NEMO assimilation component development strategy

A. VIDARD, F. VIGILANT

Project:
NEMOVAR development

INRIA-LJK

April, LOCEAN, 2009

plan

1. Tangent - Adjoint Module (TAM)
   - Reminder
   - Methodology
   - Status and Issues
2. Development Organization
   - Within NEMOVAR
3. Planning
   - NEMO - NEMOTAM "Release"
   - ANR delivery

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The Direct Model

The NEMO model is an algorithm and it can be seen as a function $\mathcal{H}$. $\mathcal{H}$ is compound of different K steps (routines e.g) $\mathcal{H}_p$ ($p \in (1, \cdots, K)$), such as:

direct model algorithm

$$\mathcal{H} = \mathcal{H}_K \circ \mathcal{H}_{K-1} \circ \cdots \circ \mathcal{H}_1 \quad (1)$$

where $\mathcal{H}_p$ is the p^{th} steps.

We define a model reference $\mathcal{H}^{Ref}$. as the core model as a start to develop the TAM.

TAM

With $\mathbf{H}$ the linearised (derivated?) model of $\mathcal{H}^{Ref}$., we have:

linear model algorithm

$$\mathbf{H} = \mathbf{H}_K \circ \mathbf{H}_{K-1} \circ \cdots \circ \mathbf{H}_1 \tag{2}$$

TAM development is:

- write the (derivated) step $\mathbf{H}_p$ of the direct step $\mathcal{H}_p$
- write the corresponding adjoint step $\mathbf{H}_p^*$ (and test it !!)
- compose $\mathbf{H}$ and $\mathbf{H}^*$ (and re-test the adjoint !!)
- Check that the backward integration gives access to the correct Cost Function Gradiant

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Active - Passive variables

The first step is identified Active from Passive variables. Active variables are linked the control and have an influence on the cost function.
Remind that we (may) need access the value of active variables computed with the direct model. Some approximations are done here as considering some active variables as passive (slow evolution e.g).
Active variables considered as passive list:

- uslp, vslp, wslp, avmu, avmv, hlmp

Derivation

No specific issue as long as:

- active variables are identified
- IN and OUT variables are identified

Adjoint

The adjoint code of **3** consecutive blocks ***A***, ***B*** and ***C***:

$$\boldsymbol{A} \longrightarrow \boldsymbol{B} \longrightarrow \boldsymbol{C} \tag{3}$$

is:

$$\boldsymbol{A}^* \longleftarrow \boldsymbol{B}^* \longleftarrow \boldsymbol{C}^* \tag{4}$$

but,
some care must be taken as $\boldsymbol{C}^*$ may need "initial" data as they are before been computed through ***A*** (and/or ***B***)

Adjoint Test

To test the adjoint we compute the following:

$$< \boldsymbol{M}\boldsymbol{x} \, , \, \boldsymbol{y} > \quad = \quad < \boldsymbol{x} \, , \, \boldsymbol{M}^{*}\boldsymbol{y} > \tag{5}$$

In practise, we analyze the perturbated output $\delta \boldsymbol{y}$ of an pertubated input $\delta \boldsymbol{x}$. Thus, we have:

$$< \boldsymbol{M}\delta\boldsymbol{x} \, , \, \delta\boldsymbol{y} > \quad = \quad < \delta\boldsymbol{x} \, , \, \boldsymbol{M}^{*}\delta\boldsymbol{y} > \tag{6}$$

- generate $\delta \boldsymbol{x}$ randomly
- initialize all adjoint variables
- compute $\boldsymbol{M}\delta\boldsymbol{x}$ and then $\boldsymbol{M}^{*}\delta\boldsymbol{y}$
- compare both scalar product

Direct Module

TAM Module

$\mathcal{F}(kstp, \mathcal{X}_i)$

Tangent Routine
$F(kstp, \mathcal{X}_i, X_i^{TL_{IN}}, X_j^{TL_{OUT}})$

Adjoint Routine
$F^{AD}(kstp, \mathcal{X}_i, X_j^{AD_{IN}}, X_i^{AD_{OUT}})$

Test Routine
$TF(kstp, \mathcal{X}_i, X_i^{TL_{IN}}, X_j^{TL_{OUT}}, X_j^{AD_{IN}}, X_i^{AD_{OUT}})$

Figure: Direct and TAM module

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Status

- list of options not available: Bulk, OBC, Agrif, BDY, VVL, zdf, trabbl, esopa, (diag)
- paralelization routines "should" work like the ones in the direct model
- Most of individual routines $\mathbf{H}_{\boldsymbol{p}}^{\boldsymbol{AD}}$ are tested and passed
- Currenlty debugging *STEP_TAM.F90* ($\equiv \mathbf{H}^{\boldsymbol{AD}}$)

Status

Not available TAM routines:

- dyn: adv_cen2, adv_ubs, ldf_iso, ldf_bilap, ldf_bilapg, dynspg_exp, dynspg_ts
- tra: adv_tvd, adv_muscl, adv_muscl2, adv_ubs, adv_qck, ldf_bilap, ldf_bilapg

Not available TAM options:

- dyn_vor_ene, dyn_vor_een, dyn_vor_mix, key_ldf_ano
- hpg_sco, hpg_hel, hpg_wdj, hpg_djc, hpg_rot

Issues

- I/O module: behaviour of iom.F90 when "REDEF" instruction is needed (writing in an existing file)
- trajectory saving in the direct model (in ASM directory)
- ***ta*** and ***sa*** are used as workspace before writing the trajectory :(
- ? dia_wri ?

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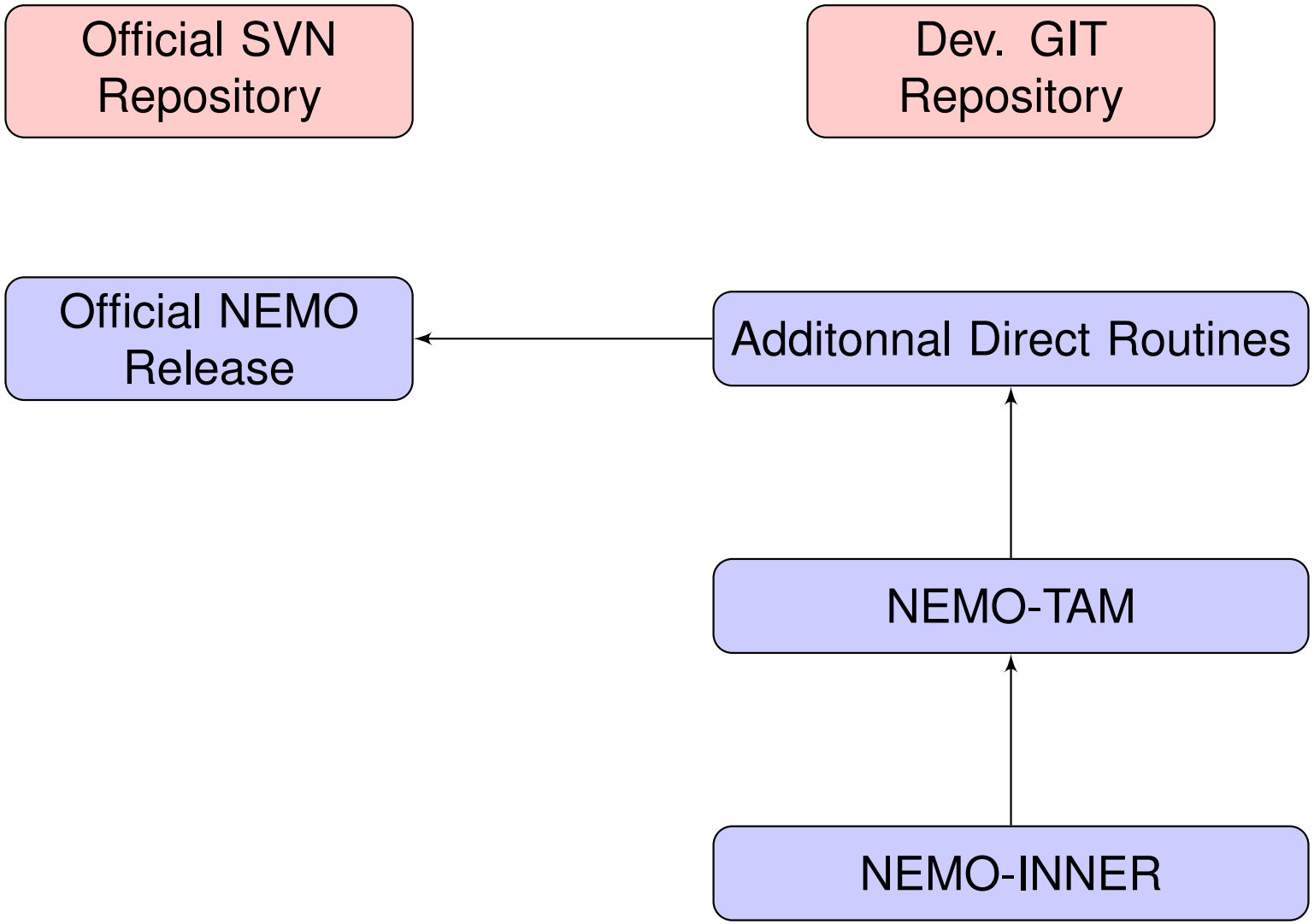

Figure: NEMO-NEMOVAR

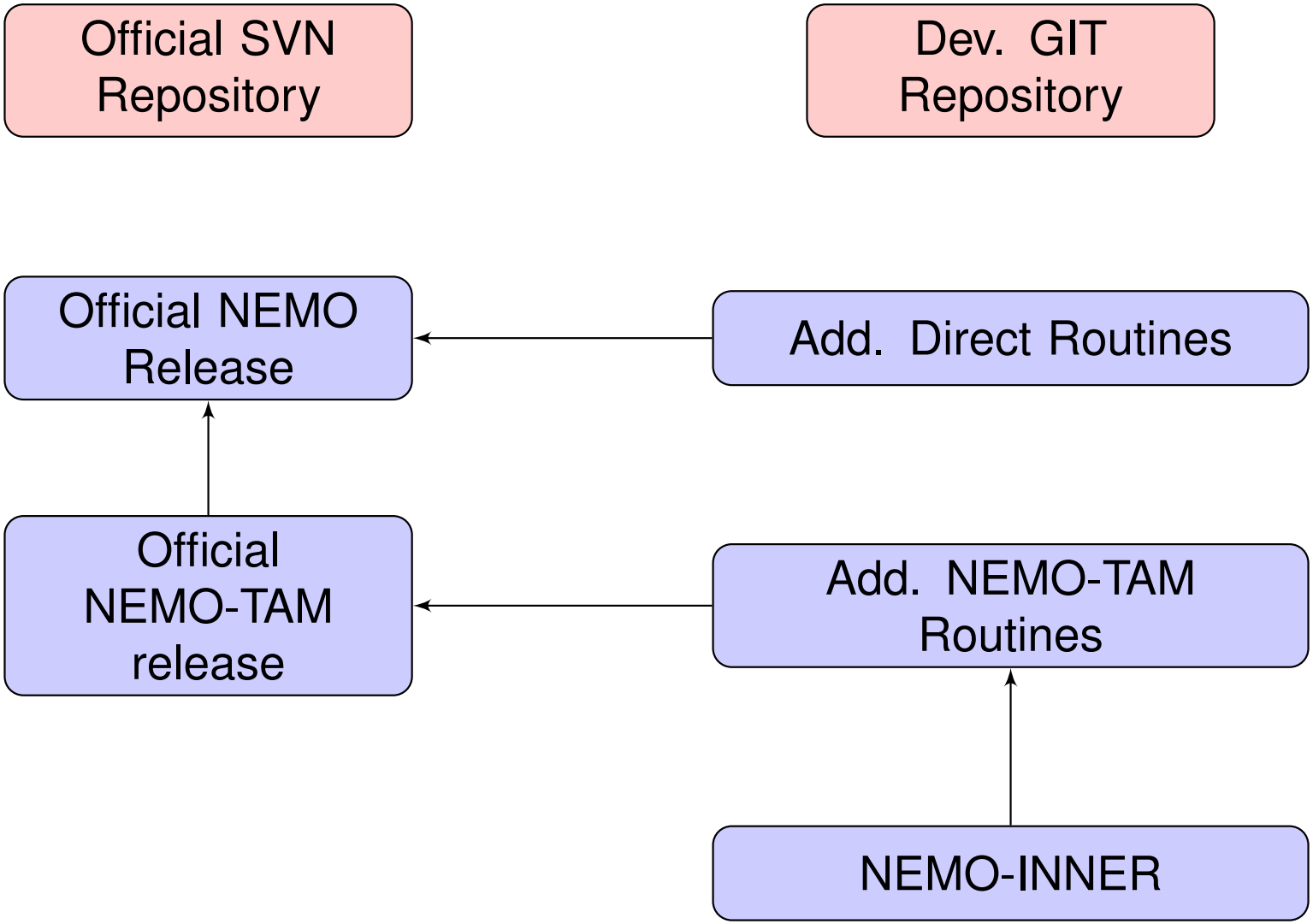

Figure: NEMO-NEMOVAR

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