Generating a Long-term Land Data Record from the AVHRR and MODIS instruments

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Land Long Term Data Record

- Develop and produce a global long term coarse spatial resolution (0.05°) data record from AVHRR, MODIS (and eventually 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 (CDR).
- Funded by NASA Earth Science Research, Education and Applications Network (REASoN) program.
Data Sources
AVHRR and MODIS Production Systems

AVHRR GAC L1B
1981 - present

- Geolocation
- Calibration
- Cloud/Shadow Screening
- Atmospheric Correction

Land products
Gridding
AVHRR products

MODIS coarse resolution
surface reflectance
2000 - present

Land products
Gridding
MODIS products

List of potential products:
- Surface Reflectance, VI,
- Land surface temperature/emissivity,
- snow, BRDF/albedo, aerosols,
- burned area, LAI/FPAR

Format:
- HDF-EOS
- Geographic projection 1/20° resolution
- Climate Modeling Grid (CMG)
- Daily now, multi-day composites later

MODIS Level 0
2000 - present

- Geolocation
- Calibration
- Cloud/Shadow Screening
- Atmospheric Correction

MODIS standard products
Full resolution and
Climate Modeling Grid (CMG)
Production of the Beta (Version 1)
Data Set Completed Summer 2006

- Algorithms:
  - Vicarious calibration (Vermote/Kaufman)
  - Cloud screening: CLAVR-1
  - Partial Atmospheric Correction:
    - Rayleigh (NCEP)
    - Ozone (TOMS)
    - Water Vapor (NCEP)

- Products:
  - Daily surface reflectance (AVH09C1)
  - Daily NDVI (AVH13C1)

- HDF-EOS Format:
  - Linear Lat/Lon projection
  - Spatial resolution: 0.05º (Climate Modeling Grid)

- Time Period:
  - 1981 – 2000 completed (Beta = version 1)

- Distribution:
  - ftp and web

- Evaluation has revealed need for corrections and refinements that will be released in version 2
LTDR Web Page

LTDR
Land Long Term Data Record

LTDR is a NASA-funded REASoN project to produce a global coverage of AVHRR, MODIS and VIIRS for Land studies. The project will create reflectance and NDVI at a resolution of 0.05 degrees. Higher order LAI/FPAR, albedo will be created at a coarser temporal resolution. AVHRR data onboard NOAA satellites from 1981-present.

Project Overview and Science Background
Documents and Presentations
AVHRR Vicarious Calibration
Data Products
Participants
Feedback
Updates/Changes History

Index of ftp://ltdr.nascom.nasa.gov

Consistent and accurate calibration is a pre requisite to creating a long-term data record. The AVHRR instrument suffers from the lack of onboard calibration for its visible to short wave infrared channels. Various vicarious calibration approaches were employed by users to account for this sensor degradation. For the LTDR REASoN project, we adopted the approach developed by Vermote and Kaufman (1995) that relies on clear ocean and accurate Rayleigh scattering computations to derive the sensor degradation in the red bands. This approach uses high clouds to predict the variation in the NIR to Red ratio and transfers the calibration to the NIR channel. This approach does not require any in-situ or aircraft measurements and is applied consistently across the AVHRR instruments onboard various NOAA satellites. Click on the satellite link to get the calibration coefficients for the corresponding AVHRR (NOAA-7, NOAA-8, NOAA-11, NOAA-14, NOAA-16).

http://ltdr.nascom.nasa.gov/ltdr/ltdr.html
Land Long Term Data Record

Quality Assessment

Welcome to the Land Long Time Data Record Quality Assessment Web Page

The objective of LTDR QA is to evaluate and document the scientific quality of the global LTDRs (Long Term Data Records) made from remotely sensed data acquired using AVHRR (Advanced Very High Resolution Radiometer), MODIS (Moderate Resolution Imaging Spectroradiometer) and VIIRS (Visible/Infrared Imaging Radiometer Suite). LTDRs are currently being produced as single global data records for each science parameter at a course resolution of 0.05 deg. Any discrepancy in the data records or QA-related issues identified by the QA process are posted on the Known Issues web page. These issues are updated as new versions of data records are produced using improved algorithms.
Data Set Evaluation

Land Long Term Data Record

A time series of summary statistics derived from all the LTER locations is maintained and monitored by the LTER QA program through the internet. Time series statistics are extracted at all aerosol and surface campaigns. Time series are important because they capture algorithmic sensitivity to aerosol loading and remote sensing (e.g., occurrence of certain weather patterns), they allow changes in the instrument characteristics and calibrate the site (listed in alphabetical order) or tile and biome combinations.

First: Year
1982
1983
1984
1985
1986
1987
1988
1989
1990

Second: Aerosol
A
B
C
D
E
F
G
H
I

Series: Tiles:
B05v05 (Savannah)
B11v03 (North)
B11v03 (North)
B11v04 (North)
B17v07 (Sahara)
B12v01 (Boreal)
B12v01 (Boreal)
B12v04 (Boreal)
B12v04 (Boreal)
B13v01 (Central)

Rho1, Rho2, and NDVI (x10^3)

NOAA-7  NOAA-9  NOAA-11  NOAA-14

Year

Fri May 5 11:27:00 2006
The calibration of the AVHRR has been thoroughly evaluated

Calibration of NOAA16 AVHRR over a desert site using MODIS data

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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 argent, well-calibrated sensor (MODIS). The approach has been tested over a stable Sahara desert site and was initially applied to compare 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 sensors 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, 3175-3184). The coefficients were consistent within less than 1%.

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Keywords: Calibration; AVHRR; MODIS

The coefficients were consistent within less than 1%

Fig. 1. 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).

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.
Comparison of PAL with LTDR at AERONET sites

PAL is not corrected for water vapor absorption

Different Calibration:
- **PAL**: Stable desert target vicarious calibration (Rao and Chen, 1996)
- **LTDR**: ocean-cloud vicarious calibration (Vermote and Kaufman, 1995)
Geolocations issues/bad ephemeris data
NOAA-7: Geolocation Accuracies (Original)
NOAA-7: Geolocation Accuracies (After processing)
NOAA-9: Geolocation Accuracies (Original)
NOAA-9: Geolocation Accuracies
(After processing)
AVHRR BRDF/Albedo Product:
Broadband Black-Sky Albedo (July 1999)

Albedo evaluation
Outreach workshop

- LTDR workshop held January 18, 2007 at the UMUC Conference Center
  - Held in conjunction with MODIS Collection 5 workshop
  - Most in C5 workshop stayed for LTDR Outreach Workshop
  - Goal was to present project status, receive feedback on products/schedule
- Approximately 140 attendees, including MODIS/AVHRR project personnel.
- Presentations from LTDR folks (algorithms, science, QA, data formats, evaluation, intercomparisons with existing AVHRR products)
- Also presentations from international AVHRR experts
  - A. Trischenko (CCRS) “Developing the AVHRR and MODIS Long Term Data Records at the CCRS”
  - P. Frost (CSIRO) “Integration of Sensors Applied on South African Ecosystems (ISAFE)”
  - M. Leroy (CESBIO) “African Monsoon Multidisciplinary Analysis (AMMA)”
- Good interaction and feedback.
Future activities

• Produce much improved (version 2) surface reflectance and NDVI data set for 1981-1999 and 2003 [September]
  – *Use coincident MODIS and AVHRR data to improve aerosol retrieval and correction in AVHRR*
• Release aerosol-corrected surface reflectance and NDVI data set (version 3) [December]
• Produce BRDF/Albedo
• Produce/Release Land Surface Temperature
• Produce Burned Area
• Release version 4 surface reflectance/NDVI data set incorporating fixes identified since version 3 release [2008]
  – Workshop will be held in conjunction with version 4 release.