Homogenization of the wind speed time series in Czech Republic

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Brazdil a kol. (2017): Spatial and temporal variability of mean daily wind speeds in the Czech Republic, 1961–2015. Climate Research. In review

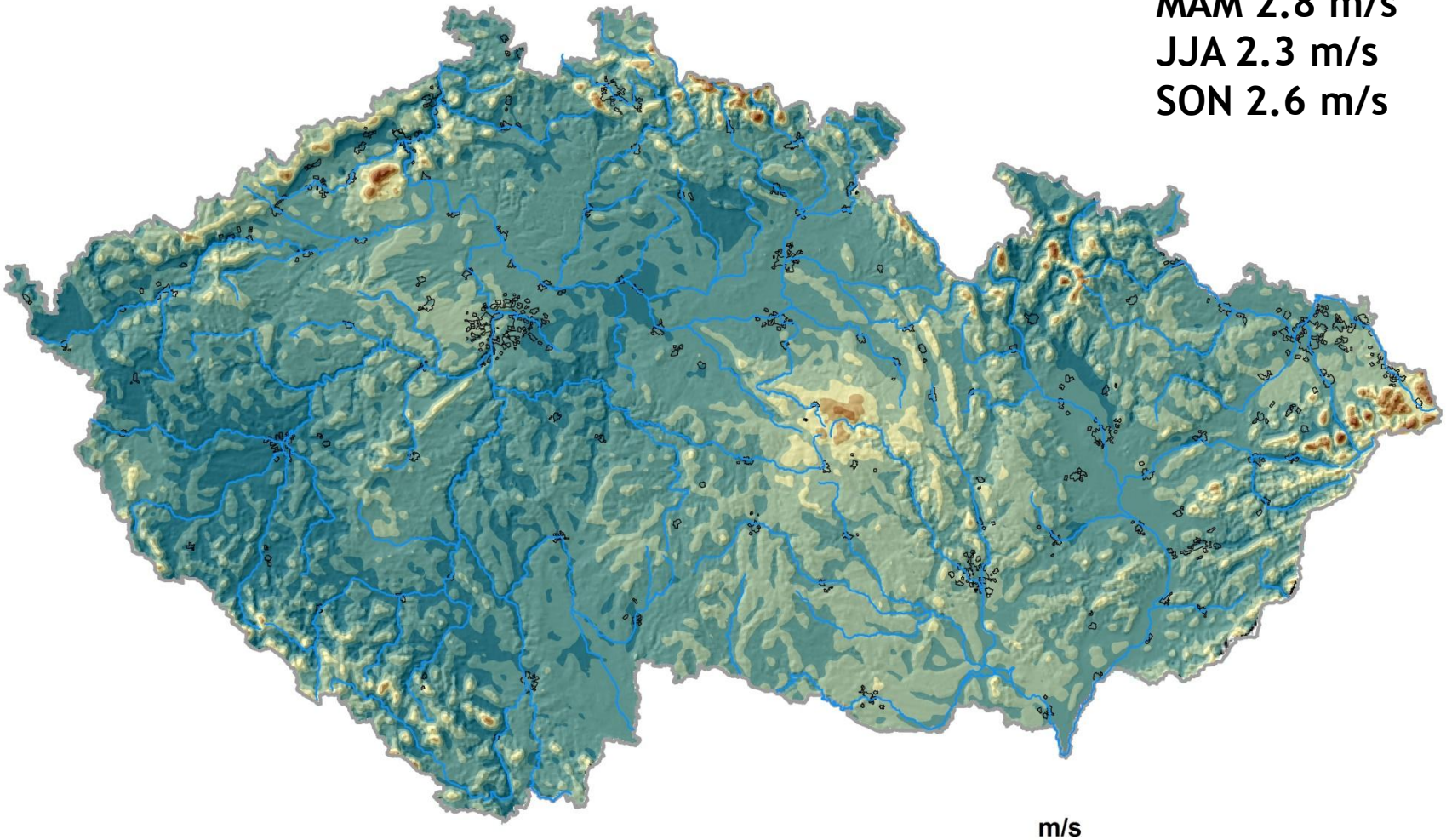
Brazdil a kol. (2016): The variability of maximum wind gusts in the Czech Republic between 1961 and 2014. Int. J. Climatol. DOI: 10.1002/joc.4827

Introduction

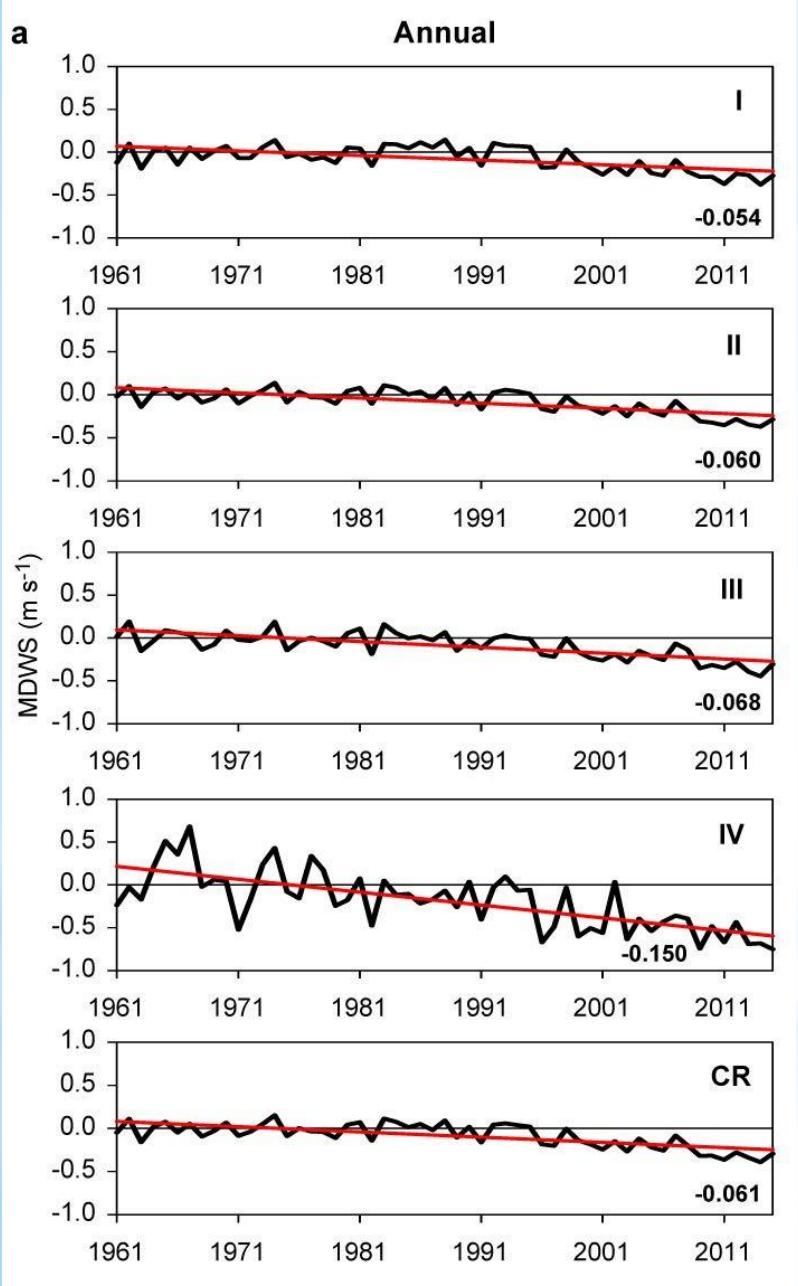
* Wind speed is one of the most problematic meteorological elements
* Spatially and temporally highly variable element
* Station practically measure only site conditions without influence of the greater neighborhood
* The problem in measurement methodology (change from Beaufort to Ultrasonic)
* Great influence of the changes in immediate surroundings – afforestation, new buildings
* Worldwide similar results, with the wind speed trend decrease – is it reality or is it caused by overall changes?

Average wind speed

Annual 2.7 m/s
DJF 3.0 m/s
MAM 2.8 m/s
JJA 2.3 m/s
SON 2.6 m/s



Average wind speed – difference 1961-1990



I. to 300 m.s.l

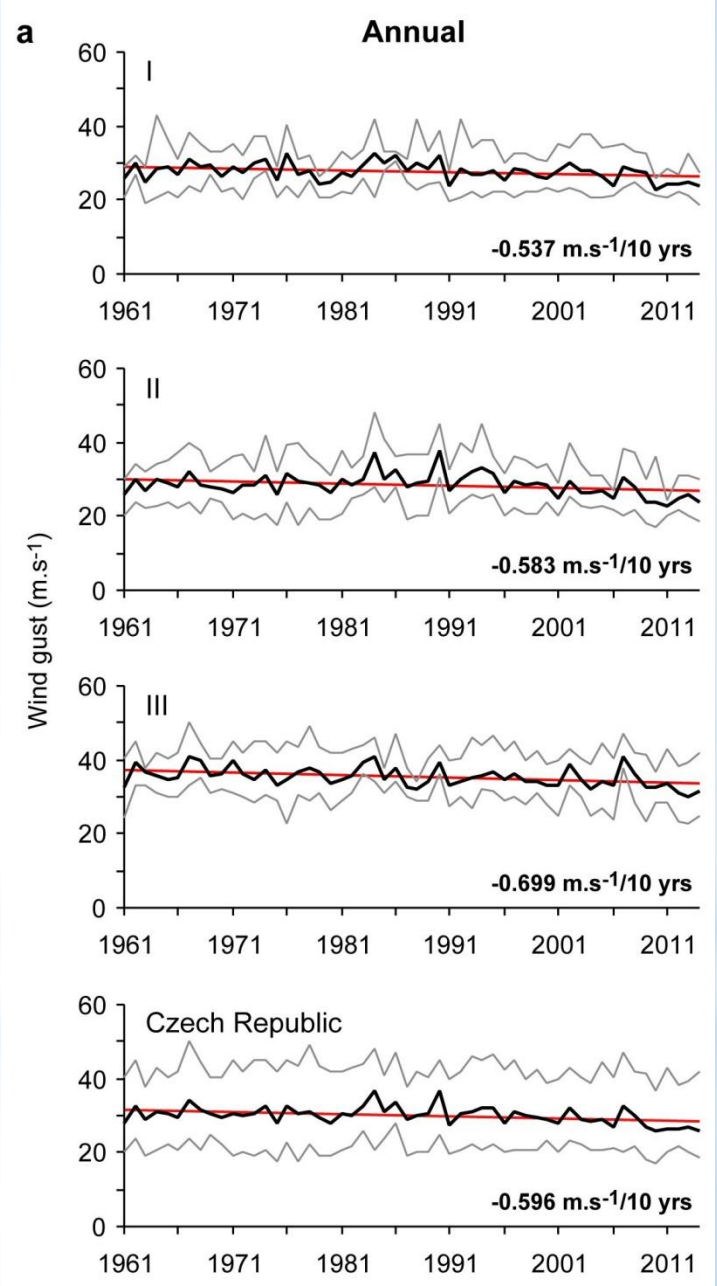
II.301-600

III.601-900/ above 600

IV. above 900/ No category

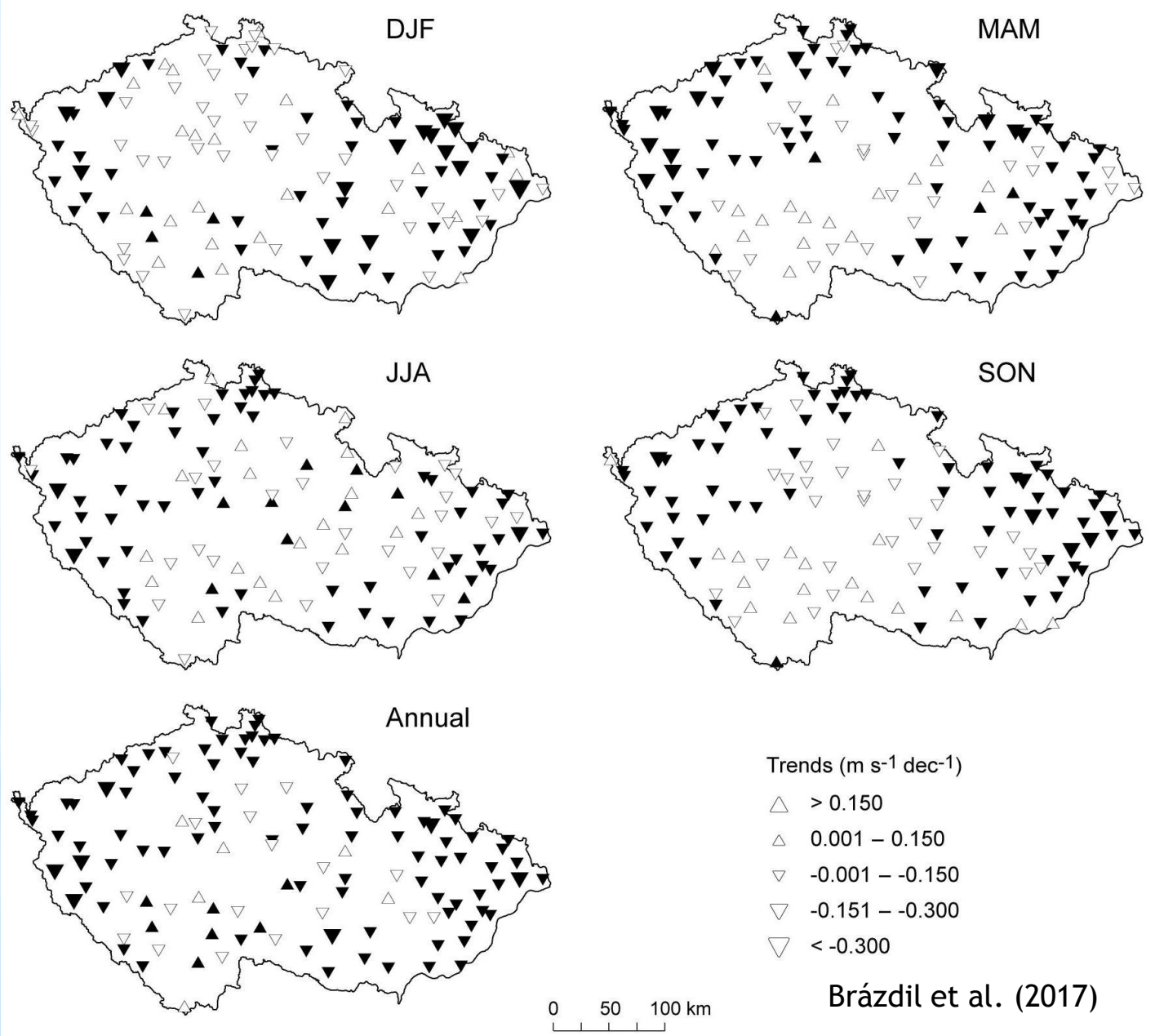
Brázdil et al. (2017)

Wind gust 1961-2014



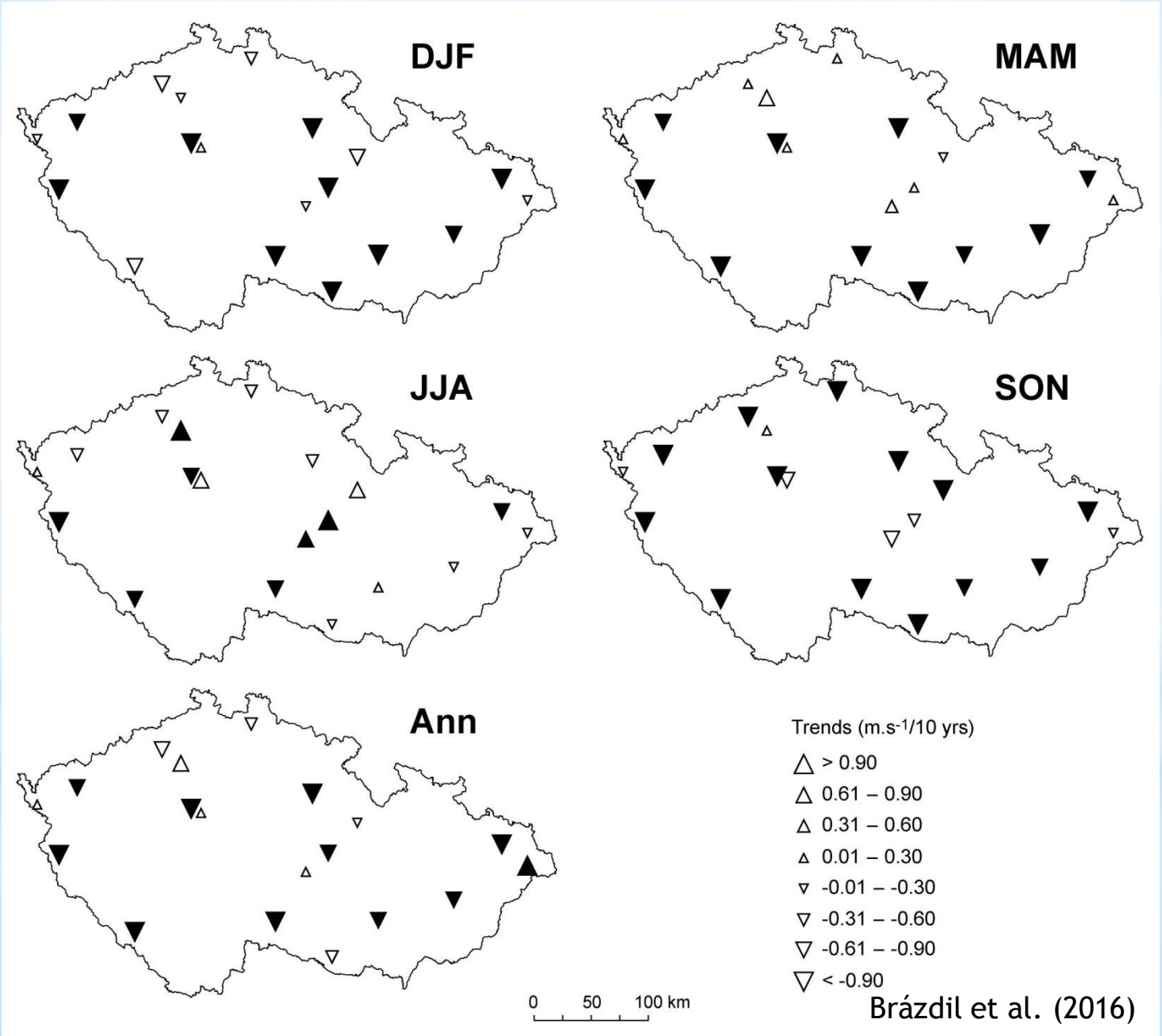
Brázdil et al. (2016)

Average wind speed



Brázdil et al. (2017)

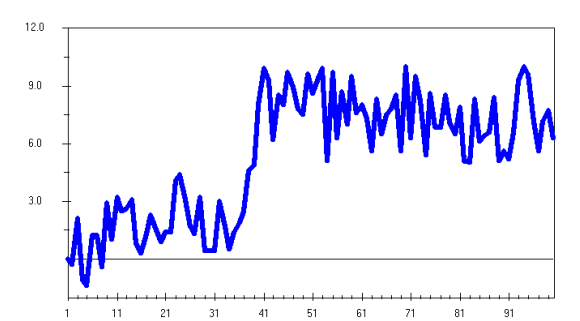
Wind gust

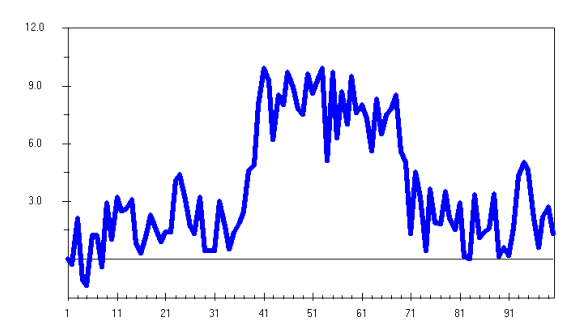


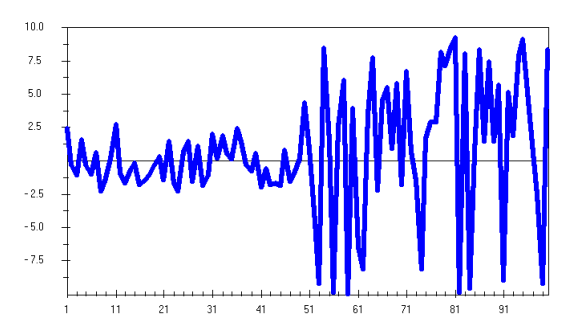
Brázdil et al. (2016)

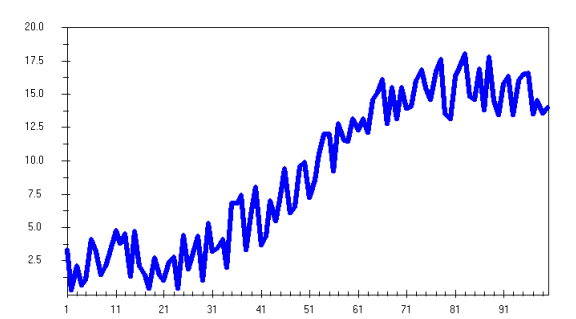
It looks great!!!
But is it all without problems?

Quality control and homogenization

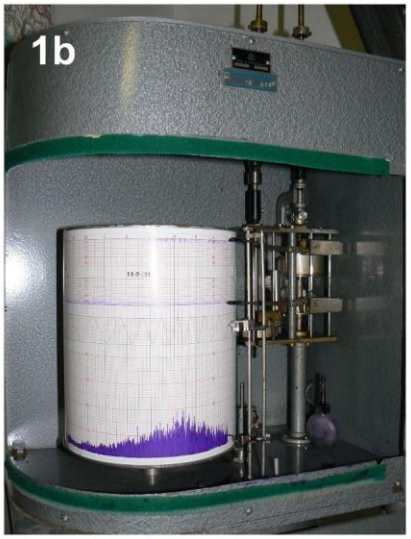








Change of intruments

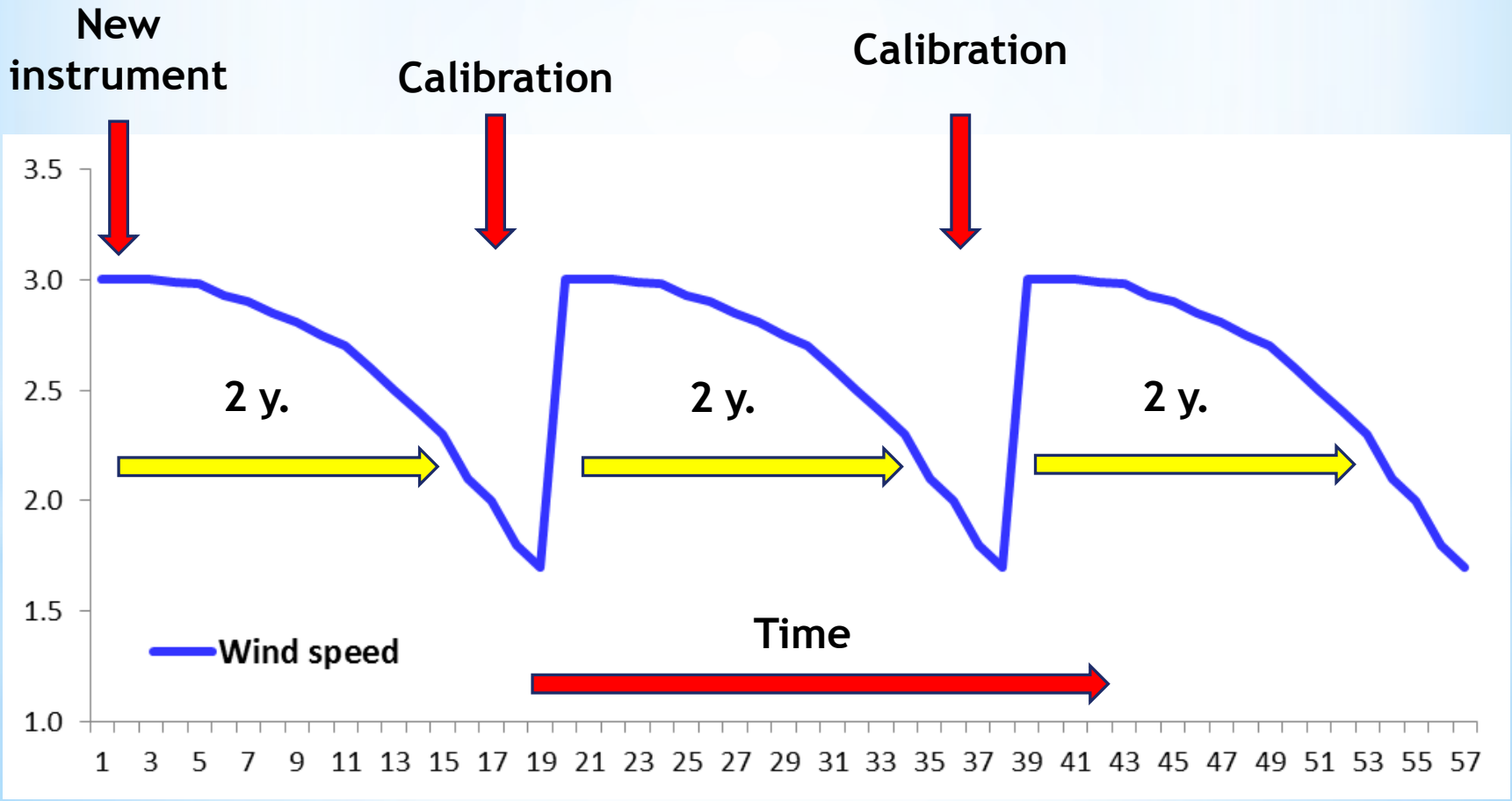


1. Metra Anemograf
2. Vaisala
3. Ultrasonic

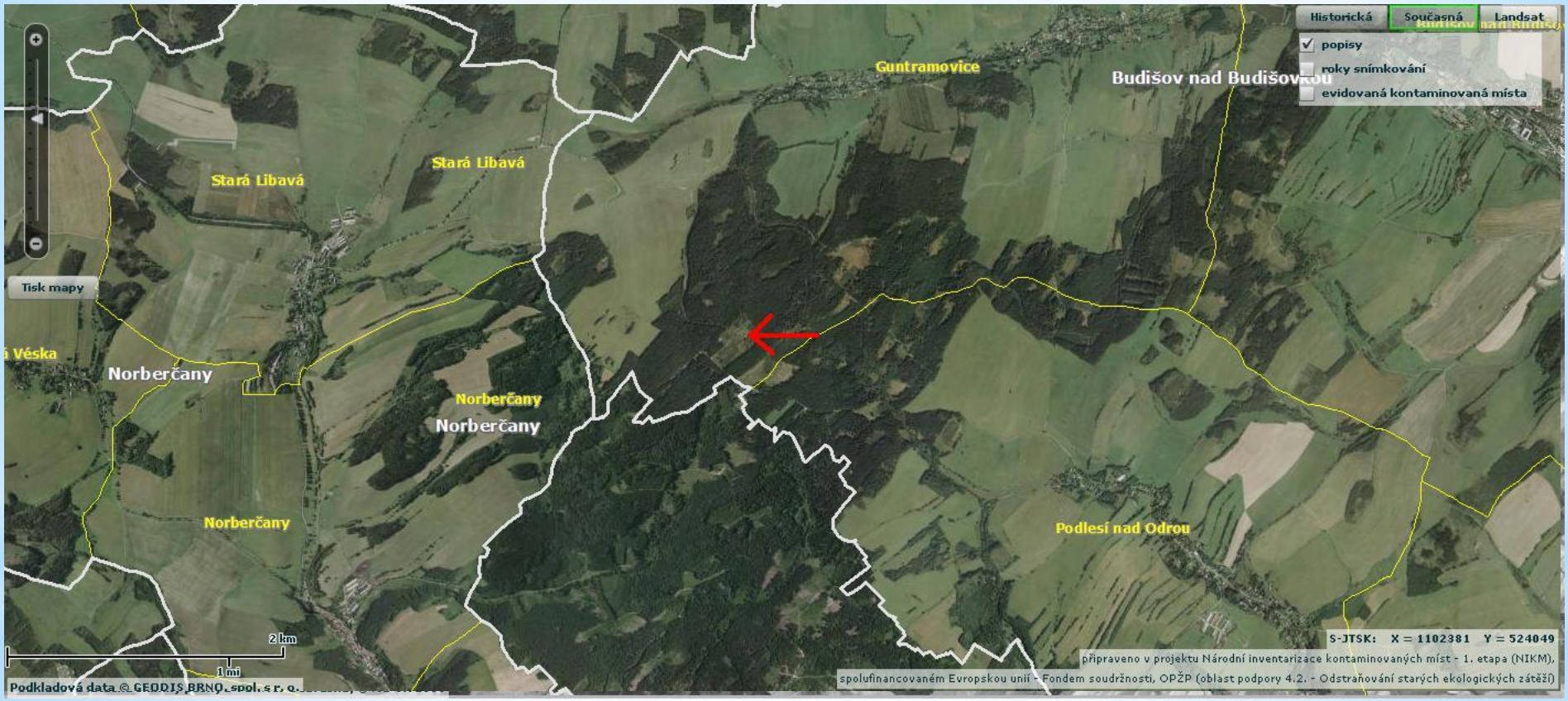
Brázdil et al. (2016)
Photo: CHMI, Ostrava

Calibration

- Necessary to correct and frequently calibrate instruments
- Anemograph or automatic cup instruments (Vaisala): The problem with the ball-bearing, when the device is unable to spin (more calm and lower high speed)

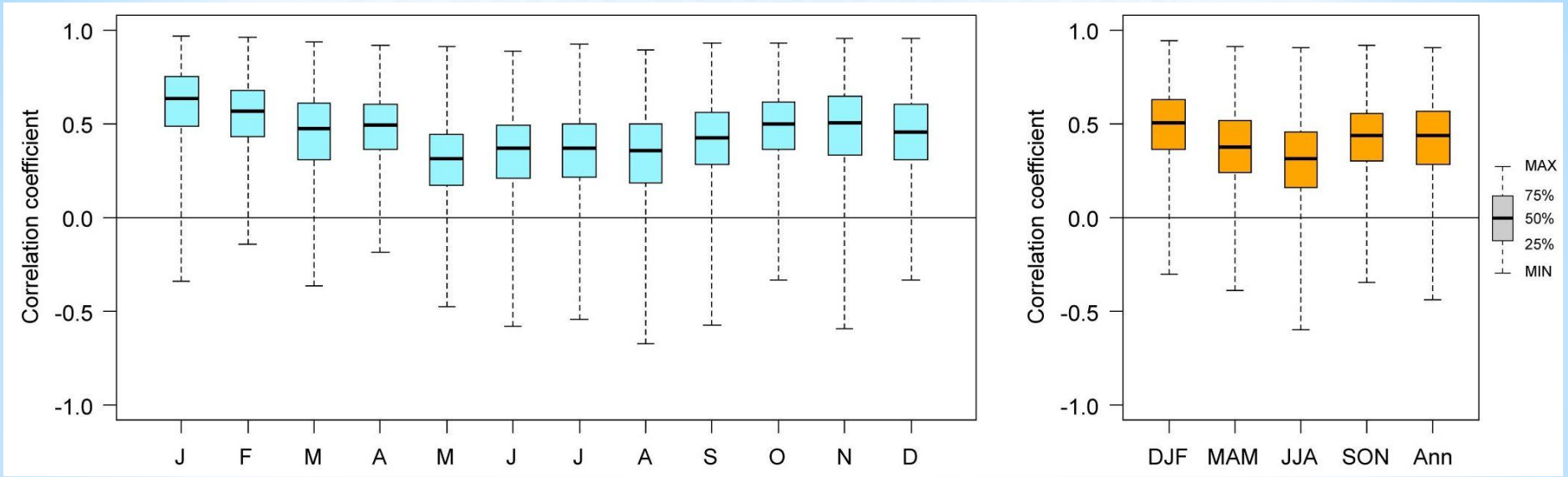


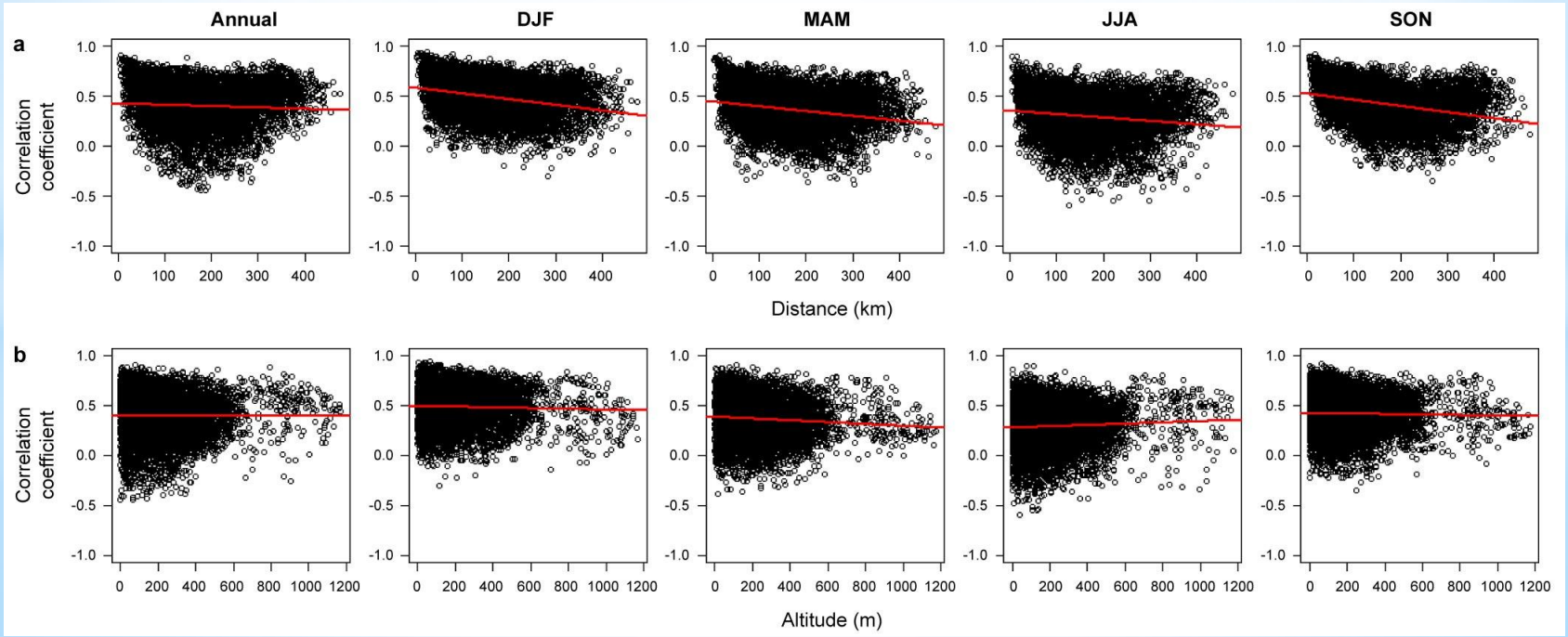
Change in surroundings



Station Červená – change 1954 – 2006
Foto: OMK Ostrava

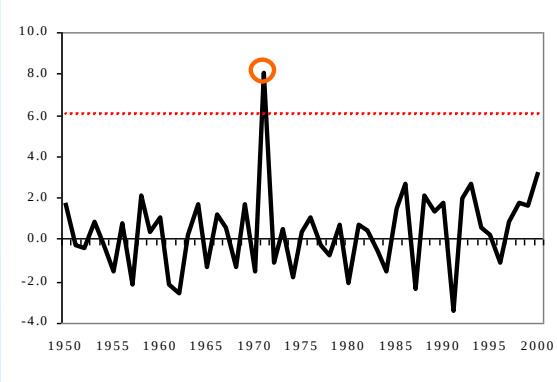
Spatial relationships





Data Quality Control

*Own approach, combination of several methods



Interquartile ranges

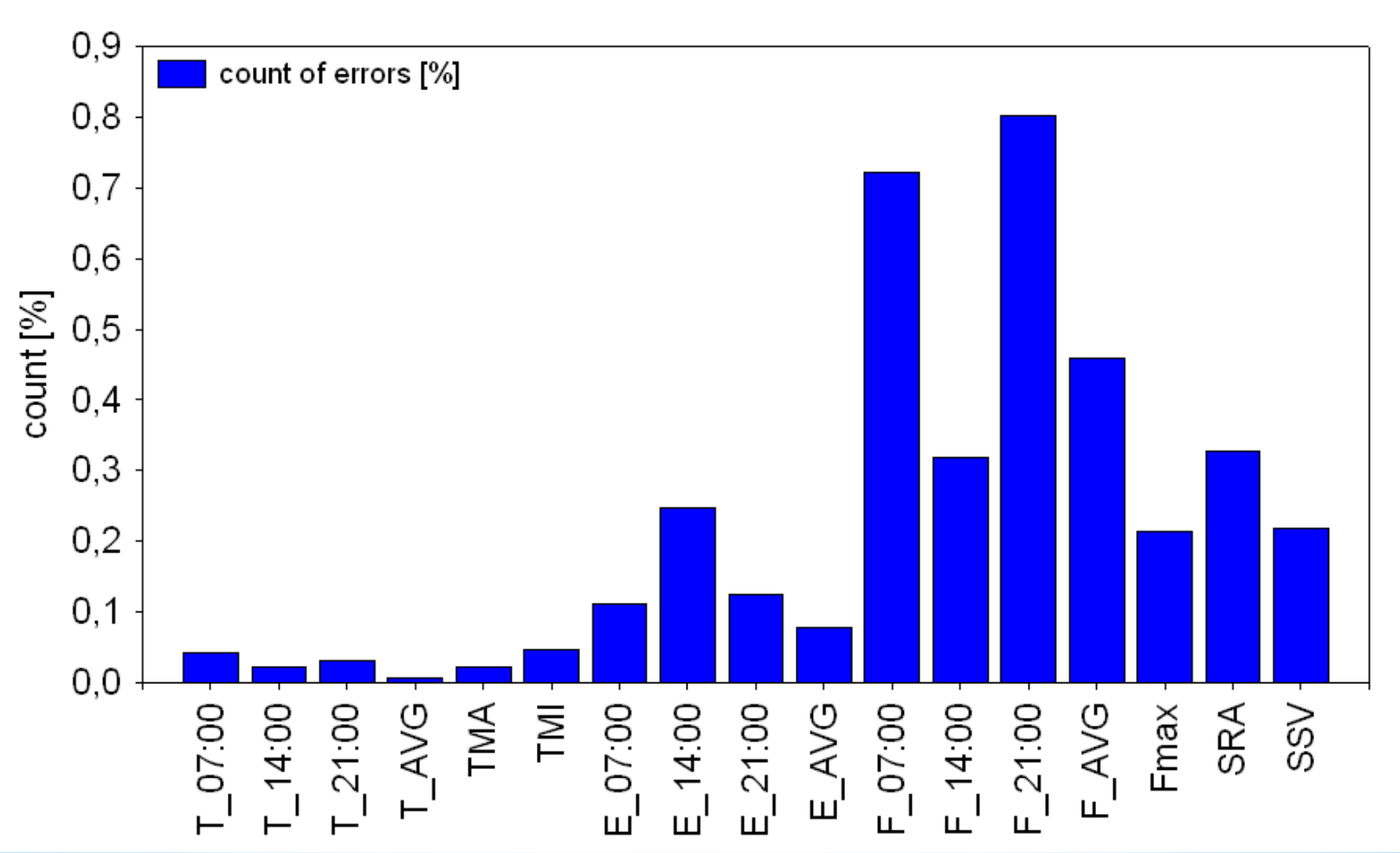
Comparing with neighbours

Comparing with expected values

A	B	C	D	E	F	G	H	I	J	K	L	M	N
REGIC	ID	YE	MONT	DA	ST_BASE	EXPECT	REMAR	ST_1	ST_2	ST_3	ST_4	ST_5	DIF1_S
T_03:30	B2BTUR01_T_03:30				241,00		Altitude	235,00	670,00	203,00	210,00	749,00	1
T_03:30	B2BZAB01_T_03:30						st_1, di	11,58					
T_03:30	B1PROT01_T_03:30						st_2, di		36,85				
T_03:30	O3PRER01_T_03:30						st_3, di			59,12			
T_03:30	O2OLOM01_T_03:30						st_4, di				62,88		
T_03:30	O1CERV01_T_03:30						st_5, di					91,95	
T_03:30	**B2BTUR01_T_03:30**	**2006**	**6**	**25**	**27,30**	**17,28**		**17,30**	**16,10**	**15,50**	**15,80**	**16,10**	**-7**

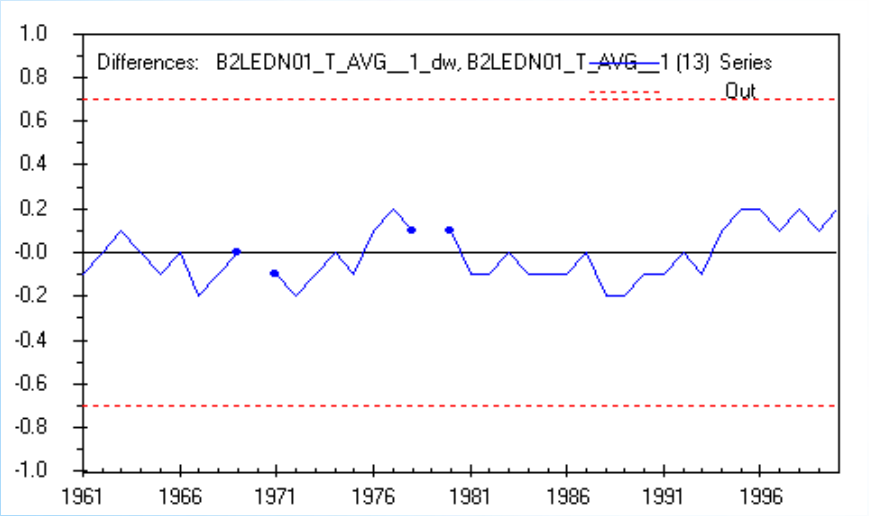
Data Quality Control

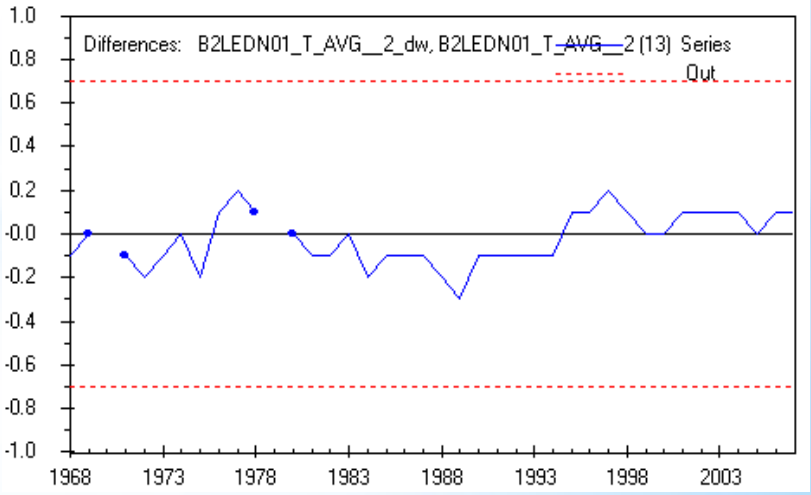
* Most suspicious values were found in the case of the wind speed (0.8 %)



Homogenization - Detection

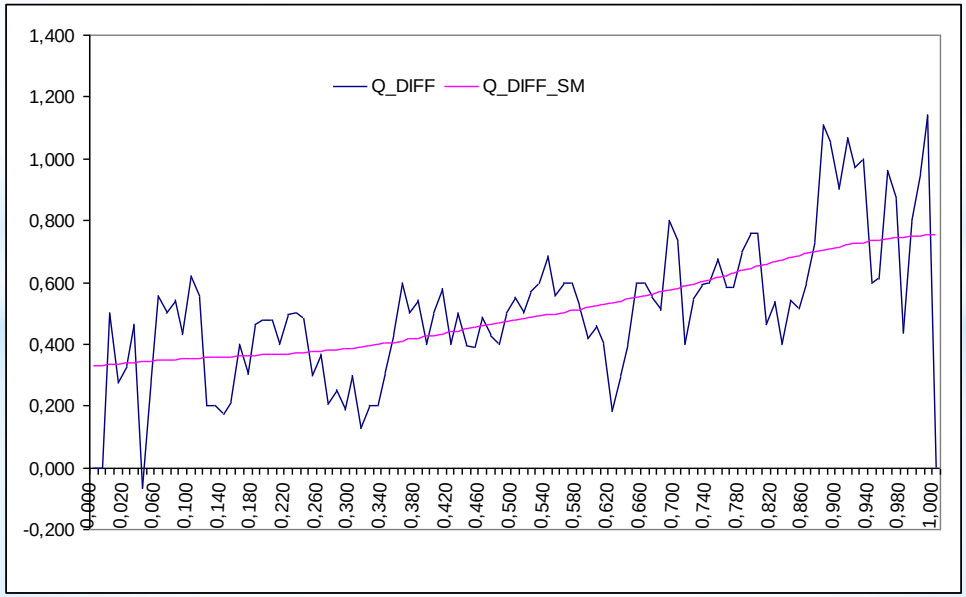
* Detection - monthly data
* Two types of reference series
  * calculated one reference series from nearest or best correlated neighbours stations
  * **Pair-wise detection** - comparison with each neighbours station individually
* SNHT, Bivariate and t-test





Correction method

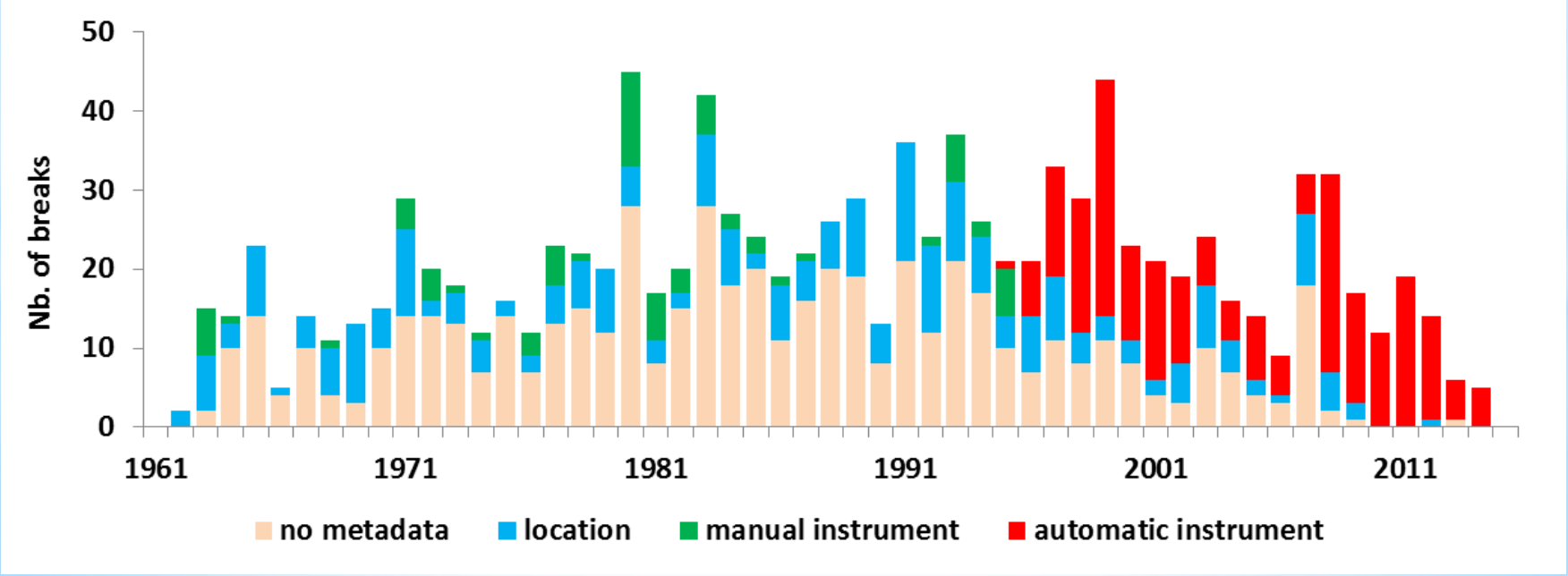
* For daily data
* Our own method – DAP (Distribution Adjusting by Percentiles) - an adaptation of a method for the correction of regional climate model outputs by Deque (2007) – variable correction
* Is based on comparison of percentiles (empirical distribution) of differences (or ratios) between candidate and reference series before and after a break.



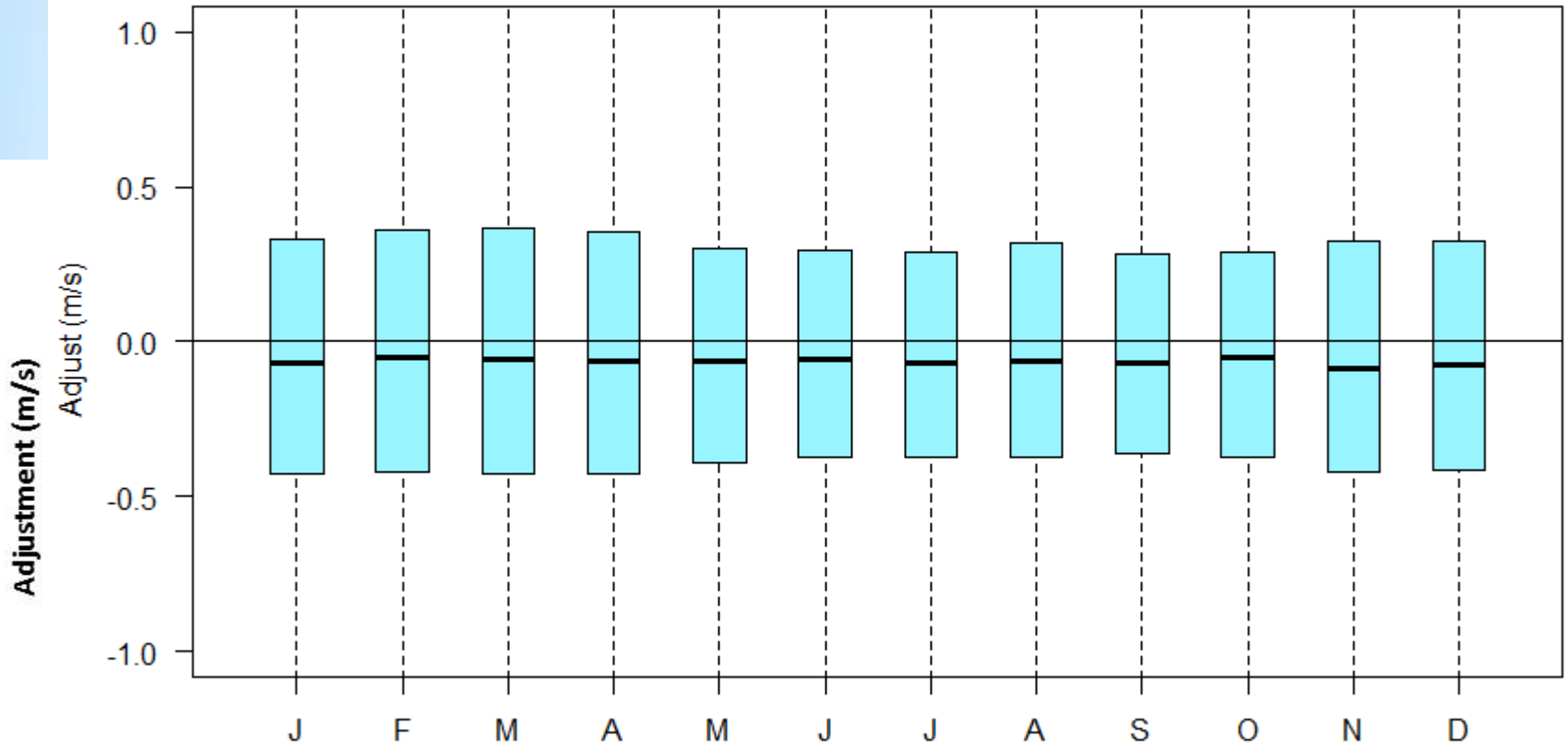
Homogenization - results

1. First in year 2008 (1961 – 2007)

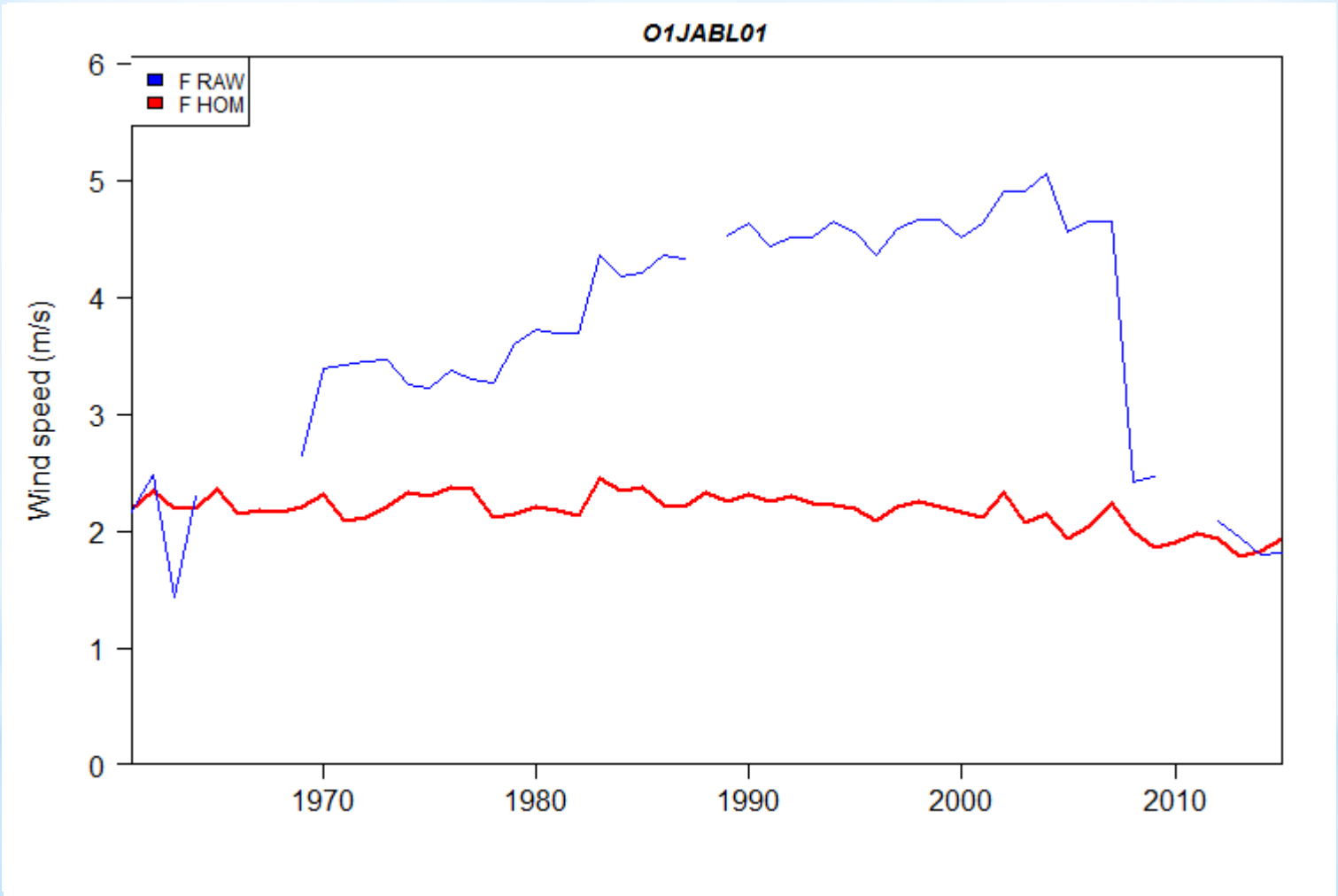
Element	Nb. series	Nb. series with break	Ratio (%)	Nb. Breaks in series			
				0	1	2	3
Temperature	181	100	55.2	81	77	21	2
Max Temp	178	122	68.5	56	88	32	2
Min Temp	179	92	51.4	87	68	23	1
Precipitation	761	117	15.4	644	110	7	0
Water vapour	173	123	71.1	50	83	34	6
Wind speed	176	132	75.0	44	85	39	8
Sunshine	102	55	53.9	47	49	5	1



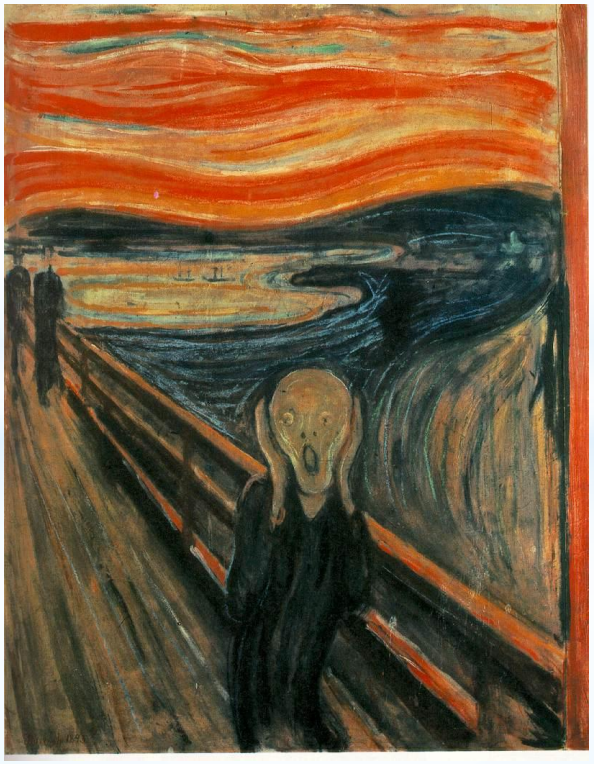
Homogenization - results



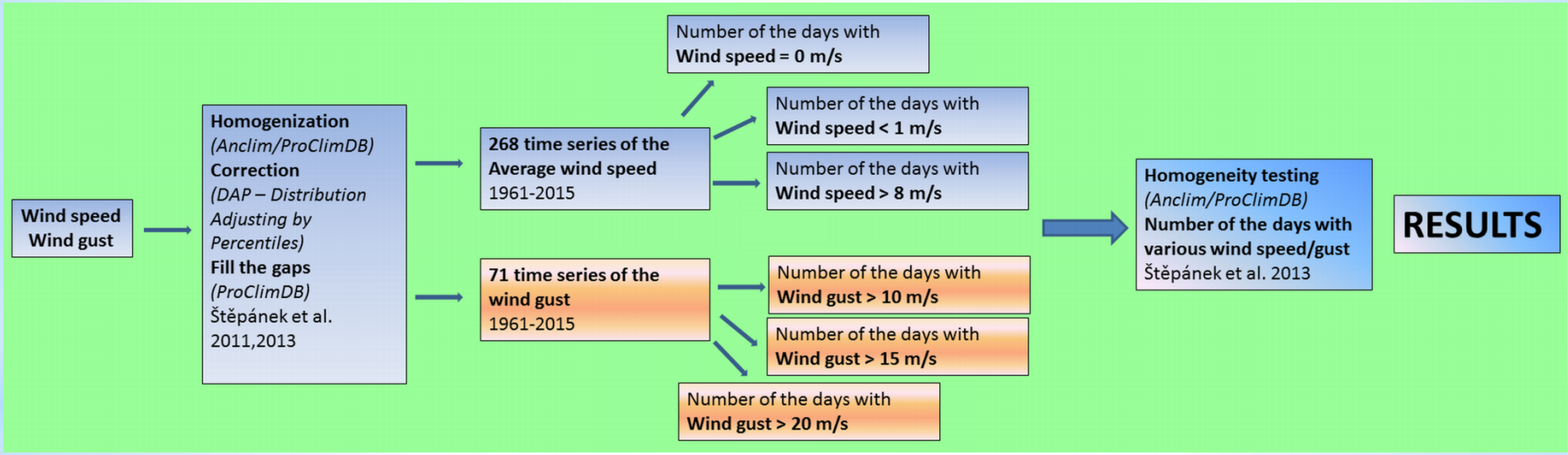
Homogenization - results



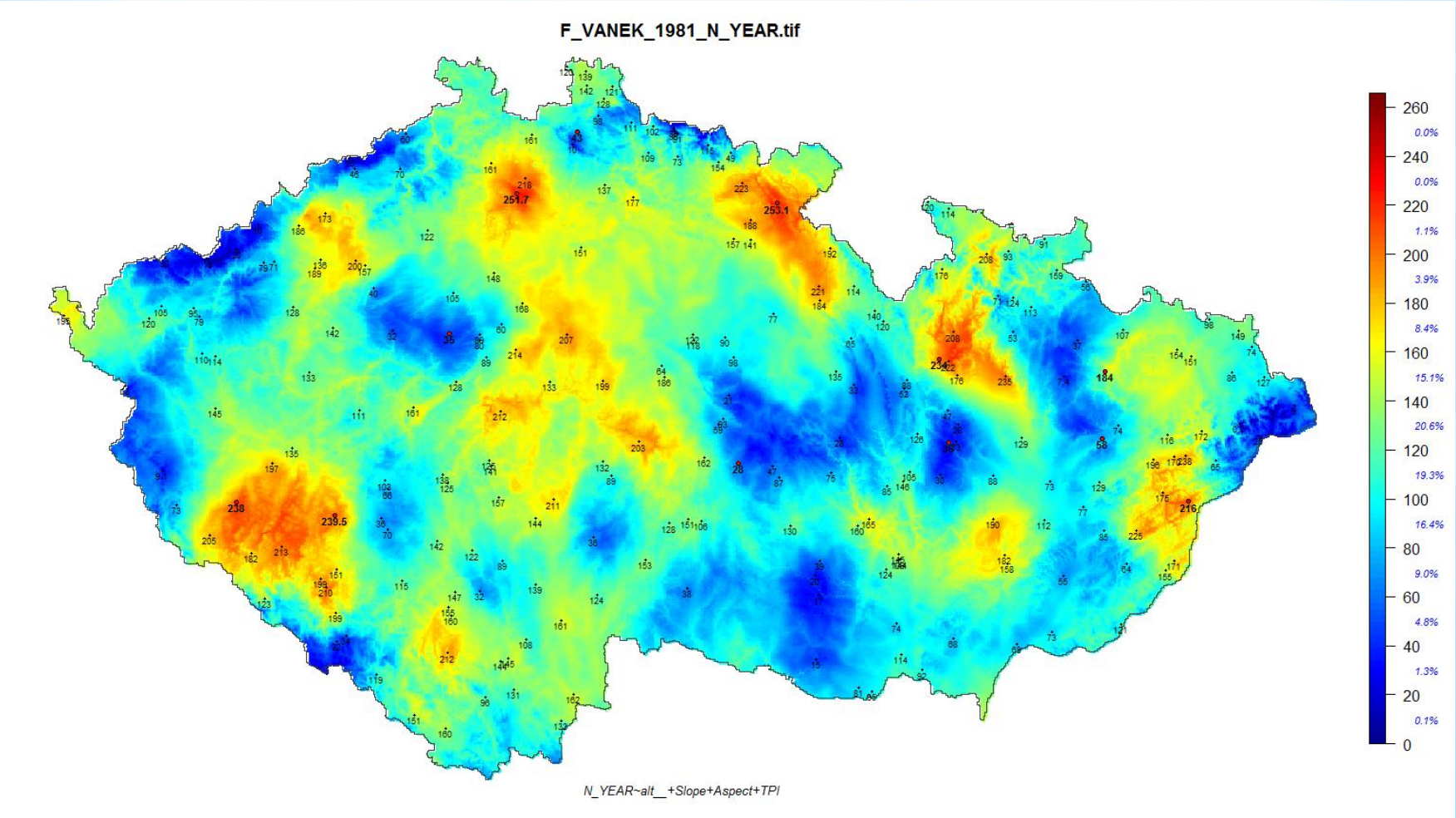
Homogenization solve everything??? Unfortunately, no!!!



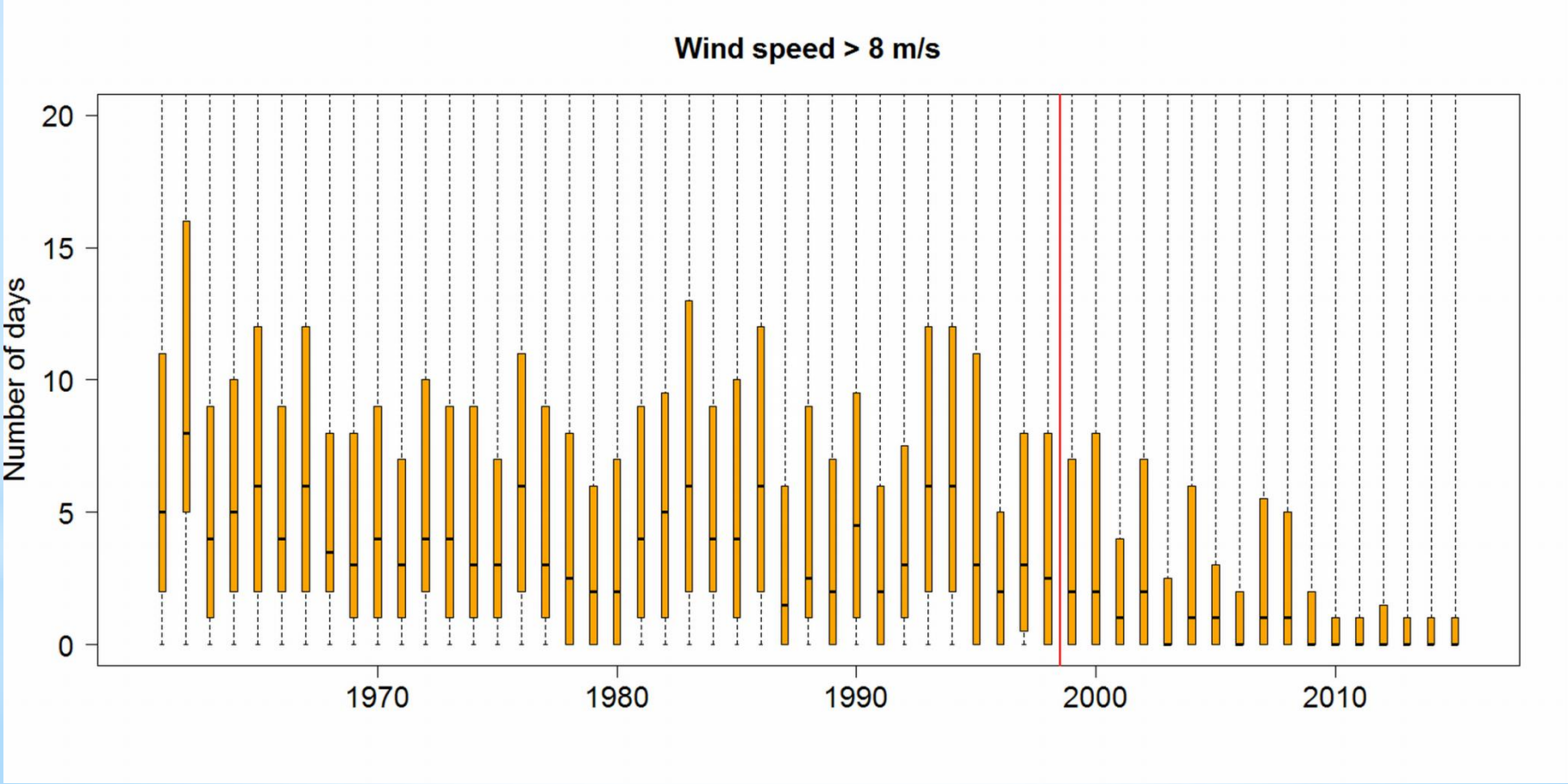
Number of day below/above certain threshold (for example: number of the windstorms)



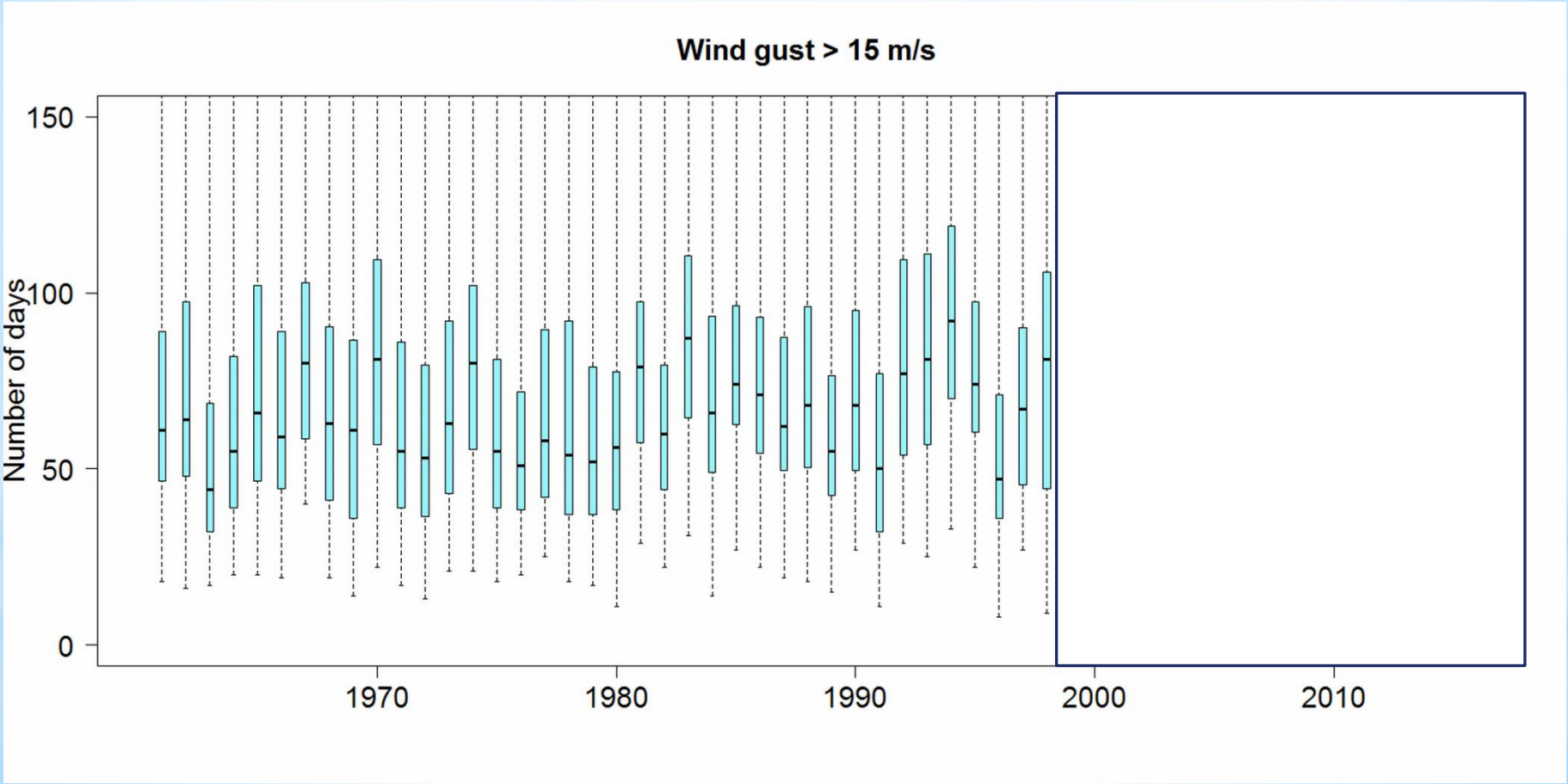
Number of days below/above certain threshold (breeze; wind < 1.5 m/s)



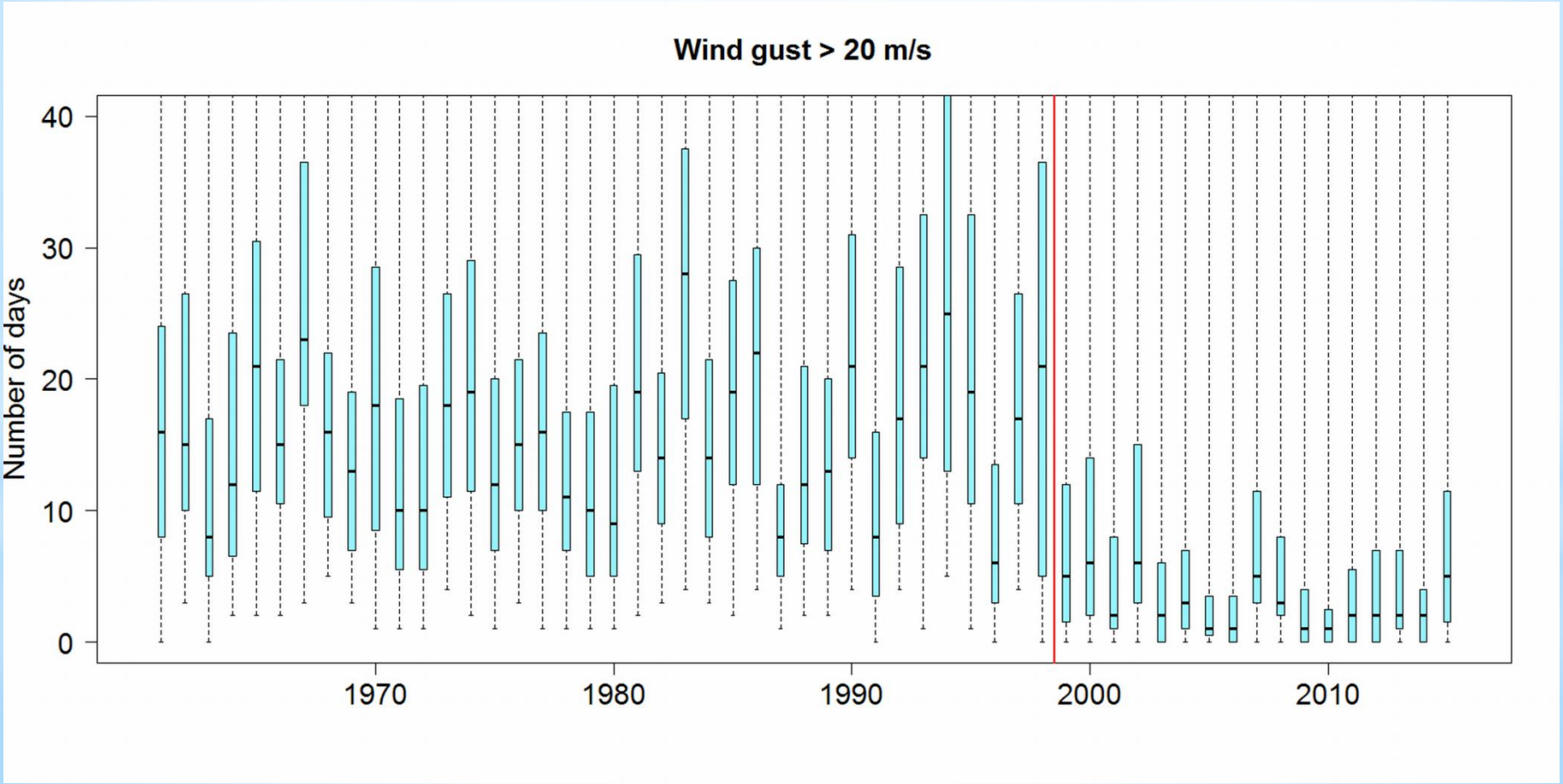
Number of days below/above certain threshold



Number of days below/above certain threshold



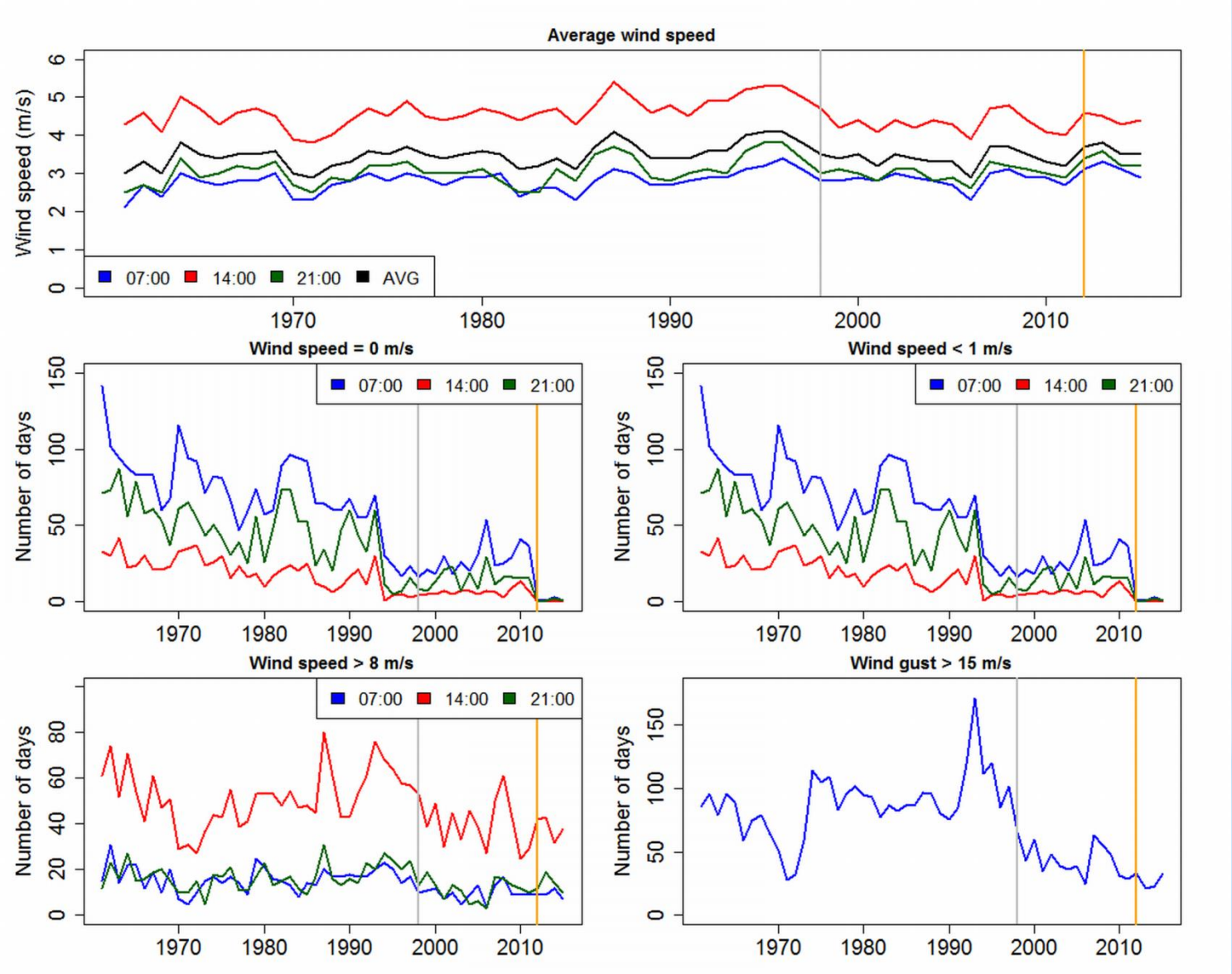
Number of days below/above certain threshold



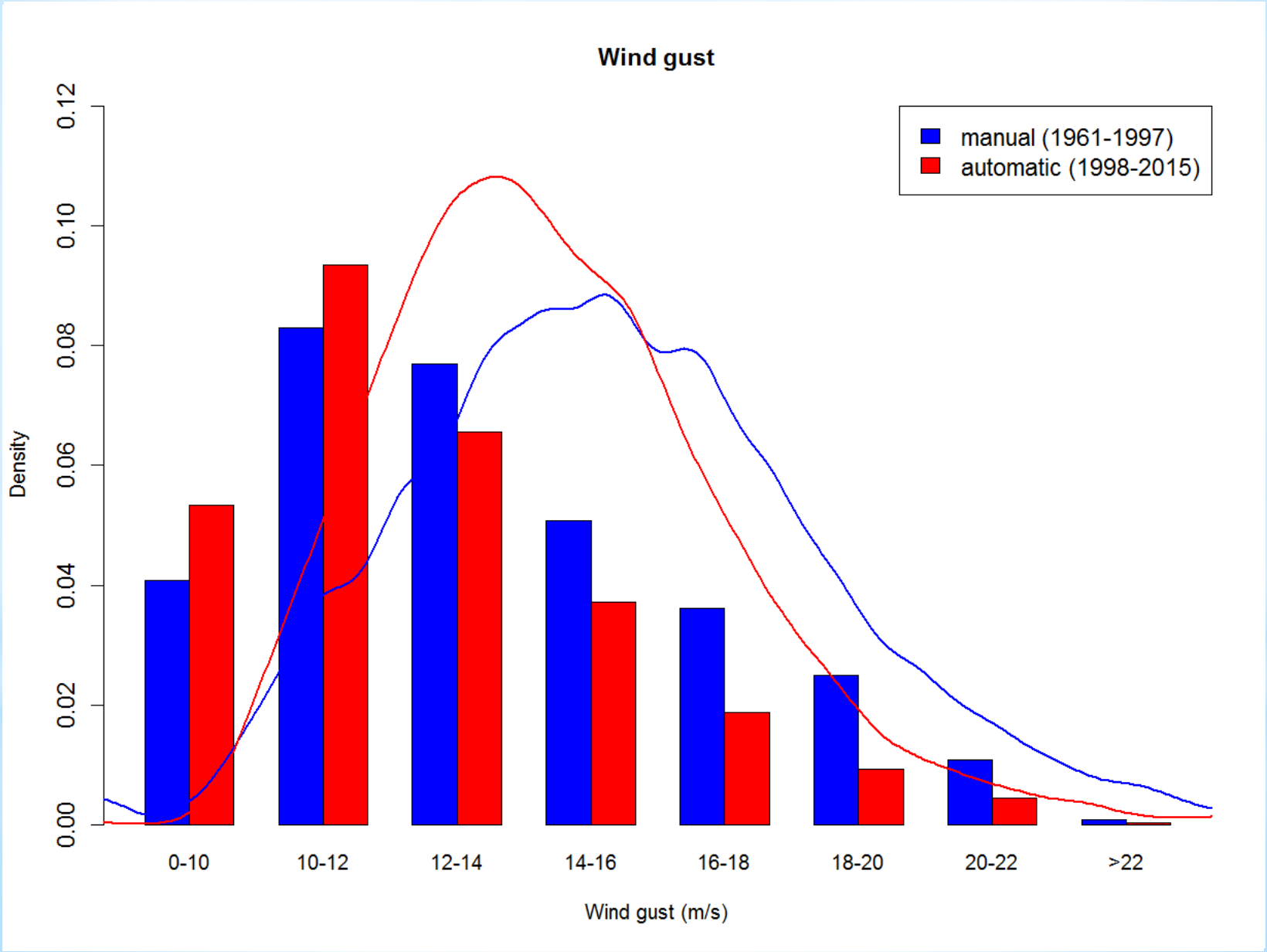
Number of days below/above certain threshold

Characteristics	1961-1990	1997-2015	Ratio (%)
Wind speed = 0 m/s	9.6	9.6	100
Wind speed < 1 m/s	54	53	98
Wind speed > 8 m/s	9.7	4.7	48
Wind gust > 10 m/s	199.8	149.8	75
Wind gust > 15 m/s	75.9	42.8	56
Wind gust > 20 m/s	22.9	11.5	50

Brno – Tuřany (raw data)

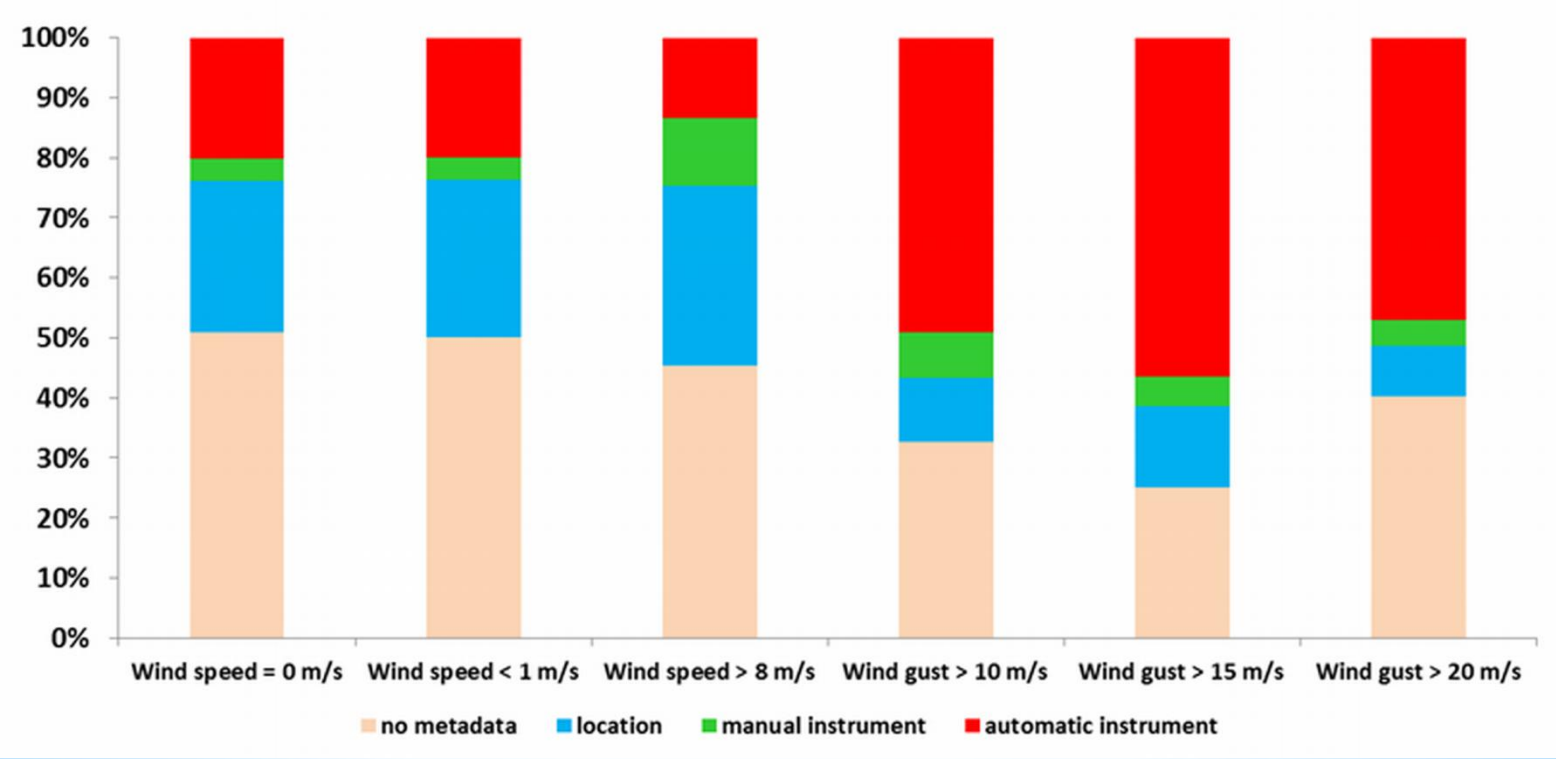


Brno - Tuřany (raw data)



Homogenization results

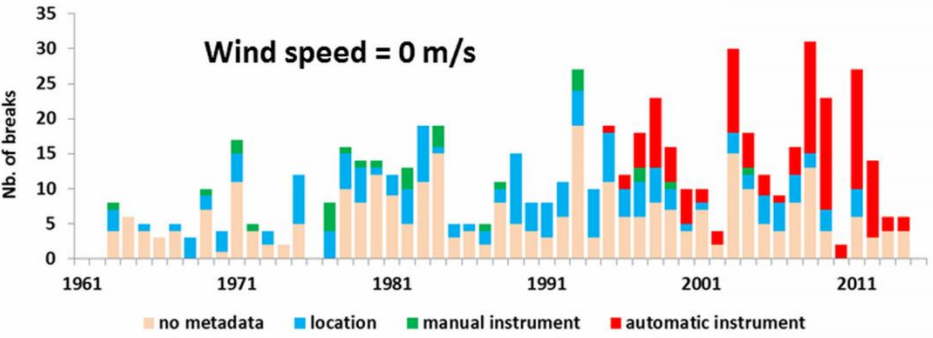
Characteristics	Nb. of stations	Nb. of inhom. stations	Percetage (%)	Nb. of breaks	breaks/station
Wind speed = 0 m/s	268	238	88.8	610	2.6
Wind speed < 1 m/s	268	264	98.5	779	3.0
Wind speed > 8 m/s	268	191	71.3	304	1.6
Wind gust > 10 m/s	71	70	98.6	159	2.3
Wind gust > 15 m/s	71	63	88.7	124	2.0
Wind gust > 12 m/s	71	63	88.7	117	1.9

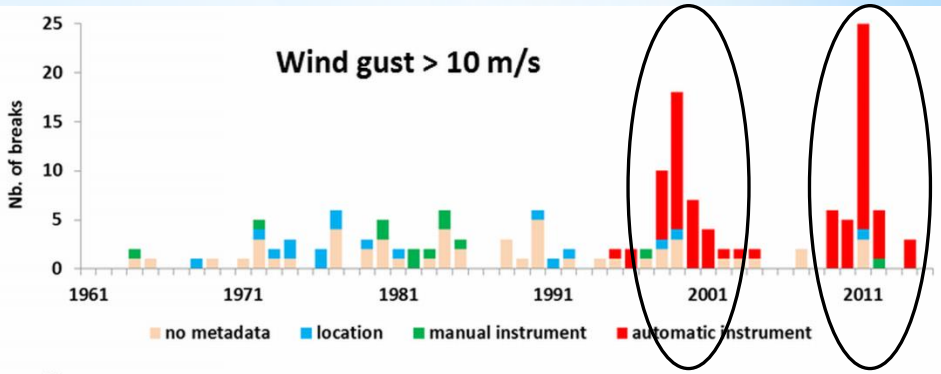


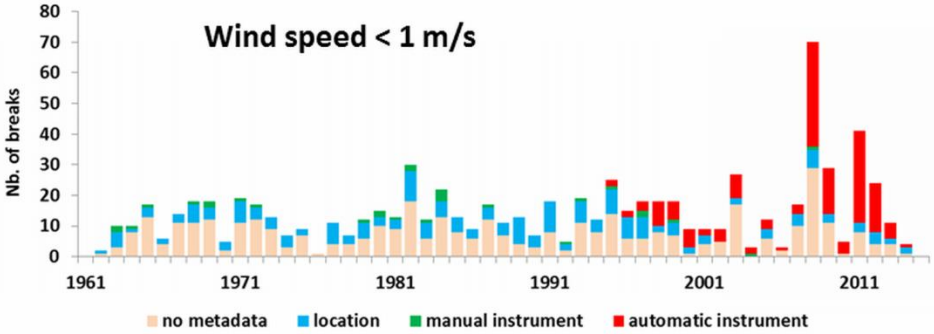
Homogenization results

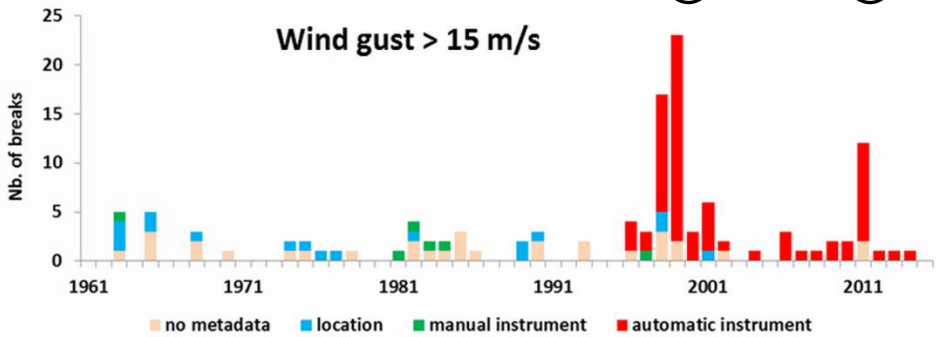
Vaisala

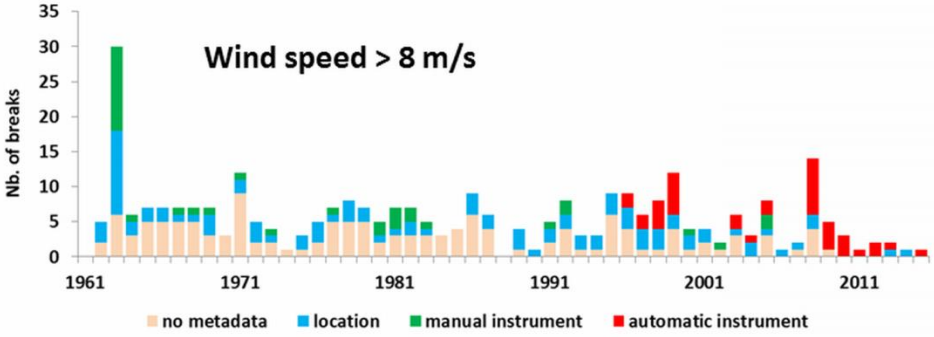
Ultrasonic/ calibration

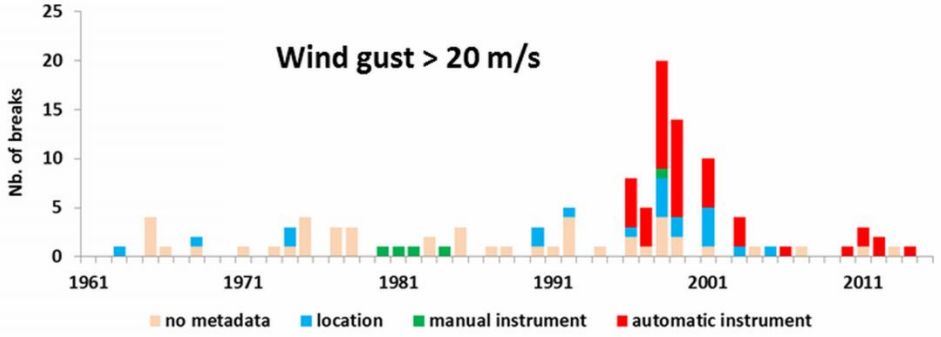












Conclusion

1. The observed change in wind speed is part of nature?

Perhaps, but regarding the way we measure it, we may never know

2. The observed change in wind speed is the work of man?

The change of the station surroundings and the increase in roughness of the terrain definitely has an impact on reducing wind speed

3. The observed change in wind speed is caused by automatiozation?

Yes, the change in methodology and measurement instruments made significant impact on the time series and the question is how much it influences trend and how we are able to rightly correct it by homogenization

Thank you for your attentation