

Assessment of performance of automatic procedure for a review of recent seismicity in Western Alps compiling an homogeneous and reliable catalog

Bosco F. (1), Spallarossa D. (2), Deschamps A. (3)

1. Arpa Piemonte, Turin, Italy
2. University of Genoa, Genoa, Italy
3. CNRS, Sophia Antipolis, France

Western Alps:

- mountain, hill, land

- moderate seismicity with high frequency with seldom greater events (5.7 Mw)

- high anthropic area

- cross-border area: seismic national and regional monitoring network on Italian and French sides:

Interreg ALCOTRA RISVAL project

- Cooperation in risk management

- Data exchange

- Comparison of data analysis

Growth of network, technological development

Great amount of data available

New analysis methods

Heterogeneities in space and time of quasi real-time data catalogs

New Automatic Catalog

- re-compiled 2012-2019 subset of RSNi network manual catalog operating routines, including travel-time and strong-motion parameters dataset.

Evaluation of performance of new automatic catalog compared with other available catalogs:

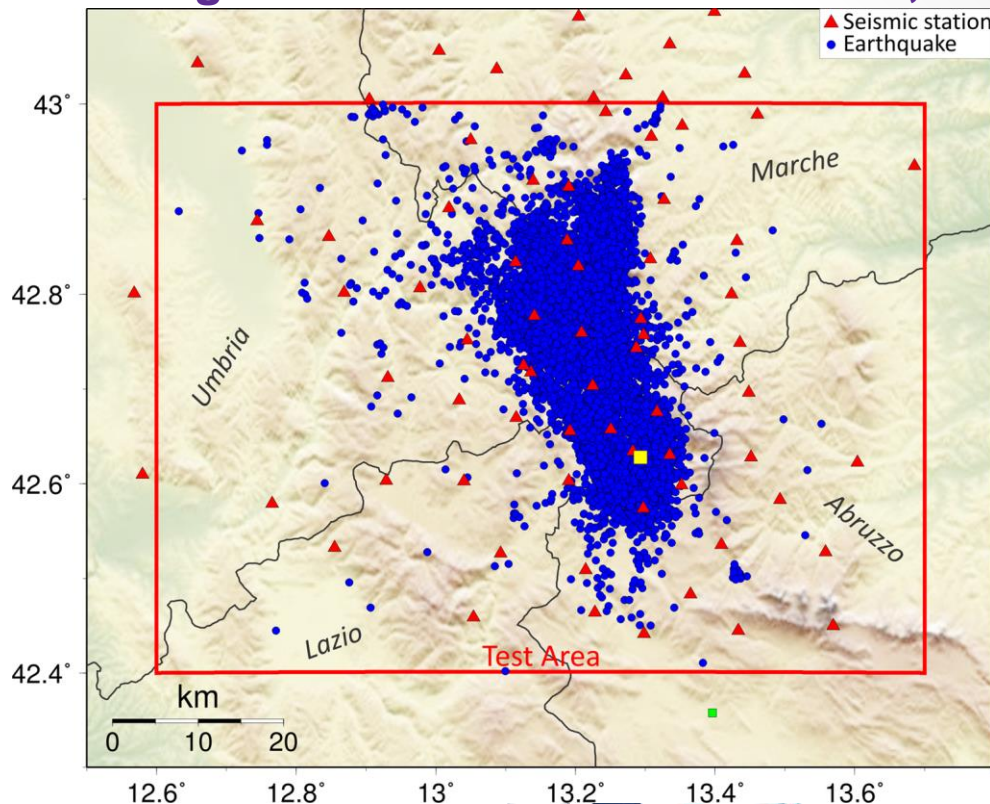
- RSNi manual (original one for NAC)

- INGV

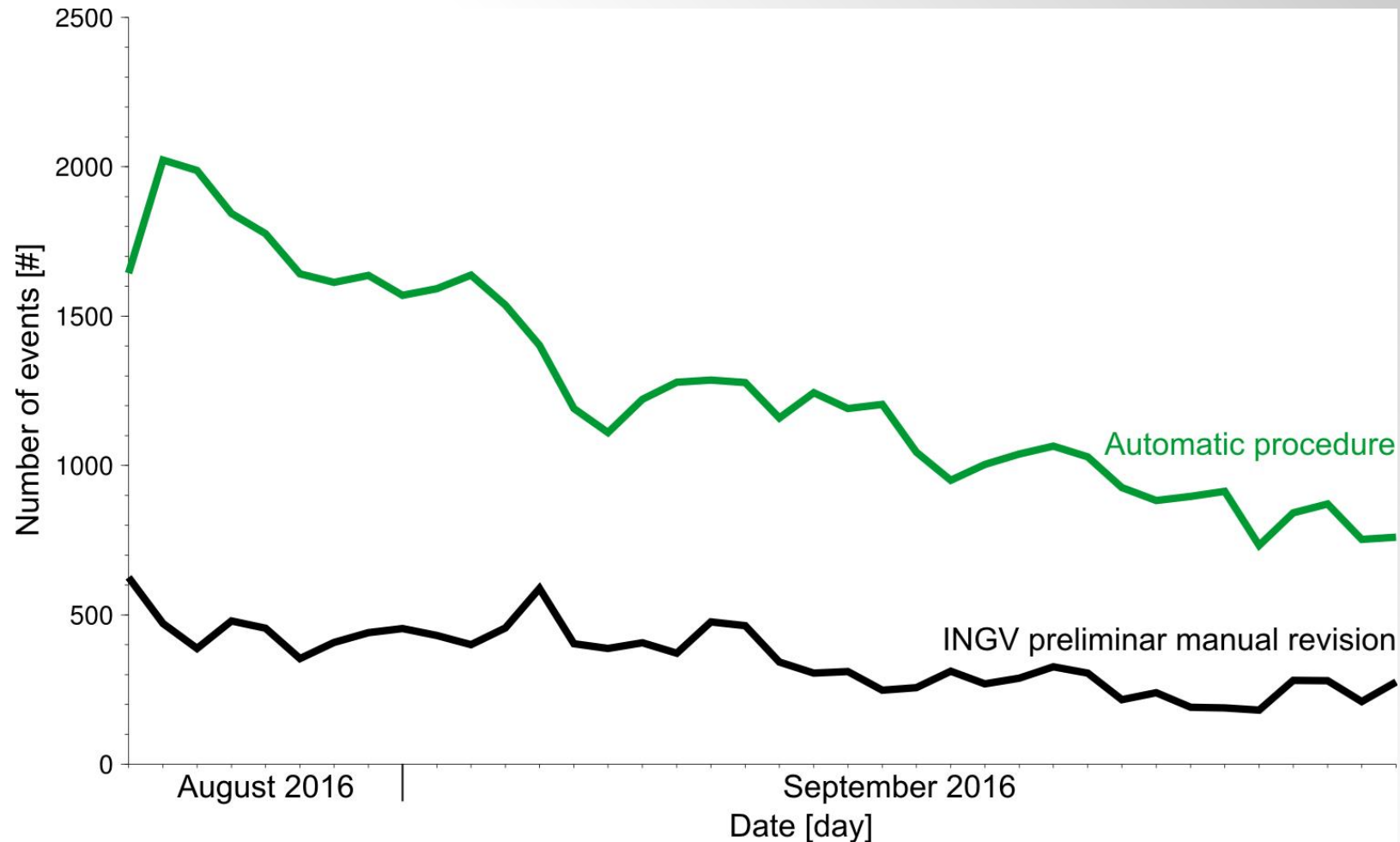
- GeoAzur

Development and implementation of procedures for the production of an automatic catalogue starting from the continuous waveform data available in the webservices (EIDA etc etc) or from stored waveform data used for catalogues.

Example: Central Italy - Scafidi et., al 2019. “A Complete Automatic Procedure to Compile Reliable Seismic Catalogs and Travel-Time and Strong-Motion Parameters Datasets”, SRL (2019) 90 (3): 1308-1317.



Example: Central Italy



RSNI network manual review routines catalog

since 1982, development:

New stations installed along years

1 SP → 3 components BB

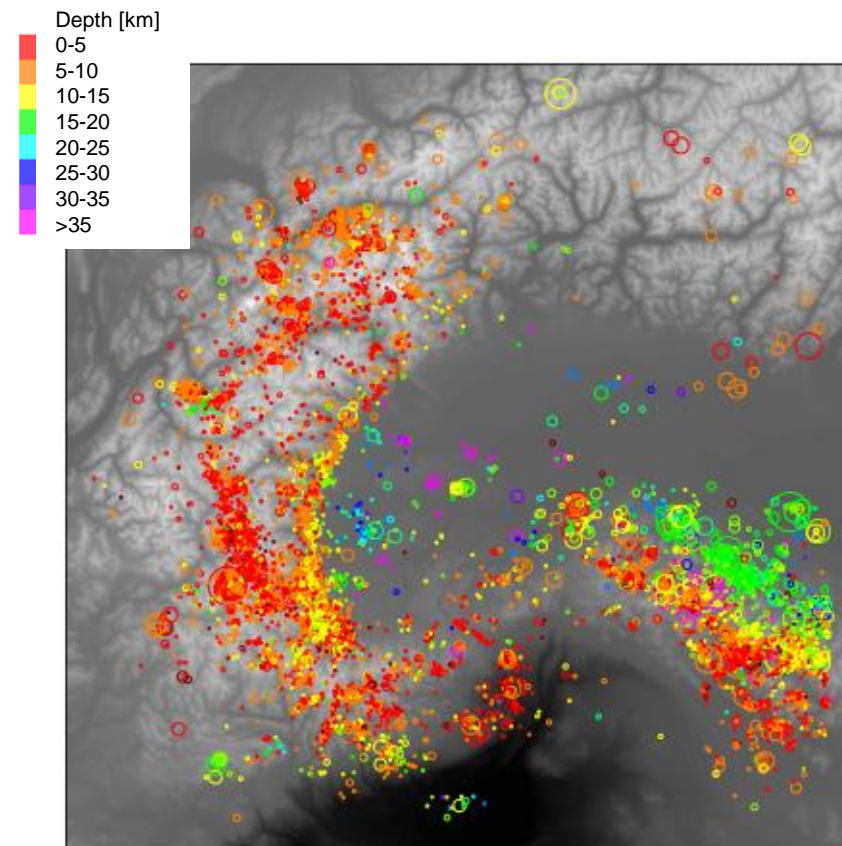
Location algorithm (Hypo 1D → NLLOC 3D)

Magnitude laws

2012-2019

13'996 events

	lon	lat	Mag(Ml)	Depth (km)
Min	5.68283	42.11870	-0.7146	-3.977
1st Qu.			0.6360	4.580
Median			0.9894	7.060
Mean			1.1221	9.268
3rd Qu.			1.4828	12.010
Max	12.4440	46.9884	5.9199	102.070



RSNI network manual review routines catalog

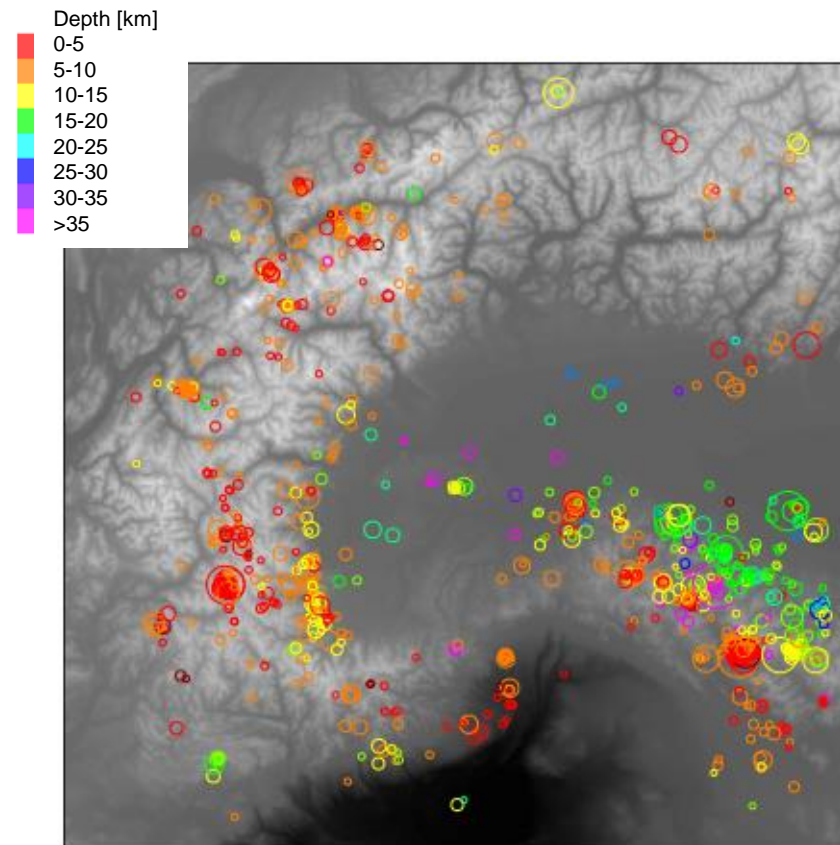
2012-2019

Magnitude ≥ 2

1548 events

21391 waveform traces

	lon	Lat	Mag(Ml)	Depth (km)
Min	6	42	1.951	-3.977
1st Qu.			2.102	5.498
Median			2.334	8.190
Mean			2.507	11.588
3rd Qu.			2.743	14.143
Max	12	47	5.920	102.070



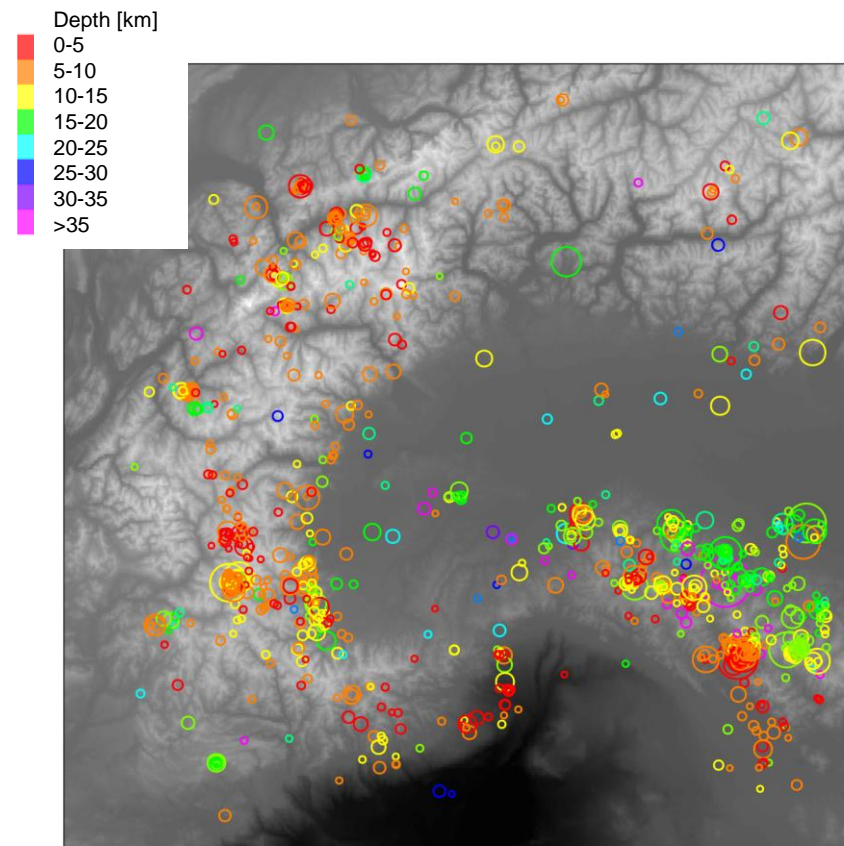
RSNI network recompiled automatic catalog

2012-2019

1548 events

21391 waveform traces

	lon	Lat	Mag(Ml)	Depth (km)
Min	5.820	42.28	1.950	1.02
1st Qu.			2.090	6.04
Median			2.300	11.04
Mean			2.452	13.68
3rd Qu.			2.650	17.94
Max	11.902	46.98	5.700	76.17



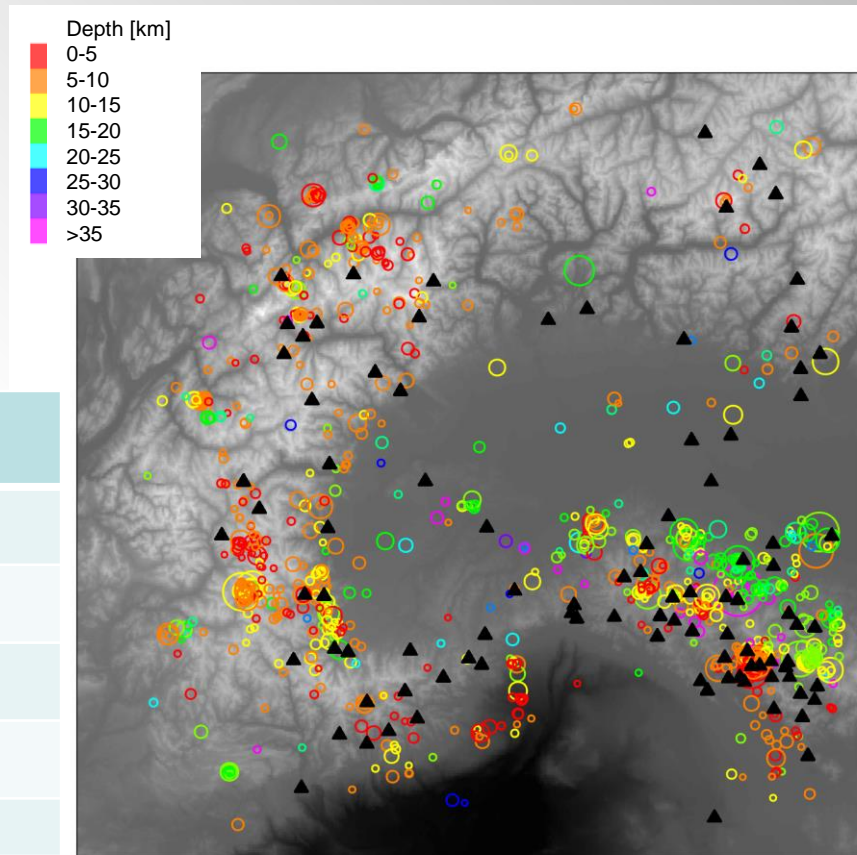
RSNI network recompiled automatic catalog

2012-2019

1548 events

21391 waveform traces

	lon	Lat	Mag(Ml)	Depth (km)
Min	5.820	42.28	1.950	1.02
1st Qu.			2.090	6.04
Median			2.300	11.04
Mean			2.452	13.68
3rd Qu.			2.650	17.94
Max	11.902	46.98	5.700	76.17



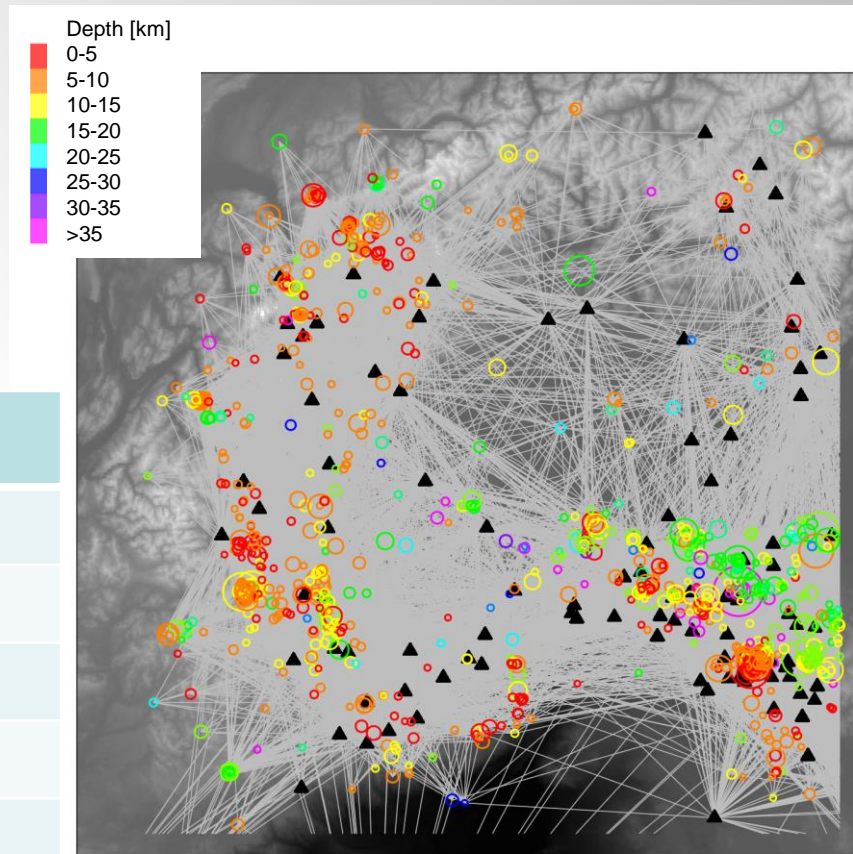
RSNI network recompiled automatic catalog

2012-2019

1548 events

21391 waveform traces

	lon	Lat	Mag(Ml)	Depth (km)
Min	5.820	42.28	1.950	1.02
1st Qu.			2.090	6.04
Median			2.300	11.04
Mean			2.452	13.68
3rd Qu.			2.650	17.94
Max	11.902	46.98	5.700	76.17



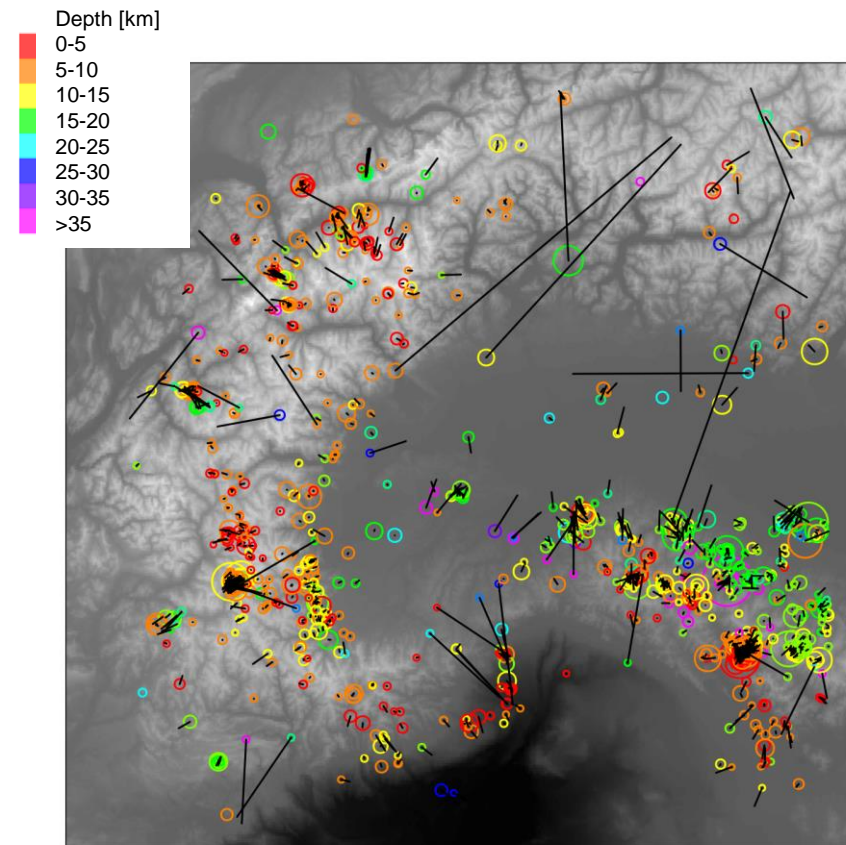
RSNI network recompiled automatic catalog

2012-2019

1548 events

21391 waveform traces

	lon	Lat	Mag(Ml)	Depth (km)
Min	5.820	42.28	1.950	1.02
1st Qu.			2.090	6.04
Median			2.300	11.04
Mean			2.452	13.68
3rd Qu.			2.650	17.94
Max	11.902	46.98	5.700	76.17



RSNI network recompiled automatic catalog

2012-2019

1548 events

21391 waveform traces

Outlier in max values, affecting mean values in Covs
Erh+Erz+Rms vs Cov(X,Y,Z,T)

3rd quantile values

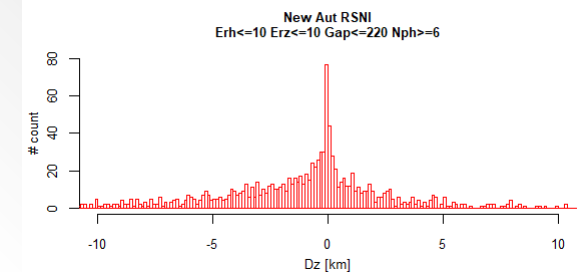
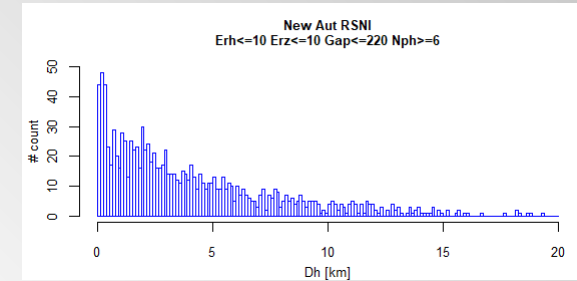
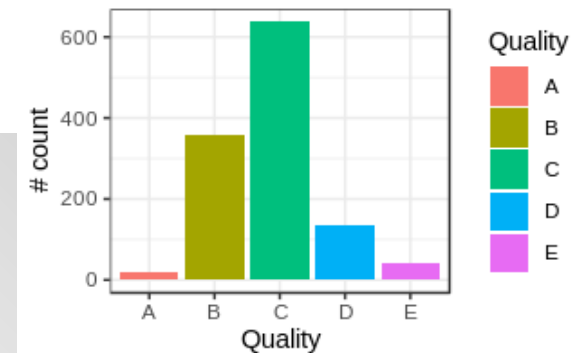
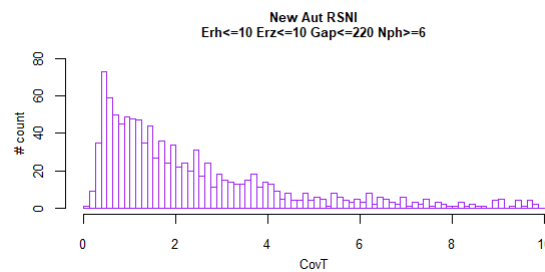
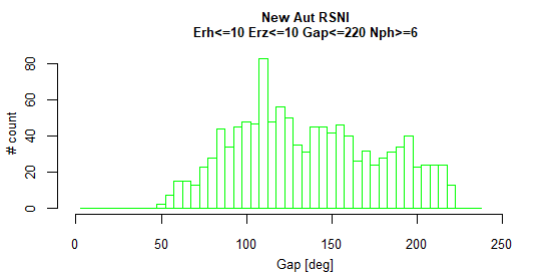
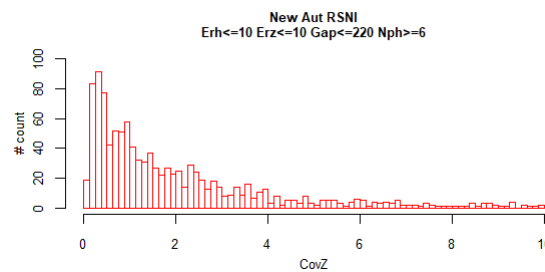
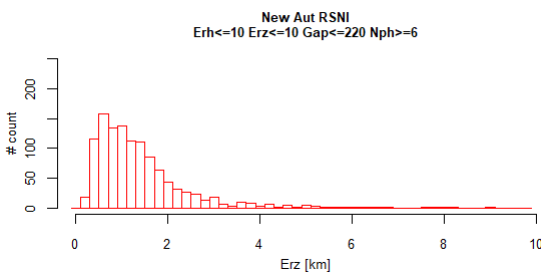
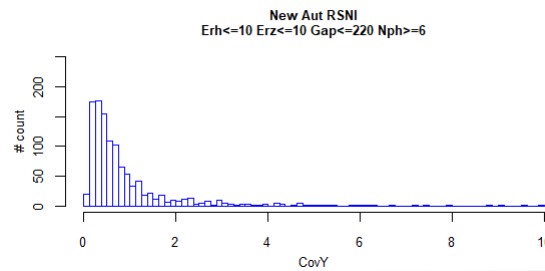
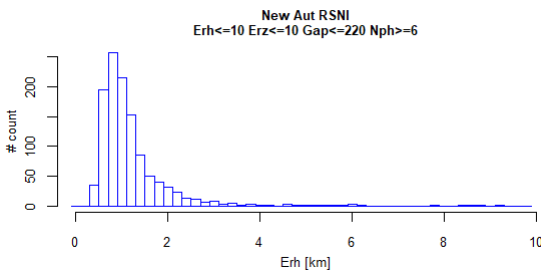
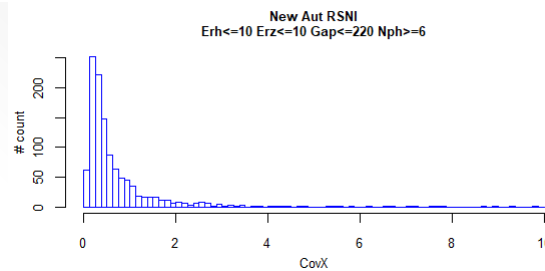
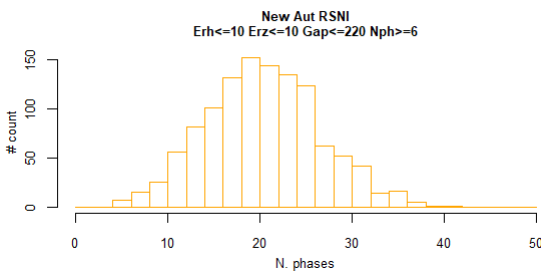
Bigger uncertainties in Z as usual

	Erh	Erz	Rms	Gap	CovX	CovY	CovZ	CovT	Dh	Dz (m-a)
Min	0.400	0.200	0.0000	49.0	0.05	0.060	0.040	0.120	0.010	-75.130
1st Qu.	0.900	0.900	0.1200	111.0	0.29	0.380	0.790	1.140	1.558	-4.0100
Median	1.200	1.400	0.1700	154.5	0.57	0.745	2.065	2.645	3.960	-0.6550
Mean	3.399	2.522	0.1813	167.0	50.55	82.565	18.122	110.724	7.372	-2.0531
3rd Qu.	1.900	2.500	0.2300	215.0	1.51	2.022	6.345	7.675	8.377	0.7525
Max	185.000	27.600	0.7800	358.0	13738.5	24092.0	760.370	26251.77	195.820	54.910

RSNI network recompiled automatic catalog

$Erh \leq 10$ & $Erz \leq 10$ & $Gap \leq 220$ & $N.ph. \geq 6$ (Hypo reliability parameters)

1165 / 1548 events



RSNI network recompiled automatic catalog

$Erh \leq 10$ & $Erz \leq 10$ & $Gap \leq 220$ & $N.ph. \geq 6$ (Hypo reliability parameters)

1165 / 1548 events

	Erh	Erz	Rms	Gap	CovX	CovY	CovZ	CovT	Dh	Dz (m-a)
Min rel. 1										-40.210
Min compl.										-75.130
Mean rel. 1					1.184	1.40	3.341	4.23	4.732	-1.435
Mean compl.					50.55	82.565	18.122	110.724	7.372	-2.0531
Max rel. 1	9.300	9.10	0.7700	220.0	51.160	66.30	82.990	99.72	61.200	25.110
Max compl.	185.000	27.600	0.7800	358.0	13738.5	24092.0	760.370	26251.77	195.820	54.910

RSNI network recompiled automatic catalog

$Erh \leq 2$ & $Erz \leq 2$ & $Gap \leq 220$ & $N.ph. \geq 10$ (Hypo reliability parameters)

913 / 1548 events

	Erh	Erz	Rms	Gap	CovX	CovY	CovZ	CovT	Dh	Dz (m-a)
Min compl.										-75.130
Min rel. 1										-40.210
Min rel. 2										-27.960
Mean compl.					50.55	82.565	18.122	110.724	7.372	-2.0531
Mean rel. 1					1.184	1.40	3.341	4.23	4.732	-1.435
Mean rel. 2					0.4973	0.6159	1.322	1.662	3.866	-1.353
Max compl.	185.000	27.600	0.7800	358.0	13738.5	24092.0	760.370	26251.77	195.820	54.910
Max rel. 1	9.300	9.10	0.7700	220.0	51.160	66.30	82.990	99.72	61.200	25.110
Max rel. 2	2.000	2.000	0.770	220.0	3.1700	3.2600	4.170	5.230	54.390	25.110

RSNI network recompiled automatic catalog

$\text{CovX} \leq 10$ & $\text{CovY} \leq 10$ & $\text{CovZ} \leq 10$ & $\text{CovT} \leq 10$ & $\text{N.ph.} \geq 6$ (NLLOC covariance parameters)

1223 / 1548 events

Testing several criteria to define reliability of data

Identifying few outlier: possible manual data that maybe have to be more accurately reviewed in a big catalog

	Erh	Erz	Rms	Gap	CovX	CovY	CovZ	CovT	Dh	Dz (m-a)
Min compl.										-75.130
Min rel. 1										-40.210
Min rel. 2										-27.960
Min rel. 3										-33.220
Mean compl.					50.55	82.565	18.122	110.724	7.372	-2.0531
Mean rel. 1					1.184	1.40	3.341	4.23	4.732	-1.435
Mean rel. 2					0.4973	0.6159	1.322	1.662	3.866	-1.353
Mean rel. 3					0.7102	0.9033	2.135	2.635	4.671	-1.424
Max compl.	185.000	27.600	0.7800	358.0	13738.5	24092.0	760.370	26251.77	195.820	54.910
Max rel. 1	9.300	9.10	0.7700	220.0	51.160	66.30	82.990	99.72	61.200	25.110
Max rel. 2	2.000	2.000	0.770	220.0	3.1700	3.2600	4.170	5.230	54.390	25.110
Max rel. 3	3.500	3.100	0.7700	329.0	8.9800	9.0900	9.700	9.980	61.200	25.110

RSNI network recompiled automatic catalog

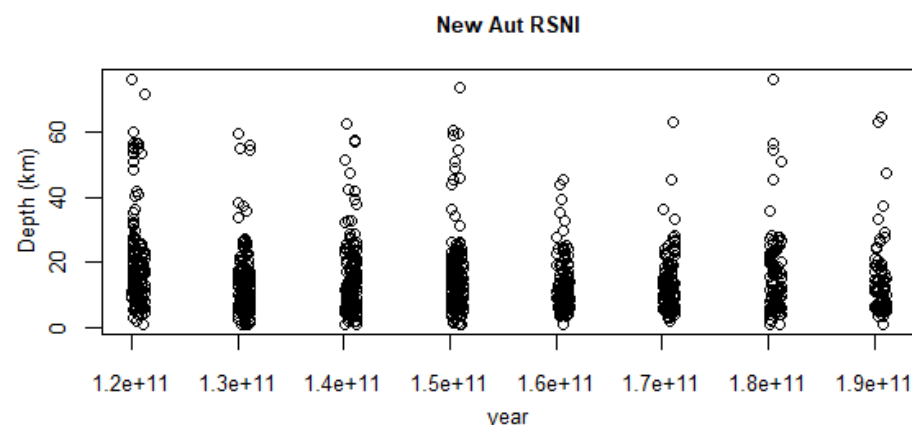
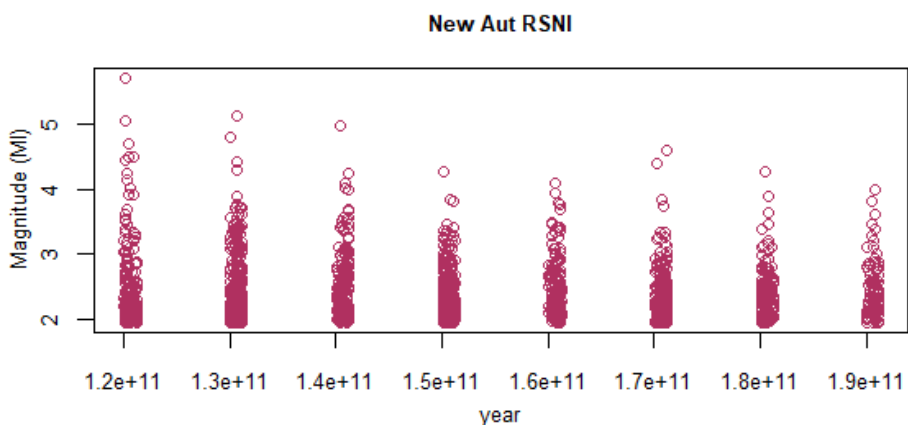
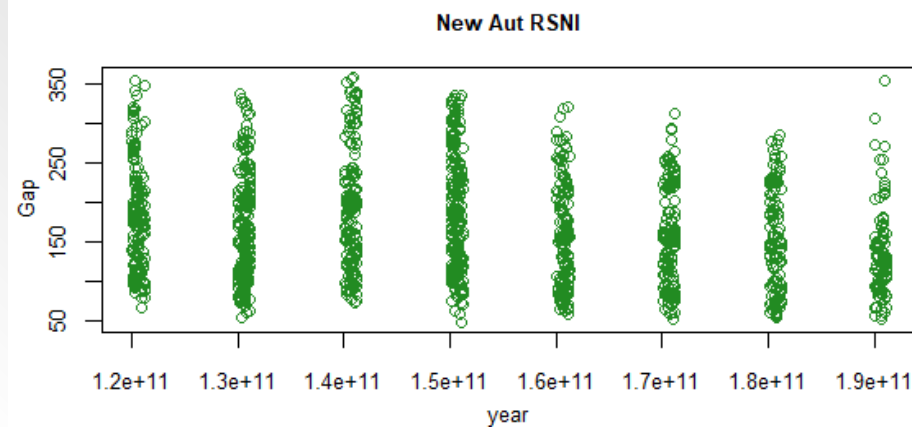
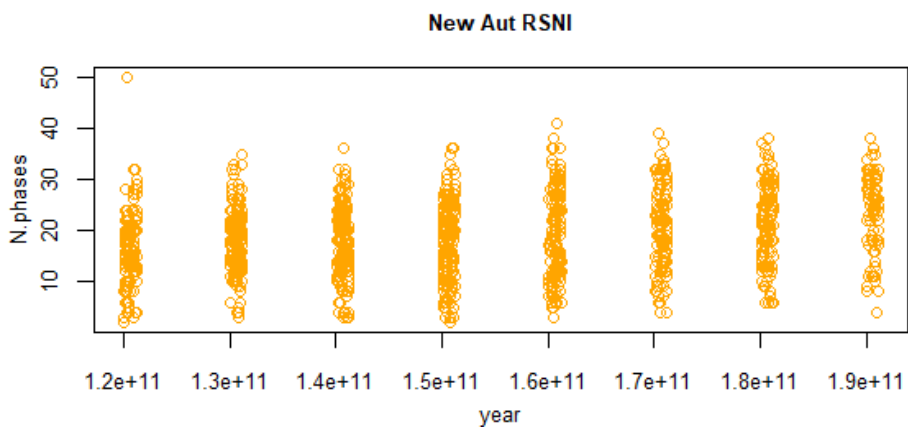
$\text{CovX} \leq 2$ & $\text{CovY} \leq 2$ & $\text{CovZ} \leq 2$ & $\text{CovT} \leq 2$ & $\text{N.ph.} \geq 10$ (NLLOC covariance parameters)

959 / 1548 events

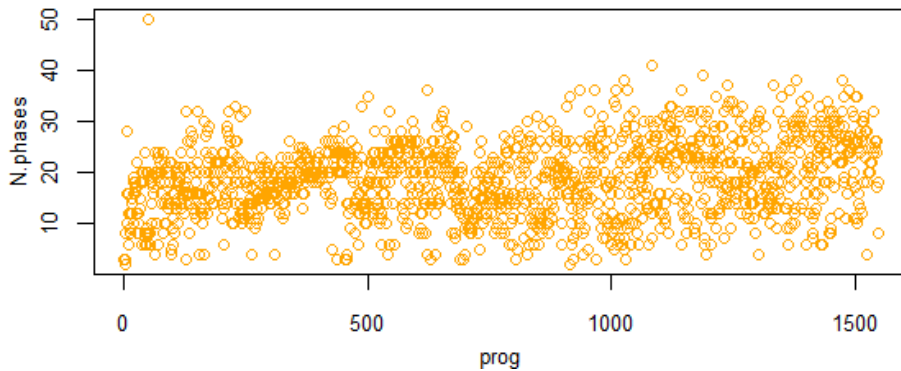
Testing several criteria to define reliability of data

Identifying few outlier: possible manual data that maybe have to be more accurately reviewed in a big catalog

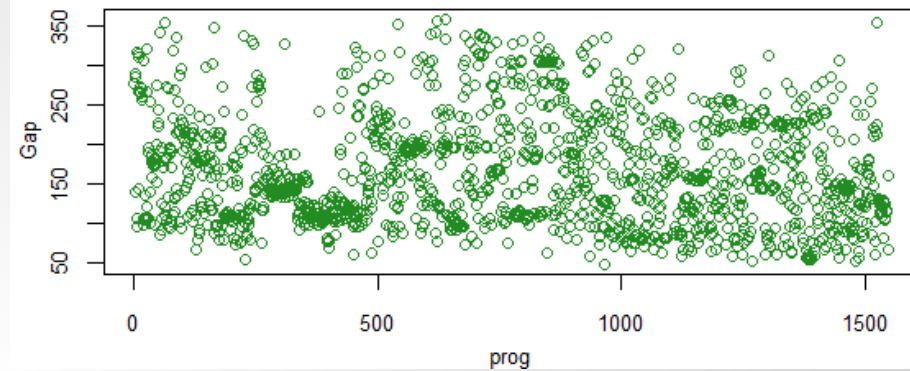
	Erh	Erz	Rms	Gap	CovX	CovY	CovZ	CovT	Dh	Dz (m-a)
Min compl.										-75.130
Min rel. 1										-40.210
Min rel. 2										-27.960
Min rel. 3										-33.220
Min rel. 4										-27.960
Mean compl.					50.55	82.565	18.122	110.724	7.372	-2.0531
Mean rel. 1					1.184	1.40	3.341	4.23	4.732	-1.435
Mean rel. 2					0.4973	0.6159	1.322	1.662	3.866	-1.353
Mean rel. 3					0.7102	0.9033	2.135	2.635	4.671	-1.424
Mean rel. 4					0.5156	0.6376	1.280	1.646	4.106	-1.394
Max compl.	185.000	27.600	0.7800	358.0	13738.5	24092.0	760.370	26251.77	195.820	54.910
Max rel. 1	9.300	9.10	0.7700	220.0	51.160	66.30	82.990	99.72	61.200	25.110
Max rel. 2	2.000	2.000	0.770	220.0	3.1700	3.2600	4.170	5.230	54.390	25.110
Max rel. 3	3.500	3.100	0.7700	329.0	8.9800	9.0900	9.700	9.980	61.200	25.110
Max rel. 4	2.200	2.000	0.7700	307.0	3.6800	3.2600	3.940	4.000	54.390	25.110



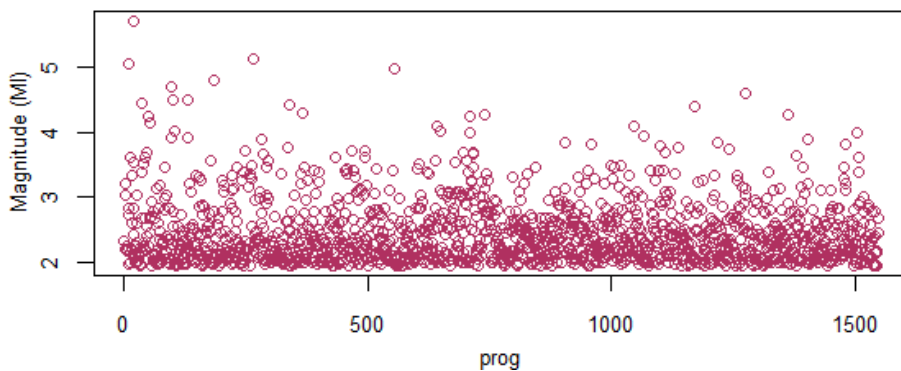
New Aut RSNI



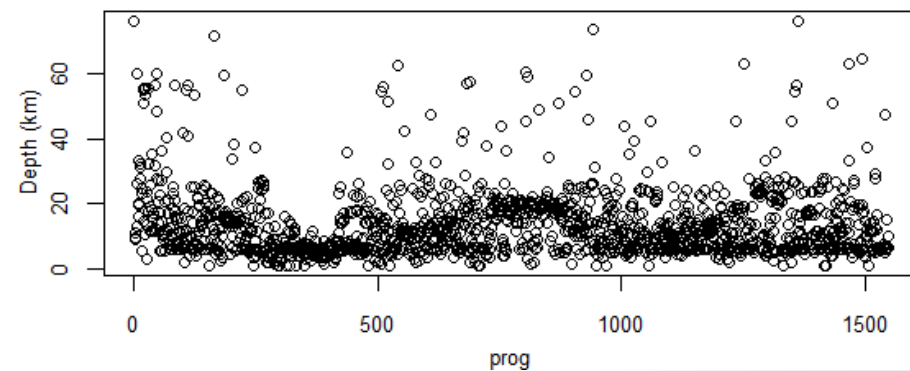
New Aut RSNI



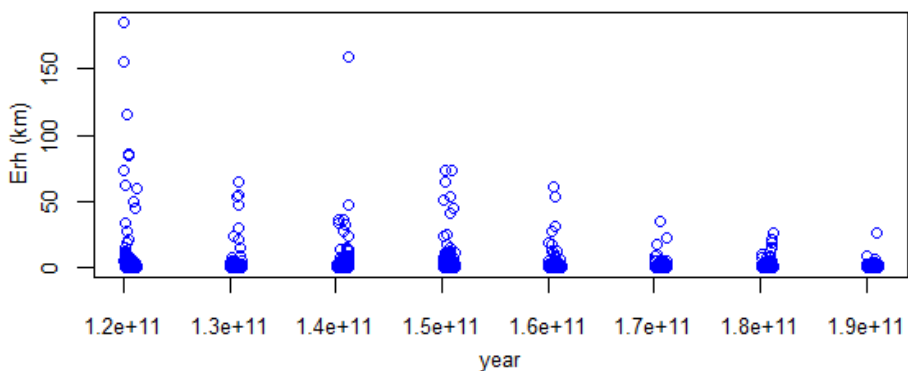
New Aut RSNI



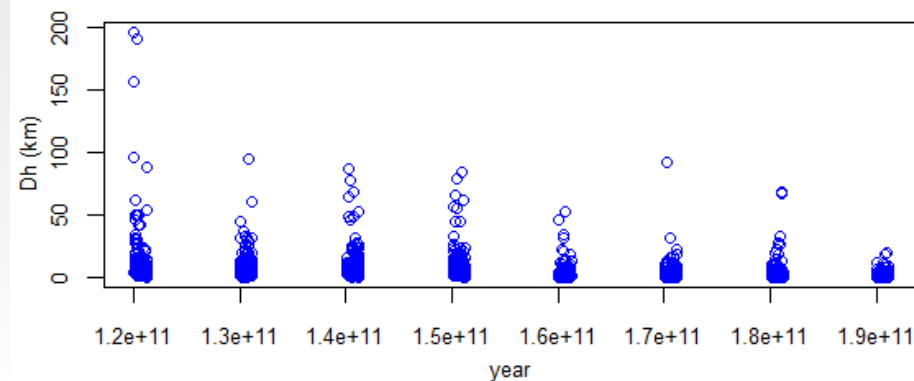
New Aut RSNI



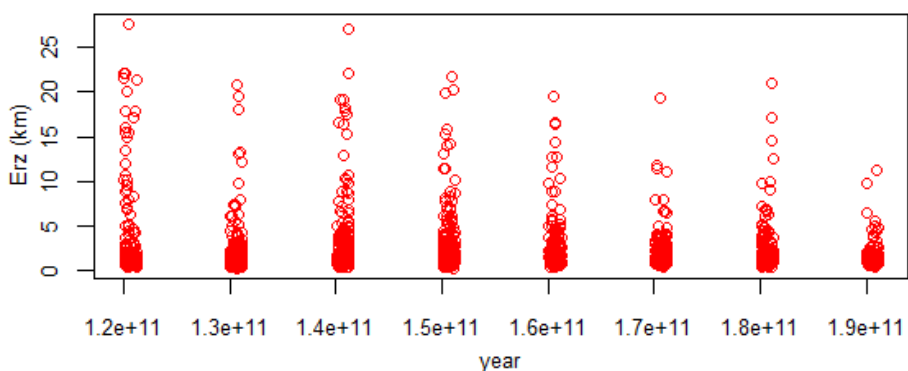
New Aut RSNI



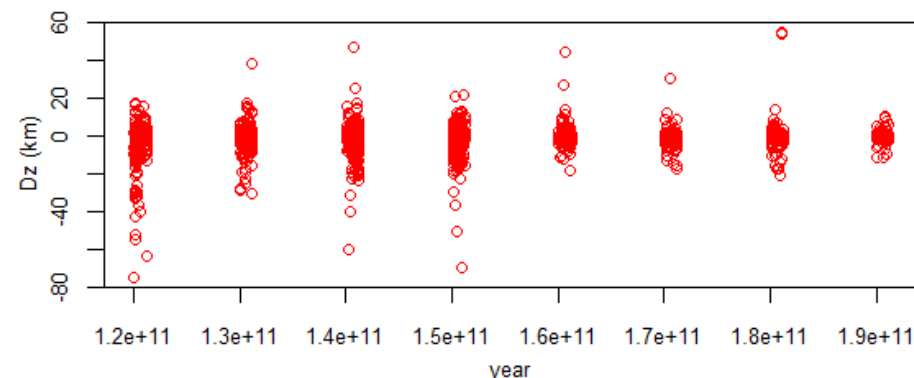
New Aut RSNI



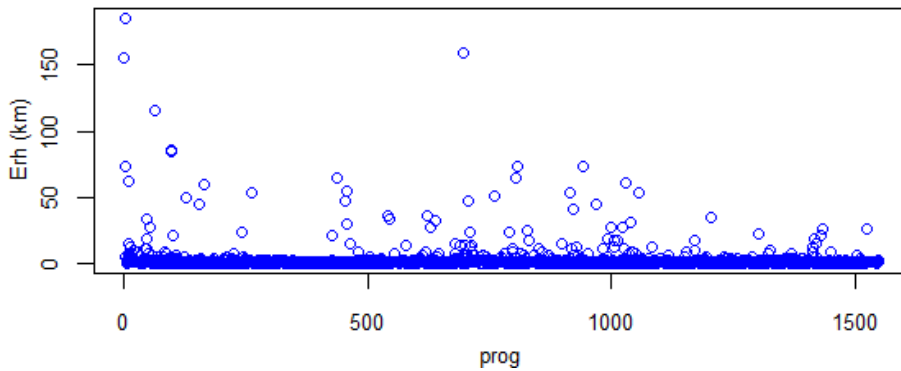
New Aut RSNI



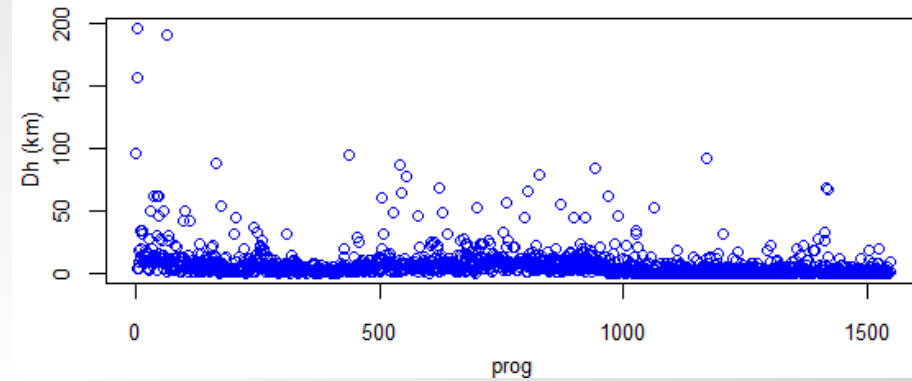
New Aut RSNI



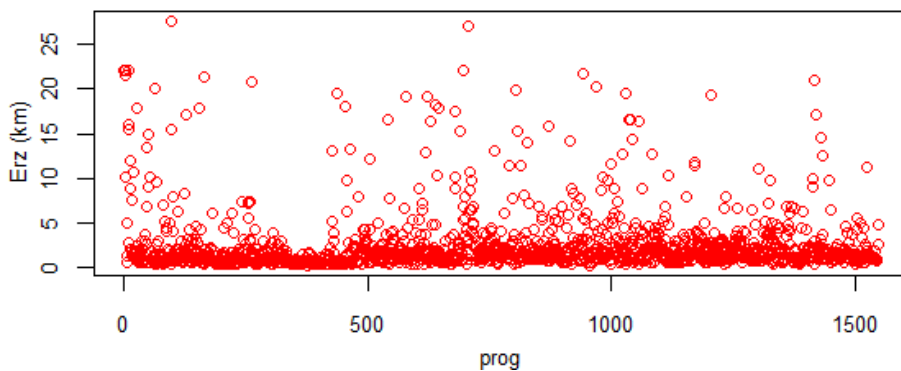
New Aut RSNI



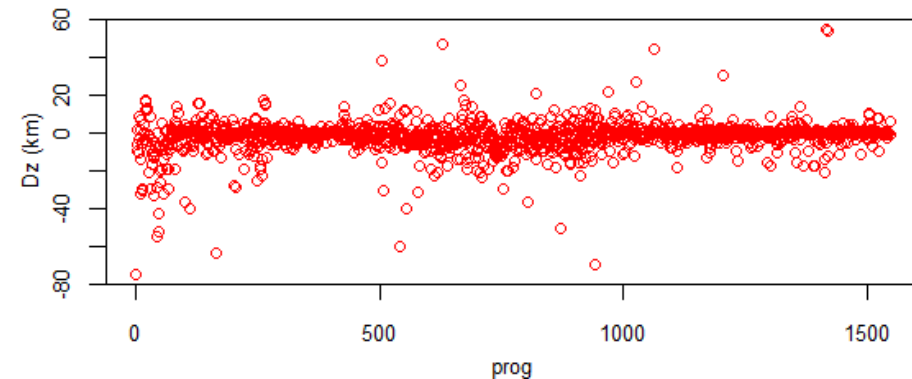
New Aut RSNI

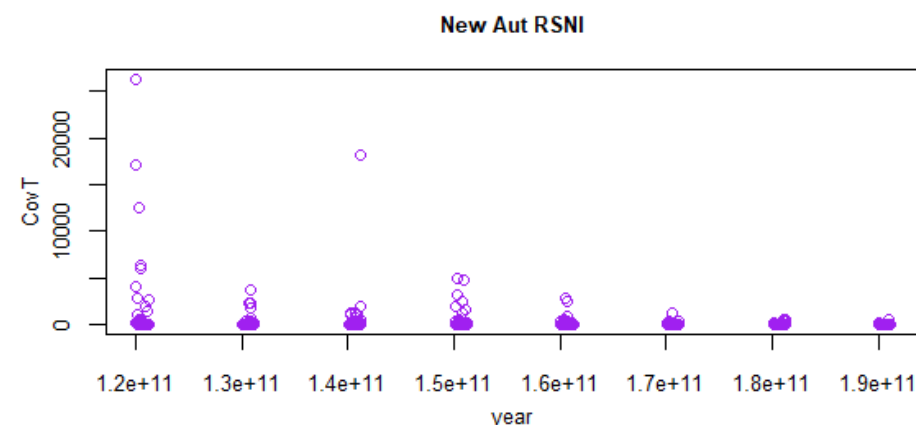
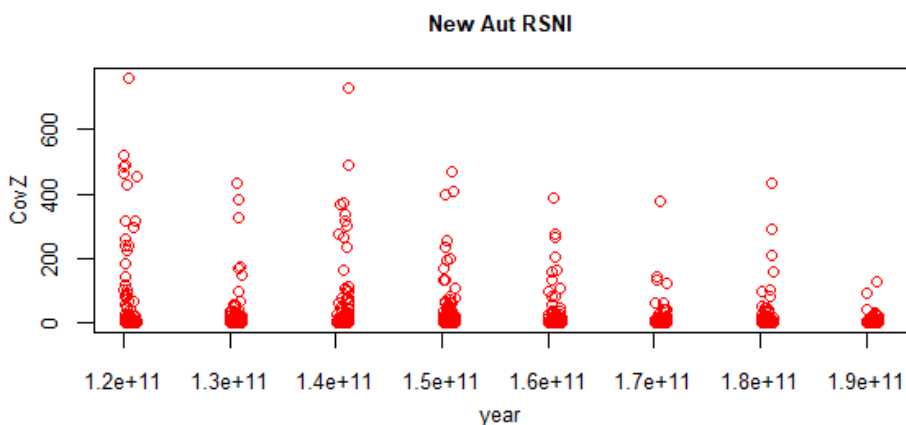
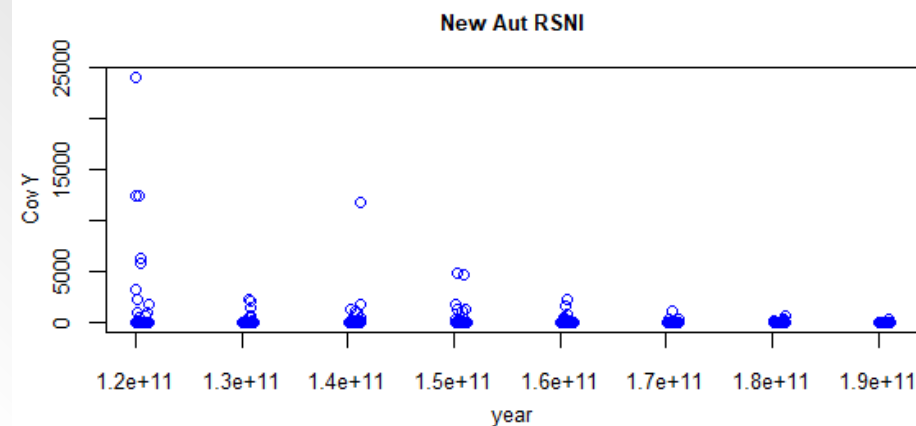
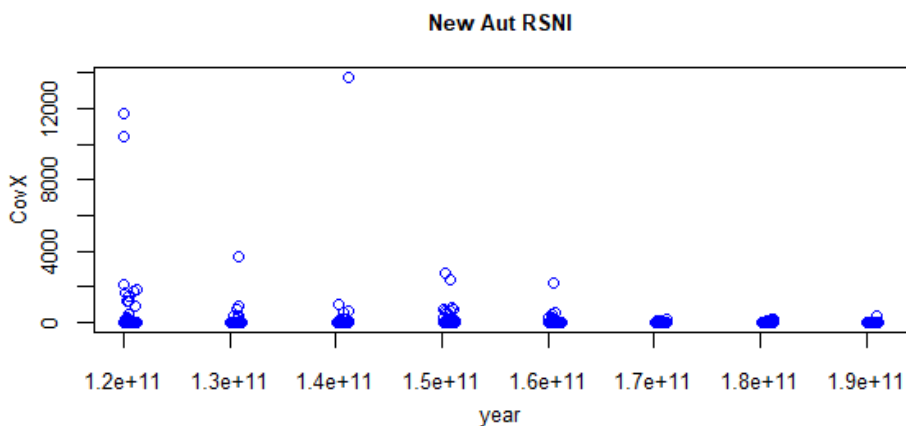


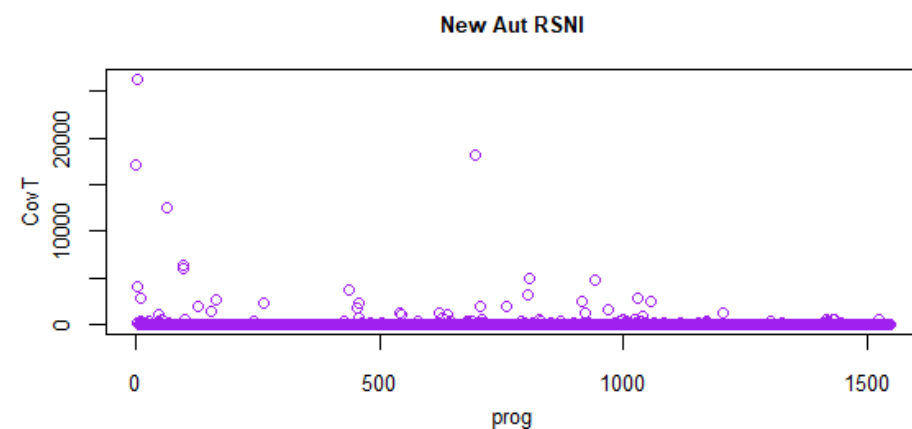
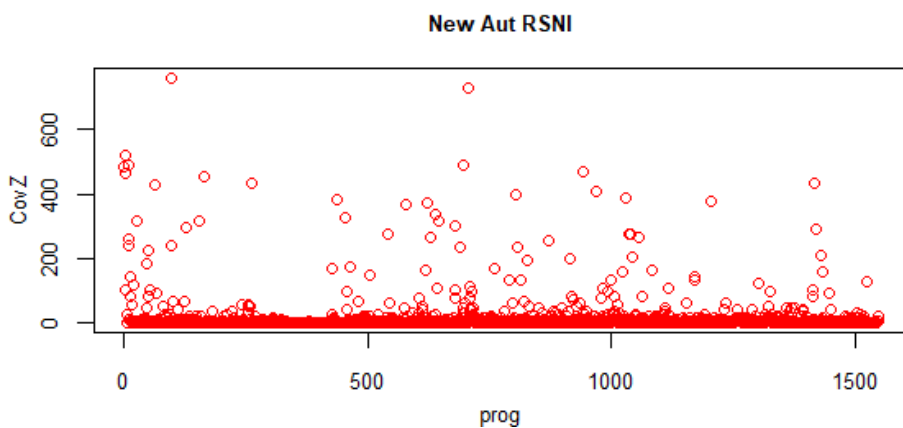
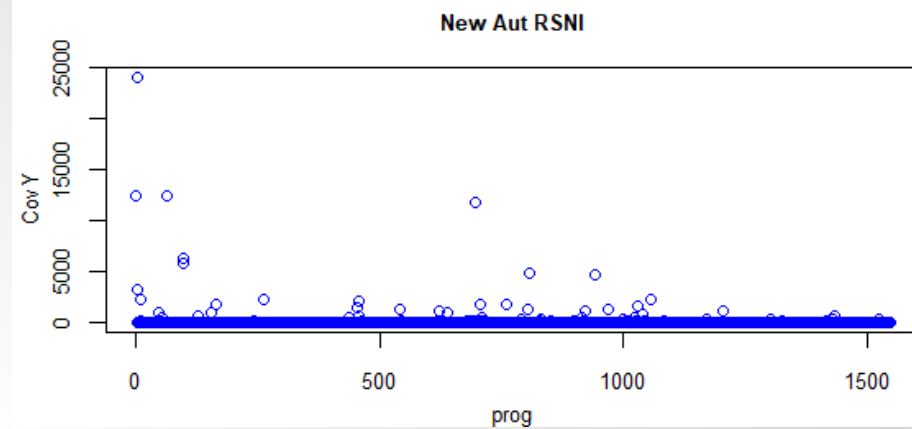
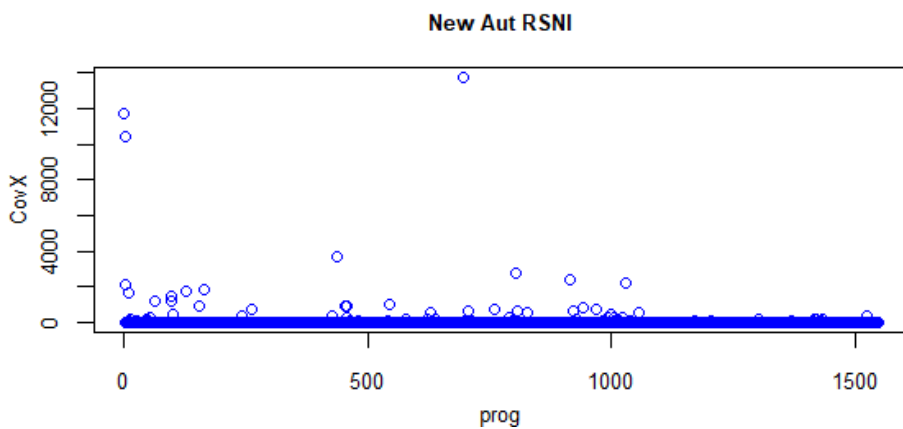
New Aut RSNI



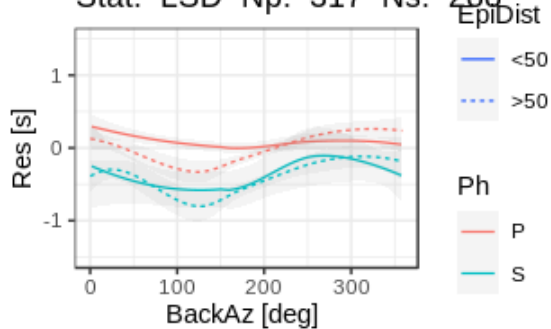
New Aut RSNI



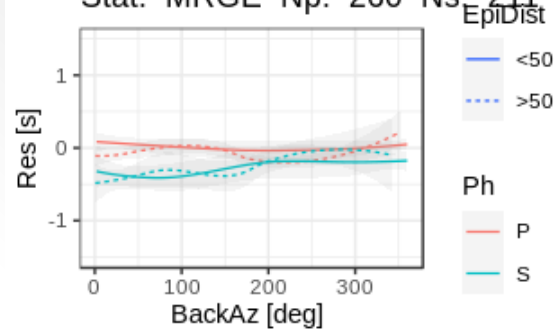




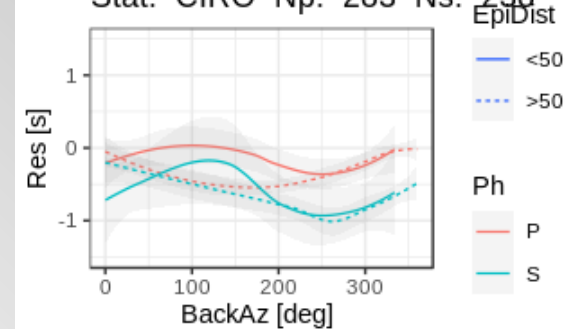
Stat: LSD Np: 317 Ns: 288



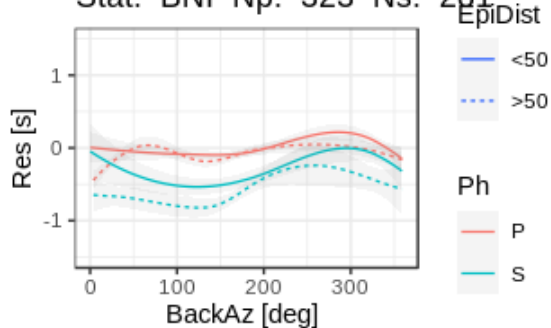
Stat: MRGE Np: 260 Ns: 211



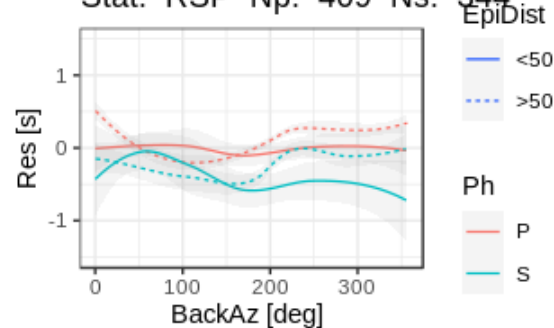
Stat: CIRO Np: 283 Ns: 238



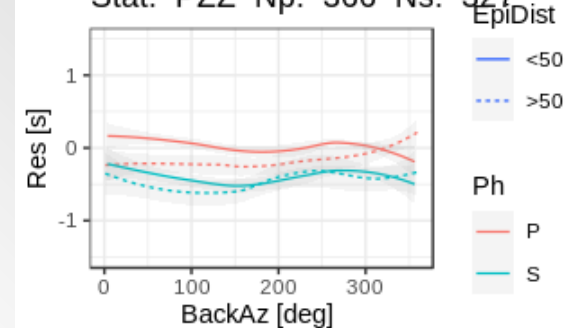
Stat: BNI Np: 323 Ns: 281



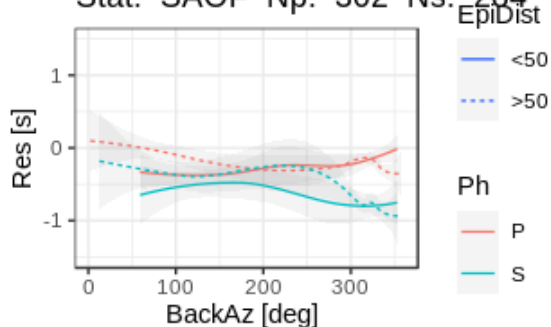
Stat: RSP Np: 409 Ns: 344



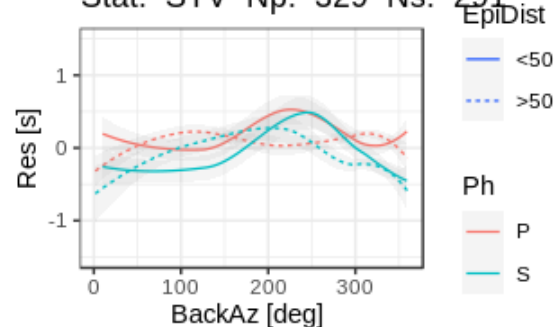
Stat: PZZ Np: 366 Ns: 327



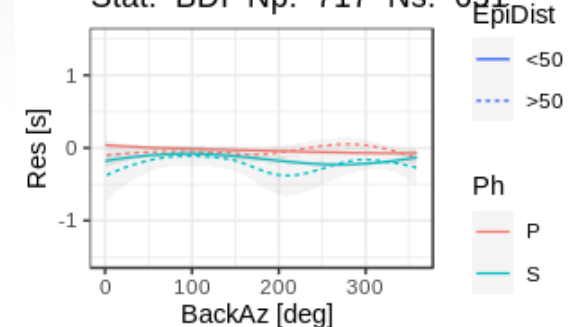
Stat: SAOF Np: 302 Ns: 284



Stat: STV Np: 329 Ns: 291



Stat: BDI Np: 717 Ns: 651



Good coherence with manual data, except for few outliers, more in earlier year
Covariance values thresholds respect with usual uncertainties parameters

Development of statistical, temporal and geo-statistical analysis of data

Revision of manual data with greater outlier (older data in catalog)

Implementation of station corrections

Analysis and comparison with other Italian and French catalogues on smaller area:

- CNRS GeoAzur (cross-border area)

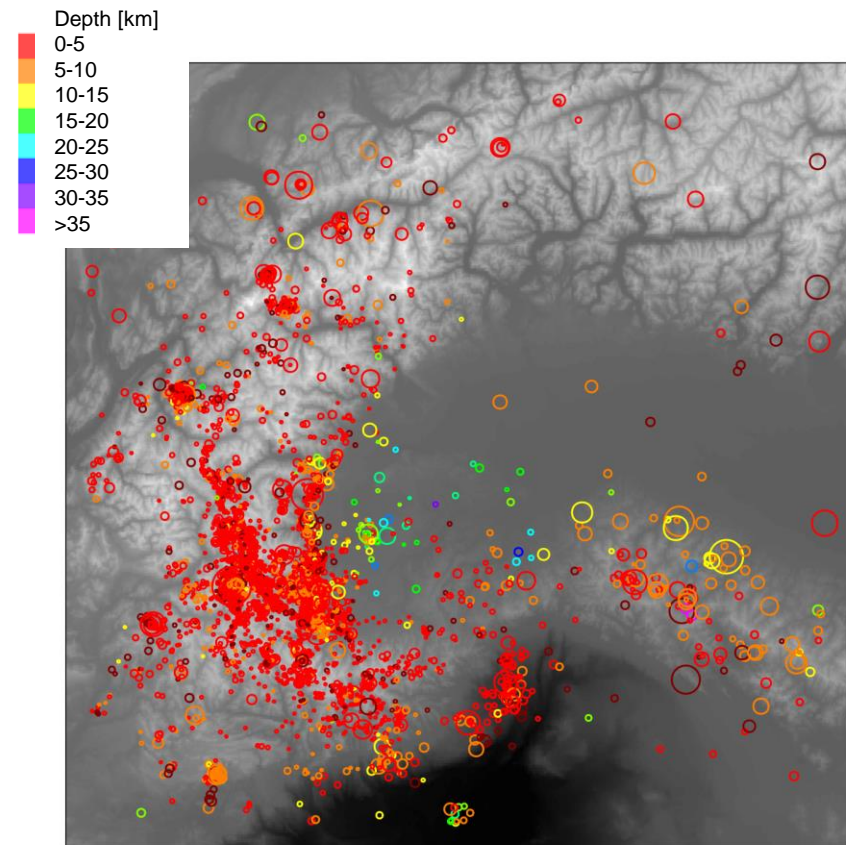
- RéNass (cross-border area)

- INGV (Italian side)

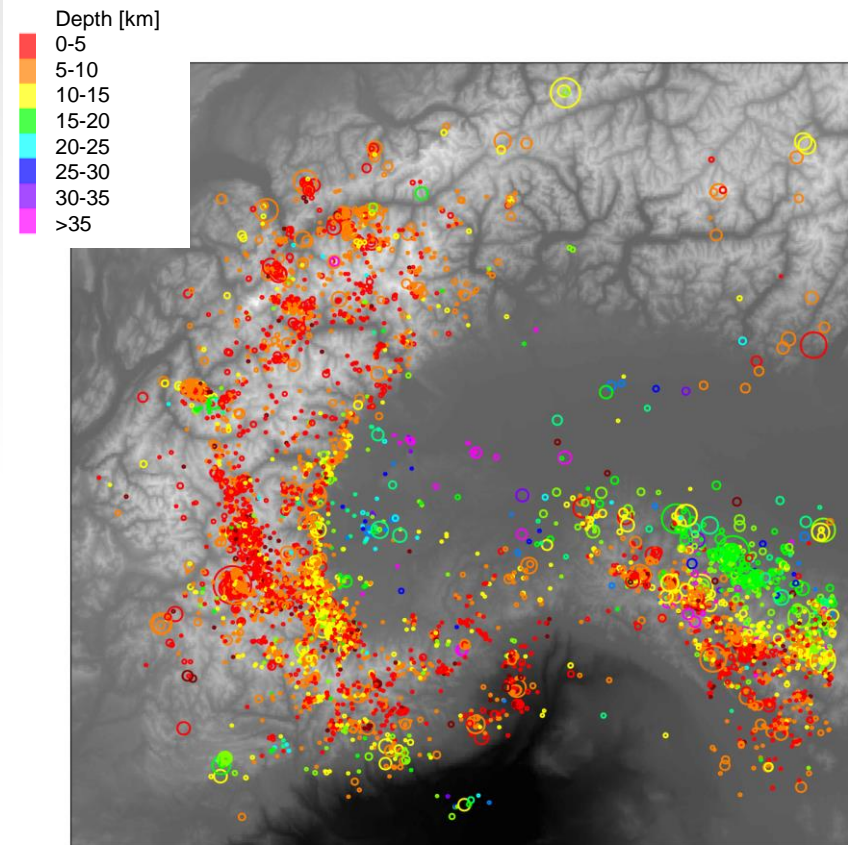
...

Analysis on continuous waveform data for a shorter interval (1 year)

CNRS network manual review routines catalog
2014-2019
5645 events



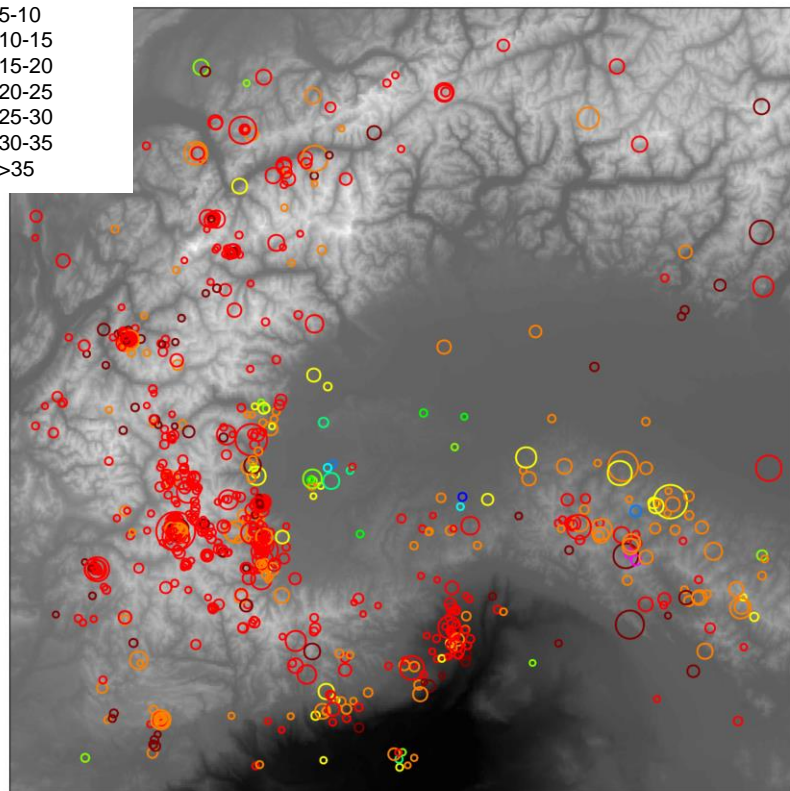
RSNI network manual review routines catalog
2014-2019
7544 events



CNRS network manual review routines catalog
2014-2019, magnitude ≥ 2
1048 events

Depth [km]

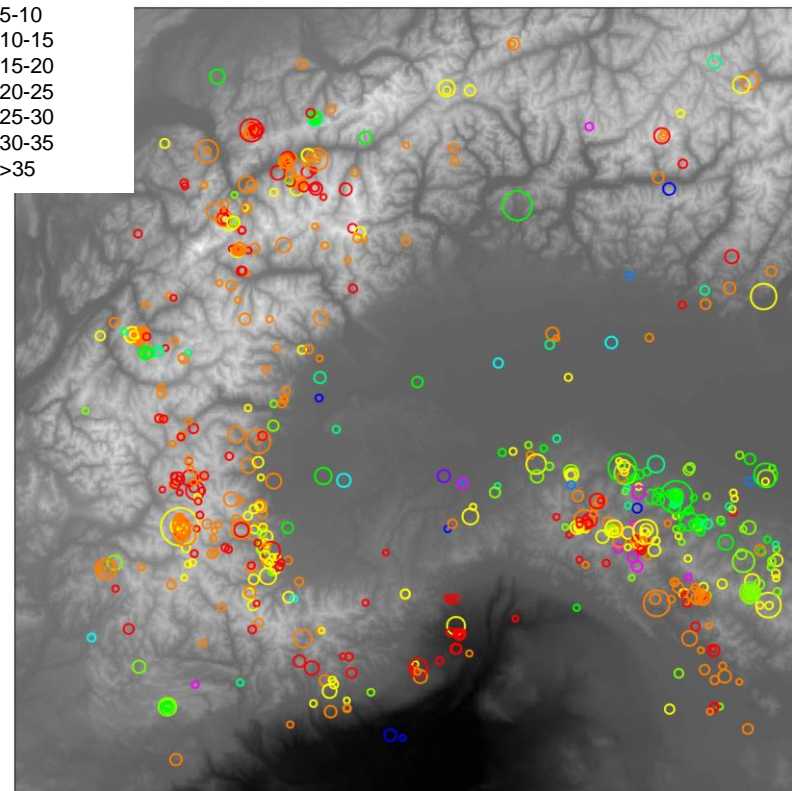
0-5
5-10
10-15
15-20
20-25
25-30
30-35
>35



RSNI network recompiled automatic catalog
2014-2019, magnitude ≥ 2
1031 events

Depth [km]

0-5
5-10
10-15
15-20
20-25
25-30
30-35
>35

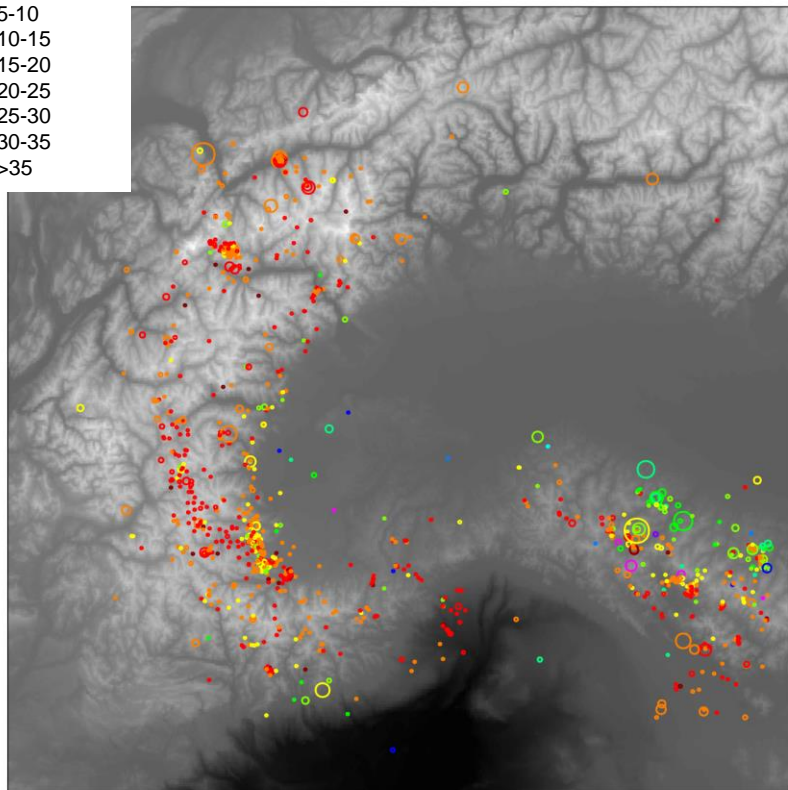


RSNI network manual review routines catalog
2019
1143 events

CASP review
2019
1340 events

Depth [km]

0-5
5-10
10-15
15-20
20-25
25-30
30-35
>35



Depth [km]

0-5
5-10
10-15
15-20
20-25
25-30
30-35
>35

