1 ❑ Validation

2 ❑ Definition of validation

- Specification of the transformations required to extract estimates of high-level geo/biophysical quantities from calibrated DNs, including specifications of uncertainties in these products
- Process of assessing by independent means the quality of the data products
- Determine the accuracy that the image-based methods are expected to perform – not pass/fail

3 ❑ Standard data products

- Radiance data products
- Set of high-level products generated

4 ❑ Validation activities

- Occurs before/after satellite launch
  - Prelaunch activities
    - Determine algorithms, characterize uncertainties
  - Postlaunch activities
    - Refine algorithms, refine uncertainty estimates based on near-direct comparison with correlative data & selected, controlled analyses

5 ❑ Validation of products

- Acquire RS imagery, derive information estimates from imagery using product algorithms from the instrument science teams
- Acquire independent measure of information product quantity, ideally from in situ measurements at ground level, using independent methods
- Compare image-based information product estimate with independent measures for identical (or similar) locations & times

6 ❑ Processing chain

- Level 0 – engineering product
  - Raw data
- Level 1 – engineering product
  - TOA radiance in a specific map projection
  - Validation – vicarious calibration
  - Validation campaigns: ground-based, airborne and on-orbit satellite sensors
    - Simultaneous radiometric measurements of spatially & spectrally homogeneous earth targets for purposes of validating the on-orbit satellite radiometric calibration

7 ❑ Processing chain

- Level 2 – scientific products
  - Scientific understanding of the remote sensing system
- Quality assessment (QA)

8 ❑ Quality assessment (QA)

- Evaluate & document the scientific quality of the high-level products
- Provided as: product metadata & as per pixel information

9 ❑ Validation methodology

- Need multiple validation methods, depends on temporal & spatial scales
- Direct measurements in the field

- Instrumentation
- Spatial sampling design
- Observation networks

10 ❑ Direct correlative measurements
- Comparisons with in situ data collected over a distributed set of validation test sites
  - Generate uncertainty directly

11 ❑ MODLAND – field data collection
- Instantaneous measures of spectral reflectance & thermal IR radiance; various bio/geophysical variables at various test sites
  - Calibration activity
  - Validation of radiometric variables
- Establish a semi-permanent array of test sites
  - Flux tower – allows extended temporal measurement of terrestrial biophysical dynamics for a range of land cover types

12 ❑ Radiometric (radiation) variables
- Reflectance spectra
  - Spectroradiometers – measure reflectance as a function of wavelength
  - Laboratory goniometer (Fig. 12.1) – measures leaf reflectance & transmittance
- Directional reflectance
  - Radiometers & spectroradiometers
  - Measure multiangle reflectance during a short period of time – 2 protocols to measure

13 ❑ Radiometric (radiation) variables
- Hemispheric albedos
  - Albedometers – measures broadband albedo
  - Pyranometers – measures solar radiation
- Radiation fluxes
  - PAR (quantum sensors)
  - Pyranometers – shortwave fluxes

14 ❑ Radiometric (radiation) variables
- Skin temperature
  - Contact sensors – transducers
  - Noncontact sensors – IR radiometer
- Thermal emissivity
  - Lab measurement or field (gold-box method)

15 ❑ Biophysical/biochemical variables
- LAI/FPAR (leaf area index/fraction of photosynthetically active radiation)
  - Allometric relationships – destructive canopy sampling for LAI
  - Indirect measurements from a light-sensitive instrument, analyze hemispherical photos
- Leaf angle distribution (LAD)
- Chlorophyll & other biochemical concentrations – measure in lab

16 ❑ Spatial sampling design
- Accuracy

- Precision
- Data quality
- Error
- Study area, sample site, subplot
  - Spatial distribution, number of sample sites, required size of individual sample site, number & size of subplots required

17 Sampling methods

- Random spatial sampling
- Stratified spatial sampling
- Systematic spatial sampling
- Stratified systematic spatial sampling

18 Observation networks

- Networks related to land surfaces
  - Phenological changes, spatial complexity
  - Commitment of resources at test sites
- Major observation networks
  - AERONET, FLUXNET, EOS Land Core Validation Sites, BigFoot, BSRN, Oklahoma Mesonet, SURFRAD, ISIS, LTER, ILTER

19 Intercomparison of algorithms & products – Figure 12.11

- Compare data in question with same type of data & products from other spaceborne sensors
  - Products wavelength dependent: reflectance, albedo, emissivity
  - Products independent of wavelength: LAI, temperature, FPAR

20 Intercomparison of algorithms & products – Figure 12.11

- Compare trends derived from independently obtained reference data & other types of satellite products
- Compare a particular data product with the same product obtained using a different algorithm
- Data assimilation methods – validated radiative transfer model

21 NASA EOS validation program

- http://eospso.gsfc.nasa.gov/
- EOS Project Science Office
- Instrument science teams
  - Levels 1-3 products
- Interdisciplinary science teams
  - Levels 3 & 4 products