AROME code architecture (generalities) and preparation of files involved in the model run

Yann Seity

(Météo-France CNRM/GMAP)

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AROME

=

ALADIN-NH dynamics

+

Méso-NH physics

General rule : modify as less as possible each code

ALADIN-NH

- ARPEGE/IFS environment managed by CNRM/GMAP, DP/COMPAS and ECMWF
- Code on clear-case
- Unix scripts
- Files : «FA» type, but easy conversion to GRIB
- Graphics : chagal, metview …
- SI SL ICI scheme
- Spectral
- Davies coupling
- A grid
- Ideal 1D/2D/3D cases
- 3D real cases

Méso-NH

- Méso-NH environment managed by GMME/Méso-NH and LA
- Code on RCS
- Unix procedures
- Files : «FM» type , possible conversion to GRIB or netcdf
- Graphic package (NCAR graphics)
- Eulerian explicit leap frog,
- C-grid
- Two way nesting
- No assimilation
- Ideal cases or real cases from Arpège, Aladin or ECMWF (initial condition + coupling)

Méso-NH physics interfaced in AROME

- Microphysics
- Turbulence (with or without subgrid scale condensation)
- Surface schemes
- (+ shallow and deep convection)

State variables

- Aladin-NH : u, v, d_4, T, qv (+ ql, qi), P on A-grid
- Méso-NH : u, v, w, θ, r_v, r_c, r_r, r_i, r_s, r_g, TKE on C-grid
- Arome :
  - Conversion from Aladin variables to Méso-NH and from tendencies of Méso-NH variables to tendencies of Aladin variables
  - Level index inversion before entering in Méso-NH code
  - Computation of z from the geopotential every time step
  - Neutralisation of «wind point to mass point» operators in turbulence scheme

New variables

4 new variables : QS (Snow), QG (Graupel), QR (Rain), QTKE (TKE)

(QI (Ice) and QL (Cloud water) already used at ECMWF or in Aladin Lopez physics)

The new GMV/GFL structure allows us since pre-cycle 27 to easily add new variables in the code.

Structure with type and attributes :

```
YS_NL%LADV=.TRUE.,
YS_NL%LREQIN=.TRUE.,
YS_NL%LGP=.TRUE.,
YS_NL%LCOUPLING=.FALSE.,
(...)
```

General computer constraints

- Both codes are in F90 (or F77)
- BUT
  - Aladin : the «KIND» of reals and integers is specified in the code :

    USE PARKIND1 ,ONLY : JPIM ,JPRB

  - Méso-NH : the «KIND» of reals and integers is forced at the compilation

➢ Constraints on compilation procedures and interface usage

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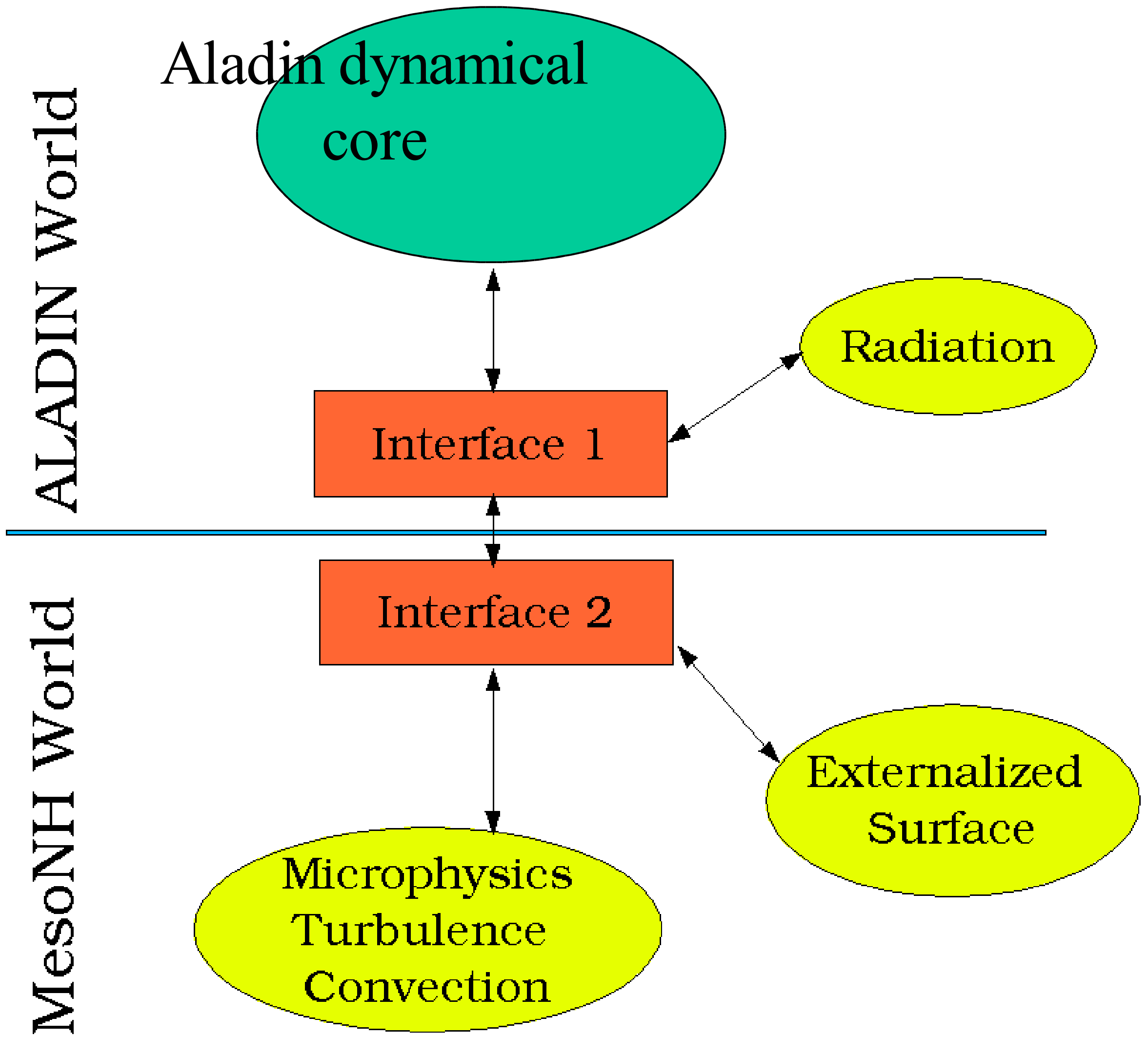
Separation of ALADIN/MesoNH parts in AROME



About Cycles…

- MesoNH MASDEV_** (currently MASDEV_46)
- Externalized surface version *.* (currently 1.1)
- ARPEGE/IFS/ALADIN CY** (currently CY30)
- ARPEGE/ALADIN CY**T* (currently CY30T1)
- AROME code is included in ARPEGE/IFS/ALADIN code library since CY29T1 with MASDEV_46 MesoNH physics and SURFEX 1.0

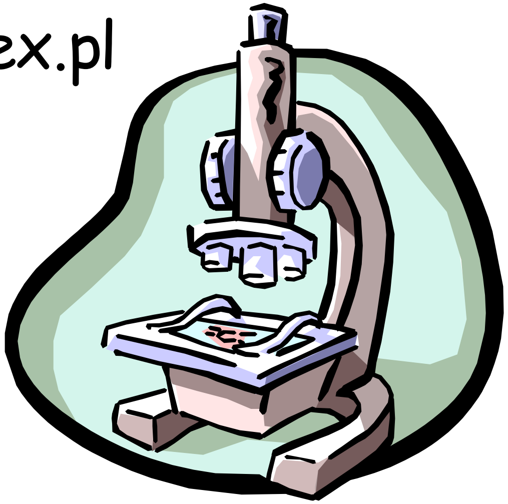
- In CY30T1, MASDEV_46_bug2 + Surfex1.1

How looking in the code ?

- Via Clear Case on andante (doc on GMAP web site)

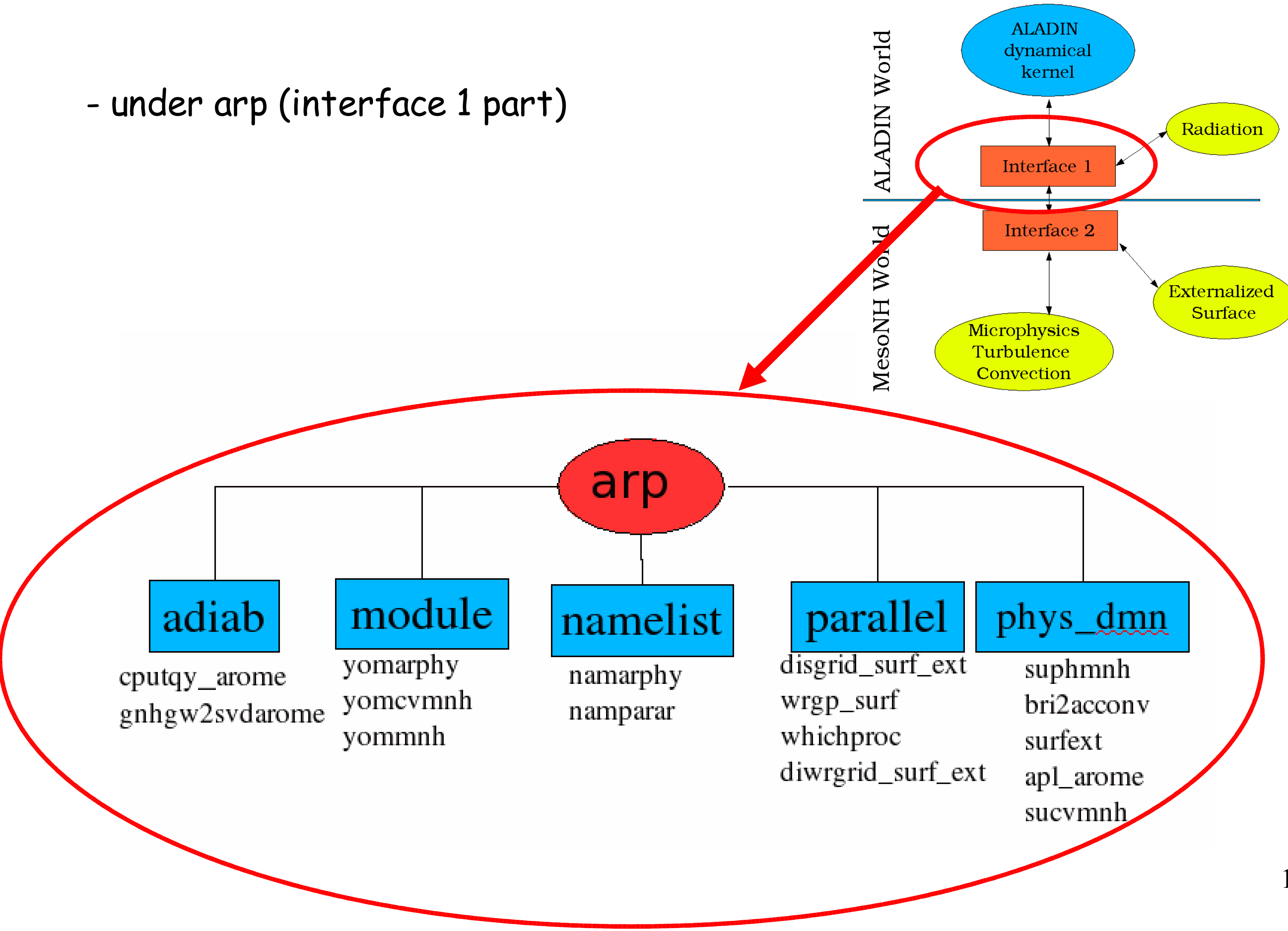
- Via gmkpack on supercomputers (tora, kami, hpcd, etc..) and on PC Linux (doc on GMAP web site). Same tree as in Clear Case. (arp, ald, xrd, tal, tfl, …)

- Via source browser (restricted access) : http://mout.meteo.fr/~marp001/f2html/index.pl



Where are AROME specific routines ?

- under arp (interface 1 part)

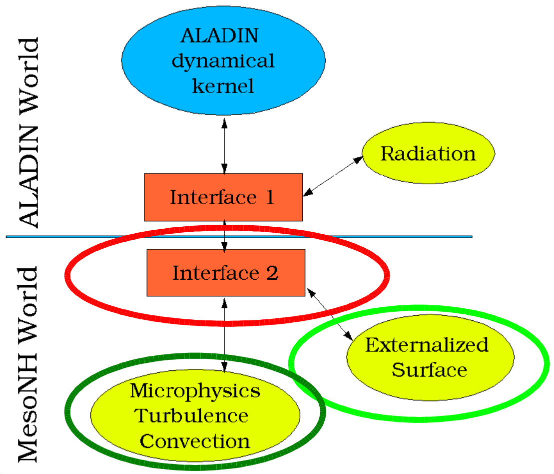


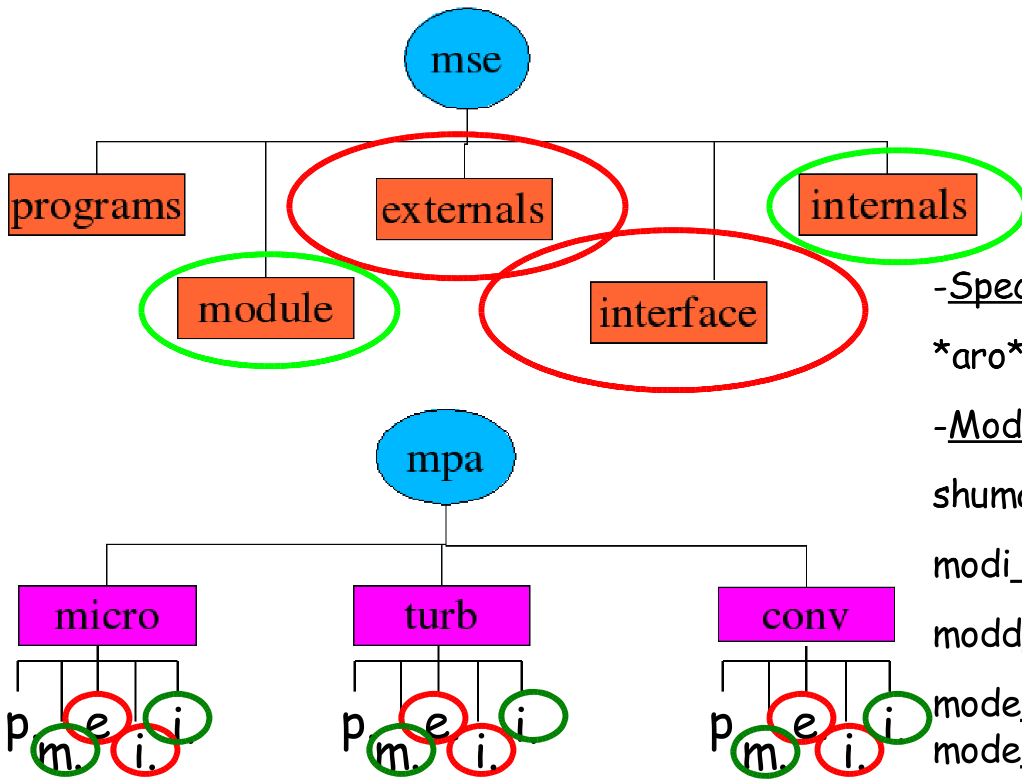
Where are AROME specific routines ?

-in MesoNH world (mse and mpa Vobs)

(.mnh or .F for subroutines and modd* modi* modn*

and mode* for modules)





-<u>Specific AROME routines :</u>

aro under mse/internals and module

-<u>Modified MesoNH routines :</u>

shuman->shumanaro in mpa/turb/internals

modi_shuman -> modi_shumanaro

modd_ref -> modd_refaro in micro/module

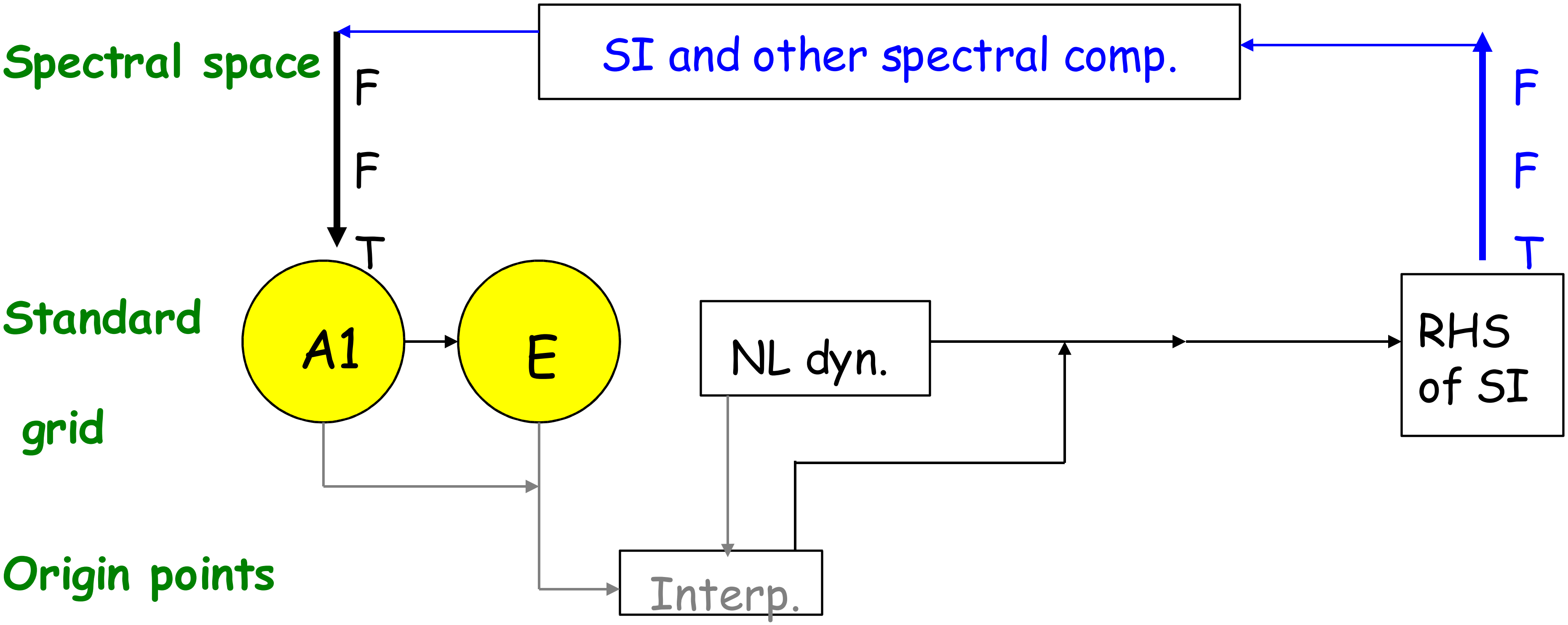
mode_fm and mode_fm_writ ->mode_fmbidon & mode_fmwritbidon under micro/module

turb_ver_dyn_flux, tke_eps_sources, modd_parameters

Time step organisation (1/2)

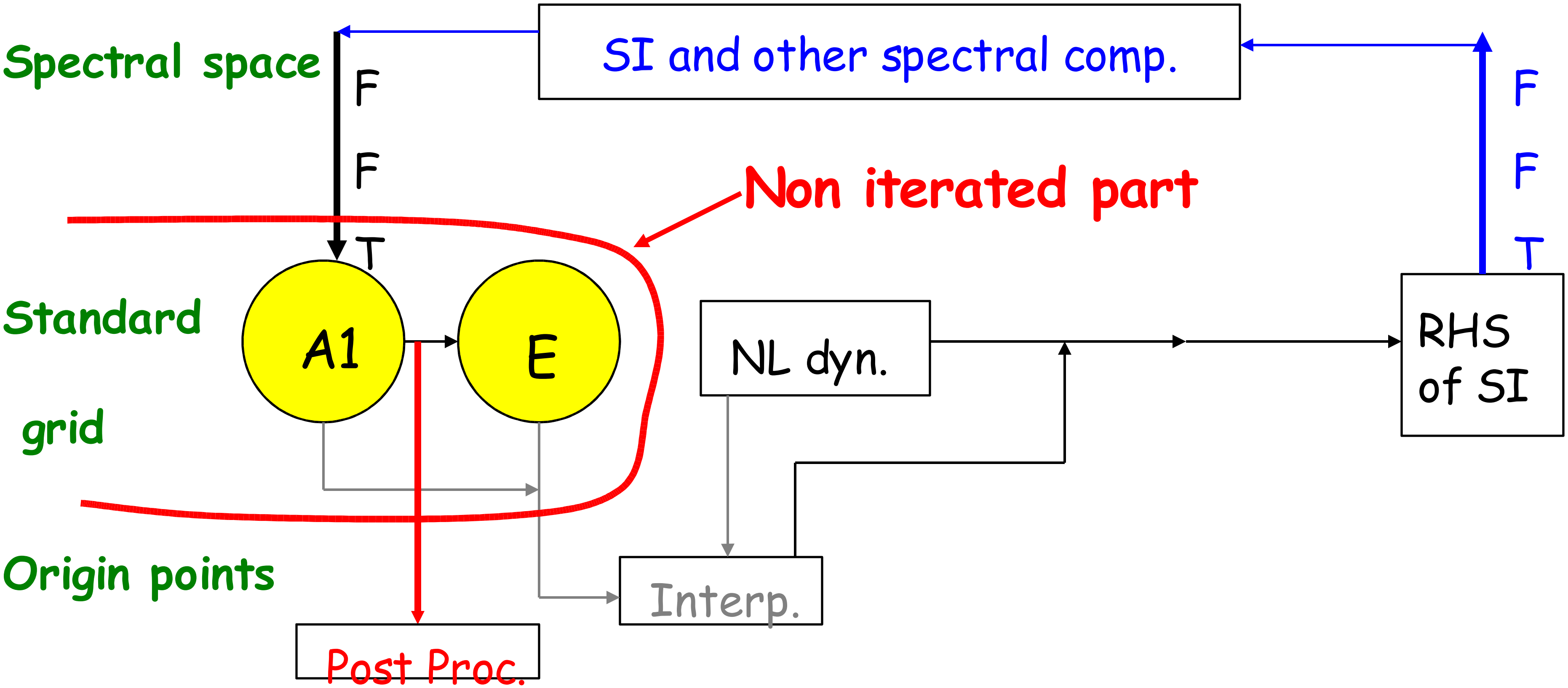
A: Ajustement : 0d process to ensure condensation of sub-saturated mixing ratios and T adjustment

E : Physics calculations

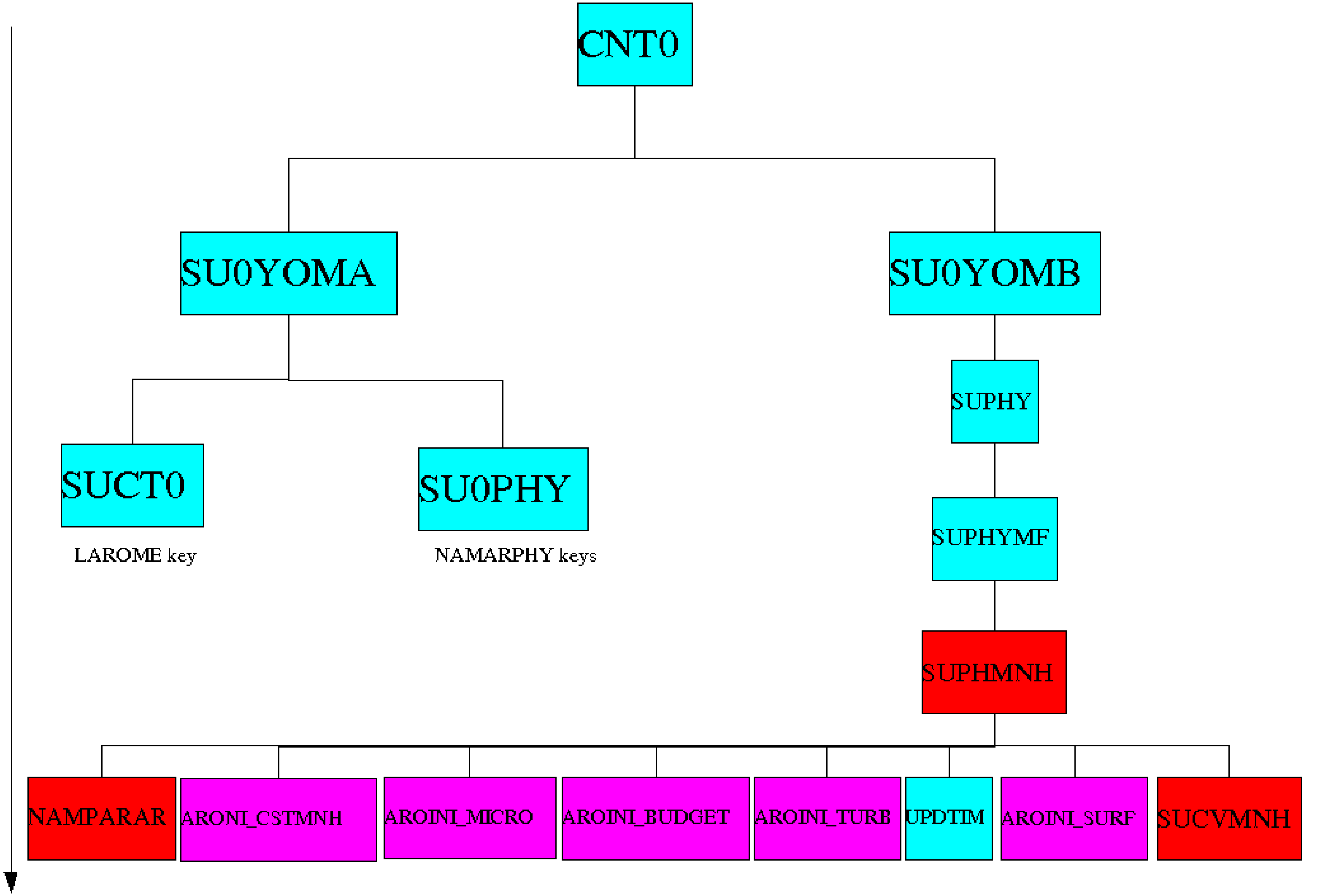


Time step organisation (2/2)

Adanced version : P/C scheme 'forward in time'



AROME setup

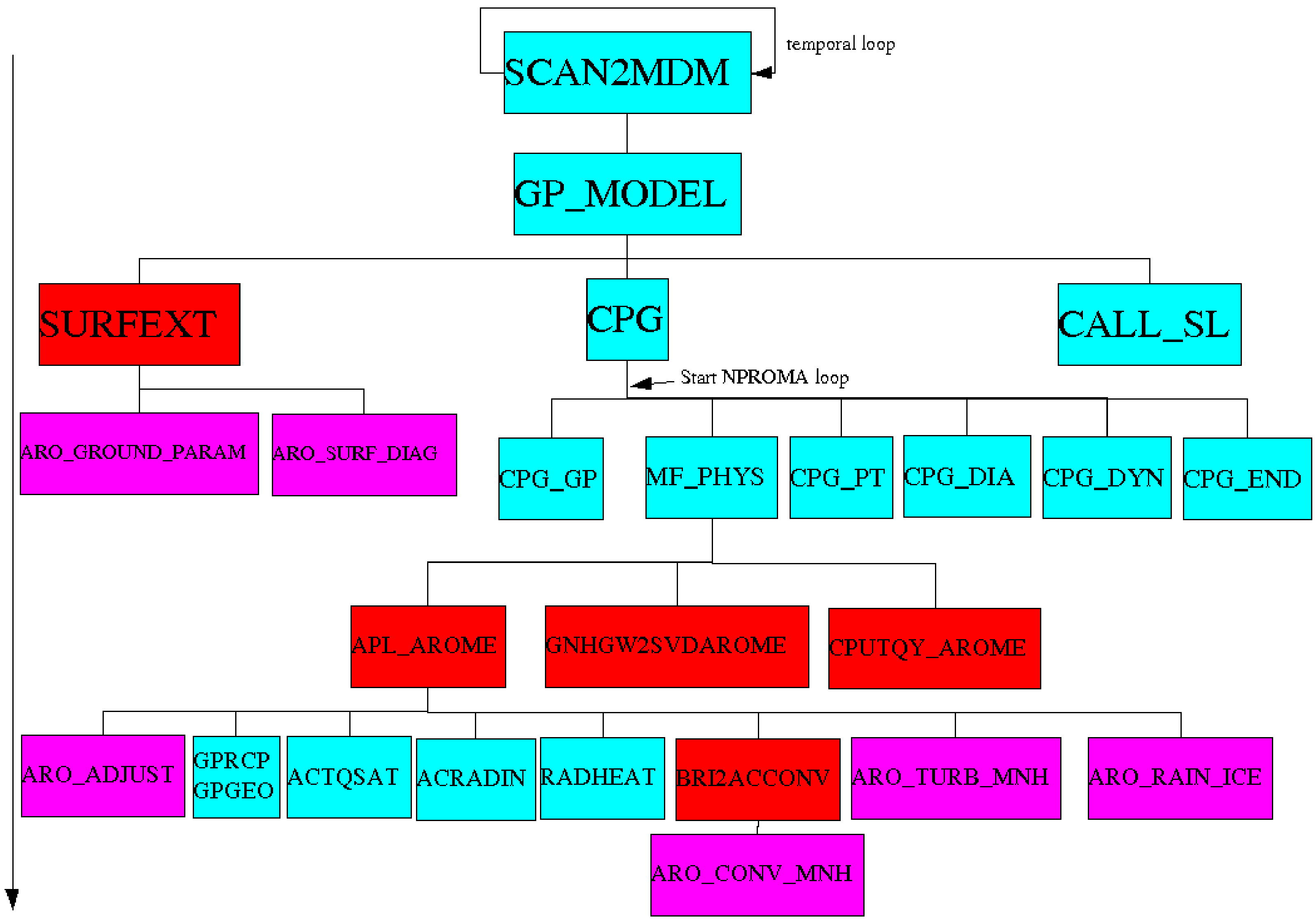


CNT0
SU0YOMA
SU0YOMB
SUCT0
LAROME key
SU0PHY
NAMARPHY keys
SUPHY
SUPHYMF
SUPHMNH
NAMPARAR
ARONI_CSTMNH
AROINI_MICRO
AROINI_BUDGET
AROINI_TURB
UPDTIM
AROINI_SURF
SUCVMNH

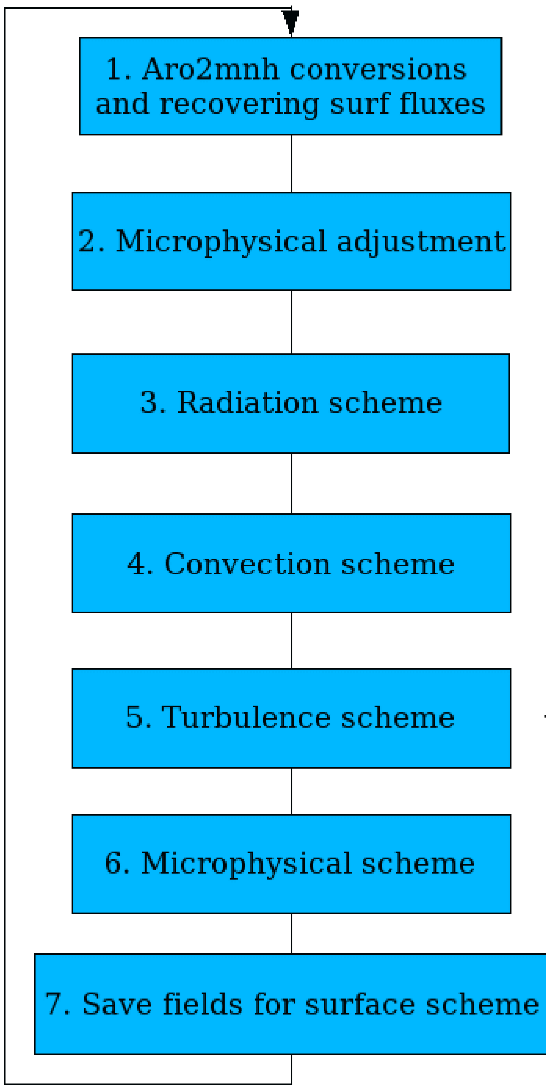
AROME parallelisation constraints

- Méso-NH : the full domain is divided into «rectangles»,
- Aladin : the full domain is divided into «bands» of latitudes, and then «blocs» on each processor (NPROMA)
- Arome : no problem with the «column» physics, except for the externalised surface (the «bloc» division is not easily compatible with the surface code)

AROME gridpoint temporal loop



Zoom under under apl_arome



T -> θ , q ->r
Level inversion

Adjusted θ, T, r*,q*,R,Cp,Neb
Tendency of T and q*

Recovering Ts, Emis., ans Albedo from surface
Tendency of T,+fluxes for surface (IR,SW)

Tendency of T and qi,qc,qv

Add rainfalls to inst. and cum. rr and rs

Tendency of T,u,v,q* and tke

Tendency of T and q*
Save cum. and inst. rainfalls for surface

Save Usurf, Vsurf, Tsurf, qvsurf, Rhosurf for surface

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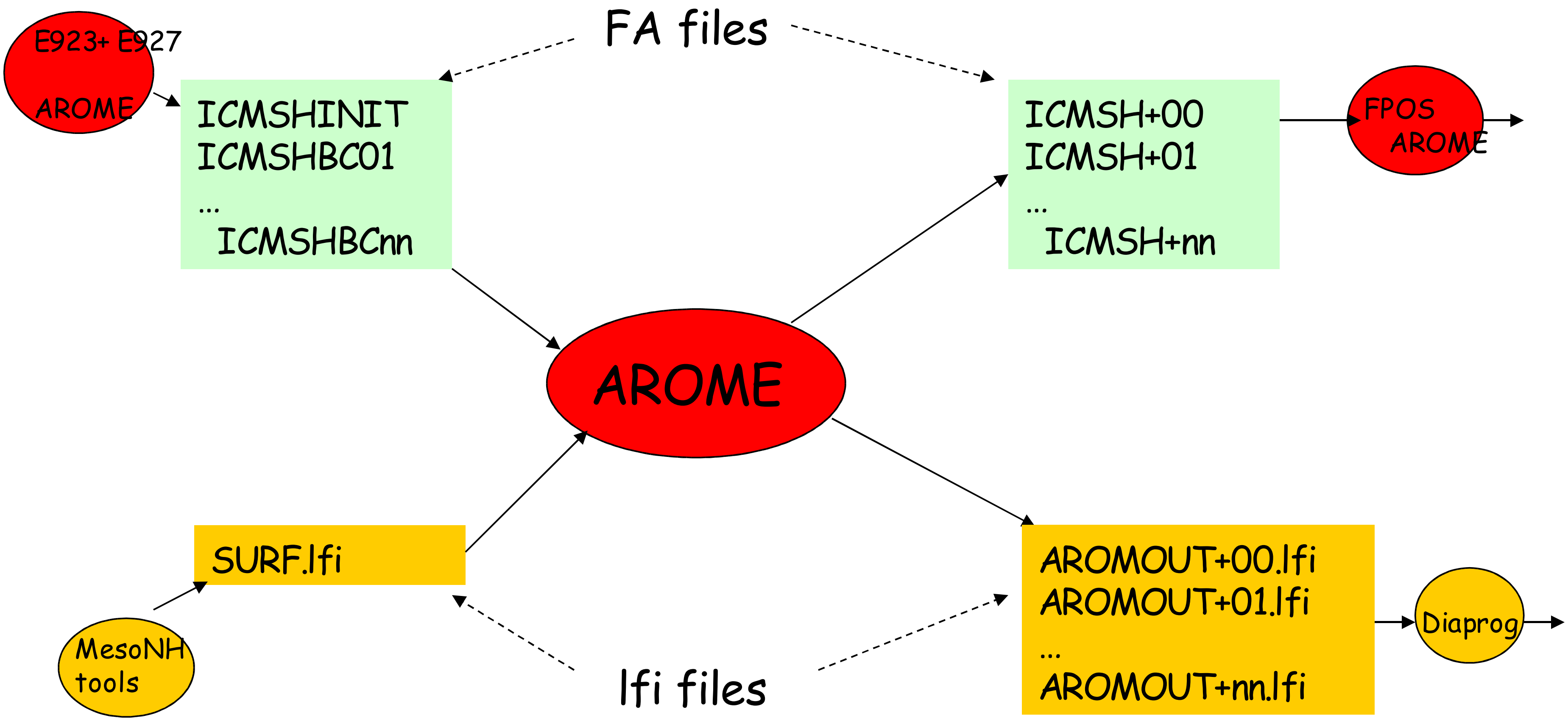
Preparation of files

General view of files involved in an AROME run



Preparation of files

I. Preparation of the clim files E923

- Step 1 : definition of orography
- Step 2 : definition of surface , soil and vegetation characteristics without annual cycle
- Step 3 : definition of monthly climatological values, modif of albedo and emissivity according to the climatology of sea-ice limit
- Step 4 : definition and modification of the vegetation and surface characteristics
- Step 5 : modification of fields created by step 2 and 4 over land from high resolution datasets (for each month)
- Step 6 : Modification of climatological values

Preparation of files (E(E)927)

I. Preparation of the initial and coupling files

E927 (or EE927)

- 75% as in ALADIN 25% new fields specific for AROME
- Interpolation on the 2.5km domain of fields from ARPEGE (E927) or ALADIN (EE927) files (analyses or forecasts)
- Initialisation of new AROME fields to 0. (Qs,Qi,Qc,Qr,Qg) or other constant values (1E-6 for TKE).

Preparation of files (E(E)927)

Content of the initial and bc files for the atmosphere (frodo tool):

- Header (date, geographical informations, a and b coeffs for hybrid vertical coordinate)
- 2d spectral fields : surfgeopoten and surfpression
- 3d spectral fields : u,v,T, Pd,Vd
- 2d gridpoint fields : aerosols (x4), ozone (x3), surface characteristics (x24)
- 3d gridpoint fields : qv, qc, qr, qi, qs, qg, tke, nebul

/= Aladin oper : NH, moist variables +TKE, gridpoint Q

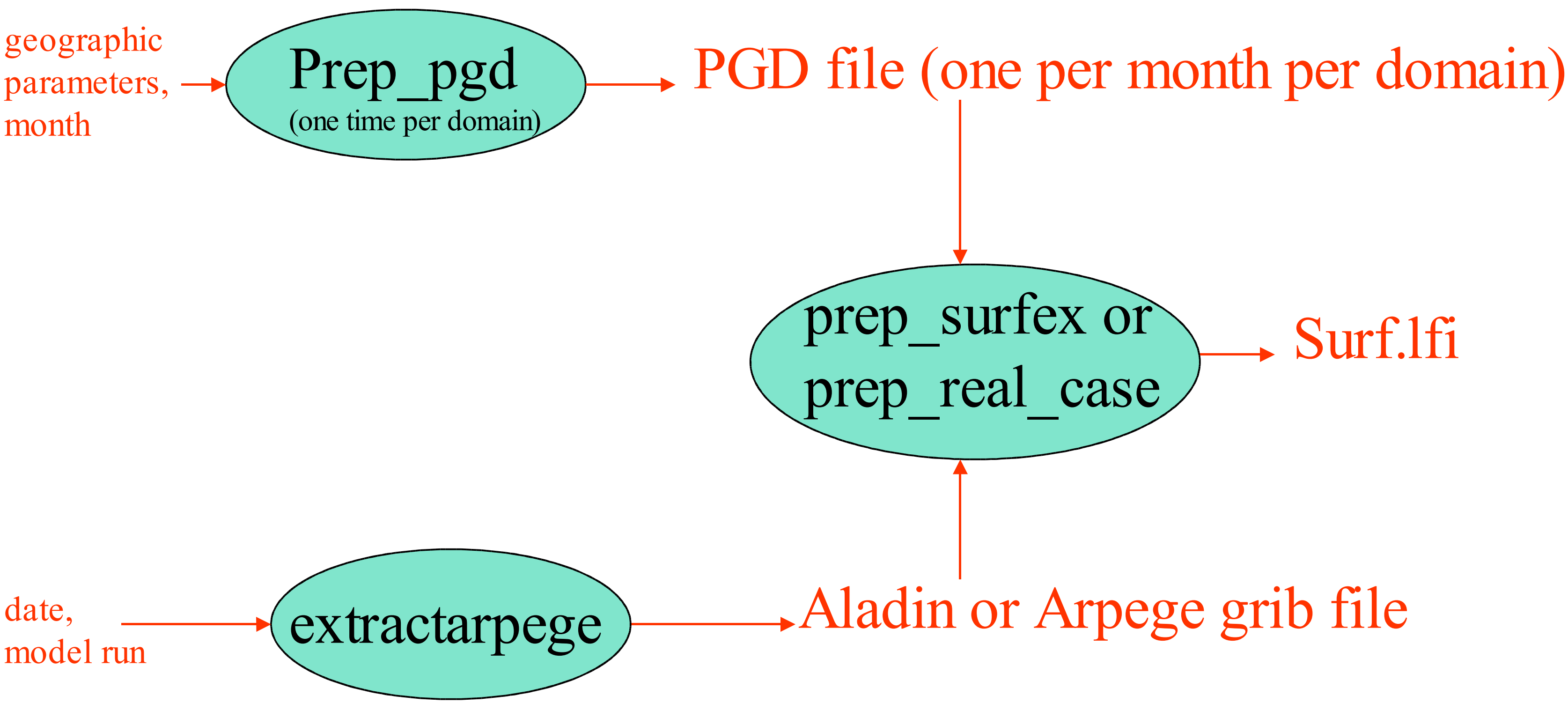
Preparation of files (E(E)927)

Content of the output files for the atmosphere :

- Header (date, geographical informations, a and b coeffs for hybrid vertical coordinate)
- 2d spectral fields : surfgeopoten and surfpression
- 3d spectral fields : u,v,T, Pd,Vd
- 2d gridpoint fields : aerosols (x4), ozone (x3), surface characteristics (x10)
- 3d gridpoint fields : qv, qc, qr, qi, qs, qg, tke, nebul

Preparation of initial surface file

MesoNH tools for preparation of the initial file for the surface :



Preparation of initial surface file

Content of the initial files for the surface :

•VERSION BUG DIM_FULL DIM_SEA DIM_NATURE

• DIM_WATER DIM_TOWN

•COVER001 COVER002 COVER003 COVER004 COVER005 COVER006 COVER151 COVER152 COVER153 COVER154 COVER155 COVE
COVER157 COVER158 COVER159 COVER160 COVER161 COVER162 COVER164 COVER165 COVER167 COVER168 COVER171
COVER174 COVER175 COVER176 COVER177 COVER178 COVER179 COVER180 COVER181 COVER182 COVER183 COVER187
COVER188 COVER189 COVER190 COVER192 COVER193 COVER194 COVER196 COVER198 COVER199 COVER201 COVER202 COVI
COVER204 COVER208 COVER209 COVER210 COVER215 COVER216 COVER218 COVER220 COVER221 COVER224 COVER227 COVI
COVER229 COVER231 COVER232 COVER233 COVER234 COVER235 COVER236 COVER237 COVER238 COVER239 COVER240 COVER
COVER243

• ZSBIS AVG_ZS SIL_ZS SSO_STDEV MIN_ZS MAX_ZS SSO_ANIS

• SSO_DIR SSO_SLOPE HO2IP HO2JP HO2IM

• HO2JM AOSIP AOSJP AOSIM AOSJM

• DUMMY_GR_NBR CH_EMIS SST Z0SEA TS_WATER

• Z0WATER TG1 TG2 TG3 WG1

• WG2 WG3 WGI1 WGI2 WGI3

• WR WSNOW_VEG1 RSNOW_VEG1 ASNOW_VEG RESA

• GROUND_LAYER PATCH_NUMBER CLAY SAND RUNOFFB

• T_ROOF1 T_ROOF2 T_ROOF3 WS_ROOF

• T_ROAD1 T_ROAD2 T_ROAD3 WS_ROAD

•T_WALL1 T_WALL2 T_WALL3

•TI_BLD TI_ROAD T_CANYON Q_CANYON

•ROOF_LAYER ROAD_LAYER WALL_LAYER BUDC

•and 3d atmospheric variables if prepared with prep_real_case

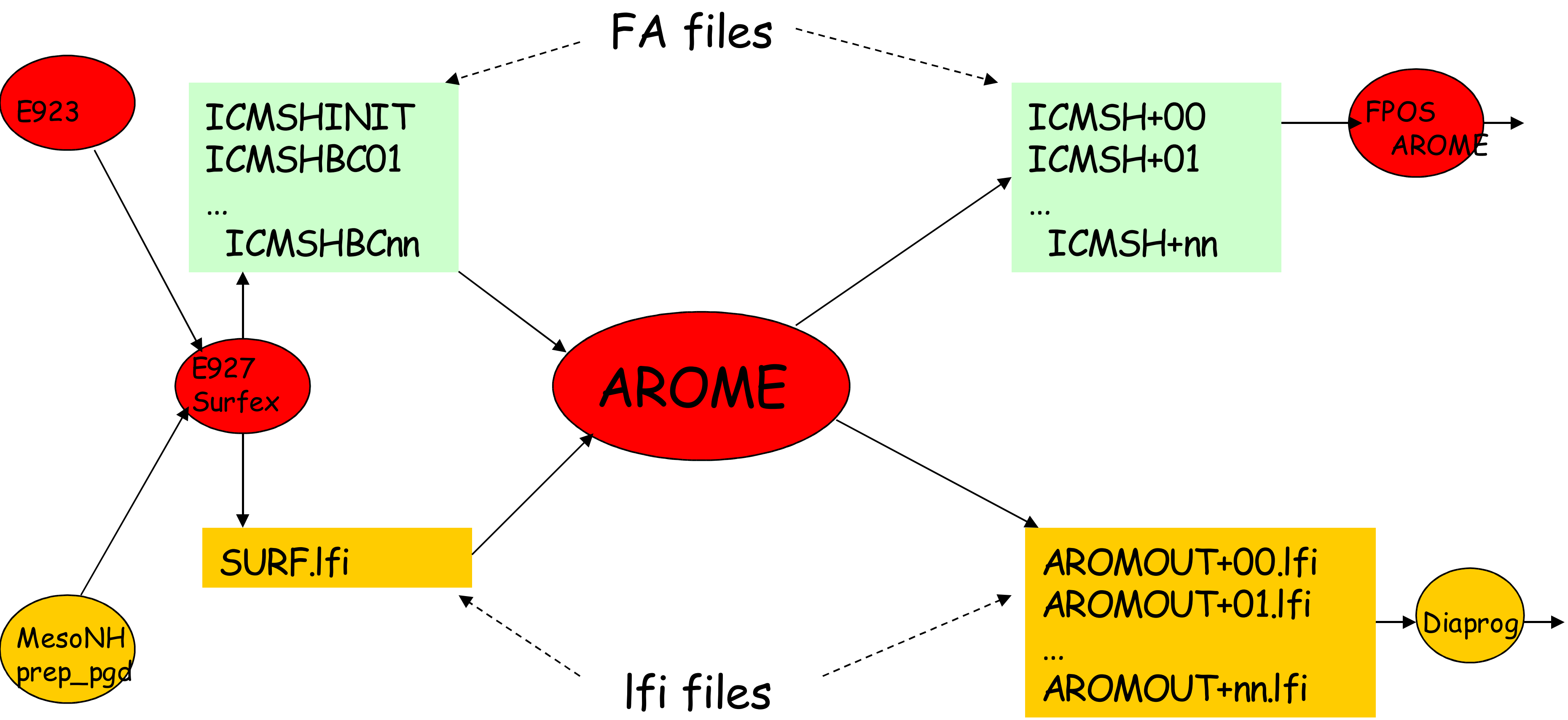
Preparation of initial surface file

Content of the output files from the surface :

- INPRR ACPRR INPRS ACPRS INPRG
- ACPRG VERSION BUG DIM_FULL DIM_SEA
- DIM_NATURE DIM_WATER DIM_TOWN
- COVER001 COVER002 COVER003 COVER004 COVER005 COVER006 COVER151 COVER152 COVER153 COVER154 COVER155 COVER156 COVER157 COVER158 COVER159 COVER160 COVER161 COVER162 COVER164 COVER165 COVER167 COVER168 COVER171 COVER174 COVER175 COVER176 COVER177 COVER178 COVER179 COVER180 COVER181 COVER182 COVER183 COVER187 COVER188 COVER189 COVER190 COVER192 COVER193 COVER194 COVER196 COVER198 COVER199 COVER201 COVER202 COVER203 COVER204 COVER208 COVER209 COVER210 COVER215 COVER216 COVER218 COVER220 COVER221 COVER224 COVER227 COVER228 COVER229 COVER231 COVER232 COVER233 COVER234 COVER235 COVER236 COVER237 COVER238 COVER239 COVER240 COVER241 COVER243
- ZSBIS AVG_ZS SIL_ZS SSO_STDEV MIN_ZS MAX_ZS SSO_ANIS SSO_DIR SSO_SLOPE HO2IP HO2JP HO2IM HO2JM AOSIP AOSJP AOSIM AOSJM DUMMY_GR_NBR CH_EMIS SST Z0SEA TS_WATER Z0WATER TG1 TG2 TG3 WG1 WG2 WG3 WGI1 WGI2 WGI3 WR WSNOW_VEG1 RSNOW_VEG1 ASNOW_VEG RESA GROUND_LAYER PATCH_NUMBER CLAY SAND RUNOFFB T_ROOF1 T_ROOF2 T_ROOF3 WS_ROOF T_ROAD1 T_ROAD2 T_ROAD3 WS_ROAD T_WALL1 T_WALL2 T_WALL3 TI_BLD TI_ROAD WSNOW_ROOF1 RSNOW_ROOF1 TSNOW_ROOF1 ASNOW_ROOF WSNOW_ROAD1 RSNOW_ROAD1 TSNOW_ROAD1 ASNOW_ROAD T_CANYON Q_CANYON ROOF_LAYER ROAD_LAYER WALL_LAYER BUDC
- RI_SEA RN_SEA H_SEA LE_SEA GFLUX_SEA T2M_SEA Q2M_SEA ZON10M_SEA MER10M_SEA
- RI_WAT RN_WAT H_WAT LE_WAT GFLUX_WAT T2M_WAT Q2M_WAT ZON10M_WAT MER10M_WAT
- RI_ISBA RN_ISBA H_ISBA LE_ISBA GFLUX_ISBA T2M_ISBA Q2M_ISBA ZON10M_ISBA MER10M_ISBA
- RI_PATCH RN_PATCH H_PATCH LE_PATCH GFLUX_PATCH T2M_PATCH Q2M_PATCH ZON10M_PATCH MER10M_PATCH
- RI_TEB RN_TEB H_TEB LE_TEB GFLUX_TEB T2M_TEB Q2M_TEB ZON10M_TEB MER10M_TEB
- RI RN H LE GFLUX T2M Q2M ZON10M MER10M

Recent developments (CY30T1)

- Improve Init & Post-Processing :



Recent developments (CY30T1)

MesoNH chemistry scheme under LUSECHEM key :

mpa/chem built as mpa/micro turb and conv

calling of setup routines under sudim1 and suphmnh, run under apl_arome

- Tested on ESCOMPTE POI2B (24 June 2001)
- RUN : 18H de simulation
- GRILLE: 180*180*43 with 4 km mesh
- Cost about 3000 CPU per hour of simulation (30 times faster than MesoNH-CHIMIE)

BUT

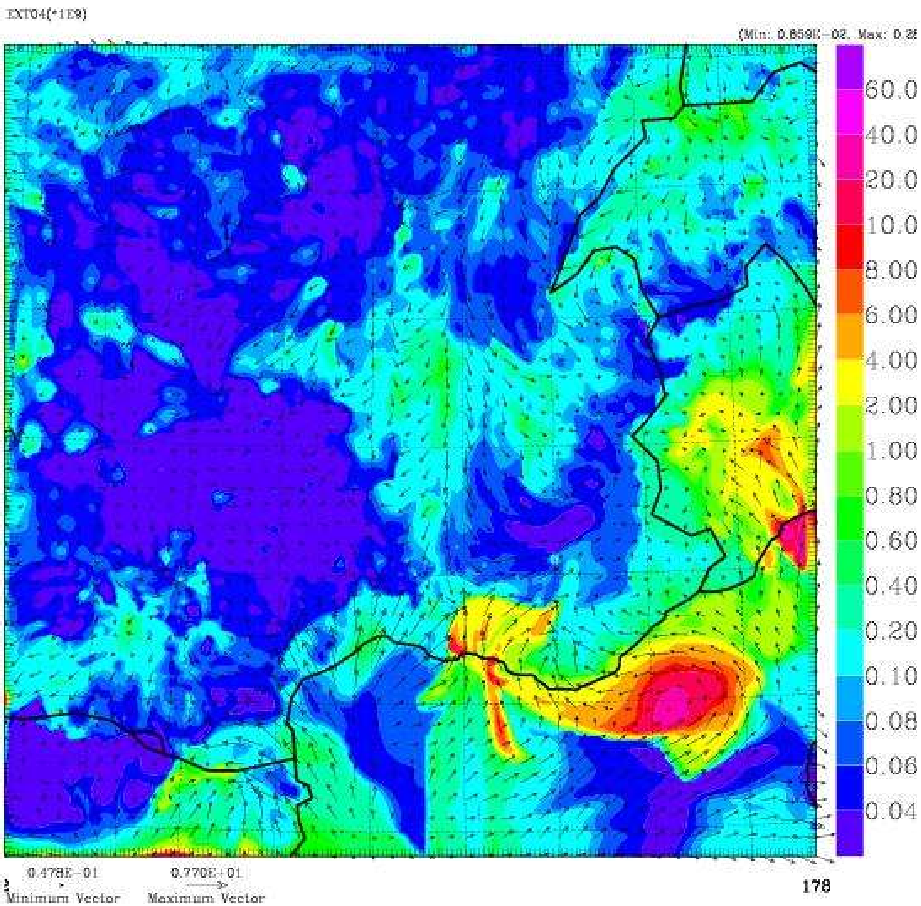
Still under validation

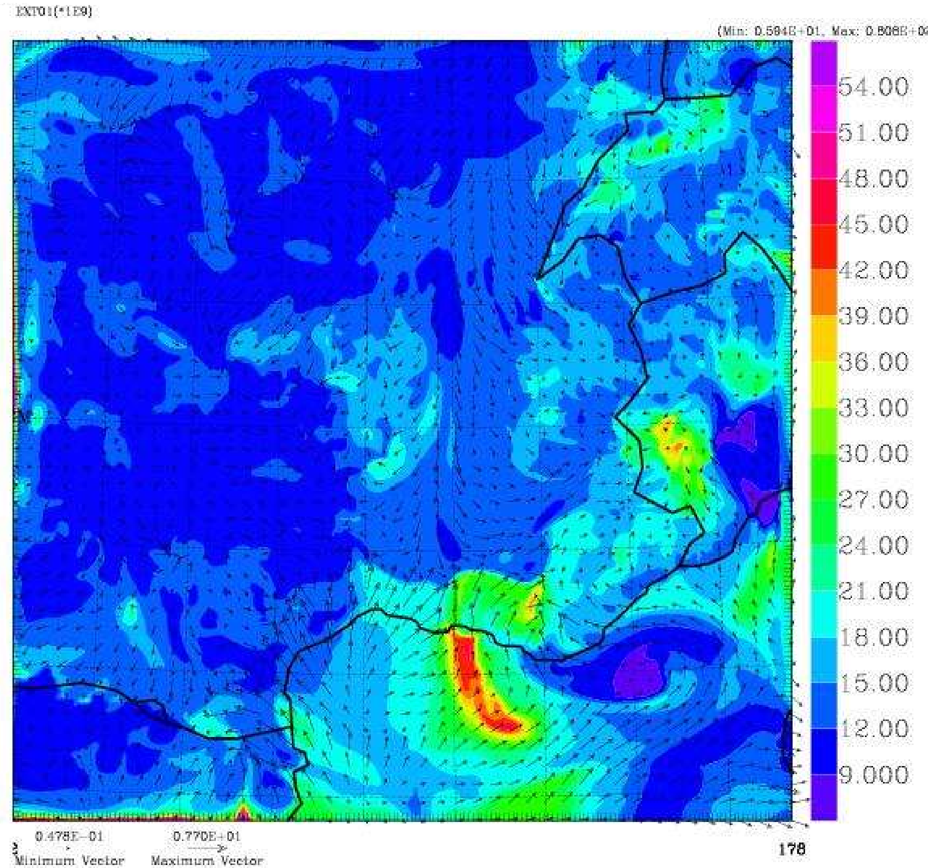
-Documentation on http://www.aero.obs-mip.fr/mesonh/

then Tutorial class, then MESO-NH-chemistry

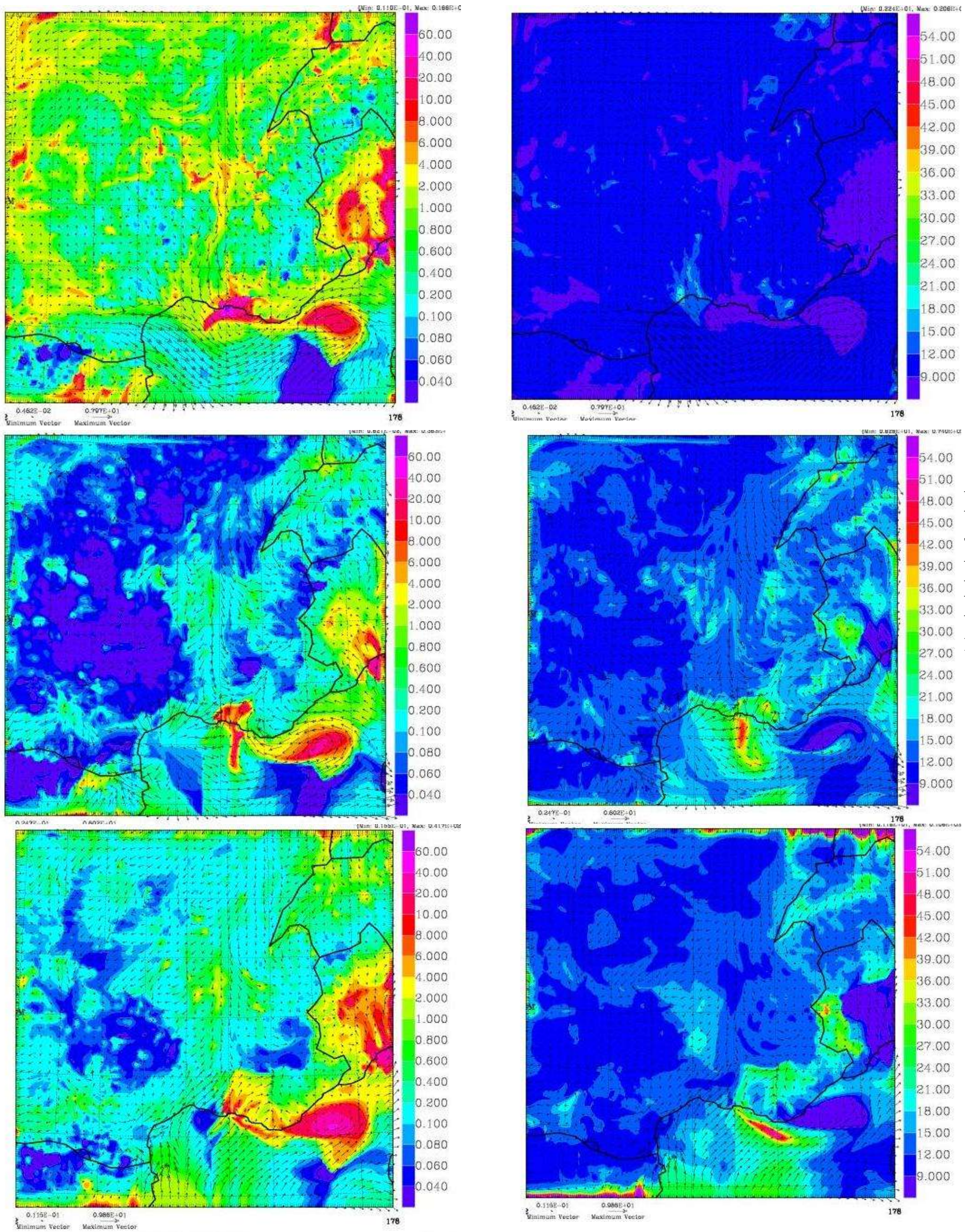
Recent developments (CY30T1)

NOx (ppb) **14 UTC** **O3 (ppb)**





NOX (ppb) **O3 (ppb)**



6 UTC

NOx : urban emissions
O3 constant (initial value); at 6 UTC photochemistry has not started)

12 UTC

Depth increasment of the mixing boundary layer -> [Nox] decreases.
Pollution plumes appears.
Photochemistry active -> O3 in polluted areas and in plumes.

18 UTC

Photochemistry decreases -> [O3] decreases
Transport in the plumes.
Problems near the boarders.