Activities in GRUAN and towards Future NWS Networks.

Reporting: *Belay Demoz*

Howard University Beltsville Site [Sterling]

Contributed to GRUAN

- **Trend detection**
- **Raman Calibration**
- **Co-location**
- **others**

Update:

- GRUAN Update
- Ceilometer network
- Wind

GRUAN @ Beltsville - Summary

NASA [ALVICE]: *D. Whiteman,* ***M. Walker*,*** *K. Vermeesch*

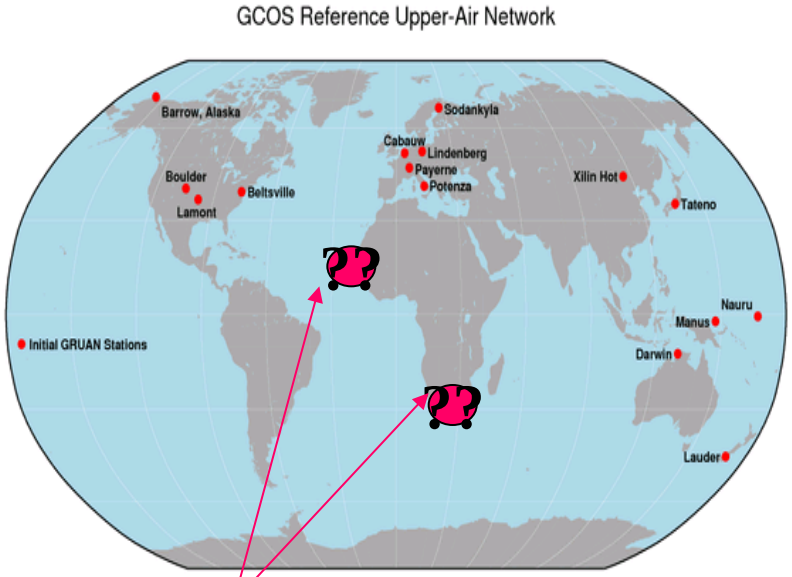
NOAA [NWS]: ***M. Hicks*,*** *J. Fitzgibbons, H. Diamond*

NGIA: ***T. Creekmore****

Howard: *B. Demoz,* ***L. Cooper+,*** *D. Venable, R. Sakai*

- **Funding:**
  - Ozone observations *(MDE and NGIA)*
  - Satellite Cal/Val. *(CFH - NOAA)*
  - HURL *(NCAS)*
  - ALVICE *(NASA)*
- **Operation:**
  - 1/wk ~ *2AM with overpass*
  - *> 2yrs of data archive*
  - *RS_Launch started (R. Sakai)*
  - *100% chamber is on order*

Certification Pending

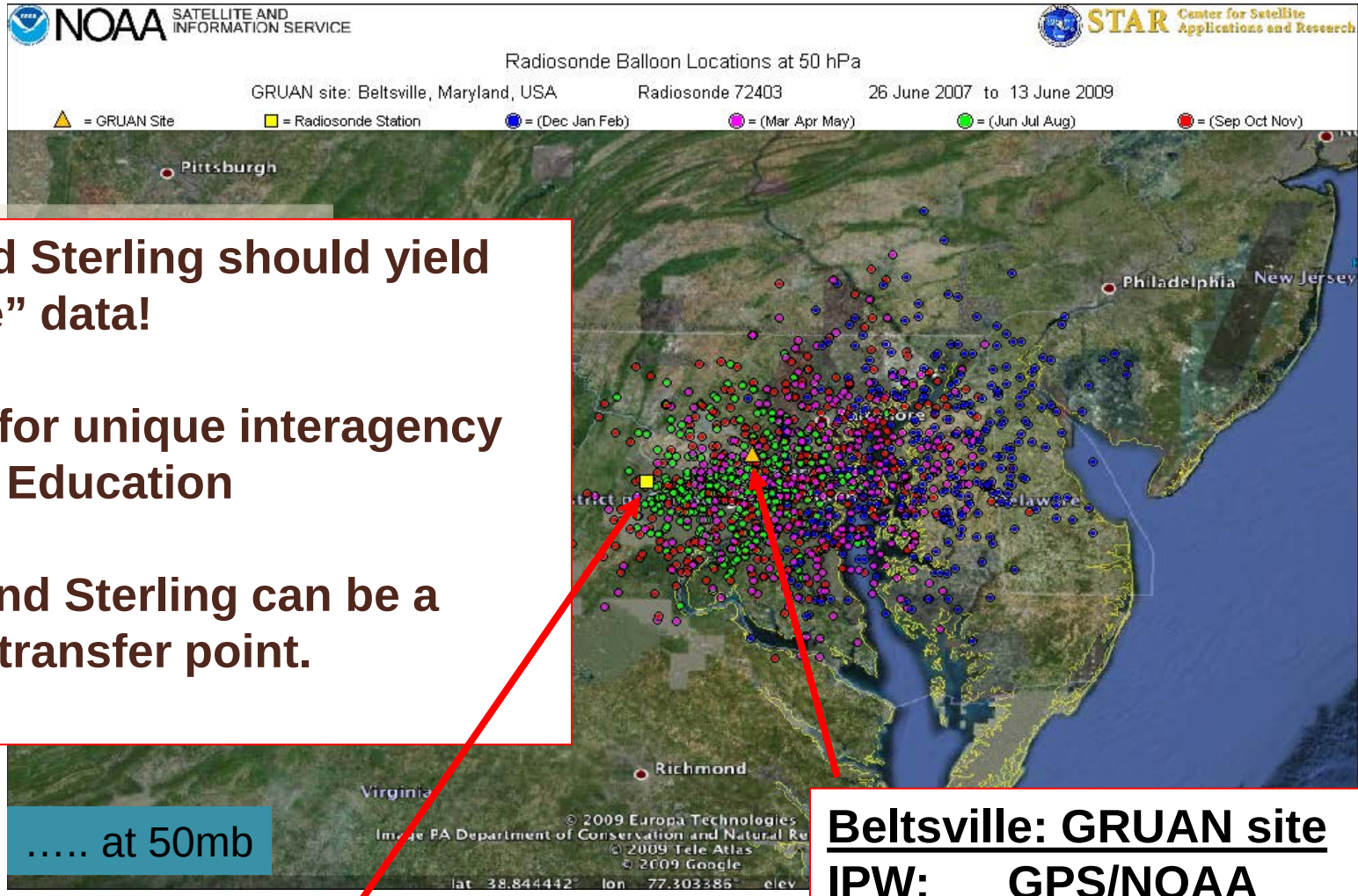


HU MOU signed.

GRUAN: co-location …

- Beltsville and Sterling should yield “same climate” data!
- Opportunity for unique interagency collaboration, Education

➔ Beltsville and Sterling can be a GRUAN-NWS transfer point.

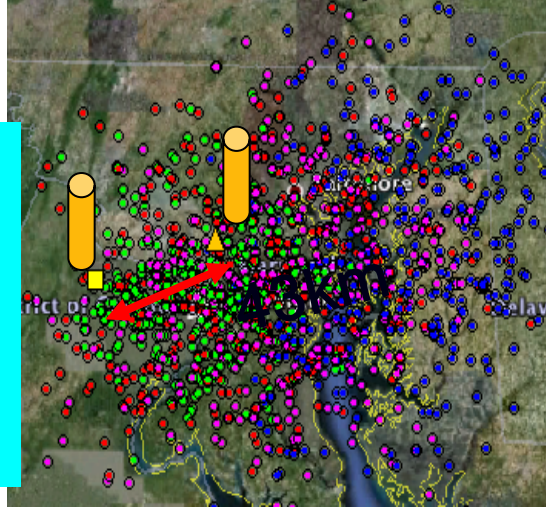


….. at 50mb

Sterling: NOAA/NWS Site
IPW: GPS/NOAA
Sonde: RRS (Routine)

Beltsville: GRUAN site
IPW: GPS/NOAA
MWR: 2 & 39 Channel
Sonde: RS92, CFH
Raman: HURL/ALVICE

GRUAN: *Co-location work*



T/q comparisons:

- ΔT within 1%

- Total vapor (IPW) ~ 1%

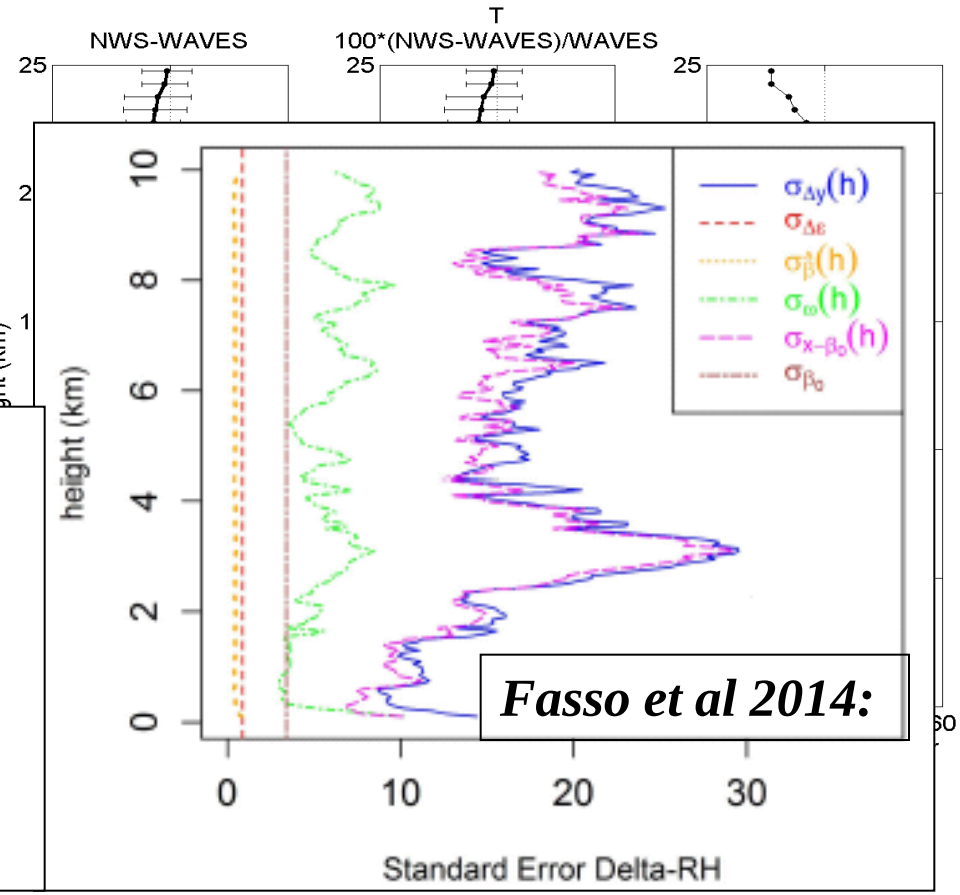
➔Δq as large as 60%!!

- largest contribution to "difference" is the *reducible envir. error*.

➔ Wish: Repeat with same type of sondes.

Source of uncertainty		$\bar{\sigma}^2$	$\bar{\sigma}^2\%$	$\bar{\sigma}$
Total uncertainty	Δ_y	343.8	100%	18,54
Collocation drift	Δ_μ	343.0	-	18.52
Bias (adjustable)	β_0^2	11.6	3.4%	3.40
Environ. Error (reducible)	$x - \beta_0^2$	293.2	85.5%	17.12
Environ. Error (irreducible)	ω^2	37.1	10.8%	6.09
Sampling error	$\hat{\beta}$	0.21	0.1%	0.46
Measurement error	Δ_ε	0.81	0.2%	0.90

Table 1. Budget of total collocation uncertainty for relative humidity (Δrh) in Beltsville-Sterling, using HFR model of Eq.s (14) and (15).

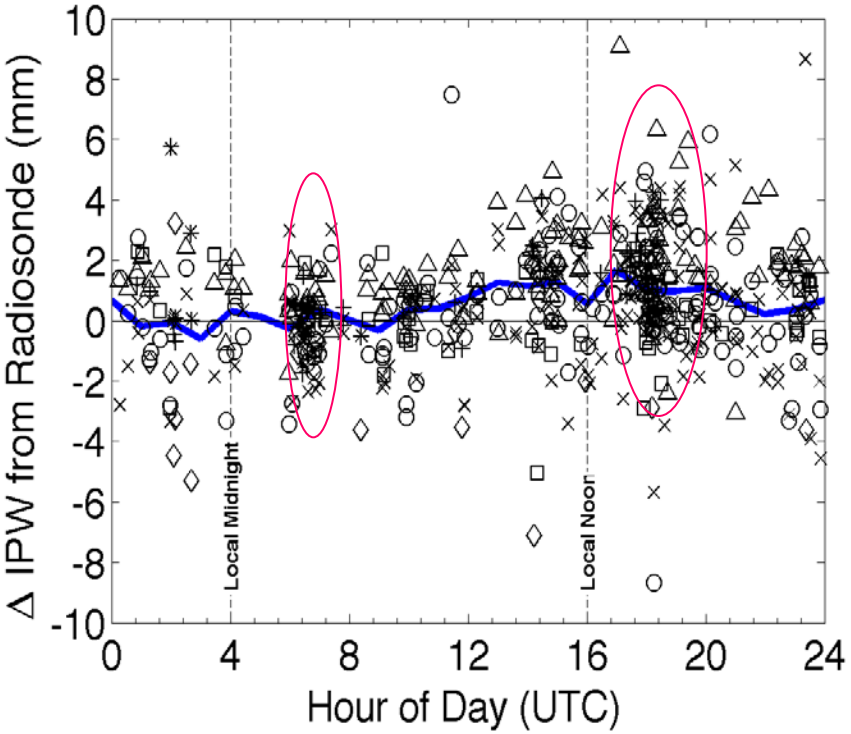


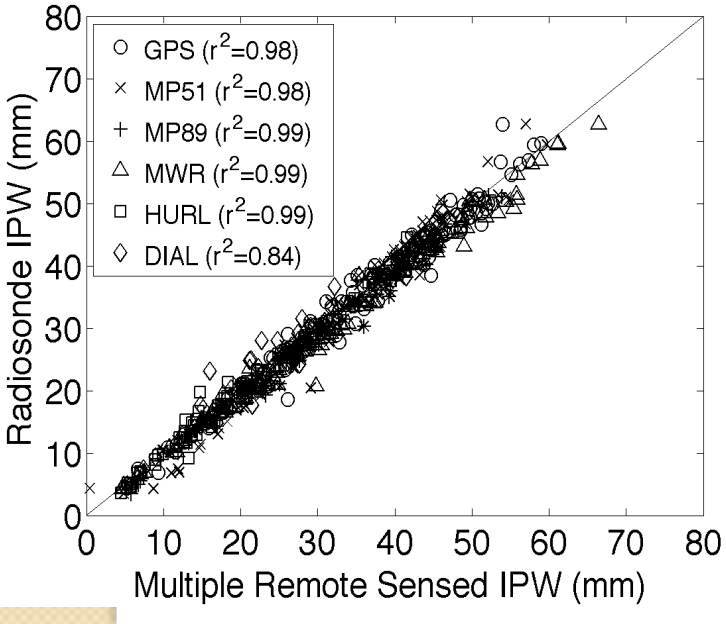
GRUAN: *"IPW" work*

Algorithm/performance testing

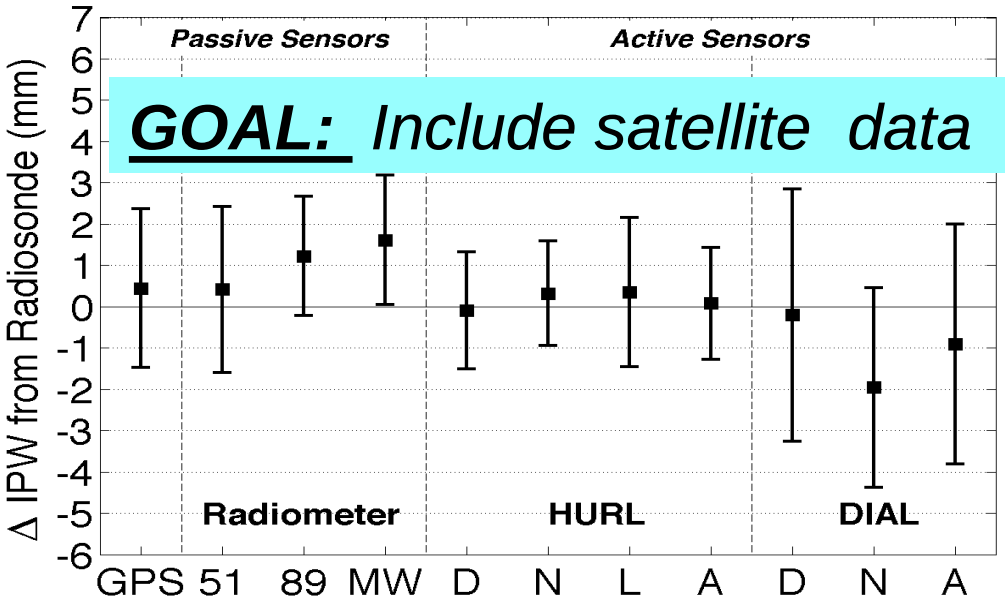
- *New sensors (DIAL)*
- *Radiometers (X2)*
- *RS92+ (Non GRUAN)*
- *Raman lidars (HURL, ALVICE)*
- *New processing tech.*
- *GPS (NOAA, Suominet)*

Ph.D. Topic: L. Cooper





GOAL: *Include satellite data*



Towards a ~~Ceilometer~~ Lidar network in the USA

Funding: NOAA/NWS

NOAA [NWS]: *Michael Hicks*, Dennis Atkinson*
Howard [NCAS]: *Belay Demoz, Demetrius Venable, Ricardo Sakai*
UMBC [CREST]: *Ruben . Delgado*
GSFC [ALVICE]: *K. Vermeesch, D. Whiteman, M. Walker*,*

Contributions: ***Leosphere, SigmaSpace. NOAA/ARL***

Advantages:

- *CL31~$28K; CL51~$35K*
- *all weather, Automatic data reporting*
- *Little maintenance required*
- *Operates 24/7 and exists*
- *Co-located weather data*

Vaisala *CL31*

- **CL31**
  - *Cloud hits (3 layers), backscatter profile range 0–7500m* ***@ 10m***
  - *Laser InGaAs laser diode, 905nm*
  - *Pulse:* ***110 ns, 1.62µJ/pulse***

Motivation:

NRC – *"Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks (2009)"*

↓

NSF/NOAA: Thermodynamic Profiling Technologies Workshop: Boulder, CO; 12-14 April, 2011

↓

NWS – Workshop: Sterling, VA. 28 March 2012.

8.1 Recommendations

8.1.1 Improvement in the utilization of existing technology:
Ceilometers are underutilized for pot[redacted]bed. ASOS data is only now retained hourly with a one-minute o[redacted]ur. The operation of ASOS instruments throughout the hour is lo[redacted]ata volumes from ASOS and transmission of those data should not be an issue with modern internet and satellite communications.

Ceilometers!!!

8.1.2 NOAA should consider implementing a regional testbed:
In order to scope the cost and feasibility of scaling up remote sensing measurements to a national observing system, a testbed of instruments should be developed in a region that has significant orographic, land use (i.e. urba[redacted]ce of the region should be guided by difficulty[redacted]-plain changes, convective storms, etc. should be considerations in choosing a region for such a testbed. The testbed should contain identical instrumentation at sites roughly placed 150km apart.

Regional Testbed

8.1.3 Data capture should be into the NOAA MADIS system:
Since a long-term national improvement to its lower tropospheric observing system will be operational in nature, NOAA will need to evaluate a testbed for such observations within its operational data framework. The NEXTGEN analysis of the future of NWS's observation should include provision for acquisition of surface remote sensing sites. MADIS will clearly be absorbed into NEXTGEN and this will provide a research to operations path.

8.1.4 Data assimilation of the remote sensing data should be a goal for the testbed:
Inclusion of new data sources into a 3DVAR or 4DVAR data assimilation system is expensive and may not improve the forecast commensurate with its cost. The value of assimilating data from a testbed of limited spatial scale needs to be assessed and can be tested with OSSEs. Research has indicated that there is positive value in assimilation ground-based remote sensing data (Turner et al., 2010) but only a few instruments were included in that study and for a limited case study. This needs to be expanded to cover a range of passive and active sensors that can credibly be placed within a testbed.

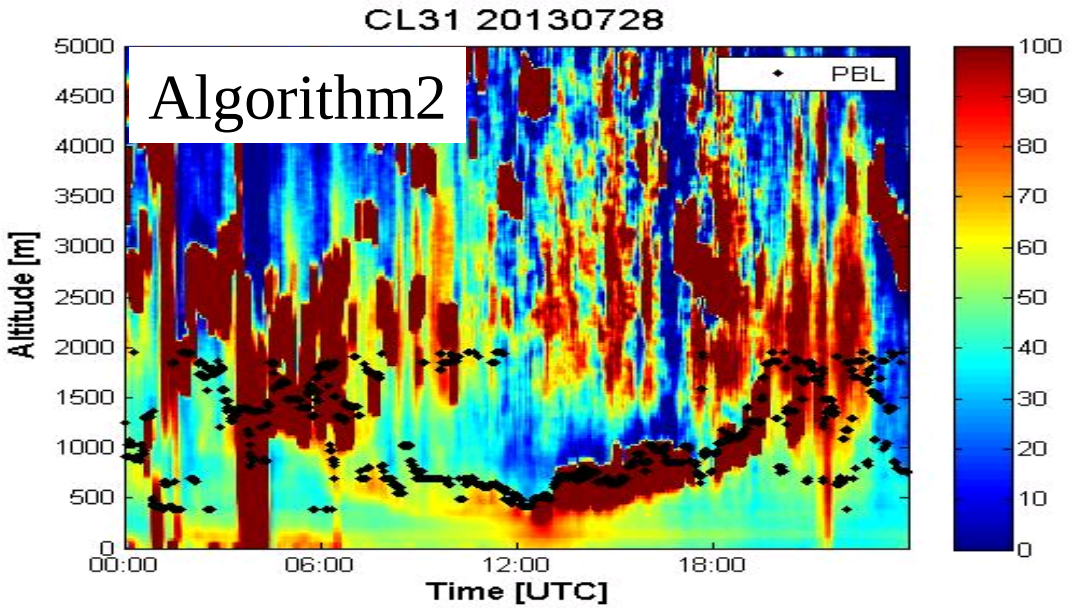
Existing data should be used for performing OSEs in combination with RUCs. These studies will provide essential insight in the impact of additional remote sensing observations.

Example: CL31 Network

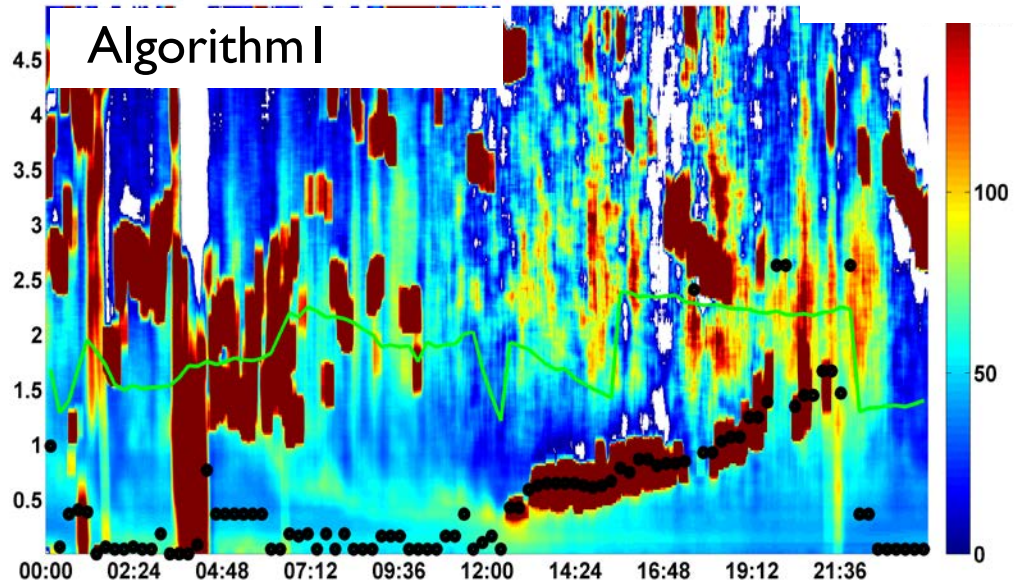
The 28 July 2013 case study

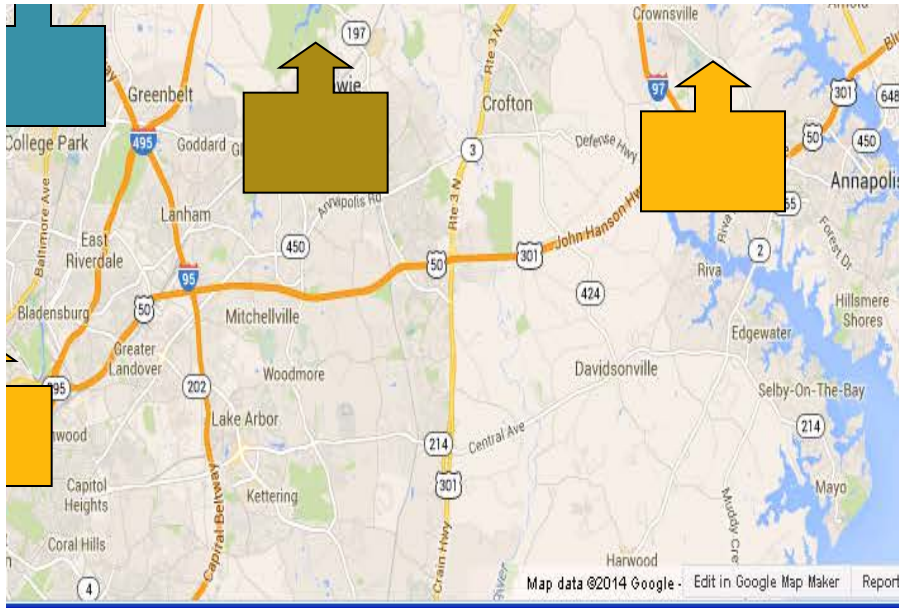
PBL:

performance of possibly five different algorithms in PBL height determination is ongoing.



CL31 - 2013Jul28





Status:

Requirements

- *no performance implication to ASOS*
- *use maintenance port for profile data*
- *transmit or process at station*

PHASE I:

- mini computer to collect through maintenance port

- cellular/network to transmit (*~20 MB/day; compressed: ~8.5 MB/day)*

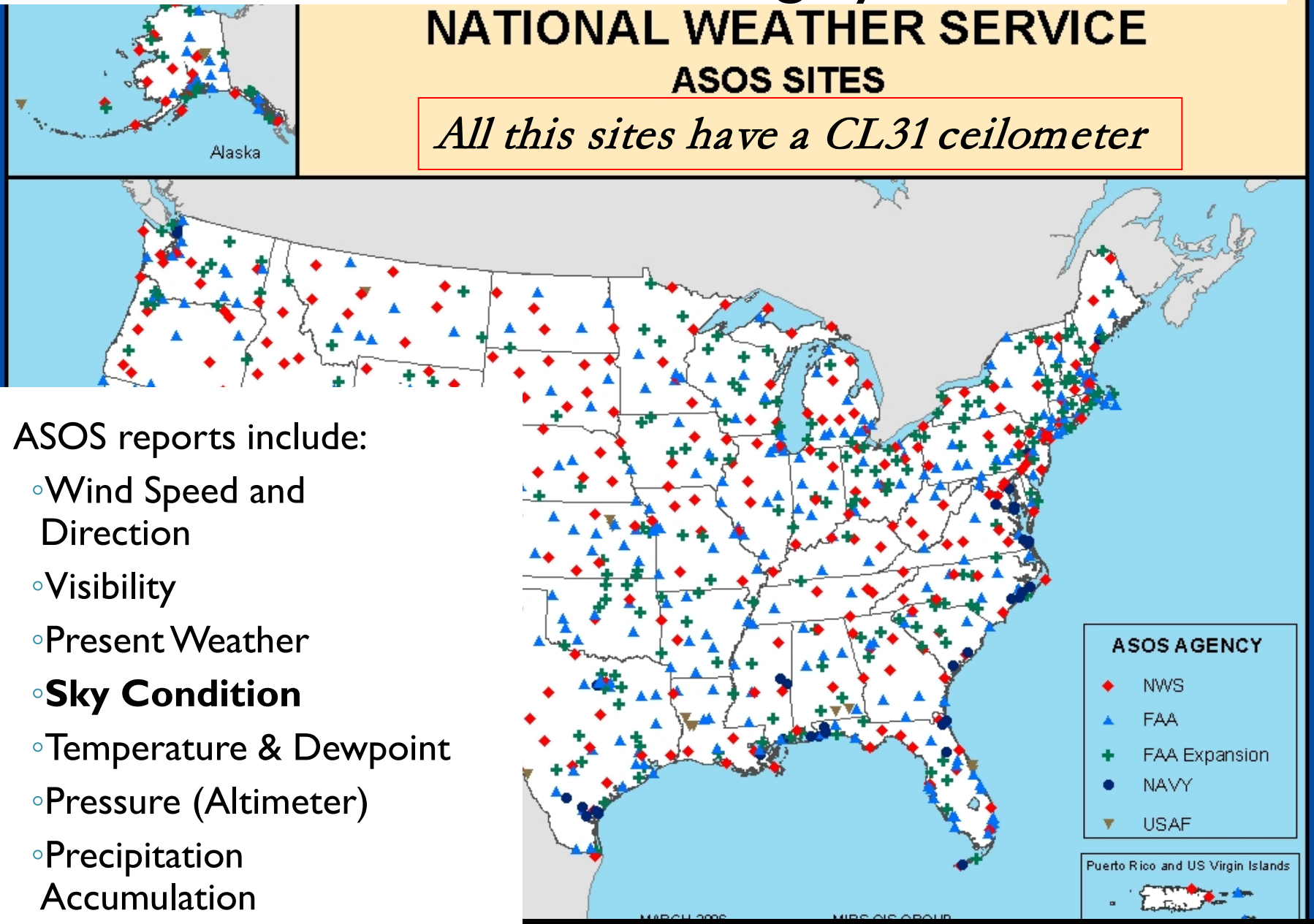
Phase II: PBLH variability

- Test algorithms, 1-yr data archive, evaluate.

Phase III: National Test *(In formulation)*

- apply nationally; Proposed to be at NCAS partner sites.

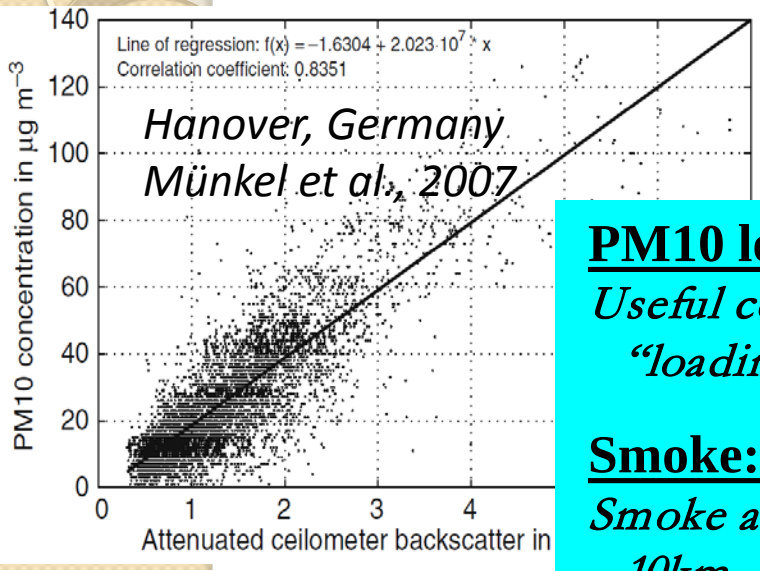
Automated Surface Observing System

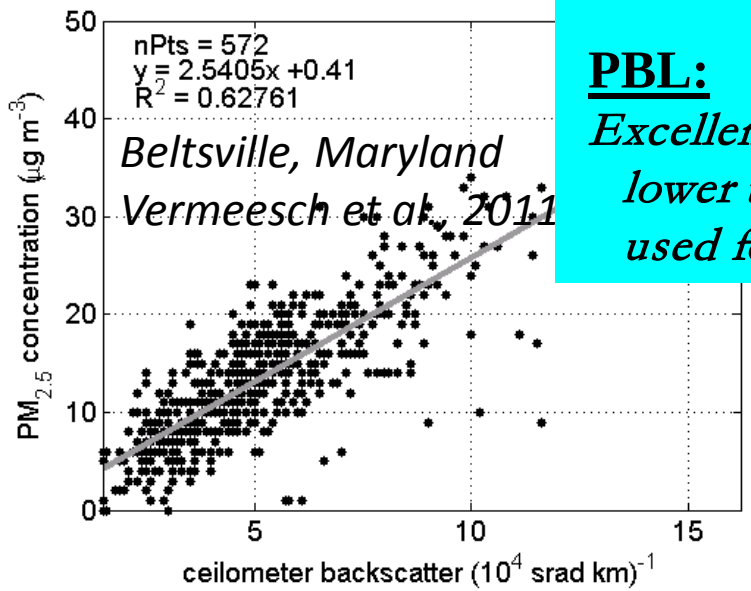


ASOS reports include:

- Wind Speed and Direction
- Visibility
- Present Weather
- **Sky Condition**
- Temperature & Dewpoint
- Pressure (Altimeter)
- Precipitation Accumulation

Ceilometers are lidars – (But, are they any good?)





PM10 loading:

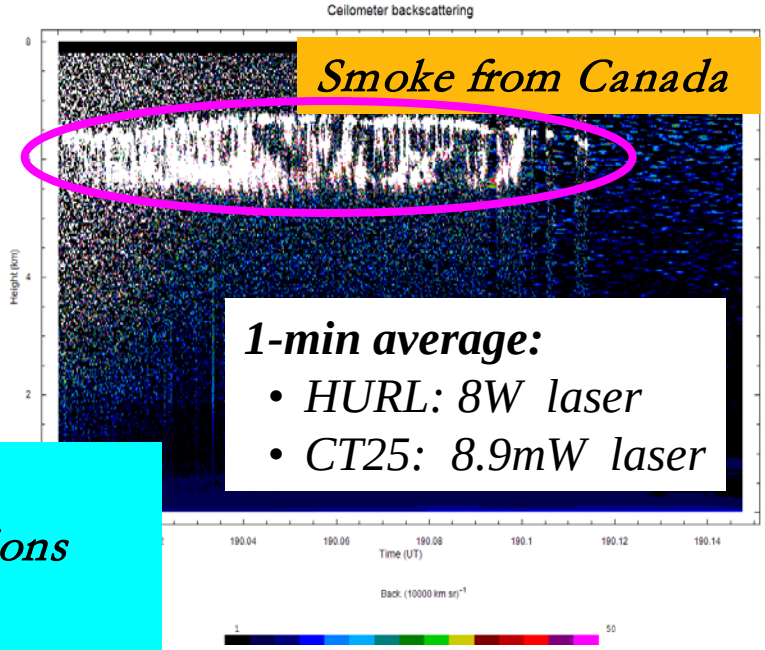
Useful continuous pollutions "loading" indicators

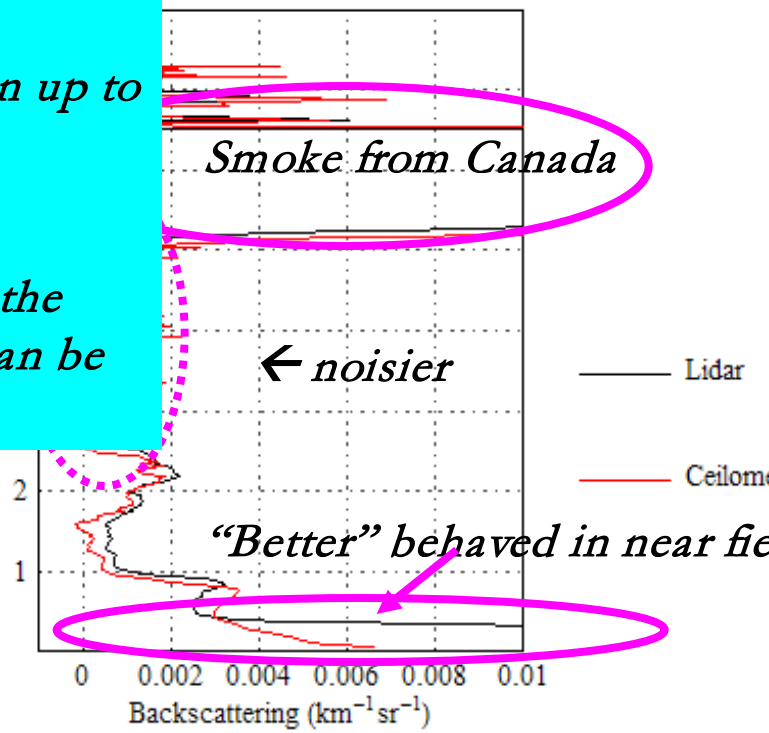
Smoke:

Smoke and cloud detection up to 10km.

PBL:

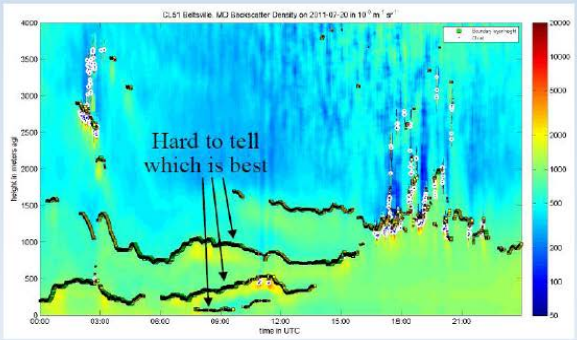
Excellent performance in the lower troposphere and can be used for PBL height



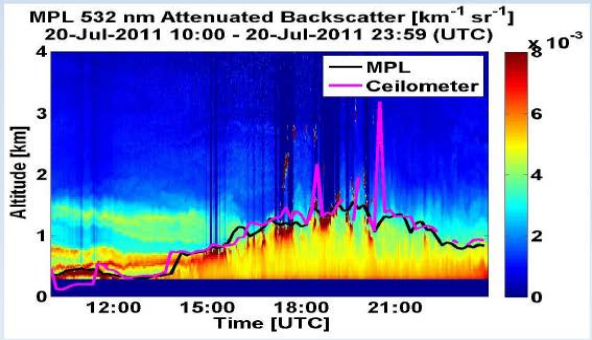


PBL height monitoring: DISCOVER-AQ (2011)

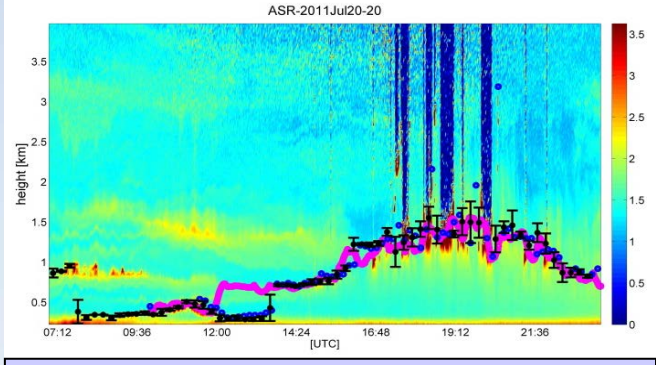
From J. Compton et al. 2012:



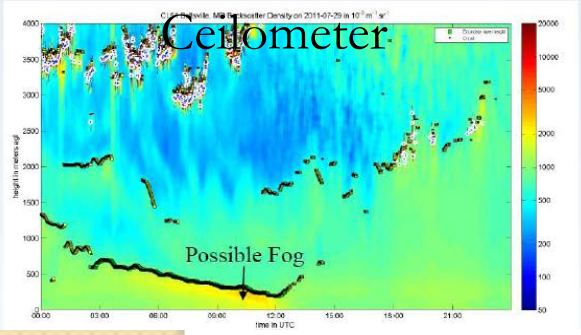
CL51

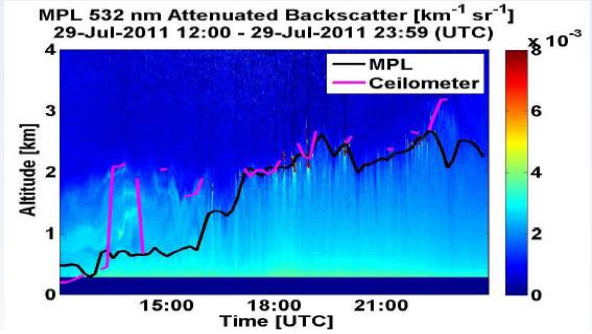


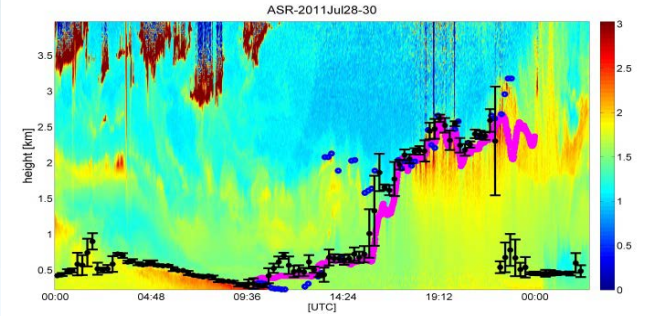
MicroPulse Lidar (MPL)



Howard Raman Lidar







Laser: InGaAs
Power: 8.9 mW
Wavelength: 910 nm

Laser: Nd-YLF
Power: 25 mW
Wavelength: 532 nm

Laser: NDYAG
Power: 8 W
Wavelength: 355 nm

GRUAN@ Beltsville - Wind

NASA/GSFC [GLOW]: *Bruce Gentry, Huailin Chen, Kevin Vermeesch*
*NASA/**LaRC [VALIDAR]:*** *Upendra Singh, Grady Koch, et al.*
Howard: *Belay Demoz, Tulu Bacha*, Sium Tesfay, Demetrius Venable*

Motivation:

- Upcoming ADM wind Satellite

- NASA Decadal Survey Plan

- Wind is a GRUAN priority-1 product

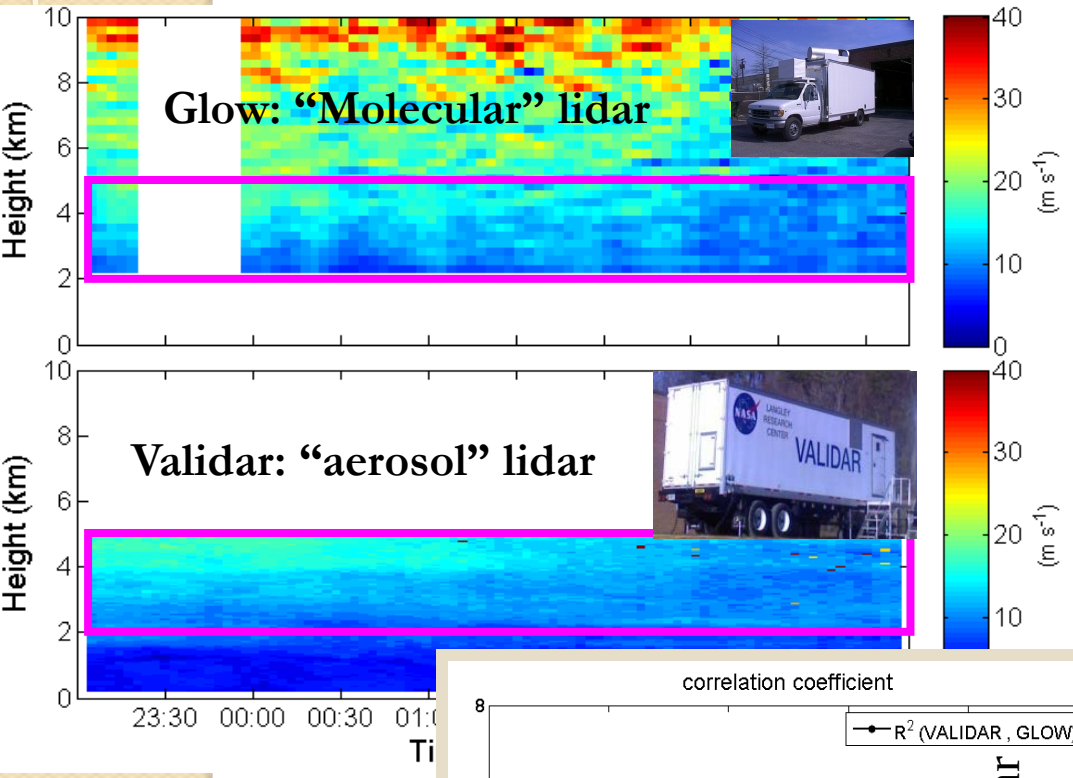
Take Home:

- Large variability in wind from instrument to instrument.

- GRUAN as ADM Validation sites?

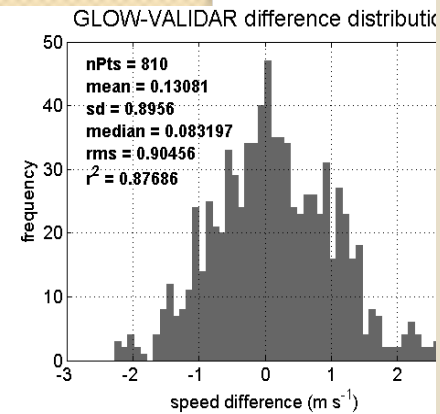
Example: 24-25 February 2009

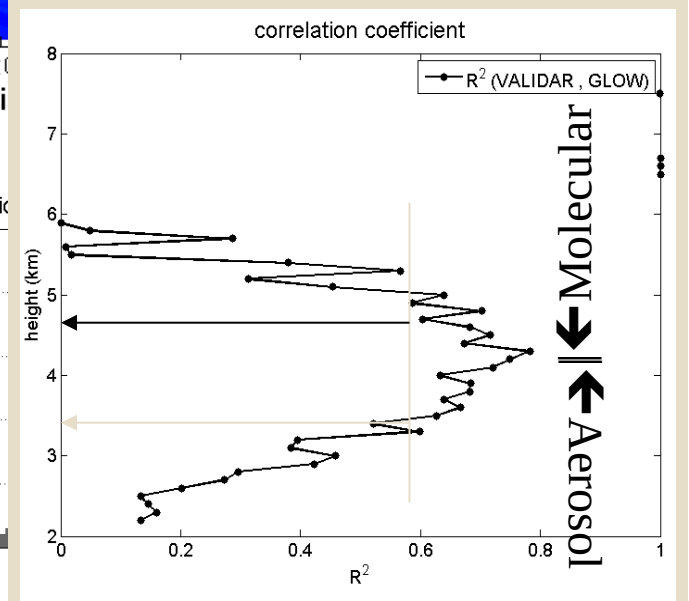
Clear Sky 3D-Wind "dual-Component" demonstration!

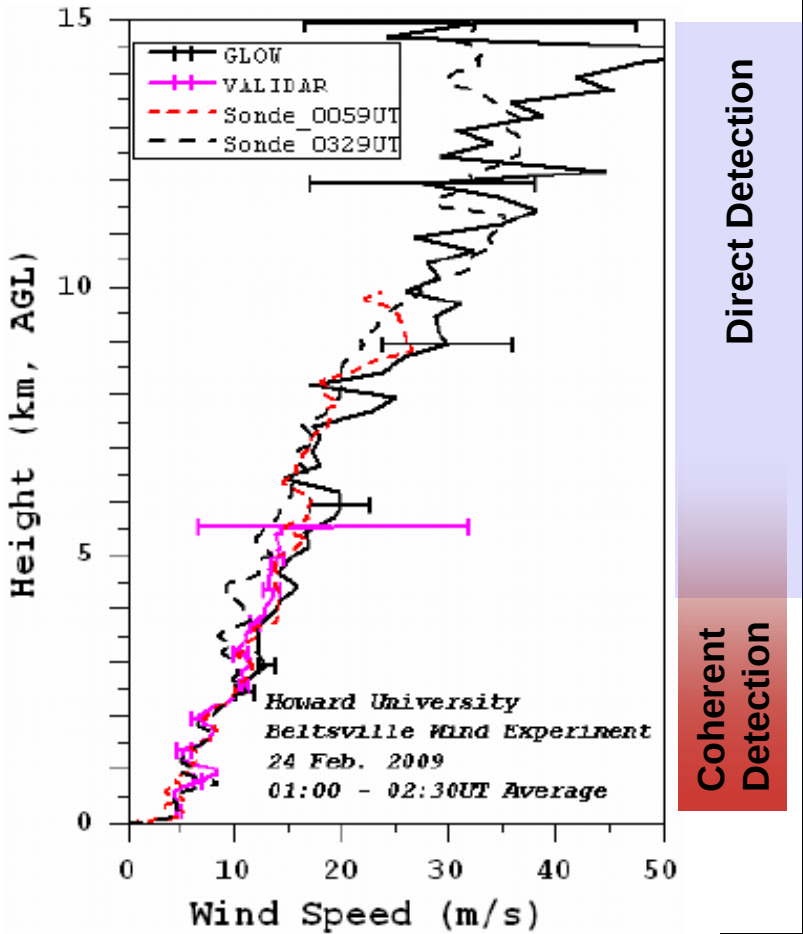


24 Feb 2009:

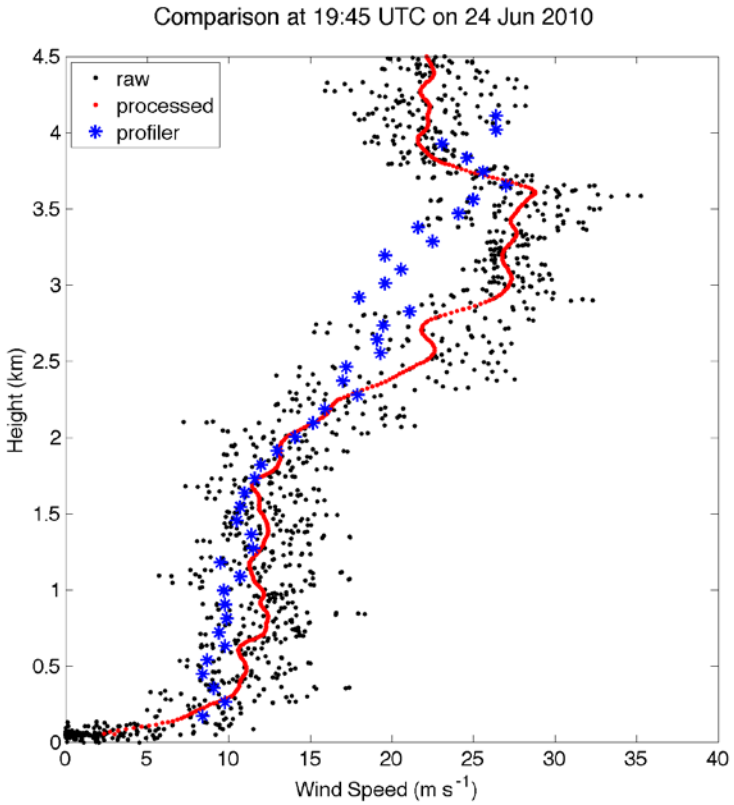
- VALIDAR: < 6km
- GLOW: 2-15km
- Optimum (R2>0.7) ➔4-5km

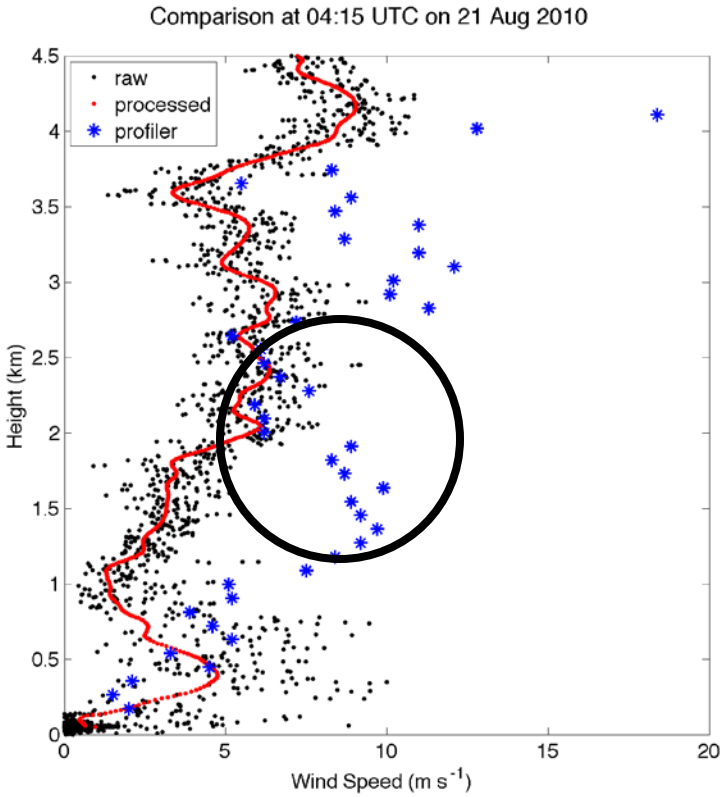






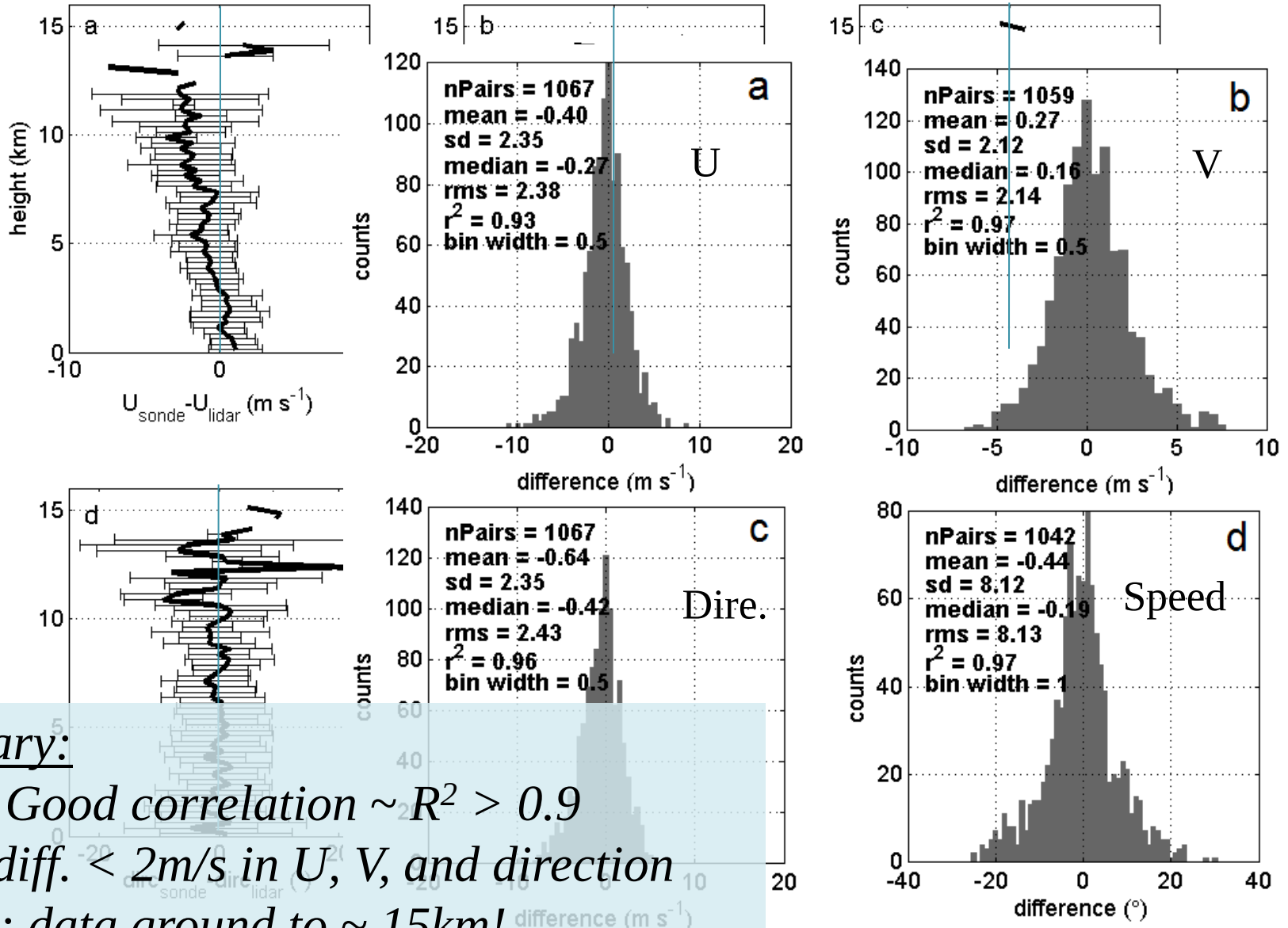
work with wind profiler





RS92-GLOW differences with height

GLOW (45 sondes)



Summary:

- *Very Good correlation ~ R^2 > 0.9*
- *rms diff. < 2m/s in U, V, and direction*
- *Note: data ground to ~ 15km!*