A 0.05 degree global climate/interdisciplinary long term data set from AVHRR, MODIS and VIIRS algorithms overview

Eric Vermote
Department of Geography, University of Maryland

Long Term Land Data Record

- Develop and produce a global long term coarse spatial resolution (0.05deg) data record from AVHRR, MODIS and VIIRS for use in global change and climate studies.
- Use a MODIS-like operational production approach including an operational QA team.
- Set up an advisory process.
- Make intermediate versions of the data sets available to the community through a web interface and solicit input from users.
- Hold community workshops for outreach and feedback.
- Prototype the development and production of a climate quality data record.

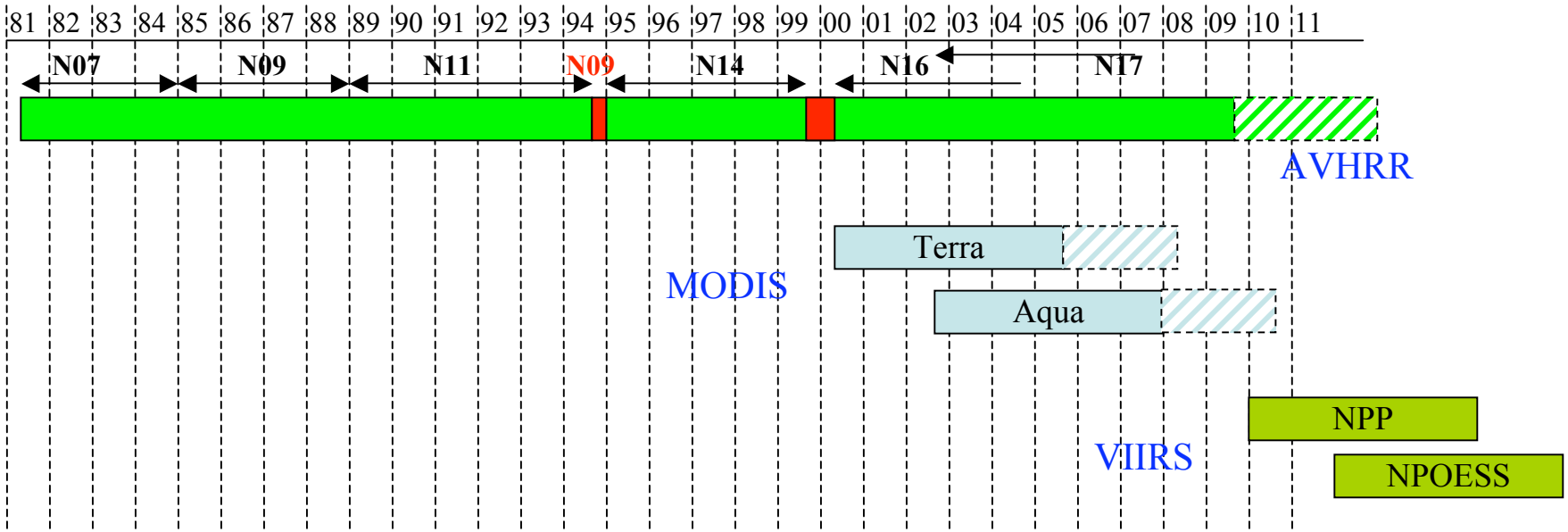
Proposed LTLDR Products

AVHRR, MODIS, VIIRS:

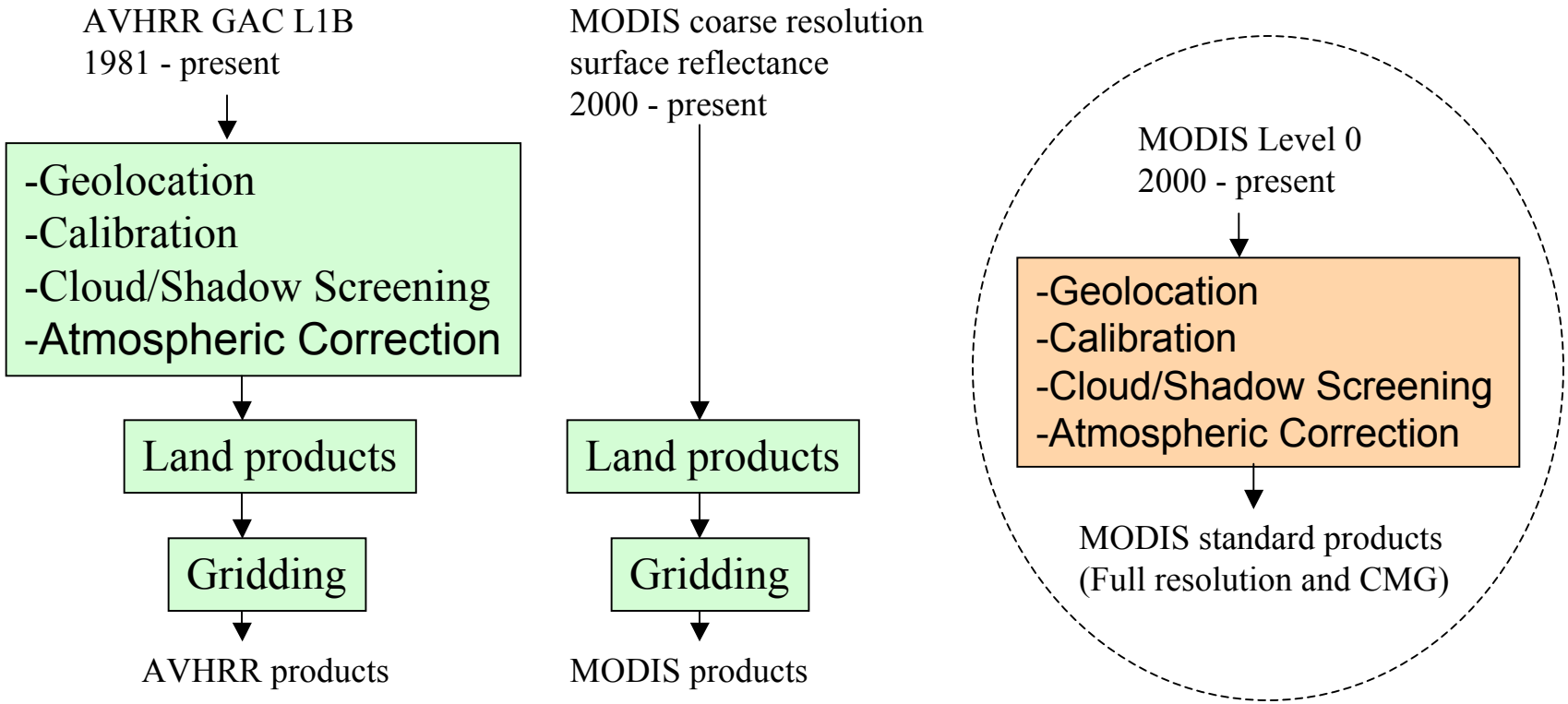
- Surface reflectance
- Surface temperature and emissivity
- Vegetation Indices
- Snow
- LAI/FPAR
- BRDF/Albedo
- Aerosols
- Burned area

Products and formats will be modified based on feedback from the User Community Workshops.

Data Sources



AVHRR and MODIS Production Systems

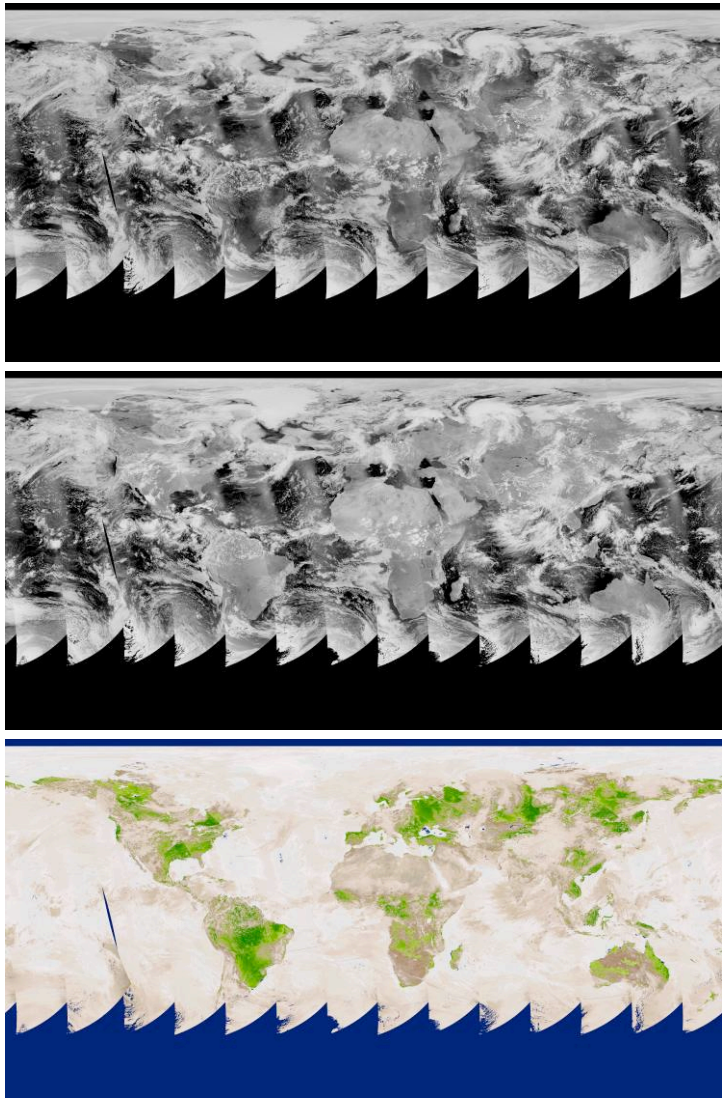


List of potential products:
Surface Reflectance, VI,
Surface Temperature and emissivity,
Snow, LAI/FPAR, BRDF/Albedo,
Aersols, burned area

Format:
HDF
Geographic projection 1/20 deg resolution
Daily, multi-day, monthly

Production of the Beta Data Set

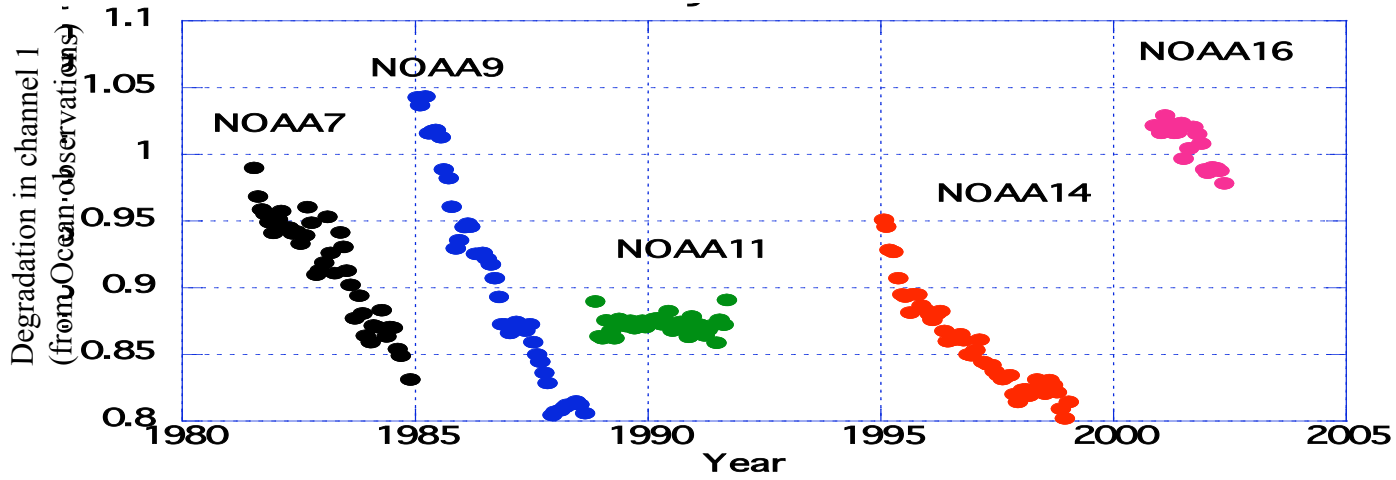
- Algorithms:
  - -Vicarious calibration (Vermote/Kaufman)
  - -Cloud screening: CLAVR
  - -Partial Atmospheric Correction:
    - -Rayleigh (NCEP)
    - -Ozone (TOMS)
    - -Water Vapor (NCEP)
- -Products:
  - -Daily NDVI (AVH13C1)
  - -Daily surface reflectance (AVH09C1)
- -Format:
  - -Linear Lat/Lon projection
  - -Spatial resolution: 0.05 Deg
  - -HDF-EOS
- -Time Period:
  - - 1981 – 2000 completed
- -Distribution:
  - -ftp and web

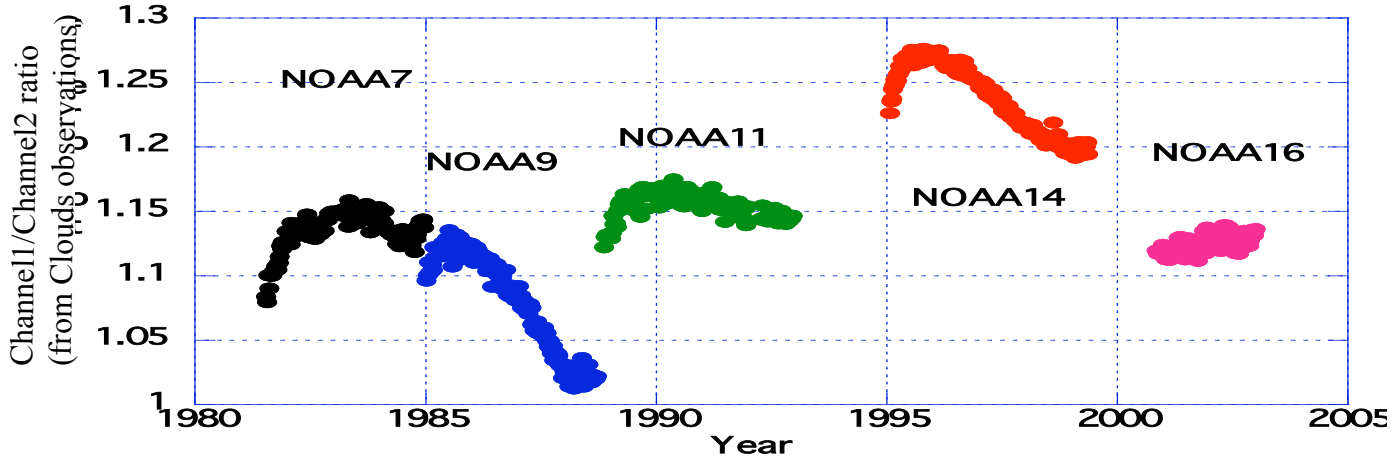


NOAA-11 - 1992193 (7/11/1992) : Ch1, Ch2 and NDVI

Consistent AVHRR calibration across platforms

- Use the Vermote/Kaufman calibration approach (Pathfinder 2)



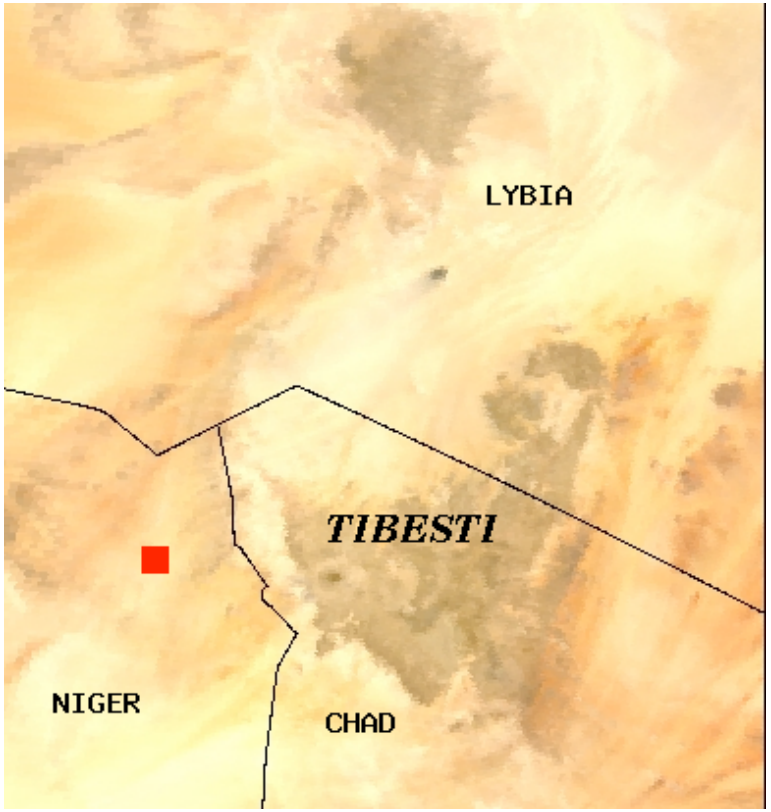


Use MODIS to validate N16 calibration / Approach

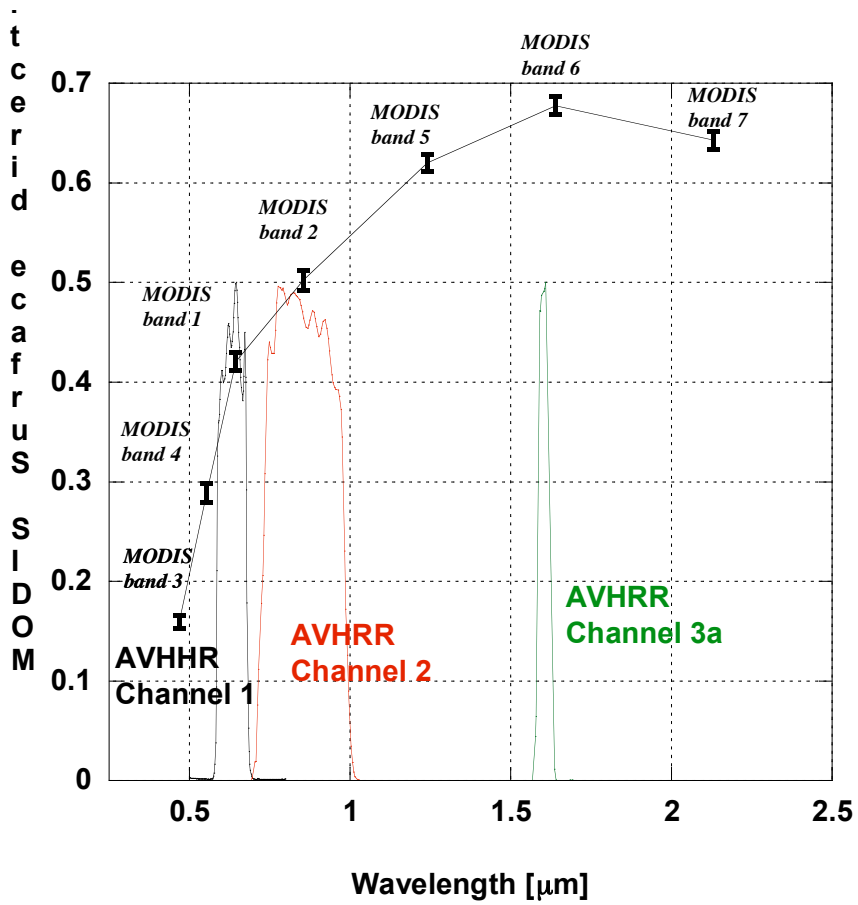
- Select a stable site.
- Rigorous cloud screening is applied to the data (using standard deviation as well).
- Characterize the reflectance spectral variation using MODIS narrow bands
- Use 2 years of data to characterize BRDF using a simple linear kernel model (3 parameters) used operational in MODIS-land
- Check the temporal stability
- Once the site is characterized, the reflectance could be predicted for any sensor using the BRDF model and spectral adjustments.

Site location

20km x 20km



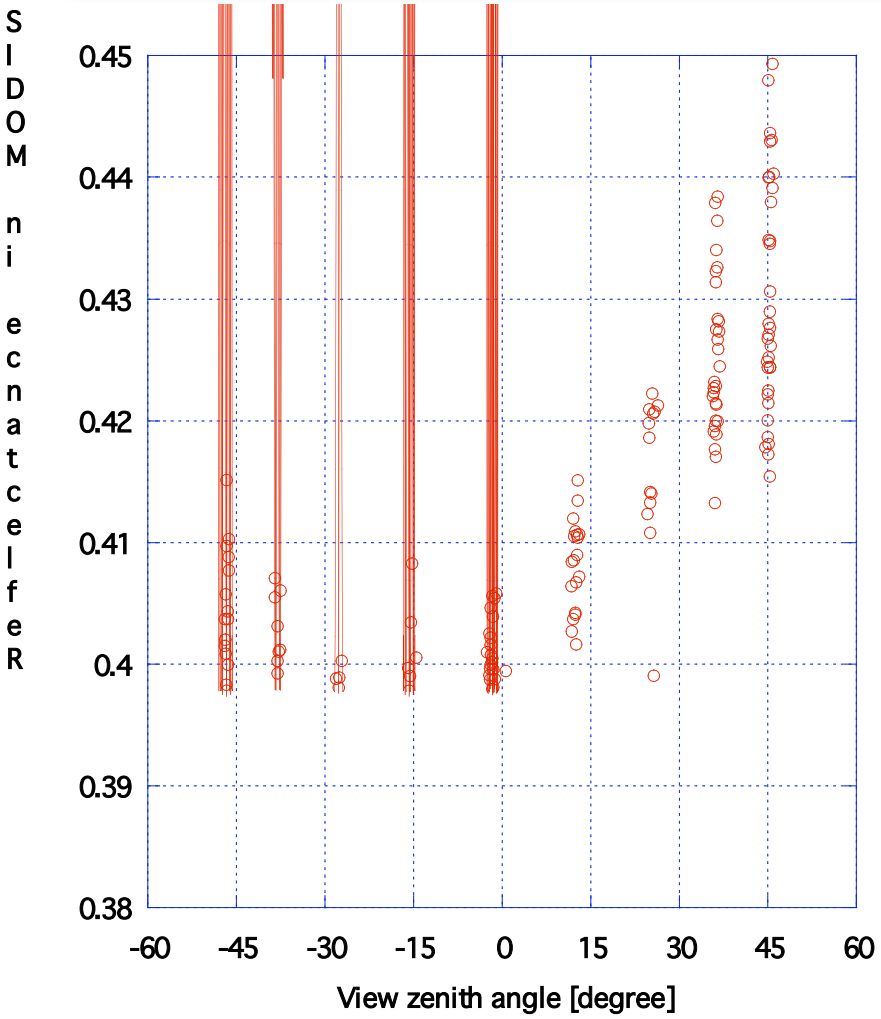
Site spectral characterization



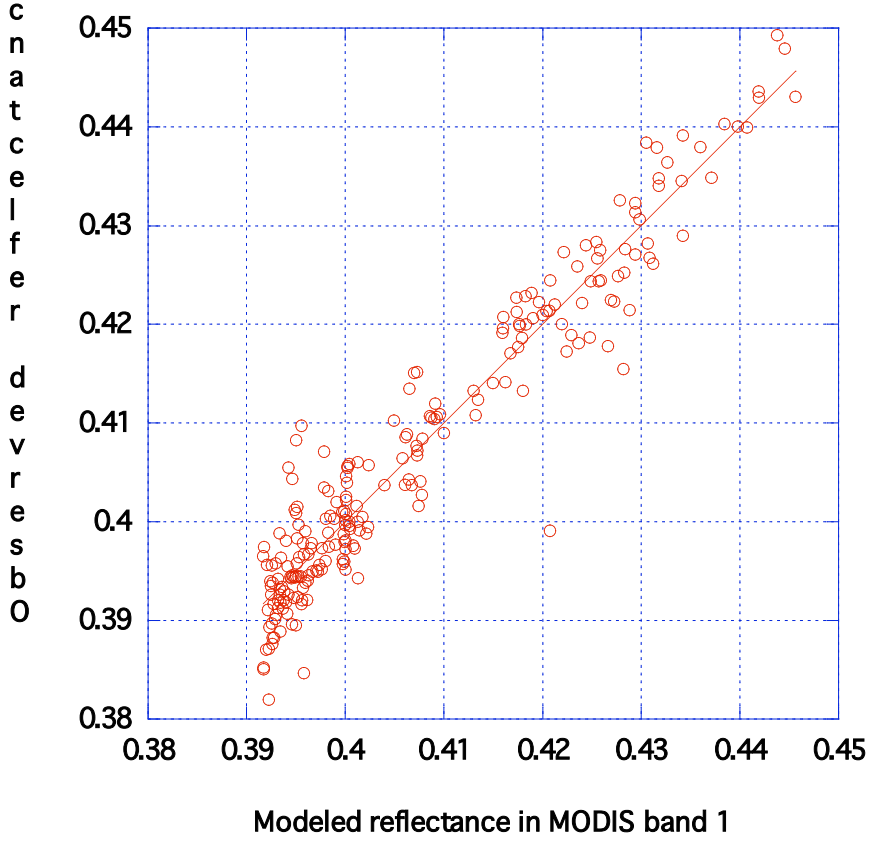
Spectral adjustment

AVHRR channel 1 = 0.952 x MODIS band 1
AVHRR channel 2 = 0.988 x MODIS band 2
AVHRR channel 3 = 0.994 x MODIS band 6

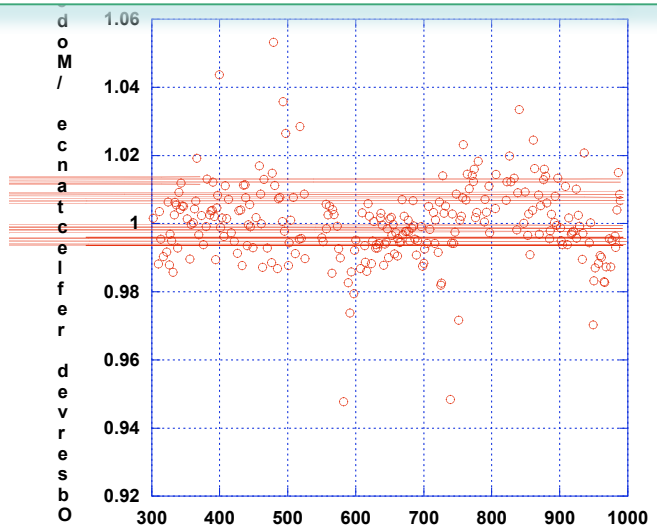
Site BRDF characterization

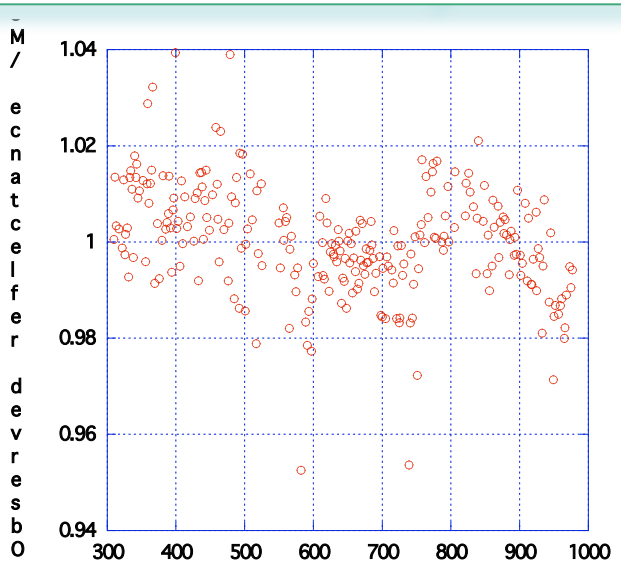


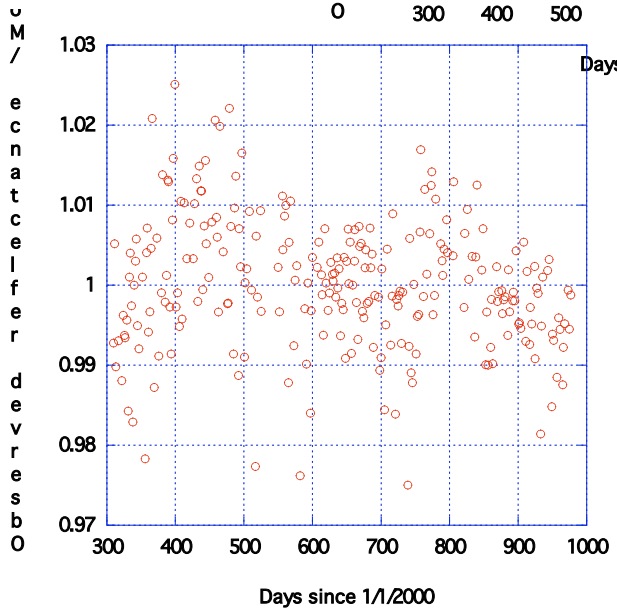
The BRDF was derived using the MODIS BRDF model (RossThick, LiSparse reciprocal linear kernel)



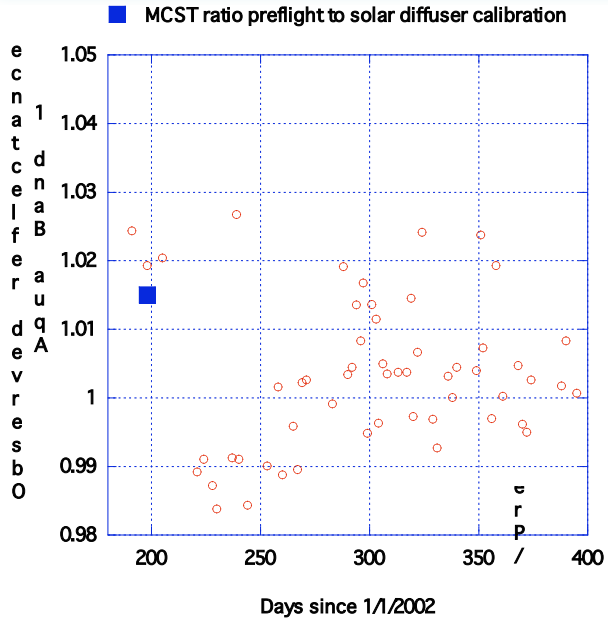
Site temporal stability

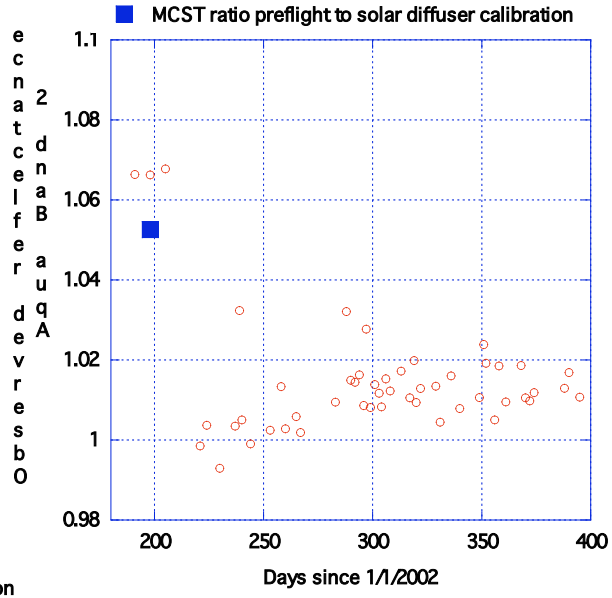


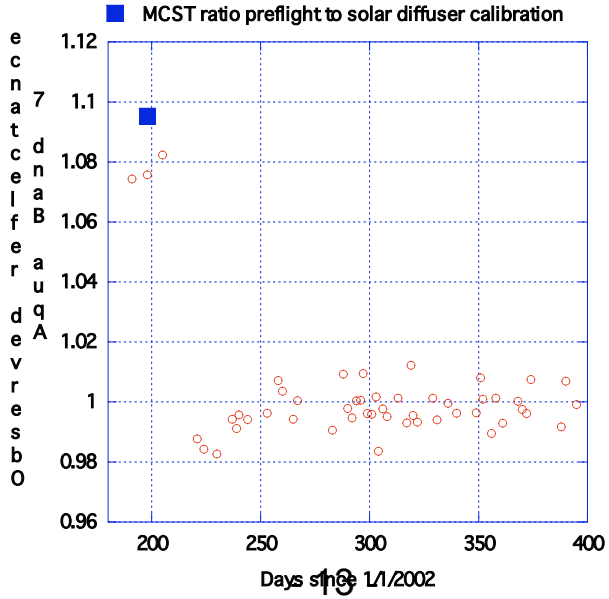




Cross Calibration MODIS Terra-> Aqua







The calibration of the AVHRR has been thoroughly evaluated

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Calibration of NOAA16 AVHRR over a desert site using MODIS data

E.F. Vermote [a,*], N.Z. Saleous [b]

[a] University of Maryland, Department of geography and NASA GSFC Code 614.5, United States
[b] SAIC and NASA GSFC Code 614.5, United States

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Abstract

This paper presents a new approach to AVHRR-sensors cross-calibration in the visible to shortwave-infrared spectral domain using an a-priori, well calibrated sensor (MODIS). The approach has been tested over a stable Sahara desert site and was initially applied to compare the absolute calibration coefficients of three different bands of the Terra and Aqua MODIS instruments. The observed agreement was better than 1% for bands 1 (0.67 μm), 2 (0.87 μm) and 7 (2.13 μm). The approach was then applied to cross-calibrate the AVHRR sensor onboard NOAA16. The absolute calibration coefficients derived for bands 1 and 2, using the Terra MODIS as a reference, were compared to the vicarious coefficients derived using the ocean and clouds method [Vermote E.F. and Kaufman Y.J. (1995). Absolute calibration of AVHRR visible and near-infrared channels using ocean and cloud views, International Journal of Remote Sensing, 16, 13, 2317–2340.]. The coefficients were consistent within less than 1%.

Keywords: Calibration; AVHRR; MODIS

Fig 2. Location of the 20 km by 20 km calibration site (centered on the red square) The image represents an area of 1000 km by 1000 km

The coefficients were consistent within less than 1%

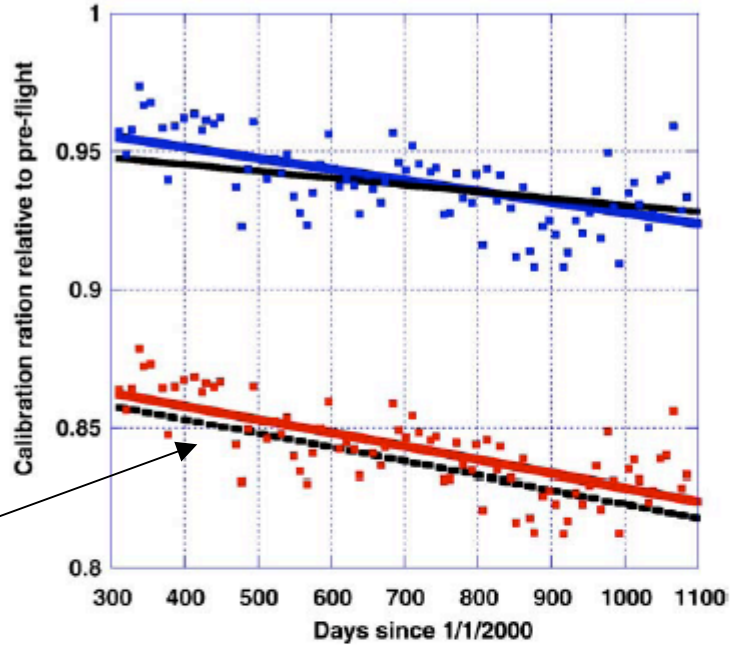
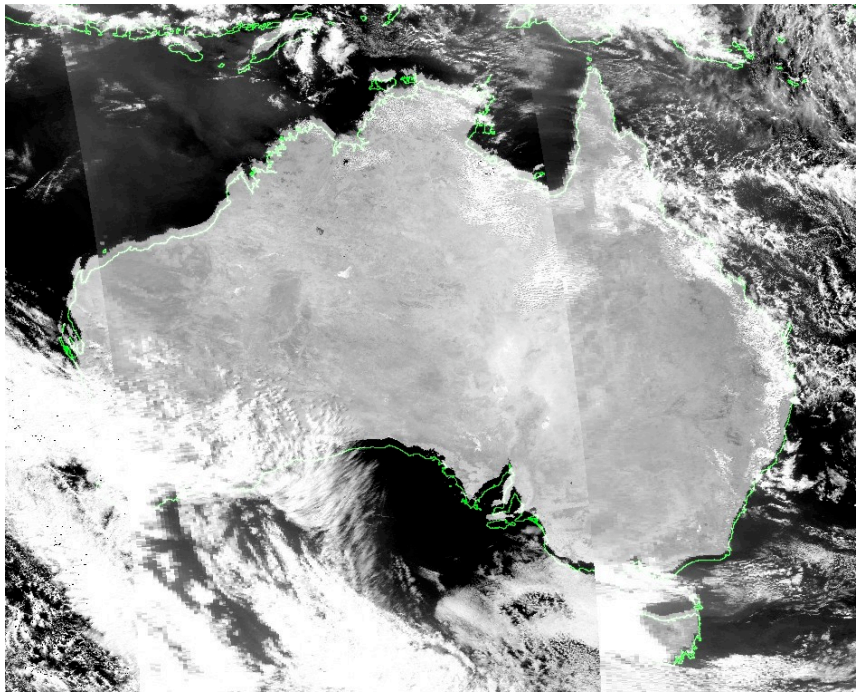
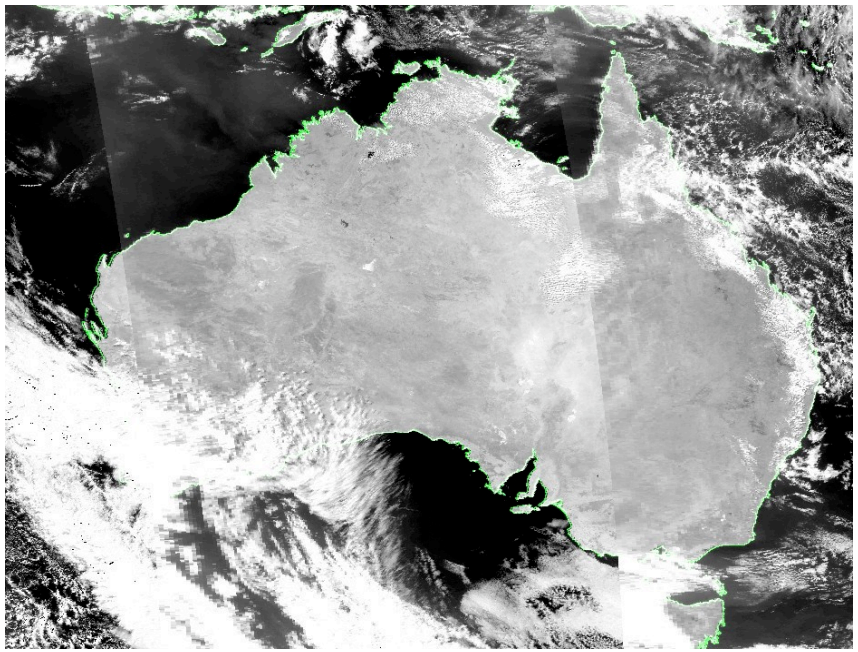


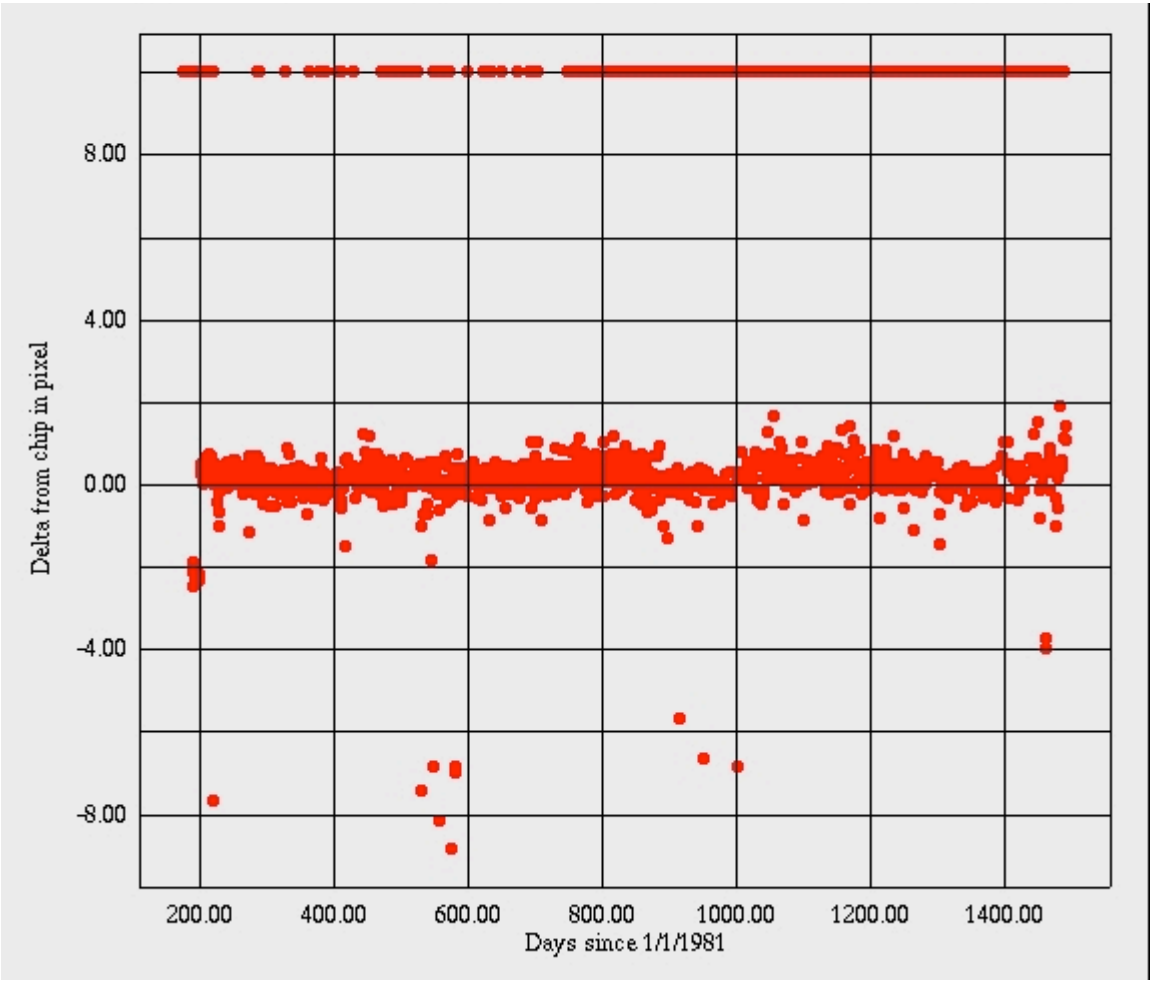
Fig. 11. Comparison of the desert calibration trends for band 1 (black solid line) and band 2 (black interrupted line), with the trends obtained using the Ocean and Clouds method (Vermote and Kaufman, 1995) for band 1 (blue line and square) and band 2 (red line and square).

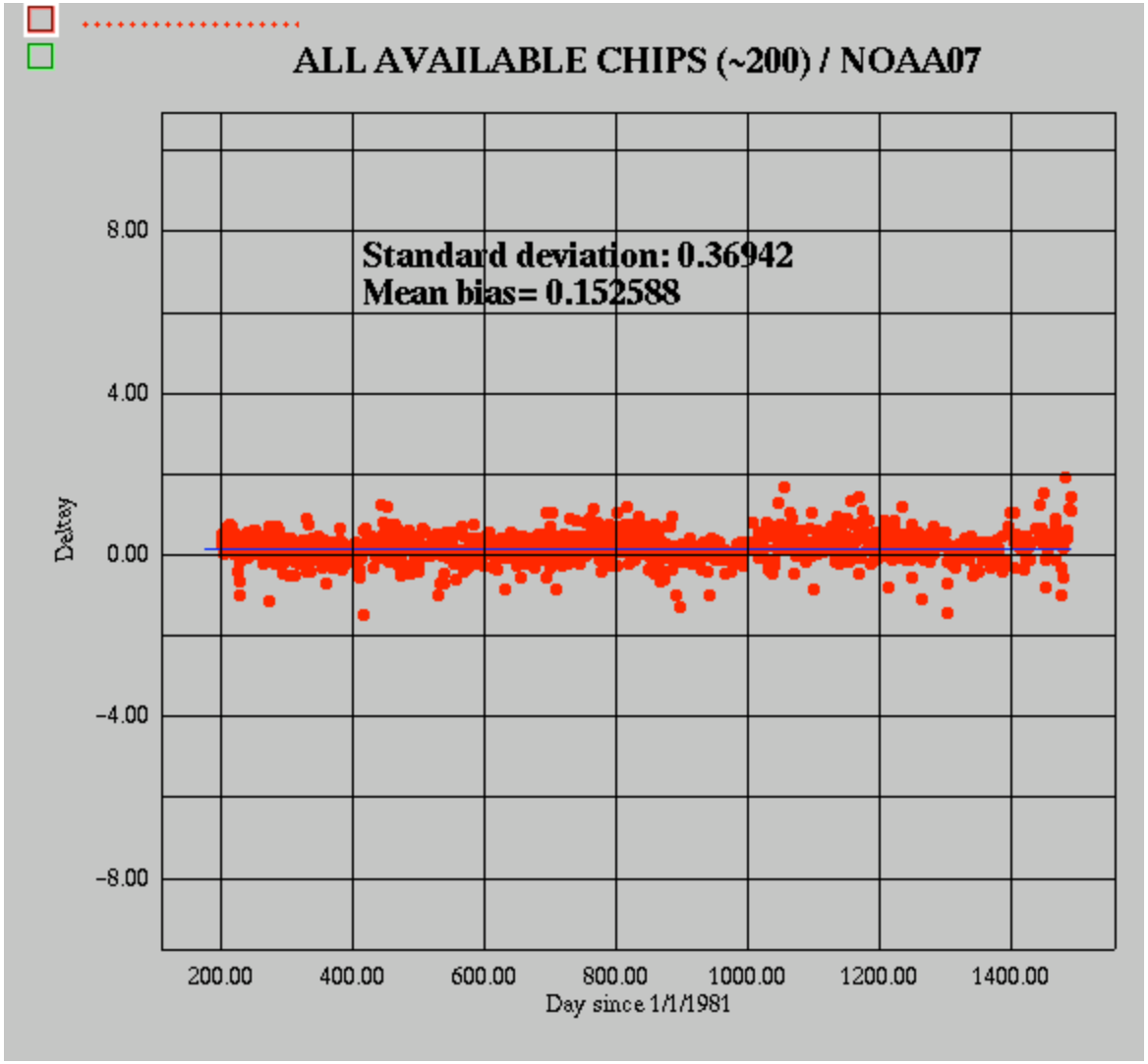
Geolocations issues/bad ephemeris data



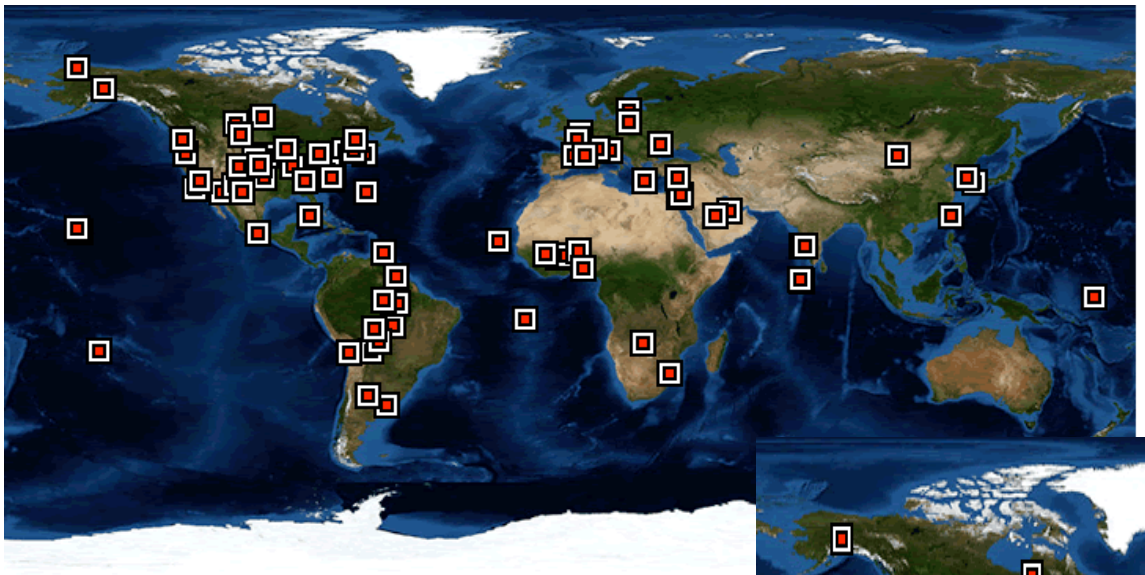


NOAA7: Geolocation accuracies based on ~ 100 chips

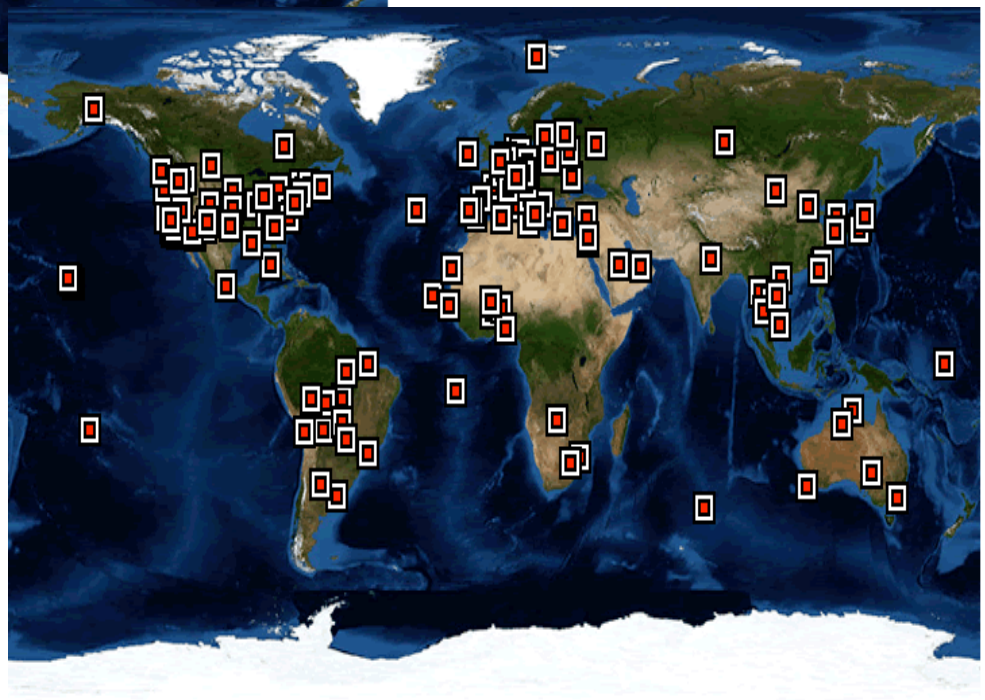



ALL AVAILABLE CHIPS (~200) / NOAA07
Standard deviation: 0.36942
Mean bias= 0.152588
8.00
4.00
0.00
-4.00
-8.00
Deltay
200.00
400.00
600.00
800.00
1000.00
1200.00
1400.00
Day since 1/1/1981

Atmospheric correction evaluation using AERONET (Jyothy presentation)

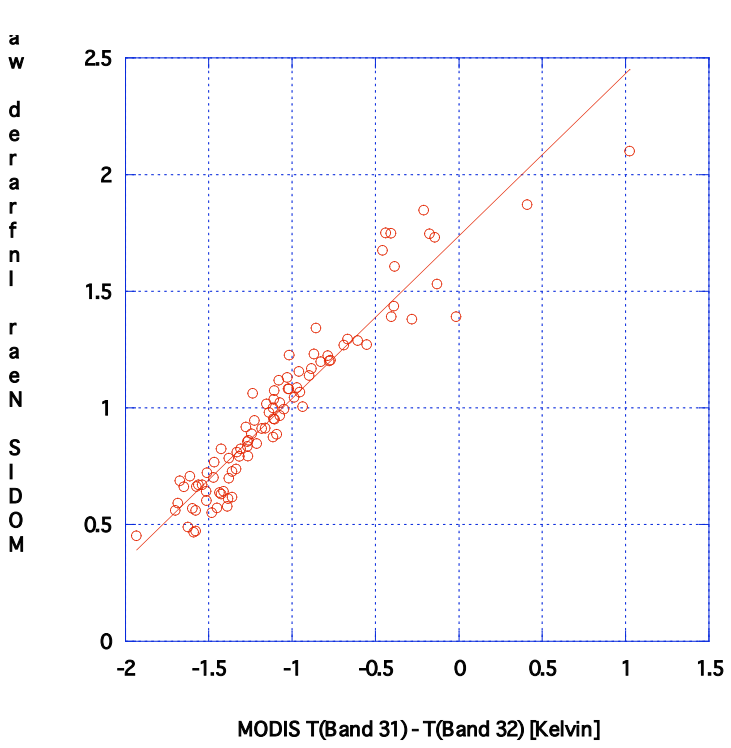


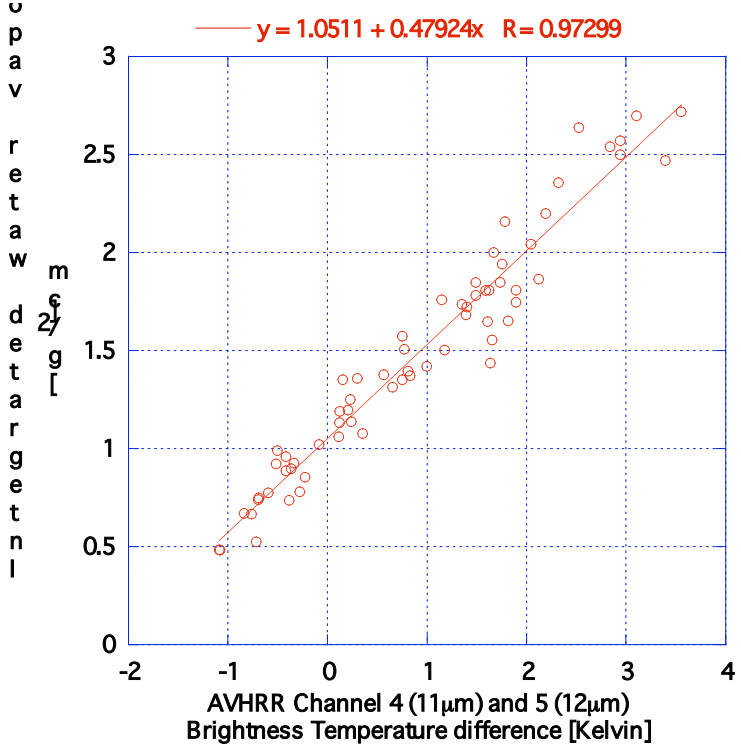
1999



2003

Future improvements for atmospheric correction
Water vapor





Use coincident MODIS/AVHRR data to develop an approach for water vapor retrieval from AVHRR.

Future improvements for AVHRR atmospheric correction: **Aerosol**

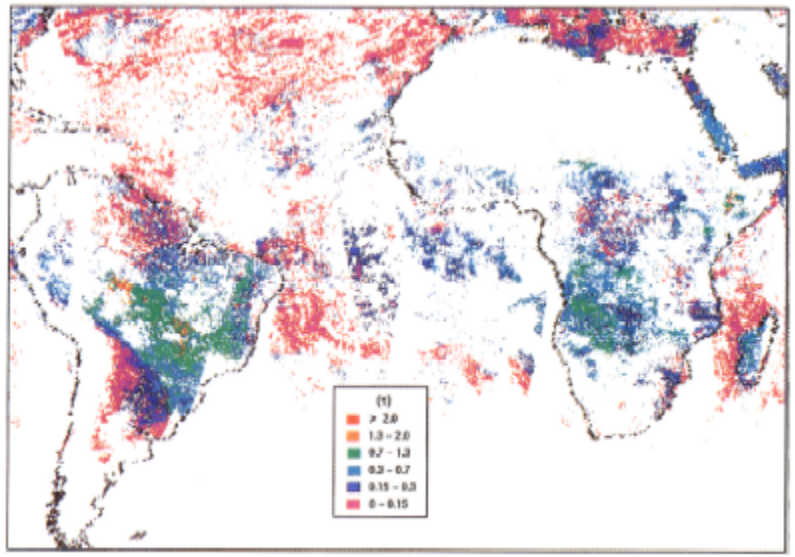


Plate 1. Maximum aerosol optical thickness at 550 nm during the week September 3–9, 1993, derived from NOAA AVHRR global area coverage (GAC) data.

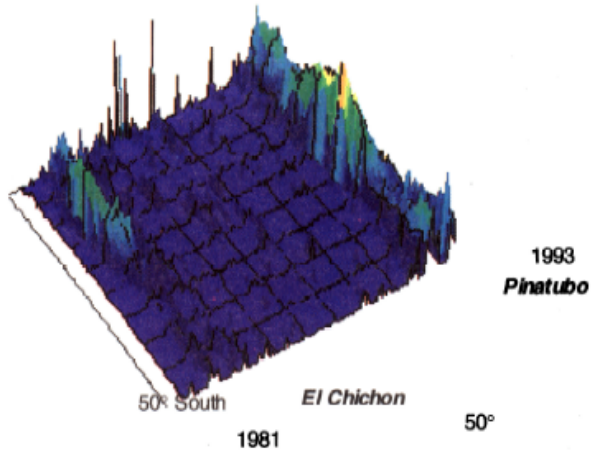


Plate 2. Monthly average of the stratospheric aerosol optical depth deduced from the advanced very high resolution radiometer (AVHRR) data showing major eruptions of El Chichon (1982) and Pinatubo (1991).

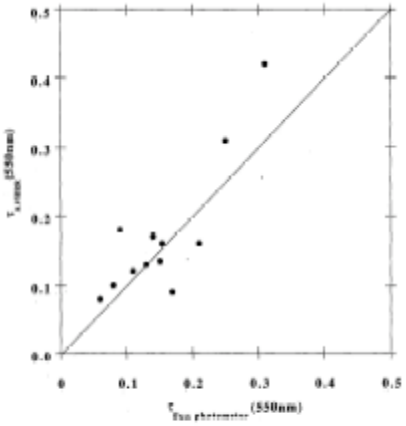


Figure 9a. Comparison of retrieved optical depth using AVHRR data and the dark target approach and measured optical depth from the Sun photometer network in August 1993 over eastern United States.

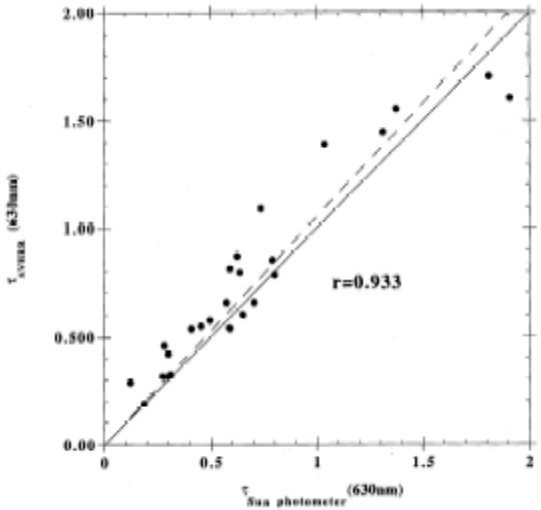


Figure 9c. Same as Figure 9b but in 1993.

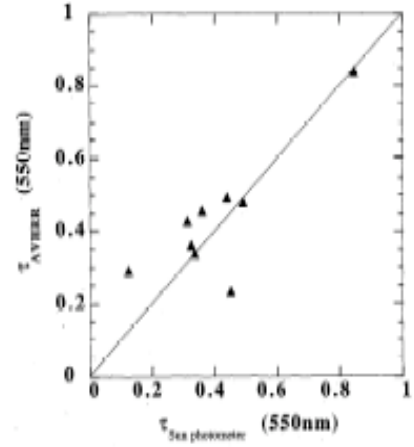


Figure 9b. Same as Figure 9a but in 1992 over Brazil.

Downstream product are being prototyped (ex: BRDF/Albedo, Schaaf et al.)

- Input: AVH09C1 (AVHRR surface reflectance, CMG, 0.05 Deg.)
- Algorithm:

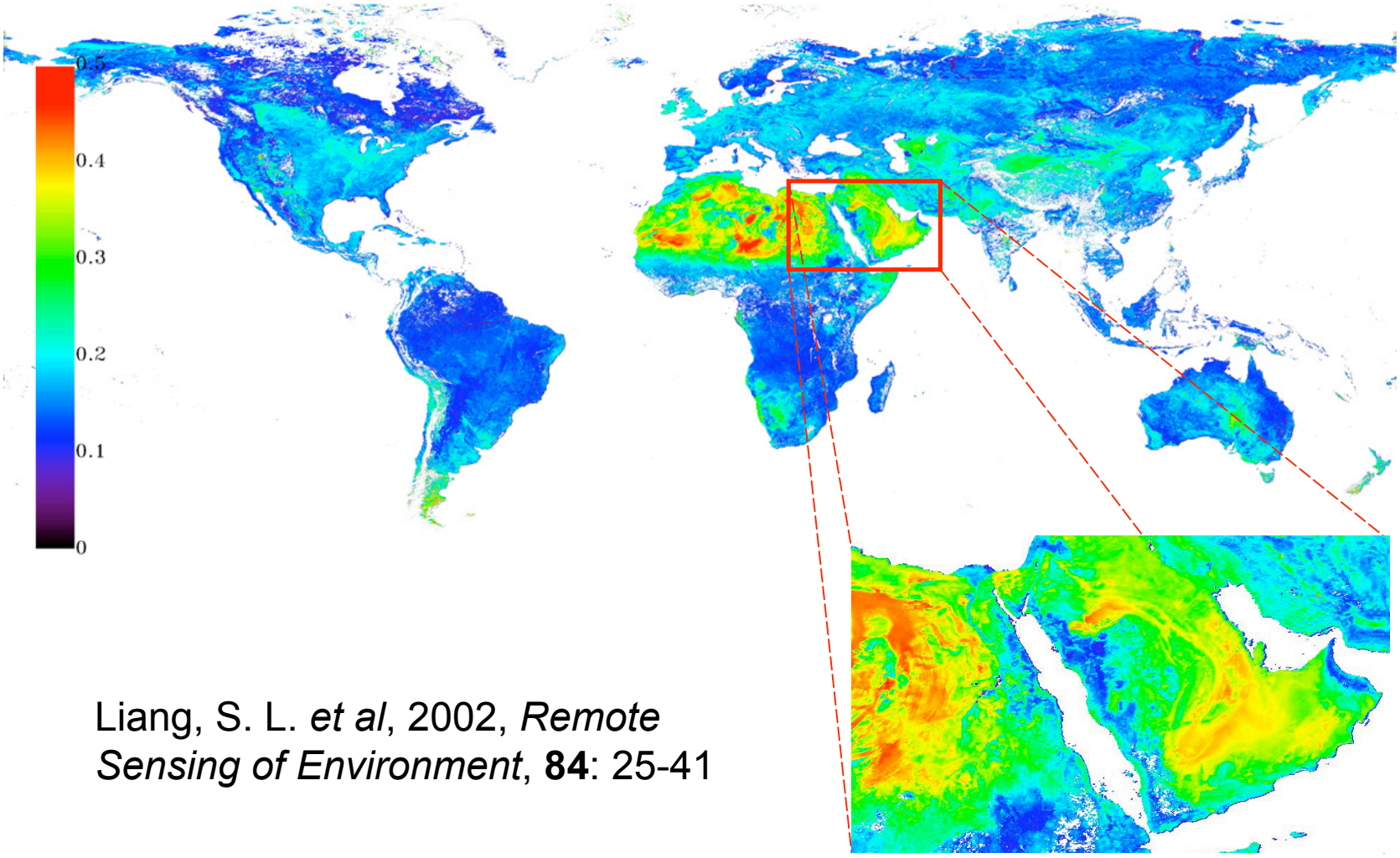
$$BRDF = f_{iso} + f_{vol} * k_{vol}(\theta_i, \theta_v, \phi) + f_{geo} * k_{geo}(\theta_i, \theta_v, \phi)$$

  • Highest Quality Full Inversion: Sufficient angular sampling with at least 7 observations.

  • Lower Quality Magnitude Inversion: Use gap-filled snow-free 5 year composite from MODIS CMG product as back-up database.

- Products (Monthly):
  - ✓ AVH43C1: BRDF kernel weights (parameters)
  - ✓ AVH43C2: Quality Assessment (QA)
  - ✓ AVH43C3: Black-Sky Albedo (BSA) and White-Sky Albedo (WSA)
  - ✓ AVH43C4: Nadir BRDF-Adjusted Reflectance (NBAR)

AVHRR BRDF/Albedo Product: Broadband Black-Sky Albedo (July 1999)



Liang, S. L. *et al*, 2002, *Remote Sensing of Environment*, **84**: 25-41

Albedo evaluation