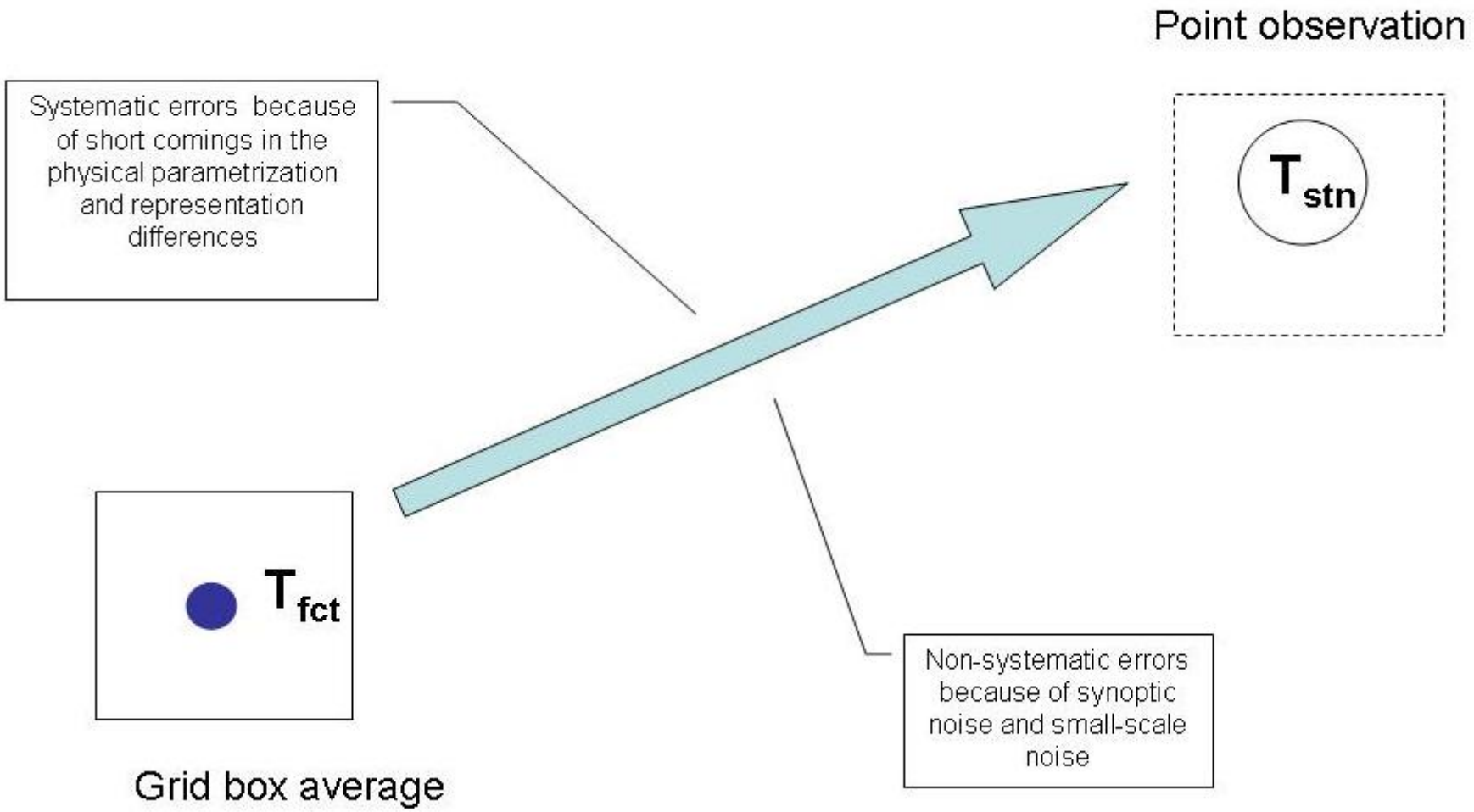
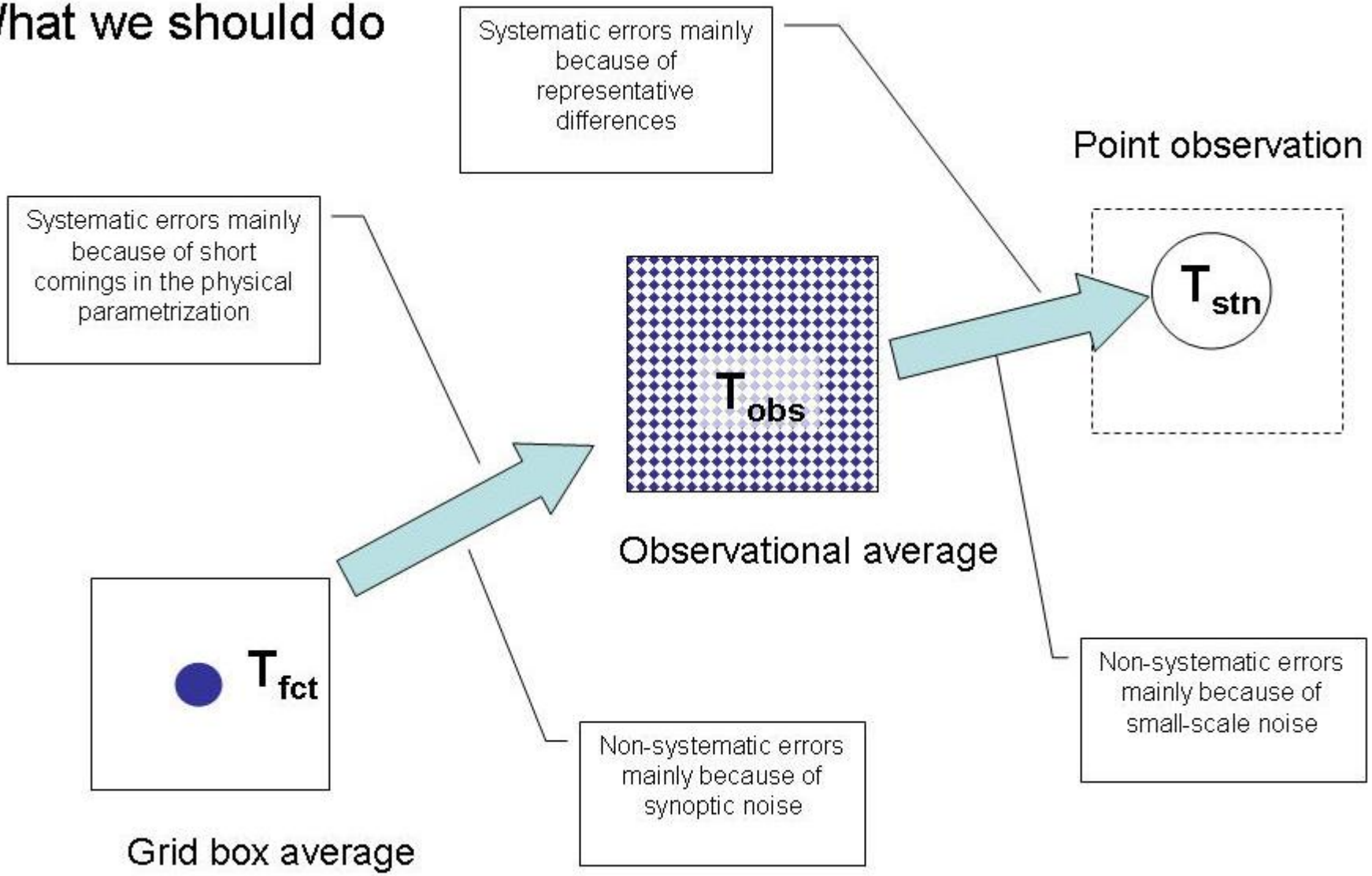
2. Kalman filtering of computer forecast output – *self learning equations?*

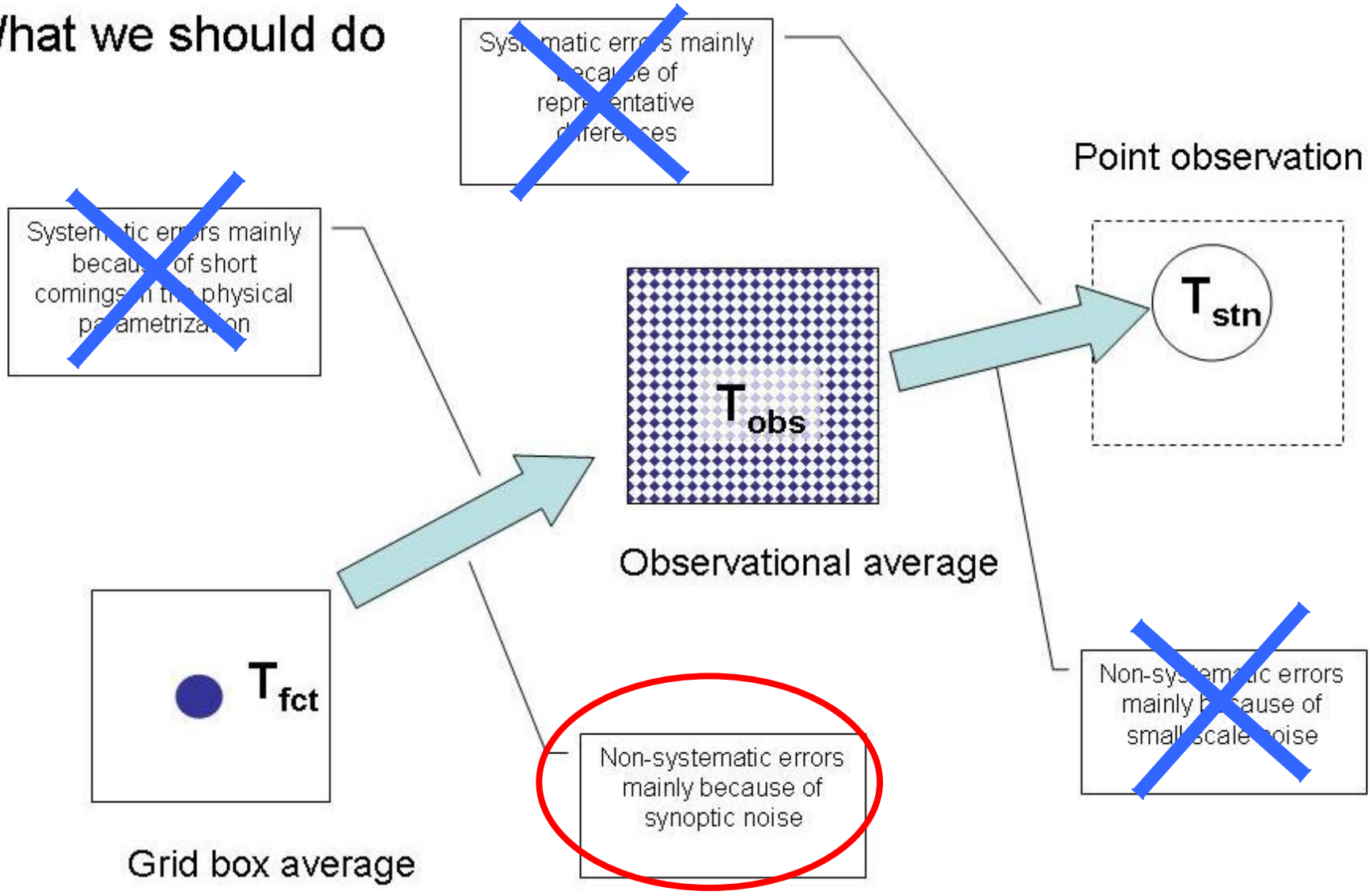
What we do


Point observation
Systematic errors because of short comings in the physical parametrization and representation differences
T_{stn}
T_{fct}
Grid box average
Non-systematic errors because of synoptic noise and small-scale noise

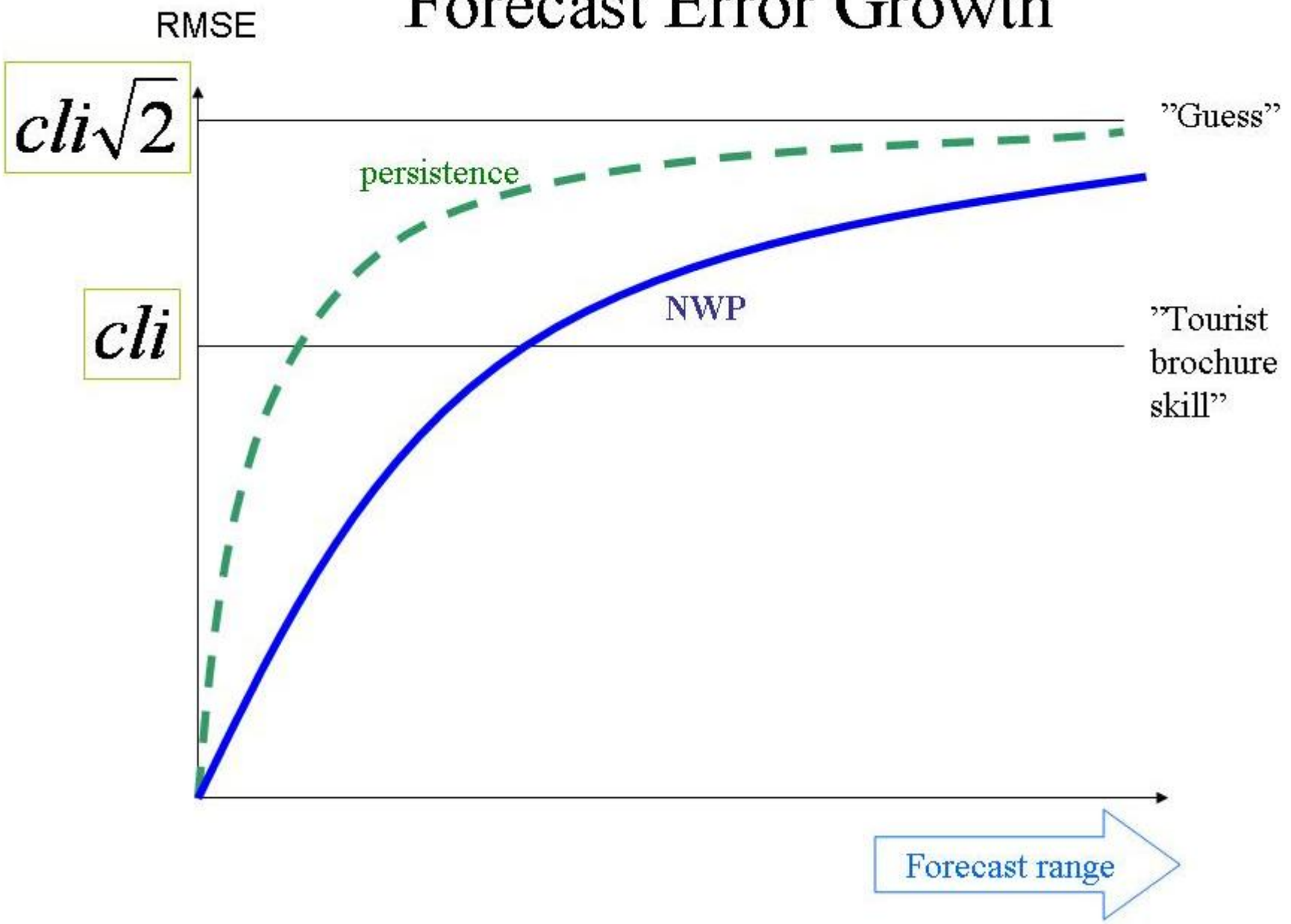
What we should do

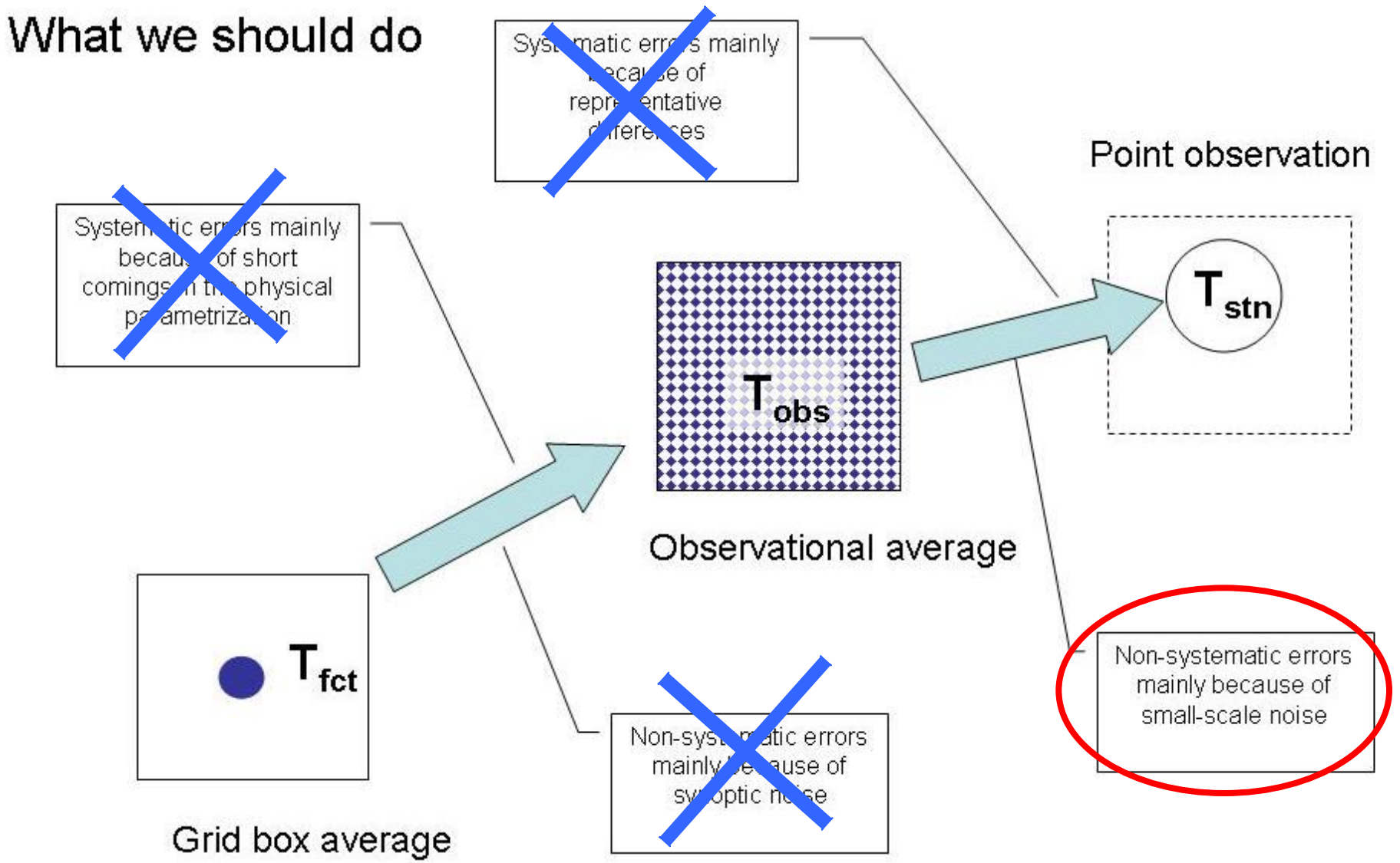


What we should do

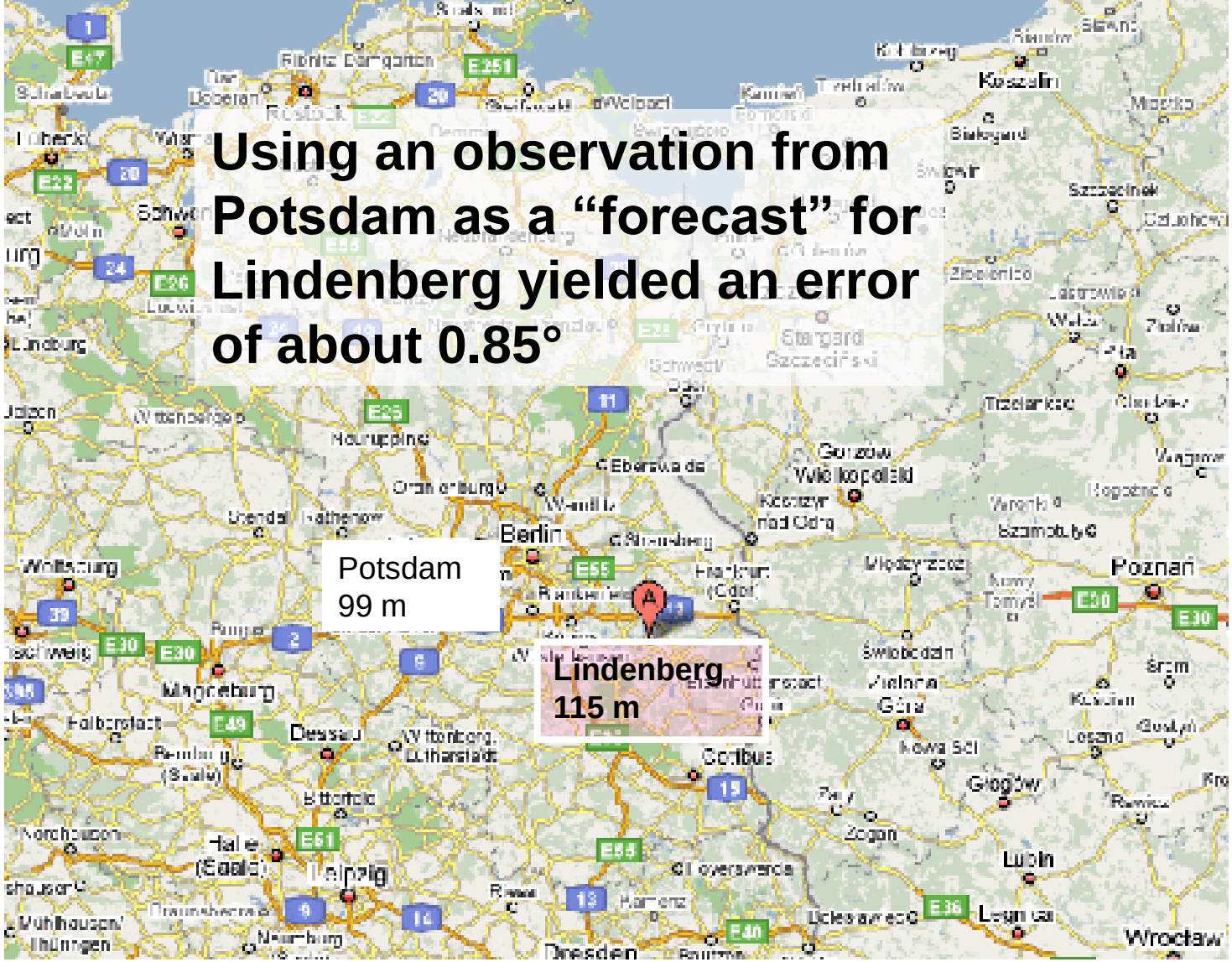


Forecast Error Growth

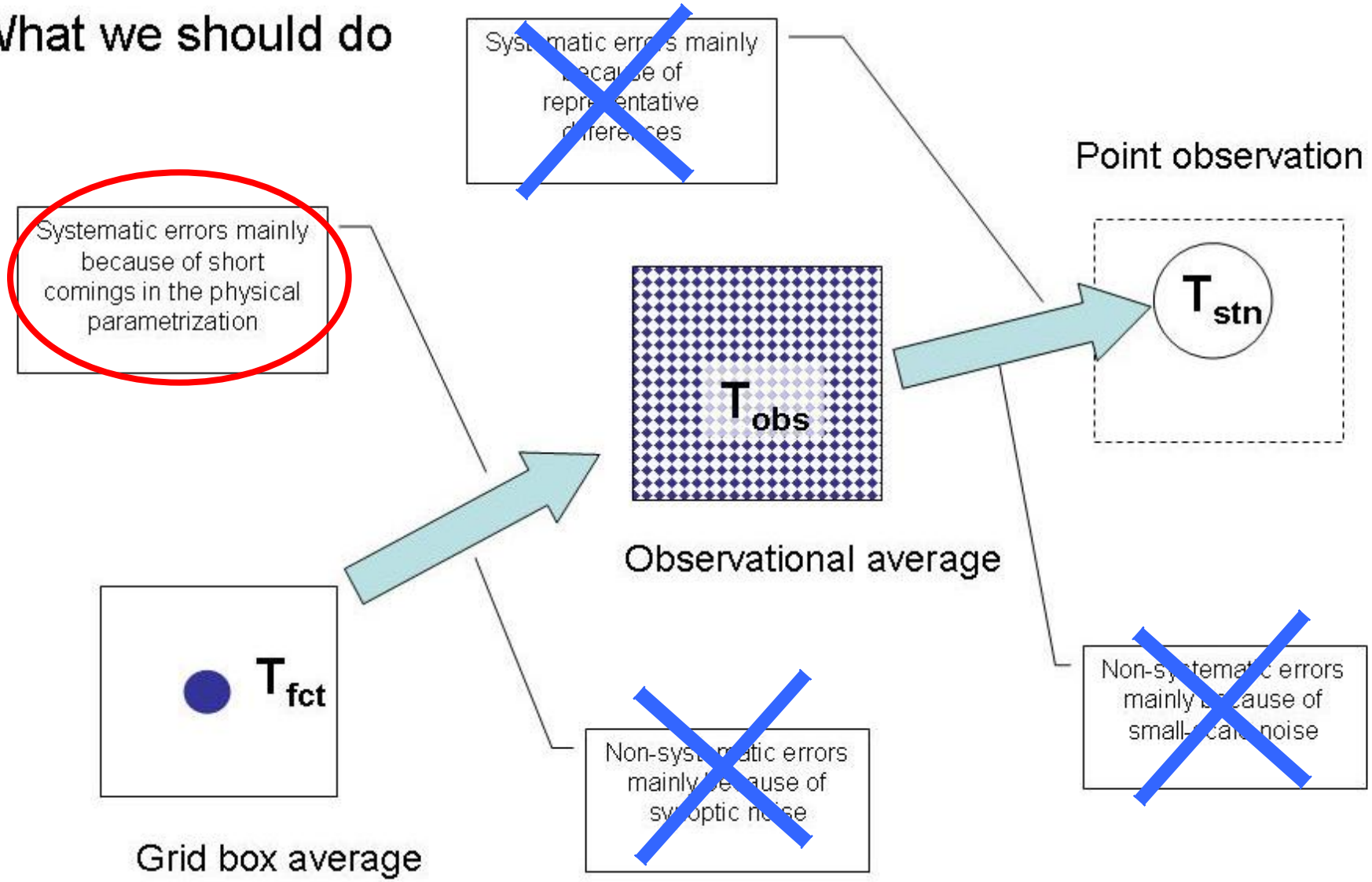


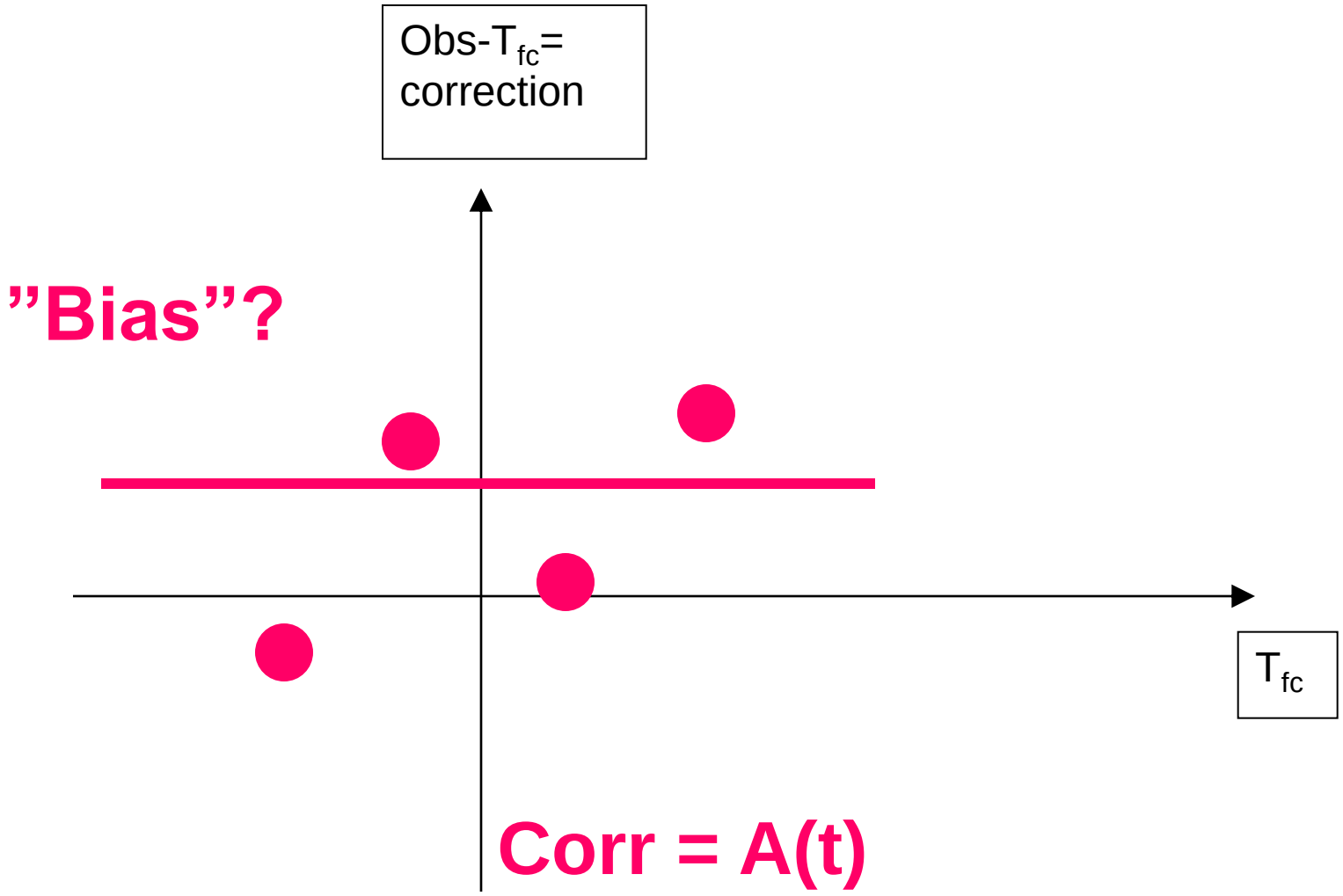


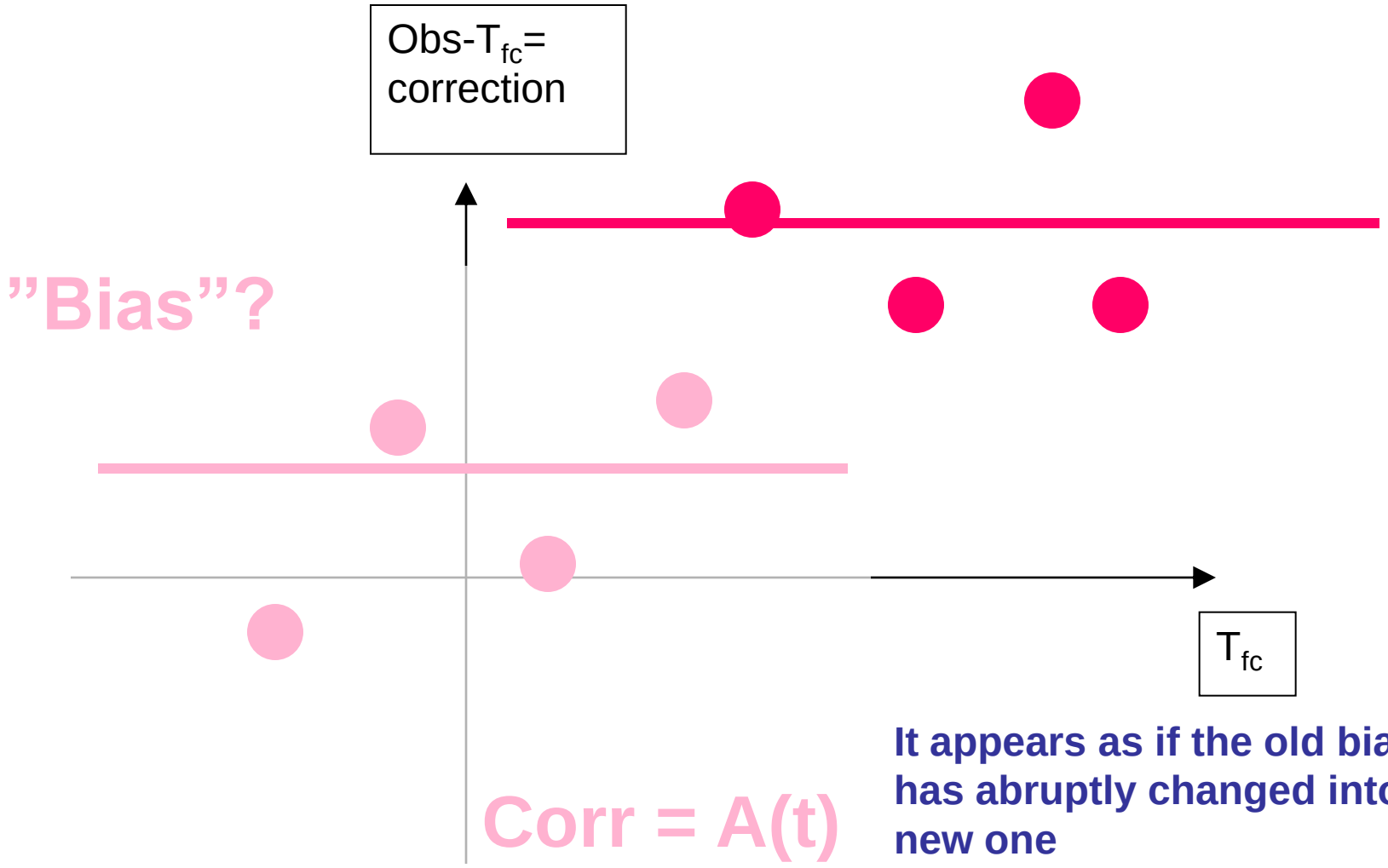
Even when we get rid of systematic errors, make the synoptic forecast perfect and only verify against representative observations – the meso-scale "noise" will still yield "non-perfect" forecasts


Using an observation from Potsdam as a “forecast” for Lindenberg yielded an error of about 0.85°
Potsdam
99 m
Lindenberg
115 m
Berlin
Poznań
Wrocław

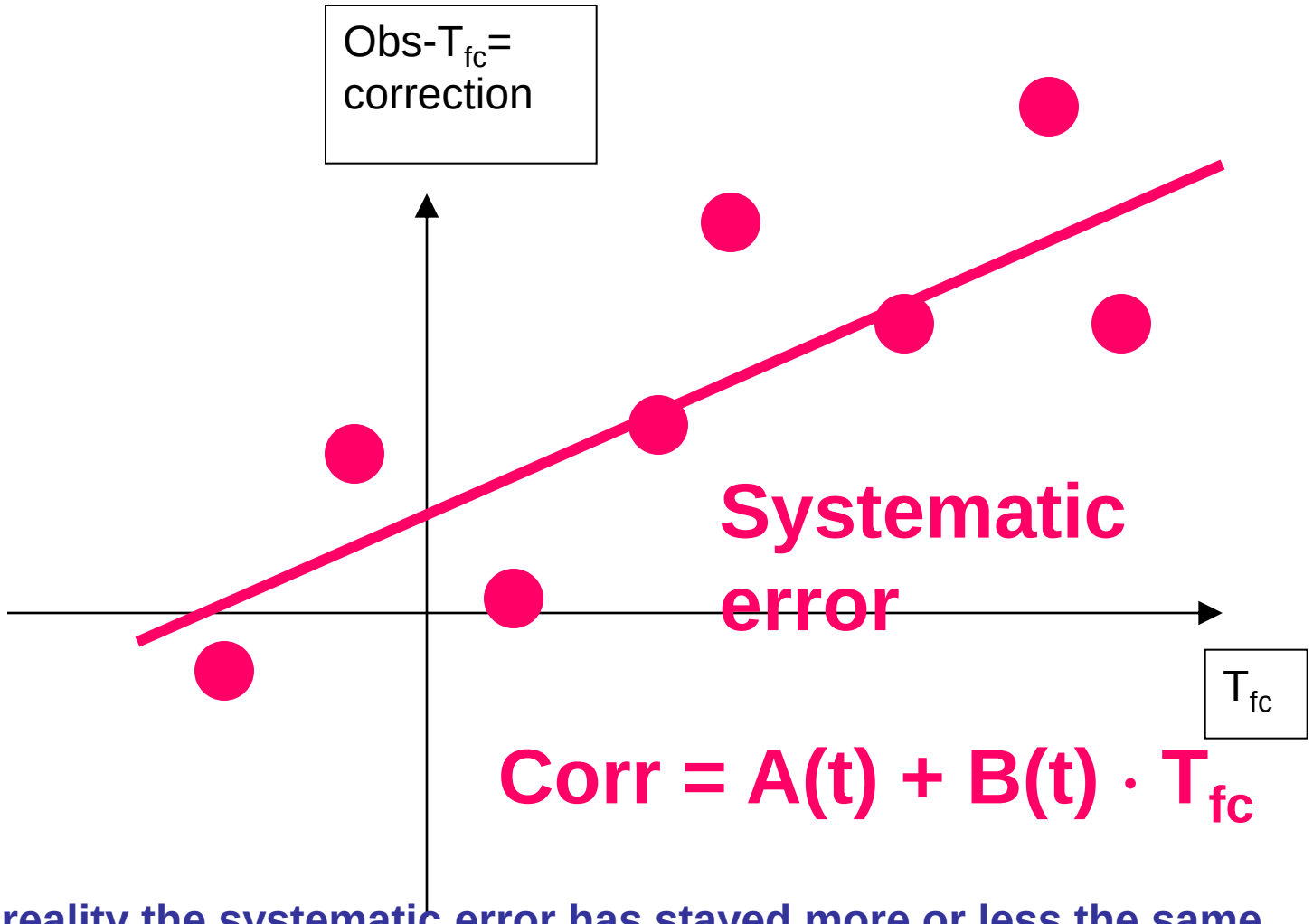
What we should do




Obs-T_{fc}= correction
”Bias”?
T_{fc}
Corr = A(t)

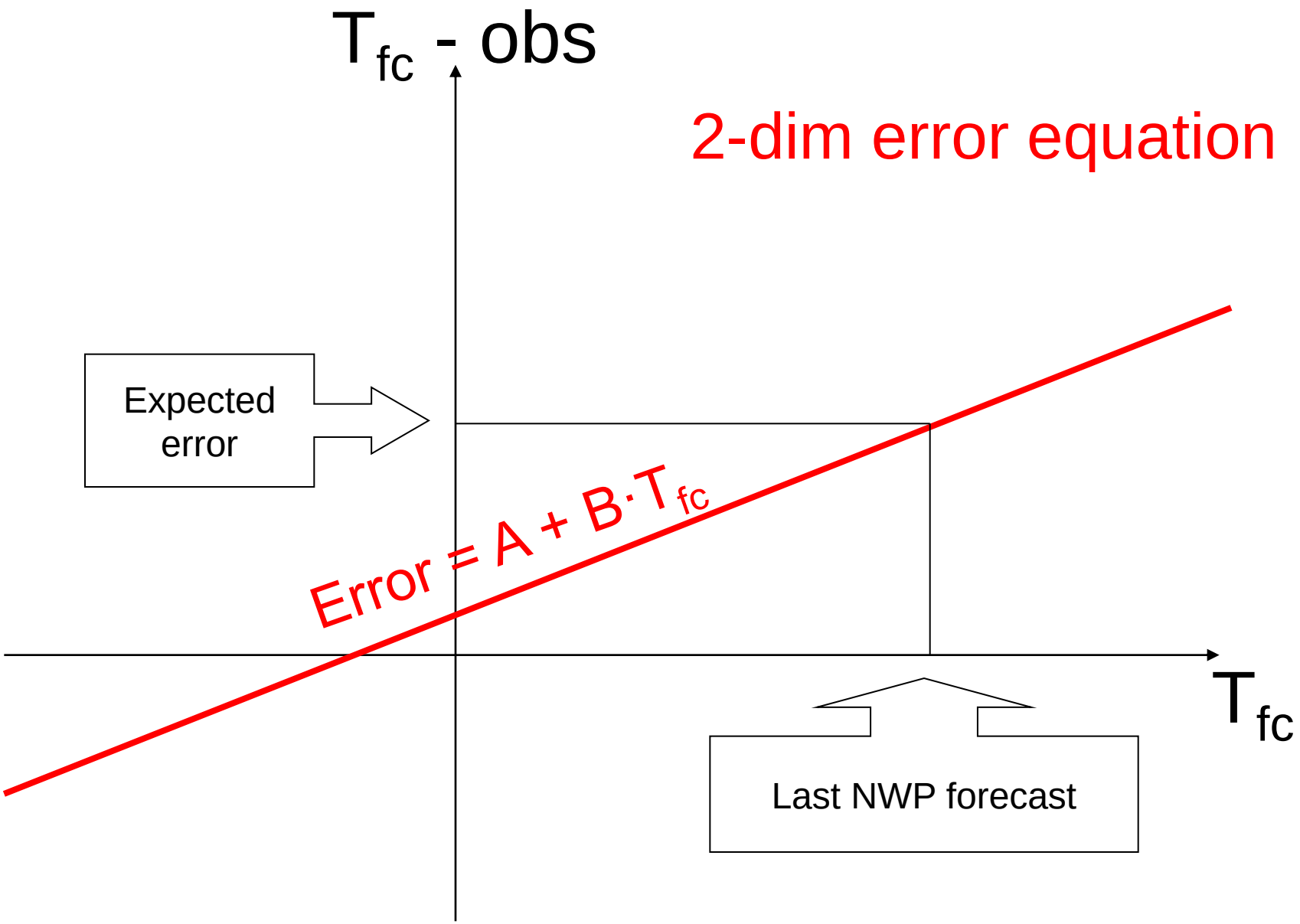


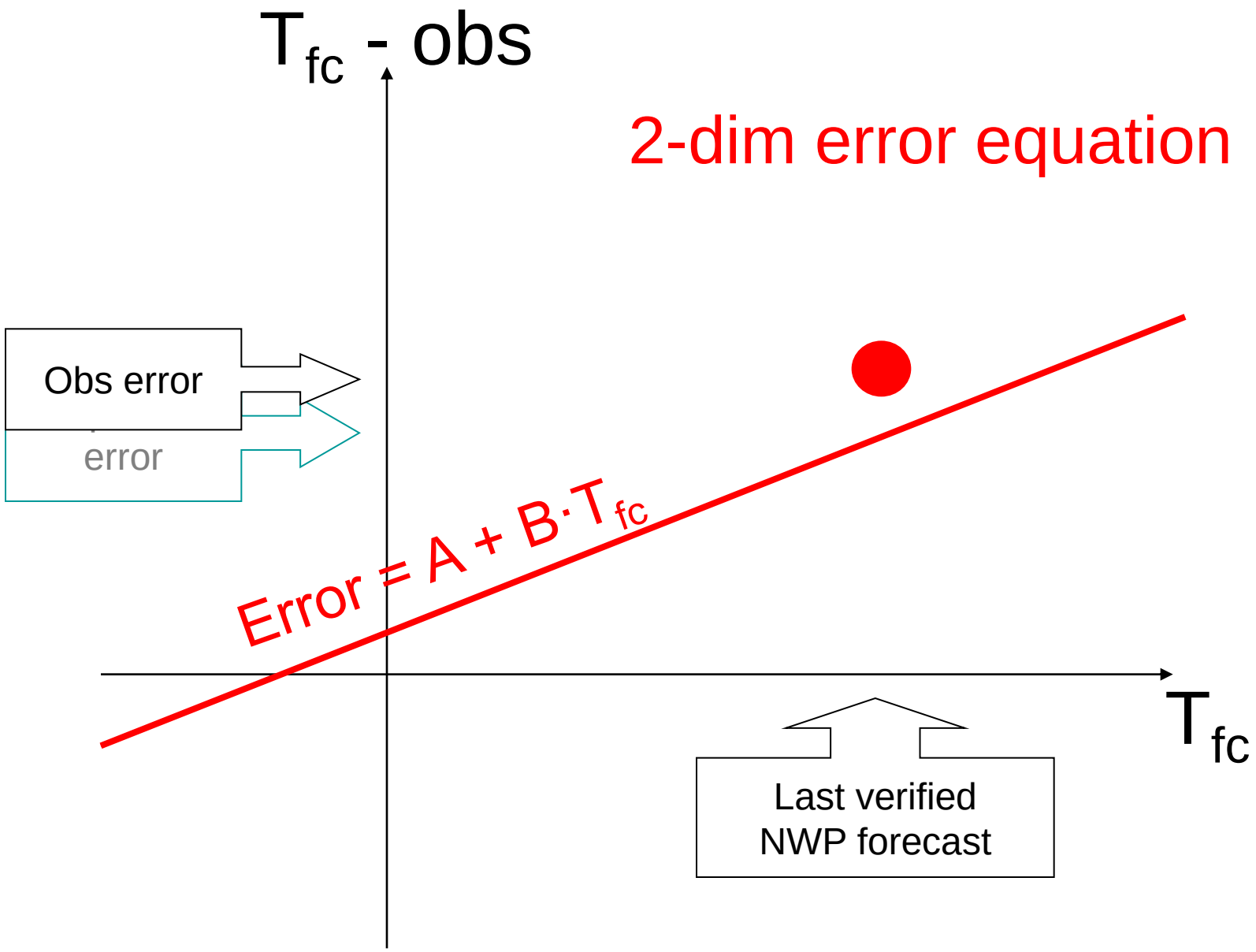
It appears as if the old bias has abruptly changed into a new one

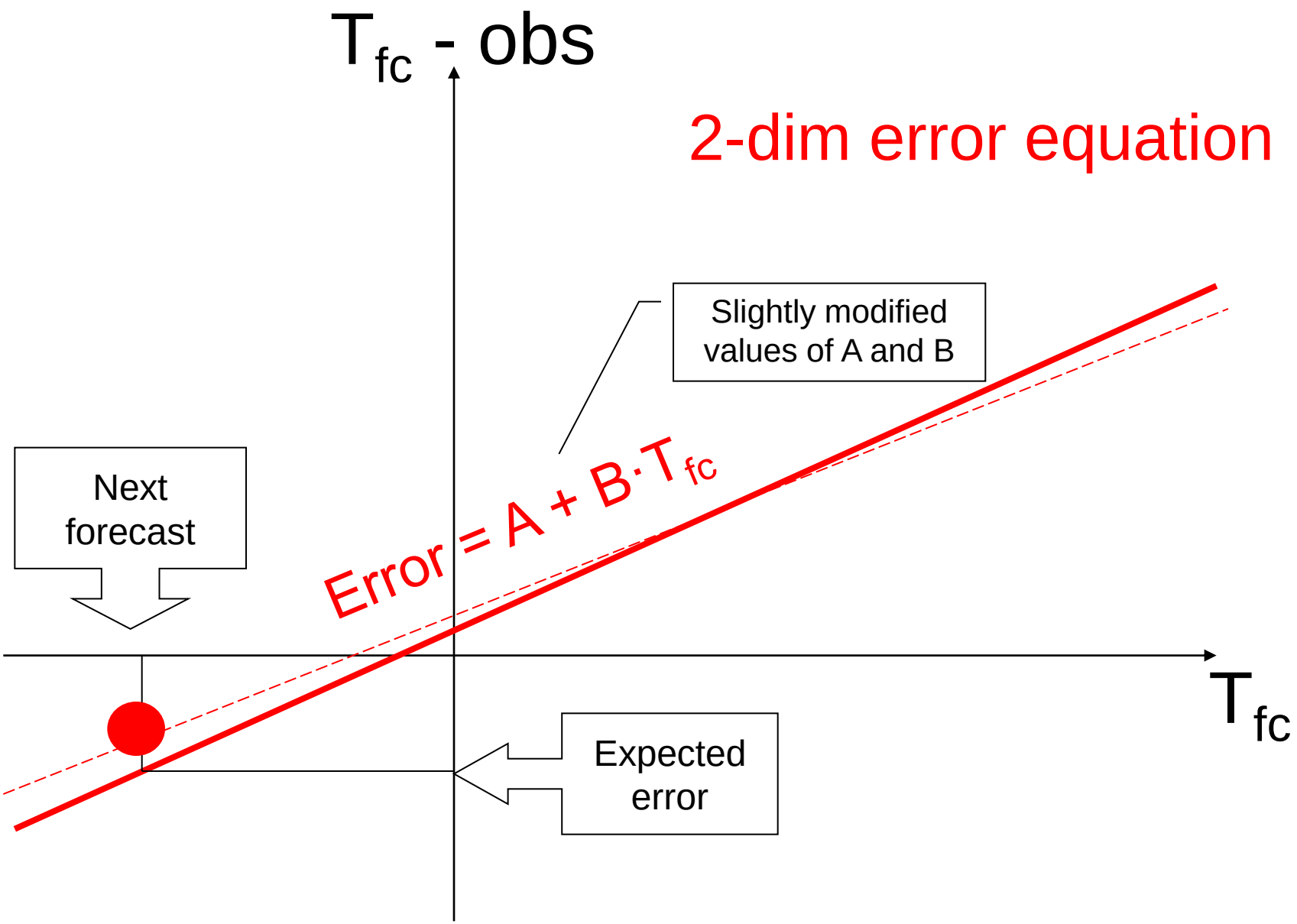


$$Corr = A(t) + B(t) \cdot T_{fc}$$

In reality the systematic error has stayed more or less the same, but defined by *two* coefficients, A and B

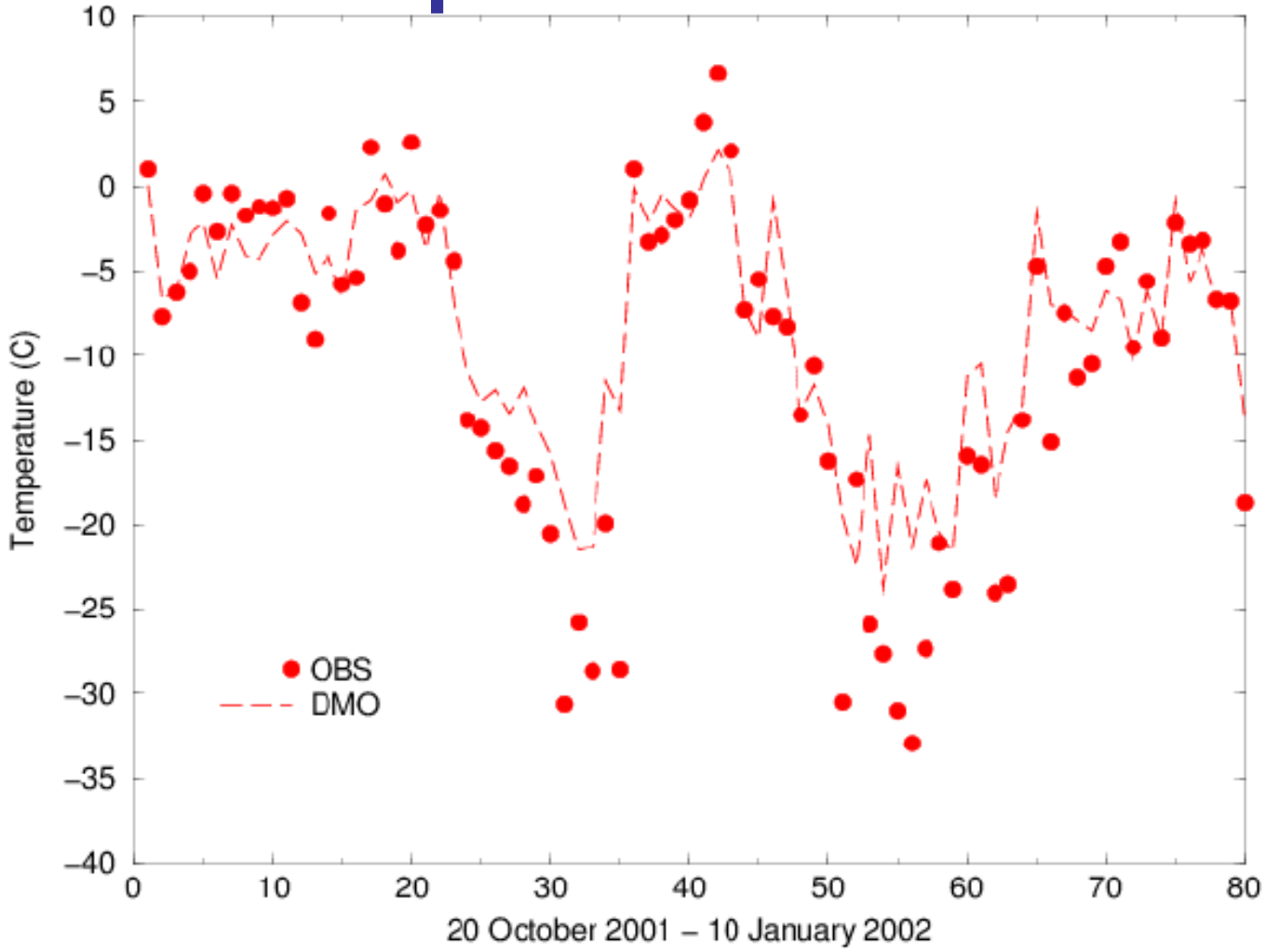

T_{fc} - obs
2-dim error equation
Expected error
Error = A + B·T_{fc}
T_{fc}
Last NWP forecast


T_{fc} - obs
2-dim error equation
Obs error
error
Error = A + B·T_{fc}
T_{fc}
Last verified
NWP forecast

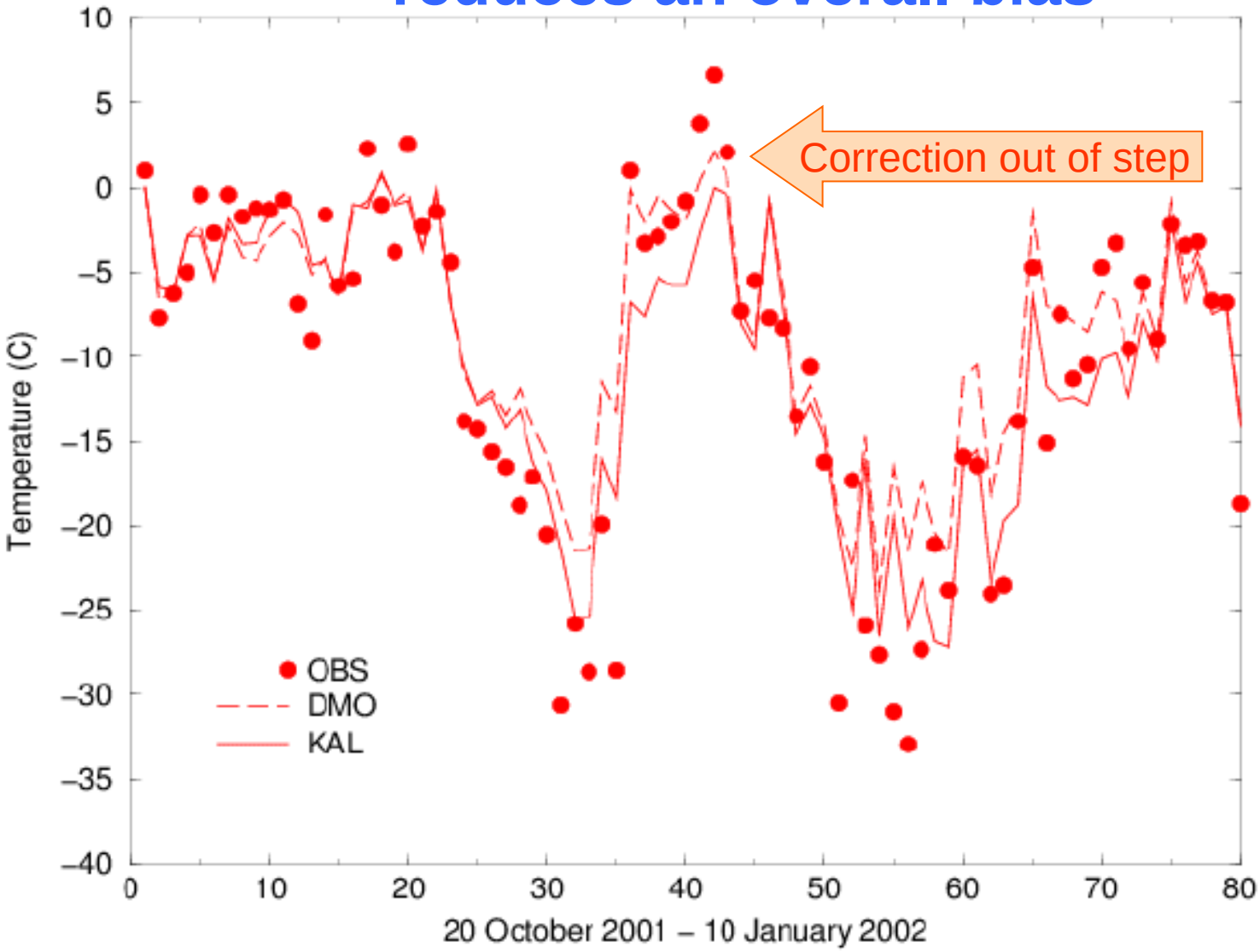

T_{fc} - obs
2-dim error equation
Slightly modified values of A and B
Next forecast
Error = A + B·T_{fc}
T_{fc}
Expected error

There are fundamental differences between 1-dimensional filtering and multi-dimensional

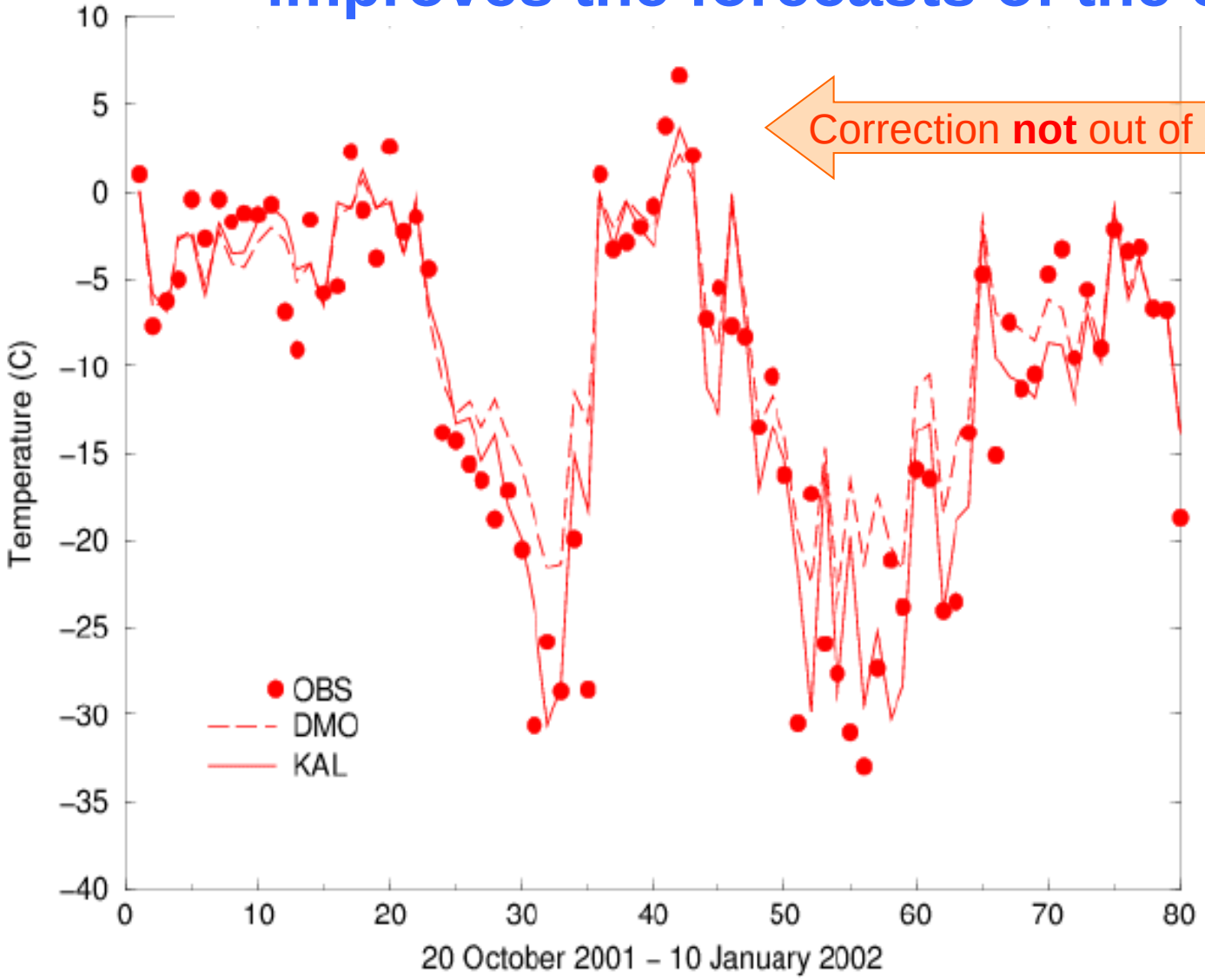
24 hour 2 m temperature forecast for Kiruna in Lapland winter 2001-2002



A 1-dimensional Kalman filter reduces an overall bias

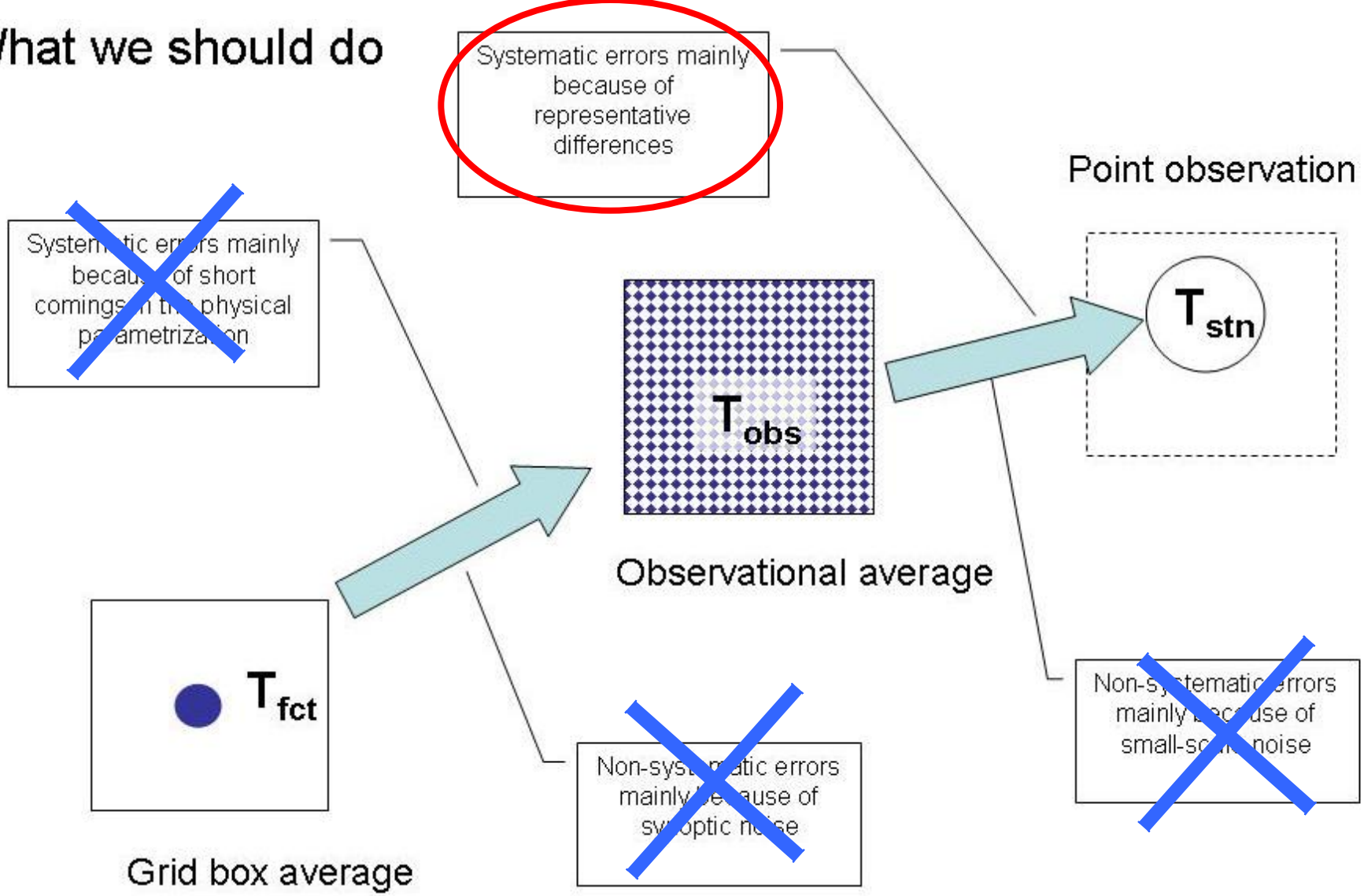


A 2-dimensional Kalman filter system also improves the forecasts of the extremes

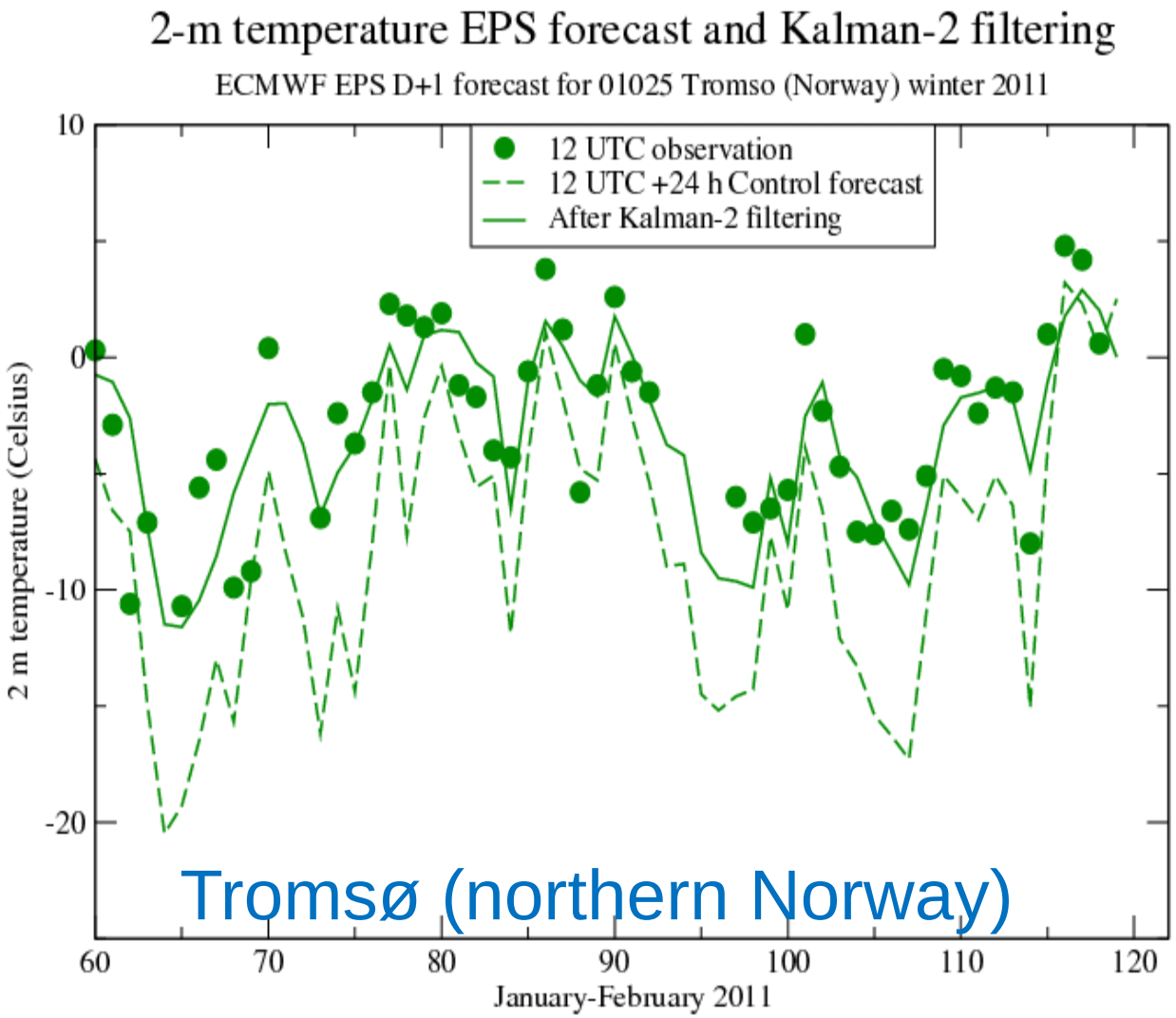


Two good achievements: The Kalman filtering has reduced two systematic errors: a positive mean error and an underestimation of the variability

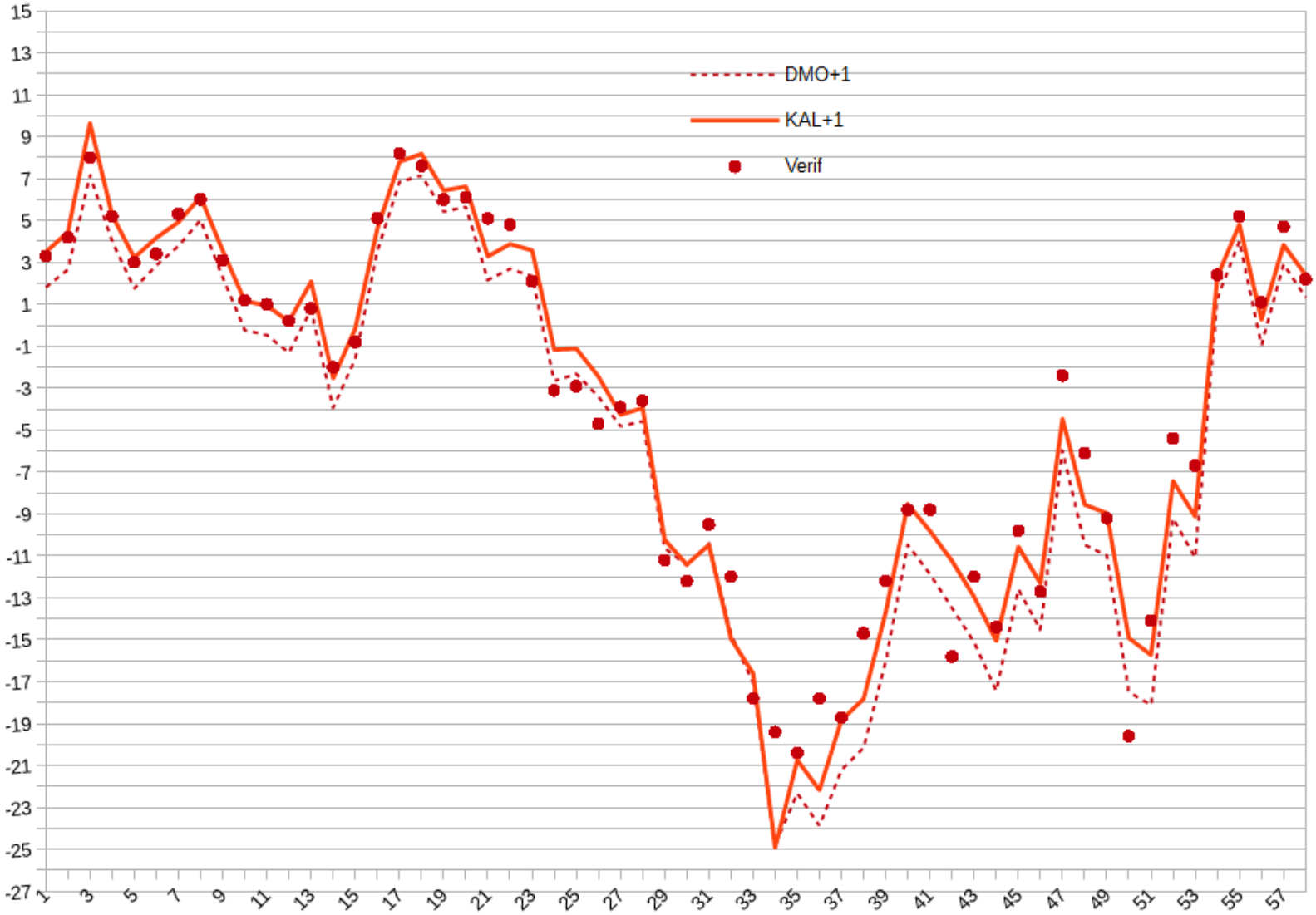
What we should do



The forecast (- - - -) varies more than reality (●). The Kalman filtering (——) corrects for both mean error and over-variability



Recent experiments of Kalman filtering ECMWF D+1 forecast for St Petersburg December 2015-January 2016



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