LDCM OLI Level 1 Product Scaling

Note: OLI Level 1 Product is radiometrically and geometrically corrected

- Terrain corrected
- Resampled

OLI Level 1 Product Scaling

- Level 1 product will be 16 bit integer - QCAL[l,s]
- Will be scaleable to reflectance or radiance with linear scaling factors (multiplicative[M] and additive[A] and/or ρMAX/LMAX and ρMIN/LMIN) that are provided with product
- Reflectance scaling factors (M_ρ, A_ρ) will be for zenith sun(θ_s=0) and include Earth-Sun distance correction(consistent with MODIS Level 1B product):
  - $\rho'[l,s] = M_\rho * QCAL[l,s] + A_\rho = \rho[l,s]\cos(\theta_s[l,s])$
  - M_ρ and A_ρ intended to be fixed for all time
  - Convert to scene and pixel specific reflectance:
    - $\rho[l,s] = \rho'[l,s] / \cos(\theta_s[l,s])$
    - Scene center θ_s provided in product metadata
- Radiance scaling factors (M_L, A_L)
  - $L_\lambda[l,s] = M_L * QCAL[l,s] + A_L$
- Where:
  - $\rho'[l,s]$ is the zenith sun exoatmospheric reflectance
  - $L_\lambda[l,s]$ is the spectral radiance (W/m^2 sr μm)
  - $\rho[l,s]$ is the local solar zenith angle exoatmospheric reflectance
  - $\theta_s[l,s]$ is the local solar zenith angle for pixel [l,s]
  - l is the line number
  - s is the sample number

Notes

- Radiance and Reflectance calibrations are independent
  - Separate traceability
    - NIST standard of spectral irradiance (via FASCAL)
    - NIST calibrated reflectance panel
  - Not related by published solar irradiance curve
- M_L and A_L will vary with time of year due to Earth-Sun distance variation

Backup

MODIS Level 1B Product (TOA Reflectance)

- For a given band:
- $\rho'[l,d] = \rho[l,d]\cos(\theta_s[l,d]) = (ES_{dist})^2 m_1[d] Q_{imagenetlin}[l,d]$
- (this is equation (1) from Xiong et al, (2003), translated into the symbols used in OLI algorithm descriptions):
- Where:
  - $\rho'[l,d]$ is the zenith sun exoatmospheric reflectance as reported in the Level 1 data product
  - $\rho[l,d]$ is the local solar zenith angle exoatmospheric reflectance
  - $\theta_s[l,d]$ is the local solar zenith angle for pixel [l,d]
  - ES_{dist} is the Earth-Sun distance in astronomical units
  - $m_1[d]$ is the reflectance calibration coefficient for detector d, based on the observations of the diffuser and the pre-launch measured reflectance of the diffuser.
  - $Q_{imagenetlin}[l,d]$ is the bias and non-linearity corrected detector response in DN
  - l is the line number
  - d is the detector number

MODIS Reflectance Calibration Factor

- $m_1[d]=(BRF \cos(\theta_{s(SD)}))/(Q_{SDnetlin}[d] (ES_{dist(SD)})^2)$

- Where:
  - BRF is the Bidirectional Reflectance Factor of the Solar Diffuser for the diffuser observation
  - $\theta_{s(SD)}$ is the solar zenith angle for the diffuser observation
  - $Q_{SDnetlin}[d]$ is the bias and non-linearity corrected response to the diffuser for this observation in DN
  - $ES_{dist(SD)}$ is the Earth-Distance for this diffuser observation

LDCM Reflectance Processing

We are proposing converting to radiance first before converting to reflectance:

$$\rho'[l,d] = \left(ES_{dist}\right)^2 R_\rho L_{bw,\lambda}[l,d] = \left(ES_{dist}\right)^2 R_\rho \frac{Q_{ImageNetLin}[l,d]}{G_L[d]}$$

Where:

R_ρ is the radiance to reflectance conversion factor for the band (1/ (W/m^2 sr μm))

$L_{bw,\lambda}[l,d]$ is the band averaged spectral radiance in W/m^2 sr μm

$G_L[d]$ is the radiance gain for detector in DN/ (W/m^2 sr μm) (absolute and relative gain lumped together)

So:

$$m_1[d]=R_\rho/G_L[d]$$