

VOLDORAD-2B Doppler radar measurements at Etna : data validation procedure

EPOS - TCS 'Volcano Observation' – Test 4.4 Quality assurance (data content and quality)

F. Donnadieu – Jan. 2021

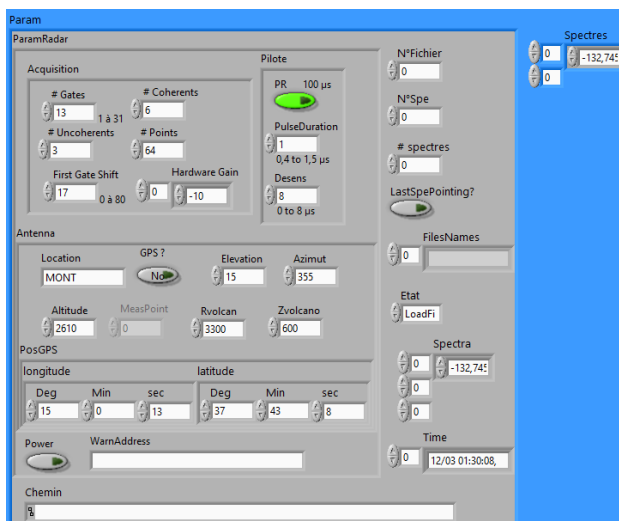
Observatoire de Physique du Globe de Clermont-Ferrand – Laboratoire Magmas et Volcans

Université Clermont Auvergne

The following describes the procedures for quality check-up of the data recorded during nominal operation of the radar and nominal beam orientation. For any questions, please contact PI of instrument (F.Donnadieu@opgc.fr).

1. VOLDORAD-2B Radar instrument

A handbook of the VOLDORAD-2B radar instrument (Donnadieu *et al.*, 2009) describes the procedure for proper operation of the radar and acquisition software, acquisition parameter settings at Etna, radar physical inspection and check up. The VOLDORAD-2B radar is a property of OPGC (Université Clermont Auvergne – CNRS) and is operated at Etna by INGV-OE in the frame of a collaborative agreement. Since 16/12/2013, acquisition settings of radar data file must be as follows:



Apart from the physical inspection of the radar, only ground echoes observed in spectra can provide clues on the nominal power amplification of the radar (most frequent breakdown).

The VOLDORAD-2B data on Etna can be displayed and downloaded from the open-access data base <http://voldorad.opgc.fr/bddtr.php> (Donnadieu *et al.*, 2015)

2. Data validation procedure

2.1. Raw Data (wifi-transmitted to INGV-OE every minute, then sent by FTP to OPGC)

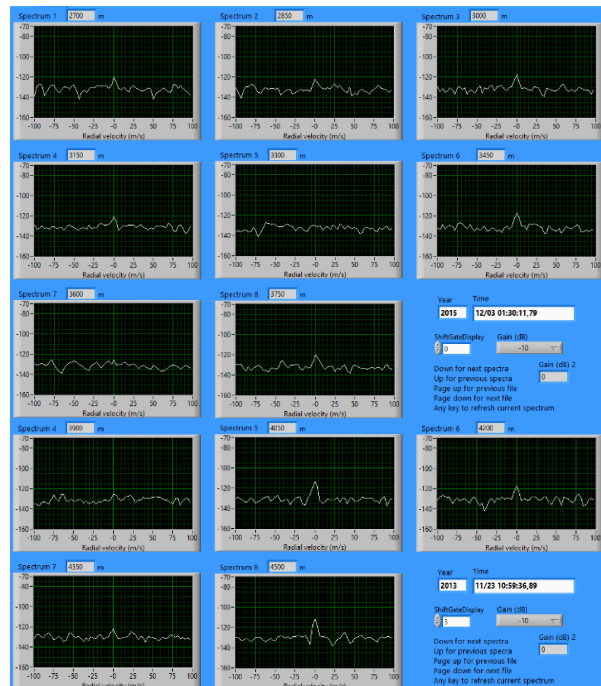
- Binary files (.SPE) are 1 minute-long and the *nominal size is about 835-840 Ko for a complete file* (1440 files/day, i.e. 1.1-1.2 Go/day).
- These files can be read and processed only through proprietary codes; each file comprises a header with instrument settings and radar spectra values at successive record times from all range gates: they provide the backscattered power spectral distribution as a function of measured Doppler velocities.
- File name from record time: YYMDDHHmms.SPE
- YY : year; M is 1-9 (January to September) or A-C (October to December); DD : day; HHmm: hour and minutes in UTC; last digit s stands for the tens of second within the minute ; e.g. 13B2308323.SPE stands for 23 Nov. 2013 at 08:32 UTC, s=3 indicates file record time ≥ 30 s and < 40 s within the minute.

Different file name structure or size=0 might indicate corrupted file. All files should be recorded in continuous succession.

2.2. Spectra (for real-time or post-processing display only)

- 13 range gates recorded ($> 16/12/2013$) from 2700 m to 4500 m
- Doppler spectra background noise around -133 ± 8 dBm (without averaging), except around nul Doppler velocity where it can be higher (ground echoes) in some gates
- Spectra acquisition rate about 0.2 s
- Power spectral distribution should show *ground echoes with a peak for 0 velocity in some range gates* (cf. table below). These values are given for a nominal beam orientation and topographic conditions in 12/2015; topographic changes of the summit cones might affect ground echoes). Doppler velocity display should scale between ± 100 m/s (64 values).
- Power Spectral Density display should scale between -160 and -70 dBm by default.

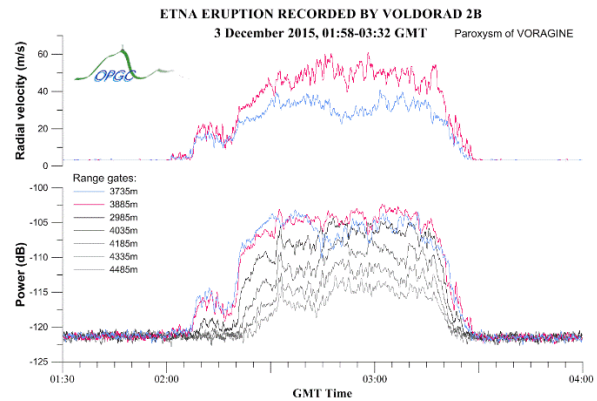
Range gate (m)	Peak of ground echoes (dBm) at velocity = 0 (dec. 2015)
4500	-110
4200	-118
4050	-112
3750	-120
3450	-117
3150	-120
3000	-117



2.3. Time series (provided through VOLDORAD data base and EPOS)

Time series of power (P, P+, P-) and velocity parameters (V+max, V-min, Vmoy) are processed from the spectra (.spe files), in real-time for monitoring purpose at INGV-OE (Mass Eruption Rate; Ejection velocities; *Donnadieu et al., 2016; Freret-Lorgeril et al., 2018*) and in post-processing at OPGC to feed the open-access data base.

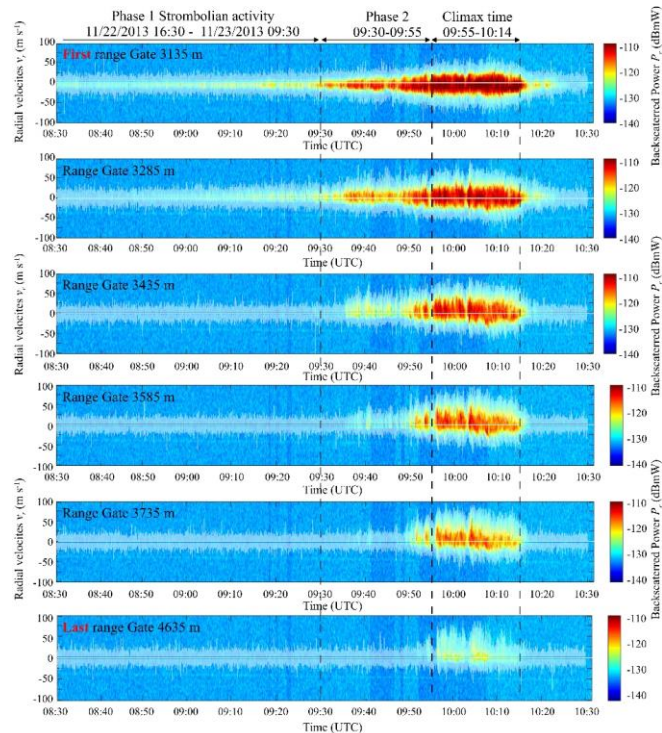
- backscattered power background noise (out of eruptive echoes) post-processed with 5 incoherent integrations:
- background level for Doppler velocities should be around 3.13 m/s in all gates (V+ and V- parameters) out of eruptive periods
- Acquisition rate: about 0.22 s, about 1.1 s for post-processing with 5 incoherent integrations



2.4. Velocigrams (available from data base as images and data set for all recorded eruptions)

Velocigrams display Doppler velocities (64 values in Y-axis from -100 to + 100 m/s) and backscattered power (color-code, dBm) at each time step (e.g. *Donnadieu et al., 2016; Valade and Donnadieu, 2011*). They are processed from Doppler spectra (.spe files) by a proprietary code filtering out ground echoes.

- 13 range gates recorded (> 16/12/2013) from 2700 m to 4500 m
- Doppler velocity display (Y-axis) should scale between +/- 100 m/s (64 values).
- Spectral background noise according to post-processing incoherent integrations (out of ground echoes around nul Doppler velocity and out of eruptive signal)



Spectral power per velocity class	Standard deviation (dBm)	incoherent integrations in post-processing	Time interval (s)
-132.5	± 3.0	1	0.22
-131.6	± 0.8	10	2.22
-132.5	± 0.6	20	4.55

References

- Donnadieu F., Hervier C., Fréville P., Fournet-Fayard J., Fournol J.-F., Menny P., Reymond C., Bernard C., 2009. The VOLDORAD 2B radar: Operational handbook, Note OPGC 07.09, Univ. Blaise Pascal Clermont-Ferrand, July 2009, 15p.
- Donnadieu F., Freville P., Rivet S., Hervier C., Cacault P (2015) The Volcano Doppler radar data base of Etna (VOLDORAD 2B). Université Clermont Auvergne – CNRS. <http://www.obs.univ-bpclermont.fr/SO/televolc/voldorad/bddtr.php>, doi: 10.18145/VOLDORAD.ETNA.2009
- Donnadieu F., Freville P., Hervier C., Coltelli M., Scollo S., Prestifilippo M., Valade S., Rivet S., Cacault P., 2016. Near-source Doppler radar monitoring of tephra plumes at Etna. *J. Volcanol. Geotherm. Res.* 312:26-39, DOI: 10.1016/j.jvolgeores.2016.01.009.
- Dubosclard G., Donnadieu F., Allard P., Cordesses R., Hervier C., Coltelli M., Privitera E., Kornprobst, J., 2004. Doppler radar sounding of volcanic eruption dynamics at Mount Etna. *Bull. Volcanol.*, 66, 5, p. 443-456. DOI : 10.1007/s00445-003-0324-8
- Freret-Logeril V., Donnadieu F., Scollo S., Provost A., Fréville P., Guéhenneux Y., Hervier C., Prestifilippo M., Coltelli M., 2018. Mass eruption rates of tephra plumes during the 2011–2015 lava fountain paroxysms at Mt. Etna from Doppler radar retrievals. *Front. Earth Sci.* 6:73. doi: 10.3389/feart.2018.00073
- Valade S. and Donnadieu F., 2011. Ballistics and ash plumes discriminated by Doppler radar. *Geophys. Res. Lett.*, 38, L22301, doi:10.1029/2011GL049415