When radiative transfer theory is applied for understanding lidar measurements, it is usually assumed that light interacts with a spatially uncorrelated medium. In situ measurements suggest that most clouds are positively auto-correlated spatially. When light travels within a positively auto-correlated cloud system, the chance of a cloudy parcel hidden behind another cloud parcel is higher than the one for an uncorrelated system. For the same amount of cloud particles, the effective extinction optical depth of the spatially auto-correlated system is equivalent to the extinction optical depth of the correspondent spatially uncorrelated system minus the extra chance of a cloud parcel hiding behind another one. This equivalent extinction adjustment is normally made, intentionally or unintentionally, when applying radiative transfer theory while assuming no spatial auto-correlation of the medium. The radiative transfer theory works fine with this equivalent extinction adjustment if multiple scattering is unimportant in a measurement. But this equivalent uncorrelated medium adjustment introduces under-estimation of multiple scattering. The impact of the spatial auto-correlation on lidar depolarization measurement data analysis and multiple scattering assessments will be presented. This study is based on simulations made with a Monte-Carlo model of lidar measurements with full Stokes vector as well as Cloud Physics Lidar (CPL) measurements. The model calculations are accelerated with FPGA-based reconfigurable computation.

U14A-03 1605h

Influence of Small-Scale Drop Size Variability on the Estimation of Cloud Optical Properties

Yuri Knyazikhin[1] (jknjazi@crsa.bu.edu)

Alexander Marshak[2] (Alexander.Marshak@nasa.gov)

Warren J. Wiscombe[2] (Warren.J.Wiscombe@nasa.gov)

John V. Martonchik[3] (John.V.Martonchik@jpl.nasa.gov)

[1]Boston University, 675 Commonwealth avenue, Boston, MA 02215-1401, United States

[2]NASA GSFC, NASA/GSFC Code 913, Greenbelt, MD 20771, United States

[3]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

Most of the existing cloud radiation models and conventional techniques of data processing assume that the mean number of drops with a given radius varies proportionally to volume. The analysis of microphysical data on liquid water drop sizes acquired during the First International Satellite Cloud Climatology Project (ISCCP) Regional Experiment (FIRE), July 1987, and the Atmosphere Radiation Measurements (ARM) Cloud Intensive Operational Period (IOP), March, 2000, shows that, for sufficiently small volumes, the number is proportional to the drop size dependent power of the volume. The drop size dependent coefficient of proportionality, or a generalized drop concentration, and the exponent are determined solely by the smallest sampling volume; they are independent of the volume drops occupy and differentiate spatial distributions of drops with different sizes. For abundant small drops (r$\leq$14μm) present, the exponent is 1 as assumed in the conventional approach. However, for rarer large drops (r>14μm), the exponents fall below unity for scales between the smallest sampling volume and a "saturation" scale. At these scales, therefore, the mean number of large drops decreases with volume at a slower rate than the conventional approach assumes, suggesting more large drops at small scales than conventional models account for; their impact is consequently underestimated. The analysis presented here indicates that depending on cloud size, the neglect of small-scale drop size variability can result in a systematic underestimation of cloud horizontal optical path.

URL: http://cybele.bu.edu/download/ms.html

U14A-04 1620h

Unbiased High Resolution 3D Aerosol Retrievals from Landsat

Alexei Lyapustin (1 - 301-614-5998; alyapust@pop900.gsfc.nasa.gov)

GEST UMBC/NASA GSFC, Mail code 920, Greenbelt, MD 20771, United States

Satellite monitoring of the man-made pollutants in urban/ industrial regions is important to understand the climate forcing of anthropogenic aerosols. Our ability to accurately study aerosols from space over land is generally limited to dark dense vegetation (DDV) targets. The urban regions of interest are notoriously difficult because of high inhomogeneity and contrast of surface, combined with the small size of sparsely located DDV targets. Such conditions enhance the atmospheric blurring of satellite images otherwise known as 3D adjacency effect. Importantly, blurring systematically increases the apparent brightness of the dark pixels resulting in the systematic overestimation of the aerosol optical thickness over land by conventional 1D methods. The small size of the DDV targets in the urban regions defines a unique niche for Landsat-like measurements for the aerosol studies. We developed a new dark target method for unbiased simultaneous retrieval of the aerosol model and optical thickness over land, based on 3-D radiative transfer theory. We will demonstrate an application of this method for a set of ETM+ images of the Washington-Baltimore area, and its initial validation with AERONET measurements.

U14A-05 1635h

Lidar Investigation of Atmospheric Stratification: Del=2, 7/3, 23/9 or 3?

Marc Lilley[1] (lilleym@physics.mcgill.ca)

Shaun Lovejoy[1] (1-514-398-6537; lovejoy@physics.mcgill.ca)

Kevin Strawbridge[2] (1-705-458-3314; Kevin.strawbridge@ec.gc.ca)

Daniel Schertzer[3] (Daniel.Schertzer@cereve.enpc.fr)

[1]Physics, McGill, 3600 University st., Montreal, Que H3A 2T8, Canada

[2]Centre for Atmospheric Research Experiments (CARE) CMS, R.R.#1, Egbert, Ont L0L 1N0, Canada

[3]CEREVE, Ecole Nationale des Ponts et Chaussées, 6-8, avenue Blaise Pascal, MARNE-LA-VALLEE 77455, France

Practically all theories of turbulence assume isotropy or at least local isotropy. In buoyancy driven flows the justification is not obvious because gravity breaks the isotropy yet acts at all scales. The classical assumption is that gravity leads to a basic stably stratified state while simultaneously postulating that the perturbations are nevertheless statistically isotropic. In the atmosphere, the scale height (about 10 km) presents a further challenge: isotropic three dimensional turbulence cannot extend to very large scales. The standard model postulates an intermediate "meso-scale gap" followed at larger scales by two dimensional horizontally isotropic turbulence. Today, although we still lack consensus about the full horizontal atmospheric statistics, the meso-scale gap separating the these D=3, D=2 regimes has not been observed and there is wide consensus that the horizontal wind is scaling in the horizontal with spectral exponent β_h =5/3 out to at least several hundred km. In the vertical direction, the spectral exponent $\beta_v > \beta_h$ implying scaling stratification with the volume of structures growing at a rate Del= $2 + (\beta_h - 1)/(\beta_v - 1)$. The two main contending proposals being $\beta_v = 11/5$ (buoyancy driven, Bolgiano-Obhukov) and β_v =3 (gravity waves, Lumley-Shur) implying Del=7/3, 23/9 respectively. In this talk we describe some recent results using state of the art lidar data of passive scalars, over the range 3m to 120km, we directly estimate Del=2.56$\pm$0.05 supporting the 23/9 dimensional "unified scaling" model . We discuss this in relation to other measurement campaigns, and also the implications for modelling the atmosphere. Finally, we show how to make multifractal models of vertical cross-sections which are very close to the data.

U14A-06 1650h

Fractal Analysis Challenges for Remote Sensing of Clouds and Other Geophysical Phenomena

Joe Brewer[1] (jabrewer@atmos.uiuc.edu)

Larry Di Girolamo[1] (larry@atmos.uiuc.edu)

[1]Department of Atmospheric Sciences, University of Illinois, 105 South Gregory Street, Urbana, IL 61801, United States

Clouds are the primary source of uncertainty in models of the weather and climate. Thus it is crucial that our overall understanding of clouds be improved, especially the radiative effects of clouds. Fractal cloud models are commonly used to investigate radiative effects caused by the spatial heterogeneity of real clouds. These complex distributions exhibit variability across a range of scales, suggesting the utility of fractal modeling as a means of simulating and exploring cloud properties. Estimation of fractal dimension, the principle parameter of fractal models, has been shown to exhibit sensitive dependence on which estimator is used, suggesting a variety of estimators must be studied to determine which gives the most accurate results. This presentation will demonstrate that fractal dimension estimation is unreliable and depends upon many factors including instrument resolution, sun-view geometry, spectral channel, averaging techniques, number of data points, and estimation algorithm used. The primary conclusion drawn from this study is that the measurement of fractal dimension cannot be achieved with confidence for clouds and other geophysical phenomena and an alternative approach must be developed in order to acquire scale invariant (fractal) properties from clouds that are input into fractal models. Thus it is necessary to develop more sophisticated fitness criteria for selecting appropriate fractal models and their corresponding parameter values.

U15A CC: 517 A Monday 1715h

Union Frontier Lectures I

Presiding: **S King,** Purdue University; **W R Peltier,** University of Toronto

U15A-01 1715h INVITED

Cold Regions Hydrology: Its State and Future

John Pomeroy (pomeroy@usask.ca)

University of Saskatchewan, Canada Research Chair in Water Resources and Climate Change Centre for Hydrology Dept. of Geography, Saskatoon, SK S7N 5A5, Canada

The major hydrological events in cold regions are related to storage and melt of snow and ice and the related energetics of phase change. Cold regions hydrology therefore is subject to a relatively unique assemblage of hydrological processes and parameters that produce a very distinctive hydrological response. Observational networks of snowfall, snow depth, ice extent, soil frost and streamflow have never been dense in cold regions, which due to their large size and remoteness adds the particular challenges of information scarcity and large scale of application to this branch of hydrology. The difficulties of field observations of snow accumulation, interception, redistribution, frozen soil moisture content, and ice-covered streamflow in remote cold regions environments mean that even routinely-gauged basins represent subjects of high uncertainty in hydrological calibration and estimation. Uncertainty in model operation is exacerbated by the temperate-environment bias of many hydrological models, in which their underlying approach, assumptions and structure may not be suited to the dynamics of cold regions hydrology. This paper reviews recent progress in defining and describing the relevant land-based hydrological cycle in cold regions, the scaling behaviour of some cold regions processes and the observational challenges provoked by cold, remote environments. It then discusses the appropriate modelling strategy for such environments and how this might be addressed in the next generation of hydrological research in high latitudes and altitudes.

U15A-02 1800h

Scientific Results from the Mars Exploration Rover Mission

Steve Squyres (squyres@astro.cornell.edu)

Cornell University, Space Sciences Building, Ithaca, NY 14853, United States

U21A CC: 220 C-E Tuesday 0830h

Remote Observation of the Earth's Surface and Atmosphere: The Challenges of Spatial Complexity Posters

Presiding: **S Lovejoy,** McGill University; **A B Davis,** Los Alamos National Laboratory

U21A-01 0830h POSTER

Optical and Radar Remote Sensing Measurements of the Extreme Flood of 2003, Indus River, Pakistan and NW India

G Robert Brakenridge[1] (6036462870; Brakenridge@Dartmouth.edu)

Son V. Nghiem[2] (8183542982; Son.V.Nghiem@jpl.nasa.gov)

Elaine Anderson[1] (6036462870; Elaine.Anderson@Dartmouth.edu)

Sebastien Caquard[1] (Sebastien.Caquard@Dartmouth.edu)