

Collection 5 MODIS LAI and FPAR Products

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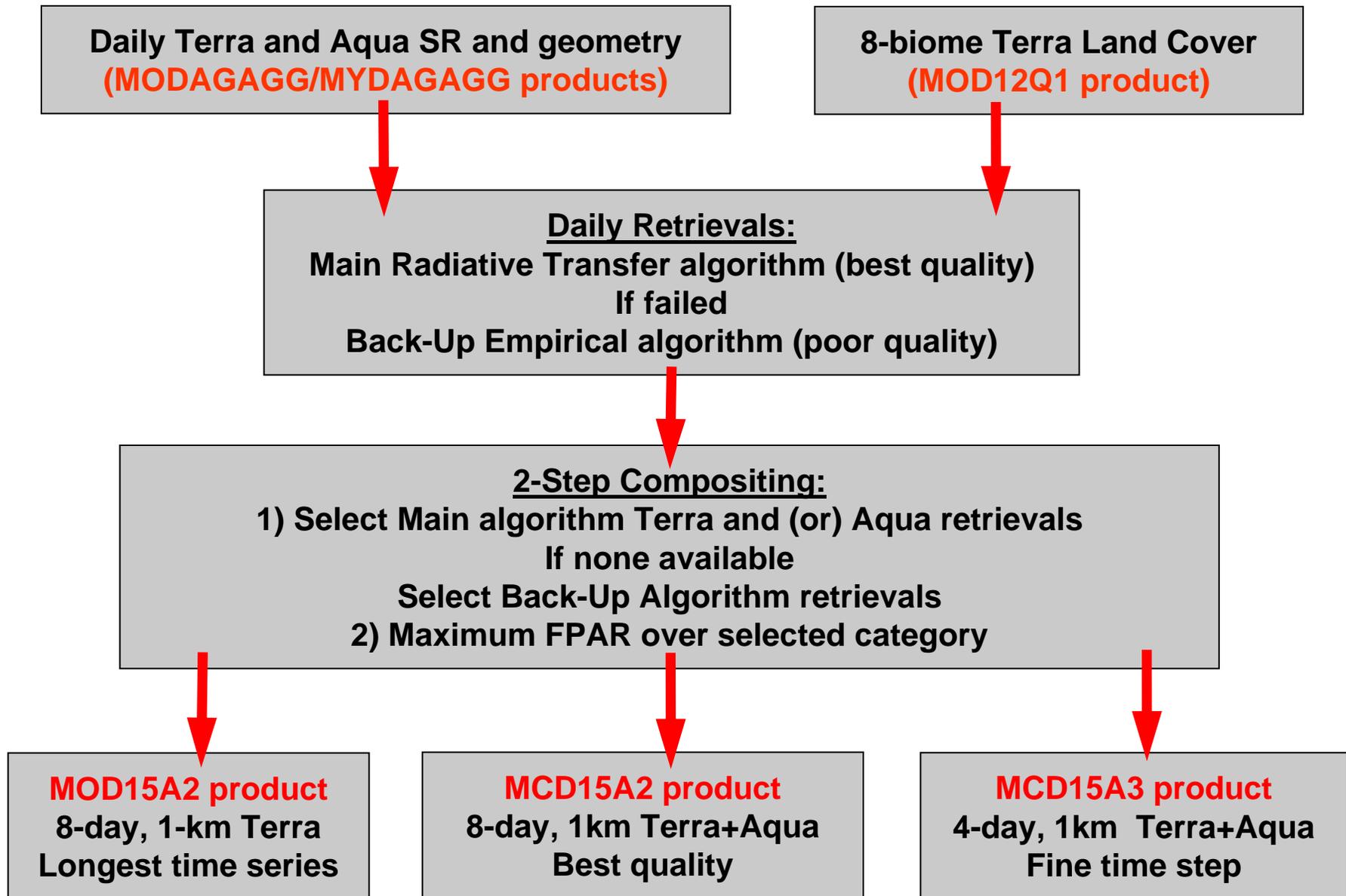
P. Votava, R. Nemani /NASA Ames Research Center



MODIS STM, University of Maryland, MD,

January 17-18, 2007

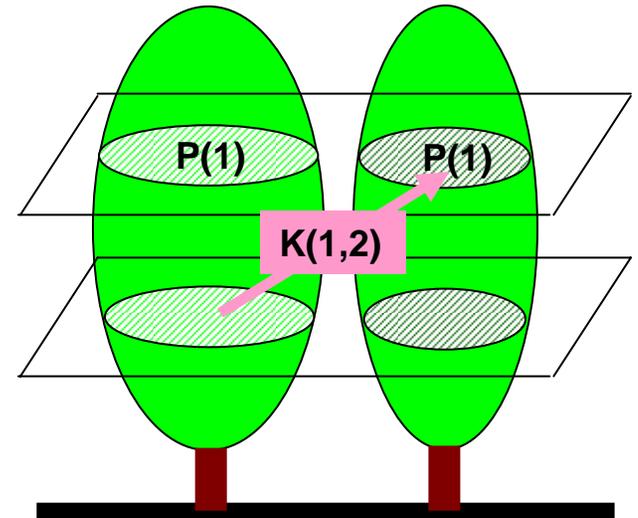
Production of the Suite of MODIS Collection 5 LAI/FPAR Products



Collection 5 Science Improvements

- **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

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- Shabanov et al. (2000). Stochastic Modeling of Radiation Regime in Discontinuous Vegetation Canopies. *RSE*, 74(1): 125-144.
 - Huang et al. (2006). Stochastic Transport Theory for Investigating the Three-Dimensional Canopy Structure from Space Measurements, *RSE*, accepted.
 - Shabanov et al. (2007). Stochastic Radiative Transfer Model for Mixture of Discontinuous Vegetation Canopies. *JQSRT*, in review.

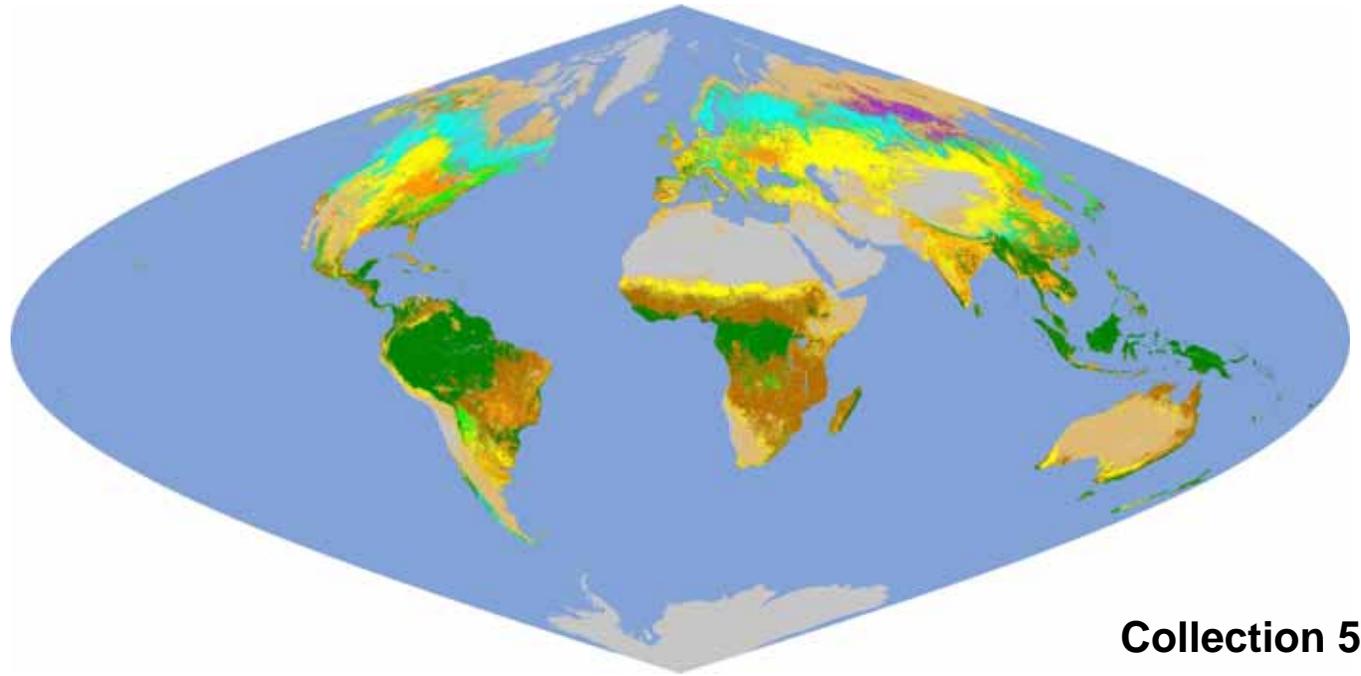
Collection 5 Product Format Changes

- **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)**

Input Land Cover Map

LC

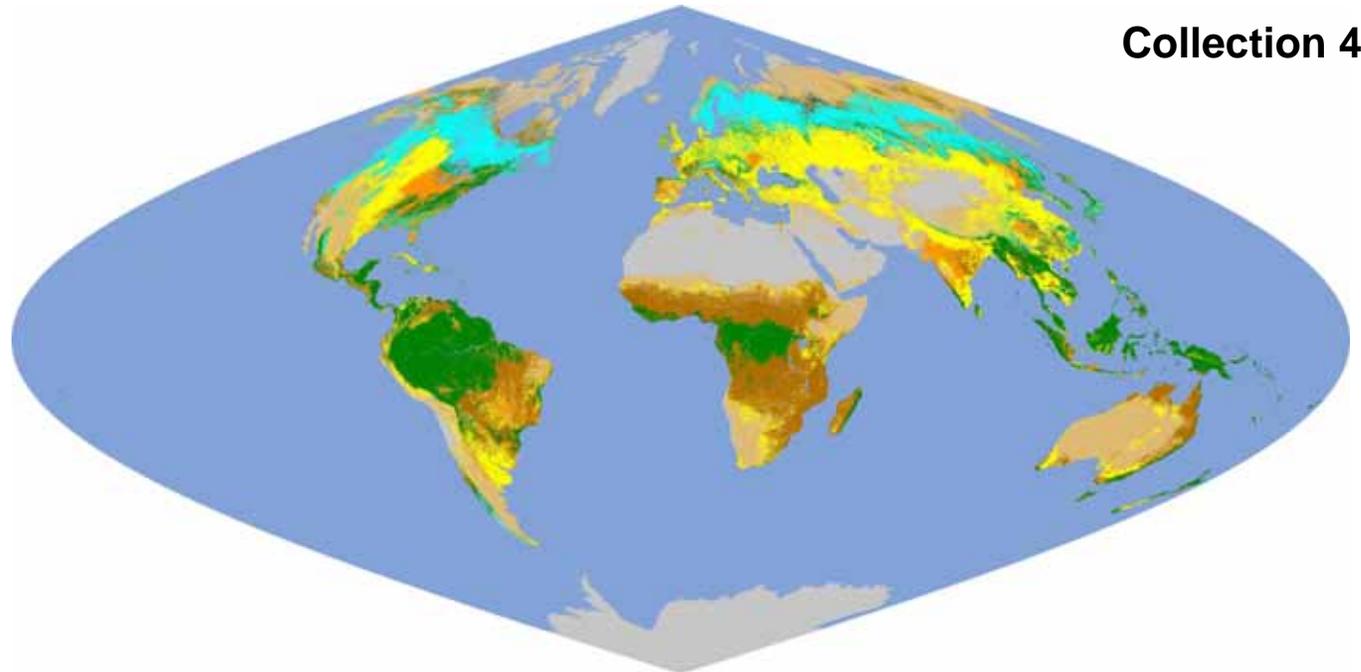
- (0) Water
- (1) Grasses/cereal crops
- (2) Shrubs
- (3) Broadleaf crops
- (4) Savannah
- (5) Broadleaf forest
- (6) Needle leaf forest



Collection 5

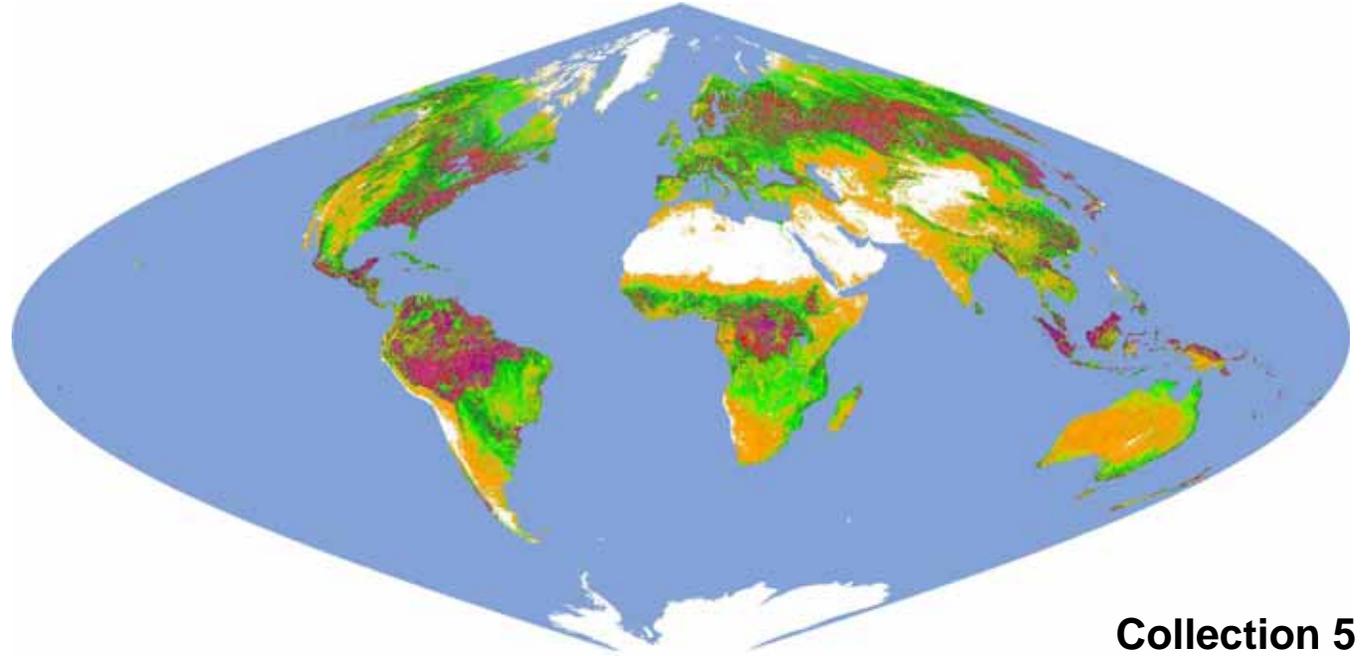
LC

- (0) Water
- (1) Grasses/cereal crops
- (2) Shrubs
- (3) Broadleaf crops
- (4) Savannah
- (5) Evergreen Broadleaf forest
- (6) Deciduous Broadleaf forest
- (7) Evergreen Needle leaf forest
- (8) Deciduous Needle leaf forest



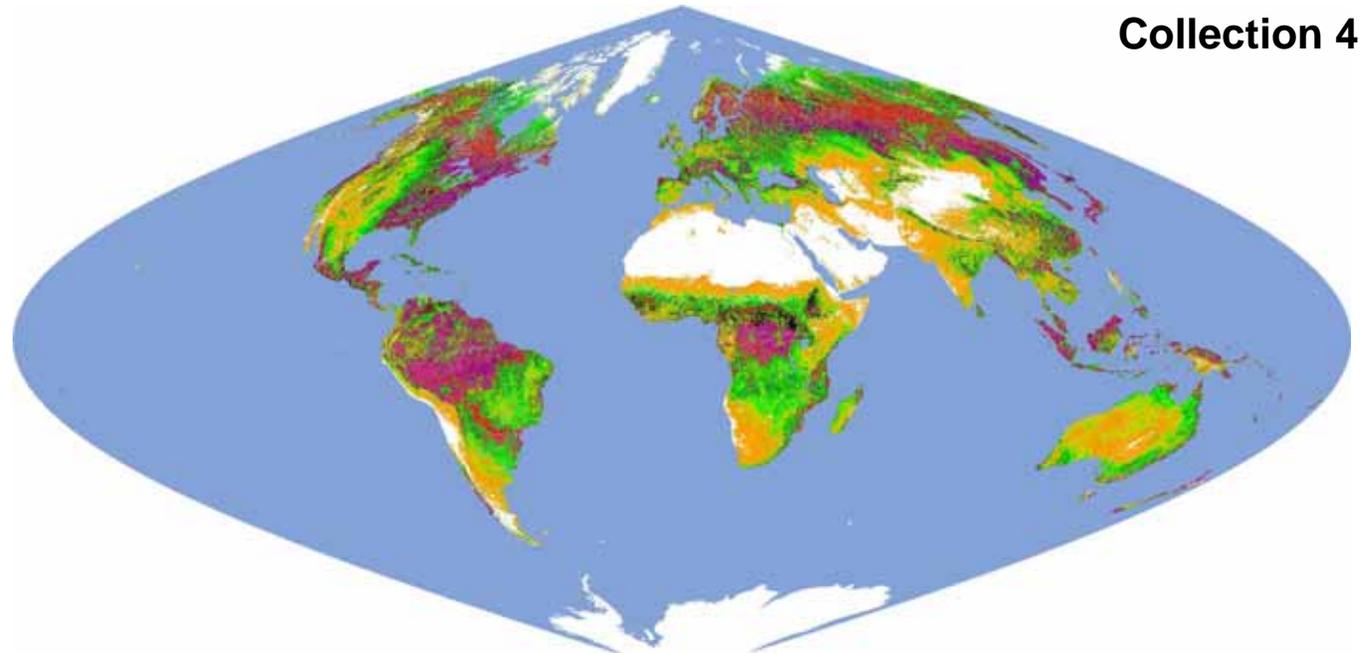
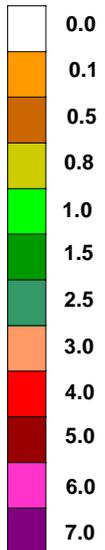
Collection 4

Terra 8-day LAI (185-192.2000)



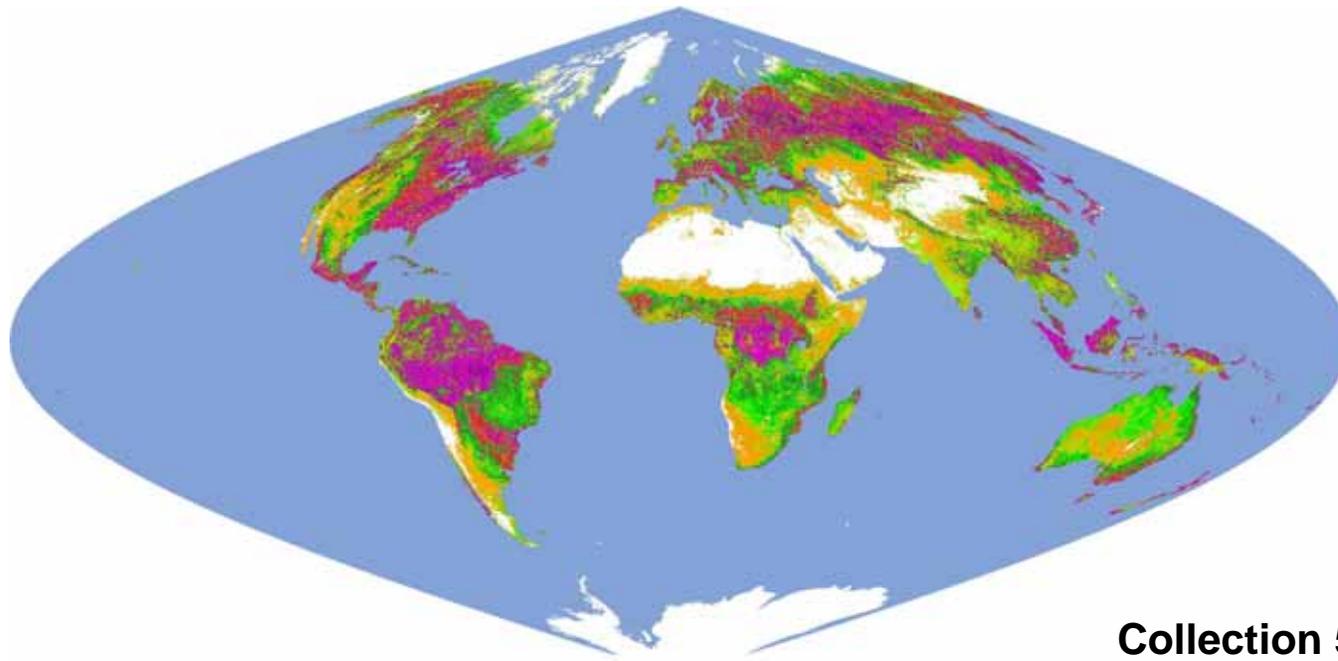
Collection 5

LAI



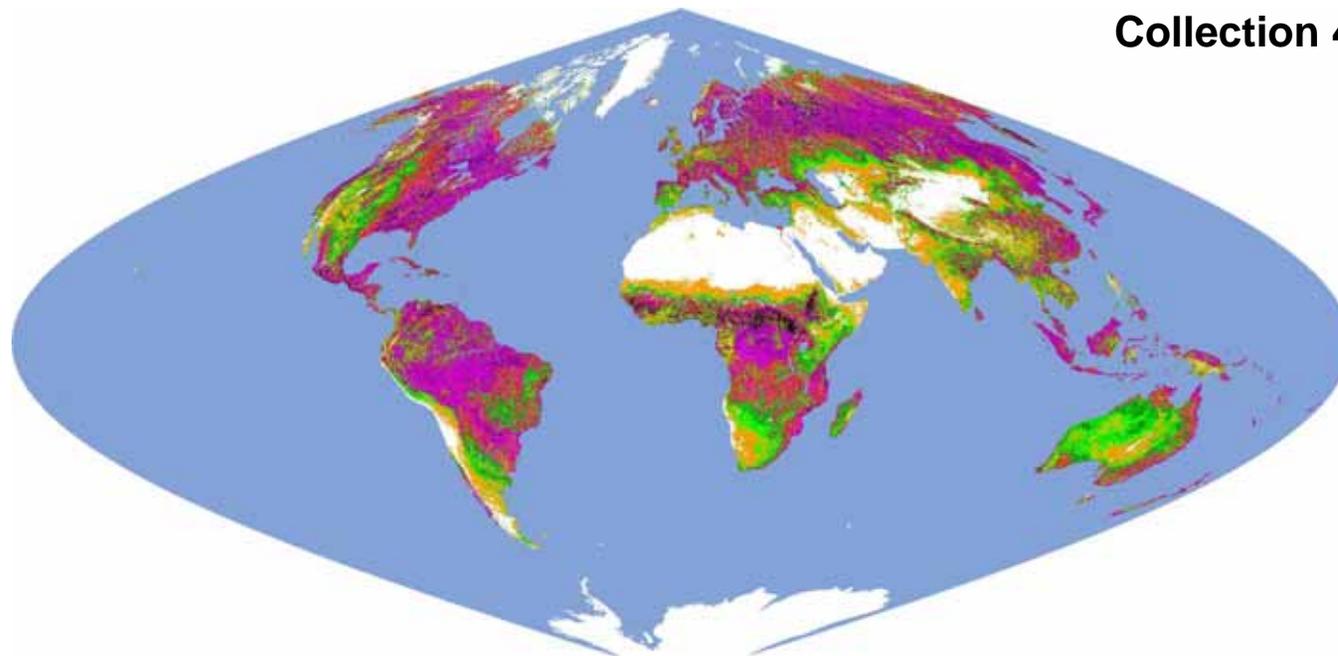
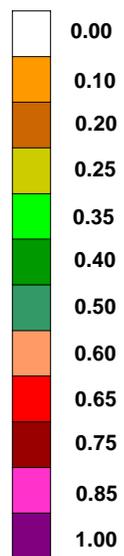
Collection 4

Terra 8-day FPAR (185-192.2000)



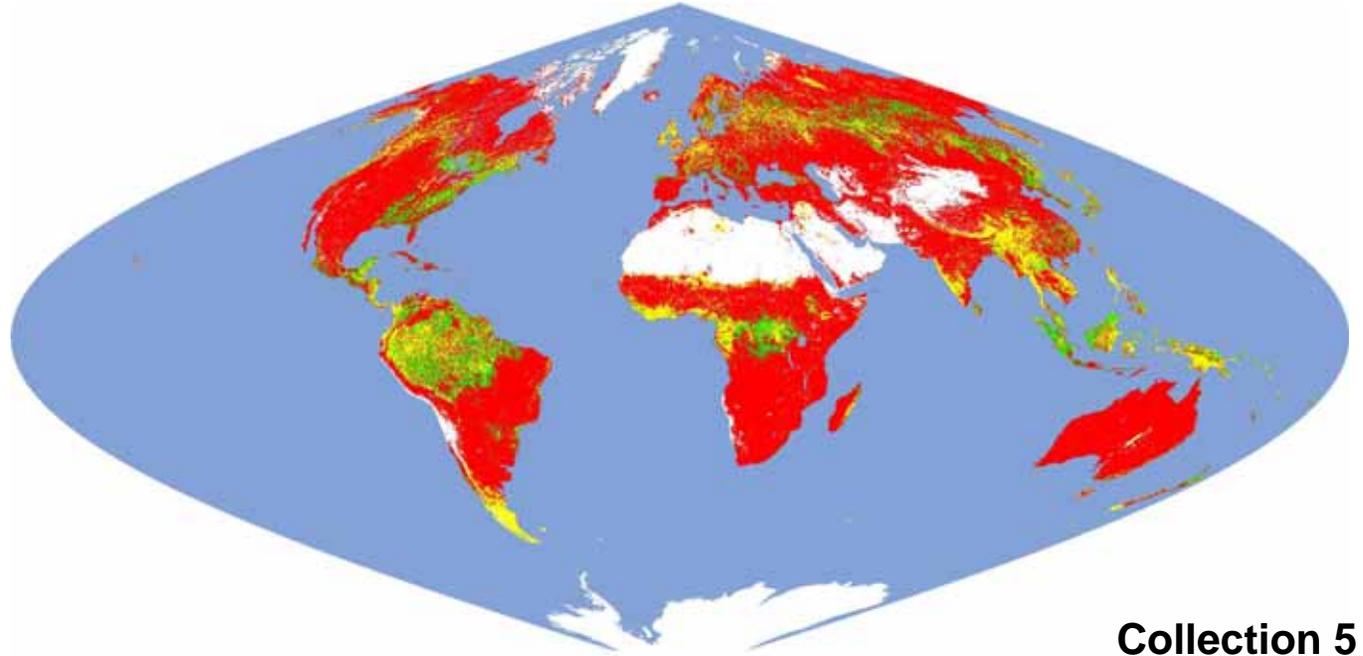
Collection 5

FPAR

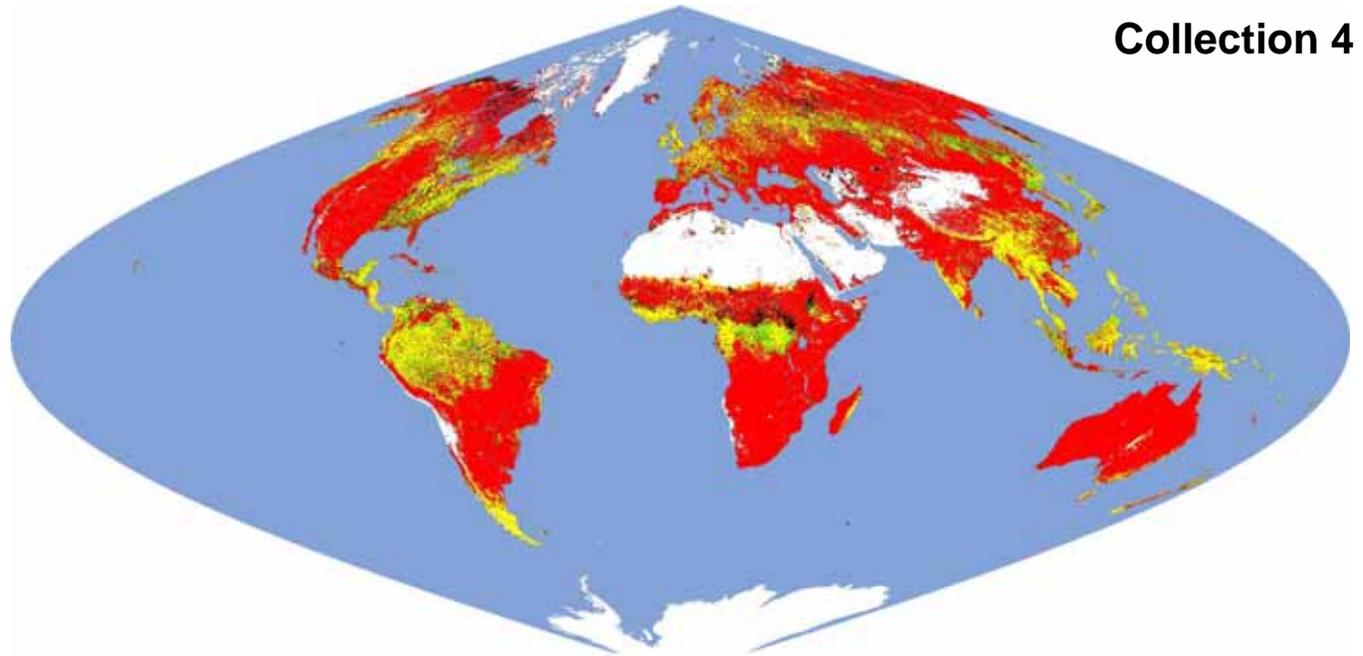


Collection 4

Terra 8-day QC (185-192.2000)

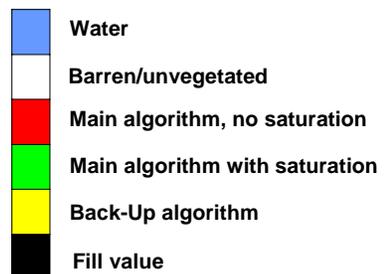


Collection 5



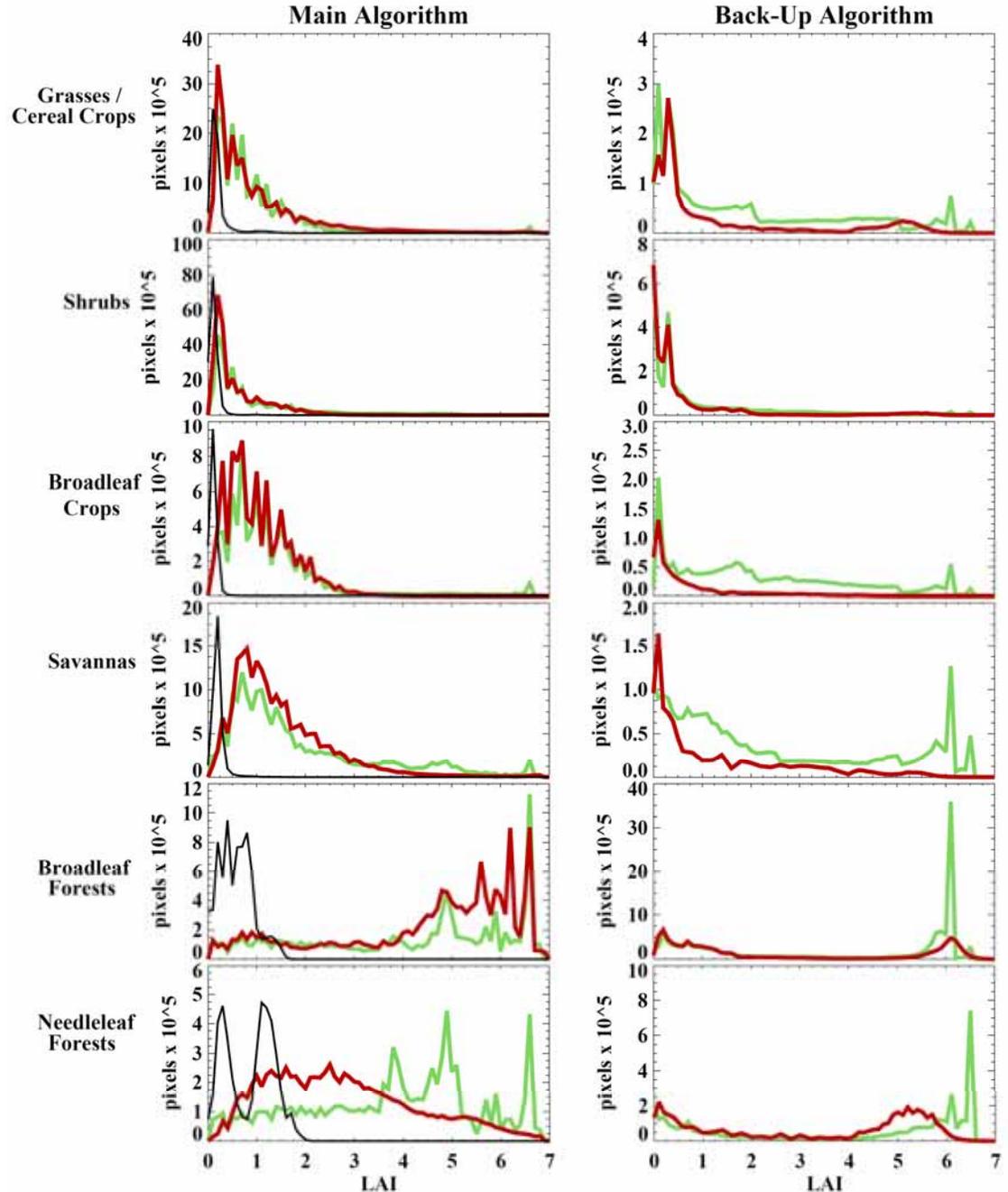
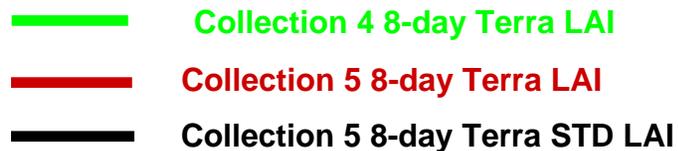
Collection 4

QC



Collection 4 vs. Collection 5 Terra 8-day LAI (185-192.2000)

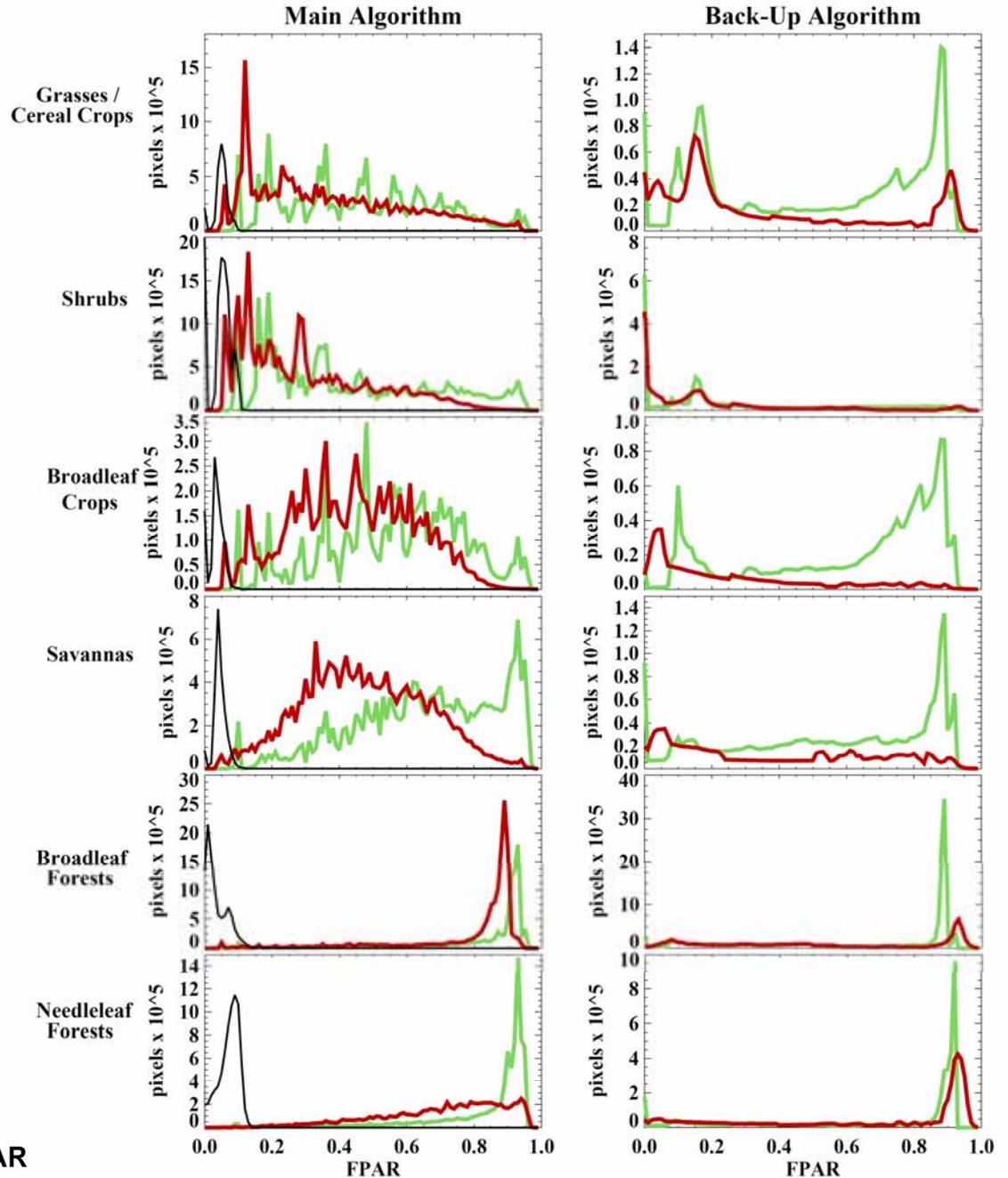
- Collection 4 and 5 LAI retrievals over herbaceous vegetation are quite similar.
- Increase amount of best quality retrievals over broadleaf forests
- Corrected LAI overestimation over needle forests



Collection 5 vs. Collection 4 Terra 8-day FPAR (185-192.2000)

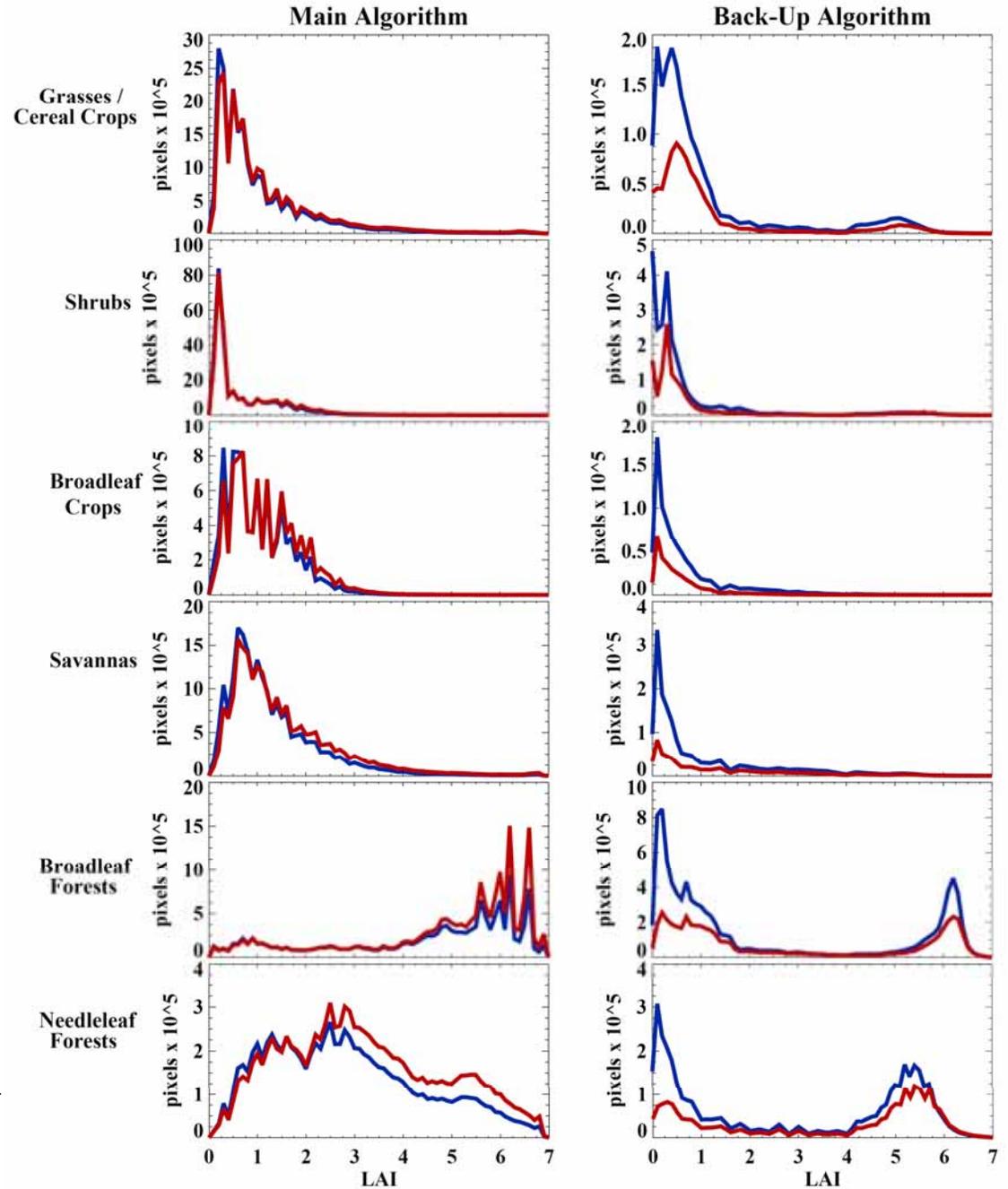
- Decreased FPAR over herbaceous biomes (especially over savannah)
- Improvements are seen in main and back-up algorithm retrievals

█ Collection 4 8-day Terra FPAR
█ Collection 5 8-day Terra FPAR
█ Collection 5 8-day Terra STD FPAR



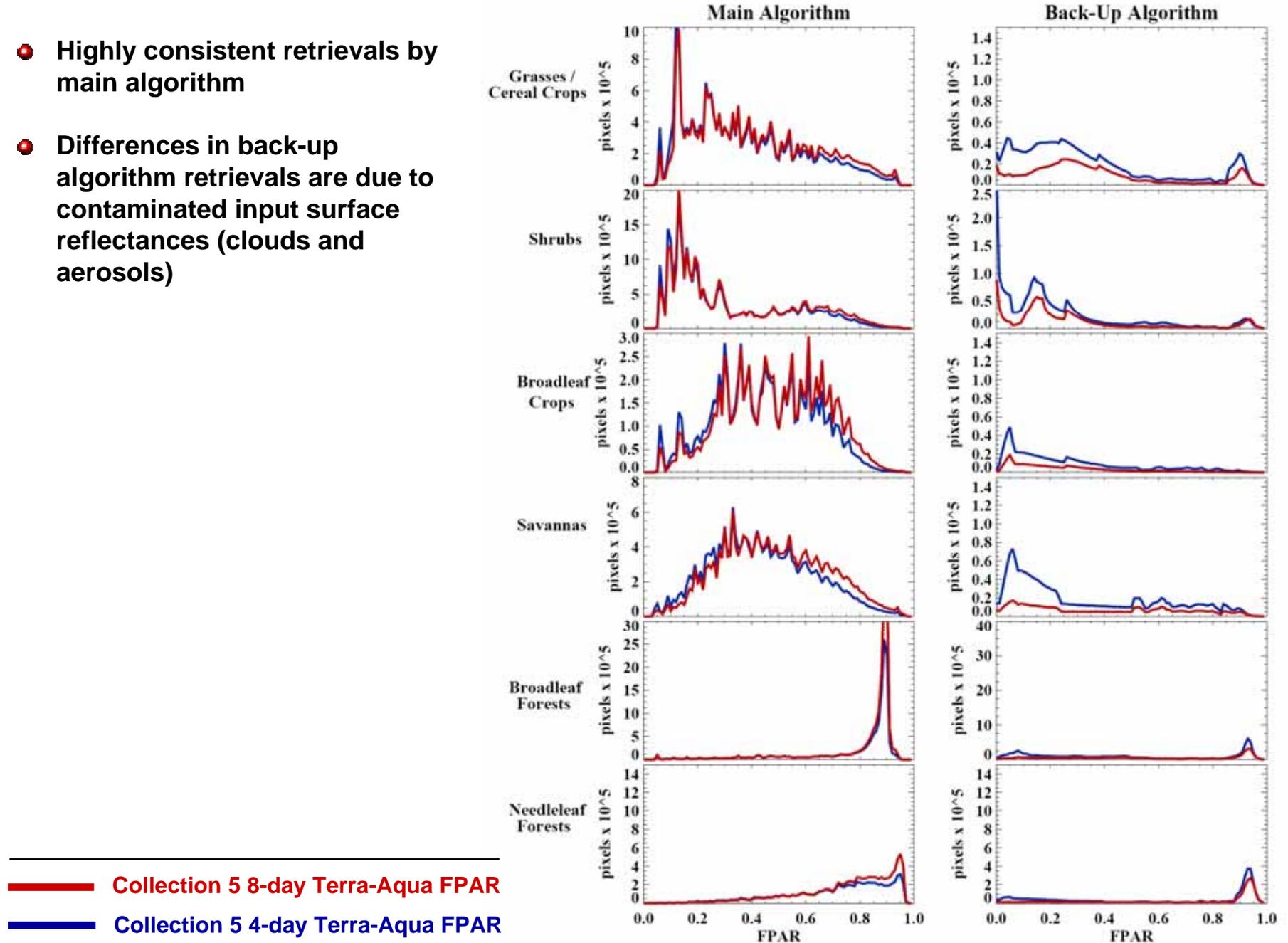
8-day vs. 4-day Collection 5 Combined LAI (201-208.2003)

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



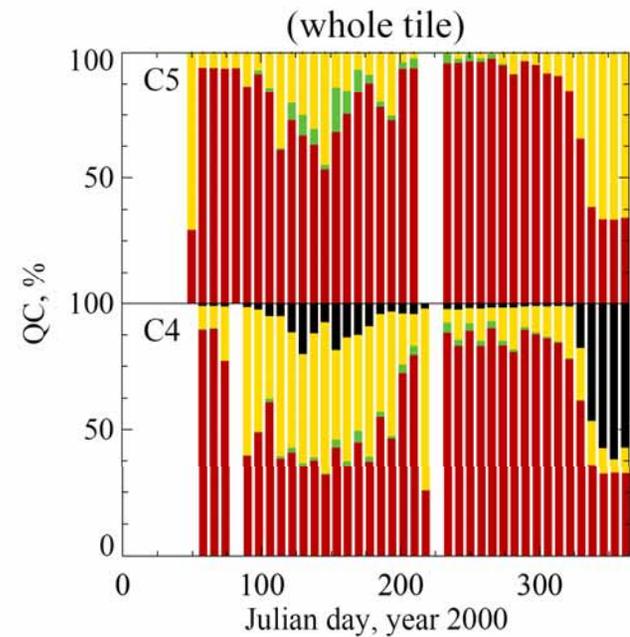
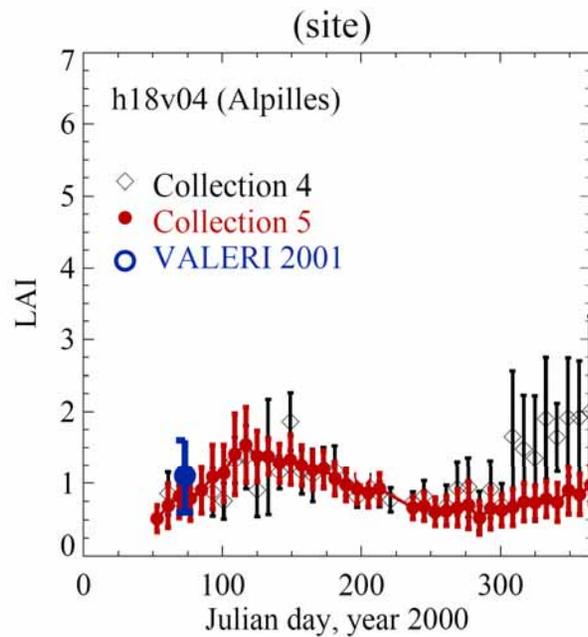
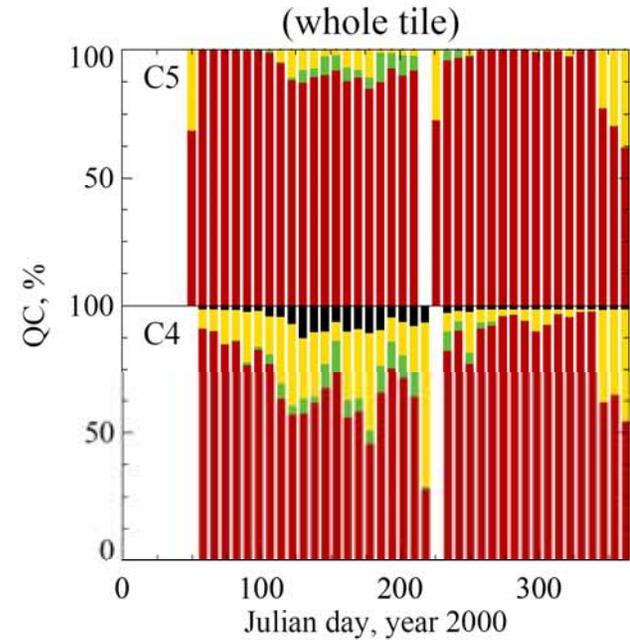
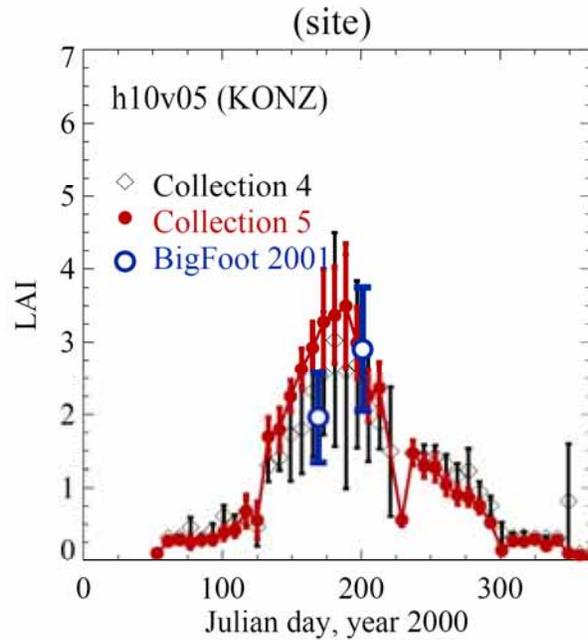
8-day vs. 4-day Collection 5 Combined FPAR (201-208.2003)

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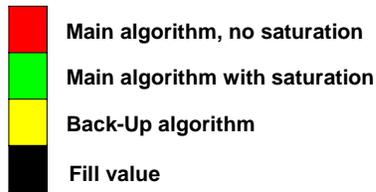


Grasses & Cereal Crops (Biome 1)

- 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

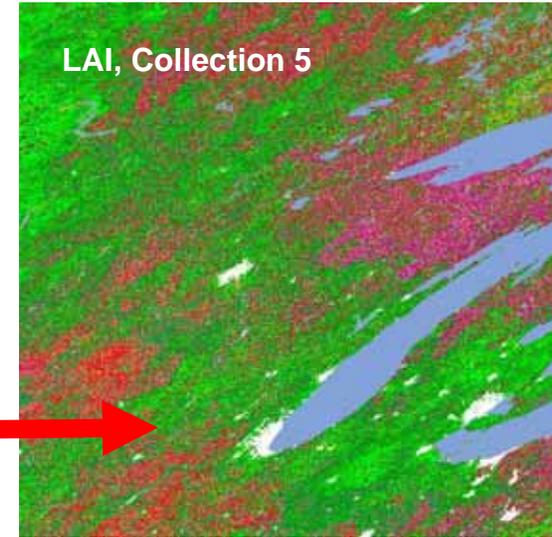
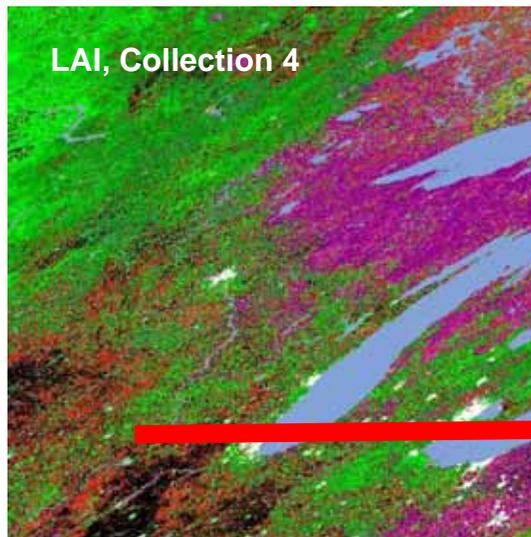
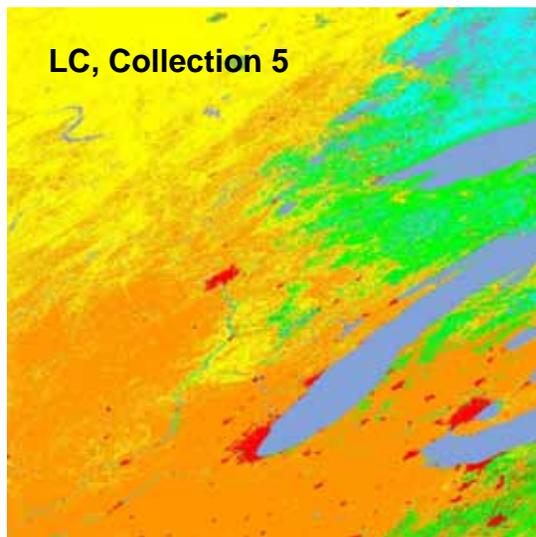
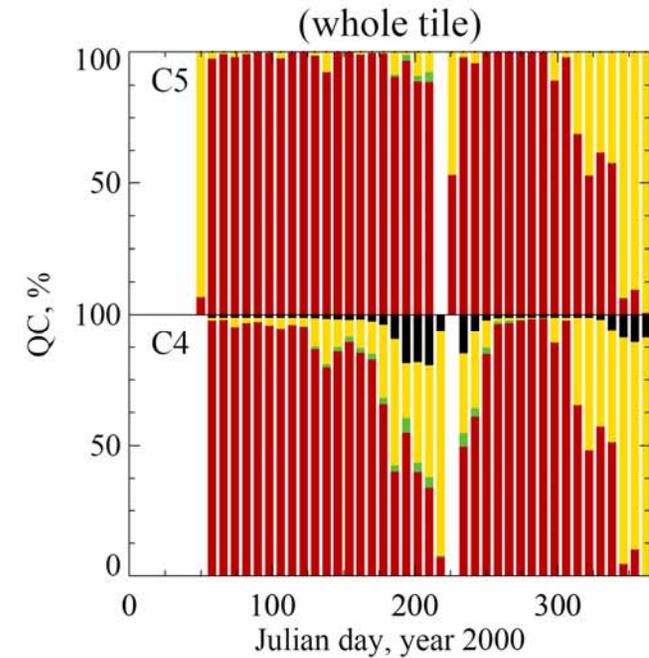
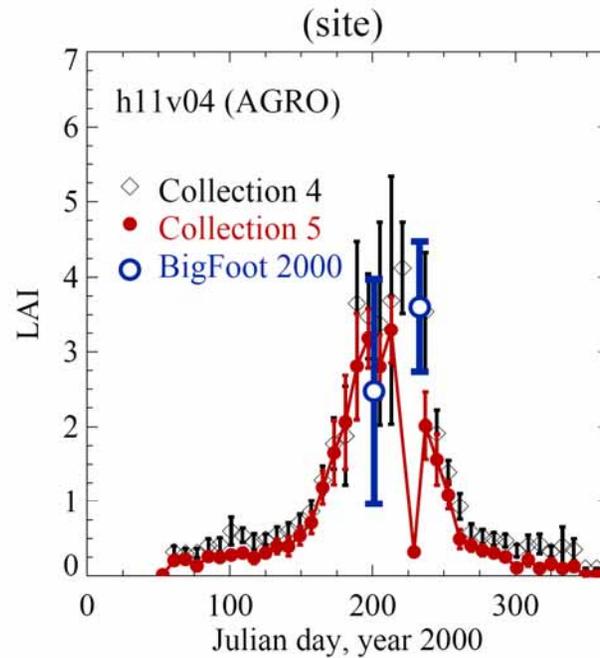


QC



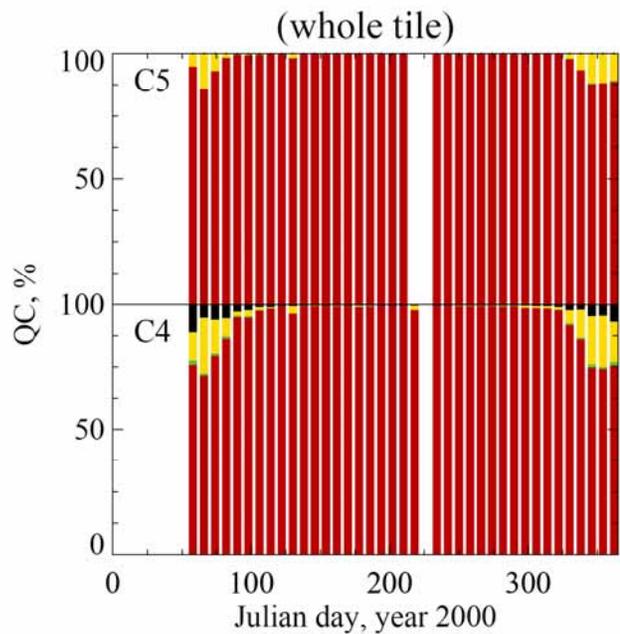
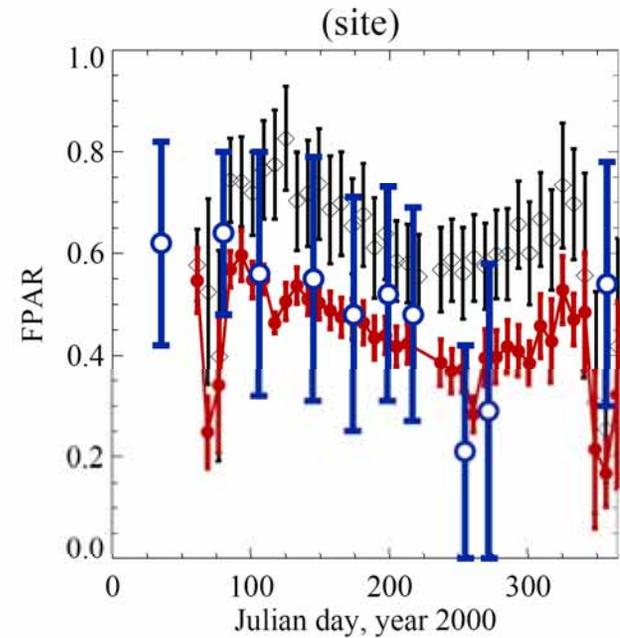
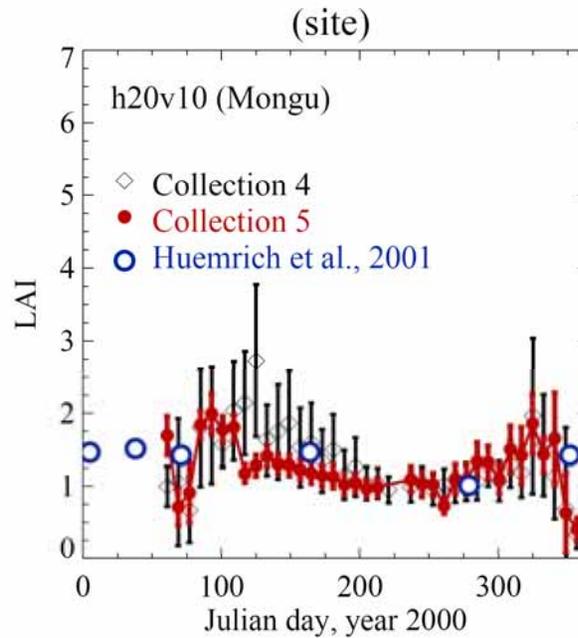
Broadleaf Crops (Biome 3)

- **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

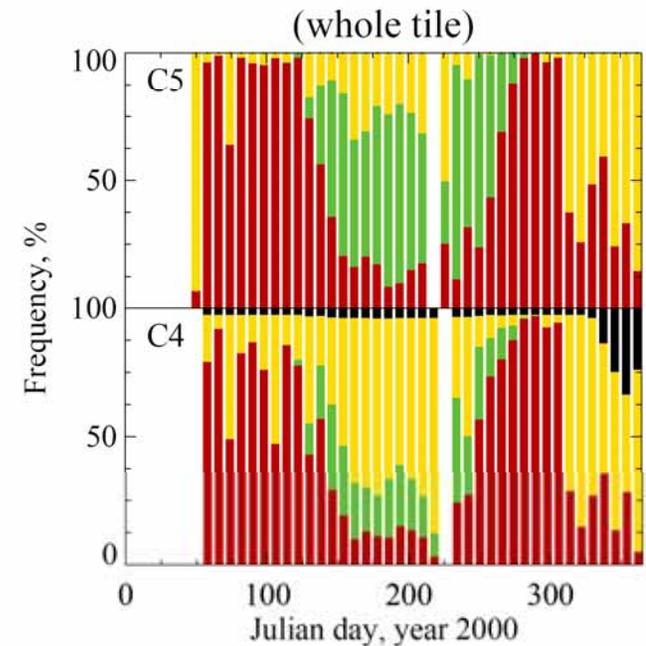
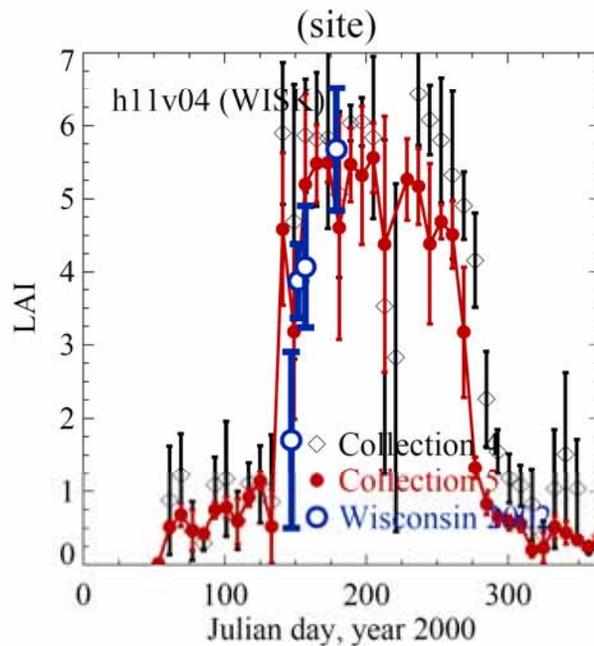
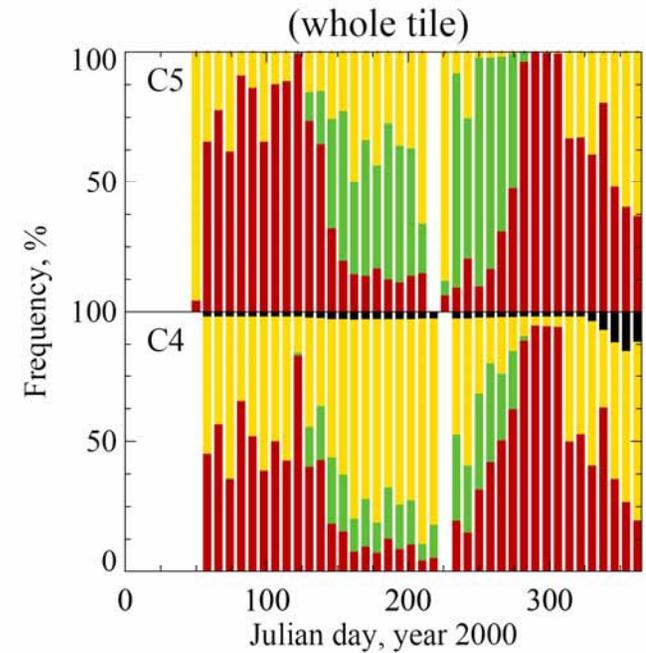
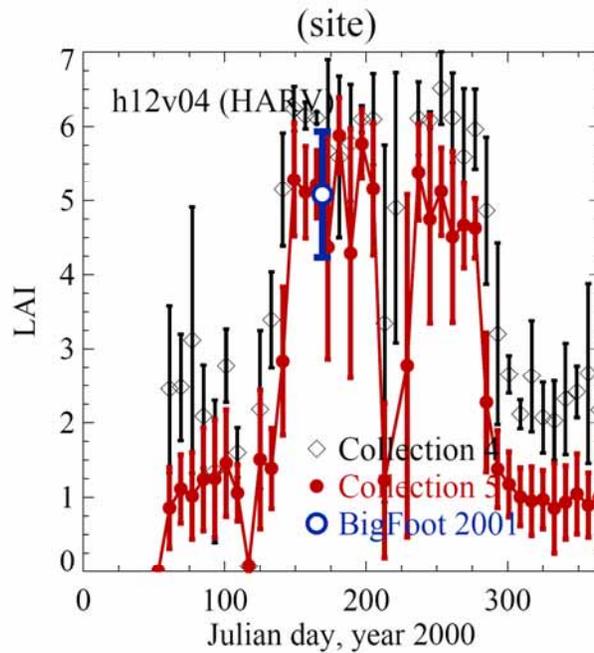


QC

- 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

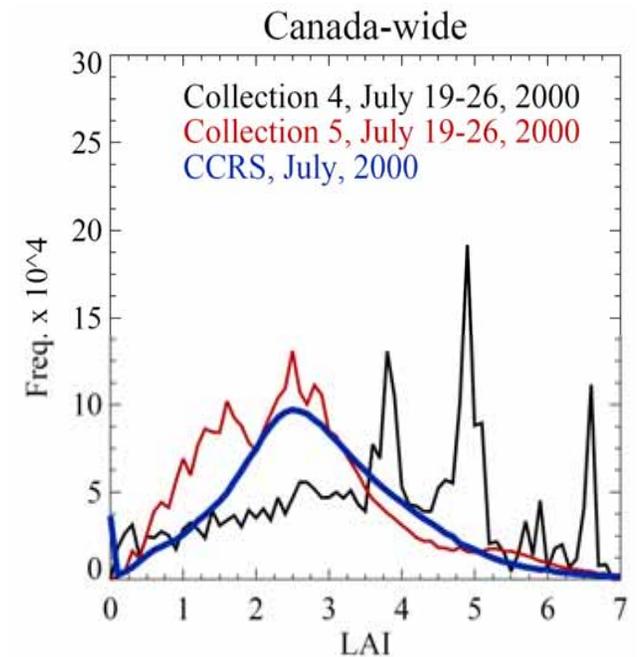
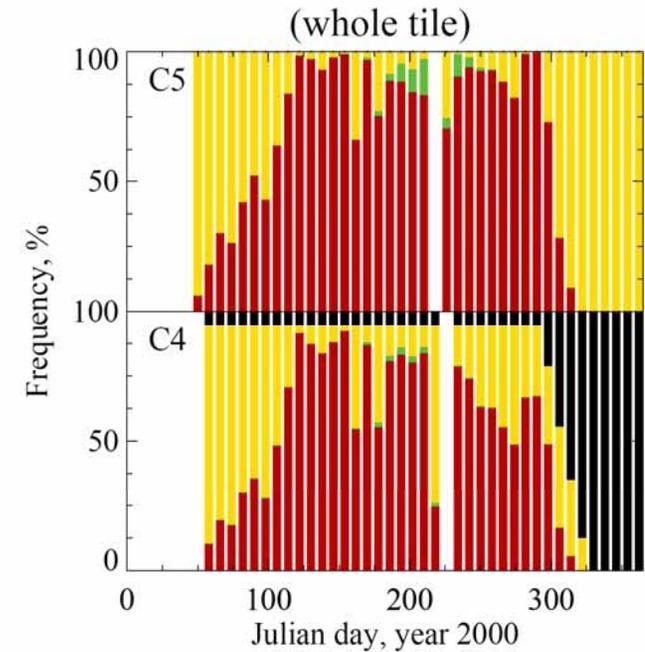
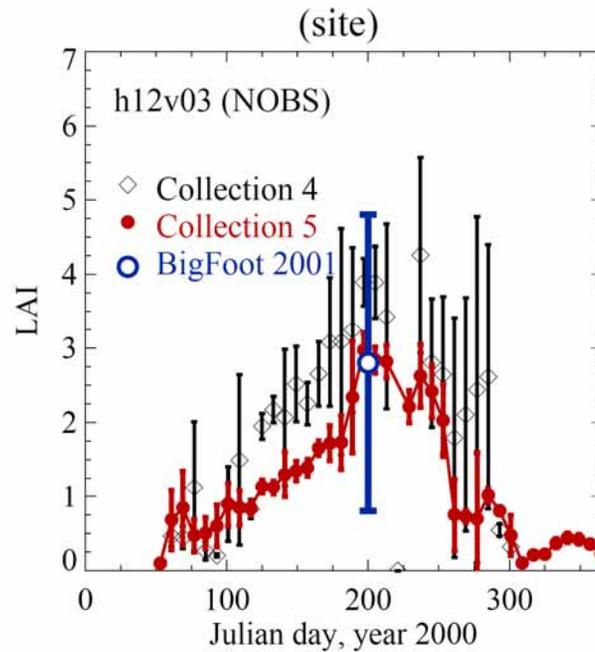


QC

- Main algorithm, no saturation
- Main algorithm with saturation
- Back-Up algorithm
- Fill value

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

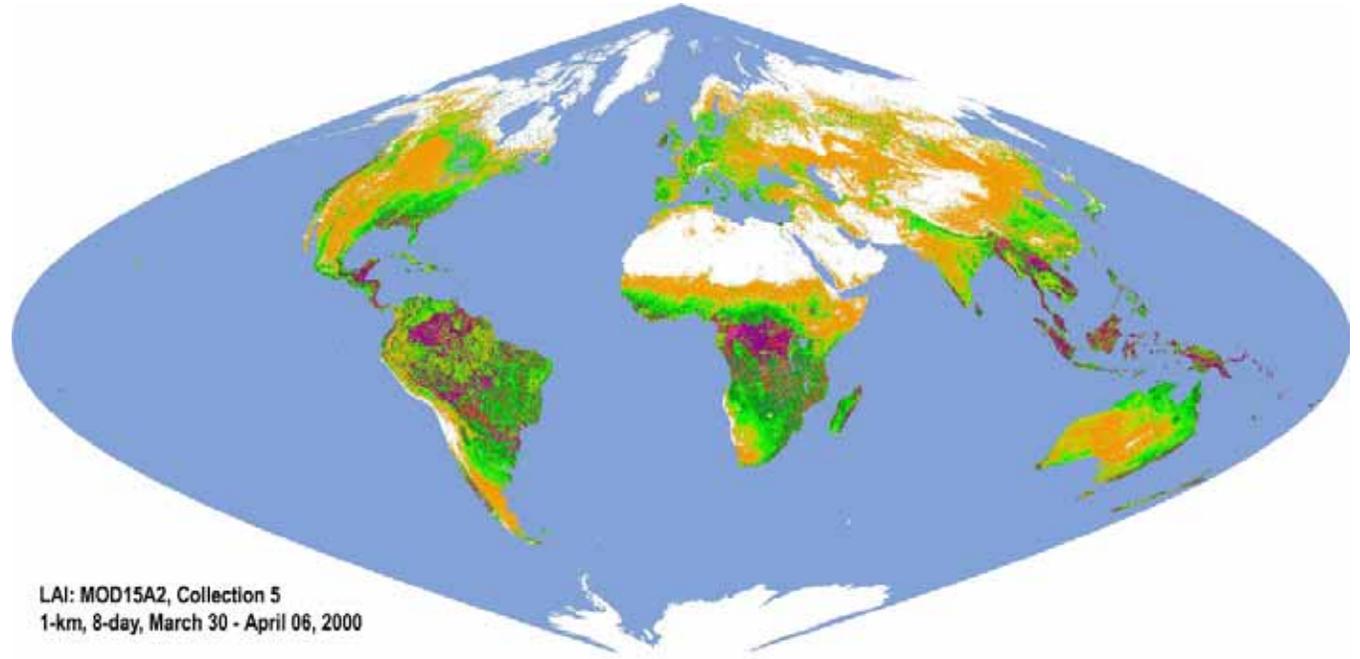
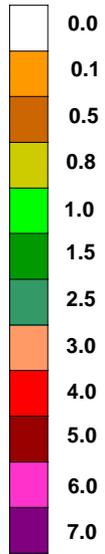
- Main algorithm, no saturation
- Main algorithm with saturation
- Back-Up algorithm
- Fill value

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



FPAR

