Uncertainties in climate information

Climate model simulations and observations are both *approximations* about the "truth", however, observational uncertainties are mostly ignored (seen as minor) in their inter-comparison.

Selection of observations is rarely guided by objective criteria and relies often on data accessibility and institutional proximity (model community is data agnostic when it comes to observations).

Uncertainty estimates provided by the products is often ignored (exceptions: data assimilation), partly because of the lack of **verification concepts that account observational uncertainty** and guidance in **uncertainty propagation**

Towards a joint uncertainty assessment

CMUG is an unique platform to bring the modelling and observational community together **towards a joint uncertainty assessment of climate information**

Some examples from seasonal forecasting carried out in VERITAS-CCI:

- How relevant is the observational uncertainty compared to model uncertainties?
- How can we use observational uncertainty estimates from CCI in the modelling community for verification?
- Can the quality of observational datasets be assessed using climate models?

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A service information for C3S

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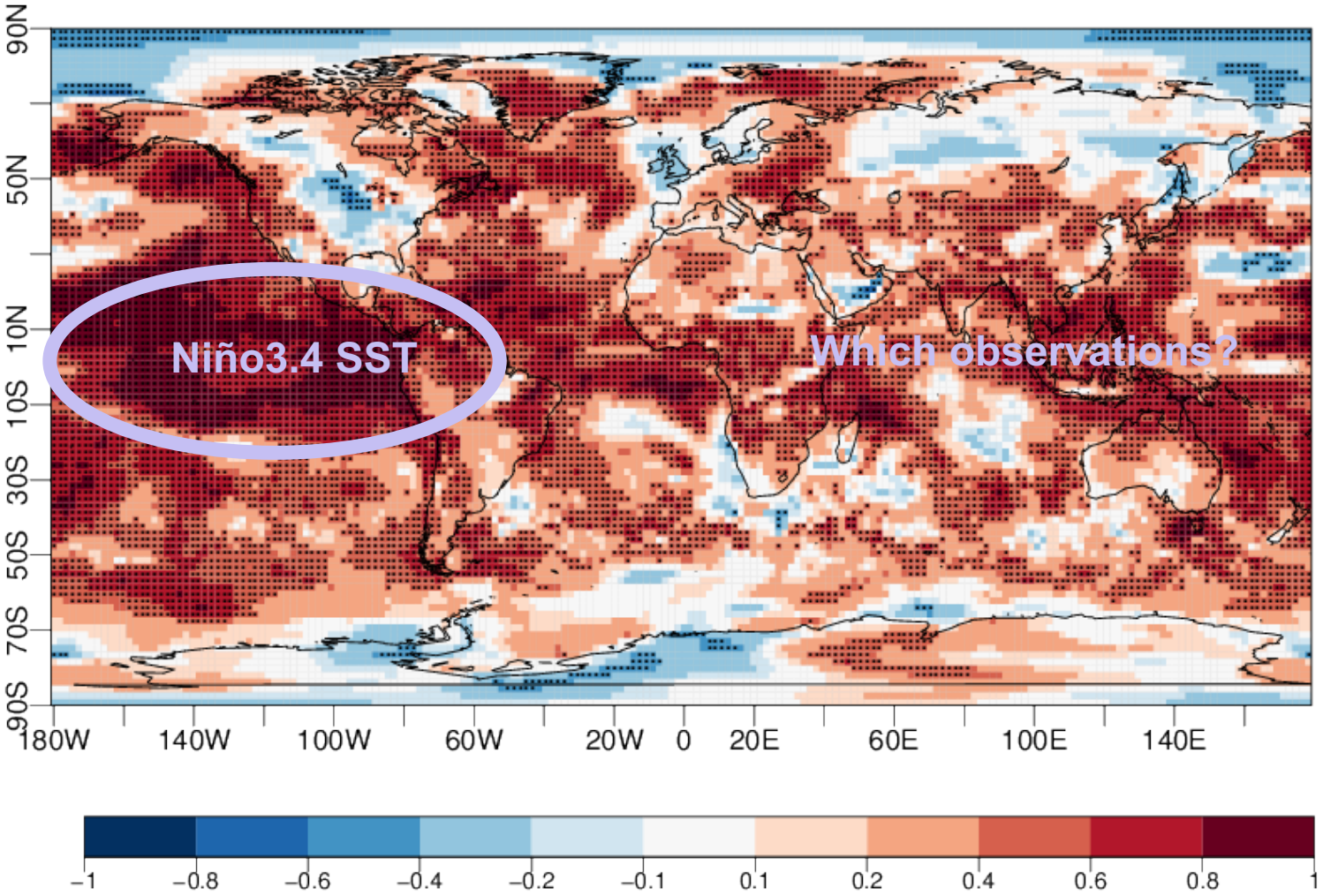
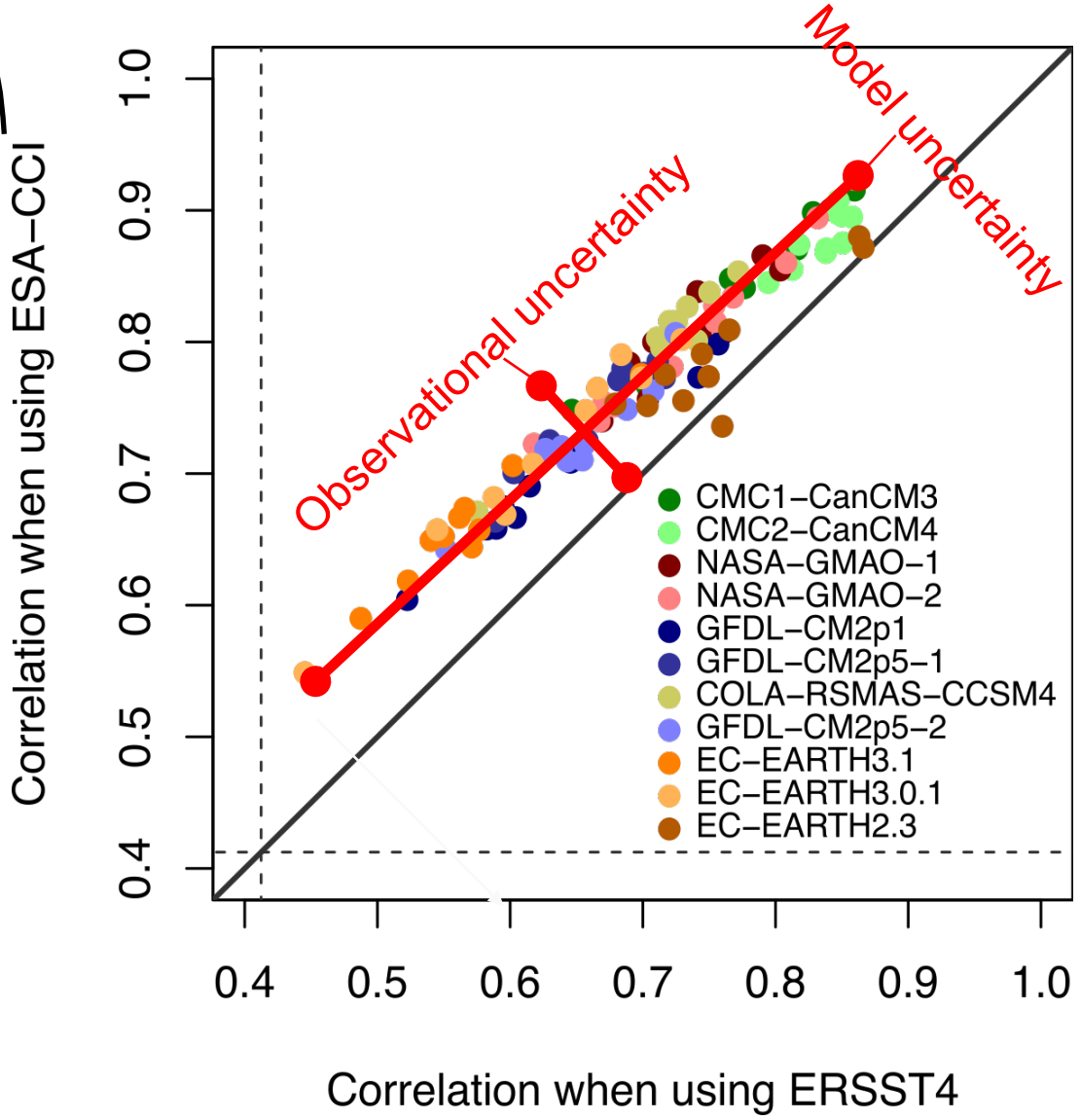
Summer seasonal forecast skill: EC-Earth3 (T511ORCA0.25)



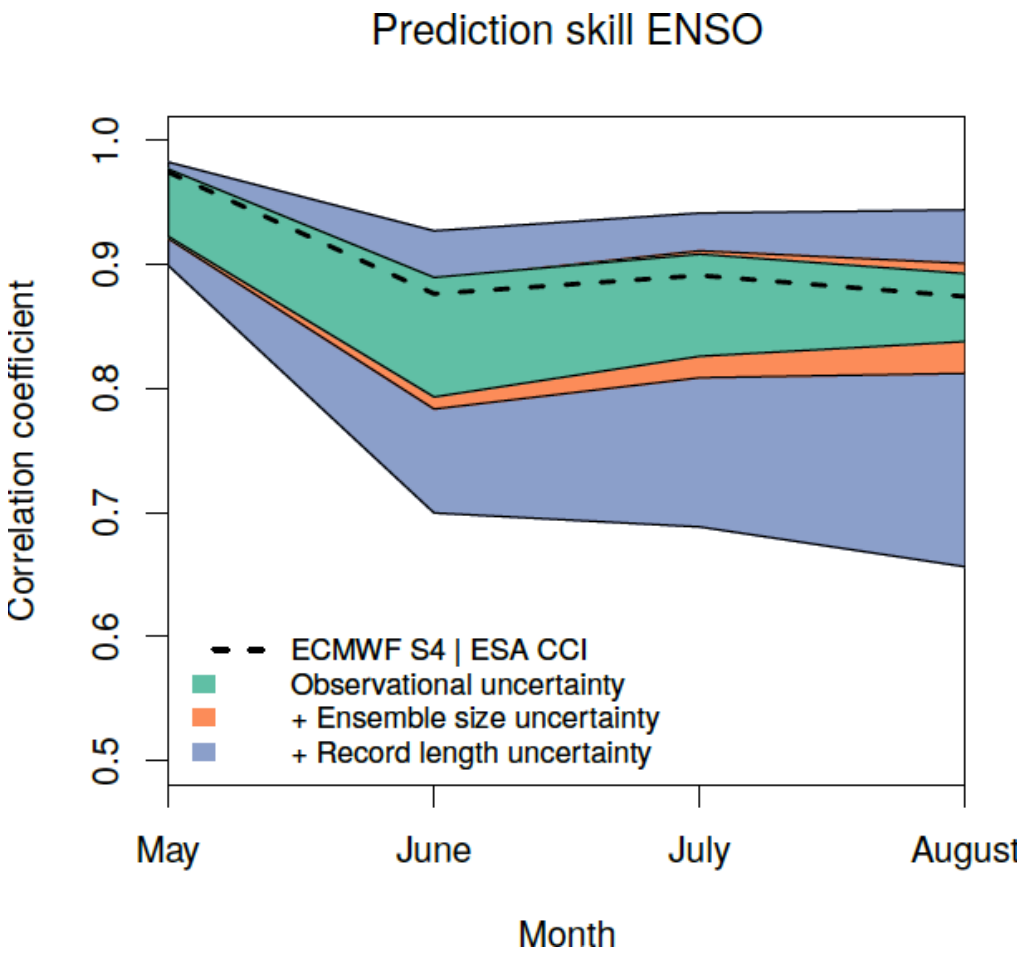
Acknowledging joint uncertainty

Independent from the models



Decomposition of uncertainties

Comparison to sample uncertainties: observational uncertainty is an important source of verification uncertainty for ENSO



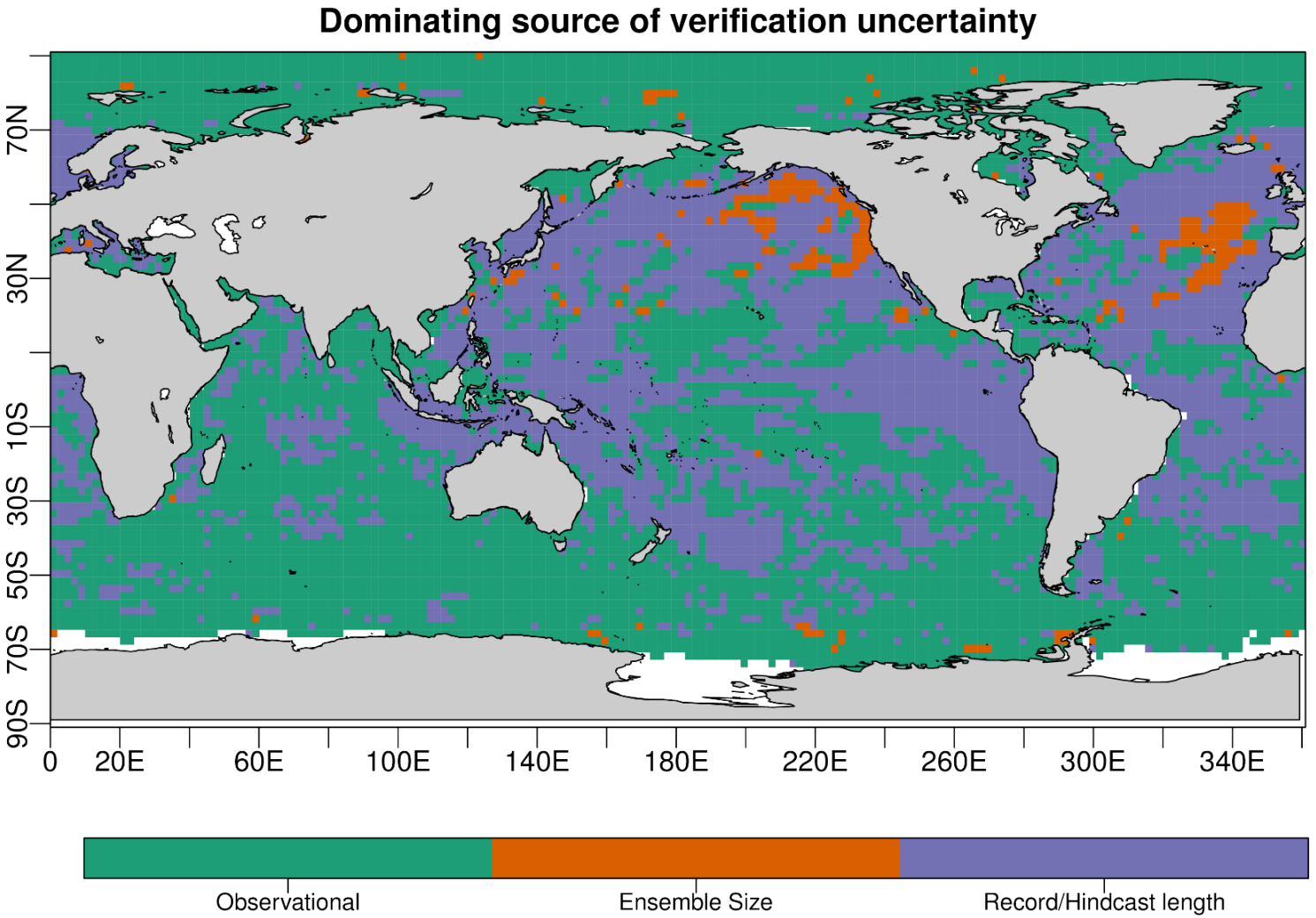
observational uncertainty

model ensemble size

length of the verification period

Partitioning forecast uncertainty

Verification at high-latitudes is limited by observational uncertainty.



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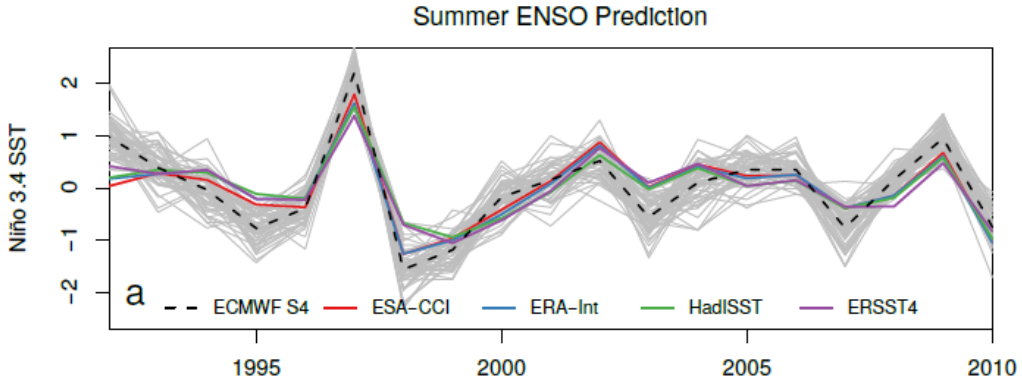
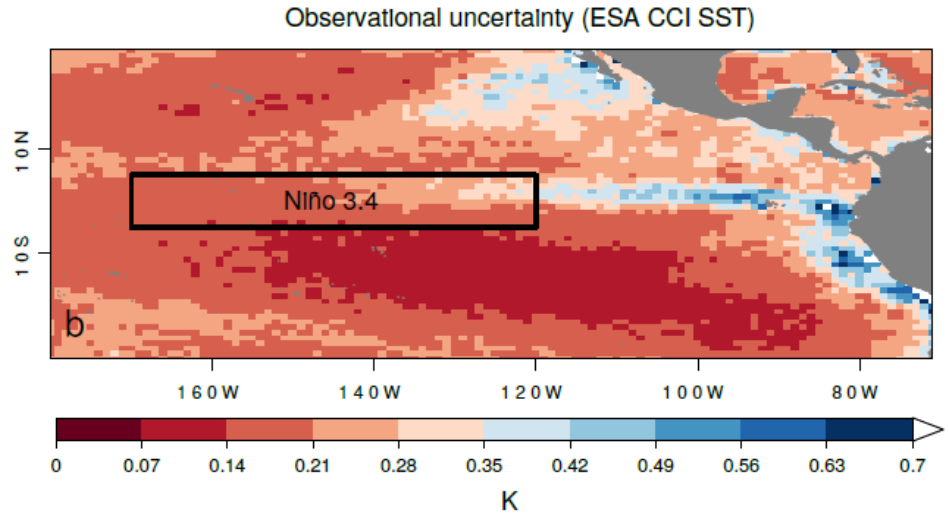
Verification scales mismatch

Model evaluation often requires spatial and temporal averaging, requires the consideration of error correlation scales





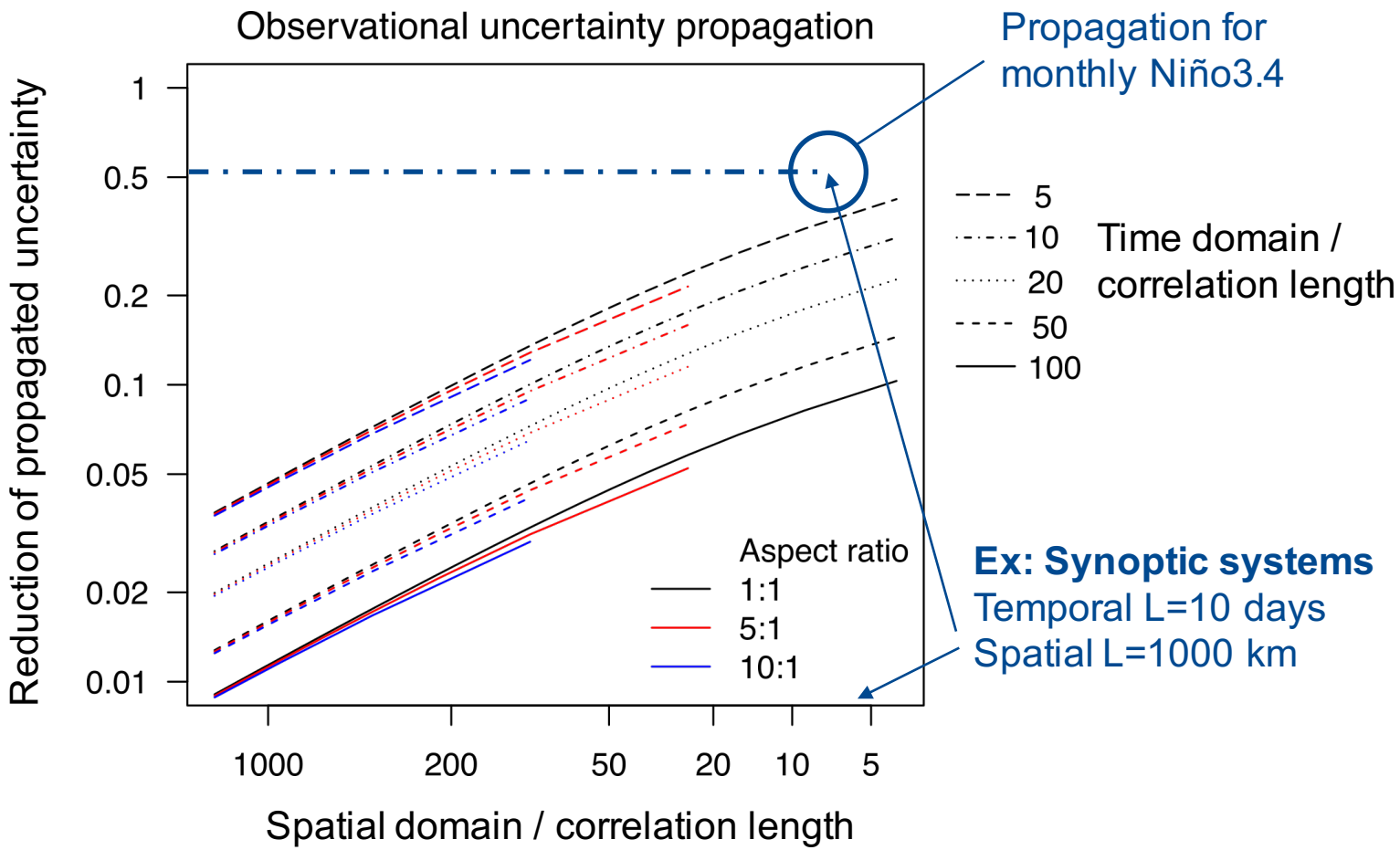
Monthly, Niño3.4

Uncorrelated uncertainty reduces by $1/\sqrt{N}$ but errors are not uncorrelated!

Daily, 4 km

A “look-up” propagation figure

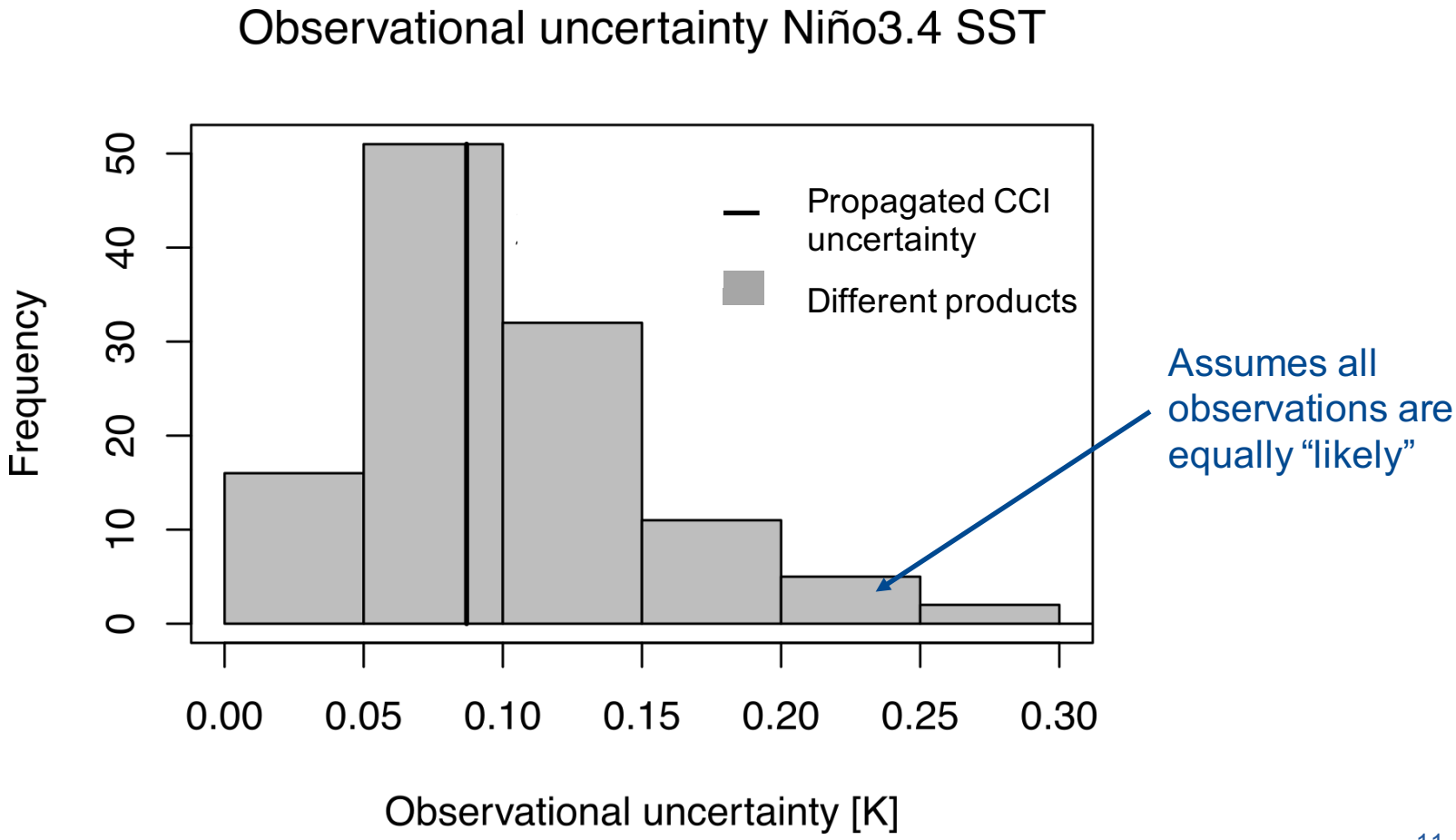
Use of error correlation scales: analytical solution that allows to look-up propagation factors



Bellprat et al. (2017) *RSE (in review)*

Comparison to multi-observations

Propagation assuming synoptic scales (1000 km, 10 days) of weather systems agrees well with deviations between existing products



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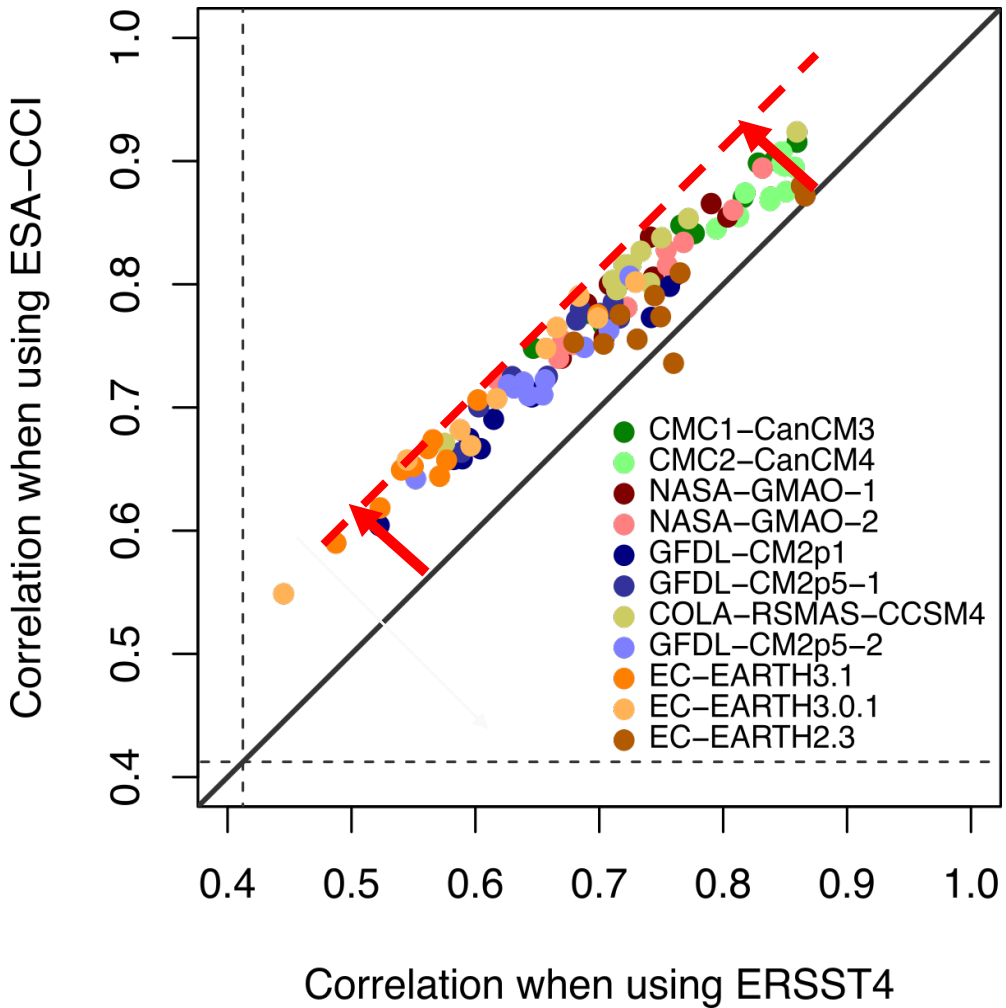
Reversing verification question

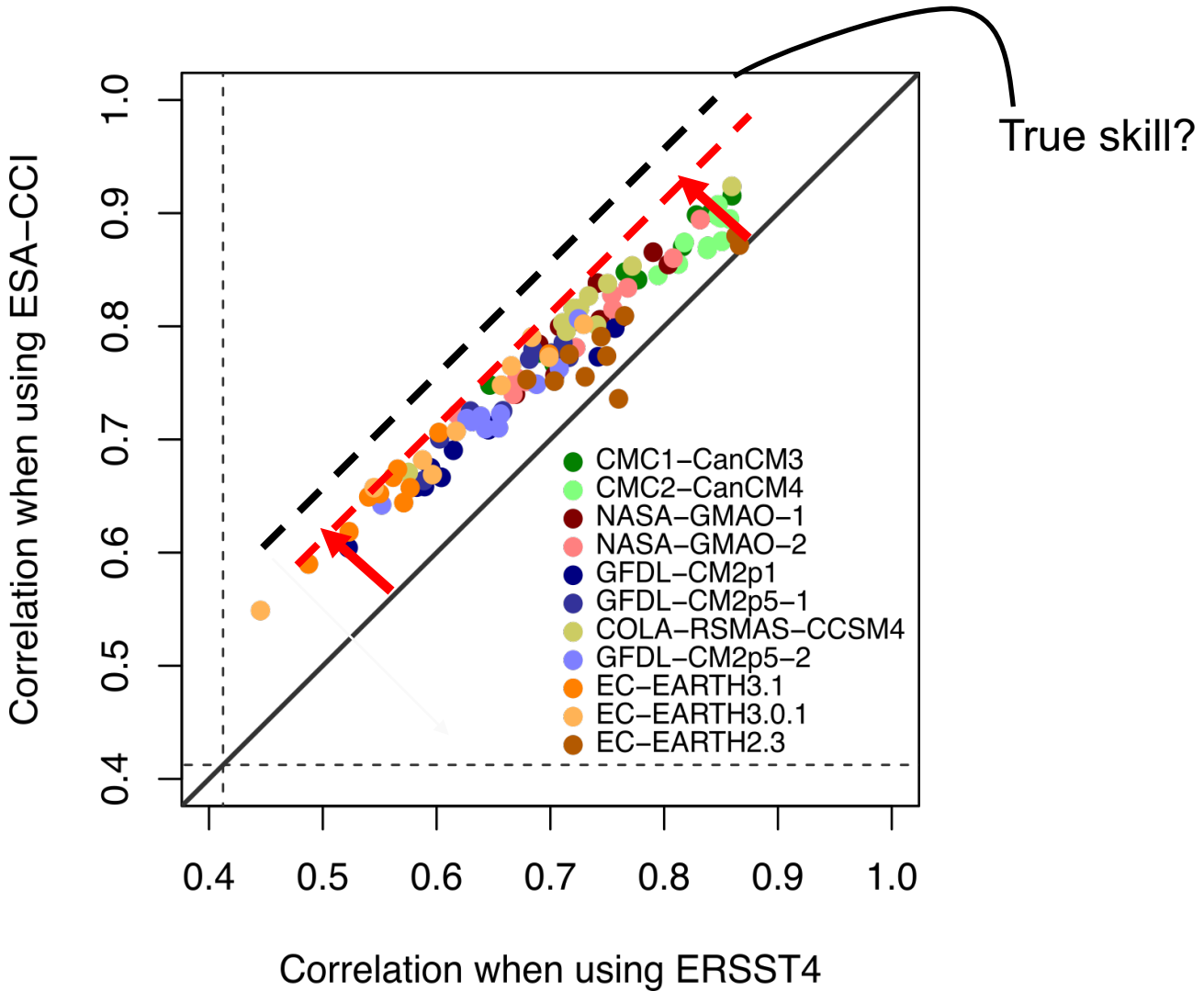
CCI SST yields systematic higher correlation skill across many models -> the observational uncertainty is smaller in CCI SST



Massonnet et al. (2016) *Science*

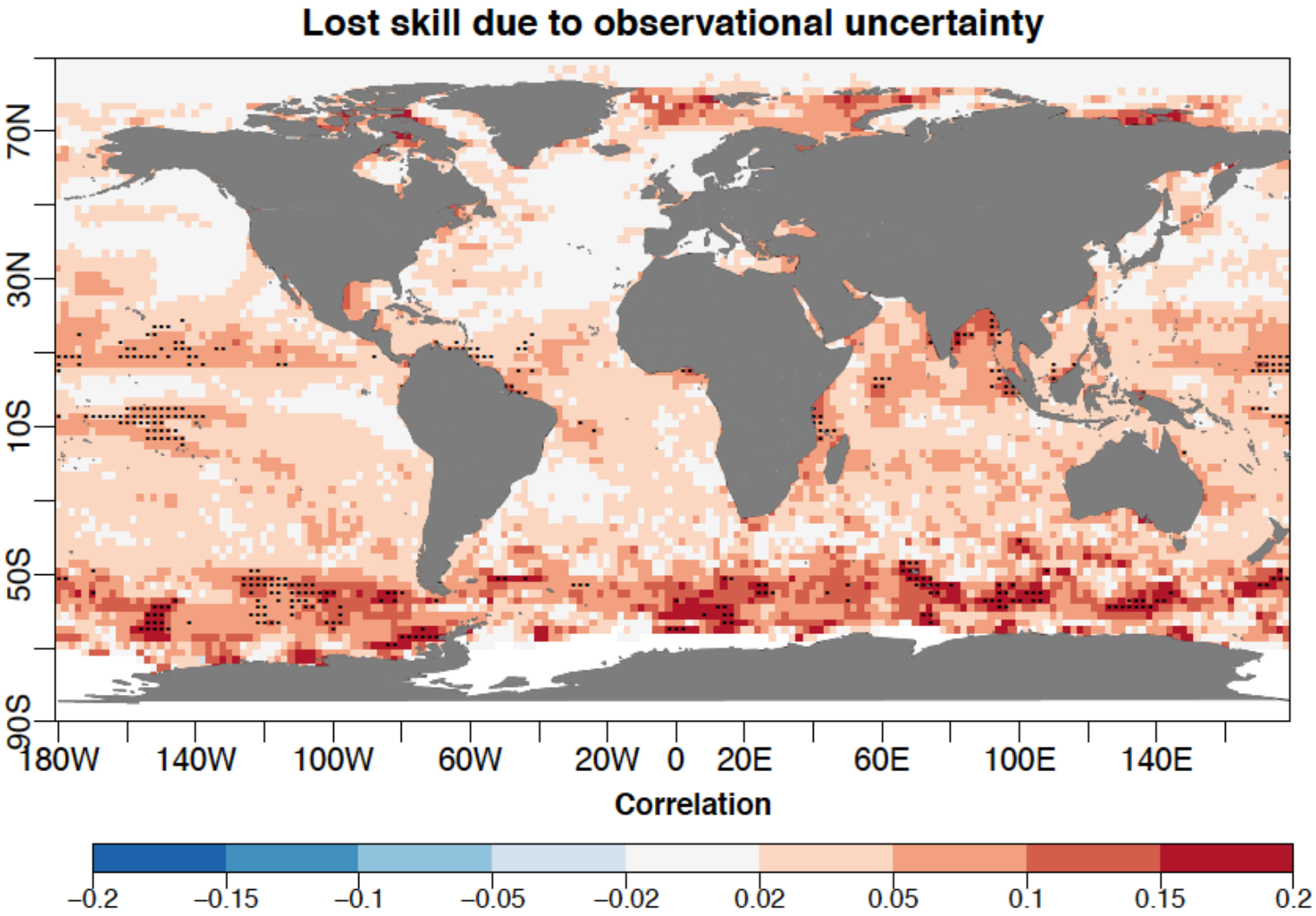
Underestimation of “true” skill

True climate predictions skill is systematically underestimated due to uncertainties in the observations



Underestimation of “true” skill

Seasonal SST forecast skill is underestimated up to 0.2 correlation



Conclusions

Acknowledging observational uncertainty opens many new research questions that could be undertaken in CMUG

- Reverse the verification question: Use multiple climate models to evaluate multiple observations (and their co-variability to other datasets) to measure their quality.

- Apply multi-model ideas to observations: do multi-observations means agree better with the models? Define metrics for model evaluation that allow to account observational uncertainties (e.g. ESMValTool).

- Work on error propagation together with CCI teams, requires strong interactions which will benefit both communities

www.bsc.es

Thank you!

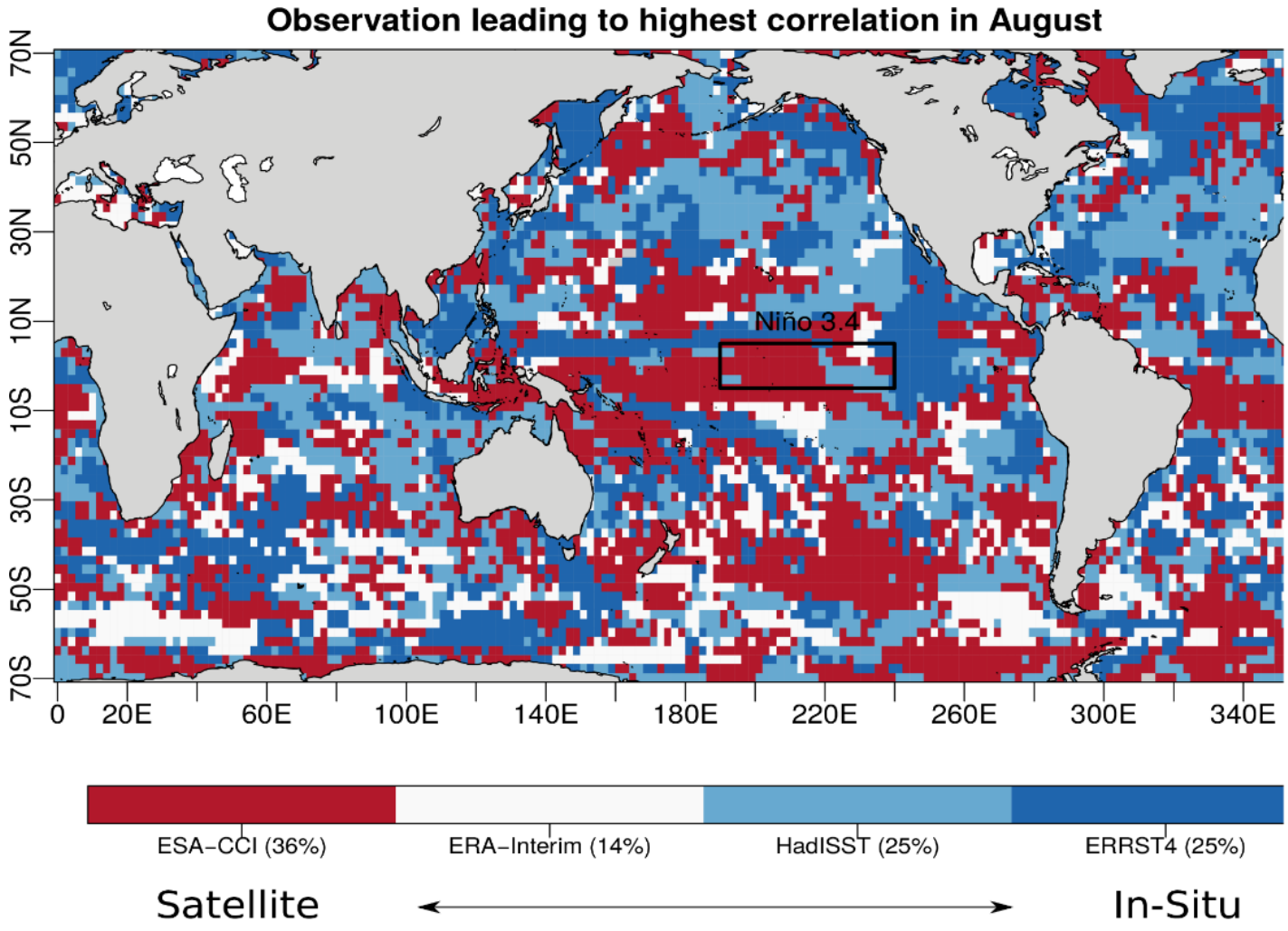
Bellprat, O., Massonnet, F., Siegert, S., Guemas, V., Doblas-Reyes, F. J. (2017), Exploring observational uncertainty in verification of climate model predictions, *Remote Sensing of the Environment (RSE)*, *in review*

Massonnet, F., Bellprat, O., Guemas, V., Doblas-Reyes, F. J., (2016). Using climate models to estimate the quality of global observational data sets, *Science. (AAAS)*

Extra Slides

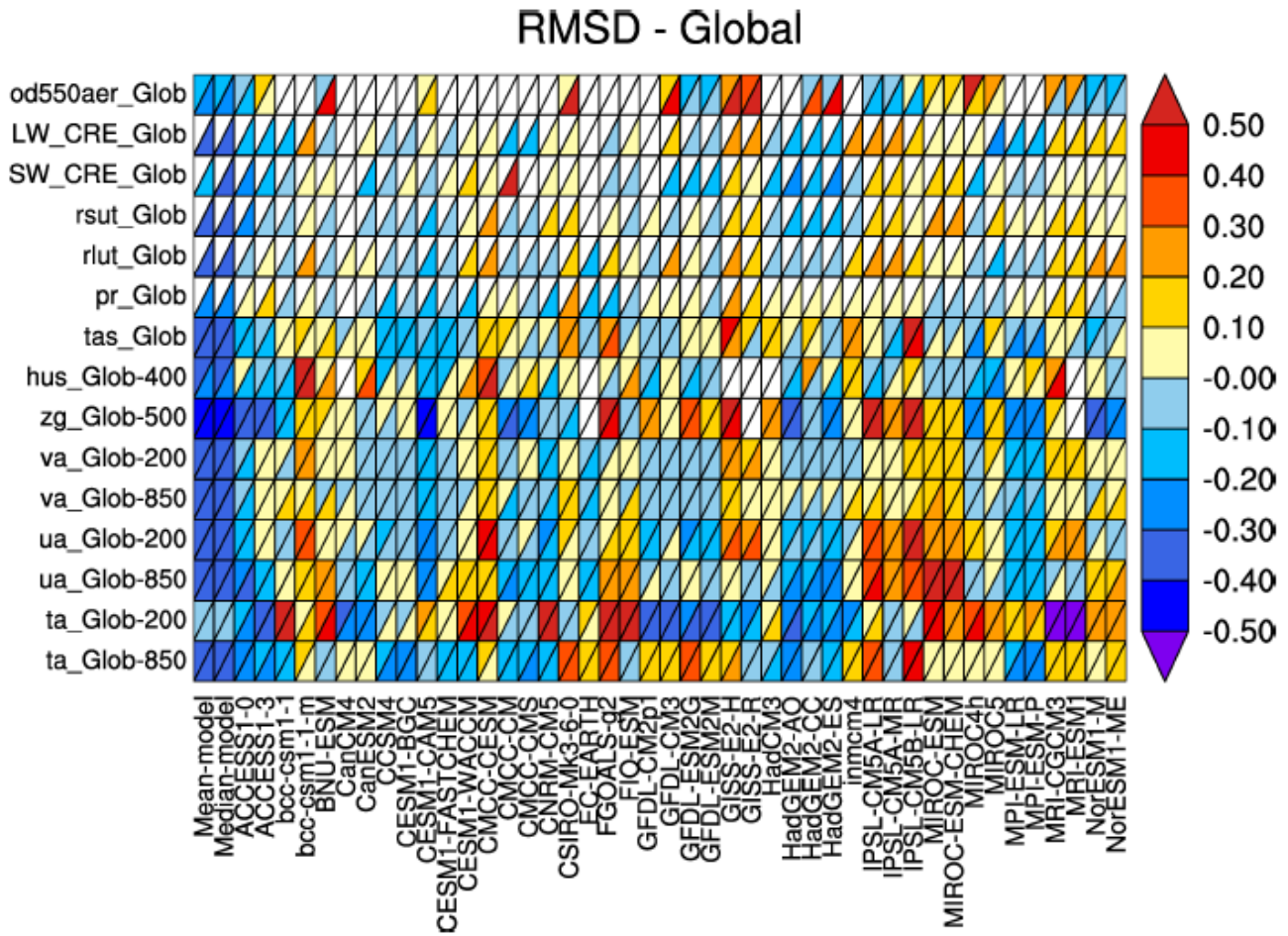
Reversing verification question

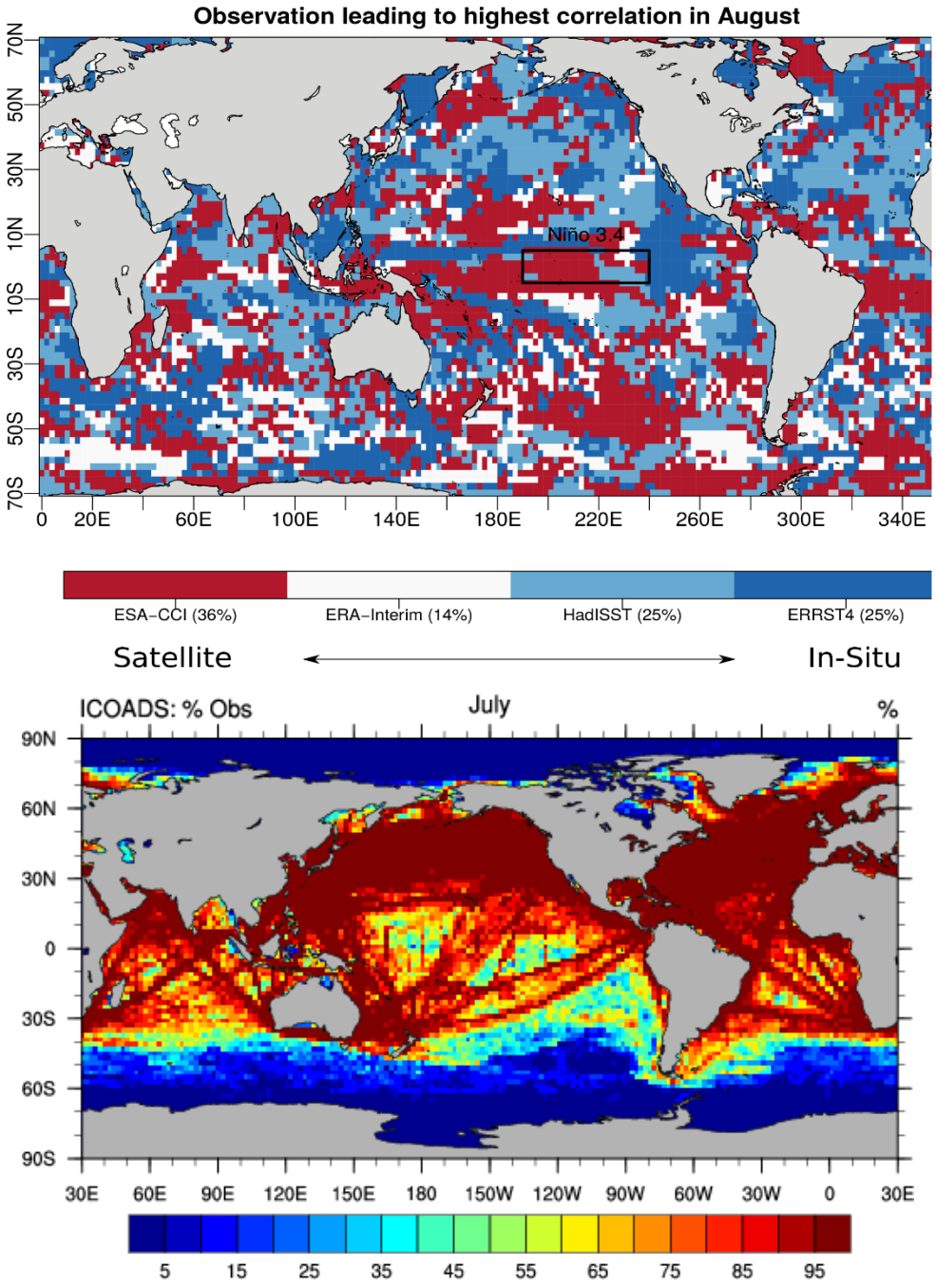
CCI SST give also globally on average the highest correlation skill



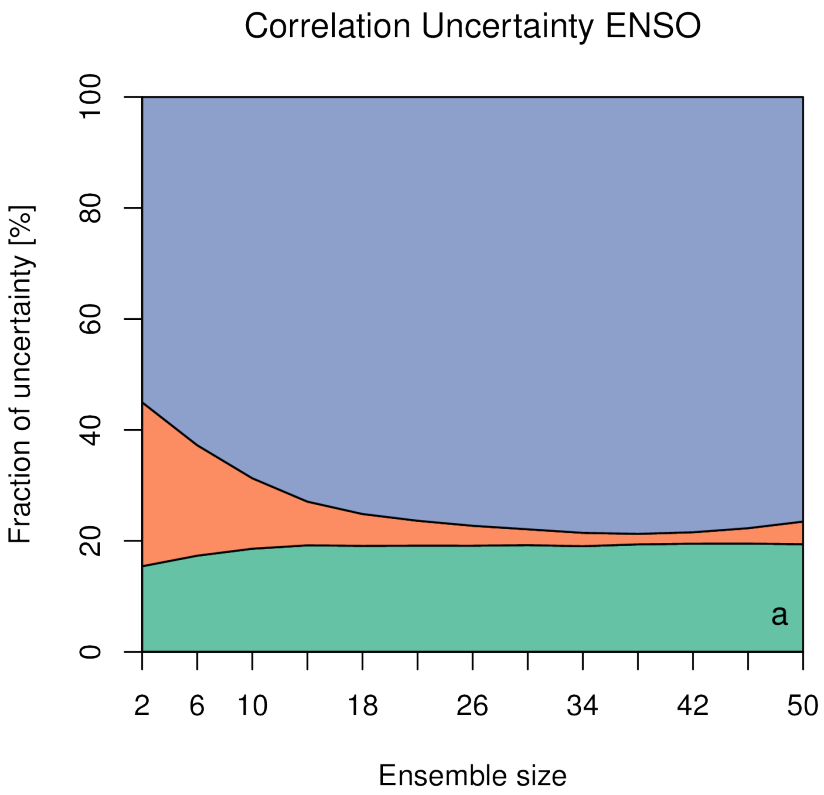
Multi-observation

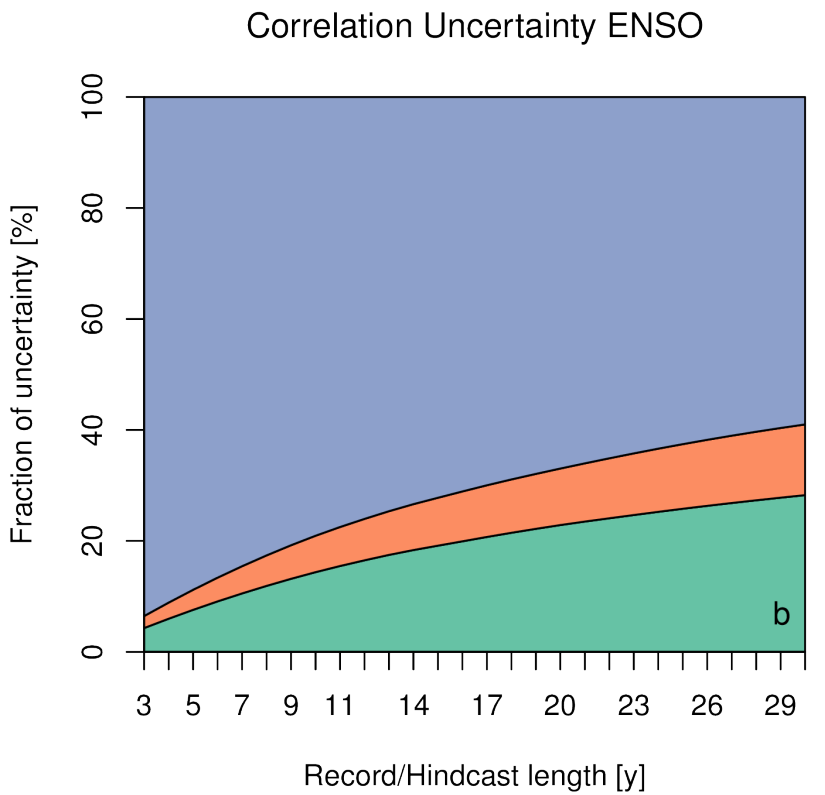
Consider multi-observation as well as multi-model means




Observation leading to highest correlation in August
70N
50N
30N
10N
10S
30S
50S
70S
0
20E
60E
100E
140E
180E
220E
260E
300E
340E
Niño 3.4
ESA-CCI (36%)
ERA-Interim (14%)
HadISST (25%)
ERRST4 (25%)
Satellite
In-Situ
ICOADS: % Obs
July
%
90N
60N
30N
0
30S
60S
90S
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
30E
5
15
25
35
45
55
65
75
85
95

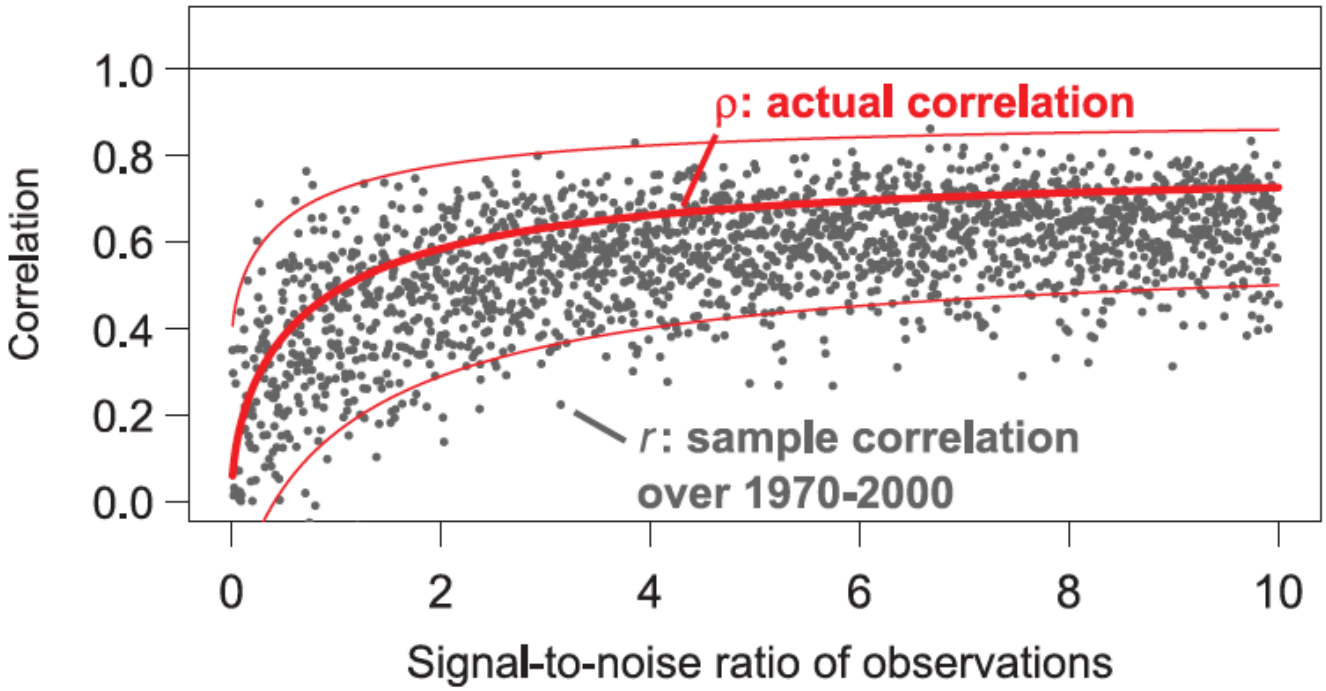
Sensitivity to sample





Effect observational uncertainty

Loss of correlation becomes particularly relevant with signal-to-noise ratios < 2



Signal-to-noise ratio SSTs

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Signal (inter-annual variability) versus observational uncertainty (noise)