Planetary Boundary Layer Height from AIRS, MERRA-2, and GPS Radio Occultation Data Products at NASA GES DISC, and Insights from Their Profiles Intercomparison

10-year (06/2006 to 12/2015) Seasonal Mean of PBL Height Comparison from AIRS, MERRA-2, and GPS-RO

Abstract

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) provides archive and distribution services for several data products in the Planetary Boundary Layer (PBL) category. As a new variable added to the Atmospheric Infrared Sounder (AIRS) Version 6 support product, the PBL height from AIRS is derived based on the gradients of the retrieved relative humidity profile, and provides the atmospheric pressure at the top of the PBL over the ocean. The GES DISC also hosts the Modern-Era Retrospective analysis for Research and Applications-2 (MERRA-2) product generated by the Goddard Earth Observing System Model Version 5 (GEOS-5) data assimilation system. The PBL height from MERRA-2 is based on the total eddy diffusion coefficient of heat. The PBL height has been made available in the Giovanni system (Giovanni is a Web-based application developed by the GES DISC providing a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data). Recently, the GES DISC began serving the global PBL height climatology product derived from the COSMIC/FORMOSAT-3 and TerraSAR-X Global Positioning System (GPS) radio occultation (RO) measurements from June 2006 to December 2015.

In a previous study, we presented the monthly PBL height data from AIRS and MERRA-2 and demonstrated the GES DISC services which support data intercomparison, such as access, plotting, subsetting, re-gridding, and generation of a multi-year monthly mean. We also provided intercomparison results, and found that different PBL height definitions contributed to significant differences of PBL height values between AIRS and MERRA-2. In this work, we present the 10-year seasonal climatologies from the AIRS, MERRA-2 and GPS-RO. We also used the cross section and vertical profile services in Giovanni to display and analyze the vertical atmosphere structure over regions where the PBL height derived from the AIRS and MERRA-2 are quite different. The examination of the AIRS and MERRA-2 three-dimensional data found that the relative humidity profiles had larger differences than the temperature profiles. The MERRA-2 gives more details than the AIRS for the vertical distribution of the humidity.

Products with PBL Height in GES DISC

- AIRS Support Product
  - Version 6, 09/2009 to present, available over the ocean
  - Pressure (hPa) at top of PBL
- MERRA-2
  - 01/1980 to present, global
  - Monthly PBL Height in Giovanni
- COSMIC/FORMOSAT-3 & TerraSAR-X GPS-RO
  - 06/2006 to 2015 climatology
  - Annual and seasonal mean of PBL Height

Dataset and 10-year Seasonal Mean Processing

- Comparison of Multi-year Seasonal Mean
  - Nearly 10 years of data: 06/2006 to 12/2015
- AIRS-only Monthly Level 3 Support Product
  - DOI: 10.5067/Aqua/AIRS/DATA324
  - Resolution: 1° x 1° (lat x lon)
  - Convert PBL top pressure (hPa) to altitude (meters), using Geopotential Height field.
  - Average ascending and descending
- MERRA-2
  - DOI: 10.5067/JRLVL8YV2Y4
  - Resolution: 0.5° x 0.625° (lat x lon)
  - Re-gridded to 1° x 1° (lat x lon), using L3L4 regridder
  - Derived PBL height using the same definition as AIRS and GPS-RO: the level of the largest relative humidity gradient
  - DOI: 10.5067/XGL1QBKFBI5B
  - Resolution: 2° x 2° (lat x lon)

Summary

- GES DISC provides PBL data and services from AIRS, MERRA-2, and GPS-RO for PBL study.
- Comparisons of AIRS-derived PBL height with model reanalysis data over the ocean show different PBL height definitions contribute to significant differences.
- The 10-year seasonal climatologies of PBL height from AIRS, MERRA-2, and GPS-RO show different seasonal changes over ocean.
- The 10-year seasonal climatology of PBL depth from AIRS is shallower than those from the MERRA-2 and GPS-RO.
- The vertical structure analysis services in the GES DISC, such as cross section and vertical profile plots, are very helpful to examine PBL height differences from different definitions and pattern differences.
- The work supports a use case for the Cloud Analytics Reference Architecture User Working Group in ESDIS.
- More vertical structure analysis work will be done to include GPS-RO data in the future.

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