MODIS Anisotropy and Albedo Product

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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.

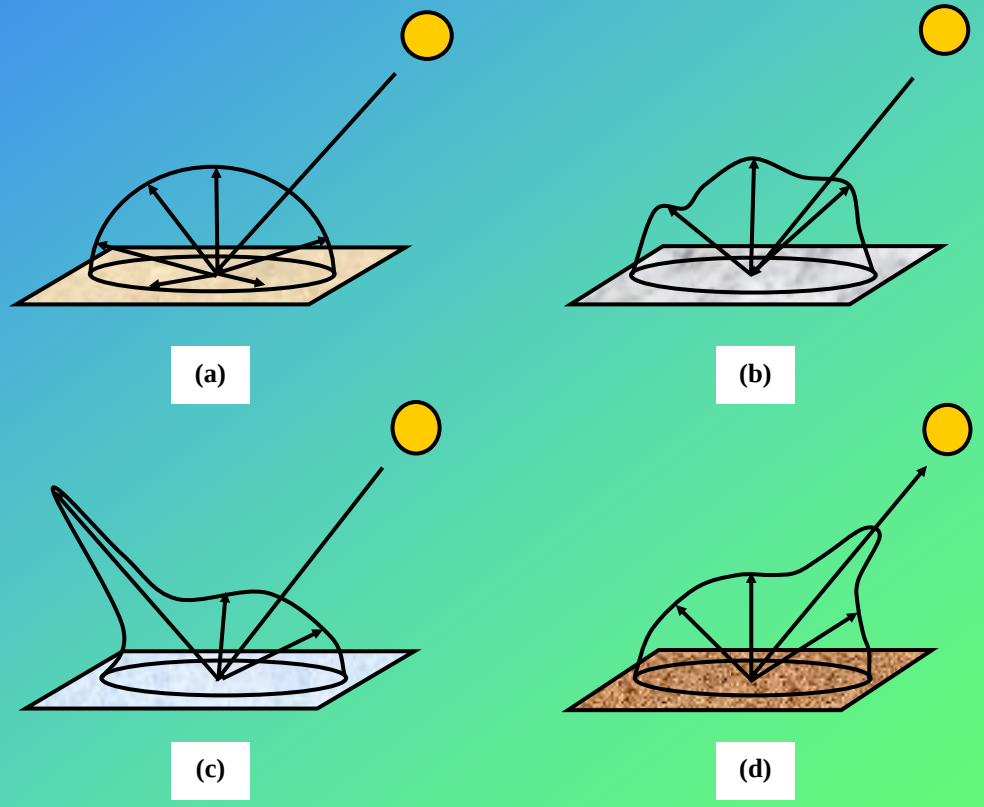
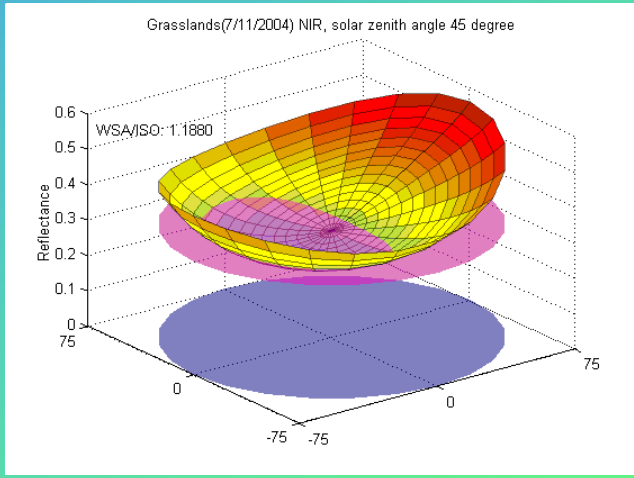
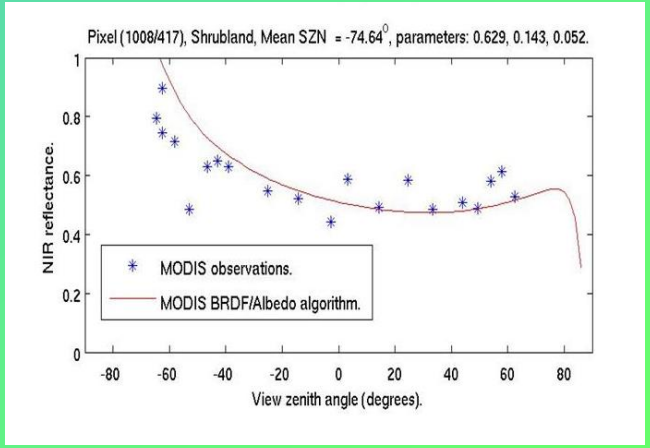


Figure 2.1 Four examples of surface reflectance: (a) Lambertian reflectance (b) non-Lambertian (directional) reflectance (c) specular (mirror-like) reflectance (d) retro-reflection peak (hotspot) -- M. Disney

MODIS Anisotropy and Albedo

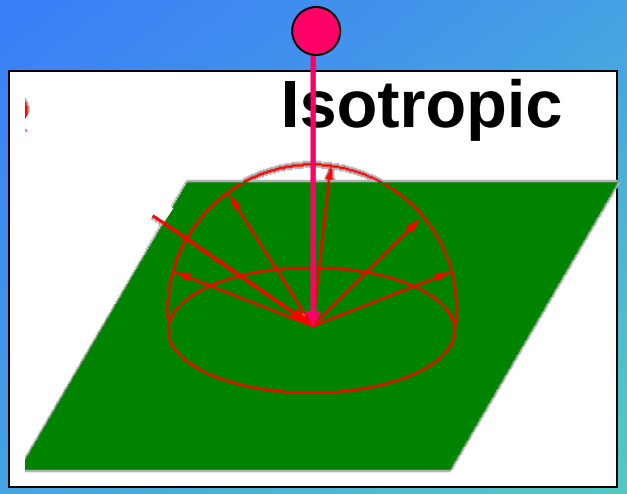
- Inputs
  - Cloud-free, atmospherically-corrected, spectral surface reflectances from Aqua and Terra (MOD09/MYD09 BRFs) are used to sample the surface anisotropy over a 16 day period
- Output
  - High quality full inversions provide well-sampled, best-fit anisotropy models of global land surfaces
    - 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

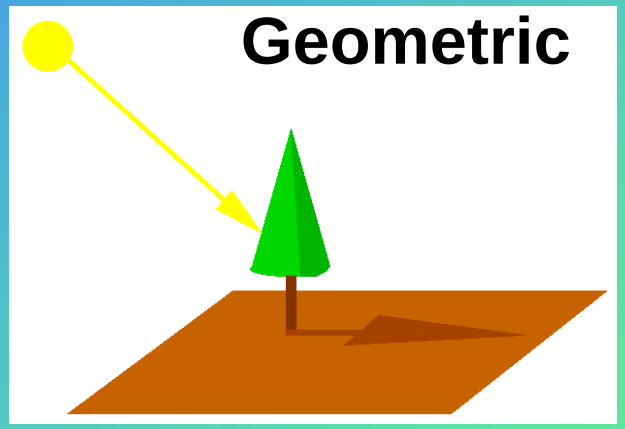


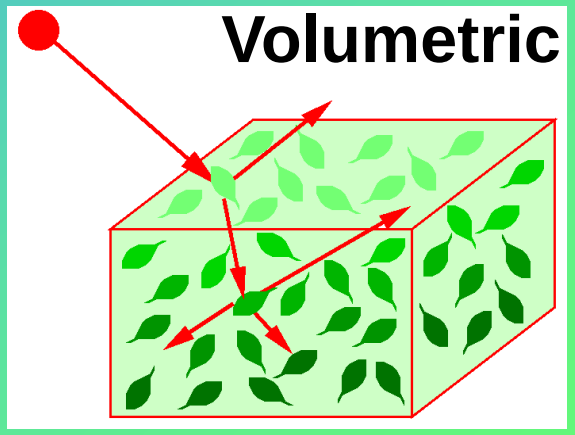


Semi-Empirical BRDF Model

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







k_{vol}, k_{geo} are kernels of view and illumination geometry
f_{iso}, f_{geo}, f_{vol} are spectrally dependent weights

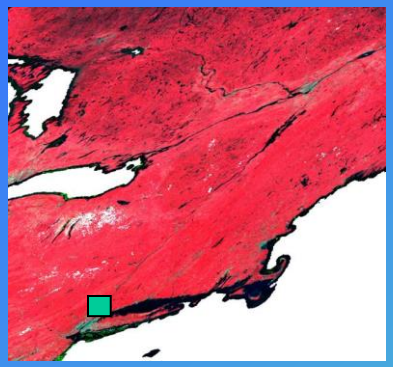
MODIS Anisotropy and Albedo

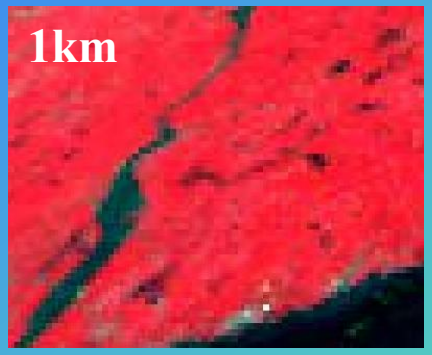
- Output
  - BRDF Model parameters
    - RossThickLiSparseR model parameters
      - Use parameters directly in simple polynomial to estimate albedo or reflectance quantities
  - Albedo quantities
    - Bihemispherical reflectance under isotropic illumination (BHRiso)
      - White-sky albedo (wholly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

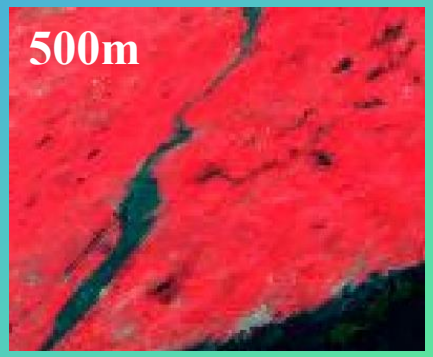
MODIS Anisotropy and Albedo Product

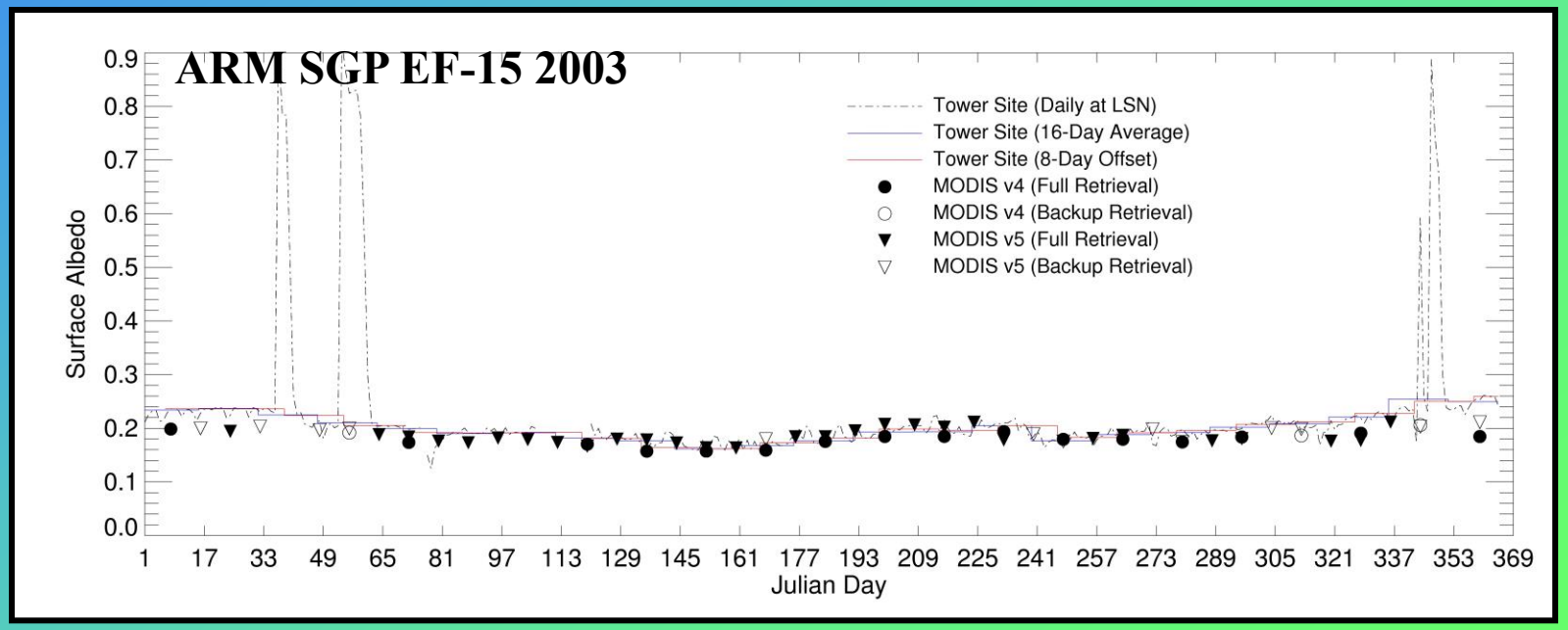
- Output
  - Spectral (Collections 004 and 005)
    - 7 shortwave bands and three broad bands
  - Spatial
    - 500m in sinusoidal $10deg^2$ tiles (005)
    - 1km in sinusoidal $10deg^2$ tiles (004, 005)
    - 0.05deg in global lat/lon (004, 005)
    - 30arcsec in global lat/lon (005)
  - Temporal
 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

MODIS Anisotropy and Albedo





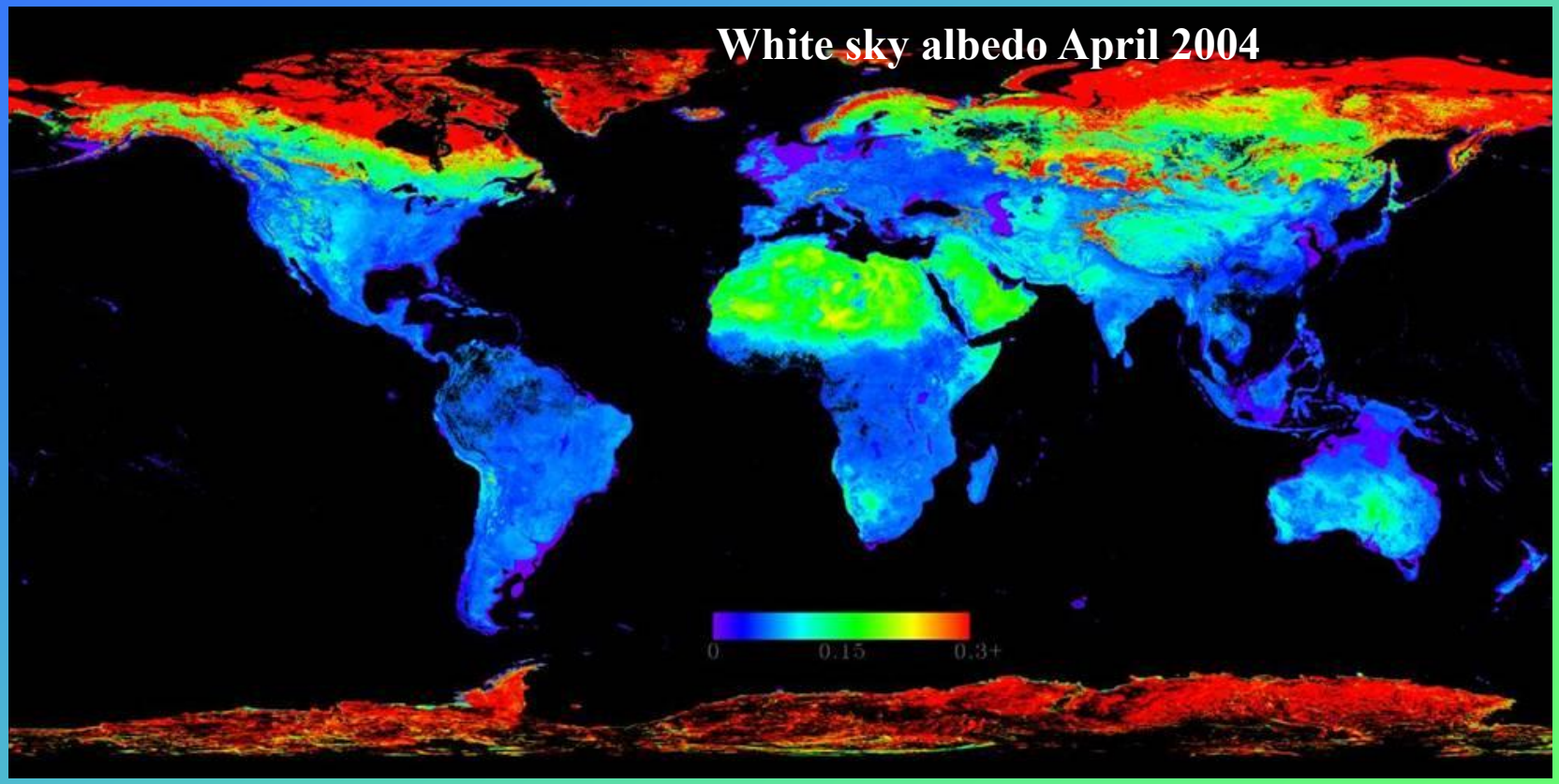




Tile Product Quality

- 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



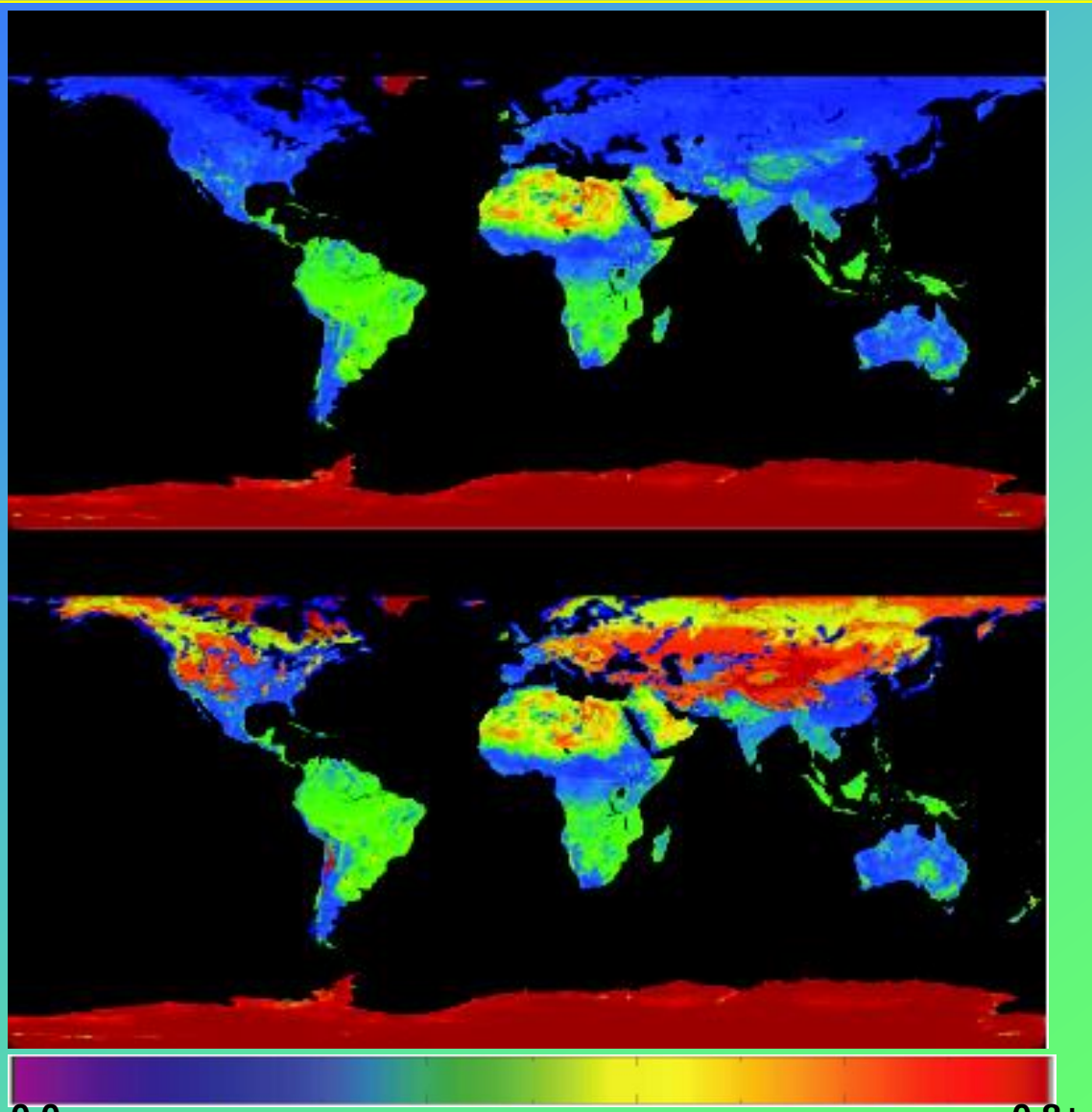
CMG Product Quality

- 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



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