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MODIS Vegetation Workshop Report

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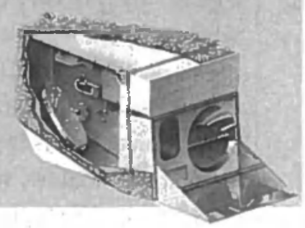

The Land Science Team for the NASA Earth Observing System Moderate Resolution Imaging Spectroradiometer (MODIS) sensor [*modis-land.gsfc.nasa.gov/*] held a special workshop to present analysis of the first year (2001) of MODIS satellite data.

Although the Terra satellite was launched on December 18, 1999, platform initiation and sensor calibration activities precluded science quality data from being delivered for much of 2000. The year 2001 is the first complete year of data collection for the MODIS sensor, allowing a first look at the entire growing season sequence for the terrestrial vegetation variables. A recent MODIS Land Workshop was convened July 16-18, 2002, at the University of Montana in Missoula to present first results and progress with measurements of these vegetation variables. The workshop was attended by 140 scientists from 13 countries and 30 states. The focus of the workshop was on Vegetation Indices, (VI), Leaf Area Index (LAI), Fraction-absorbed Photosynthetically Active Radiation (FPAR) and Net Primary Production (NPP). The MODIS Land Science team and relevant EOS Data Centers covered step-by-step details of the processing, distribution, analysis, and interpretation of the MODIS vegetation variables. The workshop also included hands-on computer labs to take a user through details of data ordering, reprojection, reformatting, and other technical tools. Proceedings of the workshop are also available on line at *www.forestry.umt.edu/ntsg/MODISCon/*. The site contains all Powerpoint talks presented, and video clips of each of the authors introducing their presentations.

Complete processing of the MODIS Land variables is now occurring within 5 days of acquisition. Details of the Level 1 and 2 processing are important to the final quality and utility of the Level 3 and 4 vegetation algorithms, so **Robert Wolfe** (NASA Goddard Space Flight Center) covered sensor calibration, geolocation, land/water masking, cloud screening, aerosol corrections, and gridding details. The MODIS Vegetation variables are archived and distributed by the EROS Data Center (EDC). Full details on ordering MODIS data, reformatting and reprojection issues, and initial data analysis were covered by **John Dwyer** (EDC).

The Vegetation Indices, presented by **Alfredo Huete** (Univ. of Arizona) are the heritage of the widely used Advanced Very High Resolution Radiometer (AVHRR) Normalized Difference Vegetation Index (NDVI). MODIS radiometric sensitivity and spectral wavelength locations are both superior to AVHRR, so an identical NDVI cannot be computed simply. However, the time series of AVHRR NDVI from 1981 to the present is essential to global-change science, so MODIS must produce an equivalent for continuity. Huete explained the MODIS continuity Vegetation Index and the efforts his team is making to merge the AVHRR and MODIS data records. MODIS land spectral channels were chosen specifically to avoid atmospheric absorption features, and target known regions of leaf pigment absorption and reflectance. So, a MODIS enhanced vegetation index has also been derived to optimize use of these features. The continuity NDVI and Enhanced VI were compared against the AVHRR NDVI for an array of intensive study sites in the U.S.

LAI and FPAR are advanced biophysical variables used to define vegetation in climate, hydrologic, and biogeochemistry models. LAI and FPAR quantify the vegetation energy exchange and mass transfer characteristics important to weather forecasting and carbon cycle models. LAI is a measure of leaf biomass, while FPAR is a radiometric measure of light absorption. In canopy radiative transfer modeling, these variables are solved together, as explained by **Ranga Myneni** (Boston University). LAI ranges from near zero in deserts to a maximum of 10 in large tropical and temperate forests. In annual croplands and grasslands, LAI can begin in the spring at zero and grow to LAI of 5-6 within three months at the peak of the growing season. Algorithm assumptions and details were covered, and field validation for 2001 from sites in South Africa, Finland, Massachusetts, and Wisconsin were presented.

NPP is the biomass growth of vegetation measured over a specific time period. NPP is effectively the beginning of the carbon cycle, quantifying the mass of carbon fixed into living plant tissue. NPP also provides a practical measure of the food, fiber, and fuel of vegetation consumed by humans. The MODIS NPP algorithm uses a commonly used production efficiency logic, where the photosynthetically active radiation absorbed by the vegetation canopy, (computed from the FPAR variable above) is transformed by a conversion efficiency term to give vegetation biomass. Climatic constraints based on known physiological responses by plants to low air temperature and desiccating humidities are derived from a daily surface meteorology datastream from the NASA Goddard Data Assimilation Office. A daily photosynthesis is computed, and summed to an 8-day NPP output product. **Steve Running** (University of Montana) presented the MODIS NPP algorithm and the array of validation activities underway, predominantly using the global FLUXNET network of eddy-covariance CO_2 flux towers,

A number of other MODIS land variables are relevant to vegetation sciences but were not the focus of this workshop. Summary presentations were given for Landcover by **Alan Strahler** (Boston University), Vegetation Continuous Fields and Fire Products by **John Townshend** (University of Maryland), Evaporation Index by **Rama Nemani** (University of Montana), and Snow Products by **Steven Running**.

The MODIS Land Team participates in a range of validation activities for these vegetation variables. The overall validation strategy for the team, presented by **Jeff Morisette** (NASA Goddard Space Flight Center) includes a global array of core validation sites where selected measurements are regularly made. The Oak Ridge Data Center hosts a wide array of terrestrial validation data sets for the MODIS vegetation variables, summarized by **Dick Olson**. The Bigfoot Project attempts to quantify the scaling problems that arise when comparing field vegetation measurements of LAI and NPP, often collected on 0.1 ha plots, to MODIS data at 1-km-pixel resolution. The Bigfoot logic, presented by **Warren Cohen** (Oregon State University) entails statistically sampling the landscape based on pre-classified high-resolution imagery such as Landsat at 30 m, then aggregating the field samples proportionally to reach a 1-km effective measurement. The Bigfoot Team has so far sampled boreal forest, deciduous forest in Massachusetts, Midwest cropland, and a Wisconsin mixed evergreen forest, with future sites planned in the New Mexico desert, Amazon rainforest, and Barrow tundra.

The FLUXNET project is an organized network of over 180 eddy-covariance CO_2/H_2O flux towers located around the world. This network, initiated by the International Geosphere-Biosphere Program, measures atmospheric eddies and CO_2 concentrations every few seconds to estimate the net CO_2 balance of the land surface. The flux measurements operate continuously, all year-around, and quantify photosynthetic uptake of CO_2 during the day, and respiratory losses at night. **Bev Law** (Oregon State University) is Chair of Ameriflux, the North American flux network, and presented the technical details of eddy covariance measurements, and annual carbon flux comparisons for a variety of sites in North America.

The presentations of every speaker identified here are on the electronic proceedings website at *www.forestry.umt.edu/ntsg/MODISCon/index.html*. The workshop also featured over 40 posters by workshop attendees using the recent MODIS data and vegetation variables. These posters are also on the workshop website.