What did we learn from POLDER and MODIS that can be used for SGLI / GCOM-C ?

Jérôme RIEDI (PI)

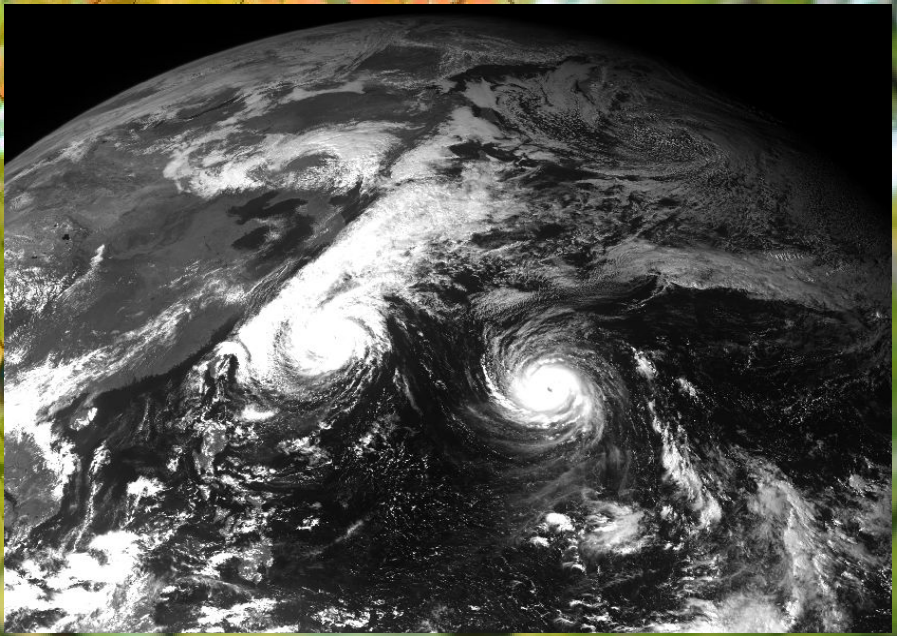
Laboratoire d'Optique Atmosphérique

Université de Lille 1 – Sciences & Technologies / CNRS

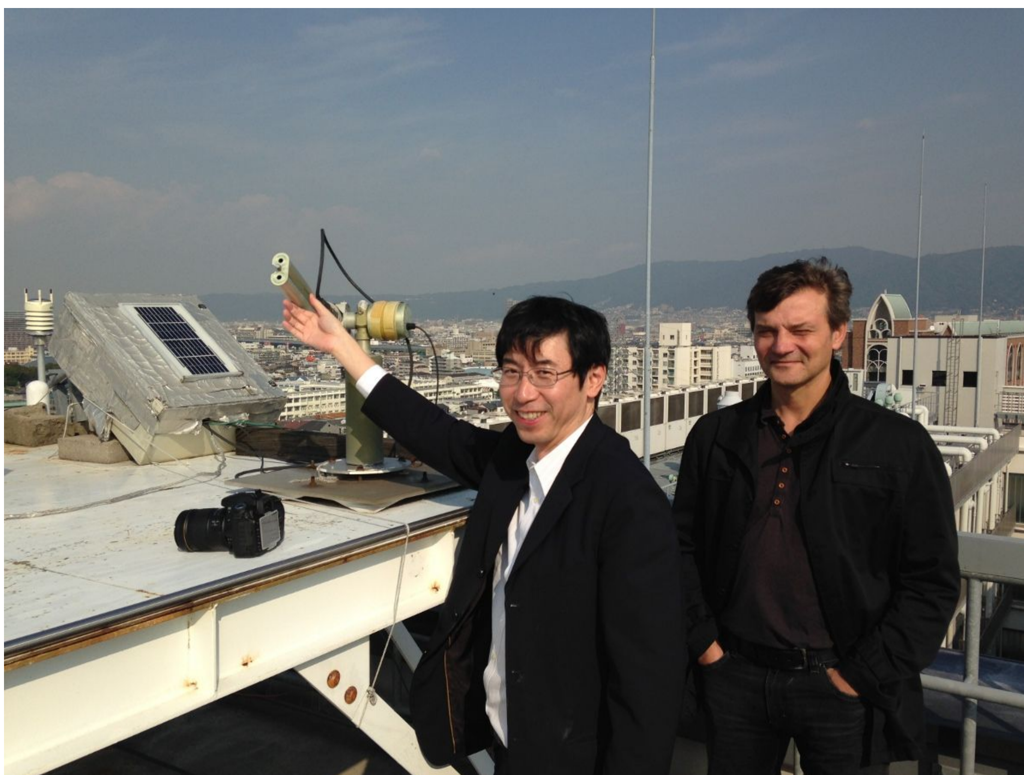
C. Cornet, L. Labonnote, G. Merlin, F. Parol and F. Thieuleux

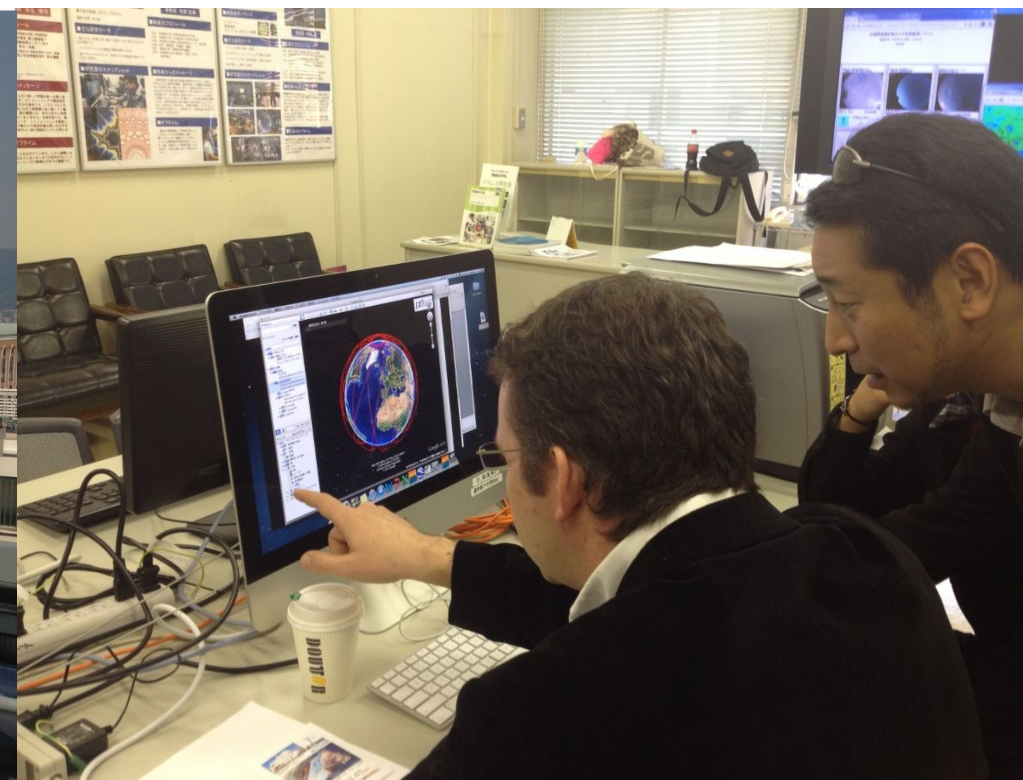
GCOM Meeting, TOKYO 2014 / 01 / 16

2013 activity log




The 3MI mission
for operational monitoring
of aerosols from EPS-SG





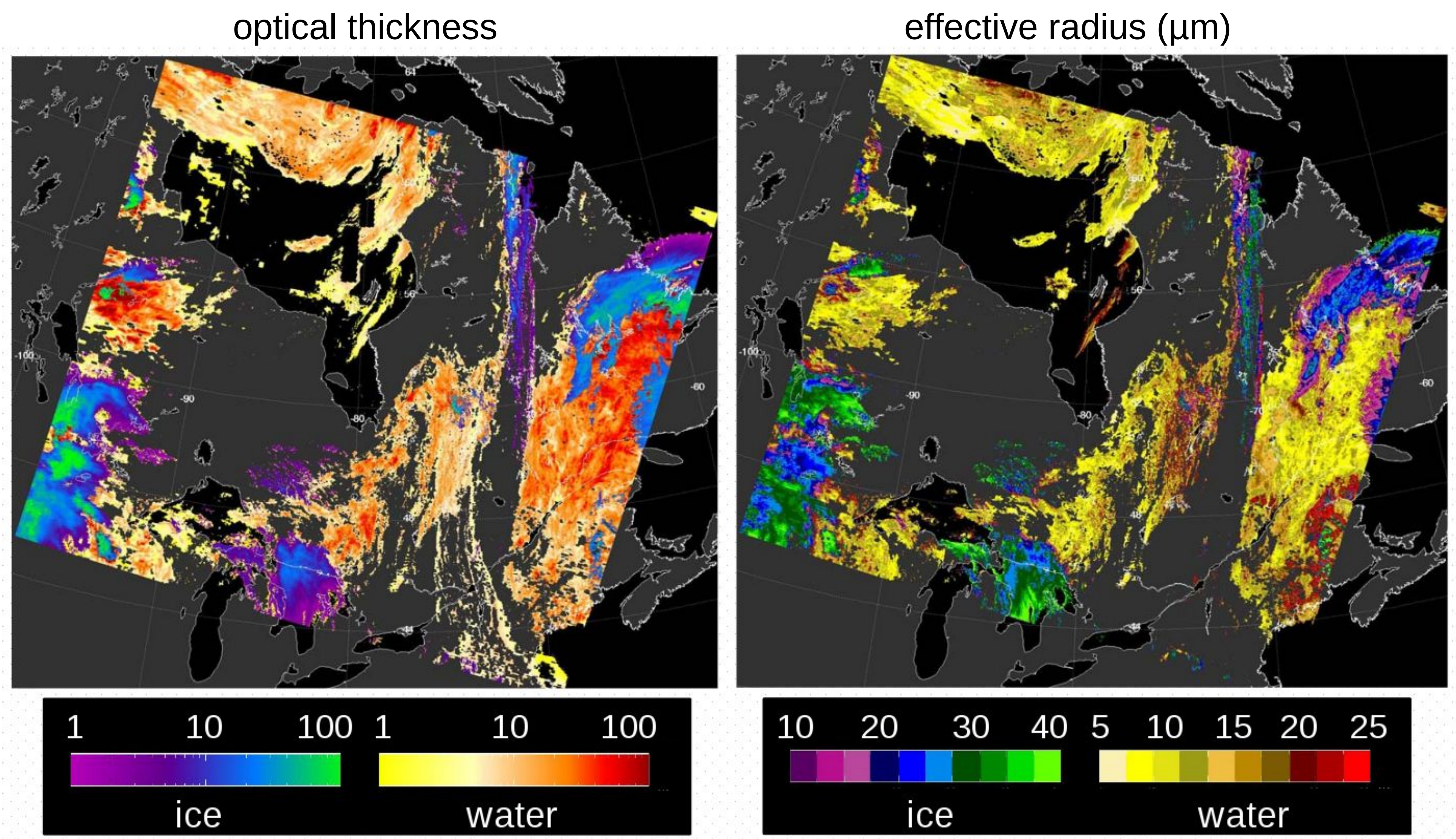
Context and Motivation

Our proposed contribution to SGLI/GCOM is on remote sensing of the following parameters using combination of multiangle, multispectral and polarimetric measurements from SGLI based on POLDER/MODIS experience :

– ***cloud thermodynamic phase*** *retrieval from polarimetric, shortwave infrared and thermal infrared measurements*
– ***cloud vertical structure*** *from exploitation of multiangle measurements in the O2 Aband and analysis of Rayleigh scattering polarisation signal*
– ***ice cloud microphysical properties*** *from multispectral (visible, near infrared) and polarimetric measurements*
– ***aerosols properties retrievals over clouds*** *from multispectral (visible, near infrared) and polarimetric measurements*

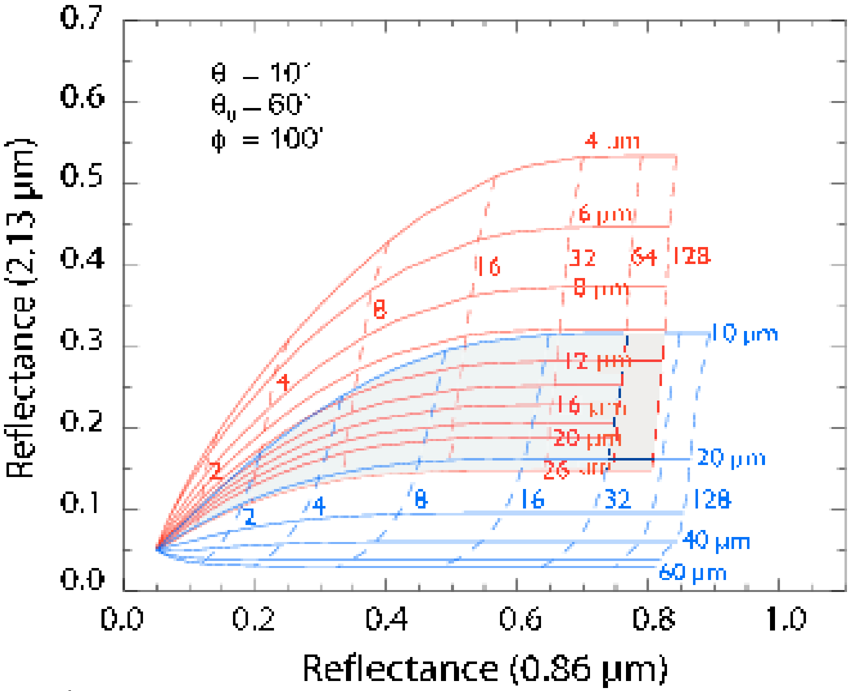
Contribution of LOA to SGLI / GCOM-C project intended at providing the necessary understanding and experience to get the best out of SGLI sensor.

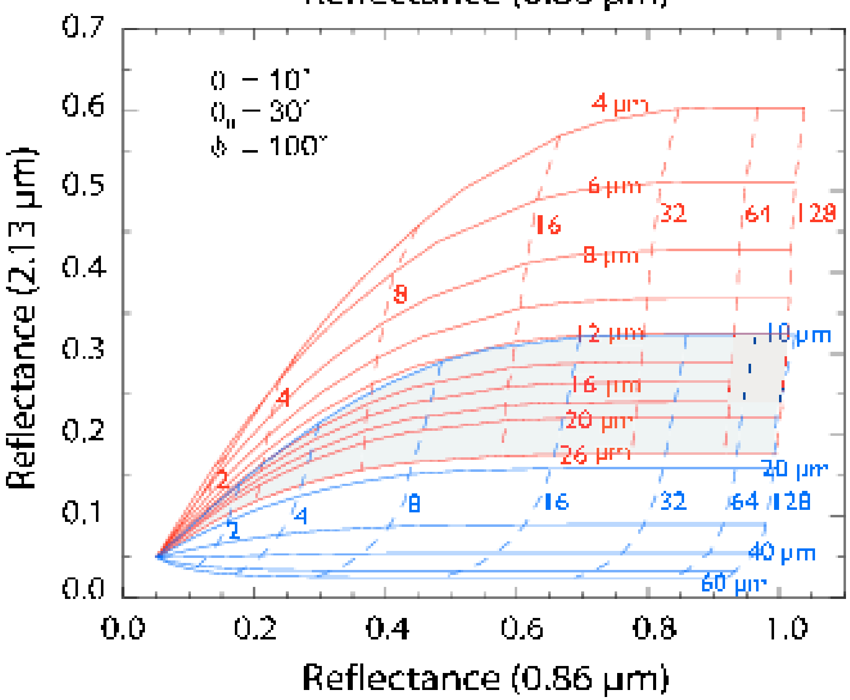
Optical Thickness, Effective Radius Retrievals



Platnick, S., M. D. King, S. A. Ackerman, W. P. Menzel, B. A. Baum, J. Riedi, and R. A. Frey, 2003: The MODIS cloud products: Algorithms and examples from Terra. IEEE Trans. Geosci. Remote Sens., 41, 459-473 – Image courtesy S. Platnick

Optical Thickness, Effective Radius Retrievals





Which cloud phase should we use ?

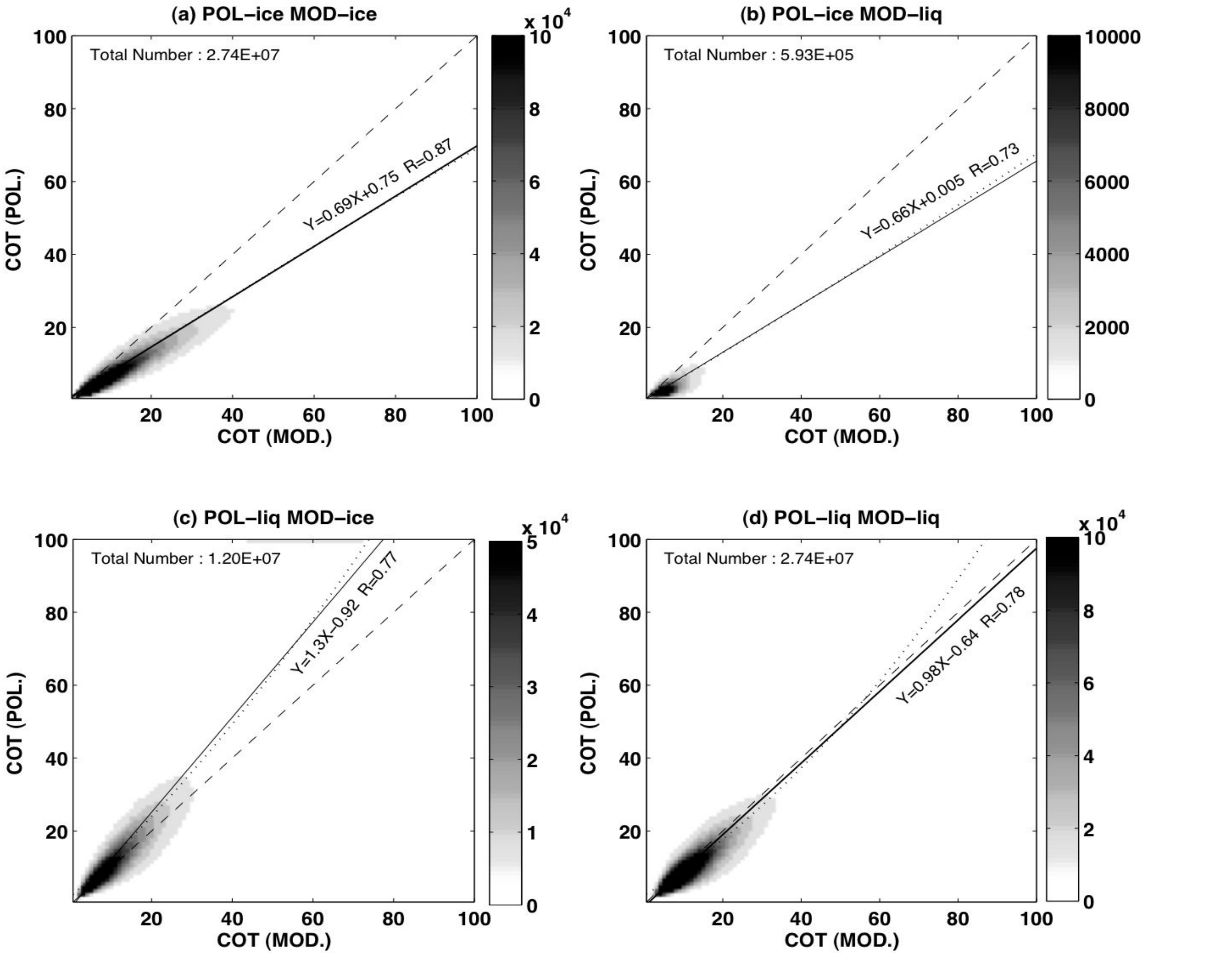
If ice cloud → which microphysical properties ?

What are the corresponding optical properties ?

Particle size and habit distribution ?

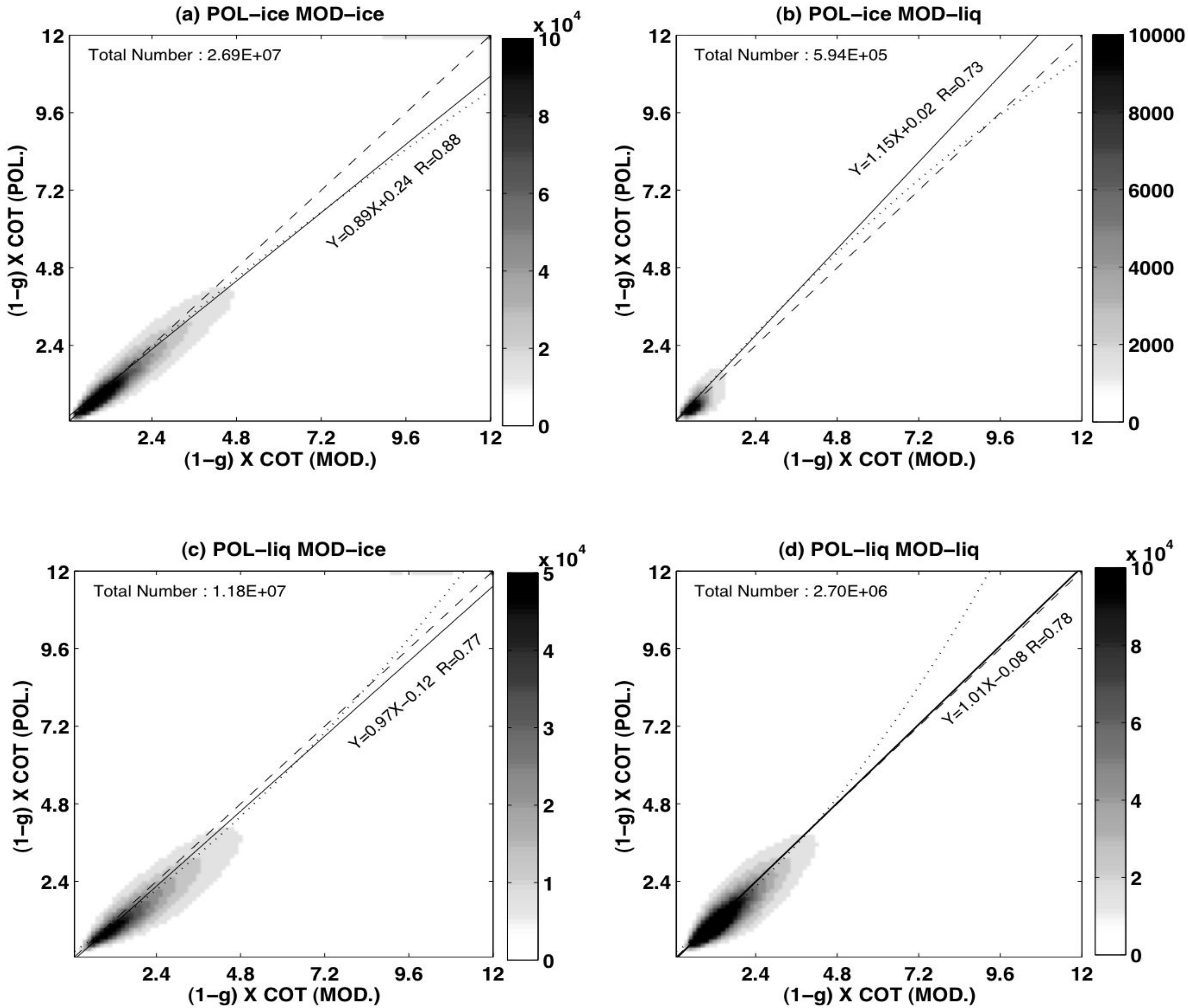
How do we extend retrievals when additional channels are available ?

POLDER vs MODIS Optical thickness



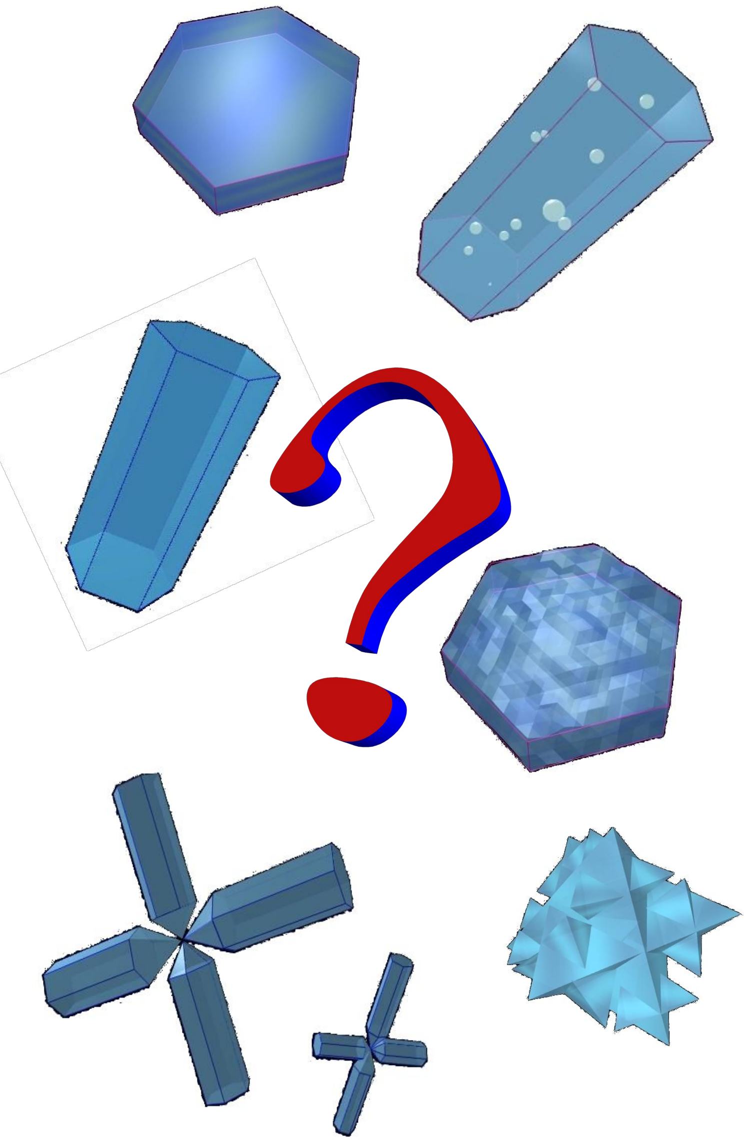
S. Zheng – PhD Thesis 2011

POLDER vs MODIS Scaled Optical thickness : Tau* = (1-g) Tau



S. Zheng – PhD Thesis 2011

Science rationale : model ice crystal properties



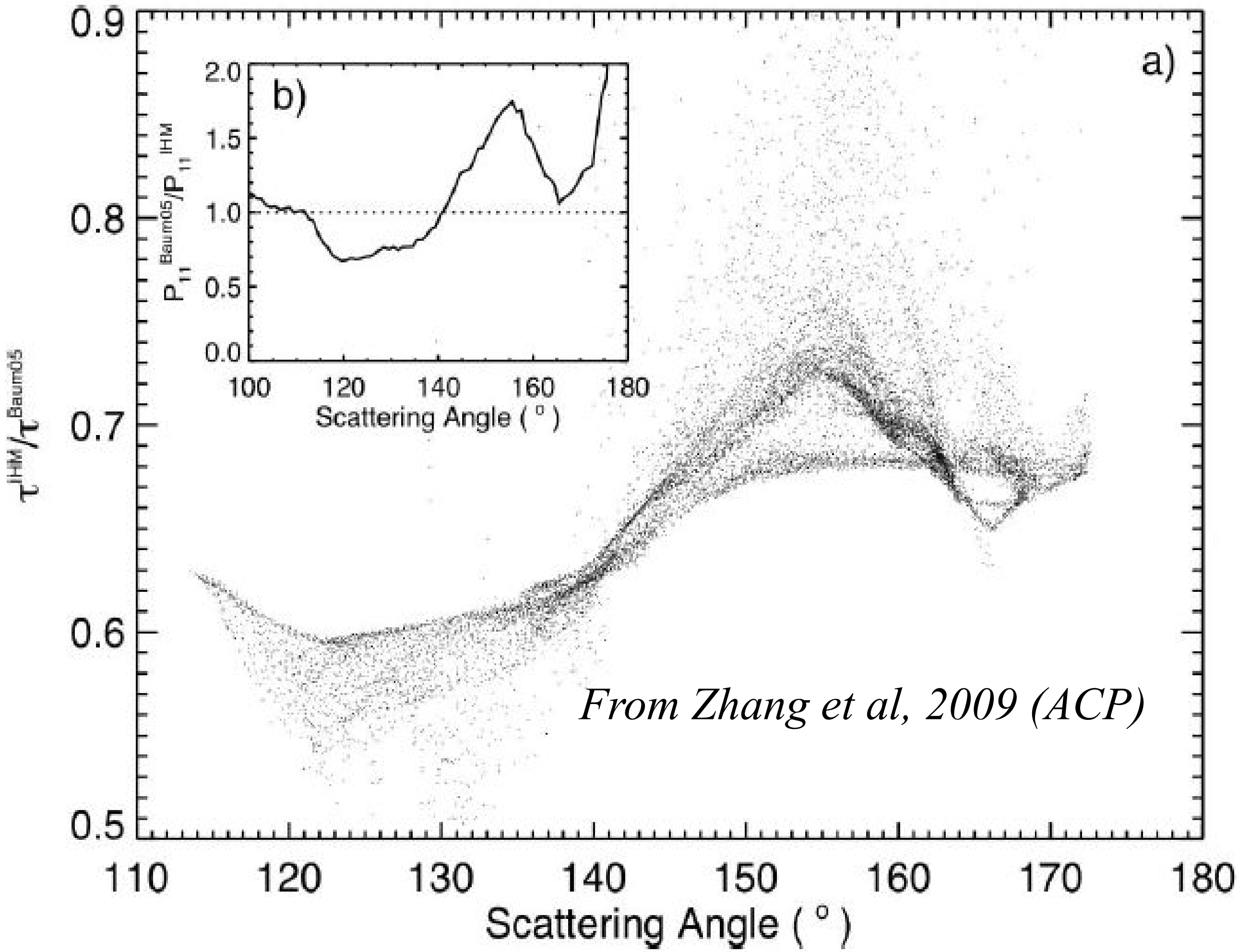


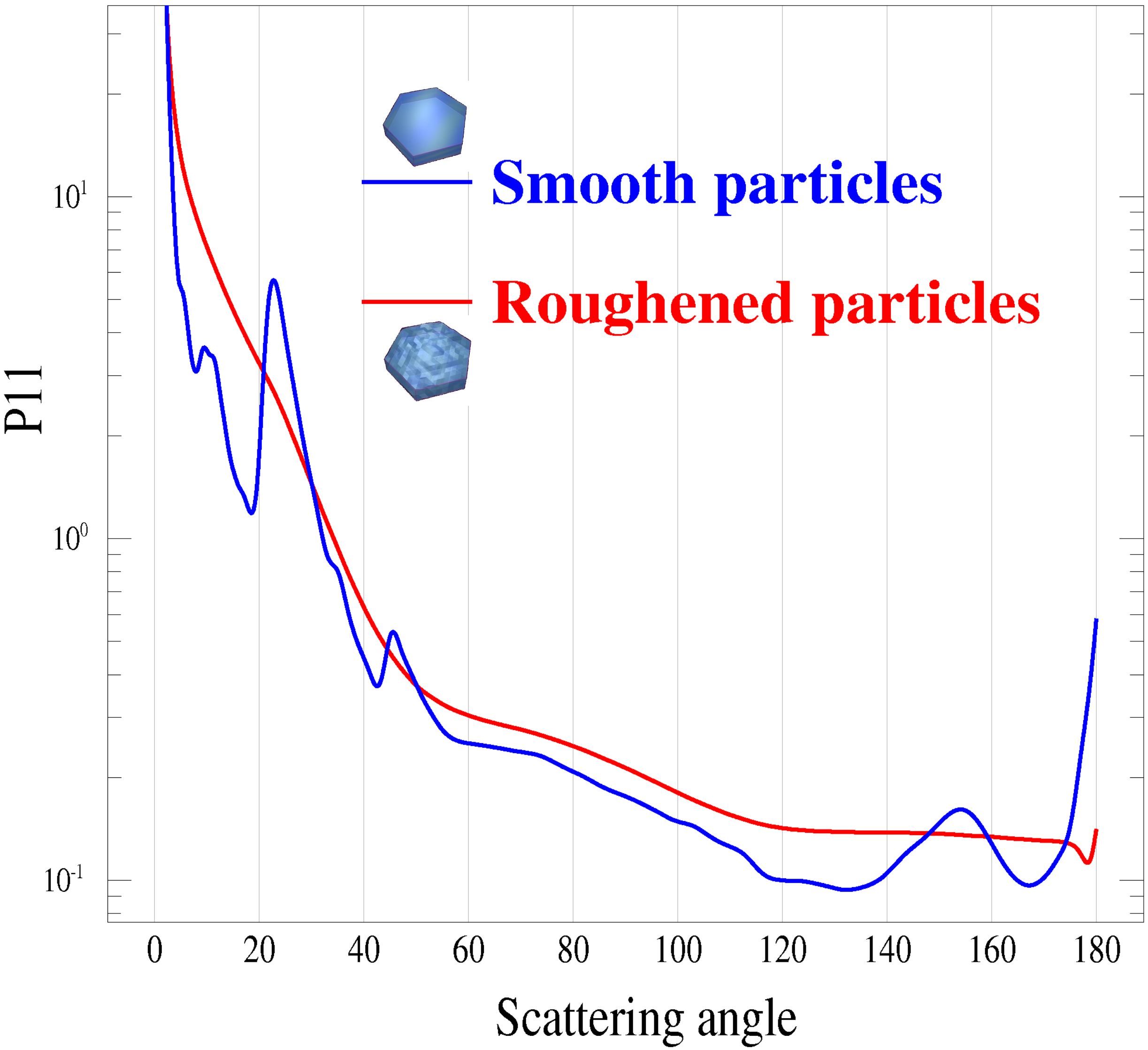
Fig. 7. The ratio of **(a)** $\tau_c^{\mathrm{IHM}}/\tau_c^{\mathrm{Baum05}}$ and **(b)** $P_{11}^{\mathrm{Baum05}}/P_{11}^{\mathrm{IHM}}$ as a function of scattering angle.

Angular reflectance features act as fingerprints of particle shapes

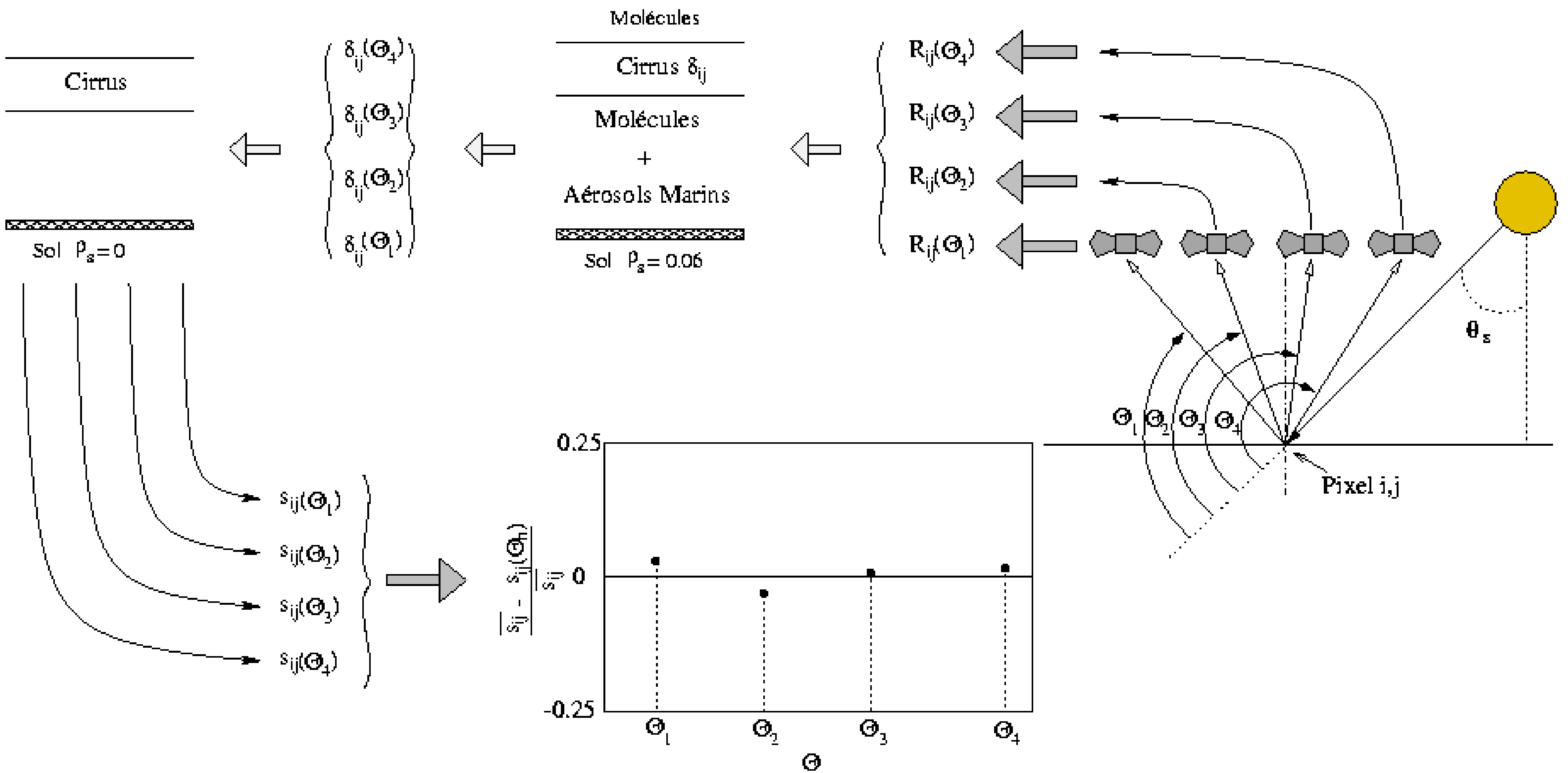
Phase functions of pristine or heterogeneous particles are very different :

- Pristine (smooth) hexagonal particles tend to produce marked angular features in the phase function which remain in observed distribution of angular reflectance

- Features vanish when surfaces are roughened or heterogeneities are introduced.

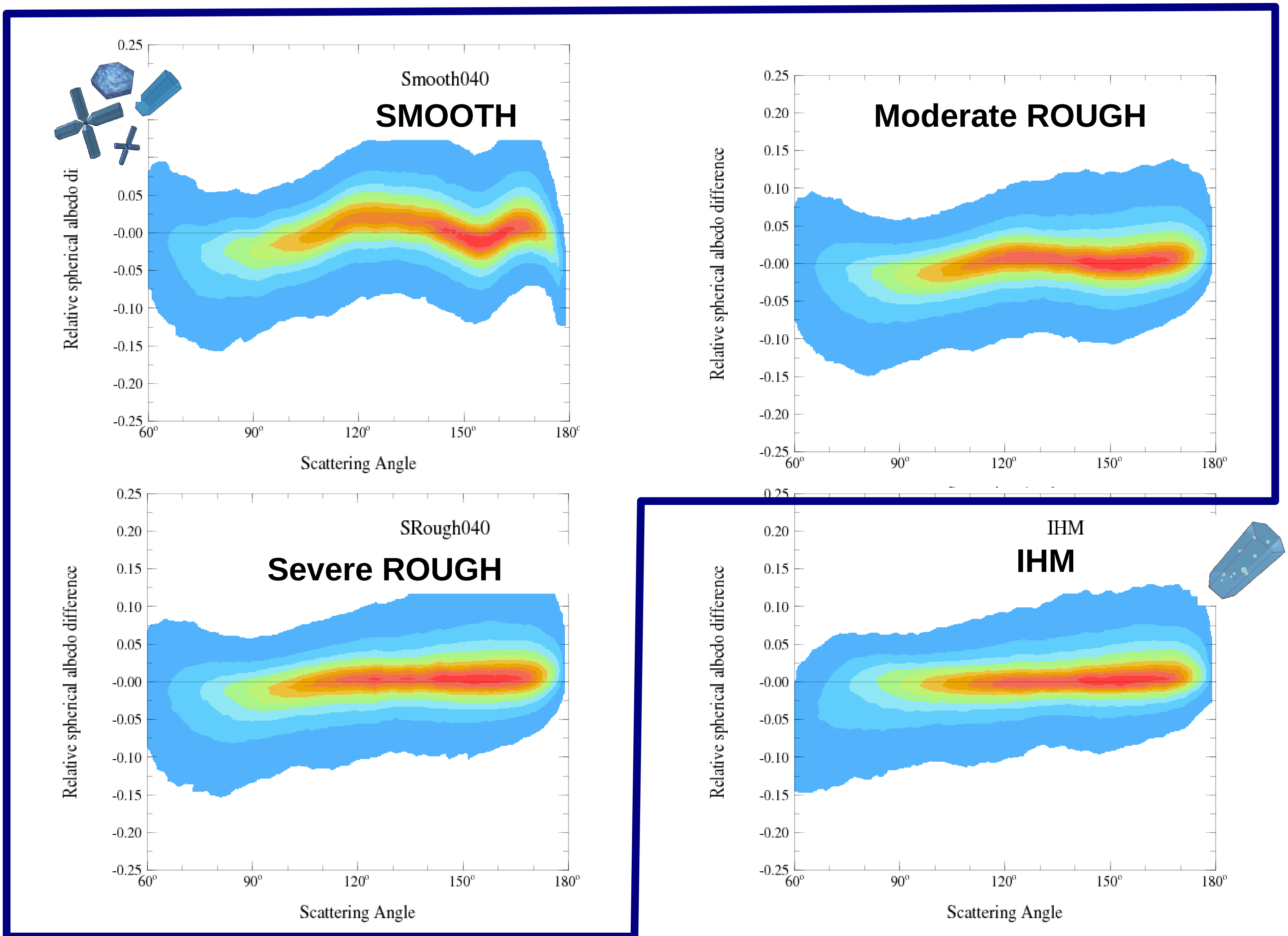


Testing cloud models from multiangle observation



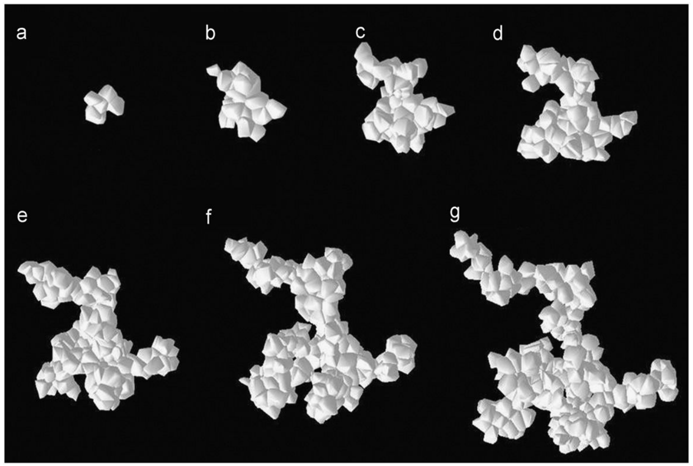
From L. Labonnote PhD Thesis – 2001

Cole, B., P. Yang, B. A. Baum,J. Riedi, L. Labonnote, F. Thieuleux, and S. Platnick (2012) Comparison of PARASOL observations with polarized reflectances simulated using different ice habit mixtures. J. Appl. Meteor. Clim., 52, 186-196.



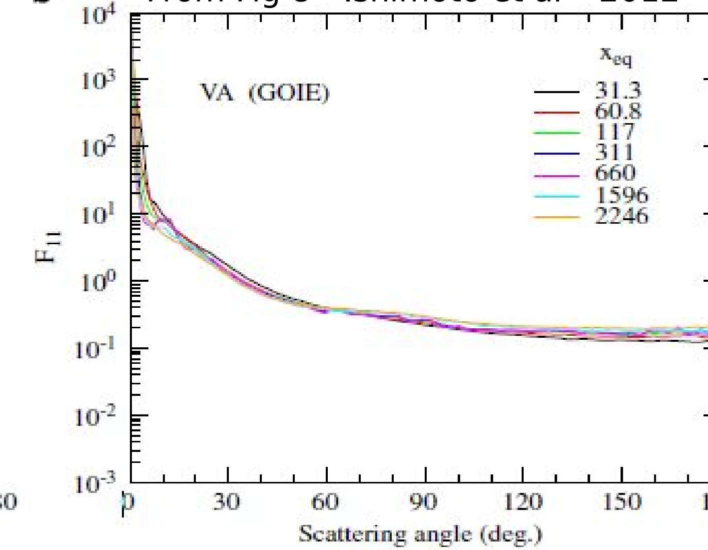
H. Ishimoto, K. Masuda, Y. Mano, N. Orikasa, A. Uchiyama : Irregularly shaped ice aggregates in optical modeling of convectively generated ice clouds Journal of Quantitative Spectroscopy and Radiative Transfer, Volume 113, Issue 8, May 2012, Pages 632-643

H. Letu, T. Y. Nakajima, and T. N. Matsui, "Development of an ice crystal scattering database for the global change observation mission/second generation global imager satellite mission: investigating the refractive index grid system and potential retrieval error," Appl. Opt. 51, 6172-6178 (2012)

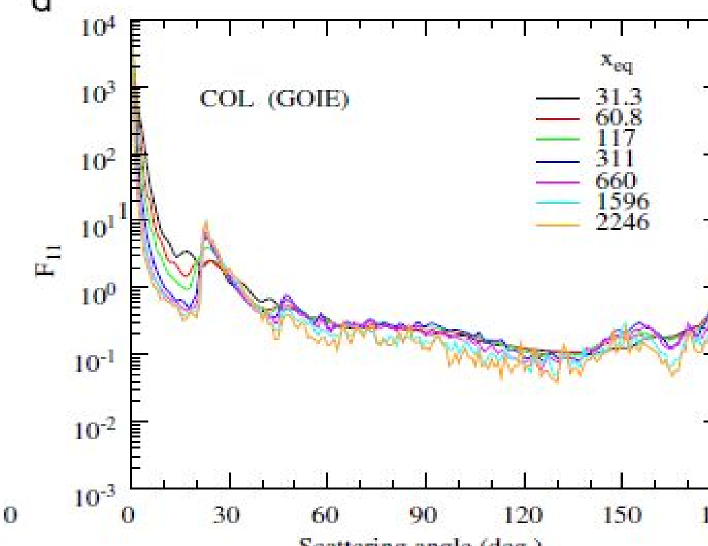


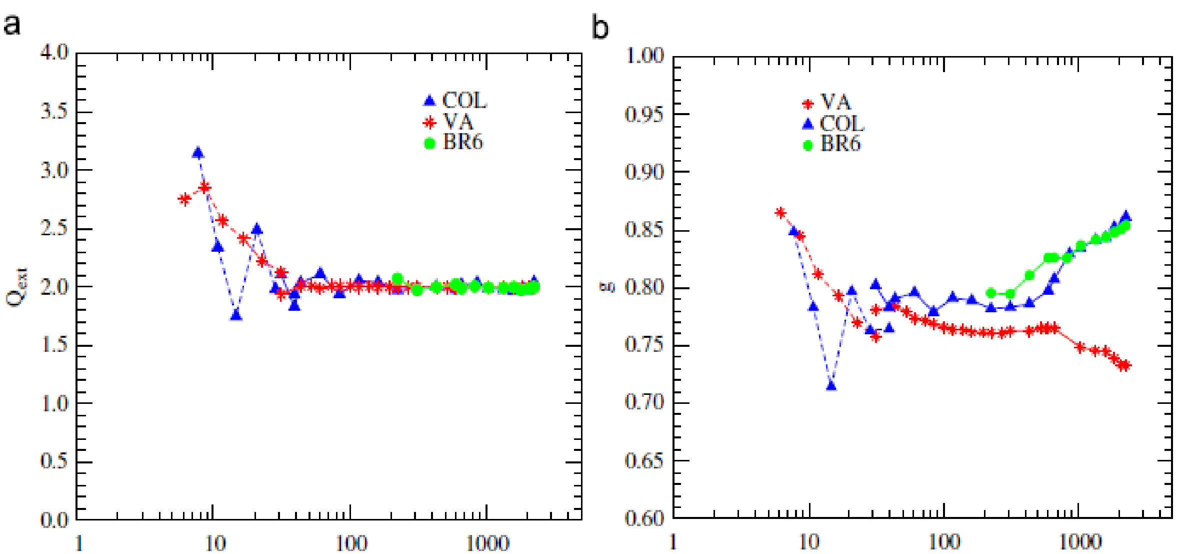
Numerically created Voronoi aggregates for a model of irregular ice particles. (from Ishimoto et al – 2012 - Fig 3.)

b From Fig 8 - Ishimoto et al – 2012



d

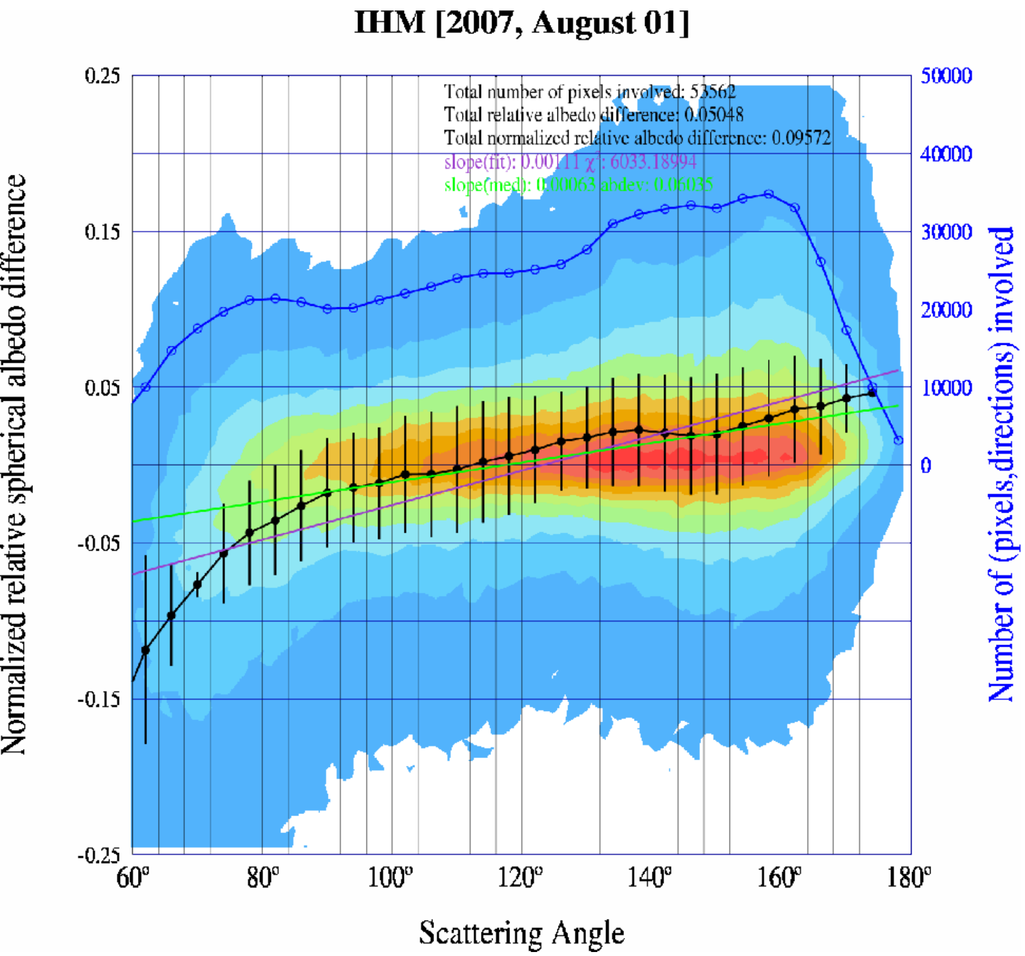


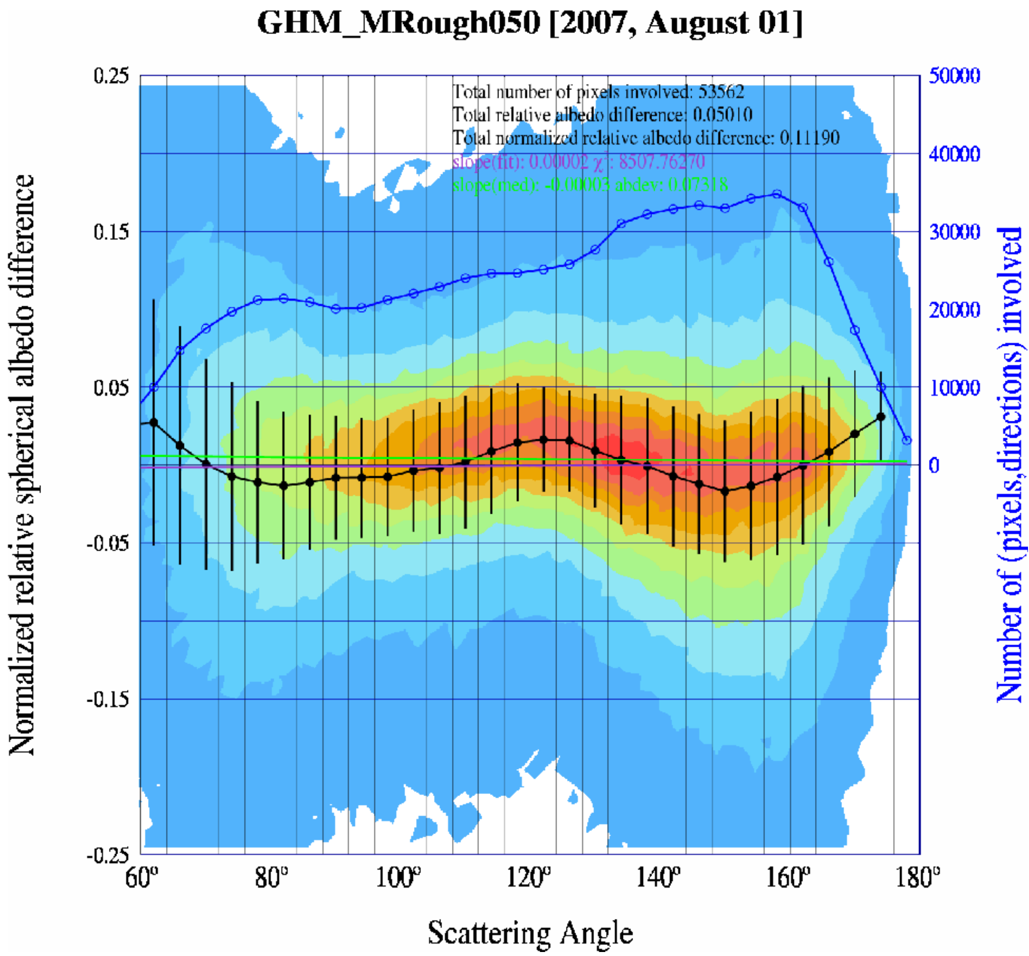


From Fig 10 Ishimoto et al – 2012

RESULTS OF SAD TEST FOR IHM AND Roughened GHM

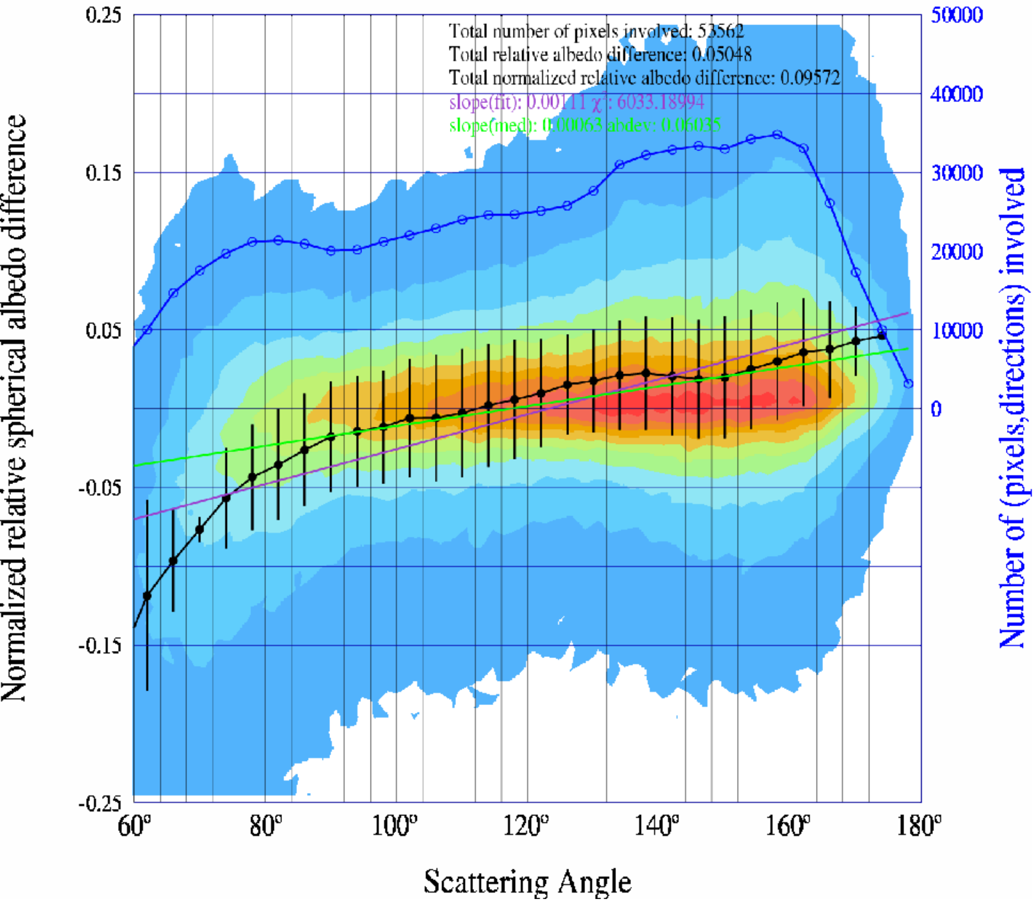
IHM : Inhomogeneous Hexagonal Model (Labonnote et al)
GHM : Generalized Habit Mixture (Baum et al, Yang et al)



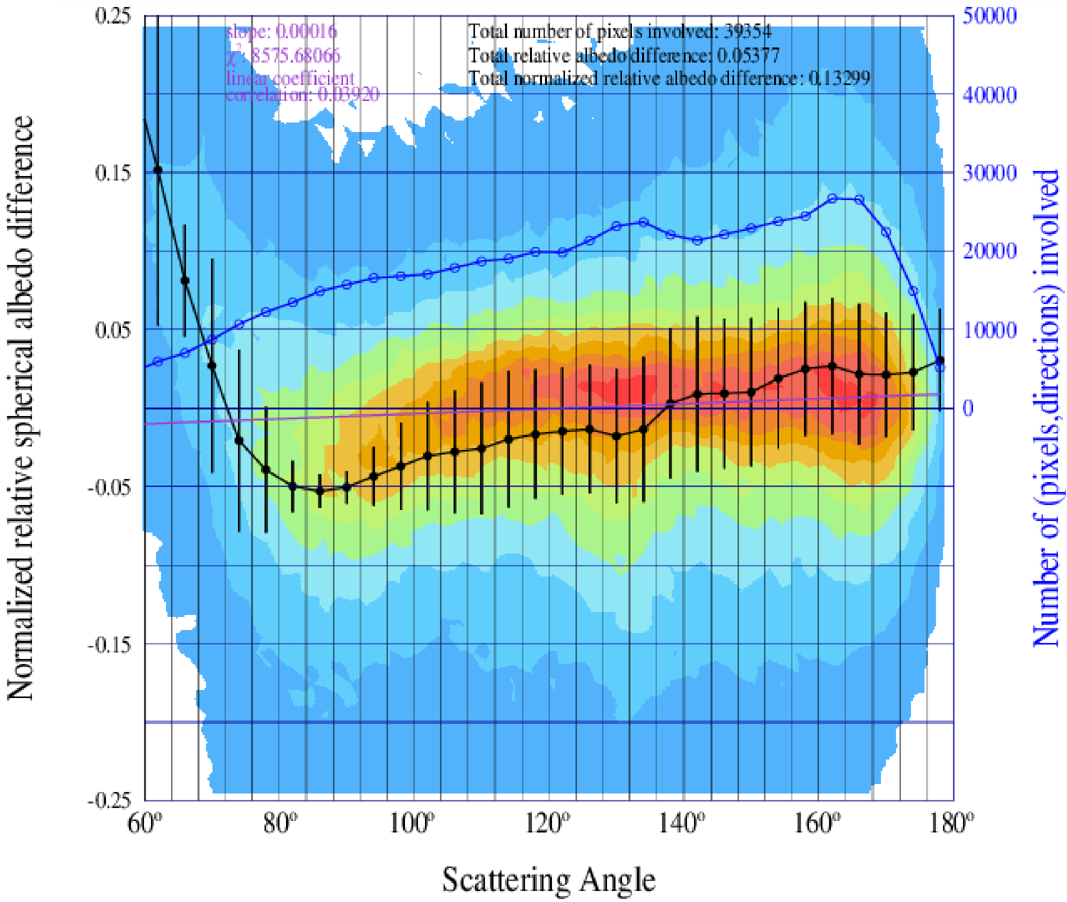


RESULTS OF SAD TEST FOR IHM AND VORONOI AGGREGATE

IHM

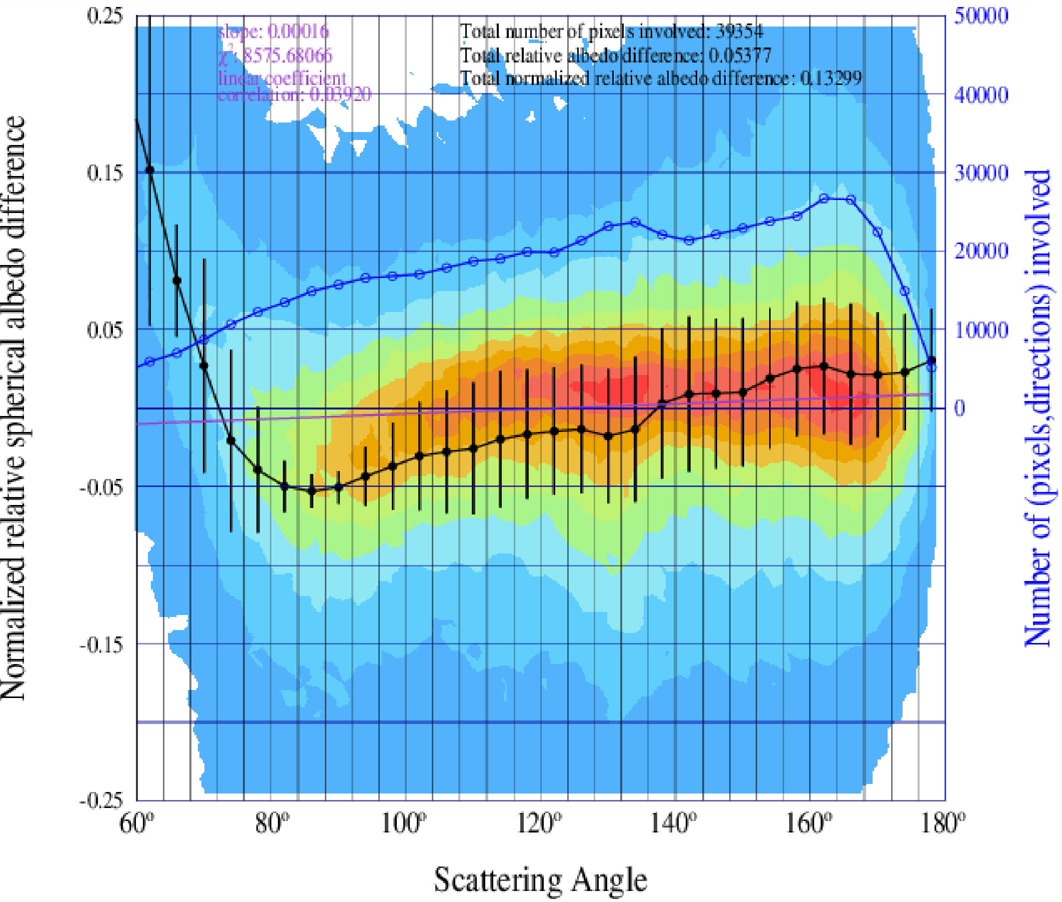


VORONOI AGGREGATE

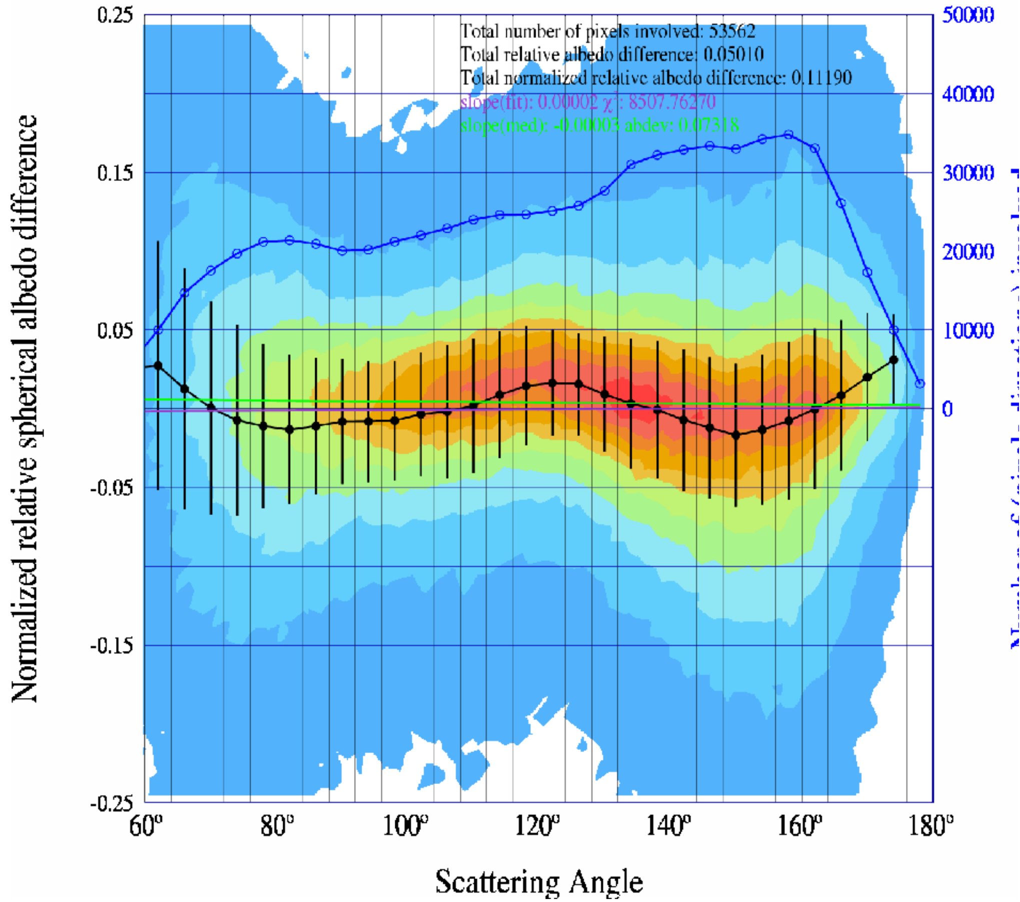


RESULTS OF SAD TEST FOR GHM AND VORONOI AGGREGATE

VORONOI AGGREGATE



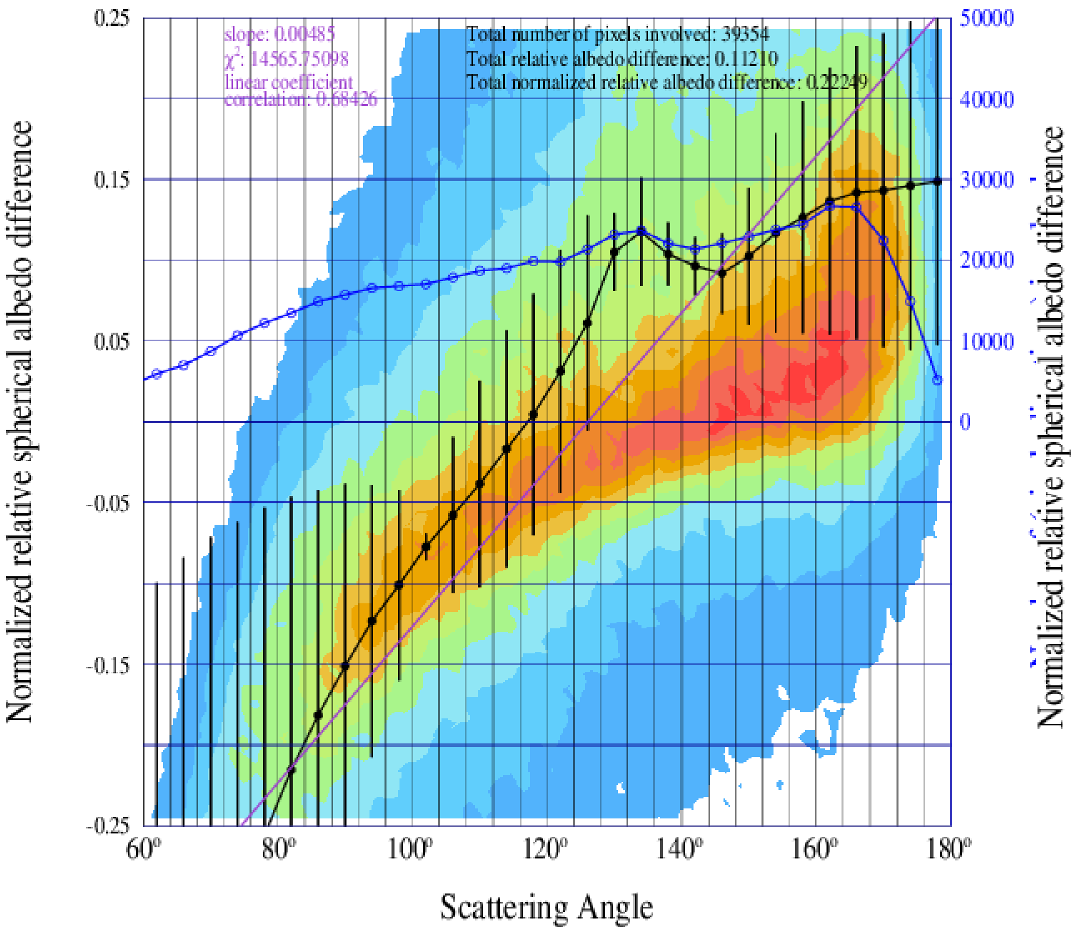
MODERATE ROUGH GHM



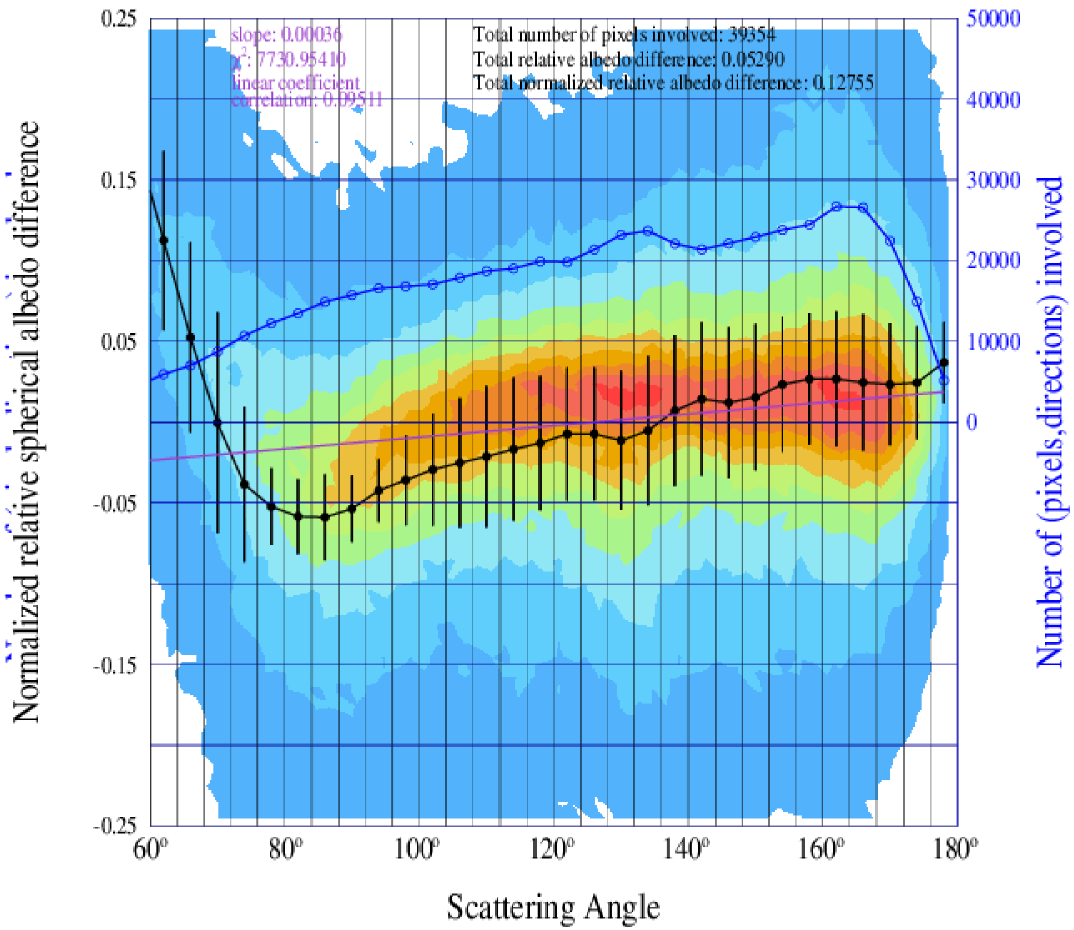
RESULTS OF SAD TEST FOR VORONOI AGGREGATE

CRYSTAL SIZE IMPACT ?

VERY SMALL (higher Qext and g)



LARGE



Information content analysis for cloud retrieval using multispectral polarization observation

- Motivation : Retrieve more information on cloud properties beyond (Tau,Reff) → access to vertical profile of cloud properties
- Goal : build a retrieval algorithm based on optimal estimation technique for SGLI and 3MI
- Approach : extend bispectral retrieval of cloud properties to use all information available from SGLI and then 3MI
- Methodology : perform an information content analysis to define accessible parameters from multispectral polarized observation

Information content analysis for cloud retrieval using multispectral polarization observation

We evaluate degree of freedom (DOF) for a given observation and state vector

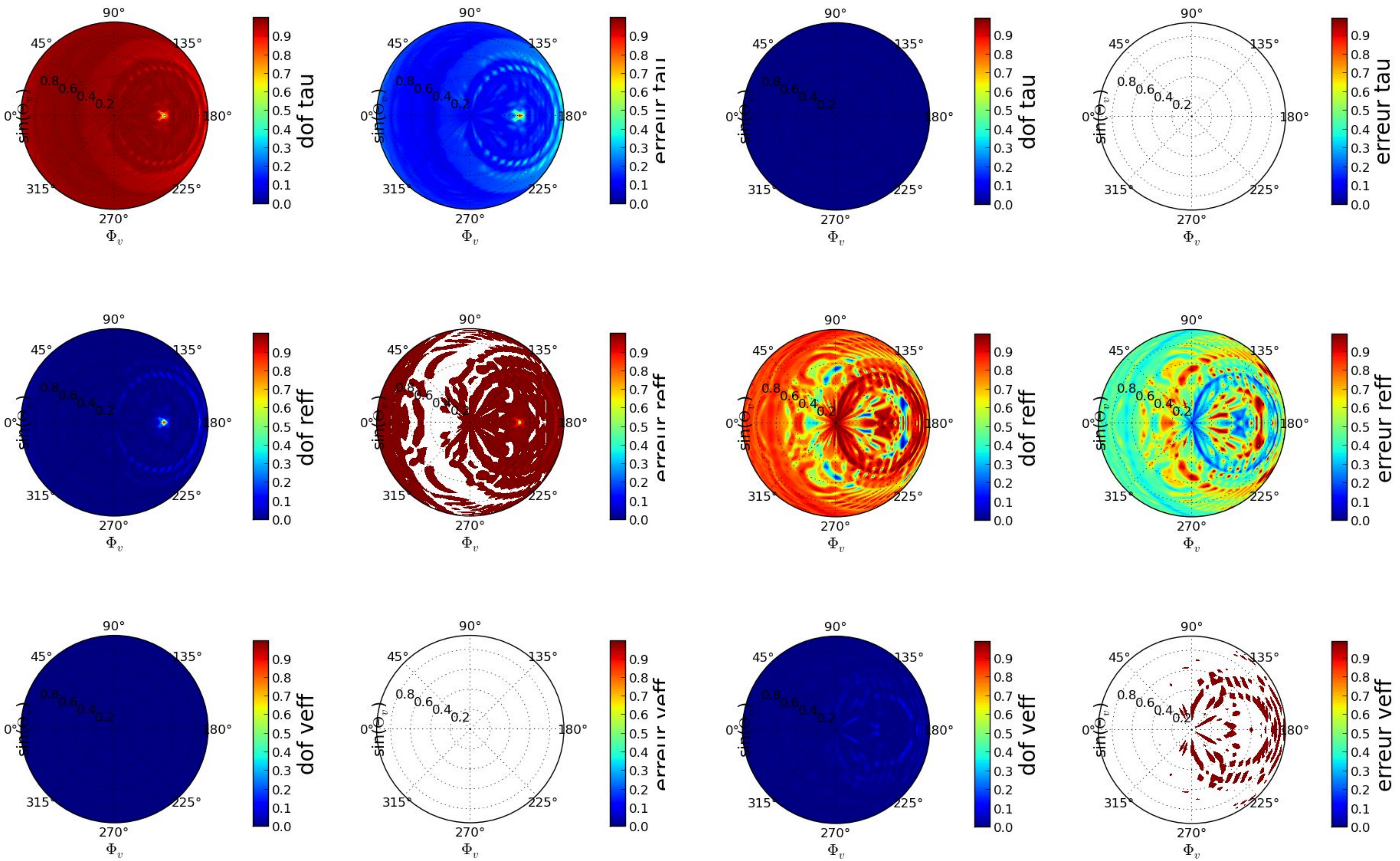
If DOF > 0.5 parameter can be retrieved from the given observation vector.

We first analyze single view measurements using 2 channels and compared with and without polarisation

Analysis if performed for all accessible geometries → representation in polar diagram with sun geometry fixed.

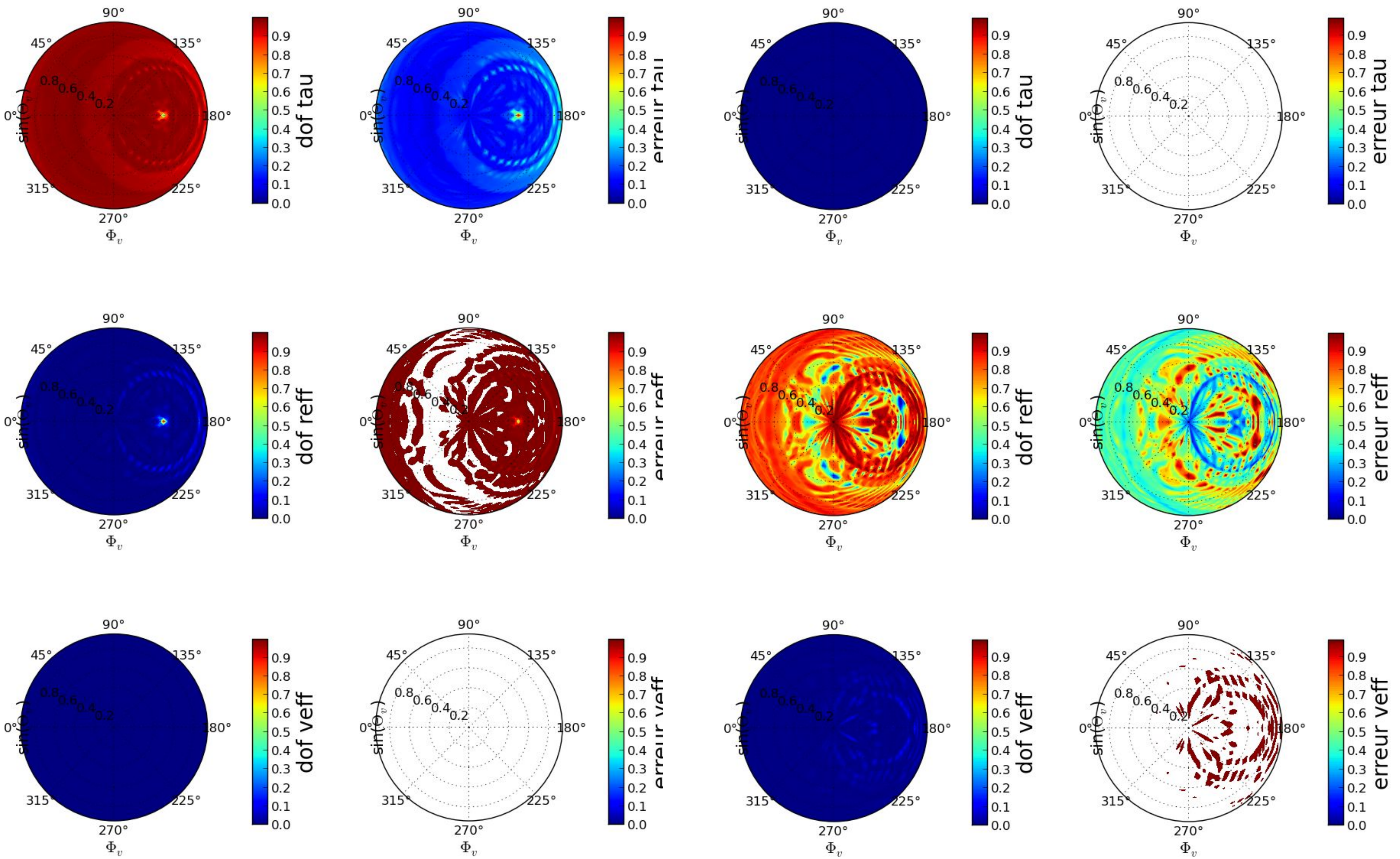
Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, ve=0.02, sza=30
Wv=0,670 (1 channel observation vector)

Total reflectance | Polarized reflectance



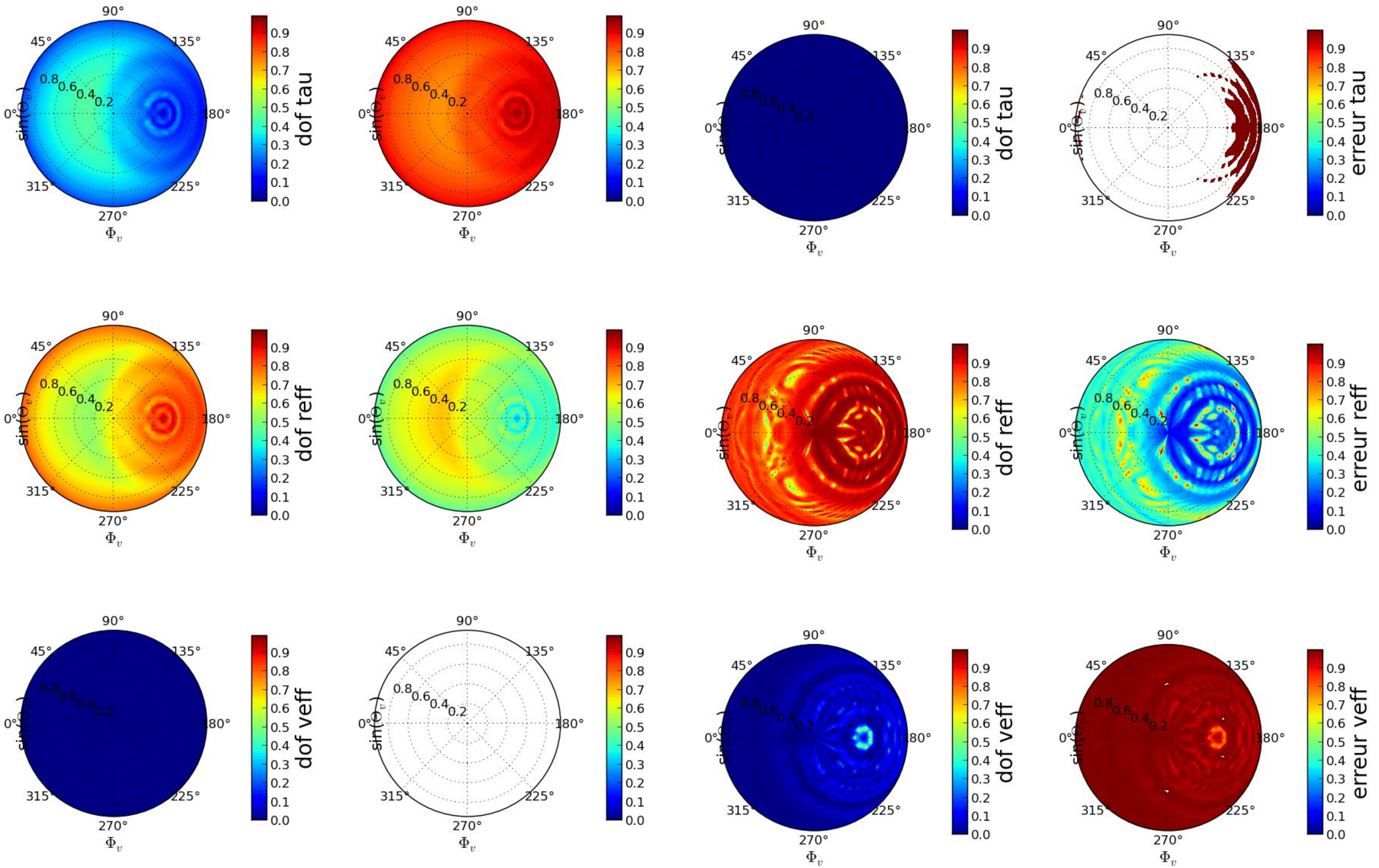
Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, ve=0.02, sza=30
Wv=0,670 (1 channel observation vector)

Total reflectance | Polarized reflectance



Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, ve=0.02, sza=30
Wv=2.2 micron (1 channel observation vector)

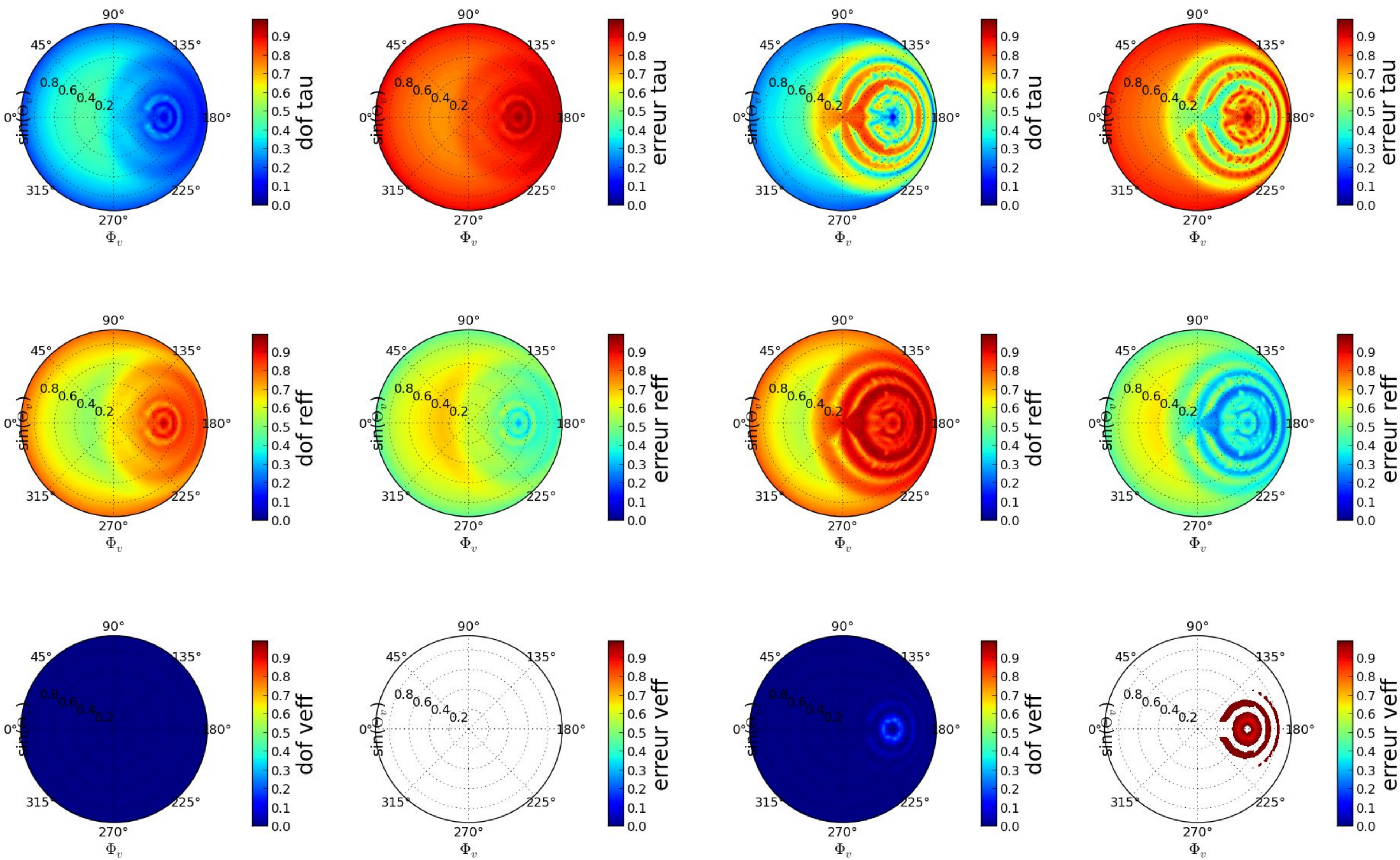
Total reflectance | Polarized reflectance



Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, ve=0.02, sza=30
Wv=2.2 micron (1 channel observation vector)

Total reflectance

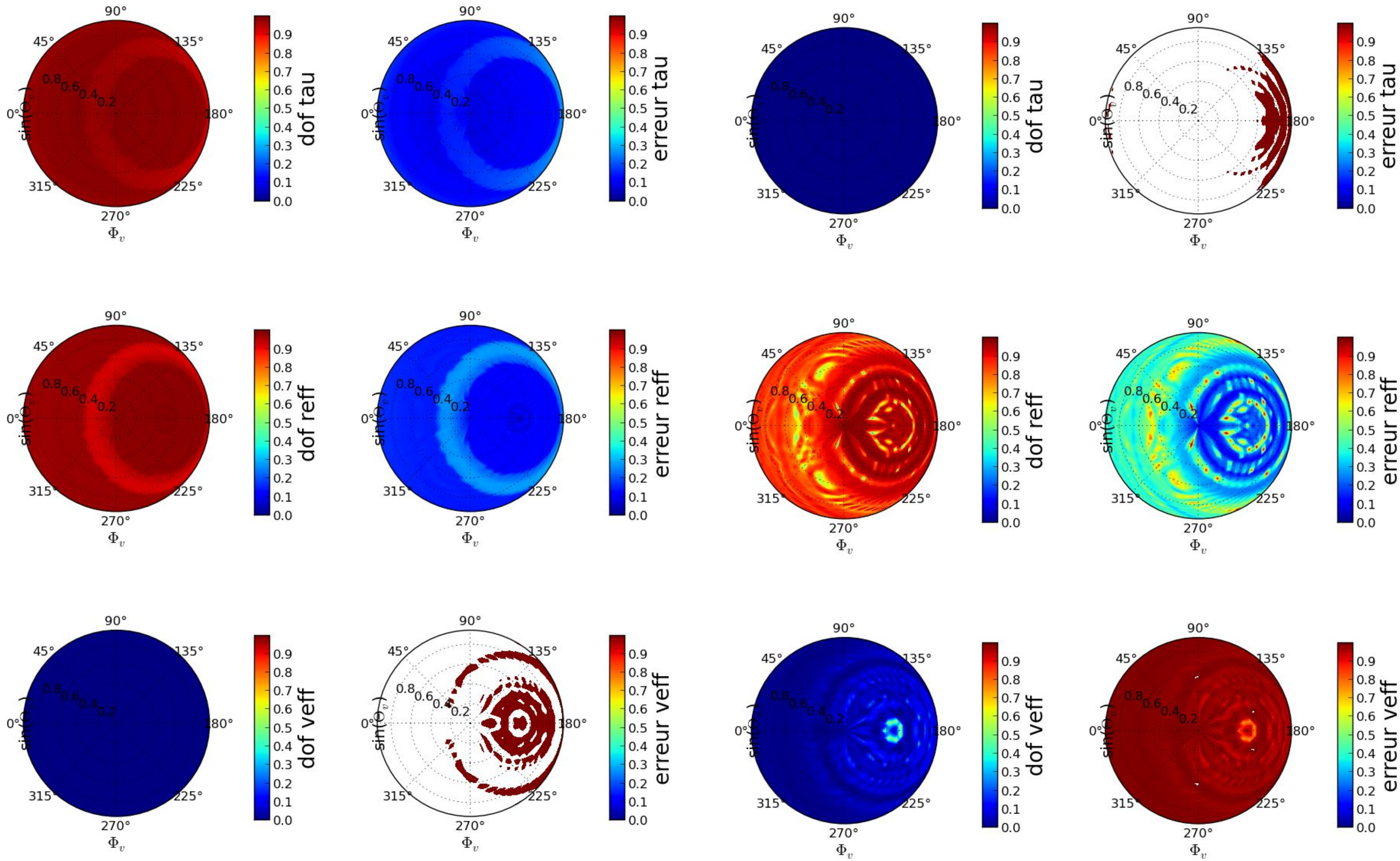
Polarized AND Total reflectance



Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, ve=0.02, sza=30
Wv=0.670 and 2.2 micron (2 channels observation vector)

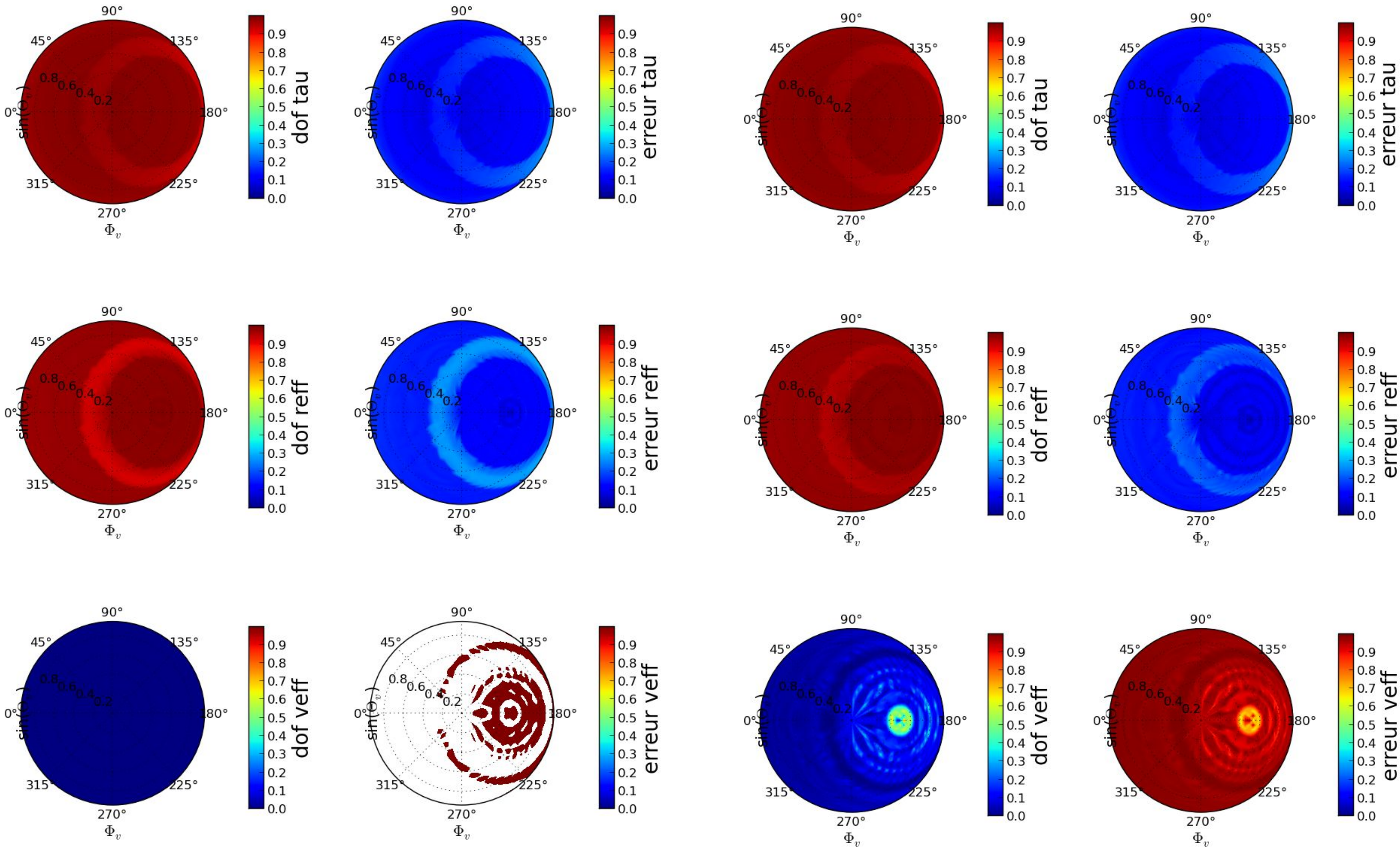
Total reflectance

Polarized reflectance



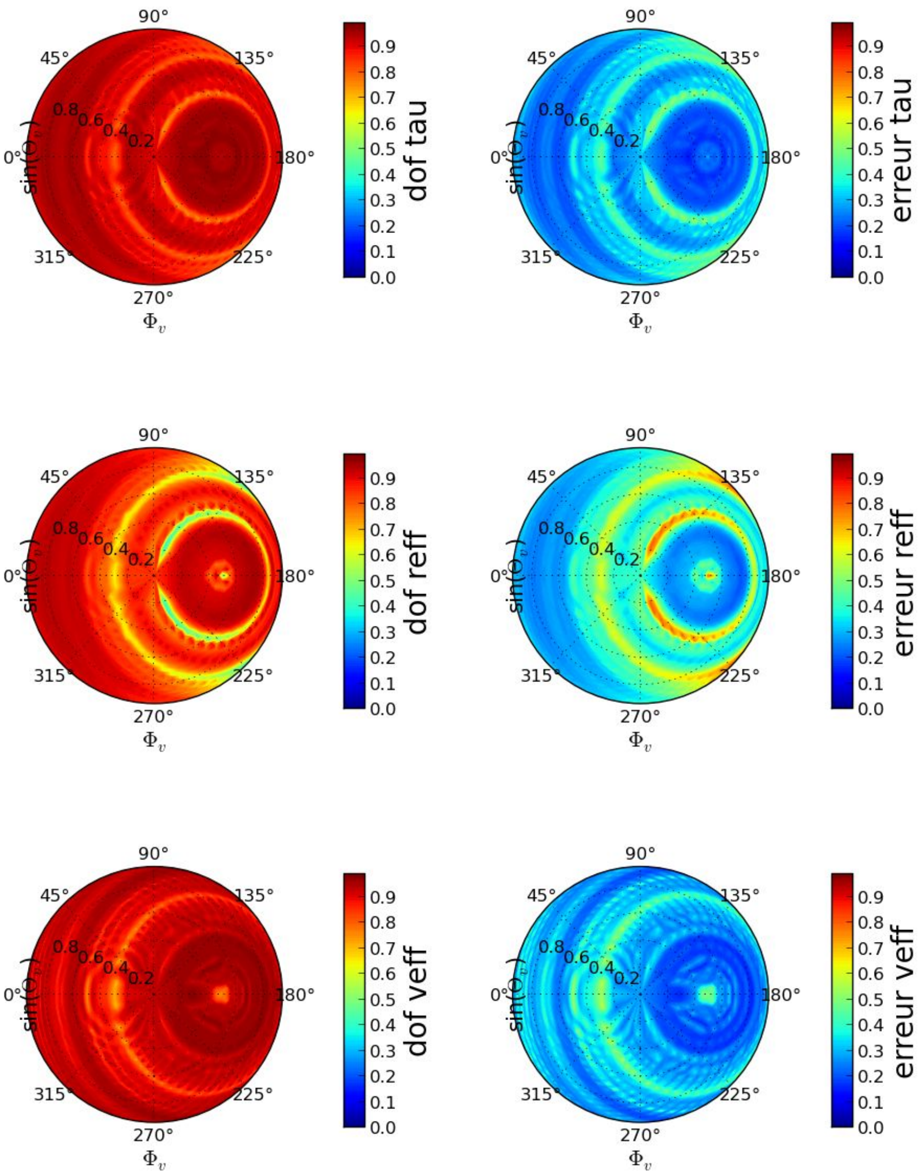
Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, ve=0.02, sza=30
Wv=0.670 and 2.2 micron (2 channels observation vector)

Total reflectance | Polarized AND total reflectance

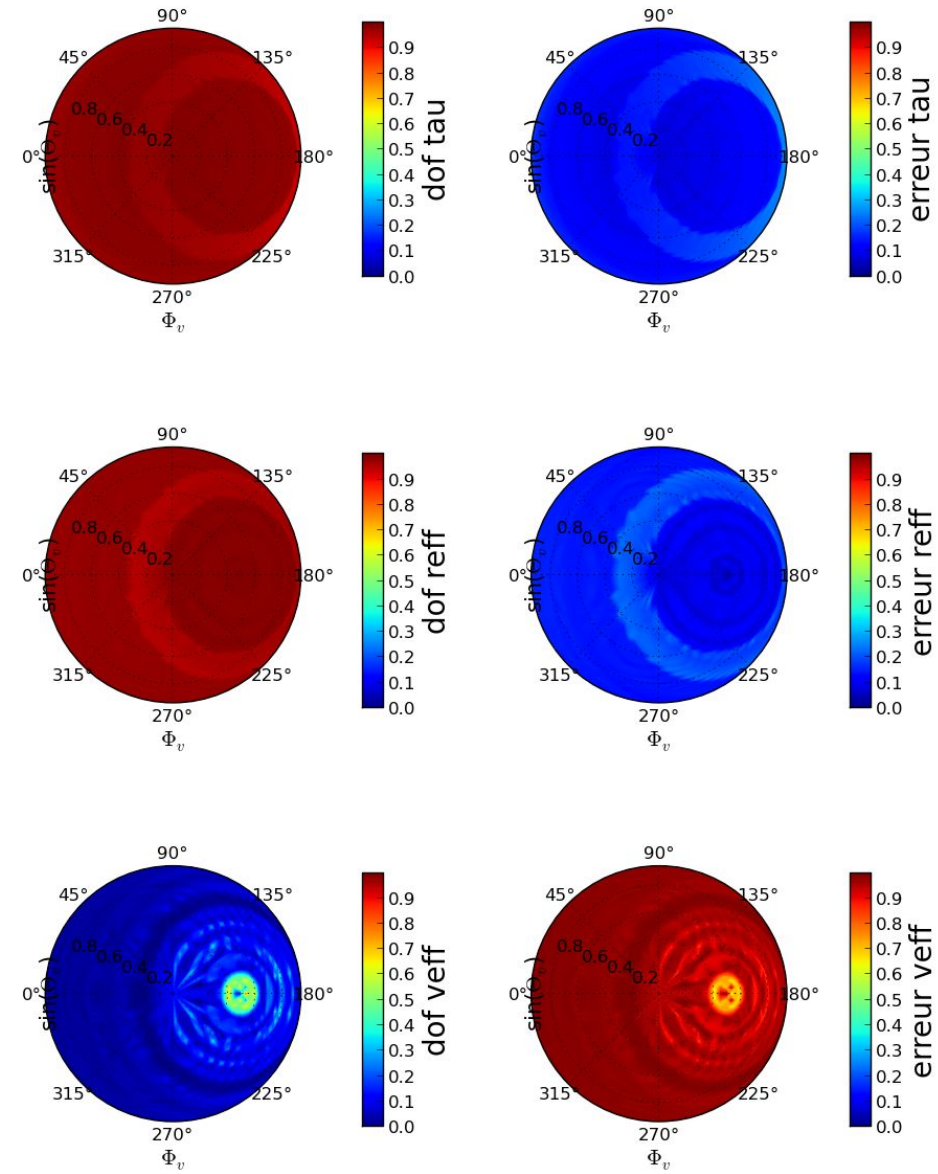


Retrieval of Tau, Reff and Veff (state vector)
Tau=10, re=10, sza=30
Wv=0.670 and 2.2 micron (2 channels observation vector)

Polarized AND total reflectance : Veff =0.15



Polarized AND total reflectance : Veff =0.02



Conclusions

- We are testing the proposed SGLI ice models librairies by means of SAD test :

  → Preliminary results look very encouraging : Voronoi aggregate models perform very similarly to currently best IHM or GHM models

  → Will finalize the analysis : perform full comparison with GHM models for all sizes and also test polarization consistency

- We have started investigating retrieval of cloud properties using single view 2 channels polarized and total reflectance observations :

  →Preliminary results show that Veff might be accessible depending on observation configuration and value

  → will continue analysis based on dual view geometry (SGLI)