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Titre: The unreasonable effectiveness of dimension reduction in complex geophysical flow modelling

Sous-titre: How to reduce the number of degrees of freedom of a complex model by a factor of 1000 or larger

Abstract:

Nowadays complex numerical models produce so huge an amount of real numbers that making sense of them, i.e. producing verbal interpretations of them, has become a challenging task. Post-processing methods are needed that reduce the amount of information to be submitted to the human being in charge of interpreting model results. In this respect, dimension reduction is an approach that is worth considering.

No theoretical developments about dimension reduction methods will be presented. Instead, four applications will be dealt with, which are all concerned with tracer transport in the sea. First, the Mururoa Atoll lagoon is reduced to a well-mixed box. The lagoon-averaged tracer concentration of this one-variable model compares very well with that of a complex, 3D model encompassing tens of thousands of variables. A somewhat similar approach is applied to the Prince William Sound, Alaska; in this case, a box and a pipe are seen to be necessary. Then, the ventilation of the World Ocean is idealised by a leaky funnel model, i.e. a semi-infinite pipe with porous walls, whose section is variable. Finally, the timescale to tracer equilibrium in the World Ocean is tackled with a complex model that can be idealised as a three-box model, yielding indications of importance for paleoclimate studies.

These examples illustrate the usefulness of dimension reduction as a tool for interpreting the results of complex models. That this tool is efficient is essentially due to the fact that the parameters of reduced-dimension models have a clear physical meaning.