IRIS
Incorporated Research Institutions for Seismology

AT A GLANCE 2018

WHO WE ARE

IRIS is a consortium that includes virtually every U.S. university with a commitment to research in seismology or a closely related field, as well as Educational Affiliates, U.S. Affiliates, and Foreign Affiliates. A Board of Directors composed of faculty members from the Consortium membership and expert committees nominated by the community and appointed by the Board guide every aspect of IRIS's work.

IRIS VISION

IRIS is a world leader in advancing discovery, research, and education in seismology to understand our planet and to benefit society.

IRIS MISSION

- Facilitate and conduct investigations of seismic sources and Earth properties using seismic and other geophysical methods.
- Promote exchange of geophysical data and knowledge through the use of standards for network operations, data formats, and exchange protocols, and by pursuing policies of free and unrestricted data access.
- Foster cooperation among IRIS members, affiliates, and other organizations in order to advance geophysical research and convey benefits from geophysical progress to all.

Students testing cables with an ohmmeter during an IRIS/PASSCAL experiment in Oklahoma in June 2016.
Photo credit: Chris Hayward

WHAT WE DO

FACILITATE

The IRIS Consortium, with funding from the National Science Foundation (NSF), provides a suite of community-governed, multi-user facilities for instrumentation and data management to support research and education in seismology and the Earth sciences. A high-performance network of more than 150 permanent stations provides data for global studies of earthquakes and deep Earth structure. A mobile array of seismometers and atmospheric sensors are being deployed in Alaska. More than 4,000 portable instruments, including magnetotelluric systems, are available for short-and long-term loan to university-based researchers for detailed studies as part of NSF-funded field programs. Future observing needs are addressed through systematic engineering efforts. Data from all of these observational systems, along with extensive collections of seismic data contributed by other organizations, are freely and openly available through the IRIS Data Management Center.
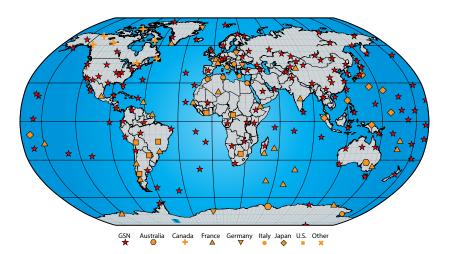
COLLABORATE

Over its 30-year history of operations, IRIS has collaborated with numerous federal agencies, foreign governments, and academic researchers in the United States and around the world to promote best practices of open data availability, full retention of maximum bandwidth, continuous data recording, and direct community access to state-of-the-art seismological instrumentation and software. For example, since its inception, IRIS has collaborated closely with the International Federation of Digital Seismograph Networks in global site selection of high-quality permanent seismograph stations and in encouraging policies for free and open data exchange. IRIS shares knowledge gained and lessons learned from more than 30 years of operating seismological infrastructure by conducting training courses that encourage the creation and/or operation of high-quality, sustainable networks worldwide.

EDUCATE

The IRIS Education and Public Outreach program, funded by NSF, is committed to advancing awareness and understanding of seismology and geophysics, while inspiring careers in the Earth sciences. Creating a more Earth science literate public is also an important mission at Consortium member and affiliated institutions, as only a small minority of the people who participate in our programs are expected to become professionals who use Earth science in their work. IRIS Education and Public Outreach directly links the public, schools, and undergraduate institutions with the activities of the academic research community by demonstrating how basic seismological observations are made and used in Earth science investigations. Through a wide variety of activities, IRIS encourages students to engage in scientific inquiry and appreciate the importance of the Earth sciences in their lives.

GLOBAL SEISMOGRAPHIC NETWORK

GSN Australia Canada France Germany Italy Japan U.S. Other

The Global Seismographic Network is a permanent tele-metered network of seismological and geophysical sensors. A key source of free and open data for seismological research and Earth science education, the network is also a principal global source of data for earthquake locations, earthquake hazard mitigation, earthquake emergency response, and tsunami warning. Work continues on updating this 150-station, nearly 30-year-old network, as well as on implementing an upgraded data quality assurance system. Updated stations show remarkable improvement in data quality. The Global Seismographic Network, funded by NSF and the USGS, is primarily operated and maintained through the USGS Albuquerque Seismological Laboratory and the University of California, San Diego, IRIS/IDA group, and managed by IRIS. Twenty-three affiliate stations and arrays around the globe contribute to the network.

GSN Modernization

Through a US Department of Energy $5.7M five-year interagency agreement, the USGS purchased new very broadband borehole sensors to update instrumentation at Global Seismographic Network stations. As of May 2018, IRIS/IDA and USGS staff have installed more than 20 of these instruments, and they are performing very well. We anticipate that when all of the new sensors have been deployed, we will see an improvement in earthquake detection thresholds.
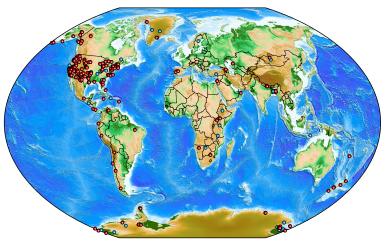*Photo credit: Peter Davis*

PORTABLE SEISMOLOGY

IRIS facilitates portable array seismology worldwide for diverse scientific and educational communities with end-to-end experiment support services, state-of-the-art portable seismic instrumentation, and advanced field and database management tools. Over its history, the IRIS portable seismology program (PASSCAL) has supported deployment of over 1000 experiments to image Earth beneath tectonic plate boundaries, the stable parts of continents, mountain belts, and volcanoes. These data further understanding of natural hazards, groundwater resources, and deep Earth structure. By integrating planning, logistical, instrumentation, and engineering services, and supporting the efforts with professional staff, IRIS has enabled seismologists to mount large-scale experiments throughout the United States and around the globe. The access to professionally supported state-of-the-art equipment and archived, standardized, open data has revolutionized the way that geophysical research is conducted.

Locations of active experiments using IRIS portable seismic instrumentation from January 2015 through August 2018. Blue dots (52) denote experiments started prior to January 2015 but that were still active during the timeframe. Red dots (206) are experiments were initiated after January 2015.

Mike Lundgren prepares to sling the air compressor by helicopter from the completed EarthScope TA station F21K in Alaska's Brooks Range—8 pm on the summer solstice. *Photo credit: Jeremy Miner*

TRANSPORTABLE ARRAY–ALASKA

From 2014 through 2017, IRIS deployed 280 EarthScope USArray Transportable Array (TA) seismograph stations in Alaska. Of these 280 stations, 195 are new stations and 85 are cooperating stations from existing networks operated largely by the Alaska Earthquake Center, but also by the Alaska Volcano Observatory, National Tsunami Warning Center, and Canadian Hazard Information Service. Many of the stations include meteorological instruments, a strong motion sensor, and/or a soil temperature profiler. Despite the lack of roads or infrastructure in most regions of interest, the stations are arranged in a grid with a spacing of about 85 km, covering all of interior Alaska and parts of Canada's Yukon, Northwest Territories, and British Columbia. IRIS anticipates completing observations in 2019. The Alaska-TA enables far better imaging of the tectonic structure of America's most extensive subduction zone where many large earthquakes have occurred, such as the one in 1964 on Good Friday.

Magnetotellurics Array

The EarthScope USArray program has also supported magnetotelluric (MT) surveying across the conterminous United States to determine the electrical conductivity structure of the crust and upper mantle. To date, IRIS and subawardee Oregon State University have occupied ~1100 MT stations on a grid with ~70 km spacing to record the ambient, long-period magnetic and telluric (electric) fields at each site. These data are also of great interest in assessing the impact of space weather events on the nation's electrical grid.

POLAR PROGRAMS

GEOICE on the Ice

The austral summer (2017/2018) marks the last field test of the NSF-supported Geophysical Earth Observatory for Ice-Covered Environments (GEOICE) program and is being used to evaluate next-generation polar-rated seismic instrumentation in Antarctica. This four-year collaborative development effort, which includes IRIS, Central Washington University (CWU), and New Mexico Tech, will allow investigators to optimize array designs for enhanced resolution and minimized logistics by combining different sensor capabilities and taking advantage of the corresponding differences in size, weight, and deployment requirements. PASSCAL Instrument Center staff have been working closely with CWU to ensure the operational parameters of the systems are appropriate to ice-covered environments, and are wrapping up several seasons of field testing in various environments around Antarctica. Final procurement for the GEOICE systems has been completed, and the new equipment should be ready for general pool usage starting next austral summer.
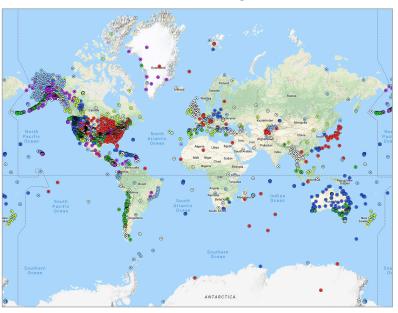
IRIS Polar Programs provides engineering support for experiments in Antarctica and the Arctic, maintains and updates a specialized pool of cold-rated equipment, and supports field operations in Earth's high-latitude regions. This engineering support, along with advances in technology, has greatly improved data quality and return from these extremely remote and logistically expensive polar regions, optimizing experiment costs and greatly improving the scientific return for seismologists and glaciologists alike. NSF's Division of Polar Programs supports base-level engineering efforts through additions to the polar equipment pool, cold-chamber and testing facilities, and engineering personnel. In addition, IRIS also installed and now operates stations as part of the Greenland Ice Sheet Monitoring Network, an international effort to enhance the scientific community's capability in seismic and geodetic observation of the dynamic behavior of the Greenland Ice Sheet as it interacts with the atmosphere, ocean, and solid Earth.

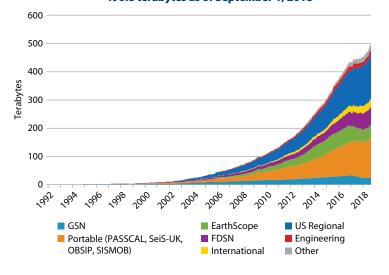A "cold-hardened" seismometer package developed at the PASSCAL Instrument Center is deployed in West Antarctica in 2014 as part of the POLENET project (station HOWD). IRIS and UNAVCO have collaborated in joint engineering efforts in power, packaging, communications, and deployment technologies to develop seismic and geodetic systems that can operate autonomously year-round in the harsh Antarctic climate. *Photo credit: Eric Kendrick*

DATA SERVICES

The core mission of Data Services is to collect, curate, and distribute data from IRIS programs. Data Services also manages seismic data from other components of EarthScope, backbone stations from networks that are members of the International Federation of Digital Seismograph Networks (FDSN), regional networks supported by the USGS, and stations operated by partner organizations worldwide. Collectively, these data are one of the largest scientific archives of globally distributed observational data in the world. IRIS offers a wide and growing variety of services that Earth scientists rely on in over 150 countries worldwide, increasingly through web services. Data distribution is nearing one petabyte in volume annually. Data Services creates a wide range of data products, such as visualizations of wave propagation for researchers and specialized products for public outreach, and plays a key role in facilitating quality control of time-series data managed at the IRIS Data Management Center.
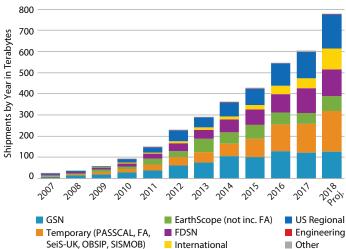
Location of 3,587 Stations Providing Data in Real Time

IRIS DMC Archive
496.8 terabytes as of September 1, 2018

Legend:
- GSN
- EarthScope
- US Regional
- Portable (PASSCAL, SeiS-UK, OBSIP, SISMOB)
- FDSN
- Engineering
- International
- Other

Shipments by Network Category
783 terabytes projected on September 1, 2018

Legend:
- GSN
- EarthScope (not inc. FA)
- US Regional
- Temporary (PASSCAL, FA, SeiS-UK, OBSIP, SISMOB)
- FDSN
- Engineering
- International
- Other

IRIS Data Workshop: Pretoria, South Africa

IRIS Data Services, in cooperation with the FDSN, regularly holds international workshops to describe "best practices" for the management of metadata and time-series data from seismological networks. The goal of these workshops is to enable open data sharing and exchange of ideas among local network operators, as well as with the global seismological community through the IRIS Data Management Center and other FDSN data centers. These workshops also provide training in the use of the SeisComp3 seismological network management system. This system, which is available at no cost to seismic network operators, enables them to more easily share their data with scientists around the world by participating in the Federated FDSN Data Center System (see below). The most recent IRIS Data Workshop was held in August 2017 in Pretoria, South Africa; previous workshops were held in Central and South America and in Southeast Asia.

Seismological Data Center Federation

The goal of the Seismological Data Center Federation is to make it easier to exchange seismic data among different national data centers. Over the past several years, the FDSN has moved toward web-based service architectures that allow scientists to access their data holdings in a similar manner. Leveraging the uniformity in services across FDSN data centers, IRIS has developed a service that periodically queries each of the federated centers to develop a single database with a complete inventory of the time-series holdings at all of the federated data centers. Using this federated data model, researchers can now make a single data request based on network codes, channel types, distances from event locations, or a multitude of other types of queries and obtain all of the data that meet these criteria regardless of where the data are archived. No longer does the data requester need to know which data center manages data from a particular seismic network. Currently standardized, FDSN-approved services are available at 18 different data centers around the world (see map) and the number of participating data centers is expected to grow in the coming years.

EDUCATION AND PUBLIC OUTREACH

The Education and Public Outreach program combines the expertise of Consortium members and IRIS staff to create products and activities that advance awareness and understanding of seismology and geophysics, and inspire careers in Earth science. These products and activities include: self-directed exploration over the web and via social media, interactive museum exhibits, public lectures, and lessons for middle school through undergraduate classrooms that explore Earth's interior. Each year, a select group of undergraduates spends the summer conducting research under the guidance of scientists at Consortium member institutions and affiliates. IRIS staff also widely distribute "Teachable Moment" slide sets for use in classrooms within a day of major earthquakes, as well as animations and videos of earthquake and related processes.

Summer Internships for Undergraduates

Since its inception in 1998, the IRIS Undergraduate Internship Program, with support from NSF's Research Experiences for Undergraduates program, has provided 220 students with the opportunity to work with leaders in seismological research and to produce research products worthy of presentation at large professional conferences. IRIS provides centralized support for both students and mentors, but the program takes advantage of the Consortium's extensive host pool to expose the interns to research opportunities across the full spectrum of seismology. Although students conduct research at different IRIS member institutions, program activities have enabled each summer's cohort to successfully bond, starting with a week-long orientation at New Mexico Tech and the PASSCAL instrument Center. Mentoring is a critical component of the program and involves both a near-peer intern alumni mentor and structured support from research mentors. A research experience has been shown to be a key element in the selection of a career, and our long-term tracking of intern alumni indicates that over 75% go on to geoscience careers.
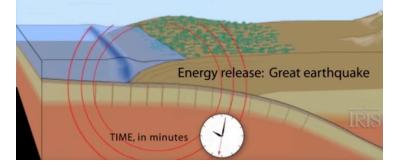
IRIS Station Monitor

The new IRIS Station Monitor provides access to continuous, real-time ground motion from hundreds of locations around the globe. This easy-to-use app allows users to view seismic recordings, choose from hundreds of stations, learn about recent events, display recordings from past earthquakes, and see annotations of wave arrivals. Station Monitor also links to other products from IRIS Data Services. For notable events, there are links to IRIS educational products, including the Teachable Moments PowerPoint slide set and other general information, the new IRIS-developed Global Seismogram Viewer, and information provided by the USGS. Station Monitor is available on the web at https://www.iris.edu/app/station_monitor/ and is available as a free app for iOS and Android devices.

Formation of Ghost Forest in a Subduction Zone
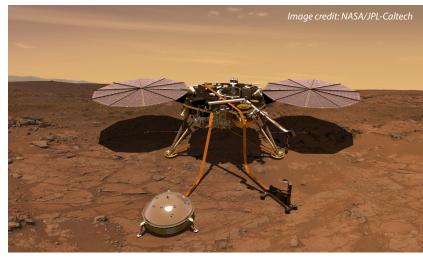Leading edge jumps out & up beneath sea. A tsunami forms.

IRIS Animation Series

Because seismology concepts can be difficult to convey through text or images alone, IRIS has developed a suite of over 120 animations that cover an array of seismology-related topics. The clips range from a few seconds to several minutes in length, sometimes animating plate tectonic and earthquake processes by compressing time from centuries to seconds and scaling dimensions from hundreds of kilometers to centimeters. The animations are not meant to turn boring lectures into entertainment, but rather to walk the viewer through both basic seismology-related topics and tricky concepts such as magnitude, intensity, and focal mechanisms. As a result of the concise format and their dynamic nature, there have been over 4.3 million views of IRIS animations through our YouTube channel alone.

Mars InSight Mission

After a month of traveling with the Mars Roadshow and sharing the excitement of NASA's InSight Mission to put the first seismometer on the Martian surface, IRIS staff watched InSight launch on May 5, 2018, at Vandenburg Air Force Base in California. InSight's landing on Mars is planned for November 26, 2018. IRIS is an educational partner on the InSight Mission, with the goal of engaging students with seismic data from Mars. Working with the IRIS Data Management Center, the IRIS Education and Public Outreach program expects data from the seismometer to be available in the spring of 2019 to students and the public. Classrooms will be able to stream Martian seismic data, allowing students to watch for marsquakes and meteorite impacts.
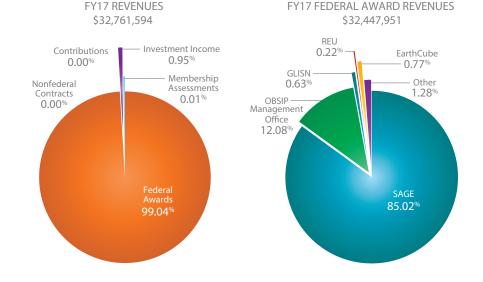

Image credit: NASA/JPL-Caltech

FINANCIAL OVERVIEW

Founded in 1984, the Incorporated Research Institutions for Seismology is a 501(c)(3) not-for-profit consortium of research institutions. IRIS is incorporated in the State of Delaware.
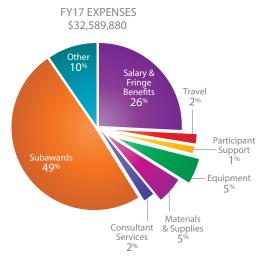
Revenues

In FY17, IRIS had total revenues of $32,761,594. More than 98% of this revenue was from the National Science Foundation. The two largest awards were the SAGE (Seismological Facilities for the Advancement of Geoscience and Earthscope) and USArray Cooperative Agreements awarded by NSF's Earth Sciences Division and the Ocean Bottom Seismograph Instrument Pool (OBSIP) Management Office Cooperative Agreement awarded by NSF's Ocean Sciences Division.

FY17 REVENUES
$32,761,594

Contributions 0.00%
Investment Income 0.95%
Membership Assessments 0.01%
Nonfederal Contracts 0.00%
Federal Awards 99.04%

FY17 FEDERAL AWARD REVENUES
$32,447,951

REU 0.22%
EarthCube 0.77%
GLISN 0.63%
Other 1.28%
OBSIP Management Office 12.08%
SAGE 85.02%

Expenses

In FY17, IRIS had total expenses of $32,589,880. About 49% of these expenses were associated with subawards. The largest go to the New Mexico Institute of Mining and Technology, which operates the PASSCAL Instrument Center, the University of California, San Diego (UCSD), which maintains part of the Global Seismographic Network and operates the Array Network Facility for USArray, and Lamont-Doherty Earth Observatory, UCSD, and Woods Hole Oceanographic Institution, each of which operate ocean bottom seismometers for the IRIS-managed Ocean Bottom Seismograph Instrument Pool.

FY17 EXPENSES
$32,589,880

Other 10%
Salary & Fringe Benefits 26%
Travel 2%
Participant Support 1%
Equipment 5%
Materials & Supplies 5%
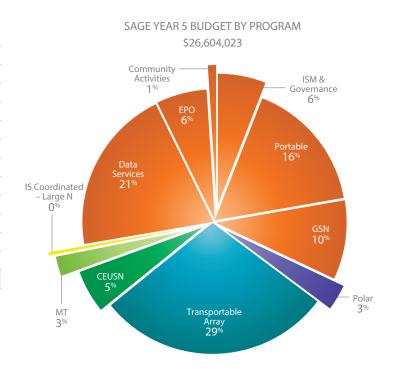Consultant Services 2%
Subawards 49%

SAGE Budget

We are currently in the fifth and final year of the SAGE Cooperative Agreement with the National Science Foundation, which is primarily funded by NSF's Earth Sciences Division. SAGE supports IRIS core programs in Instrumentation Services, Data Services, and Education and Public Outreach. SAGE also supports IRIS' EarthScope activities, including the USArray Transportable and Magnetotelluric Arrays.

A complete copy of IRIS' financial statements and auditor's reports are available from the IRIS business office by contacting admin@iris.edu.

	Year 4 10/2016–9/2017	Year 5 10/2017–9/2018
Instrumentation Services Mgmt	$1,539,330	$1,572,084
Portable Seismology	$4,389,165	$4,340,153
GSN	$2,732,460	$2,593,465
Polar	$850,000	$850,000
Transportable Array	$7,680,115	$7,685,467
CEUSN	$1,257,220	$1,410,167
Magnetotelluric Array	$1,112,586	$643,055
IS Coordinated Activities	$40,890	$107,674
Data Services	$5,439,179	$5,432,915
EPO	$1,696,065	$1,655,320
REU	$125,812	$43,856
Community Activities	$121,655	$269,867
Total	**$26,984,477**	**$26,604,023**

SAGE YEAR 5 BUDGET BY PROGRAM
$26,604,023

THE IRIS
TEAM

The IRIS Board of Directors

Douglas Wiens, Chair	Washington University in St. Louis
Clifford Thurber, Vice Chair	University of Wisconsin, Madison
Karen Fischer	Brown University
Samantha Hansen	The University of Alabama
Keith Koper	The University of Utah
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Vera Schulte-Pelkum	University of Colorado, Boulder
Donna Shillington	Lamont-Doherty Earth Observatory of Columbia University
Michael West	University of Alaska Fairbanks

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Major Subcontractors

New Mexico Tech	Portable Networks
University of California, San Diego	Project IDA, USArray
University of Texas, El Paso	Texan Instrument Facility
Oregon State University	USArray Magnetotelluric Instruments

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Josephine Aka	A/P Manager
Kent Anderson	Portable Program Manager
Robert Austin	Business Analyst/Purchasing
Manochehr Bahavar	Product Specialist
Rick Benson	Deputy Director, DMC Operations
Ryan Bierma	Transportable Array Station Specialist
Doug Bloomquist	Lead Engineer, Transportable Array
Wendy Bohon	Informal Education Specialist
Tammy Bravo	Education & Outreach Specialist
Robert Busby	Transportable Array Manager
Robert Casey	Deputy Director, Cyberinfrastructure
Adam Clark	Lead Web Developer
Michael Couch	Station Specialist–Alaska
Gale Cox	Office Manager, DMC
Robert Detrick	President
Mladen Dordevic	Web Developer
Perle Dorr	Public Outreach Manager
Max Enders	Station Deployment Coordinator
Nicholas Falco	Web Developer
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Un Joe	Data Control Technician
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Robin Morris	Project Cost Controller
Anh Ngo	Operations Programmer
Doan Nguyen	Station Specialist-Lower 48
Howard Peavey	Transportable Array Station Specialist
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Rhonda Porter	Executive Assistant
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Gillian Sharer	Deputy Director, Quality Assurance
Candy Shin	Chief Financial Officer
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Mike Stults	EarthCube Developer
Yazan Suleiman	Web Services
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Marlo Swanson	Business Operations/HR Manager
Justin Sweet	Project Associate
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Mary Templeton	Quality Control Analyst
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Trayce Turner	HR Generalist/Administrative Assistant
Mick Van Fossen	Web Services
Inge Watson	Senior Systems Administrator
Robert Weekly	Quality Assurance & Deployment Engineer
Bruce Weertman	Web Services & Quality Assurance Developer
Russ Welti	Software Engineer
Robert Woodward	Director of Instrumentation Services

The IRIS Consortium Voting Members

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Baylor University
Binghamton University, State University of New York
Boise State University
Boston College
Boston University
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California Institute of Technology
California State Polytechnic University, Pomona
California State University, East Bay
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IGPP/Lawrence Livermore National Laboratory
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Indiana University
James Madison University
Kansas State University
Lamar University
Lawrence Berkeley National Laboratory
Lehigh University
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Massachusetts Institute of Technology
Miami University of Ohio
Michigan State University
Michigan Technological University
Missouri University of Science and Technology
Montana Tech/University of Montana
New Mexico State University
New Mexico Tech

North Carolina State University
Northern Arizona University
Northern Illinois University
Northwestern University
Oklahoma State University
Oregon State University
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Rutgers University
Saint Louis University
San Diego State University
San Jose State University
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Syracuse University
Texas A&M University
Texas Tech University
Virginia Tech
Washington University in St. Louis
West Virginia University
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Woods Hole Oceanographic Institution
Wright State University
Yale University
The University of Alabama
The University of Arizona
The University of Kansas
The University of Oklahoma/Energy Center
The University of Tennessee, Knoxville
The University of Texas at Arlington
The University of Texas at Austin
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University of Puerto Rico
University of Rochester
University of South Carolina
University of South Florida
University of Southern California
University of Washington
University of Wisconsin–Madison
University of Wisconsin–Milwaukee
University of Wisconsin Oshkosh
University of Wyoming

For names of IRIS Educational Affiliates, U.S. Affiliates, and Foreign Affiliates see https://www.iris.edu/hq/about_iris/membership.

PASSCAL Polar Field Engineer Kevin Nikolaus inspects a seismic station in Kasatog Valley in southeastern Greenland during a servicing trip for the Greenland Ice Sheet Monitoring Network (GLISN) in August 2018. *Photo credit: Aurora Roth*