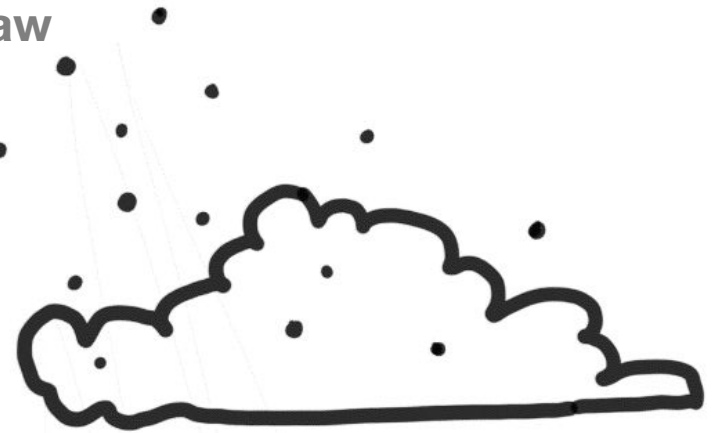


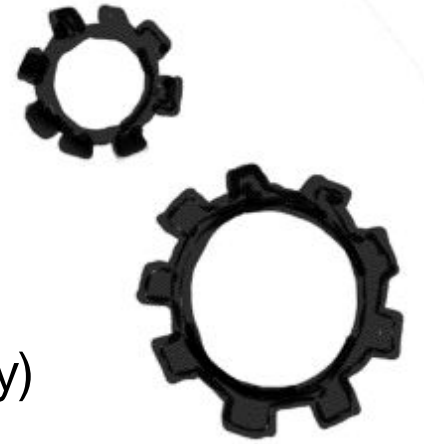
Detection of **systematic errors** in a global aerosol model to explain limits in parametric uncertainty reduction

Léa Prévost, Leighton Regayre, Kunal Ghosh, Jill Johnson, Ken Carslaw

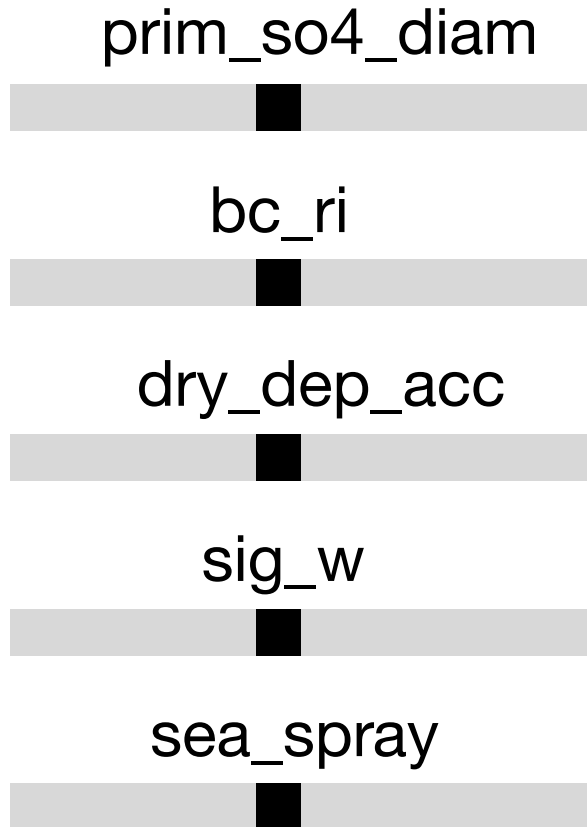


Systematic errors

(or structural uncertainty)

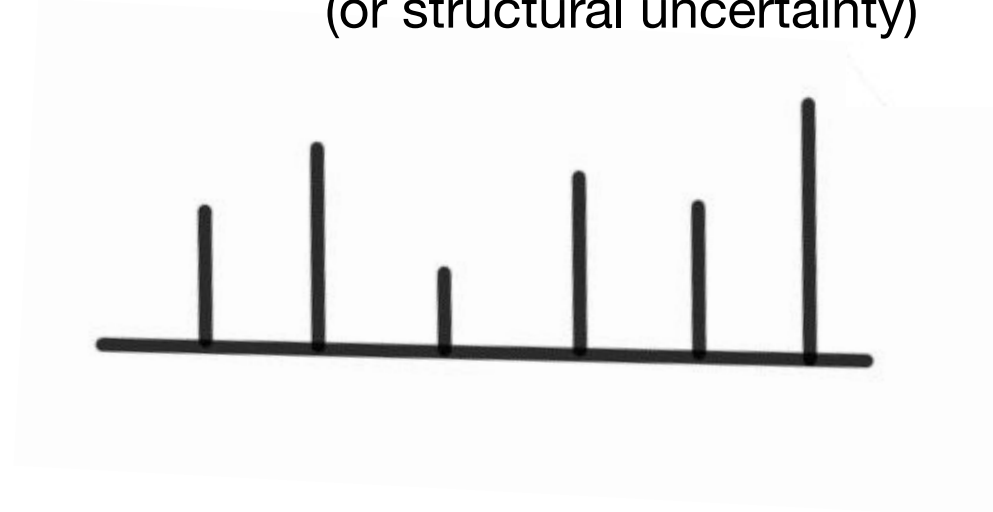


Parametric uncertainty

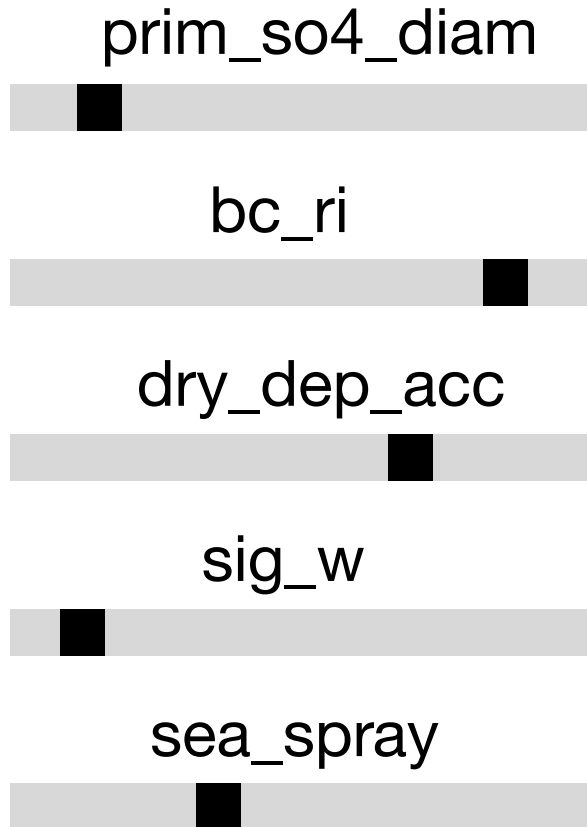


Systematic errors

(or structural uncertainty)

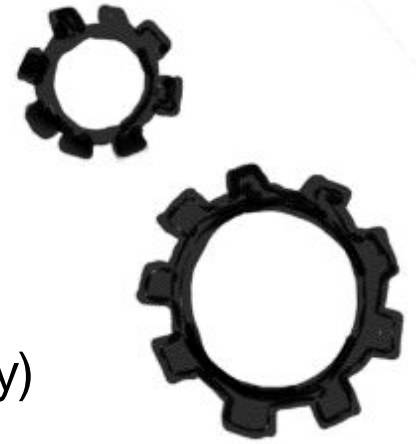


Parametric uncertainty



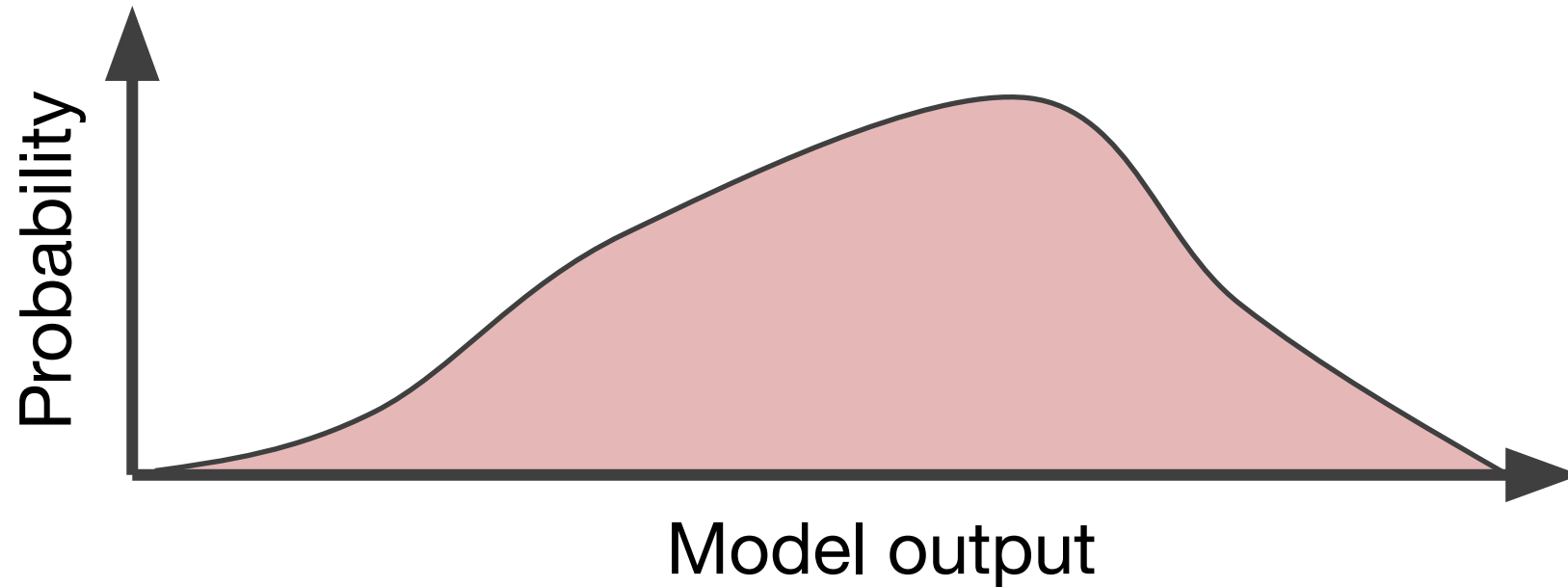
Systematic errors

(or structural uncertainty)



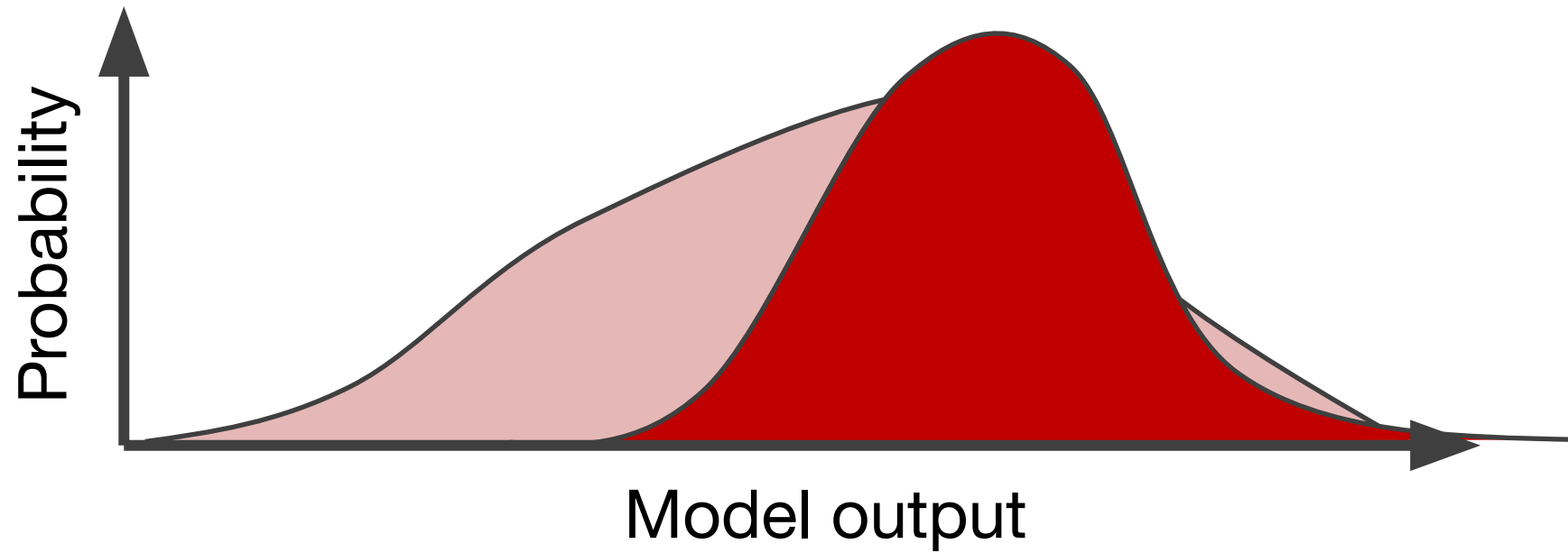
Reducing a model's parametric uncertainty

Perturbed Parameter Ensemble + emulation = **Full parameter space**
(PPE)



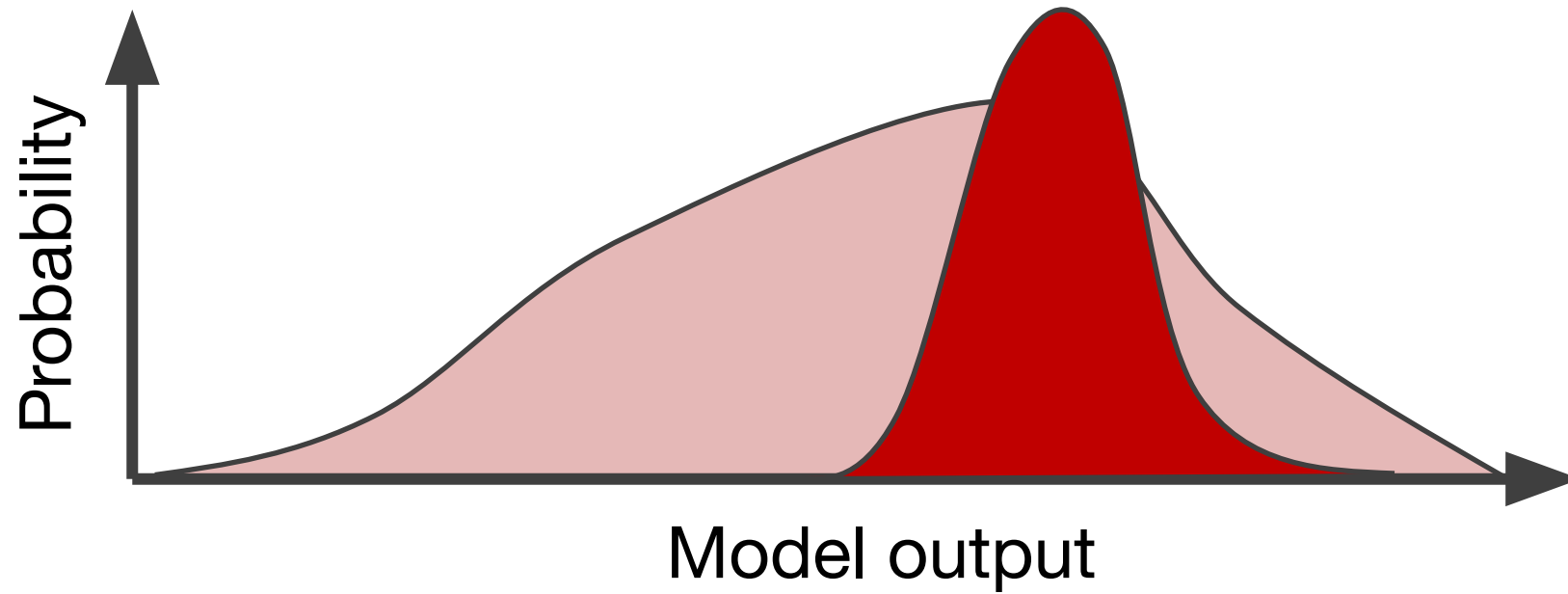
Reducing a model's parametric uncertainty

Full parameter space + measurements = **constrained parameter space**



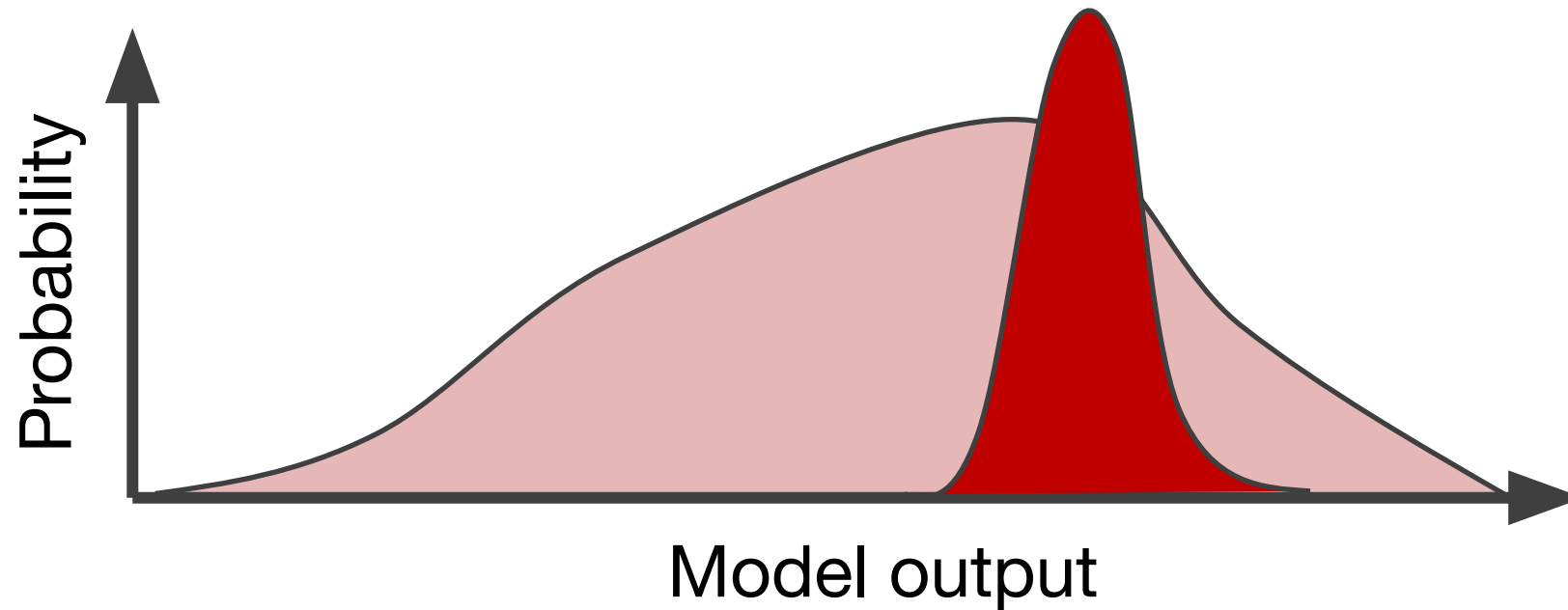
Reducing a model's parametric uncertainty

Full parameter space + measurements = **constrained parameter space**



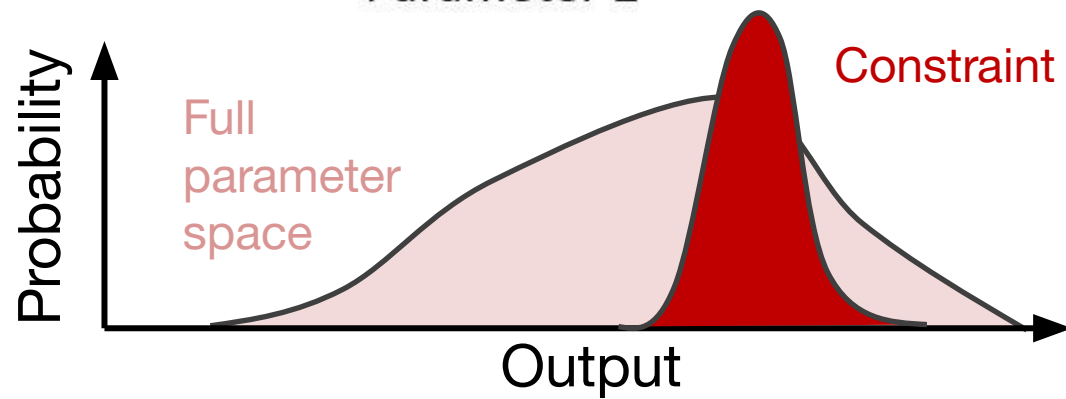
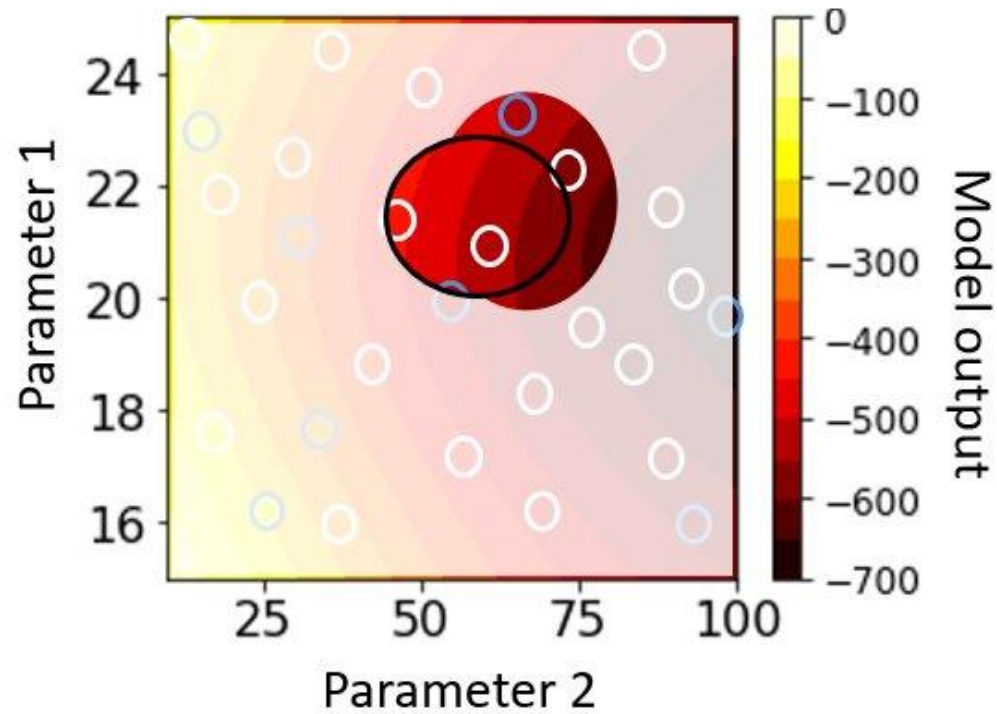
Reducing a model's parametric uncertainty

Full parameter space + measurements = **constrained parameter space**



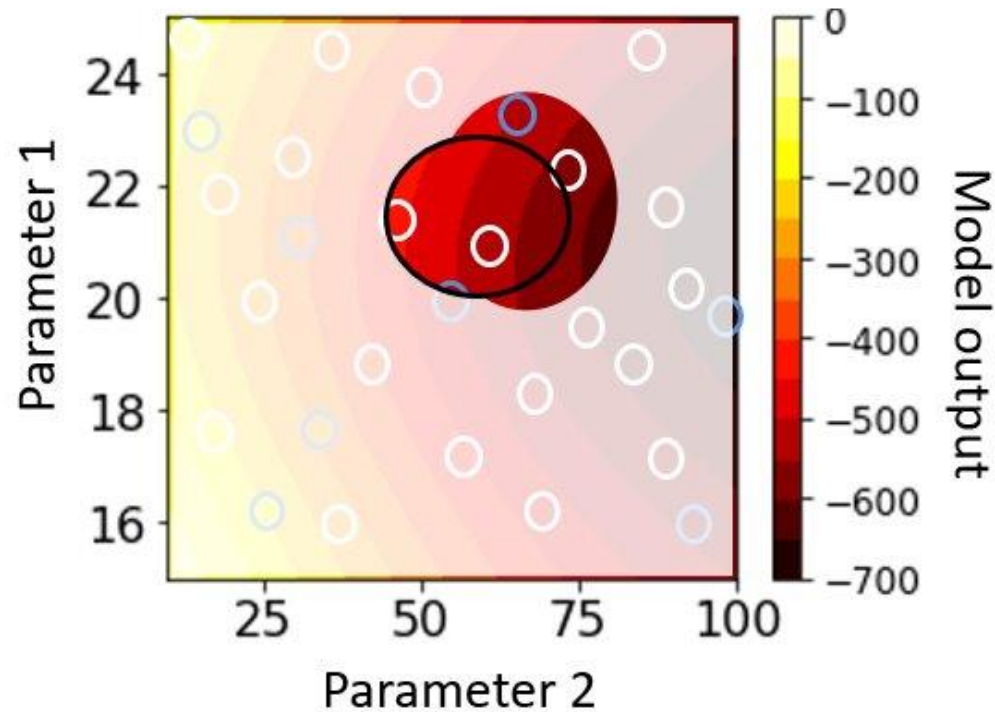
Consistency between observational constraints

Consistent

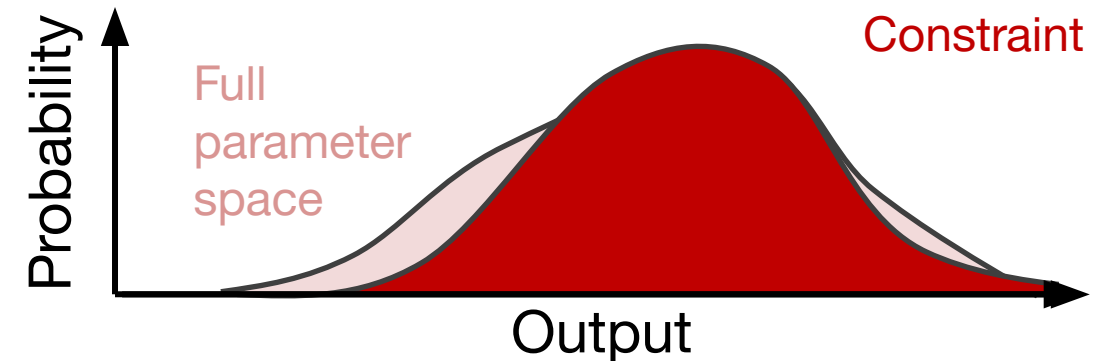
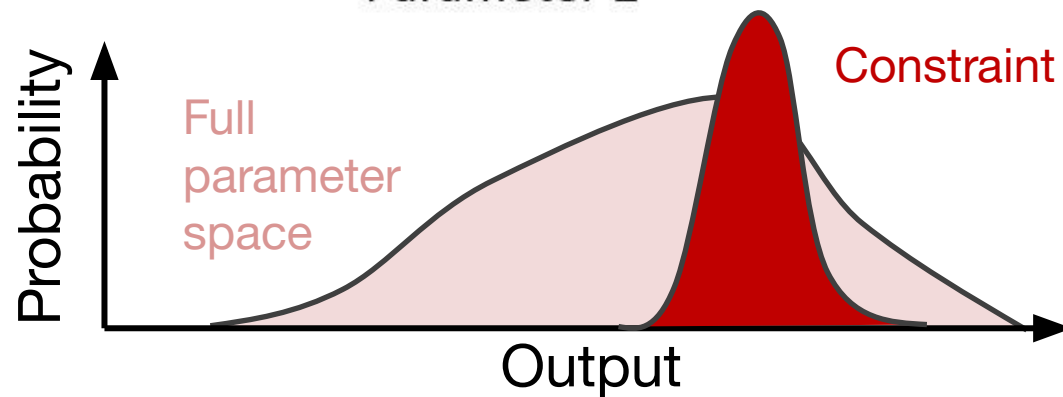
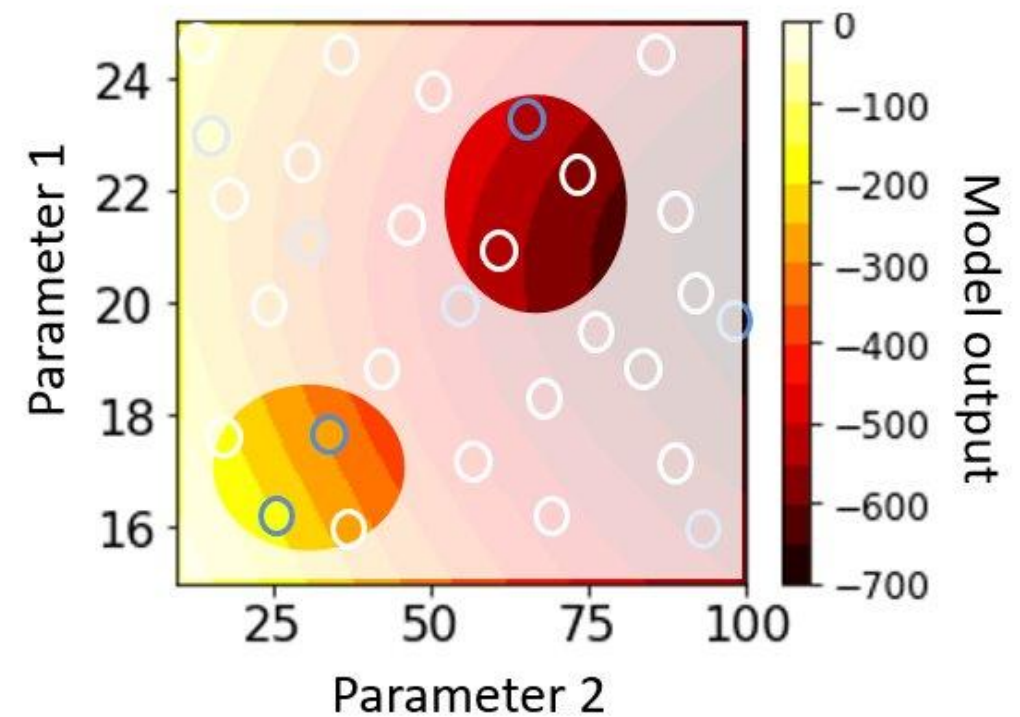


Consistency between observational constraints

Consistent

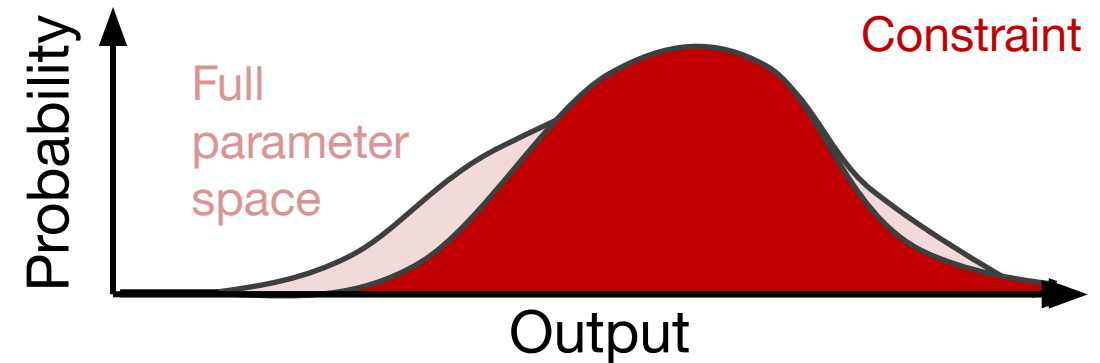
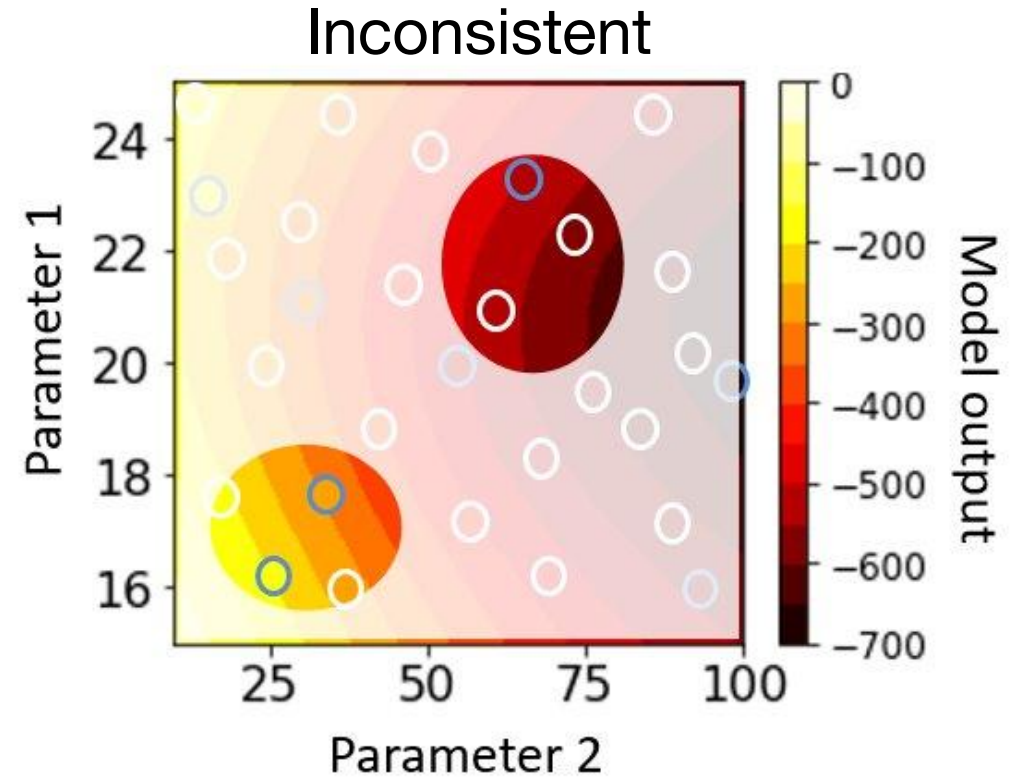


Inconsistent



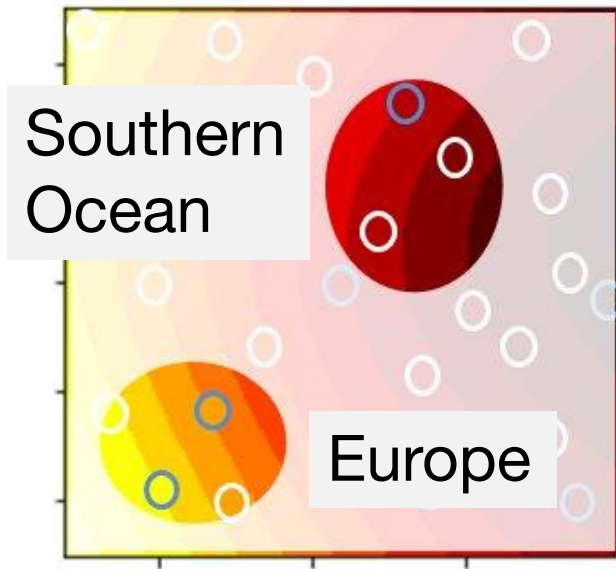
Inconsistency between observational constraints

Point to systematic errors that block parametric uncertainty constraints

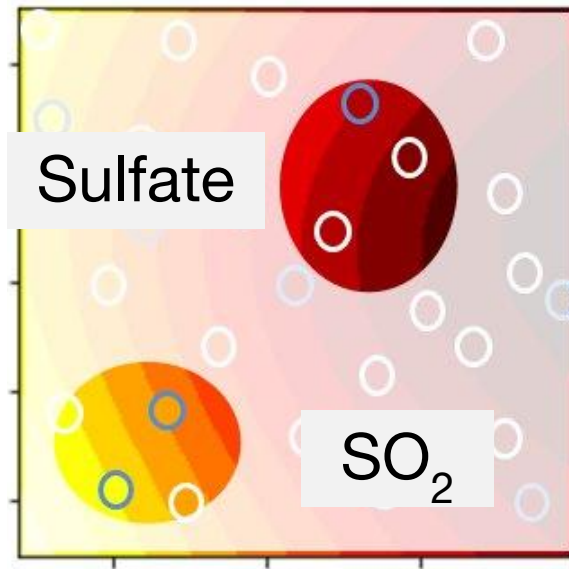


Types of inconsistencies

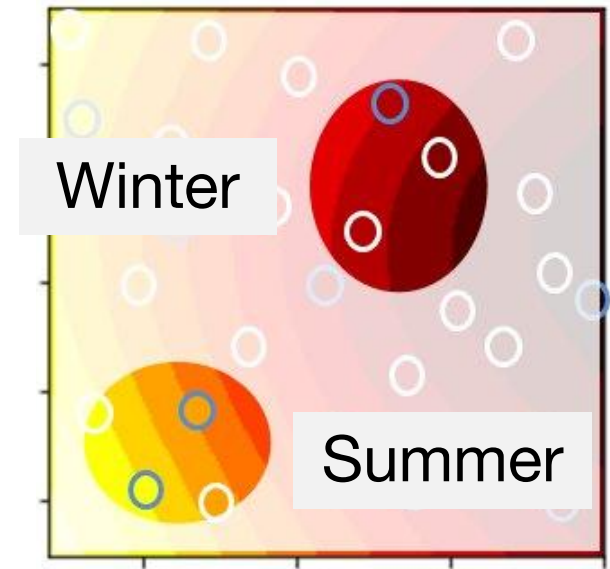
Inter-regional



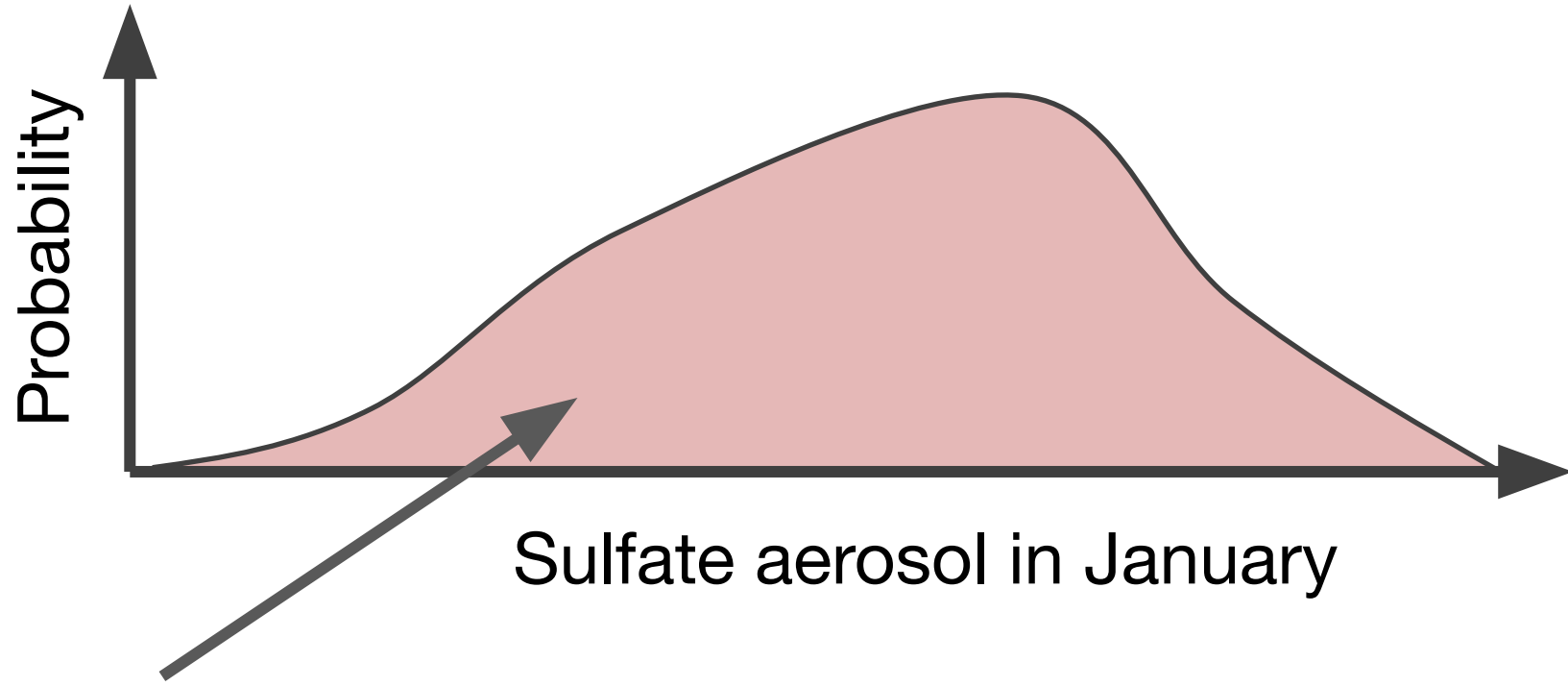
Inter-variable



Inter-seasonal



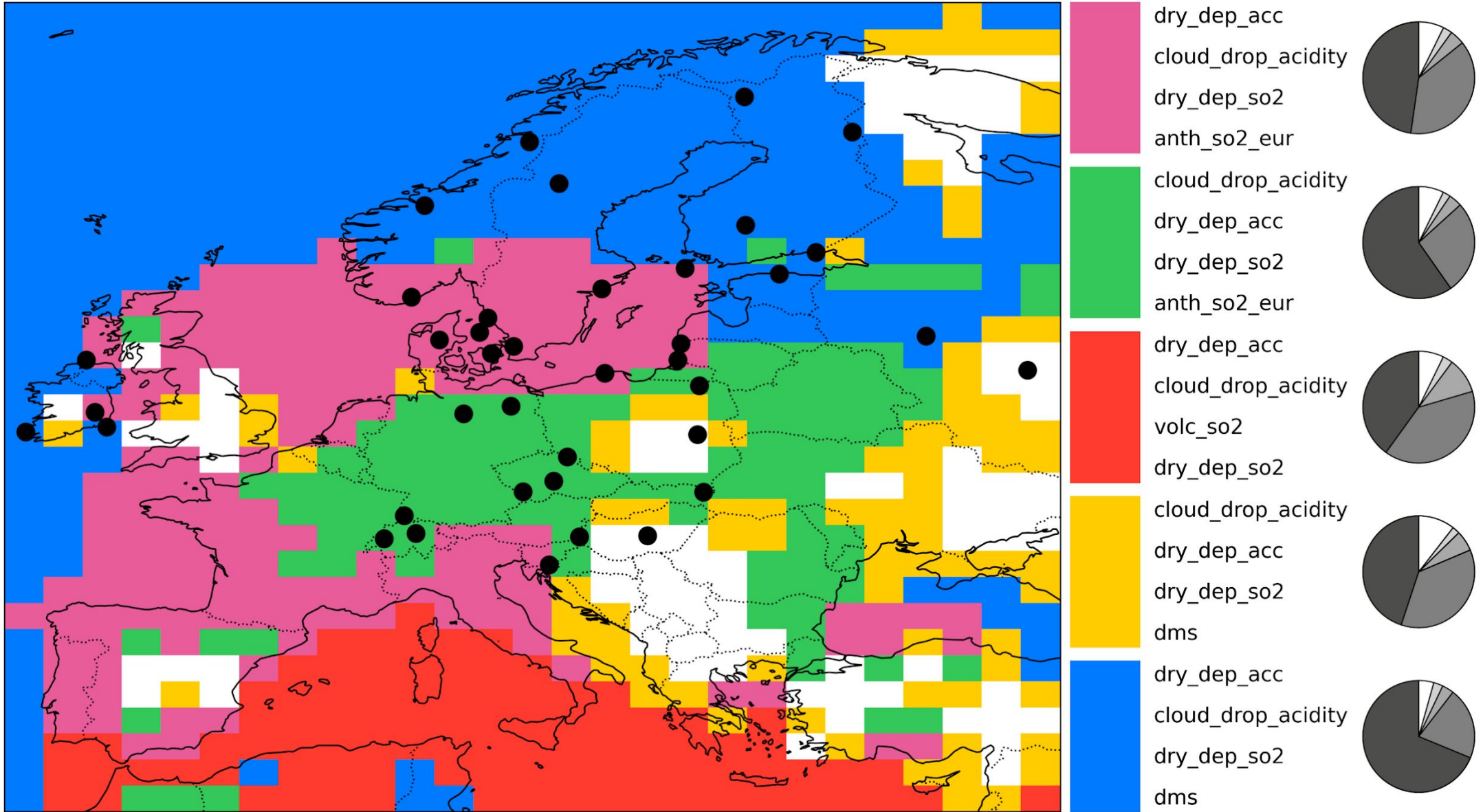
PPE of UKESM1 aerosol scheme + emulation = **Full parameter space**

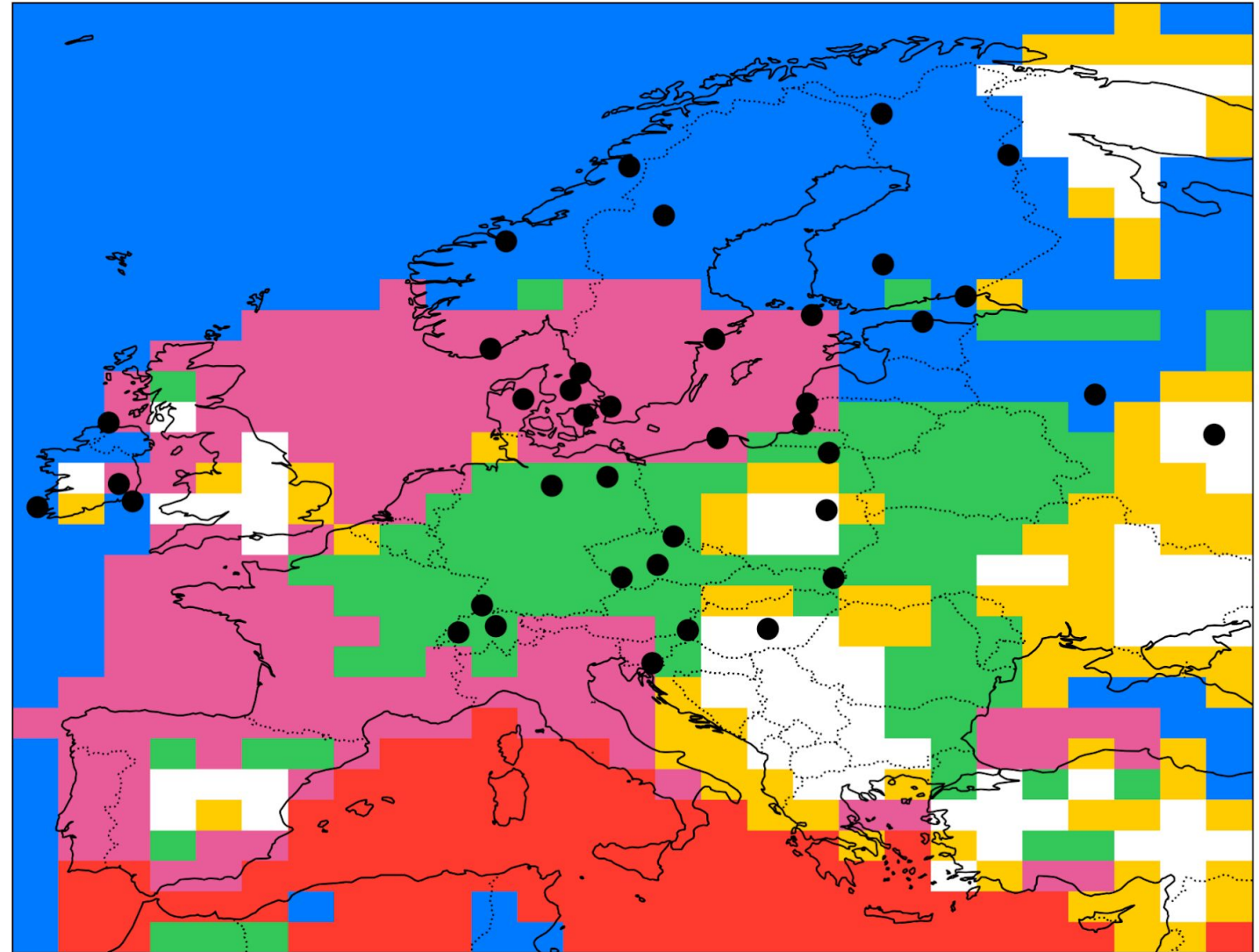
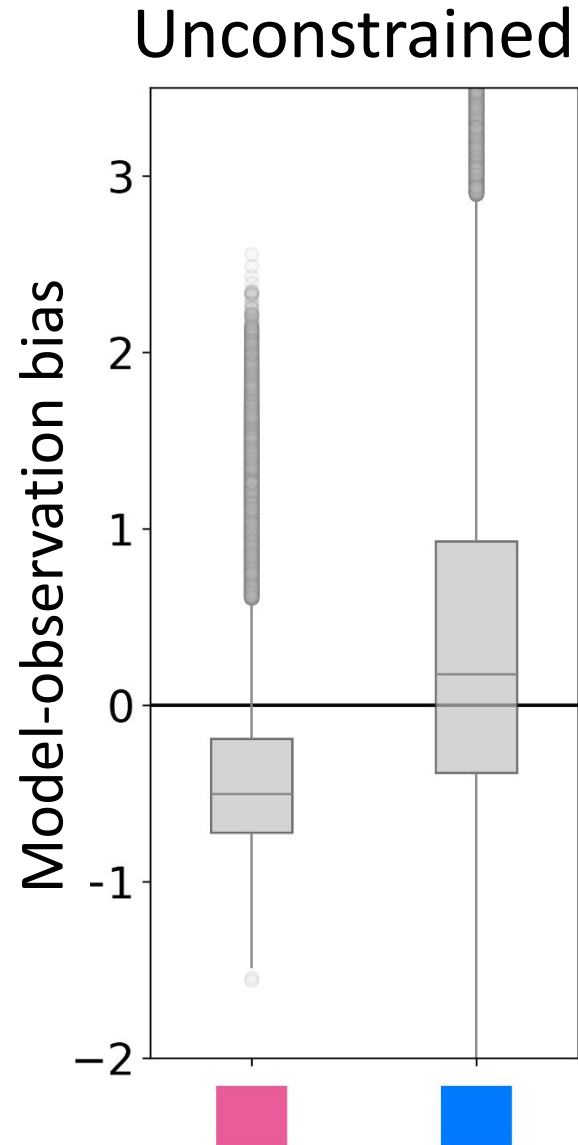


1 million parameter combinations in every grid box!

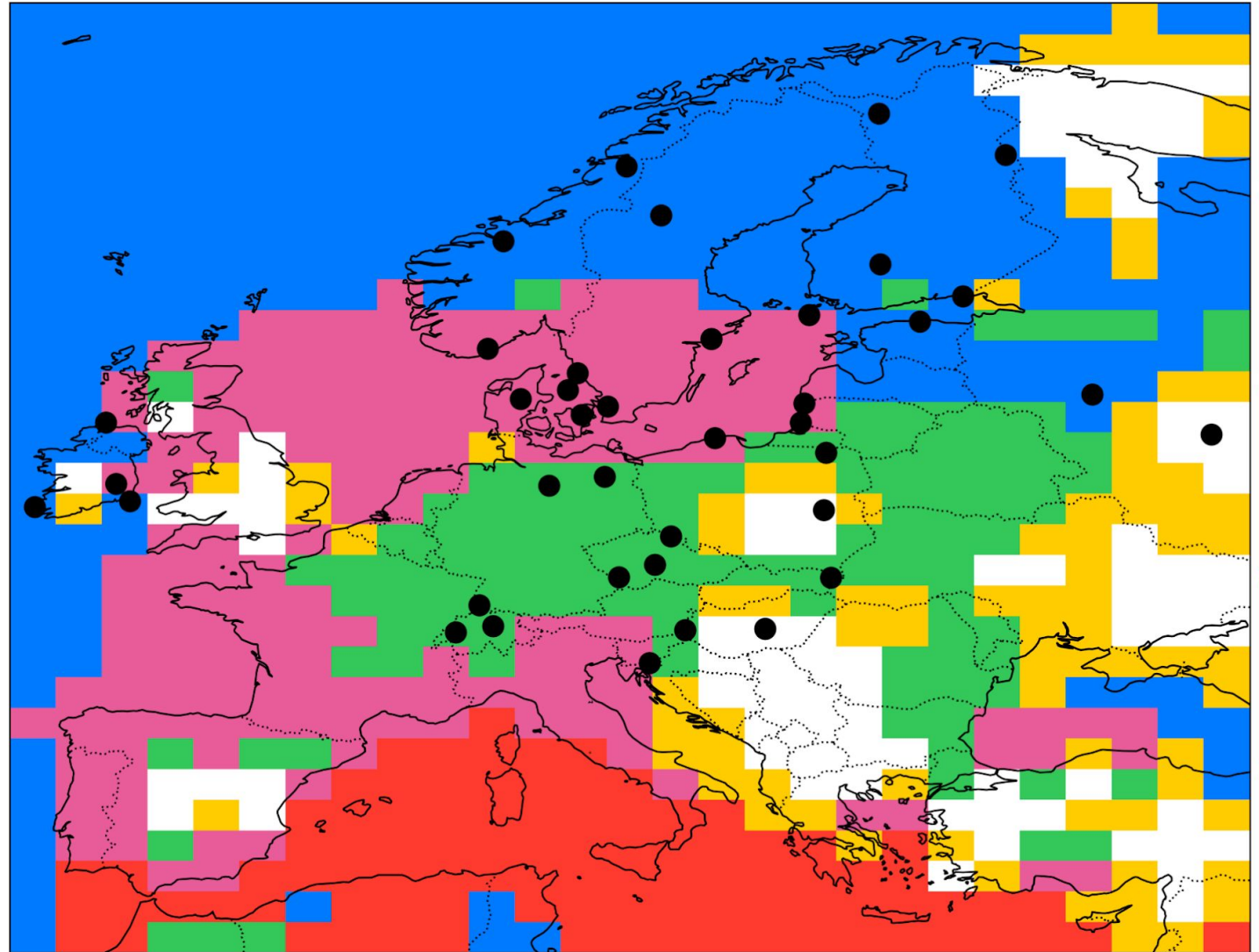
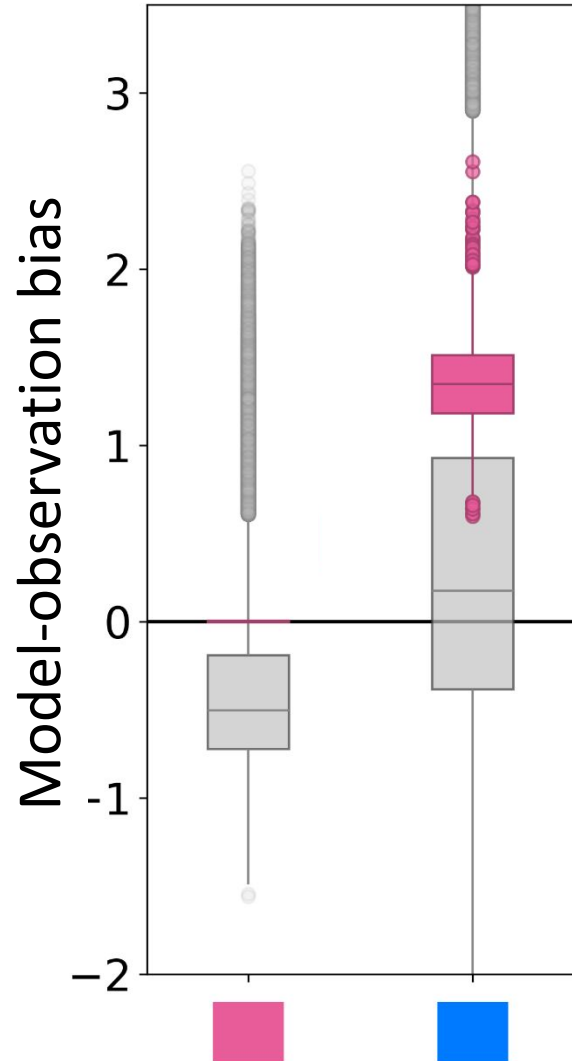
Clustering depending on most important parameters

Sulfate (January)

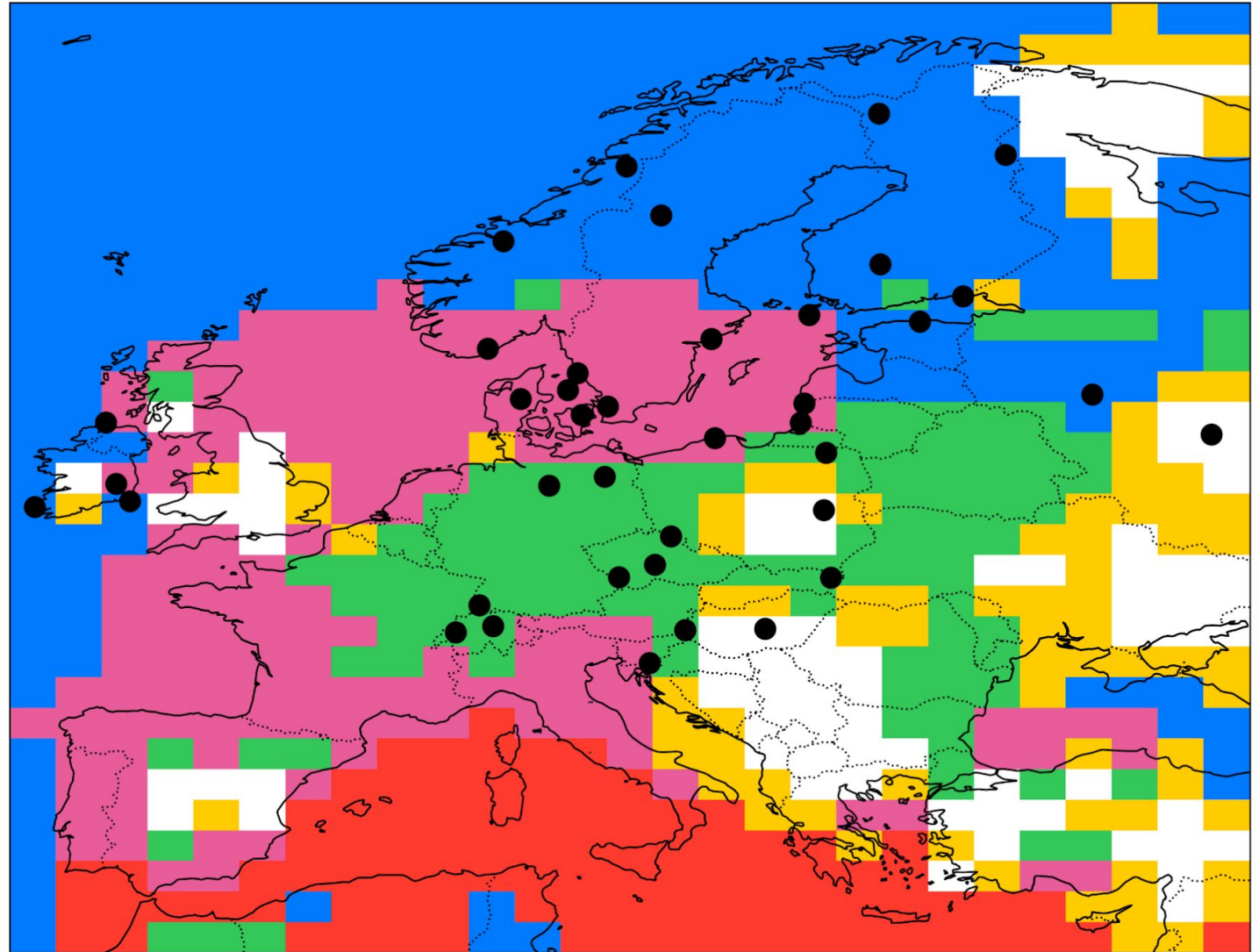
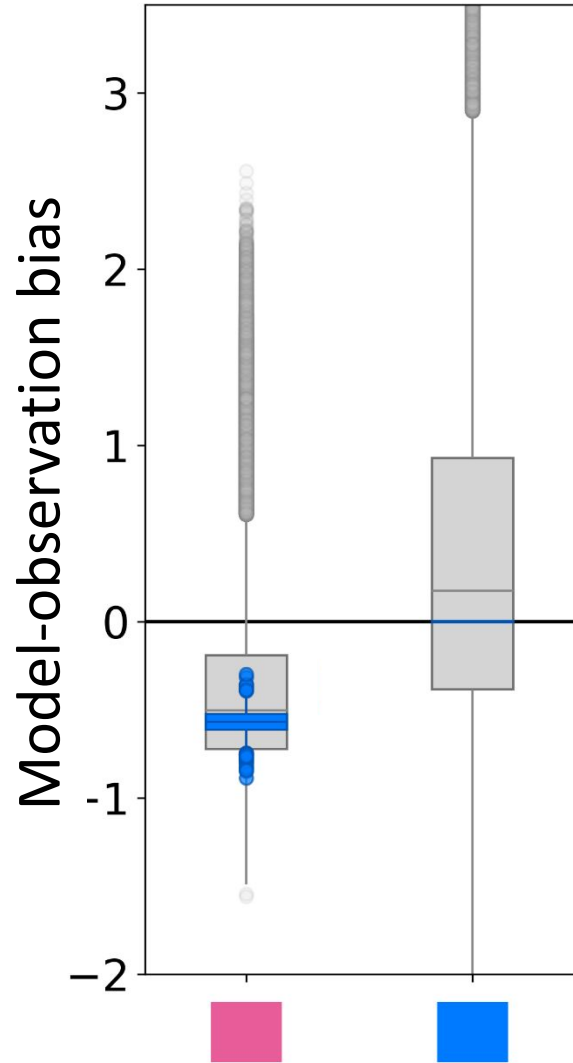




Constraint to pink

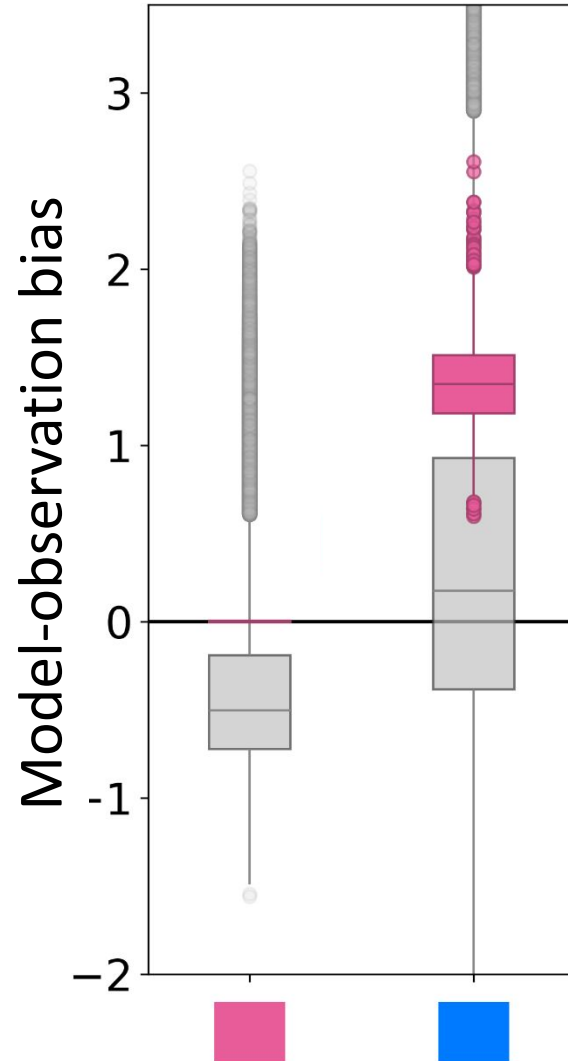


Constraint to blue

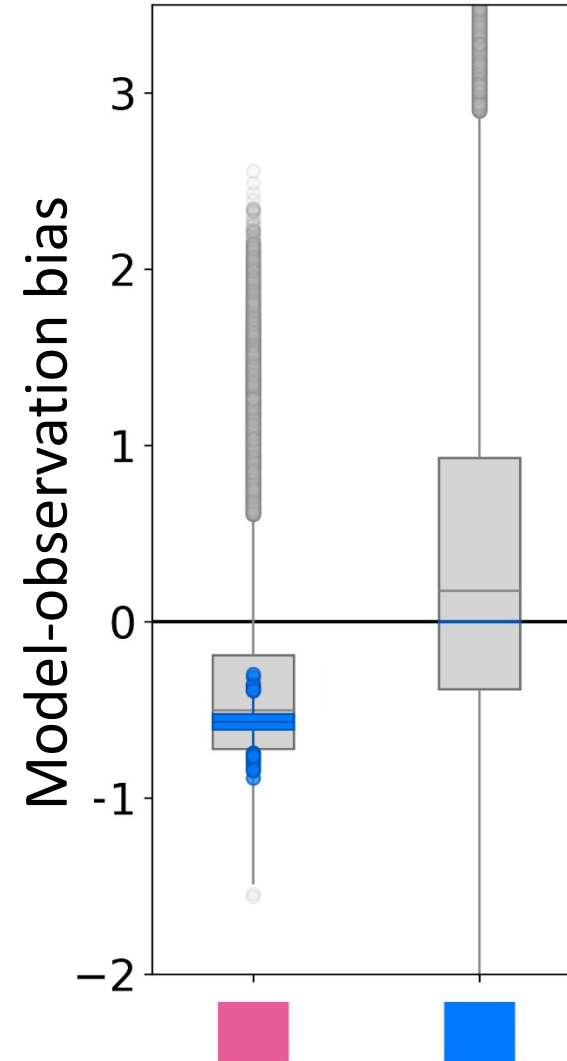


Sulfate inter-regional inconsistency

Constraint to pink



Constraint to blue

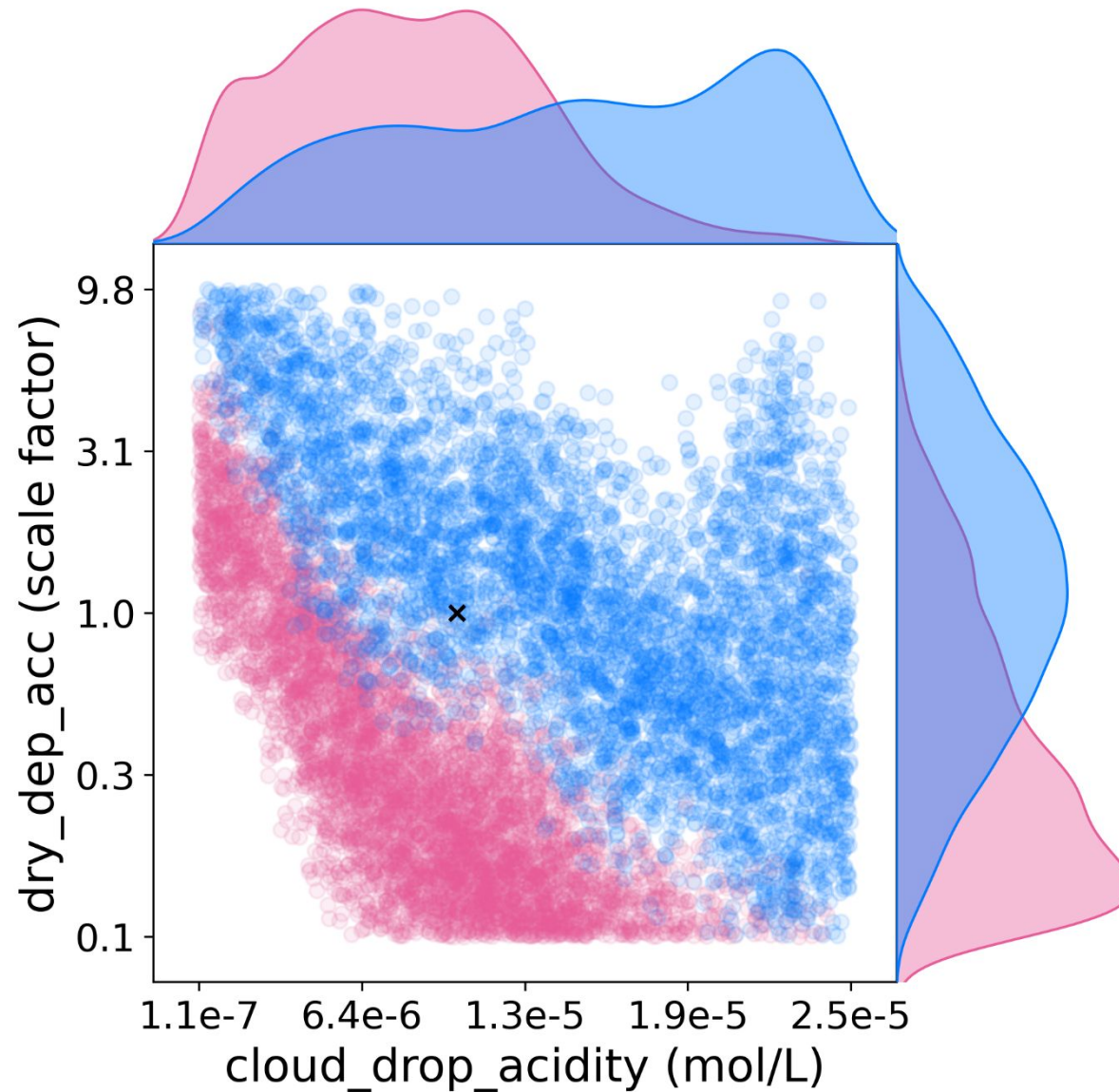


Sulfate inter-regional inconsistency

5000 model variants



UNIVERSITY OF LEEDS

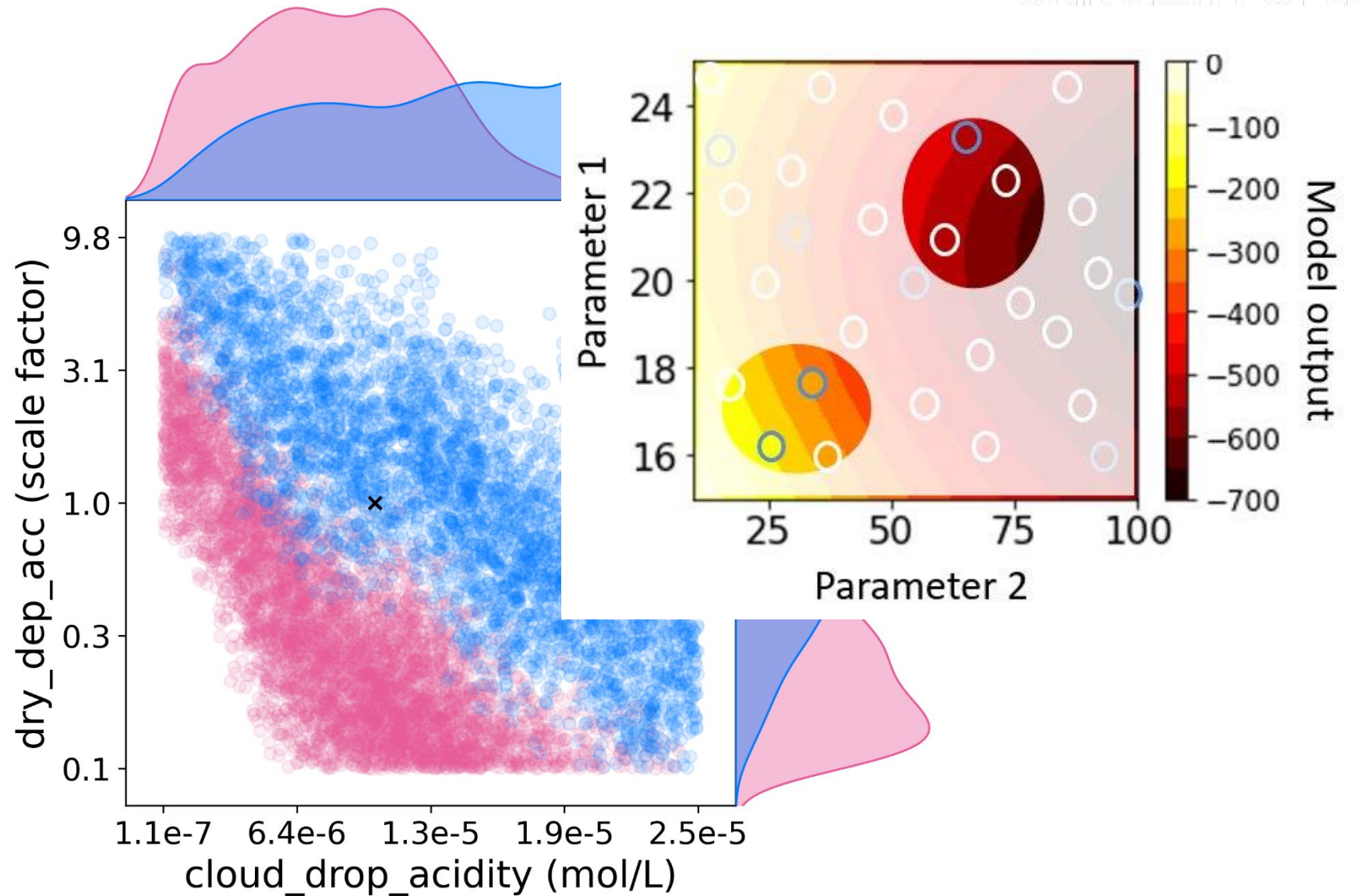


Sulfate inter-regional inconsistency

5000 model variants



UNIVERSITY OF LEEDS

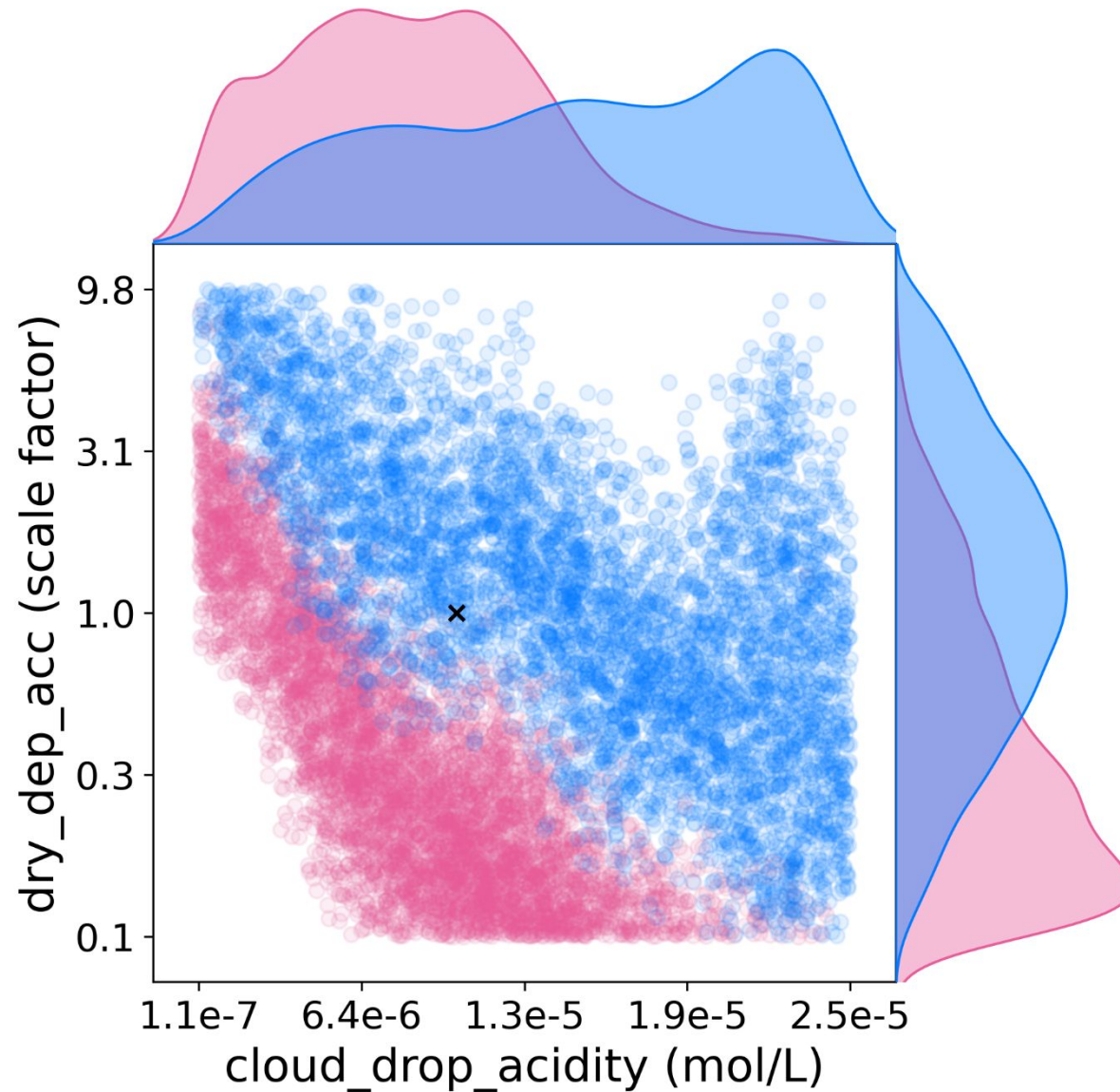


Sulfate inter-regional inconsistency

5000 model variants



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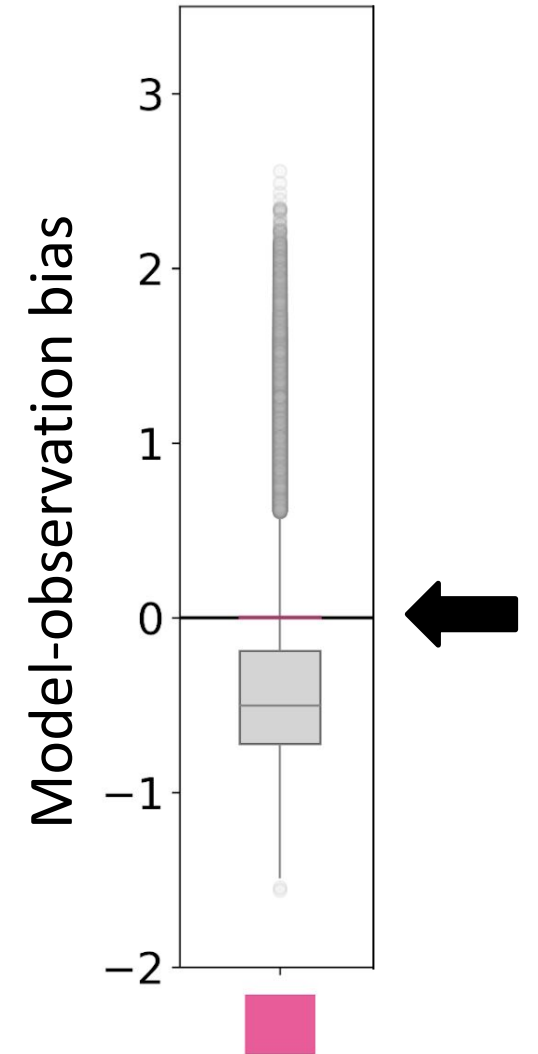
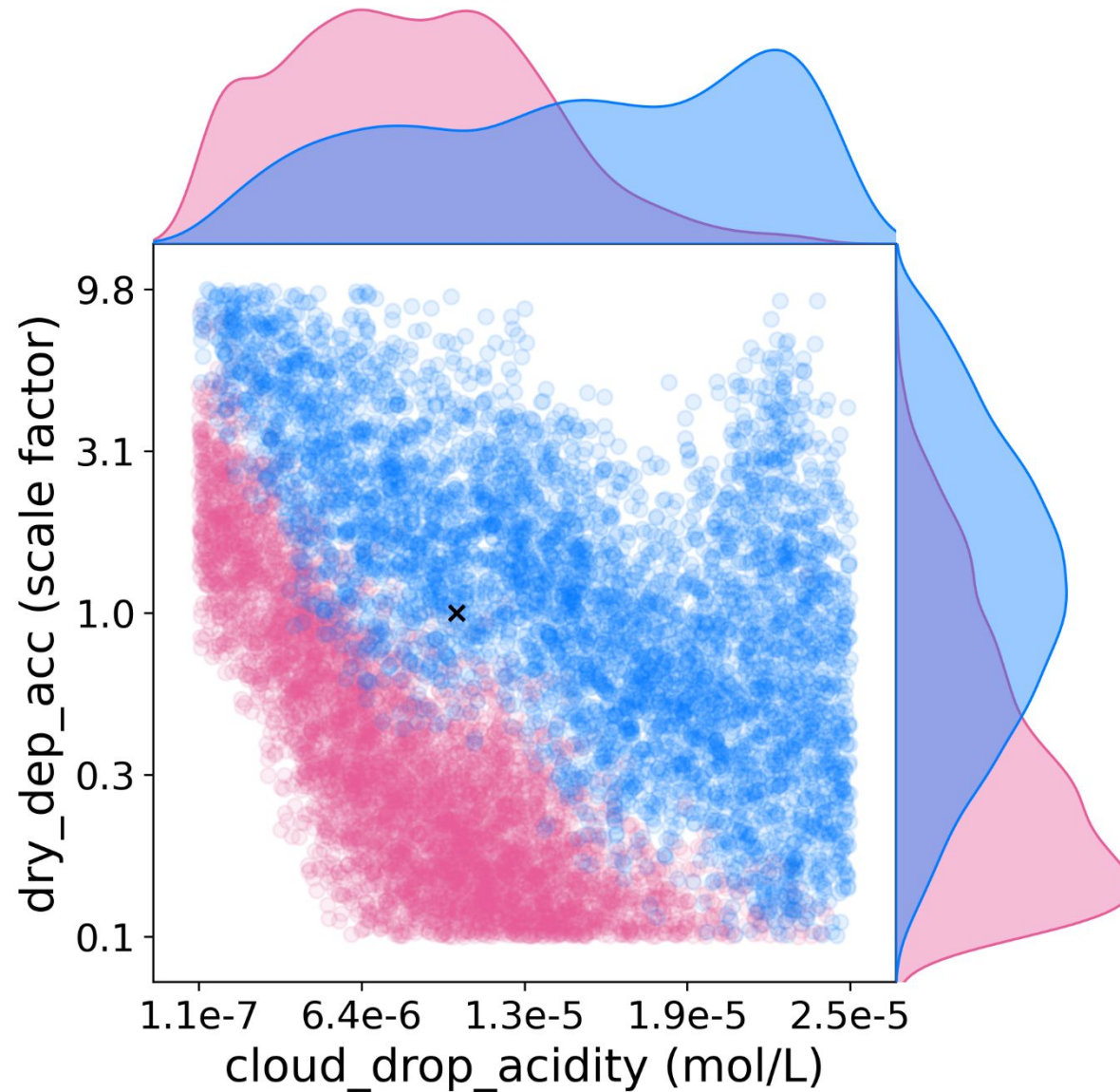


Sulfate inter-regional inconsistency

5000 model variants



UNIVERSITY OF LEEDS

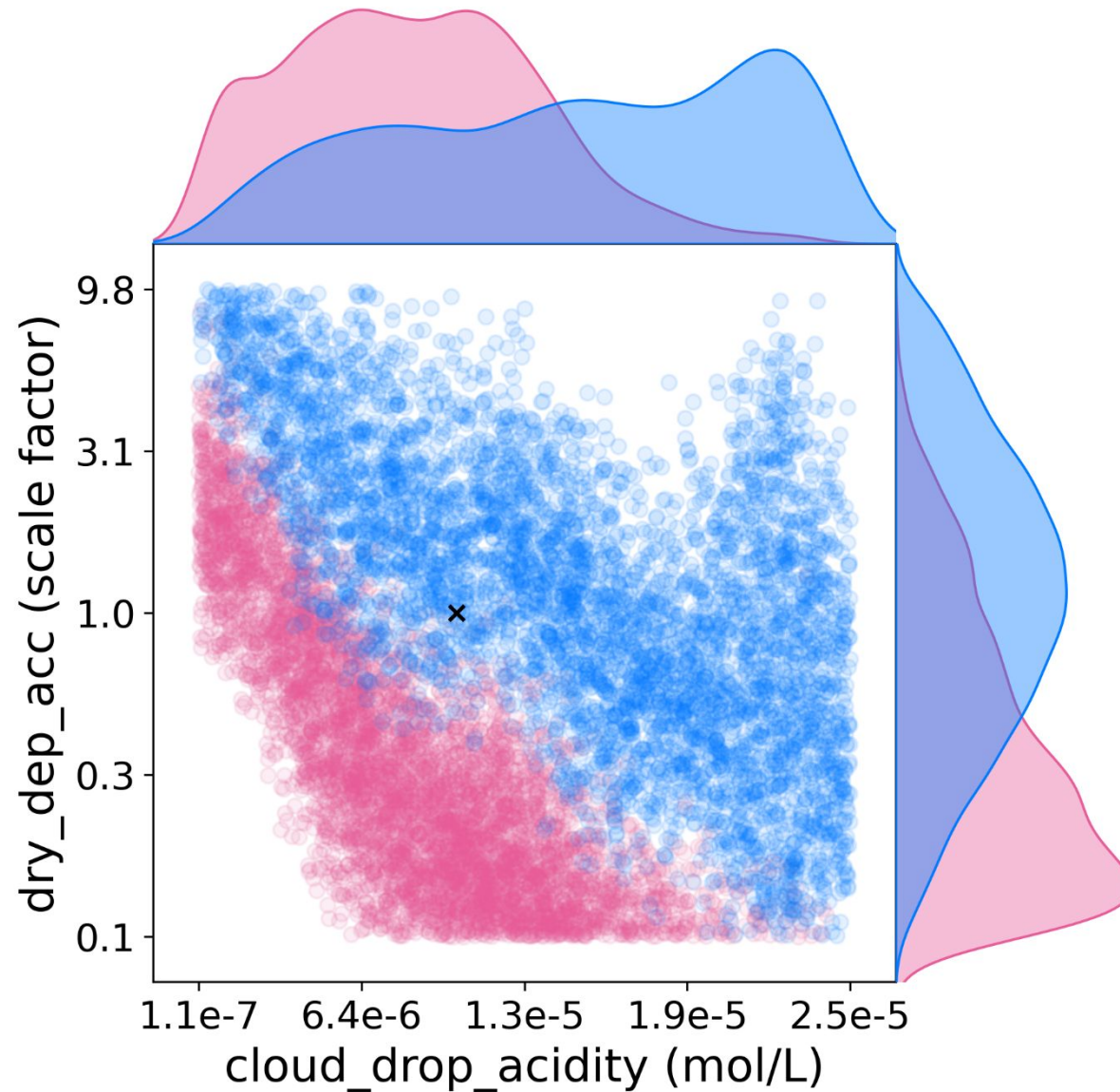


Sulfate inter-regional inconsistency

5000 model variants

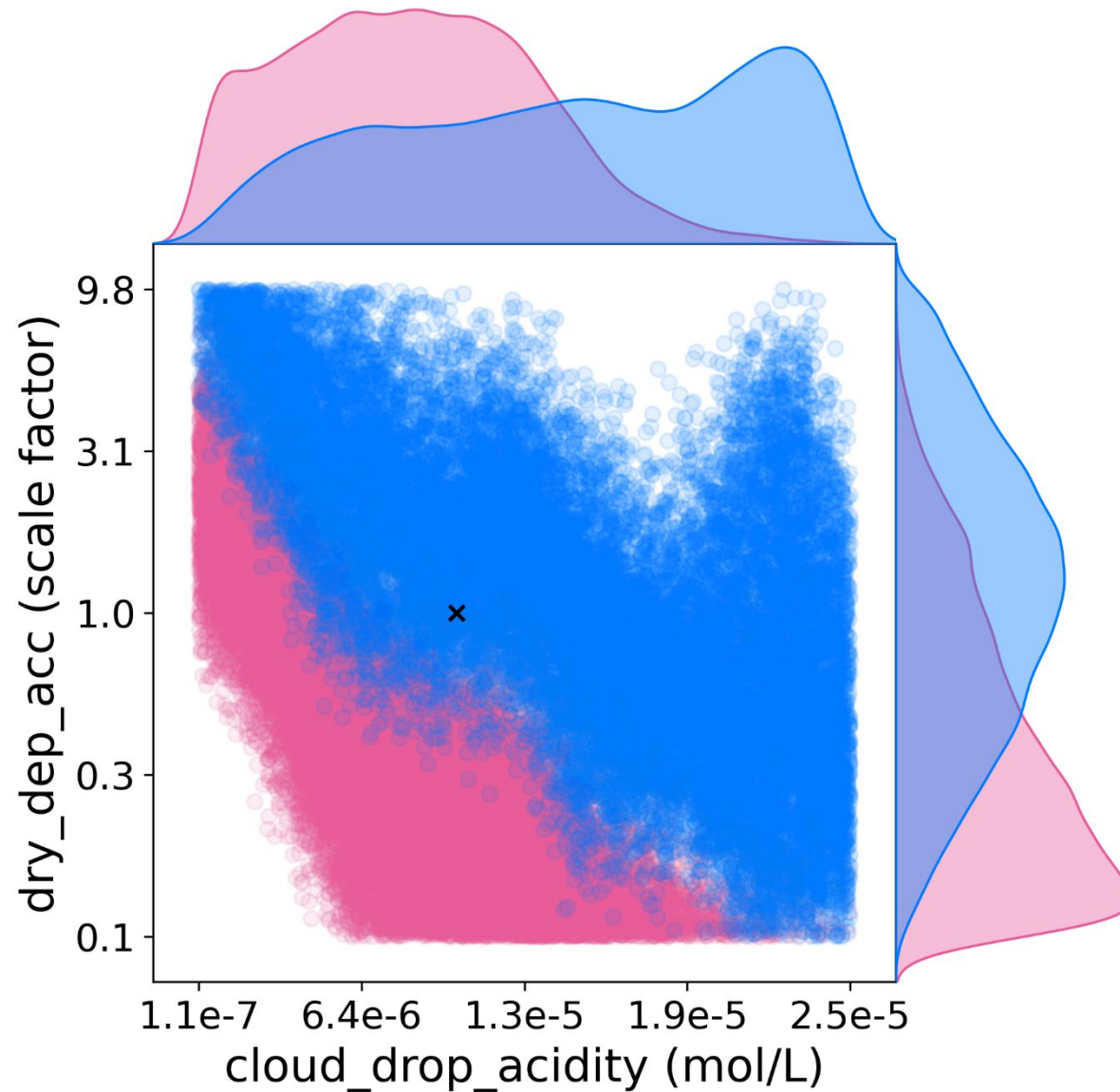


UNIVERSITY OF LEEDS



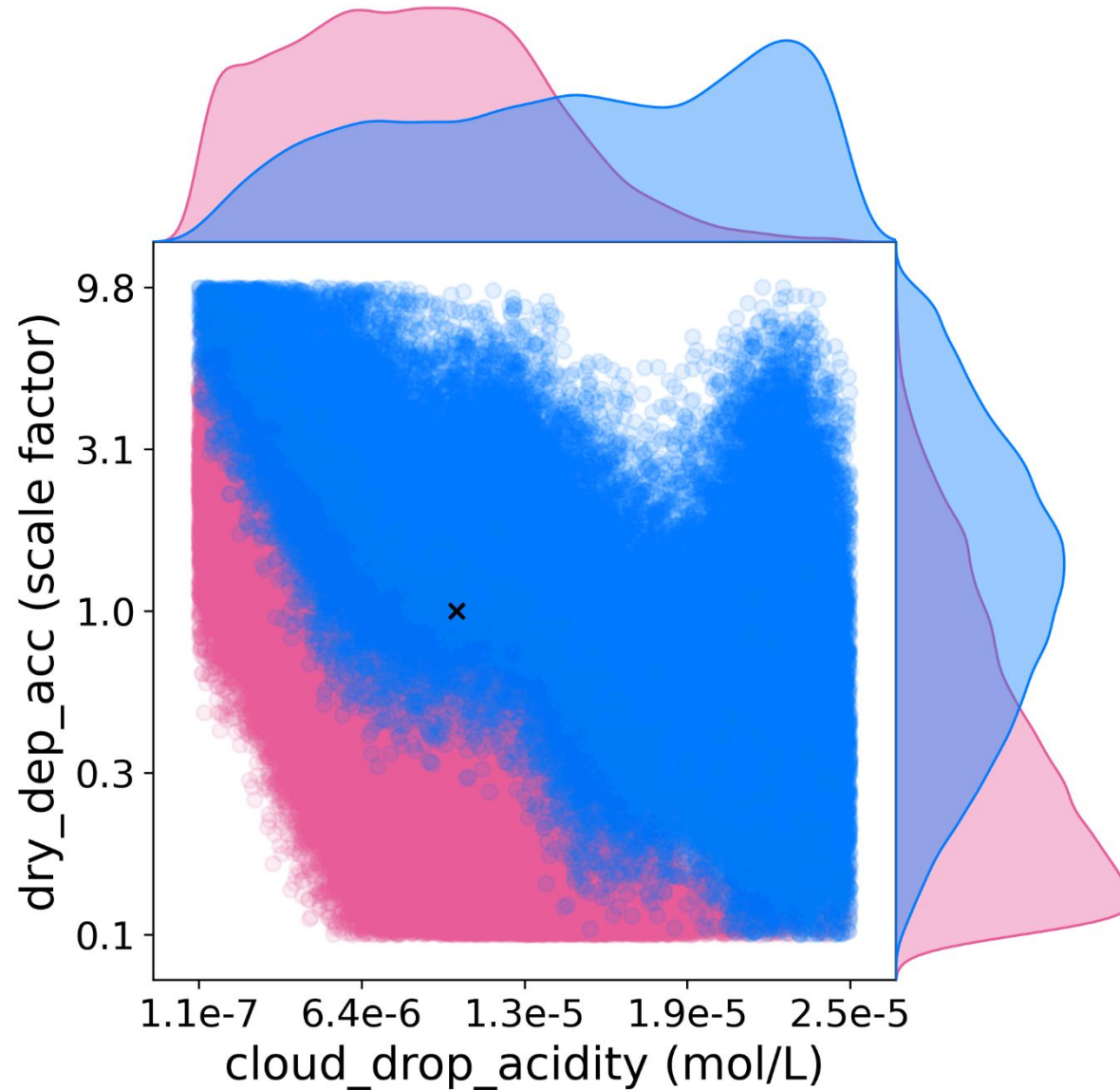
Sulfate inter-regional inconsistency

25 000 model variants

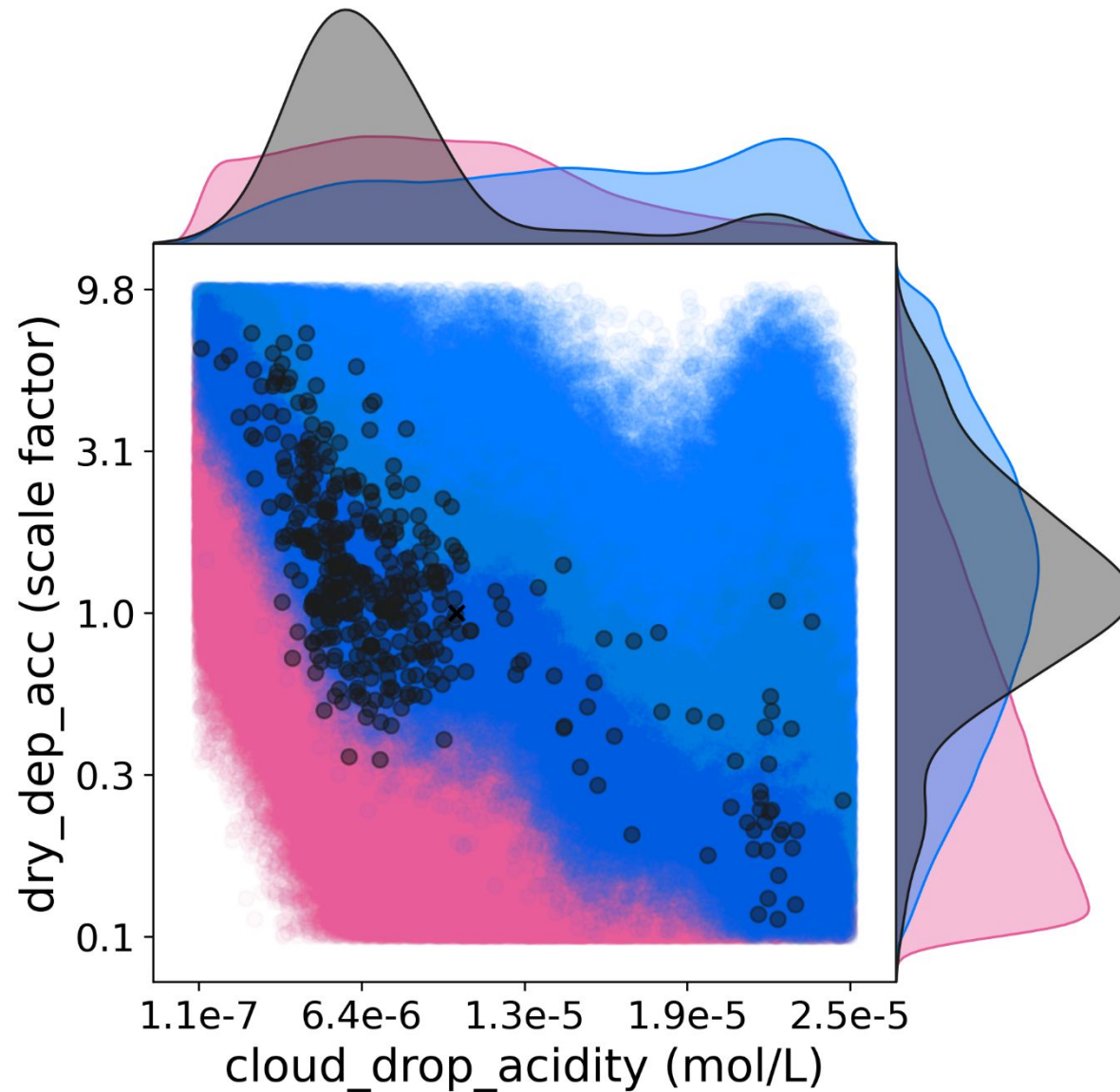


Sulfate inter-regional inconsistency

50 000 model variants



Sulfate inter-regional inconsistency

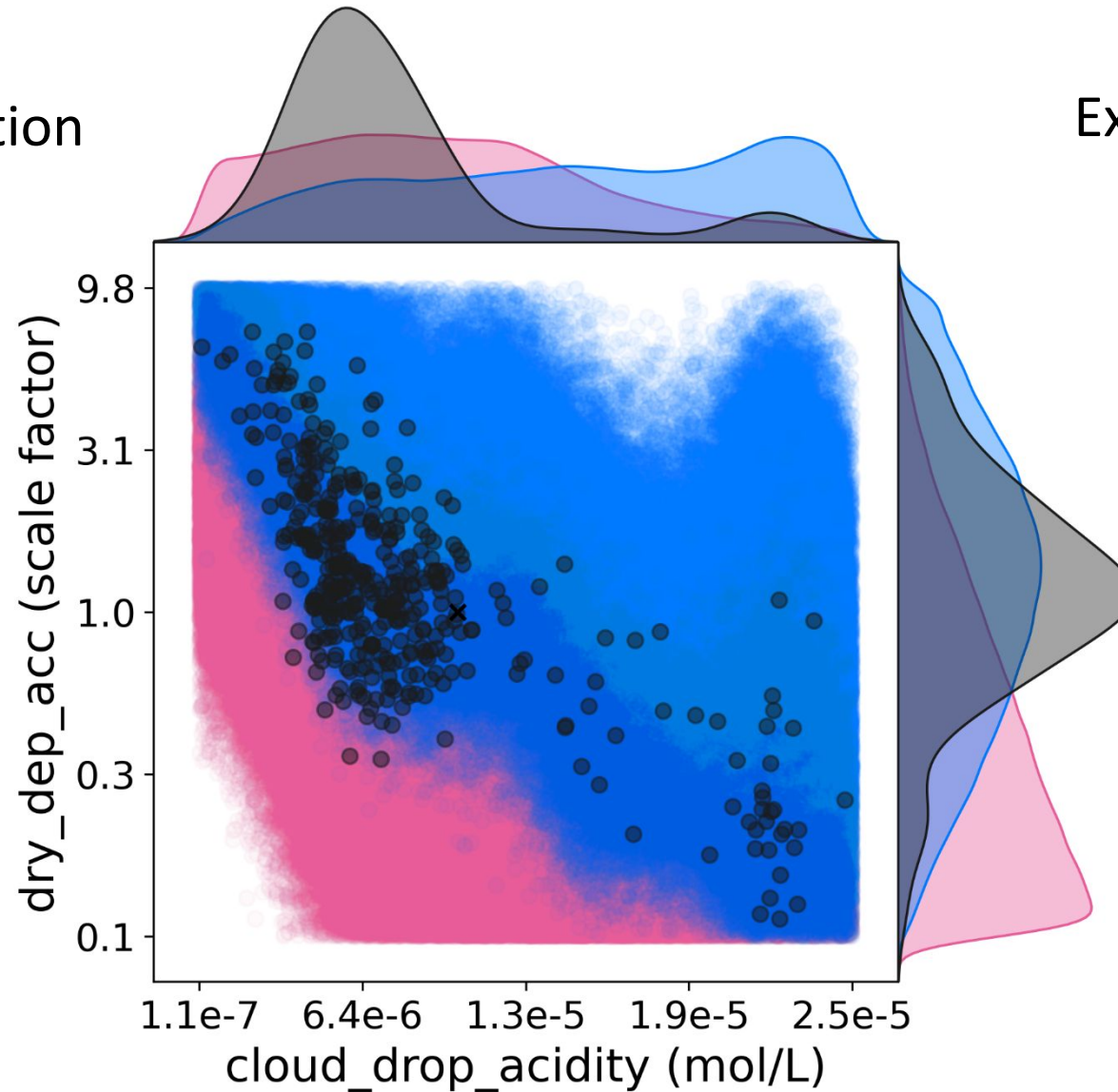


Sulfate inter-regional inconsistency

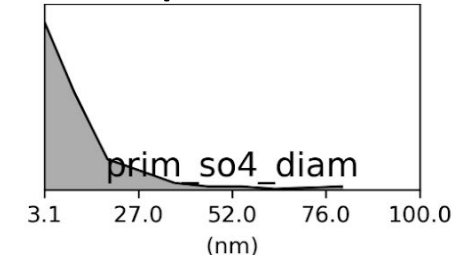
235 000 model variants



Large model-observation
biases retained

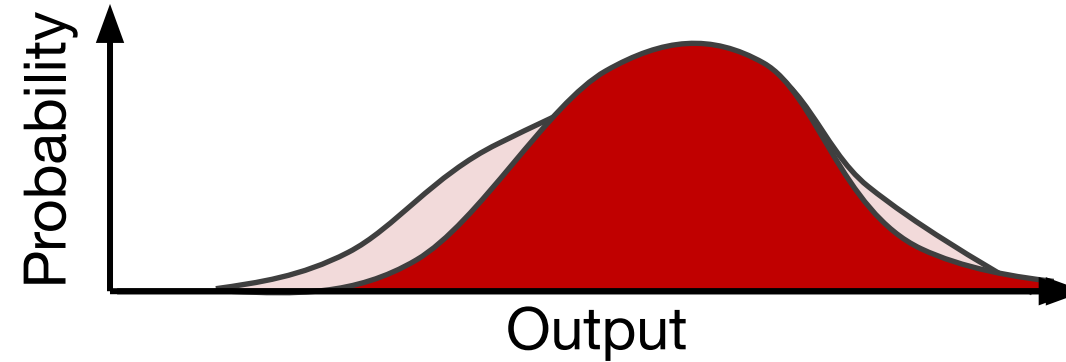


Extreme parameter values

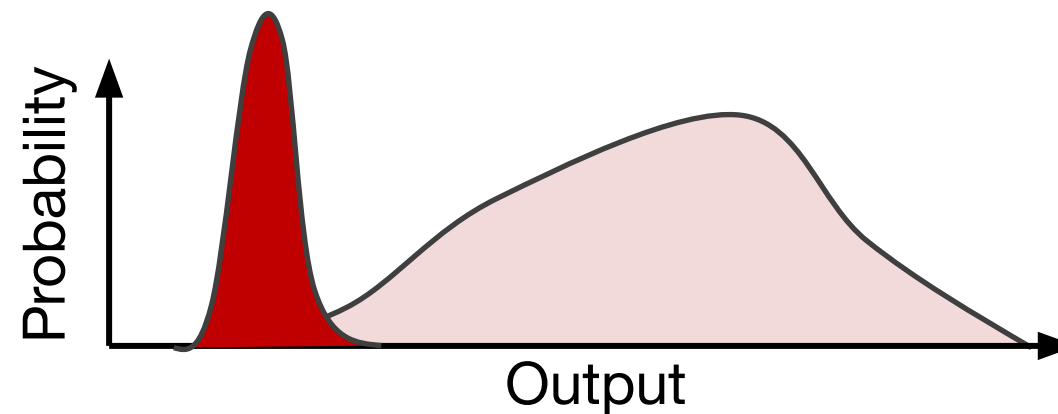


Consequence of systematic errors

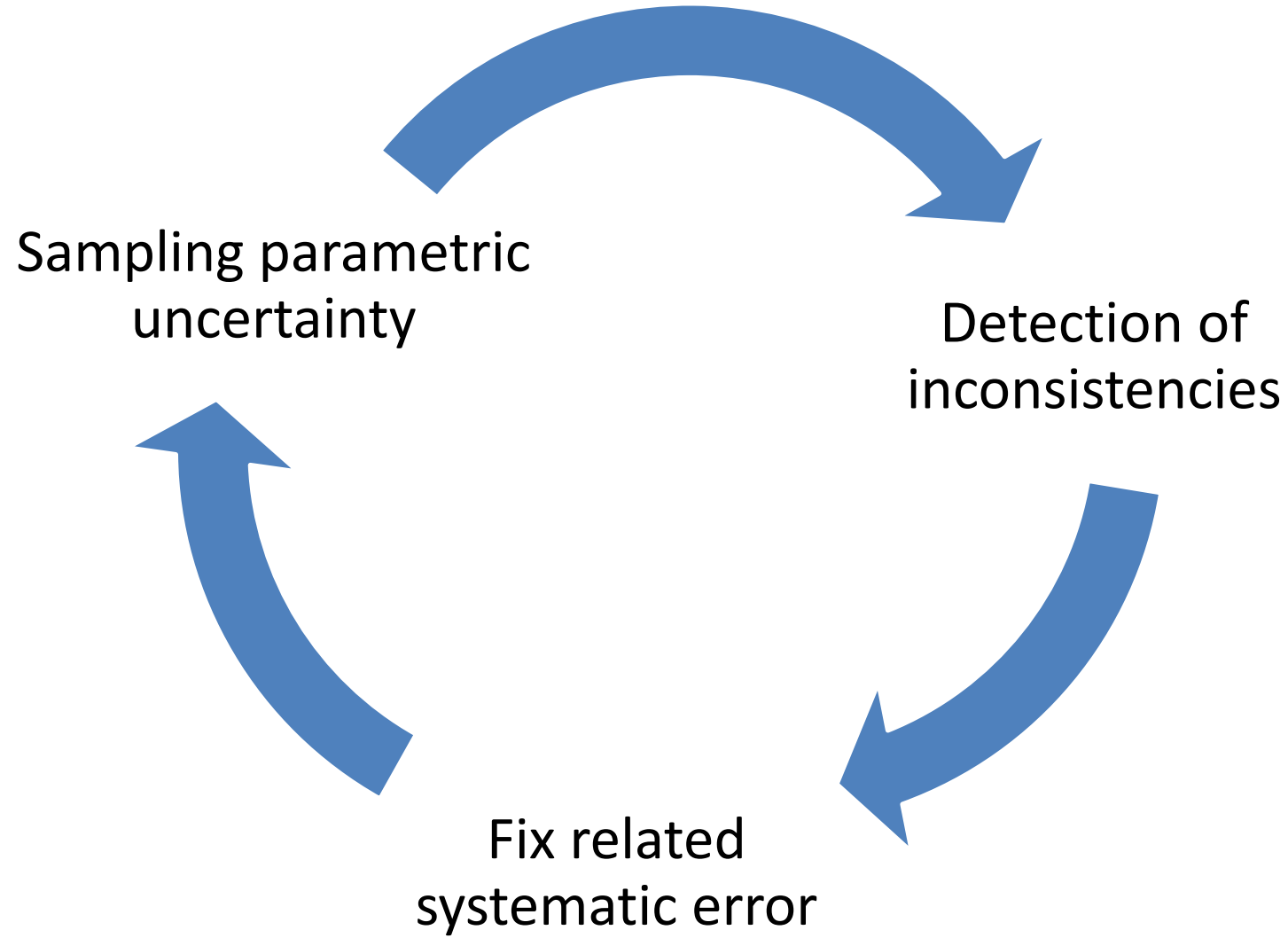
- Weaker constraints (more parameter combinations kept)



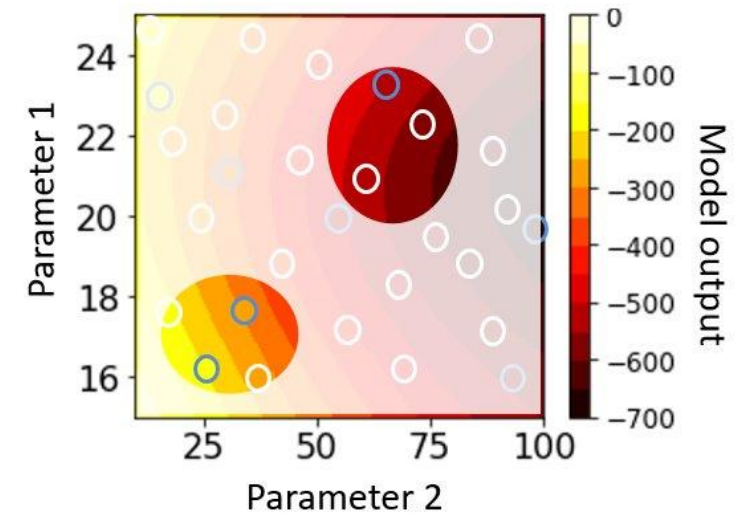
- Narrow, but incorrect constraints



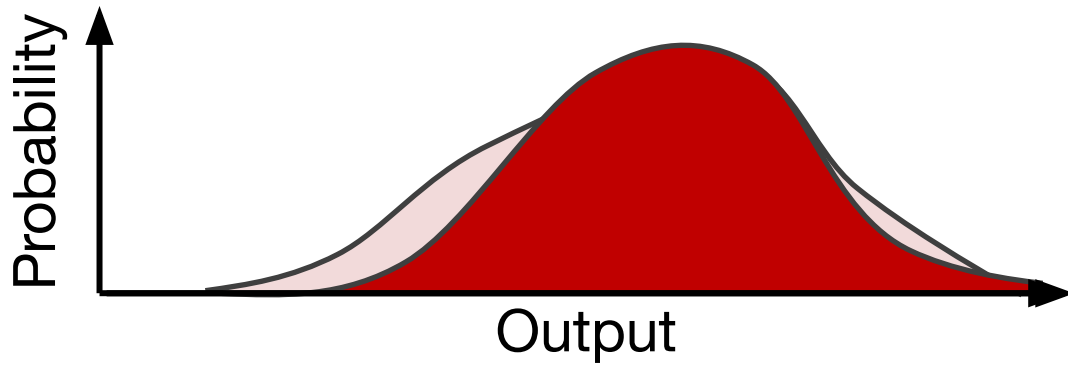
Ideal cycle of model development



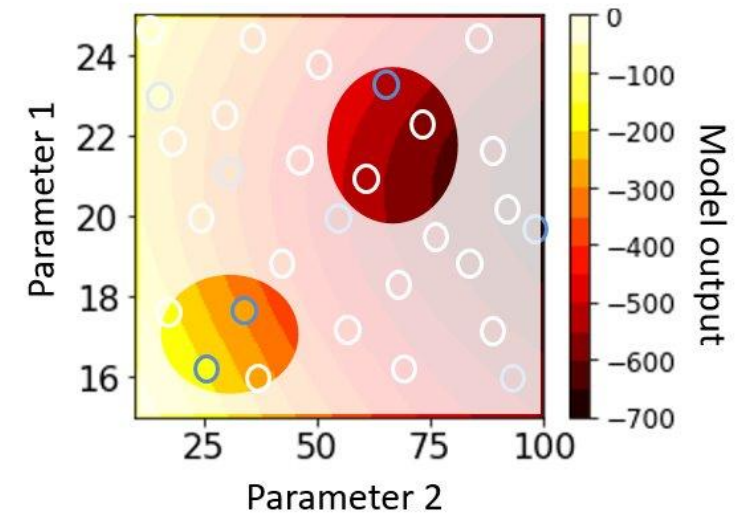
Systematic errors lead to inconsistent observational constraints...



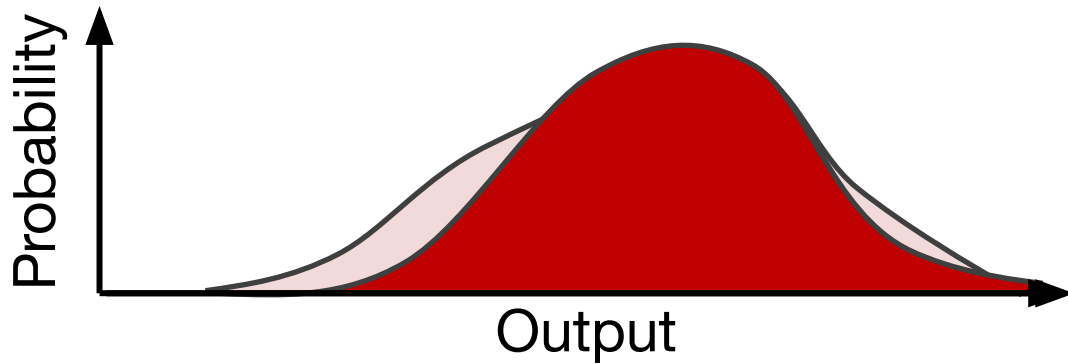
Systematic errors lead to inconsistent observational constraints...



...which limit the reduction of parametric uncertainty.



Systematic errors lead to inconsistent observational constraints...



...which limit the reduction of parametric uncertainty.

We need to identify and fix systematic errors that lead to robust progress in uncertainty reduction.

