Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

ALARO physics developments

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ALADIN /HIRLAM

DHMZ ZAMG ROMANIA ANM

Talk outline

- ALARO-0
  - Status overview
  - Confirmation of multi-scale behaviour
  - SURFEX, lightning diagnostics
- ALARO-1 developments
  - Turbulence scheme
  - Radiation scheme
  - Convection
- Outlook

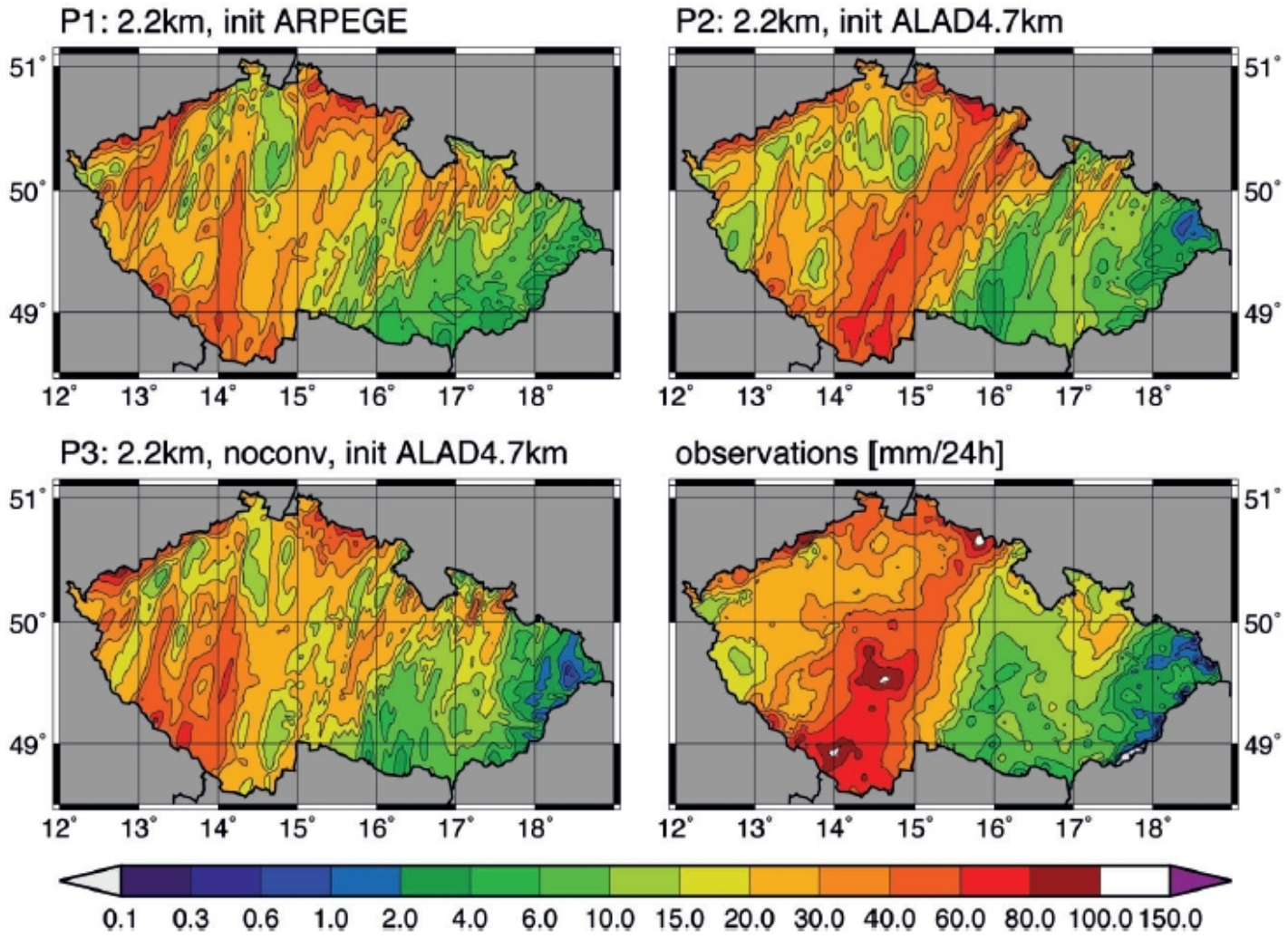
ALARO-0 status

- In the operational use in ALADIN countries
  - at, be, cz, hr, hu, pt, ro, sk, si, tr
    model resolution between 8 km – 4 km, 2km
- In EPS systems
  - ALADIN-LAEF, GLAMEPS, EPS at HMS
- In climatological simulations
- Plans for a usage in
  - HarmonEPS convection-permitting ensemble system
  - multi model systems

Flood event

24h precipitation amount

1 June 06 UTC – 2 June 06 UTC



Flood event

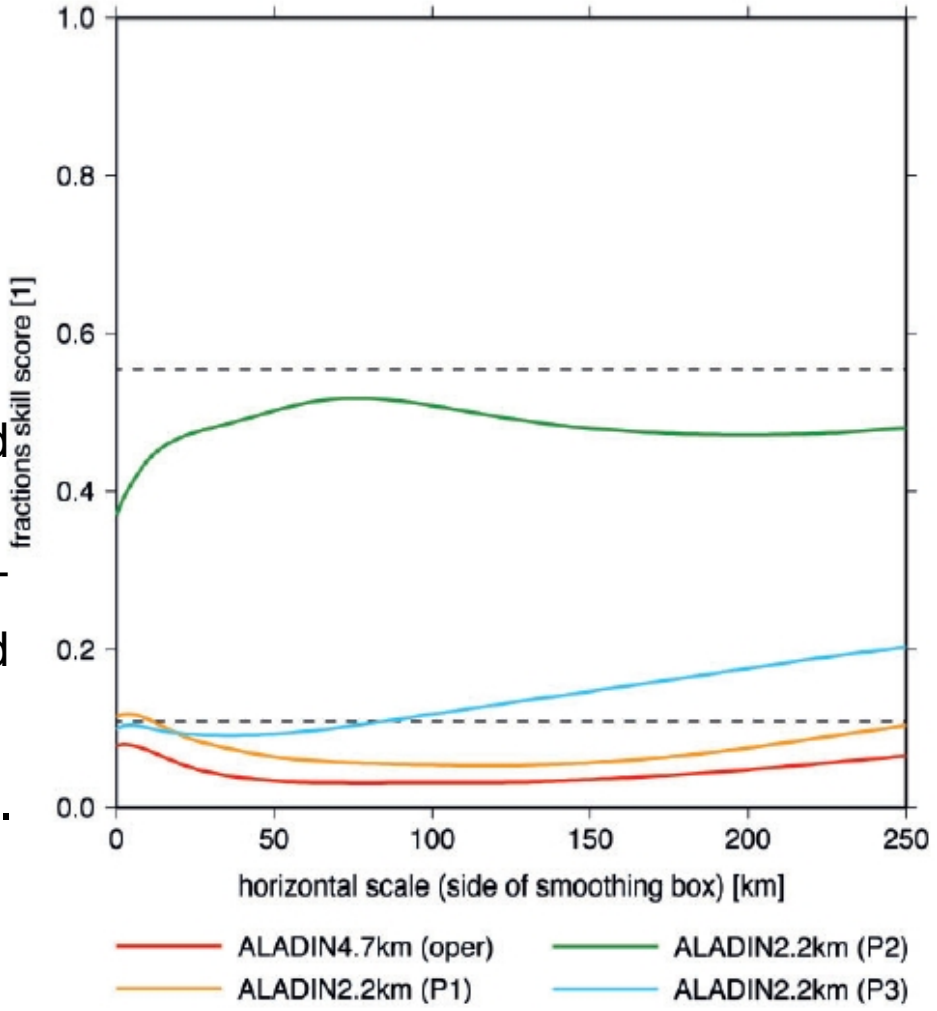
Fraction skill score for the threshold 60 mm/ 24h

Green – 2.2 km with 3MT and starting from interpolated ALARO 4.7km

Blue – 2.2 km without 3MT and starting from interpolated ALARO 4.7km

Yellow – 2.2 km dyn.adap. ARPEGE

Red - operational ALARO 4.7km



Flood event

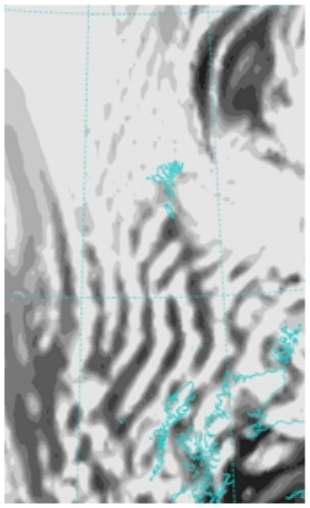
- Plus
  - focus of the precipitation satisfactory simulated
  - significantly better performance than ECMWF (point and area precipitation)
  - area average for various catchments realistically simulated
  - added predictability for large-scale heavy precipitation event

- Minus
  - some local precipitation peaks are underestimated
  - best forecast on (31.05.2013), next days runs underestimated more

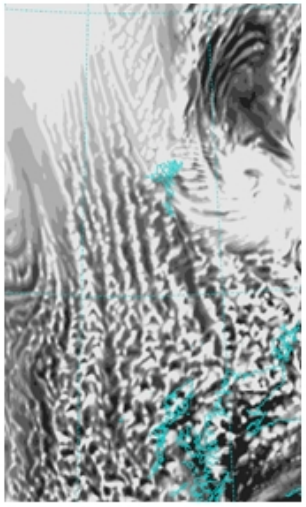
ALARO

- Demonstration of multi-scale behaviour
  - grey-zone experiment defined by WGNE group (http://www.knmi.nl/samenw/greyzone/index.html) (Radmila's presentation)
  - regional climate simulations - extreme precipitation events (Rozemien's poster)

WGNE grey-zone test, ALARO-0, cloud cover at 24h range



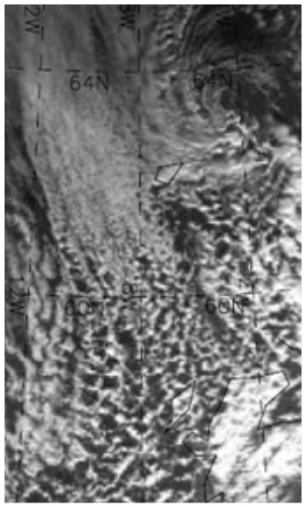
δx=8km

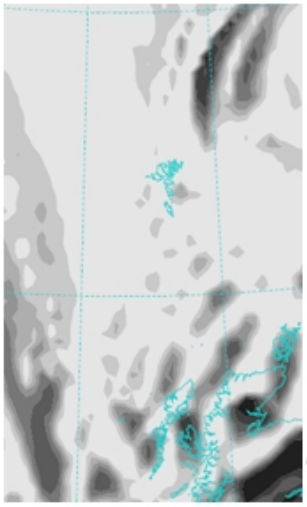


δx=2km

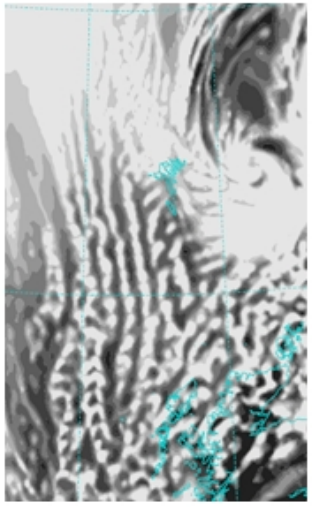
MODIS

observation

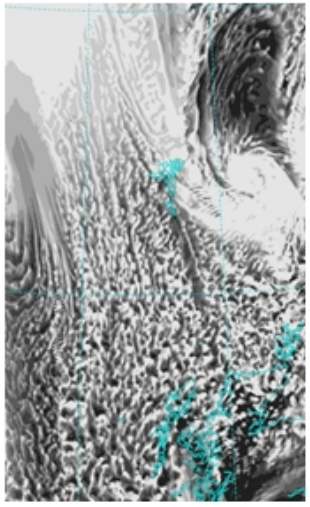




δx=16km



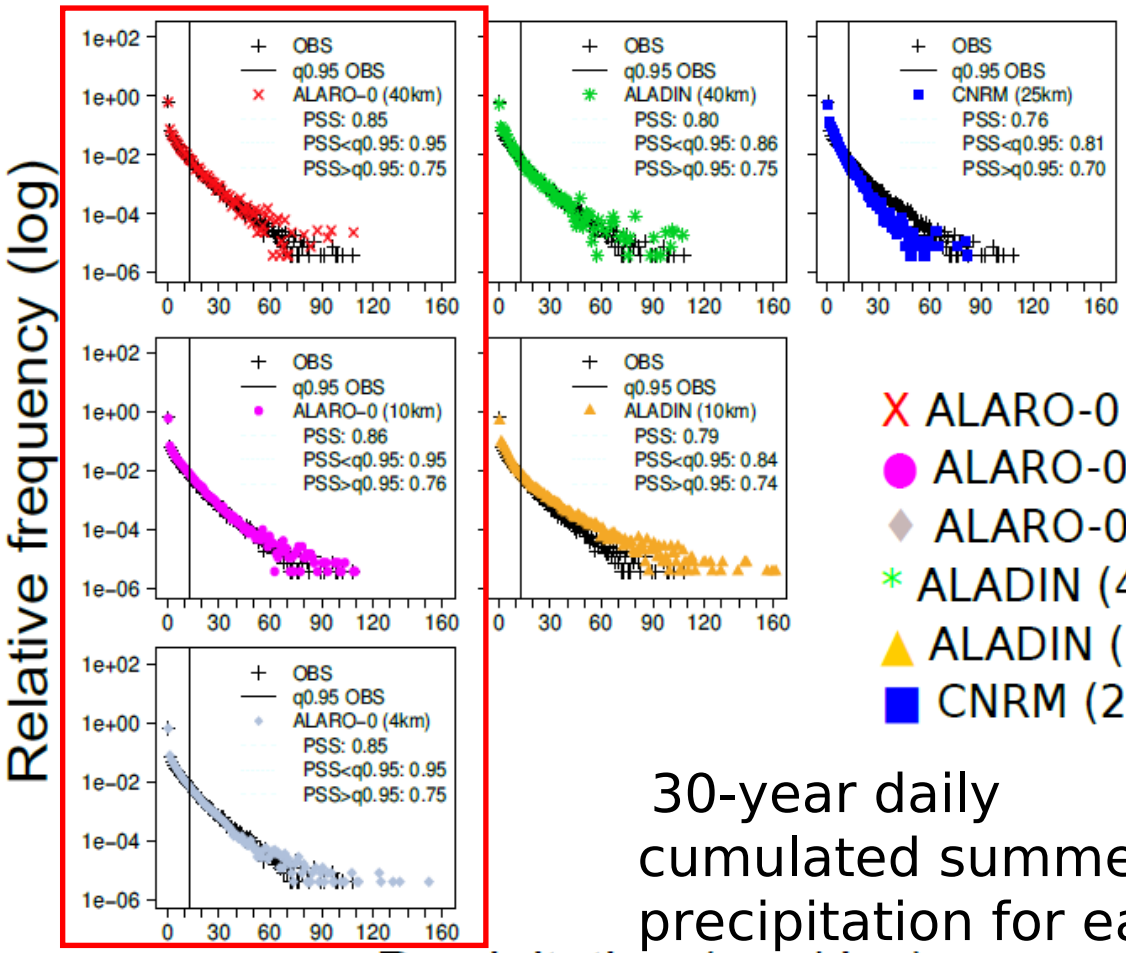
δx=4km



δx=1km

Improvement of ALARO-0

- modeling of extreme precipitation events



30-year daily cumulated summer precipitation for each station in Belgium

Convection diagnostics

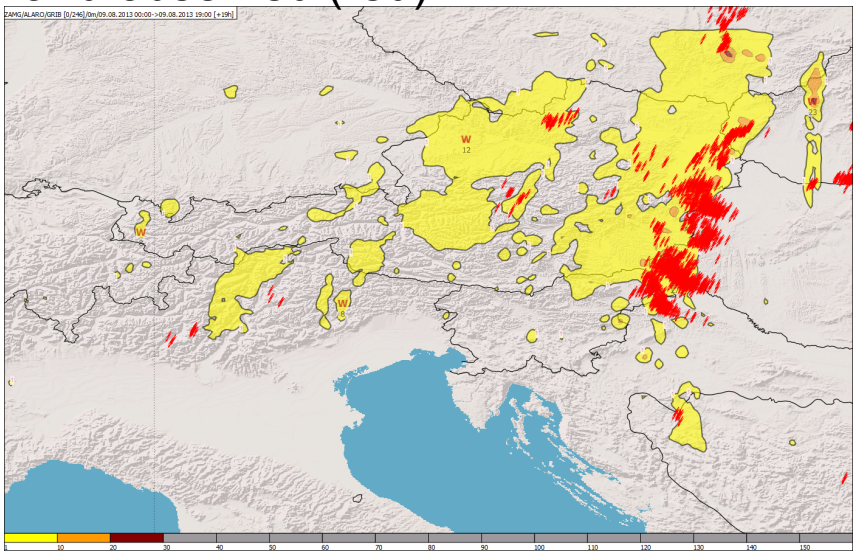
- mixed layer CAPE
- storm motion vector, vertical wind shear, relative helicity
- lightning diagnostics
  - 4 different methods in test
- diagnosed hail
  - vertical integral of graupel,
  - as an instantaneous flux maximum over a given period

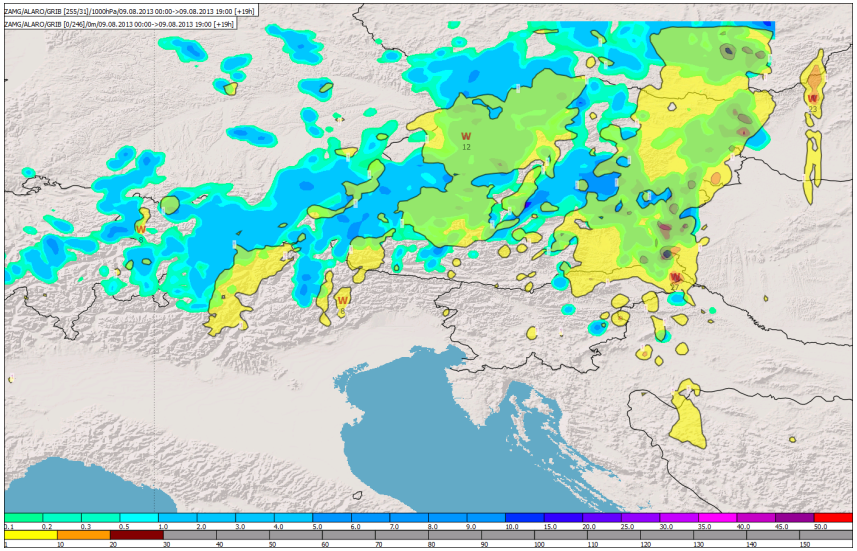
Lightning diagnostics

- to estimate lightning densities 4 different methods are implemented :
  - based on Price and Rind 1992
    - f (vertical wind speed)
  - based on McCaul et al. 2009:
    - f (graupel flux in mixed phase layer region) or
    - f (integrated solid hydrometeors)
    - blended version of above two
- as an accumulated flux
- based on cy38t1

Lightning diagnostics

Forecasted lightning density (yellow – low intensity) and observed (red)





Forecasted lightning density (yellow, orange) and precipitation

SURFEX

- Coupling SURFEX_V7.2 to ALARO within cycle CY38T1
  - implementation
  - tested in one case
- Coupling SURFEX and TOUCANS
  - via the neutral drag coefficient Cdn
  - modifications of routines

- (Rafiq's poster)

ALARO-1 developments (<10 km, down to 1 km)

- Turbulence scheme TOUCANS
- Radiation
- Convection
  - Unsaturated downdraft scheme
  - CSD (Complementary Subgrid Draft)
    deep convection parameterization with a set of high resolution-specific features

TOUCANS

- Coding, scientific evaluation and validation

  The new elements are:
  - emulation of the EFB and RMC01 scheme
  - prognostic TTE (following ZEKRE13)
  - a new more accurate fit of QNSE scheme
  - new revised parametrisation of TOMs (Non-local diffusion of heat and moisture separately).
  - prognostic mixing length (cleaning)
  - computation of SCC (shallow convection cloudiness) still to decide
    - currently based on JFG shallow convection parameterization
    - new non-linear dependence of buoyancy flux on SCC - based on Marquet and Geleyn 2013 and Lewellen and Lewellen 2004 data

TOUCANS

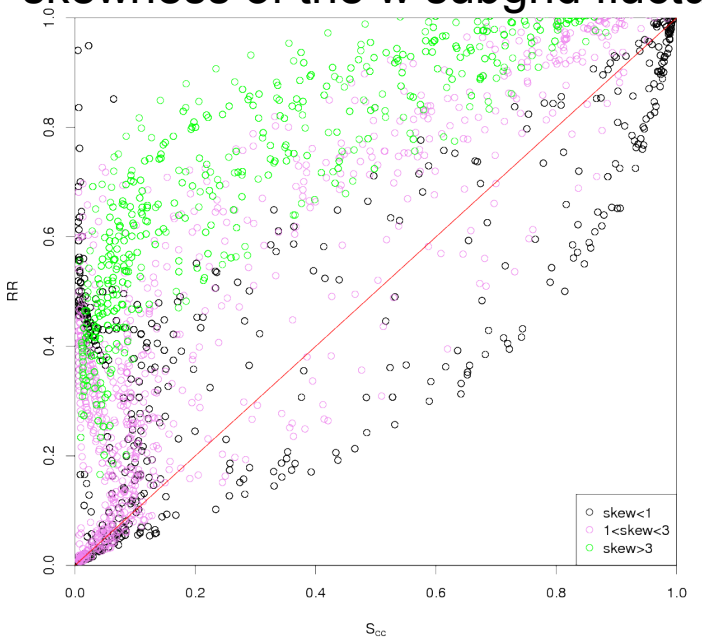
non-linear dependence of buoyancy flux on SCC

Two effects on SCC can be separated

Q - specific horizontal part

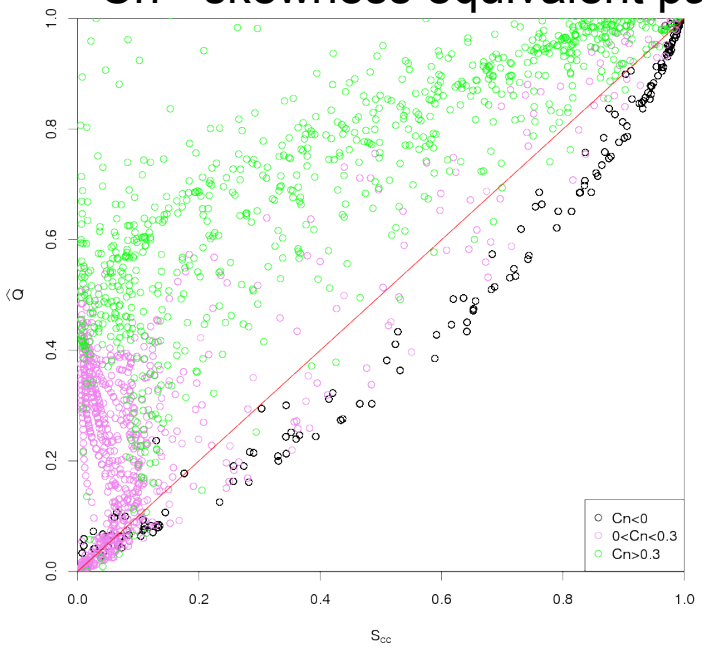
M - transversal vertical aspect

Dependence of RR on SCC
(in RR 2 effects are combined)
skewness of the w subgrid fluctuations



Dependence of Q on SCC

Cn - skewness equivalent parameter



less dispersion and a more regular scaling for Q(SCC)

TOUCANS

- Testing and code debugging, tuning various options
- Searching for an optimal set-up for operational use

Radiation scheme

ACRANEB2 baseline version is finalized

Developments in last months:

- statistical model
  - reformulated statistical model, giving more accurate EBL flux estimate when adjacent exchanges are excluded
  - however, introduction of clouds requires inclusion of adjacent exchanges in EBL flux and thus prevents use of new statistical model
  - workaround is to compute EBL flux by costly exact computation called intermittently
  - 3 hour update frequency of bracketing weights turned to be reasonable

Radiation scheme

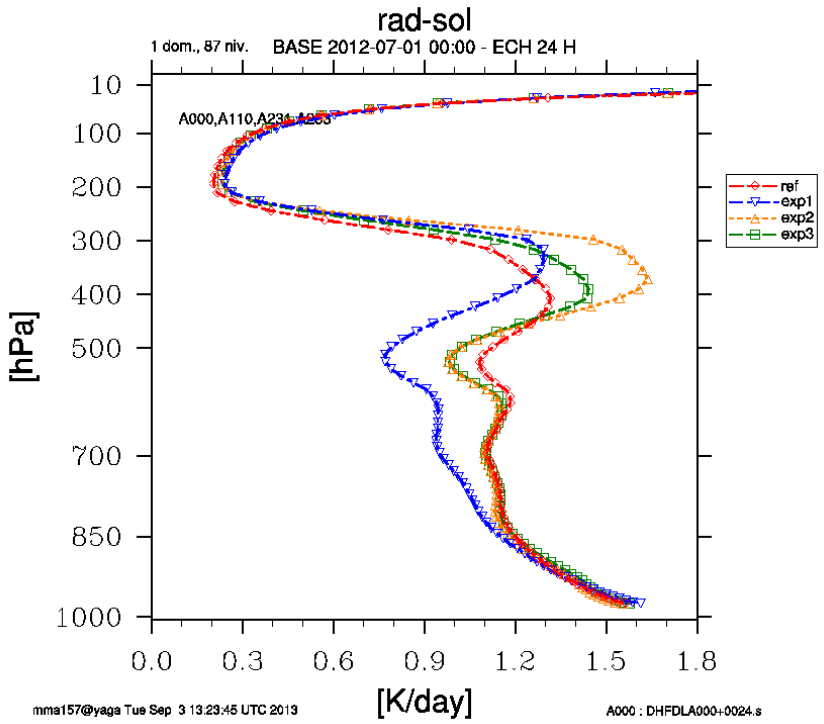
- clouds
  - cloud simulation model was updated and saturation of shortwave cloud absorption was unified with secondary gaseous saturation
  - optical properties of ice clouds were refitted against more modern reference; compromise between cost and accuracy

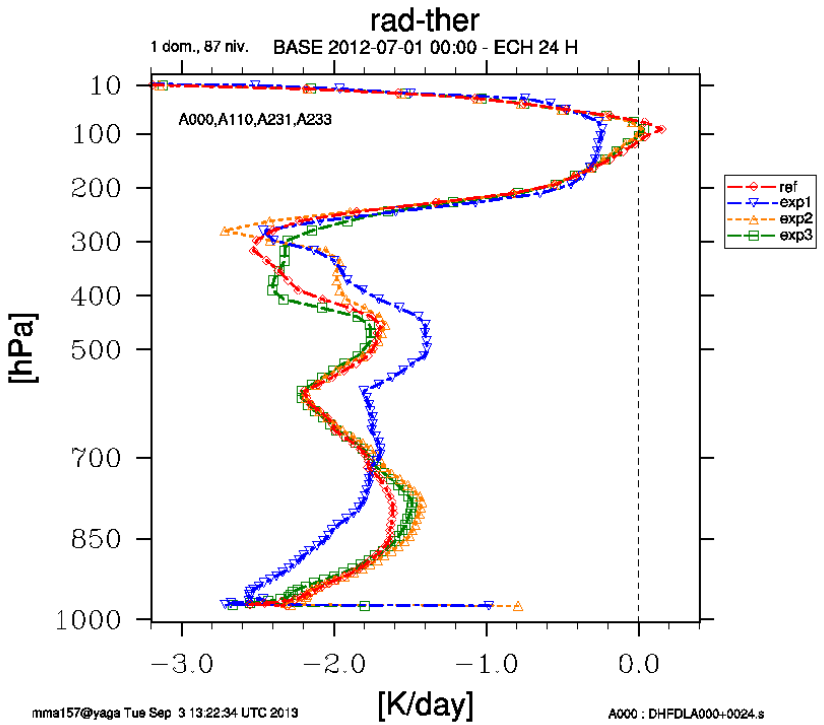
Radiation scheme

- Rayleigh scattering
  - saturation of Rayleigh scattering was parameterized
  - it relies on dominant role of primary scattering
- surface albedo
  - dependency of direct surface albedo on sun elevation was revised in ISBA case
  - Geleyn's formula was generalized by adding proportion of Lambertian reflection
  - setting this proportion to 0.6 greatly improves direct albedo of land and snow

Radiation scheme

24 hour DDH heating rates for full integrations including aerosols and clouds





solar

red - FMR/RRTM reference
blue - ACRANEB
yellow - ACRANEB2 without ice clouds
green - ACRANEB2

thermal

ACRANEB2

- extensive testing is 3D ongoing (cy38t1)
  - it is premature to draw the conclusions
  - it is necessary to get rid of biases which are probably arising from broken error compensations
- extra cost in ALADIN/CHMI oper configuration is about 8% with respect to ALARO integration using old ACRANEB scheme
- phased into cy40t1; available under both APLPAR and APL_AROME via new INTFLEX phys-dyn interface

ACRANEB2 baseline namelist settings

```
&NAMPHY
  NRAY=2,                 - activation of ACRANEB2
  NTHRAYFR=-1,            - 1 hour intermittency for LW gaseous
                            transmissions
  NRAUTOEV=3,             - 3 times longer update interval for
                            statistical weights (3 hours in this case)
  LRPROX=.F.,             - include adjacent exchanges in EBL
                            computation
/
&NAMPHY3
  RLAMB_SOLID=0.6,        - proportion of Lambertian reflection for
                            solid  surfaces
/
```

Convection

- Non-saturated downdraught
  - with or without the complementary sub-grid option
  - the necessity of a re-tuning of the updraught or of microphysics
  - modifications of the equivalent cloudiness (removing an earlier inconsistency)

(Pieter De Meutter's presentation)

- Complementary Subgrid Upraft
  - some novelties included
  - tests show a satisfactory extinction when increasing resolution, together with a gradual increase of the maximum 'real updraft' mesh fraction towards 1

Plans

- Assembling strategy in 2 steps
  - Step 1:
    - TOUCANS, Unsaturated downdraft and radiation (ACRANEB2)
  - Step 2:
    - complementary sub-grid drafts (CSD),
    - TOUCANS evolution,
    - prognostic graupel,
    - thermodynamic adjustment,
    - unified cloud treatment in radiation, shallow convection, thermodynamic adjustment and 3MT,
    - Cellular Automaton some adaptations needed

Plans

- Physics-dynamics interface
- Orographic effect parametrization for radiation

- Validation
  - investment in testbeds and facilities
  - validation of developments
  - tests at higher resolution (scales around 2 km mesh-size)

Plans

Revision, update of plans in one month at

ALARO-1 Working days
Vienna, 12-14 May 2014

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