RELAMPAGO RMA1 Dataset

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Summary: This data set contains data from the Radar Meteorologico Argentino - 1 (RMA1) C-Band dual-polarization Doppler radar in Cordoba city, Cordoba, Argentina during the RELAMPAGO field campaign. These data are in **CFRadial** format and an initial data quality check has been performed on the data. Radar operations and strategy were designed between Argentinian National Weather Service (SMN), INVAP S.E and RELAMPAGO scientists.

Required acknowledgement in presentations and publications: RMA1 data was provided by Secretaría de Infraestructura y Política Hídrica, Subsecretaria de Obras Hidráulicas, Ministerio de Obras Públicas of the Argentinean National Government framed within SINARAME Project. The SINARAME project is an Argentinean effort to expand the radar network over the whole country.

Radar system: This radar - RMA1 - is a C-Band, Doppler, dual-polarization radar, located on a 35 m tower at the Universidad Nacional de Córdoba.

Radar location:

RMA1 is located in Cordoba Province, capital city

Lat: -31.441328°, Lon: -64.191922°, 484 m. a. m. s. l.

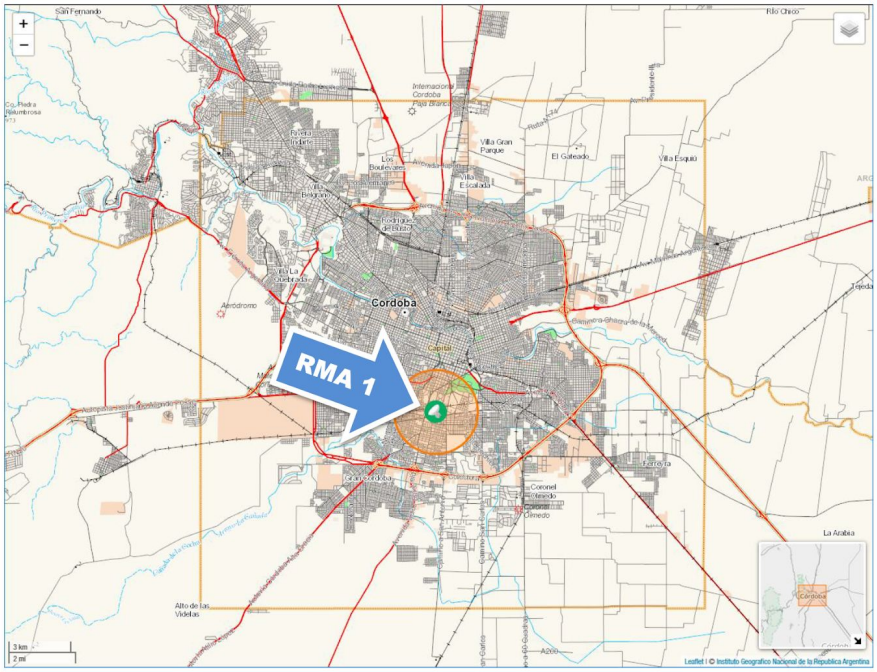


Image of the RMA1 radar taken on 7 June 2016 (photo credit: Steve Nesbitt).

Aerial Image of the RMA1 (photo credit: Universidad Nacional de Córdoba)

Table of RMA1 Technical Specifications:

RMA Technical specifications

INVAP

Parameter	Value
Brand and Model	INVAP RMA-C320 (Doppler, dual polarization)
Operational frequency	C-Band, 5625 MHz for RMA1 (Cordoba) site
Dual Pol transmission mode	Simultaneous transmission and reception (H + V)
System Sensitivity (ISO/DIS 19926-1:2019)	Better than -7 dBZ at 50 km with 1us pulse and for SNR=0 dB including radome and waveguide losses and atmospheric attenuation
Radome losses	0.4 dB (dry, one way)
Transmitter	Coaxial Magnetron, solid state modulator
Max peak power	320 kW
Max pulse duration	3 us
Max duty cycle	0.001 (0.1%)
Antenna	Parabolic, center feed, 4.48 meters
Gain (typical)	Better than 46 dBi (simulations: 46.6 dBi)
Beam width @ -3dB (typical)	0.87° +/- 0.03° (simulations: H=0.84°, V=0.90°)
side lobes (typical)	Better than -27 dB (simulations: better than -30 dB)
cross-pol isolation (typical)	Better than -35 dB (simulations: better than -40 dB)
Receiver	Antenna mounted, over azimuth, double conversion superheterodyne
Intermediate Frequency (IF):	First: 905 MHz, Second: 70 MHz
noise figure (typical)	Better than 3 dB
Waveguide & rotary joint losses (typical)	2.0 dB on TX + 2.0 dB on RX
Encoders resolution	0.044° (13bits)

File history: These files were obtained from Sistema Nacional de Radares Meteorológicos (SINARAME) Operation Centre located at Servicio Meteorologico Nacional and converted from BUFR to cfradial format using RadxConvert at the University of Illinois at Urbana-Champaign.

Fields in the files:

TH	Total Reflectivity (uncorrected/unfiltered) at horizontal polarization [dBZ]
TV	Total Reflectivity (uncorrected/unfiltered) at vertical polarization [dBZ]
DBZH	Reflectivity factor (noise corrected/clutter filtered) at horizontal polarization [dBZ]
TDR	Signal to noise ratio [dB]
ZDR	Differential reflectivity (noise filtered) [dB]
RHOHV	Cross correlation hv [unitless]
PHIDP	Differential phase shift [degrees]
VRAD	Doppler velocity at horizontal polarization [m s^{-1}]
VRADV	Second trip echoes mask/map
WRAD	Spectral width at horizontal polarization [m^2 s^{-2}]
WRADV	Signal Quality Index [unitless]
CM	Clutter mask/map

Please refer to the following table for filters applied to the RMA1 fields during RELAMPAGO:

RMA1 RELAMPAGO Configuration

INVAP

Algorithm and parameters

Variable	Noise compensation	Atmospheric attenuation compensation	Range attenuation compensation	Ground clutter filter	Masking	Rain attenuation correction
TH Uncorrected Reflectivity	Disabled	Enabled	Enabled	Disabled	Disabled	Disabled
DBZH Corrected Reflectivity	Enabled	Enabled	Enabled	Enabled	SNR > 1 dB	Disabled
VRAD Doppler Velocity	Enabled	N/A	N/A	Enabled	SNR > 1 dB	Disabled
WRAD Doppler Spectrum Width	Enabled	N/A	N/A	Enabled	SNR > 1 dB	Disabled
ZDR Differential Reflectivity	Enabled	N/A	N/A	Enabled	SNR > 1 dB	Disabled
KDP Specific Differential Phase	Enabled	N/A	N/A	Enabled	SNR > 7 dB	Disabled
PHIDP Differential Phase	Enabled	N/A	N/A	Enabled	Disabled	Disabled
RHOHV Correlation coefficient	Disabled	N/A	N/A	Disabled	Disabled	Disabled
SNR Signal to Noise ratio	Disabled	N/A	N/A	Disabled	Disabled	Disabled
SQI Signal Quality Index	Enabled	N/A	N/A	Disabled	Disabled	Disabled

Scanning strategies:

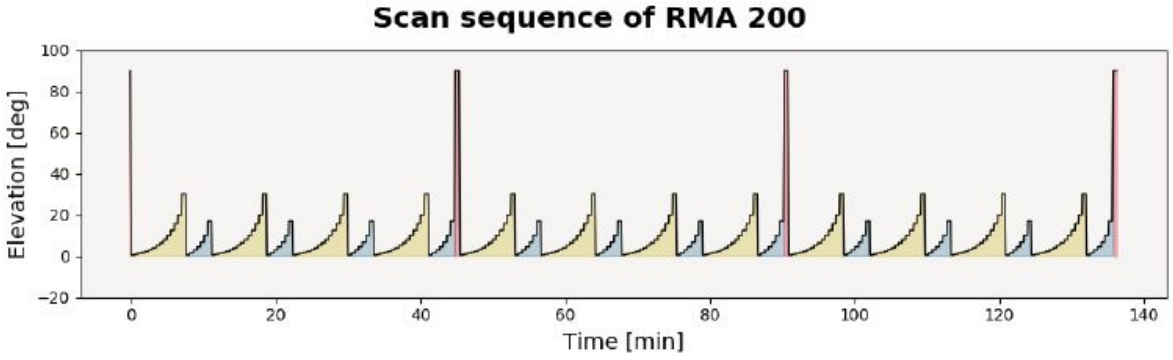
The cfradial files do not contain information on the scan strategies used, but by matching the elevation angles, maximum range, fields available, and resolution, you can obtain the radar parameters from the following tables.
Strategy 200 was considered between October 1st 2018 to November 7th 2018 - 9UTC
Strategy 301 was considered between November 7th 2018 9 UTC to the end of the sample.

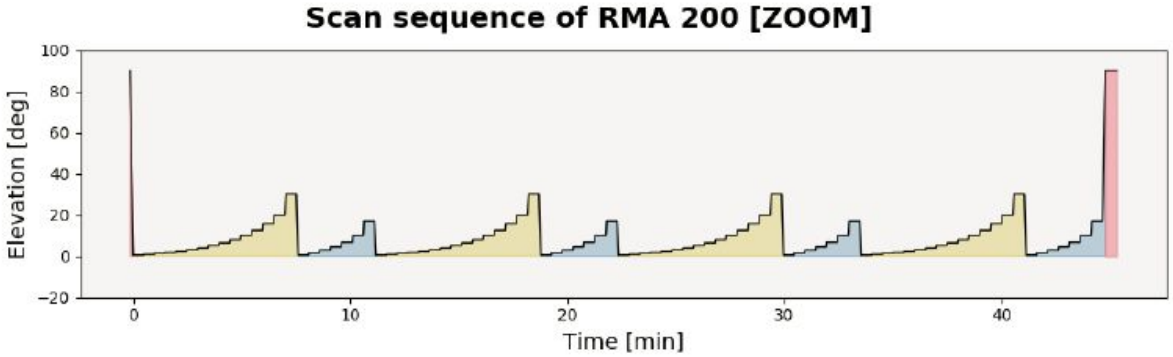
SCANNING STRATEGY 200

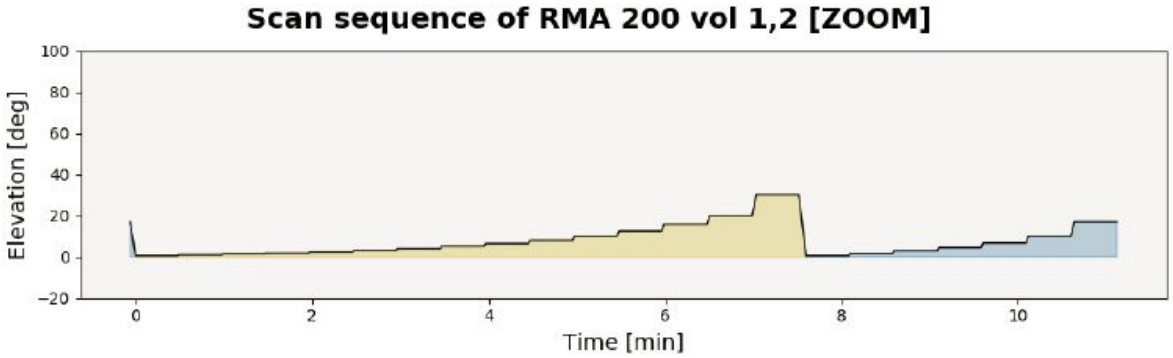
RMA1 RELAMPAGO early scan configuration INVAP

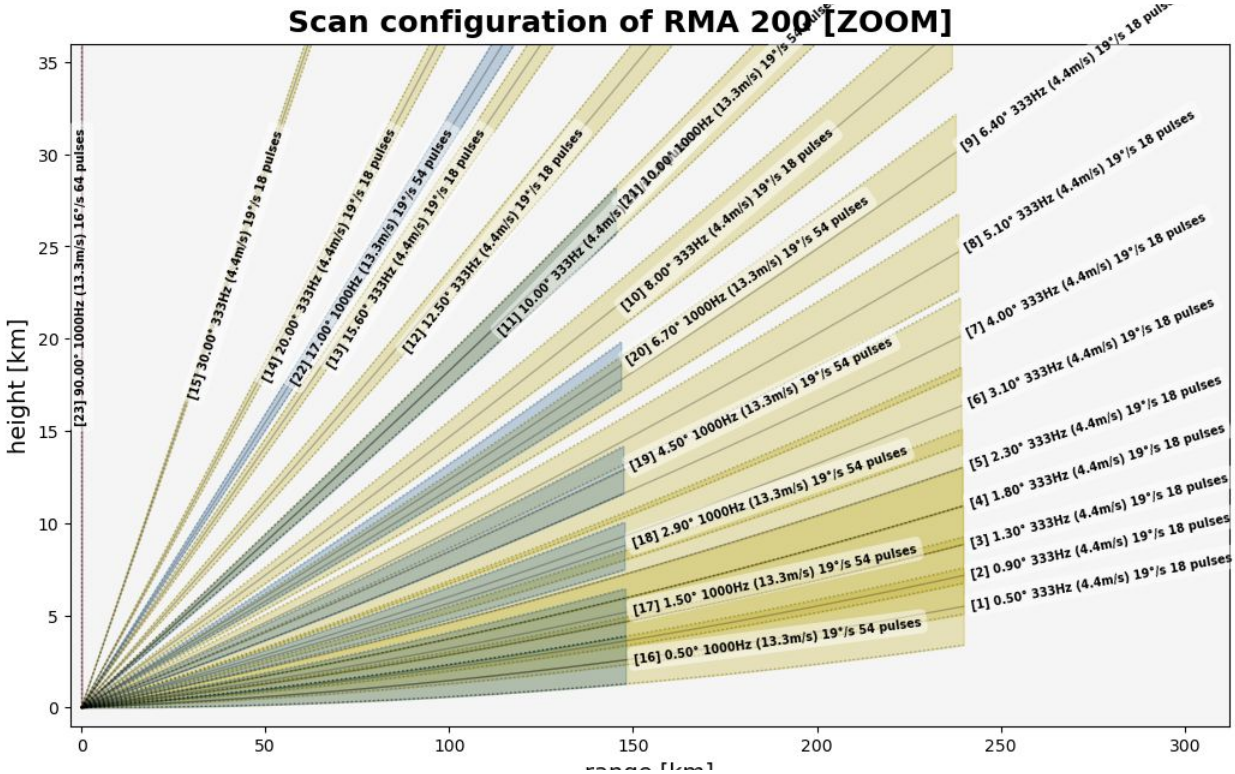
Scanning strategy (id 200)

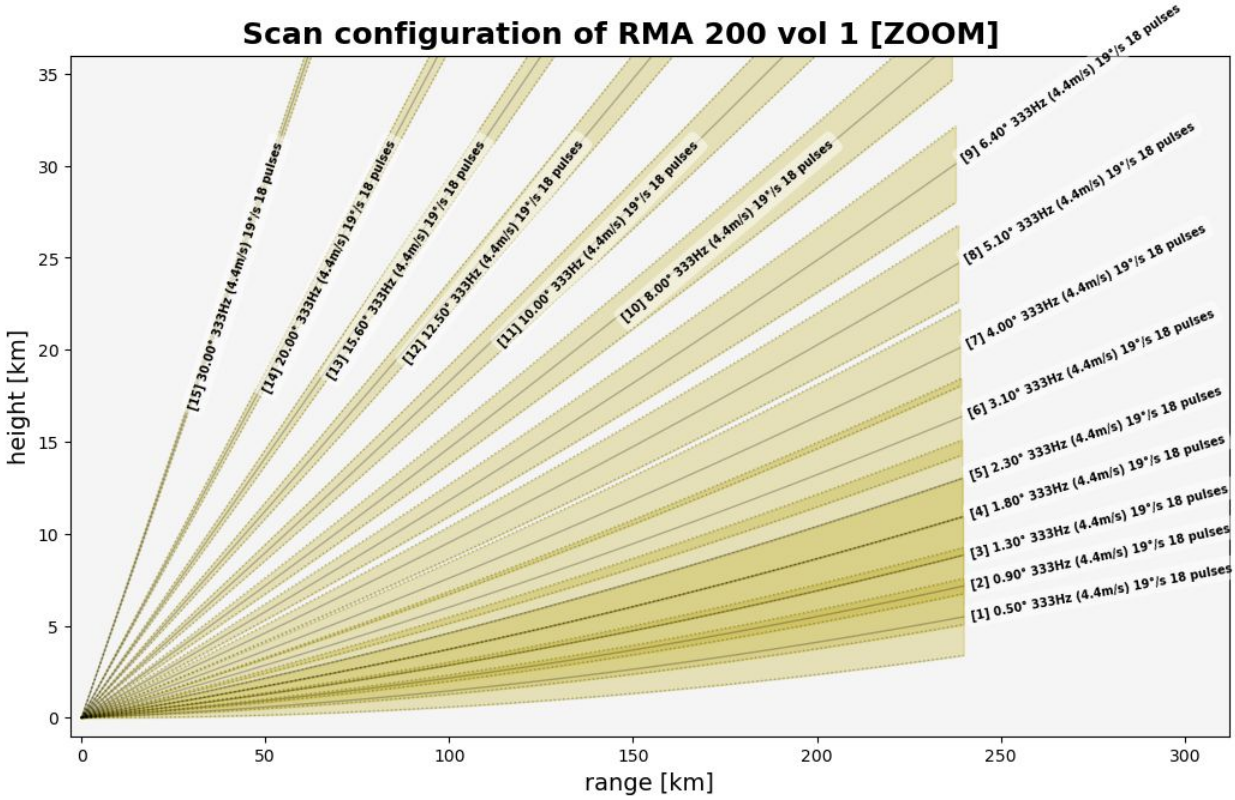
vol id	scan id	elev	pulses per beam (1 deg)	range [km]	pulse lenght [us]	PRF [1/s]	duty cycle [%]	scan time [s]	step time [s]	nyquist [m/s]	nyquist [km/h]	scan speed [deg/s]
1	1	0.5	18	240	3	333	0.1	19.4	0.57	4.8	17.1	18.5
1	2	0.9	18	240	3	333	0.1	19.4	0.57	4.8	17.1	18.5
1	3	1.3	18	240	3	333	0.1	19.4	0.63	4.8	17.1	18.5
1	4	1.8	18	240	3	333	0.1	19.4	0.63	4.8	17.1	18.5
1	5	2.3	18	240	3	333	0.1	19.4	0.8	4.8	17.1	18.5
1	6	3.1	18	240	3	333	0.1	19.4	0.85	4.8	17.1	18.5
1	7	4	18	240	3	333	0.1	19.4	0.94	4.8	17.1	18.5
1	8	5.1	18	240	3	333	0.1	19.4	1.02	4.8	17.1	18.5
1	9	6.4	18	240	3	333	0.1	19.4	1.13	4.8	17.1	18.5
1	10	8	18	240	3	333	0.1	19.4	1.26	4.8	17.1	18.5
1	11	10	18	240	3	333	0.1	19.4	1.41	4.8	17.1	18.5
1	12	12.5	18	240	3	333	0.1	19.4	1.57	4.8	17.1	18.5
1	13	15.6	18	240	3	333	0.1	19.4	1.88	4.8	17.1	18.5
1	14	20	18	240	3	333	0.1	19.4	2.83	4.8	17.1	18.5
1	15	30	18	240	3	333	0.1	19.4	4.86	4.8	17.1	18.5
2	1	0.5	54	148	1	1000	0.1	19.4	0.89	14.3	51.3	18.5
2	2	1.5	54	148	1	1000	0.1	19.4	1.06	14.3	51.3	18.5
2	3	2.9	54	148	1	1000	0.1	19.4	1.13	14.3	51.3	18.5
2	4	4.5	54	148	1	1000	0.1	19.4	1.33	14.3	51.3	18.5
2	5	6.7	54	148	1	1000	0.1	19.4	1.62	14.3	51.3	18.5
2	6	10	54	148	1	1000	0.1	19.4	2.37	14.3	51.3	18.5
2	7	17	54	148	1	1000	0.1	19.4	7.64	14.3	51.3	18.5
3	1	90	64	36	1	1000	0.1	23	8.46	14.3	51.3	15.6

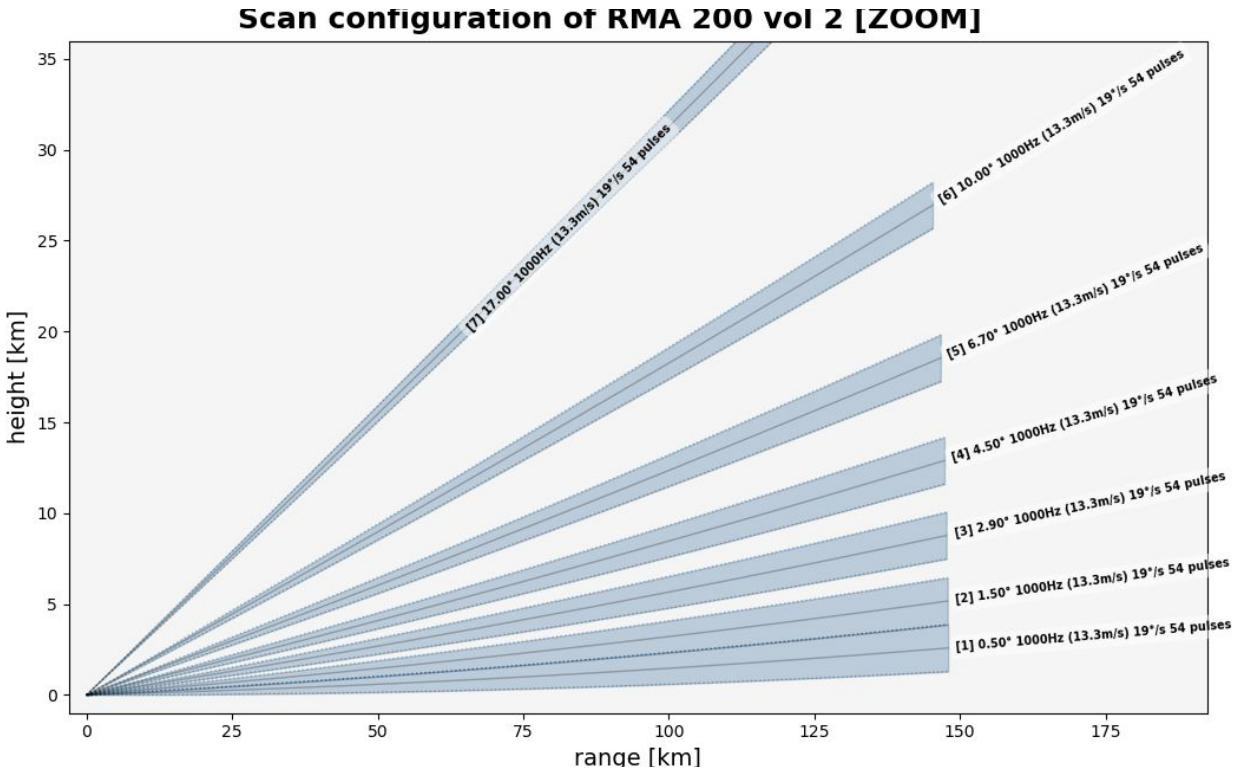

Scan sequence of RMA 200
Elevation [deg]
Time [min]


Scan sequence of RMA 200 [ZOOM]
Elevation [deg]
Time [min]


Scan sequence of RMA 200 vol 1,2 [ZOOM]
Elevation [deg]
Time [min]


Scan configuration of RMA 200 [ZOOM]
height [km]
range [km]
[23] 90.00° 1000Hz (13.3m/s) 16°/s 64 pulses
[15] 30.00° 333Hz (4.4m/s) 19°/s 18 pulses
[14] 20.00° 333Hz (4.4m/s) 19°/s 18 pulses
[22] 17.00° 1000Hz (13.3m/s) 19°/s 54 pulses
[13] 15.60° 333Hz (4.4m/s) 19°/s 18 pulses
[12] 12.50° 333Hz (4.4m/s) 19°/s 18 pulses
[11] 10.00° 333Hz (4.4m/s) 19°/s 18 pulses
[21] 10.00° 1000Hz (13.3m/s) 19°/s 54 pulses
[10] 8.00° 333Hz (4.4m/s) 19°/s 18 pulses
[20] 6.70° 1000Hz (13.3m/s) 19°/s 54 pulses
[19] 4.50° 1000Hz (13.3m/s) 19°/s 54 pulses
[18] 2.90° 1000Hz (13.3m/s) 19°/s 54 pulses
[17] 1.50° 1000Hz (13.3m/s) 19°/s 54 pulses
[16] 0.50° 1000Hz (13.3m/s) 19°/s 54 pulses
[9] 6.40° 333Hz (4.4m/s) 19°/s 18 pulses
[8] 5.10° 333Hz (4.4m/s) 19°/s 18 pulses
[7] 4.00° 333Hz (4.4m/s) 19°/s 18 pulses
[6] 3.10° 333Hz (4.4m/s) 19°/s 18 pulses
[5] 2.30° 333Hz (4.4m/s) 19°/s 18 pulses
[4] 1.80° 333Hz (4.4m/s) 19°/s 18 pulses
[3] 1.30° 333Hz (4.4m/s) 19°/s 18 pulses
[2] 0.90° 333Hz (4.4m/s) 19°/s 18 pulses
[1] 0.50° 333Hz (4.4m/s) 19°/s 18 pulses


Scan configuration of RMA 200 vol 1 [ZOOM]
height [km]
range [km]
[15] 30.00° 333Hz (4.4m/s) 19°/s 18 pulses
[14] 20.00° 333Hz (4.4m/s) 19°/s 18 pulses
[13] 15.60° 333Hz (4.4m/s) 19°/s 18 pulses
[12] 12.50° 333Hz (4.4m/s) 19°/s 18 pulses
[11] 10.00° 333Hz (4.4m/s) 19°/s 18 pulses
[10] 8.00° 333Hz (4.4m/s) 19°/s 18 pulses
[9] 6.40° 333Hz (4.4m/s) 19°/s 18 pulses
[8] 5.10° 333Hz (4.4m/s) 19°/s 18 pulses
[7] 4.00° 333Hz (4.4m/s) 19°/s 18 pulses
[6] 3.10° 333Hz (4.4m/s) 19°/s 18 pulses
[5] 2.30° 333Hz (4.4m/s) 19°/s 18 pulses
[4] 1.80° 333Hz (4.4m/s) 19°/s 18 pulses
[3] 1.30° 333Hz (4.4m/s) 19°/s 18 pulses
[2] 0.90° 333Hz (4.4m/s) 19°/s 18 pulses
[1] 0.50° 333Hz (4.4m/s) 19°/s 18 pulses



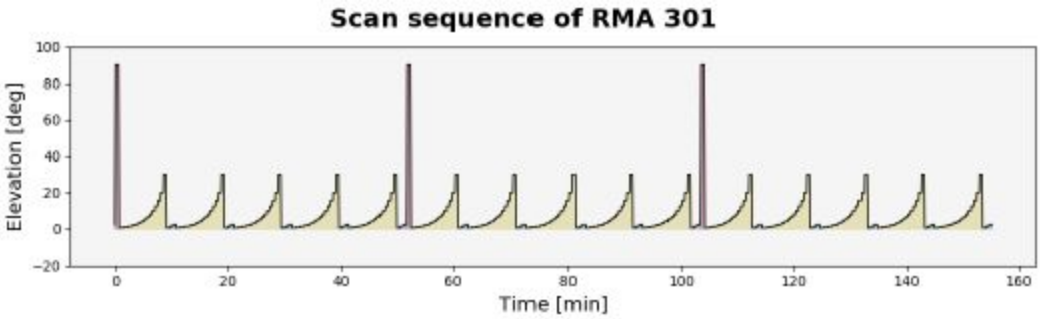
SCANNING STRATEGY 301

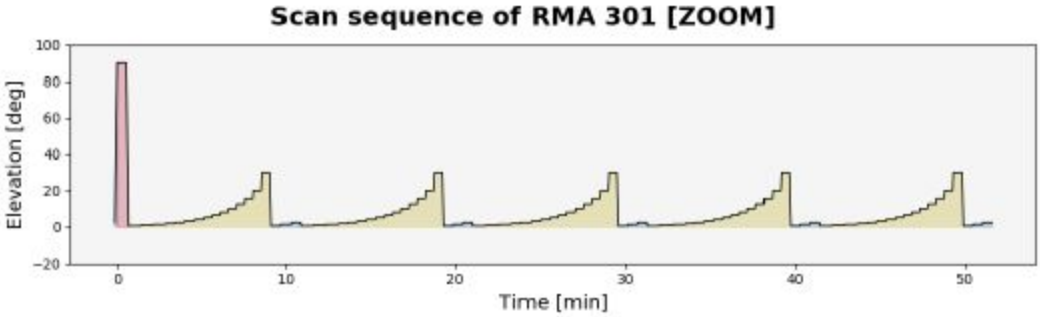
RMA1 RELAMPAGO scan configuration

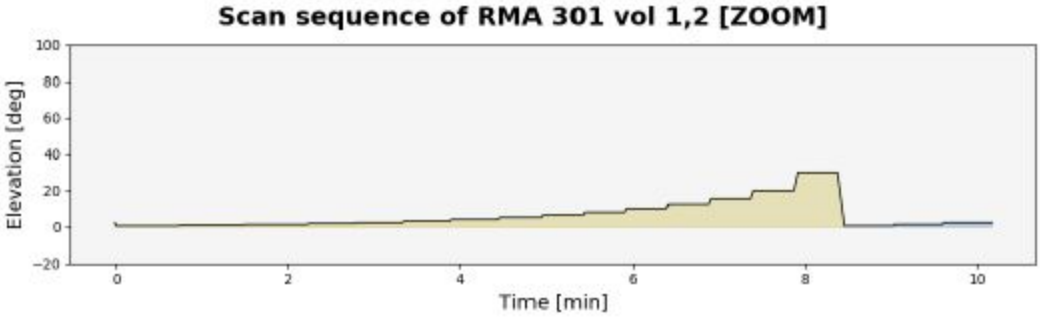
INVAP

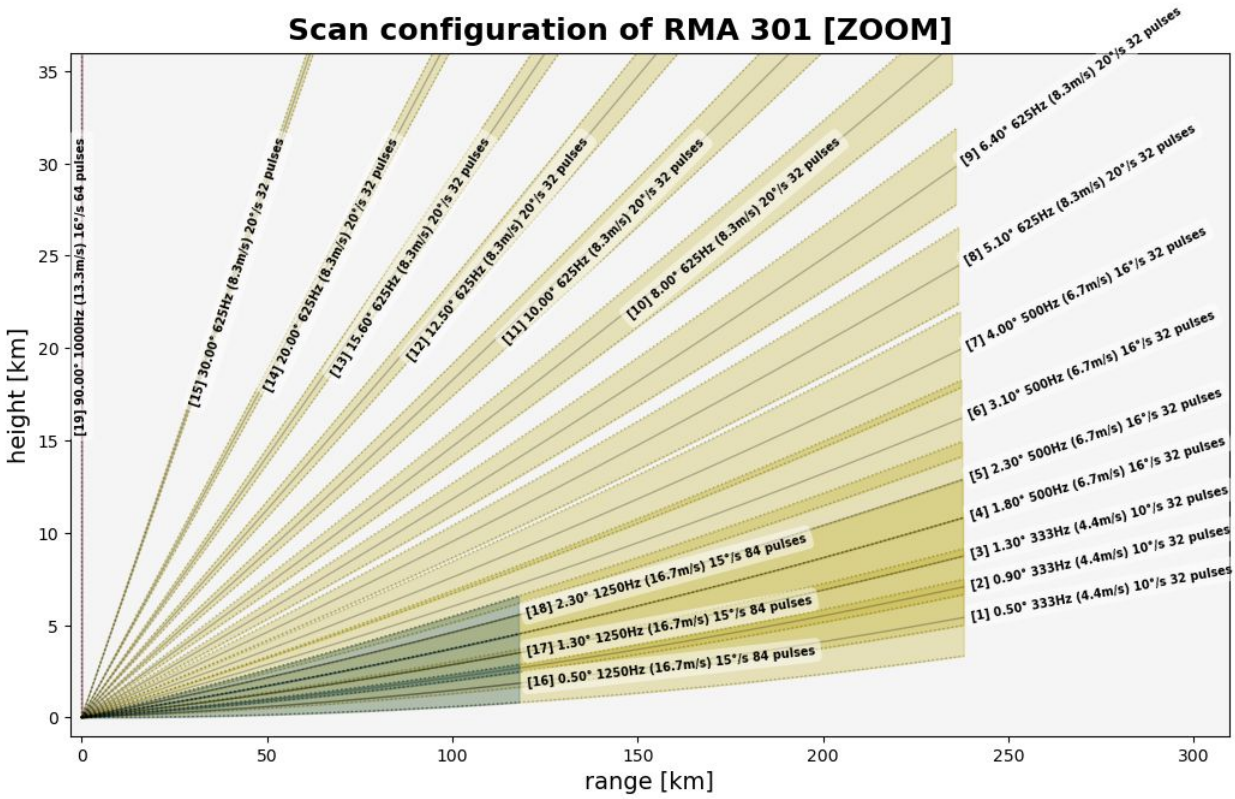
Scanning strategy (id 301)

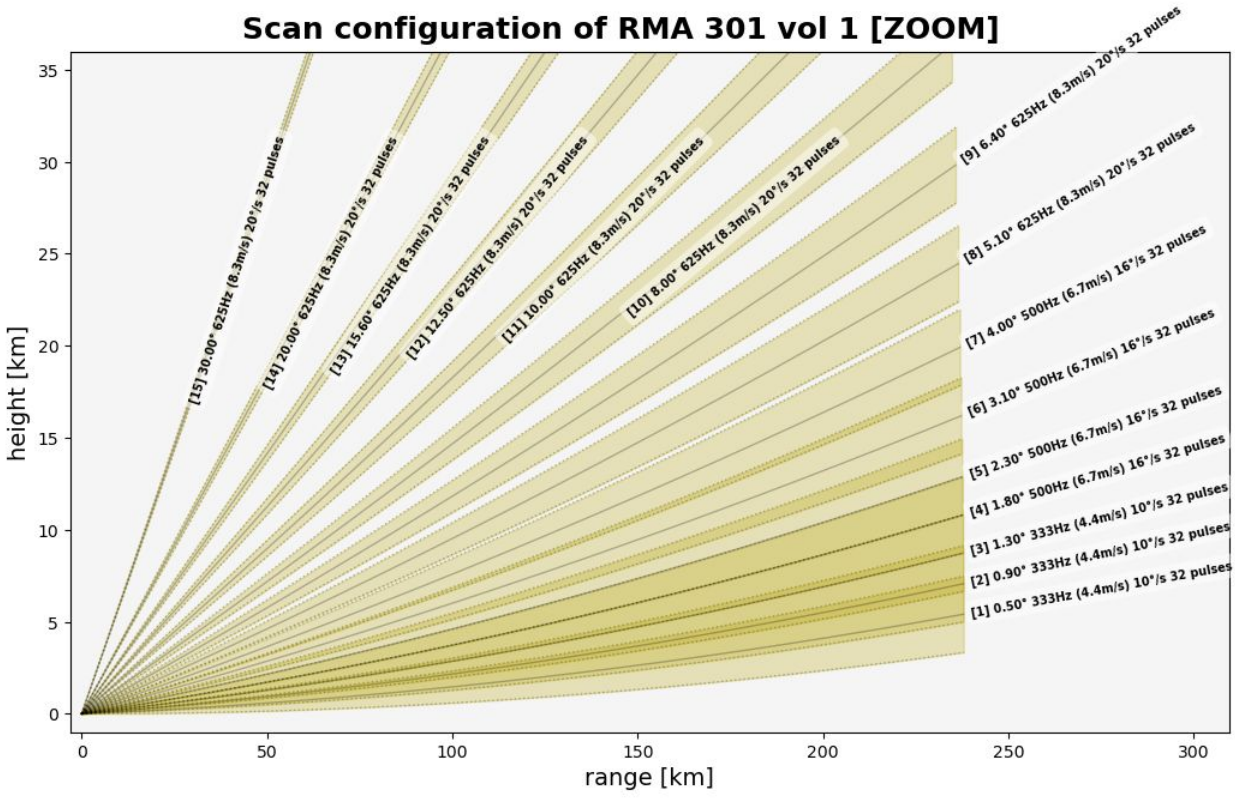
vol id	scan id	elevation [deg]	pulses per beam (1 deg)	range [km]	pulse lenght [us]	PRF [1/s]	duty cycle [%]	scan time [s]	step time [s]	nyquist [m/s]	nyquist [km/h]	scan speed [deg/s]
1	1	0.5	32	238	3.0	333	0.1	34.6	0.57	4.8	17.1	10.4
1	2	0.9	32	238	3.0	333	0.1	34.6	0.57	4.8	17.1	10.4
1	3	1.3	32	238	3.0	333	0.1	34.6	0.63	4.8	17.1	10.4
1	4	1.8	32	238	2.0	500	0.1	23.0	0.63	7.1	25.7	15.6
1	5	2.3	32	238	2.0	500	0.1	23.0	0.80	7.1	25.7	15.6
1	6	3.1	32	238	2.0	500	0.1	23.0	0.85	7.1	25.7	15.6
1	7	4.0	32	238	2.0	500	0.1	23.0	0.94	7.1	25.7	15.6
1	8	5.1	32	238	1.6	625	0.1	18.4	1.02	8.9	32.1	19.5
1	9	6.4	32	238	1.6	625	0.1	18.4	1.13	8.9	32.1	19.5
1	10	8.0	32	238	1.6	625	0.1	18.4	1.26	8.9	32.1	19.5
1	11	10.0	32	238	1.6	625	0.1	18.4	1.41	8.9	32.1	19.5
1	12	12.5	32	238	1.6	625	0.1	18.4	1.57	8.9	32.1	19.5
1	13	15.6	32	238	1.6	625	0.1	18.4	1.88	8.9	32.1	19.5
1	14	20.0	32	238	1.6	625	0.1	18.4	2.83	8.9	32.1	19.5
1	15	30.0	32	238	1.6	625	0.1	18.4	4.86	8.9	32.1	19.5
2	1	0.5	84	118	0.8	1250	0.1	24.2	0.80	17.8	64.1	14.9
2	2	1.3	84	118	0.8	1250	0.1	24.2	0.89	17.8	64.1	14.9
2	3	2.3	84	118	0.8	1250	0.1	24.2	8.38	17.8	64.1	14.9
3	1	90.0	64	36	1.0	1000	0.1	23.0	8.46	14.3	51.3	15.6

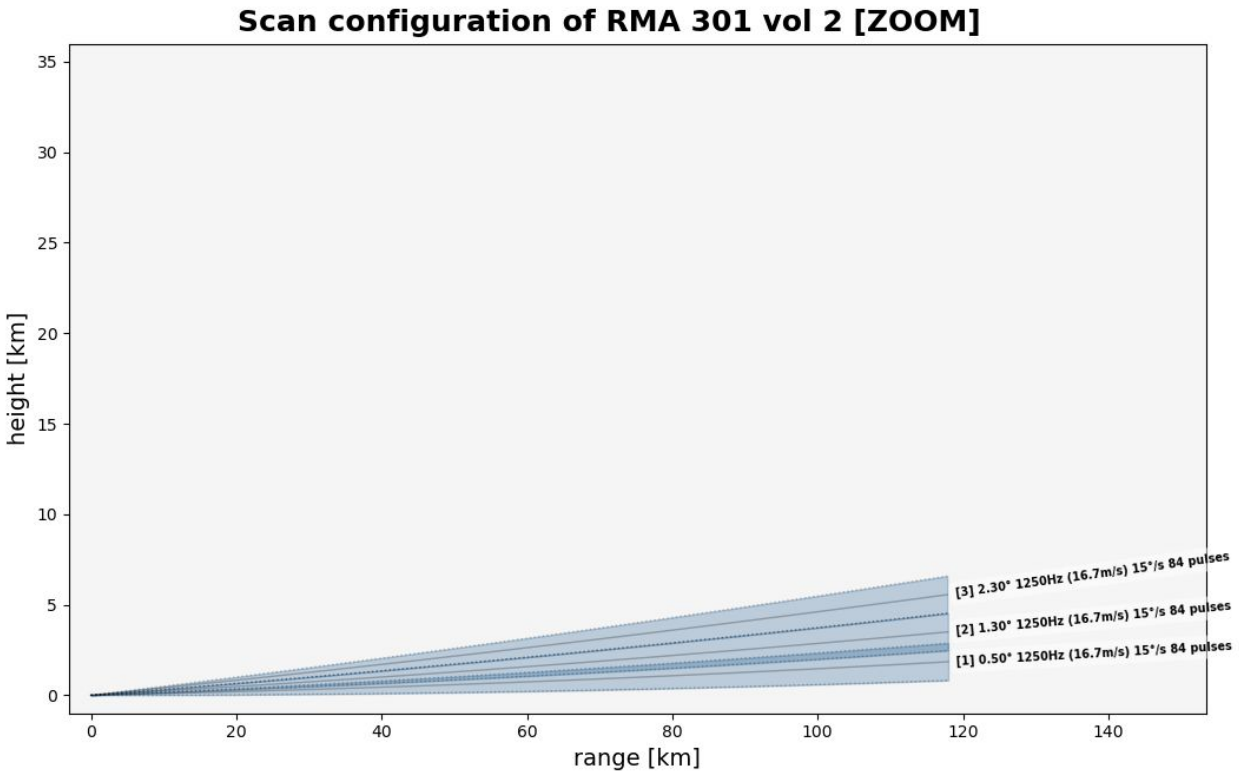

Scan sequence of RMA 301
Elevation [deg]
Time [min]


Scan sequence of RMA 301 [ZOOM]
Elevation [deg]
Time [min]


Scan sequence of RMA 301 vol 1,2 [ZOOM]
Elevation [deg]
Time [min]


Scan configuration of RMA 301 [ZOOM]
height [km]
range [km]
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
[19] 90.00° 1000Hz (13.3m/s) 16°/s 64 pulses
[15] 30.00° 625Hz (8.3m/s) 20°/s 32 pulses
[14] 20.00° 625Hz (8.3m/s) 20°/s 32 pulses
[13] 15.60° 625Hz (8.3m/s) 20°/s 32 pulses
[12] 12.50° 625Hz (8.3m/s) 20°/s 32 pulses
[11] 10.00° 625Hz (8.3m/s) 20°/s 32 pulses
[10] 8.00° 625Hz (8.3m/s) 20°/s 32 pulses
[9] 6.40° 625Hz (8.3m/s) 20°/s 32 pulses
[8] 5.10° 625Hz (8.3m/s) 20°/s 32 pulses
[7] 4.00° 500Hz (6.7m/s) 16°/s 32 pulses
[6] 3.10° 500Hz (6.7m/s) 16°/s 32 pulses
[5] 2.30° 500Hz (6.7m/s) 16°/s 32 pulses
[4] 1.80° 500Hz (6.7m/s) 16°/s 32 pulses
[3] 1.30° 333Hz (4.4m/s) 10°/s 32 pulses
[2] 0.90° 333Hz (4.4m/s) 10°/s 32 pulses
[1] 0.50° 333Hz (4.4m/s) 10°/s 32 pulses
[18] 2.30° 1250Hz (16.7m/s) 15°/s 84 pulses
[17] 1.30° 1250Hz (16.7m/s) 15°/s 84 pulses
[16] 0.50° 1250Hz (16.7m/s) 15°/s 84 pulses


Scan configuration of RMA 301 vol 1 [ZOOM]
height [km]
range [km]
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
[15] 30.00° 625Hz (8.3m/s) 20°/s 32 pulses
[14] 20.00° 625Hz (8.3m/s) 20°/s 32 pulses
[13] 15.60° 625Hz (8.3m/s) 20°/s 32 pulses
[12] 12.50° 625Hz (8.3m/s) 20°/s 32 pulses
[11] 10.00° 625Hz (8.3m/s) 20°/s 32 pulses
[10] 8.00° 625Hz (8.3m/s) 20°/s 32 pulses
[9] 6.40° 625Hz (8.3m/s) 20°/s 32 pulses
[8] 5.10° 625Hz (8.3m/s) 20°/s 32 pulses
[7] 4.00° 500Hz (6.7m/s) 16°/s 32 pulses
[6] 3.10° 500Hz (6.7m/s) 16°/s 32 pulses
[5] 2.30° 500Hz (6.7m/s) 16°/s 32 pulses
[4] 1.80° 500Hz (6.7m/s) 16°/s 32 pulses
[3] 1.30° 333Hz (4.4m/s) 10°/s 32 pulses
[2] 0.90° 333Hz (4.4m/s) 10°/s 32 pulses
[1] 0.50° 333Hz (4.4m/s) 10°/s 32 pulses



Calibration: Data is provided with the calibration and filtering applied by the data provider. Data includes ground clutter filter and noise and atmospheric attenuation compensation. Low SNR cells had been masked out for some products. Please refer to the following table.

Radar was calibrated before the RELAMPAGO Intensive Observational Period by INVAP SE. Antenna pointing, differential reflectivity and absolute reflectivity calibration were performed.

Antenna pointing calibration:

The offset correction for pointing bias applied before RELAMPAGO was computed over data recorded from August 3 to September 11, 2018.

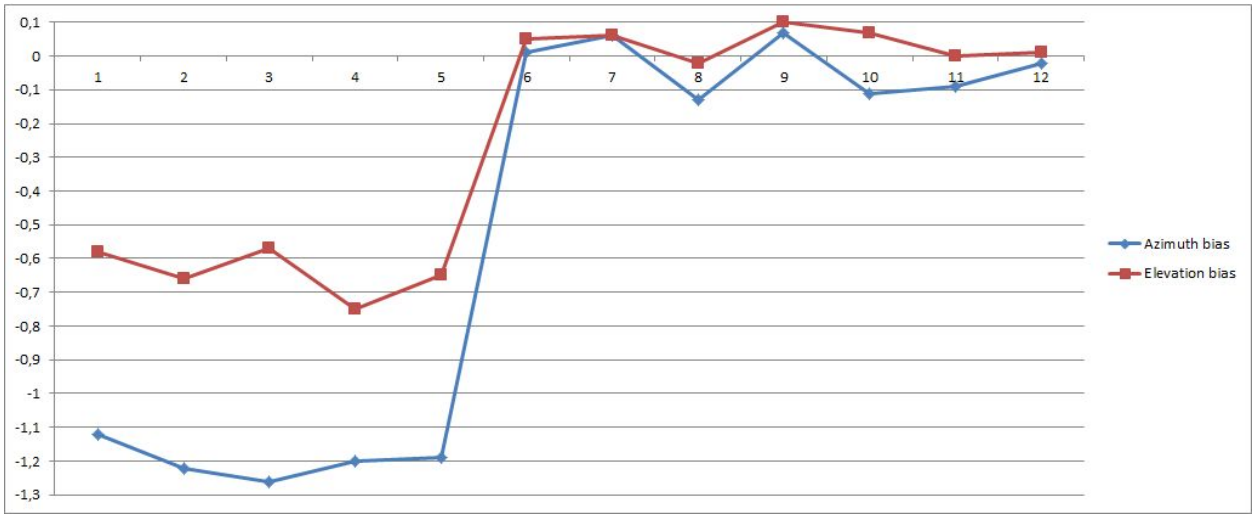
Antenna pointing Correction considering the sun: Date and time: Sep-11, 2018 18:47:02 UTC, Azimuth Bias: -1.19°, Elevation Bias: -0.65°.

Residual Antenna pointing Correction: Date and time: Sep-11, 2018 21:07:41 UTC, Azimut Bias: 0.01°, Elevation Bias: 0.05°.

After calibration more data was recorded. The following table includes the complete dataset.

Date UTC	Azimut Bias	Elevation Bias
2017-11-15 19:40	-1.12	-0.58
2018-08-03 20:58	-1.22	-0.66
2018-08-04 13:38	-1.26	-0.57

2018-08-04	18:39	-1.20	-0.75
2018-09-11	19:10	-1.19	-0.65
2018-09-11	21:07	0.01	0.05
2018-10-02	18:59	0.06	0.06
2018-10-03	14:56	-0.13	-0.02
2018-10-03	17:51	0.07	0.10
2019-04-17	15:09	-0.11	0.07
2019-04-17	15:34	-0.09	0.00
2019-05-29	18:07	-0.02	0.01



Differential reflectivity calibration by vertical pointing

The offset correction for ZDR bias applied before RELAMPAGO was computed over data recorded from September 13 to October 3, 2018.

ZDR correction: Date and time: October 3, 2018; ZDR Bias [dB]: 0.99113; Bias deviation ZDR [dB]: -16.3; Accuracy of bias estimation ZDR [dB]: 0.008

Residual ZDR verification: Date and time: October 18, 2018; ZDR Bias [dB]: 0.06; Bias deviation ZDR [dB] -17.8; Accuracy of bias estimation ZDR [dB]: 0.01

After calibration more data was recorded. The following table includes the complete dataset.

Date UTC	ZDR bias [dB]
2018-09-13 00:03:50	0.99360
2018-09-13 00:15:53	1.00080

2018-09-13 00:28:00	1.00670
2018-09-13 00:40:08	1.01150
2018-09-13 00:52:16	1.00740
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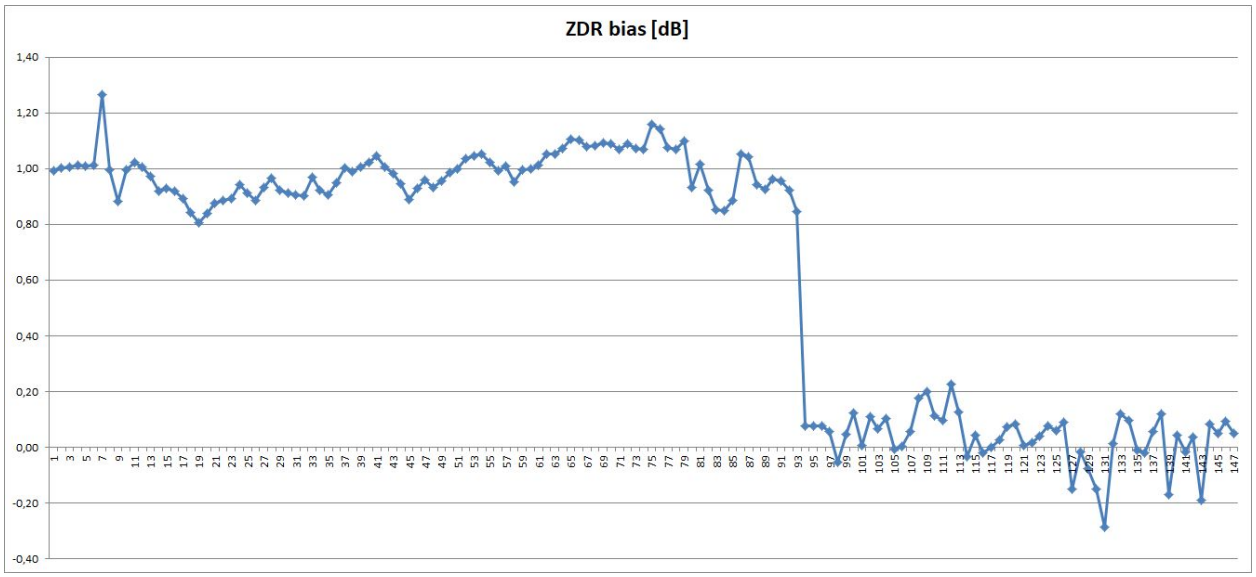

Absolute Reflectivity Calibration

Date and time: 2018-10-02

Reflectivity Bias [dBZ]: 2

Time covered: From October 6th. 2018 to April 1st 2019.

APPENDIX.

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END USER LICENSE AGREEMENT

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I accept and agree to these terms. Further, I represent and warrant that I have full right, power and authority to enter into this Agreement and to execute this Agreement for and on behalf of myself and my employer.