

Comparison of different geostatistical approaches to estimate wind speed at hourly scale in the province of Granada (Southern Spain)

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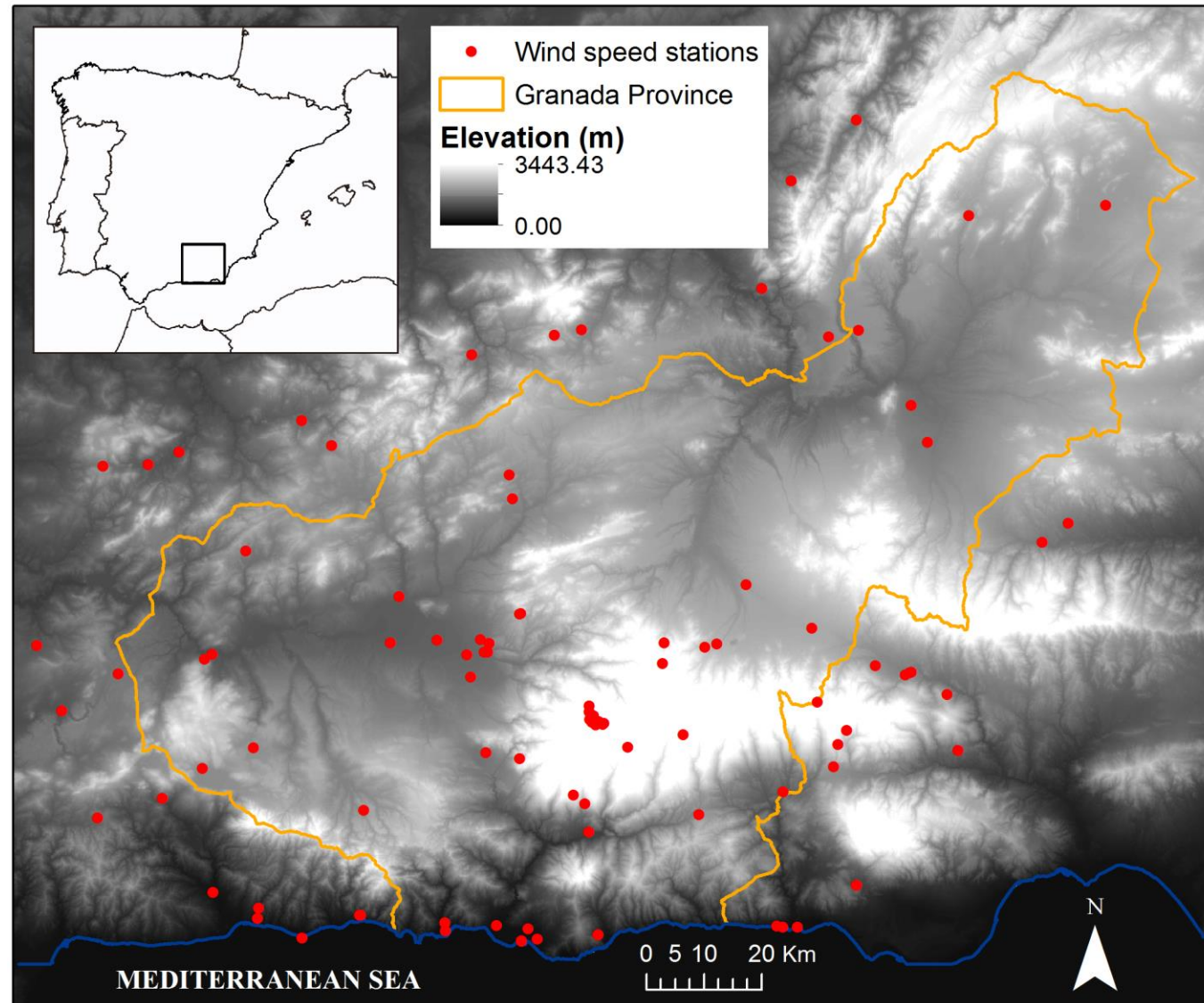
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Case study

Granada Province (South Spain) (12637.40 Km²)

Objectives

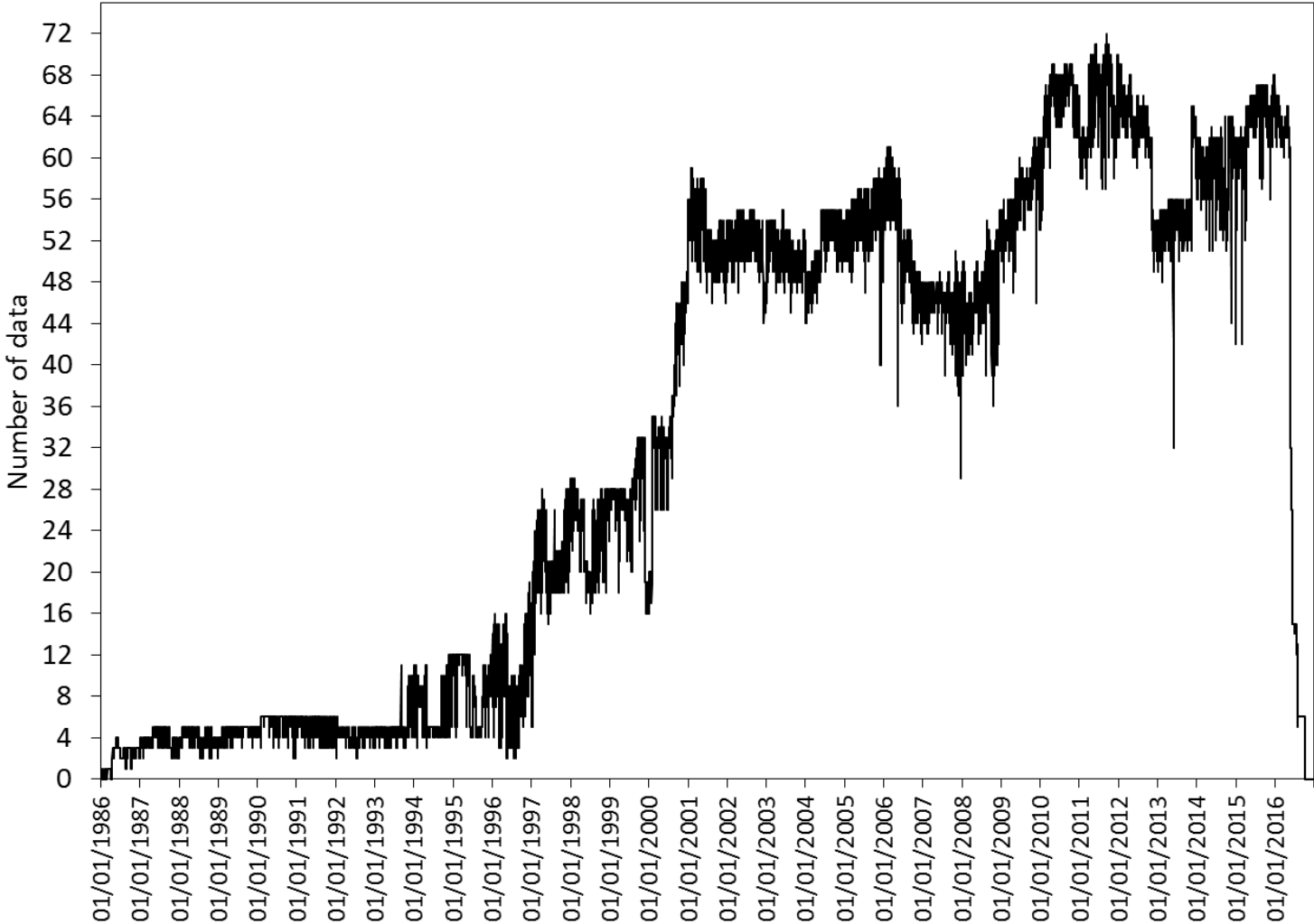
- Comparison of different geostatistical approaches and transformations of data to estimate wind speed at hourly scale .
- Estimation using the best approach (300 m spatial resolution, hourly temporal resolution)



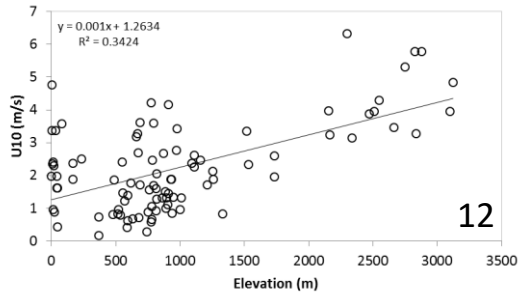
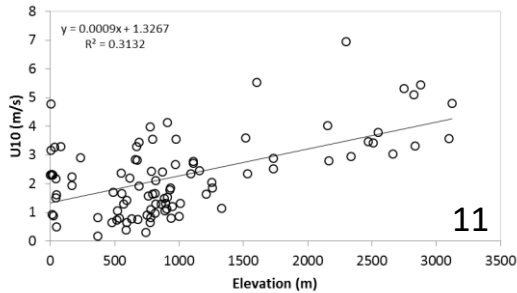
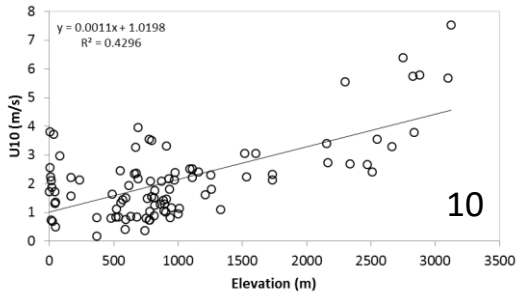
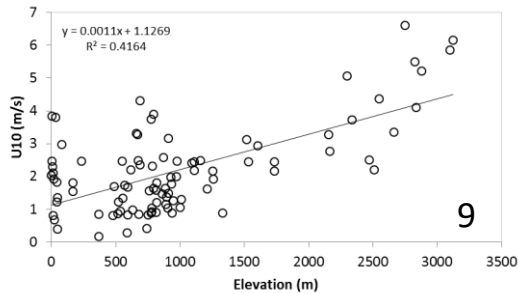
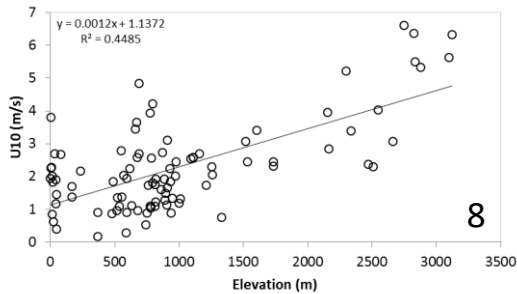
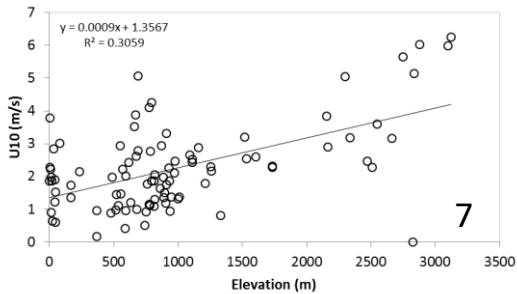
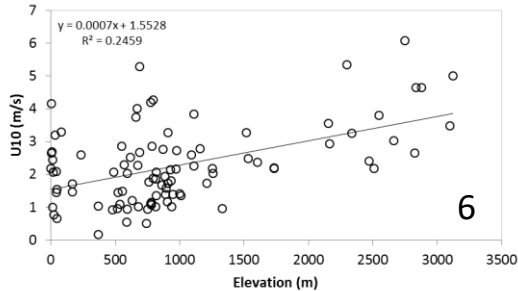
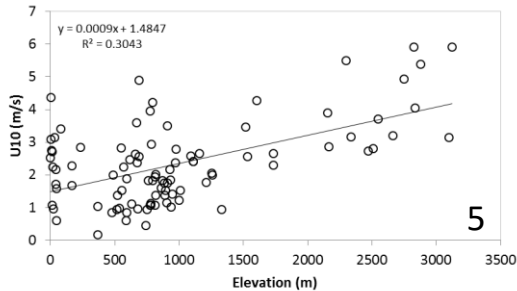
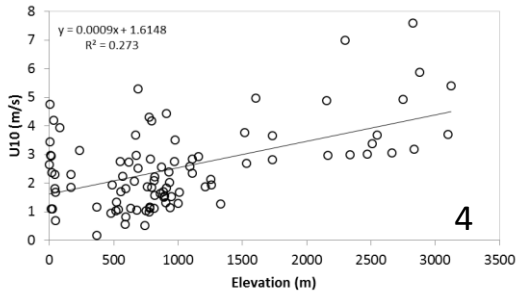
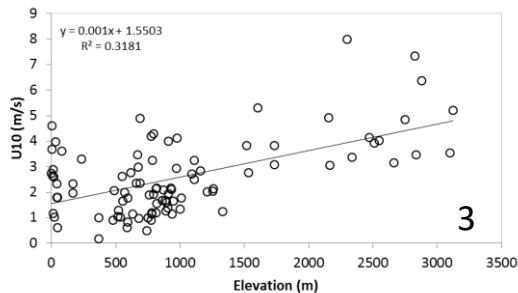
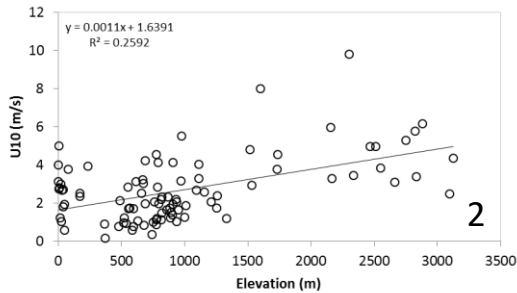
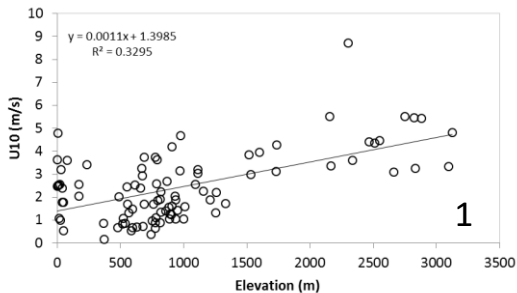
Data

Hourly wind speed (**U10**) 96 stations
1986-2016
AEMET
REDIAM
IFAPA
RED DE PARQUES NACIONALES
CETURSA

Estimation
1996-2016



Methodology: Monthly models



Methodology

Geostatistical techniques: Ordinary Kriging, Kriging with external drift, Regression-Kriging, Regression

Data transformation: Without transformation, mesoscale, logarithm

Transformation

Inverse

Inverse of the variance

Mesoscale

$$U_{80} = U_{10} \frac{\ln\left(\frac{80}{rug}\right)}{\ln\left(\frac{10}{rug}\right)}$$

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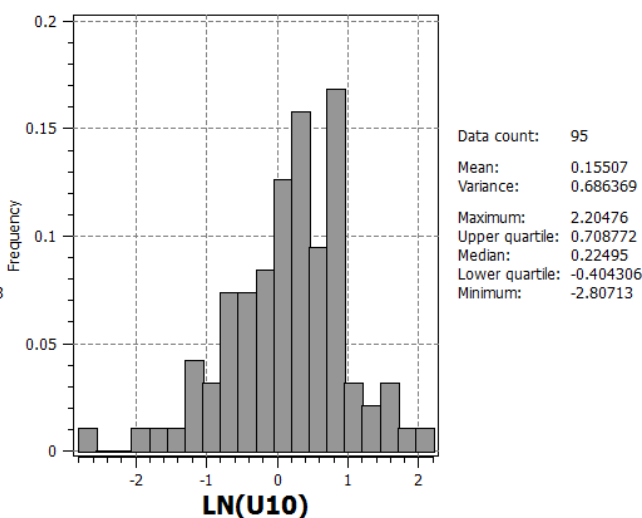
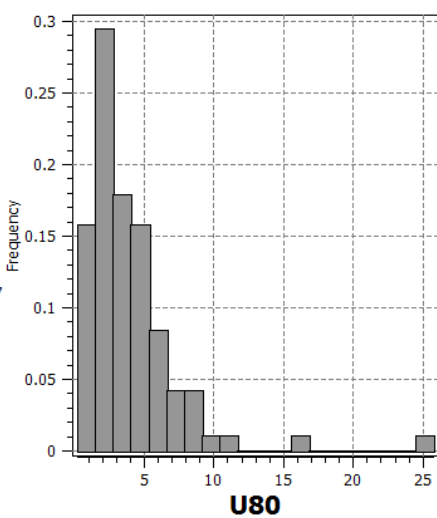
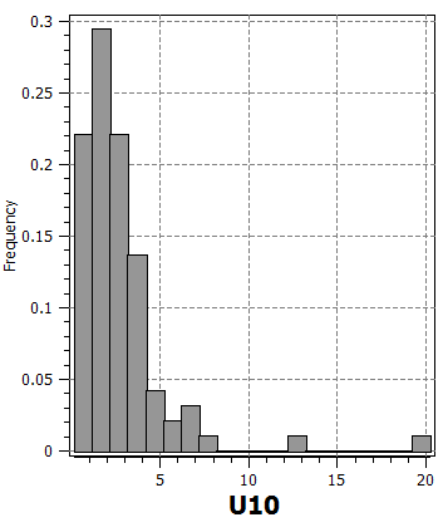
$$VAR(U_{10}) = VAR(U_{80}) \left(\frac{\ln\left(\frac{10}{rug}\right)}{\ln\left(\frac{80}{rug}\right)} \right)^2$$

Logarithm

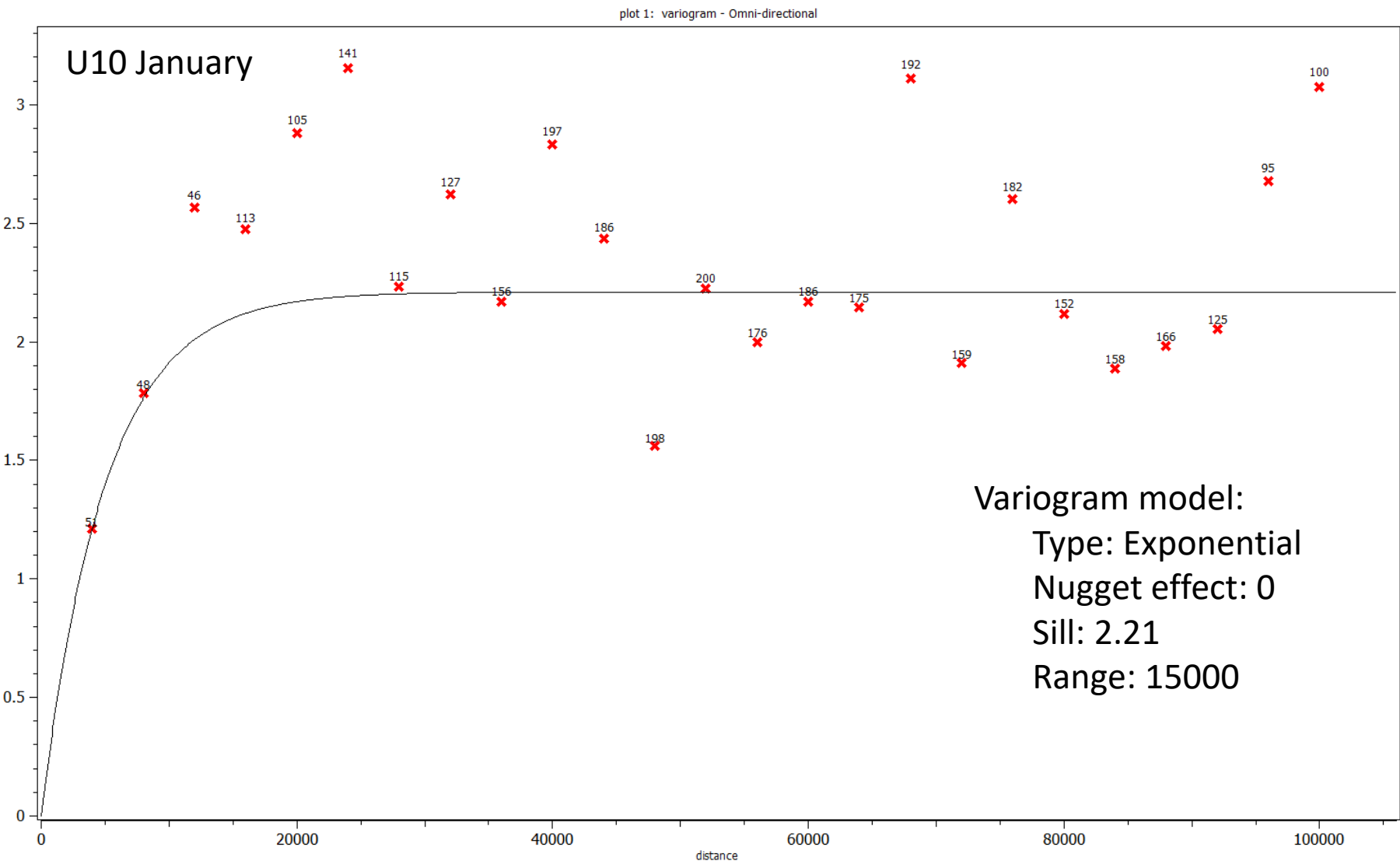
$$LU_{10} = \ln(U_{10})$$

$$U_{10} = \exp(LU_{10})$$

$$VAR(U_{10}) = \exp\left(2\sqrt{VAR(LU_{10})}\right)$$



Results Variograms



Results

Variograms

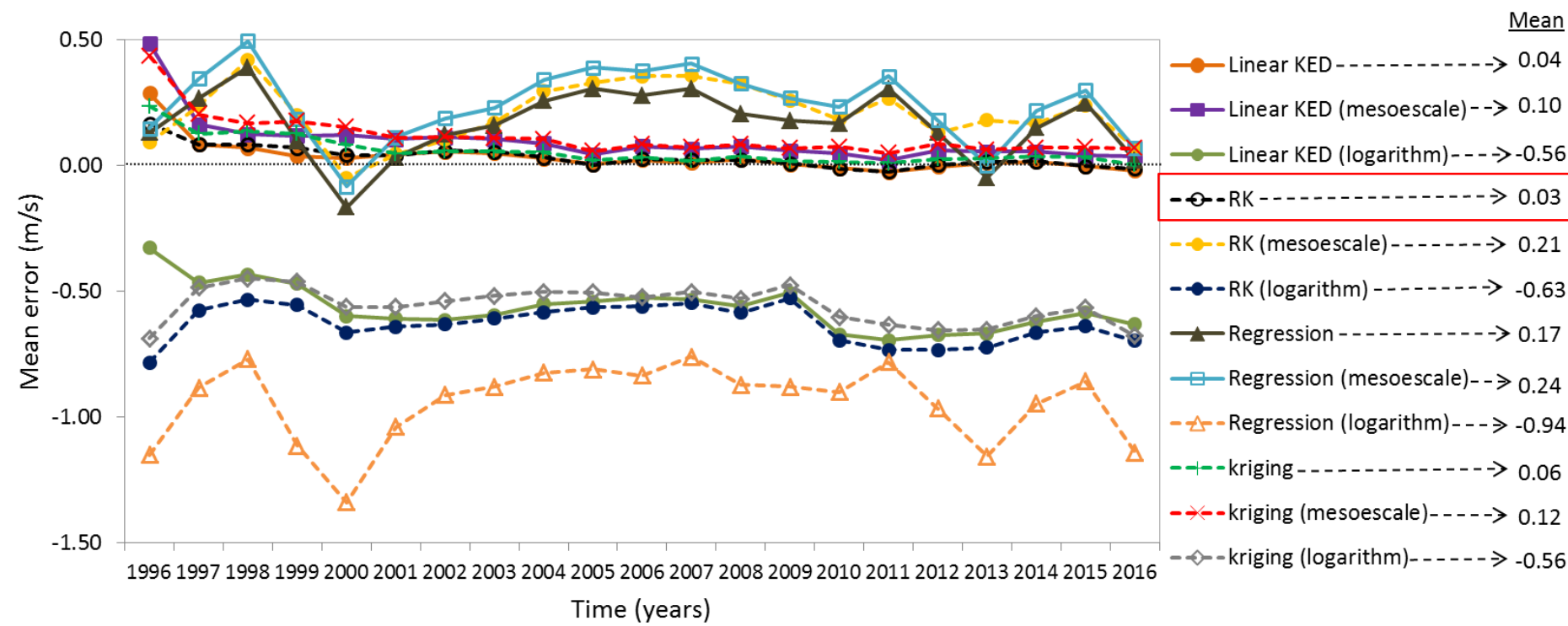
Variograms of the data (exponential)

Month	Sill			Theoretical range (km)		
	U10	U80	LN(U10)	U10	U80	LN(U10)
1	2.21	5.03	0.71	5.00	2.20	4.50
2	2.82	6.77	0.71	6.00	2.40	3.30
3	2.17	4.88	0.56	3.90	3.00	3.30
4	2.01	4.69	0.56	4.50	3.30	4.50
5	1.56	3.62	0.59	4.20	2.40	1.80
6	1.43	3.46	0.63	0.90	0.90	0.90
7	1.73	3.80	0.87	2.10	1.80	9.60
8	1.93	4.01	0.72	3.30	1.80	9.30
9	1.80	3.71	0.75	3.00	1.80	11.40
10	1.92	3.81	0.73	6.30	4.20	9.60
11	1.81	4.24	0.70	6.00	6.00	9.00
12	1.85	4.10	0.78	3.90	4.20	8.40

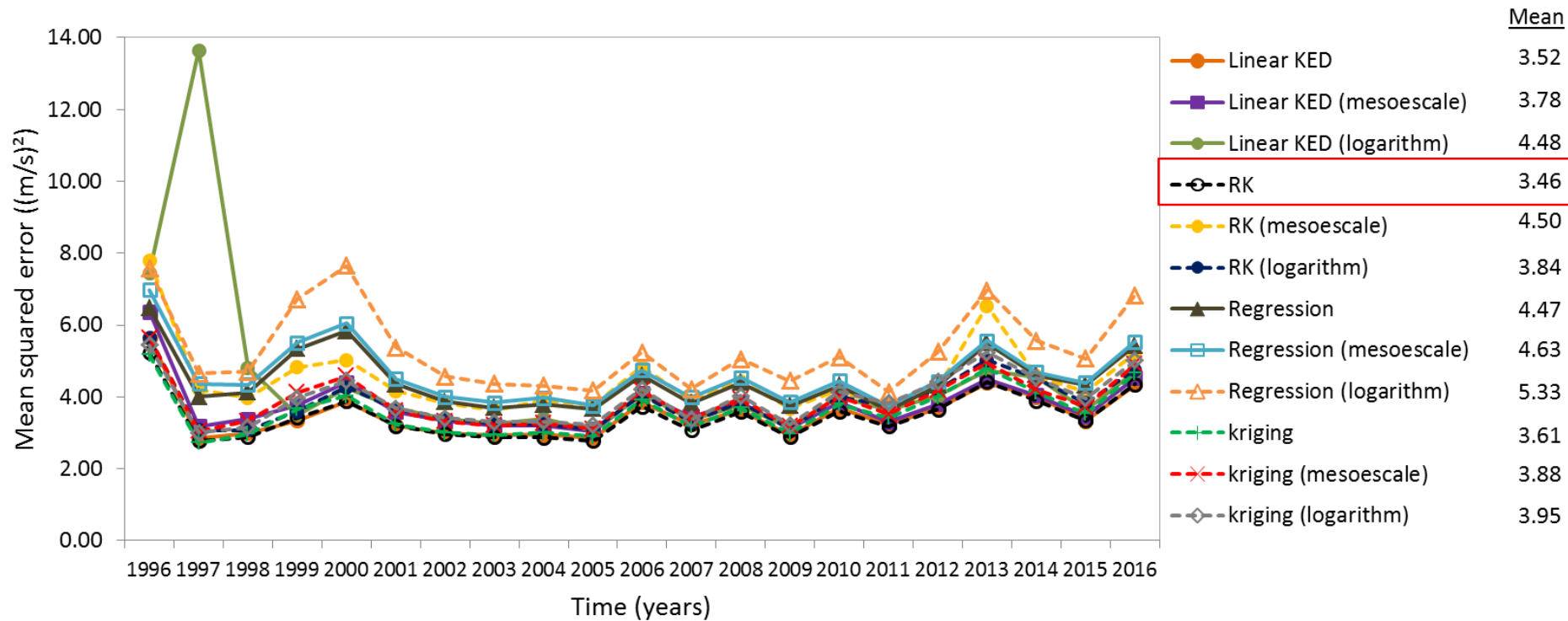
Variograms of the residuals (exponential)

Month	Sill			Theoretical range (km)		
	U10	U80	LN(U10)	U10	U80	LN(U10)
1	1.48	3.88	0.65	3.30	3.00	2.10
2	2.09	5.62	0.65	3.90	2.10	4.20
3	1.48	3.86	0.47	4.50	2.40	3.30
4	1.46	3.88	0.49	3.30	2.10	3.30
5	1.08	2.94	0.52	3.00	2.10	5.10
6	1.08	3.01	0.57	1.80	2.10	8.40
7	1.20	3.07	0.80	2.10	1.80	8.40
8	1.06	2.74	0.52	4.20	3.00	2.40
9	1.05	2.63	0.58	5.10	3.30	3.00
10	1.10	2.59	0.55	2.40	2.10	4.50
11	1.24	3.39	0.61	3.30	3.90	5.40
12	1.21	3.21	0.68	4.50	2.40	6.90

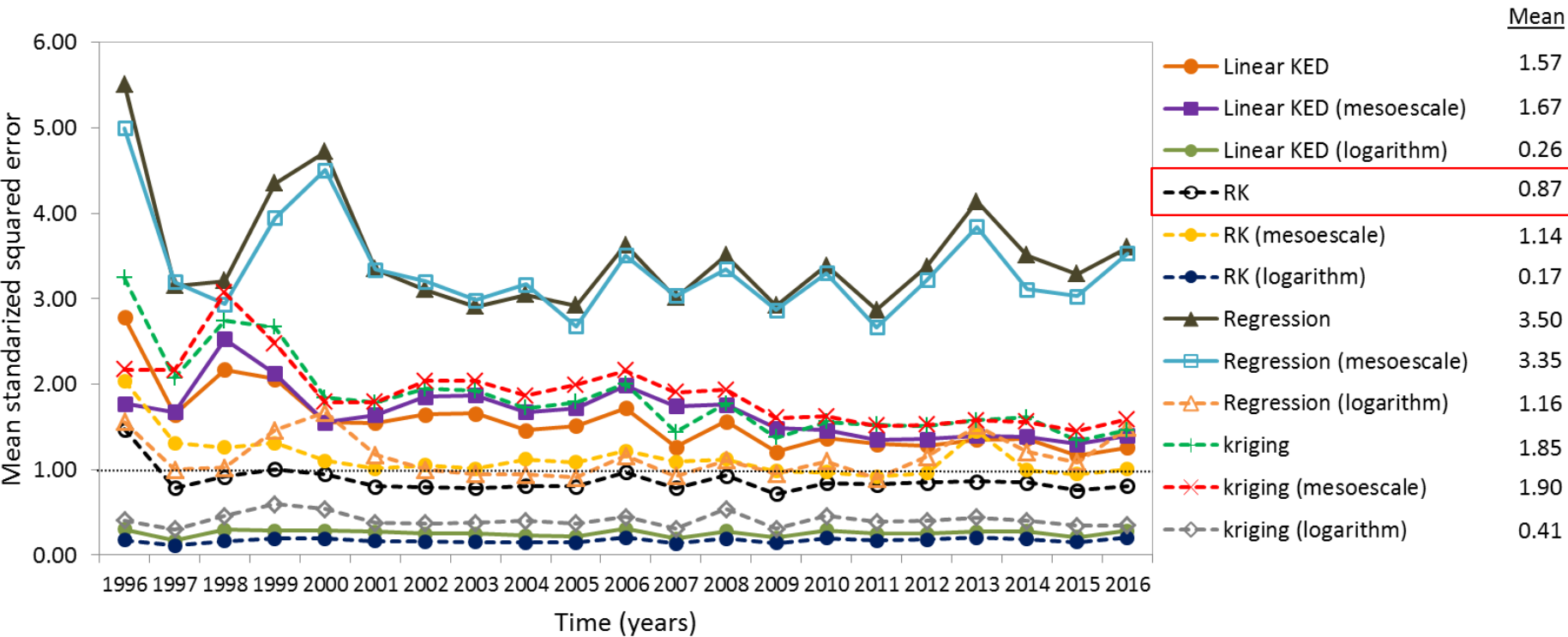
Results: Cross validation experiment (Mean Error)



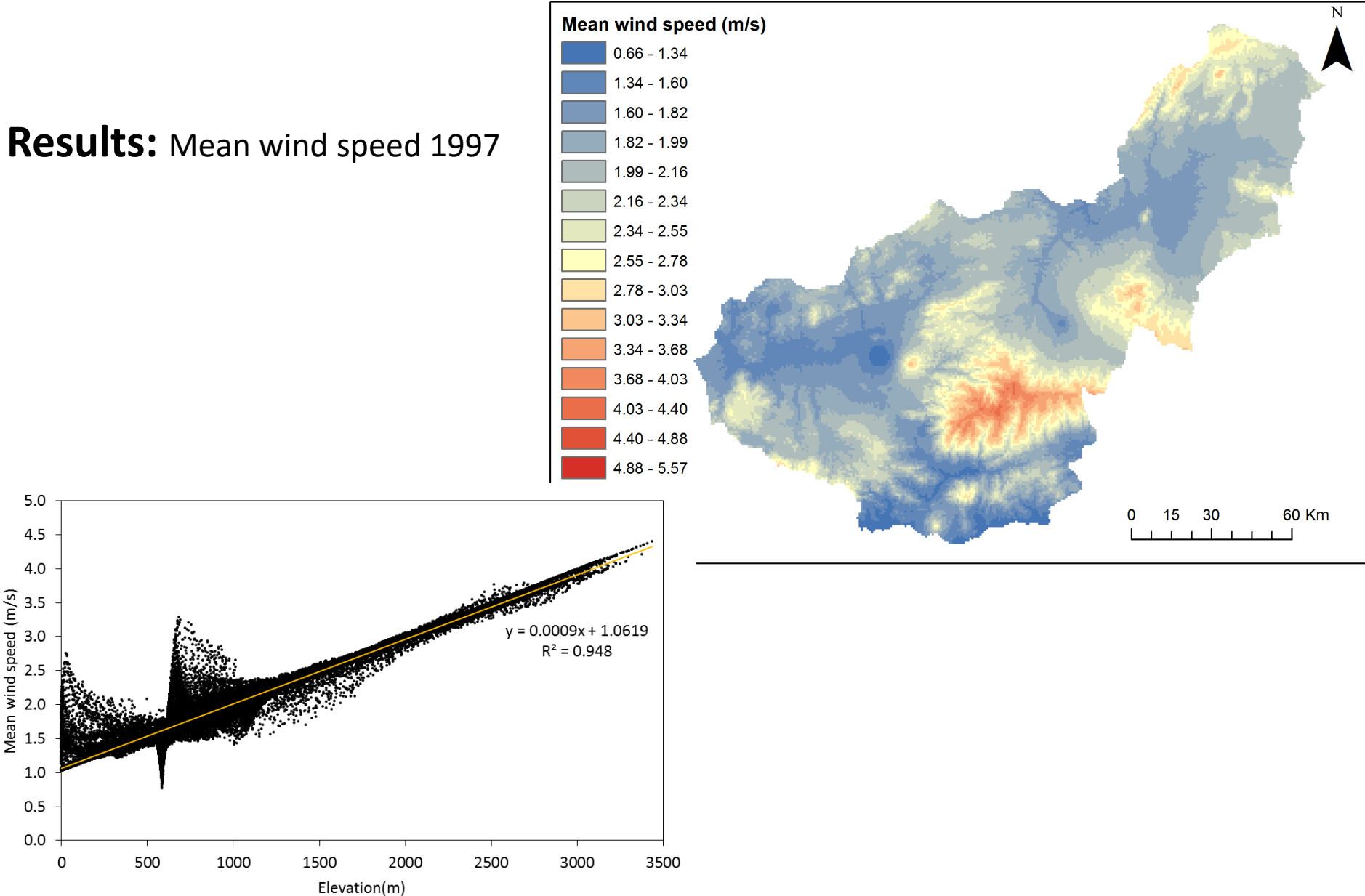
Results: Cross validation experiment (Mean squared error)



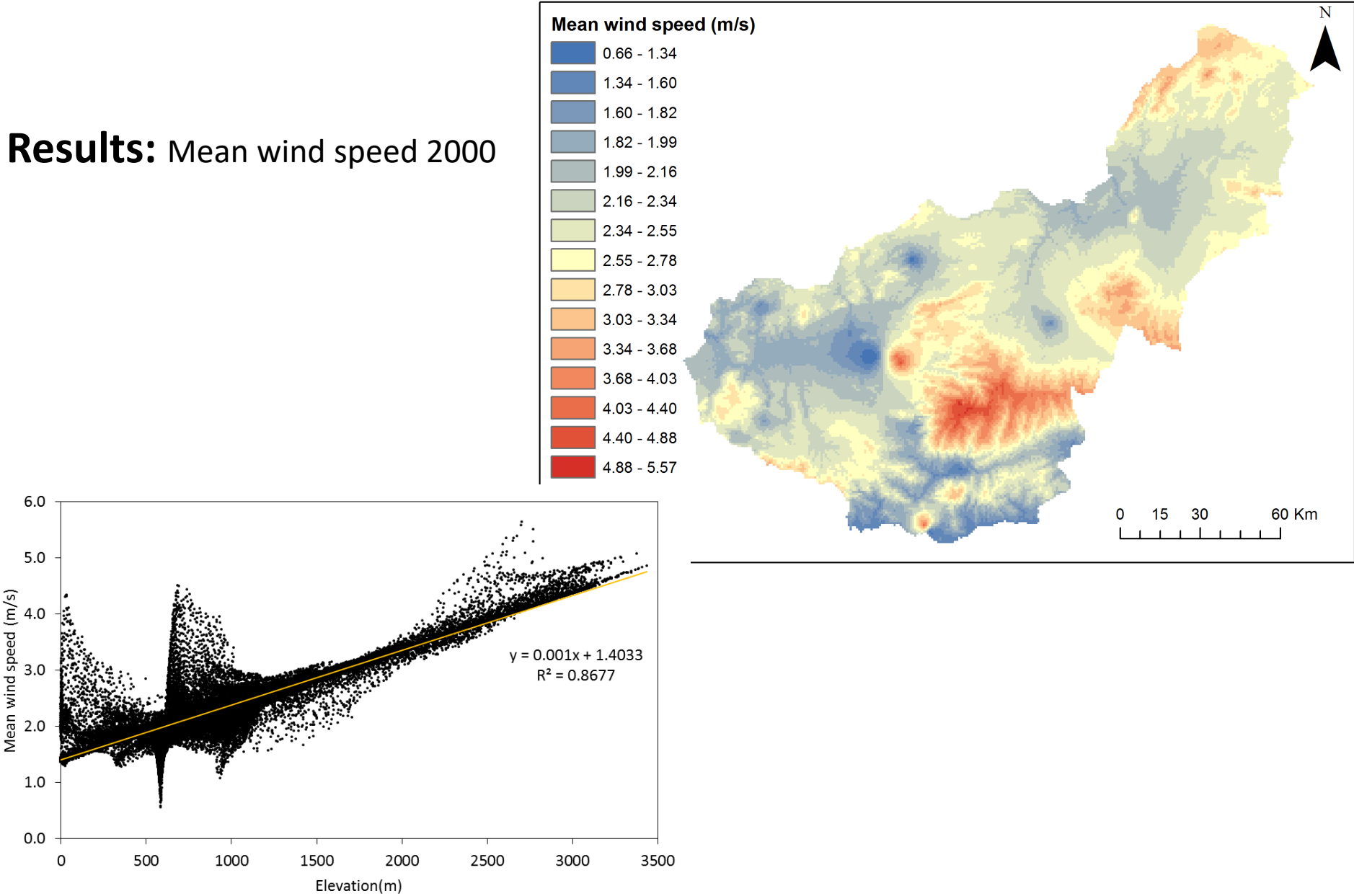
Results: Cross validation experiment (mean standardized squared error)



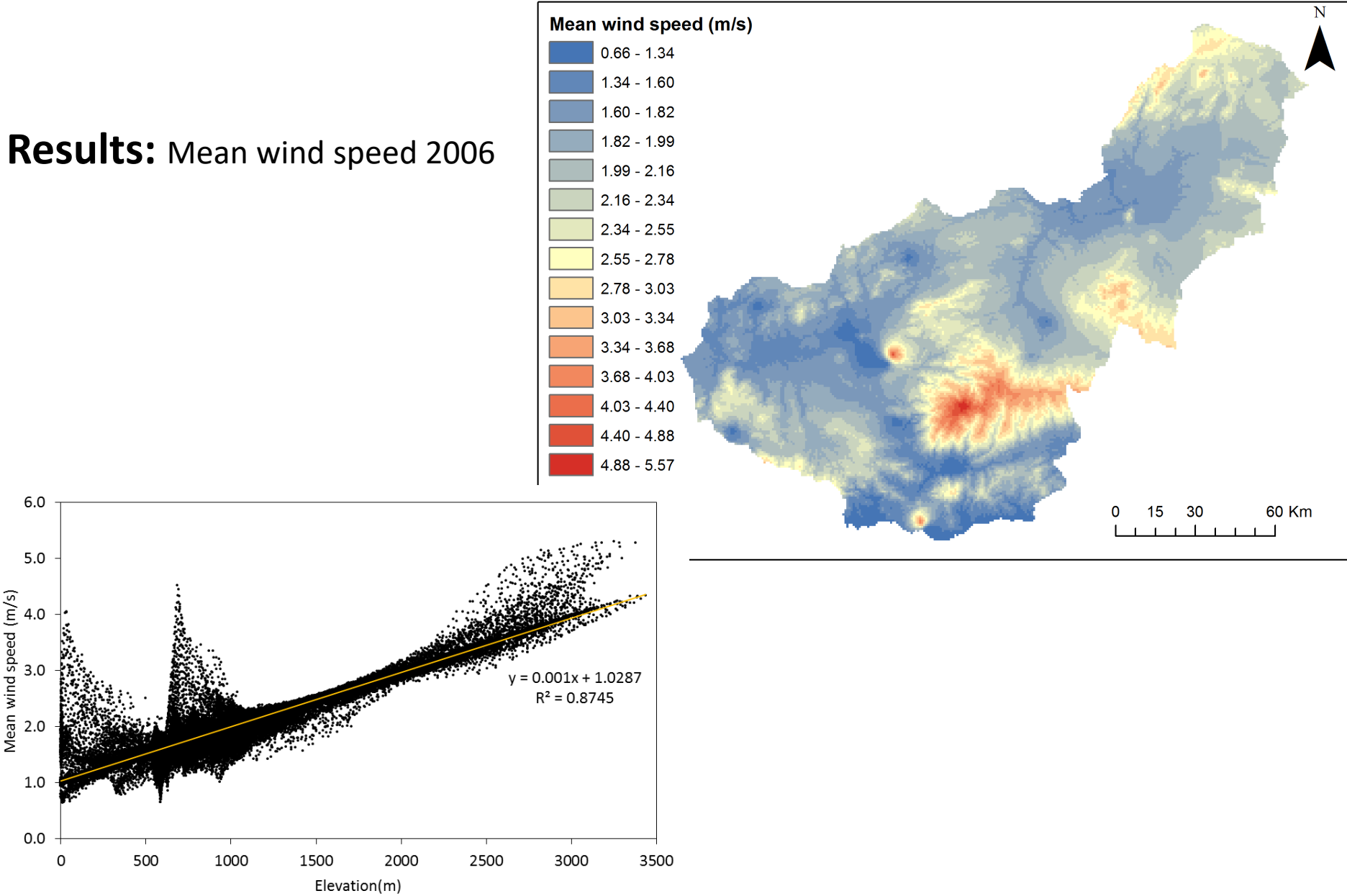
Results: Mean wind speed 1997



Results: Mean wind speed 2000



Results: Mean wind speed 2006



Results: Mean wind speed 2012

