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D 9.2 – WP1.2

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Abstract

This report describes the meteorological ensemble models which will be used by participants of work package one (WP1). The data will be used to drive dispersion models and to explore the impact of uncertainty in meteorology on dispersion forecasts. Ensemble dispersion calculations are scheduled to take place during the second year of the CONFIDENCE project.

<End of abstract>

Meteorological Data Description

Contents

Introduction

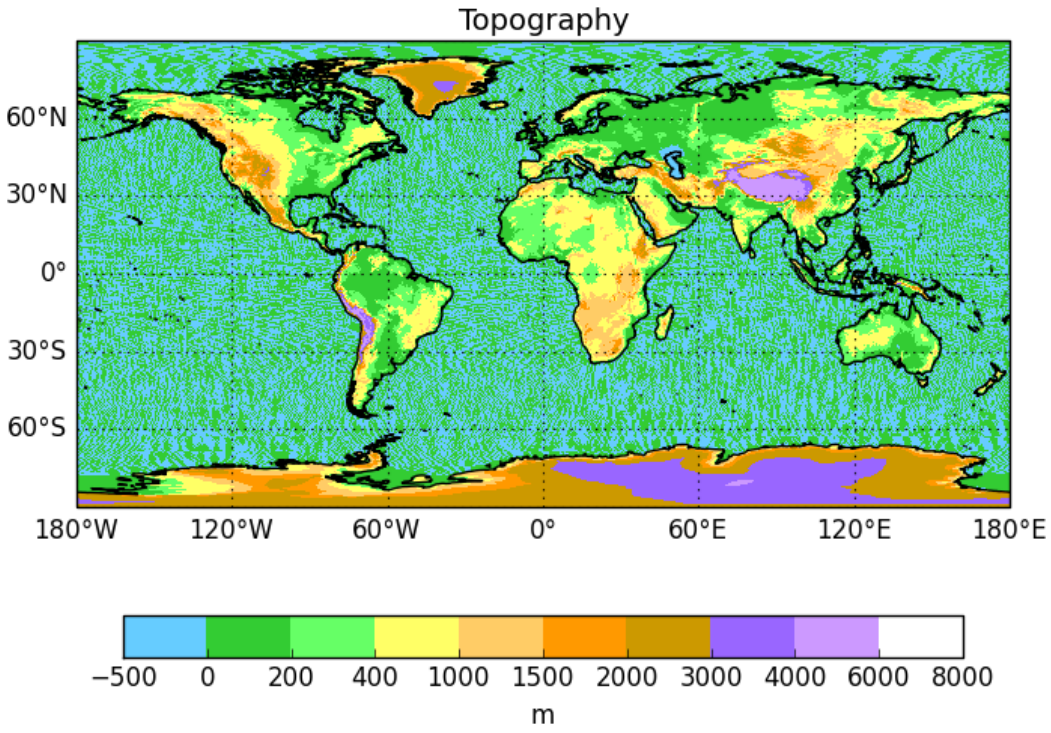
Atmospheric dispersion models rely on meteorological information such as information about the 3-dimensional winds, temperature, and rainfall in order to perform their dispersion calculations. Typically, numerical weather prediction (NWP) models provide this information. However, there is increasing pressure to present information on the uncertainty of the dispersion predictions. There are three main sources of uncertainty for dispersion models, the driving meteorology, the dispersion model itself and information about the material released (also known as the source term). Many dispersion models are now looking to meteorological ensemble predictions systems to provide estimates of the uncertainty in the driving meteorology. Part of the aim of work package 1 of the CONFIDENCE project is to provide an assessment of the ability of these ensemble prediction systems to provide sufficient uncertainty information for dispersion modelling.

The first task in CONFIDENCE work package 1 looks at quantifying the different sources of uncertainty. To quantify the uncertainty provided by the meteorological ensembles the study will use a number of ensembles for two types of case study. The first case study is the 2011 accident at the Fukuhsima Dai-ichi nuclear power plant that occurred following a huge earthquake and tsunami. The second type of case study will focus on hypothetical releases from locations within Europe.

This document provides an overview of the meteorological data used to perform dispersion calculations for the work package 1. For each meteorological data set a table provides key information about the horizontal, vertical and temporal resolution as well as the number of ensemble members and the standard format of the data. The information also includes a figure showing the model domain, a short description of the model and some key references providing additional information about the model. Deterministic models are also included in the document as it is possible to use an “ensemble” of deterministic models or a “lagged” ensemble of subsequent runs of one model as an alternative source of uncertainty information.

ECMWF Ensemble Data

Horizontal Coordinates: Latitude-Longitude Domain: Global Resolution: ~18km by 18km	**Vertical** Coordinates: Hybrid pressure Resolution: Variable (91 levels) Model Top: 0.01 hPa
Temporal Forecast Length: 15 days Resolution (time step): 3 hours Run frequency: Twice a day	Ensemble: Yes Number of Members: 51 Format(s): Grib



Short Description

The Ensemble Prediction System (EPS) forecasts run operationally by the European Centre for Medium Range Weather Forecasting (ECMWF) are primarily intended for medium-range (3-15 day) applications. The ensemble consists of a control forecast with unperturbed initial conditions and 50 forecast members with perturbed initial conditions. Perturbations are provided through a combination of an ensemble data assimilation and initial-time singular vectors. Random model errors

due to physical processes and subgrid-scale effects are simulated through stochastic physics parameterisation schemes (Buizza et al., 1999).

References

Buizza, R., Miller, M. and Palmer, T.N. (1999). Stochastic representation of model uncertainties in the ECMWF ensemble prediction system, Q. J. R. Meteorol. Soc. **125**, 2887-2908.

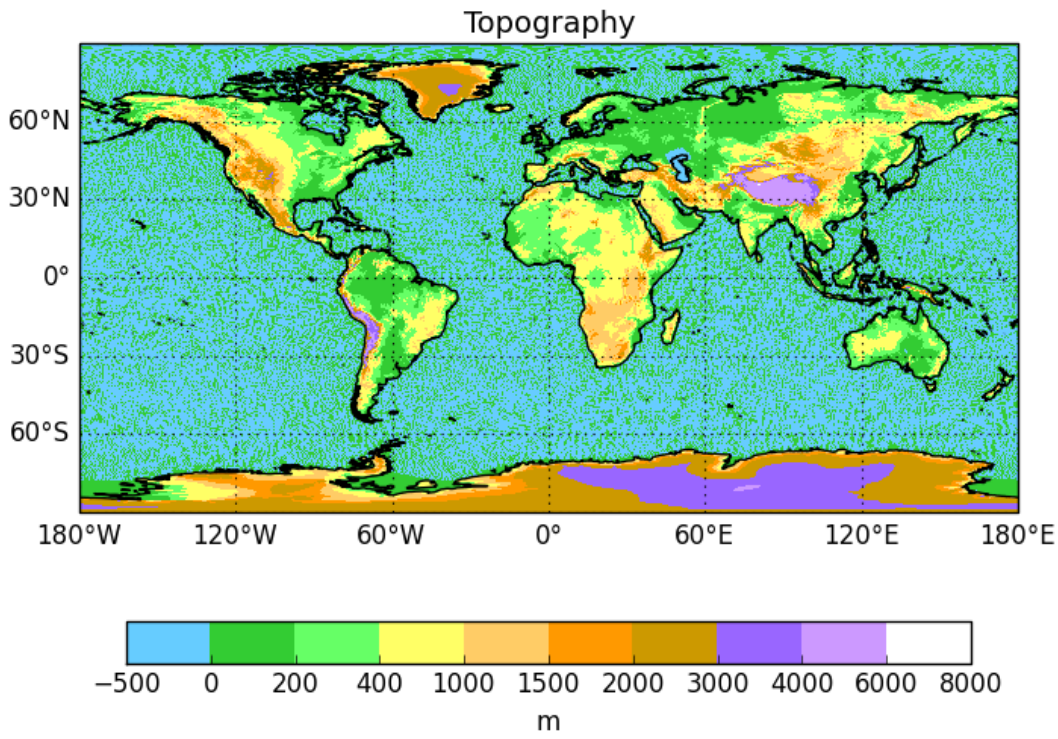
Buizza, R., Bidlot, J.R., Wedi, N., Fuentes, M., Hamrud, M., Holt, G. and Vitart, F. (2007). The new ECMWF VAREPS (variable resolution ensemble prediction system), Q. J. R. Meteorol. Soc. **133**, 681-695.

Availability

Available from Tigge (http://www.ecmwf.int/en/research/projects/tigge) at reduced horizontal and vertical resolution

ECMWF Deterministic Data

Horizontal	**Vertical**
Coordinates: Latitude-Longitude Domain: Global Resolution: ~9km by 9km	Coordinates: Hybrid pressure Resolution: Variable (91 levels) Model Top: 0.01 hPa
Temporal Forecast Length: 15 days Resolution (time step): 3 hours Run frequency: Twice a day	Ensemble: No Number of Members: N/A Format(s): Grib



Short Description

The high resolution global forecast model run operationally by the European Centre for Medium Range Weather Forecasting (ECMWF) provides 10-day forecasts twice a day at 00UTC and 12UTC. It is a spectral NWP model (Simmons et al., 1989) using a 4D variational data assimilation system (4D-Var), see Rabier et al. (2000) and Mahfouf and Rabier (2000) with 91 vertical levels.

References

Mahfouf, J.-F., Rabier, F., 2000. The ECMWF operational implementation of four-dimensional variational assimilation. II: experimental results with improved physics. Q. J. R. Meteorol. Soc.126, 1171-1190. dx.doi.org/10.1002/qj.49712656416

Rabier, F., Järvinen, H., Klinker, E., Mahfouf, J.-F., Simmons, A., 2000. The ECMWF operational implementation of four-dimensional variational assimilation. I: experimental results with simplified physics. Q. J. R. Meteorol. Soc. 126, 1143 - 1170. dx.doi.org/10.1002/qj.49712656415

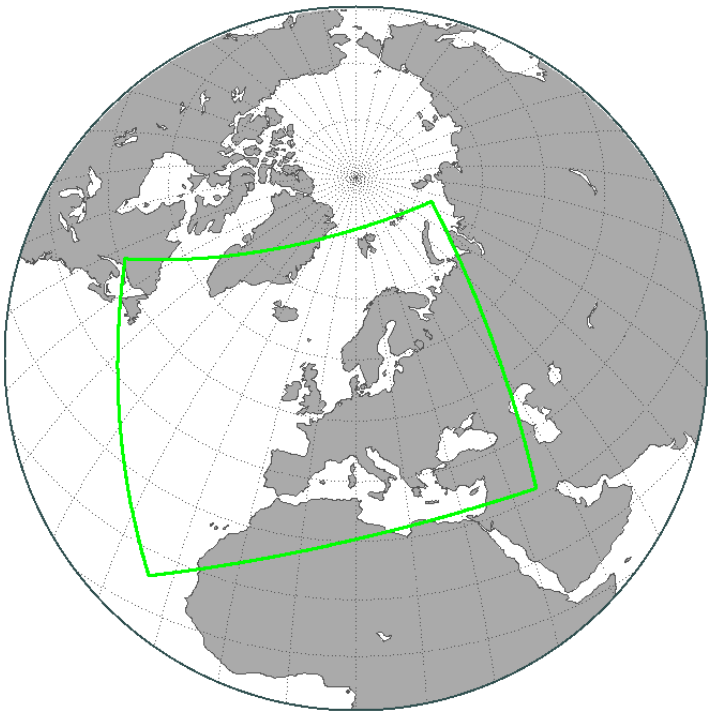
Simmons, A.J., Burridge, D.M., Jarraud, M., Girard, C., Wergen, W., 1989. The ECMWF medium-range prediction models: development of the numerical formulations and the impact of increased resolution. Meteorol. Atmos. Phys. 40, 28-60. dx.doi.org/10.1007/BF01027467

Availability

Available from Tigge (http://www.ecmwf.int/en/research/projects/tigge) at reduced horizontal and vertical resolution

Grand Limited Area Model Ensemble Prediction System (GLAMEPS)

Horizontal Coordinates: rotated geographic Domain: Europe Resolution: 0.075deg horizontal res., ~8km, 3h	**Vertical** Coordinates: model in sigma-hybrid, but output in pressure-levels only Resolution: 3 pressure levels (925,850,500hPa) Model Top: 500 hPa
Temporal Forecast Length: 54 Resolution (time step): 3h Run frequency: 2+2 times daily (control runs + alternating half members 4 times daily)	Ensemble: Yes Number of Members: 54 Format(s): NetCDF



Short Description

GLAMEPSv2 is the ensemble forecasting system of the HIRLAM consortium run as time-critical facility at ECMWF and used as operational EPS at the Norwegian Meteorological Institute. It consists of four sub-ensembles:

- Two HIRLAM ensembles with 3D-Var for controls
- Two Alaro ensembles (downscaling) with SURFEX or ISBA for surface

Stochastic physics is perturbed in HIRLAM and there are perturbed surface observations in HIRLAM. The ensemble is nested in the ECMWF ensemble.

References

https://hirlam.org/trac/wiki/Glamepsv2ProductionUserInfo

http://www.umr-cnrm.fr/aladin/IMG/pdf/frogner_asw2016.pdf

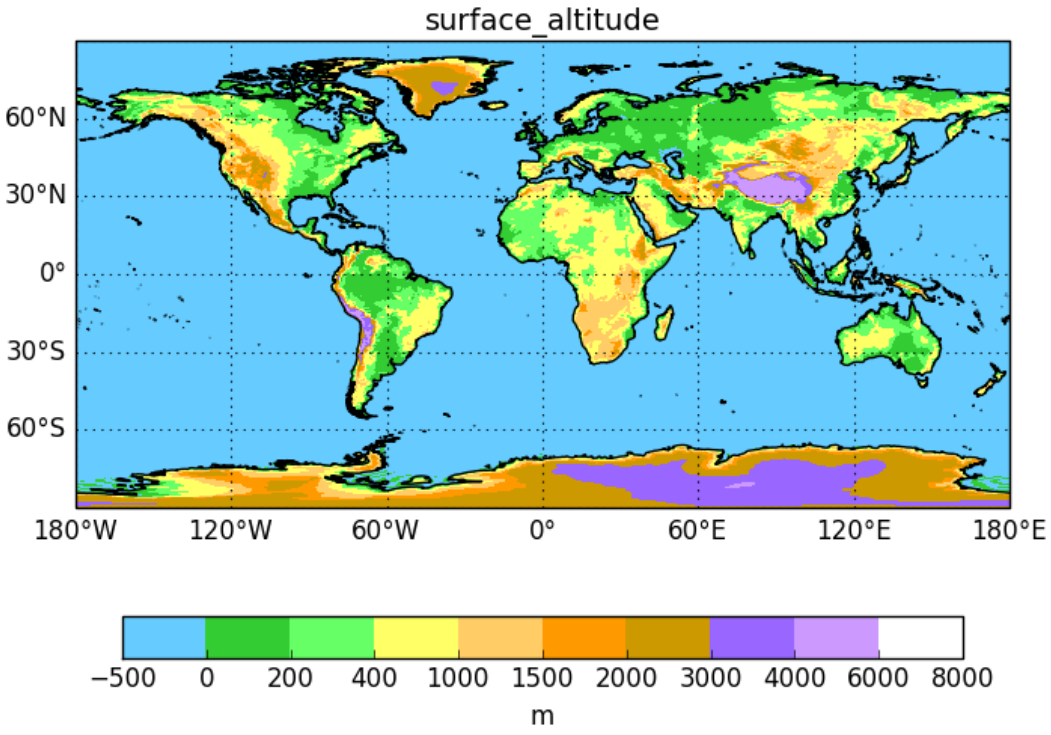
Availability

License: allowed for scientific use

No archive possible, no data-download-page currently

MOGREPS-G (Met Office Global and Regional Ensemble Prediction System – Global model)

Horizontal	**Vertical**
Coordinates: Latitude-Longitude Domain: Global Resolution: 0.45° longitude by 0.30° latitude ~33km by 33km at mid-latitudes (Due to increase to 18km in Summer 2017)	Coordinates: Hybrid height Resolution: Variable (70 levels) Model Top: 76km
Temporal Forecast Length: 7 days Resolution (time step): 3 hours Run frequency: Four times a day	Ensemble: Yes Number of Members: 12 (Due to increase to 18 in Summer 2017) Format(s): pp



Short Description

The Met Office Global and Regional Ensemble Prediction System, MOGREPS, is the operational ensemble forecasting system developed at the Met Office (Bowler et al., 2008, Tennant and Beare, 2014). The MOGREPS system is primarily intended for short-range weather prediction (1 to 2 days ahead), especially in relation to high-impact severe weather events such as windstorms and extreme rainfall. Initial conditions are obtained from the global deterministic 4D-Var data assimilation, while perturbations are generated using the Ensemble Transform Kalman Filter (ETKF) approach, which is a computationally efficient form of the ensemble Kalman filter. Model uncertainties are represented using stochastic physics schemes to target structural and sub-grid scale sources of model error.

References

Bowler, N. E., Arribas, A., Mylne, K. R., Robertson, K. B., & Beare, S. E. (2008). The MOGREPS short-range ensemble prediction system., Q.J.R. Meteorol. Soc., 134, 703-722. https://doi.org/10.1002/qj.234

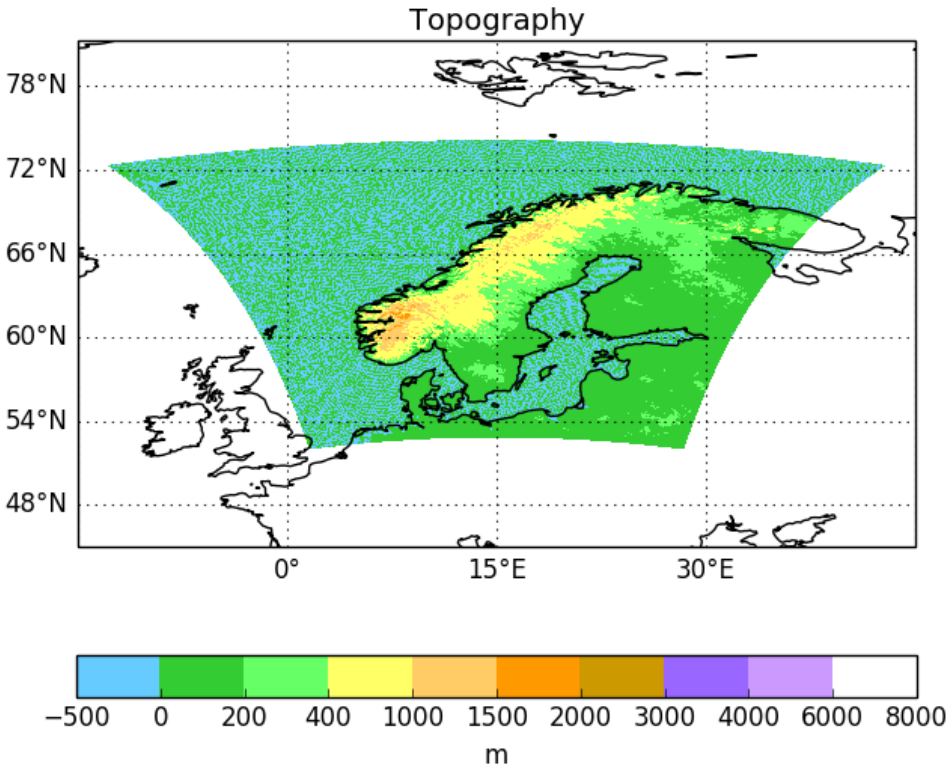
Tennant, W. and S. Beare, (2014). New schemes to perturb sea-surface temperature and soil moisture content in MOGREPS. Q.J.R. Meteorol. Soc., 140,1150-1160. doi: 10.1002/qj.2202

Availability

Available from Tigge (http://www.ecmwf.int/en/research/projects/tigge) at reduced horizontal and vertical resolution

Norwegian Meteorological Institute Met CoOp Ensemble Prediction System (NMI MEPS)

Horizontal	**Vertical**
Coordinates: Lambert Conformal (km) Domain: Northern Europe Resolution: 2.5km by 2.5km	Coordinates: Hybrid pressure Resolution: Variable (64 levels) Model Top: 10hPa (~25km)
Temporal Forecast Length: 66 hours for control run and one member, 48 hours for 8 members Resolution (time step): 1 hour Run frequency: Four times a day	Ensemble: Yes Number of Members: 10 (1 Arome control, 9 perturbed Arome members) Format(s): NetCDF



Short Description

The MetCoOps ensemble prediction system MEPS is the operational ensemble forecasting system of the Meteorological Cooperation on Operational Numerical Weather Prediction. The model code is

based on HARMONIE-AROME cy40h1.1. Initial and boundary perturbations are based on the Scaled Lagged Averaged Forecasting (SLAF) method and boundary data is from ECMWF-IFS deterministic model and perturbation.

References

Bengtsson, L., U. Andrae, T. Aspelien, Y. Batrak, J. Calvo, W. de Rooy, E.Gleeson, B. Hansen-Sass, M. Homleid, M. Hortal, K. Ivarsson, G. Lenderink, S. Niemelä, K. Pagh Nielsen, J. Onvlee, L. Rontu, P. Samuelsson, D. Santos Muñoz, A. Subias, S. Tijm, V. Toll, X. Yang, and M. Ødegaard Køltzow, 2017: The HARMONIE-AROME model configuration in the ALADIN-HIRLAM NWP system. Mon. Wea. Rev. doi:10.1175/MWR-D-16-0417.1, in press.

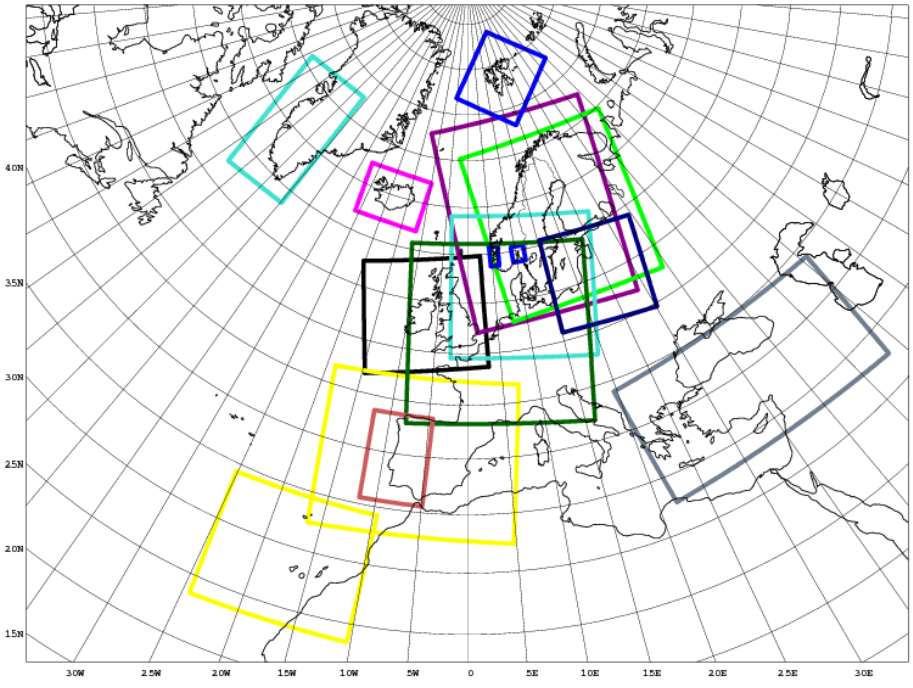
Andrae, U, 2017, The MetCoOp ensemble MEPS, ALADIN-HIRLAM Newsletter Nr 8, 98-104

https://metcoop.smhi.se/dokuwiki/nwp/metcoop/meps/start

Availability

The HARMONIE-AROME model at KNMI

Horizontal Coordinates: Lambert Conformal (km) Domain: The Netherlands and surroundings Resolution: 2.5km by 2.5km	**Vertical** Coordinates: Hybrid pressure Resolution: Variable (60/65 levels) Model Top: 1.4/10 Pa
Temporal Forecast Length**:** 48 hours Resolution (time step): 1 hour Run frequency: 8 times per day	Ensemble: No Format(s): GRIB



Real time HARMONIE Forecast Systems in HIRLAM and ALADIN services

Short Description

The non-hydrostatic convection-permitting HARMONIE-AROME model is developed in a code cooperation of the HIRLAM Consortium with Météo-France and ALADIN, and builds upon model components that have largely initially been developed in these two communities. The forecast model

and analysis of HARMONIE-AROME are originally based on the AROME-France model from Météo-France (Seity et al, 2011, Brousseau et al, 2011), but differ from the AROME-France configuration in various respects. A detailed description of the HARMONIE-AROME forecast model setup and its similarities and differences with respect to AROME-France can be found in (Bengtsson et al. 2017). *[From: HIRLAM (2017)]*

KNMI runs an operational suite with HARMONIE-AROME cy36h1.4 for a 2000x2000 km area around the Netherlands, the green area in the figure. Lateral boundary conditions are taken from a special version of the Hirlam limited area model which in its turn takes its lateral boundary conditions from the ECMWF HRES model. This version uses 60 levels up to 1.4 Pa.

An experimental suite runs version cy38h1.2 on the same area but with 65 levels up to 10 Pa. This model is embedded directly in the ECMWF HRES model.

References

Bengtsson, L., U. Andrae, T. Aspelien, Y. Batrak, J. Calvo, W. de Rooy, E. Gleeson, B. Hansen-Sass, M. Homleid, M. Hortal, K. Ivarsson, G. Lenderink, S. Niemelä, K. Pagh Nielsen, J. Onvlee, L. Rontu, P. Samuelsson, D. Santos Muñoz, A. Subias, S. Tijm, V. Toll, X. Yang, and M. Ødegaard Køltzow (2017): The HARMONIE-AROME model configuration in the ALADIN-HIRLAM NWP system. Mon. Wea. Rev., in press. Monthly Weather Review, 145(5):1919–1935.

Brousseau, P., Berre, L., Bouttier, F., and Desroziers, G. (2011): Background-error covariances for a convective-scale data-assimilation system: Arome–france 3d-var. Quarterly Journal of the Royal Meteorological Society, 137(655):409–422.

HIRLAM (2017): The HIRLAM homepage. http://www.hirlam.org.

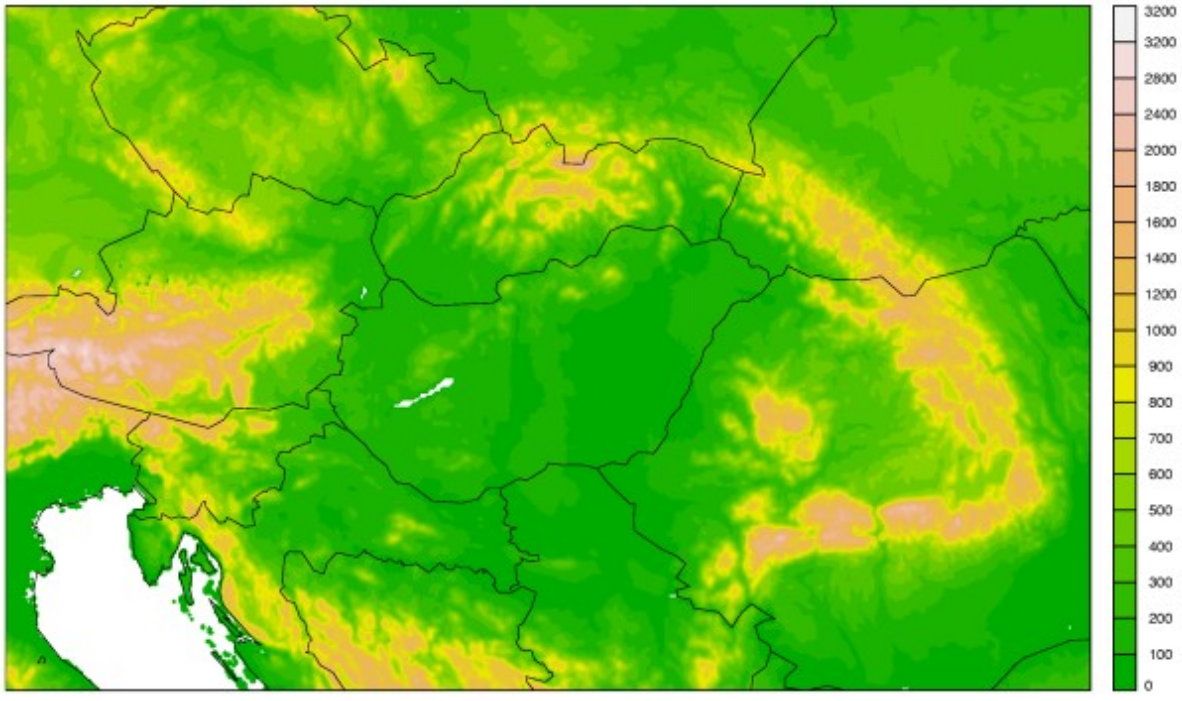
Seity, Y., Brousseau, P., Malardel, S., Hello, G., Bénard, P., Bouttier, F., Lac, C., and Masson, V. (2011): The arome-france convective-scale operational model. Monthly Weather Review, 139(3):976–991.

Availability

Data from both the operational and the experimental suites are archived for later use.

AROME-EPS of Hungarian Meteorological Service

Horizontal Coordinates: model in Lambert, outputs in Latitude-Longitude Domain: Carpathian Basin Resolution: ~2.5km, 1h	**Vertical** Coordinates: model in sigma-pressure hybrid, but output in pressure and height levels Resolution: 60 model levels, 12 PBL height-level and 32 pressure-level in output files
Temporal Forecast Length: 36 Resolution (time step): 1h Run frequency: 1 time daily (18UTC)	Ensemble: Test AROME-EPS for research (operationally ALADIN-EPS) Number of Members: 11 Format(s): FA files are converted to NetCDF format



Short Description

ALADIN-EPS is running as an operational ensemble system of the Hungarian Meteorological Service (OMSZ) since 2008. This hydrostatic model based system has 8km horizontal resolution. The long-term strategy aims to step forward to the direction of a convection-permitting ensemble system. For

that purpose non-hydrostatic AROME model with 2.5 horizontal resolution provides an ideal solution. AROME deterministic mode runs are widely used at OMSZ since its operational introduction in 2009.

The tests of AROME-EPS started in 2012 and now OMSZ has the necessary experience to make it operational if computer resources enables that.

Two perturbation methods have been tested in AROME-EPS framework:

- Ensemble Data Assimilation (EDA) method was used to perturb the initial condition fields.
- The Stochastically Perturbed Parameterized Tendencies (SPPT) method was applied to represent model uncertainties.

Boundary conditions: The use of ECMWF ENS interpolating boundary condition files are preferred.

References

http://www.umr-cnrm.fr/aladin/IMG/pdf/sppt_szucsm_3.pdf

Szintai B., M. Szűcs, R. Randriamampianina, and L. Kullmann, 2015: Application of the AROME non-hydrostatic model at the Hungarian Meteorological Service: physical parametrizations and ensemble forecasting. Időjárás, Vol. 119. No. 2, 241

Availability

AROME-EPS test result are available occasionally at OMSZ and they can be provided to partners.

ALADIN-EPS operational results are shared in TIGGE-LAM:

https://software.ecmwf.int/wiki/display/TIGL/Models