MODIS Anisotropy and Albedo Product

Crystal Schaaf

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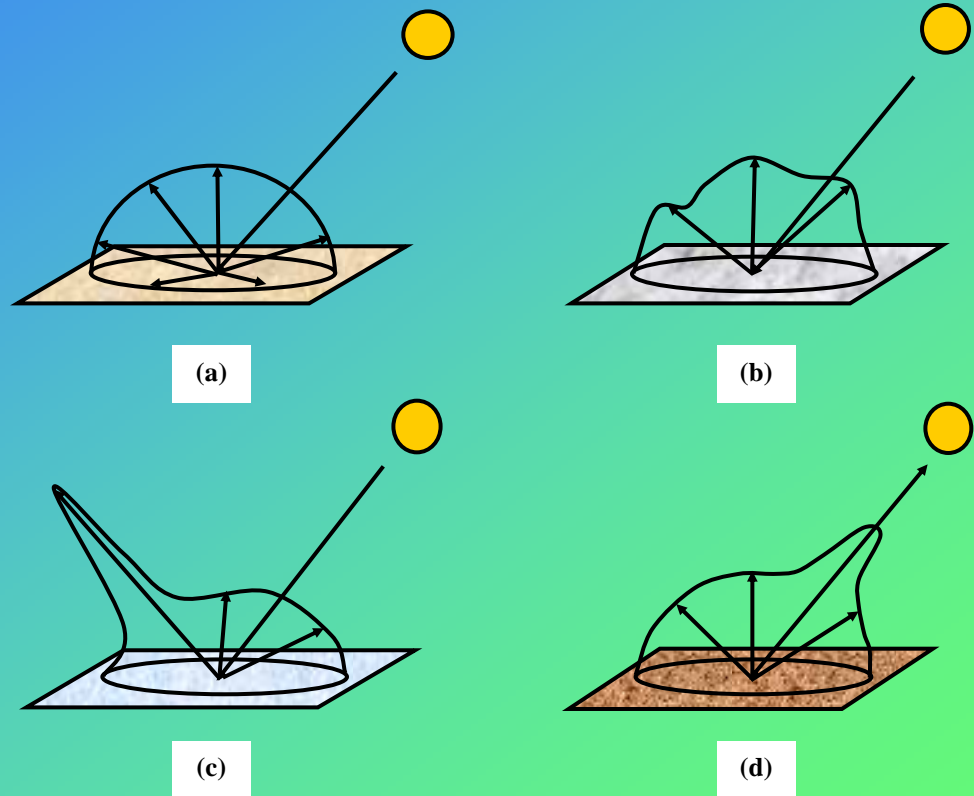**Boston University**

and many collaborators…

MODIS Anisotropy and Albedo

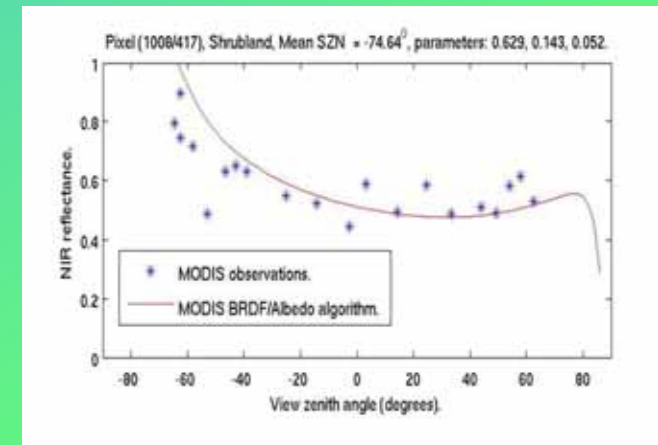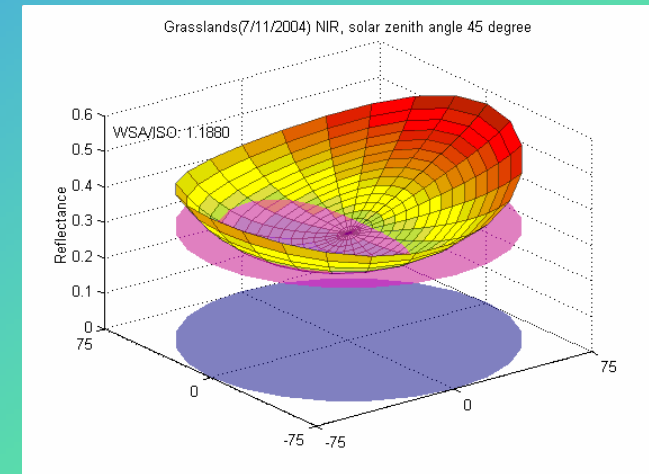**Anisotropy: The reflective character of a surface.**

Albedo: The proportion of solar radiation that is reflected by a surface.

Figure 2.1 Four examples of surface reflectance: (a) Lambertian reflectance (b) non-Lambertian (directional) reflectance (c) specular (mirror-like) reflectance (d) retro-reflection peak (hotspot) -- M. Disney
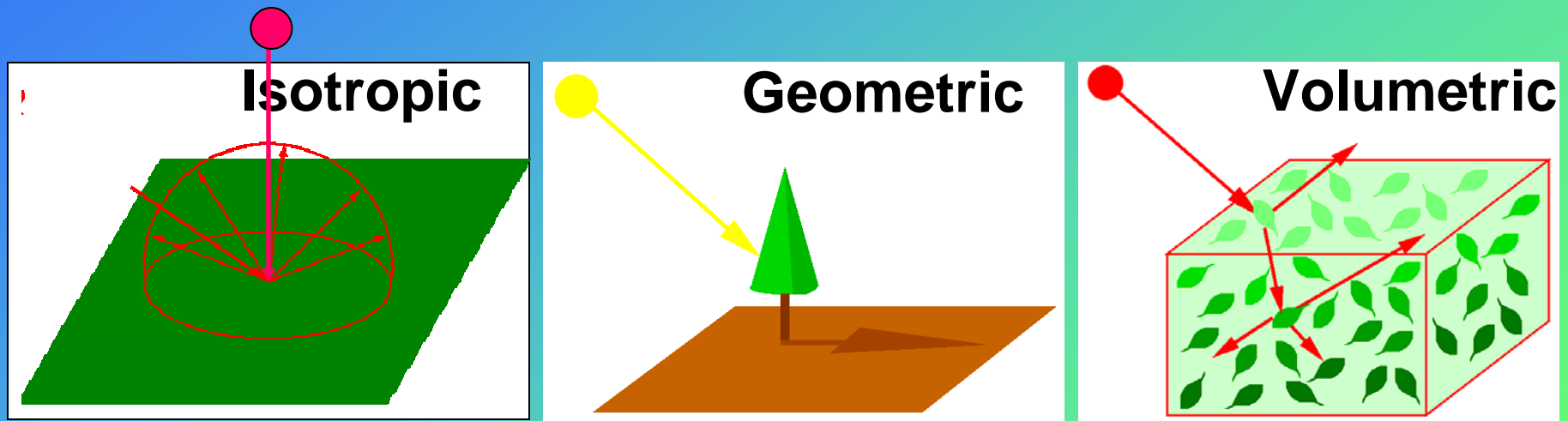
MODIS Anisotropy and Albedo

- Inputs
  - Cloud-free, atmospherically-corrected, spectral surface reflectances from Aqua and Terra (MOD09/MYD09 BRFs) are used to sample the surface anisotropy over a 16 day period

- Output
  - High quality full inversions provide well-sampled, best-fit anisotropy models of global land surfaces
    - Ross Thick Li Sparse Reciprocal semi-empirical model captures volumetric and geometric-optical scattering
  - Lower quality back-up algorithm performs magnitude inversions by coupling available reflectances with an *a priori* BRDF database

Grasslands(7/11/2004) NIR, solar zenith angle 45 degree

WSA/ISO: 1.1880

Pixel (1008/417), Shrubland, Mean SZN = -74.64°, parameters: 0.629, 0.143, 0.052.

- MODIS observations.
- MODIS BRDF/Albedo algorithm.

View zenith angle (degrees).

Semi-Empirical BRDF Model

$$\alpha_\lambda(\theta_i, \Phi_i; \theta_r, \Phi_r) = f_{iso} + f_{geo}k_{geo} + f_{vol}k_{vol}$$

Isotropic **Geometric** **Volumetric**

k_{vol}, k_{geo} are kernels of view and illumination geometry

f_{iso}, f_{geo}, f_{vol} are spectrally dependent weights
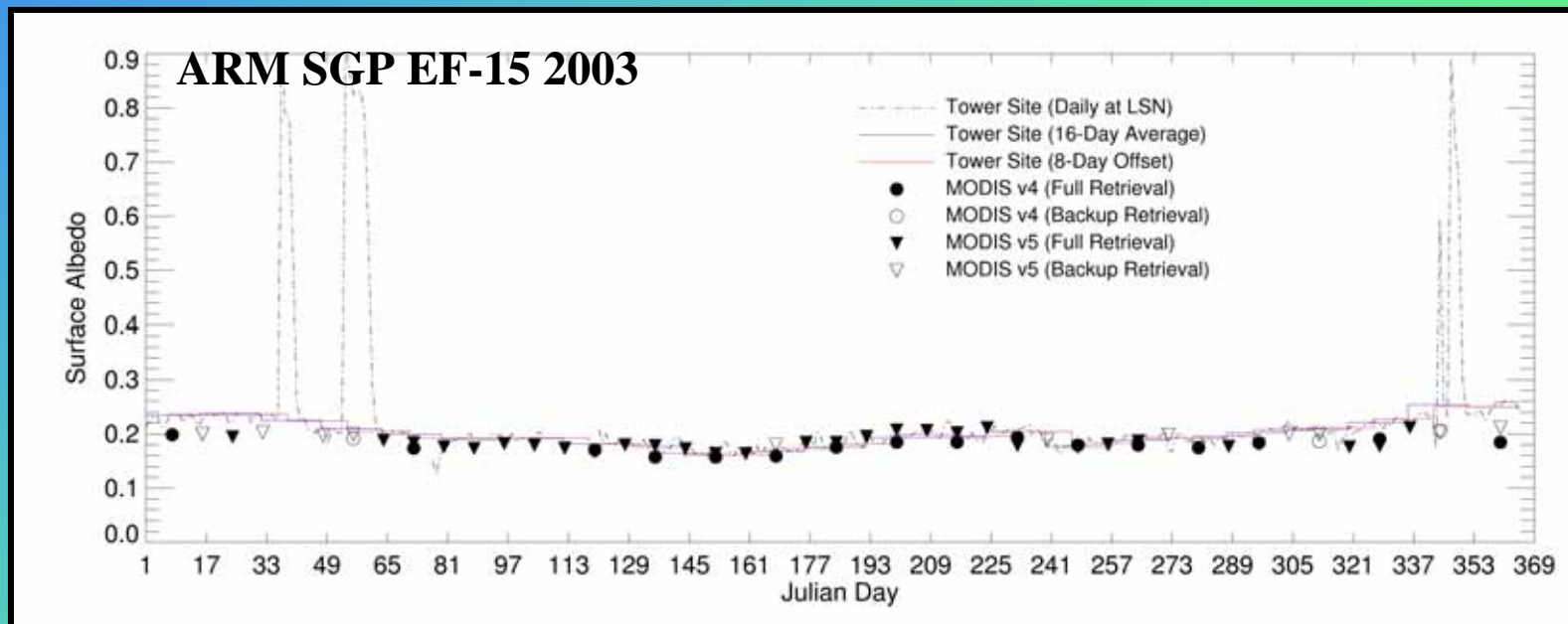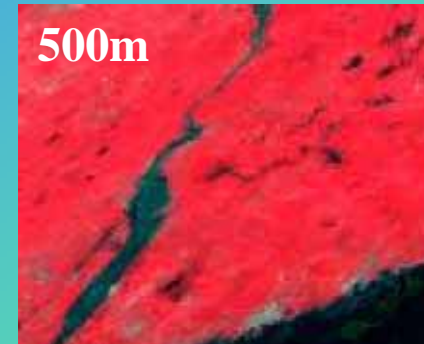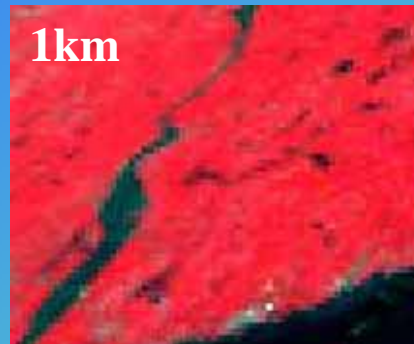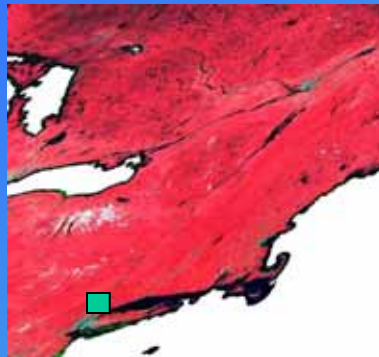
MODIS Anisotropy and Albedo

- Output
  - BRDF Model parameters
    - RossThickLiSparseR model parameters
      - Use parameters directly in simple polynomial to estimate albedo or reflectance quantities
  - Albedo quantities
    - Bihemispherical reflectance under isotropic illumination (BHRiso)
      - White-sky albedo (wholly diffuse)
    - Directional-hemispherical reflectance (DHR) at local solar noon
      - Black-sky al bedo (direct)
  - Nadir BRDF-Adjusted Reflectance (NBAR)
    - View angle corrected surface reflectances

adjoining swaths

NBAR May 2004

MODIS Anisotropy and Albedo Product

- Output
  - Spectral (Collections 004 and 005)
    - 7 shortwave bands and three broad bands
  - Spatial
    - 500m in sinusoidal 10deg^2 tiles (005)
    - 1km in sinusoidal 10deg^2 tiles (004, 005)
    - 0.05deg in global lat/lon (004, 005)
    - 30arcsec in global lat/lon (005)
  - Temporal
    - Every 16 days (004)
    - Every 8 days based on the last 16 days (005)
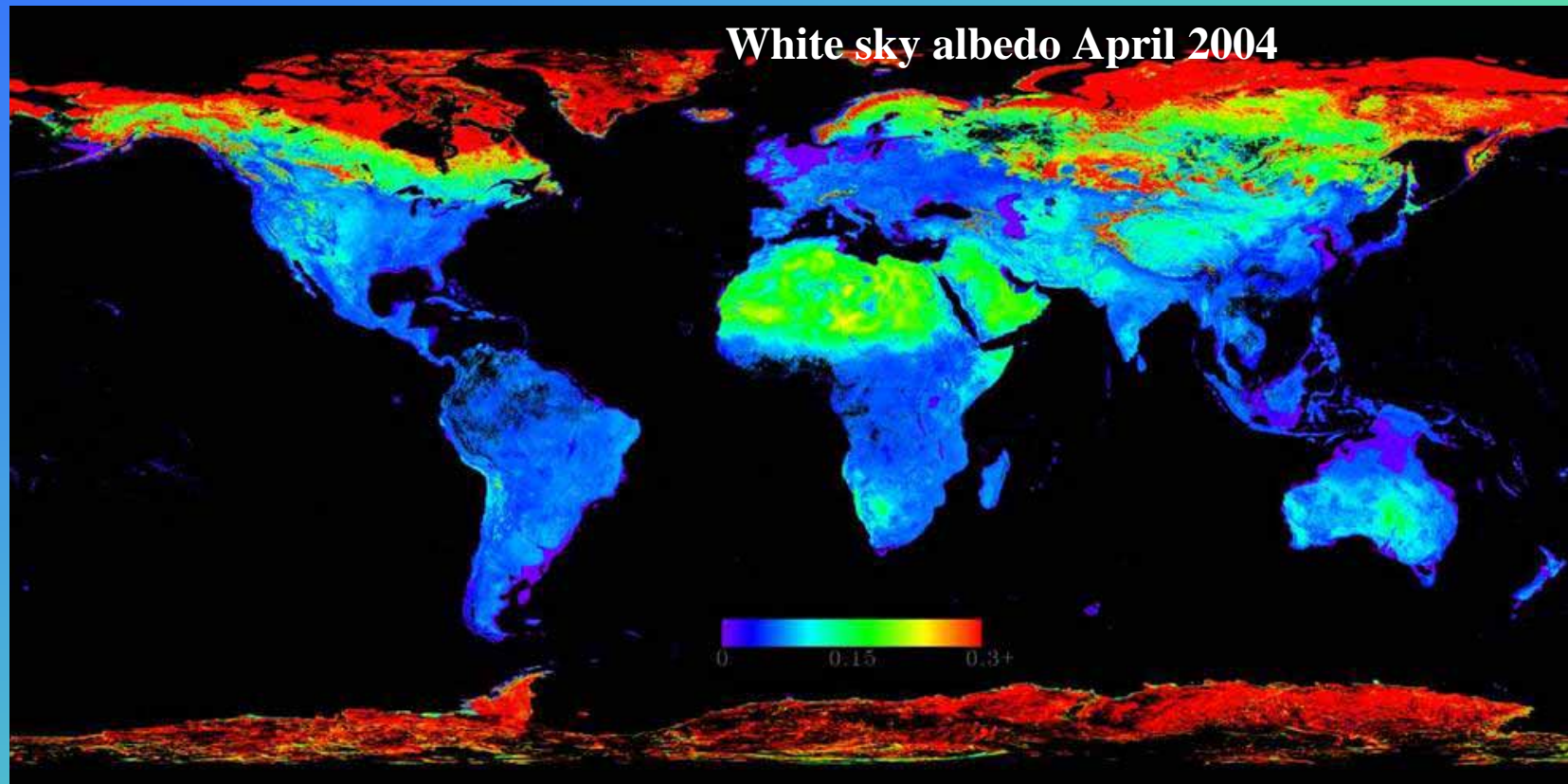
MODIS Anisotropy and Albedo

Tile Product Quality

- MCD43 only (Terra +Aqua)

- Validated Stage-1

- Inland waters now produced (to capture snow and ice)

- MCD43A2/B2 now contain the quality flags
    - byte mandatory QA (full/magnitude inversions or fill)
    - byte snow/snow-free (majority situation over 16 day period)
    - 16 bit packed information
        - platform
        - land/water mask
        - szn of local solar noon
    - 32 bit spectral inversion information

MODIS Anisotropy and Albedo
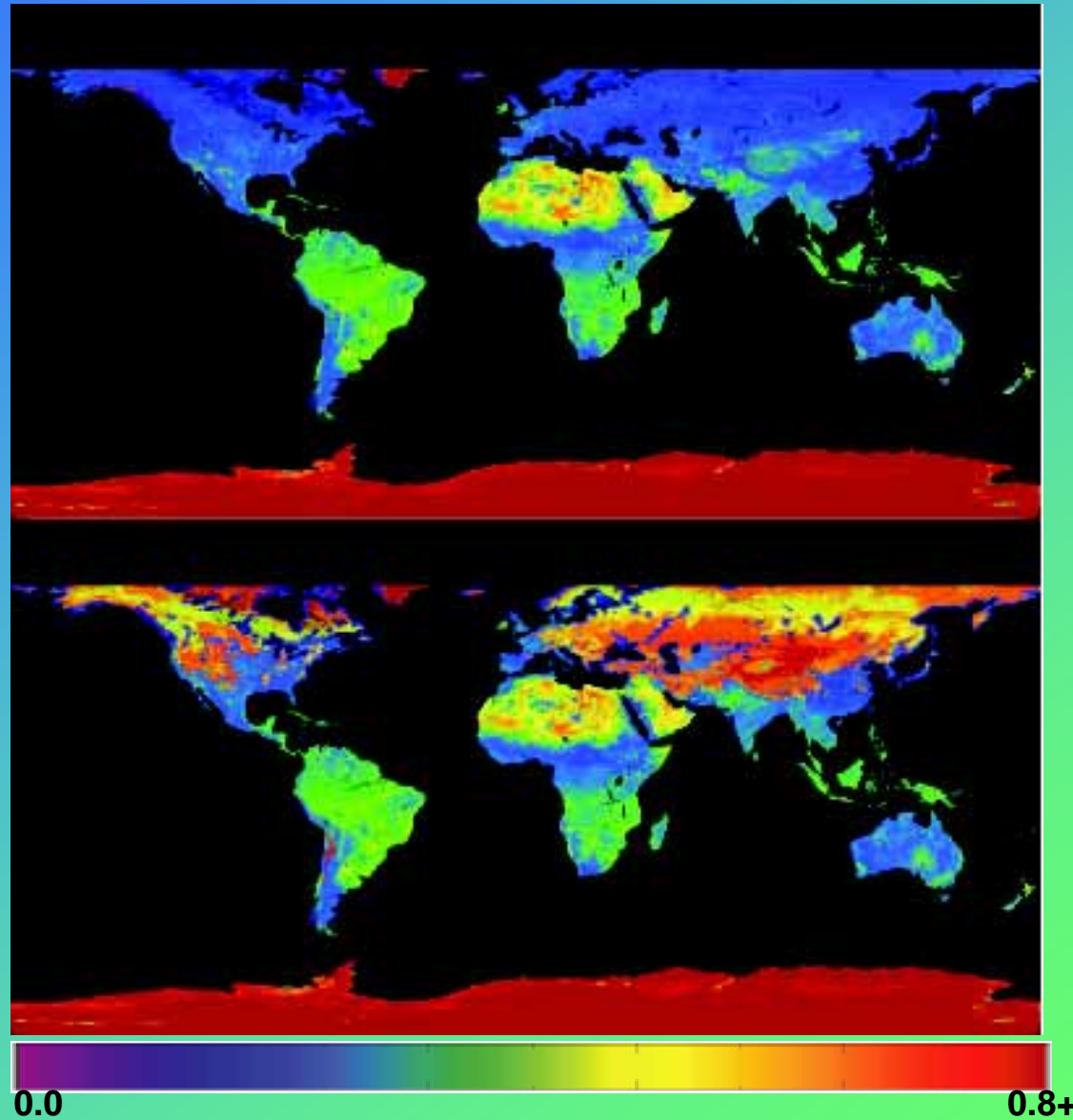

White sky albedo April 2004

CMG Product Quality

- MCD43C – 0.05degree CMG
- MCD43C1 now Parameters, C3 Albedo, C4 NBAR
  - in keeping with MCD43A/MCD43B
- MCD43C2 contains a snow-free quality version of parameters
- MCD43C1-C4 still contain replicated quality flags
  - byte quality flags (in data fields 31-34)
    - QA, szn of lsn,% inputs, % snow
- MCD43D – 1km CMG – not archived at EDC
  - serves as input for gap filled anisotropy and albedo products
  - joint effort between MODIS land and atmospheres teams
- MCD43D31 - MCD43D34
  - byte quality flags
    - QA, szn of lsn, % inputs, % snow

Gap-filled Snow-free Products

Global gap-filled white-sky albedo 1-16 Jan 2002 snow-free (top), snow-covered (below), 0.86μm

(Moody et al., 2005

0.0   0.8+

MODIS Anisotropy and Albedo

- Format changes make bridging reprocessing collections difficult – we don't recommend it.
- Increased spatial resolution serves regional users
  - But also serves as an improved subgrid characterization for global scale users.
- Increased temporal resolution provides more opportunities for high quality retrievals that will capture land surface dynamics
  - NBAR serve as the primary input to the MODIS land cover and phenology products
- Research efforts
  - Further improvement of backup algorithm
  - Utilization of the BRDF shape information for structural characterization
  - Implementation of more frequent anisotropy and albedo measures to serve the Direct Broadcast and eventually NPP/NPOESS communities