Intercomparison of the Lidar systems operated during GoAmazon 2014/15 experiment

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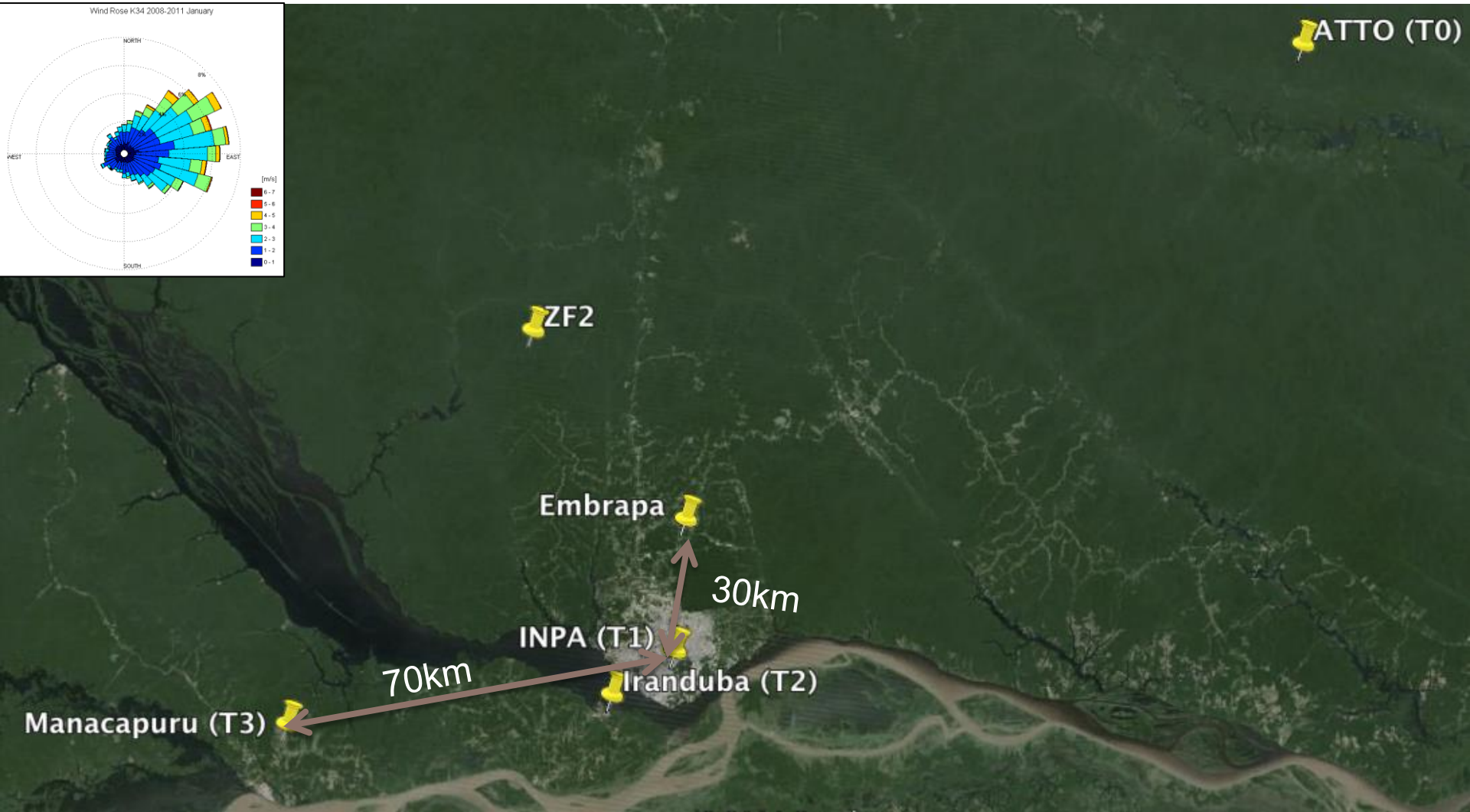
Outline

IOP2 Lidar Network

- Lidar Setup and Experimental Site
- Lidar Signal Avaliation
- Side-by-Side Intercomparison

The GoAmazon 2014/15 project

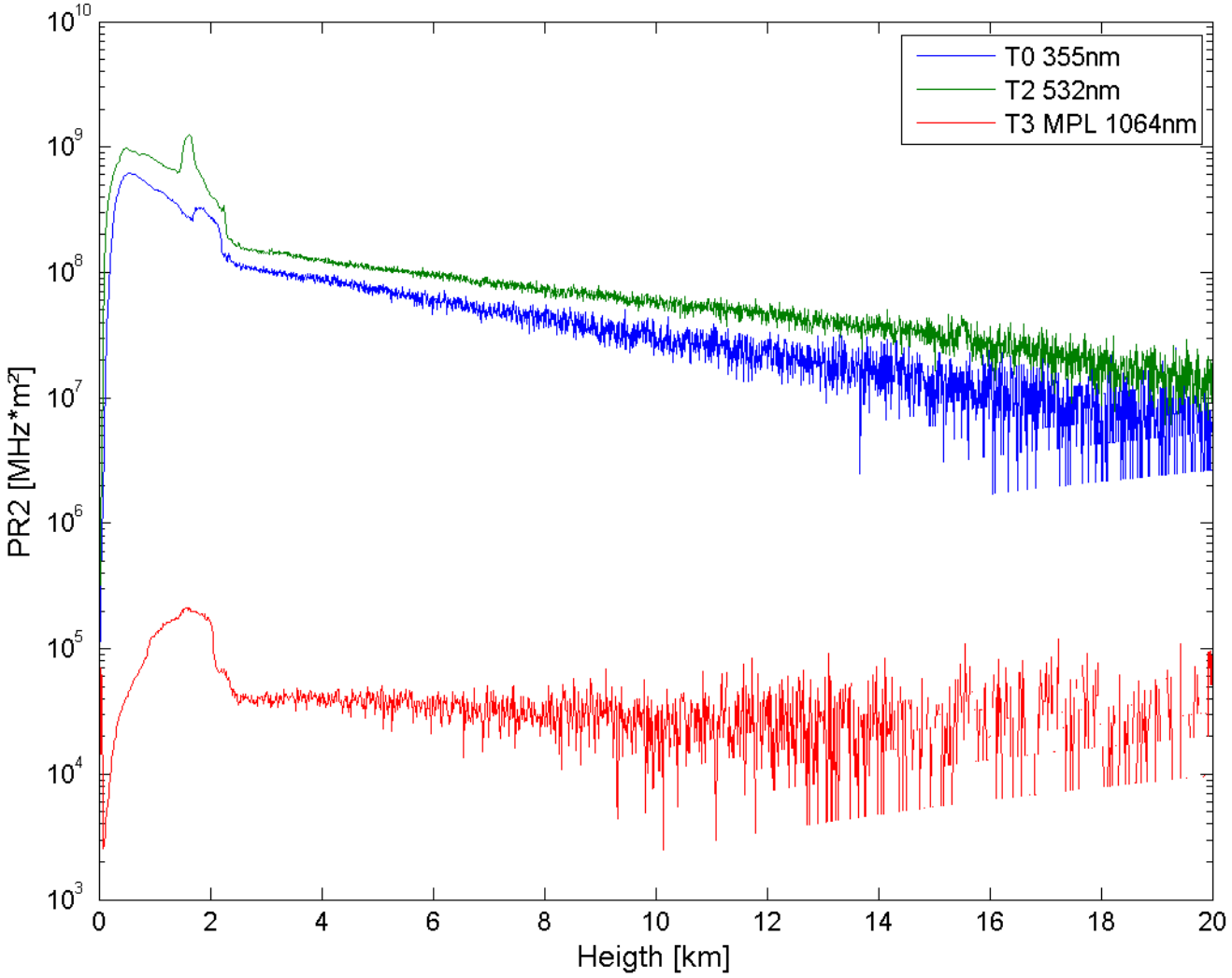
Experimental Sites



Lidar Systems

	UV Raman Lidar LFA (T0)	VIS Raman Lidar IPEN (T2)	IR MPL ARM mobile facil
Manufactor	Raymetrics	Raymetrics	Sigma Space
Laser	Nd-YAG	Nd-YAG	Nd-YLF
Wavelangth	355 nm	532 nm	1064 nm
Repetition Rate	10 Hz	20 Hz	2500Hz
Vertical Resolution	7.5 m	7.5 m	15 m
Channels	2 AN, 3 PC	1 AN, 2 PC	2 PC
Detection	355 nm (elastic), 387nm (N2) and 408nm (H20)	532 nm (elastic) and 608 nm (N2)	Co and Cross Pol

Lidar Signal



- Range Corr. Signal
- 5 min averege

Alignment

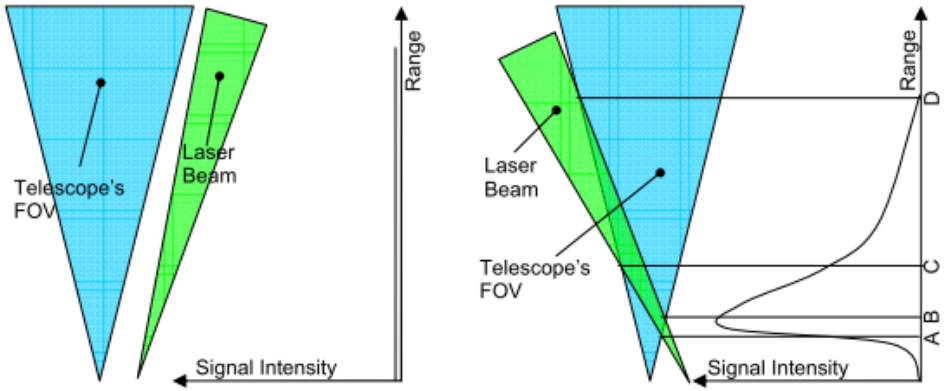


Figure 2a (left): Totally misaligned signal, Figure 2b (Right): Misaligned Signal

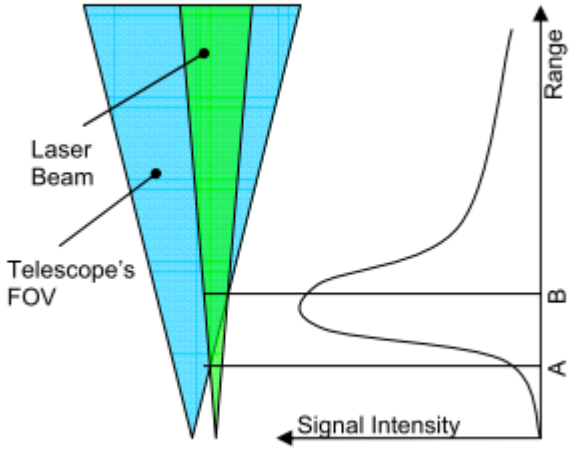
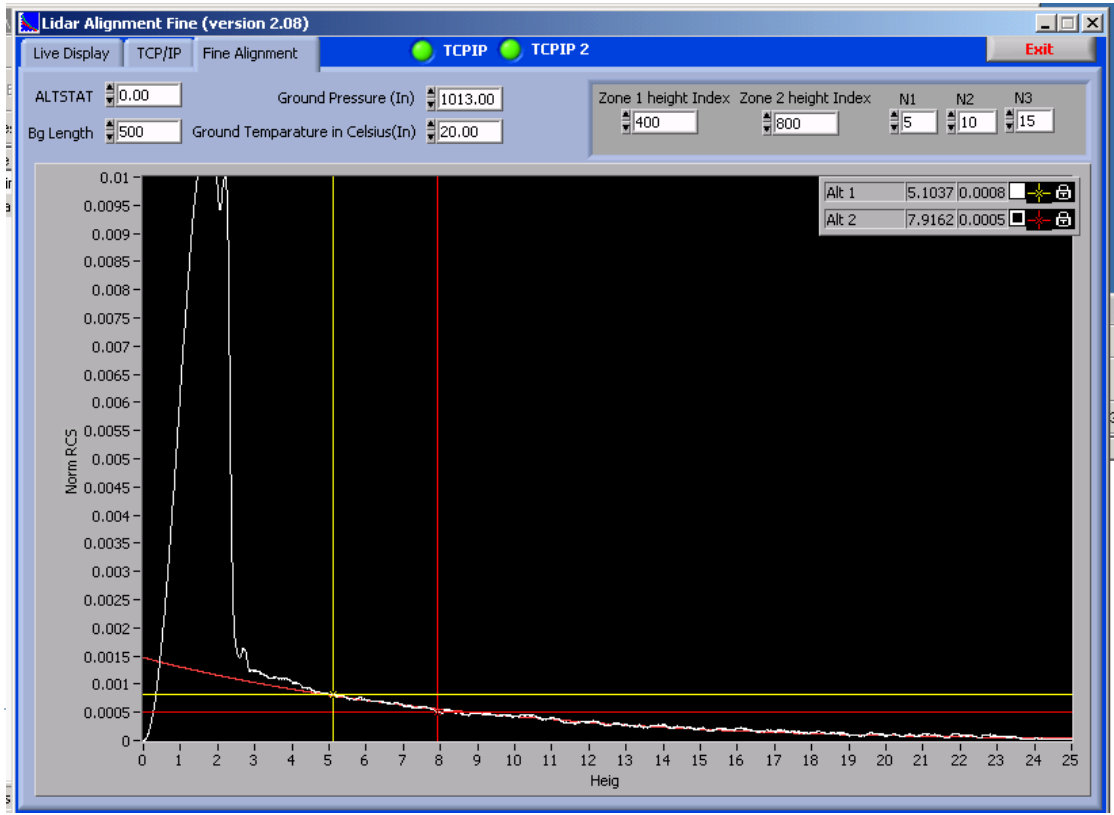
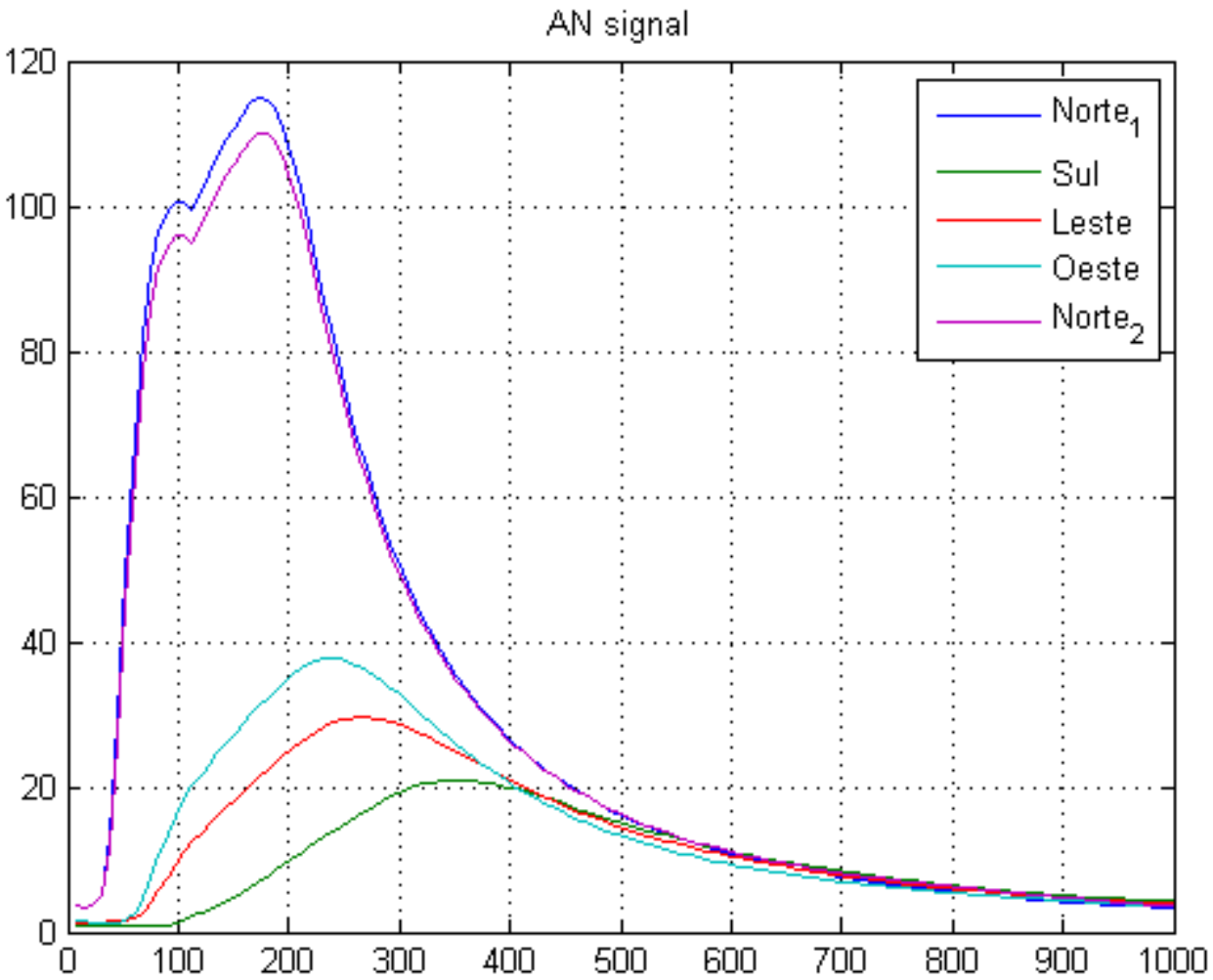


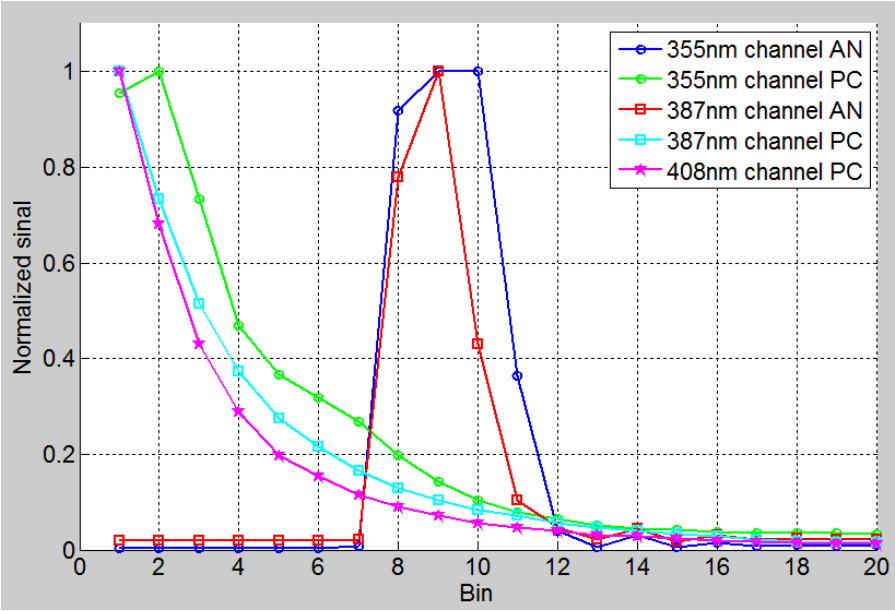
Figure 1

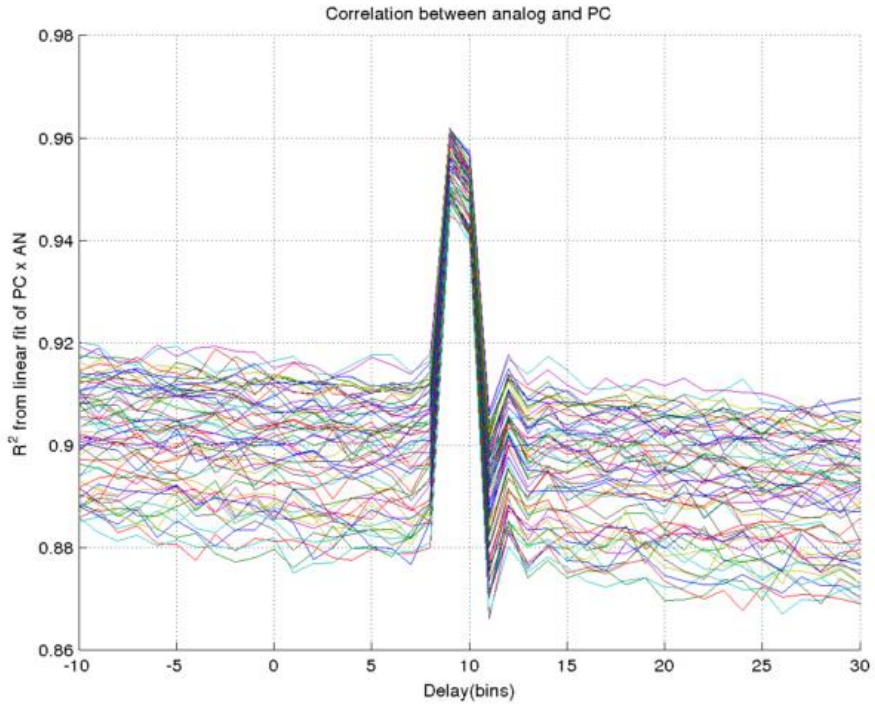


Alignment: Telecover

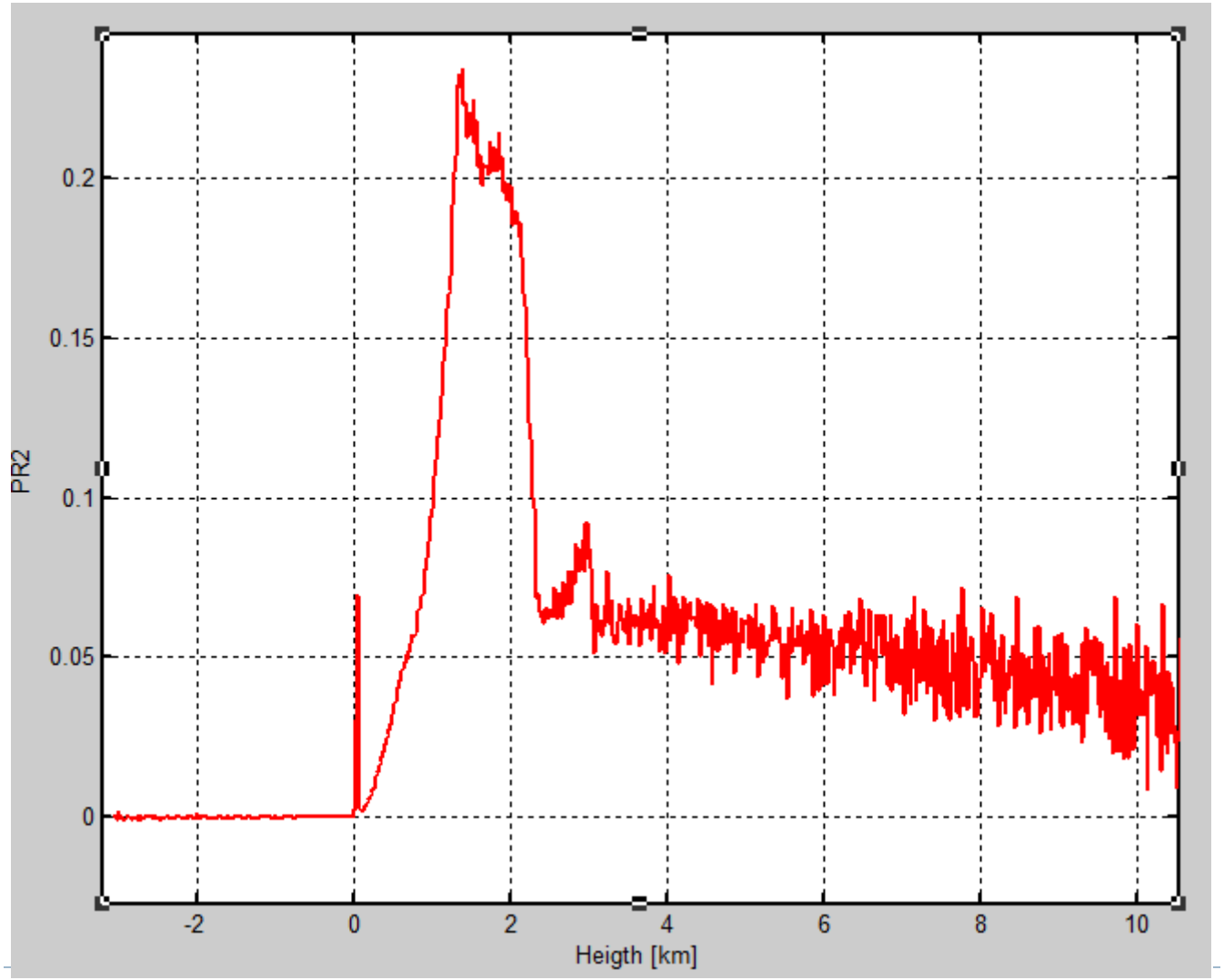


Zero Bin Calibration

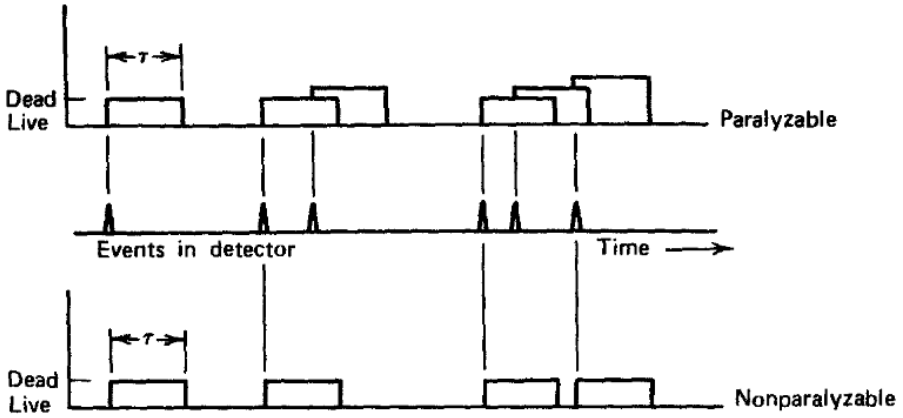




Zero Bin Calibration



Dead Time Correction



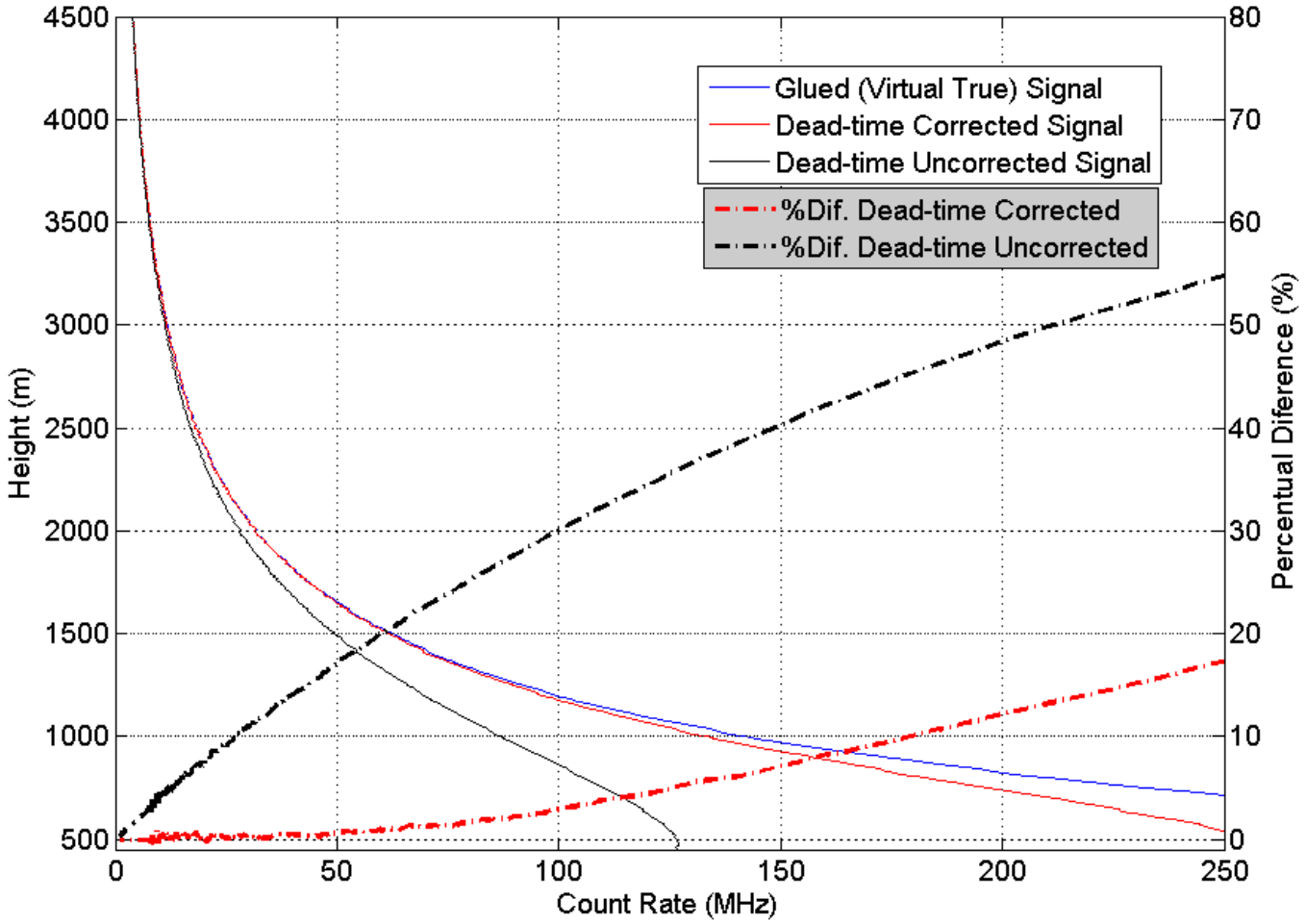
$$C = \frac{N}{1 - N\gamma}$$

N = N (z, t): **non-corrected** counting rate (PC)

C = C (z, t): **corrected** counting rate

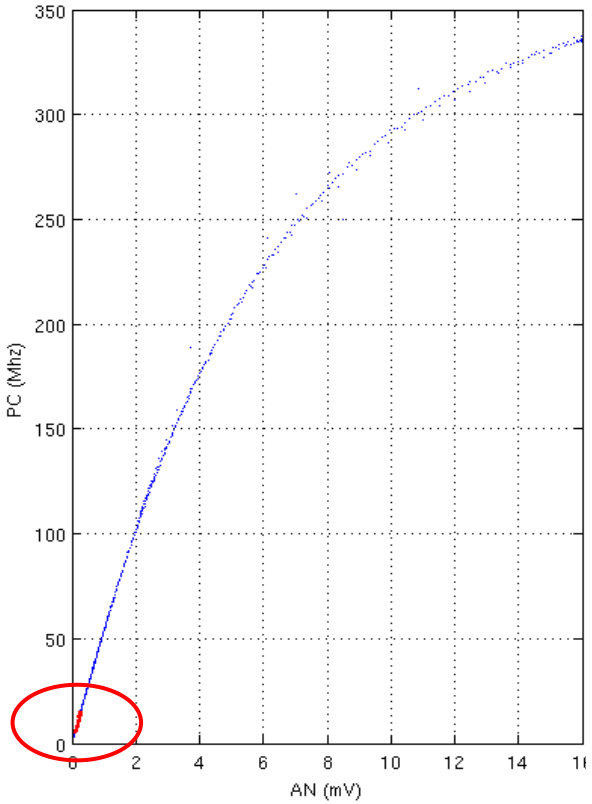
γ: dead-time

Dead-Time Correction



Glueing AN e PC

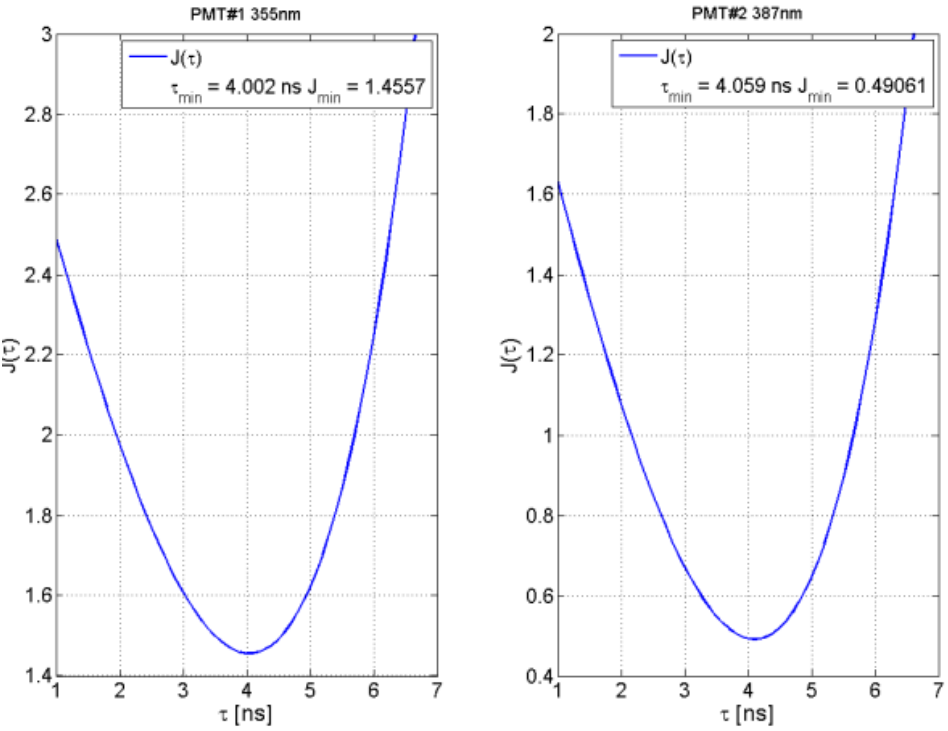
$$\hat{C} = aAN + b$$



$$J(t_j, \gamma) = \frac{1}{n_j} \sum_{i=1}^{n_j} \left(\frac{C(z_i, t_j, \gamma) - \hat{C}(z_i, t_j)}{\sigma_{ij}} \right)^2$$

Minimizing J
as a function of γ

Dead-Time Determination



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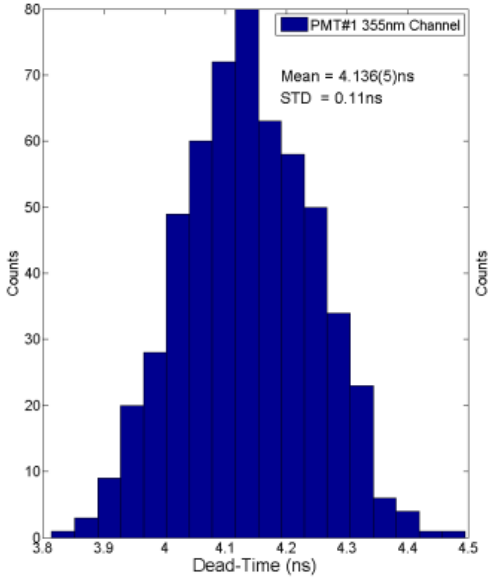
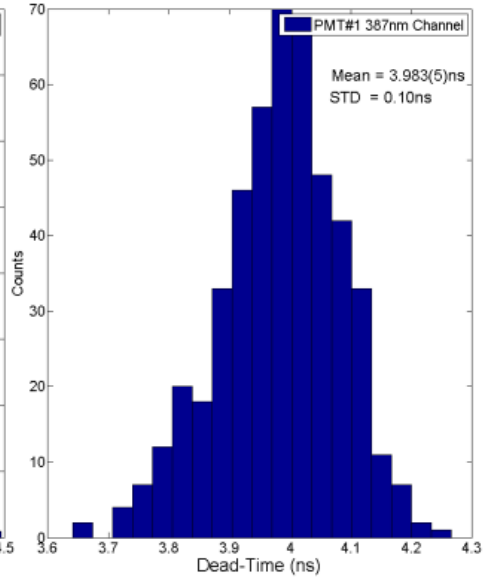




Dead-Time:

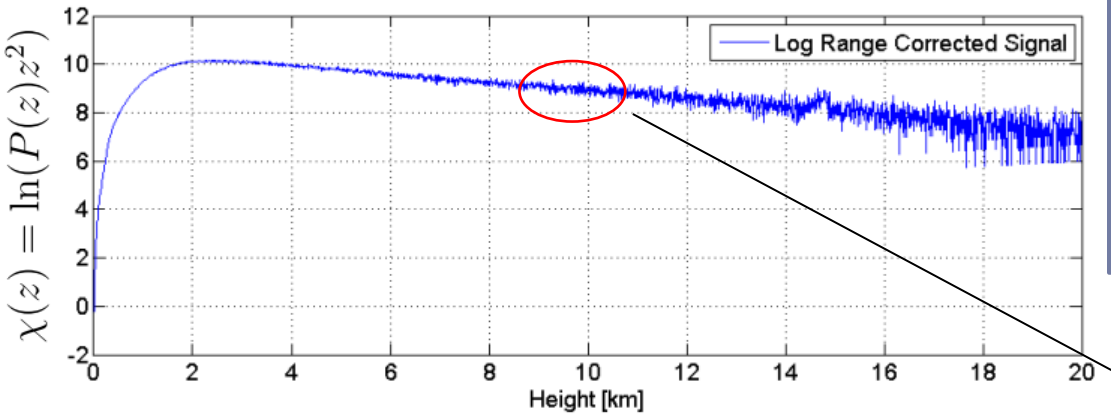
$\gamma_{PMT\#1} = 4{,}14 \pm 0{,}11\ ns$

$\gamma_{PMT\#2} = 3{,}98 \pm 0{,}10\ ns$

Expected: 1/250MHz = 4ns

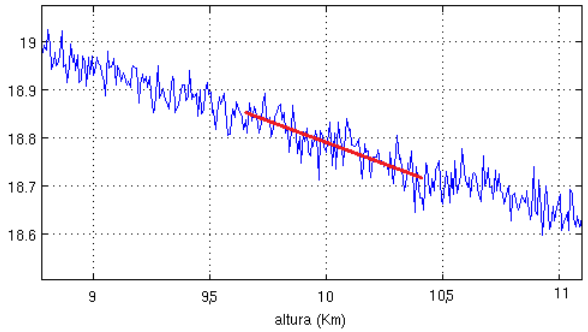
Ruído pdf. Poisson

- The dead-time correction change the data pdf from a Poisson distribution. Can we use $\sigma_P = \sqrt{P}$?



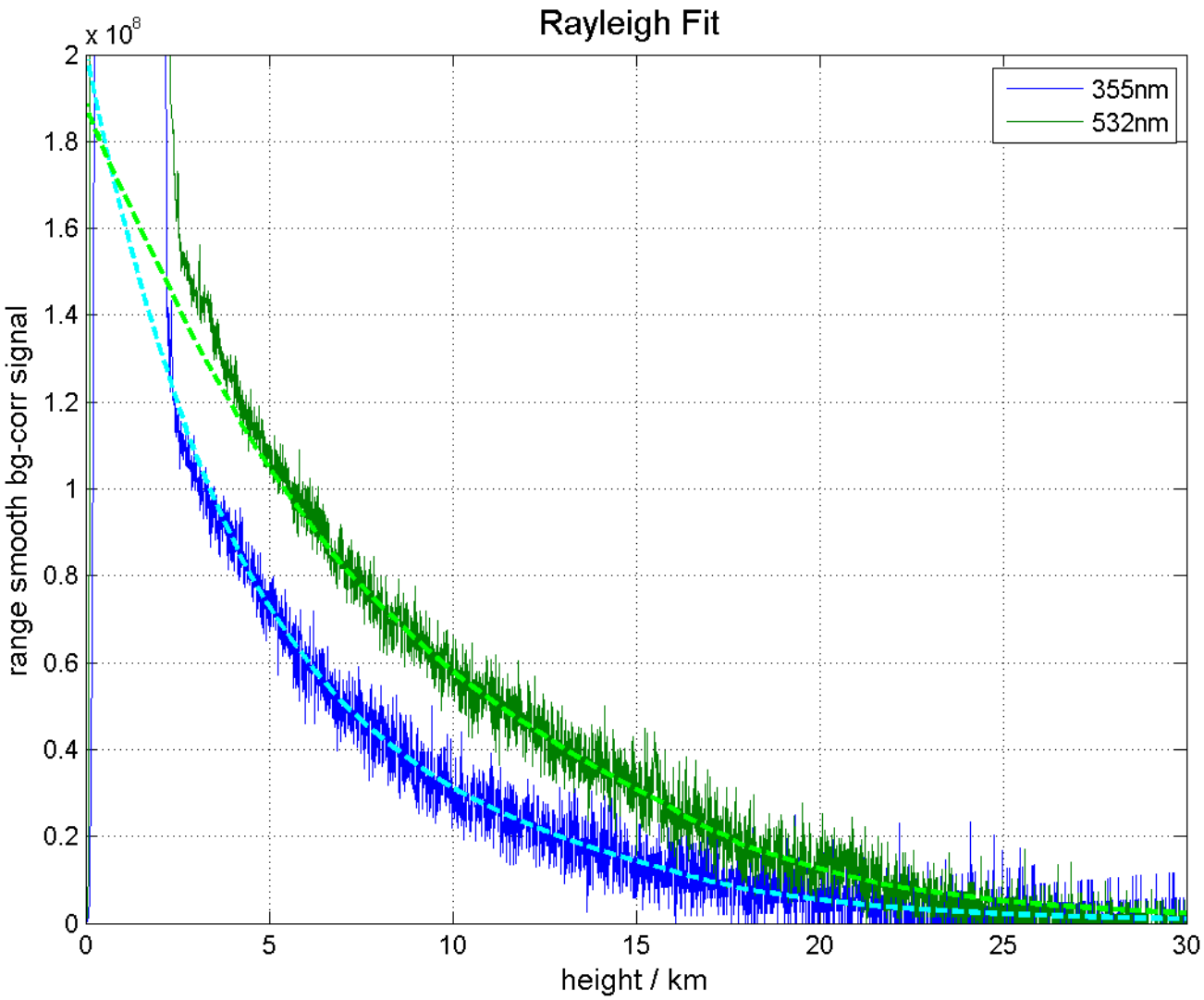
We can estimate the standard daviation calculating using the chi²:

$$\sigma^2_{ext}(z) = \frac{1}{n-\mu}\sum_{z_1}^{z_2}(\chi(z)_i - \hat{\chi}(z))^2$$
$$= var(\chi(z))$$

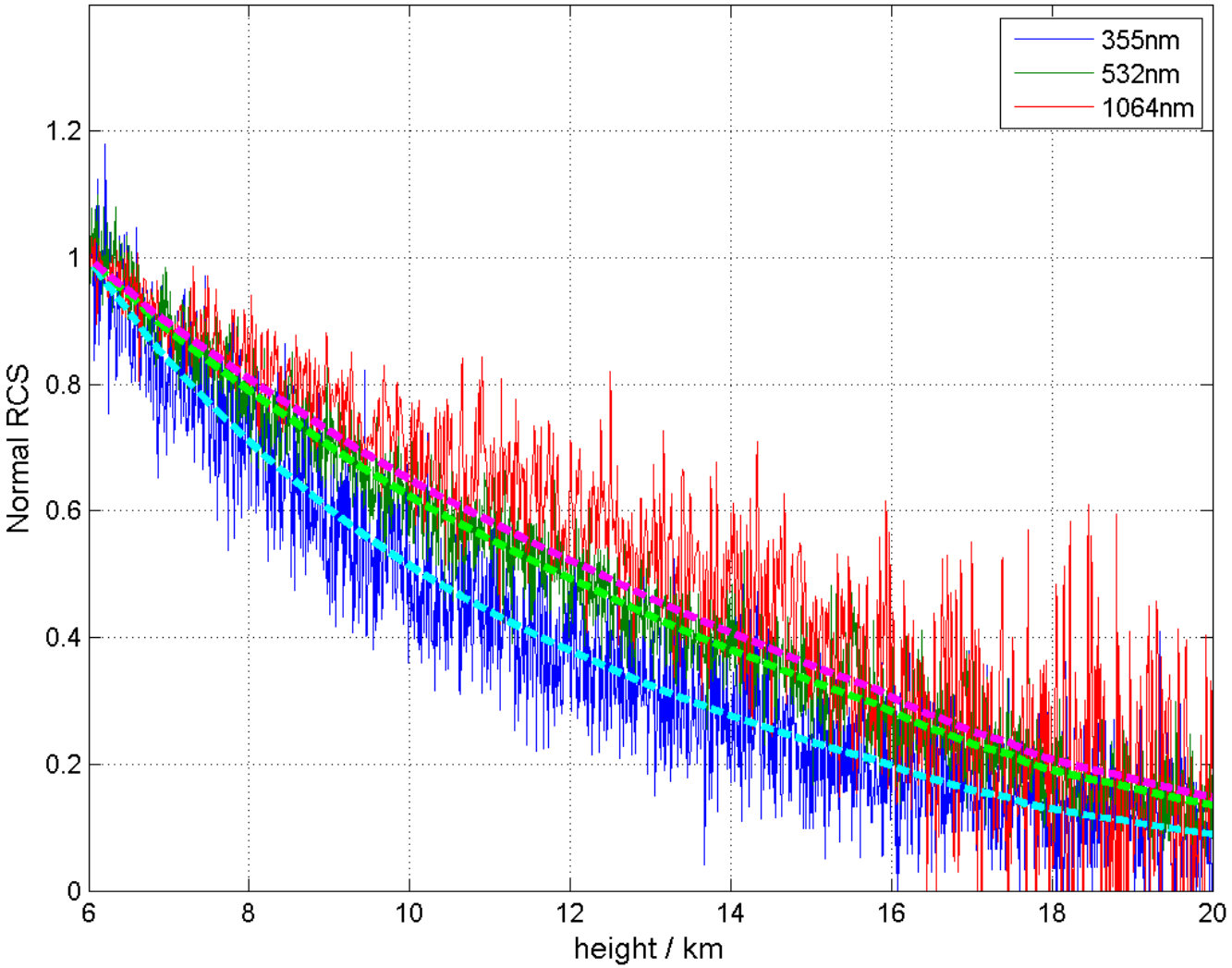


Signal Characteristics

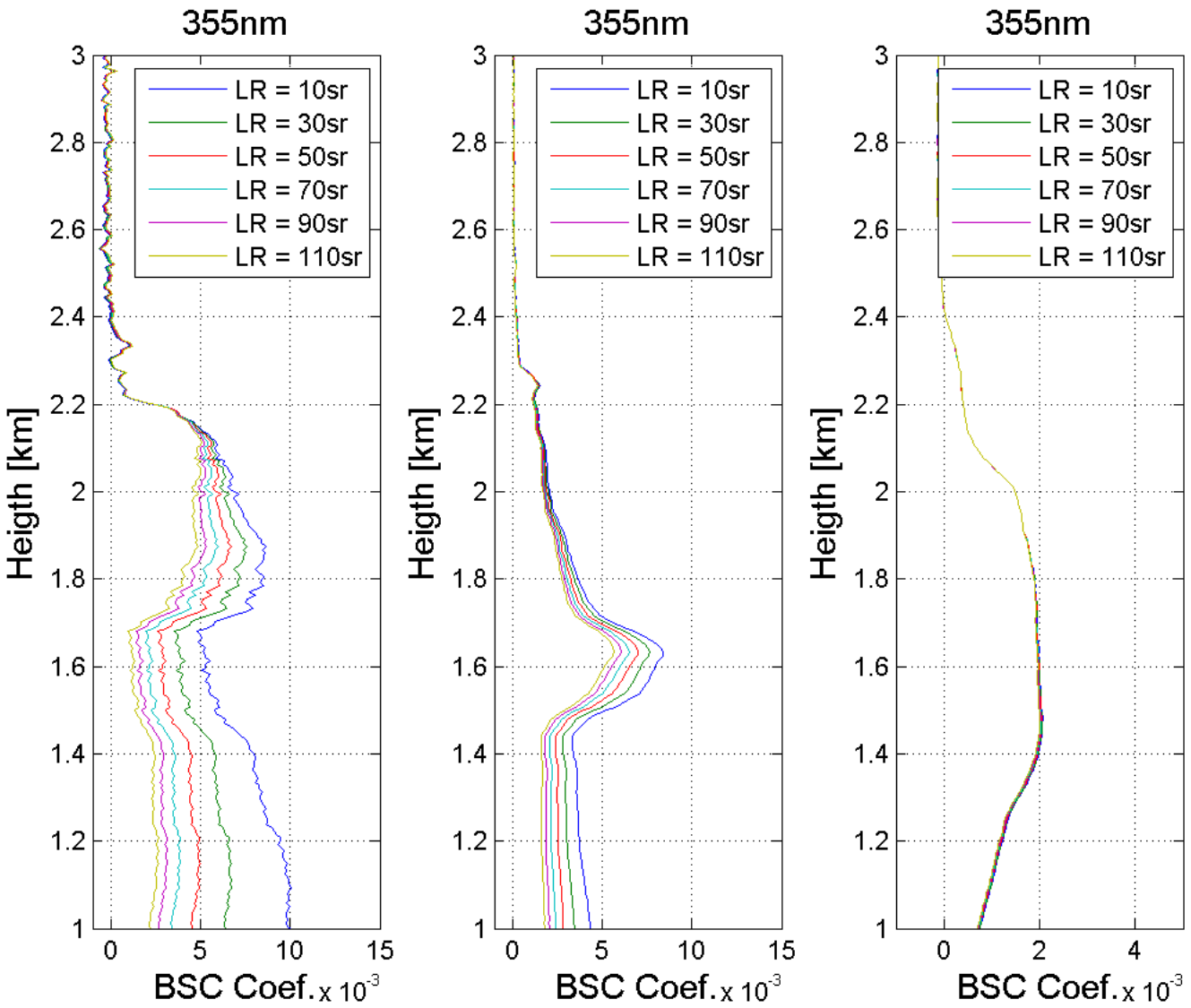
Signal Characteristics: Molecular Fit



Signal Characteristics: Molecular Fit

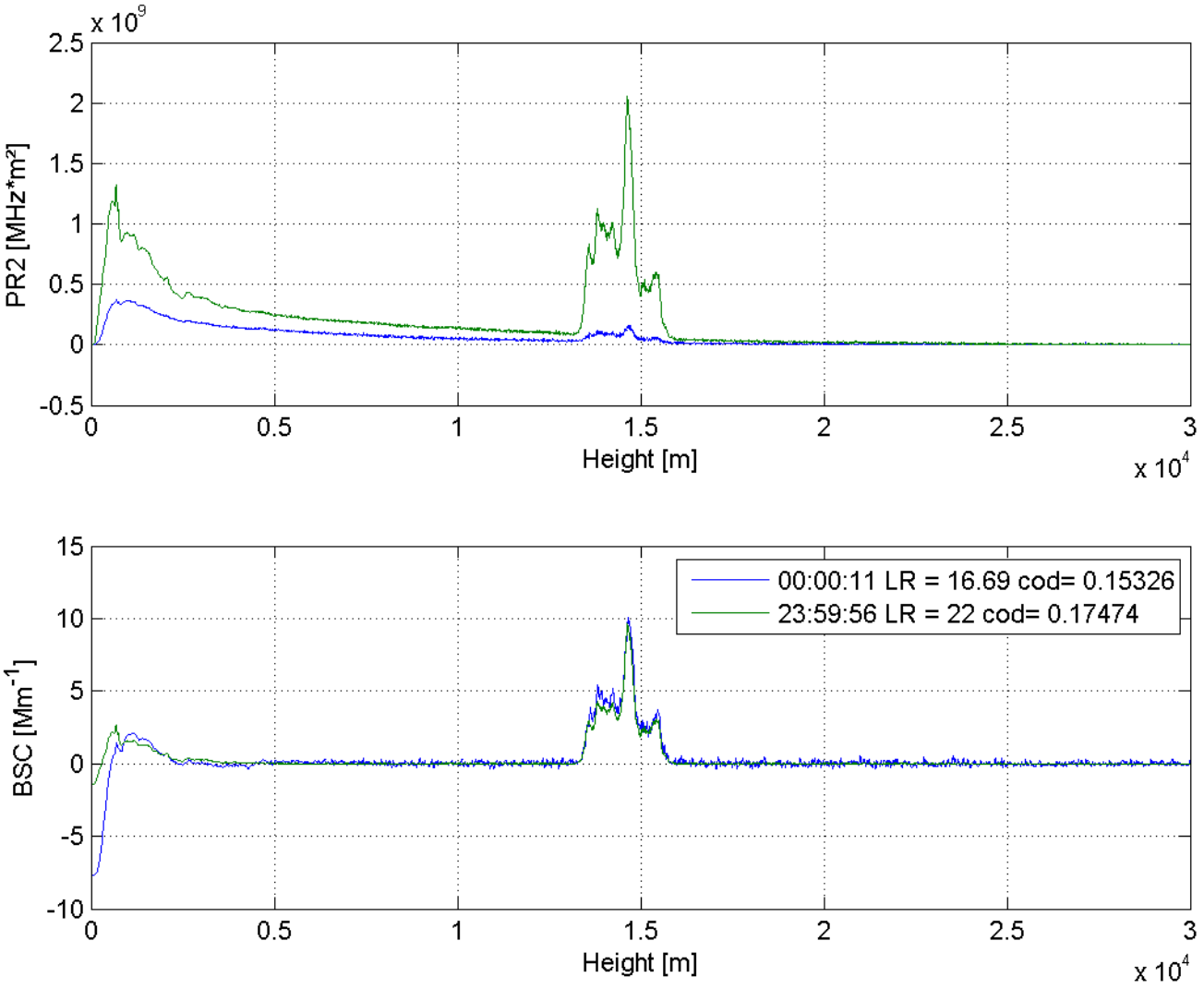


Signal Characteristics: Lidar Ratio Sensitivity

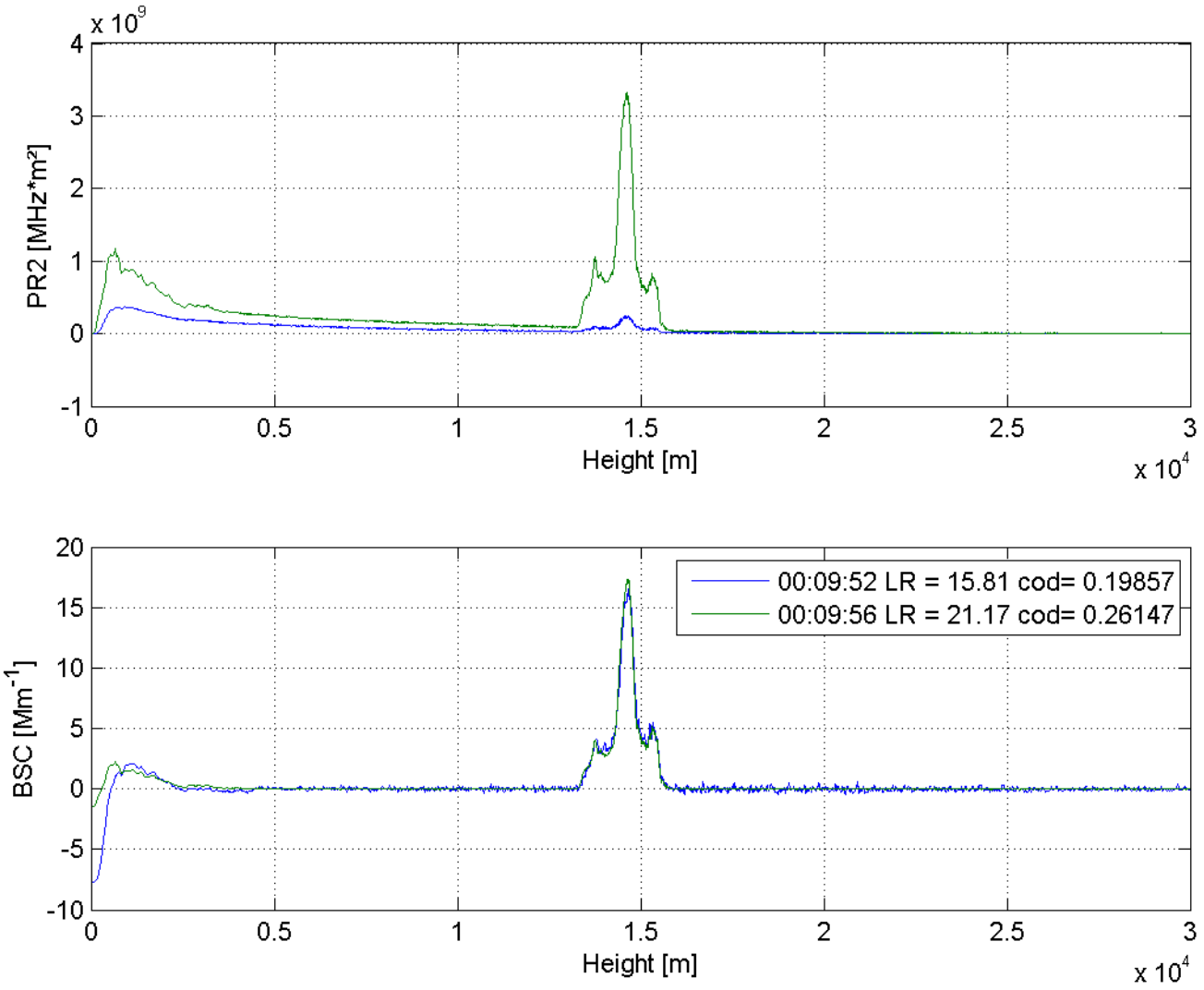


Side-by-Side Intercomparison

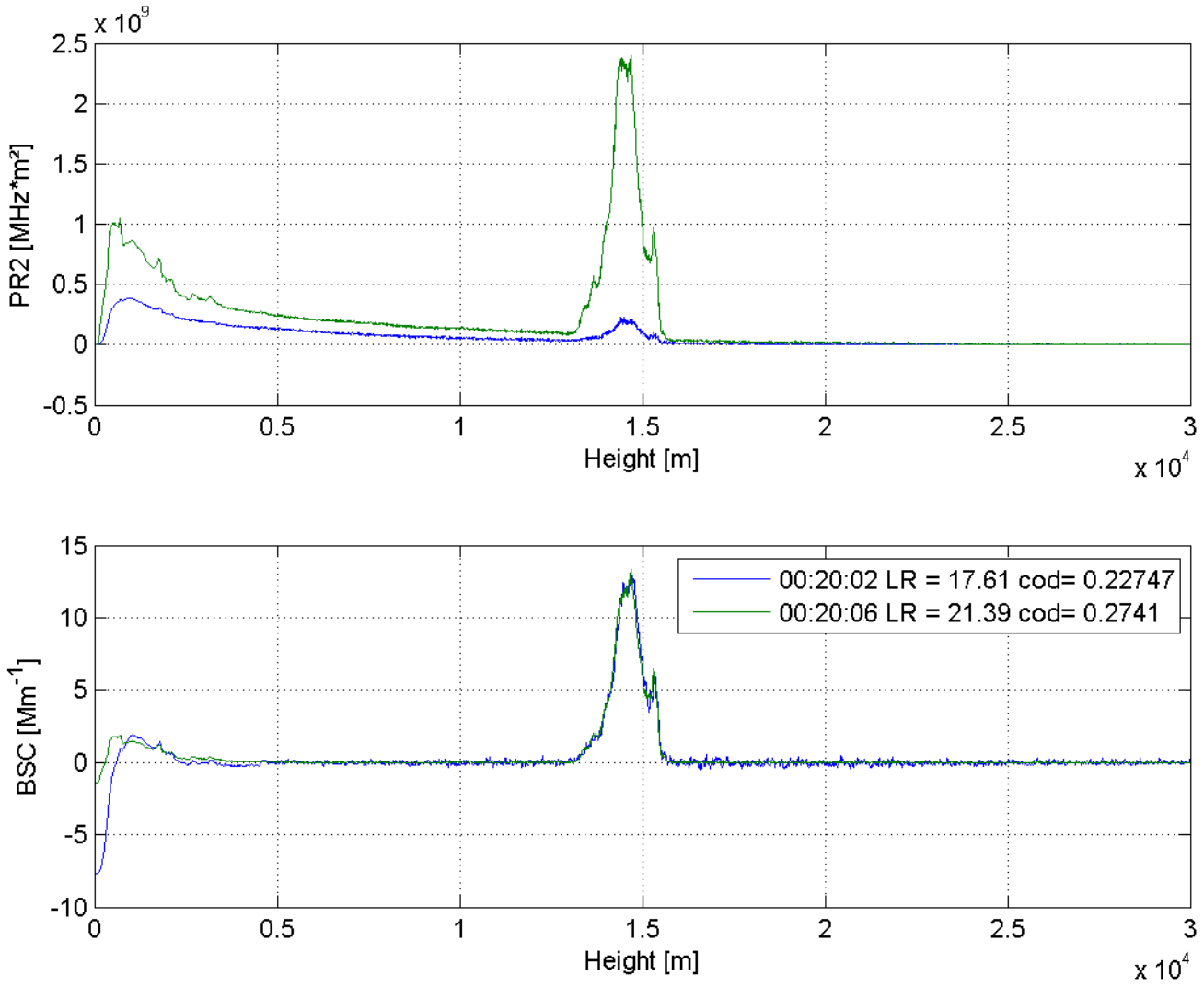
Si


x 10^9
2.5
2
1.5
1
0.5
0
-0.5
PR2 [MHz*m²]
0
0.5
1
1.5
2
2.5
3
Height [m]
x 10^4
15
10
5
0
-5
-10
BSC [Mm^-1]
00:00:11 LR = 16.69 cod= 0.15326
23:59:56 LR = 22 cod= 0.17474
Height [m]
x 10^4

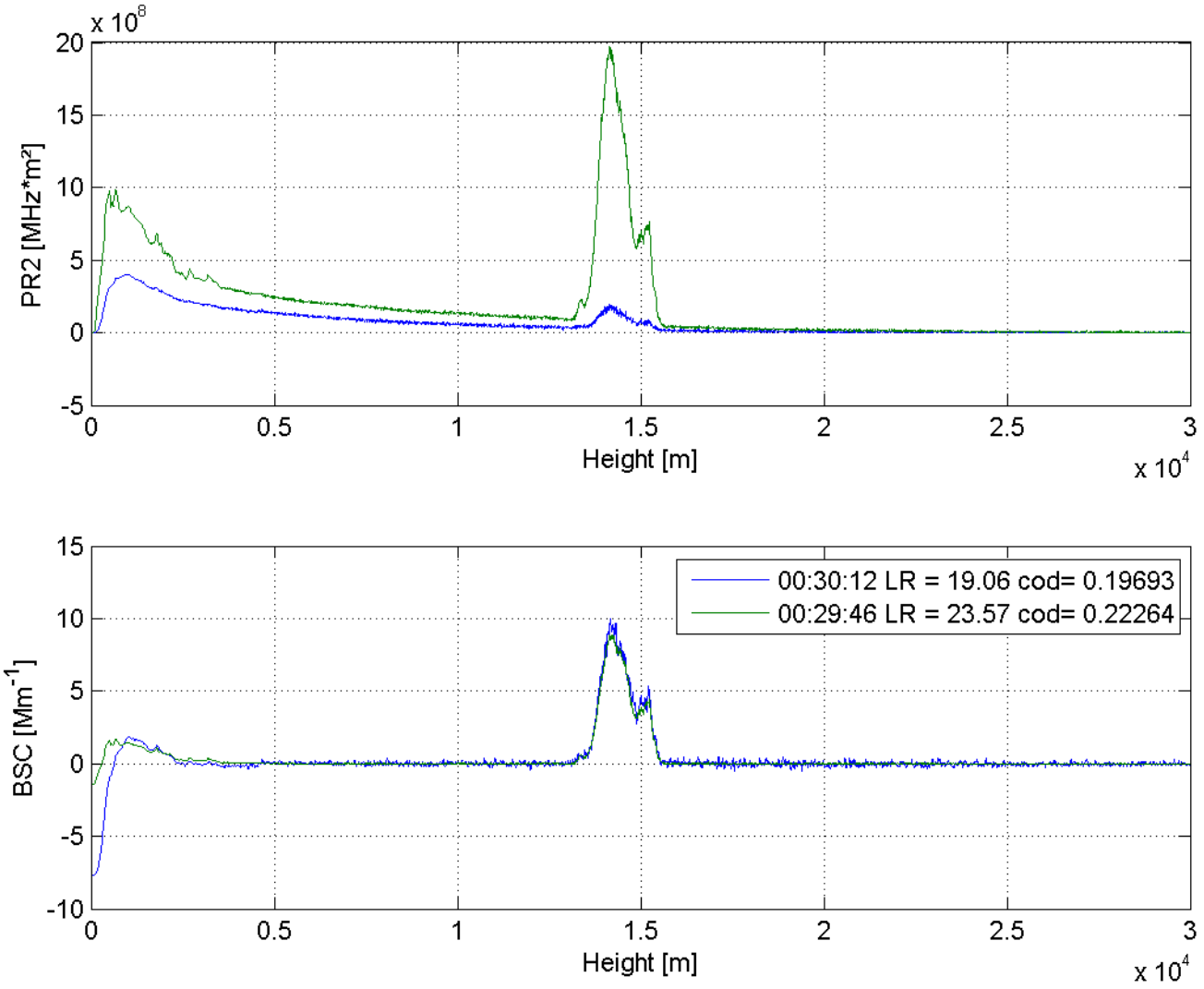
Si


x 10^9
PR2 [MHz*m²]
Height [m]
x 10^4
BSC [Mm^-1]
00:09:52 LR = 15.81 cod= 0.19857
00:09:56 LR = 21.17 cod= 0.26147
Height [m]
x 10^4

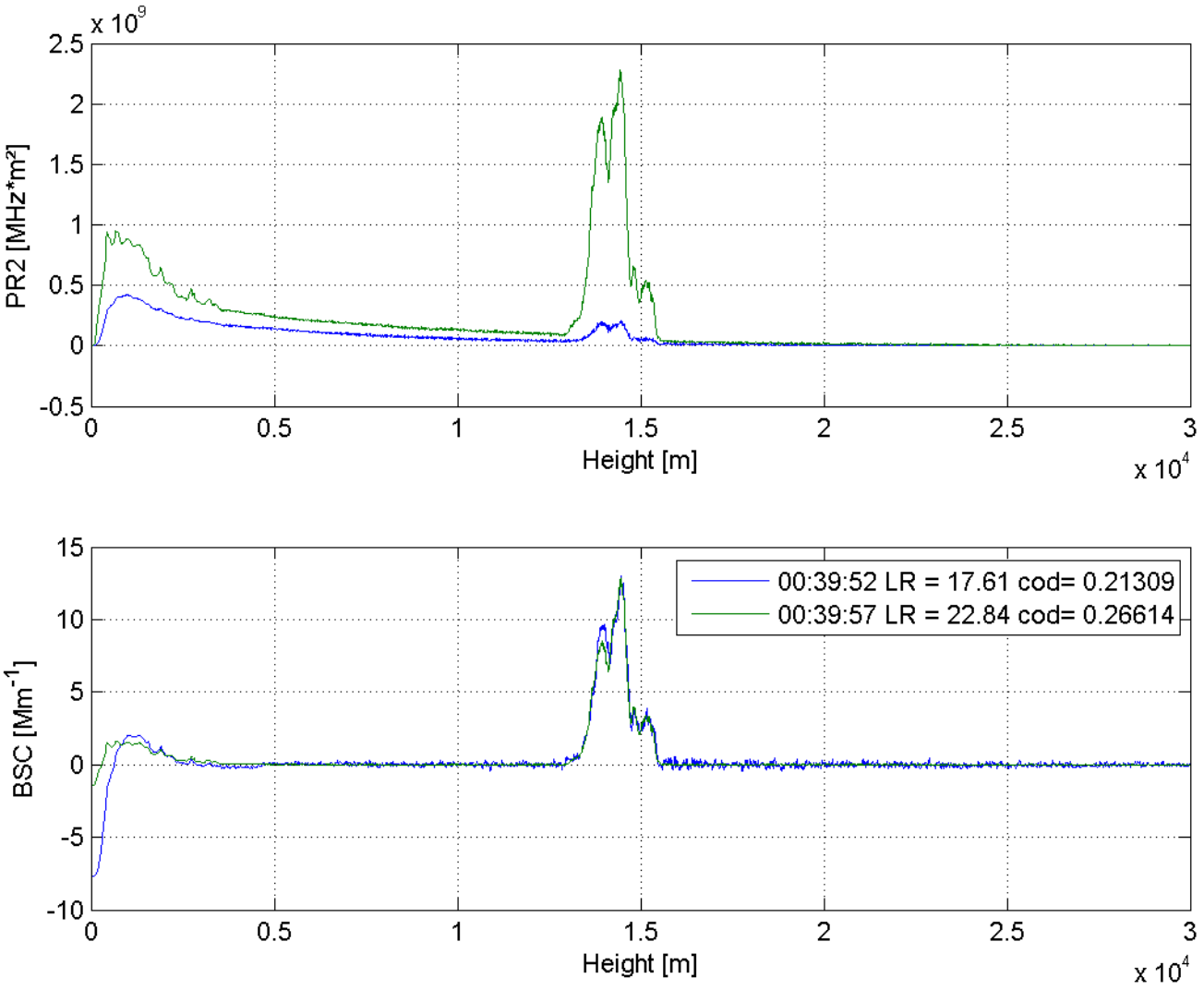
Si


x 10^9
PR2 [MHz*m²]
Height [m]
x 10^4
BSC [Mm^-1]
00:20:02 LR = 17.61 cod= 0.22747
00:20:06 LR = 21.39 cod= 0.2741

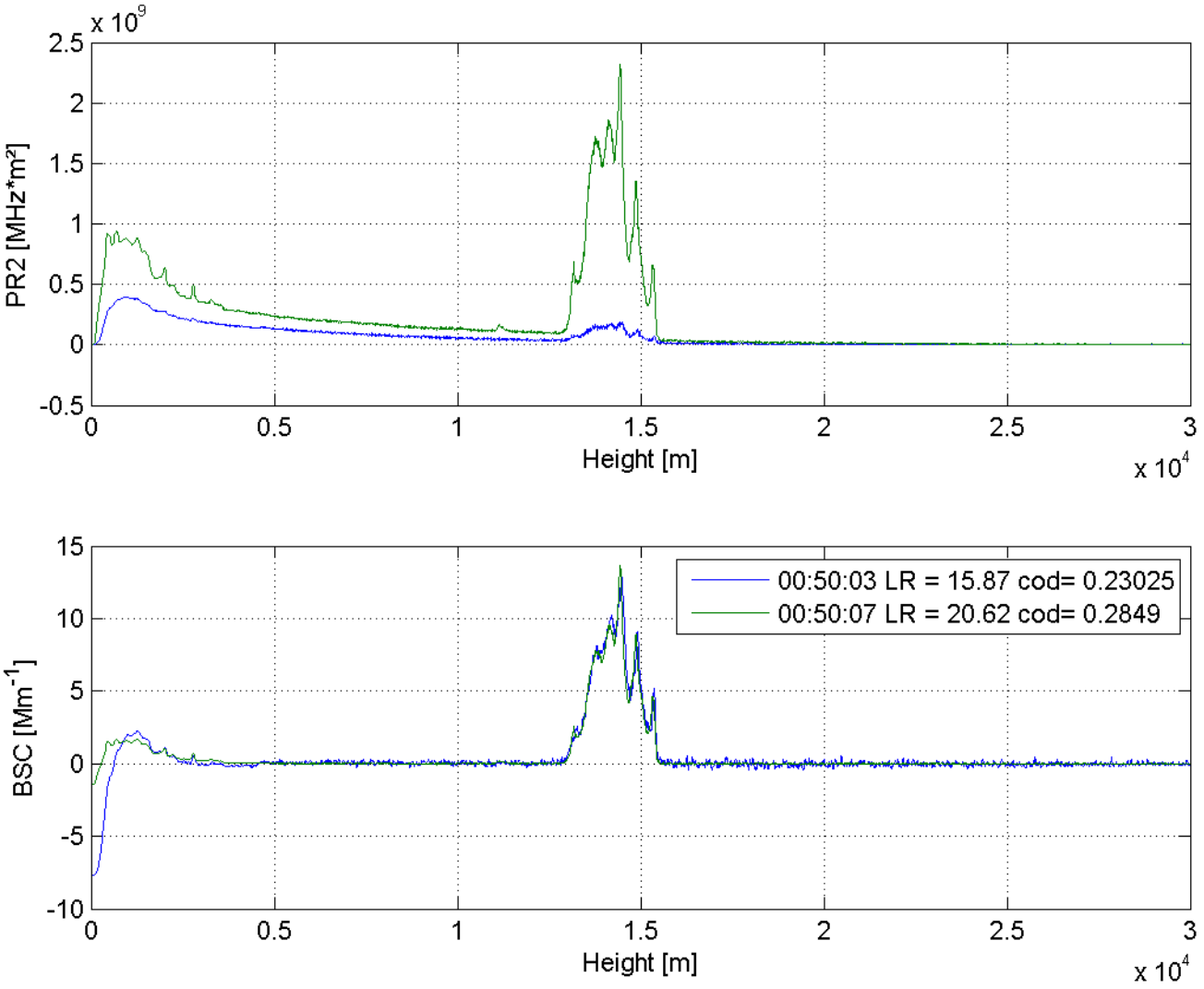
Si


x 10^8
PR2 [MHz*m²]
Height [m]
x 10^4
BSC [Mm^-1]
00:30:12 LR = 19.06 cod= 0.19693
00:29:46 LR = 23.57 cod= 0.22264

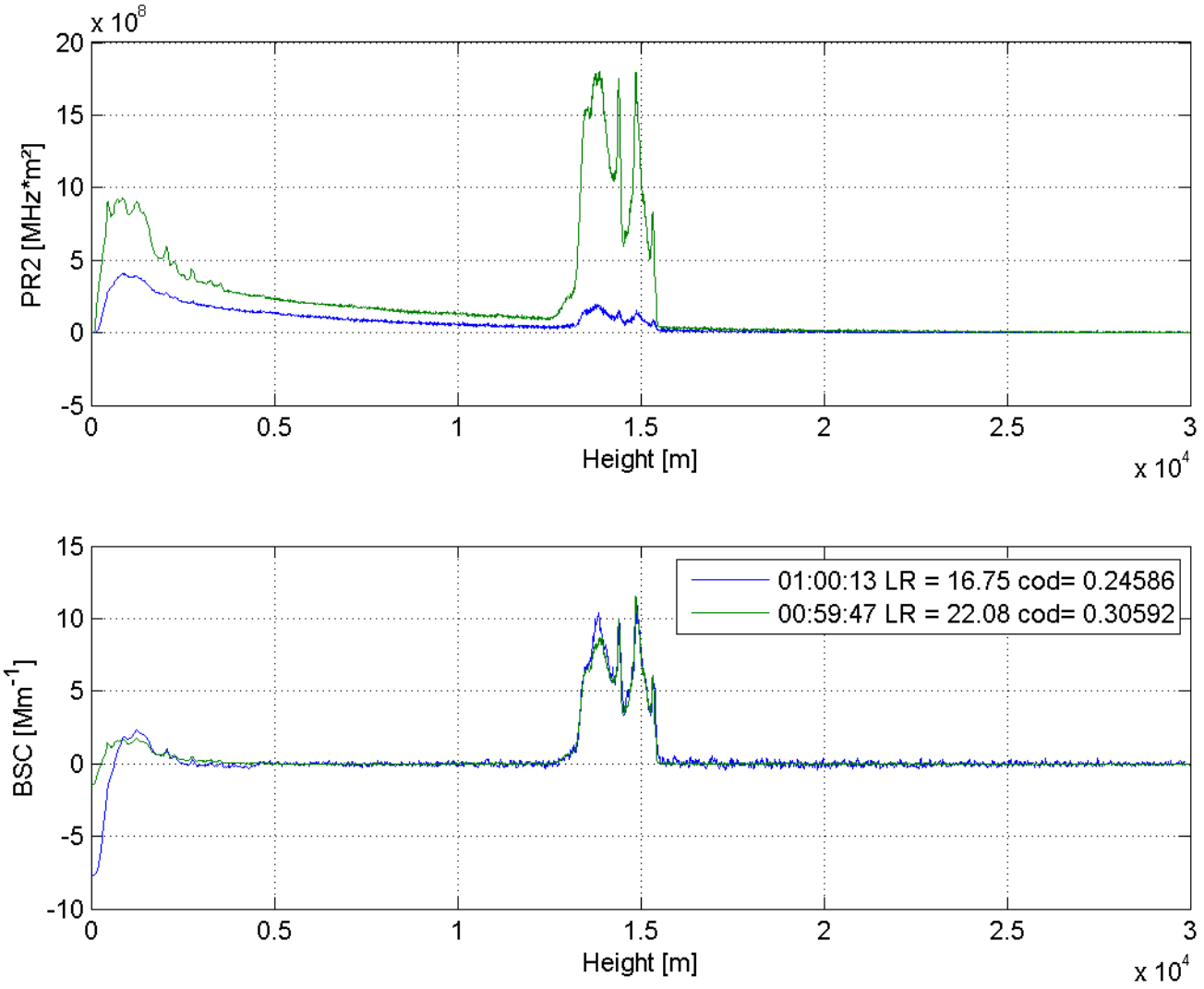
Si


x 10^9
PR2 [MHz*m²]
Height [m]
x 10^4
BSC [Mm^-1]
00:39:52 LR = 17.61 cod= 0.21309
00:39:57 LR = 22.84 cod= 0.26614
Height [m]
x 10^4

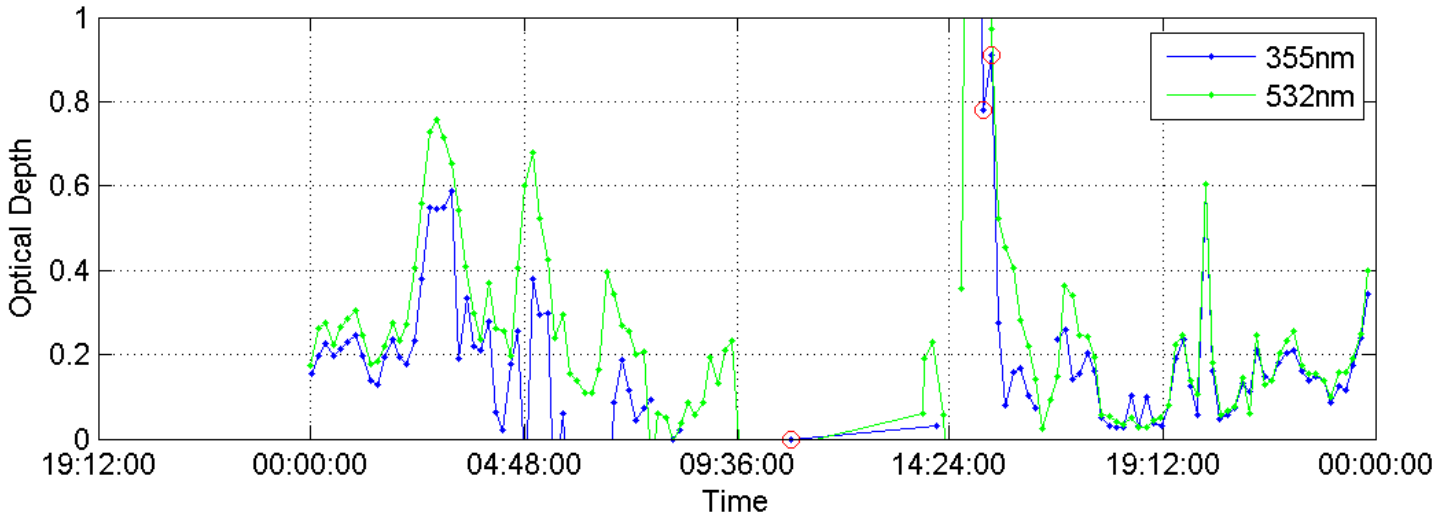
Si

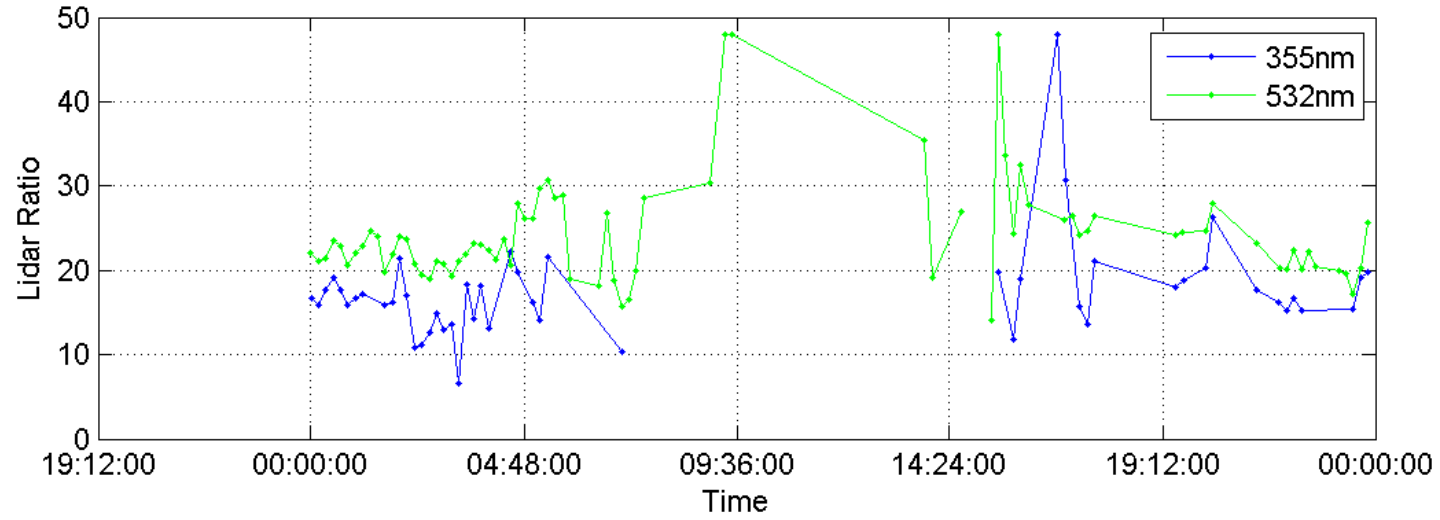

x 10^9
PR2 [MHz*m²]
Height [m]
x 10^4
BSC [Mm^-1]
00:50:03 LR = 15.87 cod= 0.23025
00:50:07 LR = 20.62 cod= 0.2849

Si

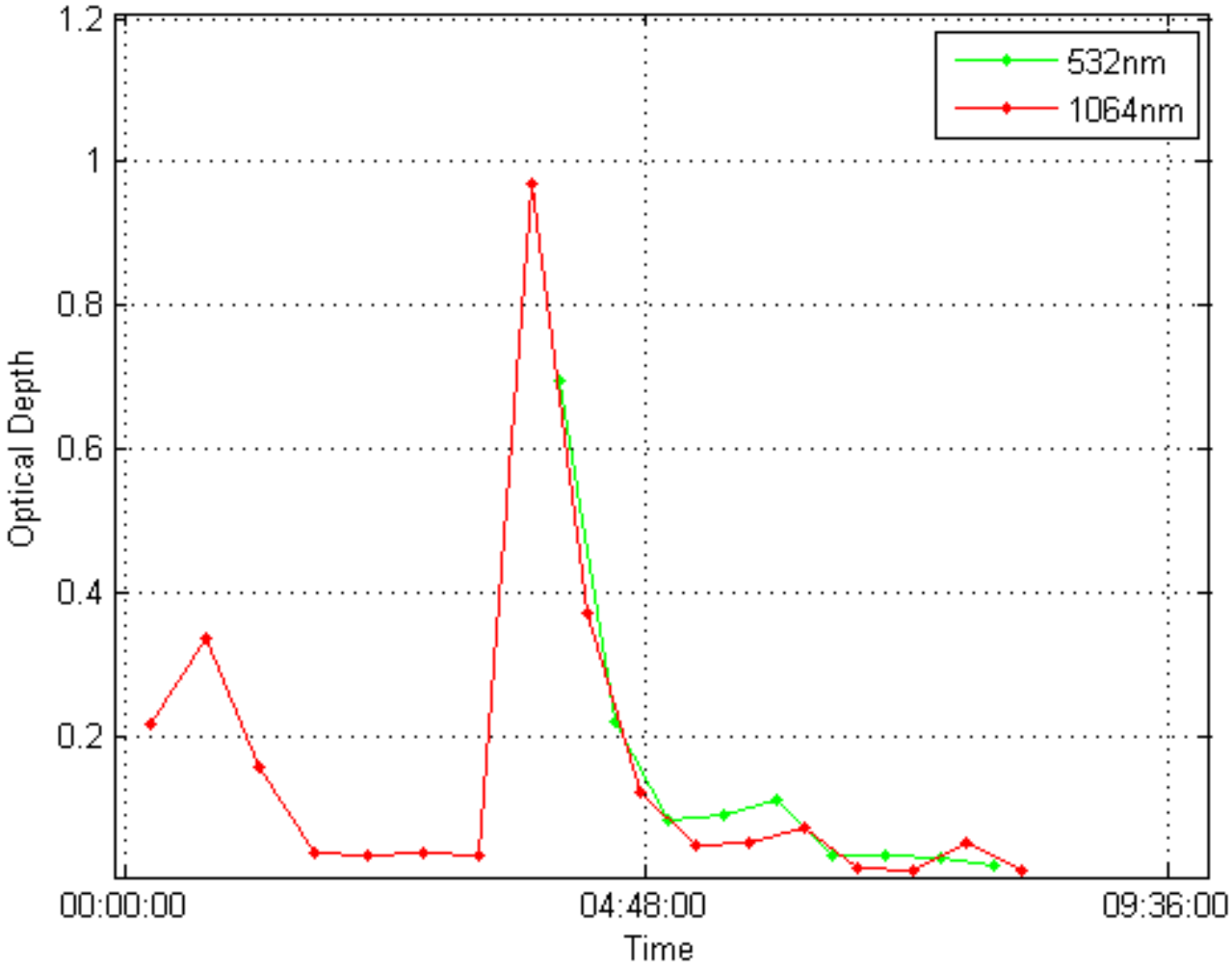

x 10^8
PR2 [MHz*m²]
Height [m]
x 10^4
BSC [Mm^-1]
01:00:13 LR = 16.75 cod= 0.24586
00:59:47 LR = 22.08 cod= 0.30592
Height [m]
x 10^4

Side-by-Side Intercomparison





Side-by-Side Intercomparison



Conclusion

- Tests showed a good quality of Raman lidar data.
- The combination of different wavelengths of the instruments in addition to the Raman and polarization capabilities can generate very interesting results.
- There are still more tests to be done

Obrigado