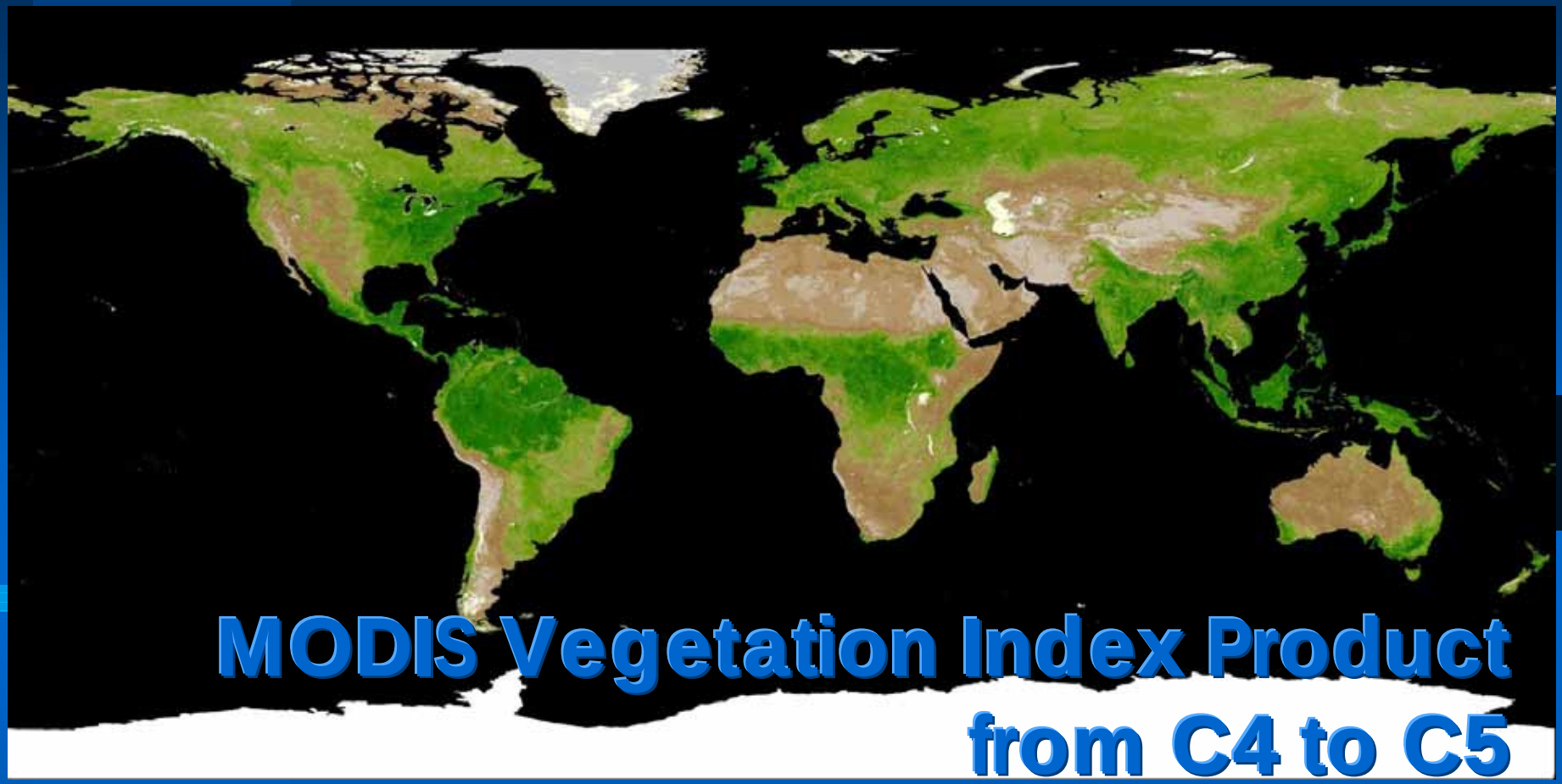
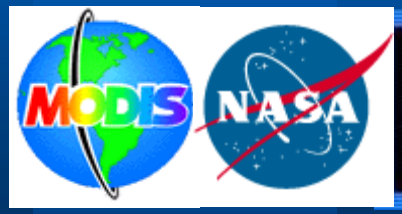


MODIS Vegetation Index Product from C4 to C5

Kamel Didan & Alfredo Huete, TBRS Lab.
The University of Arizona

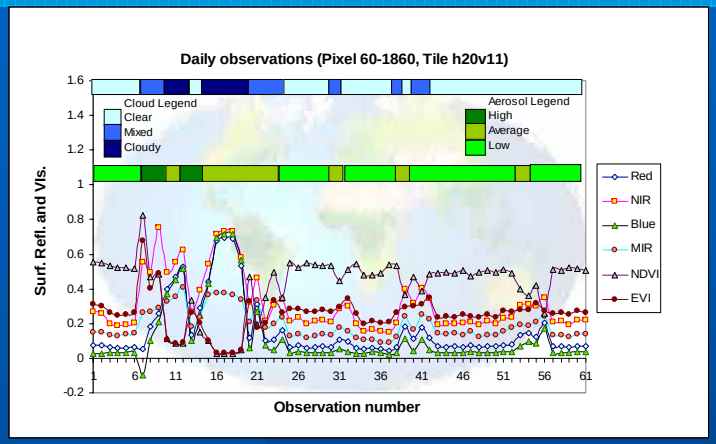


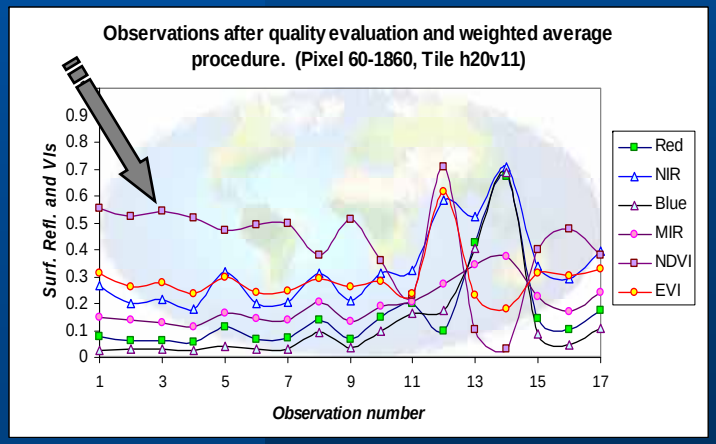
MODIS Land Collection 5/LTDR Workshop
University of Maryland University College, January 17-18, 2007

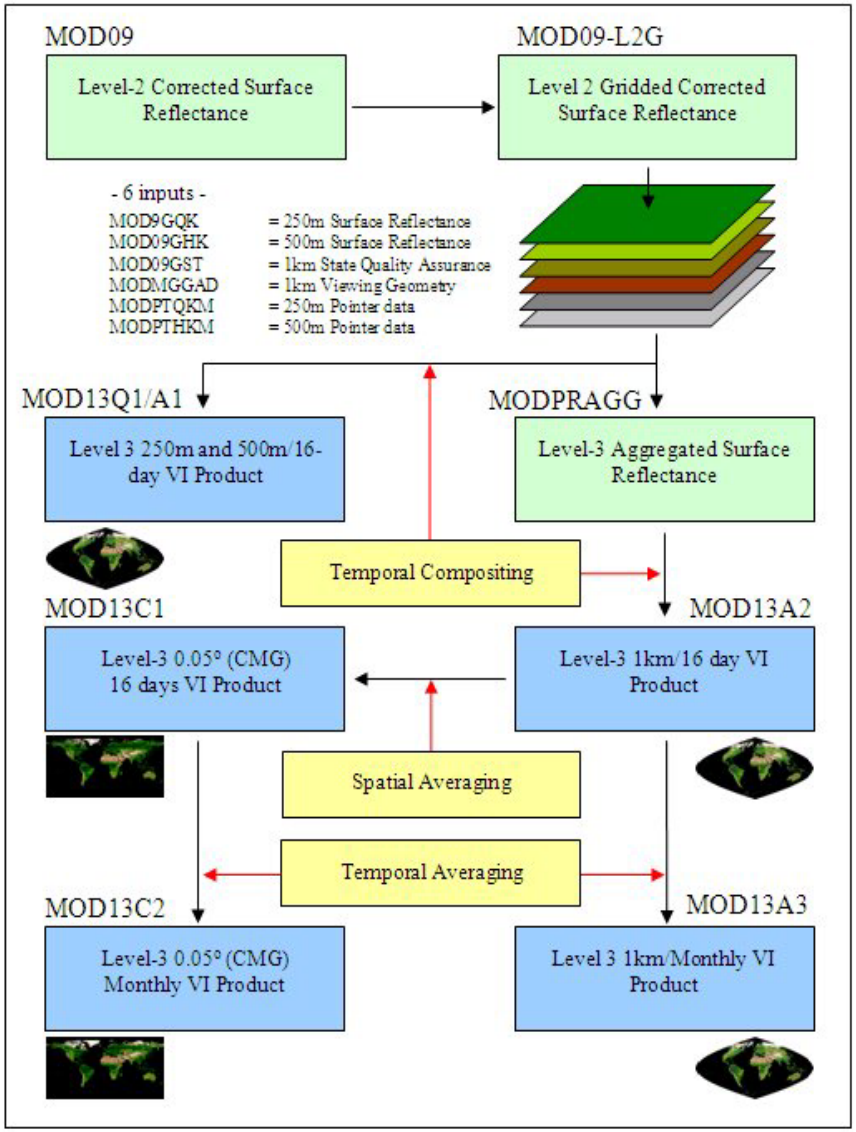
Outline

- VI product & Algorithm
- C5 changes
- C4 vs. C5
- Validation statement
- Future plans (C6?)

Algorithm and Product Dependencies

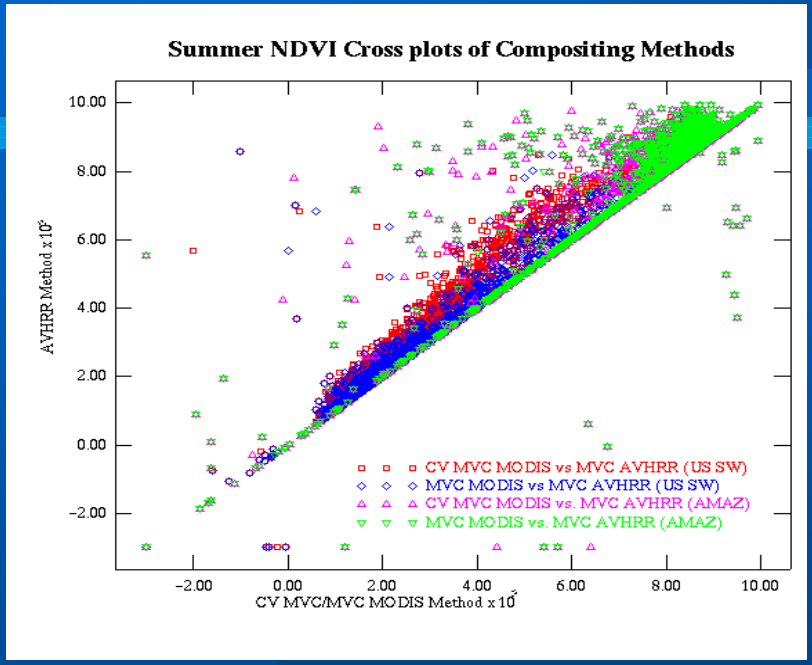


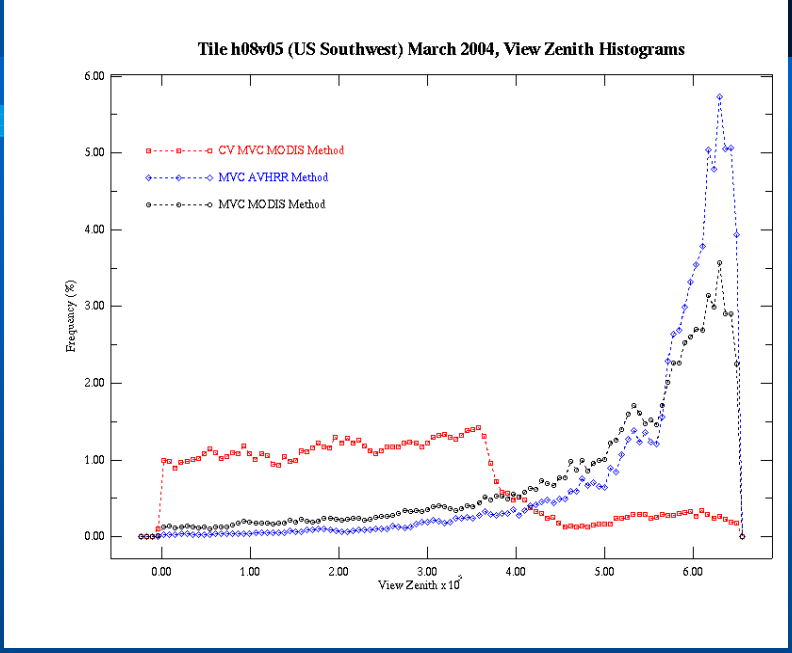


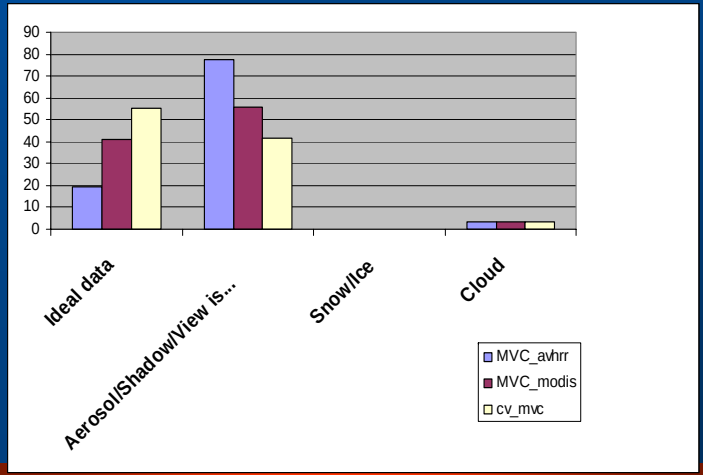


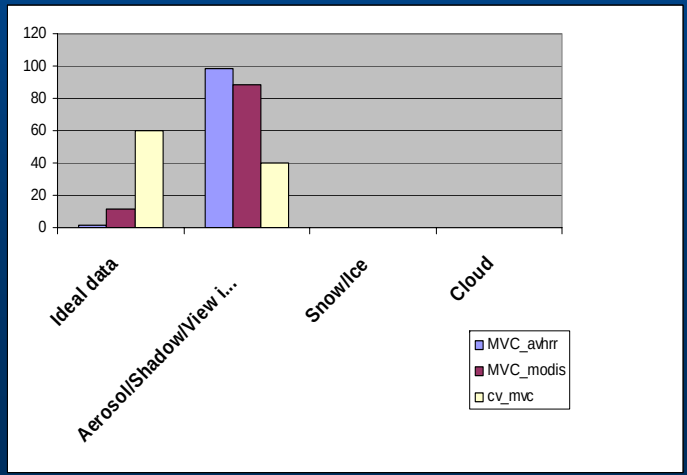
CV-MVC compositing

AVHRR-MVC vs. MODIS-MVC vs. MODIS CV-MVC









SUMMARY of C5 changes

1. Added per pixel reliability (Second most important change)
2. Added the composite day of the year to the output
3. Replaced the NDVI_QA and EVI_QA with one VI_QA layer
4. Restructured the VI_QA data layer to eliminate redundant information

SUMMARY of C5 changes

1. Improved input data filtering (& added adjacent cloud filter)

2. Modified the compositing approach:
   1. To identify mislabeled cloud
   2. Modified CV-MVC to favor smaller view angle

3. Adopted a phased production for Terra and Aqua to keep the streams separate while increasing the temporal frequency (Most important change)

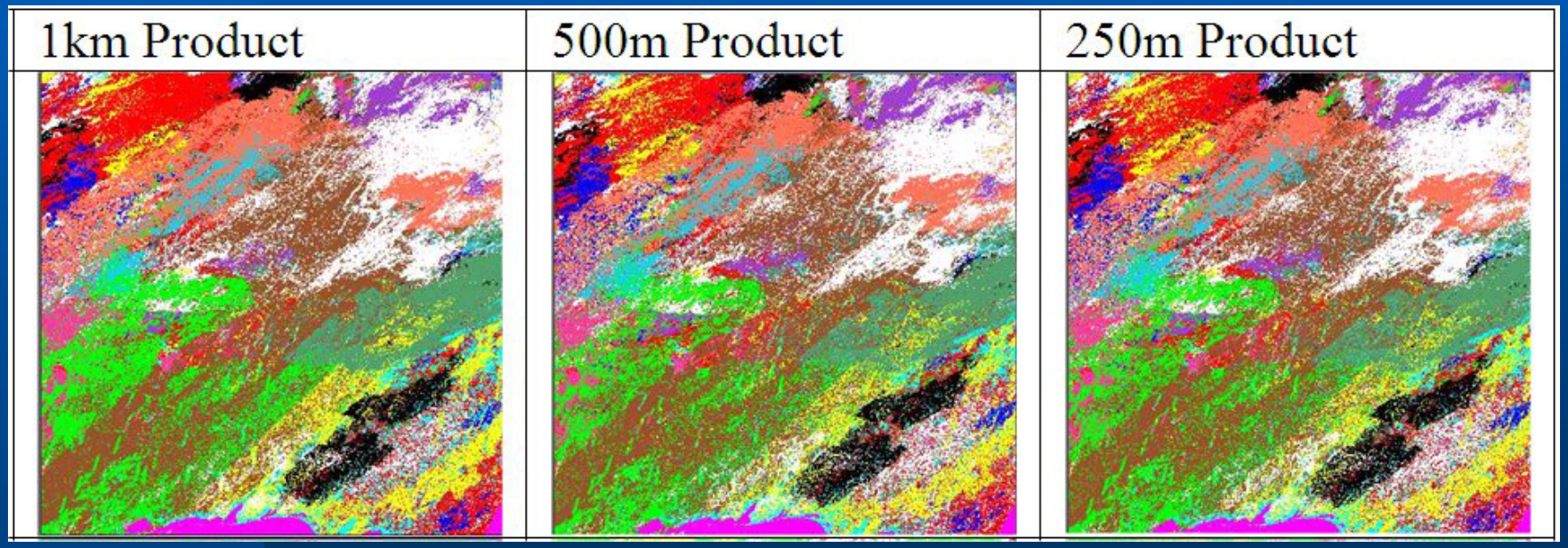
One VI QA layer (restructured)

- **NDVI QA and EVI QA are identical**
- **Eliminated this redundancy**

Bit	Old QA map (C4 and earlier)	New QA map (C5 and later)
0	MODLAND QA	MODLAND QA
1		
2	VI usefulness	VI usefulness
3		
4		
5		
6	Aerosol	Aerosol
7		
8	Adjacent cloud	Adjacent cloud
9	Atm. BRDF correction	Atm. BRDF correction
10	Mixed cloud	Mixed cloud
11	Land/water flag 00: Ocean 01: Coast 10: Wetland 11: Land	Land/water flag 000: Shallow ocean 001: Land (Nothing else but land) 010: Ocean coastlines and lake shorelines 011: Shallow inland water 100: Ephemeral water 101: Deep inland water 110: Moderate or continental ocean 111: Deep ocean
12		
13	Snow/Ice	Snow/Ice
14	Shadow	Shadow
15	Composite method	

Composite day of the year

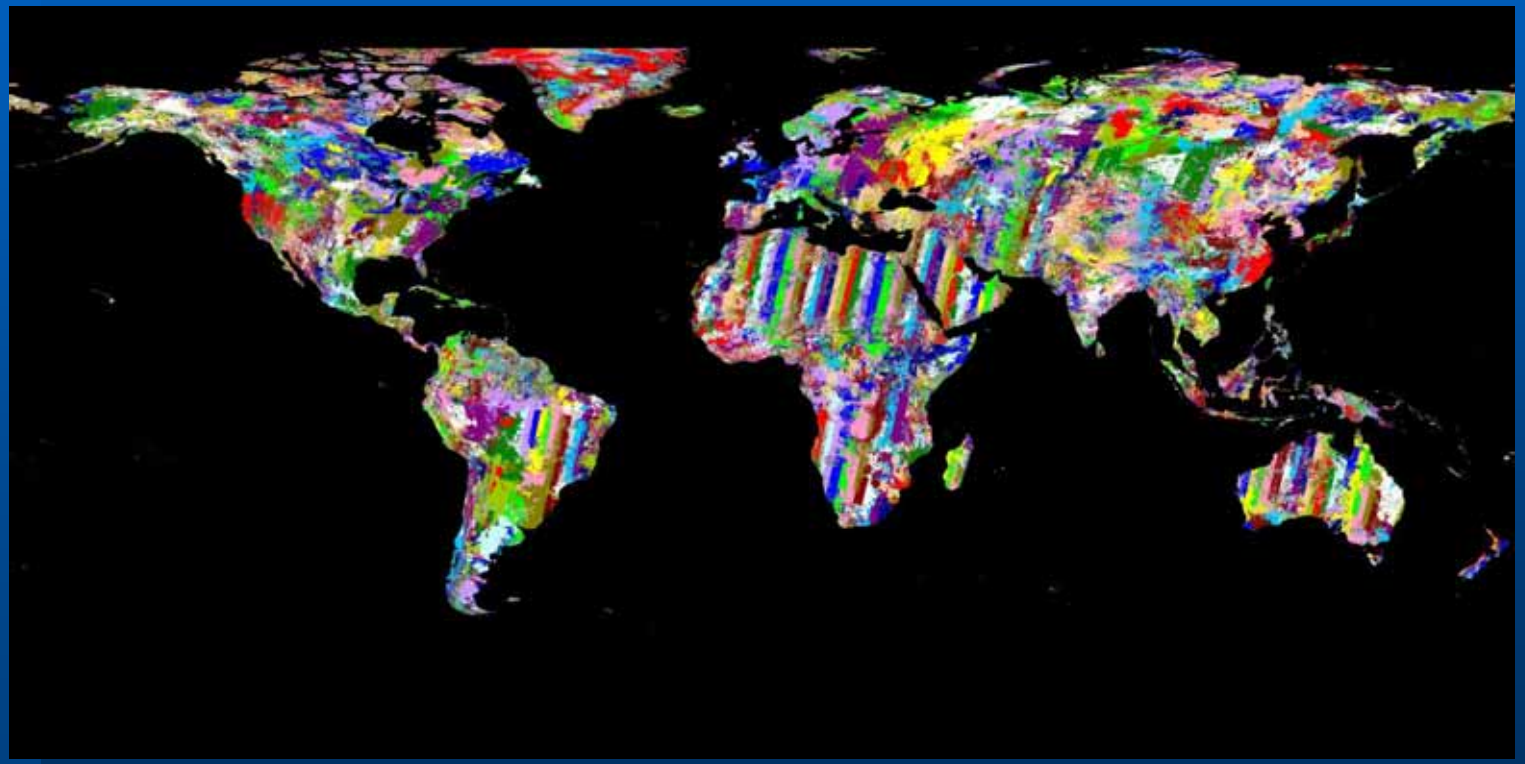
- **Useful for temporal comparisons and validation work**



Southeast US (h10v05)

Composite day of the year

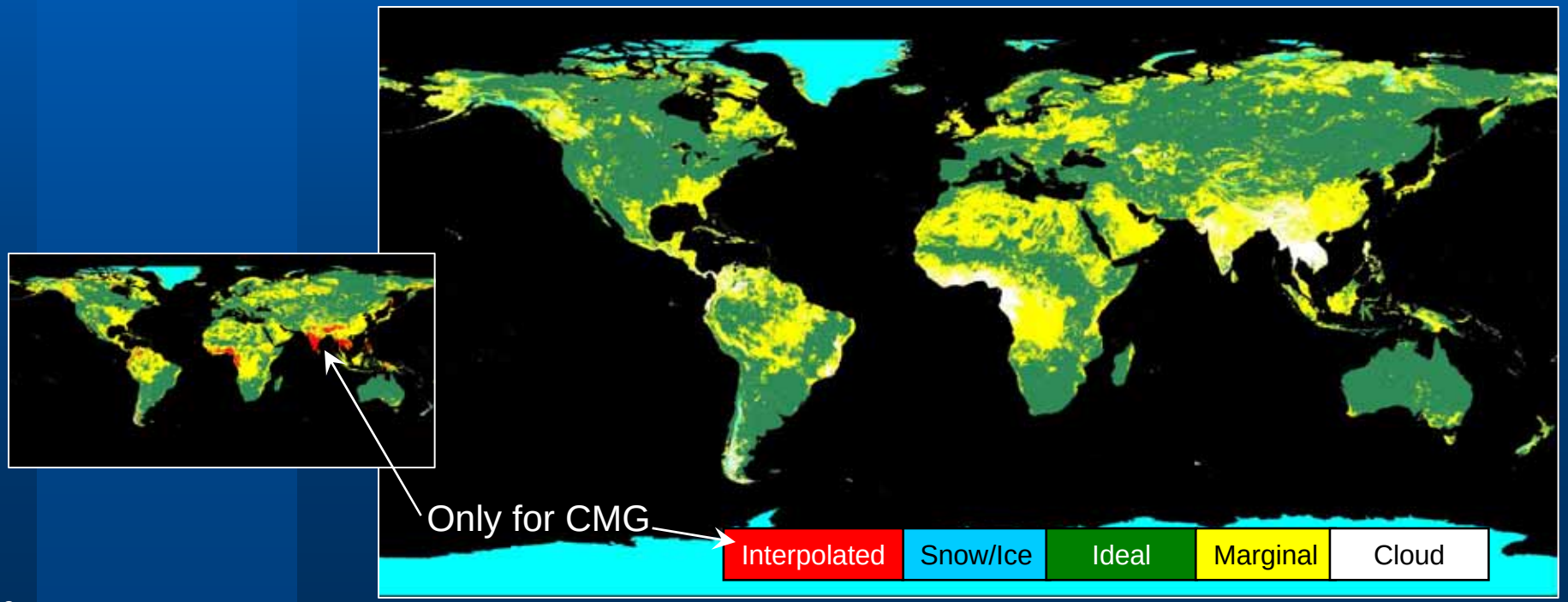
Days used
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16



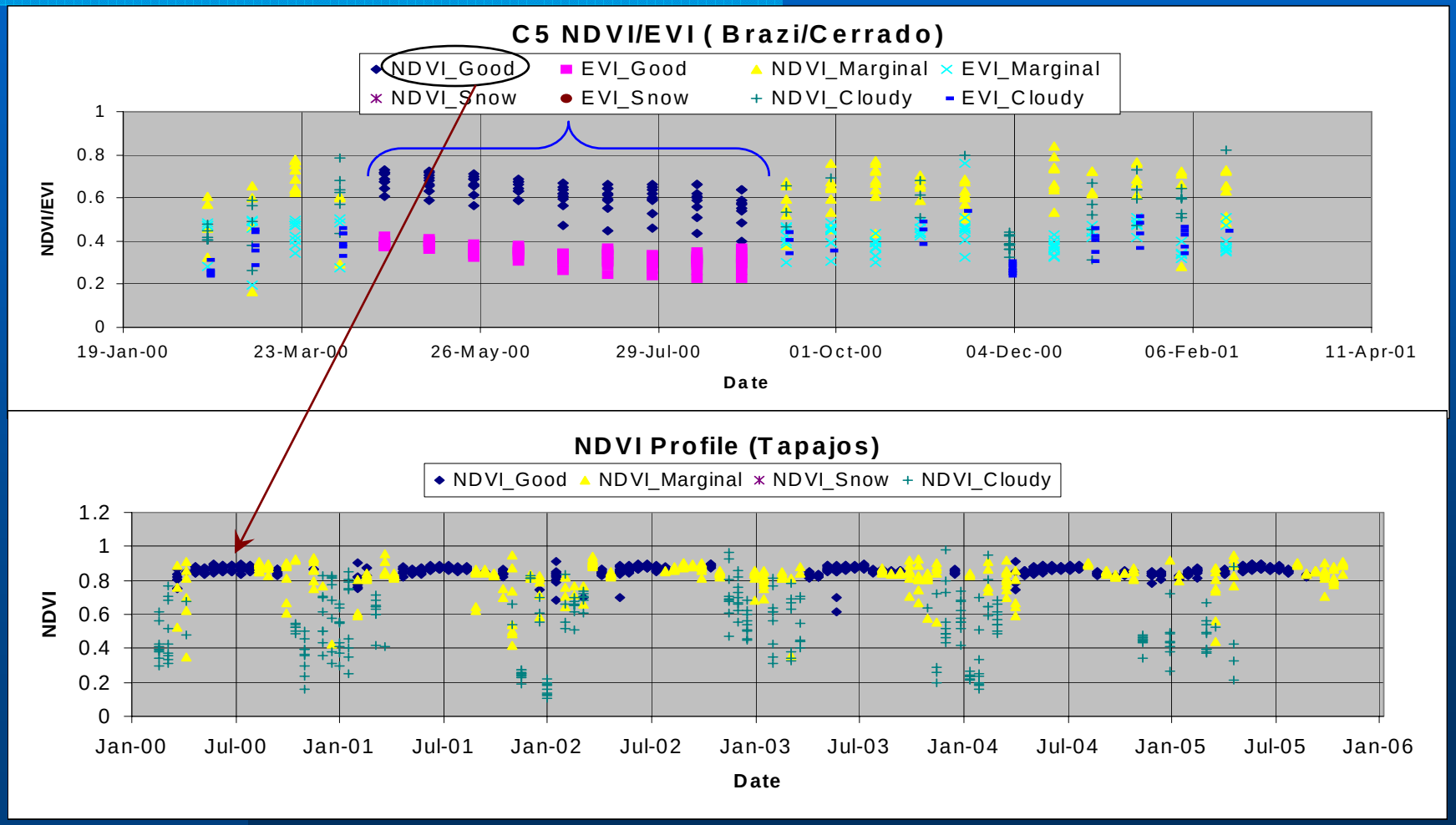
Composite period 2000-161

Per pixel data reliability

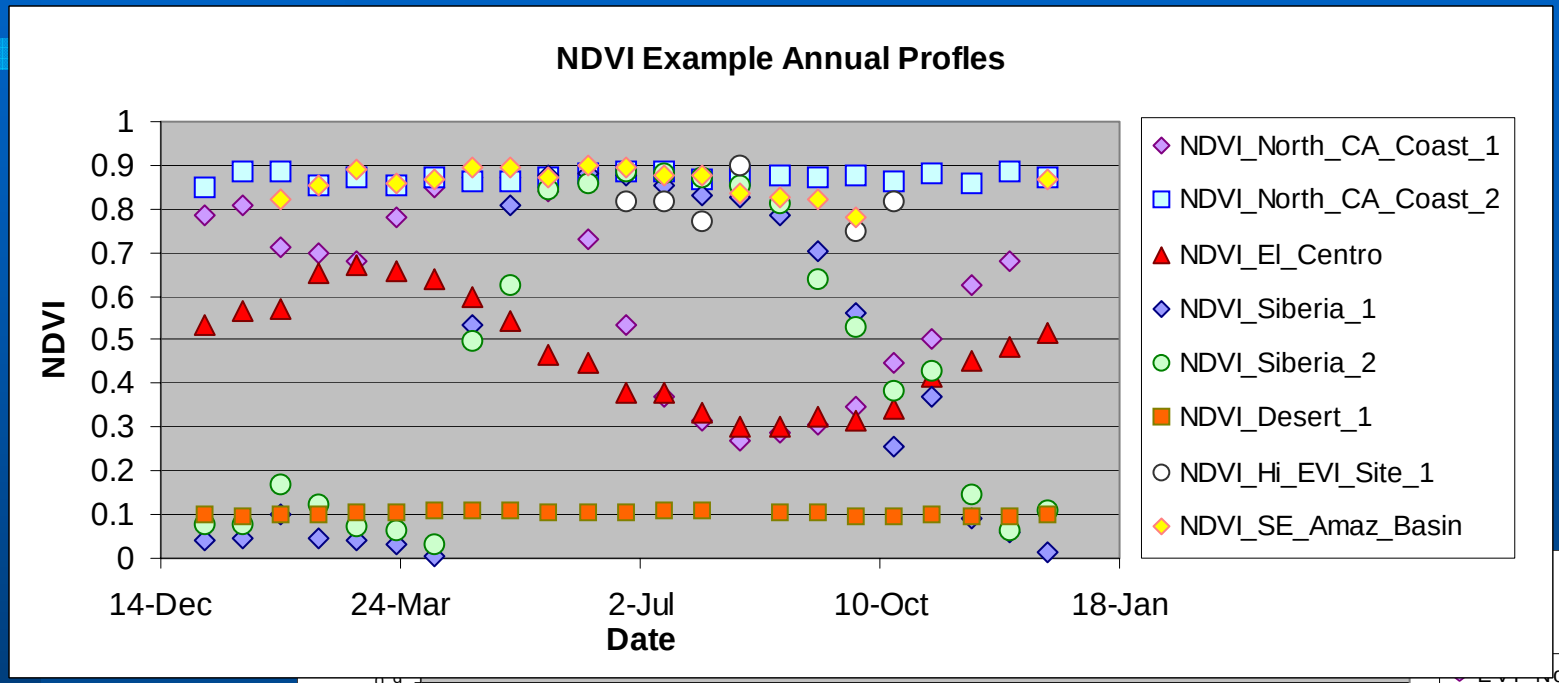
- Eliminate the need for QA fields/binary manipulation.
- Ordinal number & few (4) categories
- Powerful tool for time series/Phenology analysis
  - Helps in extracting 'true' growing season profile

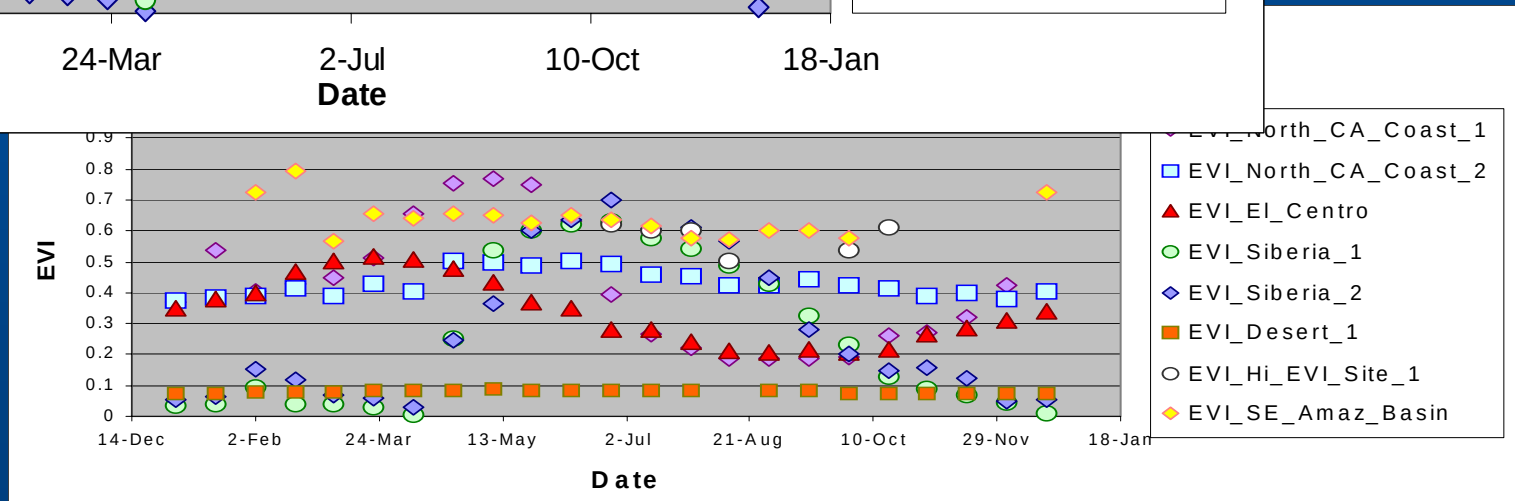


Data reliability applications

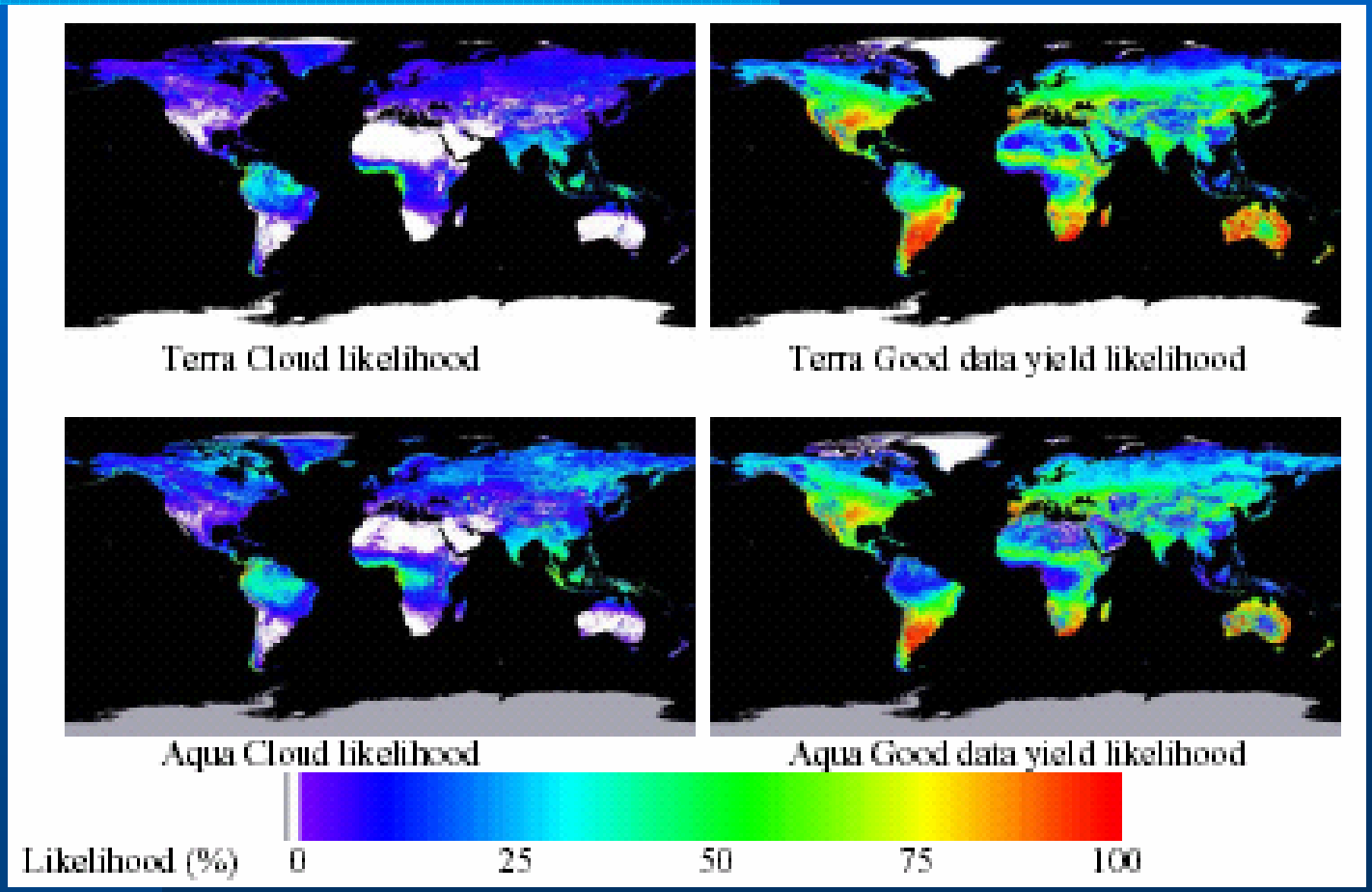


Data reliability application





Global performance

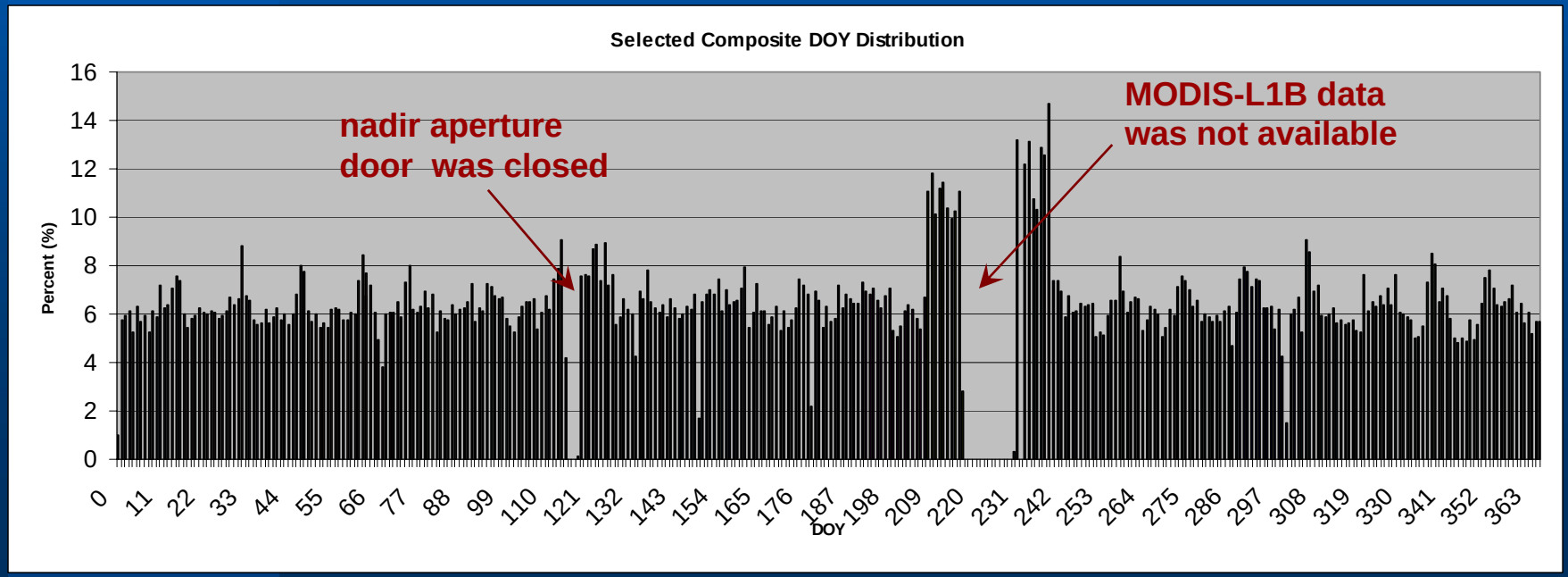


Phased Production

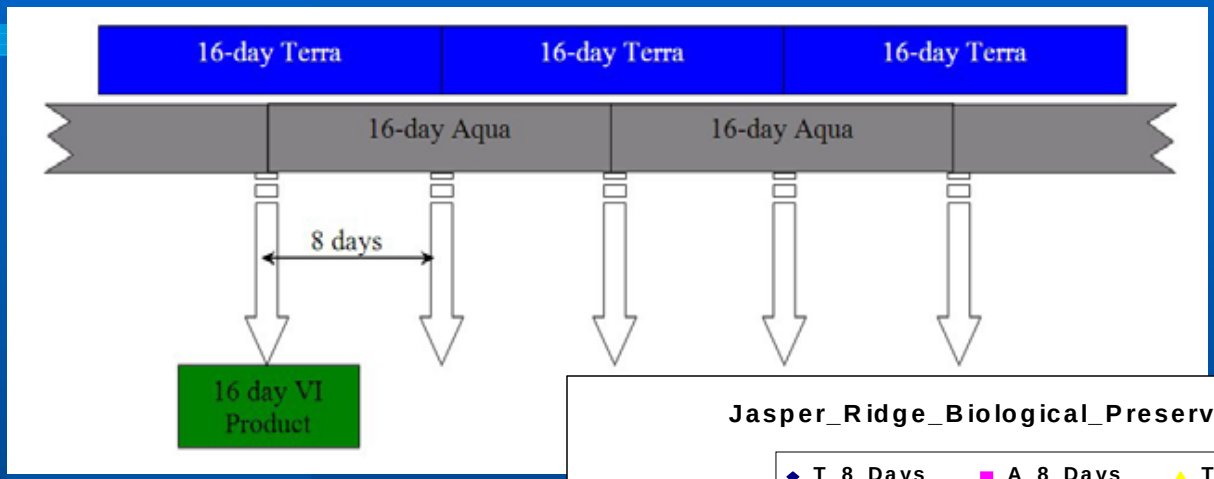
- Terra & Aqua data are highly identical, but slight differences & other issues makes combining them potentially problematic
  - Produced on the same day, so in most cases there is no point in using both (C4 and earlier)
- Improve the use efficiency without combining the two
  - Phased production was an ideal solution
    - Increased temporal frequency
    - Now there is a reason to use both
- Only Aqua will be phased

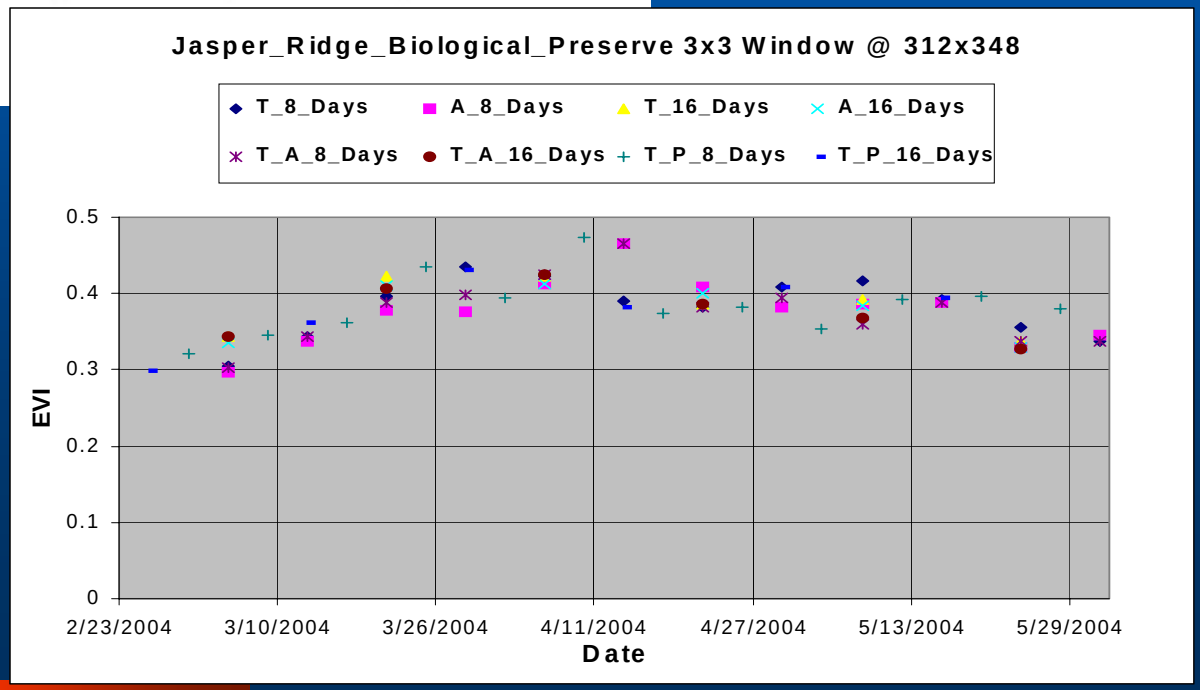
Phased Production

- **In order for this to work there should be no bias in the selected composite day of the year.**



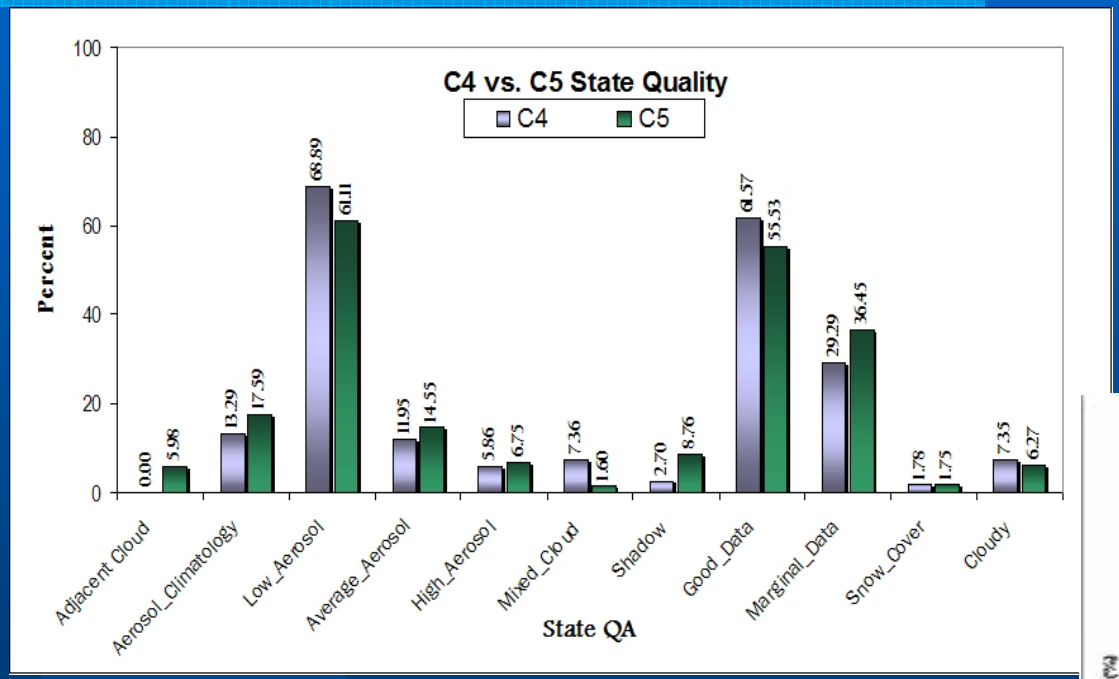
Phased production





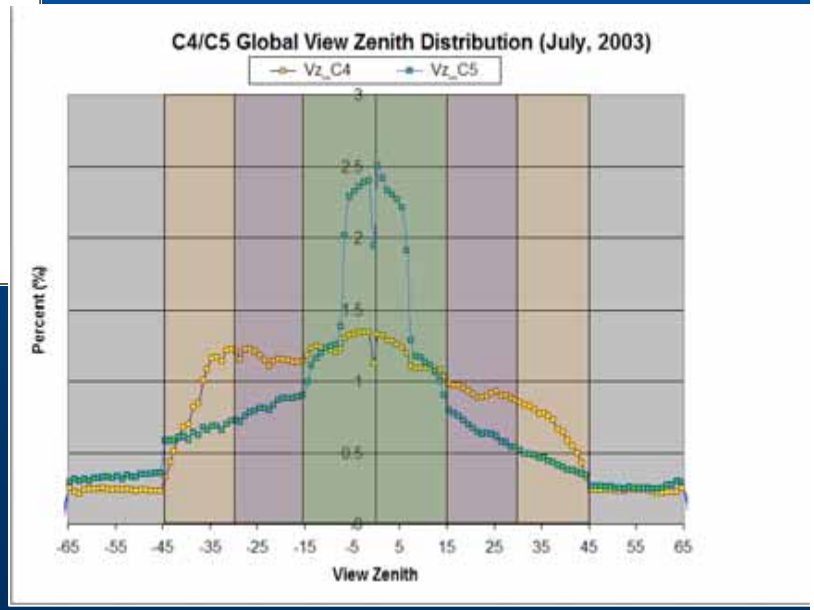
C4 and C5 Comparisons

C4 and C5 Comparisons

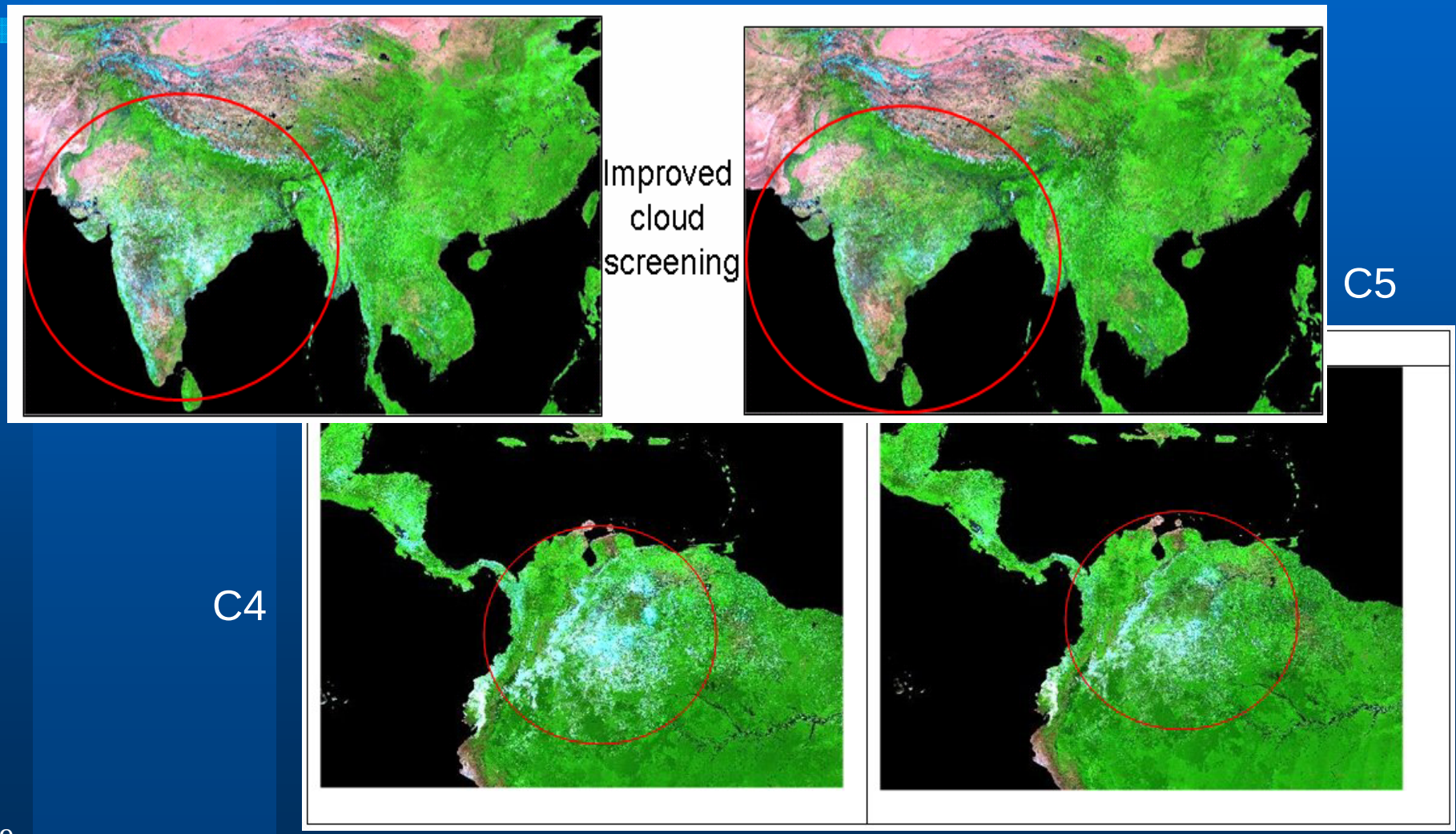


Improved data quality screening

Reduced BRDF

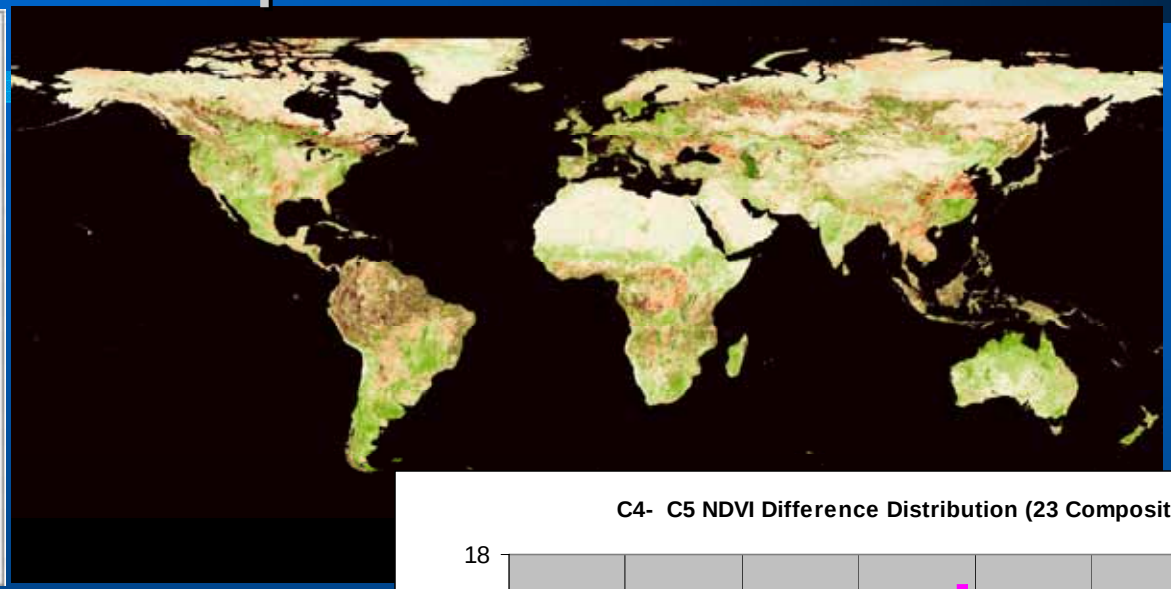


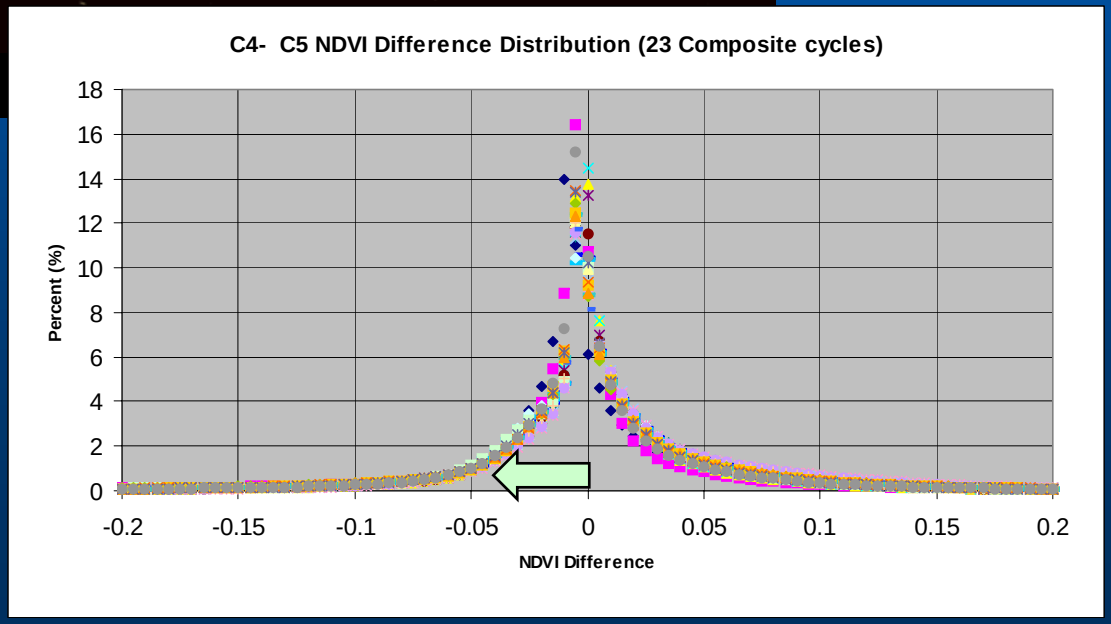
Cloud reduction



NDVI comparisons

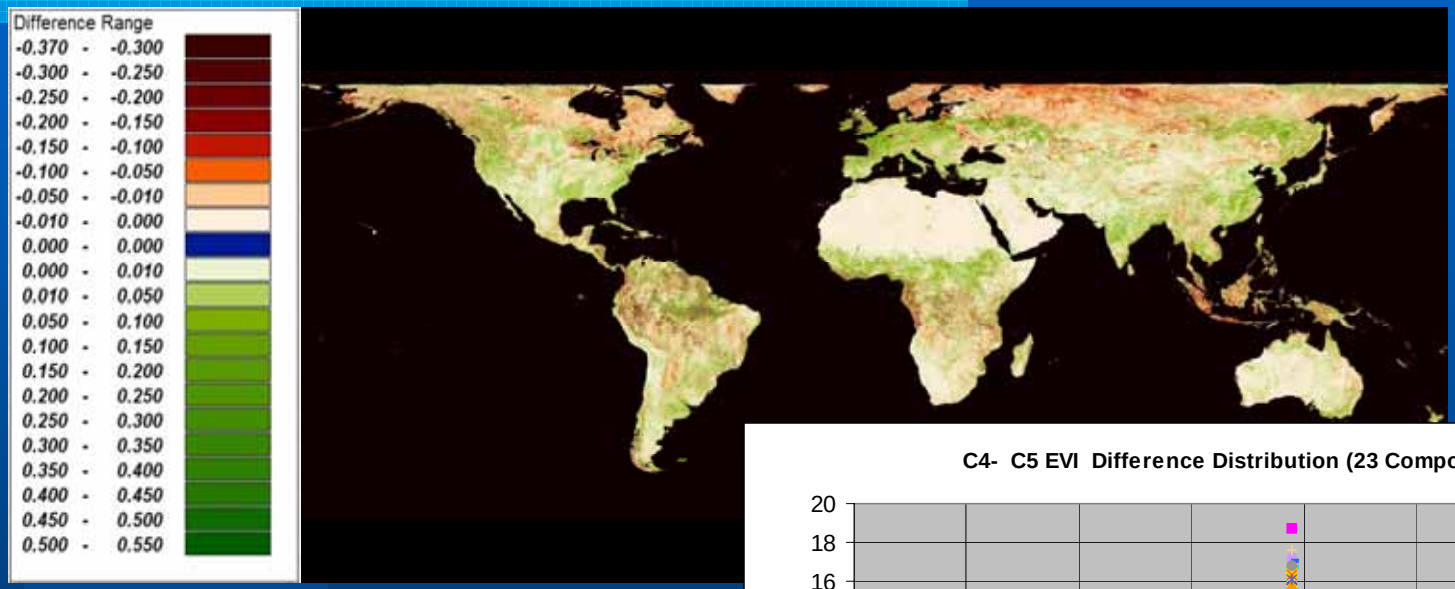
Difference Range	
-0.370	-0.300
-0.300	-0.250
-0.250	-0.200
-0.200	-0.150
-0.150	-0.100
-0.100	-0.050
-0.050	-0.010
-0.010	0.000
0.000	0.000
0.000	0.010
0.010	0.050
0.050	0.100
0.100	0.150
0.150	0.200
0.200	0.250
0.250	0.300
0.300	0.350
0.350	0.400
0.400	0.450
0.450	0.500
0.500	0.550

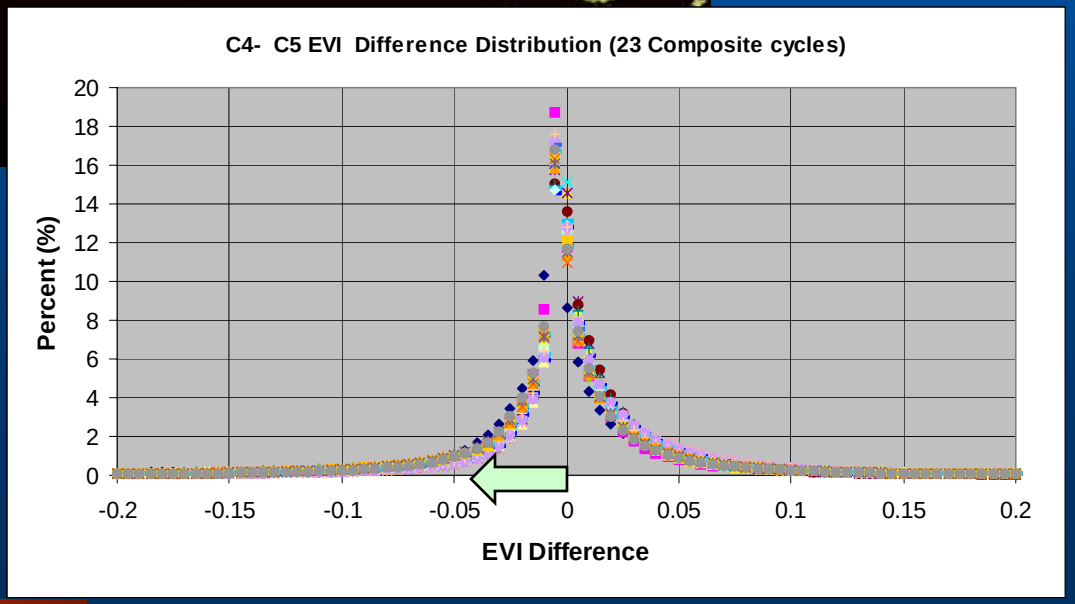




Consistent & slight decrease in C5

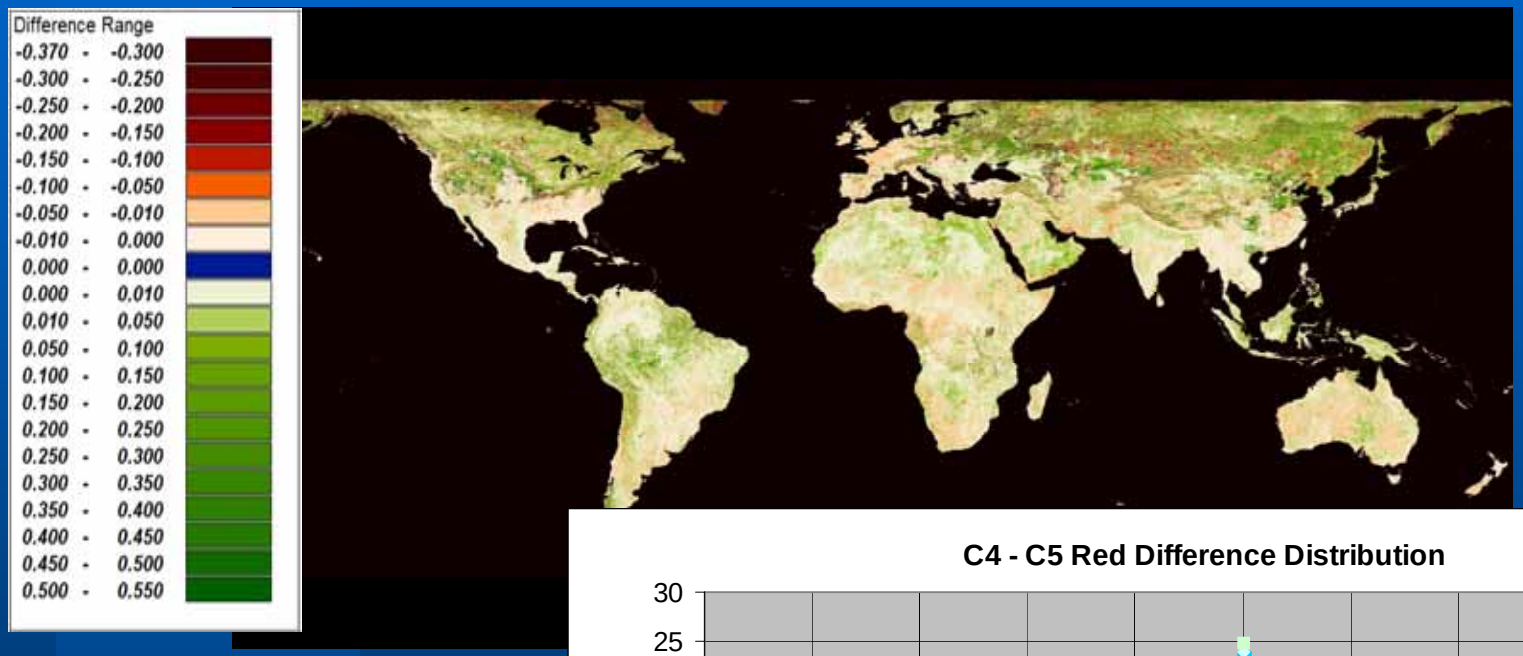
EVI Comparisons

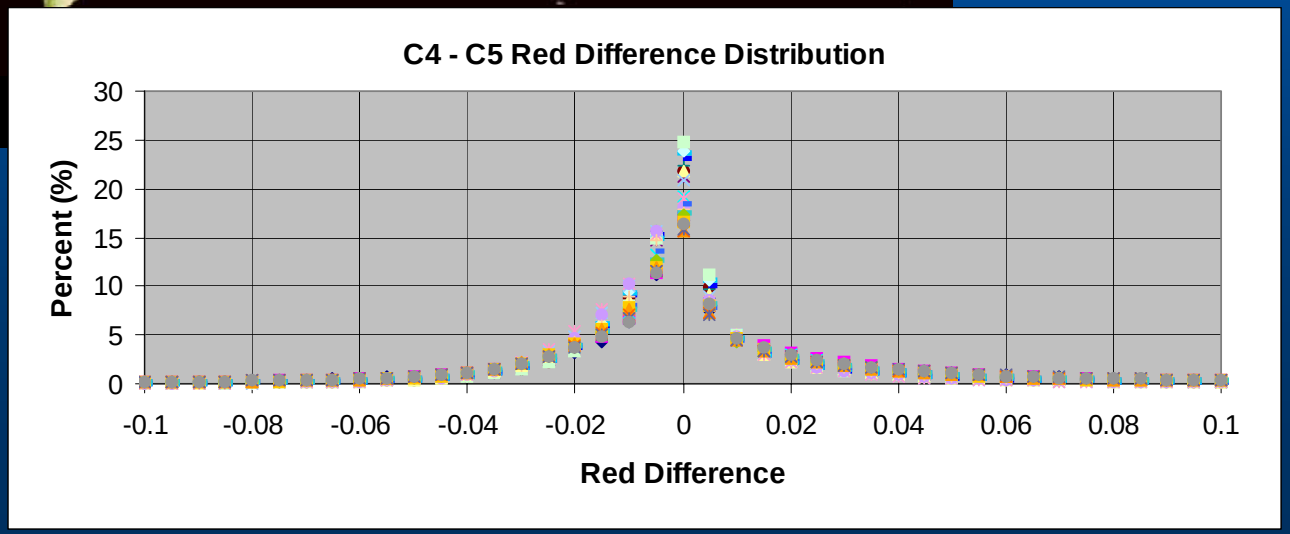




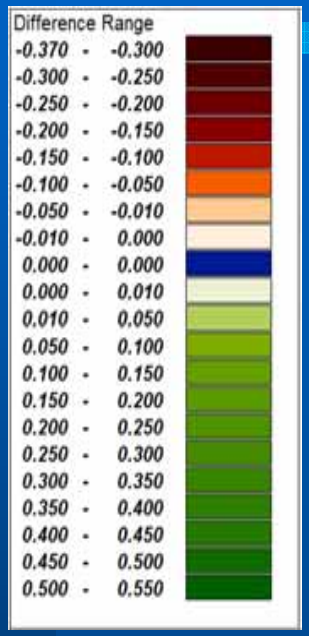
Consistent & slight decrease in C5

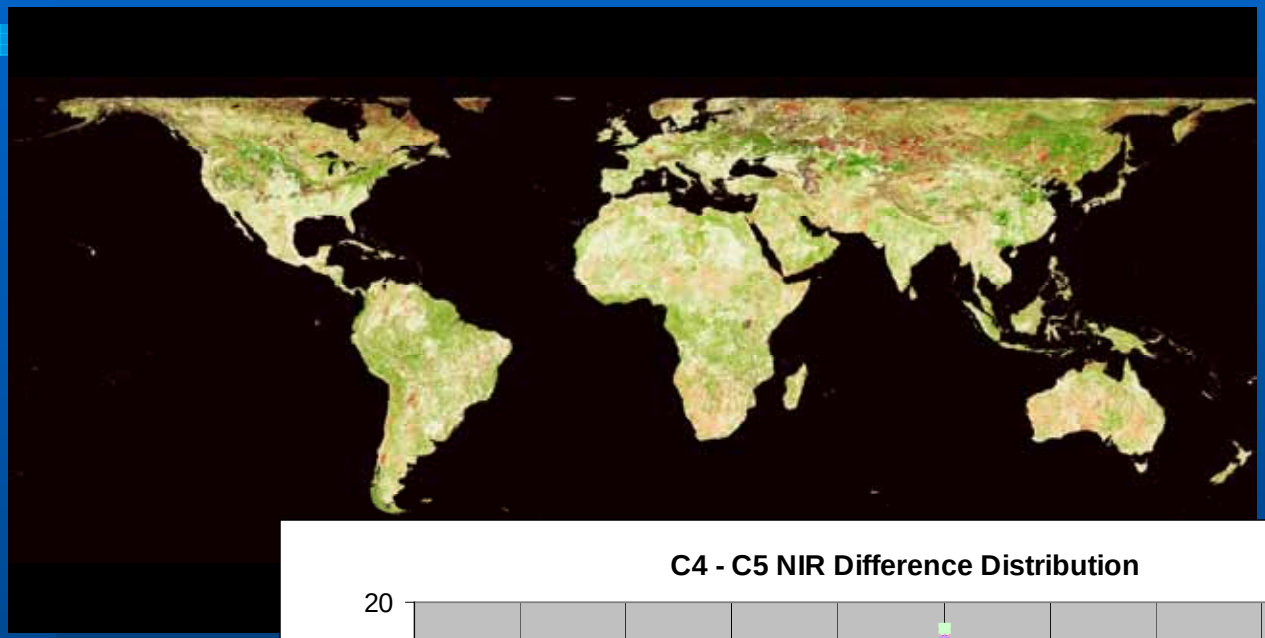
Red LSR Comparisons

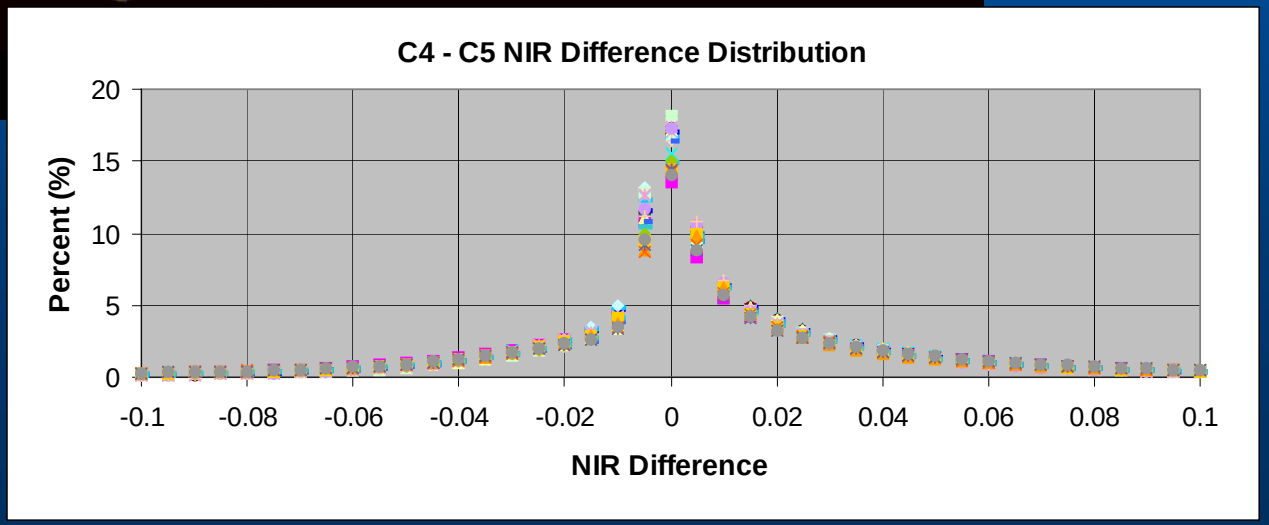




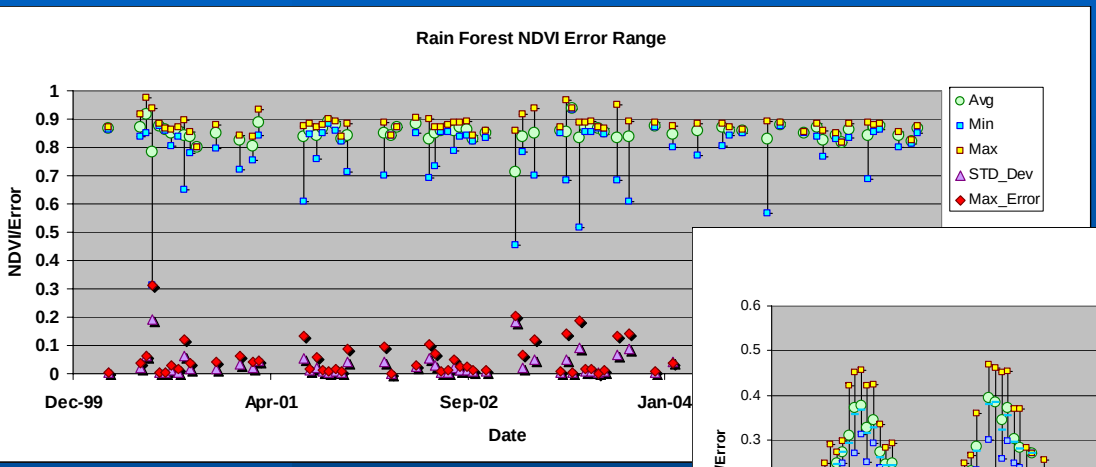
NIR LSR Comparisons

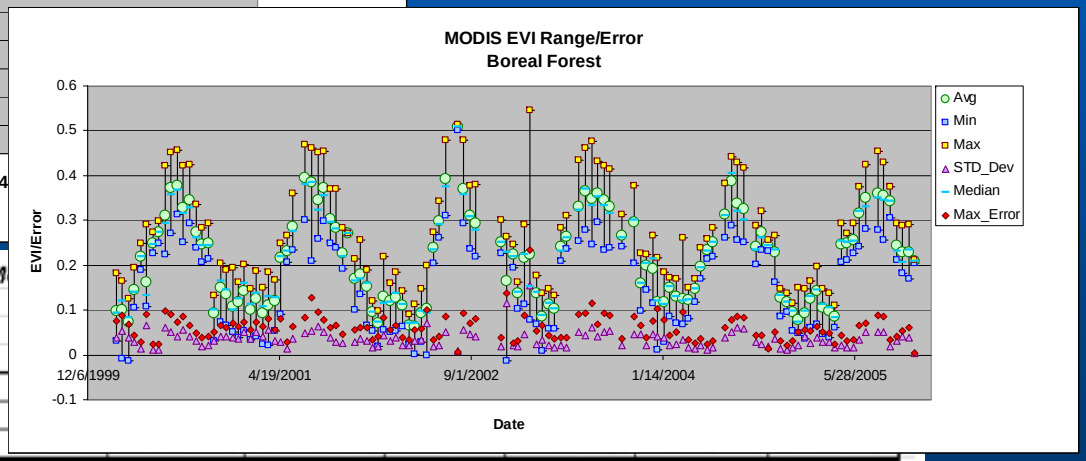






Noise related Error budget





	Humid RF	Humid RF	Desert	Desert	Moist N L	M						
NDVI Statistical Analysis for the MODIS 5+ year record												
Avg.	0.880	0.875	0.109	0.158	0.892							
Min	0.869	0.862	0.104	0.152	0.882							
Max.	0.937	0.916	0.116	0.169	0.905							
Error/Ra	0.068	0.054	0.012	0.017	0.022	0.030	0.043	0.032	0.394	0.076	0.055	0.053
Rel Err	7.739	6.200	11.340	10.663	2.515	3.473	5.087	3.655	560.181	-322.204	6.299	5.951
STD_De	0.017	0.014	0.003	0.005	0.007	0.008	0.012	0.008	0.127	0.019	0.015	0.012
Median	0.872	0.872	0.109	0.157	0.892	0.875	0.841	0.879	0.017	-0.026	0.867	0.884
Global Abs Error		0.0715										
Global Rel Error		6.2922	%									

Validation statement

- Maturity= "Validated Stage 2“
- The MODIS Vegetation Index product is retrieved accurately using a state of the art MODIS specific, quality driven, constrained view, maximum value composite method. For most cloud and snow free, low to no aerosol load, the VI values are very reliable. Over inland water bodies (rivers, lakes, etc...) surface reflectance inputs and VI values are unstable and should be used with caution. Strong correlations are also found with the nadir-adjusted (NBAR) NDVI and EVI products. Various field validation campaigns indicate good agreement of VI values for most biomes, and cross sensor correlations (AVHRR, Landsat, SPOT, etc…) are very strong. The VI product is particularly reliant on coherent inter-band (red and NIR) atmosphere corrections. Unstable values may be encountered over more extreme bright or dark surfaces.

C6 plans (towards CDR)

- MODIS specific
  - Completely cloud free & gap filled
    - It is pointless to produce/use cloudy observations
    - Gaps should be filled with obs. from the historical record (similar to the CMG approach)
  - Dynamic composite (First good observation)
    - No fixed composite cycle, but VI produced when a good pixel becomes available
- General CDR
  - EVI2 for continuity

$$EVI2 = 2.6\frac{\rho_{NIR} - \rho_{red}}{1 + \rho_{NIR} + 3\rho_{red}}$$

  - EVI Backward compatibility (paper to be submitted) and no-Blue band sensors
  - BRDF???