PBL Height from AIRS and MERRA-2 Products at GES DISC and Preliminary Intercomparison Result

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NASA Sounder Science Team Meeting
PBL Sounding Workshop
Greenbelt, MD
October 1, 2018

Outline

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

  AIRS and MERRA/MERRA-2

- Data Service at GES DICS for Comparison

  Giovanni multi-year monthly/seasonal mean, AIRS product subsetting, NCO (NetCDF Operators) for Ascending/Descending average, resolution remap

- Preliminary Comparison Plots
- Summary

Products with PBLH at GES DISC

- AIRS

  In AIRS support product

  PBLH only on the ocean

  Not a highly visible parameter

  09/2002 ~ present

- MERRA and MERRA-2

  NASA Goddard Earth Observing System (GEOS) model reanalysis product

  MERRA: Modern-Era Retrospective analysis for Research and Applications

  MERRA-2: second MERRA, GEOS-5 model

  1980 ~ present

  Hourly, daily, monthly

  Monthly PBLH available in Giovanni

Dataset and Services for PBLH Comparison

- Long Term Monthly Average Comparison

  15-year monthly mean: 2003 to 2017, short term climatology

- AIRS

  V6 Level-3 AIRS-only monthly support product: AIRS3SPM.006

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

  Ascending/Daytime and Descending/Nighttime

  Pressure (hPa) at PBL top

- MERRA-2

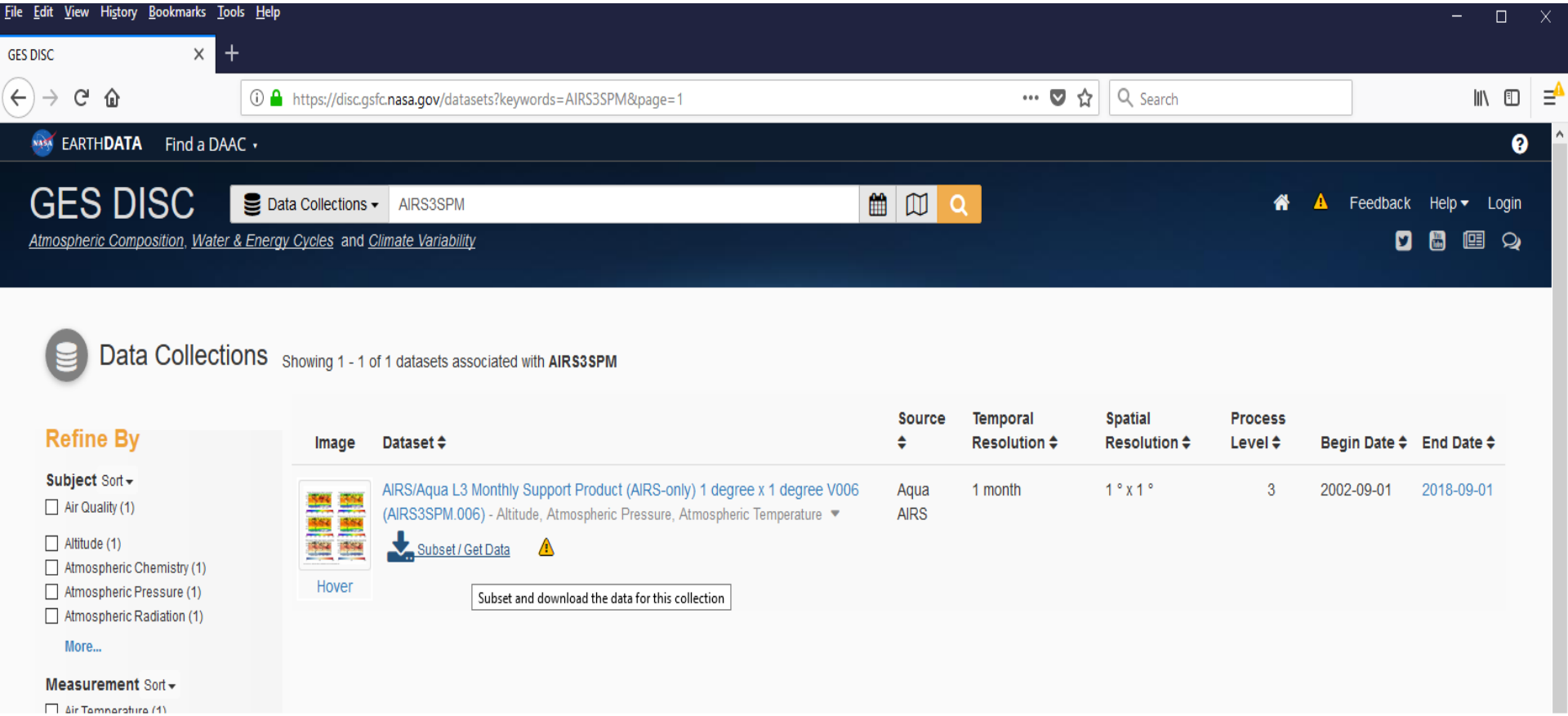
  Monthly

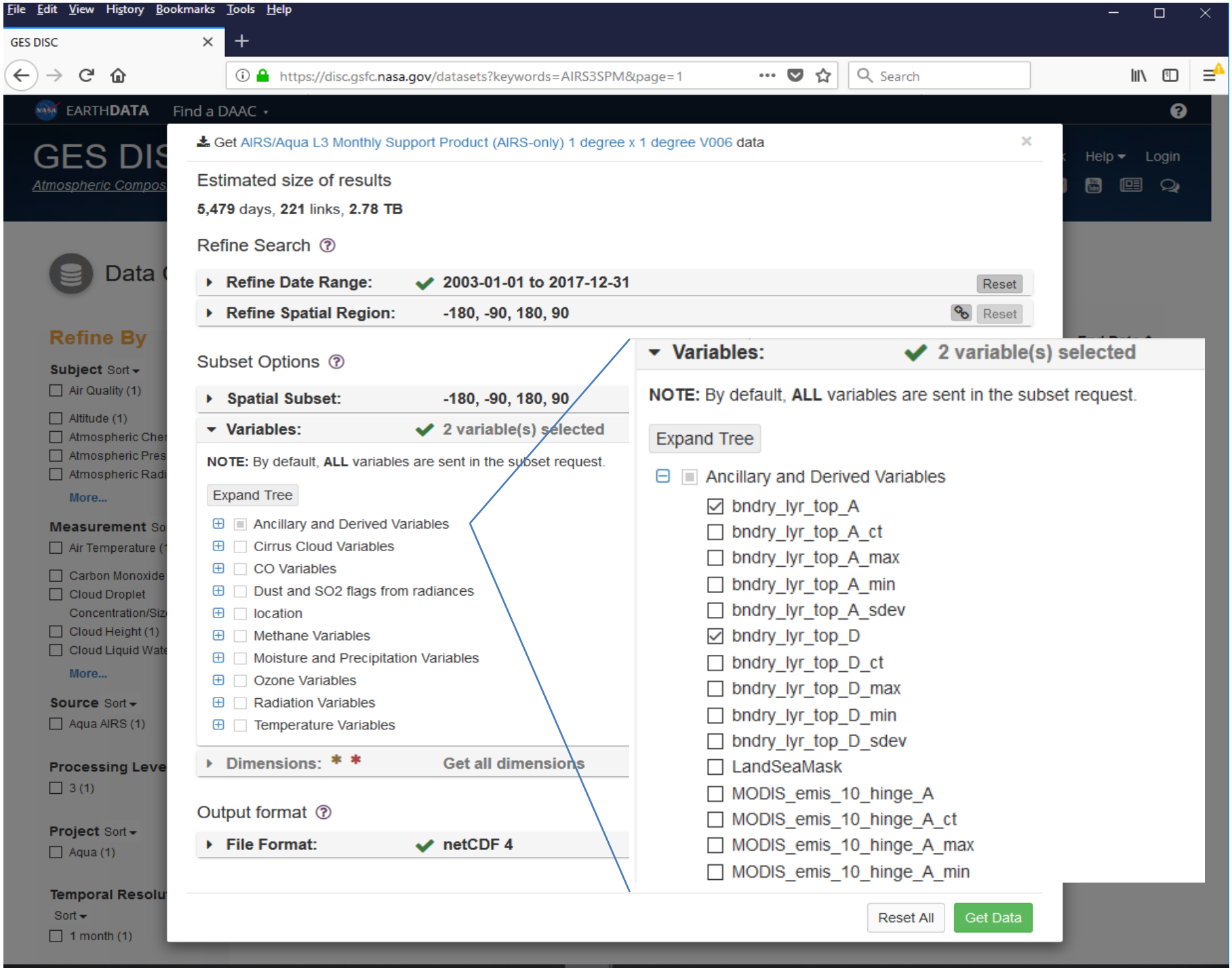
  Resolution: 0.5^0 X 0.625^0 (lat X lon)

  PBL height/depth in meter

AIRS PBLH from Data Subset Service

- Go to GES DISC homepage https://disc.gsfc.nasa.gov
- Search AIRS3SPM




File Edit View History Bookmarks Tools Help
GES DISC
https://disc.gsfc.nasa.gov/datasets?keywords=AIRS3SPM&page=1
Search
EARTHDATA
Find a DAAC
Help
Login
Get AIRS/Aqua L3 Monthly Support Product (AIRS-only) 1 degree x 1 degree V006 data
Estimated size of results
5,479 days, 221 links, 2.78 TB
Refine Search
Refine Date Range: 2003-01-01 to 2017-12-31 Reset
Refine Spatial Region: -180, -90, 180, 90 Reset
Subset Options
Spatial Subset: -180, -90, 180, 90
Variables: 2 variable(s) selected
NOTE: By default, ALL variables are sent in the subset request.
Expand Tree
Ancillary and Derived Variables
Cirrus Cloud Variables
CO Variables
Dust and SO2 flags from radiances
location
Methane Variables
Moisture and Precipitation Variables
Ozone Variables
Radiation Variables
Temperature Variables
Dimensions: * * Get all dimensions
Output format
File Format: netCDF 4
Variables: 2 variable(s) selected
NOTE: By default, ALL variables are sent in the subset request.
Expand Tree
Ancillary and Derived Variables
bndry_lyr_top_A
bndry_lyr_top_A_ct
bndry_lyr_top_A_max
bndry_lyr_top_A_min
bndry_lyr_top_A_sdev
bndry_lyr_top_D
bndry_lyr_top_D_ct
bndry_lyr_top_D_max
bndry_lyr_top_D_min
bndry_lyr_top_D_sdev
LandSeaMask
MODIS_emis_10_hinge_A
MODIS_emis_10_hinge_A_ct
MODIS_emis_10_hinge_A_max
MODIS_emis_10_hinge_A_min
Reset All
Get Data
Refine By
Subject Sort
Air Quality (1)
Altitude (1)
Measurement
Air Temperature
Carbon Monoxide
Cloud Height (1)
Source Sort
Aqua AIRS (1)
Processing Leve
3 (1)
Project Sort
Aqua (1)
Temporal Resolu
Sort
1 month (1)

Processing PBLH in AIRS

- Use NCO (NetCDF Operator)

  Powerful open source tools for manipulating netCDF file
- Ascending/Daytime and Descending/Nighttime Average

  ncrename -v bndry_lyr_top_D,bndry_lyr_top_A PBLDfname PBLDtoAfname
  ncea PBLAfname PBLDtoAfname PBLADAveragefname
  ncrename -v bndry_lyr_top_A,bndry_lyr_top_ADAverage PBLADAveragefname
- 15-year Monthly Mean (2003-2017)

  ncea AIRS.????.01.xxxxxx.nc AIRS.01.MonthlyMean.xxxxxx.nc
- Convert Pressure at PBL Top to Altitude

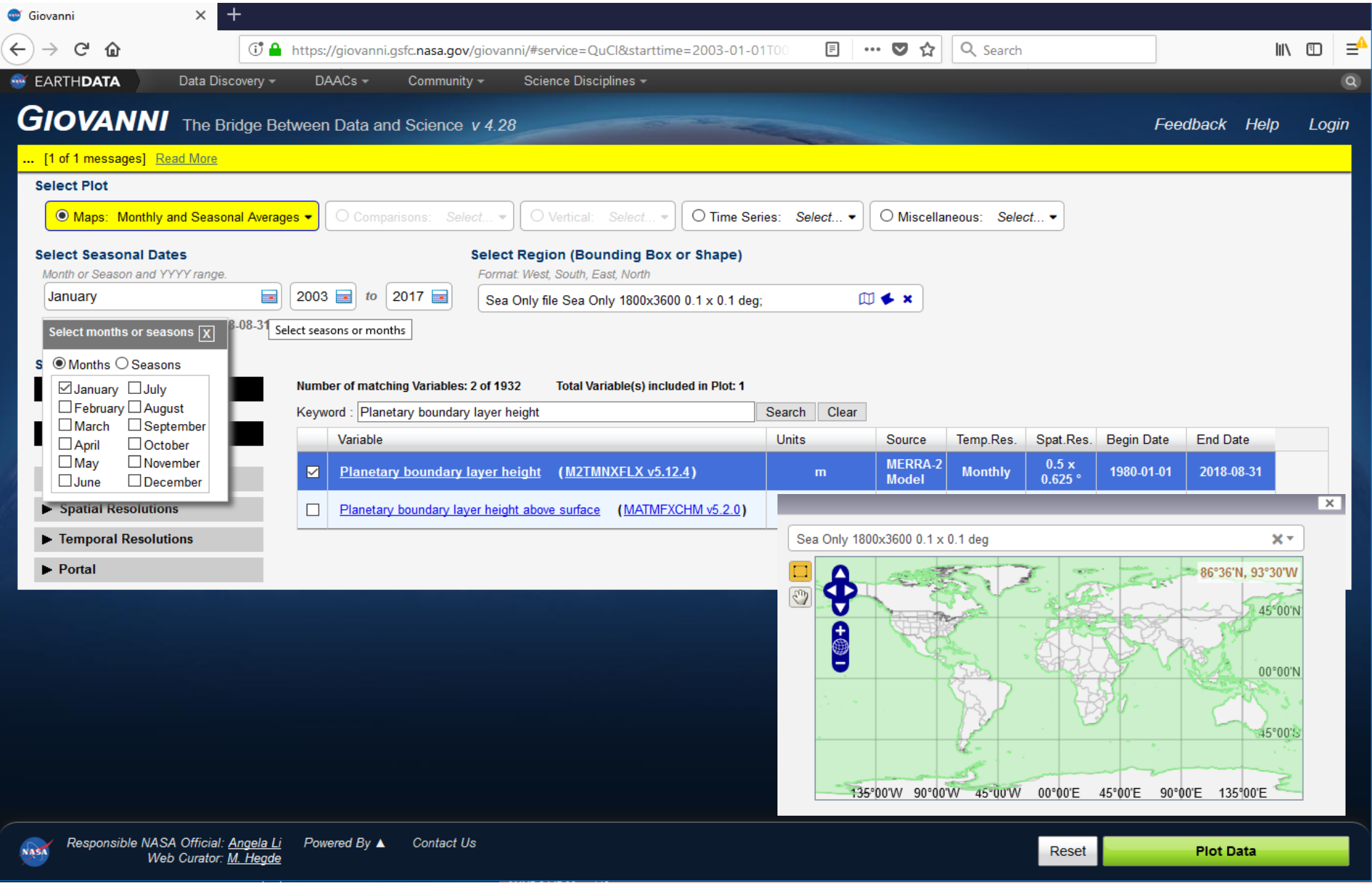
$$PBLH\ (m) = 44308\ X\ (1- (P_{PBLtop}/P_{Surface})^{0.1903})$$

Surface pressure $P_{Surface}$: AIRS L3 standard product AIRS3STM
From NOAA GFS model

ncap2 -s "bndry_lyr_top_ADAverageMeter=44308*(1-(bndry_lyr_top_ADAverage/SurfPres_Forecast_ADAverage)^0.1903)" inputfname outputfname

MERRA-2 PBLH from Giovanni

- Giovanni Monthly and Seasonal Average Service https://giovanni.gsfc.nasa.gov/



Processing MERRA-2 PBLH

- Generate the 15-year monthly mean from Giovanni

  download files in netCDF format

- Resolution Match to AIRS

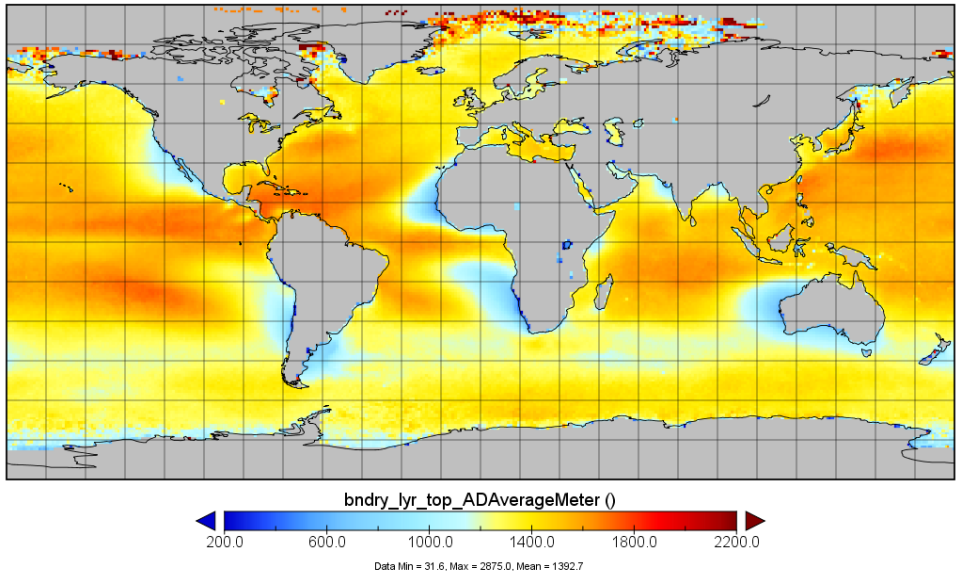
  Use NCO to remap MERRA-2 from 0.5^0 X 0.625^0 (lat X lon) to 1^0 X 1^0 (lat X lon)

  ncremap -a conserve -i infile -g ./180x360_SCRIP.20150901.nc -O ./rgr

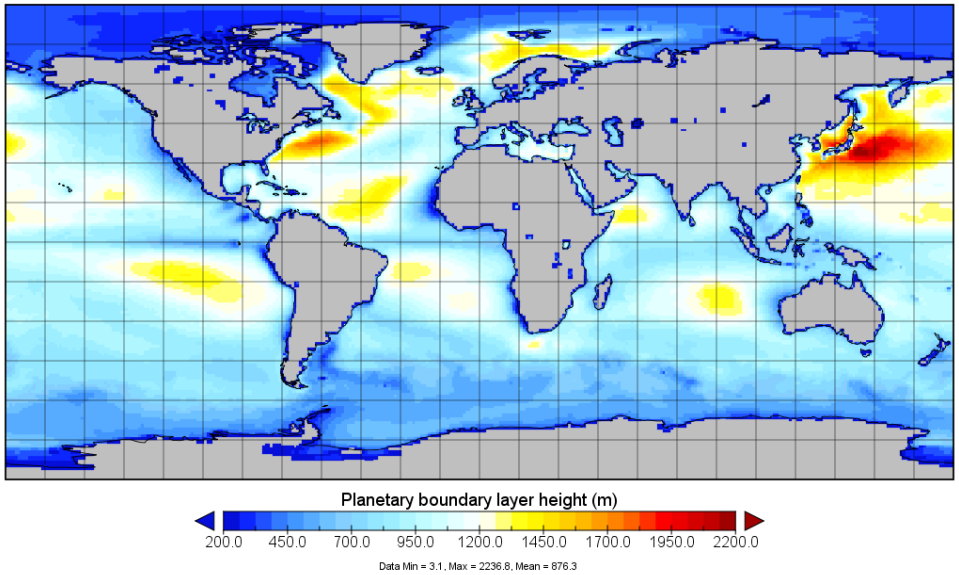
- Use Panoply get plots

Preliminary Comparison Results (Jan & Feb)

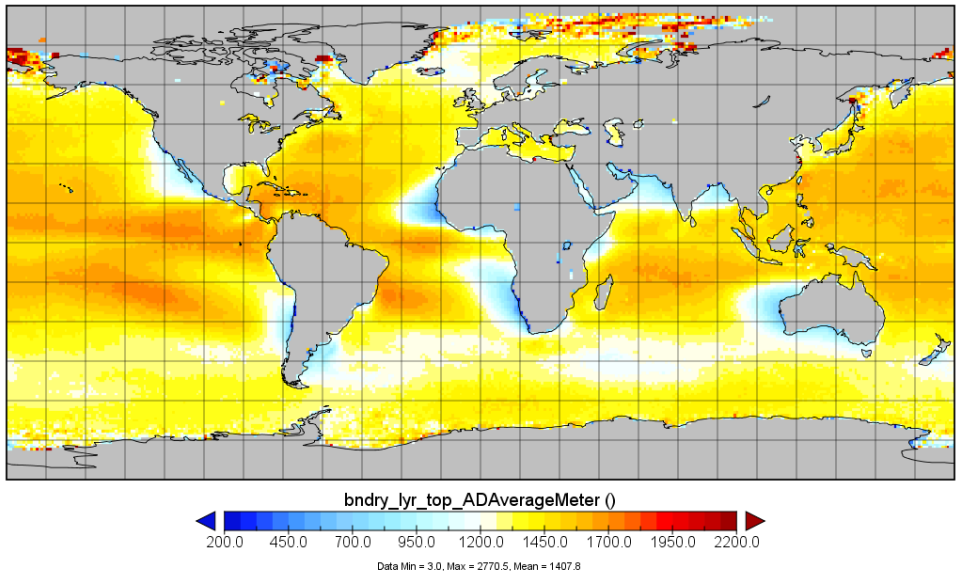
AIRS January PBLH (m)



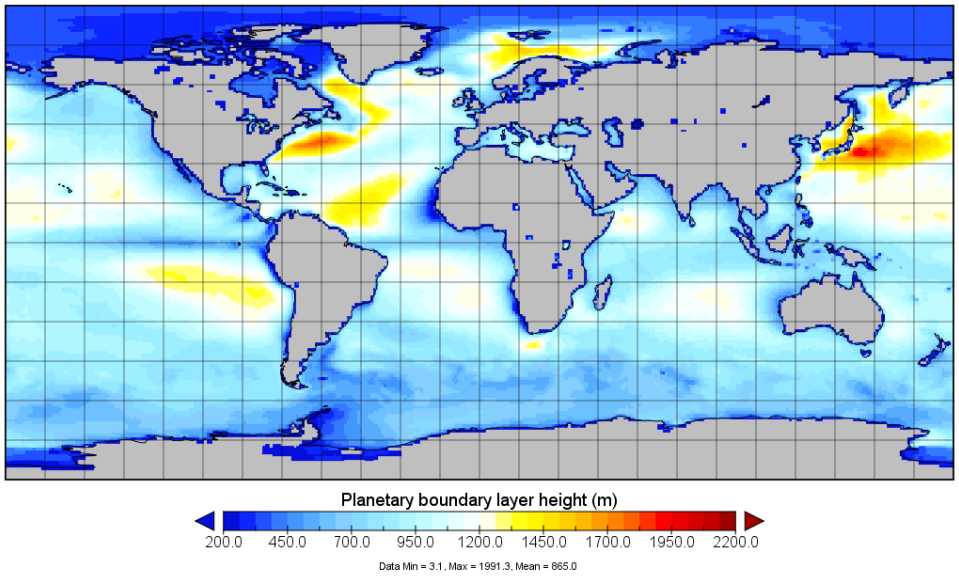
MERRA-2 January PBLH (m)



AIRS February PBLH (m)

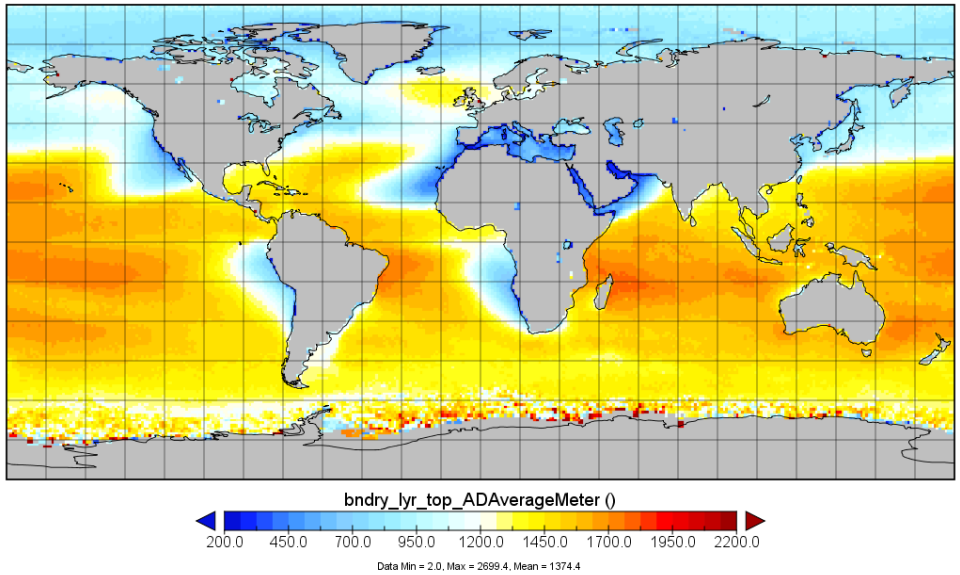


MERRA-2 February PBLH (m)

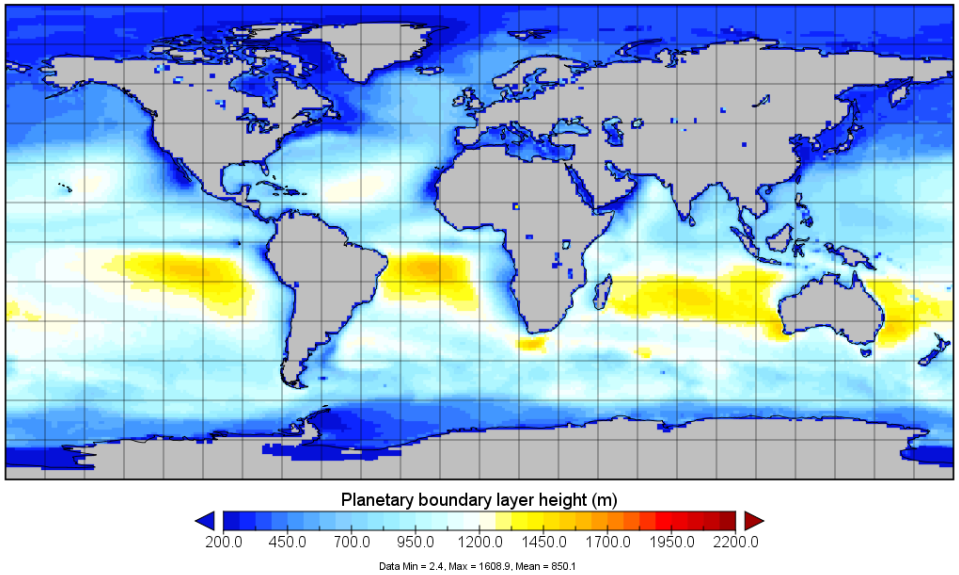


Preliminary Comparison Results (Jul & Aug)

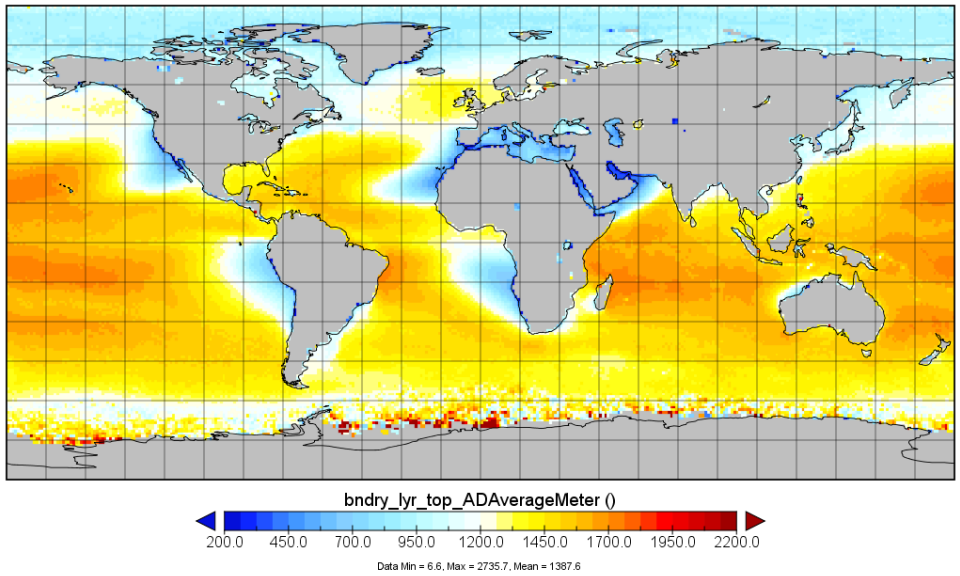
AIRS July PBLH (m)



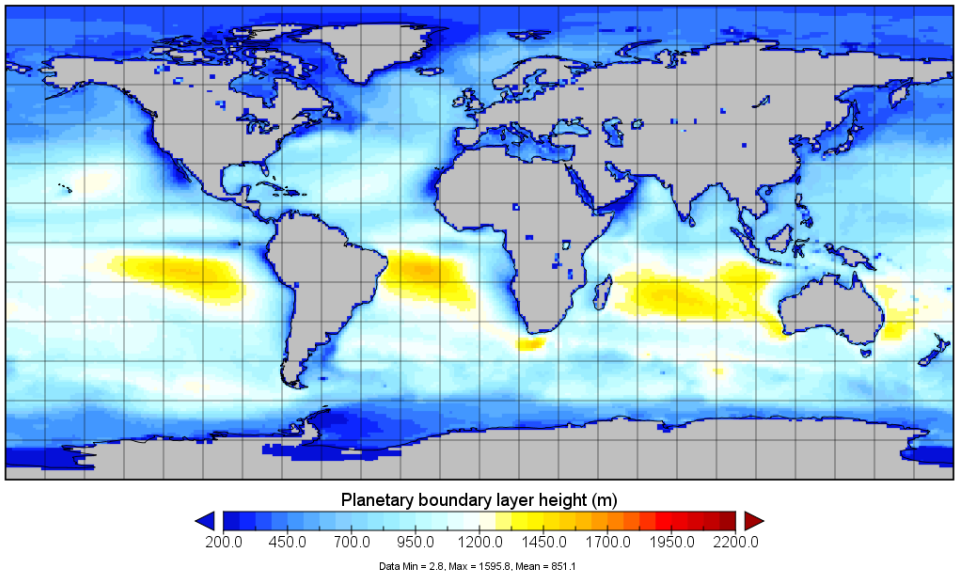
MERRA-2 July PBLH (m)



AIRS August PBLH (m)

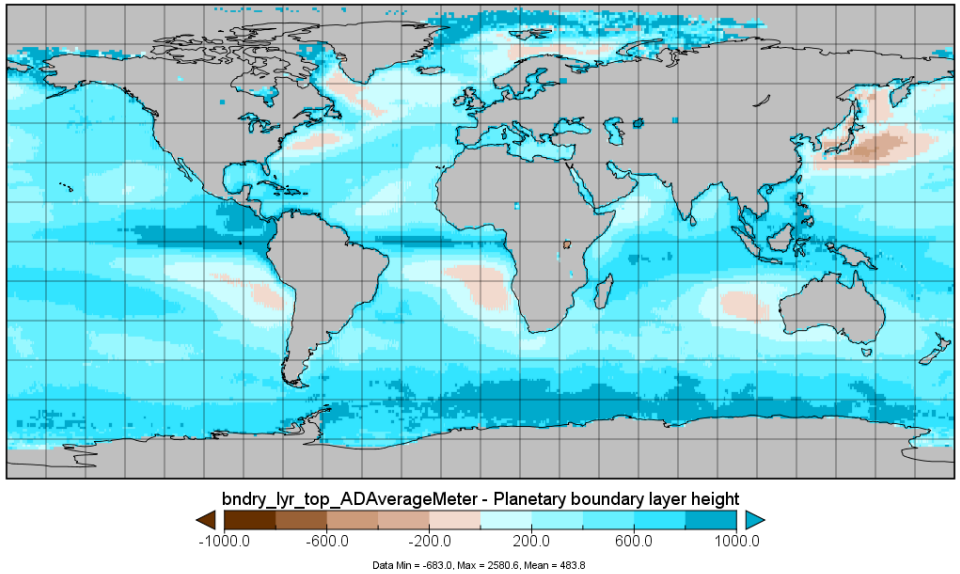


MERRA-2 August PBLH (m)

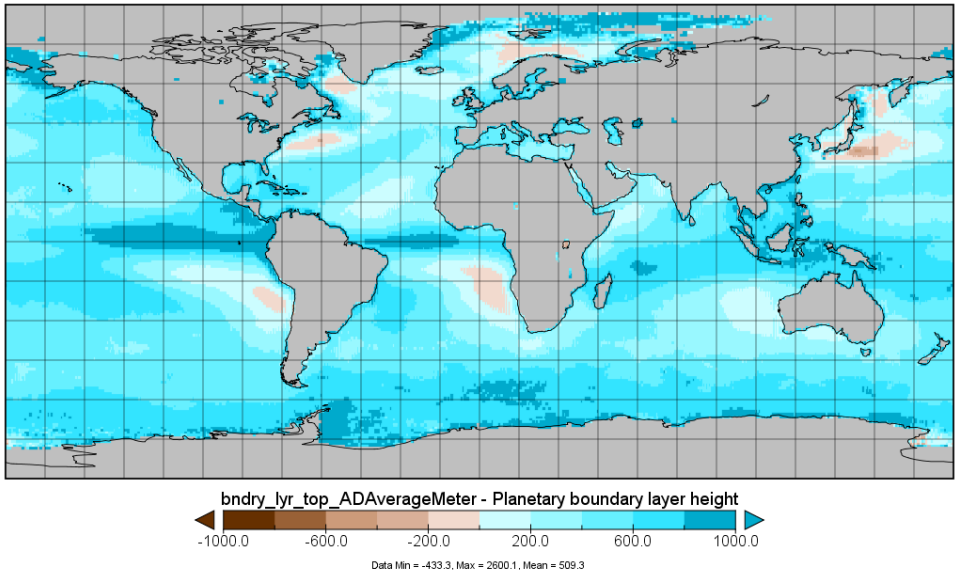


PBLH Difference (AIRS - MERRA2) (Jan, Feb, Jul, Aug)

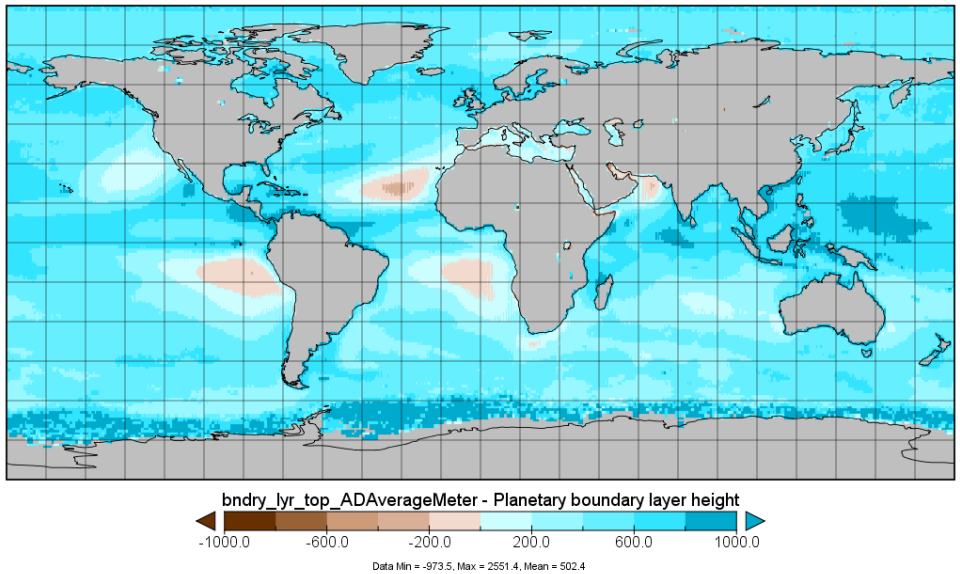
January PBLH Differnce (AIRS - MERRA2) (m)



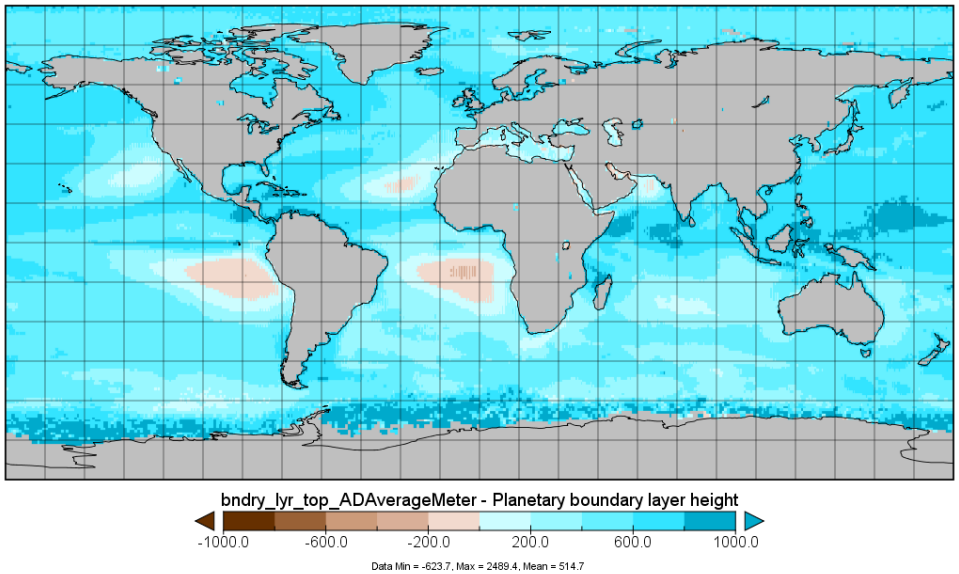
February PBLH Difference (AIRS - MERRA2) (m)



July PBLH Difference (AIRS - MERRA2) (m)



August PBLH Difference (AIRS - MERRA2) (m)



PBLH Difference between AIRS and MERRA-2

- AIRS PBLH much deeper than MERRA-2 in every month

  Globally AIRS about 500m higher

- AIRS PBLH

AIRS document: 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.

Derived from gradient of potential temperature (θ) and relative humidity (RH) vertical profiles.

Threshold of -0.06K/hPa for θ and 0.4%/hPa for RH

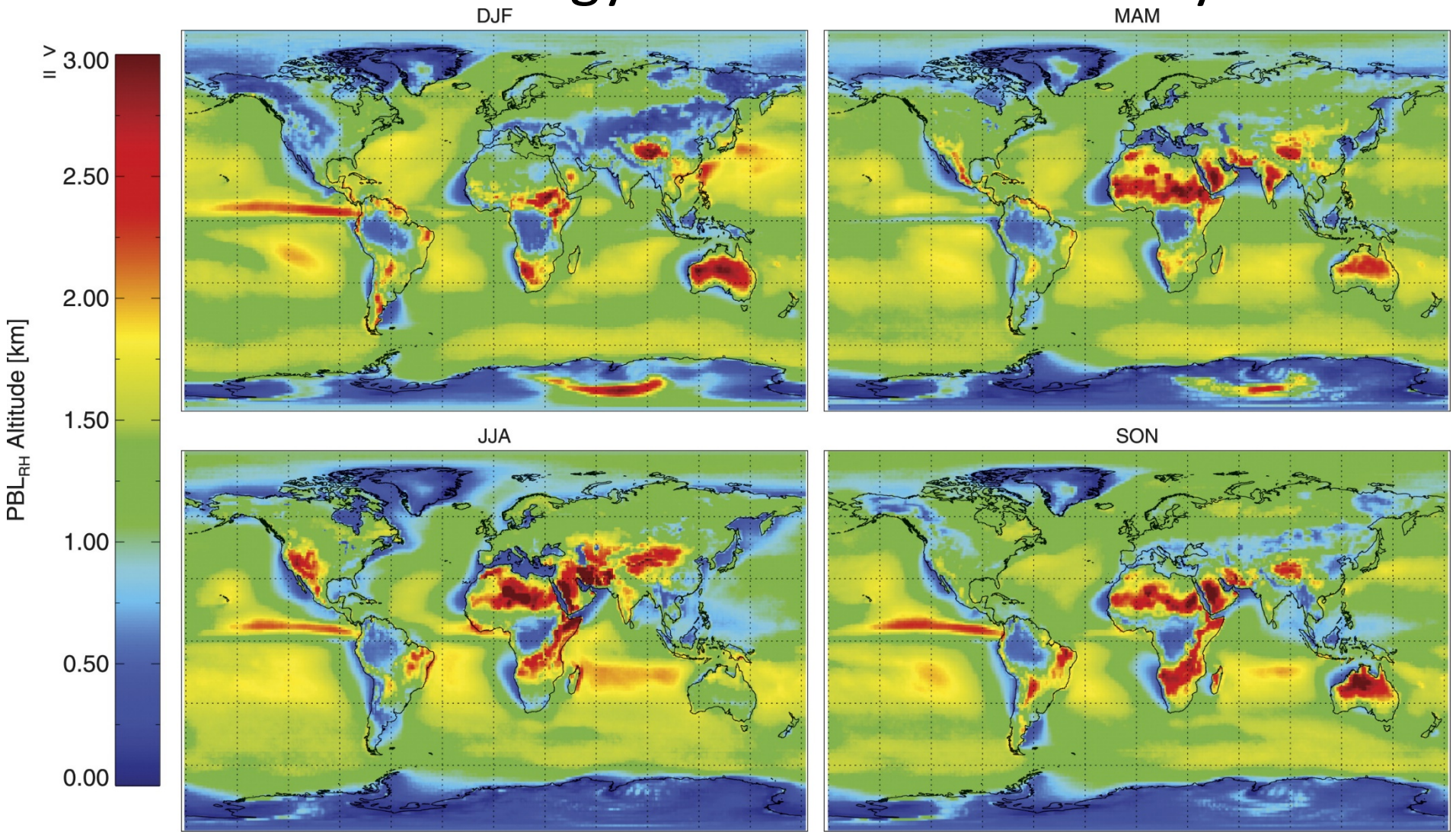
- MERRA-2 PBLH

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

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

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

PBLH Climatology from ECMWF Reanalysis

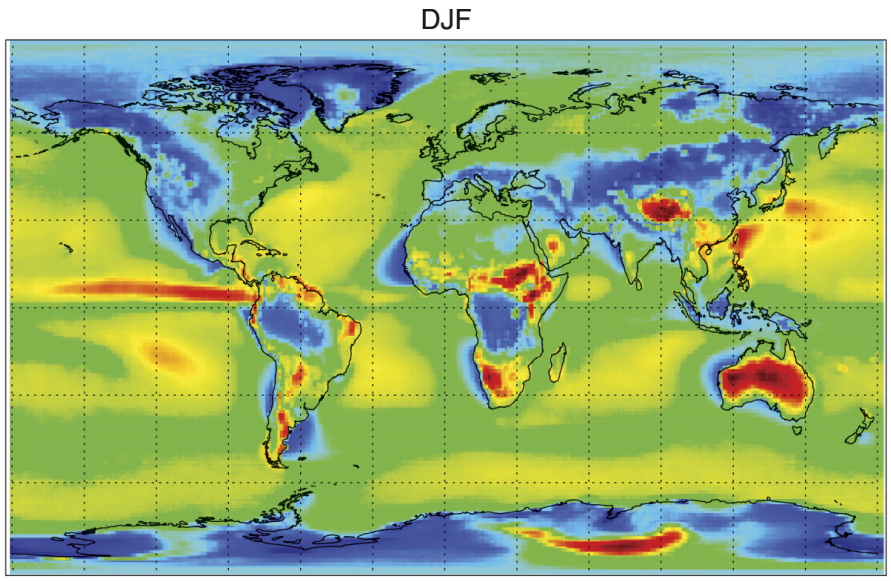


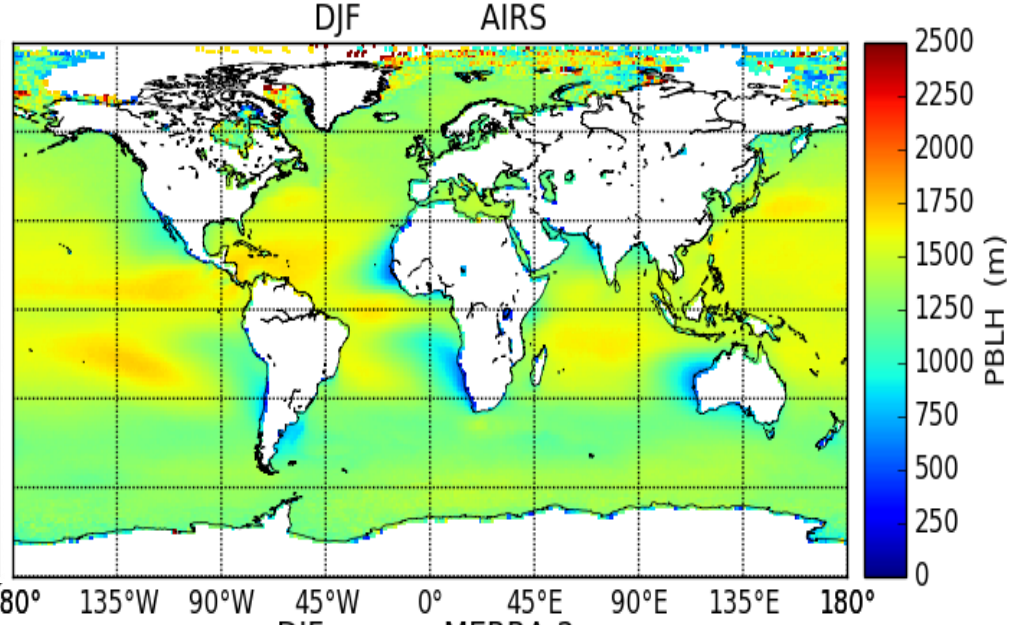
Axel von Engeln and Joao Teixeira (2013): A PBLH Climatology derived from ECMWF Reanalysis Data.

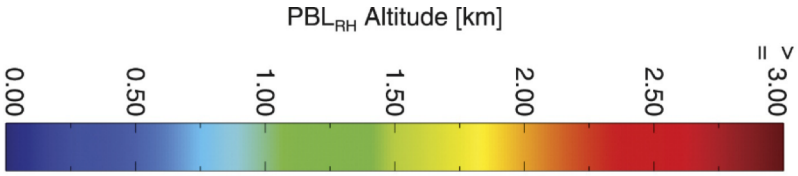
20-year (1990-2009) Seasonal Climatology from ERA-Interim

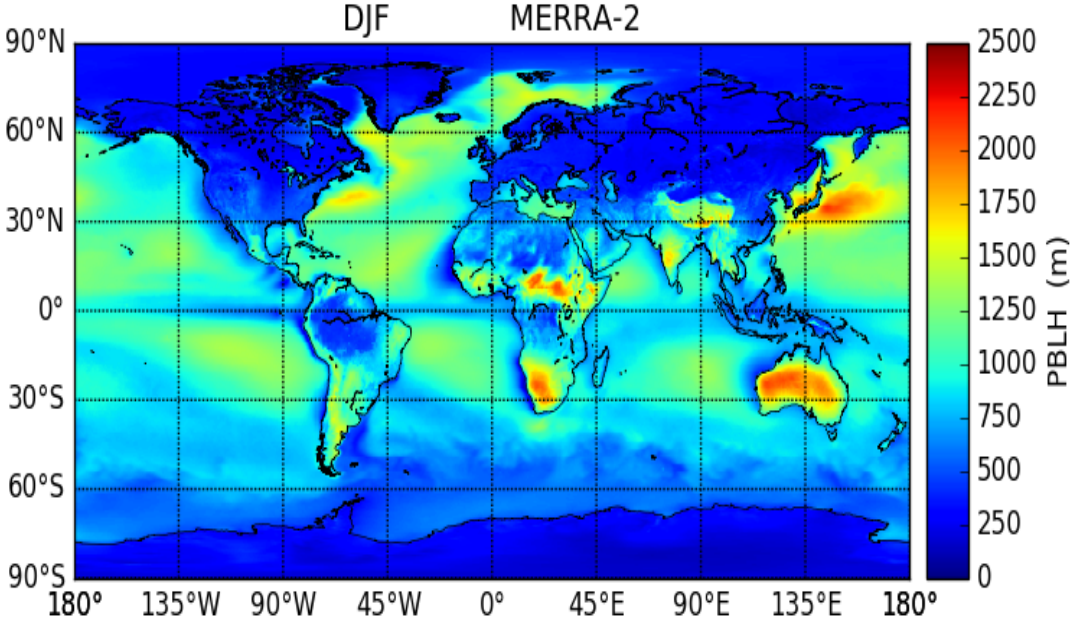
PBLH derived from minimum gradient of RH vertical profile

ERA, AIRS, MERRA-2 Comparison: DJF Season





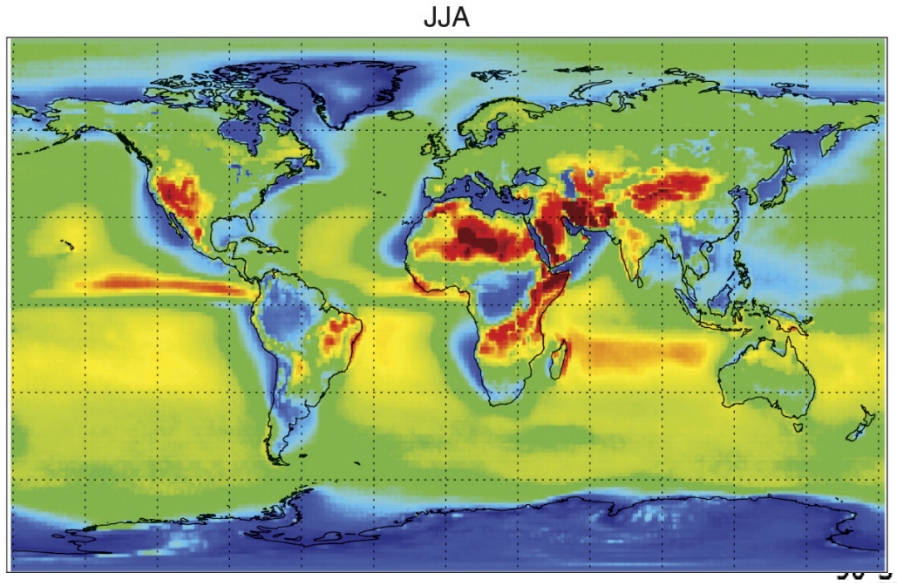


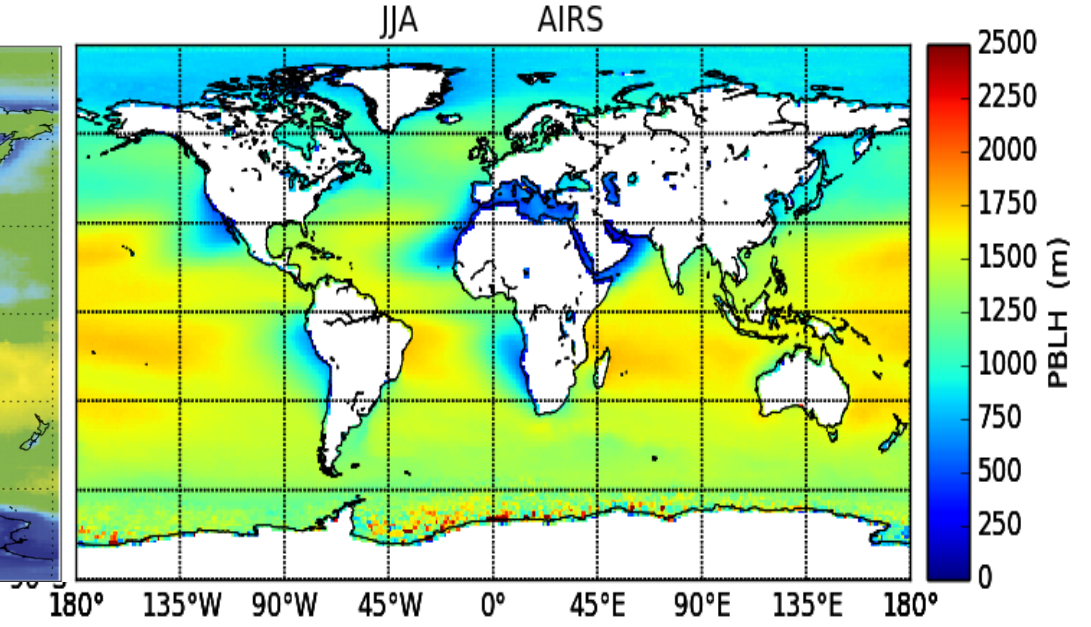


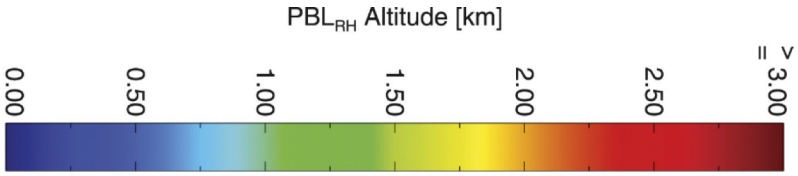
ERA vs AIRS: 500m deeper
AIRS vs MERR-2: 500m deeper
Indian and Atlantic Ocean: best pattern match
ITCZ: very deep PBL
50^0S ~ 65^0S Zone

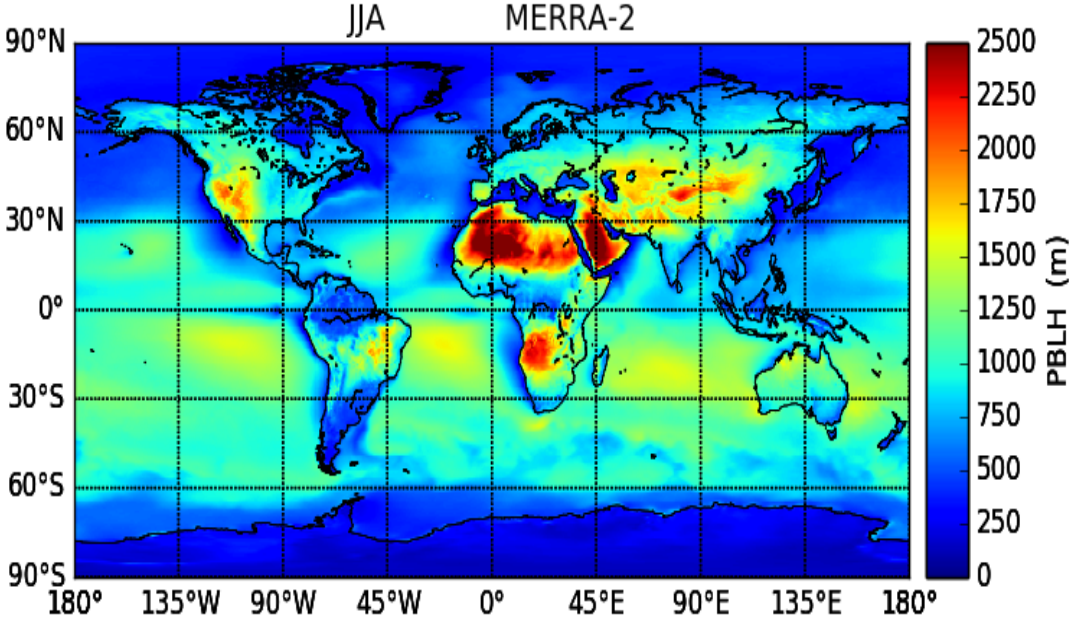
AIRS: 2003 ~ 2017 Others: 1990 ~ 2009

ERA, AIRS, MERRA-2 Comparison: JJA Season









ITCZ: very deep PBL

50^0S ~ 65^0S Zone

Summary

- GES DISC provides data and services for PBL study
- Preliminary comparison of AIRS derived PBLH with model reanalysis data show obvious difference, but AIRS can capture long-term PBL signals on the ocean.
- Different PBLH definitions may contribute to the differences.
- Next step: look at the vertical profiles .

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

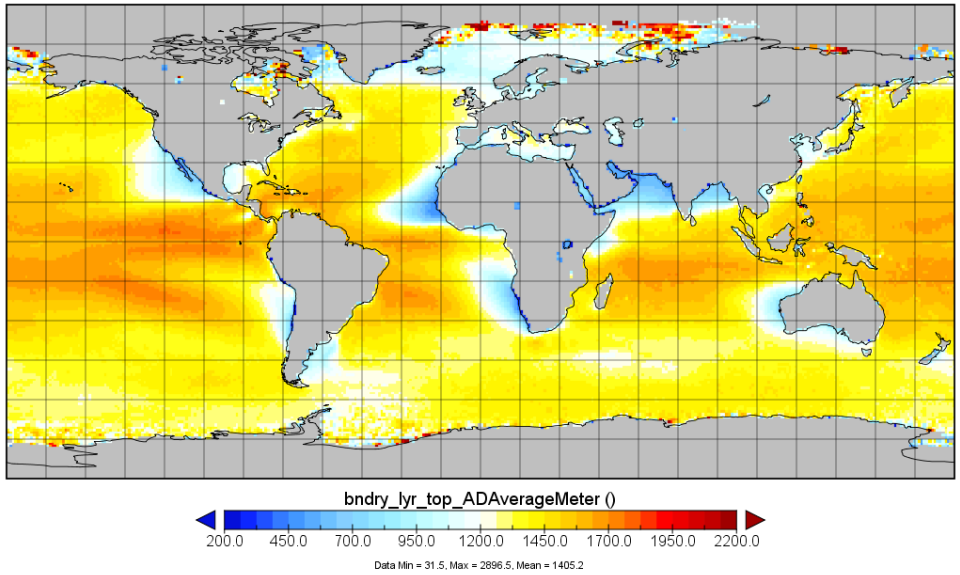
https://disc.gsfc.nasa.gov/

gsfc-help-disc@lists.nasa.gov

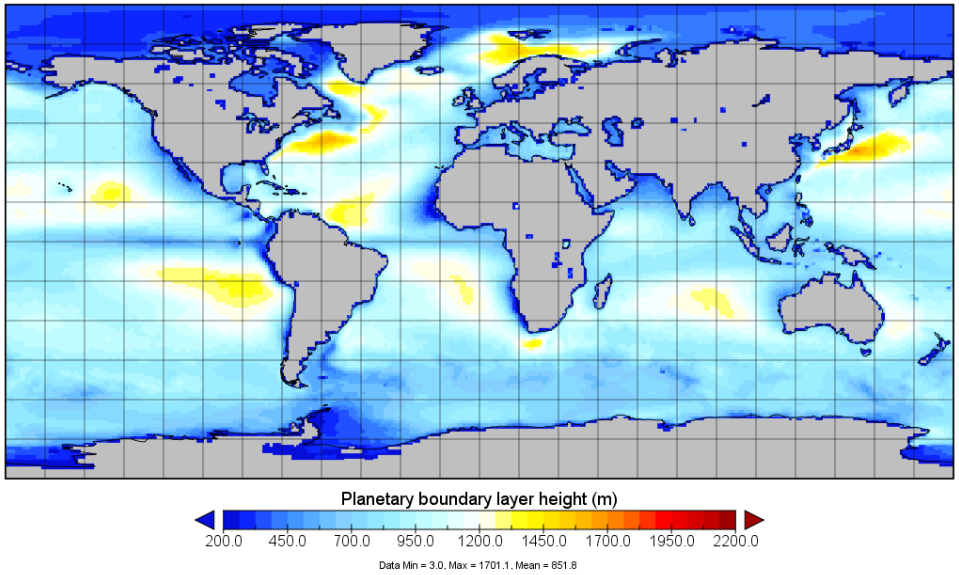
Backup Slides

Preliminary Comparison Results (Mar & Apr)

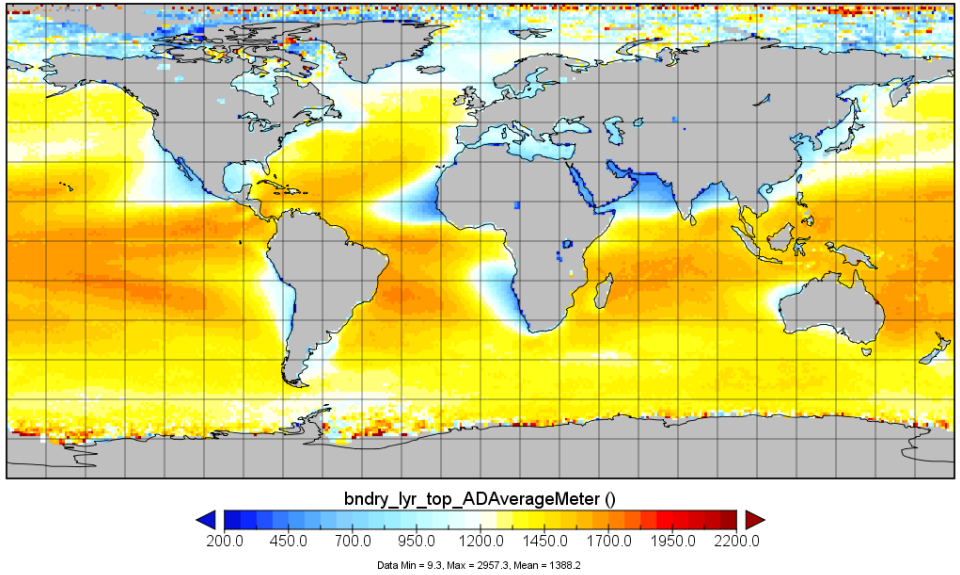
AIRS March PBLH (m)



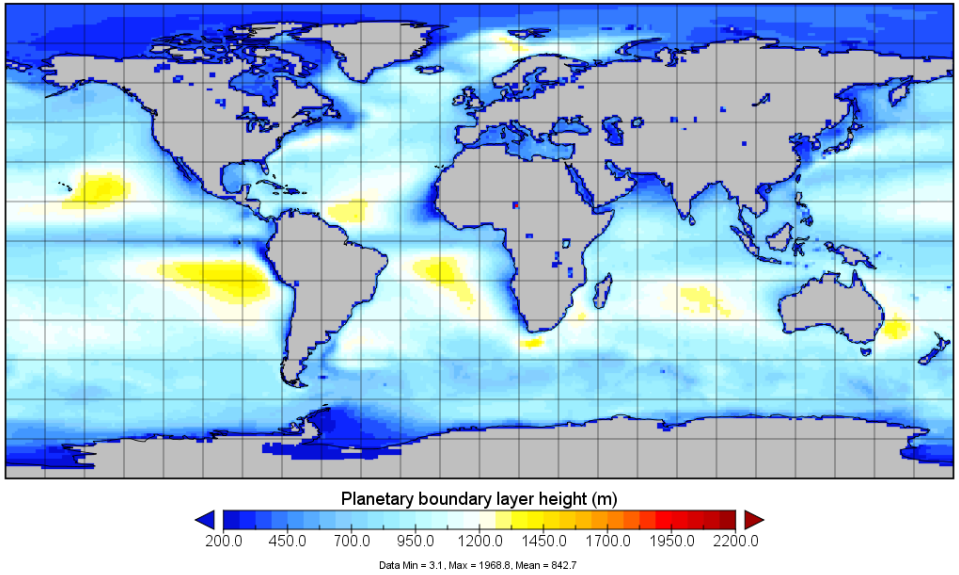
MERRA-2 March PBLH (m)



AIRS April PBLH (m)

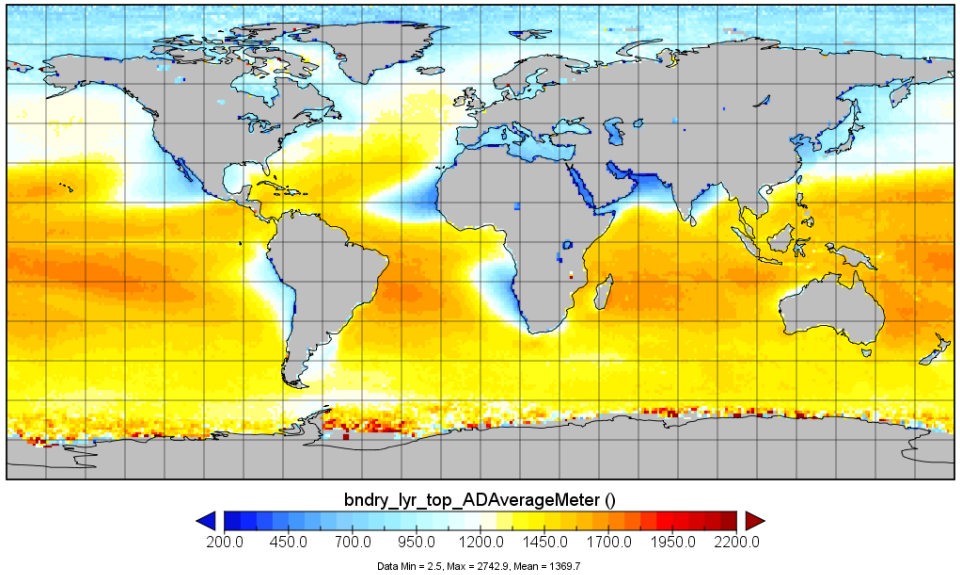


MERRA-2 April PBLH (m)

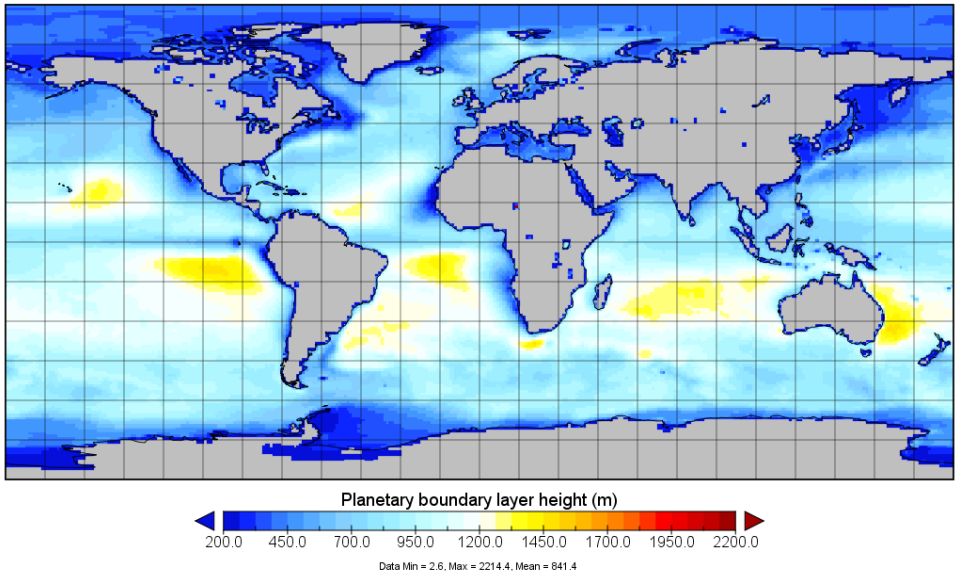


Preliminary Comparison Results (May & Jun)

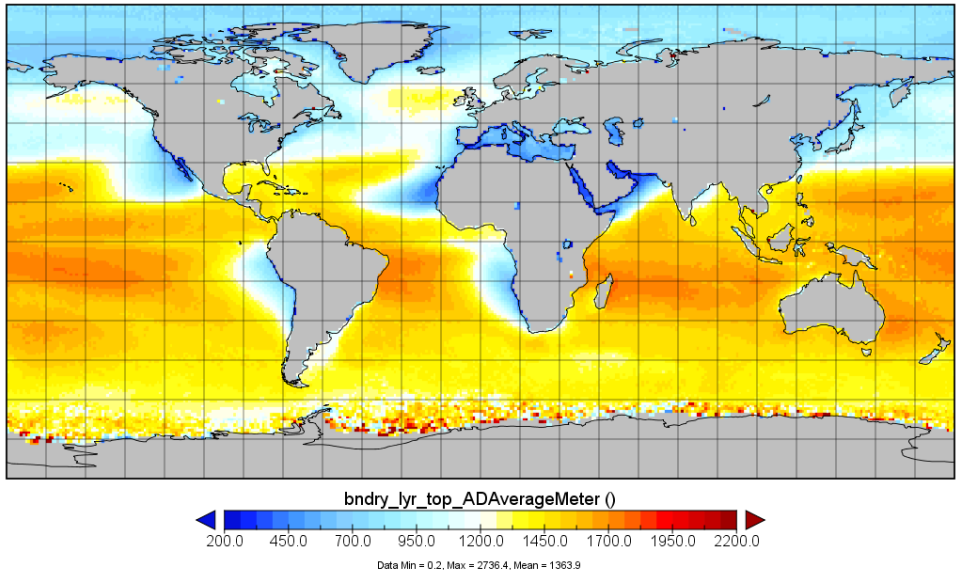
AIRS May PBLH (m)



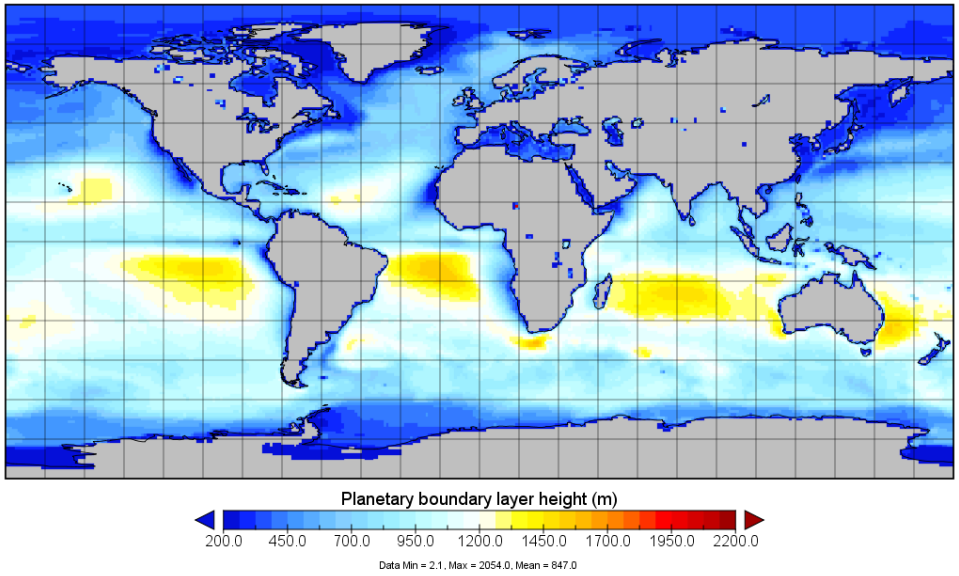
MERRA-2 May PBLH (m)



AIRS June PBLH (m)

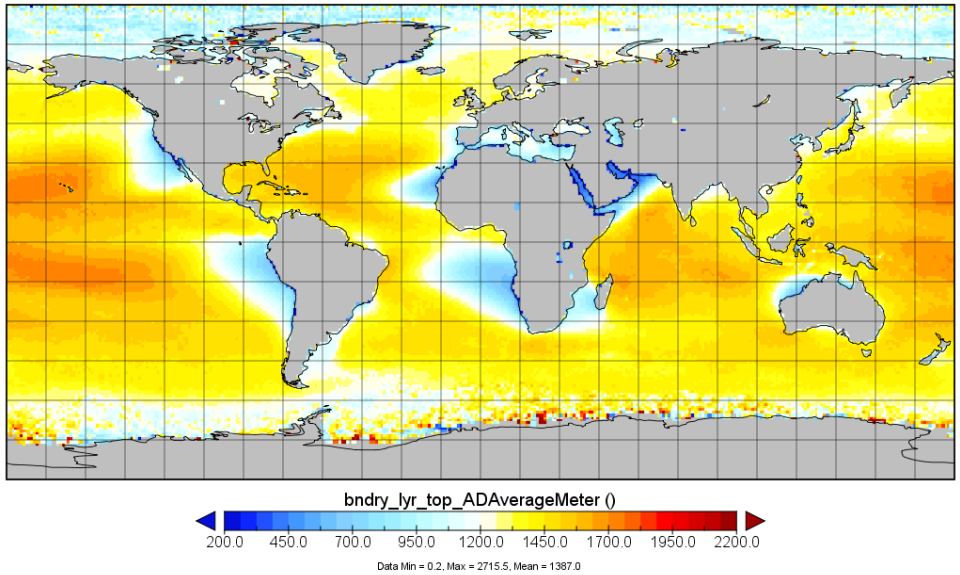


MERRA-2 June PBLH (m)

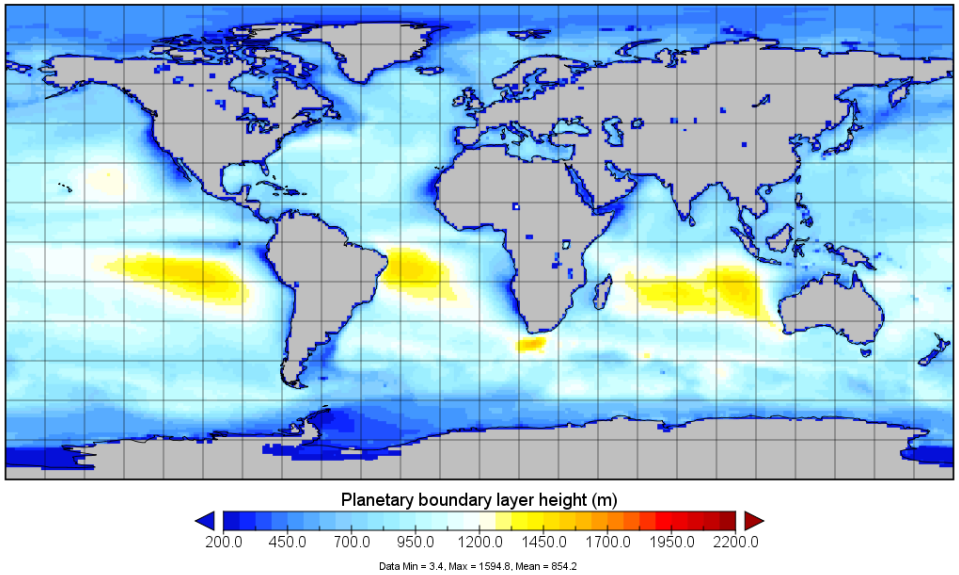


Preliminary Comparison Results (Sep & Oct)

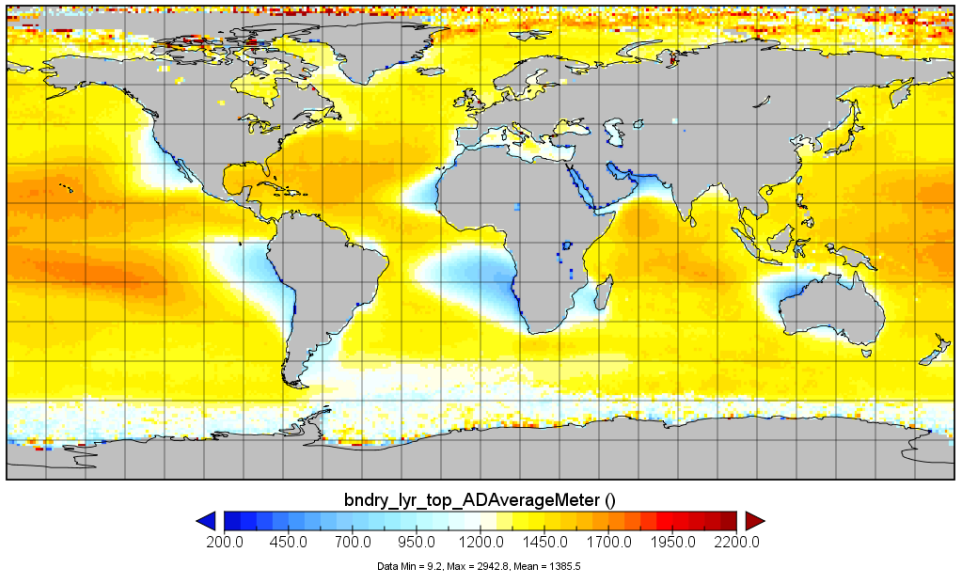
AIRS September PBLH (m)



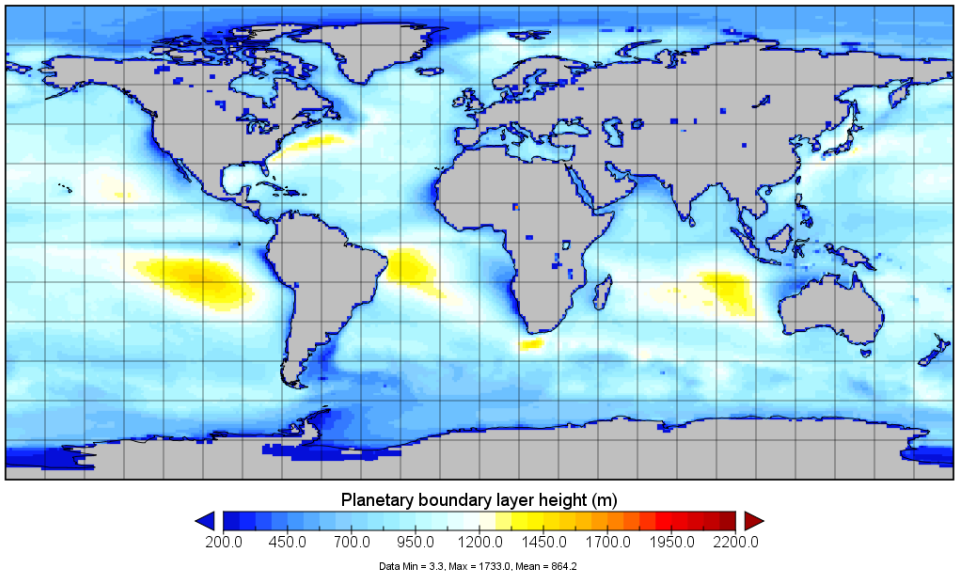
MERRA-2 September PBLH (m)



AIRS October PBLH (m)

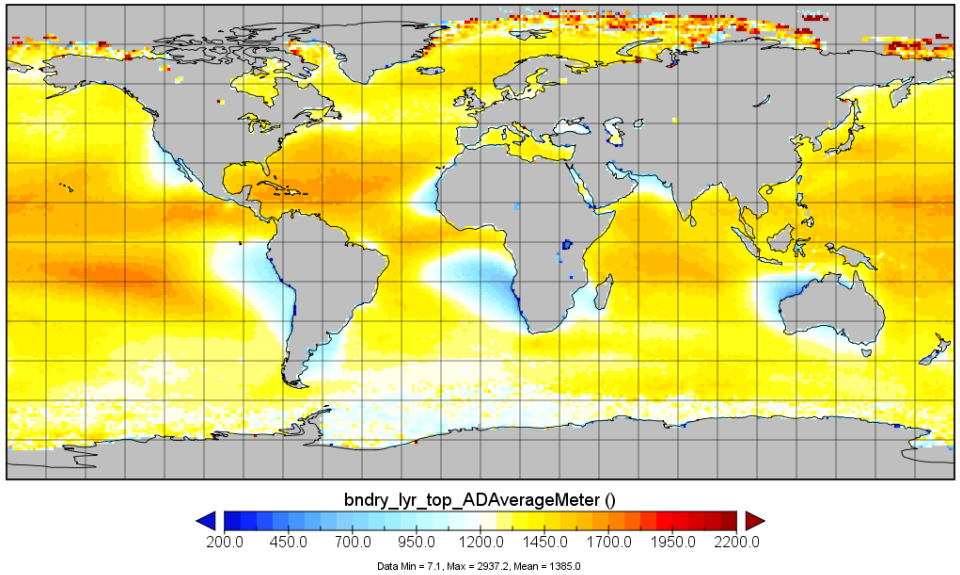


MERRA-2 October PBLH (m)

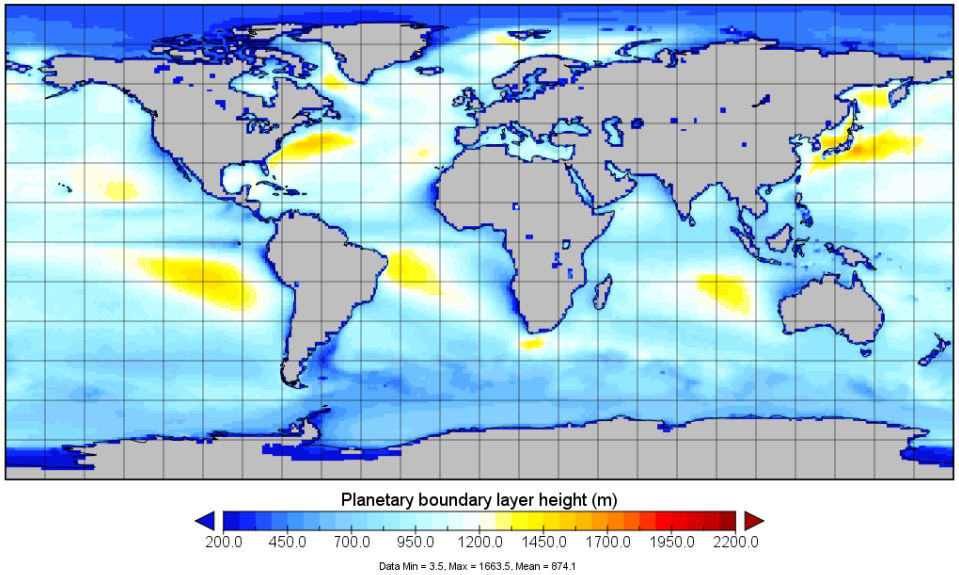


Preliminary Comparison Results (Nov & Dec)

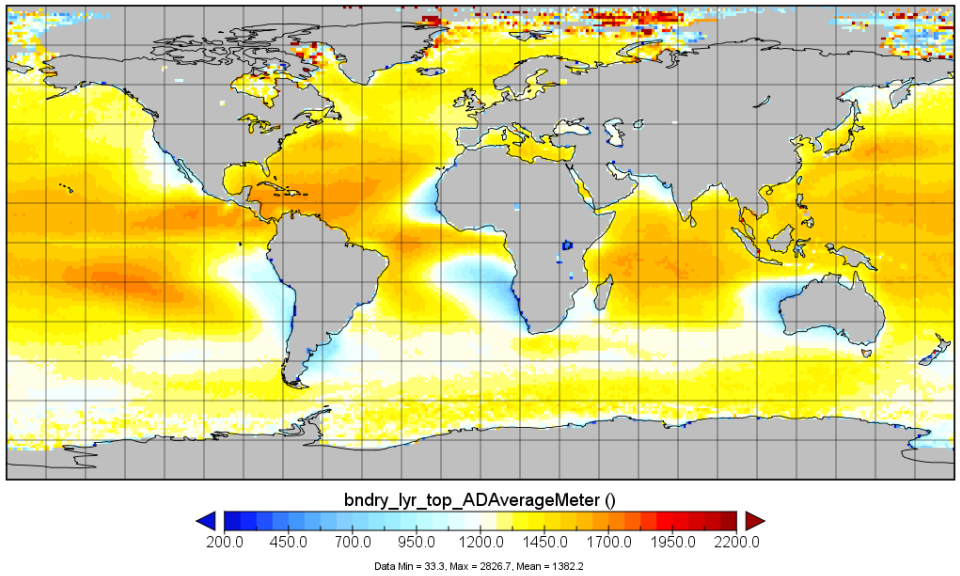
AIRS November PBLH (m)



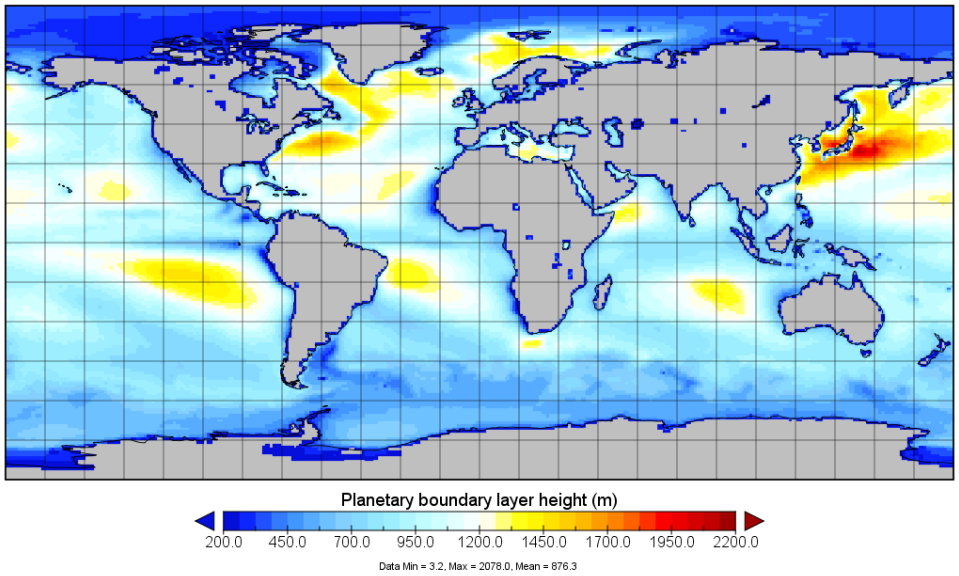
MERRA-2 November PBLH (m)



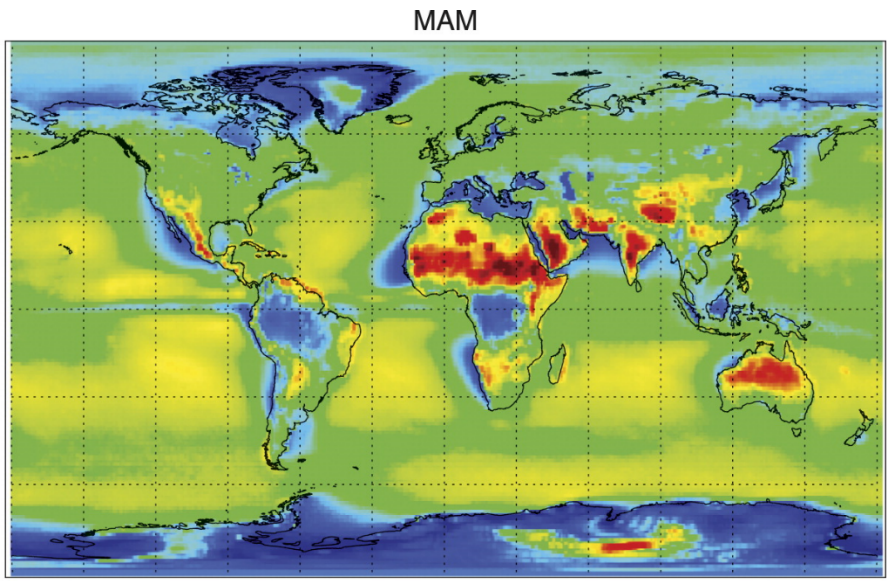
AIRS December PBLH (m)

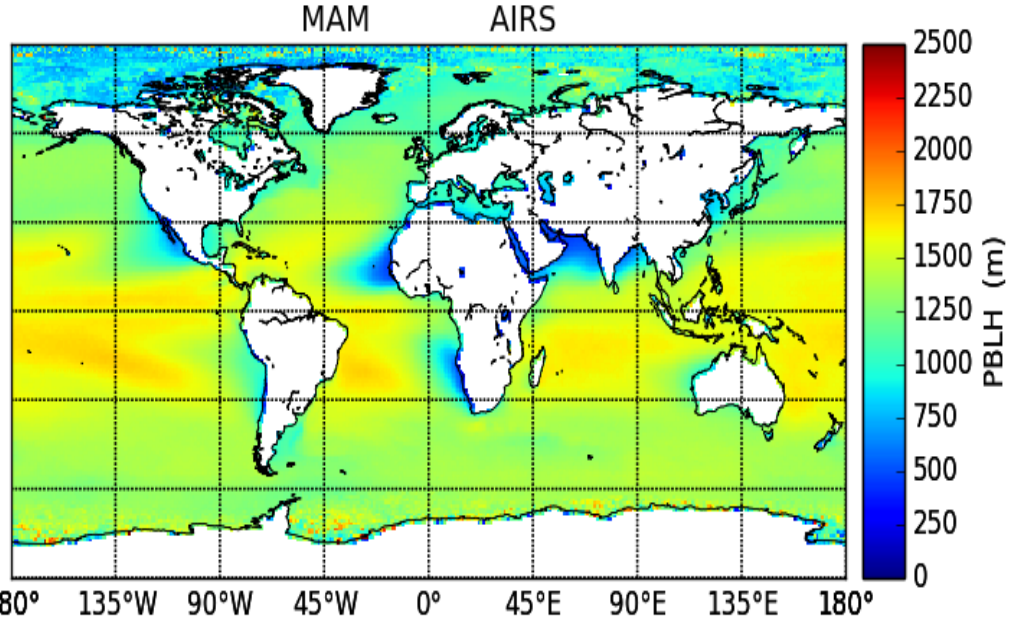


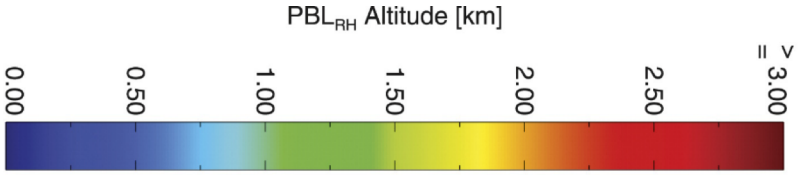
MERRA-2 December PBLH (m)

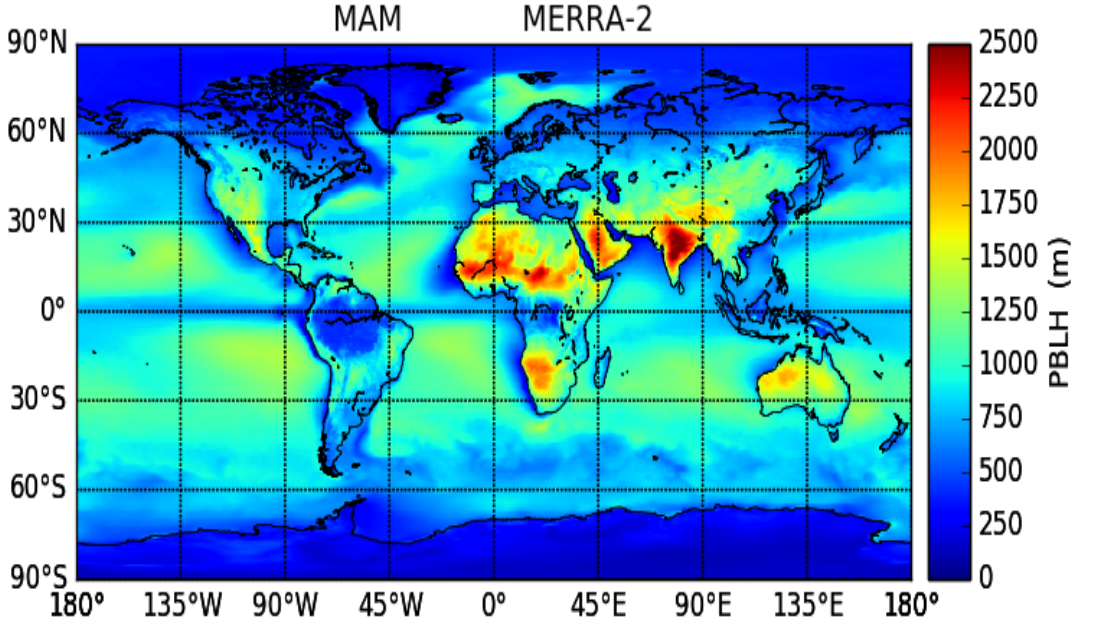


ERA, AIRS, MERRA-2 Comparison: MAM Season





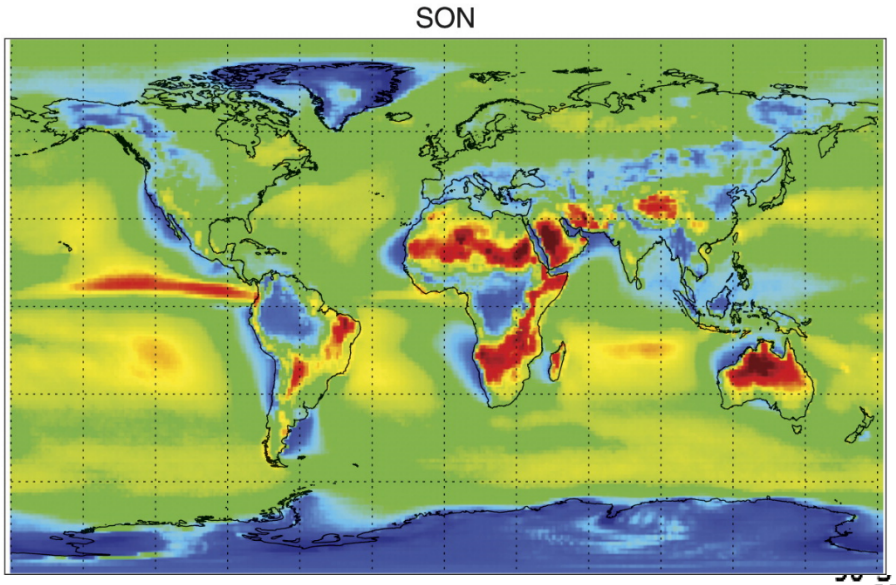


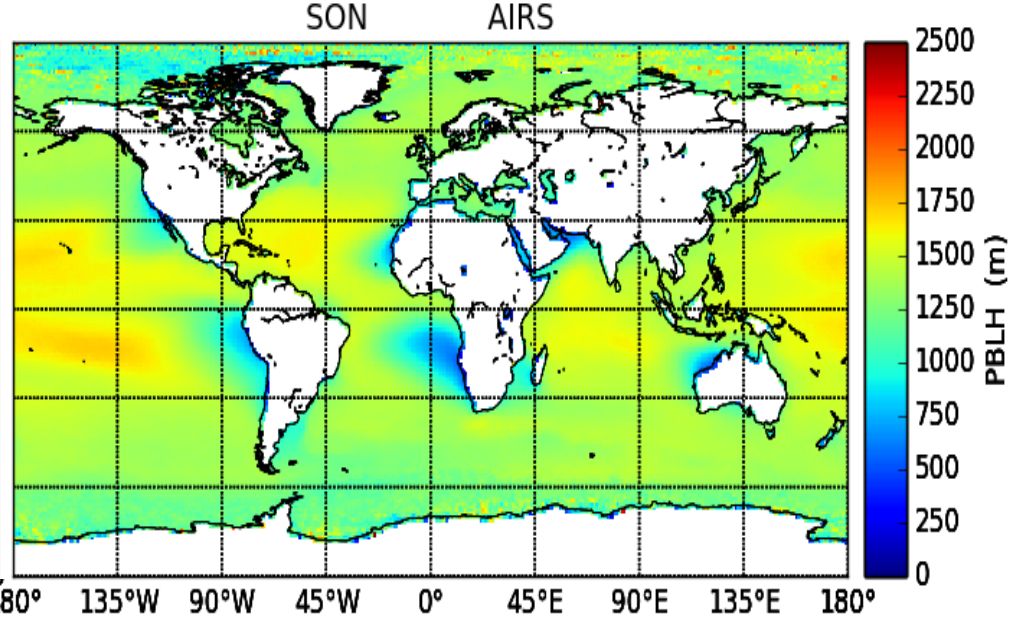


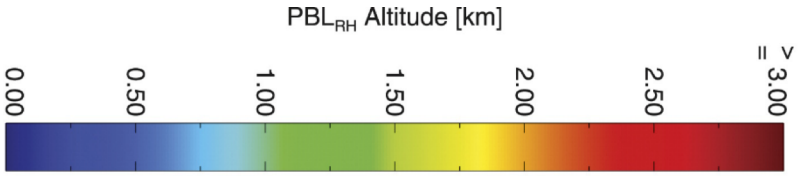
ITCZ: not very deep PBL

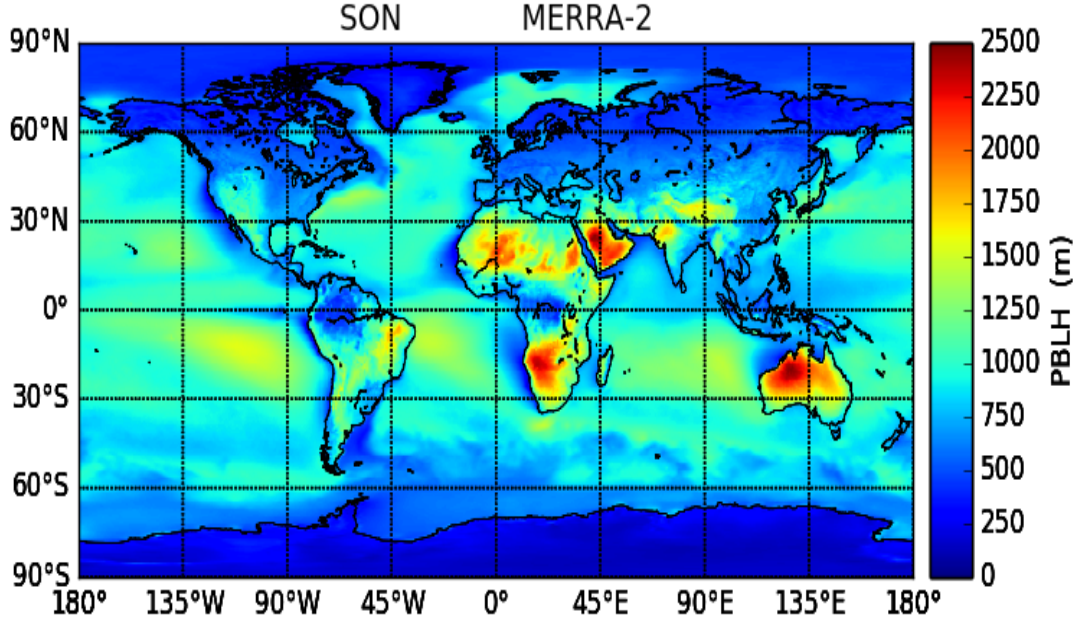
50^0S ~ 65^0S Zone

ERA, AIRS, MERRA-2 Comparison: SON Season









ITCZ: very deep PBL

50^0S ~ 65^0S Zone