PACE Plankton, Aerosol, Cloud, ocean Ecosystem **PARABOLA**

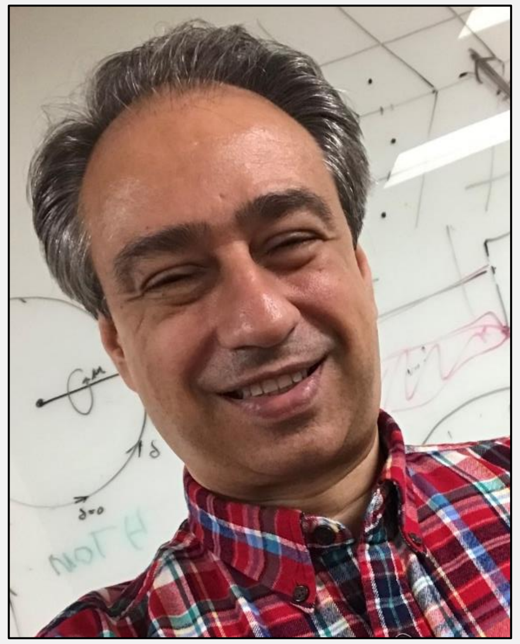
***P**ol**A**rimetric **R**etriev**A**ls of **B**iomass-burning aerosols **O**ver **LA**nd*

Advanced products:

PM 2.5 retrievals

PI:

Jacek Chowdhary



CU, NASA/GISS

(Focus: RT)

Co-Is:

Snorre Stamnes

NASA/LaRC

(Focus: PACE-MAPP)

Hans Moosmüller

DRI

(Focus: Smoke)

Matteo Ottaviani

NASA/GISS, Terra Research

(Focus: PM2.5)

Applications:

Aerosol Circulation

Co-I:

Keren Mezuman

CU, NASA/GISS

(Focus: Aerosol Circulation)

PACE Plankton, Aerosol, Cloud, ocean Ecosystem PARABOLA

PolArimetric RetrievAls of Biomass-burning aerosols Over LAnd

Advanced products:
PM2.5 retrievals

Collaborators:

- **Bastiaan van Diedenhoven** (SRON)
- **Johnathan Hair** (NASA/LaRC)
- **Alexei Lyapustin** (NASA/GSFC)
- **Vanderlei Martins** (UMBC)
- **Lorraine Remer** (UMBC)
- **Kenneth Sinclair** (NASA/GISS)
- **Gregory Schuster** (NASA/LaRC, retired)

Applications:
Biomass Burning Smoke, PM2.5 Health

Collaborators:

- **Susanne Bauer** (NASA/GISS)
- **Fred Harris** (UNR, EPSCoR)
- **Meagan DeLessio** (NASA/GISS)
- **Bret Schichtel** (NPS, IMPROVE)
- **Matthew Strickland** (UNR)
- **Kostas Tsigaridis** (NASA/GISS)
- **Adam Watts** (US DoA, FASMEE)

PACE-SAT 3:
Cross-collaboration?

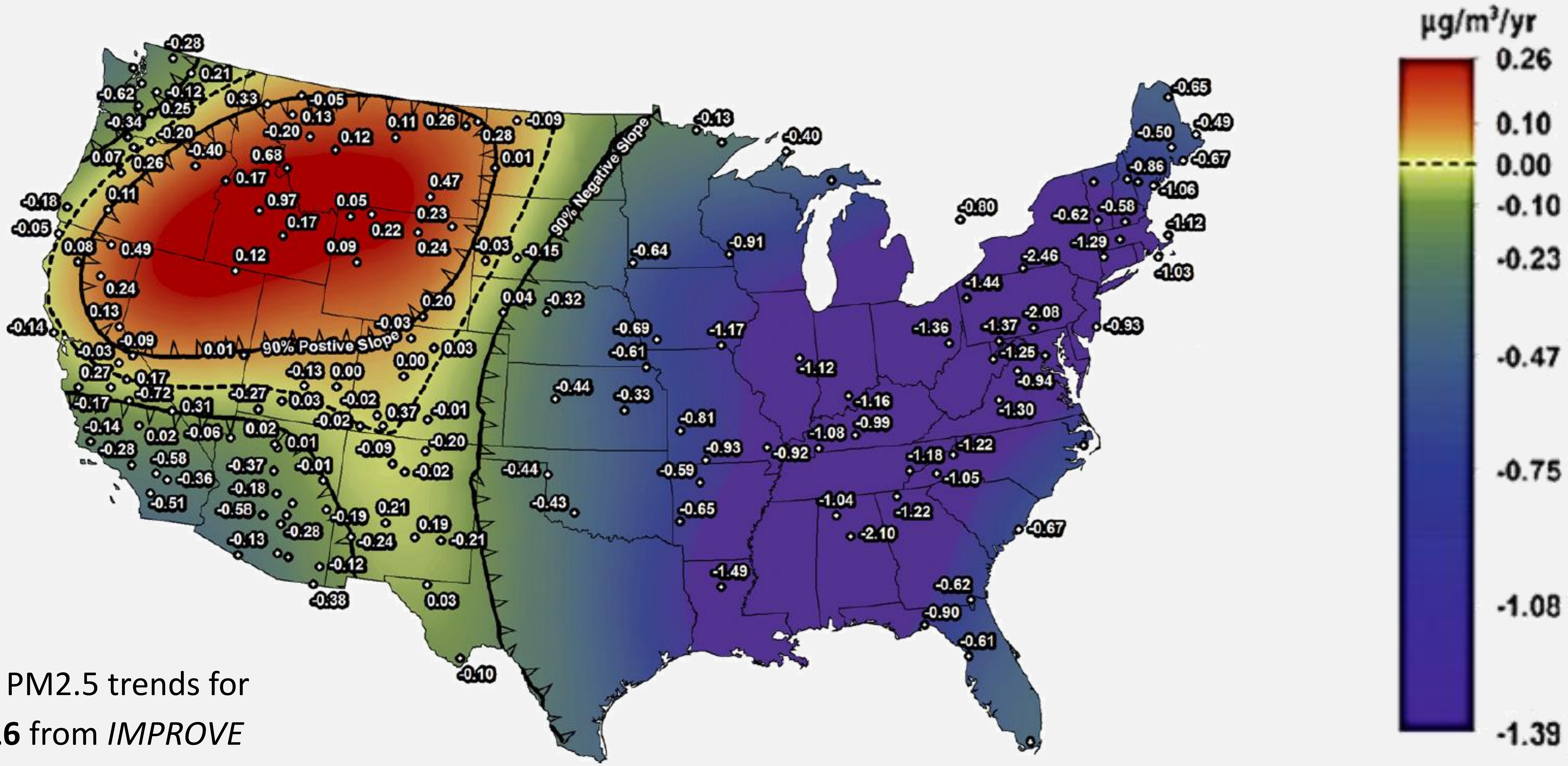
PI:

- **Fred Heummrich** (UMBC)
- **Dave Schimel** (NASA/JPL)

Motivation

Quantifying properties of fine particulate matter resulting from **biomass burning** in the atmosphere is crucial for assessing the impact of smoke on **PM2.5** properties and on aerosol circulation studies.

McClure and Jaffe (2018)



Observed PM2.5 trends for
1988–2016 from *IMPROVE*

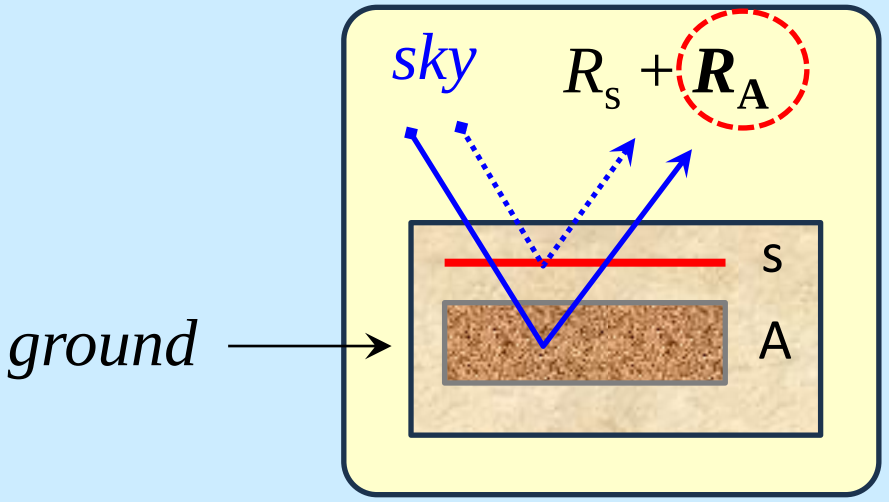
Motivation

Quantifying properties of fine particulate matter resulting from **biomass burning** in the atmosphere is crucial for assessing the impact of smoke on **PM2.5** properties and on aerosol circulation studies.

Spaceborne data offer the best means to retrieve them over **land that lack PM2.5 ground-based monitoring capabilities.**

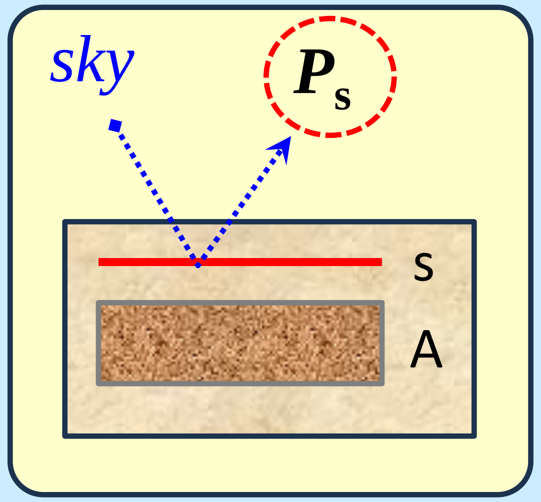
However, *radiometric remote sensing retrievals* are also very sensitive to spatial and spectral variations land surface albedo.

radiometry



Fortunately, *spaceborne polarimetric retrievals* are much less sensitive to spatial and spectral variations in land surface albedo

polarimetry



Motivation

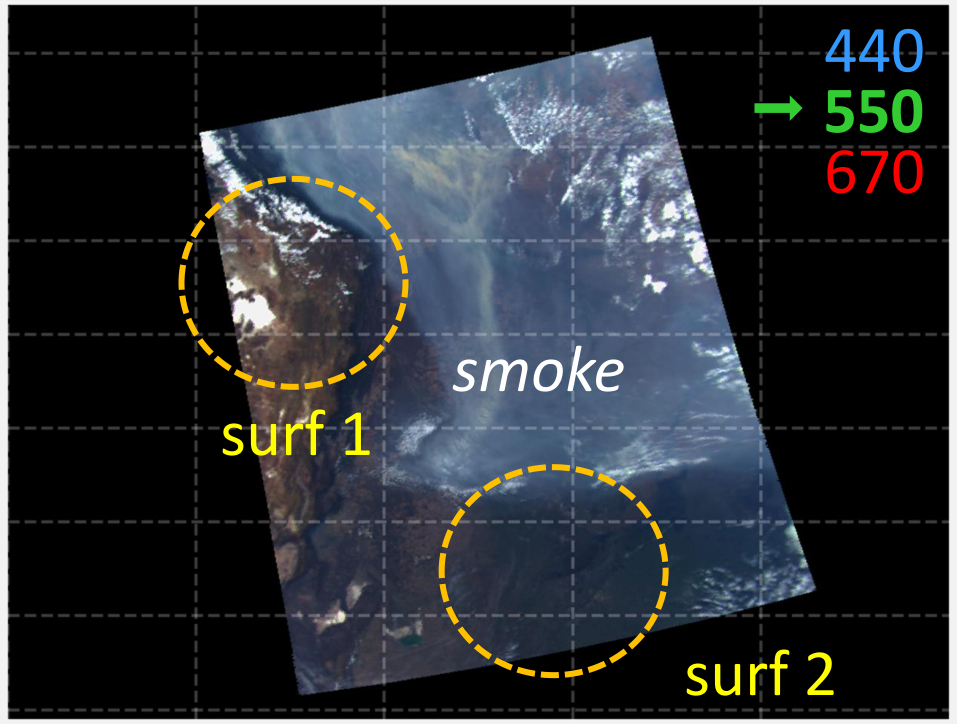
Quantifying properties of fine particulate matter resulting from **biomass burning** in the atmosphere is crucial for assessing the impact of smoke on **PM2.5** properties and on aerosol circulation studies.

HARP2 image (Amazon smoke: 9-18-2024)

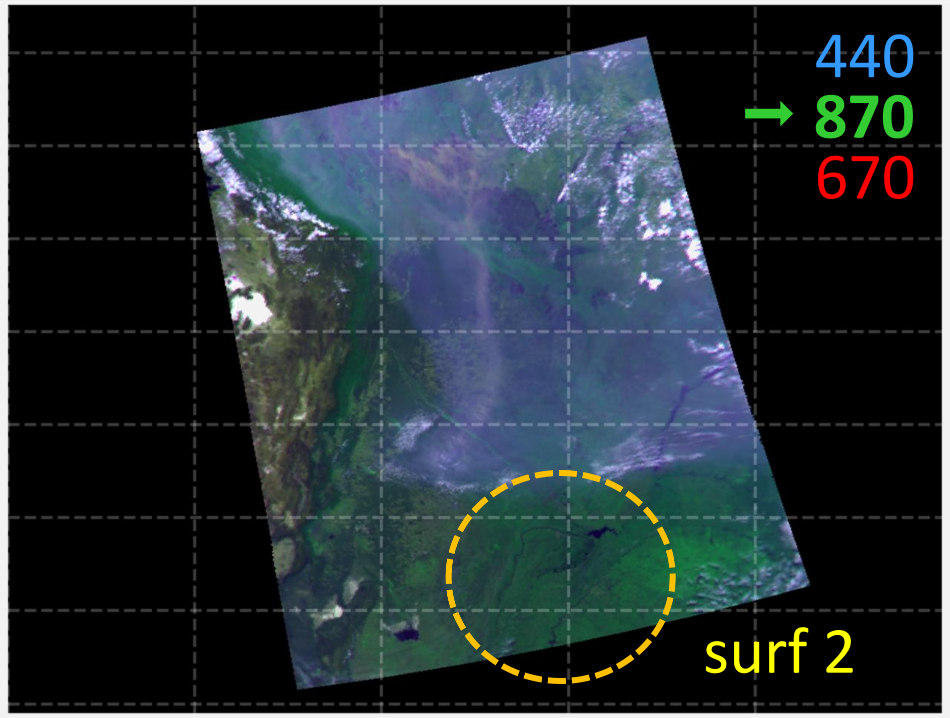
Total radiance

Land surface:

- Large spatial variation
- Large spectral variation



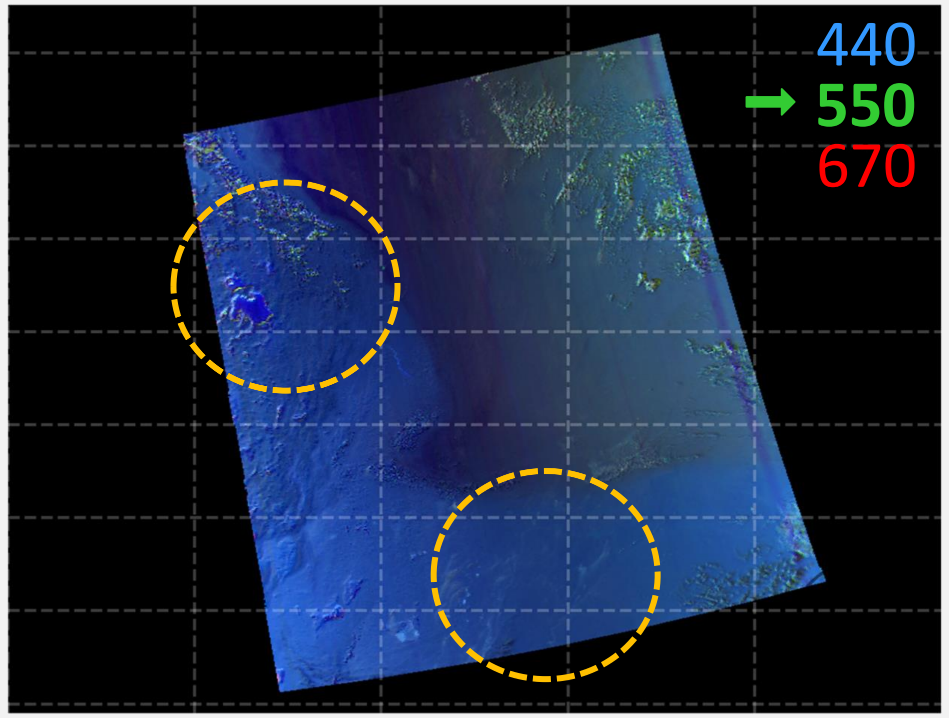
spectral



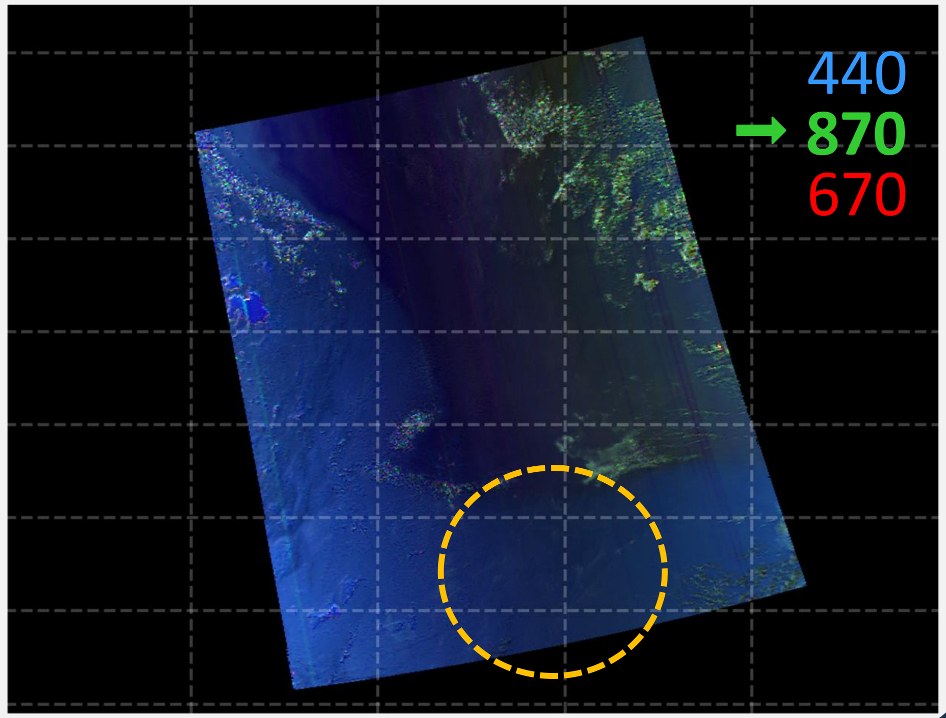
Polarized radiance

Land surface:

- Small spatial variation
- Small spectral variation



spectral



Objectives

1: ***Expand*** *current aerosol retrieval algorithm to include land surface regions*

We will include land surface reflectance models in our Microphysical Aerosol Properties from Polarimetry (MAPP) algorithm that was developed for PACE retrieval of aerosols over oceans.

2: ***Focus*** *on diluted wildfire smoke properties over the Western US region*

We will target diluted wildfire smoke plumes over the Western US because these plumes increasingly dominate PM2.5 air quality in the Western US.

3: ***Validate*** *smoke retrieval products using airborne and ground-based data sets*

We will use data from the PACE Postlaunch Airborne eXperiment (PACE-PAX) campaign, from ground-based stations, and from stakeholders to perform post-launch validation of our retrieval products.

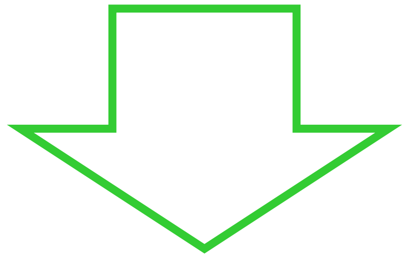
4: ***Deliver*** *MAPP-land code, Algorithm Theoretical Basis Document, smoke products, 2 papers*

We will work with the PACE Project Science Office to deliver the MAPP-land retrieval algorithm and associated Algorithm Theoretical Basis Document (ATBD) through the PACE Science Data Segment (SDS). We will provide our stakeholders with MAPP-land products.

Progress

Object. 1: ***Expand** current aerosol retrieval algorithm to include land surface regions*

We will include land surface reflectance models in our Microphysical Aerosol Properties from Polarimetry (MAPP) algorithm that was developed for PACE retrieval of aerosols over oceans.



BPDF R_p:
2 approaches

- Linear Parametric (**LP**) model: variables α, β, m

$$R_p(\vartheta, \vartheta_0, \Theta) = \frac{\alpha \times \exp(\pi - \Theta)/2 \times \exp(-\beta) \times F(m, \Theta)}{4(\cos\vartheta_0 + \cos\vartheta)}$$

- R_p (**LP**) has been integrated into PACE-MAPP algorithm

- Shadowed Isotropic Gaussian Facet (**SIF**) model: variables α, σ, m

$$R_p(\vartheta, \vartheta_0, \Theta) = \frac{\alpha \times \pi \times F(m, \Theta)}{4(\cos\vartheta_0 + \cos\vartheta)} \times S(\vartheta, \vartheta_0, \Theta) \times P(\vartheta, \vartheta_0, \Theta, \sigma)$$

- R_p (**SIF**) has been integrated into PACE-MAPP algorithm

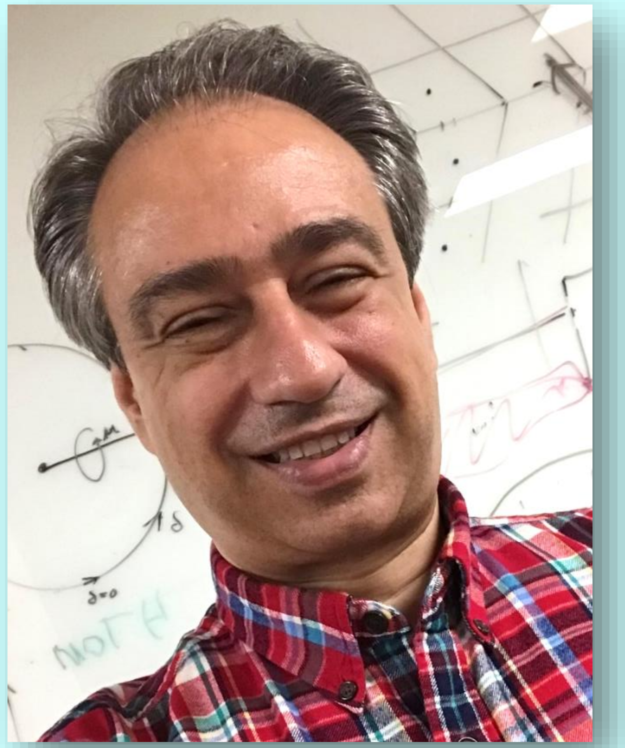
BPDF R_I:
1 approach

- Ross-Thick-Li-Sparse (**RTLS**) kernels: weights k_1, k_2, k_3

$$R_I(\vartheta, \vartheta_0, \Theta) = k_1 + k_2 \times f_2(\vartheta, \vartheta_0, \Theta) + k_3 \times f_3(\vartheta, \vartheta_0, \Theta)$$

- Weights k_1, k_2, k_3 to be taken from MAIAC

- R_I (**RTLS**) to be integrated into PACE-MAPP algorithm



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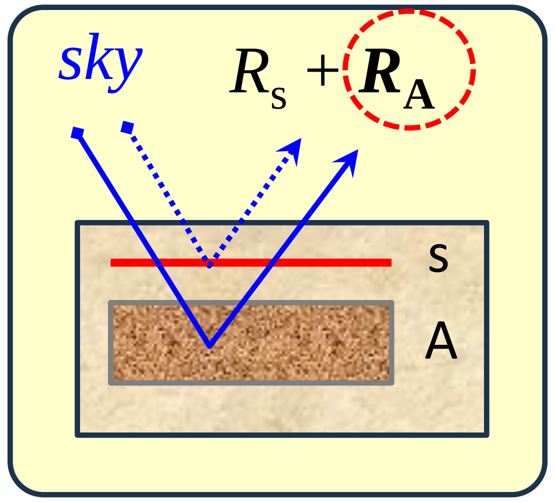
Backup slides: RSP results

Airborne RSP measurements of surface polarization

radiometry



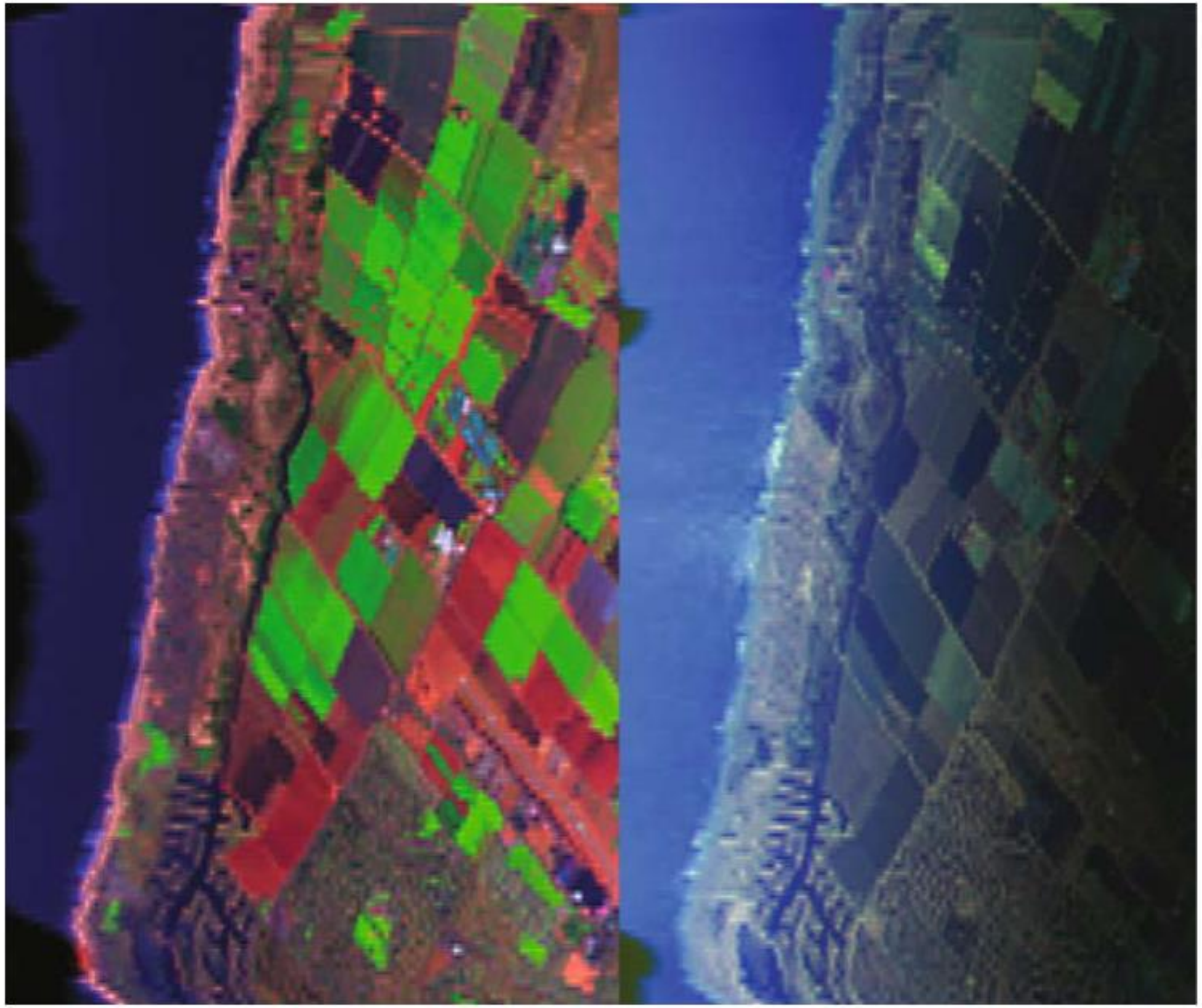
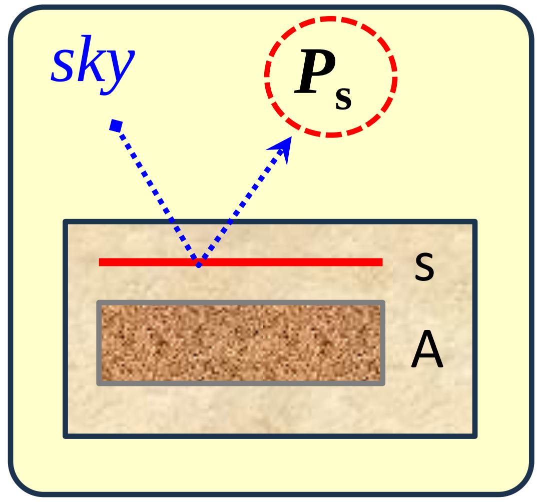


Fig. 10.1. False-color images created using RSP observations obtained on an aircraft flying at 3000 m above Oxnard and Ventura, California, USA. The red, green and blue colors are the 2250, 865 and 410 nm reflectances (left) and polarized reflectances (right) respectively.

polarimetry



Airborne RSP measurements of surface polarization *(atmospheric corrected)*