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*
Data


- Processing at JPL
  - Double-differencing
  - Nav. data modulation removed
  - Canonical transform on L1/CA data
  - LT water vapor assuming T from NCEP
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

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.