EMPIRICAL POLARIZATION DISTRIBUTION MODELS: UPDATE

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POLARIZATION: RECAP

- Motivation:
  - radiance measurements need to be corrected for polarization effects
  - uncertainty due to polarization contributes to uncertainty in reflectance
- Polarization state fully specified by degree of polarization *P*, angle of polarization χ and total intensity *I* (alternatively, may be specified by Stokes parameters *I, Q, U*)

Polarized reflectance *Polarized radiance*

$$P = \frac{\rho_p}{\rho} = \frac{I_p}{I} = \frac{\sqrt{Q^2 + U^2}}{I}$$

Total reflectance *Total radiance*

where

$$I = I_{0^\circ} + I_{90^\circ} \ ,$$
$$Q = I_{0^\circ} - I_{90^\circ} \ ,$$
$$U = I_{45^\circ} - I_{135^\circ} \ ,$$

$$\chi = \frac{1}{2}\arctan(U/Q).$$

- Goal: produce empirical Polarization Distribution Maps (PDMs) for *P* and χ as a function on RAZ and VZA based on the PARASOL data for λ = 490 nm, 670 nm, 865 nm

RECENT RESULTS

- "Empirical Polarization Distribution Models for CLARREO-Imager Intercalibration" (with Costy Lukashin) close to publication (JTECH)
- Produced first working version (C++/C) of PDM Module for the **clear-sky ocean** (described here)
  - Implemented degree of polarization *P* (so far)
  - Implemented interpolation of *P* values between PARASOL bands (470 nm, 670 nm, 865 nm)

PDM MODULE: FUNCTION AND I/O

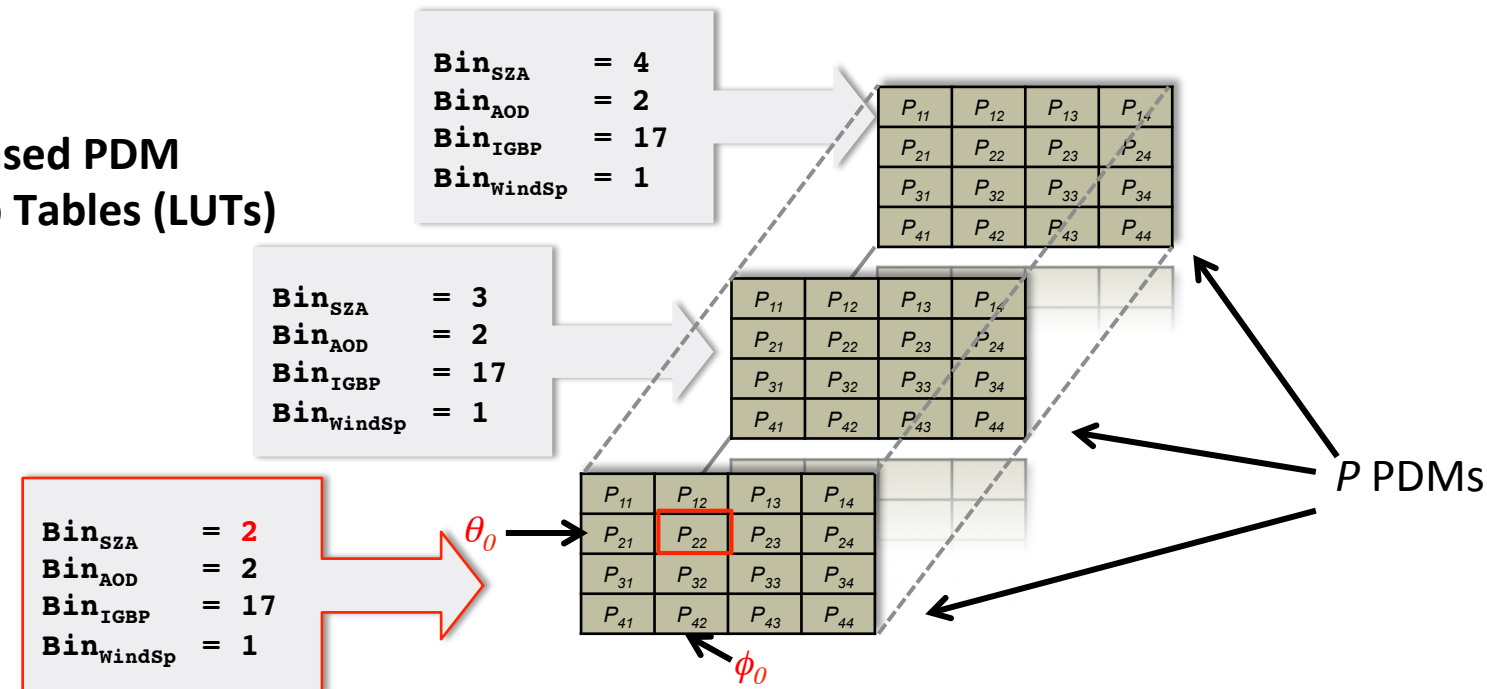
- **Module inputs**: Solar Azimuth, Detector Azimuth, VZA, SZA, IGBP, wind speed (if ocean), cloud phase (if cloudy), cloud fraction, AOD (if clear) from MODIS/VIIRS, season (if applicable)
- **Module outputs**: empirical mean P, mean χ, δP, $\delta\chi$, theoretical P and χ (ADRTM)
- PDM lookup tables stored as **HDF files.**

FIRST VERSION OF PDM MODULE: CLEAR-SKY OCEAN

Dimension name	# bins	bins
RAZ	180	Range: [0°,360°], bin size 2°
VZA	70	Range: [0°,70°], bin size 1°
SZA	6	[10°, 70°], bin size 10°
AOD	2	[0, 0,.04), [0.04,0.6), [0.6,1.4), [1.4,150)
IGBP	1	17
Wind Sp.	1	[0, 3.5)

Example Inputs: SZA = **27°**, AOD = **0.5**, IGBP = **17**, Wind Speed = **2.5**, RAZ = ϕ_0, VZA = θ_0

HDF-based PDM Lookup Tables (LUTs)

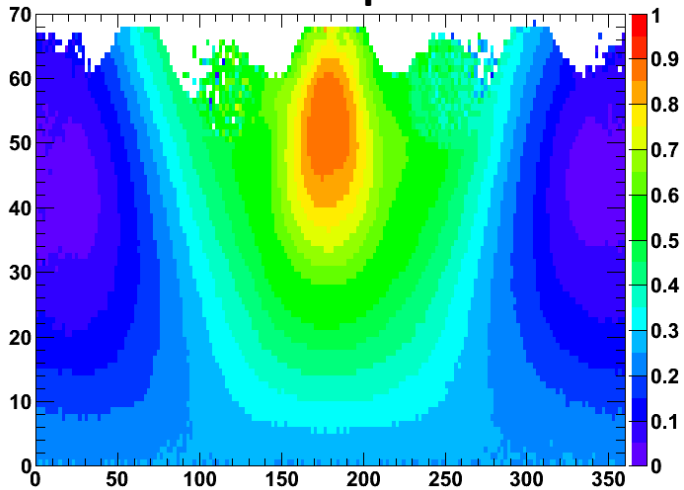


TESTING THE PDM MODULE: TRIVIAL TEST

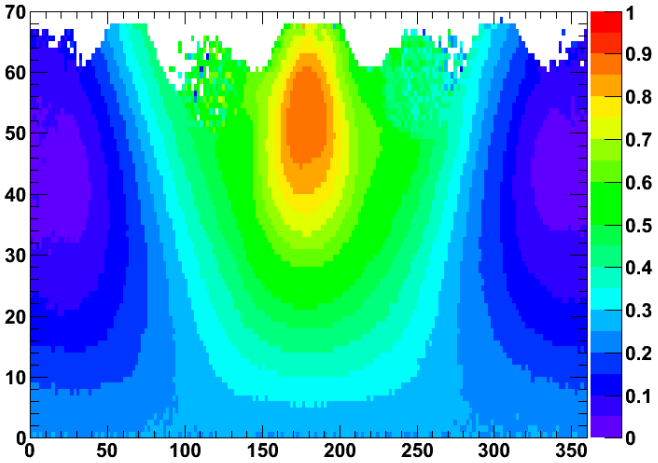
- Generated random (RAZ,VZA) pairs for different values of AOD, SZA.
- *Averaged* P output should be equal to LUT input

λ = **670** nm, SZA = **49°**, AOD = **0.4**

LUT input



Module Output



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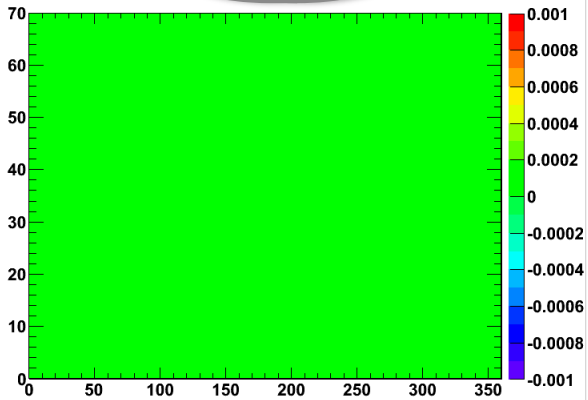
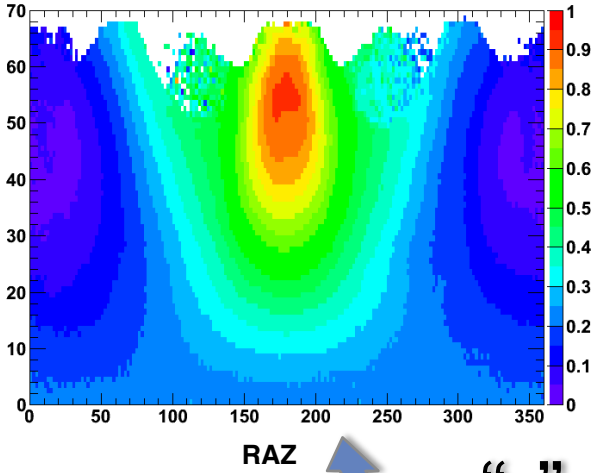


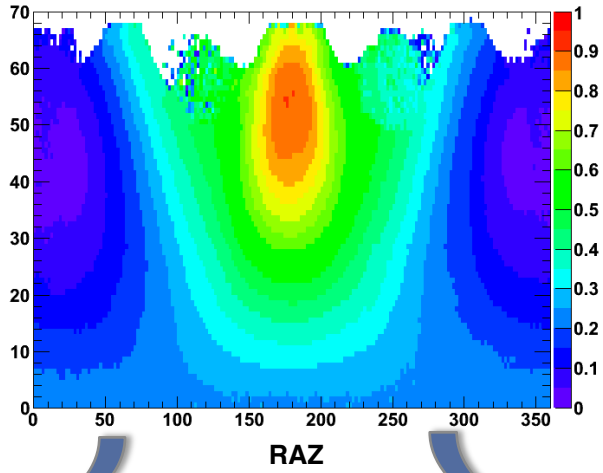
TESTING THE PDM MODULE: INTERPOLATION

λ = **670** nm, SZA = **49°**, AOD = **0.5**

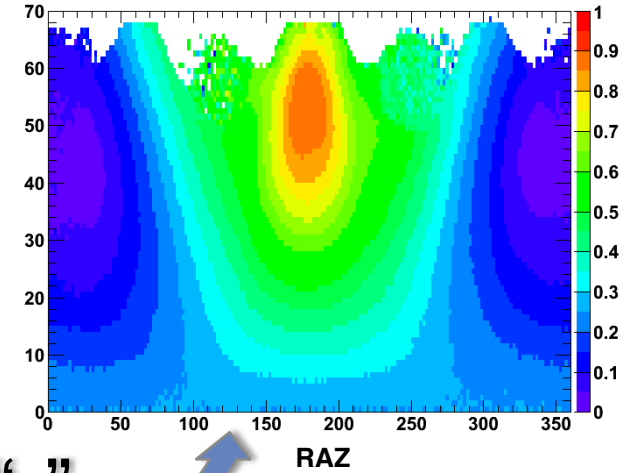
P for λ = 670 nm



Interpolated P for λ = 767 nm



P for λ = 865 nm



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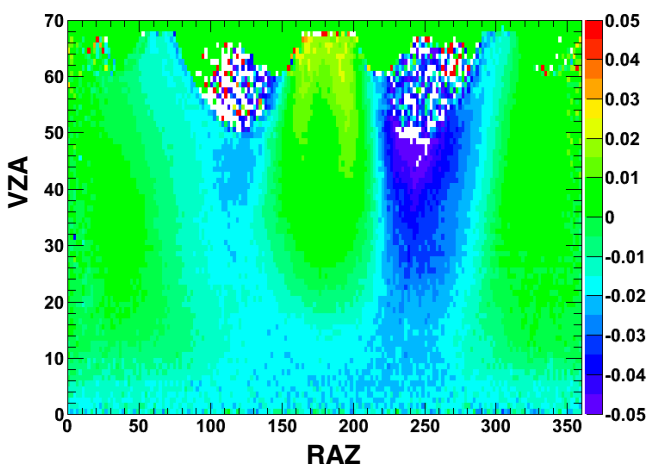
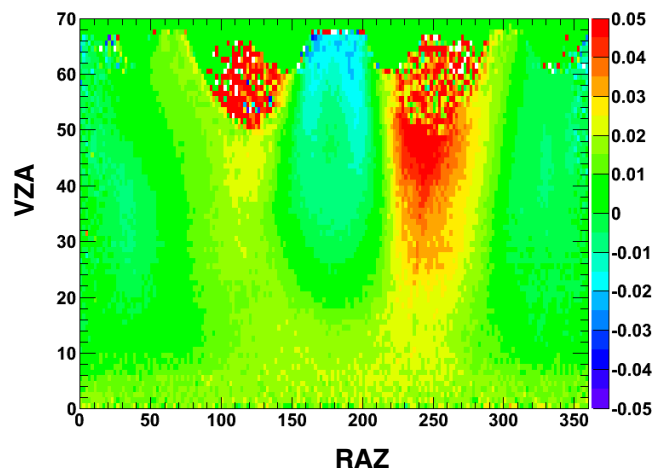
Residuals





TO BE DONE

- Implement χ in the PDM module
- Work on fitting the PDMs (results in a functional form to smooth out the stats. fluctuations, gaps in data, save disk space)
- Implement other scene (ice& water clouds)/surface types