Arpège/IFS in OOPS Framework

- 3D-Var demonstration of IFS in OOPS
- OOPS Framework calls IFS Fortran
- State for IFS
- Observation Operator
- J_B modularisation
- Cleaning and reorganisation for Cycle 38
- New Scalability opportunities
- IFS Fortran plugs into OOPS

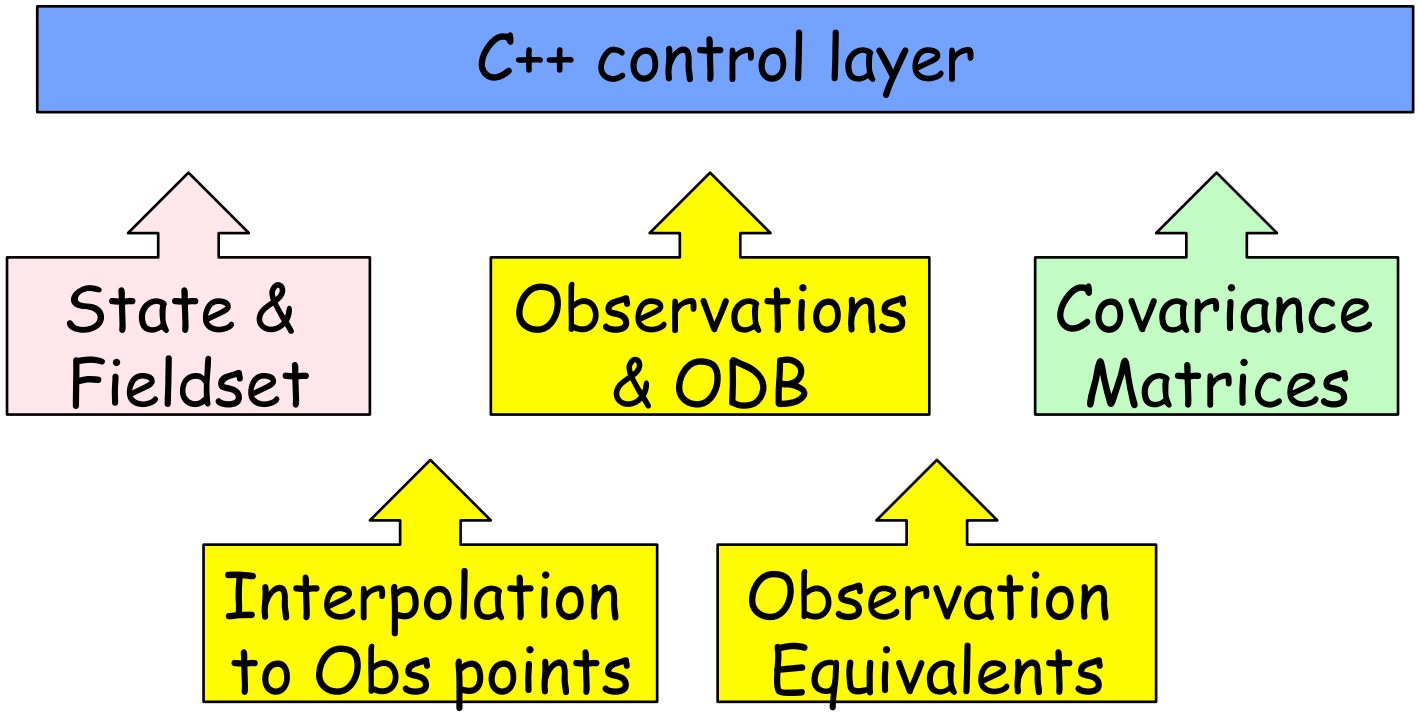
Yannick Trémolet, Mike Fisher, Anne Fouilloux, John Hague,
Tomas Wilhelmsson, George Mozdzynski, Mats Hamrud,
Karim Yessad, Jean-Noël Thépaut and Deborah Salmond

Warning …
Work-in-Progress

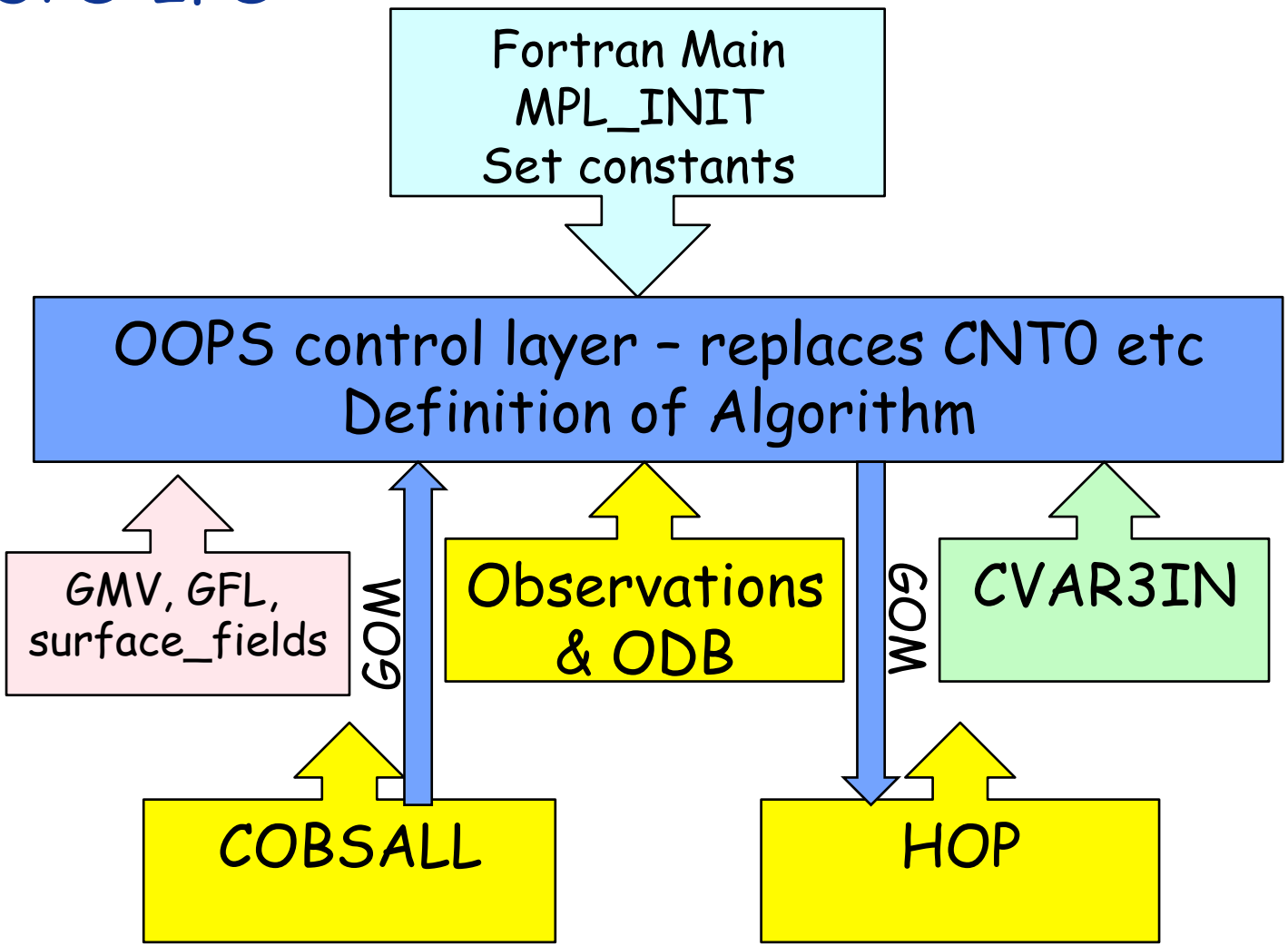
3D-Var demonstration of IFS in OOPS

- 3D-Var will be the first milestone of the OOPS project to demonstrate how parts of the IFS can be extracted and plugged in to the OOPS control layer
- Model is not needed for 3D-Var – need State/Fieldset
- Work with One Observation type (AMSU-A) with vertical interpolation in RTTOV
- Most of the work in the Fortran code is to be included in (and improve) the Arpege/IFS cycles
- Minimise changes to low level IFS code

Proposed OOPS-Framework



OOPS-IFS


Fortran Main
MPL_INIT
Set constants
OOPS control layer – replaces CNT0 etc
Definition of Algorithm
GMV, GFL,
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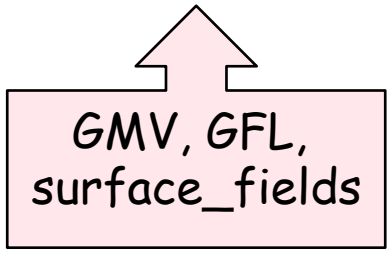
Observations
& ODB
GOM
CVAR3IN
COBSALL
HOP

IFS Fieldset

Tomas

Derived Types for IFS Fieldset:

```
type :: ifs_fields
  type(ifs_geometry_type)    :: geom
  type(type_yomgmv)          :: gmv
  type(type_yomgfl)          :: gfl
  type(type_yom_ygfl)        :: ygfl
  type(type_surface_fields)  :: surf
end type ifs_fields
```




```
TYPE :: TYPE_YOMGFL
PRIVATE
REAL(KIND=JPRB),POINTER :: GFL         (:,:,:,:) => NULL()
REAL(KIND=JPRB),POINTER :: GFLT1       (:,:,:,:) => NULL()
REAL(KIND=JPRB),POINTER :: GFLSLP      (:,:,:,:) => NULL()
REAL(KIND=JPRB),POINTER :: GFL5        (:,:,:,:) => NULL()
REAL(KIND=JPRB),POINTER :: GFL_DEPART  (:,:,:,:) => NULL()
REAL(KIND=JPRB),POINTER :: GFLPT       (:,:,:,:) => NULL()
REAL(KIND=JPRB),POINTER :: GFLPC       (:,:,:,:) => NULL()
END TYPE TYPE_YOMGFL
etc.
```

IFS Geometry object

List of IFS Modules with geometry information:

```
yomcver   Variables for vertical finite elements
yomdim    Dimensions of model working arrays
yomgc     Grid point boundaries
yomgem    NGPTOT, transformed sphere, vertical coords
yomlap    Constants related to the Laplace space
yomleg    Description of Legendre polynomials
yommp     Distributed memory parallelization
```

Or from Karim's OOPS Action Cleaning document:

```
hdim_mod     Horizontal dimension variables
vdim_mod     Vertical dimension variables
Etc.
```

Multiple instances of data in IFS MODULES

```
MODULE YOMGFL
SAVE
REAL, POINTER :: GFL(:,:,:,:)
INTEGER       :: NSCALAR
LOGICAL       :: LFLAG
TYPE :: TYPE_YOMGFL
  PRIVATE
  REAL, POINTER :: GFL(:,:,:,:)
  INTEGER       :: NSCALAR
  LOGICAL       :: LFLAG
END TYPE TYPE_YOMGFL
CONTAINS

SUBROUTINE SET_YOMGFL(T)
TYPE(TYPE_YOMGFL), INTENT(IN) :: T
  GFL     => T%GFL
  NSCALAR = T%NSCALAR
  LFLAG   = T%LFLAG
END SUBROUTINE SET_YOMGFL
```

```
SUBROUTINE SAVE_YOMGFL(T)
TYPE(TYPE_YOMGFL), INTENT(OUT) :: T
  T%GFL     => GFL
  T%NSCALAR = NSCALAR
  T%LFLAG   = LFLAG
END SUBROUTINE SAVE_YOMGFL

END MODULE YOMGFL
```

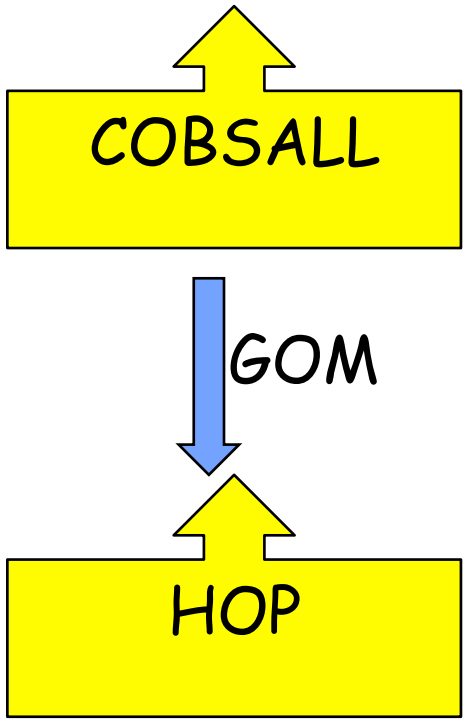
Original

```
MODULE YOMGFL
SAVE
REAL,ALLOCATABLE :: GFL(:,:,:,:)
INTEGER          :: NSCALAR
LOGICAL          :: LFLAG
END MODULE YOMGFL
```

* Saves much re-coding of IFS where global data is USE-ed from MODULES

Encapsulate H(x) in IFS

- Horizontal Interpolation to OBSERVATION Locations
  - Based on Karim's reorganised version @ 37
  - COBSALL (calls COBS and COBSLAG)
  - What modules are input and where they are set?
  - Made simple driver to call COBSALL
  - New Derived Types for GOMS and GLOBS
    - are passed through calling tree
- Calculate OBSERVATION EQUIVALENTS
  - HOP – (without HDEPART & HJO) → RTTOV
  - Split HOP into routines for different Obs Types
  - What modules are input and where they are set?
  - Made simple driver to call HOP



Cleaning and reorganising of HOP — Anne

- 94 subroutine calls directly from HOP and 231 IF tests

- In hop.F90 we have:

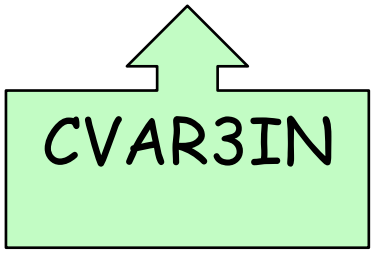
```
...
  CALL GETDB('HOP', NUPTRA, IRET, INFO, 0, ZINFO, 0, &
   & KSET, ITSLOT, -1, IOBSTYPE, ICDTYP_TOVS, ISENSOR_GETDB)

IF (ICDTYP_TOVS == NSTRO3) then
...
elseif  (ICDTYP_TOVS == NGTHRB)  then
...
```

- But in getdb we also have the same IF statements…

```
if (cdretr == 'HOP') then
    if  (ICDTYP == NSTRO3) then
        llexecv(9) = .TRUE.              ! For get_soe_reo3.sql request
   elseif  (ICDTYP == NGTHRB)  then
       llexecv(3) = .TRUE.               ! For sat_atovs.sql
...
```

Jb – CVAR3IN

Mike



- Modularisation (or encapsulation) of Jb
- Already fairly self-contained
- Involves ~170 subroutines including ~30 for LELAM
- Modules USE-ed
  1. Constants – same for all instances of Jb
  2. Owned by Jb – different for different instances of Jb
     - Will be moved to derived types
  3. Not owned by Jb

- CVAR3IN now compiles & links independently of IFS
- Also CVAR3INAD and Jb setup needed for 3D-Var

Jb – Global variables

- New derived type TYPE_JB_STRUCT containing derived types in YOMJG and YOMWAVELET

- All global variables will be removed and all references to variables in YOMJG and YOMWAVELET will be converted to references to elements of the derived types

- For example `LJBWAVELET` will become

```
JB_STRUCT%WJBCONF%LJBWAVELET
```

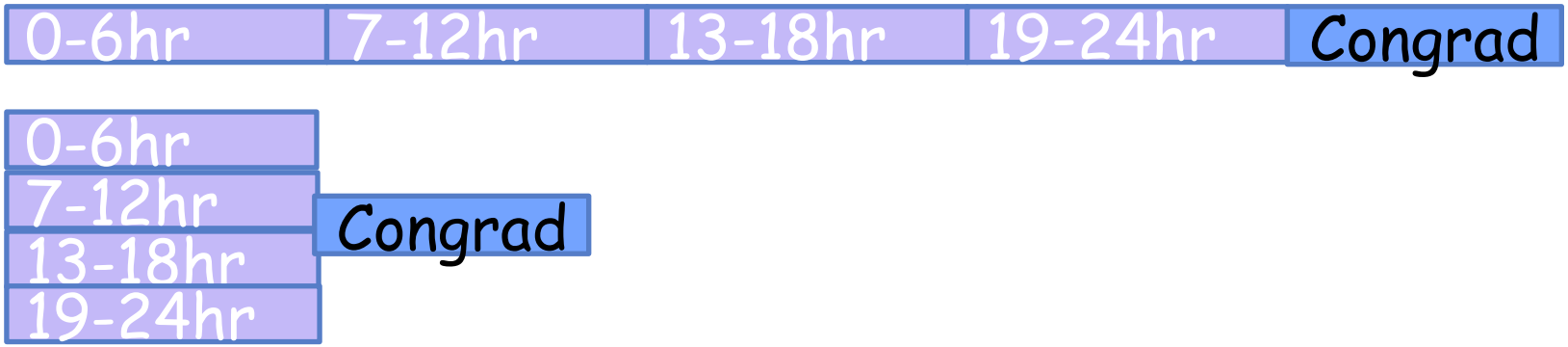
- Fortran does not allow elements of a derived type to be specified by in a namelist – so namelist read must contain name of entire derived type ☹

Scalability

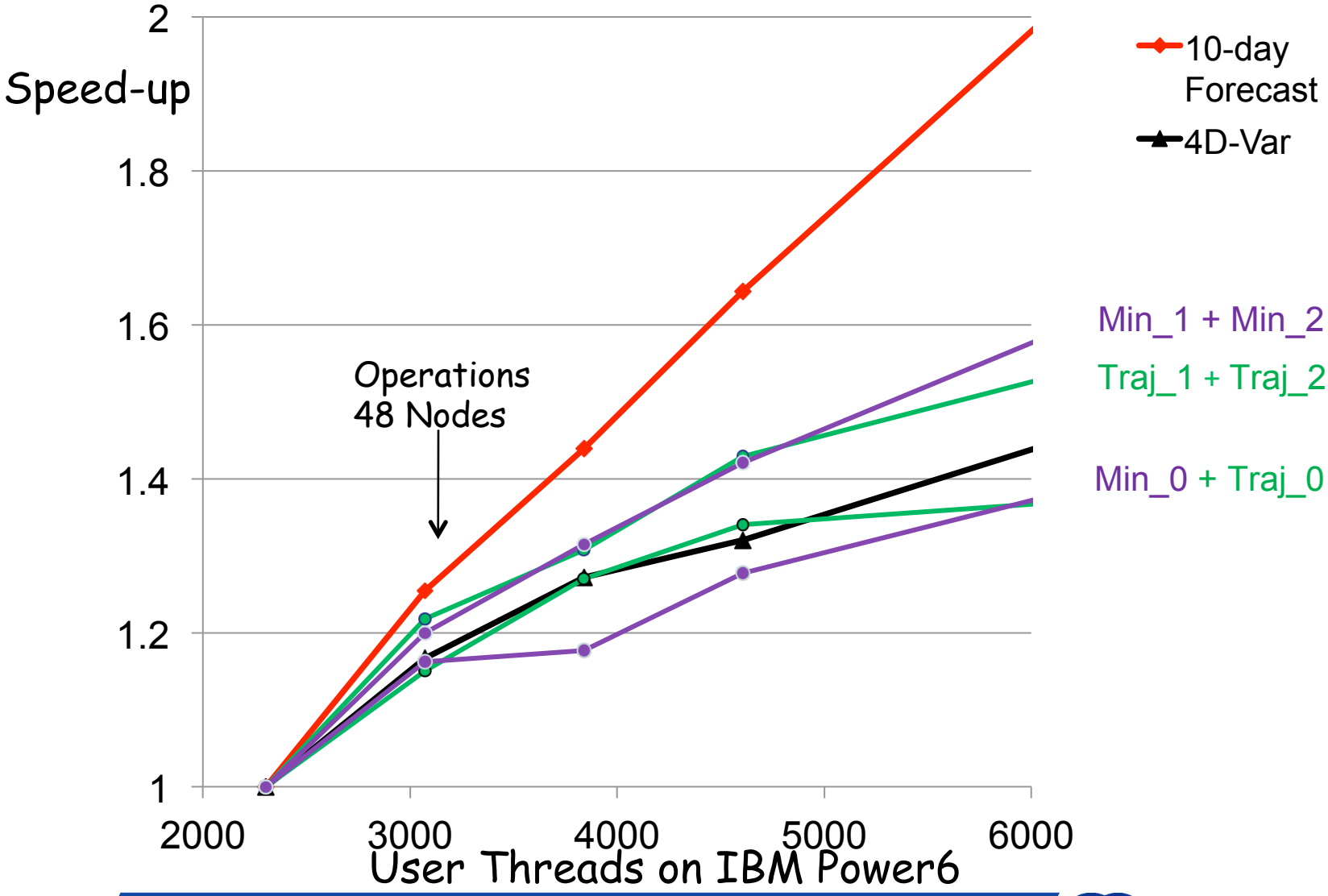
- OOPS will allow us to uncover more parallelism in 4D-Var

- Run with 1 execution instead of 7 will reduce start-up costs and I/O

- For weak constraint 4D-Var: Traj and Min steps for different sub-windows of time window can run in parallel as part of same execution - not possible in current IFS



Scalability of T1279 Forecast and 4D-Var



ECMWF

Cleaning and reorganisation for Cycle 38

- Karim's document V6e + pre-OOPS reorganisation
  - New derived types
    - SLCOMM and YOMGEM (Appendix J)
    - GOMS_MIX and YOMGLOBS
    - IFSFieldset
  - Remove YOMDIM from PP routines
  - Removal of unused variables in modules (Appendix G)
  - PARAMETER constants in YOMLUN
  - Split HOP
  - Move 600000 lines of data set-up (Appendix N)
    - IFS source reduced from 1600000 to 1000000 lines ☺
  - Cleaning of ODB & new ODB norms checker
- Tested in 37r3 – bit-reproducible with 37r2 for 4D-Var

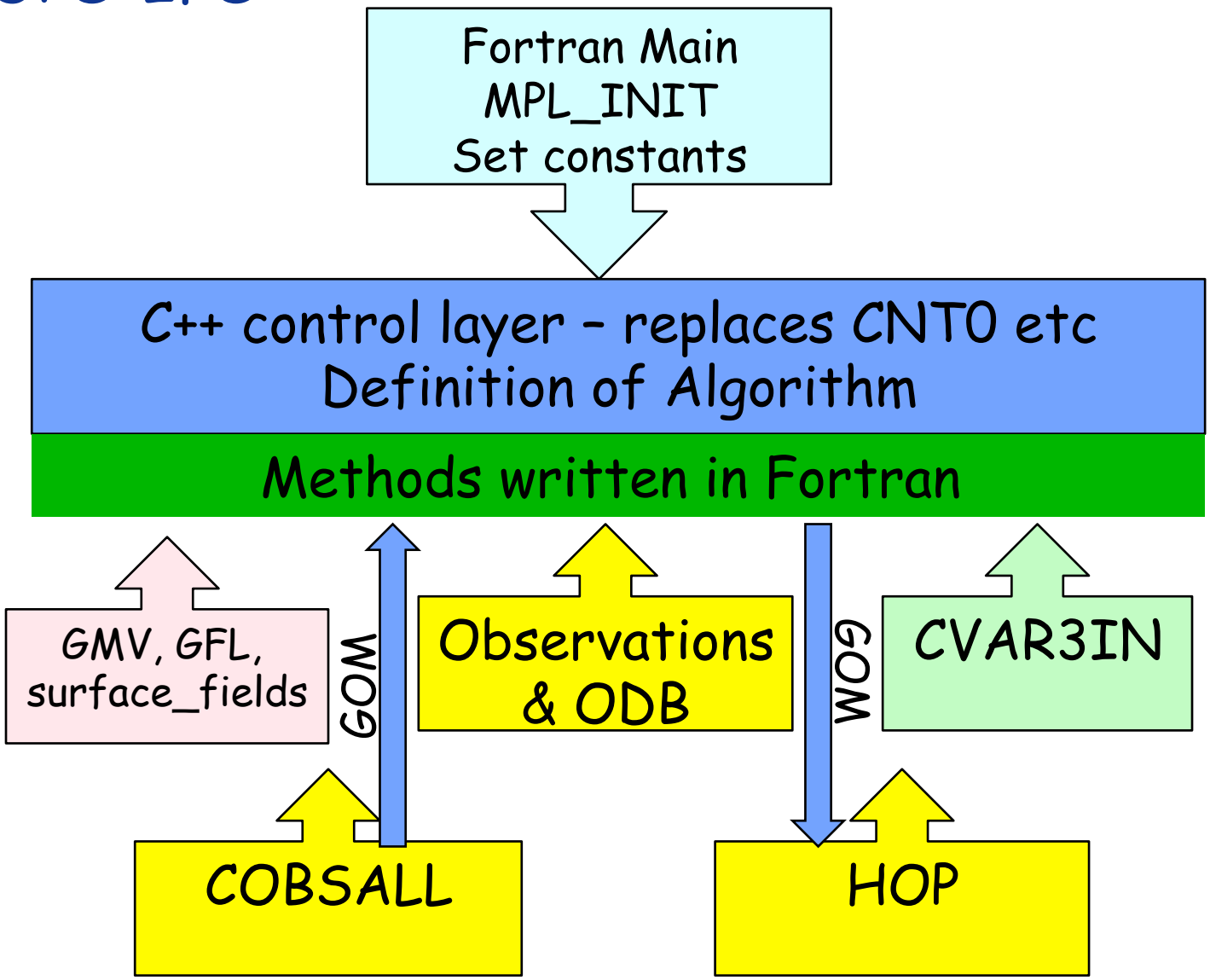
Coding Norms for Cycle 38

- Coding Norm improvements
  - Removal of unused declarations - CCPT(04)
  - Modules USE with ONLY – NORM(09)
    - Remainder OK – eg. YOMDB and MPL_MODULE
  - 5565 in CY36 -> 4606 in CY37 -> 3482 in CY37R3

	CY36	CY37	CY37R3
Useless declarations	1057	452	188
USE without ONLY	927	869	619
> 50 arguments	1326	1280	1249
GOTO	706	673	639

- New coding norm document Olivier Rivière & Mike Fisher

OOPS-IFS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HOP

IFS Fortran plugs into OOPS C++

- New directory 'oops'
- Contains methods to be called by C++
- Methods will be written in Fortran and interface to IFS routines
- Modifications to 'current IFS' routines will be minimised

List of methods needed by OOPS

- Geometry

…

- Model

…

- Fields

…

- Observation Operators

```
radiance_setup
radiance_delete
rad_equiv     ->HOP
rad_equiv_tl  ->HOPTL
rad_equiv_ad  ->HOPAD
rad_variables
rad_locations
```

- Observation Vectors

```
obsvec_create
obsvec_delete
obsvec_copy
obsvec_assign
obsvec_add
obsvec_sub
obsvec_mul
obsvec_axpy
obsvec_dotprod
obsvec_diff ->HDEPART
obsvec_read ->GETDB
obsvec_save ->PUTDB
```

List of Methods needed by OOPS contd.

Covariance Matrices: B & R

- Background Errors

```
b_setup
b_delete

b_mult
b_imul

b_sqrt     ->CVAR3IN
b_sqrtad   ->CVAR3INAD
b_sqrti    ->
b_sqrtiad  ->
```

- Observation Errors

```
r_setup
r_delete

r_mult
r_imul

r_sqrt
r_sqrtad
r_sqrti    ->/OBSERR
r_sqrtiad  ->/OBSERR
```

Warning …
Some aspects are still under discussion
Your input is important

Questions?