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

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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)

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

30S-30N

V6

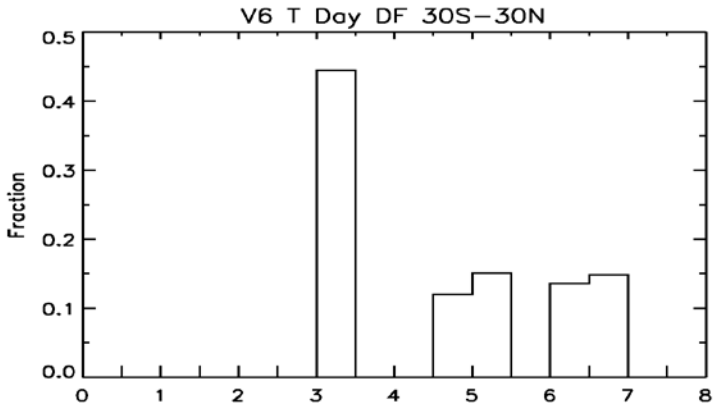
V6.2

V6.22

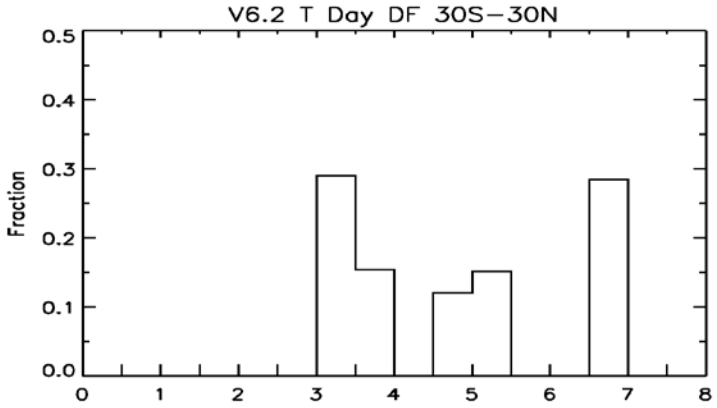
Good Daytime 30S-30N Degree of Freedom and Verticality

30S-30N

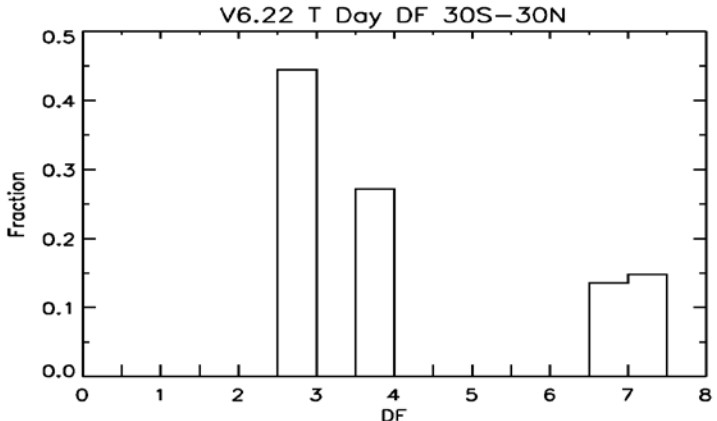
Degree of Freedom



V6



V6.2



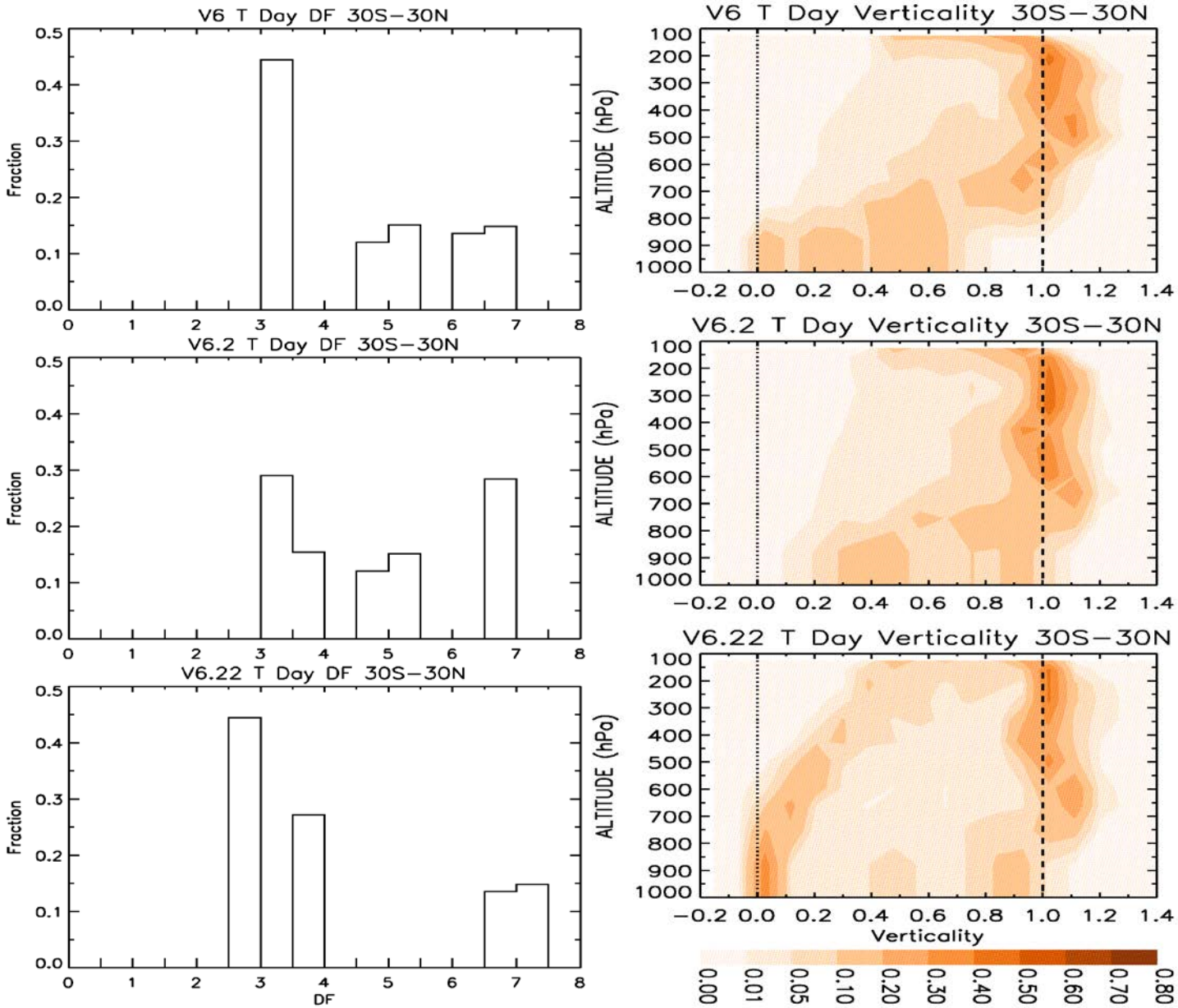
V6.22

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

30S-30N

Degree of Freedom

Verticality



V6

V6.2

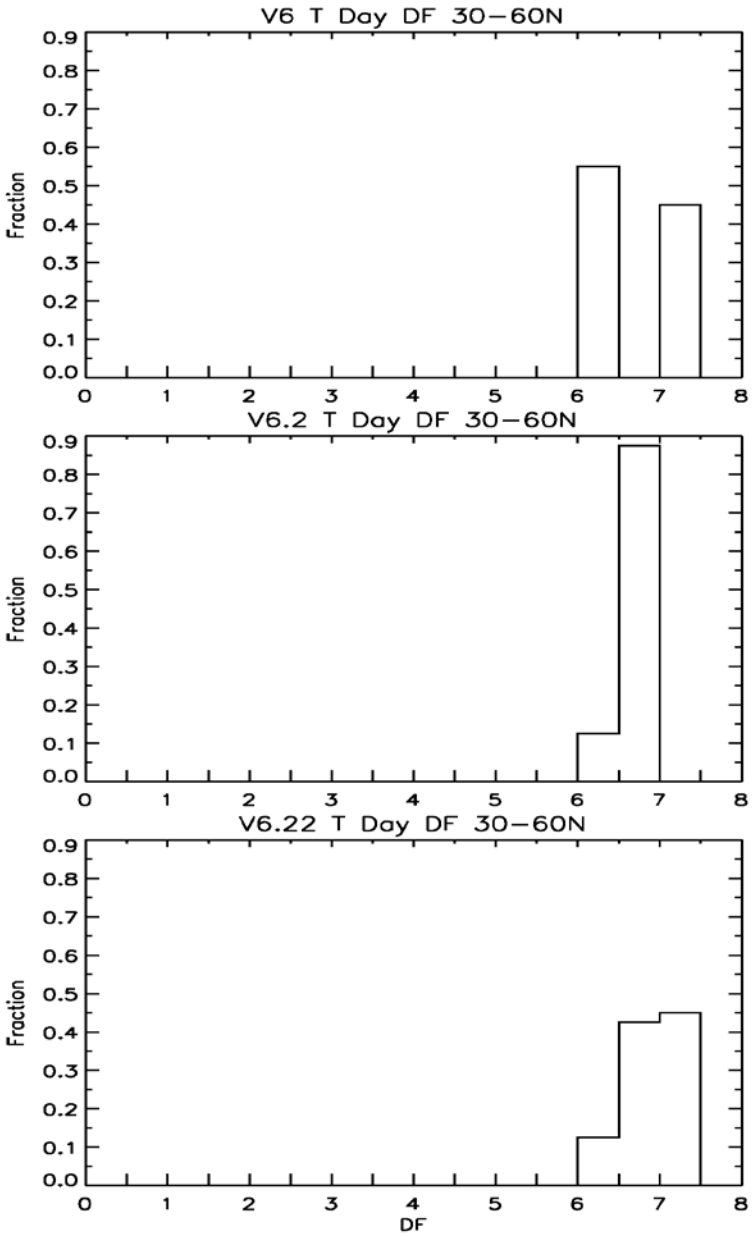
V6.22

Good Daytime 30-60N Degree of Freedom and Verticality

30-60N

Degree of Freedom

Verticality



V6

V6.2

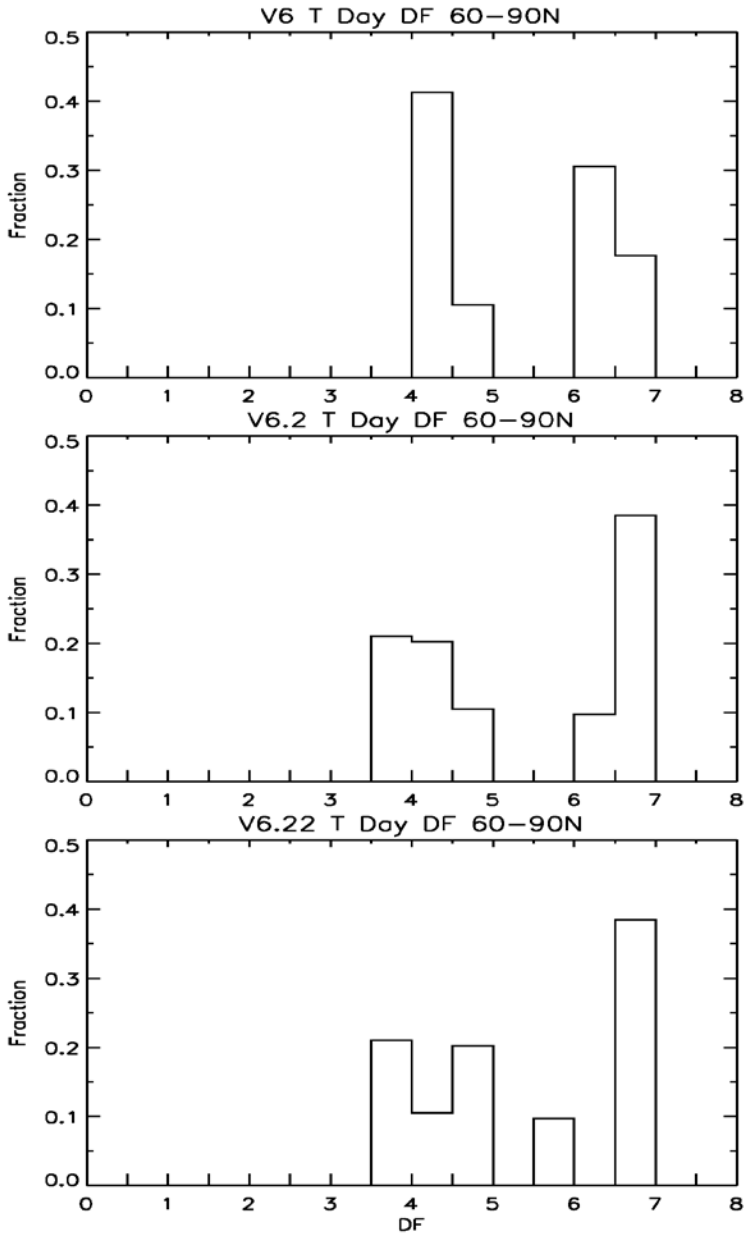
V6.22

Good Daytime 60-90N Degree of Freedom and Verticality

30-60N

Degree of Freedom

Verticality



V6

V6.2

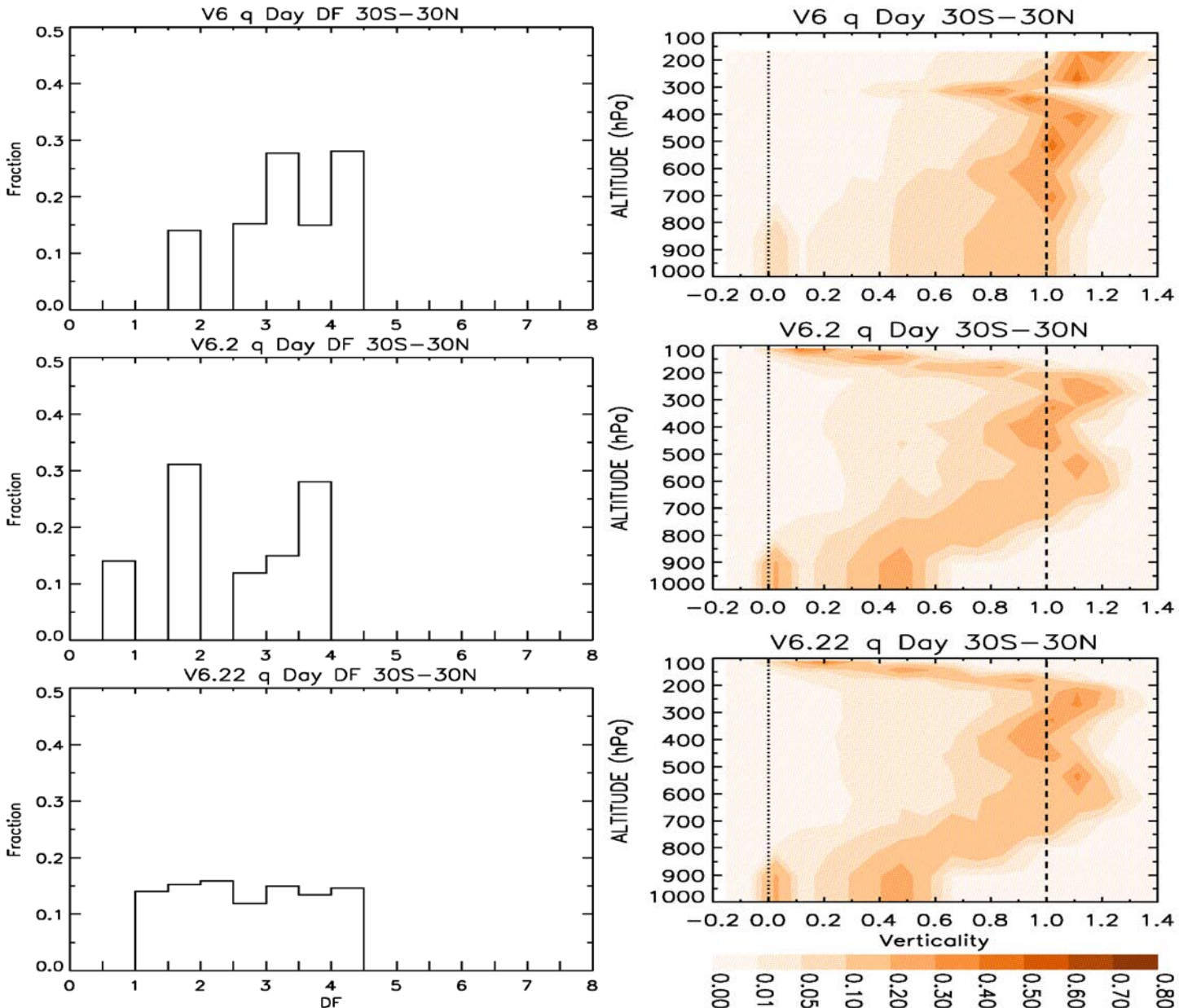
V6.22

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

30S-30N

Degree of Freedeom

Verticality



V6

V6.2

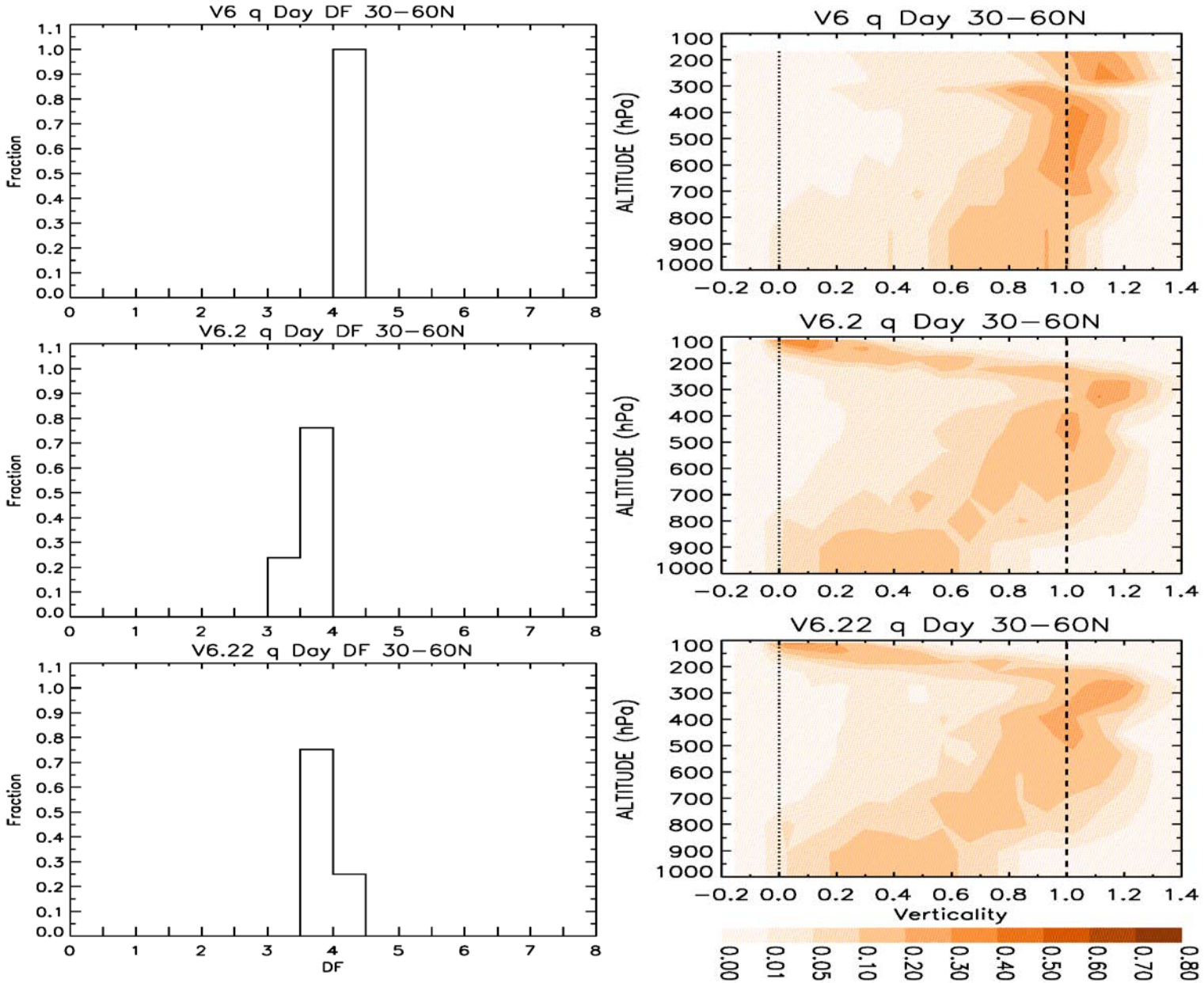
V6.22

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

30-60N

Degree of Freedeom

Verticality



V6

V6.2

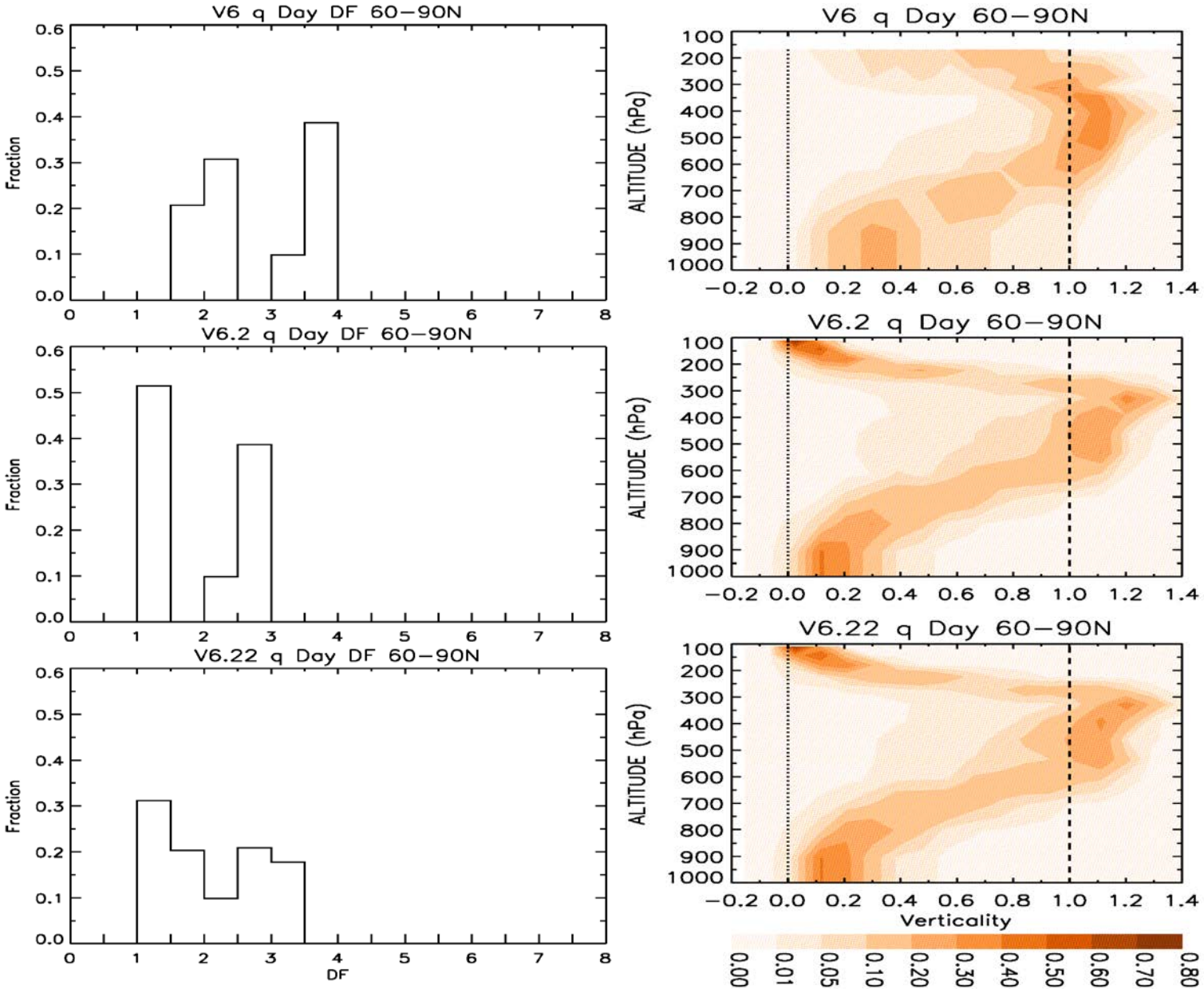
V6.22

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

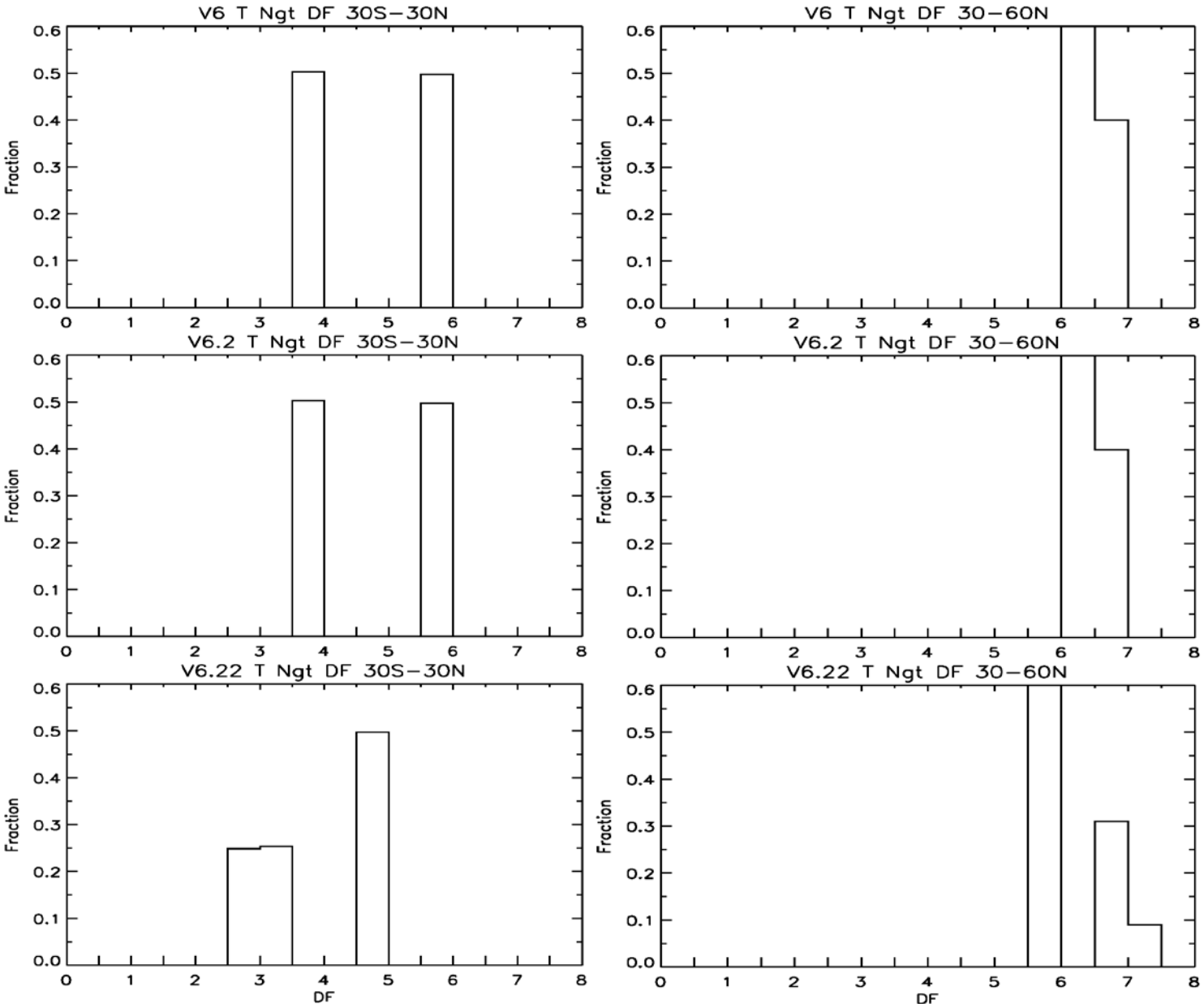
60-90N

V6.2

V6.22

Good Nightime T Degree of Freedom Histograms

30S-30N | 30-60N | 60-90N



V6

V6.2

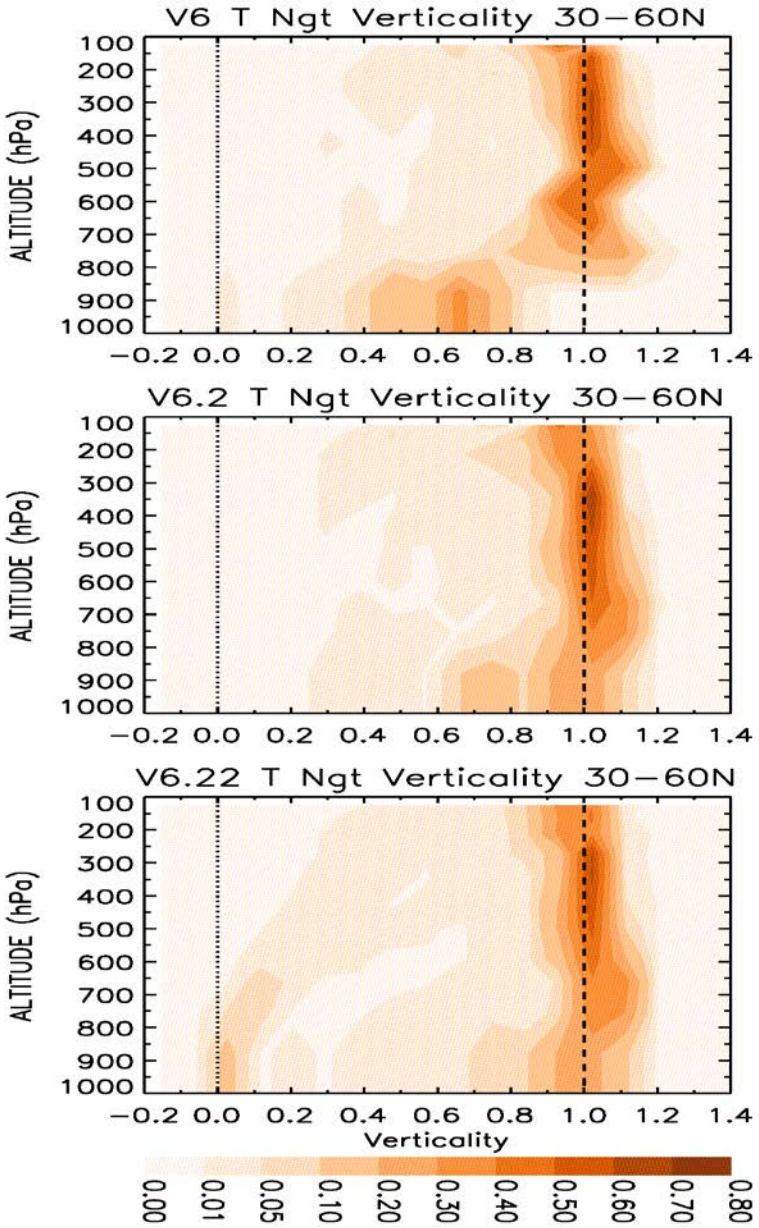
V6.22

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

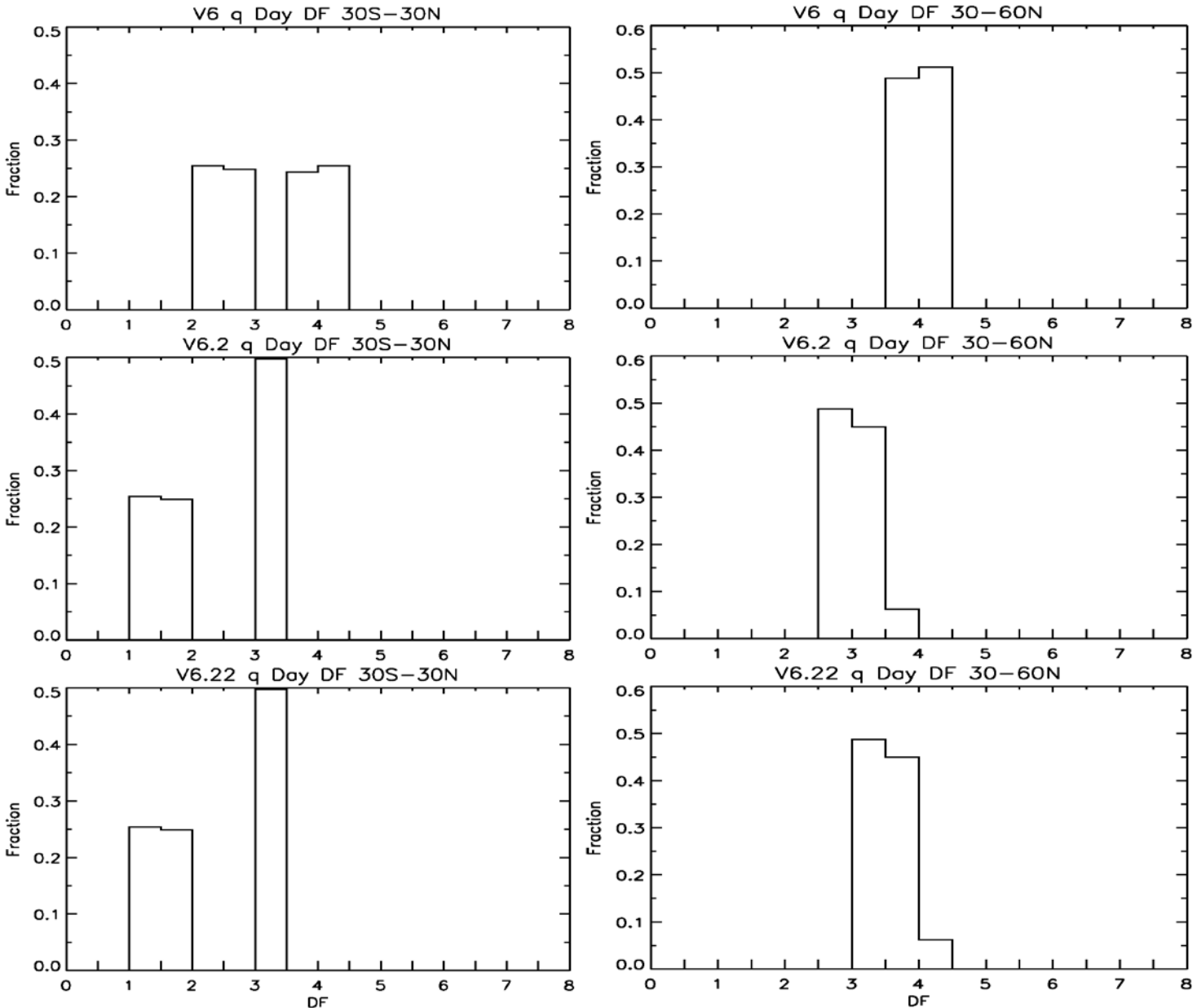
60-90N

V6.2

V6.22

Good Nightime q Degree of Freedom Histograms

30S-30N | 30-60N | 60-90N



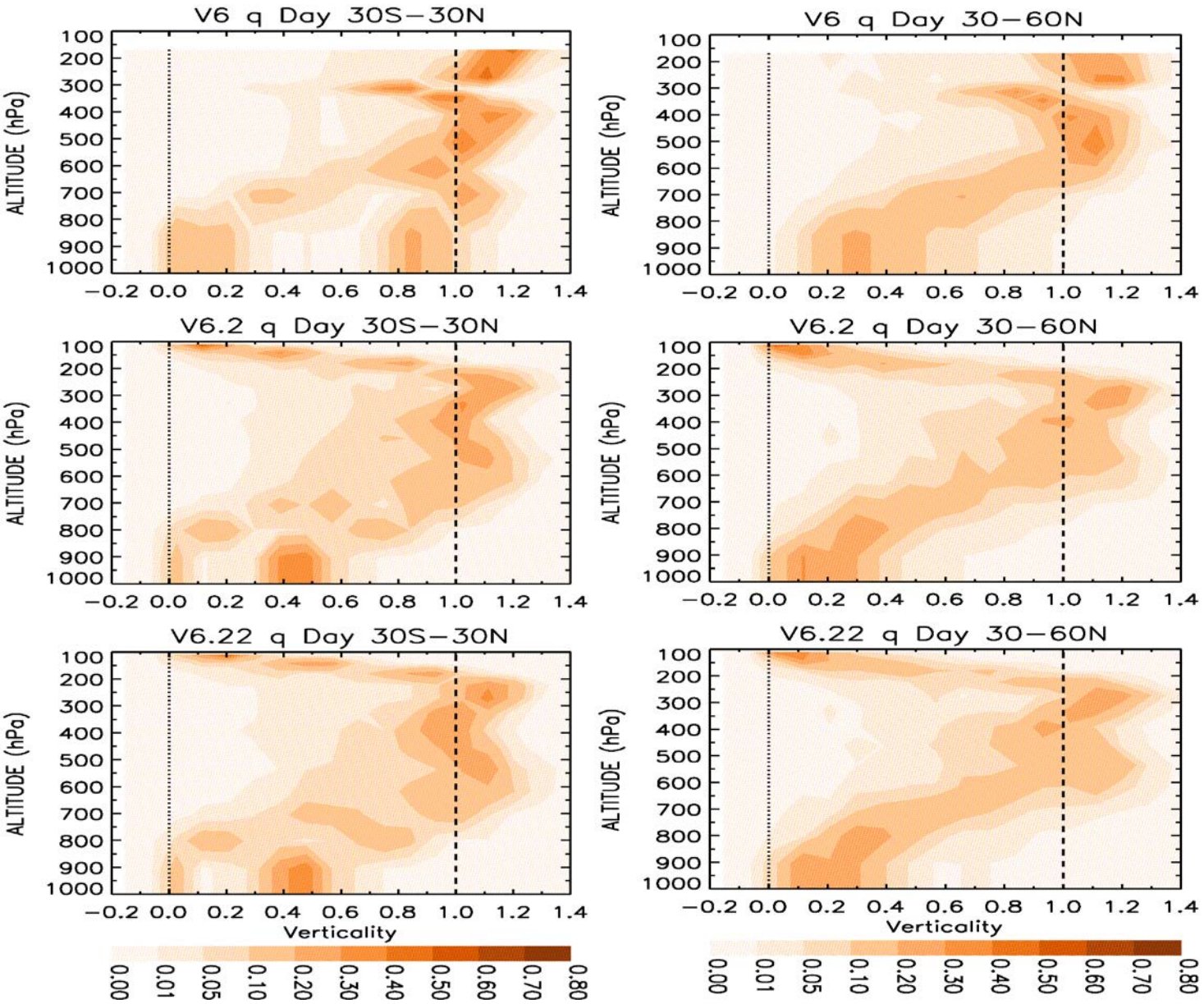
V6

V6.2

V6.22

Good Nightime q Verticality Histograms

30S-30N | 30-60N | 60-90N

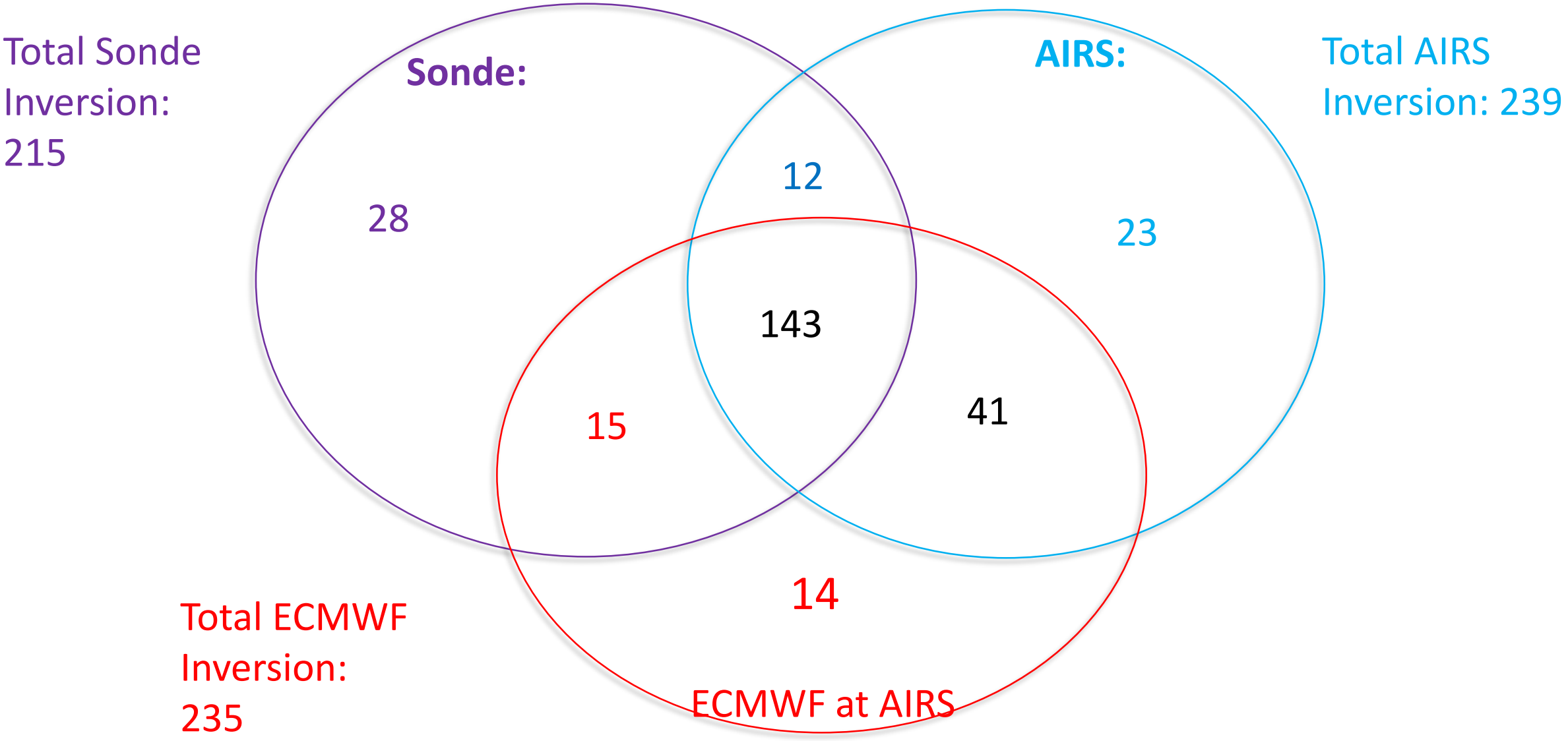


V6

V6.2

V6.22

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



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

Day Day Ngt Ngt

V6 T

V6 q

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

Day Day Ngt Ngt

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

Day | Day | Day | Ngt.

V6.2 q

V6 q

AIRS & ECMWF, Strength > 5 K/km

Ngt

Ngt

Ngt

Ngt.

V6 T

V6 q

AIRS & ECMWF, Strength > 5 K/km

Ngt

Ngt

Ngt

Ngt.

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

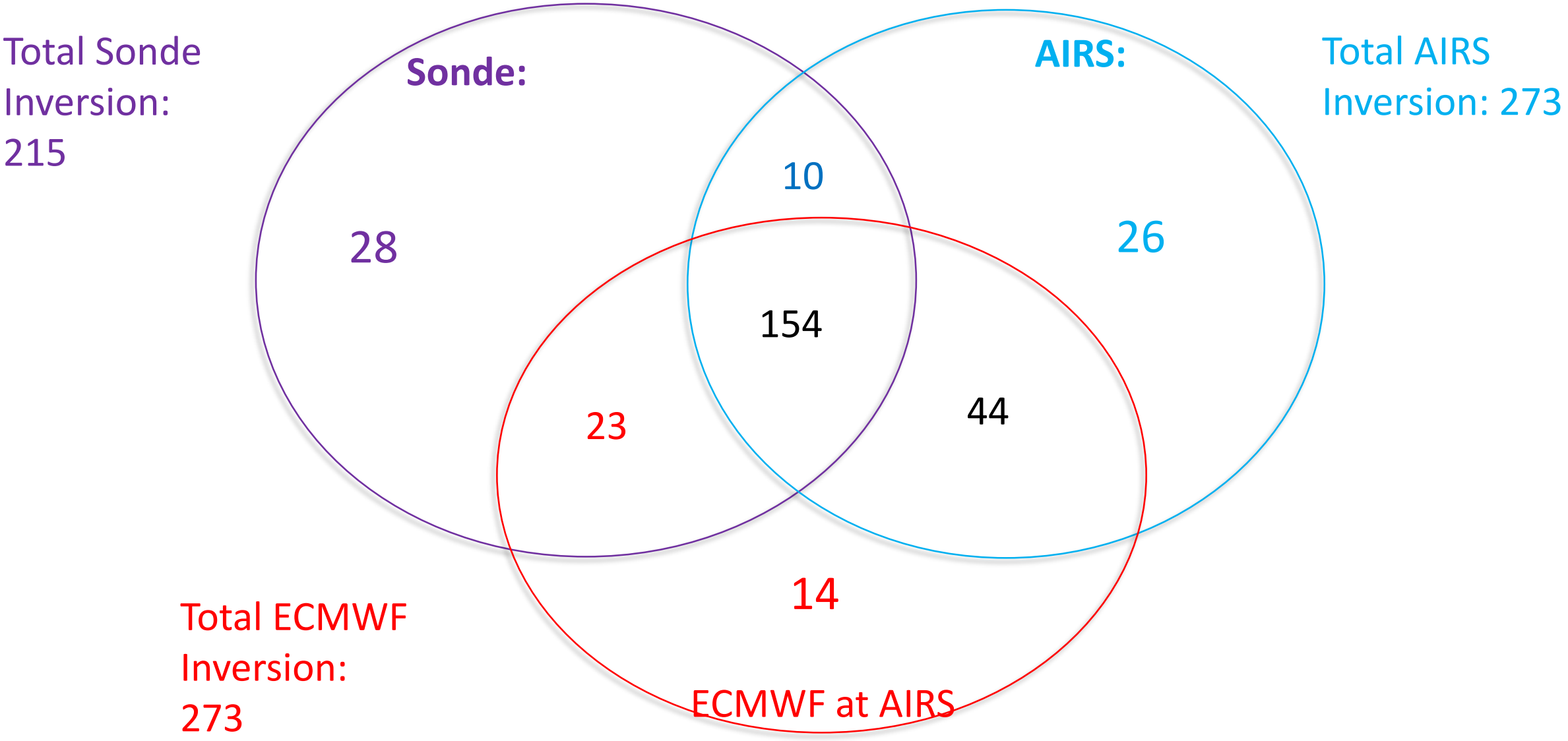
30-60N

60-90N

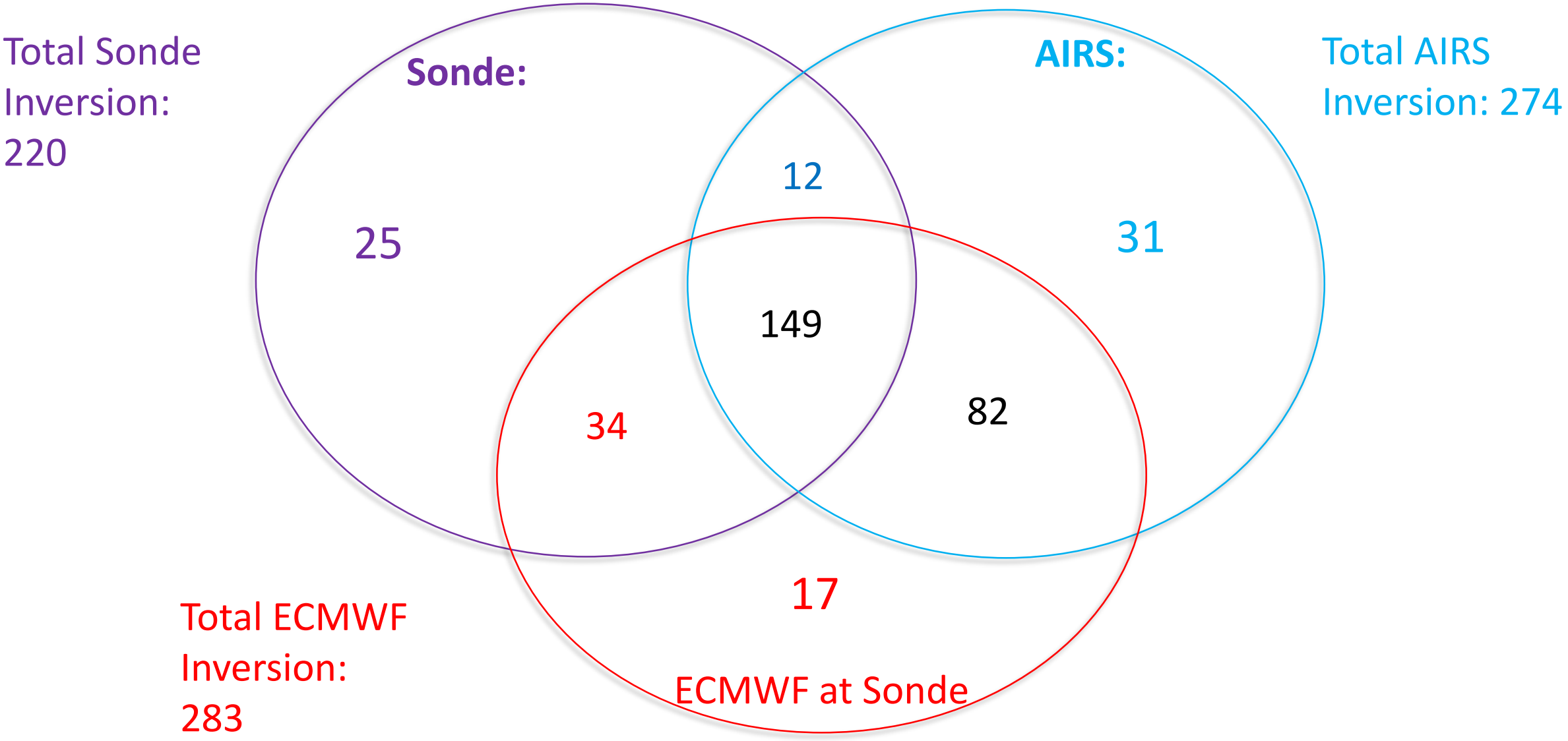
V6

V6.2

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



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



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