Summing up the course

A typical weather forecast problem:

Clouds are forecast to disperse and the temperature to drop

+2º ⟶ -4º

A classical, physical-meteorological, deterministic problem

The weather forecasters are invited to "prove their value" compared to the NWP by modifying the forecast

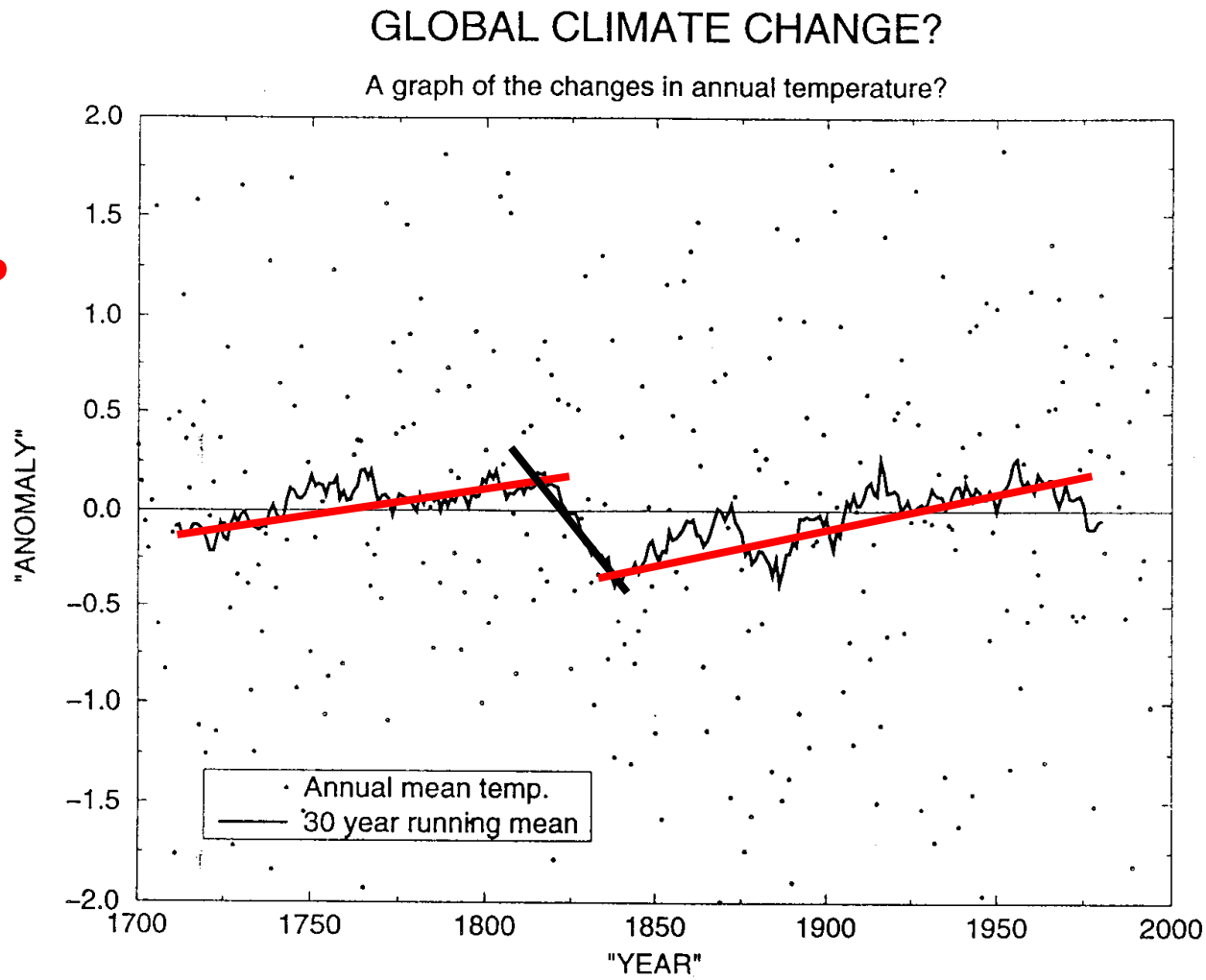
However, their "added value" might be of some other kind. . .

What looks like thirty year running averages of annual mean temperatures show interesting variations

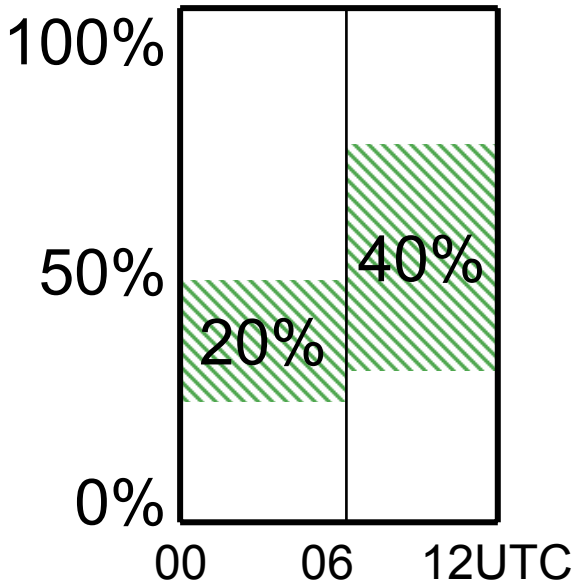
What caused the warming up to 1815?

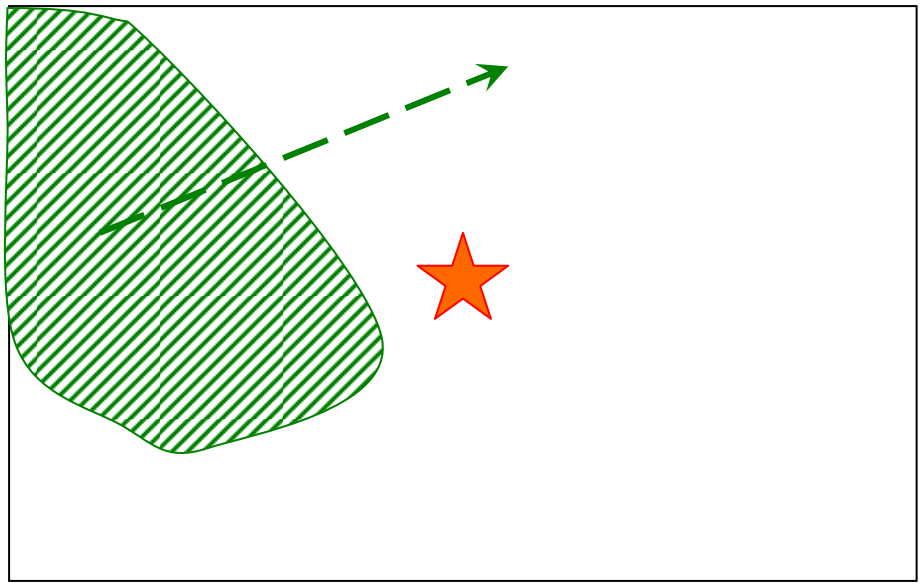
What caused the cooling thereafter?

And the subsequent gradual warming by almost 0.1°/decade?



Correlated time periods





12-18UTC 06-12 UTC	R	-
R	12	8
-	28	52

The timing is uncertain for a narrow band of rain that will pass. The total certainty is < 100% since the rain is geographically scattered

Corr = 0.65 Rain at all = 48%

Persistent rain = 12%

The initial transition matrix can be decomposed into a weighted sum of two new matrices

$$\begin{pmatrix} .62 & .38 \\ .15 & .85 \end{pmatrix}^{n} = \begin{pmatrix} .28 & .72 \\ .28 & .72 \end{pmatrix} + \underbrace{0.47^{n}}_{\text{Eigen value}} \cdot \begin{pmatrix} .72 & -.72 \\ -.28 & .28 \end{pmatrix}$$

Persistence probabilities

Climate probabilities

Time folding factor

Variability

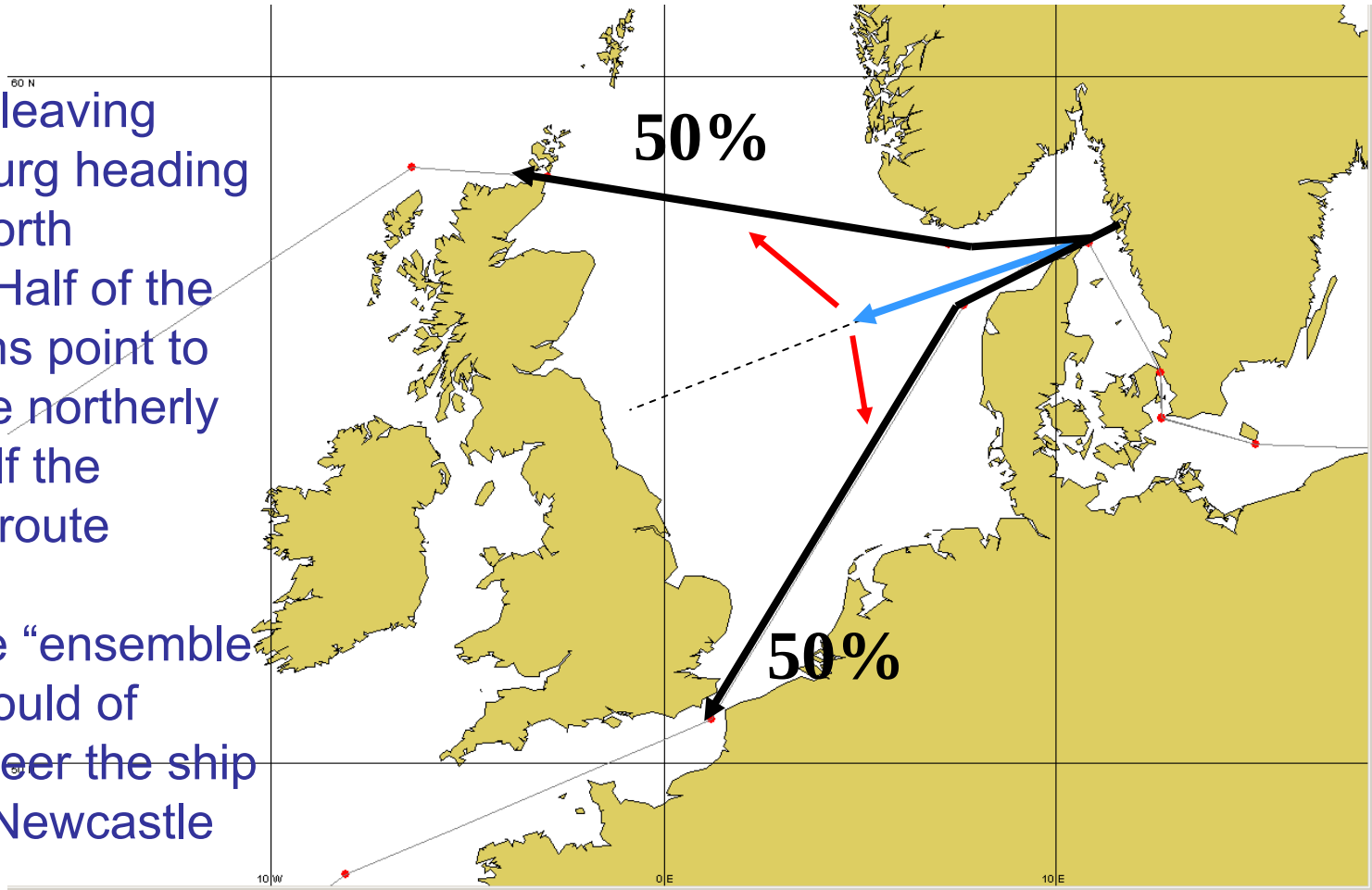
Meteorological interpretation

A common objection to the use of mean forecasts:

-It may lead to absurdities in bi-modal situations

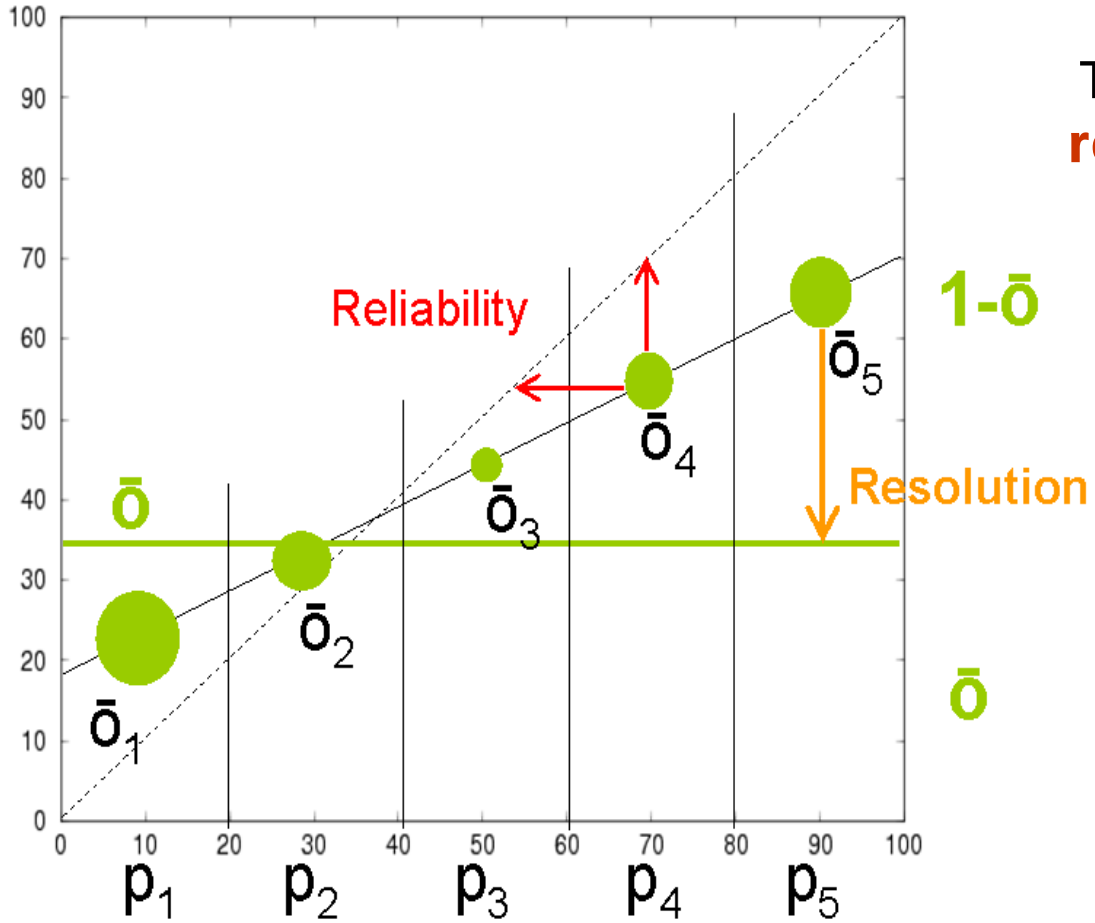
A ship is leaving Gothenburg heading for the North Atlantic. Half of the indications point to taking the northerly route, half the Channel route

Using the “ensemble mean” would of course steer the ship towards Newcastle harbour!

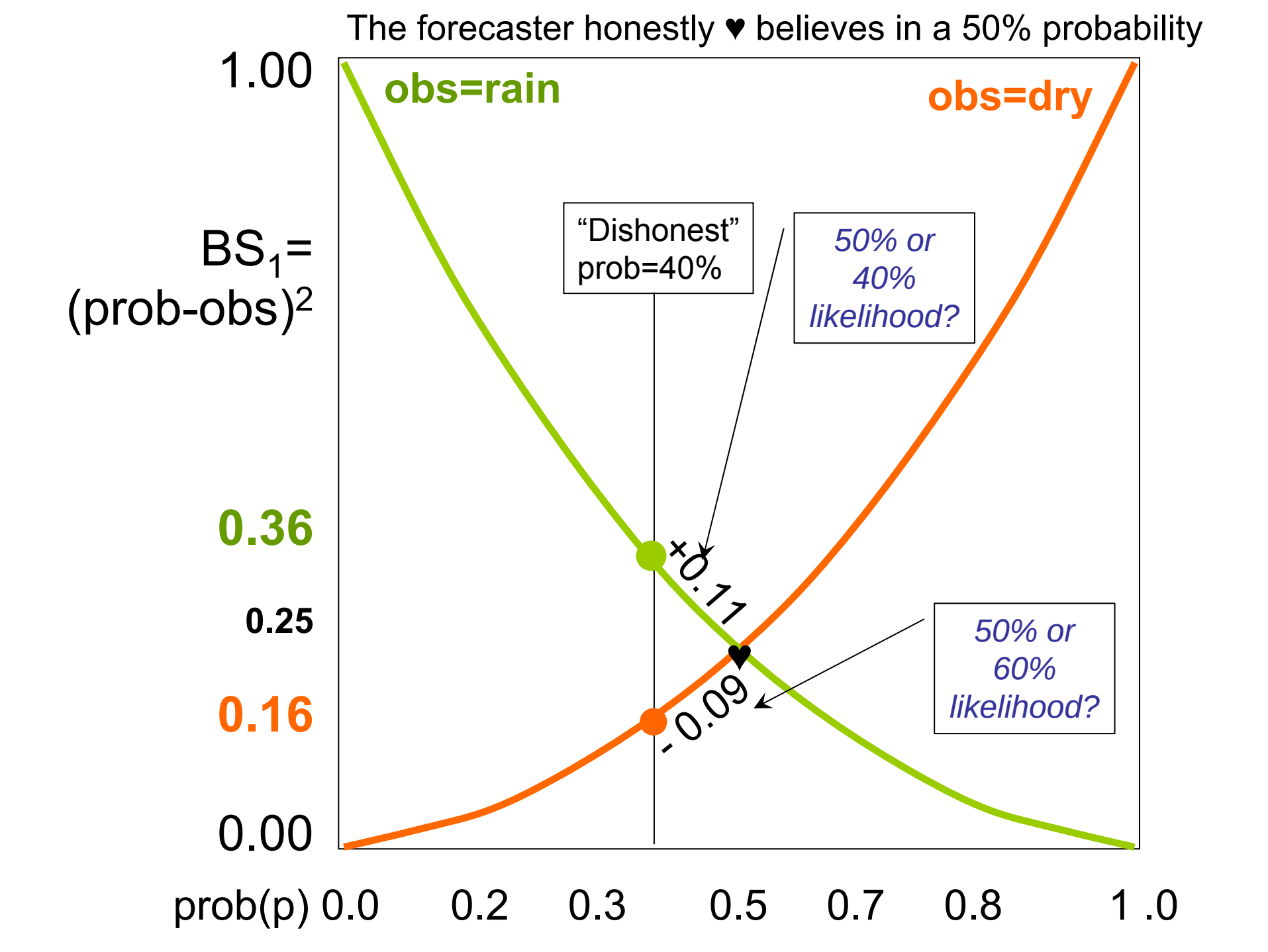


But this is exactly what the ship routers would advice, as a “stand-by”

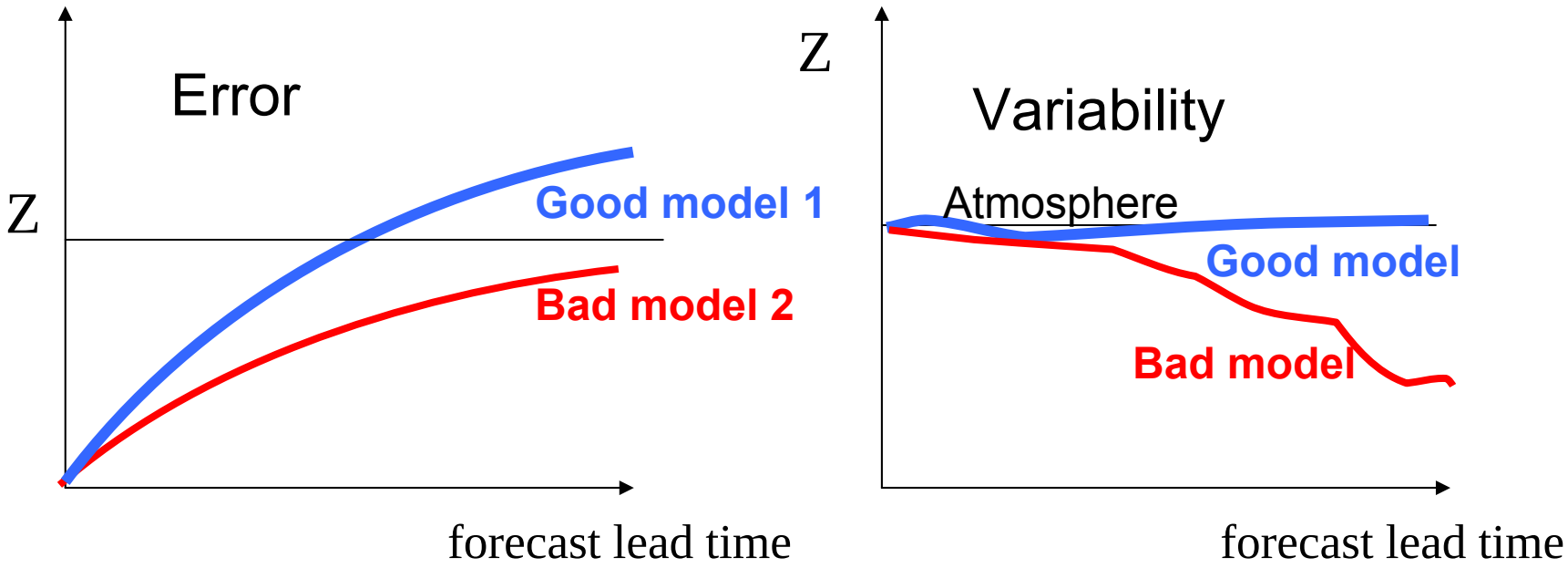
$$BS = \frac{1}{N}\sum_{k=0}^{M} N_k (f_k - \bar{o}_k)^2 - \frac{1}{N}\sum_{k=0}^{M} N_k (\bar{o}_k - \bar{o})^2 + \bar{o}(1-\bar{o})$$



The second term is a **resolution** measure:

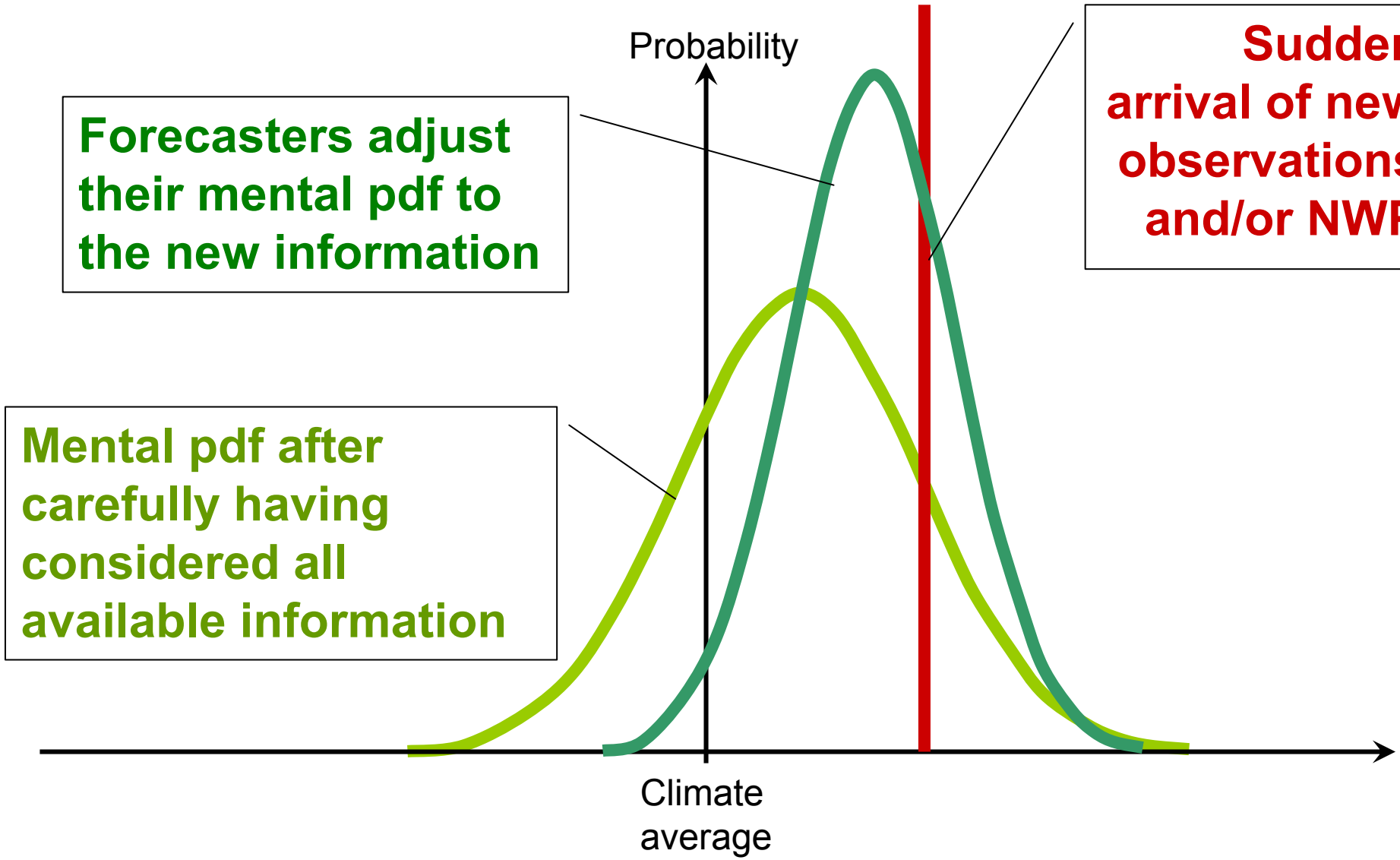

The forecaster honestly ♥ believes in a 50% probability
1.00
obs=rain
obs=dry
BS1=
(prob-obs)2
"Dishonest"
prob=40%
50% or
40%
likelihood?
0.36
+0.11
0.25
50% or
60%
likelihood?
0.16
- 0.09
0.00
prob(p) 0.0
0.2
0.3
0.5
0.7
0.8
1 .0

A bad NWP model with under-variability might have lower RMSE than . . .



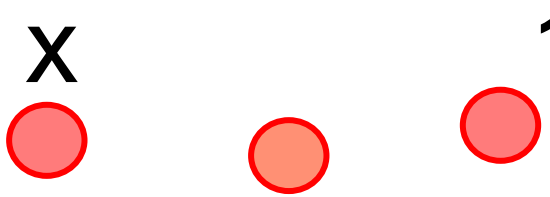
. . . a good NWP model with correct variability and therefore higher RMSE

Intuitive Bayesianism among weather forecasters



Thomas Bayes' experiment

The thrower (Thomas Bayes) doesn't know where the white line is, and is only told, afterwards, on which side of the white line the ball ends up

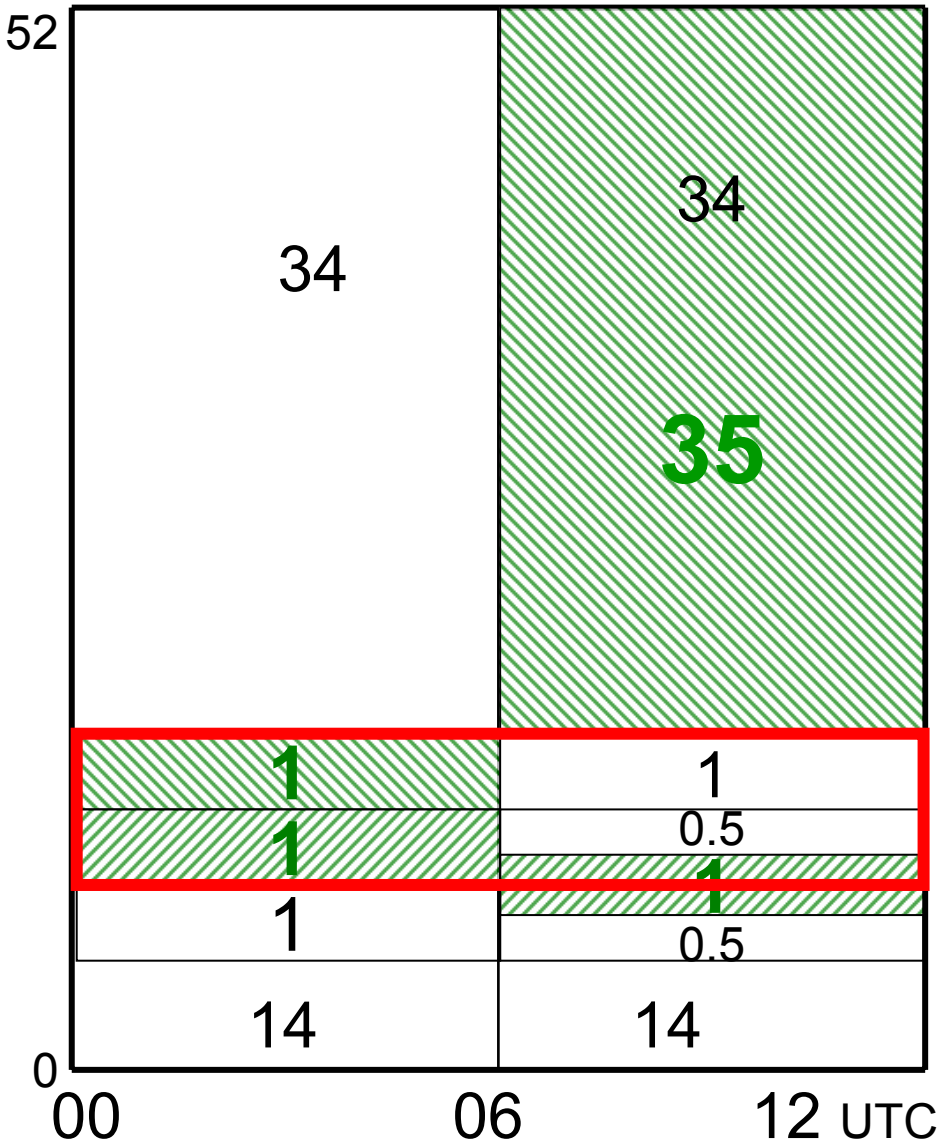


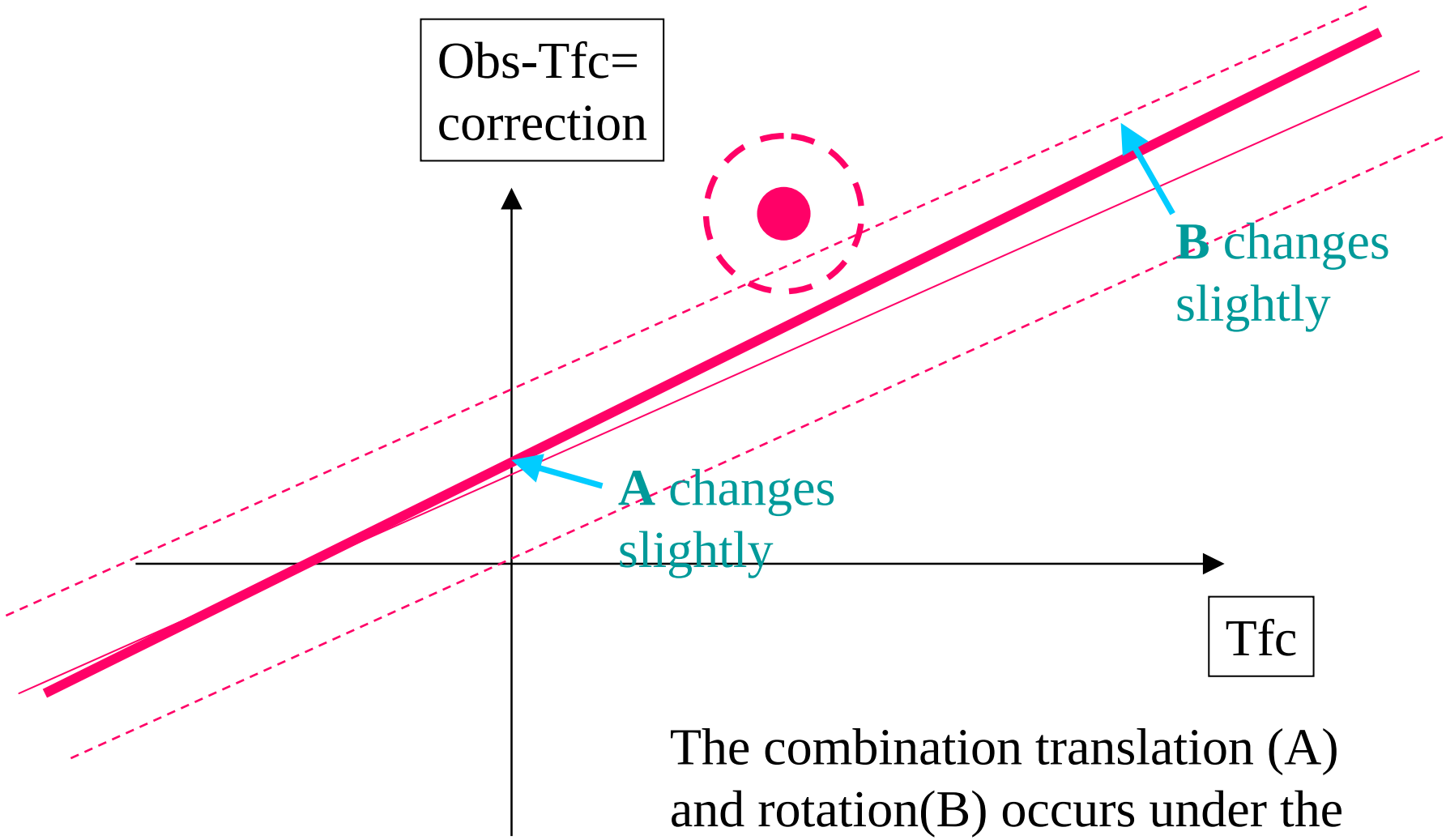
Left

Left

Right

Probabilities in %





Corr = A + B · Tfc

The combination translation (A) and rotation(B) occurs under the variational condition of ”least effort”

Which ones of the 40 forecasts are more or less certain or uncertain?

Categorical

Obs Fc	R	–
R	20	10
-	10	60

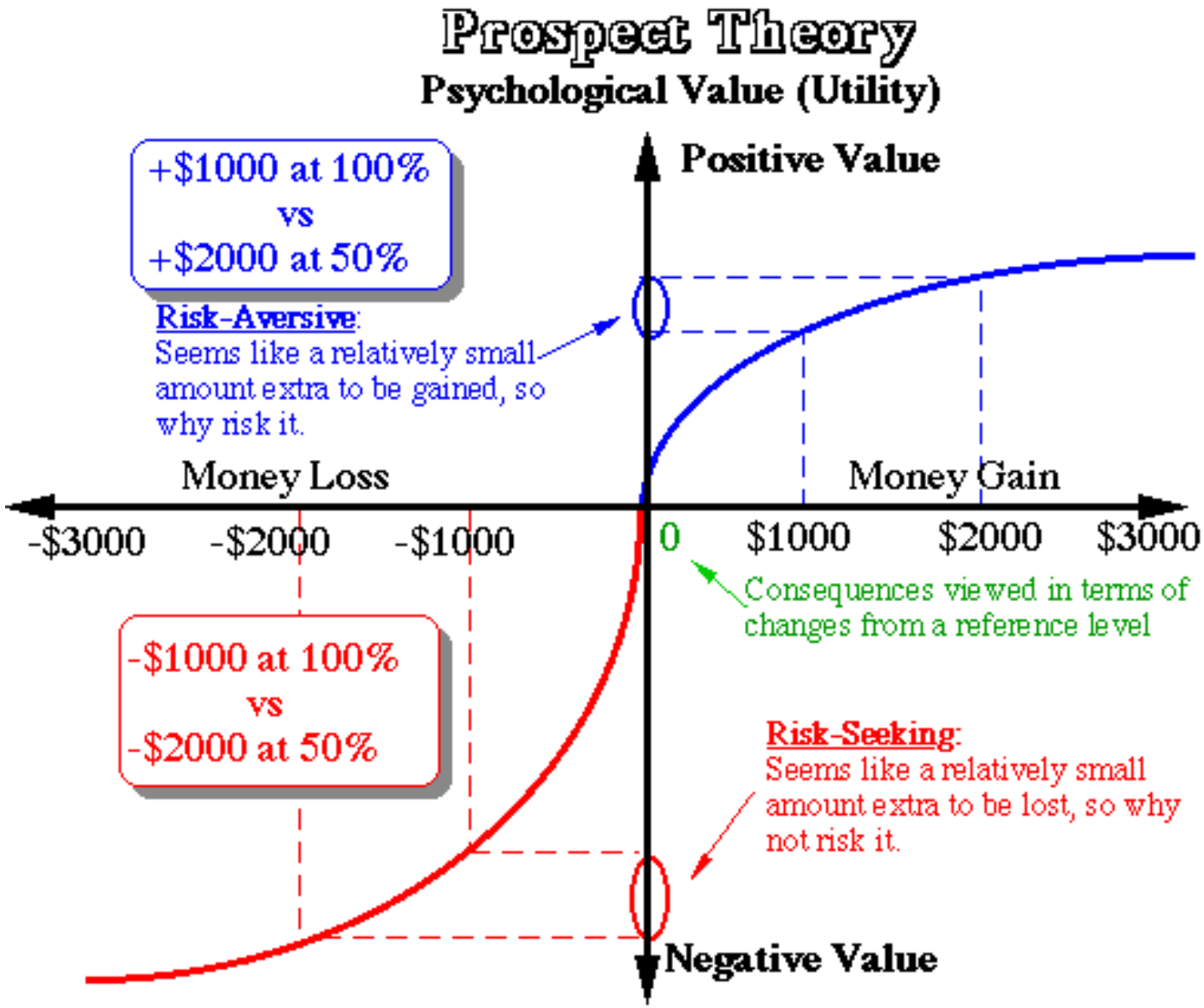
Non-categorical

Obs Fc	R	-
R	10	0
???	20	20
-	0	50

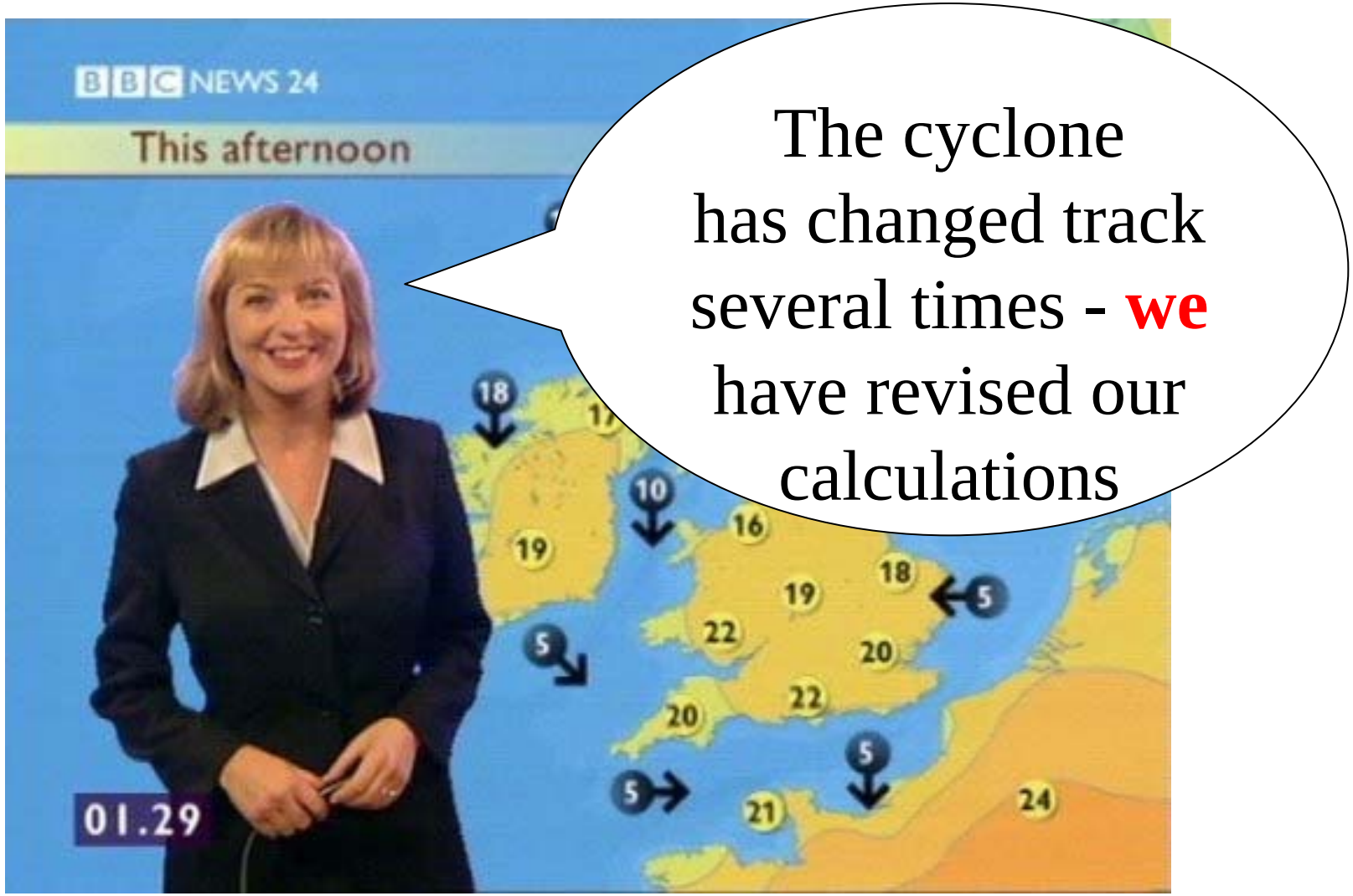
Probabilistic

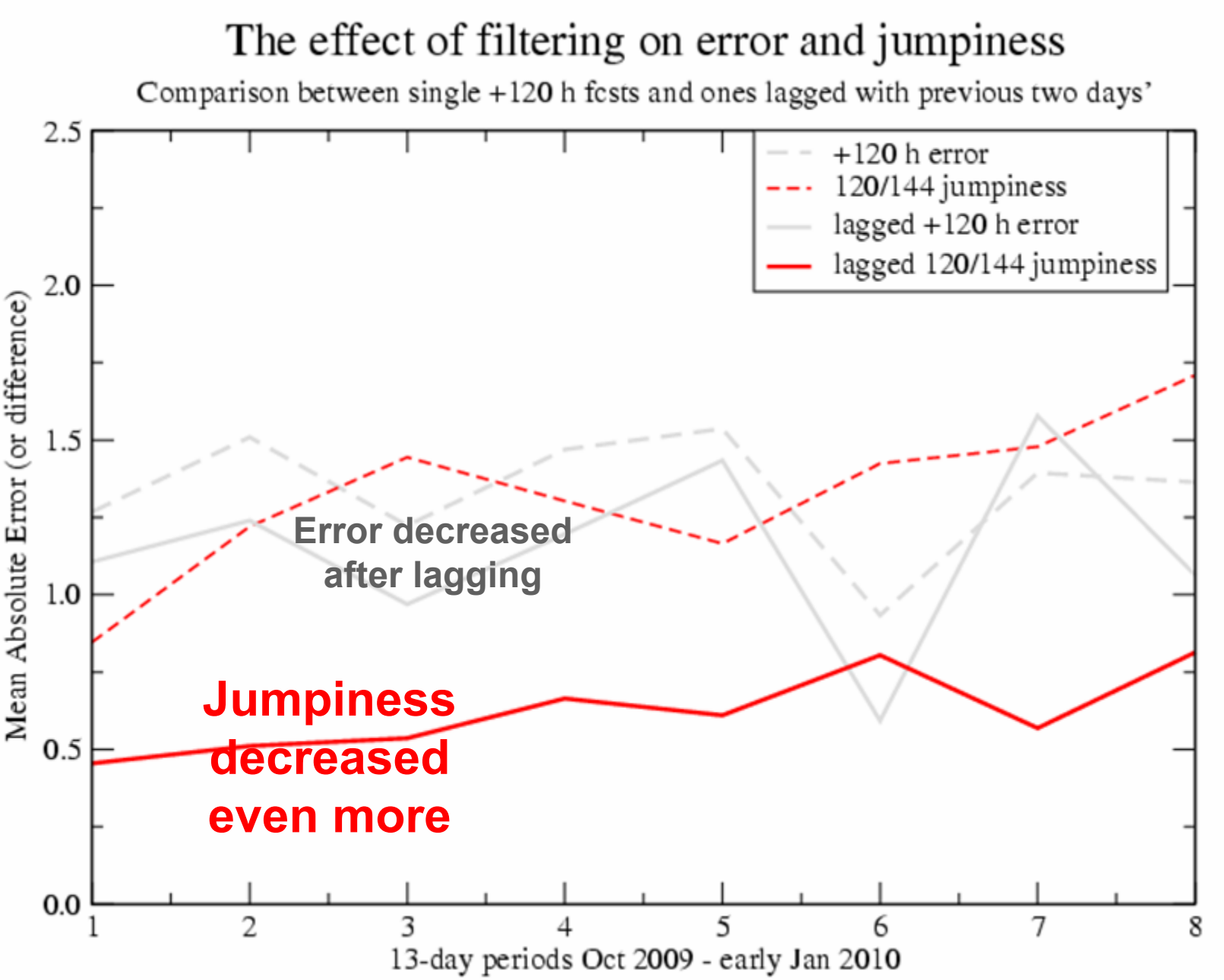
Obs Confidence	R	–
certain	10	0
certain	0	50

Can we quantify that uncertainty?


Prospect Theory
Psychological Value (Utility)
+$1000 at 100%
vs
+$2000 at 50%
Positive Value
Risk-Aversive:
Seems like a relatively small amount extra to be gained, so why risk it.
Money Loss
Money Gain
-$3000
-$2000
-$1000
0
$1000
$2000
$3000
Consequences viewed in terms of changes from a reference level
-$1000 at 100%
vs
-$2000 at 50%
Risk-Seeking:
Seems like a relatively small amount extra to be lost, so why not risk it.
Negative Value

They took an active responsibility for the problems

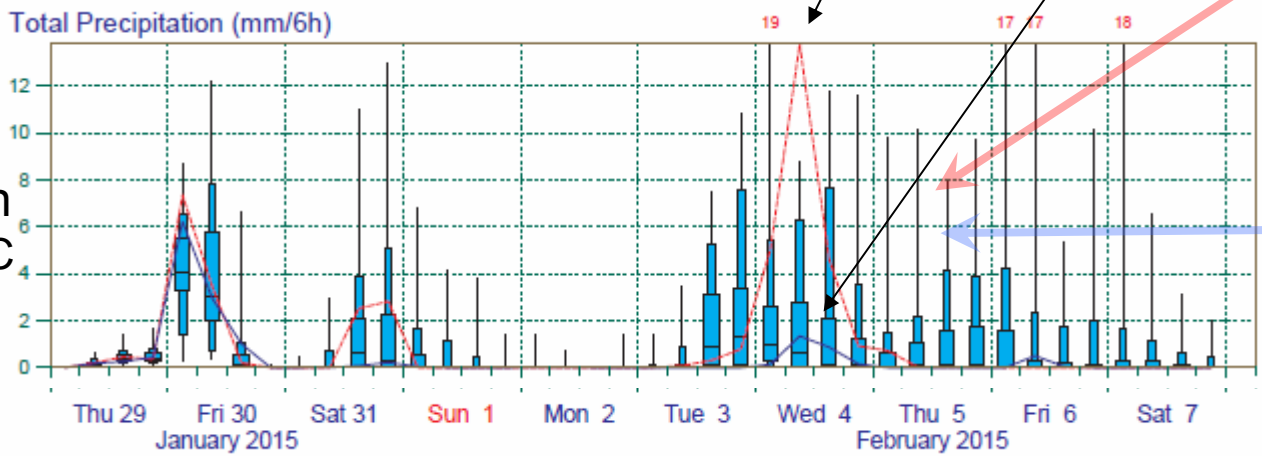



The effect of filtering on error and jumpiness
Comparison between single +120 h fcsts and ones lagged with previous two days'
+120 h error
120/144 jumpiness
lagged +120 h error
lagged 120/144 jumpiness
Mean Absolute Error (or difference)
2.5
2.0
1.5
1.0
0.5
0.0
Error decreased after lagging
Jumpiness decreased even more
1
2
3
4
5
6
7
8
13-day periods Oct 2009 - early Jan 2010

EPS gram for Bologna covering this week

In the 29 Jan forecast EPS Control has 14 mm, Ops only 1 mm

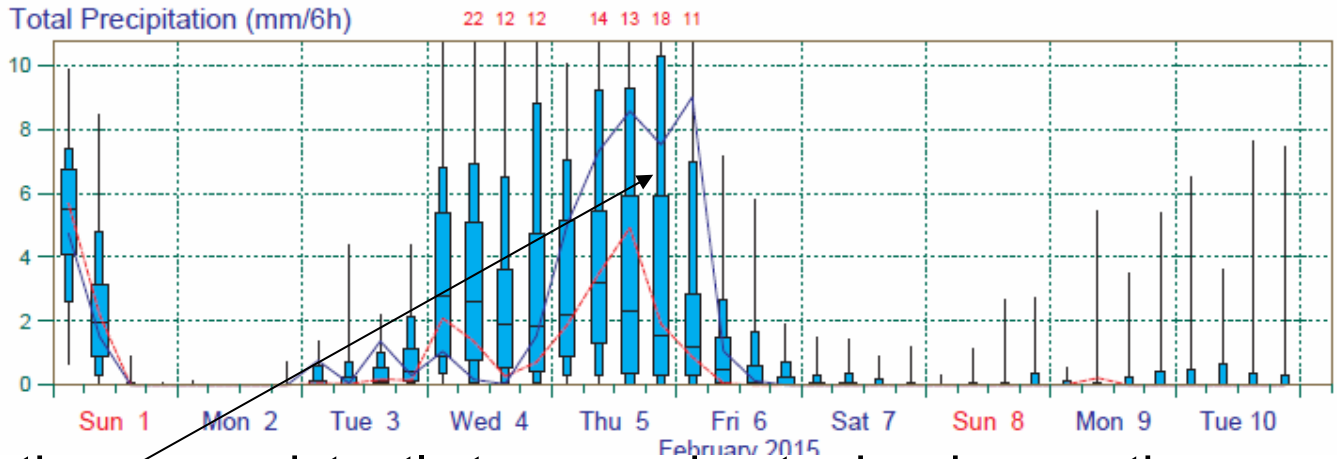
29 Jan
00 UTC



Can the EPS help us to **confirm** which one to trust?

There is a probability of rain which the Control and Ops may or may not support

1 Feb
00 UTC



The EPS continues consistently to warn about rain whereas the Control and Ops have “jumped”, which they are “entitled” to do!

a) From the 2004 movie “Shall we dance?”

This shows that she is not an educated Bayesian!

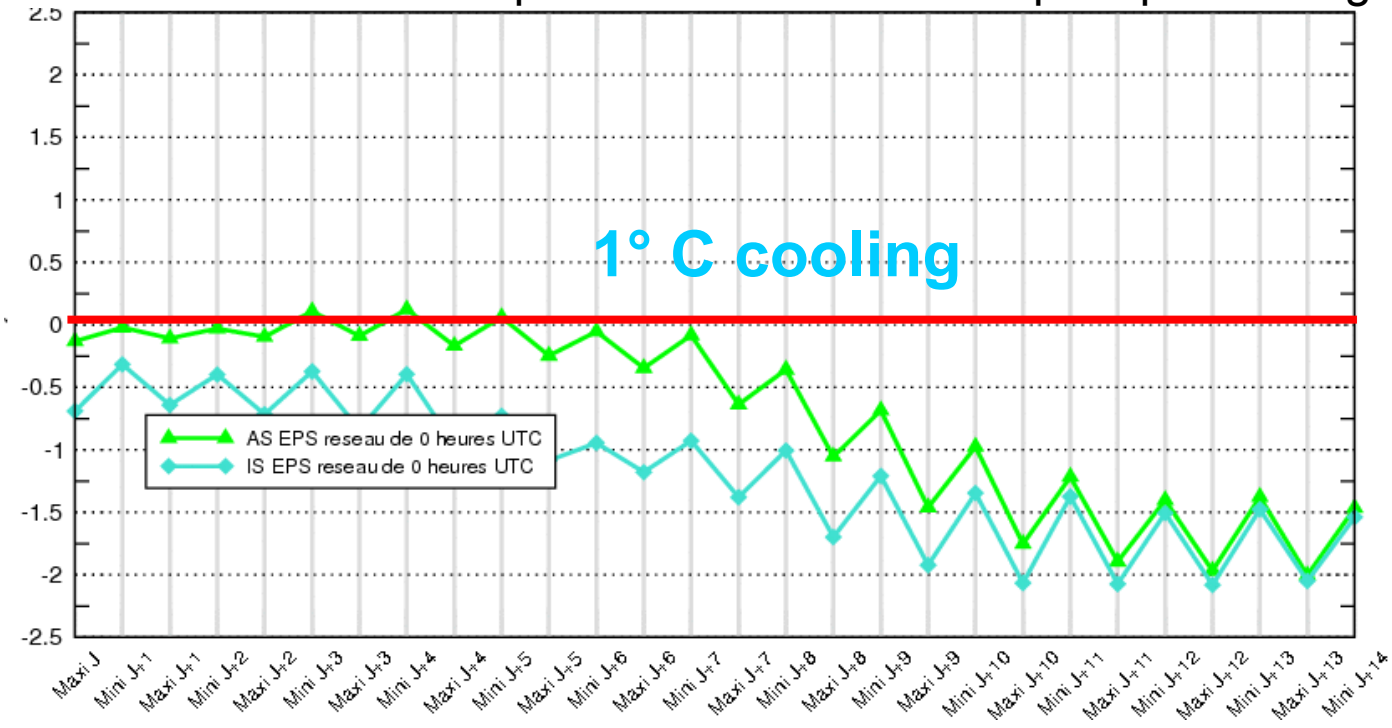
Regression to the mean deceptions in weather forecast verification

During an anomalous period, a non-biased NWP model will, due to *random* errors, display *systematic* mean errors increasing with forecast length.

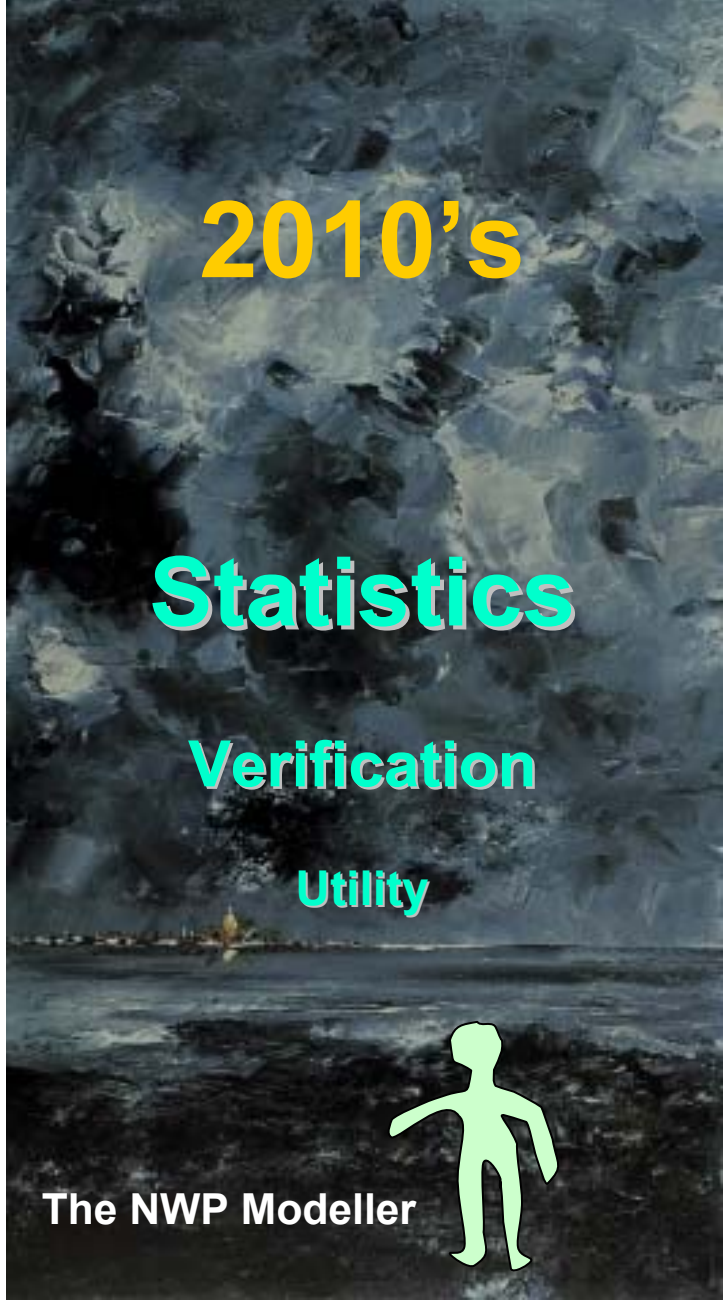
Mean error for the 2m-temperature based on EPS

February 2011 – French stations

=direct model output = statistical post-processing




1960's
Numerical
Weather
Prediction
The Forecaster


2010's
Statistics
Verification
Utility
The NWP Modeller