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

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Rationale

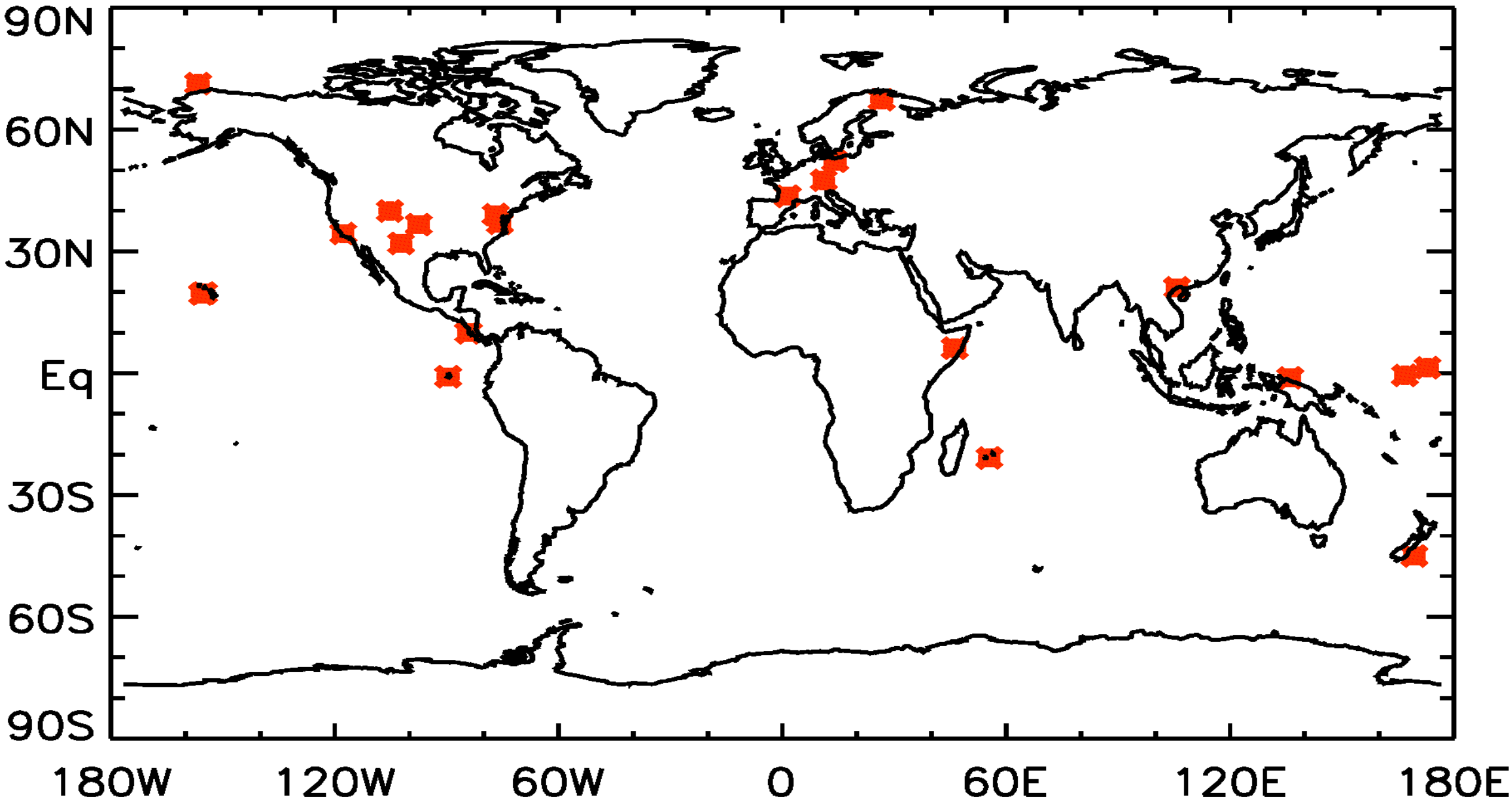
- Boundary layer inversion is important in both climate science (e.g., land-atmosphere interaction) and application (e.g., air pollution)

- Many application cases are interested in individual profiles. Statistical averaging is not useful here

- The ability of AIRS/NN and ECMWF to capture boundary layer inversion

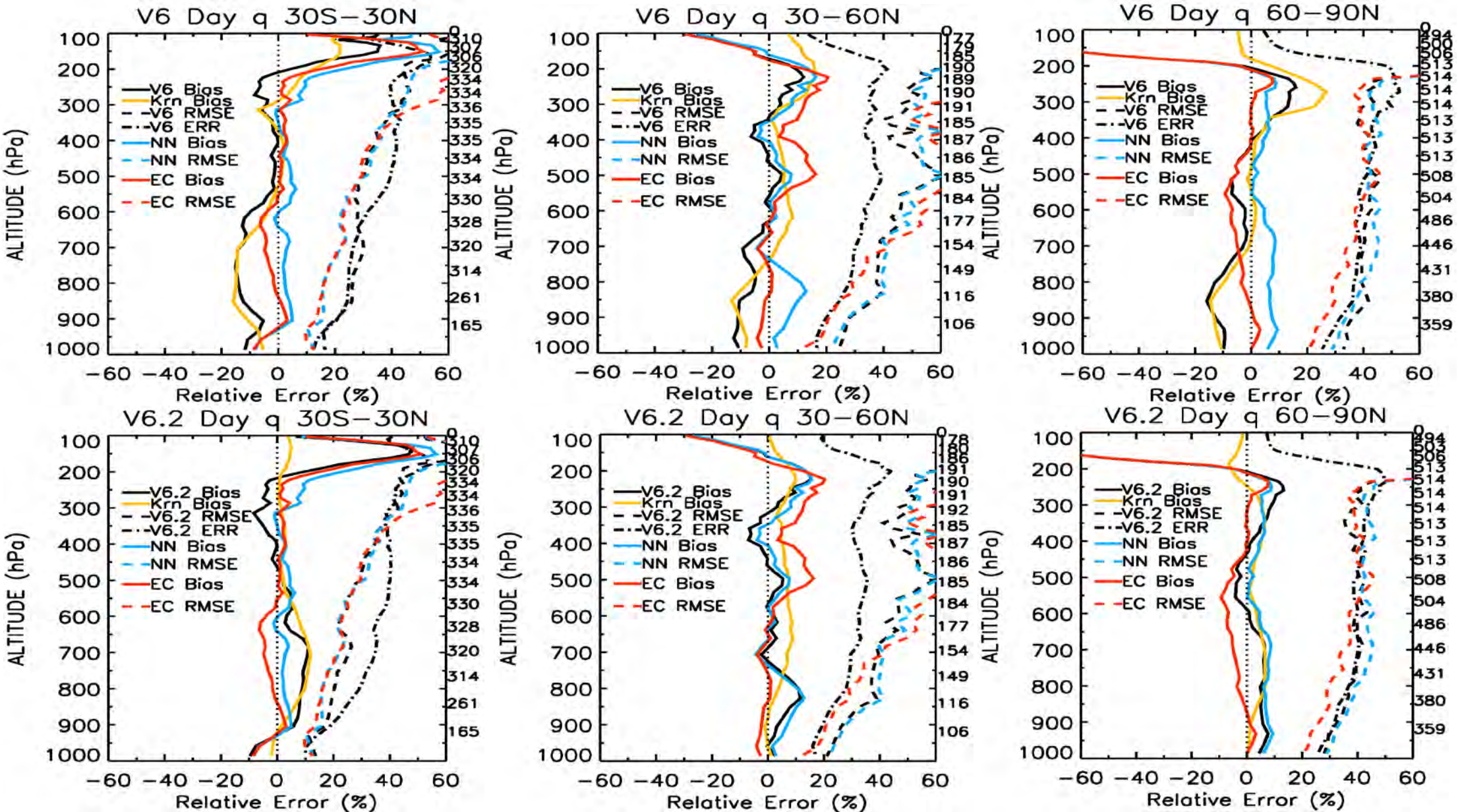
- Dedicated sondes: Not assimilated by ECMWF

Dedicated Sonde Sites



Good Daytime q Biases and RMSE

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

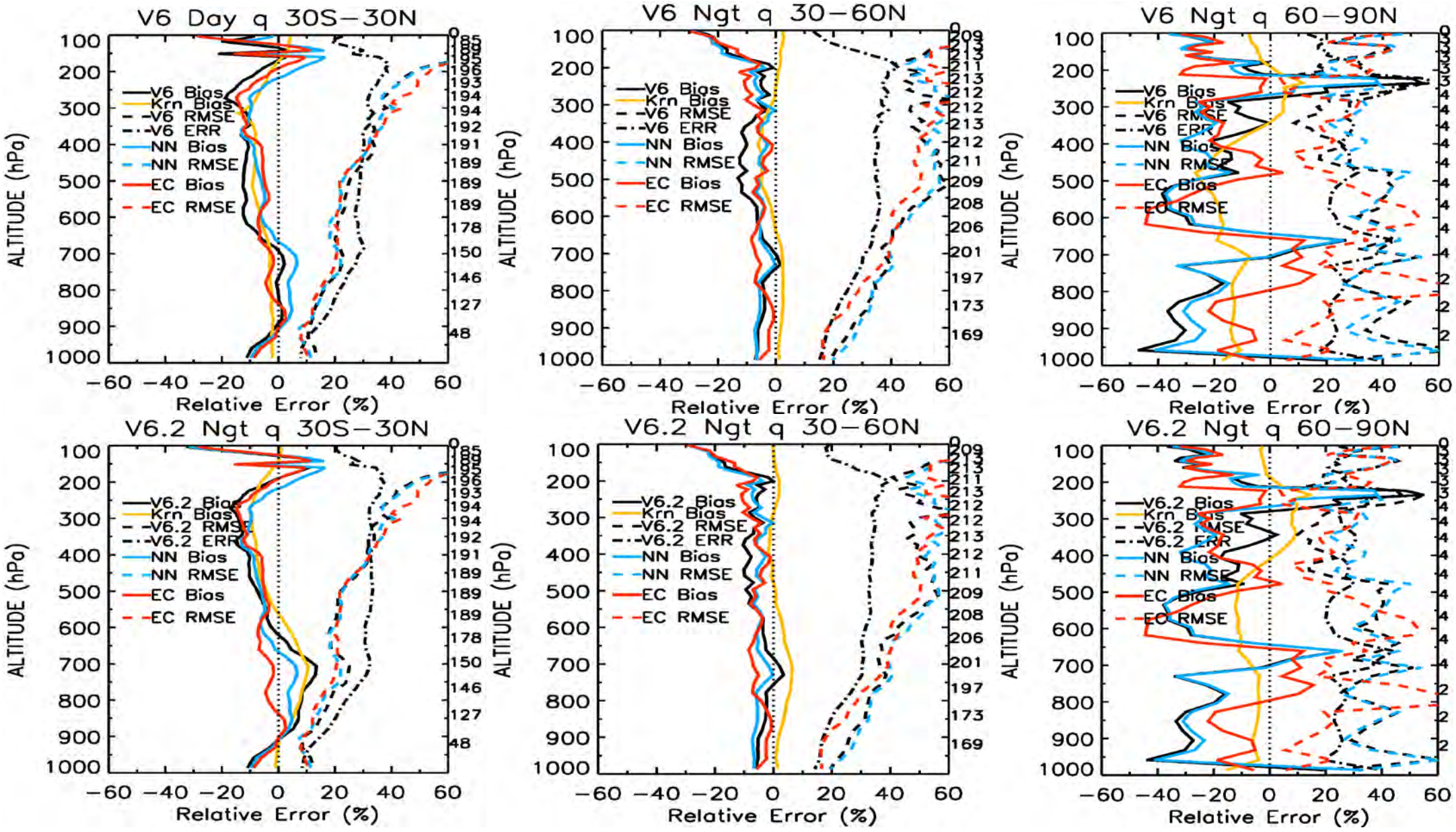


V6

V6.2

Good Nightime q Biases and RMSE

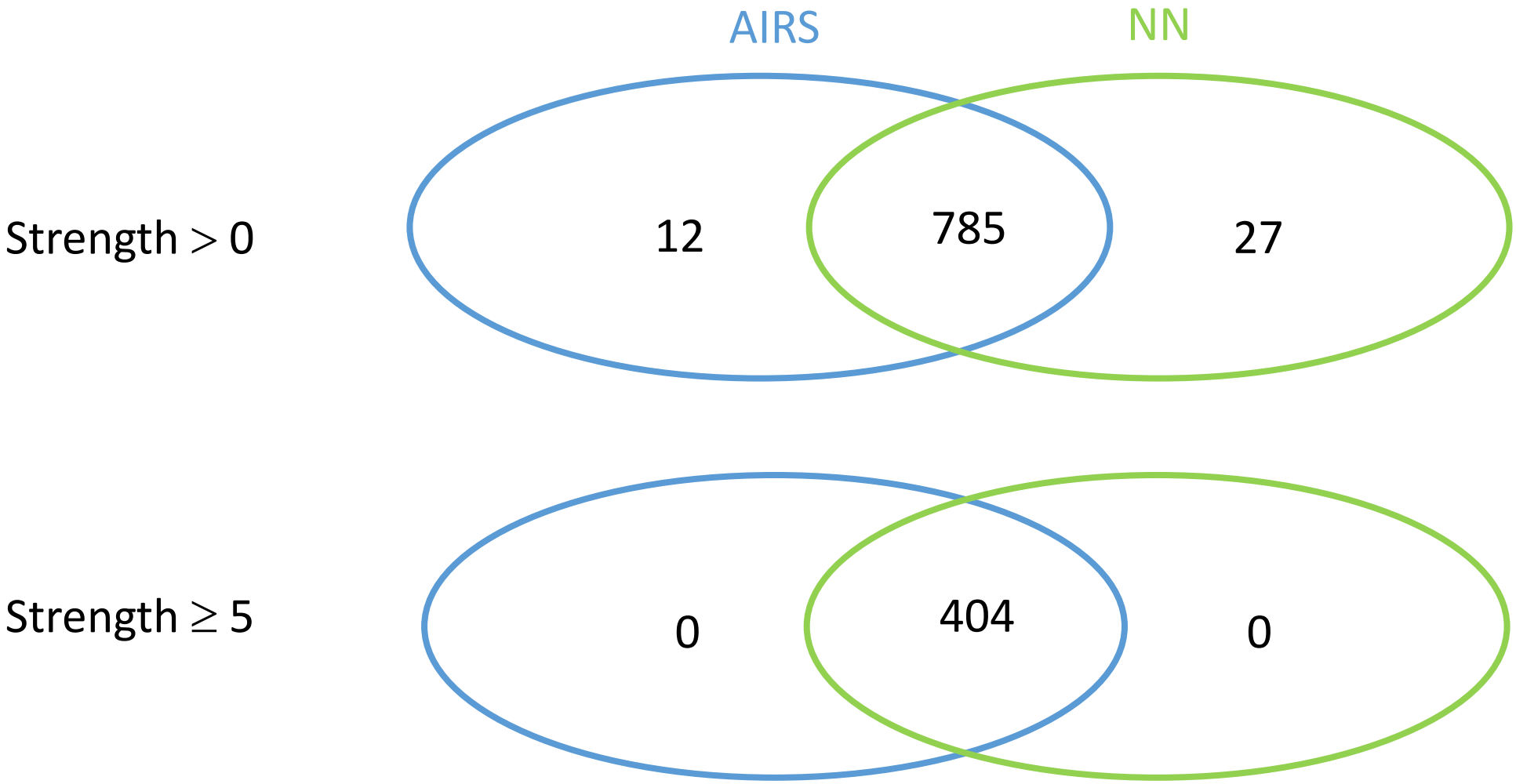
30S-30N | 30-60N | 60-90N



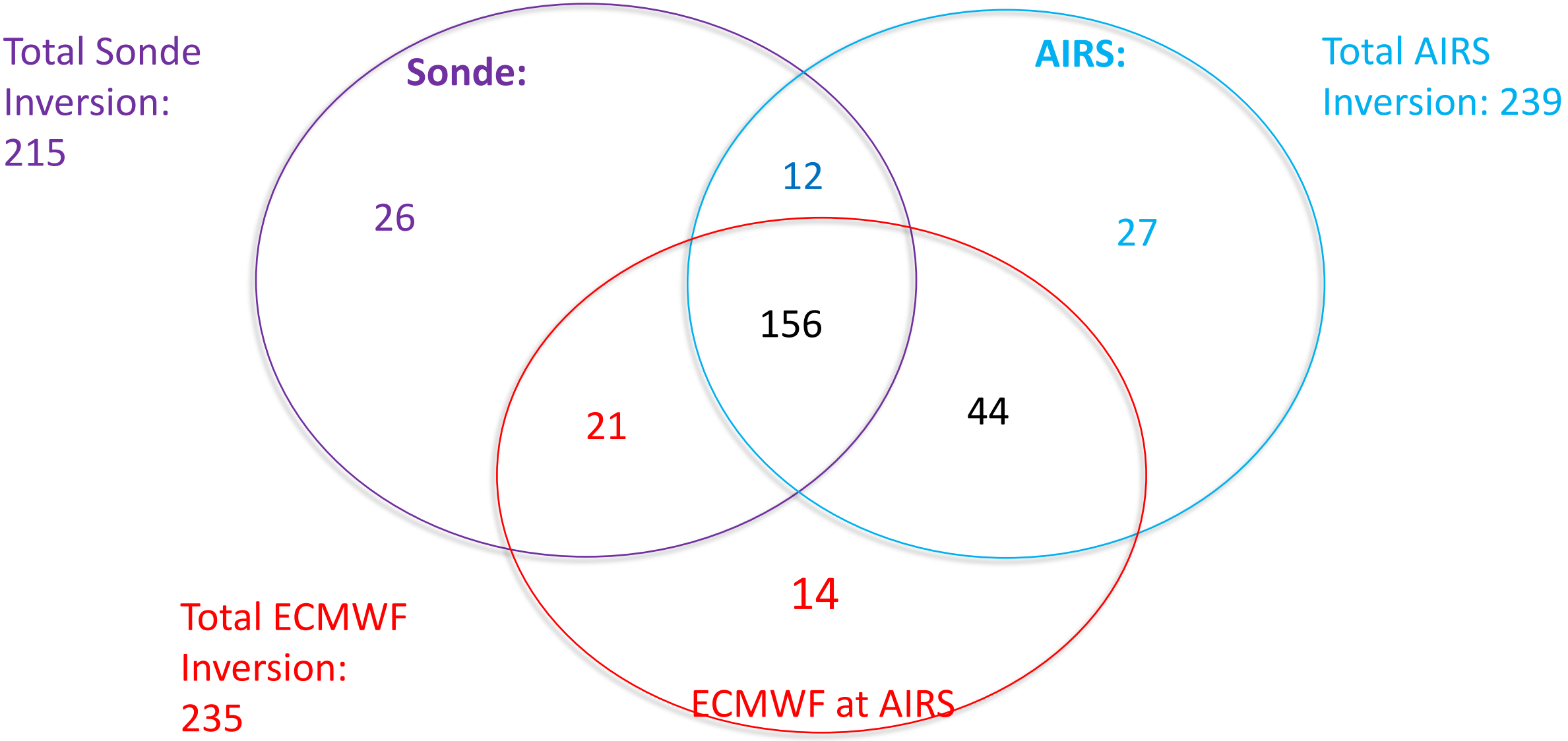
V6

V6.2

Total Sonde-AIRS Match Up: 1922



Total Sonde-AIRS V6 Match Ups: 1741
Strength ≥ 5 K/km



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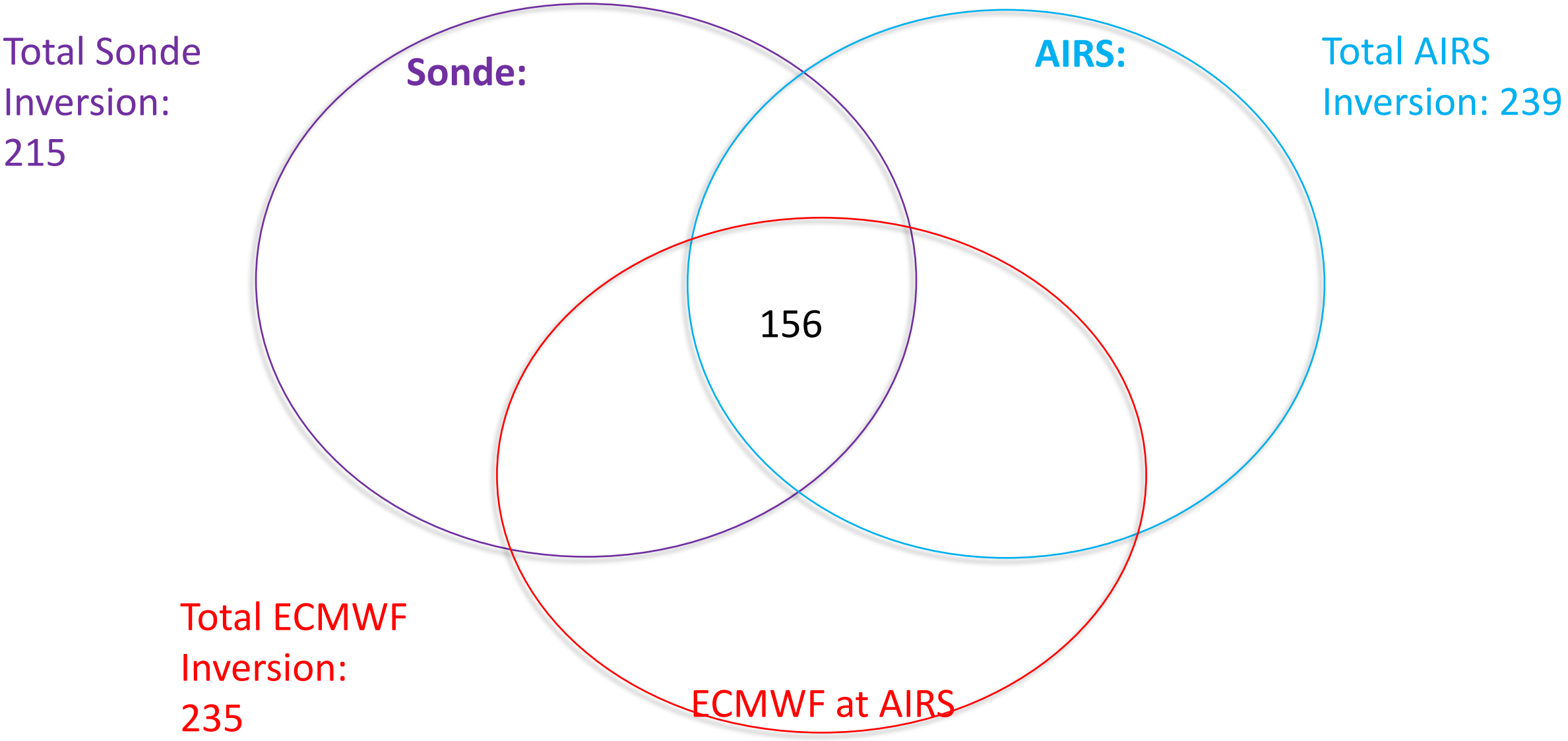
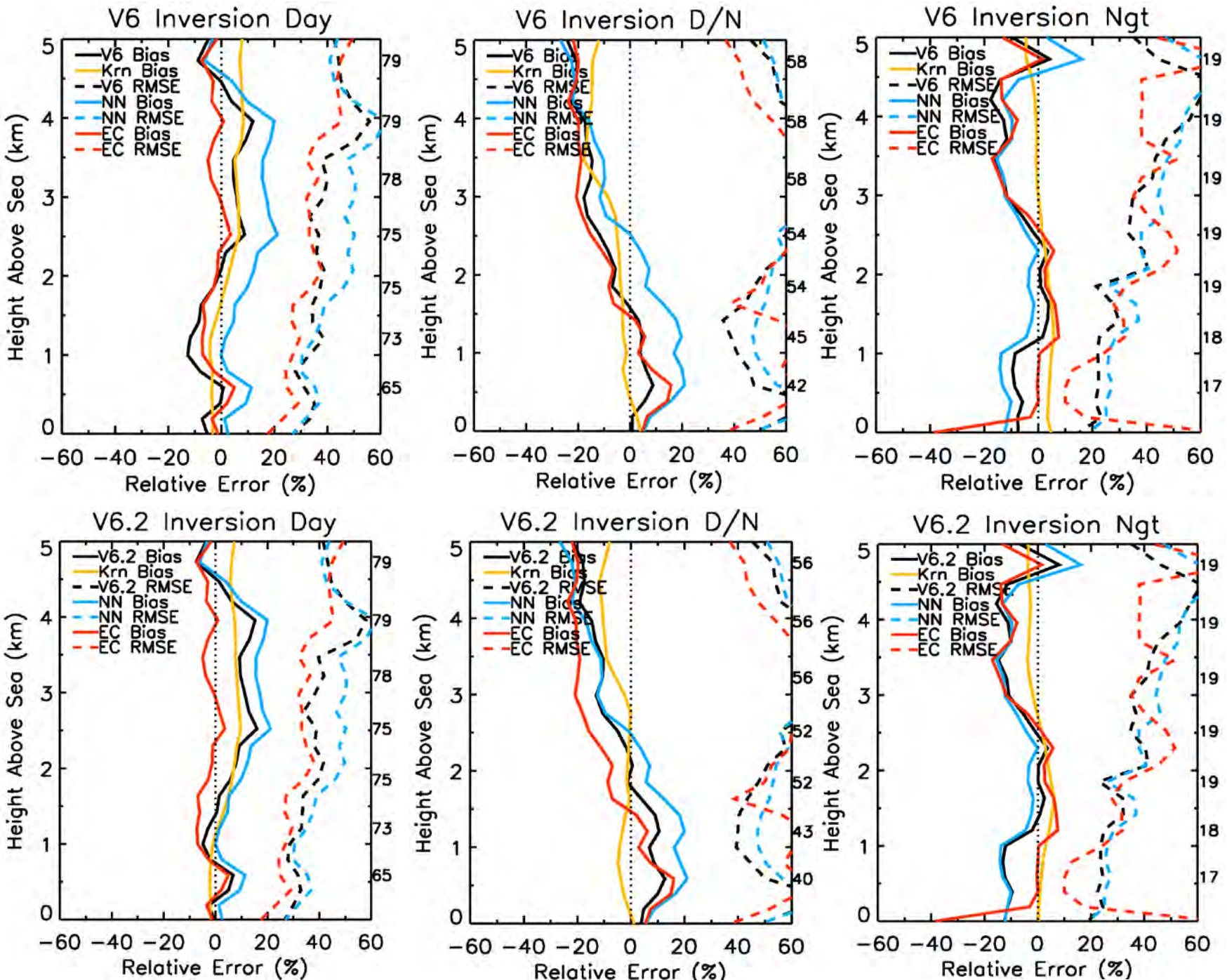
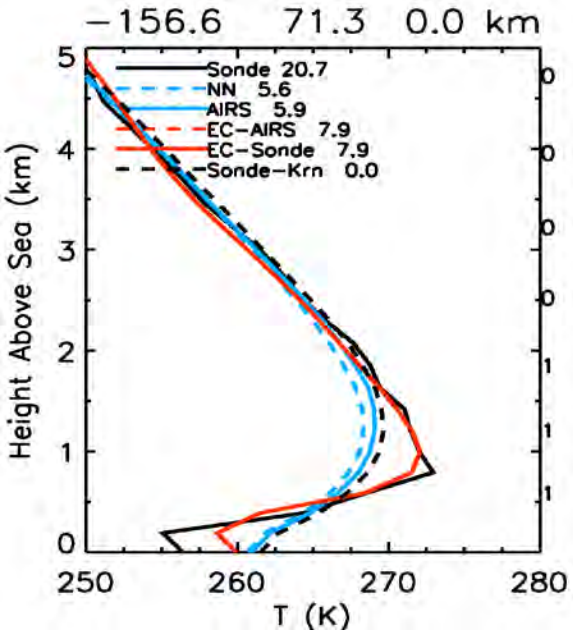


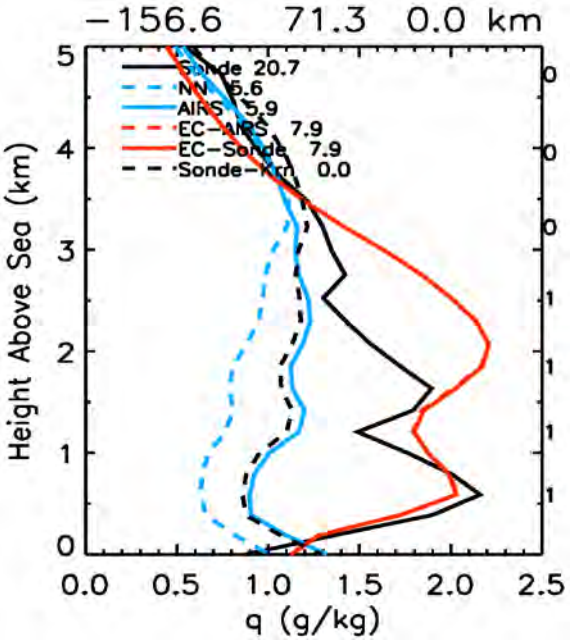


V6, NN, ECMWF q biases and RMSE, when all have T inversion strength > 5K/km

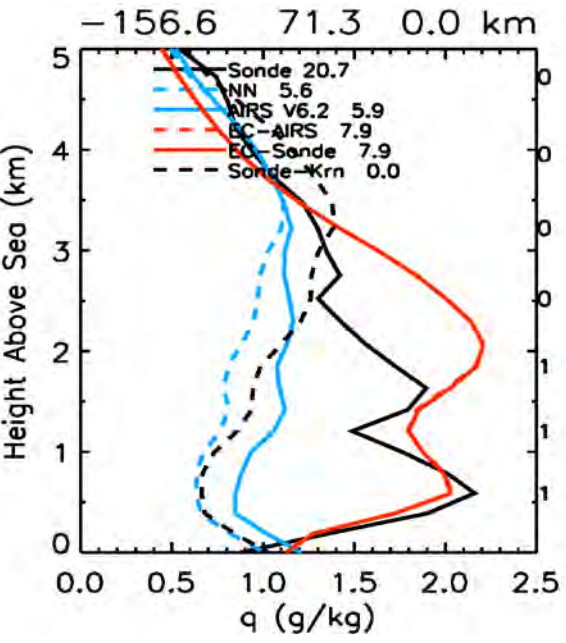
Corresponding V6.2 q profiles



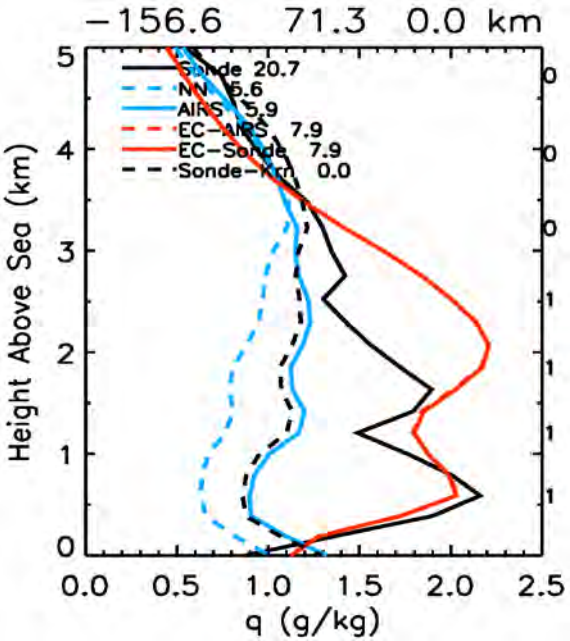
T Inversion, captured by Sonde, AIRS/NN, ECMWF



Corresponding V6 q profiles



Corresponding V6.2 q profiles

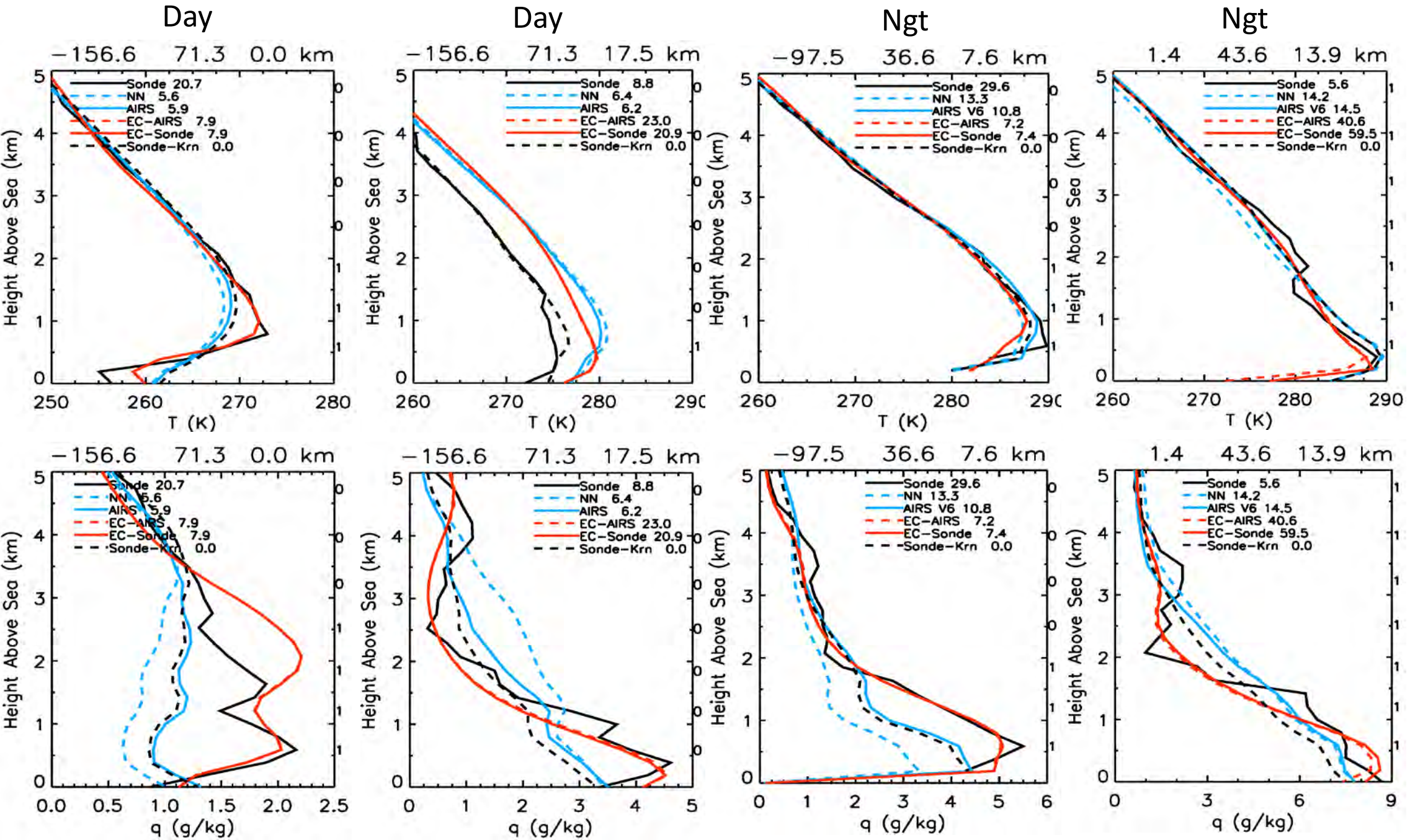


Corresponding V6 q profiles

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



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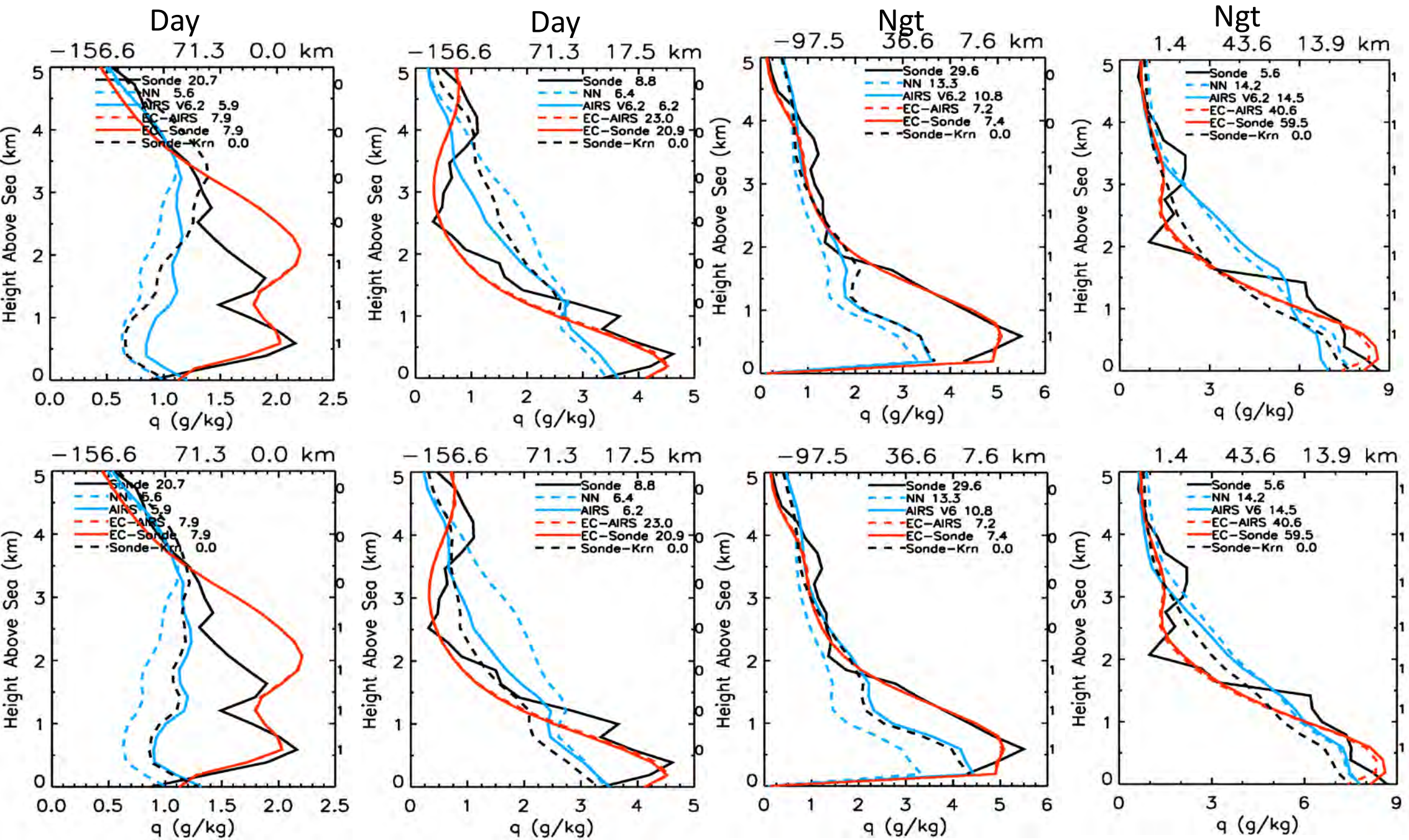
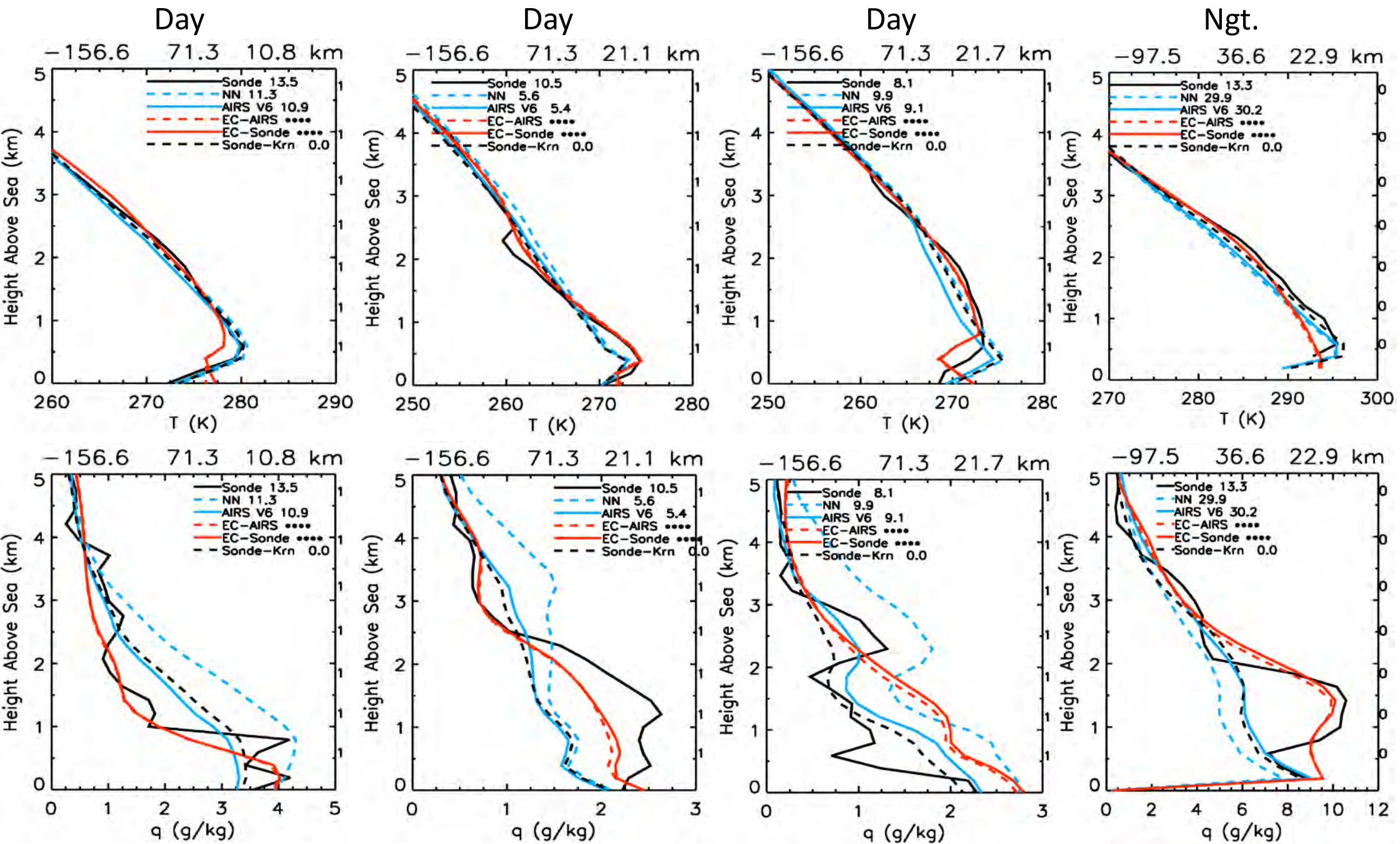


V6.2 q

V6 q

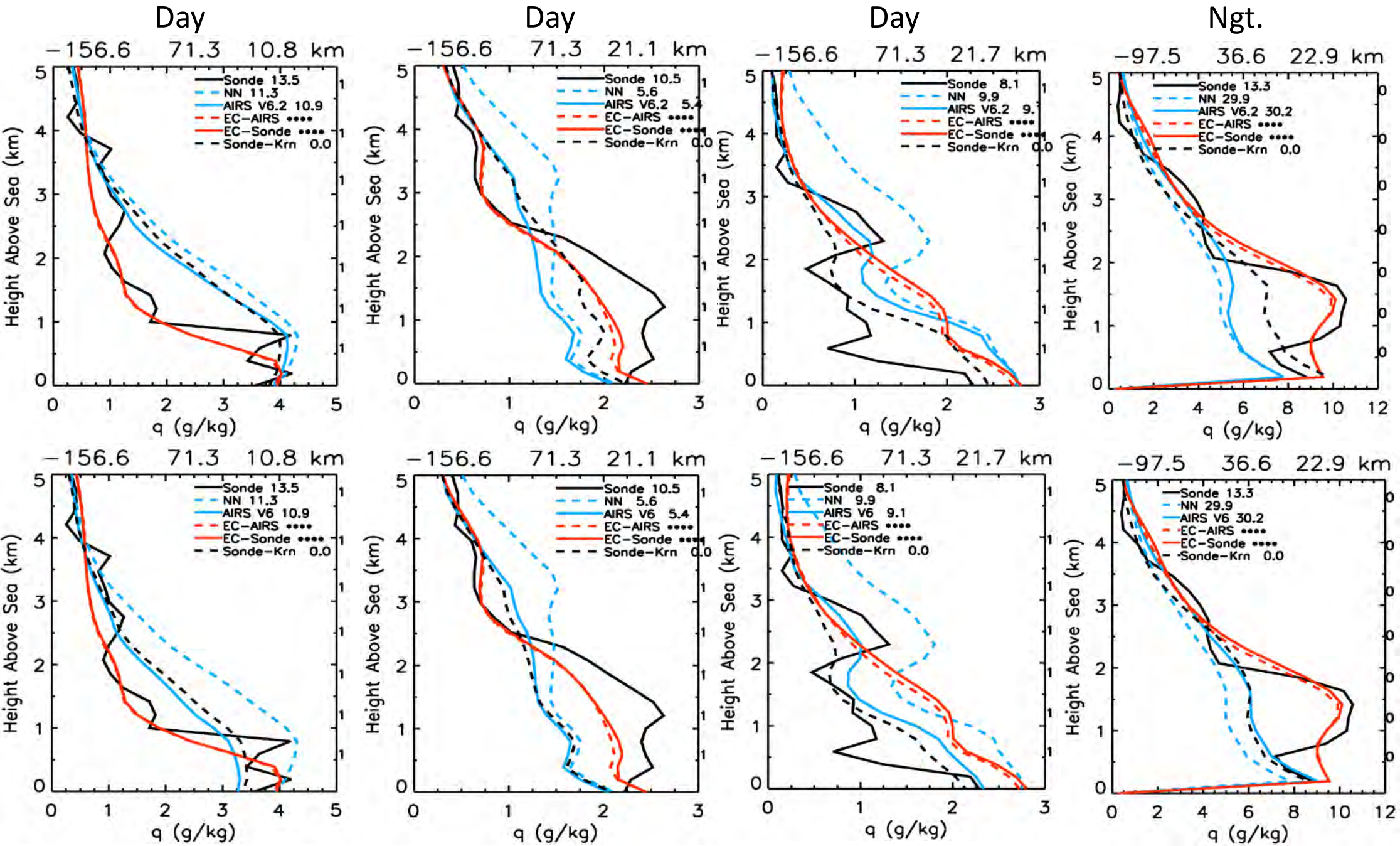
Sonde & AIRS, Strength > 5 K/km



V6 T

V6 q

Sonde & AIRS, Strength > 5 K/km



V6.2 q

V6 q

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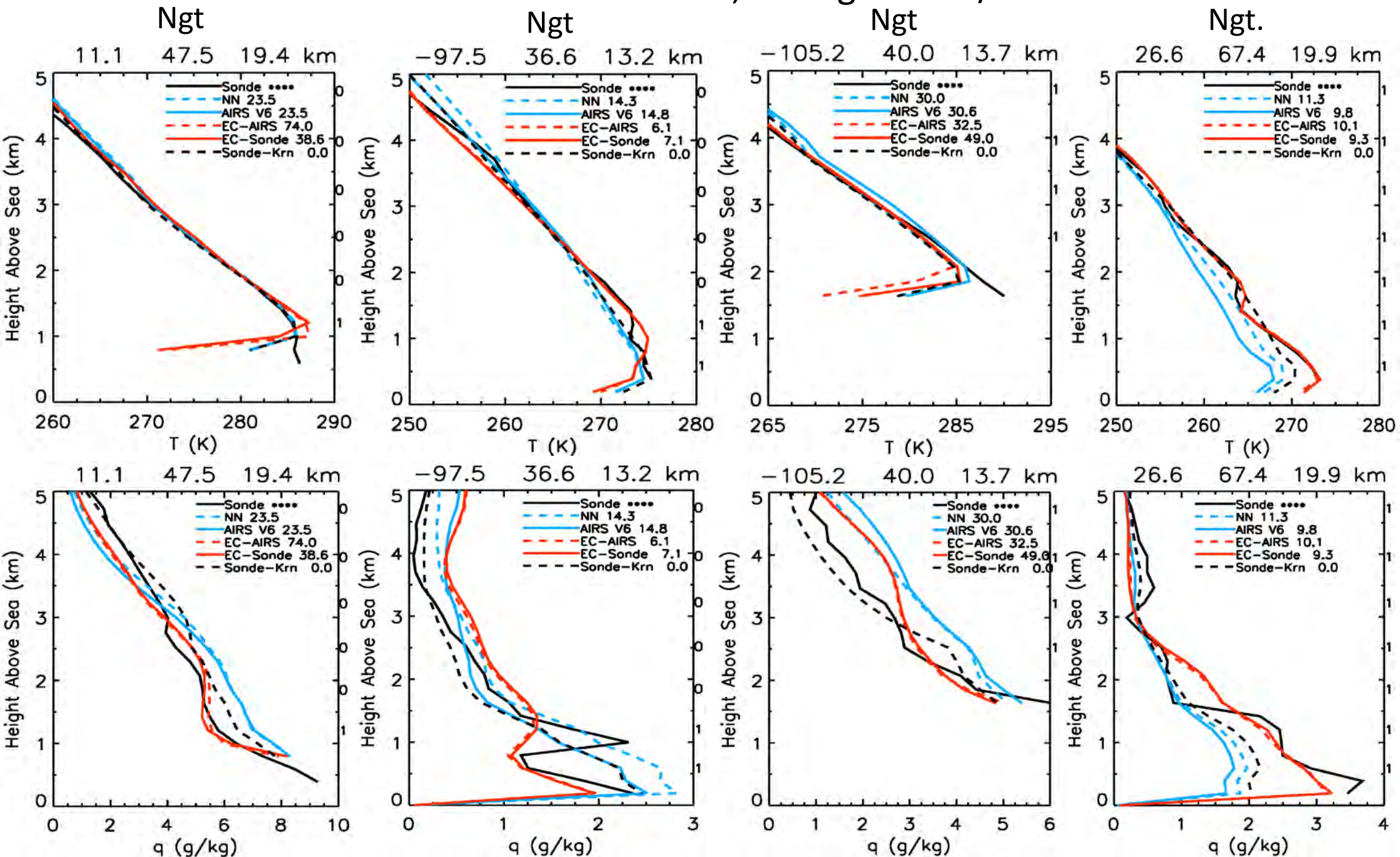

V6 T

V6 q

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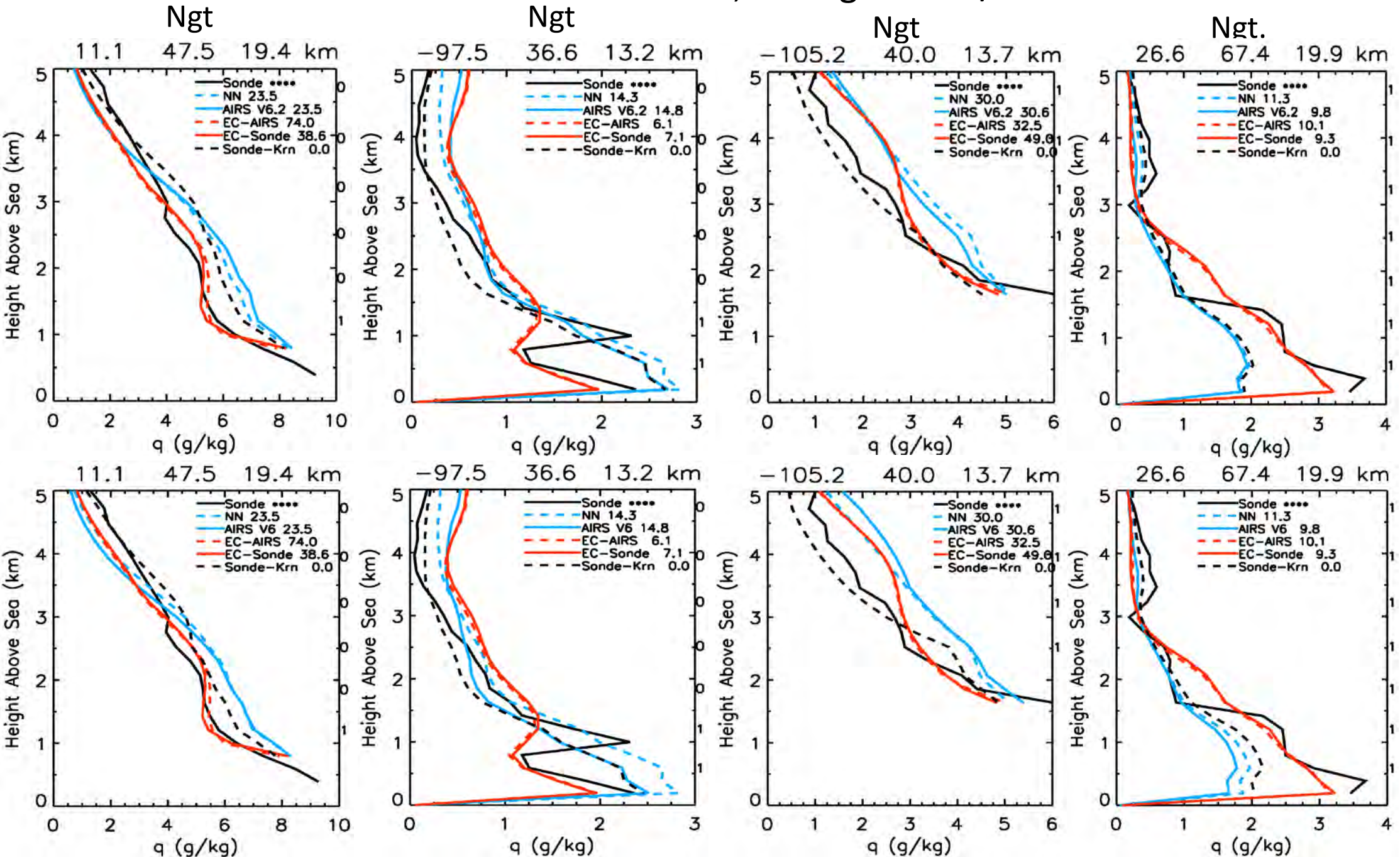
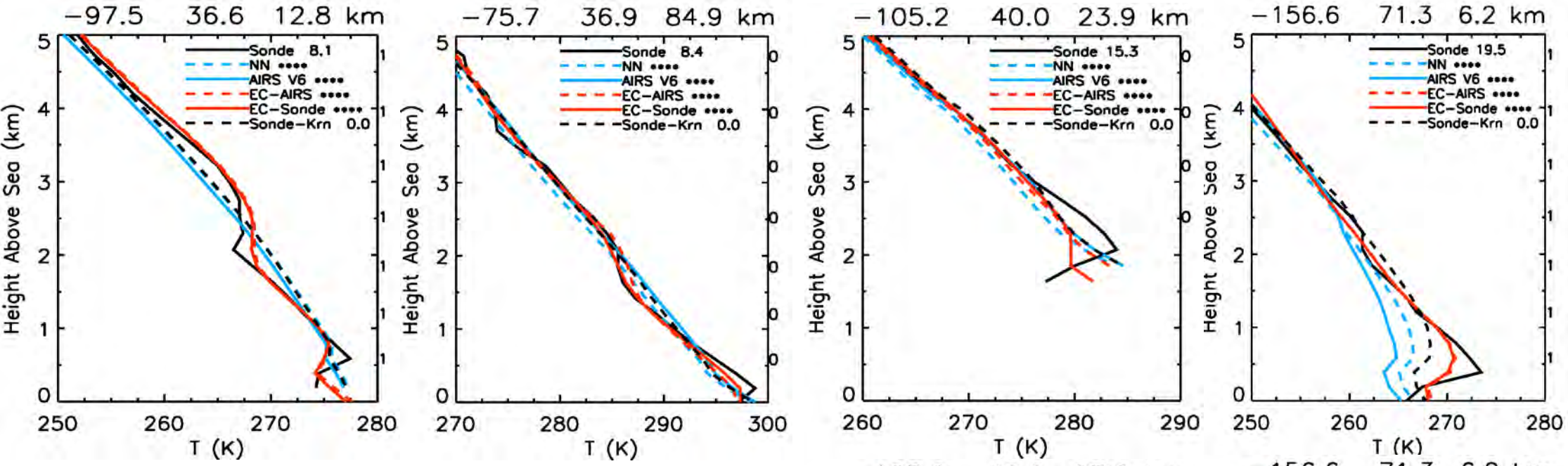


V6.2 q

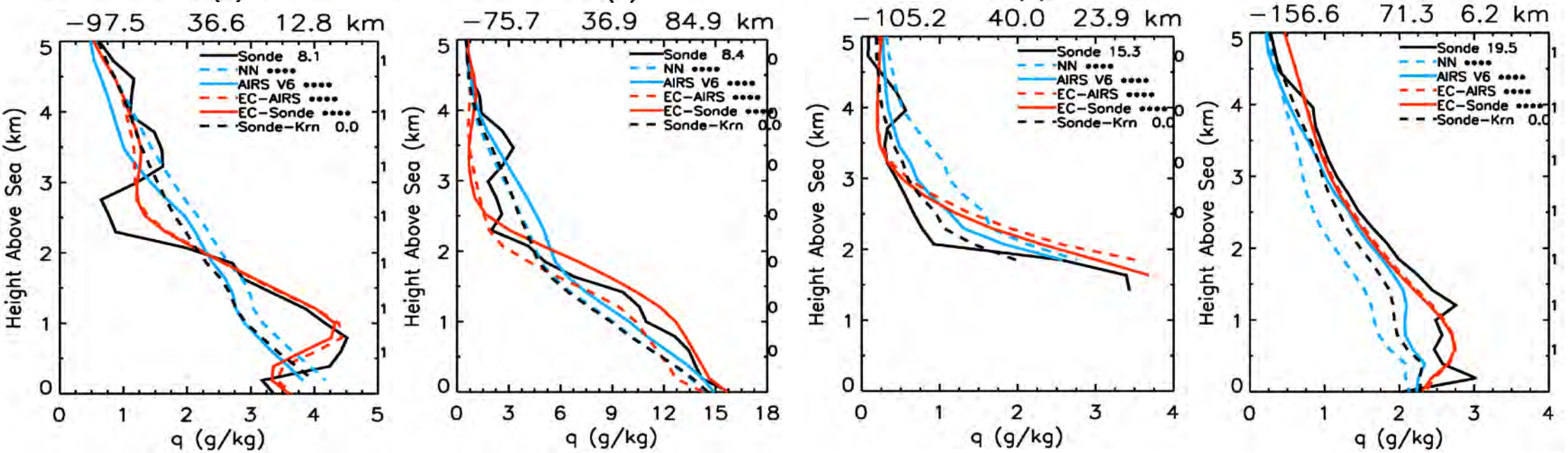
V6 q

Sonde Only, Strength > 5 K/km

Ngt | Ngt | Day | Day



V6 T



V6 q

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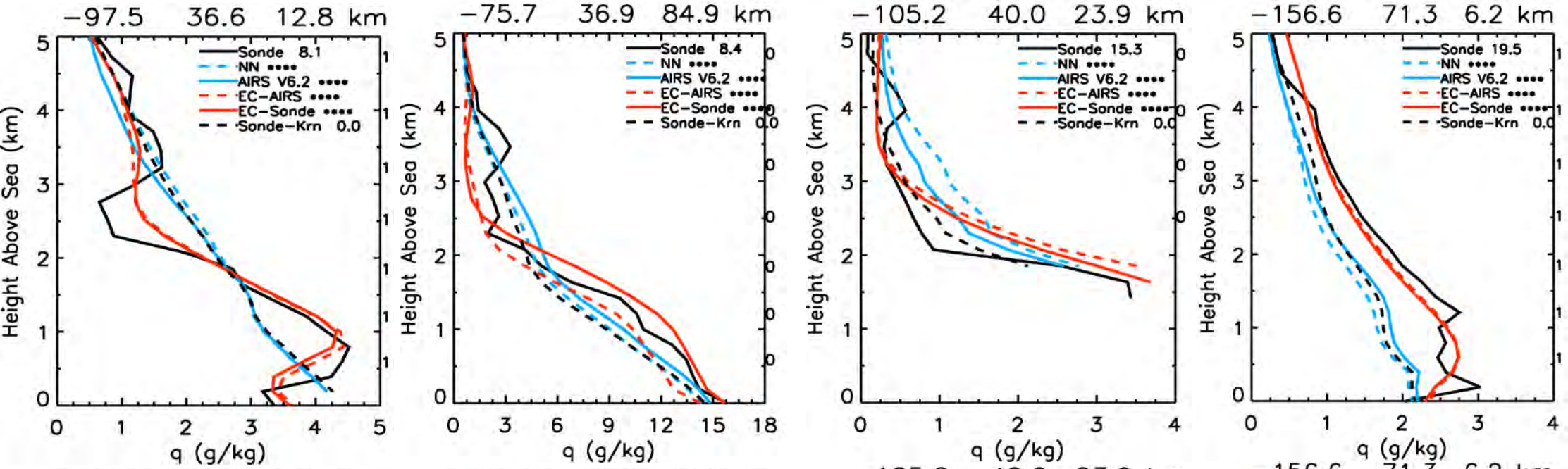
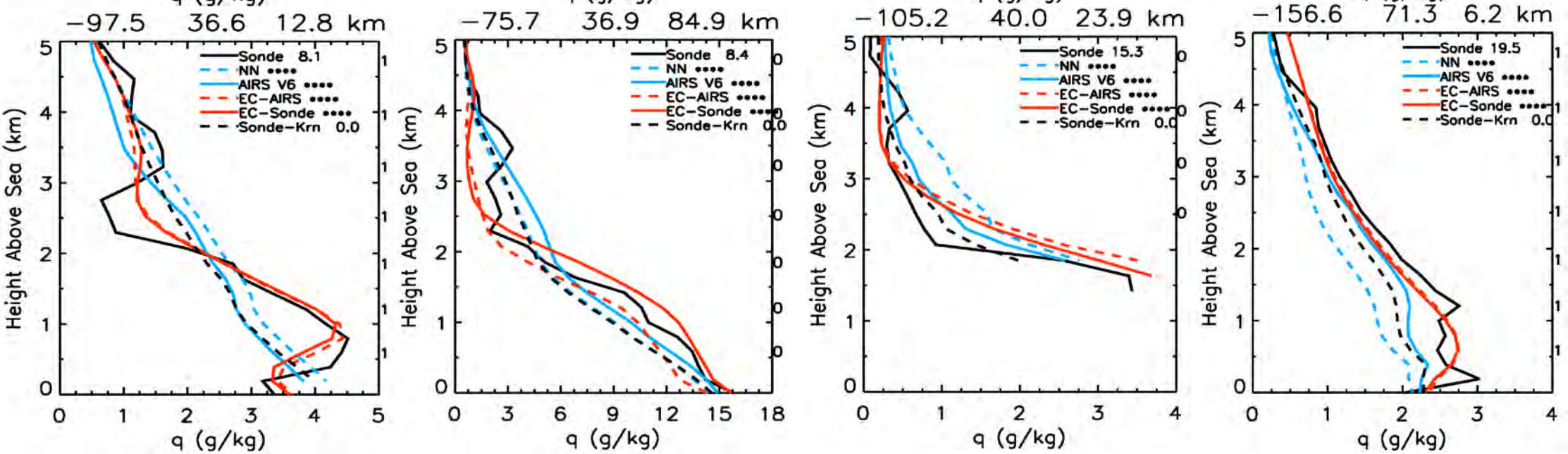
Ngt | Ngt | Day | Day



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

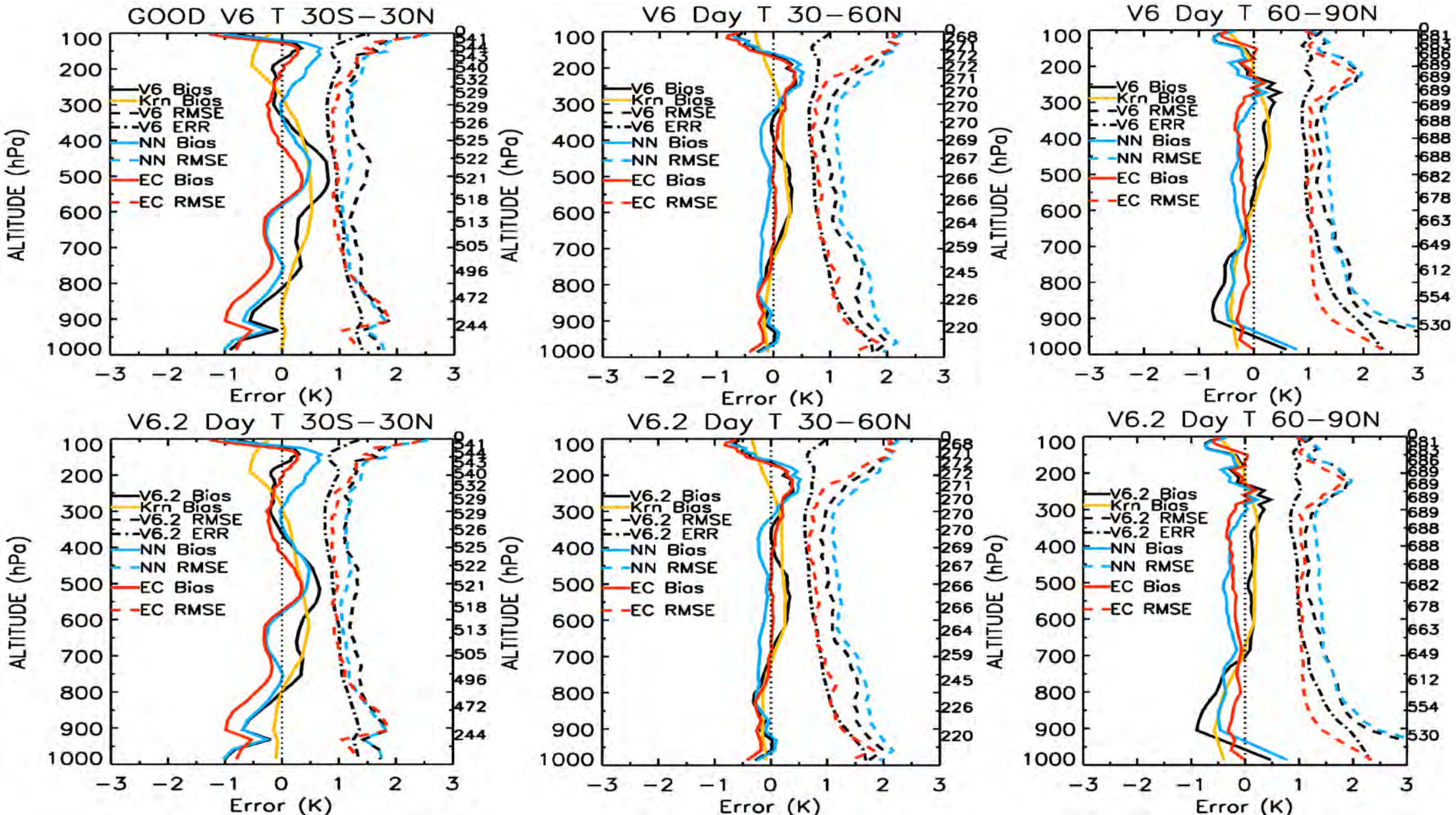
- When strong T inversion, both ECMWF and AIRS tend to capture the q variability in the lower troposphere. In many cases, ECMWF has a better skill (scarily!!!)

- 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

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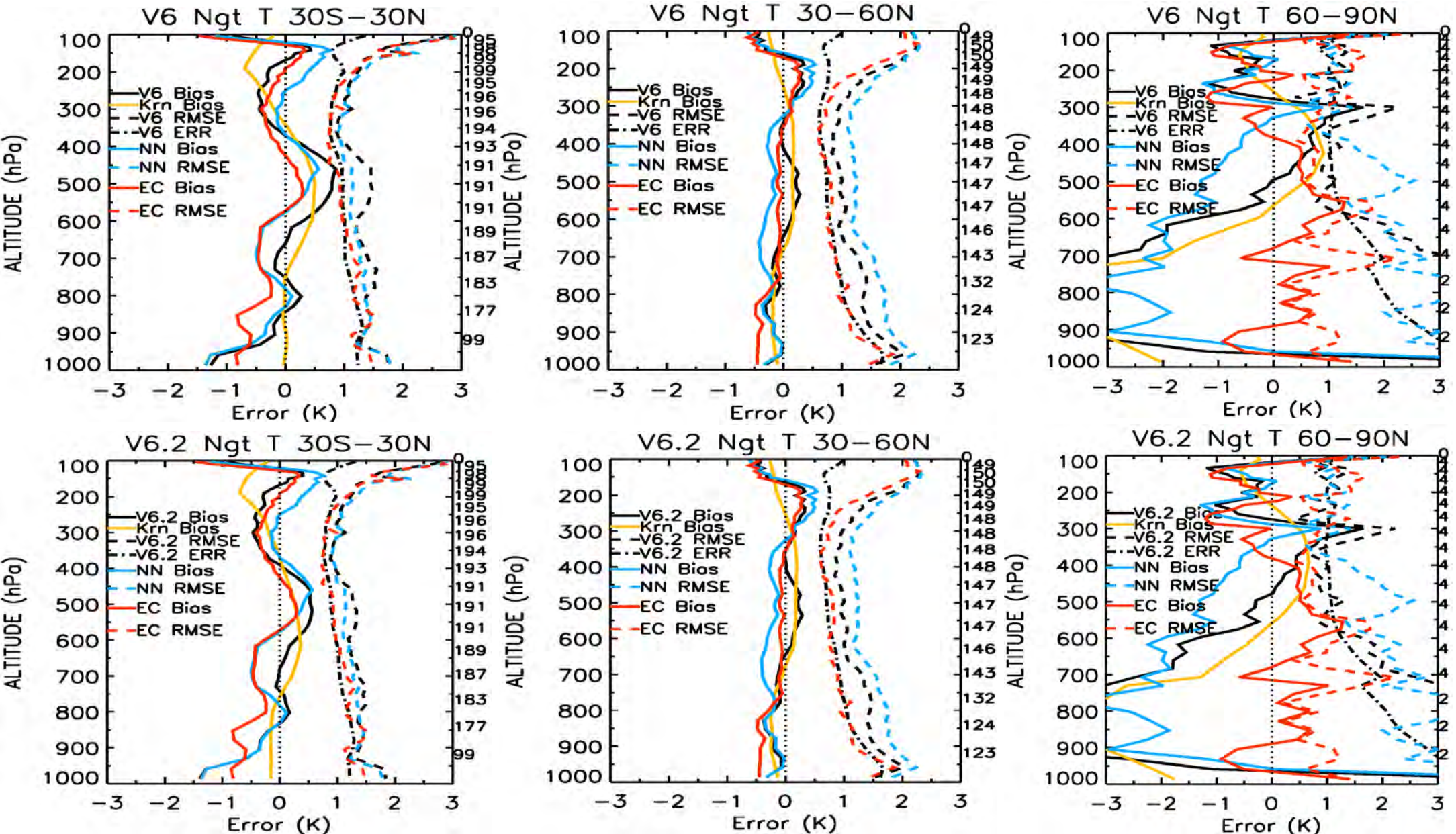
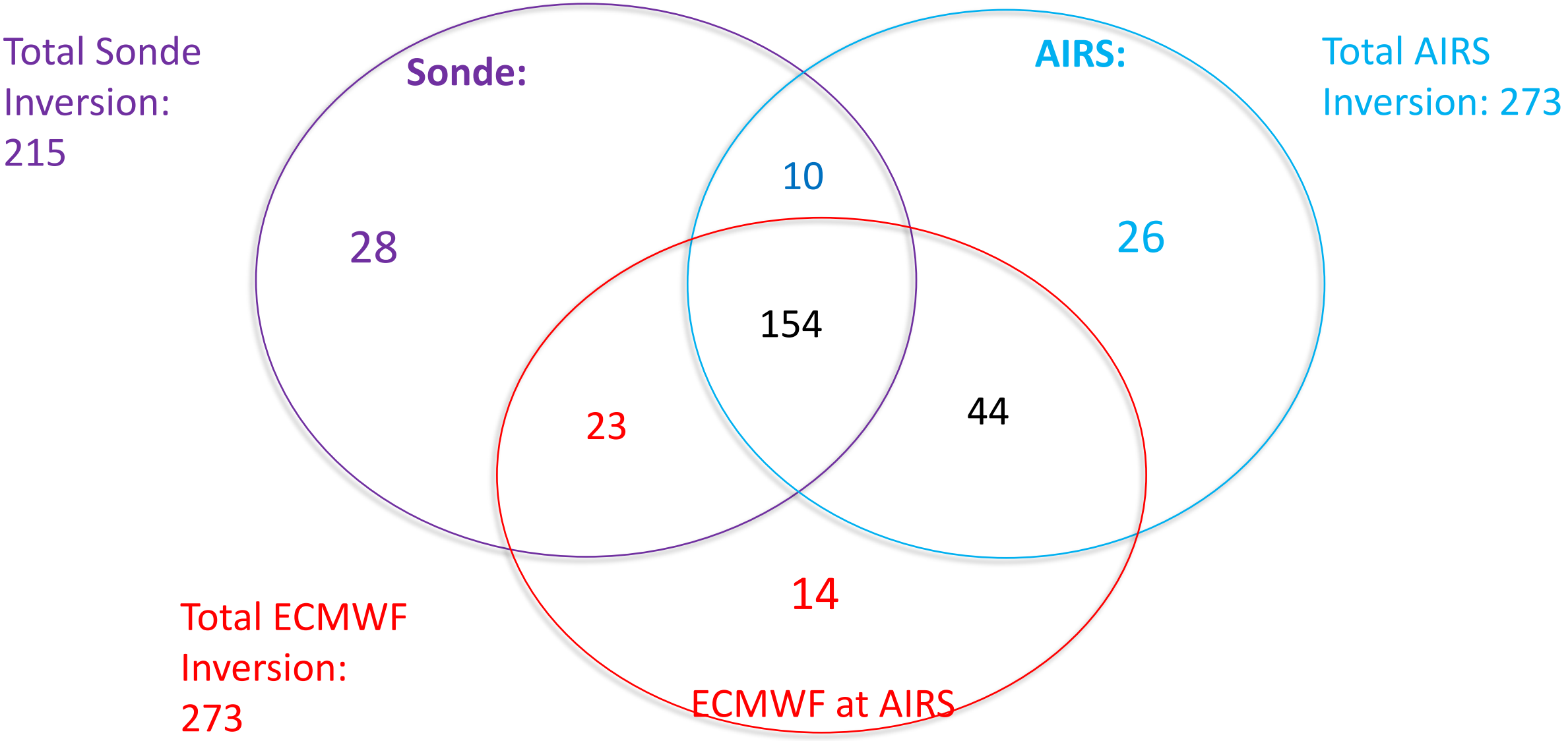


V6

V6.2

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



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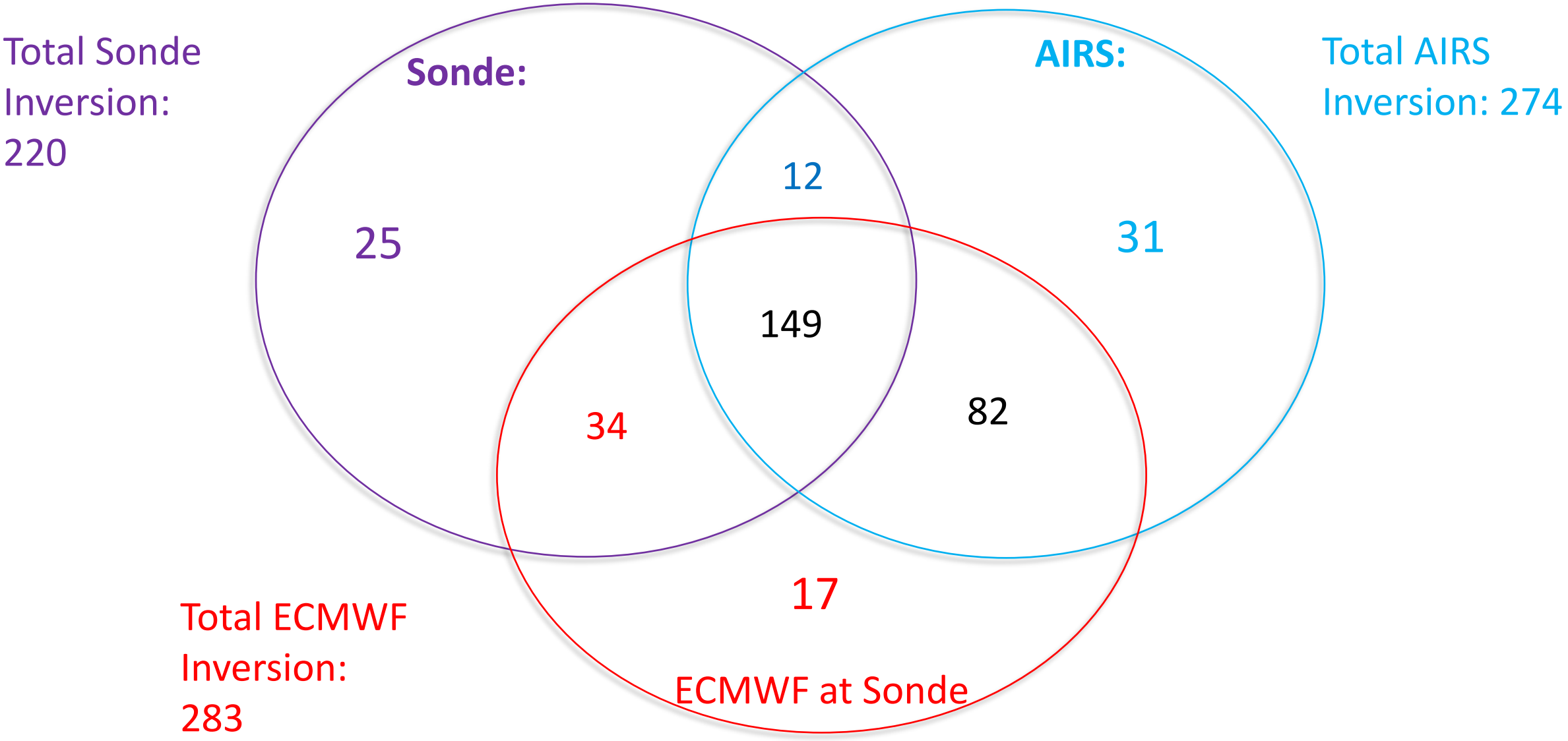
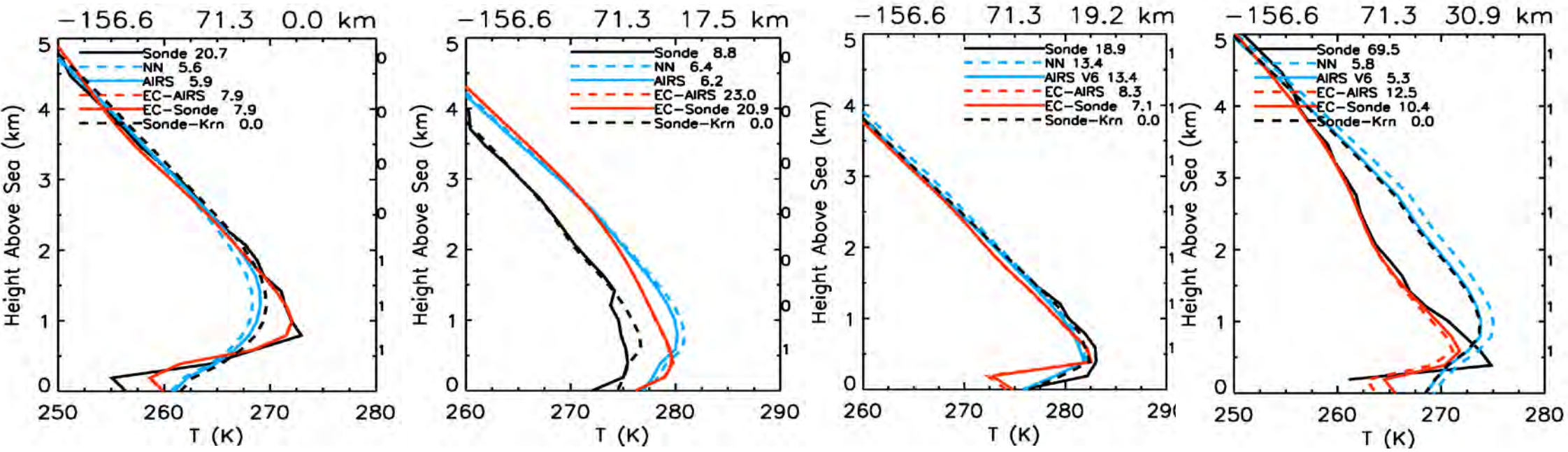
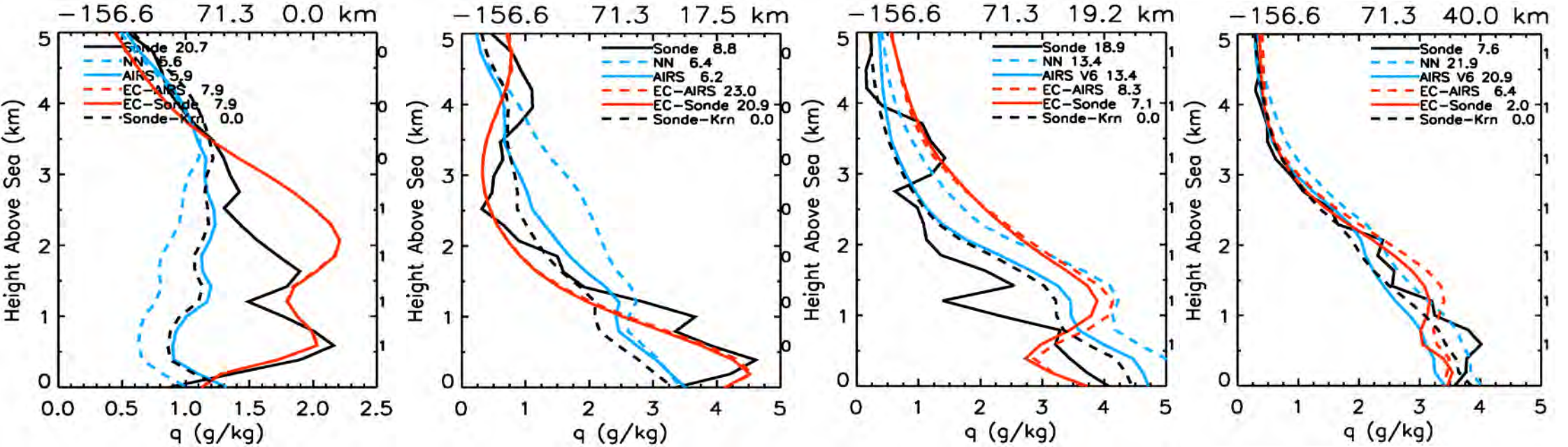


Daytime Sonde & AIRS & ECMWF, Strength > 5 K/km



V6 T



V6 q

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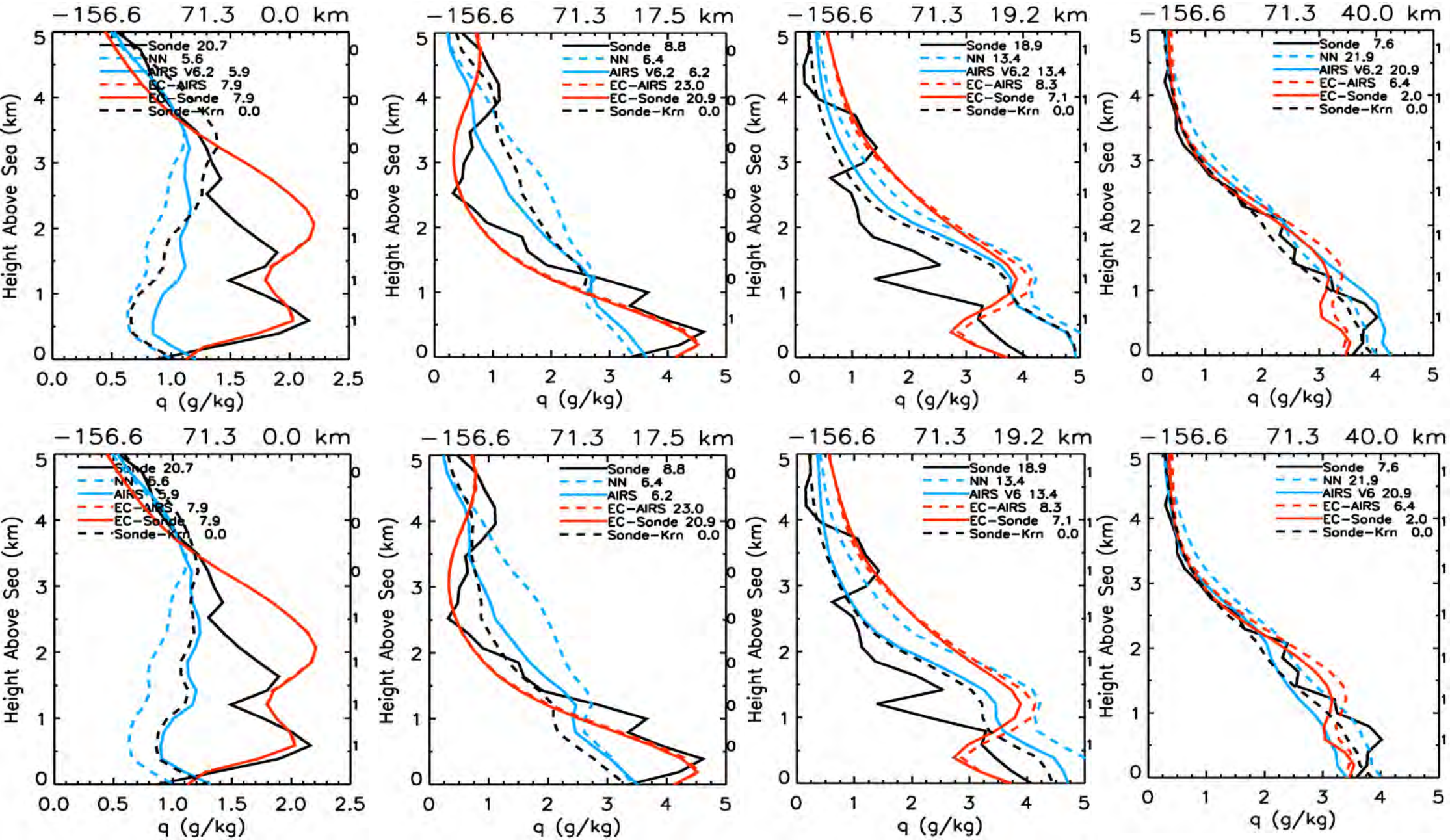
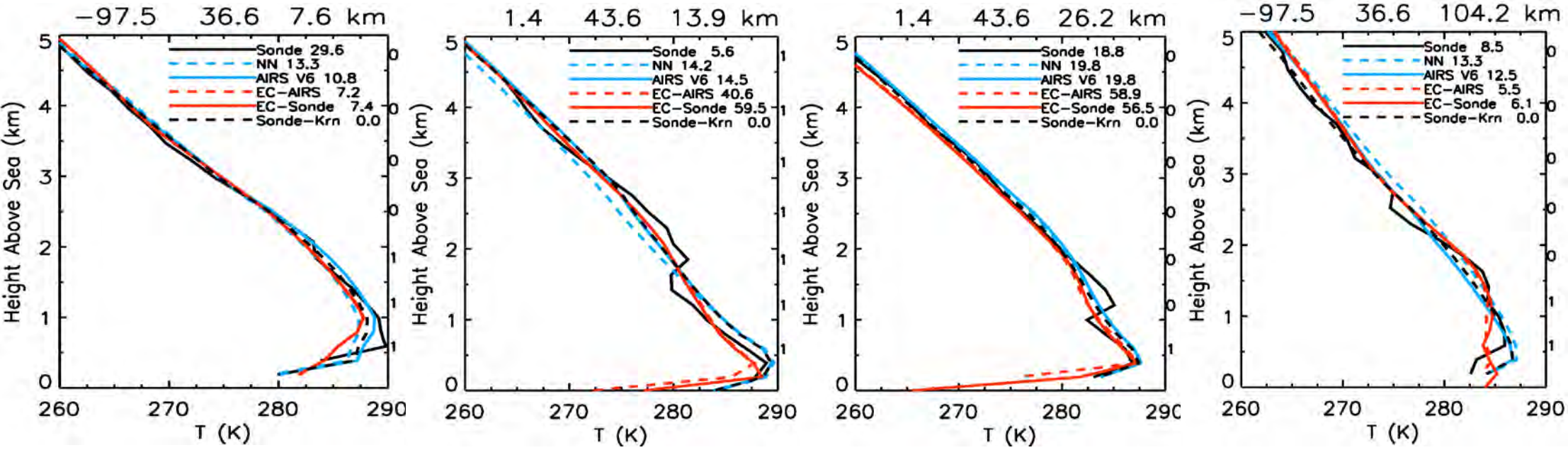


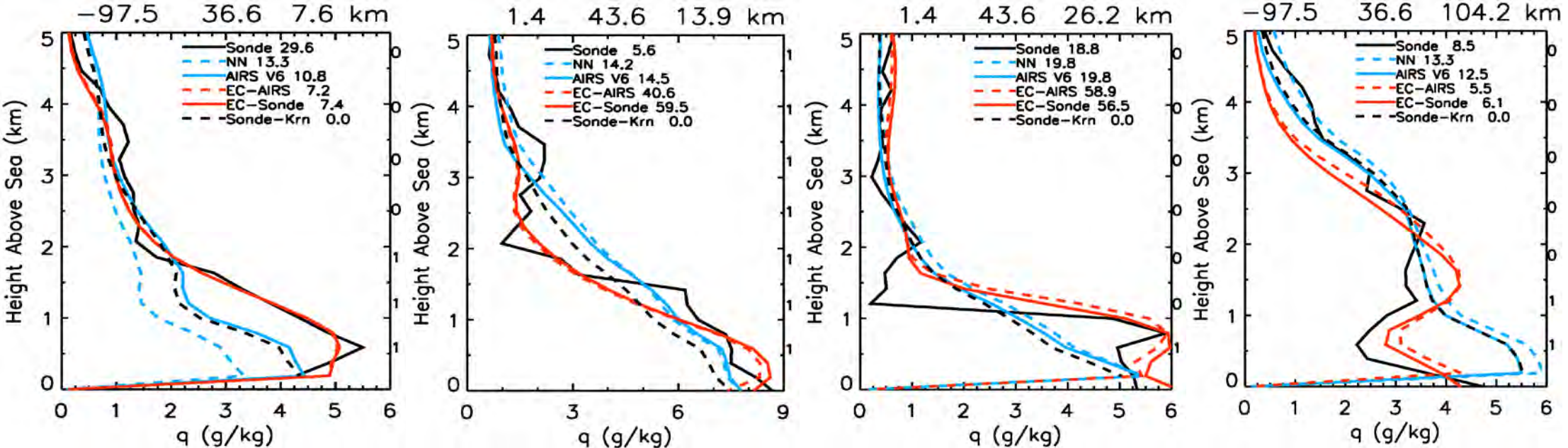
V6.2 q

V6 q

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



V6 T



V6 q

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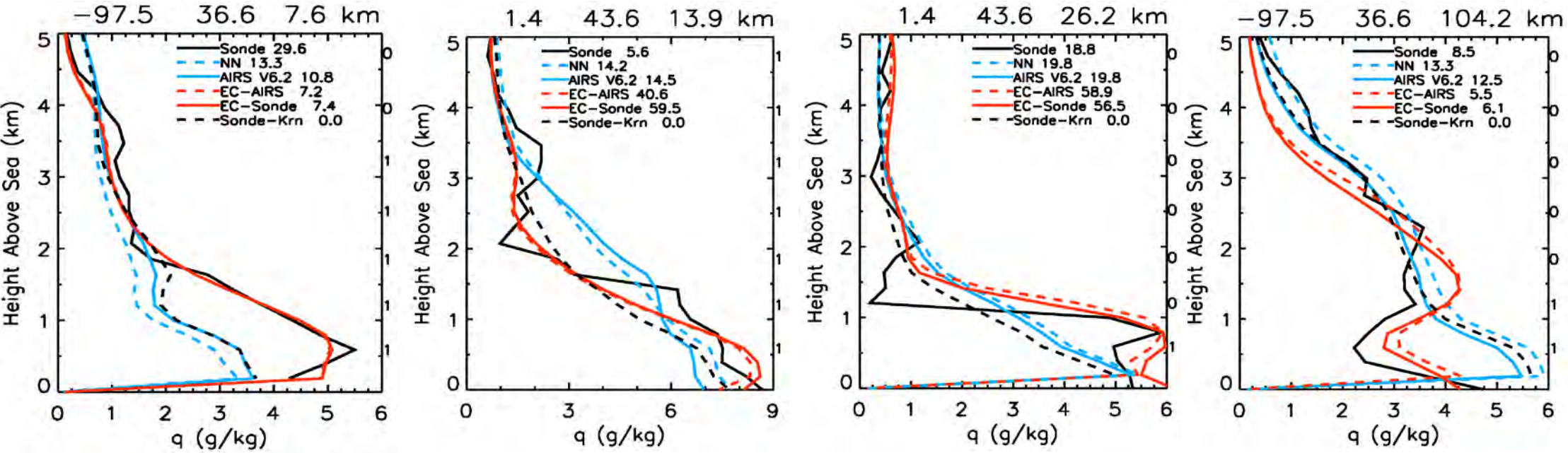
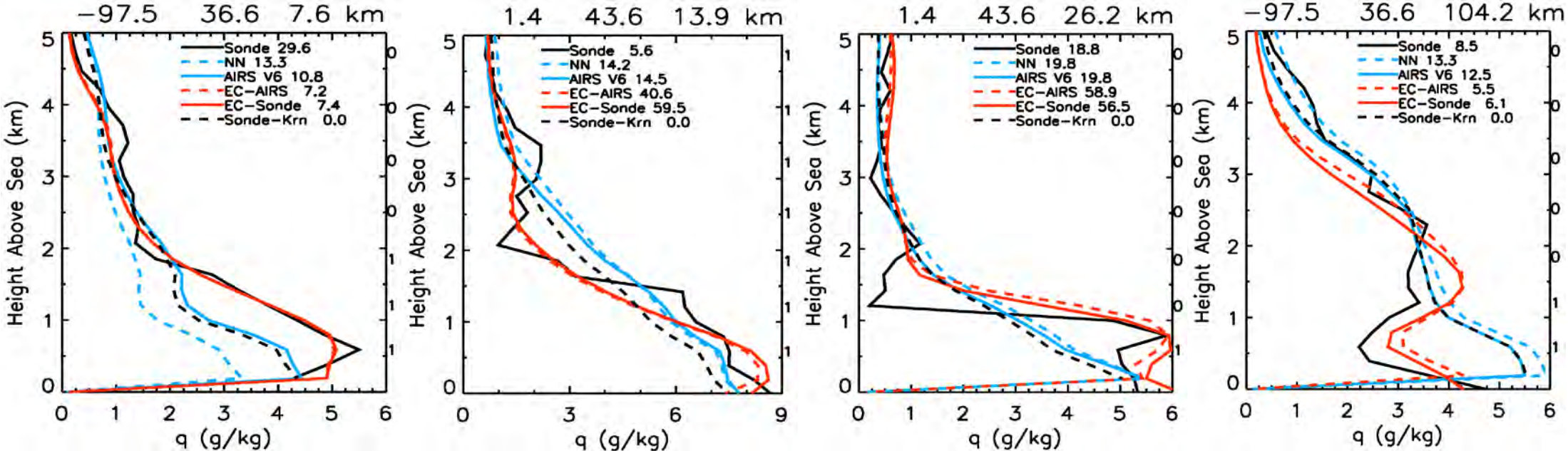


V6.2 q



V6 q