The Remote Sensing Information Partner (RSIP)  
And Rainfall Studies in New Mexico

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Interface 2002,  
Montreal Canada April 19, 2002
Barriers to Wide Dissemination of NASA Remote Sensing Data

- **Awareness**: The potential user community is large but for most part, they are unaware of the availability of NASA data.
- **Responsiveness**: What the delivery mechanism of the data and expertise, it must be based on dialogue and partnership with the users.
- **Cost**: Data costs were viewed as the deciding factor in limiting use.
- **Format**: Data must be delivered in formats that are compatible with the ways users do their business.
- **Interdisciplinary approach**: Remote sensing data are most useful when they are interlayered with other relevant data to allow different information to come into play.
Response to Lack of Awareness

- Develop an outreach campaign aimed at increasing the visibility of geospatial data products and tools
- Establish linkage between NASA, the State and Local Agencies, through Existing Centers such as State Extension Services
- Undertake one or a series of pilot projects that would demonstrate clearly the value of geospatial data and tools in operational settings
Obstacles in Using EOS Data

- Complex format (HDF, HDF-EOS)
- Esoteric Projections (e.g., Integerized Sinusoidal)
- Large file sizes
- Too much information in files
- Insufficient bandwidth for downloading of the data
- Insufficient storage on the user's local platform
- Inability of the user's visualization/analysis package to handle the HDF-EOS format
- Unavailability of a means to seamlessly utilize data sets from various sources so as to minimize the amount of preprocessing on the part of the user (i.e., interoperability)
The Utility of GIS for Applications
RSIP Purpose

• The purpose of the RSIP project is to provide participating institutions inexpensive access to the globally covered GES data holdings, and the ability to routinely acquire these data for local use or for future distribution.

• The GES DAAC benefits in this arrangement by assuring that NASA data are more widely distributed, thus affording a better usage for NASA efforts.

• The participating RSIP "nodes" benefit by obtaining customized data products preprocessed into a form that can be readily used for applications purposes (e.g., GIS-compatible formats).

• The GES DAAC has collaborated with several institutions to set up the mechanism to operationally provide these special earth science data products from the DAAC for local use.
One Solution - Remote Sensing Information Partner (RSIP) Concept

**BENEFITS:**

- Local environmental agencies, policymakers, applications users obtain data in a cost effective and efficient manner, in a form they can readily use (e.g., regional subsets in a GIS-compatible format)
- Distribution of data management responsibilities to local data centers, consistent with future Earth Science Enterprise trends
- Relevant data are placed in the hands of those who are in the best position to ascertain the potential needs of their local communities in the derivation of value-added products
- Collaboration is encouraged or strengthened between NASA and the participating nodes, or among the nodes themselves in cases of environmental issues of mutual concern

**SAMPLE PRODUCTS:**

- **Rutgers University**
  - MODIS 16-day Surface Reflectance
  - MODIS 16 day Vegetation Index
  - MODIS 8 day Vegetation Index

- **University of New Mexico**
  - TRMM Rainfall data
  - MODIS atmospheric data
  - SeaWiFS channel data

- **George Mason University (GMU)**
  - MODIS channel data
  - MODIS land/ocean data

- **JPL DAAC**
  - MODIS Sea Surface Temperature (SST)
Prospective Local RSIP Customers

- Earth Data Analysis Center (EDAC) at University of New Mexico
  - Middle Rio Grande Conservancy District
  - Office of the State Engineer
  - NM Department Energy, Minerals, and Natural Resources
  - Sevilleta National Wildlife Refuge
- Center for Remote Sensing and Spatial Analysis at Rutgers University
  - State agricultural agencies
  - Commercial interests in regional and international agriculture
- Center for Earth Observing and Space Research George Mason University
  - State and local agencies through Virginia Access (VAccess)
- Pennsylvania State University (possible RSIP)
  - State / County public health departments
# Prospective Local RSIP Customers

- George Mason University / Virginia Access (VAccess)

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### Federal Agencies

- EPA Environmental Protection Agency
- Forest Service
- USGS United States Geological Service
- NASA National Aeronautics and Space Admin
- USDA United State Department of Agriculture
RSIP Activities

- MOU and Requirements
- Generation of Prototype GIS Compatible Remote Sensing data
- Development of Access, Visualization and Remapping Software
- Value-added Data Flow to RSIP Partners
- Joint Presentations (USGS Middle Rio Grande, Fire-Ecology, American Water Resources Workshop)
- First RSIP Training Workshop January 8-9, 2002
## Example Products Requested by RSIPs

<table>
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<tr>
<th>Data Product</th>
<th>Size (MB)</th>
<th># Arrays</th>
<th>Format</th>
<th>Projection</th>
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<td>35</td>
<td>35</td>
<td>HDF</td>
<td>Swath</td>
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</table>
Overall RSIP Data Delivery Concept

- MODIS Direct Broadcast
- Standard data products from DAAC heritage systems
- Standard MODIS data products from DAAC ECS system
- Subscription
- DAAC data pre-processing (subset, mosaic, re-project, reformat)
- FTP
- Local RSIP storage
- Local Users
Value-Added TRMM Subsets

TRMM Standard Products

- Gridded Orbital Subset (Binary)
  - TMI rain profile (0.5°)
  - TRMM combined Surface Rain (0.1°)
  - VIRS All Channel Data (0.25°)

- Regional Subsets
  - All states south of 35°N
  - TRMM Field Experiments
  - Other related Experiments

- GIS Compatible Subset (ARC/INFO)
  - TMI surface rain
  - TCI surface rain

- Coincidence Subset (HDF)
  - Satellite products—all Level 1 and 2 at GV sites and FE regions
  - GV products—GV products at 4 DD sites

- TRMM FE Subsets
  - Satellite Coincident subset
  - Gridded Regional Subset
  - TRMM FE Ancillary Data

- Parameter Subset (HDF)
  - TMI Surface Rain
  - PR Surface Parameters
  - TCI Surface Parameter
  - VIRS Channel 4 (IR)
Data Flow for U. New Mexico

1. TRMM G2B31 Subsetted Binary File
2. Data for State Extracted and Converted to ASCII
   - ASCII Table File Output (.TXT)
3. Data Record for Surface Rainfall Rate Extracted from Table
4. ASCII Raster Format File Output (.RASTER)
5. Data Ingested into Arc/Info GIS Software
6. Arc/Info Interchange Format Generated (.e00)
7. Grid Data Changed to Point File (for Shapefile Conversion)
8. Arc/View Shapefiles Produced (3 Files) (.shp, .shx, .dbf)

- U. NM (Earth Data Analysis Center) ERDAS Output
- DAAC Arc/Info Output
MODIS Surface reflectance tile in ISIN projection: MOD09A1 image shows a sample of the Level 3, 8-day (started 2000273 (Sept. 30) composite of 1 km Level 3 Surface Reflectance bands 1 (red), 4 (green) and 3 (blue).

An example of MODIS data GIS application. MODIS Level-1 B false color Bands 2,1,1 image overlayed with county boundaries.

Re-projected tile in Lambert Azimuthal (LA) Equal Area projection using the Nearest Neighbor (NN) resample method.

Subsetted MODIS surface reflectance data in LA projection using MRT.

Data Flow for Rutgers University
Center for Remote Sensing and Spatial Analysis
MODIS Customized Products for PSU

MODIS NDVI/EVI 16-days Composite 250m resolution

Click on the image for better view

MODIS LST Daily 1Km resolution

LST - March 6th 2001
GEO-TIF GIS file
README
LST - March 22nd 2001
GEO-TIF GIS file
README
LST - April 7th 2001
GEO-TIF GIS file
README
LST - April 15th 2001
GEO-TIF GIS file
README
DAAC OpenGIS - Compliant Client

- Client being developed by DAAC to promote data and information exchange (knowledge sharing) among individual RSIPs
- OGC-compliant Java applet
- Allows user to select desired data sets and create maps from RSIP nodes, other OGC-compliant servers, and DAAC map servers:
  - Web Mapping Testbed / Distributed Oceanographic Data System (WMT-DODS)
  - NASAWeb GIS Software Suite (NWGISS), developed to serve HDF-EOS data to OGC clients
- Currently being enhanced to allow for temporal searching and retrieval of data subsets in addition to map generation
Data Distribution via RSIPs

- Network of secondary data distributors with more knowledge of local users.
- Nodes add additional information to data product before sending to users.
- Interoperable distributed data.
OpenGIS as a potential solution

- Open GIS Consortium (OGC)
  - Founded in 1994
  - Partnership of Industry, Government, Educational institutions
  - http://www.opengis.org

- Goal is to create interoperability specifications to allow the transparent exchange of Geospatial data regardless of data format.
DAAC OGC Client

- Parses capability document to show available layers.
- Allows user to make GetMap requests of server.
- Displays layers of images created by map servers.

Example URL:

Create maps from satellite data stored at multiple nodes in the RSIP network.

Search for data either by desired RSIP or data type

Ancillary layers can be added to the images you are interested in for reference.

Zoom in on the area you are interested in. Use your mouse to draw a box around a region, then use the magnify tool to zoom in on that part of the image.

View the actual data values using the Get Coverage button to view the actual data values for a region or entire image.

Turn layers on/off using the checkbox next to the name of the layer in the scrollable panel at the bottom.

Restart the process, select the clear tool to wipe away all layers.
DAAC OpenGIS - Compliant Client
Future Work

- Expansion of the RSIP network to include operational data flows to CRSSA, GMU/Vaccess and PSU
- Inclusion of near realtime MODIS ocean products derived from Direct Broadcast into the RSIP data flows
- Complete automation of the receipt, preprocessing and delivery of MODIS customized products to the RSIP nodes
- Completion of the OpenGIS-compliant client to promote interchange of data and information among participating nodes
- Collection of metrics from the RSIPs to demonstrate that the objectives of the program are being fulfilled
Precipitation Estimate of TRMM in the Rio Grande Region

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GDAAC and CEOSR/GMU
S. Morain, A. Budge, P. Neville, C. Bales
EDAC/UNM
Objectives

- Examine TRMM Algorithms Performance in Relatively Dry Regions
- Compare TRMM and EDAC Rain Gauge Network Data
- Assess Value of Satellite Data to Regional Water Resource Management
Comparison of TRMM Satellite Rainfall with US Gauge Data

Rainfall accumulation (1/1/98-7/31/98) from 3B42 daily 1x1 degree merged satellite product

Rainfall accumulation for the same period from hourly gauge data over the US

Chiu and Vongsaard GMU
Data

- TRMM Microwave Imager Hydrometeor Profile (2A12) and PR precipitation profile (2A25) binned at 0.5 degree (3G68)
- 3G68 averaged to 3-hourly seasonal data
- TRMM and Other Satellite Combined Daily 1x1 degree Rain Rate (3B42)
- TRMM and Other, includes Gauge (3B43) Monthly 1x1 degree Rain Rate
- TSDIS TRMM Mission Index: Average Daily 1x1 degree Sensor rain rates for all satellite passes
3B42 and 3B43 Algorithm Input

3B42: Daily 1x1 degree
   - VIRS (1B01) IR Histogram
   - TMI Rain Rate (2A12)

3B43: Monthly 1x1 degree
   - Monthly TMI (3B42 intermediate product)
   - VIRS IR Histogram (3B42 Intermediate product)
   - SSM/I Monthly Rain Rate (3A46)
   - CAMS or GPCP Gauge Analysis (3A45)
TRMM Analysis Tools

- TSDIS Orbit Viewer
- GMU/GDAAC Convert 3B42 and 3B43 into GrADS Compatible Files
- GMU/GDAAC Develope Prototype GrADS based TRMM On-line Analysis to display area accumulation and time series of rain rate
- URL: [http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/trmm_online_analysis/](http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/trmm_online_analysis/)
- Grid Analysis and display system GrADS URL [http://grads.iges.org/grads/head.html](http://grads.iges.org/grads/head.html)
TRMM COMBINED RAINFALL
MONTHLY MEAN 1998 - 2000

1998

1999

2000
Water Divisions in New Mexico

Average rain rate (mm/d) in red for the period Jan 1998-Dec 2000
http://www.ncdc.noaa.gov/onlineprod/drought/xmgr.html
Precipitation (Inches)

New Mexico - All Divisions: 1998 (Monthly Averages)
Precipitation (Inches)

New Mexico - All Divisions: 1999 (Monthly Averages)
Precipitation (Inches)

New Mexico - All Divisions: 2000 (Monthly Averages)
3B43 agrees with WD gage data except for October 2000

1998-2000 total acc. WD=877mm 3B43=860mm 3B42=1589

mmCor(WD,3b42)=0.82 Cor(WD,3b43)=0.87 Cor(3B42,3B43)=0.78
Scatter Diagram of Monthly Rain Rate over NM (32-37N, 103-109W) for the period Jan 1998-Dec 2000

Water Divisions Average Rain Rate (mm/hr)

1998-2000 total acc. WD=877mm 3B43=860mm 3B42=1589 mm

$3B42 = 0.01 + 1.21 \ WD$

$3B43 = 0.01 + 0.64 \ WD$
Comparison of TMI, PR and WD Seasonal Rainfall (mm/hr) in New Mexico (32-37N, 103-109W)

1998-2000 Average (32-37N, 103-109W) TMI (2A12)=0.138mm/hr
PR(2A25)=0.087mm/hr WD: Water Districts Average=0.040mm/hr

Cor(WD,PR)=0.28  Cor(WD,TMI)=0.67  Cor(PR, TMI)=0.71
Comparison of TMI and PR Rain Rate Over NM

Daily Rain Rate from TRMM Mission Index
EDAC Rain Gauge Network

- Developed to Monitor Environmental Changes
- Consists of 28 Automatic Weather Stations Measuring Temperature, Relative Humidity and Precipitation
- Data Enable Comparison with and Interpretation of Satellite Data
In cooperation with the UNM Sevilleta Long Term Ecological Research Program, an array of **21 tipping-bucket rain gauges** has been deployed on the Sevilleta National Wildlife Refuge.

Tipping buckets record rain events of 1/100 inch. Temperature and humidity data are available from 10 sites at 5 minute intervals.
The summer 2000 “monsoon season” was late in coming and was fairly dry at the Sevilleta NWR. The small amounts of rain make coincident TRMM satellite overpass times critical for accurate measurements. Even in a wetter season, the overpass times would mean that most of the rain events would be missed.
Discussions and Conclusion

- TRMM 3B43 consistent with WD gauge data in NM. Low bias noted for high rain months which may be due to non-inclusion of some rain events in the operational CAMS product.
- PR and TMI are twice -three times higher than WD, respectively.
- Gauges underestimating: wind correction, evaporation (Vigra).
- High TMI rain due to large ice scattering, implication for development of next version of TMI land algorithm.
- DSD and Z-R relation seasonally and geographically dependent.