

2015

Lamont-Doherty Earth Observatory Postdoctoral Symposium

Photo credits:

Front cover (clockwise from top left):
Campsite in Semail Ophiolite, Oman, Sarah Lambart
Columnar joints in the Columbia River Flood Basalt, WA, Natalia Zakharova
RV Laurence M. Gould, West Antarctic Peninsula, Jeff Bowman
Early morning in Jabal Akhdar, Al Hajar mountain range, Oman, Natalia Zakharova

Agenda (Page 2): **Wetlands, Ghent, NY,** Miriam Cinquegrana

Back cover: **Sunset at Rothera Station, West Antarctic Peninsula,** Jeff Bowman

Cover design and layout: Miriam Cinquegrana

From the Office of the Director

Greetings! Welcome to the 2015 LDEO Postdoctoral Symposium. Since its founding in 1949, Lamont-Doherty has been a leader in the Earth sciences. Our scientists were among the first to map the seafloor and provide concrete proof for the theory of plate tectonics. We have collected deep-sea sediment cores in order to understand Earth's past climate, and have explored the ice caps on both the North and South Poles with sophisticated instruments. We were the first to predict an El Niño event and have illuminated the oceans' role in triggering abrupt climate change. We work to understand how the deep earth feeds global volcanism and triggers earthquakes; how the atmosphere changes when we add greenhouse gases and other pollutants; how the oceans transport great quantities of heat and control the ever-changing cycles of climate. When such fundamental Earth processes occur with dire consequences and with increasing frequency, as they have in recent years with the 2004 Indian Ocean tsunami, 2005 Hurricane Katrina, 2011 Japan earthquake, 2012 Super-storm Sandy, 2013 Typhoon Haiyan and 2014 North American Polar Vortex, everyone is reminded that Earth sciences play a central role in human survival and adaptation.

With each year, our understanding of Earth improves. Yet, new discoveries await us. It is that next insight on the horizon that keeps our researchers excited to learn more about how and why Earth changes as it does. Our diverse and vibrant community of postdoctoral scientists represents our youngest and newest talent, working towards our goal to develop and communicate new knowledge about the origin, evolution and future of the natural world. Our postdoctoral scientists, under the guidance of our more senior scientists, are transitioning from students to colleagus amd will become future leaders in their respective fields, advancing our knowledge of the natural world even further.

We hope that this Postdoctoral Symposium provides you with an overview of the fundamental research carried out by our dynamic group of postdoctoral scientists.

Sean C. Solomon
Director
Lamont-Doherty Earth Observatory

Arthur Lerner-Lam
Deputy Director
Lamont-Doherty Earth Observatory

Kuheli Dutt
Assistant Director
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Lamont-Doherty Earth Observatory

Lamont-Doherty Earth Observatory
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Postdoctoral Symposium

Wednesday, 8 April 2015 - Comer Seminar Room - Lamont Campus - 10:00 am - 4:00 pm

10:00a – 10:05a	*Welcome Note:* Sean C. Solomon, Director, LDEO
10:05a – 11:00a	*Biology & Paleo Environment Division* Presenters: Nicholas Balascio, Nigel D'souza, Heather Ford, Mathieu Levesque, Kimberly Popendorf
11:00a – 11:30a	*Geochemistry Division* Presenters: Kelsey Dyez, Yael Kiro, Nicolas Young
11:30a – 11:40p	*Coffee break*
11:40a – 12:45p	*Seismology, Geology & Tectonophysics Division* Presenters: Lucia Gualtieri, Christopher Havlin, Patty (Pei-Ying) Lin
	Marine Geology & Geophysics Division Presenters: Céline Grall, Jean-Arthur Olive, Natalia Zakharova
12:45p – 1:30p	*Lunch Break*
1:30p – 3:00p	*Ocean & Climate Physics Division* Presenters: Louis Clément, Lee Murray, Ji Nie, Sarah Purkey, Jack Scheff, Lukas Valin, Aiko Voigt, Allison Wing
3:00p – 4:00p	*Poster Session over Coffee and Dessert* Presenters: Chandranath Basak, Jeff Bowman, Elizabeth Corbett, Lucia Gualtieri, Cyrus Karas, Yael Kiro, Bess Koffman, Tobias Koffman, Sarah Lambart, Lee Murray, David Porter, Cristina Recasens, Kevin Uno, Yakov Weiss, Jian Zhao

ORAL SESSION ABSTRACTS
Biology and Paleo Environment

Alkenone-based Holocene temperature reconstructions from lakes on Svalbard
Nicholas Balascio

High-resolution Holocene paleoclimate reconstructions can be used to extend instrumental climate records allowing us to examine the natural variability of Earth's climate system and properly assess 20th century anthropogenic influences. Understanding arctic climate is particularly important because the region is extremely sensitive to climate forcing and projected to warm more than any other region over the next century. We have been working to generate centennial- to decadal-scale, alkenone-based temperature reconstructions from lake sediment records at several sites on Svalbard. The Svalbard Archipelago is near the boundary of the Arctic and Atlantic Ocean basins where there are interactions between the northward advection of warm Atlantic water, sea-ice extent in Fram Strait, and atmospheric dynamics related to the North Atlantic Oscillation. These records define the timing and magnitude of past temperatures in the region driven by these oceanographic and atmospheric circulation patterns. In particular, we examine the variability during the mid-Holocene, when insolation-driven warming occurred, and spanning the last 2,000 years, to define regional temperature changes during the Medieval Climate Anomaly and Little Ice Age.

Why is chlorophyll elevated near natural seeps in the Gulf of Mexico? Evidence for bottom-up, and top-down controls on planktonic microbes.
Nigel D'souza

The Gulf of Mexico has a large number of deep (>1000 m) natural hydrocarbon seeps, that release up to 1.1×108 L oil year-1, and while their impact on benthic productivity is well documented, less is known about their impact on surface water organisms. Evidence from ocean-color satellites, as well as shipboard flow-through, and in-situ autonomous-profiler-based fluorescence measurements revealed elevated chlorophyll concentration in surface waters near natural hydrocarbon seeps. We found evidence for the upwelling of nutrient-rich water from depth at these seep sites that could potentially facilitate phytoplankton growth (bottom up control). However, shipboard experiments with surface water samples collected in the vicinity of natural seeps indicated a more complex process. While addition of oil and nutrients (N, P, trace metals), independently increased chlorophyll concentrations, biological oxygen demand (BOD), bacterial cell counts, and enzymatic activities involved in oil degradation, lowered predation (top-down control) also synergistically contributed to these rate processes. The nature of interactions between oil-degrading heterotrophic bacteria, phytoplankton, and their micropredators in these assemblages remains unanswered. Current approaches to investigating the impacts of hydrocarbons on microbial communities tend to focus primarily on the bottom-up controls, and often overlook the top-down controls and complex food-web interactions that influence these processes. We emphasize this knowledge gap, and highlight the need to consider both, top-down and bottom-up controls in assessing the impact of hydrocarbons on planktonic microbial communities.

Adventfjorden (Advent Bay), Svalbard, Norway
Photo credit: Nicholas Balascio

Biology and Paleo Environment

Changes in North Atlantic Bottom Water Circulation During the Mid-Pleistocene Transition
Heather Ford

During the Mid-Pleistocene Transition (MPT), climate cyclicity changed from ~41 thousand year cycles to 100 thousand year cycles in the absence of any obvious orbital forcing. Here we reconstruct North Atlantic deep-water conditions using the Mg/Ca values of infaunal Uvigerina spp. at Deep Sea Drilling Program Site 607. This record, coupled with the previously published oxygen stable isotope record, is used to separate out the effects of temperature and ice volume signals. We find that bottom water temperature cooled prior to and during the MPT and that global ice volume gradually increased across this interval. At ~900 ka (Marine Isotope Stage 22), $d^{13}C$-depleted, cold southern-component water flooded the N. Atlantic suggesting weaker North Atlantic Deep Water formation during this interval. After 900 ka, glacial cycles are dominated by southern-component water and interglacial are dominated by northern-component water. This suggests that, in the North Atlantic, the MPT was marked by changes in the character and strength of bottom water circulation.

Long-term growth and gas exchange responses of conifers to drought in Central Europe
Mathieu Levesque

Higher atmospheric CO2 concentrations (ca) can under certain conditions increase tree growth by enhancing photosynthesis resulting in an increase of intrinsic water-use efficiency (iWUE) in trees. However, the magnitude of these effects and their interactions with rising temperature and decreasing water availability are still poorly understood. We investigated long-term growth and gas exchange responses of mature European larch, Norway spruce, Scots pine, black pine and Douglas-fir in relation to rising ca and temperature at a xeric site in the dry inner Alps and a mesic site in the Swiss lowlands. Radial growth, and δ13C and δ18O in tree rings were measured for the period 1960–2009. iWUE significantly increased over the last 50 years by 8–29% and varied depending on species, site conditions and seasons. Despite the increase in iWUE, radial growth has significantly declined for most species since the 1980s and was not related to tree ageing, but coincided with a warming trend at both study sites. Overall, our results indicate that the warming-induced drought stress has overridden the potential CO2 'fertilization' on tree growth irrespective of site water availability, hence challenging today's predictions of improved forest productivity of Central European forests.

Different strategies for phosphorus uptake and allocation between bacteria and phytoplankton: defining the microbial role in phosphorus cycling
Kimberly Popendorf

Microbial uptake of dissolved phosphorus is an important lever in controlling both microbial production and the fate and cycling of marine phosphorus. We investigated the relative role of heterotrophic bacteria and phytoplankton in phosphorus cycling by measuring the phosphorus uptake rates of individual microbial groups (heterotrophic bacteria and the phytoplankton groups Synechococcus, Prochlorococcus, and picoeukaryotic phytoplankton) in the phosphorus-depleted Gulf of Mexico using radioisotope labeling coupled with cell sorting flow cytometry. We found that heterotrophic bacteria were the dominant consumers of phosphorus on both a per cell biomass basis and a population basis—heterotrophic bacteria uptake per cell (amol P µm-3 hr-1) was roughly an order of magnitude greater than phytoplankton uptake rates, and heterotrophic bacteria were responsible for generally greater than 50% of total picoplankton phosphorus uptake. We suggest that this variation in uptake rates reflects variation in cellular phosphorus allocation strategies, and found that, indeed, the fraction of cellular phosphorus uptake utilized for phospholipid production was significantly higher in heterotrophic bacteria compared to cyanobacterial phytoplankton. These findings indicate that heterotrophic bacteria may be uniquely adapted to outcompete phytoplankton for phosphorus acquisition in low-phosphorus environments, and play a dominant role in cycling dissolved phosphorus.

ORAL SESSION ABSTRACTS
Geochemistry

Can 40-kyr cycles in paleo-pCO2 be resolved for the early Pleistocene?
Kelsey Dyez

In the late Pleistocene (last 800,000 years), Earth's surface temperature was closely related to the relative concentration of CO2 in the atmosphere (pCO2). Throughout this time period, snow and ice progressively trapped bubbles of atmospheric gases in layer upon layer of the Antarctic ice sheet; the gas concentration of these bubbles has been the primary source of information about pCO2 levels for this time period. However, the oldest continuous record of ice-core pCO2 yet recovered only extends to ~800,000 years. Before that, just before the mid-Pleistocene transition, 40-kyr climate cycles (rather than roughly 100-kyr climate cycles in the late Pleistocene) dominated the early Pleistocene. The early Pleistocene also had less-intense glacial intervals and smaller ice sheets than the late Pleistocene. What role did pCO2 play in this warmer world? Here we aim to answer this question by estimating past pCO2 concentrations using an alternative method that relies on the boron isotopic composition (δ11B) of calcite from planktic foraminifera. Preliminary data suggest that early Pleistocene carbon dioxide concentrations do indeed vary at the 40-kyr timescale and that pCO2 was roughly in phase with surface temperature.

Extreme aridities in the Middle East during the last interglacials revealed by the halite sections from the Dead Sea cores
Yael Kiro

Thick sections of halite from the Dead Sea deep drilling core were precipitated during very dry periods, when lake levels were low and fresh water availability was scarce. These sections consist of alternating halite and mud layers, reflecting transitions between dry and wet periods. The halite alternates between small cumulate crystals that formed on the water surface and large bottom-growth crystals. The large crystals are associated with mud layers and mud in between the crystals, while the small cumulate crystals have less detritus and contain rafts, which are formed under high evaporation conditions. The salts accumulated in the brines during glacials and wetter periods, when the lake level is high, and probably stratified, and precipitated during drier periods, when the fresh water discharge into the lake decreased. Given the chemical composition of the Dead Sea past lakes from fluid inclusions in the halite (Na/Cl~0.3-0.6), ~10-14 cm of halite precipitates per 1 m of lake level drop. Based on both salt and water mass balances, the amount of halite, its Br concentration and the chemical composition of fluid inclusions (Na, Cl, Mg), the discharge into the lake decreased to less than 50% of present (pre-1964) discharge.

Alpine glaciation on Baffin Island over the last millennium
Nicolas Young

In the Northern Hemisphere, moraines deposited by mountain glaciers during the Little Ice Age (LIA; ~1350-1850 CE) typically represent the largest extent of glaciers during the late Holocene. Yet in some settings, pre-LIA moraines are preserved offering a unique opportunity to develop longer chronologies of late Holocene glacier change. In turn, these chronologies can be used to assess spatiotemporal patterns of glaciation and their associated climatic driving mechanisms. Unfortunately, determining absolute ages for late Holocene moraines in the Arctic has proven extremely difficult. Lichenometry has often been used to 1) broadly constrain the timing of moraine abandonment, and 2) correlate moraines between valleys, whereas in other cases, fresh (unvegetated) moraines are casually ascribed to the LIA. Recent advancements in 10Be surface exposure dating now allow for robust late Holocene glacier chronologies in some Arctic settings. Here, I will present a new 10Be-based record of glaciation from Baffin Island and discuss its implications.

Piermont Marsh, NY
Photo credit: Elizabeth Corbett

ORAL SESSION ABSTRACTS
Seismology, Geology and Tectonophysics

Understanding and modeling seismic noise
Lucia Gualtieri

Seismic noise is the continuous oscillation of the Earth recorded worldwide, in response to the interaction amongst the atmosphere, the ocean and the solid Earth. Seismic noise occurs independently from the earthquake activity and it is generated in the ocean by the non-linear interaction of ocean gravity waves. The strongest noise signal is called secondary microseisms and it occurs at period smaller then about 10 s. Noise source location and amplitude can be derived from a realistic ocean wave model and schematized as vertical single forces along the ocean surface. Thus, the amplitude of the three-components of noise spectra can be modeled using normal mode summation. The fundamental mode of Rayleigh waves is the dominant signal and allow us to well estimate the amplitude of the vertical component of noise spectrum in various environments. The discrepancy between real and synthetic spectra on the horizontal components enables instead to estimate the amount of noise Love waves, for which a different source mechanism is needed. The ocean plays an important rule on the amplification of seismic noise. The effect of the ocean on seismic noise is computed on Rayleigh waves using normal modes and on body waves by defining the wavefield as the superposition of plane waves. This site effect varies strongly with period and ocean depth, although in a different way for body waves than for Rayleigh waves, amplifying different source regions at different periods.

Geophysical manifestation and geodynamic consequences of melt in the upper mantle
Christopher Havlin

Melt migration in the asthenosphere and into the lithosphere modifies the viscosity structure of the upper mantle and influences a range of tectonic processes including the creation and evolution of plate boundaries, stability of continental lithosphere and lithosphere-asthenosphere coupling. While the seismic properties of rocks are strongly influenced by the presence of melt, trade-offs between melt and other thermodynamic variables (e.g., temperature, water content, grain size) complicate interpretation of seismic observations in terms of melt fraction. In this study, we use numerical modeling to investigate the geodynamics of melt migration, accumulation and infiltration into the lithosphere and its geophysical consequences. 2D geodynamic models show that basal heating of the lithosphere by infiltrating melt can significantly thin the lithosphere at 10s of km/Myr, resulting in significant topography along the lithosphere-asthenosphere boundary (LAB) and qualitatively explaining variations in the depth and amplitude of the "seismic LAB" imaged by converted phases. To directly compare geodynamic models and seismic observations, we convert the thermodynamic variables calculated by the geodynamic models to seismic velocity and calculate synthetic seismic observations. Thus far, we have successfully applied the approach in 1D to modeling converted phases at melting onset and shear wave velocity structure beneath oceanic lithosphere.

Anisotropic shear-velocity structure of the lithosphere-asthenosphere system in the central Pacific from the NoMelt experiment
Pei-Ying Patty Lin

Accurate and comprehensive evaluations of seismic anisotropy from the ocean basins provide useful constraints on deformation and melting processes in the earth. We conducted the NoMelt experiment on ~70 Ma Pacific lithosphere between the Clarion & Clipperton fracture zones. Here we characterize the shear-velocity structure and its seismic anisotropy across the lithosphere-asthenosphere system beneath the array using surface-wave dispersion from ambient noise and earthquake-generated Rayleigh waves. Models of shear velocity as a function of depth derived from intra-array Rayleigh-wave phase velocities are characterized by a thin lid with high velocity overlying a modest low velocity zone and can pretty well fit the dry-olivine with a simple cooling model with no melt adding in. The Rayleigh-wave phase velocities show remarkable strong and clear evidence of azimuthal anisotropy with fast-directions parallel to fossil spreading direction at shorter periods. The anisotropy appears to weaken slightly at intermediate periods, before strengthening and rotating slightly towards a more EW direction at the longest periods. The model of seismic anisotropy as a function of depth suggests strong seafloor-spreading fabric in the upper 60 km and the strength is relatively week in the asthenosphere.

Marine Geology and Geophysics

Subsidence and deformation of the Ganges-Brahmaputra Delta Plain – Preliminary results from 2D multi-channel seismic data and flexural modeling, BanglaPIRE Project

Céline Grall

Subsidence histories of deltas differ widely, reflecting complex interplay among controls such as glacio-eustatic changes, tectonics, isostatic loading, and sediment compaction. The subsiding Ganges-Brahmaputra delta plain is located in the northeastern boundary of the Indian-Asian collision zone. It is surrounded by both Himalayan and Indo-Burman collision arcs, which act as flexural loads on the lithosphere and is responsible for some of the subsidence of the delta plain. The Late Quaternary subsidence history of the delta plain is here constrained by combining high-resolution seismic data (BrahmaSeis data, BanglaPIRE project), industrial seismic data, core observations, and well data. The Last Glacial Maximum stratigraphic boundary is characterized by reflector truncation at the base of the river plain and a strong reflector corresponding to a gravel layer. It is used for estimating the subsidence since deposition. Then we model the flexural loading and the sediment compaction to determine if these reasonably account for the observed subsidence of the delta plain. In our initial 2D models, we compute the bending of the lithosphere by considering models with both a constant and a variable lithospheric flexural rigidity for infinite and semi-finite plate models, respectively. Subsidence that may be derived from compaction is computed from a porosity variation with depth given by Athy's Law, deduced from velocity analyses of seismic reflection data using average parameters for sand-rich terrigenous sediments. Preliminary results suggest that the Sylhet Basin located in the northeastern part of the delta plain along the uplifted Shillong Plateau reveals a rapidly subsiding Holocene history, which mainly results from the flexural loading by the overthrusting Shillong Plateau. Below this basin, a large negative Free-Air Gravity Anomaly, presumably due to the bending of the lithosphere, may be used to evaluate the consistency of our results.

Can abyssal hill bathymetry record climate-driven variations in mid-ocean ridge melt production?

Jean-Arthur Olive

Recent studies have proposed that climate-driven sea level oscillations can lead to fluctuations in the amount of melt supplied to intermediate spreading ridges on Milankovitch time scales (23, 41, and 100 kyrs). This process is thought to result in characteristic length scales in abyssal hill bathymetry (0.7, 1.2 and 3 km for a spreading half-rate of 3 cm/yr). We assess the validity of this last claim by constructing the response function linking melt supply to abyssal hill bathymetry over a range of frequencies, using models of crustal emplacement and faulting. First, we show that variations in lower crustal thickness on such short wavelengths are unlikely to create seafloor topography through isostatic or flexural compensation. Next, we find that short-term fluctuations in the rate of dike intrusions have no effect on the growth of axis-bounding normal faults, whose spacing and associated relief dominate the bathymetric signal. It is therefore likely that apparent "Milankovitch length scales" in the bathymetry only reflect the inherent spacing of normal faults (1-5 km). The only way a fluctuating melt supply would be recorded in bathymetry would be to erupt all of the extra melt as lava flows confined within a few hundred meters of the axis.

Evaluating In Situ Stress and Induced Seismicity Risks for CO2 Geologic Storage

Natalia V. Zakharova

Induced seismicity has emerged as one of the primary concerns for large-volume CO_2 storage. In order to evaluate formation stability under injection conditions, detailed knowledge of in situ formation stress and geomechanical properties is required. Borehole measurements, combined with laboratory rock tests and failure modeling, provide effective tools for geomechanical analysis. In this study we apply these techniques to geomechanical analysis at a potential CO_2-storage site in the Newark Rift basin in northeastern U.S. Effects of borehole deviation and anisotropic rock strength on wellbore failure are considered. A complex pattern of local variations in stress orientation with depth is observed at multiple scales, including sharp rotations of the principal horizontal stresses and small-scale departures from the mean orientation. Preliminary estimates of stress magnitude suggest that shallower reservoirs at the site are critically stressed and may be prone to failure, while significant capacity for pore pressure increase exists in deeper reservoirs. These observations emphasize the importance of in situ stress measurements for accurate evaluation of effective stresses in CO_2 reservoirs and caprocks. Additional measurements are underway to better constrain rocks strength, anisotropy effects, and the magnitude of minimum horizontal stress in the region, and to evaluate relative importance of these factors.

ORAL SESSION ABSTRACTS
Ocean and Climate Physics

Generation of internal waves by eddies impinging on the western boundary of the North Atlantic
Louis Clément

Despite the major role played by mesoscale eddies in redistributing the energy of the large-scale circulation, our understanding of their dissipation is still incomplete. This study investigates the generation of internal waves by eddies in the North Atlantic western boundary where eddies dissipate. The eddy presence and decay are measured from the altimetric surface relative vorticity associated with an array of full-depth current meters extending ~100 km offshore at 26.5°N. In addition, internal waves are analysed over a topographic rise from 2-year high-frequency measurements of an Acoustic Doppler Current Profiler (ADCP), which is located 13 km offshore in 600 m deep water. Despite a polarity independence of the eddy decay observed from altimetric data, the bottommost 100 m flow is enhanced for anticyclones (25.2 cm/s) compared with cyclones (-4.7 cm/s). Accordingly, the internal wave field is sensitive to this polarity-dependent deep velocity. This is apparent from the eddy-modulated enhanced shear spectra and dissipation rates, which are obtained from a finescale parameterization. The local generation of internal waves significantly contributes to the eddy decay at the western boundaries. The present study underlines the importance of oceanic western boundaries for removing the energy of low-mode westward propagating eddies to higher mode internal waves.

A novel proxy for variability in atmospheric oxidative capacity from satellite observations
Lee T. Murray

The hydroxyl radical (OH) is central to the chemistry of the lower atmosphere, effecting the distribution and atmospheric residence time of many pollutants and reactive greenhouse gases. Understanding how and why OH concentrations have changed is a key step to assessing the impact of those changes on human and ecosystem health, and the role of chemical feedbacks on the climate system. Here, I introduce a novel proxy for local changes in OH abundances from space, combining simultaneous observations of total ozone columns (a proxy for tropospheric photolysis frequencies) and tropospheric NO2 from the Aura Ozone Monitoring Instrument, and total columns of water vapor and CO from the Aqua Atmospheric Infrared Sounder. I demonstrate that the proxy calculated from synthetic satellite observations sampled within hindcast simulations of the global GEOS-Chem tropospheric chemistry-transport model for Oct. 2004 to Dec. 2012 is well correlated with the simulated monthly anomalies in OH column densities. The proxy calculated from the satellite observations is consistent with an independent proxy for global mean OH variability from global surface networks measuring methyl chloroform, and offers the potential to characterize the dominant spatiotemporal patterns of OH variability and their causes over the past decade.

Responses of tropical deep convection to the QBO: cloud-resolving simulations
Ji Nie

Observational studies suggest that the stratospheric quasi-biennial oscillation (QBO) can modulate tropical deep convection. We use a cloud-resolving model with a limited domain, representing a convective column in the tropics, to study the mechanisms of this modulation. Temperature variations typically seen in easterly and westerly phases are imposed in the upper troposphere and lower stratosphere of this model. The responses of convection are studied over different sea surface temperatures, holding the reference temperature profile fixed. The equilibrium precipitation rate shows slight increases in response to an QBO easterly phase temperature perturbation over small SST anomalies, and strong decreases over large SST anomalies, and vice versa for the QBO westerly phase perturbation. A column moist static energy budget analysis reveals that the QBO modulates the convective precipitation through two pathways: it changes the high cloud properties and thus the column radiative cooling, and it alters the shape of the large-scale vertical motion and thus the efficiency of energy transport by the large-scale flow. The non-monotonicity of the QBO influence on precipitation with respect to SST results from the competition of these two effects.

Ocean and Climate Physics

Determining ventilation rates of Antarctic Bottom Water in the Ross Sea
Sarah Purkey

Over the past three decades, Antarctic Bottom Water (AABW) has warmed and declined in volume around the globe, suggesting a global scale slowdown of the bottom limb of the Meridional Overturning Circulation (MOC). It has been implied previously that these global-scale changes can be traced back to variability within the AABW formation regions along the Antarctic continent. Here, we present preliminary research quantifying recent changes in the rates of ventilation in the newly formed AABW in the Ross Sea. We use the Transient Tracer Distribution method to estimate ventilation rates of different water masses found in the Ross Sea using in situ measurements of chlorofluorocarbons (CFCs) and sulfur hexafluoride (SF6) along repeated hydrographic sections. We compare the AABW tracer ages and water mass properties from the 2000s to the earlier sections occupied in the 1990s to identify any changes in ventilation, mixing, or circulation. Finally, for a more comprehensive look at recent ventilation rates and variability of Antarctic Bottom Water, we hope to extend this analysis into the South Indian and Weddell Sea.

Does greenhouse warming always dry out the continents?
Jack Scheff

Many lines of evidence and conventional wisdom in geology suggest that terrestrial environments of warm Cenozoic greenhouse worlds were more well-watered than today (and terrestrial environments of the last glacial were usually much drier than today.) Yet, high-profile work in modern climate physics, much of it from my division at Lamont, suggests that water will become net scarcer on the continents in our warm greenhouse future and that soil moisture will broadly decline. Is there a contradiction - could modern climate models be missing something? Could the paleoenvironmental record be misinterpreted? Or can the difference be explained by other, non-greenhouse factors? I will explore several possibilities for resolving this dilemma, and describe current and planned idealized climate-model experiments, global proxy compilations, and paleoclimate simulation analyses that will improve our understanding of how (and whether) terrestrial aridity systematically depends on global temperature.

Space-based spectroscopy of the atmospheric chemistry of remote forests and deserts
Luke Valin

Formaldehyde (CH2O) is a key oxidation product of atmospheric chemistry and is detectable from satellite-based UV/Visible spectrometers. We investigate the influence of the hydroxyl radical (OH), the most important atmospheric oxidant, and of hydrocarbons (e.g., methane, isoprene) on the concentration of CH2O using 3D models and space-based observations of CH2O. I find that space-based measurements of the CH2O column offer the potential to better understand the processes affecting atmospheric oxidation rates not previously appreciated (e.g., the methane lifetime, photochemical smog formation), particularly in remote regions, where OH radical concentrations are low.

Precipitation and circulation response to warming shaped by radiative changes of clouds and water vapor
Aiko Voigt

The atmospheric circulation controls how global climate change will manifest regionally. Substantial circulation changes are expected under global warming, including a narrowing of the intertropical convergence zone, a slow down and poleward expansion of the tropical circulation, and a poleward shift of mid-latitude stormtracks and jets. Yet, climate model projections of the circulation response to climate change remain uncertain. I present simulations with two different aquaplanet climate models and analyse these simulations using the cloud and water-vapour locking method. I find that radiative changes of clouds and water vapour are key to the regional response of precipitation and circulation to global warming. Model disagreement in the response of key characteristics of the atmospheric circulation - the intertropical convergence zone and the Hadley circulation - arises from disagreement between the models in radiative changes of tropical ice clouds and their coupling to the circulation. We find that cloud changes amplify a poleward shift of the extratropical jet, whereas water vapour changes oppose such a shift, but the degree of compensation is model-dependent. We conclude that radiative changes of clouds and water vapour are not only integral to the magnitude of future global-mean warming but also determine patterns of regional climate change.

Ocean and Climate Physics

Organization of Tropical Convection in Idealized Numerical Simulations
Allison Wing

Tropical clouds and relative humidity play a key role in both the planetary energy balance and the sensitivity of global climate to radiative forcing. Both clouds and relative humidity are also strongly modulated by the organization of atmospheric convection, which results in a large fraction of tropical cloudiness and rainfall. Here, I investigate the organization of tropical convection in the context of self-aggregation, a spontaneous transition in numerical simulations from randomly distributed to organized convection despite homogeneous boundary conditions. I explore the influence of domain geometry on the mechanisms and temperature-dependence of self-aggregation. Specifically, a cloud-system-resolving model is used to perform 3-d simulations of radiative-convective equilibrium in a non-rotating, elongated channel domain, with interactive radiation and surface fluxes and fixed sea surface temperatures. I quantify the fundamental physical mechanisms that lead to the development of multiple convectively active regions, as well as their growth rate and spatial scale. Cloud-radiative feedbacks and surface flux feedbacks are found to be important in the initial instability. Aggregation is also associated with changes to the domain mean temperature, humidity, and cloud distribution.

Painted desert in Petrified Forest National Park, AZ
Photo credit: Natalia Zakharova

POSTER PRESENTATION
Biology and Paleo Environment

Describing polar marine microbial communities by their metabolic structure: Can we bridge the gap between community structure and ecosystem function?
Jeff Bowman

Taxonomic marker gene studies, such as the 16S rRNA gene, have been used to successfully explore microbial diversity in a variety of marine, terrestrial, and host environments. For some of these environments long term sampling programs, such as the Palmer LTER project off the West Antarctic Peninsula, are beginning to build a historical record of microbial community structure. Although these 16S rRNA gene datasets do not intrinsically provide information on microbial metabolism or ecosystem function, this information can be developed by identifying metabolisms associated with related, phenotyped strains. Here we introduce the concept of metabolic inference; the systematic prediction of metabolism from phylogeny, and describe a complete pipeline for predicting the metabolic pathways likely to be found in a collection of 16S rRNA gene phylotypes. This framework includes a mechanism for assigning confidence to each metabolic inference that is based on a novel method for evaluating genomic plasticity. We applied this framework to 16S rRNA gene libraries from the Palmer LTER, including surface and deep summer samples and surface winter samples. Using statistical methods commonly applied to community ecology data we found that metabolic structure differed between summer surface and winter and deep samples, comparable to an analysis of community structure by 16S rRNA gene phylotypes. While taxonomic variance between samples by was primarily driven by low abundance taxa, metabolic variance was attributable to high abundance pathways. This suggests that clades with a high degree of functional redundancy can occupy distinct adjacent niches. Overall our findings demonstrate that inferred metabolism can be used in place of 16S rRNA gene sequences to describe community structure. Coupling metabolic inference with targeted metagenomics and an improved collection of completed genomes could be a powerful way to analyze microbial communities in a high-throughput manner that provides direct access to metabolism and ecosystem function.

Quantifying the microbial utilization of methanogenesis and methane loss from global wetlands
J. Elizabeth Corbett

Methanogenesis in the subsurface porewater of various wetland sites was quantified with isotope-mass balance equations. Sampling sites included permafrost collapse-scar bogs, northern peatlands, and currently a coastal brackish wetland. From the peatland sites, bogs produced less CO2-meth than fens (2.9 ± 1.3 mM and 3.7 ± 1.4 mM, respectively). Methanogenesis was a more utilized decomposition process in the bogs than the fens. However, greater amounts of CO2-meth found in fen sites was most likely due to the presence of more labile organic substrates resulting in greater overall production. More CH4 was lost in fens (89 ± 2.8%) than bogs (82 ± 5.3%) from plant-mediated transport as fens are dominated by vascular plants (Carex) while bogs are dominated by Sphagnum mosses. In permafrost sites, mid-bogs produced twice the amount of CO2-meth as bog moats (1.6 ± 0.63 mM and 0.82 ± 0.20 mM, respectively). Less methanogenesis was found in bog moats as recently thawed organic matter is exposed to initial decomposition processes and methane production grows over time. A similar amount of CH4 was lost from bog moats as mid bogs (63 ± 7.0% and 64 ± 9.3%, respectively) likely due to the greater density of vascular plants found within a bog moat.

Core of the Newark basin sediments collected in the LDEO Test Well-4
Photo credit: Natalia Zakharova

Biology and Paleo Environment

Inter-hemispheric climatic effects from Pliocene constrictions of tropical oceanic seaways
Cyrus Karas

The climatic effects of the constrictions of the Central American Seaway (CAS) and the Indonesian Seaway have been shown to be of global relevance during the Pliocene epoch. The constriction of the CAS reached a critical threshold during the early Pliocene (~4.8-4 Ma) and model simulations predicted a warming of the Northern Hemisphere and a cooling of the Southern Hemisphere, the climatic effects of which are known as "Panama hypothesis". The constriction of the Indonesian Seaway had profound climatic effects on the surrounding ocean areas in particular during ~4-3 Ma, with possible relevance for the Northern Hemisphere Glaciation. To test the climatic effects of the Panama and Indonesian gateway changes, we present combined measurements of Mg/Ca and δ18O from planktic foraminifera from Atlantic cores from both hemispheres during the Pliocene epoch. Our reconstructions support the "Panama hypothesis", showing sea surface cooling (~2°C) and freshening of Southern Hemisphere between ~4.8-3.9 Ma, whereas the North Atlantic (Site 552A) indicates warmer and more saline conditions at this time. During ~3.9-3.3 Ma, our data show that the Indonesian Seaway might have initiated cooling of both hemispheres at high latitudes including a reduction of the Atlantic Meridional Overturning Circulation, leading to the start of the present ice house climate.

Paleovegetation at Hominin Fossil Sites from Leaf Wax Biomarkers in Paleosols
Kevin T. Uno

My research is aimed at addressing the question, "Did climate play a role in human evolution?" Geochemical data from terrestrial and marine sedimentary archives have greatly advanced our understanding of how African climate changed across key junctures in human evolution. An outstanding and significant challenge to investigating the role of climate in human evolution has been a lack of paleovegetation records from the same terrestrial sediments that host hominin fossils and therefore represent local ecological conditions. I apply the novel approach of measuring carbon isotope ratios from plant wax biomarkers in fossil soils, or paleosols, to reconstruct vegetation in the fossil-rich Lower Omo Valley in Ethiopia from 3.7 to 1.1 Ma. The new leaf wax isotope data yield two key results. The first is a significant increase in C4 grasses around 2.8 Ma, which is coincident with a major faunal shift and dietary shift in several mammalian lineages. It also coincides with first appearance of the robust hominin Paranthropus aethiopicus in the Omo Valley. This demonstrates a direct effect of vegetation change on fauna, including ancestral hominins. Second, superimposed over a secular trend toward increased C4 biomass through time are frequent large swings in vegetation, possibly driven by orbital cyclicity. Landscape variability documented in the leaf wax isotope data provide evidence for highly variable environmental conditions that have been proposed as a critical selective pressure in human evolution.

Mount La Perouse rock avalanche, Alaska
Photo credit: Clément Hibert

POSTER PRESENTATION
Geochemistry

Paleo Intermediate Water Circulation and Oxygen Minimum Zone Fluctuations in the Arabian Sea
Chandranath Basak

Antarctic Intermediate Water (AAIW) forming south of the subtropical font is one of the most important water masses originating in the Southern Ocean which transports salt, nutrients, and dissolved gases (such as CO2 and O2) to different parts of the Ocean. Findings from paleo studies in the Atlantic, and Pacific report fluctuating AAIW production during past abrupt climate changes. In contrast, knowledge about the role of paleo AAIW during abrupt climate change events in the Arabian Sea is relatively understudied. Oxygen Minimum Zones (OMZs) are inhospitable to the majority of marine ecosystem and favors marine denitrification. With imminent climate warming, it is predicted that the OMZs will expand. Arabian Sea today represents one of the largest oxygen-deficient oceanic body on Earth. During past Northern Hemisphere warmer intervals, the Arabian Sea OMZ intensified, however, the responsible mechanism is unclear. This project will map the flowpath of AAIW and evaluate the role of different intermediate waters (e.g., AAIW, Red Sea Intermediate water) in modulating Arabian Sea OMZ fluctuations in the past, using neodymium isotopes (expressed as εNd) in fossil fish teeth/foraminifera. Preliminary data hint at the importance of Red Sea intermediate water during abrupt climate change events in the Arabian Sea.

Extreme aridities in the Middle East during the last interglacials revealed by the halite sections from the Dead Sea cores
Yael Kiro

Thick sections of halite from the Dead Sea deep drilling core were precipitated during very dry periods, when lake levels were low and fresh water availability was scarce. These sections consist of alternating halite and mud layers, reflecting transitions between dry and wet periods. The halite alternates between small cumulate crystals that formed on the water surface and large bottom-growth crystals. The large crystals are associated with mud layers and mud in between the crystals, while the small cumulate crystals have less detritus and contain rafts, which are formed under high evaporation conditions. The salts accumulated in the brines during glacials and wetter periods, when the lake level is high, and probably stratified, and precipitated during drier periods, when the fresh water discharge into the lake decreased. Given the chemical composition of the Dead Sea past lakes from fluid inclusions in the halite (Na/Cl~0.3-0.6), ~10-14 cm of halite precipitates per 1 m of lake level drop. Based on both salt and water mass balances, the amount of halite, its Br concentration and the chemical composition of fluid inclusions (Na, Cl, Mg), the discharge into the lake decreased to less than 50% of present (pre-1964) discharge.

Centennial-Scale Shifts in the Position of the Southern Hemisphere Westerly Wind Belt Over the Past Millennium
Bess G. Koffman

The Southern Hemisphere (SH) westerly winds are a major driver of regional and global climate, yet their behavior on decadal to centennial timescales during the late Holocene remains poorly understood. We present the first high-resolution (sub-annual) dust particle dataset from West Antarctica, developed from the West Antarctic Ice Sheet (WAIS) Divide deep ice core (79.468° S, 112.086° W), and use it to reconstruct past atmospheric circulation. In addition, we present automatic weather station and ERA-Interim reanalysis data in order to characterize local and regional-scale atmospheric circulation. We use correlations with reanalysis zonal wind speed to calibrate the dust size distribution record over the period 1979-2002, finding significant positive interannual relationships ($r = 0.3$-0.5, $p < 0.1$). Using our coarse particle percentage record (defined as number of particles mL-1 [4.5-15]/[1-15] µm diameter *100), and through comparison with spatially distributed climate reconstructions from the SH middle and high latitudes, we infer latitudinal shifts in the position of the SH westerly wind belt during the Medieval Climate Anomaly (MCA; ~950-1350 C.E.) and Little Ice Age (LIA; ~1400-1850 C.E.) climate intervals. We suggest that the SH westerlies occupied a more southerly position during the MCA, and shifted equatorward at the onset of the LIA (~1430 C.E.) in response to high-latitude SH cooling and a contraction of the SH Hadley cell.

Geochemistry

The Svalbard-Barents Sea Ice Sheet: did it contribute to Meltwater Pulse 1a?
Toby Koffman

At the Last Glacial Maximum (LGM), the Svalbard-Barents Sea Ice Sheet (SBSIS) was a largely marine-based ice sheet – arguably the most climate-sensitive type of ice sheet. The SBSIS affords a potential analog for the modern West Antarctic Ice Sheet. To establish a chronology of SBSIS volume change, we calculated 10Be and 26Al exposure and burial ages for bedrock samples along a transect between 225 and 633 m elevation on the west ridge of Torbjornsenfjellet in southwestern Spitsbergen. The two higher-elevation samples show younger exposure dates than the three lower-elevation samples, indicating that glaciers did not completely erode through bedrock containing cosmogenic nuclides from prior exposure. To develop a more robust SBSIS deglaciation chronology, work is in progress to measure in-situ 14C concentrations from this same suite of samples. The multi-nuclide ice-sheet SBSIS history should help to clarify the sensitivity of marine-based ice sheets to oceanic and atmospheric warming and thus lead to improved predictions of 21st century sea-level rise.

Experimental investigation of the pressure of crystallization
Sarah Lambart

Carbonation of peridotite may be an important sink in the global carbon cycle and in some natural systems attain 100% carbonation. One way to achieve this may be via reaction-driven cracking that maintains or enhances permeability and reactive surface area. Without reaction-driven cracking, in situ mineral carbonation could fill pore space, limiting reaction progress and leaving much of the silicate unaltered. However, the conditions most favorable for reaction-driven cracking are poorly understood. In this talk, I will present the underlying thermodynamics of the process, discuss ongoing and proposed laboratory and field simulation and consider future prospects for large-scale CO2 sequestration via fluid-rock interaction.

A coupled geochemical and geodynamical approach for mantle melting beneath Hawaii
Sarah Lambart

The presence of the Hawaiian plume is manifested by the Hawaiian swell and voluminous eruption of Ni-rich lavas with enriched isotopic compositions. Here we estimate the conditions of melt generation needed to reproduce both features.
The Hawaiian plume axis is thought to be currently between Loihi, Kilauea and Mauna Loa, which are 25 km, 32 km and 44 km radially away from the plume axis, respectively. Assuming a simple model in which magmas are accumulated melts produced on a circular sampling zone of 50 km diameter centered beneath each volcano, we find that the variability in Nd isotopic ratio and Ni content observed between Lohi, Kilauea and Mauna Loa can be reproduced by the melting of a 55 km plume radius at a potential temperature, TP = 1525°C and with 7% pyroxenite in the source. We also computed the density deficit and relate it to the volume flux volume flux: we obtain 3.2 km3/Yr, a value similar to the estimations based on the Hawaiian swell model.

Dust input to the South Atlantic: provenance and paleoclimatic implications
Cristina Recasens

Wind-blown dust can be used to trace past and present atmospheric circulation patterns, through the study of its geographical provenance, its spatial distribution and temporal variability. Antarctic and marine records indicate that Patagonia has been a principal source of dust for the southern latitudes, particularly during glacial times. We analyzed an extensive set of samples from the 12.76-m piston core TN057-6, located at 3751 m water depth on the Agulhas Ridge in the Southeast Atlantic, north of the present-day position of the Subantarctic Front and South of the Subtropical Convergence Zone. From the core's location downwind from South America and its depth above the abyssal plain the major source of terrigenous sediment is wind-blown dust material originating in South America, and temporal changes in the dust composition can be used to trace changes in the dust source regions. To fingerprint better the terrigenous detritus, we measured the chemical compositions and Sr-Nd-Pb-He-Th isotope ratios in the fine (<5 μm) fraction terrigenous material, in samples ranging in age from MIS 6 to present-day. Our results show that the glacial and interglacial samples have different provenances. While the glacial dust compositions are consistent with purely Patagonian sources, the material deposited during interglacial periods presents more radiogenic Sr and Pb values and more negative εNd suggesting the contribution of a different lithogenic source, with possible mixing with the Patagonian sources.

Geochemistry

Peridotite vs pyroxenite source lithologies of primordial helium in the Iceland and Hawaiian plumes
Yaakov Weiss

Recent studies have suggested that chemical compositions of olivine phenocrysts can be used to distinguish between olivine-rich and olivine-poor lithologies (peridotite and pyroxenite) in the mantle sources of MORB and OIB. Olivine phenocrysts are also used for 3He/4He analyses, allowing us to address linkages between basalt source lithologies and primordial helium storage in the mantle. We report 3He/4He analyses of olivine phenocrysts from Iceland and Hawaii. 3He/4He in Iceland samples vary between 7-26 (R/RA) and correlate negatively with Mn/Fe and positively with Ni/Mg of the olivine phenocrysts, as well as 187Os/188Os and Gd/Lu in host lavas. These relationships suggest mixing between a degassed and incompatible element depleted peridotitic source (MORB-type?), and a primordial 3He enriched plume source containing lithologies with lower modal olivine/garnet (pyroxenite?). Hawaiian samples, on the other hand, form a positive trend in 3He/4He vs Mn/Fe space, compared to the negative trend of the Iceland samples. Thus, the Iceland and Hawaiian plumes give contrasting results for the high 3He/4He host lithology – more pyroxenite-rich for Iceland and peridotite-rich for Hawaii. Plotting the Iceland and Hawaiian plume data together for 3He/4He vs Mn/Fe, the two divergent trends intersect at the composition of Loihi, characterized by intermediate pyroxenite/peridotite and 3He/4He of 9–28 RA. Baffin Island and West Greenland picrites have the highest known magmatic 3He/4He and high olivine Mn/Fe, indicating high 3He/4He peridotites as well as pyroxenites in the Iceland plume. When plotted with the Iceland-Hawaii samples, they lie on an extension of the Hawaiian trend. This raises the possibility (pending more data) that there is a global trend showing high 3He/4He residing in peridotite.

Yosemite National Park, CA
Photo credit: Sarah Lambart

POSTER SESSION
Ocean and Climate Physics

Quantifying climate feedbacks from lightning in the GISS ModelE2 chemistry-climate model
Lee T. Murray

Nitrogen oxides (NOx) produced by lightning perturb reactive greenhouse gases and aerosol particles, generating positive and negative radiative forcing components. Lightning responds to climate and composition (aerosols), thereby representing a complex chemistry-climate feedback mechanism. I present preliminary results aimed at quantifying chemistry-climate feedbacks from lightning across the 21st century, using time-slice simulations of the GISS ModelE2 chemistry-climate model under the RCP4.5 emission scenario with three different lightning flash rate parameterizations. Global mean lightning activity generally increases at 2090 relative to 2000 (+0% to +20% across the three parameterizations), but with different spatial patterns. We find the globally integrated net forcing from lightning to be -0.26 W m-2 at the top of the atmosphere for all climates and lightning distributions, relative to zero-lightning simulations. This is comparable in magnitude to the estimated forcing from present-day anthropogenic NOx emissions (-0.22 W m-2) despite that source being 5 to 10 times greater. This reflects the higher photochemical efficiencies and sensitivity to longwave absorption in the clean and cold tropical upper troposphere where lightning NOx is released. The constancy of the radiative forcing magnitude despite changes in the lightning flash rate implies that lightning may only be a small feedback mechanism within the climate system.

Dynamics of the basin-wide North Atlantic Deep Water flux and Deep Western Boundary Current at 26.5°N
Jian Zhao

The North Atlantic Deep Water (NADW), is traditionally considered to be mainly confined within the deep western boundary current (DWBC). In-situ observations find that the DWBC at 26.5°N has complicated spatial structure that leads to different abyssal volume flux anomalies near the western boundary, western sub-basin and across the section. This study combines an eddy resolving ocean circulation model and a simple wind driven 2-layer model to investigate the relation between the DWBC and the basin-wide NADW flux. The comparisons between the simple model and the ocean general circulation model (OGCM) results suggest that the DWBC off the Bahamas is modulated by spin-up (spin-down) of the large-scale barotropic wind-driven gyre circulation and westward propagating waves and eddies. However, the NADW anomalies are mainly caused by the mass redistribution between the upper and the abyssal ocean induced by pressure changes at the eastern and western basin boundaries. The processes affecting the boundary pressure profiles can be local Ekman pumping (suction) near the eastern boundary and waves or eddies impinging onto the western boundary. The different dynamics accounting for the DWBC and NADW variability indicate that caution should be taken when using the DWBC as an index for the lower branch of the Atlantic Meridional Overturning Circulation (AMOC).

The Wave, AZ
Photo credit: Sarah Lambart

The effect of the ocean-continent boundary and seafloor sediments on secondary microseisms

Lucia Gualtieri

Seismic noise in the period band 3-10s is generated at the surface of the ocean by the interaction of ocean gravity waves. Noise signal is dominated by Rayleigh waves and it is recorded worldwide, both at the ocean seafloor and on land. Microseismic Rayleigh waves, like any other elastic wave, lose energy traveling from the ocean to the continent and crossing slow-velocity layers (e.g. seafloor sediments). In order to investigate three of the main factors which strongly affect the propagation of seismic waves from the ocean to the continent -- the shape of the ocean-continent boundary, the source location and the presence of seafloor sediments -- we simulate the propagation of the seismic waves using spectral-elements in realistic Earth models. The wavefield generated by a source located at the ocean surface is mainly composed by the fundamental mode and the first overtone of Rayleigh waves. A mode conversion from the first overtone to the fundamental mode of Rayleigh waves occurs moving from deep to shallow water and again at the ocean-continent boundary. The amplitude of land-recorded seismograms is affected by the distance between the source and the continental shelf and by the ocean depth below the source. Seafloor sediments around the source region strongly affect the seismic noise wavefield by trapping energy.

Landmannalaugar, Iceland
Photo credit: Lucia Gualtieri

Meet our Postdoctoral Scientists

Shima H. Abadi
Research: My research interests focus on reconstructing and localizing of a sound source signal under water in an unknown environment. One of the main applications of my research is localizing marine mammals under water and analysis of whale calls before, during, and after periods of active source activity. I am working on data recorded by R/V Langseth operations in Cascadia 2012. It has been documented that certain baleen whale calls have been recorded by OBSs. I use the data recorded by seismic streamers to look for any changes in calling patterns in the vicinity of active source seismic operations.
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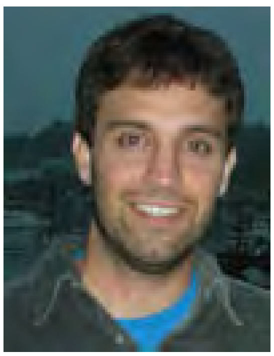

Nicholas Balascio
Research: My research interests are in Arctic paleoclimatology. I generate high-resolution paleoclimate reconstructions based on the analysis of lake sediments in order to extend instrumental climate records and examine the natural variability of the climate system. My current project is focused on applications of molecular biomarkers at sites on Svalbard, including the use of alkenone paleothermometry to reconstruct past temperatures, and the isotopic analysis of leaf wax compounds to examine hydroclimate changes.
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Division: Biology and Paleo Environment

Chandranath Basak
Research: I am currently involved in a project where I use biogeochemical models in order to understand the chemical behavior of particle reactive elements in modern Ocean. I also use radiogenic stable isotopes (Sr, Nd, Pb) to reconstruct past deep ocean circulation changes as we ll as study the distribution of trace elements and their isotopes in the modern global ocean.
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Division: Geochemistry

Jeff Bowman
Research: I investigate the role of marine microbes in biogeochemical cycles using sequence based techniques. In my current project I'm developing a method to infer the metabolic potential of a microbial community from its taxonomic structure. I'm also involved in a project to evaluate the role of bacterial symbionts in phytoplankton bloom dynamics. I hope to apply metagenomic and metatranscriptomic analysis to determine what bacterially genes are differentially expressed during early and late phytoplankton bloom stages.
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Division: Biology and Paleo Environment

Louis Clément

Research: My research interests are primarily in observational physical oceanography. I am currently working on understanding the various processes which can contribute to the turbulence in a fracture zone canyon, adjacent to the Mid-Atlantic Ridge, and to the upwelling branch of the overturning circulation in the South Atlantic. I worked previously on the effect of eddies on the meridional overturning circulation in the North Atlantic and also on the generation of internal waves by decaying eddies at the western boundary.

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Division: Ocean and Climate Physics

J. Elizabeth Corbett

Research: I investigate greenhouse gas emissions and subsurface production from various types of wetland environments. I do this with isotope-mass balance calculations to determine the amount of CO2 produced from methanogenesis, the amount of methane produced in the subsurface before loss, and the percent of methanogenesis that escapes to the atmosphere. I use these calculated amounts to compare various types of global wetlands and sites containing different types of vegetation to assess which environments may contribute the most to global climate change.

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Division: Biology and Paleo Environment

Nigel A. D'souza

Research: My research focuses on studying impacts of oil and natural gas inputs on the microbial and planktonic community in the Gulf of Mexico, focusing on changes in community composition, activity, and fate of the organisms. In addition to lab based microcosm manipulations, I will also use data from water-column profiling and satellite remote sensing, to map the impacts of oil inputs on the microbial and planktonic communities.

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Division: Biology and Paleo Environment

Kelsey A. Dyez

Research: I work on Pleistocene climate change from a geochemical perspective. My research is focused on the driving forces behind tropical ocean temperatures, characterizing how the Agulhas current has changed over time, and the role of CO2 in past climate change. I am currently involved in a project to reconstruct pCO2 in the Pleistocene.

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Division: Geochemistry

Alexander Evans

Research: I am a postdoctoral research scientist interested in understanding the evolutionary, tectonic, geodynamic, and geophysical processes of solid planets. My work includes analyses of altimetry, gravity, geomorphology, and tectonics to determine the structure, surface, and internal evolution of solid planets. So far my research has focused on the investigation of the Earth, Moon, Mercury, and Mars. I have also been involved in the design, development, and implementation of planetary exploration missions.

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Division: Seismology, Geology & Tectonophysics

Heather L. Ford
Research: I use minor element and stable isotope geochemistry of ocean sediments to understand past climate. My current research focuses on understanding bottom water circulation changes during the Mid-Pleistocene Transition. I'm also interested in tropical Pacific climate over the last five million years and El Niño-Southern Oscillation.
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Division: Biology and Paleo Environment

Céline Grall
Research : My current research focus includes the evolution of both subsidence and deformation of the Gange-Brahmaputra Delta Plain (BanglaPIRE project). I include in the process and interpretation of seismic data but also use (and partially develop) gravimetric, compaction, flexural and thermal modelling.
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Division: Marine Geology and Geophysics

Lucia Gualtieri
Research: My interests lie in understanding the processes responsible for the generation of seismic noise signals recorded worldwide at seismic stations. I use ocean wave models to show how wave action can be used deterministically to predict seismic noise. I work with both observational datasets and analytical/numerical models. More broadly, I am interested in the interaction between the atmosphere/ocean and the solid Earth.
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Division: Seismology, Geology and Tectonophysics

Christopher Havlin
Research: I study geophysical fluid dynamics using computational and theoretical tools and mainly focusing on multiphase flows. My current project develops new ways to infer the thermodynamic state of the mantle (e.g., melt fraction, temperature) using a combination of geodynamic and seismic forward modeling and comparison to geophysical observations. I am also interested in other geologic problems related to multiphase flow such as glacial hydrology and crustal magma transport.
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Division: Biology & Paleo Environment

Clément Hibert
Research: My research focuses on the remote study of gravitational instabilities using seismology. I developped methods to identify, locate and estimate the volume of rockfalls occurring at Piton de la Fournaise volcano. My work have shown that the rockfall activity can be used as a precursor of summit eruptions. My current project in LDEO is to investigate short and long-period seismic waves generated by catastrophic landslides all over the world, in order to trace back the dynamics and the properties of these phenomenon.
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Division: Seismology, Geology & Tectonophysics

Peter James
Research: I analyze topography and gravity fields recovered by various NASA spacecrafts in order to infer the makeup of planetary interiors. In particular, I am currently a participant in the MESSENGER mission to Mercury and the GRAIL mission to the Moon.
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Division: Seismology, Geology & Tectonophysics

Cyrus Karas
Research: I am interested in the reconstruction of ocean temperatures, salinities, productivity and changes in ocean circulation during the last 6 million years. An important focus of my research is to elucidate the paleoceanographic effects of ocean gateway dynamics during the Pliocene epoch. I concentrate on the constrictions of the Central American Seaway and the Indonesian Seaway which both had wide-ranging climatic effects.
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Division: Biology and Paleo Environment

Yael Kiro
Research: I am studying the paleoenvironment and paleoclimate of the Dead Sea and the Levant using halite petrography and the chemical composition of fluid inclusions from the Dead Sea core. Other research interests include water–rock interaction, coastal aquifer systems, sea–groundwater interaction, modeling and the geochemistry of the Dead Sea.
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Division: Geochemistry

Bess G. Koffman
Research: I study past climate variability by looking at atmospheric dust and trace elements deposited on polar ice sheets. My current research is focused on the geochemical fingerprinting of dust in the Southern Hemisphere. The overall goal is to identify atmospheric transport patterns and to gauge the importance of different dust sources in terms of iron deposition into the ocean in past climates.
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Division: Geochemistry

Tobias N. Koffman
Research: I seek to understand rates and consequences of changes in coupled ocean-atmosphere-cryosphere-biosphere dynamics on time scales from seasons to eons, with a focus on orbital-to-millennial scale climate changes of glaciers and ice sheets. My current research goal is to continue to develop improved methods of in-situ cosmogenic nuclide surface-exposure dating using precise field geology combined with cutting-edge laboratory techniques.
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Division: Geochemistry

Sarah M. Lambart
Research: I am an experimentalist. My current research is split in two different projects: (1) the experimental investigation of the reactive cracking process and on the applications for the CO2 sequestration, and (2) the understanding of mantle melting and basalt genesis processes via experiments and thermodynamical modeling.
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Division: Geochemistry

Mathieu Levesque
Research: I study the effects of global climate change on temperate forests. I use a combination of dendroecological methods (tree-ring width, wood anatomy, δ13C and δ18O) to better understand growth and physiological responses of trees to rising atmospheric CO2 concentrations and changing climatic conditions in Central Europe and Eastern North America.
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Division: Biology and Paleo Environment

Patty (Peiying) Lin
Research: I am primarily interested in using seismic waves to study planetary interiors, like heterogeneities and seismic discontinuities, which hold important clues on a planet's compositional, thermal, and dynamical state, as well as its evolution. My research especially centers on using array approach to push the resolution to shorter scales.
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Monica Rouco Molina
Research: I use physiological and molecular techniques to investigate the effect of environmental conditions on phytoplankton physiological ecology and community diversity. My current project focuses on understanding the abundance and distribution of the cyanobacteria Trichodesmium sp. in the ocean and the molecular mechanisms that allow them to persist in low nutrient regions.
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Division: Biology and Paleo Environment

Lee T. Murray
Research: My research focuses on quantifying the chemistry-climate interactions of short-lived, chemically reactive gases in the troposphere. I investigate how these processes vary across a wide range of time scales, and between different global atmospheric models. I especially examine the role of lightning, a major source of fixed nitrogen to the atmosphere.
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Division: Ocean and Climate Physics

Ji Nie
Research: I study tropical meteorology, specifically tropical convection and its interaction with large-scale dynamics, with tools from simple theoretical models to comprehensive numerical models. My current work focus on the responses of tropical deep convection and associated precipitation to the stratosphere quasi-biennial oscillation (QBO). I am also working on understanding subtropical extreme precipitate events from a new dynamical framework.
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Division: Ocean and Climate Physics

Jean-Arthur Olive
Research: My research focuses on the evolution of rift systems, with particular emphasis on tectonic, hydrothermal and magmatic interactions at mid-ocean ridges. I combine numerical and analytical modeling to investigate the dynamics of long-term normal fault growth, hydrothermal circulation, and the thermo-mechanical behavior of the lithosphere.
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Division: Marine Geology and Geophysics

Stanislav Parez
Research: My research focuses on properties of electric double layers formed at solid-liquid interfaces. I have also been studying the dynamics of granular systems with its application to landslides. I am currently working in debris flow and turbidity currents.
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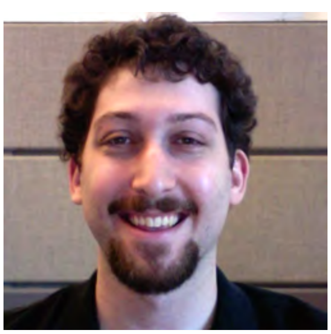
Division: Seismology, Geology & Tectonophysics



Ethan Peck
Research: My work focuses in the use of global chemistry climate models and identifying climate mechanisms related to energetic particle precipitation. I hope to one day be a professor at a research university so that I may continue conducting research and teach future generations of scientists.
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Division: Ocean and Climate Physics

Kimberly J. Popendorf
Research: I study the role of microbes in ocean biogeochemical cycles, with a particular focus on microbial phosphorus dynamics in oligotrophic surface waters. I am interested in both the influence of nutrient availability on microbial processes and the influence of microbial processes on basin-scale chemical fluxes. To study these microbial processes I employ a variety of analytical techniques including isotope labeling in environmental samples, cell sorting flow cytometry, and mass spectrometry analysis of cellular biochemicals.
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Division: Biology & Paleo Environment

David Porter

Research: I am interested in the interactions between different components of the climate system, focusing on the interplay between the atmosphere, ocean, and ice near polar ice shelves and tidewater glaciers. Currently, I am investigating the role of the ocean in the observed changes of many of Greenland and West Antarctica 's outlet glaciers.
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Division: Marine Geology & Geophysics

Sarah G. Purkey

Research: My research focuses on using in situ observations to quantify recent physical and chemical changes within the Southern Ocean in order to further our understanding of how these changes narrate and feed back into climate change. My current work is focused on using chemical tracers to detect changes in ventilation rates of Antarctic Bottom Water in the Ross Sea.
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Division: Ocean and Climate Physics

Cristina Recasens

Research: My research focuses on understanding the changes in dust supply and provenance in the southern latitudes. I want to define the dust sources from Southern South America and investigate the role of glaciations in dust supply, by comparing the sources with the sinks or final resting places of dust. For this purpose, I use Sr, Nd, Pb, Hf and He isotopes and major and trace elements chemistry. My previous works focused on Late Quaternary environmental changes recorded in lacustrine sediments in southern Patagonia using a multiproxy approach, and specializing for my PhD in freshwater diatoms.
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Division: Geochemistry

Jack Scheff

Research: I am an NSF AGS postdoctoral fellow working on a range of questions about global hydroclimate and hydroclimate change in the past, present and future. I am also more broadly interested in climate change and its impacts, as well as atmospheric circulation change. My background is in atmospheric science (theory and model analysis), but I am broadening my work into paleoproxy and observational analysis as well.
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Division: Ocean and Climate Physics

Kevin T. Uno

Research: My primary research interest is in reconstructing ancient terrestrial ecosystems using light stable isotopes (H, C, N, & O) and other geochemical tools. I analyze isotopes from leaf waxes extracted from Plio-Pleistocene paleosols from East Africa to evaluate vegetation and hydroclimate over the past ~4 million years. I also study modern and fossil teeth and tusks of East African mammals usinghistological and stable isotope methods.
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Division: Biology & Paleo Environment

Luke C. Valin

Research: I investigate patterns of atmospheric oxidation, the process by which pollutants are formed and removed from the atmosphere. Formaldehyde, a trace gas, is formed primarily by the oxidation of methane but also the oxidation of less abundant organic compounds. Spatially-detailed measurement of formaldehyde is possible from satellite-based UV/Visible spectrometers. I am using these measurements and atmospheric models to study the processes controlling atmospheric oxidation.

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Division: Ocean and Climate Physics

Aiko Voigt

Research: My research interests are in atmospheric and climate dynamics in general, and in the coupling between clouds, water vapor and the large-scale circulation in particular. To this end I run ensembles and hierarchies of global climate models. I am currently investigating the role of clouds and water vapor for the position of the intertropical convergence zone and the extratropical jet.

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Division: Ocean and Climate Physics

Yakov Weiss

Research: My research focuses on understanding the systematics of He isotopic compositions in mantle-derived melts. Combined with major and trace elements and other isotopic compositions on MORB and OIB samples, as well as pristine micrometer-scale melt-inclusions trapped within diamonds the heterogeneity of the Earth's mantle and geodynamics processes can be better restricted.

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Division: Geochemistry

Allison A. Wing

Research: I am an atmospheric scientist interested in tropical meteorology, tropical cyclones, and extreme weather and climate. My research has focused on understanding how cloud clusters and convective systems in the tropics organize. Currently I am investigating the role of radiative - convective feedbacks in tropical cyclone formation, using idealized numerical models. I've also done some recent work on tropical cyclone intensity trends and variability.

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Division: Ocean and Climate Physics

Nicolas E. Young

Research: My primary research interest lies in reconstructing the paleo-dimensions of Arctic ice masses through the Holocene to better understand patterns of Holocene climate change in the Arctic. To do this, my research utilizes cosmogenic surface-expousure dating to pinpoint moments in time when glaciers were in expanded or retracted states. I am also interested in the interplay between climatic and dynamic processes in dictating ice-sheet behavior.

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Division: Geochemistry

Natalia V. Zakharova

Research: My research focuses on reservoir characterization and risk assessment for CO2 geologic storage. I am particularly interested in developing better understanding of fractured media, and evaluating induced seismicity risks from underground fluid injections. I use borehole geophysical data for petrophysical, geochemical and geomechanical analysis, and integrate them with core and large-scale geophysical surveys to characterize geologic formations across multiple scales.

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Division: Marine Geology and Geophysics

Jian Zhao

Research: My research focuses on observing and modeling large-scale ocean circulations and their variability, with an emphasis on understanding the dynamics of western boundary currents and abyssal circulations, and their roles in climate variability. I have developed and used a 2-layer model and analyzed simulations from an ocean general circulation model to help understand the mechanisms responsible for the observed variability of the Atlantic Meridional Overturning Circulation (AMOC) along 26.5N.

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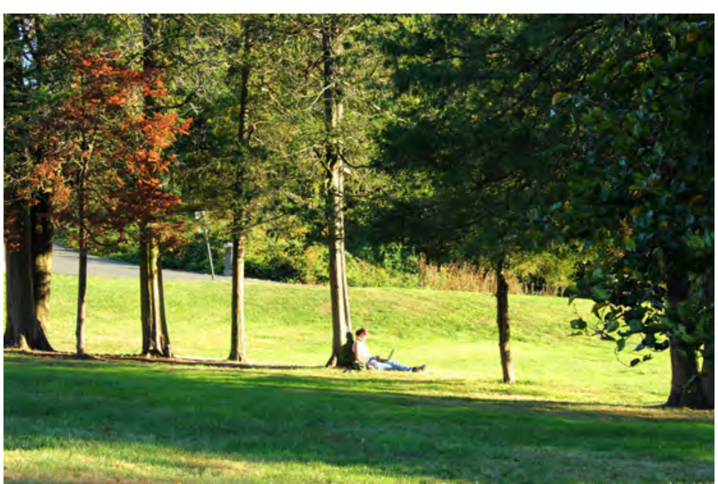
Division: Ocean and Climate Physics

Photo credit: Miriam Cinquegrana

Photo credit: William Menke



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Dead Sea, Yael Kiro

Blue-footed booby, Galapagos Island, Kelsey Dyez

A marmot at the Palouse Falls, WA, Natalia Zakharova

Iceberg in Greenland, David Porter

NOTES

Goats on layered gabbro rocks, Semail Ophiolite
Photo credit: Sarah Lambart

Aboard a Zodiac raft, West Antarctic Peninsula
Photo credit: Jeff Bowman

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