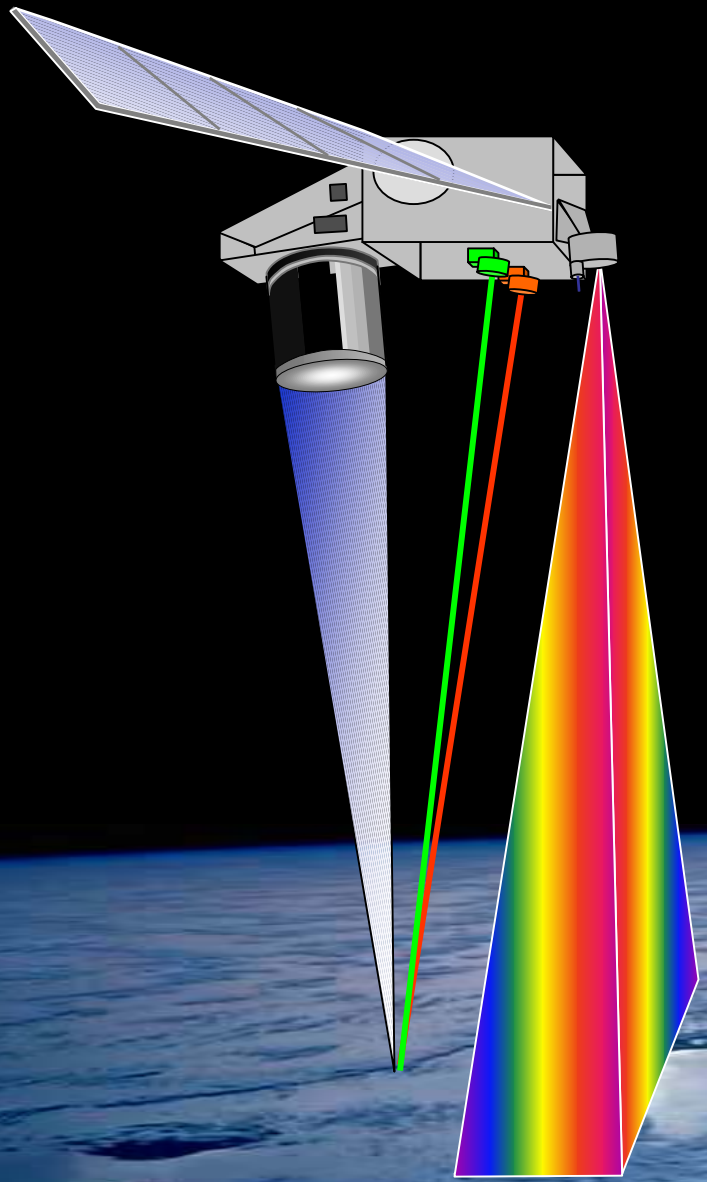


PhyLM

The Physiology Lidar-Multispectral Mission

Exploring complex ecosystems of our global oceans

Underlying Science

Objective : Characterize key upper-ocean carbon cycle components, including phytoplankton carbon biomass and physiology

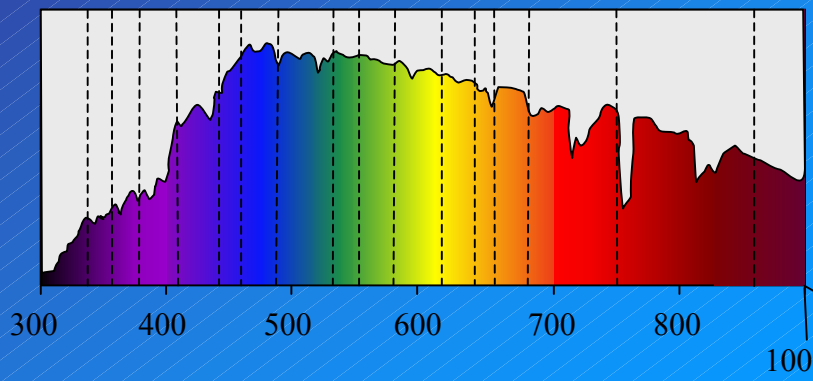
Approach : Dedicated global ocean mission focused on retrieving multiple upper ocean components using inversion approaches

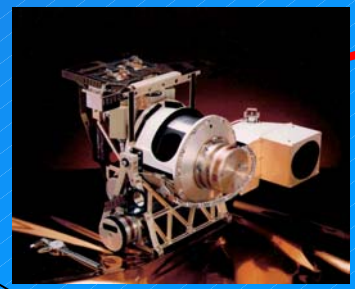
Requirement : Exceptional water leaving radiance retrievals

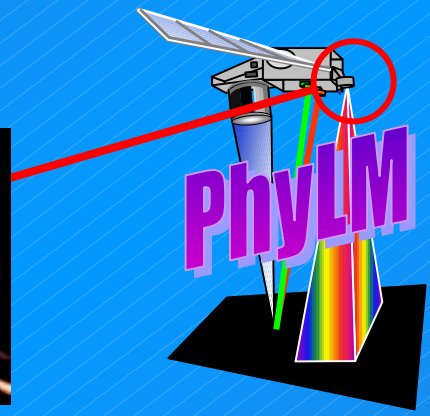
Why? :
- Inversion approach more sensitive to L_{wn} errors than ratio algorithms
- Central rate parameter of interest (💻) has much smaller range of variability than chlorophyll biomass
- Separation of optically active components (e.g., cDOM, pigments) necessary for physiology
- Characterization of algal absorption spectra, since physiology is best described by absorption:C ratios rather than Chl:C ratios

How? :
- Enhanced passive radiometer coupled with active Lidar system
- Passive wavebands extended into UV region for atmospheric correction and advanced quantification of cDOM
- Passive wavebands extended in NIR for coastal atmospheric correction
- Lidar measurements for atmospheric profiling and in—water optics

Passive Radiometer







- *Design*: Advanced SeaWiFS
- *Lead Scientist*: Chuck McClain
- *Sensor Technology Advisor*: Alan Holmes (SeaWiFS designer)

- *Features*:
  - 18 wavebands (UV, VIS, NIR)
  - Routine Lunar & Solar Calibrations
  - 12 – 14 bit signal digitization
  - 500 m resolution goal
  - Improved optical components (e.g., mirrors)
  - Improved focal plane design (e.g., septum b/w detectors)
  - Improved detectors (e.g., CCD)
  - Noon orbit, 650 km
  - Global coverage every 2 days

Passive Radiometer

The PhyLM Mission

PhyLM	MODIS	SeaWiFS	MERIS
345	____	____	____
360	____	____	____
380	____	____	____
412	412	412	412
443	443	443	442
460	____	____	____
490	488	490	490
510	____	510	510
532	531	____	____
555	551	555	560
595	____	____	____
620	____	____	620
667	667	670	665
678	678	____	681
____	____	____	709
765	748	765	753/760/779
865	870	865	870/890/900
1000	____	____	____
1240	____	____	____

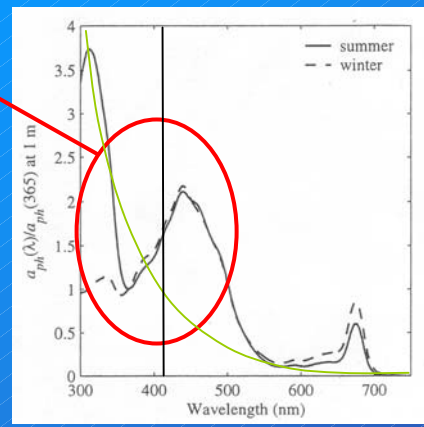
Hoepffner & Sathyendranath (MEPS, 1991)

- (Chl a)

413 (Chl a)
435 (Chl a)
461 (Chl c)
464 (Chl b)
490 (Carot)
532 (Carot)
583 (Chl c)
623 (Chl a)
644 (Chl a)
655 (Chl c)
676 (Chl a)

Passive Radiometer

λ	L-typical	Passband	S:N @500m	
345	9.000	20	685	absorbing aerosols
360	7.503	20	833	cDOM
380	7.221	20	1149	
412	8.250	20	1633	algal absorption
443	7.750	20	2052	- accessory pigments
460	6.900	20	2110	- gross taxonomy
490	6.250	20	2181	heritage wavelengths
510	4.750	20	1972	slope of backscatter
532	4.170	20	1800	lidar match-up
555	3.500	20	1766	absorption minimum
595	2.700	20	1590	fluorescence baseline
620	1.900	20	1360	chlorophyll fluorescence
667	1.500	20	1289	
678	1.398	20	1249	
765	0.900	30	1190	atmospheric correction
865	0.850	35	902	- open ocean
1000	0.520	40	417	- coastal
1240	0.280	50	<400	



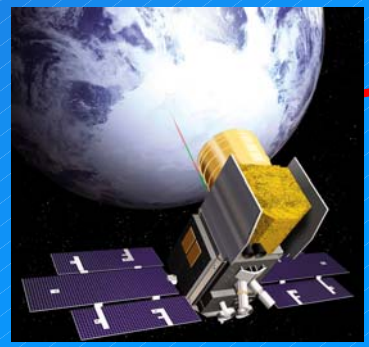
Morrison & Nelson (2004)
Limnol. Oceangr.
49:215-224

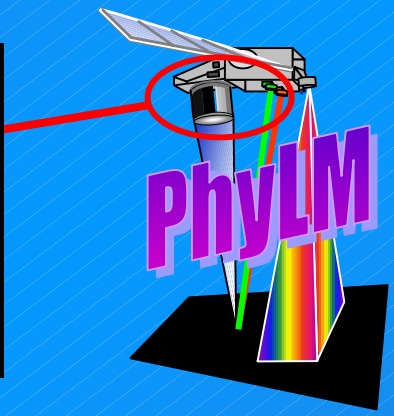
The PhyLM Mission

NASA

The PhyLM Mission

Lidar measurements

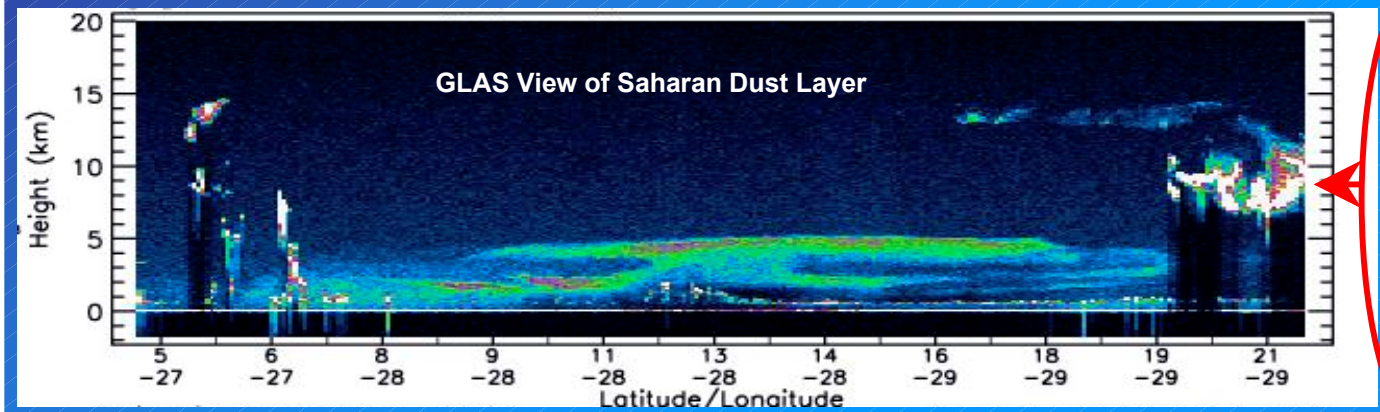


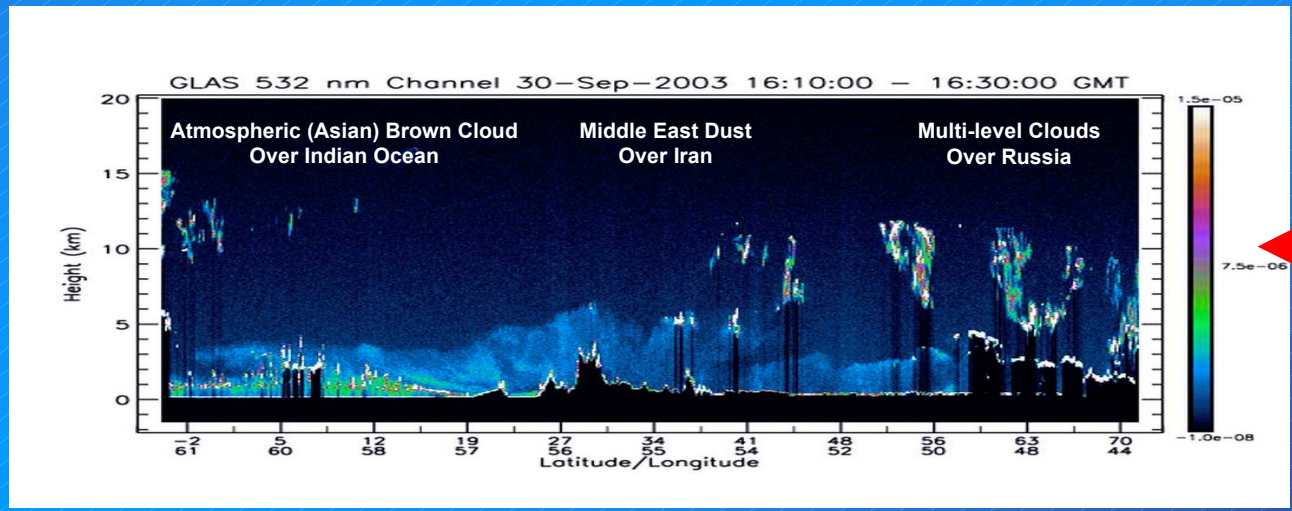


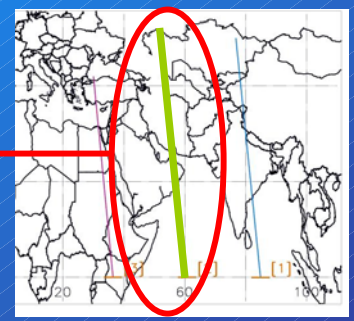
- *Design*: GLAS / Calypso heritage
- *Lead Scientist*: James Spinhirne
- *Features*:
  - Nd:Yag laser @ 532 and 1064 nm
  - 500 mJ pulse @ 532 nm
  - 40 – 400 pulse per second repetition rate
  - 40 M footprint
  - 1.5 m receiver telescope
- *Products*:

	Priority	*Measurement*
532/1064 nm for atmospheric aerosol profiles	1^0	
532 nm for in-water particle scattering coefficient	1^0	
645 nm for Raman scattering (fluorescence correction)	2^0	
685 nm for ***high-biomass*** chlorophyll fluorescence	2^0	

GLAS atmospheric profiling







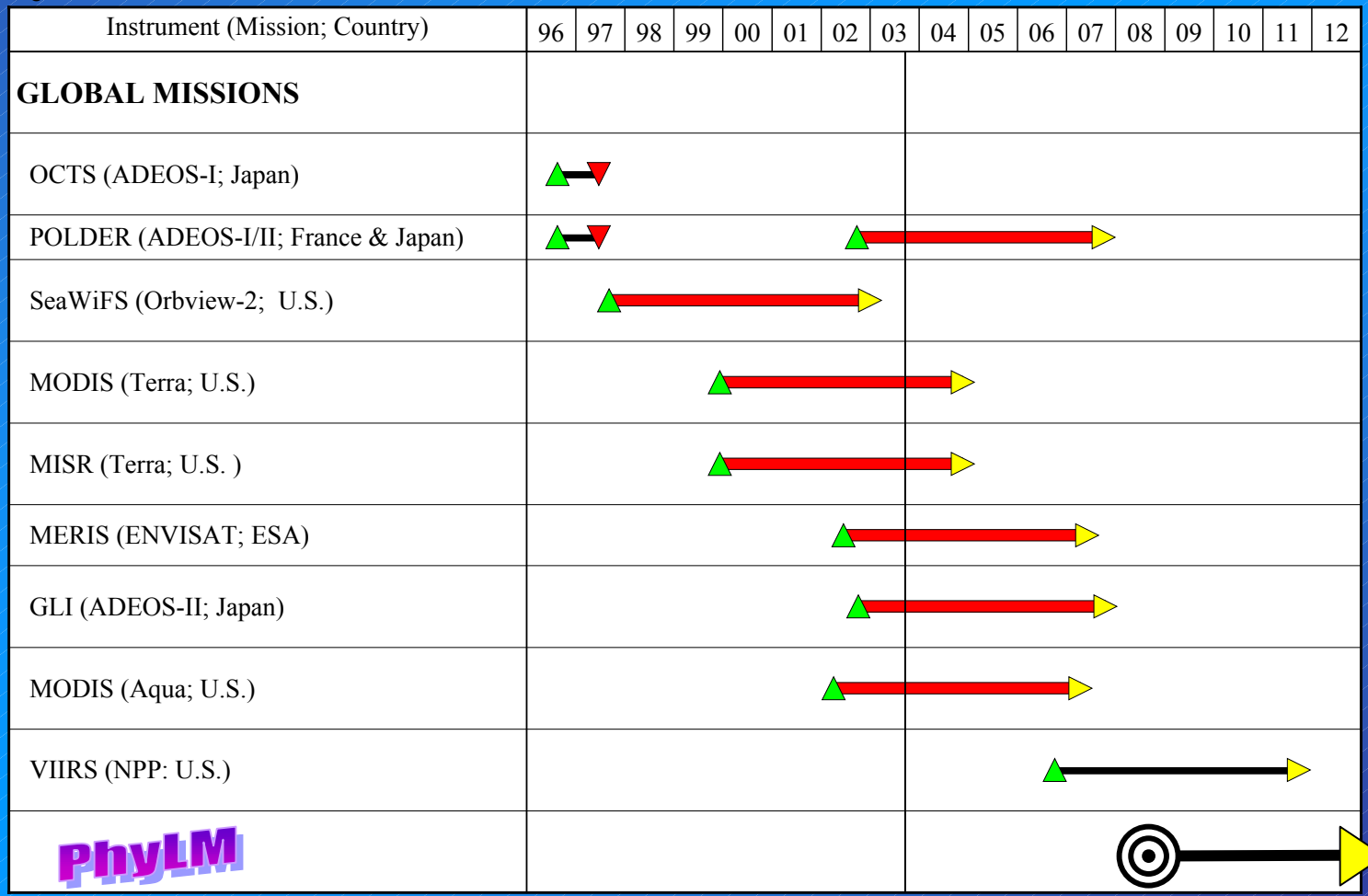
The PhyLM Mission

Global Ocean Biogeochemistry Missions

The PhyLM Mission

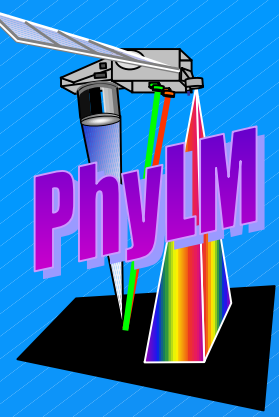
OCEAN BIOGEOCHEMISTRY MISSIONS

Page 1 of 1 9/17/03



The PhyLM Mission

PhyLM Concept Summary

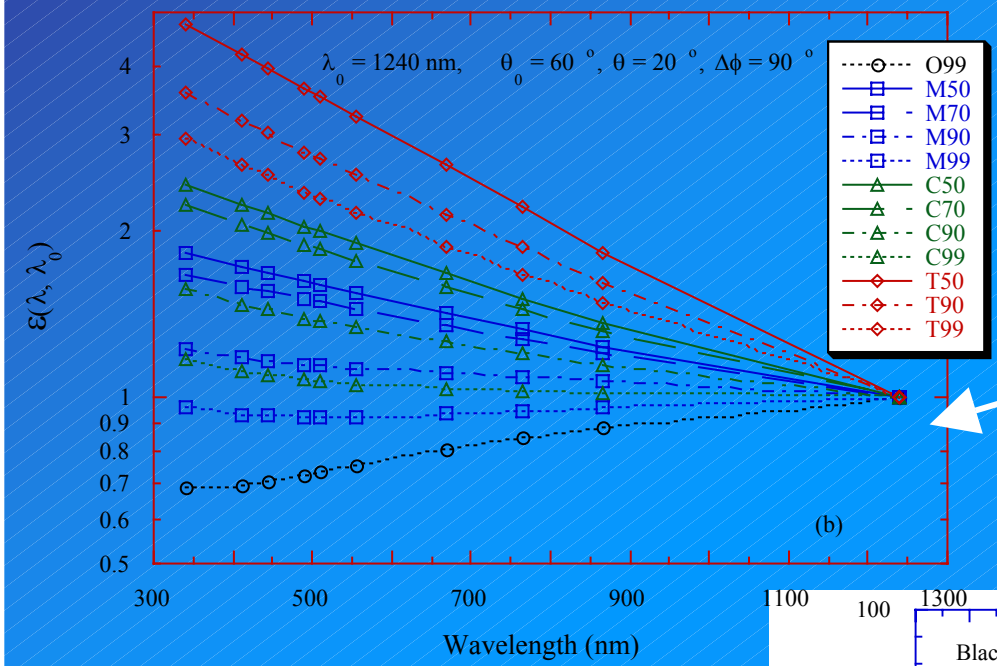


- ESSP-class mission dedicated Ocean science
- Advances/expansion of established technology
- Exceptional ocean color data is *The Order 1 objective*
- Support for VIIRS (focus on calibration/validation, near-noon orbit)
- PhyLM & VIIRS follows 'two mission coverage' strategy and give redundancy in event of sensor failure
- Coastal/shelf/high production areas
- Proof of concept opportunity for lidar in—water retreivals
- Project Principle Investigators: M. Behrenfeld & C. McClain
  Formulation Manager: Jan Gervin
  Engineering Advisor: Lloyd Purves
  Science team TBD

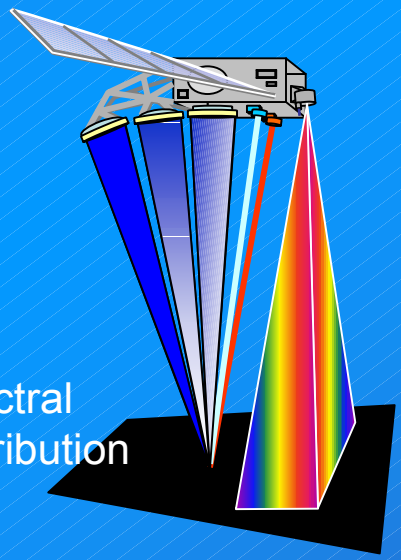
….A Community Mission….

Backup Slides

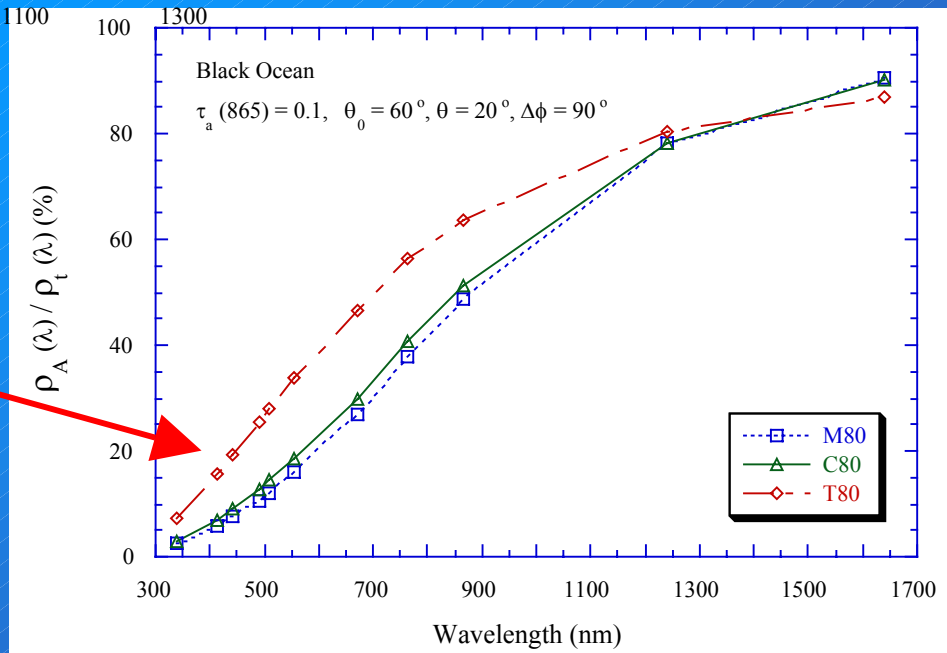
Aerosol Reflectance



Relative spectral aerosol contribution

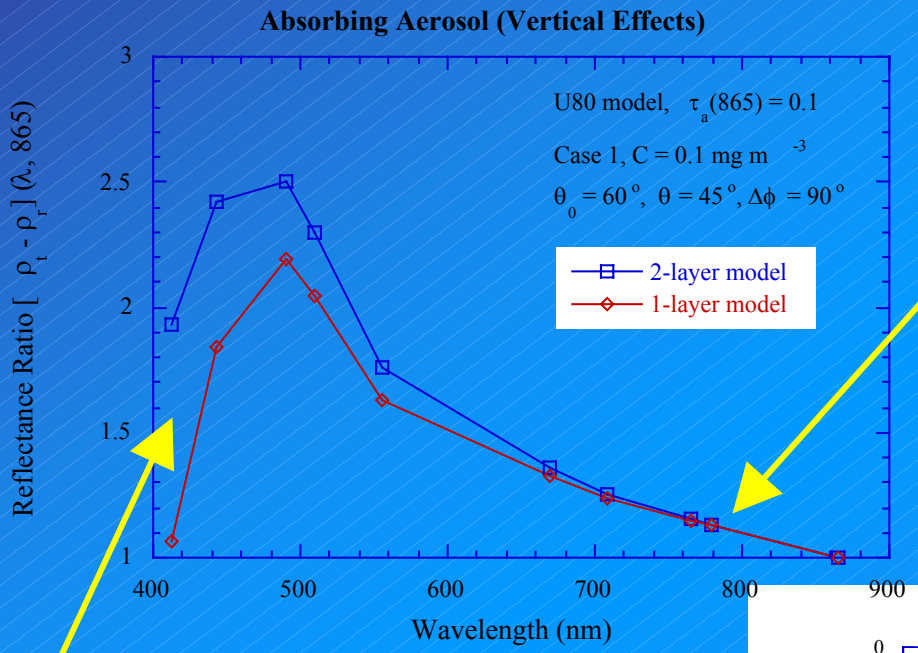


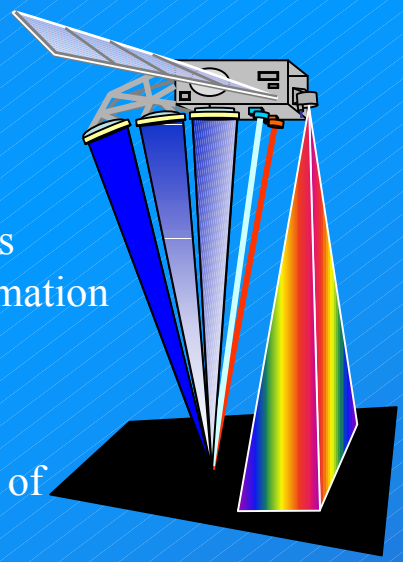
At the UV and blue wavelengths, Rayleigh radiance is dominated and aerosol reflectance is about 5-15% of the sensor-measured signals.



The PhyLM Mission

Absorbing Aerosols: Problems

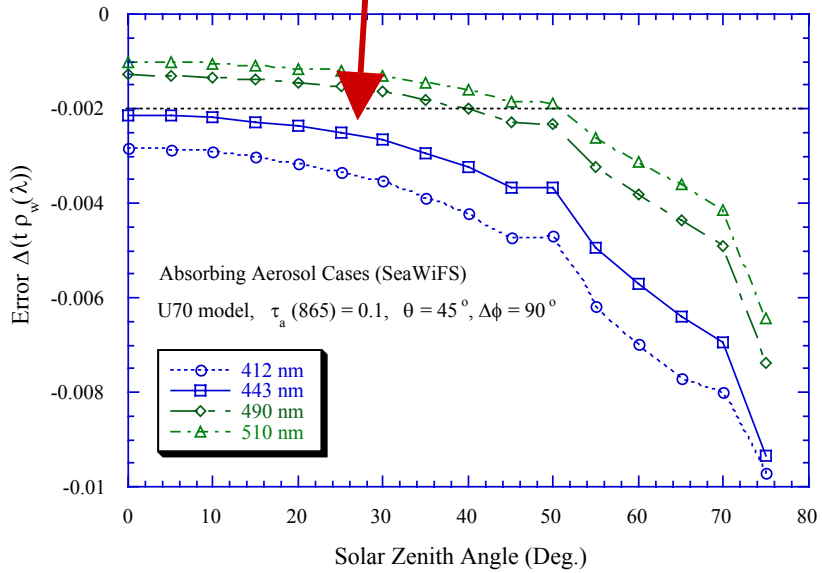




NIR Reflectances provide no information

Underestimation of water-leaving spectrum significantly

Significant differences in the blue and UV bands



- **Need UV bands to identify the strongly absorbing aerosols**
- **Need Lidar data to provide aerosol vertical profile**

The PhyLM Mission

NASA