Cloudy Atmospheric Boundary Layer (ABL) Observations over Subtropical Eastern Oceans from COSMIC GPS Occultation (VOCALS/Southeast Pacific Science)

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Motivations

- Low cloud feedback remains large uncertainty in climate models (IPCC-2007).
- Atmospheric boundary layer (ABL) processes control low cloud evolution.
- Global observation of ABL thermodynamic structures is absent.
- Transition from stratocumulus to trade cumuli remains big challenges in weather and climate models.
- GPS Radio Occultation (RO) soundings could fill the gap by providing high vertical resolution ABL structure globally in all weather conditions.

GPS Radio Occultation (RO) Technique

GPS radio occultation senses the atmospheric using GPS radio signals that traverse the atmosphere as a moving receiver sets or rises behind the horizon relative to the GPS satellite. The time delay of the GPS signals due to the refraction (bend) of the signal in the atmosphere is precisely recorded, which can be used to infer the bending angle and refractive index of the atmosphere.

Data Used for ABL Studies


Stratocumulus-topped Boundary Layer

ABL Height Definition: Height of Maximum Refractivity Gradient

Conclusions

- GPS RO signals are very sensitive to the mean large-scale ABL top.
- COSMIC RO detects ABL height variations, which compares favorably to radiosondes.
- ECMWF analysis underestimates the height of the ABL and the gradient across the ABL top, comparing with VOCALS radiosondes over Southeast Pacific.
- All three analyses (ECMWF, NCEP & GEOS-5) produce shallower ABL and different spatial patterns of ABL heights.
- ECMWF analysis produces fewer super-refractions than COSMIC RO observations over Southeast Pacific.
- ECMWF analysis produces similar spatial patterns of ABL heights and gradients.
- ABL heights derived from GPS RO should not be affected by the systematic N-biases.
- The biased ABL structure derived from GPS RO can be corrected with the aid of external constraints and provide global measurements of ABL vertical structures.

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References


Conclusions

- GPS RO signals are very sensitive to the sharp moisture gradient across the ABL top.
- ECMWF analysis systematically underestimates the height of the ABL and the gradient across the ABL top compared with VOCALS radiosondes over Southeast Pacific.
- All three analyses (ECMWF, NCEP & GEOS-5) produce shallower ABL and different spatial patterns of ABL heights compared to COSMIC RO observations over Southeast Pacific.
- ECMWF analysis produces fewer super-refractions at the ABL top than the smaller gradient at the ABL top in RO sounding measurements.
- ABL heights derived from GPS RO should not be affected by the systematic N-biases.
- The biased ABL structure derived from GPS RO can be corrected with the aid of external constraints and provide global measurements of ABL vertical structures.

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