

DDH in AROME

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Outlook

1. A short overview of DDH
2. DDH in AROME
3. Namelists
4. DDH tools
5. Visualiztioan

1. A short overview of DDH: Introduction

- Model output:
 - Prognostic variables
- DDH:
 - Horizontal average of
 - Prognostic variables
 - Terms of model equations (turbulence, microphysical processes, radiation, pressure gradient force, ...)

1. A short overview of DDH:

Equations

- DDH is based on model equations in flux form

$$\frac{\partial}{\partial t} \left(\chi \frac{\partial p}{\partial \eta} \right) = - \underbrace{\nabla_{\eta} \cdot \left(\chi \mathbf{v} \frac{\partial p}{\partial \eta} \right)}_{(1)} - \underbrace{\frac{\partial}{\partial \eta} \left(\chi \dot{\eta} \frac{\partial p}{\partial \eta} \right)}_{(2)} + \underbrace{S_d \frac{\partial p}{\partial \eta}}_{(3)} - \underbrace{g \frac{\partial F_{\varphi}}{\partial \eta}}_{(4)} - \underbrace{g S_{\varphi} \frac{\partial G_{\varphi}}{\partial \eta}}_{(5)}$$

- Horizontal divergence
- Vertical divergence
- Adiabatic source (pressure gradient force,...)
- Divergence of physical fluxes (turbulence, microphysics, ...)
- Tendencies due to physical parameterizations

No physical tendencies!

1. A short overview of DDH: Equations (cont.)

$$\chi : 1, \vec{v}, q_v, q_l, q_n, k, c_p T, \vec{M}, s$$

(k : kinetic energy; s : entropy; \vec{M} : angular momentum)

1. A short overview of DDH:

Classification of terms in DDH

1. Variables: $\frac{1}{g} \chi \delta p$

2. Dynamical tendencies: $\frac{\delta t}{g} \nabla_{\eta} \cdot (\chi \mathbf{V} \delta p)$ and $\frac{\delta t}{g} S_d \delta p$

3. Dynamical fluxes: $\frac{\delta t}{g} \chi \dot{\eta} \frac{\partial p}{\partial \eta}$

4. Physical fluxes: $\delta t \cdot F_{\varphi}$

5. Physical tendencies: $g S_{\varphi} \delta G_{\varphi}$

Full levels: variables and tendencies

Half levels: fluxes

1. A short overview of DDH: **Horizontal domains**

- Global
- Zonal band
- User defined or local domain
 - Point:
 - mesh point (i,j); domain type=1
 - geographic (λ, φ) ; domain type=4
 - Quadrangle
 - geographic coordinates of all points; domain type=2
 - Rectangle
 - geographic coordinates of two points; domain type=3

1. A short overview of DDH: **Horizontal domains (cont.)**

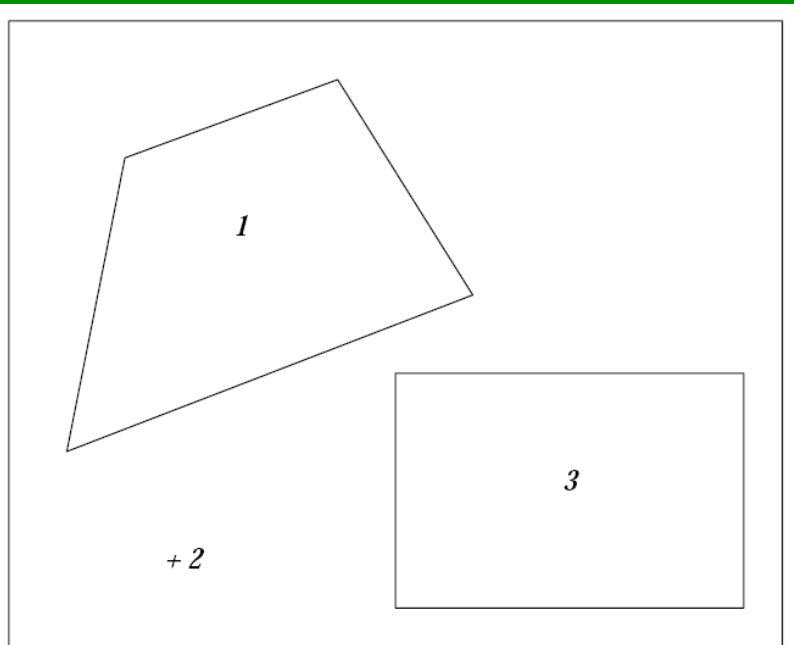


Figure 2.1: Case 1

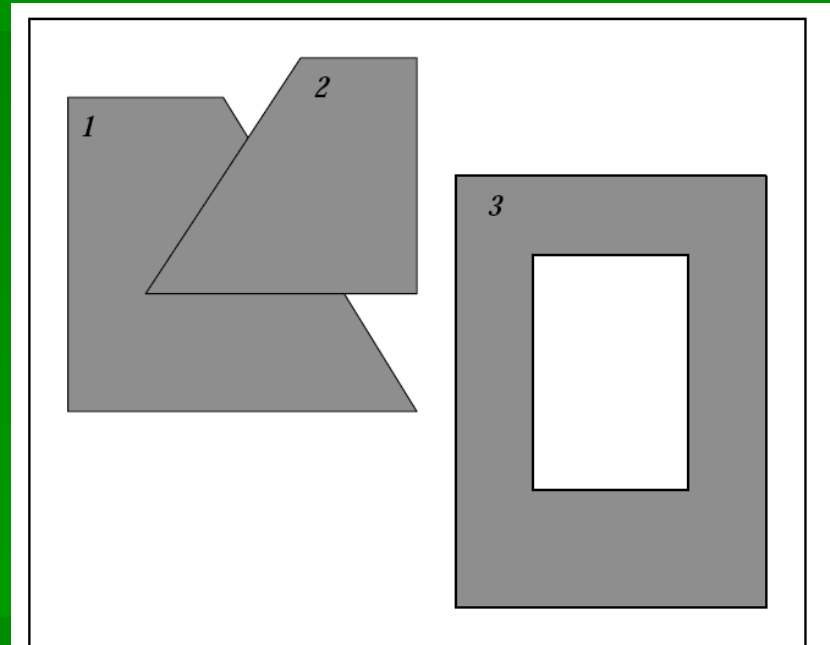


Figure 2.5: Case 4

1. A short overview of DDH: **Output files**

Format: lfa

Name:

- Global domain: DHFGLeeee+nnnn
- Zonal bands: DHFZOeeee+nnnn
- User defined: DHFDLeeee+nnnn

eeee: experiment name

nnnn: output time

1. A short overview of DDH:

Output files, content

Descriptions:

date, output time, number of output values, number of levels, logical keys, numbers describing data, descriptions of domains, ...

Data:

- variables at time 0 and t
- Dynamical tendencies
- Dynamical fluxes
- Physical fluxes
- Physical tendencies

2. DDH in AROME: Introduction

- Only physical fluxes are changed for AROME.
- New water species are added.
- Dynamical fluxes and tendencies are calculated if derivatives are available but not for all variables
- Meso NH physics gives tendencies.
- Fluxes are calculated from tendencies (some of them are not physical and called pseudo fluxes, e.g. flux of dry growth of graupel).
- Tendencies from physical processes are accessed through budget system of Meso NH model.
- Data flow had to be changed.
- Setup must be done for MNH budgets and for DDH, a lot of care must be taken.
- Results are very sensitive to changes in physical parameterizations.

2. DDH in AROME: Code organization

APL_AROME

RAIN_ICE

BUDGET
XBUR*

AROEND_BUDGET
XBUR*

- ZBUR(KLON,0:KLEV,NBUPROCNBR(6))
(normalisation rho, delta p)
- PAPFT(KLON,0:KLEV,KPHFT) (cumul vertical en flux)

CPG_DIA

ARO_CPPHDDH
APFT(KLON,0:KLEV,KPHFT)
> PDHCV(KPROMA, 0:KFLEV,
NDHCVSU) (vers la partition en domaines internes, moyenne horizontale)

2nd

3. Namelists

&NAMDDH

LHDGLB = .FALSE.,
LHDZON = .FALSE.,
LHDDOP = .TRUE.,
LHDHKS = .TRUE.,
LHDMCI = .FALSE.,
LHDENT = .FALSE.,
LHDPRG = .FALSE.,
LHDPRZ = .FALSE.,
LHDPRD = .FALSE.,
LHDEFG = .FALSE.,
LHDEFZ = .FALSE.,
LHDEFD = .TRUE.,
LHDLIST = .TRUE.,
LONLYVAR = .FALSE.,
LHDORIGP = .TRUE.,
LHDCDPI = .TRUE.,
BDEDDH(i,j) ...

&NAMCT0

NFRCO=180,
NFRDHFD=1,
NDHFDTS(0)=10,
NDHFDTS(1)= 90,
NDHFDTS(2)= 93,
NDHFDTS(3)= 96,
NDHFDTS(4)= 99,
NDHFDTS(5)= 102,
NDHFDTS(6)= 105,
NDHFDTS(7)= 108,
NDHFDTS(8)= 111,
NDHFDTS(9)= 114,
NDHFDTS(10)=117,

&NAMOPH

LINC=.FALSE.,

&NAMPHY

LPHCDPI= .FALSE.

&NAMARPHY

LBUFLUX=.FALSE.

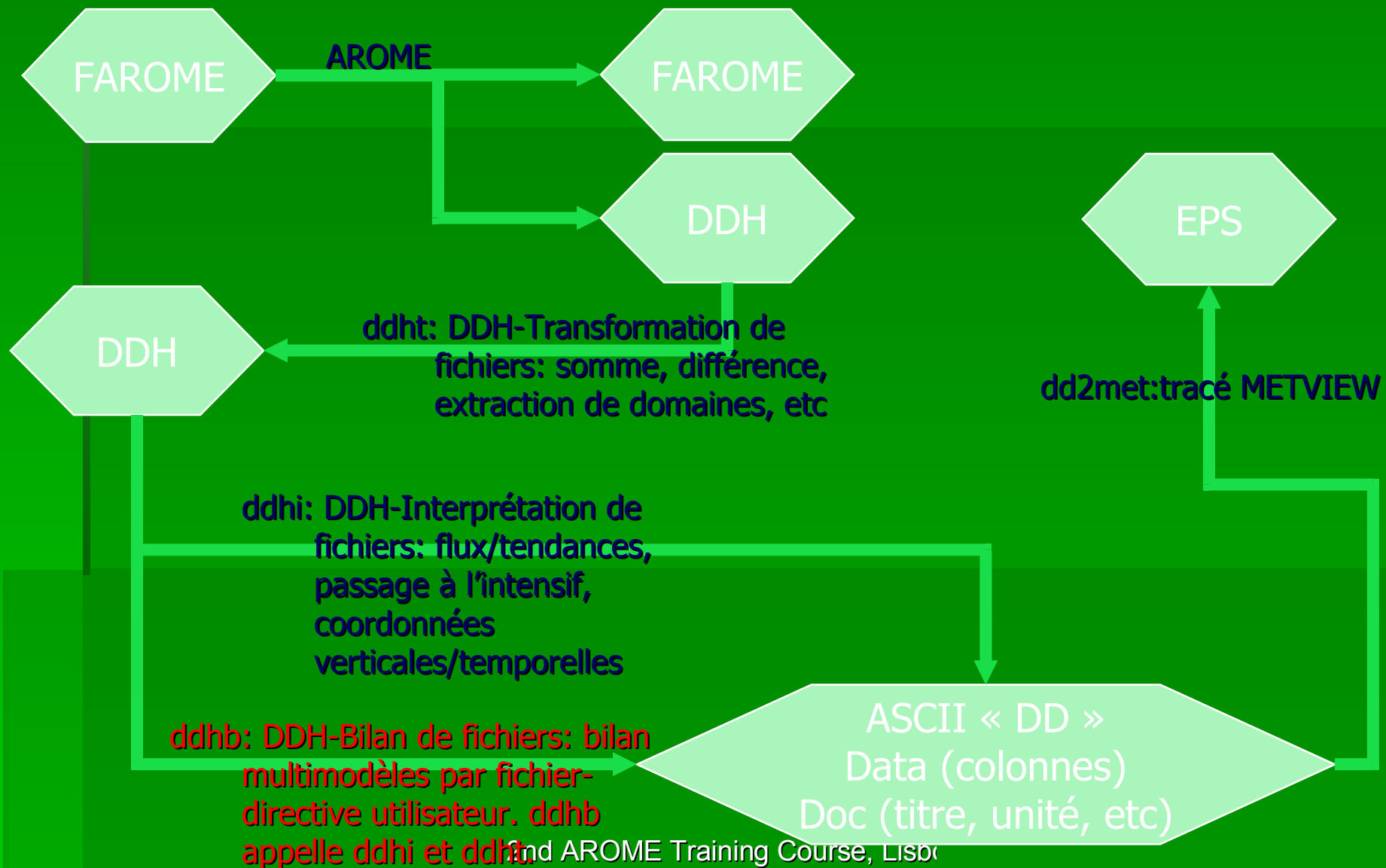
3. Namelists: Example

- &NAMDDH
- LHDHKS=.TRUE.,
- LHDDOP=.TRUE.,
- LHDEFD=.TRUE.,
- BDEDDH(1,01)=4.,
- BDEDDH(2,01)=1.,
- BDEDDH(3,01)=4.00,
- BDEDDH(4,01)=0043.950,
- BDEDDH(1,02)=4.,
- BDEDDH(2,02)=1.,
- BDEDDH(3,02)=6.100,
- BDEDDH(4,02)=0043.950,
- BDEDDH(1,03)=3.,
- BDEDDH(2,03)=2.,
- BDEDDH(3,03)=1.5,
- BDEDDH(4,03)=44.5,
- BDEDDH(5,03)=8.1,
- BDEDDH(6,03)=42.2,
- LHDLIST=.TRUE.,
- LONLYVAR=.FALSE.,
- LHDORIGP=.TRUE.,
- LHDCDPI=.TRUE.,

4. DDH tools

- Programs and scripts used to read DDH files, to get information about file contents, to extract data for one domain, visualization, ...
- Some tools:
 - lfaedit: browsing DDH file in specified editor
 - ddht: extracts domain and some operations on files
 - ddhi: extracts descriptions from DDH lfa files

4. DDH tools (cont.)



5. Visualization

