

**Amateur Radio on the  
International Space Station (ARISS)  
Annual Report to NASA  
2009**

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# **Amateur Radio on the International Space Station Annual Report to NASA, 2009**

## **Introduction**

Amateur Radio on the International Space Station (ARISS) is an educational outreach program sponsored by NASA, in which students engaged in a science and technology curriculum are given the opportunity to speak with the International Space Station (ISS) on-orbit crew. Using amateur radio, the students ask questions about life in space or other space-related topics. Students fully engage in the ARISS contact by helping set up an amateur radio ground station at the school and then using that station to talk directly with the onboard crew member for approximately ten minutes, the time of an ISS overhead pass. Preparation for the experience motivates the children to learn about radio waves, space technology, science, geography and the space environment. In many cases, students help write press releases and give presentations on the contact to their fellow students and to the local community. Through this hands-on experience, students are engaged in the Science, Technology, Engineering and Mathematics (STEM) fields, and pushed toward STEM-related careers. From the first school contact in December, 2000 to the last school contact of FY 2009 (the 484<sup>th</sup> school to date), ARISS has continued to inspire the next generation of explorers...as only NASA can.

## **Organization**

ARISS is an international working group, consisting of delegations from 9 countries including several countries in Europe as well as Japan, Russia, Canada, and the USA. The organization is run by volunteers from the national amateur radio organizations (American Radio Relay League (ARRL) in the U.S.) and the international AMSAT (Radio Amateur Satellite Corporation) organizations from each country. Since ARISS is international in scope, the team coordinates locally with their respective space agency (e.g. ESA, NASA, JAXA, CSA, and the Russian Space Agency) and as an international team through ARISS working group meetings, teleconferences and through electronic mail. The team brings approximately \$5 million per year of in-kind support to the ISS program, primarily through technical and educational volunteer support to the schools, hardware development, and operations support.

During FY2009, the international team formed 123 partnerships with schools (grades K-12 and universities), Boy Scouts, Girl Scouts, museums and camps. Among those that collaborated with ARISS were the U.S. Department of State and the U.S. Department of Education in celebration of International Education Week, Washington D.C.'s National Air and Space Museum, Delta Researchers Schools, NASA Explorer Schools, WHEELS (a NASA Exploration Experience traveling exhibit), UNICEF-Belgium and Challenger Learning Centers.

## **Program Objectives**

ARISS strives to meet NASA education goals of strengthening NASA's and the nation's future workforce through attracting and retaining students in STEM disciplines and engaging the general public in NASA's mission. The preparation for ARISS contacts exposes students,

the general public, and the ISS crew members to amateur radio. Young people are then exposed to human spaceflight by direct contact with crew members onboard the ISS. Astronauts and cosmonauts benefit from these contacts as they speak to people who are not solely involved with their ISS mission, reducing feelings of isolation during their long stay in space. Opportunities exist for experimentation and for the evaluation of new technology as it relates to this program, and ARISS provides a contingency communications network for NASA and the ISS crew. The increase in public awareness of NASA and amateur radio benefits the next generation by promoting interest in the fields of science, technology, engineering and mathematics.

## Educational Outreach

### Elementary through Secondary Schools

ARISS provides a forum through which students are inspired and engaged in STEM-related activities. Teachers employ NASA lesson plans and lithographs in their science and math curricula. Lessons culminate in an amateur radio contact with the ISS. During the past year, children at the elementary, middle and secondary levels, throughout the world, have benefited from this unique experience as demonstrated below.

- Young women at the Sacred Hearts School in Honolulu, Hawaii continued to support the ARISS program by running the Hawaii ground station under the direction of their teacher and a local AMSAT volunteer.
- St. Teresa's School in South Wairarapa and the Wairarapa Home School Association from Carterton, Wairarapa, New Zealand both participated in ARISS contacts. These were the first contacts with New Zealand youth.
- Students attending King George Elementary School in Moose Jaw, Saskatchewan, Canada took part in a question and answer session with Sandra Magnus via an ARISS contact. The audience of over three hundred included Ray Boughen, Minister of Education Provincial Parliament, Dale McBain, City of Moose Jaw Mayor (both former educators) and Brenda Edwards, Director of Education for Prairie South School Division.
- Pinehurst School students in Ashland, Oregon experienced an ARISS contact with spaceflight participant Richard Garriott. The connection was made through two telebridge stations: WH6PN in Hawaii and W6SRJ in California. In addition to their participation in the question and answer session, the Pinehurst students built a turnstile antenna for satellite contacts which they used to download a sampling of Garriott's Slow Scan Television (SSTV) images.
- Approximately 600 people from the Armada, Michigan community gathered for the ARISS contact between Armada Area Schools and Mike Fincke. Special guests included Armada Area Schools Superintendent Dr. Arnold Kummerow, Armada Area Schools Assistant Superintendent of Finance and Operations Michael Musary, district principals and school board members.
- An ARISS contact between Astronaut Mike Barratt and Liberty Middle School was integrated into the Camas, Washington Space Education Program, an eight-week curriculum. For twenty years, all Liberty sixth graders have taken part in hands-on activities in the program as "astronauts in training," culminating with a 10-hour flight in the school's space station, Alpha-Z. Students learned to use flight software, practiced using radios to link to their mission control and teachers, and mastered



special software that allowed teachers and fellow students to record how the “astronauts” were progressing with their mission research. Students and teachers learned lessons on how Amateur Radio works, what it is, how to proceed with the ARISS contact, and a little about the organizations that sponsor ARISS.

- Hampton Bays Middle School (Hampton Bays, New York) students had built a mockup of the ISS and they simulated working in it. They simulated communicating from it during their ARISS contact while they asked astronaut Mike Fincke their interview questions. The Hampton Bays Amateur Radio Club supported the school in this endeavor. The Information Technology department provided live coverage of the contact to all schools in the district via intranet, and posted video of activities on the school web site.
- Youth from Chatham Public School in Taree, NSW, Australia, took part in an ARISS contact from the studios of Radio 2RE. John Key, the New Zealand prime minister, tied in to the contact and sent greetings to the ISS crew from the Asia/Pacific region. Thirty-eight radio stations belonging to the Super Radio Network covered the event the following morning.
- Space Flight Participant Charles Simonyi requested scheduling an ARISS contact for Mountain View, California’s the Girls’ Middle School (GMS), an independent 6th-8th grade school known for its science classes. GMS nurtures, educates, and empowers girls with hands-on curriculum that encourages critical thinking and corroboration, and ARISS educational activities fit their goals. The ARISS Team set up a Slow Scan Television (SSTV) Web site so that Simonyi could transmit SSTV pictures to students. After he stepped on board the ISS on a Saturday, he was already on the radio making contacts Sunday morning over North America, and continued that through the week.
- Fassett Middle School, Oregon, Ohio experienced an ARISS contact with astronaut Mike Fincke. ARISS was incorporated into the curriculum with students studying the position and motion of objects such as satellites in the universe, gravity, and how technology affects our quality of life. The school district superintendent came to watch the ARISS contact, and the ARISS Team reported Fincke was as enthusiastic as ever with students while answering their questions. At the end of the contact, students gave him “long-lasting and resounding applause.”
- Marcelino Canino Middle School in Puerto Rico participated in an ARISS contact with spaceflight participant Charles Simonyi. Under the school’s Microsatellite Student Program, students design, construct, build and launch microsatellites which are tracked and recovered with the help of ham radio operators. The aim is for students to become future competitive professionals. Over 300 students from other elementary and high schools attended the school’s ARISS contact, as did the Puerto Rico Secretary of Education. Of major interest to the students was Joseph Acaba, the first astronaut of Puerto Rican descent. The school was assisted with technology/ham lesson plans by two area ham clubs, including the Puerto Rico DX Club.

- Students from St. Edward School, Ashland, Ohio participated in a contact. ARISS activities were integrated into the science curriculum covering topics on satellite images, global positioning of satellites, telescopes, and radio waves. Students researched the topics, wrote papers and informational articles, interviewed amateur radio operators, and studied and applied science and math objectives.

## Higher Education

ARISS partnered with college and university students in STEM-related fields, giving them the chance to apply what they have learned in their classrooms to hands-on activities, furthering their interest and abilities in science and technology, and promoting STEM-related career opportunities. Over the past year, students at the higher education levels throughout the world have received benefits from this program as follows:

- Students and faculty at the Santa Rosa Jr. College in Santa Rosa, California were responsible for the set-up and operation of the ARISS telebridge ground station located there.
- Students attending Kursk State Technical University in Russia proposed an experiment to measure the unevenness of the vacuum atmosphere. The experiment under development will fly on the amateur radio satellite ARISSat-1.
- Students from Humber College Institute of Technology and Higher Learning, Toronto, Ontario, using knowledge acquired from their radio communications courses, designed and built a radio system as part of a school technical design project. They then submitted an ARISS application and arranged for a voice contact with Sandra Magnus onboard the ISS.
- Students from the Peruvian National University of Engineering engaged in an ARISS contact with Russian cosmonaut Gennady Padalka during the “Second International Conference of Small Satellites.” Kursk State Technical University, Russia provided the radio equipment for the contact. College students posed questions to the cosmonaut related to the importance of satellite development and studies on climate change and global warming. Among the participants was the Kursk State Technical University delegate, Valery Pikkiev, who is involved with developing a space experiment for ARISSat-1.

## Informal Education

The ARISS program supported education outside of the classroom. Forty-seven contacts were performed with museums, Scouts, space camps, community centers, Challenger Learning Centers, planetariums and other informal educational groups.

- The National Air and Space Museum in Washington, D.C. participated in Space Day on May



2. Visitors participated in hands-on activities, met astronauts and learned about space from experts and museum displays. The ARISS contact with Michael Barratt was the feature event. Astronaut Ricky Arnold II was present to answer questions prior to the contact. The museum recorded the session in high definition for future use. AMSAT and ARRL members manned an exhibition booth and distributed AMSAT, ARRL and NASA education material, including 2009 Space Station calendars. Approximately 20,000 people attended the museum throughout the day.

- Students from Maryland, North Carolina and Quito, Ecuador participated in a joint ARISS contact as part of International Education Week (IEW). Poolesville High School students in Maryland visited the U.S. Department of Education in Washington, D.C., and the North Carolina and Ecuador schools tied in via videoconference. The contact was followed by an interview session with a panel of experts. Former astronaut Don Thomas gave a presentation on International Exploration and ARISS Chairman Frank Bauer gave an overview of amateur radio and ARISS. They were joined by GSFC (Goddard Space Flight Center) Earth Observation expert Robert Cahalan. Amateur radio operators from Hawaii, Italy, China, England, Spain and Canada joined through a teleconference, giving talks about amateur radio and their countries' cultures.

- Delta Researcher Schools participated in an ARISS contact at the Space Expo in Noordwijk, the Netherlands. The event was a joint collaboration between the Delta Researcher School project (DRS), ESA's Human Spaceflight Education Team, Space Expo and ARISS. The schools that attended the event were winners of a competition. Those that submitted the best questions to the DRS project leaders were selected for this opportunity. A presentation was given to the children explaining remote communications and ham radio and information was provided about Frank De Winne and his activities on board the ISS.

- Patients at the Children's Hospital of Eastern Ontario in Ottawa, Canada spoke with Sandra Magnus during their ARISS contact. A representative from another children's hospital in Calgary was present and was very impressed with the event; he plans to submit an ARISS application for his hospital.



- Youth visiting Challenger Learning Centers in Lanham, Maryland, Columbia, South Carolina, Tampa, Florida and Brownsburg, Indiana participated in a round-robin ARISS contact with spaceflight participant Richard Garriott. A second contact was arranged between Garriott and Challenger Learning Centers located in Indianapolis, Indiana, Paducah, Kentucky and St. Louis, Missouri. Former astronaut Owen Garriott was present for both contacts and concluded each session with a discussion about ham radio.

- Baiting Hollow Scout Camp (BHSC) is a year-round camp, located in Calverton, New York, for boy scouts, cubs, Venture Crews, and their families. This year's camp theme was "The Final Frontier." Scouts learned from members of the Peconic Amateur Radio Club about the space program, ham radio, ARISS, ham stations, and how the ARISS radio systems work. Ham Radio has been a BHSC activity for decades, and the radio is always active two days a week. Two years ago, the Long Island Amateur Radio Simplex Club put up a new tower and antenna, and ARRL Section Manager Tom Carruba helped get some equipment. A week after the ARISS contact, the Peconic club took ARISS Delegate Rosalie White's advice, and invited the scouts to a license class scheduled to start three weeks later.
- Flemish Space Days, an event organized by the Flemish Space Industry (VRI), was held in the Brabant in Leuven, Belgium. An ARISS contact with Michael Barratt was the highlight of the event. Other activities available to the youth and public were interactive booths, educational workshops and movies on space, avionics and astronomy.
- Students from Garfield Elementary School in Boise, Idaho took part in a series of technology lessons including an ARISS contact. While students participated in these, a large number of teachers in the area received NASA's hands-on training in science and technology projects including ARISS. The ARISS Team had networked for several weeks beforehand with a NASA team called WHEELS, who drove a truck (NASA Exploration Experience traveling exhibit) to Boise. The hands-on displays were toured by hundreds of students. The teachers wrote that their lesson plans applied the ARISS learning experiences to Idaho Science Standard, and that ARISS was integrated into the specific "Communication Mini-Unit," as follows: Where's the Remote, exploring how dependent we have become on wireless technology. Historical Review of Wireless Technology, the historical significance that wireless technology has played in our world. Wireless Communication and Careers, to explore job opportunities that require use of wireless technology. Cameron Eagans, KI4KLW, a recent graduate of the area high school, gave a school assembly that emphasized how science and math related to his college studies and career goals, he talked about ham radio operations, and students took part in a radio demonstration. Communication Through Codes (Symbols), identifying the major components of a wireless communication system, and utilizing codes. Every student in the school observed the ARISS contact. Teachers reported that after they began using ARISS in weeks prior to the contact, students showed an increased interest in technology, math, and science. One added, "Preparing for the contact with the space station has been an excellent way to provoke students' discussions."
- The HMS Beagle Project participated in an ARISS contact with Mike Barratt. The event was held in Parati, Brazil, with a student audience of sixty. The project (which aims to rebuild the ship that carried Darwin around the world) and NASA signed an International Space Act Agreement with Barratt as the initiator and main connection on the NASA side of the project. The project will unite ISS astronaut photography with ocean surface water and other biological and physical samples taken by the crew of the new Beagle.

- An ARISS contact took place between youth working with UNICEF Belgium and Frank De Winne, UNICEF's goodwill ambassador. The event took place at the Euro Space Center in Transinne, Belgium. UNICEF Belgium ran a campaign called WaSH (Water, Sanitation, Hygiene) to make students aware of how important water is for mankind. Some of the students involved in the campaign were given the opportunity to travel to the center to speak with the Expedition 20 astronaut.

- ARISS partnered with the European Space Agency (ESA) to hold a contact at the European Space Operation Centre (ESOC) in Darmstadt, Germany during an open day event, "The Long Night of the Stars." Students from a local school, "Schuldorf Bergstrasse," in Seeheim participated in the contact. Astronauts Robert Thirsk, Frank de Winne and Christer Fuglesang took turns answering students' questions. An audience of two hundred was present for the contact and several audio and video links were provided for all the visitor rooms of the event, enabling other guests to listen in.



- Nova East Star Party, sponsored by the Royal Astronomical Society of Canada, Halifax Center in Nova Scotia experienced an ARISS contact with Robert Thirsk. Four hundred people attended the event. The Nova East Star Party is Atlantic Canada's oldest and largest Star Party which draws both professional and amateur astronomers from the Atlantic Provinces, Quebec, Eastern Ontario and the New England States. The focus of the event was public outreach and education. Through daytime seminars and workshops and evening observing sessions, the public was introduced to the wonders of the night sky.
- The International Year of Astronomy inspired a few scout guides from Maur, Switzerland, to create a special scout event, "Astrocamp 2009," where participants learned about astronomy and space technology, communication technologies, journalism and public relations. The highlight of the event was an ARISS contact that was held with Girl and Boy Scouts of Maur "Pfadimuur."
- The Chanute Air Museum exhibits aviation and aerospace artifacts that relate to the life and accomplishments of Octave Chanute, Chanute Field/Chanute Air Force Base and its technical training programs. The museum reaches out to youth with its Aviation Camp and this year hosted its first "Space Jam Enterprise 2009" for Boy and Girl Scouts. An ARISS contact was featured during the event. The Space Jamboree exposed the scouts to space and technology, inspiring the youth to pursue careers and hobbies in these fields.
- Astronaut Robert Thirsk participated in an ARISS contact with students attending the Inukjuak Space Camp in Kuujuaq Quebec. The contact was held on Canada Day, July 1. The Canadian Space Agency, ICOM Canada and Makivik Corporation (a non-

profit organization that promotes economic growth of Inuit businesses) sponsored the event.

- The Mahopac Public Library in New York held an ARISS contact in conjunction with its two week celebration of National Library Week through the ALA (American Library Association). The theme of the celebration was “Worlds connect @ your library.” A contest was held to determine which school children would ask questions of JAXA astronaut Koichi Wakata.

## Public Outreach

ARISS inspired the public to explore science through its outreach efforts. Through presentations, papers, trade shows, amateur radio exhibits in museums and other public forums, and through ARISS participation in amateur radio events and activities, the public's interest in science has been advanced. Several examples of these items are described below.

- Public Relations
  - Announcements were made by the ARISS team and each school prior to and following each contact on the ARISS Web sites and through press releases. As a result, members of the community and members of the local, national, and in some cases international press attended each school contact. These events touched a worldwide public audience in the millions.
  - News items were posted to LM\_NET, (a school Library Media listserv for school library media specialists) whenever an ARISS radio contact was scheduled in the U.S. during school hours.
  - American Radio Relay League (ARRL) covered ARISS school contacts and other ARISS related items in articles printed in its monthly journal (150,000 circulation), posted on the ARRL Web site (100,000 regular readers), and written in their e-newsletter (circulation 77,000).
  - The European Space Agency (ESA) promoted ARISS school contacts on its Twitter site.
  - An ARISS-U.S. member posted ISS amateur radio related items to a Twitter site.
  - Japan Amateur Radio League (JARL) regularly carried articles on ARISS school contacts and other ARISS achievements.
  - The Wireless Institute of Australia carried stories about local ARISS school contacts on its Web site, newsletters, and podcasts.
  - A Saskatchewan native, responsible for the Radio Amateurs of Canada (RAC) educational program, publicized ARISS to Canadian schools and the press.
  - AMSAT published ARISS news items in its *AMSAT Journal*, published bimonthly, and on its Web site.
  - The ARRL continued its PR campaign called "We Do That." A portion of its brochure and the accompanying Web material covered ARISS.
  - An ARISS commemorative event was held during the month of December 2008 through early January 2009 to celebrate 25 years of ham radio in space. A special certificate was developed for those who communicated with the ISS, either 2-way direct (with the ISS crew, the digipeater, or crossband repeater), or 1-way reception of SSTV or voice downlink.

- *Make Magazine* published an article on the ARISS project SuitSat-2 (now ARISSat-1).
  - The Fall 2008 issue of *CQ VHF* ran an article about the ARISS meetings held in Moscow during July 2008.
  - An article was written about the ARISS contact between youth attending the Berkeley Heights Recreation Summer Playground in New Jersey and Expedition 17 astronaut Greg Chamitoff. The story, “Believe in Your Dreams - Anatomy of an ARISS Contact,” was published in the April 2009 issue of *CQ Magazine*.
  - An ARISS member wrote an article about the ARISS program that was published in the Spring 2009 issue of *CQ VHF*.
- Presentations and Papers
    - Prior to each school contact, AMSAT mentors, ARISS volunteers and school students gave presentations on space, science education and amateur radio to teachers, school staff, family members and the public in attendance.
    - Several ARISS presentations were given at the Dayton Hamvention 2009. These talks included a status on SuitSat-2, the VHF antennas for the Columbus module and a status on the ARISS program. In addition, Richard Garriott spoke at the AMSAT Forum, giving a presentation about his ARISS activities while onboard the ISS. He was the keynote speaker at the AMSAT Banquet and talked about his training, flight, and amateur radio operations. He also spoke at the ARRL National Convention. The Dayton Hamvention is an internationally attended amateur radio convention that draws crowds of 25,000 annually.
    - Several ARISS presentations were given at the 2009 AMSAT Space Symposium held in Baltimore, Maryland. The following presentations were given:
      - “The Transformation of SuitSat-2 into ARISSat-1,” Gould Smith, WA4SXM
      - “Mechanical design of ARISSat-1,” Robert Davis, KF4KSS
      - “Software Radio Technology on ARISSat-1,” Anthony Monteiro, AA2TX
      - “Amateur Radio on the ISS,” Keith Pugh, W5IU
      - “Amateur Radio Operations on Shuttle, Mir and ISS: Lessons Learned,” Frank Bauer, KA3HDO
    - An ARISS representative gave a presentation on the ARISS program at the 2009 Great Lakes Division Symposium in Findlay, Ohio.
    - The Association of Science – Technology Centers (ASTC) held its 2008 annual conference in Philadelphia, Pennsylvania. NASA representatives gave presentations on NASA’s education and outreach programs as well as NASA resources. An ARISS member was present to give an overview of the ARISS program.

- The ARRL ARISS Program Manager was interviewed on *QSO*, a ham radio interview and talk show, and discussed Richard Garriott's flight, the ARRL, ARISS and AMSAT. The interview ran several times on a Nashville station and once on a Miami station.
  - The Michigan Association for Computer Users in Learning (MACUL) hosted its 33rd annual conference in Detroit, Michigan on March 18-20. MACUL aims to bring educators together to share knowledge about educational uses of computers and technology. An ARISS representative attended the conference and gave a talk on the ARISS program, showing clips of the Martin Luther King Academy (Mount Clemens, Michigan) ARISS contact which took place in September 2007. The MACUL conference draws 3,000 educators annually.
  - ARISS-Canada delegate Maurice-André Vigneault wrote a short story for the Ottawa Valley Mobile Radio Club (OVMRC) news bulletin, *The Rambler* and Radio Amateurs of Canada (RAC) magazine, *TCA*. The article was about contacts made between the Canada Science and Technology Museum's VE3JW Amateur Radio Exhibit and Spaceflight Participant Charles Simonyi during his 2009 ISS flight.
  - An Ohio Department of Education staff member wrote a story (with the help of ARISS Delegate Rosalie White) about ARISS educational activities for the agency's main web page -- the story was posted for 1 year.
- Public Outreach Events and Activities
    - An aerospace museum at Alfonso Air Base in Brazil placed an amateur radio station in its ISS exhibit. The radio continues to monitor ARISS activities.
    - In promoting education, science and technology, Wings over the Rockies Air and Space Museum in Denver, Colorado incorporated amateur radio stations in its Avionics display. A station, callsign K0WAR was also set up in its International Space Station module exhibit.
    - The Christa McAuliffe Planetarium in Concord, New Hampshire set up an amateur radio station which is capable of operating from HF to UHF and has an antenna system for working satellites. The planetarium is home to the NASA Educator Resource Center (ERC) for New Hampshire.
    - ARISS Canadian Delegates set up a satellite communication demonstration station with an ARISS display at the Quebec City Hamfest in nearby St-Romuald. Pamphlets explaining the purpose of ARISS and AMSAT were distributed.



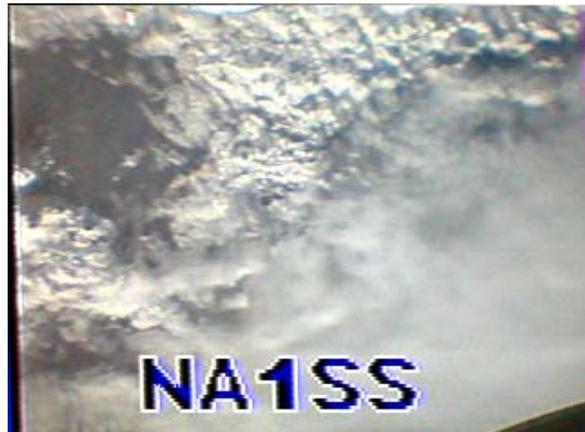
The Canadian Space Agency also provided handouts, stickers and decals.

- An ARISS member gave an interview on the concept and development of SuitSat-1. His interview was posted to the Design News, Engineering Concept Conduit Web page.
  - ARISS distributed International Space Station 2009 calendars to over 40 schools that were involved with ARISS contacts. They were also distributed to ARISS volunteers worldwide as a token of appreciation for their hard work and dedication to the program. Over five hundred calendars were distributed.
- Voice over the Internet Protocol
    - The program's outreach to both students and the general public has expanded using Voice over the Internet Protocol (VoIP) technology which links the ISS to amateur radio over the internet. Internet Radio Linking Project (IRLP) and EchoLink have been successful in increasing the audience base of ARISS contacts as additional schools and individuals have tied into the audio made available through VoIP. Of the 123 ARISS school contacts that took place during FY2009, audio from 78 of those was fed into the IRLP and/or EchoLink servers.

## Crew Operations

Crew members may use the ISS Ham equipment to speak to friends, family and the general public to help prevent feelings of isolation. The radio system may also be used for backup communications in the event there is an interruption in the prime ISS communications system.

- Spaceflight participant Richard Garriott flew to the ISS on October 12, 2008 with Expedition 18 crew members. He took part in several ARISS activities while onboard the International Space Station. These activities included speaking with hundreds of children at seven Challenger Learning Centers throughout the U.S. as well as five other schools around the world, exposing youth to the world of math, science, communications, teamwork and problem solving. Garriott also made over 500 general contacts and participated in Jamboree on the Air (JOTA), an event in which Scouts worldwide speak to each other via amateur radio. In addition, Garriott took a Kenwood VC-H1 Slow Scan Television (SSTV) communicator to the ISS and transmitted thousands of SSTV images which were received by the ham community worldwide.
- During Expedition 18, Mike Fincke and Yuri Lonchakov made general contacts with stations around the world which included those in Brazil, Australia, Canada, the U.S., Russia and Thailand. They also ran the radio in packet and crossband repeater modes and transmitted several SSTV images. Fincke participated in JOTA as well. On March 14, ground stations sent Happy Birthday wishes to Fincke.
- Mission Specialist Joseph Acaba, KE5DAR, made voice contacts with stations in Puerto Rico during his flight on STS-119.
- On March 26, spaceflight participant Charles Simonyi flew to the ISS with the Expedition 19 crew. Among the ground stations contacted during his taxi flight were those in the U.S., Canada, Australia, Hungary and Venezuela. He also used the VC-H1 to transmit SSTV images.



## Astronaut Training

The ARISS-U.S. team provides training sessions to astronauts to prepare them for their amateur radio licensing exams. The astronauts are given an overview of the ARISS radio systems and school operations. A refresher course may also be provided prior to flight. ARISS-Russia prepares the cosmonauts for their exams and trains the crews on ISS Ham hardware.

During FY2009, astronauts Mike Fossum, KF5AQG, Tracy Caldwell, KF5DBF and Doug Wheelock, KF5BOC were prepared for, took and passed their amateur radio licensing exams. Training on ARISS hardware and school operations was provided to astronauts Sandra Magnus, KE5FYE, Andre Kuipers, Nicole Stott, KE5GJN, Catherine Coleman, KC5ZTH, Doug Wheelock, KF5BOC, Christer Fuglesang, KE5CGR/SA0AFS and Tracy Caldwell, KF5DBF.



Several astronauts participated in ARISS simulated contacts over the year. Using the Kenwood D700 radio in the JSC Service Module mockup, they spoke with students around the world to prepare for contacts from the ISS. Simulated contacts were performed by Frank De Winne, Chris Hadfield, Cady Coleman, Bob Thirsk, Andre Kuipers, Satoshi Furukawa, Soichi Noguchi, Timothy J. Creamer, Doug Wheelock and Paolo Nespoli.

## **New and Current Initiatives**

### **NASA Web Sites**

The NASA Teaching From Space (TFS) Web site was developed and put on-line in Spring 2009. A new ARISS Web page also became available. The TFS site may be found here: <http://www.nasa.gov/audience/foreducators/teachingfromspace/home/index.html>

To view the ARISS site directly:

<http://www.nasa.gov/audience/foreducators/teachingfromspace/home/ariss.html>

### **Telebridge Station Network**

A telebridge station is used when a direct ARISS contact with the ISS is not possible due to timing constraints or visibility. A dedicated ARISS amateur radio ground station, located somewhere in the world, establishes the radio link with the ISS. Voice communications between students and the astronauts are then patched over regular telephone lines. This year the ARISS team expanded its telebridge network, adding stations in Argentina and Australia. In doing so, the team gained ground coverage which provided greater opportunities when scheduling school contacts. There are now nine telebridge stations in operation with locations in Australia (Queensland, South Australia), Belgium, the U.S. (California, Hawaii, Maryland), South Africa and Argentina (Buenos Aires, Neuquen). See Appendix C for maps.

### **New NASA Program Evaluations**

The NASA Education Evaluation Information System (NEEIS) site closed down at the end of 2008. NASA has developed new student and teacher evaluations for its education programs which went on line in early 2009: <http://education.jsc.nasa.gov/ARISS/eval/>

Oklahoma State University (OSU) is currently developing a Project Management System Web site to be used for the collection of contact related metrics and will be used for generating various reports for organizations such as the United Nations, the Office of Education and Congress. OSU anticipates completing its site by January 2010.

### **Columbus Module Status**

The Columbus module with ARISS L/S band patch antennas was launched in February 2008. Columbus will accommodate an additional amateur radio station, as well as a ham radio transponder. This new equipment, which is being worked through the European team (ARCOL), will allow operations on new frequencies that will make it possible for ARISS to establish wideband and video operations for the first time and allow continuous transponder operation.

In addition, the European Space Agency and AMSAT-NA have teamed up to provide VHF antennas for the Columbus module that will be shared by ARISS and AIS (Automatic

Identification System), the tracking system for ships. The antennas will be launched on STS-129, slated for November 2009, and installed on a subsequent extravehicular activity (spacewalk). There are plans to move the VHF and UHF Ericsson radios, already onboard the ISS, to the Columbus module. A power supply is needed for the radios; the ARISS team is currently working this issue.

### **Istochnik - Russian Telemetry System**

Due to reception problems during Soyuz landings, a suggestion was made for the Russians to use a new system, Istochnik-M, for telemetry transmissions. The system was launched on February 10, 2009 aboard Progress 32P and installed in the Service Module. The Istochnik telemetry reception and recording system enables the ISS to receive telemetry from the Soyuz spacecraft during descent and to record it on the Istochnik-M telemetry system. The system captures Soyuz data through the amateur radio antenna and transfers it to the laptop for display. The information is relayed to the ground and the crew and the ground is able to monitor the separation of the three modules during Soyuz descent operations. Once testing has been completed, the system is expected to be used four times a year. As the amateur radio is turned off during undockings, no disruptions to ARISS operations are anticipated.

### **ISS National Lab**

The 2005 NASA Authorization Act designated the U.S segment of the ISS as a national laboratory. The ISS National Laboratory will offer opportunities for educational activities, providing a unique resource for research and development in science, technology, and engineering. At the end of 2008, it was determined that ISS amateur radio activities would be incorporated in the U.S. segment as a formal payload of the ISS National Laboratory.

### **SuitSat-2 Becomes ARISSat-1**

In September 2005, the components of an amateur radio satellite, SuitSat-1 were delivered to the ISS. The Expedition 12 crew assembled the satellite using a Russian Orlan spacesuit, already on board the ISS and past its useful life, to house the amateur radio system. The suit was then deployed during an EVA on February 3, 2006.

ARISS is supporting the development of a second SuitSat project under the leadership of the Russian ISS Partners. This second project will commemorate several anniversaries: Sputnik's 50th, Korolev's 100<sup>th</sup> birthday, Tsiolkovsky's 150th birthday, and Robert Goddard's 125<sup>th</sup> birthday.

The intent was to house the new amateur radio system in another surplus Orlan spacesuit. Due to space limitations on the ISS, the spacesuit that was to be used for SuitSat-2 was discarded in July 2009. A new configuration was needed to accommodate the radio system. A plan was devised such that U.S. supplied solar panels will form the sides of the satellite and plates will form its top and bottom. The radio will be housed inside. This new configuration was renamed "ARISSat-1."

Work on the satellite has continued with the U.S. team supplying the internal housekeeping unit (IHU), the software defined radio (SDR), the antennas and cameras. The U.K. is

providing handles that will be used in handling and deploying the satellite and the Russians are providing the battery.

Many educational activities are planned for ARISSat-1. The satellite will send voice greetings in several languages recorded by students. It will also send via Morse code call signs of those who have contributed to amateur radio in space. SSTV images and telemetry will be transmitted to Earth. Students will provide creative work and technical documents that will be included on a memory stick which will be placed inside ARISSat-1. This work may also be posted on a Web site for viewing.

College students have already been involved with the development and testing of the software defined radio and Scouts have participated in the assembly of two non-flight safety boxes. The satellite has four ports available for student experiments and Kursk State Technical University in Russia has developed an experiment to be included on ARISSat-1.

Lesson plans have been written for grades K-3, 4-6, and 7-12. Older students may participate in the satellite activities that will be posted on the ARISSat Web site.

ARISS expects to launch and deploy ARISSat-1 in 2010.

## **ARISS Face to Face Meetings**

### **Purpose of ARISS International Face-to-Face Meetings**

Because ARISS is managed by an international team of volunteers, and because the ARISS program covers a diverse and large number of aspects such as current and future hardware, school and community education, publicity, operations with crew, crew support, (and so on), the volunteers meet as a team once each month on a teleconference call. Each of the 5 major ARISS committees that make up the entire team also meet among themselves on a weekly, monthly, or bi-monthly basis. Because the ARISS Team members come from many different cultures, the team learned that in order to interface effectively, we needed to hold an annual international delegate face-to-face meeting.

International delegate meeting agendas cover a broad array of items that are voted on after full discussions based on each country's point of view. The most recent meeting was held in the European Space Agency (ESA) European Space Research and Technology Centre (ESTEC) in Noordwijk, the Netherlands on June 18 – 19, 2009.



### **Details from the Most Recent ARISS International Partner Meeting**

As reported above, the ARISS Meeting agenda covers a diverse and large number of aspects, including school and community education, on-orbit and future hardware, publicity, operations with crew, crew support, etc.

The ARISS Team is made up of 5 regions representing the 5 primary space agencies (U.S., Canada, Russia, Europe and Japan). ARISS radio activity for youths is divided equally between these regions, and at ARISS meetings, regions report on their school successes. Each region gave an update on its activities.

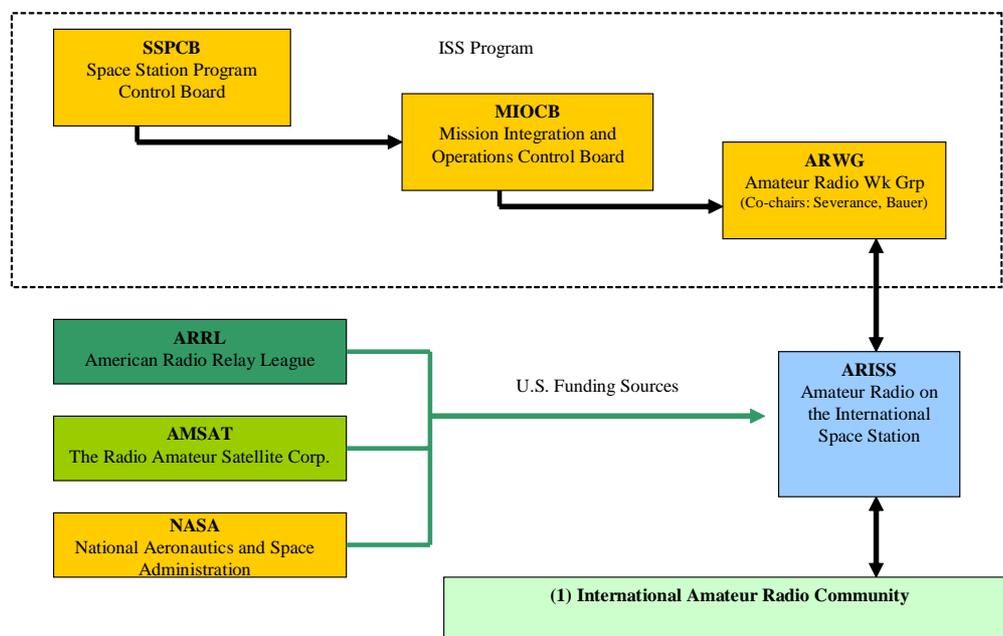
Other topics reported at the face-to-face meeting included:

- Progress on Amateur Radio on the Columbus Module (ARCOL).
- SSTV status.
- ARISS hardware status including the Yaesu FT-817 radio, the power switching assembly and a power supply for the Kenwood VC-H1.
- SuitSat-2 (ARISSat-1) status.
- The next ARISS International Meeting, possibly at NASA Johnson Space Center, late 2010.

## Amateur Radio Working Group Meeting

ARISS is an international working group that receives U.S. funding from NASA, the ARRL and AMSAT and receives funding and in kind resources and support from ARRL, AMSAT and amateur radio operators worldwide. An Amateur Radio Working Group (ARWG) charter has been written in order to formalize the multilateral agreement between all participating space agencies that are partnering with the ARISS team. ARWG is delegated from the Mission Integration and Operations Control Board (MIOCB) and chartered to coordinate the planning, development, integration and operation of amateur radio on the ISS. The ARISS Chairman and NASA OC7 Operations Planning and Amateur Radio Lead co-chair ARWG and representatives come from the space agencies JAXA, CSA, ESA and Roscosmos (Energia). Other members will include cosmonaut and astronaut representatives and a Houston support group representative. ARWG representatives have been assigned from the U.S., Japan, Canada and Europe. The group continues to work with Energia to find management and cosmonaut representatives from Russia.

A joint ARISS delegates - ARWG meeting was held prior to the international partners meeting in the Netherlands on June 17. A presentation was given on the VHF-UHF antennas that will be installed on the Columbus module and the group discussed which radios should be installed in this new European segment. The talks included how to manage the different radio systems so that they do not interfere with each other. The team also spoke about the radio equipment currently onboard and discussed the equipment that will need to be flown in the future.



**ARWG Related Board Structure**

## **ARISSat Meetings**

ARISS and AMSAT-NA members met in Phoenix, Arizona for several meetings over the year to discuss the development of ARISSat-1. At the meetings, the team gave status reports on the different modules and worked on software, hardware, antennas, cables and the experiment interface. The volunteers tested the various system components and ran integration tests. As the Orlan spacesuit was disposed of, the team met the challenge and devised a new housing unit for the radio using solar panels. The team discussed how the U.S. components will be delivered to Russia and talked about delivery dates, launch dates and an EVA for the deployment of ARISSat-1.

Several demonstrations of the SuitSat (ARISSat) prototype were given at the Microchip Master's conference in Phoenix, the Central States VHF Society's 43rd annual conference in Chicago and the 2009 Dayton Hamvention in Ohio.

## **NASA Education Office Meeting**

The NASA Education Office invited ARISS-U.S. volunteers to Johnson Space Center for a meeting on May 1 – 2. The team discussed how to increase the educational value of the ARISS contact including the educational proposal, lesson plans and how to integrate the contact into the school curriculum as well as NASA resources available to help meet those needs. Also discussed was the ARISS Planning Guide that is being developed to be aligned with the one used for Educational Downlinks and the ARISS bookmark that is in development which will be distributed to educators. The bookmark will have information about ARISS, NASA, ARRL and AMSAT and will replace the lithograph ARISS has been using. The meetings also covered, among other items, the new NASA surveys for students and teachers, the Oklahoma State University data collection system, required NASA reports, ARISS press releases and government policies and Space Act Agreements.

## **Program Evaluation/ Outcomes/Continuity**

Teachers and students evaluate the ARISS program after their contact with the ISS by completing the NASA surveys. Additionally, input obtained from crew debriefs is taken into consideration for program improvement. Awards in excellence given to ARISS members are also an indicator of the program quality. Students and teachers continuing their education in fields related to the ARISS program, schools which set up radio stations or continue on with related technologies, and remarks made by those involved with the program can provide necessary feedback to improve and refine the program. The items listed below are indicators of this program's success.

- Stephanie Radcliff experienced an ARISS contact as a student at Daviess County High School (DCHS) in Owensboro, Kentucky in May 2001. Today she is a graduate of Embry-Riddle University, and holds a degree in the aerospace field. She has applied for and hopes to be accepted for astronaut training. Harold Wilson, the coordinating teacher of the DCHS-ARISS contact, remarked that it was the ARISS contact which inspired Stephanie to pursue this career.
- “We are also working with the Schenectady Amateur Radio Association and our after-school program to begin a ham radio club for students. Thanks for making this [contact] possible for us.” –Rita Moore, Central Park Middle School, NES, Schenectady, New York
- Bradley Henicke of Houston took part in a 2001 ARISS school contact and lessons, and soon after became KD5FAL. In 2009 he graduated 38<sup>th</sup> of 1046 from the Air Force Academy and enrolled at Rice University for a master's in mechanical engineering.
- Student SAREX volunteer, Mike Sufana, received his Aerospace Engineering degree and is now working at Northrop Grumman.
- SAREX student, Melissa Mladnic, from Jerling Jr. High, is attending Purdue University School of Aerospace Engineering with aspirations of becoming an astronaut.
- A student who participated in a SAREX contact with astronaut Ken Cameron in 1994 is now an Air Force Academy graduate. She dreams of becoming an astronaut and attributes much of her interest in flying to her participation in that contact years ago. As a young girl, she was able to ask her question, “How does a fish swim in space?” Today she is a pilot and she continues her flight training on fighter jets.
- On May 2, 2009, ARISS mentor and telebridge operator Tony Hutchison was presented with the Chris Jones Memorial Award during the Wireless Institute of Australia's (WIA) Annual General Meeting at Monash University, Churchill. Hutchison received the award in recognition of his work with the ARISS program. The award is the highest honor the WIA can confer on a person.
- Frank Bauer was inducted into CQ Magazine's Amateur Radio Hall of Fame for making a significant contribution to amateur radio. This award is given to persons

who not only excel in personal performance in amateur radio, but also give back to amateur radio in a significant manner. Frank was ARISS Chairman from 1996-2009 and AMSAT VP Human Spaceflight, 1991-2009.

- ARRL President Joel Harrison presented past ARISS Chairman Frank Bauer with the ARRL President's Award. This award is voted on by the Board of Directors and given out every 7 or 8 years to honor someone's outstanding work.
- "It was an awesome 'once in a lifetime experience' that will become more important in the lives of these students as they look back upon this event in years to come. Having a personal contact with someone in space increased the students' interest in space by three fold. Sandra Magnus was very enthusiastic and answered the students' questions in a manner they could relate to. She was very encouraging of the students. It was an inspirational and moving experience." - Principal Ward Milligan, King George Elementary School, Moose Jaw, Saskatchewan, Canada
- Spaceflight Participant Richard Garriott received the Dayton Amateur Radio Association Special Achievement Award for 2009. Garriott received the award based on his tremendous support and participation in many ARISS activities during his ISS flight.
- "I have never seen this kind of quiet on students at a school wide event before." - Principal of Cedarview Middle School, Ottawa, Ontario, Canada on his school's contact with Robert Thirsk
- Little Lilly's English Public school, Vidhyaranyapura, Bangalore experienced a SAREX (Space Amateur Radio Experiment) contact in 1995. The school established Little Lilly's Radio Club Station VU3LLE. As of 2008 more than 100 high school students had received their callsigns. In May 2009, the school hosted an AMSAT-India workshop to celebrate the fourth anniversary of HAMSAT (VO-52) in space. Exhibitions highlighted AMSAT projects, ARISS and a variety of software and hardware used for satellite tracking as well as antennas built by students.
- "It was wonderful and thrilling." - Asomiya Pratidin, the highest circulated Assamese (local language) daily newspaper describing the ARISS contact between astronaut Mike Fincke and students of Aham Jatiya Vidyalaya.

## **Future ARISS Projects**

### **Exploration (Moon Mars and Beyond) Initiative**

In March 2006, Amateur Radio operators from AMSAT Germany tracked and received data from Voyager 1 using the 20m antenna at Bochum at a distance of 14.7 billion km. Its data was checked and verified against data from the Deep Space Network station. This was good news for the Amateur Radio community as NASA is currently pursuing an exploration of space “to the Moon, Mars, and Beyond.” ARISS is considering educational payloads that may be included on these missions. A repeater on the moon, a remote amateur television, and a Mars telecommunications satellite are such possible payloads. These payloads will generate interest among students, encouraging participation in amateur radio projects and in space, science and technology.

## **Appendices**

- Appendix A    ARISS Metrics FY2009  
                  U.S. School Contacts FY2009, Diversity by State
  
- Appendix B    ARISS Roles and Responsibilities
  
- Appendix C    Telebridge Stations Map
  
- Appendix D    School Contact Maps  
  
                  Map, ARISS-USA Radio Contacts, FY2009  
  
                  Map, ARISS-USA Radio Contacts through FY2009  
  
                  Map, ARISS-International Radio Contacts through FY2009

## Appendix A

### ARISS Metrics FY2009

Total number of school contacts	123
Contact audio on VoIP/Web cast	78
International contacts	88
U.S. school contacts	35
Total rural school contacts	15
U.S. rural school contacts	5
NASA Explorer Schools	1
Title 1 schools	9
Informal education contacts	47

## U.S. School Contacts FY2009, Diversity by State

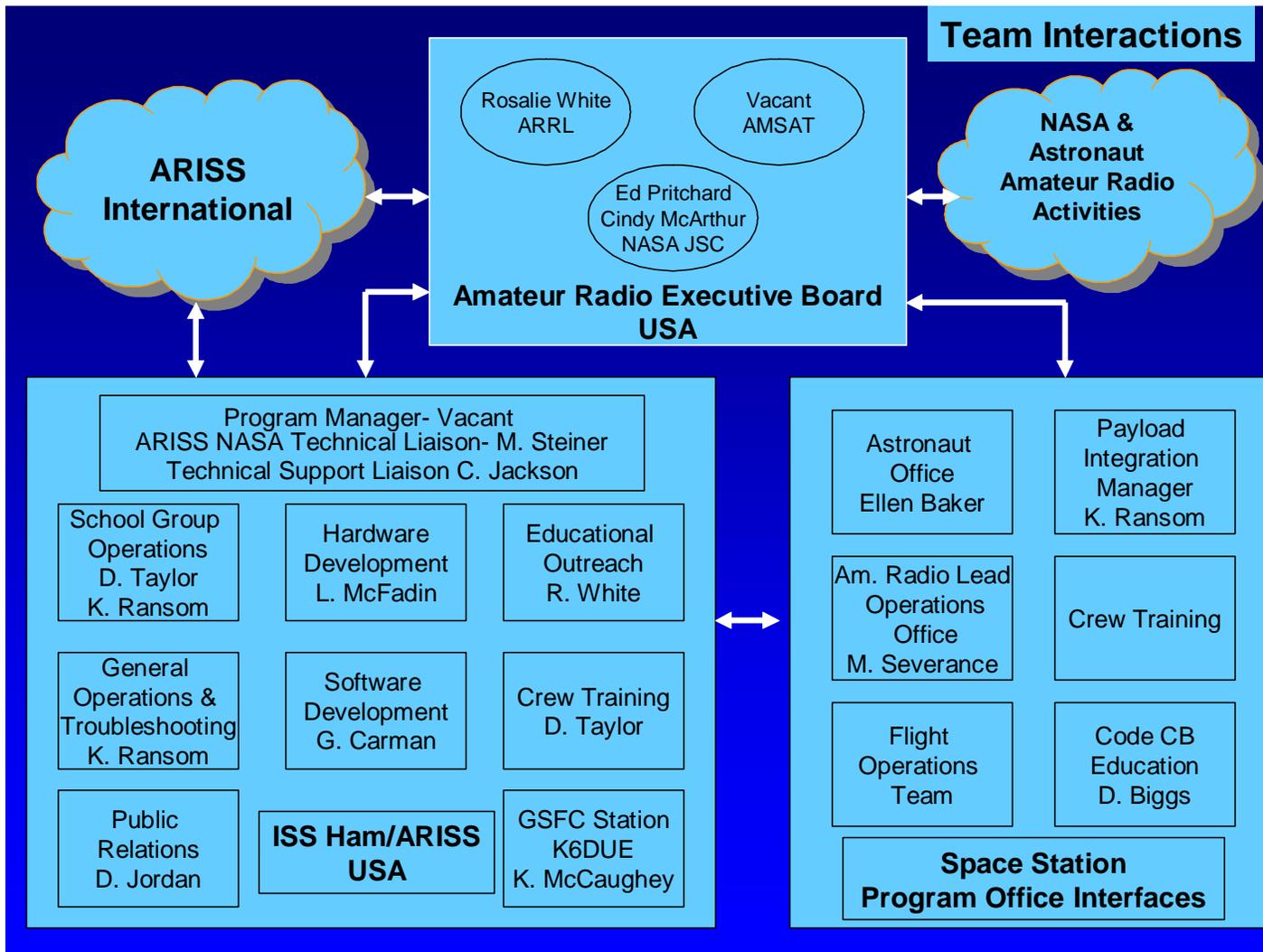
School	City, State	Enrollment	% Caucasian	% African American	% Hispanic	% Asian	% Multiracial	% American Indian/Native Alaskan	% Economically disadvantaged	% Special Ed or IEP	% Limited English
<b>California</b>											
The Girls' Middle School	Mountain View, California	129	78	3	9	10					
Buchanan High School	Clovis, California	3243	62	3	17	12	3	<1	10		3
<b>District of Columbia</b>											
National Air and Space Museum - Space Day	Washington, DC	(36K at museum)									
<b>Florida</b>											
Milwee Middle School	Longwood, Florida	423	47	16	28	3	7		56	16	6
CLC#1 Verizon Challenger Learning Center at MOSI	Tampa, Florida	CLC#1 – 419 for all 4 groups									
<b>Idaho</b>											
WHEELS Idaho Historical Museum (Garfield Elementary)	Boise, Idaho	453	80	3	14	3		<1	57		
<b>Illinois</b>											
Octave Chanute Air Museum	Rantoul, Illinois	1000									
Ellis Elementary School	Belleville, Illinois	478	56	32	3	1	8	<1	45		0
<b>Indiana</b>											
CLC#2 Indianapolis Challenger Learning Center	Indianapolis, Indiana	22									

CLC#1 Brownsburg Challenger Learning Center	Brownsburg, Indiana	CLC#1 – 419 for all 4 groups							
<b>Kentucky</b>									
CLC#2 Learning Center at Paducah	Paducah, Kentucky	105							
<b>Maryland</b>									
Poolesville High School	Poolesville, MD	861	88	5	3	4		<1	3
CLC#1 Howard B. Owens Science Center's Challenger Center	Lanham, Maryland	CLC#1 – 419 for all 4 groups							
<b>Michigan</b>									
Ann Arbor Hands-On Museum	Ann Arbor, Michigan	100							
Armada Area Schools *Middle and High Schools*	Armada, Michigan	1139	96	<1	2	1		<1	8
<b>Missouri</b>									
CLC#2 Challenger Learning Center—St. Louis	St. Louis, Missouri	47							
<b>New Jersey</b>									
Summer Playground Camp	New Providence, New Jersey	100							
<b>New York</b>									
Baiting Hollow Scout Camp	Calverton, New York	300							
Mahopac Public Library	Mahopac, New York	20							
Hampton Bays Middle School	Hampton Bays, New York	836	67	1	32	1			11 12
<b>North Carolina</b>									
Enloe Magnet High School	Raleigh, North Carolina	2562	46	38	3	12		<1	25
<b>Ohio</b>									
St. Edward School	Ashland, Ohio	175	99	<1		<1			
<b>Oregon</b>									

Oregon City Schools, Fassett Middle School	Oregon, Ohio	499	80		12		6		41	13
Pinehurst School	Ashland, Oregon	27	70	4	7			19	41	
<b>Pennsylvania</b>										
Erie Planetarium South Park Elementary School	Erie, Pennsylvania South Park, Pennsylvania	200								
		745	93	5	<1	<1		<1	18	
<b>Puerto Rico</b>										
Marcelino Canino Canino Middle School (NES)	Dorado, Puerto Rico	522				100			92	
<b>South Carolina</b>										
CLC#1 Challenger Learning Center of Columbia	Columbia, South Carolina									CLC#1 – 419 for all 4 groups
<b>Texas</b>										
KIPP:3D Academy United Space School	Houston, Texas Seabrook, Texas	243		15	84				86	5 6
Stephen F. Austin Elementary School	Richmond, Texas	588	76	5	17	1		<1	10	13 1
Liberal Arts and Sciences Academy High School	Austin, Texas	850	53	8	24	14		<1	34	
Mayor of Austin, friends, family and students	Austin, Texas	250								
<b>Washington</b>										
Carl Sandburg Elementary School	Kirkland, Washington	486	87	2	3	6	2	<1	6	11 2
Liberty Middle School	Camas, Washington	693	90	1	3	4	1	<1	22	14

# Appendix B

## ARISS Roles and Responsibilities



## Appendix C

### ARISS Telebridge Stations



**Active Ground Stations and Those Being Prepared for Operation**

## **Appendix D**

### **Maps**

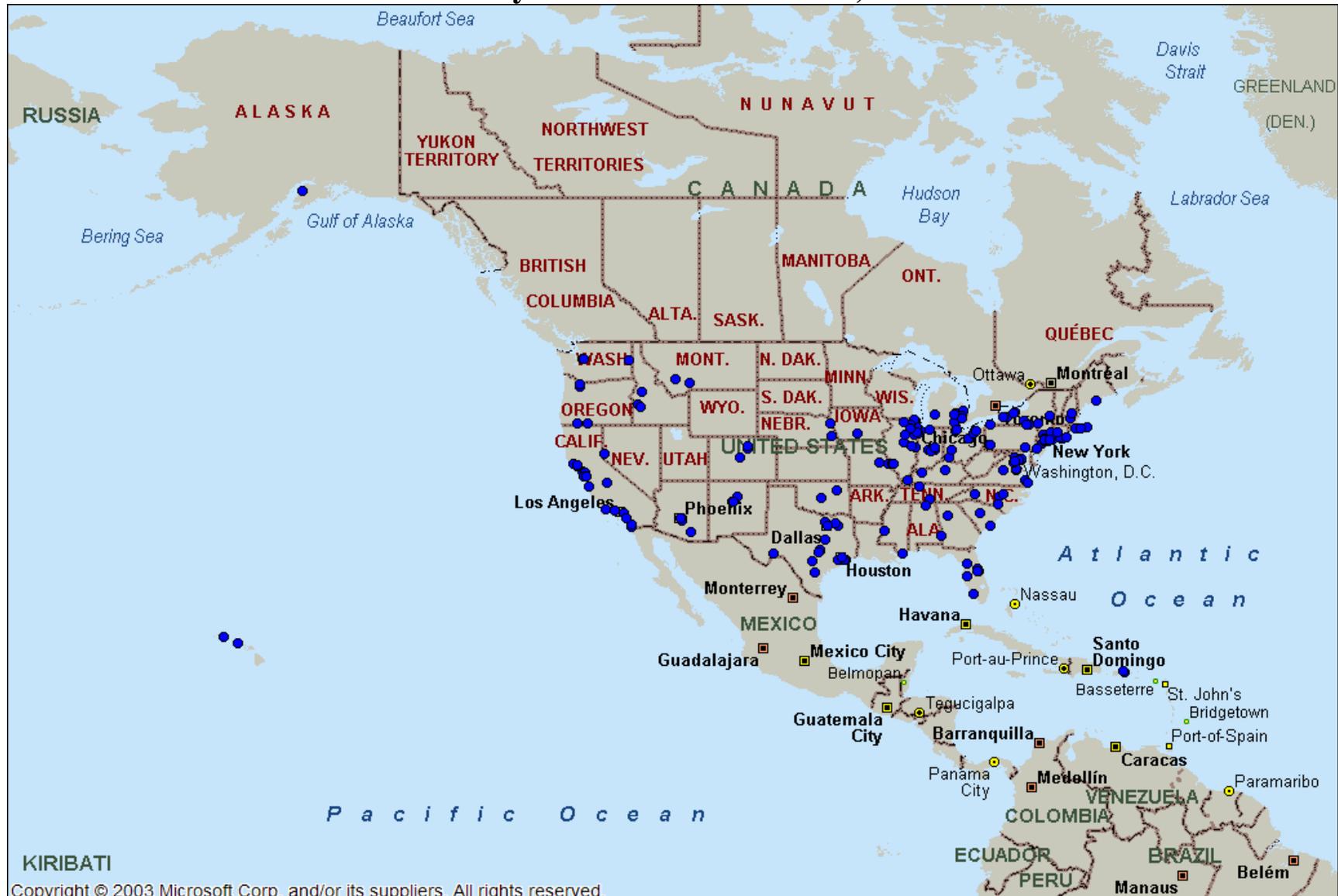
Map, ARISS-USA Radio Contacts, FY2009

Map, ARISS-USA Radio Contacts through FY2009

Map, ARISS-International Radio Contacts through FY2009



## ARISS USA-only School Radio Contacts, FY2001-2009

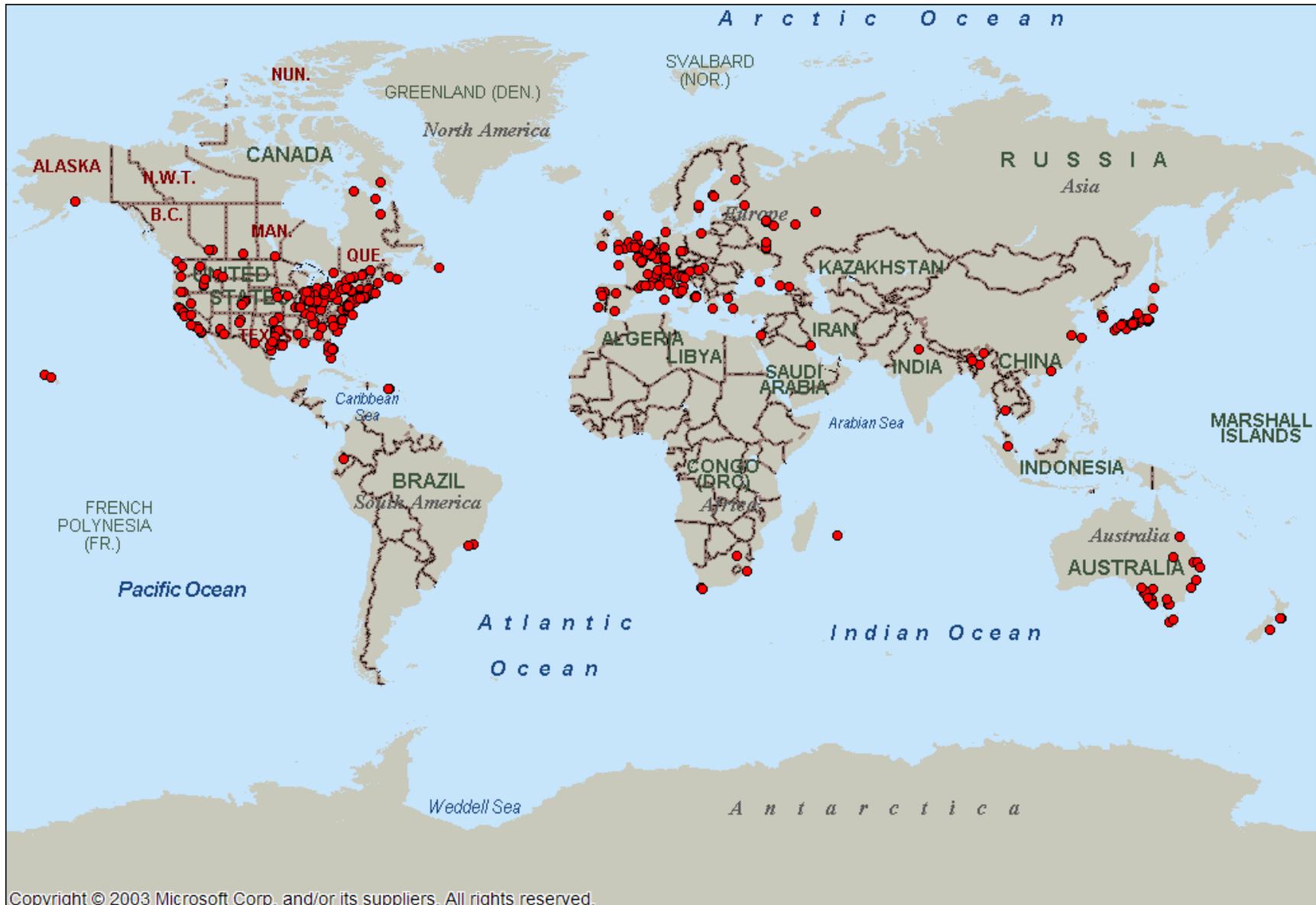


Notes: 1) ARISS assisted 212 U.S. schools and 272 other schools worldwide with radio contacts through FY2009.

2) Students at numerous other schools from around the USA and the world benefited from listening to radio contacts via Webcasts/audio streaming.

3) ISS crewmembers performed general outreach Amateur Radio contacts with children and adults from around the world.

## ARISS-International School Radio Contacts FY2001 – 2009



- Notes:
- 1) A total of 484 ARISS school contacts were made through FY2009.
  - 2) Students at numerous other schools from around the world benefited from listening to radio contacts via Web casts/audio streaming.
  - 3) ISS crew members performed general outreach Amateur Radio contacts with children and adults from around the world.