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Variational data assimilation in NEMO using YAO.

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Data assimilation in ocean models (e.g. NEMO) is widely used to estimate initial conditions or constrain some parameters. Operational distributed products mainly use sequential assimilation technics. Other assimilation technics such as the 4D variational assimilation (4DVAR) should be developed to improve ocean products. 4DVAR is based on the minimization of a cost function that represents some distance between the background parameters, the observations and the output from the model. But the 4DVAR approach is still difficult to implement mainly because of some technical limitations: (i) the need of producing and maintaining a so-called adjoint code to compute the gradient of the cost function, (ii) the difficulties to optimize the computation in time and in memory for huge numerical codes. To solve these problems, some dedicated softwares were created to facilitate the implementation.

In this context, YAO is a software dedicated to the programming of numerical models. A numerical code is decomposed into a chain of modulus representing the different instructions. The modules are connected together by using graph formalism. Each modulus represents a function and its Jacobian; its inputs are connected to the outputs of the forward modulus. This approach allows us to construct very general systems in which some modulus may be represented by already existing programs. Running the graph forward represents the direct model; running it backwards and associating the different Jacobians represents the adjoint of the direct model. A simplified version of NEMO, the so-called Gyre configuration, was coded within the YAO framework. Twin variational data assimilation experiments showed the efficiency the YAO adjoint of NEMO. Due to the structure of YAO, a more complete version of NEMO can be easily implemented using YAO.