National Aeronautics and Space Administration

SAGE III/ISS

Stratospheric Aerosol and Gas Experiment

An Earth Science Mission on the International Space Station

SAGE-III/ISS Science Team Meeting

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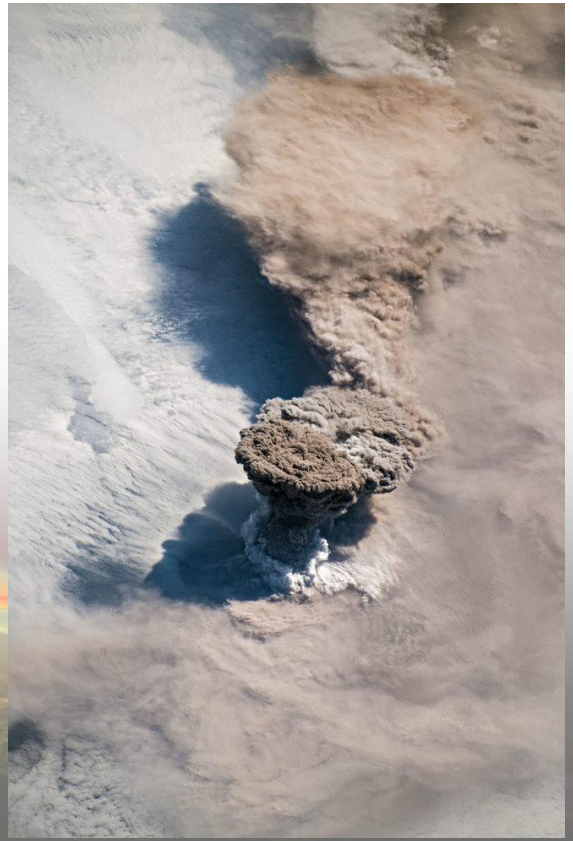
The 2019 Raikoke eruption: Can smoke and Sulfuric acid aerosol be separated?

Raikoke Eruption

- Located on Kuril Archipelago (48.3 N, 153.3 E)
  - Means “hellmouth” in Ainu language

- Erupted in June 2019
  - VEI-4
  - Ash reached 13 – 17 km
  - Has a history of mid-sized eruptions



2019 NH Wildfires

- Pyrocumulonimbus
  - Product of intense burning events
  - Comparable to moderate-sized volcanic events (Peterson et al. 2018)
  - Inject smoke and BVOCs into stratosphere
  - Smoke composed of black and brown carbon of variable composition
  - Capable of significantly impacting stratospheric chemistry and physics (Yu et al. 2019; Kablick et al. 2020)

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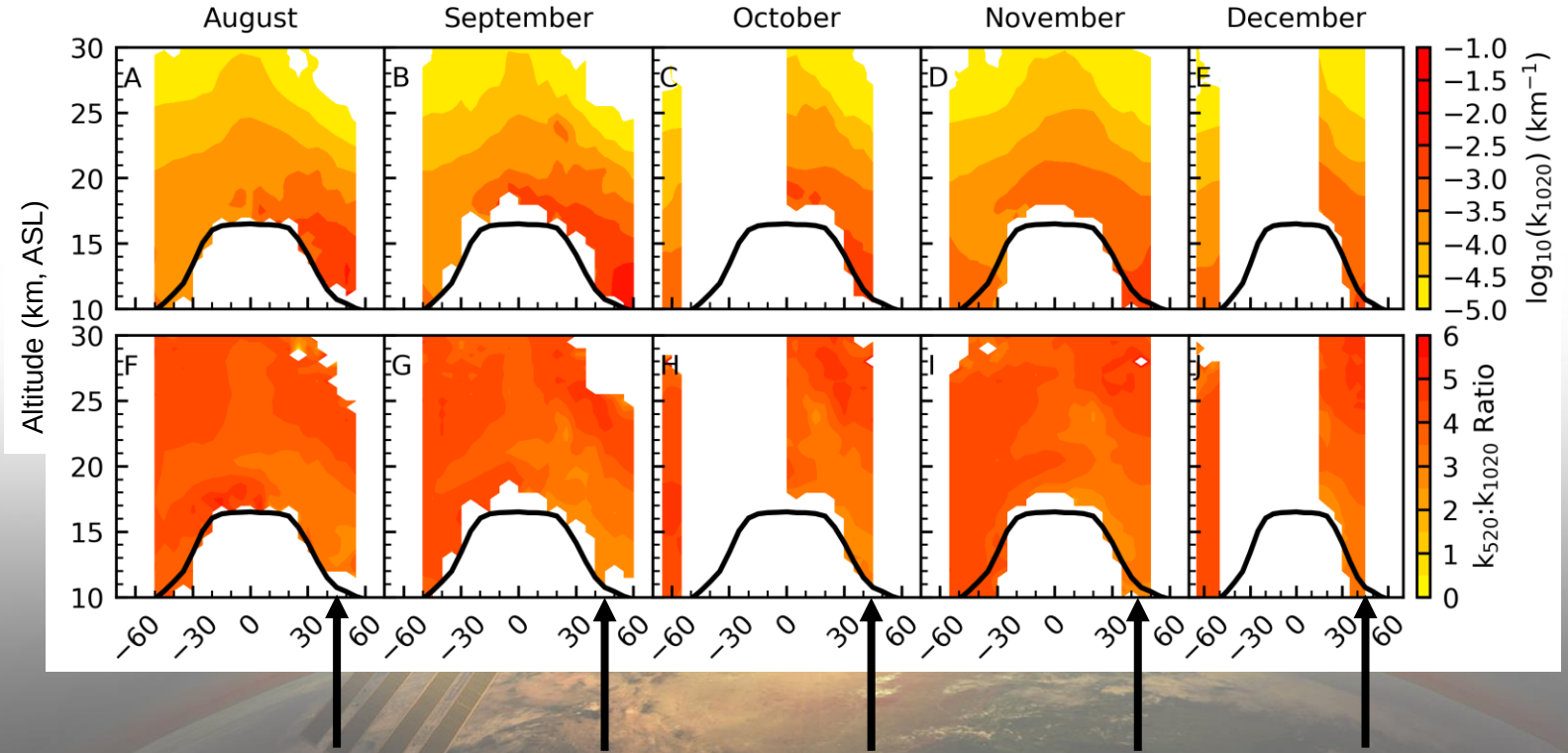
- 2019 northern hemisphere impacted by 2 major wildfires
  - Coincident with Raikoke eruption
  - Canada
  - Siberia

Questions

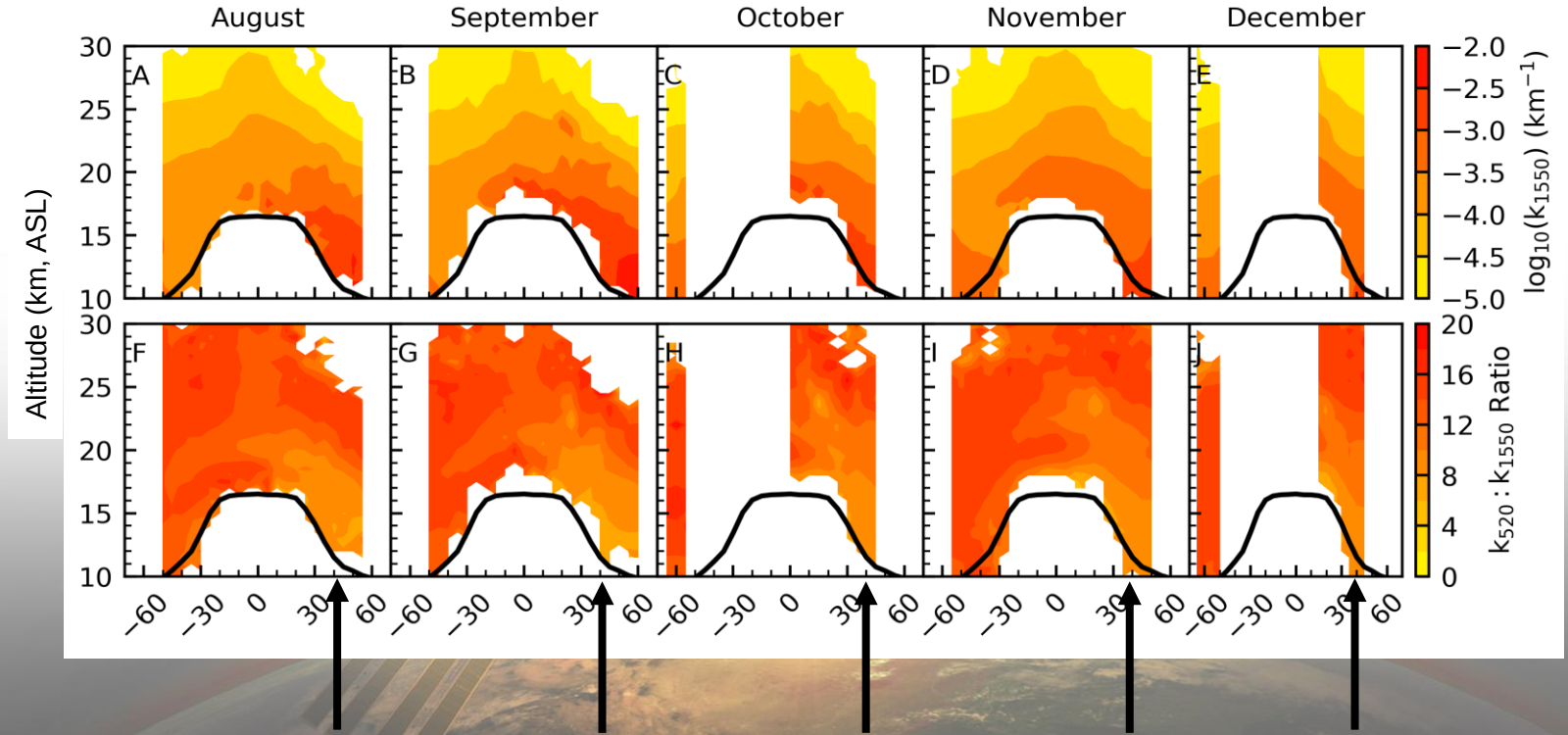
Did NH pyrocbs interact with Raikoke plume? (probably)
Can we see this interaction in the SAGE III/ISS data?

Observing Raikoke in SAGE 1020 nm Channel



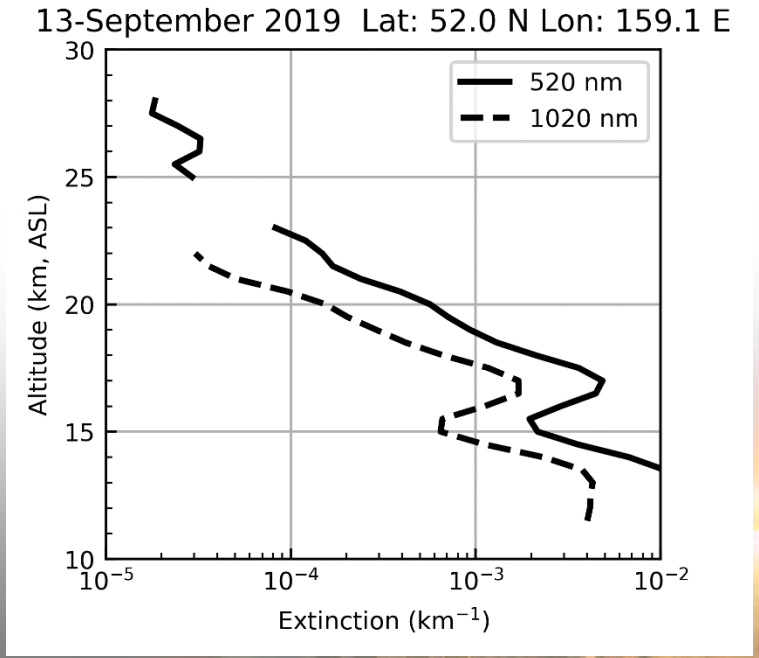
Arrows indicate Raikoke latitude

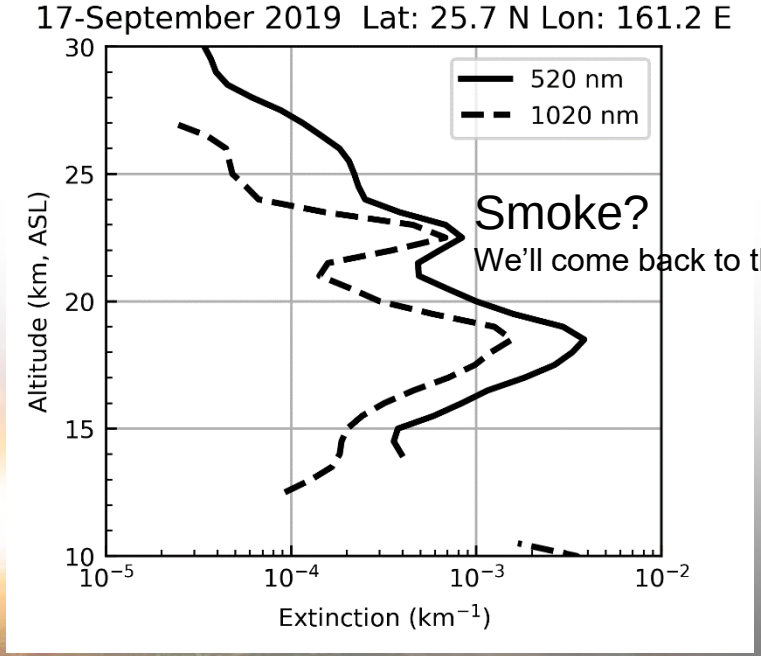
Observing Raikoke in SAGE 1550 nm Channel



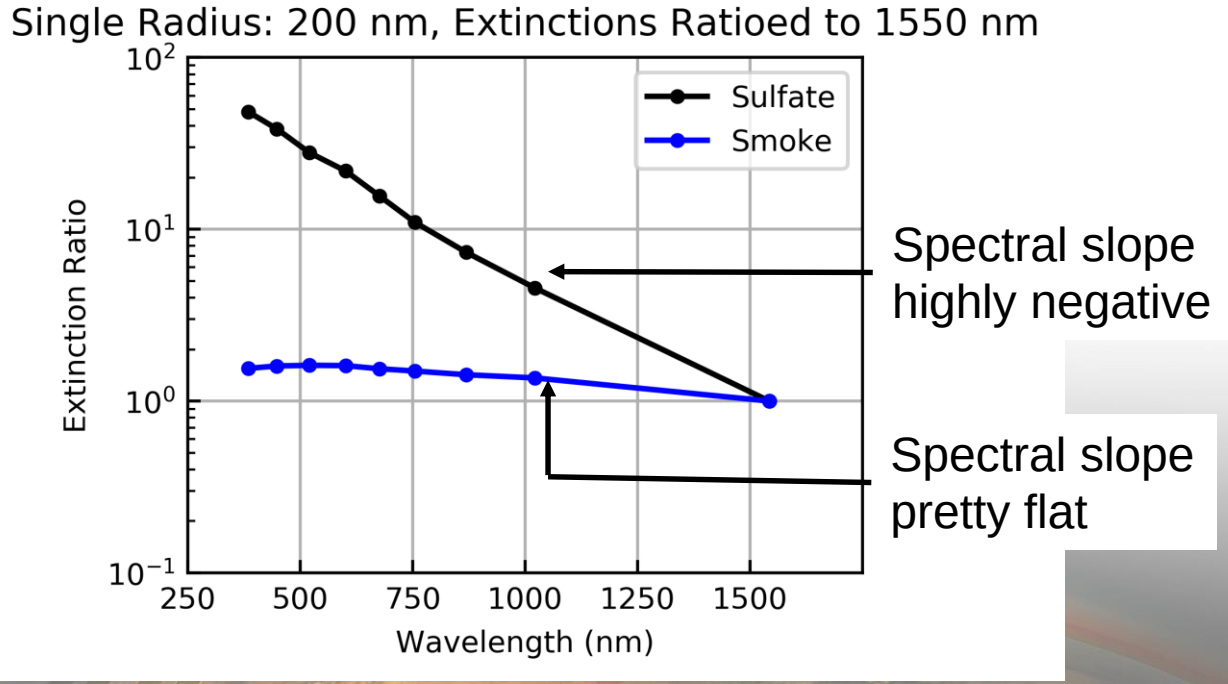
Arrows indicate Raikoke latitude

Example Profiles

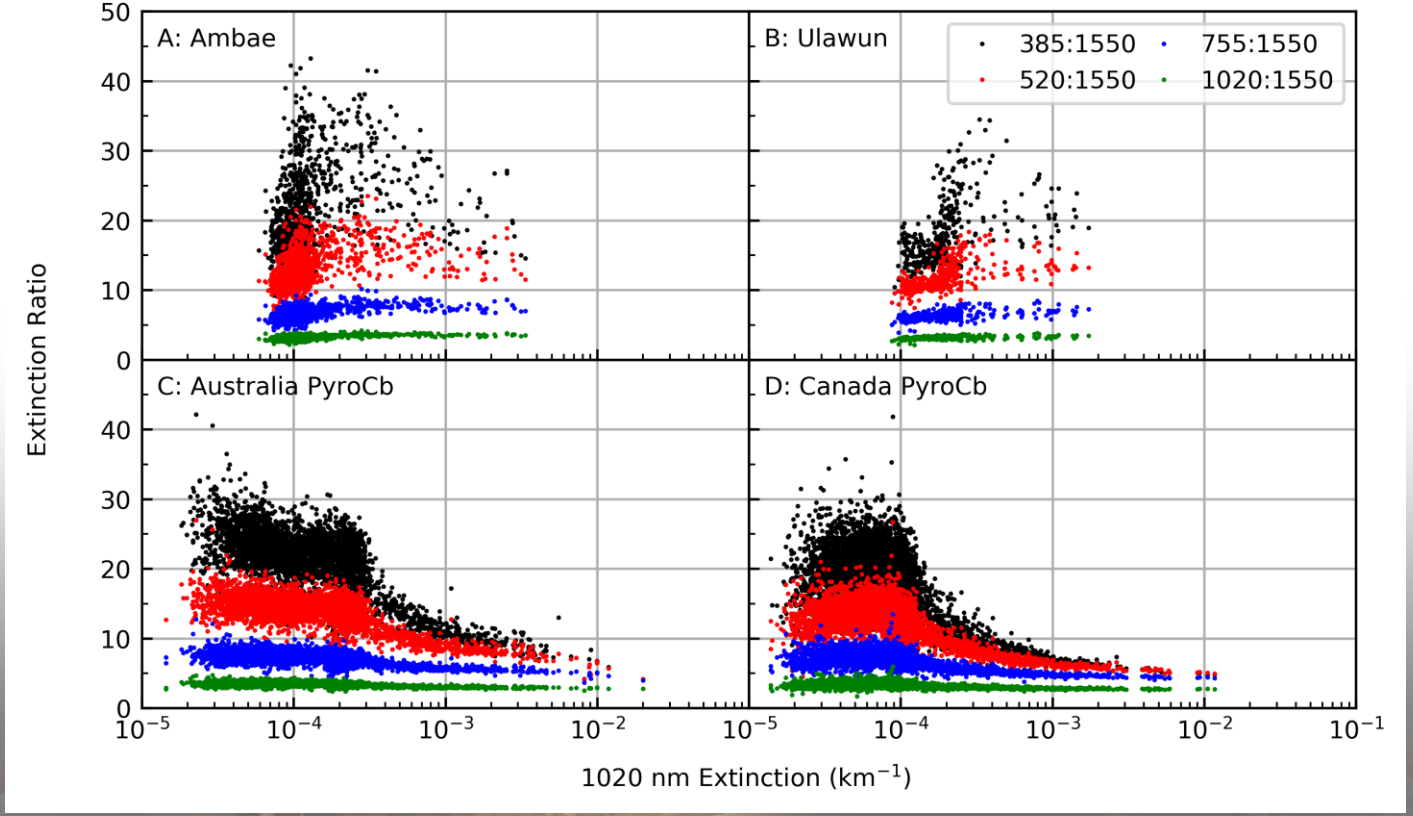




Spectral Characteristics



Breaking up SAGE data by event type



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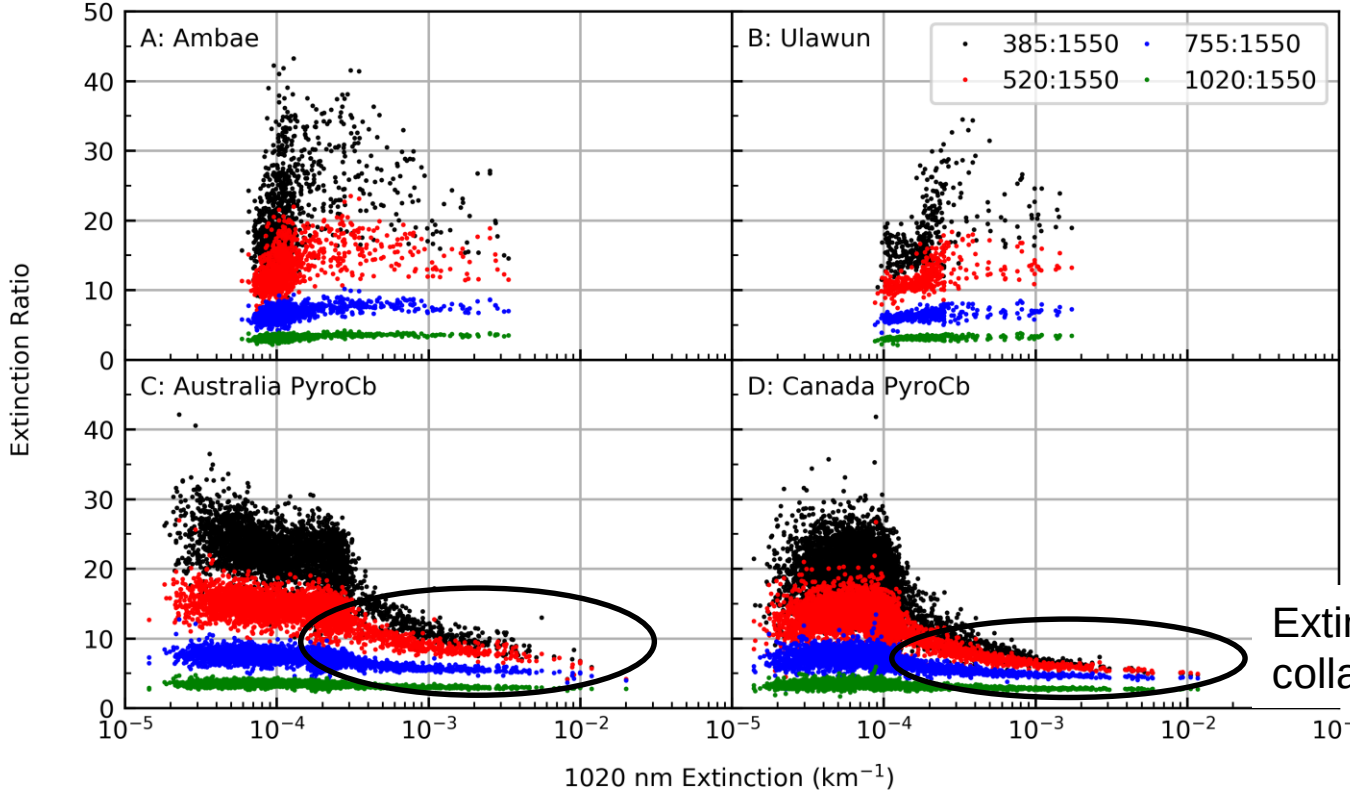


Extinction ratios collapse to <~5

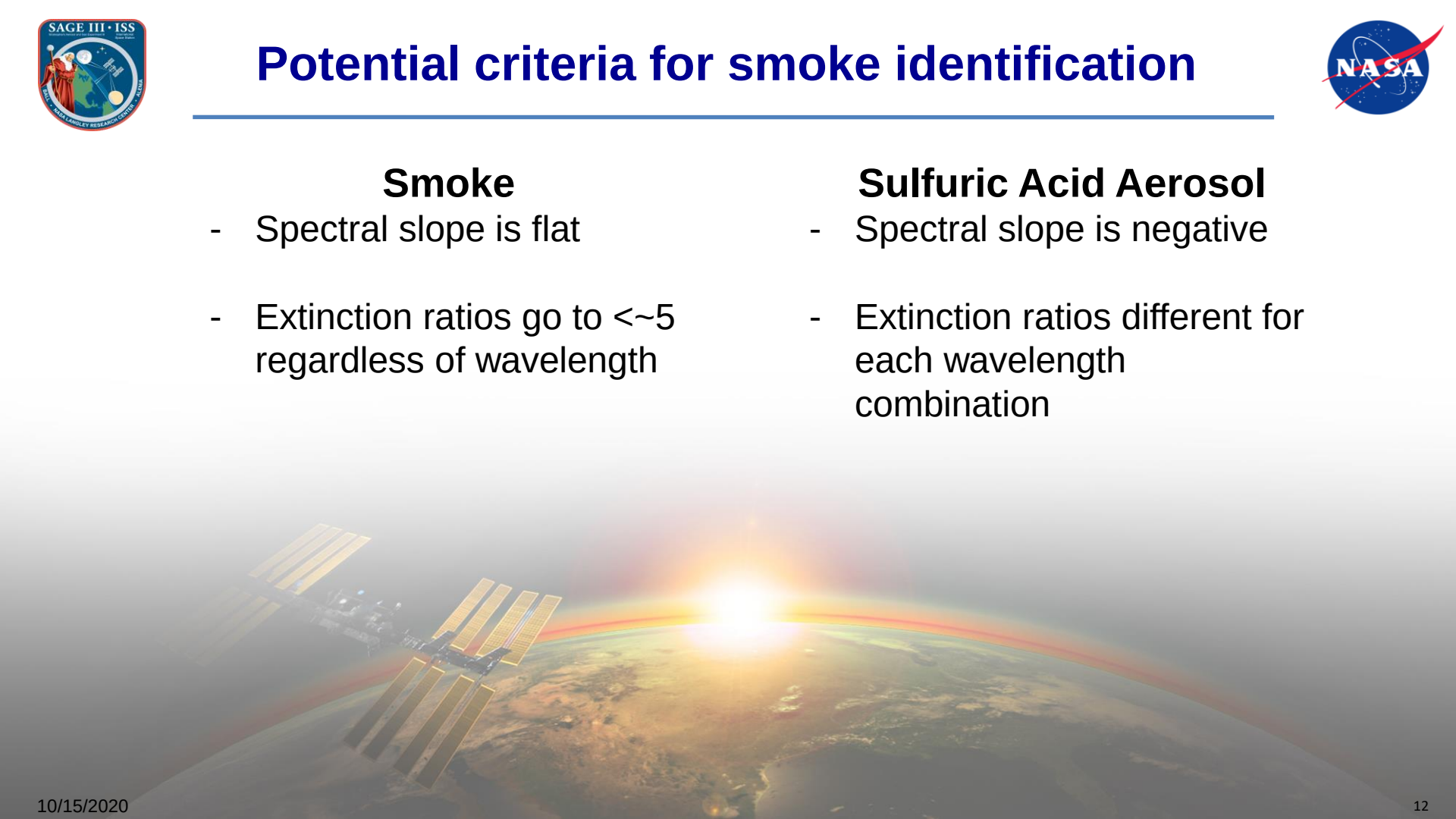
Potential criteria for smoke identification

Smoke

- Spectral slope is flat
- Extinction ratios go to <~5 regardless of wavelength

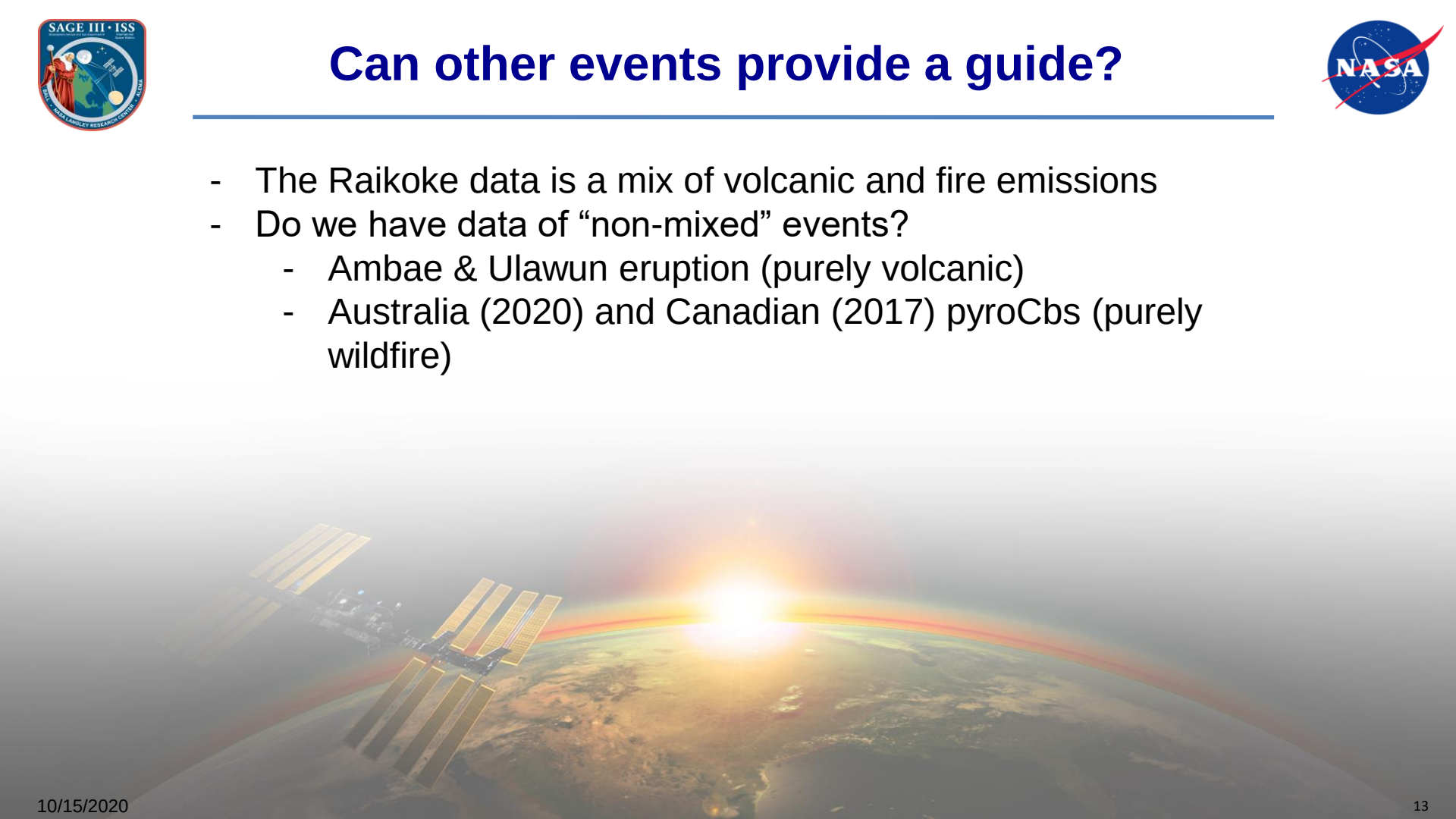
Sulfuric Acid Aerosol

- Spectral slope is negative
- Extinction ratios different for each wavelength combination

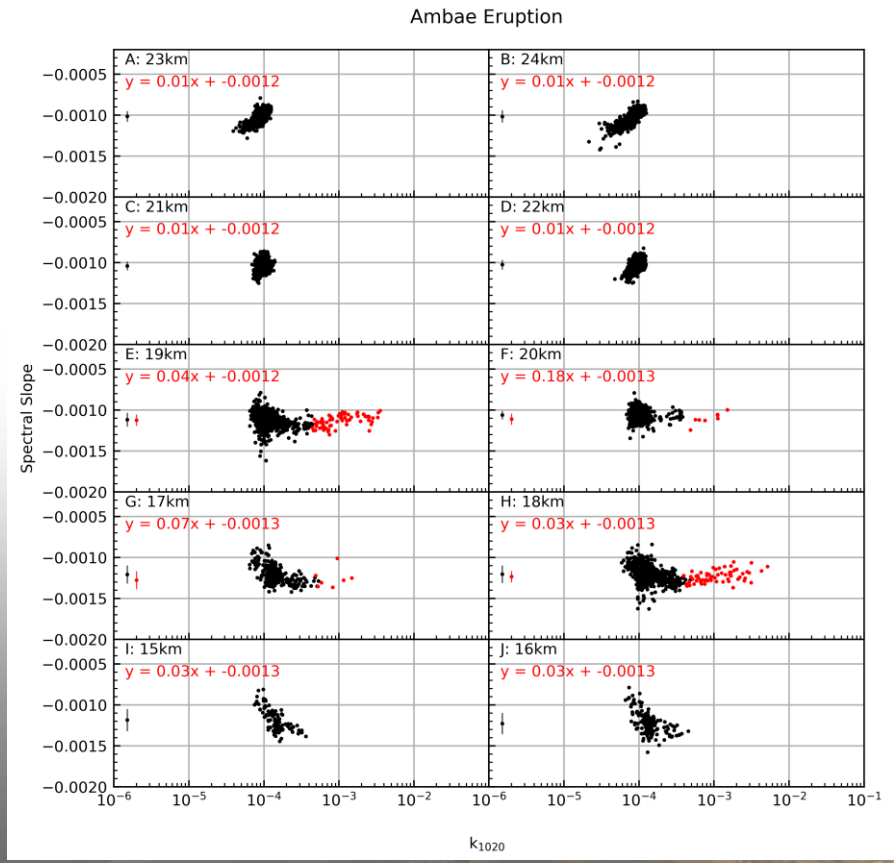


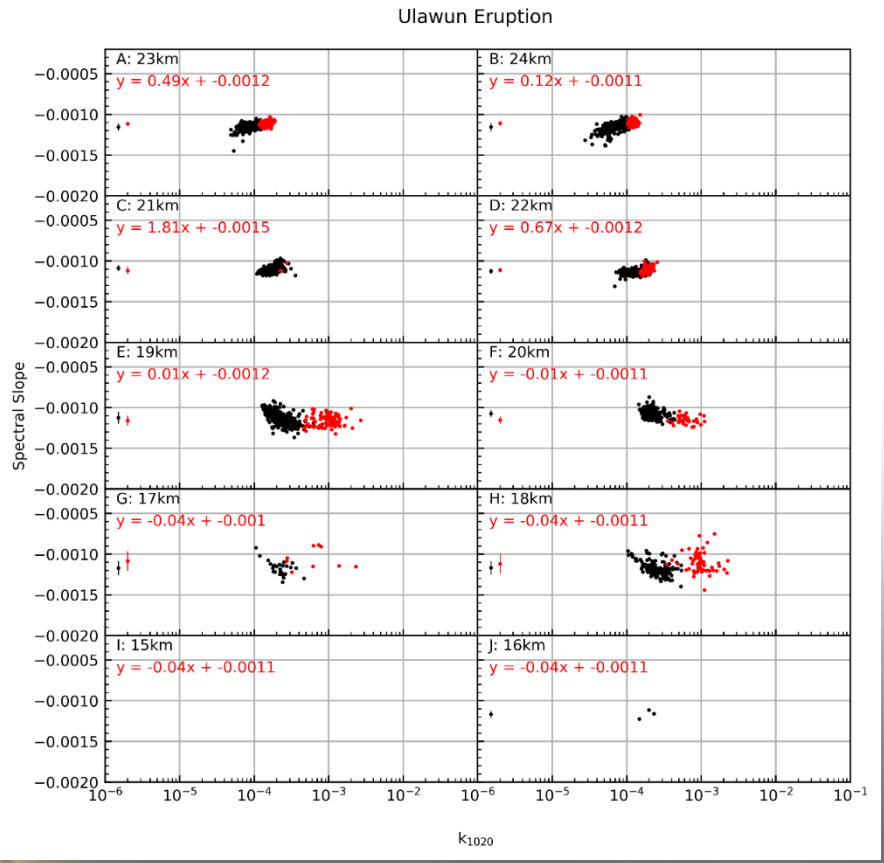
Can other events provide a guide?

- The Raikoke data is a mix of volcanic and fire emissions
- Do we have data of “non-mixed” events?
  - Ambae & Ulawun eruption (purely volcanic)
  - Australia (2020) and Canadian (2017) pyroCbs (purely wildfire)

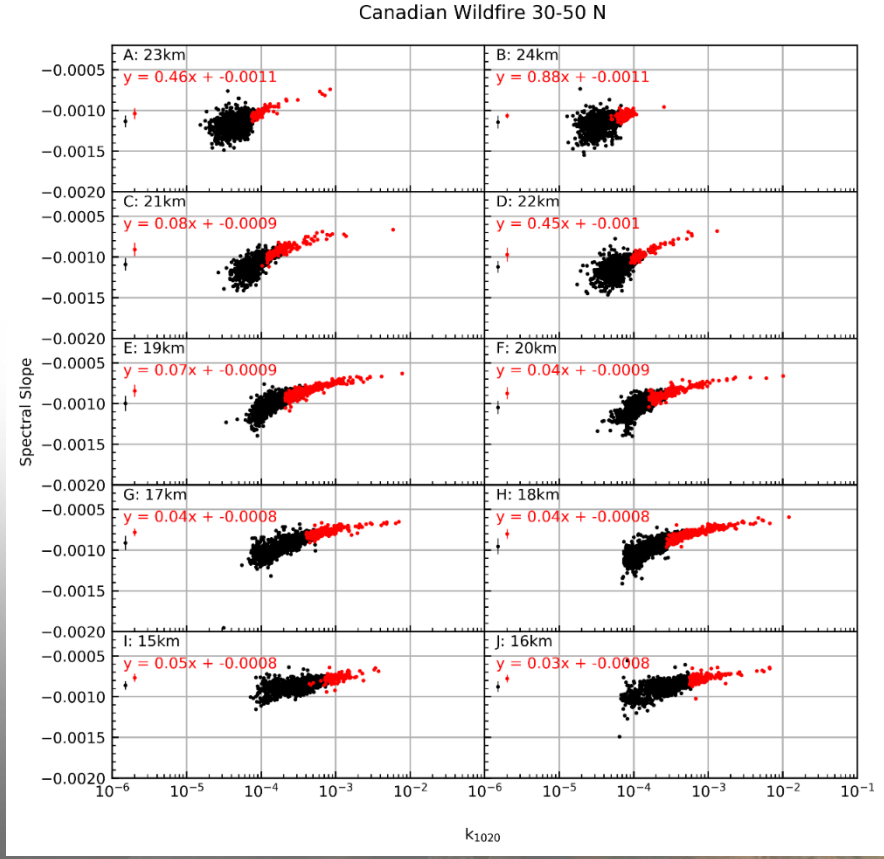


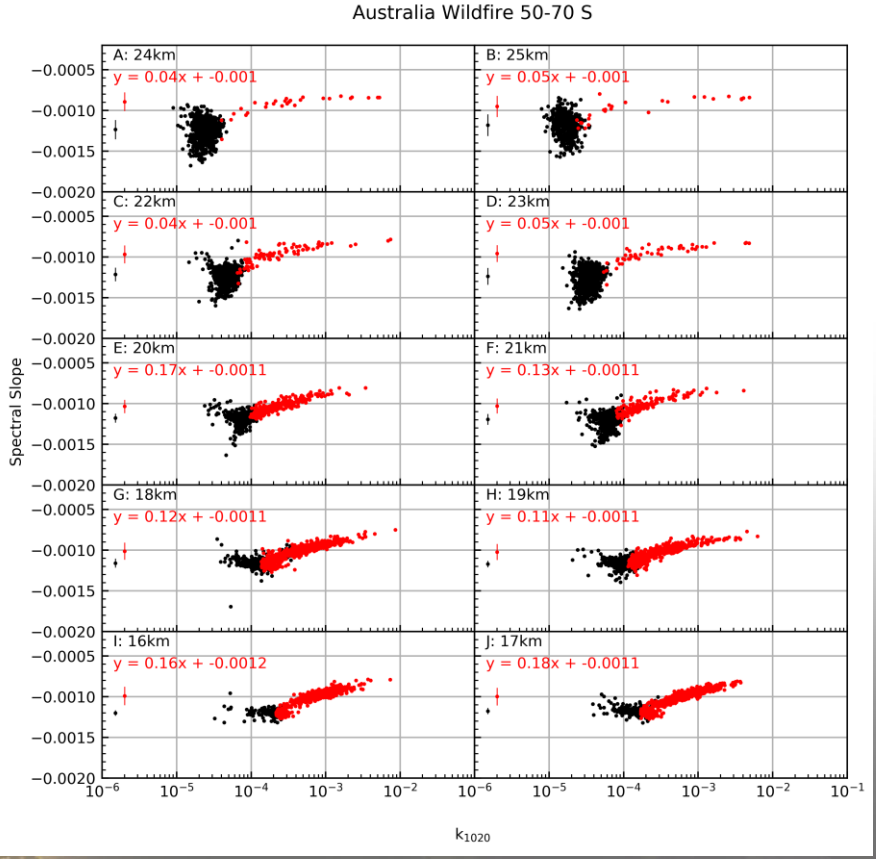
Volcanic Events



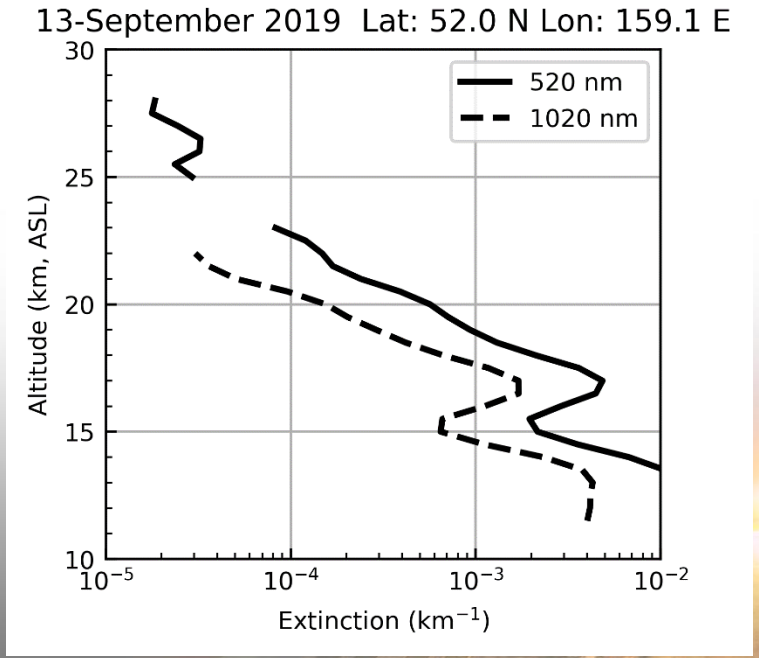


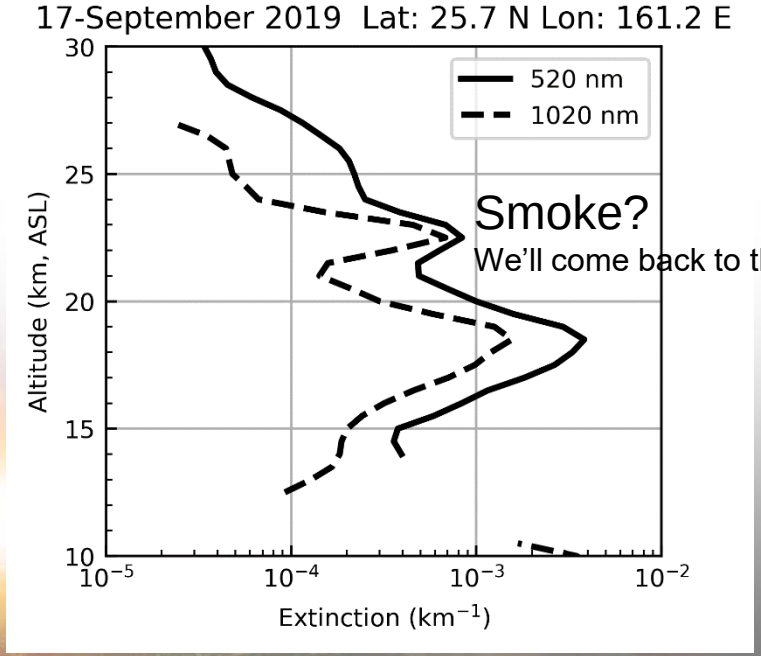
PyroCb Events





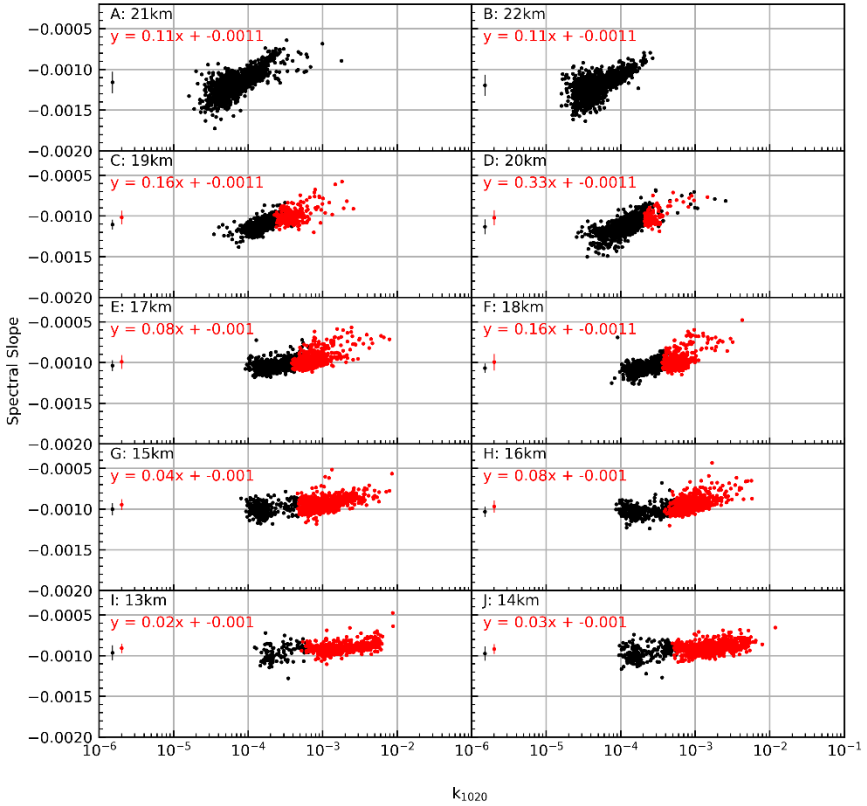
Example Profiles Revisited



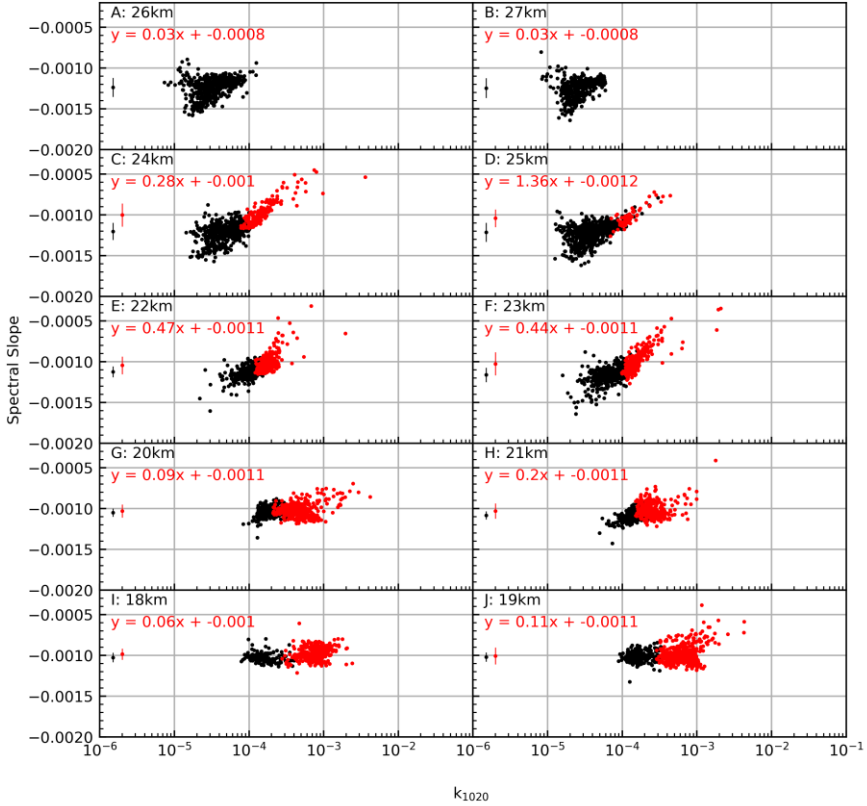


Raikoke Event

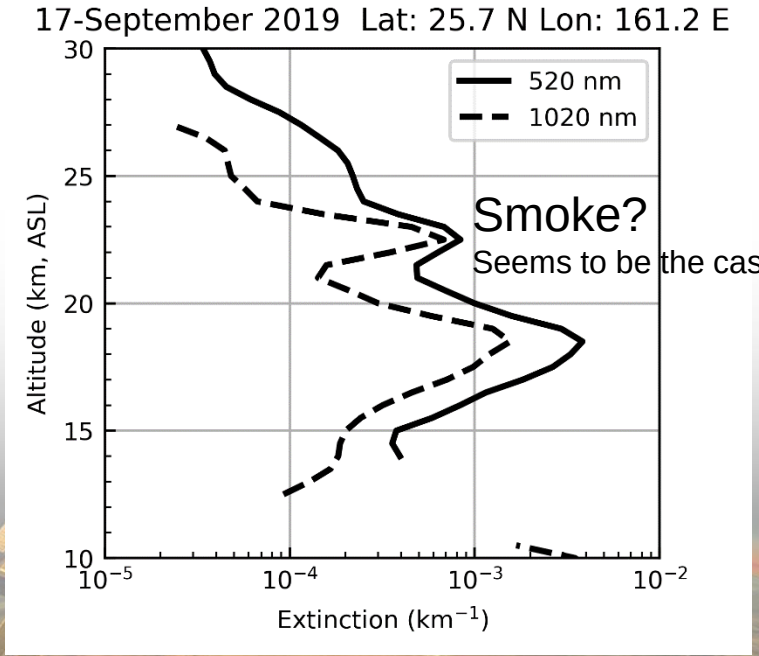
Raikoke 50 N



Raikoke 25 N



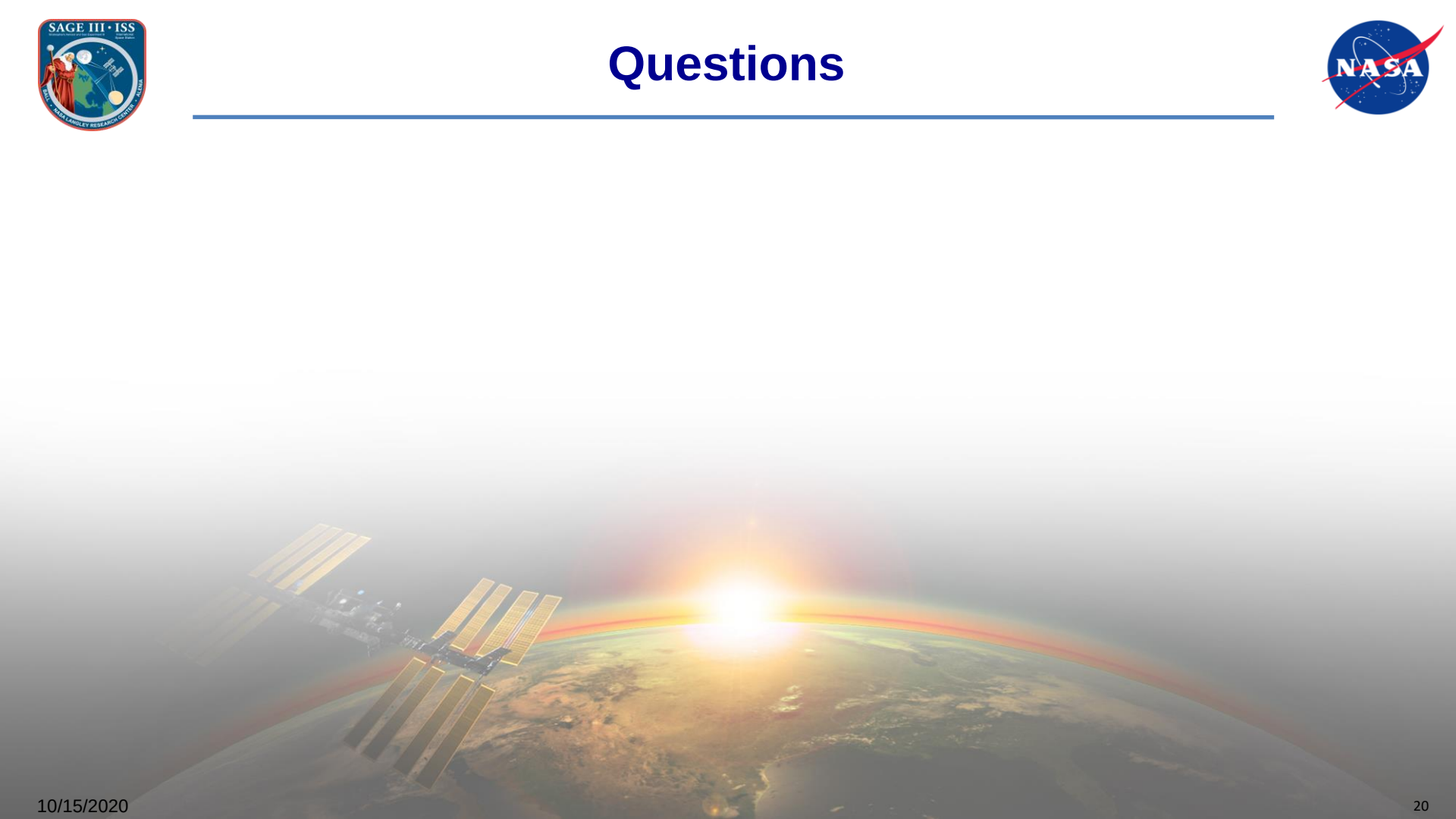
Example Profiles



Recap

- The stratosphere has been impacted by multiple pryoCb and volcanic events since the launch of SAGE III/ISS
- SAGE III/ISS has proven capable of detecting these events, even for months afterward
- Smoke and sulfuric acid aerosol have different spectral characteristics
  - These characteristics may be exploited to differentiate effects/evolution of event types
  - May be useful for identifying “not sulfate” aerosol clouds
    - Important for chemistry and PSC formation
- SAGE III/ISS data indicates the presence of smoke and sulfuric acid aerosol
  - Individual profiles may contain both aerosol types
  - Smoke tends to occupy the higher altitudes

Questions



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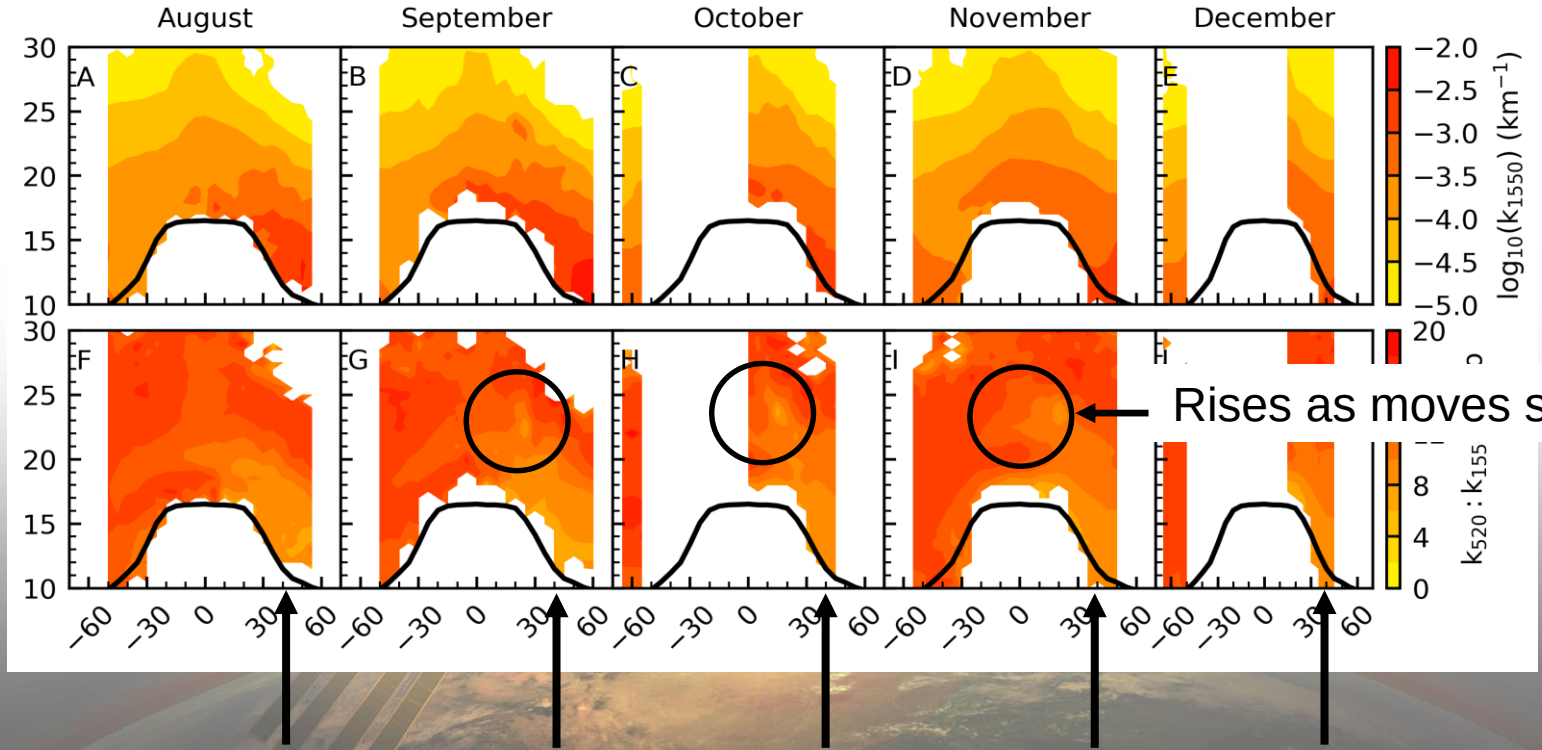

Example Profiles