

Use of Radio Spectrum for Meteorology:
Weather, Water and Climate Monitoring
and Prediction:

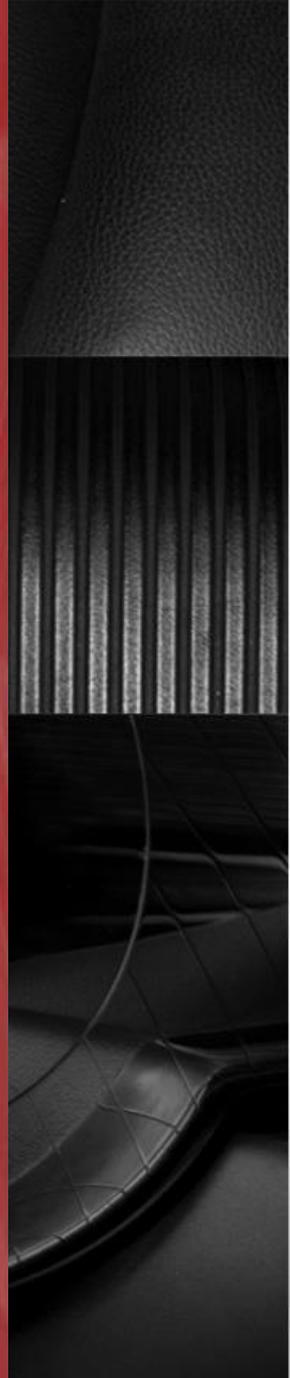
***Transition of U.S. Radiosonde
Operations Due to Commercialization of
Spectrum***

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National Oceanic and Atmospheric Administration



Background



- The Transition of U.S. Radiosonde Operations was initiated in response to the U.S. spectrum of the 1695 – 1710 MHz band for shared use with Advanced Wireless System-3
- This initiative required a redesign of the Geostationary Operational Environmental Satellite – R-Series (GOES-R) into a lower operational frequency band
 - This redesign shifted the GOES-R operational frequencies lower in the band, such that the lower edge of the signal overlapped with frequencies used by radiosondes (1679–1683 MHz)
- To avoid interference with GOES-R signals, radiosondes operations required relocation to operate in the another band, 400.15 – 406 MHz
 - The GOES-R Satellite was launched in November of 2016, is completing calibration and validation testing, and is expected to become operational in January of 2018
 - Relocation of radiosonde operations at eight sites located near GOES earth station receivers has already been completed before the launch to ensure no operational conflicts

A Brief History *



- In 1892 two French scientists used a balloon to fly a meteograph, leading to the discovery of the Tropopause six years later by Léon Teisserenc de Bort
- In 1924 the US Signal Corps first experimented with using the temperature dependence of electrical circuits as a temperature measurement instrument
- The first modern radiosonde, sending precise encoded telemetry from weather sensors, was also invented in France by Robert Bureau
 - Bureau coined the name "radiosonde" and flew the first instrument in 1929
 - "Sonde" translates to "Probe" in English
- The NOAA National Weather Service (NWS) has been making atmospheric observations using radiosondes since the late 1930's

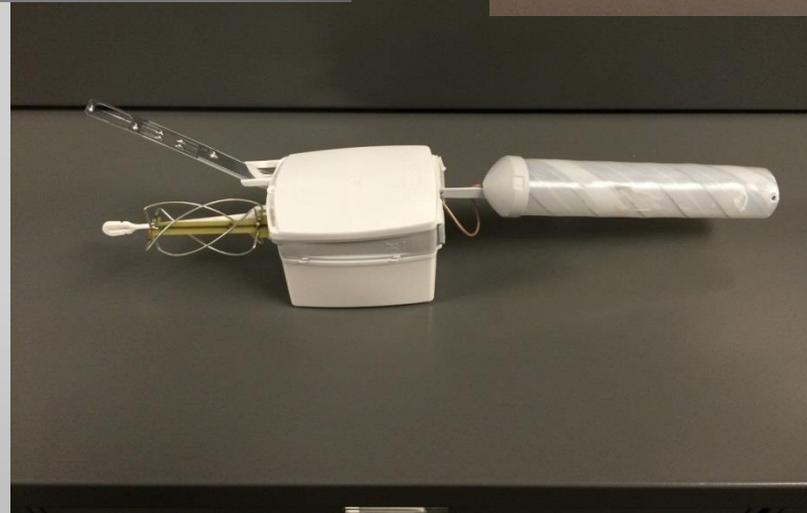
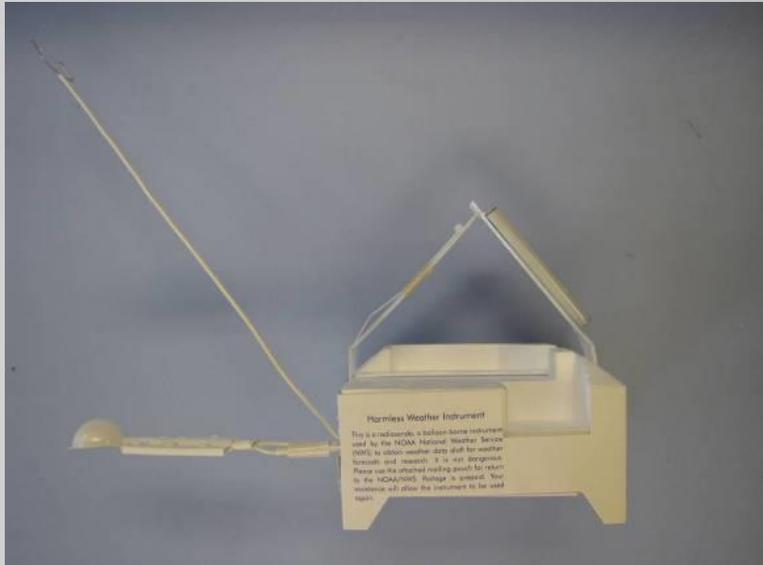
* Source: Wikipedia

The Radiosonde



- A radiosonde is a meteorological instrument used to make in-situ observations of the atmosphere, from the surface to 30,000 meters altitude
- Radiosondes are launched daily around the world, at synoptic hours of 00:00 and 12:00 UTC
- Data is used in weather forecasting and climate research, including numerical weather prediction models
- The U.S. Radiosonde Network consist of 92 radiosonde observing stations located throughout the Continental U.S, Alaska, Hawaii, Puerto Rico, and Pacific Islands
 - The U.S. also supports and supplies 10 Cooperative Hurricane Upper Air Stations (CHUAS) in the Caribbean
 - These stations were not affected by the commercialization of spectrum
- U.S. Radiosondes currently operate in two radio-frequency bands
 - 1675 – 1683 MHz, and
 - 400.15 – 406 MHz

The Radiosonde



U.S. Radiosonde Network

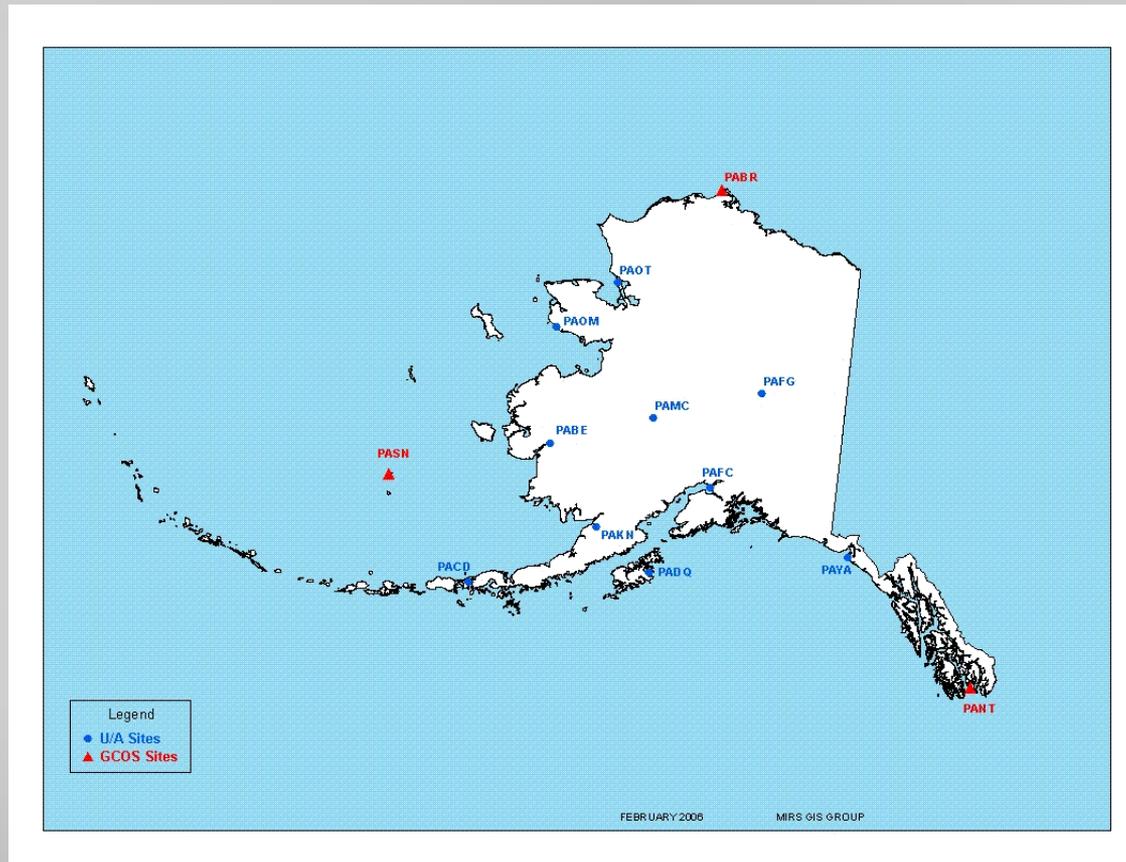


- The U.S. Radiosonde Network is primarily operated by the National Oceanic & Atmospheric Administration's (NOAA) National Weather Service (NWS) of the U.S. Department of Commerce
- Consists of 92 upper air stations:
 - 67 Stations in Continental U.S. *
 - 13 Stations in Alaska **
 - 9 Stations in the Pacific Islands
 - 2 Stations in Hawaii
 - 1 Station in the Caribbean (San Juan, Puerto Rico)
- U.S. Radiosonde operations are part of the World Weather Watch Programme

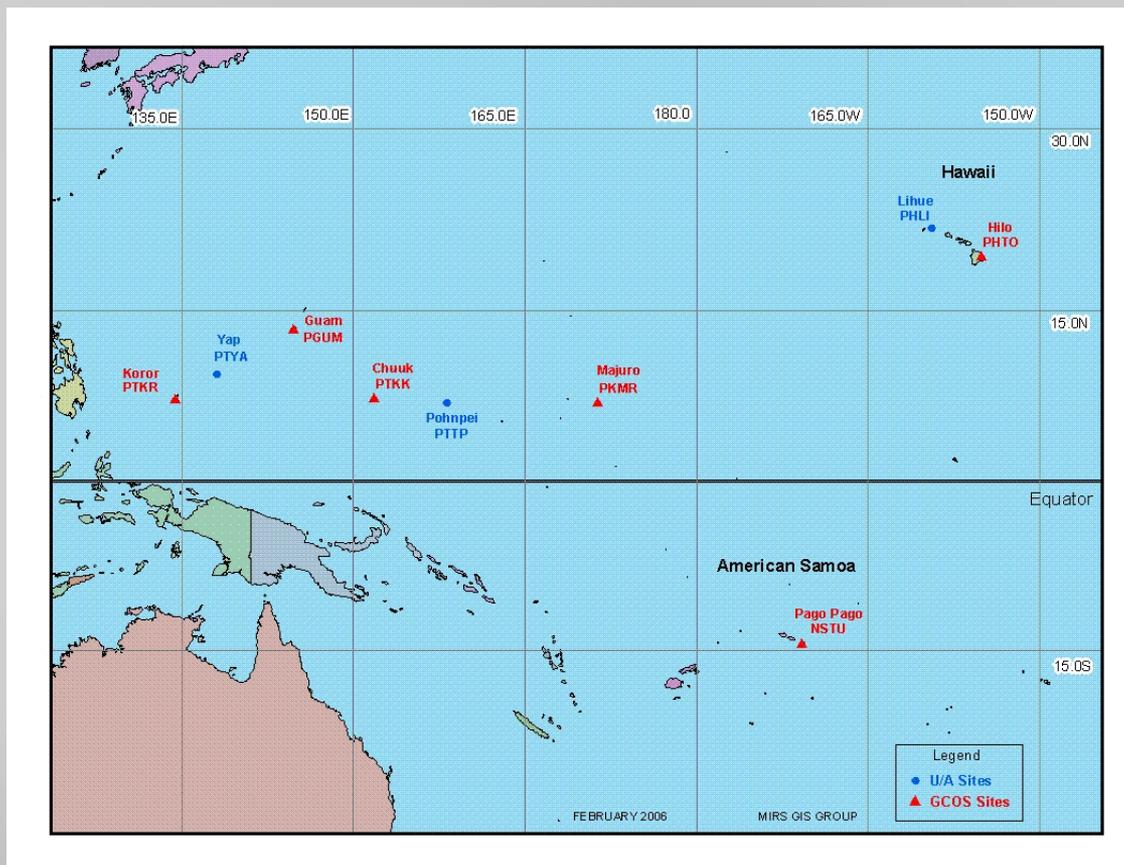
* Wallops Island, Virginia site operated by NASA

** Barrow, Alaska is operated by the Department of Energy

Alaska



Pacific Islands



Radiosonde Function



- NWS radiosonde sensors measure profiles of pressure, temperature, relative humidity, and wind speed and direction with a relatively high degree of accuracy and precision
- The radiosonde uses a radio transmitter to transmit sensor measurements to a ground-based receiving and data processing system
- Wind speed and direction aloft are also obtained by tracking the position of the radiosonde using Global Positioning System (GPS)
- Received signals are converted to meteorological values to derive significant levels using computer processing, put into a special code form, and then disseminated to data users via the Advance Weather Interactive Processing System (AWIPS)
- High vertical resolution flight data, among other data, are also archived and sent to the NOAA's National Center for Environmental Information (NCEI)
- Today's radiosondes are small, expendable instrument packages typically weighing between 100 and 307 grams

Radiosonde Observations



- The radiosonde rises at about 300 meters per minute to obtain a thermodynamic 'profile' of the atmosphere
- A typical observation "weather balloon sounding" is collected in approximately two hours
- The radiosonde can ascend to over 35 km and drift more than 300 km from the point of release
- The radiosonde is suspended 25 to 35 meters below the balloon to minimize contamination of the temperature measurements due to solar, radiant heat being shed from the balloon skin
- During the flight, the radiosonde is exposed to temperatures from -90°C to $+50^{\circ}\text{C}$ and an air pressure less than 1 percent of what is found on the Earth's surface (10 hecto-Pascals)
- If the radiosonde enters a strong jet stream it can travel at speeds in excess of 400 km/hr.
- The NWS uses approximately 74,460 radiosondes per year
- Less than 20% of radiosondes are returned to the NWS for reconditioning
 - These rebuilt radiosondes are used again at a significant cost reduction

Radiosonde Data Use



Understanding and accurately predicting changes in the atmosphere requires adequate observations of the upper atmosphere

- Radiosondes provide a significant source of upper-air observations data and will remain so into the foreseeable future
- Data applications include:
 - Input for computer-based weather prediction models
 - Local severe storm, aviation, fire weather, and marine forecasts
 - Weather and climate change research
 - Input for air pollution model
 - Ground truth for satellite data

Typical Radiosonde Launch

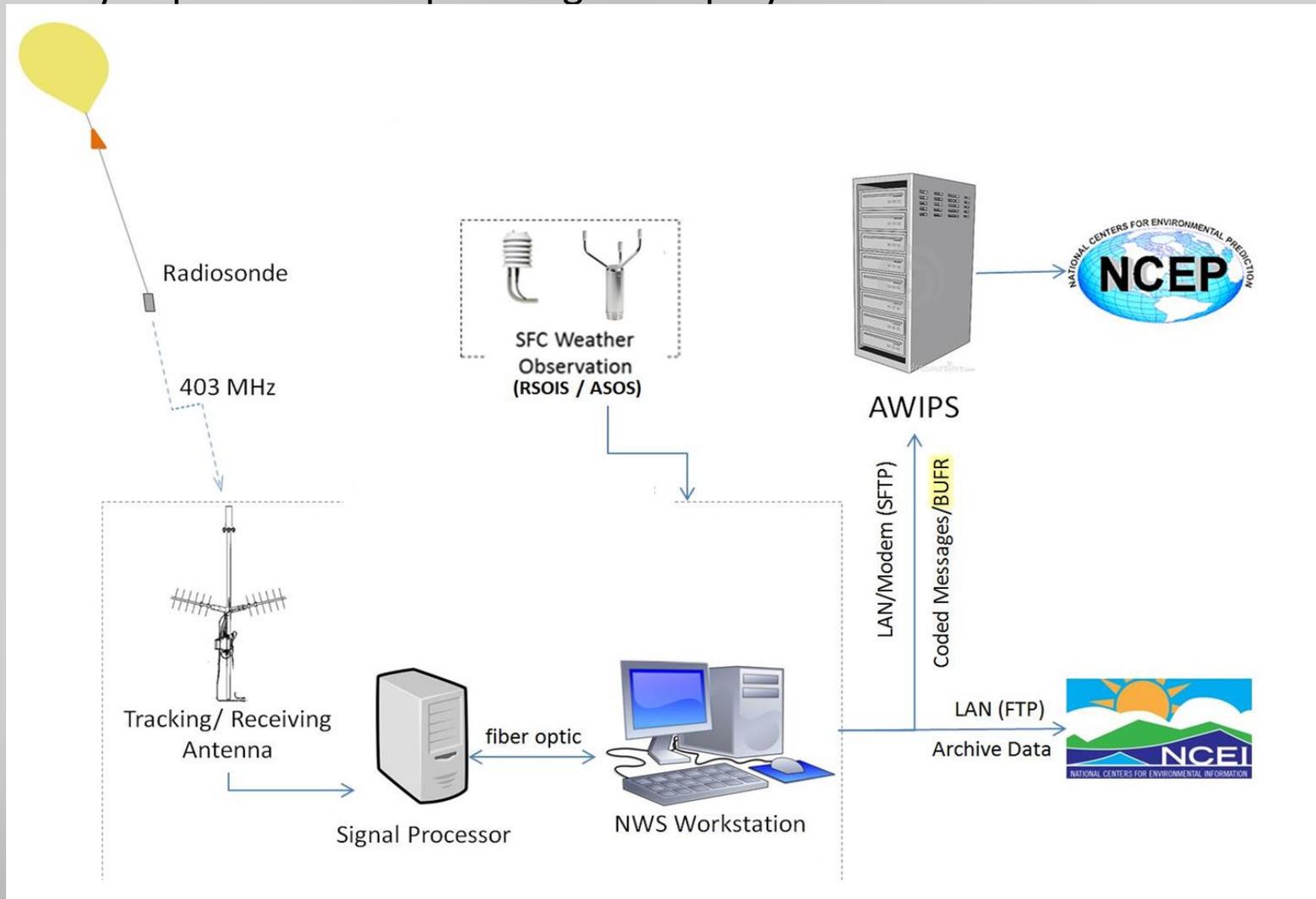


NWS Sterling Field Support Center, Sterling, VA

403 MHz Standard System



Currently in procurement planning for deployment to most locations



Transition of U.S. Radiosonde Operations Due to Commercialization of Spectrum

Transition Progress



- Procured one system in 2015 for operational evaluation at Field Support Center
- Installed eight Transition Radiosonde Observing Systems at sites most likely to cause interference to meteorological satellite operations
- A second system was installed in Kodiak, Alaska station in 2016 and placed into operation in 2017
- Contracts have been awarded to begin site preparations and install four additional systems in Alaska in 2018
- Preparing requirements for standard systems to be deployed to upper-air stations that are not remote from NWS Forecast Offices
- One-year pre-award testing program is planned for systems, before awarding contracts to supply new ground systems and radiosonde instruments
- Expect Transition to be complete in 2022



QUESTIONS?