Land Surface Product Climatologies for the Data Assimilation Project: Preliminary Results from MODIS

Hongliang Fang[1], Shunlin Liang[1], John Townshend[1], Robert Dickinson[2]

[1]Department of Geography, University of Maryland, College Park, Maryland, 20742
[2]Earth & Atmospheric Science, Georgia Institute of Technology, Atlanta, Georgia, 30332

Introduction

Land surface products are being produced by multiple EOS instruments, separately. Estimating a set of atmospheric and surface variables from one instrument is often an ill-posed inversion problem. Thus, one has to make assumptions while trying to obtain realistic solutions, and as a result, most products need significant improvements. Furthermore, different products of land variables from different inversion algorithms are physically inconsistent for most cases.

We are developing a prototype data assimilation system to generate an improved suite of land products from multiple EOS data sets, such as broadband albedos, leaf area index (LAI), temperature, and so on. It will also generate new products, such as new broadband albedos, incident radiation, broadband emissivities, and shortwave and longwave net radiation. The methodologies are shown in Figure 1, and this poster describes the progress in developing land surface climatologies from MODIS products.

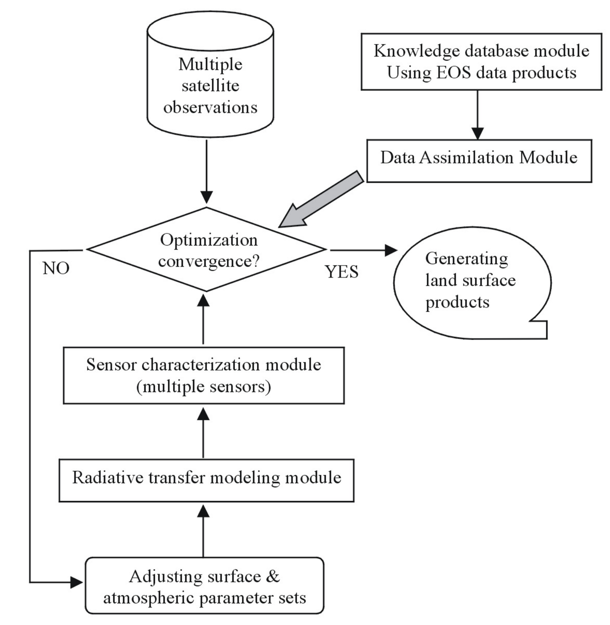

Figure 1. Illustration of the data assimilation system

Land surface climatology

The general idea is to use the surface and atmospheric radiation models with parameters that are adjusted to optimally reproduce the spectral radiance received by the EOS sensors. Such adjustments are made by identifying reasonable close "first guesses" for the model parameters and determining statistically optimum estimates of the parameters. The first guesses are the land product climatologies. Figures 2, 3 and 4 show the climatological (average) values of surface albedo (MOD43B3), LAI (MOD15A2), surface emissivity and temperature (MOD11B1), respectively. The climatological values and the error matrices computed from the current EOS standard products are composed into a knowledge database. By imposing the physical laws (radiative transfer modeling) and constraints to the top-of-atmosphere (TOA) radiance, we will be able to improve these products significantly.

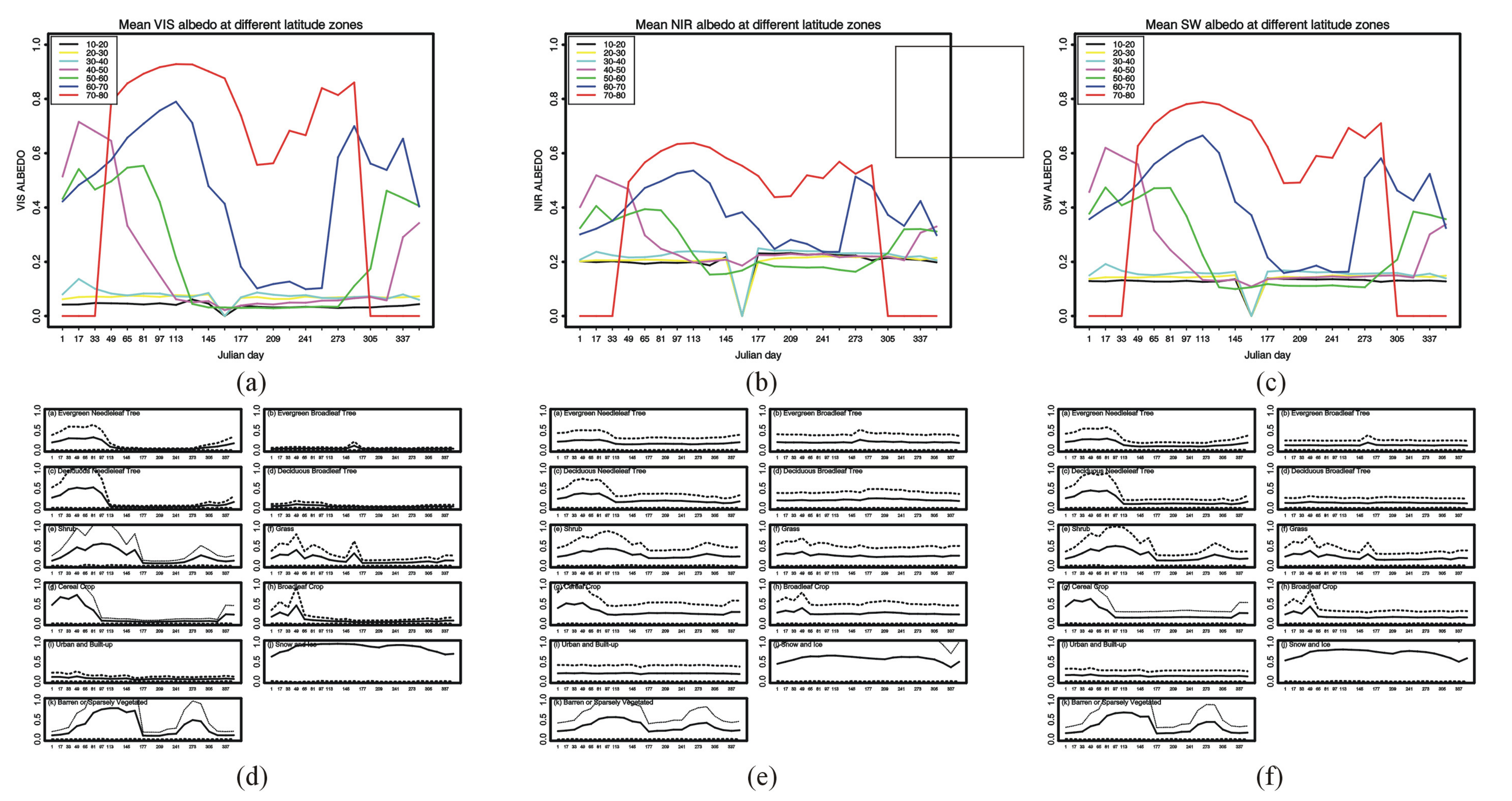

Figure 2. Albedo climatologies for North America, 2001. (a), (b), and (c) are mean albedos at different latitude zones for visible, near-infrared and total shortware bands, respectively. (d,) (e), and (f) are mean albedos and their standard deviation for different Plant Functional Types (PFT) for visible, near-infrared and total shortwave bands, respectively. The PFT is from the MODIS land cover products (land cover type 5).

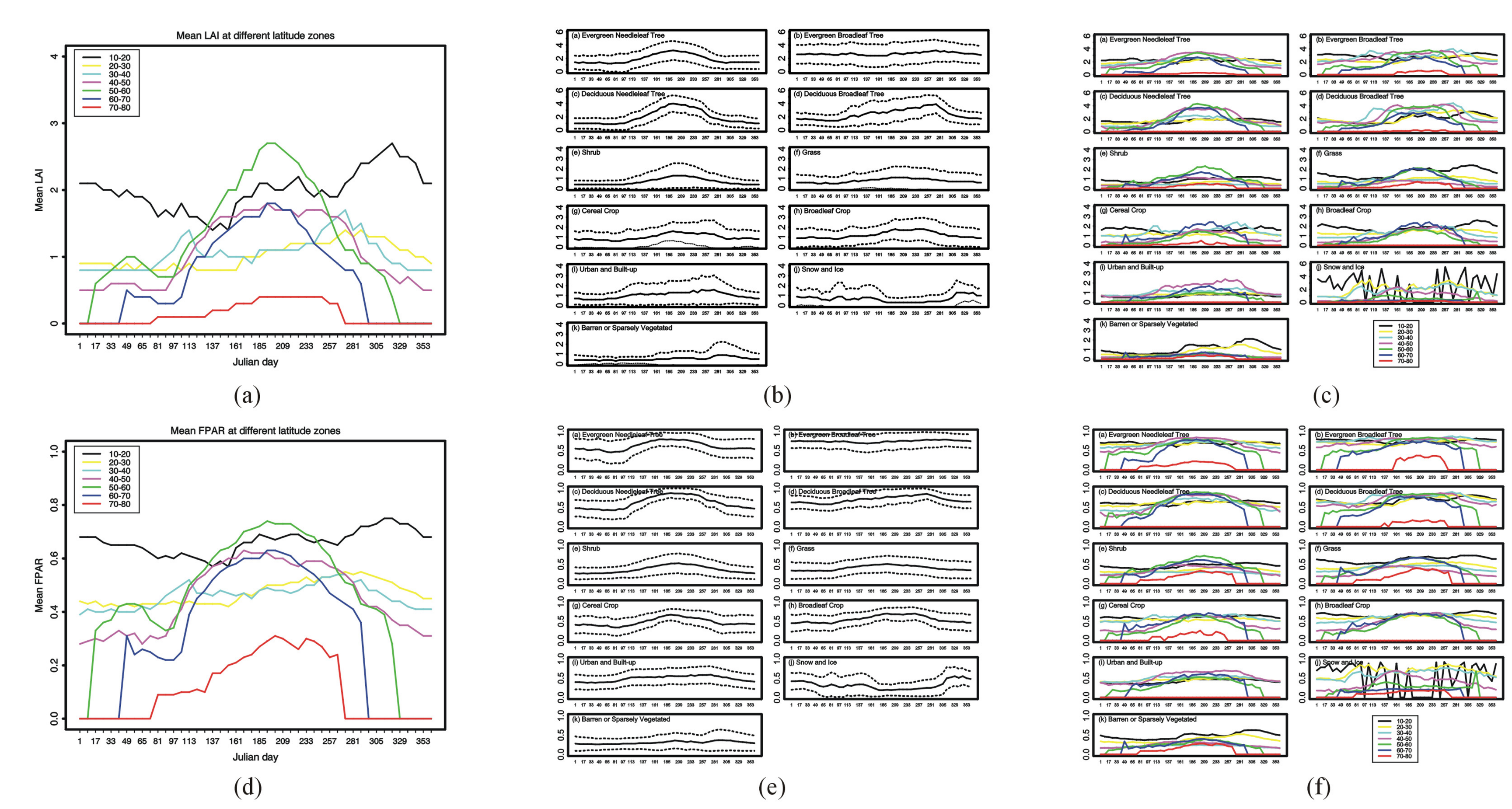

Figure 3. LAI/FPAR climatologies for North America, 2000-2004. (a). Mean LAI at different latitude zones; (b) Mean LAI for different Plant Functional Types; (c) Mean LAI for different PFT at different latitude zones; (d) Mean FPAR different latitude zones; (d) Mean FPAR for different Plant Functional Types; (f) Mean FPAR for different PFT at different latitude zones.

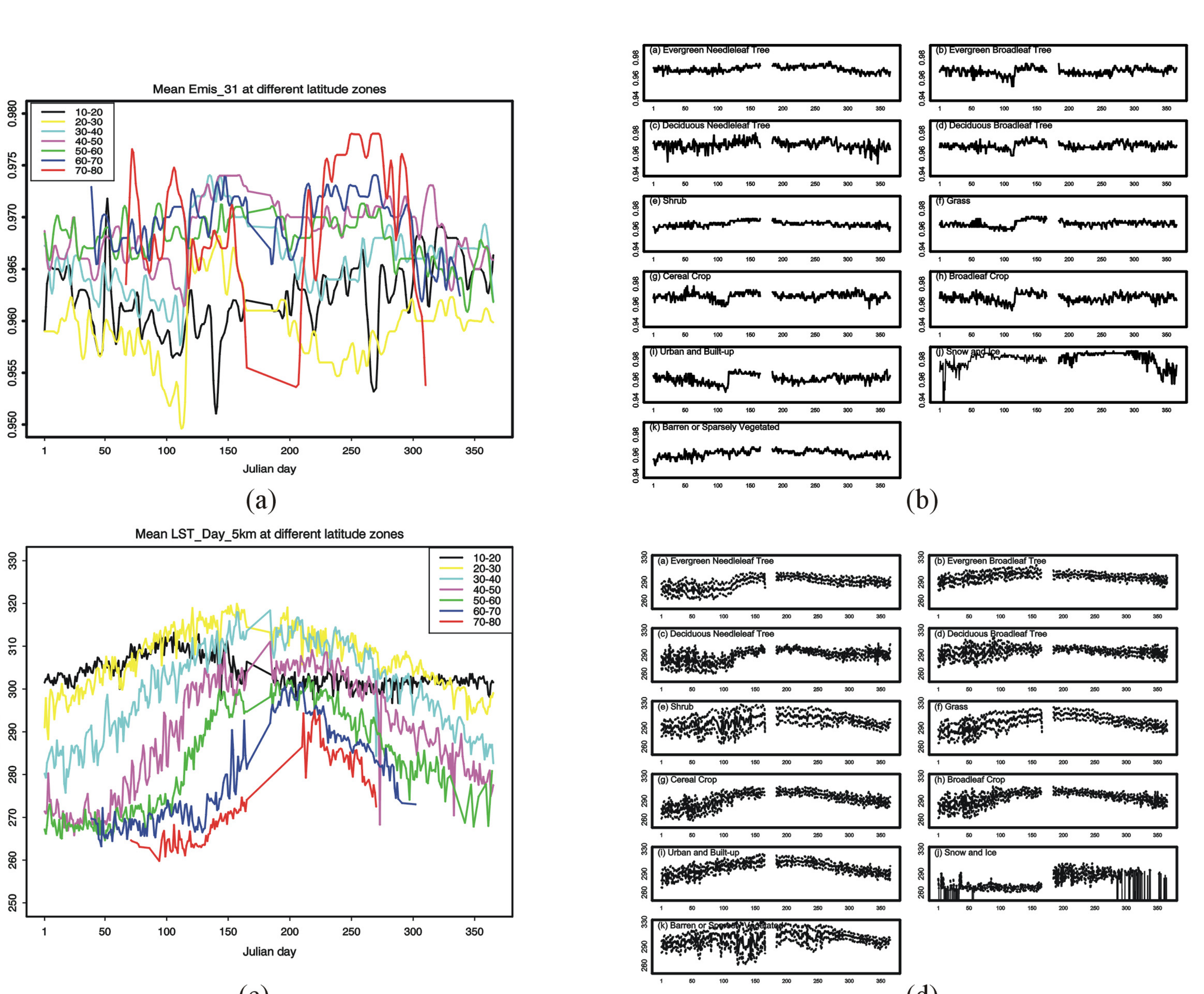

Figure 4. Emissivity and land surface temperature climatologies for North America, 2001. (a) Emissivity (band 31) at different latitude zones; (b) Emissivity (band 31) for different PFTs. (c) Daytime land surface temperature (5km) at different latitude zones; and (d) Daytime land surface temperature (5km) for different PFTs.

Land surface continuous data sets

Most current land products are not continuous in both space and time because of a variety of reasons (e.g., cloud contamination, insufficient number of data points for retrieval). Although the QA (quality assurance) layers are useful, both good and bad retrievals are mixed in the data layers. We developed a data assimilation filter (DAF) to provide continuous data sets for climate modelers and other users. The general idea of this DAF for LAI is shown in Figure 5. Based on the QC examination, the missing pixel is filled with its multi-year average first. Then, an improved ecosystem curve fitting (ECF) method based on vegetated continuous field (VCF) is applied. Using the results from the above as the background value, and the MODIS raw LAI as the observed ones, the DAF integrate the pixel's multi-year trend and yearly variation. Some preliminary results are shown below. Figure 6 shows the improved LAI products over North America. On day 225, 2001, the MODIS raw LAI data were of very low quality due to large cloud coverage (Fig 6a). Our new value-added products are spatially complete and greatly improved the data quality and their utility (Fig. 6b). In year 2001, there are no LAI data for days 169 due to instrument problems. The LAI of this day was restored with the DAF technique (Fig. 6c) .

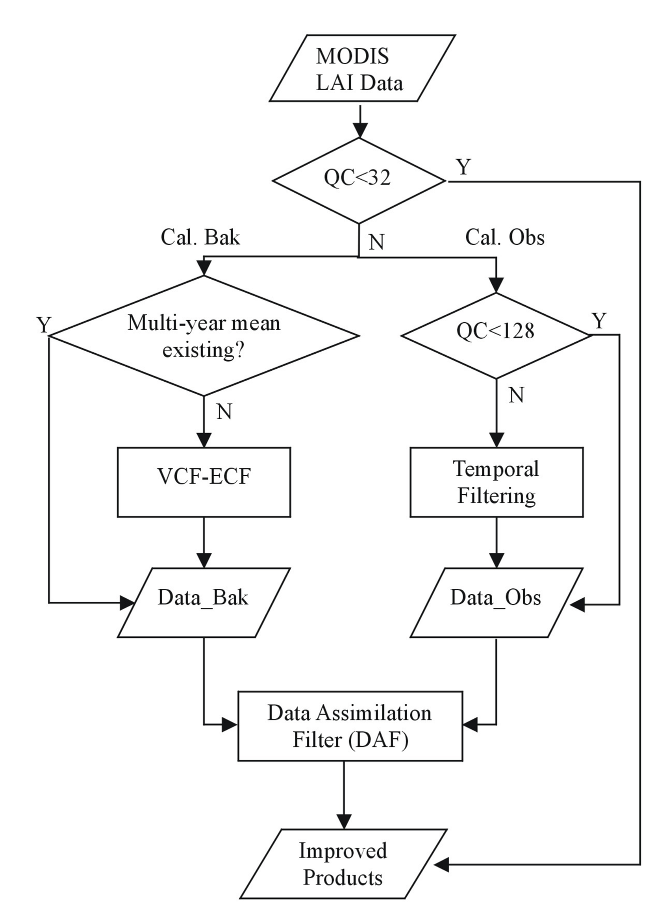

Figure 5. Flowchart of the data assimilation filtering (DAF).

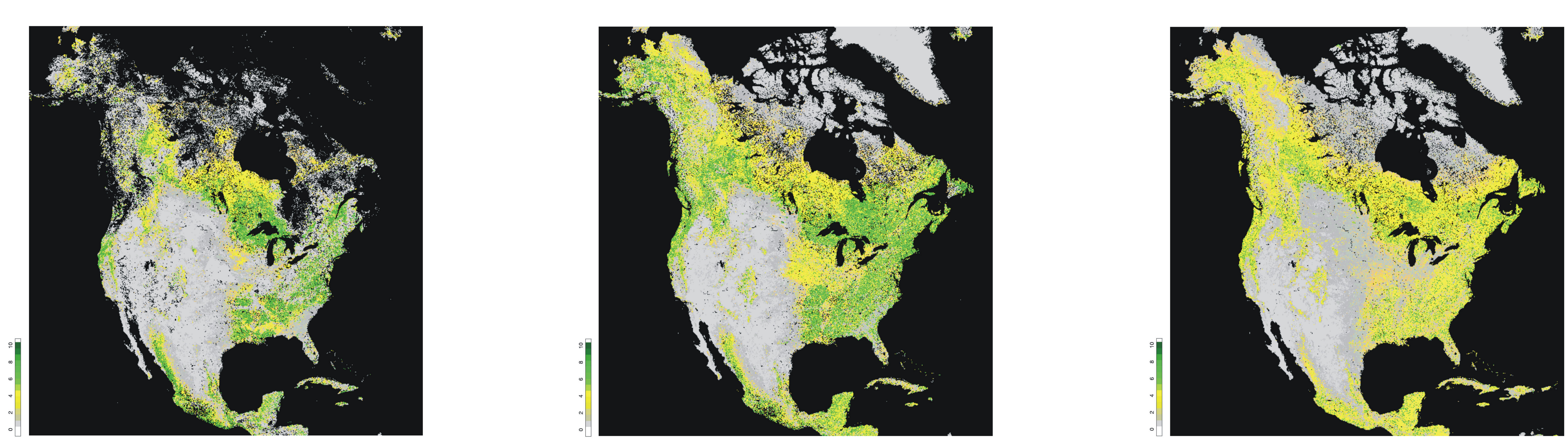

Figure 6. (a) Original MODIS LAI data products over North America (day 225, 2000). (b) New value-added MODIS LAI data sets with the data assimilation filter (DAF) (day 225, 2000); (c) New restored MODIS LAI data sets at day 169, 2001.

Acknowledgments This project is funded by NASA grant NNG04GL85G (Principal investigator: Dr. Shunlin Liang, sliang@geog.umd.edu).