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1 Program schedule

1.1 12-1 pm: Lunch & poster presentations in Snee atrium

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<td>Natalie Mahowald</td>
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1.2 1-2:20 pm: Oral senior thesis presentations in Snee Rm. 2146

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<td>Arthur DeGaetano</td>
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<td>Eva Golos</td>
<td>Investigating glacier elevation changes in the Russian High Arctic</td>
<td>Matthew Pritchard</td>
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<td>An analysis of tsunami signals from ocean-bottom magnetic measurements</td>
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2 Poster presentation abstracts

2.1 Climate sciences

2.1.1 S. Clark - The sensitivity of global climate to the episodicity of fire aerosol emissions

One of the major ways in which forest and grass fires have an impact on global climate is through the release of aerosols. Recent studies that have focused on determining the radiative forcing and other climate impacts of fire aerosols have used a smoothed out emissions scheme derived from the Global Fire Emissions Database that captures only the seasonal cycle of fire aerosol emissions. Here we present the results of a sensitivity study that investigates the climate response to three new emission schemes, based on the standard GFED scheme, that represent fires as intense pulses of emissions that occur only on a monthly, yearly, or five-yearly basis. We base our results on two sets
of runs of version 5 of the Community Atmosphere Model (CAM5). One set, which uses a data
ocean model, is used to compute radiative forcings, while the other set, which uses a slab ocean
model, is used to study long term climate impacts. Overall we find that in the modified cases with
increased levels of episodicity, the all sky direct effect radiative forcing increases, the clear sky
direct effect radiative forcing remains relatively constant, and the magnitude of the indirect effect
radiative forcing decreases by about 1 W/m^2. In the long term, we find that an increase in aerosol
emission episodicity leads to an asymmetric change in indirect radiative forcing in the NH compared
to the SH contributes to a slight shift in the annual average position of the ITCZ. This shift is found
to have a mixed effect on the overall performance of the model at predicting precipitation rates in
the tropics. Given these results we conclude that future studies that look to assess the present day
global climate impacts of fire aerosols should make use of the new datasets that contain observations
of fire emission rates on a daily, rather than monthly scale.

Contact: Spencer Clark, skc48@cornell.edu
Mentor: Natalie Mahowald

2.1.2 N. Kaminsky- Broader impacts of abiotic floral stimuli: Manduca sexta as a behavioral
model for relative humidity on local-patch scale

Anthropogenic forcing on climate will create unprecedented shifts in individual, communal and
ecosystem behavior. Adequate assessment of organismal behavior with gradual or onset climate
change is necessary. The highly sensory Manduca sexta hawkmoth provides a confident model for
experimental manipulation of abiotic factors in a projected climate environment. We manipulate
relative humidity (RH) on the local scale, and make inference on both landscape and habitat scale
for further experimentation. Manduca make informed and innate sensory decisions on feeding when
presented with an RH gradient. We develop a basic behavioral framework for the Manduca RH re-
sponse because we seek an environmental and behavioral context for projected climate conditions.
Model insect behavior remains yet another scarcely developed area for cross-disciplinary research
on the consequences of our recent climactic trend.

Contact: Noah Kaminsky, nk299@cornell.edu
Mentor: Robert Raguso

Noah will be pursuing a Masters of Arts in Teaching Secondary Earth Science Education at the
American Museum of Natural History in New York City. Through this program he has committed
to teaching for four years in New York afterward completing the program.

2.2 Geophysics

2.2.1 A. Semple- Triggered local seismic activity at the Northern Chilean volcano Putana

The Central Andes is relatively poorly monitored despite the occurrence of many seismic and vol-
canic events. In 2009 there was a measurable amount of ground deformation at the volcano Putana
(Pritchard et. al, 2013). I am studying seismic data for Putana, a volcano in northern Chile near
the border of Bolivia, provided by Soler, as well as the USGS earthquake archive, to learn about
Putanas current seismic activity. Based on USGS earthquake archive searches, I analyze the seismic
record and monitor the response at Putana. Putana displayed many local earthquake swarms after
the February 27th, 2010 M8.8 earthquake in Southern Chile, and displayed similar behavior after
a M6.3 earthquake 60km away from Putana on March 4th 2010. However, after an earthquake in
July of 2010 with a similar distance, depth, and direction from Putana as the March 4th earthquake
the seismic activity at Putana was much more subdued than after the March 4th earthquake. Earth-
quakes originating over 100km away from Putana with magnitudes of 6.3 and below do not seem to elicit a seismic reaction from the volcano. To further complete a study of the volcanoes in this region of the Central Andes, the seismic data from Lascar, Irruputuncu, and Ollague, a line of volcanoes within 200km of Putana, should be examined along with seismic data at Putana to compare and contrast each volcano's individual reactions to the same earthquakes.

Contact: Alana Semple, ags243@cornell.edu
Mentor: Matt Pritchard

2.3 Paleobiology & paleoclimate

2.3.1 S. Sang- Differential evolutionary outcomes in Turritella geminate species across the Central American Isthmus

The closure of the Central American Seaway, which had connected the Atlantic and Pacific oceans, occurred around 3 million years ago, and led to differing environmental conditions on both sides of the Central American Isthmus. Closely related marine species with a common ancestor, or geminate species, developed as a result of geographic separation and different selective pressures. This study plans to construct evolutionary phylogenies of fossil and living Turritella, an abundant and diverse group of marine snails, using both genetic sequencing and morphological analysis. These phylogenies will serve as a backdrop for analyzing evolution in this group over the past 3 million years, especially as it relates to speciation, larval development mode, and rate of genetic change in Turritella.

Contact: Stephanie Sang, ss2666@cornell.edu
Mentor: Warren Allmon

2.3.2 G. Vezeau- Paleoclimate interpretation of Calvert Cliffs mollusks

One of the defining features of the global Cenozoic climate is its variability. The $\delta^{18}O$ record indicates a global cooling trend in the upper Miocene. Regional climate patterns in this time period are less well constrained. Previous work on the depositional environment of the Calvert Cliffs of Maryland in North America seemed to indicate a regressive sea level trend and slight warming trend. This study seeks to expand on this analysis by applying temperature data collected in the World Ocean Database (WOD). Volumetric samples were obtained from fossiliferous sediment previously collected from the Windmill Point Member of the St. Marys Formation. Mollusk fossils were counted and identified, almost all to the species level. The depth and geographic ranges of extant congeners of the fossil species were collected and used to constrain expendable bathythermograph (XBT) data from the WOD. The average depth range was determined to be 7-30 meters, and the average temperature range obtained from the constrained XBT data was determined to be 20.9-22.4 °C. These results appear to corroborate the conclusions reached in previous research on the Calvert Cliffs.

Contact: Grace Vezeau, gev8@cornell.edu
Mentor: Warren Allmon

2.4 Planetary science

2.4.1 N. Bardabelias- Examining joints in the West Spur of Gusev Crater, Mars

I analyzed data from the Mars Exploration Rover Spirit to examine the orientations of potential joints on exposed bedrock in the West Spur region of the Columbia Hills in Gusev Crater, Mars.
Joints are planar cracks along which no displacement of the host rock is observed, and their orientations indicate the directions of stresses experienced in the Columbia Hills. Aligned joint orientations would be consistent with a single regional stress, while mixed joint orientations would indicate multiple local stress regimes. My preliminary analysis of high-resolution stereo image data from the rover show that this method can be used to determine orientations of joints, and thus my ongoing research should be able to constrain regional stress regimes in the Columbia Hills.

Contact: Nicole Bardabelias, nmb54@cornell.edu
Mentor: Steven Squyres

3 Oral thesis presentation abstracts

3.1 Climate sciences

3.1.1 J. Sussman- Synoptic causes of Changes in the statistical distribution of January daily maximum temperatures in the interior Northeastern U.S.

The frequency of anomalously warm January daily maximum temperatures in the interior Northeast has increased over the past 60 years. This study focuses on the increase in maximum temperatures in the region, as related to changes in the shape of the statistical distribution of daily maximum temperatures. Possible causes for these changes from a synoptic pattern standpoint are a focal point. The January maximum temperature data for this region show an increase in the maximum temperatures, but not a uniform shift in the overall distribution of daily maximum temperatures.

A principal components analysis (PCA) of 500 hPa heights for January days, followed by a cluster analysis is used to determine the most commonly occurring synoptic weather patterns in the United States in January. This allows for analysis of changes in the frequency of occurrence for each pattern, as well as changes in the temperature distribution associated with different patterns. The analysis in this study show a statistically significant change in January synoptic weather patterns, and in the temperatures associated with some of these patterns. Some amplified ridge-trough patterns have increased in frequency, while zonal patterns and less amplified ridge-trough patterns have declined. Within all patterns the average daily maximum temperature has increased by up to 5°C with the largest changes occurring in zonal patterns that are typically associated with the warmer temperatures.

Contact: Jeffrey Sussman, jms646@cornell.edu
Mentor: Arthur DeGaetano

Jeffrey is continuing his studies at Scripps Institution of Oceanography for a PhD in Earth Sciences within the Climate-Ocean-Atmosphere program.

3.2 Geophysics

3.2.1 E. Golos- Investigating glacier elevation changes in the Russian High Arctic using remote sensing

Quantifying changes in glacier mass balance is crucial to understanding the effects of global climate change, because of the impact of the cryosphere on the Earths albedo, and also because of the contribution of glacial melt to eustatic sea level. We assessed glacial elevation changes in the Russian Arctic archipelago of Severnaya Zemlya, a location of particular importance because the High Arctic is projected to experience twice as much warming as the global average (Moholdt et al., 2012). However, due to its extreme latitude, standard remote sensing sources (including SRTM
and Landsat) cannot be used, so to determine elevation changes we must turn to other remote sensing techniques. This study utilized the Advanced Spaceborn Thermal Emission and Reflection Radiometer (ASTER), which employs stereoptic imagery to generate a Digital Elevation Model (DEM) of 60-km by 60-km scenes.

The purpose of this study is twofold in nature. Firstly, we coregistered the ASTER scenes to evaluate how closely the ASTER-reported coordinates of an elevation measurement corresponded to the true geographic location over non-glaciated terrain. To do this, we modified the horizontal co-registration procedure of Willis et al., 2012, Willis et al., 2012b, and Melkonian 2011: the elevation model of the Viewfinder Panorama Project (viewfinderpanoramas.org) was used as a reference DEM. Of 258 scenes thusly coregistered, 93 scenes were noticeably improved, 165 decreased in quality, and 156 were not noticeably changed from the original ASTER-Ferranti difference. The new scenes that were found to improve or preserve the fit were then vertically coregistered; otherwise, the original scenes were used in the vertical coregistration process. Because of the variability in success, this coregistration method is only feasible for certain scenes, most notably those with large amounts of snowfree ground and no cloud cover; it should only be used as one possible option for coregistration, dependent on the characteristics of individual scenes.

Finally, we formed an elevation change rate, or \( \frac{dh}{dt} \), map from the vertically coregistered ASTER scenes. The rates were found by fitting a linear regression to the ASTER elevations at each pixel. Our data coverage was sparse, with only 15.5% of the total land area covered, but both positive and negative changes occurred, with an average \( \frac{dh}{dt} \) rate of \(-0.5 \pm 0.1 \text{ m/yr}\) over the extent of our coverage. This corresponds to a volume change of \(-3.0 \pm 0.7 \text{ km}^2\). Some regions with denser coverage do correspond to previously published results, ie Moholdt et al., 2012. Incorporation of other data sources, especially a timestamped reference DEM, would allow us to better constrain and reduce the effects of seasonal variability on the rates.

Contact: Eva Golos, skc48@cornell.edu
Mentor: Matt Pritchard

Eva is continuing her education at MIT’s Earth, Atmospheric, and Planetary department for a PhD in geophysics. She will be focusing on seismology.

### 3.2.2 N. Schnepf - An analysis of tsunami signals from ocean-bottom magnetic measurements

Tsunamis cause changes in both pressure and oceanic charge density, consequently the propagation of tsunamis through the Earth’s main magnetic field induces additional electromagnetic fields. Incorporating magnetometers into tsunami warning systems would provide direction and velocity vector components from a single site (as opposed to pressure-based warning systems that need at least two sites to determine direction), as well as be less influenced by ocean bathymetry enabling a more advanced prediction capabilities. This study focused on analyzing the electromagnetic signature of four Pacific Ocean tsunamis triggered by 8.0-8.1 magnitude earthquakes (the 2006 Tonga, 2007 Kuril Islands, 2007 Solomon Islands, and 2007 Peru events). Data was obtained from ocean bottom magnetometers in the Northwest Pacific, as well as land stations spread throughout the Pacific and Indian Oceans. The Cornell Multi-grid Coupled Tsunami model (COMCOT) was used to predict the arrival time of the tsunami at each of the ocean-bottom stations and the stations raw magnetic field signals were qualitatively examined for the tsunami arrival. Unfortunately, while Toh et al. (2011) reported a marked change in the magnetic field components with the arrival of the 2007 Kuril Islands tsunami using data from his Northwestern Pacific station, similar significant changes in amplitude are not evident in the data used in this study. Instead, a wavelet analysis was done on each component of the magnetic field data for each station to extract the frequency components of the data, as well as their time dependency. To remove extraneous atmospheric magnetic signals, a cross-wavelet analysis was conducted. The cross-wavelet analysis showed that for the
Tonga event, the arrival of the peak wavelet amplitudes coincided with the estimated time of arrival for the tsunami at stations T13 and T14. For the Solomon Islands event, a peak in wavelet amplitude also coincided with the arrival of the tsunami. However, for the Peru and Kuril Islands events, as well as the Tonga events station T15, the estimated arrival of the tsunami was not coincident with a peak in wavelet amplitude. This may be due to affects of ground conductance, as well as ionospheric-seismic coupling. A better understanding of these phenomena is vital for constructing more accurate models of the electromagnetic fields associated with earthquakes and tsunamis, as well as improving tsunami arrival forecasts.

Contact: Neesha Schnepf, nrs59@cornell.edu
Mentor: Matt Pritchard

Neesha is continuing her studies at MIT’s Earth, Atmospheric, and Planetary department for a PhD in planetary sciences. She will be focusing on geomagnetism and paleomagnetism.

3.3 Meteorological sciences

3.3.1 J. Lee - Verification of tropical storm track prediction in Southeast Asia using GFS model

This study investigates the skill of the Global Forecast System (GFS) model in predicting tropical cyclones (TCs) tracks and intensity in SE Asia from 2007 to 2011. Data from 27 TCs passing through the grid box of 20 to 25 N and 110 to 120 E are analyzed. The GFS lowest central pressure forecast is used to determine the forecasted location of the TCs. Forecast tracks and central pressures are compared to the TC best track records produced by the Joint Typhoon Warning Center (JTWC). Average errors and biases in latitude, longitude, absolute distance and central pressure are calculated for all the TCs. The GFS forecast tracks exhibit greater longitudinal errors than latitudinal errors, as well as North and East biases relative to the observation. Elliptical forecast cone is proposed so as to visually account for the directional biases of the GFS model.

Contact: Joseph Lee, cl794@cornell.edu
Mentor: Mark Wysocki

Joseph is continuing his education at the University of Colorado at Boulder’s atmospheric PhD program. He will be studying the boundary layer’s urban meteorology, as well as the related renewable energy implications.