Score definitions

WMO Lead Centre for Deterministic NWP Verification

The following definitions should be used:

Mean error

$$M = \frac{1}{S_w} \sum_{i=1}^{n} w_i (x_f - x_v)_i$$

where the sum of the weights

$$S_w = \sum_{i=1}^{n} w_i$$

Root mean square (rms) error

$$rms = \sqrt{\frac{1}{S_w} \sum_{i=1}^{n} w_i (x_f - x_v)_i^2}$$

Correlation coefficient between forecast and analysis anomalies

$$r = \frac{\sum_{i=1}^{n} w_i (x_f - x_c - M_{f,c})_i (x_v - x_c - M_{v,c})_i}{\sqrt{\left(\sum_{i=1}^{n} w_i (x_f - x_c - M_{f,c})_i^2\right)\left(\sum_{i=1}^{n} w_i (x_v - x_c - M_{v,c})_i^2\right)}}$$

rms vector wind error

$$rms = \sqrt{\frac{1}{S_w} \sum_{i=1}^{n} w_i (\vec{V}_f - \vec{V}_v)_i^2}$$

Mean absolute error

$$MAE = \frac{1}{S_w} \sum_{i=1}^{n} w_i |x_f - x_v|_i$$

rms anomaly

$$rmsa = \sqrt{\frac{1}{S_w} \sum_{i=1}^{n} w_i (x - x_c)_i^2}$$

standard deviation of field

$$sd = \sqrt{\frac{1}{S_w} \sum_{i=1}^{n} w_i (x - M_x)_i^2}$$

where

$$M_x = \frac{1}{S_w} \sum_{i=1}^{n} w_i x_i$$

S1 score

$$S1 = 100 \frac{\sum_{i=1}^{n} w_i (e_g)_i}{\sum_{i=1}^{n} w_i (G_L)_i}$$

Where:

x_f = the forecast value of the parameter in question;

x_v = the corresponding verifying value;

x_c = the climatological value of the parameter;

n = the number of grid points or observations in the verification area;

$M_{f,c}$ = the mean value over the verification area of the forecast anomalies from climate;

$M_{v,c}$ = the mean value over the verification area of the analysed anomalies from climate;

$\vec{V_f}$ = the forecast wind vector;

$\vec{V_v}$ = the corresponding verifying value.

The differentiation is approximated by differences computed on the verification grid:

$$e_g = \left(\left| \frac{\partial}{\partial x}(x_f - x_v) \right| + \left| \frac{\partial}{\partial y}(x_f - x_v) \right| \right)$$

$$G_L = \max \left(\left| \frac{\partial x_f}{\partial x} \right|, \left| \frac{\partial x_v}{\partial x} \right| \right) + \max \left(\left| \frac{\partial x_f}{\partial y} \right|, \left| \frac{\partial x_v}{\partial y} \right| \right)$$

The weights w_i applied at each grid point or observation location are defined as:

Verification against analyses: $w_i = \cos \theta_i$, cosine of latitude athe the grid point i

Verification against observations: $w_i = 1/n$, all observations have equal weight