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Automated classification of Permanent Scatterers time-series based on statistical characterization tests

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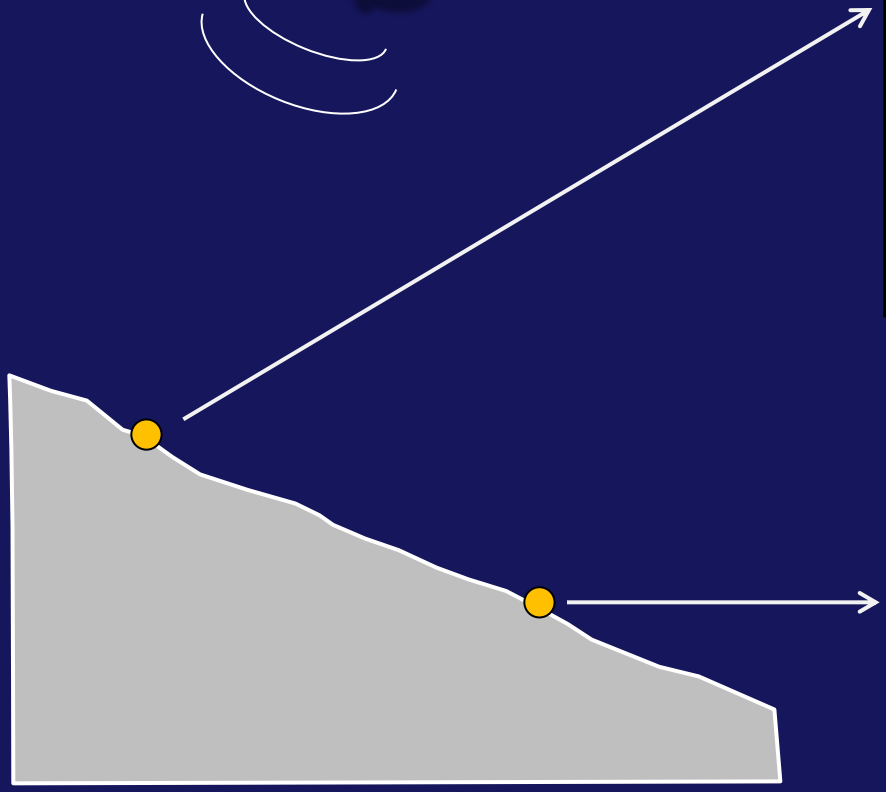
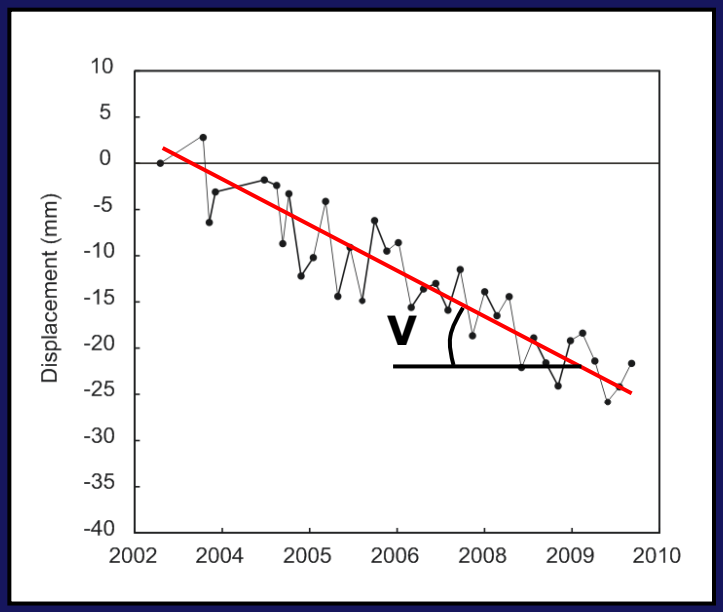
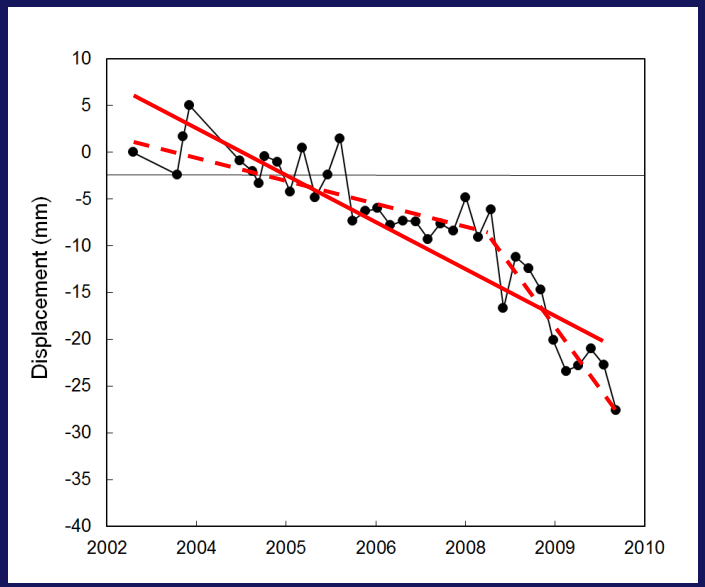
Problem statement







Workflow

1) Identification of typical temporal patterns
- Visual analysis of 1000 PS time series
- ERS and ENVISAT data from the EPRS-E project

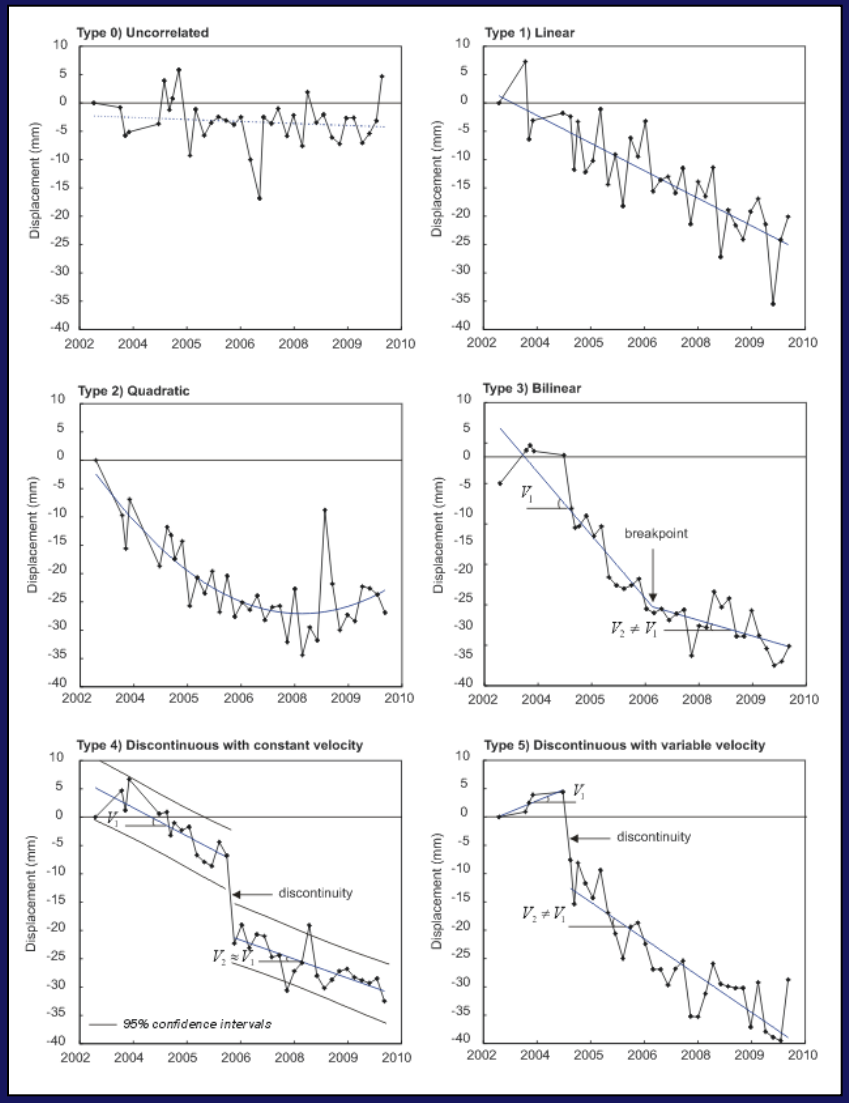
2) Automatic classification procedure

3) Calibration of statistical thresholds

4) Sample application

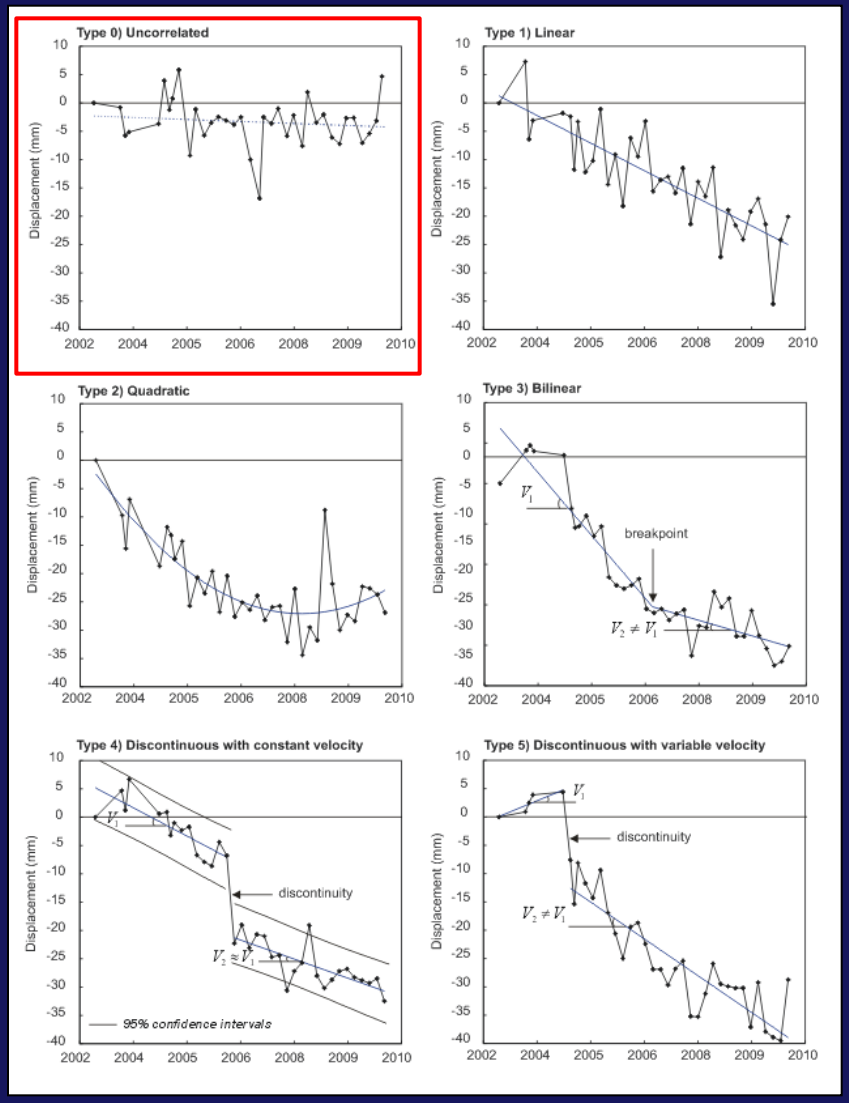
1) Typical temporal patterns

The six «target trends»

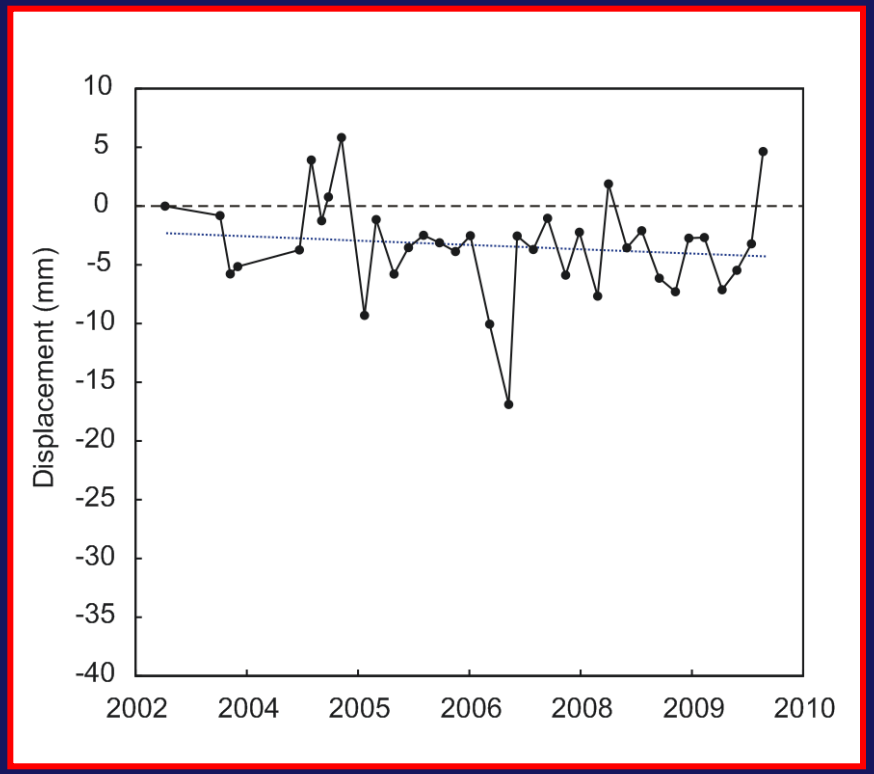


1) Typical temporal patterns

The six «target trends»



Type 0) Uncorrelated



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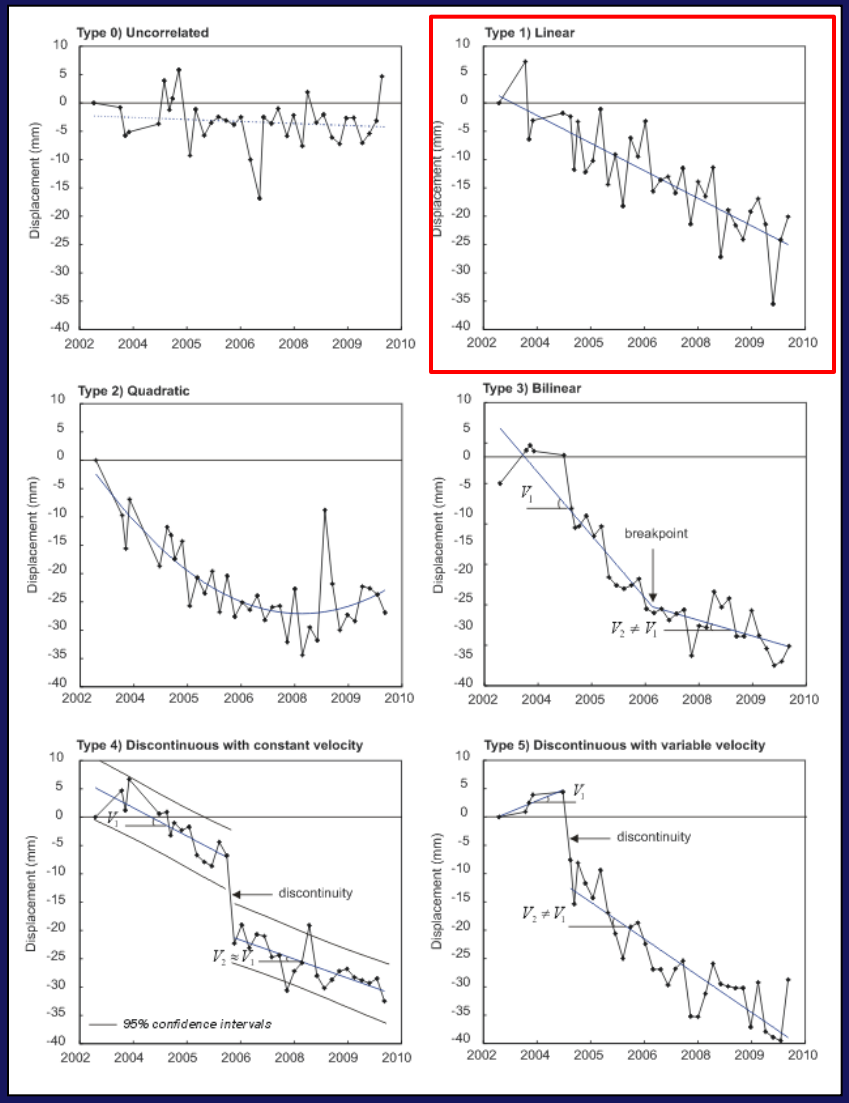
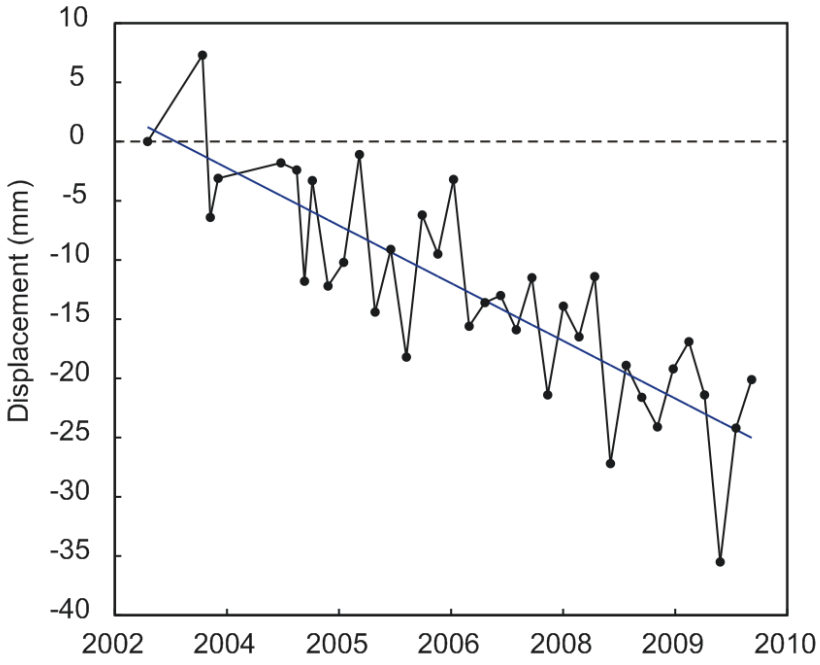


Type 1) Linear



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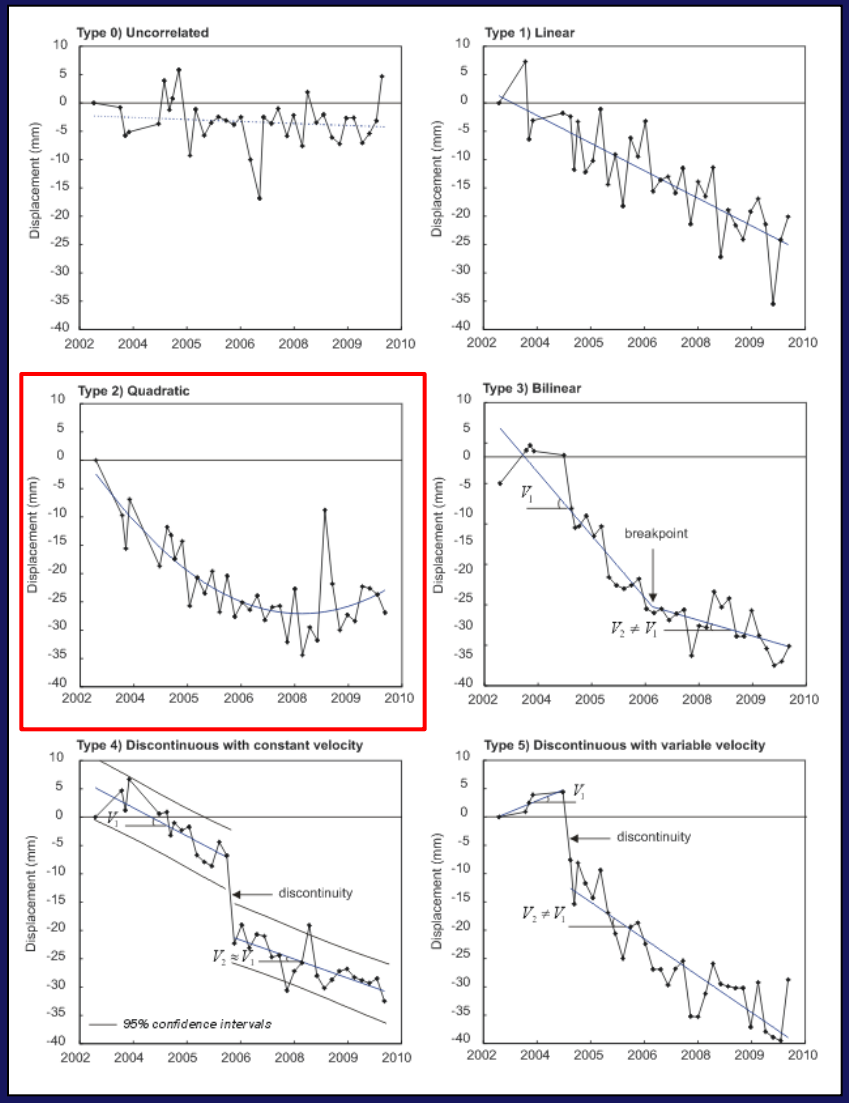
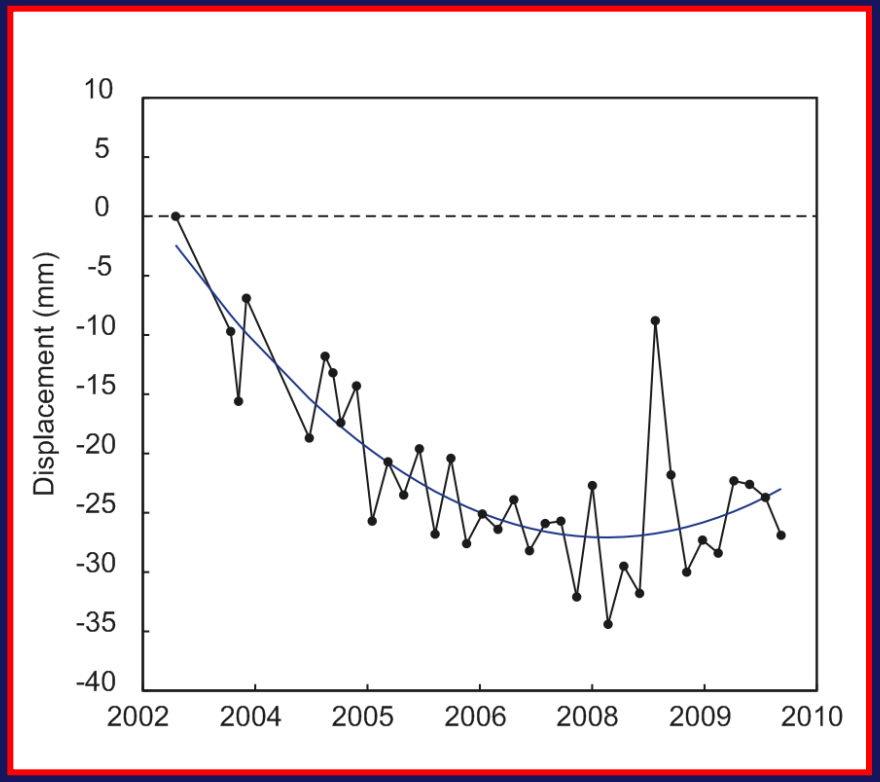


Type 2) Quadratic



1) Typical temporal patterns

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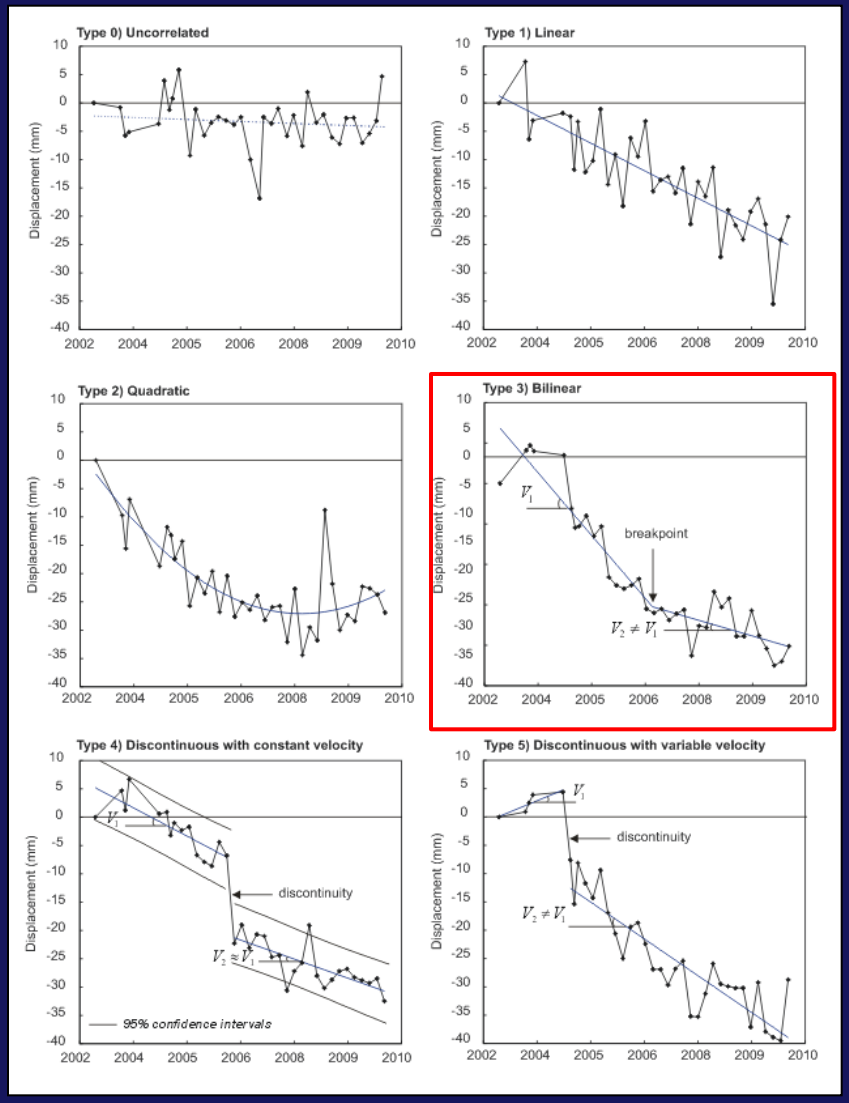
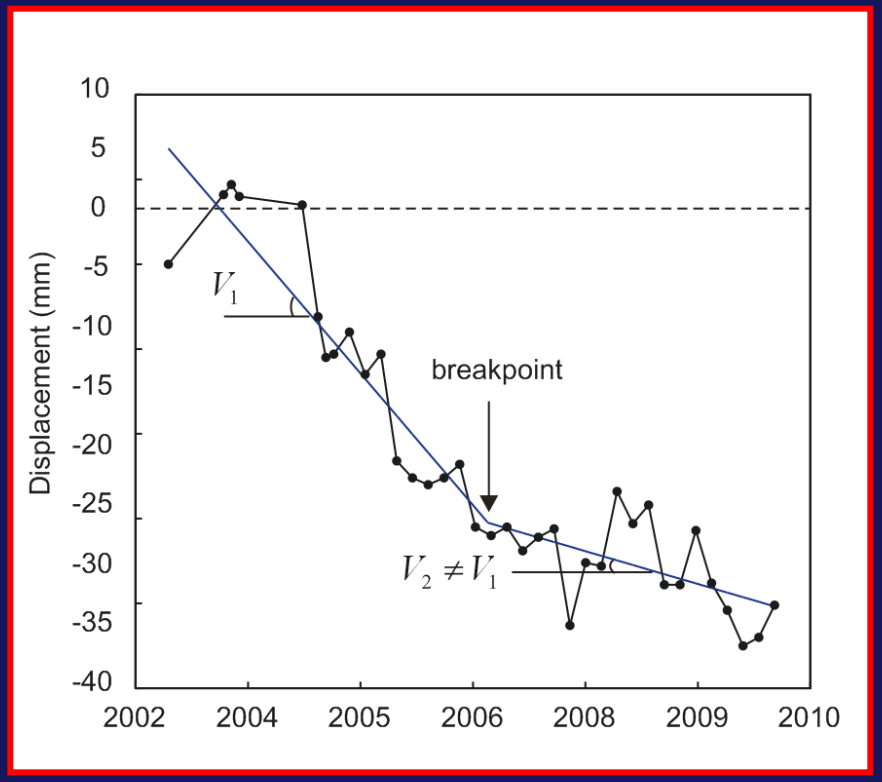


Type 3) Bilinear



1) Typical temporal patterns

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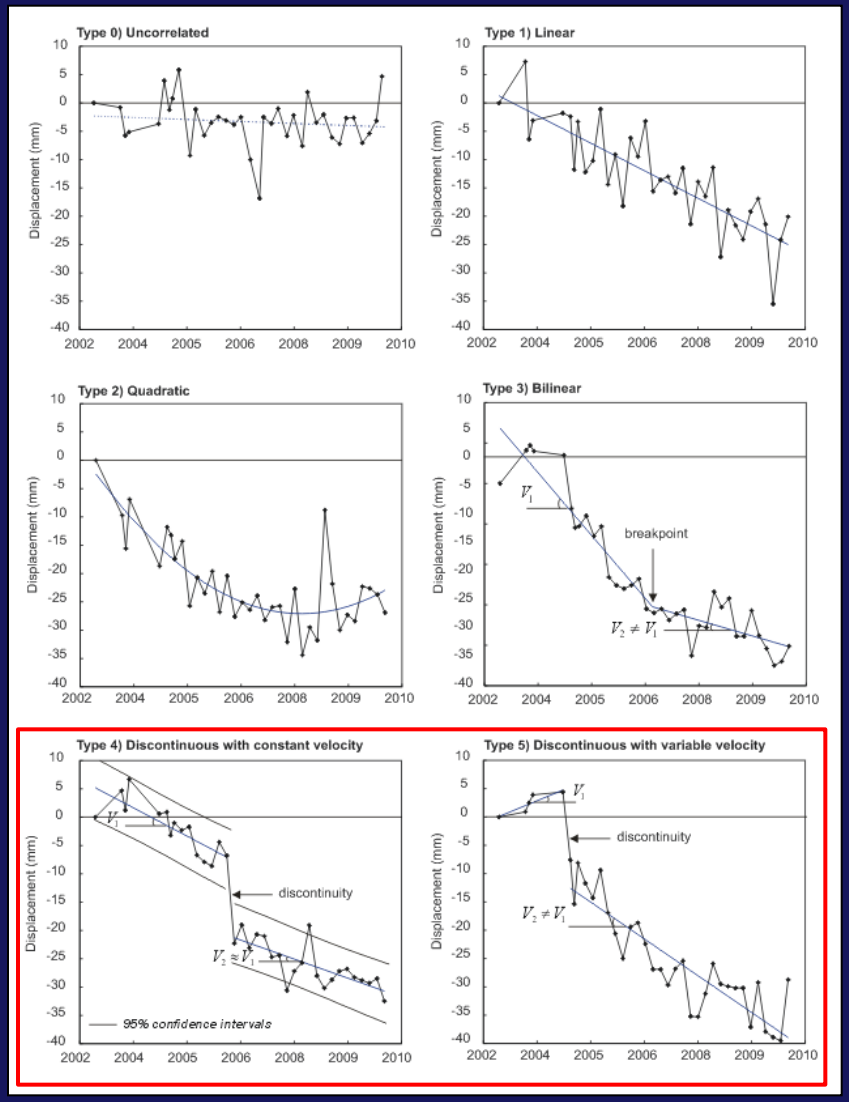
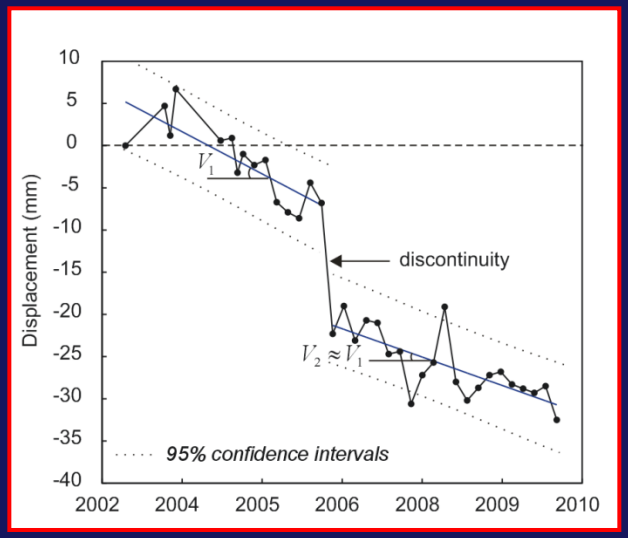
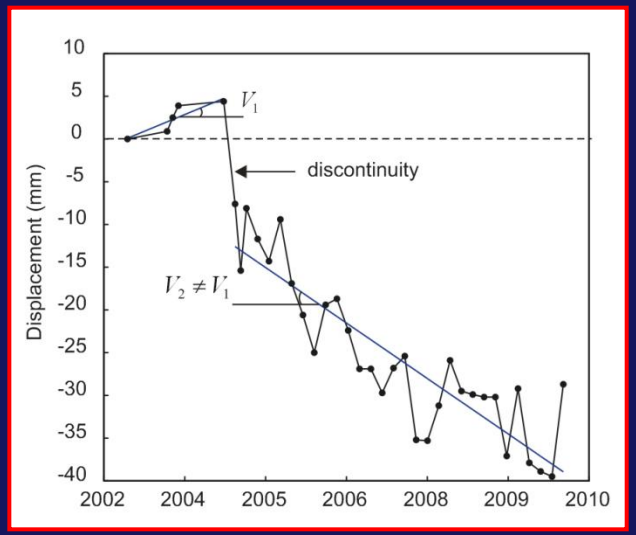


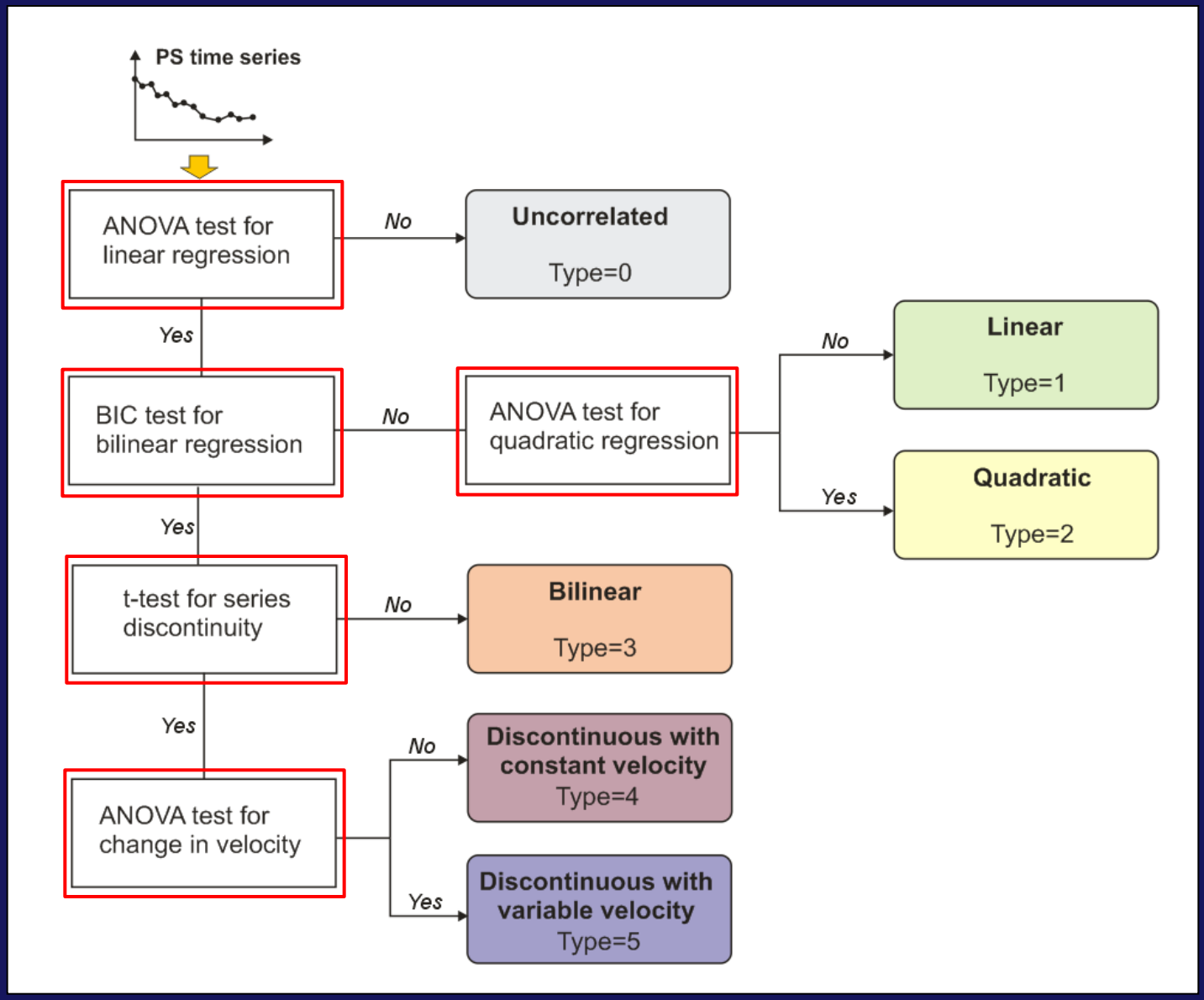
Type 4) Discontinuous constant velocity



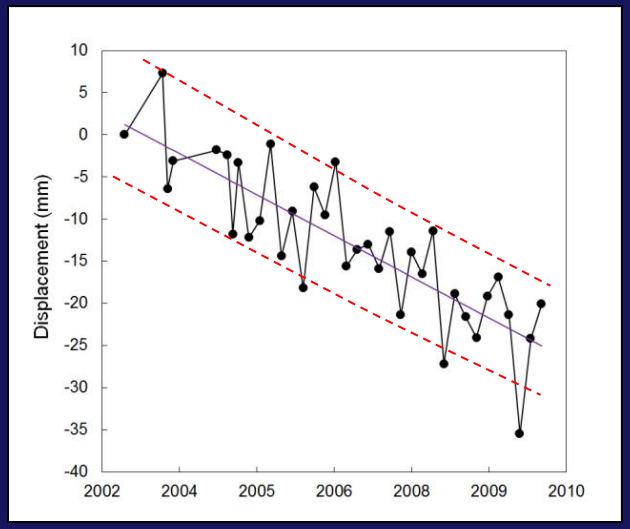
Type 5) Discontinuous variable velocity



2) Automatic classification procedure



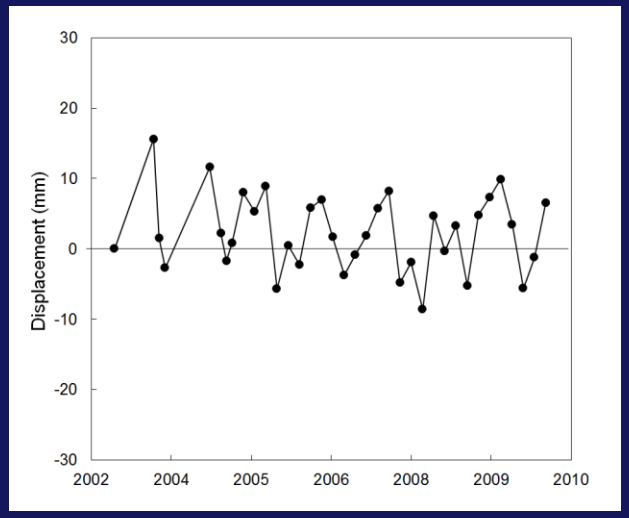
2) Descriptive parameters



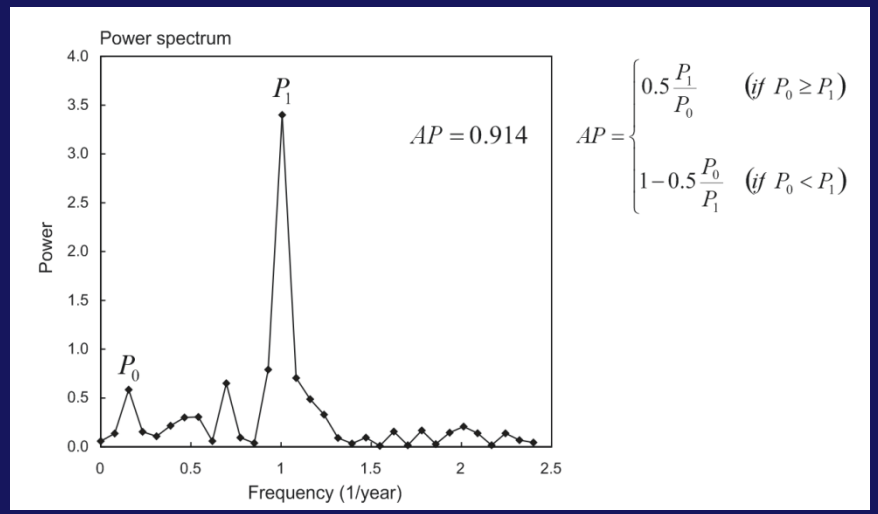
Scatter around the mean trend

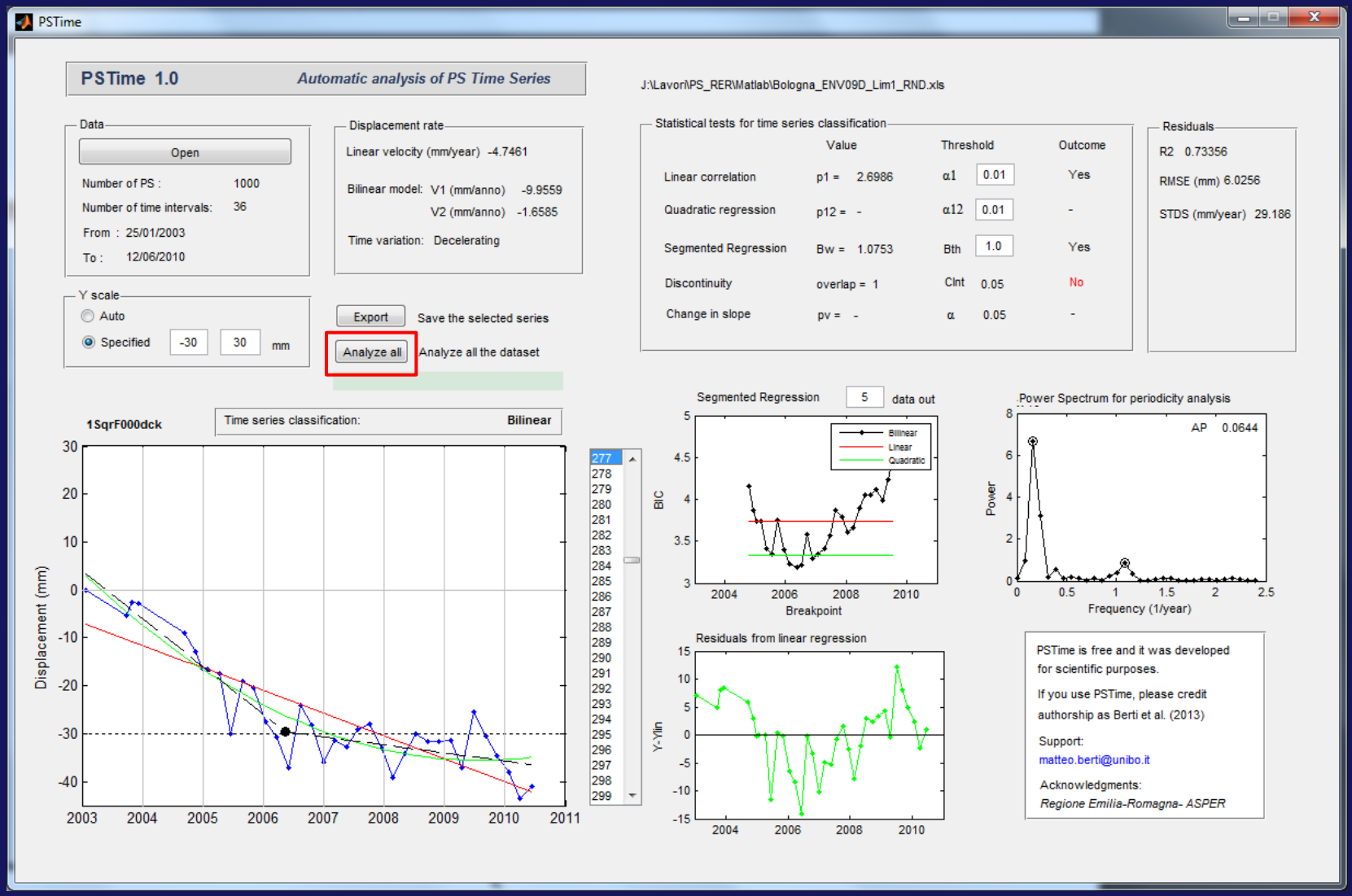
- coefficient of determination, r^2
- Root Mean Square Error, RMSE
- Standard Deviation of Slope, STDS

Annual periodicity index



FFT



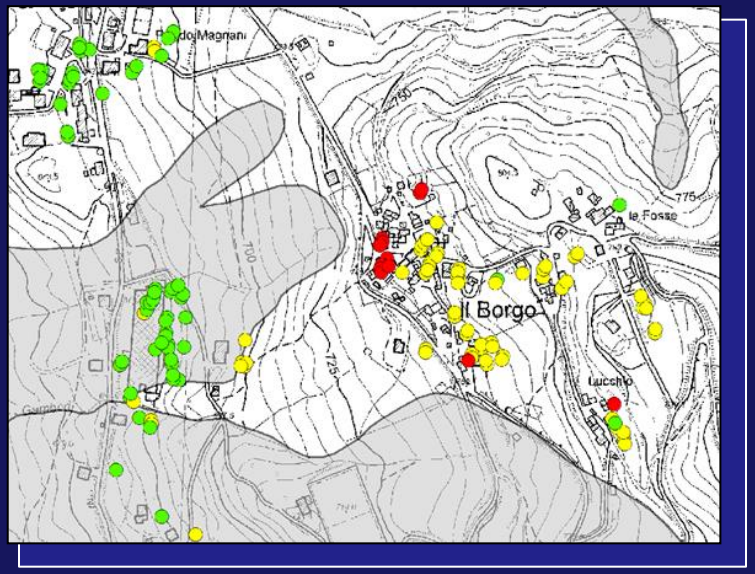


Free download: *http://www.bigea.it/ricerca/pstime*

2) PSTime Output Table

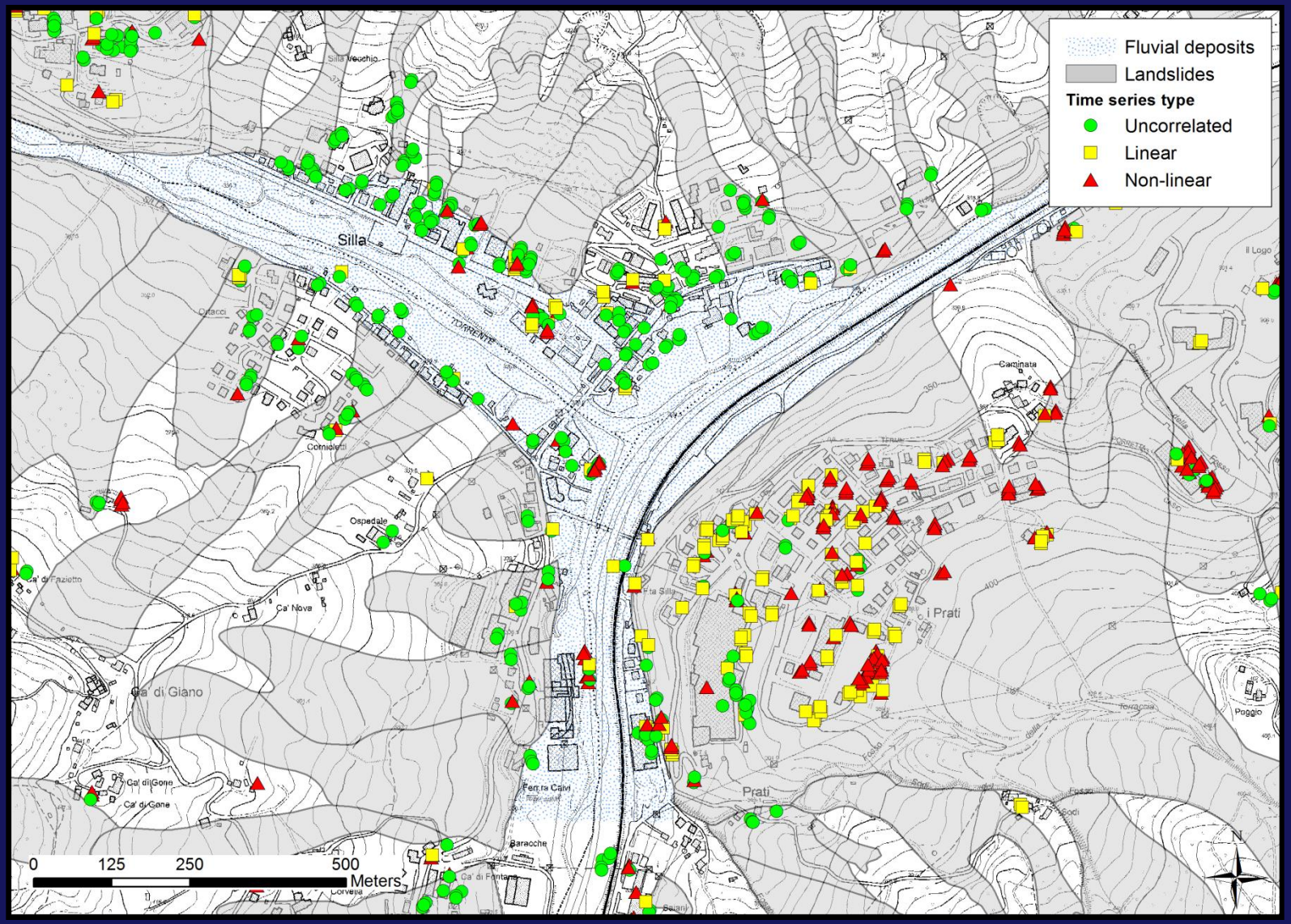
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Code	V_Lin	R2	RMSE	STDS	Period	PF1	PF2	PF12	TRS	TRSW	Class	V1	V2	Break	dV	Acc
2	1SqrF000VBw	-1.03	0.22	4.08	29.72	0.62	0.00	0.01	0.16	0	0.00	1	-1.03	-1.03	None	0.00	0
3	1SqrF000V3A	-0.57	0.10	3.51	22.84	0.11	0.05	0.01	0.02	2	0.00	0	-0.57	-0.57	None	0.00	0
4	1SqrF000V6b	-0.81	0.12	4.56	34.03	0.41	0.04	0.10	0.58	0	0.00	0	-0.81	-0.81	None	0.00	0
5	1SqrF000V8P	-0.97	0.16	4.63	28.79	0.32	0.01	0.00	0.03	2	0.00	0	-0.97	-0.97	None	0.00	0
6	1SqrF000UhH	-1.46	0.34	4.28	32.62	0.67	0.00	0.00	0.17	0	0.00	1	-1.46	-1.46	None	0.00	0
7	1SqrF000VCA	-0.56	0.07	4.27	31.41	0.33	0.12	0.12	0.19	0	0.00	0	-0.56	-0.56	None	0.00	0
8	1SqrF000Uwp	-0.72	0.12	4.09	20.57	0.06	0.04	0.00	0.00	1	1.04	0	-0.72	-0.72	None	0.00	0
9	1SqrF000W28	-0.49	0.08	3.41	25.60	0.17	0.09	0.02	0.02	2	0.00	0	-0.49	-0.49	None	0.00	0
10	1SqrF000VpX	-1.42	0.39	3.73	25.86	0.36	0.00	0.00	0.31	1	1.09	5	6.82	-1.01	16/10/2004	7.82	-1
11	1SqrF000Vp3	-0.85	0.14	4.49	37.84	0.31	0.03	0.00	0.00	2	0.00	0	-0.85	-0.85	None	0.00	0
12	1SqrF000WP9	-3.81	0.69	5.40	38.11	0.26	0.00	0.00	0.09	0	0.00	1	-3.81	-3.81	None	0.00	0
13	1SqrF000WOm	-0.76	0.25	2.76	18.89	0.27	0.00	0.00	0.18	0	0.00	1	-0.76	-0.76	None	0.00	0
14	1SqrF000WVj	-0.69	0.19	3.00	23.10	0.13	0.01	0.01	0.20	0	0.00	1	-0.69	-0.69	None	0.00	0
15	1SqrF000WLb	-0.53	0.04	5.47	52.14	0.75	0.24	0.28	0.28	0	0.00	0	-0.53	-0.53	None	0.00	0
16	1SqrF000Vpr	-0.46	0.03	5.67	52.63	0.60	0.33	0.63	0.96	0	0.00	0	-0.46	-0.46	None	0.00	0
17	1SqrF000WQY	-1.50	0.19	6.58	34.17	0.15	0.01	0.00	0.01	1	1.11	3	8.70	-3.03	25/12/2004	11.74	-1
18	1SqrF000WHU	-1.09	0.14	5.79	40.43	0.26	0.03	0.09	0.95	0	0.00	0	-1.09	-1.09	None	0.00	0
19	1SqrF000VQz	-0.29	0.01	5.30	47.89	0.42	0.51	0.65	0.52	0	0.00	0	-0.29	-0.29	None	0.00	0

GIS



4) Sample application

Confluence of the Silla and Reno rivers (Bologna Province, Italy) – Envisat data (2002-2010)



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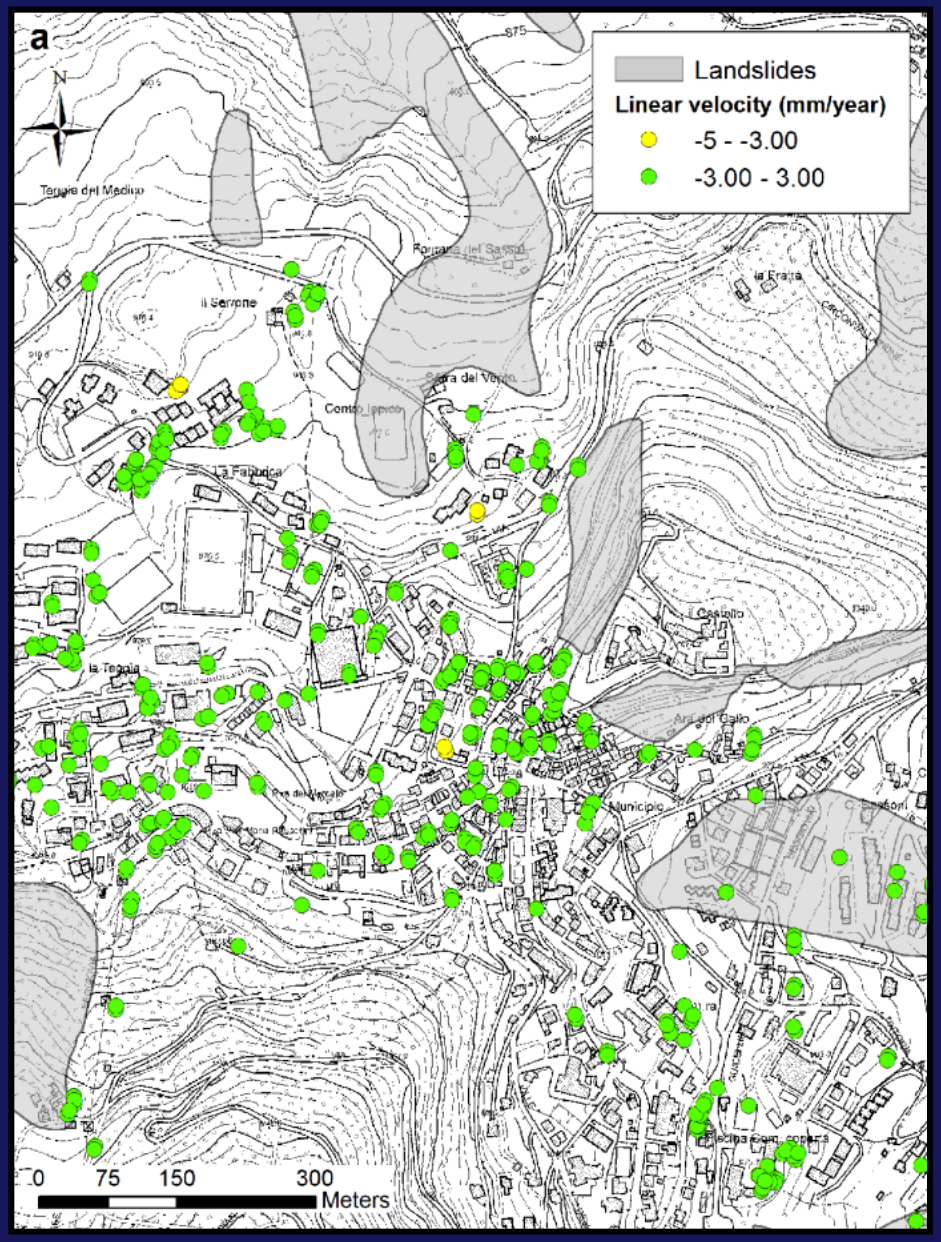
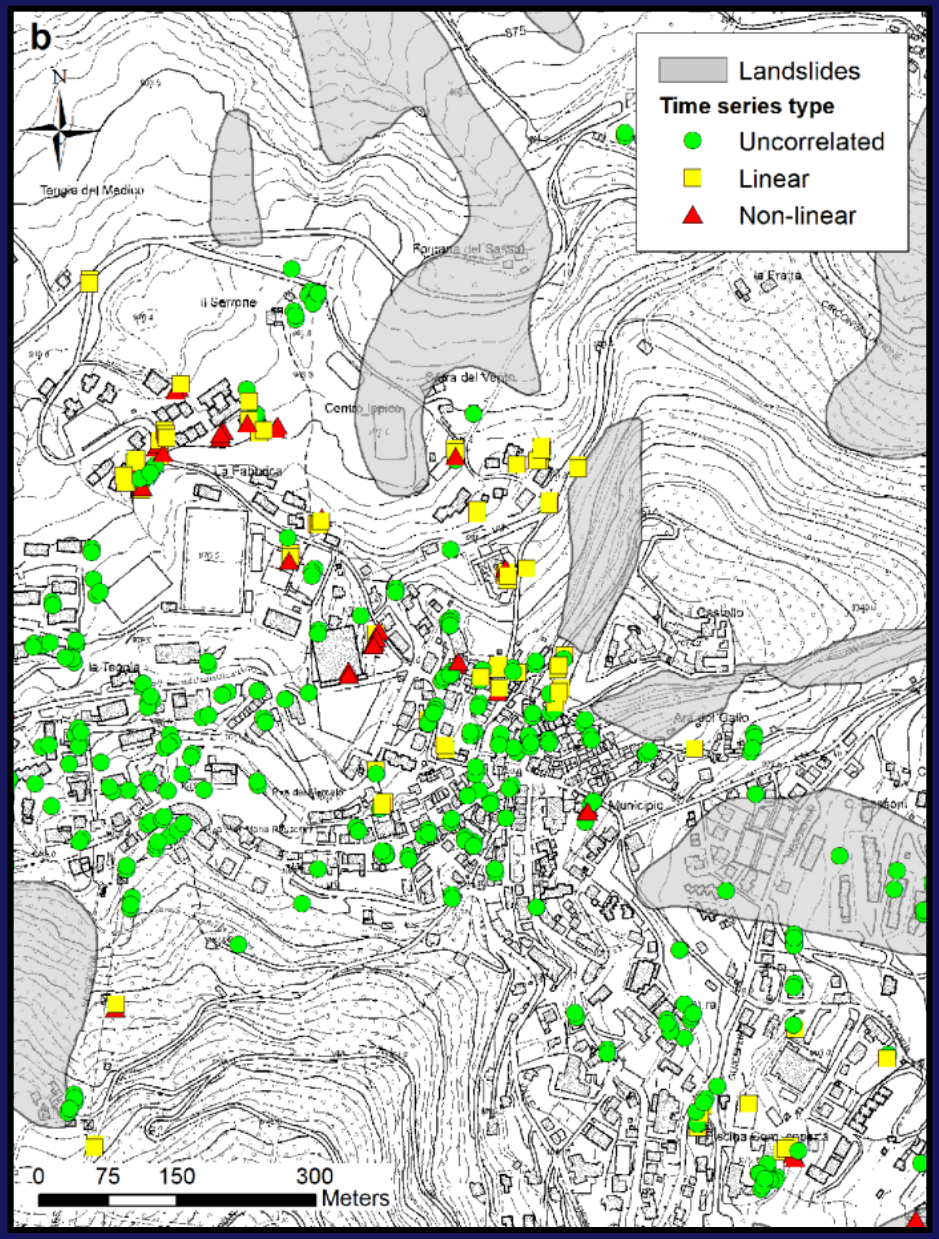


Sestola village (Modena Province, Italy)

Envisat data (2002-2010)

Mean velocity

4) Sample application



Sestola village (Modena Province, Italy)

Envisat data (2002-2010)

Time series classification

Conclusions

- Permanent Scatterers time series can be automatically classified by a sequence of statistical tests

- Time series analysis provides useful information on ground deformation processes

- Particularly useful to detect non-linear behaviour

PSTime is free... try it !!