horizontally homogeneous at approximately one third of the height of the planetary boundary layer (PBL). In order to determine the consistency between this model behavior and observations, radiosonde data from the BOREAS experiment were analyzed. The data used in this analysis were from temporally concurrent measurements (daytime or afternoon), taken over a wide enough range of surface types and on scales comparable to a GCM grid size. An algorithm similar in nature to that used in the GCM studies and other observational studies was used to compute blending heights. Blending heights were observed over more than 50% of the vertical soundings from seven locations that were analyzed. The ratio between PBL height and blending heights varied between spring and summer seasons, as expected. Seasonal averages of the daily maximum height of the blending height from spring and summer seasons will be presented. The relation between blending height and surface ground temperature as well as air temperature will also be discussed.

GC44A-05 1630h

Complexity of mid-Holocene climate variability revisited

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The mid-Holocene (8,000 to 4,000 BP) has long been interpreted as a warm stable interval and the 6,000-year BP has been the preferred target date used in paleoclimate modeling exercises. However, recent high-resolution proxy-records from around the world reveal that the mid-Holocene contained considerable climate variability at century to millennial scales. Moreover, the evidence shows that the mid-Holocene may not have been as warm on a global scale. We present a mean-continental temperature reconstruction for North America that suggest temperature variations on the order of $\pm$ 0.2°C during the Holocene. This is compared to several other climate proxy records around the world. At this scale, it is difficult to identify synchronicities, leads and lags due to regional differences in climate, proxy sensitivity to climate change and dating control, except in cases of high climate variability such as the LIA. It appears that the mid-Holocene is also an interval of high climate variability. We discuss possible scenarios including synchronicity, leads and lags during the mid-Holocene on a global scale.

URL: http://www.uottawa.ca/academic/arts/geographie/lpcweb/

GC44A-06 1645h

Climate change inferred from borehole temperatures: minimal "snow effect" from North America

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Borehole temperature-depth profiles contain information about surface ground temperature histories over time scales of several centuries and in particular prior to the widespread availability of surface air temperature records [*Huang et al, Nature, 2000; Harris and Chapman, GRL, 2001*]. Borehole-based reconstructions on the regional and hemispheric scale yield significantly different magnitudes of warming in the past 500 years when compared to proxy-based reconstructions. Borehole reconstructions suggest that the Northern Hemisphere warming has been about 1.1 °C while proxy methods indicate warming closer to 0.7 °C [*Mann et al, Nature, 1999*]. One suggested reconciliation of borehole and proxy reconstructions is that long-term variations in seasonal snow cover may bias the borehole record. A spurious long-term warming signal relative to SAT trends could be introduced by alteration of the duration or onset of seasonal snow cover over the course of decades or longer. We have developed a "snow effect" model that predicts transient warming or cooling of the surface ground temperature due to changes in the onset, duration, and depth of snow events [*Bartlett et al, in review*]. We use our model to compute the response of ground temperatures at the regional scale to seasonal snow cover of the past century in North America. Snow and air temperature data used in the model come from the United States Historical Climatology Network (NOAA-NCDC NDP-070) and the Canadian Daily Climatic Dataset (CDCD). Results indicate that variations in snow onset and duration have had the greatest influence in Central North America, leading to ground warming on the order of 0.1-0.2 °C / 100 yrs in this region relative to SAT trends. Other regions within North America have experienced negligible effects over the past century. We conclude that the magnitude of the snow effect in North America is insufficient to reconcile completely regional borehole and proxy reconstructions of climate change. References:

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GC51A CC: 220 C-E Friday 0830h

Multiangle Remote Sensing of the Terrestrial Environment IV Posters

Presiding: **N G Loeb,** Hampton University**; A Lyapustin,** NASA Goddard Space Flight Center

GC51A-01 0830h POSTER

Comparing the Retrieval of Cloud-top Height by Different EOS Terra Sensors

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The Moderate Resolution Imaging Spectroradiometer (MODIS) and the Multi-angle Imaging Spectroradiometer (MISR) are two of the instruments aboard the Terra Earth Observing System (EOS). Algorithms for the retrieval of cloud-top heights have been implemented in order to get a product that can be applied in climate change studies, climate modeling and atmospheric research. Cloud height information can be used to analyze the Caribbean climate and to understand deforestation patterns on rain forests. The algorithms to retrieve this kind of information are based on CO2 slicing method and stereo matching methods. Cloud height information appears in terms of cloud top pressures. To compare MODIS cloud top pressures with MISR cloud top heights, it is important to look for a good atmospheric profile for the Caribbean such as by looking at field instrument observations. Available data from MODIS and MISR is geolocated in different latitudes and longitudes. MISR technique is an innovative method that assigns height values in a geometric form. As part of this study it is intended to assimilate the sensors paths through the Caribbean over a period of every 16 days. In order to compare MODIS cloud-top pressures and MISR cloud-top heights, cloud-top pressures must be converted into cloud-top heights. Radiosonde observations can be used to get pressure-height profiles over the Caribbean. Also this kind of data can be used to validate MODIS and MISR parameters. Do cloud height measurements from MODIS can be better comparing to MISR measurements? Do cloud height measurements from MODIS or MISR can be used to classify cloud types?

GC51A-02 0830h POSTER

Current Status of Cloud Masks for the Multi-angle Imaging SpectroRadiometer

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The Multi-angle Imaging SpectroRadiometer (MISR) on-board EOS-Terra makes observations at 9 angles (1 nadir, 8 oblique) in the visible and near-infrared. Cloud detection is a critical part of the MISR mission, but is made more complicated by the fact that there are no spectral channels longward of 866 nm in wavelength. This has led to the development of several novel approaches to cloud detection. For MISR, three independent cloud masks have been developed: the Radiometric Camera-by-camera Cloud Mask (RCCM), the Stereoscopically-Derived Cloud Mask (SDCM), and the Angular Signature Cloud Mask (ASCM). This poster will demonstrate the current status of the three MISR cloud masks and the strengths and weaknesses inherent in each. Methods of evaluating the cloud masks will also be shown, including visible inspection and comparisons with the Moderate Resolution Imaging Spectroradiometer (MODIS). Finally, analyses of the minimum detectable optical depths will be demonstrated, through the use of ground based data.

GC51A-03 0830h POSTER

Multiangle Remote Sensing of Optically Thin Cirrus Clouds From MISR Using Support Vector Machines

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Thin cirrus clouds, those with optical depths less than 1, can potentially have large radiative effects on the atmospheric and surface energy budgets in regions where they are prevalent. They also present an impediment to the retrieval of clear sky properties such as aerosol optical depth, temperature profiles, etc. Such clouds, however, are notoriously difficult to detect using standard satellite remote sensing techniques. The unique multiangle sensing capability of the Multiangle Imaging SpectroRadiometer (MISR) on NASA's Terra satellite, in particular the availability of cameras with view angles as large as 70.5 degrees, gives MISR the ability to detect thin cirrus clouds that are invisible to nadir-looking instruments. While MISR has been operational for over four years and many scenes containing thin cirrus have been examined on a per case basis, there remains a need to objectively and automatically identify just the cirrus clouds within any given scene. Based on our previous work applying machine learning technology to develop a more robust MISR cloud mask, we have developed a thin cirrus cloud detector for MISR, using Support Vector Machines (SVMs), and taking advantage of spectral, spatial and angular signature information from MISR's 45.6, 60 and 70.5-degree cameras. For a few representative cases, we will demonstrate the accuracy of the SVM cirrus retrieval, especially in comparison to a traditional nadir-looking retrieval, emphasizing the usefulness of the multiangle approach. We then show how this trained SVM can be used to generate a climatology of thin cirrus clouds.

GC51A-04 0830h POSTER

Multiangle Remote Sensing of Cloud Properties From POLDER-1 and POLDER-2

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The POLDER (Polarization and Directionality of the Earth"s Reflectances) instrument was routinely functioning aboard ADEOS (Advanced Earth Observing Satellite) and ADEOS-2 respectively from November 1996 to June 1997 and from April 2003 to October 2003. This multispectral imaging radiometer-polarimeter allows to observe a target under up to 14 different viewing directions and in several narrow spectral bands of the visible and near-infrared spectrum (443 to 910 nm). This new type of multiangle instruments offers new opportunity for deriving cloud parameters at global scale. This POLDER multiangle capability is here illustrated (i) in the determination of the cloud thermodynamic phase from 865 nm-polarization measurements performed at various scattering angles and (ii) in the derivation of the cloud optical thickness from several bidirectional reflectances performed at 670 nm over land and 865 nm over ocean. Emphasis is also given to the estimation of the shortwave albedo from POLDER multidirectional and multispectral measurements; the shortwave albedo values estimated from ADEOS 2-POLDER observations compare rather well to the ones derived from quasi-simultaneous measurements from Terra-CERES. Finally, the PARASOL mission expected for launch in fall 2004 will deploy a third POLDER-like instrument. PARASOL will fly in formation as a part of a constellation of satellites including Aqua, CALIPSO and CloudSat. This unprecedented multi-instrumental dataset is expected to provide new insight in retrieval of cloud properties at global scale.

URL: http://earth-sciences.cnes.fr/POLDER/

GC51A-05 0830h POSTER

RAMOS: A Space Mission With Real-Time Stereoscopy of Atmospheric Phenomena

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RAMOS (Russian American Observational Satellites), scheduled for launch in 2009, is a joint mission of the Russian Federation and the United States of America. Two low earth-orbit satellites with complementary instrument suites will fly in tandem orbits at an altitude of $\sim$ 500 km and a variable mean separation of $\sim$ 300 km. The satellites will be capable of simultaneous viewing of the same location on or above the earth's surface, allowing for real-time stereoscopic imaging of the earth's environment. The sensors suite is composed of pointable multifiltered infrared (1.5 - 7.5 μm), visible, and ultraviolet imaging radiometers. The nominal spatial footprints are $\sim$ 100 m at the earth's surface. One satellite will have polarization capability, and the other will have an infrared spectrometer built into the radiometer. During its projected two-year lifetime, RAMOS will be used as a testbed for a variety of space-based measurements of the terrestrial environment that require real-time stereoscopy. These experiments will include: (1) simultaneous measurements of the altitudes and temperatures, to accuracies of $\pm$100 m and $\pm$2 K, respectively, of the cloud tops in the eyewalls of tropical cyclones, in order to test theoretical predictions that such measurements can provide, via remote sensing, an accurate determination of the intensity of a tropical cyclone; (2) simultaneous measurements of the altitudes and velocities of cloud fragments, to accuracies of $\pm$100 m and $\pm$10 m s^{-1}, respectively, to determine the practicality and usefulness of such measurements for the purpose of numerical weather prediction; and (3) time-dependent tomography of volcanic plumes and of smoke clouds from forest fires and anthropogenic sources.

GC51A-06 0830h POSTER

Estimation of instantaneous 670 nm TOA albedo for ice clouds from POLDER multidirectional measurements

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An algorithm that determines the 670-nm top-of-atmosphere (TOA) albedo of ice clouds over ocean using POLarization and Directionality of the Earth's Reflectance (POLDER) multidirectional measurements is developed. A plane-parallel layer of ice cloud with various optical thicknesses and light scattering phase functions is assumed. For simplicity, we use a double Henyey-Greenstein phase function to approximate the volume-averaged phase function of the ice clouds. A multidirectional reflectance best-fit match between theoretical and POLDER reflectances is used to infer effective cloud optical thickness, phase function and TOA albedo. Sensitivity tests show that while the method does not provide accurate independent retrievals of effective cloud optical depth and phase function, TOA albedo retrievals are accurate to within 3% for both a single layer of ice clouds or a multilayer system of ice clouds and water clouds. When the method is applied to POLDER measurements and retrieved albedos are compared with albedos based on empirical angular distribution models (ADMs), zonal albedo differences are generally smaller than 3%. When albedos are compared with those on the POLDER-I ERB and Cloud product, the differences can reach 15% at small solar zenith angles.

GC51A-07 0830h POSTER

High-accuracy Multiangle Spectropolarimetric Imaging Concept for Aerosol Remote Sensing from Space

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Satellite remote sensing has a key role in measuring the distribution, radiative impact, and regional and global spatial context of tropospheric aerosols. A synergistic combination of multispectral, multiangle, and polarimetric approaches would improve the accuracies of aerosol optical depth and particle property characterizations compared to what is achievable using each method by itself. In this paper we discuss the science benefits and technical feasibility of combining key attributes of multiple aerosol remote sensing instruments into a single instrument package. The features of the conceptual instrument are: spectral coverage from the near-UV to the shortwave infrared; global coverage within a few days; intensity and polarimetric imaging simultaneously at multiple view angles; kilometer to sub-kilometer spatial resolution; and measurement of the degree of linear polarization in one visible and one shortwave-infrared spectral band, i.e., a subset of the full spectral complement, with an uncertainty of 0.5% or less. The polarimetric accuracy is the driving requirement of the instrument design, and is stipulated in order to achieve uncertainty goals in optical depth (0.01) and single scattering albedo (0.03) that appear difficult to reach given the current state-of-the-art of the calibration of intensity-only measurements. Bispectral polarimetry is invoked to enable size-resolved retrievals of particle real refractive index. After examining many approaches and technologies for imaging polarimetry, we conclude that ultrafast time-multiplexing is the best option for meeting the instrument performance requirements. The approach is based upon innovative advances in high-precision imaging polarimetry developed for ground-based solar astronomy. Rapid modulation of the linear polarization Stokes components Q and U, coupled with synchronous demodulation in a charge-caching focal plane, provides two essential benefits: (1) the same detector is used to measure the relative proportions of Q or U to the total intensity, thus circumventing inaccuracies introduced by detector gain changes or uncertainties in flight, and (2) rapid interlacing of the measurements at sub-pixel scale insulates against false polarization signals as the spacecraft flies over a spatially varying scene. Technology advances needed to implement this approach are identified.

GC51A-08 0830h POSTER

Designing and Optimizing Future Spaceborne Multi-angular, Polarimetric Sensors

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Polarimetric measurements in the visible/near-infrared spectral region improve aerosol and cloud microphysical and compositional retrievals. The retrieval approaches exploit the unique polarimetric signatures of aerosols and clouds as function of scattering angle, thereby driving the requirement for data collection over a large range of scattering angles (ideally between 0 and 180 degrees). Scattering angle coverage is a function both of the sensor/sun/target geometry and the sensor architectural approach toward acquiring multi-angular data. These two functions must be considered when designing and implementing a spaceborne, multi-angular polarimetric sensor. The orbital geometry trade is dictated by the range of possible orbits and will quickly reduce to a subset of optimal orbital scenarios. However, the desired parameter of interest (aerosols vs. clouds properties), its spatial variability, and global extent must be considered when selecting an optimal orbit. For example, while a noon-equatorial crossing-time provides the best scattering angle coverage for the retrievals, the increased presence of clouds may preclude use of much of the data for characterizing aerosols. The sensor architectural trade investigates differing sensor approaches to providing sufficient scattering angle coverage. Current polarimetric sensor designs include both the over-lapping imagery approach (e.g. POLarization and Directionality of the Earth's Reflectances - POLDER) and the single-pixel, scanning approach (e.g. Research Scanning Polarimeter - RSP). POLDER (a spaceborne sensor) traded the benefit of image data with a large swath width against the collection of simultaneous polarimetry. RSP (an airborne sensor) collects multi-angular data by scanning the air mass during over-flight with a set of polarimetric compensating mirrors. The RSP design allows for simultaneous polarimetry and potentially very large scattering angle ranges on orbit, but is restricted to a single-pixel detector because of the compensating mirror requirements. We have explored both the sensor design and implementation trades that will lead toward an optimized mission for retrieving aerosol and cloud properties using multi-angular, polarimetric data. In addition, we assessed the performance of an RSP-like design for space. Specifically, we investigated the impact of aerosol spatial inhomogeneity on the performance of a single-pixel, scanning sensor design operating in a low-earth orbit (LEO) such as the EOS Aqua orbit of 705 km. Possible mitigation strategies to reduce the impact of the spatial inhomogeneity on aerosol property retrieval performance are also reviewed.

GC51A-09 0830h POSTER

Use of Multiangle Satellite Observations To Retrieve Aerosol Properties and Ocean Color

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Retrieval of aerosol optical depth over ocean is routinely performed by many different single-view satellite instruments. Because most of the ocean surface is sufficiently black in the red and near-IR, its reflectance at these wavelengths can be conveniently ignored, which greatly simplifies the retrieval process. Once the aerosol properties are determined using these wavelengths, the scene can then be atmospherically corrected to determine the amount of water-leaving radiance in all the visible spectral bands of the instrument (i.e., the ocean color). It is this particular surface information which can be analyzed to determine aspects of the biological and chemical content of the water. However, there are many regions where this black water criterion is not met, particularly in coastal waters with continental runoff and areas with heavy phytoplankton bloom. In these situations, aerosol retrievals become much more difficult and the ocean color more uncertain. Preliminary studies indicate that simultaneous (or near-simultaneous) multiangle satellite observations (e.g., by MISR) of the ocean can help to provide more robust aerosol and ocean color retrievals. Here, the directional properties of the ocean color radiances

(and not the lack of ocean color in the red and near-IR) can potentially supply the necessary surface constraint needed to perform a reasonably accurate aerosol and ocean color retrieval. As such, the applicability of this retrieval algorithm could extend over a much wider range of water conditions than is currently routinely attempted. An additional benefit of this approach is that it allows all spectral bands of the the multiangle instrument to be used by the algorithm, thus providing a more robust determination of aerosol properties. We will show some results of case studies using MISR data, performed over different water conditions (open ocean, coastal waters, blooms), and will assess the potential of using surface constraints based on the directional properties of water-leaving radiance.

GC51A-10 0830h POSTER

A-SRVN - AERONET-based Surface Reflectance Validation Network

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The federally funded AERONET program established the necessary foundations for the global testing and validation of the satellite aerosol retrievals. No similar infrastructure for the surface reflectance validation currently exists. The ground-based measurements are sparse, represent only local conditions, and do not directly scale to satellite footprint except for homogeneous surfaces. We are developing an AERONET-based framework for validation of surface BRDF and albedo (A-SRVN). The A-SRVN will automatically collect MISR, MODIS and available ETM+ data worldwide for small areas around AERONET sites, and perform the most accurate atmospheric correction using aerosol and water vapor data from AERONET along with NCEP ozone data. The algorithm relies on a new 3D radiative transfer solution that has a high accuracy, is valid across all scales of the remote sensing, and has an analytical form amenable to developing optimized retrieval algorithms. In addition to surface reflectance validation, the A-SRVN products will help sensor vicarious calibration and cross-calibration, as well as detecting the long-term calibration trends which is imperative in the climate change research.

GC51A-11 0830h POSTER

Mobile Field Goniospectrometry

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Multiangle remote sensing needs multiangle models and multiangle ground reference data. The ground data can be measured using goniometers. Many targets are in difficult terrains and hard to bring into laboratory, which makes the ground data collection more complicated We have developed several field goniometers to measure the directional and spectral reflection signatures of various targets. The heaviest of the instruments is fully manual and very robust for field work. It can be transported using a light trailer and mounted in an hour. The new very light goniometer measures the BRDF automatically in few minutes. It can be carried by two persons even large distances to difficult places. Both of these instruments use the ASD Field Spec PRO FR spectrometer with a 4m light fibre allowing optics to be mounted up and the heavy parts down. The dimensions — arm length about 2m — and optics (1–8 degree view angles) limit the useful spot diameter to about 3, 10 or 30cm, making the system useful for small vegetation and soil. These two wide angle goniometers are complemented by a narrow angle backscattering goniometer utilising beamsplitters to measure up to exact backscattering direction and about 15 degree around. We present BRDF and spectra for undergrowth (lichen, moss, peat, twigs) from a field campaign in August 2003, and various grasses dry and wet. We recognise significant differences in the directional pattern between different species (factors of 2-10) and varying structural properties, making the use of directional signal for remote sensing very attractive. We are working with scattering models of snow and soil, and will continue with vegetation soon.

GC51A-12 0830h POSTER

Multiangular Reflectance of a Glacier Surface

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The worldwide retreat of glaciers provides one of the clearest signals of a change in global climate. In order to monitor the temporal behaviour of glacier surfaces and volumes, remote sensing techniques have proved to be extremely useful. Conventional classification techniques like supervised classifications on Landsat ETM+ images allow us to classify glacier surfaces and to monitor their change. These classifications are based upon the conversion of spectral radiance in nadir direction into surface reflectance and require extensive atmospheric and topographic modelling. Currently the Landsat ETM+ sensor shows anomalies. For most of these reasons, we try an experimental classification procedure to classify a glacier surface. We use the multiangular reflectance properties of the glacier Hintereisferner (Austria) to calculate its albedo for glacier surface patches like snow, firn and ice. On the 12th of August 2003, a time-synchronous acquisition of in situ multi-angular spectrometer measurements and digital camera data acquisition was accomplished. Furthermore, four local mode data acquisitions were done in the same month by the MISR instrument, which is onboard of the Terra satellite. After analysis of the various datasets, we attempt to derive BRDFs (Bidirectional Reflectance Distribution Functions) for the different glacier surfaces. Calculations are performed in those areas were digital camera frames overlap and can be validated by the in situ spectrometer measurements. The albedos derived from the MISR data were compared to the other datasets in order to investigate MISR's possibilities in the future for glacier classification schemes. Manual delineations of specific glacier zones help to improve the classification scheme and serve as validation data.

GC51A-13 0830h POSTER

Airborne Multi-Angle Hyper-Spectral Measurements of White Caps on the Open Ocean

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The influence of whitecaps on the atmospheric correction of ocean color measurements is highly dependent on the spectral variation of albedo that is assumed for the whitecaps. Field measurements of breaking waves in the surf zone indicate a strong spectral variation in whitecap reflectance with the reflectance at 1650 nm nm decreasing by 95% relative to that at 440 nm. The cause of this spectral variation is thought to be the strong absorption by water at longer wavelengths that attenuates light reflected from submerged bubbles. Measurements made during an ocean cruise suggest that the magnitude of this decrease is typically less in the open ocean where the wave breaking is less violent and bubbles are not injected as deep into the water. Nonetheless, even in the open ocean, when whitecaps are large and bright similar decreases in reflectance from 440 nm to 860 nm to those observed in the surf zone are seen. Unfortunately, although measurements in the vicinity of 1600 and 2200 nm are important for remote sensing of aerosols and the atmospheric correction of ocean color measurements, the longest wavelength used for the open ocean measurements was 860 nm. Information about typical reflectance decreases from 440 nm to these longer wavelengths is therefore missing. One approach to remedying this absence of information about the spectral variation of white cap albedo across the solar spectrum is to use an airborne imaging spectrometer. However, a significant difficulty in using airborne, or ship-borne, instrumentation to measure the spectral albedo of whitecaps is the contamination of data by sun glitter. It is usually much more difficult than anticipated to filter data to reject glitter, even for ship-borne measurements with a television camera that provides a visual reference. This means that most data that is reported is obtained under overcast conditions. One approach to alleviating the problems caused by sun glitter is to using multi-angle remote sensing. If different angles are observed sequentially as an aircraft flies over the white caps this has two advantages compared with a single view. Firstly the bidirectional reflectance behavior of white caps and sun glitter is expected to be very different and secondly the white caps should persist longer than a glint reflection. Thus, bidirectional reflectance distribution function measurements of ocean white caps would appear to represent an ideal approach determining the spectral reflectance of white caps. To this end we have modified the scan approach of the HyperSpecTIR imaging spectrometer. Instead of scanning perpendicular to the flight direction and thereby generating an image, the cross-track scan is turned off while the v/h compensation and image stabilization system are left on. This keeps the system tracking a single line on the ground while the plane moves forward, generating a data set of the same line, viewed at multiple angles. In this paper we present the results of multi-angle hyperspectral white cap observations from an initial data collection over the Santa Barbara channel.

GC51A-14 0830h POSTER

Monitoring Earthquake Dewatering Processes Using MISR Satellite Data

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The devastating Gujarat earthquake which hit the province of Gujarat in India on January 26, 2001, provoked an extensive liquefaction process. This presentation reports on the spatio-temporal distribution of this liquefaction-induced surface phenomenon by analyzing time seriesmeasurements collected by the MISR sensor on board the Terra platform.The analysis of MISR measurements in the near-infrared spectral domain reveals the spatial extent of the surface water and its persistence.This event reactivated ancient river channels in the Rann of Kachchh.Other regions further away from the epicenter have also been affected by the liquefaction process. Indeed, the presence of water along theNagar Parkar fault a few days after the earthquake was unveiled by the analysis of the MISR multi-angle data taken in the red spectral domain. Our study expands and complements the observations from geographically limited ground investigations. It demonstrates that the liquefaction phenomenon has affected areas far away from the epicenter.

GC51A-15 0830h POSTER

Sua Pan Surface Bidirectional Reflectance: An Experiment to Validate the Surface Products of the Multi-angle Imaging SpectroRadiometer (MISR) During SAFARI 2000.

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The Southern Africa Regional Science Initiative dry season campaign was carried out during August and September 2000 at the peak of biomass burning. The intensive measurements in this campaign provided the opportunity to validate the surface products of the Multi-angle Imaging SpectroRadiometer (MISR), onboard NASA's EOS Terra platform. MISR validation team participated with a suite of ground-based instruments, including the PARABOLA and sun radiometers, to measure the surface bidirectional reflectance and atmospheric aerosol. A participating airborne sensor was the Cloud Absorption Radiometer (CAR) flown onboard the convair-580 research aircraft. The CAR observations provide measurements of the surface bidirectional reflectance (BRF). This paper presents a validation study of MISR surface products by comparing MISR retrieval of the surface BRF, at Sua Pan, Botswana, with those evaluated on the ground and from the air, using the PARABOLA and CAR observations, respectively.

GC51A-16 0830h POSTER

Performance of the MISR LAI and FPAR algorithm: A Case Study in Africa

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The Multi-angle Imaging SpectroRadiometer (MISR) instrument is designed to provide global imagery at nine discrete viewing angles and four visible/near-infrared spectral bands. The MISR standard products include green leaf area index (LAI) of vegetation and fraction of photosynthetically active radiation absorbed by vegetation (FPAR). These parameters are being routinely processed from MISR data at the Langley Atmospheric Sciences Data Center since October 2002. A principal objective of the MISR approach is to retrieve LAI and FPAR without requiring a static, pre-specified global biome map. Single angle retrievals require this information to constrain the results, and incorrect information on biome type in such algorithms can fatally impact the retrievals. The typical overall accuracy in most biome maps is about 70%. Thus, about 30% of LAI retrievals should be treated as unreliable in the case of single-angle data. Performance of the MISR LAI/FPAR algorithm for a limited set of data from Africa suggests that concurrently valid LAI retrievals and correct biome identification occurs, on average, in about 20% of the pixels, given the current level of uncertainties in the MISR surface reflectance data. The other 80% of the LAI values are retrieved using incorrect information about the biome type; however, the use of multiangle data minimizes the impact of biome misidentification on the LAI retrievals. In about 70% of the cases examined, uncertainties in the observations were the limiting factor in controlling the LAI uncertainty, not the ability to classify the biome type. Thus, the joint use of angular and spectral information without a prescribed biome map or training data results in comparable accuracy to LAI values obtained from single-angle retrievals that require a pre-defined biome map. The multiangle algorithm can therefore adapt to changing or unknown land cover.

GC51A-17 0830h POSTER

Combined Multiangular and Hyperspectral Observations for Improved Modeling of Forest Productivity

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There is a strong parallel between ecosystem productivity and land surface reflectance, in the sense that structural and foliar-chemical variables exert first order control over both processes. However, bidirectional reflectance and productivity are rarely linked explicitly in model analyses. Though some significant challenges exist, progress can be made by understanding the complementary information contained in the angular and spectral signatures of vegetation at the landscape scale, in the context of reflectance and productivity models. We present results from a combined multiangular (AirMISR) and hyperspectral (AVIRIS) remote sensing airborne campaign which was conducted over three northeastern U.S. forest research sites in 2003. Target sites included the Bartlett Experimental Forest, New Hampshire, USA; Howland Experimental Forest, Maine, USA; and Harvard Forest, Massachusetts, USA. Complementary, near-simultaneous field observations were obtained primarily in the Bartlett site, which has been extremely well-characterized spatially by previous field and modeling studies. Field observations include canopy hemispherical photography, from which several structural metrics have been obtained, and foliar nitrogen content.

GC51A-18 0830h POSTER

Forest Cover Indicator Based on Spectral and Directional Remote Sensing Data.

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The exact extend and change of Canada forests are of great importance in climate change and sustainable development as forests provide wildlife habitat and ecosystem mechanisms to clean air and water, and sequester carbon. Measuring the area of forested land in Canada on a regular basis provides an indicator of the availability of these important ecosystem services. A methodology was developed to quantify forest cover based on crown closure estimates. Field data, spectral and directional remote sensing imageries, and a canopy radiative transfer model (Five-Scale) are used for mapping crown closure at 1-km resolution. The main challenge of the research is in the transition zone between boreal forest and the tundra, where few inventory data are available and the trees are found in clusters. The results will be used in a Canada-wide forest indicator that aimed at monitoring yearly changes in the forest extend due in part to forest fires, insect defoliation, regrowth and changes due to climate change. Initial results using SPOT-VGT data and foliage clumping information from ADEOS-POLDER are presented.

GC51A-19 0830h POSTER

Multi-angle Imaging SpectroRadiometer Data Products and Tools

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The Multi-angle Imaging SpectroRadiometer (MISR) data are processed, archived and distributed by the Atmospheric Sciences Data Center (ASDC) at NASA's Langley Research Center. Available MISR data products include Level 1 calibrated instrument data, Level 2 aerosol, cloud, and land surface products and Level 3 globally gridded statistical summaries of selected Level 1 and Level 2 parameters aggregated over various time scales (daily, monthly, seasonal and annual). The ASDC also provides access to tools that aid in the visualization and analysis of the MISR data products. Web interface tools such as the MISR Browse Tool and the MISR Level 3 Imagery allow quick access to imagery. Software tools such as hdfscan and misr-view can aid in analysis of the data products. Detailed information about the MISR data products, tools and documentation are available from the ASDC web site, http://eosweb.larc.nasa.gov.

URL: http://eosweb.larc.nasa.gov

GC52A CC: 524 C Friday 1030h

Multiangle Remote Sensing of the Terrestrial Environment–I

Presiding: **D J Diner,** Jet Propulsion Laboratory, California Institute of Technology**; B Cairns,** Lamont-Doherty Earth Observatory

GC52A-01 1035h

Retrieval of Aerosol Optical Depth Over Europe Derived From ATSR-2 Data for the Year 2000

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At TNO Physics and Electronics Laboratory the retrieval of aerosol properties from ATSR-2 data (ERS-2 satellite) is performed by means of several scientific algorithms. The dual view algorithm for application over land and the single view algorithm for application over ocean have been merged into a fast and efficient algorithm that allows for near real-time processing and which is suitable for operational use. It includes all necessary corrections for surface and atmospheric effects including fully automated cloud screening procedures. The algorithm can be applied to retrieve the aerosol optical depth (AOD), Ångström parameter and the aerosol types. A preliminary analysis will be presented here from newly obtained data for the year 2000 over Europe. The retrieved AOD compares favorably with collocated sun-photometer data from the Aerosol Robotic Network (AERONET).

GC52A-02 1050h INVITED

Aerosol Properties from Multi-angle Satellite Imaging

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The MISR instrument, flying aboard the NASA Earth Observing System's Terra satellite, is pioneering the use of multi-angle imaging to monitor aerosols globally, from space. MISR obtains nine along-track images at view angles ranging from $+70^\circ$ through nadir to -70°, in each of four wavelengths, near-simultaneously. The instrument systematically covers air-mass-factors between one and three, and in mid-latitudes, samples scattering angles extending from about 60° to 160°. These data contain information about particle size distribution, shape, composition, and amount. Large air-mass-factors provide sensitivity to optical depth even for very thin hazes. Provided the aerosol optical depth is of order 0.15 or larger, size- and shape-discrimination makes it possible to distinguish non-spherical mineral dust and thin cirrus from spherical pollution particles over dark water, and to obtain information about the single scattering albedo as well as the size distribution of pollution components. If discrete features are visible in aerosol plumes, the height of the aerosol itself is obtained via stereo-matching. Such information is of value for identifying aerosol sources and sinks, for assessing the direct radiative impact of aerosols on global climate, and for aerosol transport model validation. Having constraints on aerosol micro-physical properties also improves the accuracy of optical depth retrievals. This work is performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

URL: http://www-misr.jpl.nasa.gov