New flexible DDH structures for Arpege/Aladin/Alaro/Arome

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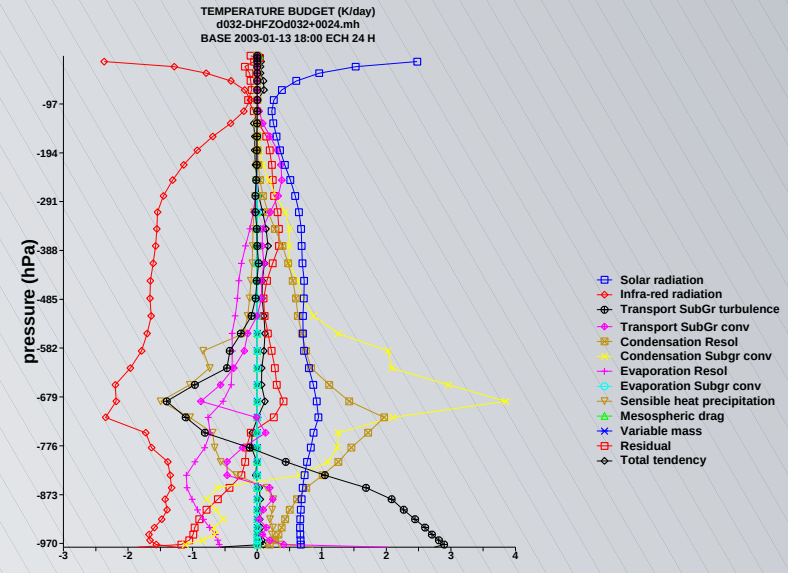
What are DDH ?

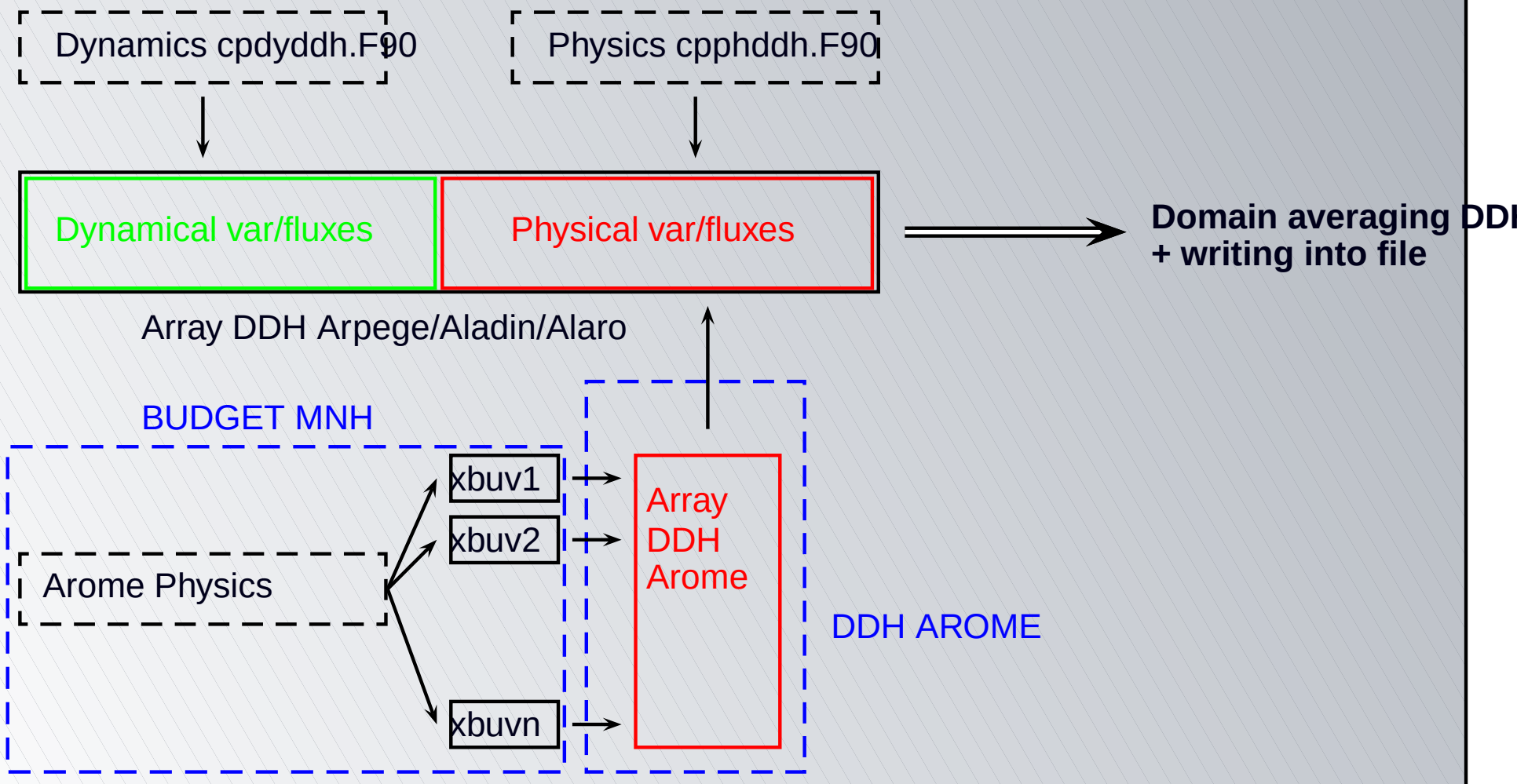
- Diagnostics in Horizontal Domains
- Made to provide on user-defined domains the budget of prognostic variables of the model for searchers and model's developpers.
- Also provides others domain averaged quantities for diagnostics.

Domains may be:

- zonal bands
- rectangular areas
- single points
- whole globe



Dataflow before cy35t1



Example of weaknesses of old dataflow

```
      IF  (LBUFLUX)  THEN
          IF (LTURB)  NHDQLNFP=  NHDQLNFP+12
          IF (LKFBCONV)  NHDQLNFP=  NHDQLNFP+4
          IF (LRAYFM)  NHDQLNFP=  NHDQLNFP+2
          IF (LHDORIGP.AND.LMICRO)  THEN
             IF (LOWARM)  NHDQLNFP=  NHDQLNFP+7
            NHDQLNFP=  NHDQLNFP+73
          ENDIF
```

```
IF (LKFBCONV)  NDDHFT  =  NDDHFT+4
IF (LTURB)     NDDHFT  =  NDDHFT+12
IF  (LHDORIGP)  THEN
   IF (LMICRO)  THEN
      IF (LOWARM)  NDDHFT  =  NDDHFT+7
     NDDHFT  =  NDDHFT+73
   ENDIF
ENDIF
IF (LRAYFM)    NDDHFT  =  NDDHFT+2
```


$\Rightarrow$ hardcoded indexes, duplication of setups in Arome ...

Motivations for a new dataflow

- Difficulties for debugging and mantaining it because of growing numbers of entries due to evolution of physical parametrizations
- Need for common structure between Arp/Ald/Alo and Arome (see Phys-Dyn interface issues)
- Getting rid of fixed structures with one index preassigned to a specific field in setup through an hardcoded index
- Providing a more user-friendly tool that can also be used for other purposes than DDH.

Use of self-allocatable structures

Data is gathered within an array RDDH_DESCR of self-documented type structures DDHFLEX

```
TYPE(DDHFLEX),ALLOCATABLE,DIMENSION(:):: RDDH_DESCR
```

with

```
TYPE DDHFLEX
  CHARACTER(LEN=11)::CNAME !name of field
  CHARACTER(LEN=1)::CFLUX !'F' if flux 'V' if variable 'T' if tendency
  CHARACTER(LEN=3)::CMOD  ! 'ARP','ARO': name of model
  LOGICAL:: LKDDH !TRUE if to be stored into DDH
  ! rfield has to be a pointer because allocatable not allowed in structu
  REAL(KIND=JPRB),DIMENSION(:,:),POINTER:: RFIELD  ! value of retrieved fi
  INTEGER(KIND=JPIM):: NFIELDIND! position of flux in ddh array
END TYPE DDHFLEX
```

Adding an entry to the budget: use of ADD_FIELD_3D

Call to ADD_FIELD_3D allows to add an entry to the RDDH_DESCR array
Arguments of ADD_FIELD_3D(PMAT,CDNAME,CDFLUX,CDMOD,LDINST,LDDH) are the following:

- PMAT: the array to be stored.
- CDNAME: name of field.
- CDFLUX: 'F' if flux ,'T' if tendency,'V' if variable
- CDMOD: 'ARO' if AROME, 'ARP' otherwise (but you may add some other label if you wish)
- LDINST:'TRUE' if instaneous field
- LDDH:'TRUE' if field is stored to be in DDH

Warning: wrong entries in ADD_FIELD_3D means wrong postprocessing of the field ! Check syntax in xrd/module/ddh_mix.F90 before !

```
CALL ADD_FIELD_3D(ZTMPAF,'VQI','V','ARP',.TRUE.,.TRUE.)
CALL ADD_FIELD_3D(ZTMPAF(:,:),CLNAME,'T','ARP',.TRUE.,.TRUE.)
CALL ADD_FIELD_3D(PFRSO(:,:,1),'FCTRAYSO','F','ARP',.TRUE.,.TRUE.)
```

Use of ADD_FIELD_3D

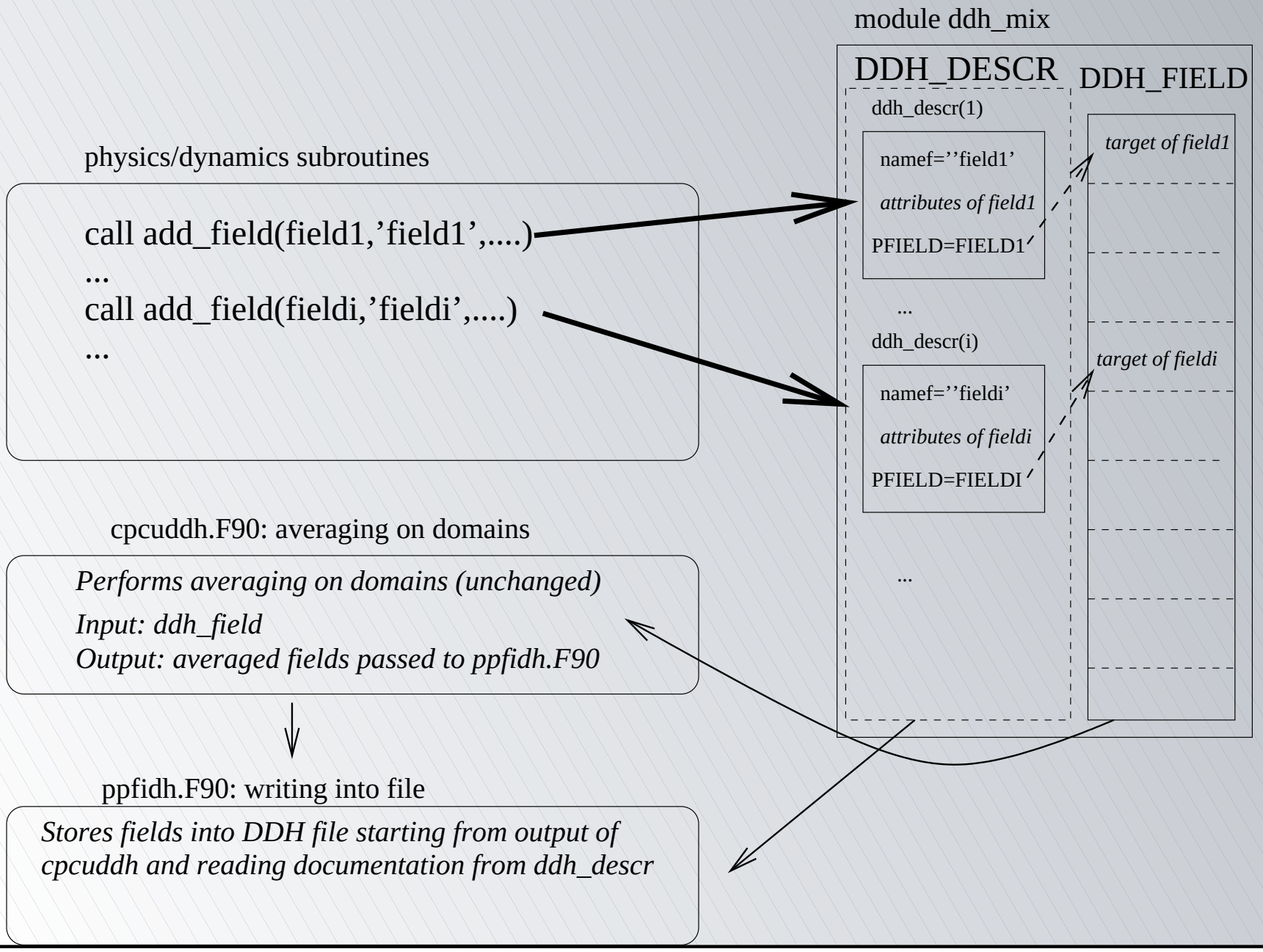
ADD_FIELD_3D is the key subroutine of the new dataflow (and also the only one to be mantained...)

- First call during execution; dimension of array DDH_DESCR is increased by one and documentation of field is filled
- Successive calls: data is stored in RDDH_FIELD at the right place (after a security check)
- According to attributes some operations can be performed if necessary in this subroutine.

Algorithmic constraints:

- Same sequence of calls to ADD_FIELD_3D must occur at each timestep (e.g it is not possible to retrieve a field every two timesteps or change the order of the call during execution). If not, there is a security check based on the field's name that makes the program stop.

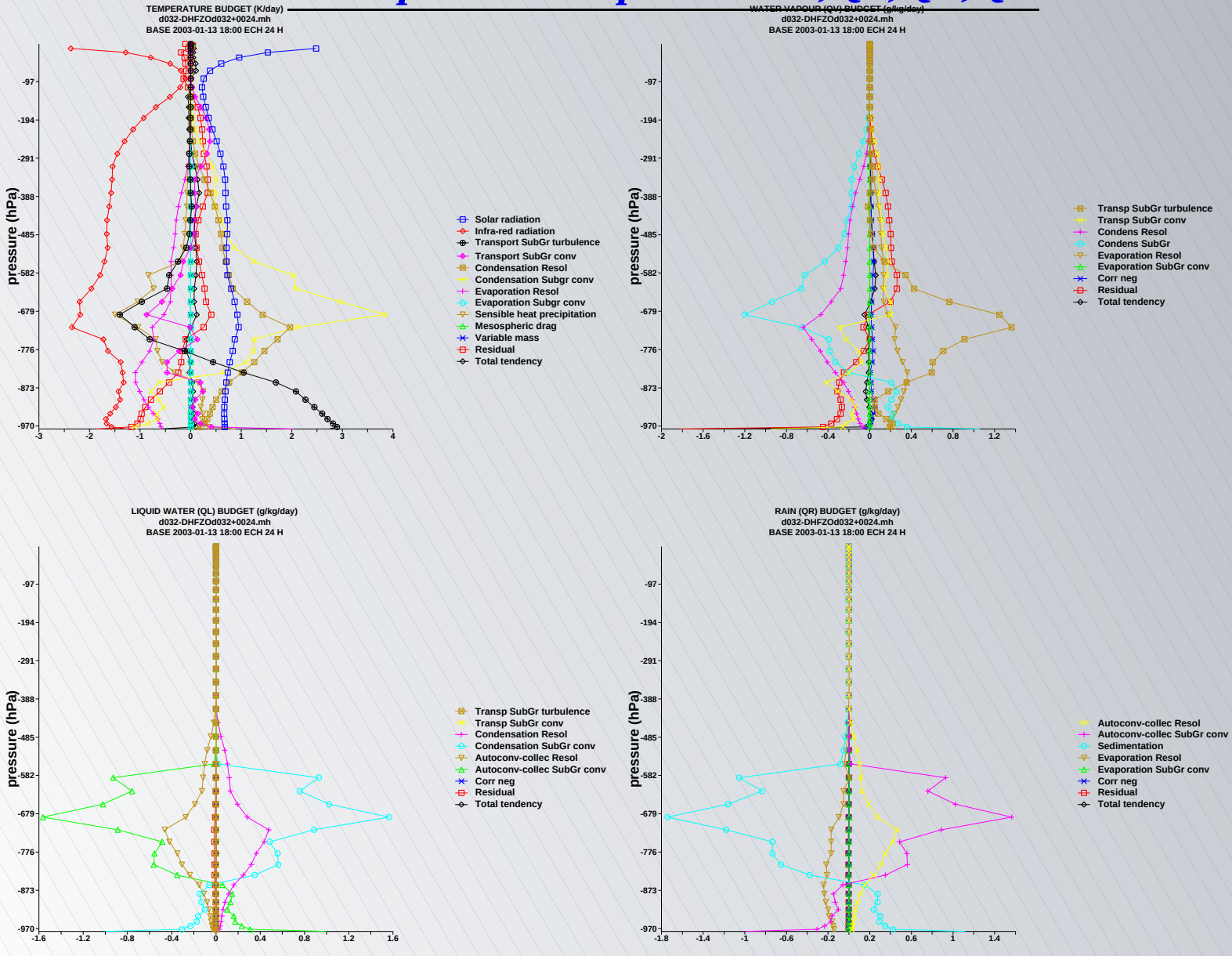
Architecture of the code



Plotting DDH files with ddhtoolbox

- DDH files are obtained using the same namelist options than historical files
- ddhtoolbox obtained from Jean-Marcel and is documented within DDH documentation on gmapdoc
- Budget are retrieved using ddhb utility:
  ddhb -v aladin/CT -i DHFDLALAD+0036 =>.dta file with ascii data
- '-v aladin/CT' means you are reading $DDHB_BPS/aladin/CT.fbl file containing the list of terms in the budget of variable CT
  => Updated .fbl files can be obtained by Jean-Marcel (or created after the name of articles in DDH file if you use last version of ddhtoolbox)

Example of DDH products:T,QV,QL,QR



DDH evolution on the cycles

- cy35t1: new dataflow available in Arome.**Validated**
- cy35t2: new dataflow available in Arp/Ald/Alo/Aro under the key LFLEXDIA (otherwise old dataflow is used) **Validated in Arpege, Aladin and Arome.**
- cy36t1: introduction of code for dynamical terms (not validated)
- cy36t2:
  - tendances and fluxes will be extracted from cptend_new directly for more consistency with evolution equations under LFLEXDIA key only => start now to use new dataflow in Alaro in order to have it validated. (A branch for having this feature available in cy36t1 can be available if requested). Work from JM.Piriou.
  - condensed water species added under LFLEXDIA (JM.Piriou)

Remaining issues

- 2D fields are to be added in new structures: creation of ADD_FIELD_2D
- Use of common structure with Physics-Dynamics interface (see specific talk)
- Dynamical terms to be introduced and validated (F.Voitus)

Conclusion

- Positive experiences with new dataflow at Météo-France in Arpege, Aladin and Arome: LFLEXDIA=.TRUE. will become default.
- Algorithmic validated in Arpege/Aladin and Arome. In Alaro calls to ADD_FIELD_3D to be checked.
- Retrieval of physical fluxes and variables to be moved in cptend_new from cy35t2 on
- Some evolutions will occur due to evolution of physics-dynamics interface but algorithmic will probably remain the same.
- ECMWF interested and aware of this work
- Extensive documentation available on gmapdoc's website