



Australian Government

Geoscience Australia

Comparison of spatial interpolation methods using a simulation experiment based on Australian seabed sediment data

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- Introduction
- Methods
 - Data preparation
 - Experimental design
 - Data analysis
- Results
- Conclusions
- Acknowledgements

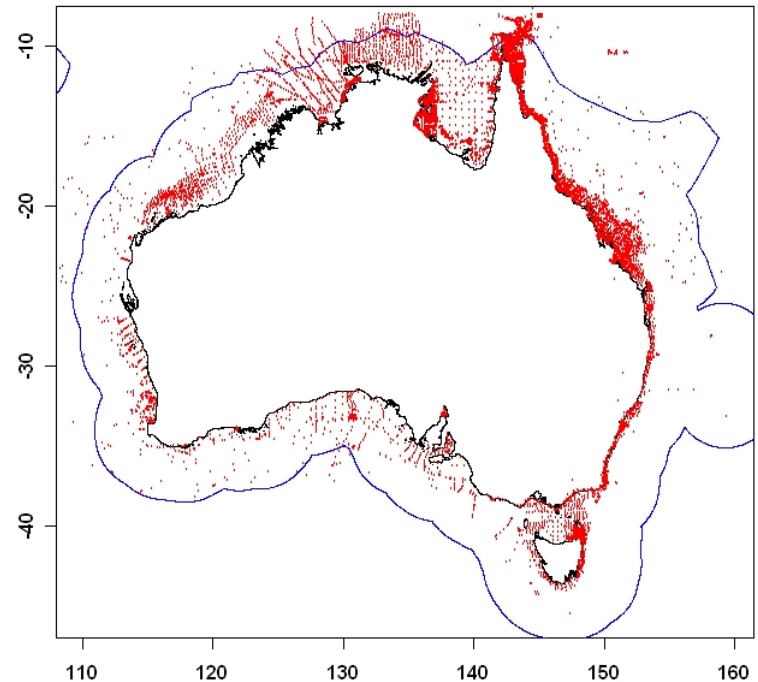
Introduction

- Area: 8,900,000 km²
- Sample No.: 12,500
- Sample density: 1.4 / 1000 km²
- Inverse distance weighting (IDW)

Aims

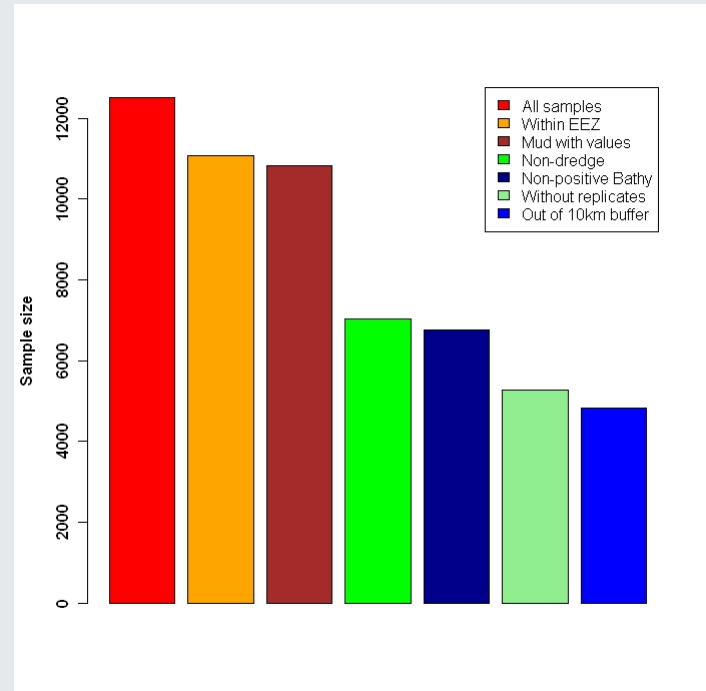
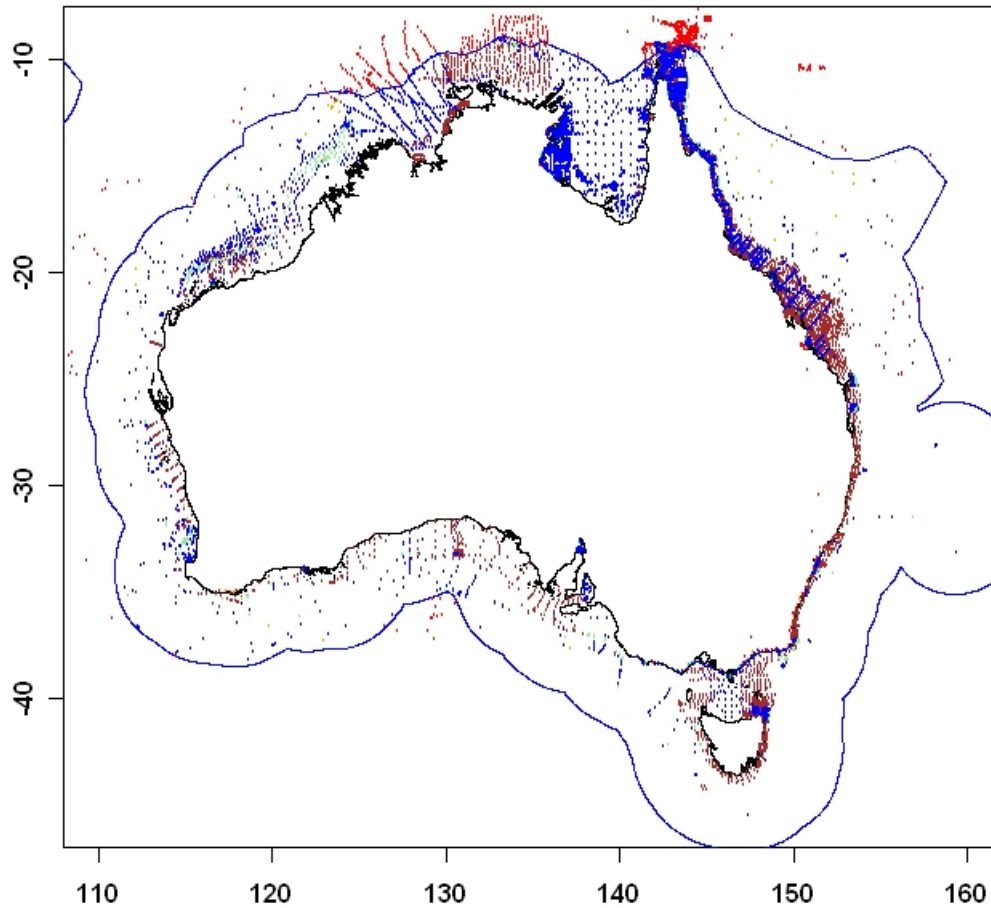
- Study the effects of region, sample density and stratification on the performance of several spatial interpolation methods
- Identify appropriate spatial interpolation methods

Distribution of mud samples in Australian EEZ area

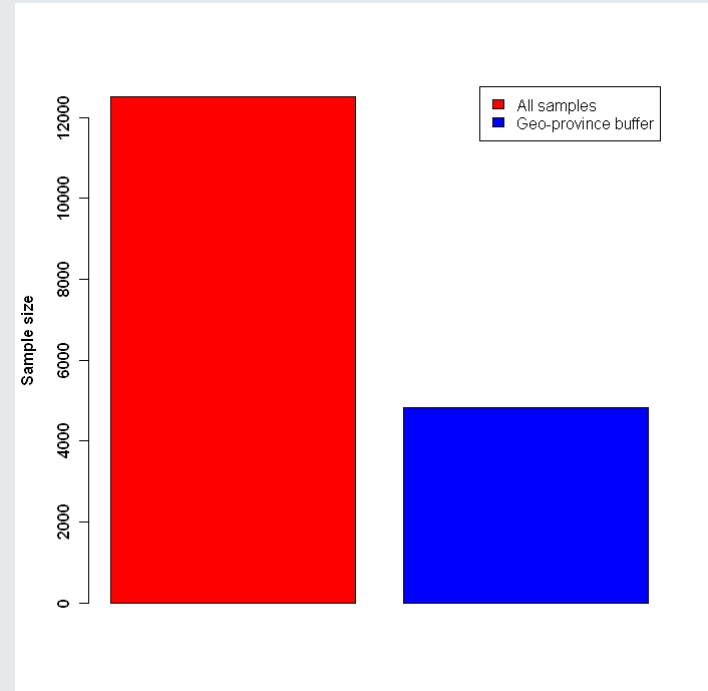
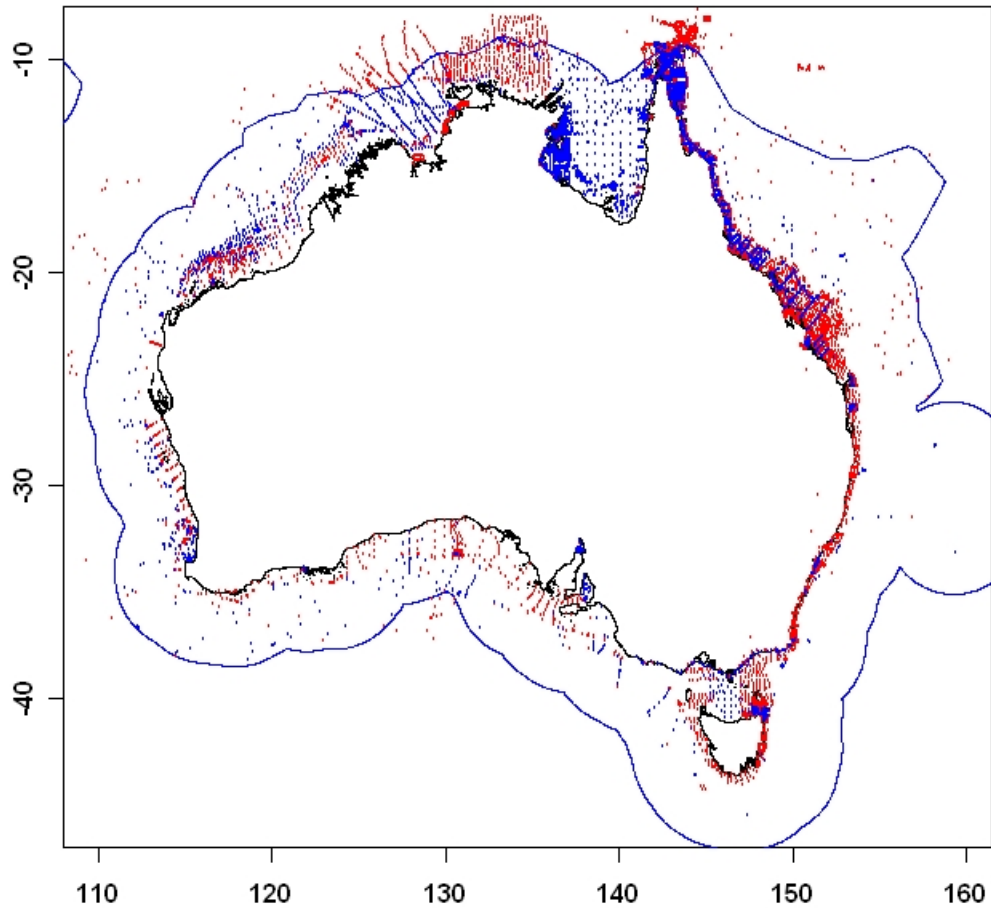


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Distribution of mud samples in Australian EEZ area



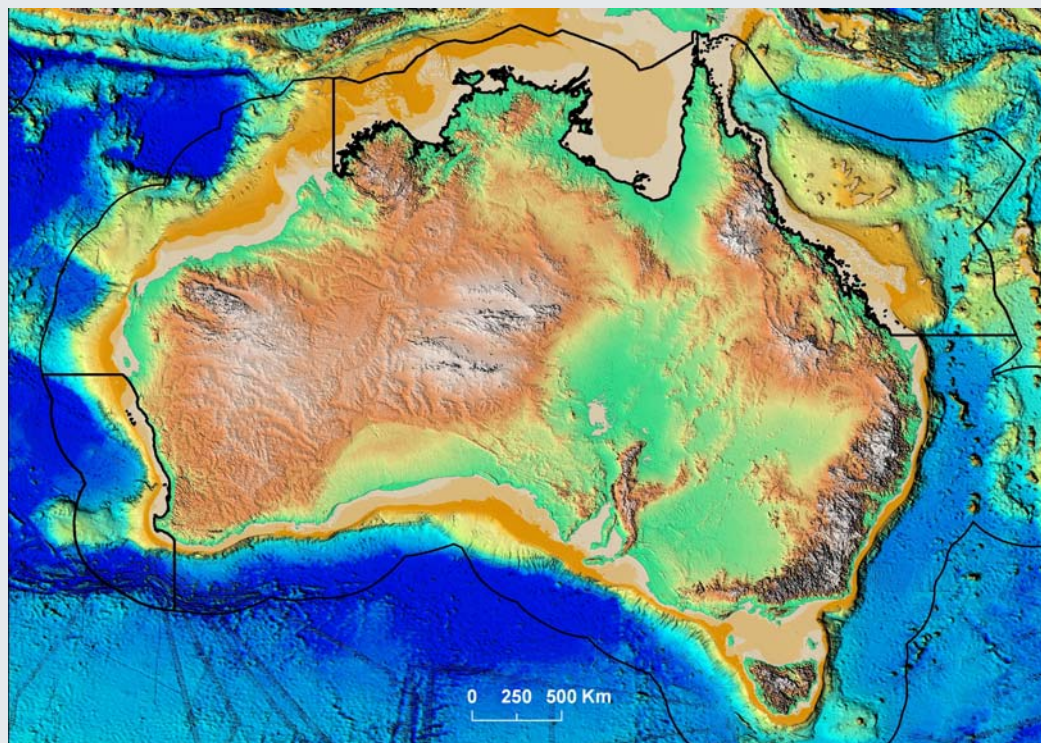
Distribution of mud samples in Australian EEZ area



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Experimental design

- **Regions**
- Stratification (geo-province)
- Sample density
- Spatial interpolation methods
- Cross-validation

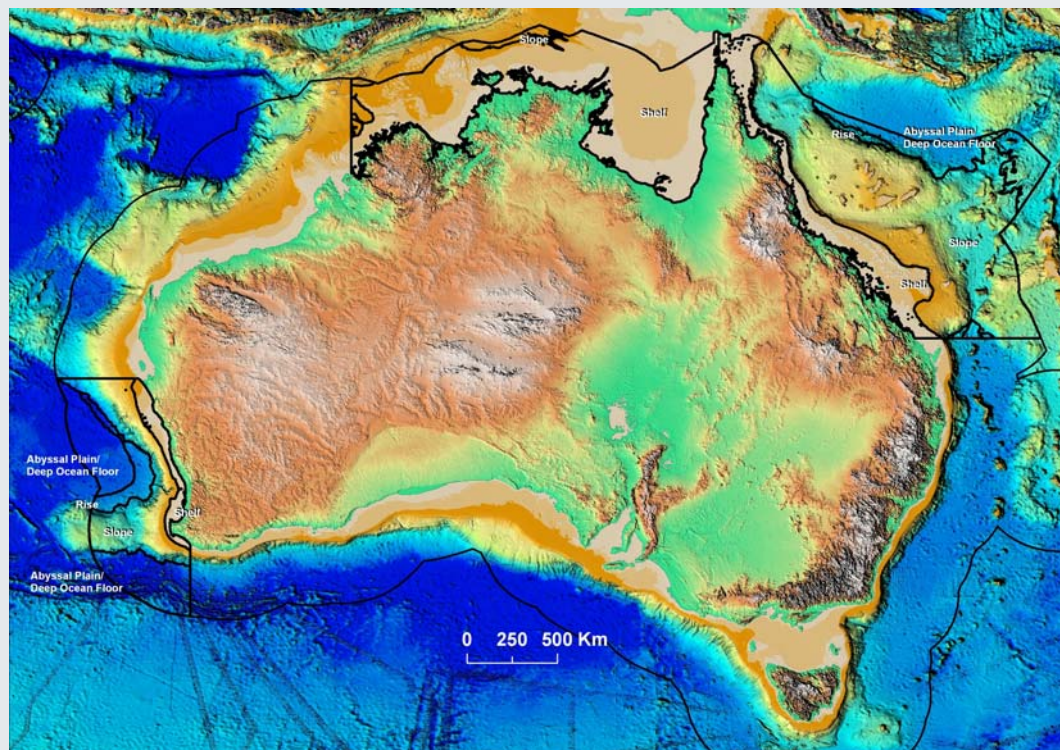


Features of each region

Region	Orientation	Bathymetry (m)	Area (km ²)	Sample No	Sample density (per 1000 km ²)
North	W-E	-318	896693	1687	1.9
Northeast	NW-SE	-4150	1366125	1828	1.3
Southwest	N-S	-5539	523350	177	0.3

Experimental design

- Regions
- **Stratification (geo-province)**
- Sample density
- Spatial interpolation methods
- Cross-validation

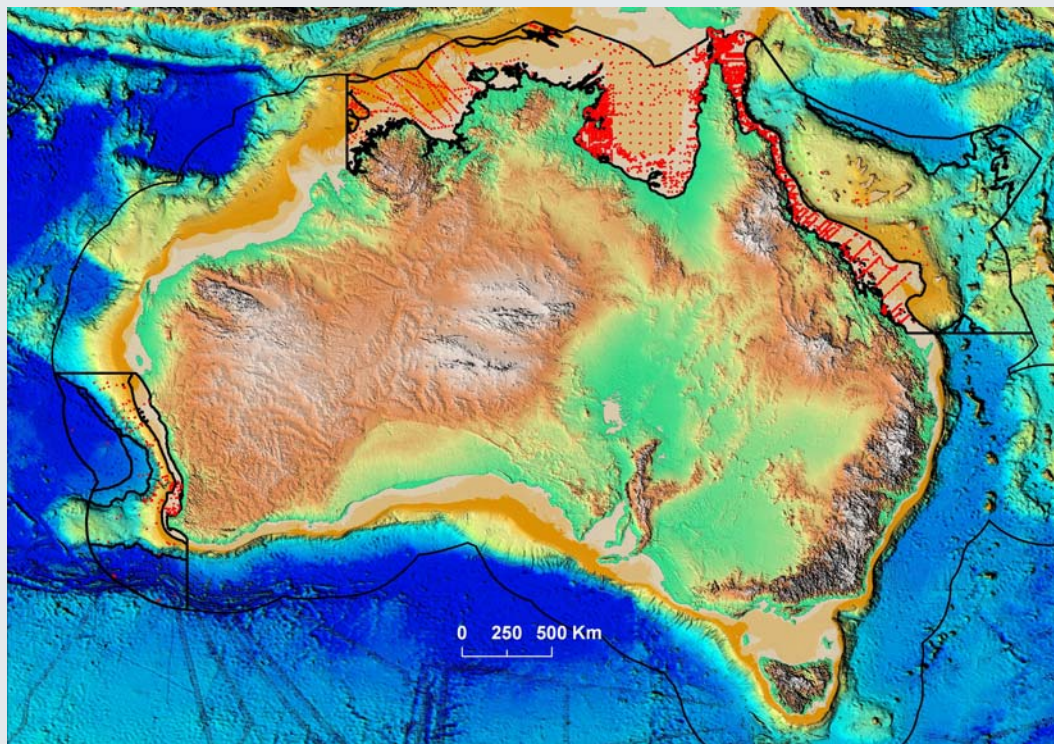


Area (km²) of geo-provinces in each region

Region	Shelf	Slope	Rise	Abyssal plain/ Deep ocean floor
North	855085	41608	0	0
Northeast	254369	930353	18563	162840
Southwest	52932	214938	52237	203233

Experimental design

- Regions
- Stratification (geo-province)
- **Sample density**
- Spatial interpolation methods
- Cross-validation

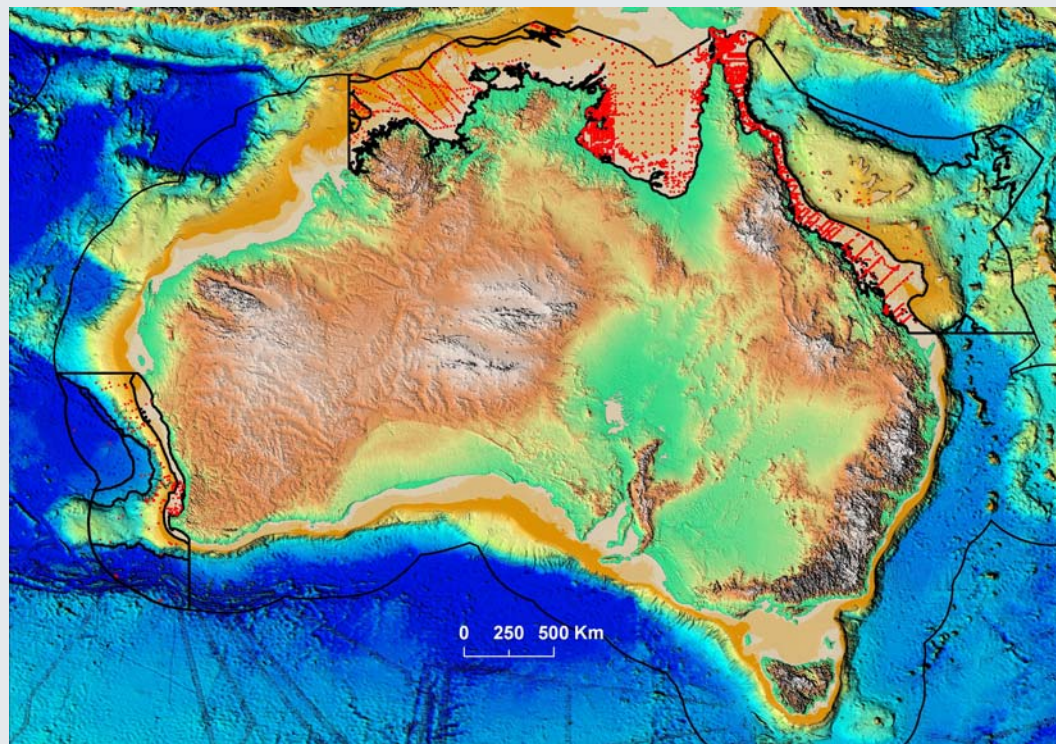


Sample number for each sample density in each region

Sample density	20%	40%	60%	80%	100%
North	337	675	1012	1350	1687
Northeast	366	731	1097	1462	1828
Southwest	35	71	106	142	177

Experimental design

- Regions
- Stratification (geo-province)
- **Sample density**
- Spatial interpolation methods
- Cross-validation



Sample number for each geo-province in each region

Geo-province	Shelf	Slope	Rise	Abyssal plain/ Deep ocean floor
North	1634	53	0	0
Northeast	1785	41	0	2
Southwest	65	101	3	8

Experimental design

- Regions
 - Stratification (geo-province)
 - Sample density
 - **Spatial interpolation methods**
 - Cross-validation
- IDW
 - Ordinary kriging (OK)
 - Universal kriging (UK)
 - Kriging with an external drift (KED)
 - Ordinary co-kriging (OCK)
 - Regression kriging (RK)
 - Thin plate splines (TPS)

Experimental design

- Regions
- Stratification (geo-province)
- Sample density
- Spatial interpolation methods
- **Cross-validation**

Data analysis

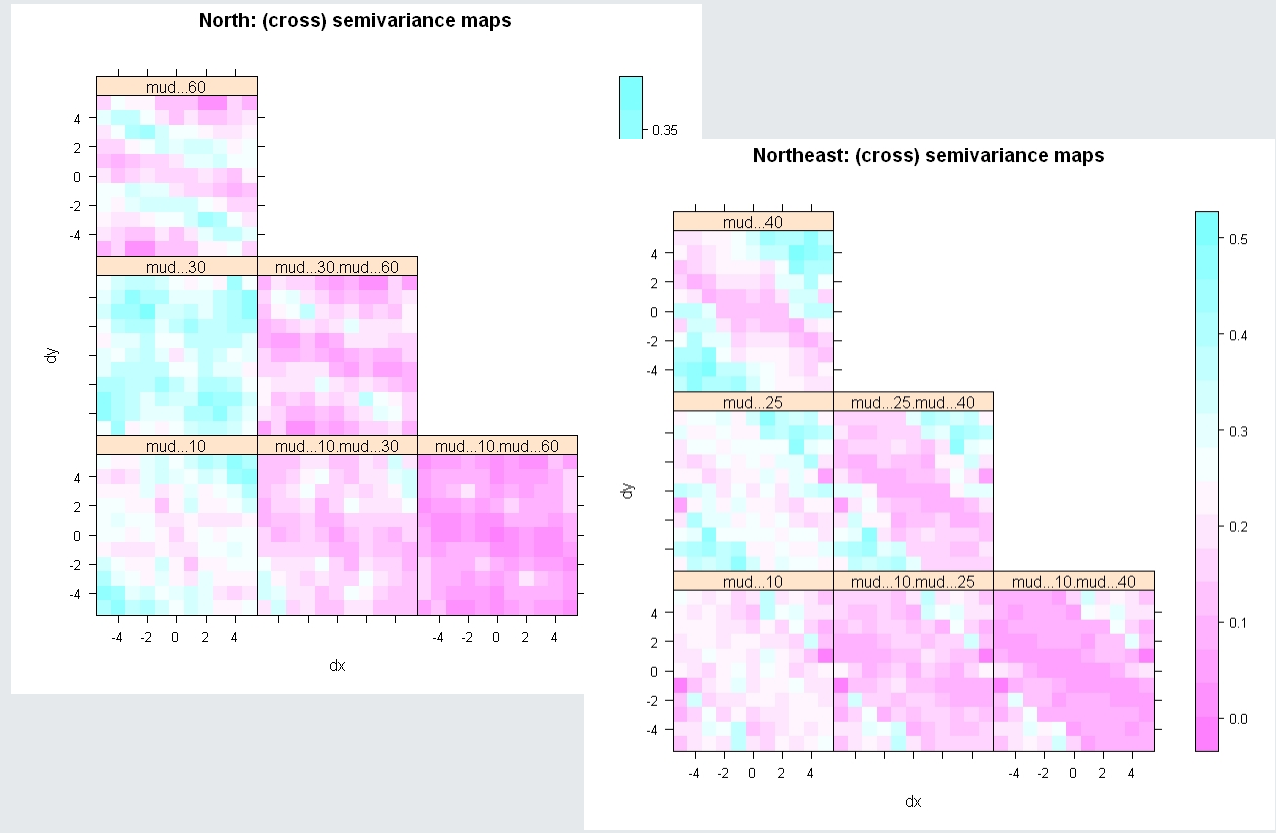
- Parameters
- Variogram
Modelling
- Performance of
methods

Data analysis

- **Parameters**
- Variogram
Modelling
- Performance of
methods
 - Distance power for IDW: 1 and 2
 - UK: $X + Y + X \cdot Y + X^2 + Y^2 + X \cdot Y^2 + Y \cdot X^2 + X^3 + Y^3$
 - KED: bathymetry as a secondary variable

Data analysis

- Parameters
- **Variogram Modelling**
- Performance of methods



Region	Data transformation	Model		Isotropy	
		OK	UK/KED	OK	UK/KED
N	Square root	Spherical	Spherical	Yes	Yes
NE	Square root	Exponential	Spherical	No	Yes
SW	Arcsine	Spherical	Spherical	Yes	Yes

Data analysis

- Parameters
- Variogram
Modelling
- **Performance of
methods**

Measurement: Mean absolute error (MAE)

Root mean square error (RMSE)

Statistical analysis: Generalised linear model with a quasi family

Software: ArcGIS 9.2

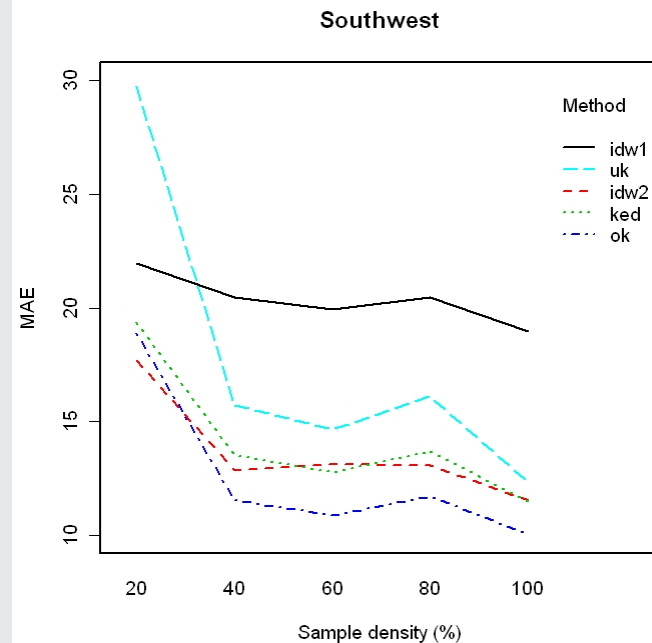
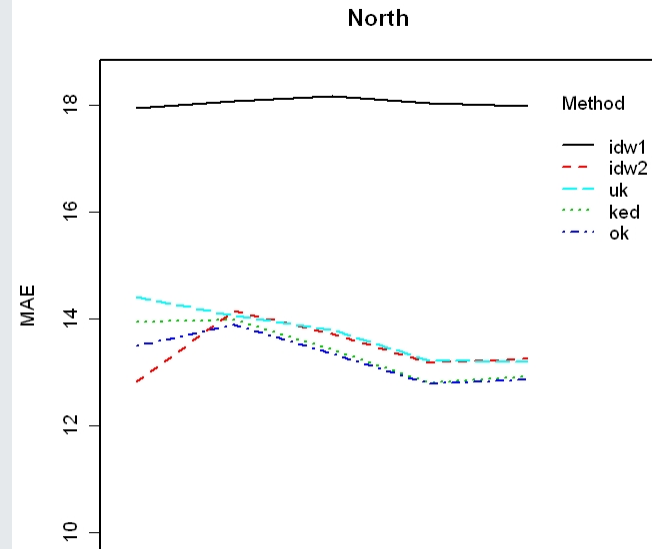
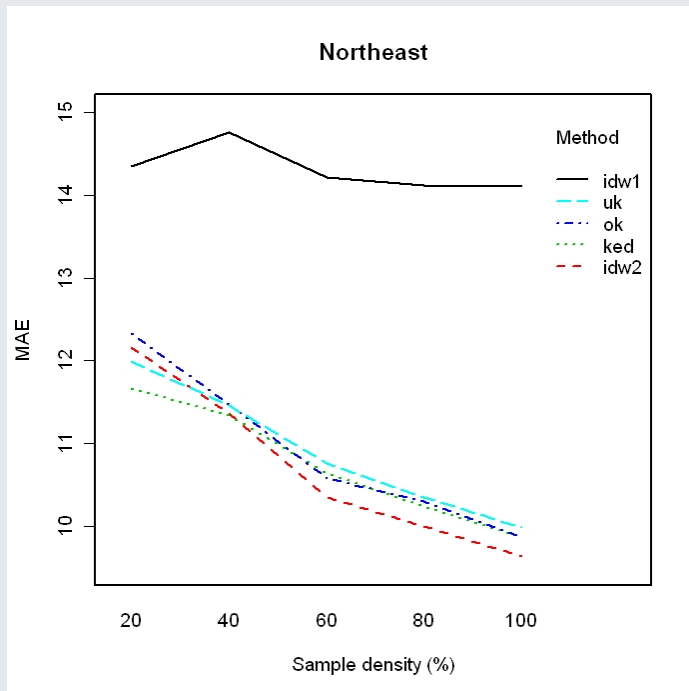
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Results

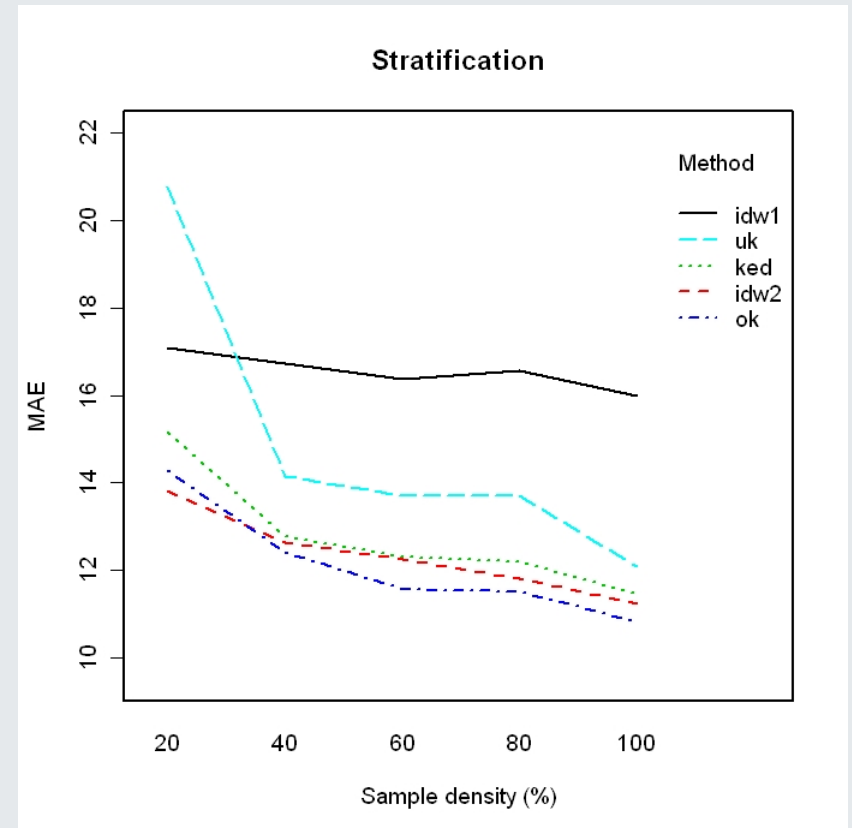
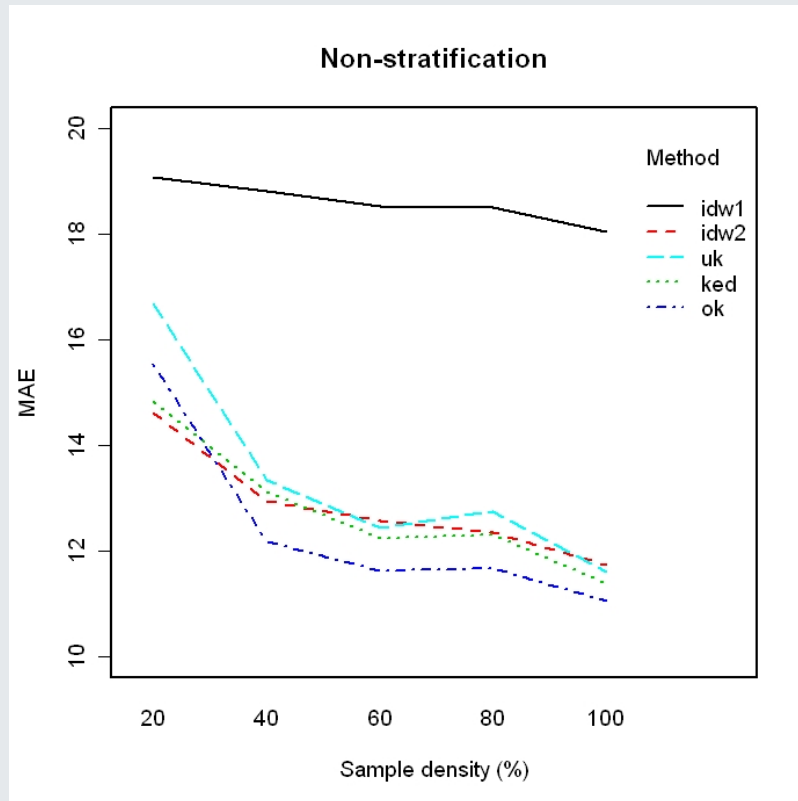
Effects of method, sample density, stratification and region on absolute mean error (AME) of spatial interpolation methods

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)
NULL			149	125.0590		
method	4	39.5176	145	85.5414	84.5949	0.0000
samp.dens	1	13.3880	144	72.1534	114.6380	0.0000
stratification	1	0.1894	143	71.9640	1.6219	0.2058
region	2	33.8173	141	38.1467	144.7844	0.0000
method:samp.dens	4	3.8651	137	34.2816	8.2740	0.0000
method:stratification	4	3.0152	133	31.2664	6.4546	0.0001
method:region	8	5.5892	125	25.6773	5.9823	0.0000
samp.dens:stratification	1	0.0445	124	25.6328	0.3807	0.5387
samp.dens:region	2	7.3575	122	18.2753	31.5004	0.0000
stratification:region	2	0.1886	120	18.0867	0.8075	0.4489
method:samp.dens:stratification	4	0.3168	116	17.7698	0.6783	0.6086
method:samp.dens:region	8	2.4910	108	15.2788	2.6662	0.0108
method:stratification:region	8	3.5785	100	11.7003	3.8302	0.0006
samp.dens:stratification:region	2	0.0281	98	11.6722	0.1203	0.8868

Interaction among sample density, method and region



Interaction among sample density, method and stratification

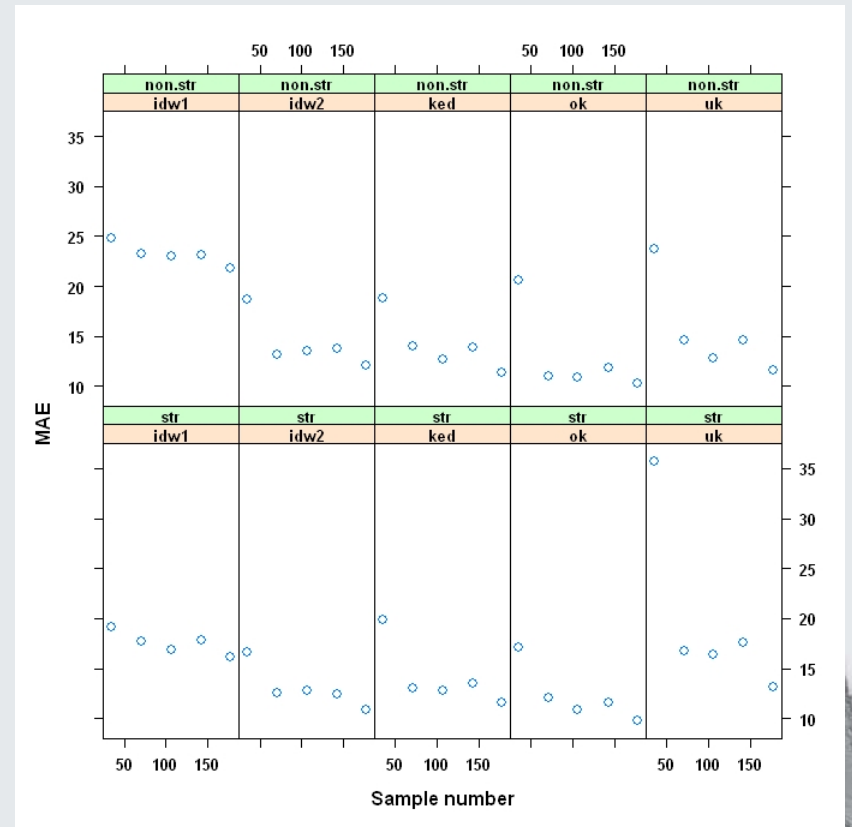
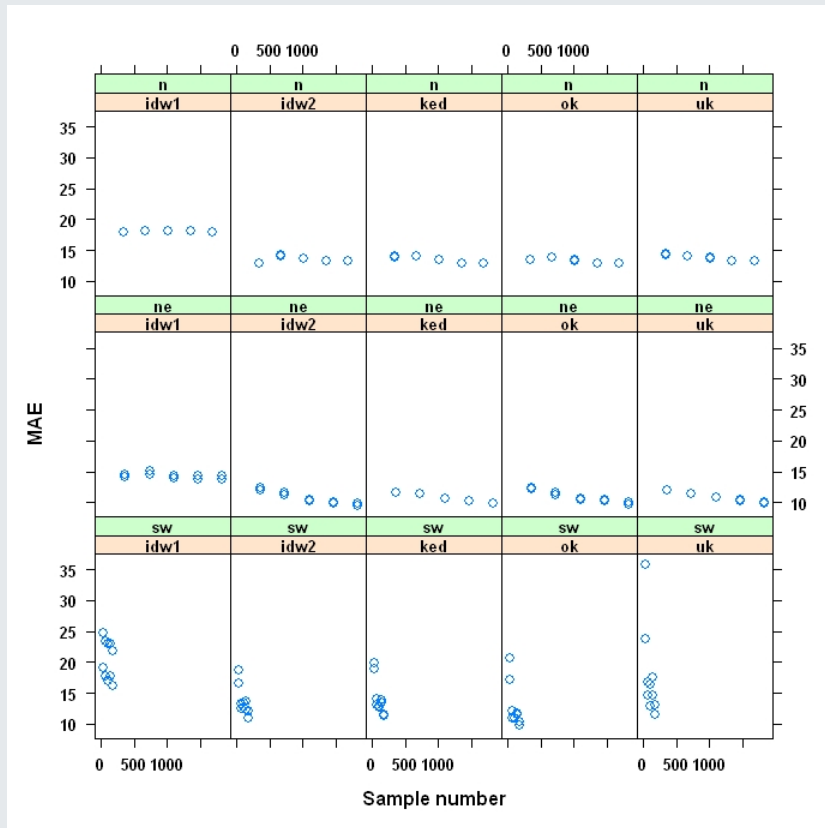


Results

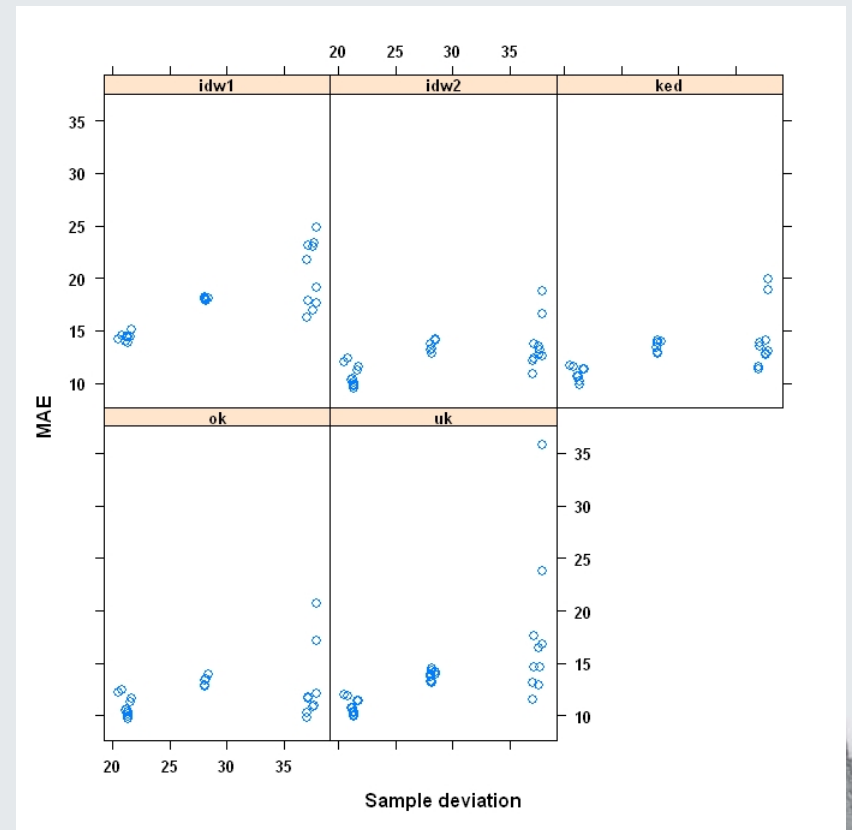
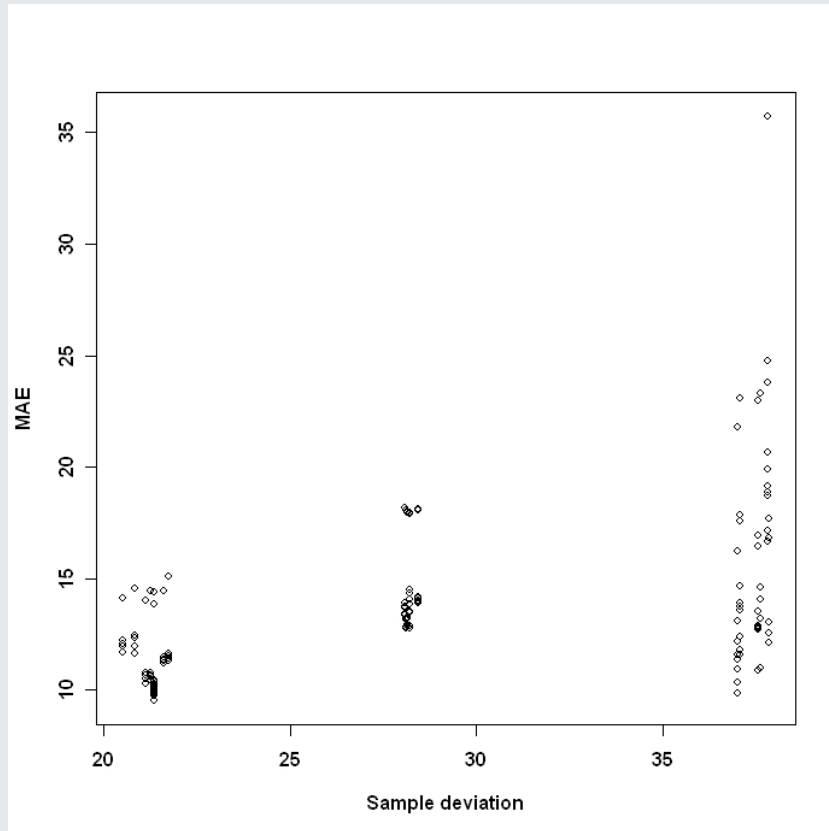
Effects of method, sample number, sample deviation and stratification on absolute mean error (AME) of spatial interpolation methods

	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)
NULL			149	125.0590		
method	4	39.5176	145	85.5414	27.3647	0.0000
samp.no	1	19.9641	144	65.5773	55.2981	0.0000
std	1	11.8231	143	53.7542	32.7486	0.0000
stratification	1	0.1845	142	53.5697	0.5111	0.4761
method:samp.no	4	3.3278	138	50.2419	2.3044	0.0626
method:std	4	2.1488	134	48.0930	1.4880	0.2105
method:stratification	4	3.0149	130	45.0781	2.0878	0.0870
samp.no:std	1	2.8457	129	42.2324	7.8823	0.0059
samp.no:stratification	1	0.0698	128	42.1626	0.1933	0.6610
std:stratification	1	0.0252	127	42.1374	0.0697	0.7922
method:samp.no:std	4	0.9504	123	41.1870	0.6581	0.6224
method:samp.no:stratification	4	2.3121	119	38.8749	1.6011	0.1788
method:std:stratification	4	0.8343	115	38.0406	0.5777	0.6794
samp.no:std:stratification	1	0.0499	114	37.9906	0.1383	0.7107

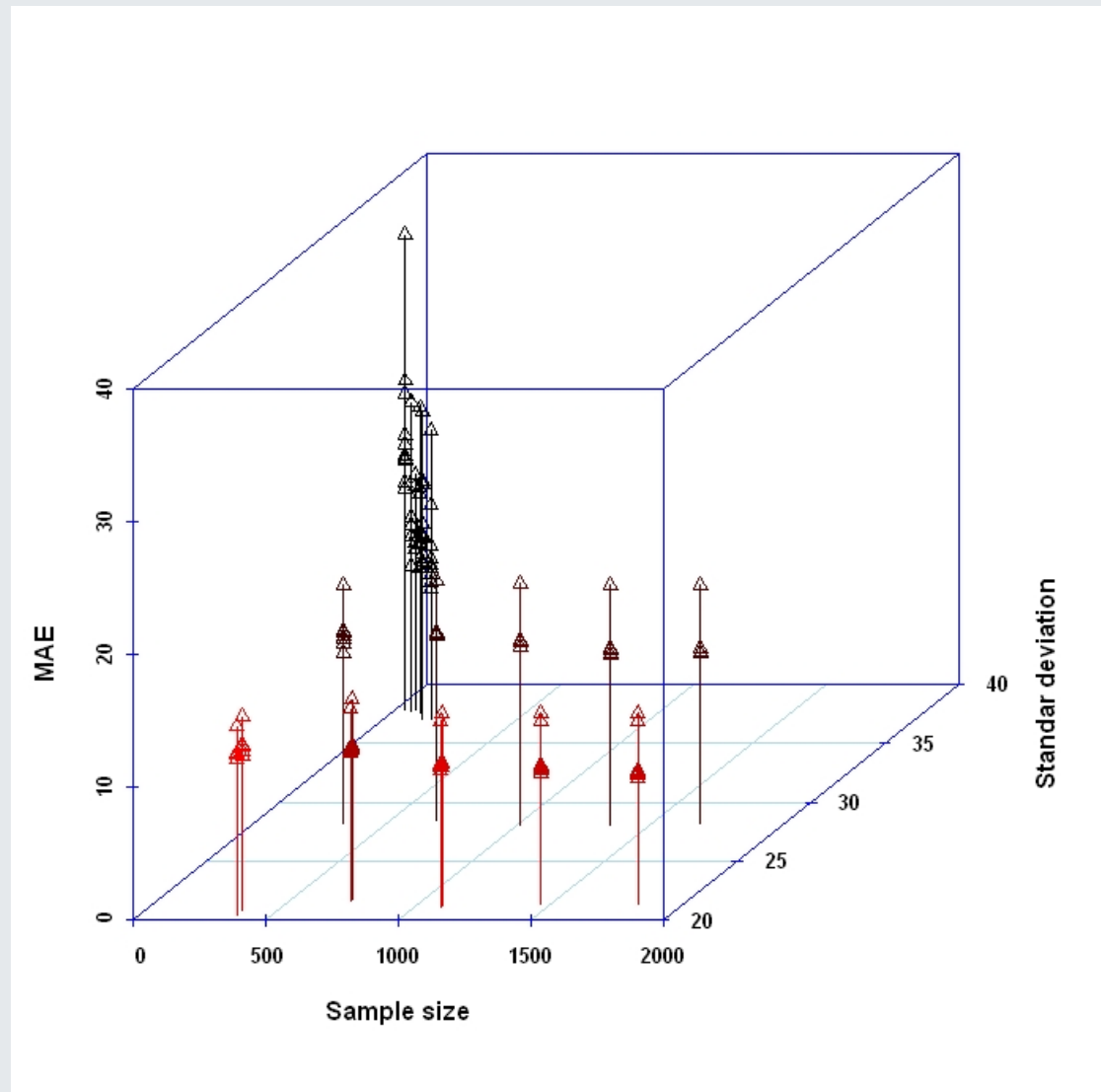
Effects of sample size



Effects of sample deviation



Interaction of sample size and deviation



Conclusions

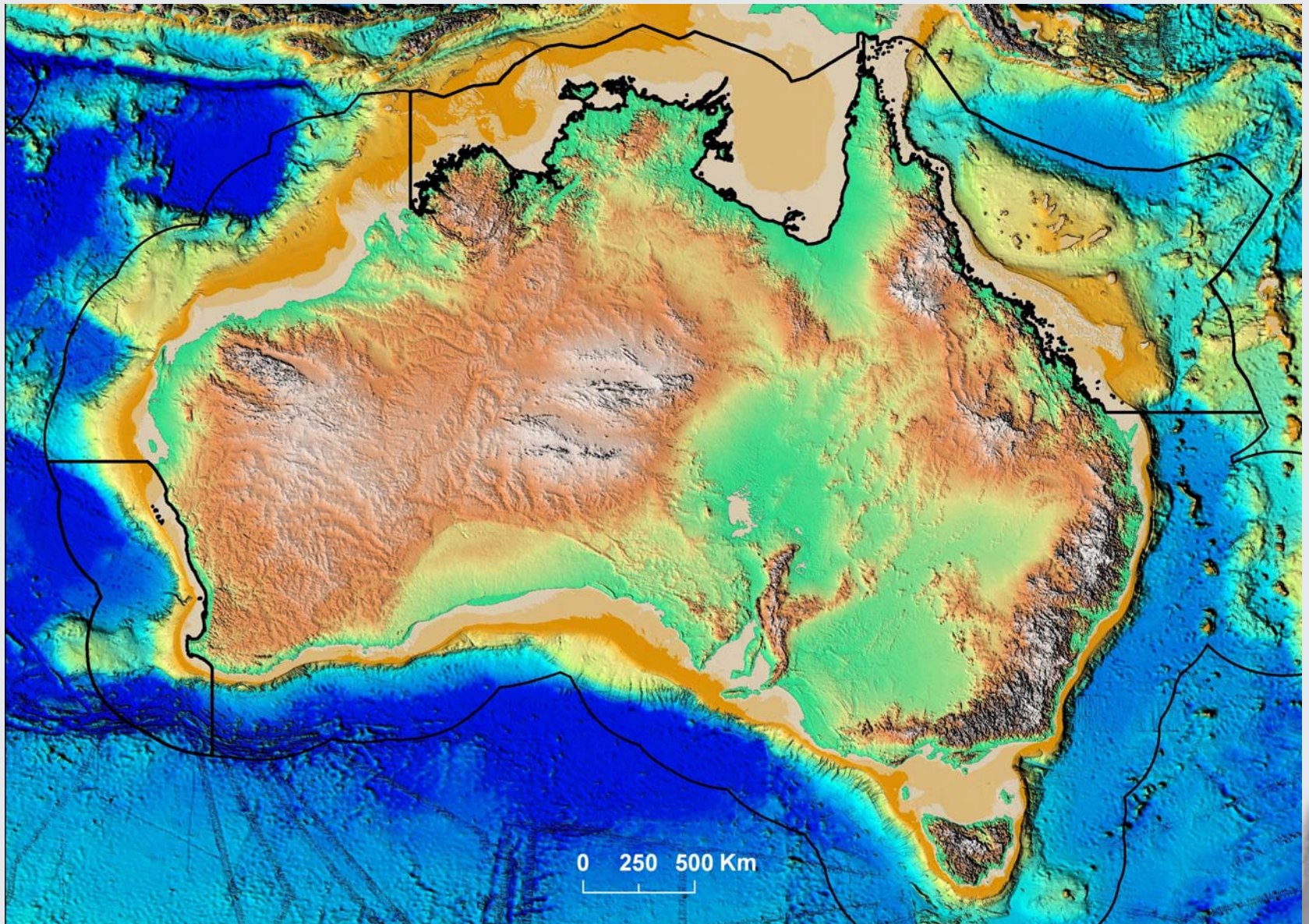
Method: OK, IDW2, KED, UK and IDW1

Region: NE, N and SW; mainly reflects the effects of sample variance

Stratification: No significant effects

Samples size: Accuracy increases with sample size/density

Sample variance: Accuracy decreases with sample deviation



Acknowledgements

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