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[Project Reports](#)  
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[Award Functions](#)  
[Manage Financials](#)  
[Program Income Reporting](#)  
[Grantee Cash Management Section Contacts](#)  
[Administration](#)  
[Lookup NSF ID](#)

## Preview of Award 1440435 - Annual Project Report

[Cover](#) |  
[Accomplishments](#) |  
[Products](#) |  
[Participants/Organizations](#) |  
[Impacts](#) |  
[Changes/Problems](#)

### Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1440435
Project Title:	LTERR Palmer, Antarctica (PAL): Land-Shelf-Ocean Connectivity, Ecosystem Resilience and Transformation in a Sea-Ice Influenced Pelagic Ecosystem
PD/PI Name:	Hugh W Ducklow, Principal Investigator Douglas G Martinson, Co-Principal Investigator
Recipient Organization:	Columbia University
Project/Grant Period:	09/01/2014 - 08/31/2020
Reporting Period:	09/01/2015 - 08/31/2016
Submitting Official (if other than PD\PI):	N/A
Submission Date:	N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

### Accomplishments

#### \* What are the major goals of the project?

The Palmer Long Term Ecological Research (PAL) program seeks to obtain a comprehensive understanding of the Antarctic seasonal sea ice-influenced ecosystem – the climate, plants, microbes, animals, biogeochemical processes, ocean, and

sea ice south of the Antarctic Polar Front (northernmost extent of ice-influenced water). Since its inception in 1990, the central hypothesis of PAL has been that the seasonal and interannual variability of sea ice affects all levels of the Antarctic marine ecosystem, from the timing and magnitude of primary production to the breeding success and survival of penguins and whales. Our site on the western side of the Antarctic Peninsula (WAP) addresses multiple spatial and temporal scales from hemispheric, decadal, climate-relevant scales to regional and local, daily to seasonal, process-relevant scales.

**\* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

**Climate and sea ice**

We analyzed the 2015-2016 air-sea-ice interactions that led to simultaneous record-breaking winter-spring sea ice extents in the WAP but near-average sea ice extents observed elsewhere. We completed several WAP and Antarctic-wide ice-climate analyses that investigated mechanisms driving sea ice changes. We also contributed to several investigations on ice-ecosystem interactions relevant to PAL and to two cross-site syntheses studies. Work continued on a data-model investigation of the role of ocean heat on sea ice dynamics in the PAL study area with improvements made to model initializations. Satellite-derived sea ice data sets were updated on PAL DataZoo, and other satellite-derived products (e.g., SST) were provided as needed.

**Physical Oceanography**

We continued to collect, process and distribute shipboard CTD and ADCP at every station visited, and thermistor/current mooring data at 4 locations throughout the 2015 field season. The moorings were recovered, refurbished and after the data were downloaded, one mooring was redeployed for the 2016 field season. These data are collected to provide the physical setting of the ecosystem and in the long term to allow us to determine the manner in which the physical system is changing. This year brought us to a complete understanding of the circulation system providing the all-important nutrient maximum upper circumpolar deep water.

**Phytoplankton**

As usual, we conducted both nearshore (Palmer Station, October to April) and offshore (LMG cruise, January) investigations of phytoplankton ecology, continuing the PAL 25 year time series. Recent results from analysis of the time series datasets are described in the results section following.

This year we also continued to conduct significant community outreach. Oscar Schofield as part of his efforts as chair of Southern Ocean Observing System has formed a WAP international working group with a focus to standardize the measurements between the many field stations. Additionally money external to the LTER program is being used to purchase an Imaging Flowcytobot which will allow the team to cost effectively collect data on phytoplankton species composition. In collaboration with the Janice McDonnell in the NSF sponsored Polar Ice program, we conducted a young scientist and teacher workshop focused on polar science during the 2016 Ocean Sciences meeting in New Orleans. A second teacher workshop was conducted during the week of June 27th at Rutgers.

**Zooplankton**

This season the zooplankton group again emphasized the role that zooplankton play in

carbon and nutrient cycling, and long-term changes in zooplankton community structure. We also continued our efforts sampling ice-edge zooplankton communities to examine how they affect biogeochemical cycling in these environments. In addition, we analyzed our long-term depth-stratified data set to examine diel vertical migration in WAP zooplankton. PhD student Patricia Thibodeau, who started in my laboratory in fall 2014 began her field work on pteropod (pelagic snail) biogeography and feeding ecology as related to the effects of ocean warming and acidification. A new MSc student, John Conroy, started in August 2016. The macrozooplankton on-line data are now up to date through 2015 on the Data zoo website.

### **Seabirds**

We have been expanding our gentoo penguin sampling program to match the sampling regime that has been in effect longer-term with Adélie penguins, to test hypotheses regarding competition between the two species and between penguins and whales. The specific metrics of interest include diets, foraging locations, dive-depths and fledging weights. Including both species, during the 2015-16 field season we obtained 39 diet samples, 371 fledging weights and deployed 14 satellite tags that returned data on the foraging distributions and dive-depth profiles of 42 individual birds. Our focal study areas include Biscoe Point, the Joubin Islands, and Torgersen, Humble and Dream islands. In January two field team members participated in the annual LTER cruise, continuing surveys of seabirds and marine mammals within the LTER grid, including a 5-day field camp on Avian Island to extend the time series on aspects of Adélie penguin ecology to compare with Palmer Station populations. This cruise included an opportunity to census penguins in the Rosenthal Islands 25 km north of Palmer Station. This region has not been surveyed since 1974, and disclosed the existence of many large previously unknown seabird colonies including penguins.

### **Cetaceans**

We continue to collect data on the demography, behavior, and ecology of baleen whales as they recover from whaling and test whether their ecological role may lead to competition among krill predators as climate changes affect the marine ecosystem. To understand the demography (sex ratio, pregnancy rates) and breeding population identity of the whales in the LTER study area as a feeding ground we collect skin and blubber biopsy samples and photographs of flukes. These data are analyzed to compare with the genetic identity of whales from tropical breeding grounds. We link the relative abundance of whales within the penguin foraging range by collecting sightings and concurrent quantitative estimates of krill from echosounder surveys to understand if/when whales are locally abundant and how this relates to krill availability. To understand how the foraging behavior and movement ecology at broad spatio-temporal scales within the LTER study region relates to the physical and biological features of the seascape we deploy satellite-telemetry tags and link foraging locations with oceanographic data to determine the features that promote the necessary conditions for whales to feed.

### **Microbial ecology and biogeochemistry**

We exploited highly anomalous early season sea ice conditions at Palmer Station by establishing a 3-week ice station in Arthur Harbor, to investigate under ice microbial communities, and just received an EAGER award to support sequencing on samples

from that work (J. Bowman PI). The crazy ice year continued with extensive sea ice cover during the LMG 1601 LTER cruise, preventing many station occupations and two planned mooring deployments. At Palmer Station we conducted pilot studies with a new prototype Equilibration Inlet Mass Spectrometer to estimate Net Community Production from dissolved oxygen and argon concentrations.

### **Synthesis and modeling**

Data analysis studies were conducted on historical biogeochemical data from the Palmer LTER annual regional survey cruise and seasonal small boat sampling at Palmer Station. Numerical modeling studies were conducted across a hierarchy of model resolution scales exploring ocean-atmosphere-sea ice physical dynamics and ocean biogeochemistry (1-D water column model), regional physical circulation-biogeochemistry (MIT Ocean General Circulation Model), and the impact of climate change on Southern Ocean biogeochemistry (Community Earth System Model).

### **Information Management**

We continued to make improvements to a redeveloped data workflow infrastructure, upgrading scripts, documentation and data integrity checks. Data exports from the PAL LTER Datazoo to the LTER network's PASTA were upgraded from EML version 2.1.0 to 2.1.1. We began work with PAL scientists developing a workflow to produce and maintaining an integrated data product from datasets collected across labs on cruises since 1990. Much thought was put into the design of this workflow to maintain submission of individual time series datasets and providing a structure to support updates to data and processes at any point within the workflow, while maintaining the ability to regenerate the integrated product reliably over time and personnel. Initial versions of the product are being analyzed and refined, with a standard product released to project scientists. The project is being documented and designed to be maintained for the long-term by PAL IM personnel as a standard research product.

#### **Specific Objectives:**

The specific objectives of this award are to answer the following questions with a strategically-designed program of oceanographic and ecological observations and experiments conducted at Palmer Station and along the western Antarctic Peninsula.

1. Long-term change and ecosystem transitions. What is the sensitivity or resilience of the ecosystem to external perturbations as a function of the ecosystem state?
2. Lateral connectivity and vertical stratification. What are the effects of lateral transports of freshwater, heat and nutrients on local stratification and productivity and how do they drive changes in the ecosystem?
3. Top-down controls and shifting baselines. How is the ecosystem responding to the cessation of whaling and subsequent long-term recovery of whale stocks?
4. Foodweb structure and biogeochemical processes. How do temporal and spatial variations in foodweb structure influence carbon and nutrient cycling, export, and storage?
5. Education and outreach activities. In what ways do we communicate our results to the public and how are they incorporated in new education initiatives? What are the Broader Impacts of PAL research on the WAP?

## Significant Results:

**Climate and sea ice**

Circumpolar Antarctic sea ice extent saw new record-highs during the first-half of 2015, which was then followed by near average sea ice extent for the second-half of the year (**Fig 1**). This abrupt shift in circumpolar sea ice extent coincided with a shift from a strong positive SAM index to a slight weakening of SAM and the emergence of a strong El Nino in the tropical Pacific (**Fig 2**). Sea ice in the WAP area in 2015 started well below-average in January-April but became well above average for the rest of 2015 and early 2016 (January-April) (**Figs 3, 4**). From mid-winter 2015 onward the WAP area experienced positive sea-level pressure anomalies (**Fig 2**) and cold conditions, reflective of its high latitude response to El Nino. Because Antarctic sea ice extent has been breaking new records since 2012, there has been much attention on the drivers of these changes. There is no single driver that explains the record high sea ice extents. Different seasons and regions contributed to the record high sea ice extent anomalies, coincident with different atmospheric and ocean circulation anomalies. Antarctic sea ice is intrinsically highly variable.

**Physical Oceanography**

Winds and ocean dynamics control delivery of UCDW to the shelf, where UCDW-core eddies and advective intrusions are steered to the northern half of the LTER grid via  $f/h$  contours. The strong changes isolated in the northern half of the grid pose the question what can make these changes appear in the southern region?

Examination of ocean stratification determine why the sea ice season has changed so dramatically has led to the concept of the Antarctic Sea Ice Wall (ASIW). Because of the role of temperature in density in warm subtropical waters, there is a location while moving from the polar oceans where cooling of water to the freezing point will cause convection too deep to achieve freezing: the ASIW is that location (**Fig 5**).

A major mechanism of water mass transformation is interleaving via thermohaline layering. UCDW eddy cores are destroyed by interleaving with cooler shelf waters, which at the same time spread heat and other scalars laterally.

**Phytoplankton**

In the Palmer region, there was significant interannual variability in water column chlorophyll *a* (chl-*a*), which varied by a factor of 5 over the 20-year time series. Additionally, there is a significant positive increase in the seasonally integrated concentration of chl-*a*. Increasing chl-*a* is associated with diatoms. The second most abundant phytoplankton taxa were cryptophytes associated with surface cold meltwater probably from sea ice melt. Mixed flagellates were also a significant fraction of the chl-*a* and showed less interannual variability than the diatoms and cryophytes. The results suggest continued warming of the West Antarctic Peninsula will result in changes in phytoplankton concentration and community composition. A Slocum glider dataset with over 30,000 water column profiles showed a strong relationship between mixed layer depth and phytoplankton distributions. Combined data from shelf-wide glider surveys and 22 years of hydrographic cruise data show that the spatial distribution of UCDW on the continental shelf is associated with bathymetric depressions. The high spatial resolution provided by the gliders allow the first near-synoptic measurements of mesoscale features in this region. Unmixed UCDW intrudes onto the shelf as

subsurface eddies with widths on the order of 10 km. Close to 30% of the UCDW detected by gliders on the shelf appears to form subsurface eddies, revealing the importance of mesoscale processes to the delivery of the heat to the shelf that is rapidly warming the region.

### Zooplankton

Vertically migrating zooplankton move between surface waters at night where they feed and the mesopelagic zone where they reside during the day. Since there is only a brief daily period of darkness, zooplankton may not exhibit vertical migration behavior. We conducted day and night tows at discrete depth intervals through the epipelagic and mesopelagic zones from 2009-15, and with epipelagic net tows from 1993-2013. Taxa that consistently exhibited diel migration in all years included calanoid copepods (e.g., *Metridia gerlachei* and *Calanoides acutus*) and ostracods. Other taxa migrated only during some years (e.g., *Limacina helicina* and *Euphausia crystallorophias*). The Antarctic krill *Euphausia superba* did not vertically migrate, but the abundant gelatinous salp *Salpa thompsoni* did—with a night:day abundance ratio of 2 in surface waters. Inter-annual and north-south variation in environmental parameters such as sea ice affected migration. We found that DVM increased for some species in regions with more ice (e.g., *Metridia gerlachei*, **Fig. 6**, and other calanoid copepods) and appears to increase for some species with increasing primary production (e.g., ostracods).

### Seabirds

Gentoo penguins first bred in the Palmer area in the mid-1970s, initially occupying the Joubin Islands, then Biscoe Point in 1993-94 and finally Dream Island in 2009-10. In terms of demographic changes in these colonies, the Dream populations rarely breed successfully and have failed to increase, while the other two populations, even though only about 10 km apart, have shown contrasting patterns of change that have been difficult to explain. Gentoo penguins are an ice-intolerant species and the 2015-16 breeding season was marked by anomalously heavy sea ice conditions, including the period of chick growth that ultimately determines fledging weight. Fledging weight is a major determinant of overwinter survival and thus of future recruitment and population change. In 2015-16 fledging weights on the Joubins were nearly 750 g heavier than on Biscoe Point and nearly 300 g heavier than the long-term average (**Fig 7**). This is the first evidence that foraging regions may not only be colony-specific over relatively small spatial scales, but that populations may be asymmetrically vulnerable to sea ice imposed costs on foraging efficiencies associated with these regions. This is an extremely significant finding in the context of both interpreting our long-term data and aligning future research with current hypotheses.

### Cetaceans

We are currently completing ecological analysis of humpback and minke whale foraging behavior from satellite tags and have determined that there are significant differences in the foraging habitat and behavior between species: minke whales forage in close proximity to sea ice almost exclusively but have to range over greater areas to find suitable foraging habitat while humpback whales have longer and more focused foraging areas on the continental shelf throughout summer. In fall, humpback whales focus in ice-free regions around the Gerlache Strait and forage into the Antarctic winter (**Fig 8**). The data from our multi-sensor tag collected the first information on bubble-net

feeding by humpback whales in the Southern Ocean (**Fig 9**), a feeding strategy that has been observed in northern hemisphere populations.

### **Microbial ecology and biogeochemistry**

3 mss in prep demonstrate new findings on seasonal succession of microbes in the nearshore region. Please see **figures 10-12** for descriptions and details.

### **Synthesis and modeling**

Hauck et al. (2015) found substantial variations in model-simulated Southern Ocean air-sea CO<sub>2</sub> flux and export flux and their sensitivity to climate change across coupled earth system models. Boyd et al. (in press) demonstrated that in CESM simulations Southern Ocean physical-chemical heterogeneity may increase due to climate change with likely important but as yet unresolved biological implications. Eveleth et al. (in press) showed strong relationships among interannual variations in seasonal sea-ice, physical dynamics and geochemical measures of net community production (partial pressure of carbon dioxide; oxygen-argon ratios) along the West Antarctic Peninsula and Drake Passage Fig 13).

Key outcomes or Other achievements:

#### **\* What opportunities for training and professional development has the project provided?**

The PAL LTER Information Manager, James Connors, continues to serve on the Information Management Executive Committee. James Connors attended the annual Information Management Meeting (Estes Park, CO w/ LTER ASM) in August/September of 2015.

In the recent reporting period we have trained numerous undergraduate, graduate and postdoctoral students (see Participants files). Select undergraduates participate in Antarctic field work at Palmer Station and aboard the LM GOULD

Our Education and Outreach program is training K12 teachers in Polar Science through the LTER Schoolyard and Research Experience for Teachers programs.

#### **\* How have the results been disseminated to communities of interest?**

**Education and outreach activities: In what ways do we communicate our results to the public and how are they incorporated in new education initiatives? What is the Broader Impacts of PAL research on the WAP?**

The Rutgers education and outreach team has designed a variety of education programs focused on communicating the research of the Palmer LTER to predominantly a K-12 educator and student audience. We match these efforts with a companion NSF award from the Polar Science Division (grant#1525635) called Polar Interdisciplinary Coordinated Education or Polar ICE (see website polar-ice.org). Below we report on the key tasks and achievements for the project.

*Schoolyard LTER: Engage educators and students in video conference calls from Palmer.*

The Education and Outreach team worked with Palmer LTER scientists to offer seven video teleconference calls (VTCs) to virtually connect students and their teachers to Palmer. Teachers completed an application process and agreed to teach 2-3 lessons prior to their call, with hands-on activities that would help prepare the students for the experiences (see recruiting flyer in Figure 14). Students also submitted their science questions 24 hours in advance. These questions were shared with the Palmer scientists prior to the call to help them prepare their responses.

There were seven calls in total. The first call (January 23, 2016) was part of an informal 4-H Extension program called Rutgers science Saturdays. In this program we engaged 40 middle school youth in learning about Palmer and asking questions.

We did six calls for middle school educators and their students.

We provided professional development and online coaching to help prepare the educators for the calls. We also most importantly checked the Adobe Blackboard software to reduce the risk of technical difficulties.

Through this effort, we reached 21 educators and 630 students directly. They participated by asking questions and watching participating in the calls live. Based on reports from the educators, we estimate that 3,990 kids watched the recorded phone call with their teacher. These students also participated in hands-on activities and talked about the LTER in their class. A complete list of the questions that were asked by the students and answered by the scientists can be found on the website.

You can see the recordings and question lists at <http://polar-ice.org/educator-resources/palmer-lter-education-outreach/>.

*Schoolyard LTER: Engage educators in professional development related to Palmer LTER research.*

The Science-Investigator (Sci-I) Project is designed to increase educator and student skills in designing and conducting science investigations as well as analyzing and interpreting data in alignment with [Next Generation Science Standards \(NGSS\)](#) requirements through the lens of polar science. The Sci-I Project was made available to science teachers from grades 6-9. Preference was given to educators that work in school districts that serve predominately underserved and underrepresented communities.

The Sci-I Project is a *year-long project* that consists of a *Summer Educator Workshop* – June 27-30, 2016. Twenty-four educators from California, and New Jersey explored polar science and data through interactions with six Palmer LTER scientists and participate in polar data-focused activities. A large portion of the workshops was devoted to using exemplar student science investigations as case studies to highlight how to effectively lead students in designing, developing, and conducting polar science investigations. Educators, who were paired (2 from 12 schools), will be asked during the school year to teach 2 [polar-related science classroom lessons](#) that use real polar data from the Palmer LTER data zoo.

Educators will assist their student in designing and conducting [science investigations](#) using real data. Students participating in the Sci-I Project will have the unique opportunity to conduct their own investigations related to the topics and data of polar LTER research explored through this project. The students will work on these investigations throughout the winter 2016 and spring 2017 and then present their results and findings to polar scientists and to one another at the [Student Polar Research Symposium](#) (February 2016 – CA, and June 2017 – NJ).

*Our intended impact for this work is to: 1) contribute to the engagement of middle school youth in science and 2) increase student identity as a scientist through increased enthusiasm and personal engagement with scientists. Our objective is to make science personally relevant to students and influence their long-term interest in science through authentic science data experiences.*

*We will also be hosting the Education and Research Testing Hypothesis (EARTH) workshop (July 25-29, 2016). Developed by MBARI, EARTH providing teachers with a means for integrating real-time data with existing educational standards and tested curriculum in an interactive and engaging way. Polar-ICE and Palmer LTER will be collaborating with MBARI to host 25 K-12 educators at Rutgers and Columbia Universities. Educators will create lessons that focus on Palmer LTER data. The lessons will be shared broadly through the Polar-ICE, LTER, and EARTH/MBARI websites.*

The Rutgers outreach team also has planned an evening workshop for October 13, 2016 focused on the LTER children's' book focused on Palmer Station. Rutgers has maintained a network of approximately fifty K-8 schools in NY-NJ that are integrating marine science themes and concepts in their school curriculum. MARE is a whole school program that trained 2,940 educators, in 30 New Jersey K-8 schools, and impacting more than 20,000 children. The MARE program which was



developed by the Lawrence Hall of Science at the University of California- Berkeley and has been running more than sixteen years in NJ, engages elementary age students in non-fiction science reading, and hands-on lessons, and demonstrations that promote Ocean Literacy. The Education and Outreach group will use professional development workshops, webinars, and general marketing efforts to promote the Palmer focused books through this network. Educators and students will be introduced to the penguin observation activity developed by Beth Simmons and encouraged to follow LTER research in their classrooms.

*Support the Research Experience for Teachers (RET) program:* We have selected 2 educators from the Polar ICE Science Investigation workshop to work on development of Data Nuggets and other Palmer related lessons that can be shared with the our education network. In addition, these educators will facilitate one-day workshops for their peers in the fall 2016. They will also collect student data on the effectiveness of the newly developed lesson plans. These educators will be encouraged to engage students in authentic field-based science using Palmer LTER data. The goal of the LTER RET program is to enhance the professional development of K-12 science educators through research experience at the emerging frontiers of science in order to bring new knowledge into the classroom.

Lastly, the Rutgers education and outreach team will be developing public outreach materials and programs that bring attention to Palmer LTER. We will develop a high quality slide show that can be used by the program team in presentations for general audiences. Team members will develop quality slides/graphics and a select number of data visualizations that help the public understand Palmer LTER science. We expect this work to be completed in the fall 2016.

We also are collaborating with Public Radio (You're the Expert) on November 9, 2016 at the George Street Playhouse in New Brunswick, NJ to share Palmer LTER research stories and information. We expect 300 Rutgers students to attend the taping of the show. The show will be made available to the public through NPR radio broadcasts and their website.

**\* What do you plan to do during the next reporting period to accomplish the goals?**

1. Continue field research as dictated by NSF in Operational Notice, and lab research as described in proposal.
2. Convene annual project science meeting in September.
3. Hold smaller, special-focus workshops with project coPIs and students.
4. Organize cross-site workshop with California Current LTER site.
5. Complete joint publications for BioScience with McMurdo Dry Valleys site.

**Supporting Files**

Filename	Description	Uploaded By	Uploaded On
Findings figures.pdf	Figures supporting Significant Results (pdf) file Findings figures	Hugh Ducklow	07/07/2016

**Products**

**Books**

**Book Chapters**

Stammerjohn, S. and Maksym, T. (2016). Gaining (and losing) Antarctic sea ice: Variability, trends and mechanisms. *Sea Ice, 3rd Edition 3rd*. Thomas, D.. Wiley-Blackwell. West Sussex. 728. Status = PUBLISHED; Acknowledgement of Federal

Support = Yes ; Peer Reviewed = Yes ; ISBN: 978-1-118-77838-8.

Steinberg, D.K. (). Chapter 6: Marine zooplankton biogeochemical cycles. *Marine Plankton* Castellani, C. and Edwards, M.. Oxford Univ. Press. Oxford, UK. . Status = AWAITING\_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

## Inventions

### Journals or Juried Conference Papers

Bowman, J.S. and Ducklow, H.W. (2015). Microbial Communities Can Be Described by Metabolic Structure: A General Framework and Application to a Seasonally Variable, Depth-Stratified Microbial Community from the Coastal West Antarctic Peninsula. *PLoS ONE*. 10 (8), e0135868. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1371/journal.pone.0135868

Boyd, P.W. and Cornwall, C.E. and Davison, A. and Doney, S.C. and Fourquez, M. and Hurd, C.L. and Lima, I.D. and McMinn, A. (2016). Biological responses to environmental heterogeneity under future ocean conditions. *Global Change Biology*. 22 (8), 2633--2650. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/gcb.13287

Brum, J.R. and Hurwitz, B.L. and Schofield, O. and Ducklow, H.W. and Sullivan, M.B. (2015). Seasonal time bombs: dominant temperate viruses affect Southern Ocean microbial dynamics. *The ISME Journal*. 10 437-449. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi:10.1038/ismej.2015.125

Cimino, M.A. and Moline, M.A. and Fraser, W.R. and Patterson-Fraser, D.L. and Oliver, M.J. (2016). Climate-driven sympatry may not lead to foraging competition between congeneric top-predators. *Scientific Reports*. 6 (18820), . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi: 10.1038/srep18820

De Jong, J.T.M. and Stammerjohn, S.E. and Ackley, S.F. and Tison, J.-L. and Mattielli, N. and Schoemann, V. (2015). Sources and fluxes of dissolved iron in the Bellingshausen Sea (West Antarctica): The importance of sea ice, icebergs and the continental margin. *Marine Chemistry*. 177 518–535. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi:10.1016/j.marchem.2015.08.004

Eveleth, R. and Cassar, N. and Doney, S. C. and Munro, D. R. and Sweeney, C. (). Biological and physical controls on O<sub>2</sub>/Ar, Ar and pCO<sub>2</sub> variability at the Western Antarctic Peninsula and in the Drake Passage. *Deep Sea Research Part II: Topical Studies in Oceanography*. . Status = AWAITING\_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: <http://dx.doi.org/10.1016/j.dsr2.2016.05.002>

Gleiber, M.R. and Steinberg, D.K. and Schofield, O.M.E. (2015). Copepod summer grazing and fecal pellet production along the Western Antarctic Peninsula. *Journal of Plankton Research*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: DOI doi: 10.1093/plankt/fbv070

Hauck, J. and Völker, C. and Wolf-Gladrow, D.A. and Laufkötter, C. and Vogt, M. and Aumont, O. and Bopp, L. and Buitenhuis, E. and Doney, S.C. and Dunne, J. and Gruber, N. and Hashioka, T. and John, J. and Le Quéré, C. and Lima, I.D. and Nakano, H. and Séférian, R. and Totterdell, I. (2015). On the Southern Ocean CO<sub>2</sub> uptake and the role of the biological carbon pump in the 21st century. *Global Biogeochemical Cycles*. 29 1451. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Heikkinen, Nina (2016). Penguin Populations are Changing Dramatically: Rapid warming on the Antarctic Peninsula is killing some species but helping others. *Climate Wire*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Hobbs, W.R. and Massom, R. and Stammerjohn, S. and Reid, P. and Williams, G. and Meier, W. (2016). A review of recent

changes in Southern Ocean sea ice, their drivers and forcings. *Global and Planetary Change*. -. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: <http://dx.doi.org/10.1016/j.gloplacha.2016.06.008>

Meredith, M.P. and Stammerjohn, S.E. and Venables, H.J. and Ducklow, H.W. and Martinson, D.G. and Iannuzzi, R.A. and Leng, M.J. and van Wesse, J.M. and Reijmer, C.H. and Barrand, N.E. (2016). Changing distributions of sea ice melt and meteoric water west of the Antarctic Peninsula. *Deep Sea Research Part II: Topical Studies in Oceanography*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: <http://dx.doi.org/10.1016/j.dsr2.2016.04.019>

Stammerjohn, S. (). Antarctica [in "State of the Climate in 2015"]. *Bulletin of American Meteorological Society*. 97 (7), . Status = AWAITING\_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Steinberg, D.K. and Landry, M.L. (). Zooplankton and the global carbon cycle. *Annual Review of Marine Science*. 9 . Status = AWAITING\_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Stukel, M.R. and Asher, E. and Couto, N. and Schofield, O. and Strebel, S. and Tortell, P. and Ducklow, H.W. (2015). The imbalance of new and export production in the western Antarctic Peninsula, a potentially "leaky" ecosystem. *Global biogeochemical Cycles*. 29 . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2015GB005211

## Licenses

## Other Conference Presentations / Papers

### Other Products

*Data and Research Materials (e.g. Cell lines, DNA probes, Animal models).*

Recently designed and produced merged and integrated data files from individual datasets collected across PIs and research components aboard Palmer annual cruises since the beginning of the project. The project is being documented and is designed to be regularly maintained for the long-term by PAL IM personnel as a standard research product for the project.

## Other Publications

## Patents

## Technologies or Techniques

### Thesis/Dissertations

Gorman, Kristen B.. *Integrative Studies of Southern Ocean Food-Webs and Pygoscelis Penguin Demography: Mechanisms of Population Response to Environmental Change*. (2015). Simon Fraser University. Acknowledgement of Federal Support = Yes

Gleiber, M.. *Long-Term Change in Copepod Community Structure in the Western Antarctic Peninsula: Linkage to Climate and Implications for Carbon Cycling*. (2014). College of William and Mary. Acknowledgement of Federal Support = Yes

Pedulli, Marco. *Seasonal Nitrate Drawdown, Potential New Production and Export Production for Waters off the Western Antarctic Peninsula (WAP) Region*. (2014). University of Massachusetts Dartmouth. Acknowledgement of Federal Support = Yes

## Websites

## Participants/Organizations

**What individuals have worked on the project?**

<b>Name</b>	<b>Most Senior Project Role</b>	<b>Nearest Person Month Worked</b>
Ducklow, Hugh	PD/PI	2
Martinson, Douglas	Co PD/PI	3
Conners, James	Co-Investigator	6
Doney, Scott	Co-Investigator	2
Fraser, William	Co-Investigator	11
Friedlaender, Ari	Co-Investigator	4
McDonnell, Janice	Co-Investigator	3
Schofield, Oscar	Co-Investigator	3
Stammerjohn, Sharon	Co-Investigator	3
Steinberg, Deborah	Co-Investigator	2
Bowman, Jeff	Postdoctoral (scholar, fellow or other postdoctoral position)	6
Dzemwoyo, Shungu	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Kavanaugh, Maria	Postdoctoral (scholar, fellow or other postdoctoral position)	6
Saenz, Ben	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Ferraro, Carrie	Other Professional	2
Fraser, Donna	Other Professional	6
Hunter-Thompson, Kristin	Other Professional	3
Lichtenwalner, Sage	Other Professional	2

Miles, Travis	Other Professional	1
Aragon, David	Technician	1
Cook, Ben	Technician	6
Cope, Joseph	Technician	6
Farry, Shawn	Technician	6
Haskins, Christina	Technician	6
Iannuzzi, Richard	Technician	6
Lima, Ivan	Technician	4
McAtee, Carrie	Technician	6
Porter, Mathew	Technician	4
Rheuban, Jennie	Technician	4
Roberts, Darren	Technician	2
Shelton, Naomi	Technician	6
Swaim, Zach	Technician	3
Waite, Nicole	Technician	3
Johnston, David	Staff Scientist (doctoral level)	2
Nowacek, Doug	Staff Scientist (doctoral level)	2
Read, Andrew	Staff Scientist (doctoral level)	2
Brown, Michael	Graduate Student (research assistant)	10
Carvalho, Ana Filipa	Graduate Student (research assistant)	12
Carvalho, Filipa	Graduate Student (research assistant)	10
Couto, Nicole	Graduate Student (research assistant)	12
Kim, Hyewon	Graduate Student (research assistant)	12

McKee, Darren	Graduate Student (research assistant)	12
Moreno, Carly	Graduate Student (research assistant)	2
Olson, Emily	Graduate Student (research assistant)	3
Pallin, Logan	Graduate Student (research assistant)	8
Pickett, Erin	Graduate Student (research assistant)	12
Pickett, Erin	Graduate Student (research assistant)	8
Rohr, Tyler	Graduate Student (research assistant)	12
Schultz, Cristina	Graduate Student (research assistant)	12
Seth-Pasricha , Mansha	Graduate Student (research assistant)	12
Sontag, Philip	Graduate Student (research assistant)	12
Stone, Joshua	Graduate Student (research assistant)	12
Thibodeau, Patricia	Graduate Student (research assistant)	12
Kaplan, Rachel	Non-Student Research Assistant	5
Sullivan, Conor	Non-Student Research Assistant	5
Bhatnagar, Anjali	Undergraduate Student	2
Conroy, John	Undergraduate Student	2
Corso, Andrew	Undergraduate Student	2
Crews, Laura	Undergraduate Student	2
Evens, Kayla	Undergraduate Student	2
Farischon, Chelsea	Undergraduate Student	3
Floedino, James	Undergraduate Student	2
Gonclaves, Ashley	Undergraduate Student	5

Hall, Danielle	Undergraduate Student	2
Leshko, Shana	Undergraduate Student	2
Mac, Frank	Undergraduate Student	2
Ordovas-Montanes, Maria	Undergraduate Student	2
West, Leigh	Undergraduate Student	1
Miner, Kimberly	Other	1
Ribanna, Dittrich	Other	2
Schattman, Emilie	Other	1
Vario, Chelsea	Other	1
Whitlock, Griffin	Other	1

#### Full details of individuals who have worked on the project:

##### **Hugh W Ducklow**

**Email:** hducklow@ldeo.columbia.edu

**Most Senior Project Role:** PD/PI

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Lead PI

**Funding Support:** Institutional support

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

##### **Douglas G Martinson**

**Email:** dgm@ldeo.columbia.edu

**Most Senior Project Role:** Co PD/PI

**Nearest Person Month Worked:** 3

**Contribution to the Project:** Co-investigator, supervisor of physical oceanography component

**Funding Support:** Columbia University

**International Collaboration:** No

**International Travel:** No

**James Conners****Email:** jconners@ucsd.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 6**Contribution to the Project:** Information Manager**Funding Support:** Scripps Inst of Oceanography**International Collaboration:** No**International Travel:** No

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**Scott Doney****Email:** sdoney@whoi.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 2**Contribution to the Project:** data synthesis and numerical modeling**Funding Support:** Woods Hole Oceanographic Institution**International Collaboration:** No**International Travel:** No

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**William Fraser****Email:** bfraser@3rivers.net**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 11**Contribution to the Project:** Leads all work related to seabird investigations**Funding Support:** Polar Oceans Research Group**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Ari Friedlaender****Email:** ari.friedlaender@oregonstate.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 4**Contribution to the Project:** Leads all work related to marine mammal investigations**Funding Support:** Oregon State University**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Janice McDonnell**



**Email:** mcdonnel@marine.rutgers.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Education & Outreach Coordinator

**Funding Support:** Rutgers University

**International Collaboration:** No  
**International Travel:** No

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**Oscar Schofield**

**Email:** oscar@marine.rutgers.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Leads all work related to phytoplankton investigations

**Funding Support:** Rutgers University

**International Collaboration:** No  
**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Sharon Stammerjohn**

**Email:** Sharon.Stammerjohn@Colorado.EDU  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** research on sea ice and climate

**Funding Support:** University of Colorado

**International Collaboration:** No  
**International Travel:** No

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**Deborah Steinberg**

**Email:** debbies@vims.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** Leads all work related to zooplankton investigations

**Funding Support:** Virginia Institute of Marine Science

**International Collaboration:** No  
**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Jeff Bowman**

**Email:** bowmanjs@ldeo.columbia.edu

**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** research on microbial diversity

**Funding Support:** Columbia University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Shungu Dzemwoyo**

**Email:** shungudzemwoyo.garaba@uconn.edu

**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)

**Nearest Person Month Worked:** 2

**Contribution to the Project:** field scientist

**Funding Support:** UCONN

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Maria Kavanaugh**

**Email:** mkavanaugh@whoi.edu

**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** No

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**Ben Saenz**

**Email:** blsaenz@gmail.com

**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)

**Nearest Person Month Worked:** 1

**Contribution to the Project:** research on sea ice and climate

**Funding Support:** University of Colorado

**International Collaboration:** No

**International Travel:** No

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**Carrie Ferraro**

**Email:** ferraro@marine.rutgers.edu

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 2

**Contribution to the Project:** education specialist

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Donna Fraser**

**Email:** patterdo@3rivers.net

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Data Management

**Funding Support:** Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Kristin Hunter-Thompson**

**Email:** hunterthomson@marine.rutgers.edu

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 3

**Contribution to the Project:** education specialist

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Sage Lichtenwalner**

**Email:** sage@marine.rutgers.edu

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 2

**Contribution to the Project:** education specialist

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Travis Miles**

**Email:** tnmiles@marine.rutgers.edu

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 1

**Contribution to the Project:** glider pilot

**Funding Support:** Rutgers

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**David Aragon**

**Email:** dkaragon@marine.rutgers.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 1

**Contribution to the Project:** glider pilot

**Funding Support:** Rutgers/NASA

**International Collaboration:** No

**International Travel:** No

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**Ben Cook**

**Email:** bpcfx7@gmail.com

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Field Technician

**Funding Support:** Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Joseph Cope**

**Email:** joecope@vims.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Field and laboratory Technician

**Funding Support:** Virginia Institute of Marine Science

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Shawn Farry**

**Email:** farrysc@hotmail.com

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Field Team Leader

**Funding Support:** Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Christina Haskins**

**Email:** haskins@marine.rutgers.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Assisted in project field logistics & glider missions

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Richard Iannuzzi**

**Email:** iannuzzi@ldeo.columbia.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** programmer

**Funding Support:** Columbia University

**International Collaboration:** No

**International Travel:** No

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**Ivan Lima**

**Email:** ilima@whoi.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 4

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** No

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**Carrie McAtee**

**Email:** mcateecarrie@gmail.com

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Field Technician

**Funding Support:** Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Mathew Porter**

**Email:** mporter@dzs.org

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 4

**Contribution to the Project:** Assisted with field work at Palmer Station

**Funding Support:** Detroit Zoological Society and Polar Oceans Research GroupNo

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Jennie Rheuban**

**Email:** jrheuban@whoi.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 4

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** No

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**Darren Roberts**

**Email:** robertdarrens@gmail.com

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Assisted with field work aboard LMG

**Funding Support:** Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Naomi Shelton**

**Email:** nshelton@ldeo.columbia.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Field and laboratory Technician

**Funding Support:** Columbia University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Zach Swaim**

**Email:** zach.swaim@duke.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 3

**Contribution to the Project:** field team participant and data management

**Funding Support:** Duke University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Nicole Waite**

**Email:** waite@marine.rutgers.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 3

**Contribution to the Project:** Assisted in field work at Palmer Station

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**David Johnston**

**Email:** dwj2@duke.edu

**Most Senior Project Role:** Staff Scientist (doctoral level)

**Nearest Person Month Worked:** 2

**Contribution to the Project:** field team participant and data management

**Funding Support:** Duke University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Doug Nowacek**

**Email:** dpn3@duke.edu

**Most Senior Project Role:** Staff Scientist (doctoral level)

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Assisted with field work at Palmer Station

**Funding Support:** Duke University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Andrew Read**

**Email:** aread@duke.edu

**Most Senior Project Role:** Staff Scientist (doctoral level)

**Nearest Person Month Worked:** 2

**Contribution to the Project:** field team participant and data management

**Funding Support:** Duke University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Michael Brown**

**Email:** mbrown@marine.rutgers.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 10

**Contribution to the Project:** scientist

**Funding Support:** Rutgers

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Ana Filipa Carvalho**

**Email:** filipa@marine.rutgers.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Works of data and gliders for PhD

**Funding Support:** Rutgers University

**International Collaboration:** Yes, Portugal

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Filipa Carvalho**

**Email:** pipa85@gmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 10



**Contribution to the Project:** scientist

**Funding Support:** Teledyne Webb

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Nicole Couto**

**Email:** ncouto@marine.rutgers.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Works of data and gliders for PhD

**Funding Support:** Teledyne Webb Research

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Hyewon Kim**

**Email:** hk2768@columbia.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** research on biogeochemistry

**Funding Support:** Columbia University

**International Collaboration:** Yes, Korea, Republic Of

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Darren McKee**

**Email:** dmckee@ldeo.columbia.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** research on physical oceanography

**Funding Support:** Columbia University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Carly Moreno**

**Email:** cmmoreno@live.unc.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 2

**Contribution to the Project:** field scientist

**Funding Support:** UNC

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Emily Olson**

**Email:** emolson@udel.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 3

**Contribution to the Project:** field scientist

**Funding Support:** LTER

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Logan Pallin**

**Email:** logan.pallin@oregonstate.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 8

**Contribution to the Project:** Assisted with field work at Palmer Station

**Funding Support:** Oregon State University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Erin Pickett**

**Email:** erin.p.pickett@gmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Using project data for MSc.

**Funding Support:** Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Erin Pickett**

**Email:** erin.pickett@oregonstate.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 8

**Contribution to the Project:** Assisted with field work at Palmer Station and on LMG

**Funding Support:** Oregon State University and Polar Oceans Research Group

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Tyler Rohr**

**Email:** trohr@whoi.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Cristina Schultz**

**Email:** cschultz@whoi.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Mansha Seth-Pasricha**

**Email:** mansha@marine.rutgers.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Assisted in field work onbaord the LMG

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Philip Sontag**

**Email:** pts29@scarletmail.rutgers.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Assisted in field work onbaord the LMG

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Joshua Stone**

**Email:** jpstone@vims.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Assisted in field work onboard the LMG

**Funding Support:** Virginia Institute of Marine Science

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Patricia Thibodeau**

**Email:** psthibodeau@vims.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Field and laboratory work for PhD

**Funding Support:** Virginia Institute of Marine Science

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Rachel Kaplan**

**Email:** rachellinneakaplan@gmail.com

**Most Senior Project Role:** Non-Student Research Assistant

**Nearest Person Month Worked:** 5

**Contribution to the Project:** Field and laboratory Technician

**Funding Support:** Columbia University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Conor Sullivan**

**Email:** conor.andrew.sullivan@gmail.com

**Most Senior Project Role:** Non-Student Research Assistant

**Nearest Person Month Worked:** 5

**Contribution to the Project:** Field and laboratory Technician

**Funding Support:** Columbia University

**International Collaboration:** No  
**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Anjali Bhatnagar**  
**Email:** ambhatnagar@email.wm.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** cruise volunteer

**Funding Support:** Wm & Mary

**International Collaboration:** No  
**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**John Conroy**  
**Email:** jaconroy@vims.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** Field and laboratory Technician

**Funding Support:** Virginia Institute of Marine Science

**International Collaboration:** No  
**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Andrew Corso**  
**Email:** adcorso@email.wm.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** cruise volunteer

**Funding Support:** Wm & Mary

**International Collaboration:** No  
**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Laura Crews**  
**Email:** lcrews@stanford.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Kayla Evens**

**Email:** kayla.evens13@ncf.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** field intern

**Funding Support:** LTER

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Chelsea Farischon**

**Email:** c.farischon@yahoo.com

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 3

**Contribution to the Project:** field intern

**Funding Support:** LTER

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**James Floredino**

**Email:** 1jf1050@gmail.com

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Assisted in field work at Palmer Station

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Ashley Gonclaves**

**Email:** ashmgon@gmail.com

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 5

**Contribution to the Project:** field intern

**Funding Support:** Rutgers

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Danielle Hall**

**Email:** dkhall@email.wm.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** cruise volunteer

**Funding Support:** Wm & Mary

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Shana Leshko**

**Email:** sbl2137@barnard.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** lab research

**Funding Support:** Barnard College

**International Collaboration:** No

**International Travel:** No

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**Frank Mac**

**Email:** fmm63@scarletmail.rutgers.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Assisted in field work at Palmer Station

**Funding Support:** Rutgers University

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Maria Ordovas-Montanes**

**Email:** m.ordov@yahoo.com

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** data synthesis and numerical modeling

**Funding Support:** Woods Hole Oceanographic Institution

**International Collaboration:** No

**International Travel:** No

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**Leigh West****Email:** ltw2110@columbia.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Field team member**Funding Support:** Field and laboratory Technician**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Kimberly Miner****Email:** kimberleyrain@gmail.com**Most Senior Project Role:** Other**Nearest Person Month Worked:** 1**Contribution to the Project:** Field team member**Funding Support:** Columbia University**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Dittrich Ribanna****Email:** Ribanna.Dittrich@ed.ac.uk**Most Senior Project Role:** Other**Nearest Person Month Worked:** 2**Contribution to the Project:** field scientist**Funding Support:** Univ of Edinburgh, Scotland**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days

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**Emilie Schattman****Email:** emilieschattman@gmail.com**Most Senior Project Role:** Other**Nearest Person Month Worked:** 1**Contribution to the Project:** field scientist**Funding Support:** Columbia University**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days



**Chelsea Vario****Email:** Chelsea.L.Vario@dartmouth.edu**Most Senior Project Role:** Other**Nearest Person Month Worked:** 1**Contribution to the Project:** Field team member**Funding Support:** Columbia University**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days**Griffin Whitlock****Email:** griffinwhitlock@gmail.com**Most Senior Project Role:** Other**Nearest Person Month Worked:** 1**Contribution to the Project:** field scientist**Funding Support:** Columbia University**International Collaboration:** No**International Travel:** Yes, Chile - 0 years, 0 months, 3 days**What other organizations have been involved as partners?**

<b>Name</b>	<b>Type of Partner Organization</b>	<b>Location</b>
Alfred-Wegener Institute for Polar and Marine Research	Other Organizations (foreign or domestic)	Bremerhaven Germany
British Antarctic Survey	Other Organizations (foreign or domestic)	Cambridge, UK
Cornell University	Academic Institution	Ithaca, NY
Detroit Zoological Society	Other Nonprofits	Detroit, MI
Duke University	Academic Institution	Durham, NC
Hebrew University of Jerusalem	Academic Institution	Jerusalem, Israel

**Full details of organizations that have been involved as partners:****Alfred-Wegener Institute for Polar and Marine Research****Organization Type:** Other Organizations (foreign or domestic)

**Organization Location:** Bremerhaven Grmany

**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:**

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### **British Antarctic Survey**

**Organization Type:** Other Organizations (foreign or domestic)

**Organization Location:** Cambridge, UK

**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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### **Cornell University**

**Organization Type:** Academic Institution

**Organization Location:** Ithaca, NY

**Partner's Contribution to the Project:**

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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### **Detroit Zoological Society**

**Organization Type:** Other Nonprofits

**Organization Location:** Detroit, MI

**Partner's Contribution to the Project:**

Financial support

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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### **Duke University**

**Organization Type:** Academic Institution

**Organization Location:** Durham, NC

**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:**

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**Hebrew University of Jerusalem****Organization Type:** Academic Institution**Organization Location:** Jerusalem, Israel**Partner's Contribution to the Project:**

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**What other collaborators or contacts have been involved?**

Nothing to report

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**Impacts****What is the impact on the development of the principal discipline(s) of the project?**

The principal discipline(s) of our project are (polar Antarctic) oceanography, ecology and biogeochemistry. Our research focused on polar ecosystem responses to climate change is frequently included in scientific syntheses and climate change reports as key examples of the status of the Antarctic environment under rapid climate change. A recent, current example is a book chapter on Antarctic conservation edited by Andrew Constable (Australian Antarctic Division).

Our pioneering application of autonomous glider technology in polar, ice-covered areas has set precedents now followed in most other major Antarctic seas.

**What is the impact on other disciplines?**

Nothing to report.

**What is the impact on the development of human resources?**

We have active teacher training programs as described above.

We afford undergraduate students the unparalleled experience of participating in Antarctic fieldwork. Many go on to grad school in allied fields.

**What is the impact on physical resources that form infrastructure?**

Our glider and animal tagging programs contribute to infrastructure for autonomous observations in the polar environment.

**What is the impact on institutional resources that form infrastructure?**

Nothing to report.

**What is the impact on information resources that form infrastructure?**

Contributions to integrated dataset syntheses across LTER sites and into ecology more generally

**What is the impact on technology transfer?**

Nothing to report.

**What is the impact on society beyond science and technology?**

Communicating the science of climate change and ecosystem transformation to the informed, interested and concerned public via presentations to alumni, municipal and other groups.

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**Changes/Problems****Changes in approach and reason for change**

Nothing to report.

**Actual or Anticipated problems or delays and actions or plans to resolve them**

Nothing to report.

**Changes that have a significant impact on expenditures**

Nothing to report.

**Significant changes in use or care of human subjects**

Nothing to report.

**Significant changes in use or care of vertebrate animals**

Nothing to report.

**Significant changes in use or care of biohazards**

Nothing to report.