MERCATOR, developing an integrated system for operational oceanography

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ABSTRACT - MERCATOR, initiated by the french ocean community to develop operational oceanography, is motivated by the need of a global and permanent monitoring system of ocean dynamics, and the conviction that it is feasible now. The purpose is to bring into play a system able to simulate the global tridimensional ocean circulation (eddy-resolving PE model), assimilate satellite and in situ observations, and be used in a permanent and near-real-time mode to answer end-user research and operational applications. MERCATOR is a contribution to the Global Ocean Data Assimilation Experiment (GODAE).

1 - INTRODUCTION

MERCATOR is supported by all french agencies involved in oceanography : CNES (French Space Agency), CNRS/INSU (National Center for Scientific Research / Science of the Universe), IFREMER (French Institute of Research and Exploitation of the Sea), IRD (Research Institute for Development), Météo-France (French Meteorological Agency) and SHOM (Navy Hydrographic and Oceanographic Service) with a focal role given to CERFACS (European Center for Research and Advanced Training in Scientific Computation) to coordinate these join efforts.

From the project kick-off in early 1996, MERCATOR passed major high-level decision steps at national level : in September 1998, the supporting agencies validated the Feasibility phase conclusions and confirmed their common will to carry out the project through the Definition & Prototyping phase. Important collaborations were decided at european and international level ; since the very beginning, MERCATOR built close links with the GODAE experiment which is the privileged framework for international collaborations. At european level, common interest in developing initial ocean state for climate studies were identified between ECMWF and MERCATOR, and for North Atlantic basin mesoscale modelisation, MERCATOR and EuroGOOS agreed on the basis of a fruitful interaction through the EuroGOOS Atlantic Pilot Project (Le Provost).

2 - THE PROJECT MISSION

The purpose of the MERCATOR project is to develop an integrated system
- to simulate the global ocean circulation (high resolution Primitive Equations model)
- assimilate satellite and in situ data,
- be used in an operational mode.

MERCATOR will provide ocean long-term modelisation with data assimilation (hindcast mode) and near-real time ocean nowcast and forecasts to answer end-user application needs such as research, commercial or military ones, and will contribute to seasonal climate forecasting by developing the ocean component of coupled ocean/atmosphere systems.

MERCATOR covers the whole ocean monitoring chain, from ocean observations data handling to end-users products : the development of an integrated system with a routine and near-real time ability is the driving line. The data handling component deals with near-real time acquisition and

validation of ocean satellite and in situ observations. At modelisation & assimilation level, the end-objective is an eddy-resolving assimilating model covering the global ocean.
Project scheduling is based on the GODAE scheduling, with a target period in 2003-2005.

3 - PROJECT STATUS

The feasibility phase took place in year 1997 and 1998. This period lead to the definition of a development strategy based on an incremental approach, where the geographical coverage starts from the Atlantic basin to extend to the global ocean, and the assimilation scheme starts from optimal interpolation to evoluate towards more complex methods (adaptive filtering or variational schemes). Development tools were selected during this period : modelisation components will be based on the general ocean circulation OPA model (Madec, 1998) developed by LODyC ; assimilation strategy relies – as a starting point - on an improved version of the optimal interpolation SOFA scheme (De Mey, 1999) developed by LEGOS to assimilate altimetry, SST and vertical T&S profiles ; the driving unit of the system (algebric coupling concept) will be based on the PALM software developed by CERFACS ; the major observation dataset for assimilation will be given by near-real time altimetry (TOPEX/POSEIDON and ERS-2, then JASON1 and ENVISAT) and profilings floats (ARGO project, and its french CORIOLIS component).
Following this development strategy, two configurations were defined : a regional North Atlantic configuration including the Mediterranean sea, and a global ocean configuration. The regional North Atlantic component will focus on high resolution ocean depiction specially for mesoscale studies, and pre-operational applications such as French Navy, commercial or coastal ones. The global component aims at providing boundary conditions for the regional component and the best ocean state estimates for the scientific community, specially for climate studies.

The beginning of prototyping phase focussed on satellite & in situ observation data handling, and North Atlantic regional modelisation.
The MERCATOR data handling component have been working on near-real time altimetry in close collaboration with the DUACS project (CLS, Boone 1997), and put a special effort on in situ near-real time ability for profiling floats, XBT/CTD and surface drifters. Acquisition, validation and archiving facilities were developed for near-real time in situ data transmitted by the Global Transmission System (GTS). A sea experiment (POMMIER campaign : oct1999-oct2000) was decided to develop operational experience of ocean multi observation-based monitoring : a few profiling floats (PROVOR type) will be deployed in the investigation area (Eastern North Atlantic) to test pre-operational processing chain and the near-real time monitoring ability of the MERCATOR data component. Collaboration were set-up with the CORIOLIS french project for profiling floats deployment and validation, and the Eumetsat SAF-Ocean (Météo-France/Lannion) for sea surface temperature. Today the data component is able to provide an observation-based ocean monitoring with altimetry and in situ data ; combined observation products will be developed now with a special effort on quality assesment to prepare data assimilation.

The MERCATOR North Atlantic Modelisation component has been working on the development of a high resolution version (5 to 7 km horizontal resolution, 43 levels on the vertical) of the OPA model covering the North Atlantic basin and the Mediteranean sea, with assimilation with the SOFA scheme of altimetry, sea surface temperature and T&S vertical profiles. This ongoing work has been conducted in close collaboration with the french CLIPPER project (Treguier, 1999) involving LPO, LEGI, LODyC and LEGOS french oceanography laboratories. Clipper purpose is the interpretation of WOCE observations by carrying out model simulations of the Atlantic ocean circulation. The Clipper/Mercator community has today a range of low, middle and high resolution regional model configuration to conduct scientific and validation experiments. Modelling and

assimilation work will continue towards a fully validated high resolution configuration in North Atlantic and Mediterranean sea.

Specific work on the System architecture specification, conducted during years 1998 and 1999, enables at the same time the definition of a preliminary version of an integrated MERCATOR system. Main achievements in modelling, assimilation and data processing will be integrated in this demonstration and test platform for a near-real-time implementation in early 2001.

For the North Atlantic component, the POMME experiment (Reverdin, 1999) in 2001 is identified as a target period. This scientific experiment (ocean dynamics and biology) where in situ observations, satellite observations and assimilating models will be available will give a good opportunity to test at regional scale 'integrated' oceanography concepts ; MERCATOR will provide operational support to the scientific community involved. At basin scale, collaboration between MERCATOR and the european EuroGOOS Atlantic Pilot Project should give a major opportunity to go a step forward towards a real operational oceanography, with the validation of forecasting system performances and interfacing with user application systems.

Following its incremental approach, the project will now extend its effort to the global ocean component to build, in the GODAE perspective, a complete analysis and prediction ocean monitoring system.

4 - REFERENCES

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