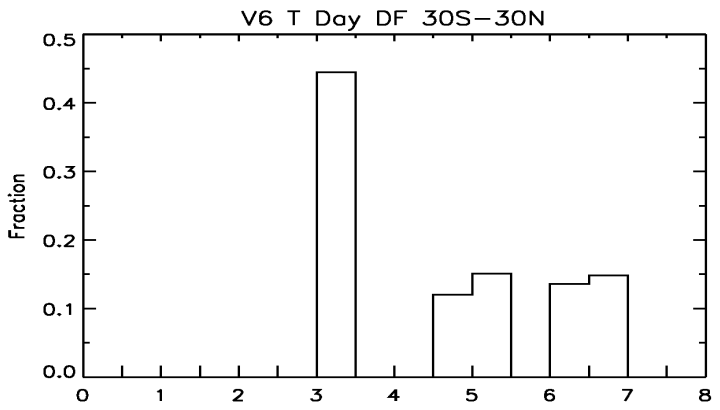
30S-30N

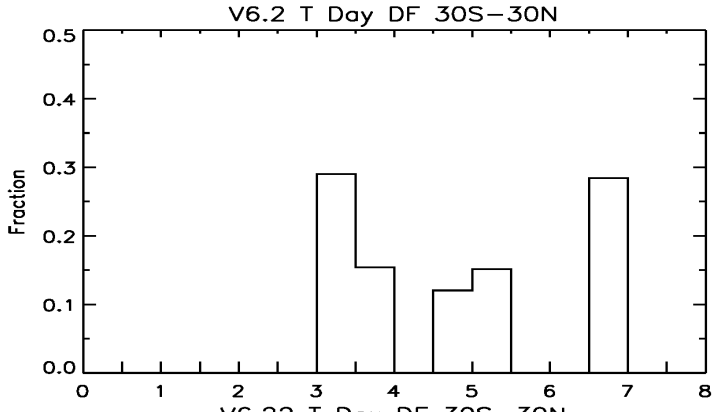


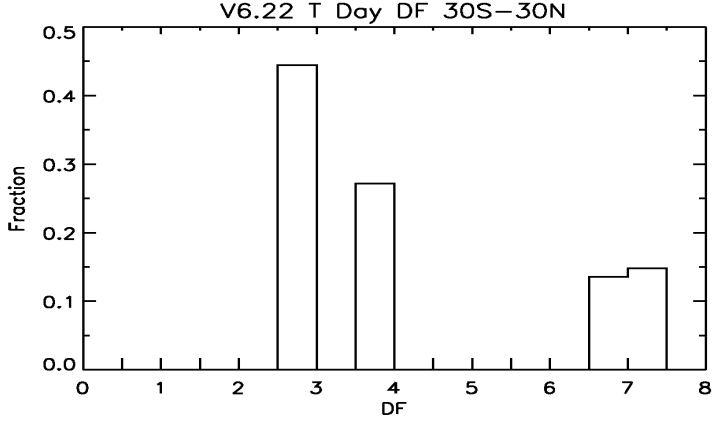




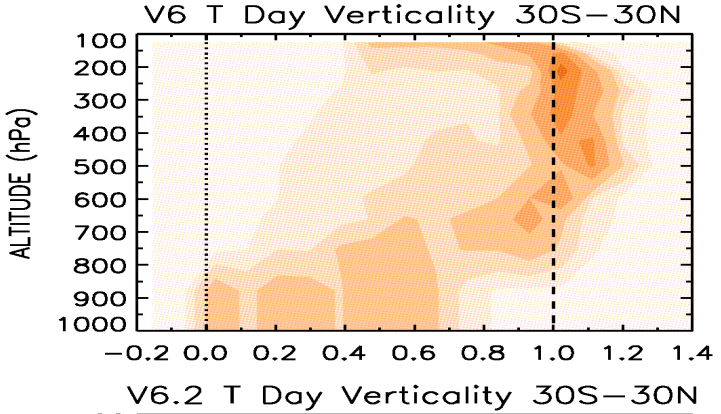
Degree of Freedom



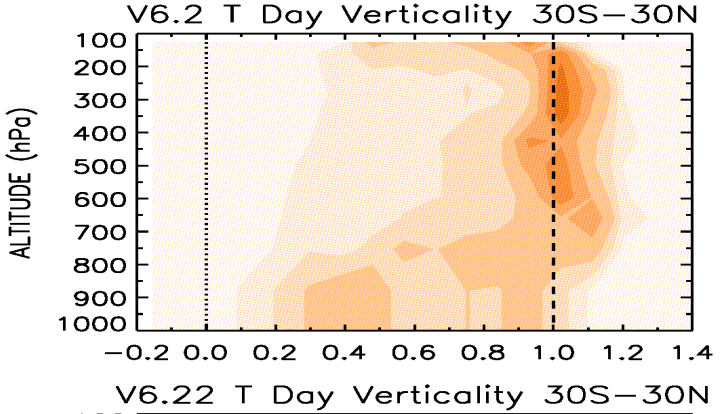




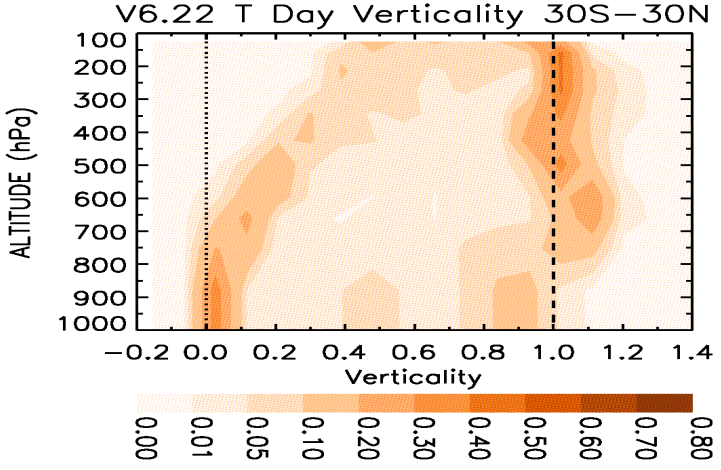
Verticality



V6



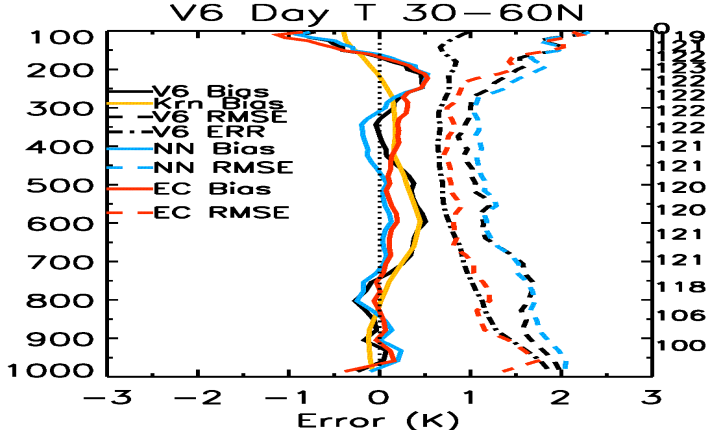
V6.2

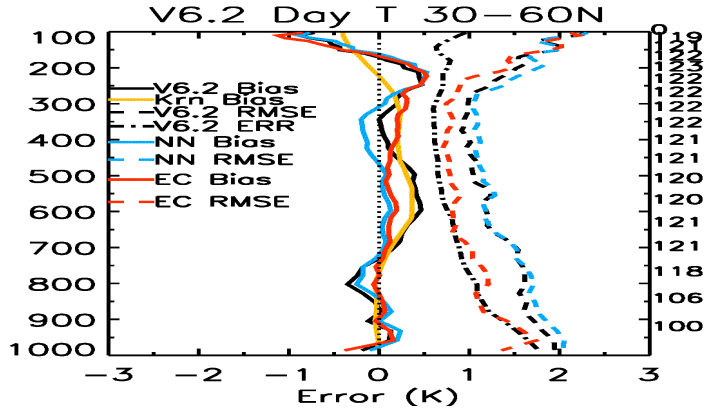


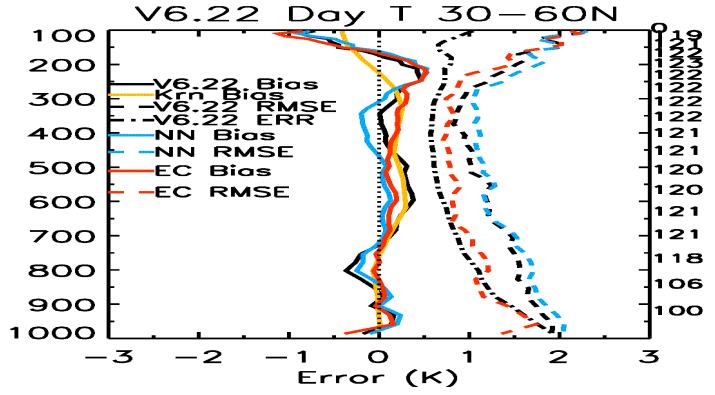
V6.22

Good Daytime 30-60N Degree of Freedom and Verticality

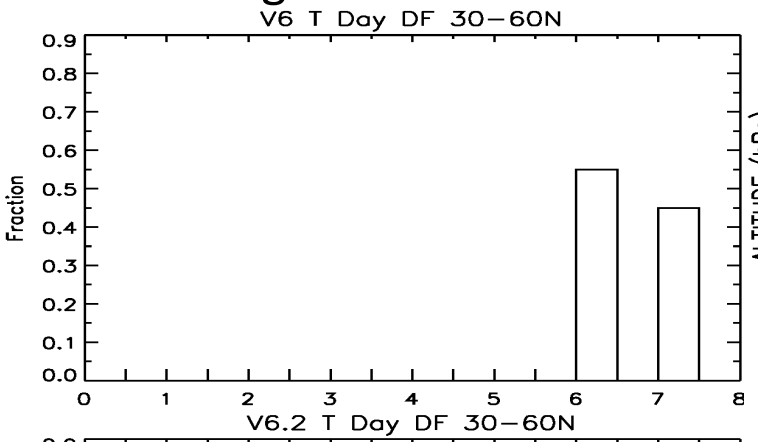
30-60N

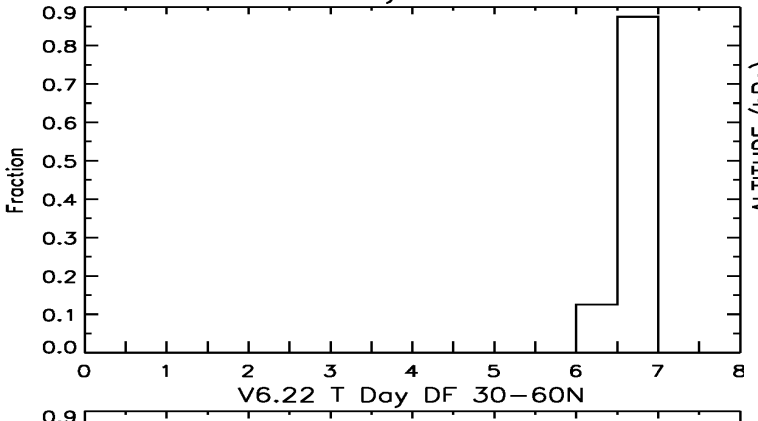


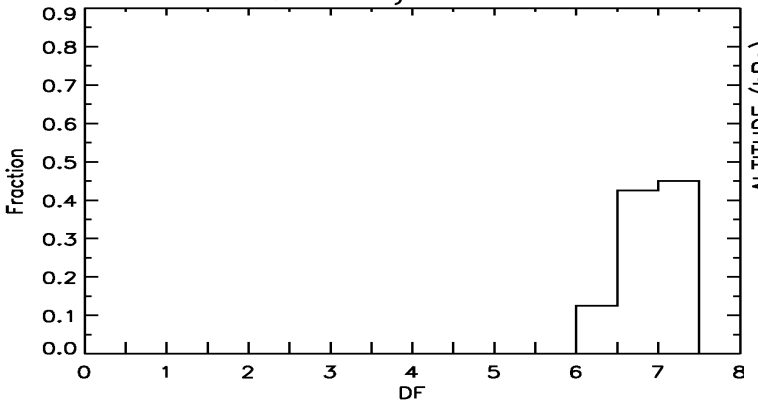




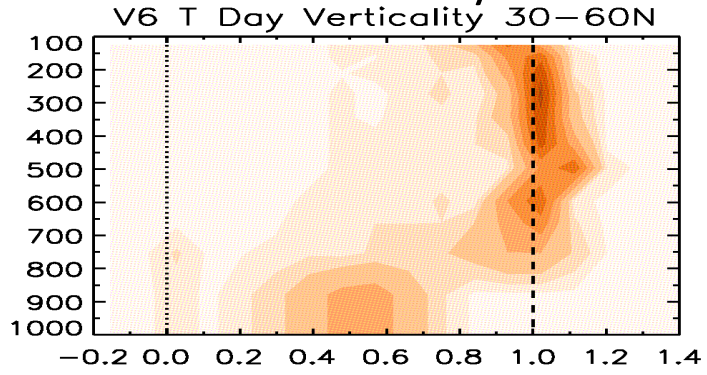
Degree of Freedom



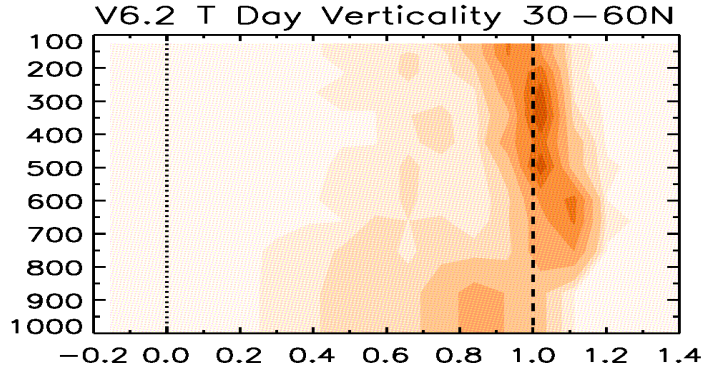




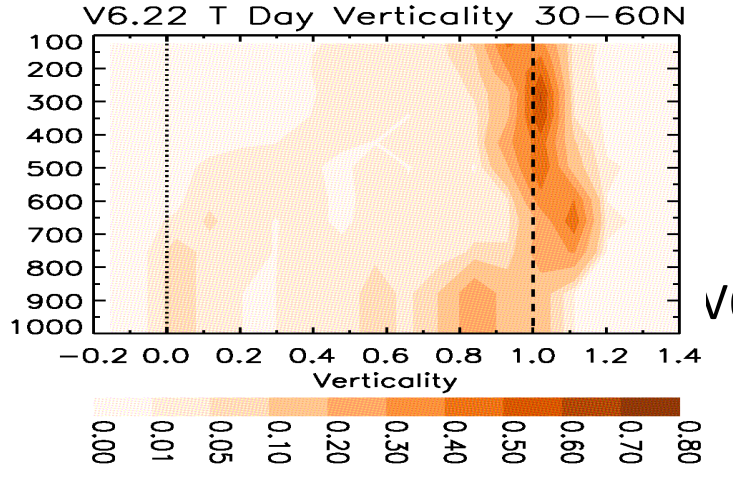
Verticality



V6



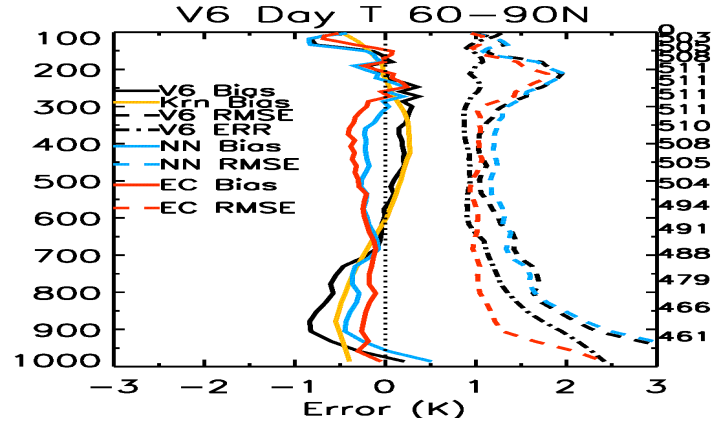
V6.2

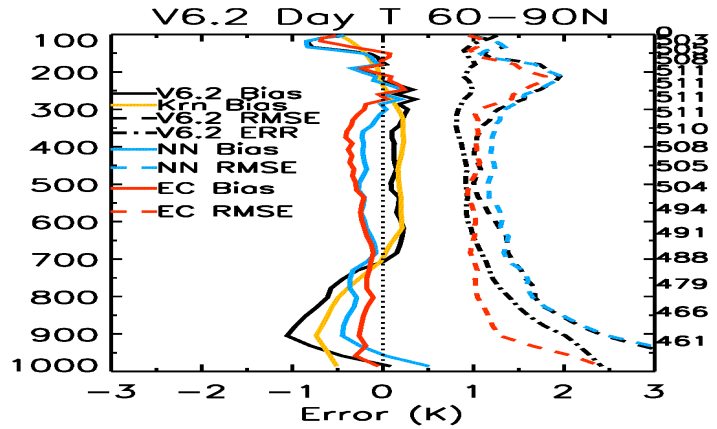


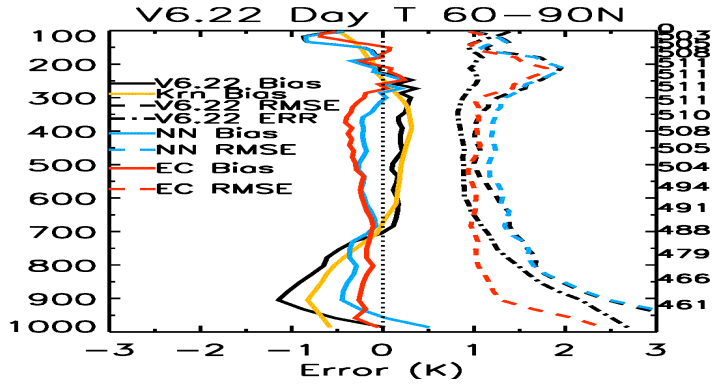
V6.22

Good Daytime 60-90N Degree of Freedom and Verticality

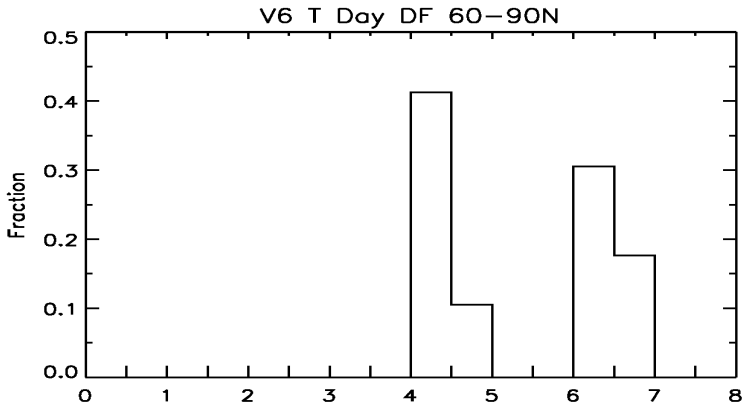
30-60N

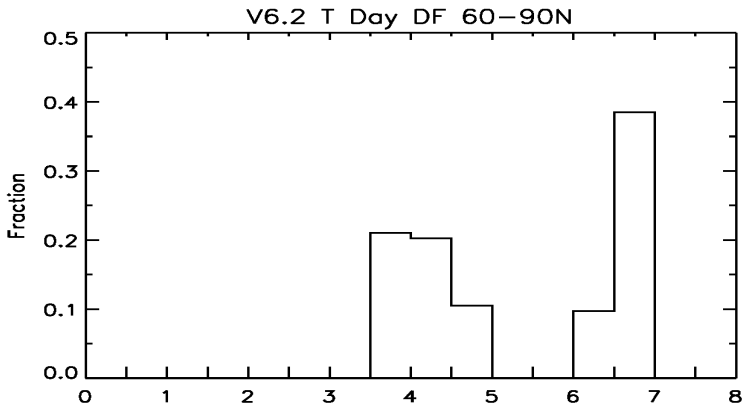


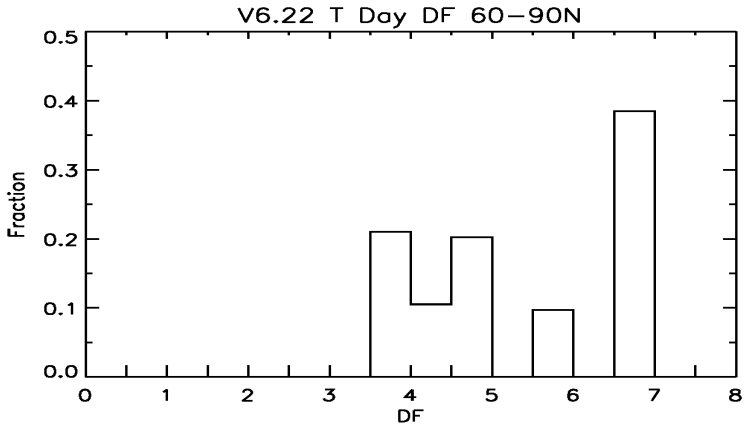




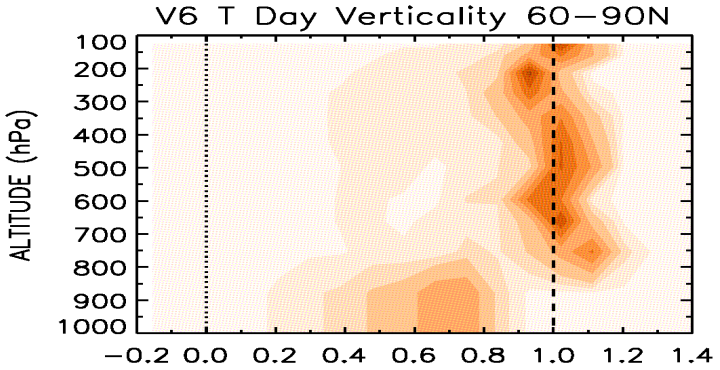
Degree of Freedom



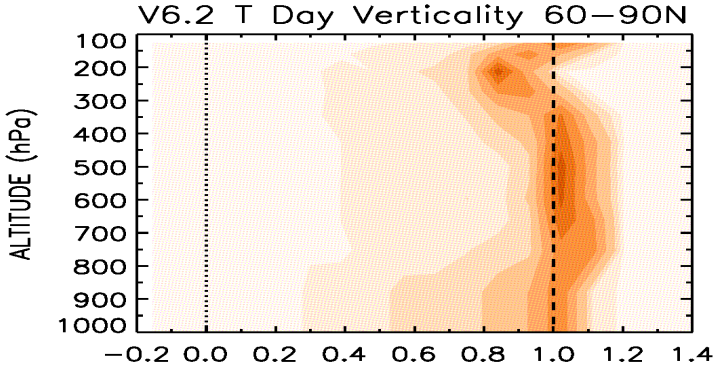




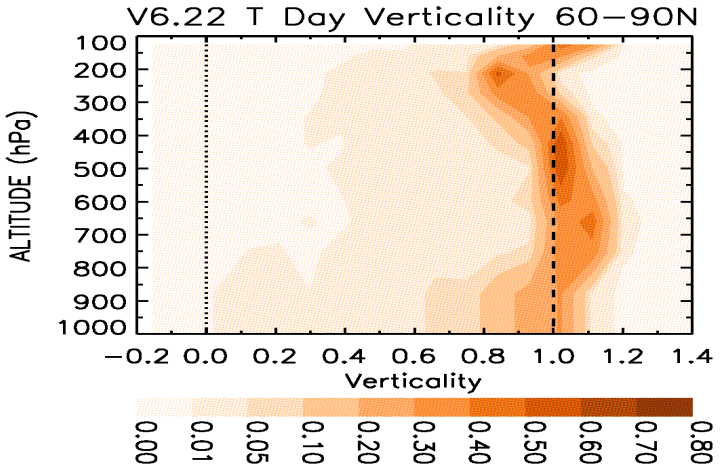
Verticality



V6



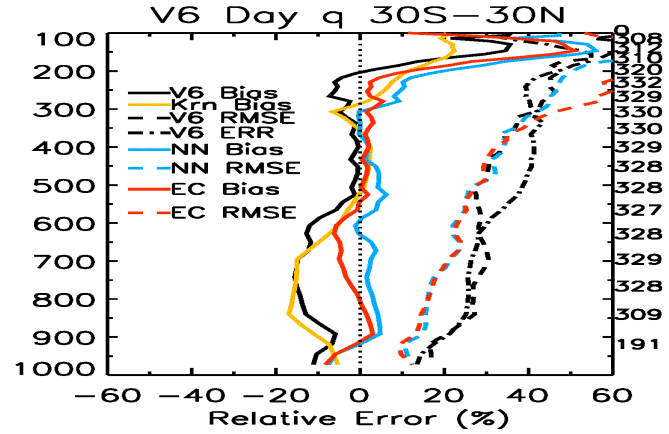
V6.2

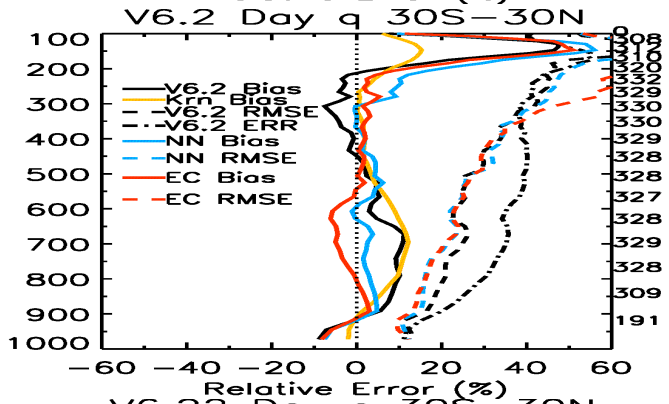


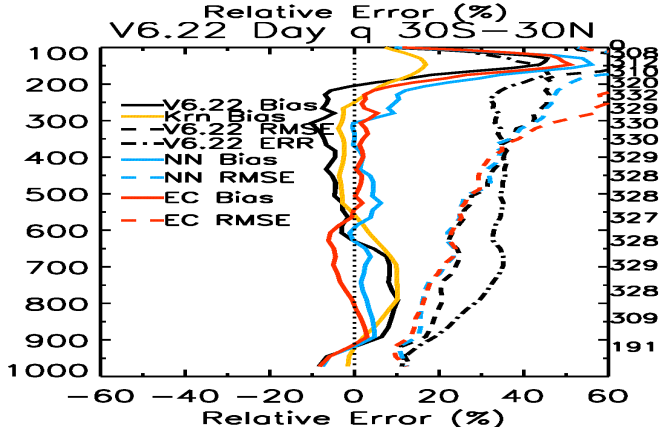
V6.22

Good Daytime q Biases and RMSE, Degree of Freedom and Verticaltiy

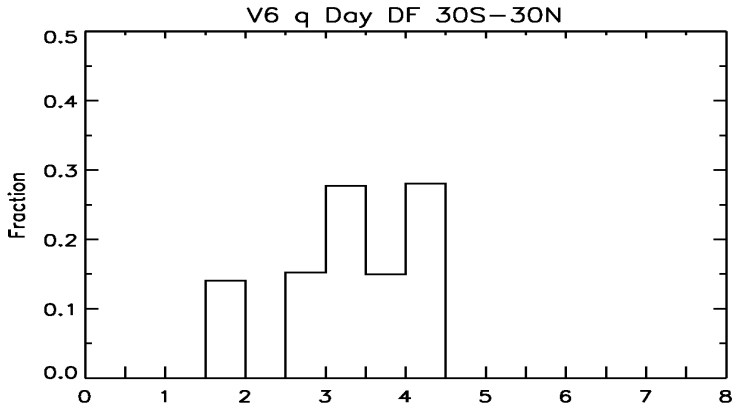
30S-30N

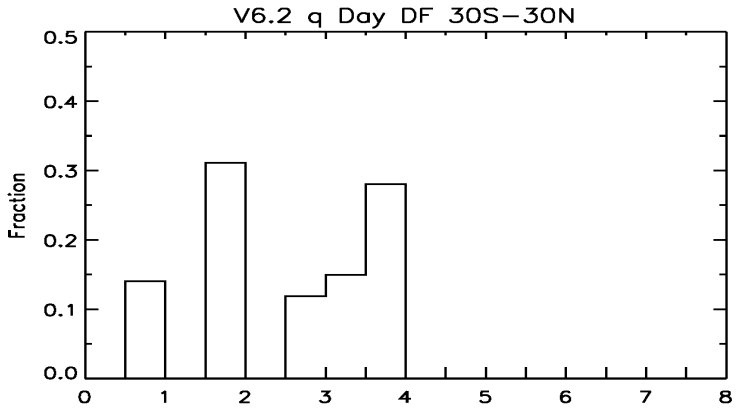


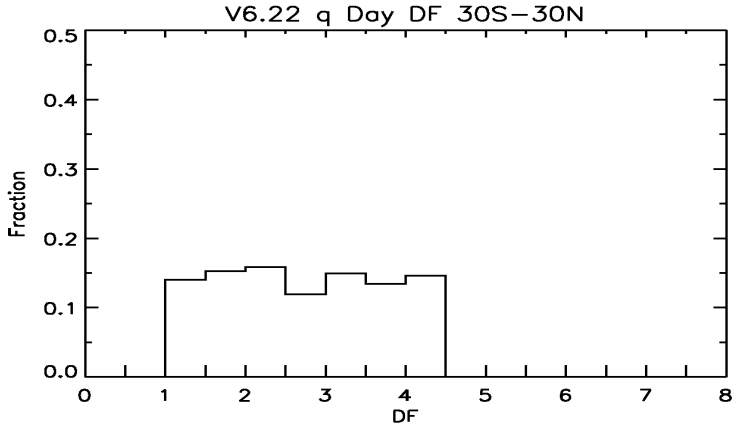




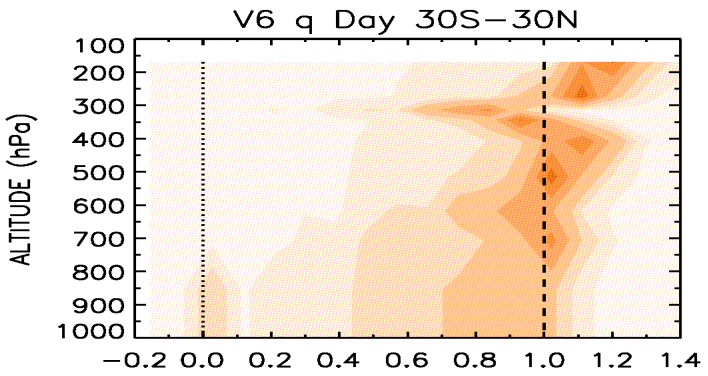
Degree of Freedeom



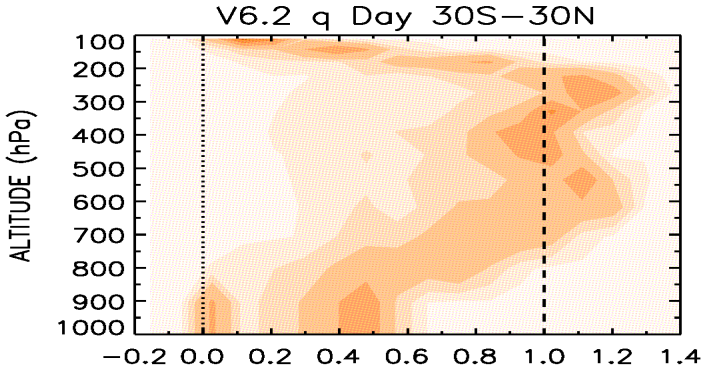




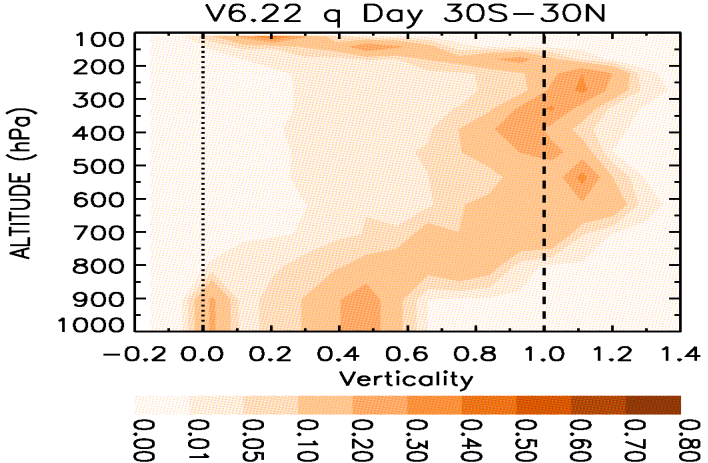
Verticality



V6



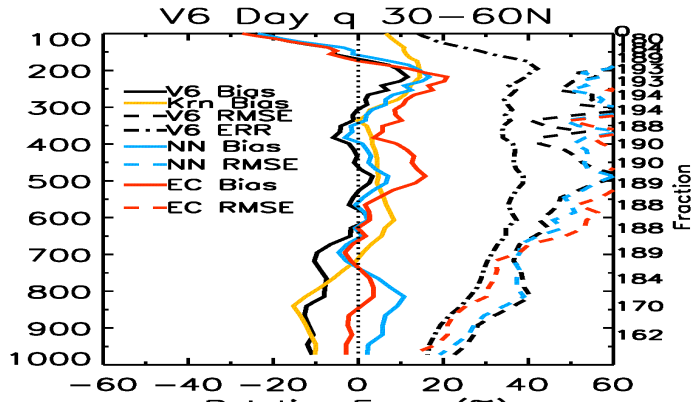
V6.2

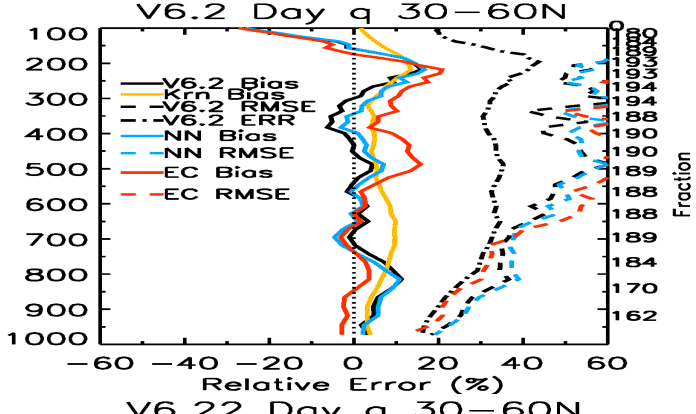


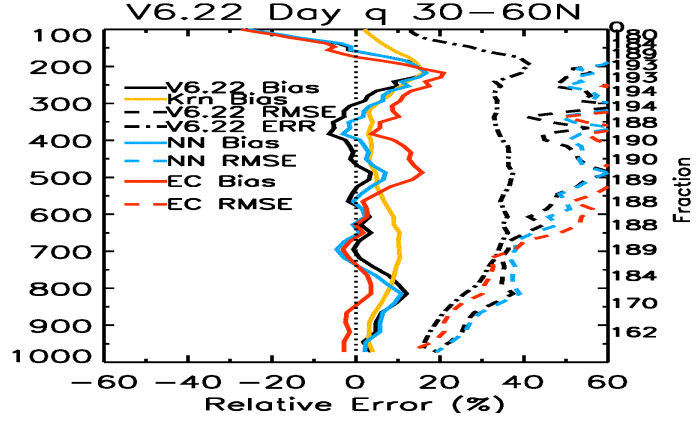
V6.22

Good Daytime q Biases and RMSE, Degree of Freedom and Verticaltiy

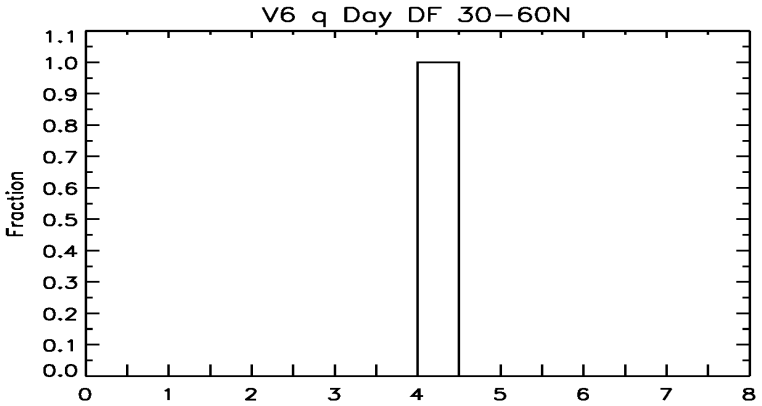
30-60N

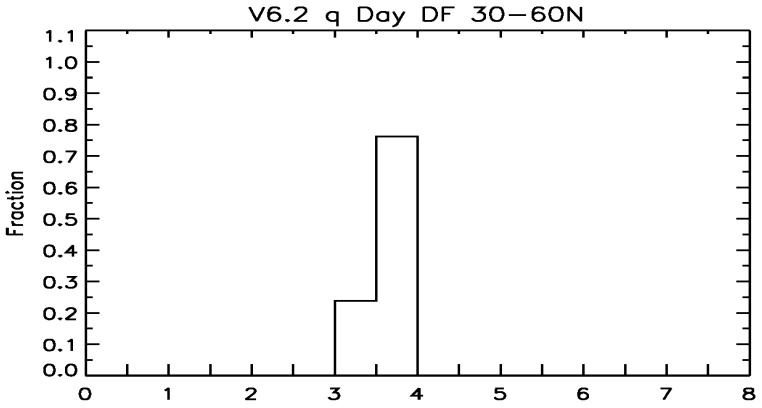


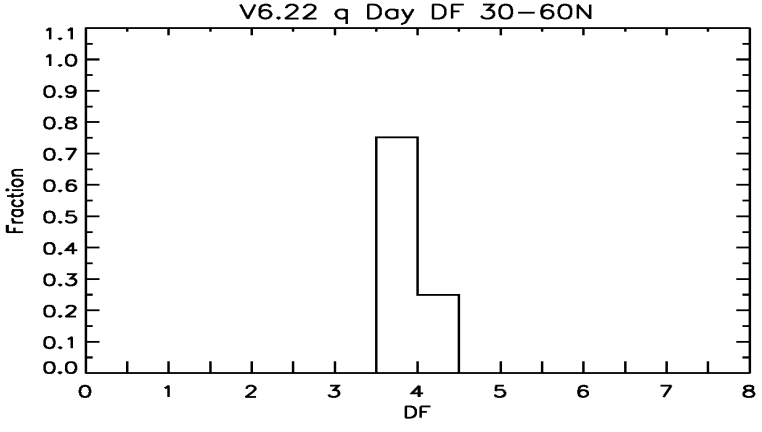




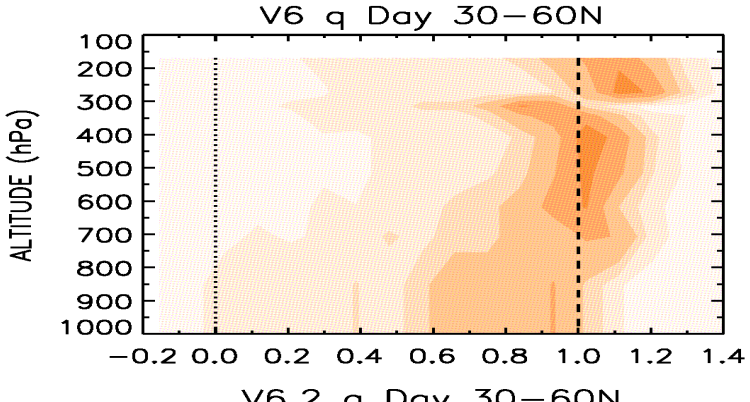
Degree of Freedeom



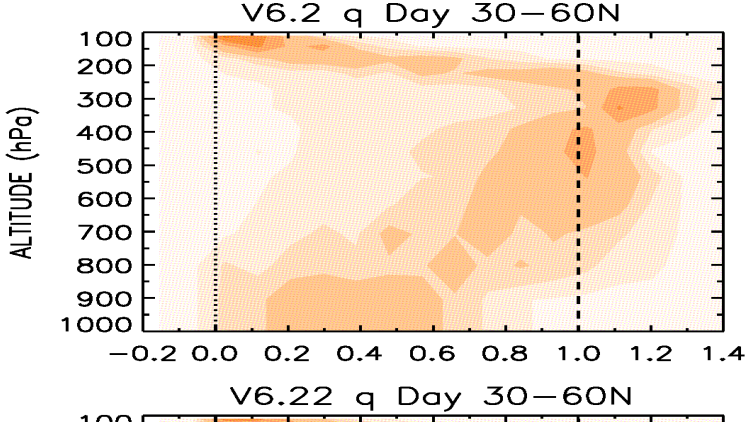




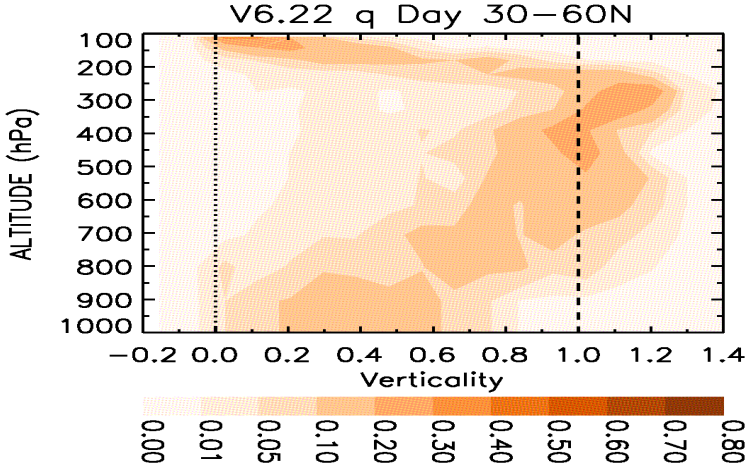
Verticality



V6



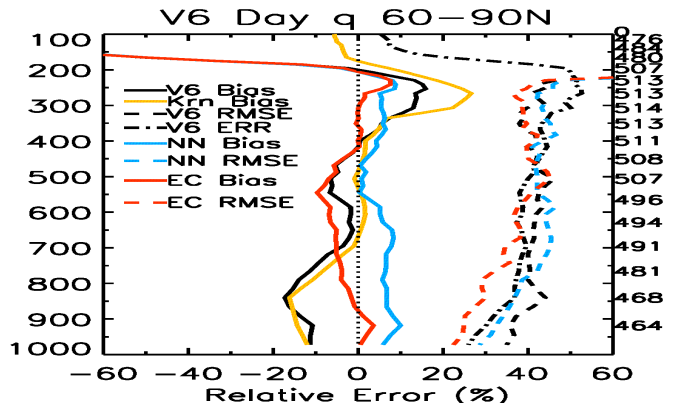
V6.2

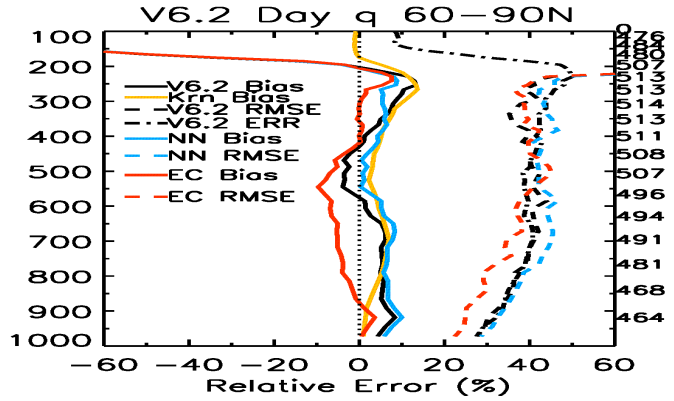


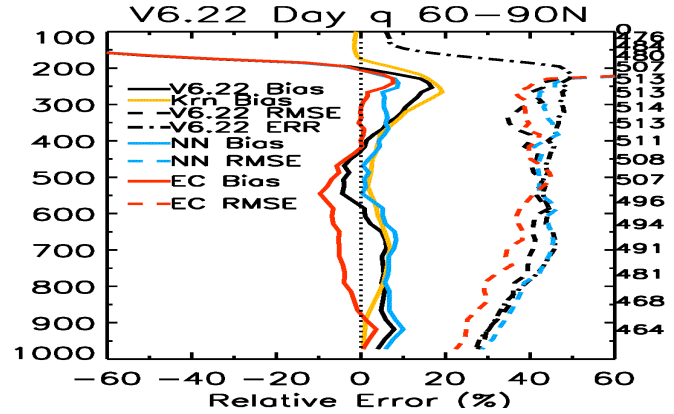
V6.22

Good Daytime q Biases and RMSE, Degree of Freedom and Verticaltiy

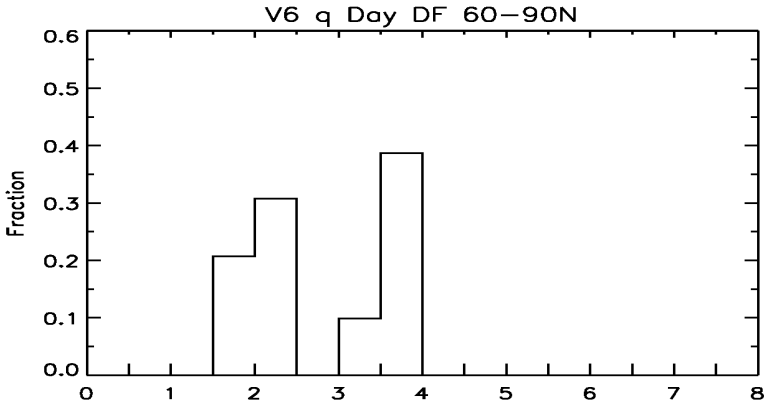
60-90N

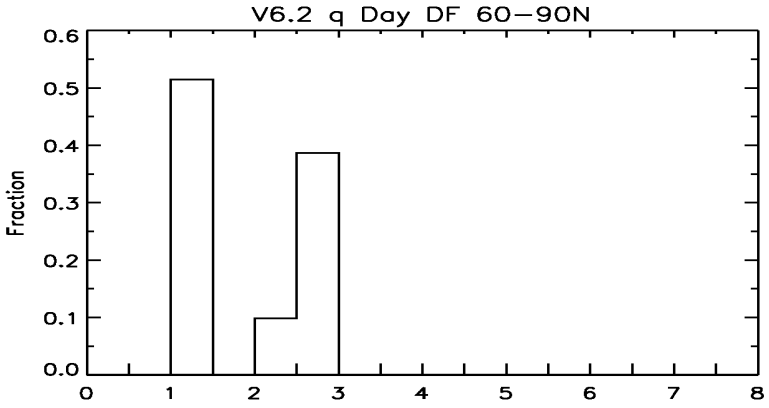


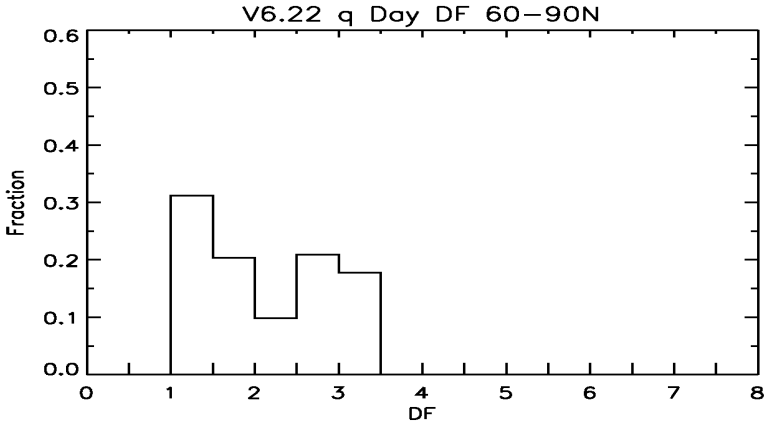




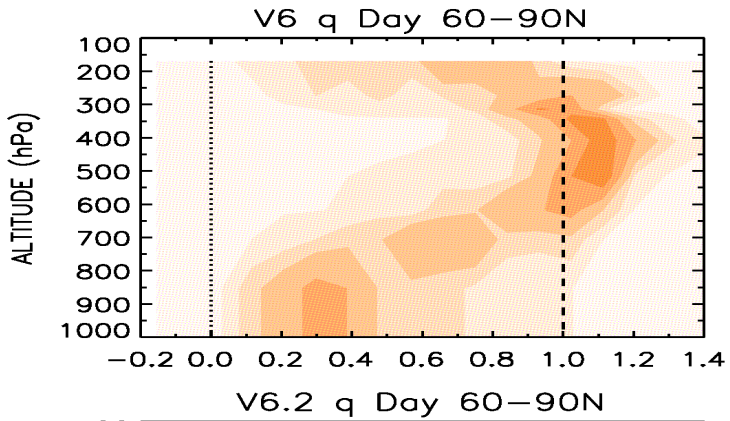
Degree of Freedeom



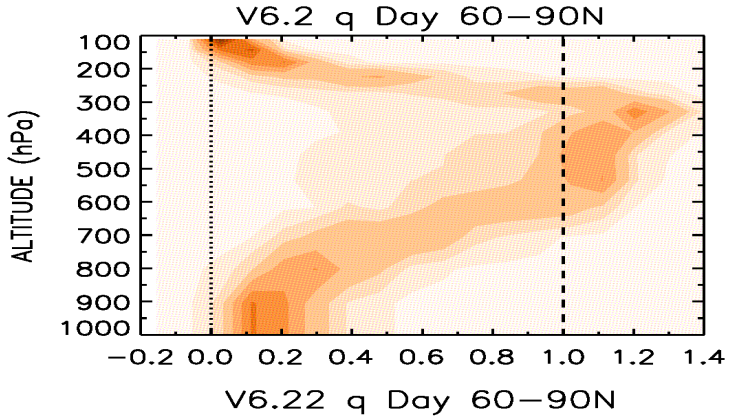




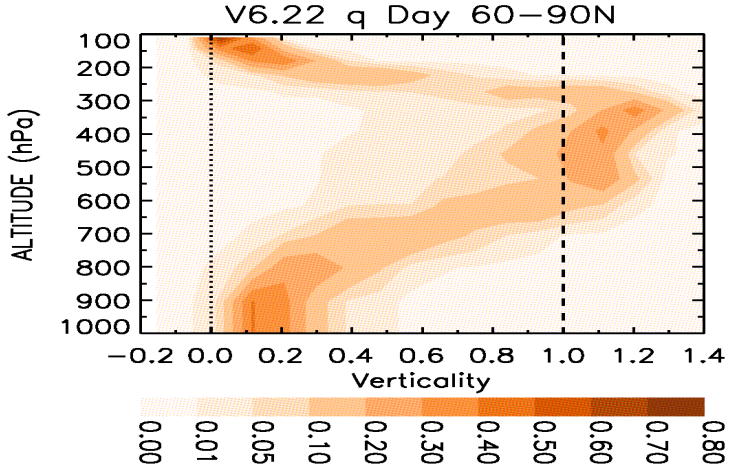
Verticality



V6



V6.2



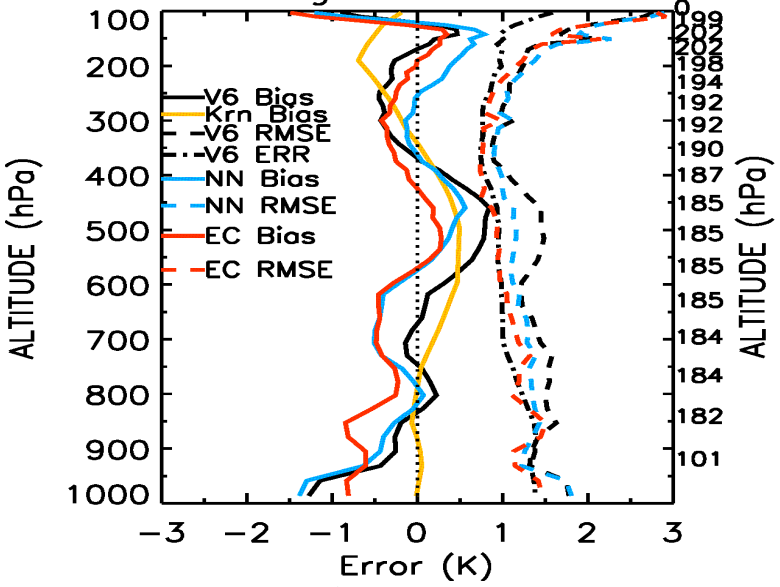
V6.22

Conclusions:

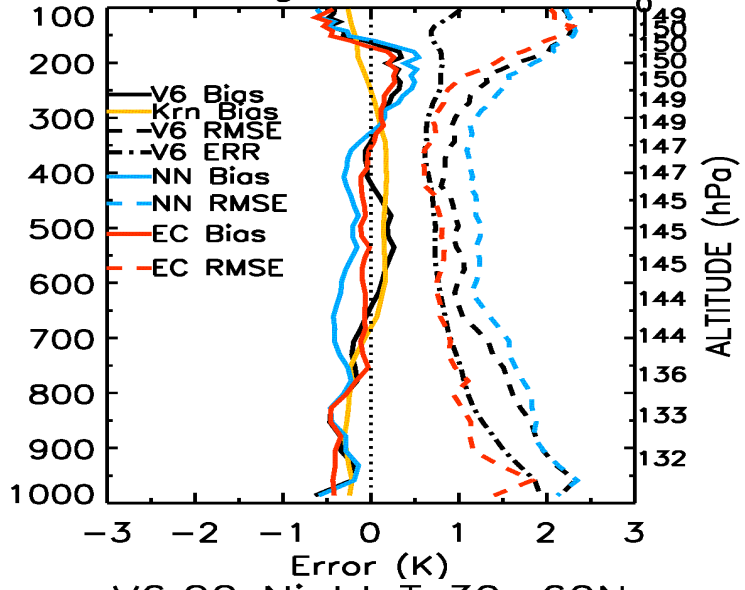
- For T, V6.22 mainly improves tropical mid-tropospheric T from V6 and V6.2, while not changing T profiles in mid- and high- latitudes.
- For T, V6.22 has reduced degree of freedom and boundary layer-mid tropospheric verticality in the tropics
- For q, V6.22 is similar to V6.2, removing the daytime dry biases of V6 in the lower troposphere
- For q, V6.22 has reduced daytime boundary layer verticality in the tropics, mid-latitudes, and polar region

Good Nitghtime T Biases and RMSE

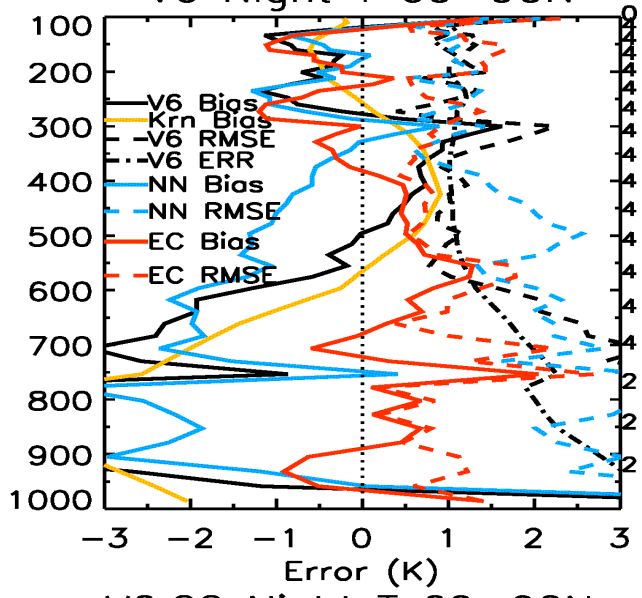
30S-30N



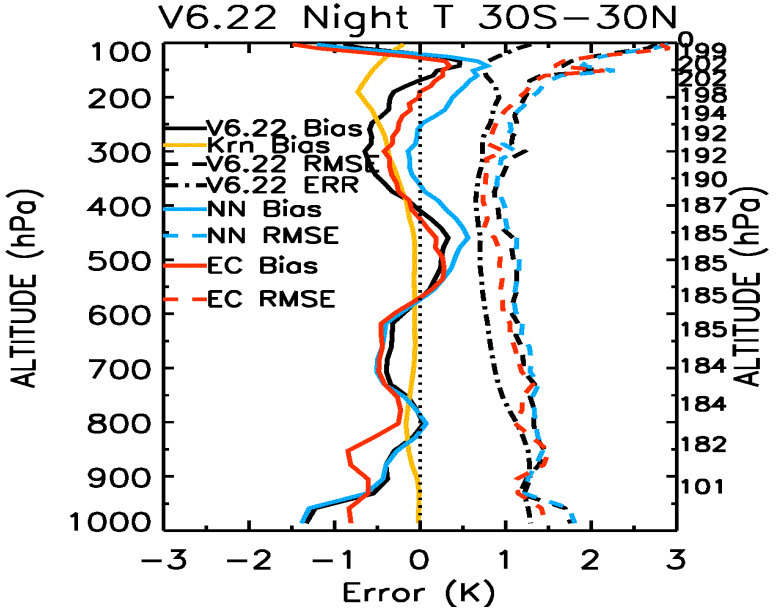
30-60N

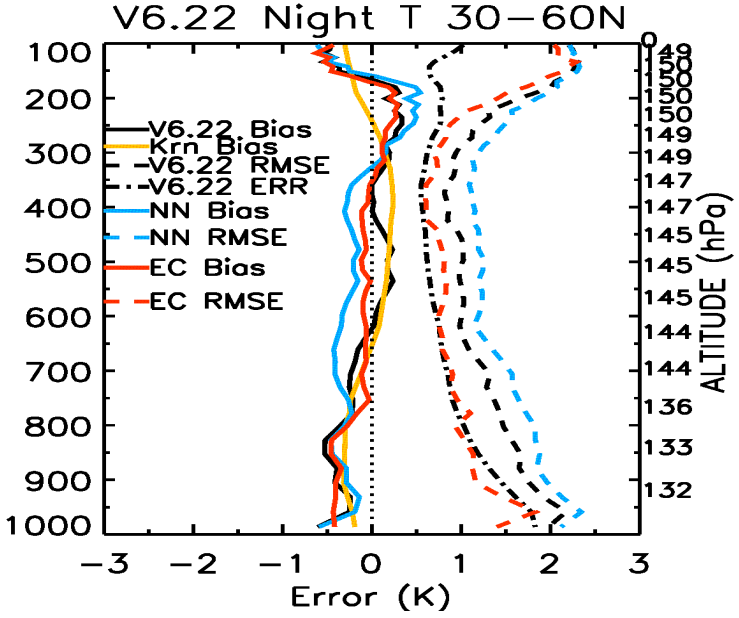


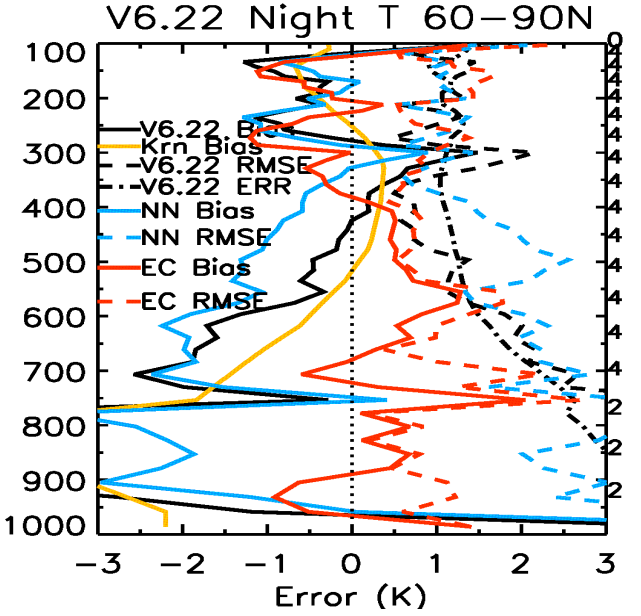
60-90N



V6



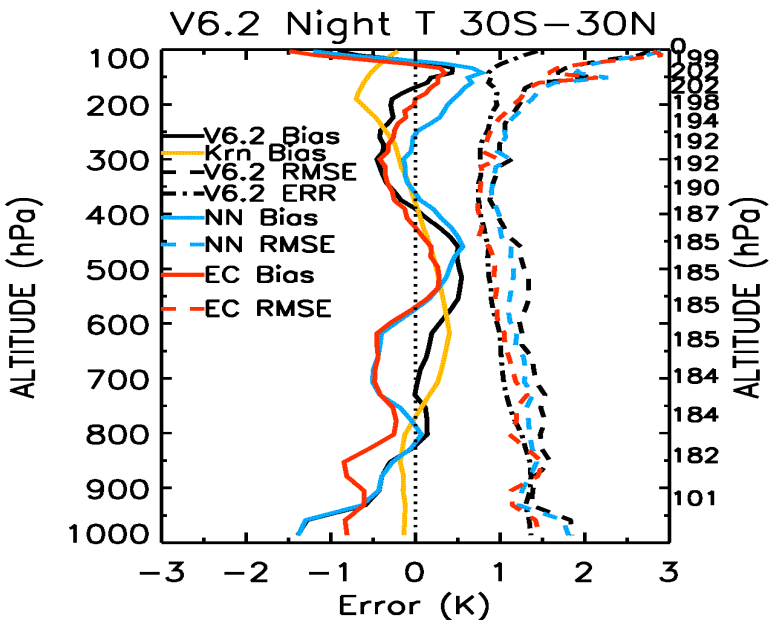




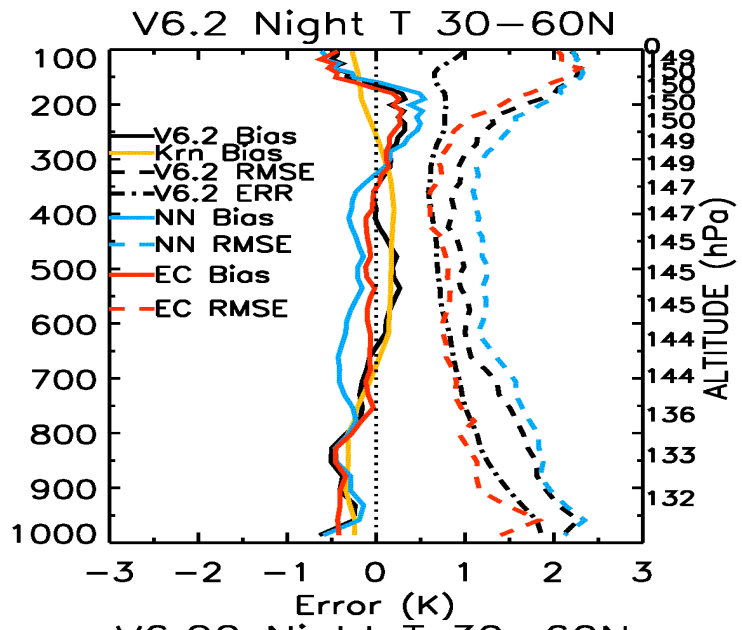
V6.22

Good Nitghtime T Biases and RMSE

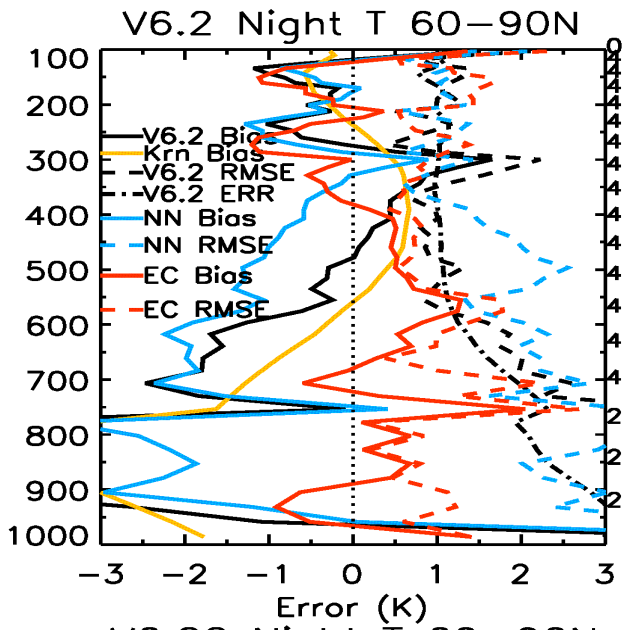
30S-30N



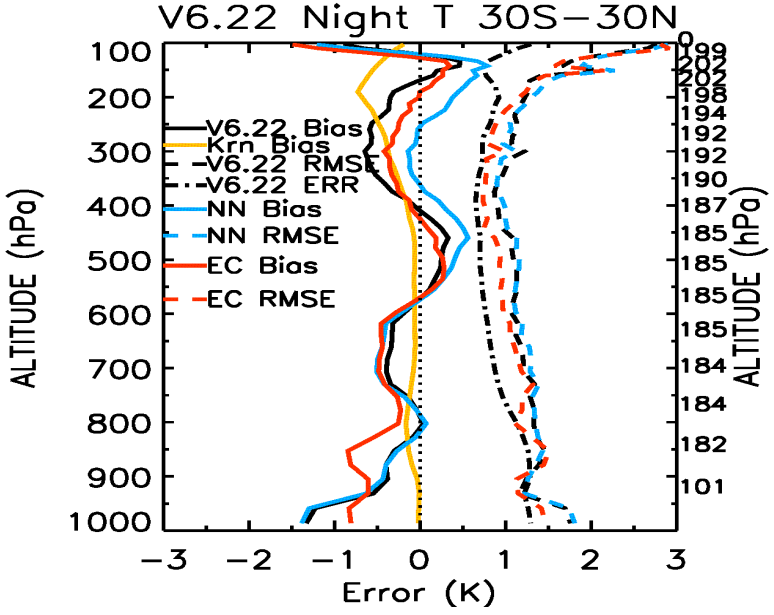
30-60N

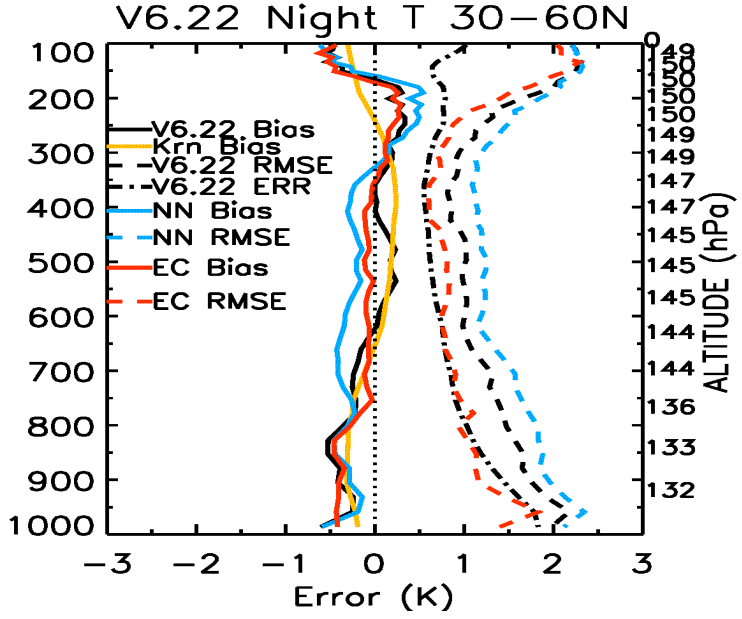


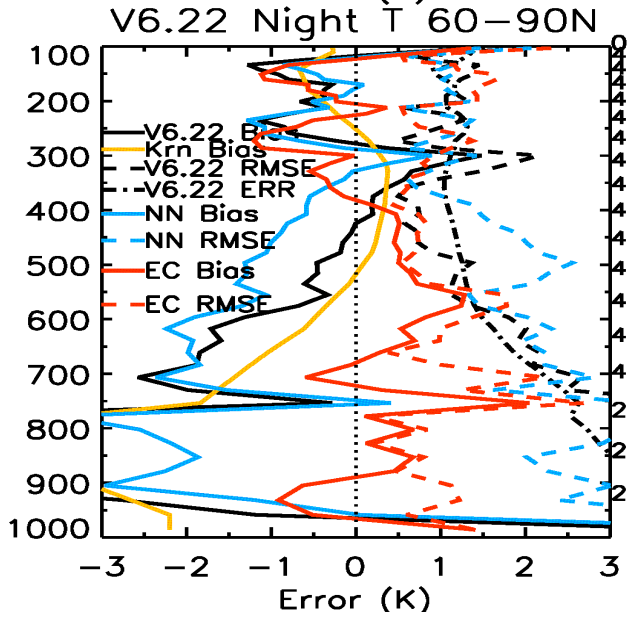
60-90N



V6.2







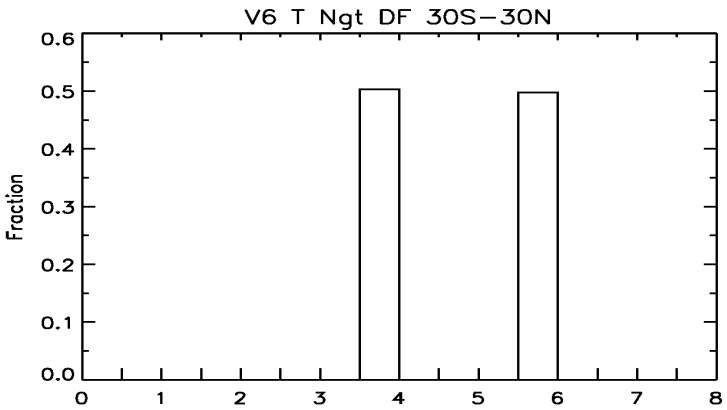
V6.22

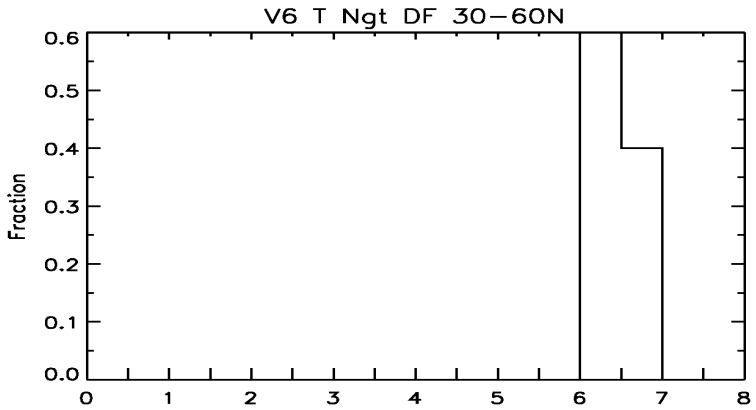
Good Nightime T Degree of Freedom Histograms

30S-30N

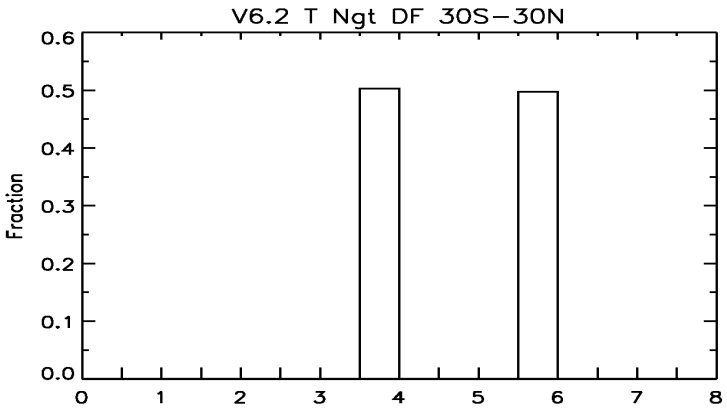
30-60N

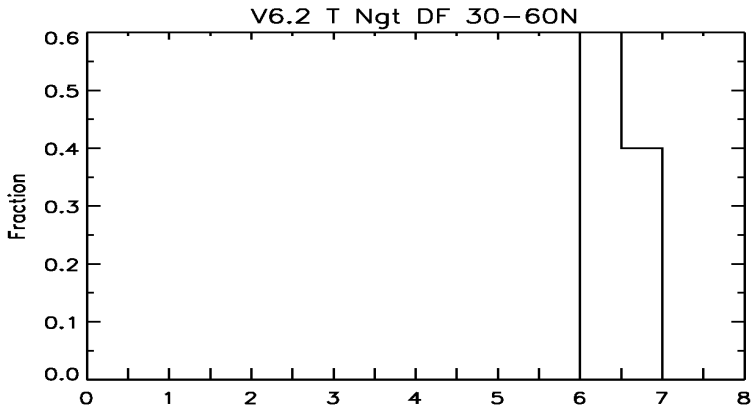
60-90N



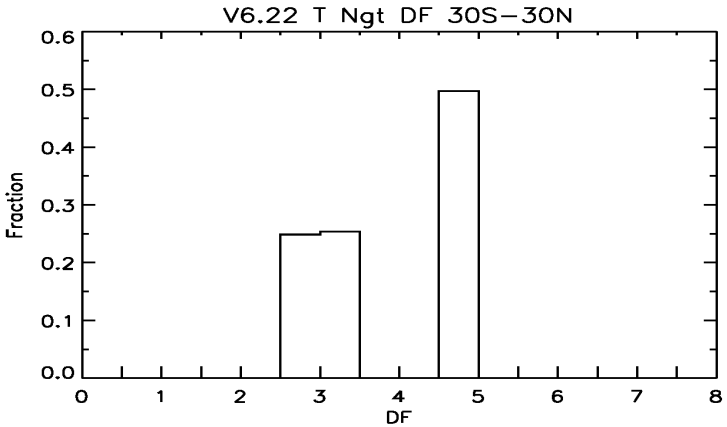


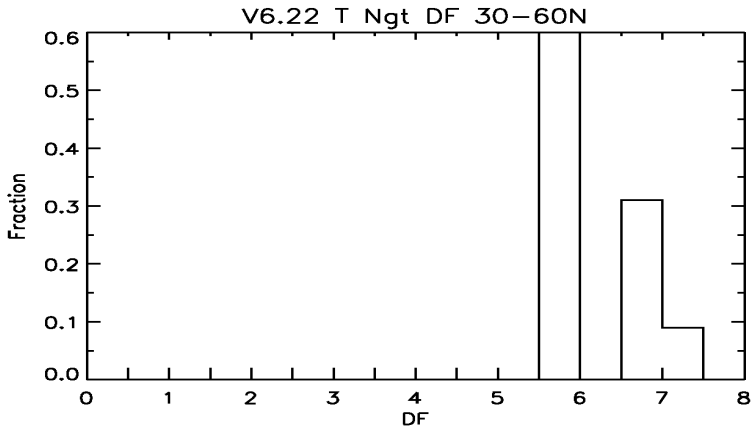
V6





V6.2





V6.22

Good Daytime T Verticality Histograms

30S-30N

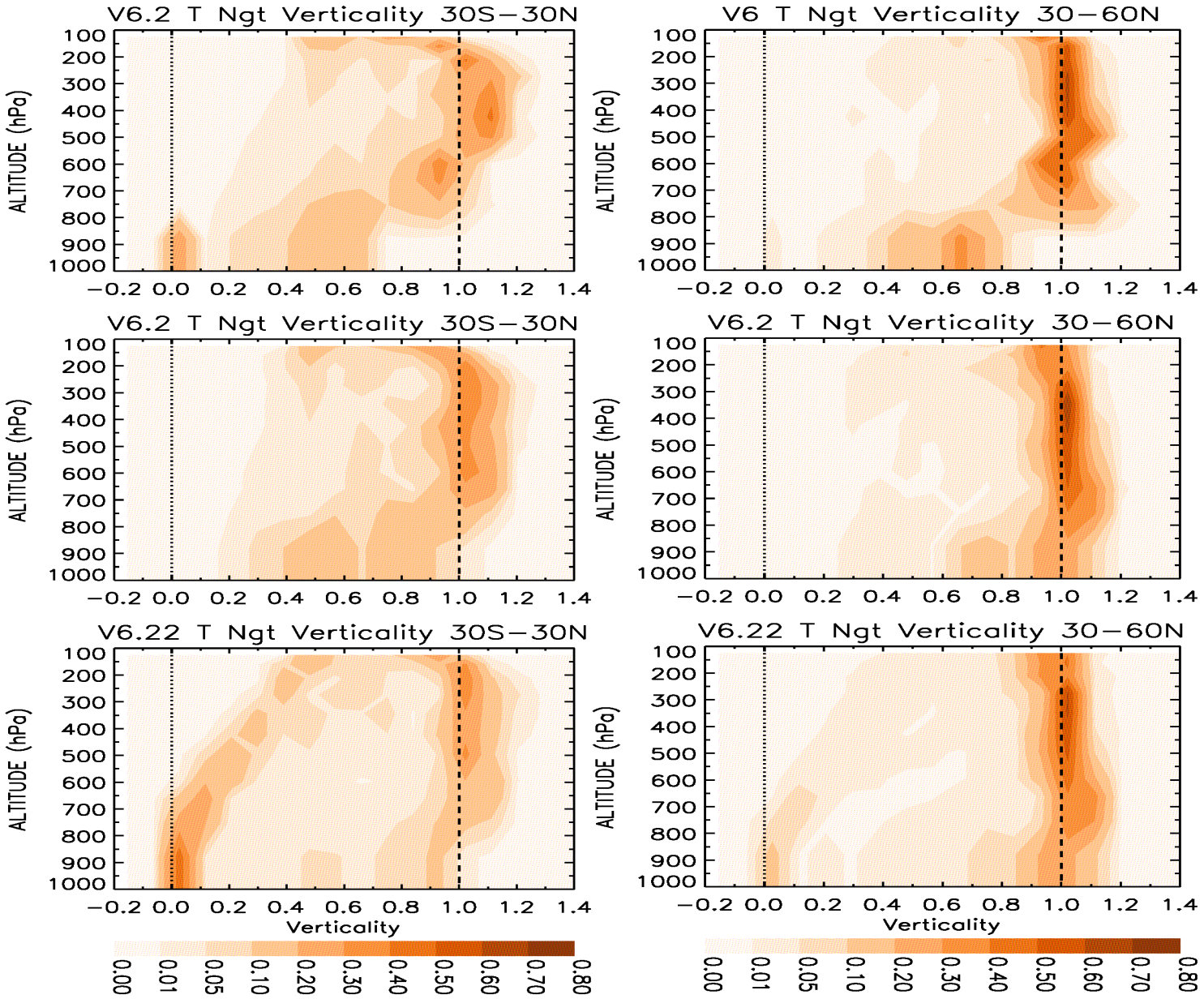
30-60N

60-90N

V6

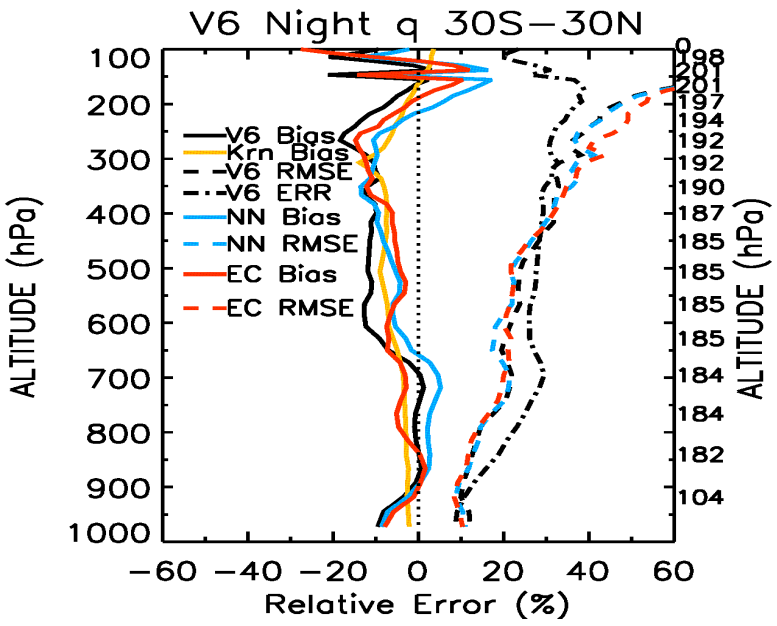
V6.2

V6.22

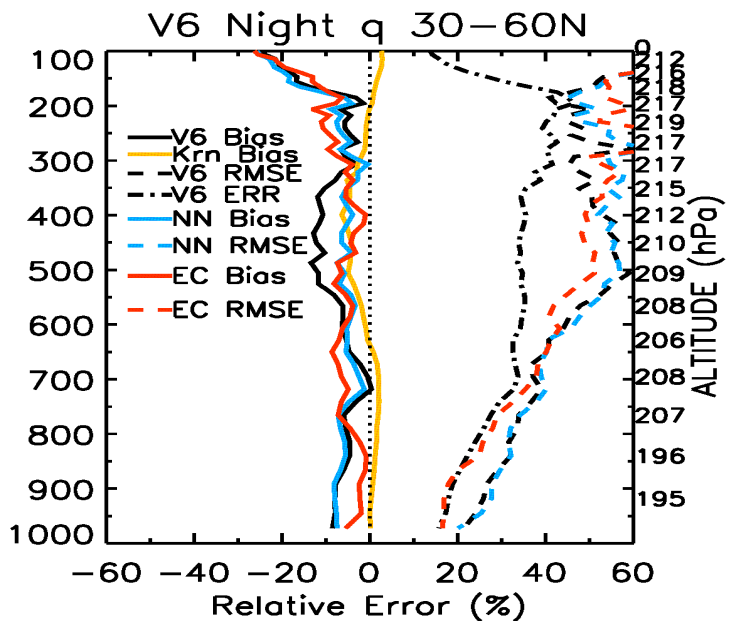


Good Nightime q Biases and RMSE

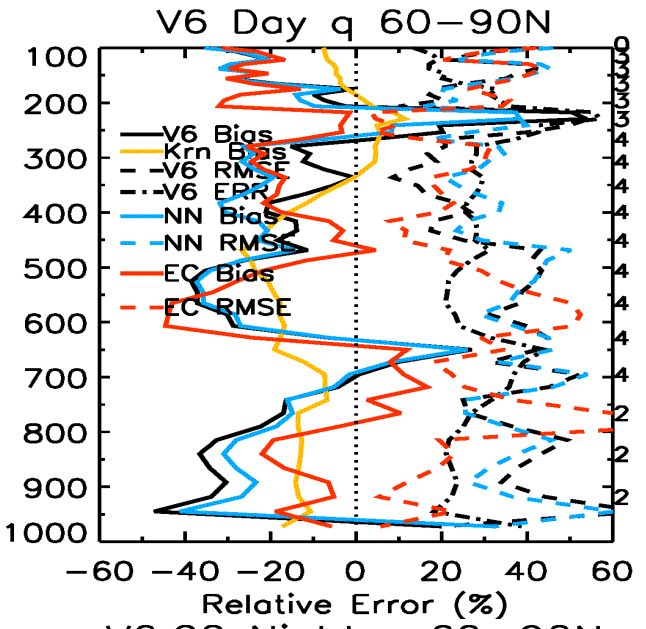
30S-30N



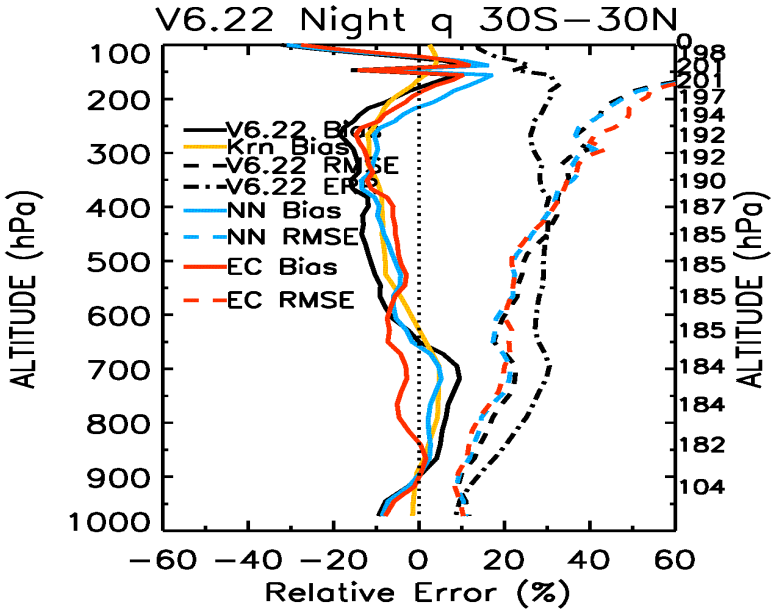
30-60N

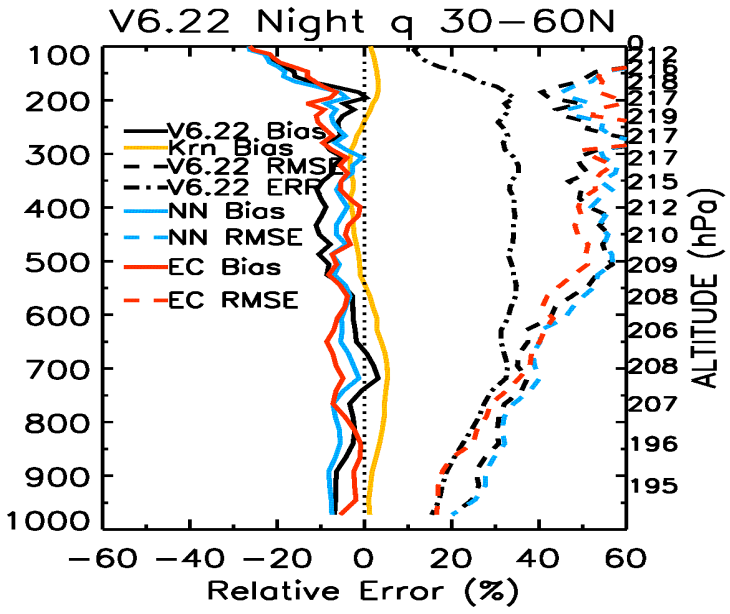


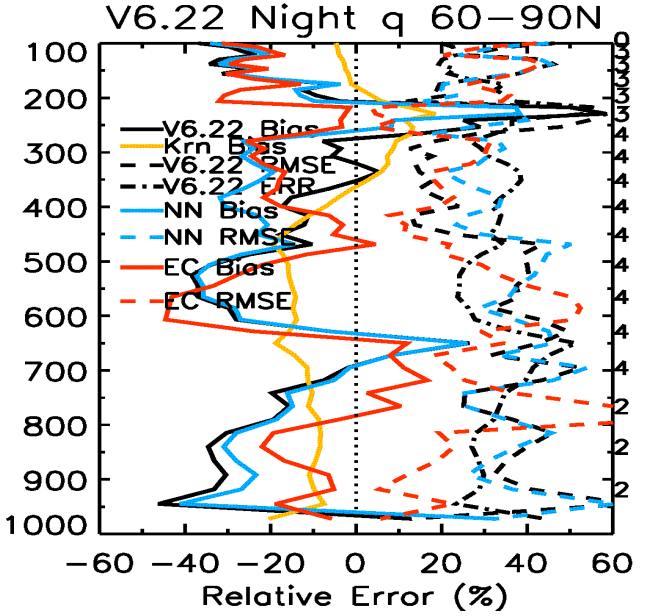
60-90N



V6



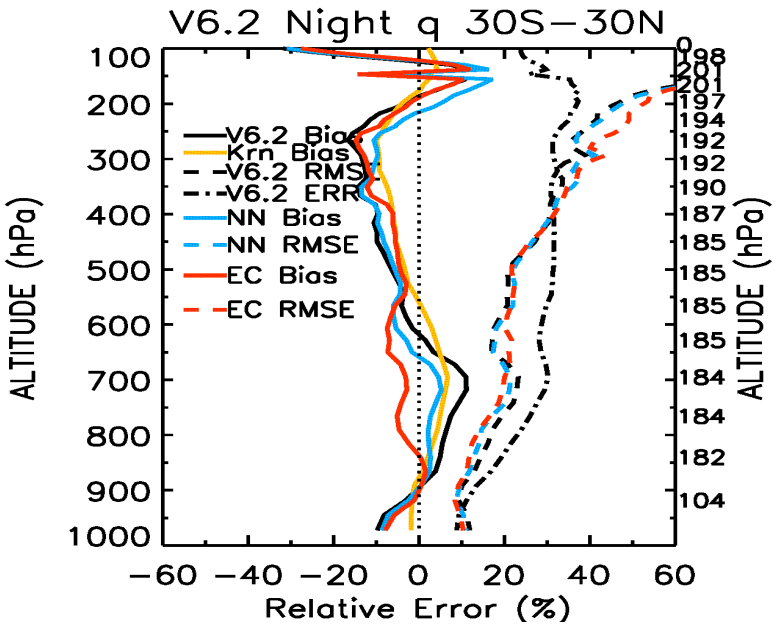




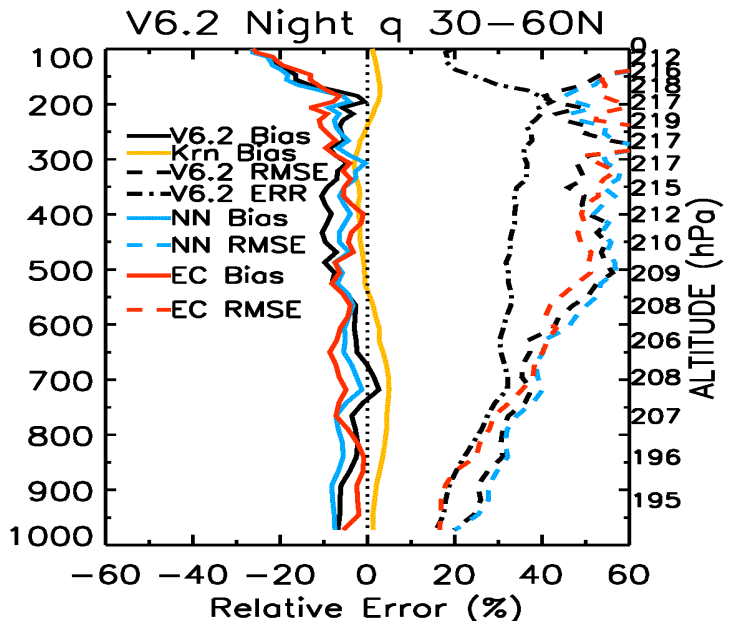
V6.22

Good Nightime q Biases and RMSE

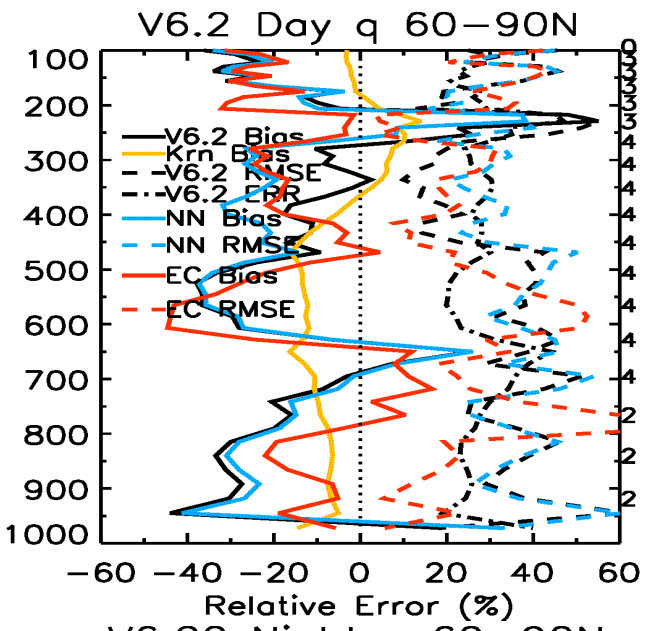
30S-30N



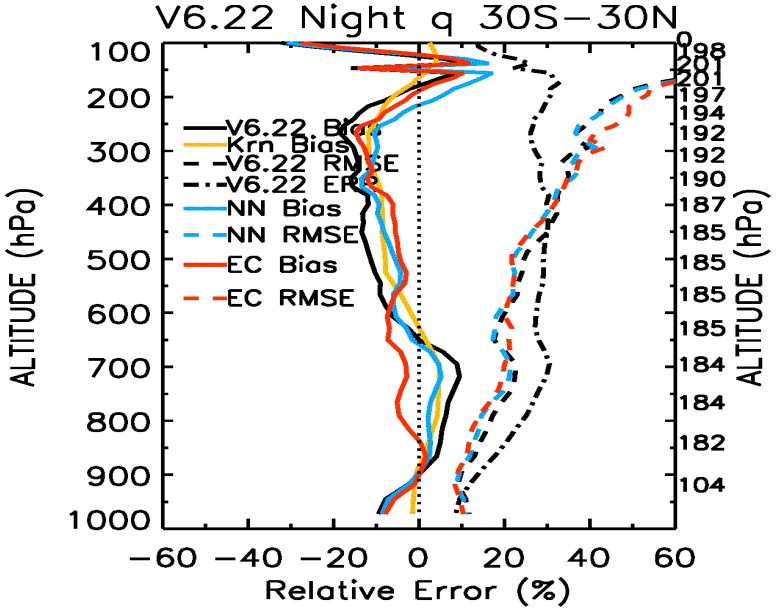
30-60N

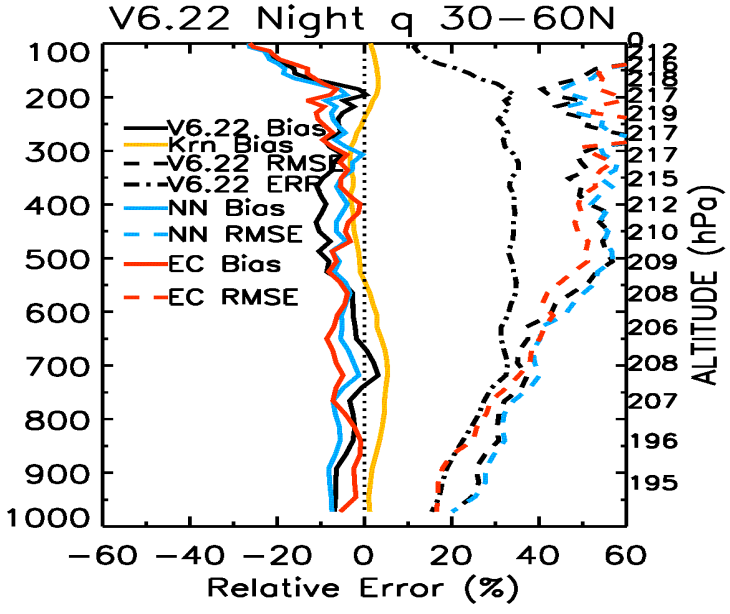


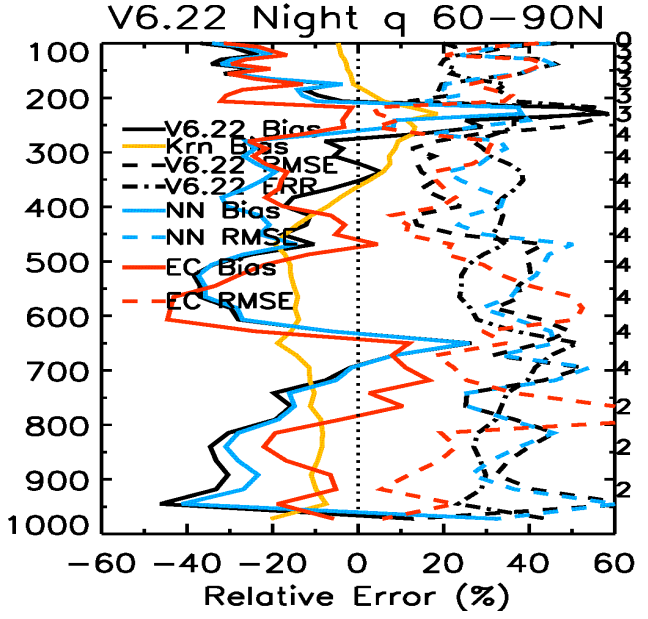
60-90N



V6.2







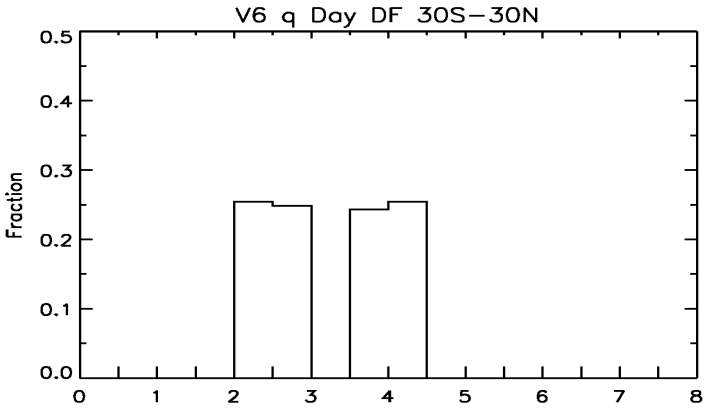
V6.22

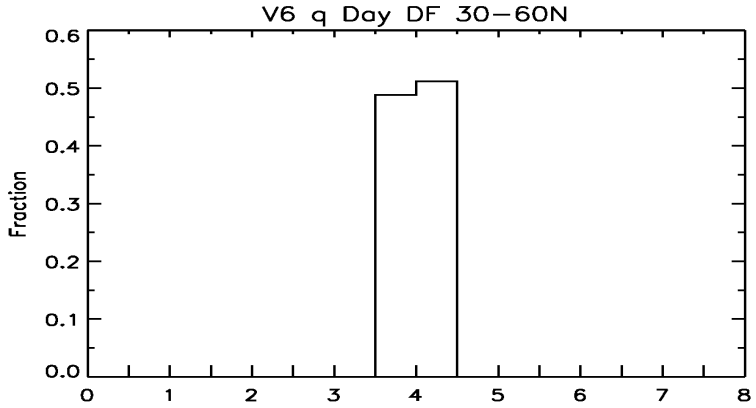
Good Nightime q Degree of Freedom Histograms

30S-30N

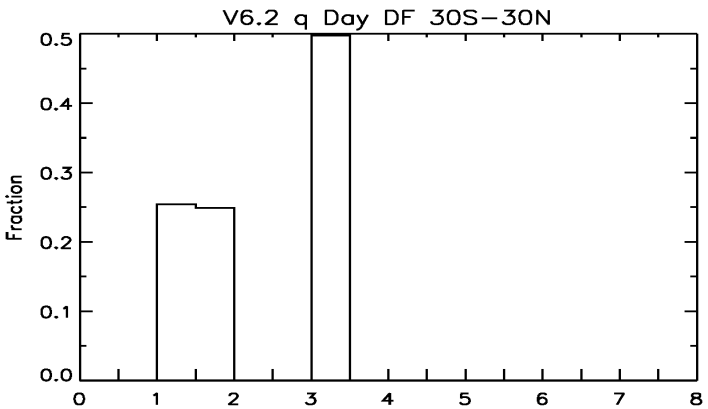
30-60N

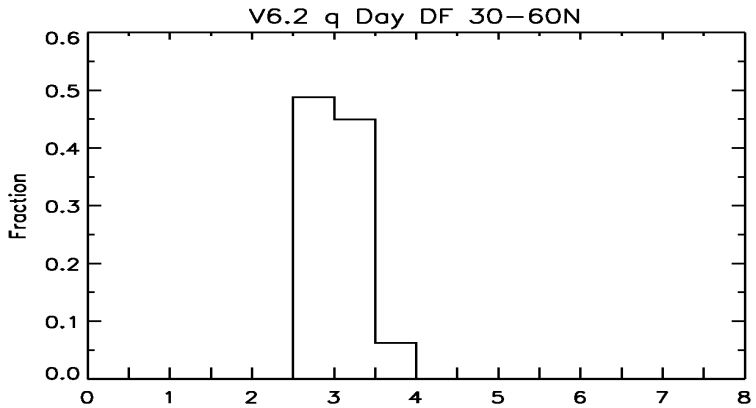
60-90N



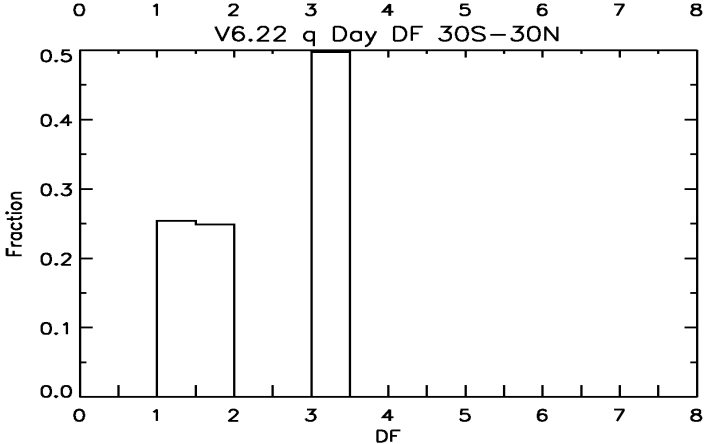


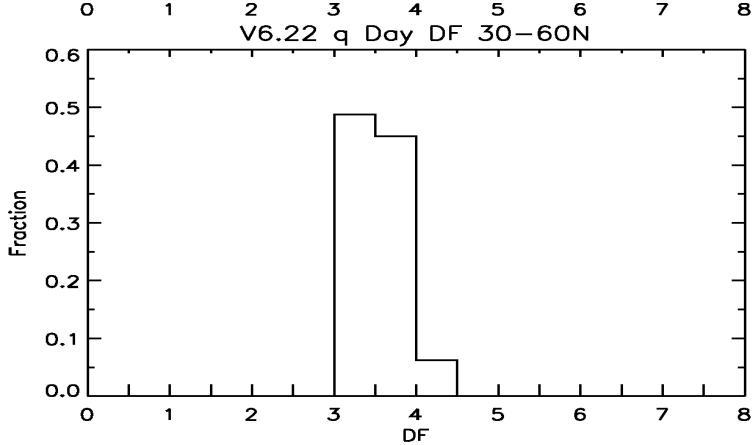
V6





V6.2





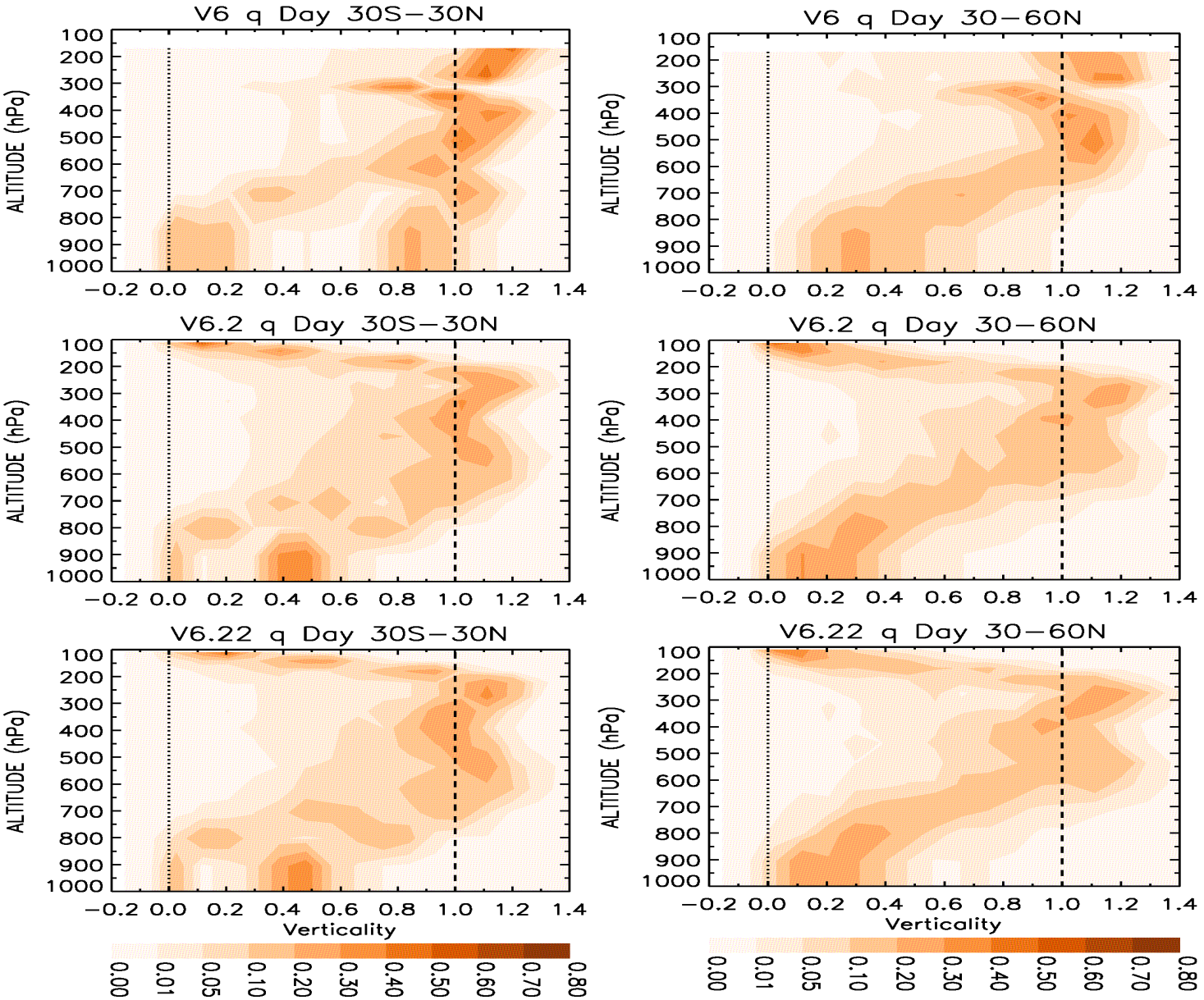
V6.22

Good Nightime q Verticality Histograms

30S-30N

30-60N

60-90N



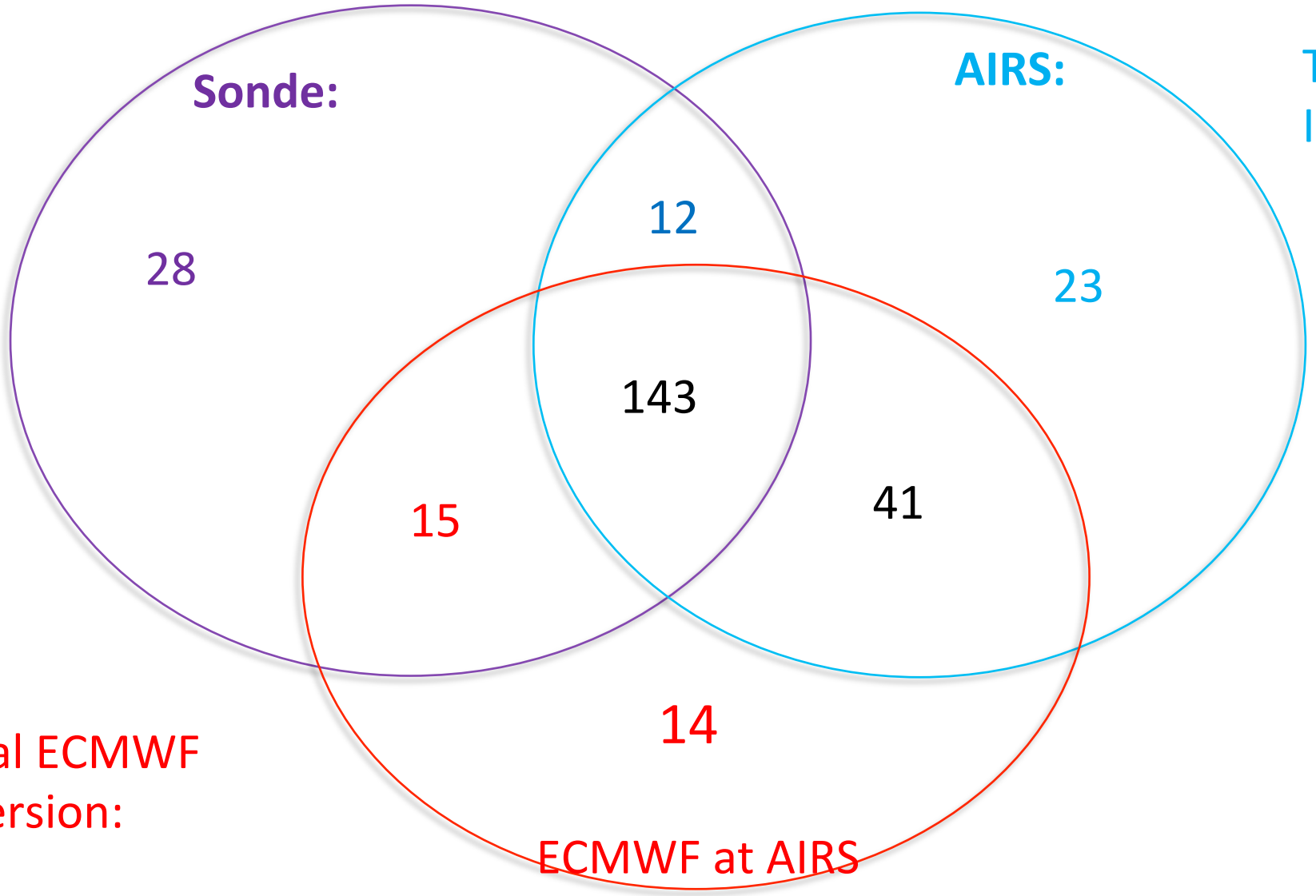
V6

V6.2

V6.22

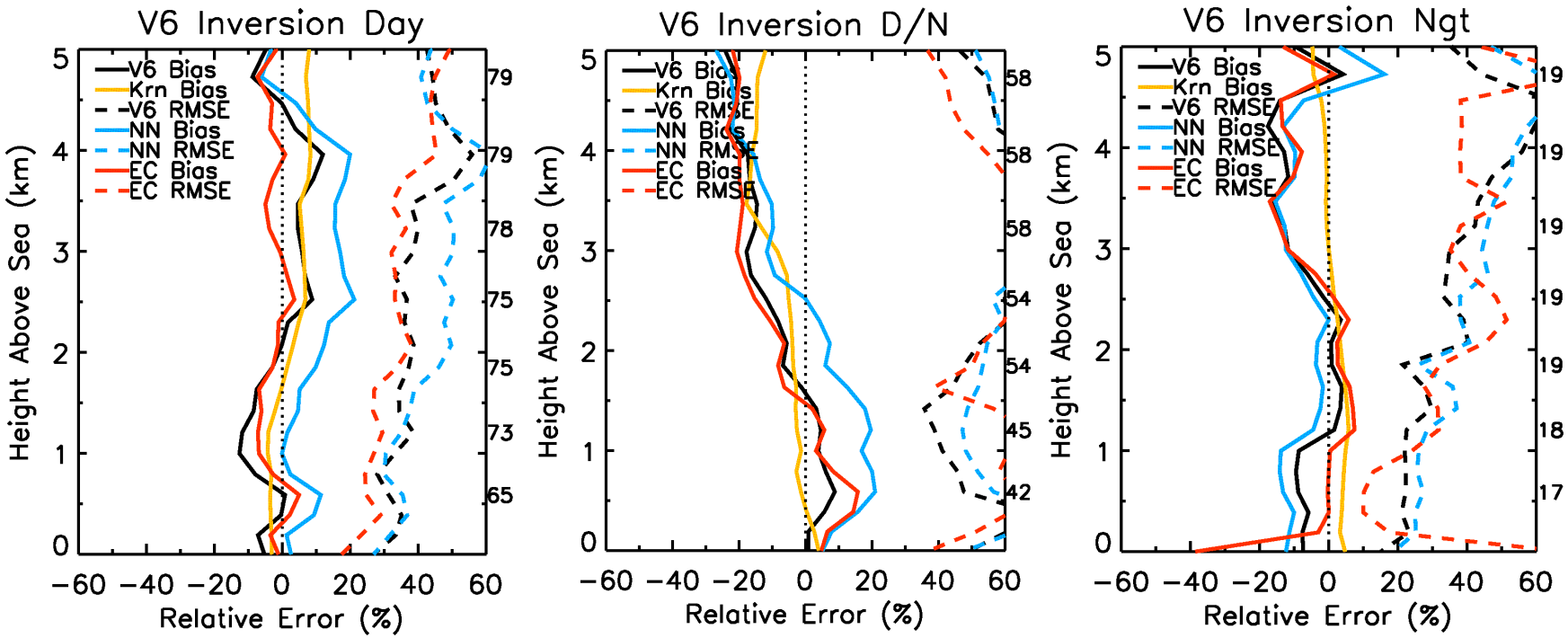
Total Sonde-AIRS V6.22 Match Ups: 1534
Strength ≥ 5 K/km

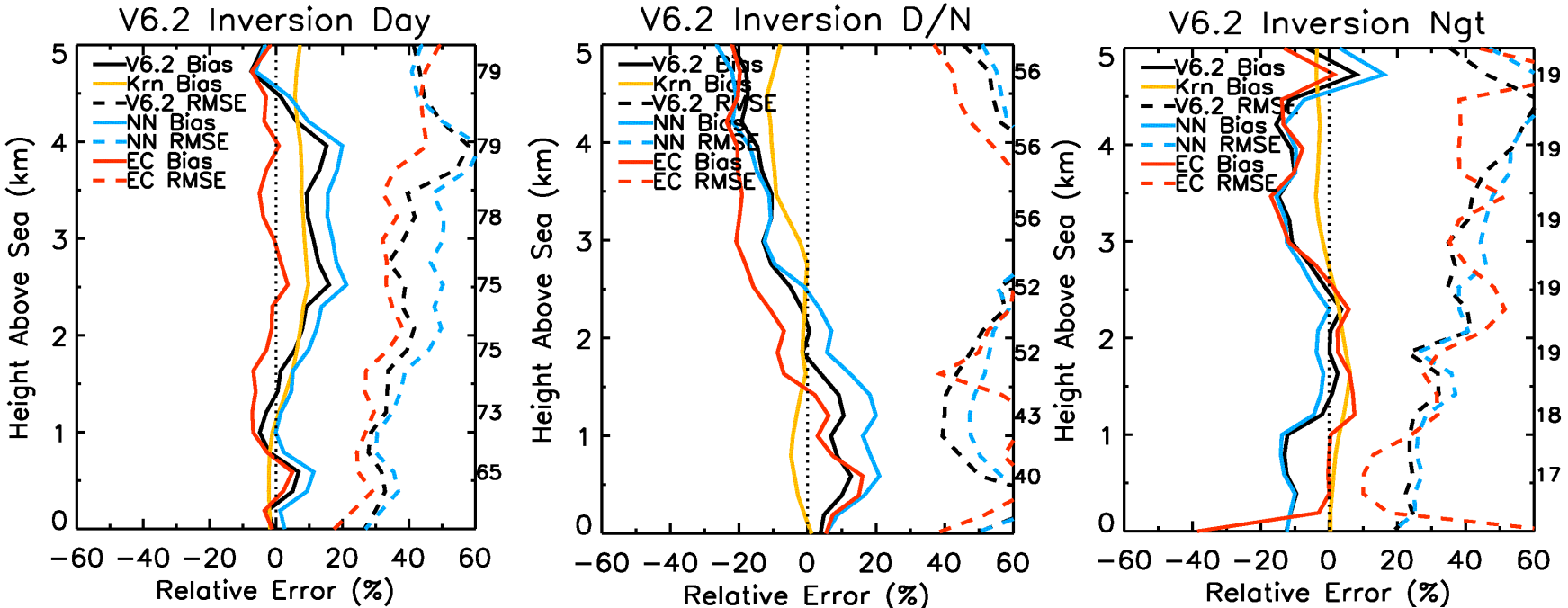
Total Sonde Inversion: 215



Total AIRS Inversion: 239

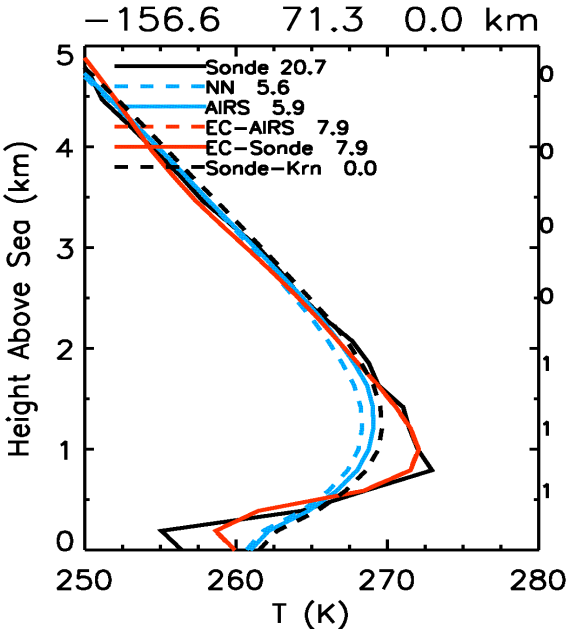
Total ECMWF Inversion: 235



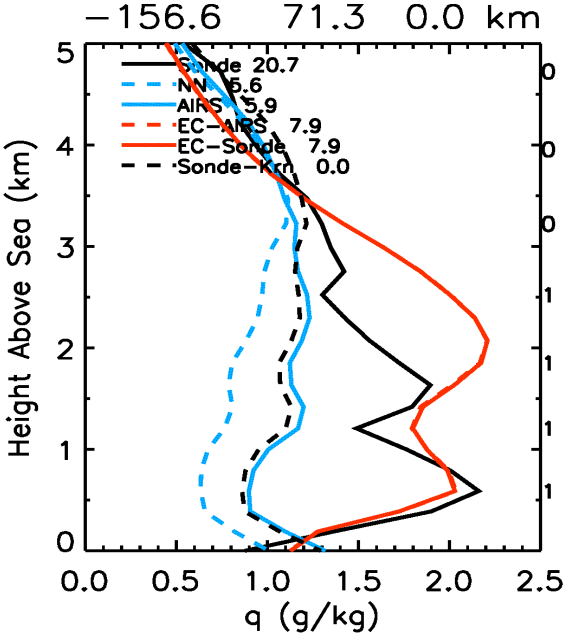


V6, NN, ECMWF q biases and RMSE, when all have T inversion strength > 5K/km

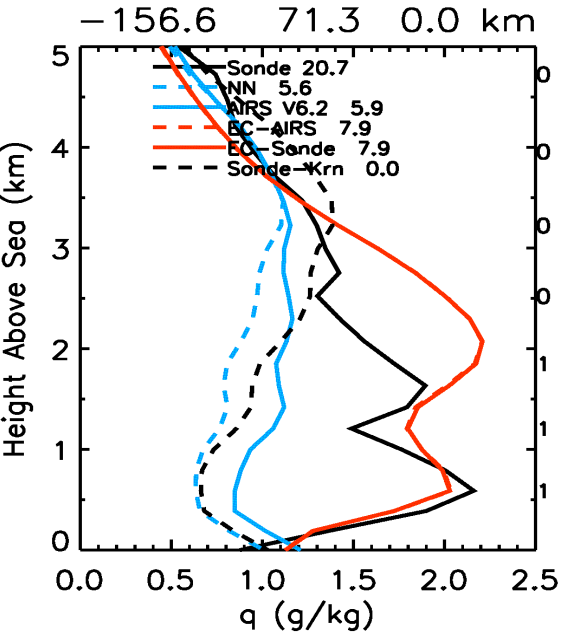
Corresponding V6.2 q profiles



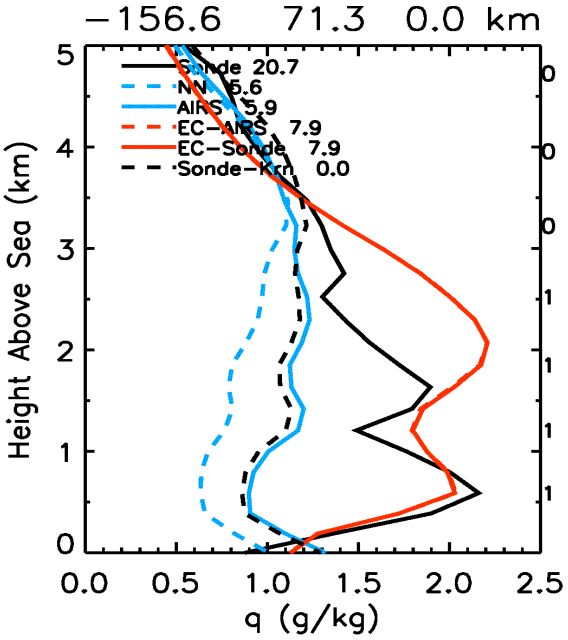
T Inversion, captured by Sonde, AIRS/NN, ECMWF



Corresponding V6 q profiles



Corresponding V6.2 q profiles

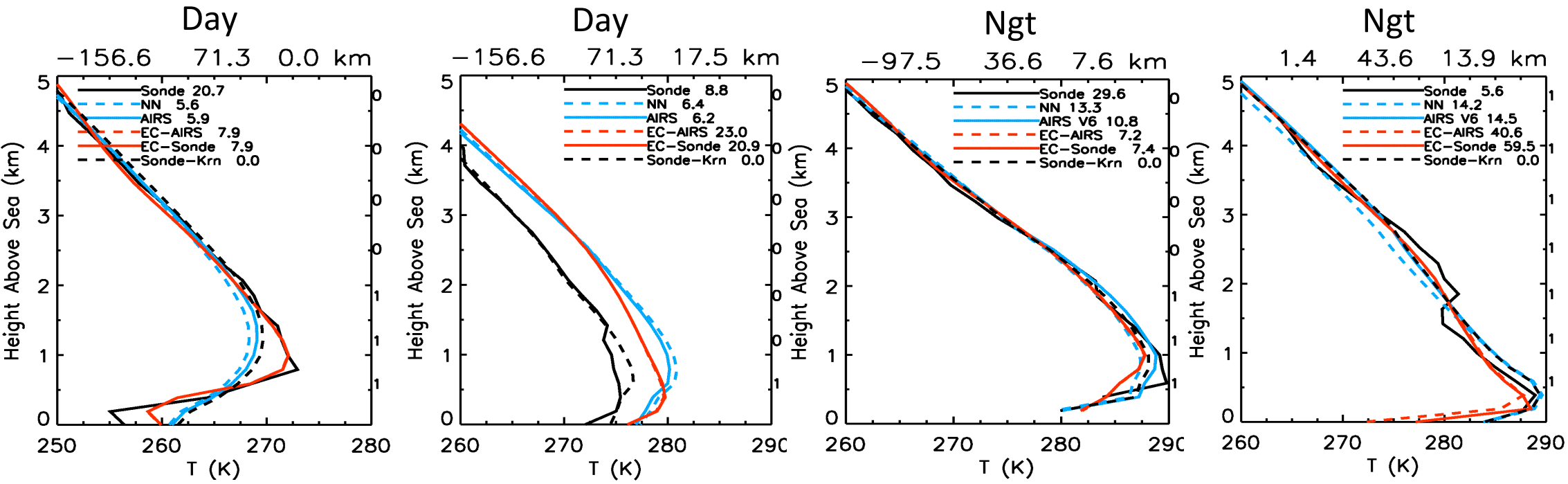


Corresponding V6 q profiles

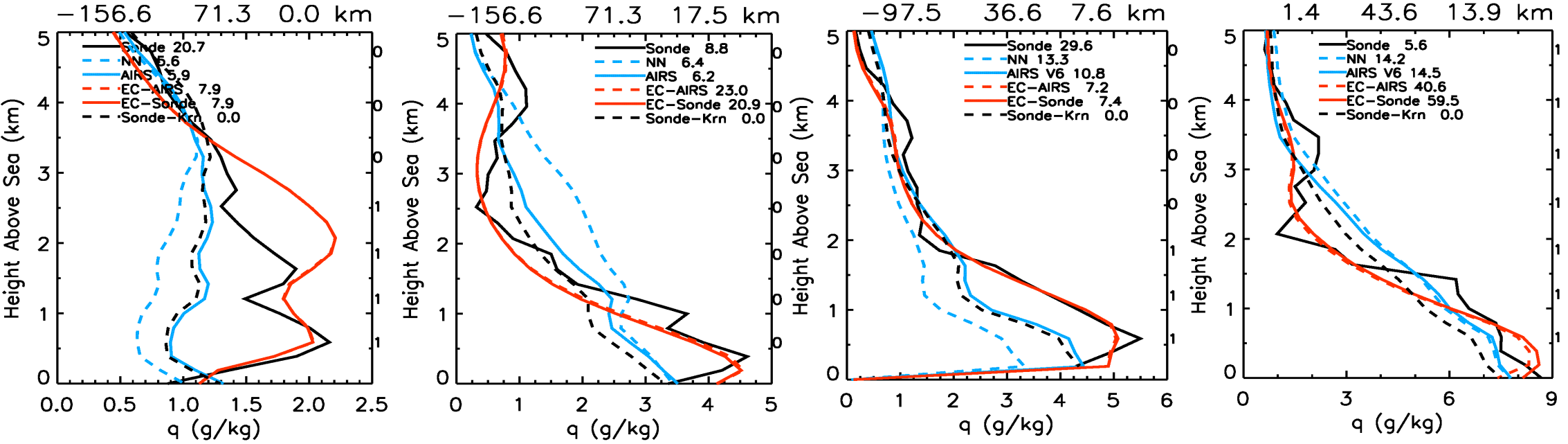
Note:

- ECMWF tends to follow the zig-zag, recalling these sonde profiles are not assimilated
- AIRS retrieval tends to follow the zig-zag
- Change in the kerned sonde profiles (black-dashed) between V6 and V6.2 ~1-km above the surface, Indicating the changes in averaging kernels in the lower troposphere

Sonde & AIRS & ECMWF, Strength > 5 K/km

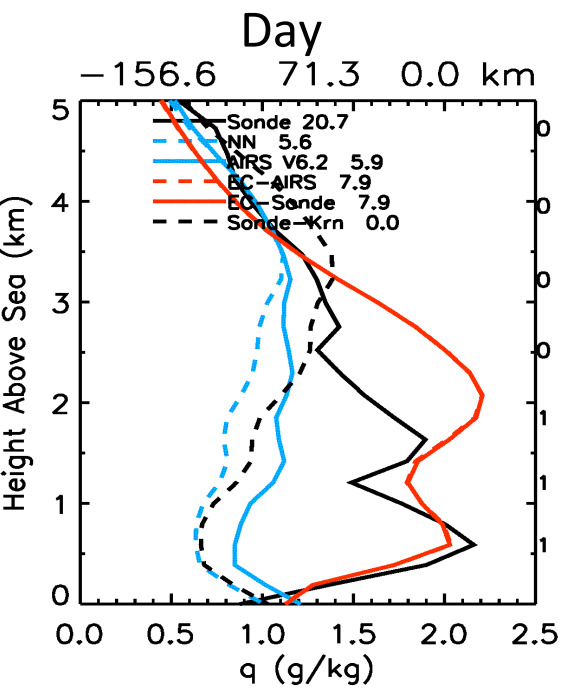


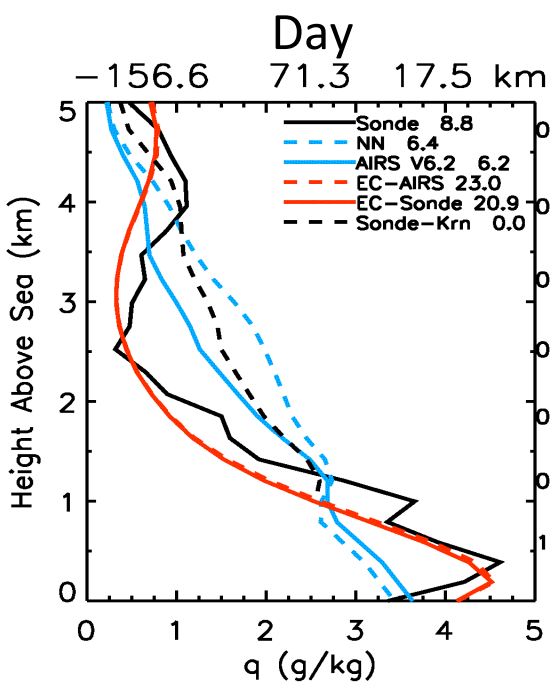
V6 T

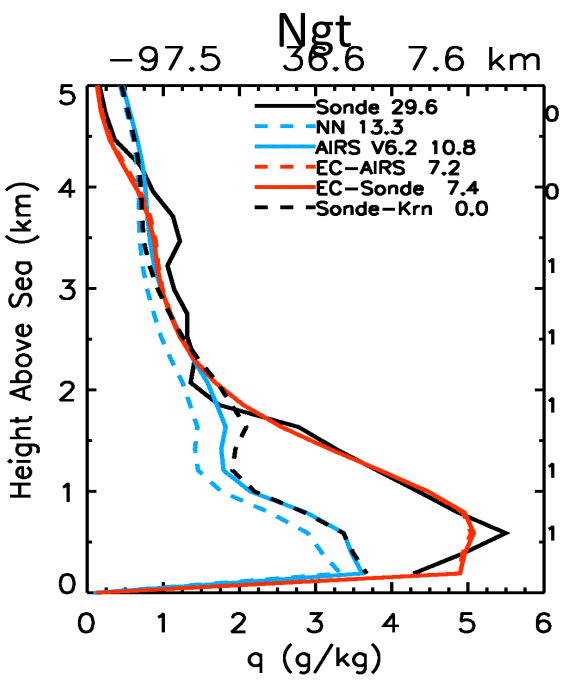


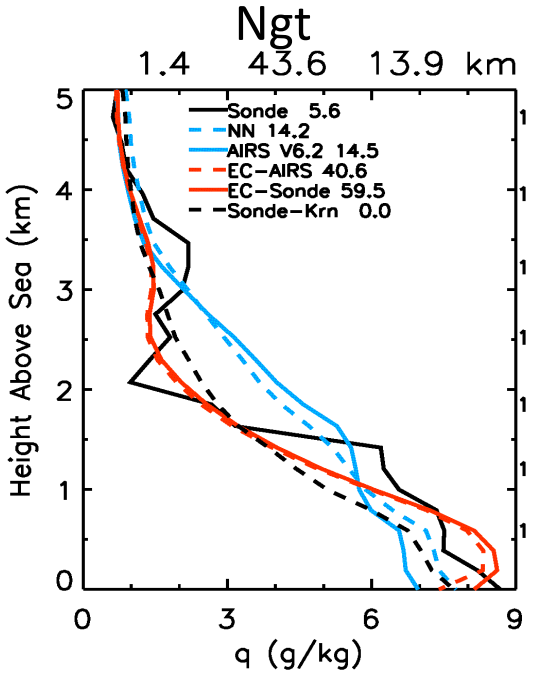
V6 q

Sonde & AIRS & ECMWF, Strength > 5 K/km

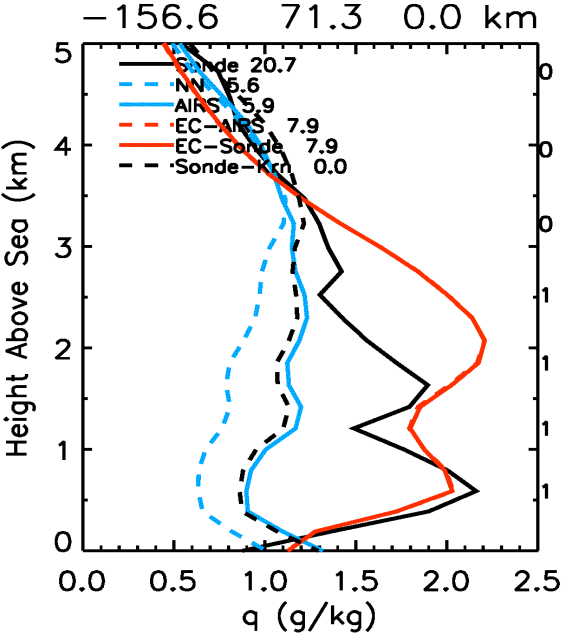


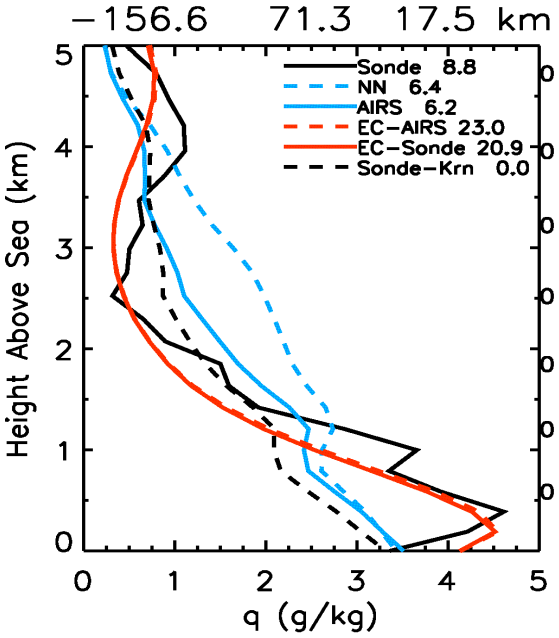


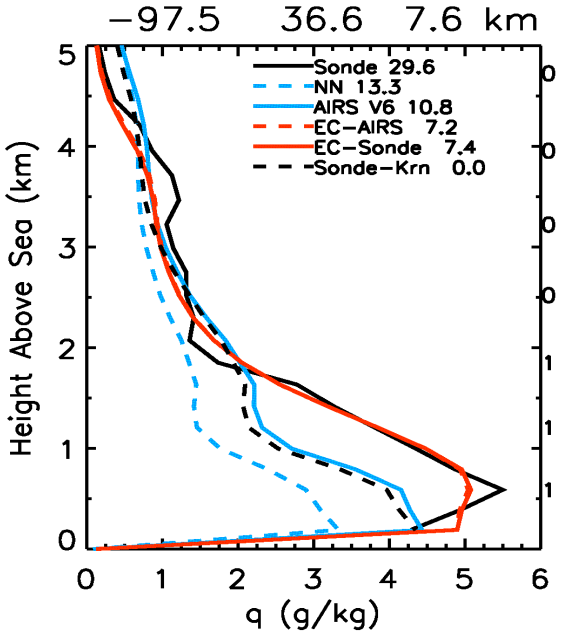


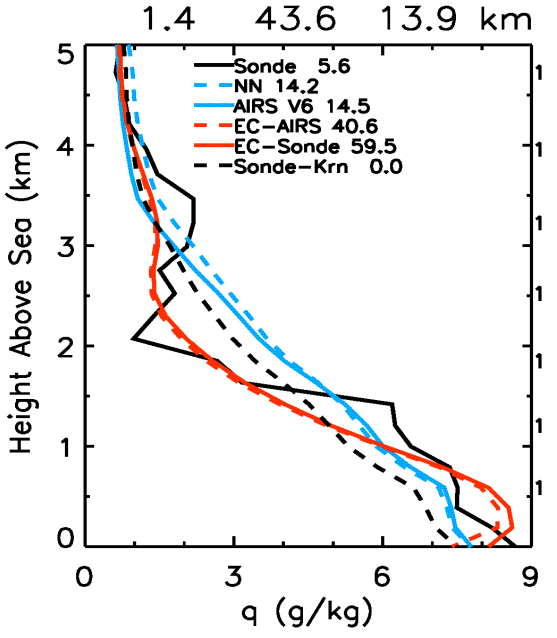


V6.2 q





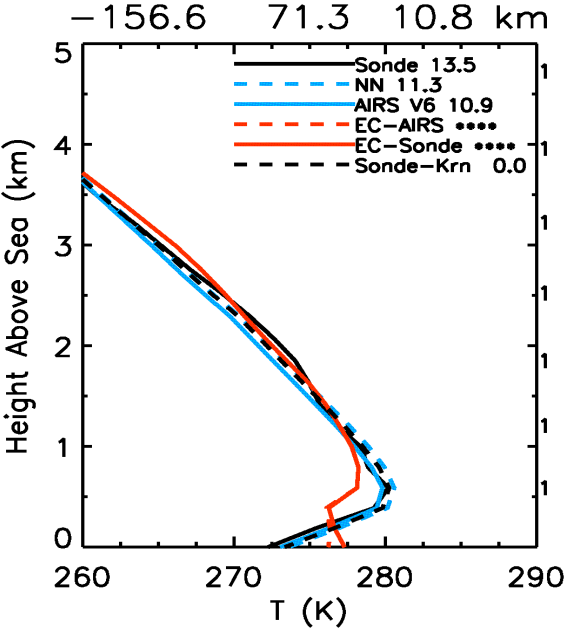




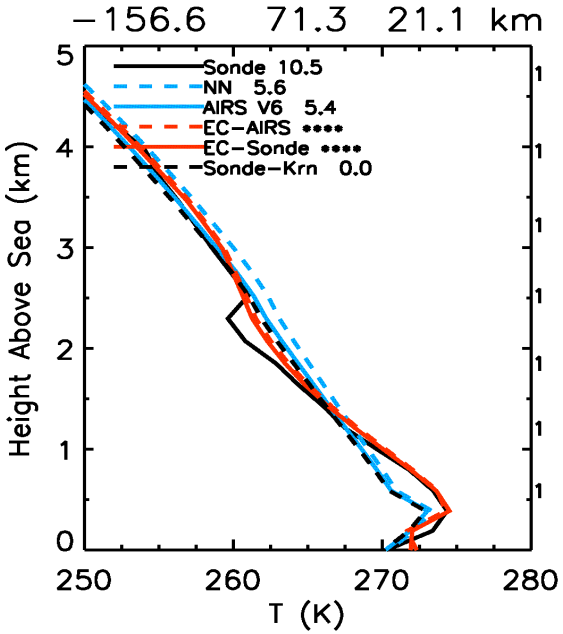
V6 q

Sonde & AIRS, Strength > 5 K/km

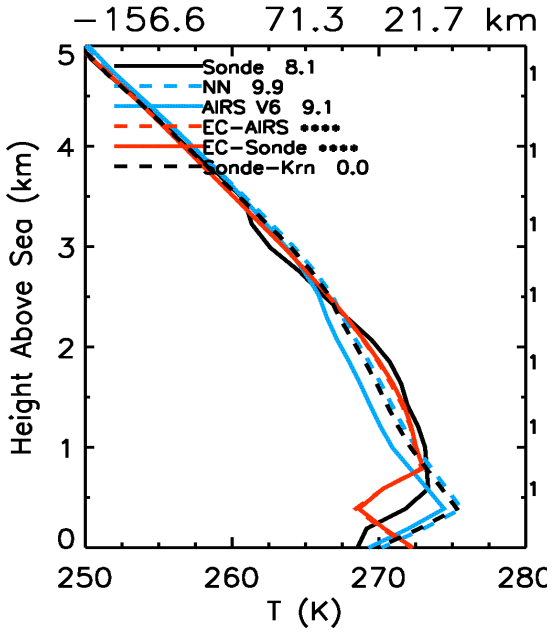
Day



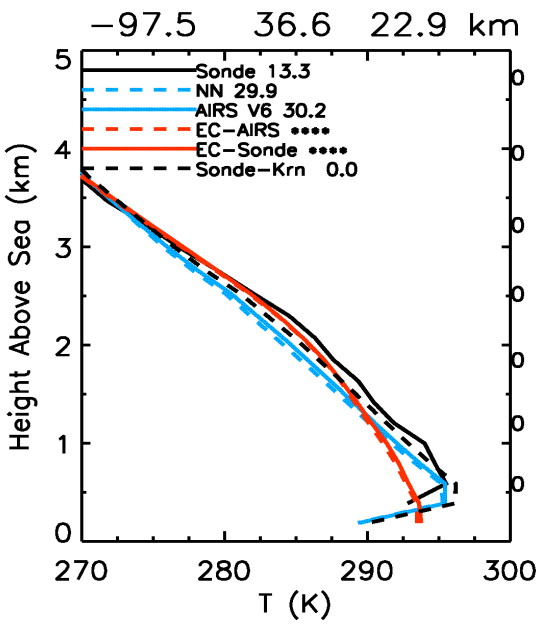
Day



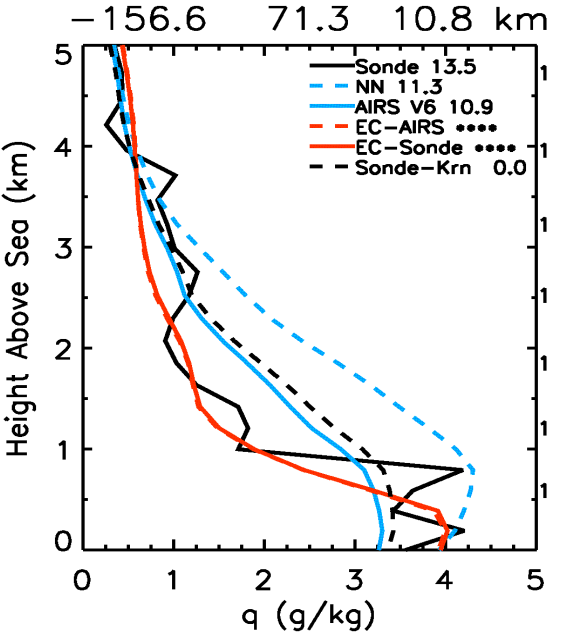
Day

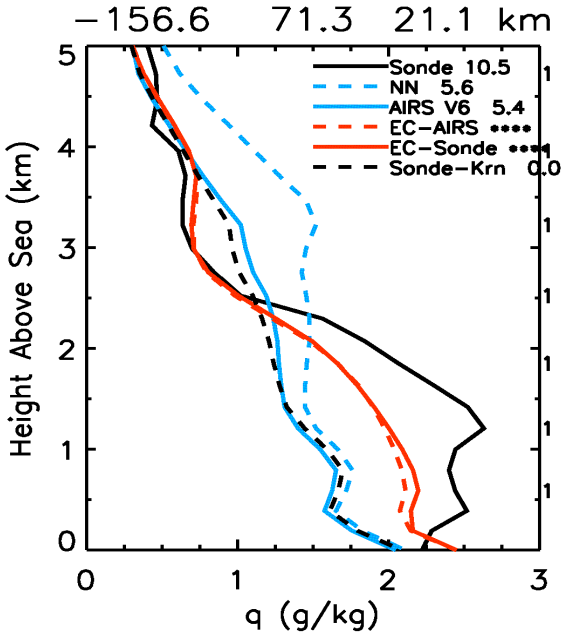


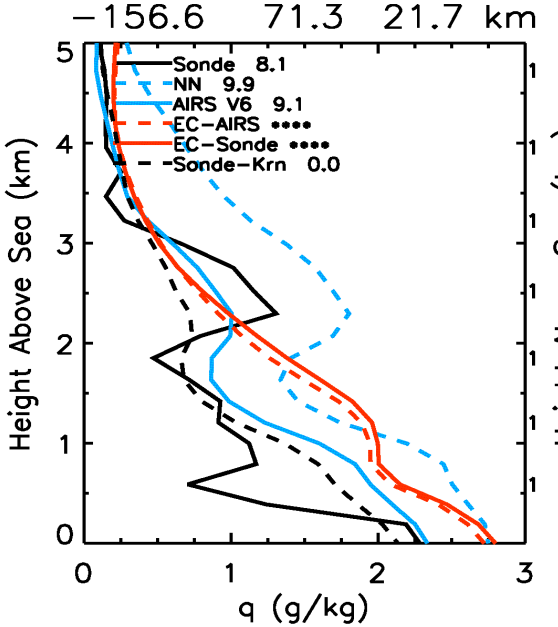
Ngt.

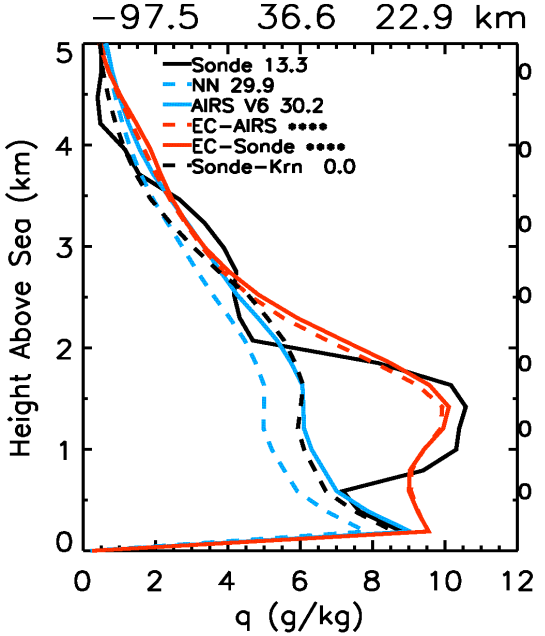


V6 T



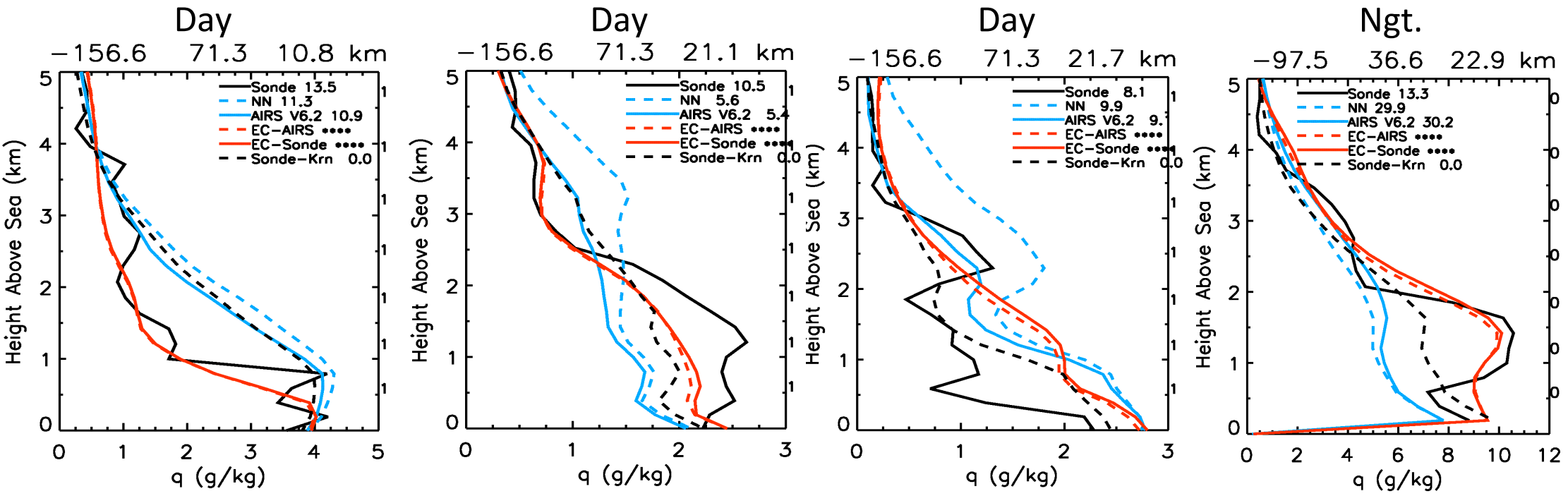




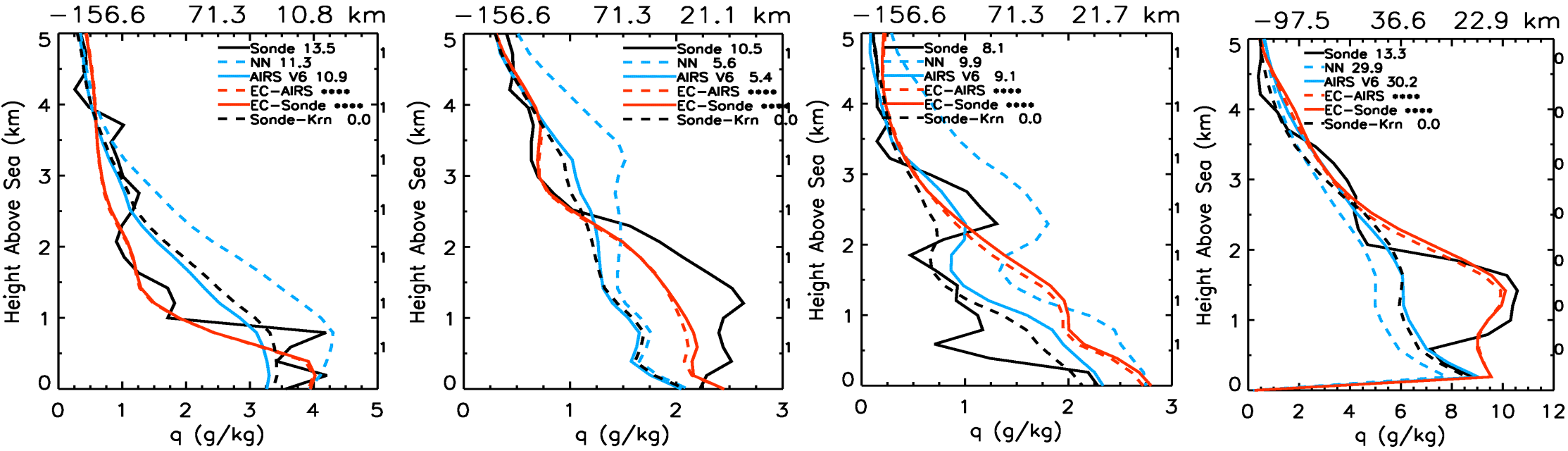


V6 q

Sonde & AIRS, Strength > 5 K/km

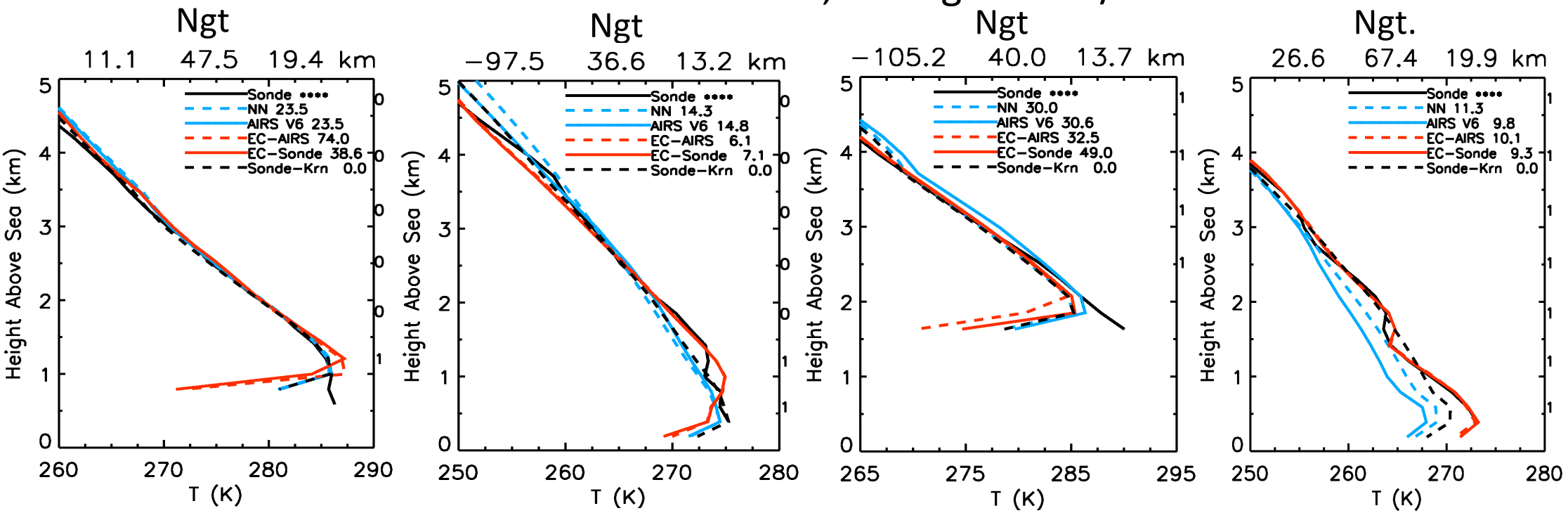


V6.2 q

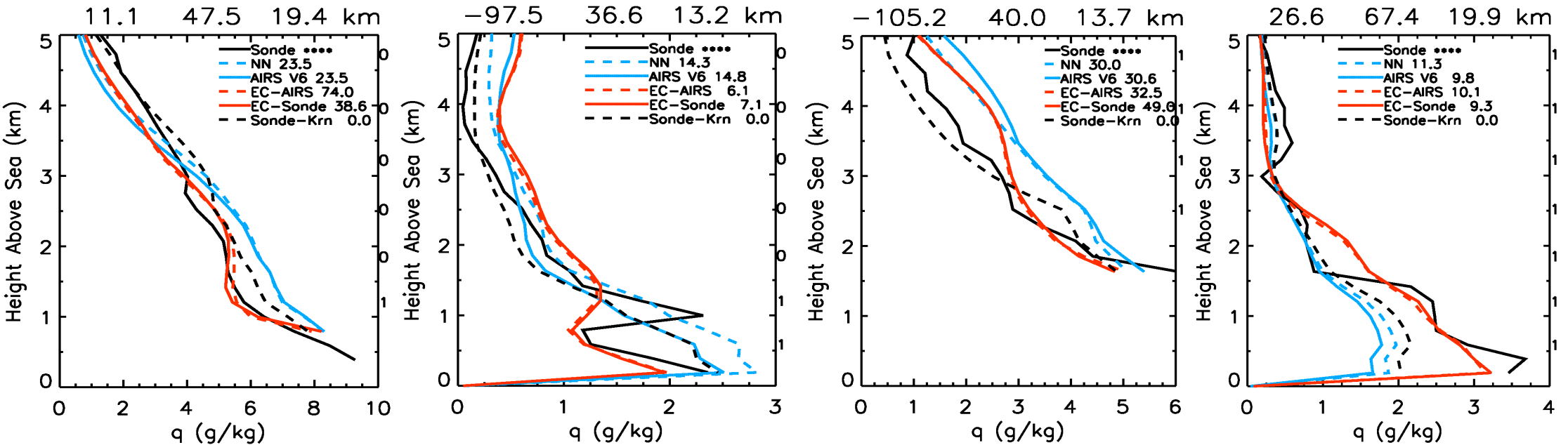


V6 q

AIRS & ECMWF, Strength > 5 K/km

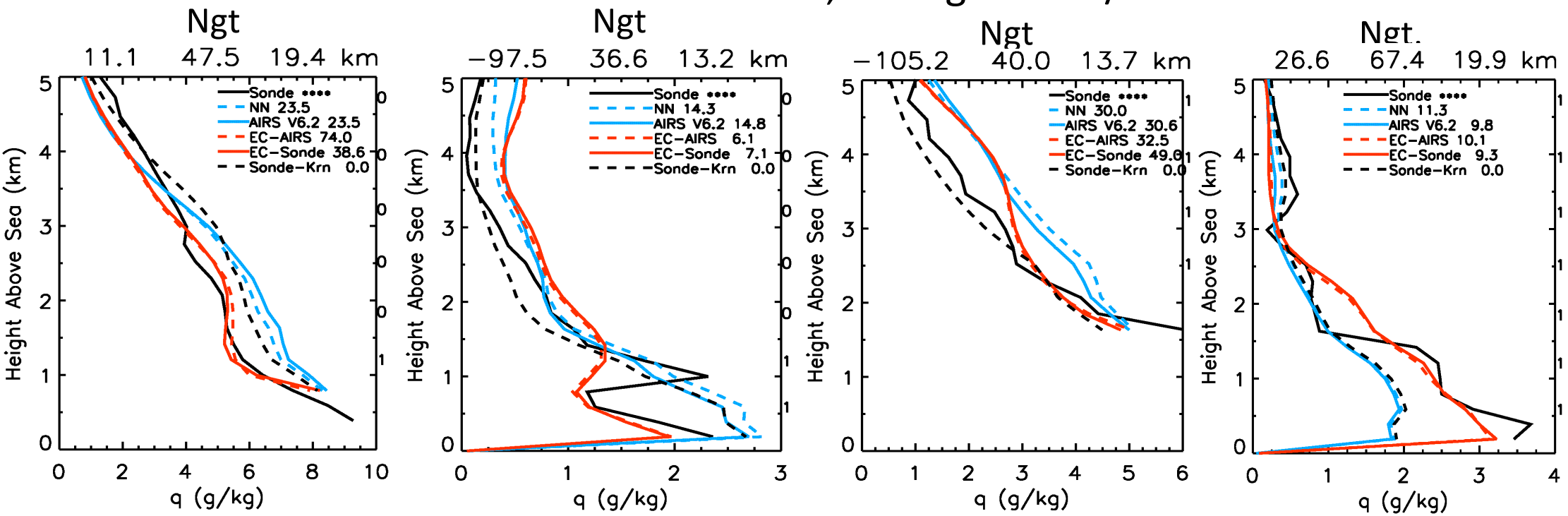


V6 T

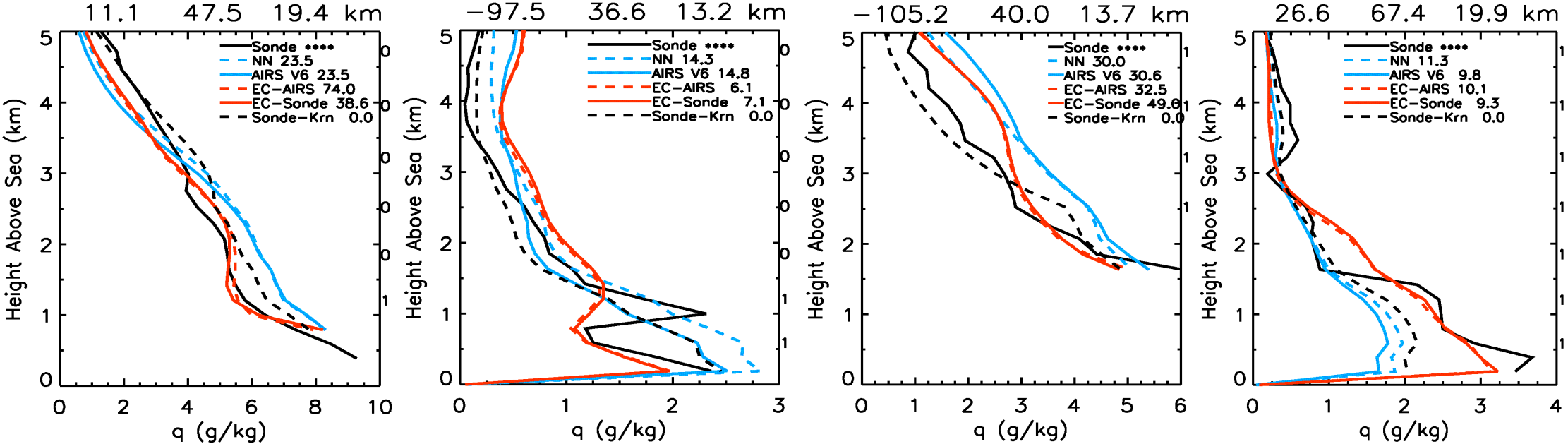


V6 q

AIRS & ECMWF, Strength > 5 K/km



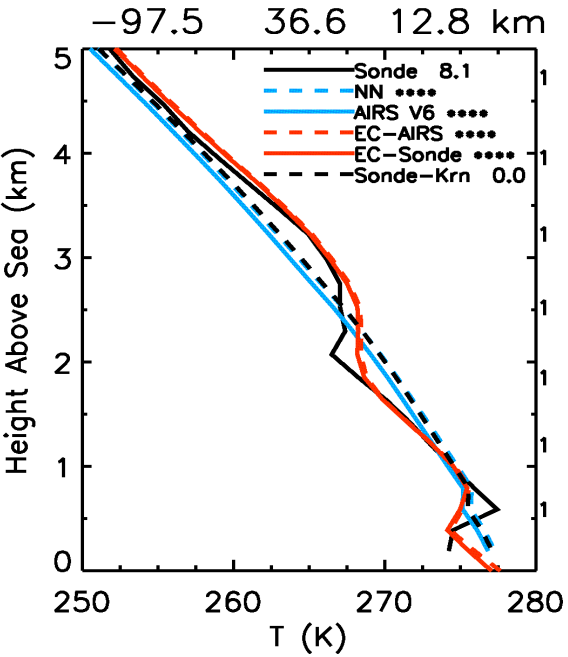
V6.2 q



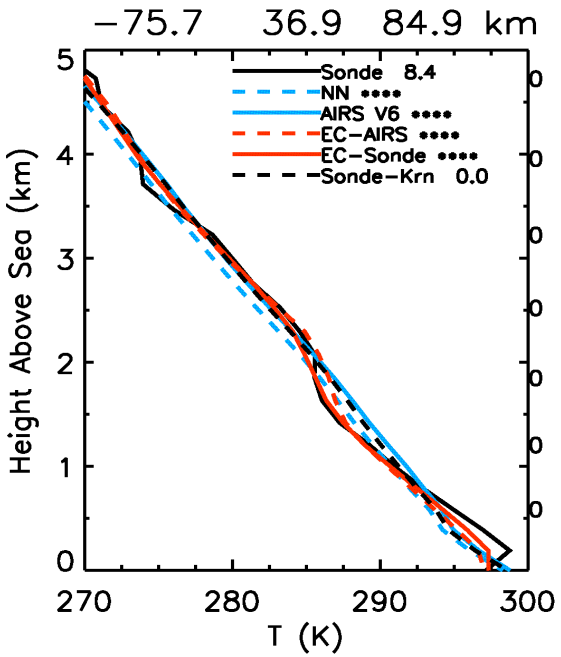
V6 q

Sonde Only, Strength > 5 K/km

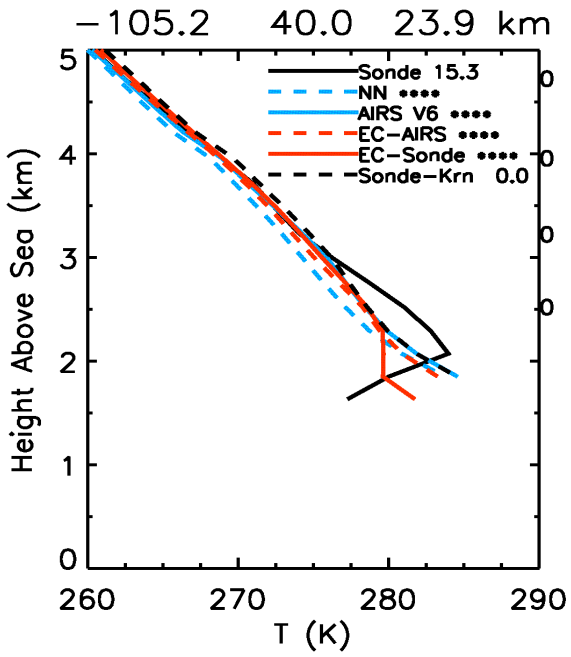
Ngt



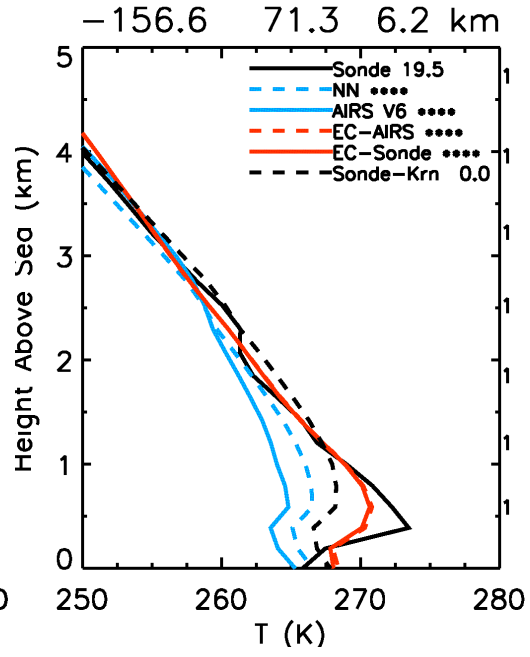
Ngt



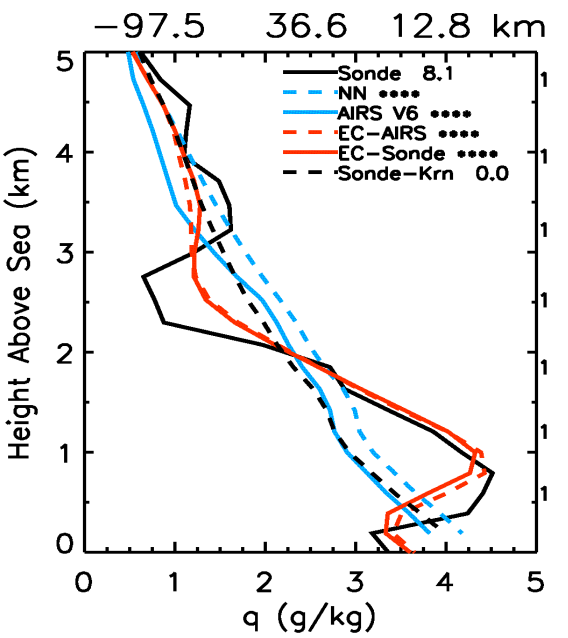
Day

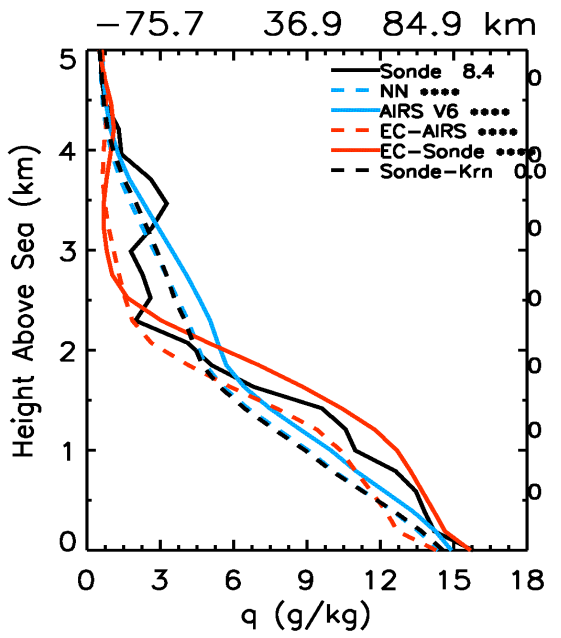


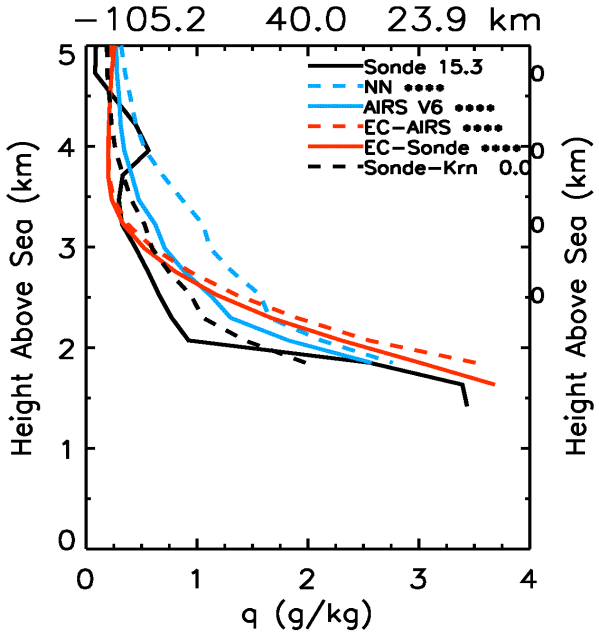
Day

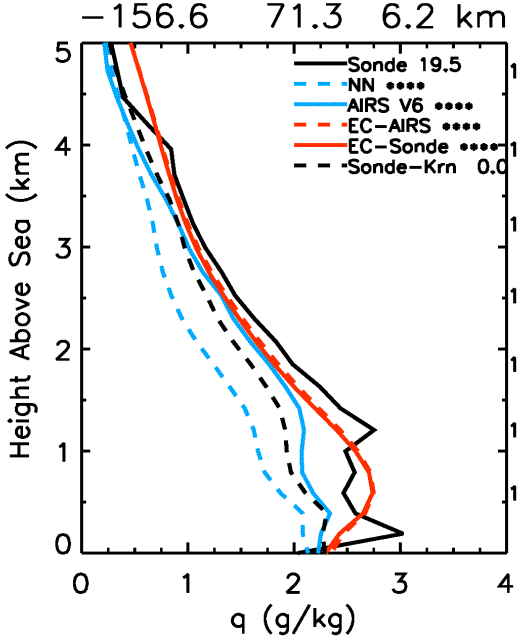


V6 T





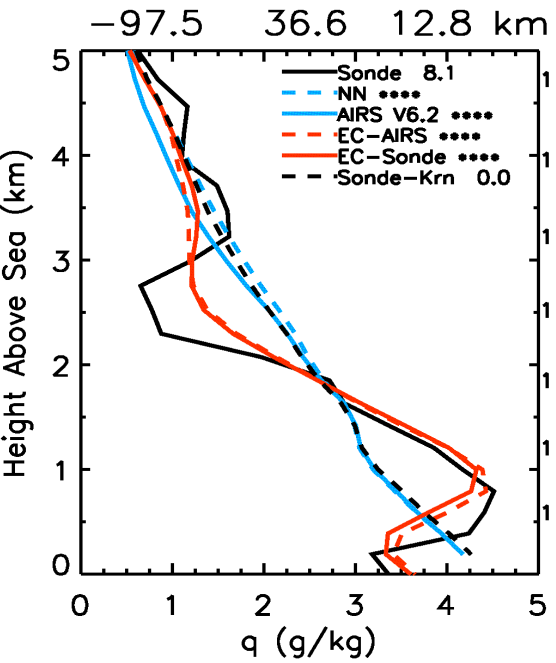




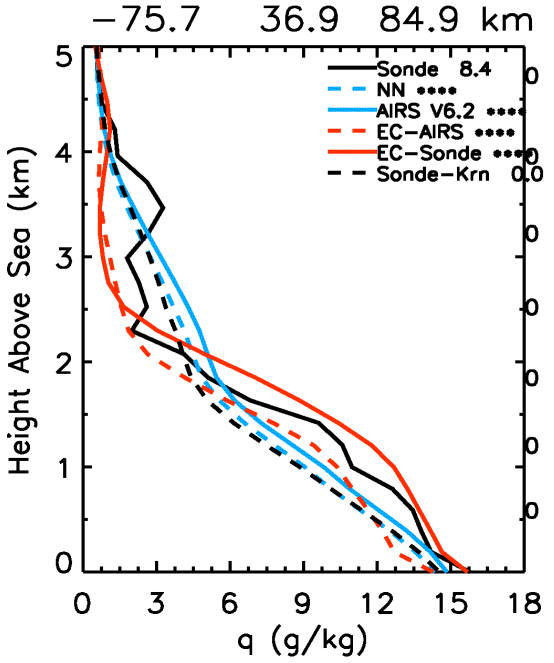
V6 q

Sonde Only, Strength > 5 K/km

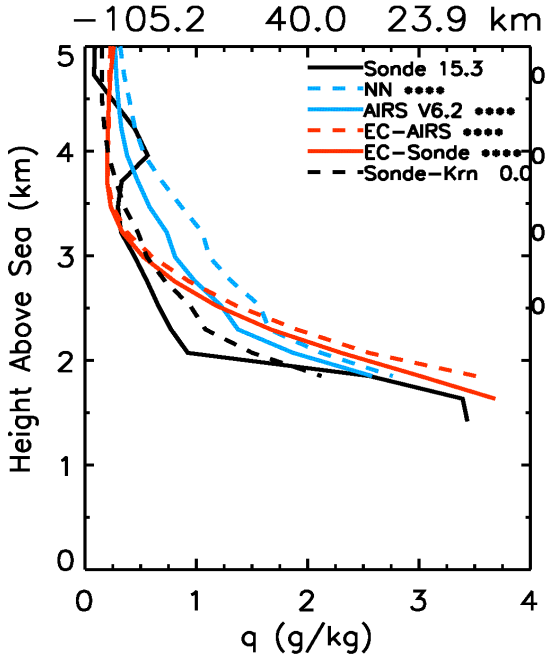
Ngt



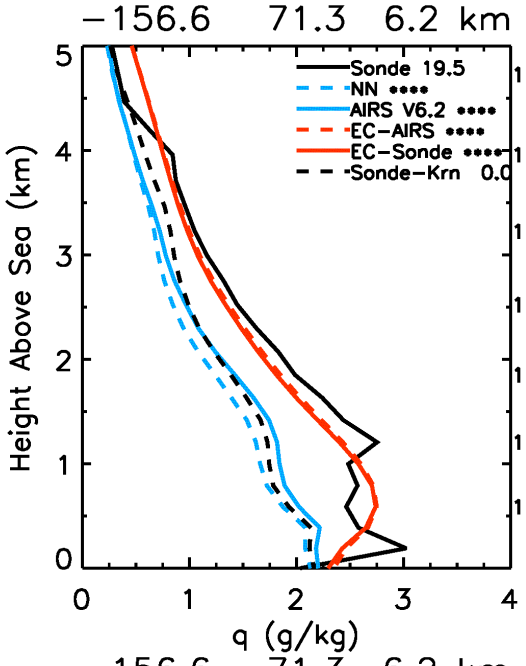
Ngt



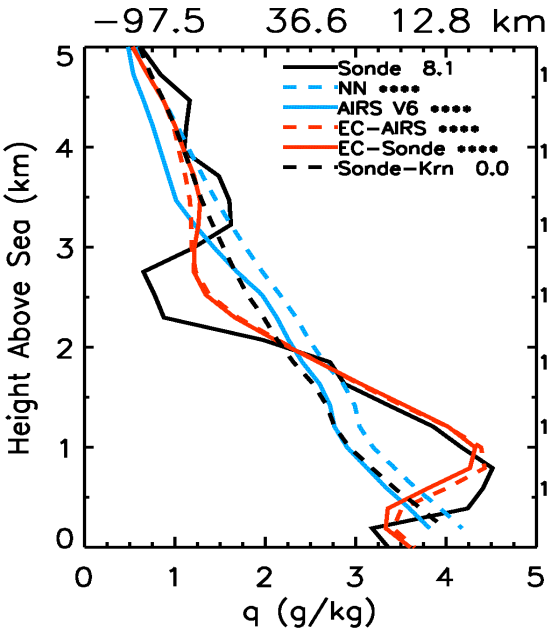
Day

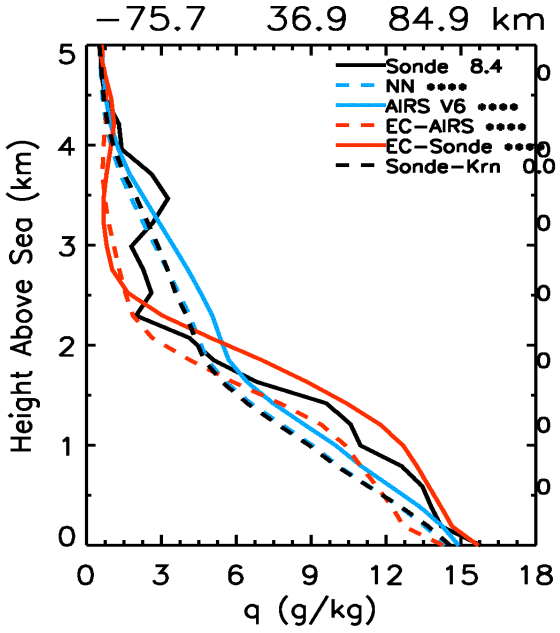


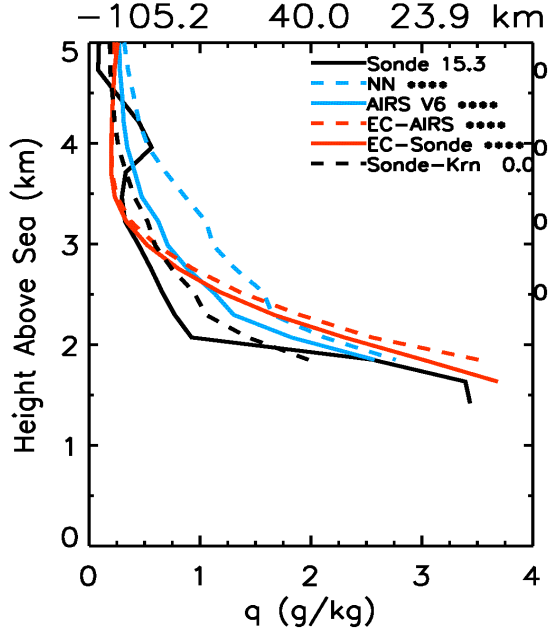
Day

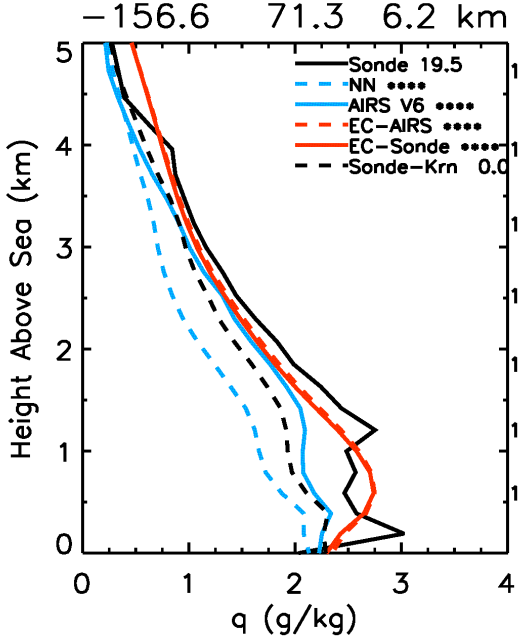


V6.2 q









V6 q

Conclusion:

- AIRS V6.2 reduces the daytime dry biases in the lower troposphere, with positive biases with smaller amplitudes

- For strong T inversion (strength > 5K/km), AIRS and NN simultaneously see inversion or not. Inversion is captured by NN in the initial condition

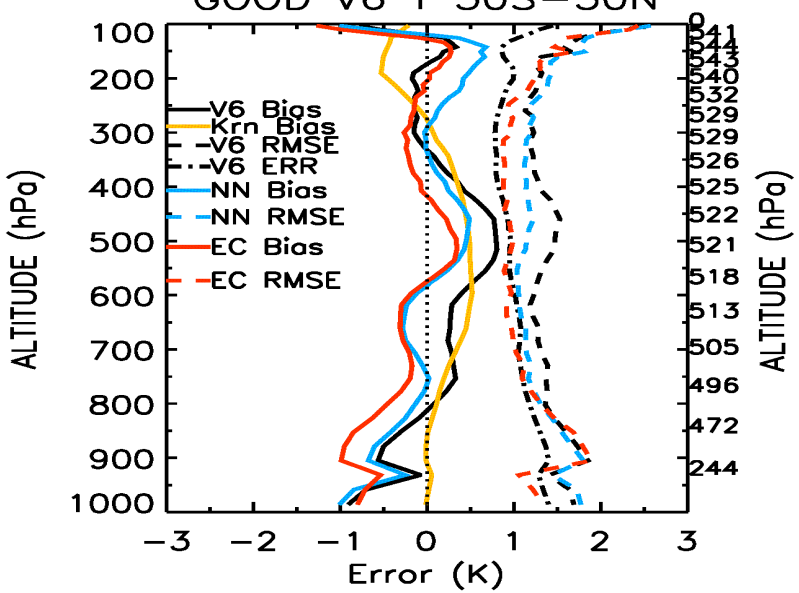
- When strong T inversion, both ECMWF and AIRS tend to capture the q variability in the lower troposphere. In many cases, ECMWF has a better skill (scarily!!!)

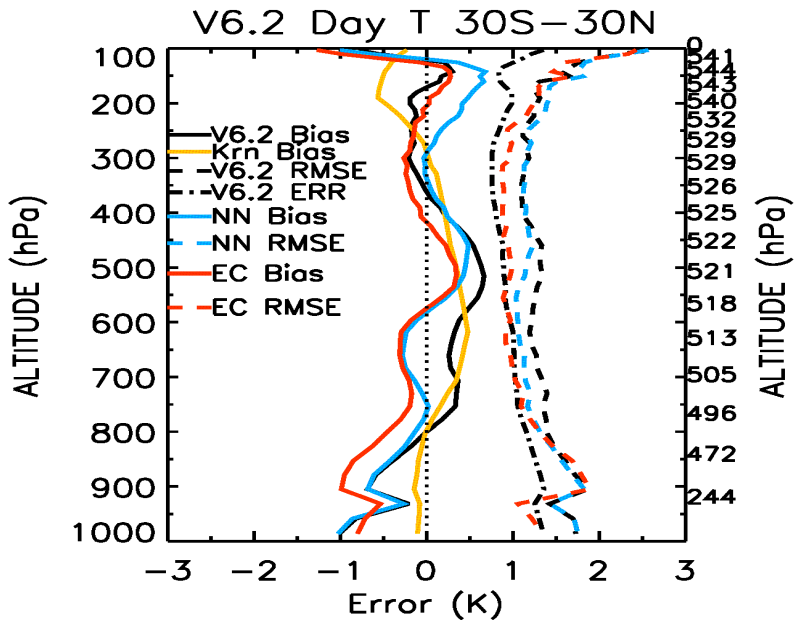
- Averaging kernels have changed, indicating information for retrievals is altered

- In quite an amount of these cases, V6.2 q are farther away from the sonde profiles in the lower troposphere than V6 q

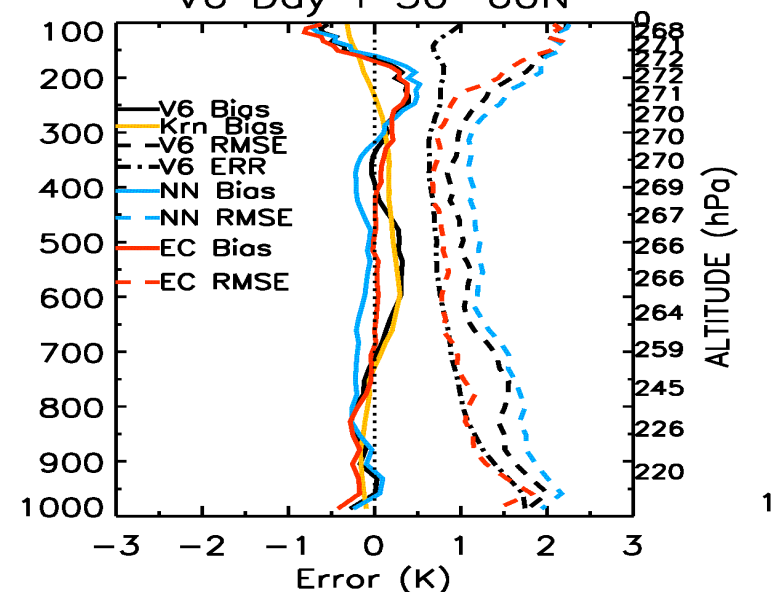
Good Daytime T Biases and RMSE

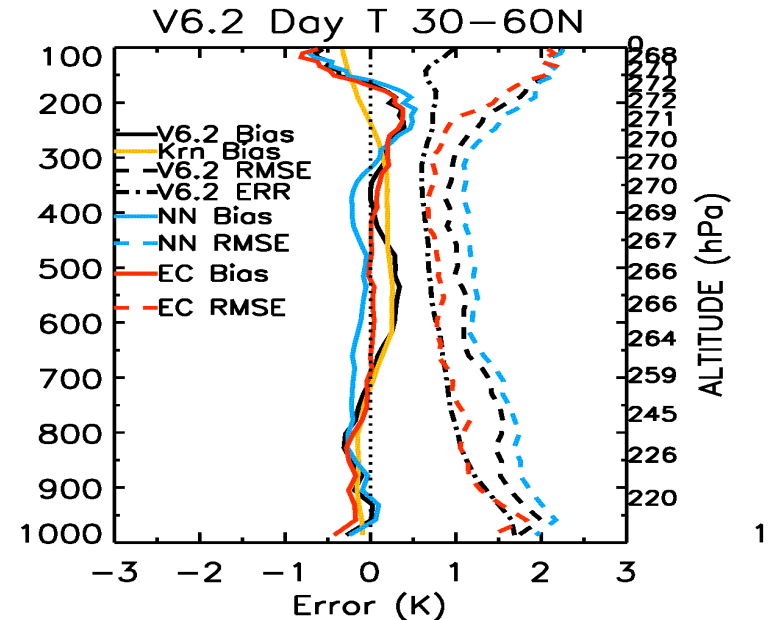
30S-30N



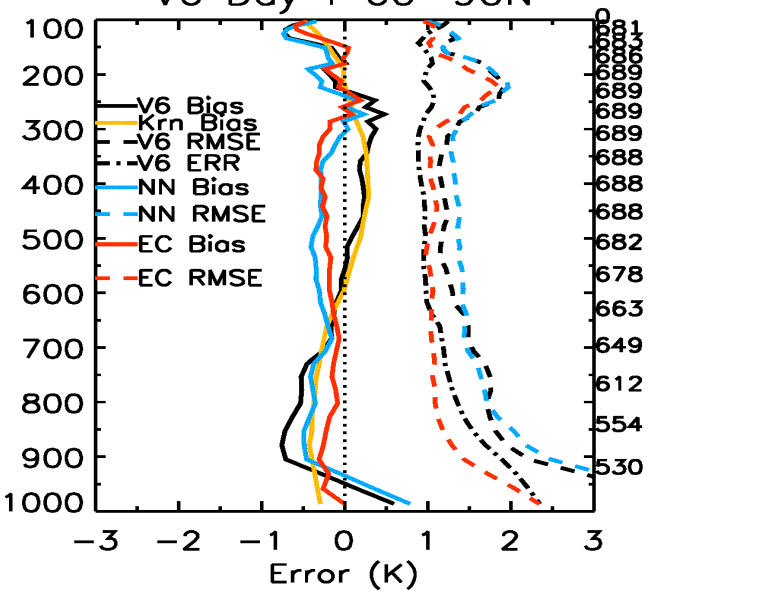


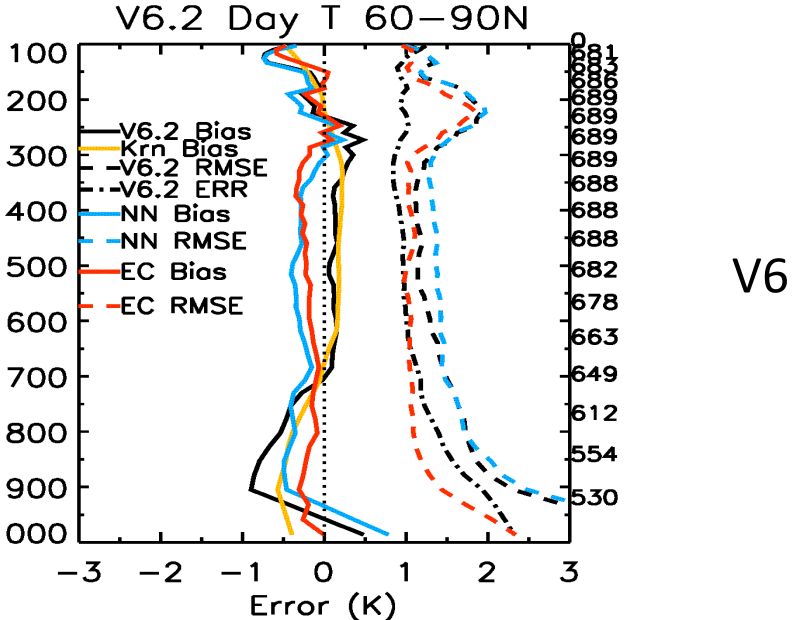
30-60N





60-90N



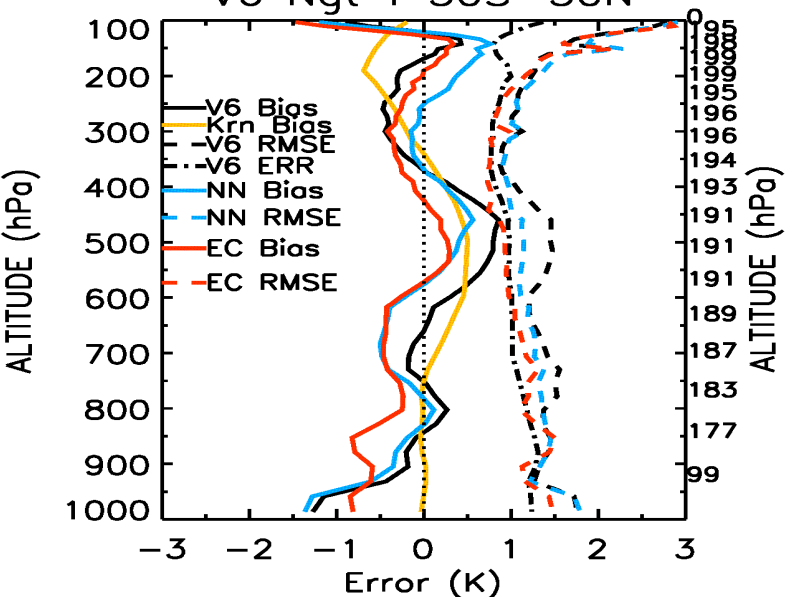


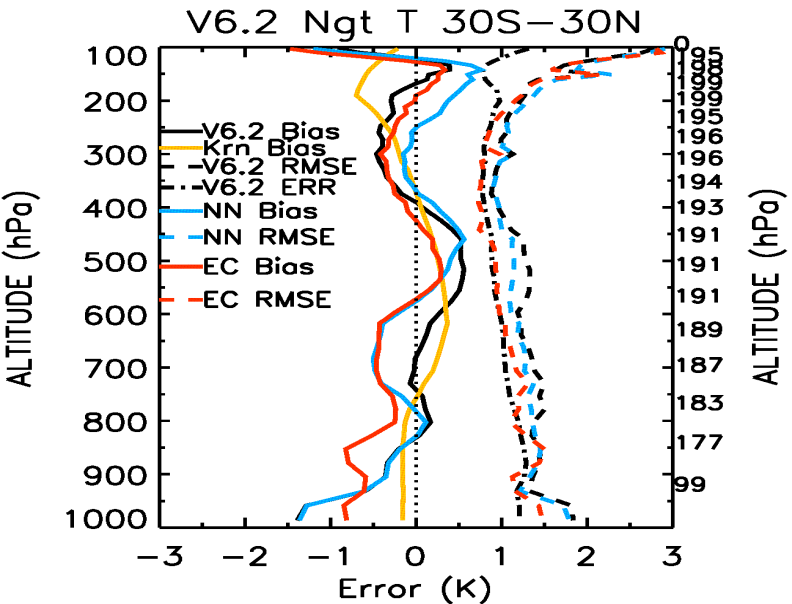
V6

V6.2

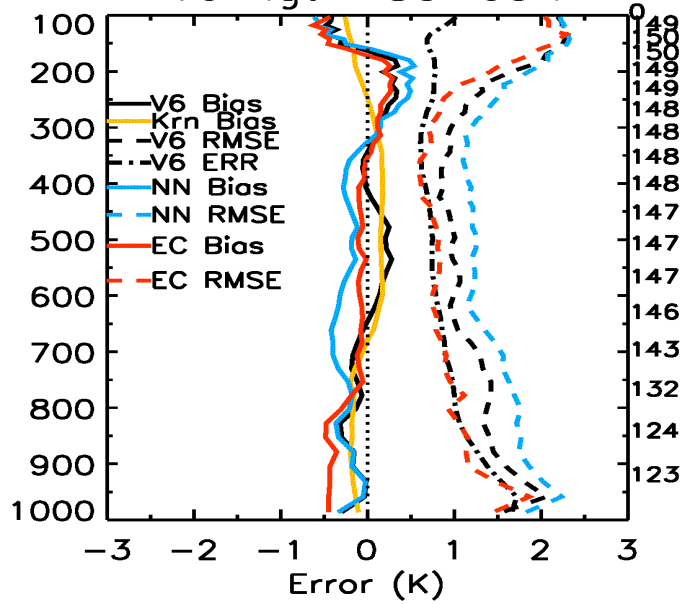
Good Nightime T Biases and RMSE

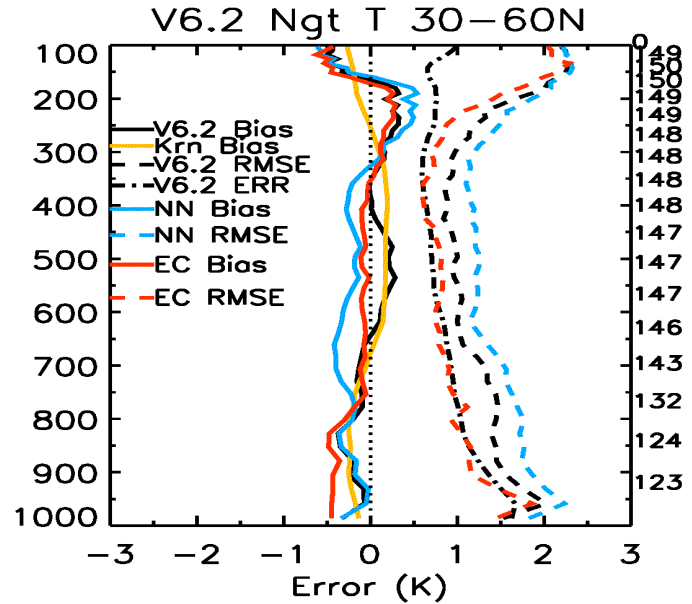
30S-30N



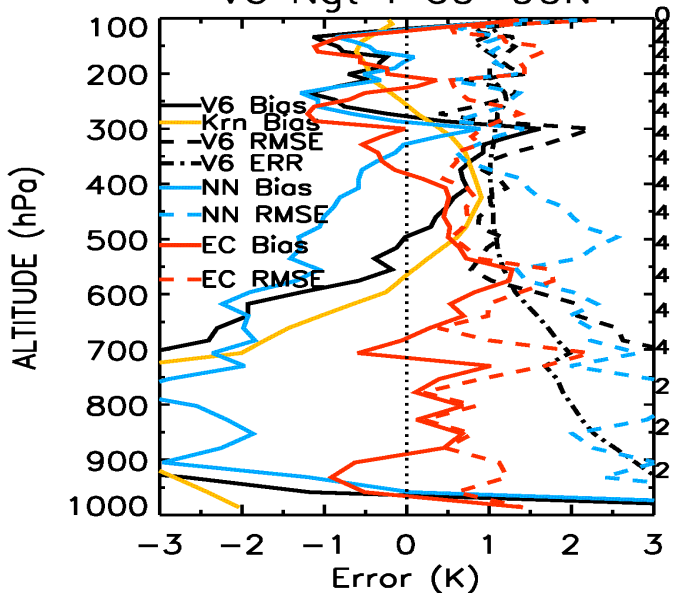


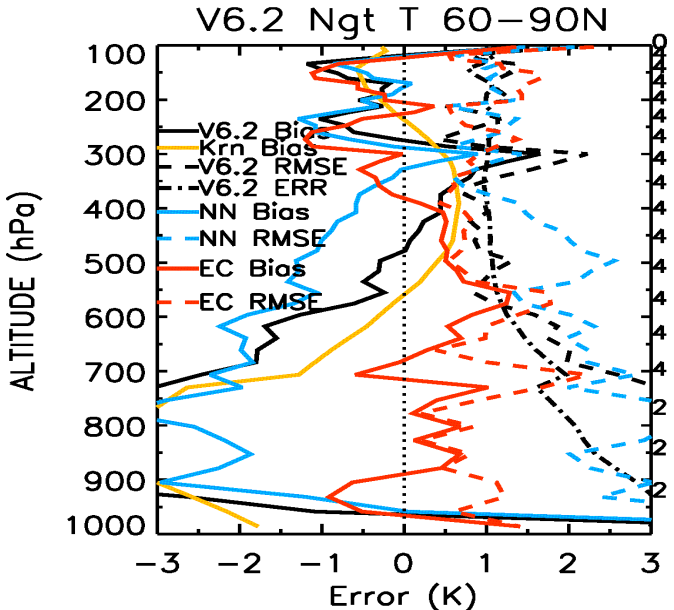
30-60N





60-90N



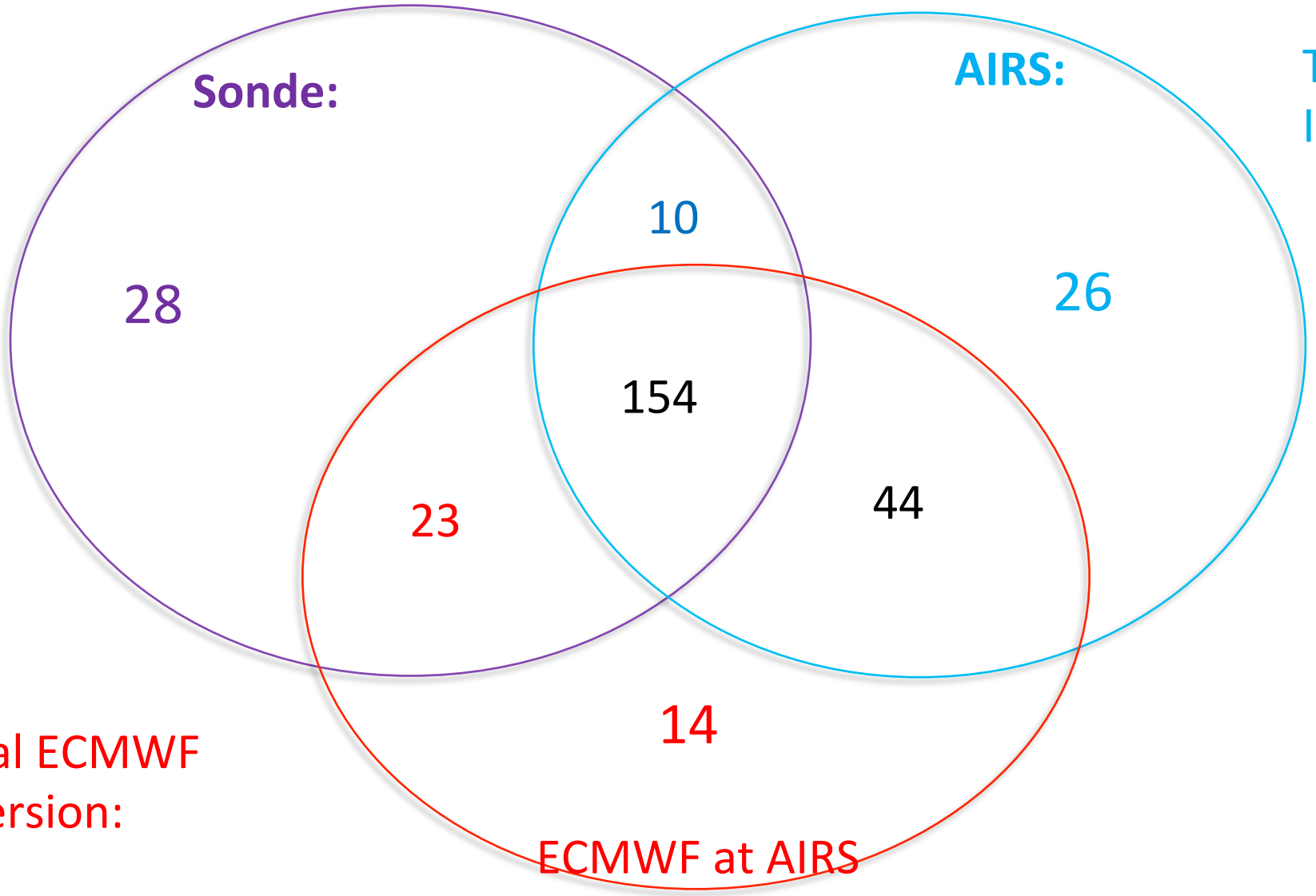


V6

V6.2

Total Sonde-AIRS V6.2 Match Ups: 1916
Strength ≥ 5 K/km

Total Sonde Inversion: 215

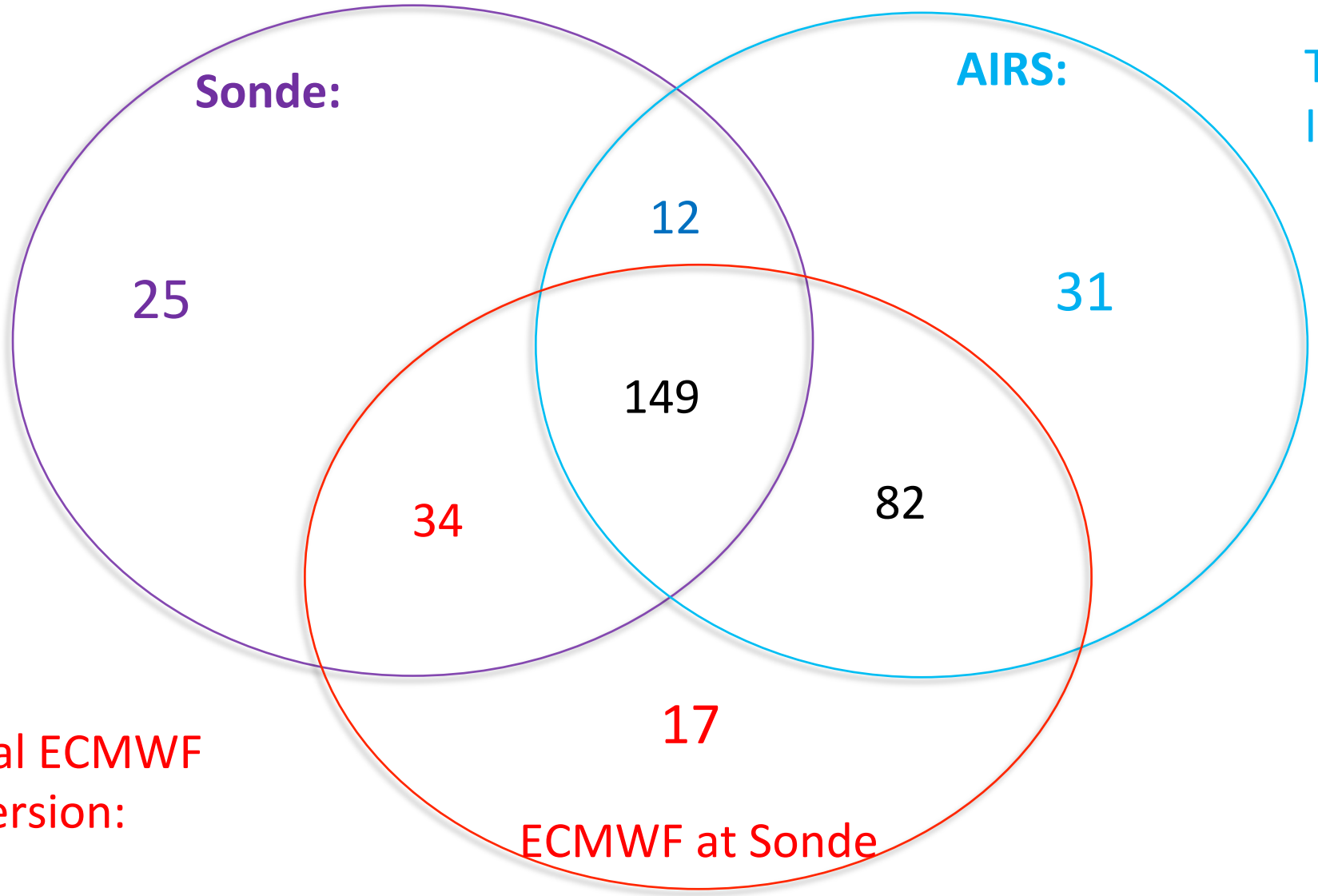


Total AIRS Inversion: 273

Total ECMWF Inversion: 273

Total Sonde-AIRS V6 Match Ups: 1916
Strength ≥ 5 K/km

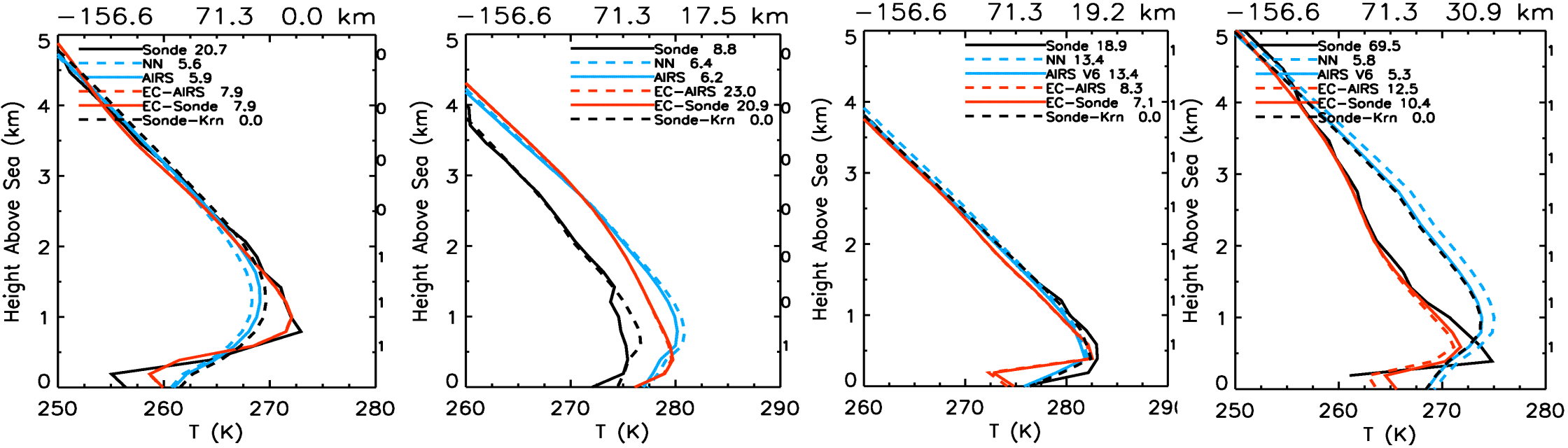
Total Sonde Inversion: 220



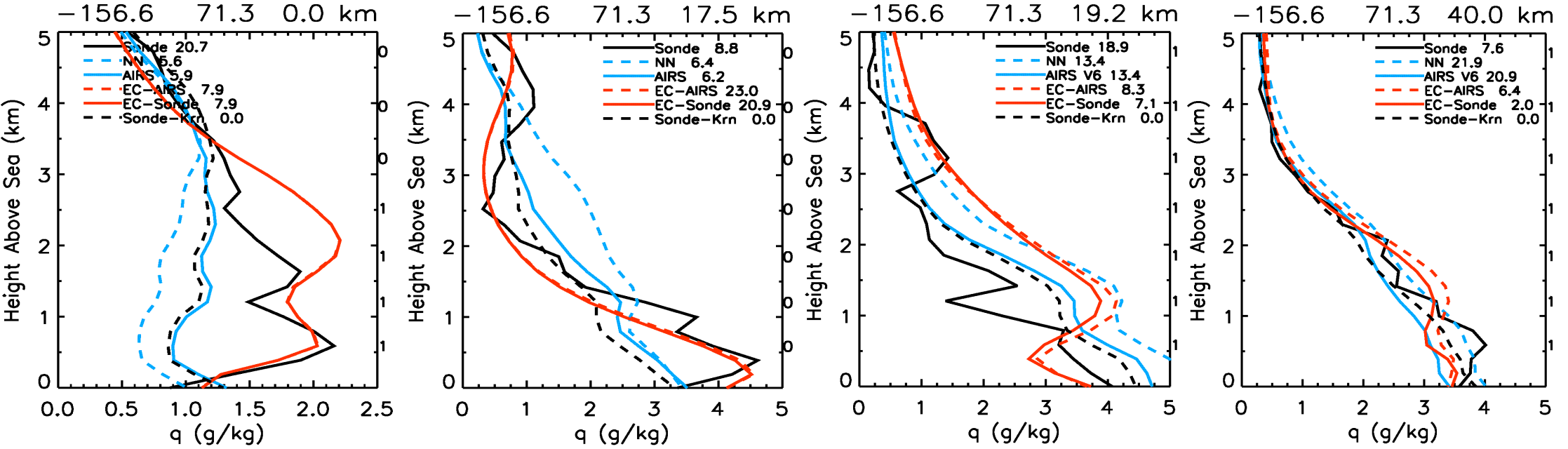
Total AIRS Inversion: 274

Total ECMWF Inversion: 283

Daytime Sonde & AIRS & ECMWF, Strength > 5 K/km

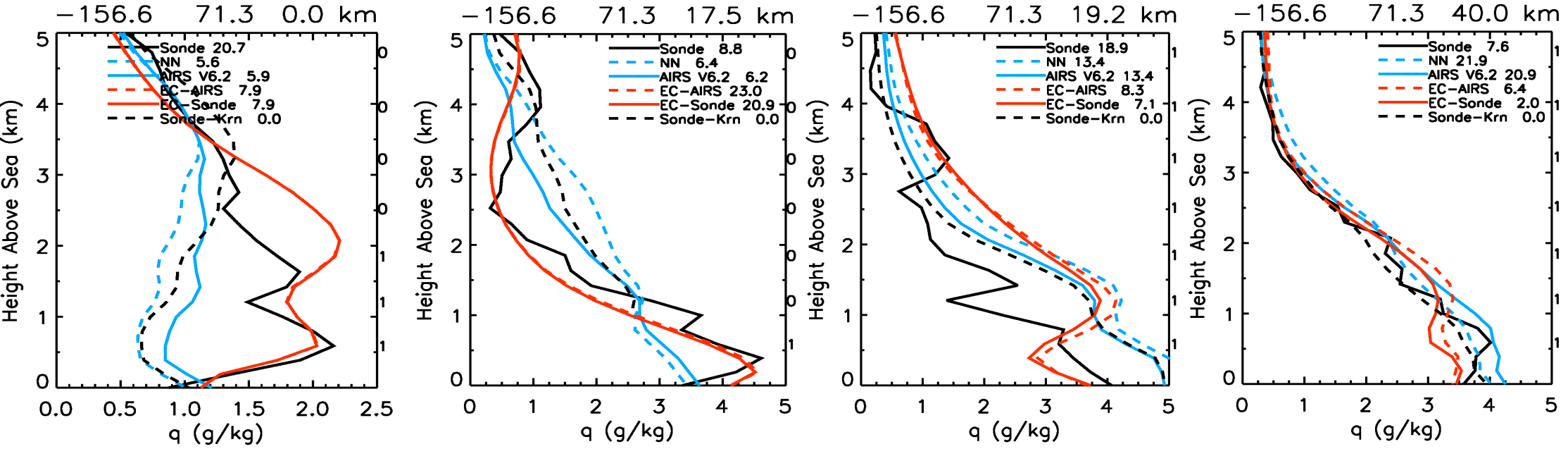


V6 T

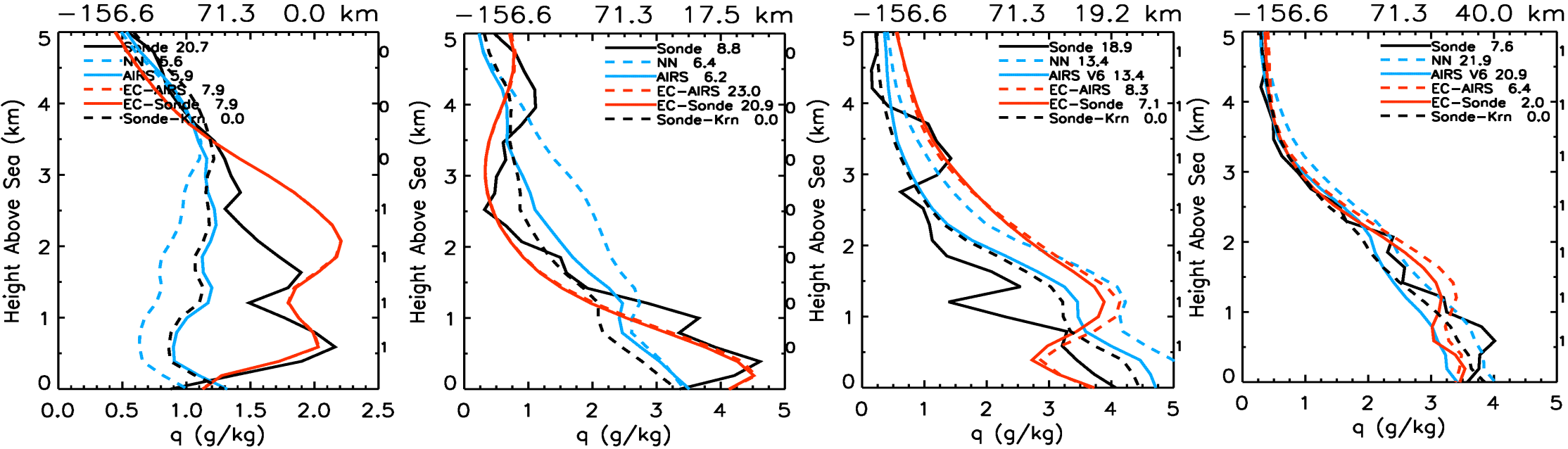


V6 q

Daytime Sonde & AIRS & ECMWF, Strength > 5 K/km

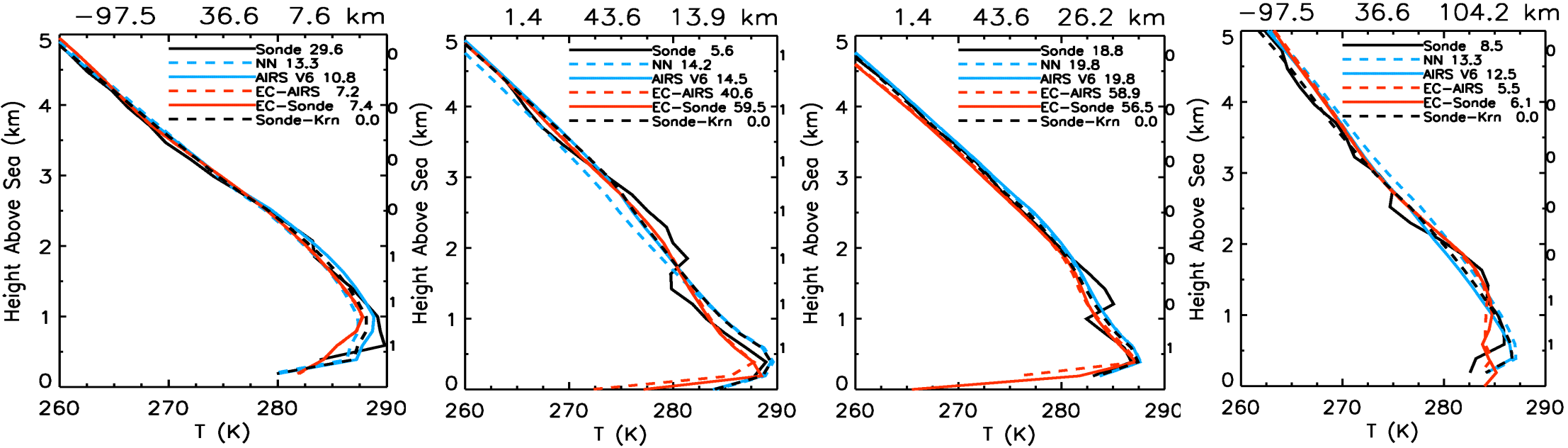


V6.2 q

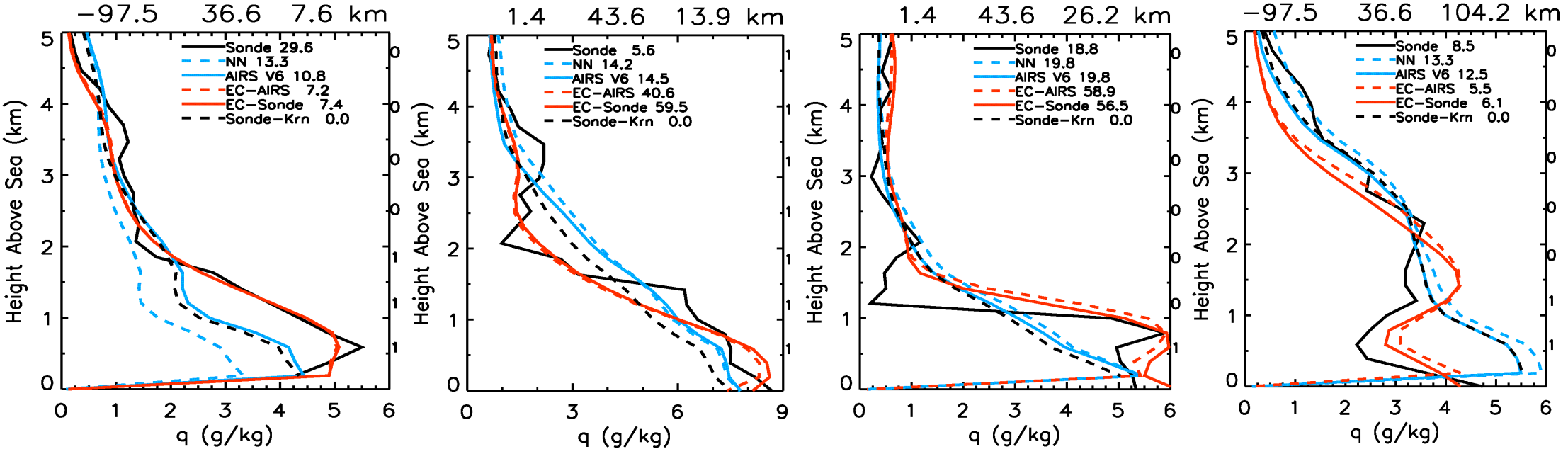


V6 q

Nightime Sonde & AIRS & ECMWF, Strength > 5 K/km

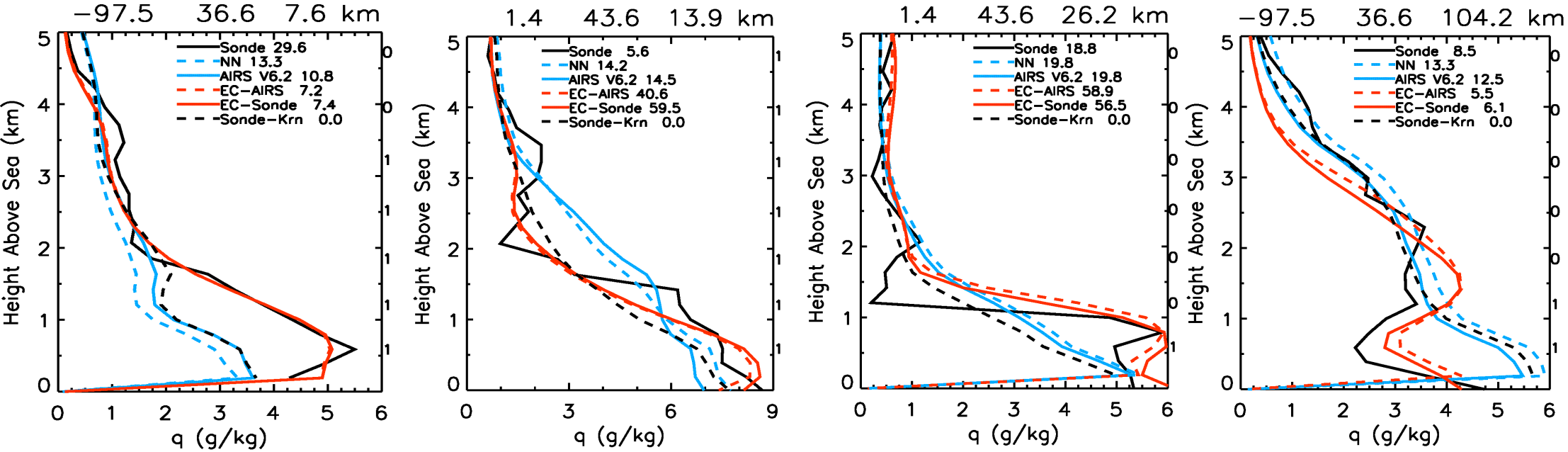


V6 T

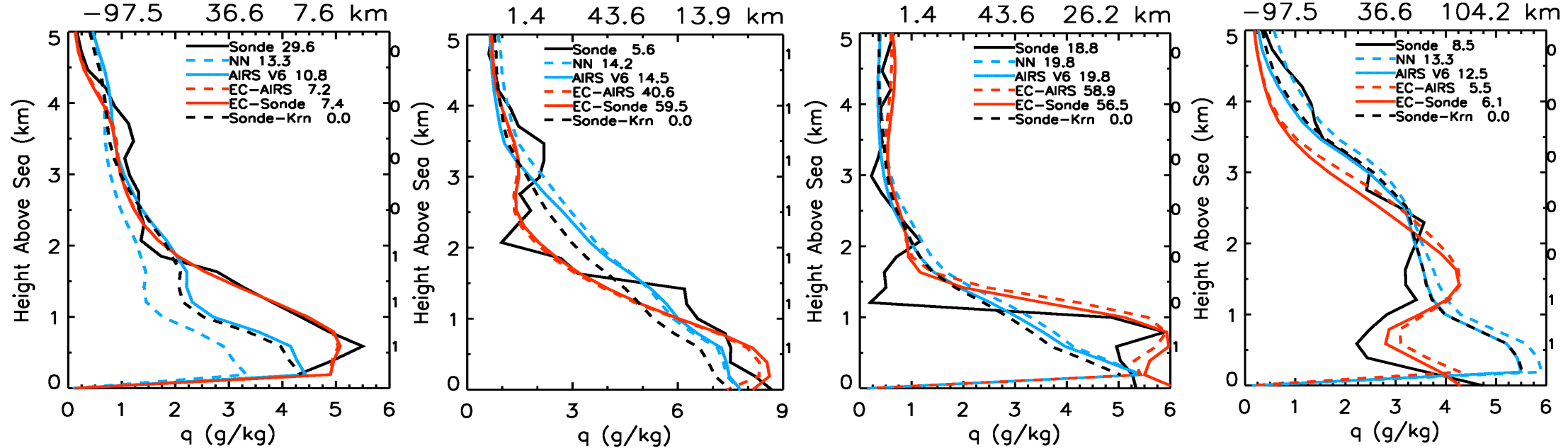


V6 q

Nightime Sonde & AIRS & ECMWF, Strength > 5 K/km



V6.2 q



V6 q