

# Maritime Aerosol Network (MAN) as a component of AERONET – current status



8th AeroCom Meeting, Geophysical Fluid Dynamics  
Laboratory, Princeton, New Jersey, October 5-7, 2009

# Maritime Aerosol Network (MAN) - as spatial extension to AERONET

Alexander (Sasha) Smirnov - presenter

Brent Holben, David Giles, Norm O'Neill, Ilya Slutsker, Tom Eck, Peter Croot, Andreas Macke, Sergey Sakerin, Tim Smyth, Mike Harvey, Giuseppe Zibordi, Tymon Zielinski, Patricia Quinn, K. Krishna Moorthy, Vladimir Radionov, Joaquim Goes, Remi Losno, Jean Sciare, Yann Courcoux, Kenneth Voss, Carlos Duarte, Norm Nelson, Nicholas Nalli, Simon Belanger

NASA Goddard Space Flight Center, Greenbelt, Maryland, USA  
(e-mail: [Alexander.Smirnov-1@nasa.gov](mailto:Alexander.Smirnov-1@nasa.gov))

# List of collaborators

- **USA – Woods Hole Oceanographic Institution; Bigelow Laboratory for Ocean Sciences; University of California at Santa Barbara; NOAA Pacific Marine Environmental Laboratory; University of Hawaii; University of Miami; University of Washington; Howard University**
- **Canada – Institut Maurice-Lamontagne (Québec); Université du Québec à Rimouski (Québec); Université de Sherbrooke (Québec)**
- **UK – Plymouth Marine Lab; University of East Anglia; University of Edinburgh**
- **Germany – Leibniz Institute of Marine Sciences- IFM-GEOMAR (Kiel); Institute for Meteorology (Hamburg)**
- **Russia - Institute of Atmospheric Optics (Tomsk); Arctic and Antarctic Institute (St. Petersburg); Institute of Oceanology (Moscow)**
- **France - Laboratoire des Sciences du Climat et de l'Environnement (Gif-sur-Yvette); Laboratoire d'Optique Atmosphérique (Lille); Laboratoire Inter-universitaire des Systèmes Atmosphériques at the University Paris7 (Paris); Université de la Réunion (La Réunion); Service Hydrographique et Oceanographique de la Marine (Brest)**
- **New Zealand – National Institute of Water and Atmospheric Research (Wellington)**
- **Australia – The Commonwealth Scientific and Industrial Research Organisation (Canberra)**
- **Spain- Mediterranean Institute for Advanced Studies (Mallorca)**
- **South Africa – University of the Witwatersrand**
- **Indonesia - Agency for the Assessment and Application of Technology (Jakarta)**
- **Italy – Joint Research Center (Ispra)**
- **Poland – Sopot Institute of Oceanology**
- **India - Space Physics Laboratory (Trivandrum)**

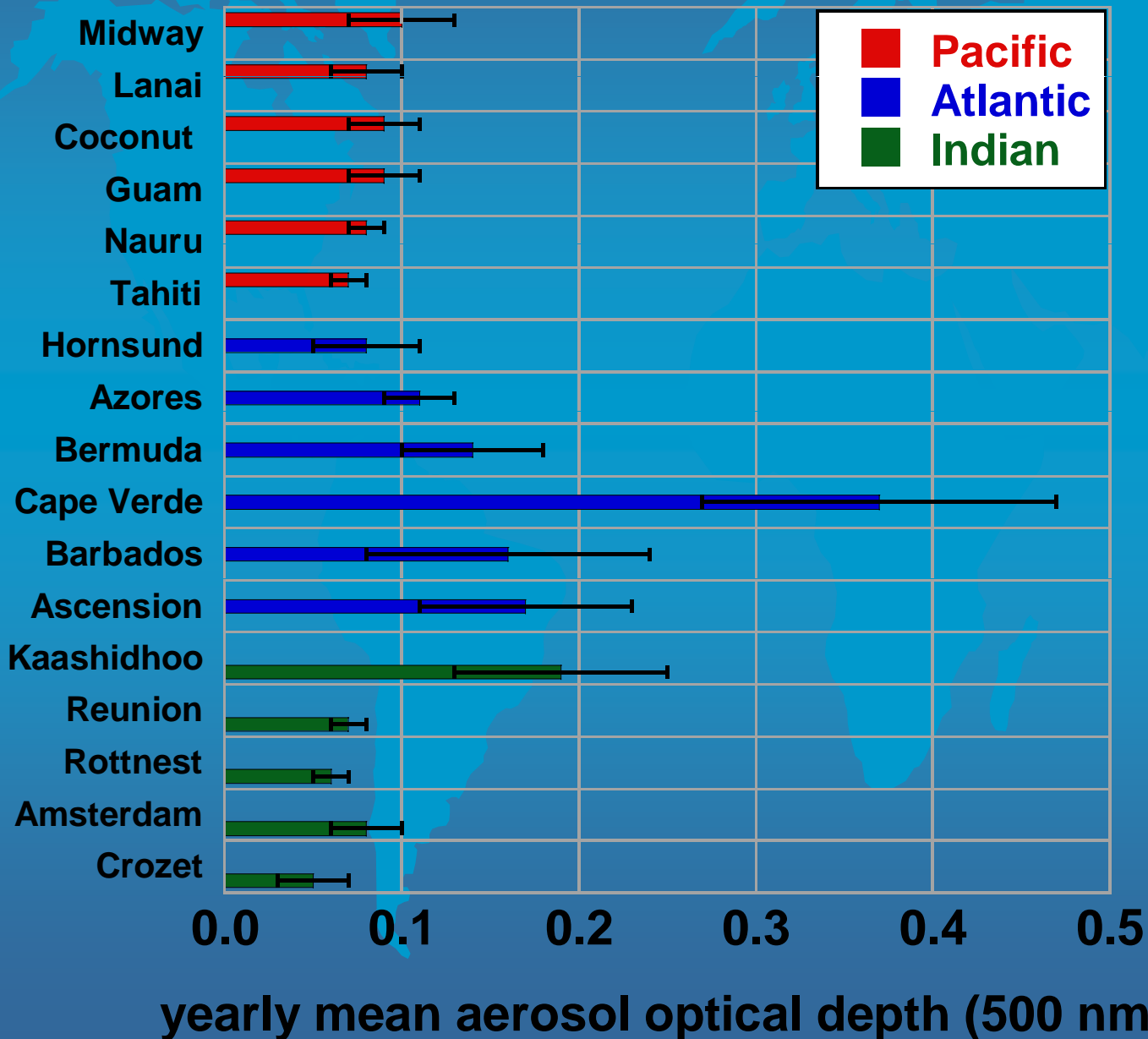
# Many thanks to

- W.W.Newcomb, M.Sorokin, A.Scully, A.Tran, D.A.Siegel, P.K.Quinn, D.Covert, L.Logan, M.Reynolds, D.Hamilton, L.Rainville, A.Jayakumar, S.Schick, D.Menzies, P. Schoessow, E.Emry, M.Conley, A.Proshutinsky, E.Joseph, A.Flores (**USA**); V.Radionov, M.Panchenko, O.Kopelevich, S.Gulev, A.Sinitsyn, D.Kabanov, S.Terpugova, V.Polkin (Sr), A.Tikhomirov, Yu.Turchinovich, N.Vlasov, A.Gubin, V.Polkin (Jr), A.Kalsin (**Russia**); S.Kinne, Y.Zoll, A.Wassmann, M.Heller, A.Tessendorf, M.Schlundt, , C.Schlosser, T.Hanschmann, B.Pospichal (**Germany**); P.Goloub, F.Jourdin, L.Blarel, C.Petus, S.Triquet, J.Nicolas, S.Devidal, L.Martinon, M.Faillot, P.Hernandez (**France**); A.Baker, C.Powell, C.Gallienne (**UK**); P.Larouche, C.Bourgeault-Brunelle, M.Palmer (**Canada**); H.Power, T.Bromley, R.Martin (**New Zealand**); J.Piskozub, J.Kowalczyk, A.Ponczkowska, B.Lednicka, K.Zielinski, P.Makuch (**Poland**); S.Piketh, D.Williams, B.Kuyper (**South Africa**); K.Niranjan, S.Babu, V.S.Nair, S.N.Beegum (**India**); R.M.Castillo (**Spain**)

# Distribution of island-based AERONET sites



# Aerosol optical depth over the oceans (AERONET island-based measurements)



Globally averaged

$$\tau_a (500 \text{ nm}) = 0.11$$

$$\sigma = 0.04$$

$$\alpha (440-870 \text{ nm}) = 0.60$$

$$\sigma = 0.16$$



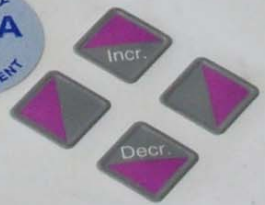
SOLAR LIGHT CO.

NASA

MICROTOPS II  
Ozone Monitor - Sunphotometer



Sun target



On/Off

Scan  
Escape

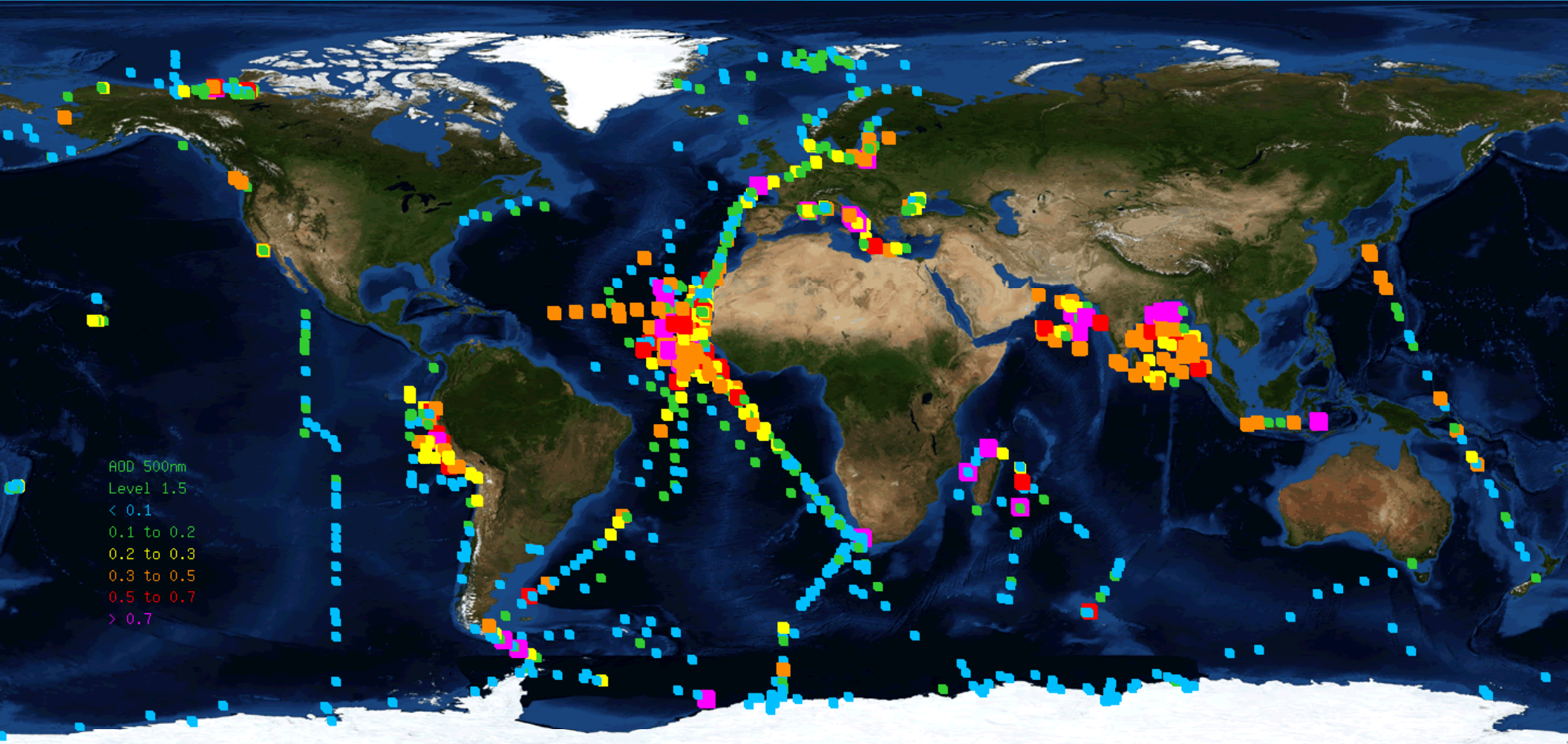
Menu  
Enter

Made In USA

05/14/2007

GPSmap 60CSr  
Location  
±17'  
N 38 59.545  
W 076 50.372

# Maritime Aerosol Network global coverage





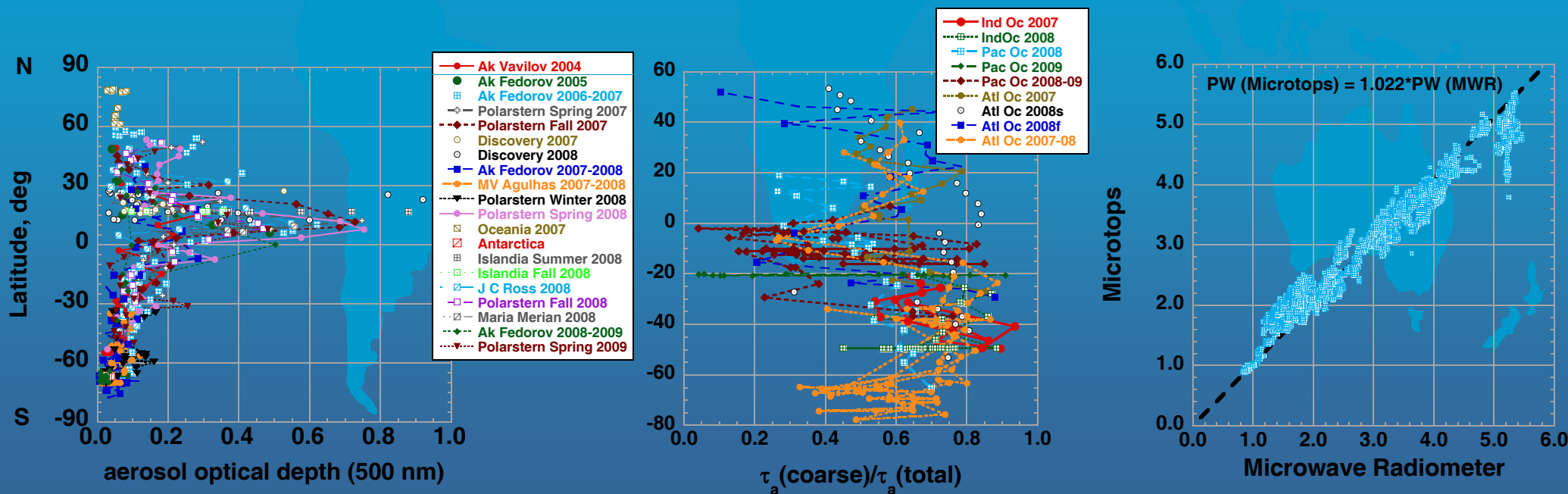
# Scientific Objectives



- Climate change studies (direct and indirect forcing)
- Satellite retrieval validation
- Ocean color studies (atmospheric correction)
- Validation of global aerosol transport model simulations
- Global aerosol distribution

# MAN products:

- Aerosol optical depth (Level 1; Level 1.5; Level 2)
- Water vapor content (Level 1; Level 1.5; Level 2)
- Aerosol optical depths: fine (sub-micron) and coarse (super-micron) at 500 nm (the spectral deconvolution algorithm by O'Neill et al. 2004)





# AERONET

## MARITIME AEROSOL NETWORK



- + AEROSOL OPTICAL DEPTH
- + AEROSOL INVERSIONS
- + SOLAR FLUX
- + OCEAN COLOR
- + MARITIME AEROSOL

- + Home
  - + AERONET Home
- ### Maritime Aerosol
- + AEROSOL/FLUX NETWORKS
  - + COLLABORATORS
  - + DATA
  - + NASA PROJECTS
  - + PUBLICATIONS
  - + STAFF
  - + SYSTEM DESCRIPTION

### MARITIME AEROSOL NETWORK (MAN)

The Maritime Aerosol Network (MAN) component of AERONET provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These data provide an alternative to observations from islands as well as establish validation points for satellite and aerosol transport models. Since 2004, these instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the World Oceans.



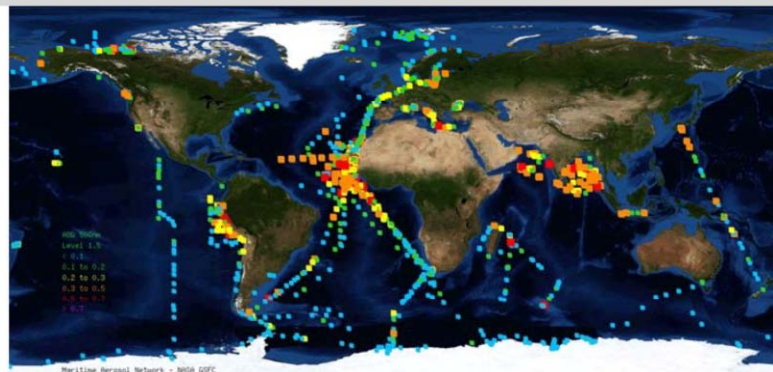
Microtops instruments currently in the network have five channels but they may have one of two configurations: 340, 440, 675, 870, 936nm or 440, 500, 675, 870, and 936nm. In addition, the instrument has built-in temperature and pressure sensors as well as the ability to log accurate time and geographical position using a GPS. The Microtops instruments are calibrated at the NASA Goddard Space Flight Center (GSFC) calibration facility via a transfer calibration procedure between the Microtops and the master Cimel sun photometer at GSFC, which has a calibration traceable to a Langley calibration of a Cimel sun photometer on Mauna Loa, Hawaii. In general, the estimated uncertainty of the aerosol optical depth in each channel does not exceed plus or minus 0.02, which is slightly higher than the uncertainty of AERONET field (not master) instruments.

Additional information on data processing and quality may be found by choosing the "Data" link in the left column.

### MAN Publication Reference:

Smirnov, A., B. N. Holben, I. Slutsker, D. M. Giles, C. R. McClain, T. F. Eck, S. M. Sakerin, A. Macke, P. Croot, G. Zibordi, P. K. Quinn, J. Sciare, S. Kinne, M. Harvey, T. J. Smyth, S. Piketh, T. Zielinski, A. Proshutinsky, J. I. Goes, N. B. Nelson, P. Larouche, V. F. Radionov, P. Goloub, K. Krishna Moorthy, R. Matarrese, E. J. Robertson, and F. Jourdin (2009), **Maritime Aerosol Network as a component of Aerosol Robotic Network**, *J. Geophys. Res.*, 114, D06204, doi:10.1029/2008JD011257.

### CRUISES



Level 1.5 | Level 2.0


The table below provides information for past, ongoing and planned cruises. The Ship column provides links to the information and data for each cruise. The Region column provides a KML file to view the cruise in Google Earth.

Year	Ship	Region	Status	
2004	RV Akademik Sergey Vavilov	Atlantic Ocean Transect, Southern Ocean	Completed	
2005-2006	RV Akademik Fedorov	Atlantic Ocean Transect, Antarctica	Completed	
2006-2007	RV Akademik Fedorov	Atlantic Ocean Transect, Antarctica	Completed	
2007	Ecklonia	Atlantic Ocean near South African Coast	Completed	
2007	RV Polarstern	Atlantic Ocean Transect	Completed	
2007	RV Urania	Mediterranean Sea	Completed	
2007	Trans Future 5	Pacific Ocean Transect	Completed	
2007	RV Oceania	Baltic, Norwegian, Greenland Seas	Completed	
2007	RV Aranda	Gulf of Bothnia	Completed	
2007	CCGS Louis St. Laurent	Beaufort Sea	Completed	
2007	Roger Revelle	Arabian Sea	Completed	
2007	RV Oceania	Baltic Sea	Completed	
2007	Roger Revelle	Arabian Sea	Completed	
2007	University of Bari	Adriatic Sea	Completed	
2007	RV Polarstern	Atlantic Ocean Transect	Completed	
2007	RRS Discovery	Canary-Cape Verde	Completed	
2007	RV Marion-Dufresne	South Indian Ocean	Completed	
2007-2008	NOAA Ronald H. Brown	Pacific Ocean Transect	Completed	
2007-2008	MV SA Agulhas	Southern Ocean	Completed	
2007-2008	RV Akademik Fedorov	Atlantic Ocean Transect, Antarctica	Completed	
2008	RRS Discovery	Canary-Cape Verde	Completed	
2008	RV Polarstern	Southern Atlantic	Completed	
2008	RV Knorr 2008	North Atlantic Ocean	Completed	
2008	Trans Future 5	Pacific Ocean Transect	Completed	
2008	RV L'Atalante	Gulf of Lion	Completed	
2008	RV Polarstern	Atlantic Ocean Transect	Completed	
2008	MV Akbar 2008	Bay of Bengal	Completed	
2008	RV Islandia	Cape Verde	Completed	
2008	USCGC Healy	Bering Sea	Completed	
2008	CCGS Amundsen	Beaufort Sea	Completed	
2008	Trans Future 5	Pacific Ocean Transect	Completed	
2008	RP FLIP	Santa Barbara Basin	Completed	
2008	NRV Alliance	Ligurian Sea	Completed	
2008	RRS James Clark Ross	Atlantic Ocean Transect	Completed	
2008	RV Islandia	Cape Verde	Completed	
2008	NOAA Ronald H. Brown	Caribbean Sea, Pacific Ocean	Completed	
2008	RV Polarstern	Atlantic Ocean transect	Completed	
2008	RV Maria S. Merian	Central and Tropical Atlantic	Completed	
2008	RV Marion-Dufresne	South Indian Ocean	Completed	
2008	RV Meteor	Pacific Ocean	Completed	
2008-2009	RV Sagar Kanya	Bay of Bengal	Completed	
2008-2009	RV Akademik Fedorov	Atlantic Ocean transect	Completed	
2009	RV Polarstern	Northern Greenland Sea	Completed	
2009	RV Marion Dufresne	2009 CCGS Amundsen	Beaufort Sea	Completed
2009	Norwegian Sun	2009 RP FLIP	Tropical Pacific	Completed
2009	R/V Marcus G. Langseth	2009 RV Ocean Watch	Around the Americas	Ongoing
2009	FORV Sagar Sampada	2009 RV	South China Sea	Ongoing
2009	RV Hesperides	2009 RV Melville	South Pacific Ocean	Planned
2009	NRV Alliance	2009 RV Polarstern	Atlantic Ocean transect	Planned
2009	RV Oceania	2009 RV Meteor	Tropical Atlantic	Planned
2009	RV Baruna Jaya IV	2009 RV Marion Dufresne	South Indian Ocean	Planned
2009	RV Marion Dufresne	2009 RV Antea	South Indian Ocean	Planned
2009	RV Polarstern	2009 RV Sonne	South Pacific Ocean	Planned
2009	RV Akademik	2009 Trans Future 5	Pacific Ocean	Planned
2009	RV Islandia	2009 RRS James Cook	Atlantic Ocean transect	Planned
2009	RRS Discovery	2009 RV Oceania	Baltic Sea	Planned
2009	RV Jan Mayen	2009-2010 RV Akademik Fedorov	Atlantic Ocean transect, South Ocean	Planned
2009	RV Kilo Moana			
2009	NOAA Ronald H. Brown			
2009	RV Oceania			

- ### AERONET Site Lists
- + Text Format
  - + Google Earth Format
  - + All Lists



# R/V Polarstern 2007 (fall) cruise


GODDARD SPACE FLIGHT CENTER
+ Visit NASA.gov

## AERONET

### AEROSOL ROBOTIC NETWORK


+ AEROSOL OPTICAL DEPTH
+ AEROSOL INVERSIONS
+ SOLAR FLUX
+ OCEAN COLOR
+ MARITIME AEROSOL

Web Site Feature Announcement
AERONET Data Synergy Tool - Access Earth Science data sets for AERONET sites
+ 2008 AERONET Review - 6 November 2008

- + Home
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**MARITIME AEROSOL NETWORK (MAN)**

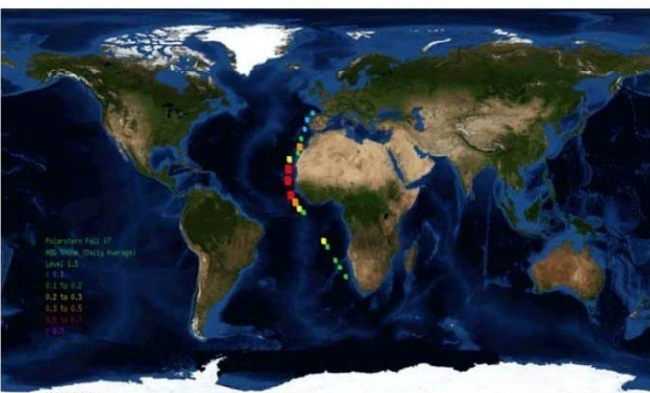
2007 RV Polarstern Cruise



RV Polarstern belongs to the Alfred Wegener Institute for Polar and Marine Research ( Bremerhaven, Germany). The cruise took place from October to November 2007. The cruise area included an Atlantic transect from Bremerhaven to Cape Town. One-hundred and ninety-three (193) measurement series spanning 20 days were acquired during the cruise.

Dr. Prof. Andreas Macke was a Principal Investigator for optical depth measurements. Mr. Yann Zoll and Mr. Andreas Wassmann from the same institution operated sun photometer onboard.

**DATA**



+Download Data and Track

**AERONET DATA ACCESS**

**AEROSOL OPTICAL DEPTH**

- + Data Display
- + Download Tool
- + Download All Sites
- + Climatology Tables
- + Climatology Maps

**AEROSOL INVERSIONS**

- + Data Display
- + Download Tool
- + Download All Sites

**SOLAR FLUX**

- + Data Display

**OCEAN COLOR**

- + Data Display

**DATA SYNERGY TOOL**

- + Data Display

**AERONET Site Lists**

- + Text Format
- + Google Earth Format
- + All Lists



Measurements onboard: Mr. Yann Zoll

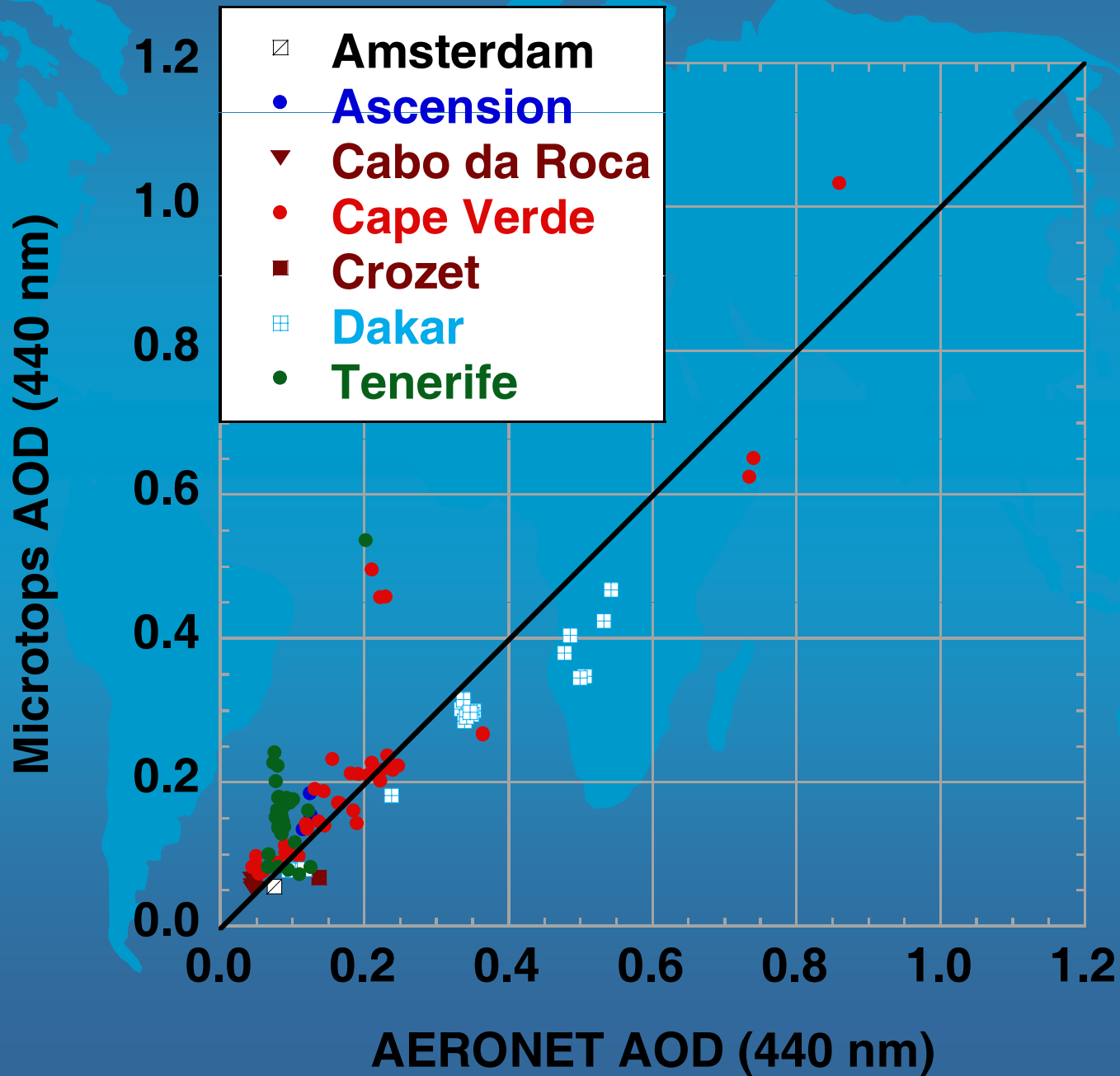


Measurements onboard: Mr. Andreas Wassmann

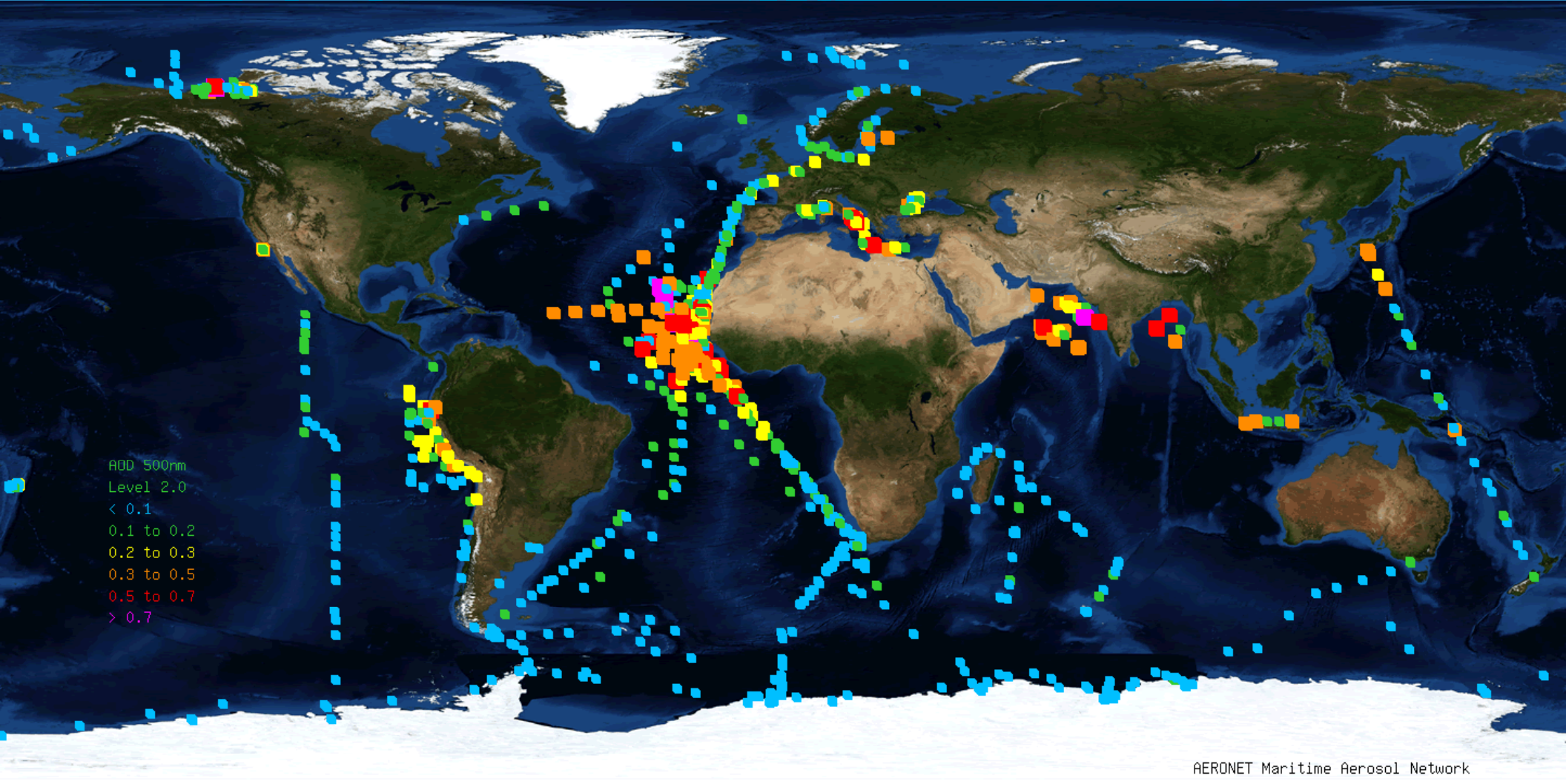
## PUBLICATIONS



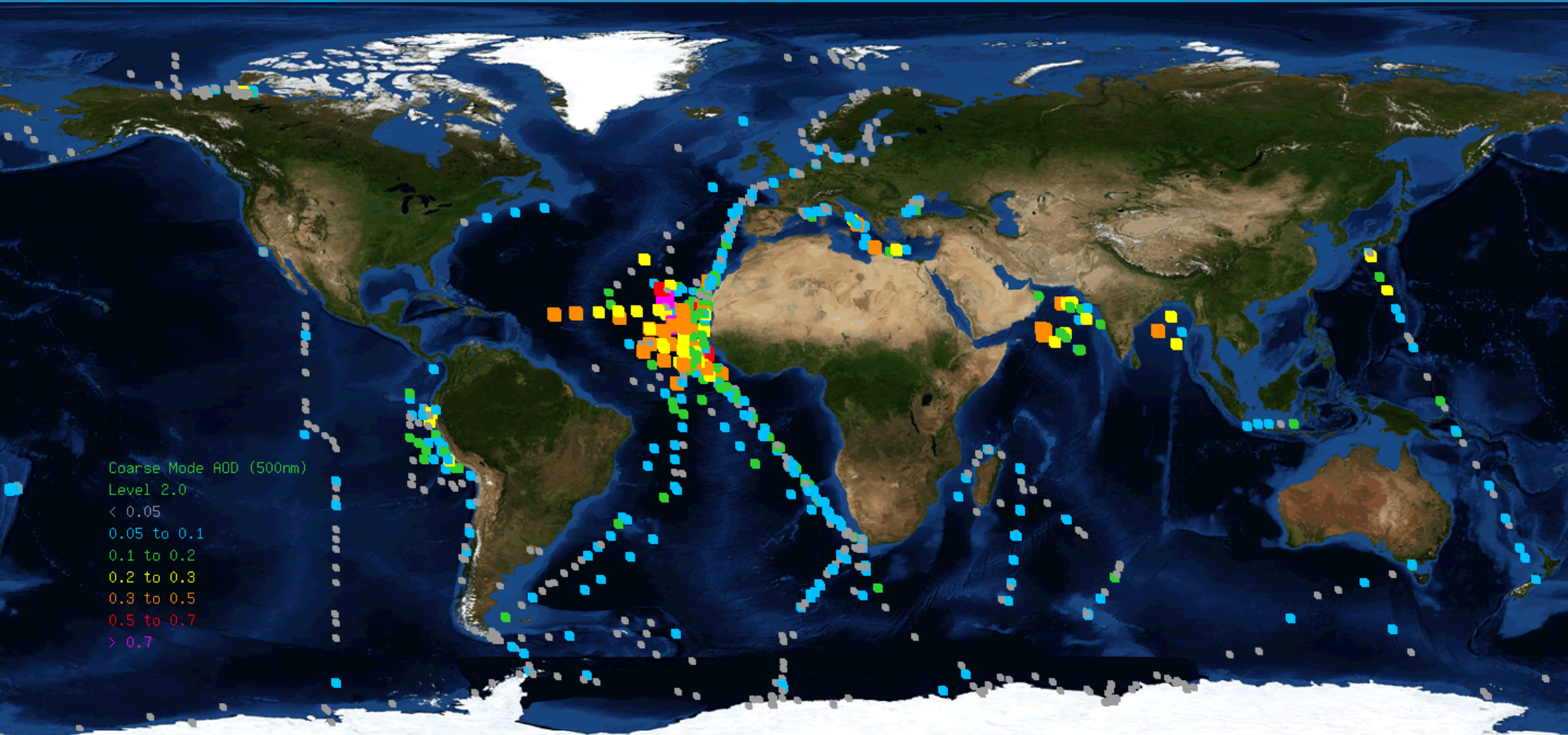
# Ship-based and AERONET $\tau_a$ comparison



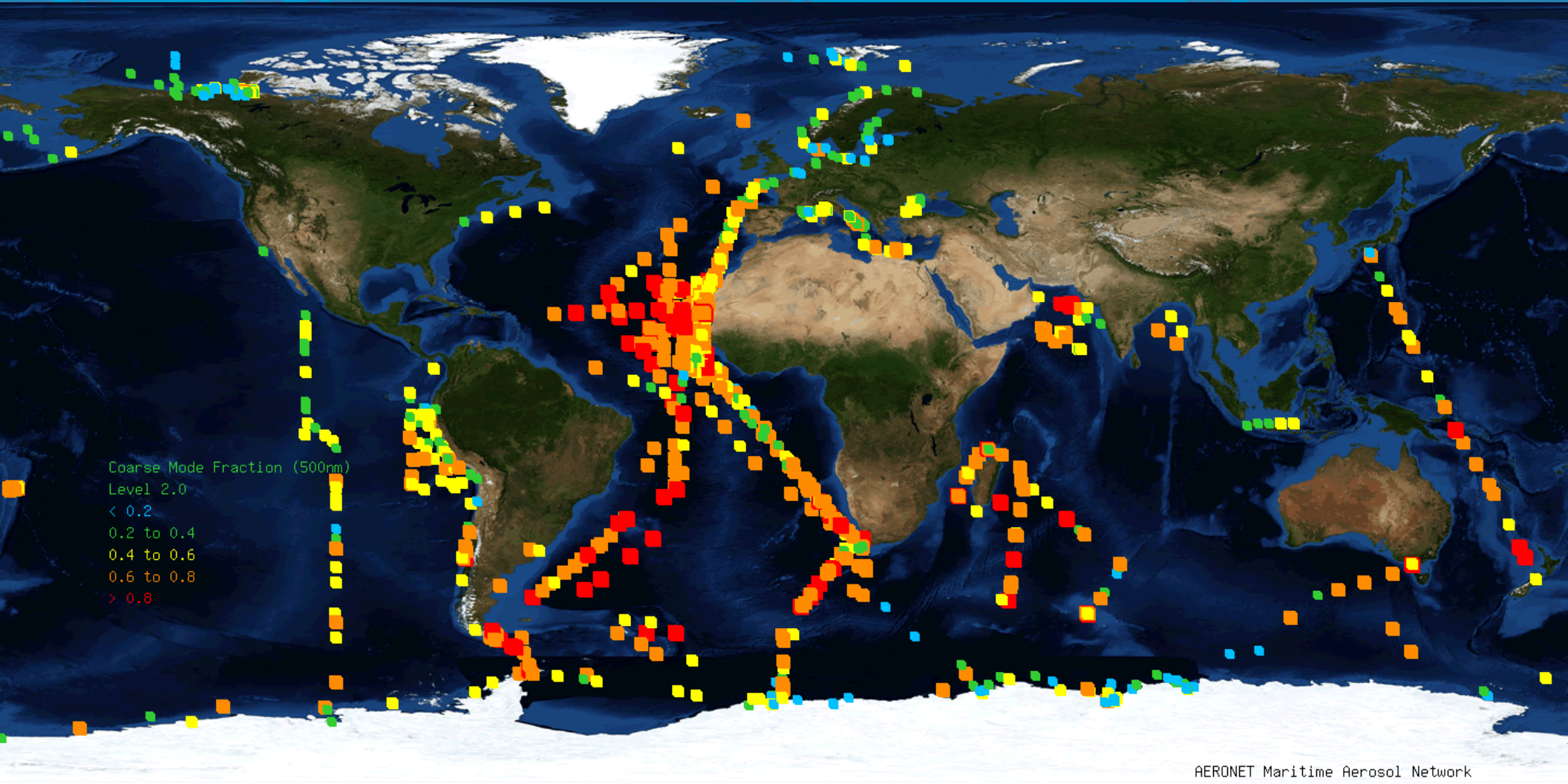
# Maritime Aerosol Network aerosol optical depth (Level 2)



# Maritime Aerosol Network aerosol optical depth (coarse)

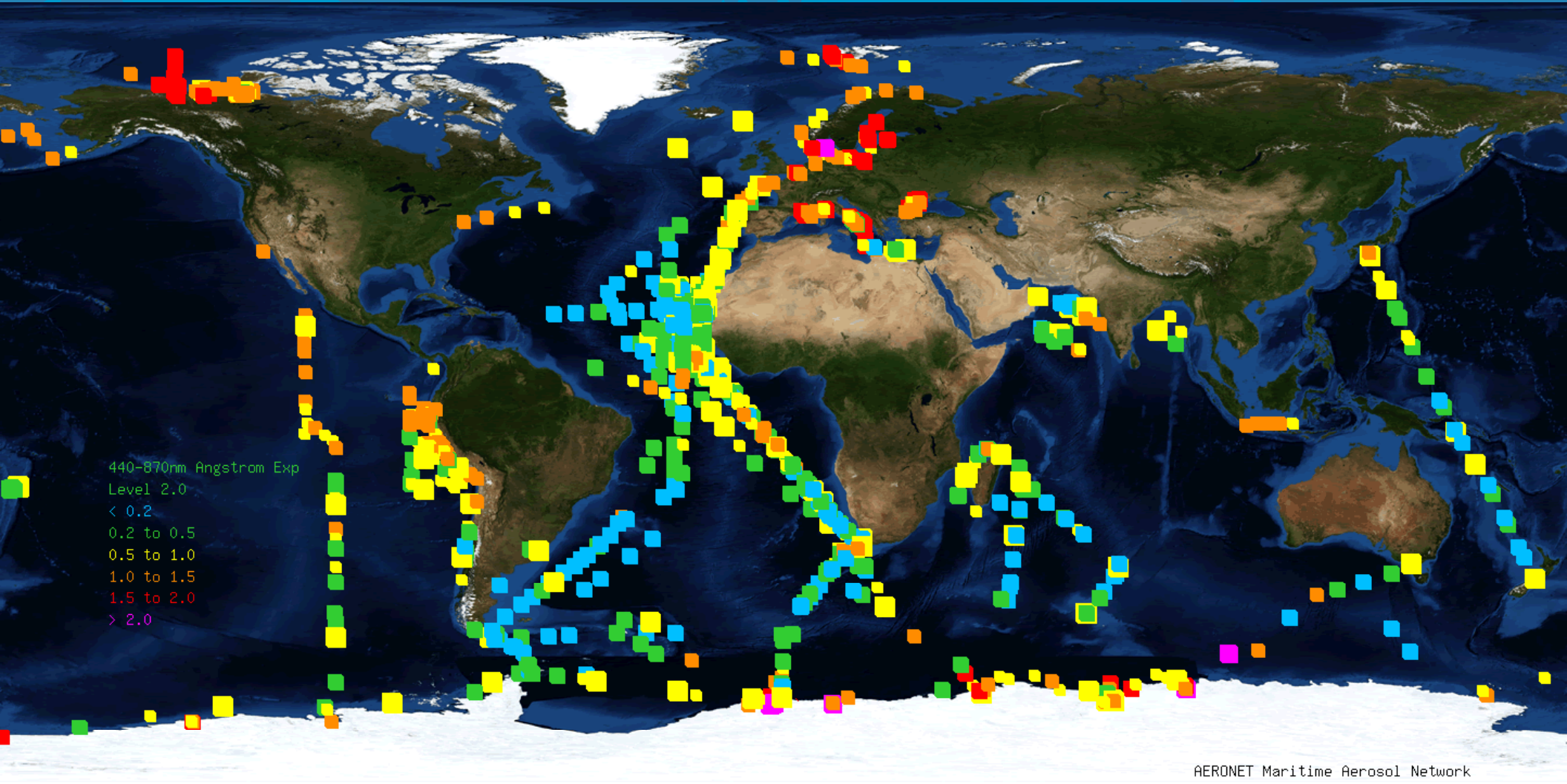


# Maritime Aerosol Network aerosol optical depth (coarse fraction)

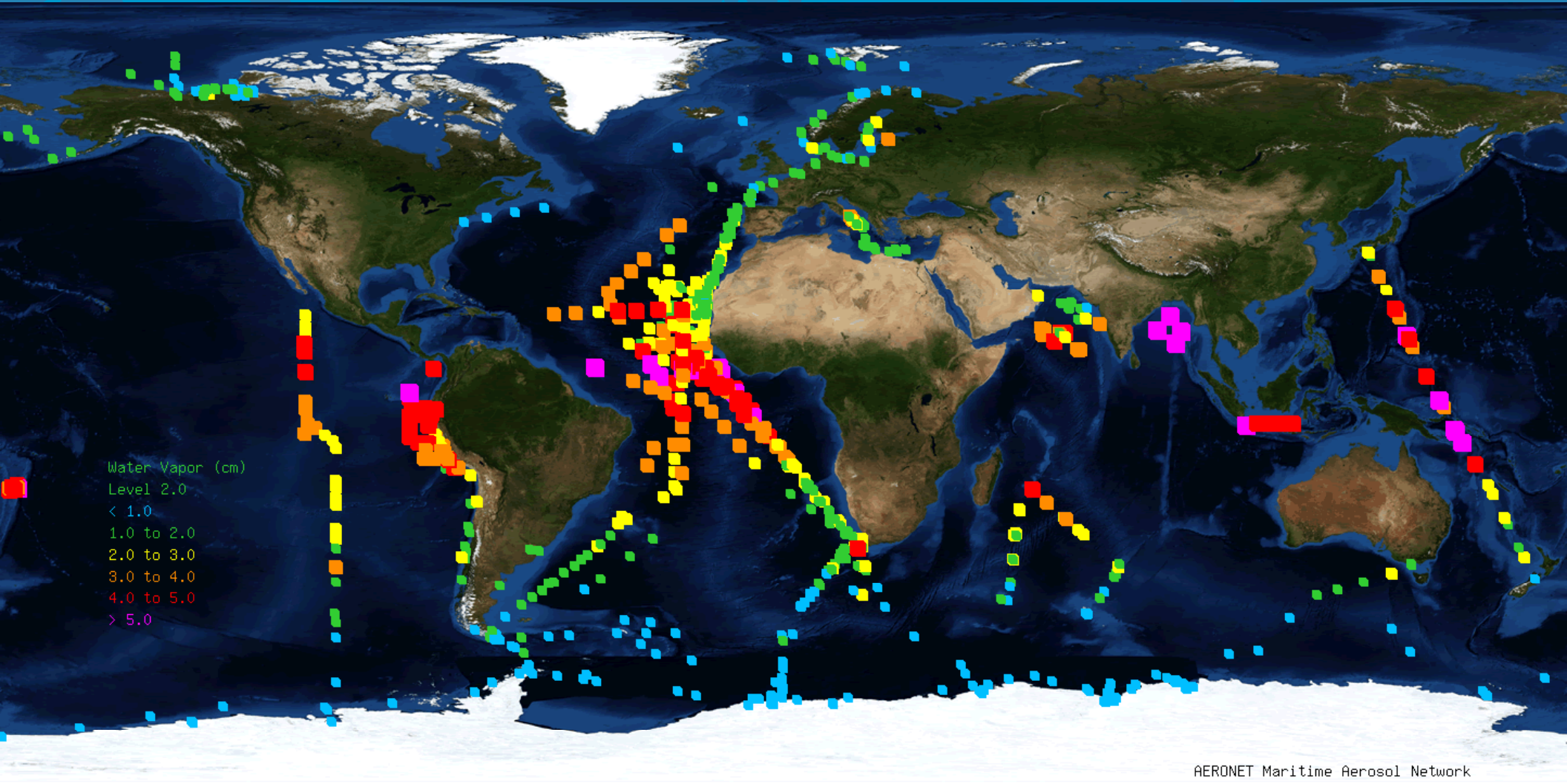




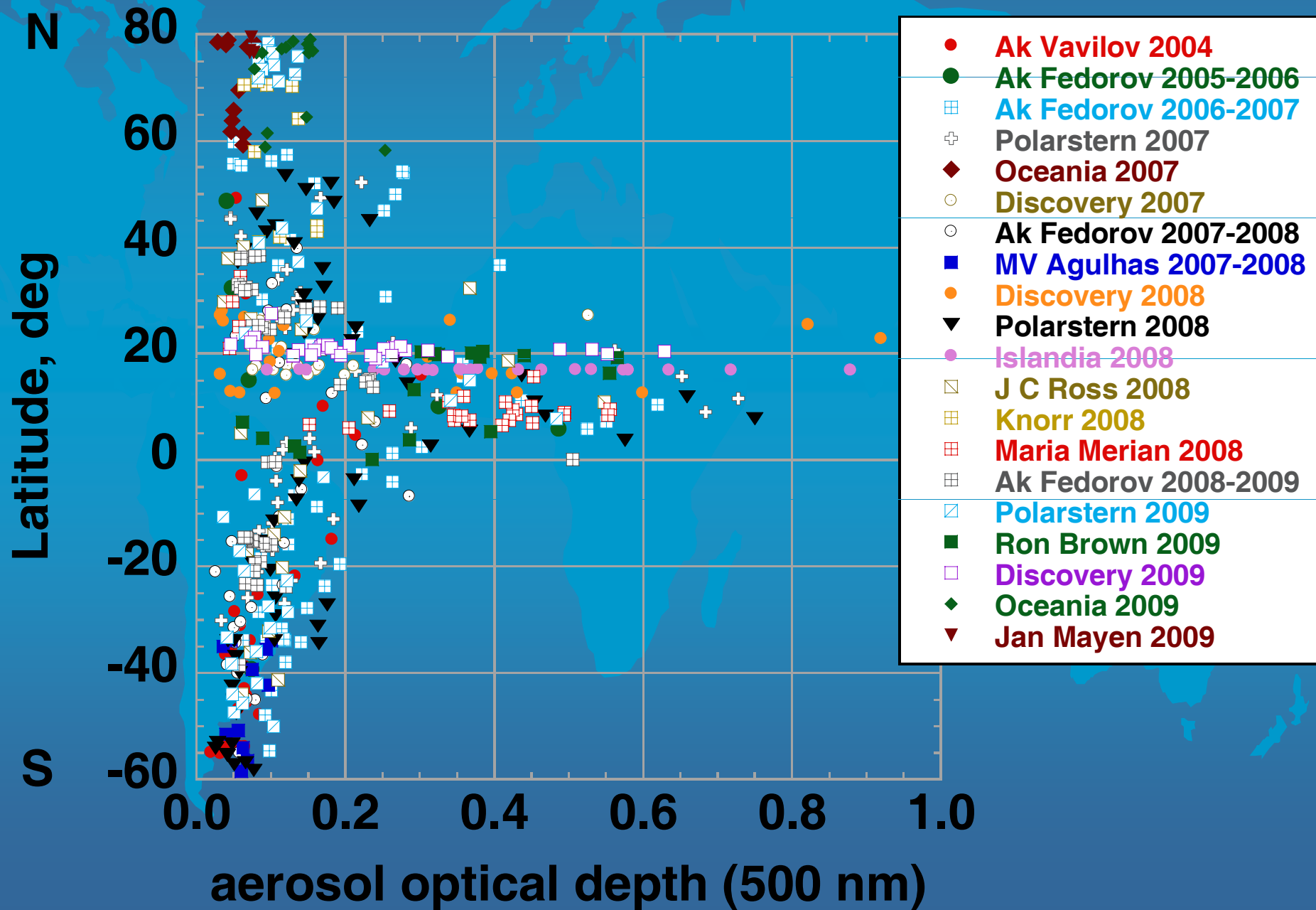
# Maritime Aerosol Network Angstrom parameter (Level 2)



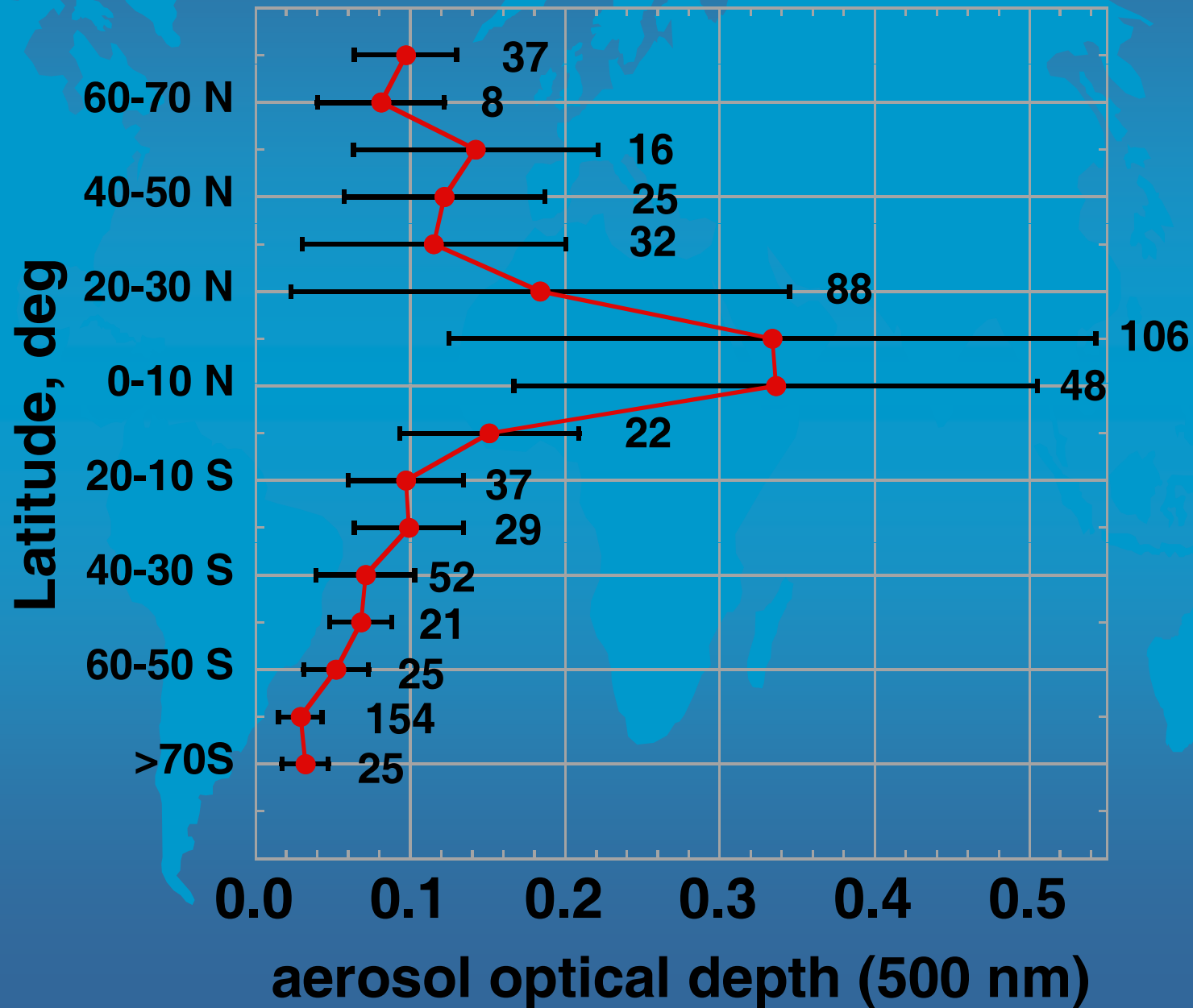
# Maritime Aerosol Network water vapor content (Level 2)



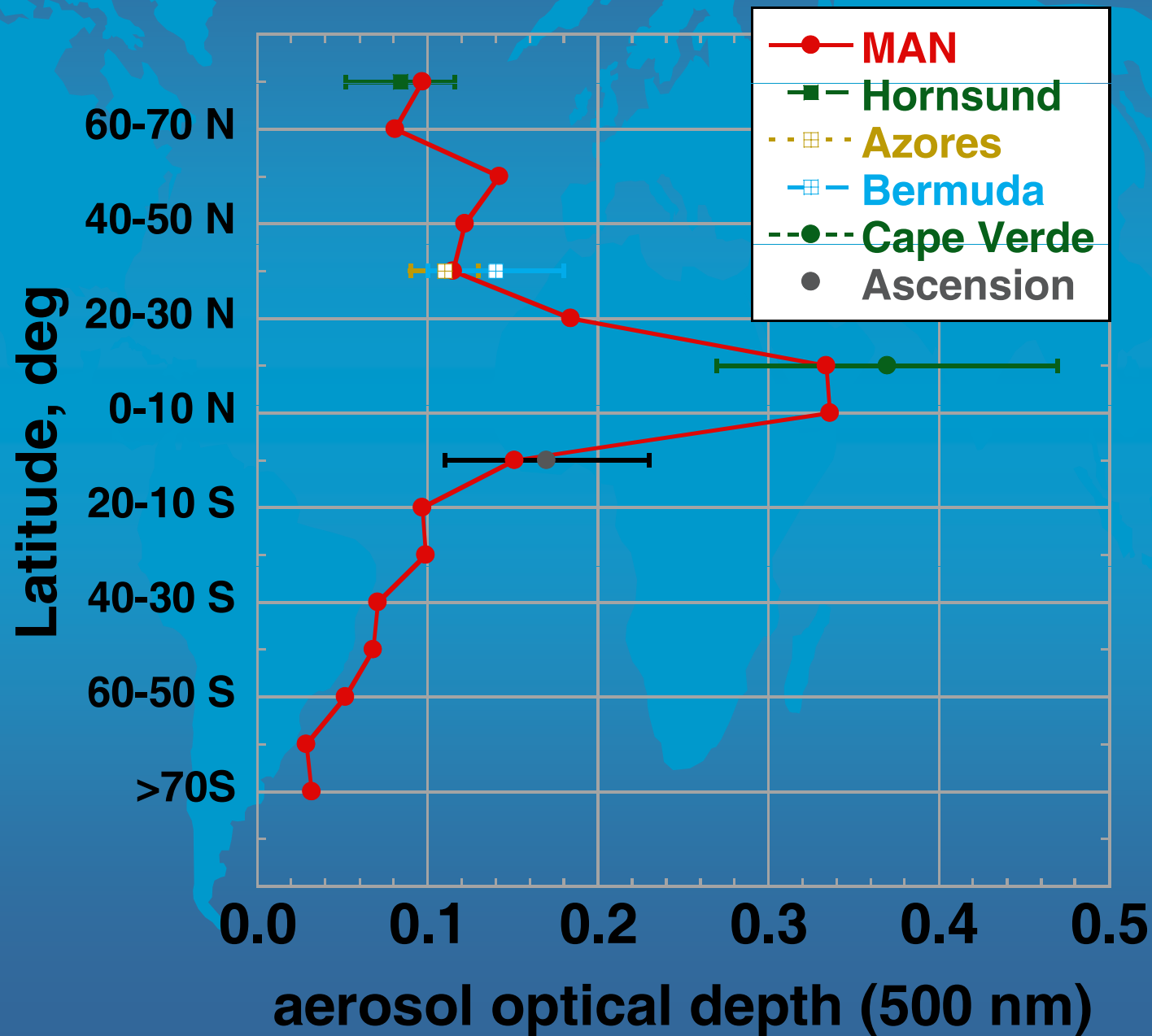
# Latitudinal dependence of aerosol optical depth in the Atlantic Ocean



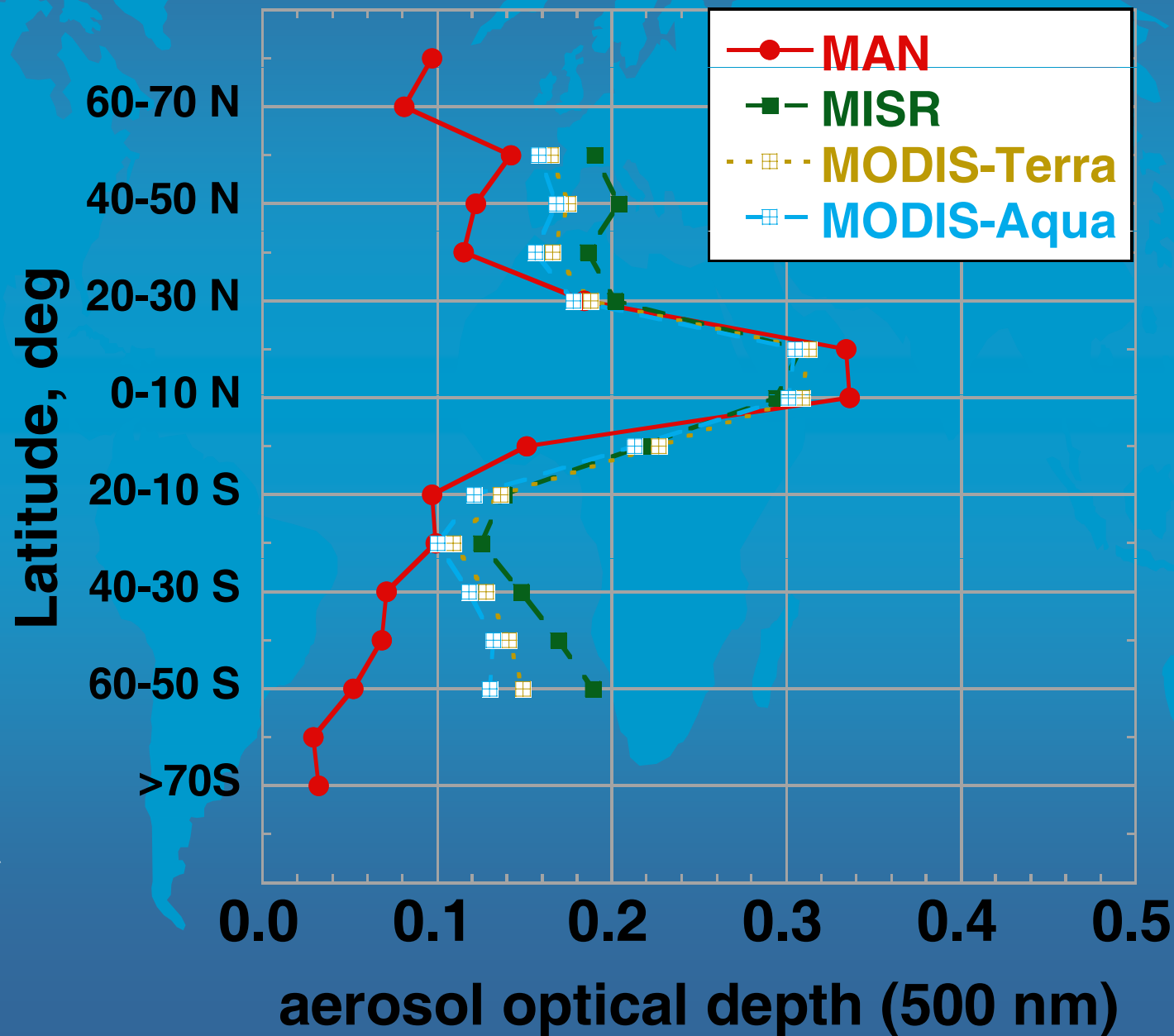
# Aerosol optical depth by latitudinal belts (Atlantic Ocean)



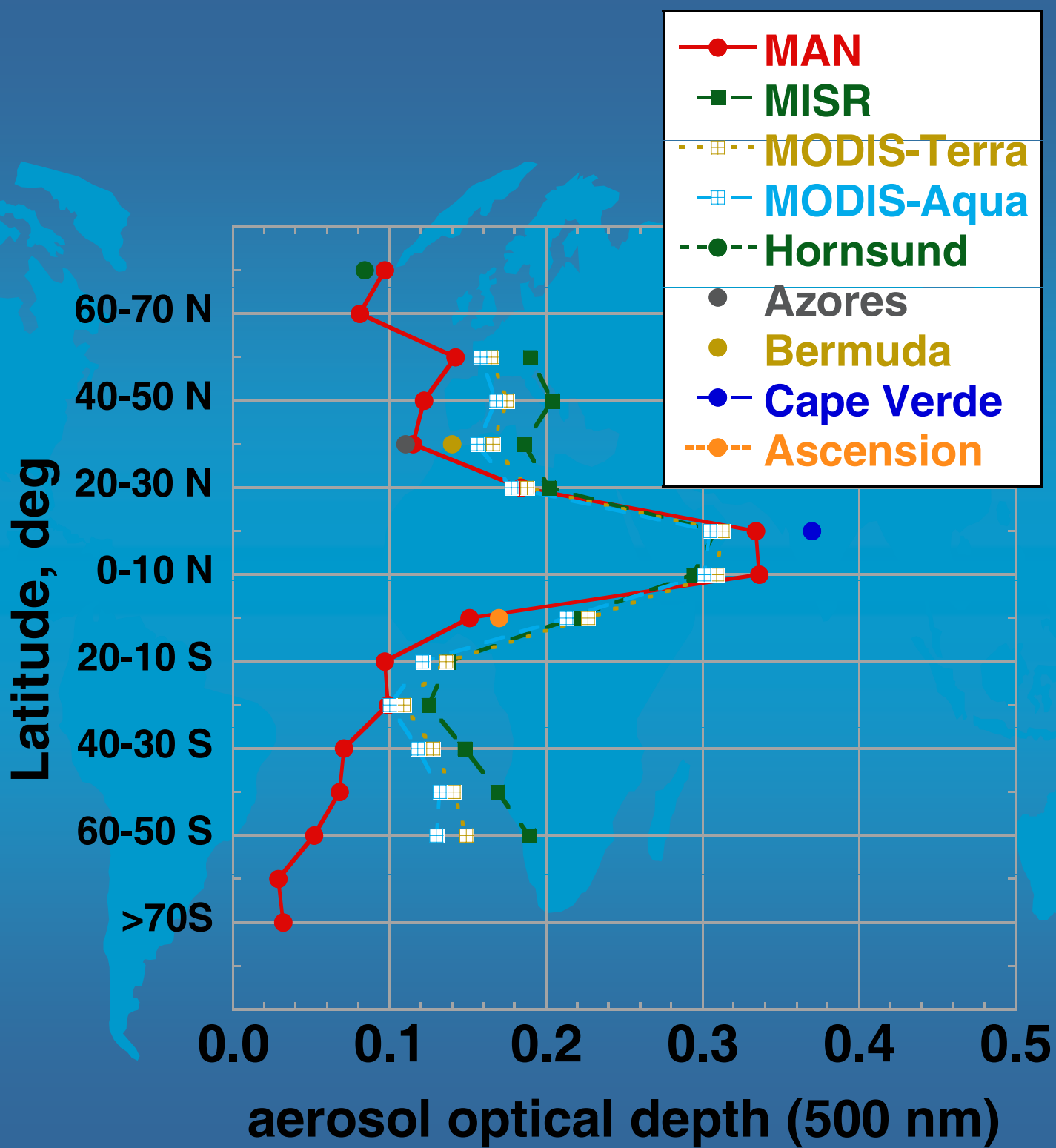
# Aerosol optical depth by latitudinal belts (Atlantic Ocean)



# Aerosol optical depth by latitudinal belts (Atlantic Ocean)

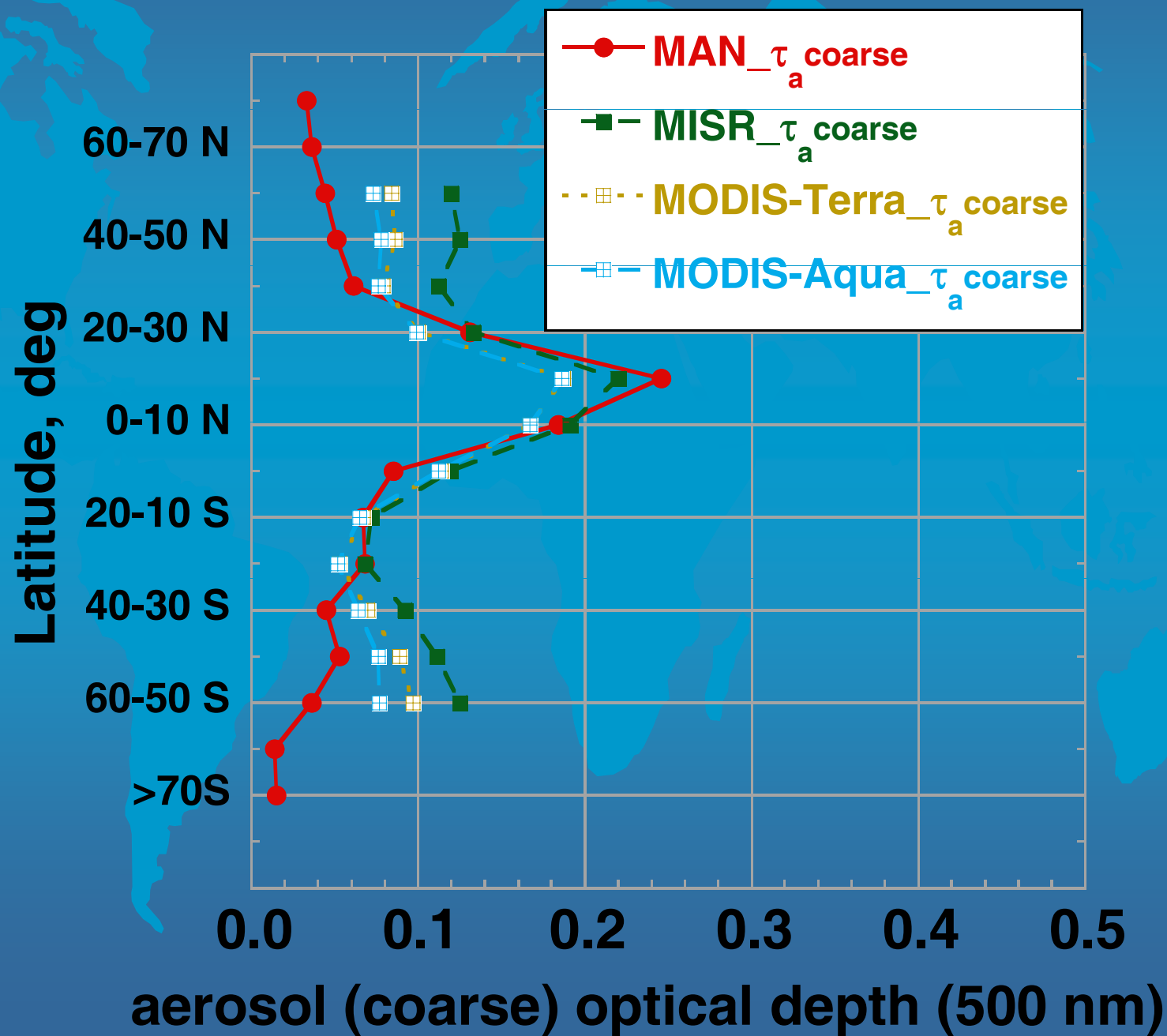


MISR and  
MODIS data  
courtesy of  
P.Kishcha –  
JGR 2009



MISR and  
MODIS data  
courtesy of  
P.Kishcha –  
JGR 2009

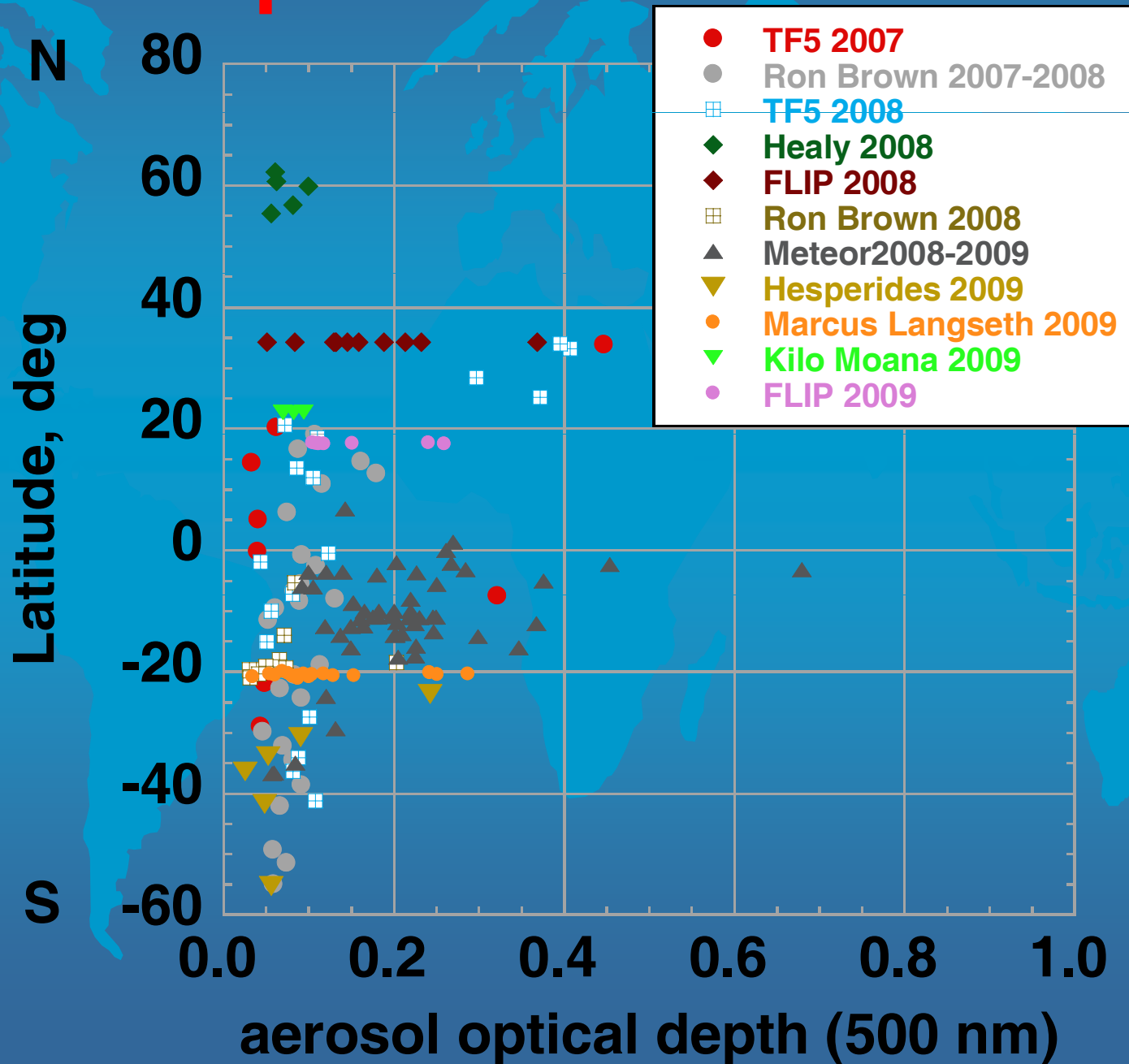
# Aerosol optical depth by latitudinal belts (Atlantic Ocean)



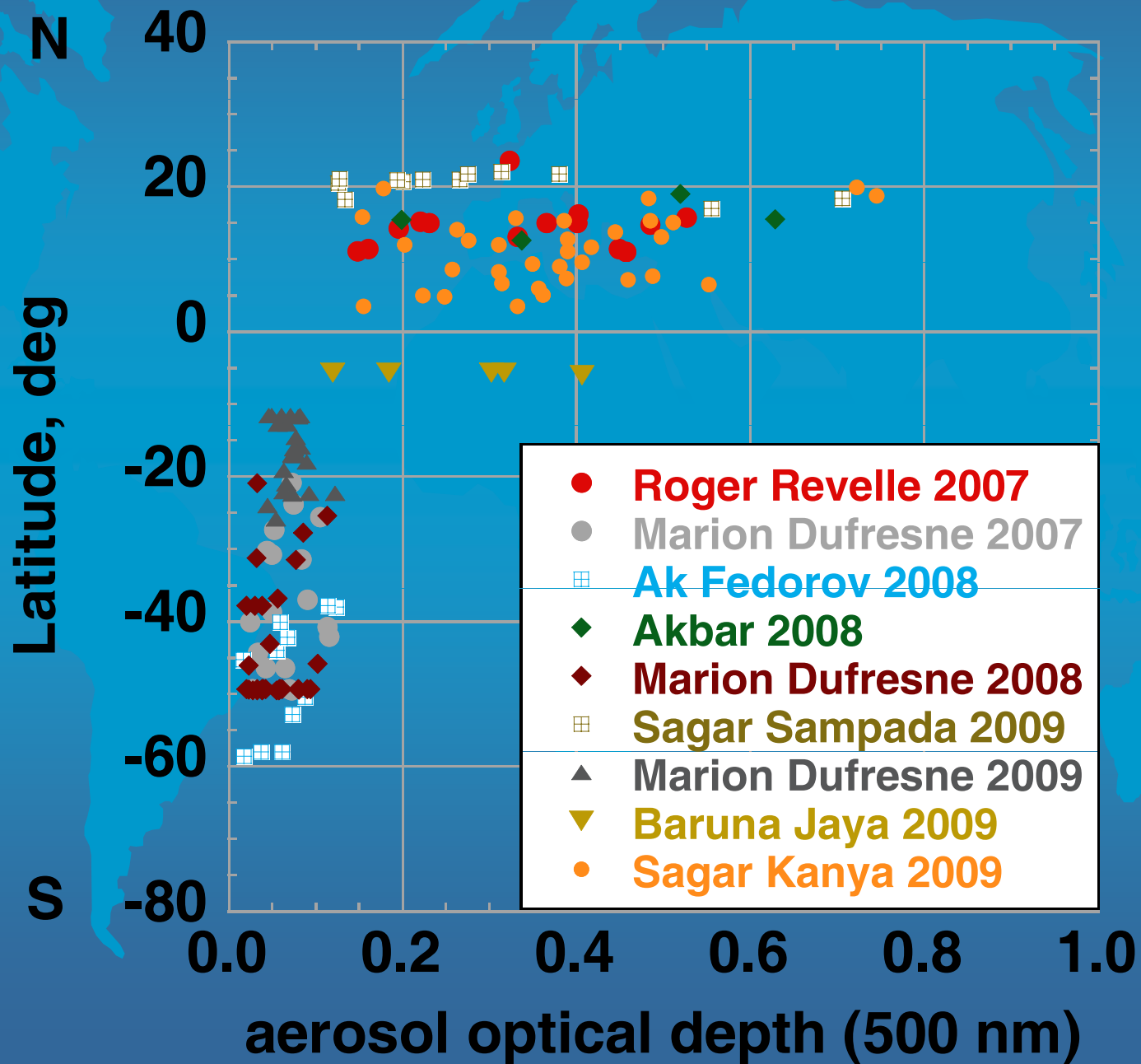
MISR and  
MODIS data  
courtesy of  
P.Kishcha –  
JGR 2009



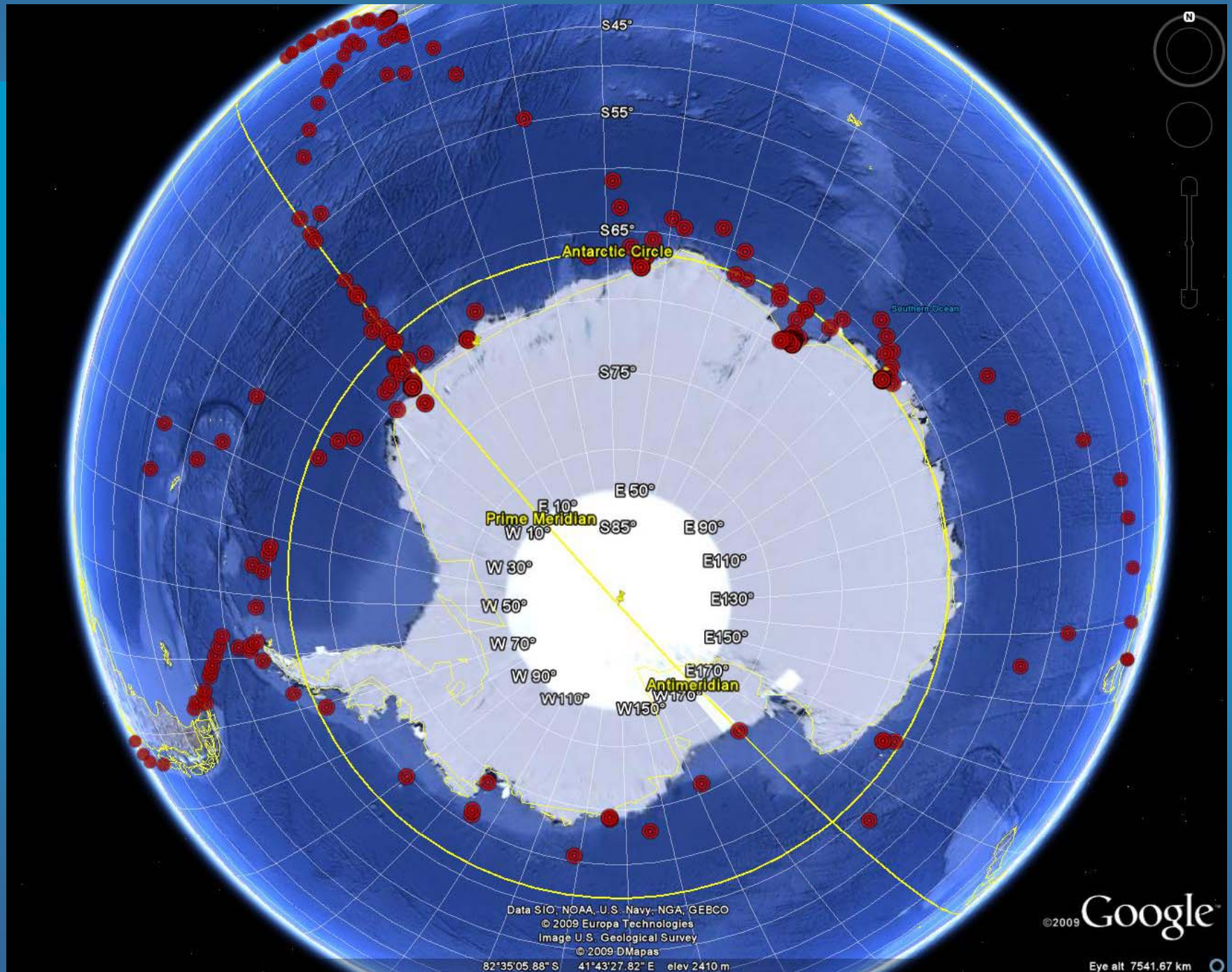
# Latitudinal dependence of aerosol optical depth in the Pacific Ocean



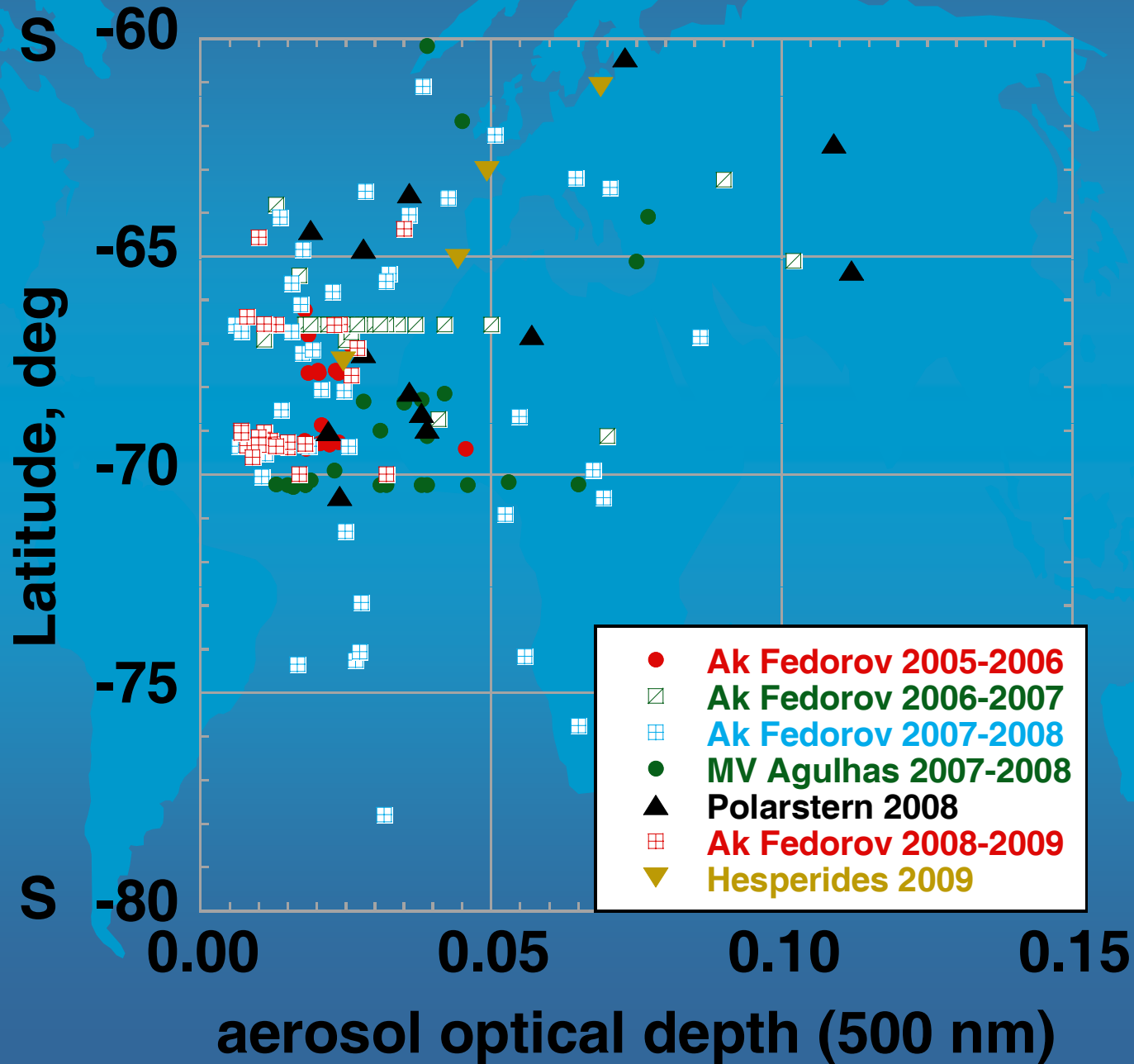
# Latitudinal dependence of aerosol optical depth in the Indian Ocean



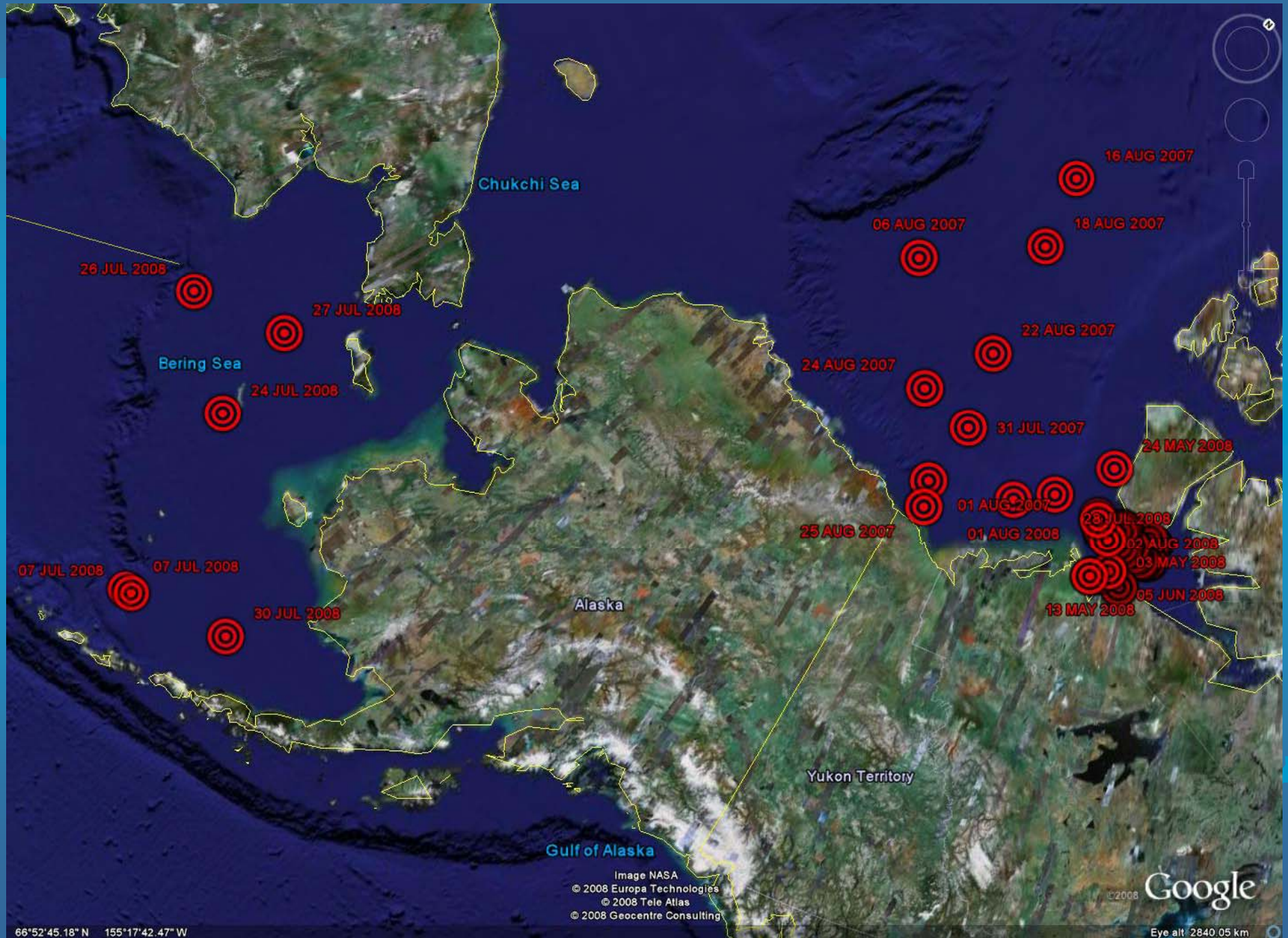
# Measurements in the South Ocean



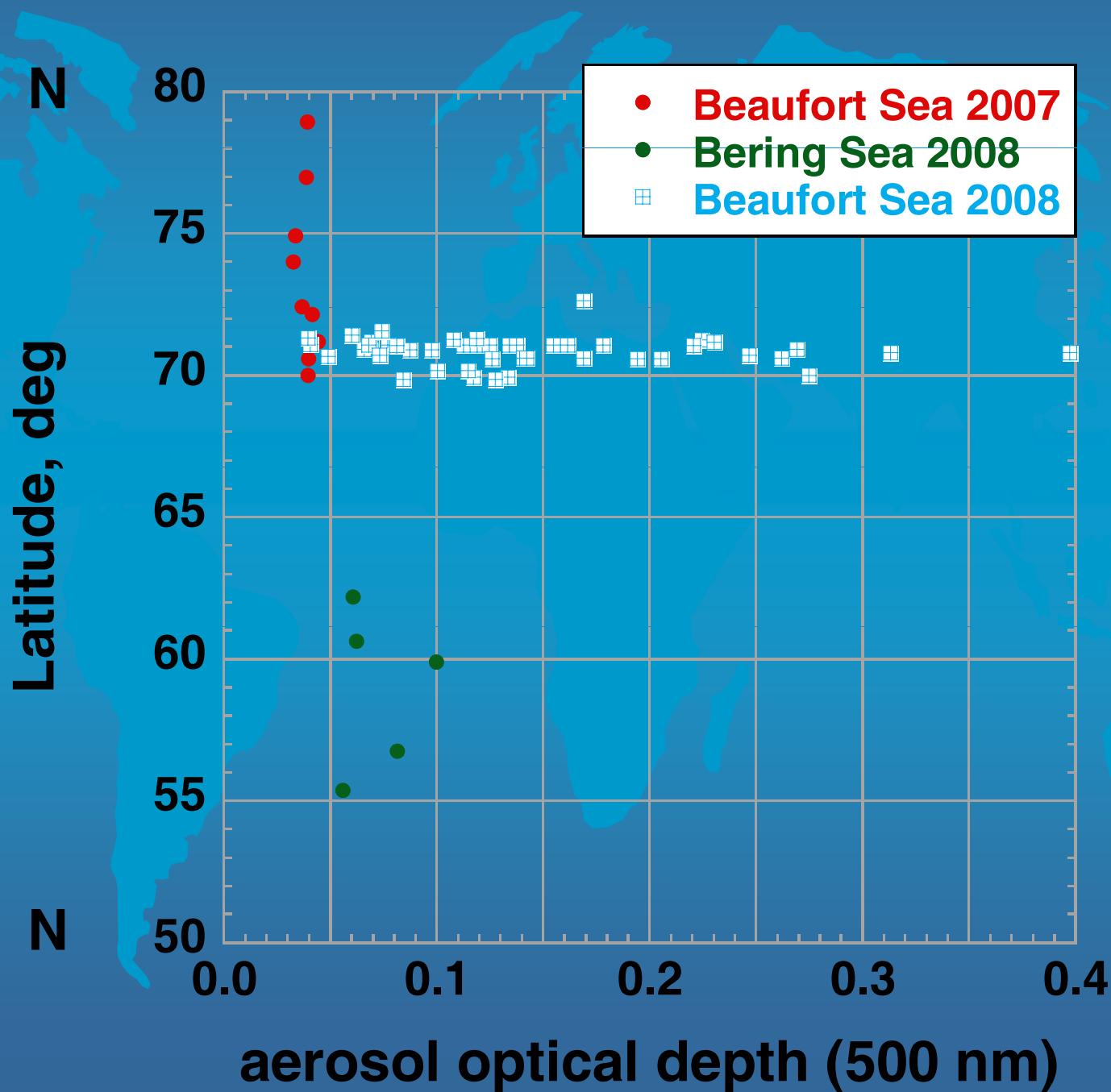
# Latitudinal dependence of aerosol optical depth in the South Ocean



# Bering Sea and Beaufort Sea



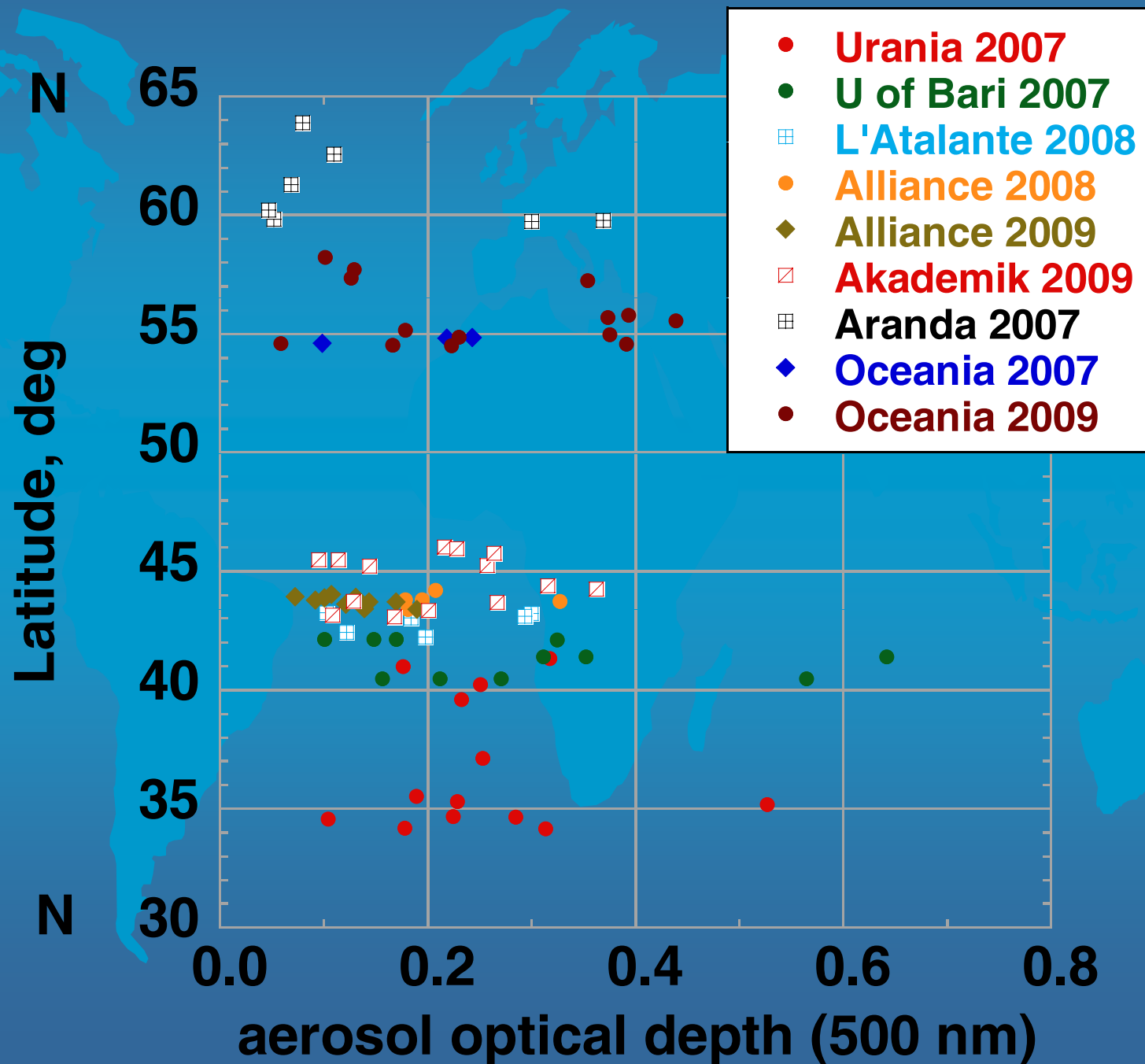
# Bering Sea and Beaufort Sea



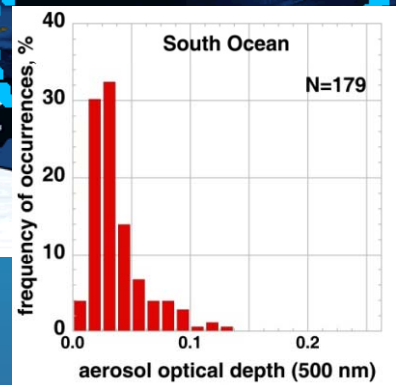
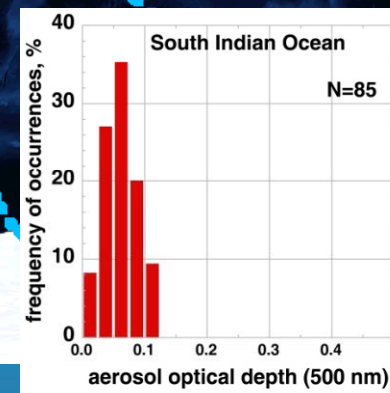
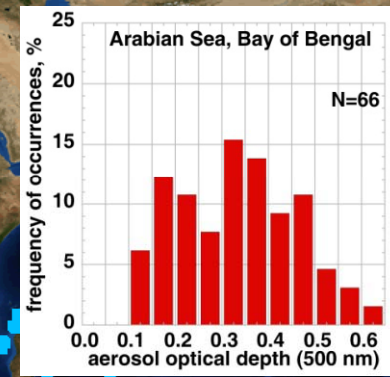
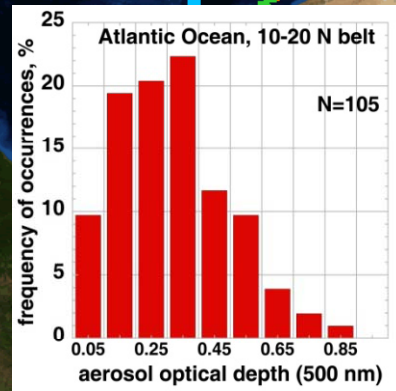
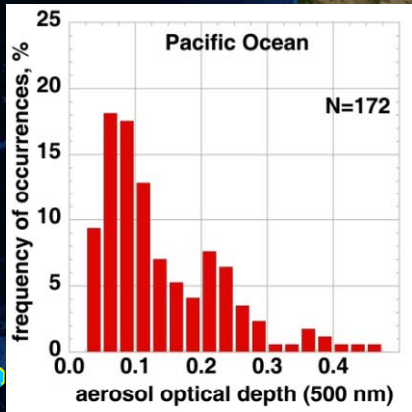
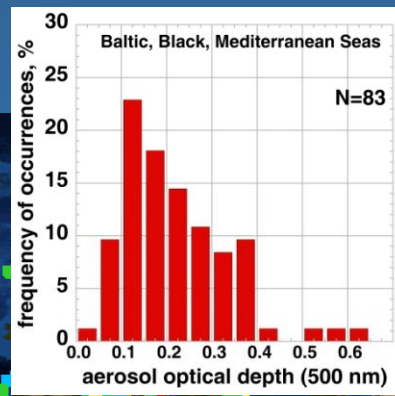
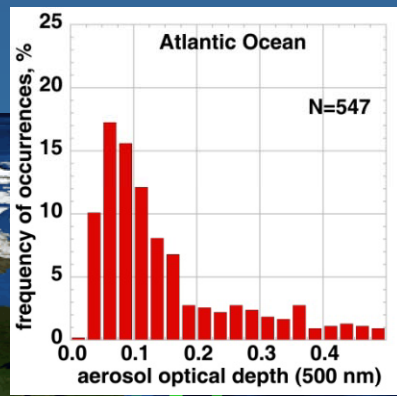
# Baltic, Black, Mediterranean Seas



# Baltic, Black, Mediterranean Seas

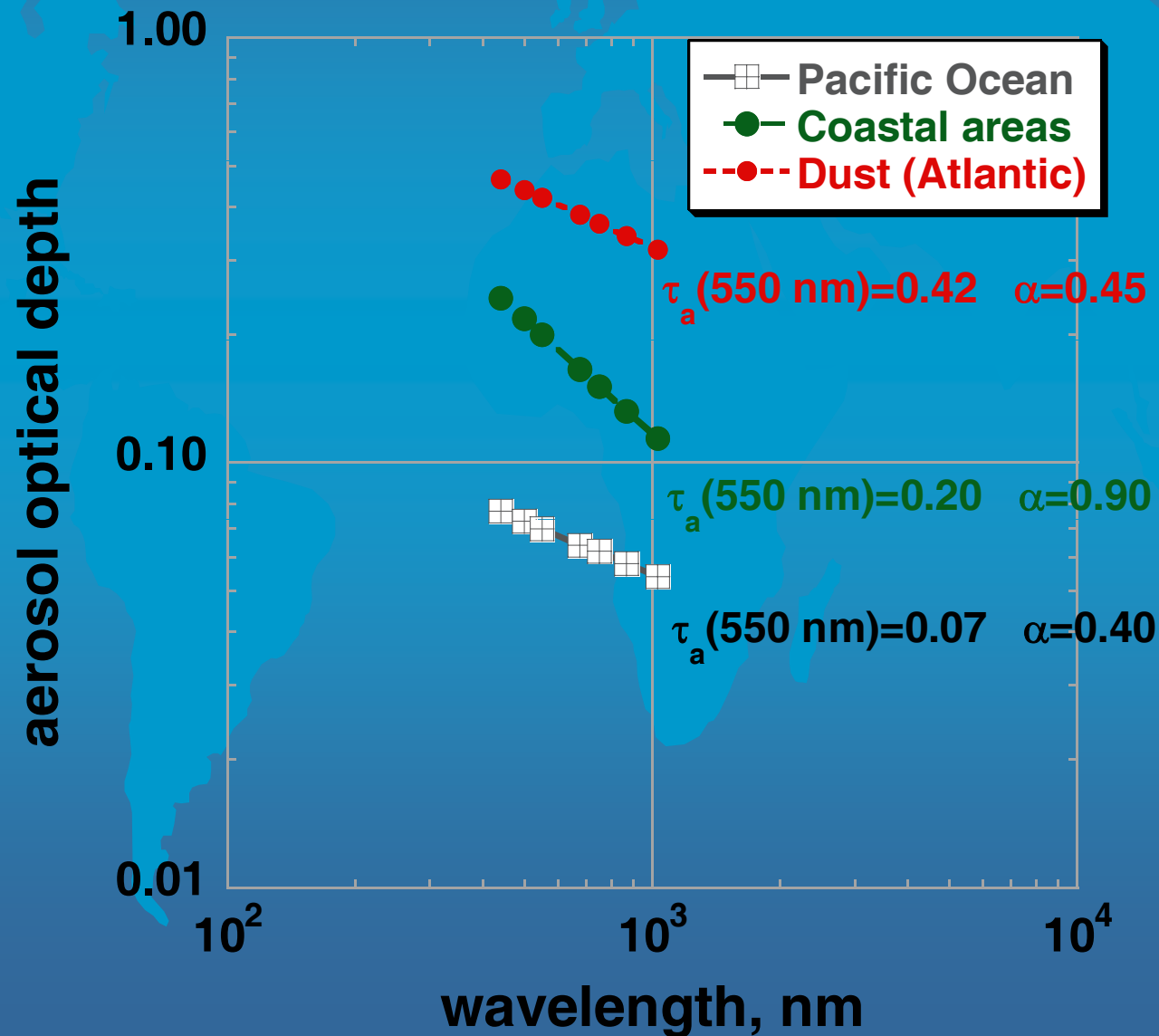




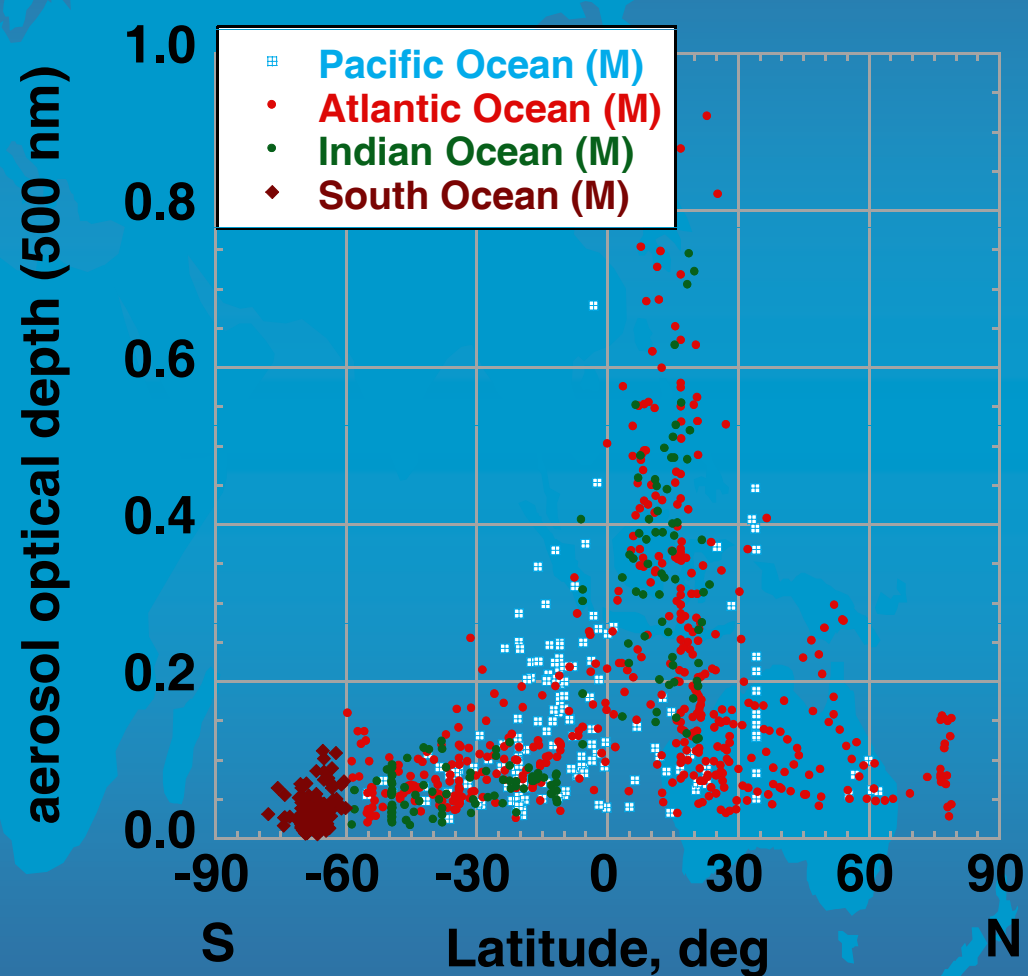
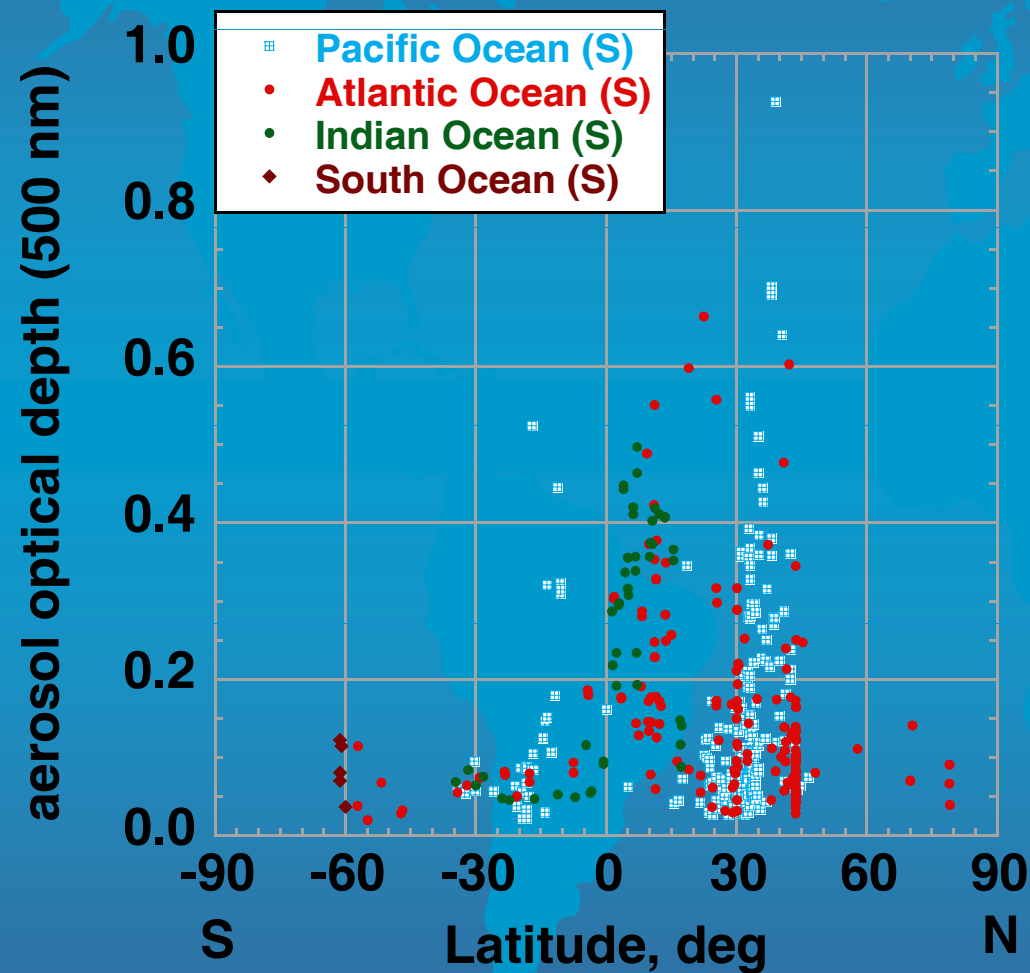


0.1 to 0.2  
 0.2 to 0.3  
 0.3 to 0.5  
 0.5 to 0.7  
 > 0.7

# Typical sea areas (as of 1988)



# The SIMBIOS and MAN datasets



# Summary

- Number of cruises completed – 62
- Number of measurement days – 1157
- Number of measurement series – 7641
- Number of ongoing cruises – 2
- Number of planned cruises - 11

# Summary

- In the last several years data acquisition was extended to the areas that previously had very little or no record at all (South Ocean)
- Data are easily accessible in the web-based public data archive and will stimulate research and international collaboration in various scientific areas

# Acknowledgments



- We thank Dr. Hal Maring of the NASA Headquarters for his support of AERONET

**Long live the Sun,  
Let darkness disappear!**

*Alexander Pushkin (1825)*



**Thank you for your attention**