Collection 5 MODIS LAI and FPAR Products

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Production of the Suite of MODIS Collection 5 LAI/FPAR Products

Daily Retrievals:
Main Radiative Transfer algorithm (best quality)
   If failed
   Back-Up Empirical algorithm (poor quality)

2-Step Compositing:
1) Select Main algorithm Terra and (or) Aqua retrievals
   If none available
   Select Back-Up Algorithm retrievals
2) Maximum FPAR over selected category

MOD15A2 product
8-day, 1-km Terra
Longest time series

MCD15A2 product
8-day, 1km Terra+Aqua
Best quality

MCD15A3 product
4-day, 1km Terra+Aqua
Fine time step

8-biome Terra Land Cover
(MOD12Q1 product)
Objectives: Refine of RT simulations to improve consistency of MODIS and simulated surface reflectances
- to achieve better agreement of retrieved and measured at ground LAI/FPAR
- to improve rate of best quality retrievals (main RT algorithm)

The approach: Implement RT simulations with new Stochastic RT model (cf. references below), which simulates average over satellite pixel RT field. The model captures 3D effects of vegetation heterogeneity (foliage clumping and species mixture) through parameterization of vegetation structure with two stochastic moments:
- probability of finding species at horizontal plane $z_1$, $p(z_1)$
- correlation of two species at two spatial locations, or pair-correlation function $K(z_1, z_2)$

Implementation: In Collection 4 we optimized LAI retrievals over herbaceous biomes by tuning parameters of existing Look-Up Tables (LUTs). In Collection 5 LUTs for all biomes were recalculated with the stochastic RT model:
- herbaceous vegetation: resolved FPAR overestimation
- woody vegetation: increased retrieval rate over woody biomes and resolved LAI overestimation over needle leaf forests

Collection 5 Product Format Changes

- Introduced two new combined products (4-day and 8-day). The products are generated by compositing daily Aqua and Terra observations with standard compositing scheme. Combined 8-day products improves quality of retrievals (mostly over broadleaf forests, while Combined 4-day products improves temporal resolutions, desirable feature for ecological and climate applications

- Introduced new SDS. In addition to standard SDS (LAI, FPAR, QC, extra_QC), two new layers were added to specify uncertainties of retrievals: standard deviation of LAI and FPAR. The standard deviations are available from the retrieval technique: MODIS main RT algorithm generates LAI/FPAR data not as deterministic values, but as statistical averages over acceptable solutions of the inverse problem

- Implemented internal compression

- Minor changes to QA: simplified definition of MODLAND_QC (good quality vs. other quality), and introduced new bit, sensor (Aqua, or Terra based retrievals)
Terra 8-day LAI (185-192.2000)

Collection 5

Collection 4

LAI

0.0
0.1
0.5
0.8
1.0
1.5
2.5
3.0
4.0
5.0
6.0
7.0
Terra 8-day QC (185-192.2000)

Collection 5

Collection 4

QC
- Water
- Barren/unvegetated
- Main algorithm, no saturation
- Main algorithm with saturation
- Back-Up algorithm
- Fill value
Collection 4 vs. Collection 5 Terra 8-day LAI (185-192.2000)

- Collection 4 and 5 LAI retrievals over herbaceous vegetation are quite similar.
- Increase amount of best quality retrievals over broadleaf forests
- Corrected LAI overestimation over needle forests
Collection 5 vs. Collection 4 Terra 8-day FPAR (185-192.2000)

- Decreased FPAR over herbaceous biomes (especially over savannah)
- Improvements are seen in main and back-up algorithm retrievals
Highly consistent retrievals by main algorithm

Differences in back-up algorithm retrievals are due to contaminated input surface reflectances (clouds and aerosols)
Highly consistent retrievals by main algorithm

Differences in back-up algorithm retrievals are due to contaminated input surface reflectances (clouds and aerosols)
Grasses & Cereal Crops (Biome 1)

- KONZ grasses site in KS, USA; Alpilles agricultural crops site in France
- Retrieved LAI is consistent with field measurements
- Increased rate of best quality retrievals (main algorithm)
- Eliminated fill values

QC
- Main algorithm, no saturation
- Main algorithm with saturation
- Back-Up algorithm
- Fill value
Major Crop Types (Biome 3)

- AGRO cropland site in IL, USA
- Retrieved LAI is consistent with field measurements
- Increased rate of best quality retrievals (main algorithm)
- Eliminated fill values
Savannah (Biome 4)

- Mongu savannah site in Bolivia, South Africa
- LAI is nearly unchanged
- Corrected FPAR overestimation

QC
- Main algorithm, no saturation
- Main algorithm with saturation
- Back-Up algorithm
- Fill value
Deciduous Broadleaf Forests (Biome 6)

- Harvard forest broadleaf forest site in MA, USA, and broadleaf forest site in WI, USA
- More accurate LAI seasonal cycle
- Increase in best quality (main algorithm) retrievals
**Evergreen Needle leaf Forests (Biome 7)**

- NOBS needle leaf forest site in Canada and Canada-wide LAI product from CCRS
- Resolved LAI overestimation at regional scale
- Increase in best quality (main algorithm) retrievals
- Eliminated fill values during winter

**QC**
- Main algorithm, no saturation
- Main algorithm with saturation
- Back-Up algorithm
- Fill value
Future Work (Collection 6 Enhancements)

- Minimize spurious seasonality in needle leaf forests (due to snow, low SZA)
  - improved simulations with stochastic RT model with snow patterns as background
  - research on impact of low SZA on MODIS surface reflectances at high Northern latitudes

- Improving retrievals over mixed forests
  - reference MODIS continuous fields LC product to evaluate LC mixture
  - utilize Stochastic Mixture RT model to perform retrievals over mixed forests

- Optimization of retrievals with SWIR data
  - analyze MODIS SWIR data for information content/noise
  - implement SWIR LUTs with stochastic RT model and test retrievals
  - potential areas of improvements: Northern high latitudes evergreen needle leaf forests and broadleaf evergreen forest in Amazonia and Central Africa

- Development of high resolution (250-m) LAI/FPAR products
  - research on impact of landcover on retrievals (250-m vs 1-km)
  - research on consistency of MODIS 250-m and 1-km surface reflectances
  - evaluate consistency of 250-m and 1-km LAI/FPAR retrievals
Collection 5 MODIS Terra 8-day, LAI/FPAR product

LAI

0.0
0.1
0.5
0.8
1.0
1.5
2.5
3.0
4.0
5.0
6.0
7.0

FPAR

0.00
0.10
0.20
0.25
0.35
0.40
0.50
0.60
0.65
0.75
0.85
1.00

LAI: MOD15A2, Collection 5
1-km, 8-day, March 30 - April 06, 2000

FPAR: MOD15A2, Collection 5
1-km, 8-day, March 30 - April 06, 2000