XIOS in INCA
Implementation and how to use

Inca How To – 4 novembre 2015

Implementation in INCA

- Implementation in INCA5 (LMDZORINCA_v6)
- Results validated against IOIPSL output at curie.

- In INCA :
  - src/INCA_PARA/**xios_inca.F90** : One module doing all interfacing to XIOS
  - **src/INCA_XML/** : new directory in INCA containing xml files for running with XIOS
  - New parameter **XIOS=y/n** in inca.card (linked with **XIOS_INCA_OK** in inca.def) to activate running with XIOS

xios_inca_send_field

```
USE XIOS_INCA

(…)
REAL, INTENT(in) :: pmid(PLON,PLEV)
REAL, INTENT(in) :: area(PLON)
(…)
CALL xios_inca_change_context("inca")
(…)
CALL xios_inca_send_field(“pmid”, pmid)
CALL xios_inca_send_field(“area”, area)
(…)
CALL xios_inca_change_context("LMDZ")
```

Syntax: **CALL xios_inca_send_field(field_id, field)**

field_id: a unique identifier, the same id is set in the field definition in parameter file field_def_inca.xml which must be present at run time
CHARACTER(len=*)

field: the variable to send to XIOS. The variable size is “PLON”, it can have one supplementary axis: presnivs (PLON,PLEV)

xios_inca_change_context : indicate to the run that we are now working with inca context (and variables defined for inca) and then we return to lmdz context

xml parameter files

To run INCA with XIOS all diagnostic output files are configured through xml files.
Following 4 files needs to be present at each execution :

- iodef.xml — Main input file for XIOS
- context_inca.xml — Axis and domain information, include field and file def
- field_def_inca.xml — Definition for each variable send from INCA
- file_def_inca.xml — Definition of all output files and there variables

And in inca.card : XIOS=y (→ in inca.def : XIOS_INCA_OK=y)

The above xml file are stored in INCA/src/INCA_XML/ directory.

xml parameter files

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- field_def_inca.xml — Definition for each variable send from INCA

- **file_def_inca.xml** → **Specify all output files and there variables**
  → Change to set your output level
  → Remove variables, change levels, change freq...

And in inca.card : XIOS=y (→ in inca.def : XIOS_INCA_OK=y)

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xml parameter files

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Follwing 4 files needs to be present at each execution :

- iodef.xml Main input file for XIOS
- context_inca.xml Axis and domain information, include field and file def
- **field_def_inca.xml => Definition for each variable send in INCA**
  => Only change if added new variable in INCA
- **file_def_inca.xml => Specify all output files and there variables**
  => Change to set your output level
  => Remove variables, change levels, change freq...

And in inca.card : XIOS=y (→ in inca.def : XIOS_INCA_OK=y)

The above xml file are stored in INCA/src/INCA_XML/ directory.

3- field_def_inca.xml

```
<field_definition id="inca" domain_ref="dom_chem" level="1" prec="4" operation="average" freq_op="1ts" enabled=".TRUE.">

 <field_group id="common_variable">
   <field id="pmid" axis_ref="presnivs"  name="pmid" long_name="mid-level air pressure" standard_name="mid_level_air_pressure"   unit="Pa"/>
   <field id="temp"  axis_ref="presnivs" name="temp" long_name="temperature model level" standard_name="mid_model_level" unit="K"/>
   <field id="h2o"  axis_ref="presnivs" name="mmrh2o" long_name="water Mass Mixing Ratio" standard_name="mass_fraction_of_h2o_in_air" unit="kg kg-1"/>
   <field id="ps" name="ps" long_name="surface air pressure" standard_name="surface_air_pressure"  unit="Pa"/>
   <field id="area" operation="once" name="area" long_name="area of gridbox" standard_name="area_grid_box" unit="m2"/>
   <field id="pdel" axis_ref="presnivs"  name="pdel"  long_name="pressure difference model level"  standard_name="pressure_difference_model_level" unit="K"/>
 </field_group>


 <field_group id="aerosol" enabled=".TRUE.">
   <field id="Rn222" axis_ref="presnivs" name="mmrrn222" long_name="radon222 Mass Mixing Ratio" standard_name= "mass_fraction_of_radon_222_in_air" unit="kg kg-1" />
   <field id="Pb210" axis_ref="presnivs" name="mmrpb210" long_name="Pb210 Mass Mixing Ratio" standard_name=
"mass_fraction_of_lead_210_wet_aerosol_particles_in_air" unit="kg kg-1" />
   <field id="SO2" axis_ref="presnivs" name="mmrso2" long_name="SO2 Mass Mixing Ratio" standard_name="mass_fraction_of_sulfur_dioxide_in_air" unit="kg kg-1" />
   <field id="H2S" axis_ref="presnivs" name="mmrh2s" long_name="H2S Mass Mixing Ratio" standard_name="mass_fraction_of_hydrogen_sulfide_in_air" unit="kg kg-1" />
   <field id="DMS" axis_ref="presnivs" name="mmrdms" long_name="DMS Mass Mixing Ratio" standard_name="mass_fraction_of_dimethyl_sulfate_in_air" unit="kg kg-1" />
(…)
</field_group>
```

Several groups already defined :

- common_variable → always in output
- ges → only in GES config
- aerosol → only in AER and NMHC_AER config
- chemistry → only in NMHC_AER config
- forcage → only in AER and NMHC_AER config (need to be done)
- (soon : vegetation → only in NMHC_AER with ORCHIDEE coupling)

These restrictions are defined in src/INCA_PARA/xios_inca.F90

3- field_def_inca.xml

```
<field_definition id="inca" domain_ref="dom_chem" level="1" prec="4" operation="average" freq_op="1ts" enabled=".TRUE.">

  <field_group id="common_variable">
    <field id="pmid" axis_ref="presnivs"  name="pmid" long_name="mid-level air pressure" standard_name="mid_level_air_pressure"   unit="Pa"/>
    <field id="temp"  axis_ref="presnivs" name="temp" long_name="t                                  "mid_model_level" unit="K"/>
    <field id="h2o"  axis_ref="presnivs" name="mmrh2                                  ion_of_h2o_in_air" unit="kg kg-1"/>
    <field id="ps" name="ps" long_name="s
    <field id="area" operation="once"
    <field id="pdel" axis_ref="p                                                      el" unit="K"/>
  </field_group>


 <field_group i
    <field id="                                                                      kg kg-1" />
    <field id=
"mass_fra
    <field i                                                                          >
    <field i                                                                         L" />
    <field i                                                                         -1" />
(…)
</field_grou
```

Definition for each variable send in INCA

- one line per variable

Only change if you added new variables in INCA

Does not control output files

DO NOT REMOVE VARIABLES FROM HERE

This file is stored with the model source code in src/INCA_XML/ because it is closely related to the version of the code.

4- file_def_inca.xml

```
<file_definition>
 <file id="common" name="inca_common_xios" output_freq="1d" enabled=".TRUE.">
   <field field_ref="pmid" />
   <field field_ref="temp" />
   <field field_ref="h2o"  />
   <field field_ref="ps"   />
   <field field_ref="area"   />
   <field field_ref="pdel"   />

 </file>

 <file id="aero" name="inca_aero_xios" output_freq="1d" enabled=".TRUE.">
          <field field_ref="OD443_CIDUSTM" />
          <field field_ref="OD550_CIDUSTM" />
          <field field_ref="OD670_CIDUSTM" />
          <field field_ref="OD765_CIDUSTM" />
          <field field_ref="OD865_CIDUSTM" />
          <field field_ref="OD443_CINO3M" />
          <field field_ref="OD550_CINO3M" />
          <field field_ref="OD670_CINO3M" />

(…)
 </file>
(…)
</file_definition>
```

Several output files already defined :

- *inca_common_xios.nc*
- *inca_forcage_xios.nc*
- *inca_aero_xios.nc*
- *inca_chem_xios.nc*
- *inca_emi_xios.nc*
- *inca_dvel_xios.nc*
- *inca_washrate_xios.nc*
- (soon : *inca_veget_xios.nc*)

Add a new variable in INCA

1) Add in the INCA module where the variable is calculated:

```
CALL xios_inca_send_field(“newid”,new_var)
```

2) In field_def_inca.xml, add declaration of the variable

3) In file_def_inca.xml : add the variable in all files where you want to write it

Exemple to add a variable only on surface :

1) `Call xios_inca_send_field(“O3surf”, o3(:,39))`

2) In field_def_inca.xml, add declaration of the variable :

```
<field id="O3surf" name="xxx" long_name="xxx" unit="xxx"/>
```

3) in file_def_inca.xml : add the variable in all files where you want to write it.

Create new variable from existing in field_def_inca.xml

=> Possiblity to add operation: maximum, minimum, once, accumulate

=> Possibility to create new variables from an existing variable, using attribute field_ref

Example:
The variable with id=Var1 is send in INCA. Using this variable as reference, 2 new variables are defined in field_def_inca.xml.

<field **id="Var1"** name="var" long_name="variable one" unit=""/>

<field **id="Var1_max"** name="var_max" **field_ref="Var1"** long_name="Maximum variable one" unit="" **operation="maximum"**/>

<field **id="Var1_min"** name="var_min" **field_ref="Var1"** long_name="Minimum variable one" unit="" **operation="minimum"**/>

Create new variable from existing in field_def_inca.xml

=> Possibility to add or extract a scalar to a variable

In INCA

CALL xios_inca_send_field("Var1",var1)

CALL xios_inca_send_field("Var2",**Var1-360**)

In field_def_inca.xml:

<field id="Var1" name="var1" long_name="variable one" unit=""/>

<field id="Var2" name="var2" long_name="variable two" unit=""/>

Or second method :

In INCA

CALL xios_inca_send_field("Var1",var1)

In field_def_inca.xml:

<field id="Var1" name="var1" long_name="variable one" unit=""/>

<field id="Var2" name="var2" long_name="variable two" unit=""/> **Var1-360 </field>**

Control output

How can I change the name for a variable?

- In file_def_inca.xml to change only for one specific file or in filed_def_inca.xml if you want to change in all output files

How can I change the long_name for a variable?

- As for the variable name, see above

How do I know if a variable is averaged, instant, min or max?

- See field_def_inca.xml. The default is average.

How can I write instant variables?

- Option 1) set output_freq=1ts in file_def_inca.xml for one file. You'll then have output at each time step.
- Option 2) set operation=instant on the file description line, in file_def_inca.xml

→ For example operation=”instant” + output_freq=”1d”, once a day the instant variables will be written.

Control output

How can I change the frequency of an output file?

- Change output_freq on the line description for the file

How can I create a new output file?

- Open file_def_inca.xml and add a new file section.

Using LMDZORINCA_v6 configuration

config.card:
- There is a new component IOS (for XIOS)
- Set number of cores MPI for each executable with 1MPI for the xios server.

```
#===========
#D-- Executable -
[Executable]

ATM= (gcm.e, gcm.e, 32MPI, 4OMP)
SRF= ("", "")
SBG= ("", "")
CHM= ("", "")
IOS= (xios_server.exe, xios.x, 1MPI)
```

Output are concatenated during the simulation on process allocate to xios
→ There is no more rebuild (or in certain case an empty job)