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Supplement of

Histogram via entropy reduction (HER): an information-theoretic alternative for geostatistics

Stephanie Thiesen et al.

Correspondence to: Stephanie Thiesen (stephanie.thiesen@kit.edu)

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Supplementary material

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Supplement S1: Summary statistics of the resampled datasets

Table S1.1 and Table S1.2 summarize the statistics of the learning, validation, test, and full datasets.

10 **Table S1.1: Summary statistics of the resampled datasets – Short-range dataset (SR0 and SR1).**

| Sample size | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 | 2000 (val. set) | 2000 (test set) | 10 000 (full set) |
|-------------|-------|-------|-------|-------|-------|-------|-------|--------------------|--------------------|----------------------|
| SR0 | | | | | | | | | | |
| mean | -0.57 | -0.59 | -0.58 | -0.59 | -0.59 | -0.58 | -0.57 | -0.53 | -0.56 | -0.55 |
| sd. | 1.05 | 1.06 | 1.02 | 1.01 | 0.99 | 0.99 | 0.99 | 0.99 | 1.00 | 0.99 |
| H | 4.27 | 4.38 | 4.34 | 4.33 | 4.31 | 4.32 | 4.32 | 4.31 | 4.34 | 4.34 |
| max. | 1.76 | 1.92 | 1.92 | 1.92 | 1.92 | 1.92 | 2.05 | 2.08 | 2.02 | 2.08 |
| median | -0.42 | -0.50 | -0.51 | -0.56 | -0.54 | -0.52 | -0.52 | -0.46 | -0.50 | -0.49 |
| min. | -3.68 | -3.68 | -3.68 | -3.68 | -3.68 | -3.68 | -3.68 | -3.67 | -3.71 | -3.71 |
| kur. | 3.21 | 3.04 | 3.12 | 3.15 | 3.17 | 3.14 | 3.12 | 3.18 | 3.07 | 3.09 |
| sk. | -0.62 | -0.43 | -0.41 | -0.35 | -0.35 | -0.32 | -0.30 | -0.36 | -0.33 | -0.34 |
| SR1 | | | | | | | | | | |
| mean | -0.52 | -0.54 | -0.55 | -0.57 | -0.57 | -0.57 | -0.56 | -0.54 | -0.54 | -0.55 |
| sd. | 1.17 | 1.17 | 1.14 | 1.12 | 1.11 | 1.10 | 1.10 | 1.11 | 1.12 | 1.11 |
| H | 4.46 | 4.54 | 4.51 | 4.50 | 4.49 | 4.49 | 4.49 | 4.49 | 4.52 | 4.50 |
| max. | 2.50 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.99 | 2.96 | 2.86 | 2.99 |
| median | -0.36 | -0.51 | -0.51 | -0.55 | -0.56 | -0.54 | -0.53 | -0.51 | -0.48 | -0.51 |
| min. | -3.66 | -3.66 | -3.66 | -3.84 | -3.84 | -4.01 | -4.01 | -4.63 | -4.25 | -4.63 |
| kur. | 2.82 | 2.83 | 2.93 | 2.94 | 2.99 | 3.03 | 3.04 | 3.24 | 3.09 | 3.11 |
| sk. | -0.40 | -0.15 | -0.19 | -0.19 | -0.18 | -0.20 | -0.20 | -0.28 | -0.26 | -0.25 |

sd. = standard deviation; H = entropy; max. = maximum; min. = minimum; kur. = kurtosis; sk. = skewness.

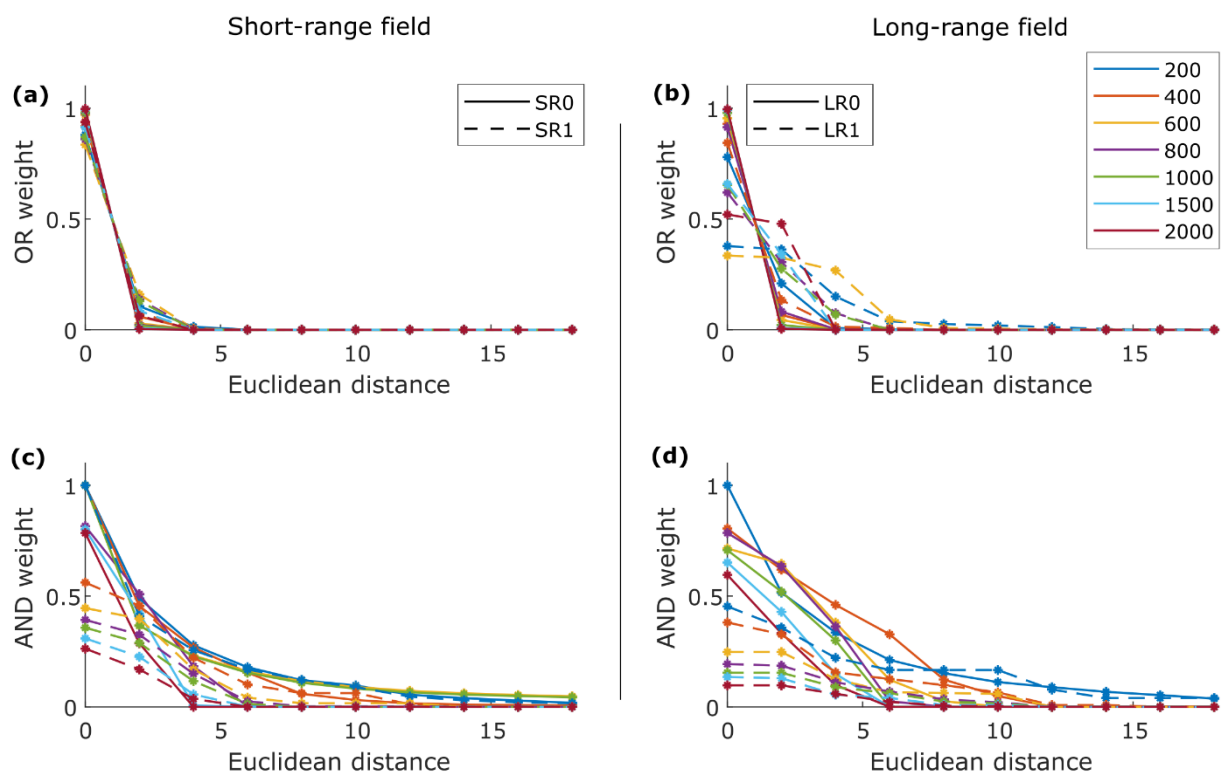
Table S1.2: Summary statistics of the resampled datasets – Long-range dataset (LR0 and LR1).

| Sample size | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 | 2000 (val. set) | 2000 (test set) | 10 000 (full set) |
|-------------|-------|-------|-------|-------|-------|-------|-------|--------------------|--------------------|----------------------|
| LR0 | | | | | | | | | | |
| mean | -0.98 | -0.96 | -1.03 | -1.01 | -1.01 | -1.01 | -1.02 | -1.00 | -1.02 | -1.01 |
| sd. | 0.90 | 0.88 | 0.89 | 0.89 | 0.90 | 0.91 | 0.91 | 0.90 | 0.91 | 0.90 |
| H | 3.99 | 4.02 | 4.07 | 4.09 | 4.09 | 4.11 | 4.11 | 4.11 | 4.12 | 4.12 |
| max. | 1.04 | 1.15 | 1.23 | 1.23 | 1.23 | 1.23 | 1.23 | 1.28 | 1.27 | 1.28 |
| median | -0.77 | -0.81 | -0.92 | -0.92 | -0.91 | -0.91 | -0.92 | -0.88 | -0.89 | -0.89 |
| min. | -2.78 | -2.78 | -3.07 | -3.07 | -3.07 | -3.08 | -3.08 | -3.00 | -3.07 | -3.08 |
| kur. | 2.11 | 2.18 | 2.26 | 2.24 | 2.21 | 2.16 | 2.20 | 2.22 | 2.16 | 2.20 |
| sk. | -0.09 | -0.07 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | -0.03 | 0.00 | -0.01 |
| LR1 | | | | | | | | | | |
| mean | -0.92 | -0.91 | -0.99 | -1.00 | -1.00 | -1.01 | -1.01 | -1.01 | -1.00 | -1.00 |
| sd. | 0.98 | 1.00 | 1.01 | 1.02 | 1.03 | 1.04 | 1.03 | 1.05 | 1.03 | 1.03 |
| H | 4.21 | 4.31 | 4.34 | 4.37 | 4.38 | 4.40 | 4.39 | 4.41 | 4.39 | 4.40 |
| max. | 1.40 | 1.87 | 1.87 | 1.87 | 1.96 | 1.96 | 2.00 | 2.29 | 2.14 | 2.29 |
| median | -0.88 | -0.91 | -0.97 | -0.98 | -0.99 | -0.99 | -0.98 | -0.98 | -0.96 | -0.96 |
| min. | -3.19 | -3.65 | -3.65 | -3.74 | -3.74 | -3.74 | -3.95 | -4.02 | -3.75 | -4.02 |
| kur. | 2.51 | 2.67 | 2.56 | 2.56 | 2.59 | 2.50 | 2.53 | 2.59 | 2.44 | 2.53 |
| sk. | -0.09 | 0.02 | 0.06 | 0.04 | 0.06 | 0.05 | 0.04 | -0.02 | 0.02 | 0.00 |

sd. = standard deviation; H = entropy; max. = maximum; min. = minimum; kur. = kurtosis; sk. = skewness.

Supplement S2: Parameter tuning

This supplement consolidates the final parameters used in the models presented in Sect. 4.2. Particularly for HER, Fig. S2.1 presents the final weights optimized for Eqs. (4) and (5). It was limited to 18 grid units (nine distance classes), due to the small contribution of the faraway classes. Similarly, Fig. S2.2 shows α and β weights of Eq. (6). Finally, Table S2.1 and Table S2.2 summarize the calibrated parameters obtained for each model (varying method, sample size and dataset type).



20 **Figure S2.1: HER optimized weights by distance class: a,b) w_{OR} , Eq. (4), and c,d) w_{AND} , Eq. (5). SR datasets on the left panel and LR datasets on the right panel. Continuous line refers to datasets without noise and dashed lines to datasets with noise.**

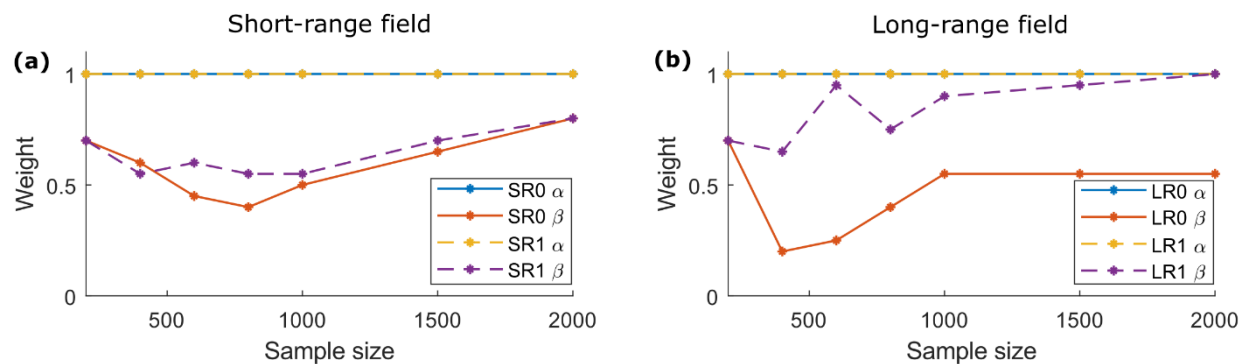


Figure S2.2. HER α and β weights by sample size, Eq. (6): a) SR datasets on the left panel and b) LR datasets on the right panel. Continuous line refers to datasets without noise and dashed lines to datasets with noise.

Table S2.1: Method calibration by sample size – Parameters of the models for the short-range dataset (SR0 and SR1).

| Model sample size | | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 |
|-------------------|------------------------------|------------------|------------|-----------|-----------|-----------|-----------|-----------|
| Method | Parameter | SR0 | | | | | | |
| NN | n.n. | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| IDS | exp. | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| OK | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | lag width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | variogram | Spherical | Spherical | Spherical | Spherical | Spherical | Spherical | Spherical |
| | eff. range | 35.99 | 35.43 | 33.63 | 33.50 | 33.13 | 33.21 | 33.65 |
| | nugget | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | sill | 1.24 | 1.28 | 1.16 | 1.13 | 1.11 | 1.09 | 1.08 |
| | max. lag | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| | n.n. [min.,max.] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] |
| HER | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | class width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | bin widths ($z, \Delta z$) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | model range | 36.00 | 24.00 | 26.00 | 26.00 | 26.00 | 26.00 | 26.00 |
| | α | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | β | 0.70 | 0.60 | 0.45 | 0.40 | 0.50 | 0.65 | 0.80 |
| | Method | Parameter | SR1 | | | | | |
| NN | n.n. | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| IDS | exp. | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| OK | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | lag width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | variogram | Spherical | Spherical | Spherical | Spherical | Spherical | Spherical | Spherical |
| | eff. range | 43.53 | 35.81 | 35.43 | 34.69 | 32.70 | 32.18 | 33.30 |
| | nugget | 0.28 | 0.15 | 0.18 | 0.18 | 0.17 | 0.17 | 0.20 |
| | sill | 1.29 | 1.39 | 1.25 | 1.22 | 1.19 | 1.16 | 1.12 |
| | max. lag | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| | n.n. [min.,max.] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] |
| HER | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | class width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | bin widths ($z, \Delta z$) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | model range | 38.00 | 26.00 | 26.00 | 26.00 | 26.00 | 26.00 | 26.00 |
| | α | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | β | 0.70 | 0.55 | 0.60 | 0.55 | 0.55 | 0.70 | 0.80 |

n.n. = number of neighbors; exp. = exponent of the weighting function; eff. range = effective range; max. = maximum; min. = minimum.

Table S2.2: Method calibration by sample size – Parameters of the models for the long-range dataset (LR0 and LR1).

| Model sample size | | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 |
|-------------------|------------------------------|------------------|------------|----------|----------|----------|----------|----------|
| Method | Parameter | LR0 | | | | | | |
| NN | n.n. | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| IDS | exp. | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| OK | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | lag width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | variogram | Gaussian | Gaussian | Gaussian | Gaussian | Gaussian | Gaussian | Gaussian |
| | eff. range | 67.47 | 66.93 | 69.10 | 68.23 | 69.12 | 71.82 | 73.01 |
| | nugget | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | sill | 1.06 | 0.99 | 1.03 | 1.03 | 1.05 | 1.10 | 1.10 |
| | max. lag | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | n.n. [min.,max.] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] |
| HER | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | class width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | bin widths ($z, \Delta z$) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | model range | 46.00 | 48.00 | 48.00 | 46.00 | 46.00 | 48.00 | 48.00 |
| | α | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | β | 0.70 | 0.20 | 0.25 | 0.40 | 0.55 | 0.55 | 0.55 |
| | Method | Parameter | LR1 | | | | | |
| NN | n.n. | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| IDS | exp. | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| OK | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | lag width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | variogram | Gaussian | Gaussian | Gaussian | Gaussian | Gaussian | Gaussian | Gaussian |
| | eff. range | 81.79 | 76.14 | 71.43 | 69.02 | 74.43 | 78.75 | 78.05 |
| | nugget | 0.29 | 0.31 | 0.29 | 0.28 | 0.30 | 0.29 | 0.29 |
| | sill | 0.99 | 0.95 | 0.98 | 1.00 | 1.03 | 1.10 | 1.08 |
| | max. lag | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | n.n. [min.,max.] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] | [3,20] |
| HER | n.n. | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | class width | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | bin widths ($z, \Delta z$) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | model range | 48.00 | 46.00 | 44.00 | 44.00 | 44.00 | 46.00 | 46.00 |
| | α | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | β | 0.70 | 0.65 | 0.95 | 0.75 | 0.90 | 0.95 | 1.00 |

n.n. = number of neighbors; exp. = exponent of the weighting function; eff. range = effective range; max. = maximum; min. = minimum.

30 Supplement S3: Summary statistics of the model predictions

This supplement summarizes the statistics of the deterministic predictions (mean of z) for the test set by method and learning sets (from 200 to 2000 observations). HER outcomes refer to the AND/OR aggregation. The four random fields types are presented from Table S3.1 to Table S3.4. Finally, Fig. S3.1 illustrates their residue correlation (obtained by calculating the Pearson correlation coefficient between the true values and the residue of the predictions).

35 **Table S3.1: Summary statistics of the prediction on test set by model – Short-range dataset without noise (SR0).**

| Method | Statistics | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 |
|------------|------------|-------|-------|-------|-------|-------|-------|-------|
| SR0 | | | | | | | | |
| NN | mean | -0.54 | -0.55 | -0.56 | -0.56 | -0.56 | -0.56 | -0.56 |
| | sd. | 1.01 | 1.03 | 1.01 | 1.00 | 1.00 | 1.01 | 1.00 |
| | H | 4.17 | 4.33 | 4.31 | 4.31 | 4.31 | 4.34 | 4.33 |
| | max. | 1.76 | 1.92 | 1.92 | 1.91 | 1.91 | 1.91 | 1.91 |
| | median | -0.44 | -0.47 | -0.57 | -0.57 | -0.53 | -0.53 | -0.52 |
| | min. | -3.68 | -3.68 | -3.68 | -3.68 | -3.68 | -3.68 | -3.68 |
| | kur. | 3.37 | 3.13 | 3.06 | 3.04 | 3.07 | 3.08 | 3.08 |
| | sk. | -0.56 | -0.43 | -0.36 | -0.30 | -0.32 | -0.30 | -0.32 |
| IDS | mean | -0.54 | -0.57 | -0.58 | -0.59 | -0.57 | -0.57 | -0.57 |
| | sd. | 0.79 | 0.88 | 0.89 | 0.90 | 0.91 | 0.93 | 0.94 |
| | H | 3.96 | 4.13 | 4.16 | 4.19 | 4.21 | 4.24 | 4.26 |
| | max. | 1.58 | 1.80 | 1.79 | 1.80 | 1.80 | 1.79 | 1.80 |
| | median | -0.55 | -0.53 | -0.53 | -0.56 | -0.53 | -0.54 | -0.53 |
| | min. | -3.49 | -3.49 | -3.51 | -3.53 | -3.54 | -3.56 | -3.58 |
| | kur. | 3.56 | 3.28 | 3.27 | 3.17 | 3.15 | 3.13 | 3.10 |
| | sk. | -0.44 | -0.37 | -0.37 | -0.32 | -0.32 | -0.30 | -0.30 |
| OK | mean | -0.53 | -0.56 | -0.56 | -0.57 | -0.56 | -0.56 | -0.56 |
| | sd. | 0.86 | 0.92 | 0.93 | 0.94 | 0.95 | 0.97 | 0.97 |
| | H | 4.11 | 4.21 | 4.24 | 4.26 | 4.27 | 4.30 | 4.30 |
| | max. | 1.63 | 1.86 | 1.90 | 1.90 | 1.90 | 1.90 | 1.90 |
| | median | -0.47 | -0.49 | -0.49 | -0.52 | -0.51 | -0.51 | -0.51 |
| | min. | -3.60 | -3.56 | -3.57 | -3.63 | -3.66 | -3.67 | -3.67 |
| | kur. | 3.46 | 3.18 | 3.13 | 3.09 | 3.08 | 3.08 | 3.08 |
| | sk. | -0.46 | -0.41 | -0.39 | -0.34 | -0.35 | -0.32 | -0.33 |
| HER | mean | -0.54 | -0.56 | -0.58 | -0.57 | -0.57 | -0.57 | -0.57 |
| | sd. | 0.87 | 0.95 | 0.92 | 0.96 | 0.94 | 0.98 | 0.98 |
| | H | 4.08 | 4.23 | 4.21 | 4.26 | 4.24 | 4.31 | 4.31 |
| | max. | 1.70 | 1.82 | 1.81 | 1.83 | 1.82 | 1.83 | 1.86 |
| | median | -0.50 | -0.51 | -0.54 | -0.57 | -0.54 | -0.53 | -0.53 |
| | min. | -3.55 | -3.55 | -3.57 | -3.61 | -3.58 | -3.59 | -3.61 |
| | kur. | 3.54 | 3.18 | 3.22 | 3.10 | 3.13 | 3.10 | 3.07 |
| | sk. | -0.54 | -0.43 | -0.37 | -0.31 | -0.32 | -0.30 | -0.31 |

sd. = standard deviation; H = entropy; max. = maximum; min. = minimum; kur. = kurtosis; sk. = skewness.

Table S3.2: Summary statistics of the prediction on test set by model – Short-range dataset with noise (SR1).

| Method | Statistics | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 |
|------------|------------|-------|-------|-------|-------|-------|-------|-------|
| SR1 | | | | | | | | |
| NN | mean | -0.50 | -0.52 | -0.55 | -0.55 | -0.56 | -0.55 | -0.56 |
| | sd. | 1.15 | 1.16 | 1.14 | 1.14 | 1.13 | 1.11 | 1.11 |
| | H | 4.45 | 4.51 | 4.49 | 4.50 | 4.50 | 4.48 | 4.49 |
| | max. | 2.50 | 2.70 | 2.70 | 2.70 | 2.70 | 2.70 | 2.99 |
| | median | -0.43 | -0.51 | -0.53 | -0.54 | -0.54 | -0.53 | -0.54 |
| | min. | -3.66 | -3.66 | -3.66 | -3.84 | -3.84 | -3.84 | -4.00 |
| | kur. | 2.86 | 2.79 | 2.92 | 2.91 | 2.90 | 2.97 | 2.97 |
| | sk. | -0.27 | -0.05 | -0.05 | -0.09 | -0.14 | -0.13 | -0.18 |
| IDS | mean | -0.49 | -0.53 | -0.55 | -0.58 | -0.56 | -0.56 | -0.56 |
| | sd. | 0.85 | 0.92 | 0.92 | 0.95 | 0.95 | 0.96 | 0.96 |
| | H | 4.09 | 4.22 | 4.24 | 4.28 | 4.27 | 4.29 | 4.30 |
| | max. | 2.19 | 2.37 | 2.34 | 2.28 | 2.27 | 2.19 | 2.07 |
| | median | -0.47 | -0.47 | -0.50 | -0.53 | -0.51 | -0.53 | -0.52 |
| | min. | -3.42 | -3.30 | -3.29 | -3.50 | -3.52 | -3.59 | -3.55 |
| | kur. | 3.17 | 2.84 | 2.97 | 2.86 | 2.91 | 2.98 | 2.92 |
| | sk. | -0.23 | -0.13 | -0.19 | -0.21 | -0.21 | -0.22 | -0.23 |
| OK | mean | -0.49 | -0.52 | -0.54 | -0.57 | -0.55 | -0.56 | -0.56 |
| | sd. | 0.79 | 0.90 | 0.91 | 0.93 | 0.93 | 0.94 | 0.94 |
| | H | 3.99 | 4.20 | 4.21 | 4.24 | 4.25 | 4.25 | 4.25 |
| | max. | 1.58 | 2.30 | 2.22 | 2.20 | 2.21 | 2.17 | 1.90 |
| | median | -0.48 | -0.46 | -0.48 | -0.51 | -0.49 | -0.49 | -0.49 |
| | min. | -3.17 | -3.16 | -3.19 | -3.31 | -3.44 | -3.51 | -3.45 |
| | kur. | 3.22 | 2.82 | 2.84 | 2.76 | 2.85 | 2.94 | 2.89 |
| | sk. | -0.22 | -0.19 | -0.24 | -0.25 | -0.26 | -0.27 | -0.26 |
| HER | mean | -0.50 | -0.53 | -0.54 | -0.57 | -0.55 | -0.56 | -0.56 |
| | sd. | 0.90 | 0.96 | 0.98 | 0.98 | 0.97 | 0.97 | 0.97 |
| | H | 4.16 | 4.28 | 4.31 | 4.33 | 4.31 | 4.31 | 4.30 |
| | max. | 2.24 | 2.31 | 2.35 | 2.28 | 2.28 | 2.26 | 2.00 |
| | median | -0.47 | -0.48 | -0.50 | -0.54 | -0.51 | -0.53 | -0.52 |
| | min. | -3.32 | -3.32 | -3.38 | -3.46 | -3.45 | -3.55 | -3.54 |
| | kur. | 3.11 | 2.70 | 2.89 | 2.82 | 2.85 | 2.98 | 2.89 |
| | sk. | -0.27 | -0.13 | -0.14 | -0.16 | -0.20 | -0.19 | -0.24 |

sd. = standard deviation; H = entropy; max. = maximum; min. = minimum; kur. = kurtosis; sk. = skewness.

Table S3.3: Summary statistics of the prediction on test set by model – Long-range dataset without noise (LR0).

| Method | Statistics | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 |
|------------|------------|-------|-------|-------|-------|-------|-------|-------|
| LR0 | | | | | | | | |
| NN | mean | -1.03 | -1.02 | -1.01 | -1.02 | -1.02 | -1.01 | -1.02 |
| | sd. | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 |
| | H | 3.98 | 4.06 | 4.10 | 4.11 | 4.11 | 4.12 | 4.11 |
| | max. | 1.04 | 1.15 | 1.15 | 1.23 | 1.23 | 1.23 | 1.23 |
| | median | -0.92 | -0.91 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 |
| | min. | -2.78 | -2.78 | -3.07 | -3.07 | -3.07 | -3.08 | -3.08 |
| | kur. | 2.10 | 2.13 | 2.20 | 2.18 | 2.20 | 2.15 | 2.16 |
| | sk. | 0.00 | 0.02 | 0.03 | 0.02 | 0.03 | 0.01 | 0.00 |
| IDS | mean | -1.04 | -1.02 | -1.02 | -1.02 | -1.02 | -1.02 | -1.02 |
| | sd. | 0.85 | 0.87 | 0.88 | 0.89 | 0.89 | 0.90 | 0.90 |
| | H | 3.91 | 3.98 | 4.05 | 4.07 | 4.07 | 4.08 | 4.09 |
| | max. | 0.99 | 1.08 | 1.14 | 1.15 | 1.16 | 1.14 | 1.14 |
| | median | -0.86 | -0.88 | -0.89 | -0.88 | -0.88 | -0.88 | -0.89 |
| | min. | -2.72 | -2.71 | -3.01 | -3.01 | -3.01 | -3.02 | -3.02 |
| | kur. | 1.95 | 2.01 | 2.11 | 2.12 | 2.12 | 2.11 | 2.13 |
| | sk. | -0.12 | -0.03 | -0.03 | -0.01 | -0.01 | -0.02 | -0.01 |
| OK | mean | -1.04 | -1.02 | -1.02 | -1.02 | -1.02 | -1.02 | -1.02 |
| | sd. | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 |
| | H | 4.11 | 4.11 | 4.12 | 4.12 | 4.12 | 4.12 | 4.12 |
| | max. | 1.34 | 1.28 | 1.24 | 1.28 | 1.27 | 1.27 | 1.27 |
| | median | -0.93 | -0.88 | -0.89 | -0.89 | -0.89 | -0.89 | -0.89 |
| | min. | -2.89 | -2.97 | -3.08 | -3.08 | -3.07 | -3.07 | -3.07 |
| | kur. | 2.12 | 2.15 | 2.17 | 2.17 | 2.16 | 2.16 | 2.16 |
| | sk. | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| HER | mean | -1.04 | -1.02 | -1.02 | -1.02 | -1.02 | -1.02 | -1.02 |
| | sd. | 0.88 | 0.88 | 0.89 | 0.90 | 0.90 | 0.90 | 0.91 |
| | H | 3.98 | 4.03 | 4.07 | 4.09 | 4.09 | 4.09 | 4.09 |
| | max. | 1.02 | 1.13 | 1.14 | 1.22 | 1.20 | 1.15 | 1.15 |
| | median | -0.89 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 |
| | min. | -2.77 | -2.78 | -3.06 | -3.07 | -3.07 | -3.08 | -3.07 |
| | kur. | 2.02 | 2.09 | 2.17 | 2.16 | 2.16 | 2.13 | 2.14 |
| | sk. | -0.05 | 0.00 | 0.00 | 0.00 | 0.01 | -0.01 | -0.01 |

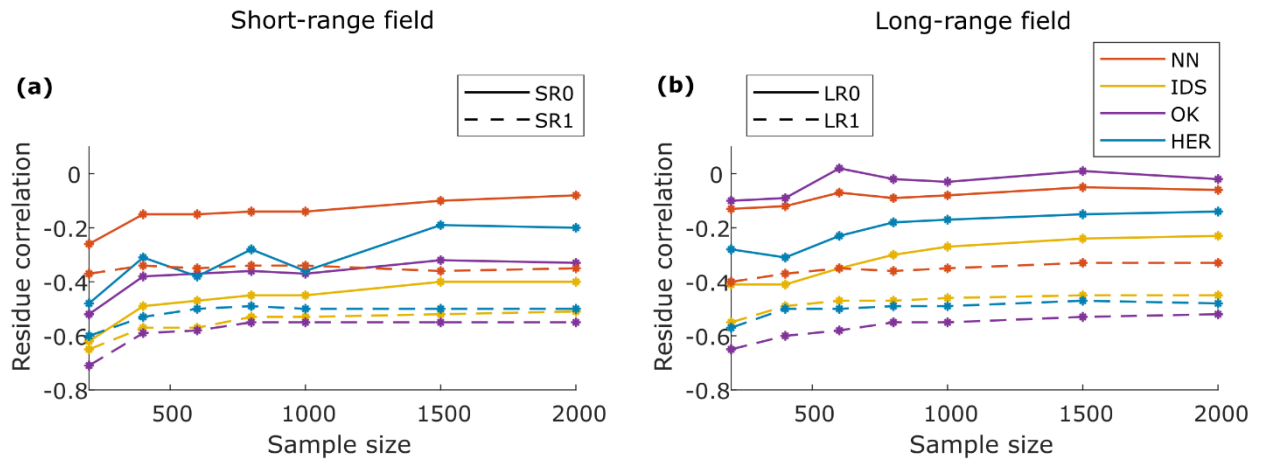
sd. = standard deviation; H = entropy; max. = maximum; min. = minimum; kur. = kurtosis; sk. = skewness.

Table S3.4: Summary statistics of the prediction on test set by model – Long-range dataset with noise (LR1).

| Method | Statistics | 200 | 400 | 600 | 800 | 1000 | 1500 | 2000 |
|------------|------------|-------|-------|-------|-------|-------|-------|-------|
| LR1 | | | | | | | | |
| NN | mean | -1.00 | -0.99 | -1.00 | -1.01 | -1.01 | -1.00 | -1.01 |
| | sd. | 1.00 | 1.02 | 1.03 | 1.03 | 1.04 | 1.05 | 1.05 |
| | H | 4.23 | 4.33 | 4.36 | 4.35 | 4.39 | 4.40 | 4.40 |
| | max. | 1.40 | 1.87 | 1.87 | 1.87 | 1.87 | 1.87 | 1.87 |
| | median | -0.90 | -0.94 | -0.97 | -0.99 | -0.99 | -0.99 | -0.98 |
| | min. | -3.19 | -3.65 | -3.65 | -3.65 | -3.65 | -3.65 | -3.87 |
| | kur. | 2.50 | 2.66 | 2.56 | 2.57 | 2.57 | 2.51 | 2.49 |
| | sk. | -0.11 | 0.03 | 0.02 | 0.10 | 0.08 | 0.06 | 0.03 |
| IDS | mean | -0.99 | -0.98 | -0.99 | -1.01 | -1.00 | -1.01 | -1.01 |
| | sd. | 0.86 | 0.90 | 0.91 | 0.92 | 0.92 | 0.93 | 0.93 |
| | H | 4.04 | 4.14 | 4.14 | 4.16 | 4.18 | 4.17 | 4.16 |
| | max. | 1.21 | 1.76 | 1.48 | 1.45 | 1.61 | 1.54 | 1.43 |
| | median | -0.79 | -0.85 | -0.85 | -0.88 | -0.90 | -0.88 | -0.90 |
| | min. | -3.04 | -3.12 | -3.12 | -3.12 | -3.05 | -3.15 | -3.25 |
| | kur. | 2.21 | 2.39 | 2.28 | 2.31 | 2.32 | 2.26 | 2.26 |
| | sk. | -0.26 | 0.01 | 0.04 | 0.06 | 0.05 | 0.05 | 0.03 |
| OK | mean | -0.98 | -0.96 | -0.98 | -1.00 | -1.00 | -1.01 | -1.01 |
| | sd. | 0.79 | 0.83 | 0.85 | 0.86 | 0.87 | 0.88 | 0.89 |
| | H | 3.89 | 4.01 | 4.00 | 4.02 | 4.02 | 4.04 | 4.05 |
| | max. | 0.81 | 1.29 | 1.25 | 1.32 | 1.30 | 1.14 | 1.19 |
| | median | -0.78 | -0.81 | -0.81 | -0.84 | -0.84 | -0.86 | -0.88 |
| | min. | -2.85 | -2.82 | -2.74 | -2.76 | -2.69 | -2.84 | -2.92 |
| | kur. | 2.28 | 2.38 | 2.17 | 2.18 | 2.18 | 2.13 | 2.13 |
| | sk. | -0.40 | -0.10 | -0.04 | -0.01 | -0.01 | -0.01 | -0.01 |
| HER | mean | -0.99 | -0.97 | -0.98 | -1.01 | -1.00 | -1.01 | -1.01 |
| | sd. | 0.85 | 0.89 | 0.89 | 0.90 | 0.90 | 0.92 | 0.91 |
| | H | 4.01 | 4.11 | 4.07 | 4.11 | 4.11 | 4.12 | 4.11 |
| | max. | 1.20 | 1.64 | 1.32 | 1.33 | 1.36 | 1.30 | 1.30 |
| | median | -0.80 | -0.83 | -0.83 | -0.86 | -0.89 | -0.89 | -0.89 |
| | min. | -3.00 | -2.98 | -2.82 | -2.90 | -2.83 | -2.98 | -3.13 |
| | kur. | 2.21 | 2.46 | 2.23 | 2.28 | 2.27 | 2.23 | 2.23 |
| | sk. | -0.28 | 0.03 | 0.02 | 0.05 | 0.04 | 0.05 | 0.02 |

sd. = standard deviation; H = entropy; max. = maximum; min. = minimum; kur. = kurtosis; sk. = skewness.

40 Fig. S3.1 illustrates for the residue correlation of the models calculated using the test set. The more negative the residue correlation, the greater the tendency of true z values being overestimated in low-valued regions of the field and underestimated in high-valued regions.



45 **Figure S3.1: Performance comparison of NN, IDS, OK and HER: a) residue correlation for SR datasets and b) residue correlation for LR datasets. Continuous line refers to datasets without noise and dashed lines to datasets with noise.**