Preliminary results of new operation mode JULIA Medium Power at JRO

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Abstract

The main radar of the Jicamarca Radio Observatory (JRO), for several years, has operated with two main modes, the ISR mode with big transmitters (1.5 MW), operating around 1000 hours per year, to survey the ionosphere and obtain parameters such as drifts, densities and composition; and the JULIA mode with low power transmitters (20 kW), operating around 4000 hours per year, to measure mostly coherent echoes such as Equatorial Electrojet, Spread F and 150 km echoes to provide with a proxy of the behavior of the ionosphere.
Starting in 2022, two new solid-state transmitters were installed at JRO, with peak power of 96 kW each, making it possible to not only detect coherent echoes but to be able to estimate zonal and vertical drifts in the ionosphere too. This new mode, called JULIA Medium Power (JULIA MP), is capable of measuring the same coherent echoes as the original JULIA but able to estimate zonal and vertical drifts up to 500 km.
This work will present the preliminary results of this mode, comparisons of the coherent echoes obtained with JULIA and JULIA MP and finally show the quality of drifts we are getting with this medium power mode.

1. Introduction

For several years we had the limitation to obtain drifts for periods not longer than 1000 hour per year since we were only able to get drifts while running with big transmitters. This changed last year, when two (02) new solid state transmitters, of 96 kW peak power each and 10 % duty cycle, were put operational at JRO as one of the many upgrades we are implementing in the last couple of years.

With this new transmitters and the antenna capabilities we were able to not only improve the signal quality of the coherent echoes that we monitor every time we are running the JULIA mode, but also we are able to obtain drifts, with the new mode JULIA MP mode.

Figure 1. New 96 kw solid-state transmitters

2. Configuration

The JULIA MP mode has been design to obtain the coherent echoes detected with the JULIA mode plus adding a ISR medium power mode, to be able to obtain the vertical and zonal drifts. In the following tables we described the differences of the JULIA modes for day and night time.

Day Time

	JULIA			JULIA MP		
Mode	**150km echoes**	**EEJ (Oblique)**	**Biestatic**	**ISR Medium power**	**150 km echoes**	**EEJ (Oblique)**
IPP (km)	375 km	375 km	375 km	1500 km	1500 km	300 km
Tx Pulse / code	15 km | (Barker 5)	15 km | (Barker 5)	7.8km | (barker 13)	45 km | (barker 3)	9 km | (barker 3)	9 km | (barker 3)
Sampling window	Ho=78.45km DH=1.5km NSA=101	Ho=78.45km DH=1.5km NSA=101	Ho=0km DH=0.6km NSA=251	H0=0 DH=1.5 Km NSA=980	H0=0 DH=1.5 Km NSA=980	H0=0 Km DH=1.5 Km NSA=196
Tx / antenna	2 x 8 kW | Nd + Sd, Nu + Su	1 x 8 kW | Oblique Yagi array	1 x 8kW | Yagi array @ JRO	2 x 96 kW | All up, All down	2 x 96 kW | All up, All down	1 x 8 kW | Oblique Yagi array
Rx antenna	Nd + Sd, Nu + Su	Oblique Yagi array	Yagi array @ Ica	All up, All down	All up, All down	Oblique Yagi array

Night Time

	JULIA		JULIA MP		
Mode	**ESF**	**Imaging**	**ISR Medium power**	**ESF**	**Imaging**
IPP (km)	937.5 km	937.5 km	1500 km	1500 km	1500 km
Tx Pulse / code	18.75 km | (Barker 5)	84 km | (Binary 28)	45 km | (barker 3)	3 km | (flipped)	84 km | (binary 28)
Sampling window	Ho=0km DH=3.75km NSA=240	Ho=0km DH=1.5km NSA=745	H0=0 DH=1.5 Km NSA=980	H0=0 DH=1.5 Km NSA=980	H0=0 Km DH=1.5 Km NSA=196
Tx / antenna	1 x 8 kW | Nd + Sd	2 x 8 kW | Eu	2 x 96 kW | All up, All down	2 x 96 kW | All down	2 x 8 kW | 65th module
Rx antenna	Wd, Ed	8 antenna modules	All up, All down	Wd, Ed	8 antenna modules

3. Results comparing JULIA and JULIA MP

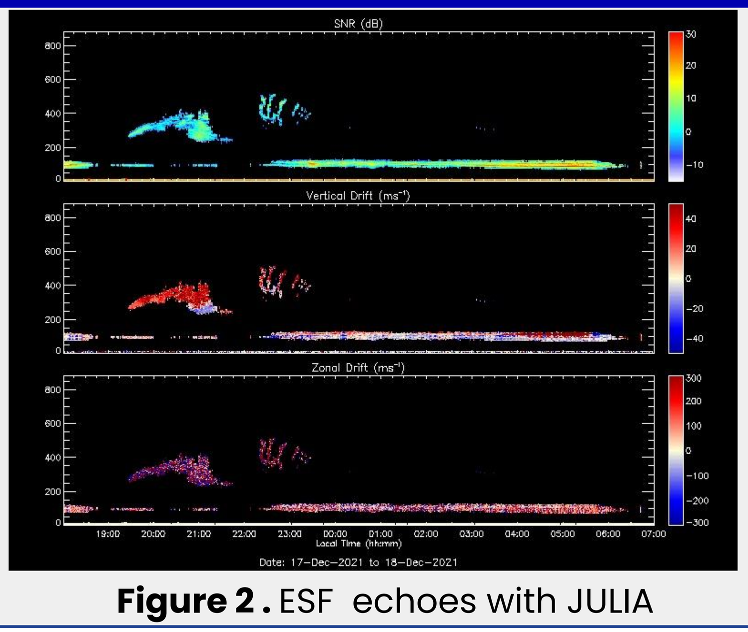

Figure 2 . ESF echoes with JULIA

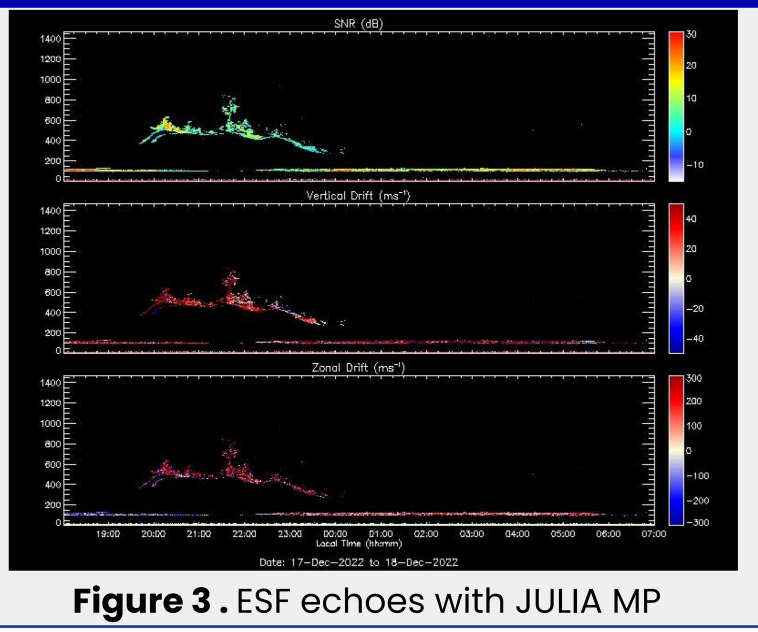

Figure 3 . ESF echoes with JULIA MP

3. Results comparing JULIA and JULIA MP

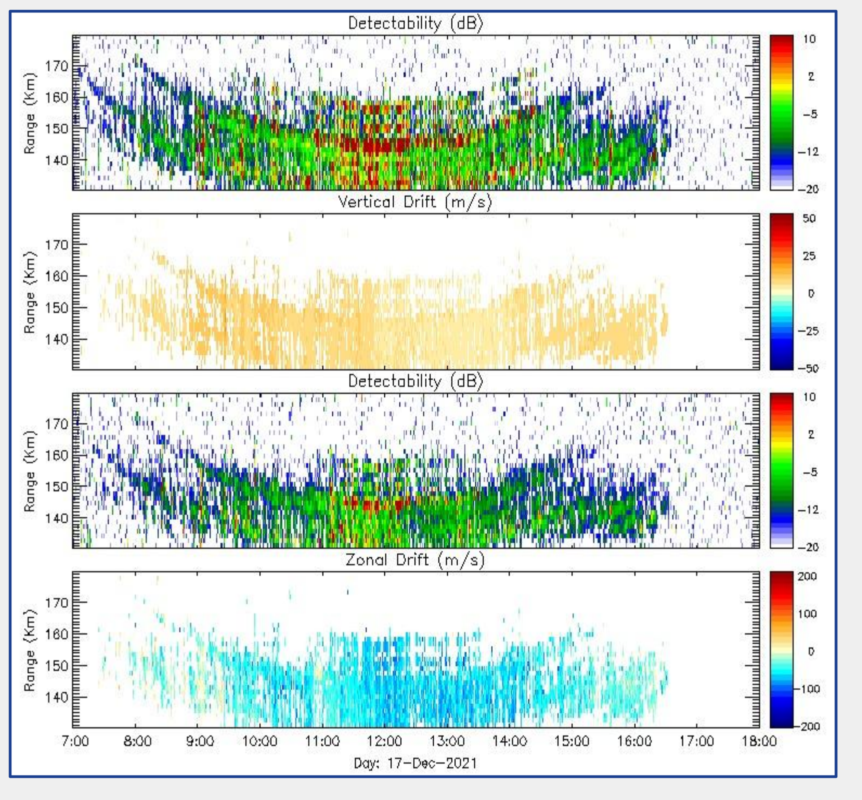

Figure 4 . 150 km drifts with JULIA

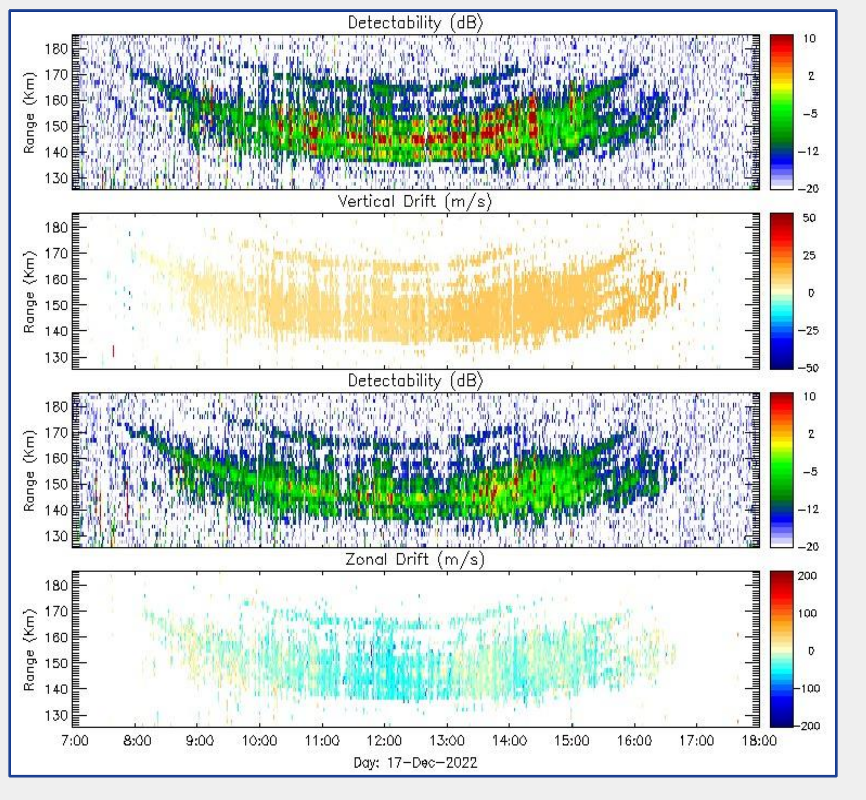

Figure 5 . 150 km drifts with JULIA MP

4. Results comparing JULIA MP Drifts and only ISR Medium Power

From this comparison it is noticeable that the drifts presented in Figure 6 shows more noise than the one on Figure 7. This is because the JULIA MP mode shares the same antenna between ISR MP mode and ESF mode, which on its turn obtains less signal in total. In order to improve the signal quality on ISR MP mode from JULIA MP it is necessary to increase the duty cycle of the experiment, but that will imply the need to calibrate the spark gaps constantly, instead of twice a day as it is nowadays, so we are currently developing 08 new solid-state TRs for 50 kW peak power and a 10 % duty cycle that will allow us to increase the duty cycle and for the system to be completely unattended.

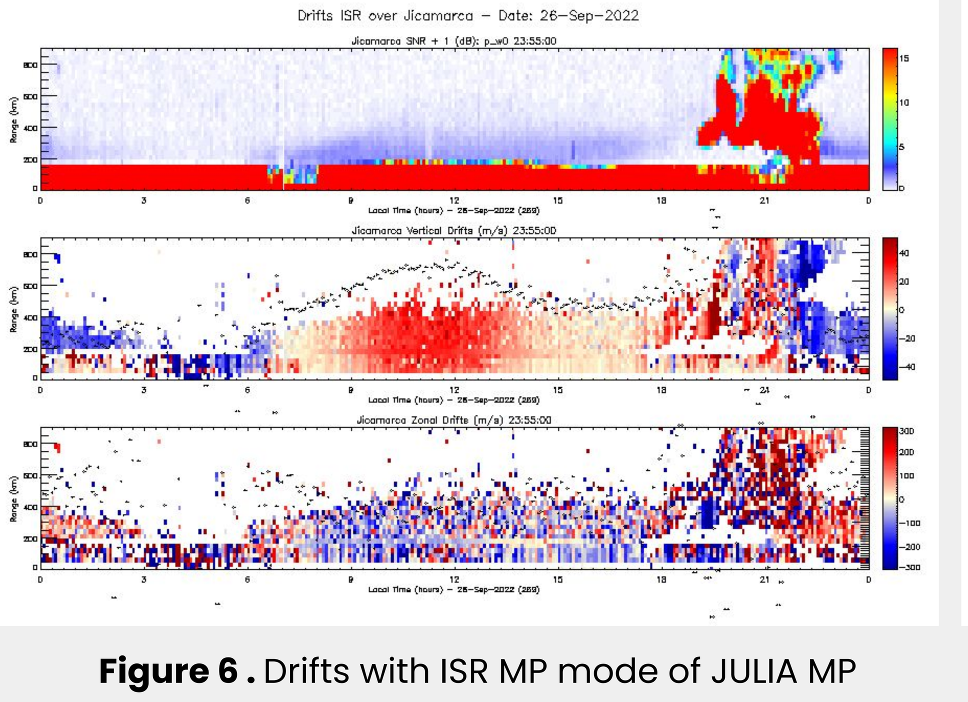

Figure 6 . Drifts with ISR MP mode of JULIA MP

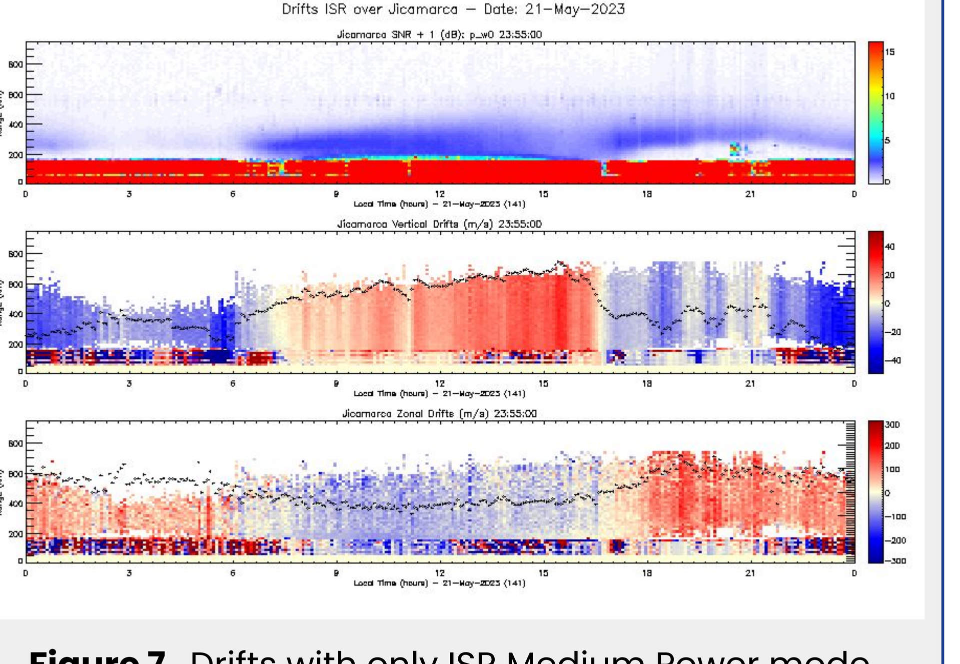

Figure 7 . Drifts with only ISR Medium Power mode

5. Conclusions and Future Work

- This new mode allow to obtain drifts not only during ISR campaigns (around 1000 h/year) but also during our "low" power campaigns (around 4000 h/year)
- In order to improve the drifts quality on JULIA MP mode, it is necessary to increase the duty cycle for the experiment.
- Because of the drift quality on the JULIA MP mode, the last few months we have been running only ISR Medium Power to prioritize on Drifts.
- For future work, in order to increase the duty cycle to have more average power and obtain better results there is a project to developed 8 new solid state TRs that will handle up to 50 kW peak power and up to 10% of duty cycle each.

6. Acknowledgments

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