

A comparative study of VHF to S band scintillations around the northern EIA crest of the Indian zone

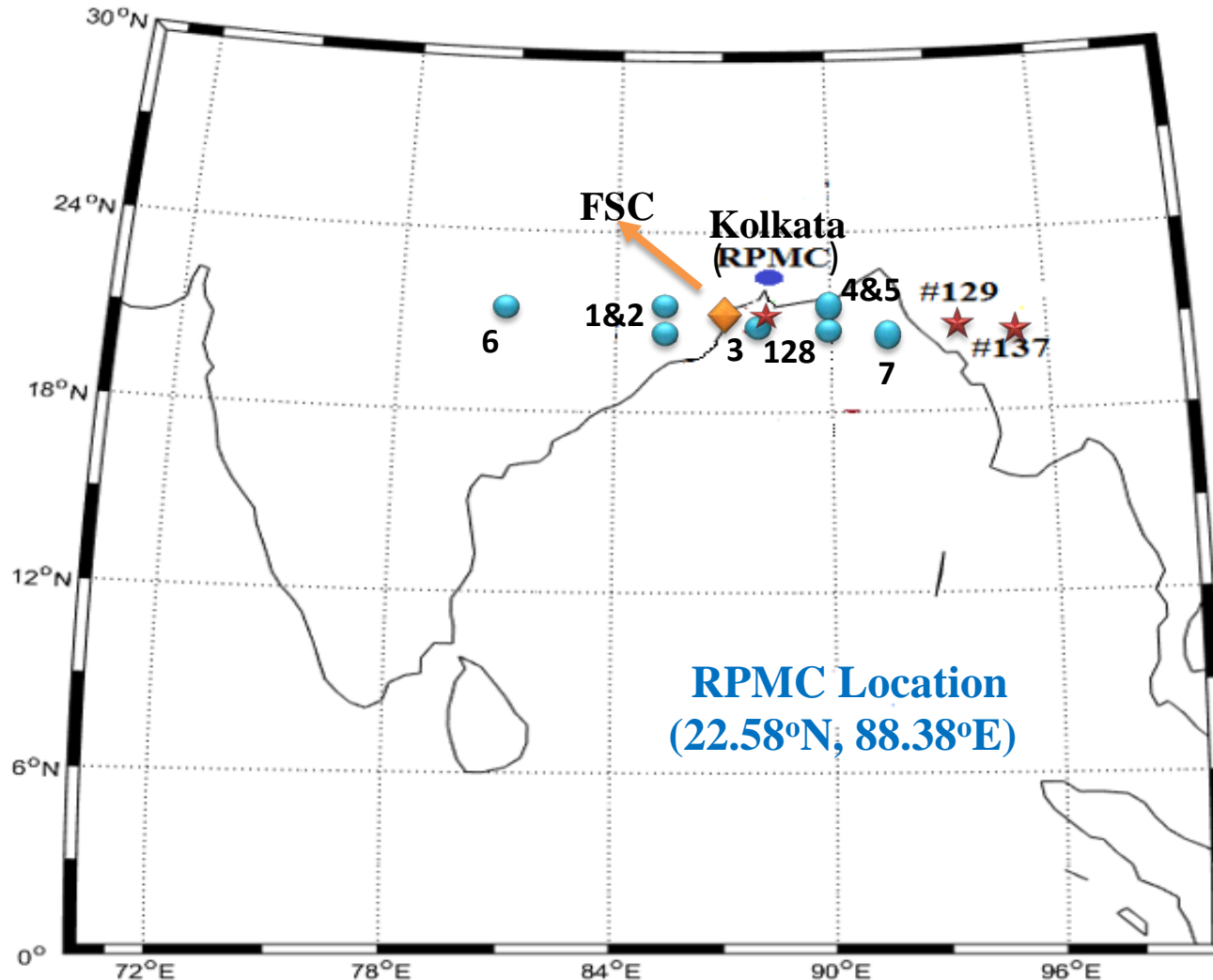
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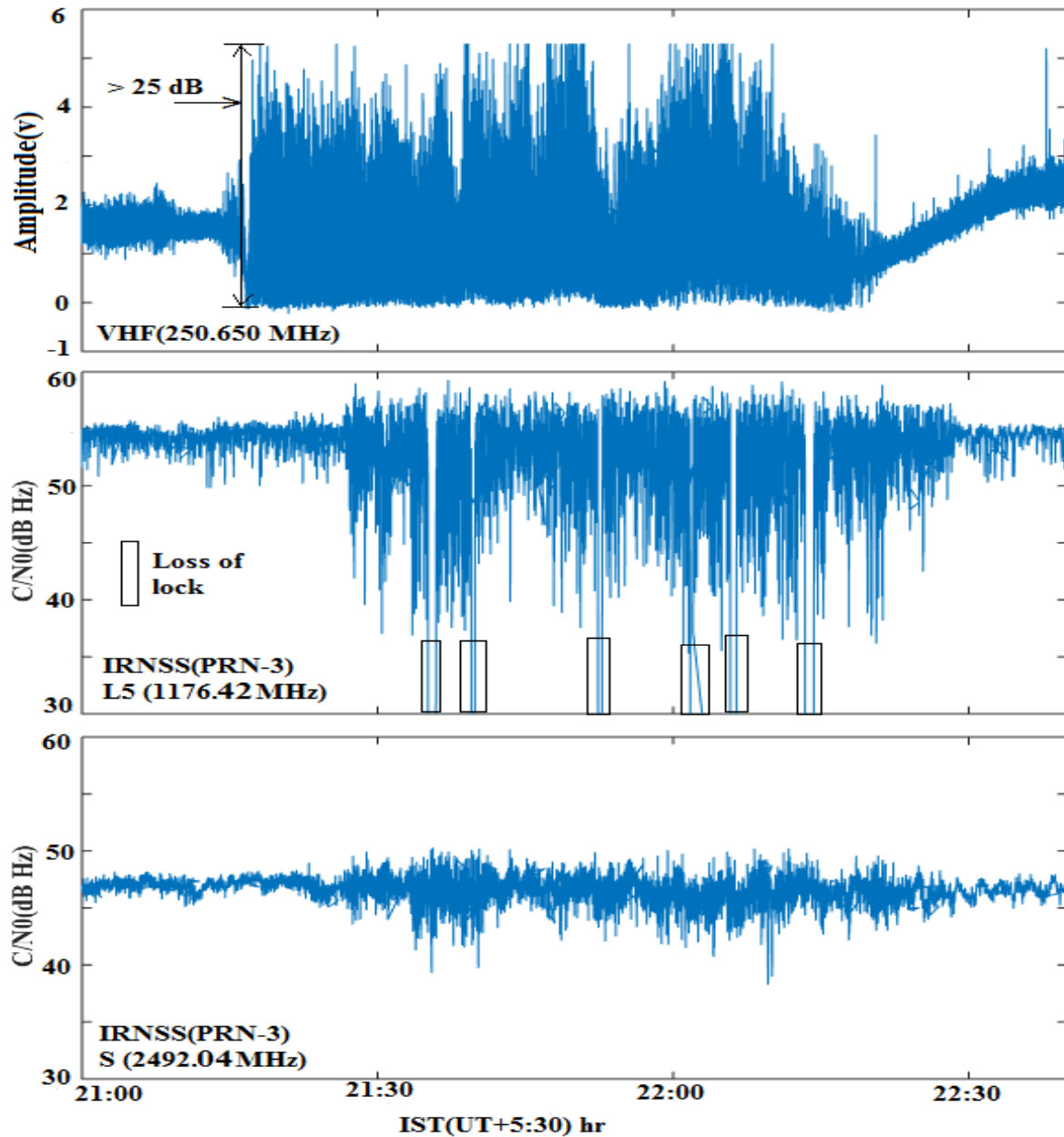
Location of RPMC(Kolkata) and IPP of different IRNSS, SBAS and VHF Satellites



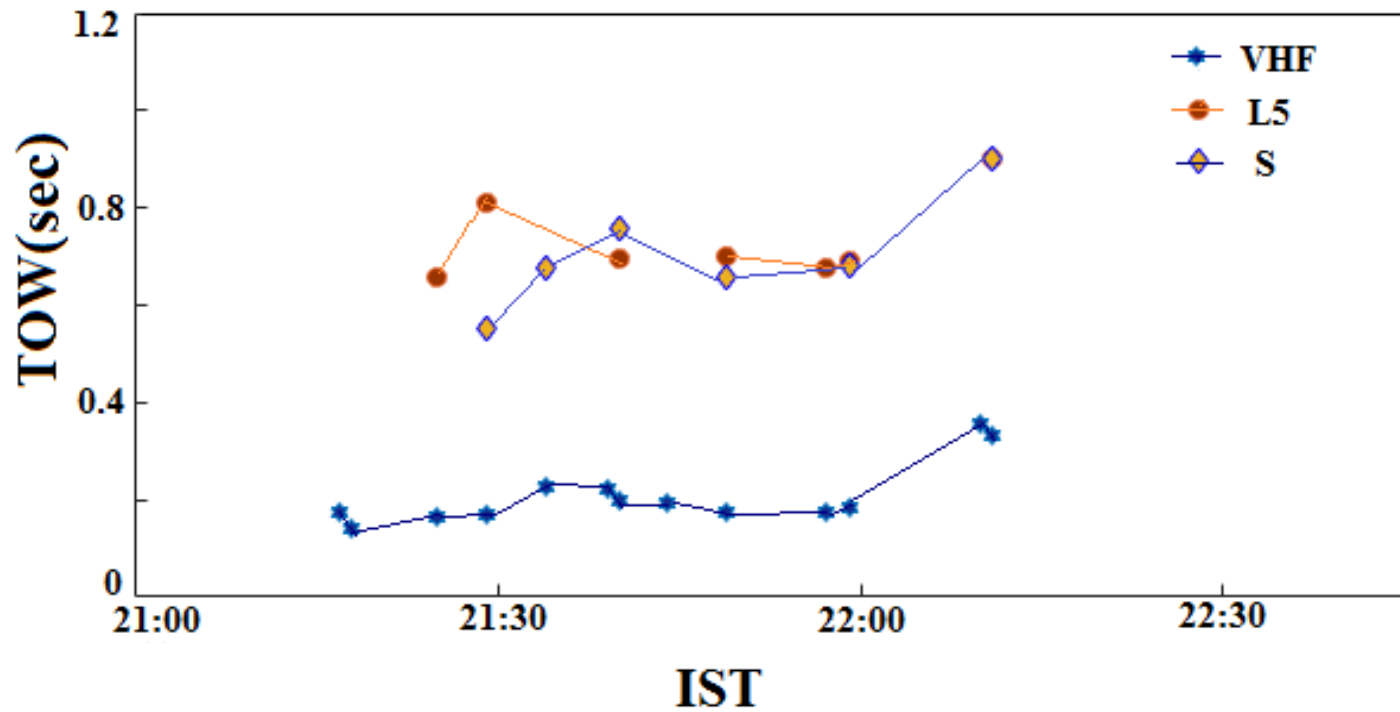
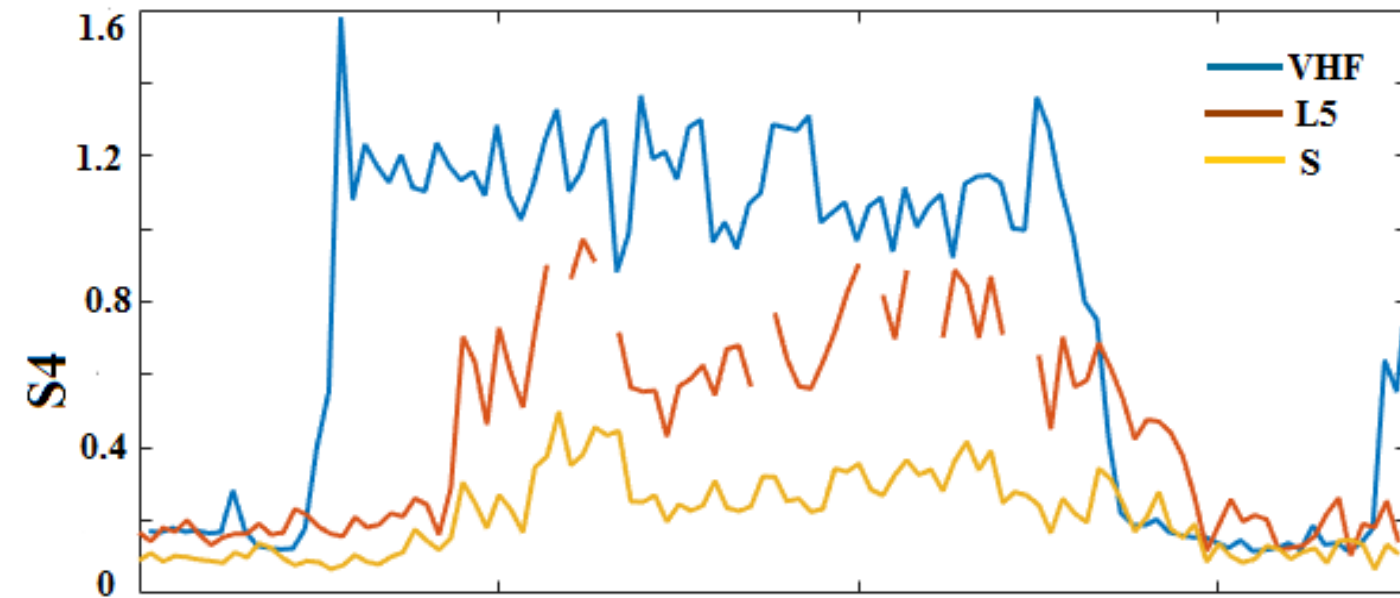
FSC(21.1°N, 86.9°E)
#1&2(21.16°N, 85.65°E)
#3(20.96°N, 87.98°E)
#4&5(21.18°N, 90.11°E)
#6 (21.01°N, 81.90°E)
#7 (20.71°N, 92.30°E)
#128(21.30°N, 88.00°E)
#129(21.11°N, 93.89°E)
#137(21.07°N, 95.13°E)

Period of observation:
April, 2015 – December, 2015

7th April, 2015



- ❑ Mostly saturated scintillation with P-P fluctuation >25 dB characterize scintillation at VHF.
- ❑ Severe scintillation leading to loss of lock of satellite channel are evident in the L5 band.

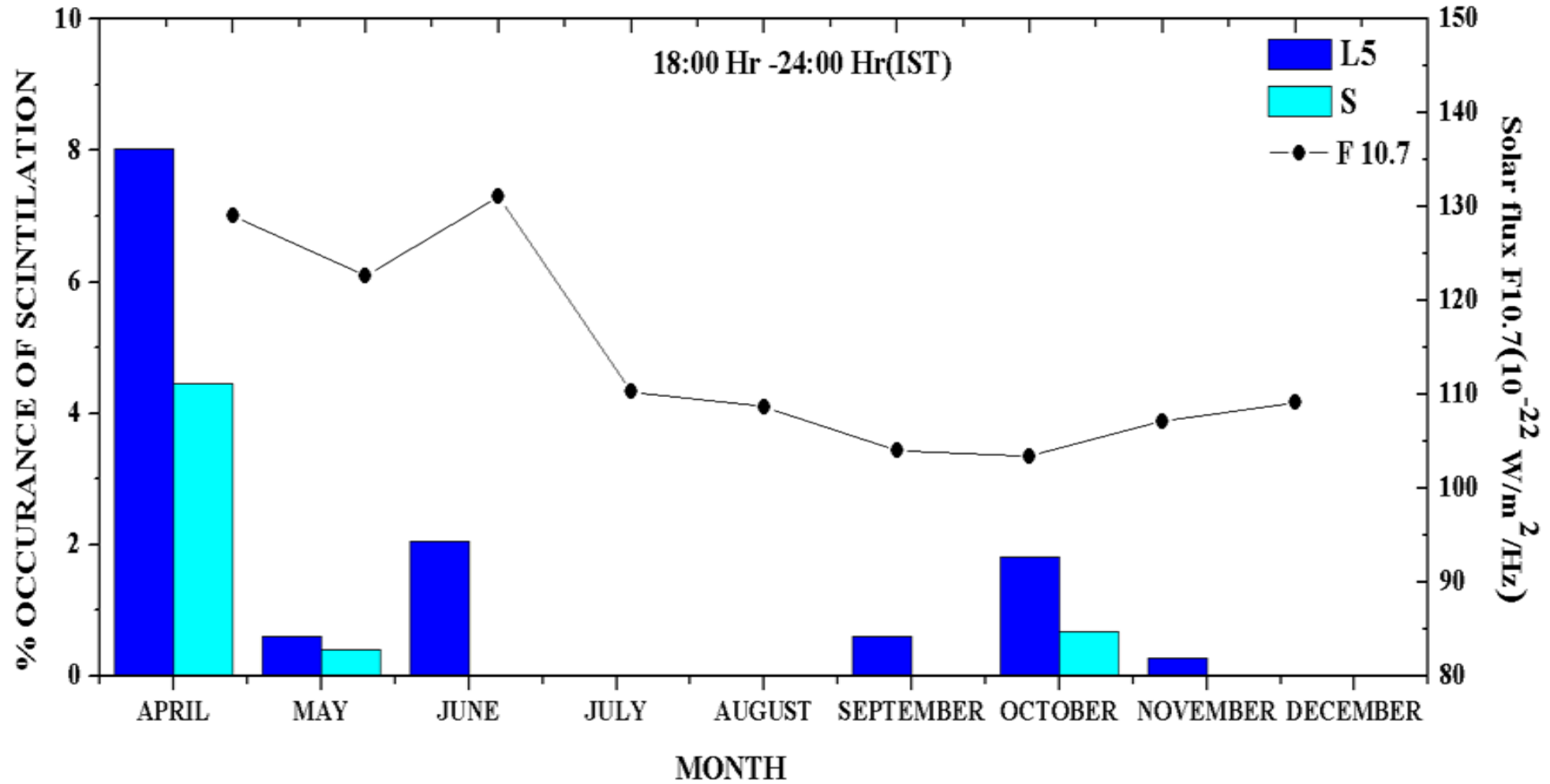


□ Comparatively weak scintillation mostly limited to <10 dB categorized S band scintillation.

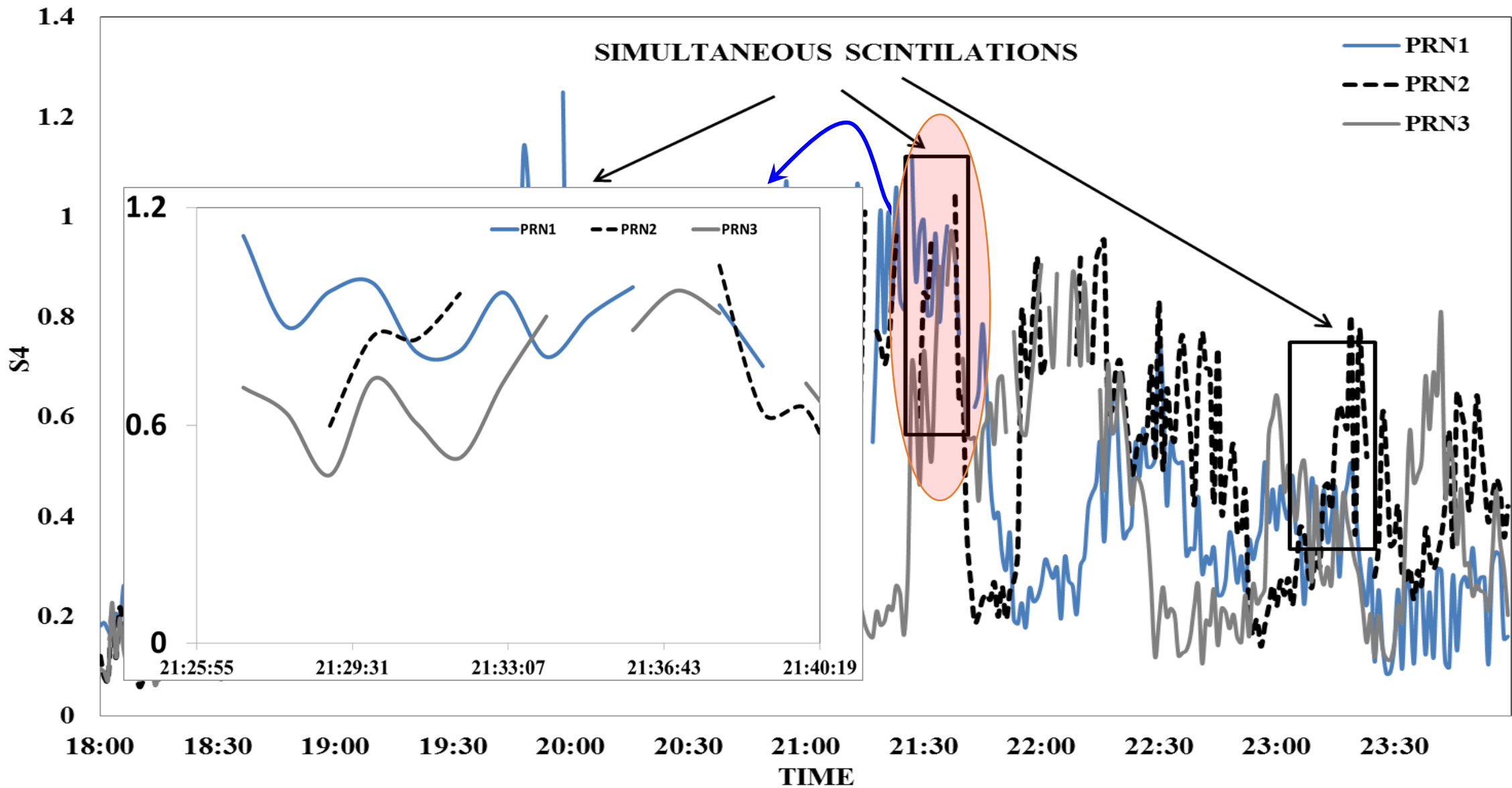
No of cases observed for loss of lock is 51

- Loss of lock in L5 frequency band signals are mostly followed by a fading > 9 fades/minute at S band frequency (practically in all cases)
- before the occurrence of loss of lock S_4 at S band signals ~ 0.35
- depth of fading at S band being $\sim 4.2 \pm 1.3$ dB during and prior to loss of lock at L5
- Longest time of duration of loss of lock is found to be ~ 69 sec on April 22, 2015 during 23:28:20-23:29:28 IST h

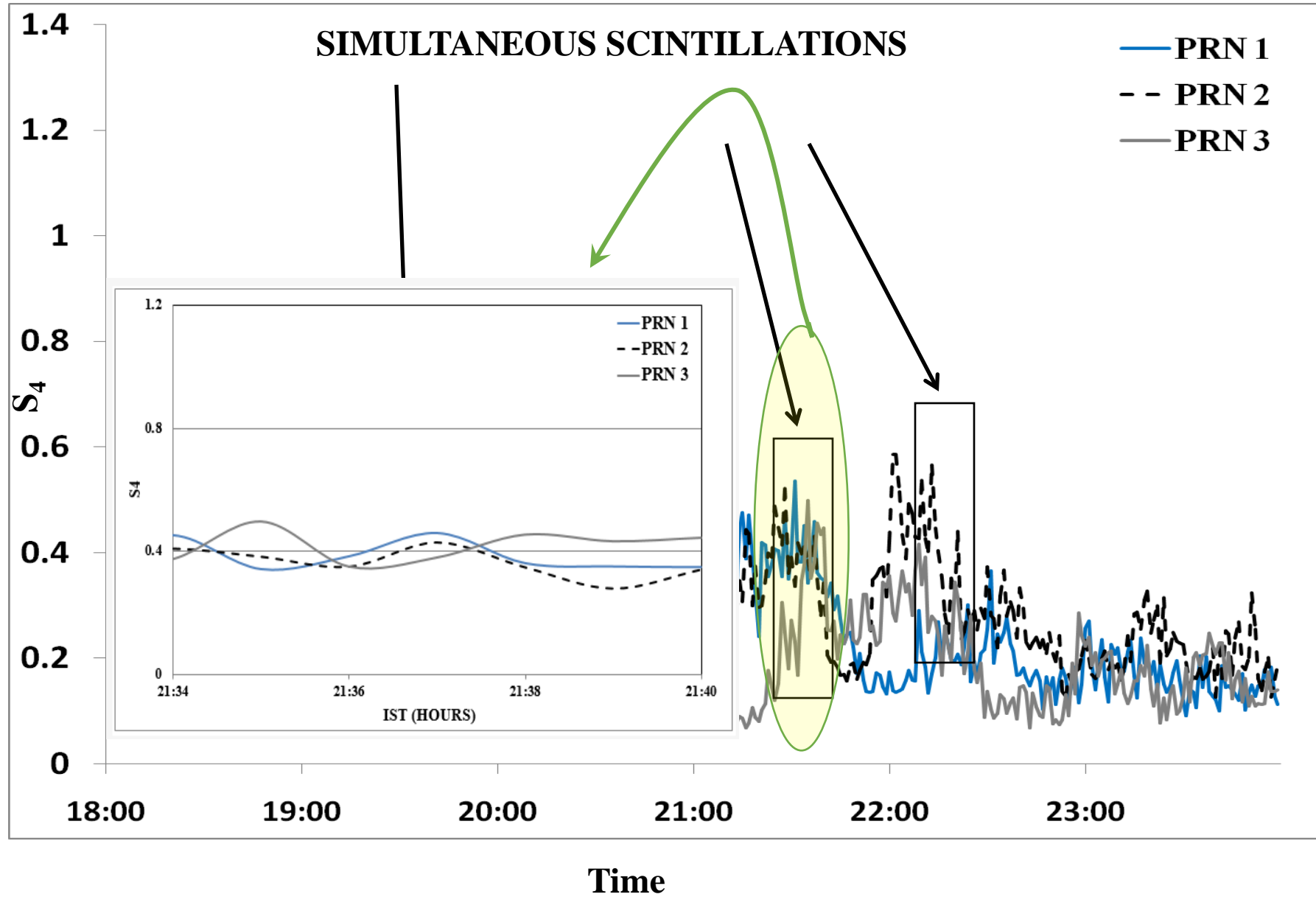
MONTHLY STUDY OF SCINTILLATIONS FOR PRN 3 (IRNSS)



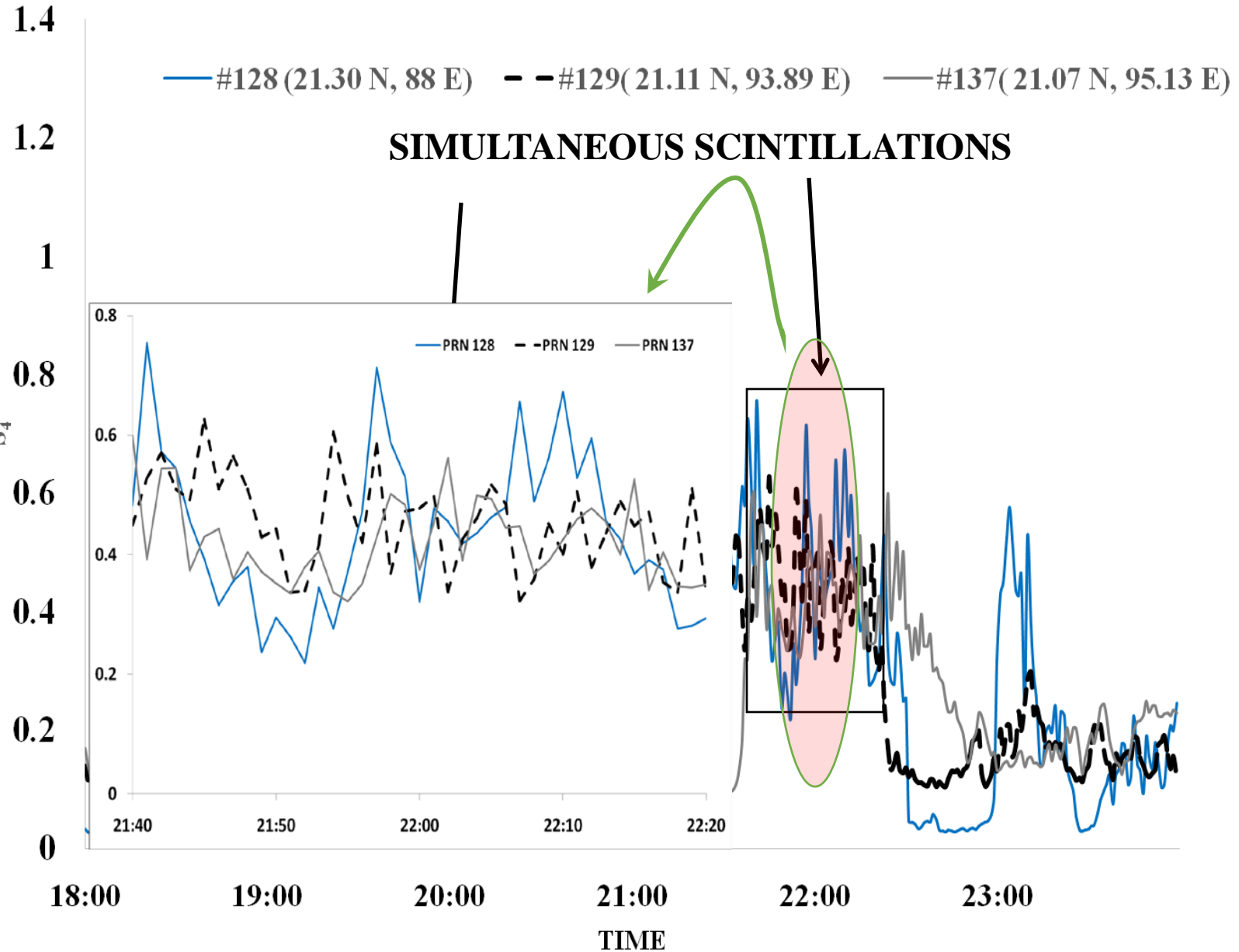
7th April, 2015 (L5 BAND)



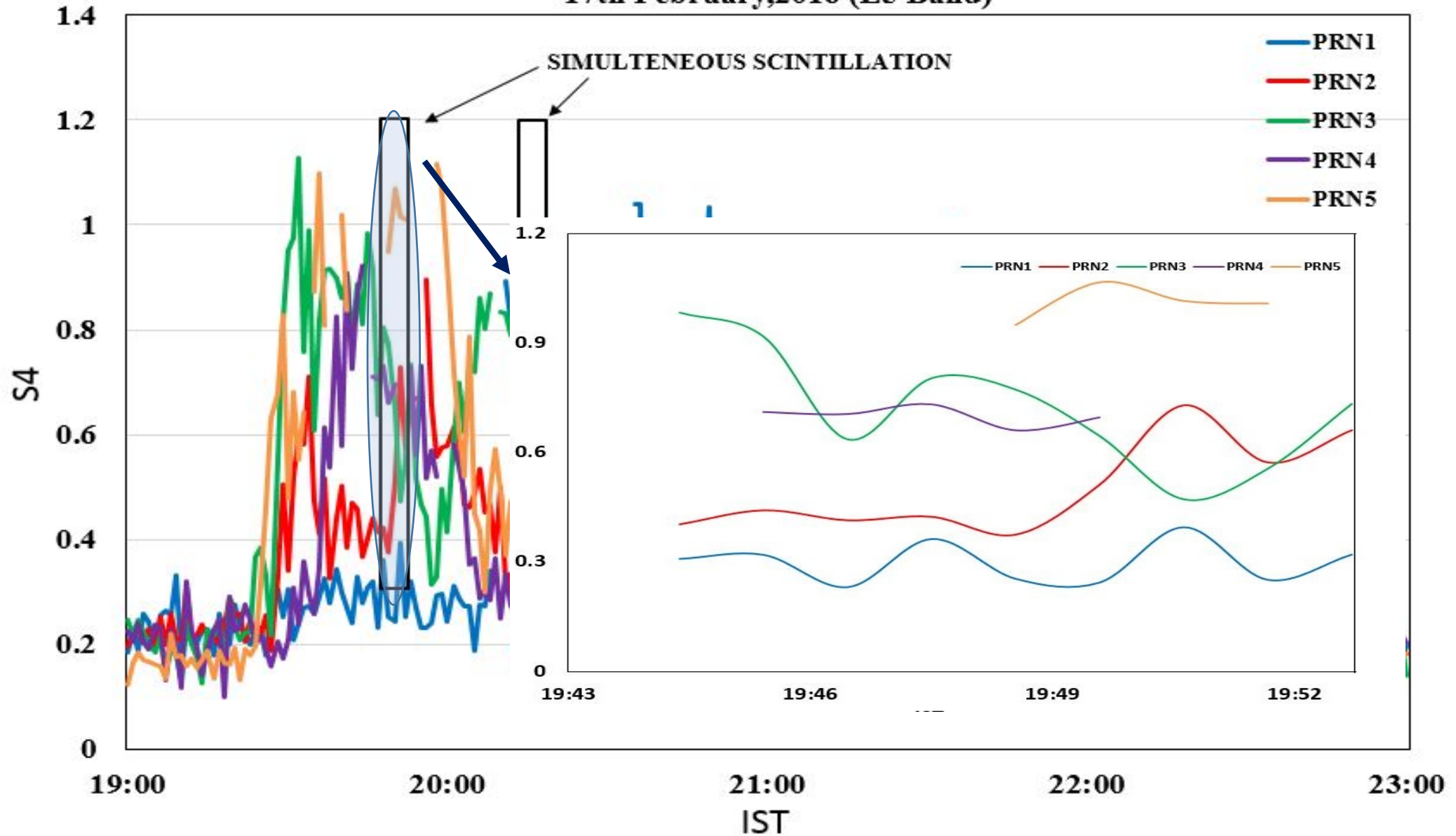
7 th April, 2015 (S BAND)

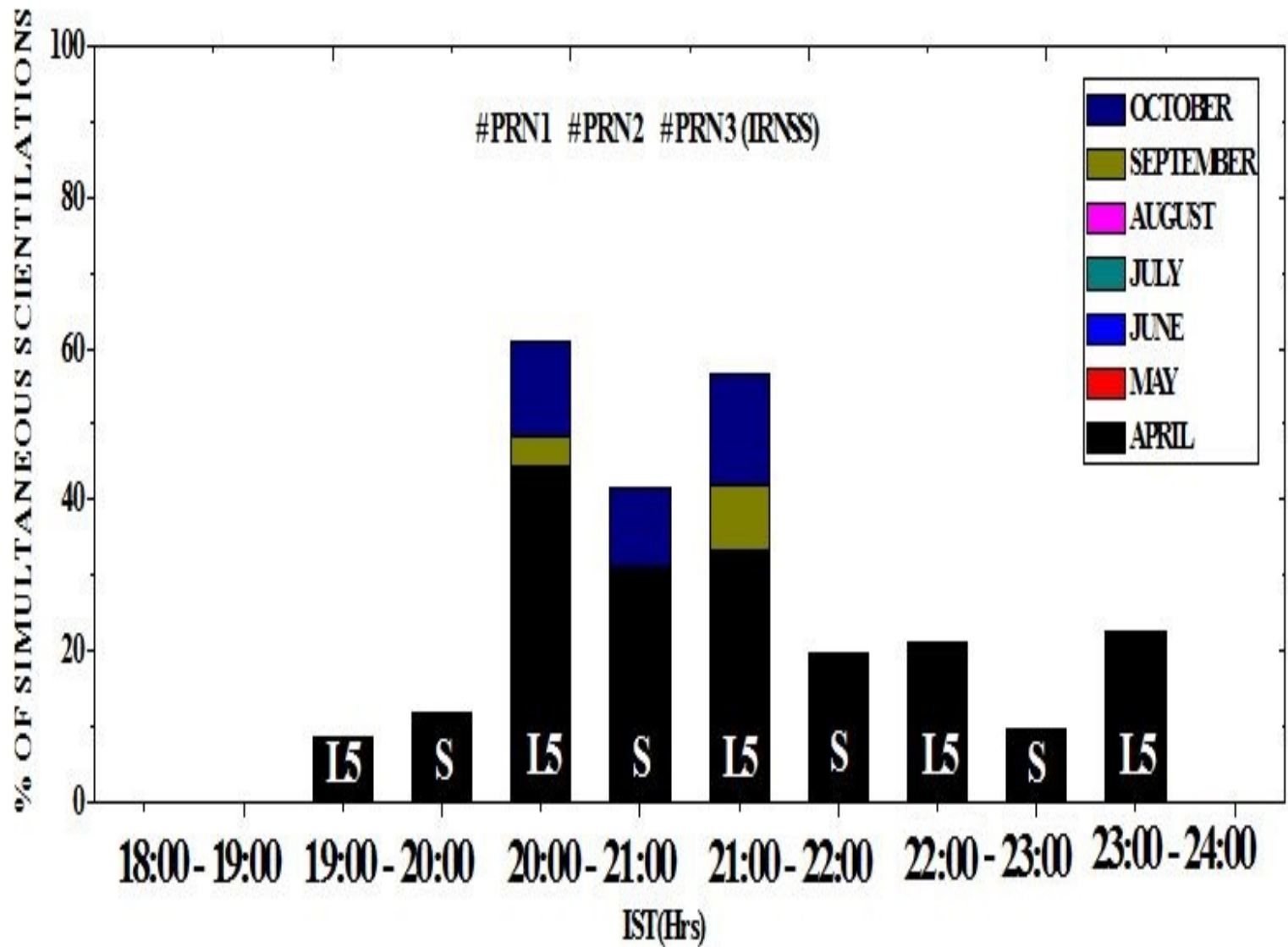


7th April, 2015 (SBAS)



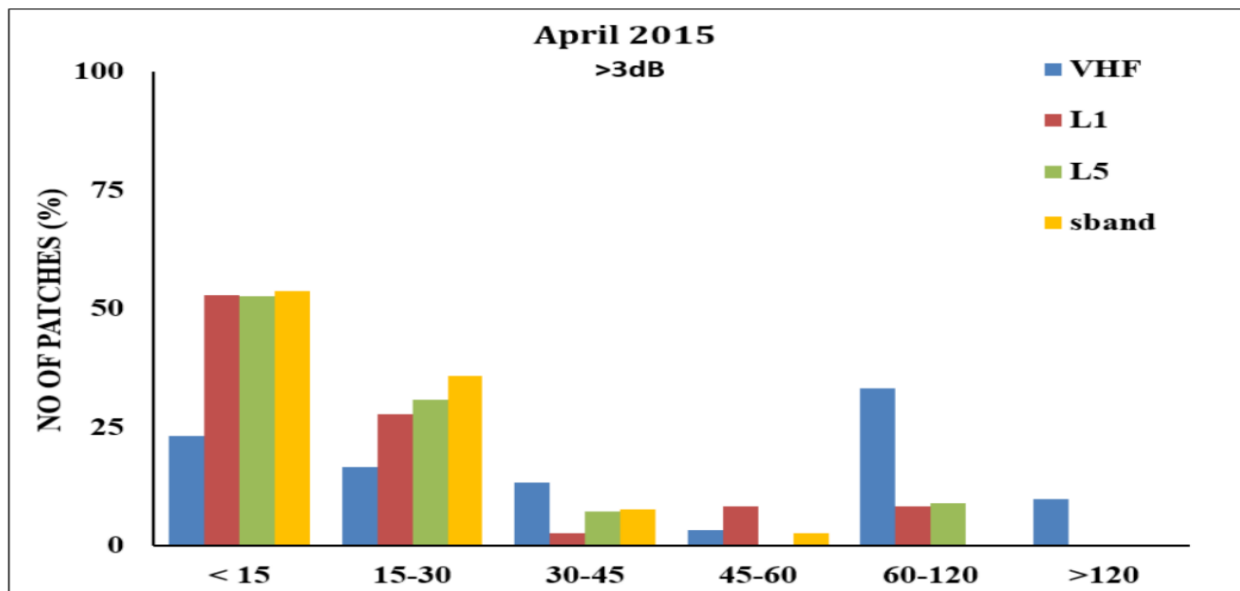
17th February, 2016 (L5 Band)



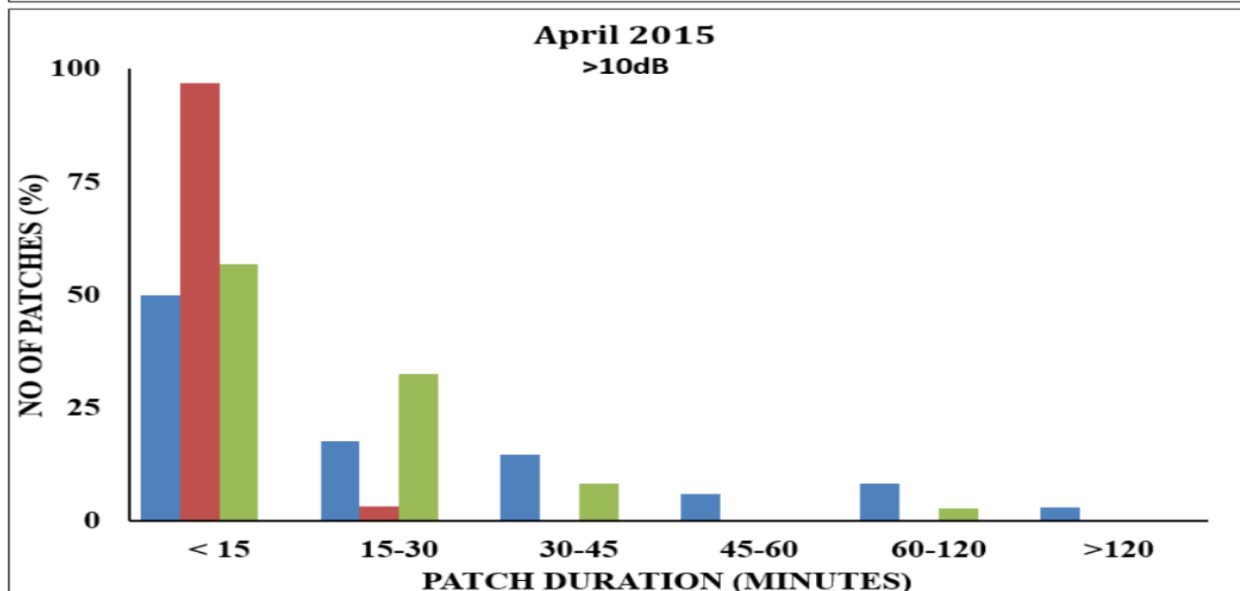


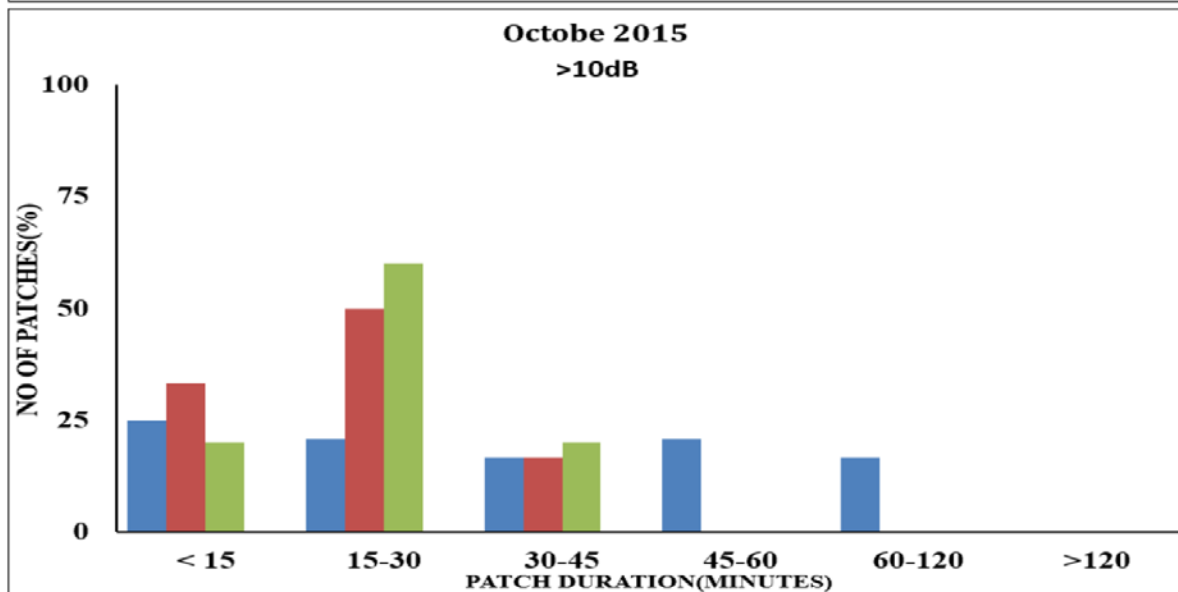
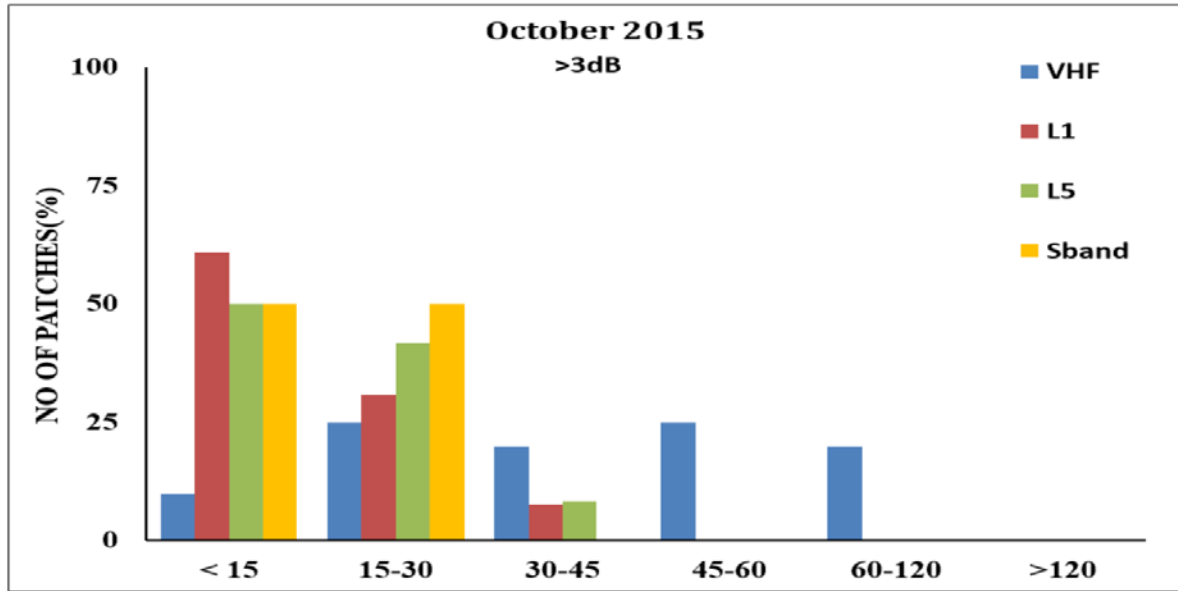
- Obviously post sunset period around 20-21 hr IST is much susceptible to multi satellite and multi frequency scintillation presenting problems to the augmentation technique.
- Disturbing fail-safe navigation around the EIA crest.

Patch Distribution

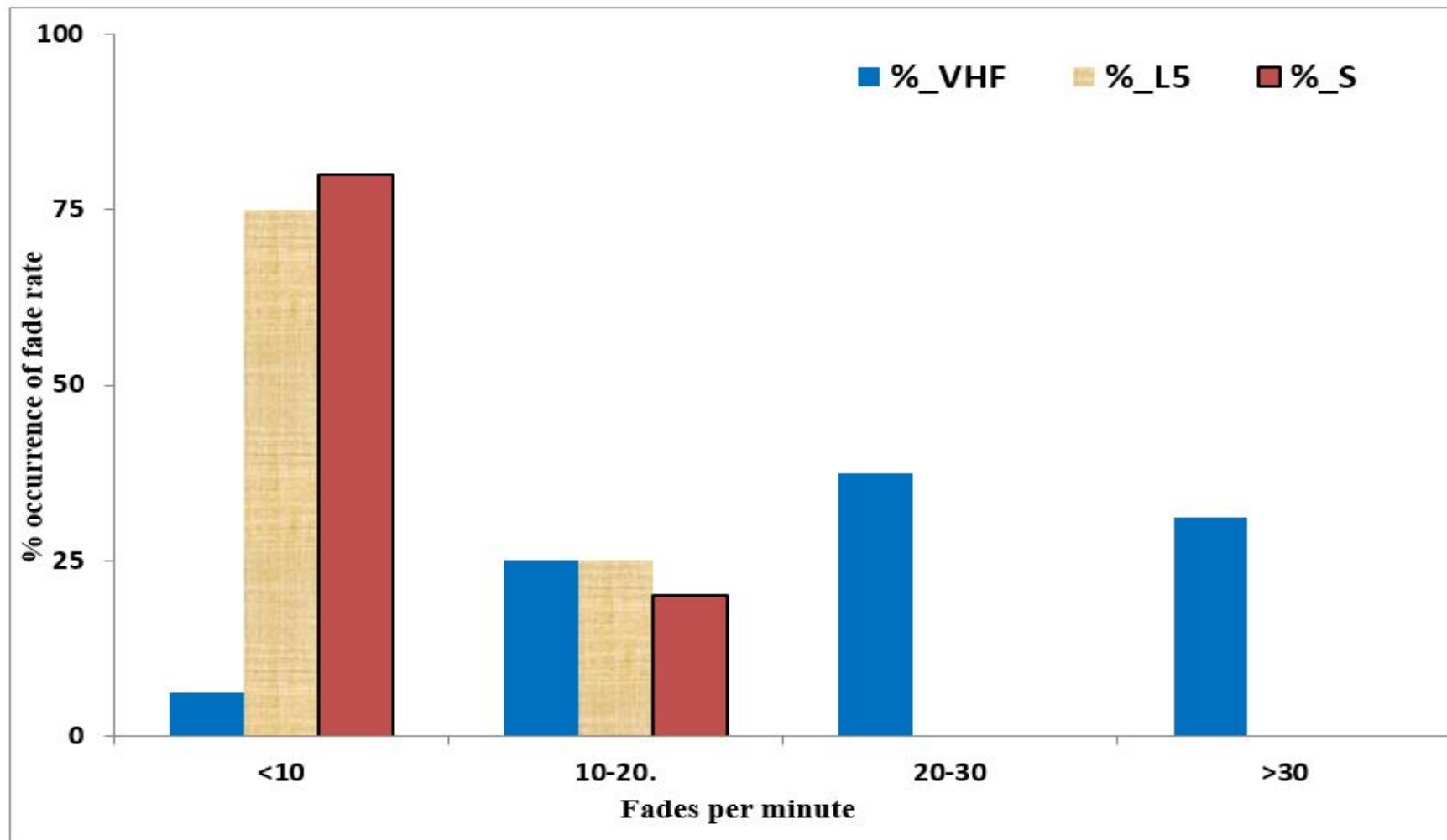


Mostly short duration patches dominates the S band scintillation at > 3dB level.

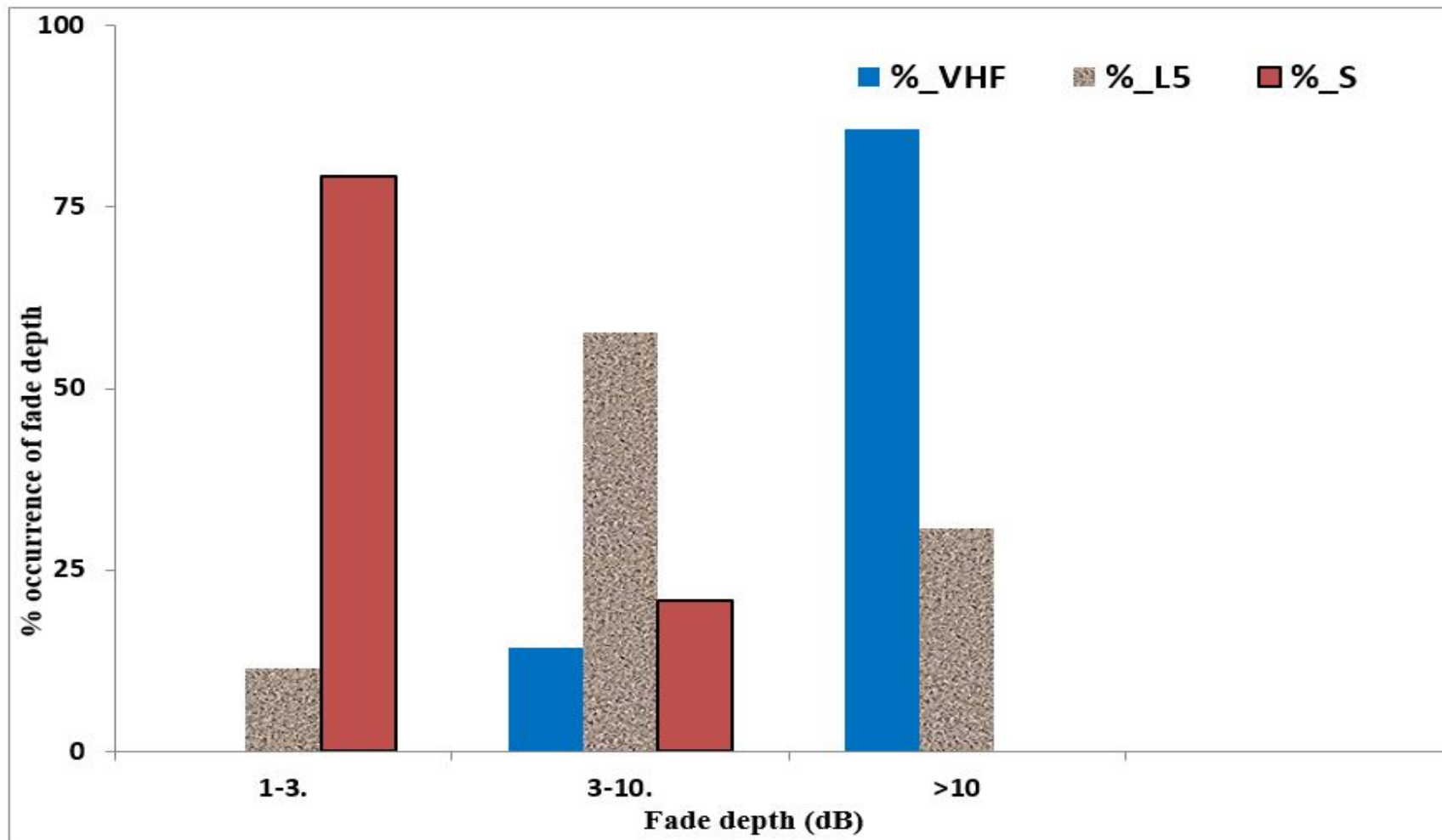




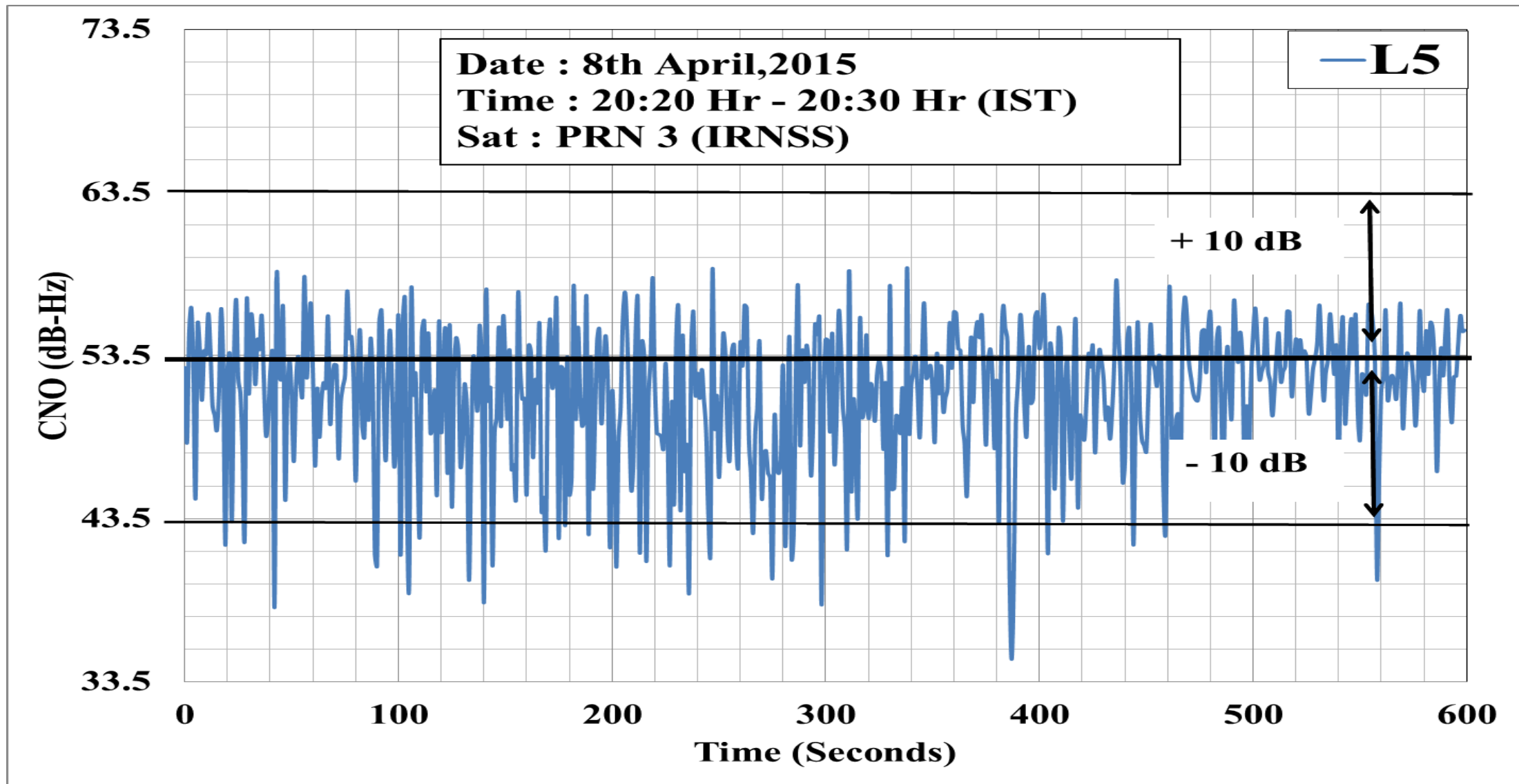
□ For scintillation >10 dB level short duration patches dominant at L1 while longer duration patches are predominant at VHF and L5 bands.

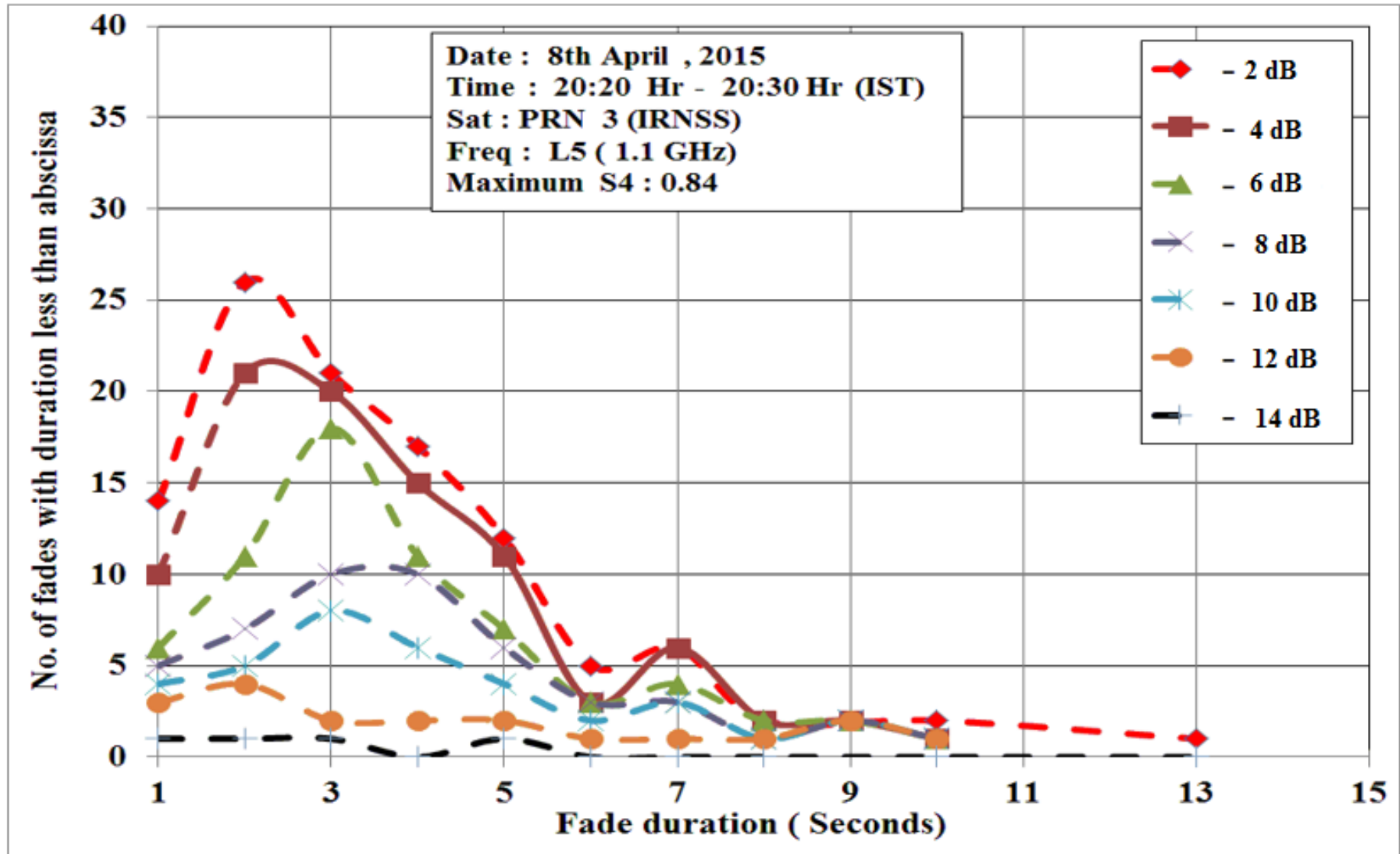


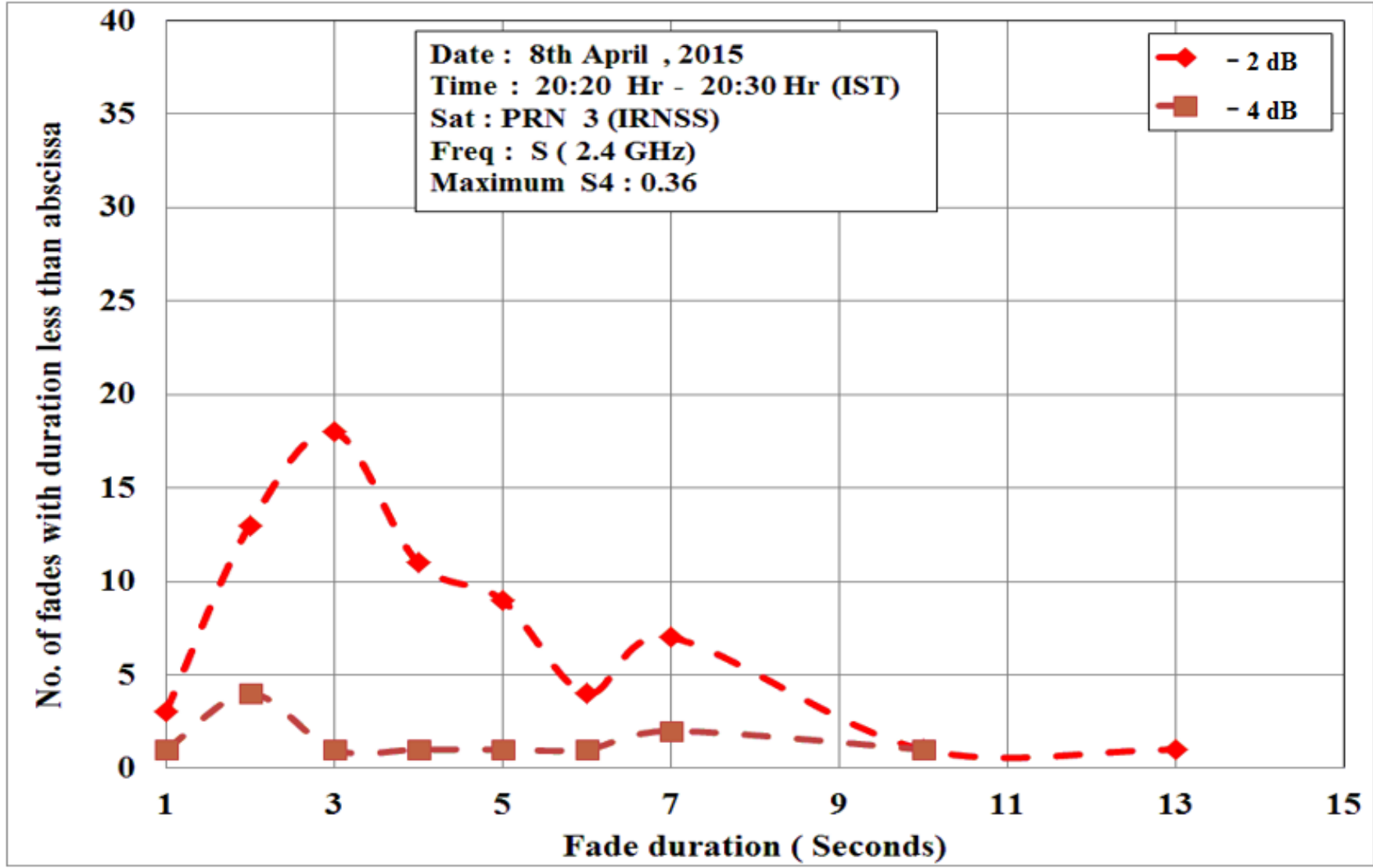
- Scintillation at VHF are characterize by fast fading rate (~ 50 fade/min) before saturation.
- Fade rates at L5 and S band are comparatively low.

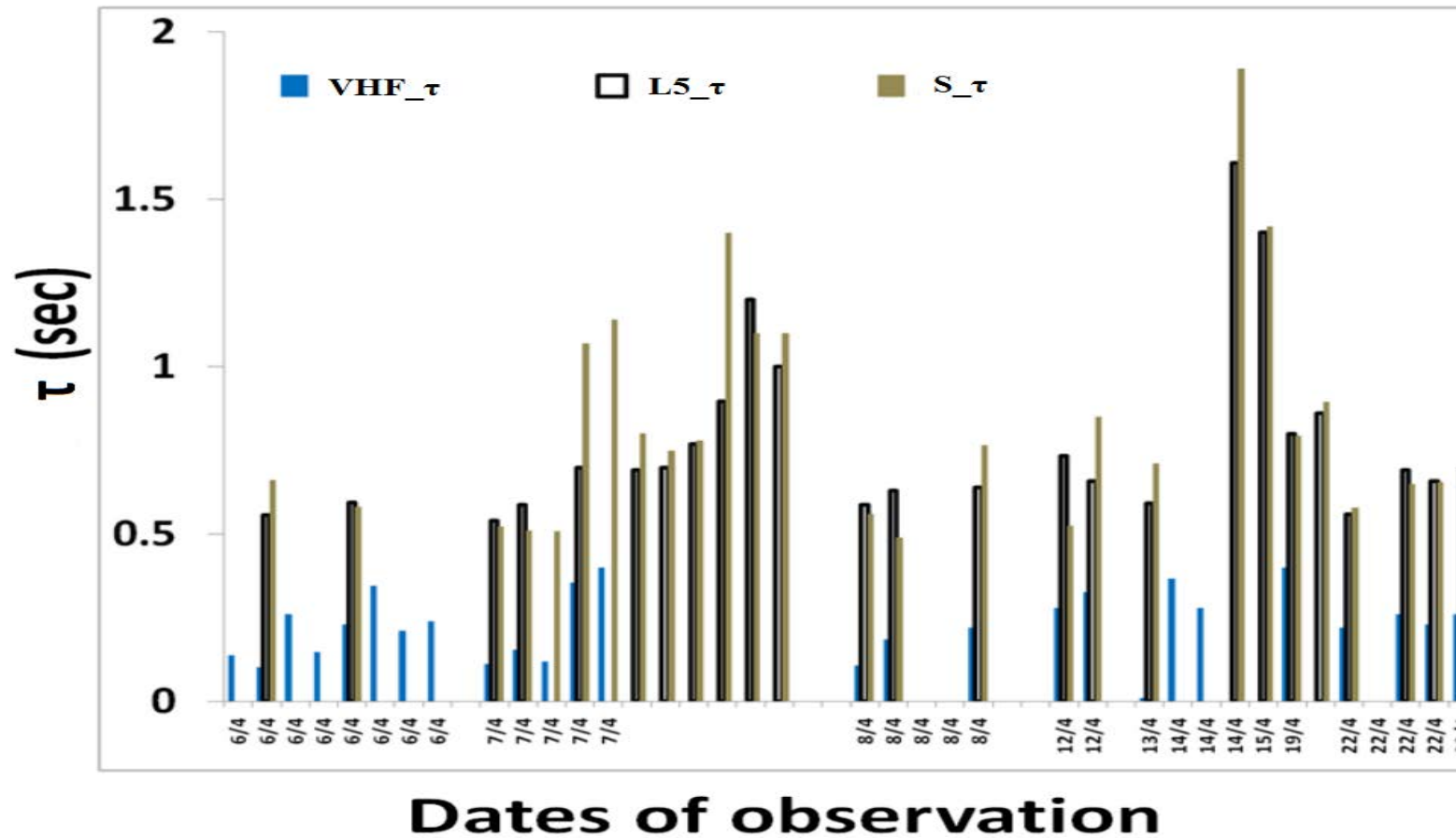


- ❑ Before saturation a hierarchy in depth of fading from S to VHF band is prominent.
- ❑ Highest fade depth at VHF and lowest at S band is evident.

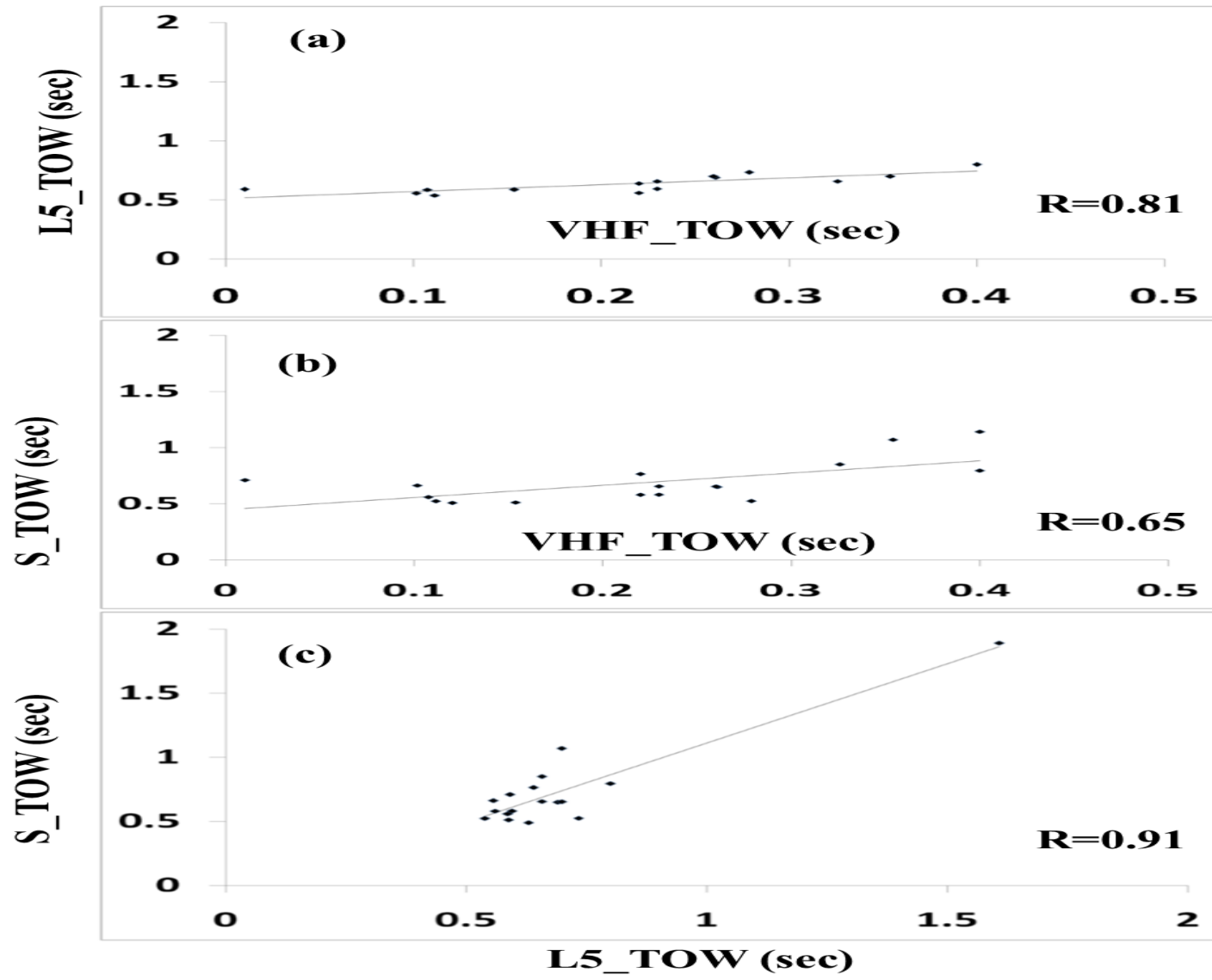


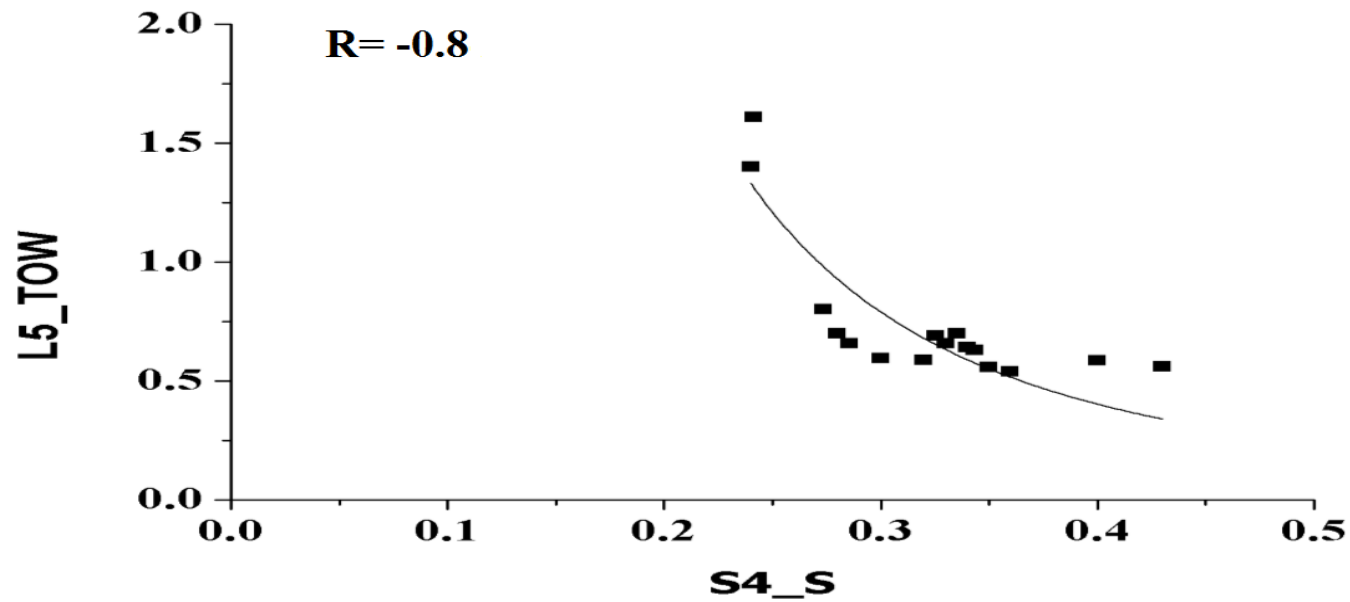
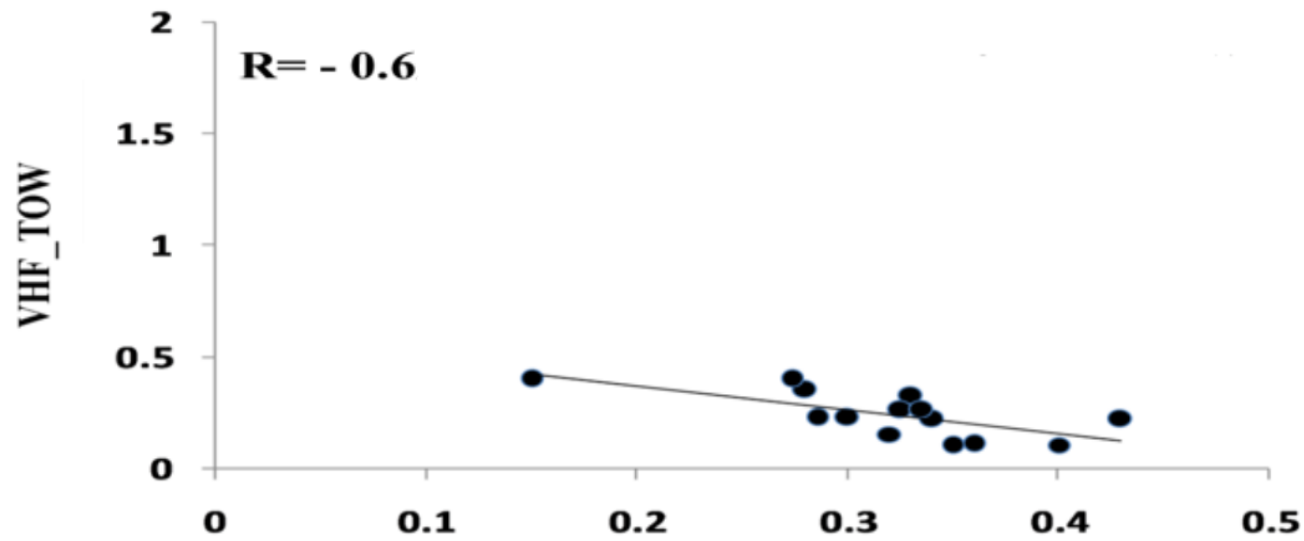






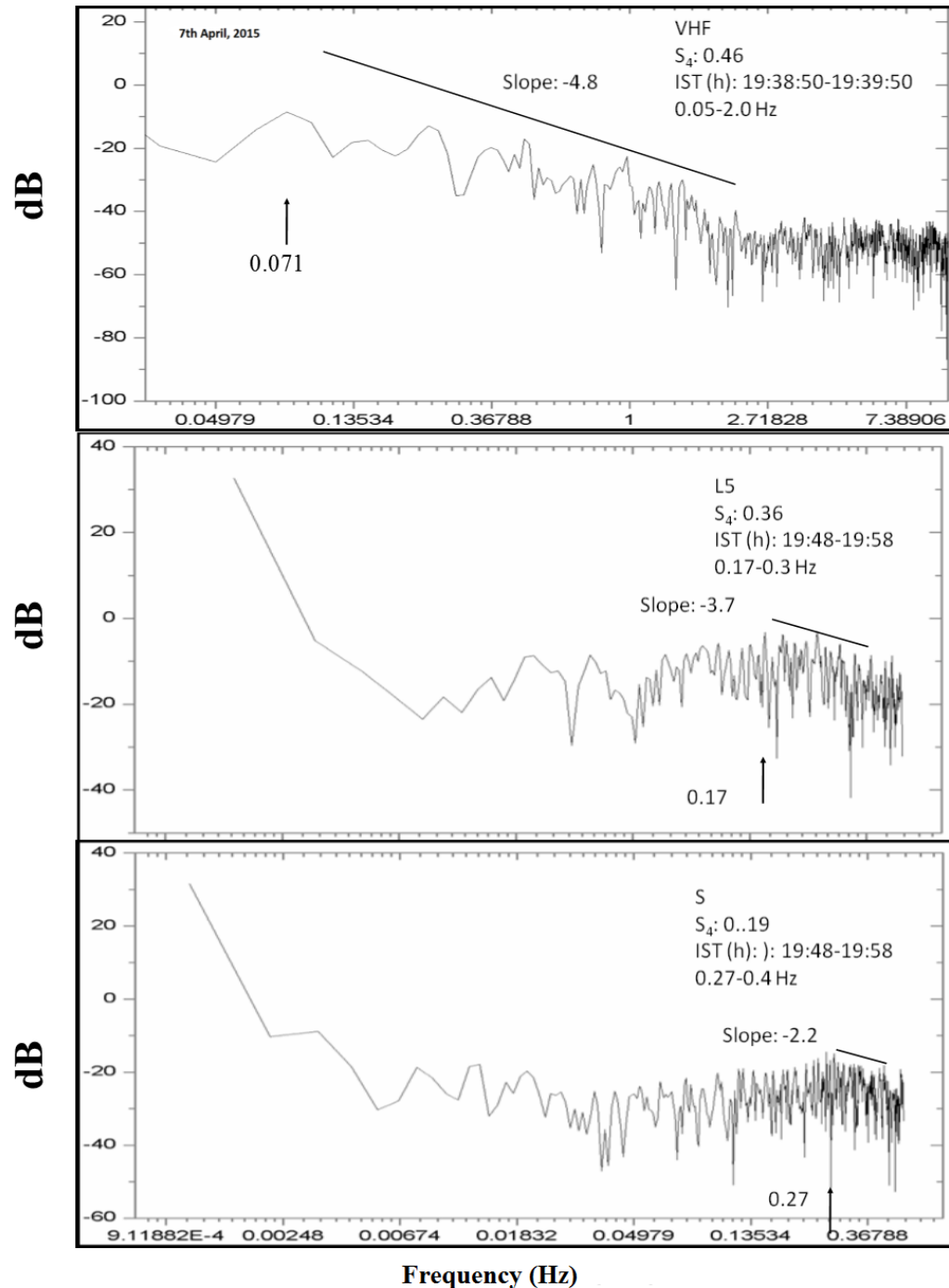
- In the saturation regime, fast fading rate as revealed through lower values of τ (decorrelation time) characterize scintillation at VHF while comparatively higher of τ value implying slower fading distinguishes the scintillation at S and L5 band.



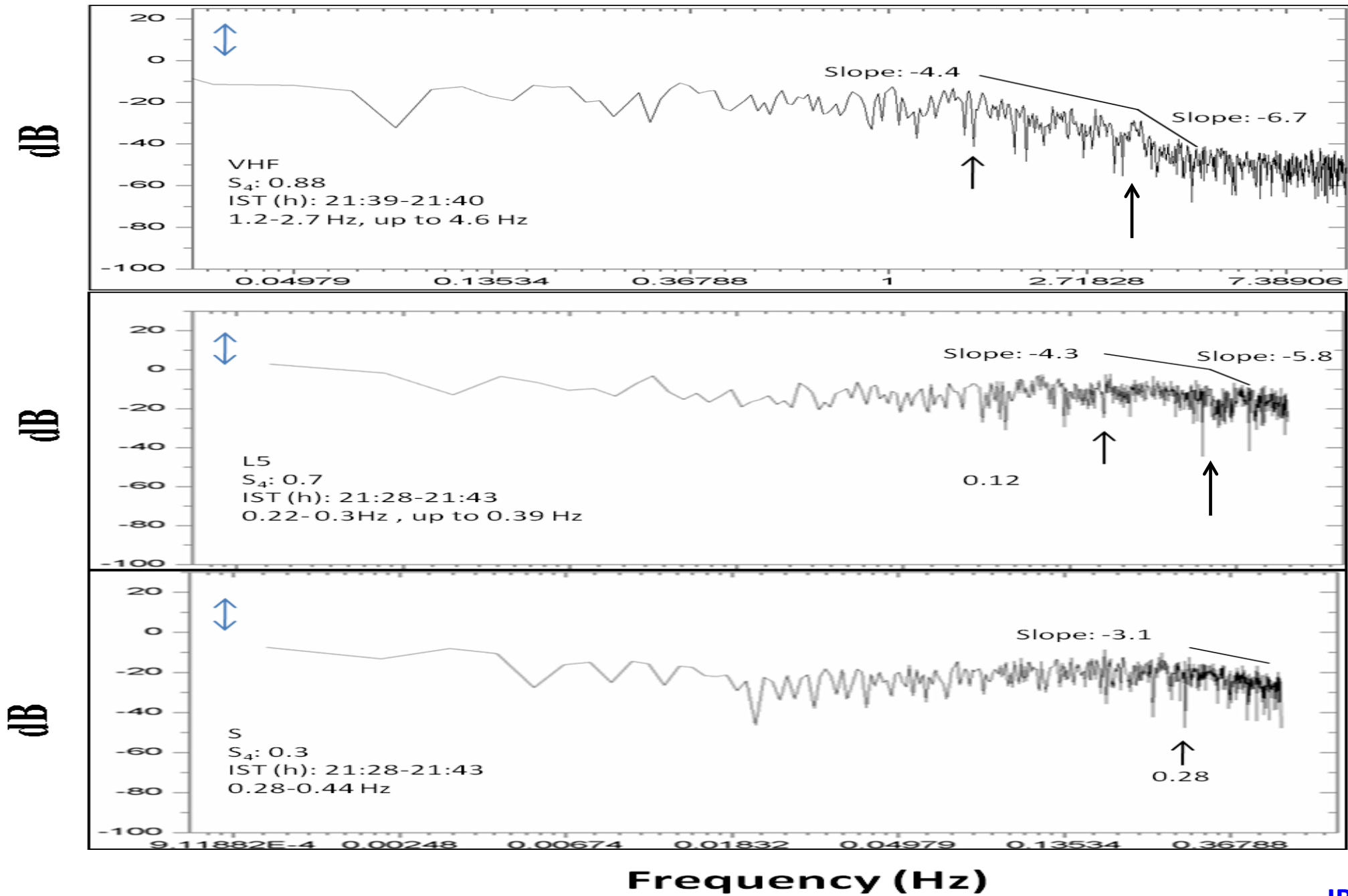


- Assuming S4 at S band as the strength parameter as the scintillation intensified fade rate becomes faster and faster at L5 and VHF bands.

7 April, 2015



- In the weak scintillation regime at VHF a steeper spectral slope, lower Fresnel frequency implying larger scale irregularities contribute to scintillation.
- Comparatively shallower spectral slope implying slower fading and higher Fresnel frequency implying smaller scale irregularities in the range (250-300 m) dominates scintillation at L5 and S band.



At VHF

$$(f_B)_1 \sim 1.34 \text{ Hz}$$

$$(f_B)_2 \sim 3.43 \text{ Hz}$$

At L5 Band

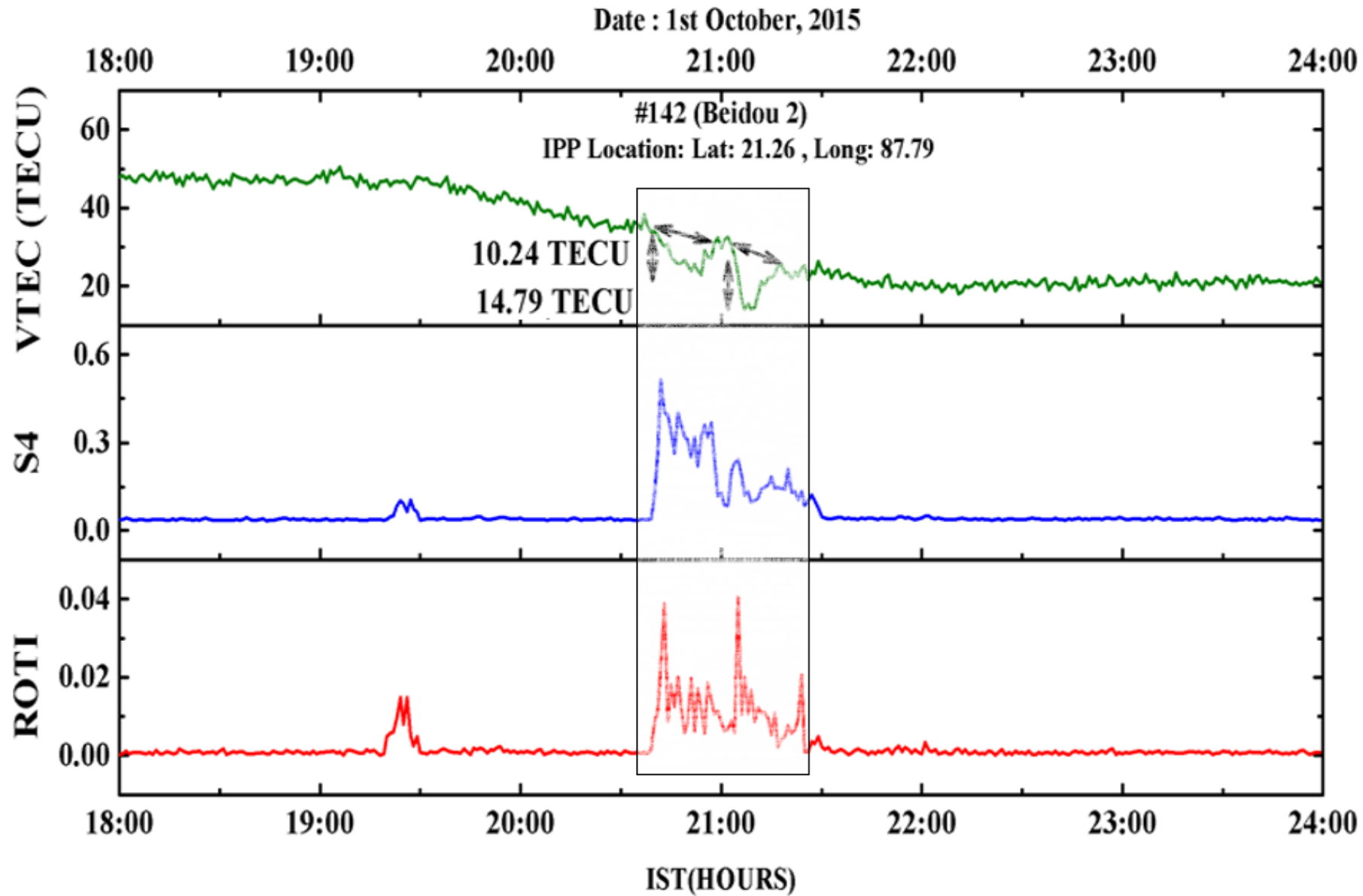
$$(f_B)_1 = 0.12 \text{ Hz}$$

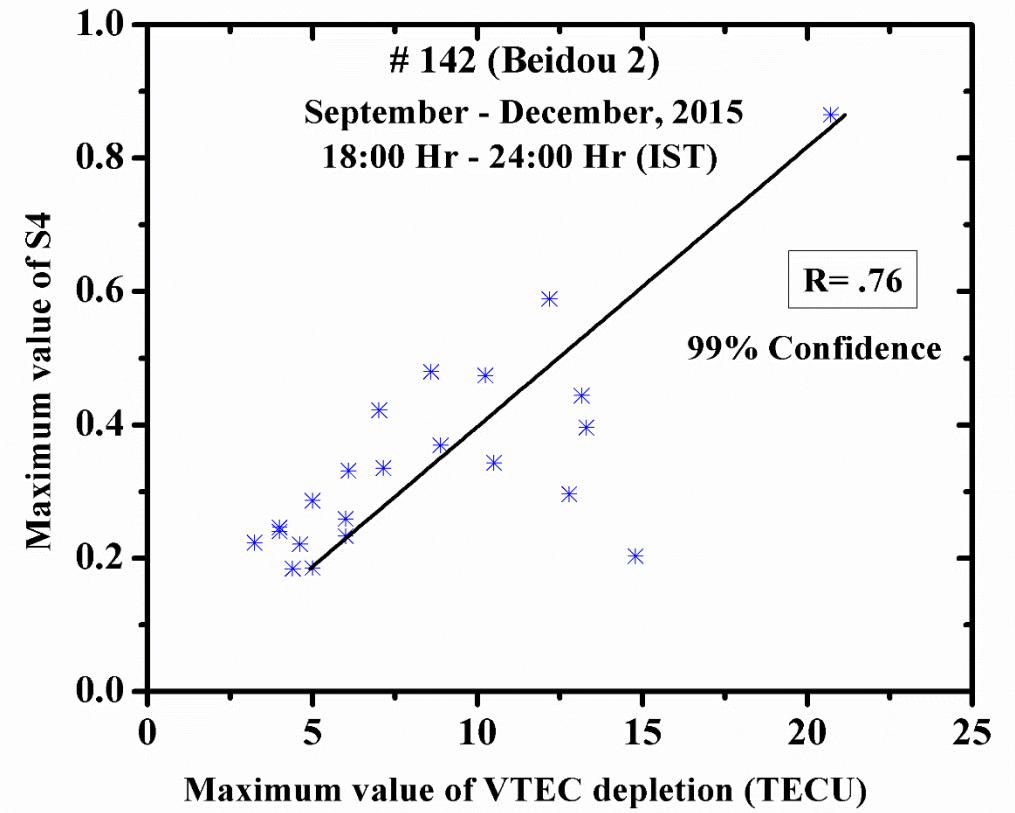
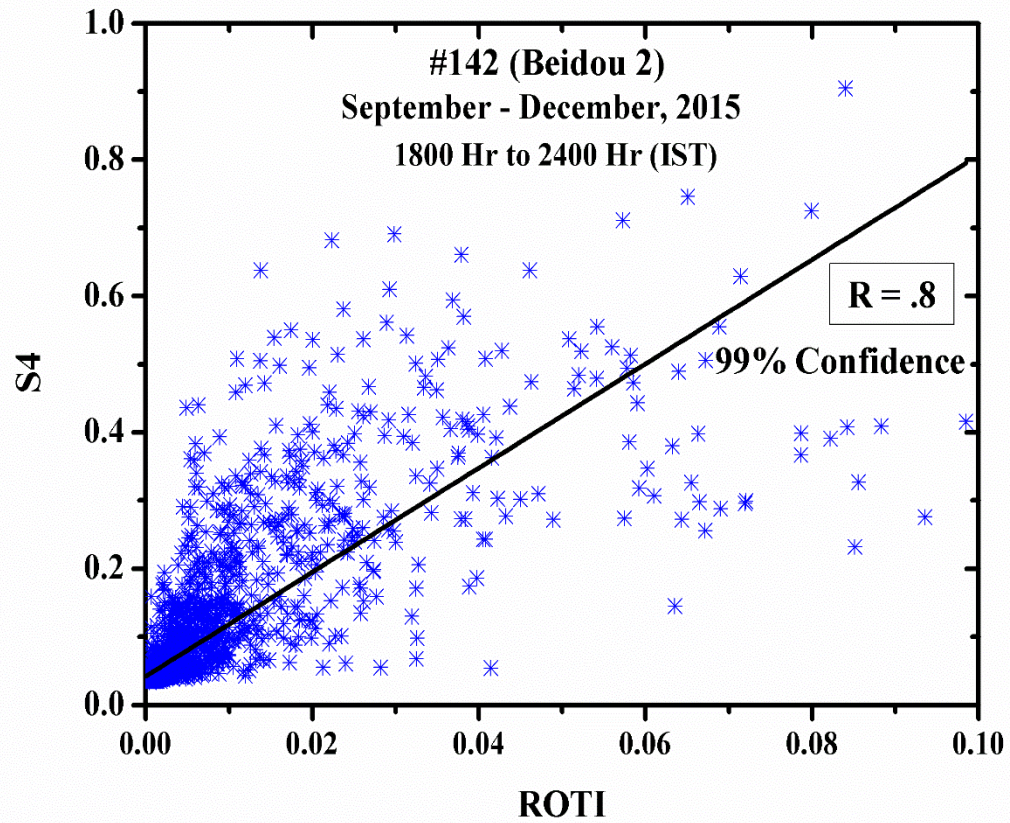
$$(f_B)_2 = 0.34 \text{ Hz}$$

- **At L5 scale size varies in the range 387-529 m corresponds to first break frequency and 285-323 m for second break frequency**
- **At VHF > 900 m and 845-952 m**

PATCH TIME	FREQUENCY BAND		
	coherence distance(meter)		
	VHF	L5	S
B	9.2±3.5	71.7±6.7	82.3±5.8
M	4.5±1.1	68.6±6.1	70.6±3.8
E	15.0±5.1	82.5±4.0	94.1±3.4

TEC depletion and scintillation





Summary

- **Though there are reports of scintillation occurrence at C band occurrences at S band are reported for the first time**
- **Number of cases are found when scintillations at S band occurred simultaneously with VHF and L band.**
- **S band scintillation study can give an idea of loss of lock at lower frequency band.**
- **Unfortunately the available receiver does not give the phase information at S band.**

Thank you