The NASA Micro-Pulse Lidar Network (MPLNET)

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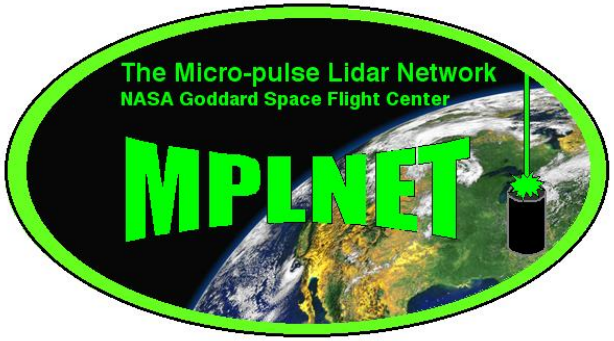
Si-Chee Tsay, NASA GSFC Code 613

Site Operations & Science Investigations
…. many network partners around the world

MPLNET is funded by the NASA Radiation Sciences Program and the Earth Observing System



What's New:

Version 3 Development
- New Products, QA Flags, CF Compliant netcdf 4, & Met Input
- New Website, online data ordering, & enhanced image browsing

Network Status & Polarized MPL Deployment
- 18 Active sites
- 7 active polarized sites, 5 more by summer, more upgraded next year

Network Expansion
- 4 new sites by this summer
- Several more planned by next year
- Site strategy

Product Level	Version 2					Version 3				
	Latency	QA Flags	QA Screening	Product Datasets	Variables	Latency	QA Flags	QA Screening	Product Datasets	Variables
L1	<01.50hours	None	None	NRB	Signal Diagnostics	<01.50hours	Yes	None	NRB	Signal Diagnostics VolumeDepolRatio
L1.5	NextDay	Limited	None	L1.5B(Heights)	CloudBaseandTopHeights AerosolTopHeight PBLHeight	Browse Images: <01.50hours Data: NextDay	Yes	None	CLD	CloudBaseandTopHeights DepolRatio Phase:Water,Mixed,Ice/Cirrus ThinCloudExtinctionProfile ThinCloudOpticalDepth
				L1.5(Aerosol)	BackscatterProfile ExtinctionProfile LidarRatio(column) PBLAOD GriddedColumnAOD *AlsoatAERONETTimes				AER	AerosolTopHeight BackscatterProfile ExtinctionProfile LidarRatio(column) GriddedColumnAOD DepolRatioProfile *AlsoatAERONETTimes
									PBL	PBLHeight PBLAerosolOpticalDepth *AlsoatAERONETTimes
L1.5V						Browse Images: <01.50hours Data: NextDay (<01.50hours approved users)	Yes	Yes	CLD	CloudBaseandTopHeights DepolRatio Phase:Water,Mixed,Ice/Cirrus ThinCloudExtinctionProfile ThinCloudOpticalDepth
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L2	Months to Years (manual upon request)	Yes	Yes	L1.5B(Heights)	CloudBaseandTopHeights AerosolTopHeight PBLHeight	X Weeks after AERONET L2	Yes	Yes	CLD	CloudBaseandTopHeights DepolRatio Phase:Water,Mixed,Ice/Cirrus ThinCloudExtinctionProfile ThinCloudOpticalDepth
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									PBL	PBLHeight PBLAerosolOpticalDepth *AlsoatAERONETTimes

Met: Standard Atmos

Met: GEOS-5

Met: GEOS-5

Met: NCEP

Met: GEOS-5

MPLNET: Version 3 Update

MPLNET Data Products: Version 2 (2006-current) *nectcdf 3, error propagation from raw data to final product*

Level 1: Lidar Signals, Instrument Diagnostics
Latency: < 1.5 hrs most sites, others next day.
No QA Flags, No QA Screening.

Level 1.5: **L1.5b:** Aerosol, PBL, and Cloud Heights
L1.5a: Aerosol Backscatter, Extinction, Optical Depth,
Lidar Ratio (at AERONET times and 24/7 day-to-night)
Latency: next day. Limited QA Flags, No QA Screening.

Level 2: Same as L1.5 above, except no PBL, aerosol only with AERONET
Latency: X months+ after Level 2 AERONET is available.
QA Screening applied.

MPLNET Data Products: Version 3 (in development) *utilizes GEOS-5 met, all data files netcdf 4 CF Compliant*
Online Data Ordering Too
Subset packaging
other formats: nc3, GALION?

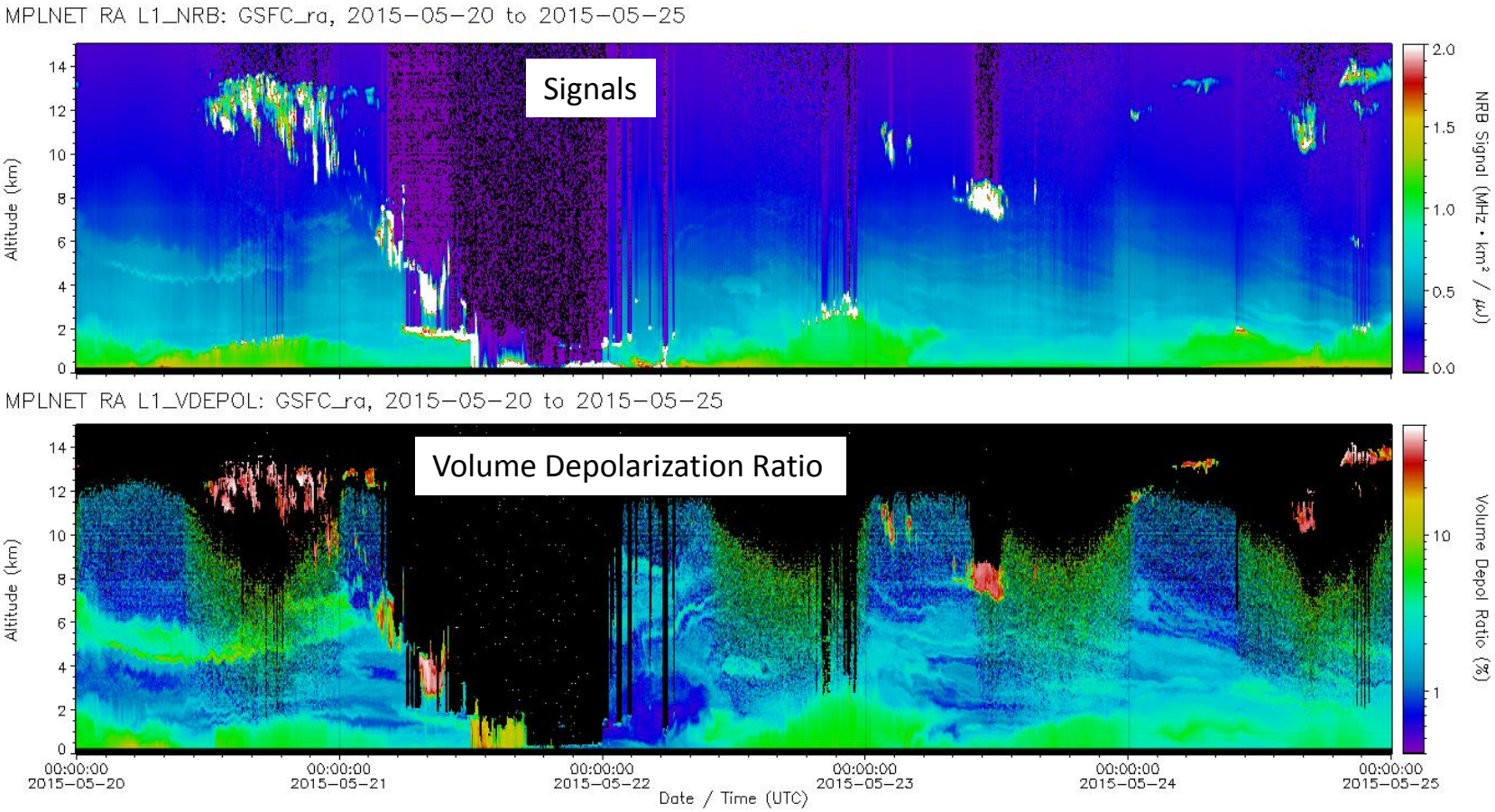
Level 1: Lidar Signals, Instrument Diagnostics, Volume Depol Ratio
Latency: < 1.5 hrs. QA Flags provided, No QA Screening.

Level 1.5: **Cloud:** Heights, Phase, Thin Cloud Extinction & Optical Depth
Aerosol: Height, Backscatter, Extinction, AOD, Lidar & Depol Ratio
PBL: Height, PBL AOD
Latency: < 1.5 hrs for browse images, data next day. QA Flags provided, No QA Screening.

Level 1.5V: **Cloud:** Heights, Phase, Thin Cloud Extinction & Optical Depth
Aerosol: Height, Backscatter, Extinction, AOD, Lidar & Depol Ratio
PBL: Height, PBL AOD
Latency: **< 1.5 hrs for browse images, data next day. ICAP < 1.5 hrs**. QA Flags provided, QA Screening.

Level 2: Same as L1.5 above.
Latency: X weeks after Level 2 AERONET is available.
QA Flags provided, QA Screening applied.

V3 Data May 20 – 24, 2015 GSFC: L1 Signals



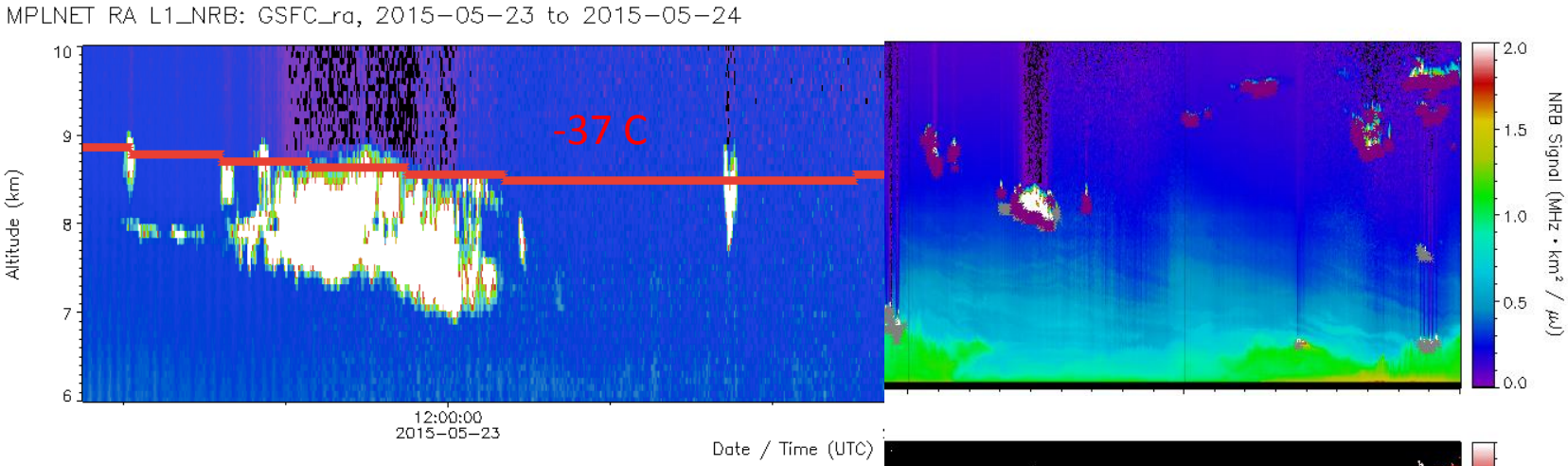
Welton et al., New Polarized MPL, JTECH, in prep, 2015

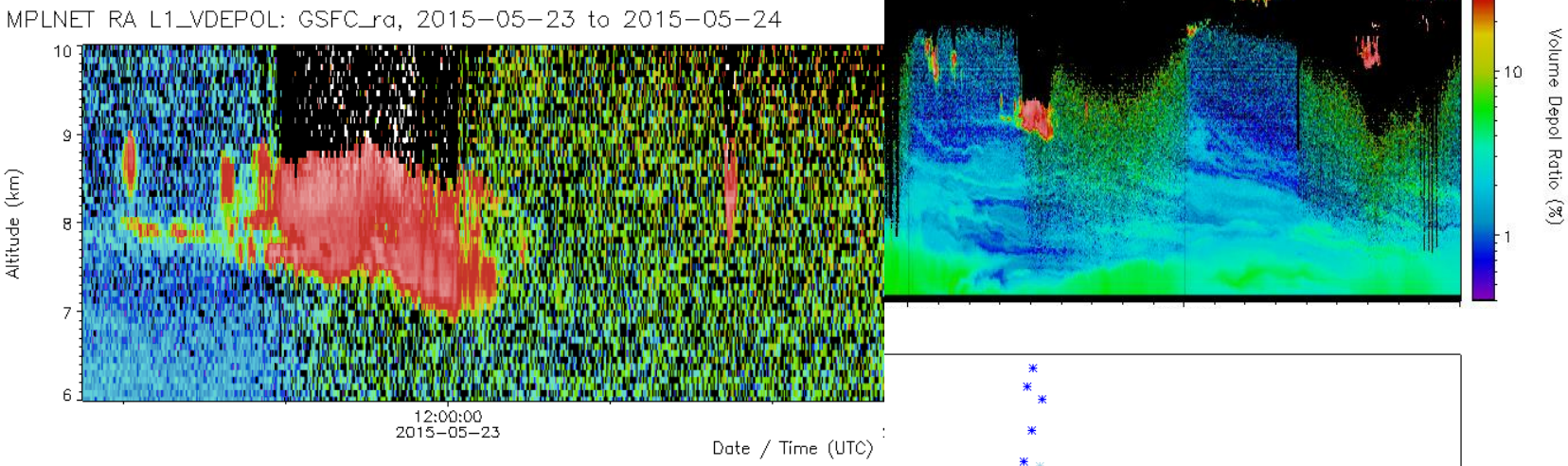
Incorporate both older MPLs and new polarized MPLs

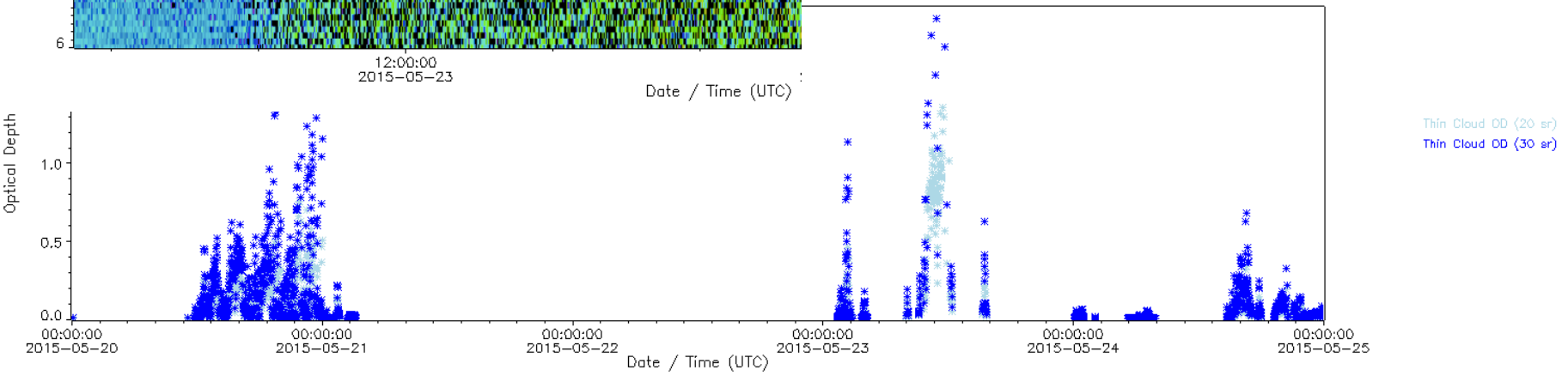
New signal averaging scheme:
- running boxcar average, re-gridded to 1 minute
- this applies to all higher level products (-> aerosol retrievals up to cloud edge)

All Products will have QA Flags:
- No data acquired (no raw lidar signal data)
- instrument status (temps, energy, calibrations)
- Failed retrieval (no PBL, Fernald fail, etc)
- Specific product screen (ex. L15V_AER)

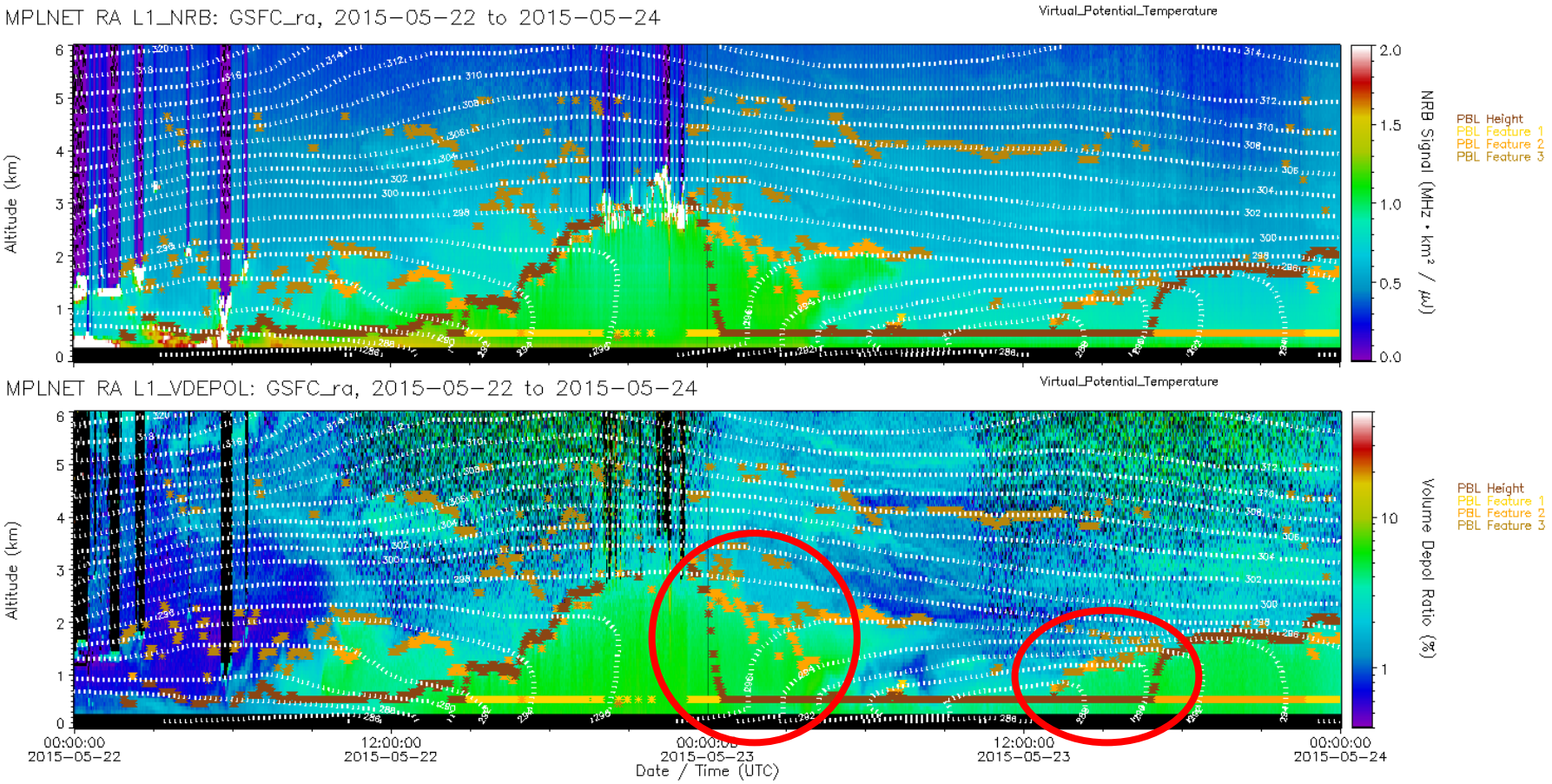
V3 Data May 20 – 24, 2015 GSFC: L15 Clouds







V3 Data May 22 – 23, 2015 GSFC: L15 PBL Heights



Lewis et al., Improved boundary layer depth retrievals from MPLNET, JGR, 2013

Current default uses cloud screened 5 minute signal average

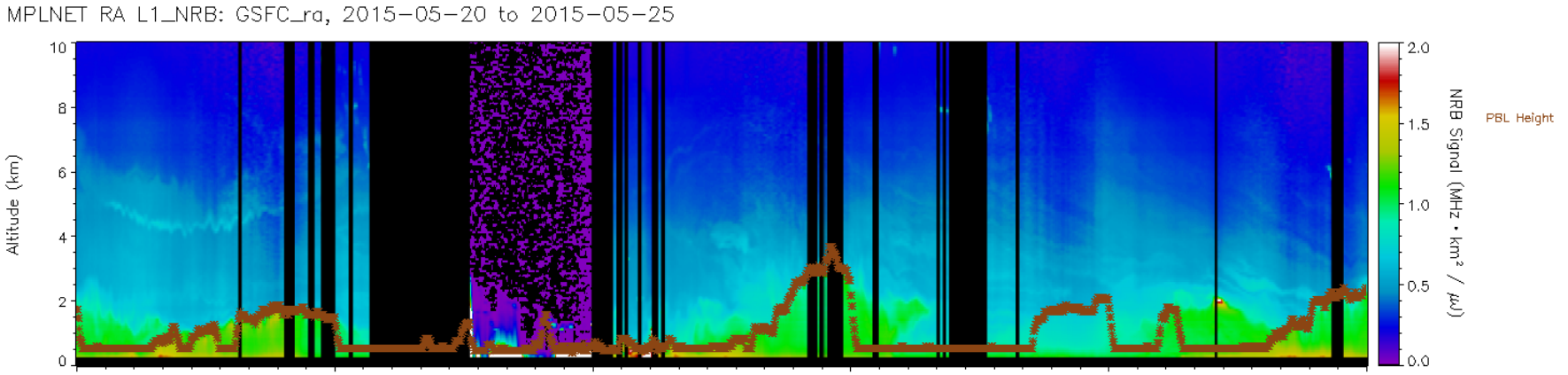
can run without screen, currently assessing operational performance

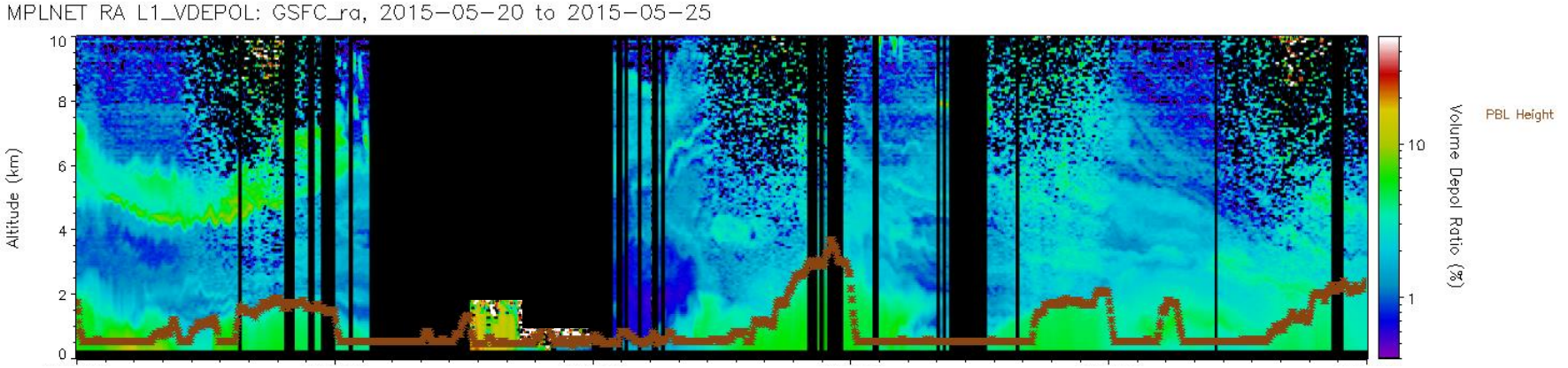
Determines up to 3 potential PBL Heights

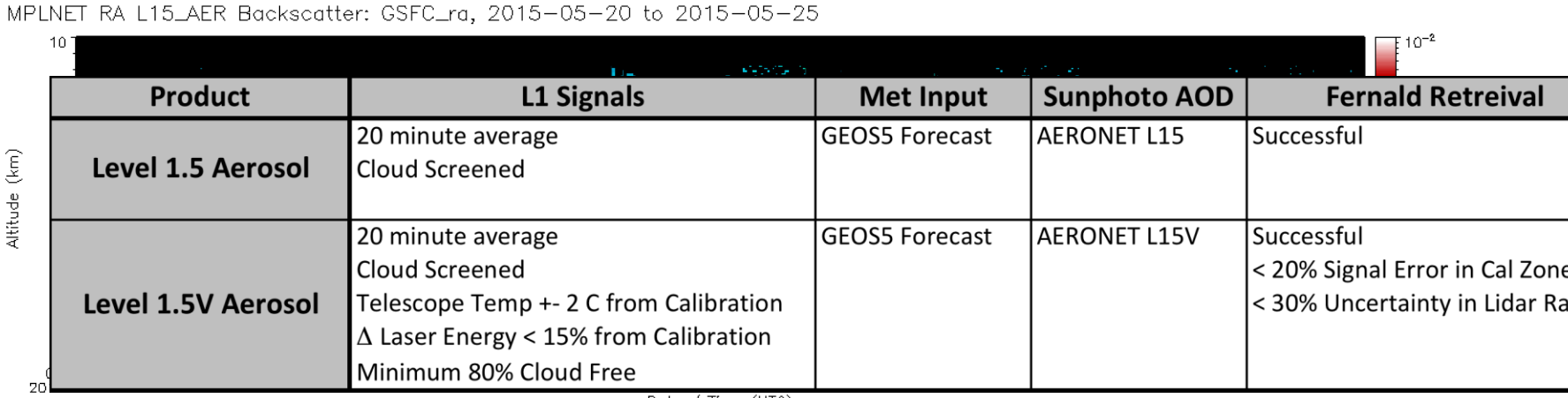
Algorithm selects "most likely" PBL Height, others provided in product

studying issues related to initial PBL growth and collapse during evening

V3 Data May 20 – 24, 2015 GSFC: L15V Aerosols (Beta)

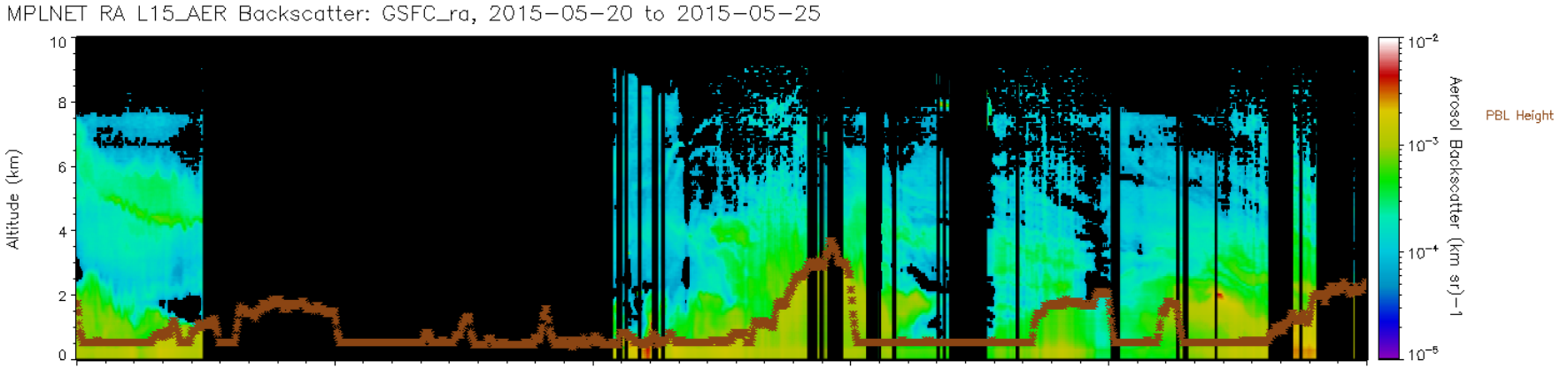


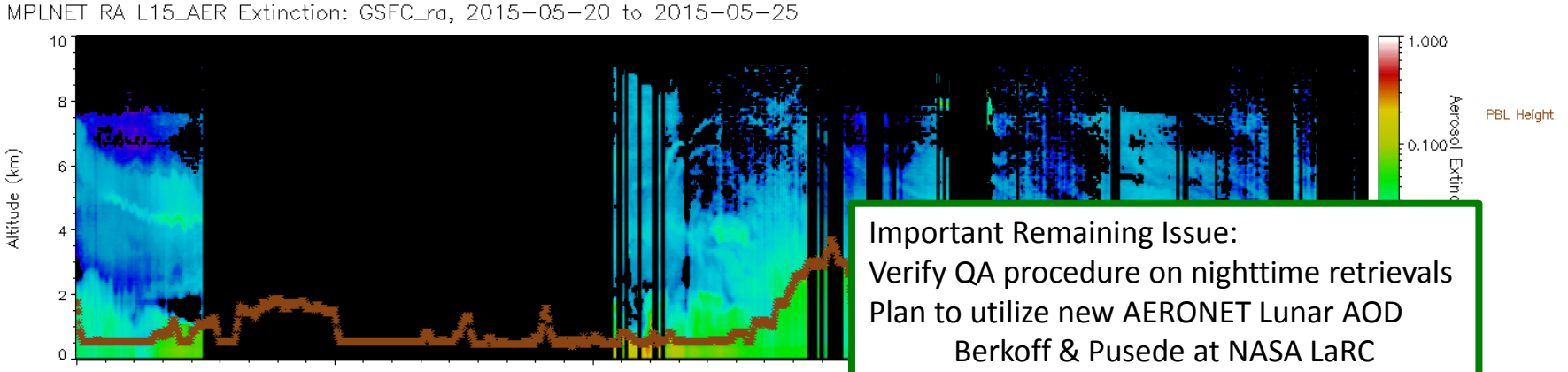




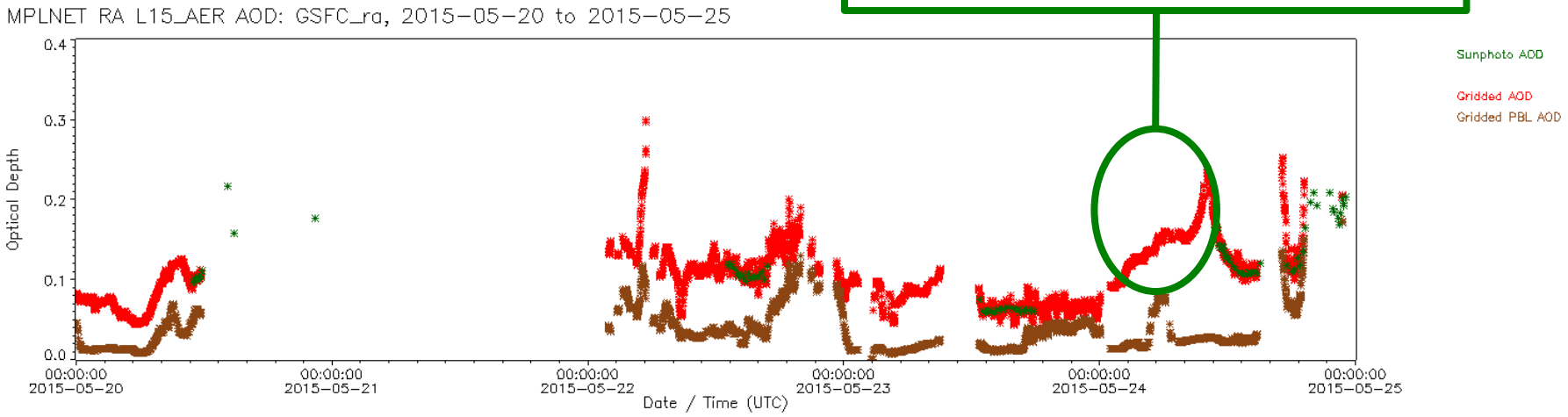
Product	L1 Signals	Met Input	Sunphoto AOD	Fernald Retreival
Level 1.5 Aerosol	20 minute average Cloud Screened	GEOS5 Forecast	AERONET L15	Successful
Level 1.5V Aerosol	20 minute average Cloud Screened Telescope Temp +- 2 C from Calibration Δ Laser Energy < 15% from Calibration Minimum 80% Cloud Free	GEOS5 Forecast	AERONET L15V	Successful < 20% Signal Error in Cal Zone < 30% Uncertainty in Lidar Ratio

V3 Data May 20 – 24, 2015 GSFC: L15V Aerosols (Beta)

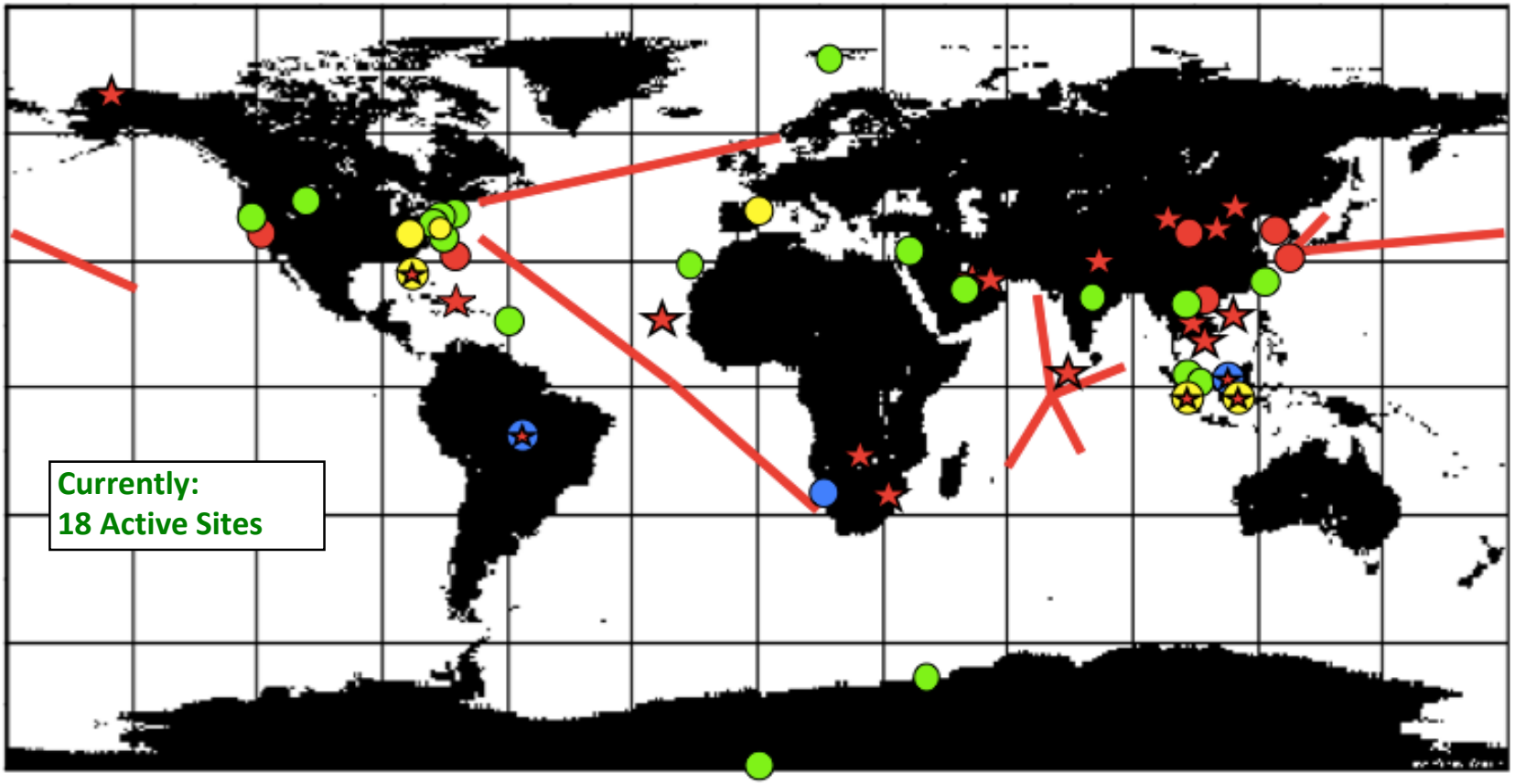




Important Remaining Issue:
Verify QA procedure on nighttime retrievals
Plan to utilize new AERONET Lunar AOD
Berkoff & Pusede at NASA LaRC



MPLNET Status: Current sites, Polarized MPLs, Strategy

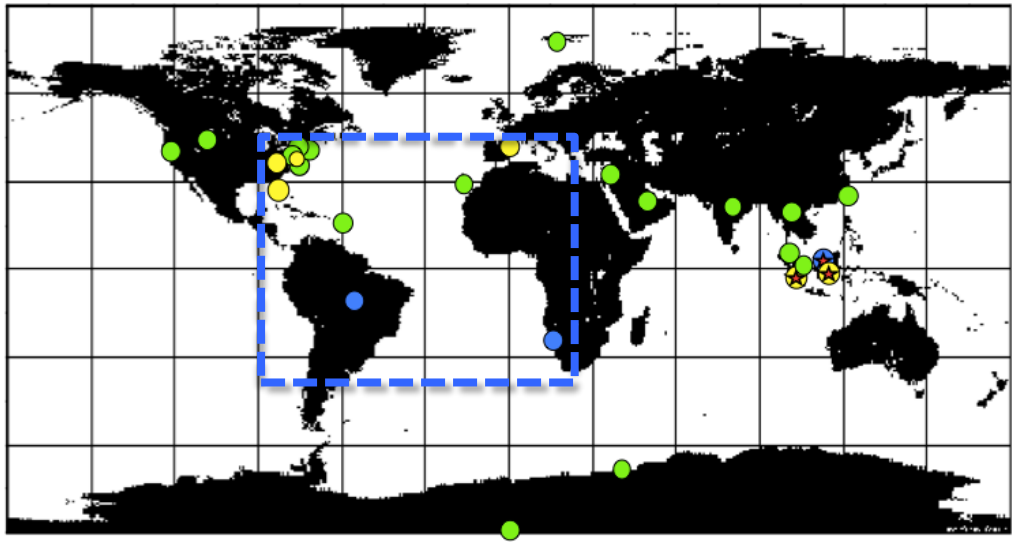


active
inactive
planned
proposed

long term site
field campaign
former field campaign, planned/proposed site
ship cruise

* most sites co-located with AERONET

The Next Few Years in the Western Dust (and Smoke) Box:



Existing Sites:

- **Ragged Point Barbados.**
  Upgrade to P-MPL this summer.
- **Miami/RSMAS.**
  P-MPL, will join MPLNET by summer.
- **Barcelona UPC.**
  P-MPL will join MPLNET by summer.
- **App State U North Carolina.**
  P-MPL will join MPLNET by summer.
- **Mid-Atlantic.**
  4 Sites, 2 P-MPL. 3rd will upgrade 2016.
- **Tenerife.**
  Old MPL, not standard network model. Need upgrade to P-MPL.
  Group does own original version of P-MPL, but should be upgraded to our network standard.

Proposed Sites: Leverage LALINET and revive connections with Saharan dust community and old SAFARI network

- **Puerto Rico & Houston.**
  Good local contacts, tie in with dust transport. In-situ sampling at each.
- **Chad.**
  Recently approached by Lake Chad Basin Commission (LCBC). Proposed site at ?.
- **Senegal**
  Tried international agreement with LPA partner in 2006. Could try again, but some issues to overcome.
- **Namibia.**
  Joint with NASA ORACLES & ARM LASIC. Site TBD. Smoke-cloud interaction focus.
- **South America / LALINET Coop.**
  Site TBD. Provide 1 P-MPL to LALINET to start, more could follow. Tie-in with dust desired.

Principal Investigator:
Brent Holben, NASA GSFC

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Jon Rodriguez, FIBERTEK
Jason Kraft, FIBERTEK

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Ilya Slutsker, SSAI
David Giles, SSAI

Calibration & Quality Assurance:
Thomas Eck, USRA
Alexander Smirnov, SSAI
Joel Schafer, SSAI

Administrative Support and Shipping:
Amy Scully, SSAI

Scientific Research:
Brent Holben, NASA GSFC
Thomas Eck, USRA
Alexander Smirnov, SSAI
Aliaksandr Sinyuk, SSAI
David Giles, SSAI
Joel Schafer, SSAI

AERONET Update

David Giles

AeroCenter Update

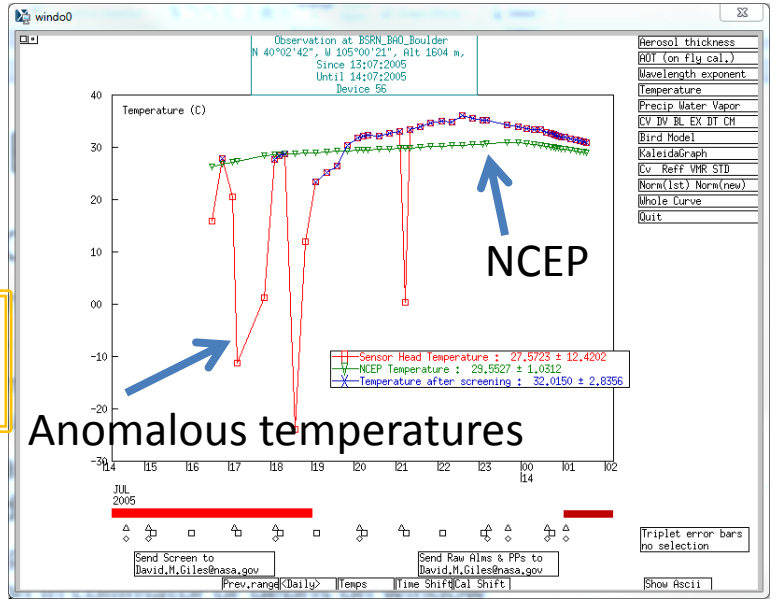
27 May 2015

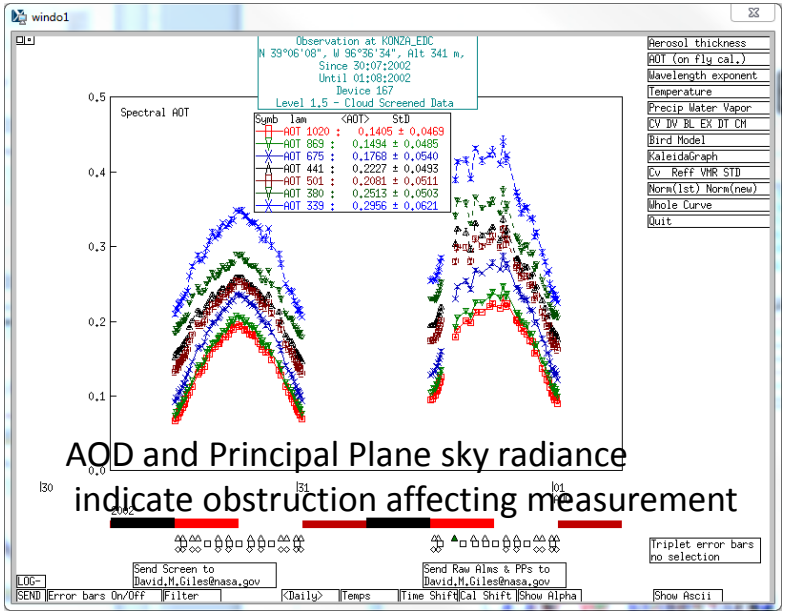
AERONET is funded by
the NASA Earth Observing System project office
and the Radiation Sciences Program (NASA HQ),
Joint Polar Satellite System (NOAA),
and large field campaigns

AERONET Version 3 Update: AOD

- V3 Level 1.0: Unscreened data (NRT)
  - Applies new temperature characterizations
  - Applies NO2 OMI L3 climatology (2004-2013)
- V3 Level 1.5: Based on Level 1.0 and uses modified automatic cloud screening (NRT)
  - Improves removal of optically thin cirrus contamination
  - Preserves more highly variable smoke
  - Compares well to Version 2 Level 2
- **V3 Level 1.5V: Based on Level 1.5 and uses new automatic quality controls (NRT)**
  - **Removes sensor temperature artifacts**
  - **Removes AOD affected by solar eclipses**
  - **Removes AOD impacted by window obstructions**
  - **Removes AOD with poor spectral dependence**
- V3 Level 2.0: Based on Level 1.5V with pre- and post-calibration applied and minimal manual intervention
  - Significantly improves timeliness of Level 2.0 data availability
  - Applies more objective removal scheme
  - Requires minimal manual analysis to remove uncommon data anomalies

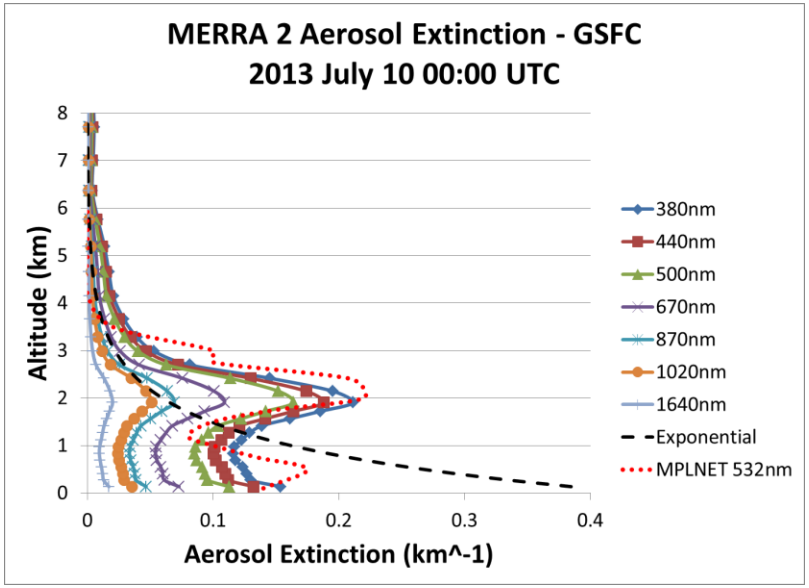
New L15V Product

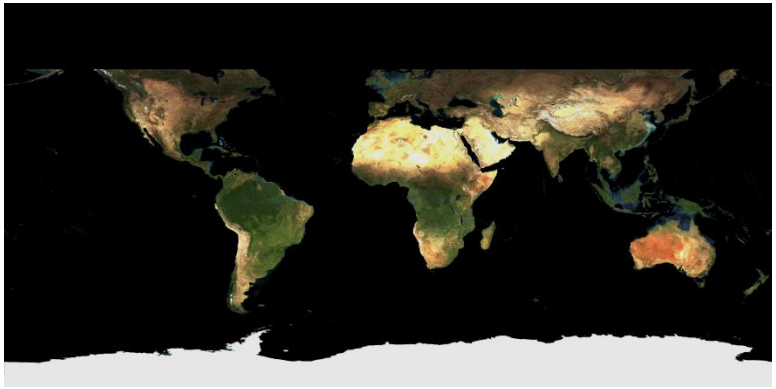




AERONET Version 3 Update - Inversions

- Implement a vector radiative transfer code
  - radiation field in UV (e.g., 380 nm retrieval)
  - degree of linear depolarization
- Integrate spectral MERRA-2 aerosol extinction profiles to estimate aerosol vertical profile (Hybrid scans)
- Incorporate MODIS snow-free BRDF and snow BRDF to characterize surface albedo
- Provide lidar and depolarization ratio products
- Estimate uncertainties for each retrieval (e.g., random error plus biases due uncertainty in AOD and sky radiance calibration)
- Update inversion quality assurance criteria





MODIS NBAR January 1-8, 2013

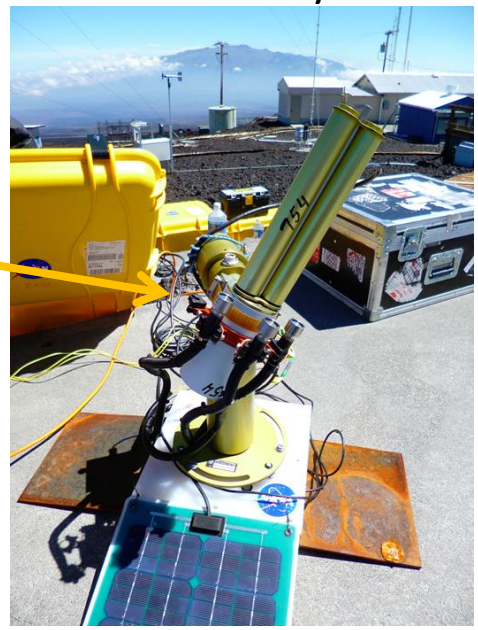
Expected V3 release in early 2016

New Instrumentation/Enhancements

- Greater flexibility controlling measurement scenarios (e.g., Hybrid, cross-scan)
- Control box upgrades: SD card storage, GPS, USB, Sim card, and Zigbee
- Lunar measurements
  - 1st to 3rd quarter lunar phase (waxing to waning gibbous)
  - Processing for lunar measurements (e.g., ROLO - Tom Stone, USGS Flagstaff)
- Synergism with MPLNET, PANDORA, and in situ measurements
- Development toward attachment for total column CO_2 and CH_4 measurements (Emily Wilson)
  - GreenNet: http://ssed.gsfc.nasa.gov/mini-LHR/index.html

Cimel Sun/Sky/Lunar Radiometer

Mini-Laser Heterodyne Radiometer



Summary

- Version 3
  - AERONET Release Early 2016
  - MPLNET Release, coincident with, or shortly after AERONET
    - need to test AERONET V3 first
    - if we continue using GEOS5 FPIT products then not ready till end of 2015
      - might switch to standard MERRA-2
  - New Level 1.5V products are most significant addition to our network products

- Network regional focus for next few years
  - Western end of dust belt
    - West Africa to Caribbean and Americas (mostly addition of MPLNET lidars)
      - Potential input for “western” SDS-WAS capability
  - South America and Southern African smoke & pollution
    - S Africa: Brent at meeting in Namibia this week -> “revival of the SAFARI community”
      - Looking to rebuild network sites throughout region
    - S America focus mostly adding lidars (working with LALINET component of GALION)

- GALION: as co-chair my interest is to push for better lidar data availability and NRT access
  - Better site planning with in-situ networks (GAW and others) & interaction with SDS-WAS
  - New GAW “local site” designation is important for AERONET/MPLNET & GALION
    - All AERONET/MPLNET sites fit description

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