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OASIS4 at ECMWF – Coupling earth-system-component models to an operational numerical weather-prediction model

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We give an overview on current status and plans at ECMWF regarding the application of the coupling software OASIS4. OASIS4 will be applied to link ECMWFs integrated forecast system (IFS) (i) with an ocean model as part of the seasonal forecast activities and the MERSEA project and (ii) with chemical transport models (CTMs) as part of the GEMS project. The decision to use OASIS4 will be explained against the background of ECMWFs software development strategy. Practical experience gained during the implementation of OASIS4 and first performance results will be presented.

Improving forecast quality and long term predictability requires that numerical weather prediction takes into account the interaction of the atmosphere with ocean and land processes. Including trace gases and aerosols in weather prediction enlarges the portfolio of the medium range forecasts and re-analysis, making it possible to simulate the impact of atmospheric composition on dynamics, cloud formation or radiation.

At ECMWF, the two approaches of integrating and of coupling have been pursued to widen the scope of IFS. Integrating more processes by including improved routines in the model code is a successful strategy to increase the quality of the model. Within an integrated model, the new processes and variables can directly interact, and they can directly benefit from ECMWFs sophisticated 4D-VAR data assimilation system. Numerical techniques have been developed to simulate different processes on different

resolutions in order to save computational costs.

If integration seems to be not feasible, existing earth system component models can be two-way coupled to IFS. This kind of coupling requires a synchronous run of the models which delays the feedback, at least, by the time of the coupling interval. Two-way coupling is the obvious approach when the domains of the coupled model and IFS differ, but share a well defined 2D-boundary. This is the case in the current coupling between ocean models HOPE / OPA and IFSs by means of OASIS2.

Two-way-3D coupling between IFS and a CTM is applied in the GEMS subproject on Global Reactive Gases because the complexity of atmospheric chemistry simulations can hardly be integrated in IFS. Two-way-3D coupling is a more challenging concept because the CTMs and IFS cover partly the same spatial domain and include equivalent variables. These duplications and the feedback delay can cause inconsistencies, in particular when IFS is run in data assimilation mode within the coupled system.

In contrast to integration, the benefit of coupling is more flexibility in the choice of the coupled models. Further, coupling does not substantially increase the complexity of the IFS code, whose current size already requires a large code management effort.

The OASIS4 software allows effective 2D and 3D coupling based on direct communication between mpi - tasks. This performance advantage led to the decision to use OASIS4 as a common interface in IFS for coupling the ocean model OPA and the CTMs MOZART, MOCAGE and TM5. The prism team assists the implementation of OASIS4 at ECMWF and included the support of IFSs reduced Gaussian grid in OASIS4.