Impact of a Solar Radio Burst on the EPN GNSS Network

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Summary

- GNSS monitoring stations are sensitive to wide band interferences from solar origin
- Illustration with the 24 September 2011 flare
- $\Delta C/N_0$ variations clearly show the signature of the solar radio burst at L1 (1575.42 MHz), and can be used to estimate the RHCP solar flux
- Reasonable agreement between observed and deduced solar flux: hint at a ~100% RHCP burst?
- Antenna & receiver technical details are the limiting factors of the study

EPN GNSS Network

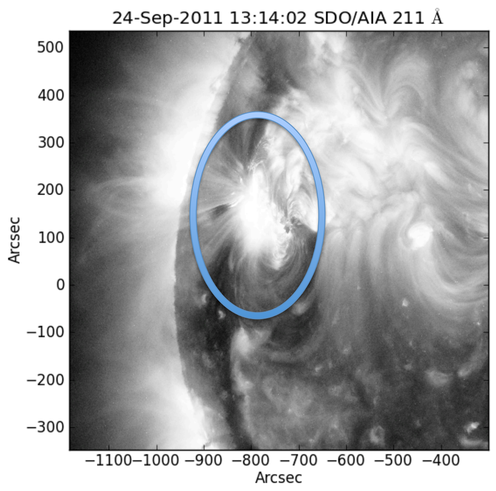
- > 240 GNSS (GPS, GLONASS) stations from the **E**UREF **P**ermanent **N**etwork (Bruyninx et al., 2012)
- Carrier-to-noise density (C/N_0) data between each station and each GNSS satellite (elevation>50°), at a given frequency, every 30s
- $\Delta C/N_0$: difference between day-1 and day of interest. It allows to quantify the effects of the solar burst on C/N_0 at GPS frequencies, and get rid of multi-path reflections

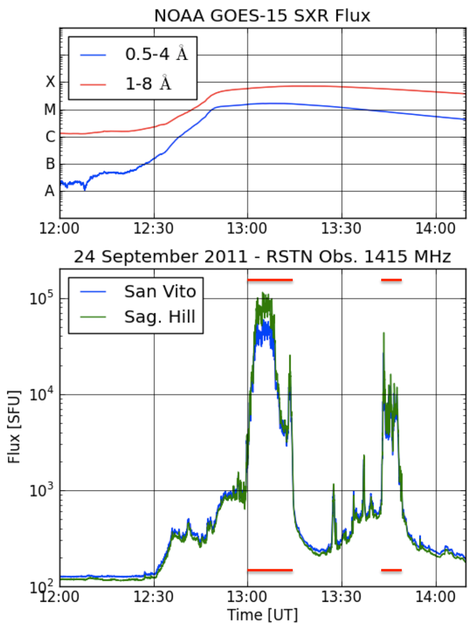
24-Sept-2011 solar event

- NOAA AR 1302, located N13E59, of magnetic type: β-γ
- M7.1 GOES SXR event; peak time: 13:20 UT
- Intense radio event observed from metric to microwave range

Frequency [MHz]	Peak time [UT]	Peak flux [SFU]
410	13:13	69k
610	13:07	80k
1415	13:04-13:06	60k - 110k
2695	13:02	12k

- 1415 MHz-flux is close to GPS bands, but discrepant measurements (San Vito/Sagamore Hill)
- From 13:00 to 14:00 UT, 2 episodes of strong emissions (>1k SFU) occurred, for a total duration of about 25 minutes

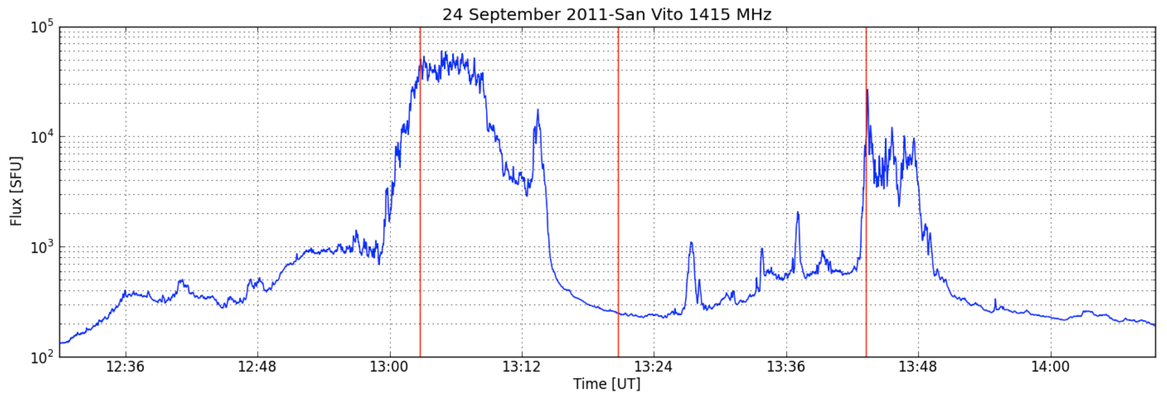




Overview of the solar event of Sept. 24 2011

Impact on the EPN Network

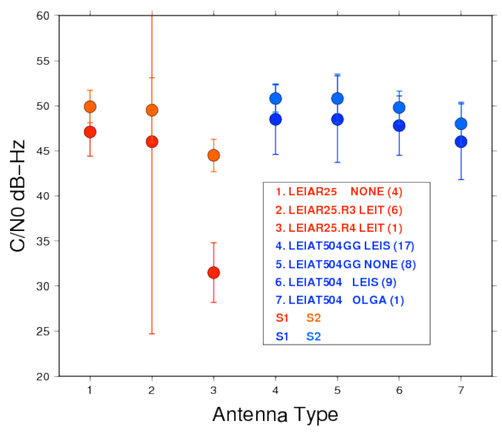
- We focus on the evolution of the relative carrier-to-noise density, $\Delta C/N_0$, with time, at frequency L1
- Drops of ~15 to ~20 dB are observed for L1 at 13:06 UT
- Strong correlation with local solar elevation



Map of relative $\Delta C/N_0$ at L1 (GPS) during the radio burst

Flux estimation

- Satellite PRN 21 is chosen because it's visible from all stations during the event
- Selection of stations with LEICA antenna (AR25 & AT504GG), for which gain diagrams are known
- $\Delta C/N_0$ is corrected for solar elevation
- N_0 level is estimated from observations on the previous day, and assuming a carrier level of -158.5 dBW
- $F_{sun}[SFU]=N_0[W/Hz] \times (1-\Delta C/N_0)/(\Delta C/N_0)/ A_{eff}[m^2] / 10^{-22}$



Antenna	AR25	AT504GG
N_0 [dB(W/Hz)]	~ -205.9	~ -207.5

Estimates of the N_0 level, based on C/N_0 median values (S1 markers), on the day before, between 12:30 and 14:00 UT

$\Delta C/N_0$ drop (top) & estimated RHCP flux (bottom)

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