

## **GEC3 Student Day , September 24, 2010**

### **Presentation Abstracts**

#### **Session I**

**1:00**

##### Trace aldehydes and ketones in surface ocean waters.

Ed Hudson (Departments of Chemistry & Atmospheric and Oceanic Sciences, McGill University)

Aldehydes and ketones are among the trace organic gases found in seawater. After transfer across the sea-air interface, they may affect atmospheric chemistry and climate. It is unknown whether the oceans represent a net source or sink, with respect to the atmosphere, for these compounds. Methods allowing the routine determination of aldehydes and ketones in seawater would help us better understand their biogeochemistry. This presentation will outline the development of a low-cost, environmentally friendly method (based on solid phase microextraction, SPME) to measure one- to nine-carbon aldehydes and ketones in seawater, and its application to surface waters from the Northwestern Atlantic and lower St. Lawrence Estuary.

**1:15**

##### A Geographic Frost Information System for Quebec's Eastern Townships.

Vahid Ikani (Département de Géomatique Appliquée, Université de Sherbrooke)

Frost is the main factor limiting agricultural production in many parts of the world. According to La Financière Agricole du Quebec (FADQ) farmers in the Eastern Townships see their production reduced by frost. Although it is a commonplace occurrence frost is still a poorly understood phenomenon in terms of the meteorological and environmental factors which influence its distribution in space and time. Until a physically correct model has been developed it is difficult to anticipate how frost will influence future agricultural production.

The objective of this research is to develop a physical model to predict surface equilibrium temperatures using meteorological data, topography - vegetation data and remotely sensed data as inputs. The purpose is to create a frost information system within which different aspects of the frost problem can be modeled and better understood, such as frost risk under specified conditions, be they ambient or modeled, and its variation in relation to specified changes in environmental conditions, such as the addition of shelter-woods and other means of modifying frost risk. Such a system would also allow evaluation of factors such as clear-cutting of mountain slopes on the frost-risk to farmers in the valley below (a problem noted in northern Sweden), prior to the clear-cutting, before the damage has been done. Such a system would also be useful to provide site-specific warnings of frost-risk of much higher resolution than the frost-risk warnings issued by Environment Canada.

The topographic and vegetation databases used are at a spatial resolution of 30m, now available for most of Canada. In related projects this database is employed to model spatial

variations in snow cover properties. Meteorological inputs are from weather stations distributed throughout the field area (The Eastern Townships) and from general and regional circulation models. A variety of satellite data (AVHRR, MODIS, LANDSAT...) will be employed, as well as micrometeorological stations in specific locations to train the model system and validate its outputs.

**1:30**

### Implications of Land Use and Climate Change on Water Quality in Agricultural Watersheds.

Bano Mehdi (Department of Geography, McGill University)

The main objective of this research is to determine the future quality of surface water due to possible changes in climate and in crop land use. Most studies that have examined the impacts of climate change in a given watershed, have assumed a static landscape. However, we can expect land use to continue to evolve with time. Agricultural land use is highly site specific and is determined by multi-scale factors (e.g. national subsidies, environmental policies, new technology, distance to markets and local demands) which influence the decision making processes of producers to manage their landscape. The farm is therefore an important entity for making decisions regarding land use change, but it is rarely the unit of study.

The drivers of land use change at the farm level will be investigated, through the means of a questionnaire sent to producers. The responses will ascertain decision-making factors which govern current crop land use on the farm in general, and they will also determine factors of decision making that are applicable to an overall warmer climate. From the responses, the given drivers of change will be applied to a land use model; CLUE-S (Conversion of Land Use and its Effects- Small Scale). In conjunction with other large-scale drivers, several scenarios of the spatial distribution of crop land will be established for the 2040 time horizon, in two watersheds (one in Bavaria and one in Québec).

To determine a future climate, relevant parameters (temperature, precipitation, evaporation and solar radiation) for the time horizon 2041-2070 will be obtained from numerous runs of the Canadian Regional Climate Model (CRCM) from the Ouranos Consortium.

Finally, scenarios of water quality in both watersheds will be investigated (in collaboration with University of Munich), through the application of a water quality model, by using the inputs of future spatial distributions of land use and future climate scenarios. For this purpose, the hydrological model SWAT (Soil and Water Assessment Tool) will be applied to both watersheds to determine water quality in light of the potential changes that may occur.

**1:45**

Effect of Nonionic Surfactant Brij 35 on the Fate of Oxytetracycline Antibiotic in a Sandy Soil.

Eman ElSayed (Department of Bioresource Engineering, McGill University)

In many parts of the world, river water is used for irrigation. Treated, partially treated, or sometimes untreated water from wastewater treatment plants is discharged directly into rivers thereby degrading river water quality. Consequently, irrigation water may contain surfactants and this may affect fate and transport of chemicals such as pesticides and antibiotics in agricultural soils. Therefore, a field lysimeter study was undertaken to investigate the effect of a nonionic surfactant, Brij 35, on fate and transport of a commonly used cattle antibiotic, Oxytetracycline. Nine PVC lysimeters, 1.0 m long x 0.45 m diameter, were packed with a sandy soil to a bulk density of 1350 kg/m<sup>3</sup>. Cattle manure, containing Oxytetracycline, was applied at the surface of the lysimeters at the recommended rate of 10 t/ha. Then waters having three levels of the nonionic surfactants Brij 35 (0, 500, 5000 mg/L) were applied for irrigation. Both soil and leachate samples were collected over a 90-day period and analyzed. Results showed that surfactants significantly increased the mobility of the antibiotic in the soil as compared to the control. Thus the reuse of wastewater containing surfactants could enhance the mobility of contaminants and consequently increase ground water pollution.

**2:00**

Can we detect emission reductions from REDD+ under current capabilities?.

Johanne Pelletier (Department of Biology, McGill University)

In preparation for the creation of a new agreement that could address as much as one fifth of global greenhouse gas emissions by Reducing Emissions from Deforestation and forest Degradation (REDD+), important work on methodological issues is still needed to secure the capacity to produce measurable, reportable, and verifiable emissions reductions from REDD+ in developing countries. To contribute to this effort we have quantified uncertainties in emission estimates from land-cover changes for Panama, one of the first countries to be supported by the Forest Carbon Partnership Facility of the World Bank and by UN-REDD. Performing sensitivity and uncertainty analyses using a land-cover change emissions model, we identified forest carbon stocks and the quality of land-cover maps as the key parameters affecting model uncertainty. We also used the model to compare emission reductions from five different deforestation avoidance scenarios drawn from governmental input. None of the scenarios lay outside the confidence bounds surrounding the baseline emissions obtained from the uncertainty analysis. These results suggest that with current data, real emission reductions in developing countries could be obscured by their associated uncertainties. These new considerations should be taken into account in the design of REDD+ agreements.

**2:15**

Capturing Elemental Gaseous Mercury in Stationary and Flow Systems.

Graydon Snider (Department of Chemistry, McGill University)

Gaseous mercury is known to undergo photocatalytic oxidation by UVA-irradiated titania surfaces. We show TiO<sub>2</sub> could be employed to reduce mercury concentrations in gas streams and stationary systems, even at very high (> 1 ppm) Hg<sub>0</sub>(g) concentrations. Surface characterization of the TiO<sub>2</sub> layer has shown mercury oxide (HgO) is the primary reaction product. We are now investigating the effects other coal combustion products may have on the capture efficiency of HgO(s).

**Session II**

**3:30**

Potential for added value in precipitation simulated by high-resolution nested Regional Climate Models.

Alejandro Di Luca (Department of Atmospheric Science, UQAM)

Regional Climate Models (RCMs) constitute the most common method to perform affordable high-resolution regional climate simulations. From a practical viewpoint, the key issue in their evaluation is to determine whether RCM simulations improve the representation of climatic statistics compared to those of the driving data (i.e., to determine if RCMs add value), which are either GCM simulations or analyses of observations (reanalyses). A necessary condition for RCMs to add value to the driving data is that the climate statistics of interest contain non-negligible fine spatial scale variability. This variability can then be used as a measure of the potential of RCMs to add value (hereafter indicated as PAV, for potential added value).

In this presentation, I will discuss some quantities that can be used to characterize the PAV generated by various RCMs when simulating the precipitation field under current climate conditions (driven by reanalysis data). The dependence of PAV on various factors such as the season, the region, and the temporal resolution of the data will be examined. Results will focus on North America and will make use of RCM simulations performed in the context of the North American Regional Climate Change Assessment Program (NARCAAP). In this project simulations with six RCMs were generated for current climate conditions over a domain covering Canada, United States and parts of Mexico. Finally, a brief discussion on how the PAV concept can be used to analyze the added value of RCMs in future climate simulations will be included.

3:45

Climate Change vulnerability and adaptation: Why and how to mobilise local capacity?

Fidelis Folifac (School of Urban Planning, McGill University)

Reducing vulnerability and improving adaptation to climate change requires both scientific and social processes. Scientific contributions, such as predictive models, are essential to the extent that local capacity can be mobilised to harness, disseminate and use the generated information. This requires stakeholders' sense of interdependence, and willingness to collaborate and engage in collective actions. My presentation will demonstrate how pro-marginalised platforms can be used to initiate collaborative agenda and collective action. It uses the case of "Buea Water-4-Life Schools Competition" where a competitive platform was used to bring together local researchers and practitioners, policy and decision-makers and the youths to examine the causes and solutions to the Buea water supply crisis. Based on early outcomes, it is argued that cross-cutting themes such as water can attract a wide range of actors, elicits tacit knowledge on vulnerability and adaptation, and can lead to unexpected outcomes which will further mobilise local capacity for improved climate change awareness, reduced vulnerability and improved adaptation. This is a time intensive process that can be realised with reasonable financial commitment. The challenge of process sustainability calls for a proactive agenda on promoting research that blends rigor and relevance at the local level.

4:00 Chemical Partitioning of Mercury in a Coal-fired Power Plant Plume. Daniel Deeds

(Department of Atmospheric and Oceanic Sciences, McGill University)

Mercury emitted from coal-fired power plants partitions between 3 bulk atmospheric reservoirs: gaseous elemental mercury (GEM), gaseous oxidized mercury (GOM) and particulate mercury (PHg). While GEM is thought to persist in the atmosphere on the timescale of a year, GOM and PHg are removed on much shorter timescales, due to relatively higher solubilities and deposition rates. How mercury is distributed between these three forms (i.e. its "speciation"), and how it repartitions after emission, determines to a large extent whether a single emitter of mercury is a global and/or local polluter. We will discuss mercury speciation in the plume of a coal-fired power plant in Nanticoke, Ontario as measured during an Environment Canada aircraft campaign in 2000. The emissions from the Nanticoke plant will be placed in the local, regional and global context, especially with regards to nearby aquatic ecosystems (e.g. Lake Erie to the south).

4:15

Global Ecological Integrity as the Basis for Regulating the Global Economy.

Geoff Garver (Department of Geography, McGill University)

An article by Johan Rockström and colleagues in *Nature* in September 2009 put forth nine proposed “planetary boundaries” that together delimit “safe operating space” for the human enterprise. The authors suggest that these boundaries – based on climate change, extinctions of species, global nutrient cycles, toxic chemical pollution, atmospheric aerosols, stratospheric ozone, freshwater use and land use – might form the basis for “novel and adaptive” forms of governance at the global, regional and local levels. My research examines how these new forms of governance might develop. First, the overall objectives for framing normative limits on human use of the ecosphere must be considered: what is meant by “safe operating space” and what objectives flow from it? Second, metrics must be established that can indicate progress toward meeting those objectives. The proposed planetary boundaries, and related metrics such as ecological footprint and human appropriation of net primary productivity, provide a starting point. Third, an adaptive methodology is needed for transposing those metrics into regulatory and policy regimes, taking into account scientific uncertainty, political obstacles (such as strong commitment to economic growth) and challenges in devising fair ways to distributed or allocate regionally and locally the responsibility to respect global limits.

4:30

Can molar gas ratios positively identify the nature and origin of massive ground ice of Herschel Island, Yukon?

David Fox (Department of Geography, McGill University)

An exciting new tool has been developed in recent years that enables geocryologists to accurately identify the origin and nature of massive ground ice features. The molar ratios of O<sub>2</sub>, N<sub>2</sub> and Ar gases entrapped in massive ground ice is a novel, periglacial field technique that results in a positive disassociation between buried glacial and non-glacial intrasedimental ice (Lacelle et al., 2007 and Cardyn et al., 2007). Massive ground ice, large tabular ice bodies with a volumetric ice content exceeding 95%, is a unique permafrost feature that persists throughout permafrost landscapes (International Permafrost Association, 1998). Massive ground ice features, discovered in the headwalls of retrogressive thaw slumps on Herschel Island, Yukon, have been analyzed extensively in order to comprehend the structure, composition and spatial extents (Pollard, 1990). However, the origin of this buried ice, be it buried glacial or non-glacial intrasedimental ice, is a fundamental question that has yet been fully understood. To understand the origin of massive ground ice features is to understand the paleoclimates and environments that spawned their creation. Moreover, ground ice features have a major influence on the geomorphology of permafrost landscapes and directly control rates of coastal erosion, active layer depth migrations and thermokarst activity, all of which are projected to increase under many climate change scenarios. The established research sites of Herschel Island offer a unique opportunity to employ new scientific methods to understand this longstanding question.

4:45

Can we predict carbon stocks in tropical ecosystems from tree diversity? Comparing species and functional diversity in a mixed species plantations and a natural forests.

Maricarmen Ruiz Jaen (Department of Biology, McGill University)

Linking tree diversity to carbon storage can provide further motivation to conserve tropical forests and to design carbon-enriched plantations. Here, we examine the role of tree diversity and functional traits in determining carbon storage in the mixed-species plantation of Sardinilla and in the natural tropical forest of Barro Colorado Island in Panama. We used species richness, functional trait diversity, species dominance, and functional trait dominance to predict tree carbon storage across these two forests. Second, we compared the species ranking based on wood density, maximum diameter, maximum height, and leaf mass per area (LMA) between sites to reveal how these values changed between different forests. Increased species richness, a higher proportion of nitrogen fixers, and species with low LMA increase carbon storage in the mixed-species plantation, while a higher proportion of large trees and species with high LMA increased tree carbon storage in the natural forest. Furthermore, we found that tree species greatly vary in their absolute and relative values between study sites. Different results in different forests mean that we cannot easily predict carbon storage capacity in natural forests using data from experimental plantations. Managers should be cautious when applying functional traits measured in natural populations in the design C-enriched plantations.