

Reaching for the Stars with Radio

A sixth grade class' space contact heats things up in Arizona.

Kaci Heins, KF7RCV

It's been almost a year since I first heard about the Amateur Radio on the International Space Station (ARISS) program (www.arrl.org/amateur-radio-on-the-international-space-station). In that time I have shepherded my sixth grade class at Northland Preparatory Academy (NPA) in Flagstaff, Arizona from the application process to the big day we made our contact with NASA Flight Engineer Joe Acaba, KE5DAR, on the International Space Station (ISS). The effort was certainly worthwhile. Joe spoke from space to a gymnasium full of students, ham radio operators, faculty and community members who listened to NPA students ask questions and heard his answers.

Once I heard about the ARISS program I thought it would be an excellent experience for the students, but having no knowledge of Amateur Radio I knew I would need help. I contacted the Coconino Amateur Radio Club (CARC) hoping for their assistance in developing a persuasive ISS contact proposal to submit to the ARISS program. Joe Hobart, W7LUX, responded saying that the club would be glad to help us prepare for our ARISS contact. He was excited about this opportunity because many of the club members had been looking for ways to share ham radio with young students.

I wrote up the basic contact proposal for ARISS and Joe added the necessary radio information. In order to demonstrate my dedication to the project and to my students, I decided to get my license as well. I studied using *The ARRL Handbook* and took practice tests. I passed my test and received the call sign KF7RCV. Soon after, I found out our ARISS proposal had been accepted, so I needed to start bringing radio related activities into the classroom.

Learning About Radio

I am very passionate about science, technology, engineering and mathematics education (STEM) and the impact it can have on middle school students, so I decided to start an after-school science program. After much deliberation, the club members came up with the name "Space Spartans" and one student created a mission patch to represent our club.

Joe Hobart, W7LUX, of the CARC, came by to answer my students' questions. He talked about the different bands, frequencies and proper radio etiquette while talking to other hams. Joe brought a radio to the classroom so the students could actually talk to other hams. Students asked the hams about the weather,

how they became interested in radio and what kinds of ham radio activities they did.

Joe then contacted hams at the science center in Phoenix, about 150 miles away, using the linked repeater system. Since many of the students had been to the center before, they were surprised to be able to talk to them at that distance. To wrap up his presentation Joe talked about the importance of Amateur Radio in emergencies such as the 2010 Shultz Pass fire that burned one side of the San Francisco Peaks. The CARC was there relaying information to those who needed it. Joe also talked about ham radio's own satellites and about the various ham radio contests people can participate in. Overall, the students learned a lot, which helped build excitement for our radio contact with the ISS.

Space Signals

Our next big ISS-related project was assembling our own radio telescope. The NASA Radio JOVE program (radiojove.gsfc.nasa.gov) allows students to acquire radio emissions from the sun

and Jupiter using a radio telescope they build from a kit — which is the best part! Thanks to some generous donations from CARC members, we were able to purchase the Radio JOVE kit. We held three Saturday meetings for students to read the instructions and build the JOVE receiver with a little help from Joe. The students learned about basic electronics (circuitry, resistors, amplifiers, etc) and how to solder.

After a few weekends with some dedicated students, the Radio JOVE receiver was complete. Joe was very impressed with their work, especially since these sixth graders got it right the first time! The toughest part was getting administrative approval to put up the antenna on our new building, but we did and radio club members set up the antenna and JOVE receiver.

Initially, Joe thought there would be too much noise around the school. He was right — the noise was off the charts. We couldn't distinguish the solar flares from the local noise, especially with school in full session, its lights and many electronic devices all contributing to the din. We talked about how everything emits radio waves and why the school was generating so much "noise." We will need to learn to distinguish the solar storms from the other noise. Yes, this isn't the best situation, but it is a good lesson for students in problem solving.



Joe, W7LUX, Elms some students in the fine art of soldering as they assemble their Radio JOVE receiver.



The Space Spartans pose for a team photo prior to their balloon launch.

Unfortunately, Jupiter was below the horizon during school. The JOVE setup became an extension of our use of the Goldstone radio telescope. The NASA Goldstone Apple Valley Radio Telescope (www.spacehike.com/gavrt.html) in Apple Valley, California permits students to use a 34 meter NASA telescope to acquire radio waves from a pulsar. This formed a basis for talking about how radio waves travel across space at the speed of light. The JOVE kit showed them we could acquire data on a smaller scale recording solar bursts and even storms on Jupiter. It was a good opportunity to talk about the electromagnetic spectrum and how these storms release an enormous amount of energy, some in the form of radio waves.

We went on to talk about different satellites and careers at NASA that relate to monitoring the sun with the JOVE project. We went over the importance of monitoring the sun and solar storms because it affects the way our electronics and satellites work. I explained that

if we lose these satellite communications systems then less vulnerable communications methods like ham radio will keep us in touch.

High Flying Radio

One of the projects the Space Spartans had great fun with while waiting for our ARISS contact was high-altitude ballooning. We were able to join with students at Embry Riddle Aeronautical University in Prescott, Arizona for a project that permitted all the Space Spartans to be involved with a high-altitude balloon launch.

After the launch, we all went to the Embry Riddle space lab to track the balloon on the big screen TVs. We used the repeater on the balloon to talk to the Embry Riddle student chase team as they were getting close to Flagstaff. Again, Joe, W7LUX, joined us for the launch and to help the students use the radio.

I used the opportunity to tie in our contact with the ISS, explaining that it is ~250 miles above the Earth but because the radio waves travel at the speed of light it's just like talking on the phone. The students were a little disappointed that they would only get to talk with the ISS for 10 minutes. That became a teachable moment as we went into detail about how fast it's traveling and how far above the horizon it would be as it passed overhead.

For our second balloon launch we joined with the Changes in Altitudes program and the students did something a little different. Joe set up a radio station at the school in Flagstaff. We used the repeater on the balloon to talk with student families about 200 miles away. One student was able to talk to his sister and she loved it! The experience may have inspired a future ham.

As we tracked and chased the balloon, students used ham radio to relay information to each other about balloon altitude, speed and direction. This was very exciting for the students, especially after the balloon burst and it became a race to see if we could catch the landing. Having the students converse on the radio a month before our ARISS contact was good practice and a great example of a real life application of ham radio.

We also partnered with Project Aether (education.projectaether.org). Project Aether launches balloons and cameras into the auroras from a site in Alaska. This project was a valuable teaching tool because we could follow the Project Aether team online and have a video chat with them before and after our balloon launch. The Space Spartans built a LEGO man and the Project Aether team attached it to their balloon flying it, our Space Spartan mission patch, and our NPA school flag close to an aurora. I explained to my students how solar storms affected the Earth's magnetic field and created the aurora. GoPro, a sponsor of Project Aether, supplied the camera that took the LEGO man photo and donated a \$400 camera to NPA as well!

The Main Event

Finally, the time arrived for our ARISS contact. We wrote the proposal to include the entire school so I needed to publicize the event. I spent an entire day in my space camp flight suit going to every science class in each grade to promote the event and have students generate questions. I picked 22 questions, which I knew was a lot, but the students thought up many excellent questions!

I also collaborated with my good friends Ronnie Thomas and Bejanae Kareem at Parkside Elementary School in Atlanta before our contact. Ronnie and I were on the same team at Space Academy for Educators and we worked together in the Teaching From Space Reduced Gravity program. They gave me the idea to create a "space week" around the radio contact to get the students even more excited! I brought in some moon and meteorite samples I obtained from

The Space Station

In order for the Space Spartans to contact the ISS, a ham station was needed that could track and communicate with the ISS as it orbited overhead. Several members of the Coconino ARC worked with Joe, W7LUX, to prepare the station. Assisting Joe were Ken, KF7DUR, an expert with VHF/UHF communications; JD, N6IME, an expert with audio systems; Rob, WB7QDQ, an excellent handyman, and Bob, NF7E, an expert voice operator who coached the students. Six club members loaned equipment for the ISS contact. The primary station consisted of:

- Yaesu FT-857 transceiver
- TE systems 1452G amplifier
- Cushcraft A144-10T CP antenna
- Yaesu G-5500 alt-az rotator
- MSI L1300 netbook computer
- SatPC32 transceiver frequency and rotor control program

A backup station consisting of another FT-857, M² EB-144 / RK2M Eggbeater antenna and a Honda EU2000i generator were also on hand in case Murphy decided to visit. Conducting a contact with a window of 10 minutes for an audience of 550 is no time for a failure! The antennas and amplifiers were located on the gymnasium roof (about 35 feet high). The station was in the gymnasium. It took 150 feet of cable to connect the two locations.

Working with Embry Riddle Aeronautical University, the Space Spartans participated in launching a high-altitude balloon that carried a repeater to the edge of space.



Johnson Space Center, we launched model rockets made by my science club, we viewed a solar eclipse and, the week before the contact, we had a video chat with an astronaut through the Space Out Sports program.

Getting our contact a “go” was the most stressful part. The timing of the scheduled rendezvous of the Space X company’s Dragon spacecraft and the ISS looked like it might conflict with our contact. We had a wonderful mentor at ARISS, Keith Pugh, W5IU, who kept in touch with us and helped us maintain a positive attitude.

Our initial plan was to contact Flight Engineer Dr Don Pettit, KD5MDT, but a scheduling conflict made him unavailable. Thankfully, Joe Acaba, KE5DAR, stepped up and said he would make contact with us. The day before the contact CARC members came to the school and set up the equipment in the gym. We then went through a dress rehearsal that went beautifully as we talked with a local ham who was our “astronaut.” We actually got through every student in less than 10 minutes with our local ham responding to each question.

Space Chat

Finally, May 24, 2012, the day of our ARISS contact arrived. We had a full gym, the mayor, student family members, staff and guest speaker Dr Jeff Hall who is the director of Lowell Observatory in Flagstaff. I started the assembly off with a video of what my Space Spartans science club had accomplished and then talked about the importance of STEM education, ARISS and the career opportunities that STEM provides students when they enter the real world. Dr Hall then talked about careers in science and engineering with a question and answer session at the end.

Joe had installed some satellite tracking software on our JOVE computer. We didn’t have the opportunity to use it much before our contact, but we projected the orbital position of the ISS on a screen together with each student’s question so everyone in the gym could see. Watching the ISS getting closer and closer to Arizona really excited the students. One math teacher saw the sine wave path the ISS appears to make on the map. After the contact, he went to his classroom and took the opportunity to teach his students why the ISS makes that sine wave path.

As the ISS came into range, we lined up the students and prepared for our contact. We began calling the ISS. At first we didn’t get a response, which made me very anxious fearing that, after all this effort, we wouldn’t be able to establish contact. My heart sank at the prospect.



The Space Spartans’ LEGO man gets a space-eye view of Arizona.



Kaci Heins, KF7RCV, in her blue flight suit, stands by while one of her students uses the Coconino ARC radio setup to contact the ISS.

Then suddenly we heard Joe, KE5DAR, and the contact was on. We zipped through 16 questions. Joe did a great job responding to the students’ questions with quick, precise and occasionally hilarious answers!

At the end of the contact, we thanked everyone for their help and received great applause. I really felt the students understood what a unique and special opportunity this was. Later that day students who I had never taught or met before stopped me in the hall and thanked me for such a cool opportunity.

Epilogue

This program was a huge success! To top it off we made the front page of the *Arizona Daily Sun* the next day. As exciting and fulfilling as this experience was, it was also very stressful. I plan to take a break before planning another such event, but I do plan to apply for the ARISS program again. Big thanks to NASA and the Teaching From Space program for providing these amazing opportunities for the next generation of scientists, engineers and explorers!

Having my students acquire data through Goldstone, JOVE and ballooning had them working like real scientists. Did it always work out perfectly? No, but those are teachable moments where you have *them* figure out ways to solve the problem just as real scientists do. All these STEM projects had a tie-in with ham radio, which led up to our ISS contact. My hope is that my students understood the moment we heard back from Joe Acaba, KE5DAR, on the ISS, that radio waves were what allowed that moment to be possible. That radio waves carrying their voices were making their way up to the ISS at the speed of light. What a great way to end the school year and to see what we learned about radio brought to life through such a special occasion.

Photos courtesy Kaci Heins, KF7RCV.

Kaci Heins, KF7RCV, teaches sixth grade at Northland Preparatory Academy in Flagstaff, Arizona. She places a strong emphasis on science, technology, engineering and mathematics education and has an after-school club called the “Space Spartans” where she involves her students in many science-related projects. Kaci has attended the NASA Space Academy for Educators and the Teaching from Space Reduced Gravity programs, and also the ARRL Teachers Institute on Wireless Technology (www.arrrl.org/teachers-institute-on-wireless-technology). Her ham radio activities focus on using ARISS to excite her students about space and radio technologies. Kaci can be contacted at 4490 Belmont Springs, Belmont, AZ 86015, runsemo@hotmail.com.

Amateur Radio on the International Space Station — ARISS



The ARISS program is a cooperative venture of ARRL (the National Association for Amateur Radio), AMSAT (the Radio Amateur Satellite Corporation), NASA, and other international space agencies. ARISS organizes and schedules contacts via Amateur Radio between ISS crew members and educational organizations. With the help of experienced Amateur Radio volunteers and coordination from the ARISS partnership team, crew members speak directly with large youth audiences in a variety of public forums such as school assemblies, science museums, Scout Camporees and Jamborees, and space camps where students, teachers, parents, and communities learn about space, space technologies and Amateur Radio.

Goals of the ARISS program include

- Inspiring an interest in science, technology, engineering, and math (STEM) subjects and in STEM careers among young people
- Providing an educational opportunity for students, teachers, and the general public to learn about space exploration, space technologies, and satellite communications
- Providing an educational opportunity for students, teachers, and the general public to learn about wireless technology and radio science through Amateur Radio
- Providing an opportunity for Amateur Radio experimentation and evaluation of new technologies



For more information about ARISS, including information about submitting a proposal to host an ARISS contact, visit www.ariss.org. Recorded ARISS interviews with astronauts on the ISS and other information is available at www.arrl.org/ARISS.

To learn more about opportunities to explore wireless technology with Amateur Radio, and for resources for classrooms available through ARRL's Education & Technology Program, visit www.arrl.org/amateur-radio-in-the-classroom.

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