

# Update on the PACS Polarimeter Data Processing and Algorithm Development

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1- UMBC

2- NASA GSFC

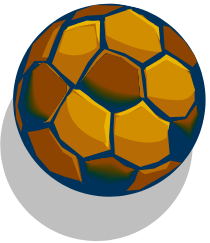
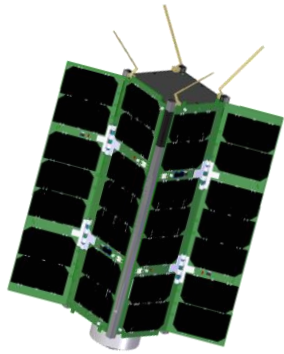
3- SSAI

4- Univ. Lille

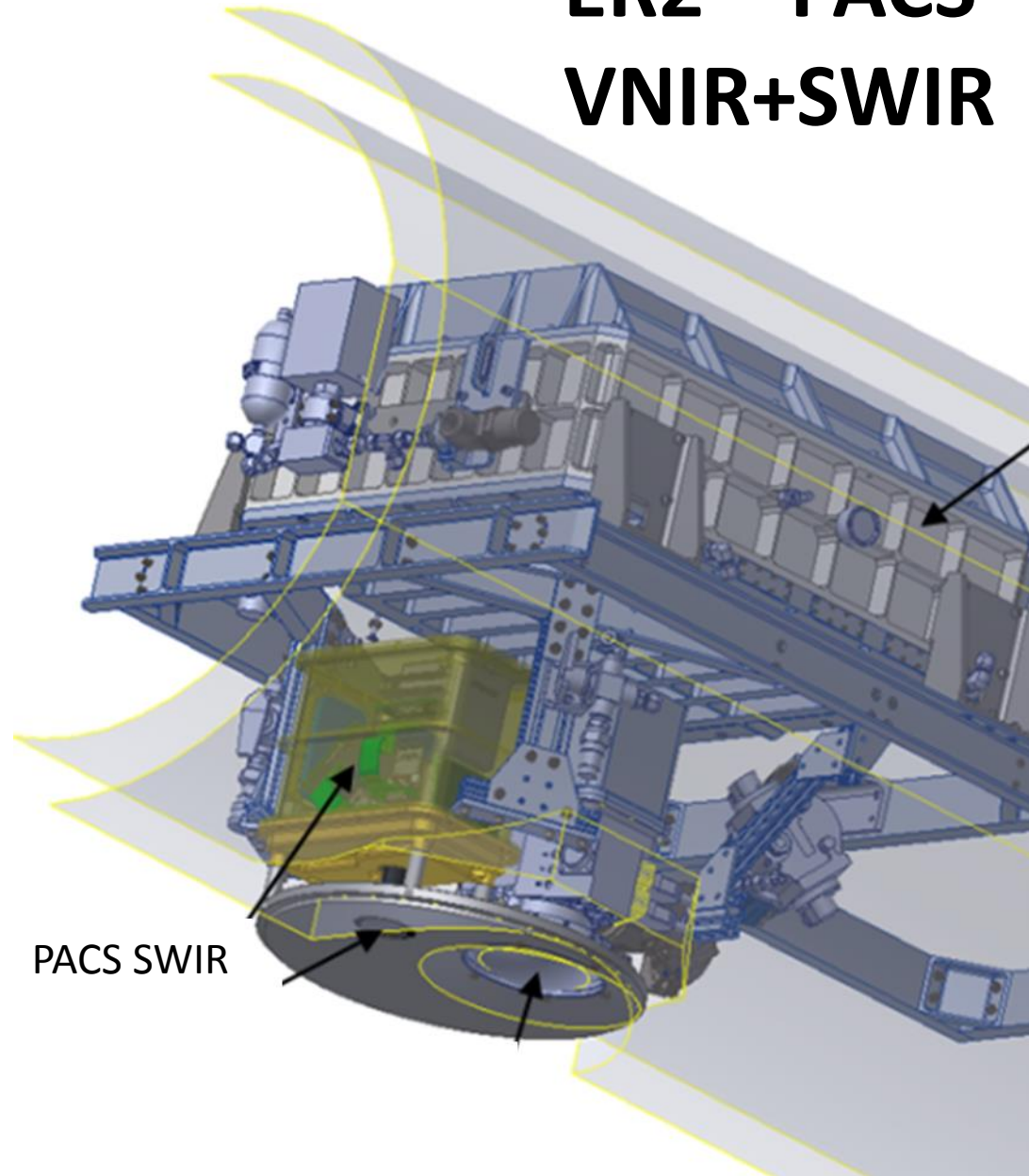


# Incarnations of PACS:

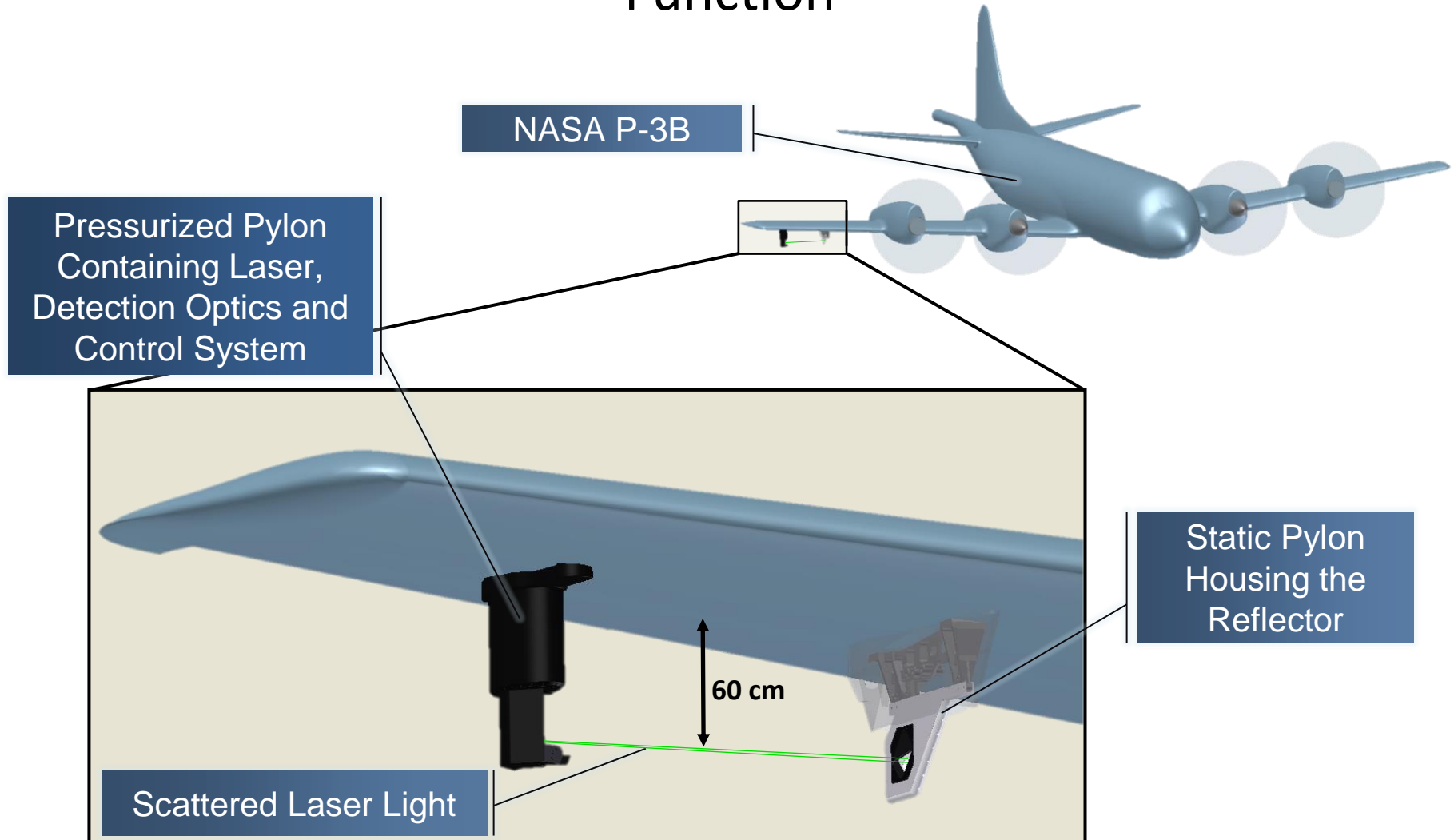
**HARP  
CubeSat  
Satellite**



**ER2 – PACS  
VNIR+SWIR**



# An Inlet-Free Airborne Imaging Nephelometer (**O-INEPH**) for the Measurement of Atmospheric Particle's Phase Function



# PACS Data Analysis

## 1) L1 polarimeter data

### a. Analyses and comparisons with L1 data

- Radiance comparisons with AMS and MODIS
- Geo-location comparisons with AMS
- Multi-angle geo-registration

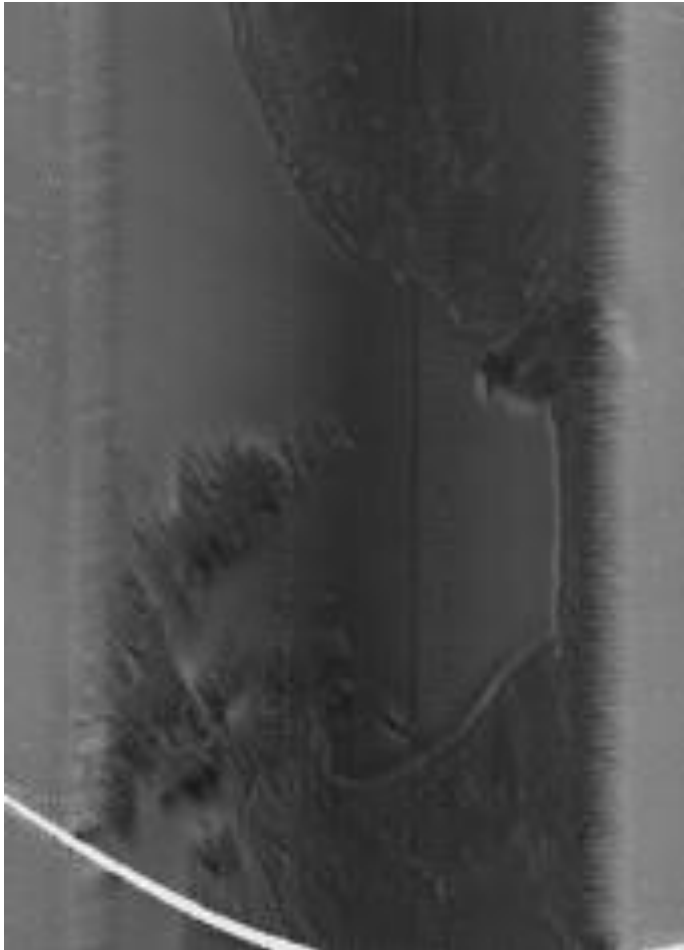
### b. Analyses and comparisons to be done with L1 data in 2014

- Radiance and multi-angle polarization comparisons with AirMSPI and RSP

### c. Availability:

- LACO server at UMBC (June 2014); Transfer to Langley DAAC (TBD/2014)
  - Level 1B data in HDF5, Quick look images, Hyperangular movies

# Example of hyperangular observations of sunglint from PACS-Aircraft



10/16/2013

DoLP - Red

HARP - Systems Requirement Review  
UMBC proprietary

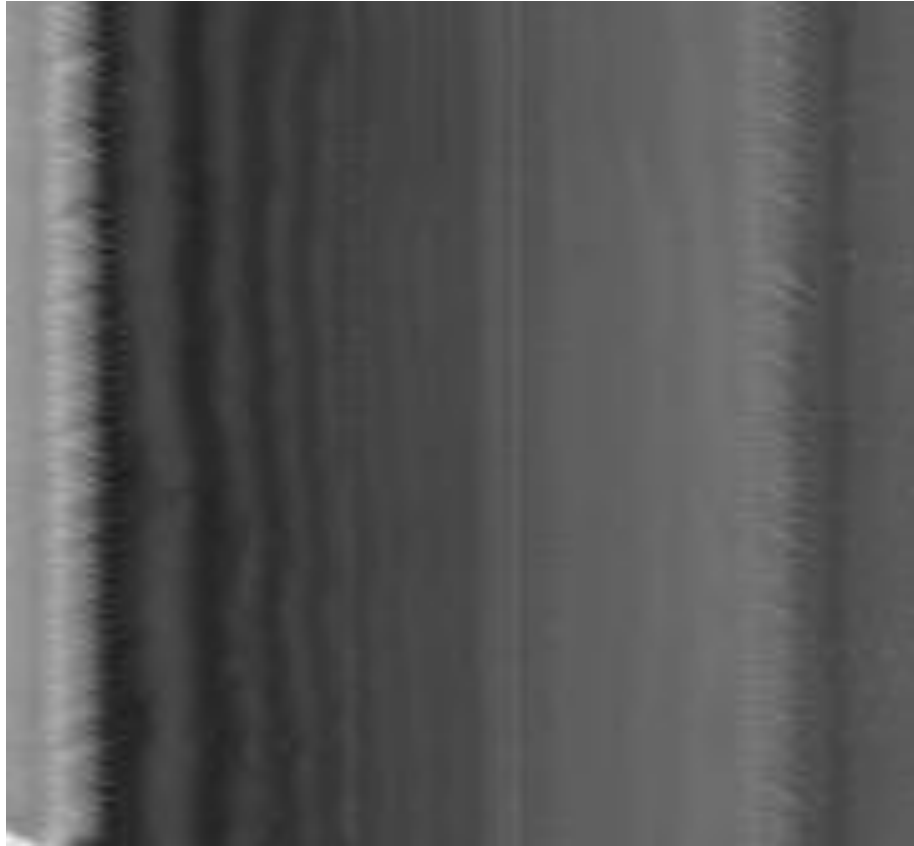
Intensity RGB



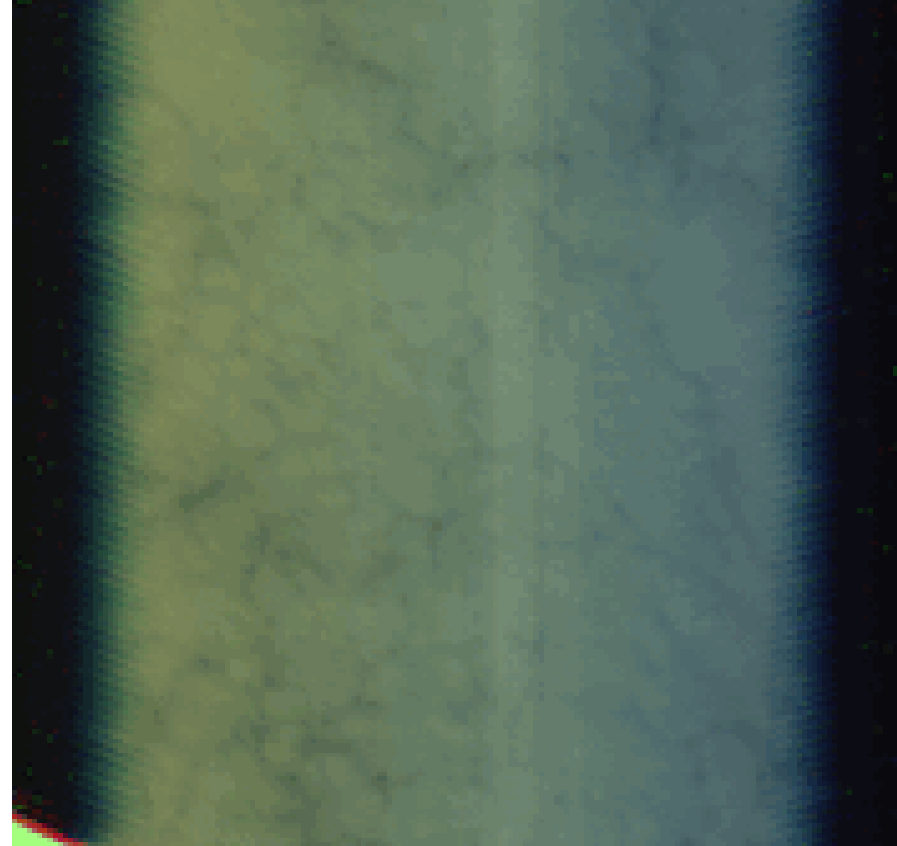
# Multiple Viewing Angles (>100 angles)



# Hyperangular Movie of Cloudbow from PACS-Aircraft

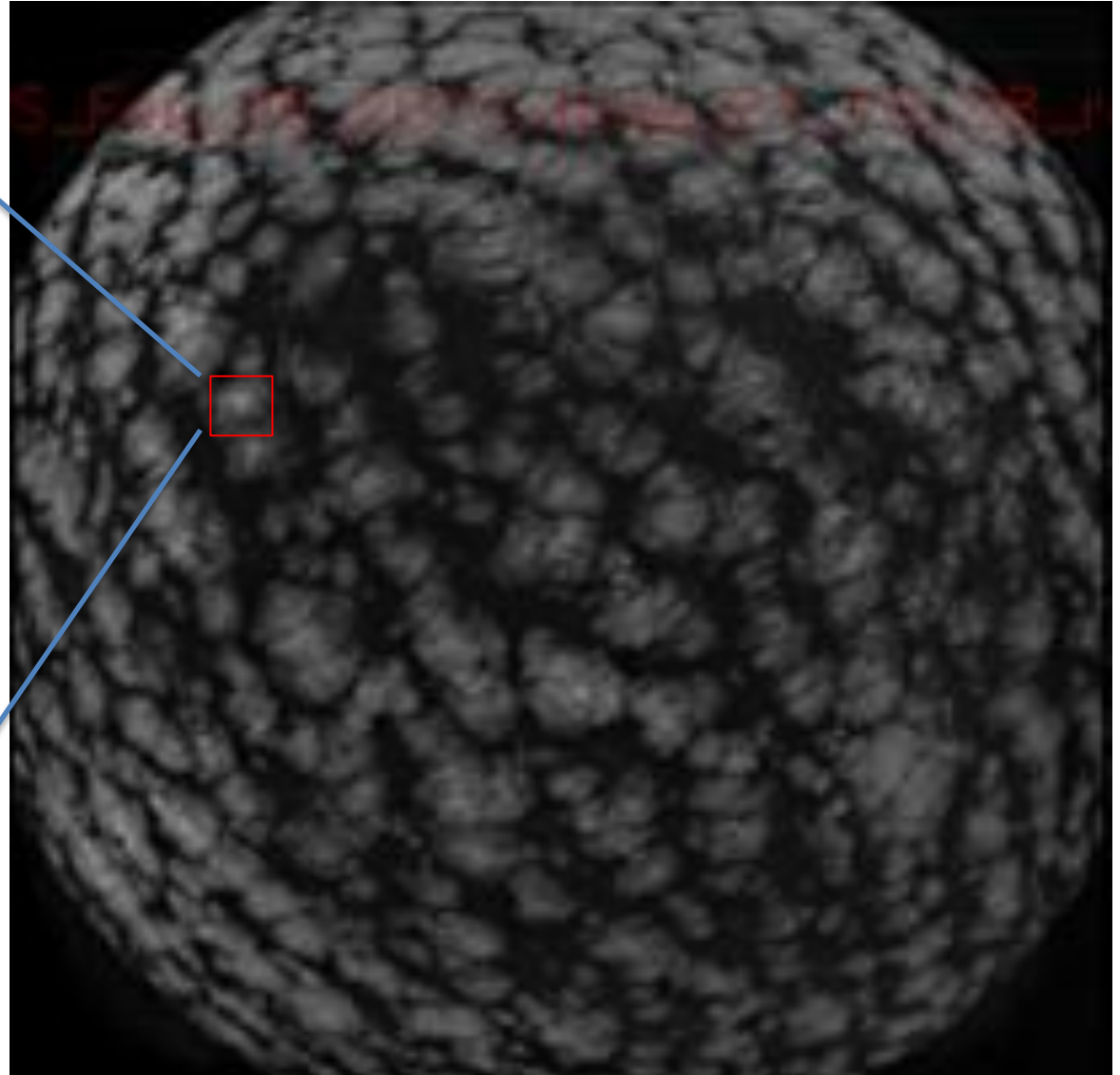
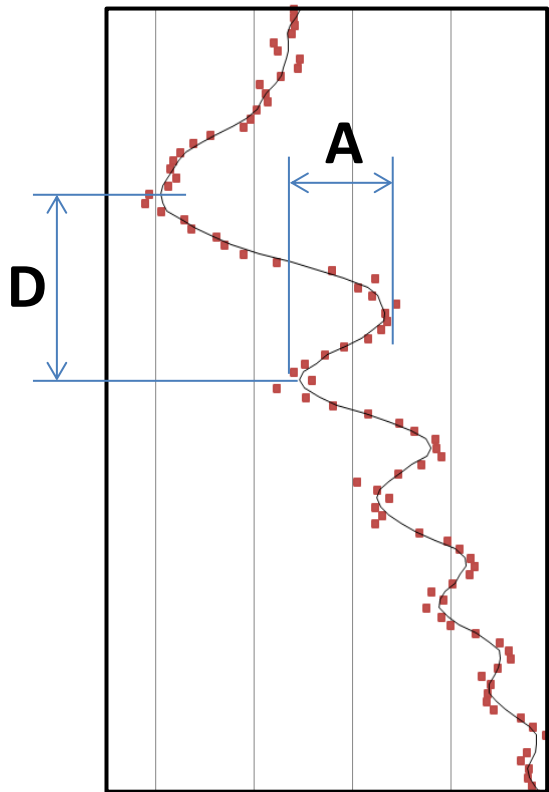


DoLP - Green



Intensity RGB

# Cloudbow Measurements Possible for highly variable Scenes



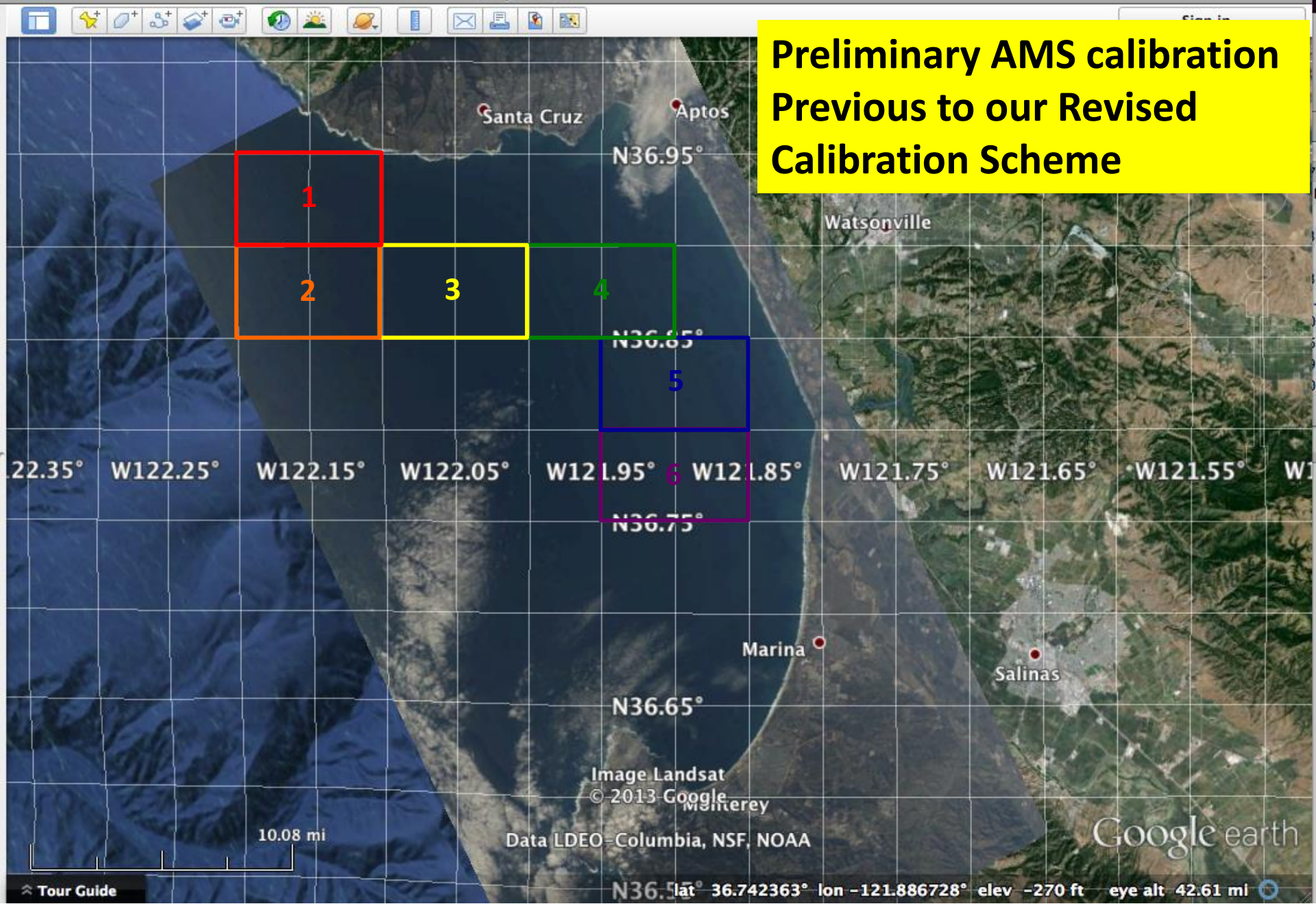
**D and A**  
parameters allow for  
measurements of cloud droplet  
effective radius and variance



# Data intercomparisons:

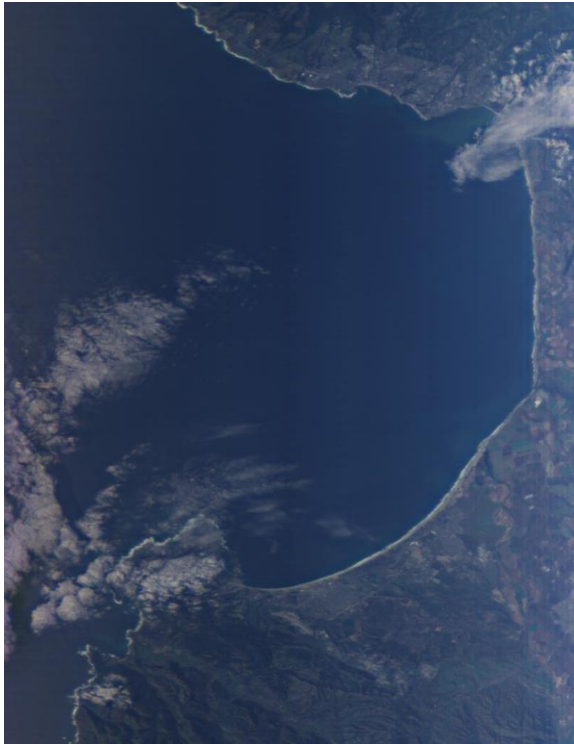
- Leigh Munchak did preliminary intercomparisons with AMS and MODIS
- Calibration issues have been addressed after first intercomparison attempt
- Final intercomparisons are pending final level 1B production, which is happening now
- Work with Knobelspiesse for intercomparisons with RSP and AirMSPI

**Preliminary AMS calibration  
Previous to our Revised  
Calibration Scheme**

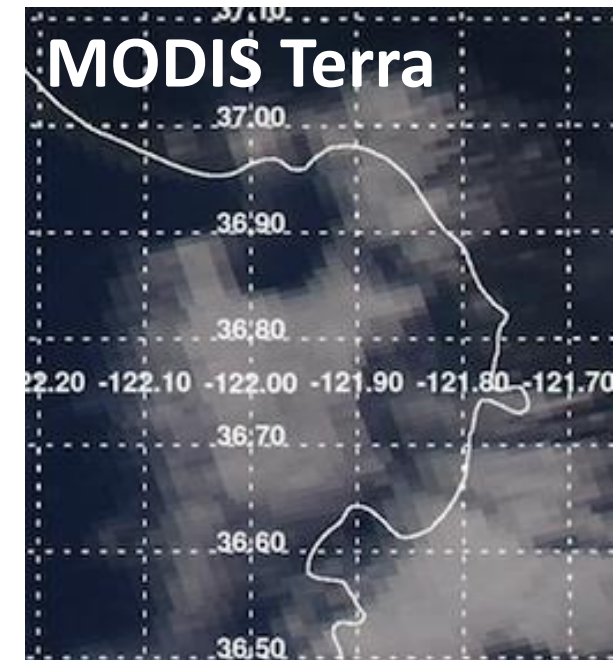
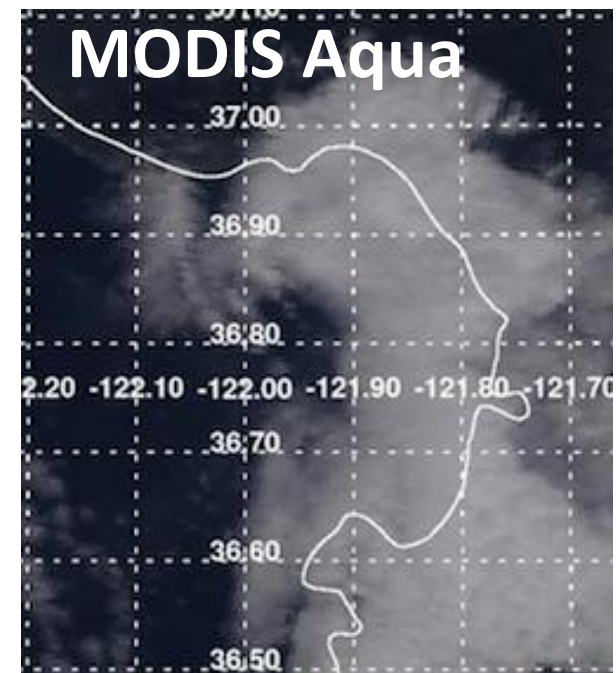
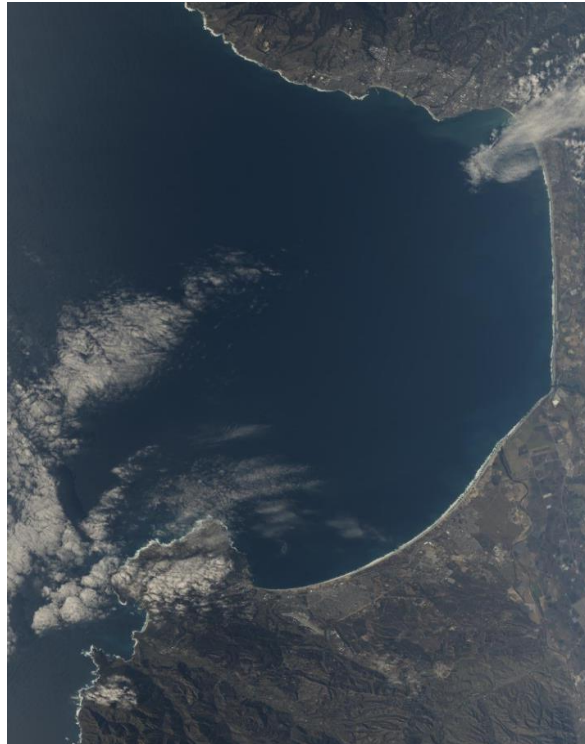


# Preliminary Intercomparisons

**PACS**



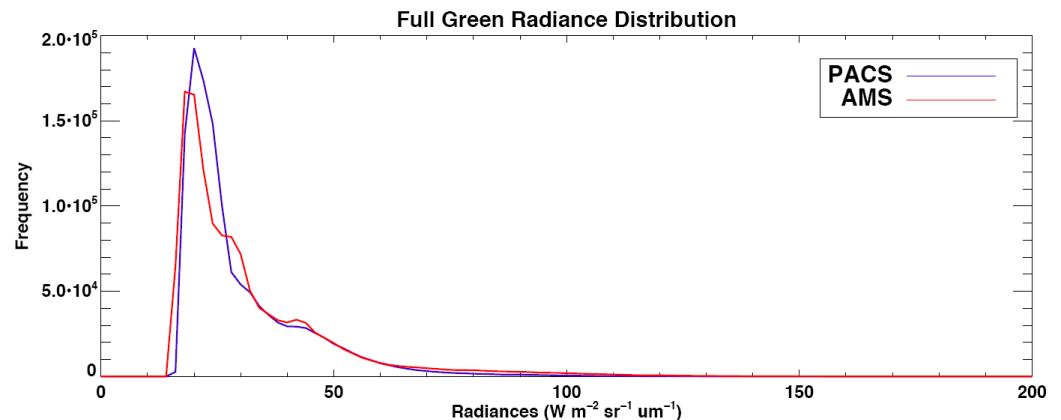
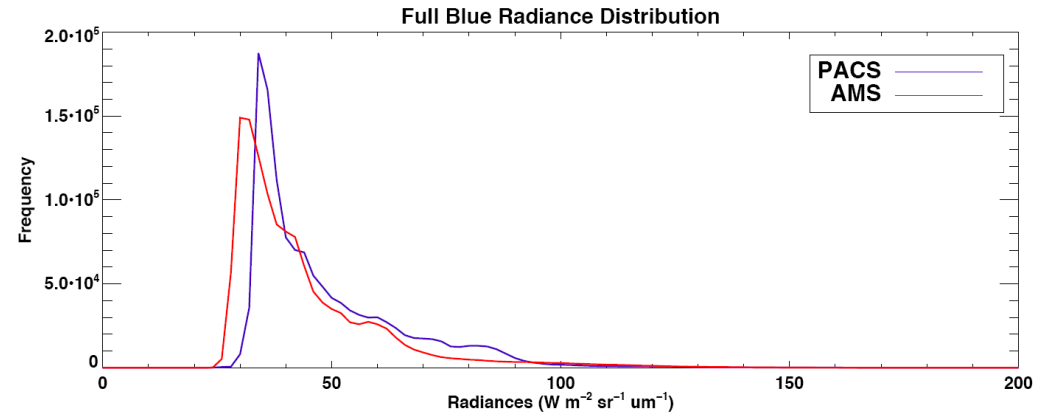
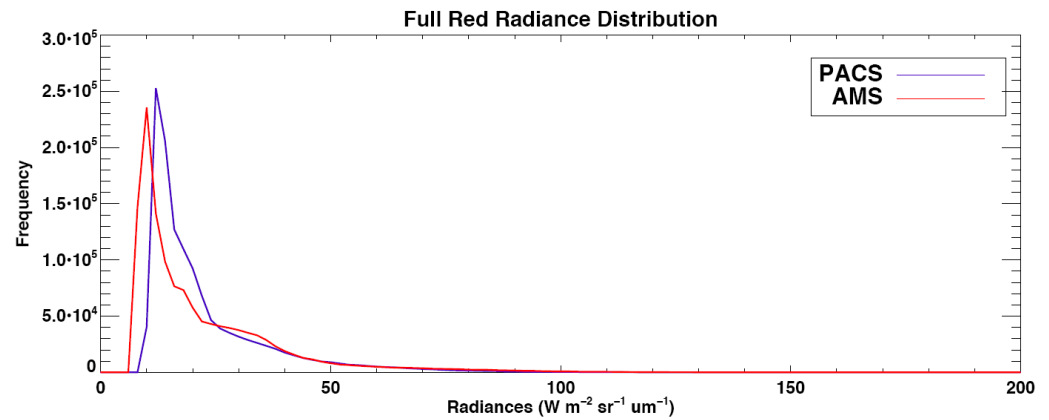
**AMS**





# Preliminary Radiance comparisons with AMS

- No spectral corrections
- Prior to our calibration re-work
- More comparisons to come after completing level 1B processing
- Add AirMSPI and RSP



# PACS Data Analysis

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- Multi-angle geo-registration

### b. Analyses and comparisons to be done with L1 data in 2014

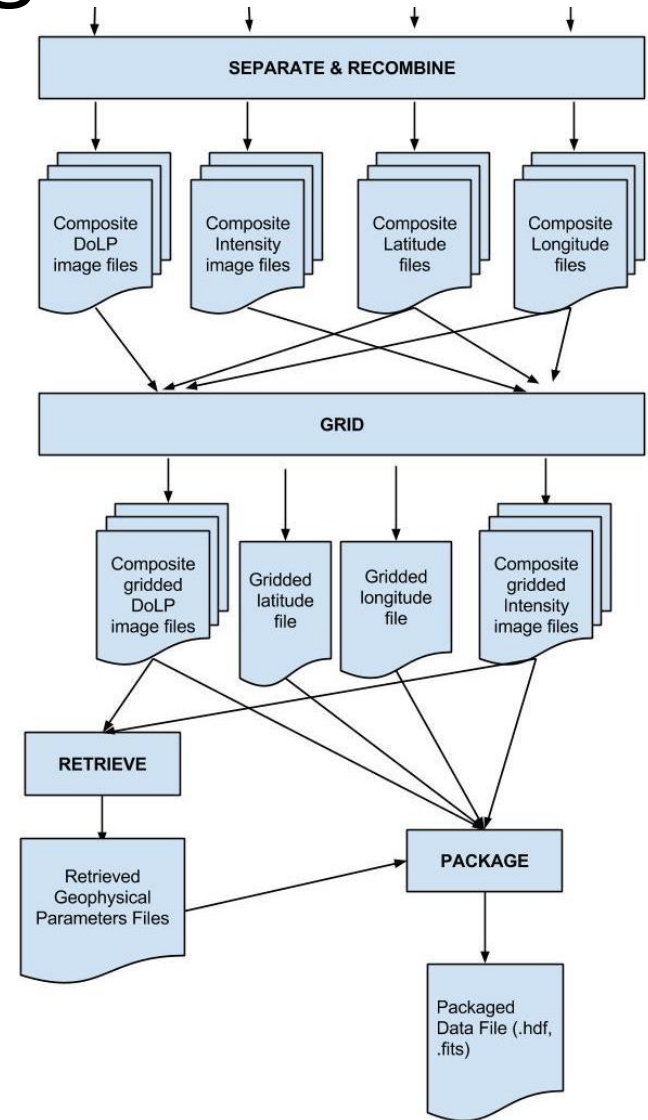
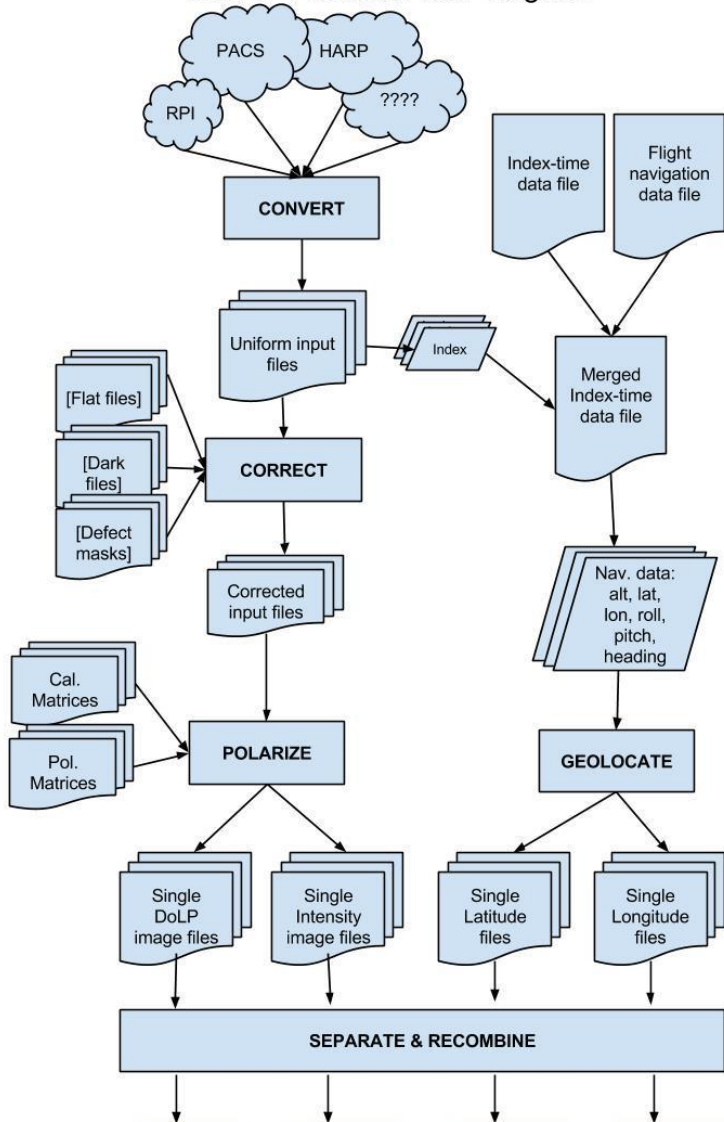
- Radiance and multi-angle polarization comparisons with AirMSPI and RSP

### c. Availability:

- LACO server at UMBC (June 2014); Transfer to Langley DAAC (TBD/2014)
  - Level 1B data in HDF5, Quick look images, Hyperangular movies

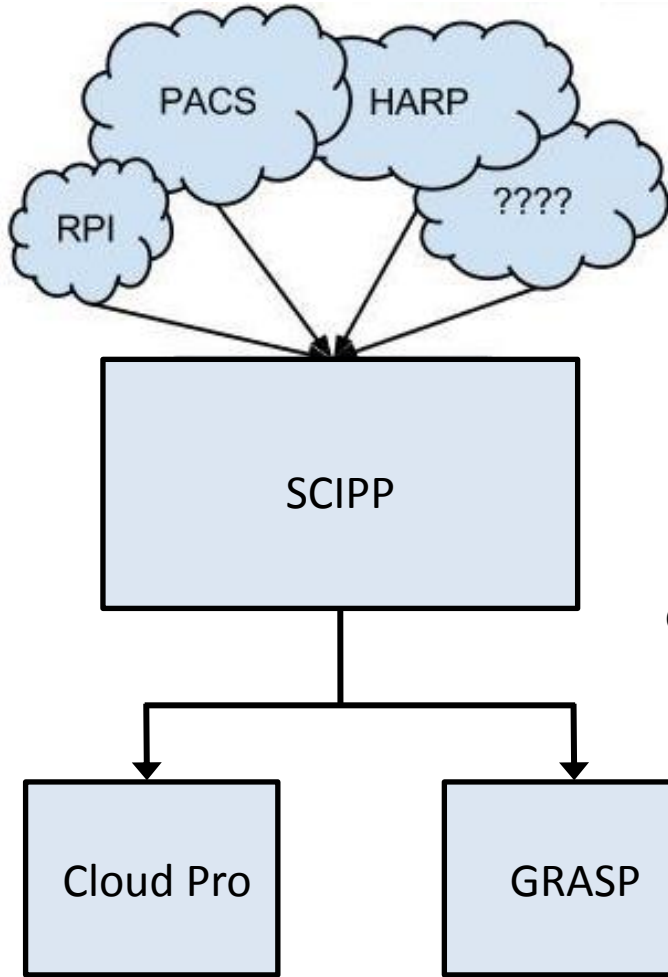
# SCIPP Data Processing Framework

SCIPP Process Flow Diagram

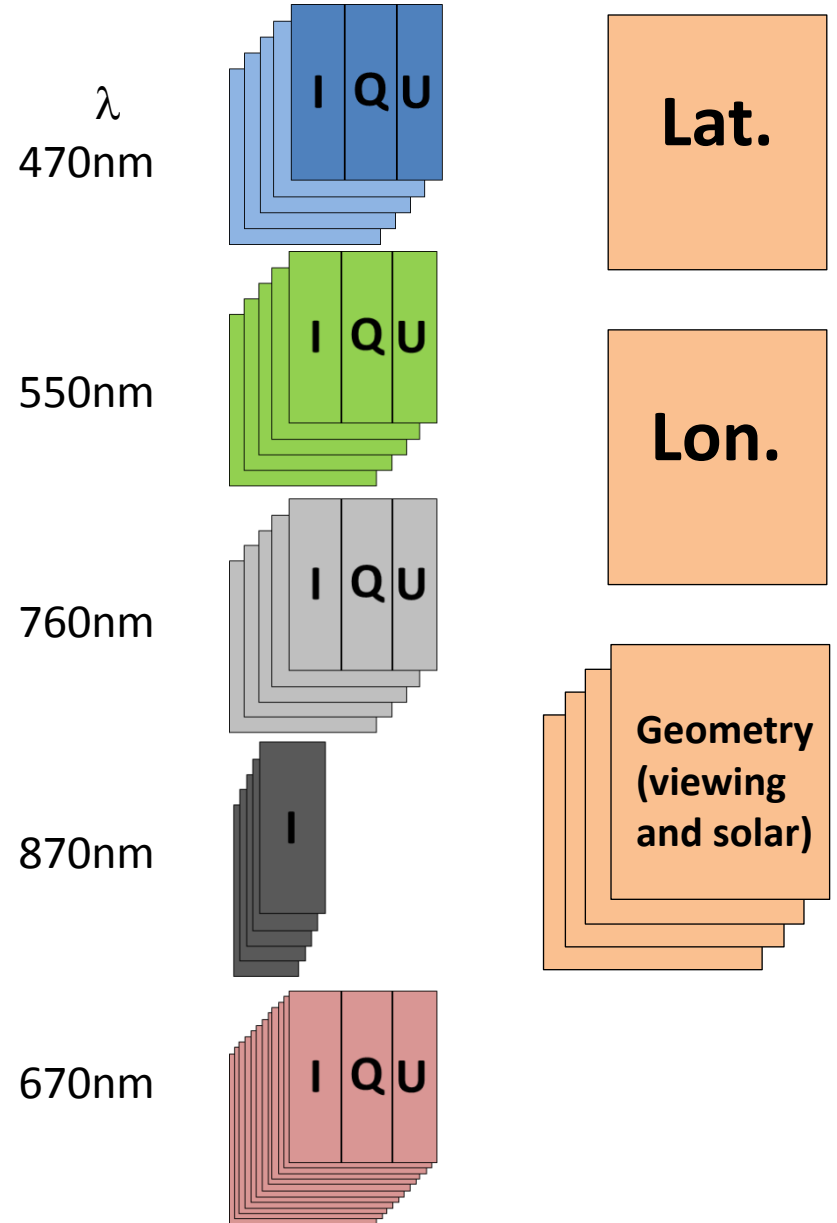




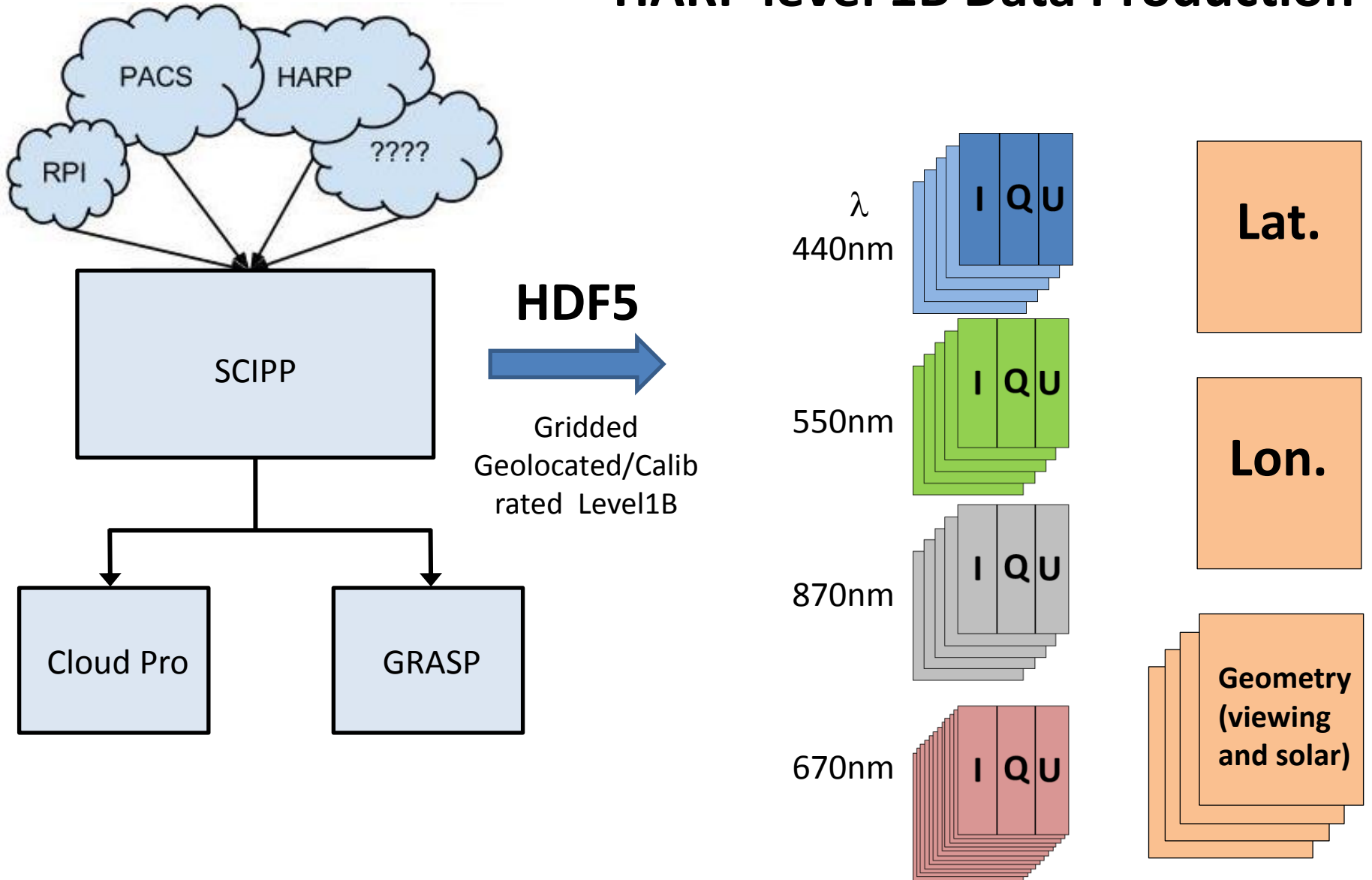
# PACS level 1B Data Production



**HDF5**  
→  
Gridded  
Geolocated/Calib  
rated Level1B



# HARP level 1B Data Production



# PACS Data Analysis

## 2) PACS L2 analysis activities

a. What analyses of L2 have been going on regarding

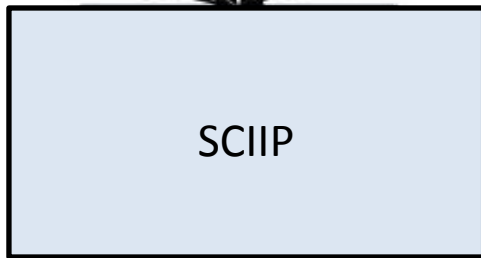
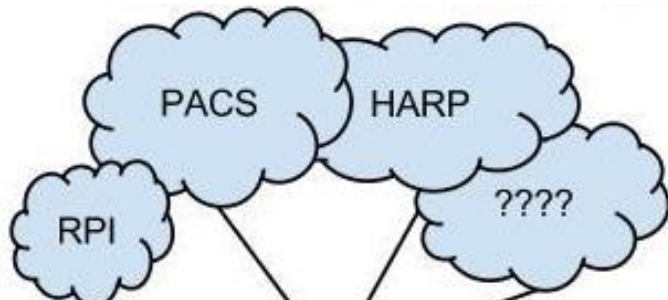
- i. Aerosols
  - » Adaptation of the GRAPS algorithm for PACS retrievals
  - » Studies of aerosol retrievals above clouds
- ii. Clouds
  - » Retrievals of cloud droplet distributions
  - » Retrieval of cloud thermodynamic phase

b. Availability of L2 products

- L2 products for aerosol and clouds to be produced and made available at the UMBC server
  - Cloud droplet effective radius and effective variance
  - Cloud thermodynamic phase
  - Cloud height
  - Fine and coarse AOD
  - Aerosol microphysics (size parameters fine and coarse modes, aerosol type)

# PACS/HARP

## Level 2 Aerosol Algorithm



### CloudPro:

Parametric retrievals:

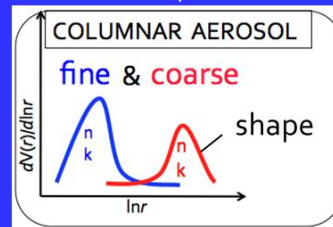
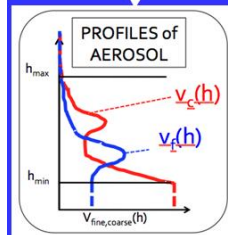
- Cloud Height
- Droplet Effective radius and variance
- Cloud Phase

### GRASP: Generalized Retrieval of Aerosol and Surface Properties

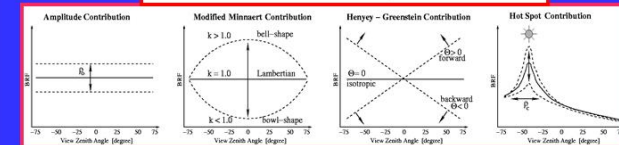
[Open source code](#)



### GRASP



### Surface BRDF, BPDF



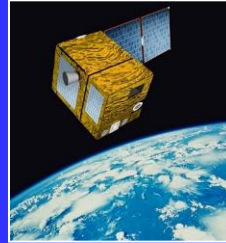
# GRASP: Generalized Retrieval of Aerosol and Surface Properties

Open source code

AERONET



POLDER



lidar

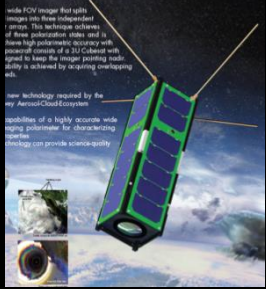


AERONET

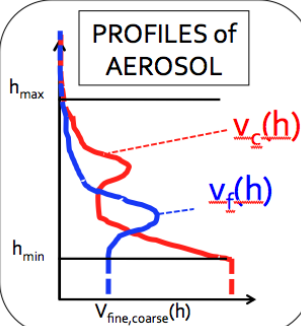


GRASP

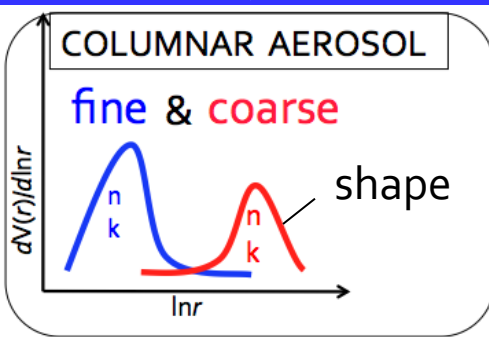
PACS/HARP



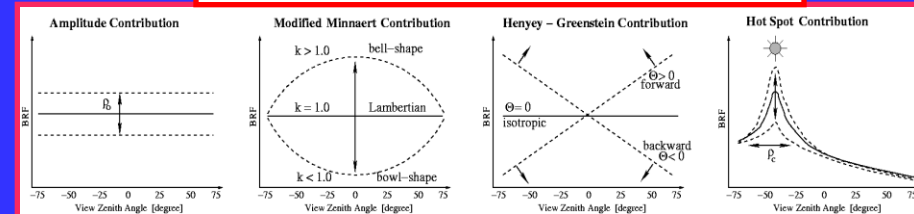
PROFILES of AEROSOL



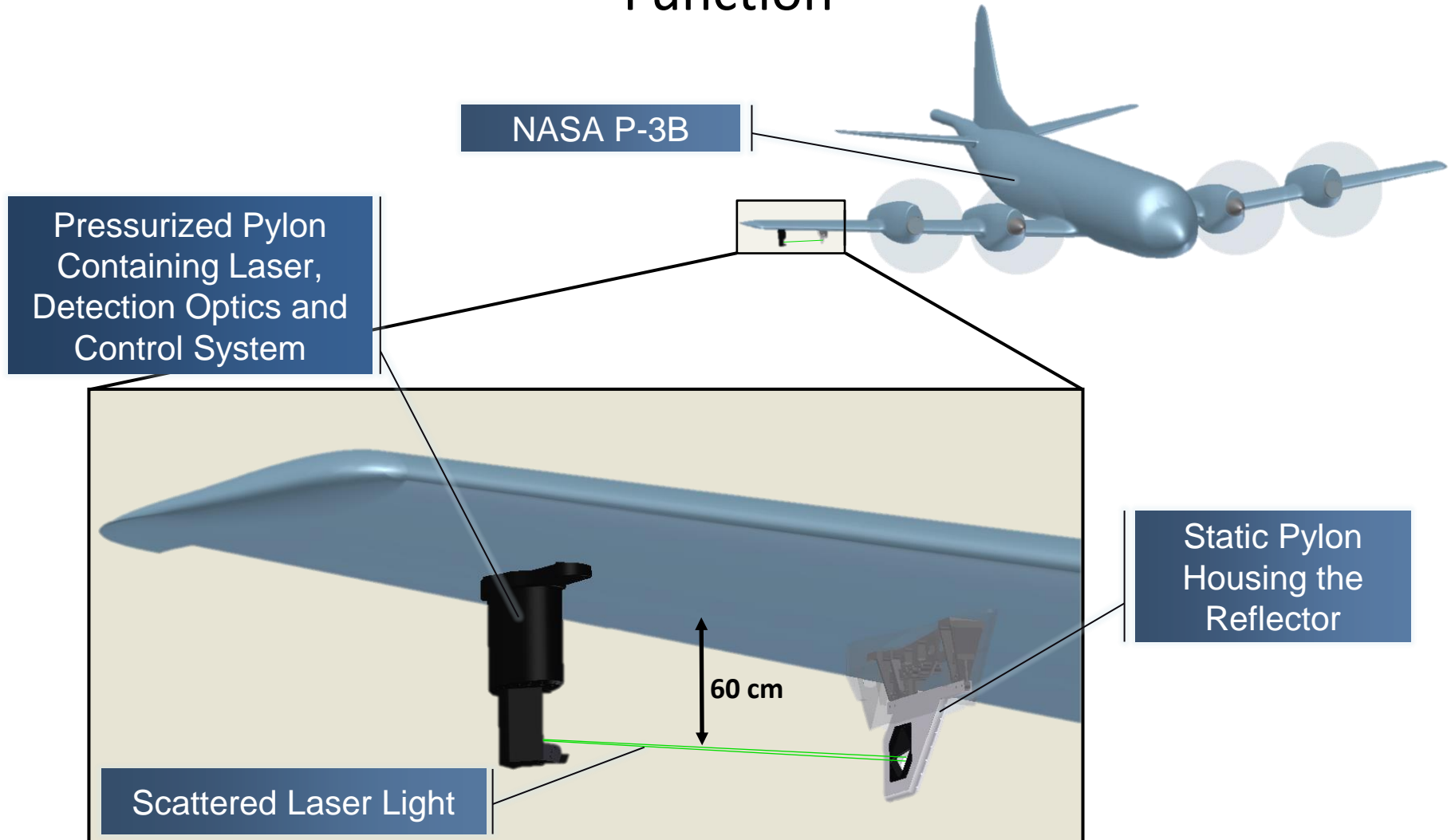
COLUMNAR AEROSOL



Surface BRDF, BPDF



# An Inlet-Free Airborne Imaging Nephelometer (**O-INEPH**) for the Measurement of Atmospheric Particle's Phase Function

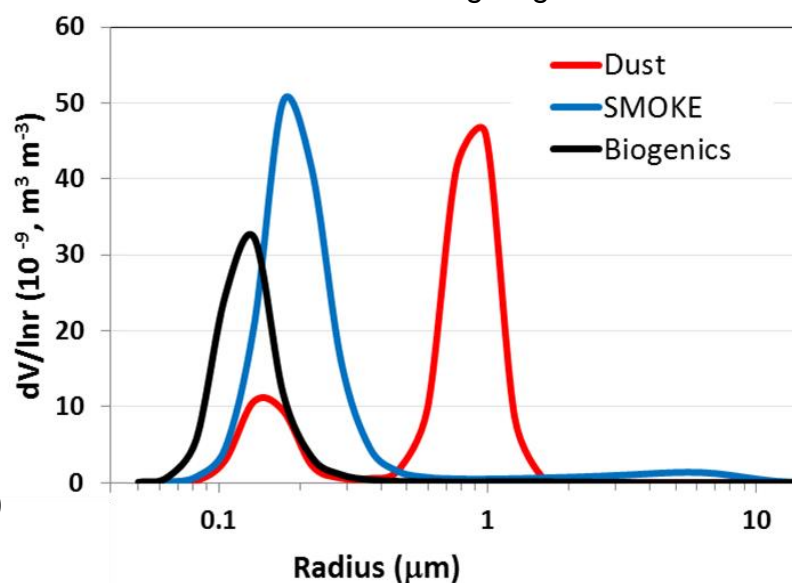
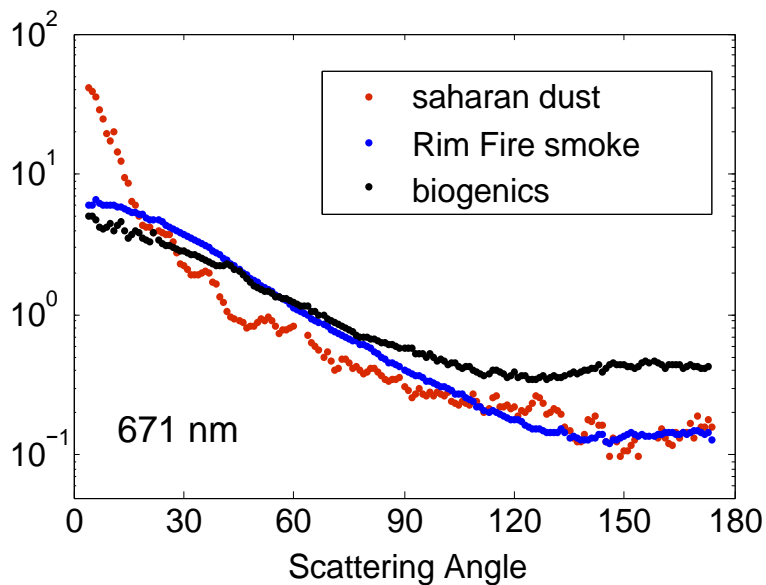
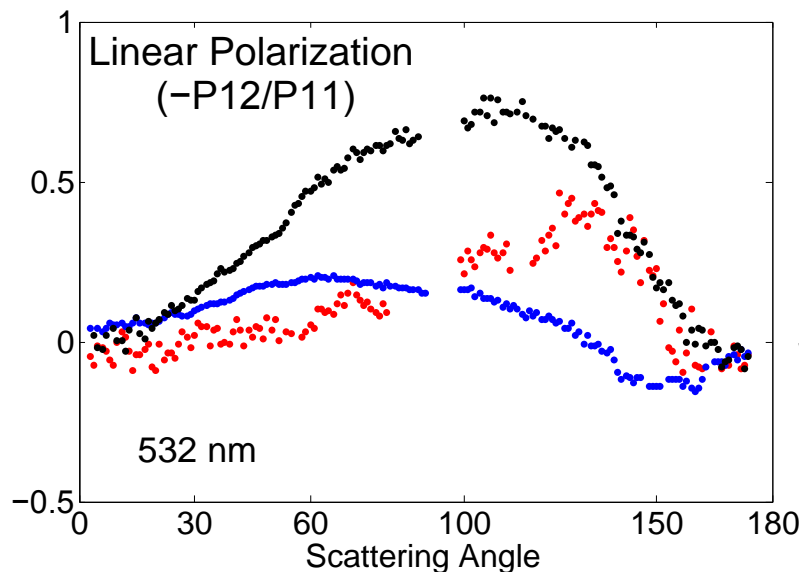
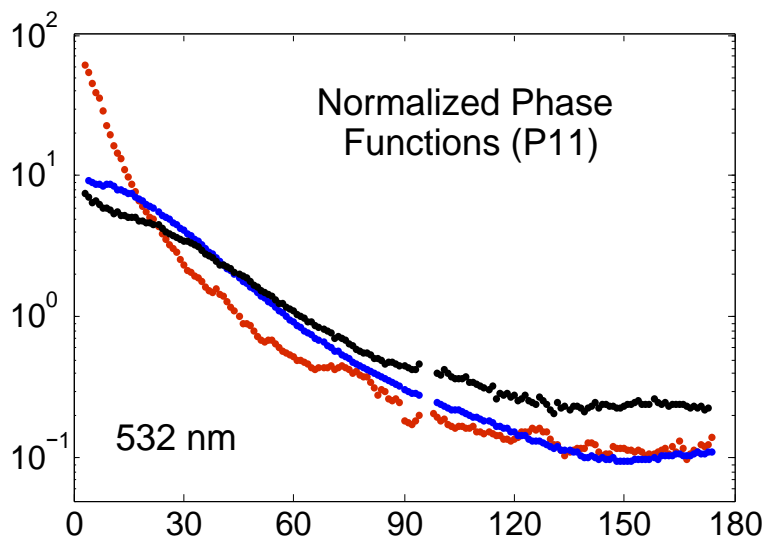




The **UMBC polarized Imaging Nephelometer (PI-Neph)** successfully measured phase matrix components P11 (phase function) and P12 leading to retrievals of size distributions, refractive index, and sphericity fraction for a wide variety of aerosols at  $3\lambda$  (470, 532, 632nm).



J.V. Martins  
W.R. Espinosa  
F.D. Orozco  
L.A. Remer



Size distributions retrieved from P11 using Dubovik retrieval

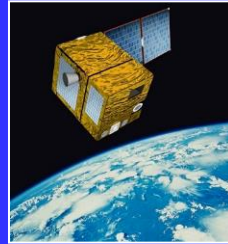
# GRASP: Generalized Retrieval of Aerosol and Surface Properties

Open source code

AERONET



POLDER



lidar

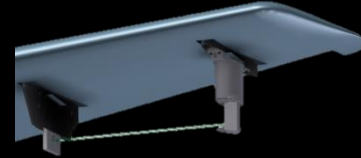


AERONET



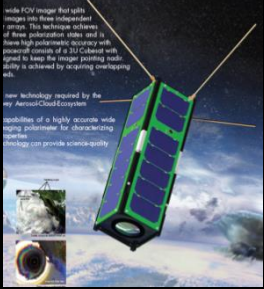
GRASP

PI-NEPH

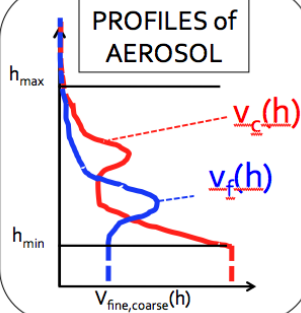


single scattering

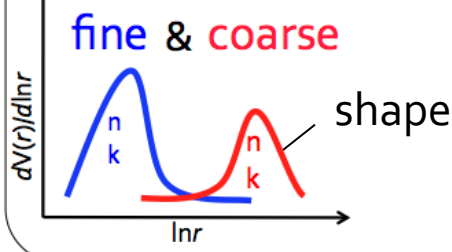
PACS/HARP



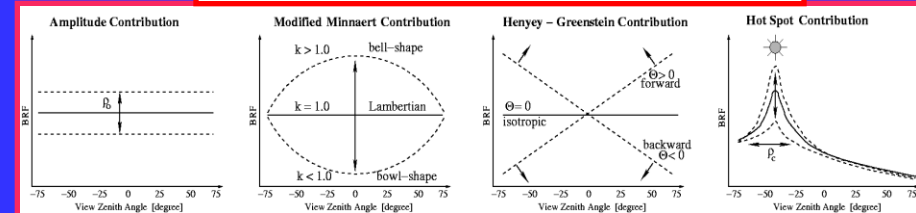
PROFILES of AEROSOL



COLUMNAR AEROSOL



Surface BRDF, BPDF



# PACS Data Analysis

## b. Availability of L2 products

- L2 products for aerosol and clouds to be produced and made available at the UMBC server
  - Cloud droplet effective radius and effective variance
  - Cloud thermodynamic phase
  - Cloud height
  - Fine and coarse AOD
  - Aerosol microphysics (size parameters on fine and coarse mode, aerosol type)

## c. Use of DISCOVER-AQ data

- PACS group has run the PI-Neph instrument during DISCOVER-AQ/PODEX and SEAC4RS. This data analysis is about to be completed and will be available for validation and aerosol microphysical characterization
- PI-Neph + LARGE data set for aerosol retrieval validation of the polarimeter retrievals

# PACS Data Analysis

d. Use of other PODEX or related datasets for such analyses (e.g. CPL, AMS, etc.)

- PI-Neph + LARGE data set for aerosol retrieval validation of the polarimeter retrievals
- CPL will be used for cloud height validation

e. Future Plans for data analyses in 2014-2015

- Apply L2 algorithm to the whole PACS data set from PODEX
- PI-Neph data set will be used in conjunction with the LARGE aerosol data for validation of the polarimeter retrievals from the ER2 aircraft.



# PACS



# HARP

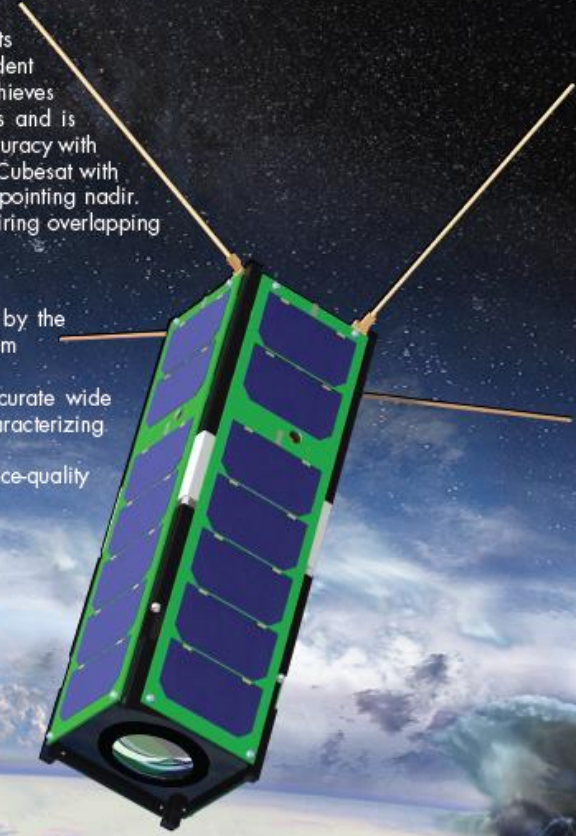
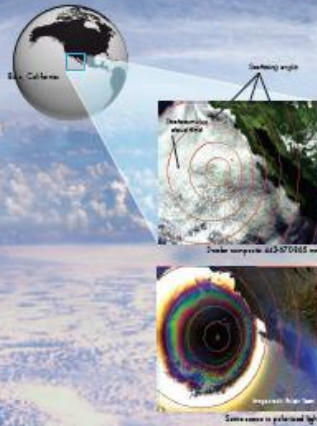
## Hyper-Angular Rainbow Polarimeter

In-Space Validation of Earth Science Technologies (InVEST)

The HARP payload is a wide FOV imager that splits three spatially identical images into three independent polarizers and detector arrays. This technique achieves simultaneous imagery of three polarization states and is the key innovation to achieve high polarimetric accuracy with no moving parts. The spacecraft consists of a 3U Cubesat with 3-axis stabilization designed to keep the imager pointing nadir. The hyper-angular capability is achieved by acquiring overlapping images at very fast speeds.

### OBJECTIVES:

- Space validation of new technology required by the NASA Decadal Survey Aerosol-Cloud-Ecosystem (ACE) mission
- Prove the on-flight capabilities of a highly accurate wide FOV hyper-angle imaging polarimeter for characterizing aerosol and cloud properties
- Prove that cubesat technology can provide science-quality Earth Sciences data



# Thank you!!!