AROME at HIRLAM institutes –
the HARMONIE system

- What is HARMONIE and the HARMONIE system?
- Recent developments within HARMONIE.
- Near future plans.

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2nd Arome training course
IM, Lisbon, Portugal,
4 - 7 March 2008.
What is HARMONIE?

• During 2004 and 2005 HIRLAM and ALADIN consortia decided to deepen already existing cooperation in NWP. One of the main goals of the new cooperation is to develop a km-scale operational NWP system.

HARMONIE
Hirlam Aladin Regional/Meso-scale Operational NWP In Europe

• The learning process by running AROME (and/or ALADIN) on daily basis.

<table>
<thead>
<tr>
<th>Institute</th>
<th>Version</th>
<th>Domain</th>
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<tbody>
<tr>
<td>SMHI</td>
<td>cy31t0</td>
<td>Southern and Northern Sweden (2.5km L60)</td>
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<tr>
<td>FMI</td>
<td>cy32h2</td>
<td>Southern Finland (2.5 km L40)</td>
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<tr>
<td>DMI</td>
<td>cy32t2</td>
<td>Denmark (2.5km L40)</td>
</tr>
<tr>
<td>KNMI</td>
<td>cy31h1</td>
<td>Netherlands (2.5km L40)</td>
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What is the HARMONIE system?

- Starting point for HIRLAM in 2004
  - Source code of ALADIN/AROME
  - Unknown compilation tool GMKPACK
  - Individual shell scripts and namelists for different processes.

**CLEAR NEED FOR COMMON “HARMONIE” SYSTEM!**

1. Combine all the important processes in one launch.
   - Compilation.
   - Climate and boundary generation (and data assimilation).
   - Forecast (Arome, Aladin and Alaro with different physics options).
   - Postprocessing and file conversions.
   - Verification.

2. An easy start for beginners and a flexible tool for researchers.

3. Easy access **for all of us** through HARMONIE repository (subversion).
Recent developments within HARMONIE (1/2)

• Most of the recent developments has been concentrated on developing the scheduling system (mini-SMS) for HARMONIE.

• To avoid the misunderstanding: the system presented in the following slides is NOT going to be used in exercises!

• However... anyone who is interested to try it during the week or later, please don't hesitate to ask advice!
HARMONIE repository

- **https://hirlam.org/trac/browser/trunk/harmonie**

- **src**: Source code of ARPEGE/IFS CY33T0.

- **nam**: Namelists for
  1. climate generation
  2. fullpos (postprocessing and boundary generation)
  3. different forecast options (Arome, Aladin, Alaro etc.)

- **scr, sms, msms, config-sh**: Scripts for running the model(s). Configuration files for different platforms: environment and submission database.

- **util**: Tools
  1. **gl** converter, LBC, interpolation tool etc.
  2. **monitor** verification and monitoring
  3. **gmkpack 6.2.4** compilation tool
  4. **ddh** tool for handling ddh files

• **Open access from all HIRLAM and ALADIN institutes!**
• Documentation at **https://hirlam.org/trac/wiki/HarmonieSystemDocumentation**
Functionality of HARMONIE system
How to make an AROME experiment on HPCE@ECMWF

1. **Assumption:** Installation of the `ROOTPACK` exists.

2. **Preparations:**
   - i) Login to HPCE.
   - ii) Setup your experiment directory

```bash
mkdir EXPNAME
cd EXPNAME
PATH_TO_HARMONIE/config-sh/Harmonie setup [-r release][-h host]
```

PATH_TO_HARMONE =
/ms_perm/hirlam/harmonie_release/trunk/

Install `ROOTPACK` =
/ms_perm/hirlam/harmonie/pack

Build an experiment
Configuration files

1. System configuration `config-sh/config.hcpe`:
   - Defines the environment, paths to work area, climate database, `ROOTPACK`, `HOMEPACK` etc.
   - This you don't have to touch... unless you want to install the system on your own platform.

2. Submission directives `config-sh/submit.hpce`:
   - Defines the batch job directives for all processes.
   - Usually, you don't have to touch.

3. Experiment configuration `sms/config_exp.h`:
   - Most important!
   - Defines your experiment
     i) model (Arome, Aladin h/nh, Alaro etc.)
     ii) host model (IFS, Hirlam, Aladin)
     iii) time-step, domain, resolution, cycling interval, boundary interval... etc.
How to make an AROME experiment on HPCE@ECMWF

- Start your experiment

  Harmonie start
  DTG=2008010100 DTGEND=2008013100 LL=24

- Graphical mini-SMS window:
How to make an AROME experiment on HPCE@ECMWF

• Start your experiment

Harmonie start
DTG=2008010100 DTGEN=2008013100 LL=24

• Graphical mini-SMS window:
  - Compilation (*Build*)
  - Preparation (*MakeCycleInput*)
  - Forecast (*MakeForecast*)
  - Postprocessing (*Postprocessing*)
How to make an AROME experiment on HPCE@ECMWF

**Build**

- **Build_pack**: compilation of source code modifications for model.

- **Make_gl**: compile the gl-tool.

- **Make_monitor**: compile the verification code.
How to make an AROME experiment on HPCE@ECMWF

- **MakeCycleInput**

  - **Climate**: climate file generation.
  
  - **Prepare_pgd**: *surfex physiography* generation (not shown).
  
  - **Extract_bd**: extract original boundary files from *ECFS* or *MARS*.
  
  - **LBC**: boundary file generation by *gl* or *Fullpos*. 
How to make an AROME experiment on HPCE@ECMWF

• **MakeForecast**

  - *Forecast*: runs the model.
  - *Archive_fc*: archives all forecast files to selected disk area.
How to make an AROME experiment on HPCE@ECMWF

• Postprocessing

- **Extract4ver**: extracts the station equivalents from model data.

- **Postp_family**: postprocessing by Fullpos.

- **Grib_family**: conversion to **GRIB** format.

- **ECMWF**: at ECMWF, archiving to **ECFS** or **ECTMP**.

- **FetchOBS**: fetches observations from **MARS** for verification (not shown).

- **Verify**: verify the experiment (not shown).
The HARMONIE system doesn't yet provide

**An assimilation system**

- One important meteorological part is still missing.

**Surfex physiography generation**

- Code for Surfex physiography generation is not included in the HARMONIE system.

- At HPCE, the system relies on the pre-installed Meso-NH tools provided by Meteo France.
Recent developments within HARMONIE (2/2)

Scientific development:

• So far most of the scientific work has been concentrated on developing model diagnostics for validation purposes.

• Activity around model physics and data assimilation has been recently started.
Comparison against radar data (radar simulator)

AROME 31JUL2007 00 UTC Forecast. Radar reflectivity [dBZ] 31JUL2007 09:00 UTC (ARO,2.5km).

Radar reflectivity [dBZ] simulated from AROME +9h forecast.

Observed radar reflectivity [dBZ].

Raders:VAN, IKA, ANJ, KUO, KOR, VIM
Antenna=0.3°

Max: 44.8418

Max: 46.5645

Observed radar reflectivity [dBZ].
Comparison against radar data (radar simulator)

Frequency distribution of radar reflectivity.

AROME's distribution = blue bars
Observed distribution = black bars

Size spectrum analyser under development!
Comparison against satellite data

Evaluation of the cloud structure in AROME
Wind/precipitation studies at KNMI
Findings

• Too strong precipitation for deep convection.

• Too strong outflow from the convective systems (“fireworks”).

• Mesoscale convective systems seems to be too large in the model.

• Too weak winds near the surface over the land areas (KNMI).
Near future plans within HARMONIE

PHYSICS
• SURFEX developments (inclusion of forest tile).
• Inclusion of Lake scheme in SURFEX.
• Development of EDMF
• Impact of boundaries and initial conditions on AROME.
• Impact of deep convection parameterization on resolved deep convection.
• Radiation scheme intercomparison and optimization.

DATA ASSIMILATION (according to work plan)
• Construction and testing of a common 3D-VAR system based on ALADIN.
• Setup of a mesoscale surface DA-system (soil, water surface, snow etc.).
• Remote sensing data: radar reflectivity/winds, GPS, satellite data.