Science Data Validation Plan

Summary Charts

JPL D-18515, Rev. D
August 16, 2001

Science questions

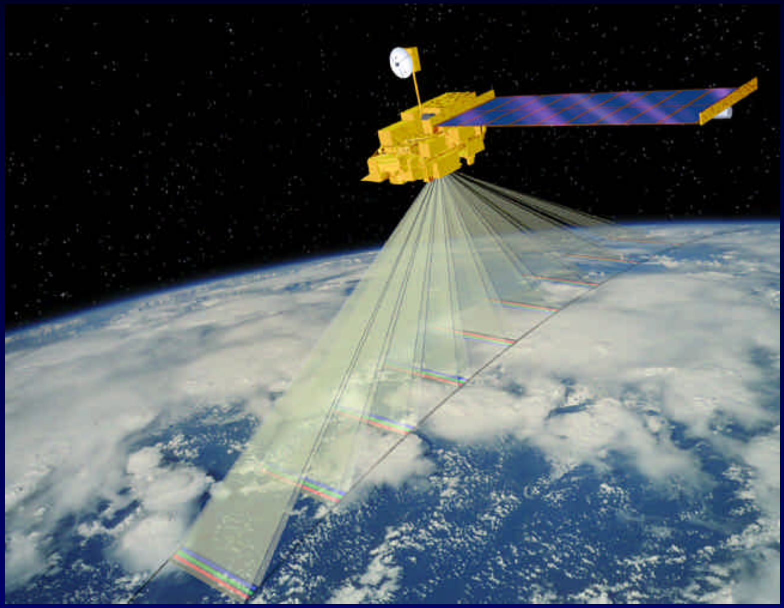
What is the abundance and distribution of airborne particulates, and what are their impacts on climate?

What effect does reflection from different types of clouds have on climate?

How does the surface respond to climate change, and how do changes in surface cover and brightness impact our climate?

Using multi-angle observations

Angular “signatures” distinguish different types of surfaces, aerosols, and clouds



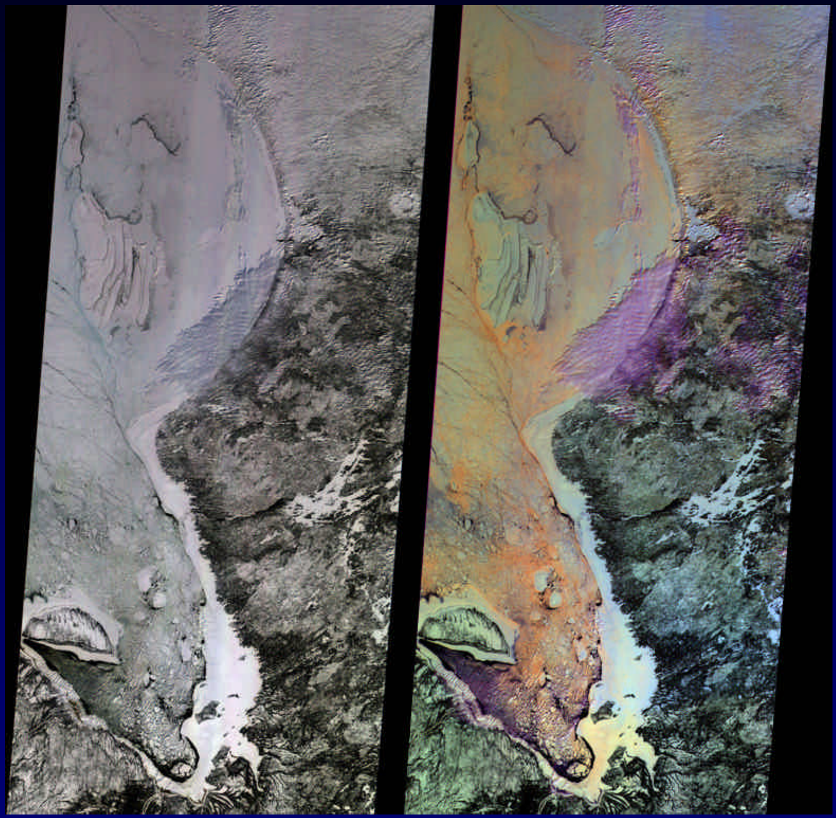
Long slant paths enhance sensitivity to aerosols and cirrus

Stereoscopic effect enables retrieval of cloud and plume heights

Time lapse from forward to aftward views enables retrieval of cloud-tracked winds

Multi-angle spectral data enables determination of surface albedo, vegetation properties, and canopy structure

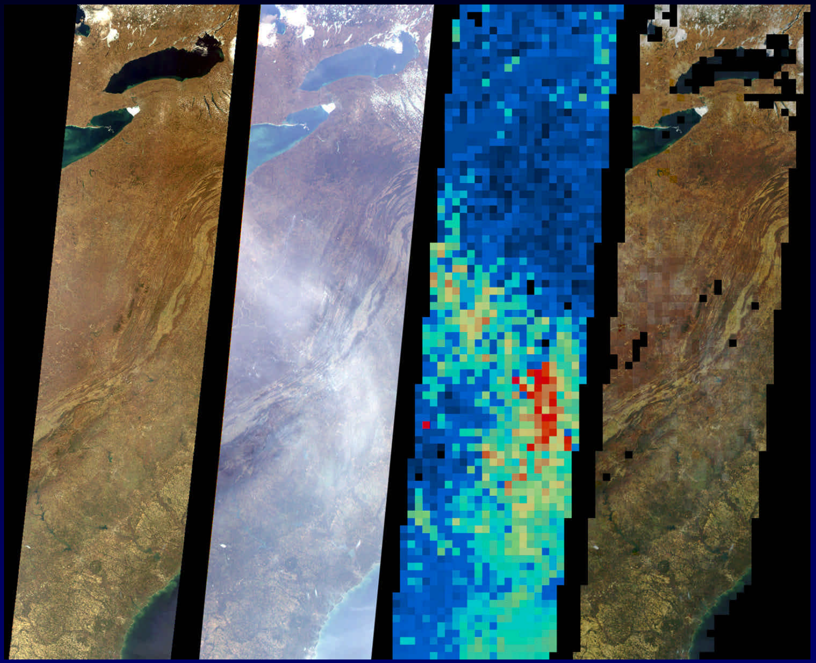
Science data products:
Level 1 Georectified Radiance Imagery



nadir multispectral image multiangle composite image

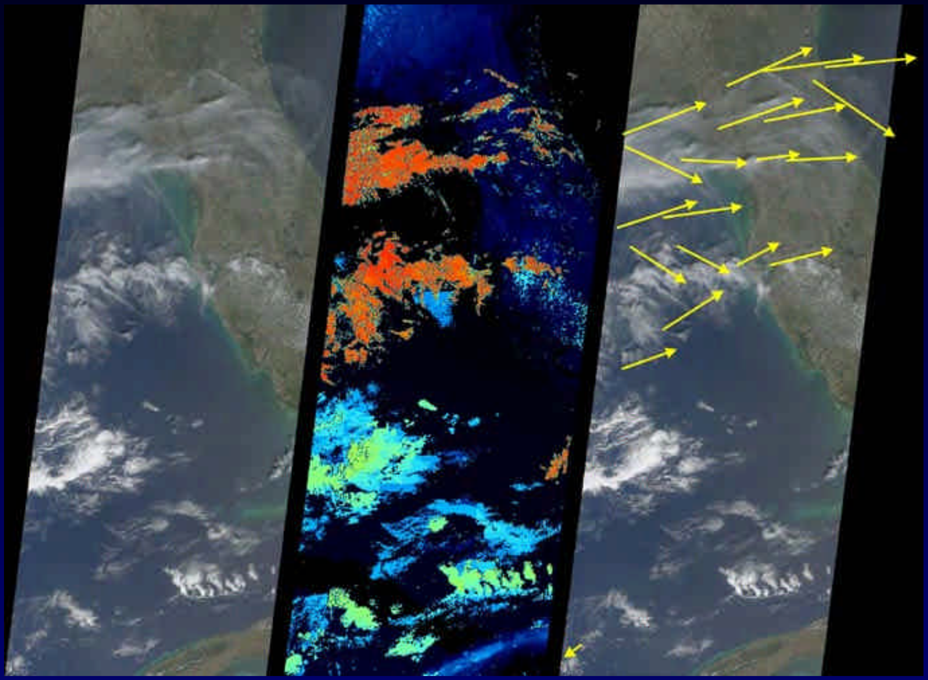
Georectified, co-registered radiances
Radiometric and geometric data quality indicators

Science data products:
Level 2 Aerosol/Surface



Aerosol column optical depths and compositional model identifiers
Land surface hemispherical-directional and bidirectional reflectance factors (HDRF, BRF)
Land BRF model parameters
Bihemispherical and directional-hemispherical reflectance (BHR, DHR)
Leaf area index (LAI) and fractional absorbed photosynthetically active radiation (FPAR)
Water-leaving equivalent reflectance
Phytoplankton pigment concentration

Science data products:
Level 2 Top-of-atmosphere/Cloud



Level 1 image　Level 2 heights　Level 2 winds

Radiometric, stereoscopic, and angular signature cloud masks
Stereoscopic heights, winds, and reflecting level reference altitude (RLRA)
Bidirectional reflectance factors, local albedos, view obscuration, and texture information projected to the RLRA
Coarse resolution restrictive and expansive albedos
Altitude-binned regional scene classifiers
Cloud and topographic shadow masks

Maturity level designations for product parameters: Alpha and Beta

Alpha

Pre-release designation used as a test bed to discover and correct errors affecting software operability.

Applies to entire products. Data products are visible to the science team, but not the public.

Not appropriate for scientific publication.

Beta

Early release used to gain familiarity with data formats.

Intended as a test bed to discover and correct errors.

Minimally validated and still may contain significant errors. General research community is encouraged to participate in the QA and validation, but need to be aware that product validation and QA are ongoing.

Parameter may be used in publications as long as beta quality is indicated by the authors. Drawing quantitative scientific conclusions is discouraged. Users are urged to contact science team representatives prior to use of the data in publications, and to recommend members of the instrument team as reviewers.

The Data Quality Summary states estimated uncertainties.

May be replaced in the archive when an upgraded product becomes available, but should be reproducible upon demand.

Maturity level designations for product parameters: Provisional and Validated

Provisional

Incremental improvements are still occurring. Obvious artifacts or blunders observed in beta product have been identified and either minimized or documented.

General research community is encouraged to participate in the QA and validation, but need to be aware that product validation and QA are ongoing.

Parameter may be used in publications as long as provisional quality is indicated by the authors. Users are urged to contact science team representatives prior to use of the data in publications, and to recommend members of the instrument team as reviewers.

The Data Quality Summary states estimated uncertainties.

May be replaced in the archive when an upgraded product becomes available, but should be reproducible upon demand.

Validated

Validation results have been published in the peer-reviewed literature.

The Data Quality Summary states estimated uncertainties.

The Data Quality Summaries are updated as new validation results become available, including all referenceable publications.

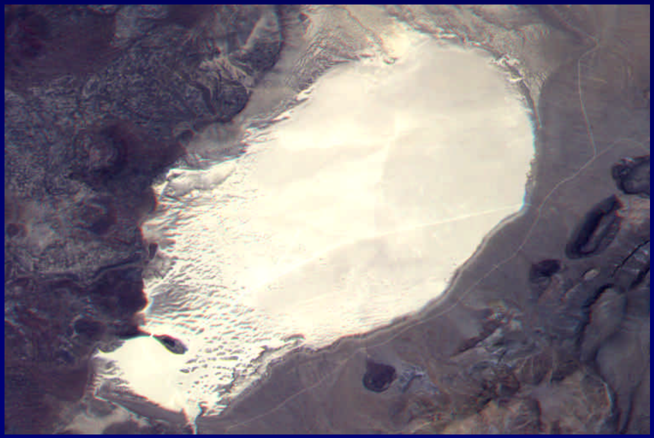
Parameter, together with its published uncertainties, may be used to derive quantitative scientific conclusions that are suitable for publication.

May be replaced in the archive when an upgraded product becomes available, but should be reproducible upon demand.

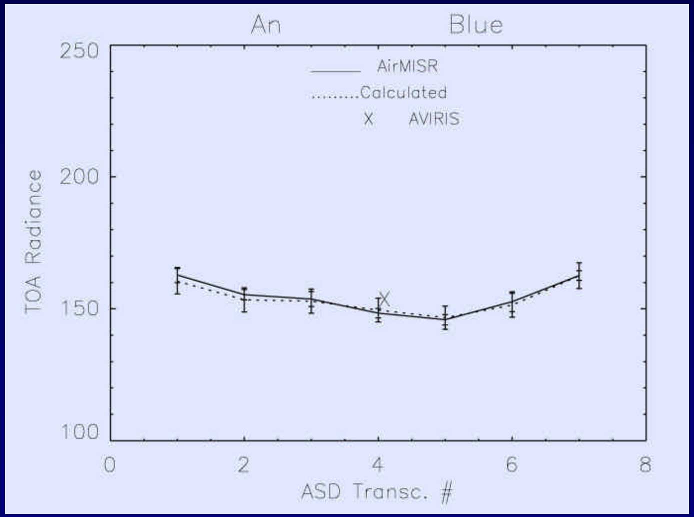
Validation approach: Radiometry

Characterization of surface reflectance

MISR radiometric calibration from the On-Board Calibrator is validated against field observations, as well as AirMISR, Landsat, AVIRIS, and MODIS calibrated radiances



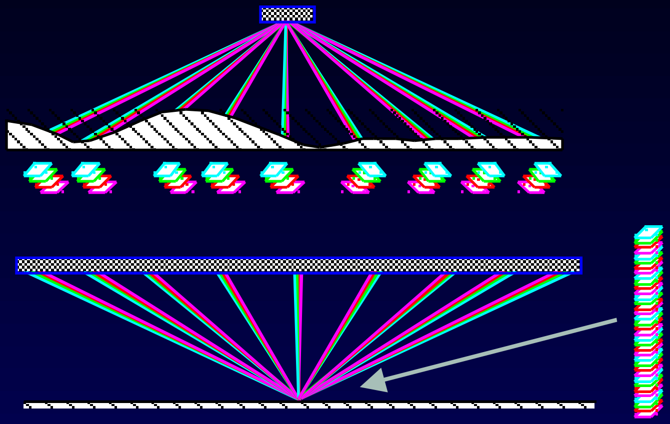
AirMISR nadir view of Lunar Lake, NV



Top-of-atmosphere radiances from vicarious calibration compared to aircraft observations

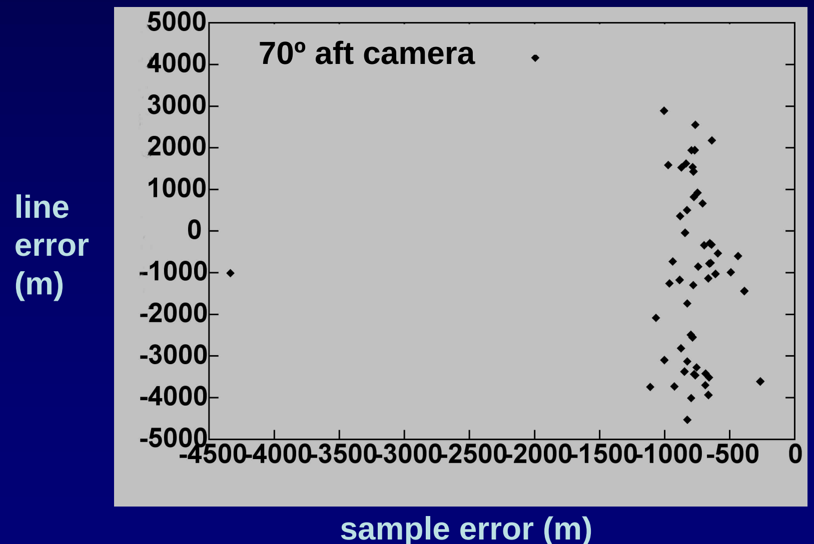
C.J. Bruegge et al., JPL

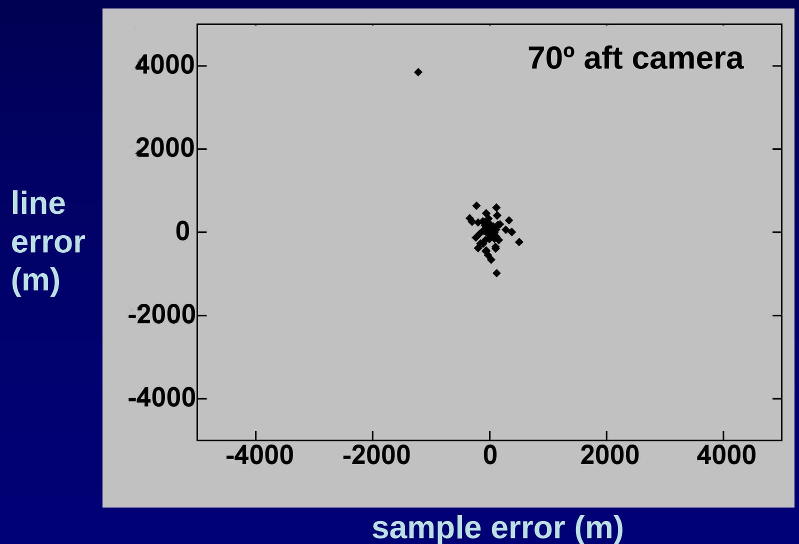
Validation approach: Georectification



MISR Camera Geometric Models are validated using globally distributed ground control points, and comparing projected data with ground truth derived from image matching

Reprojection of multi-angle imagery





Example comparison of geolocation errors before (left) and after (right) geometric calibration

V.M. Jovanovic et al., JPL

Validation approach: Aerosol

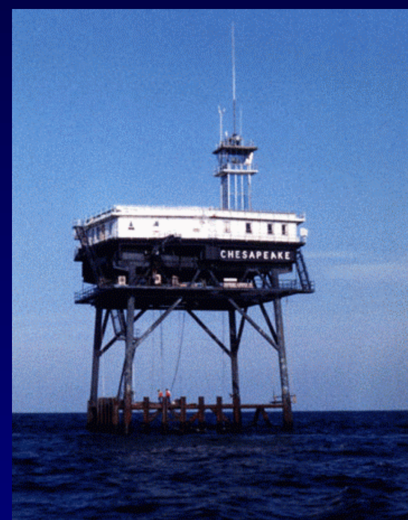
CIMEL solar radiometer

AERONET

MISR aerosol validation is based upon intensive field campaigns involving in-situ, ground-based, and aircraft observations, as well as long-term, statistical comparisons with networks such as AERONET

Reagan sunphotometer

MFRSR shadowband radiometer



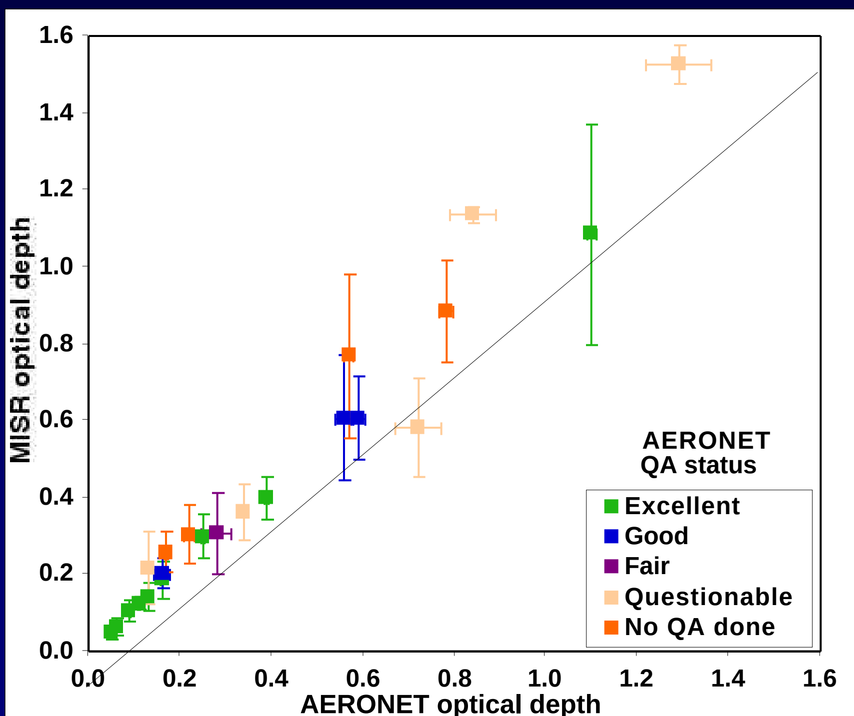
Chesapeake Lighthouse platform

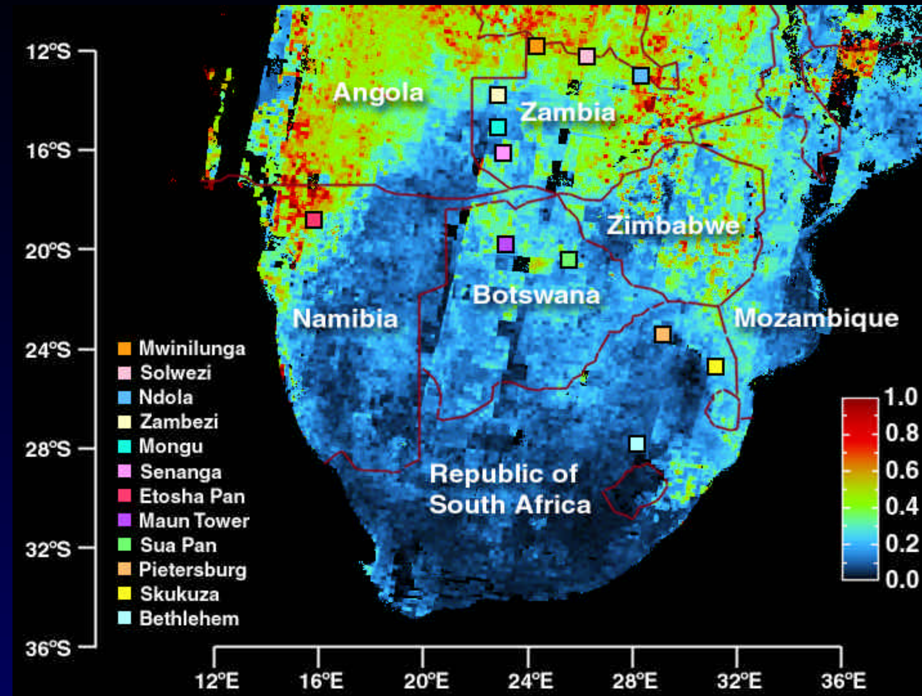
International Global Atmospheric Chemistry Project
ACE - Asia
Asian Pacific Regional Aerosol Characterization Experiment

NSF C-130

Example of aerosol optical depth validation using radiometer network

Southern Africa
14 August - 29 September 2000





558-nm optical depths

AErosol RObotic NETwork

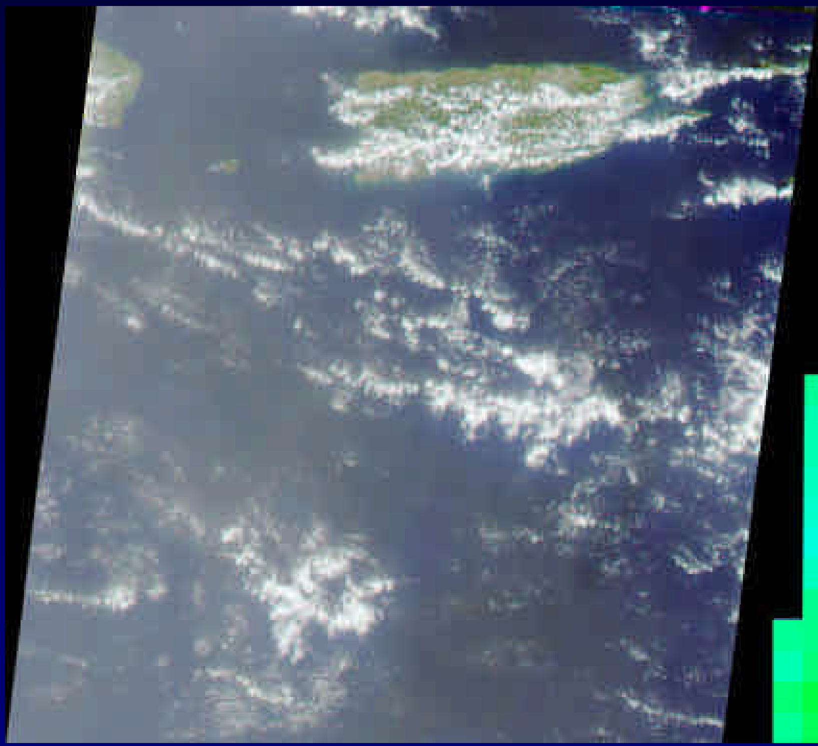
AERONET data: B. Holben and M. Helmlinger

D.J. Diner et al., JPL and B.N. Holben, GSFC

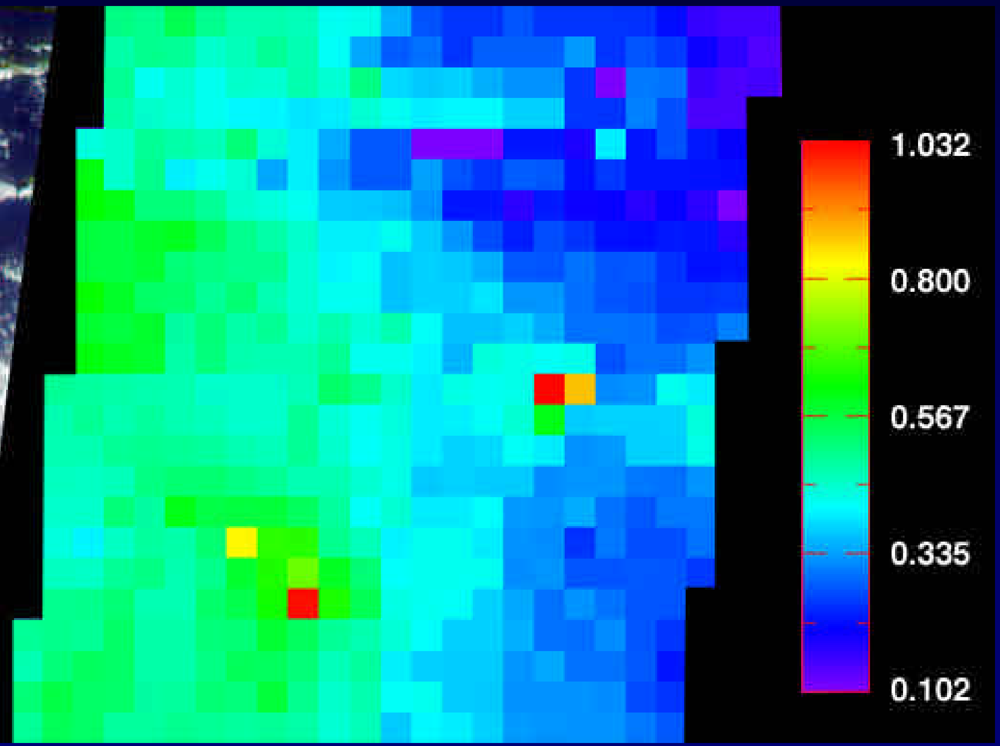
Example of aerosol retrieval during intensive field validation campaign

PRiDE
Puerto Rico
Dust Experiment
June 25 - July 27, 2000

Puerto Rico, 24 July 2000



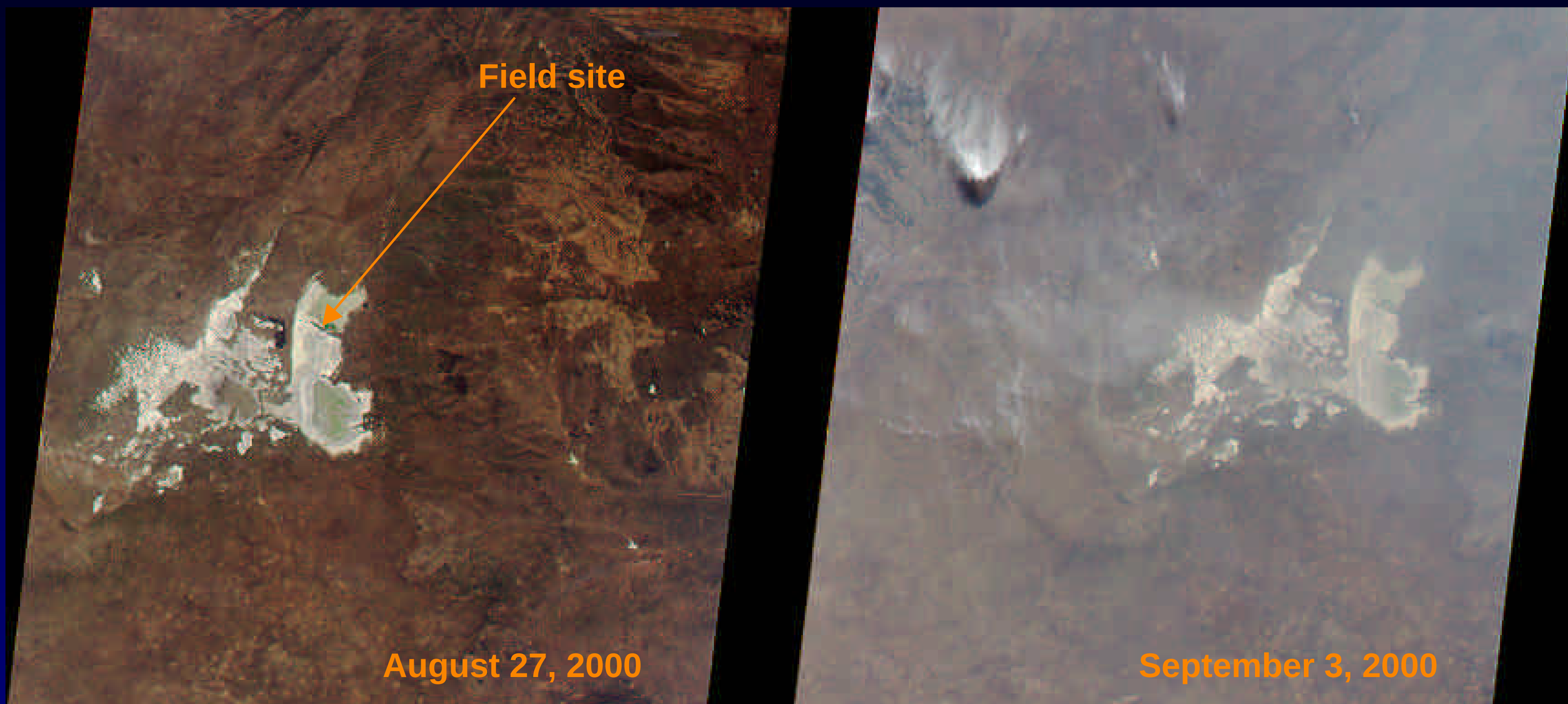
60º-forward image



retrieved “best fit” optical depth

R. Kahn, JPL

Example of aerosol optical depth validation with ground-based solar radiometers



46º-aft MISR top-of-atmosphere images

Retrieved 558-nm optical depths
MISR: 0.117 ± 0.027
Reagan: 0.083
CIMEL: 0.086

Retrieved 558-nm optical depths
MISR: 0.886 ± 0.095
Reagan: 0.724
CIMEL: 0.777

D.J. Diner, M. Helmlinger, B. Gaitley, JPL

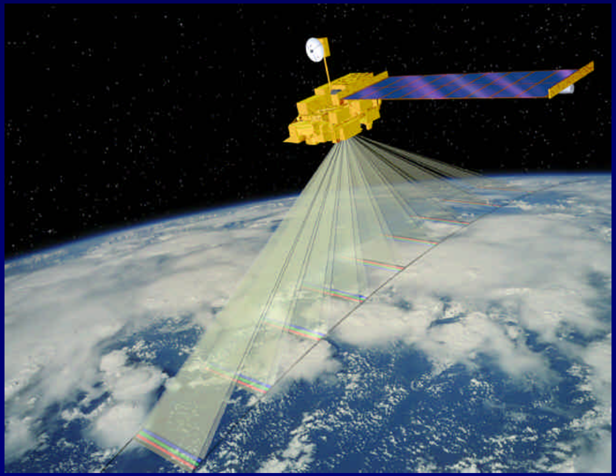
Validation approach: Surface

PARABOLA III

ASD spectrometer

MISR surface validation is based upon intercomparisons with other satellite sensors, as well as deployments involving scaling from
field (~ few meters) to
airborne (tens of meters) to
spaceborne (hundreds of meters)

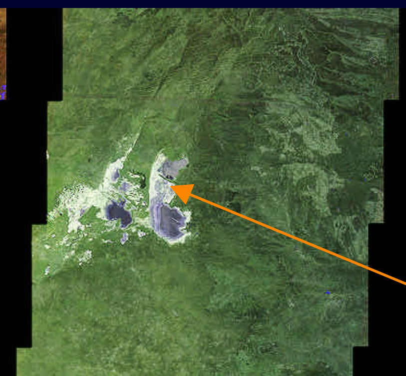
AirMISR



MISR

Example of surface validation
Comparison of MISR retrievals with PARABOLA III data
Sua Pan, Botswana, 27 August 2000

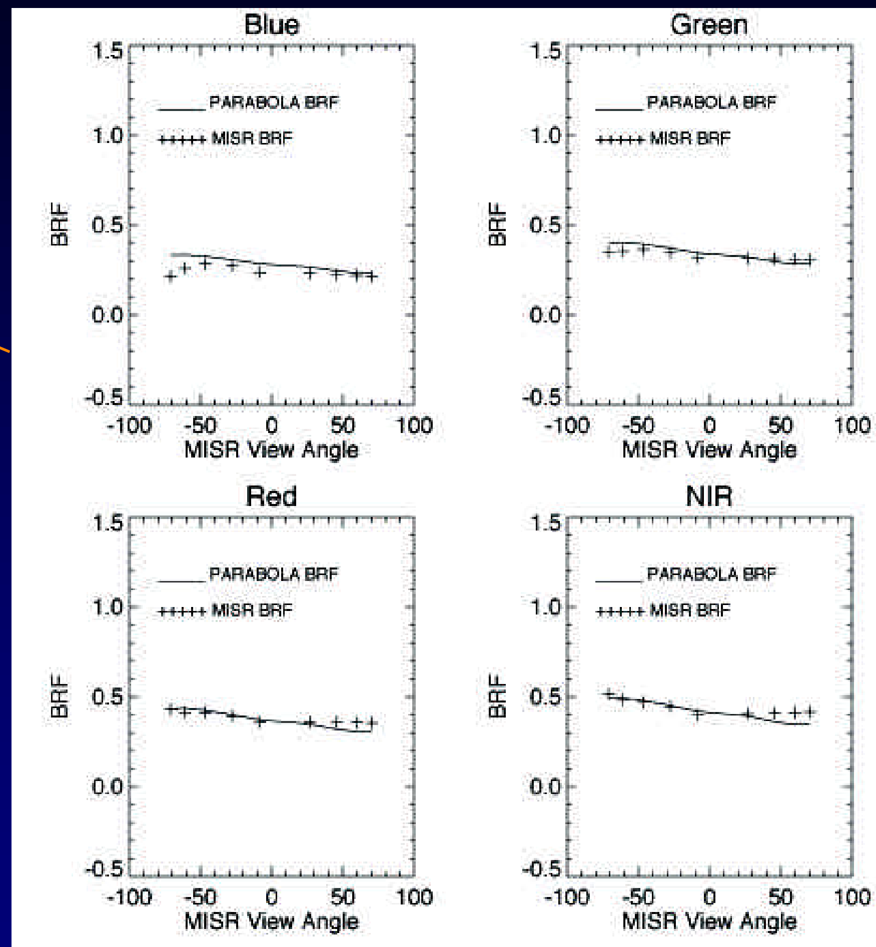
retrieved BRF
true color



retrieved BRF
multi-angle false color

retrieved DHR
true color

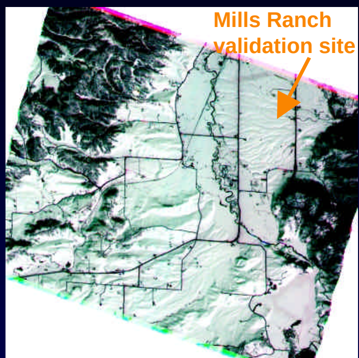
retrieved DHR
infrared false color



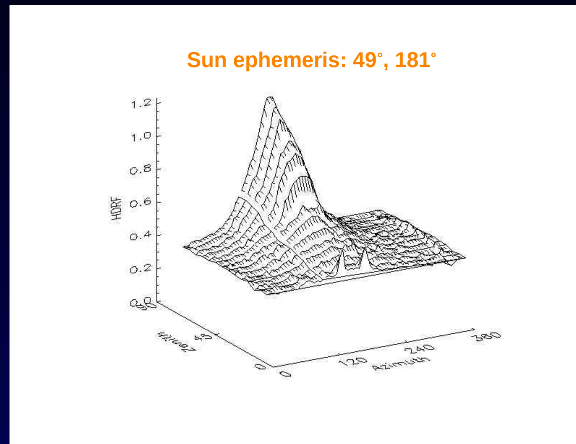
BRF = bidirectional reflectance factor
DHR = directional hemispherical reflectance (albedo)

W. Abdou, M. Helmlinger, and D.J. Diner, JPL

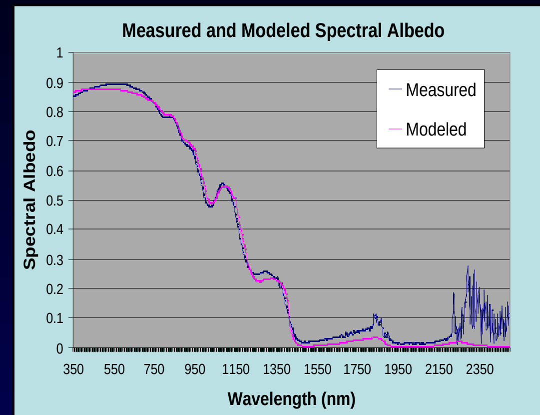
Examples of field validation of snow albedo



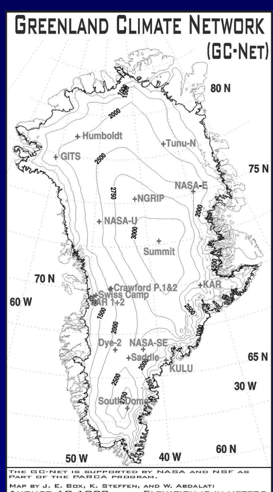
AirMISR nadir HDRF image over Steamboat Springs, CO March 8, 2001

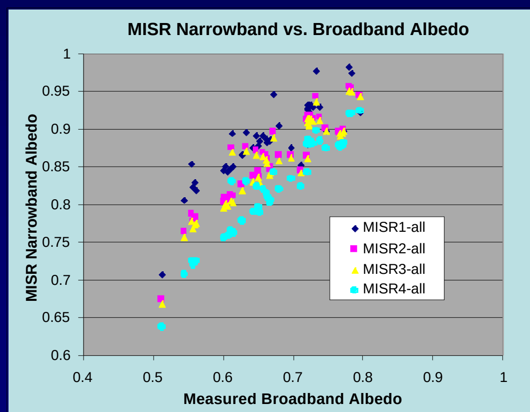


PARABOLA III measurements of snow HDRF

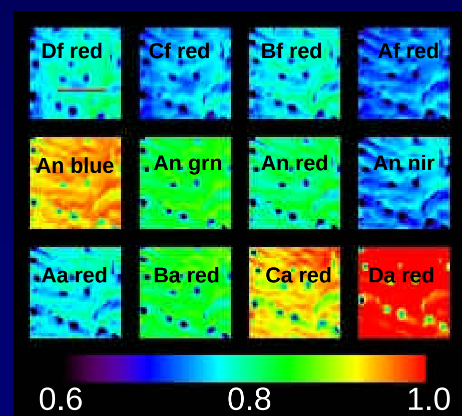


ASD albedo measurements and DISORT model output





Narrowband to broadband snow albedo conversions

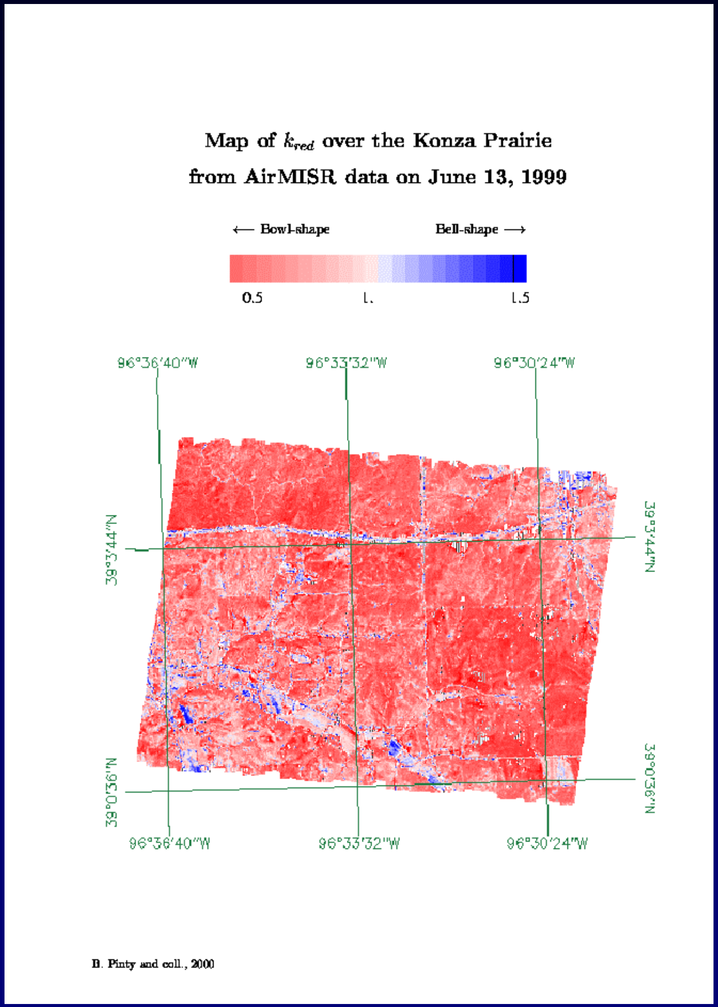


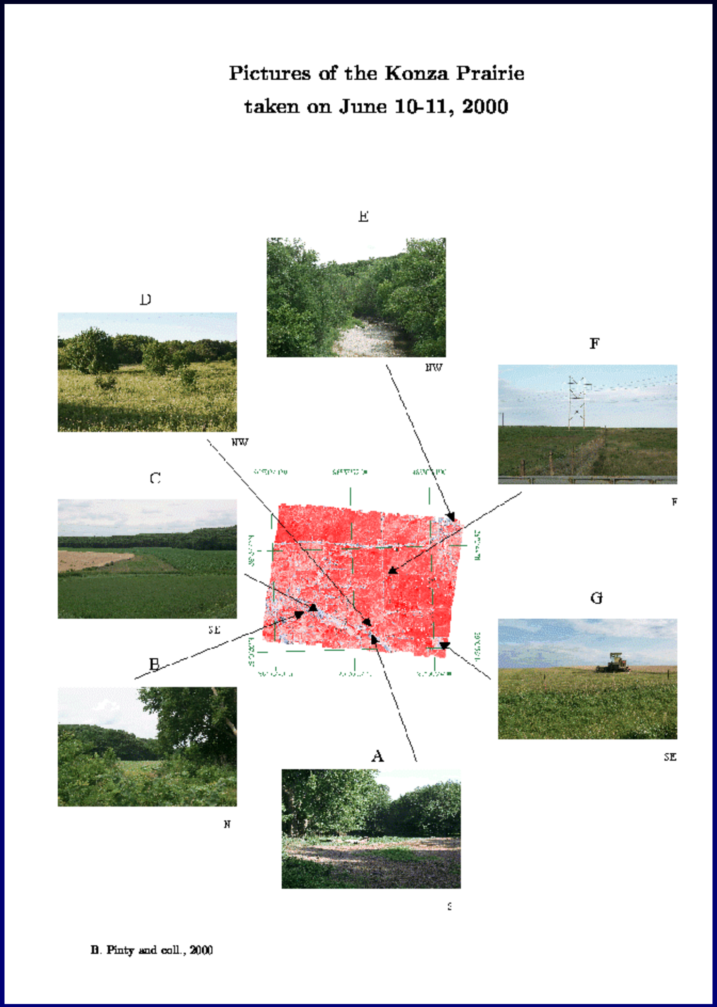
Broadband albedo:
Measured = 0.778
MISR-derived = 0.79

MISR HDRF at the ETH/CU camp on the Greenland Ice Sheet

A. Nolin and J. Stroeve, University of Colorado

Example of field verification of correspondence of angular signatures with surface type





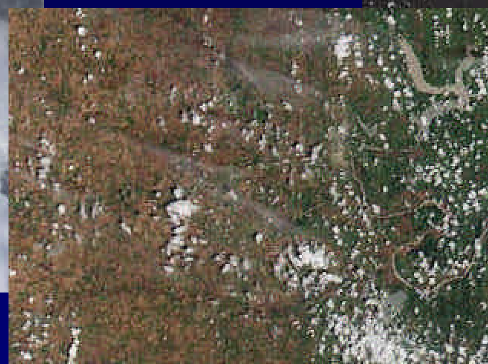
B. Pinty et al. and N. Gobron et al., Joint Research Centre

Validation approach: Cloud

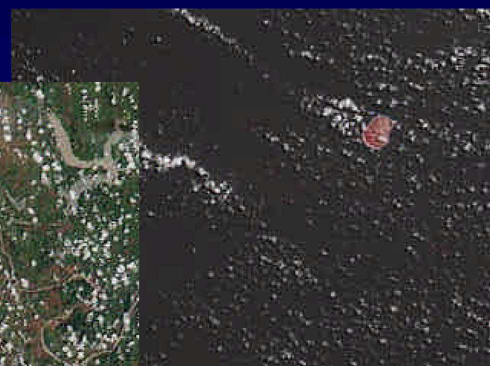
MISR cloud validation is based upon multi-satellite sensor comparisons, case studies using in-situ and aircraft observations, and long-term statistical studies using ground-based measurements (e.g., at the DOE ARM sites and others)

Tropical Western Pacific--Manus

North Slope of Alaska--Barrow

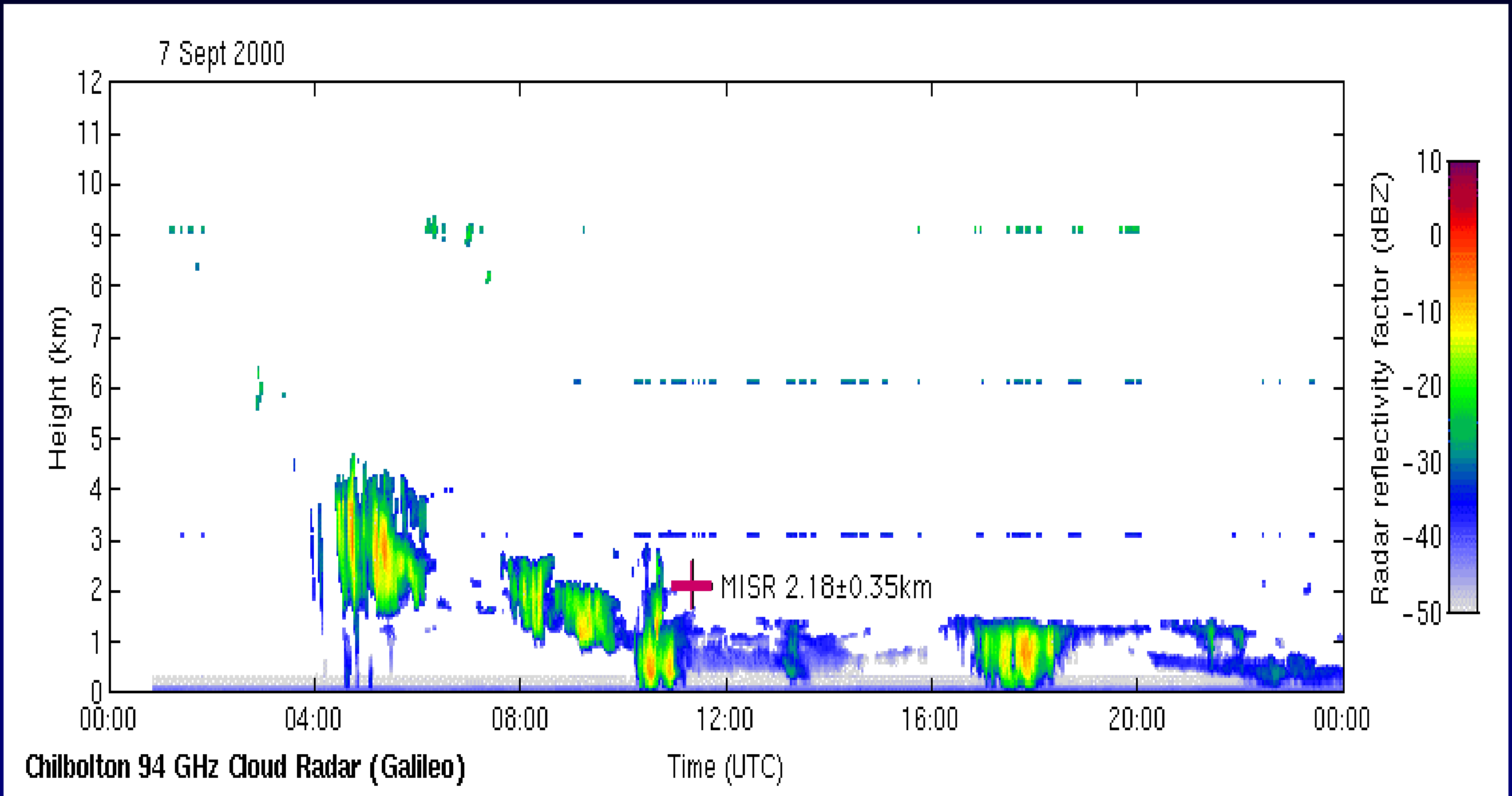


Southern Great Plains--Lamont, OK



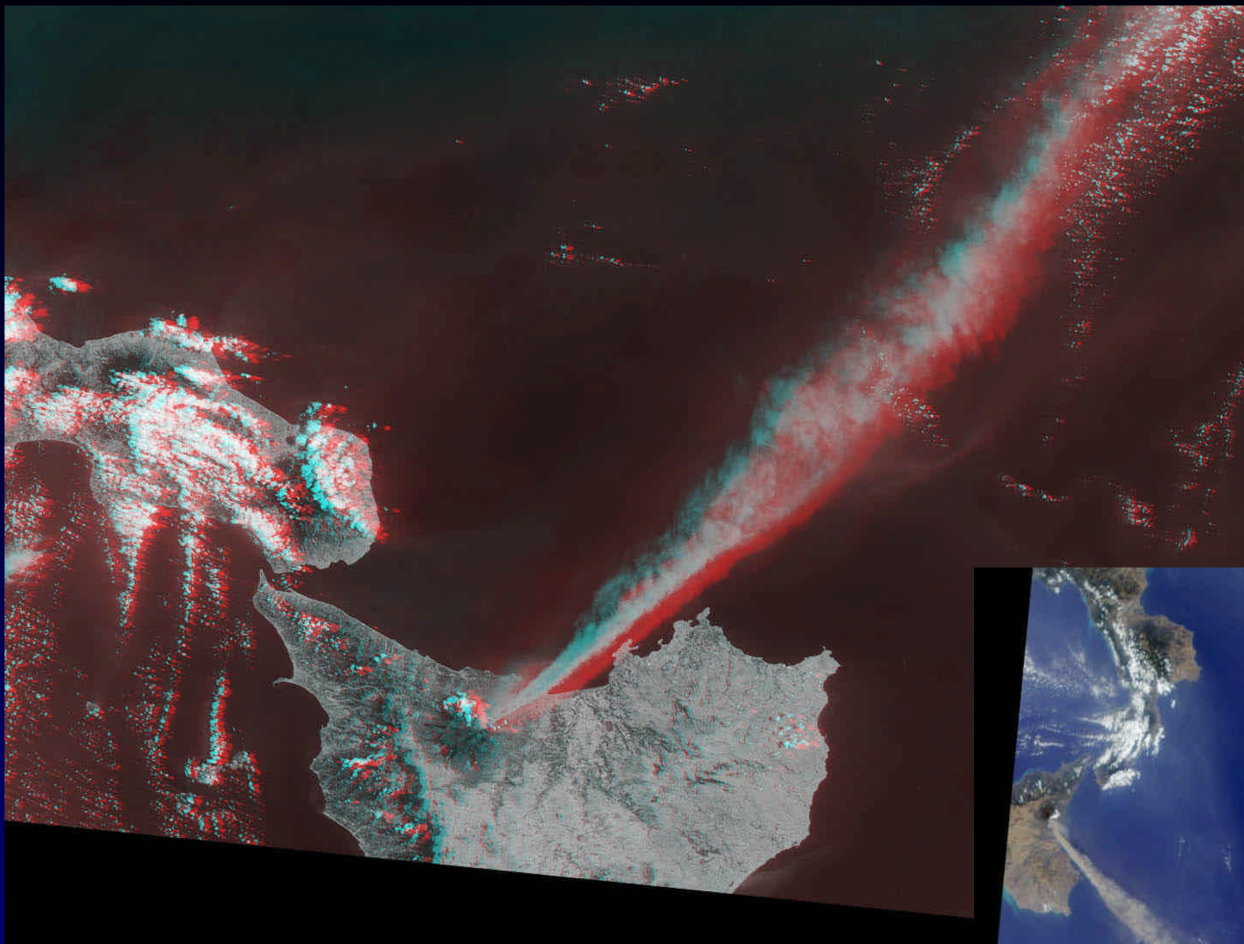
Tropical Western Pacific--Nauru

Example of stereo cloud height validation
Comparison of MISR cloud-top height with radar echo tops
Chilbolton, England, 7 September 2000

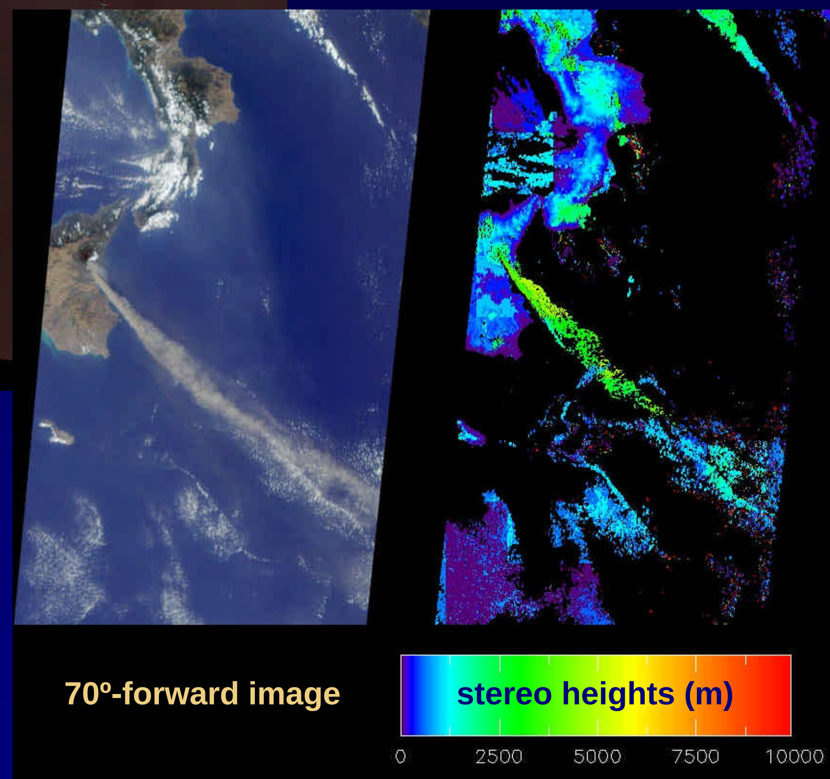


J-P. Muller, University College London

Example of visual verification of stereo height retrievals using anaglyphs



stereo anaglyph
(view with red/blue glasses--red filter over left eye)
image rotated, north at left



Eruption of Mt. Etna
22 July 2001

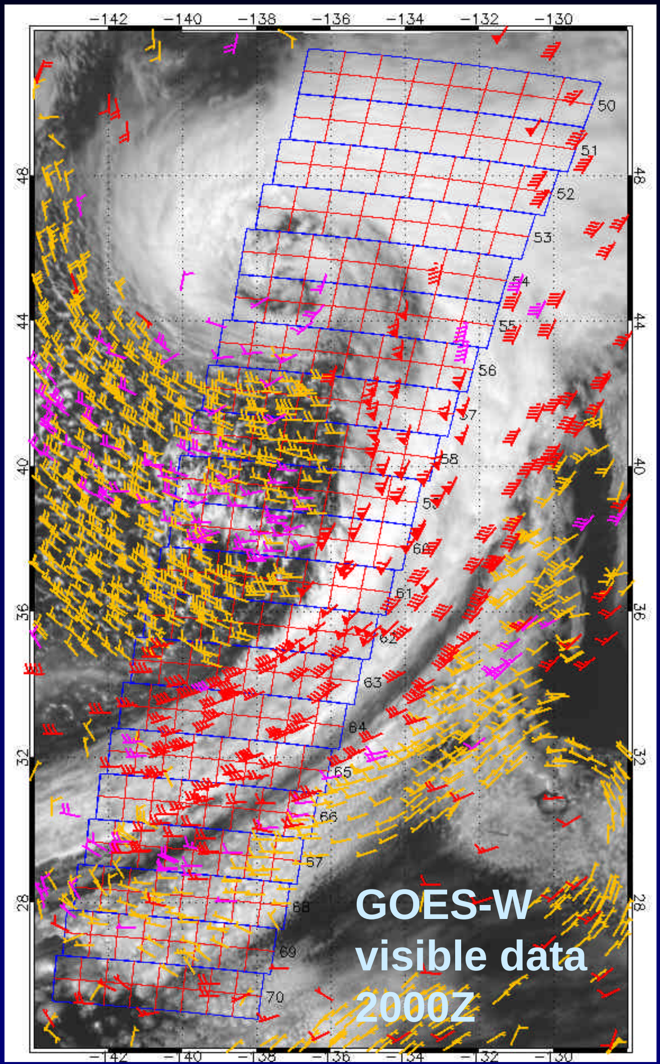
D.J. Diner, JPL

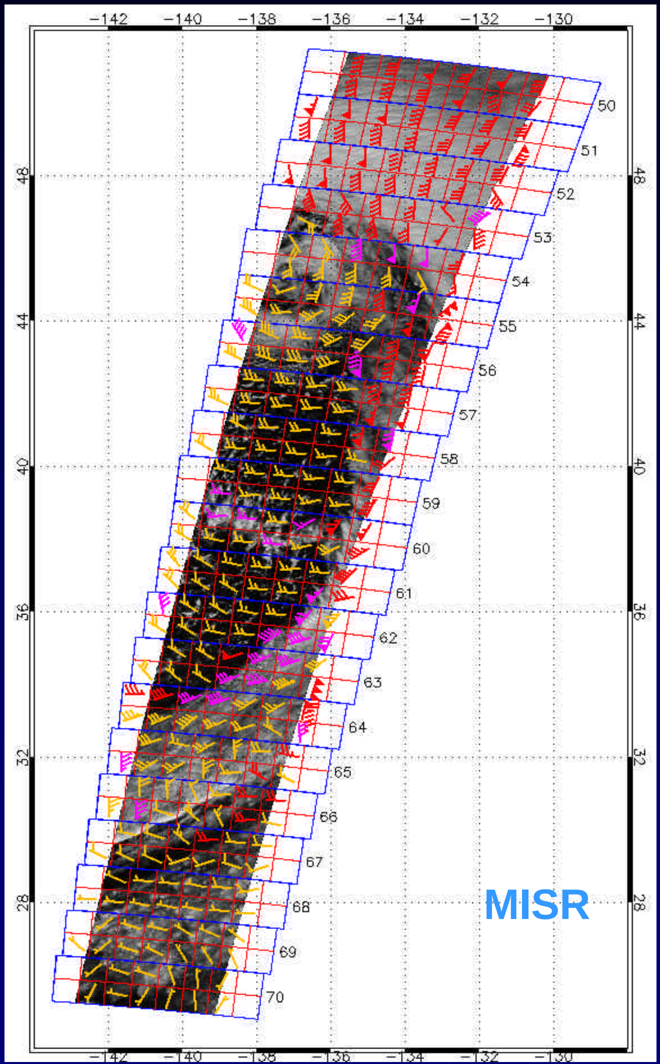
Example of multi-satellite cloud-tracked winds comparison

Mature extratropical cyclone

Eastern Pacific

26 April 2000





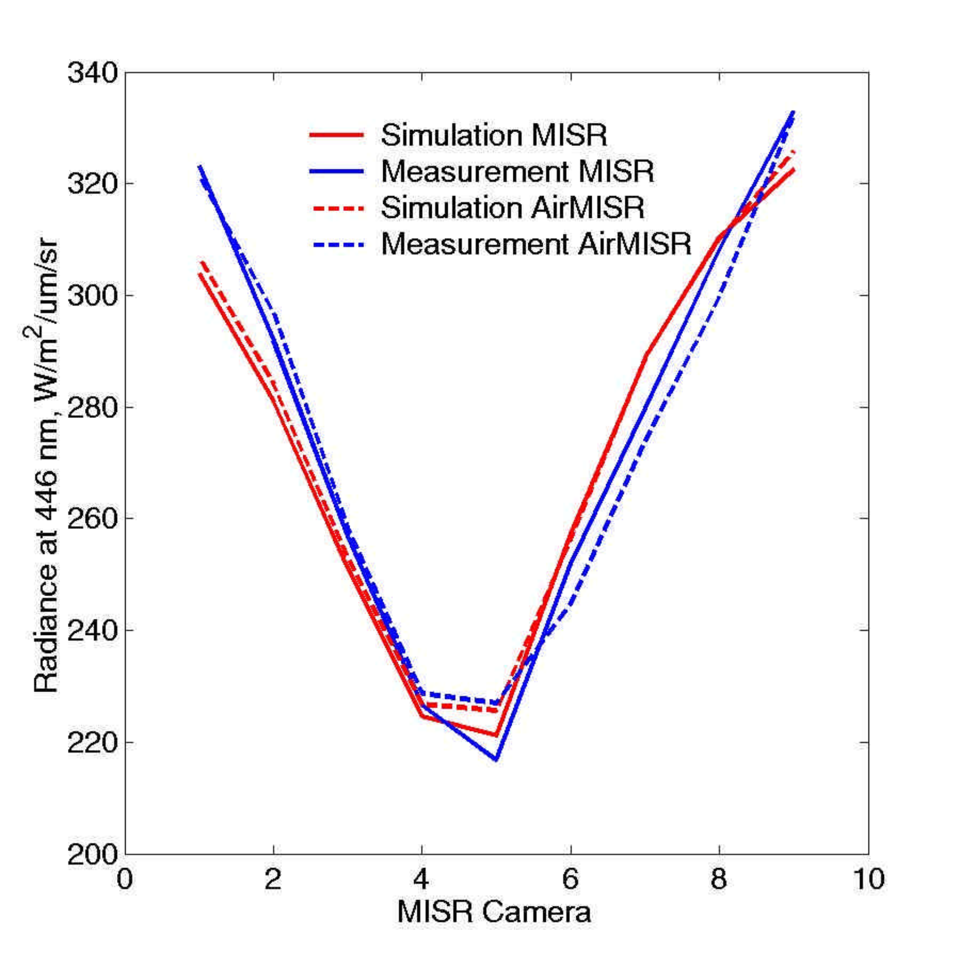
A. Horvath, University of Arizona

Example of MISR cloud radiance measurements compared to AirMISR and theoretical simulation

Stratus clouds

Southern Great Plains ARM site

March 3, 2000



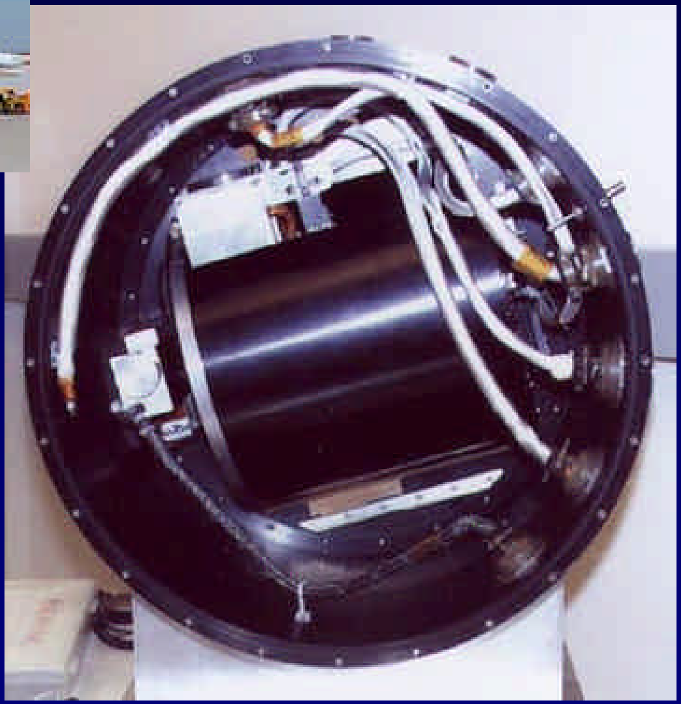
R. Marchand, Pacific Northwest National Laboratory

AirMISR

Single, gimballed MISR-like camera

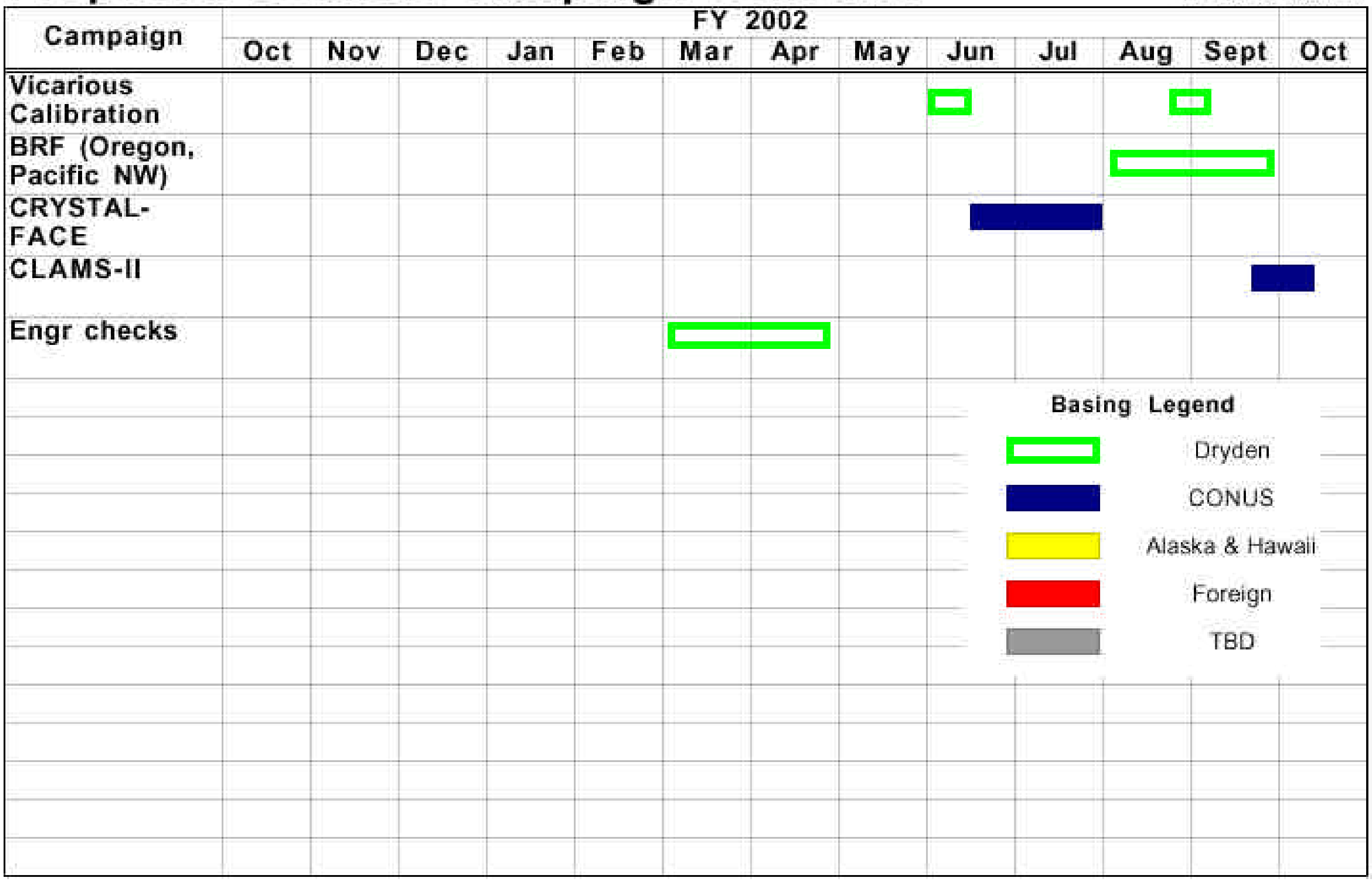
9 x 11 km area covered at all angles

27.5 m resolution map-projected product



Proposed AirMISR Campaign Schedule

version of 5/31/01



Recent field experiments

Site	Date	Purpose/ Investigator	Data
ACE-Asia	3/23/01-5/3/01	Aerosol validation R. Kahn	MISR, AATS, C-130, R/V Ron Brown, Kosan island station
Beltsville Agricultural Research Center	7/21/01	BRF validation S. Liang	MISR, AirMISR, PARABOLA
Chesapeake Lighthouse (CLAMS)	7/9/01-8/2/01	Aerosol validation R. Kahn	MISR, AirMISR, Lidar, MAS, others
Rogers Dry Lake, Lunar Lake, Railroad Valley	6/6/01-6/30/01	Vicarious calibration C. Bruegge	MISR, AirMISR, AVIRIS, Landsat, field
Steamboat Springs	3/8/01	Snow albedo validation A. Nolin	AirMISR, PARABOLA Solar radiometers
Southern Africa (SAFARI-2000)	8/13/00 - 9/25/00	Aerosol/surface J. Conel	MISR, AirMISR, PARABOLA, field, many others
SGP ARM Site	3/3/00	Cloud validation R. Marchand	MISR, AirMISR, ARM

Planned field experiments

Site	Date	Purpose/ Investigator	Data
Desert playas	6/02, 9/02	Vicarious calibration C. Bruegge	MISR, AirMISR, field
Florida (CRYSTAL)	7/02	Tropical cirrus R. Marchand, L. Di Girolamo, R. Kahn	MISR, AirMISR,
Oregon	8/02	Forest BRF J. Martonchik	MISR, AirMISR
SGP ARM Site	2003	Mixed phase clouds R. Marchand	MISR, AirMISR, ARM

Validation-related publications

Abdou, W.A., M.C. Helmlinger, J.E. Conel, S. Pilorz, C.J. Bruegge, B.J. Gaitley, and J.V. Martonchik (2001). Ground measurements of surface bidirectional reflectance factor (BRF) and hemispherical directional reflectance factor (HDRF) using the Portable Apparatus for Rapid Acquisition of Bidirectional Observation of the Land and Atmosphere (PARABOLA III). *J. Geophy. Res.* 106, 11967 - 11976.

Abdou, W.A., C.J. Bruegge, M.C. Helmlinger, B.J. Gaitley, W.C. Ledeboer, S.H. Pilorz, J.E. Conel, and J.V. Martonchik (2001). Vicarious reflectance-based absolute radiometric calibration of AirMISR. *Rem. Sens. Environ.* 77, 338-353.

Bruegge, C.J., M.C. Helmlinger, J.E. Conel, B.J. Gaitley, and W.A Abdou (2000). PARABOLA III: a sphere-scanning radiometer for field determination of surface anisotropic reflectance functions. *Rem. Sens. Rev.* 19, 75-94.

Bruegge, C. J., N. Chrien, and D. Haner (2001). A Spectralon BRF data base for MISR calibration applications. *Rem. Sens. Environ.* 77, 354-366.

Chrien, N.L., C.J. Bruegge, and B.J. Gaitley (2001). AirMISR laboratory calibration and in-flight performance results. *Rem. Sens. Environ.* 77, 328-337.

Diner, D. J., W.A. Abdou, C.J. Bruegge, J.E. Conel, K.A. Crean, B.J. Gaitley, M.C. Helmlinger, R.A. Kahn, J.V. Martonchik, S.H. Pilorz, and B.N. Holben (2001). MISR aerosol optical depth retrievals over southern Africa during the SAFARI-2000 dry season campaign. *Geophys. Res. Lett.* 28, 3127.

Horvath, A. and R. Davies (2001). Simultaneous retrieval of cloud motion and height from polar-orbiter multiangle measurements. *Geophys. Res. Lett.* 28 , 2915.

Kahn, R., P. Banerjee, D. McDonald, and J. Martonchik (2001). Aerosol properties derived from aircraft multi-angle imaging over Monterey Bay. *J. Geophys. Res.* 106, 11977-11995.

Kahn, R., P. Banerjee, and D. McDonald, (2001). The sensitivity of multiangle imaging to natural mixtures of aerosols over ocean. *J. Geophys. Res.* in press.

Marchand, R.T., T.P. Ackerman, M.D. King, C. Moroney, R. Davies, J-P.A.L. Muller, and H. Gerber (2001). Multiangle observations of Arctic cloud from FIRE ACE: June 3, 1998, case study. *J. Geophys. Res.* 106, 15201.