Near-Real-Time Aerosol Data from the WMO Global Atmosphere Watch

John A. Ogren

NOAA, Earth System Research Laboratory, Boulder, CO, USA

Chair, WMO/GAW Science Advisory Group for Aerosols

with valuable contributions from

Elisabeth Andrews (NOAA/ESRL and CU/CIRES)

Markus Fiebig (NILU, WDCA)

Gelsomina Pappalardo (CNR-IMAA, GALION)

Christoph Wehrli (PMOD/WORCC, GAW-PFR)

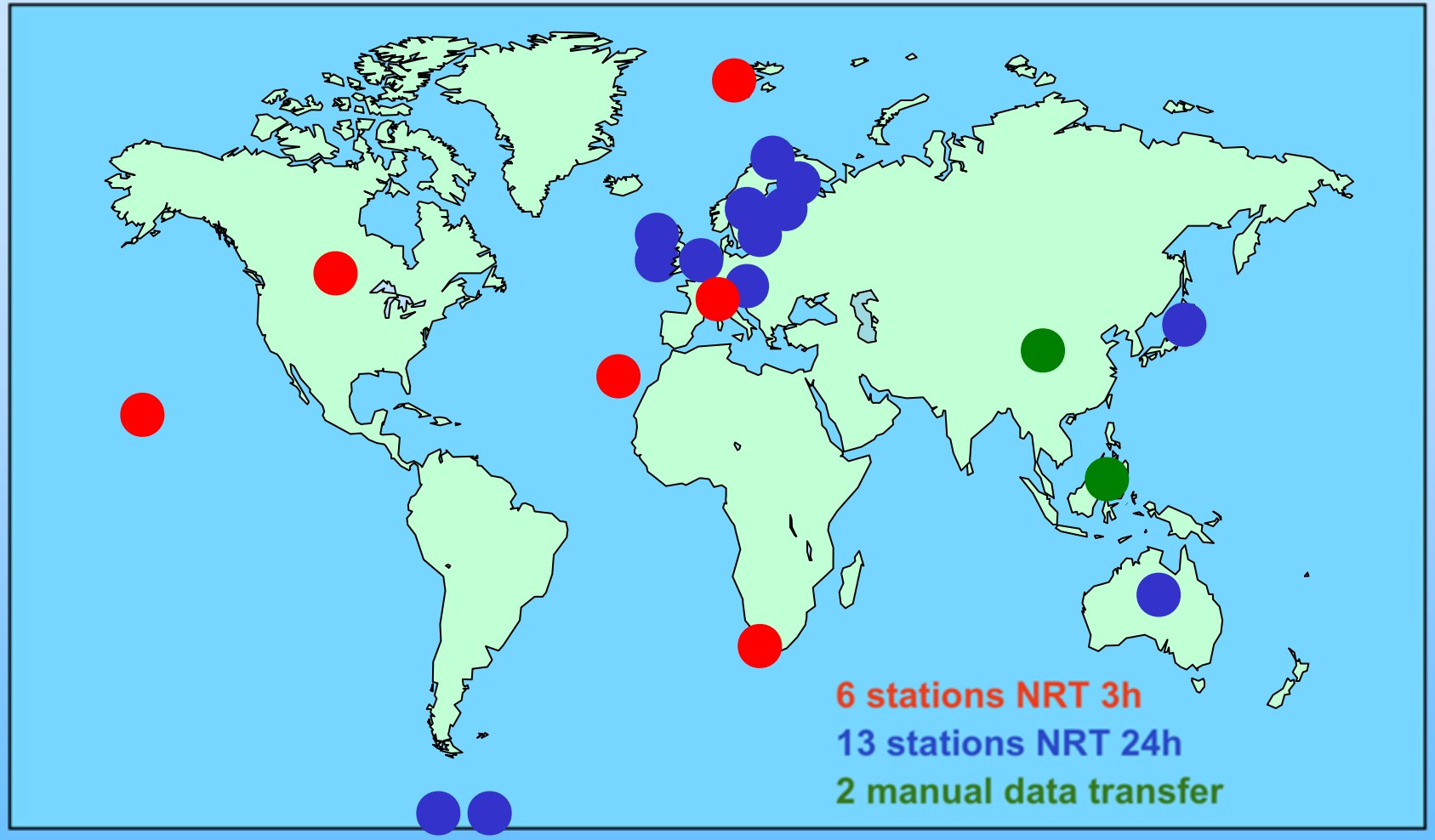
WMO GAW

- **Backbone provided by National Meteorological Agencies**
- **Contributions from many affiliated networks and stations, not just weather bureaus**
- **No central funding for measurements or data centers**
- **Not organized as a provider of NRT data**

GAW Aerosols

- **Science Advisory Group for Aerosols**
- **World Calibration Center for Aerosol Physical Properties (IfT)**
- **World Data Center for Aerosols (NILU)**
- **Three measurement areas**
  - Aerosol optical depth
  - Aerosol vertical profiles (Lidar)
  - In-situ aerosol properties
    - Optical (light scattering and absorption)
    - Chemical (mass concentration, speciation)
    - Microphysical (number conc., size dist., CCN)
- **Emphasis on regional (non-urban) sites**
- **Primary focus on climate, recognizing applications in air quality.**

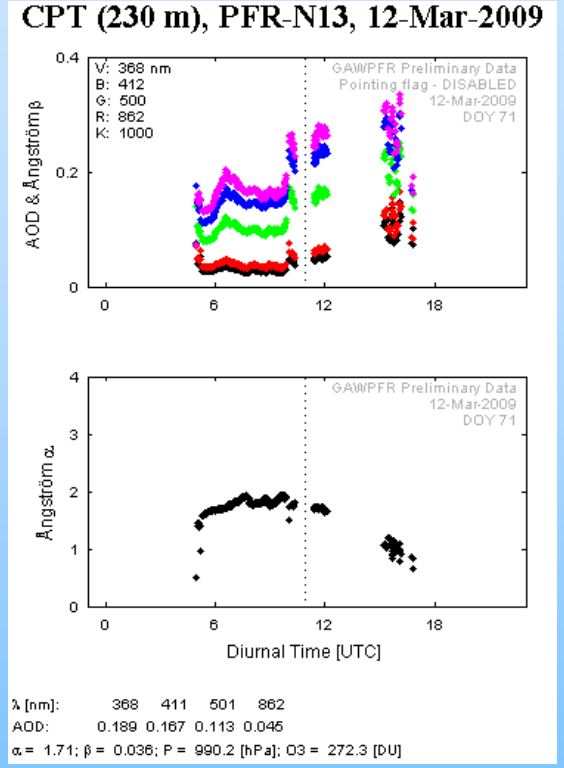
GAW Precision Filter Radiometer Network



- Automated, tracking sun photometer, observations 1 min^{-1}
- 4 channels at 862, 500, 412, 368nm, 5nm bandwidth
- Potential for ~30 stations providing NRT data
- Coordinated by World Optical Depth Research and Calibration Centre, http://www.pmodwrc.ch/worcc/

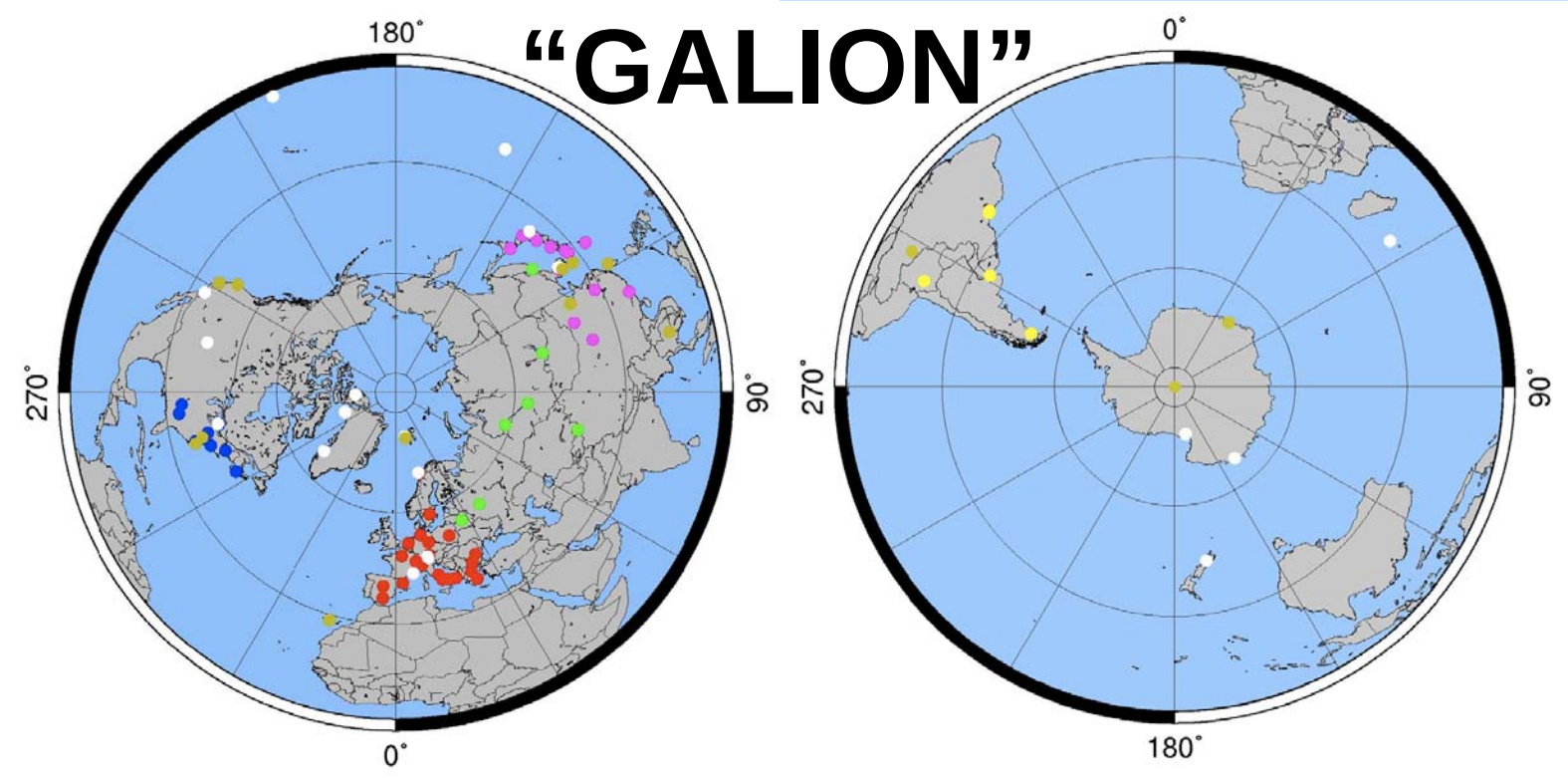
Status of GAW AOD Network

- **PFR Network**
  - NRT data currently available from WORCC/Davos
  - Automated NRT screening (instrument health, clouds, outliers) by WORCC
  - In future, NRT data from WDCA
  - Active comparisons with AERONET at overlap sites



- **Other national/regional networks (~10)**
  - Cross-calibration and data harmonization needed
- **Goal: an integrated global AOD network as a component of GCOS**

GAW Aerosol LIDAR Observing Network

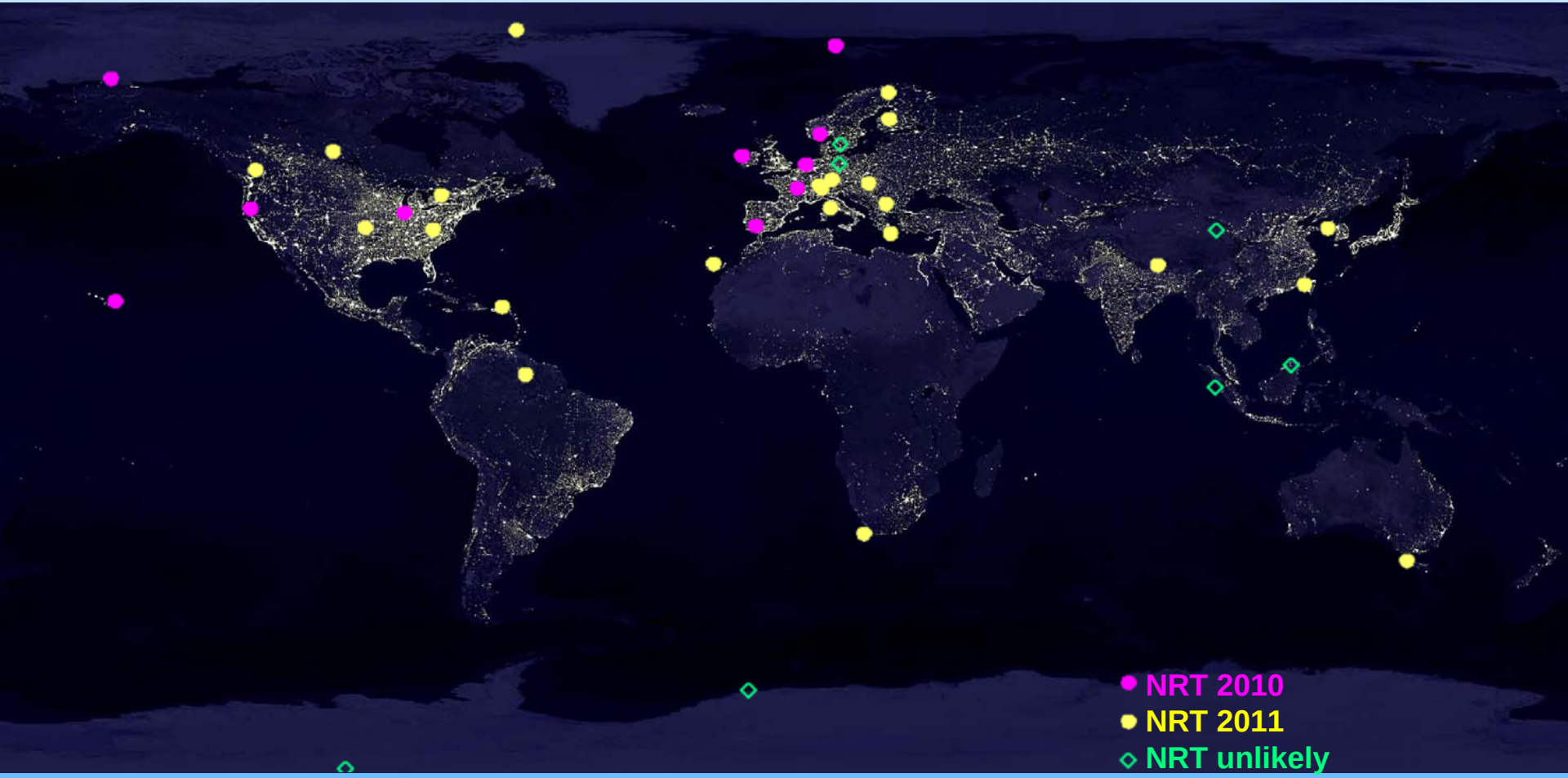


- **A federation of seven regional networks**
  - AD-NET violet, ALINE yellow, CISLiNet green, EARLINET red, MPLNET brown, NDACC white, REALM blue
- **ftp://ftp.wmo.int/Documents/PublicWeb/arep/gaw/gaw178-galion-27-Oct.pdf**

GALION: Aerosol Vertical Profiles

- **Objectives**
  - develop aerosol vertical profile climatology
  - provide input to forecast models of "chemical weather"
- **Basic measurement scheme (minimum)**
  - measurements every Monday and Thursday
  - within a few hours of sunset
  - more frequent observations during special events (e.g., volcano!)
- **Federation of multiple networks with a variety of instruments**
  - simpler automated backscatter lidars …
  - advanced, multi-wavelength Raman or high-spectral resolution
- **Products**
  - all sites: backscatter profiles
  - some sites: complex retrievals of aerosol microphysical properties
  - Currently providing limited NRT data for dust forecasting and model evaluation (WMO SDS-WAS)
- **Next steps in developing GALION**
  - Quality assurance plan
  - Data management plan
  - Database development
  - NRT data access plan
  - Workshop in Geneva, 20-23 Sept 2010

GAW In-situ NRT Data Availability

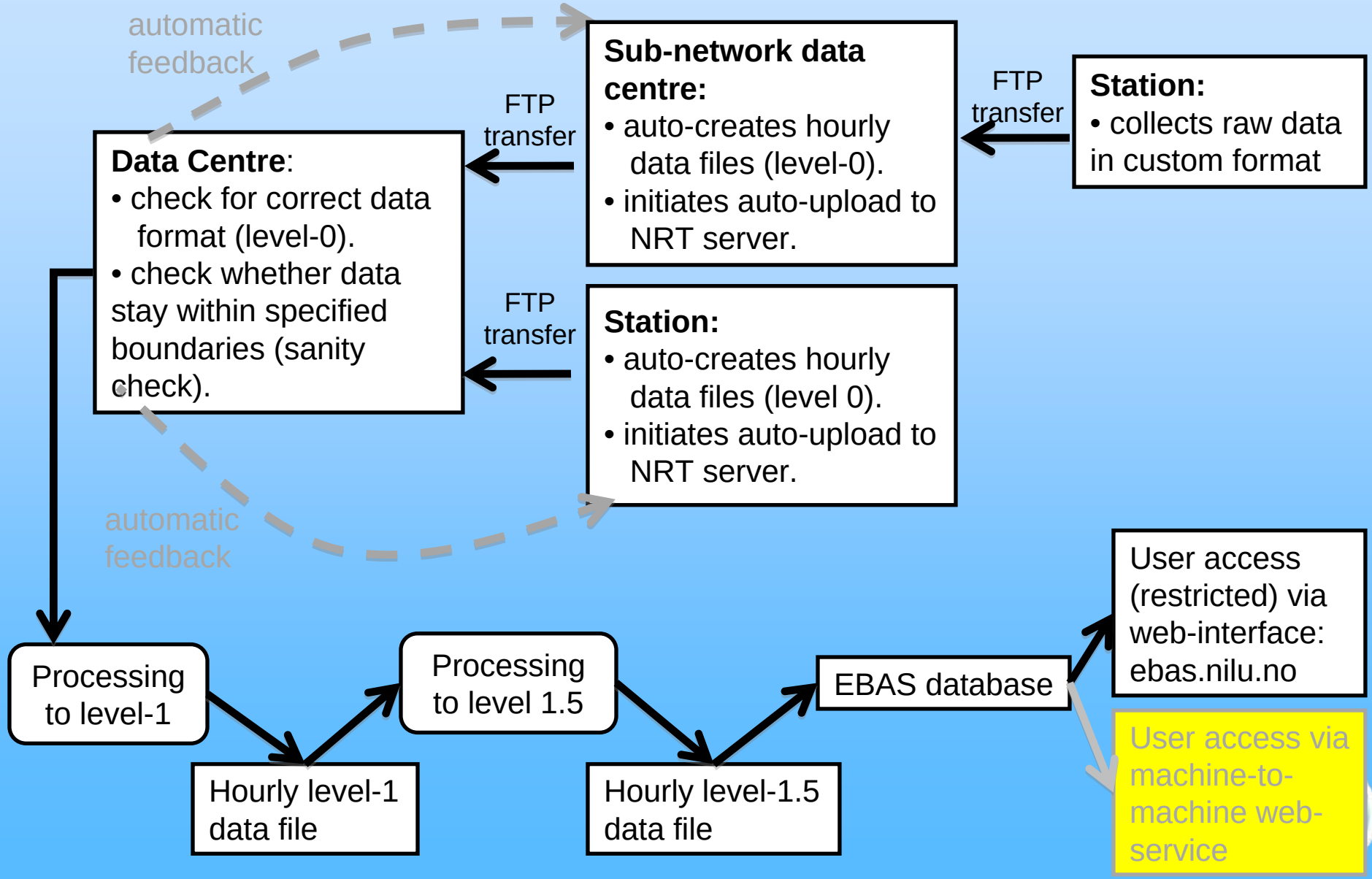


- Map shows ground stations with continuous light scattering measurements (~35 by 2011)
- Most also have light absorption measurements

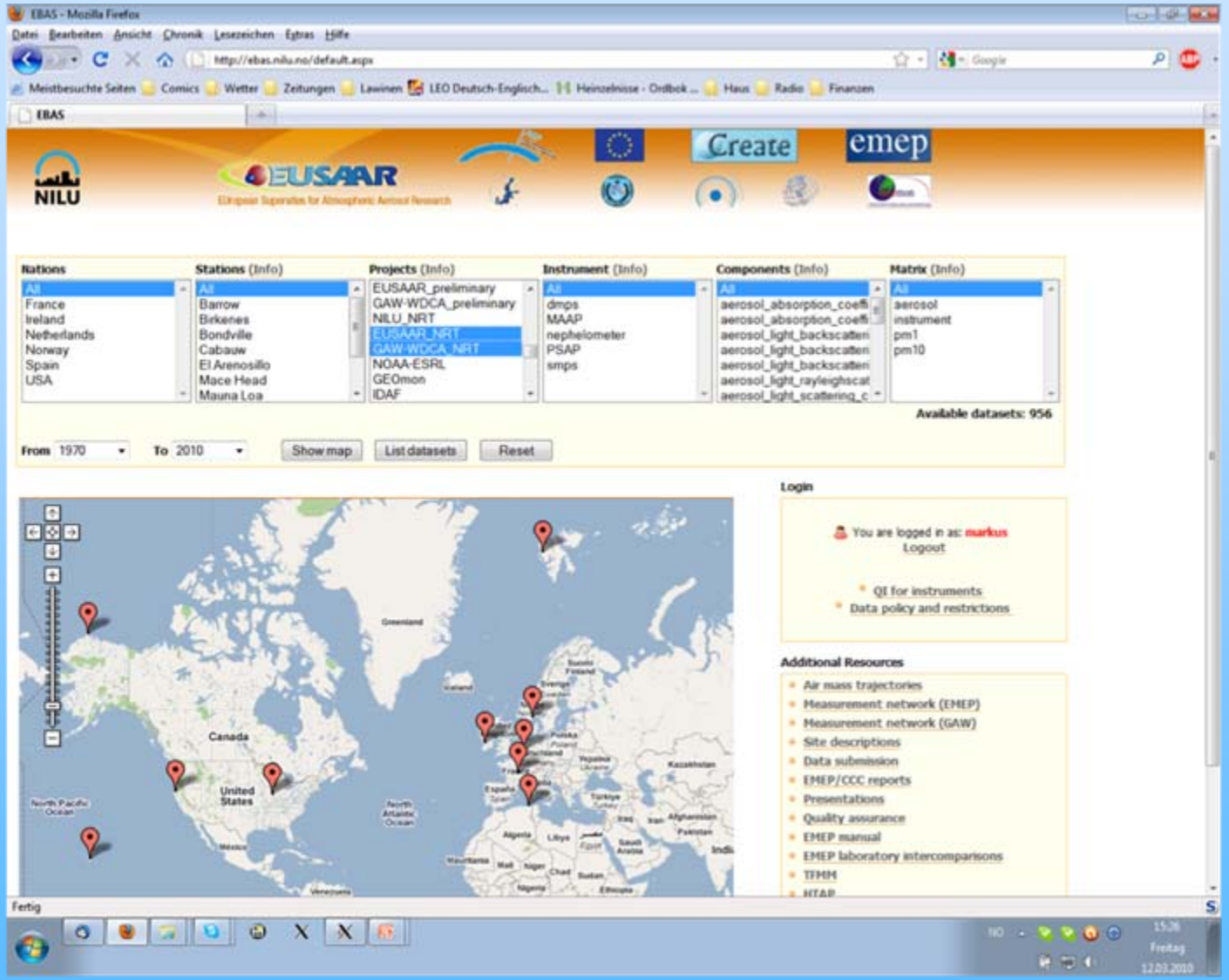
Summary of GAW In-situ Aerosol Data

- **NRT measurements of aerosol properties**
  - Optical (light scattering and absorption)
  - Microphysical (number conc., size dist.)
  - Chemical (a few stations will have on-line aerosol mass spectrometers in a few years)
- **Centralized processing at WDCA**
  - Zero/calibration checks removed, sanity checks applied, outliers flagged, inversions run
- **Hourly-averages available within 1-6 hr, higher time resolution possible**

WDCA NRT Data Flow

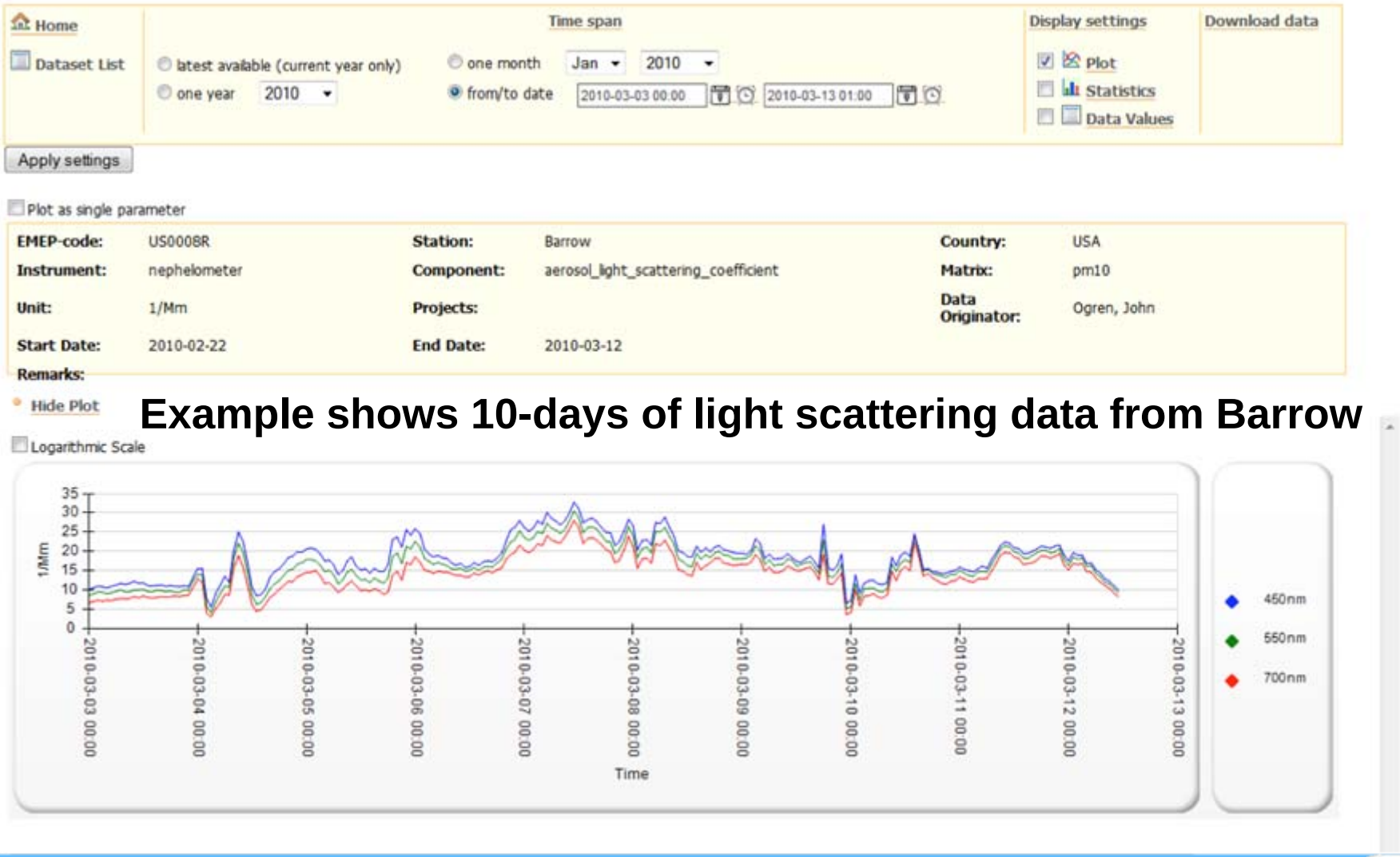


Interactive NRT Web Interface



http://ebas.nilu.no/default.aspx

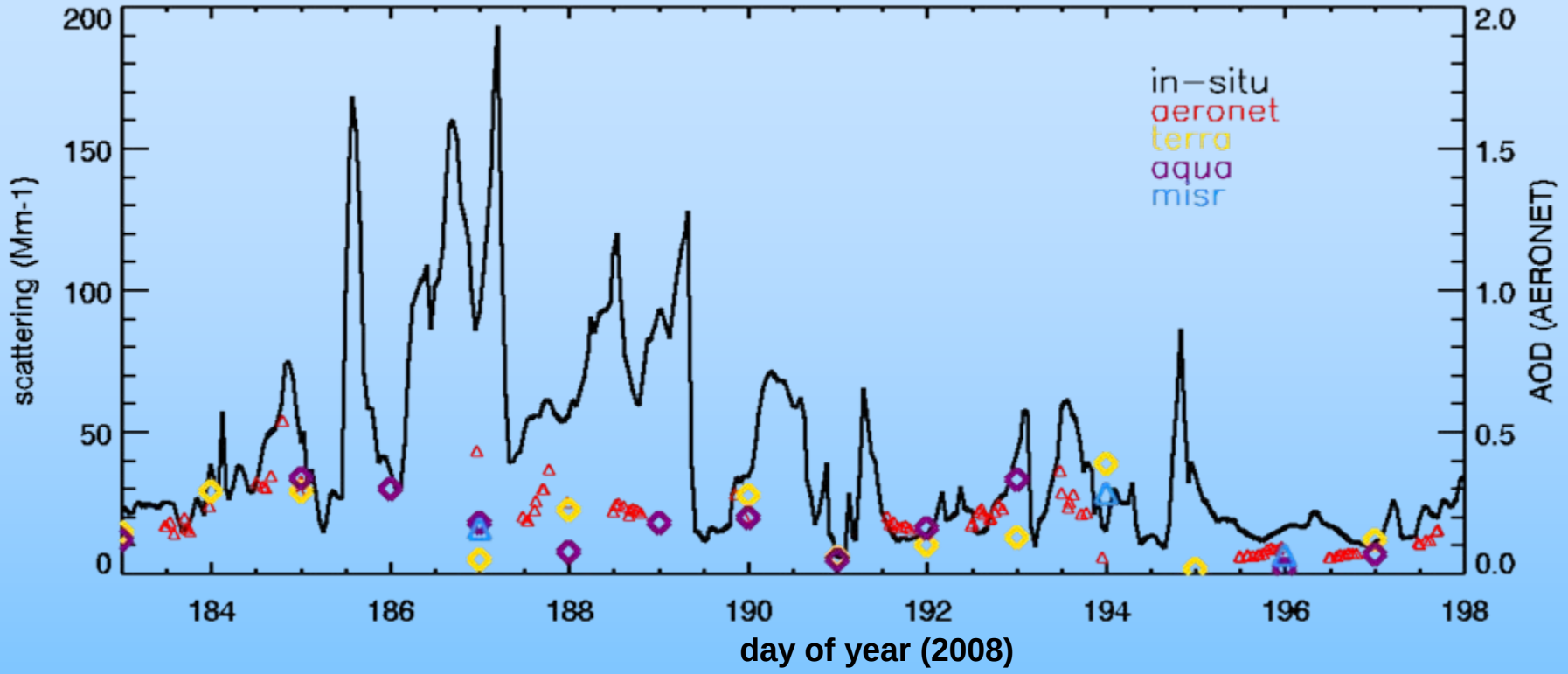
WDCA NRT Data Plots



Example shows 10-days of light scattering data from Barrow

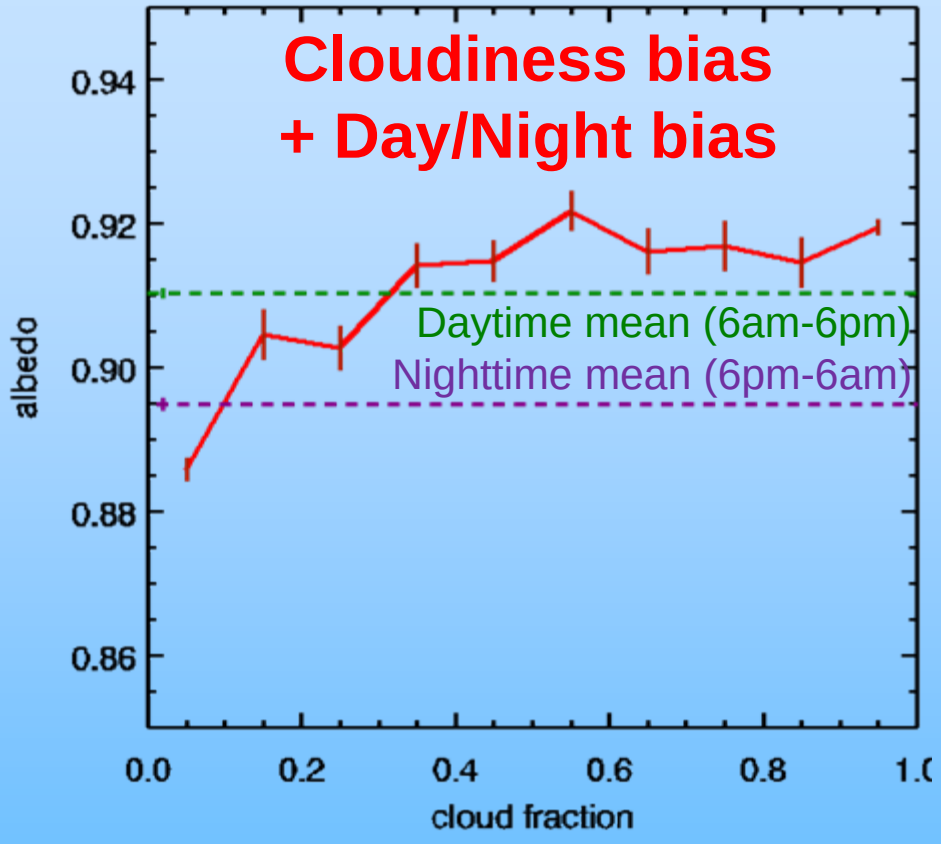
http://ebas.nilu.no/default.aspx

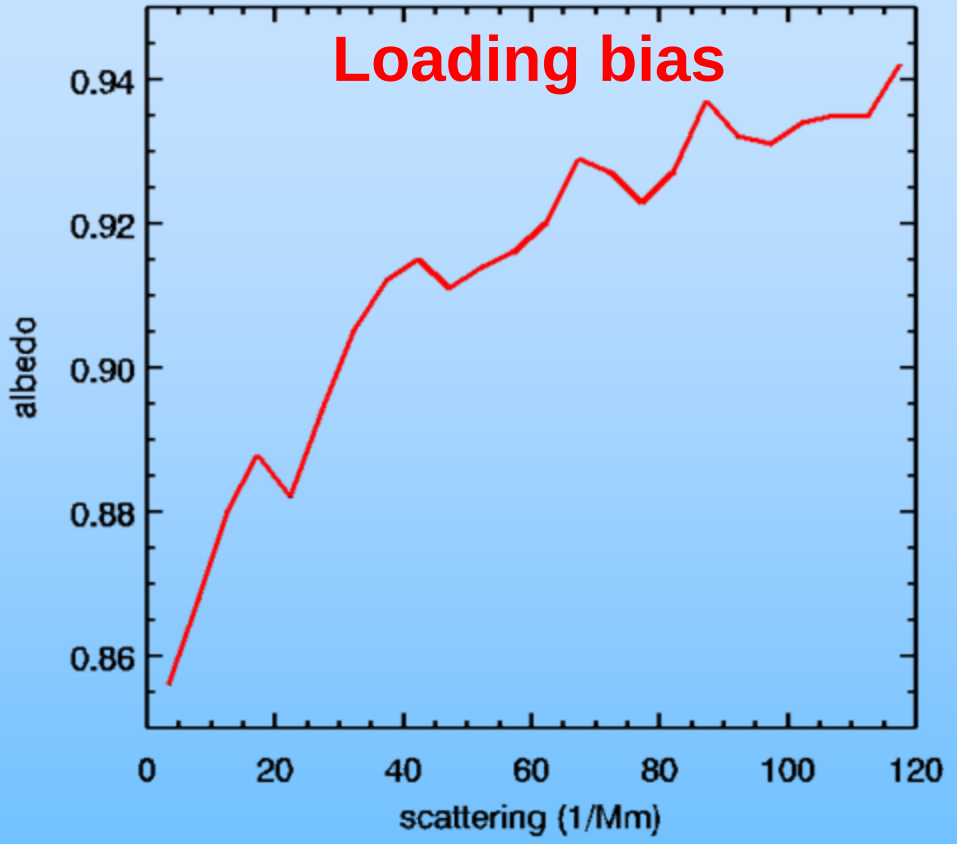
In-situ Data Resolve Temporal Gradients



- **Bondville, IL - July 1-15, 2008**
- **Hourly averaged in-situ scattering coeff. (550 nm)**
- **Hourly averaged sun photometer AOD (500 nm)**
- **“Daily” averaged AOD from satellites**

In-situ Data Reveal Sampling Biases





- **Single-scattering albedo calculated from in-situ aerosol scattering and absorption measurements**
- **Based on hourly averaged 2008 data from Bondville, Illinois**
- **Cloud fraction values are for daytime only, from SURFRAD network**

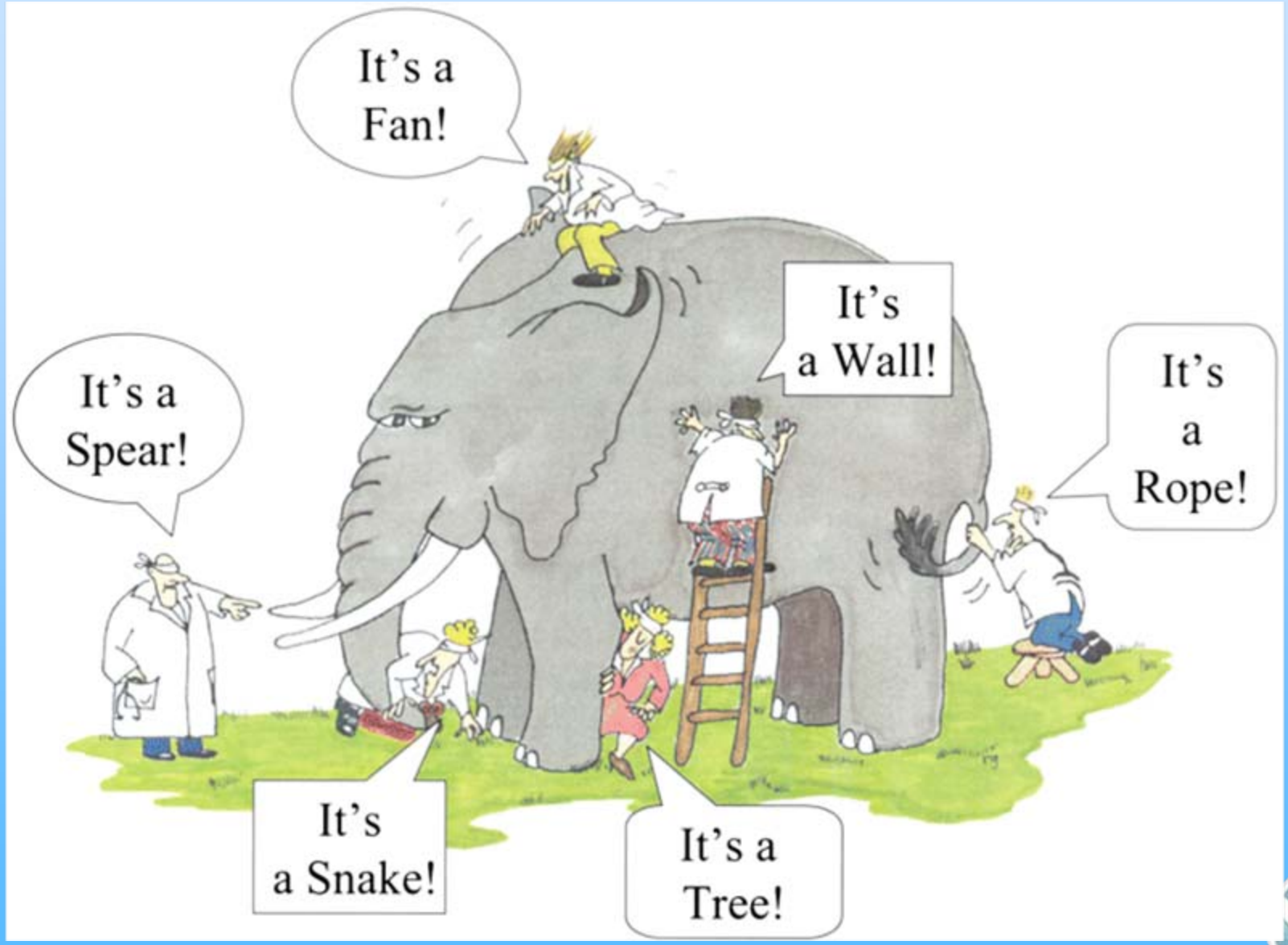
Discussion Topics

- **Desired/acceptable time lag for NRT data**
- **Value of homogeneity of data formats**
- **Approaches for synthesizing AOD + lidar + in-situ observations**
  - Dealing with disparity of spatial and temporal resolutions
- **Dealing with relative humidity**
  - Remote sensing at ambient RH
  - In-situ at low RH
- **Data policy needed**
  - Acknowledgement of data providers
  - Feedback from users to providers
  - Prevent use of NRT data in lieu of final, quality-controlled data
  - Prevent transfer to third-parties that haven't agreed to data policy

Credits

- **The WDCA near-real-time infrastructure was developed through the EU FP6 project EUSAAR in collaboration with the stations:**
  - Cabauw, Netherlands (TNO)
  - Mace Head (National University of Ireland, Galway)
  - Puy de Dôme (Laboratoire de Météorologie Physique, Université Clermont-Ferrand)

Parting thought…



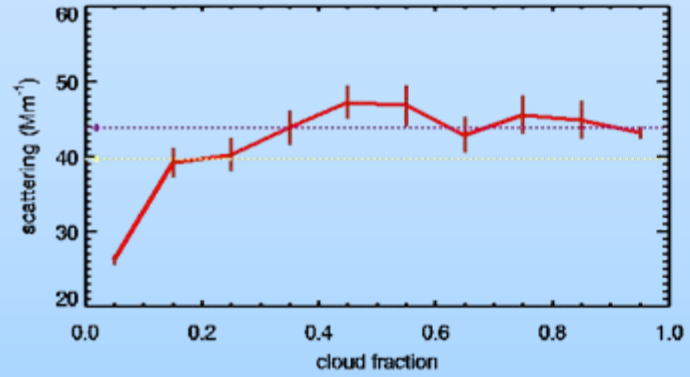
SUPPLEMENTAL SLIDES

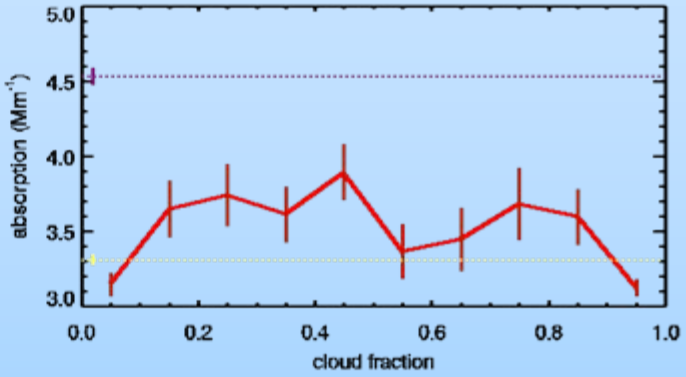
Lessons from Volcano

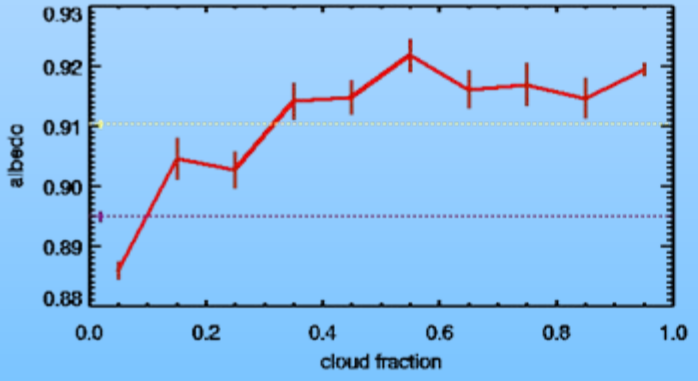
- **We weren't prepared to present all the observations!**
- **Station-specific web plots often needed an expert to interpret**
- **Syntheses were the most useful way to present data**
  - Gelsomina Pappalardo (EARLINET)
  - Robin Hogan (U. Reading)
- **UMBC "Smog Blog" might be a useful format**
- **Need a web page that explains and synthesizes**
  - Model forecasts
  - Satellite observations
  - Lidar observations
  - Sun photometer observations
  - In-situ observations
- **What organization(s) have sustained interest and funding to create and maintain such a web page?**
- **What other events generate such public interest in aerosols? (fires, dust storms, radioactive releases)**

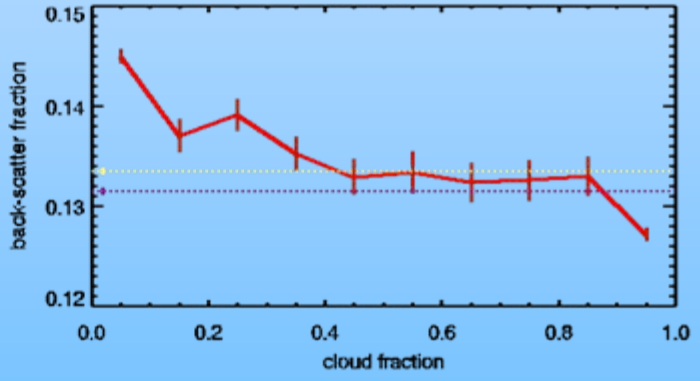
Outline

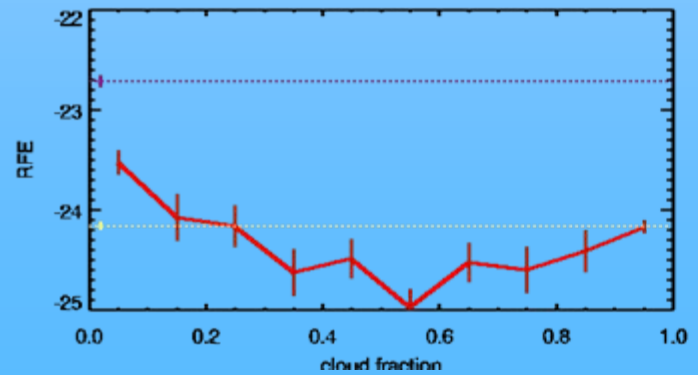
- **Intro (GAW)**
- **AOD (GAW-PFR)**
  - description, map, data example
- **Lidar (GALION)**
  - description, map, data example
- **In-situ (scattering, absorption, numbers)**
  - description, map, data example
- **WDCA**
  - Interactive web-based GUI
- **Discussion**
  - Questions for users
    - Value of homogeneity of data formats
    - Optimal update frequency
    - Acceptable usage, data policy
- **Conclusions**

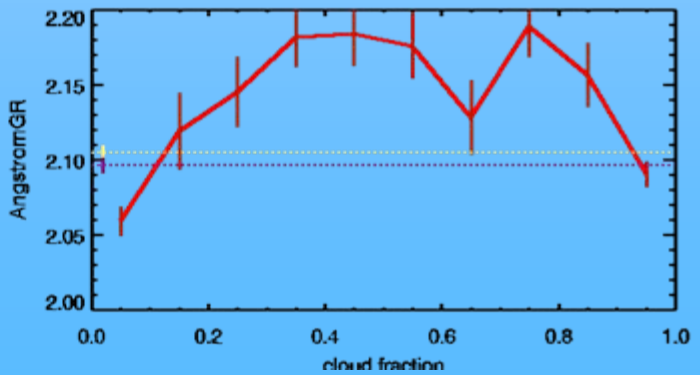

scattering (Mm^{-1})
cloud fraction


absorption (Mm^{-1})
cloud fraction


albedo
cloud fraction


back-scatter fraction
cloud fraction

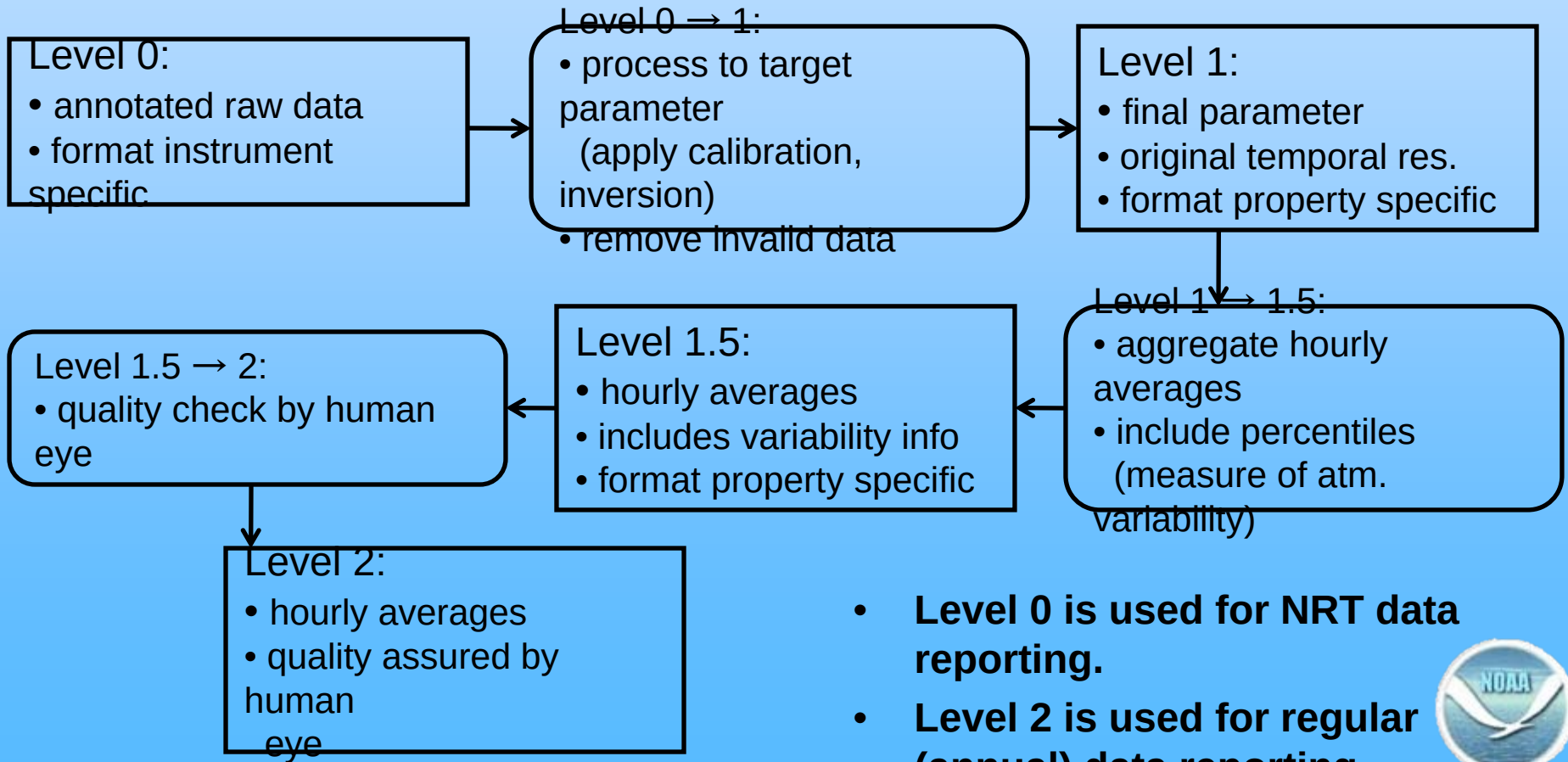

RFE
cloud fraction


AngstromGR
cloud fraction

Data formats used for NRT data collection

4 data levels and pertaining file formats have been defined:

- All format definitions use EBAS NASA-Ames format: NASA-Ames 1001 format with additional specifications accomodating GAW required metadata (ASCII based, user friendly).
- Format is generic and easily adapted to new parameters / instruments.



- **Level 0 is used for NRT data reporting.**
- **Level 2 is used for regular (annual) data reporting.**

More Features, Credits

- **Data ownership and project association clearly visible in data files and web interface.**
- **In order to allow users to assess the data quality of their instruments, also instrument status variables (e.g. supply voltages, sample flows, pressures, temperatures) are accessible.**
- **Data providers (”instrument owners”) may flag data sequences invisible to other users if they consider data quality doubtful.**

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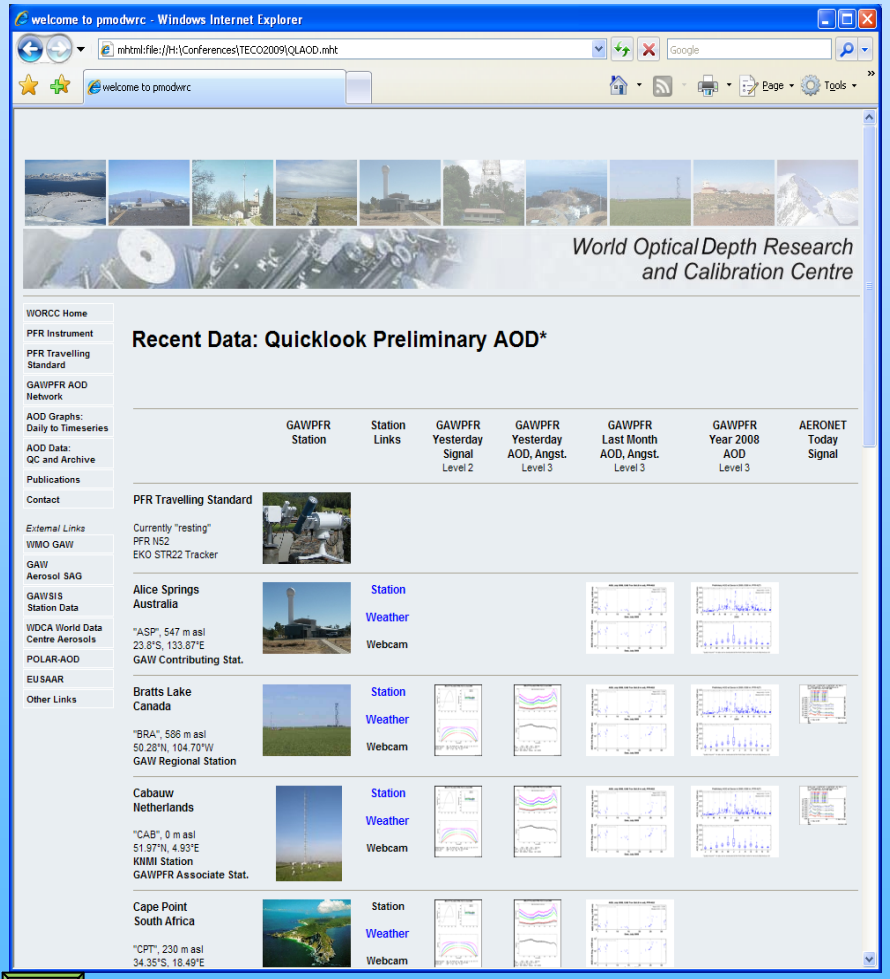
Quick-look access at WORCC

http://www.pmodwrc.ch/worcc/



Quick-look plots

Annual mean plot

- **Daily summary plots**
- **Numerical values with metadata are available on request.**
- **Hourly means in NARSTO format are available from WDCA, updated annually.**

Precision Filter Radiometer

PFR at Cape Point, South Africa

PFR specifications

- Automated, solar spectral radiometer (Sun-photometer)
- 4 channels at 862, 500, 412, 368nm, 5nm bandwidth
- Measurement rate 1 minute
- Data logger with 30 day storage capacity, PC or TCP/IP access
- Built on demand by PMOD/WRC