We examined weekly variation in the stable carbon isotope signature of ecosystem respiration ($\delta^{13}C_R$) using the Keeling plot approach at two forests in Oregon USA: a wet (>2300 mm annual precipitation) 20-year-old *Pseudotsuga menziesii* plantation located in the Coast Range near the Pacific Ocean, and a dry (∼520 mm annual precipitation) 250-year-old *Pinus ponderosa* forest located on the eastern slope of the Cascade Mountains. The two forests experience similar regional weather patterns with wet winters and dry summers, but the coastal site has milder temperatures and greater soil and atmospheric water content. Air was sampled on 51 and 42 separate nights at the *Pinus* and *Pseudotsuga* forests, respectively, between 2001 and 2002. Both forests exhibited greater intra-annual variation in $\delta^{13}C_R$ than has been previously observed in C3 ecosystems (>8.0 $^o/_{oo}$ over the year). Mean annual $\delta^{13}C_R$ matched that expected based on annual precipitation, averaging -25.4 $^o/_{oo}$ at the *Pinus* forest and -26.2 $^o/_{oo}$ at the *Pseudotsuga* forest. Variability in $\delta^{13}C_R$ at both sites was highest during seasons when rainfall was abundant (autumn, winter and spring) and lowest during summer drought. During the period of drought, soil temperature was positively correlated with $\delta^{13}C_R$ at both forests. When all seasons were analyzed, $\delta^{13}C_R$ was negatively correlated with soil water content at both forests. The *Pseudotsuga* forest was more strongly coupled to soil and atmospheric water content than the *Pinus* forest. This difference could be related to availability of a deep water source at the *Pinus* forest that buffers it from drought effects. $\delta^{13}C_R$ at the *Pinus* forest was significantly but weakly related to canopy conductance suggesting that $\delta^{13}C_R$ is coupled to canopy gas exchange. $\delta^{13}C_R$ was significantly correlated between the two forests after removal of outliers associated with extreme, site-specific meteorological events (i.e. local freezes), demonstrating that $\delta^{13}C_R$ is coupled across forests located >100 km apart. This coupling is presumably due to shared regional climate.

B41A-07 0930h

Land-use change effects on fluxes and isotopic composition of CO_2 and CH_4 in Panama, and possible insights into the atmospheric H_2 cycle

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Land-use changes in tropical regions are believed to release a quantity of C to the atmosphere which is similar in magnitude to the entire “missing” sink for anthropogenic CO_2. Our research attempts to evaluate carbon cycling in three land-cover systems in central Panama: cow pasture, native tree plantation, and undisturbed moist forest. In this ongoing project, we are collecting samples of air from profiles in the stable, nocturnal boundary layer, which is dominated by ecosystem respiration. Samples are analyzed for CO_2 and its isotopes, CH_4 and its C isotopic composition, N_2O, H_2, CO, and SF_6. We use a flux-gradient method to estimate ecosystem-scale fluxes of trace gases from soil to the atmosphere. Keeling plot intercepts reflect the respiratory contribution of C3 and C4 biomass under contrasting land cover systems, and how this varies with pronounced wet-dry seasonal cycles. C isotopes of methane and gradients of molecular hydrogen provide insight into the source of methane production from pasture and plantation soils. Rainforest soils, in contrast, are sinks for both atmospheric methane and hydrogen. The process oriented nature of this field experiment will contribute to parameterization of carbon cycle models at a variety of spatial scales.

URL: http://ww2.mcgill.ca/biology/faculty/potvin/sardinilla.htm

B41A-08 0945h

Can We Monitor Ecosystem Function Using Keeling Plot Analyses of Nocturnal Cold-Air Drainage?

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The carbon isotope signature of ecosystem respiration, $\delta^{13}C_R$, as measured by the Keeling Plot approach, has been related to short-term variations in weather and ecosystem function in several recent studies. In order to obtain an adequate range of [CO_2] and to sample a consistent vegetation type, investigators typically select sampling locations in relatively flat terrain and uniform canopy cover, but these are unusual conditions for many forested ecosystems. In a pilot study, we are collecting samples for Keeling Plot analyses in cold-air drainage systems in small (60-100 ha), deeply-incised watersheds, one covered with old-growth (ca 450-years-old) Douglas-fir/hemlock forest and one covered with young (ca 45-years-old) Douglas-fir forest. We found that the nightly range of [CO_2] was typically 380-460 ppm, sufficient to develop good estimates of $\delta^{13}C_R$. At any point in time there was little variation in [CO_2] with height through the canopy (0.5-30m), so the required range was obtained by sampling over several hours. There was no indication that samples taken from different heights or at different times of night represented sources with different isotopic signatures. The isotopic signature of respired CO_2 in the older watershed averaged about 1 per mil greater than that of the young watershed, and $\delta^{13}C_R$ of both locations correlated with modeled stomatal conductance 6 days prior to flask sampling.

B41B MCC: Level 2 Thursday 0830h

Very High Resolution Land Cover Mapping Applications to Resource Management Posters *(joint with H, GC, PA)*

Presiding: **S J Goetz,** Woods Hole Research Center**; T Stone,** Woods Hole Research Center

B41B-0876 0830h INVITED POSTER

Stream Health Linkages with High Resolution Land Cover and Landscape Configuration Metrics

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The amount of impervious surface area (ISA, e.g. roads, parking lots, buildings) within a watershed has long been known to impact the quality of nearby streams and waterways, as measured by their chemical and biotic composition. Vegetation in riparian zones can reduce the negative impacts of ISA by buffering runoff and reducing flow velocities that incise stream channels. Methods to map impervious areas and stream buffers are therefore of great interest to a broad community of natural resource managers. Traditionally, stream buffers and ISA were mapped using visually interpreted aerial photographs and, for example, assigning coefficients to land use categories - a type of “classify and multiply” approach. We have developed methods, using decision tree algorithms, to map these critical landscape variables using high resolution satellite imagery (4m Ikonos). Our approach provides highly accurate maps of impervious surfaces and tree cover. We report on analyses of the links between these maps and stream health for 246 small watersheds within a 1300 km2 area of the mid-Atlantic region - an area of highly altered land cover and rapid land use change. Impervious surface area was found to be the primary predictor of stream health, followed by tree cover in riparian buffers, and total tree cover within entire watersheds. A number of issues associated with mapping using Ikonos imagery were encountered, including differences in phenological and atmospheric conditions, shadowing within canopies and between scene elements, and limited spectral discrimination of cover types. We report on both the capabilities and limitations of Ikonos imagery for these applications, and considerations for extending these analyses to other areas.

B41B-0877 0830h POSTER

High Resolution Mapping of the Impermeable Surfaces of Barnstable County, Cape Cod and their Relationship to Water Quality

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We have developed several impermeable surface maps for all Cape Cod (Barnstable County) to help assess the contribution of paved and other impermeable surfaces to declines in local and regional water quality. These maps have been assembled with the cooperation of many town planning departments, the Cape Cod National Seashore, Mass Military Reservation, the Cape Cod Commission, the Association to Preserve Cape Cod (APCC) and from IKONOS data. The map are being used to predict where new impermeable surface will occur, define current and future hotspots of non-point pollution, and to map the relationships of impermeable surfaces to the zones of contribution (ZOC) of municipal wells. The maps are also used to define the percentage of impermeable surfaces in buffer zones around ponds and estuaries. Combining these data with census data on housing and population density allows us to define the importance of impervious surface as minor or major factors in water pollution.

B41B-0878 0830h POSTER

Hyperspectral Forest Fuel Assessment in the South Platte, Colorado

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There is strong evidence that many current forests are denser and more vulnerable to catastrophic fires than they were historically. In 2002 fire season approximately 3,000 structures were damaged or destroyed in nearly 67,000 forest fires that burned nearly 2.67 million ha in the U.S. Those fires emphasized their importance in the urban/wildland interface and their dramatic effects on ecosystem carbon storage. Therefore it is important to assess regional fire probability in order to appropriately minimize these risks with fuel treatments. Fire risk is controlled by a series of factors, and among which, fuel loading is a critical one that could be managed through fuel removal. Fuel loading describes the characteristics and quantities of biomass, which can be broken down in to several size-classes, normally by vegetation types and forest canopy cover levels. Fuel loading is widely mapped using aerial photos and multi-band satellite images, with intense field sampling. However, the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) data, with detailed spectral signatures on plant features such as liquid water thickness, vegetation greenness and cellulose contents provide great potential for separating dominant vegetation, live/dead material and canopy cover based on the variations in plant chemicals. In this study we used high altitude AVIRIS data and field spectral measurements to separate fuel loading classes using various hyperspectral unmixing techniques in the Upper South Platte, Colorado. First, we performed minimum noise fraction (MNF) transformation and pixel purity index (PPI) analysis to pickup endmembers with pure spectral signatures. Then, we examined the resulting classes with their key spectral features, and compared them with field spectral measurements. Finally we classified fuel loading in the area into 17 categories, which include 5 canopy cover levels for Ponderosa pine and Douglas-fir. It was indicated in our AVIRIS derived fuel loading map that 13.2% of the study area is over 60% canopy cover with high fuel loading. We validated our remote sensing analysis in an USFS fuel treatment area. It was shown that AVIRIS derived liquid water thickness and vegetation index were strongly related to green leaf biomass and canopy cover respectively in conifer stands, while cellulose content reflected total carbon (live or dead) stored in vegetation.

B41B-0879 0830h POSTER

Using Declassification Intelligence Satellite Pictures With Quickbird Imagery to Study Urban Land Cover Dynamics: a Case Study from Kazakhstan

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Recent declassification of high-resolution intelligence satellite pictures from the CORONA, ARGON, LANYARD, GAMBIT, and HEXAGON (KH-1 through KH-9) programs has provided more than 910,000 scenes of the Earth's surface collected between 1960 and 1980. Public access to this historical image record enables investigation into urban land cover dynamics. The spatial resolutions of these photographic images are nominally comparable to current high-resolution commercial satellite imageryIKONOS, QuickBird. However, the declassified imagery suffers from multiple limitations including variable dynamic ranges, geometric distortions, and sparse imaging system metadata. Can these data be used to characterize urban land cover dynamics in conjunction with current sensors? Within the context of a NASA LCLUC project on Kazakhstan, we acquired QuickBird imagery for the cities of Astana (2002/05/04) and Almaty (2002/09/08). The QuickBird data were converted to spectral radiance and geometrically rectified. CORONA and GAMBIT data of Astana and Almaty were acquired from the USGS archives. Only a single CORONA image was found for Astana (1971/09/17). For Almaty, two GAMBIT images (1964/04/23 and 1966/01/27) and two CORONA images (1968/08/13 and 1971/09/17) were found. The images, as film diapositives, were scanned at 1600 dpi on a flatbed scanner. The CORONA and GAMBIT images were co-registered to the QuickBird images. Image co-registration proved problematic due to the differing sun/target/sensor geometries of the CORONA and GAMBIT imagery and the coarser spatial resolution of the CORONA data. While the declassified imagery nominally has very high spatial resolution (CORONA 2m; GAMBIT 1m), it appears fuzzier than the native raster data from QuickBird, due to the analog data source and multiple image transfer steps. In the 1968 and 1971 images for Almaty and the 1971 image of Astana, each city extended over the edge of the film. Subsequent mosaicking resulted in seams that were evident across both images due to uncontrolled radiometric differences and some urban features did not align due to registration errors. Subsets of the imagery were generated for areas that depicted significant land cover change and were compared with subsequent dates. Types of observed urban land cover change that were observed include urban expansion, urban densification, landscape transformation, and afforestation. These results demonstrate the utility of harvesting historical land cover data from the declassified intelligence satellite datasets for the study of urban land cover dynamics.

URL: http://www.calmit.unl.edu/kz/

B41B-0880 0830h POSTER

Using IKONOS and Aerial Videography to Validate Landsat Land Cover Maps of Central African Tropical Rain Forests

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Compared to the traditional validation methods, aerial videography is a relatively inexpensive and time-efficient approach to collect "field" data for validating satellite-derived land cover map over large areas. In particular, this approach is valuable in remote and inaccessible locations. In the Sangha Tri-National Park region of Central Africa, where road access is limited to industrial logging sites, we are using IKONOS imagery and aerial videography to assess the accuracy of Landsat-derived land cover maps. As part of a NASA Land Cover Land Use Change project (INFORMS) and in collaboration with the Wildlife Conservation Society in the Republic of Congo, over 1500km of aerial video transects were collected in the Spring of 2001. The use of MediaMapper software combined with a VMS 200 video mapping system enabled the collection of aerial transects to be registered with geographic locations from a Geographic Positioning System. Video frame were extracted, visually interpreted, and compared to land cover types mapped by Landsat. We addressed the limitations of accuracy assessment using aerial-base data and its potential for improving vegetation mapping in tropical rain forests. The results of the videography and IKONOS image analysis demonstrate the utility of very high resolution imagery for map validation and forest resource assessment.

URL: http://www.whrc.org/Africa

B41B-0881 0830h POSTER

The TerraSAR mission – opportunities for research and applications

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The German TerraSAR-X mission, scheduled to launch in October 2005, will acquire fully polarimetric imaging radar data at X-band from a spaceborne platform at resolutions that have previously only been available from airborne systems. Depending on the operating mode resolutions down to $1m$ on the ground are possible. The 11-day orbit repeat cycle provides a relatively high temporal sampling rate for change-studies, which can be further increased by using the multi-mode or multi-incidence angle capabilities. Every point on earth will be observable every 4.5 days; for 95% of the earth's surface even every 2.5 days. The aperture can be split and be used for along-track interferometry. Like the high-resolution optical data that has now become available from IKONOS and QUICKBIRD, the spatial detail contained in TerraSAR radar data will be particularly valuable in the detection and classification of urban features. But the reliable all-weather monitoring capability afforded by high-resolution radar data also has important applications in many other fields including ecology, hydrology, oceanography or geology. The polarimetric information and the potential for acquiring frequently sampled time-series data will enable unprecedented opportunities for a broad range of studies. Here we report on the status of the TerraSAR mission and discuss the opportunities for scientific and commercial applications.

B41B-0882 0830h POSTER

An Analysis of Two Amazonian Forests using an Automated Crown Detection Algorithm and IKONOS Imagery

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Spatial analysis of tree crowns in high-resolution satellite images (e.g., IKONOS) can improve estimates of carbon stocks at regional and local scales, aid in demographic studies at the stand level, and aid in forestry efforts. These data, at 1-4 meter resolution, represent a direct view of forest structural properties at the landscape level, but it is often difficult to convert the detail seen by eye into useful quantitative information. In this study, we developed an automated crown detection program that combines iterative local maximum finding and local minima finding methods with analysis of extracted ordinate data. We calibrated the algorithm at one site, Fazenda Cauaxi (3.75° S, 48.37° W), with tree geometry and stand data and validated it with stand data at another site, Tapajos National Forest (3.08° S, 54.94° W). Panchromatic IKONOS images were used from these two Amazonian undisturbed forest sites in Para, Brazil. Mean, minimum and maximum crown widths for field data at Cauaxi are (mean 10.6 m +/- 1.6 S.D., min 1.0 m, max 40.7 m) and automated estimation are (mean 12.7 m +/- 5.6 S.D., min 2.0 m, max 34.0 m). Mean DBH for field data at Cauaxi is 30 cm +/- 3.4 S.D. and for automated routine is 54.0 cm +/- 19 S.D. Automated estimation at Tapajos of mean, minimum and maximum crown widths are (mean 12.3 m +/- 5.9 S.D., min 2.0 m, max 38.0 m). Mean DBH for field data is 51.9 cm +/- 16.9 S.D. and for automated routine is 53.0 cm +/- 20.2 S.D. The automated crown algorithm provides good estimates of mean values and distributions for crown width and stand density. Average DBH estimates are similar to field data. Automated DBH and biomass distribution requires improvement, but this estimation is also limited by lack of site-specific allometric equations. Forest structural characteristics are extremely difficult to obtain in many tropical forests, but high-resolution images may well hold the key to unlocking information about the functioning of these highly important ecosystems.

B41B-0883 0830h POSTER

Leaf-Canopy inversion model though a Neural Network algorithm: Application to coffee cherry estimation using UAV images

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Over the past two years, NASA has had great interest in exploring the economic potential of deploying UAVs (Unmanned Aerial Vehicles) as long-duration platforms equipped with high resolution imaging systems for commercial agricultural applications. In October 2002, a team in the Ecosystem Science and Technology Branch at NASA/Ames Research Center prepared and successfully flew a UAV, equipped with off-the-shelf camera systems, over coffee plantations at Kauai (Hawaii). The idea is to help growers to find the best possible harvesting strategy. The most important information that needs to be conveyed to the growers is the percentage of ripe, unripe and overripe cherries in the field. It is of vital importance to devise a robust and reliable "intelligent "algorithm capable of predicting the amount of ripe cherries present in any digital image coming from the onboard cameras. During the campaign, the two UAV camera systems produced digital images that contain information about the down-looking plantation field. These images need to be processed to extract information concerning the percentage of ripe (yellow) cherries. To date, no robust automated algorithm has been developed to perform this task. Currently, every image is viewed by human eyes on a case by case basis. We propose a neural network algorithm that can automate the process in an intelligent way. Biologically inspired Neural Networks are made of elements called "neurons" that can simulate the brain activity during a learning process. The idea is to design an appropriate neural network that learns the relation between the reflectance coming from an image and the percentage of cherries present in a coffee field. We envision a situation in which reflectance from digital images at different wavebands is processed by a trained neural network and the percentage of the different cherries estimated. The key factor is training the network to recognize the reflectance/cherry percentage relation. Over the past few years in collaboration with NASA, we have developed a coupled leaf/canopy model (LCM2) in order to capture the essential biophysical processes associated with the interaction between light and vegetation. LCM2 has recently been modified to include different cherries as absorbing and scattering elements. The model can be fed with different inputs that describe the basic leaf chemistry and the morphology of the fields under consideration (as well as other external variables like sun and view angle) and give canopy reflectance as output. In this way, the model can be run to simulate the reflectance/cherry percentage relation. A set of data points representative of that map can be collected and the neural network trained to learn that relation.