Amateur Radio on the International Space Station (ARISS)

Annual Report to NASA 2008

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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, the 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 2008 (the 361st 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 FY2008, the international team formed 40 partnerships with schools (grades K-12 and universities), Boy Scouts, Girl Scouts, museums and camps. Among those that collaborated with ARISS were the National Planetarium in Malaysia, the Boy Scouts of America in Oakwood, Illinois, Michael Sobell Sinai School in Harrow, UK, the Kuwait Science Club, the National Air and Space Museum in Washington, D.C, and Isummasaqvik School in Quaqtaq, Quebec.

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 engaged and educated 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.

- An ARISS contact was held with Lycee mixte René Gosse in Clermont L'Herault, France. In preparation for the contact, students studied Math, French, Ecology and Sustainable Development and Physics, including the history of space exploration, principles of inertia, and radio waves. The school held a workshop "English for the Sciences" which enabled students to develop their knowledge of English while exposing them to international scientific exchanges, primarily written in English. This course was then extended to a second workshop "Scientific exchanges in English." The ARISS contact was a continuation of this second workshop and presented an opportunity for the students to apply their knowledge and language skills. The project concluded with a visit to the "Cité de l'Espace" in Toulouse. The school partnered with Radio Club F6KEH also known as "Emetteurs Biterrois."

- 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.

- Han Gwang Boys & Girls High School in Pyeong Taek City, Republic of Korea was founded in 1955 and consists of 4 schools under the same name, Han-Gwang (boys' junior & senior high schools and girls' junior & senior high schools). Five thousand students are enrolled in the schools. Han Gwang has an amateur radio club station DS0IC, which is the largest school club station in Korea with approximately 150 operators (100 students and 50 teachers). South Korean space visitor Yi So-yeon, HL0ARISS, spoke with the youth through an ARISS contact. Over 500 people attended the event which received media coverage from five television stations and ten newspapers.

- Approximately 100 students, grades Kindergarten through high school, from Isummasaqvik School in Quaqtaq, Quebec took part in the ARISS program. The school held a contest to create a mission patch which was worn on T-shirts by everyone participating in the contact. All classes participated in space related projects which were displayed in the school on the day of the ARISS event. Plans have been made to form a space club at the school.

- Students from Central Middle School in Parsippany, New Jersey, participated in an ARISS contact with alumnus Garrett Reisman, KE5HAE. Over 900 students, parents and others gathered at the school for the event. One radio station, three television stations (ABC, CBS, NJ12) and four newspapers including the Star Ledger, the Daily Record, Parsippany Life and the New York Times reported on the contact. The school also had its district communication, "Video on the Go" connected. The activity was recorded and available for viewing on their Web site. All 14 district schools had the opportunity to view the contact live.

- Youth attending Schulehaus Feld 1 in Richterswil, Switzerland participated in a successful ARISS contact. To prepare for the event, children produced drawings, plays, research papers and multimedia products which were displayed the day of the contact. More than 500 students, parents, teachers and visitors gathered in the sports hall to watch as 21 students posed questions to Greg Chamitoff, KD5PKZ, aboard the ISS. An audio link was set up outside the sports hall for other visitors to listen in. Two television stations (SF DRS Aktuell Schweizer Fernsehen, Regional Fernsehen Tele Zürich), one radio station (Radio Zürichsee) and three newspapers (Zürichsee Zeitung, Neue Zürcher Zeitung NZZ, Tages-Anzeiger) covered the event.

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 classes 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 ground station located there.

- Under the guidance of Dr. Pawel Kabacik, Assistant Professor at the Institute of Telecommunications and Acoustics, Wroclaw University of Technology, an ARISS-Europe student team developed ARISS antennas for the ISS Columbus Module. These antennas were tested, flight certified and installed in October 2007. The Columbus module was carried to the ISS on Atlantis which launched on February 7, 2008.

- Students attending Kursk State Technical University in Russia have proposed an experiment to measure the unevenness of the vacuum atmosphere. The experiment under development will fly on the amateur radio satellite SuitSat-2.

- Kursk State Technical University students spoke with Yuri Malenchenko, Expedition 16 flight engineer, on board the ISS via amateur radio.

Informal Education

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

- Malaysian space visitor Dr. Sheikh Muszaphar Shukor, 9W2MUS, participated in five ARISS contacts during his ISS mission. Five different groups of Malaysian school children gathered at the National Planetarium in Kuala Lumpur to speak with Shukor. The planetarium gave presentations on space exploration to the youth during their visits and each student was issued a QSL (postcard) to commemorate the event. NASA astronaut Robert "Hoot" Gibson was present during the final session and gave talks about space.

- On May 3, 2008, AMSAT and ARISS participated in Space Day, celebrating the 50th anniversary of NASA and NASA's achievements through space exploration. AMSAT and ARISS members manned an exhibition booth at the National Air and Space Museum in Washington, D.C. An ARISS contact was scheduled between youth, ages 12-18 and astronaut Garrett Reisman, KE5HAE. Space Day draws approximately 10,000 visitors to the Air and Space Museum annually.

- Boy Scouts of America held a Space Jamboree at Camp Robert Drake in Oakwood, Illinois. The Scouts participated in a NASA Mission to Mars Expedition through a Digital Learning Lab and over one hundred Scouts earned their Radio Merit Badges. Approximately 400 Scouts and parents witnessed an ARISS contact during the event.

- An ARISS contact was scheduled with the Department of Astronomy & Space Sciences (DASS) at the Kuwait Science Club in Safat, Kuwait. DASS spreads scientific awareness in the fields of astronomy and space sciences by actively engaging the public in exploring the cosmos. The Ministry of Education held a national competition for all schools in Kuwait which encouraged students to do research in space science. Four students were selected from 3 levels (elementary, middle, high school) to ask questions of the astronaut during the ARISS event. Young people learned about space stations, satellites and amateur radio through this activity.

- Boy Scouts from Los Padres Council Troop 105 in Santa Barbara, California met with faculty members at the University of California, Santa Barbara (UCSB) who

instructed the Scouts as they worked on their Astronomy, Space Exploration and Radio Merit Badges. Cub Scouts attending the event worked on their Astronomy and Science belt loops and Astronomy and Science academic pins. The Physics Department provided its astronomy observation deck for an ARISS contact as the Scouts learned about the ISS and its crew.

- Long-term patients at the Arnold Palmer Hospital for Children in Orlando, Florida participated in an ARISS contact with Garrett Reisman, KE5HAE. An ARISS team member gave a presentation to the children on amateur radio and the ARISS program and ARISS lithographs were distributed. The hospital provided a talk on the medical advancements made through space science which are now available due to NASA and its research.

- Students visiting the National Science Museum of Korea participated in an ARISS contact with spaceflight participant Yi So-yeon, HL0ARISS. An audience of approximately 800 gathered to watch as So-yeon answered the students' questions. Over five television stations and four newspapers covered the event.

- Twelve schools took part 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 won their place at the event by submitting questions to the DRS project leaders. Each school submitted five questions and the best ones were chosen. The questions were translated from Dutch into English, providing the students, ages 10-12, with the opportunity to practice their English while speaking with an astronaut in space.

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 115,000).
    - 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 started a new PR campaign called "We Do That." A portion of its new brochure and the accompanying Web material cover ARISS.
    - The Spring 2008 issue of *CQ VHF* magazine published an article on SuitSat-2 development. The article was based on ARISS hardware manager's AMSAT Symposium 2007 paper.
    - SuitSat appeared on the cover of *Under the Hood's* June issue, a supplemental issue of the *EE Times*.
    - An article, "Communication from Space Inspires Young Minds" was written about ARISS and was posted to the NASA ISS "Behind the Scenes" and Kennedy Web sites. Several ARISS members were interviewed for the story, including astronaut Bill McArthur, KC5ACR.

- 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.

    - An ARISS presentation was given at the Dayton Hamvention 2008. ARISS telebridge operator and mentor Tony Hutchison, VK5ZAI, gave a presentation on "A Ham Radio Operator's View of ARISS" at the AMSAT Forum. The Dayton Hamvention is an internationally attended amateur radio convention that draws crowds of 25,000 annually.

    - A teacher from Upper St. Clair School in Pennsylvania gave a presentation at the Radio Amateur Satellite Corporation (AMSAT) Space Symposium 2007. Her presentation, "Launching Dreams: The Long-term Impact of SAREX and ARISS on Student Achievement" covered her experiences with her students, the space program, the Shuttle Amateur Radio Experiment (SAREX) program and the ARISS program. She gave real life examples of the positive impact these experiences have had on her children. Her paper has been appended to this report (Appendix D).

    - An ARISS member presented the amateur radio satellite SuitSat-1 as a "teardown" subject for the 2008 Embedded Systems Conference in San Jose, California. He also spoke on the development of SuitSat-2.

    - The National Association of Rocketry's National Convention, NARCON 2008, was held March 14 -16 in Rochester, Minnesota. An ARISS member gave a presentation on the ARISS educational outreach program during the seminar session.

    - The first AMRASE International Aerospace Research Conference was held in December 2007 in Rio de Janeiro. Brazilian astronaut Marcos Pontes was one of the speakers at the meeting. He gave a presentation on his training and his participation in the Centenario Mission onboard the ISS. He also talked about the importance the ARISS program plays in the education of youth.

    - ESA astronaut Paolo Nespoli, IZØJPA, gave two presentations to Italian schools which had participated in ARISS contacts in October 2007. On April 23, Nespoli spoke to 565 students from Galileo Galilei High School of Civitavecchia, Guglielmo Marconi High School of Civitavecchia and Giosuè Carducci Secondary School in Santa Marinella. On April 24, he spoke with 400 students from Aula Magna of the Faculty of Engineering of the University of L'Aquila. An ARISS member gave a talk on the ARISS program and Nespoli gave a presentation on the Esperia Mission which also highlighted the ARISS contacts.

    - Two ARISS presentations were given at the 2008 Radio Amateur Satellite Corporation (AMSAT) Space Symposium held in Atlanta, Georgia. "ARISS Update" was presented by Frank Bauer, KA3HDO and "SuitSat-2 Progress" was given by Lou McFadin, W5DID.

- The Challenger Center Lead Flight Directors Conference was held in Wellington, Kansas on August 24 – 28. A presentation was given during the conference which covered the ARISS program and the school application process.

- An ARISS member gave a talk to Rockwell Collins Amateur Radio Club in Richardson, Texas. The talk covered AMSAT satellites and ARISS projects.

- 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.

  - AMSAT-NA continued with its effort to have every board member attend an ARISS contact in the U.S.A., Canada or Australia, in order to promote the program and to provide a stronger support system within the AMSAT community. Several members have already attended.

  - 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.

  - Six staff members at the Christa McAuliffe Planetarium in Concord, New Hampshire passed their amateur radio exams. Two passed the General Class test; the rest, Technician. On May 3, an amateur radio station was set up at the planetarium 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.

  - On September 13, the public was invited to Goddard Space Flight Center in Greenbelt, Maryland to attend Launchfest, an event to celebrate NASA's 50th anniversary. There were many exhibits and demonstrations of space related activities including model rocket launches and space robots. ARISS members supported the Launchfest event with its own exhibit booth, providing information, distributing lithographs and generating much interest in the program. Approximately 13,000 attended the event.

- Voice over the Internet Protocol

  - Work has continued in expanding the program's outreach to both students and the general public 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 40 ARISS school contacts that took place during FY2008, audio from 22 of those was fed into the IRLP 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, W5KWQ, joined the Expedition 18 crew and flew to the ISS on October 12. 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 the youth to the world of math, science and communications as well as teamwork and problem solving. Garriott also participated in Jamboree on the Air (JOTA) and made over 500 general contacts. In addition, Richard took a Kenwood VC-H1 Slow Scan Television (SSTV) communicator with him onboard the ISS and transmitted thousands of SSTV images which were received by the ham community worldwide.

- Astronaut Mike Fincke, commander of Expedition 18, made several general contacts and participated in JOTA.

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 given prior to flight. ARISS-Russia prepares the cosmonauts for their exams and trains the crews on ISS Ham hardware.

In July 2008, ARISS-US members attended a training audit in Russia. The U.S. team was able to work with the Russians to reduce training requirements on the U.S. astronauts.

During the FY2008, training on ARISS hardware and school operations was provided to Timothy Creamer, KC5WKI, Soichi Noguchi, KD5TVP, Koichi Wakata, KC5ZTA, Mike Barratt, KD5MIJ, Bob Thirsk, VA3CSA, Chris Hadfield, KC5RNJ/VA3OOG, Mike Fincke, KE5AIT, Joe Acaba, KE5DAR, Ricky Arnold, KE5DAU, Nicole Stott, KE5GJN, Sandy Magnus, KE5FYE and Shannon Walker, KD5DXB.

In January, Cosmonauts Oleg Skripochka, RN3FU and Oleg Kononenko, RN3DX participated in ARISS simulated contacts using the Kenwood D700 radio in the JSC Service Module mockup. They spoke with the training support team who participated as students. In February, Mike Fincke and Koichi Wakata became the first astronauts to train by participating in simulated contacts with school children from around the world. Simulated contacts with students were also performed throughout the year by Nicole Stott, Sandra Magnus, Bob Thirsk, Frank De Winne, and Andre Kuipers.

New Initiatives

Digital Learning Network

Johnson Space Center developed a module on the ARISS program for the Digital Learning Network (DLN) which went on line in August. The module provides grades K-12 with a foundation of what amateur radio is and how it is used. It includes demonstrations from ARISS lesson plans and highlights special projects such as SuitSat-2. The DLN module also provides education resource links to be used pre- and post-ARISS contact. Thousands of school children are reached through DLN each year.

NASA Web Sites

The NASA International Space Station Science Web site was updated with ISS experiments, including the ARISS program. A brief summary and description of the program as well as contact information was provided.
http://www.nasa.gov/mission_pages/station/science/experiments/ARISS.html

Work on the NASA Education Portal is currently in progress. The ARISS portion of this Web site is under review and will go on line once approved.

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. There are currently six telebridge stations in operation with locations in Australia (Queensland and South Australia), Belgium, and the U.S. (California, Hawaii, Maryland). This year the ARISS team began working to expand its telebridge network. In doing so, the team hopes to have better ground coverage which will allow for greater opportunities when scheduling school contacts. Stations under consideration include those in South America (Uruguay, Argentina) and Perth, Australia. See Appendix E for maps.

ARISS Application Updated

The ARISS application was revised this year to update and simplify instructions. A checklist was provided to the applicants to ensure necessary steps are followed for a successful contact. A survey was included to follow the long term effects this educational program has on the participating schools and their communities.

New NASA Evaluation

The NASA Education Evaluation Information System (NEEIS) site has closed down. A new program evaluation is being developed and should be on line in early 2009. Schools have been asked to provide information to the ARISS program directly until the new site is available.

ISS Hardware Deliveries

On September 10, ARISS flight backup hardware was launched to the ISS. The Kenwood D - 700 radio, the SSTV adapter and associated cables and a headset for the Ericsson radio were part of the Progress 30P manifest. The radio was installed in late September, making it easier for the crew to change program modes.

A Kenwood VC-H1 Slow Scan Television (SSTV) communicator was launched to the ISS with Richard Garriott in October. The VC-H1 was left onboard the ISS to be used in future amateur radio activities.

Columbus Module

The Columbus module with ARISS L/S band patch antennas was launched on February 7, 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.

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

ARISS is supporting the development of a second SuitSat project under the leadership of the Russian ISS Partners. The second SuitSat project will commemorate several anniversaries: Sputnik's 50th, Korolev's 100th birthday, Tsiolkovsky's 150th birthday, and the 125th anniversary of Robert Goddard's birth. SuitSat-2 is designed to have greater capabilities than its predecessor, increasing opportunities for student involvement and experimentation. The Russians will provide a battery and a surplus Orlan spacesuit to house the amateur radio system. The U.S. team will supply the internal housekeeping unit (IHU), the software defined radio (SDR), antennas, cameras and solar panels. There will be four ports available for student experiments. SuitSat-2 will send voice greetings in several languages recorded by students and it will send via Morse code a list of callsigns of those who have contributed to amateur radio in space. Slow Scan Television (SSTV) images and telemetry will be transmitted to Earth. Students will

provide creative work and technical documents to be included on a DVD which will fly on SuitSat-2. College students have already been involved with development and testing of the software defined radio and Scouts have participated in the assembly of two non-flight SuitSat-2 safety boxes. Kursk State University in Russia has submitted a proposal for one of the experiments to be included on SuitSat-2. Another experiment is being developed by Westbridge Academy with help from Microchip Technology, Inc. in Arizona. Lesson plans have been written for grades K-3, 4-6, and 7-12. Older students may participate in SuitSat activities that will be posted on the SuitSat Web site. SuitSat-2 is expected to launch in 2009 and to be deployed on a subsequent spacewalk.

ARISS International Face to Face Meetings

Purpose of 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 2008 meeting was held in Moscow, Russia on July 17 - 18.

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.

Ed Pritchard from the NASA JSC Education Office attended the meeting and gave a presentation on NASA Education and the role it plays in relation to ARISS. The Teaching from Space Office provides funding to the ARISS program and assists in promoting and expanding ARISS' educational outreach.

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

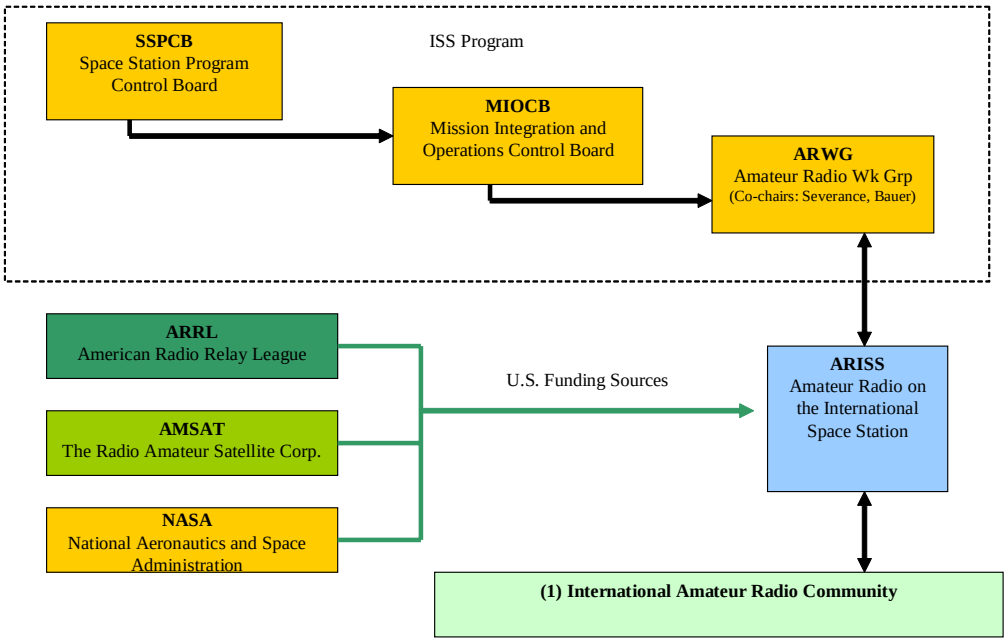
- Progress on Amateur Radio on the Columbus Module (ARCOL).
- Kenwood radio system and reprogramming efforts.
- SSTV status.
- ARISS hardware status including the Yaesu FT-817 radio, IBM A31 computer, power switching box.
- SuitSat-2 project.
- Discussion on planning to use our worldwide team for the Exploration *(Moon, Mars and Beyond)* Initiative.
- Next ARISS International Meeting, now planned for June 2009 at ESA/ESTEC, Noordwijk, the Netherlands.

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 Ops 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 US, Japan, Canada and Europe. The group continues to work with Energia to find management and cosmonaut representatives from Russia. The first ARWG meeting was held in Moscow, Russia on July 14-16. The meeting began with introductions and an overview and history of the ARISS program. Astronaut and cosmonaut training, school operations, SuitSat experiments, and spaceflight participants were discussed. Also covered were possible ARISS opportunities on the ISS. The group agreed that it should work with the space agencies' education offices to establish lesson plans with computer programs and hands-on activities and that these should be made available in several languages. It determined that the documentation on the on-orbit hardware configuration, the ARWG charter, and the ISS Program Office information on ARISS needs to be updated and maintained. ARWG also needs to work with the space agencies and other partners on ARISS funding.



ARWG Related Board Structure

Technical Interchange Meetings

GCTC TIM

ARISS members attended a Technical Team Interchange Meeting (TIM) at the Gagarin Cosmonaut Training Center (GCTC) on July 7 – 11. The purpose of the meeting was to address issues and coordinate training for the astronauts.

Technical Team TIM

Following the ARISS International Face to Face Meeting in Moscow, ARISS team members met at RSC Energia for a Technical Interchange Meeting on July 21 - 23. The team discussed the need for the Amateur Radio Working Group (ARWG) with Sergei Krikalev who agreed to assign management and cosmonaut representatives in the near future.

The team discussed the development of SuitSat-2 including the Kursk University experiment, the availability of an Orlan suit and battery data and availability. It also covered how the U.S. components should be delivered to Russia and talked about scheduling delivery dates, launch dates and an EVA for SuitSat-2 deployment.

Richard Garriott's mission was discussed. The team talked about his planned school contacts, personal contacts, tag-ups with the ground team and SSTV activities.

Options on how to restore the Kenwood D700 radio to its launch configuration were also addressed. It was agreed to test the computer and cable and to then reprogram the Kenwood using the Memory Control Program (MCP) software. If reprogramming failed, the backup radio would be sent to the ISS.

Program Evaluation/ Outcomes/Continuity

Teachers evaluate the ARISS program after their contact with the ISS by submitting a NASA Education Evaluation Information System (NEEIS) report. 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 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

- 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.

- An ARISS contact took place between Glenden State School in Queensland, Australia and Sunita Williams, KD5PLB, in April 2007. In January 2008 the school was presented with an Australia Day Award in recognition of the contact. The mayor who bestowed the award noted that the contact was a very unique educational outreach activity which involved the community.

- On February 14, *Universe Today* published an article, "I Heart the ISS: Ten Reasons to Love the International Space Station." Reason number six cited ARISS and EarthKAM as educational programs that the general public can participate in.

- "I would like to express my appreciation of the work everyone is doing. I work at the Herstmonceux Science Centre in England and interrupted an astronomy lecture this evening so that our students could listen to the ISS exchange with the school in

Canada. It would be an understatement just to say that our students (of all ages) were impressed with the way the astronaut handled the questions and the magic opportunity ARISS afforded the pupils of the school involved. On behalf of everyone at the centre, a very big thank you." - Stuart Constable, M0CHW, on the Isummasaqvik School contact in Quaqtaq, Quebec, Canada

- Gaston Bertels, ON4WF, ARISS delegate and mentor, was inducted into *CQ* magazine's Amateur Radio Hall of Fame for making a significant contribution to amateur radio and our planet. 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. He was then recognized at the Ham Fair in Friedrichshafen, Germany (Europe's largest ham convention) for his many contributions to amateur radio including his dedication to ARISS and his work on the Columbus antennas.

- ARISS International Chairman, Frank Bauer, KA3HDO, received a "2008 Outstanding Aerospace Engineer Award" from the Purdue University Aerospace Engineering Department. This award is given to less than 2% of the Aerospace Engineering Alumni. The primary NASA employees selected previously for this award were astronauts. One factor in his reception of this award was his high impact work to inspire students, world-wide, in STEM careers through ARISS.

- Spaceflight Participant Richard Garriott was very pleased with his support from ARISS and the ham radio community while on ISS. He stated, "On my recent flight I had the great opportunity to speak directly with and trade call signs with hundreds of hams around the globe. For me it was an unexpected joy to find so many enthusiastic hams, who were so well informed and interested in my activities in orbit…I understood how well "networked" the global ham community really is. I received specific reports back through Mission Control-Moscow about technical aspects of my work and how the community was enjoying the transmissions. This redoubled my enthusiasm to do quality work for the amateur radio legions around the world as I realized how much it meant to those with whom I had the chance to talk…On those last days (of my flight) I was very moved when sent many "soft landing" messages from individuals and classrooms full of children as I passed by. The ham community has added greatly to my personal feelings of success on my flight. I can only hope that you enjoyed it as much as I did."
  Thanks so much and 73, Richard, W5KWQ

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 NEEIS FY2008 Final Program Report

Appendix B ARISS Metrics 2008
U.S. School Contacts FY2008, Diversity by State

Appendix C ARISS Roles and Responsibilities

Appendix D Launching Dreams: The Long-term Impact of SAREX and ARISS on Student Achievement, Patricia Palazzolo, KB3NMS

Appendix E Telebridge Stations Maps

Appendix F School Contact Maps

Map, ARISS-USA Radio Contacts, FY2008

Map, ARISS-USA Radio Contacts through FY2008

Map, ARISS-International Radio Contacts through FY2008

Appendix A

NEEIS FY2008 Final Program Report*

*The NEEIS FY2008 numbers are incomplete. ARISS typically touches 15,000 students/year.

FY2008 FINAL PROJECT REPORT

General Information

Project Title: Amateur Radio on ISS (ARISS)

Project Manager:
Name: Edward Pritchard
Email: edward.j.pritchard@nasa.gov
Phone: 281-483-4212
Report Entry/Update Date: Dec-2008

Project Information

1. Primary Project Type:

(X) NASA-Wide ( ) Center-Unique ( ) Directorate:

Primary Directorate - Project Lead:
( ) Exploration Systems
(X) Space Operations
( ) Science
( ) Aeronautics Research
( ) No Directorate

( ) Partnership ( ) Multi-Center

2. Project Category:

(X) Elementary and Secondary
( ) Higher Education
( ) Minority University Research and Education Program
( ) e-Education
( ) Informal Education

3. Project Focus:

( ) Teacher/Faculty Preparation and Enhancemen
(X) Student Support
( ) Curriculum Support and Dissemination
( ) Education Technology
( ) State Based Improvement
( ) Research and Development

4. Objectives and Measures Details:

( ) Outcome One: Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals, through a portfolio of investments, (Higher Education -- Employ & Educate)
Categories, Objectives:

( ) 1.1 Faculty and Research Support

( ) 1.2 Student Support

( ) 1.3 Student Involvement Higher Education

( ) 1.4 Course Development

( ) 1.5 Targeted Institution Research and Academic Infrastructure

Output Measures:

( ) Measure 1.1.1 ( ) Measure 1.2.1 ( ) Measure 1.3.1 ( ) Measure 1.3.2

( ) Measure 1.4.1 ( ) Measure 1.4.2 ( ) Measure 1.5.1 ( ) Measure 1.5.2

Outcome Measures:

( ) Measure 1.1.2 ( ) Measure 1.1.3 ( ) Measure 1.2.2 ( ) Measure 1.2.3

( ) Measure 1.3.3 ( ) Measure 1.3.4 ( ) Measure 1.3.5 ( ) Measure 1.4.3

( ) Measure 1.4.4 ( ) Measure 1.4.5 ( ) Measure 1.5.3 ( ) Measure 1.5.4

( ) Measure 1.5.5

Efficiency Measures:

( ) Measure 1.1.4 ( ) Measure 1.1.5 ( ) Measure 1.2.4 ( ) Measure 1.2.5

( ) Measure 1.3.6

(X) Outcome Two: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty, (Elementary and Secondary Education -- Educate & Engage)
Categories, Objectives:

( ) 2.1 Educator Professional Development-Short Duration

( ) 2.2 Educator Professional Development-Long Duration

( ) 2.3 Curricular Support Resources

( ) 2.4 Student Involvement K-12

Output Measures:

( ) Measure 2.1.1 ( ) Measure 2.2.1 ( ) Measure 2.2.2 ( ) Measure 2.3.1

( ) Measure 2.3.2 ( ) Measure 2.3.3 ( ) Measure 2.4.1 ( ) Measure 2.4.2

( ) Measure 2.4.3 ( ) Measure 2.4.4

Outcome Measures:

( ) Measure 2.1.2 ( ) Measure 2.1.3 ( ) Measure 2.2.3 ( ) Measure 2.2.4

( ) Measure 2.2.5 ( ) Measure 2.2.6 ( ) Measure 2.2.7 ( ) Measure 2.3.4

( ) Measure 2.3.5 ( ) Measure 2.4.5 ( ) Measure 2.4.6 ( ) Measure 2.4.7

() Measure 2.4.8 ( ) Measure 2.4.9

Efficiency Measures:

( ) Measure 2.1.4 ( ) Measure 2.2.8 ( ) Measure 2.2.9 ( ) Measure 2.2.10

( ) Measure 2.3.6 ( ) Measure 2.3.7 ( ) Measure 2.3.8

( ) Outcome Three: Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission, (Informal Education -- Engage & Inspire)
Categories, Objectives:

( ) 3.1 Resources

( ) 3.2 Professional Development for Informal Ed Providers

( ) 3.3 Informal Education Provider Involvement Opportunities

Output Measures:

( ) Measure 3.1.1 ( ) Measure 3.1.2 ( ) Measure 3.1.3 ( ) Measure 3.2.1

( ) Measure 3.2.2 ( ) Measure 3.3.1 ( ) Measure 3.3.2 ( ) Measure 3.3.3

( ) Measure 3.3.4

Outcome Measures:

( ) Measure 3.1.4 ( ) Measure 3.1.5 ( ) Measure 3.1.6 ( ) Measure 3.2.3

( ) Measure 3.2.4 ( ) Measure 3.3.5 ( ) Measure 3.3.6 ( ) Measure 3.3.7

Efficiency Measures:

( ) Measure 3.1.7 ( ) Measure 3.1.8 ( ) Measure 3.2.5 ( ) Measure 3.2.6

( ) Measure 3.2.7 ( ) Measure 3.3.8 ( ) Measure 3.3.9

Global Efficiency Measures - Applicable to all outcomes and objectives.
Efficiency Measures:

( ) Efficiency 1 ( ) Efficiency 2 ( ) Efficiency 3

Primary Objectives:

( ) 1.1 ( ) 1.2 ( ) 1.3 ( ) 1.4 ( ) 1.5

( ) 2.1 ( ) 2.2 ( ) 2.3 ( ) 2.4

( ) 3.1 ( ) 3.2 ( ) 3.3

Secondary Objectives:

( ) 1.1 ( ) 1.2 ( ) 1.3 ( ) 1.4 ( ) 1.5

( ) 2.1 ( ) 2.2 ( ) 2.3 ( ) 2.4

( ) 3.1 ( ) 3.2 ( ) 3.3

5. Project Content:

( ) Science, Technology, Engineering, Math or Geography (STEM)

(X) Aerospace

(X) Other

Project Details Information

1. Applicants : 0

2. Location of Project Activities :

(X) NASA Center(s) (X) Museum/Planetarium(s)

(X) University Campus(es) ( ) Industry or Private Sector Facilities

(X) Community College Campus (X) Elementary/Middle/High School(s)

(X) Community Facilities ( ) Other

3. Project Activities Techniques and Resources :

(X) Computer Training	(X) Mentoring (K-12 or College Students)
(X) Demonstrations	(X) Movies/Video
(X) Group Discussions	(X) Problem Solving Activities
(X) Hands On Activities	(X) Research Analysis
(X) Field Trips	(X) Team Activities/Projects
(X) Independent Study	(X) Textbooks
(X) Interdisciplinary Activities	(X) Tours
(X) Internet/Communications Technology Training Sessions	( ) Video Teleconferences
( ) Investigation	( ) Working Group
( ) Laboratory	( ) Other
(X) Lectures	

4. Standards (Was support provided for any of the following standards?):

(X) National Mathematics Standards	(X) National Science Standards
(X) National Geography Standards	(X) National Technology Standards
(X) State Frameworks	(X) Local Frameworks
( ) Other	( ) Not Applicable

5. Participant Products (By end of the project, the participants prepared one or more of the following.):

(X) Action Plan	(X) Research Proposal
(X) Article for Publication	Report
(X) Presentation for a Conference	(X) Oral
(X) Course Outline/Revision	(X) Written
(X) Course Problem Set/Activity	( ) Software
(X) Drawing or Art	( ) Teacher's Manual
(X) Journal/Lab Workbook	Teaching/Learning Activity using:
Lesson Plans using:	( )Experienced-Based Activity
(X) Experienced-Based Activity	( ) Scientific/Engineering Methods of Inquiry
(X) Scientific/Engineering Methods of Inquiry	( ) Technology
(X) Technology	( ) Interdisciplinary Approaches
(X) Interdisciplinary Approaches	( ) NASA Materials
( ) NASA Materials	( ) Technical Paper for Publication
(X) Multimedia Product (includes video)	(X) Educational Video
(X) Physical Model or Product	( ) No Product Required
(X) Portfolio	( ) Other

(X) Project Design

(X) Research Paper

6. Project Content :
(X) Science (X) Mathematics (X) Engineering (X) Technology ( ) Other

7. Networking and Electronic Resources :

Does the Project provide some means to promote ongoing communications among participants after the Project is over?
(X) Yes ( ) No ( ) Not Applicable

Did the Project introduce participants to NASA On-line Resources?
(X) Yes ( ) No ( ) Not Applicable

8. Multiplier Effect :

Did you take any actions to encourage and/or facilitate a "multiplier" effect to extend the benefits of the Project beyond participants once the Project is over?
(X) Yes ( ) No ( ) Not Applicable

9. Underrepresented Groups :

Did you take any actions to make your Project announcements and information available to members of various populations which are generally underrepresented?
(X) Yes ( ) No ( ) Not Applicable

10. Funded (The project funded the following for the participants.) :

( ) Course fees/Credits Paid/CEU
( ) Expenses/Per Diem
( ) Fellowship/Scholarship
( ) Grant
( ) Materials, books to be kept by the participant
( ) Membership in a Professional Organization
( ) Stipend/Honorarium
( ) Other

Resource Details Information

1. Funding :

Total

Funds from Educational Organizations/Institutions: $0

Funds from Educational Organizations/Institutions:	$0
Other:	$0
Total Funding:	$0

2. Staffing :

( ) This Program is primarily managed by a contractor/grantee

(X) This Program is primarily managed by NASA staff.

Number of NASA Civil Servants involved :

	Total
Administrative	0
Astronauts	0
Audio/Video Specialists	0
Computer Specialists	0
Education Specialists	0
Engineers	0
ERC Staff	0
On-line Resources Specialists	0
Pilots	0
Program/Project Managers	0
Scientists	0
Support Staff	0
University Affairs Officers	0
Total NASA Civil Servants:	0

TOTAL NUMBER OF PRESENTATIONS: 0
TOTAL NUMBER OF PRESENTERS: 0

Total number of NASA presenters: 0
Total number of contractor presenters: 0
NUMBER OF RETIREES (NON-NASA AND/OR NASA): 0

3. Partnerships/Collaborations - Rollup :

	Total
NASA Contractor Partnerships/Collaborations:	0
Other Industry Partnerships/Collaborations:	0
Community/Local Partnerships/Collaborations:	0
Museum/Planetarium Partnerships/Collaborations:	0
Non-Profit Partnerships/Collaborations:	0
Other Federal Agency Partnerships/Collaborations:	0
Higher Education Institution Partnerships/Collaborations:	0
Other NASA Center Based Partnerships/Collaborations: (not including the ED Branch or PAO if it is separate from the Education Office)	0
Other NASA HQ Program Office Partnerships/Collaborations:	0
K-12 School Partnerships/Collaborations:	0
K-12 School District Partnerships/Collaborations:	0
Professional Society Partnerships/Collaborations:	0
State Government Partnerships/Collaborations:	0
Education Resource Center Partnerships/Collaborations:	0
Community College Partnerships/Collaborations:	0
Total Partnerships/Collaborations:	0

4. Fellowships and Scholarships :

	Total
Students 9-12:	0
Undergraduate Students:	0
Graduate Students:	0
Post Doc:	0
Other:	0
Total Fellowships and Scholarships:	0

5. NASA Materials Distributed - Rollup :

	Total
Total Number of NASA educational materials (videos, publications, wall posters,-- not patches, pencils, bookmarks, etc.) distributed:	0
Number of NASA individual educational materials demonstrated by presenter(s) during the Program:	0

6. NASA Facilities :

( ) Drop Tower

( ) Ground Trainers

( ) Hanger

( ) Control Room

( ) Drop Tower

( ) Ground Trainers

( ) Hanger

( ) Laboratories

( ) Launch Pad

( ) Maintenance Facilities

3. Students:

( ) Wind Tunnel

Participant Counts Information

A. DIRECT PARTICIPANTS:

1. Teachers:

K-4:	288	53
5-8:	1,041	1,054
9-12:	1,567	2,500
Community College:	612	800
4 year undergraduate:	61	0
4 year undergraduate/graduate:	171	0
*Pre-Service Teachers:	2	0
Post Doctoral:	5	0
Total Students:	3,745	4,407

**The "Preservice Teachers" are not included in any totals. It is assumed that these participants will be reported under some other category e.g. 'Undergraduate Students', etc.*

4. Additional Participants:

	Physical Presence Number	Distance Learning Number
Administrators:	222	2
Civic Group:	1,826	126
Education Specialists:	139	3
Parents:	1,010	157
Professional:	153	15
Other:	907	12
Total Additional Participants:	4,257	315

TOTAL OF ALL DIRECT PARTICIPANTS: 13,144
(From A) (System Generated)

	Number	Number
K-4:	288	53
5-8:	1,041	1,054
9-12:	1,567	2,500
Community College:	612	800
4 year undergraduate:	61	0
4 year undergraduate/graduate:	171	0
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Education Specialists:	139	3
Parents:	1,010	157
Professional:	153	15
Other:	907	12
Total Additional Participants:	4,257	315

TOTAL OF ALL DIRECT PARTICIPANTS: 13,144
(From A) (System Generated)

B. EDUCATION OUTREACH/ANONYMOUS PARTICIPANTS:

1. Education Community:

Conferences/conventions, museums/booths	37236
Estimated Newspaper/Magazine Audiences	4,118,165
Estimated TV/Radio Broadcast Audiences	11,040,095
Estimated CD-Rom Users	10,602
Web Audiences: Unique IP Addresses (*not included in totals below)	4,886
Other:	4,068
Total General/Outreach:	**15,210,166**

TOTAL OF ALL OUTREACH PARTICIPANTS: 15,210,166
(From B) (System Generated)

GRAND TOTAL OF ALL PARTICIPANTS: 15,227,699
(System Generated)

	Participants (number)
Conferences/conventions, museums/booths	37236
Estimated Newspaper/Magazine Audiences	4,118,165
Estimated TV/Radio Broadcast Audiences	11,040,095
Estimated CD-Rom Users	10,602
Web Audiences: Unique IP Addresses (*not included in totals below)	4,886
Other:	4,068
Total General/Outreach:	**15,210,166**

TOTAL OF ALL OUTREACH PARTICIPANTS: 15,210,166 (From B) (System Generated)

GRAND TOTAL OF ALL PARTICIPANTS: 15,227,699 (System Generated)

Summary Information

1. Comments:

Appendix B

ARISS Metrics FY2008

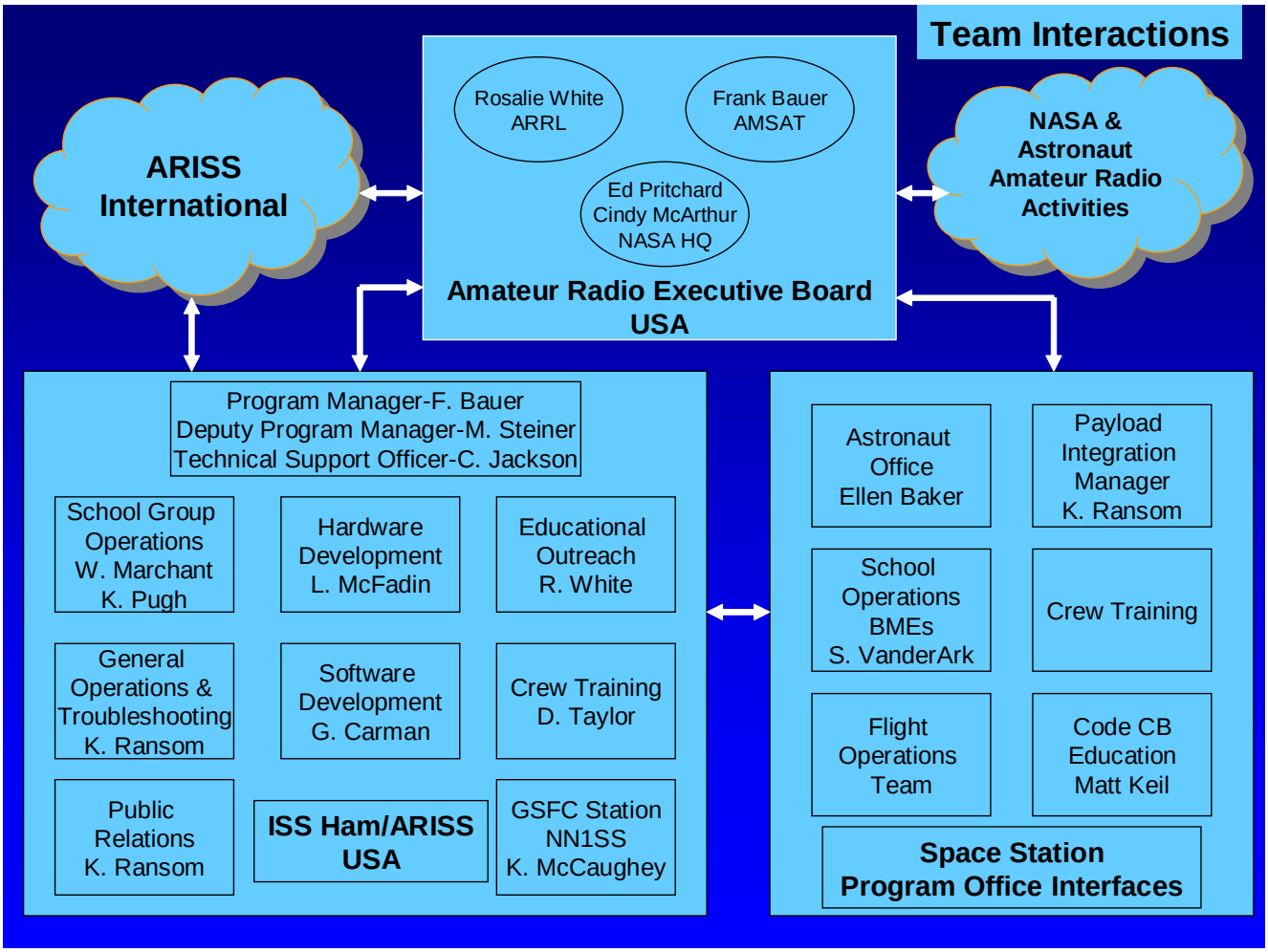
Total number of school contacts	40
Contact audio on VoIP/Web cast	22
International contacts	29
U.S. school contacts	11
Total rural school contacts	5
U.S. rural school contacts	1
NASA Explorer Schools	0
Title 1 schools	1
Informal education contacts	21

U.S. School Contacts FY2008, Diversity by State

School or Event	City, State	Enrollment	% Caucasian	% African American	% Hispanic	% Asian	% Multiracial	% American Indian or Native Alaskan	% Economically disadvantaged	% Special Ed or IEP	% Limited English
California											
Los Padres Council Troop 105	Santa Barbara, CA	100									
District of Columbia											
NASM Space Day	Washington, D.C.	200									
Florida											
Arnold Palmer Hospital	Orlando, FL	30									
Illinois											
Prairielands Council, BSA	Champaign, Illinois	3000									
Prairielands Council, BSA	Champaign, Illinois	300									
New Jersey											
Central Middle School	West Parsippany, NJ	755	57	4	9	30			12		
Town of Berkeley Heights	Berkeley Heights, New Jersey	200									
Ohio											
Challenger Learning Center of Lucas County	Oregon, Ohio	80									
Texas											
Robinson Elementary	Robinson, TX	295	78	4	16	<1		1	30	8	<1
Round Rock Texas Scouts	Round Rock, Texas	100									
United Space School	Seabrook, TX	35									

Appendix C

ARISS Roles and Responsibilities



Appendix D

Launching Dreams: The Long-term Impact of SAREX and ARISS on Student Achievement, Patricia Palazzolo, KB3NMS

Abstract

At the beginning of the 21st century, NASA described its educational mission a objective in terms of "inspiring the next generation of explorers . . . as only NASA can." Thanks to the dedication of the amateur radio community, over 300 successful school contacts have taken place through Amateur Radio on the International Space Station (ARISS), with a future schedule set to average one contact per week. Prior to ARISS, well over 200 school-to-shuttle contacts were accomplished via Shuttle Amateur RAdio EXperiment (SAREX). Each event was filled with eager students, proud parents and teachers, and excited members of the media who could not help but be caught up in the thrill of it all! But, what happened *after* the last student squeezed in a question before the orbiter or ISS moved out of the "footprint". . . *after* the glow of that "fifteen minutes of fame" had dimmed. . .*after* the return to homework, tests, football practice, and music lessons? The question remains: Has indeed this "next generation of explorers" been inspired? Has the SAREX/ARISS experience actually made a positive difference in students' lives?

NASA's new approach to education acknowledges that inspiration provides the base, but it must lead to engagement, followed by education, and finally employment. In this "case study" paper, a veteran teacher will trace the nearly two-decade history of her students' involvement with SAREX/ARISS from their middle school days to their current careers. She will follow their paths to illustrate how their involvement in these programs at a young age contributed to the inspiration that – as NASA's current approach to education emphasizes – has continued to engage them in science and technology throughout their lives.

About the Author

Patricia Palazzolo is a grade 7 – 12 Gifted Coordinator in the Upper St. Clair (PA) School District, but is probably best known as "Pennsylvania Teacher-in-Space." In 1985, she was named Pennsylvania finalist for what was to become the ill-fated Challenger mission. In that role, she has addressed over 50,000 Americans and conducted teacher workshops from Colorado to New Brunswick. Her students have sent sea-monkeys and Chia Pet seeds into orbit with John Glenn, spoken with cosmonaut Sergei Krikalev while he circled the Earth as the first Russian on the American space shuttle, and contacted astronaut Mike Fincke on the International Space Station via amateur radio. Pat was the 2002 recipient of the Anne Morrow Lindbergh K-12 Aerospace Educator Award.

Launching Dreams: The Long-term Impact of SAREX and ARISS on Student Achievement

Patricia Palazzolo, KB3NMS

Introduction

NA1SS, this is WB4GCS on Primary. . .

NA1SS, this WB4GCS on Primary. . .

Nothing but static.

NA1SS, this is WB4GCS on Secondary. . .

Uh oh! At that, my heart nearly stopped! Secondary. . . and still no response? What was wrong? The huge room was filled with students, family members, teachers, and members of the media . . . and all eyes were glued to the wall-sized tracking screen. We could see that the International Space Station was in the "footprint" over Piittsburgh, yet we heard nothing. Would the months of preparation leading up to this moment end in disappointment?

Once again, the calm voice of our amateur radio "wizard," Jim Sanford:

NA1SS, this is WB4GCS on Primary. . .weak but readable. . .

And then we **all** heard it!

WB4GCS, this is the International Space Station, NA1SS. Your signal is getting stronger.

The collective breath released by all, and the brightness of the grins on every face, seemed powerful enough to blast us all into orbit without a shuttle! The excited students began their Q & A with Expedition 9 astronaut Mike Fincke. . . but, in fact, the opportunity for this exchange had its beginnings fifteen years earlier with an entirely different group of eager middleschoolers.

Orbiting the Turnpike

Back in 1985, over 11,000 teachers completed lengthy applications in hopes of becoming NASA's first "Teacher-in-Space." After a long and grueling selection process, two teachers were chosen to represent each state and US territory. I was thrilled to be selected as one of the two Pennsylvania representatives. I was assigned to the same training group as New Hampshire teacher Christa McAuliffe; after Christa's eventual selection as America's Teacher-in-Space, I was both pleased and honored that NASA appointed the remaining state finalists "Space Ambassadors" and assigned us the task of promoting aerospace education in our home states. In the months leading up to the Challenger launch I, like the rest of the Teacher-in-Space finalists, received requests to drive ever farther to conduct school assemblies, run teacher workshops, and give speeches. The public was definitely caught up in the dream.

The nightmare came that January.

3—2—1—Liftoff! I watched Challenger rise, brighter than the sun, into that clear blue sky and heard the voice of the Public Affairs Officer come over the loudspeakers at the viewing site: *Obviously a major malfunction. . .the vehicle has exploded.*

I returned to Pennsylvania to find a blur of phone calls, cameras in my face and questions -- questions as to possible damage to children's psyches, questions as to whether the Teacher-in-Space Project had been nothing more than a public relations stunt, and questions as to whether we should be spending any money at all on the space program. What I did *not* return to find was any lack of the ability of space exploration to continue to inspire students and teachers.

And so it was on a warm spring day in 1989 that I received a phone call out of the blue from Mary Ellen Chuss-Mirro, a dynamic teacher in the small Sacred Heart School in the small town of Bath on the opposite side of Pennsylvania. She had read that I was "NASA Space Ambassador" to the state and wondered if I had any ideas for "experiments" her middle school students could conduct to keep them busy so they would not "drive her husband crazy" while he drove them around the Bethlehem Raceway on a two-hour "mission" in the van that they had converted into a "space shuttle." I came up with several suggestions and, intrigued, called her back several weeks later to find out if the mission had been a success. Delighted with the outcome and bubbling with enthusiasm, she said her only concern was that she did not know how she would "top it" the following year.

"I do," I said, "Come on a mission across the entire state! My students will serve as Mission Control for your orbiter!"

The detailed planning would have made NASA proud. . . police escorts set up along the way, stops arranged at various venues on the route (including a special welcome by the Governor in Harrisburg), experiments designed, a special "rover" built to be used to explore "Planet Pittsburgh" upon the crew's arrival, and computer tracking programs written by my students so they would be able to provide hourly reports to our entire student body about the location, speed, fuel consumption rate, and likely "landing" time of the "orbiter," known as *Missioner II*.

A real coup on our part, or so we thought, was having secured the use of a cell phones for the duration of the mission across the Commonwealth. At that time, very few "average people" had ever used, let alone owned, a cell phone. We were grateful to the company that donated the equipment and usage time of this "new-fangled" high-tech device that would help our Mission Control stay in touch with the van-turned-shuttle.

After a year of preparation, *Missioner II* blasted off on April 30, 1990 and began its five-day journey across Pennsylvania . . .and for much of the mission, the "new-fangled" high tech device known as a cell phone was useless. Fortunately, a couple of local hams, Seth Ward KC3YE (SK) and his son Glenn N3EKW, graciously volunteered to serve as our "back-up" communications system.

Not only was their ability to communicate with the van-turned-shuttle instrumental to the mission's success, it provided excitement and a genuine "Mission Control" feel to our site. The students loved seeing the radio equipment and hearing the details of the orbiter's progress across the state over the speakers. As the "shuttle" drew closer and closer to Pittsburgh, we began to hear other hams talking about it over the radio.

Did you just see that? Is that a space shuttle on the Turnpike?

On "final approach," I was a bit concerned about *Missioner II*'s clearance coming through one of Pittsburgh's famous tunnels. After hearing our ham radio volunteers discussing our tunnel situation, a ham listening in from a station in a rival school district could not contain his curiosity. He called to ask us just *what* we were trying to bring in through the tunnel. He had assumed it was some kind of big truck . . . until he heard the words "wingspan" and "tail height." Our students got a good laugh when they heard him joke, "That's Upper St. Clair for you . . . always having to show off!"

The excellent work of our amateur radio volunteers saved the day. Our eighth grade Mission Control team was able to track the shuttle to a perfect landing at our front entrance. The entire school stood outside to cheer her arrival. She was indeed an amazing sight moving down the street with a motorcycle police escort, firing 40,000 cubic feet of non-toxic smoke out of the main engines! (Yes, the firing of the main engines should not happen during a landing, but middleschoolers who have been meticulously tracking an unseen object for almost a week want to see smoke and hear noise at the end.) *Missioner II* impressed even former astronaut Joe Allen, who was kind enough to join us for the event. (My "Mission Control" students had met him when they won a trip to the Hubble launch for their design of a shuttle experiment about soap bubble kinetics in microgravity.) He grinned, patted her wing, and called her a "really slick vehicle."

The help we received from ham radio volunteers in tracking the van-turned-shuttle led to my "next generation" of students tracking the **real** thing just four years later.

From Mars to the Stars

During the same period I was working with the teacher in Bath on plans for *Missioner II*'s journey across the Commonwealth, I was contacted by visionary community members from a town much closer to Pittsburgh – Mars (yes, Mars!) Mars is about a 45-minute drive north of Pittsburgh, but at that time, was rather rural in nature. The members of the Mars Area Foundation for Education Enrichment (MAFEE) contributed funds to provide special educational and cultural experiences to help their students realize that they were part of the world.

So, what special experience did the students seek? They wrote to then-Soviet leader Mikhail Gorbachev to inquire, "Wouldn't you like the Russians to be the first to visit Mars – Pennsylvania, that is!" Never believing that they would actually receive a response, they were stunned by the arrival of a brief telex stating only that "Cosmonaut Hero Sergei Krikalev will visit the children of Mars in three weeks."

The students then wrote to NASA and said, "You're not going to let the Russians beat us to Mars, are you?" And so it was that Astronaut Mario Runco, Jr. joined Cosmonaut Sergei Krikalev for the first US-Soviet mission to Mars (Pennsylvania!)

And so it was, too, that I was called upon to serve as a true "Space Ambassador" . . . especially when Sergei arrived alone, had no return ticket on Aeroflot, we had no translator available, and the nation he came from was still known as the USSR. Everyone was so grateful to have him as a guest for an entire week, but so nervous about making mistakes. We need not have been concerned. From making school visits to attending Pittsburgh Pirate games to serving as the grand marshal of a community parade, Sergei charmed us all.

Therefore, everyone took interest in his next mission to Mir. He was, after all, "our" cosmonaut. It was May of 1991 -- one year after our special shuttle-van-across-Pennsylvania event. My students who had, as eighth graders, served as Mission Control were now nearing the end of their first year of high school. They had all maintained their interest in science and technology, taking high-level courses and volunteering at the science center. By this time, encouraged by our amateur radio volunteers, I had earned my own ham license.

Yes, in May of 1991, the students were excited to know someone on Mir, but that excitement turned to worry when the Soviet Union disintegrated and stories of Sergei Krikalev being "stranded" in space made headlines. I was able to see him at the Association of Space Explorers Conference in Washington DC in the summer of 1992, not long after he had finally returned to Earth as "the last Soviet citizen" . . . and the first thing he said to me was "Mars. . .the children?" He had realized that the students he had met during his visit might indeed have been concerned about his welfare. He smiled when I gave him a chocolate space shuttle made by a Pittsburgh-area candy company to take back to his little girl. I assumed that our paths would never cross again.

It was the following summer that an amazing set of circumstances came together: I learned about the opportunity for students to speak with astronauts aboard the space shuttle through a program called SAREX, I now knew some wonderful people in the amateur radio community who might be willing to help, and I found out that the first Russian ever to fly on the

American space shuttle was to be, of all people, Sergei Krikalev. Best of all, despite an incredibly tight schedule, Sergei's mission, STS-60, was to be a SAREX mission. There was just enough time to get an application in! There would be no guarantee that my proposal would be accepted, let alone assigned STS-60, but it was worth a try. For equipment and technical support, I turned to the North Hills and Butler Area Radio Clubs. I then approached the Mars Area School District with an offer I hoped they could not refuse: I would do all the work in writing the proposal, finding the volunteers, and planning the event -- if they would allow me to propose a joint effort between my school district and theirs. . . with half the question askers coming from my district . . .yet set everything up in Mars. (My own district never did quite understand why I based the event in Mars, rather than my own school. I explained to them that part of the SAREX application required explaining how one would attract the media. How could anyone resist headlines proclaiming that the shuttle had contacted "life on Mars," not to mention the fact that the first Russian to fly on the shuttle had already visited that town?)

The students who had tracked the shuttle-van as eighth graders were now high school seniors. I turned to them to design a method of engaging the "new generation" of middleschoolers in SAREX. How could they develop a fair method of selecting the few students who would actually have an opportunity to ask a question? Letters would be sent home to every middle school child in the district. On the *outside* of an envelope, interested students would write the question they would most like to ask an astronaut on orbit. All identifying information, as well as a signed permission slip, would be sealed *inside* the envelope. My team of former students would go through all the questions and pick the best ones. Only then would the envelopes be opened and the identities of the question writers revealed.

I submitted our SAREX proposal . . . and waited.

When our proposal was accepted as one only five sites in the world to be scheduled for a SAREX contact with STS-60, there was joy in both school districts. With the help of some local hams, I began a series of assemblies to excite and inform all the students in both areas about amateur radio and space exploration. In the meantime, my team of twelfth graders took their assignment of question selection very seriously. They wanted to be sure to come up with the most important, most interesting, most diverse combination of questions possible. It was their way of passing their torch to this next generation of students.

When the envelopes were opened, we were pleased to find that the "official question askers" included an equal mix of boys and girls. All were excited about the upcoming opportunity. Fourteen students – half from Upper St. Clair and half from Mars, all from grade levels 5 through 8 – began to prepare for the big day that would come in February, 1994.

The morning of the contact day was electric. It seemed as if every newspaper and television reporter in Western Pennsylvania had descended on Mars Middle School. The "SAREX kids," sporting sweatshirts with a huge STS-60 logo on the front, proudly posed before a large banner that said "From Mars to the Stars." In between interviews, they practiced reading their questions so as to be prepared when it was their turn to hold the mike. The school's main office had been set up like Mission Control and overflow crowds were able to watch the event from the cafeteria and gym on closed circuit television. Back in Upper St. Clair, the school was open for the public to come in to watch the event unfold on a viewing screen set up in the auditorium. As the time for contact approached, a call from NASA informed us to which crew member the students would be speaking. "Looks like it's going to be Sergei," said the

voice. He could hear the cheer that erupted from the crowd. "I guess they're happy," he laughed.

We all watched the tracking program and saw the shuttle come into the footprint. Nothing. No response to our control operator's call. Tense silence as the shuttle moved away from the footprint. Finally, the voice from NASA told us that "something had come up" with the deployment of the Wake Shield Facility and that, essentially, Sergei "didn't have his ears on." I was proud of the students' response. They smiled bravely and told the media it was still exciting just to hear the radio attempts. I knew they were disappointed, but part of their preparation had been to learn that SAREX was considered **secondary** to other shuttle experiments and operations, and that a school would only have one opportunity for contact no matter what interfered. . . including other things that might "come up" on the shuttle. However, as we stood there, we heard the voice from NASA say, "Sergei would like to try again on the next pass, if you don't mind missing 90 more minutes of school." This time the cheer was even louder. The contact with Mars was being made via telebridge, so we were actually receiving the signal by bridge to a ham operator based in Australia and could thus wait for the shuttle's next pass.

The hour-and-a-half zipped by. Soon we heard our control operator calling the shuttle once again. . .and once again, there was no response. Wait. . . was that something? Perhaps. . .lots of static. . .no. . . the shuttle was out of range. The disappointment was palpable this time. (We later learned that the experts had a theory that the problem had something to do with a huge aurora.) Still, the students exhibited great dignity and maturity as they spoke of how it had been a "great learning experience."

At eleven o'clock that night, my phone rang. It was my SAREX mentor wanting to know if we would like to give it an unprecedented third try in about fifteen hours!

I began frantically calling fourteen families at midnight, trying to make arrangements for everyone to return to Mars in the morning. I made calls to the media, the volunteers, and to our dear control operator who lived almost two hours away. Everyone was willing to return.

In the morning, we woke up to an ice storm! The Mars District was closed, and my own had a two-hour delay. I kept in mind the poster I had hanging in my classroom: "You never fail unless you stop trying." There was no huge audience this time, but the amazing principal in Mars was able to get the Mars SAREX students in via police escort, our amazing control operator took a day off from work and braved the two-hour icy drive to set up the radio, and even a limited number of media returned. Unfortunately, there was no way to get my own SAREX students safely to Mars. The roads were just too bad. Then, I had an idea. I called the Johnson Space Center and asked if my kids could be patched in via speaker phone. At first, they did not like the plan, believing it would be too difficult to have first a student from Mars ask a question, followed by one from Upper St. Clair. The delay would be too great and it would be too confusing. I asked them to just please let us try. After testing the acoustics from various points in the classroom, Houston said the sound was the best when the speaker phone was placed on a chair near my desk.

As the shuttle approached the footprint (which we could not see because the equipment was in Mars), my students – on their knees – gathered around the chair, waiting for their turns to scream their questions into the speakerphone. Their parents formed a ring around them. There was no media. We waited tensely.

Then we heard the response for which we had been hoping:

This is U5MIR.

It was Sergei! This was followed by the first question, posed by one of the "Martians." My student shouted her question into the phone as soon as Sergei had completed his answer. The back-and-forth system was working well . . . until my school began dismissing buses early due to the increasingly bad weather. *Bus 43. . .Bus 71. . .* came over the PA system. The people in Houston informed us that they were hearing our bus announcements and threatened to cut us off. At that, some parents grabbed mousepads to tape over the speakers in the room while others raced to the main office to ask the principal to cut the announcements. The student questions continued successfully. At one point, a woman took Sergei's place in answering. It was difficult for him to make out children's voices, in English, over a less-than-ideal sound system. However, having the opportunity to speak with both Cosmonaut Sergei Krikalev and Astronaut Jan Davis on the first Russian-American shuttle flight was indeed very memorable! It was also a very special example of adults modeling persistence and teamwork for students. From the ham volunteers to the school administrators to the astronauts themselves, it was obvious that the willingness to be flexible and work hard could make important dreams come true!

4 The Next Generation: John Glenn, Sea- Monkeys, and Ch-ch-chia!

My special group of seniors felt good about having played a role in exposing my new generation of students to the wonders of science and technology. They headed off to college. . .Francesca to Georgetown with hopes of medical school. . . Noah to Notre Dame with plans for medical research. . . Kevin to USC for computer engineering. . . Amy to Cornell to study planetary science and earth systems. . .Joe off to Villanova for chemistry. . .Mike on to Michigan as a physics major. . . and others off to similar pursuits. As they departed, they kidded me: They had tracked a shuttle mock-up on the Turnpike. My next group of students had communicated with the genuine orbiter. What was to follow? Would my next students get to go into orbit themselves?

Not exactly. . . but thanks to the continued efforts of this "first generation" of students, my new group did get to send a "little piece of Upper St. Clair" into orbit. Over my many years of teaching, I have witnessed the imagination, learning, and accomplishments of my former students ripple out to touch others in wider and wider circles, like the rings of water from the proverbial pebble tossed in a pond. Amy continued following her passion for space science through college. At one point, while attending one of the very selective summer NASA Academies, she became friends with a grad student who had designed a ratchetless ratchet wrench that was going to be flown as a shuttle experiment. He had just a tiny bit of space remaining in his container and was musing about "some teacher" perhaps being able to have kids think of what to do with that space. Amy immediately responded, "I know just the teacher! I know just the kids!"

I received a phone call from her the very last week of school and was told that we had one week to try to design an experiment for that small bit of "leftover space". . . and that experiment had to meet all NASA's requirements or we would lose the opportunity. In short, my students had to operate as real scientists. My middle school students at first had difficulty

understanding that the experiment would be loaded into the shuttle during the summer and sit there for at least two months. . . so, no, they could not send up anything that was alive. . .and our allotted space was just a few test tubes. They finally hit upon the idea of sending Sea-Monkey (brine shrimp) eggs, since they would be able to "bring them to life" after their time in space. But they also wanted to send some flora along with their fauna. Suddenly, one of the students started singing the "Chia Pet" jingle: *Ch-ch-chia. . .Ch-ch-chia!* Why not? One never seems to see them for sale except at holiday time, so they must store well. The experiment design began in earnest, with the students working through much of the summer to meet NASA's standards. Most memorable was the day they were actually able to load their experiment into the special container NASA had sent us, and to place the mission patch they had designed themselves on that container. The patch depicted both a Sea-Monkey logo and Chia-pet sheep, as well as the students' own motto: *Let Our DREAMS Take Flight. . .* with "DREAMS" standing for "**D**oing **R**eal **E**xperiments **A**dds **M**eaning to **S**cience."

Throughout the design process, the students had known only that their experiment would fly on "a" mission. It turned out to be "**the"** mission of 1998: STS-95 -- 77-year-old John Glenn's return to space. That being the case, my little team received far more than their "fifteen minutes" of media attention. Nevertheless, the stars in their eyes were not so bright as to dim their excitement at viewing the launch and feeling humbled to realize that something they had put together was indeed being carried into orbit. And for Amy, now starting her Masters in Science, Technology, and Public Policy at George Washington University, it was another ripple in the pond. The students involved in this project began high school on fire and took advantage of every science and engineering opportunity throughout the next four years. When they were high school seniors, they finally had the opportunity to meet John Glenn and his wife Annie in person during the couples' visit to Pittsburgh. The Glenns generously spent half an hour with us privately. As I watched these students speaking to Colonel Glenn, I realized that their resumes now included Governor's School for the Sciences, several national awards for science and engineering projects, important summer internships, Eagle Scouts, and even the collection and refurbishment of thirty discarded wheelchairs that were then sent to poor hospitals in Vietnam. They had all been awarded scholarships to top universities – with one even having been already accepted for a full ride to medical school – and they had not yet officially graduated from high school!

5 The Adventure Continues: From SAREX to ARISS

Early in 2004, yet another opportunity presented itself.

I had a voicemail message at school asking me to call NASA . . . something about being a "crew pick" for an ARISS contact. What did that mean?

As it turned out, Pittsburgh astronaut Mike Fincke was going to be the Science Officer for Expedition 9 on the International Space Station. . . and he had selected my school with which to do an ARISS contact! I was thrilled, yet confused. I had never met Mike Fincke and he had never attended Upper St. Clair Schools. How did I get to be his "crew pick?" Why wasn't he going to do an ARISS with his own school? Was this a prank?

I soon learned that it was a genuine opportunity! Col. Fincke had promised an Upper St. Clair grad working in life sciences/countermeasures at the Johnson Space Center that, if he ever had the chance to go into space, he would do a school contact with the school of her choice. When his flight assignment came, he remained true to his promise and she, of course, selected her alma mater for contact. Although this particular young woman, Lesley Lee, had graduated before I began teaching in the district, she was aware of the kinds of special projects my students and the supportive community had been able to "pull off" over the years. This project would definitely require skill to be successful because, unlike the SAREX which had been difficult enough to accomplish in Mars, this would **not** be a telebridge. This was to be a "direct." Add to that the Upper St. Clair landscape, where every building was built into a hillside, and my concerns over finding a way to set up an antenna to clear both buildings and trees grew serious. For that matter, where could I even find someone with the right antenna? Where could I find someone who could set up the correct equipment?

I turned to my local amateur radio club -- WASH, the Wireless Association of South Hills who, in turn, engaged the cooperation of WACOM, Washington Area Communications. Their energy, passion, commitment, and expertise were boundless . . . even as the contact date kept slipping and everyone had to keep changing their vacation dates. They took over everything having to do with the set-up, from stringing wire through the school roof to splashy camera and sound set-ups to T-shirts! All I had to do was deal with the students.

This time, instead of middle school, I wanted to involve a range of ages. The students selected to ask questions represented each grade level from fourth through twelfth. I named them the "ARISS Ambassadors," and informed them that part of their job would be to act as my liaisons to each of their respective classes. I would call upon them to keep their classmates updated on information related to space, science, and technology throughout their years in the Upper St. Clair School system. It would also be my hope that, as they graduated and moved on to college and careers, they would continue the ripple-in-the-pond effect of contributing to others. . .including offering any learning opportunities possible to the "next generation" of students who would follow them.

. . .This is the International Space Station, NA1SS. Your signal is getting stronger. . .

Jim Sanford, WB4GCS, turns the microphone over to ninth-grader J.T. Gralka, who asks the first question, while Kevin Smith, N3HKQ, prepares the next student to quickly take his turn. I stand off-stage to guide each student who has asked a question safely clear of the next child leaving the platform. They are starry-eyed from the experience and I know that their minds are no longer connected to their body movements. I do not want to see a domino-style pileup

of my ARISS Ambassadors! I, too, am dizzy with excitement and grateful that someone is recording Mike Fincke's answers. I vaguely realize that he is responding in ways that range from humorous to poetic, but I cannot get my mind to register anything beyond, "The kids are talking to an astronaut on the ISS! It's really happening!" I become aware that the students have had the same experience when reporters begin to ask them what they think of the answers to their questions. I almost laugh when I see the puzzled look in their eyes as they suddenly realize that they can't remember what Mike just told them. It is fine. The details will return to our brains later. For now, it is enough just to bask in the glow of a successful ARISS and thank all those who have made it possible, just as we did over a decade ago after our SAREX with STS-60. A random thought passes through my mind. . . After beginning with a contact date of "anywhere between May and September," and through numerous "slips" of the "official date" once we had been given one, we have finally made successful contact on this date. . . August 27. . . today is Sergei Krikalev's,U5MIR's, birthday.

6 The "Next Generation of Explorers": NASA's Goal of Engagement, Education, and Employment

NASA's new educational mission has set goals that move beyond simply "inspiring" children to consider careers in science and technology. It is important for students to seek strong educational foundations in these fields as a means of retaining an interested, well-trained work force, as well as to engage the public in a "vision" that supports science, technology, and space exploration. Various reports of the monumental numbers of students, teachers, and the general public who have witnessed, heard, or read about SAREX and ARISS contacts have been issued over the years. I know that after a SAREX or ARISS contact, I have had to send the ARRL reports of "my numbers" in terms of live audience, those watching from satellite locations, teachers who may have been in-serviced, newspaper article readership, and even numbers who may have viewed a news story about it on television. Those statistics reveal the tremendous outreach of SAREX/ARISS. . . and no one can watch the faces of those viewing students talking via amateur radio to an astronaut and doubt the "inspiration factor," even for those who are simply "audience members."

However, it is vital that we consider the long-term **impact** of that inspiration. The students who were actually selected to ask a question, or in some cases, to help set up the equipment, are significantly smaller in number than those reported as "audience members." Yet, if the inspiration of that hands-on experience at a crucial age can inspire these children to pursue educations and enter careers at the passionate and "high quality" level which I have witnessed among my own former students, then the positive impact of SAREX and ARISS goes far beyond any numbers found in reports. All of my students who have participated in SAREX/ARISS -- or as the original "Mission Control" team tracking *Missioner II* across Pennsylvania – have gone on to phenomenal accomplishments and careers that contribute much to society. Almost all have opted for careers in science, technology, or science-related fields (such as MBAs working for technology firms or patent lawyers). There are many medical doctors and information technology specialists. One is now an amazing calculus teacher whose classroom is next door to mine! Therefore, I will highlight just a few examples

from each of my "generations of explorers." They now range in age from twelve-year-olds to professionals in their early thirties.

7 The "First Generation": *Missioner II* Mission Control Team

- **Noah Gray** – went on to Notre Dame and then finished a PhD in neuroscience at the Mayo Clinic, where he investigated vesicle trafficking and endocytosis before joining the Cold Spring Harbor Laboratory; he later conducted research at the Janelia Farm Research Campus (Howard Hughes Medical Institute) which is the world-class center known for bringing together the best scientists from many disciplines to collaborate on small teams to try to solve some of the world's most challenging problems; currently assistant editor of *Nature Neuroscience*, the top journal in its field
- **Joseph Pickel** –completed a BS in chemistry at Villanova, followed by a PhD in polymer chemistry at University of Akron; currently a polymer chemist at the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory in Tennessee; the center is the first of five nanoscience research centers funded by the US Department of Energy; Joe's research group is dedicated to "making polymers behave the way we want them to" so that they can be useful in fuel cells, making lighter and stronger cars, biomaterials, and more. . .and, in Joe's words, "I'm loving it!"; has also had to become an expert glassblower, since polymer chemists often have to make the supplies they need for their experiments

Joe Pickel's passion for science did not end in middle school. Today he is Dr. Joseph Pickel, a polymer chemist at the Oak Ridge National Laboratory. (KnoxNews)

- **Michael Weinberger** – finished his BS in physics at Michigan and a PhD in experimental particle physics at Cornell; currently working for Texas A&M University on the CDF experiment at Fermilab in Chicago, and the CMS experiment located outside Geneva, Switzerkand; in his most recent note to me, Mike said,"I am in the middle of working right now and am actually underground in France working of electronics for the CMS particle detector as I type this."
- **Amy (Snyder) Kaminski** – studied planetary science and Earth systems at Cornell, where she also added a minor in science journalism after having attended a shuttle launch with me with a press pass; became editor of Cornell's "Science and Technology Journal"; received a Masters in Science, Technology, and Public Policy at George Washington University, specializing in Space Policy, while also authoring a book with "space law expert," John Logsdon; has published many articles on astronomy, as well as articles on space tourism; is often a featured presenter at the very NASA Academies she attended as an undergraduate; did an internship with the Rand Corporation, then worked with the FAA Commercial Space Division as the "Office Lead" on both Space Tourism and Space Debris; on the Board of Women in Aerospace and is featured in a book about 100 powerful woman in the space industry, aimed at middle school girls; currently Space Programs Examiner for the Office of Management and Budget

Amy (Snyder) Kaminski participating in a NASA Academy as a college student. Today Amy is Space Programs Examiner for the White House.

While in college, Amy alerted a "second generation" of middleschoolers about an exciting opportunity to develop and fly an experiment on the shuttle.

8 The "Second Generation": SAREX and Sea-Monkeys

Students eager to see their experiment launch with John Glenn in 1998. Megen Vo is standing on the left, teacher Pat Palazzolo on the right. Sitting left to right are students Matt Muffly, Karl Zelik, Dan Zelik, and Dan Doan.

- **Megen Vo** – was featured in the Nickelodeon program *Figure It Out!* Panel had to try to figure out what was so special about the "pets" Megen had brought to the studio in Orlando (flying them in all the way from Pittsburgh) – of course, they were our actual sea-monkeys that had been to space with John Glenn back when they were just eggs; Megen is currently in medical school at Case-Western University
- **Matthew Muffly** – accepted into the Pennsylvania Governor's School for Health Care during high school (a highly selective summer program); has been a research assistant for a hand surgeon throughout college and has had an article published in the *Journal of Hand Surgery*; is about to start medical school
- **Daniel Doan** – became concerned about problems faced by hospitals in Vietnam which do not have enough wheelchairs for their patients; for his Eagle Scout project, he rounded up broken and discarded wheelchairs from area hospitals, took classes in how to repair them, and single-handedly refurbished thirty wheelchairs in his family's garage; faced with the problem of delivering them to Vietnamese hospitals, he was able to get the World Vision organization to send them; was granted a full scholarship to undergraduate studies *and* medical school by the University of Pittsburgh while still a high school senior; currently in medical school
- **Karl Zelik** –completed a BS in biomedical engineering at Washington University in St. Louis; spent undergrad summers working with mechanical hearts in Pittsburgh; this past year he worked developing bionic prosthetics at St. Jude Hospital ; currently working on his Masters in mechanical engineering at Michigan
- **Daniel Zelik** – received a full scholarship from Iowa to work on his Bachelors in industrial engineering, with a minor in psychology; as his co-op program, he spent months at a time working with NASA at the Johnson Space Center; currently working on his PhD in human factors engineering at Ohio State

9 The "Third Generation": The ARISS Ambassadors

Sarah Perrone and Matt Boyas with their award-winning Exploravision project.

- **Matthew Boyas** – on the Future Problem Solving Team that qualified to represent Pennsylvania at the International Future Problem Solving Finals, where the team finished Fourth in the world; three Honorable Mentions from Toshiba for papers submitted for the Exploravision Contest; in January, one of those papers will be featured in a textbook called *Nanotechnology 101* (Greenwood Publishing group); has served well as an ARISS Ambassador, including assisting me in running science events for my middle school students; currently a high school junior
- **Benjamin Burns** – perfect SAT scores, but equally strong in civic responsibility; was on the First Place Design, Engineering, & Fabrication team in high school; nationally ranked as a math student; currently an undergraduate at Harvard studying engineering and physics and also working in the Harvard Observatory

10 Conclusion

After more than two decades and well over 500 successful school contacts, have SAREX and ARISS served to "inspire the next generation of explorers. . .as only NASA can?" Reports that count the numbers of people "exposed" through these events to science and technology – and, more specifically, to both amateur radio and to NASA – reveal sky-high numbers. But in this paper – a longitudinal "case study" of one teacher's lengthy involvement with these activities over the course of her career – I have sought to provide

specific follow-ups of the students most deeply involved at the time. SAREX and ARISS inspire engagement, education, and employment through

- providing “hands-on” learning
- making real-world connections among disciplines
- requiring problem-solving while under the pressure of deadlines
- demanding excellent communication skills
- illustrating the importance of technology and the joy that sharing one’s skills can give to others
- allowing adults to model the power of passion, partnership, and persistence

Ham volunteers make Upper St. Clair’s ARISS a success!

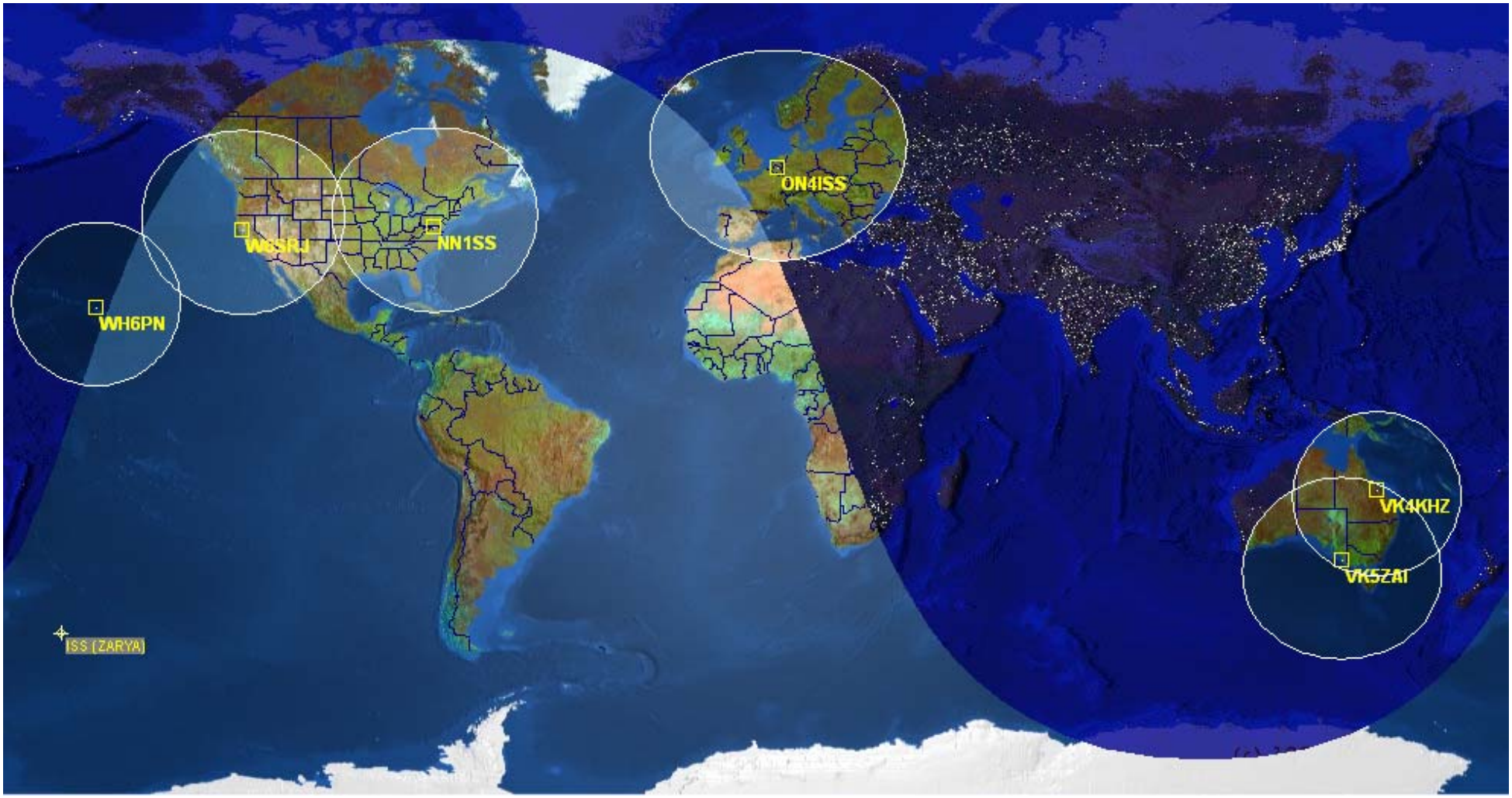
Back on Earth, astronaut Mike Fincke greets teacher Pat Palazzolo and two of the ARISS Ambassdors with whom he had spoken while on orbit.

My former students continue to work in exciting high-tech fields, and continue their willingness to help my "current generation" of students. Recently, I emailed a number of my old students requesting their help with an educational proposal for a shuttle downlink. The response was immediate and overwhelmingly positive. Mike Weinberger emailed me from underground in France, writing "I hope I am not too late to help with this project. I would love to help out the current students." From Tennessee, Joe Pickel wrote "I would LOVE to take part in this project. . .please tell me what you need and I will help out." Last spring, a team of my high school students made the national finals of an academic competition, for which they traveled to Washington DC. The highlight of the trip was a tour of the White House that Amy Kaminski was able to arrange for them.; more impressive than the tour, in their minds, however, was the fact that it was the "legendary Amy" herself who was accompanying them as they walked through the White House. Amy's willingness to "scramble" on last-minute notice to allow my students to participate in the tour. . . as well as Mike's and Joe's willingness to fit us into their hectic schedule. . .have roots, I am certain, that go back to the amateur radio and other volunteers who gave of their time and expertise when these students were so young.

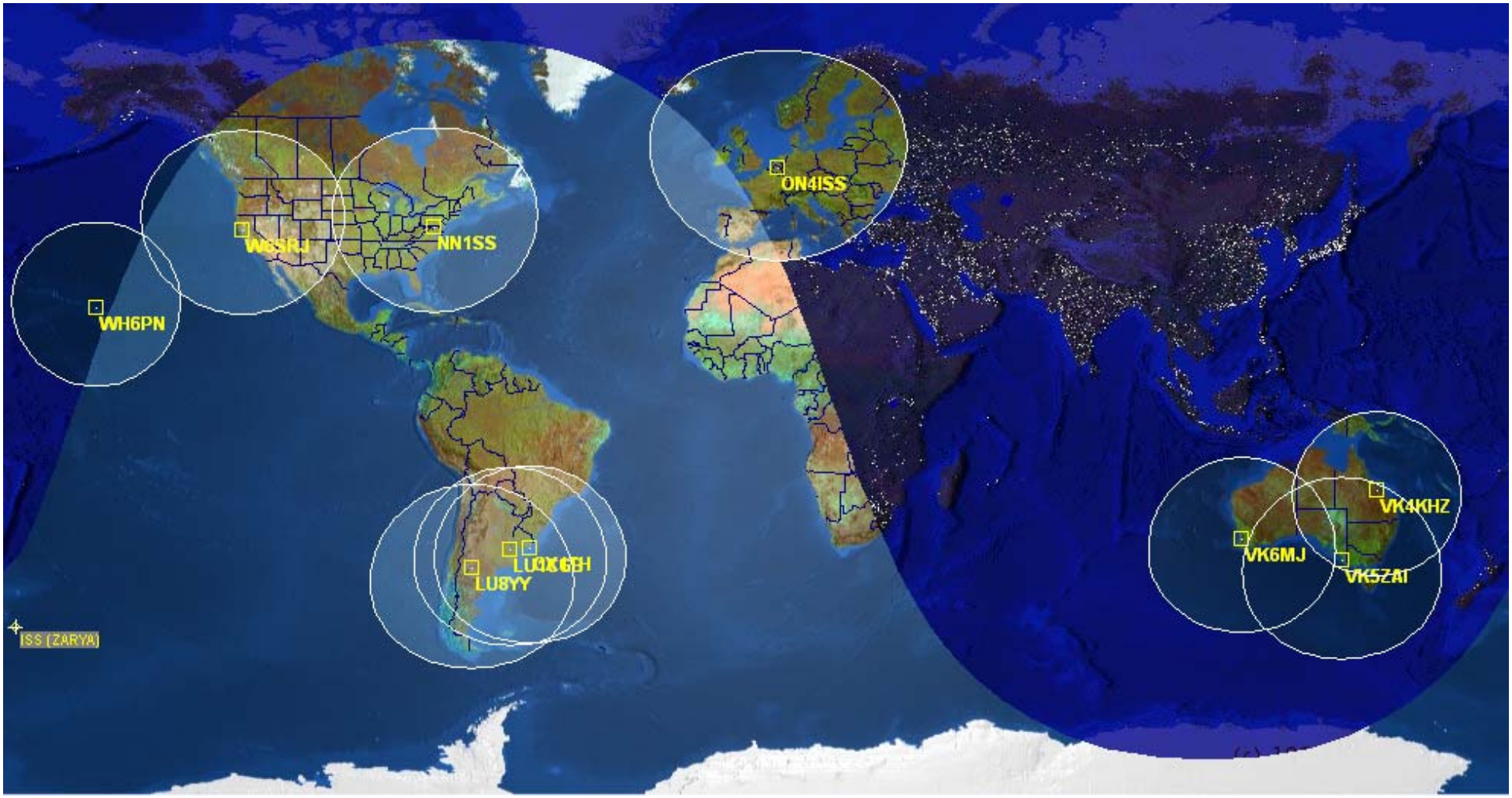
I am but one teacher who is very proud and humbled by the accomplishments of her SAREX and ARISS students over the years . . . and especially proud of the lives they have touched and their willingness to "give back." Is there a long-term impact of SAREX and ARISS on student achievement? I am but one teacher . . . There were well over 200 SAREX school contacts, and there have already been over 300 ARISS school contacts. . . just do the math.

Appendix E

Maps, Telebridge Stations



Currently Active Telebridge Stations



Active Ground Stations and Those Being Prepared for Operation

Appendix F

Maps

Map, ARISS-USA Radio Contacts, FY2008

Map, ARISS-USA Radio Contacts through FY2008

Map, ARISS-International Radio Contacts through FY2008

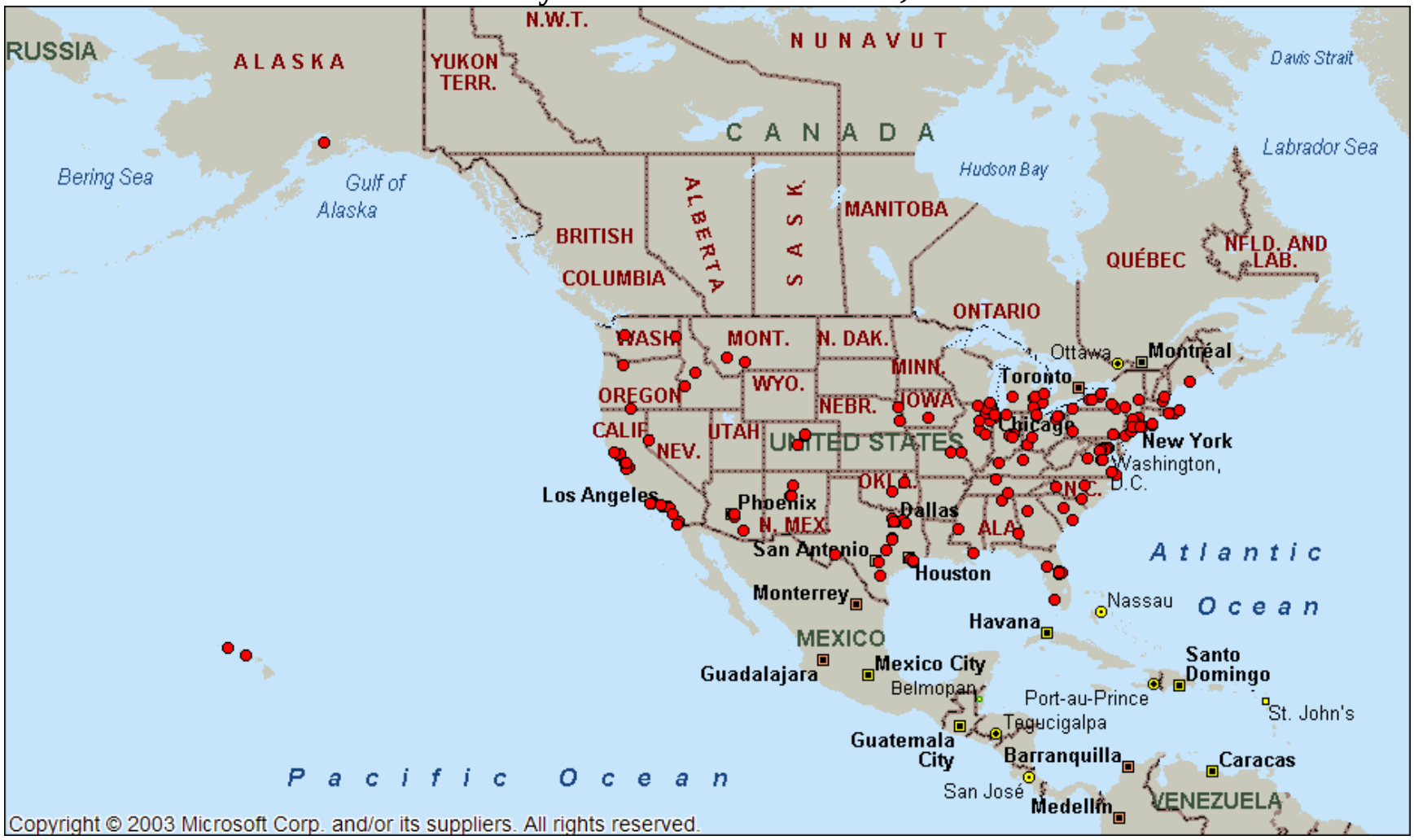
ARISS USA-only School Radio Contacts, FY2008

Notes:1) ARISS assisted 11 U.S. schools and 29 other schools worldwide with radio contacts during FY2008.

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 USA-only School Radio Contacts, FY2001-2008

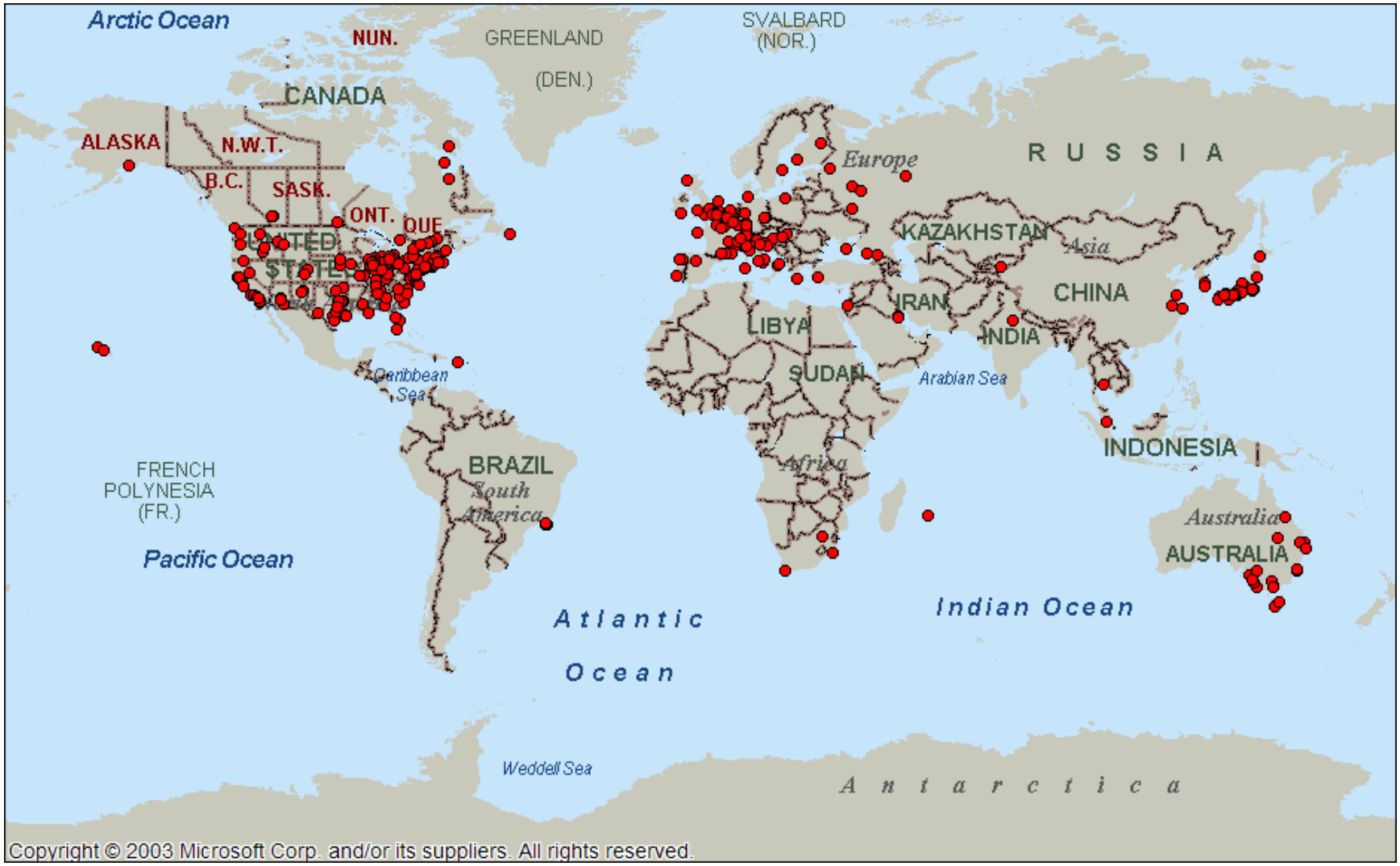


Notes:1) ARISS assisted 176 U.S. schools and 185 other schools worldwide with radio contacts through FY2008.

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 – 2008



Notes:1) A total of 361 ARISS school contacts were made through FY2008.

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.