Using Hyperspectral Vegetation Indices to Detect Differences in Red Oak Leaf Pigment Content & Phenology Along an Urban-to-Rural Gradient (NYC to the Catskills)

Project Background: Remote sensing offers an attractive alternative to direct field and lab techniques for the study of ecological processes, especially of rapidly changing and/or remote ecosystems. Whereas traditional techniques are often labor intensive, costly and destructive, hyperspectral measurements are rapid, easily acquired and non-destructive. ***This project will result in spectral quantification of differences in leaf pigment content and phenology among four Red Oak dominated forest stands, located at increasing distances from New York City.*** This will help us to better understand the physiological response of Red Oaks to changes in their environment (i.e. ozone levels, urban heat island effect, CO_2 concentrations, nitrogen deposition) that are associated with increasing urbanization in the North Eastern US..

Throughout the summer of 2007, an Earth Intern student established spectral-pigment relationships for Red Oak foliage at two of our four field sites: the 'Urban Site' in New York City, and, the 'Sub-urban Site I' at the Lamont-Doherty Earth Observatory in Palisades, NY)). In the summer of 2008, the selected Earth Intern will use these relationships to measure foliar pigment content via hyperspectral pigment indices. Field sites will include the 'Urban' and 'Sub-urban I' sites mentioned above, as well as two additional field sites which are located at greater distances from NYC: 'Sub-urban Site 2' in Black Rock Forest, Cornwall, NY, and, the 'Rural Site' in the Ashokan Reservoir, NY.

Field & Laboratory Work: Once a month, the Intern will visit each of the four field sites along our Urban-to-Rural Gradient. At each site, s/he will aid in the collection of leaf samples. These samples will be returned to the lab, where s/he measure their spectral reflectance and calculate their spectral vegetation index values. S/he will then estimate leaf pigment content using the spectral-pigment relationships established in the summer of 2007. 35 hours of work to be done per week.

Prerequisites: Some field and/or lab experience is preferred but not essential. Valid driver's license is required.

Thesis mentor information: Natalie Boelman (Terrestrial Ecology), nboelman@ldeo.columbia.edu, (845)365-8480.

Understanding the history and cause of severe drought using climate models and paleoclimate data

Project Background: Combining state-of-the-art climate model simulations with paleoclimatology can be particularly powerful for interpreting the atmosphere and ocean dynamics responsible for the spatial and temporal patterns of past droughts, which have been reconstructed from extensive networks of tree-ring chronologies. The use of models furthermore allows the testing of hypotheses about past climate states and variability that are consistent with the physics of the climate system. The student will be involved in all aspects of a project designed to analyze large-scale severe drought variability over the last two millennia using forced global climate model simulations and large-scale paleoclimate reconstructions. Specifically, in concert with the thesis mentors, the student will design and run their own climate model simulations, interpret the results of these simulations, and compare them with observations and reconstructions. Additionally, the student will be assisting the mentors in the everyday operation of an earth system model of intermediate complexity.

Opportunities exist for interested students to develop a comprehensive understanding of both the theoretical and operational aspects of climate modeling. Possible research foci include, but are not limited to, North American drought and Asian monsoon. During the summer, the student may dedicate up to 40 hours per week to this project. During the school year, the student might dedicate approximately 10 hours per week, depending on thei other academic committments.

Pre-requisites: Some background in computer programming and/or statistics is required. Specifically, the student should be familiar with Linux/Unix computer environments and FORTRAN. Skills in other analytical tools, including but not limited to Matlab, IDL, Python, or R, would be useful, but are not necessary. A general interest in any aspect of climate or global change is highly desirable.

Thesis mentors information:
Dr. Edward Cook
Dr. Benjamin Cook: bc9z@ldeo.columbia.edu
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845-365-8783

Early Miocene Sedimentation, Paleocology and Strontium Isotope Geochronology in NW Egypt

Project Background:

Stratigraphic and sedimentological data from the lower Miocene Moghra Formation (~20-16 Ma) of northwestern Egypt reveal well defined cyclicity that we hypothesize relates to sea-level change induced by the growth and decay of the East Antarctic ice sheet. Preliminary data suggest that it may be possible to place additional constraints on the changing depositional environment by analyzing the distribution in the sediments of benthic (bottom-dwelling) calcareous microfossils called foraminifers; and to use those fossils, along with planktonic (free-floating) foraminifers and calcareous macrofossils to date the sediments by measuring strontium isotopes. The strontium isotopic ratio of seawater is known to have changed appreciably during Oligocene and Miocene time, offering an excellent way to obtain high-resolution ages on marine carbonates. The early Miocene sea-level record is already quite well known. So the deposits in Egypt provide an independent test of that record and of ideas about how sea-level change modulates shallow marine sedimentation.

The proposed project will provide the summer intern with an opportunity to become involved in several of the analytical steps, beginning with the separation and identification of foraminifers. No prior experience is needed. The main requirement is a capacity to work carefully with small samples. Some basic coursework in Earth and environmental sciences will prove useful in grasping the broader context of the research. Nick Christie-Blick, Steve Pekar and Egyptian visitor Safiya Mohamed Ali Hassan will jointly supervise the stratigraphic and paleoecologic part of the project. Steve Goldstein will be in charge of isotope geochemistry if suitable material can be separated. This is new cutting edge research that we are hoping to develop into an NSF-funded project.

Hours per week: Full time during over the 8 weeks of the summer intern program.

Mentor information (primary contact): Nicholas Christie-Blick, (845) 365-8821, <mailto:ncb@ldeo.columbia.edu>ncb@ldeo.columbia.edu
Other mentors: Steve Pekar, Steve Goldstein, Safiya Hassan

Impacts of the urban environment of New York City on plant function and carbon uptake in red oak

Project Background: This project investigates the interactions between the urban environment of New York City and plant function. We are studying growth and carbon cycling in red oak seedlings growing at four sites along a 200km transect between Central Park and the Catskills. Preliminary results have indicated that environmental factors associated with NYC directly affect plant growth and function; these factors include elevated nighttime temperature, atmospheric nitrogen deposition, other pollutants, and reduced tropospheric ozone relative to surrounding rural areas. The direct impact of urbanization on plant function will have cascading effects on ecosystem function, biogeochemical cycling, and biodiversity on a regional scale. Additionally, this transect may be used as a window into the future of global warming: many studies predict that global temperatures will rise more at night than during the day[1][2][3]. Nocturnal warming is likely to have significant direct effects on plant carbon relations and the role of the biosphere as a sink for fossil fuel CO_2. Thus, results from this study may have implications for regional as well as global models of carbon cycling.

Field/labwork and data analysis: The student will spend one day a week at each of the four sites along the transect measuring height, diameter, and chlorophyll fluorescence (a measure of photosynthetic potential) in the red oak seedlings, as well as collecting samples for laboratory analysis. In total, fieldwork and transportation will amount to ~20 hrs/week. The student will also spend 5-10 hrs/week in the laboratory analyzing samples for nitrogen and carbohydrate content. The remainder of time will be spent analyzing data.

Prerequisites: 1 semester of biology preferred, but not required

Mentor information: Kevin Griffin (Plant Ecophysiology), griff@ldeo.columbia.edu, Tel. 845-365-8371

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[1] Easterling DR, Horton B, Jones PD. et al. (1997) Maximum and minimum temperature trends for the globe. Science 277 364-367

[2] Alward RD, Detling JK, and Milchunas DG. (1999) Grassland vegetation changes and nocturnal global warming. Science 283 229-231

[3] IPCC (2001) Third Assessment Report - Climate Change 2001. Intergovernmental Panel on Climate Change. United Nations Environmental Programme, Geneva Switzerland.

Title 1:
Climate Change as a Security Risk--Quantifying the Threats

Description:
CIESIN recently completed a set of background studies for the US intelligence communities quantifying risks associated with temperature increase, sea level rise, and water scarcity. The summer internship will go into greater depth on one of these threats, based on the intern's skills and interests.

Title 2:
Drivers of Emerging Infectious Disease

Description: Initial work has shown that emerging infectious disease outbreaks can be modeled spatially (Jones et al, Nature, forthcoming). We have developed a methodology to deepen this model to give greater explanatory and predictive power. The intern will help assemble data on additional drivers, such as human travel, livestock practices, anitiobiotic use, and others, and also assist in analyzing spatial patterns.

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In both cases there are no formal prereqs though experience with statistical anylysis and GIS helps

Microbiology of Arsenic Contaminated Bangladesh Aquifers

Over 50 million people in Bangladesh have most likely consumed groundwater with elevated levels of Arsenic. This has led to direct health effects including an increased risk of cancer. This water is derived from tubewells that tap the shallow aquifers. The arsenic is naturally occurring and not a contaminant or human derived. The arsenic enters the water by leaching from the sediment to water by a yet unknown process. Mechanisms have been proposed but there are shortcomings with each mechanism and there is still significant disagreement within the literature. The most widely cited mechanism is the Fe(III) reduction hypothesis where Fe(III) oxides are reduced and arsenic is liberated. However little direct evidence is available to verify this mechanism. Fortunately, certain species of bacteria are known to reduce Fe(III) may be indicators organisms for this process. The goal of this work is to use molecular techniques to examine the microbiology of the shallow aquifers and better constrain the processes controlling the release of arsenic.

Molecular techniques can be utilized to describe the microbial communities based in aquifer systems. For example analysis of the diversity of 16s rDNA the presence of bacterial species can be determined. Comparison of 16s rDNA sequences from aquifer to sequences of known species can start to elucidate the microbial processes occurring in the aquifer. For example if the 16s rDNA sequence is similar to known Fe(III) reducers, these results could help verify the Fe(III) reduction hypothesis.

The work during the summer will entail extracting DNA from sediment and filter samples already collected from Bangladesh followed by molecular techniques to analyze the microbial diversity. The Molecular techniques include the creation of clone libraries to determine the sequences of bacterial species present and terminal restriction fragment length polymorphism (TRFLP) to examine microbial diversity. No experience is necessary with molecular techniques and students with any background could succeed in the project. By the end of the summer students will be able to utilize molecular and compare results to other papers using multiple databases and analysis tools.

Thesis Mentors: Brian J. Mailloux and Greg O'Mullen

Monitoring nutrient fluxes in the Hudson River Estuary

Mentors: Ray Sambrotto (Marine Biology) and Bob Newton (Geochemistry)
Contact: bnewton@ldeo.columbia.edu 845-365-8686

The Hudson River Estuary is an aquatic ecosystem in recovery. Nearly three decades after the banning of PCB, DDT and other chlorinated pollutants, fish populations are rebounding. Even bald eagles, who rely on healthy fish populations, have returned to the Palisades Cliffs. However, a more subtle challenge, high levels of nutrients such as phosphate and nitrogen compounds, continues to threaten the long-term recovery of the Estuary. Excess nutrient fluxes to the estuary can lead to algae blooms and suffocating eutrophic conditions. Nutrients come from a variety of sources, but in the lower Hudson, are dominated by discharges from waste-water treatment plants. They are thus susceptible to regulation, given appropriate understanding of the highly variable distributions of nutrients and their consequences.

Nutrient fluxes to and within the estuary are highly variable, both spatially and in time, depending on a complex interaction of natural variations and human activity. Estimation of current conditions and trends requires collecting long time series, with reasonable spatial resolution. To address this requirement, we are conducting a multi-year program sampling in the Hudson River and Piermont Marsh, 10 miles north of New York City, collecting water, particulate, bacterial, floral, nekton and soil samples. In the summer, the program engages Lamont researchers and grad students along with teams of interns to achieve broad coverage.

The intern would participate as a team member. His/her work will be supervised by the Mentors and Post-docs working in Lamont's Marine Biology lab. Activities include:

- Helping to manage logistics for New York City High School students participating in the sampling program;
- Sampling in the field: from kayaks in the mash and from motor craft in the Estuary;
- Laboratory work: measuring nutrients in water samples, chlorophyll and particulate on water filters, and culturing bacteria.
- Assembling literature on nutrient sources and sinks in the Hudson and Raritan estuaries.

Sampling will take place in the lower Tappan Bay, near Lamont, and at various locations in New York Harbor, typically leaving from Nyack or Piermont, near Lamont-Doherty. Laboratory work will be conducted at Lamont-Doherty. The intern must have had a laboratory course in chemistry. Basic computer literacy (Excel, Word) is required. Interns will learn water sampling techniques, nutrient chemistry, laboratory skills, and data analysis. Students wishing to develop a senior thesis from the project will also be expected to begin background research on nutrient fluxes in the New York Harbor region. Hours are nominally from 9:45 a.m. until 6:00 p.m., Monday through Friday. However, hours are flexible: field trips will require longer days, and the intern's special scheduling requirements can normally be accommodated.

Measurement of the variability of trifluoromethyl sulfur pentafluoride (SF_5CF_3) and sulfur hexafluoride (SF_6) concentrations in the atmosphere

Background

SF_5CF_3 is an anthropogenic gas that has an atmospheric concentration of about 0.2 ppt. It has been increasing in the atmosphere for the past 3 decades parallel to the increase of SF_6, which has a 30 times greater concentration in the atmosphere. The origin of SF_5CF_3 is not known, but it is beginning to be used in tracer release experiments in the ocean and groundwater systems to study mixing and transport. Hence there is an interest in determining is origin. Its parallel behavior to SF_6 in the atmosphere suggests that it is related to either the manufacture or use of SF_6. SF_6 is used as an insulator in high voltage equipment such as transformers. One possible source of SF_5CF_3 is production from SF_6 in high voltage equipment. It should be possible to distinguish between a source from the manufacturing process or a source from production in high voltage equipment by measuring the variability of the SF_6 and SF_5CF_3 in the atmosphere. Manufacture of SF_6 occurs at a very few locations in the world, but use in electrical equipment is very widespread and extensive in highly populated areas such as the New York metropolitan region. The temporal variability of SF_6 has been measured in the atmosphere at Lamont and there are sharp spikes in the concentration that correlate with different wind patterns that sometimes bring air from the heavily populated region to the south and other times air from the ocean. If SF_5CF_3 is produced in high voltage electrical equipment, which is the main source of SF_6 for the atmosphere, SF_5CF_3 and SF_6 should co-vary. If SF_5CF_3 is produced only in the manufacture of SF_6, then the variability of SF_6 should be independent of the variability of SF_5CF_3.

Work

SF_5CF_3 and SF_6 are measured by gas chromatography. The student will learn the principles of gas chromatography, will work on setting up the gas chromatographic equipment for this project, will collect air samples from Lamont and possibly other locations in the New York area, will measure these samples and will work up the results.

Pre-requisites: two or more semesters of college level chemistry

Name:_____Bill Smethie_____

Phone number:___845-365-8566_____

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Project Title: Extracting a Detailed Record of Climate Variability from Non-Bioturbated Sediments of the Anoxic Soledad Basin, Mexico.

Ocean monitoring over the past several decades has shown that fluctuations of fish stocks in the California Current are to linked climate changes on inter-decadal time scales. However, few records, if any, are unambiguous enough to provide a context for these observations over longer time periods. One particularly promising and little-studied location is the bottom of an anoxic basin at 25^{o}N off Baja California that may yield a ~500 yr with decadal to interannual resolution. A ~1-m long core was successfully collected on this location in October 2007 using a box corer and immediately flash frozen on shipboard to preserve all stratigraphic information. The focus of this project over the summer will be to (1) obtain a detailed record of variations in diffuse spectral reflectance (color) from a thawed slab of this core, and (2) embed another slab in epoxy and obtain an ultra-high resolution (<annual) record of variations in sediment chemistry by X-ray fluorescence with an ITRAX core scanner at Woods Hole Oceanographic Institution. This is a lab-based project that will involve considerable method development.

Pre-requisites: At least two semesters of college level classes in the natural sciences.

Thesis mentor information: Lex van Geen avangeen@ldeo.columbia.edu and Jacob L. Mey mey@ldeo.columbia.edu, Tel. 845-365-8644.

Project Title: Developing New Methods for Identifying Low-Arsenic Aquifers Before Installing Tubewells in Bangladesh.

Elevated arsenic levels in groundwater pumped from tubewells across South and Southeast Asia is a major health concern affecting hundred of millions of people. One key feature of the problem is the extreme spatial (and rarely temporal) variability of arsenic levels observed in shallow aquifers in the region. This complicates prediction, but, on the other hand, creates an opportunity for mitigation as most villagers are within drilling distance to aquifers that are low in arsenic. Rather than focusing on costly and complicated water treatment, Columbia scientists have been exploring novel ways to predict (while drilling) whether a particular depth interval is likely to yield groundwater low in arsenic. This is a lab-based project, which involves detailed geochemical and mineralogical analysis of borehole sediment profiles. These samples include wash borings (drill cuttings) obtained in January 2007 from several locations in Bangladesh where the level of arsenic in groundwater is already well known.

Pre-requisites: At least two semesters of college level classes in the natural sciences.

Thesis mentor information: Lex van Geen avangeen@ldeo.columbia.edu and Jacob L. Mey mey@ldeo.columbia.edu, Tel. 845-365-8644.

Using Modern Mass Spectroscopy Methods to Analyze Organic Contaminant Sources in New York City.

Project Background:

This research can provide fundamental data on environmental behavior and source apportionment of organic contaminants. The aim of this study is to analyze indoor and outdoor contaminant levels and determine their major sources based on their molecular characteristics. This study can provide important and useful information to environmental scientists, policymakers, and environmental practitioners.

This project plans to have 1 to 2 weeks of fieldwork to collect aerosol particle samples and 4 to 5 weeks of lab work, including sample extraction using highly pressurized solvent extraction system, organic purification and separation, and organic identification and quantification by GC/MS/MS, a sensitive analytical method.

Dr. Yan has more than 10 years' experience in Environmental Organic Geochemistry and Dr. Chillrud is an established scientist with knowledge in Geology, Environmental Science, and Public Health. Current funding is sufficient to support above mentioned field and lab work.

Pre-requisites: At least two semesters of college level chemistry.

Thesis mentor information:

Dr. Beizhan Yan (Geochemistry), yanbz@ldeo.columbia.edu, Tel. 845-365-8448;
Dr. Steve Chillrud (Geochemistry), chilli@ldeo.columbia.edu, Tel. 845-365-8893.

Impact of Surface Processes on the Variability of Antarctic Bottom Water in the Weddell Sea

Xiaojun Yuan and Arnold Gordon

The goal of this study is to examine impacts of surface processes such as sea ice export, sea ice concentration variability, ice shelf breakups, and changes in surface wind and air temperature on the interannual variability of the Antarctic Bottom Water (AABW) exports in the Weddell Sea, which have been observed by deep sea moorings in the western Weddell Gyre for six years.

The global abyssal ocean is filled with cold, dense water that originated from the Antarctic marginal seas. This water is called the Antarctic Bottom Water (AABW), which is formed by the near surface water on the continental shelf mixing while sinking along the continental slope. The Weddell Sea has the largest amount of the AABW production around Antarctica each year. By spreading into the deep part of the world's oceans, the AABW links surface climate variability in the Polar Regions with lower latitudes, affecting global circulation.

To observe the changes in properties and strength of the outflow of Weddell Sea Deep and Bottom Waters, three deep-sea moorings have been deployed in the Western Weddell Sea, measuring temperature, salinity and current since 1999. Six years of data (April 1999 to April 2005) reveal that the production of the Weddell Sea AABW varies seasonally and interannually. The coldest pulses occurred in the winters of 1999 and 2002, while 2000 winter lacked a cold event. During this period, the Larsen B ice shelf breakups occurred mainly in two periods: from 15 February 1998- 18 March 1999, and from January 31 to March 7, 2002. Observed coldest pulses in the AABW followed the Larsen B ice shelf breakups, indicating the impact from the breakups on the bottom water formation. A numbers of questions arise. How does the Larsen B ice shelf breakup affect surface processes that influence the bottom water formation? What are the roles of surface winds and air temperature in the formation processes of the AABW? Do ice shelf breakups affect sea ice distribution in the Weddell Sea? Is the sea ice export from the Weddell Gyre an indicator of the bottom water formation? Is any surface process related to the lack of a cold event in 2000?

We plan to use a set of data ranging from surface weather stations / automatic weather station data, satellite observed sea ice concentration / sea ice drift data, and ECMWF surface winds and air temperature data to address these questions. An undergraduate student can participate this project by establishing the relationships between sea ice export and the AABW variability, between surface winds/air temperature and AABW properties, and between Larsen B ice shelf breakups and variability in sea ice concentration/sea ice export in the Weddell Gyre. Since most data exist in local computers, the student can finish the project in nine weeks. Yuan will be available most of time during the nine-week period.