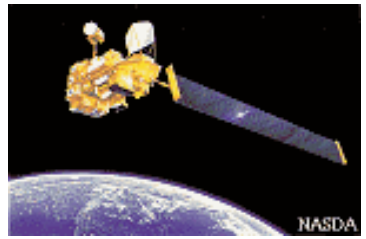

Retrieval of Ice Clouds Optical Thickness and Phase Functions using Multi-directional Measurement from POLDER

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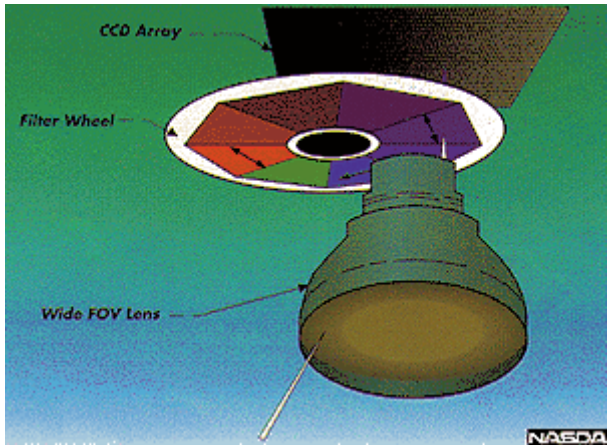
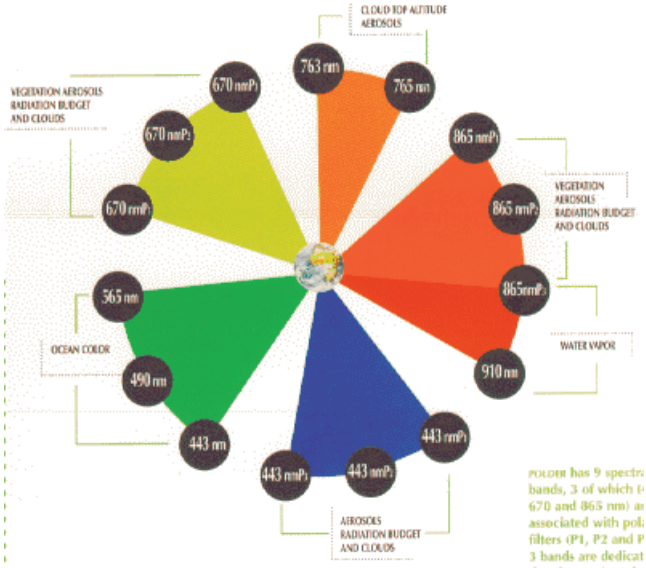
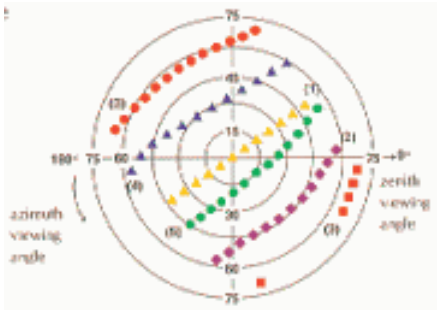
Introduction

Operational for eight months (from 30 October 1996 to 20 June 1997), POLDER (POLarization and Directionality of Earth Reflectances) is the first space instrument to simultaneously observe the polarization and the multi-spectral and directional signatures of reflected radiation.

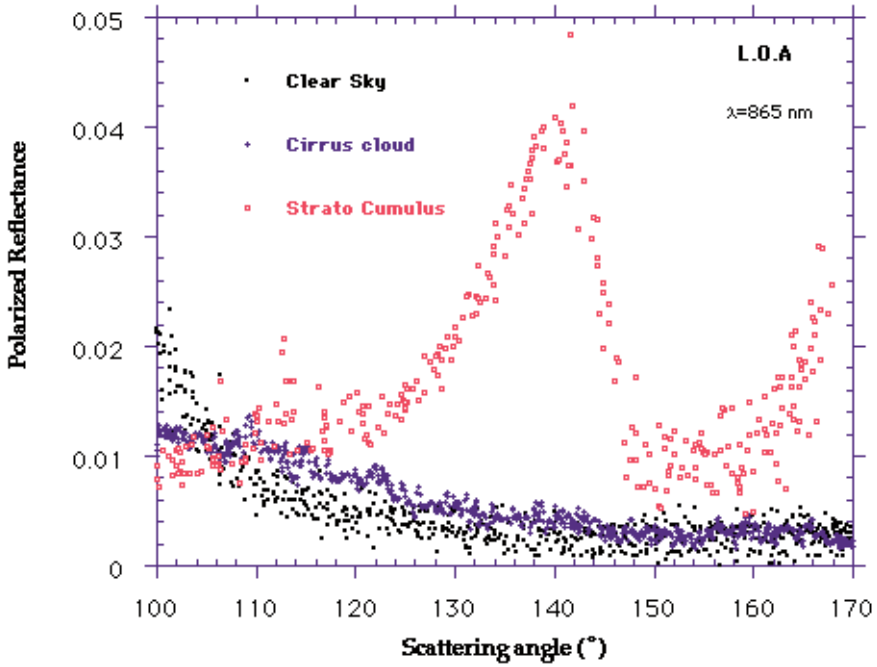


POLDER has 9 spectral bands, 3 of which (443, 670 and 865 nm) are associated with **polarized filters** (P1, P2 and P3).



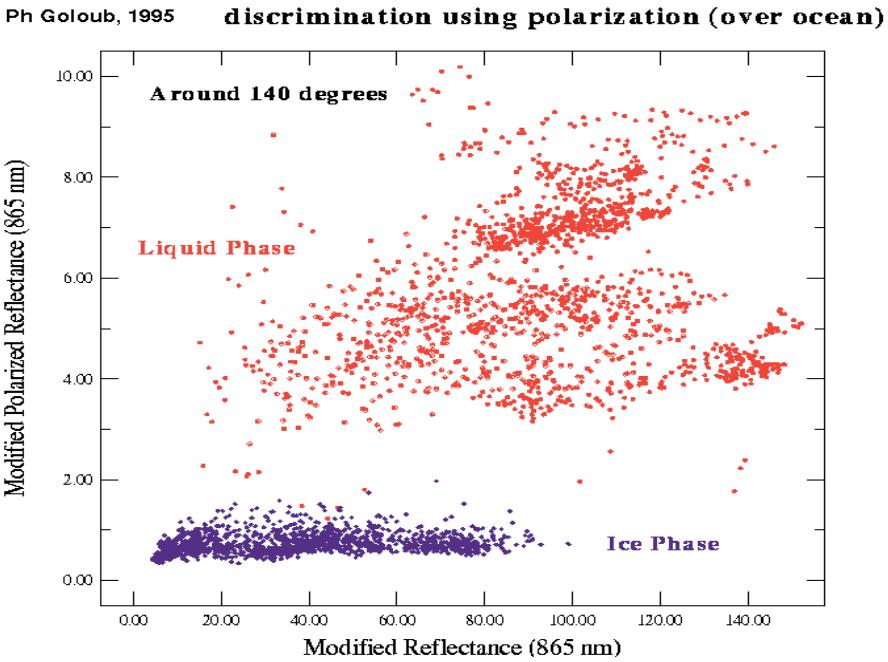


Representation in polar coordinates (zenith viewing angle, azimuth viewing angle, in degrees) of the successive viewing geometry for a target. For any target, up to 14 successive imagining sequences for a single satellite pass.



Typical Polarization Features (Liquid water cloud, Ice cloud, clear atmosphere) derived from the Polder Airborne version.

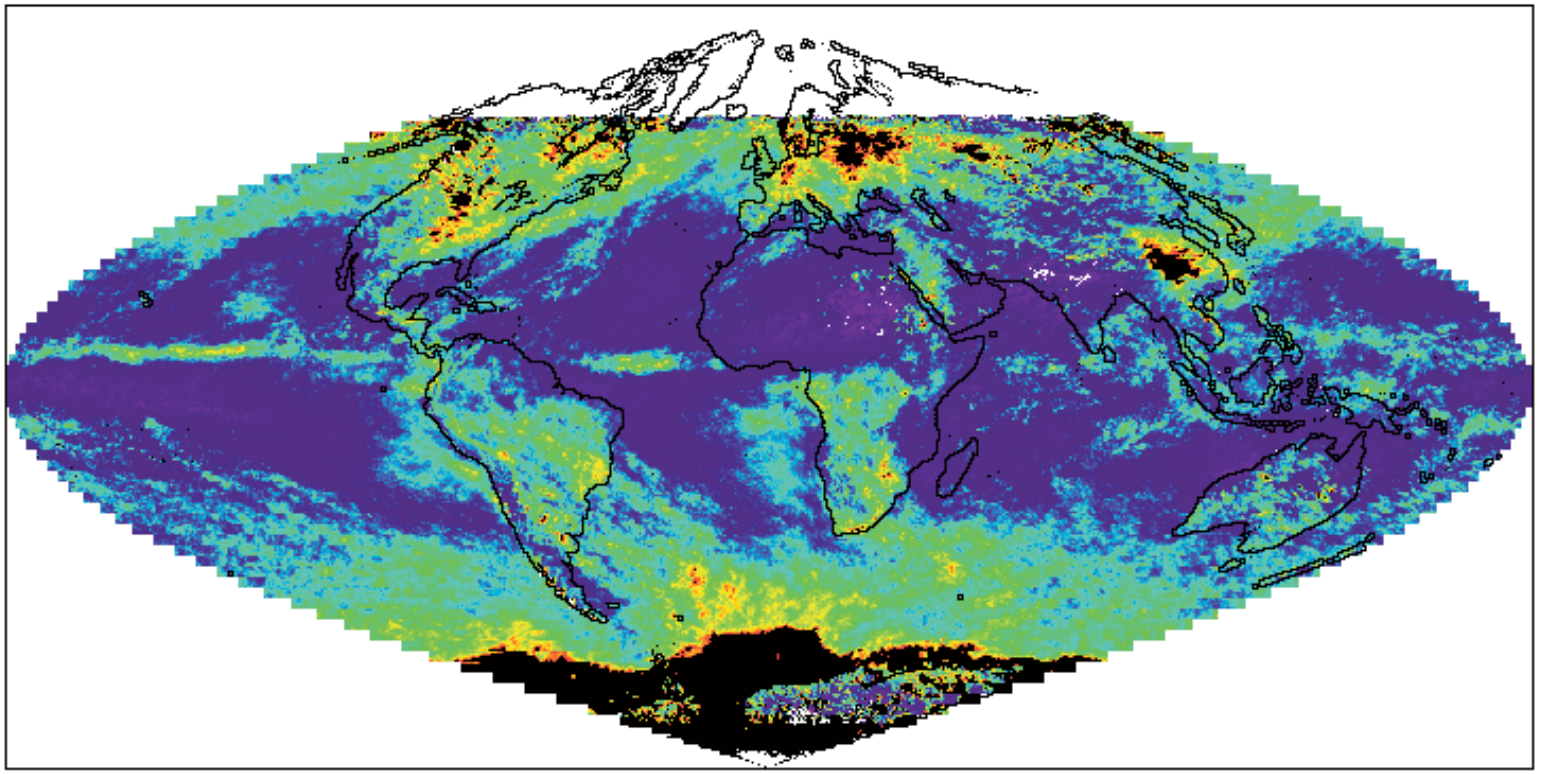
Polarized reflectance versus reflectance for cloud observations performed over ocean. Statistical result are derived from an amount of 3200 Polder images (airborne version). This plot outlines that the polarization is useful for the cloud thermodynamic phase discrimination.



Cloud optical thickness

from POLDER on ADEOS

November 1996



POLDER Data: CNES/NASDA
Processing: LOA/LSCE

Scheme

Quality Control

Normalization

Lookup Table

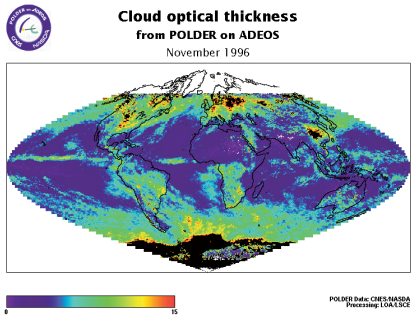
Normalized radiance
as function of azimuth
and zenith angles

↓

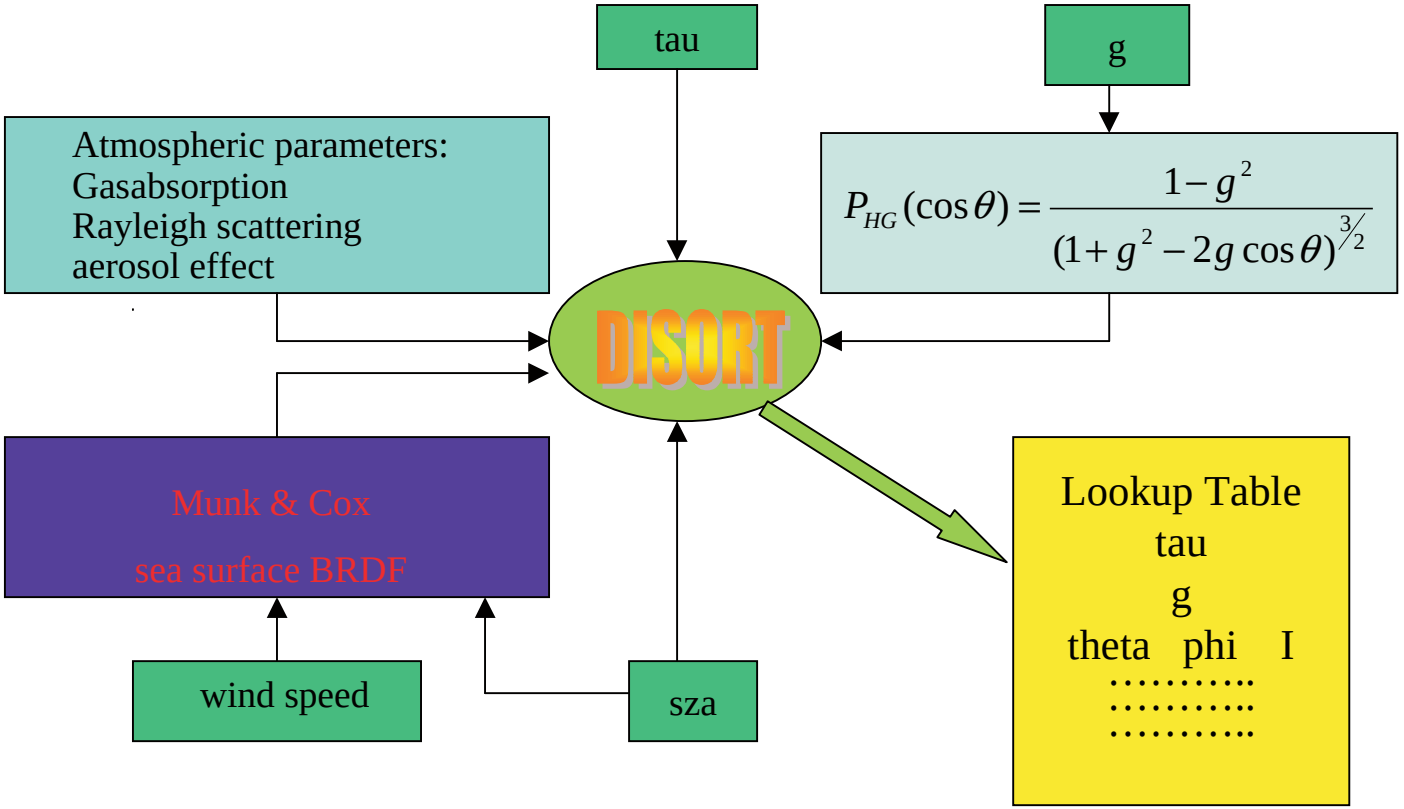
Optical Thickness
Asymmetry Factor
(Phase Function)

Case Analysis

tau
g
phase function



Given tau and g, we can make tau-g-I tables for each SZA and SW bin using DISORT.



Initial Conditions:

Atmosphere:	Plane Parallel
Cloud Phase:	Ice
Cloud Height:	8-9 km
Cloud Phase Function:	Henyey-Greenstein
Surface BRDF:	Ocean (Cox and Munk)
Wavelength:	670 nm
Single Scattering Albedo:	1
Polarization:	Unpolarized
Data Quality:	5-13 Directional Measurements

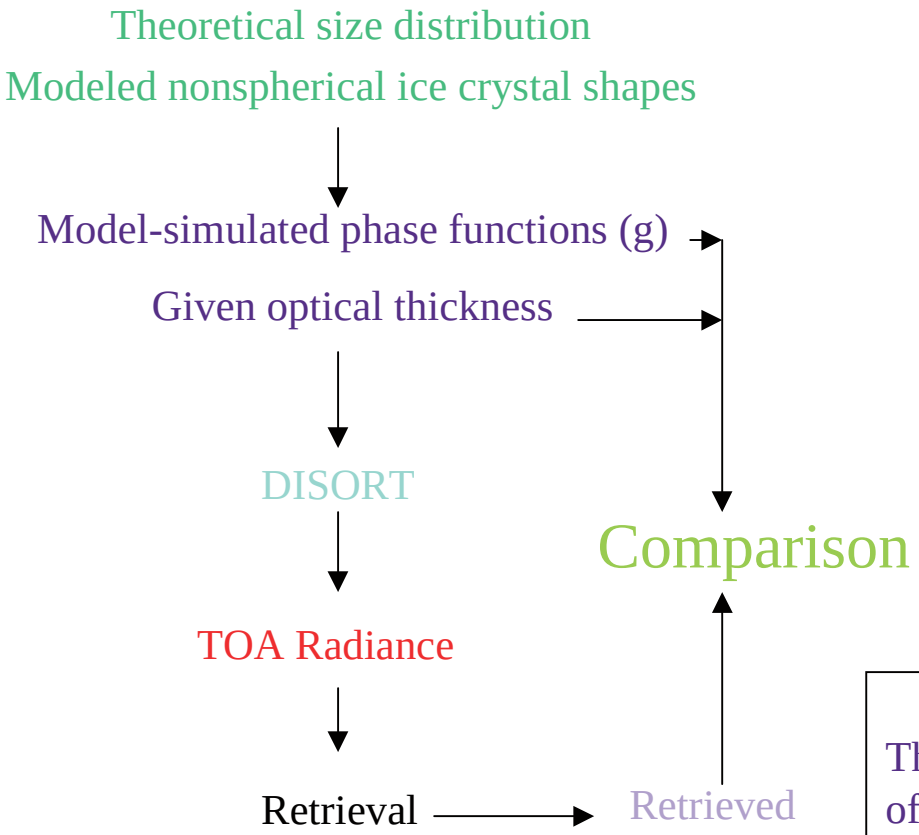
Searching in the lookup table

$$\Delta = \sqrt{\sum_{i=0}^{n} [I_m(\theta_i, \varphi_i) - I_t(\theta_i, \varphi_i)]^2}$$

where $I_m(\theta_i, \varphi_i)$ and $I_t(\theta_i, \varphi_i)$ are the measured and tabulated normalized radiances, respectively.

After searching the complete lookup table (?), the optical thickness and asymmetry factor (phase function) corresponding to the smallest standard deviation are the retrieved

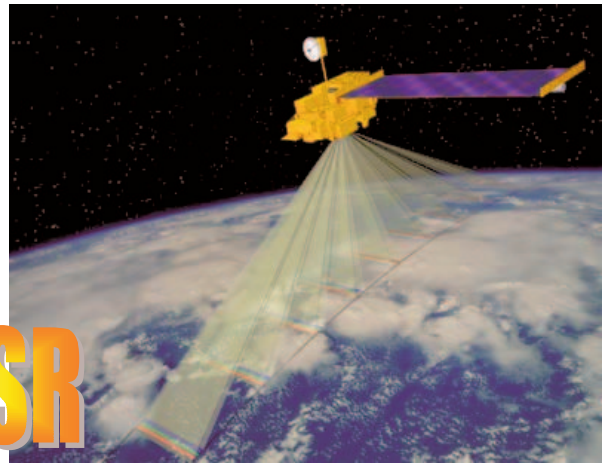
Validation



The sensitivity of retrieved to measurement numbers can also be examined.

Extended Projects

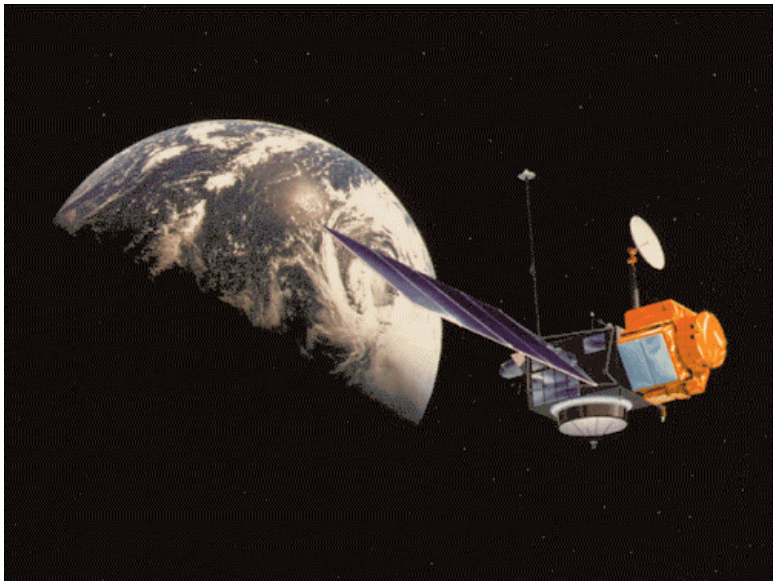
1. Using the same scheme for other multi-directional measurements such as MISR



2. Using polarized radiative transfer models such as VDISORT or ADDING-DOUBLING, and developing polarized light scattering models, for the application of polarized data from POLDER.

Applications

1. Local and global ice clouds optical thickness.
2. Local and global ice clouds asymmetry factor.
3. Ice clouds phase functions for the modeling of CERES ADM.



Error Sources

1. Plane parallel atmosphere.
2. Single layer of ice cloud, homogeneous, given height.
3. Low directional resolution.
3. One-dimensional radiative transfer model.
4. Cox and Munk sea surface BRDF model.
5. Aerosol.