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Data assimilation for computing model evidence: The attribution problem

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A new approach potentially useful for near real time, systematic causal attribution of weather and climate-related events is described. The method is purposely designed to allow its operability at meteorological centers by synergizing causal attribution with Data Assimilation (DA) methods usually designed to deal with large nonlinear models. The concept of contextual model evidence is introduced and its link with causal attribution is stressed. It is then shown how contextual model evidence can be obtained as a side-product of the statistical inference performed for the assimilation of data. Three strategies are considered: DA-based ensemble forecasting, filtering and smoothing. The theoretical rationale of this approach is explained along with the advantages, drawbacks and limits of applicability of each strategy depending on the degree of instabilities of the underlying dynamics. The prominent features of a DA-based detection and attribution procedure are discussed. The proposal is illustrated numerically with low-order nonlinear models, and is compared with standard methods for detection and attribution showing promising performance. The convergence of the different DA-based estimates of the model evidence toward the unknown true value is explored numerically in some specific case.
The method stresses on the concept of model evidence, and open questions on how to compute and interpret the response to forcing whose effects one wants to contrast with respect to model error and other source of uncertainties. Practical obstacles that need to be addressed to make the proposal readily operational within weather forecasting centers are finally laid out.