

MODIS land team

validation



Coordination

Jeff Morisette

Jaime Nickeson, Jeff Privette
& the MODIS Land Discipline team

MODIS Science Team Meeting

13 July 2004

Outline

- MODIS land validation background information
- MODIS land product “accuracy statements”
- EOS Land Validation Core Sites
- Steps forward

Why validate global land products

- Committee on Earth Observing Satellites (CEOS) definition validation = “Estimating Uncertainty”
- Good science and resource management require understanding of product accuracy/uncertainty
- Explicit statements of uncertainty fosters an informed user community and improved use of data
- International environmental protocols and agreements imply products may be independently evaluated and possibly challenged
- As more, and similar, global products are produced by NASA & other CEOS members, inter-use will require characterization of each product’s uncertainty

MODIS validation “hierarchy”

- **Stage 1 Validation:** Product accuracy has been estimated using a small number of independent measurements obtained from selected locations and time periods and ground-truth/field program effort.
- **Stage 2 Validation:** Product accuracy has been assessed *over a widely distributed set of locations and time periods* via several ground-truth and validation efforts.
- **Stage 3 Validation:** Product accuracy has been assessed and the uncertainties in the product well established via independent measurements in a systematic and statistically robust way representing global conditions.

“Accuracy Statements” & support material added to Land discipline validation page: surface reflectance example (1 of 3)

<http://landval.gsfc.nasa.gov/MODIS>

Product “pick-list”

MODIS land team validation

Home Core Sites **Val Status** Campaigns Documentation

News:

- [MODIS Vegetation workshop II](#), University of Montana, 17-19 August 2004
- [MODIS Land Data Operational Product Evaluation \(LDOPE\) software tools](#) now available to assist with the analysis and quality assessment of the MODIS Land products.
- [Call for Papers](#) - TGARS Special Issue on Global Land Product Validation
- Coordinated MODIS land validation activities will continue through the recently funded proposal: [Maintaining and Refining NASA's Land Product Validation Infrastructure](#)

MODIS News

- [Terra](#)
- [Aqua](#)

Landsat 7 News

- [Landsat ETM+ Dataset Transition](#)
- [Report following the Scan Line](#)

MODLAND Validation

MODLAND product quality and Validation. The MODLAND team contributes to and leverages off of international validation standards and activities through close coordination with the Committee on Earth Observation Satellites (CEOS) [Land Product Validation](#) subgroup, under the Working Group on Calibration and Validation ([WGCV](#)).

MODLAND uses several validation techniques to develop uncertainty information on its products. These include comparisons with in situ data collected over a distributed set of validation test sites, comparisons with data and products from other airborne and spaceborne sensors (e.g., SeaWiFS, AVHRR, MISR, TM/ETM+, ASTER), inter-comparison of trends derived from independently obtained reference data and MODLAND products, and analysis of process model results (including EOS Interdisciplinary Science models) which are driven or constrained by MODLAND products.

MODLAND's primary validation technique includes the collection of and comparison with field and aircraft data, and comparison with data and products from other satellites. The infrastructure for these efforts has resulted in the establishment of a semi-permanent array of EOS Land Validation [Core Sites](#), most of which include a flux tower, for extended temporal measurement of terrestrial biophysical dynamics over a range of landcover types. Field data are archived in cooperation with the [Oak Ridge DAAC's](#) Mercury system. Results of all validation activities are conveyed to the end-user through both published literature and the Land Product [Val Status](#)

Product “pick-list”

- Albedo/BRDF
- Fire
- LAI/Fpar
- Land Cover
- Land Surface Temperature
- Net Primary Production
- Snow/Ice Cover
- Surface Reflectance**
- Vegetation Cover Conversion
- Vegetation Indices

9)

(MOD09). The accuracy of the
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to middle infrared: first results

on earth observation. Improved
broad spectral band placement
the development of improved
al change research. Surface
developing several higher-order
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advantage of the new sensing
ster vapor and aerosol effects
and the basis for a new time-
s. This paper summarizes the
comparison with other data
ce launch. The MODIS surface
set for quantifying global

res and Tables

validation of the atmospheric correction has been done partially by continuing to validate the
posol optical thickness used in the correction algorithm by comparison to AERONET data as it is

“Accuracy Statements” & support material added to Land discipline validation page: surface reflectance example (2 of 3)

The image shows a screenshot of the EOS Land Validation website. A large blue arrow points from the text 'Accuracy Statement for each product' to the 'General Accuracy Statement' section of the MOD09 product page. The page is titled 'EOS Land Validation core sites' and features a navigation menu with 'Home', 'Core Sites', 'Val Status', 'Campaigns', and 'Documentation'. The 'Status for: Surface Reflectance (MOD09)' section includes a 'General Accuracy Statement' which states: 'Validation at stage 1 has been achieved for the surface reflectance product (MOD09). The accuracy of the MODIS operational surface reflectance product is better than .5% reflectance or 5% of the signal - which ever is greatest, with slight variation from band to band.' Below this, there is a 'Supporting Studies' section with a title 'Atmospheric correction of MODIS data in the visible to middle infrared: first results' and authors 'Eric F. Vermote, Nazmi Z. El Saleous and Christopher O. Justice'. The 'Additional Validation and Product Quality' section lists links for 'PI Maintained Validation Page' and 'Product Quality Documentation for MOD09A1 - Terra', 'MOD09GHK - Terra', and 'MOD09G0K - Terra'. A 'Summary Figures and Tables' section is also visible at the bottom, with a caption for 'Figure 1' stating: 'The validation of the atmospheric correction has been done partially by continuing to validate the aerosol optical thickness used in the correction algorithm by comparison to AERONET data as it is'.

Accuracy Statement for each product

EOS Land Validation core sites

Home Core Sites Val Status Campaigns Documentation

Status for: Surface Reflectance (MOD09)

General Accuracy Statement

Validation at [stage 1](#) has been achieved for the surface reflectance product (MOD09). The accuracy of the MODIS operational surface reflectance product is better than .5% reflectance or 5% of the signal - which ever is greatest, with slight variation from band to band.

Product status updated on October 2003

Supporting Studies:

Title: Atmospheric correction of MODIS data in the visible to middle infrared: first results
Author: Eric F. Vermote, Nazmi Z. El Saleous and Christopher O. Justice
Source: Remote Sensing of Environment, 83: 97-111.
[View Summary Results From This Document](#)

Additional Validation and Product Quality

[PI Maintained Validation Page](#)
[Product Quality Documentation for MOD09A1 - Terra](#)
[Product Quality Documentation for MOD09GHK - Terra](#)
[Product Quality Documentation for MOD09G0K - Terra](#)

Summary Figures and Tables

Figure 1: The validation of the atmospheric correction has been done partially by continuing to validate the aerosol optical thickness used in the correction algorithm by comparison to AERONET data as it is

“Accuracy Statements” & support material added to Land discipline validation page: surface reflectance example (3 of 3)

Support material for each Accuracy Statement
- updated by product PI and validation community

The image shows a composite of three browser windows from Microsoft Internet Explorer. The top window displays the 'Welcome to the EOS Land Validation Home Page' with a navigation menu and a 'News' section. The middle window shows the 'EOS Land Validation core sites' page, with a blue arrow pointing from the text above to the 'Supporting Studies' section. The bottom window shows the 'EOS Validation Product Name—MOD09' page, which includes a 'Summary Results from:' section with the title 'Atmospheric correction of MODIS data in the visible to middle infrared: first results' and an abstract. The abstract describes the MODIS instrument's capabilities and the validation process. The 'Supporting Studies' section in the middle window lists the title, author, source, and a link to the summary results.

News:

- [MODIS Vegetation workshop II](#), University of Montana, 17-19 August 2004
- [MODIS Land Data Operational Product Evaluation \(LDOPE\) software tools](#) now available to assist with the analysis and quality assessment of the MODIS Land products.
- [Call for Papers](#) - TGARS Special Issue on Global Land Product Validation
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MODIS News

- [Terra](#)
- [Aqua](#)

Landsat 7 News

- [Landsat ETM+ Dataset Transition](#)
- [Report following the Scan Line](#)

EOS Land Validation core sites

Status for: Surface Reflectance

General Accuracy Statement

Validation at [stage 1](#) has been achieved for the surface reflectance product. The accuracy is the greatest, with slight variation from band to band.

Product status updated on October 2003

Supporting Studies:

Title: Atmospheric correction of MODIS data in the visible to middle infrared: first results
Author: Eric F. Vermote, Nazmi Z. El Saleous and Christopher O. Justice
Source: Remote Sensing of Environment, 83: 97-111.
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Additional Validation and Product Quality

[PI Maintained Validation Page](#)
[Product Quality Documentation for MOD09A1 - Terra](#)
[Product Quality Documentation for MOD09GHK - Terra](#)
[Product Quality Documentation for MOD09G0K - Terra](#)

EOS Validation Product Name—MOD09

MODIS land team validation

Summary Results from:

Atmospheric correction of MODIS data in the visible to middle infrared: first results

As they relate to the validation of MOD09

Authors: Eric F. Vermote, Nazmi Z. El Saleous and Christopher O. Justice

Source: Remote Sensing of Environment, 83: 97-111.

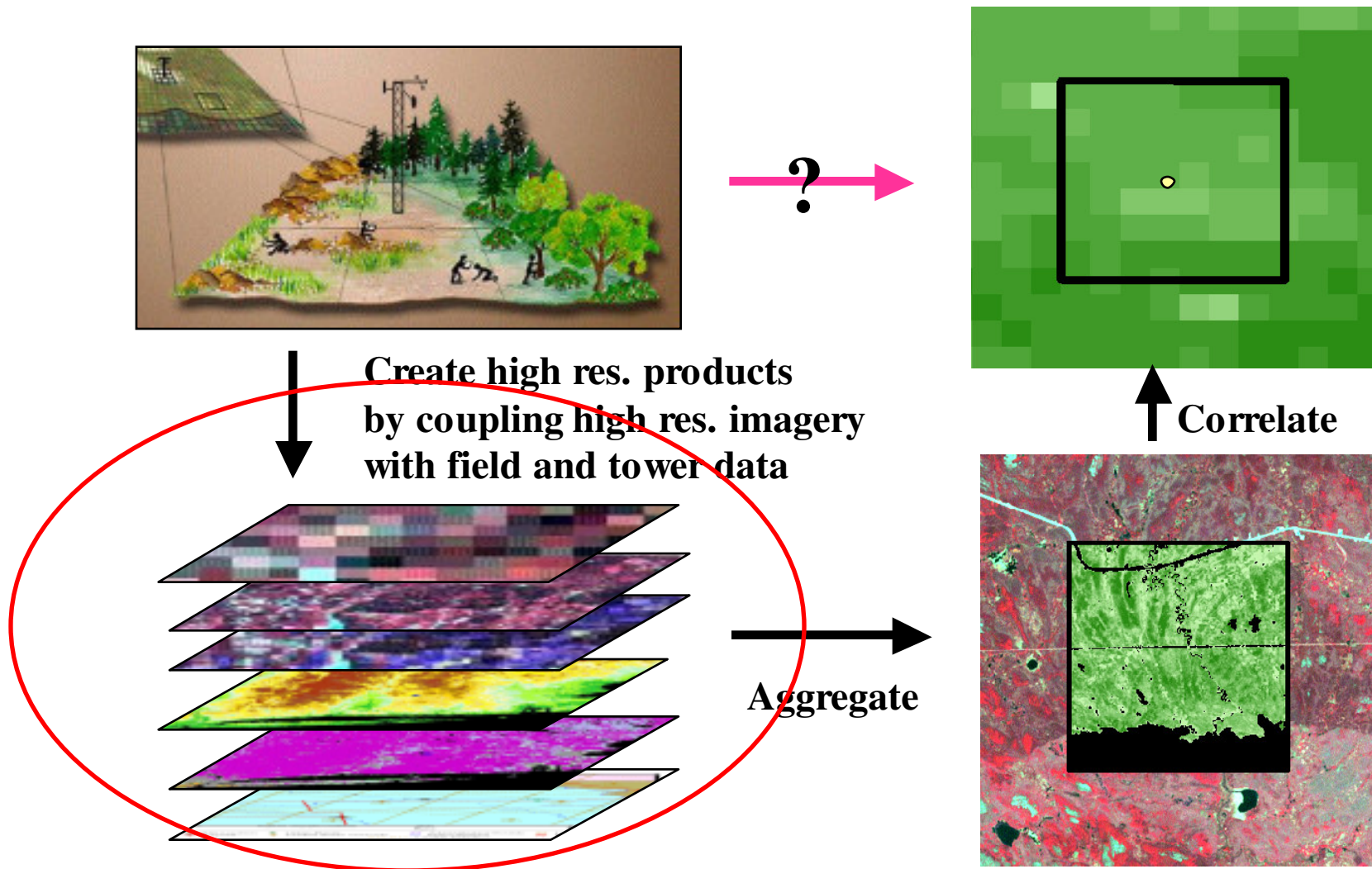
Link to: [Access Publication](#)

Abstract: The MODIS instrument provides major advances in moderate resolution earth observation. Improved spatial resolution for land observation at 250 and 500 m and improved spectral band placement provide new remote sensing opportunities. NASA has invested in the development of improved algorithms for MODIS, which will provide new data sets for global change research. Surface reflectance is one of the key products from MODIS and is used in developing several higher-order land products. The surface reflectance algorithm builds on the heritage of the Advanced Very High Resolution Radiometer (AVHRR) and SeaWiFS algorithms, taking advantage of the new sensing capabilities of MODIS. Atmospheric correction by the removal of water vapor and aerosol effects provides improvements over previous coarse resolution products and the basis for a new time-series, which will extend through to the NPOESS generation imagers. This paper summarizes the first evaluation of the MODIS surface reflectance product accuracy, in comparison with other data products and in the context of the MODIS instrument performance since launch. The MODIS surface reflectance product will provide an important time-series data set for quantifying global environmental change.

Summary Figures and Tables

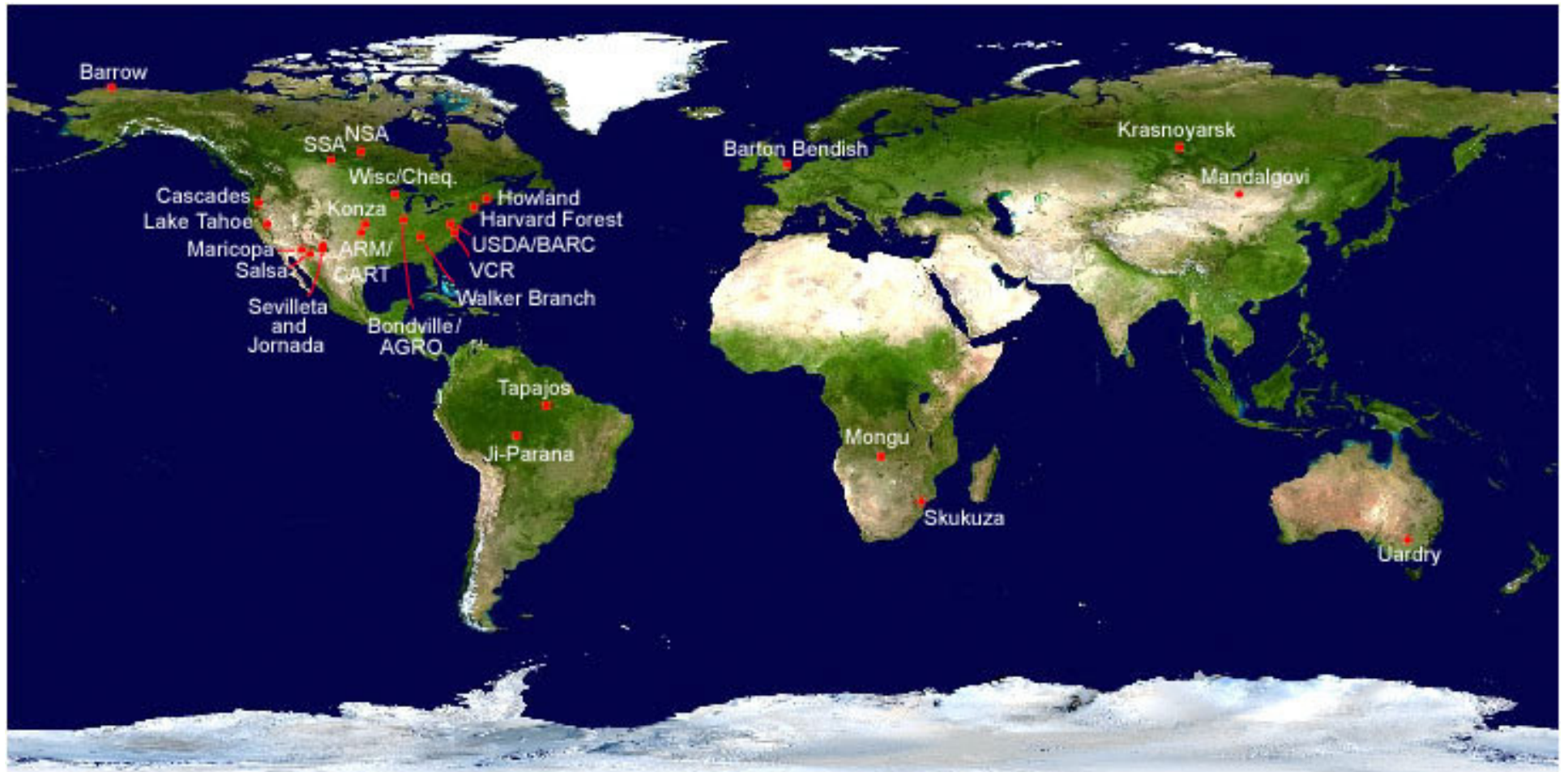
Figure 1: The validation of the atmospheric correction has been done partially by continuing to validate the aerosol optical thickness used in the correction algorithm by comparison to AERONET data as it is

From points to pixels

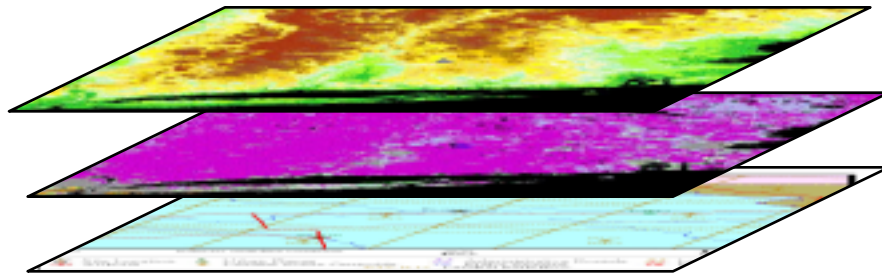


Multiple use of airborne or high res. satellite data imply some efficiencies in coordinated activities/sites

EOS Land Validation Core Sites



Core Sites data suite



Field data graphic courtesy of the BigFoot program

Satellite imagery

MODIS Subsets (Land Processes DAAC)

ETM+ (LPDAAC)

Atmospherically Corrected ETM+

ASTER data (LPDAAC)

MISR Local Mode (Langley DAAC)

SeaWiFS Subsets (GSFC)

IKONOS (Scientific Data Purchase)

“GeoCover ’90s TM (LPDAAC)”

EO-1

Ancillary layers and background information

such as existing

- elevation
- land cover
- reference layer

available through UMD

“Global Land Cover Facility”

Field and airborne data:

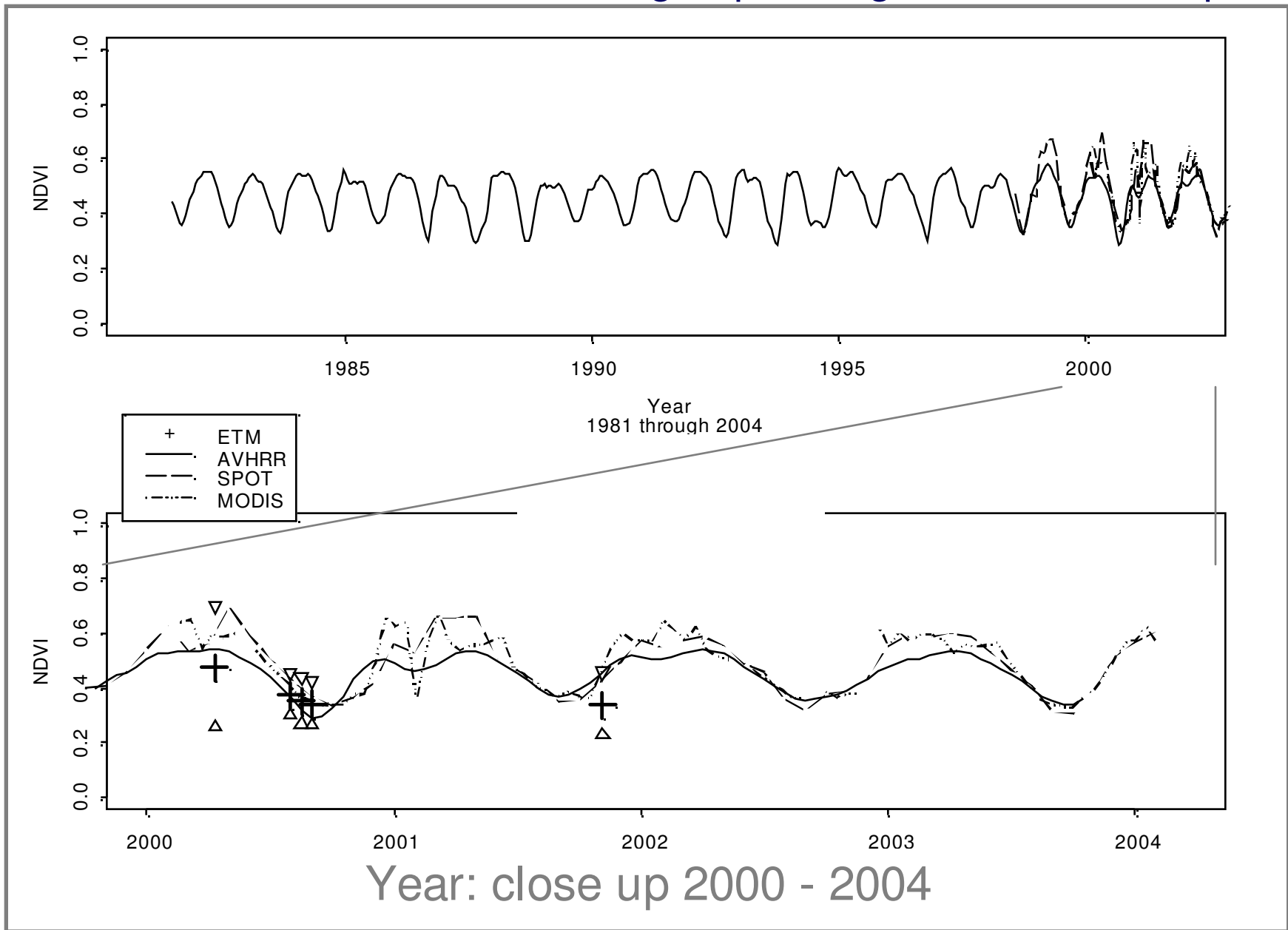
archive and access through

ORNL DAAC’s “Mercury System”

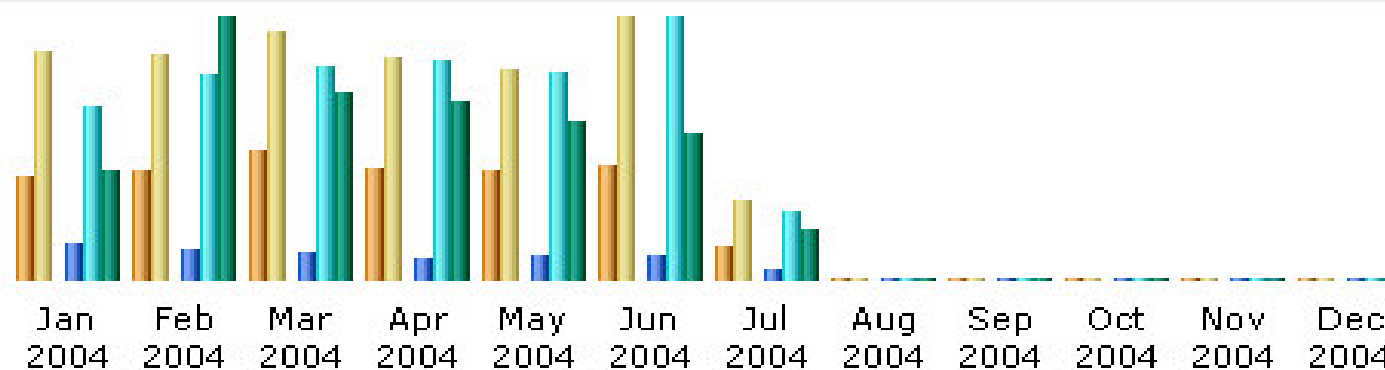
AERONET and FLUXNET data

White: available for all Core Sites
Red: available for some Core Sites

AVHRR Validation with GIMMS group: Mongu, Zambia example

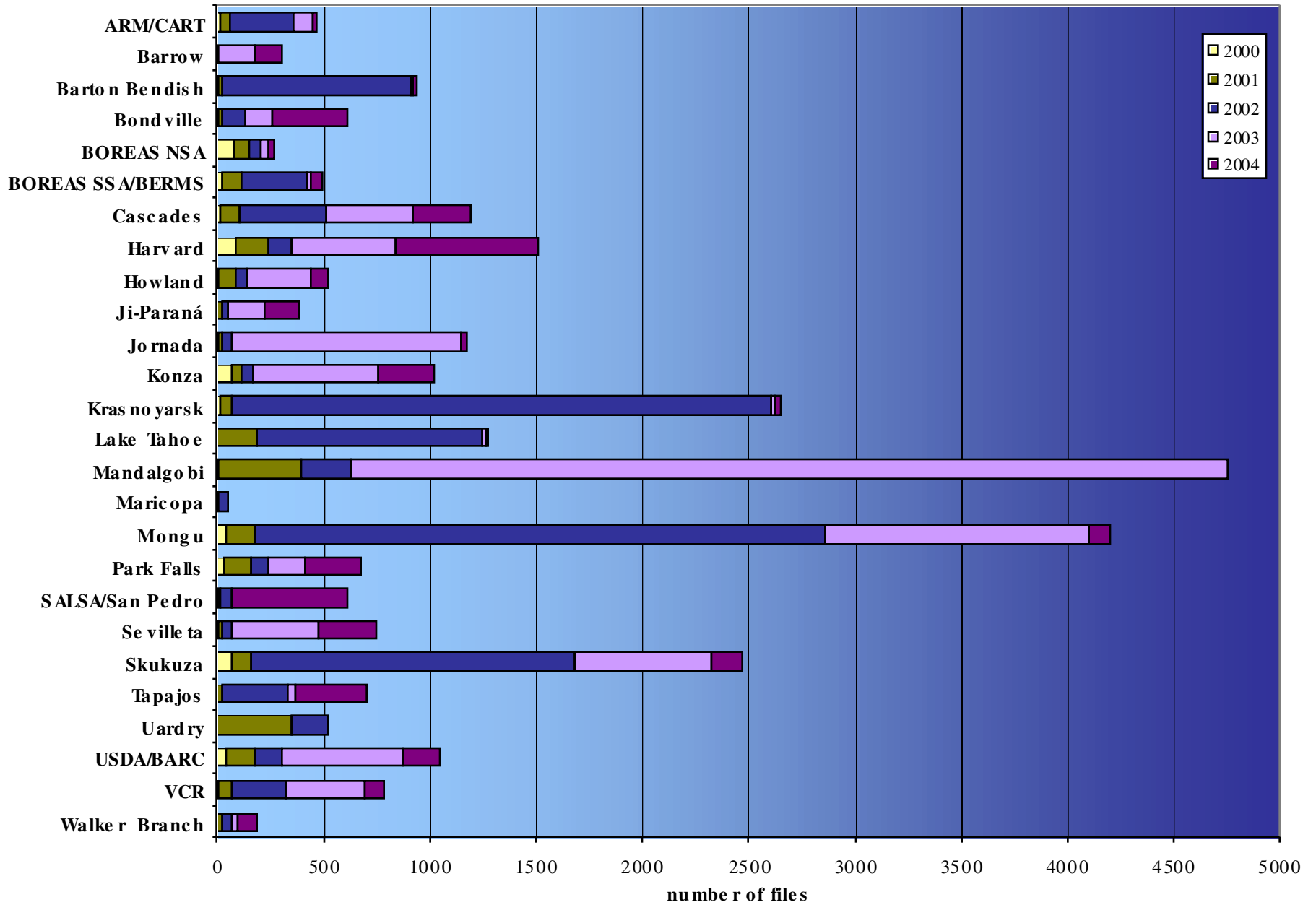


MODLAND Validation Web site stats

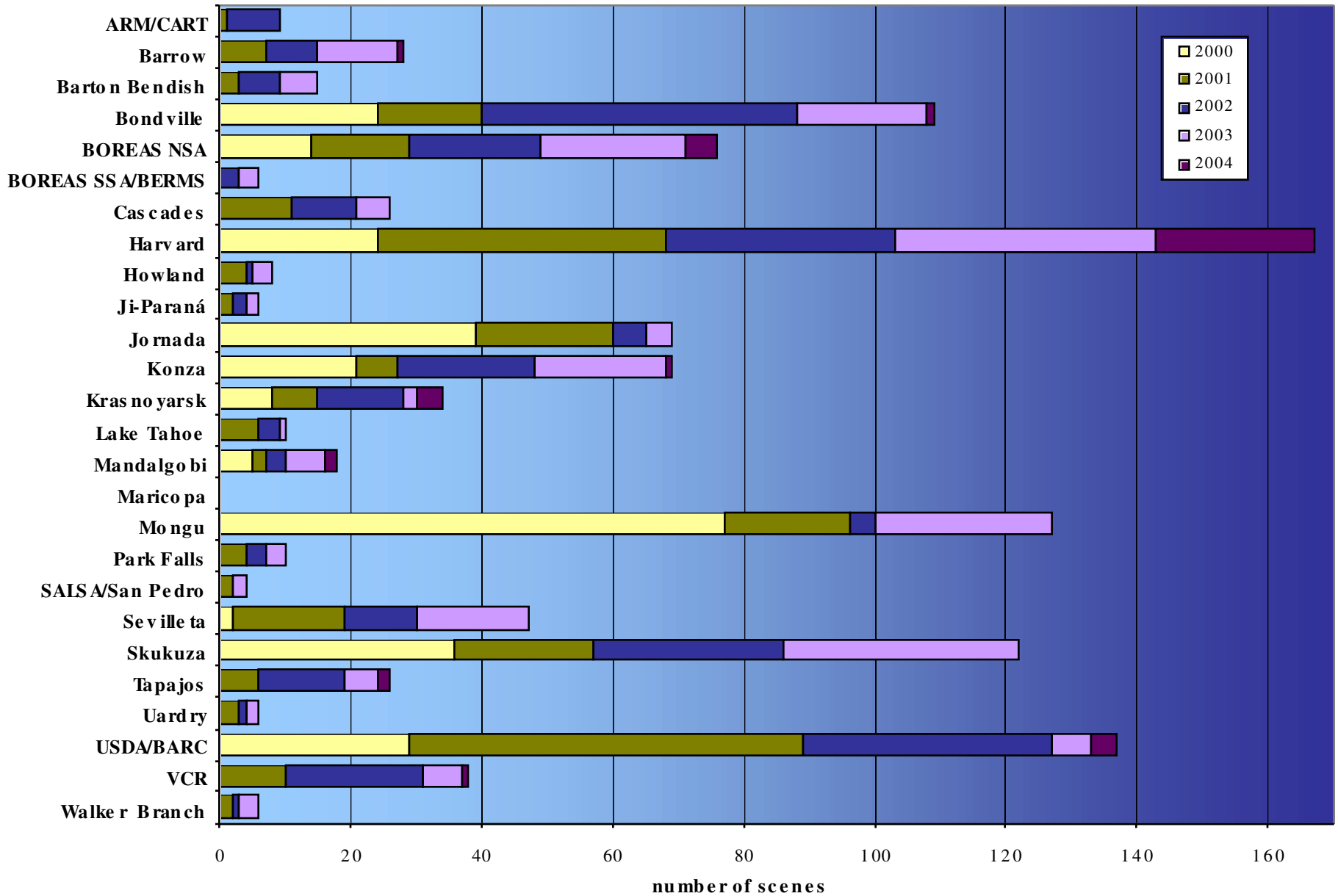


Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2004	353	770	5747	27188	183.46 MB
Feb 2004	372	765	4544	31790	443.33 MB
Mar 2004	437	836	4491	33537	318.96 MB
Apr 2004	382	753	3588	34437	304.94 MB
May 2004	370	712	3879	32393	269.15 MB
Jun 2004	390	883	3808	40846	250.49 MB
Jul 2004	115	265	1390	10670	87.33 MB
Aug 2004	0	0	0	0	0
Sep 2004	0	0	0	0	0
Oct 2004	0	0	0	0	0
Nov 2004	0	0	0	0	0
Dec 2004	0	0	0	0	0
Total	2419	4984	27447	210861	1.81 GB

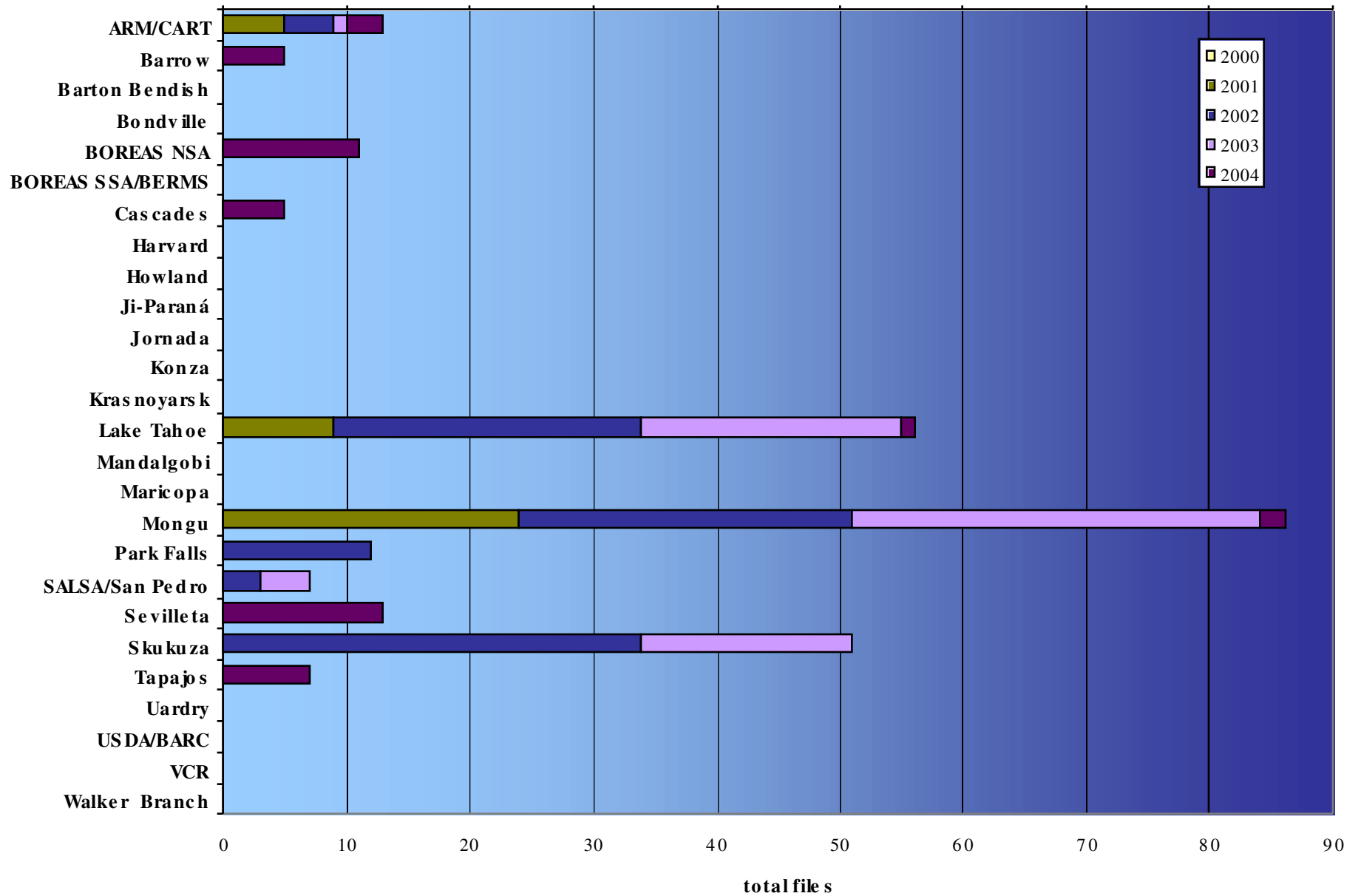
MODIS Downloads from EDC by year



ETM+ Scenes Downloaded from EDC by year



ASTER Files Downloaded from EDC by year



New Mercury search page

<http://mercury.ornl.gov/ornldaac/>

The screenshot shows a Microsoft Internet Explorer browser window displaying the ORNL DAAC Mercury Search page. The browser's address bar shows the URL <http://mercury.ornl.gov/ornldaac/>. The page features the NASA logo on the left and the Mercury logo on the right, which includes the text "Powered by MERCURY" and "Oak Ridge National Laboratory". The main heading is "ORNL DAAC Mercury Search Screen", with links for "Help" and "Rate Mercury".

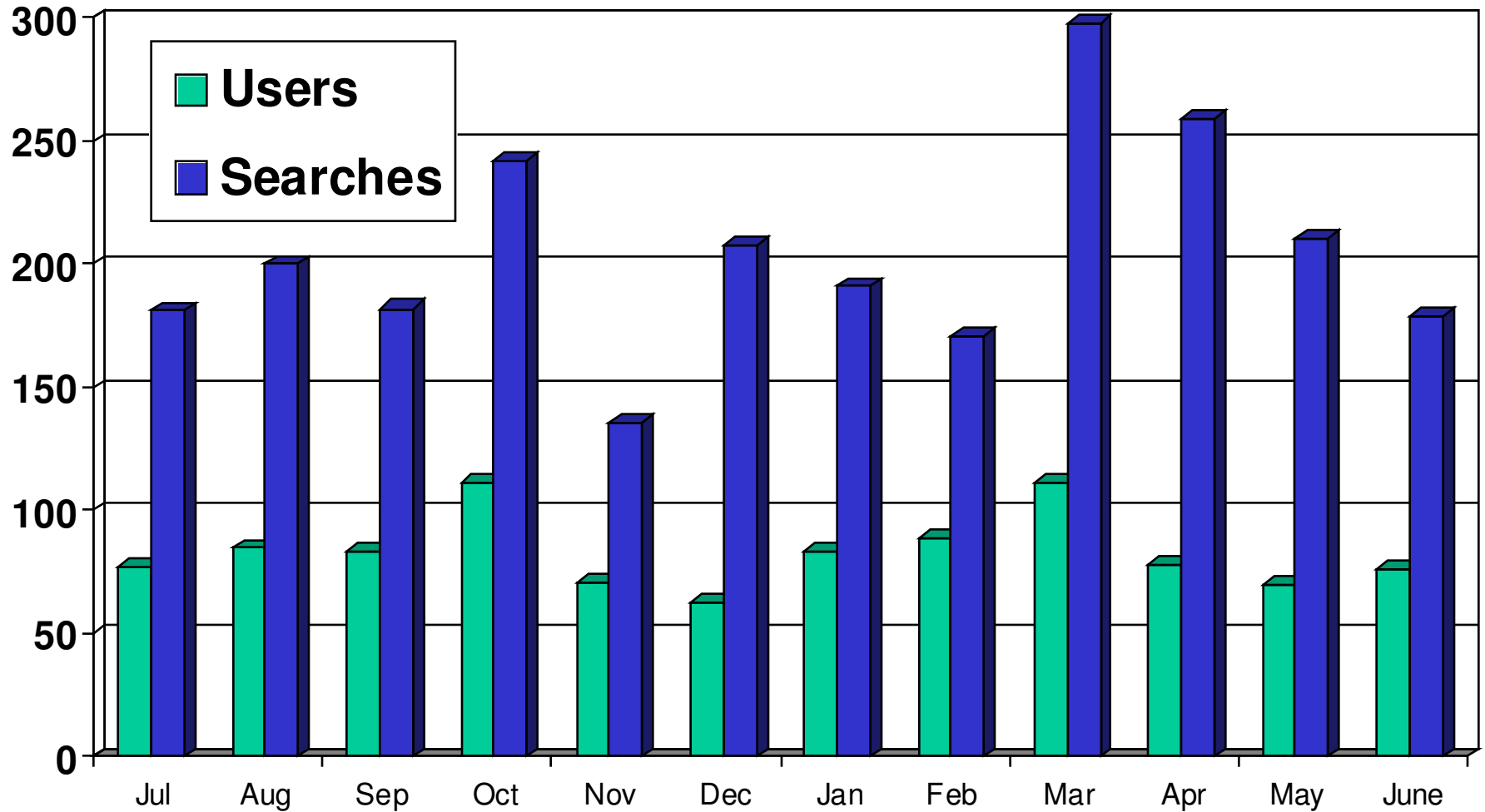
The search interface includes several tabs: "Keywords", "Spatial", "Temporal", "Sources", and "Browse". The "Keywords" tab is active. It contains two search terms, each with a "Search Within" dropdown menu set to "Entire Document" and a text input field. A dropdown menu for boolean operators is set to "AND". A hint text reads: "Hint: boolean operators, wildcards and phrases are allowed. ex: precipitation or (rain* and 'moisture content')".

At the bottom of the search area, there is a "Query being built:" field, which is currently empty and labeled "Not Editable". Below this is a "Results/Page" dropdown menu set to "10", and buttons for "Search", "Help", "Clear Page", and "Clear All".

At the bottom of the page, there are several links: [ORNL DAAC](#), [Mercury](#), [Rate Us](#), [Contact Us](#), [Disclaimer](#), and [Cookie Statement](#). The browser's status bar at the bottom indicates "Downloading from site: http://mercury.ornl.gov/ornldaac/" and "Internet".

ORNL DAAC Mercury: Searching for Data

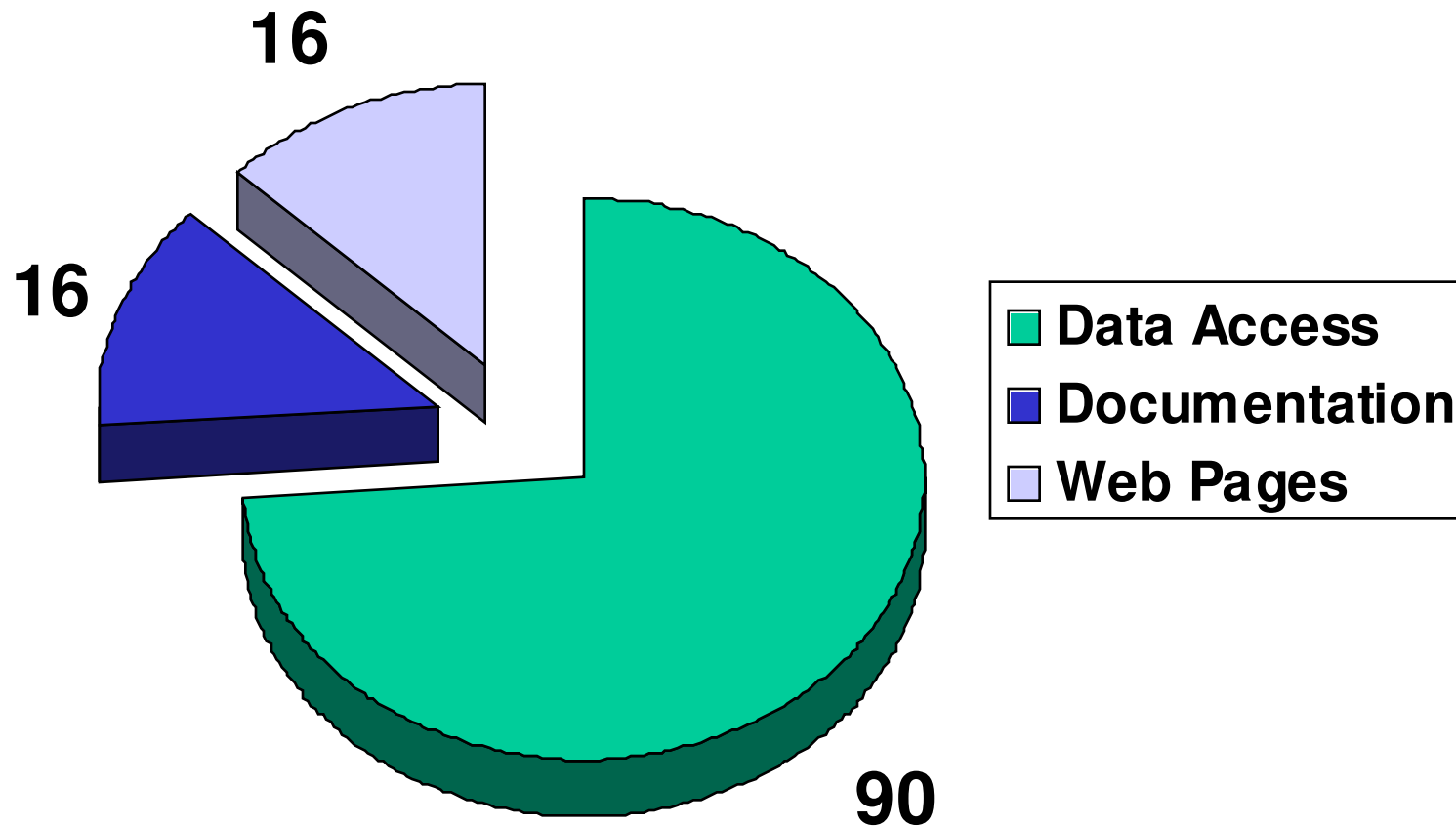
July 2003 - June 2004



Land Val: Types of Referrals*

July 2003 – June 2004

(122 referrals, 59 distinct users)



* Referral = user linked to site hosting the data or documentation

Land Val: Most Referred Data Sets

July 2003 – June 2004
(122 referrals, 59 distinct users)

Rank	Data Set Title and Information	Count
1	Compiled Meteorological Data for BigFoot Sites, 1991-2002	14
2	MODIS Land Data Products (MODLAND) for EOS Land Validation Core Sites	9
3	Leaf Area Index (LAI) Data for BigFoot Sites, 1999-2004	8
4	Aboveground Net Primary Production (ANPP) for BigFoot Sites, 1999-2004	7
4	IKONOS Data for EOS Land Validation Core Sites	7
5	AErosol RObotic NETwork (AERONET) Data for EOS Land Validation Core Sites	4
5	KonVEx Leaf Area Data for Selected BigFoot Plots, July 1999	4
5	LAI and Canopy Gap Fraction Data for Mongu, Zambia, 2000	4
5	Land Cover Surfaces for BigFoot Sites, 2000-2004	4
5	MOD04 Subsets From MODIS Atmospheric Parameters Subset Statistics (MAPSS)	4
5	MODIS/Terra BRDF/Albedo Model-1, ASCII Subsets, 7x7-km, 16-day, March 2000 Forward	4
5	MODIS/Terra Leaf Area Index and Fraction of Photosynthetically Absorbed Radiation (FPAR), ASCII Subsets, 7x7-km, 8-day, March 2000 Forward	4
5	Set of Canopy Parameters for Harvard Forest, USA, and Ruokolahti, Finland, 2000	4
5	Terra ASTER Satellite Imagery for EOS Validation Core Sites	4

Plans for high res. imager

- **AVIRIS flights (U.S. Southwest and Mexico for VI)**
- **AMSR-related aircraft mission (Ice-surface temperature with Don Cavalieri)**
- **ASTER (still confront issue with limited “allocation” and processing to L1B)**
- **ALI/Hyperion (may be limited in time to ~one year)**
- **CBERS**
 - **Free to Brazilians (joint negotiations between China and Brazil on international distribution ongoing, the Brazilian agency, INPE, position is “that, whenever possible, data and software should be distributed using a free policy”.**
 - **Looking to CEOS working group on Cal/val for an assessment of its performance, Argentina mtg, early 2005)**
 - **Wide Field Imager (WFI): 890km swath, 260 m spatial res, two bands at 660 & 830 nm**
 - **High Resolution CCD Camera: 113km swath, 20m spatial resolution, 5 bands (2 match WFI)**
 - **Infrared Multispectral Scanner (IR-MSS): 120km swath, 80km/160km spatial resolution for 4 thermal infrared/thermal channels**
 - **http://www.cbears.inpe.br/en/index_en.htm**
- **Disaster Monitoring Constellation (DMC), at Surrey, UK**
 - **32m Spatial resolution in “3 spectral band” (similar to Landsat’s 2,3, & 4)**
 - **Need further information on instruments’ performance and data access**
 - **<http://www.ee.surrey.ac.uk/SSC/G8/P3/>**
- **CHRIS/PROBA**
 - **Experimental satellite (working with JP Muller to acquire over some Core Sites)**
 - **14km swath, either 63 channels at 36m spatial res. Or 18 channels at 18m res, channels programmable bandwidth and location between 400 nm to 1050 nm**
 - **“Raw data” – exploring radiometric and geometric processing done by ESA or, potentially others (implied cost)**
- **MODLAND Validation funds existing for coordinated high res data purchase**

Plans for field data

- **Limited funding for Science team member to collect field data**
- **Need to rely on other networks/projects:**
 - Fluxnet (LAI/FPAR, VI, Albedo, NPP)
 - Aeronet (S.R., VI, NBAR)
 - BigFoot (LAI/FPAR)
 - BSRN (Albedo, snow cover)
 - USFS Forest Inventory and Analysis Program (VCF)
 - Using ORNL's user Working group to tap into LTER
 - Regional mapping projects (Norway survey/VCF; Brazil's PRODES/VCC; GOFC-GOLD/Fire & Land cover; Norwegian Fractional Snow Cover)
- **Data sharing policies need to be better documented and followed**
 - Ongoing discussion with HQ
 - Look to ORNL to help write and post
 - From the US GCRP:
"...data should be made openly available as soon as they become widely useful. Deciding when data became widely useful is the responsibility of the funding agency...."

Validation Next steps...

- **Pathfinding activity on utilizing networks for stage two validation – based on published protocols (next two slides)**
- **Integrate “accuracy statements” into CEOS/WMO data base (peer pressure for other global products (tomorrows talk))**
- **Feedback from critical user to establish accuracy requirements in light of uncertainty estimates (Montana meeting)**
- **Develop strategy for stage three validation of “critical products/Climate Data Records**

Products and Networks

	Fluxnet	Aeronet	CEOS-LPV Intercomp	ILTER	BSRN	SpecNet	Regional mapping projects
Surface Reflectance		X				X	
Land Surface Temp	X						
Snow & Ice					X		Norwegian Fractional Snow Cover
Albedo/BRDF/NBAR	X	X	X		X	X	
VI	X	X		X		X	
LAI/FPAR	X		X	X			
NPP	X						
Fire/Burnt Area							GOFC/GOLD
Land Cover			X				GLC2000 & MRLC
VCF/VCC							USFS Forest Inventory and Analysis Program (VCF) Norway survey/VCF Brazil's PRODES/VCC

Yellow indicates existing use of networks

CEOS Land Product Validation subgroup IEEE Trans on Geoscience and Remote Sensing special issue



- Special Issue: describing the state of the art research on both protocol and results for validation and accuracy assessment of global land products (Liang, Baret and Morisette, eds., input and help from Chris and Ranga)
- Three sections:
 - Surface Radiation variables
 - Ecosystem variables
 - Land cover characteristics
(including land cover change, fire, and burnt area)
- Solicit a summary from user community to write a note for each section on the implication for the uncertainty/validation of the products for a particular user community
- Submissions due October 2004, anticipated publication in early 2006