

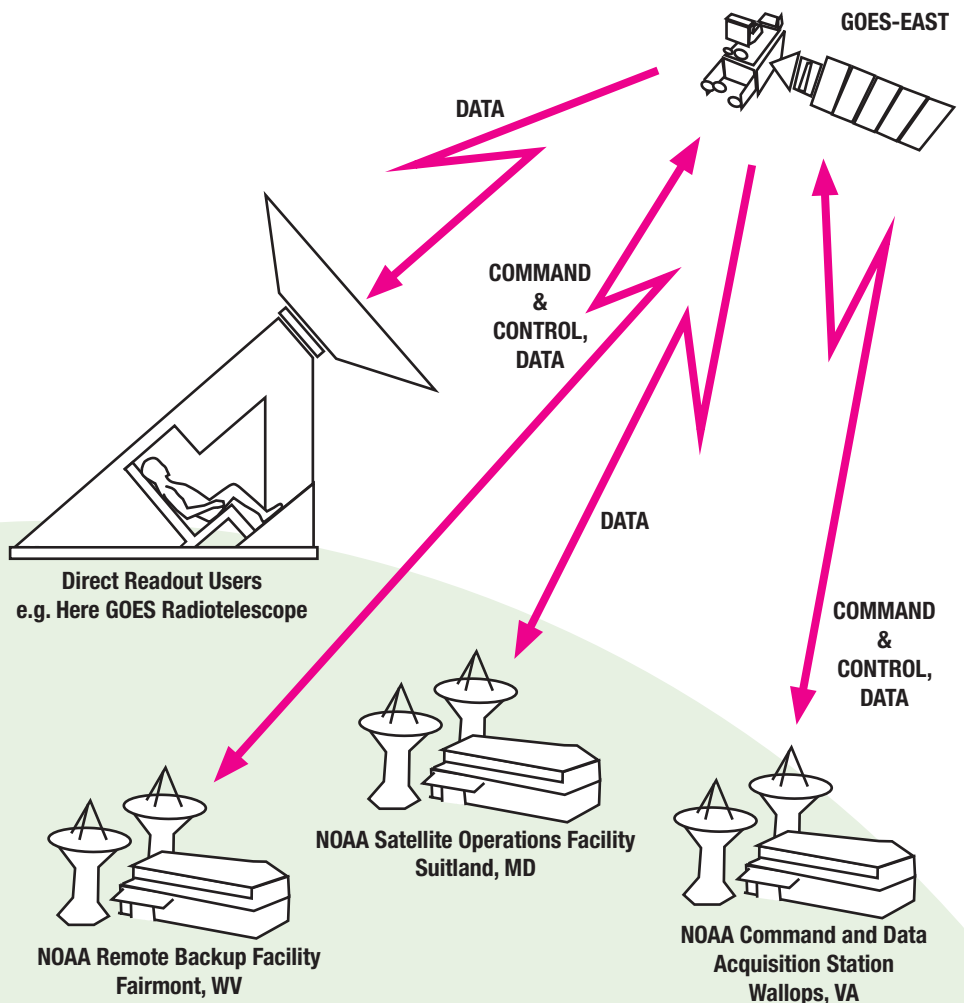
Here GOES Radio- telescope

Here GOES Radiotelescope receives images and data from GOES-16, a weather satellite.

You are invited to sit within the sculptural ground station and look through the “telescope” and see images of the Earth as they are being received from the satellite—to effectively see ourselves through GOES-16’s eyes. The generative sound heard at the telescope is a ‘sonification’ created from space weather data collected by GOES-16 and received by the station in real time. It is an audio imagining of the soundscape of solar wind hitting and flowing around Earth, as if it were a field recording of the interaction of energies around the satellite.

GOES-16 is a geostationary spacecraft about the size of a school bus with a large solar panel wing orbiting Earth about 22,000 miles away from its surface (a distance almost three times Earth’s diameter) and at a speed which matches the Earth’s spin. Its stationary nature in orbit relative to the Earth enables static structures on Earth’s surface to be in direct relationship with the satellite. Here GOES Radiotelescope’s dish is fixed and pointed directly at the satellite, which is 41-degrees above the horizon at Wave Farm in Acra, New York, to receive the faint radio signal.

GOES-16 is one of NOAA’s flagship satellites that gather data for monitoring and predicting weather on Earth. Also known as GOES-EAST, it is positioned at a longitude far above the East Coast of the United States. Its primary camera, the Advanced Baseline Imager (ABI), takes pictures of four areas: the entirety of the Western Hemisphere, the United States and its neighbors, and two cropped sections that are adjusted to follow the latest weather developments. The detectors on the ABI collect image data at



System configuration for operating GOES-EAST by radio command. The satellite is controlled by NOAA and broadcasts data over a large area of the Earth which can be received by those stations with the appropriate equipment, freely and legally.

particular wavelengths that are sensitive to different aspects of the landscape’s weather such as ozone, carbon dioxide, water vapor, snow, vegetation, and wildfires.

The initial images seen through Here GOES Radiotelescope are greyscale; they are individual spectral bands and are used in combination to evaluate conditions. For a more familiar-looking view, after reception some of the bands are combined into single images of the Earth emulating the range of wavelengths that the human eye would see from space, “true color” pictures. GOES-16 also collects and transmits data for mapping lightning events and space weather—energy and particle output from the sun which can damage satellites and electrical grids on Earth.

Here GOES Radiotelescope receives the ‘GOES ReBroadcast’ (GRB) stream of data. This stream contains the full suite of

the data from all the instruments aboard the satellite. Here GOES Radiotelescope is one of an estimated 15 independent civilian stations in the world to do so. The main users of GRB outside NOAA itself are other government agencies such as the Air Force and Navy, research institutions such as CIRA (Cooperative Institute for Research in the Atmosphere at Colorado State University) and SSEC (Space Science and Engineering Center at the University of Wisconsin-Madison), and private companies who have an interest in original weather source data, such as Accuweather for the business of forecasting, and Boeing for aerospace activities. Here GOES Radiotelescope uses off-the-shelf electronics and equipment and freely available software to receive GRB including radio tuner cards for TV satellite reception, a second-hand windows computer, a dish feed made by an amateur ↗



radio parts manufacturer in the Netherlands, and a large satellite dish augmented by wire material usually used to house guinea pigs. *Here GOES Radiotelescope* was built and operates on a small fraction of a typical budget for a corporate or government ground station.

GRB from GOES-16 produces a lot of rich data. Each full-disk Earth image received from the camera is up to 21, 696 pixels across and up to about 350 megabytes, and arrives every 10 minutes. The combination of multiple instruments and multiple views in the data stream means that *Here GOES Radiotelescope* and other ground stations receiving the GRB collect about 1 terabyte of data per day.

Since this would rapidly fill the on-site station-operating computer, *Here GOES Radiotelescope* compresses and uploads a portion of the data to online storage, which serves as a data archive for related art projects. A selection of the images from the last 24-hours is available for public exploration and download from heregoesradio.com.

Here GOES Radiotelescope creates an avenue for individuals to directly relate to the usually invisible infrastructure we rely on. Seeing the image stream from GOES-16's constant radio transmission is a reminder of the ubiquitous invisible radio data surrounding us, and how much we rely on our orbiting infrastructure and these streams for weather forecasting, navigation, communication, and many other services. By receiving the data stream as individuals, we participate directly in the activities in Earth's orbit and are reminded that such unmediated participation is possible. Visitors sitting in the physical *Here GOES Radiotelescope* structure are placed in direct positional alignment with the satellite, making the distant spacecraft relate to our bodies and the landscape we inhabit; we see the wide view of the full Earth from space, and can intuit our place on it.

heregoesradio.com

Heidi Neilson (@H_Neil / heidneilson.com) is an interdisciplinary artist interested in the connections between people on the ground and off-planet conditions and infrastructure.

Harry Dove-Robinson (@wxstar3000 / wx-star.com) is an aspiring engineer and documentary filmmaker interested in satellite remote sensing and severe weather.

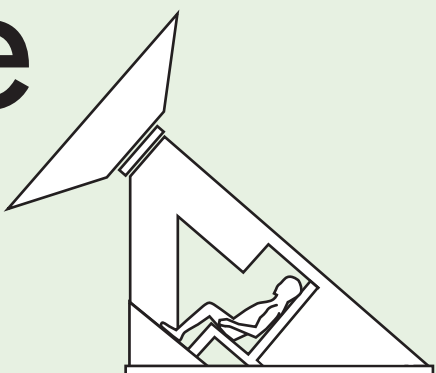
Harry and Heidi first connected in 2017 in an online forum for DIY weather satellite image transmissions. They are collaborating on *Here GOES Radiotelescope* to further interest and participation in extraterrestrial radio reception.

Many thanks to: Lucas Teske and the Open Satellite Project chat room for inspiration and open-source software development; Brett Casebolt (@N6BY) for developing and providing software; SPACES (Cleveland, OH) for initial support and launch of an early project iteration; and to Galen Joseph-Hunter, Kim Fisher, JF Mergen, and Jennifer Dove for helping with troubleshooting in many forms. And a resounding THANKS to Wave Farm for providing *Here GOES Radiotelescope* a happy home.

Wave Farm (wavefarm.org) is a non-profit arts organization driven by experimentation with broadcast media and the airwaves. Our programs—Transmission Arts, WGXC-FM, and Media Arts Grants—provide access to transmission technologies and support artists and organizations that engage with media as an art form.



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Heidi Neilson & Harry Dove-Robinson