

Land Remote Sensing Overview

JACIE Workshop

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Land Remote Sensing Program

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Today's Topics

- Brief overview of USGS land remote sensing program
- Highlights of JACIE work at USGS
- Update on NASA/USGS Landsat Data Continuity Mission (LDCM)
- Notes on alternative data sources

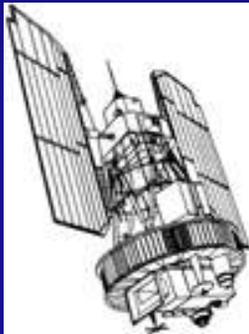


Satellite Remote Sensing at Department of the Interior (DOI)

“...the time is now right and urgent to apply space technology towards the solution of many pressing natural resource problems being compounded by population and industrial growth.”

- Department of the Interior Secretary Stewart L. Udall, 1966

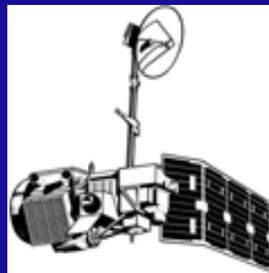
DOI/USGS Earth Resources Observation Systems Program est. 1966



Landsat 1-3

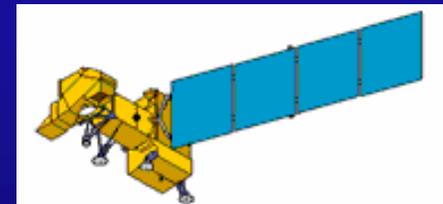
Multi-Spectral Scanner (MSS) 79 meter
Return Beam Vidicon (RBV) 80/40 meter

NASA builds, launches Landsat 1, 1972



Landsat 4-5

Multi-Spectral Scanner (MSS) 79 meter
Thematic Mapper (TM) 30 meter



Landsat 7

Enhanced Thematic Mapper Plus (ETM+)
30/15 meter

USGS Land Remote Sensing Program Mission Goals

- Leadership among U.S. civil agencies for:
 - Managing U.S. requirements for operational land imaging
 - Acquiring, managing, and distributing land-image data
 - Managing U.S. satellite resources as necessary for U.S. Government



USGS Land Remote Sensing Program Mission Components

- Operate Landsat satellite series
- Manage National Satellite Land Remote Sensing Data Archive
- Coordinate data acquisition from commercial and international sources
- Provide leadership in land remote sensing, land use change research, and data utilization (as in JACIE)
- Support U.S agriculture/forestry, land use management, global change research, hazards management
- Support U.S. homeland security and foreign policy interests

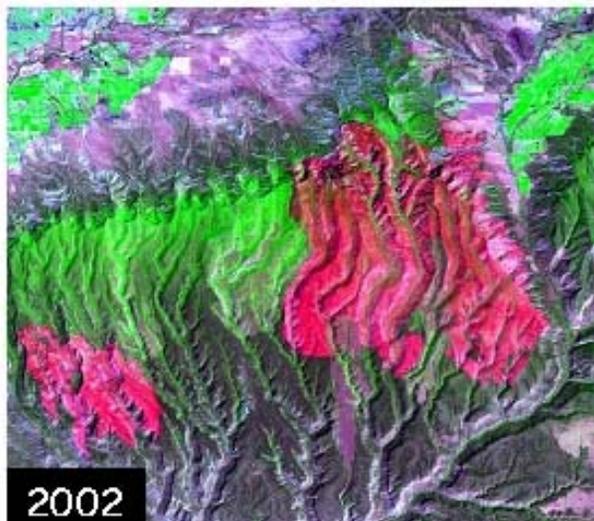
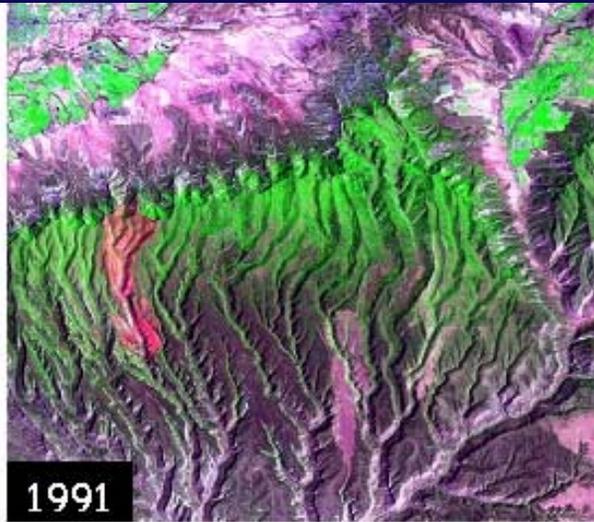
Data Archive – 34 Years and Counting

- ETM+ sensor: Landsat 7
 - 600,000+ scenes
 - 558TB of data in archive
 - Archive grows by 300GB daily
- TM sensor: Landsats 4 & 5
 - 642,000+ scenes
 - 322TB of data in archive
 - Archive grows by 30GB daily
- MSS sensor: Landsats 1 through 5
 - 641,000+ scenes
 - 20TB of data in archive



March 2006

Archive Exploitation Example: Wildfire Warning, Analysis, and Monitoring

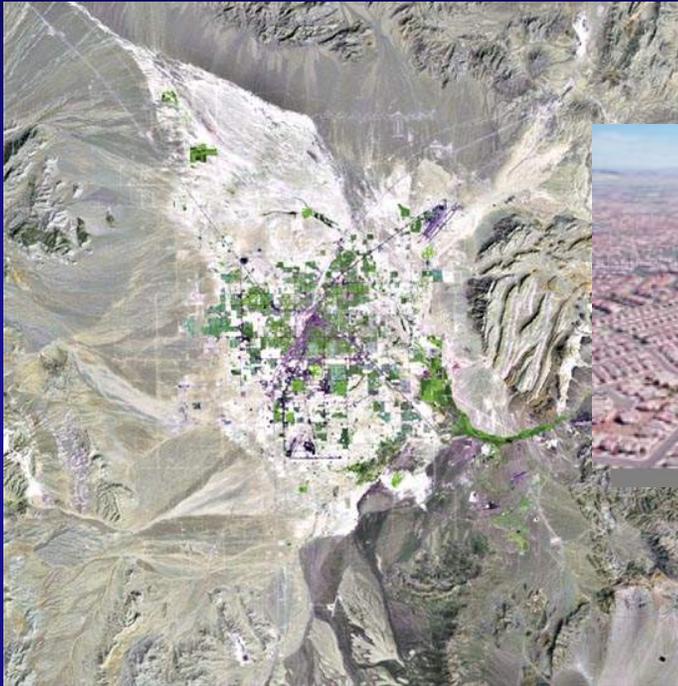


A history of fires
over the last three
decades

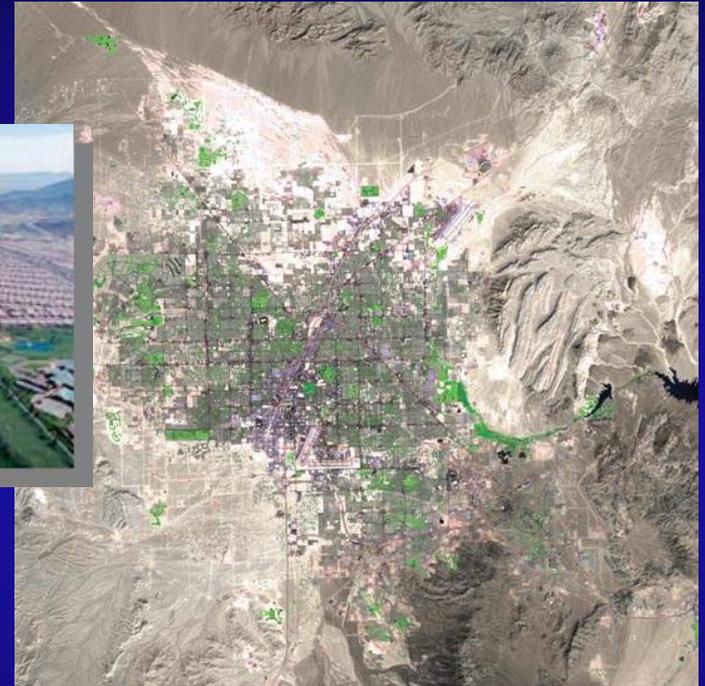
Mesa Verde
National
Park, Colorado

Archive Exploitation Example

Urban Growth: Las Vegas 1973 vs. 2000



This Landsat image shows Las Vegas in 1973 (population 358,400). Purple areas represent roads and other urban infrastructure.



By 2000, Las Vegas (population 1,563,280) had sprawled in almost all directions, especially in the Northeast and southeast.

JACIE Scope at USGS

- Supports LDCM, CRSSP* and GEOSS**
 - Increases confidence in U.S. commercial sources in the marketplace
 - Provides a model for government/industry cooperation
 - Showcases successful applications

* Commercial Remote Sensing Space Policy

** Global Earth Observing System of Systems



JACIE-Related Aerial and Satellite Calibration and Characterization

- Characterize and calibrate aerial and satellite systems in support of quality acquisitions and understanding of remote sensing data
- Verify and validate associated data products regarding ground and atmospheric truth for accurate value-added science
- Assess new remote sensing technologies
- JACIE team methods being used and expanded

Future JACIE Work at USGS

- Continue to broaden scope to include all commercial sensors:
 - National or international
 - Aerial or satellite
 - Optical, LIDAR, IFSAR, hyperspectral, etc
- Use near-term land remote sensing requirements to influence U.S. sensor priorities
- Assess next generation of US high resolution commercial satellite sensors
- Demonstrate relevance of JACIE to US role in terrestrial monitoring
- Expand applications focus (hazards/risk mgt., etc.)
- Demonstrate JACIE as a model for GEOSS support

LDCM Background

- 1999 - NASA and USGS release request for information to private industry regarding plans to acquire Landsat-like data
- 2002 - Formulation Study Phase contracts awarded by NASA to DigitalGlobe and Resource21 to study satellite design and public/private partnership viability
- 2003 – NASA releases LDCM Implementation Phase request for proposals (RFP)
 - NASA, in consultation with USGS, cancels RFP and does not award contract
 - Sole proposal did not form a fair and equitable Government/Industry partnership
 - White House establishes Landsat/NextView Interagency Working Group (IWG)
- 2004 – IWG recommends flying Operational Land Imager (OLI) on NPOESS to transition Landsat Program to operational environment



LDCM Background (Cont'd)

- August 13, 2004 - White House Memorandum (OSTP)
 - Transition Landsat measurements to operational environment on NPOESS
 - Incorporate a Landsat imager on first NPOESS
- Spring-Summer 2005 - Detailed analysis of proposal to incorporate OLI sensors on two selected NPOESS platforms
 - complexities of incorporating Landsat-type sensors on the NPOESS platforms significantly exceed earlier assessments, making that option less suitable to the goals of both programs
- December 23, 2005 - White House Memorandum (OSTP)
 - NASA to acquire a single Landsat data continuity mission in the form of a free-flyer spacecraft
 - DOI, through the USGS, to be responsible for operating the Landsat Data Continuity Mission and for collection, archiving, processing, and distribution of the land surface data



Landsat Data Continuity Mission Status

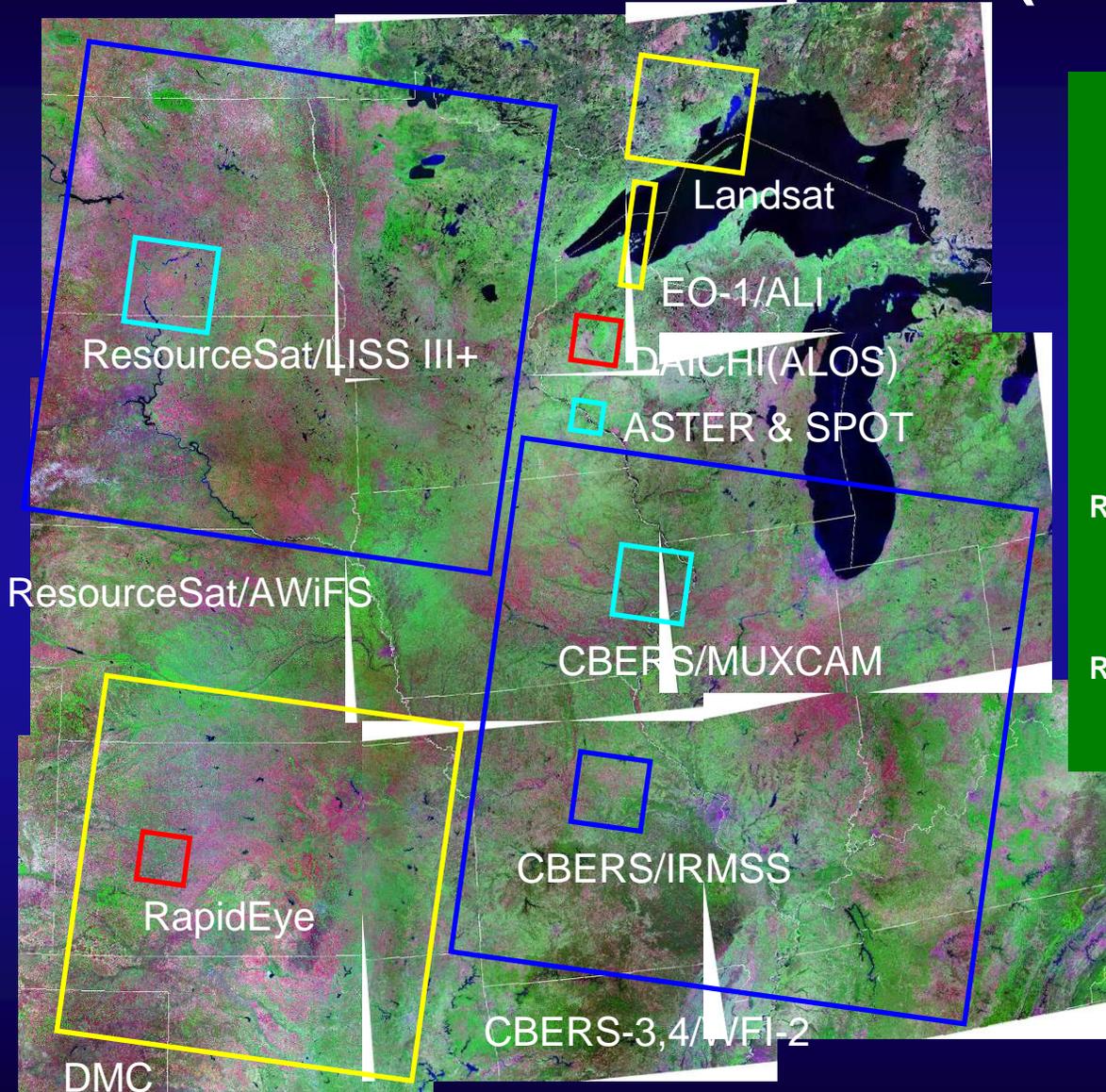
- NASA released mission-acquisition synopsis March 2006
 - Considering including financial incentives for timely delivery on orbit
- NASA coordinating satellite/sensor acquisition with USGS
- USGS coordinating data processing system acquisition with NASA
- USGS to operate satellite mission and manage/distribute data
- NASA/USGS technical team examining alternate data sources to minimize potential pre-launch data gap



Potential Alternate Data Sources

- Systems most comparable to Landsat are SPOT (French), IRS (Indian), CBERS-2 (Chinese/Brazilian), and ASTER (Japanese)
- Additional sources include ALOS (Japan), DMC (English), RapidEye (German - 2007)
 - Overall, spectral coverage is less than Landsat
 - Costs vary vs. Landsat: SPOT is more expensive, DMC is similar, ASTER & AWiFS are cheaper
 - Landsat data may be shared; some commercial systems require additional licensing fee for open distribution
- Landsat data not directly comparable to High-Res or MODIS/VIIRS data
 - IKONOS, QuickBird, and OrbView 3 are high-res but local vs. global
 - MODIS/VIIRS almost daily global coverage at a coarse (250 to 1000m) spatial resolution – not fine enough for Landsat comparisons

Alternate Data Source Options (Cont'd)



| Satellite | Sensor | Ground Sample Distance (m) |
|---------------|-----------|----------------------------|
| RapidEye | REIS | 6.5 |
| ALOS | AVNIR | 10 |
| CBERS-3,4 | MUXCAM | 20 |
| SPOT 5 | HRG | 10/20 |
| Terra | ASTER | 15/30/90 |
| ResourceSat-1 | LISS III+ | 23.5 |
| Landsat 7 | ETM+ | 15/30/60 |
| EO-1 | ALI | 30 |
| DMC | MSDMC | 32 |
| ResourceSat-1 | AWiFS* | 56 |
| CBERS-3,4 | WFI-2 | 73 |
| CBERS-3,4 | IRMSS | 40/80 |

Note: For purposes of scene size comparison only; not actual orbital paths or operational acquisitions. High-resolution scenes too small to illustrate here.

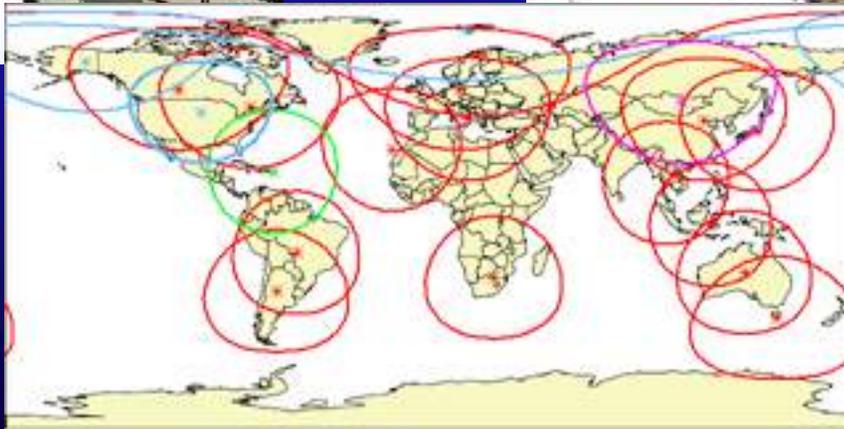
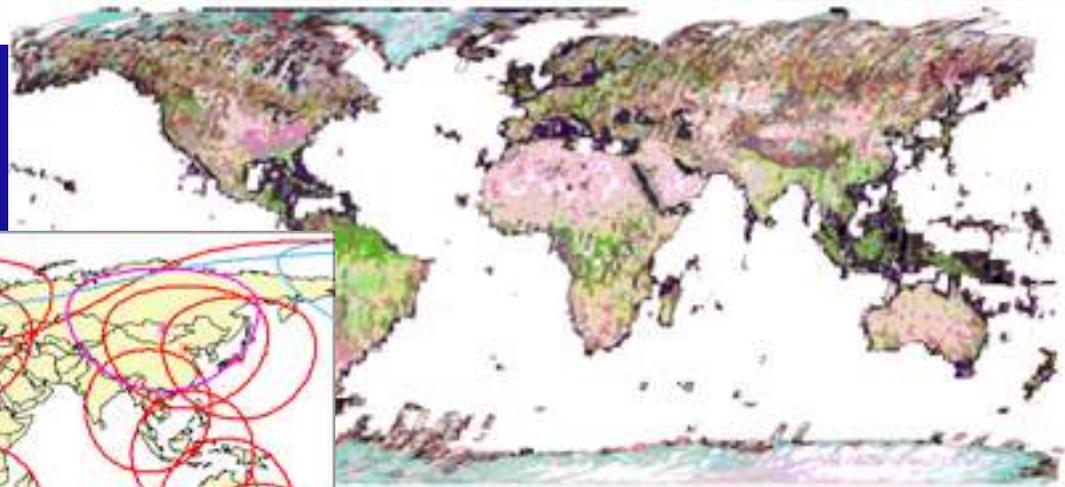
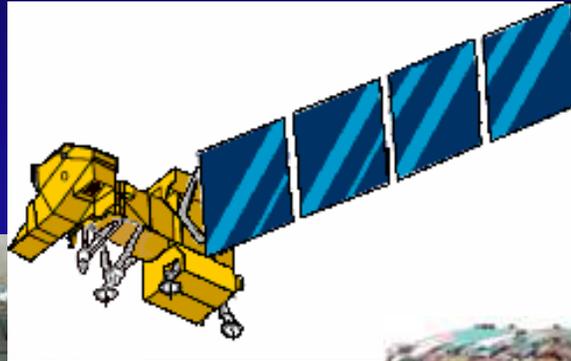
NASA/USGS Technical Working Group Findings to Date

- 1st Working Group meeting 13-14 Dec '05
- Next meeting 21-22 March '06
- Initial Results are Promising:
 - While not ETM+ quality, the IRS and CBERS data may be reasonable substitutes
 - Assessments are continuing
 - USGS/INPE CBERS-2 downlink test upcoming
- Next come operational assessments of data flow and data reception/distribution models



Back-up

Satellite Mission Operations



Landsat 5 Status

- L5 and its Thematic Mapper (TM) sensor have been on orbit for 22 years; three year design life
 - No onboard data recorder – US and 9 International Cooperators (12 ground stations) capture TM data
 - Some subsystems running on back-up components
 - Solar array drive malfunctioned Nov. 2005; operations changed to over-ride problem
 - Full US and partial global coverage resumed January 2006
 - 19 years of extended operations
 - Fuel to be depleted in 2010
 - Satellite could fail anytime before 2010



Landsat 7 Status

- L7 and its Enhanced Thematic Mapper-Plus (ETM+) sensor have been on orbit for 7 years; five year design life
 - ETM+ scan line corrector (SLC) failed May 2003; USGS developed filler products
 - 1 of 3 L7 gyros turned off May 2004; USGS developing 1-gyro flight capability
 - Other subsystems still operating nominally; global data collection
 - Landsat 7 data still worthwhile for some users, of limited use for others
 - Full US and global coverage collected throughout 2005
 - 2 years of extended MISSION operations
 - Fuel to be depleted in 2010
 - Satellite could fail anytime before 2010
- Gyro risk study projected probability of L7 failure in 2007
 - NASA/USGS Data Gap Study Team formed to investigate options and resources for Landsat-like global data sets



Research and Applications

- Fund scientists and technicians in 5 major centers and across USGS
- Understand and characterize new sensors
 - New aerial and satellite technologies
- Develop new applications and understanding of remotely sensed data
 - Extracting Impervious Surface Info from Multi & Hyperspectral Data
 - Defining Landscape Characteristics from Remote Sensing Data in Support of Human Health Investigations
 - Developing RADAR Remote Sensing Technologies
 - Multi-sensor applications for Landscape and Regional Quantification of Climate Change Impacts and Carbon Dynamics
 - Mapping Invasive Species with Hyperspectral Data

Research and Applications

- Help DOI agencies use remotely sensed information
 - Hydrologic Derivatives from SRTM, IFSAR, and LIDAR
 - Subsidence Studies of Coastal Regions Using InSAR
 - InSAR Monitoring of Earthquake, Volcano, & Landslide Processes
 - Analysis of High Resolution LIDAR for Extracting Land Surface Information
 - Predicting Soil Suitability for Application of Coal bed Methane Produced Water using Hyperspectral Data

Program Components (cont.)

- National Civil Applications Program (NCAP)
 - Civil access to National Technical Means data
 - Hazard / Emergency Response
 - Homeland Security Support
 - Technology Investigations
- Commercial Imagery
 - Commercial Remote Sensing Archive and Requirements
 - Aerial and Satellite Calibration and Characterization
- Future Missions
 - Landsat Data Continuity Mission (Landsat-8)
 - Landsat Science Team
 - Requirements for new land observation missions

Data Gap Study Team Management

- NASA and USGS lead Landsat Data Gap Study Team
 - Developing a strategy for providing data to National Satellite Land Remote Sensing Data Archive for 1-4 years
 - Technical Committee considering issues that must be resolved to support strategy (data characteristics & quality, data availability and coverage, data processing and archiving requirements, etc.)
 - Committee staffed by USGS/EROS, NASA/GSFC, NASA/Stennis
 - Programmatic Committee considering project issues and compiling final strategy document (“GEOSS” data exchange vs. commercial purchase, licensing, project funding, MOUs, data policy, etc.)
 - Committee staffed by USGS and NASA Hq’s.
- Goal is to have approved strategy in place by October 2006

