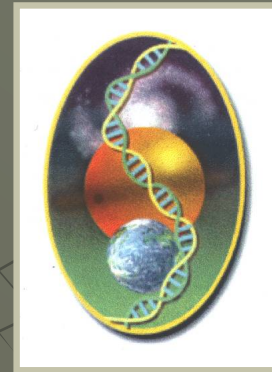
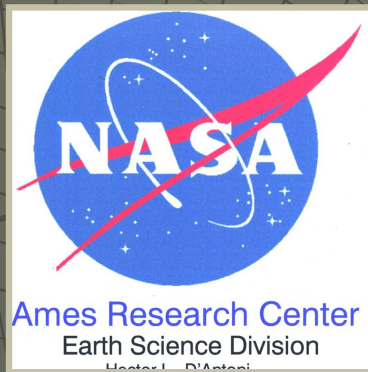


A Virtual Laboratory



Hector L. D'Antoni
NASA Ames Research Center
NASA Astrobiology Institute

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Bio-Optical Oceanography Laboratory
Department of Marine Sciences
University of Puerto Rico-Mayagüez

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Astrobiology Project

Our international research team needs high-speed communication to exchange data from observation sites in the U.S., South America and the Caribbean, and to remotely access unique facilities.



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Our Current Research and Interests

- ◆ **Astrobiology:** South America as an analog of the biosphere of a cooling and drying planet. Effects of short- and long-term climate change on the biota.
- ◆ Instrument development to retrieve consistent information from Ecosystems to cells and biomolecules.
- ◆ Development of a micro-satellite sensor consistent with our hyperspectral microscope.

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Our group at NASA ARC maintain scientific relations with:

- ◆ **Bio-Optical Oceanography (Dept. Marine Sciences, University of P. R.).** Effects of increased solar UV-B on marine plant ecosystems.
- ◆ **Environmental Toxicology Lab (Ponce School of Medicine, P.R.).** UV-B effects on human DNA, eye and muscle tissues. (P.R.)
- ◆ **National Institute for Research of Amazonia, Manaus (INPA).** Palynological paleoclimate
- ◆ **Brazilian Institute for the Environment, Brasilia (IBAMA).** Ecology, remote sensing research in Amazonia.
- ◆ **University of Mar del Plata, Argentina.** Linking remote sensing of vegetation and modern pollen dispersal.
- ◆ **Ethnographic Museum (Buenos Aires, Argentina).** Systemic analysis of human history, past climate and environment.
- ◆ **Polytechnical School (Guayaquil, Ecuador).** Archeological research of Albarradas combined with our study ENSO and Sea Surface Temperature.
- ◆ **Washington University (St. Louis, Missouri).** Development of new optical and interferometric sensors.
- ◆ **Smithsonian Institution, Washington D.C.** Long-term studies of human societies and the tropical rainforest environments of Amazonia.
- ◆ **School of Science, University of Buenos Aires, Argentina.** Modeling research on past environments.
- ◆ **INIDEP (National Institute for R & D of Fisheries, Argentina)** joint research project of the Rio de la Plata watershed.
- ◆ **San Jose State University, California** Joint Research Initiatives in Astrobiology and formation of Human Resources.
- ◆ **Alihuen Association, Santa Rosa, Argentina** Joint research of the Atuel River Wetland.

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What we have and what we need

- ◆ Our project includes 32 observation points currently connected by standard Internet.
- ◆ AMPATH will allow us to offer our collaborators access to unique facilities.
- ◆ We expect to receive data, analyses, discussion and carry out cooperation among scientists in distant locations through AMPATH.

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Our Proposal

To build a remotely operated co-laboratory for users in the AMPATH's service area.

Equipment:

- ◆ Light Microscopy Workstation
- ◆ HIRIM Microscope
- ◆ TIMS Microscope
- ◆ Sensitive Fluorescence Genetic Analysis facility
- ◆ Portable High Resolution Spectroradiometer
- ◆ Gas-exchange photosynthesis analysis
- ◆ Other instruments for chlorophyll analysis

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Other Resources

- ◆ Access to world-class Ecosystem Computer and Supercomputer facilities at NASA Ames Research Center.
- ◆ Guidance, discussion and critique from NASA scientists.

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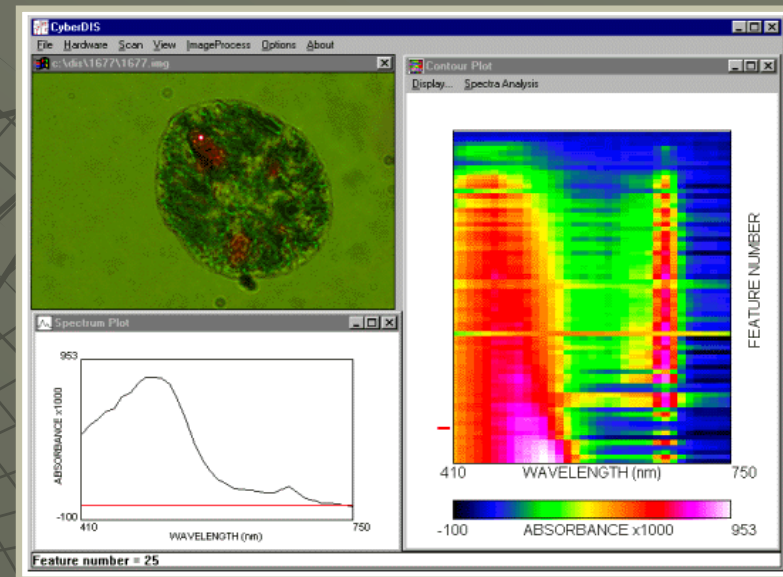
Light Microscopy Workstation



- Light microscope with planapochromatic optics.
- Digital camera with split signal to a high resolution monitor and a PC controller.
- Advanced Image Analysis software.
- Fast publication-quality prints.

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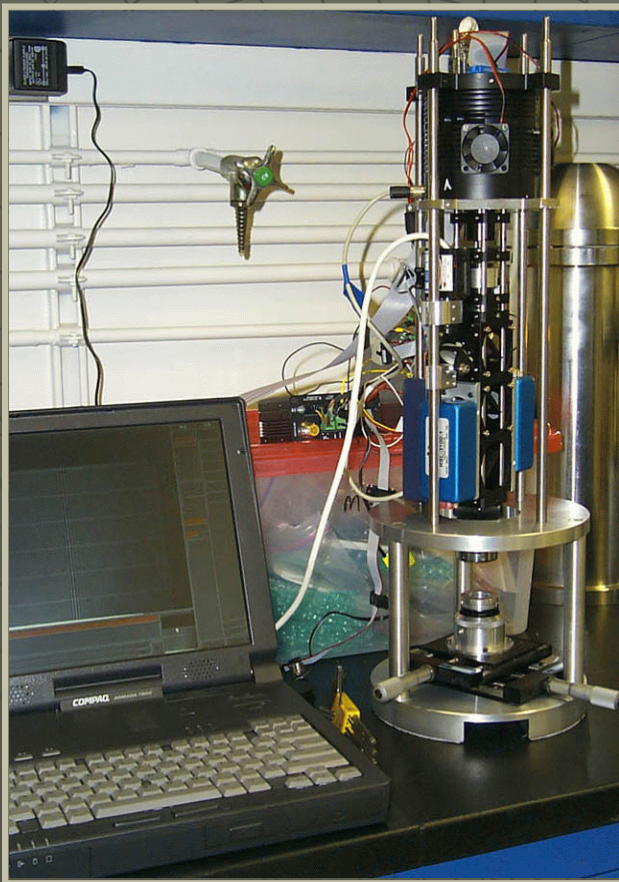
High Resolution Imaging Micro-spectrophotometer (HIRIM)



- The HIRIM (a prototype developed for NASA by Kairos Inc.) consists of a monochromator that delivers light in tunable bandwidths to a light microscope.
- Spectral range for biological signatures overlaps with the TM sensor of Landsat satellites, and in part with EO1-Hyperion.

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Tri-Spectroscopy Interferometric Micro-Imaging Sensor (TIMS)



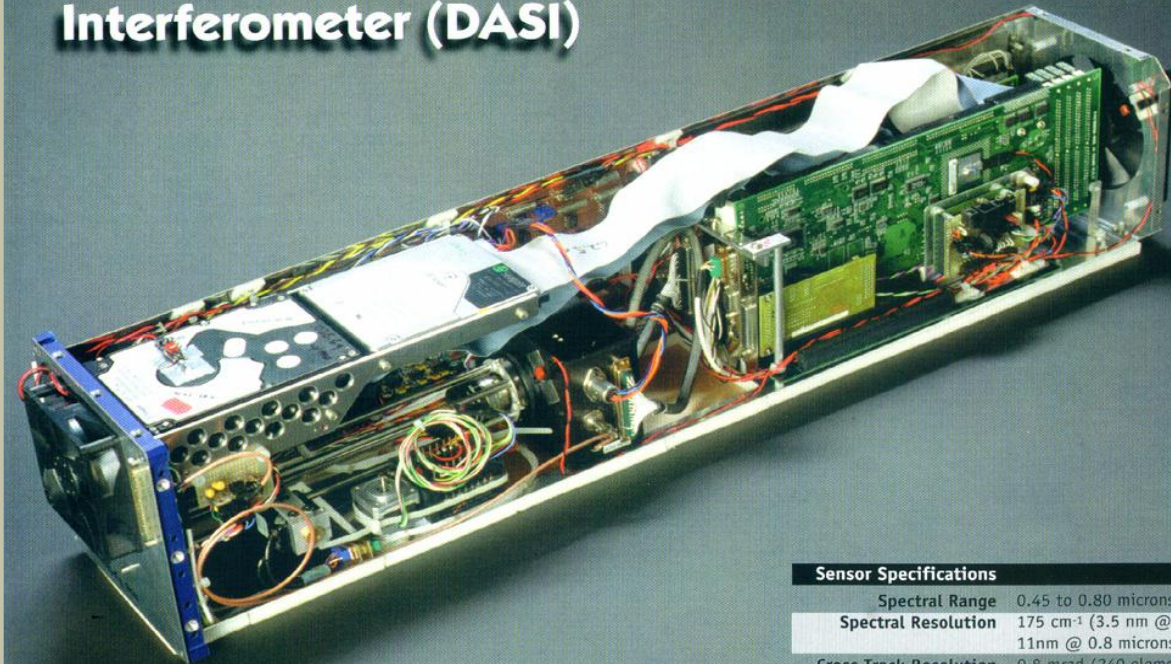
- ◆ **Developed for NASA by MEDECO, Inc. Enables live organisms observation at the “group-of-molecules” scale**
- ◆ **Multiple light sources including UV and Laser**
- ◆ **Epi-, trans- and epi-trans-illumination techniques**
- ◆ **Hyperspectral (200 nm-2 mm) at 1 nm resolution**
- ◆ **Raman, fluorescence and reflectance/transmittance spectroscopy**
- ◆ **Enhanced spatial resolution at .25 μm**
- ◆ **Low illumination levels does not affect the specimen’s photophysiologic and photochemical properties.**

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The Digital Array Scanned Interferometer (DASI)

- This sensor flew over Hawaii in a UAV platform and retrieved data compatible with TIMS.
- A new DASI sensor is being prepared for a micro-satellite.

**Digital Array Scanned
Interferometer (DASI)**



Sensor Specifications

Spectral Range	0.45 to 0.80 microns
Spectral Resolution	175 cm^{-1} (3.5 nm @ 0.45 microns, 11nm @ 0.8 microns)
Cross Track Resolution	0.8 mrad (240 elements)
Along Track Resolution	1.5 mrad (@23,000 ft elevation, 40 kts ground speed, 5 Hz frame rate)

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Sensitive Fluorescence Genetic Analysis

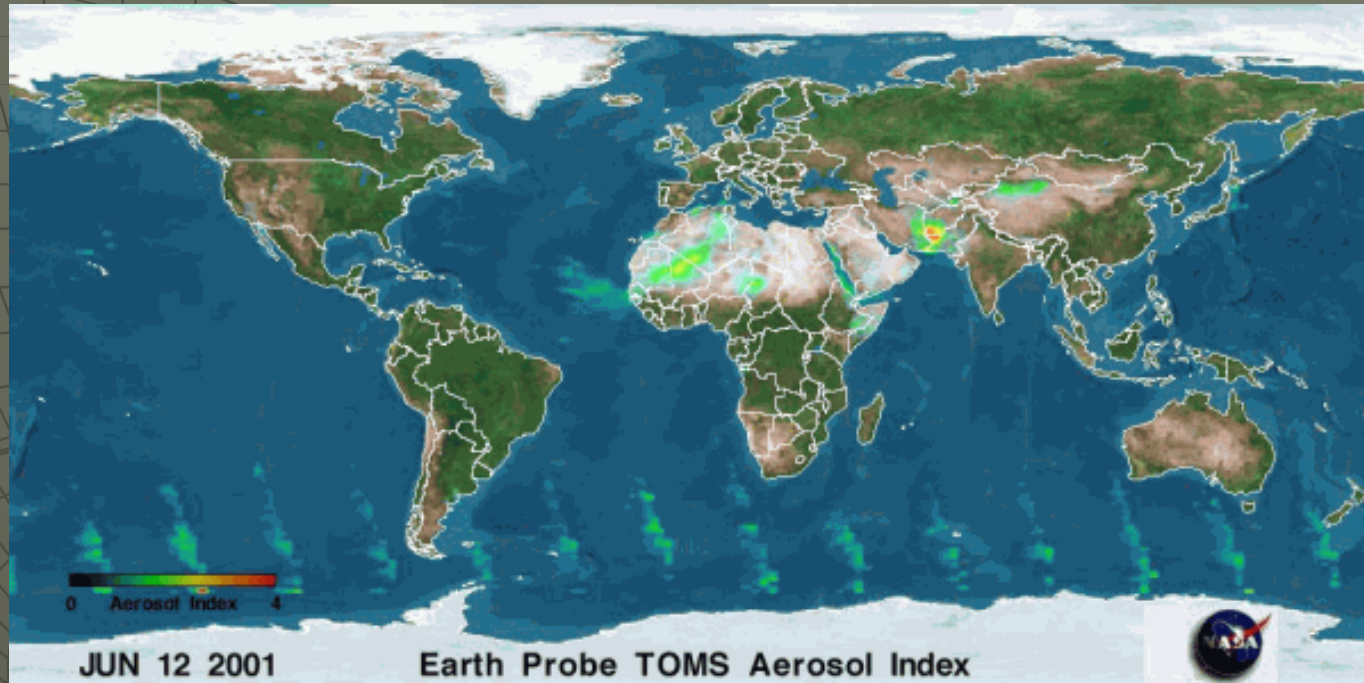
- SFGA (developed for NASA by US-Genomics), a nanochannel sequencer, reads DNA site-specifically tagged sequences.
- Can be tuned to separate single fibers of DNA and label them.
- Produces an estimated 8000 copies per hour (vs. the customary 800 a day).

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Oceanographic applications

- ◆ Spectral signatures: Harmful algal blooms, corals, seagrasses
- ◆ Canopy chemistry (mangrove leaves)
- ◆ Synthesis of flavonoids and other photoprotective pigments (in marine organisms) in response to UV fluxes
- ◆ Non destructive characterization (spectral signatures) of particles and microorganisms

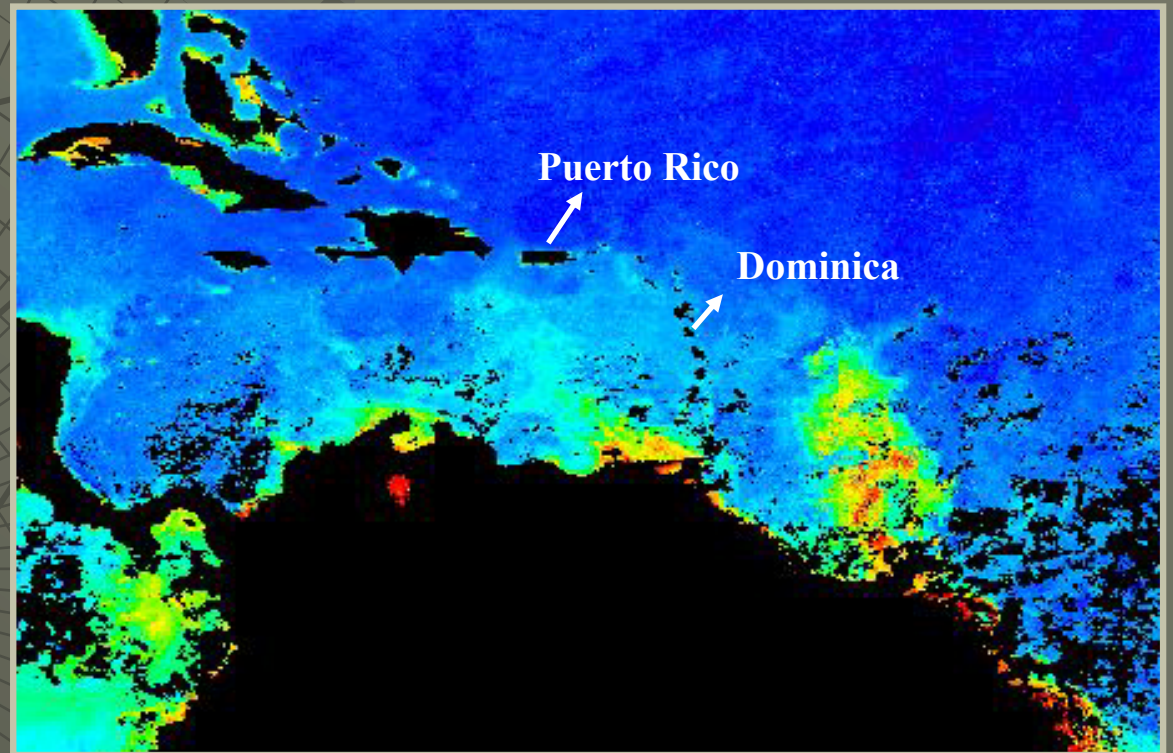
SAHARA DUST AEROSOLS



- Source of nutrients (Fe (6%), Al, P, Si, sulfates)
- *Aspergillus* and other fungi, bacteria, viruses
- Be-7, Pb-210, Hg
- DDT and other pesticides

Sahara Dust Analysis

- PM 2.5 concentration & chemical composition
- Fungi analysis
- DNA characterization of samples (i.e. bacteria)
- Respiratory health issues (i.e. asthma, allergies)



Air Monitoring (PM 2.5) Stations

Sahara Dust Satellite Data

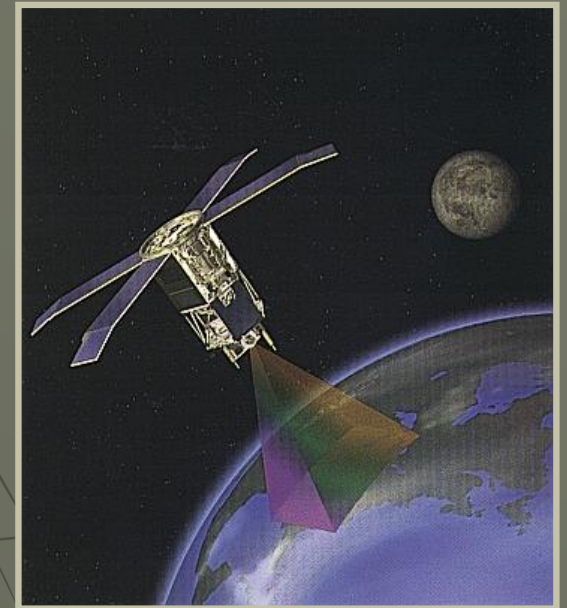
SeaWiFS: Chl *a*, Angstrom Coefficient

AVHRR: Aerosol Optical Depth

MODIS: Aerosol Optical Depth, Chl *a*

TOMS: Aerosol Optical Depth

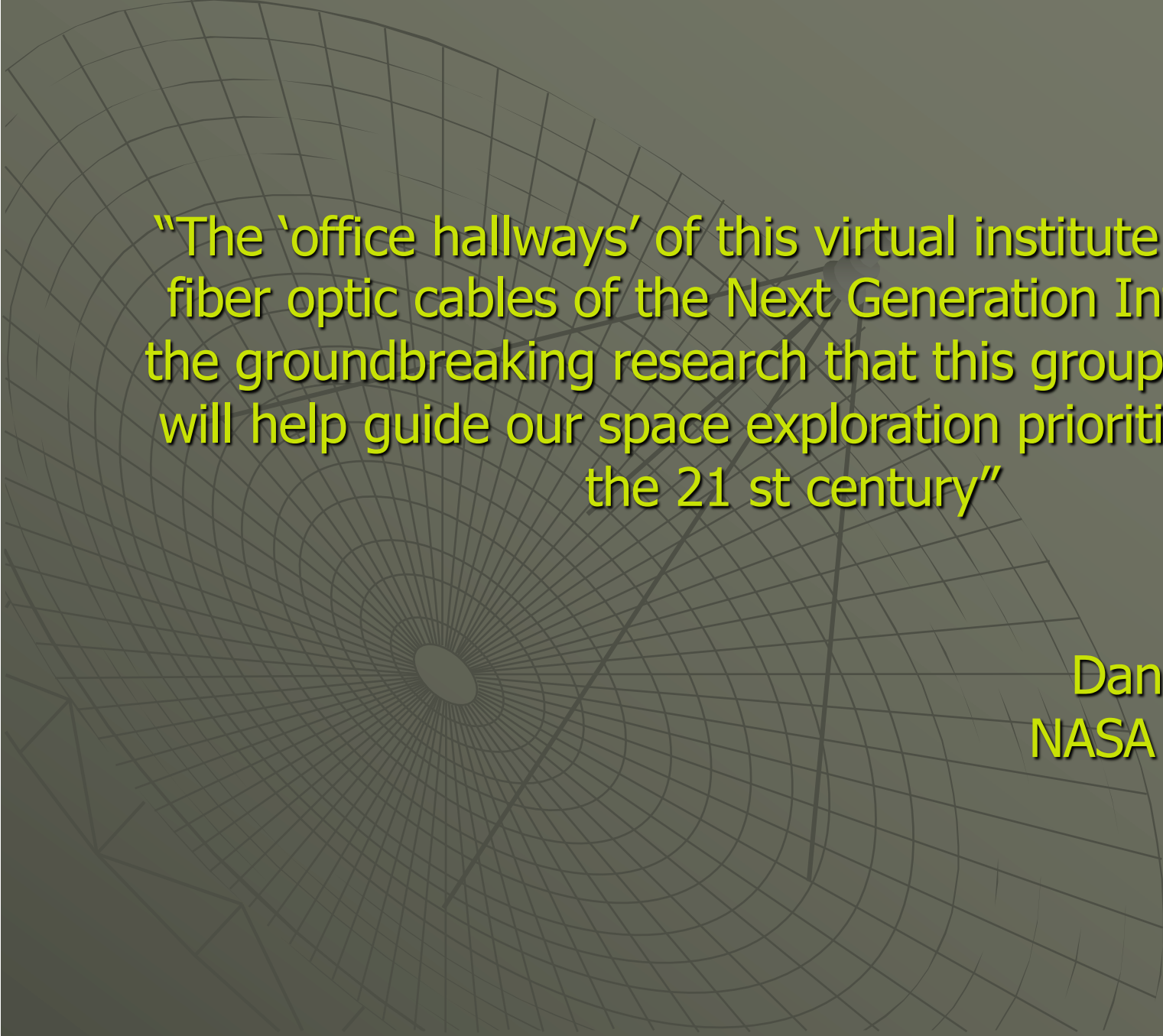
AERONET: **Aerosol Optical Depth** (from ground)



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Concluding Remarks

- ◆ **The ongoing collaborations will be enhanced by linking all participating laboratories via AMPATH.**
- ◆ **Interdisciplinary research will be possible on relatively small budgets and improved by unlimited access to unique facilities and field sites.**
- ◆ **Collaboration, teamwork, and group discussion will be greatly enhanced by AMPATH-Based Virtual Laboratories**



“The ‘office hallways’ of this virtual institute will be the fiber optic cables of the Next Generation Internet, and the groundbreaking research that this group generates will help guide our space exploration priorities well into the 21 st century”

Daniel S. Goldin
NASA Administrator