NOAA Printed Optical Particle Spectrometer (POPS)

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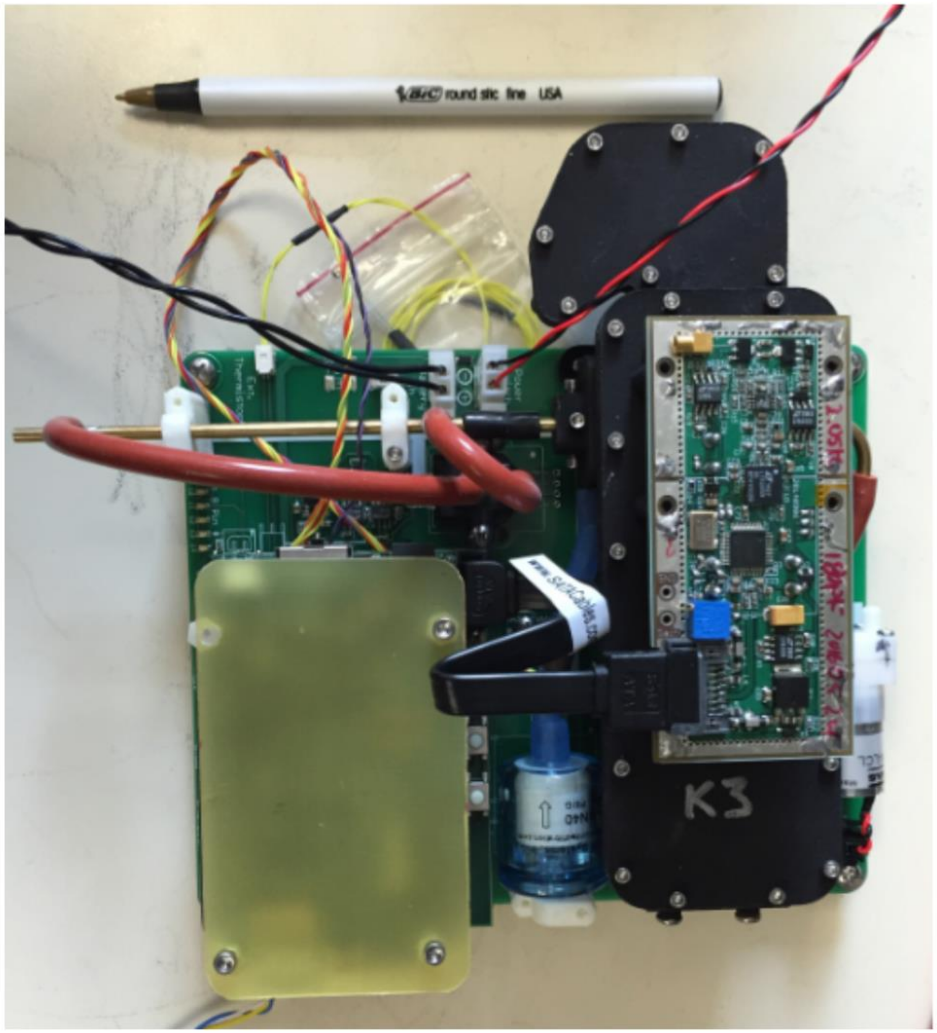
CIRES

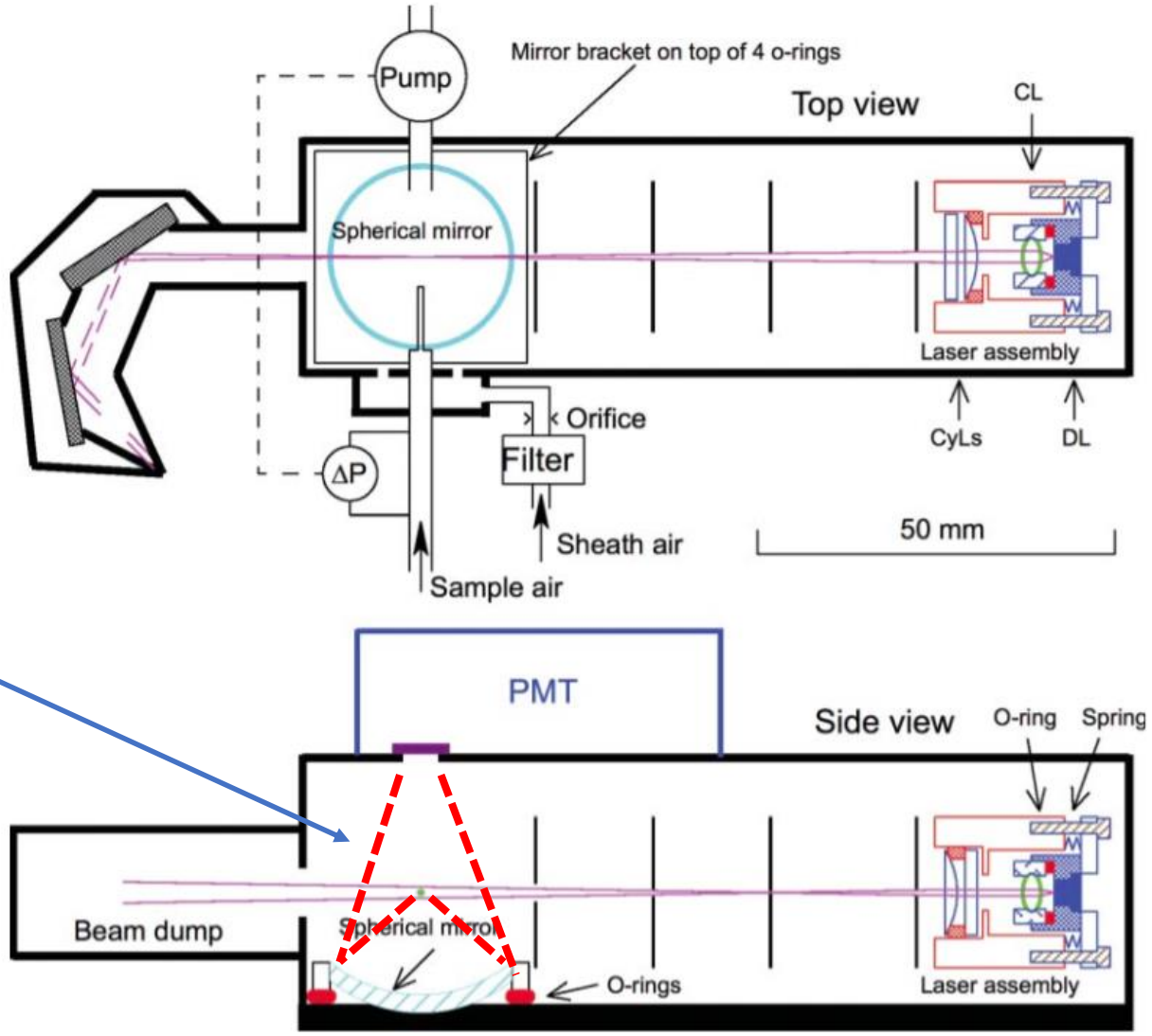
POPS Concept:

- Small / lightweight enough for met balloons
- Inexpensive enough for non-recovery deployments
- Sensitive enough / sufficient dynamic range to capture peak of the mass distribution
- Use 3-D printing technology to reduce cost of prototyping and manufacturing

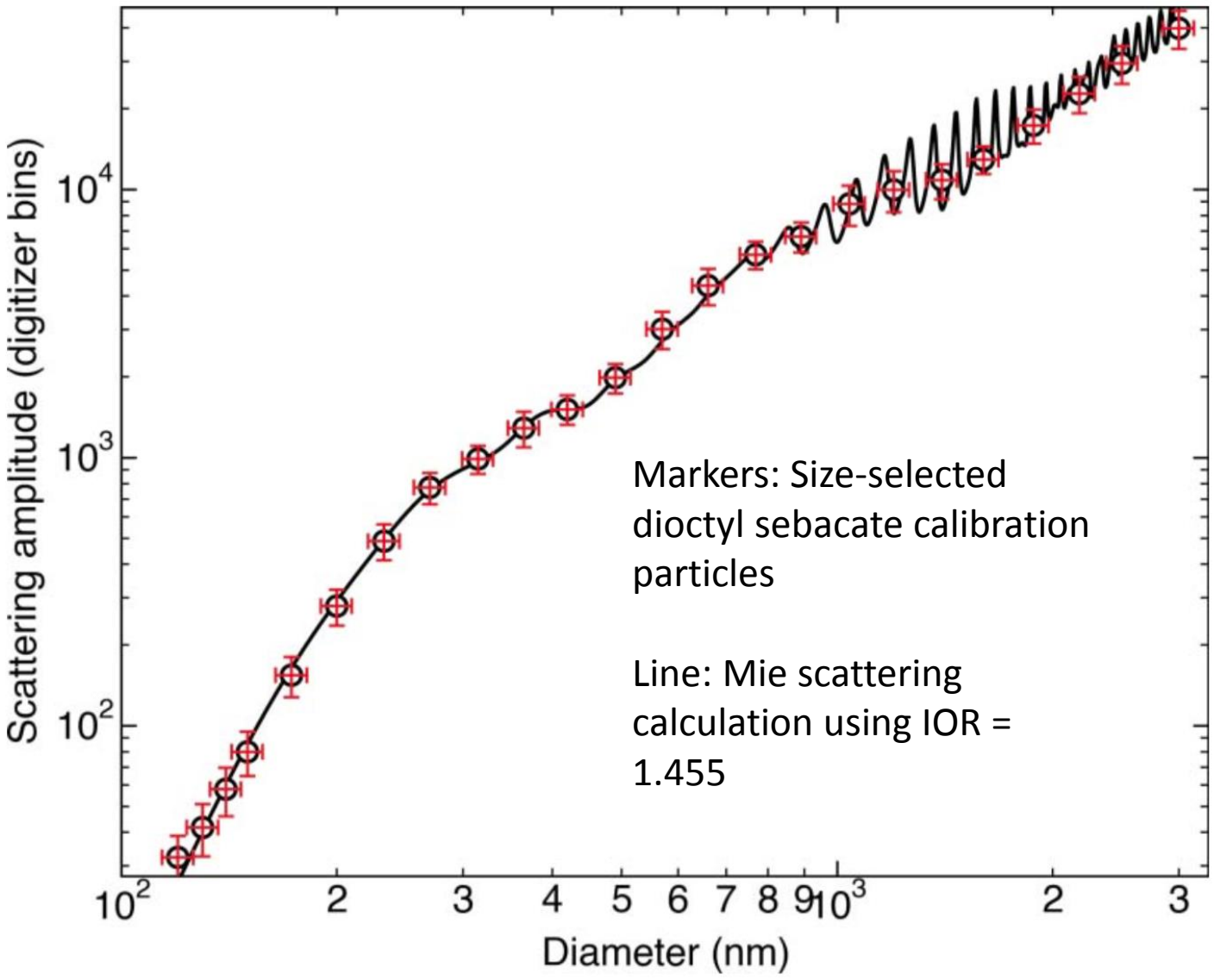
POPS History:

- Gao et al., Aerosol Science and Technology 2013 (forward scatter).
- Gao et al., Aerosol Science and Technology 2016 (38-142 degree scatter).
- POPS commercialized by Handix Scientific

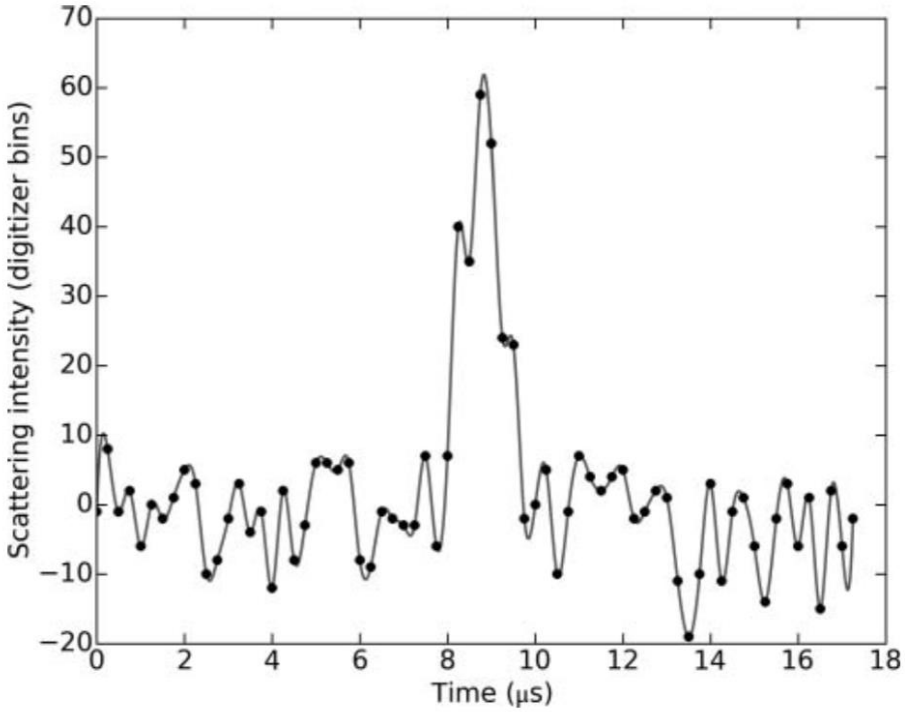




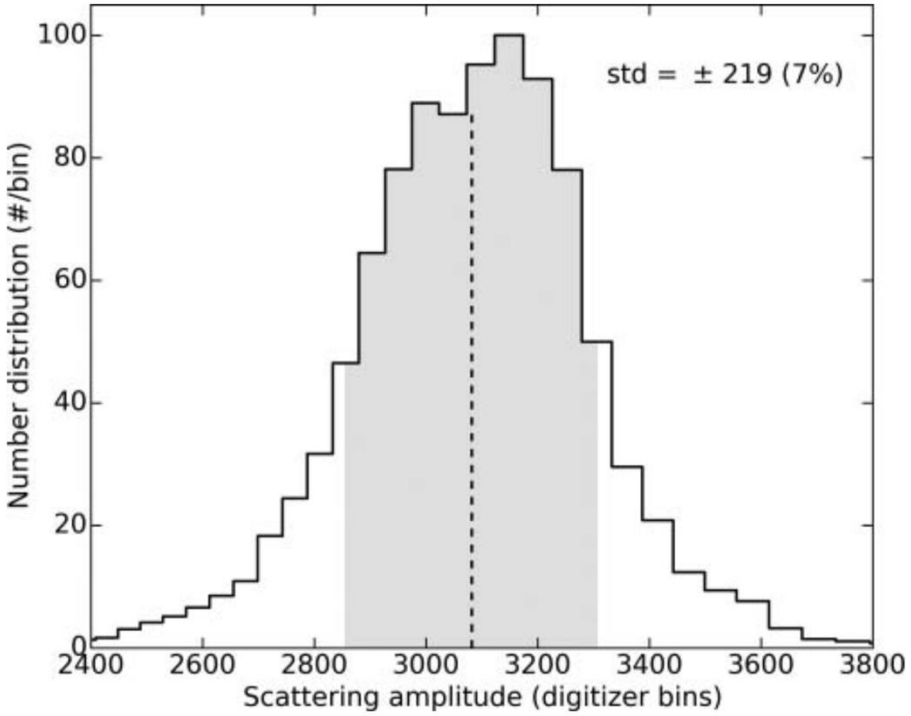
38-142 degree scatter


Scattering amplitude (digitizer bins)
10^4
10^3
10^2
10^2
2
3
4
5
6
7
8
9
10^3
2
3
Diameter (nm)
Markers: Size-selected dioctyl sebacate calibration particles
Line: Mie scattering calculation using IOR = 1.455

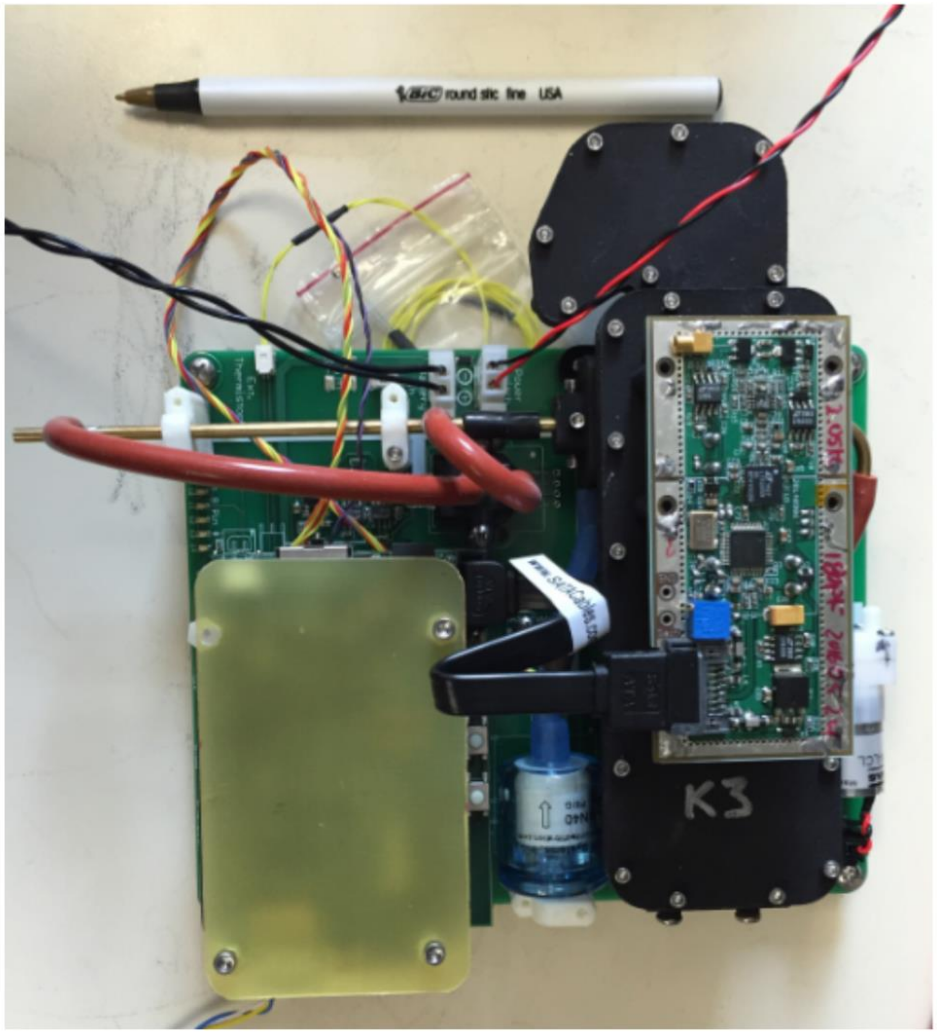
140 nm DOS particle

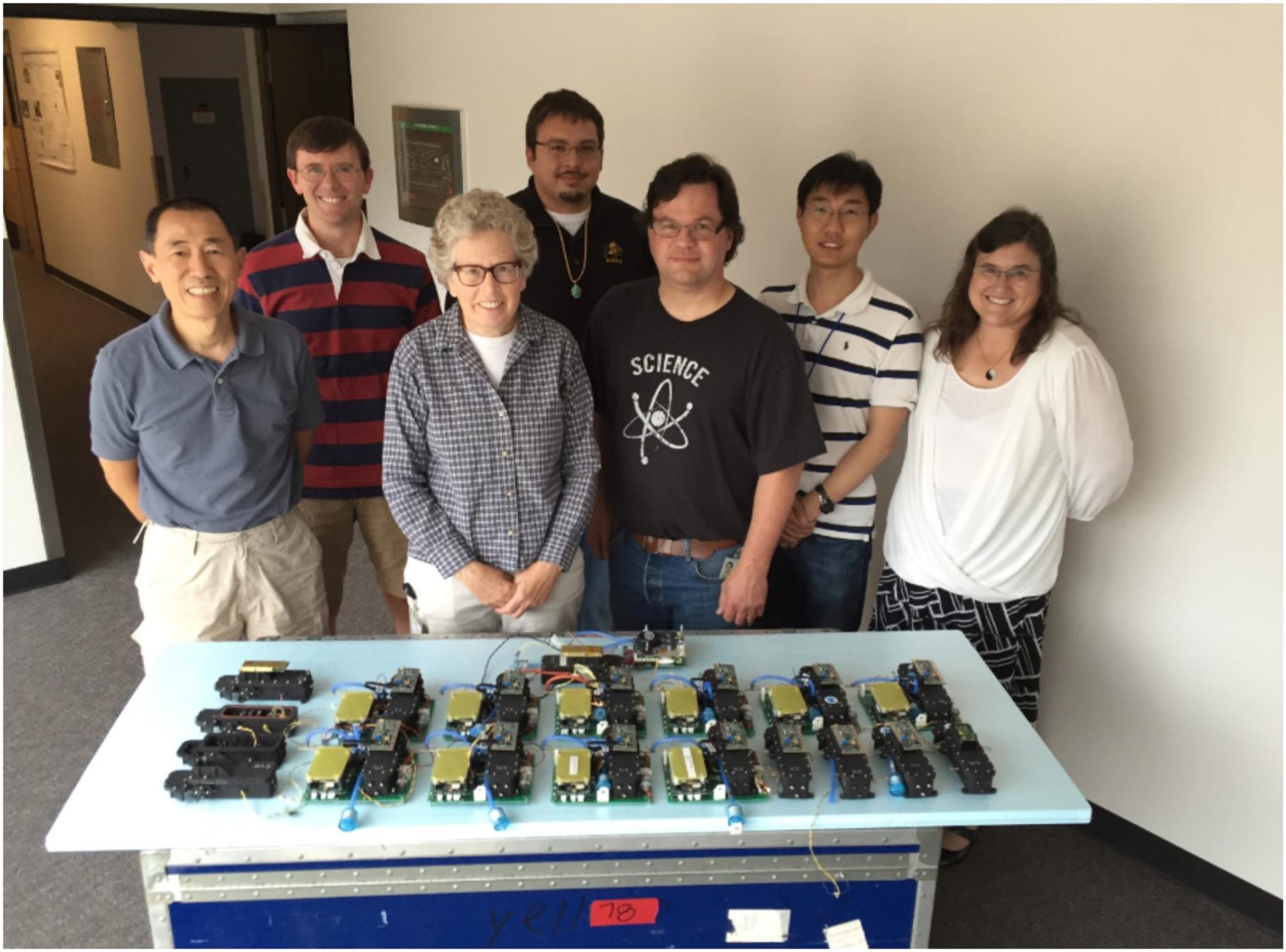


3% random uncertainty in particle diameter



- Size: 8” x 8” x 3”
- Weight: 530 g. Can be flown with iMet, O_3 and H_2O.
- Power: 12VDC, 5W
- Size range: 140 – 3000 nm **diameter**
- Flow rate: 0.18 LPM

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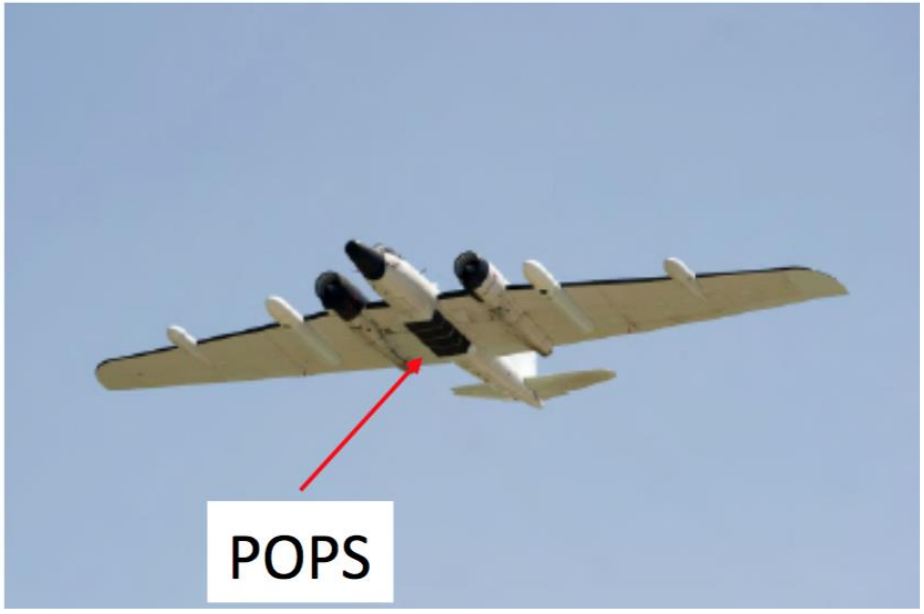
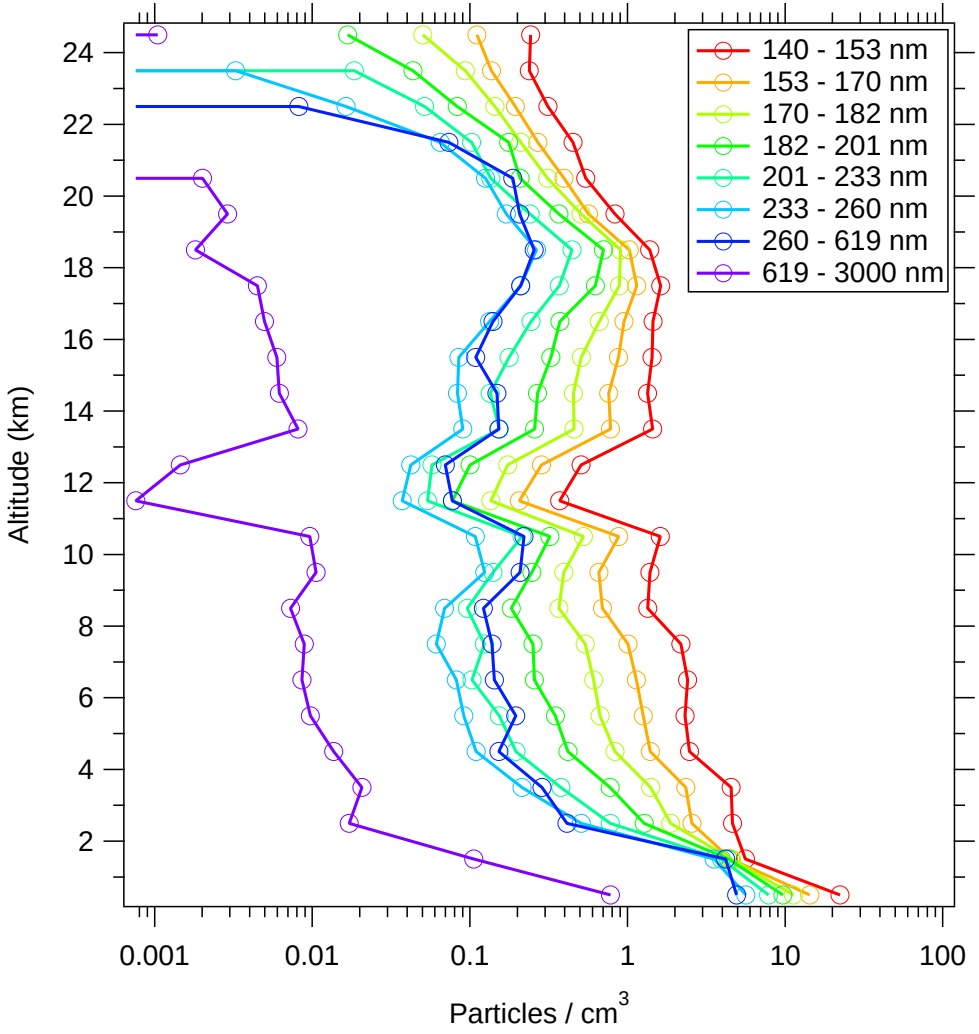
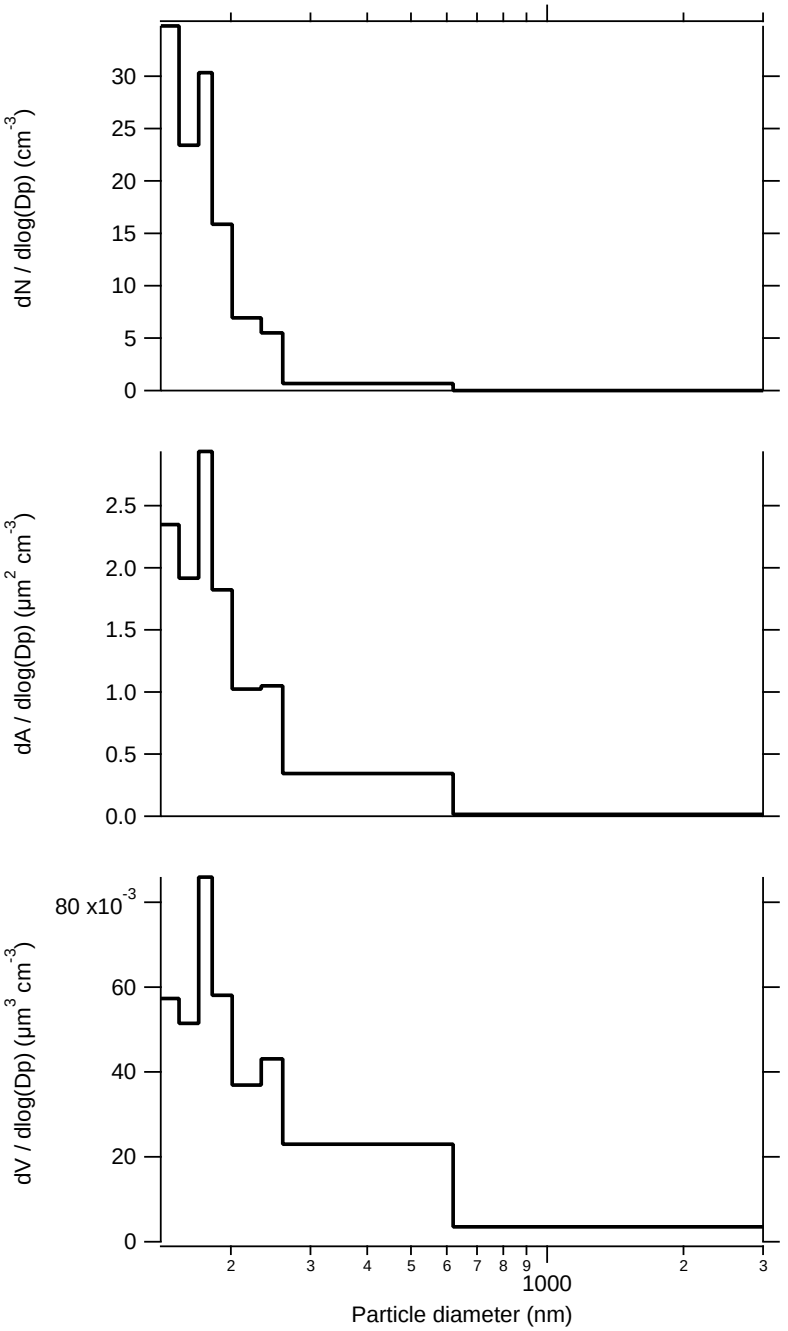

POPS

8 size bins sent down via iMet with O_3 and H_2O



17.5 – 18.5 km



Existing Data

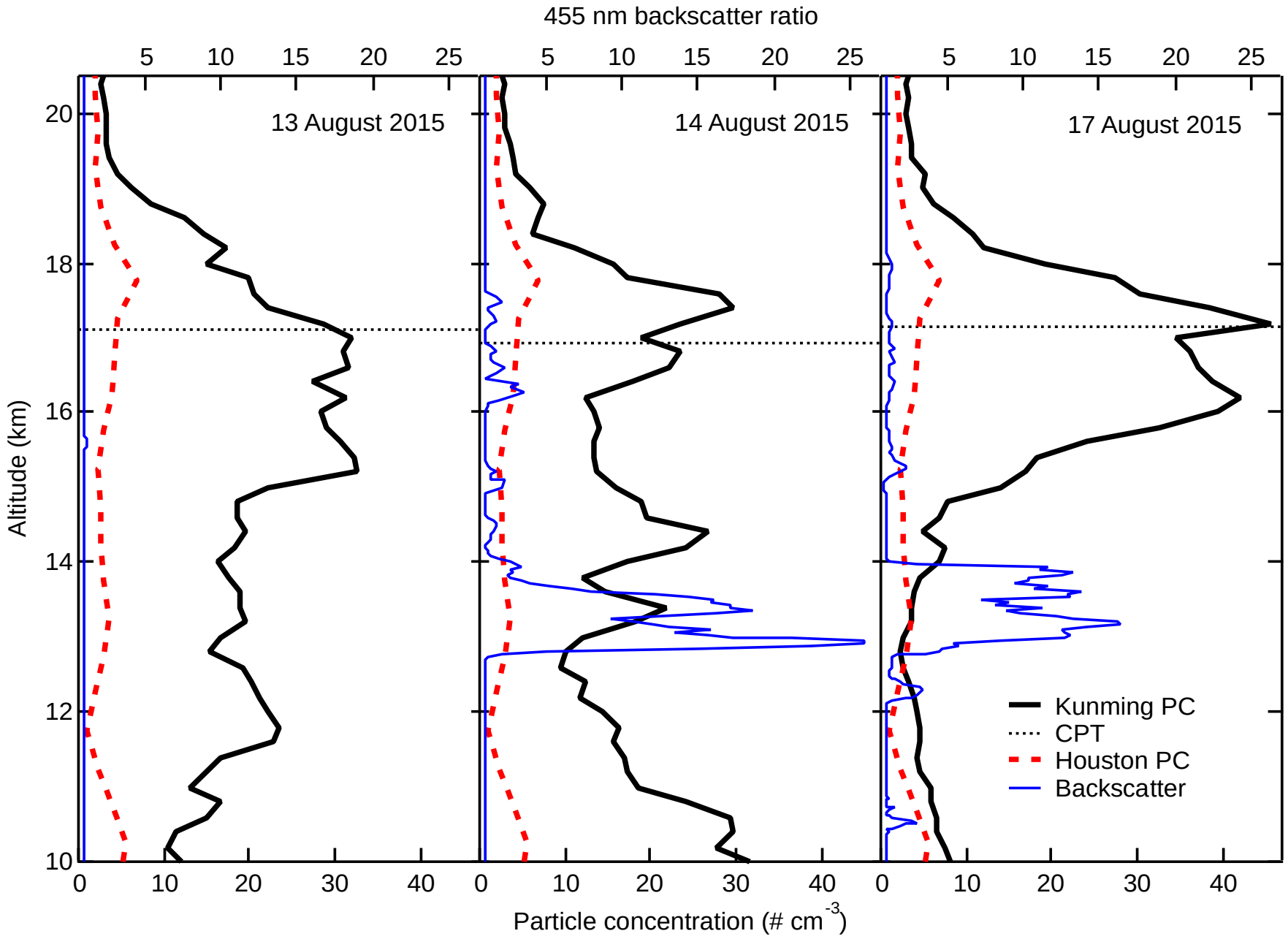
- Balloon
  - Wyoming – 1 launch
  - October 2015 – 1 launch from Houston
  - October 2015 – 3 launches from Kunming
  - March 2016 – 1 launch from Reunion
  - October 2016 – 6 launches from Lhasa
  - October 2016 – 1 launch from Guam
  - Sept. – Nov. 2016 - 3 launches from Houston
  - April 2017 – 1 launch from Reunion

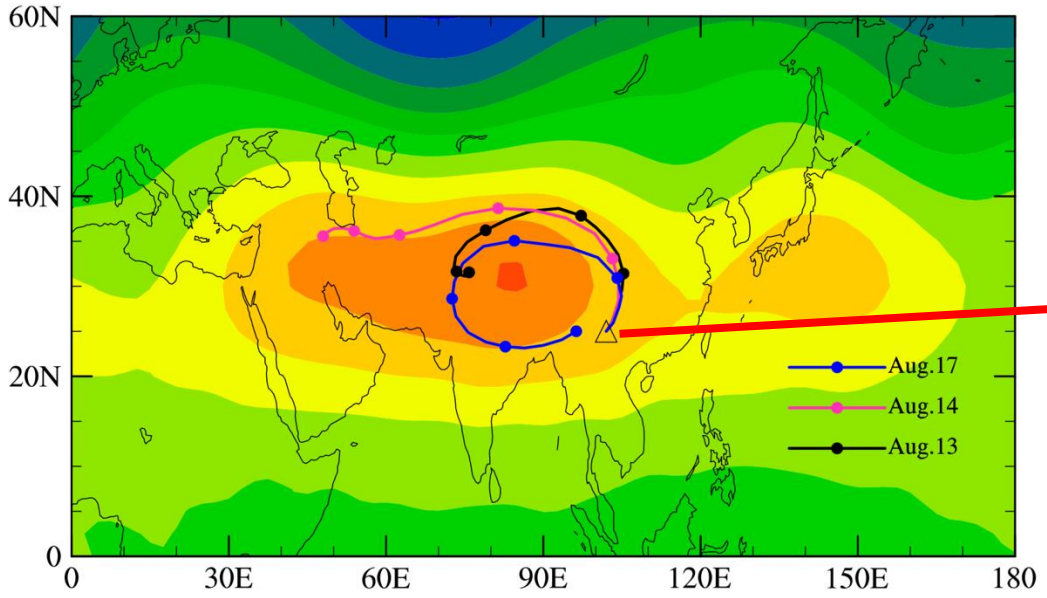
- WB-57
  - Houston – Sept. – Oct. 2016
  - Guam (POSIDON mission) Oct. 2016

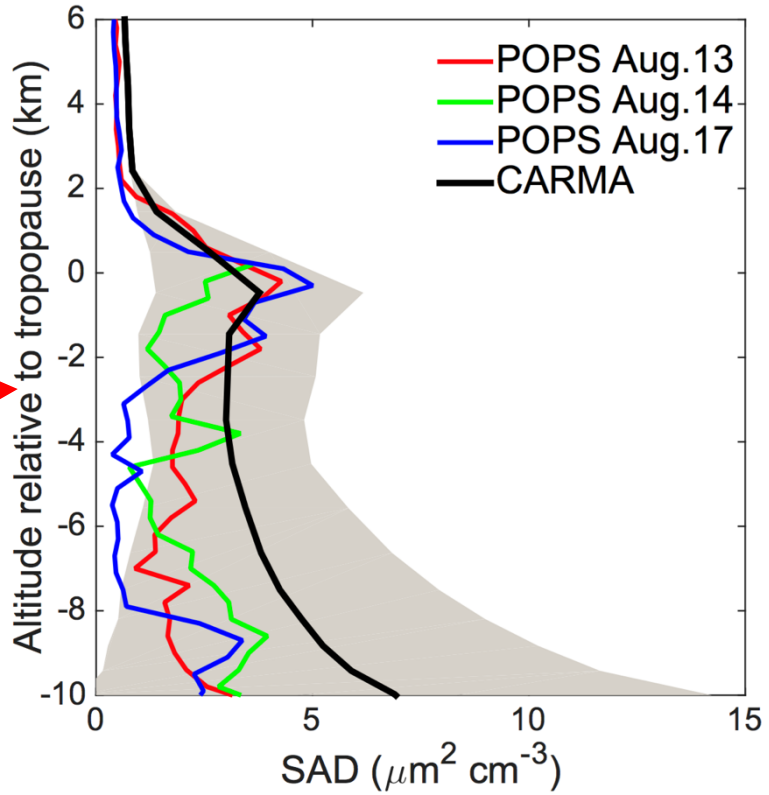
- Global Hawk – (EPOCH mission) Aug. 2017

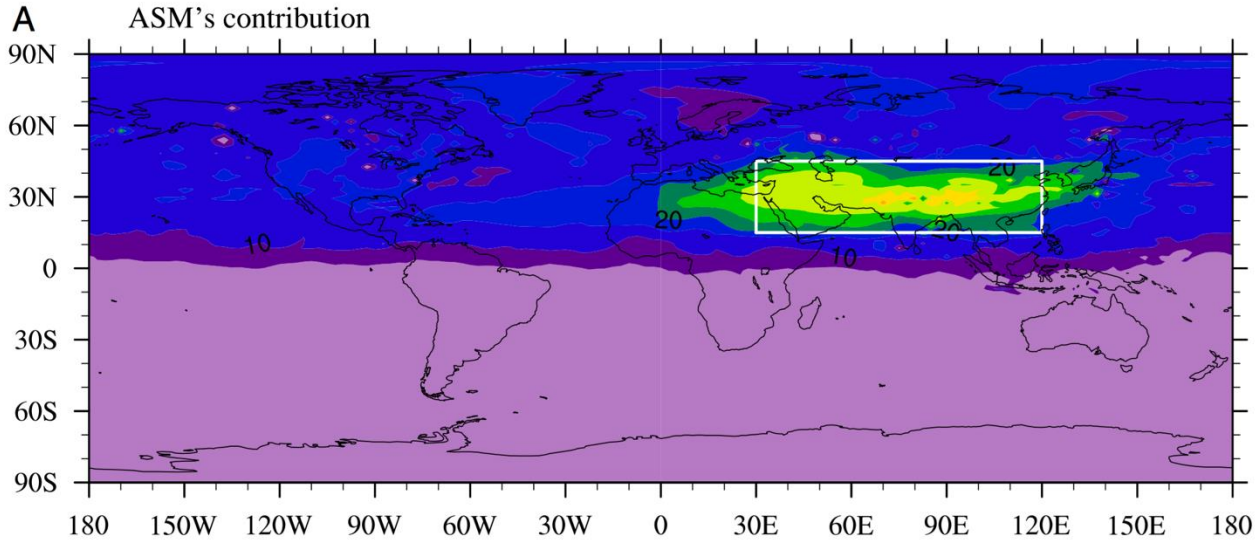
Future

- IAGOS – FZJ lead effort
- UWYO comparison?


455 nm backscatter ratio
5
10
15
20
25
13 August 2015
14 August 2015
17 August 2015
Altitude (km)
20
18
16
14
12
10
0
10
20
30
40
Particle concentration (# cm-3)
Kunming PC
CPT
Houston PC
Backscatter



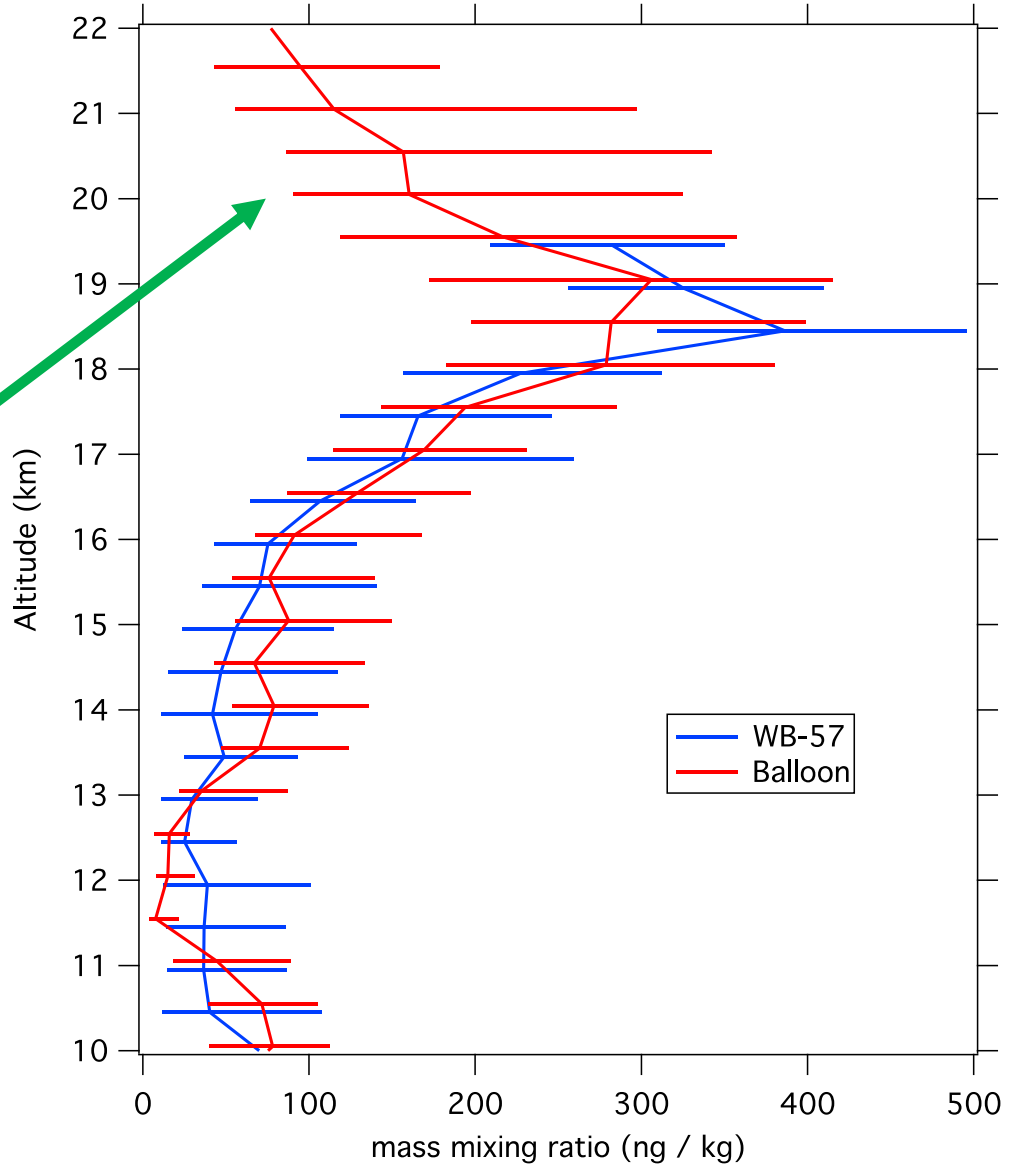




Yu et al., PNAS 2017

POPS WB-57 / Balloon comparison from POSIDON mission, Guam Oct. 2016

Apparent decrease in mass mixing ratio above the tropopause is due to loss of larger particles due to sampling with an orthogonal inlet at low pressure.



Summary

- POPS provides precise measurements of aerosol size distribution and number concentration up into the lower stratosphere.
- POPS can be deployed on weather balloons and in locations where payload may not be recovered.
- Measurement of super-micron particles requires inlet oriented parallel to the flow (upwards pointing inlet) and requires validation. Higher flow rates may be needed for sufficient statistics of larger sizes.
- Only current plan for future deployment is on IAGOS, lead by FZJ.
- NOAA would like to look for opportunity for a comparison with the UWYO / Boulder OPC.