three-dimensional system (i.e., sandstone) range from 4 to 150 per cm for the rock-metal interface and 20 to 480 per cm for the EG-rock interface, for pressures that range from 0.0134 MPa to 0.68 MPa. For the metal-EG interface, ILA values rang from 0.4 to 2.5 per cm for the same pressure range. Analysis of the images of the metal-injected sample of the drainages processes found that average ILA values of sandstone samples range from 80 to 120 per cm for the rock-metal interface and from 120 to 170 per cm for the EG-rock interface, for pressures that range from 0.0134 MPa to 0.68 MPa. For the metal-EG interface, ILA values ranged from 0.4 to 3.0 per cm for the same pressure range. The investigation also found a break though pressure for imbibition process between 0.027 and 0.034 MPa where metal saturation increases rapidly. We present the results of both imbibition process and the drainage process. Acknowledgments: Department of Energy - Fossil Energy contract DE-AC26-99BC15207. LJPN wishes to acknowledge Purdue University Faculty Scholar.

H22J-05 1705h

Horizontal Fluid Infiltration: A New Measurement Device and Some Observations

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Fluid infiltration in the vadose zone has been the subject of study since the early 1900s. Understanding infiltration processes is important to numerous problems, including forecasting moisture distribution following soil irrigation, estimating the potential for leachate generation during landfill cover design, and predicting contaminant transport to groundwater following a surface spill. Many models have been developed to describe fluid infiltration, including the well-known models by Jean-Yves Parlange and his coworkers (e.g., Smith and Parlange, Water Resources Research, 14(3), 1978). These models predict the time-rate of infiltration and the cumulative volume of infiltration based on parameters, such as sorptivity, that are often obtained from laboratory experiments. The proper design of these experiments, and appreciation of the factors controlling parameters derived from them, is therefore key to the accuracy of such models. This paper describes a new experimental setup to observe fluid infiltration under one-dimensional capillary dominated flow. Dry soil is packed in a horizontal 700 mm long polycarbonate channel that is 25.5 mm x 25.5 mm in cross-section. The top of the channel is open to the atmosphere. The upstream end of the channel is connected, via a three-valve chamber, to an infiltrant container placed on an electronic balance. Initial flooding and final draining of the three-valve chamber can be controlled without disturbing conditions in the column. The height of the infiltrant container can be adjusted to control the fluid inlet head. The end of the column is capped with a seal that allows the free exit of air. During an experiment, fluid is introduced at the upstream end of the column at a fixed head. The position of the infiltration front and the cumulative mass of fluid flowing into the column are both observed with time. At the end of each experiment, the fluid saturation along the column is obtained by sampling from the top, open surface of the column. Infiltration experiments into initially dry, uniform sand (D10 = 0.09 mm) were performed using the new setup. Either water or Soltrol 220 was used as the infiltrant. The inlet head was varied between -30 cm and 50 cm. For all experiments, a linear increase in fluid infiltration with the square root of time was observed, confirming capillary dominated flow. Results from the experiments demonstrate that the sorptivity and transmission zone saturation both increase with the infiltrant head. The results also reveal that the sorptivity of water and soltrol in a soil cannot be simply related through the fluid properties, even when the infiltrant head is zero. Both of these findings have implications for the measurement and use of sorptivity (or other related parameters) for predicting fluid infiltration.

H22J-06 1720h

Application of the Preisach Model to Soil-moisture Hysteresis

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An examination of the physics of the land phase of the hydrological cycle shows that the most important non-linearities occur in the unsaturated zone of the soil. These have been studied using switched boundary conditions applied to the one-dimensional form of Richards differential equation, modelling the wetting and drying of a column of bare or vegetated soil, at a scale of roughly one meter. However, the strongly non-linear hysteretic property of the soil moisture characteristic is usually ignored. Smooth non-linear differential, or integro-differential, operators cannot reproduce soil-moisture hysteresis. The classical Preisach Model is presented and applied to the quantitative description of soil-moisture scanning curves. The Preisach model is a deterministic, rate independent non-linear operator with return-point memory and congruent loops. Special, one parameter, classes of Preisach operators are proposed as models of soil-moisture hysteresis for particular soils. The results of fitting these operators to laboratory and field data, taken from the Grenoble GRIZZLY Soil Database, are presented and discussed.

URL: http://www.bcri.ucc.ie/BCRI_15.pdf

H22J-07 1735h

Containment of Saline Intrusion by Air Injection

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The effects of air injection on flow through porous media were explored in a series of 1 m and 2 m laboratory flow cells. Our motivation was to examine air barriers as an alternative to hydraulic barriers to retard saline intrusion in coastal areas. Steady flow conditions were created in homogeneous and heterogeneous unconsolidated sand systems. Dry air was injected at progressively higher flow rates through a well in the center of each flow cell. Discharge and NaCl-tracer concentration breakthrough data were measured at the outflow reservoir of each cell. In addition, a dye tracer was used to visualize the flow patterns. In all cases, air injection was found to produce stable, low conductivity barriers that reduced discharge by an order of magnitude or more. Effective hydraulic conductivity values determined from discharge and hydraulic head data showed exponential declines with increased air-injection rates in all cases. Numerical simulation was used to quantify hydraulic conductivity and effective porosity values in the saturated and aerated regions created by air injection, and to study advective flow behavior. Pore-filling cement formed in the air-injection region, and was analyzed to determine its composition, mass, and volume. Approximately 60% of the cement consisted of soluble minerals and 40% were less soluble carbonates. Evaporation to dryness and increase in solution pH due to stripping of CO_2 by the injected air were responsible for creating the cement. The cement occupied <10% of the pore space in the sand-cement aggregate. Both the trapped air and pore-fillings dissolved when air injection ceased, indicating that both barriers are temporary. These results serve as a preliminary proof-of-concept that air-injection barriers might effectively retard undesired subsurface flow, such as saline intrusion or contaminated groundwater.

H31A MCC: 3024 Wednesday 0800h

Early Results From NASA's EOS Aqua Spacecraft Mission III *(joint with A, OS)*

Presiding: **C L Parkinson,** NASA Goddard Space Flight Center**; D E Hagan,** Jet Propulsion Laboratory, California Institute of Technology

H31A-01 0800h INVITED

Infrared Remote Sensing Through Clouds With the AIRS-AMSU-HSB Sounding System on Aqua

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The main objective of the AIRS-AMSU-HSB sounding system on Aqua is to demonstrate accurate remote sounding of the atmospheric state in the presence of clouds. The AIRS instrument represents a breakthrough in infrared space instrumentation. The AIRS has 2378 infrared channels in the range of 3.7–15.4 microns with a nominal spectral resolution of 1200. A year after launch, the AIRS-AMSU-HSB system has demonstrated its ability of eliminating the effects of clouds on the AIRS infrared radiances (spectrum) in the presence of up to 80% cloud opacity in the AIRS fields of view. From the resulting cloud-cleared infrared radiances we have retrieved temperature profiles with radiosonde accuracy. The AIRS-AMSU-HSB instrument suite on Aqua is designed to meet both the NOAA operational weather prediction requirements as well as NASA's climate research needs. The three instrument suite will gather more accurate meteorological information about the Earth's atmosphere and its circulation than ever done before and will reduce the error of the initial sate for weather forecasting. For the first time, a satellite remote sensing instrument will achieve, worldwide, the same accuracy in temperature as currently possible only with direct measurements by balloon-borne sensors. For moisture, however, the accuracy of AIRS-AMSU-HSB will exceed that measured by balloon-borne sensors The performance of AIRS since launch has been exceptional indicating that the AIRS-AMSU-HSB instrument suite will meet or exceed its objective to deliver: Global, Day- Night, Lands-Oceans Infrared cloud-cleared Spectrum (Radiances) Atmospheric temperature profiles - 1K/1km Sea surface temperature: 0.5C Land surface temperature: 1C Infrared emissivity ratio Relative humidity profiles: 20%/1 km Total perceptible water vapor: 5% Fractional cloud cover 0.05 Cloud-top pressure and temperature Cloud spectral infrared emissivity ratio Total ozone burden of the atmosphere. In addition to several research products such as the total CO2 burden of the atmosphere, CO and CH4 profiles.

URL: http://www.jpl.nasa.gov/airs

H31A-02 0815h

One year of Monthly Images of Cloud-Filtered AIRS Data

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Since September 2002 the AIRS instrument has produced a nearly continuous record of nearly four million spectra per day. While only about 16,000 of these spectra per day, i.e. less than 1 percent of all spectra over ocean are essentially cloud-free, when agregated into monthly day/night hhhimages using 200,000 clear spectra each, they present a unique insight into remote sensing from polar orbit with hyperspectral resolution. We present 12 month sequences of images of the of observed minus predicted depth of the 791cm-1

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Q-Branch, which is related to CO2 abundance, and marine aerosol using the difference between the apparent surface temperature deduced from the 2616cm-1 window channel and the NCEP RTGSST product. Both sequences show unexpected global patterns and seasonal variability. The seasonal variability of the depth of the CO2 Q-Branch reveals patterns which may be related to fossil fuel burning, but still need to be confirmed by quantitative analysis.

H31A-03 0830h

Atmospheric Soundings from AIRS/AMSU/HSB

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AIRS was launched on EOS Aqua on May 5, 2002, together with AMSU A and HSB, to form a next generation polar orbiting infrared and microwave atmospheric sounding system. The primary products of AIRS/AMSU/HSB are twice daily global fields of atmospheric temperature-humidity profiles, ozone profiles, sea/land surface skin temperature, and cloud related parameters including OLR. The sounding goals of AIRS are to produce 1 km tropospheric layer mean temperatures with an RMS error of 1K, and 1 km layer precipitable water with an RMS error of 20 percent, in cases with up to 80 percent cloud cover. The AIRS data products are significant for studying climate variability and change, as well as for use in initialization of General Circulation Models with the objective of improving analysis fields and subsequent forecast skill. Data assimilation experiments to evaluate the impact of AIRS retrievals on analysis and forecast skill are being conducted. Sample fields of parameters retrieved from AIRS/AMSU/HSB data will be presented and validated as a function of fractional cloud cover. Select fields will also be compared to those contained in the ECMWF analysis, done without the benefit of AIRS data, on both an instantaneous and monthly mean basis, to demonstrate information that AIRS can add to that already contained in the ECMWF analysis.

H31A-04 0845h

Tropospheric O_3 Retrievals from the Baltimore Bomem Atmospheric Emitted Radiance Interferometer (BBAERI) during AIRS Validation

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We present the first results of an algorithm to retrieve tropospheric ozone abundances from the 1000 to 1100 cm^{-1} region of infrared spectra. This retrieval algorithm will be used to monitor tropospheric ozone levels and, in conjunction with meteorological observations, to determine the origins of the observed ozone. Our instrument, BBAERI, was built by ABB Bomem of Quebec, Canada and delivered to the University of Maryland, Baltimore County (UMBC) in March 2000. BBAERI's maximum optical path difference of 1 cm yields an apodized resolution of 1 cm^{-1}. Strong emission/absorption in the 10 μm region of the infrared (1000-1100 cm^{-1}) results from the ν_3 vibrational rotational transitions in the ozone molecule and gives rise to the spectral feature of interest. Spectral line spacing and pressure broadening do not allow an instrument of this resolution to resolve any of the lines, just the band shape. The retrieval consists of a statistical regression using eigenvector decomposition to constrain the solution. Regression coefficients are calculated from 2730 ozonesonde profiles varying in latitude from 25^oS to 65^oN. The regression is followed by a physical retrieval utilizing the K Compressed Atmospheric Radiative Transfer Algorithm (KCARTA) developed by Dr.L.Larrabee Strow and his group at UMBC. Validation results will be presented from field measurements taken in Huntsville Alabama November 2002 and the AIRS BBAERI Ocean Validation Experiment (ABOVE) at the Chesapeake Lighthouse June 2003. Ozonesondes used for validation were flown by Dr.Mike Newchurch, Mohammed Ayoub and Jing Song from The University of Alabama Huntsville. Additional ground ozone measurements were supplied by Dr.Eric Hintsa from Woods Hole Oceanographic Institution (WHOI).

H31A-05 0900h

Feasibility of Sensing Tropospheric Ozone with MODIS 9.6 μ Observations

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With the infrared observations made by the Moderate Resolution Imaging Spectrometer (MODIS) on board the EOS-Aqua satellite, which include the 9.73μ channel, a method is developed to deduce horizontal patterns of tropospheric ozone in cloud free conditions on a scale of about 100 km. It is assumed that on such small scale, at a given instant, horizontal changes in stratospheric ozone are small compared to that in the troposphere. From theoretical simulations it is found that uncertainties in the land surface emissivity and the vertical thermal stratification in the troposphere can lead to significant errors in the inferred tropospheric ozone. Because of this reason in order to derive horizontal patterns of tropospheric ozone in a given geographic area a tuning of this method is necessary with the help of a few dependent cases. After tuning, this method is applied to independent cases of MODIS data taken over Los Angeles basin in cloud free conditions to derive horizontal distribution of ozone in the troposphere. Preliminary results indicate that the derived patterns of ozone resemble crudely the patterns of surface ozone reported by EPA.

H31A-06 0915h

Characteristics of Water Vapor Under Partially Cloudy Conditions: Observations by the Atmospheric Infrared Sounder (AIRS)

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The variability and quality of tropical water vapor derived from the Atmospheric Infrared Sounder (AIRS) are characterized. Profiles of water vapor, temperature and surface characteristics (states) are derived from coincident Advance Microwave Sounding Unit (AMSU) and 3x3 sets of AIRS footprints. States are obtained under partially cloudy conditions by estimating the radiances emitted from the clear portions of the AIRS footprints. This procedure, referred to as cloud clearing, amplifies the measurement noise, and the amplification increases with cloud amount and uniformity. Cumulus and stratus cloud amount are related to the water vapor saturation, and noise amplification and water vapor amount may be partially correlated. The correlations between the uncertainty of retrieved water vapor, cloudiness and noise amplification are characterized. Retrieved water vapor is generally good when the amplification is less than three. Water vapor profiles are compared with correlative data, such as radiosondes and numerical weather center analyses and are in relatively good agreement in the lower troposphere

H31A-07 0930h

Measurements of Water Vapor and High Clouds Using Both the Aqua and Terra MODIS Instruments

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At present, the Moderate Resolution Imaging Spectrometer (MODIS) instruments on board both the Aqua and Terra Spacecraft platforms are collecting scientific data. MODIS has five channels located within and around the 0.94-micron water vapor band absorption region for remote sensing of water vapor. MODIS also has a narrow channel centered at 1.375 micron for remote sensing of high clouds. We have compared the near-IR water vapor products and cirrus cloud reflectance products derived from the Aqua and Terra MODIS data. The results will be presented. We have found that the Aqua MODIS cirrus cloud reflectances over certain geographical regions, such as the Tibetan Plateau and central Africa, are consistently greater than the Terra MODIS cirrus reflectances over the same regions.

H31A-08 0945h

Large-scale Transport of Carbon Monoxide as Observed by AIRS on Aqua

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We present the first observations of large-scale transport of tropospheric Carbon Monoxide (CO) as observed by the Atmospheric InfraRed Sounder (AIRS) onboard the Aqua satellite. Tropospheric CO abundances are retrieved from the 4.67 micron (2180 cm^{-1}) region of AIRS spectra in the 1-0 vibration-rotation band using the operational AIRS full retrieval algorithm running in research mode. In September 2002, locally enhanced CO amounts, correlated with MODIS fire counts in South America and Africa, are advected over the South Atlantic in qualitative agreement with previous airborne observations during TRACE-A. Back trajectory analysis confirms the general transport mechanisms while future investigation will focus on detailed chemical transport modeling. Additional transport off the southeast coast of Africa similar to the 2000 "river of smoke" episode also was observed during September 2002 in the AIRS CO retrievals.

H31B MCC: Level 1 Wednesday 0830h

Hydrogeophysics: Characterization and Monitoring of Subsurface Parameters and Processes III Posters

(joint with NG, MR)

Presiding: **A Binley,** Lancaster University**; T P Ferre,** University of Arizona

H31B-0445 0830h POSTER

Experimental Design Considerations for Estimating Flow Parameters with GPR and Hydrological Measurements

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Using a method recently developed in our group for estimating flow parameter distributions in the vadose zone with transient ground-penetrating radar (GPR) data (such as travel times or inferred values of water saturation) and hydrological data, we investigate various issues of experimental design for parameter estimation. Specifically, an extension of the pilot point