Observation of Ionospheric and Magnetic Transients on 27 November 2021

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Observations: Simultaneous ionospheric and geomagnetic transients were observed on 27 November 2021. The ionospheric transient was recorded at 2251 UTC and the magnetic transient at 2253 UTC. The ionospheric transient was observed as sudden frequency deviations (SFD) at 15, 20 and 25 MHz at Anchorage, Alaska. SFDs normally are caused by strong solar flares but, in this case, the cause was a coronal mass ejection (CME).

The transmitting stations were WWV or WWVH (15 and 20 MHz) and WWV only (25 MHz). The SFD amplitudes increased with frequency. The received signals at 15 and 25 MHz returned to nearly normal about 10 minutes after the disturbance, but 15 MHz, which was weaker than the other two, faded and eventually disappeared as propagation conditions deteriorated after local sunset. The event was recorded on an Argo software narrowband spectrum waterfall plot (figure 1).

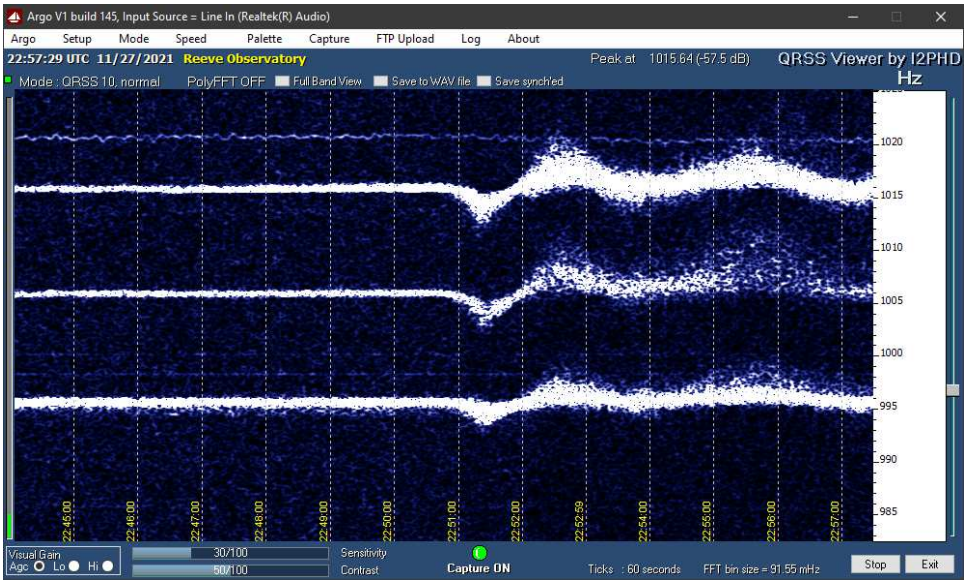

Figure 1 ~ 13-minute plot of demodulated signals for the time period from 2244 to 2257 UTC. The traces correspond to the receiver audio outputs as follows: Lower trace: 15 MHz, receiver tuning 15.000 995 MHz, LSB, carrier demodulated to 995 Hz; Middle trace: 20 MHz, receiver tuning 20.001 005 MHz, LSB, carrier demodulated to 1005 Hz; Upper trace: 25 MHz, receiver tuning 25.001 015 MHz, LSB, carrier demodulated to 1015 Hz.

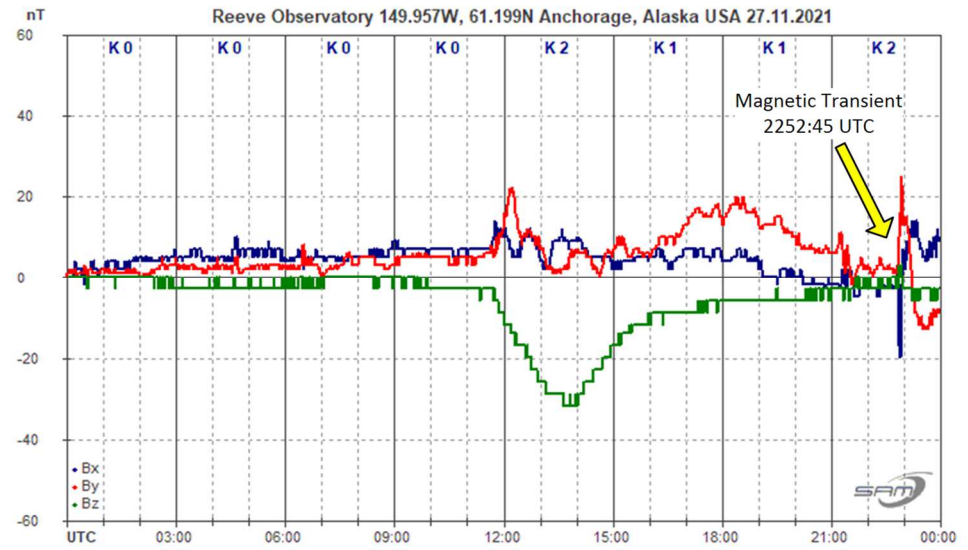

Figure 2 ~ 24-hour SAM_VIEW software plot of the X- (blue trace) , Y- (red trace) and Z- (green trace) magnetic field components for the 24 h period on 27 November. The magnetic field was relatively quiet until the transient at 2252:45 UTC when sharp deflections occurred in the X- and Y-components. These are seen as positive (Y) and negative (X) spikes in the magnetogram. Note that the K-index values throughout the day are low.

A magnetic transient occurred at 2252:45, almost 2 min after the ionospheric transient, in Earth's magnetic field X- and Y-components. The X-, or north-south, component initially showed a negative deflection and almost immediately reversed to positive relative polarity, while the Y-, or east-west, component went positive and almost immediately reversed to negative relative polarity (figure 2). The deflections were sharp, similar to a sudden impulse, but an SI was not reported by Space Weather Prediction Center (SWPC), possibly because a transient, the precursor to an SI, was not observed at the sentinel spacecraft DSCOVR.

The transients were caused when a CME impacted the geomagnetosphere, compressing it and suddenly altering the current systems flowing in the ionosphere and, in turn, changing the magnetic field measured on the ground. This particular CME originated on 24 November from a filament eruption centered near solar coordinates S36E33. SWPC correctly forecasted the CME arrival late on 27 November.

Instrumentation: See figures 3 and 4.

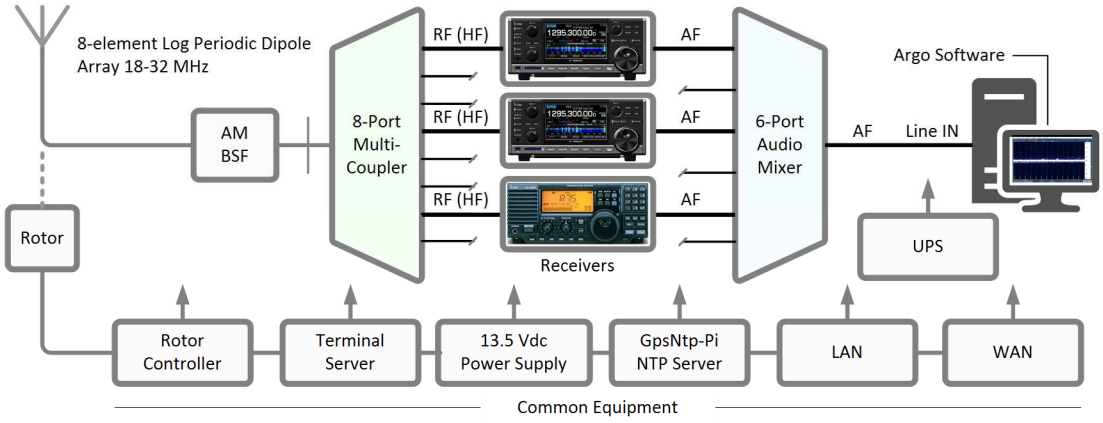

Figure 3 ~ System block diagram for the receiver instrumentation and related common equipment at Anchorage, Alaska. The receivers consisted of two Icom R-8600 wideband receivers and one Icom R-75 general coverage receiver, all set to LSB mode and connected through an audio mixer to the PC soundcard and ultimately demodulated by Argo. The HF log periodic antenna was pointed on a 107° true azimuth toward WWV. Image © 2021 W. Reeve

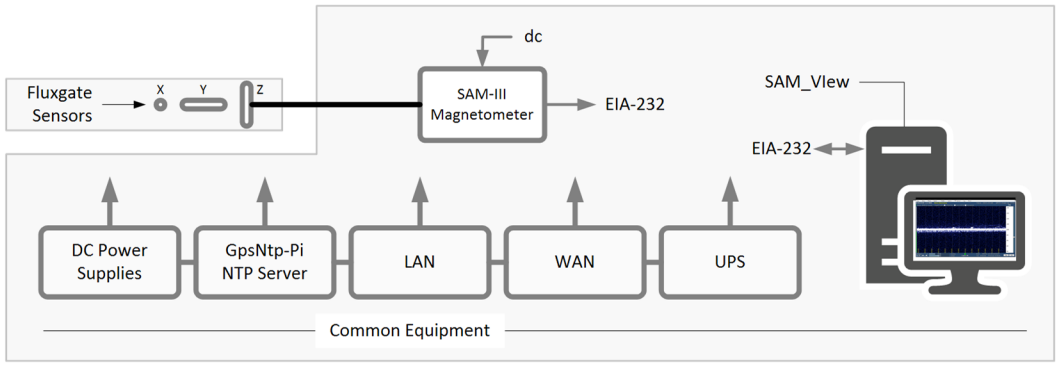

Figure 4 ~ System block diagram of the 3-axis Anchorage SAM-III station including the common equipment shared across the observatory. The SAM-III sensors are buried about 1 m below ground to reduce temperature effects. The sensor outputs are sampled by a multiplexer in the SAM-III controller and sent to the PC on an EIA-232 serial link where the data is displayed and stored by the SAM_VIEW software. Image © 2021 W. Reeve