Planetary boundary layer information from GPS radio occultation measurements

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Overview

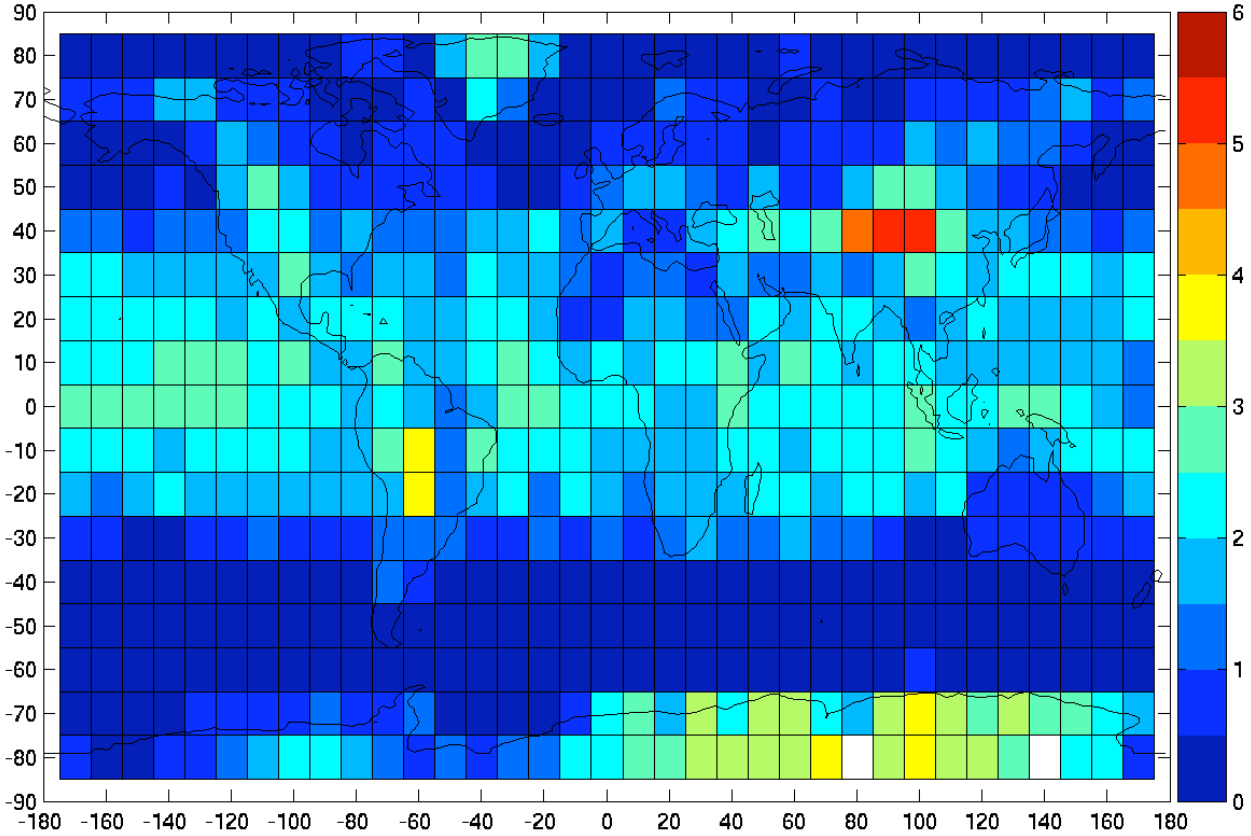
Why GPSRO are useful for studying PBL

- Global, diurnal sampling
- All-weather profiling
- High vertical resolution

Limitations

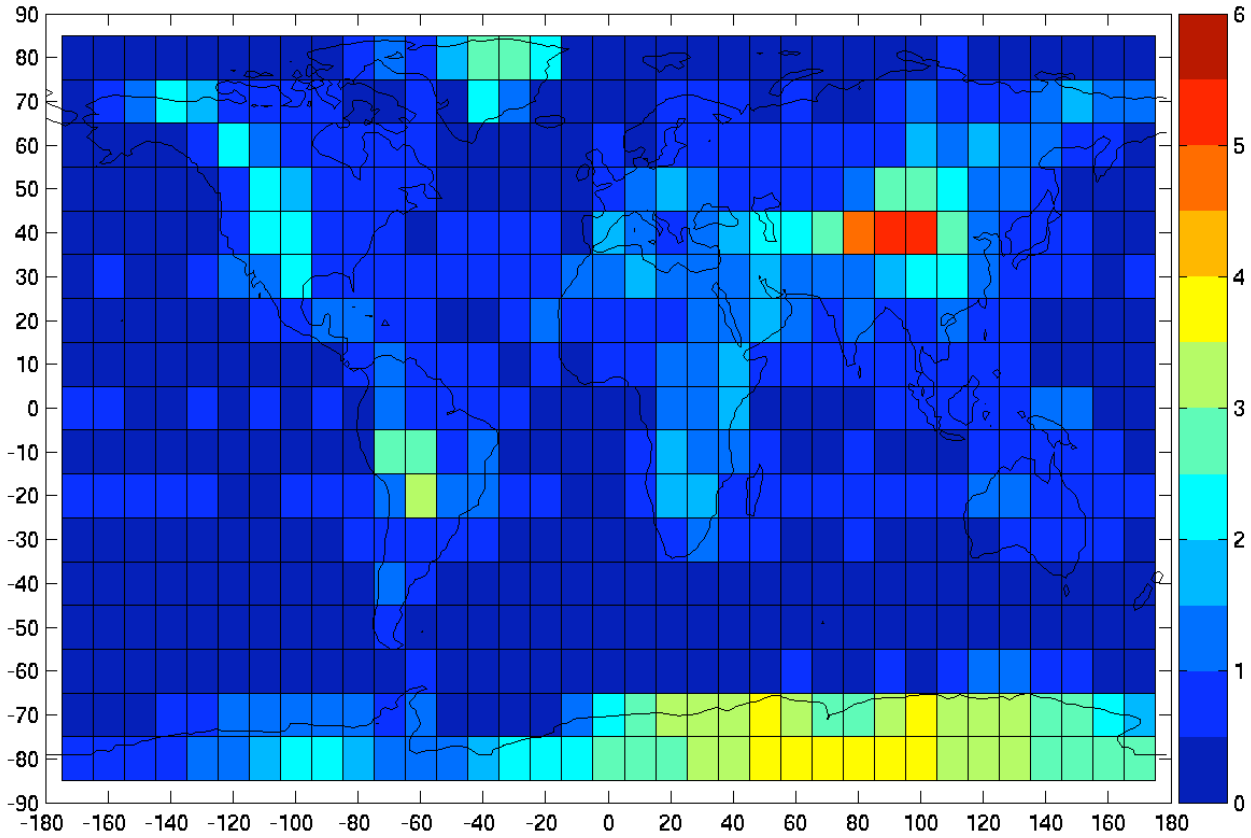
- Not all profiles reach the surface
- Negative N-bias when ducting occurs
- Temperature-humidity ambiguity

Depth Penetration (SAC-C CL)



Only 50% profiles reach < 2 km in the tropics

Depth Penetration (SAC-C OL)



~ 80% profiles reach < 2 km in the tropics

PBL Height/Depth

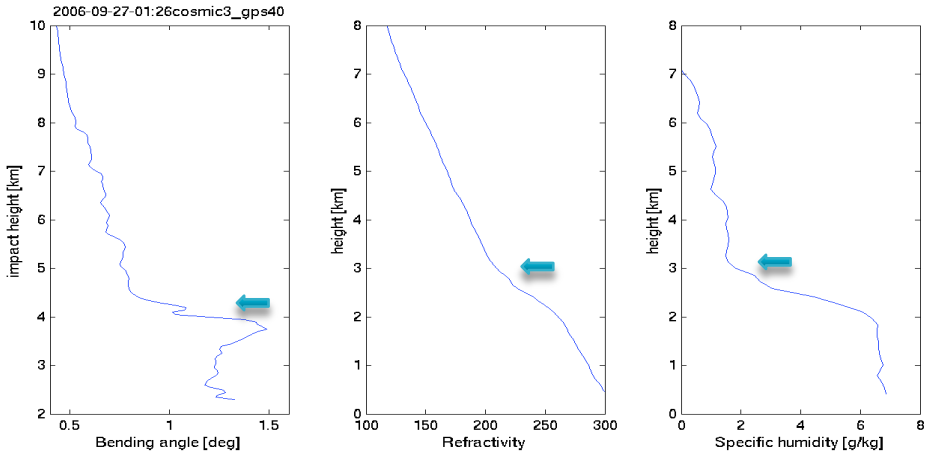
- PBL height is a crucial parameter that describes various PBL processes.
- Global climatology of PBL is poorly established due to lack of observation, esp. over the oceans.
- PBL top is often finely delineated: difficult to model and hard to resolve with most remote sensing observations.

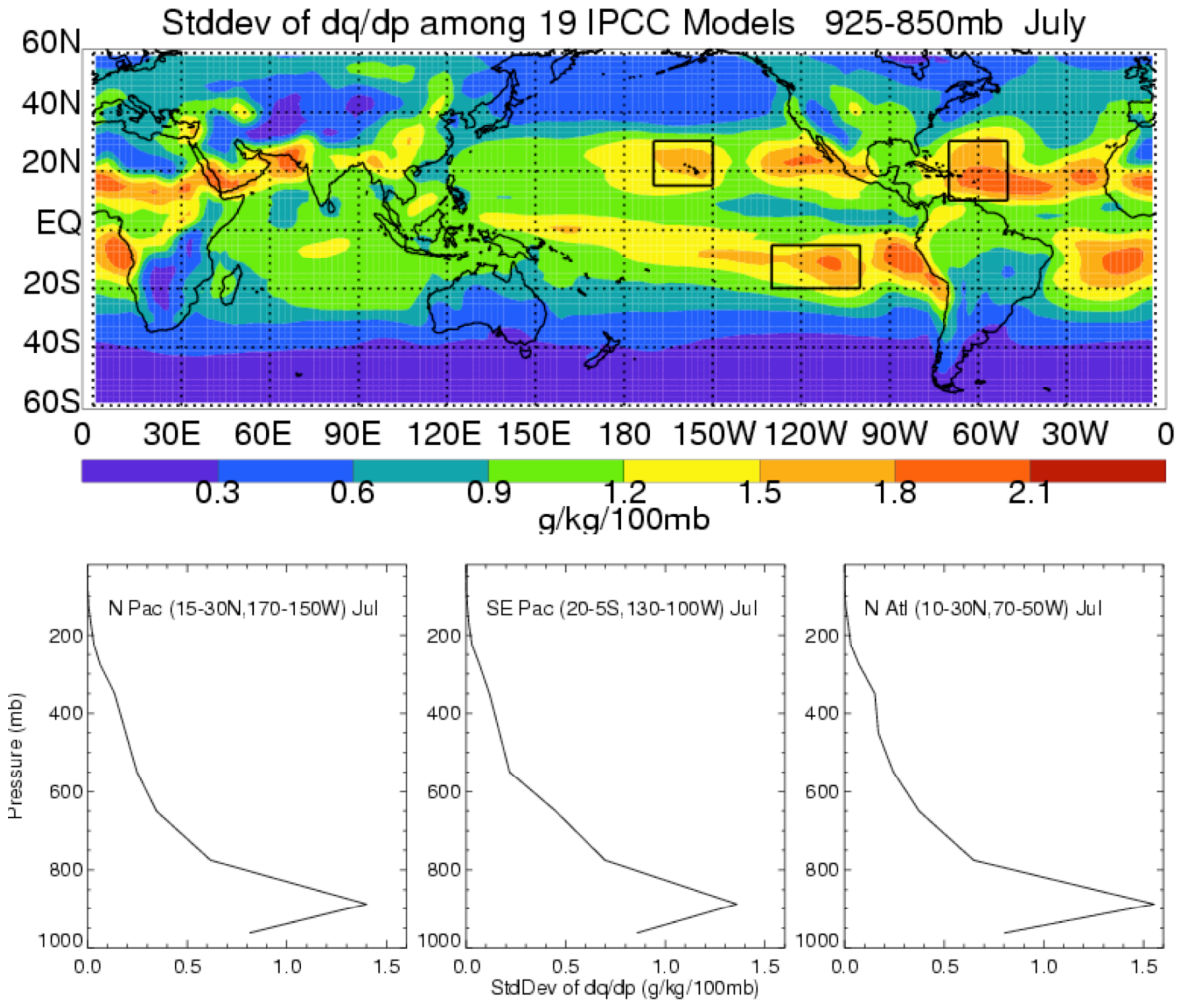
Study Objectives

1. Develop a reasonable algorithm for determining PBL height from GPSRO
2. Validate algorithm
3. Construct global PBL height climatology
4. Compare with models

PBL Height Algorithm

- Options
  - Bending angle [Sokolovskiy et al. 2007]
  - CT/FSI amplitude [von Engeln et al. 2005]
  - Refractivity [Hajj et al., 2003; Sokolovskiy et al. 2006]
- Humidity: more direct comparisons with models
  - ***determine PBL top from the minimum of dq/dz***



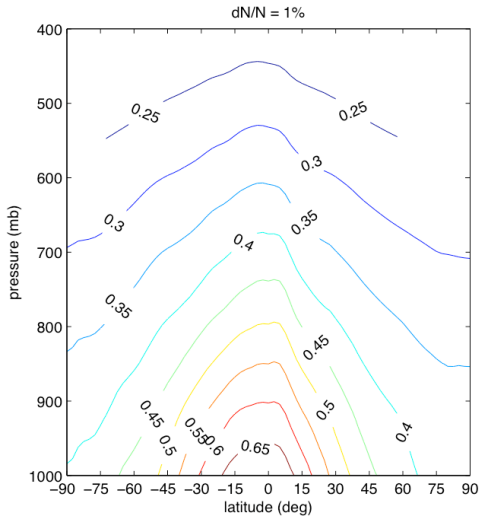

Stddev of dq/dp among 19 IPCC Models 925-850mb July
60N
40N
20N
EQ
20S
40S
60S
0 30E 60E 90E 120E 150E 180 150W 120W 90W 60W 30W 0
0.3 0.6 0.9 1.2 1.5 1.8 2.1
g/kg/100mb
N Pac (15-30N,170-150W) Jul
SE Pac (20-5S,130-100W) Jul
N Atl (10-30N,70-50W) Jul
Pressure (mb)
200
400
600
800
1000
0.0 0.5 1.0 1.5
StdDev of dq/dp (g/kg/100mb)

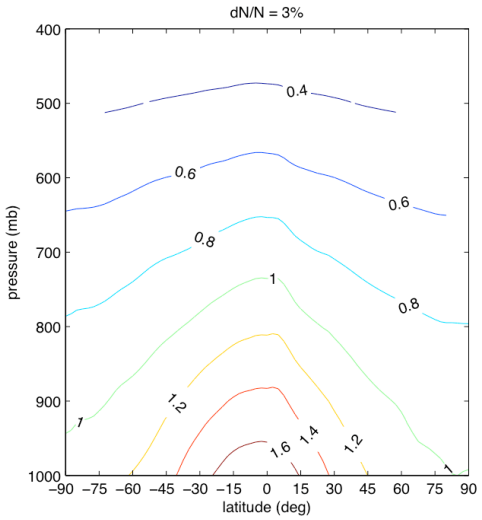
Data

- FORMOSAT-3/COSMIC in 2006-2007
- Processing at JPL
  - Double-differencing
  - Nav. data modulation removed
  - Canonical transform on L1/CA data
  - LT water vapor assuming T from NCEP
  - Data available from http://genesis.jpl.nasa.gov

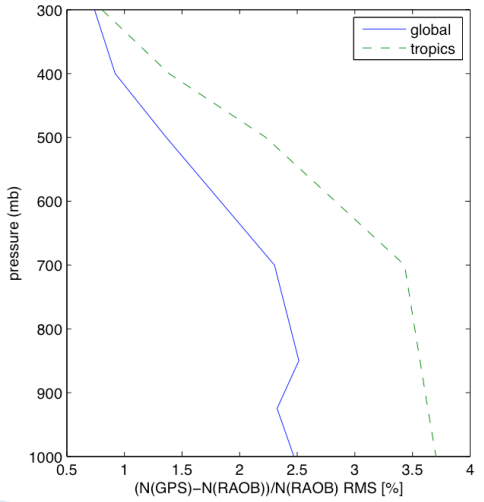
Estimated/Observed Errors

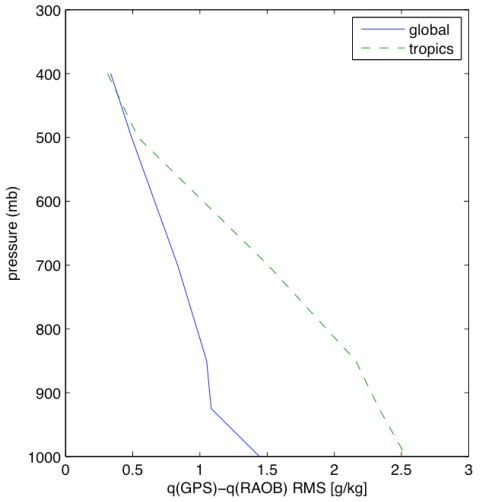
Estimated RMS errors for *q*



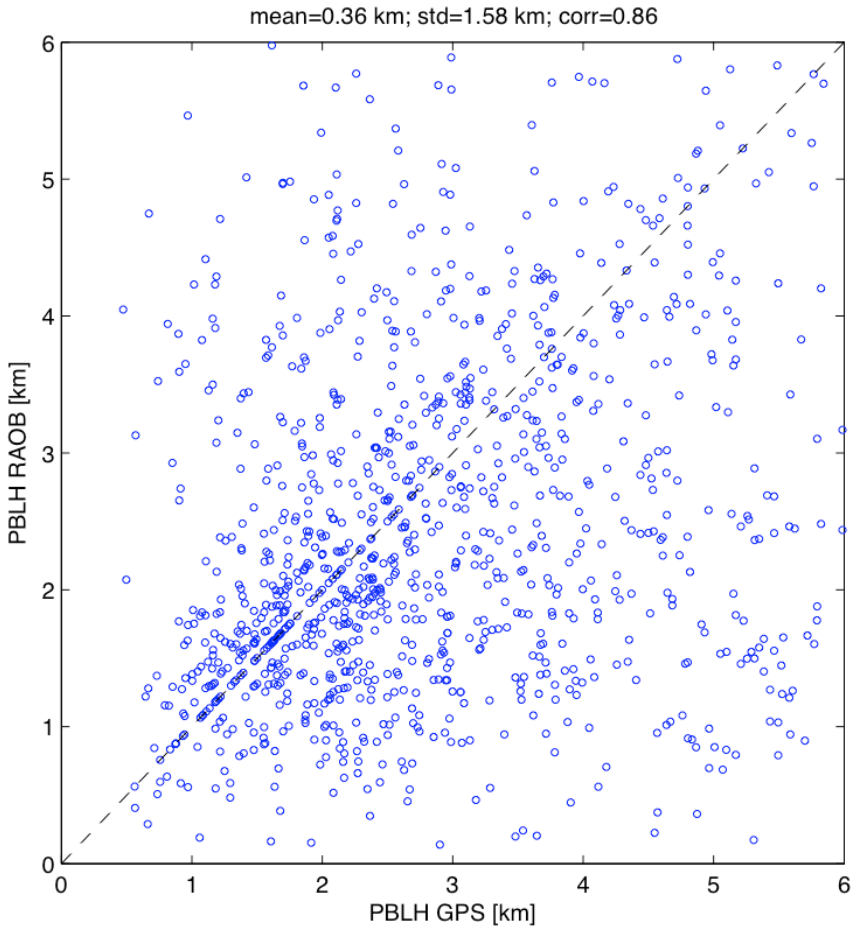


RMS diff. in *N* and *q* wrt RAOB



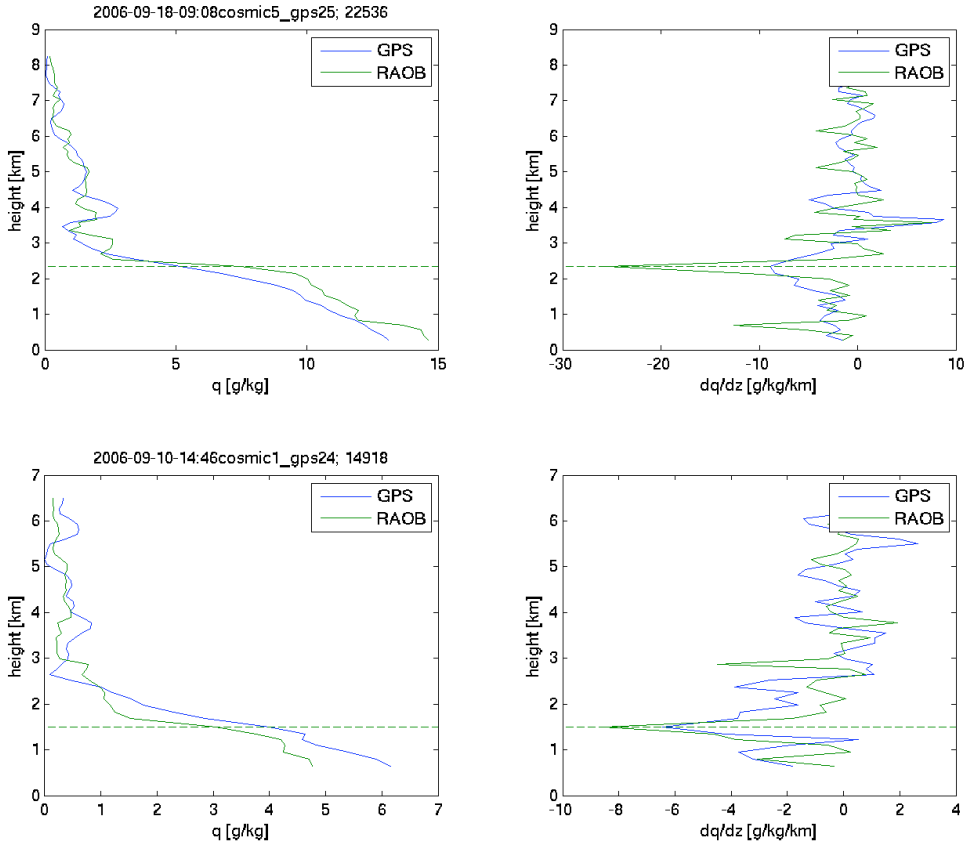


Comparison with RAOB

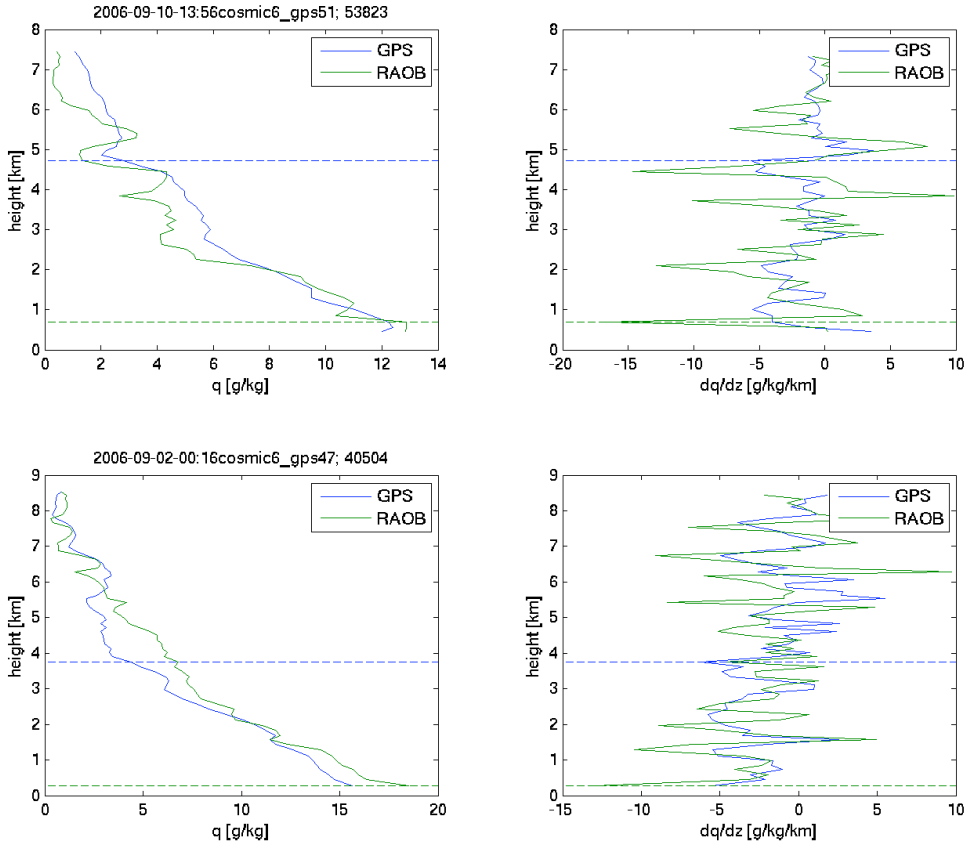


Mean agrees well, but large scatters

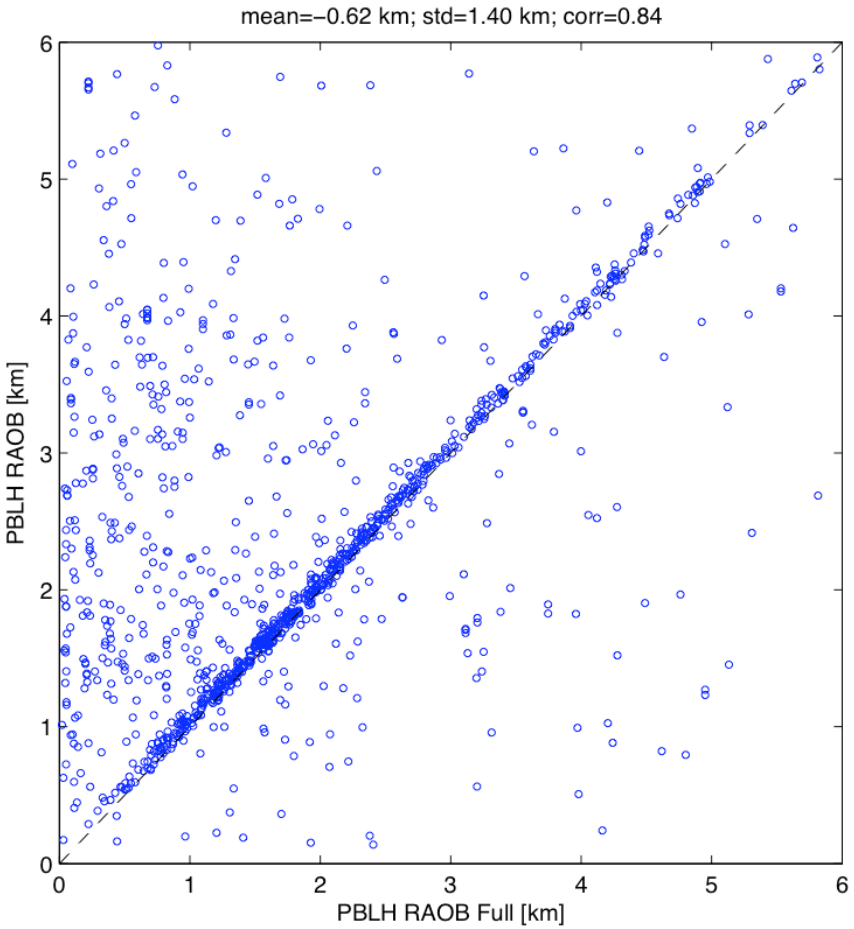
Examples: good agreement



Examples: bad agreement



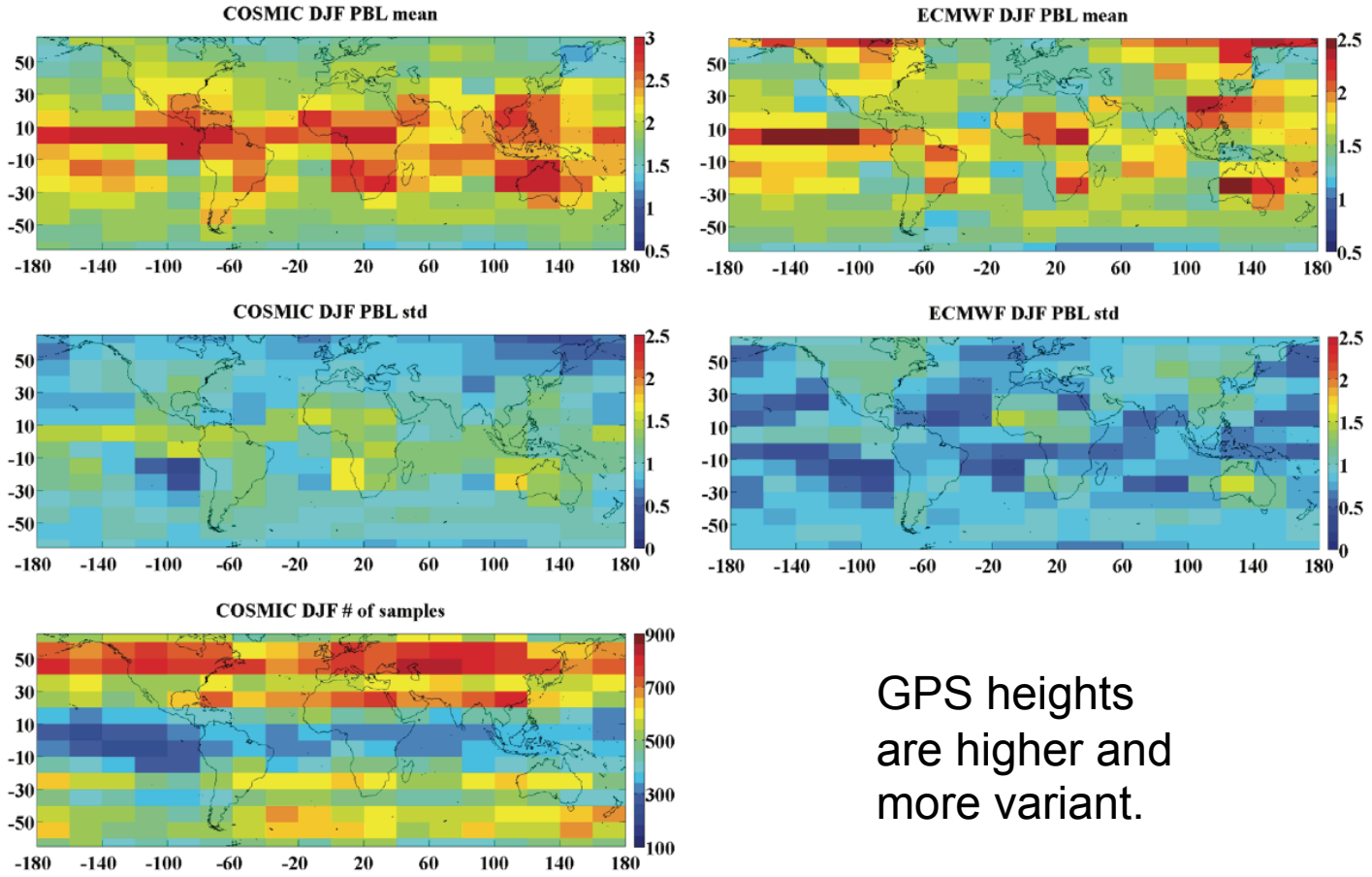
Impact of “Incomplete” Profiles



Incomplete profiles result in higher PBL heights

Comparison with ECMWF

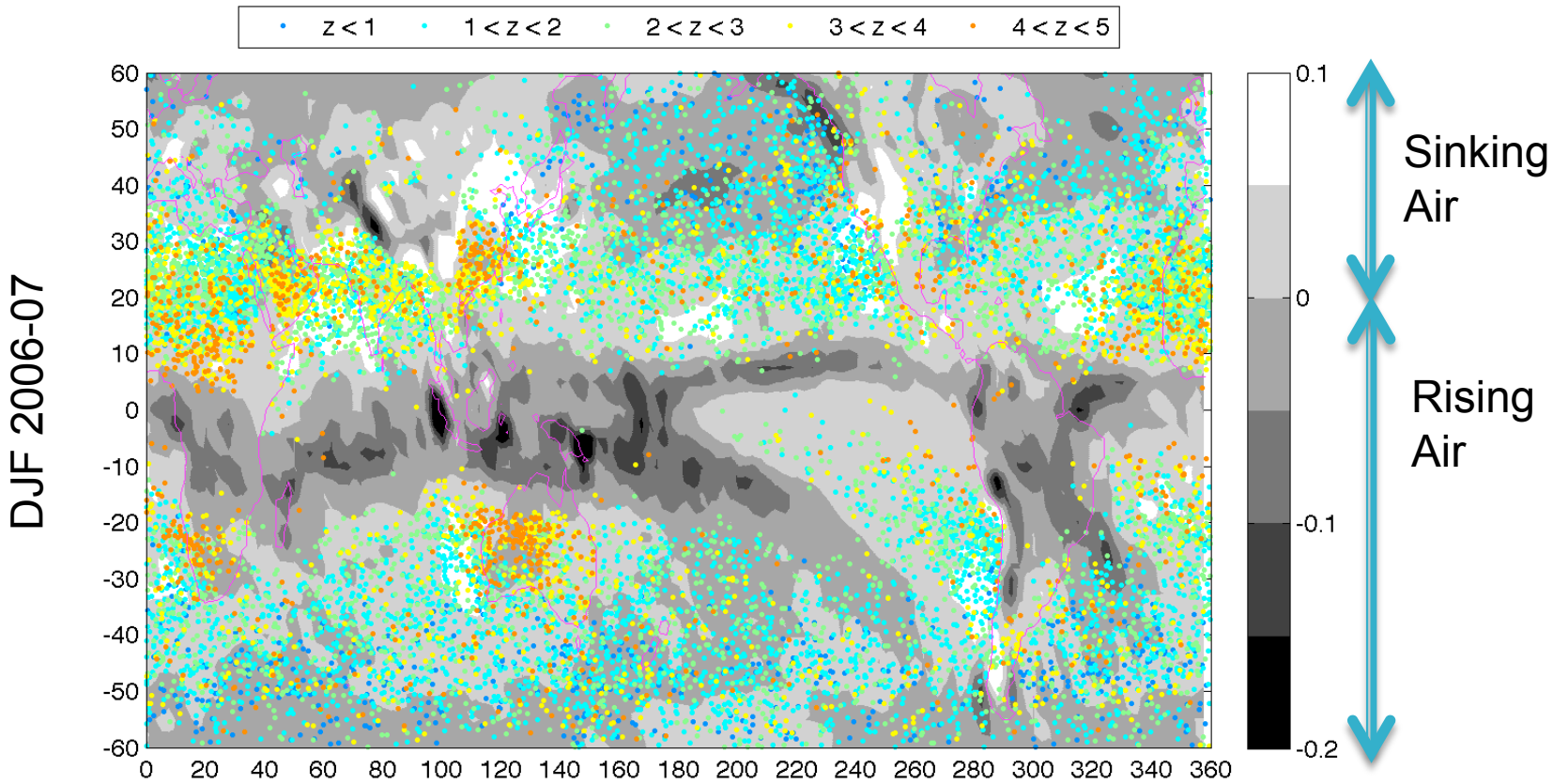
DJF 2006-07



GPS heights are higher and more variant.

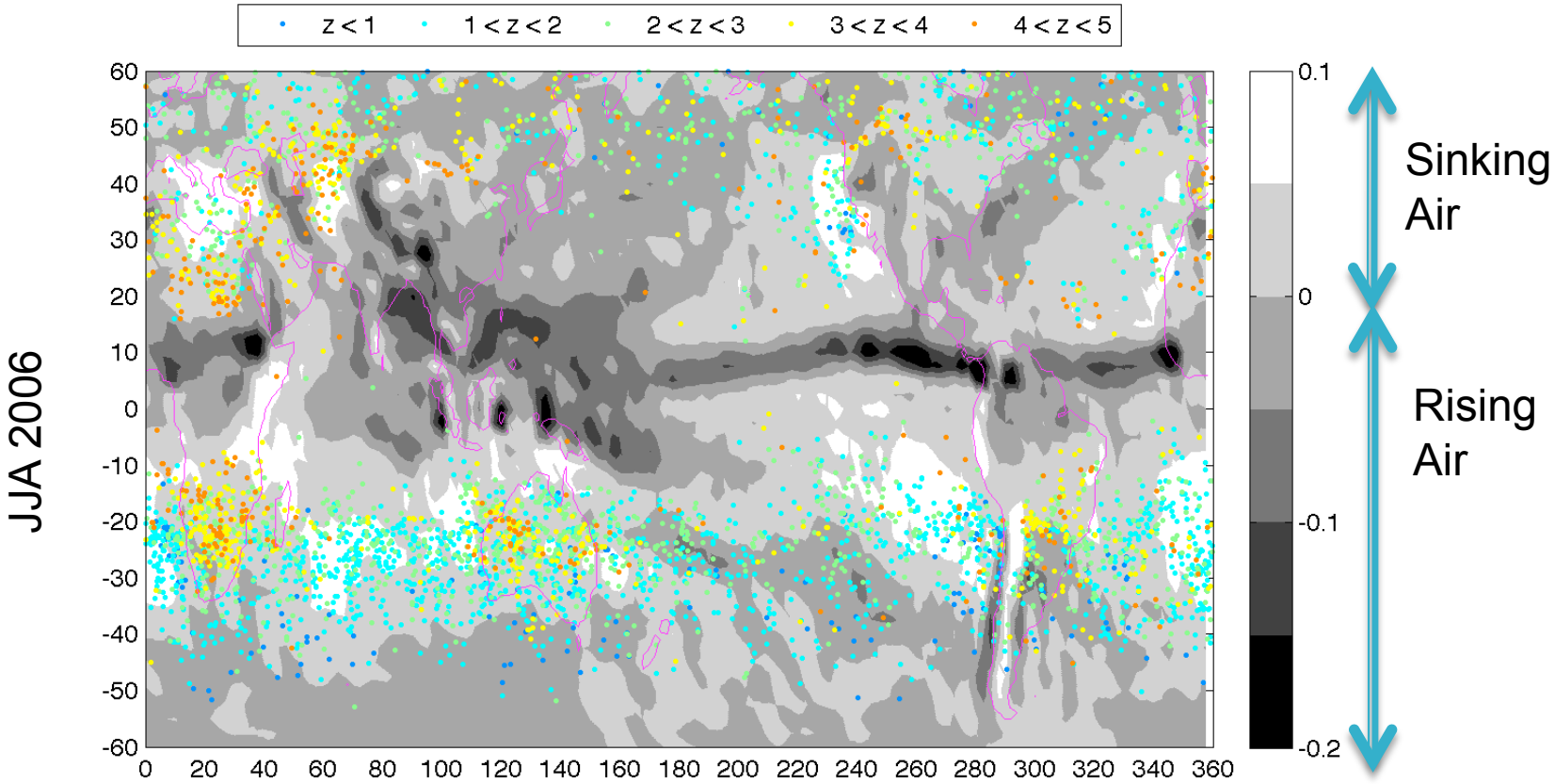
“Sharp” PBL Tops (DJF)

Profiles with “relative sharpness” in the top 25 %-tile



“Sharp” PBL Tops (JJA)

Profiles with “relative sharpness” in the top 25 %-tile



Summary

- GPSRO provides unique opportunities in sensing the PBL (global + diurnal cycle).
- A moisture-based, local-gradient, PBL height definition is proposed and investigated.
- Comparison with RAOB profiles validates approach, also exposes issues.
- Seasonal average comparison with ECMWF shows good agreement in general morphology, with GPS heights being higher and more variant.
- Sharp PBL tops are shown to be predominantly located in the subtropical subsidence region.