AOML Keynotes

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

AOML is an environmental laboratory of NOAA's Office of Oceanic and Atmospheric Research located on Virginia Key in Miami, Florida
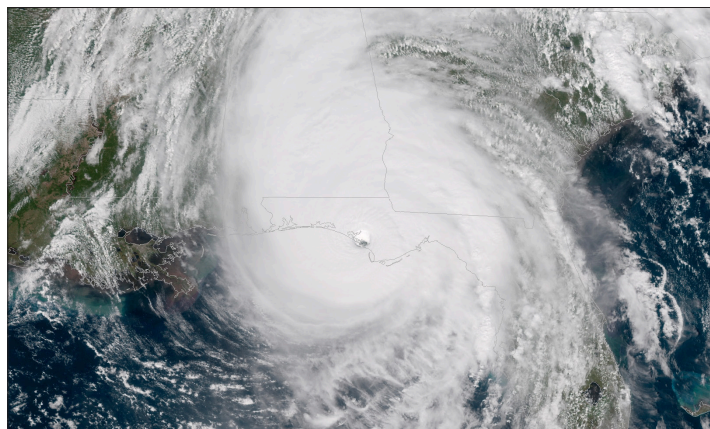
Busy 2018 Atlantic Hurricane Season Draws to an End

The 6-month long Atlantic hurricane season officially ended on November 30, but not before producing 15 named storms. Eight of the season's storms strengthened into hurricanes while two storms—Florence and Michael—further intensified into major hurricanes (maximum sustained surface winds above 110 mph) that caused catastrophic damage. An average season produces 12 named storms, six hurricanes, and three major hurricanes.

Scientists with AOML's Hurricane Research Division (HRD), in some capacity, supported nearly all of the 50 missions NOAA's Hurricane Hunter aircraft flew into eight tropical systems—Chris, Hector, (Pacific), Lane (Pacific), Gordon, Norman (Pacific), Florence, Isaac, pre-Sergio (Pacific), and Michael—racking up 380 flight hours in support of NOAA's efforts to provide the public with accurate, up-to-date forecasts. As part of the routine operational missions, as well as research flights for HRD's annual hurricane field campaign, more than 1100 dropsondes were deployed in the core and around the periphery of the storms to determine the strength and extent of the wind, regions of heaviest precipitation, and atmospheric steering currents that impact track and landfall location.

In addition to these sampling efforts, during their missions into Hurricane Michael HRD scientists deployed a small unmanned aircraft system (sUAS) called a Coyote to sample Michael's near-ocean altitudes. The sUAS successfully gathered data in the eyewall of Michael at altitudes lower than 2,500 feet that will help researchers better understand how this sparsely-observed region contributes to hurricane development. The sUAS measured winds as strong as 183 mph in Michael's eyewall, the highest ever measured by this instrument.

Additionally, AOML researchers deployed several underwater gliders over the summer in support of improved Atlantic hurricane forecasts. The gliders collected thousands of temperature and salinity profiles in the waters north and south of Puerto Rico that

NOAA-GOES east satellite image of Hurricane Michael, the 2018 Atlantic hurricane season's strongest storm, making landfall near Mexico City, Florida on October 10 with sustained winds of 155 mph.

were assimilated into hurricane forecast models, providing key ocean information to improve intensity predictions.

For the fourth consecutive year, hurricane activity began prior to the June 1 start of the season, with Tropical Storm Alberto forming on May 25. A record seven named storms—Alberto, Beryl, Debby, Ernesto, Joyce, Leslie, and Oscar—were classified as subtropical at some point. The previous record of five subtropical storms occurred in 1969. A subtropical storm is a named storm that has tropical and non-tropical characteristics. All subtropical storms eventually transitioned into tropical storms, with three—Beryl, Leslie, and Oscar—becoming hurricanes.

The 2018 Atlantic hurricane season was the first since 2008 to have four active named storms in the Atlantic simultaneously (Florence, Helene, Isaac, and Joyce). While Helene, Isaac, and Joyce remained at sea, Hurricane Florence caused catastrophic flooding in the Carolinas as it came ashore along Wrightsville Beach, North Carolina on September 14 and moved slowly inland.

Hurricane Michael, the season's most powerful storm, made landfall near Mexico Beach, Florida on October 10 with peak winds of 155 mph, just shy of Category-5 intensity. The storm became the third most intense hurricane on record in terms of minimum sea-level central pressure to strike the continental US (919 millibars), as well as the strongest storm to impact the US since Hurricane Andrew in 1992.

A significantly enhanced west African monsoon system helped produce storm activity during 2018. Near record warm sea surface temperatures and record low vertical wind shear over the subtropical and extratropical western and central North Atlantic also supported above-average activity in these regions. Additionally, a predicted El Niño event, which would have suppressed storm activity, did not materialize during the peak of the season.

2018 Atlantic Storms

Intensity	Name	Max Winds (mph)	Dates
TS	Alberto	65	May 25-31
H	Beryl	80	Jul 4-16
H	Chris	105	Jul 6-12
TS	Debby	50	Aug 7-9
TS	Ernesto	45	Aug 15-18
MH	Florence	140	Aug 31-Sep 17
TS	Gordon	70	Sep 3-8
H	Helene	110	Sep 7-16
H	Isaac	75	Sep 7-15
TS	Joyce	50	Sep 12-19
TS	Kirk	60	Sep 22-29
H	Leslie	90	Sep 23-Oct 13
MH	Michael	155	Oct 7-12
TS	Nadine	65	Oct 9-13
H	Oscar	105	Oct 27-31

Hurricane Researcher's Ashes Released into Hurricane Michael

On July 14, 2017, AOML was saddened by the loss of Michael Black, a long-term research meteorologist with the Hurricane Research Division (HRD). Michael passed away unexpectedly at 62 years of age. He was a valued friend and colleague whose pioneering research on Doppler radar and the use of Global Positioning System (GPS) dropsondes paved the way for a new methodology to more accurately assess the intensity of tropical cyclones.

After his passing, his family respectfully requested that at some future time his ashes be released into a hurricane. This is a special honor bestowed on only a few individuals who have been involved in hurricane research and/or operations.

For the 2018 Atlantic hurricane season, it was noted the 13th named storm would be called Michael. On October 7th, Tropical Storm Michael formed in the southwestern Caribbean Sea, and Michael's children were notified. They agreed this would be the perfect storm for their father's final farewell.

Tropical Storm Michael intensified and had already reached Category-3 strength (major hurricane) by the time of the farewell flight. Hurricane Michael would continue intensifying throughout the mission, reaching Category-4 strength by the end of the flight.

On October 9, Brinn Black, Michael's oldest daughter, carried her father's ashes onto NOAA's N42RF WP-3D ("Kermit") Hurricane Hunter aircraft. The ashes were wrapped in the state flag of Virginia, the state of Michael's birth (see photo below).

At the time of his passing, Michael had flown through the eye of more hurricanes than anyone in HRD. To honor this accomplishment, the memorial package also included his Senior Master Eye Rover patch (commemorating Michael's 400+ hurricane eye penetrations) and his flight suit name tag.

A highlight for Brinn was being able to sit in the Lead Project Scientist seat aboard the N42RF, a seat occupied many times in the past by her father. After Brinn left the aircraft, the plane departed for its 10+ hour mission into Hurricane Michael.

During the third pass into the eye of Hurricane Michael, the crew called for a moment of silence. A special eulogy and a prayer were read by Aircraft Operations Center technician Michael McAlister and then Michael's flag-wrapped ashes were placed in the dropsonde chute and released. Many tears were shed by those among the crew who had flown numerous missions with Michael over the years.

Michael helped pioneer the use of GPS dropsondes to collect data in hurricanes during aircraft missions. The instruments measure barometric pressure, temperature, humidity, wind speed, and wind direction as they fall through the atmosphere toward the ocean surface. The data they provide enable researchers to better understand the changes in a storm's intensity and its structure.

It was during an east Pacific research mission in 1997 when Mike suggested the flight crew try sampling the eyewall of Hurricane Guillermo with GPS dropsondes.

Michael Black

The resulting data were so exceptional it quickly became common practice to sample the eyewall of every tropical cyclone with the instruments. This first eyewall sonde, deployed 22 years ago from the NOAA N42RF, was the same aircraft used for the memorial flight.

As an additional tribute, dropsonde No. 21 was designated in Michael's honor. The "Michael Black Memorial Sonde" was signed by everyone on the flight before being released into the powerful winds of Hurricane Michael's eyewall.

This scientific mission into Hurricane Michael served as a fitting send off for a friend and colleague whose research led to major advances in tropical meteorology. Michael would have approved!

Brinn Black holds her father's ashes wrapped in a Virginia state flag and decorated with his flight suit name tag and Senior Master Eye Rover patch before release into Hurricane Michael.

Sonde No. 21, the "Michael Black Memorial Sonde" was signed by everyone aboard NOAA's N42RF Hurricane Hunter aircraft with messages of friendship and farewell.

NOAA Senior Research Council Meets in Miami, Honors Retiring Leaders

Members of NOAA's Office of Oceanic and Atmospheric Research (OAR) leadership team visited Miami in November for a Senior Research Council (SRC) meeting. The two-day event was hosted at the University of Miami's Rosenstiel School with more than 30 members in attendance. The SRC meetings provide an opportunity for OAR lab and program directors to strategize and discuss challenges and opportunities across OAR. The team also took time to recognize two of its members. AOML Director Dr. Bob Atlas and Dr. Steven Koch, Director of NOAA's National Severe Storms Laboratory, will both be retiring in 2019 after distinguished science careers with the federal government. The team thanked them for their many years of service, leadership, and scientific contributions to the nation.

Craig McLean, Ko Barrett, Steven Koch, Bob Atlas, and Gary Mattlock of OAR.

AOML Meteorologist Presents at Youth Empowerment Summit

On November 30, AOML meteorologist Sim Aberson participated in the 4th Youth Empowerment Summit of Palm Beach County, held annually in support of LGBTQ middle- and high-school students. The theme for this year's event focused on careers in STEM (science-technology-engineering-math). Sim was one of four panelists who addressed the group of approximately 140 students from Palm Beach and Martin County schools on the rewards and challenges of working in a STEM field. In particular, Sim shared his experiences of doing hurricane research and flying into hurricanes and of being an LGBTQ scientist with NOAA. The event was held at the South Florida Science Museum in Dreher Park.

Sim Aberson speaks with students about being a meteorologist with NOAA.

Hurricane Underwater Glider Mission Concludes

AOML concluded its 2018 Atlantic hurricane season underwater glider mission in November by recovering three gliders from the coastal waters of Puerto Rico in partnership with colleagues from the Caribbean Regional Association for Coastal Ocean Observing (CARICOOS) and the University of Puerto Rico. The missions began in July and ended after more than 9,700 hours of operations that resulted in the collection of approximately 5,000 temperature, salinity, and dissolved oxygen profiles in the tropical Atlantic and Caribbean Sea. All temperature and salinity profile data gathered by the autonomous vehicles were transmitted in real-time to the Global Telecommunications System, as well as the Integrated Ocean Observing System Glider Data Assembly Center, for assimilation into ocean and hurricane forecast models.

An underwater glider reaches the ocean surface prior to its recovery.

Greater Miami AMS Chapter Meets at AOML

The Greater Miami Chapter of the American Meteorological Society (AMS) hosted a meeting at AOML on December 10, 2018. Present were local chapter members, dozens of students from the University of Miami and Florida International University, and staff with AOML's Hurricane Research Division. The speaker was Brian McNoldy, a senior research associate at the University of Miami's Rosenstiel School and a Capital Weather Gang tropical meteorologist.

Attendees of the Greater Miami AMS chapter meeting at AOML.

McNoldy made a presentation entitled *The 2018 Hurricane Season in Review*, verifying that the Atlantic hurricane season was indeed above-average with 15 named storms, 8 hurricanes, and 2 major hurricanes. His presentation also included insights into the atypical Accumulated Cyclone Energy (ACE) distribution that was evident during the 2018 season and noted it was the first season to ever include seven storms that were subtropical at some point during their life cycle. AOML researcher Evan B. Forde serves as the Miami AMS chairperson.

AOML Hosts Awards Ceremony to Celebrate Staff Accomplishments

AOML's Office of the Director hosted an awards ceremony on November 29 to honor and celebrate the accomplishments of its staff. AOML director Dr. Bob Atlas, along with Deputy Director Dr. Molly Baringer, happily presented more than 40 certificates of appreciation to individuals from AOML's three science divisions and the Office of the Director in recognition of their outstanding work achievements over the past fiscal year. Additionally, 25 federal employees were recognized for their years of dedicated service to the United States federal government.

AOML's top three outstanding scientific papers for fiscal year 2017 were also announced, one of which received further recognition from NOAA's Office of Oceanic and Atmospheric Research (OAR). Mr. Craig McLean, the assistant administrator of OAR, had the pleasure of presenting OAR's Outstanding Scientific Paper Award to Drs. Luke Thompson and Kelly Goodwin of AOML's Ocean Chemistry and Ecosystems Division for their landmark paper entitled *A communal catalogue reveals Earth's multiscale microbial diversity*.

The paper, published in the journal *Nature,* presents an analysis of microbial samples collected by hundreds of researchers for the Earth Microbiome Project. It presents coordinated protocols and new analytical methods that enable bacterial and archaeal ribosomal RNA gene sequences to be followed across multiple studies, allowing researchers to explore patterns of diversity at an unprecedented scale. The result serves both as a reference database and a framework for incorporating data from future studies, fostering an increasingly complete characterization of Earth's microbial diversity.

Listed below are the names of individuals who received certificates of appreciation for their work accomplishments, the citations for AOML's top three outstanding scientific papers for fiscal year 2017, and the recipients of federal year-in-service awards (page 4).

Charles Featherstone, Graham Kolodziej, Patrick Mears, and Ian Smith—For planning and executing field programs for the Ocean Chemistry and Ecosystems Division in support of the GO-SHIP, South Florida ecosystem restoration, and ocean acidification sentinel site research efforts.

Ghassan Alaka, Mu-Chieh Ko, and Russell St. Fleur—For exceptional performance in helping transition significant updates to NOAA's Hurricane Forecast system.

OAR Assistant Administrator Craig McLean (right) thanks Dr. Bob Atlas (left) for his successful 13-year tenure as the AOML director in anticipation of Bob's upcoming retirement from federal service in March 2019.

Charita Atluri, Elizabeth Forteza, Vicki Halliwell, Jaya Nair, and Reyna Sabina—For outstanding success of the U.S. Argo ocean observing program, providing excellent oceanographic data that has led to a new era in oceanography.

Gregory Foltz—For outstanding leadership in producing an integrated, comprehensive oceanographic dataset for the tropical Atlantic Ocean.

Derek Manzello, Robert Rogers, and Jun Zhang—For exceptional authorship in refereed journals during FY-2018.

Leah Chomiak—For exceptional commitment to excellence and willingness to learn and apply new skills to ensure project success, particularly for water chemistry data analysis, laboratory safety, and maintenance of the Experimental Reef Lab.

The following peer-reviewed journal articles were selected as AOML's top three outstanding scientific papers for fiscal year 2017 (AOML authors are denoted by bolded lettering):

Dong, J., **R. Domingues, G. Goni, G. Halliwell**, H.-S. Kim, **S.-K. Lee, M. Mehari, F. Bringas**, J. Morell, and L. Pomales, 2017: Impact of assimilating underwater glider data on Hurricane Gonzalo (2014) forecasts. *Weather and Forecasting,* 32(3):1143-1159.

*Thompson, L.R., J.G. Sanders, D. McDonald, A. Amir, J. Ladau, K.J. Locey, R.J. Prill, A. Tripathi, S.M. Gibbons, G. Ackermann, J.A. Navas-Molina, S. Janssen, E. Kopylova, Y. Vázquez-Baeza, A. Gonzalez, J.T. Morton, S. Mirarab, Z.Z. Xu, L. Jiang, M.F. Haroon, J. Kanbar, Q. Zhu, S.J. Song, T. Kosciolek, N.A. Bokulich, J. Lefler, C.J. Brislawn, G. Humphrey, S.M. Owens, J. Hampton-Marcell, D. Berg-Lyons, V. McKenzie, N. Fierer, J.A. Fuhrman, A. Clauset, R.L. Stevens, A. Shade, K.S. Pollard, **K.D. Goodwin,** *et al.,* 2017: A communal catalogue reveals Earth's multiscale microbial diversity. *Nature,* 551(7681):457-463.

van Hooidonk, R., J. Maynard, J. Tamelander, J. Gove, G. Ahmadia, L. Raymundo, G. Williams, S.F. Heron, and S. Planes, 2016: Local-scale projections of coral reef futures and implications of the Paris Agreement. *Nature Scientific Reports,* 6:39666.

*Winner of OAR's Outstanding Scientific Paper Award for the Oceans and Great Lakes category.

Molly Baringer, Ghassan Alaka, Bob Atlas, Russell St. Fleur, Mu-Chieh Ko, and Craig McLean.

Molly Baringer, Bob Atlas, Hosmay Lopez, and Craig McLean.

Hosmay Lopez—For exceptional research on heat waves in the United States that will lead to longer range predictions of such events.

Denis Volkov, Charles Featherstone, James Hooper, and Andrew Stefanick—For successfully leading (Denis Volkov) and participating (all) in the GO-SHIP 2018 Repeat Hydrography cruise in the Indian Ocean, closing a 23-year gap in data from this region and completing 124 CTD casts to inform studies of climate, weather, and ocean chemistry.

Jonathan Zawislak—For successfully leading the 2018 Hurricane Field Program, including the herculean effort of coordinating more than 20 flights from multiple deployment locations, resulting in the collection of mission critical data.

Molly Baringer, Jonathan Zawislak, Bob Atlas, and Craig McLean.

Molly Baringer, Samantha Lawhorn, Bob Atlas, and Craig McLean.

Molly Baringer, Nathan Formel, Bob Atlas, and Craig McLean.

Nathan Formel—For excellence in completing the development of a Subsurface Automated Sampler and support for web-based materials and lesson plans to ensure open access to all communities.

Zachary Barton, Francis Bringas, Ricardo Domingues, Patrick Halsall, Grant Rawson, Ulises Rivero, and Diego Ugaz—For successful execution of the first joint NOAA-US Navy hurricane glider network in support of the 2018 Atlantic hurricane season.

LTJG Alyssa Thompson—For providing critical support by managing AOML's Small Boat Program and participating in field research, often going above and beyond to ensure the Ocean Chemistry and Ecosystem Division's field sampling programs were successful.

Samantha Lawhorn—For exceptional commitment to excellence and willingness to learn new skills to aid in the efficient and effective processing of various administrative functions.

AOML's Diversity, Inclusion, and You (DIY) Group—***Sim Aberson, Sean Casey, Howard Friedman, Lewis Gramer, Nancy Griffin, Andrew Kren, Renellys Perez, Grant Rawson, and Erica Rule***—For creativity and dedication in making AOML a more inclusive workplace where all employees feel engaged and valued.

Federal Year-In-Service Awards	
10 Years	**15 Years**
Gail Derr Sundararaman Gopalakrishnan James Haynes Roberta Lusic Andrew Stefanick	Manuel Fraga Kelly Goodwin Esa Peltola Robert Rogers Claudia Schmid Jia-Zhong Zhang
20 Years	**25 Years**
Charles Featherstone Gustavo Goni Shirley Murillo Michael Sam Ryan Smith	Christian Labbe John McKeever
30 Years	**35 Years**
Jay Harris John Kaplan	Yeun-Ho Daneshzadeh Paul Leighton
40 Years	**50 Years**
Charles Fischer	Robert Kohler

Farewell

NOAA Corps officer LCDR Mark Blankenship, AOML's Associate Director for the past year, departed the lab in November for his next duty assignment. Mark has been tasked with serving as the Commanding Officer of the NOAA Ship *Ferdinand R. Hassler,* a hydrographic survey vessel homeported in New Castle, New Hampshire. Mark will lead a crew in conducting surveys of navigable water along the east coast to aid in mapping the seafloor for improved maritime commerce and coastal resilience. During Mark's tenure as Associate Director at AOML, he oversaw the daily operation of the facility and was instrumental in improving safety and security measures at the lab.

Sonia Otero, a University of Miami-Cooperative Institute senior research associate with AOML's Hurricane Research Division, resigned in October to accept a software engineering position with NOAA's Office of Marine and Aviation Operations. Sonia began at AOML in 1995 as member of the Office of the Director's Automated Data Processing group. She transferred to HRD in 1999 to support the analyses of real-time tropical cyclone surface wind observations. Over the years, Sonia played a critical role in ensuring data gathered on NOAA's Hurricane Hunter aircraft were incorporated into forecast models and relayed to the National Hurricane Center for up-to-date weather forecasts.

Dr. Neda Trifonova, a University of Miami-Cooperative Institute post-doctoral scientist with AOML's Ocean Chemistry and Ecosystems Division, resigned in December to accept a position with the University of Aberdeen in Aberdeen, Scotland. Neda began at AOML in January 2017 after earning her PhD from the Department of Computer Science of Brunel University. During her almost 2 years at the lab, she developed quantitative and qualitative Bayesian models for the integrated ecosystem assessment of the Gulf of Mexico. Neda also conducted statistical analyses to identify break-points and thresholds in ecological drivers and responses.

Welcome Aboard

Dr. Xiaomin Chen joined the staff of AOML's Hurricane Research Division in December as a National Research Council post-doctoral scientist. Xiaomin will work with Drs. Jun Zhang, Frank Marks, Robert Rogers, and Joseph Cione on research projects related to the tropical cyclone boundary layer and the role of boundary layer processes in tropical cyclone intensification. He holds a PhD from the School of Atmospheric Sciences of Nanjing University In Nanjing, China.
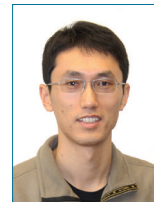
Congratulations

Drs. Molly Baringer and Claudia Schmid of AOML received a 2018 NOAA Administrator's Award in November for their role in the U.S. Argo program. Drs. Gregory Johnson of NOAA's Pacific Marine Environmental Laboratory and Stephen Piotrowicz of NOAA's Climate Program Office (posthumously) were also recognized. The award was presented for the "outstanding success of the U.S. Argo ocean observing program in providing excellent oceanographic data that has

Drs. Molly Baringer (left) and Claudia Schmid (second from right), along with Argo program support staff Charita Atluri and Reyna Sabina, AOML director Dr. Bob Atlas, and OAR assistant administrator Craig McLean.

led to a new era of oceanography." The global Argo array of free-drifting profiling floats has continually measured the temperature and salinity of the ocean to a depth of 2000 meters since 2001. The floats have provided a consistent and methodical means for measuring the physical state of the upper ocean, transforming understanding of the ocean's role in both weather and climate variability. At AOML, the Argo program is also supported by several University of Miami-Cooperative Institute staff members that include Charita Atluri, Elizabeth Forteza, Vicki Halliwell, Jaya Nair, and Reyna Sabina. AOML's entire Argo group was recognized at the AOML awards ceremony on November 29 (see photo above).

Dr. John Gamache, a meteorologist with AOML's Hurricane Research Division, received a 2018 NOAA Administrator's Award in November as part of a team from NOAA's Office of Marine and Aviation Operations. The team was recognized for its outstanding efforts to design, fabricate, and validate the next generation airborne dual-Doppler weather radar system aboard NOAA's P-3 Hurricane Hunter aircraft. Doppler radar produces detailed, three-dimensional depictions of the powerful winds and regions of heaviest precipitation found in tropical systems. The data are used to pinpoint the location of the strongest winds and how far outward they extend from a storm's center, enabling researchers to monitor and observe changes in storm intensity and structure. They are also assimilated into NOAA's operational Hurricane Weather Research and Forecasting model to help forecasters predict the track and intensity of tropical cyclones.

Dr. Frank Marks, the director of AOML's Hurricane Research Division, received the 2018 Dr. Daniel L. Albritton Outstanding Science Communicator Award in November from NOAA's Office of Oceanic and Atmospheric Research. The award is presented for outstanding achievements in communicating the meaning and value of NOAA-related science and research to non-scientific audiences. Frank was recognized for his outstanding communication of NOAA research and its relevance to the American public. His tireless efforts to advance the state of tropical cyclone knowledge has fostered improvements in ground-based, airborne, and spaceborne radar technology, data analysis, and numerical modeling. Frank's role as co-chair of NOAA's Hurricane Irene Service Assessment team contributed to increased interaction between stakeholders and the public, as well as recommendations for NOAA and the National Weather Service to improve their communication of severe weather risks. Additionally, Frank has always made time to mentor, assist, and motivate meteorologists throughout their careers—from high school students to senior staff.

Recent Publications *(AOML authors are denoted by bolded capital letters)*

Androulidakis, Y., V. Kourafalou, T. Ozgokmen, O. Garcia-Pineda, B. Lund, **M. LE HÉNAFF**, C. Hu, B.K. Haus, G. Novelli, C. Guigand, H.-S. Kang, L. Hole, and J. Horstmann, 2018: Influence of river-induced fronts on hydrocarbon transport: A multiplatform observational study. *Journal of Geophysical Research-Oceans,* 123(5):3259-3285.

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MEINEN, C.S., S. Speich, A.R. Piola, I. Ansorge, E. Campos. **M. KERSALÉ**, T. Terre, M.-P. Chidichimo, T. Lamont, O.T. Sato, **R.C. PEREZ**, D. Valla, M. van den Berg, **M. LE HÉNAFF**, **S. DONG**, and **S.L. GARZOLI**, 2018: Meridional Overturning Circulation transport variability at 34.5°S during 2009-2017: Baroclinic and barotropic flows and the dueling influence of the boundaries. *Geophysical Research Letters,* 45(9):4810-4188.

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