

DOE-G1 Light Scattering and Absorption Measurements

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BROOKHAVEN
NATIONAL LABORATORY

a passion for discovery



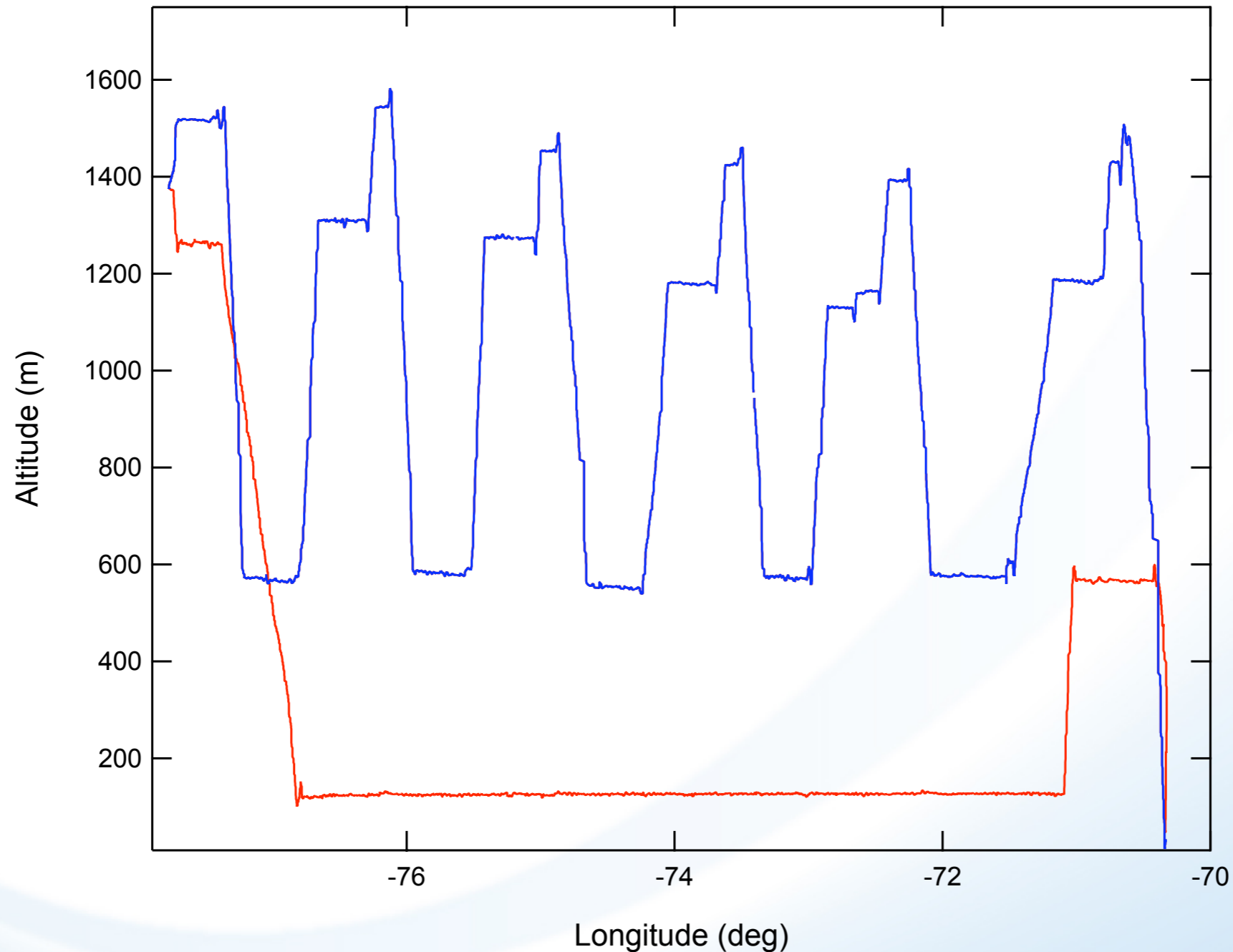
G1 Optical Instrumentation Description

- 3- λ Nephelometer (TSI)
 - 700, 550 & 450 nm
 - heated Inlet
 - Anderson-Ogden correction
- 3- λ PSAP (Radiance)
 - 648.1, 522.7 & 448.1 nm
 - heated inlet
 - spot size, flow, Bond corrections
- 1- λ Photothermal Interferometer (BNL)
 - 532 nm
 - maiden deployment

Example of flight patterns discussed today

Outbound: characterized by below, in cloud and above cloud measurements

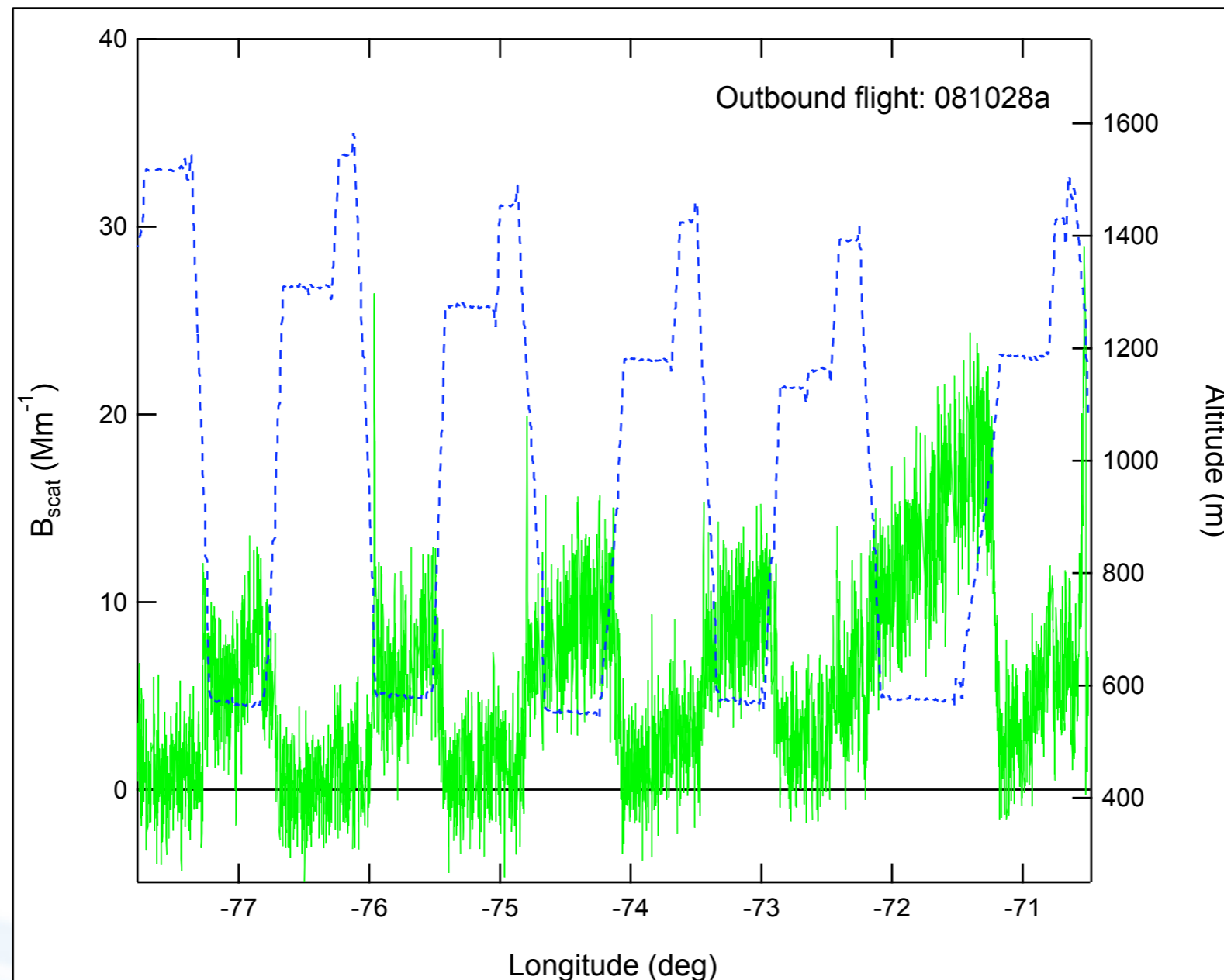
Inbound: characterized by level flight below cloud (today's focus)



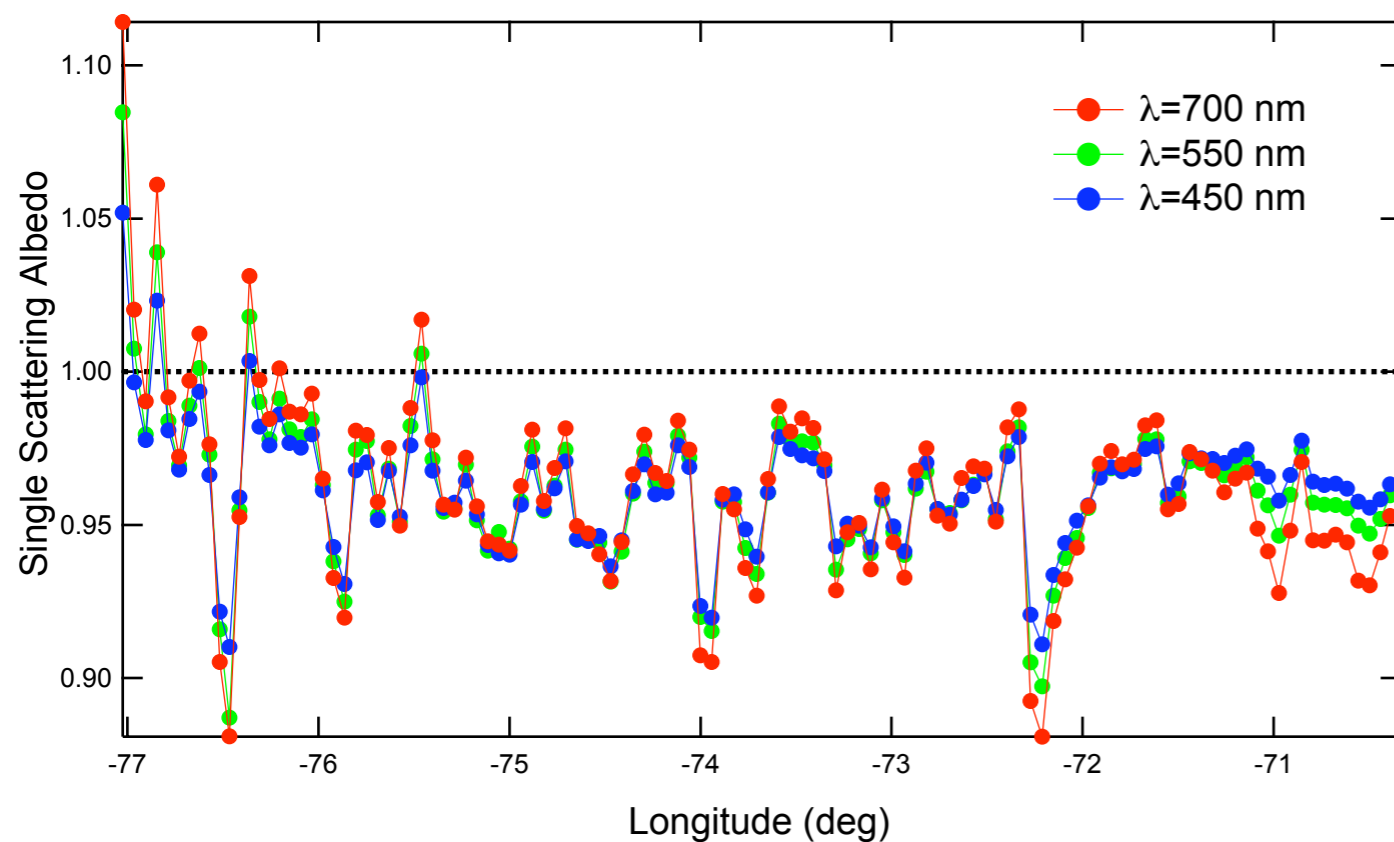
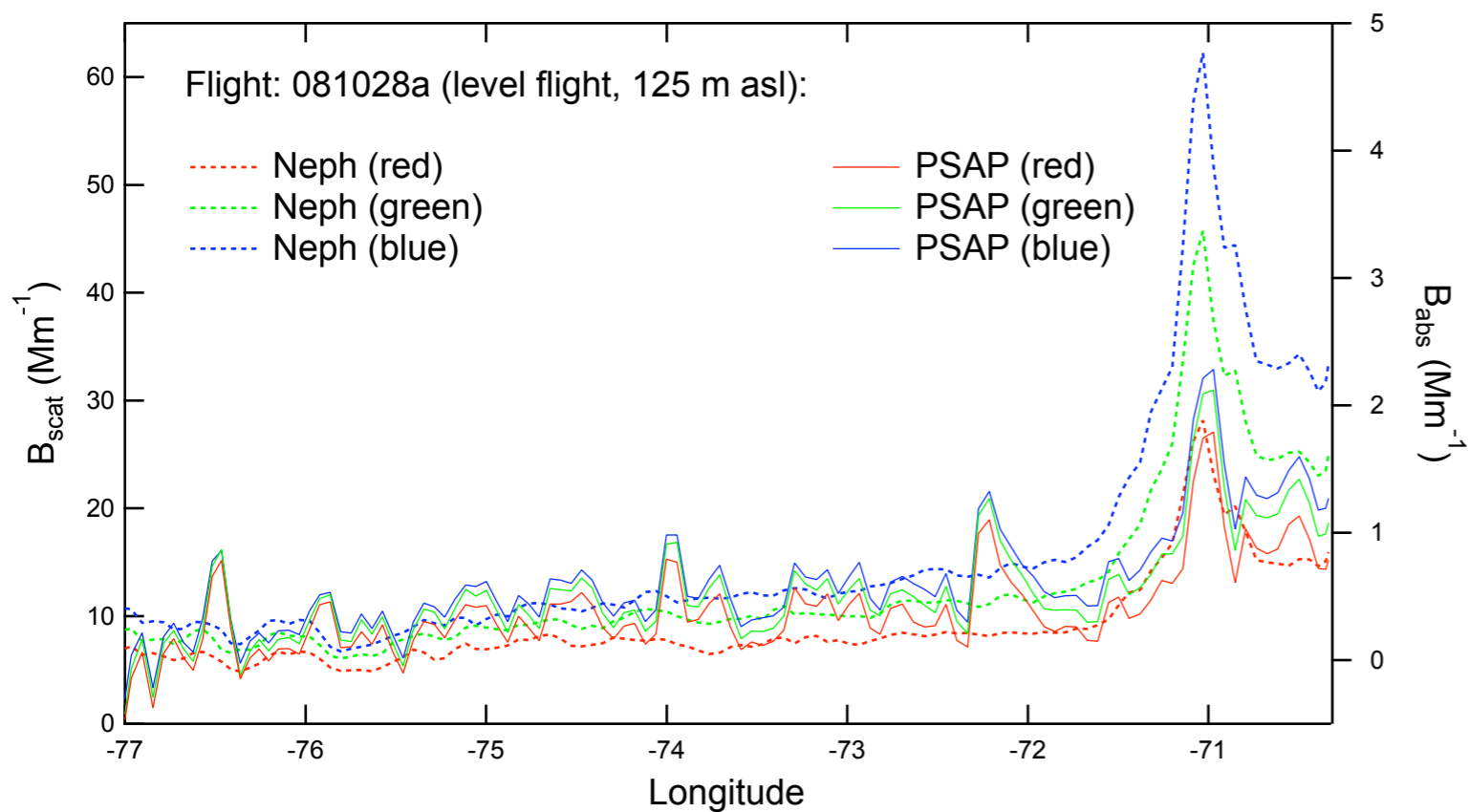
Outbound: Flight 081028a

- $B_{\text{scat}}^{\text{ac}}$ decreases from $\sim 6 \text{ Mm}^{-1}$ (-72°) to $\sim 1 \text{ Mm}^{-1}$ (-77.7°)
- $B_{\text{scat}}^{\text{ic}} \sim 3 \text{ Mm}^{-1}$ (-71°); $\sim 2.3 \text{ Mm}^{-1}$ (-73°); $\sim 1.4 \text{ Mm}^{-1}$ (-74°); $\sim 1.1 \text{ Mm}^{-1}$ (-75.5°); $\sim 0.5 \text{ Mm}^{-1}$ (-76.5°)
- $B_{\text{scat}}^{\text{bc}} \sim 12 \text{ Mm}^{-1}$ (-71.7°); $\sim 9 \text{ Mm}^{-1}$ (-73.3°); $\sim 8.7 \text{ Mm}^{-1}$ (-74.5°); $\sim 6 \text{ Mm}^{-1}$ (-77°)

ac: above cloud; bc: below cloud; ic: in cloud

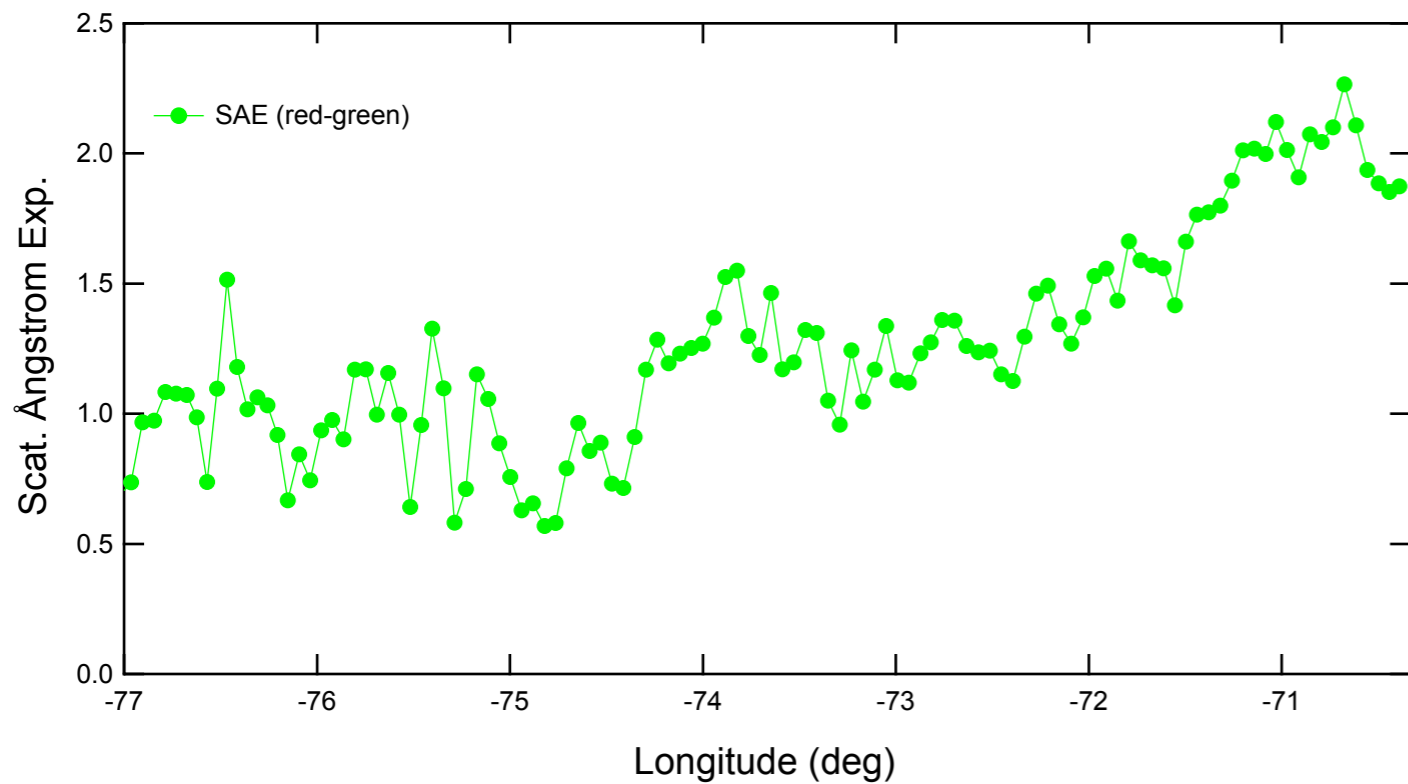


Flight 081028a: Inbound

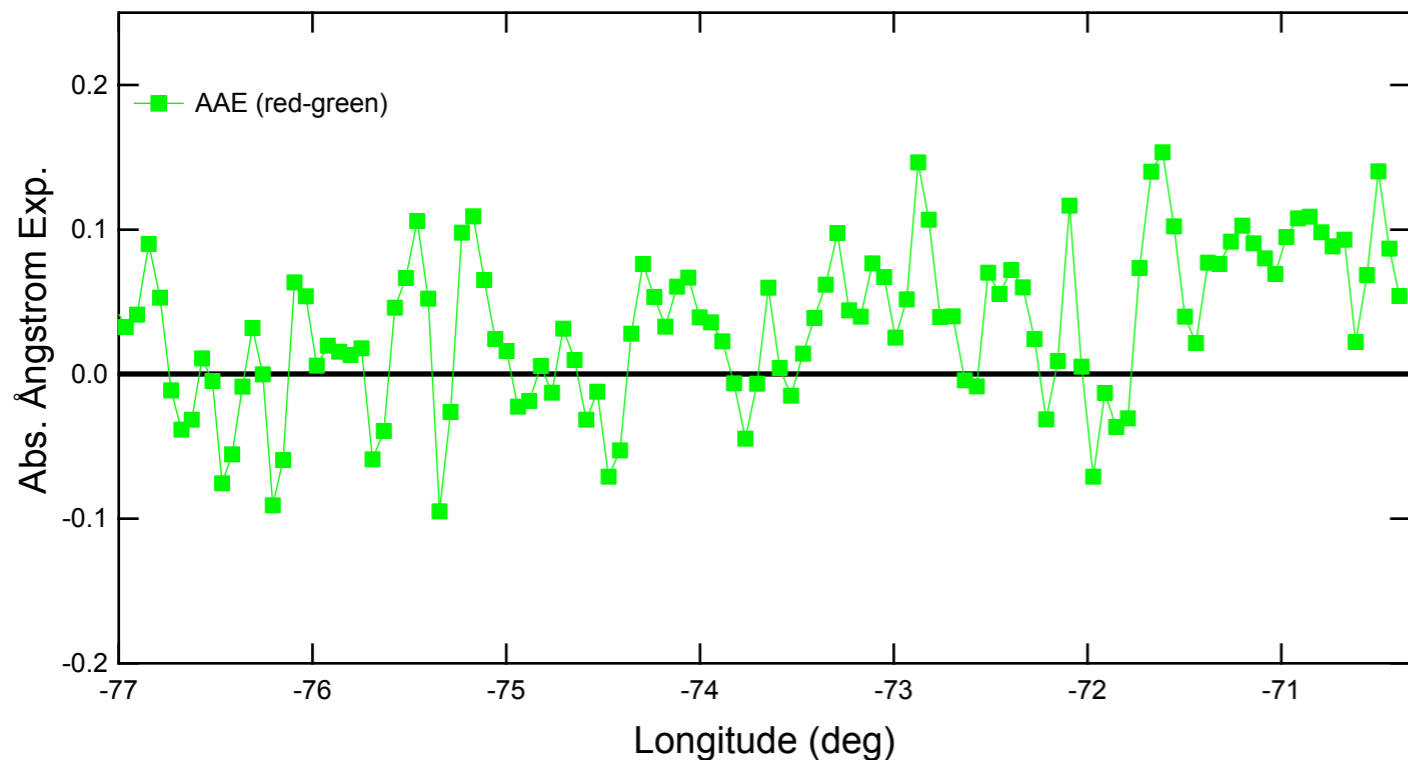


- Level flight: 125 m
- -77° (-18.5°) to -71° (-18.35°)
- B_{scat} : near shore influence
- B_{abs} : essentially no abs except near shore
- $SSA: 0.96 \pm 0.026$ (-77° to -73°)
- Near shore $SSA(\lambda)$ suggests presence of urban pollution (Bergstrom et al. 2002; Collaud Coen, et al. 2004 & Meloni et al. 2006)

Flight 081028a: Inbound



- SAE (-77° to -74°): 1.0 ± 0.25
- SAE ~ 1 suggests presence of large particles...sea salt (?)
- SAE increase near coast: presence of smaller particles

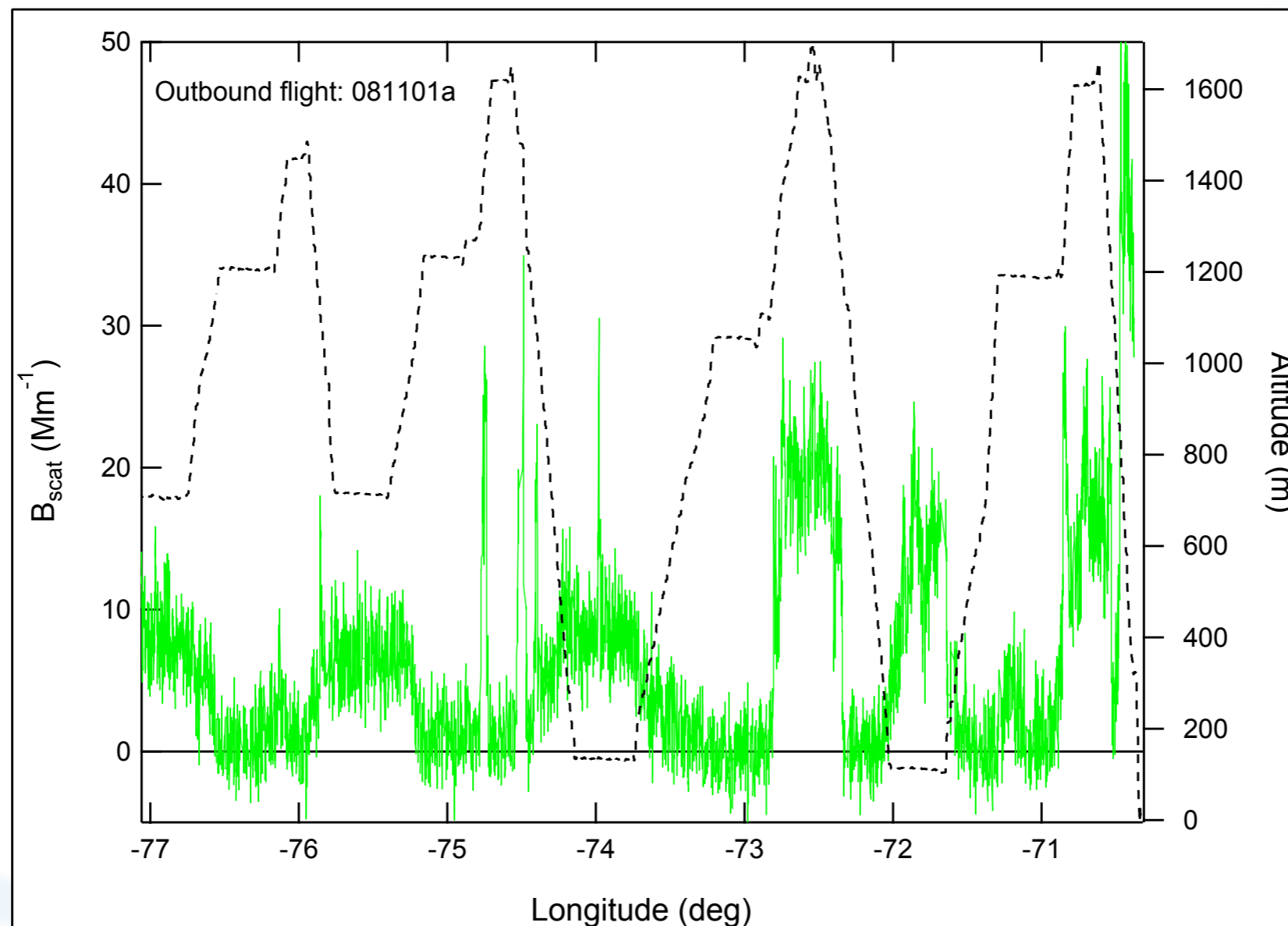


- Weak B_{abs} signal ($< 1 \text{ Mm}^{-1}$)
- AAE (-77° to -74°): 0.011 ± 0.048

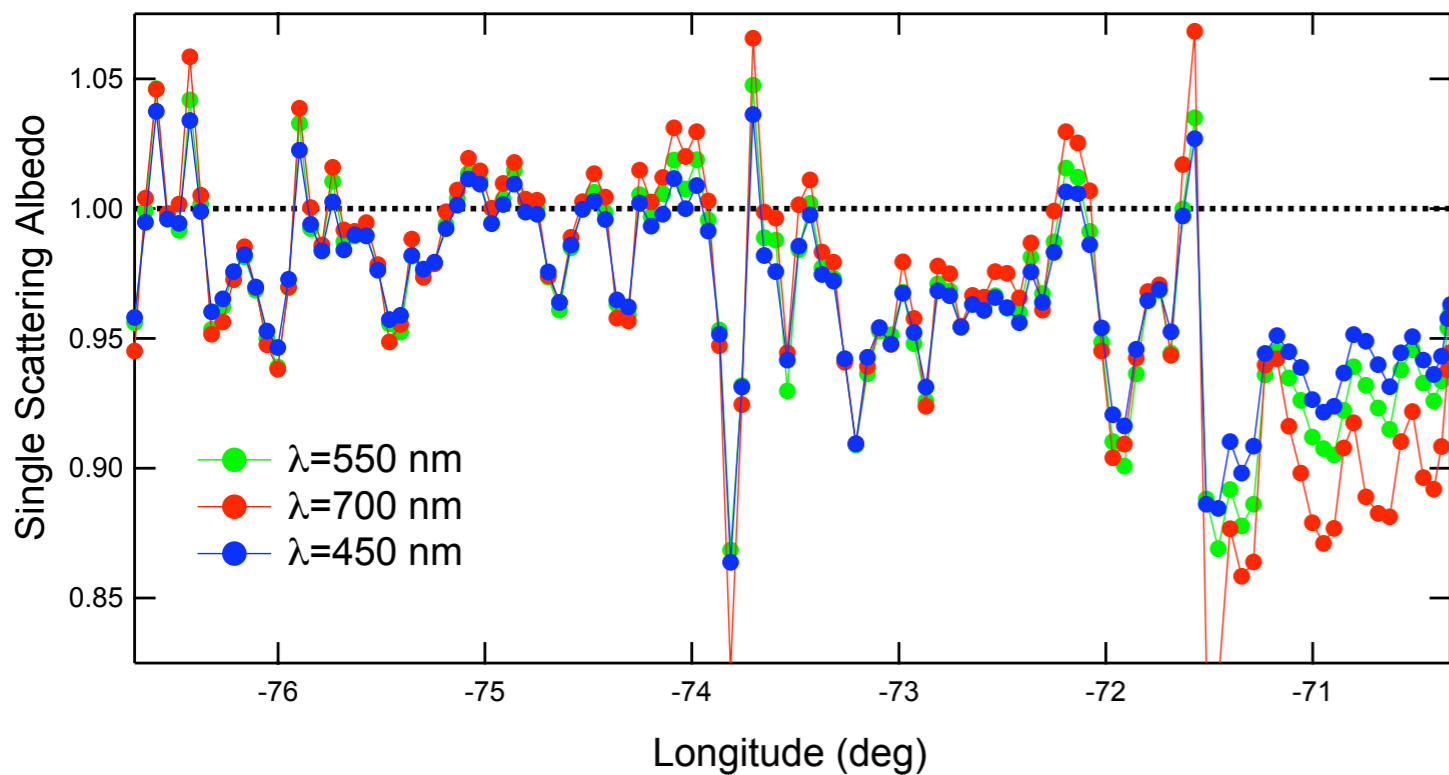
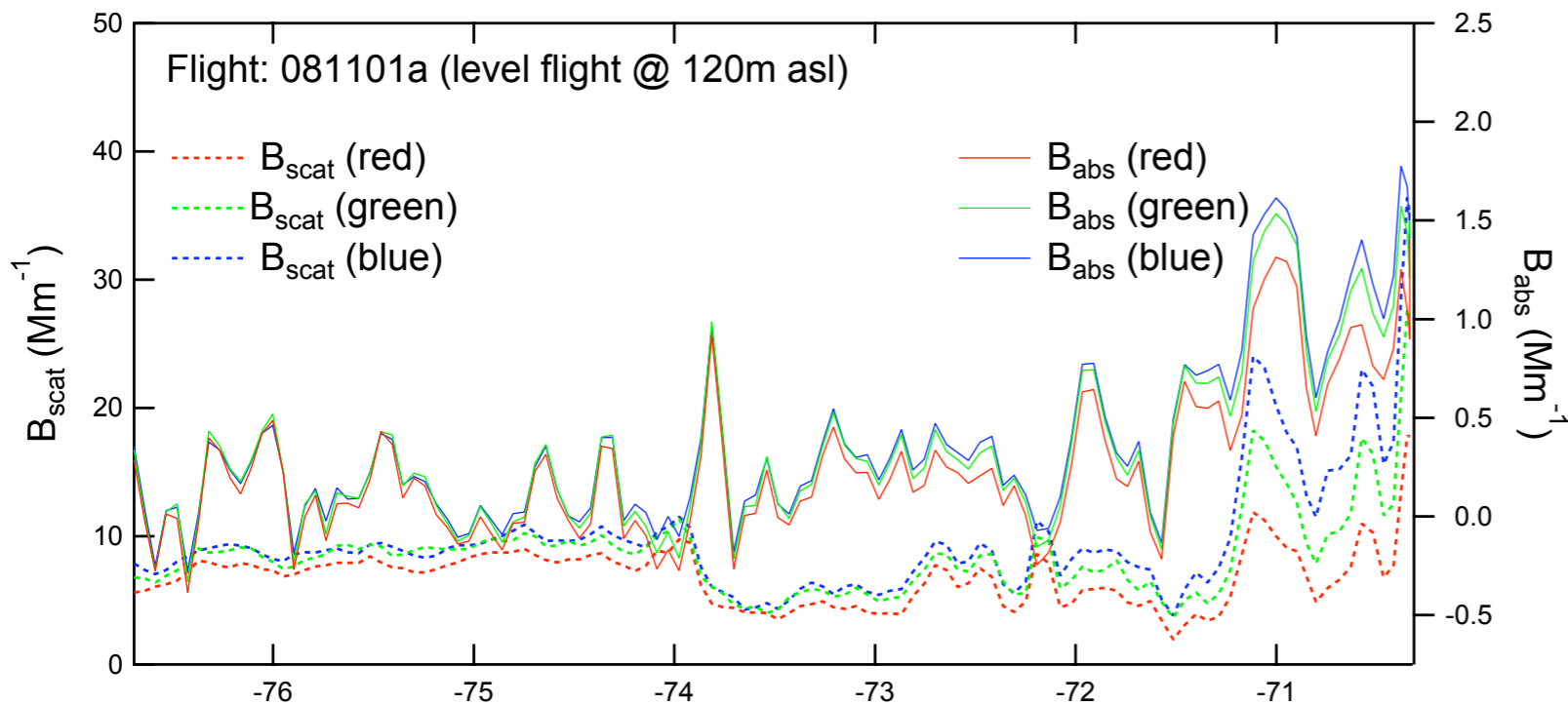
Outbound: Flight 081101a

- $B_{\text{scat}}^{\text{ac}}$ decreases from $\sim 20 \text{ Mm}^{-1}$ (-72.5°) to $\sim 1 \text{ Mm}^{-1}$ (-74.6°)
- $B_{\text{scat}}^{\text{ic}} \sim 1.5 \text{ Mm}^{-1}$ (-71.1°); $\sim 0.2 \text{ Mm}^{-1}$ (-73°); $\sim 1 \text{ Mm}^{-1}$ (-75°); $\sim 0.6 \text{ Mm}^{-1}$ (-77°)
- $B_{\text{scat}}^{\text{bc}} \sim 15 \text{ Mm}^{-1}$ (-71.7°); $\sim 9 \text{ Mm}^{-1}$ (-74°); $\sim 7 \text{ Mm}^{-1}$ (-75.5°); $\sim 8 \text{ Mm}^{-1}$ (-76.4°)

ac: above cloud; bc: below cloud; ic: in cloud

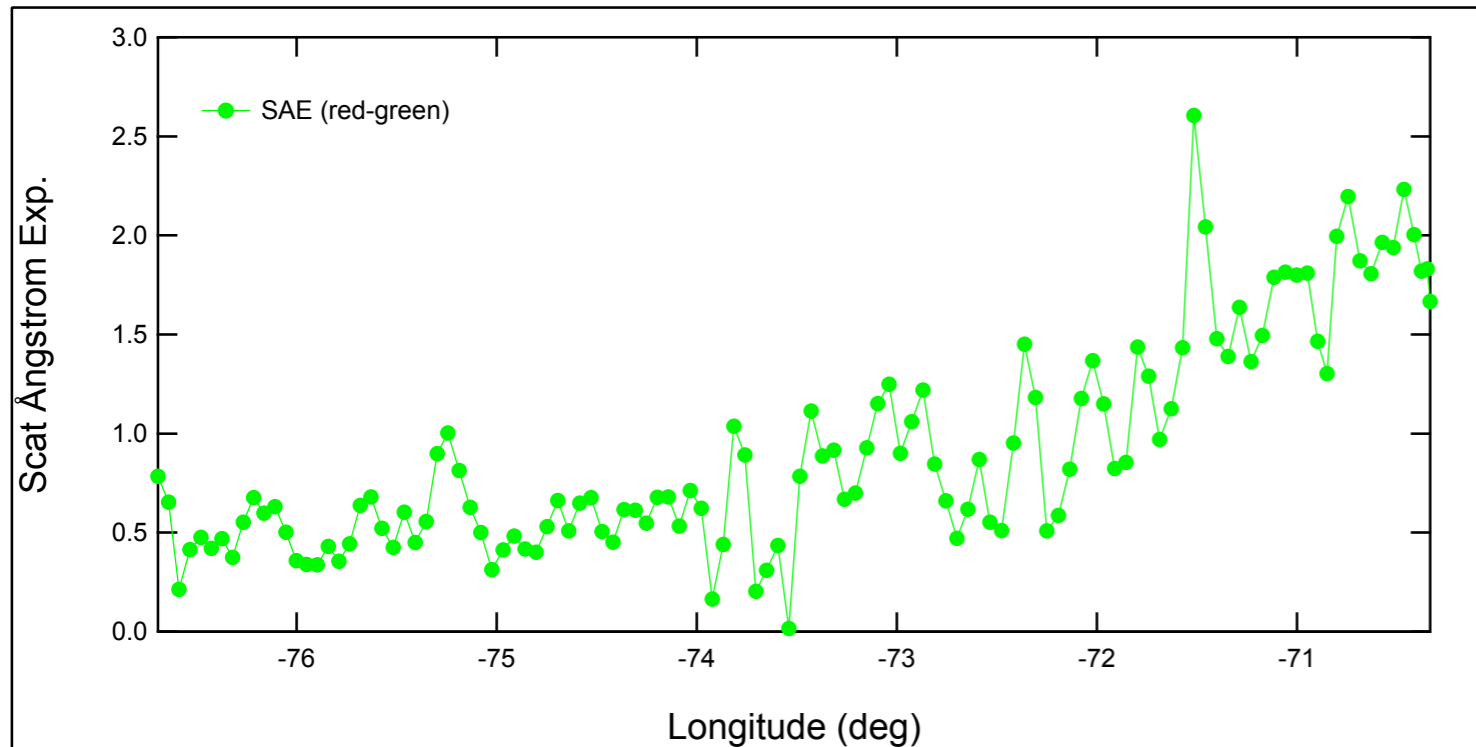


Flight 081101a: Inbound

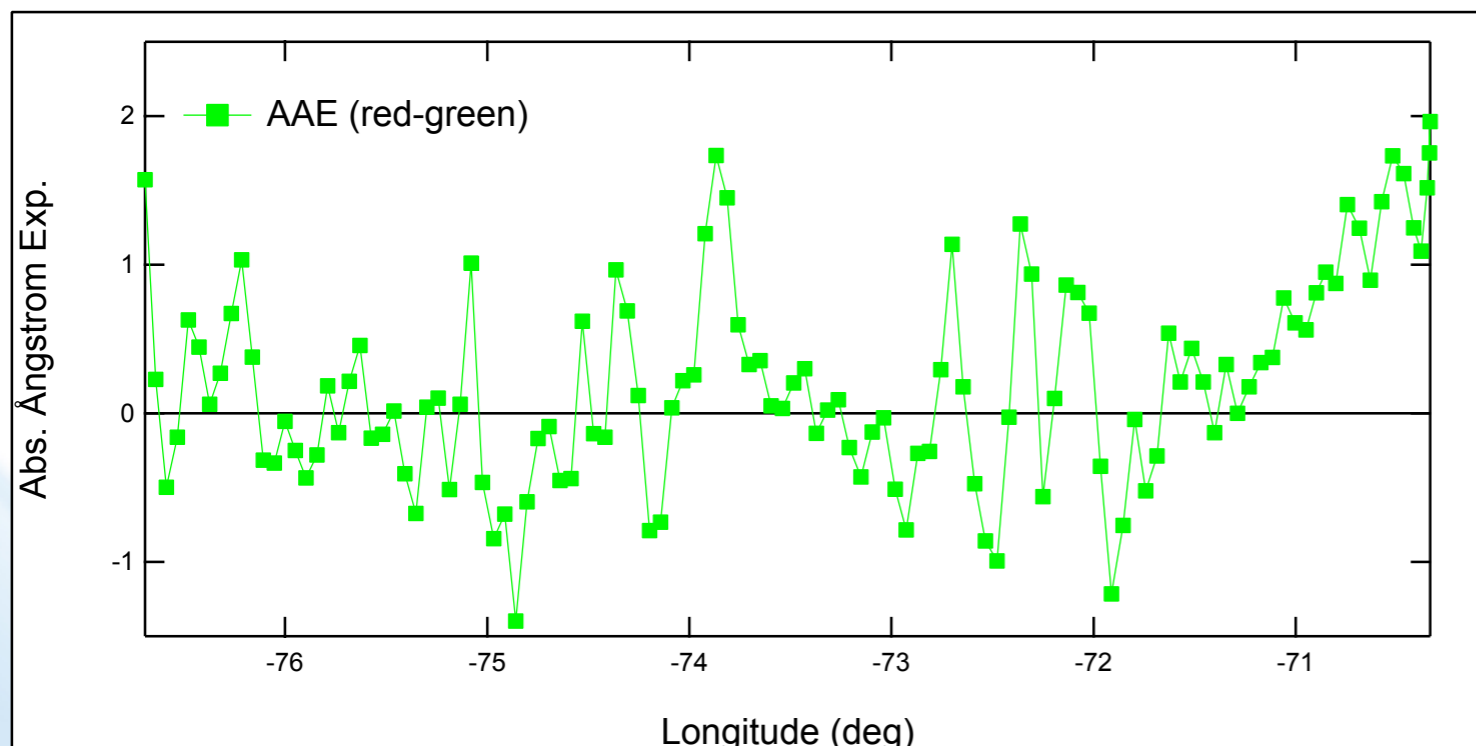


- Level flight: 120 m
- -77° (-18.5°) to -71° (-18.35°)
- B_{scat} : near shore influence
- B_{abs} : essentially no abs except near shore
- SSA: 0.98 ± 0.031 (-77° to -72°)
- Near shore SSA(λ) suggests urban pollution (Bergstrom et al. 2002; Collaud Coen, et al. 2004 & Meloni et al. 2006)

Flight 081101a: Inbound



- SAE (-76.5° to -73°): 0.57 ± 0.23
- SAE ≤ 1 suggests presence of large particles....sea salt
- Coastal influence last 110 kms



- Weak B_{abs} signal ($< 1 \text{ Mm}^{-1}$)
- AAE (-76.5° to -73°): 0.039 ± 0.56
- last ~ 110 kms, AAE incr. from ~ 0 to 1.7: suggests presence of OC aerosols; (e.g., Barnard et al., 2008; Kirchstetter, et al, 2004)

Near Shore SSA

Longitude range: -71.5° to -70.3°

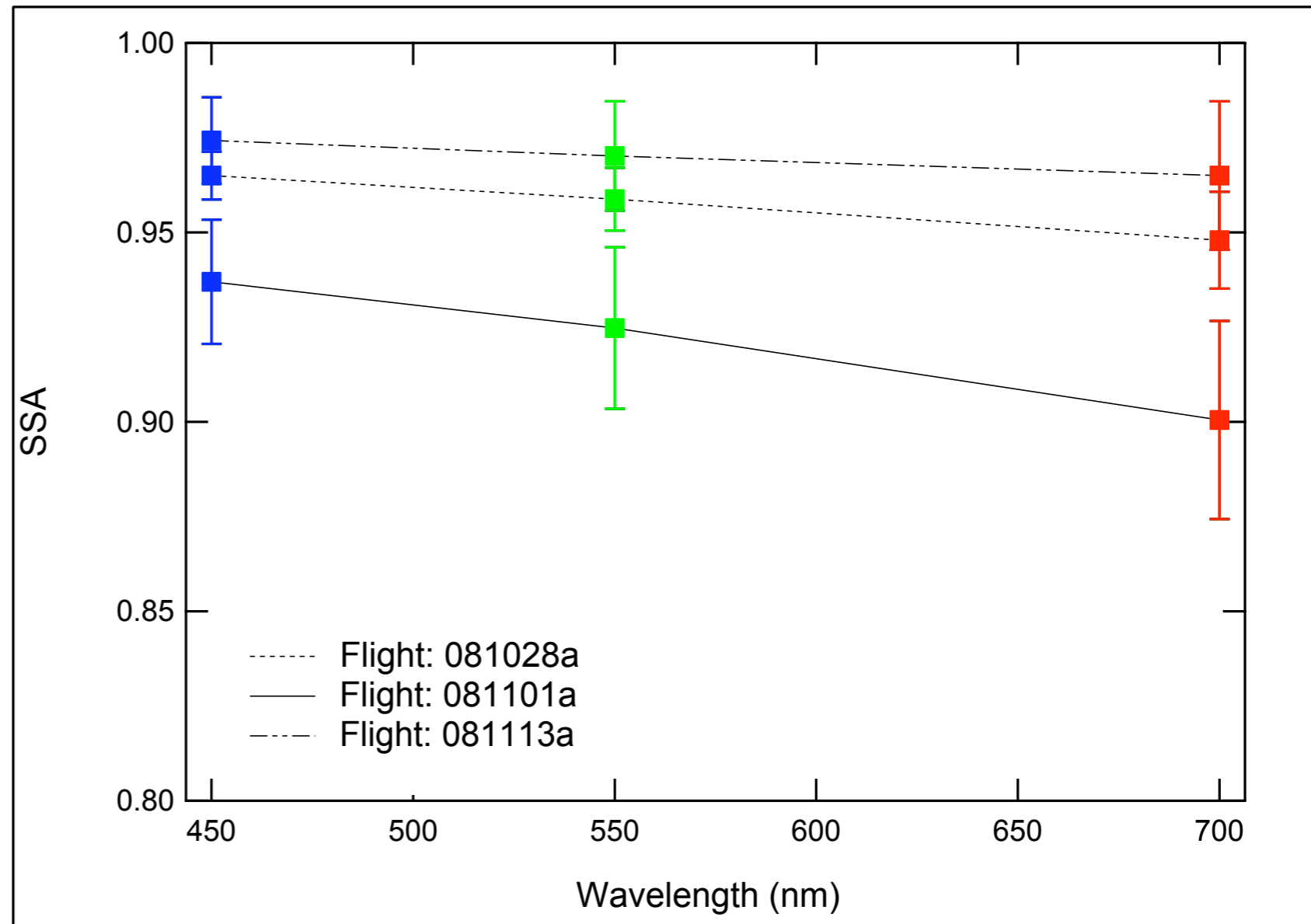
Nominal Alt: 120 m

SSA Angstrom Exp:

flight 081028a: 0.037 ± 0.027

flight 081101a: 0.098 ± 0.043

flight 081113a: 0.011 ± 0.025



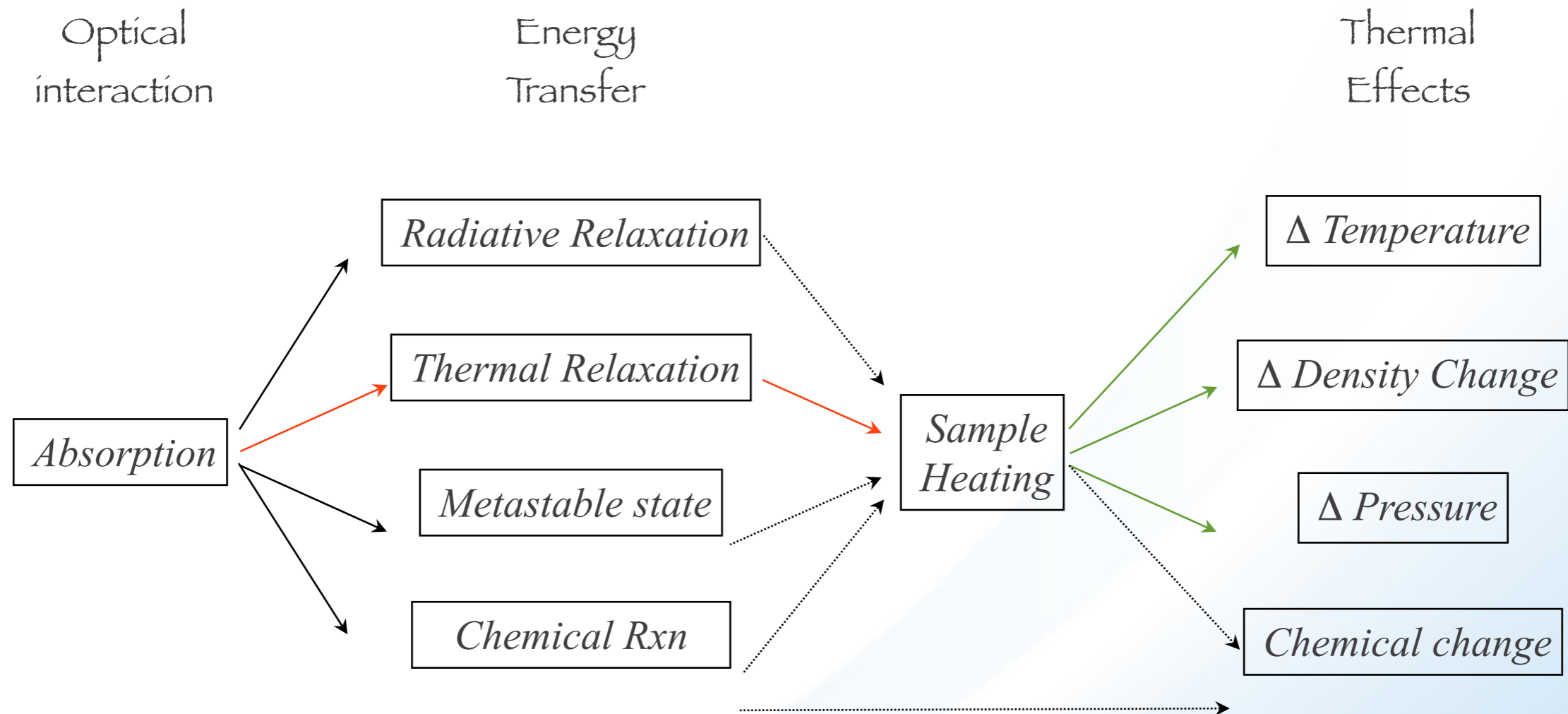
SSA(λ) suggests presence of urban pollution

Bergstrom et al. 2007 & 2002; Collaud Coen, et al. 2004; Meloni et al. 2006; Sololík & Toon, 1996

Photothermal Interferometry (PTI)

It is highly desirable to **directly** measure aerosol absorption & **without interference from aerosol scattering**

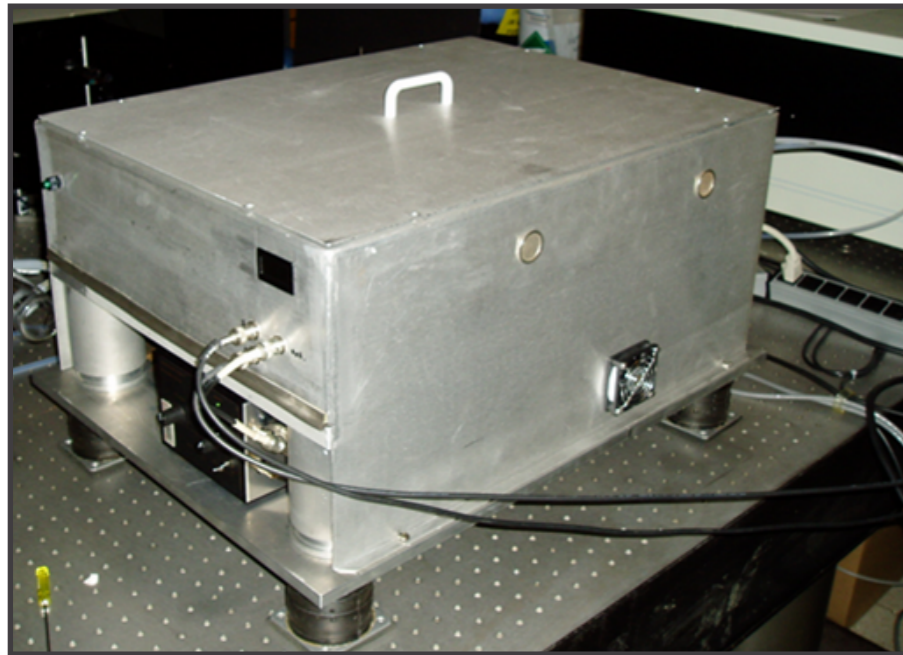
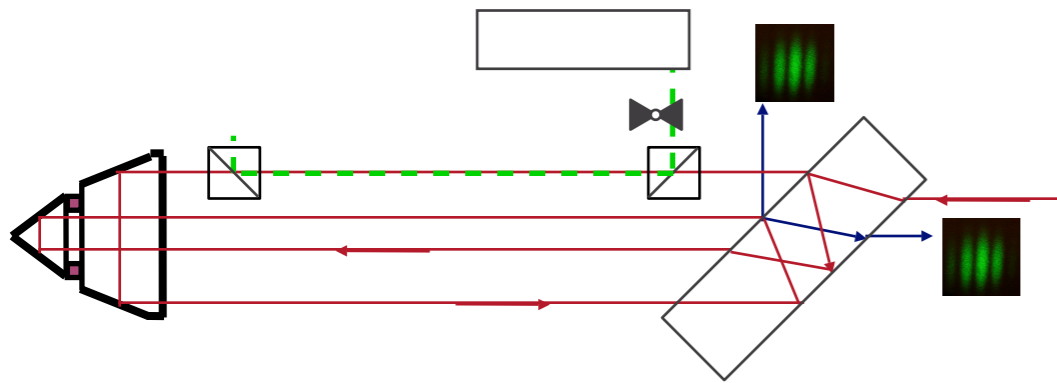
Photothermal Spectroscopy



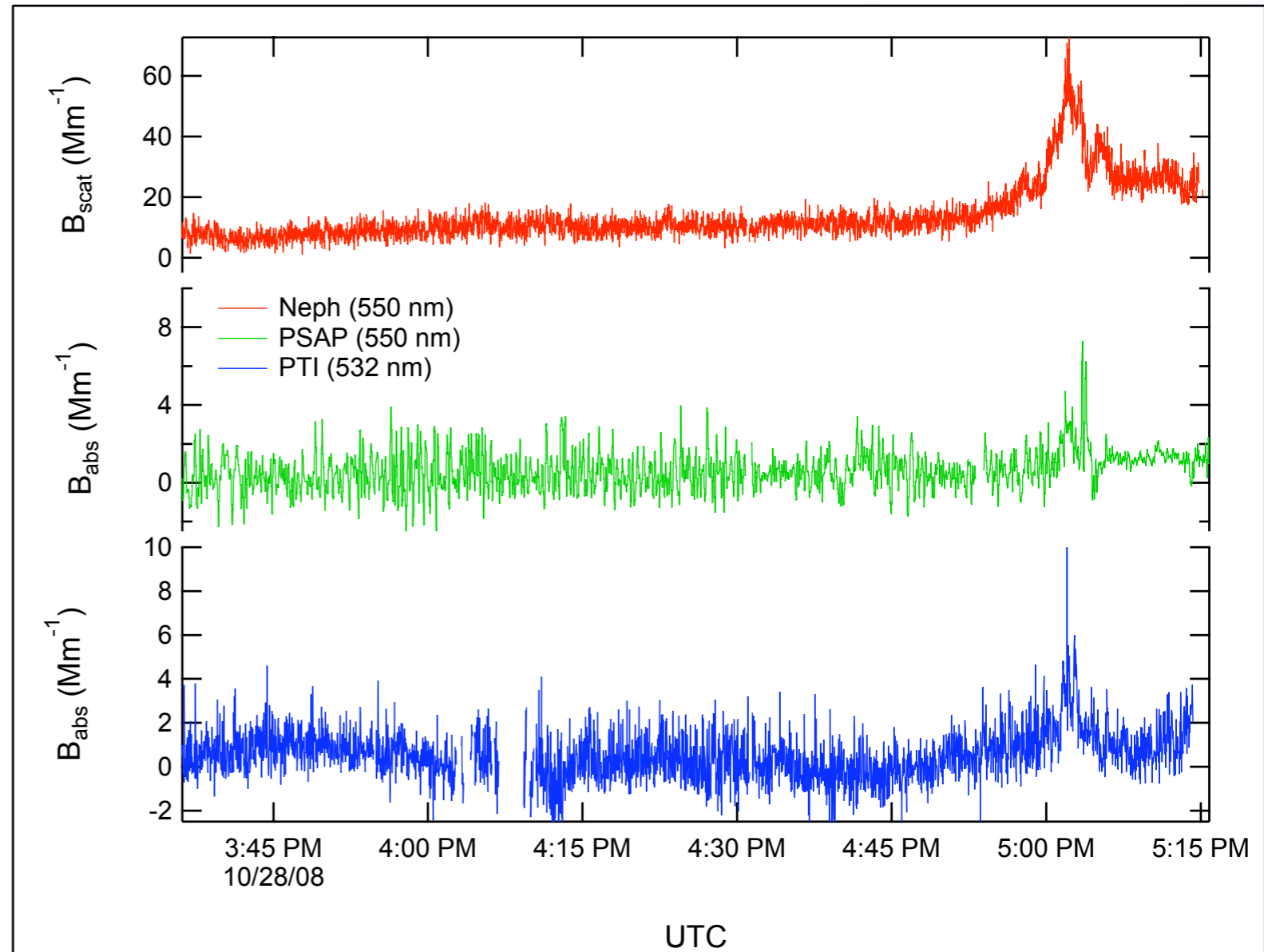
PTS relies on the thermal dissipation of spectrally absorbed energy for its signal

Maiden Deployment

Flight 081028a inbound leg



Sedlacek and Lee, 2007
Sedlacek, 2006



Summary of Observations.....so far



- B_{scat} in cloud observed to be very low ($\leq 2 \text{ Mm}^{-1}$)
- Coastal influence obs. within 100 km of shore.
- Scattering Angstrom Exponents (SAE) ~ 1 (and lower) observed. Indicative of large particles
- Exceptionally weak absorption has, so far, prevented meaningful extraction of AAE trends for cloud penetration.
- B_{abs} very small ($\leq 1 \text{ Mm}^{-1}$)
- Absorption Angstrom Exponents (AAE) $\ll 1$ over ocean: B_{abs} uncertainty or increasing imaginary part of the RI with wavelength.
- SSA wavelength dependence suggests presence of pollution near coast & no evidence of coastal dust (below cloud)
- Maiden deployment of PTI.

