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What is the skill of different ocean tracers to reduce uncertainties about model projections of the North Atlantic Meridional Overturning Circulation?

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The North Atlantic Meridional Overturning Circulation (AMOC) may weaken or even collapse in response to anthropogenic greenhouse gas emissions. Current AMOC projections based on Earth system models are highly uncertain. One key driver of this AMOC projection uncertainty is the uncertainty about model parameters such as vertical ocean diffusivity. One promising strategy to reduce this parametric uncertainty is to confront Earth system models with new observational constraints. Historical ocean data are however sparse, and gathering new observations is subject to nontrivial logistical, technical, and economic constraints. Identifying a scientifically sound, logistically feasible, and economically efficient AMOC observation system requires tackling the basic science question of how different tracer observation can constrain AMOC projections. Here we analyze this question using a Bayesian data fusion of existing observations (e.g., CFC, T) with an Earth system model of intermediate complexity (UVic) integrated from 1800 through 2300 using historic and projected climate forcings.
We derive the multivariate posterior probability density function of model parameters that takes into account spatial autocorrelation as well as the cross-correlation between the data-model residuals. We compare how the different tracers can improve estimates of the model parameters and, as a result, the long-term AMOC projections.