MODIS Summary

EDC LP DAAC

Science Advisory Panel Meeting

February 3, 2002

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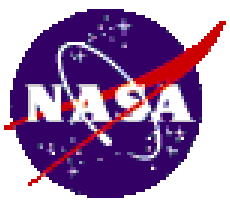
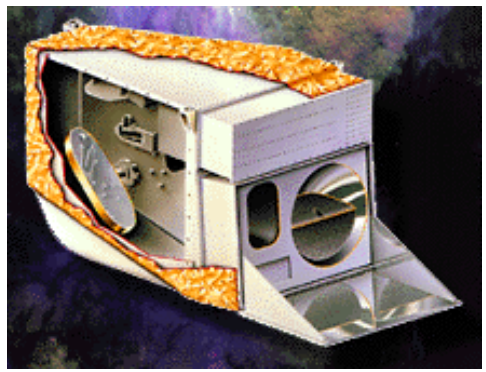


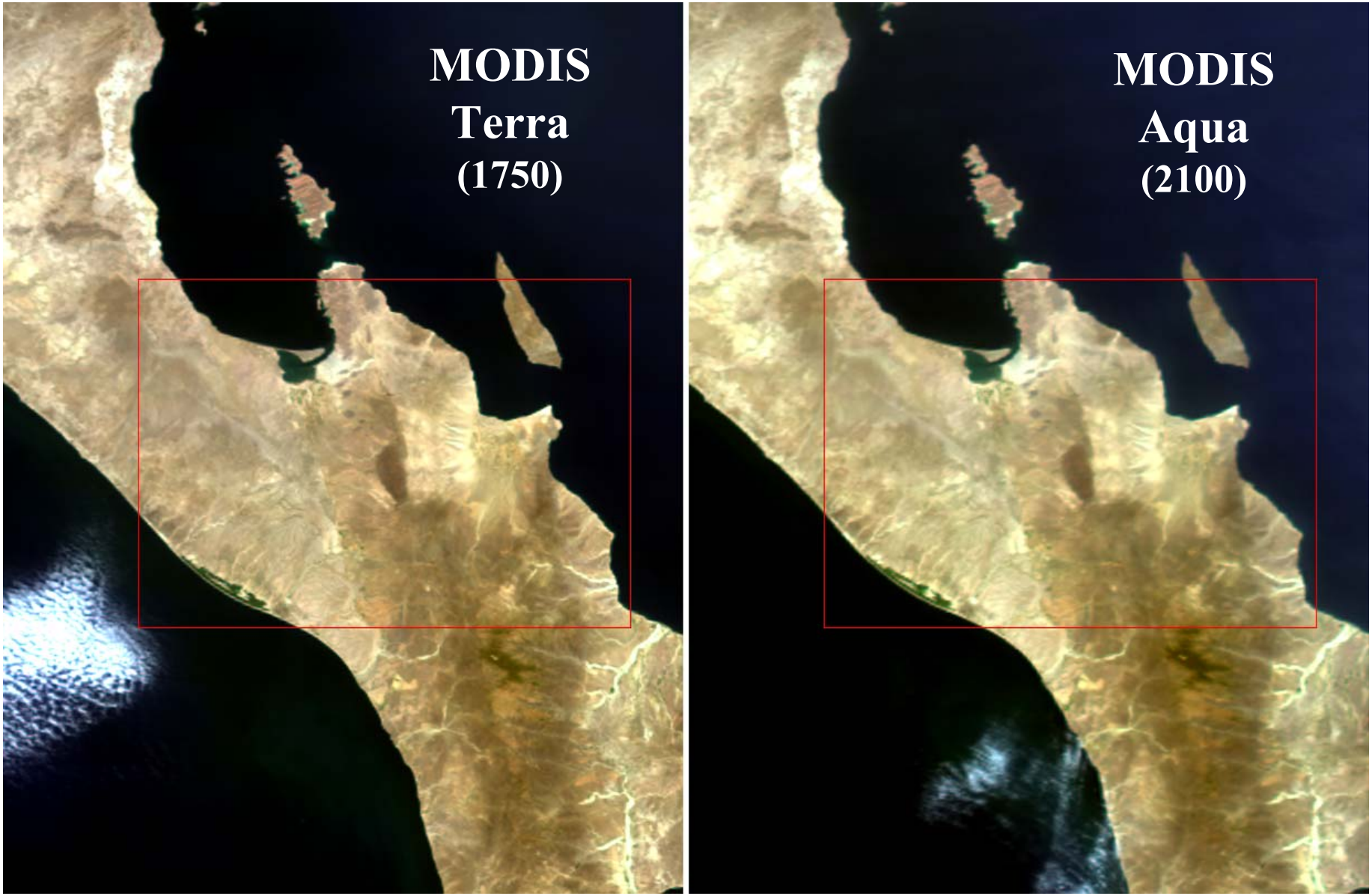
Moderate Resolution Imaging Spectroradiometer (MODIS)

- First launched December 1999 on NASA EOS Terra Polar Orbiting Satellite
- Whisk-broom scanner, 110° Field of View
- Orbit: Attitude 705 km, Inclination 98.2°, mean-period 98.9 min., 16-day repeat cycle, 10:30 am equatorial crossing time
- Senses entire equator every two days, daily full coverage above 30° latitude
- 36 spectral bands: 29 - 1 km, 5 - 500 m and 2 - 250 m nadir spatial resolution
- Second MODIS on Aqua Satellite
  - 1:30 PM equatorial crossing time



Terra Launch: Dec. 18, 1999
First Image: Feb. 24, 2000

Aqua Launch: May 04, 2002
First Image: June 26, 2002



July 25, 2002 – Lower Baja Peninsula

MODIS Land Bands

Band number	*Spatial resolution*	*Wavelength, nm*	*Waveband region*
1	*250 m*	*620-670*	*Red*
2	*250 m*	*841-876*	*Near-infrared*
3	*500 m*	*459-479*	*Blue*
4	*500 m*	*545-565*	*Green*
5	*500 m*	*1230-1250*	*Near-infrared*
6	*500 m*	*1628-1652*	*Shortwave infrared*
7	*500 m*	*2105-2135*	*Shortwave infrared*

MODIS
True color

East Coast Zoom
March 3 2000

Terra MODIS Calibration Summary

- Terra MODIS has been stable for over 26 months
- The multiple OBCs have proven to be valuable for on-orbit characterization
- Changes in system level response are well understood and have been incorporated into the L1B software
- One subsystem (power supply) has failed and a second (formatter) is marginal (was replaced last summer)
- There are no indications of additional problems
- Upcoming deep-space maneuver needed to better characterize angle-of-incidence (AOI) response
- Current Geolocation is very accurate (~50 m)

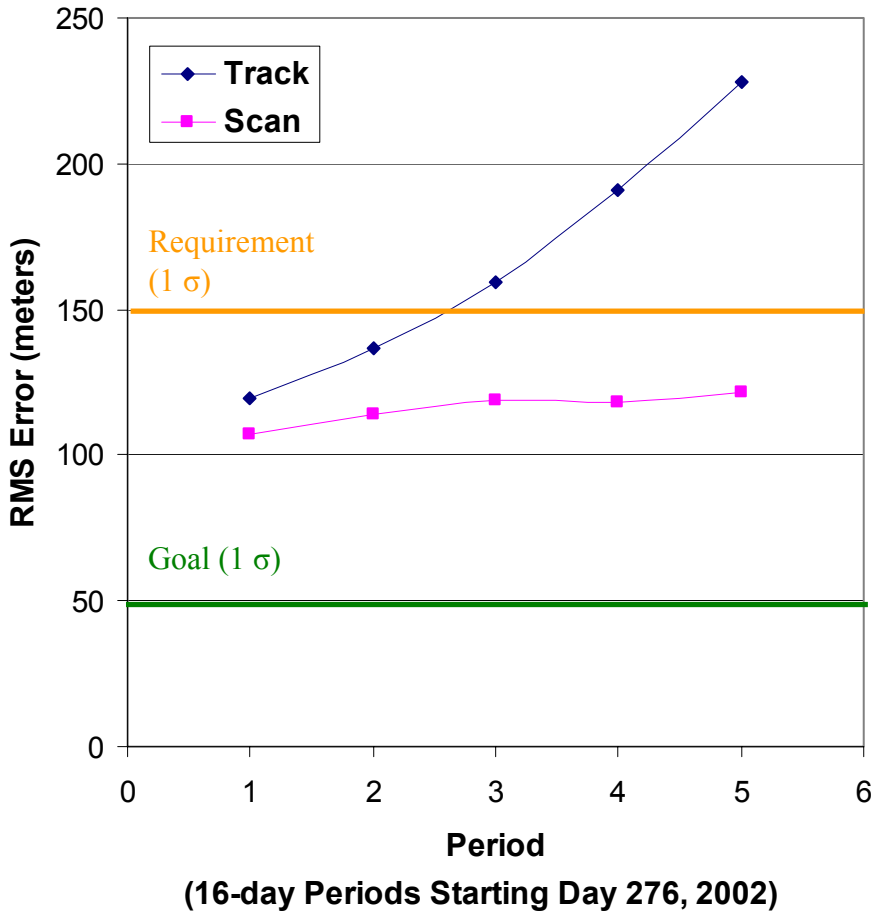
Aqua MODIS vs. Terra MODIS

- Aqua improvements
  - Thermal Emissive Bands (TEB) RSR measured in TV
  - TEB system level Response Verses Scan angle (RVS) measurement
  - **PC optical leak Aqua << Terra**
  - **SWIR thermal (5.3 micron) leak Aqua < Terra**
  - **SMIR electronic xtalk and sub-frame difference Aqua < Terra**
  - B31/B32 gain change for Sea Surface Temp. (new T_sat is about 340K)
- Aqua concerns
  - T_sat for B33, B35, and B36 (below 310K)
  - B5/B6 detector operability (B5 – 1 of 20 dead; B6 – 11 of 20 dead)

Aqua MODIS Calibration Summary

- Aqua MODIS' ground tests indicate performance better than Terra
- On-orbit data indicates only minor changes from the pre-launch test results
- Aqua MODIS geolocation holding up release of Land products
  - Want for products to be at provisional level before release (no beta products)

Aqua MODIS Geolocation Anomaly



- Unexpected within-orbit variation
  - primarily in yaw, impacts roll as well
- Large trend seen in pitch axis
- Team formed to investigate anomaly
  - recently discovered coordinate system problem – precession not being handled correctly
- Determining best solution to fix problem
  - involves attitude control flight software modification and/or ground software/operations changes

MODIS Land Products* / ESE Research Themes

- Energy Balance Product Suite
  - Surface Reflectance
  - Land Surface Temperature
  - BRDF/Albedo
  - Snow Cover
- Vegetation Parameters Suite
  - Vegetation Indices
  - LAI/FPAR
  - NPP/PSN
- Land Cover/Land Use Suite
  - Land Cover/Vegetation Dynamics
  - Vegetation Continuous Fields
  - Vegetation Cover Change
  - Fire and Burned Area

Global Water Cycle and Energy Balance

Biology and Biogeochemistry of Ecosystems and the Global Carbon Cycle

Land Cover and Land Use Change

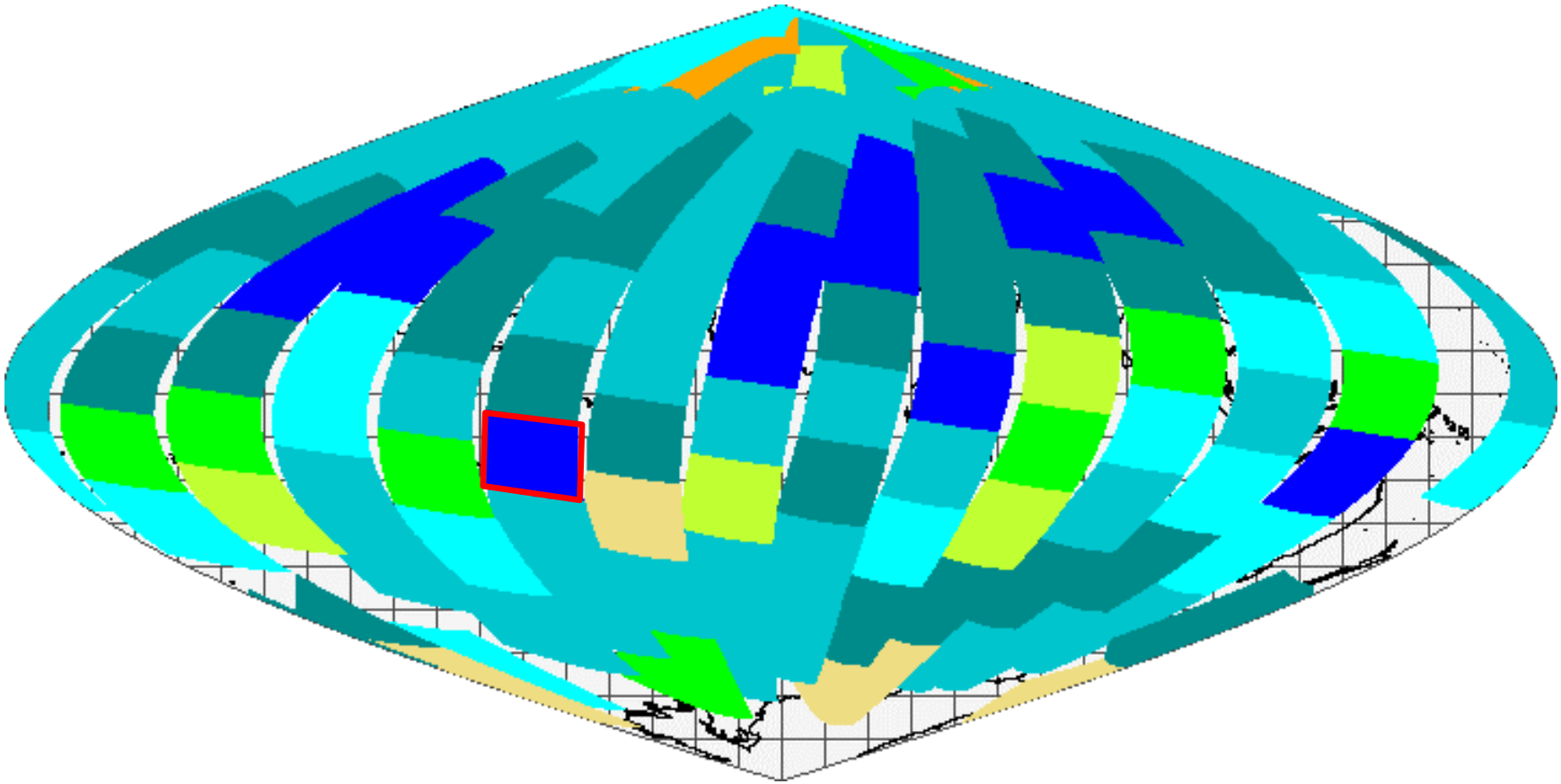
Atmospheric Chemistry and Aerosols

*Dependencies between products

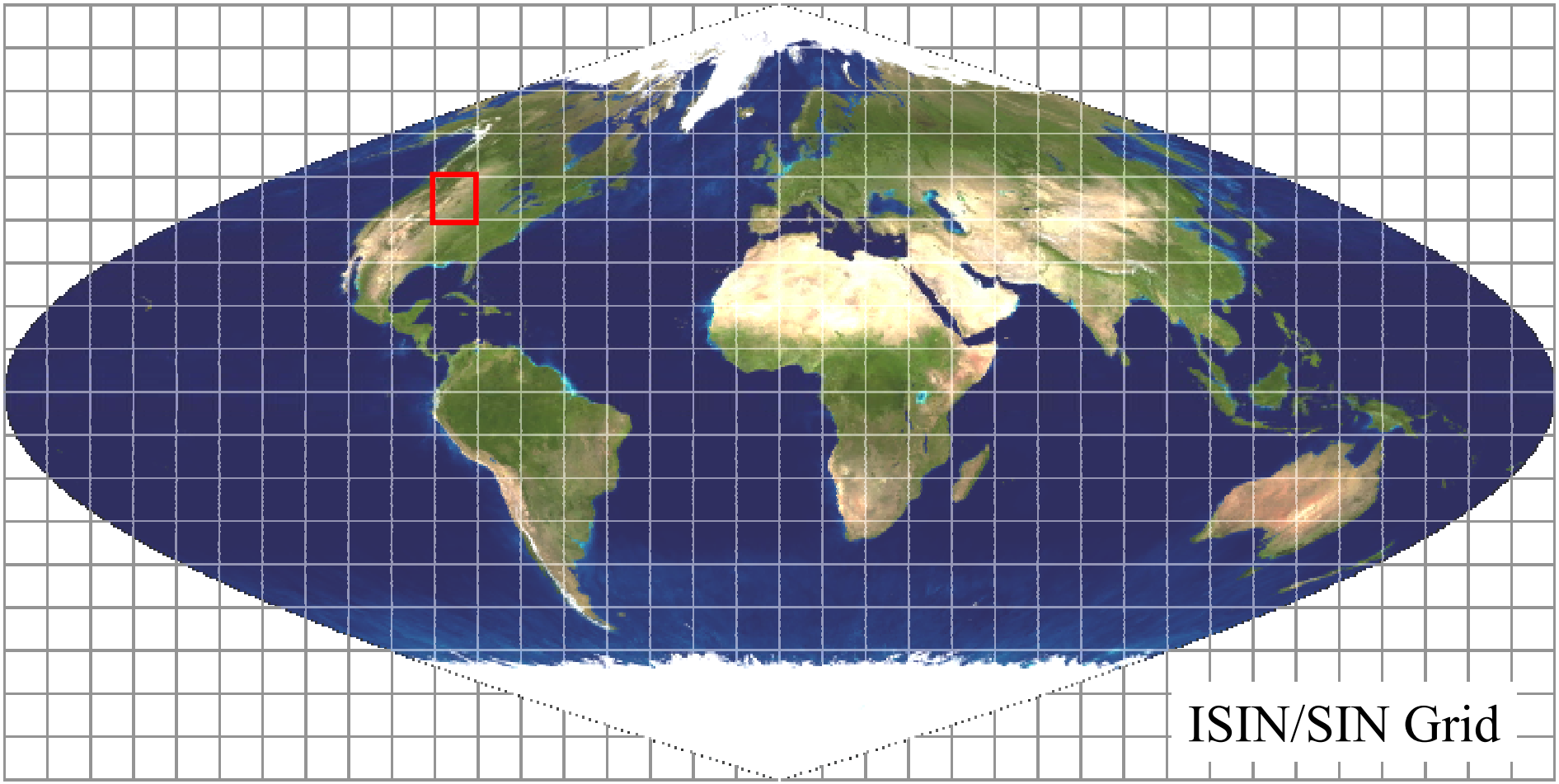
Product Level Hierarchy

- Level 2: retrieved geophysical parameters at the same location as the MODIS Level 1 instrument data
  - 288 granules; 5 min.; approx. 2340 x 2030 km
  - 250m, 500m and 1km nadir resolution
- Level 2G/3: earth-gridded geophysical parameters
  - 10 x 10 deg. tiles; ISIN (equatorial) - 7.5, 15 and 30 arcsec. resolution (roughly 250m, 500m and 1 km);
    LAEA (sea-ice products, polar projection)
  - Global climate modeling grids; 0.05, 0.25 and 0.5 degrees
  - Daily, 8-day, 16-day, monthly and yearly products
- Level 4: earth-gridded model outputs
  - Similar grids/resolutions as L2G/3 products

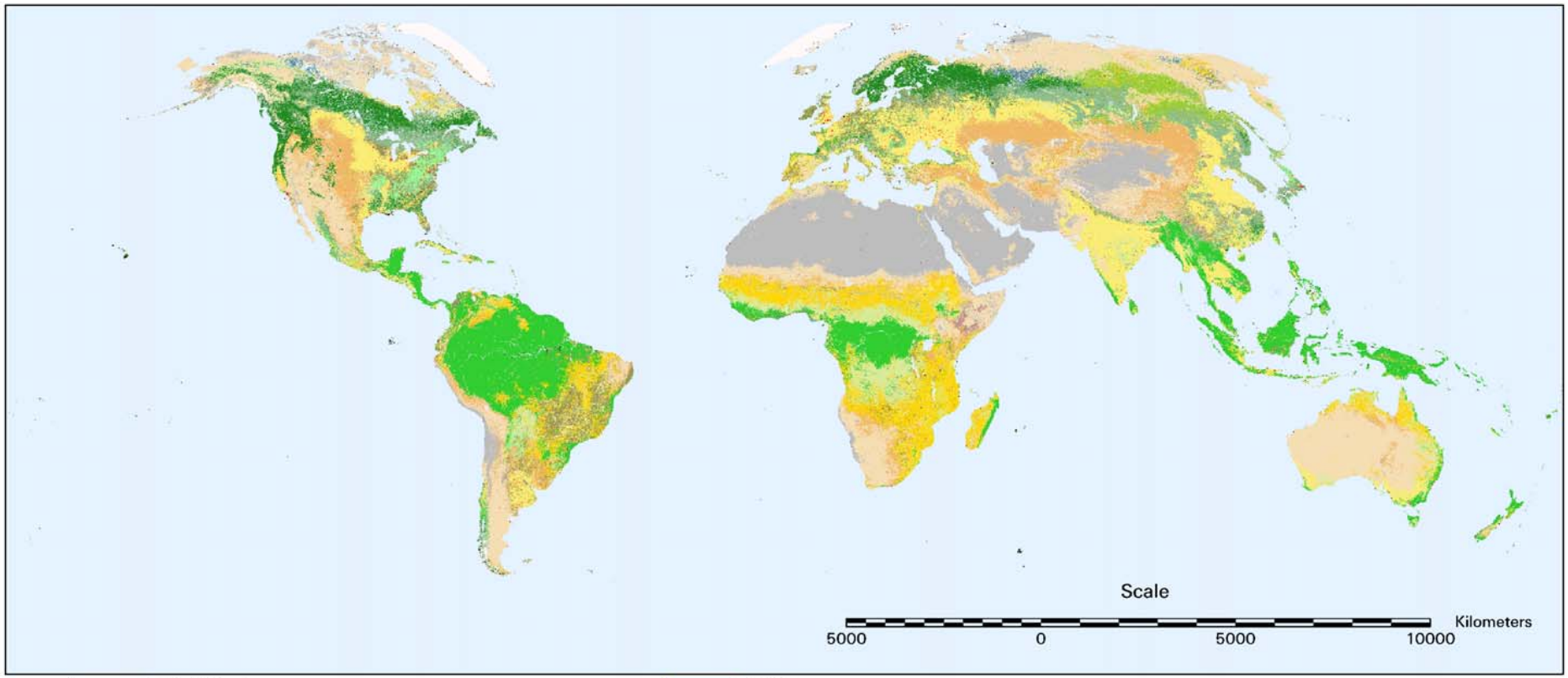
Level 1 and 2 Granules



L2G, L3 and L4 Tiles

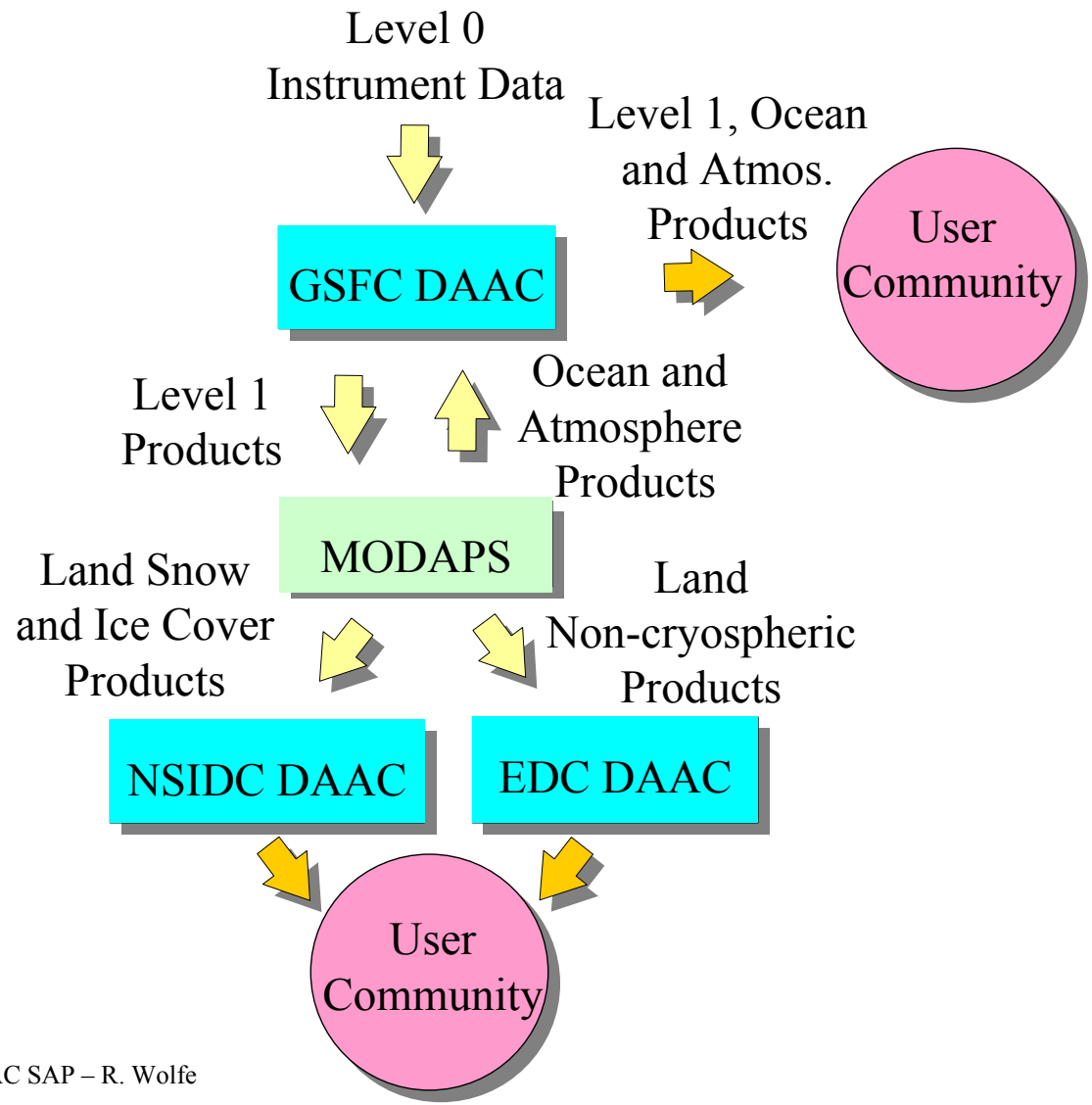


MODIS Terra Land Cover – Nov 2000 - Oct 2001

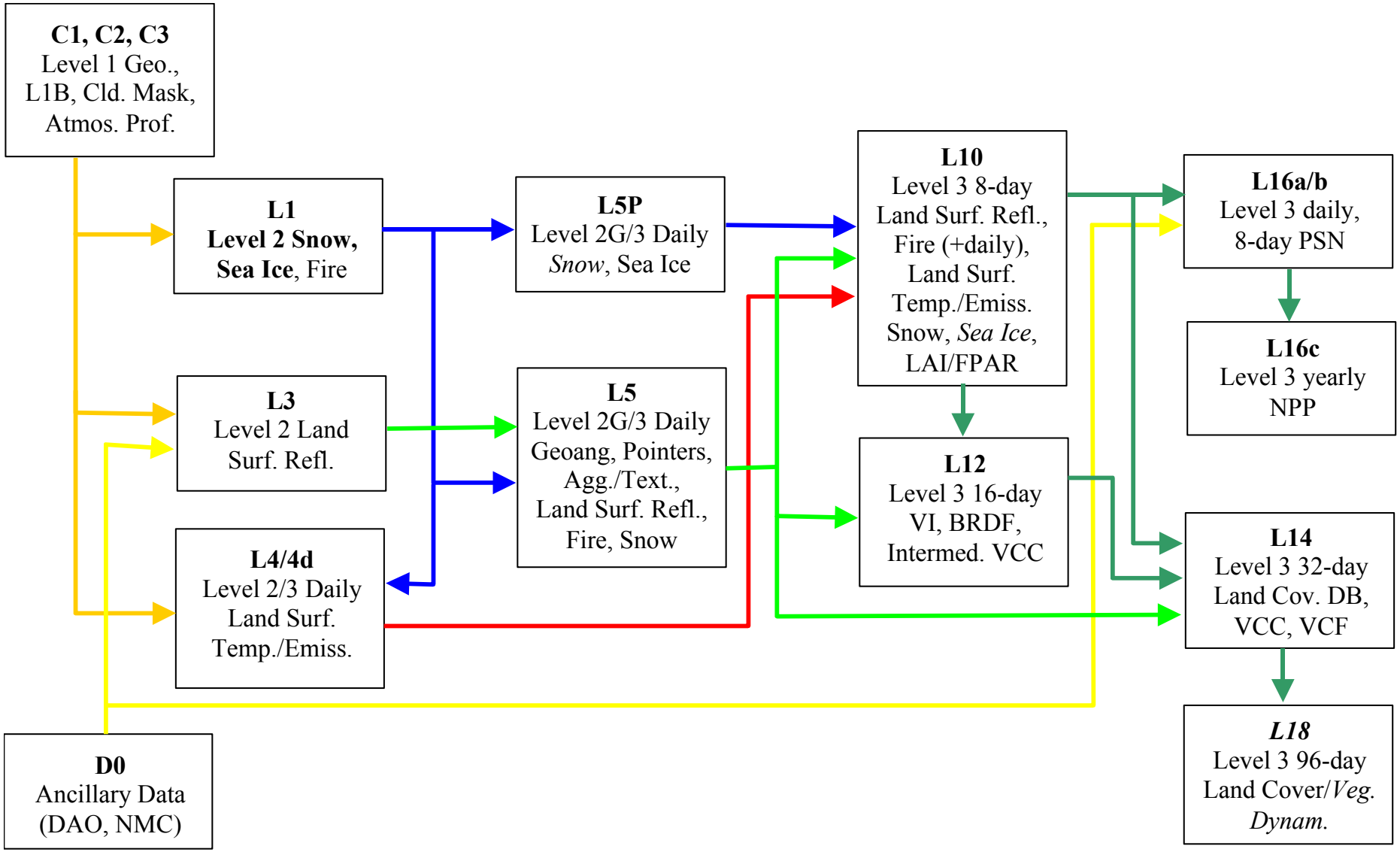


- 0 Water
- 1 Evergreen Needleleaf Forest
- 2 Evergreen Broadleaf Forest
- 3 Deciduous Needleleaf Forest
- 4 Deciduous Broadleaf Forest
- 5 Mixed Forests
- 6 Closed Shrublands
- 7 Open Shrublands
- 8 Woody Savannas
- 9 Savannas
- 10 Grasslands
- 11 Permanent Wetlands
- 12 Croplands
- 13 Urban and Built-Up
- 14 Cropland/Natural Vegetation Mosaic
- 15 Snow and Ice
- 16 Barren or Sparsely Vegetated
- 254 Unclassified

MODIS Production and Distribution



MODIS Land Process Flow



Collection Version 3 (C3)

- Terra Forward Processing started in June 2001
- Terra Reprocessing started in June 2001 and finished Jan. 2002
  - reprocessed Nov. 2000 to May 2002 (1.6 years)
  - achieved 2.3x reprocessing rate (earlier rate was 2x, later was 3x)
- 250m products production expanded after end of reprocessing
  - from 17% of land area to 37% in March 2002 and then to 100% in July 2002
  - reduced volume L2G Pointer and Geoangle products added in March 2002
- Aqua forward processing started late June 2002

Collection Version 3 (cont'd)

- Included incremental algorithm improvements
  - primarily after "Golden" year (starting Nov. 2000) completed
- Established formal algorithm change approval process
- Fixed leaky pipes and established a reconciliation process
- Established machine-to-machine interface at GES DAAC
- Produced Validation subsets over 24 sites for distribution from the LP DAAC

Collection Version 4 (C4)

- Performed four formal Science Tests of algorithm changes
  - based on global data sets for two 16-day periods – one in July 2001 and the other Jan. 2002
- Started Terra reprocessing Dec. 20, 2002
  - reprocessing from first-light (Feb. 25, 2000)
  - achieving 3.8x reprocessing rate (requirement is 2x, goal is 3.5x)
  - LP DAAC ingesting and archiving 1.8TB/day – includes both Terra C4 forward processing and reprocessing, and Aqua C3 forward processing
  - 250m products – Terra is 100% of land area; Aqua is 17%
  - At 3.5x expect to finish in Oct. 2003
  - Oceans expected to join in May – could stretch out completion by 1 to 2 months
- Started Terra forward processing Jan. 1, 2003

Collection Version 4 (cont'd)

- New products added
  - Climate Modeling Grids – currently: Land Surface Temperature/Emissivity, BRDF/Albedo; others are in progress
- Aqua Version 4 Algorithms will start in Feb. 2003 (now)
- Browse image roll-out expected soon
- Vegetation Cover Conversion – released
- Vegetation Continuous Fields – being shipped to the DAAC – too be released soon
- Net Primary Production, Burn Scar, Vegetation Dynamics (phenology, interannual change vectors) and Evapotranspiration – under development or evaluation

MODIS Land C4 Improvements

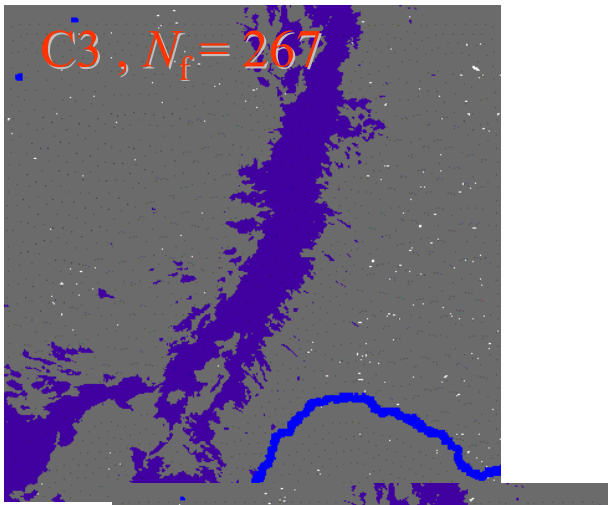
- Incremental science improvements accumulated in C3 processing.
- Change the map projection from ISIN to SIN supported by major image processing packages.
- Produce the 250m products globally for the whole data record.
- Benefit from improvements in the Level 1B product: time dependent calibration.

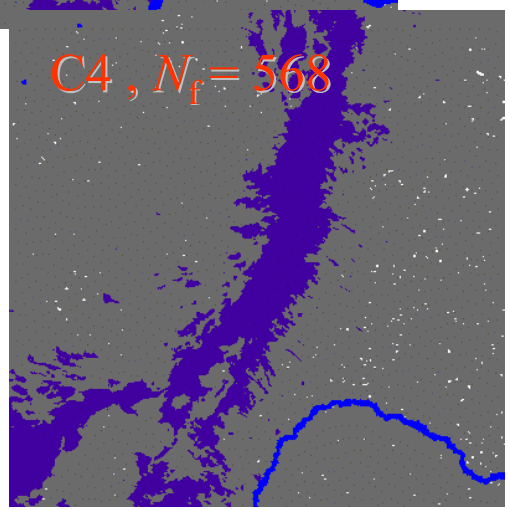
MODLAND Grid Change

- Science team recently made decision to switch to Sinusoidal Grid (drop the “I”)
- Timing: started with C4 processing
- Small differences in mapped coordinates mean comparisons between C3 (ISIN) and C4 (SIN) 1km products can be made without much loss of fidelity
  - maximum difference at 1km is 0.2 pixels in the column (sample) direction
- Relatively larger differences make inter-comparison of 250m and 500m ISIN and SIN products difficult
  - shift is up to 0.4 of a 500m pixel and 0.8 of a 250m pixel

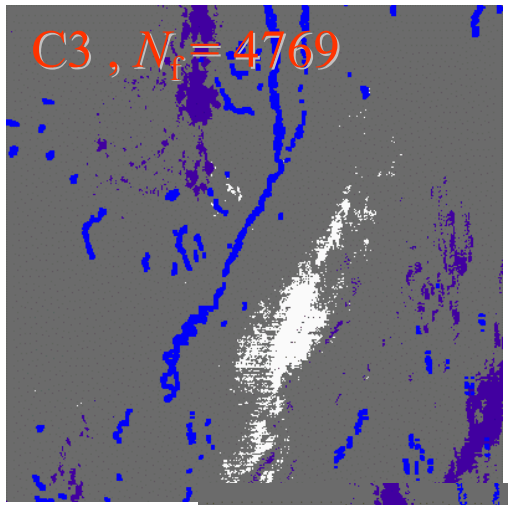
Specific Improvements (1/4)

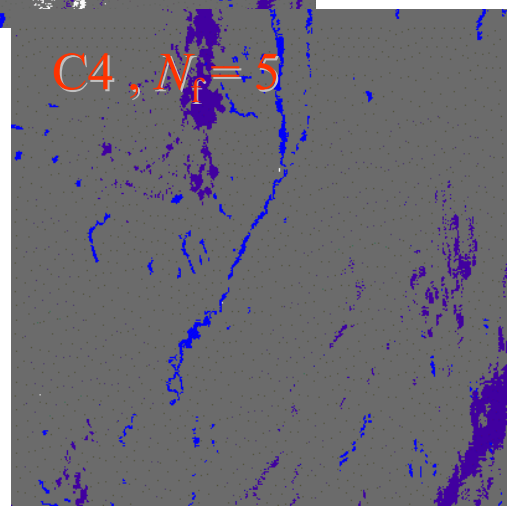
Zaire





Pakistan





Fire Product:

- More robust fire algorithm that detects more small fires and produces fewer false alarms
- Lower sensitivity to inaccuracies in the in-land water mask.

Specific Improvements (2/4)

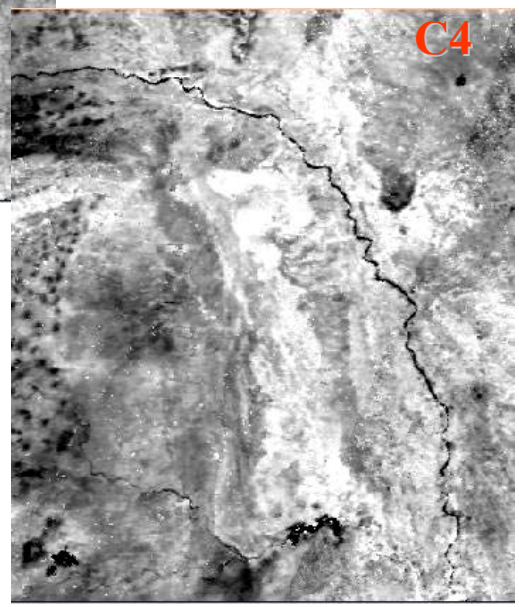
- **Surface reflectance**:
  - Improves cloud detection and implement a geometric cloud shadow mask algorithm
  - Improves aerosol retrieval and interpolation
- **Land surface temperature**:
  - Uses BRDF product
  - Incorporates a split window method in the day/night emissivity retrieval algorithm
  - Lowers the clear sky confidence threshold over lakes to 66% to perform LST retrievals over a larger areas
- **BRDF/Albedo:**
  - Improves the a priori database used in the backup algorithm based on MODIS derived model data
  - Uses new shortwave and NIR narrow-to-broadband conversion factors for pure snow

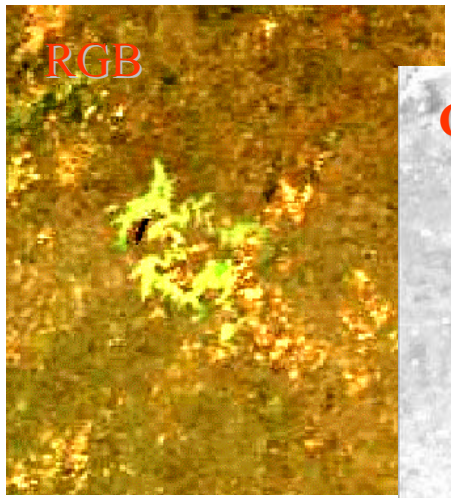
Specific Improvements (3/4)

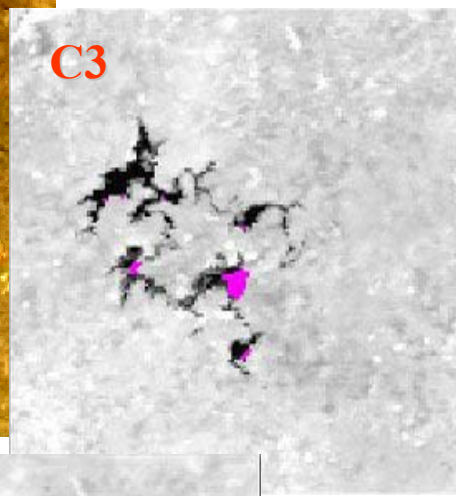
- **LAI/FPAR:**
  - Improves the LUT's in the main and backup algorithms which increased the number of high quality retrievals by 10%, removed the non-physical peak in the global LAI and improved the agreement with ground measurements
  - Uses the MODIS Land Cover product which reduced the uncertainties due to the at-launch land cover
- **VI/EVI:**
  - Weighted average scheme used for daily orbital observations
  - Improves data filtering prior to compositing and use of the aerosol quality flag – results in better spatial consistency

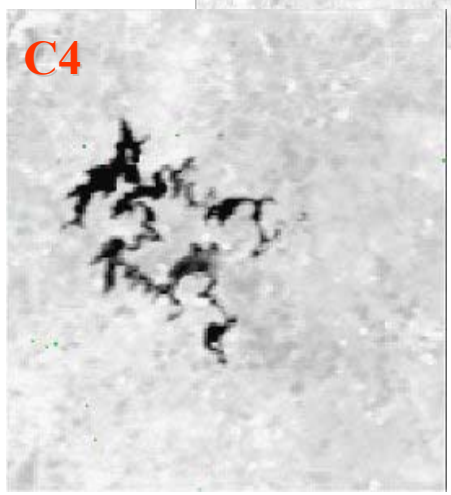
Specific Improvements (4/4)

VI/EVI









MODIS Issues/Concerns (1/2)

- Archiving volumes
  - What happens in out-years after EOS SWGD augmentation ends?
  - What happens if mission life time is extended by 2+ years?
- Long term archive
  - What is the current status and what are the implementation plans?
- MODIS data ordering
  - We still need a list of MODIS land product users.
  - What happened to our idea of a voluntary user list: asking people to add their name when they order data?
- Primary Products
  - LP DAAC SAP should help identify the MODIS primary products (in terms of use).

MODIS Issues/Concerns (2/2)

- Data deletion
  - What approach would help the DAAC?
  - Is what we are currently doing okay?
- Public Information
  - LP DAAC SAP review is needed of how the DAAC describes MODIS and its products and the general level of information available to the public.
- Browse
  - How do we move forward on getting browse into the EDG and the data pools?
  - Will the DAAC support a MODLAND developed browse client via the echo?
- Services
  - When will services such as subsetting (by parameter and region), mosaicing and resampling be available from the DAAC, via the EDG and/or the data pools?

MODLAND Group

MODIS Science Team Meeting, Jan 26, 2001

Thank you!