Program on Climate Change
UNIVERSITY OF WASHINGTON

2017 PCC Summer Institute Presentation Abstracts

Invited Talks

Management Challenges of World's Water Resources in the 21st Century: A Developing World Perspective

Hossain, Faisal, University of Washington, Department of Civil and Environmental Engineering, Asif Mahmood, Safat Sikder, Nishan Biswas and Shahryar Ahmad

We are currently experiencing the "Anthropocene" of water. Surface water is being redistributed and artificially managed to the extent that there are few free-flowing river basins left today without the human footprint caused by water diversions, barrages, dams and irrigation projects. The concept of a river basin as a fundamental water resources planning unit is gradually morphing to something that is more complex and hard to define. For example, water is frequently transferred from one large basin to another distant basin or heavily regulated through a system of reservoirs operated by rigid rules. In the developing world, it has become intractable, due to lack of information sharing or in-situ measurements, to have accurate knowledge of how humans are transferring water defying rules made by nature. It is therefore quite challenging to predict the current and near-future state of surface water availability without a 'management' component and numerical assimilation of the human forces driving this artificial redistribution of water. Satellites in space now present themselves as a viable alternative in the developing world for managing the fast changing patterns of water resources. This talk will provide an overview of challenges and the current progress made on addressing many of the water management challenges in the developing world using the vantage of space as they relate to water and food security of Asian nations. It will present some recent success and on-going efforts in overcoming the fundamental hurdles to water management. In the developing world, satellite-based water applications have often struggled for longevity or continuity. This talk will also discuss briefly ways to accelerate and scale up emerging space technology and empower developing nations for water, food and energy security which is critical for making population less vulnerable to climate change effects.

Population health and mobility after Hurricane Katrina: Lessons and lingering questions

Fussell, Elizabeth, Brown University, Population Studies and Training Center

Hurricane Katrina created a catastrophe in the city of New Orleans when the storm surge caused the levee system to fail on August 29, 2005. The short-term mental and physical health impacts were severe and the destruction of housing displaced hundreds of thousands of residents for varying lengths of time, often permanently. This event revealed gaps in our knowledge of short- and long-term population health and mobility after an extreme weather event causes a disaster. In reviewing the literature on this event, I identify lessons learned, as well as questions that remain unanswered. Greater collaboration between climate change and social scientists has the potential to address these questions if we can synthesize data at the appropriate temporal and spatial scales

and develop interdisciplinary theories and models of how people are affected by weather events and other manifestations of climate change.

Food from the future ocean

Allison, Edward, UW School of Marine and Environmental Affairs

Since the 2007/8 global financial crisis and its associated food price rises and food riots, food security has returned to prominence in international economic development programs. The quality, rather than the quantity, of available food has become the focus for work on food security, with the 'hidden hunger' of micronutrient deficiencies being of greatest concern for global human health. At the same time, the consequences of global environmental change on food systems, and unsustainable and inequitable fishing practices garner global media attention.

These global issues – malnutrition, climate change and overfishing - are linked through the role that fish and other seafood play in maintaining diet quality in up to a third of the world's population. My presentation makes a case for governing global fisheries to maintain and enhance their role in human nutrition and for designing nutrition interventions that include seafood where it is a culturally preferred food. I conclude with suggestions on how this might be achieved in a future ocean that will be warmer, less alkaline, more eutrophic but perhaps better understood, appreciated and governed.

Translating climate model output into yield impacts: an empirical approach and some examples of its application

Tebaldi, Claudia, NCAR-CGD and Lobell, David, Stanford

Over the last few years I have been working with David Lobell, from Stanford University, applying empirical models, estimated from observations, of the relation between temperature and precipitation changes and yield changes for major crops at the global scale. I will explain the approach, based on a simple linear regression, and how we try to eliminate the effects of progress and adaptation focusing on the response to climate changes, and how we can incorporate effects of CO2 fertilization. Then I'll present a few examples of the analyses we have published or we are preparing, having to do with short and long term projected impacts, and assessments of the benefits of mitigation when comparing alternative emission scenarios. I will discuss the use of single model initial condition ensembles and multi-model ensembles, and, given the focus of other presentations on extremes, I will address what we have been able to do, and its shortcomings, when it comes to quantifying impacts of extremes on crop yields.

Mechanisms and trends of extreme rainfall in Earth's most populous regions

Boos, William, UC Berkeley Earth & Planetary Science, M. Diaz (UC Berkeley), S. Sandeep (NYU Abu Dhabi), R. Ajayamohan (NYU Abu Dhabi)

In the last decade, a large community of scientists has made some progress in understanding the physical mechanisms that produce extreme precipitation events and in characterizing how these events might change in the next century. However, some of the largest gaps in this knowledge concern precipitation extremes that affect regions home to the largest and most vulnerable human populations: tropical continents. In this talk I will provide an overview of the types of the atmospheric vortices and waves that produce extreme rainfall over tropical continents, and show how these extremes are associated with population density and with projected changes in the

spatial distribution of population over the next century. I then focus on South Asia, which has by far the greatest population exposure to these extremes and the largest projected next-century changes in this exposure, using examples of some of the most deadly floods of the last forty years, including last month's floods in Bangladesh, Nepal, and India. I discuss what we know about the fundamental dynamics responsible for vortex spinup over South Asia, and present new projections for how the frequency of this spinup will change in response to increased greenhouse gas concentrations. I close by speculating on possible paths toward improved prediction and warning, which may help reduce the future human impact of tropical precipitation extremes.

Posters

Projections of Heat-Related Illnesses due to Increases in Obesity and Temperature in North Carolina

Lo, Fiona, UW Atmospheric Sciences, Beate Liepert, David Battisti

Obesity is a risk factor to heat-related illnesses. This is an increasingly important public health issue because adult obesity in North Carolina is presently at 29.7% and predicted to increase at 0.7% per year. Ambient temperatures are increasing due to climate change: heat waves will become more frequent and longer lasting and the projection is for Eastern North American temperatures to be about 1.4-2.8^{o}C warmer by 2050. Our results show that temperature has an exponential effect on the incidence of heat-related illnesses and obesity has a linear effect. Incidence rates of heat-related illnesses in North Carolina are greatest in places with the most frequent highest daily mean temperatures, in particular days above 30C. Vulnerable areas to heat-related illnesses are governed by spatial distribution of population as well as temperature.

Our research integrates models already developed in the epidemiology and climate science to estimate the incidence of heat-related illnesses in North Carolina in 2050 due to the projected increase in obesity and daily mean temperatures. This study is an example of how we can use models from climate and health fields to quantify the effects of climate change on human health.

Spatiotemporal Bias Correction of Sea Ice Predictions

Director, Hannah, UW Statistics, Adrian E. Raftery (UW Statistics & Sociology), Cecilia M. Bitz (UW Atmospheric Sciences)

Reducing sea ice cover in the Arctic has increased the need for accurate forecasts of sea ice. Predicting the contour of ice-covered regions, or the boundary that surrounds regions with greater than 15% of their area covered in sea ice, is a focus of this effort. Current sea ice forecasts are issued based on output from deterministic prediction systems. While these systems provide useful information, they have biases that vary across space and time. Using historical predictions and satellite observations of sea ice, we develop a statistical spatiotemporal model that anticipates how contours forecast by deterministic prediction systems will differ from what is observed. Forecasted contours can then be moved to correct for these expected errors, creating more accurate predictions. This new statistical post-processing technique, called contour-shifting, results in an average 21.3% reduction in the area misclassified as containing sea ice or not for a test set of monthly predictions and observations from 2001-2013.

From science to decision-making: Using public comment to advocate for climate science in federal agency regulations and initiatives

Rinnan, Scott, UW Quantitative Ecology and Resource Management Interdisciplinary Graduate Program

Scientists can advocate for evidence-based policy using the process of public comment on federal regulations. Federal agencies implement and enforce laws by establishing regulations. Before enacting new regulations, they are required to provide public notice and seek comment. During this mandated comment period, the public can provide feedback on any aspect of the proposed regulation. The agency is then required to respond to unique, fact-based public comments. Scientists can therefore use public comment as a type of "peer review" of the scientific research that goes into federal regulations. Public comment is an ideal pathway to engagement for many scientists because it is universally required across federal agencies, allows for flexibility in time commitment, and is broadly accessible across disciplines, career stages, and industries. As part of the Public Comment Project's mission to facilitate scientists' engagement in public comment, Project volunteers identify regulations of interest to specific scientific fields. Climate scientists interested in encouraging policy that addresses the human health impacts of climate change can comment on the Department of Health's Healthy People Initiative 2030, a set of 10-year national objectives with the goal of improving the health of all Americans. Climate change was specifically identified as an emerging issue in the Initiative's previous 2020 plan. We provide a summary of the Healthy People 2030 framework and guidance on writing effective public comments, in addition to an in-depth look at the public comment process itself and the tools provided by the Public Comment Project for future engagement.

Disentangling global warming, multi-decadal variability, and El Niño in Pacific temperatures

Wills, Robert, UW Atmospheric Sciences, Tapio Schneider, California Institute of Technology; John M. Wallace, UW Atmospheric Sciences; David S. Battisti, UW Atmospheric Sciences; Dennis L. Hartmann, UW Atmospheric Sciences

Unforced climate variability on decadal and longer time scales has garnered much attention, both because of its potential predictability and because it often masks the influence of externally forced climate change. A key challenge in climate science is to separate observed temperature changes into components due to internal variability and responses to external forcing. Extended integrations of forced and unforced climate models are often used for this purpose. Here we demonstrate a novel approach for separating modes of internal climate variability from long-term global warming based on differences in time scale and spatial pattern, without relying on climate models. We analyze reconstructed 20th-century sea-surface temperature (SST) anomalies in the Pacific and determine uncorrelated components of SST variability due to long-term global warming, the Pacific Decadal Oscillation (PDO), and the El Niño–Southern Oscillation (ENSO). Our results suggest that PDO and ENSO are separate processes, operating on different timescales, though they can still influence one another. We isolate the multi-decadal variability of the PDO and show that it is confined to midlatitudes, while tropical SSTs and their teleconnections mix in higher-frequency variability. This implies that PDO variability in midlatitudes is more persistent than previously thought. Our method, which we call low-frequency component analysis (LFCA), is more straightforward and more powerful than existing approaches to filter climate variability based on time scale, and provides a framework for separating modes of climate variability in other contexts.

Assessment of domestic rainwater harvesting potential in tropical monsoonal climate of south Asia using remote sensing

Mahmood, Asif, UW Civil and Environmental Engineering, Faisal Hossain, UW Civil and Environmental Engineering

South Asia is a densely populated land mostly with low income people living in the rural areas. Almost 134 million people in south Asia do not have access to improved water sources. Development of centralized piped network based water supply system is not a feasible option in these rural areas due to economic constrains. This kind of system also requires construction of large impoundment infrastructures on the water body which has enormous environmental and ecological impacts. Domestic rainwater harvesting could be the sustainable and cost effective solution in these rural areas due to its social acceptability, environmental friendliness, lower capital and maintenance cost. Estimating rainfall variability is the key to successful design of rainwater harvesting system. Traditional gauged measurement provides the magnitude of rainfall at a point location and stations are even sparsely located in the developing countries. Plethora of high resolution satellite rainfall data are available that give the spatial coverage of entire world. So rainfall estimation using remote sensing is more appropriate for hydrological applications in developing countries. The objective of this study is to find a hydro-meteorological solution using remote sensing to supply sufficient water throughout the year in rural areas of south Asia. Monthly rainfall variability of each precipitation grid was estimated by analyzing the precipitation climatology from satellite precipitation data. The whole region was classified into smaller areas according to this rainfall variability. Significant portion of the rainfall occurs during the rainy season due to the Indian monsoon. In the end, we developed a framework for storage and usage of this monsoonal precipitation by incorporating quantitative water management concept to maximize the water availability.

The role of vapor pressure deficit in crop yield projections and its interaction with rising CO2 levels

Hsiao, Jennifer, UW Department of Biology and Abigail L.S. Swann, UW,Department of Atmospheric Sciences, Department of Biology

Rising CO2 levels and warming are expected under a changing climate. Under the Clausius-Clapeyron equation, vapor pressure deficit (VPD) is also projected to increase along with rising temperatures. Great emphasis has been placed on understanding how warming and CO2 levels can affect crop yields, but the role of the embedded VPD change correlated with warming is often neglected. Warming can lead to yield loss in crops while rising CO2 levels partially alleviate it. However, the rise in VPD that happens along with warming can also be devastating for crop yields. Higher CO2 levels can partially alleviate this outcome as well, but through a different mechanism compared to that of temperature. The common practice of treating temperature and VPD effects as a whole can lead to potential issues when projecting crop yields under warming scenarios, and when quantifying the beneficial effect that can come from simultaneously rising CO2 levels. In this study, I used a process-based crop simulation model developed and calibrated for maize plants (MAIZSIM) to tease apart the impact of temperature, VPD and CO2 on crop yield, and understand the underlying mechanisms that lead up to it. Warming and high VPD treatments both lowered yield while elevated CO2 increased it. Temperature mainly affected yield through accelerating phenology while VPD affected yield through changing plant water relations. Elevated CO2 counteracted VPD effects by improving plant water relations. This led to longer growing seasons, higher photosynthetic rates and greater leaf area developed that benefited final yield. These results show the independent impact VPD has on crop yield, as well as its interacting effect with CO2 levels.

This illustrates the importance to tease apart VPD effects from that of rising temperatures in order to mechanistically understand how crop yield will be affected under future waring, and to what degree increasing CO2 levels can alleviate it.

Using the Community Firn Model to investigate the water isotope record in an ice core from the South Pole

Kahle, Emma, E. Steig, E. Waddington, and C. M. Stevens, UW, Department of Earth and Space Sciences

Firn models can be used to replicate conditions at ice core sites and investigate the past climate histories that re- sulted in the ice core record. The diffusion of water isotope ratios in ice cores can provide information about past firn conditions. We use the Community Firn Model (CFM) to compare theoretical and observational estimates of isotope diffusion in firn. We use the CFM to simulate possible past climate conditions at the South Pole, and com- pare the results with observational data from SPICEcore, the recently completed, 1751-meter ice core drilled at 90 degrees S. The CFM incorporates a collection of firn models into a single model framework, to facilitate comparison among different formulations of the densification process. We have incorporated water isotope diffusion into the CFM, following the well-established method of Johnsen. We produce vertical profiles of water isotope ratios using a range of reasonable temperature and accumulation rate histories for the site. Water isotope spectra of the model output are compared with those of the ice core data, with the ultimate goal of finding the optimal combination of climate parameters that best reproduces the observed spectra.

Climate Change Adaptation Planning for the Makah Tribe in Neah Bay, WA

Howk, Forrest, Washington Sea Grant, Micheal Chang (Makah Tribe), Laura Nelson (Makah Tribe), Katie Wrubel (Makah Tribe), Dana Sarff (Makah Tribe), Seraphina McGee (Makah Tribe)

The Makah Tribe is already experiencing the effects of climate change. We have seen decreased fish catch, drought conditions, and threats to the cultural and community livelihood for the tribe. Over the past few years, the Makah Tribe has prioritized climate change adaptation and mitigation actions. Though climate change is a global issue, the Makah Tribe is addressing our local scale effects in various ways. As described by our poster, these activities include: completing a climate change impacts assessment and adaptation plan; re-vamping the Makah fishing fleet to be more sustainable; outfitting Makah vessels with oil spill response gear; creating community climate engagement and outreach plans; and engaging Makah youth and fishermen to be proactive in implementing the Makah Climate Adaptation Plan.

Local and remote impacts of atmospheric cloud radiative effects onto the eddy-driven jet

Watt-Meyer, Oliver and Dargan M.W. Frierson, UW Atmospheric Sciences

This study examines the cause of the spread of extratropical circulation responses to the inclusion of atmospheric cloud radiative effects (ACRE) across atmospheric general circulation models. The ensemble of Clouds On-Off Klimate Intercomparison Experiment aquaplanet simulations shows that these responses include both equatorward and poleward shifts of the eddy-driven jet of varying magnitudes. These disparate extratropical responses occur despite the relatively consistent response in the tropics: a heating in the upper troposphere, which leads to a strengthening of the Hadley cell. It is argued that the eddy-driven jet response is a competition between two effects: the

local influence of clouds driving shifts of the jet through meridional gradients in ACRE and the remote impact of a strengthened Hadley cell causing an equatorward shift of the eddy-driven jet. Simulations in which cloud radiative effects are separately turned on in the tropics and extratropics demonstrate this explicitly.

Modeling how ocean conditions effect two farmed marine mussel species: Empirical tests of energy allocation to anchoring

Roberts, Emily and Carrington, Emily, UW Biology and Friday Harbor Labs

A key challenge for scientists is to determine how short and long-term environmental variability influence organisms and to use models to make predictions in current and future climate scenarios. Further, linking environmental variability with growth and survival of farmed marine organisms provides insight on how variability influences social-ecological systems. Bioenergetic models, such as Scope for Growth (SFG), are used to integrate variation in food availability and temperature into changes in organismal biomass. These frameworks do not explicitly consider the costs of structural biomaterials, such as those that play a role in attachment, mechanical defense and other traits critical to an organism's survival. We hypothesized the production of biomaterials may be influenced by the energetic state of the organism. We developed several SFG models using alternative 'allocation rules' that describe how energy might be prioritized among maintenance, growth, and biomaterials in congener marine mussels, Mytilus trossulus and Mytilus galloprovincialis. Mussels produce structural biomaterials called byssal threads to anchor themselves to rocky shores. Byssal thread attachment strength varies annually and is influenced by abiotic conditions. We ask, does byssal thread production depend on mussel energetics? We perturbed mussel energetic state by manipulating food availability and temperature in a mesocosm experiment. We evaluated five alternative models (each with different allocation rules) for their ability to predict the relationship between thread production and tissue growth using Akaike Information Criteria (AIC). Two models were well supported by the data: thread production is proportional to 1) all energy available, or 2) maintenance. This study establishes relationships between soft-tissue and structural material fluxes in mussels, and serves as a model system for incorporating structural materials into bioenergetics models.

Quick Talks

Hot off the presses: Very new, preliminary results from an August 2017 biomass burning study: Diamond, Michael and Rob Wood, UW Atmospheric Sciences

The August 2017 field season for the NASA Earth Ventures ORACLES (ObseRvations of Aerosols above CLouds and their inEractionS) has just completed. The NASA P-3 aircraft was based out of São Tomé this year to study the interactions between smoke from fires from the African continent and clouds in one of the world's three semi-permanent stratocumulus cloud decks. I will report on first impressions from the 2017 field season, and how they compare with the 2016 findings.

Climate Justice & the Carbon Bubble : Lenferna, Alex, UW Department of Philosophy

The carbon bubble is a concept used to describe the contradiction between needed action on climate change to meet the Paris Agreement targets, and the collective business model of the fossil fuel industry. In my talk I will briefly explore some of the questions of climate justice raised by the carbon bubble, such as stranded assets and equity, a just transition, and the need for regulations to

ensure fossil fuel companies are aligning their business models with internationally agreed upon climate action.

Does the atmosphere care about the land? Where and why surface properties matter for global climate: Lague, Marysa, UW Atmospheric Sciences, Abigail Swann, UW Atmospheric Sciences & Biology; Gordon Bonan, National Center for Atmospheric Research

We explore how different properties of vegetation - how rough it is, its color, how much water it uses - individually impact the atmosphere. To do this, we run a set of experiments individually perturbing a single vegetation property across a range of realistic values, using a simplified land model coupled to a full Global Climate Model. This allows us to calculate a new metric which describes how large a change in each property is needed to drive a given atmospheric response (e.g. a 0.1K increase in local air temperature). For example, making the surface darker warms the air, while making it rougher cools in some regions while warming in others. We can directly compare the climate impact of changes in different land surface properties, and compare the spatial pattern of the sensitivity of the atmosphere to these individual surface properties. The full set of experiments gives us a limit on the range of local temperature change possible from an arbitrary change in vegetation.

Effects of Climate Shocks on Fertility Behavior in Indonesia: Sellers, Sam, UW Center for Global Health and the Environment, Clark Gray, Associate Professor of Geography, University of North Carolina at Chapel Hill

The impacts of climate change on livelihoods are likely to trigger individual-level responses, including changes in fertility decision making by couples. These demographic adaptations to climate change have important implications for future economic growth, women's empowerment, and environmental sustainability. Drawing on literature linking climate variability to shifts in the timing of rice production in Indonesia, we use longitudinal household survey and high-resolution climate data to explore changes in childbearing preferences, family planning use, and births following community-level temperature and precipitation anomalies (as measured by delays in monsoon timing) between 1993 and 2015. We find that fertility desires are positively associated and family planning use negatively associated with delays in monsoon onset during the previous year, though there is no overall relationship between climate shocks and births. We show distinct responses between farm and non-farm households, with significant increases in family planning use and a reduction in desired fertility in the former following long-term temperature shocks whereas women in non-farm households experienced significant reductions in family planning use after short-term monsoon shocks. Using recent rice, food, and non-food consumption data, we also test possible pathways through which climate shocks likely affect fertility. Results from consumption models suggest multiple and complex pathways through which climate shocks affect fertility behaviors. Following short-term temperature anomalies, farm households reduce rice expenditures, but increase spending on non-food purchases, which may help these households cope with shocks. Collectively, this research highlights a largely understudied dimension of vulnerability for households in Indonesia.

Oceanic internal-wave driven mixing in the context of climate: Whalen, Caitlin, UW Applied Physics Laboratory

Winds blowing over the ocean's surface and tides flowing over rough bathymetry can produce internal waves in the ocean that can propagate horizontally as well as vertically until they break and turbulently mix the water. This mixing has a complex global geography, varying over multiple orders of magnitude throughout the global ocean. The variable mixing has consequence for the ocean's density structure, circulation, and surface properties. However, until recently climate models used a constant mixing value, and are only now beginning to include spatially and temporally variable mixing. A global mixing product based on observations is shown that will be soon be publicly available.

Connecting climate and health through near future projections of heat-related workers compensation injury claims in Washington State, 2020-2100: Calkins, Miriam, UW Department of Environmental and Occupational Health Sciences, Karin Bumbaco, UW Office of Washington State Climatologist (OWSC), Joint Institute for the Study of the Atmosphere and Ocean's (JISAO), Tania Busch Isaksen, UW Departments of Environmental and Occupational Health Sciences & Health Services, Kristie L. Ebi, UW Departments of Environmental and Occupational Health Sciences & Global Health and June Spector, UW Department of Environmental and Occupational Health Sciences

Climate change projections in the Pacific Northwest and globally indicate that ambient temperature will continue to increase, with increases in the frequency, severity, and duration of episodes of high temperatures over land. High ambient heat is associated with adverse human health outcomes. Research on these effects in Washington State demonstrate increases in mortality, hospitalizations, emergency medical service calls, and occupational injuries, with additional evidence of impacts documented in other populations around the globe. When combined with occupational factors such as those in the construction industry, where there may be barriers to control over environmental conditions, physical activity, and possible point sources of heat, individual exposures and physiological responses may exceed what would be expected bases solely on weather conditions. This analysis, slated for fall 2017, combines recent research into the risk of occupational injuries in the construction industry under warm-month conditions of outdoor humidex—a measure of apparent temperature involving dry temperature and relative humidity—with climates projections for Washington State through 2100. This quick talk will focus on the driving factors for the study, framing and approach to the analysis, and possible implications of anticipated results.

Reflections on a PCC Capstone Project: Working with Labor on Climate Issues: Twedt, Judy, Atmospheric Sciences and Digital & Experimental Arts and Miriam Calkins UW Department of Environmental and Occupational Health Sciences

In the Summer of 2016 Miriam Calkins and Judy Twedt helped form a climate caucus in the King County Labor Council, to develop conversations within the labor community about the impacts of climate change on workers. As a PCC capstone project, we developed a speakers bureau in the graduate student union, UAW4121, to support the climate caucus. This 'quick talk' is a reflection on the work of the speakers bureau over the past year, and an invitation for graduate students in the PCC community to join the speakers bureau.

The effects of pH and pCO2 on photosynthesis and respiration in the diatom Thalassiosira weissflogii: Goldman, Johanna, UW School of Oceanography, Michael L. Bender (Princeton University), Francois M.M. Morel (Princeton University)

The response of marine phytoplankton to the ongoing increase in atmospheric pCO2 reflects the consequences of both increased CO2 concentration and decreased pH in surface seawater. In the model diatom Thalassiosira weissflogii, we explored the effects of varying pCO2 and pH, independently and in concert, on photosynthesis and respiration by incubating samples in water enriched in water-18O. In long-term experiments (~6-hours) at saturating light intensity, we observed no effects of pH or pCO2 on growth rate, photosynthesis or respiration. This absence of a measurable response reflects the very small change in energy used by the carbon concentrating mechanism (CCM) compared to the energy used in carbon fixation. In short-term experiments (~ 3 minutes), we also observed no effects of pCO2 or pH, even under limiting light intensity. We surmise that in T. weissflogii, it is the photosynthetic production of NADPH and ATP, rather than the CO2-saturation of Rubisco, that controls the rate of photosynthesis at low irradiance. In short-term experiments, we observed a slightly higher respiration rate at low pH at the onset of the dark period, possibly reflecting the energy used for exporting H+ and maintaining pH homeostasis. Based on what is known of the biochemistry of marine phytoplankton, our results are likely generalizable to other diatoms and a number of other eukaryotic species. The direct effects of ocean acidification on growth, photosynthesis and respiration in these organisms should be small over the range of atmospheric pCO2 predicted for the 21st century.