A New and Inexpensive Tool for Ozone, Aerosol, and AOD Vertical Profiling

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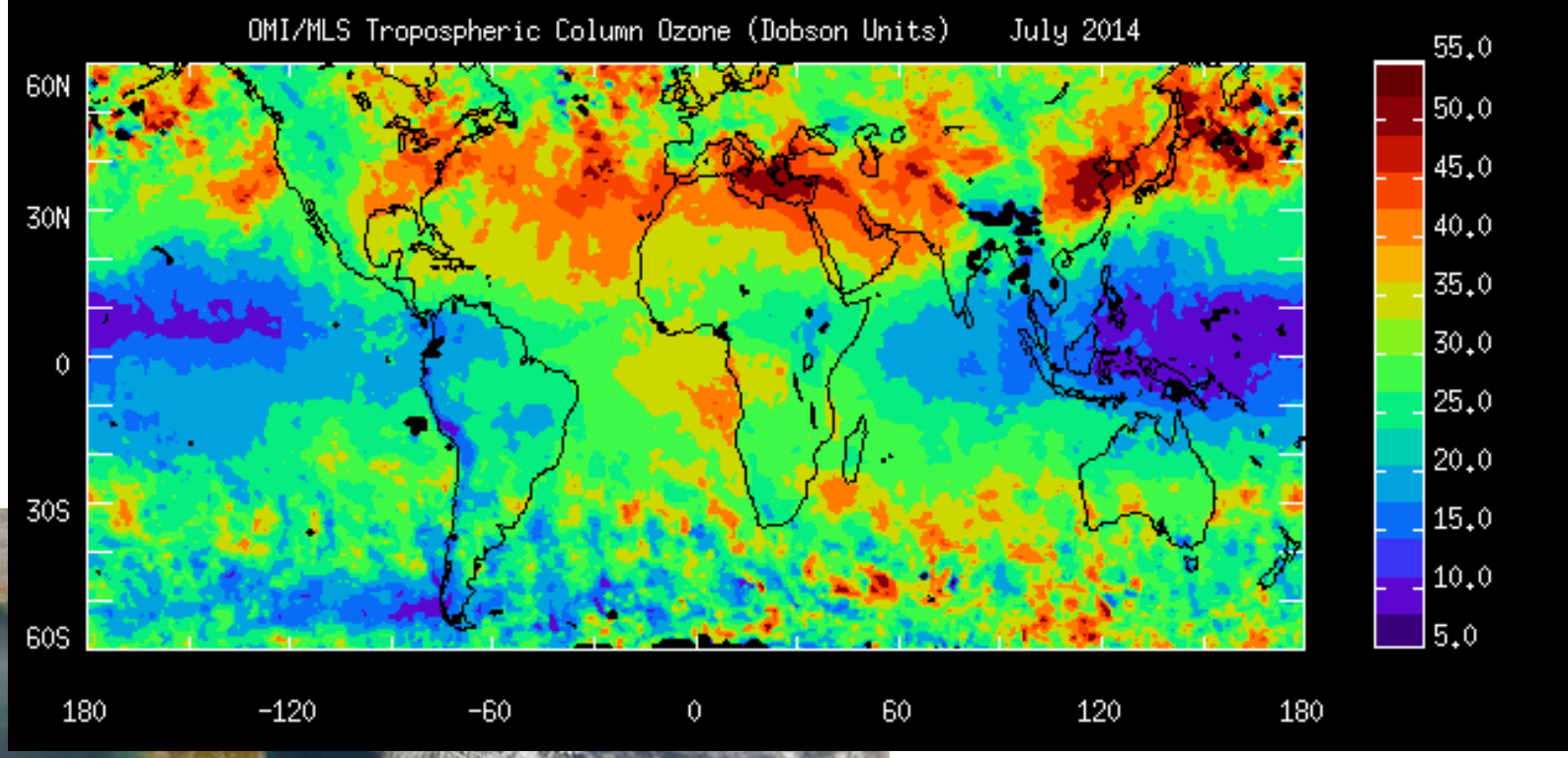
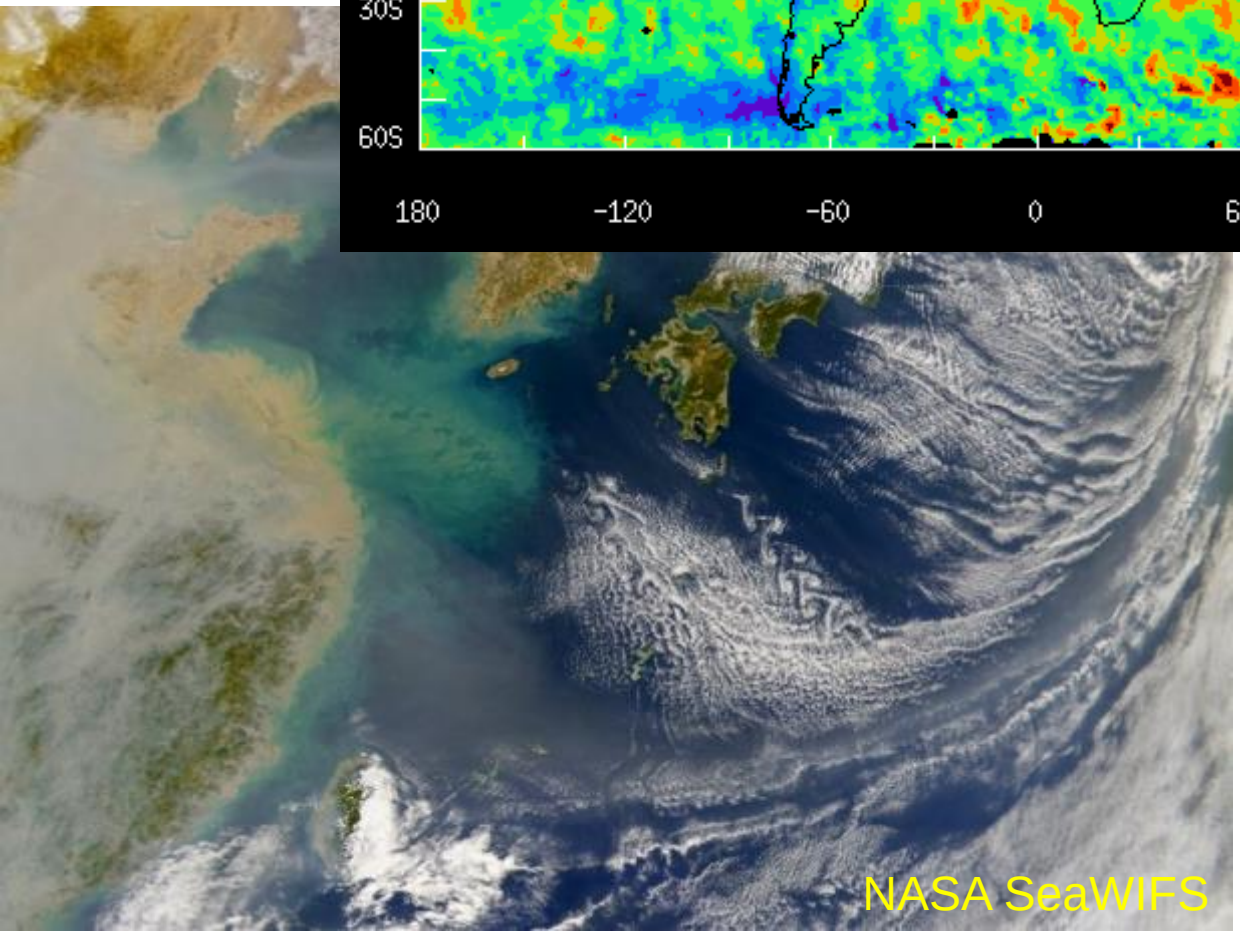




Major uncertainties:

- Transport
- Vertical distribution
- Aerosol hygroscopicity
- Aerosol light absorption

How to address these uncertainties:

• **Ideally**, global profiles (5 km) of O_3, RH, aerosol, aerosol hygroscopicity and absorption properties, AOD, and AAOD are measured at high frequency (weekly, at least) with reasonable vertical resolution.

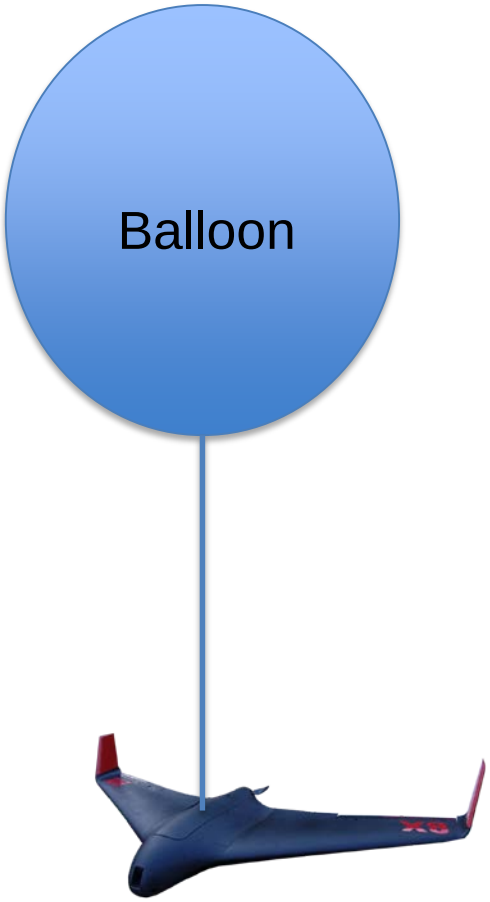
• **Realistically**, it is too difficult to do it right.

- ❑ Satellite: Little vertical info, no info on aerosol property
- ❑ Aircraft: Too expensive
- ❑ UASs: Too expensive, FAA limitation
- ❑ Non-recoverable balloon instruments: Too expensive

• **New proposed approach for measurement tool**

Key criteria: Low equipment cost, low operation cost, and reliable measurements of known uncertainty.

Our new tool:



Instrumented auto-homing glider, SKYWALKER

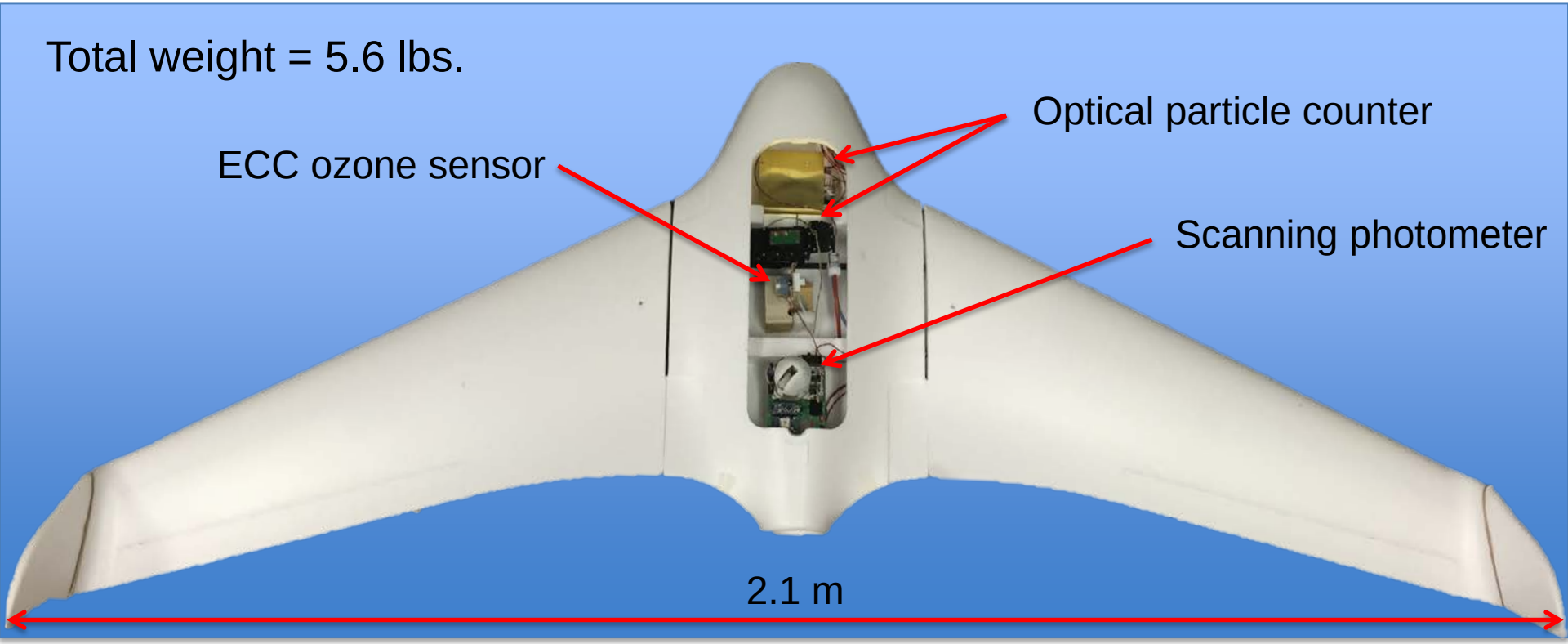
- Weather balloon based, < 6 lbs.
  - FAA regulation on small gliders might be less restrictive: Ease of operation

- Light and inexpensive instruments ($Ks per instrument, “lose-able”)
  - Low equipment cost

- Autonomously homing gliders or parafoils
  - Low operation cost ($350 per launch)
  - 5-km ceiling for easy recovery

Instrumented auto-homing glider

Total weight = 5.6 lbs.



Flight control by Black Swift Technologies

Autopilot

Tablet UI

Ground station

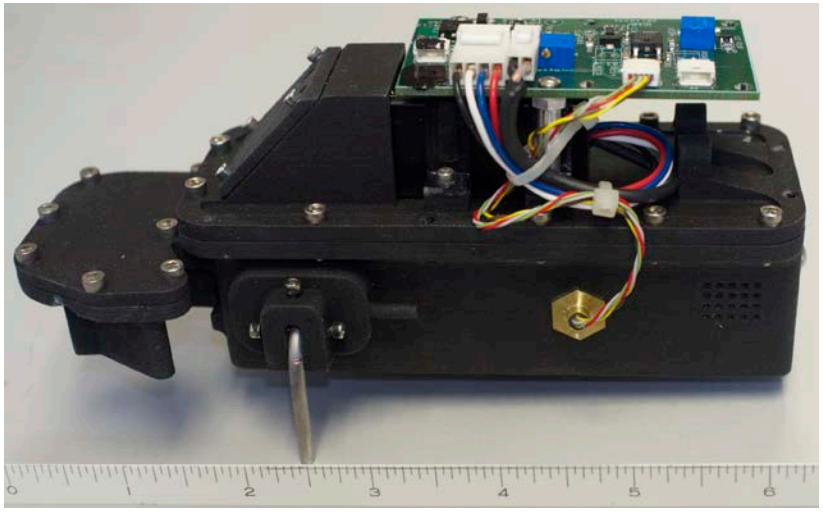
Movie of the glider test

New instruments developed at NOAA/CSD

Printed Optical Particle Spectrometer (POPS)

- Single-particle detection
- 150 - 2500nm diameter range
- 800 g, 7 Watts
- Lose-able (~$2500)

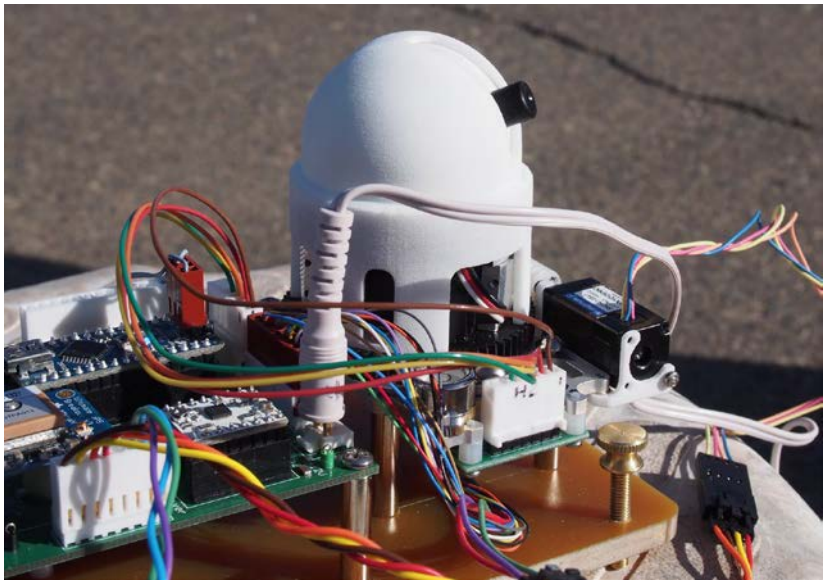
Gao et al.



Mini Scanning Aerosol Solar Photometer (Mini-SASP)

- 4 wavelength (460, 550, 670, 860 nm)
- 0.02 AOD detection limit
- 350 g, 2 Watts
- Lose-able (~$1500)

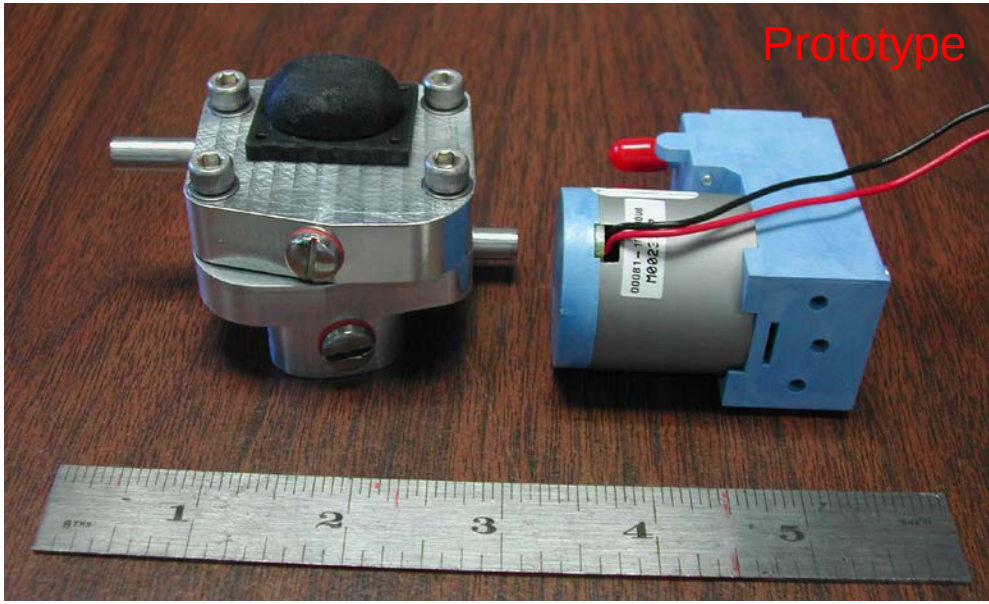
Murphy et al.



New instruments under development at NOAA/CSD/GMD

Mini-Continuous Light Absorption Photometer

- Particle absorption detection
- 3 wavelengths (467, 528, 652 nm)
- Precision < 0.2 Mm^{-1} (estimated)
- 1000 g, 10 Watts (estimated)
- Lose-able



Gao, Ting, et al.

Other possible instruments:

- Condensation Nuclei Counter (CNC)
- Filter-based Aerosol Chemical Sampler
- Whole Air Sampler (WAS)
- NO_2, CO_2, CH_4, CO sensors

Two instrument packages so far:

Package 1: Vertically resolved O_3 + Aerosols

- Deliverables:
  - O_3 profile
  - Dry aerosol AOD (derived) profiles
  - RH effect: AOD/(Dry aerosol AOD)
  - Aerosol-weighed RH
  - All instruments are robust and uncertainties can be quantified

Package 2: Aerosol optical and physical composition.

- Deliverables:
  - Aerosol particle distribution
  - Aerosol Abs. Coef. profiles
  - Aerosol AOD (derived)
  - Dry AAOD (derived)
  - CLAP is a proven instrument

Application:

The Global Ozone and Aerosol profiles and Aerosol Hygroscopic Effect and Absorption optical Depth (GOA²HEAD) Network Initiative

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Thank you for flying with GOA²HEAD

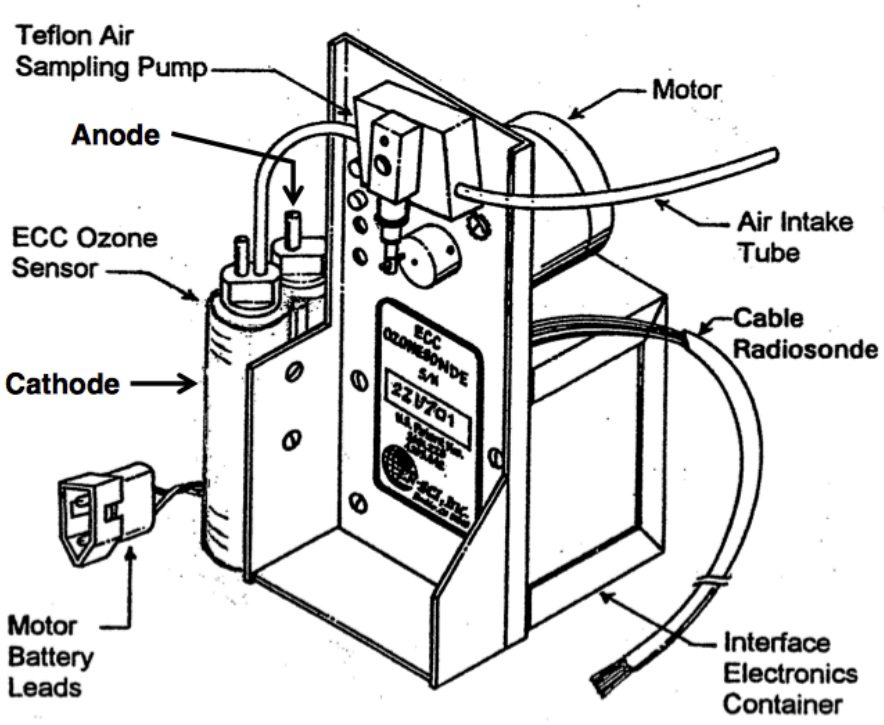
Instruments (commercially available):

Ozone (O_3)

Pressure

Temperature

Relative humidity (RH)



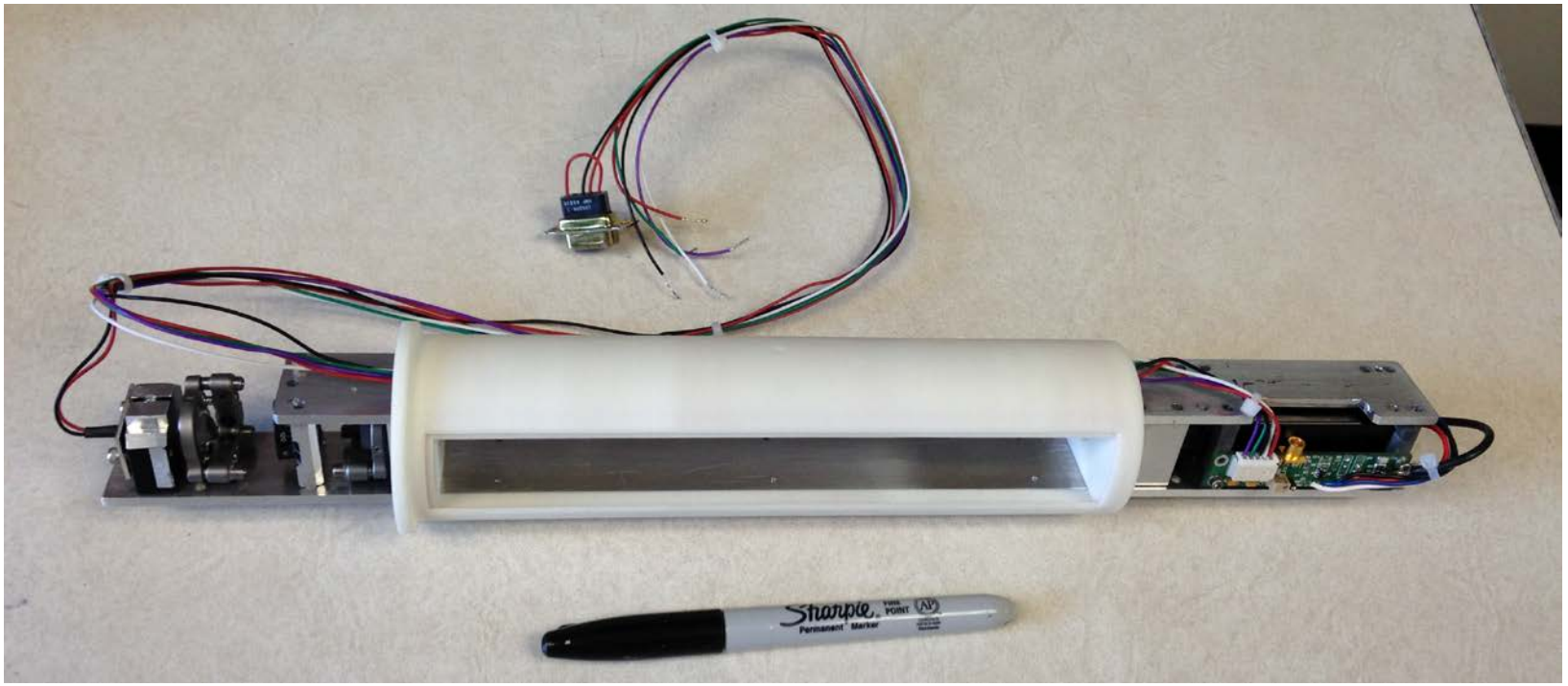
DMT ECC ozonesonde; 250 g, ~$850

New instruments developed at NOAA/CSD

Open-pass aerosol extinction sensor

- 450 or 670 nm
- Estimated 1 Mm^{-1} sensitivity
- Closable to zero signal

Gordon and Murphy



Two instrument packages so far:

Package 1: O_3, RH, dry aerosol, AOD

- Instruments: ECC O_3 (250 g), p, T, RH,(~100 g), POPS w/ dryer attachment (dry aerosol number density and size distribution, 800 g), mini-SASP (AOD, 350 g)

- Deliverables:
  - O_3, dry aerosol, and AOD profiles
  - Aerosol-weighed RH
  - Dry aerosol AOD (derived)
  - AOD
  - RH effect: AOD/(Dry aerosol AOD)

- All instruments are robust and uncertainties can be quantified

Package 2: Ambient aerosol and aerosol absorption coef.

- Instruments: ABS (dry aerosol absorption coefficient; miniaturized GMD CLAP instrument, or “mini-CLAP”), POPS (aerosol number density and size distribution), radiosonde (p, T, RH)

- Deliverables:
  - Aerosol and AAC profiles
  - Aerosol AOD (derived)
  - Dry AAOD (derived)

- CLAP is a proven instrument