NEMO Team Work Plan for 2009

Introduction

The 2009 workplan of the NEMO System Team is the combined result of the System Team expertise, the input from the NEMO community through the NEMO Developer's Committee, and the discussion during the NEMO Steering Committee. Briefly speaking, the NEMO system can be defined as a **shared**, **sustainable**, and **state-of-the-art** platform for research and operational oceanography. This definition provides three recurrent streams:

stream 1- "**shared**" = daily support to users, web & paper documentation, user interface.
stream 2- "**sustainable**" = inscribed in a long term perspective: well thought architecture and interfaces, and its continuous evolution.
stream 3- "**state-of-the-art**" = development/implementation of upgraded physics and numerics

This means that the system must be attractive to users and developers, *i.e* it must provides the best user and developer experience that we can have.

Each year, a stream 0, is added. Its subject corresponds to the more specific development of the year. In 2009 this stream is the "coupled ready" stream, *i.e.* the implementation of a generic interface to OASIS coupler in association with upgraded physics for global ocean configurations.

The document is structured as follows. First, the 2009 work plan and their associated four streams are briefly presented. Then, the road map is given, and a long-term perspective is evocated. The 2009 NEMO team human resources are presented in appendix A. The 2009 action tables are given in appendix B, and a brief description of each 2009 actions is given Appendix C.

* Work plan for 2009

Aside from the "usual" work of the NEMO team (user assistance, maintenance, bug correction, documentation/website updates, and system management), the work planned in 2009 has 4 streams. The first one (stream 0) is specific to 2009 and comes from both user and some of the consortium members, while the three other correspond to the usual streams:

Stream 0 : **"coupled ready".**

The object of this stream is to ensure that the whole system is "coupled ready". To precede the dead line of the next IPCC exercise, a validated generic coupling interface must be introduced in the system by the middle of 2009. This interface intends to be shared by all groups involved in coupled studies (IPSL, Met Office, GEOMAR-kiel, Meteo France, CERFACS, INGV, EC-Earth, …). In addition, the improvements in the physics of the global ocean that has been made in the research community during the last few years have to be offered to all users (see Stream 4.1). The actions of the stream are:

- Generic coupling interface including LIM3 (continuation and end)
- ORCA2-LIM based on NEMO (continuation & end)
- CICE interface to NEMO (continuation & end)

Stream 1 : User interfaces ("**shared**")

This is a continuing stream for which, in 2008, we have simplified the forcing interface (SBC module + on-the-fly interpolation) and the TOP interface. The major actions in 2009 will be to introduce an easy and efficient way to add/remove model output fields (new IOM for output) and the starting of 2 years work on a simplification of the new configurations settings (Configuration manager). The actions of the stream are:

- IOM for outputs (2 years, continuation &end)
- Configuration manager (2 years, start in 2009) (My_Ocean)
- Interface for other bio-models in TOP (3 years, started in 2008)
- TOP et LIM3 reference manual TOP (2009)
- Reference configurations (continuation)

Stream 2 : **Developer interfaces**. ("**sustainable**")

It consists first in simplifying the system by removing duplicated modules and obsolete options of the model (such as advection/diffusion modules for active and passive tracers, and rigid-lid option), and second, in cleaning the mpp library which is a necessary step prior to its adaptation to next generation of parallel computers. An important benefit of this stream is to optimize the whole system and as a consequence to have more time for developments. The actions of the stream are:

- Suppression of the rigid-lid option
- Merge of active and passive tracer advection/diffusion modules
- Timing and mpp cleaning (rewriting of mpp library)

Stream 4 : Developments & Implementation of new features. ("**state-of-the-art**")

Stream 4.1 : *Implementation of new features developed in the community*

It is of paramount importance to incorporate features developed in the NEMO community and identified as priorities by the Developer's Committee in order to improve the system and encourage further developments. The actions of the sub-stream are:

- Tidal mixing (Bessière 2007, Koch-Larrouy 2008, Koch-Larrouy et al 2008a,b,c)
- 3 bands light penetration + ocean colour (Lengaigne et al CD07, GRL08)
- Diurnal cycle on solar radiation (Bernie et al. 2007)

- Ice-shelf melting parameterisation (Wang & Beckmann AG07, PhD of P. Mathiot)
- Parameterisation of katabatic winds (PhD of P. Mathiot)
- Conservative Leap-Frog + Asselin filter (Leclair & Madec OM08)
- Observations operator code and increments application

Stream 4.2 : *short-term developments of new features by the consortium members*

It consists of the short-term developments associated with the priorities of each consortium members that will be incorporated into the system, as they can be useful for the user community. The actions of the sub-stream are:

- New forcing (Tidal potential, atmospheric pressure) and river input scheme (continuation & end)
- Embedding sea-ice inside the ocean (continuation & end)
- Revisit of mass and salt fluxes between ice, ocean and air (continuation & end)
- New advection schemes (PPM, Quickest and Prather)
- Lateral ocean physics (isoneutral operator, skew flux, Visbeck coefficients, slope limitation, Aiki formulation) (continuation & end)
- Ice improvements (momentum forcing, snow-ice formation, EVP rheology in LIM2)
- Improved s-coordinate option (hydrostatic pressure gradient computation, POLCOM-style s-coordinate) (continuation & end)
- Vertical physics: improvements of TKE scheme, addition of a Generic length scale model

Stream 4.3 : *long-term developments of new features by the consortium members*

It consists of the short-term developments associated with the priorities of each consortium members that will be incorporated into the system, as they can be useful for the user community. The actions of the sub-stream are:

- Revisit of the time stepping in TOP (2 years, start in 2009)
- Split-explicit + vvl conservative scheme (2 years, started in 2008)
- Inclusion of the effect of waves in the marginal ice zone (2 years, start in 2009)
- Toward a generalisation of the split-explicit free surface (2 years, start in 2009)
- Interface to the OASIS 4 coupler (2-3 years, ongoing, started in 2008)
- AGRIF and sea-ice (from 0 order to LIM2 and 3 fully AGRIFed) (3 years, started in 2008)
- Development of TAM (ANR VODA), with a major contribution from the LJK team (3 years, started in 2008)
- High parallelisation on new plateforms (GPU graphic cards, OpenMP etc …, start in 2009)

NB: Whereas the team at the Université Catholique de Louvain (UCL) that develop LIM is not a member of the consortium, it is the major developer of the sea-ice component. Therefore, it appears useful to provide their short- & long- terms work plan.

Louvain-la-Neuve (UCL) : LIM development

Short-term developments ("**state-of-the-art**") (expected in 2009)**:**

- Fine calibration of LIM3 at a 2° resolution using data assimilation techniques
- Incorporation of a representation of thin ice
- Test of different plastic yield curves and ice strength parameterizations

Long-term developments ("**state-of-the-art**") (will continue in 2010)**:**

- Coupling with a comprehensive snow model
- Development of a new sea ice rheology formulation
- New Ice rheology (2-3 years, started in 2008)
- Inclusion of sea ice biogeochemistry (1-3 years, start in 2009)

* 2009 Road map

The frequency of release of the system is about 2 per year. The overview of what is expected in each foreseen release of 2009 is:

Version 3.1 (end of Jjanuary 2009)

- All 2008 new features
- Almost all reported bugs and minor improvements
- Beta of the generic coupled interface

Version 3.2 (Jjune 2009) : the "coupled ready" tag (IPCC & co)

- Reported bugs and minor improvements
- Generic coupled interface
- New physics (including lateral mixing)
- IOM for output (including "IPCC" required/requested output)
- Embedded sea-ice + mass/salt fluxes

Version 3.3 (end 2009 or beginning 2010) :

- Reported bugs and minor improvements
- All remaining features developped in 2009

* Longer term perspectives

In addition to **#1 user interfaces** ("shared")
#2 developer interfaces ("sustainable")
#3 new features ("state-of-the-art")

In 2010, the focus would be on :

"**coastal ready**" = ready for coastal studies

- ALE coordinate
- s-coordinate ready
- configuration manager (regional and coastal configuration)
- equivalent of VIFOP for initialisation
- …

In 2011, the focus would be on :

"**Improved performances**" = on existing type of computer & toward new generation of computers

- Revisted mpp library
- Generalised free-surface, with optimised number of communication
- …

References:

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Wang, C. and A. Beckmann, 2007: Investigation of the impact of Antarctic ice-shelf meting in a global ice-ocean model (ORCA2-LIM)

Appendix A : Human ressources

Evolution of man power in 2009

- Christian Ethé (CNRS) : moved to permanent position (from 10 to 50% in NEMO team)
- End of contract for Romain Brusini (CNRS, development of the web site), replaced by Simona Flavoni (CNRS, 1 year) on the accessibility of reference simulations
- X (My_Ocean) – Post-Doc position for 2 years (configuration manager)
- Y (IsENES) – Post-Doc position for 2 years (ocean component for climate)

People involved

Name	Institution	%	Position
Yevgeny Aksenev	NERC-NOCS, Southampton	30	
Steven Alderson	NERC-NOCS, Southampton	20	
Rachid Benshila	LOCEAN-IPSL, Paris	100	
Clément Bricaut	Mercator Océan, Toulouse	50	Mercator NEMO officer
Andrew Coward	NERC-NOCS, Southampton	20	
Ian Culverwell	Met- Office, Exeter	230	
Laurent Debreu	LJK, Grenoble	10	
Yann Drillet	Mercator Océan, Toulouse	50	Mercator NEMO officer
Christian Ethé	LOCEAN-IPSL, Paris	50	
Simona Flavoni	LOCEAN-IPSL, Paris	100	CNRS-INSU 1 year contract
Christopher Harris	Met- Office, Exeter	20	
Richard Hill	Met -Office, Exeter	20	
Claire Lévy	LOCEAN-IPSL, Paris	100	NEMO project Manager and System Team Coordinator
Sébastien Masson	LOCEAN-IPSL, Paris	50	
Enda O'Dea	Met Office, Exeter	20	
Marie-Alice Foujols	IPSL, Paris	10	
Marina Lévy	LOCEAN-IPSL, Paris	10	
Gurvan Madec	LOCEAN-IPSL, Paris	30	NEMO Scientific Leader
Dave Storkey	Met -Office, Exeter	210	
Claude Talandier	LOCEAN-IPSL, Paris	100	
George Nurser	NERC-NOCS, Southampton	20	

Contributions by institution

Institution	Man-year	Nb of persons	Weeks/year
CNRS-INSU (France)	5,6	9	224
Met-Office (GB)	1	45	40
Mercator Océan (France)	1	2	40
NERC NOCS	1	4	40
European projects	2	2	80
TOTAL	10,6	21	424

Appendix B : Action Tables

The following table classifies the 2009 actions by system components, and the contributions of the partners.

Legend of table below:
P = NEMO Paris (including L. Debreu, LJK Grenoble)
E = NEMO Exeter
T = NEMO Toulouse
S = NEMO Southampton
O = Others contributors:
(1) = UCL Louvain La Neuve
(2) = POL
(3) = LPO Olivier Aumont
(4) = A. Vidard LJK Grenoble + Sophia-Antipolis
(5) = E. Maisonave CERFACS + A. Caubel IPSL
(6) = DFO, Canada

Action ending in 2009
Action planned to be pursued the next year
Recurrent action
Action that has been shifted from previous to next year

0. User supports

Description	Stream	2008				2009				P	E	T	S	O
User assistance										10	**-**	**-**	**-**	**-**
Online documentation										6	-	-	-	-
Regular bugfix										15	-	-	-	-
System management										4	1	1	1	1

1. All System components

Environment	Stream	2008				2009				P	E	T	S	O
Configuration manager	S1.3									40	-	-	-	-
ORCA2-LIM in coupled exp	S0.12									80	2	-	-	-
Reference configurations	S1.6									5	-	-	-	-
Input/Output														
Output with IOM	S1.1									32	-	-	-	-
Monthly Levitus files	S1											0.5		
Weekly forcing files	S1											0.5		
On-line diagnostics	S4.2											4		
NETCDF4	S1.2									-	-	-	8	-
Parallelism														
mpp cleaning+ timing	S3.3									8	-	-	-	-
High // on new plateforms	S4.3a									10	-	-	-	-

2. Surface modules

	Stream	2008				2009				P	E	T	S	O
Coupling interface inc. LIM3	S0.1									8	5	-	-	(5)
Interface to CICE	S0.3									-	5	-	-	-
Diurnal cycle	S4.1a									2	-	-	-	-
Atmos. pressure forcing	S4.2a									-	-	2	-	-
River input scheme	S4.2a									-	48	-	-	-

Mass & salt flux revisit	S4.2c							-	-	-	3	(1)
MEMO Bulk formulae	S4.2a							-	-	2	-	-

3. Ocean (NEMO-OPA)

Architecture	Stream	2008				2009				P	E	T	S	O
Merge of TRA and TRP	S2.2									6	-	-	-	-
Suppression of rigid-lid	S2.1									2	-	-	-	-
Schemes														
Generic time splitting	S4.3e									4	-	-	-	-
Improved OBC and BDY	S4.2c									-	-	24	-	-
Compatibility partial steps and variable volume	S4.2											2		
VVL + time splitting scheme	S4.3b									3	-	5	-	-
PPM, QCK, Prather schemes	S4.2d									4	-	2	-	-
Physics														
Tidal mixing	S4.1a									2	-	-	-	-
3 bands qsr + ocean color	S4.1a									2	-	-	-	-
Ice shelf scheme	S4.1a									4	-	-	-	-
Katabatic wind scheme	S4.1a									4	-	-	-	-
Conservative Leap-Frog	S4.1b									4	-	-	-	-
Skew flux + eiv coefficient	S4.2e									-	-	-	2	(2)
Isoneutral op. + slope limitor	S4.2e									-	3	-	6	-
Aiki lateral mixing	S4.2e									2	-	-	-	-
Generic length Scale, GOTM	S4.2g									-	-	10	-	-
Bottom friction	S4.2g									-	-	-	4	-
Tidal potential	S4.2a									-	-2	4	-	-
Hybrid S-sigma s-coord. assessmentinates	S4.2f									-	84	-	-	(2)
Horizontal pressure gradients	S4.2f									-	2	-	-	(8)
Targeted Shapiro filter	S4.2f									-	6	-	-	-

4. Sea-ice (NEMO-LIM)

Description	Stream	2008				2009				P	E	T	S	O
LIM3 reference manual	S1.5									1	-	-	1	(1)
C-grid rheology in LIM 2.0	S4.2c									-	-	5	-	(1)
LIM embedded in the ocean	S4.2b									-	-	-	3	-
AGRIF with NEMO-LIM	S4.3c									4	-	-	2	(6)
LIM3 improved thermo	S4.2c									-	-	-	9	(1)

5. Biogeochemistry (NEMO-TOP)

Description	Stream	2008				2009				P	E	T	S	O
TOP reference manual	S1.5									2	-	-	1	(3)
Revisit of TOP time stepping	S4.3a									4	-	-	-	(3)
Interface with bio-models	S1.4									4	-	-	-	(3)
Merge of TRP and TRA	S2.2									8	-	-	-	-
TOP Trends	S2.2									10	-	-	-	-

6. Assimilation – Adjoint (NEMOVAR & NEMOTAM)

Description	Stream	2008				2009				P	E	T	S	O
Observations operator code	S4.1c									-	2	-	-	-
Increments application	S4.1c									-	3	-	-	-
TAM dev.	S4.3d									6	-	-	-	(4)

TOTAL

Institutions	P	E	T	S
TOTAL nb of weeks:	**296/304**	**4035/40**	**33/40**	**40/40**

Appendix C : Detailed description of the 2009 actions

In this section we provide the list of the actions planned for 2009. They are regrouped into the 4 Streams. A colour convention is used to underline to place where the work will be mostly done:

- **LOCEAN = black**
- **NOCS = blue**
- **MERCATOR-ocean = red**
- **Met Office = Orange**

The reference to v3.2, v3.3 or even v3.4 means that the work is expected to be incorporated into the corresponding reference version, in other word that it has to be achieved by June 2009 (v3.2) or December 2009 (v3.3) or in June 2010 (v3.4) or latter (v3.X)

Stream 0 # "coupled ready"

- **S0.1 - Generic coupling interface including LIM3 (continuation and end)**

Object: Introduce in NEMO an OASIS interface that can be used with the main European atmospheric models (ARPEGE, ECHAM, HadAm, LMDz) and works with LIM2, LIM3 and CICE ice models.

Work: **(1)** achieve the generic coupled interface (5 w) **(v3.2)**
(2) adapt the interface to LIM3 (3 w) **(v3.2)**
(3) adapt the interface to HadGAM and CICE (5 w) (v3.2)

- **S0.2 - ORCA2-LIM based on NEMO** (continuation) (80w)

Provide to all groups starting coupled O/I/A simulations a reference set of forced experiments that document the effect of various physical package as well as the changes from the OPA8 to NEMO with respect to the ocean and ice components (and possibly PISCES).

Work : **(1)** Updated ORCA2-LIM2 configuration (bathy, CORE climatologic forcing) **(v3.2)**
(2) Updated physics for ORCA2-LIM2 (cf. S4.1 and S4.2e) **(v3.2)**
(3) ORCA2-LIM3 configuration **(v3.2)**
(4) CF compliance of all NEMO NetCDF outputs (2 w) (v3.2)
(4) Standard output for IPCC runs using IOM **(v3.2)**
(5) Standard plots using libIGCM library (IsENES) **(v3.3)**
(6) Reference forced simulations with a mean seasonal cycle over 2,000 years **(v3.3)**
(7) Reference forced simulations with a 1958-2004 interannual forcing. **(v3.3)**
(8) A series of runs (starting from the NEMO physics down to OPA8 physics not necessary all with both mean seasonal and interannual forcing. **(v3.3)**
(9) Web and paper documentations of the behaviour found **(v3.3)**
(10) Possibly reference experiment with other resolution (ORCA1, 05, 025…) **(v3.X)**
(11) Possibly reference experiment with ORCA2-LIM-PISCES **(v3.X)**

- **S0.3 - Interface to CICE** (5w)

Object: Introduce in the NEMO reference code an interface to CICE ice model.

Work: (1) document the interface and introduce it in NEMO (5 w) (v3.2)

Stream 1 # user interface ("shared")

- **S1.1 - IOM for outputs** (2 years, continuation &end)

Object: The strategy defined is built on the use of catalogues that are dynamically created and written once for all at the end of step. The temporal mean is no more performed in the IO library, but is done in NEMO. The write itself will use the new IOIPSL module, or a dimg module. There is many improvements associated with this strategy. One example, a call to iom_put (i.e. a write into a catalogue) can be done anywhere in the code. This will greatly improve the code readability and will allow easy output of local variable.

Work : (1) beta version expected in mid-February for the ocean (v3.2)
(2) Add a user-friendly interface (namelist or xml file) + a documentation (v3.2)
(3) introduce IOM in the other components (LIM, TOP) (v3.2)
(4) assessment of IOM behaviour on mpp computers (v3.3)

- **S1.2 - NetCDF4 IO options** (8w).

Object: NetCDF4 offers the opportunity to employ dataset chunking and compression algorithms to greatly reduce the volume of data written out by NEMO without any loss of precision. It also offers support for parallel file I/O via MPI-IO. The effectiveness of these two capabilities will be evaluated in a real application (ORCA025) and put in the reference if they are found useful. NB: require IOM to start

Work : **(1)** add support for NetCDF4 to IOM (2 w) **(v3.3)**
(2) test dataset chunking and compression algorithms (3 w) **(v3.3)**
(3) test parallel file I/O via MPI-IO (3 w) **(v3.3)**

- **S1.3 Configuration manager** (1.5 years, start in 2009) (My_Ocean)

Object: Create the configuration tools (CFG-tools): user-friendly interface, the tools, and the documentation associated to the creation of a new model configuration, and especially configurations defined as a zoom of an ORCA configuration. The tools include the generation of a grid, a bathymetry, an initial state, a forcing data set, and open boundary conditions. Manpower will be demanded in the My_Ocean FP7 European project (MCS) to build the tool.

Work: **(1)** collect the existing tools (OPABAT, ROMS-tools, etc
(2) Define the structure and implement a 1st version of the CFG-tools. **(v3.3)**

- **S1.4 - Interface for other bio-models in TOP** (3 years, started in 2008)

Object: Further improvement of the TOP interface with other bio-models.

Work: **(1)** TOP documentation **(v3.3)**
(2) simplify the overall TOP architecture together with TRA/TRP merge (w) **(v3.3)**

- **S1.5 - TRP et LIM3 reference manual**

Object: LIM and TOP (TRP) paper documentation using Latex (similar to the NEMO ocean engine documentation.

Work: **(1)** write TRP documentation (2 w) **(v3.3)**
(2) participate to the writing of LIM3 documentation realised at UCL (1 w) **(v3.3)**
(3) review of the TRP and LIM3 documentation by NOCS team (2 w) **(v3.3)**

- **S1.6 - Reference configurations** (continuation)

Object: Add new standard configurations to be used as NEMO tutorial, developer validation and benchmark purposes in order to illustrate the existing system potentiality.

Work: **(1)** illustration of the on-the-fly interpolation **(v3.3)**
(2) illustration of the different type of vertical coordinate **(v3.3)**
(3) illustration of AGRIF zoom with sea-ice **(v3.3)**
(4) illustration of off-line tracer computation **(v3.3)**

Stream 2 # Developer interface ("sustainable")

- **S2.1 - Suppression of the rigid-lid option**

Object: The rigid-lid option is obsolescent. It has to be removed from the system
Work : (1) remove key_dynspg_rl from OPA (DOM, DYN, DIA, OBC, BDY)
(2) remove the associated documentation.

- **S2.2 - Merge of active and passive tracer advection/diffusion modules**

Object: merge the passive and active advection-diffusion modules..
Work: (1) replace T and S 3D arrays by 4D arrays throughout the code (v3.3)
(2) put the 4D traceur as input argument of advection and diffusion routines. (v3.3)
(3) merge the TRC and TRA trend diagnostic module. (v3.X)

- **S2.3 - Preparing future evolution of mpp computing**

Object: Prepare further improvement of the model performance on mpp computers by revisiting the foundations of mpp and simplifying them.
Work: (1) Merge of inimpp and inimpp2 **(v3.3)**
(2 Creation of a mpp_sum giving the same results in single and multi-proc. runs. **(v3.3)**
(3) rewrite in a clean and simplified way the mpp library. **(v3.3)**

Stream 4 # Developments & Implementation of new features ("state-of-the-art")

Stream 4.1 *# Implementation of developments from the NEMO community:*

- **S4.1a - New physics for global ocean models**

Object: implementation of new ocean physics useful for global ocean models
Work: **(1)** Tidal mixing including ITF specificities **(v3.2)**
(2) 3 bands light penetration + ocean colour **(v3.2)**
(3) Diurnal cycle on solar radiation **(v3.2)**
(4) Ice-shelf melting parameterisation (coll. LEGI) **(v3.2)**
(5) katabatic winds parameterisation (coll. LEGI) **(v3.2)**

- **S4.1b - Conservative Leap-Frog + Asselin filter**

Object: Introduction of a modified leap-frog/Asselin filter time scheme in order to exactly conserve heat and salt contents in vvl case (required for embedding sea-ice in the ocean).
Work: (1) change in the time discretisation of the forcing term (v3.2)
(2) modification of the Asselin time filter (v3.2)

- **S4.1c - Observations operator code and increments application**

Object: toward a sharing of the outer loop of a data assimilation system + addition of a useful diagnostics for all users. Introduce the outer loop developed in the NEMOVAR projet.
Work: **(1)** observation operator module called by step **(v3.2)**
(2) module that add the increment of a data assimilation system **(v3.2)**

Stream 4.2 *# Short-term developments from the consortium members:*

- **S4.2a - New forcing**

Object: add new external forcing (tides, atmos. pressure, ECUME bulk formulea), an alternative scheme to introduce the river runoff and revised forcing at open boundaries (OBC)
Work: **(1)** Tide potential (3w) **(v3.2)**
(2) Improvement of OBC & BDY + documentation (1.5+1.5 w) **(v3.?)**
(3) ECUME bulk formulae introduced in sbcmod (1.5w) **(v3.?)**
(4) atmospheric pressure (1.5w) **(v3.2)**
(5) river input scheme (xx8 w) **(v3.2)?)**

- **S4.2b - Embedding sea-ice inside the ocean**

Object: introduce an sea-ice embedded into the upper ocean. More precisely 3 types of ice-ocean treatment: (a) old levitating sea-ice with virtual salt flux, (b) new levitating sea-ice with mass fluxes, and (c) fully embedded sea-ice. In addition, the mass and salt fluxes between ice-ocean and ocean-atmosphere are revisited and improved.

Work: **(1)** revisit of mass and salt fluxes (2 w) **(v3.2)**
(2) levitating sea-ice (a) and (b) cases (1 w) **(v3.2)**
(3) embedded sea-ice, (c) case (3 w) **(v3.2)**

- **S4.2c - Ice improvement**

Object: (a) Introduce the LIM3 EVP rheology as a option for LIM2 which has currently a VP rheology ; (b) Introduce floe-size dependent partitioning of the lateral and bottom melting of ice floes. Three cases will be considered: simple floe size distributions with constant floe calliper, one derived from ice breaking due to buckling, and ultimately a prognostic floe-size distribution; (c) introduce a snow-ice conversion which takes into account sea ice permeability.

Work: **(1)** C-grid rheology in LIM 2 (4w) **(v3.2)**
(2) simple floe size distribution **(v3.3)**
(3) snow-ice conversion **(v3.X)**

- **S4.2d – Advection scheme**

Object: (a) introduce 2 new advection scheme: QUICKEST and Prather.

Work: **(1)** PPM advection scheme and documentation of QUICKEST (1.5 w) **(v3.?)**
(2) Prather advection scheme **(v3.4)**

- **S4.2e – Lateral ocean physics**

Object: Introduce modern schemes to represent lateral ocean physics: Griffies iso-neutral operator that ensures the decrease of the variance of the field on which it is applied ; faster by still accurate equation of state ; skew flux formulation for Eddy Induced Velocities (eiv) ; Visbeck coefficients for the isopycnal thickness diffusion coefficient ; Aiki eddy parameterisation ; examination of the model sensitivity to different options for tapering the isopycnal slopes at the ocean surface and bottom and decide which options to make available in the reference code.

Work: **(1)** Griffies iso-neutral operator (3 w) **(v3.2)**
(2) Skew flux scheme (2 w) **(v3.2)**
(3) new equation of state **(v3.?)**
(4) Visbeck coefficients **(v3.?)**
(5) sensitivity to slope tapering (3 w) **(v3.3)**
(6) Aiki eddy effect parameterisation (2w) **(v3.2)**

- **S4.2f – s-coordinate assessement**

Object: Improved s-coordinate option (hydrostatic pressure gradient computation, POLCOM-style s-coordinate).

Work: **(1)** introduce a POLCOM-style s-coordinate **(v3.2?)**
(2) assessment of the existing horizontal pressure gradient schemeschemes **(v3.2?)**
(3) introduction of POLCOM-style best pressure gradient scheme **(v3.2?)**

- **S4.2g – Vertical physics**

Object: The vertical physics will be improved in three aspects: (a) introduction of the Generic Length Scale (GLS) turbulent close model (Umlauf and Bruchard 2003) which allow a large choice of 2 equations turbulent closure model (Mellor-Yamada, k-epsilon, k-Ω) with various stability function. Examination of the model sensitivity to different options for the surface and bottom boundary condition. Decision about which options to make available in the reference code with which default parameters. (b) Introduce in 1d_cfg of the GOTM suite of turbulence schemes which provide a wide range of options and test cases for LOTUS,

PAPA and TOGA-COARE data. (d) correction of an error in the formulation of the bottom friction and addition of this friction as a bottom boundary condition on TKE scheme

Work: **(1)** introduction of GLS scheme (6 w) **(v3.?)**
(2) assessment of the different turbulent closure (3 w) **(v3.?)**
(3) study of the surface and bottom boundary condition (w) **(v3.?)**
(4) GOTM implementation for 1D configuration + test cases (w) **(v3.?)**
(4) bottom friction and TKE botton boundary condition (4 w) **(v3.?)**

- **S4.2g – Grid scale noise filter**

Object: There has been a noticeable amount of grid scale noise in some NEMO models. The objective will be to introduce a filter that removes grid scale noise whilst allowing wave-like propagation through the system.

Work: **(1)** Implementation and testing of a targeted Shapiro filter (6w) (v3.3)

Stream 4.3 *# long-term developments from the consortium members*

- **S4.3a - Revisit of the time stepping in TOP** (2 years, started in 2009)

Object: (a) careful examination of the time stepping associated with all the terms of the TOP component. (b) introduction of alternative time stepping. (c) introduction of a clean interface between TOP and OPA-LIM with possibility of using larger time-step in TOP with OPA providing mean quantities.

Work: **(1)** examination of alternative time stepping (2 w, coll. LPO) **(v3.3)**
(2) implementation of a first revised time stepping **(v3.3)**

- **S4.3b – Conservative split-explicit non-linear free surface** (2 years, started in 2008)

Object: Insure an exact tracer conservation when using the split-explicit non linear free surface (key_dynspg_flt and key_vvl). Two different solutions will be investigated: (a) try to modify the existing algorithm and (b) implement the scheme used in POM or SYNPHONIE ocean model (NB: they both require to update first the dynamics and then tracer).

Work: **(1)** approach (a) (3 w) **(v3.3)**
(2) approach (b) (5 w) **(v3.4)**

- **S4.3c - AGRIF and sea-ice** (3 years, started in 2008)

Object: offer the capability of having an AGRIF zoom in areas where sea-ice exists. Three solutions will be investigated: (a) simplest way: sea-ice fluxes are interpolated onto the child domain ; (b) VP rheology: as done at DFO. (c) EVP rheology: AGRIF implementation similar to the one used for split-explicit free surface.

Work: **(1)** implementation of solution (a) **(v3.X)**
(2) implementation of solution (b) **(v3.X)**
(3) implementation of solution (c) **(v3.X)**

- **S4.3d - Development of TAM** (3 years, started in 2008) (ANR VODA)

Object: development of the Tangent and Adjoint Model (TAM) of NEMO.

Work: **(1)** write the linear tangent model of OPA **(v3.4)**
(2) write the Adjoint model of OPA **(v3.X)**
(2) create tutorial, test cases and reference experiment **(v3.X)**

- **S4.3e - HPC on new platforms** (3 years, start in 2009)

Object: Survey of the evolution of computer architecture (10,000 and more processors, GPU graphic cards, etc.) and of the work done in IsENES.

Work: **(1)** Survey of computer evolution
(2) Generalize and optimize the split-explicit free surface **(v3.4)**
(3) introduce a domain decomposition specific to sea-ice **(v3.X)**