PBL Heights From AIRS Version 7 & 6, COSMIC Radio Occultation, and MERRA-2 Products in GES DISC, and Their 10-year Mean Intercomparisons

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NASA Sounder Science Team Meeting
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Goddard Earth Sciences
Data and Information Services Center

Outline

- Products with Different Planetary Boundary Layer Height (PBLH) Definitions in Goddard Earth Sciences Data and Information Services Center (GES DISC)

  AIRS, COSMIC Radio Occultation (RO), and MERRA-2

- PBLH Comparison

  AIRS V7 vs V6: 2006 monthly, IR-only retrieval product

  AIRS, COSMIC RO, MERRA-2: 10-year seasonal means

- Services to Synergize Multiple Products for PBL Study
- Summary

Products with PBLH in GES DISC

- AIRS

  In AIRS support product (L2, L3), 09/2002 ~ present

  L3: 1^0 X 1^0 (lat X lon)

  Pressure (hPa) at top of PBL, available over the ocean

  AIRS V7 monthly variables available in Giovanni, daily variables coming soon

- COSMIC/FORMOSAT-3 & TerraSAR-X GNSS-RO

  06/2006 to 12/2015 (~ 10-year) climatology, 2^0 X 2^0 (lat X lon)

  Annual and seasonal mean of PBL Height

  PBL height/depth in meters

- Future Sentinel 6 RO Product (high vertical resolution)

- MERRA-2

  NASA GEOS model reanalysis product

  1980 ~ present, hourly, daily, monthly, 0.5^0 X 0.625^0

  PBL height/depth in meter

  Monthly PBLH available in Giovanni

PBLH Definition Differences

- AIRS

The boundary layer top height is the pressure of the level with the largest gradient of a relative humidity (relative to liquid phase of water) layer profile calculated on the support pressure layer grid.

Joao Martins, Joao Teixeira, and coauthors (2010): Infrared sounding of the trade-wind boundary layer: AIRS and RICO experiment.

- GNSS-RO

The PBL height is calculated as the height where the vertical gradient of the refractivity (dN/dz) is minimum.
Ao et al. (2012): Planetary boundary layer heights from GPS radio occultation refractivity and humidity profiles

- MERRA-2

Based on the total eddy diffusion coefficient of heat (K_h)

Threshold value $2 m^2 s^{-1}$

E. L. McGrath-Spangle and A. Molod (2014): Comparison of GEOS-5 AGCM planetary boundary layer depths computed with various definitions.

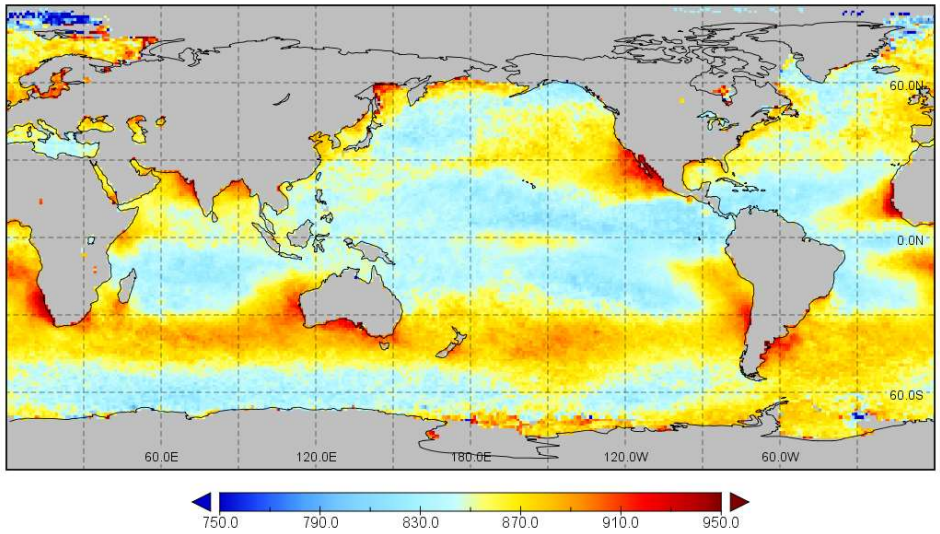
AIRS (IR-only) V6 vs V7, Jan 2006

V6

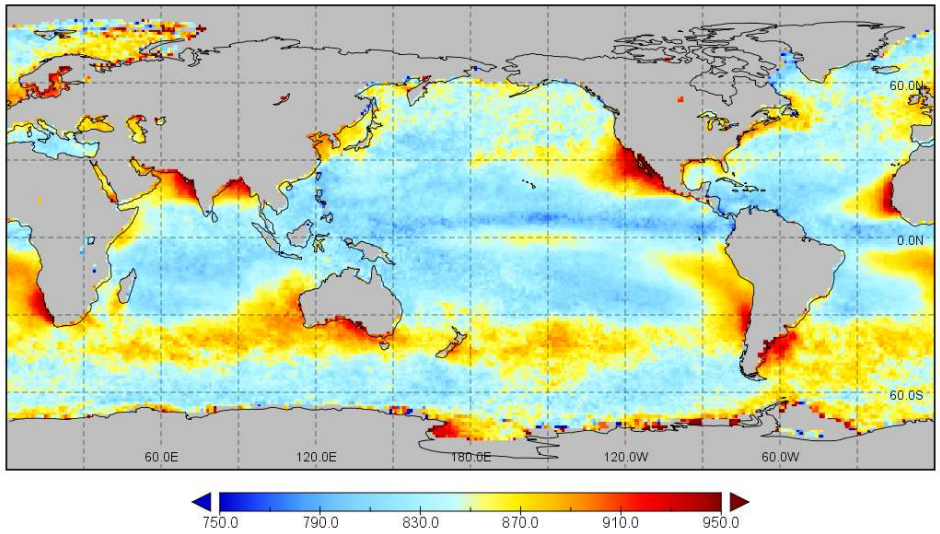
V7

Ascending/Daytime

January 2006, bndry_lyr_top_A (hPa), V6

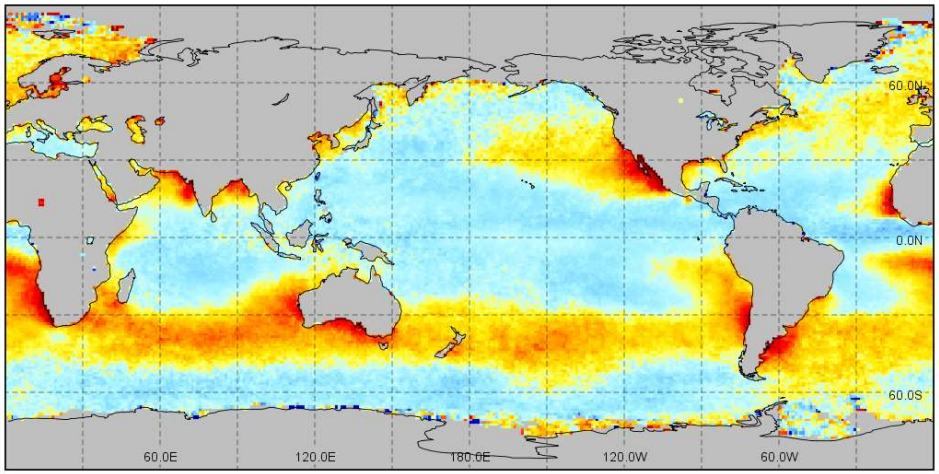


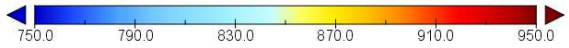
January 2006, bndry_lyr_top_A (hPa), V7



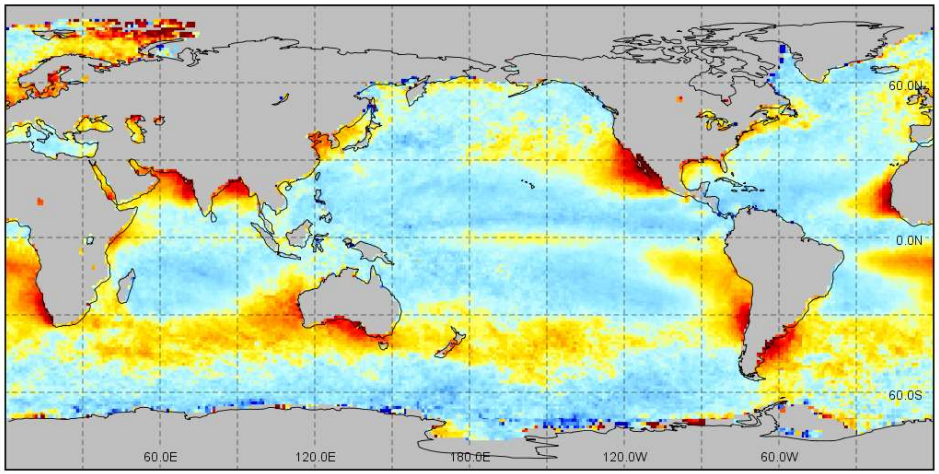
Descending/Nighttime

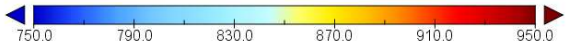
January 2006, bndry_lyr_top_D (hPa), V6





January 2006, bndry_lyr_top_D (hPa), V7



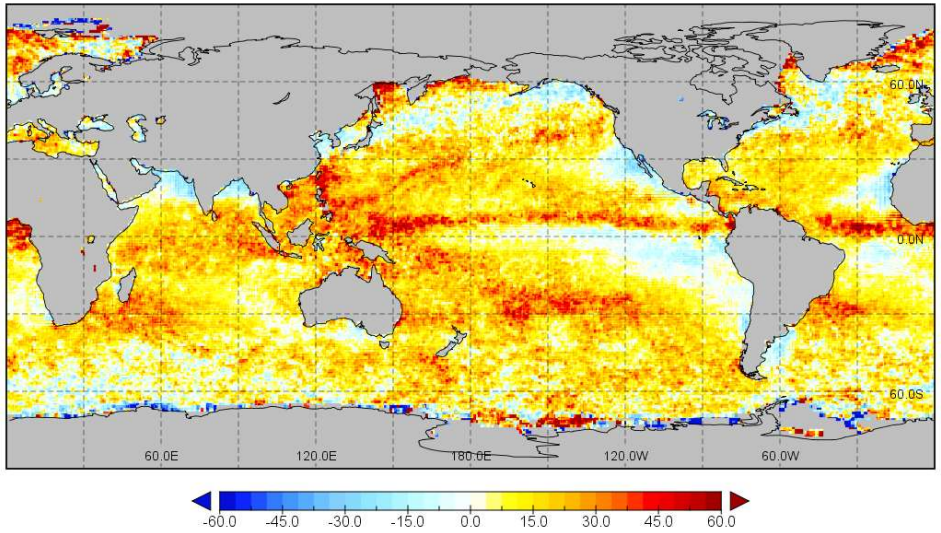


V6 minus V7, January & July 2006

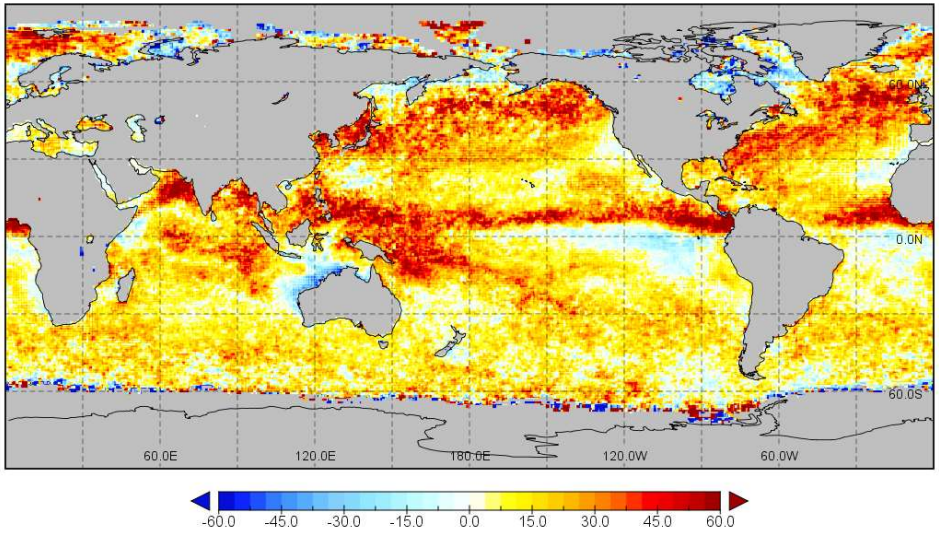
January July

Ascending/Daytime

January 2006, bndry_lyr_top_A (hPa), V6 - V7

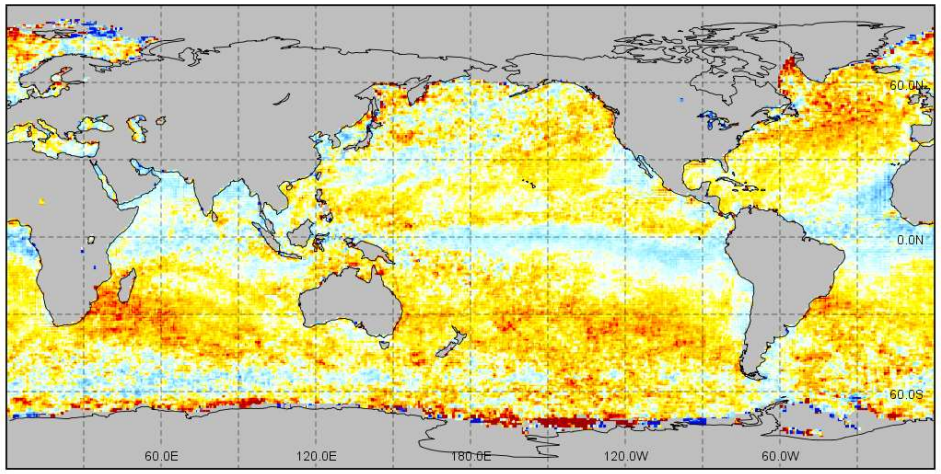


July 2006, bndry_lyr_top_A (hPa), V6 - V7

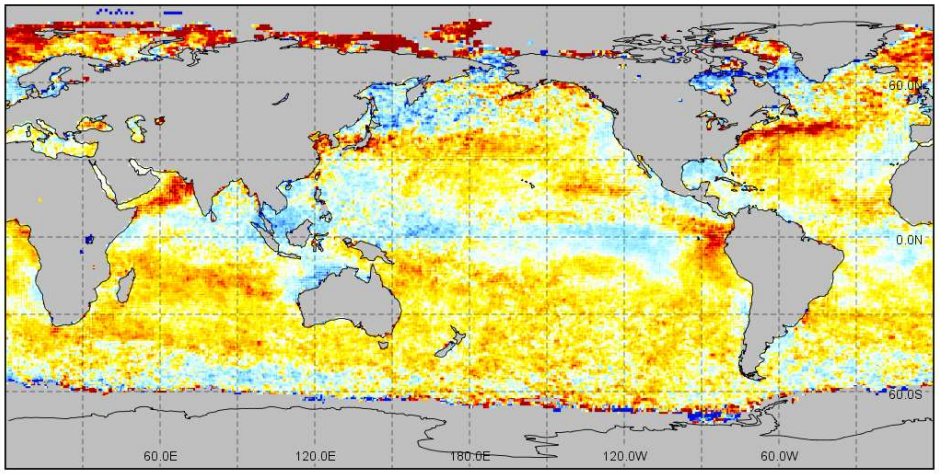


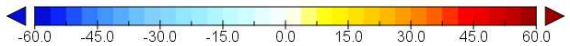
Descending/Nighttime

January 2006, bndry_lyr_top_D (hPa), V6 - V7

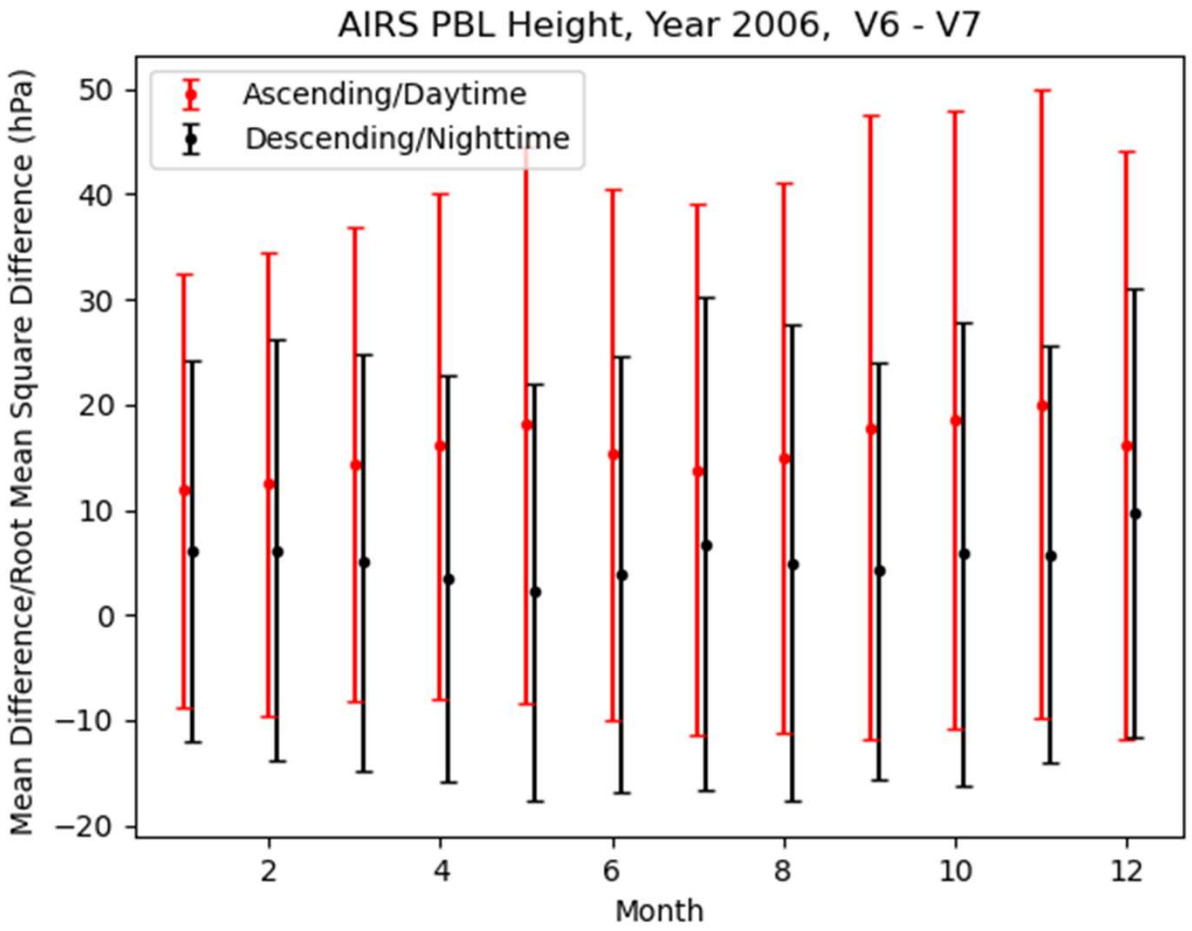


July 2006, bndry_lyr_top_D (hPa), V6 - V7





Mean Difference/Root Mean Square Difference (hPa) each month in 2006, AIRS V6 – V7



AIRS V7 vs V6

- The PBL top of AIRS V7 is higher than that of V6.

- The increment (V7 vs V6) of PBL top at ascending/daytime is more than the increment at descending/nighttime.

- V7 shows more obvious/sharp transition from a shallower PBL zone along the equator to a deeper PBL region toward north and south pole.

AIRS, GNSS-RO, MERRA-2 Comparison

- Over the ocean
- 10-year (06/2006 – 12/2015) seasonal mean
- AIRS

  Convert the PBL top pressure (hPa) to altitude (m) using geopotential height field.

  Average the ascending/daytime and descending/nighttime.

- MERRA-2

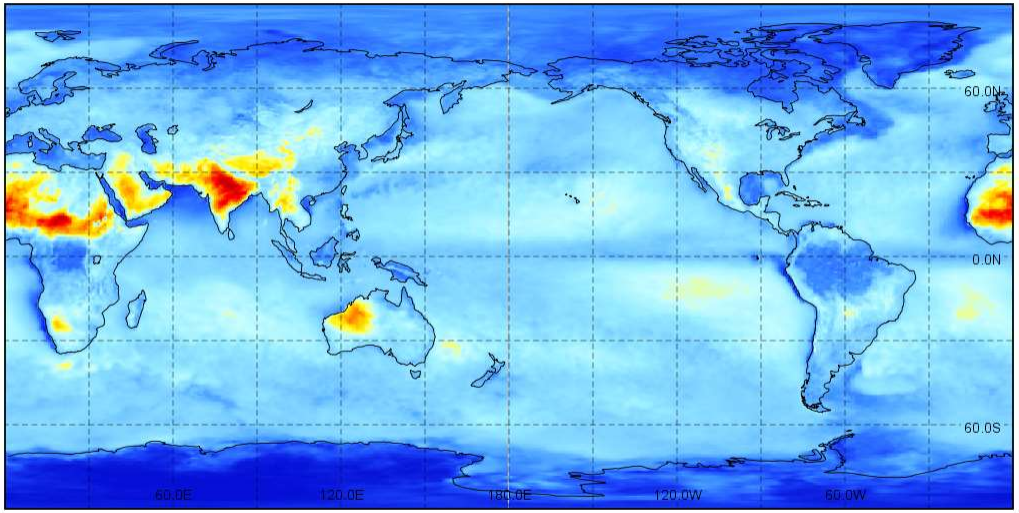
  Use AIRS PBLH definition

  Find the PBL top at the level with the largest gradient of relative humidity

  Convert PBL top pressure (hPa) to altitude (m) using geopotential field.

MERRA-2 PBL Heights with Different Definitions

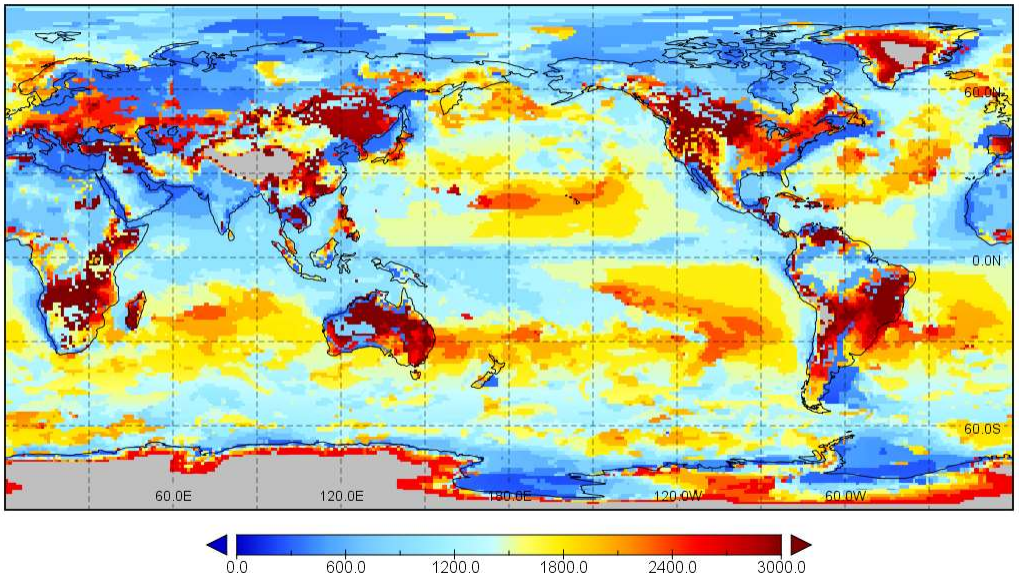
MERRA-2 PBL Height (meter) from Eddy Diffusion Coefficient of Heat, April 2010



April 2010

PBL Height in MERRA-2 product

MERRA-2 PBL Height (meter) from Relative Humidity, April 2010

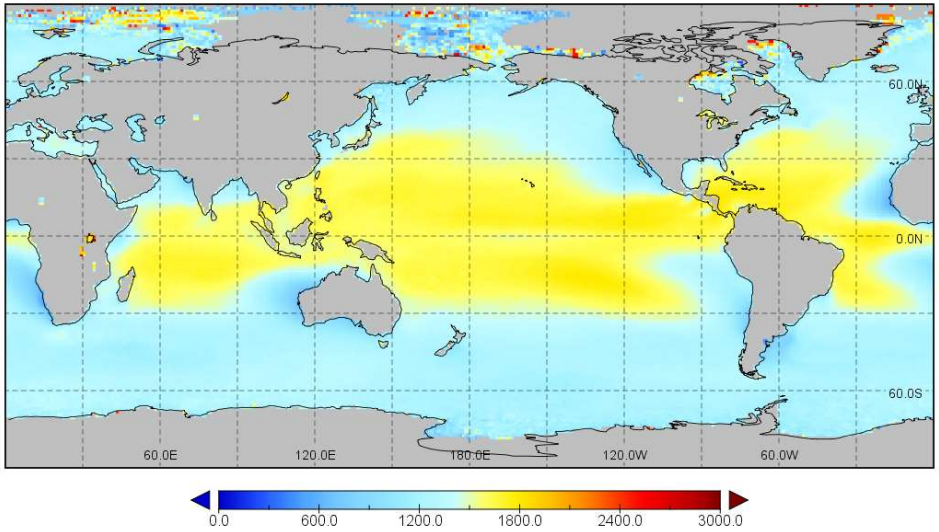


PBL Height derived with the definition in AIRS product

10-year DJF Seasonal Mean PBLH Comparison

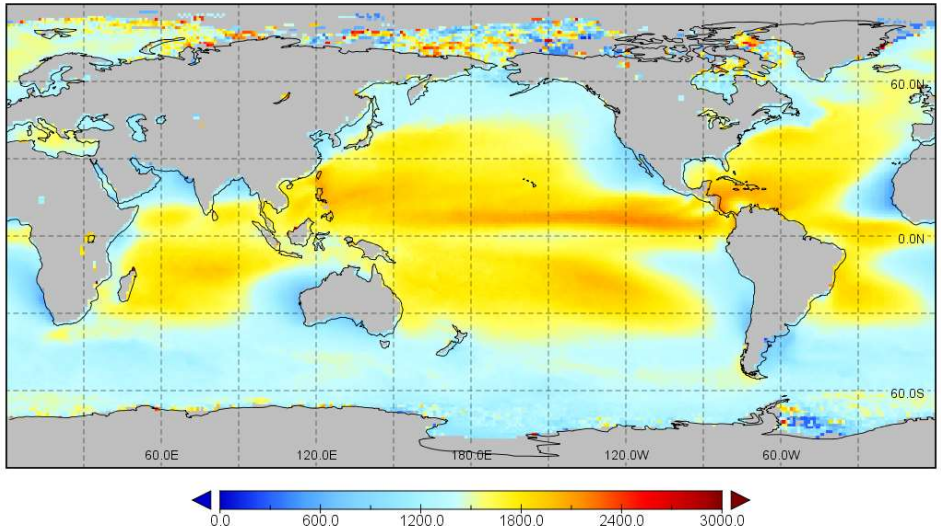
AIRS V6

DJF Seasonal Planetary Boundary Layer Height (m) from AIRS V6



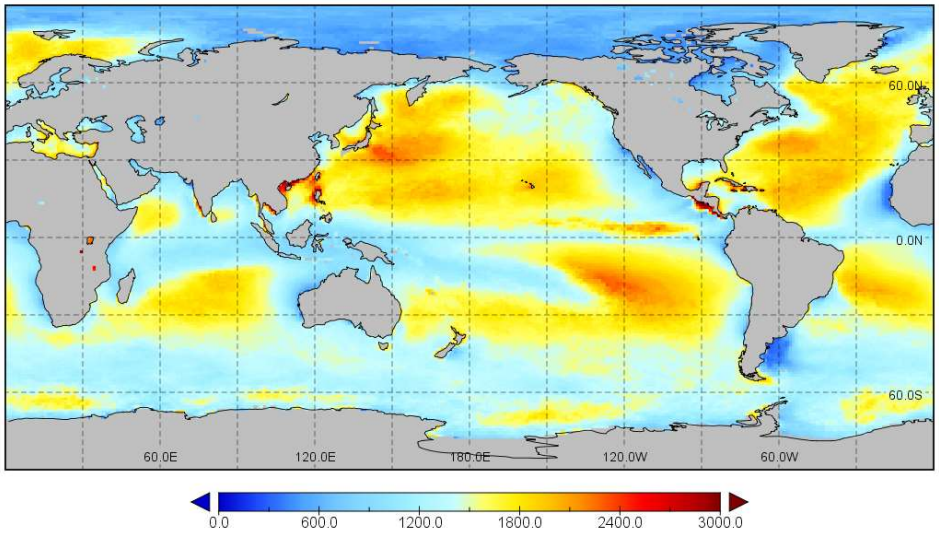
AIRS V7

DJF Seasonal Planetary Boundary Layer Height (m) from AIRS V7



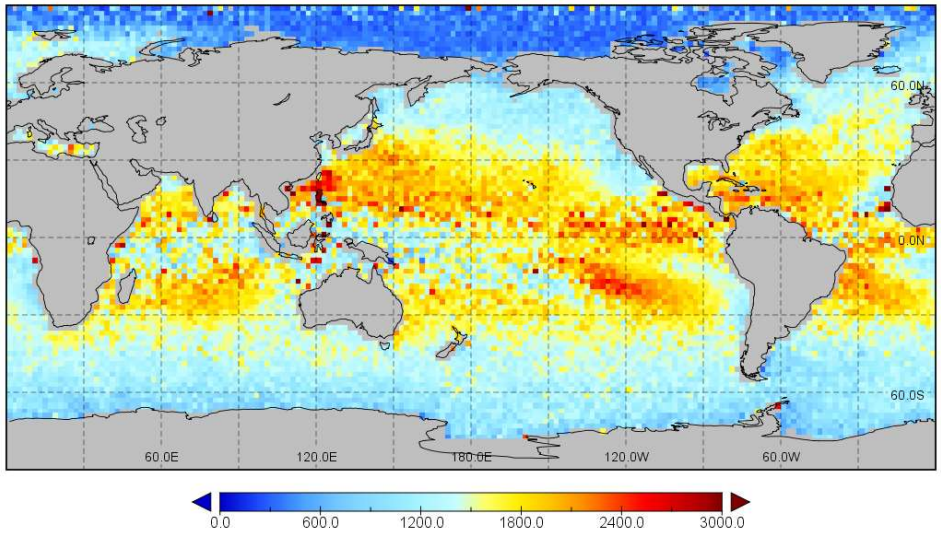
MERRA-2

DJF Seasonal Planetary Boundary Layer Height (m) from MERRA-2



GNSS-RO

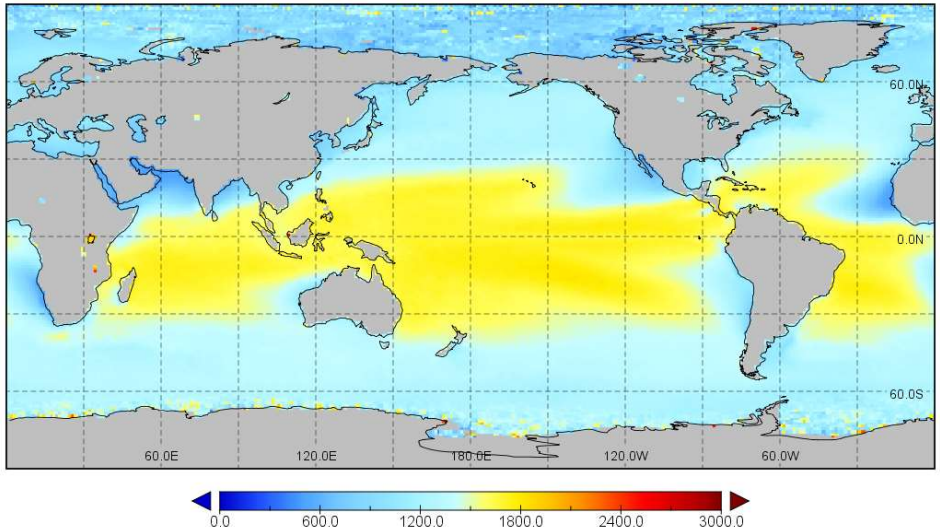
DJF Seasonal Planetary Boundary Layer Height (m) from RO



10-year MAM Seasonal Mean PBLH Comparison

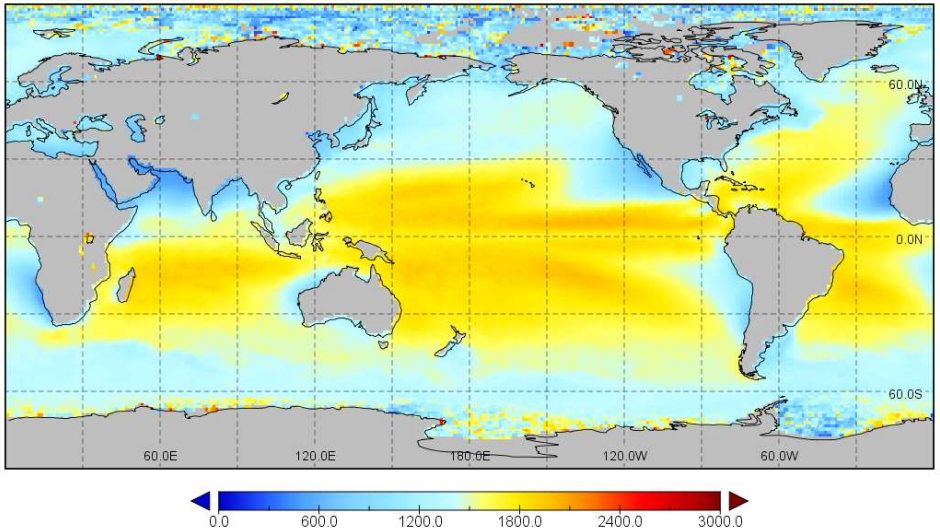
AIRS V6

MAM Seasonal Planetary Boundary Layer Height (m) from AIRS V6



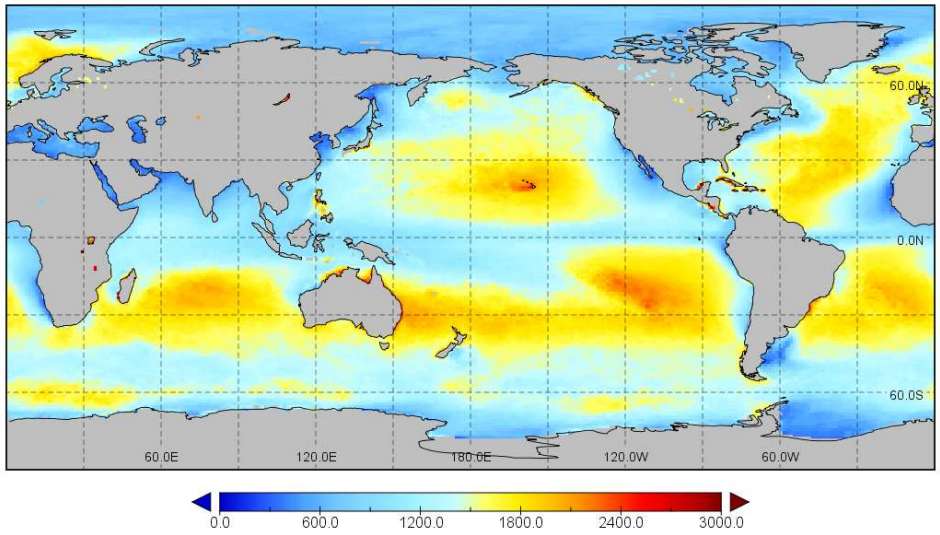
AIRS V7

MAM Seasonal Planetary Boundary Layer Height (m) from AIRS V7



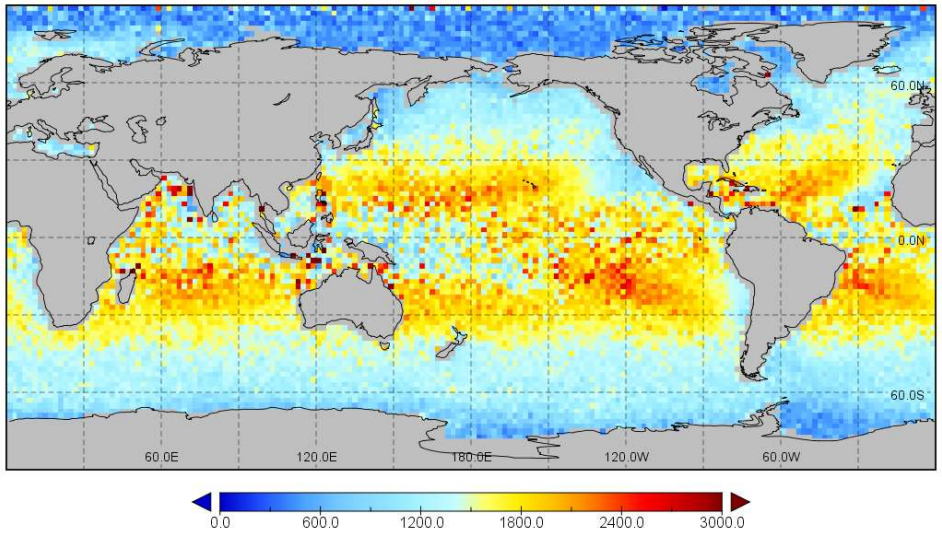
MERRA-2

MAM Seasonal Planetary Boundary Layer Height (m) from MERRA-2



GNSS-RO

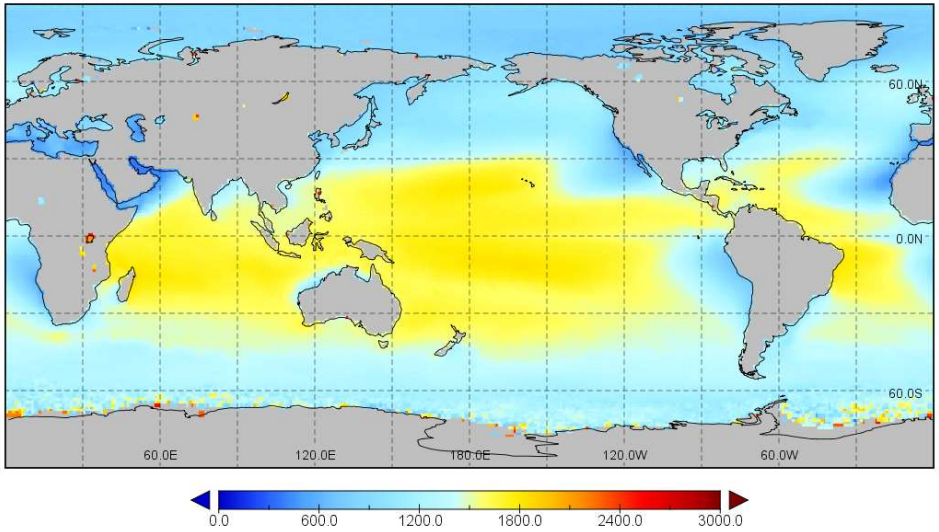
MAM Seasonal Planetary Boundary Layer Height (m) from RO



10-year JJA Seasonal Mean PBLH Comparison

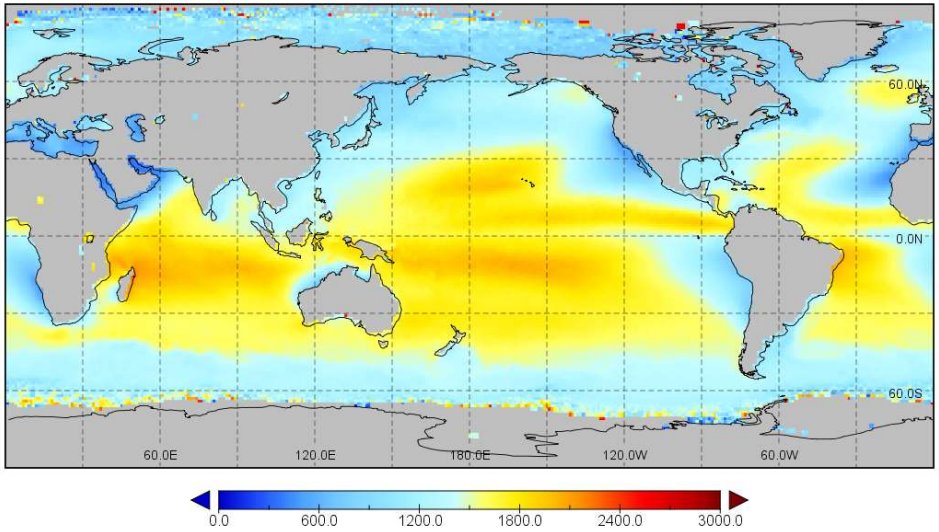
AIRS V6

JJA Seasonal Planetary Boundary Layer Height (m) from AIRS V6



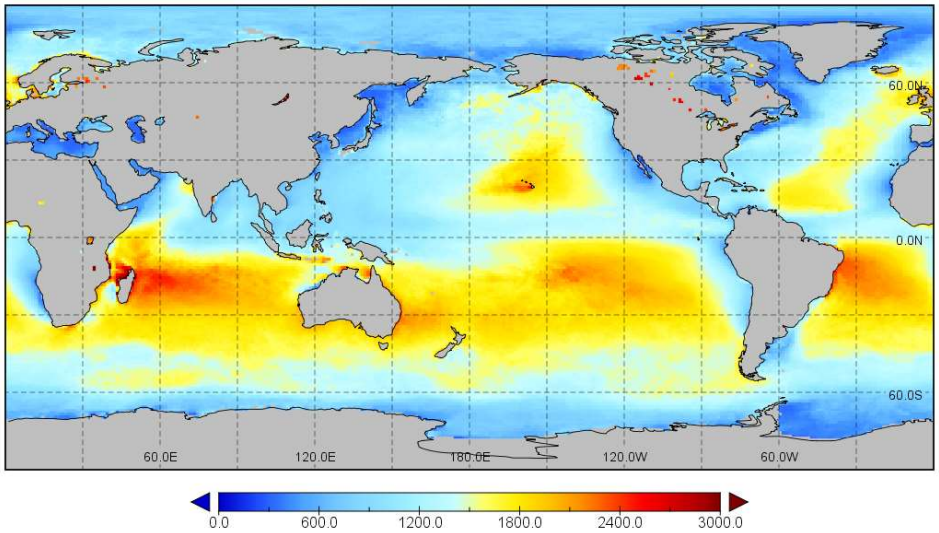
AIRS V7

JJA Seasonal Planetary Boundary Layer Height (m) from AIRS V7



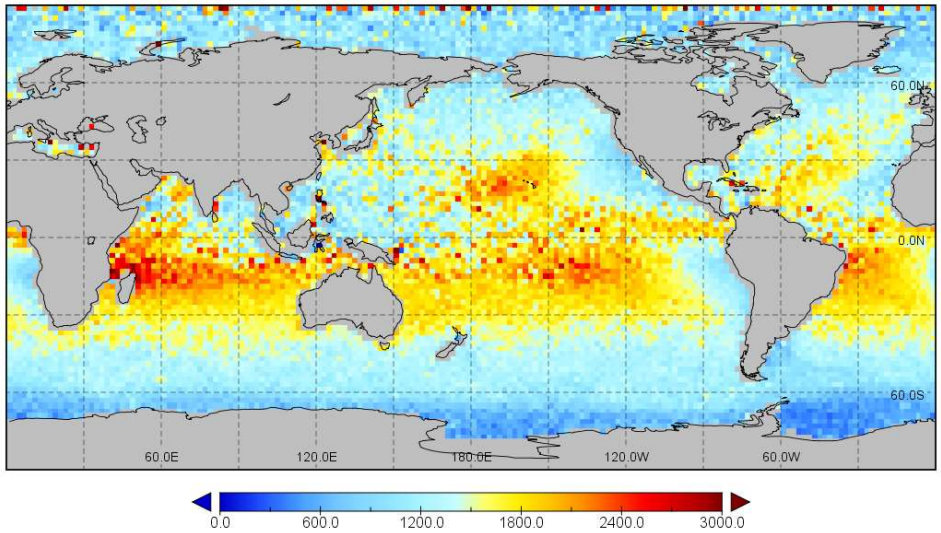
MERRA-2

JJA Seasonal Planetary Boundary Layer Height (m) from MERRA-2



GNSS-RO

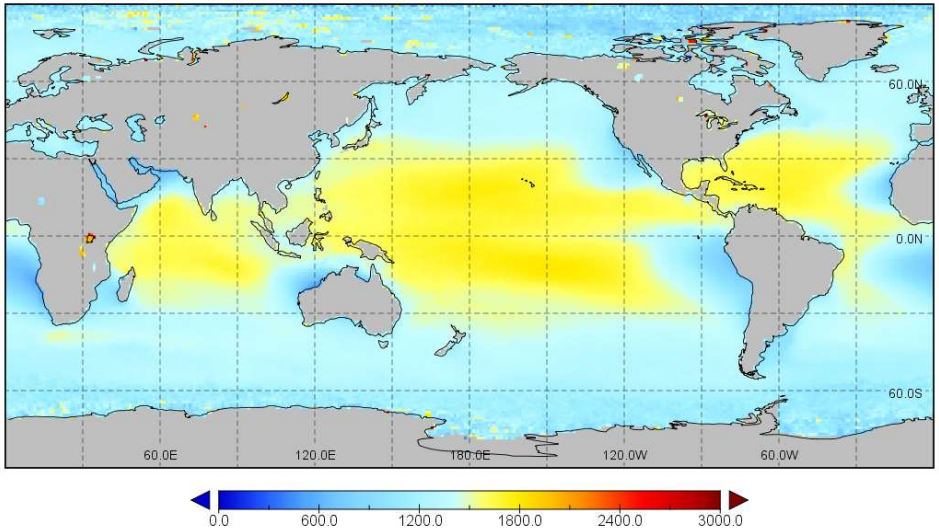
JJA Seasonal Planetary Boundary Layer Height (m) from RO



10-year SON Seasonal Mean PBLH Comparison

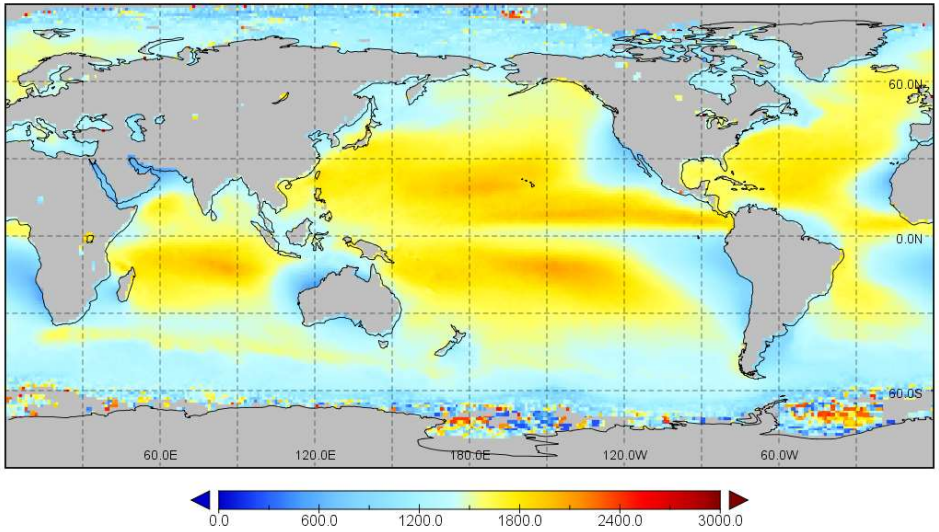
AIRS V6

SON Seasonal Planetary Boundary Layer Height (m) from AIRS V6



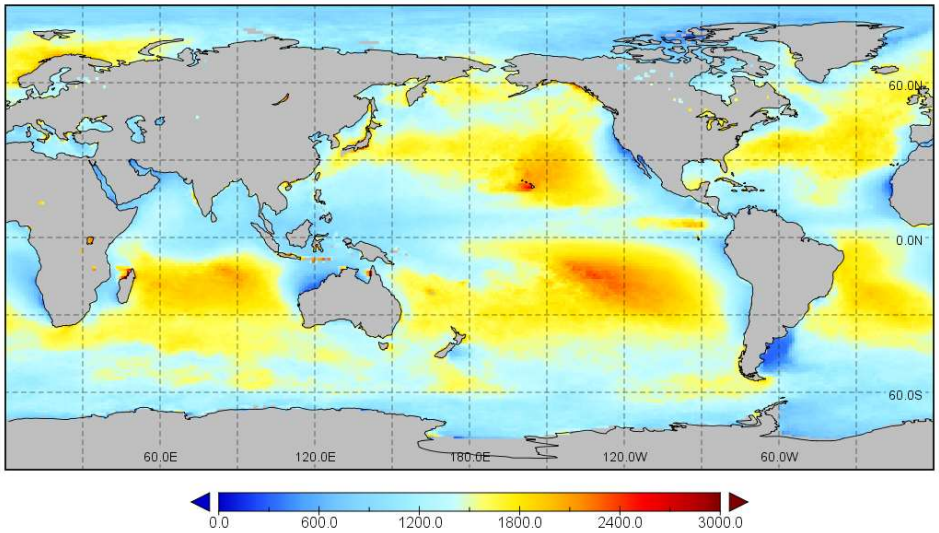
AIRS V7

SON Seasonal Planetary Boundary Layer Height (m) from AIRS V7



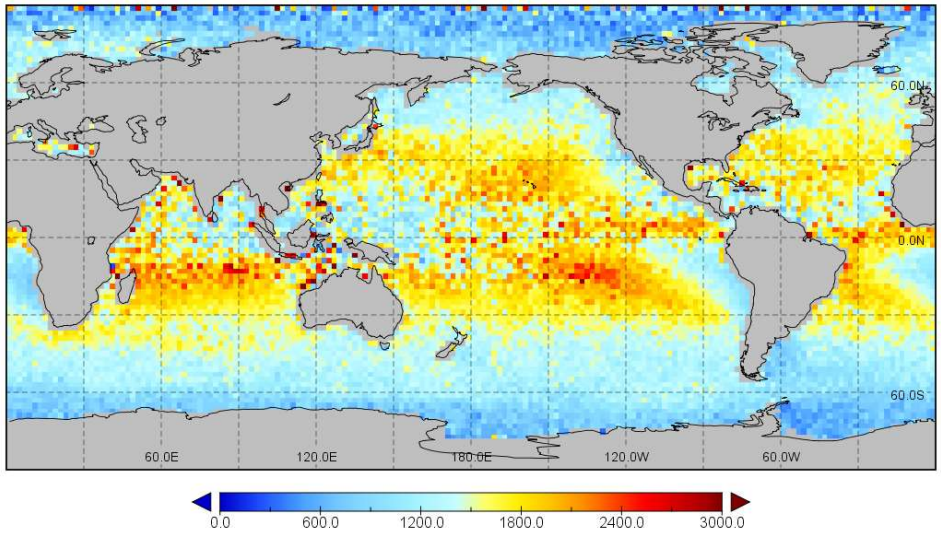
MERRA-2

SON Seasonal Planetary Boundary Layer Height (m) from MERRA-2



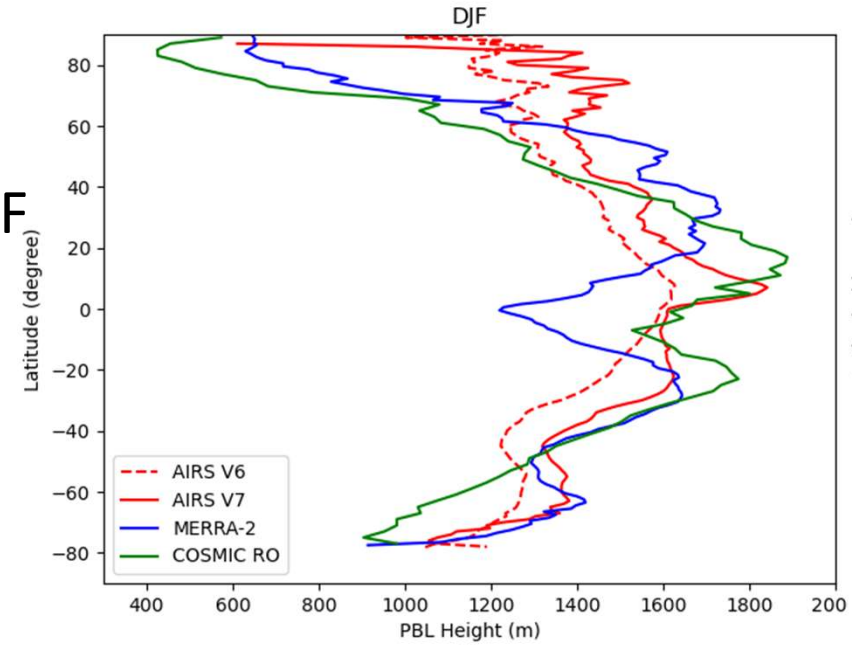
GNSS-RO

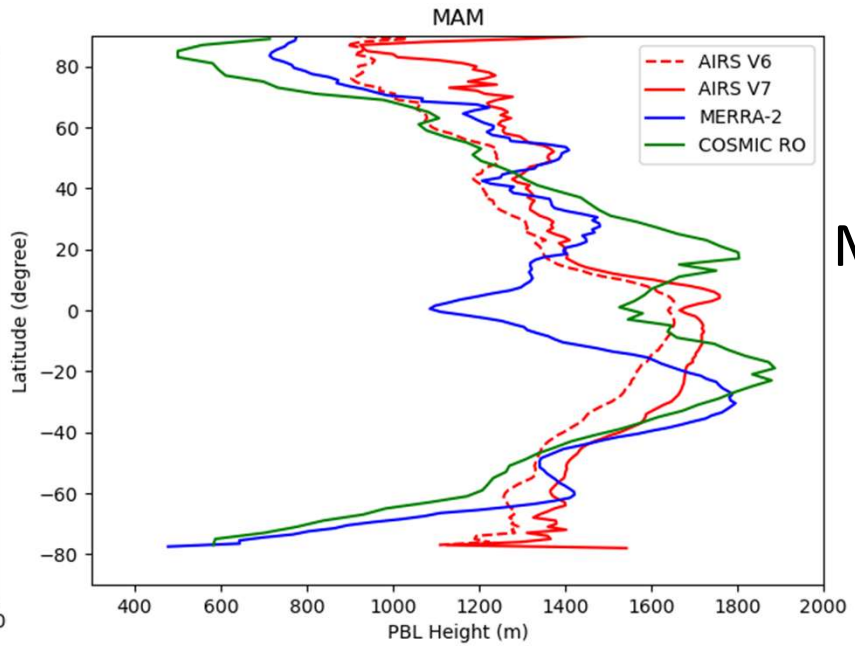
SON Seasonal Planetary Boundary Layer Height (m) from RO



10-year Seasonal Zonal Mean PBLH Comparison

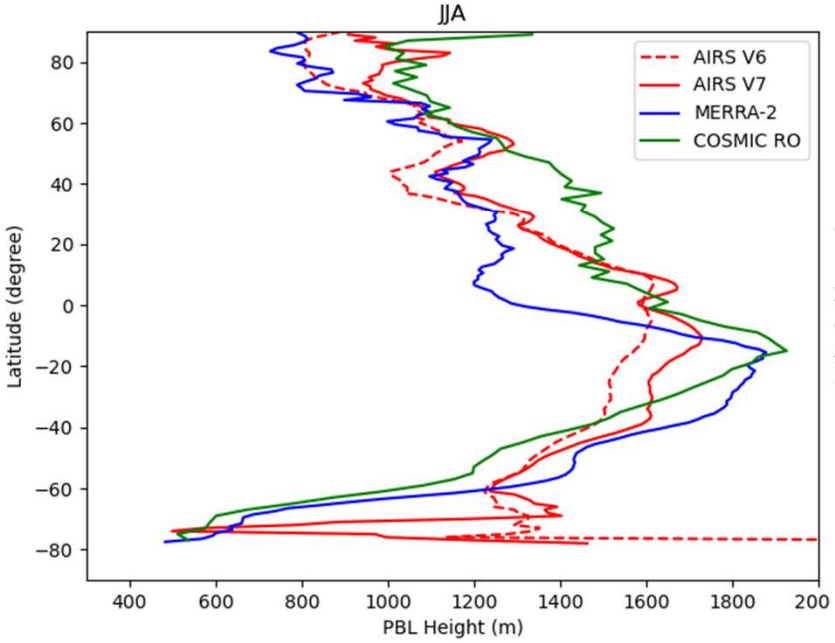
DJF

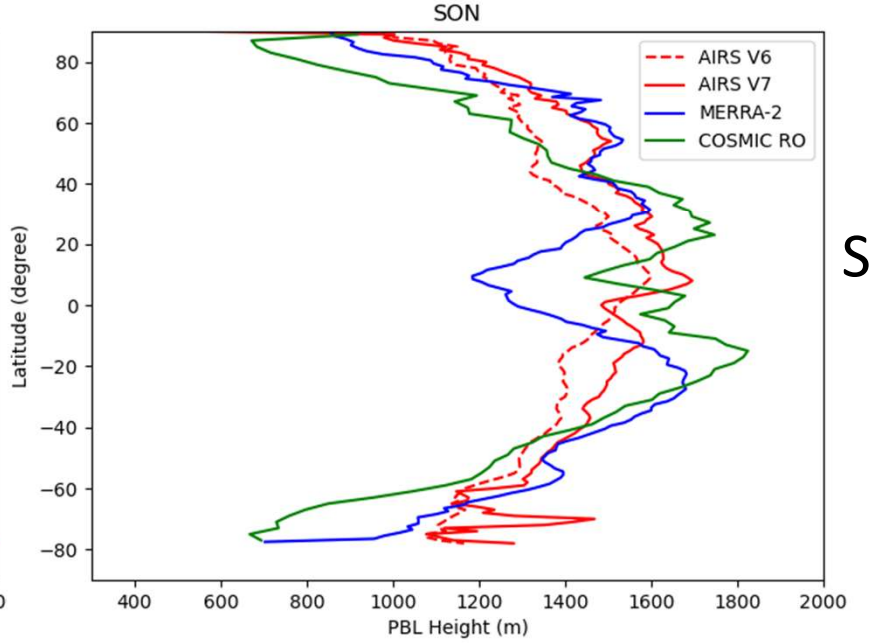




MAM

JJA





SON

AIRS, GNSS-RO, MERRA-2 10-year Seasonal Mean PBLH Comparison over the Ocean

- AIRS V7 PBLH distribution patterns are closer to GNSS-RO and MERRR-2 than AIRS V6, especially over tropics.

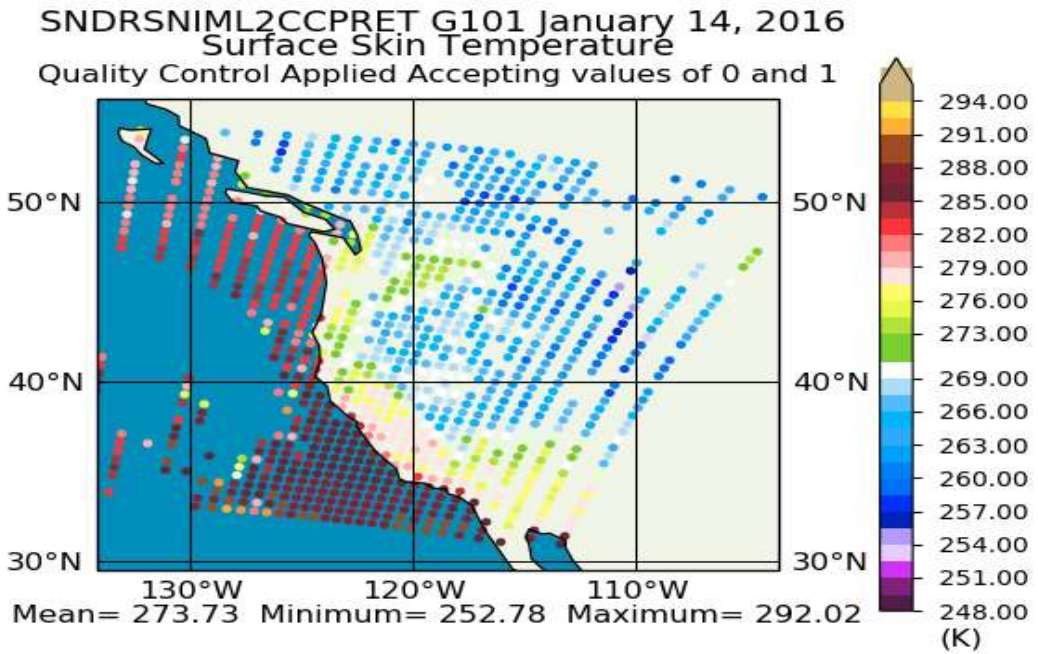
- The AIRS V7 PBLH improvements are possibly from the better retrieval of water vapor and the improved neural network first guess.

Services to Synergize Multiple Products from Multiple Sensors for PBL Study

Further PBL studies need looking at lower level (level 2) products from multiple sensors

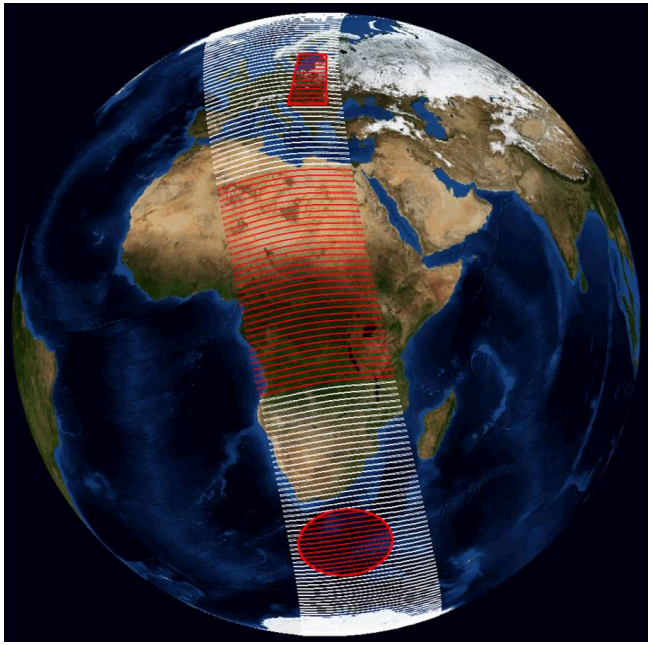
Level 2 Satellite Swath Data

- **Derived geophysical variables at the same resolution and location as the instrument source data**
- **Satellite observation geometry, not gridded**
- **Products are geospatially & temporally referenced**

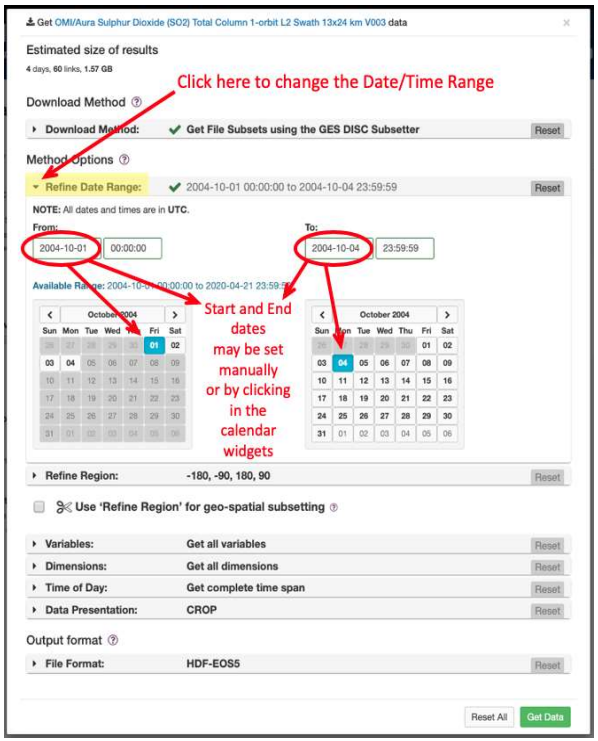


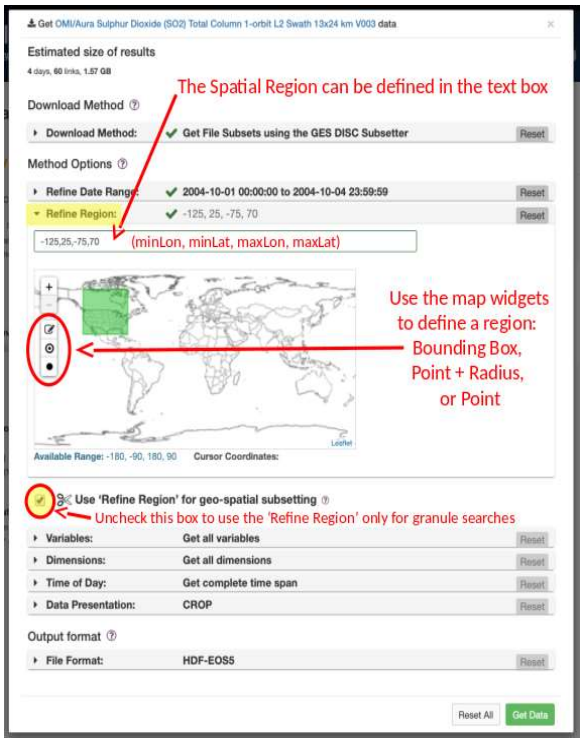
Why Subset?

- **Allows users to select desired variables, spatial domains, time slices, and dimensions**
- **Eliminates need to download entire file, thus reducing file size**
- **Saves storage and bandwidth resources**



Level 2 Subsetter (L2S) Features





- Spatial subsetting
- Variable selection
- Dimensional subsetting
- Temporal subsetting
- Guide:

  https://disc.gsfc.nasa.gov/information/howto?title=How%20to%20Subset%20Level-2%20Data

CLIMCAPS

These new sounder products can be subset with L2S:

SNDRSNIML2CCPRET
SNDRSNIML2CCPRETN
SNDRJ1IML2CCPRET

https://disc.gsfc.nasa.gov/datasets?keywords=CLIMCAPS&processingLevel=2

Summary

- GES DISC provides data and services for PBL study.
- PBLH comparisons of AIRS V6 & V7 with GNSS-RO and MERRA-2 show AIRS V7 improvements over V6.
- AIRS V7 monthly variables are available in Giovanni and daily variables are coming soon.
- Setinel-6 RO products will come next year.
- GES DISC is providing more Level 2 product services to support further study of PBL.

https://disc.gsfc.nasa.gov/

https://giovanni.gsfc.nasa.gov/

gsfc-help-disc@lists.nasa.gov