Implementation of an Ionospheric Echoes Receiver using an SDR with GNU Radio to obtain vertical and oblique ionograms

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Abstract

The Jicamarca Radio Observatory (JRO) operates a vertical incidence pulsed ionospheric radar (VIPIR) dedicated to probing the equatorial ionosphere. This high-resolution system runs 24/7 and complements the suite of observations performed at JRO. As the VIPIR ionosonde operates with a wide beam antenna and reflected signals are dispersed at distances far as 1500 km, we have designed, built, and installed four new VIPIR receivers dedicated to oblique sounding. These receivers increase and expand the system's field of view and enable unique measurements, yielding new scientific results. This poster describes the Ionospheric Echoes Receiver (IER) by listing its components and detailing the different parts of the hardware and software elements. The receivers use a USRP N200 by Ettus and an acquisition flowgraph implemented in GNU Radio Companion. In addition, we present the OOT (Out Of Tree block), which generates the demodulation signal and changes its frequency value each Inter Pulsed Period. We also show preliminary displays of the vertical and oblique ionograms acquired using the Jicamarca VIPIR and the new receivers.

Introduction

The Jicamarca Radio Observatory (JRO) operates a Vertical Incidence Pulsed Ionospheric Radar (VIPIR) ionosonde by Scion Asocciated. This radar is used to study the equatorial ionosphere over JRO. The purpose of the new receiver system is to study oblique propagation taking advantage of the dispersed echoes generated by the VIPIR transmitter at JRO (Figure (a)). The system consists of two loop antennas, one USRP N200, one GPSDO and an acquisition computer where the pre-processing stages are implemented. Oblique ionograms are generated by synchronizing precisely the beginning of the acquisition and making our GNU Radio flow graph pre processing each acquisition frequency in its correct inter pulse period.

Figure (a)

Description

Figure 1 shows the receiver stages of the Ayacucho receiver.

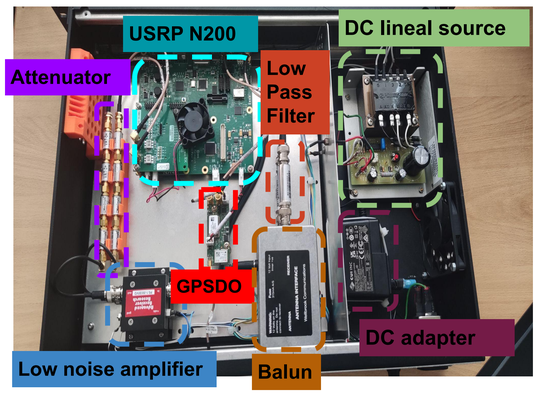


Figure 1: Ayacucho receiver loop antennas and receiver front-end.

Figure 2 shows the different pre-processing stages in GNU Radio Companion.

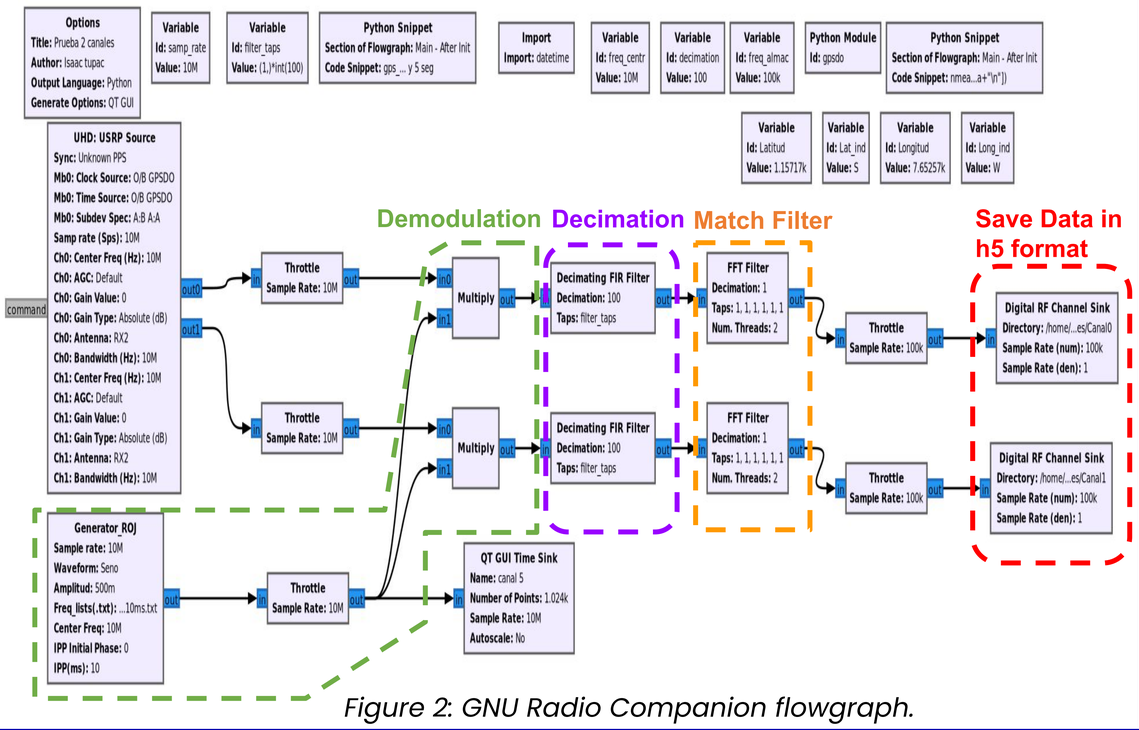
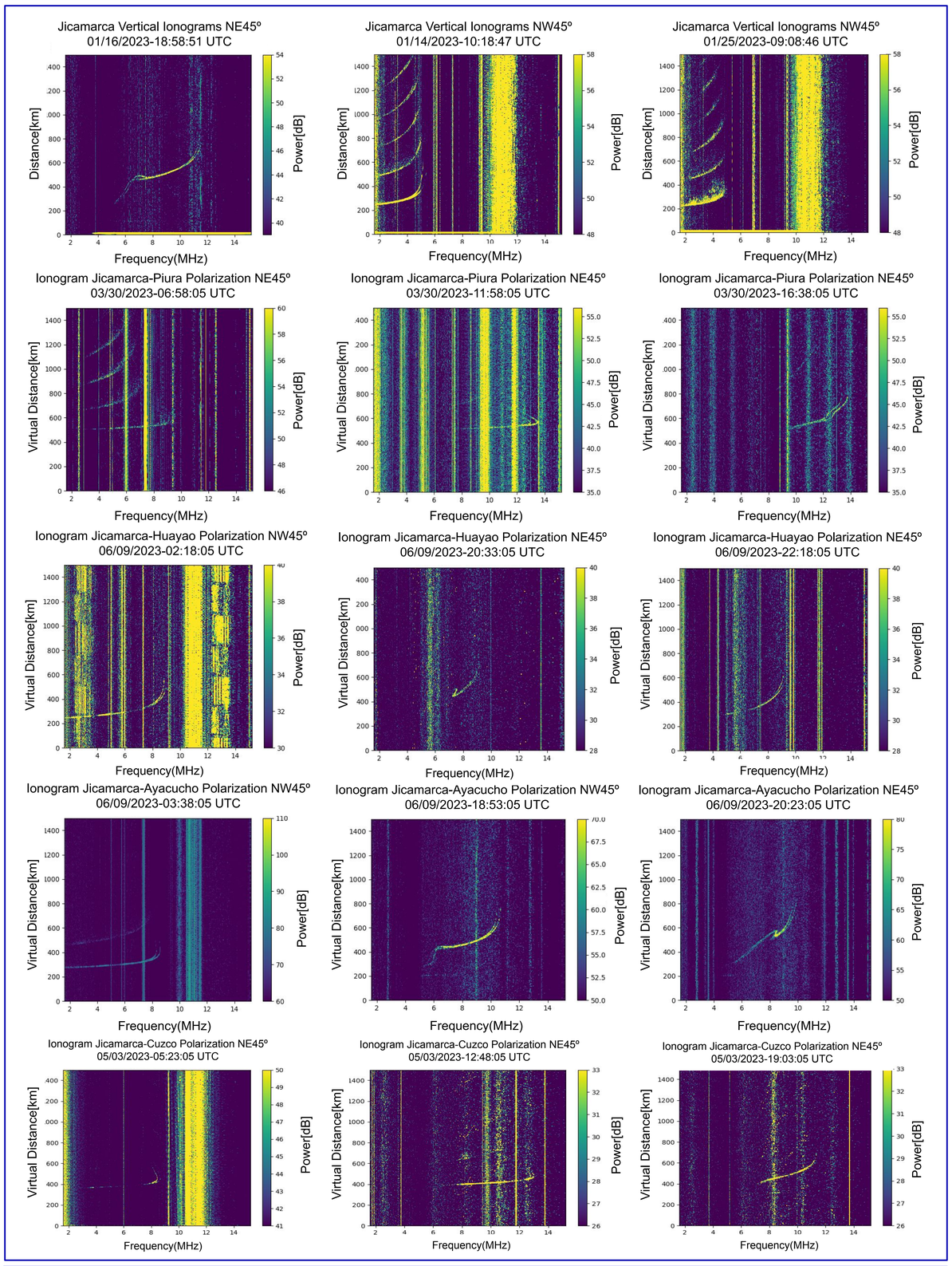


Figure 2: GNU Radio Companion flowgraph.

Results and discussions

The first row shows vertical ionograms acquired when the receiver was colocated with the transmitter at JRO. The next rows shows oblique ionograms with the receivers located in different Peruvian cities: Piura(856 km), Huancayo (169 km), Ayacucho (319 km) and Cusco (561 km).



Future work

We are working on improving the SNR of the ionograms and its classification. In addition, the data will be uploaded to a repository to share with the community. Finally we are also consider future locations of the VIPIR receivers that will optimize the detection of TIDs, plasma bubbles, and ionospheric variability in general.

Acknowledgements

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