Using JULIA long dataset to find preconditioning evidence of ESF in bottom-type layers

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Introduction

Recently Hysell et al. [2005] has suggested that the periodic structuring observed in the bottomtype (BT) scattering layers might be used to determine the occurrence or not of full-blown equatorial spread F (ESF) on a given day. The seed or precursor waves may be generated by a collisional shear instability. Preliminary observations at Jicamarca and ALTAIR have shown that such structures present wavelengths of the order of tens or hundreds of kilometers. At Jicamarca periodic structures have been observed using in-beam radar imaging techniques, however such observations are limited to few days in the last five years. On the other hand, routine observations using the JULIA system at Jicamarca have been done since 1996 on approximately 100 days per year on average, using interferometric and dual-beam observations with very narrow beams. Since the bottom-type irregularities drift at a relatively constant speed in the westward direction, using the JULIA narrow beams (~1o), the spatial periodicities might be observed as temporal periodicities in typical range-time intensity maps. In this initial work we present the statistics of the observed bottom-type periodicities and the occurrence of ESF plumes as detected with the JULIA system for years 2006-2008. Besides we present a time occurrence statistics of a weak bottom-type layer that took place previously to bottom-type layers.

JULIA radar

This system has three channels and their radiation pattern related to magnetic field are showed in figure 1. Channels A and B focus in the East, while channel C in West direction.

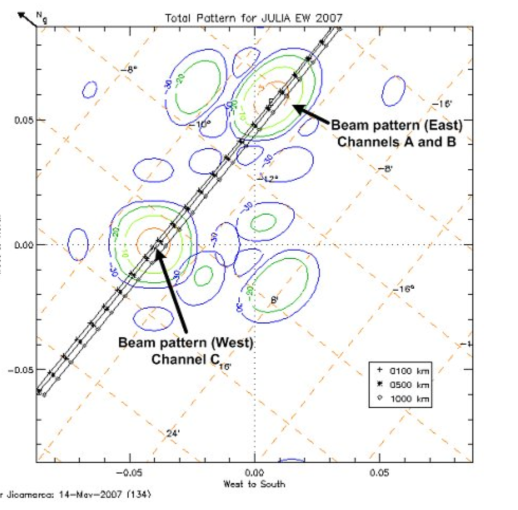

Figure 1. JULIA antennas Radiation Patterns

ESF Bottom-type patching

ESF radar imaging (RI) campaigns allows to Hysell et al. [2005] found that in bottom-type layers the plasma waves are clustered like patches and separated horizontally by about 30Km. Figure 2 show results of bottom-type layer using RI. Hysell et a. [2005] propose that such clustering took place only as previous behavior to Topside ESF. Plasma waves velocities at this regions are ~40m/s, then the corresponding time between bottom-type patches in simple RTI graphics are ~12min. Below shows the results of the present analysis of JULIA datasets for identify bottom-type patching.

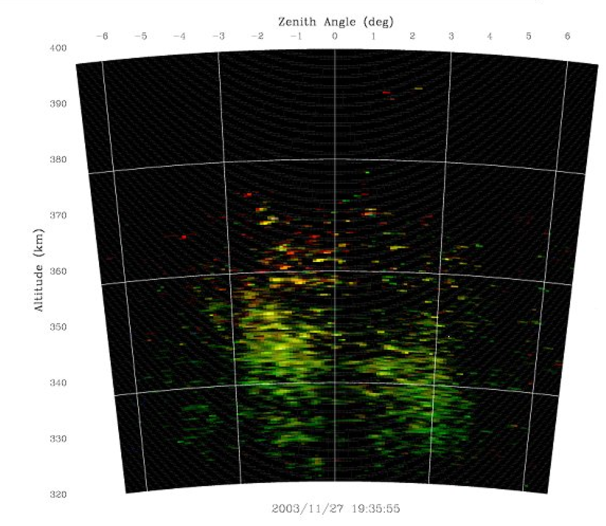

Figure 2. Bottom-type ESF patching image results using RI technique

RTI Maps of JULIA ESF

Equinox (Feb-Apr, 2006-2008) | Equinox (Aug-Oct, 2006-2007) | Solstice (Nov-Dec, 2006-2007) | Solstice (Jan, 2006-2008)

Topside preceded by BT patches: RTI Map

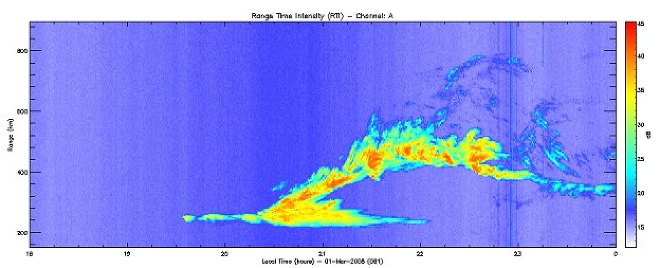

Figure 3.a RTI of Topside ESF day (061-2008)

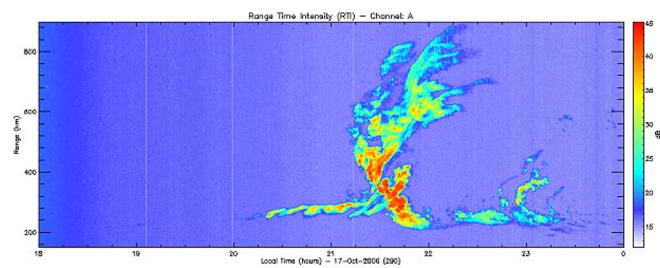

Figure 4.a RTI of Topside ESF day (290-2006)

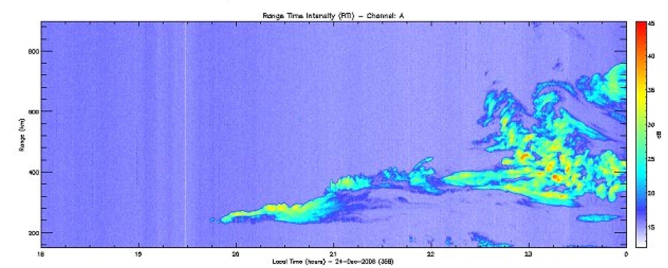

Figure 5.a RTI of Topside ESF day (358-2006)

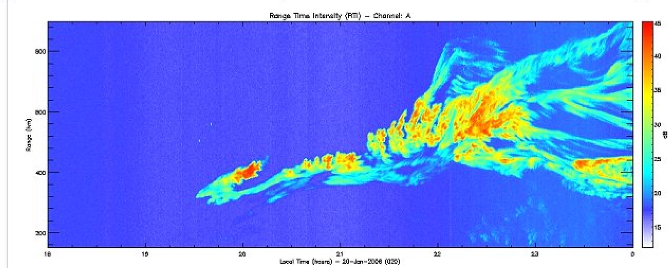

Figure 6.a RTI of Topside ESF day (020-2006)

Topside preceded by BT patches: BT layer enlarged view

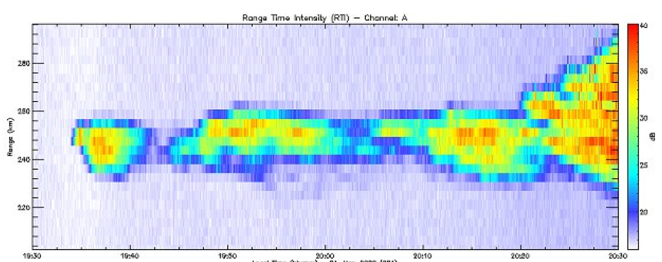

Figure 3.b RTI of Topside ESF day (061-2008): Enlarged view of BT layer

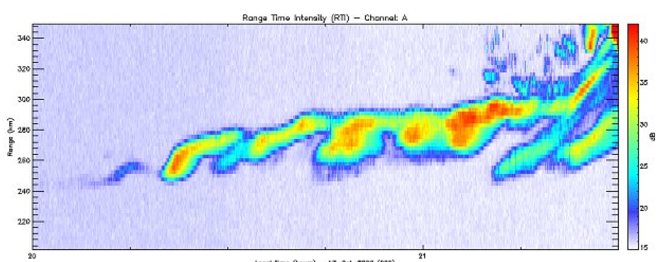

Figure 4.b RTI of Topside ESF (290-2006): Enlarged view of BT layer

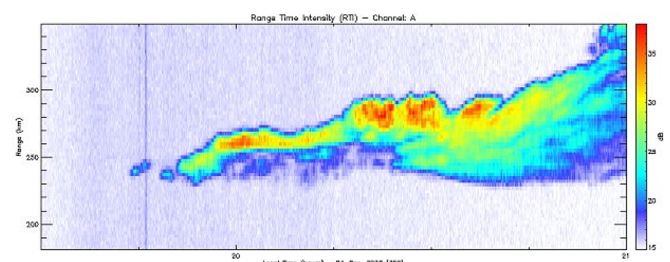

Figure 5.b RTI of Topside ESF day (358-2006): Enlarged view of BT layer

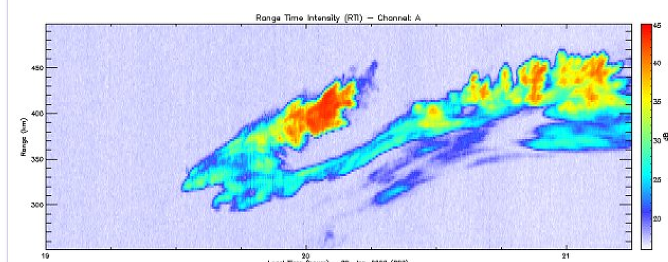

Figure 6.b RTI of Topside ESF day (020-2006): Enlarged view of BT layer

Topside preceded by BT patches: RTI Map

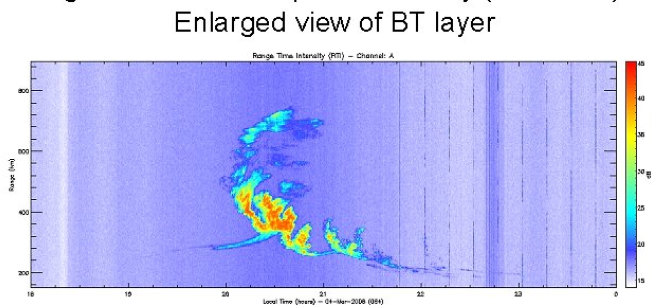

Figure 7.a RTI of Topside ESF day (064-2008)

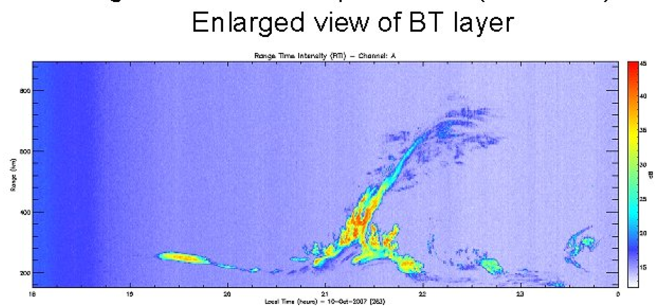

Figure 8.a RTI of Topside ESF day (283-2007)

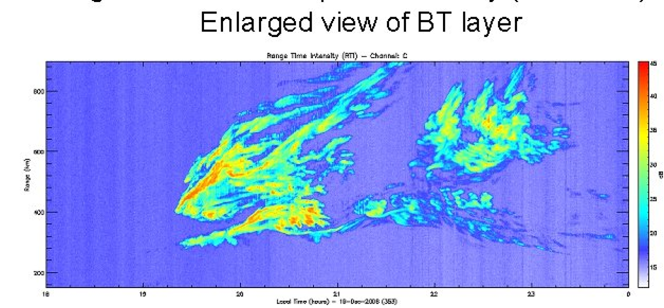

Figure 9.a RTI of Topside ESF day (353-2006)

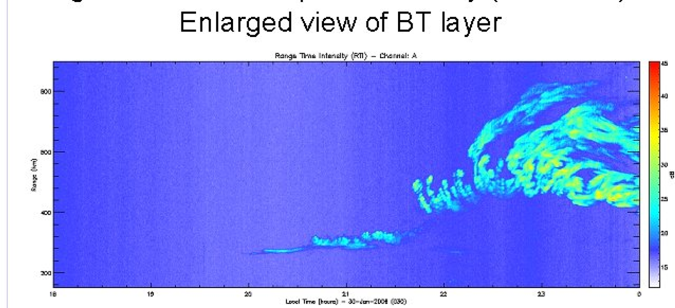

Figure 10.a RTI of Topside ESF day (030-2006)

Topside preceded by BT patches: BT layer enlarged view

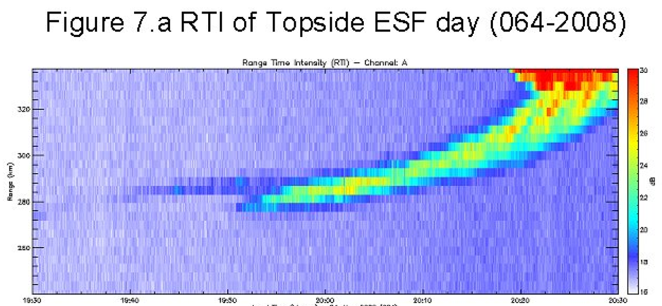

Figure 7.b RTI of Topside ESF day (064-2008): Enlarged view of BT layer

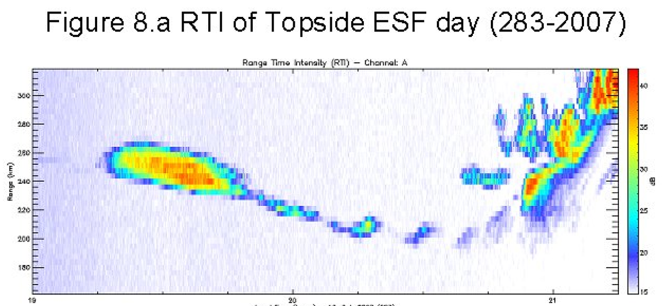

Figure 8.b RTI of Topside ESF (283-2007): Enlarged view of BT layer

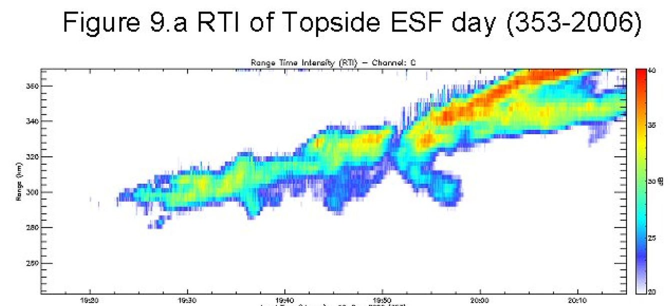

Figure 9.b RTI of Topside ESF day (353-2006): Enlarged view of BT layer

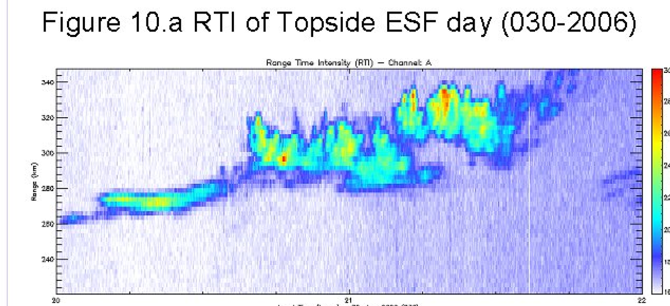

Figure 10.b RTI of Topside ESF day (030-2006): Enlarged view of BT layer

Topside not preceded by BT patches: BT layer enlarged view

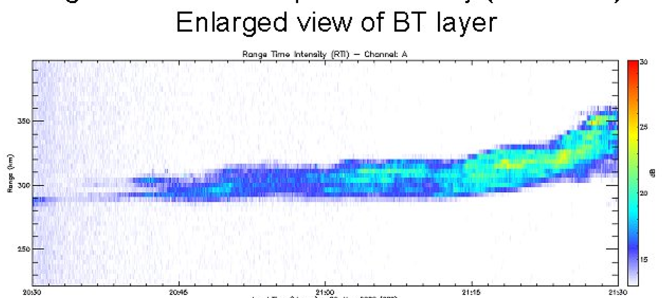

Figure 11 RTI of Topside ESF day (068-2008): Enlarged view of BT layer

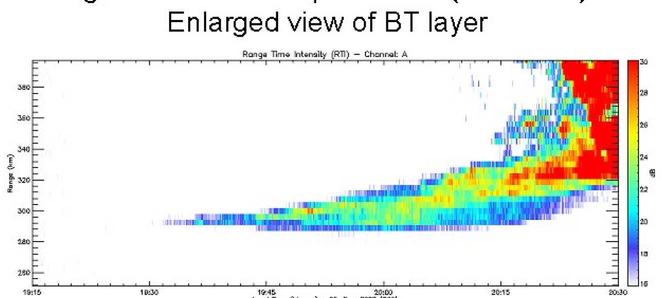

Figure 12 RTI of Topside ESF day (268-2007): Enlarged view of BT layer

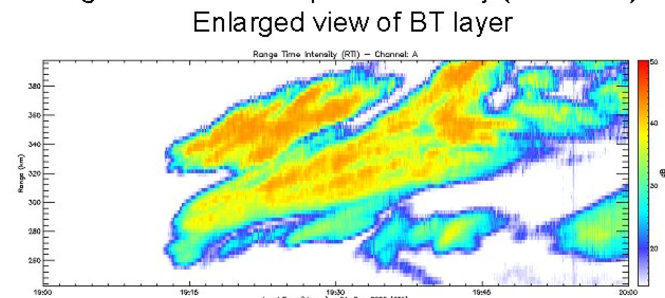

Figure 13 RTI of Topside ESF day (335-2006)

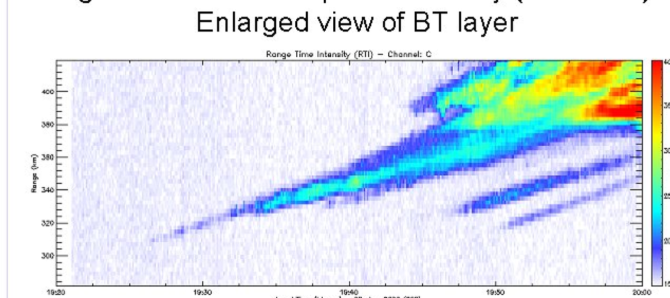

Figure 14 RTI of Topside ESF day (008-2006) Enlarged view of BT layer

Non topside preceded by BT patches: BT layer enlarged view

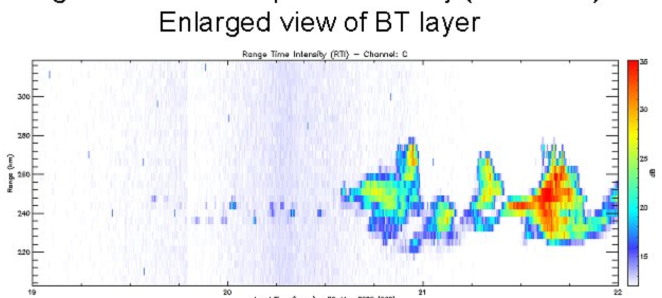

Figure 15 RTI of Bottomside ESF day (066-2008): Enlarged view of BT layer

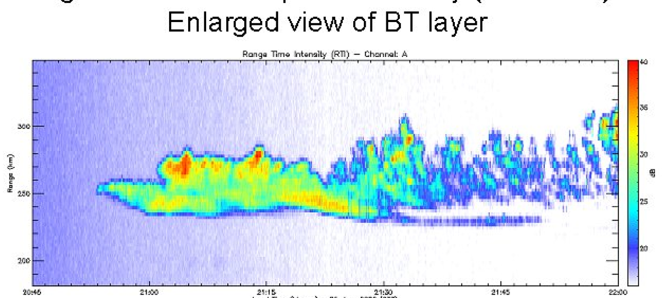

Figure 16 RTI of Bottomside ESF day (237-2007): Enlarged view of BT layer

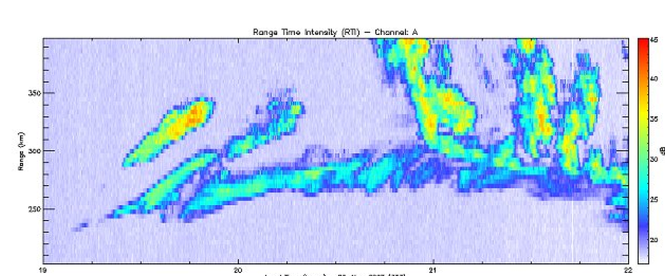

Figure 17 RTI of Bottomside ESF day (333-2007): Enlarged view of BT layer

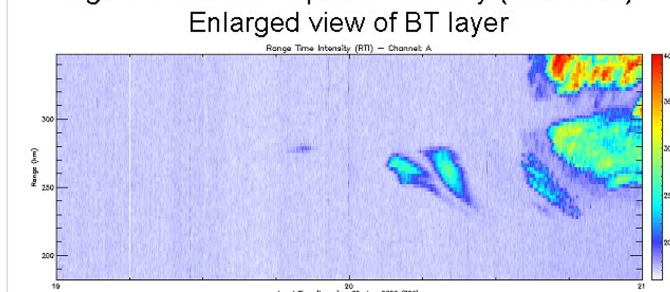

Figure 18 RTI of Bottomside ESF day (029-2006): Enlarged view of BT layer

Weak BT: BT layer enlarged view

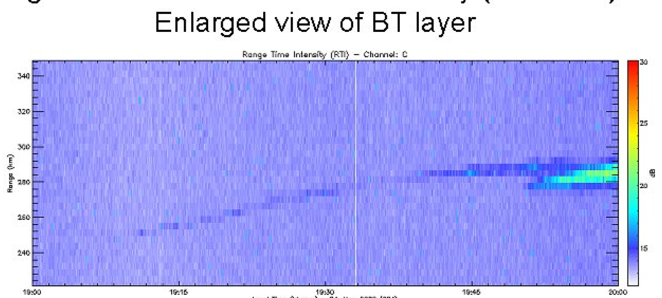

Figure 19 RTI of Topside ESF day (064-2008): Enlarged view of Weak BT layer previous to BT layer

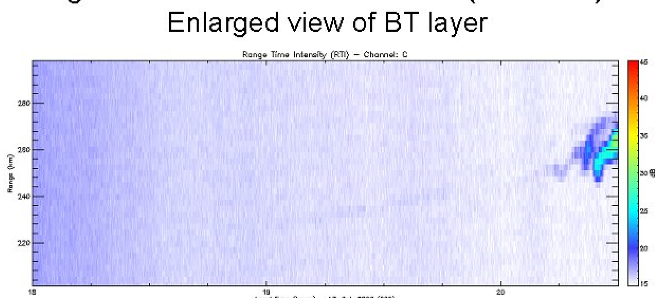

Figure 20 RTI of Topside ESF day (290-2006): Enlarged view of Weak BT layer previous to BT layer

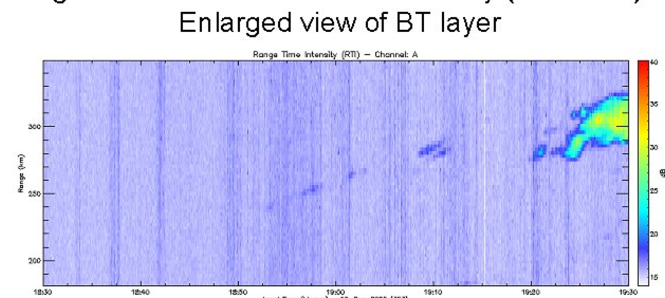

Figure 21 RTI of Topside ESF day (353-2008): Enlarged view of Weak BT layer previous to BT layer

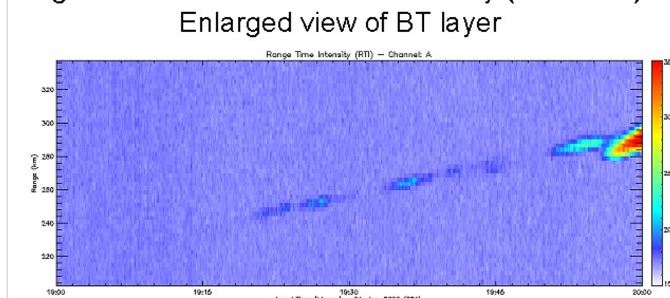

Figure 22 RTI of Topside ESF day (024-2006): Enlarged view of Weak BT layer previous to BT layer

Weak BT and BT: Time coverage

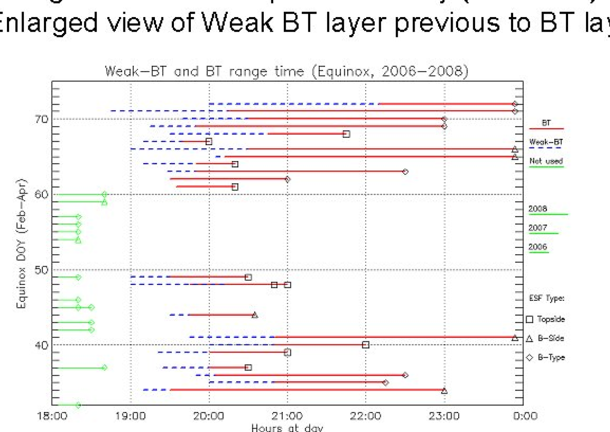

Figure 23 Time coverage of Weak-BT and BT layers

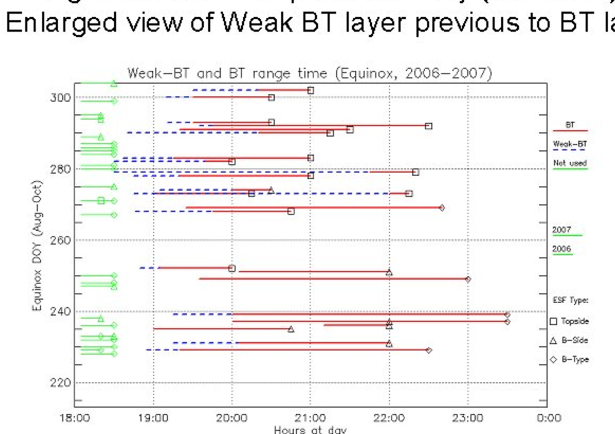

Figure 24 Similar to figure 23 but for Equinox Aug-Nov

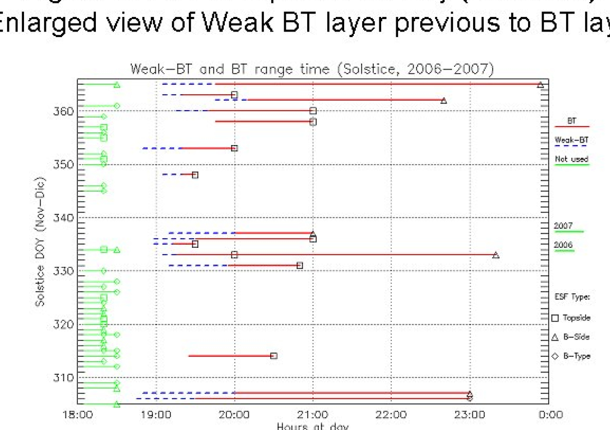

Figure 25 Similar to figure 23 but for Solstice Nov-Dec

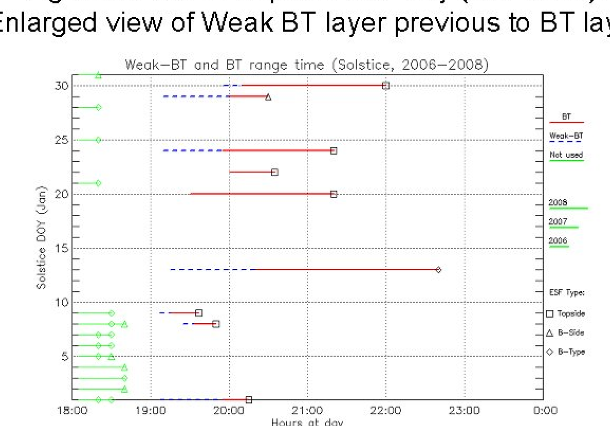

Figure 26 Similar to figure 23 but for Solstice Jan

BT-patch and BT-Weak day occurrence statistics

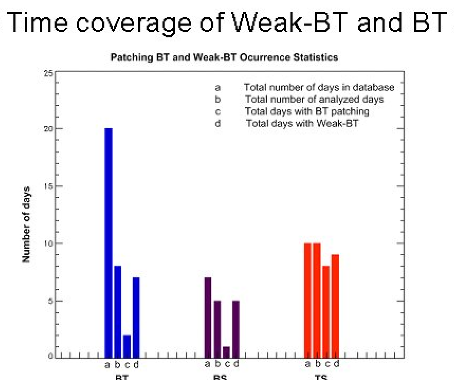

Figure 27 Day occurrence statistics BT-patch and BT-Weak

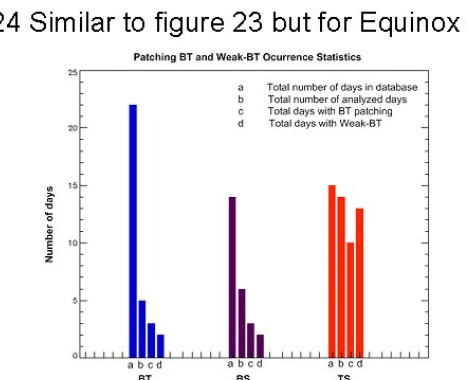

Figure 28 Similar to figure 27 but for Equinox Aug-Nov

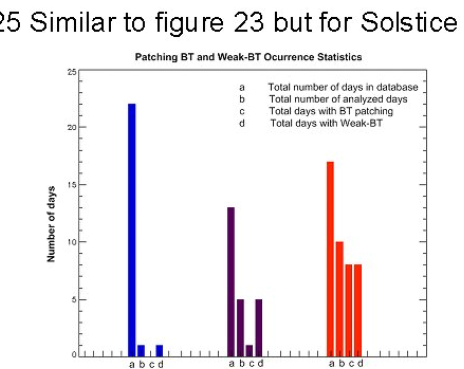

Figure 29 Similar to figure 27 but for Solstice Nov-Dec

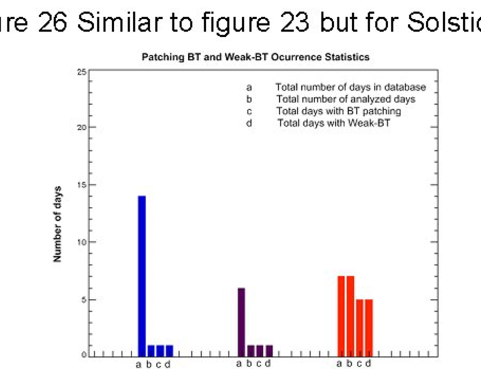

Figure 30 Similar to figure 27 but for Solstice Jan

Conclusions

Data from actual JULIA radar apparently show us the Bottom-type patches plasma waves, but because the dual beamwidth and the characteristics of the ESF these must be analysed in greater detail regarding the scope of this work in order to emit a final conclusions. Days with topside events was considered principally and with little days groups for the other types of ESF and patches events for other than topside ESF require more data to strengthen statistics. So it's necessary to complete the present work with all corresponding data base and if these new results will corroborate present results, therefore it would be one reason more to improve the actual JULIA system configuration to allow observations with enough resolution to detect such events and other for help in ESF forecast.

According to statistics BT-weak are present in a great days' percentage and has pulse behaviour whose report is not present because their tiny and weak characteristics. For now we can only conclude that if signal from this layer are improved this would increase the time of anticipation of forecast. So a conclusion about this layer is that is necessary to increase the echoes gain through RF coding or increasing transmission power.

References

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D.L. Hysell and J. D. Burcham, "Long term studies of equatorial spread F using the JULIA radar at Jicamarca", JASTP, 2001

J. L. Chau, R. F. Woodman, and L. A. Flores, "Statistical characteristics of low-latitude ionospheric field-aligned irregularities obtained with the Piura VHF radar", Annales Geophysicae, 20, 1203-1212, 2002

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