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Notes on HARMONIE plans on DA&UO: status/plans/contact persons

The 3rd LACE DA Working Days
Prague,
18-21 of June, 2012,

Collected by Jelena Bojarova

Upper air data assimilation

1.1 Development of the HARMONIE 3DVAR DA system
1.2 Development of flow-dependent methods
1.3 OOPS code overhaul at ECMWF
1.4 COPE project
1.4 Radar data assimilation
1.5 Other ground based and space-borne upper air observations

Development of the HARMONIE 3DVAR data assimilation system (I)

- ✓ Study of the climatological variability of forecast error structure functions with regards to seasonal/diurnal/rain mask/boundary layer stability/cloudy mask dependencies (Shuiy Zhuang et al; shu@dmi.dk)
  => Plan:Test the derived structure function assimilating high-resolution observations in AROME/ALARO (case studies severef low weather impact phenomena, assimilation of low level winds and assimilation of cloudy radiances)

Development of the HARMONIE 3DVAR data assimilation system (II)

Accounting of larger-scale error constraint in LAM

Jk term in cost function minimization is technically working (HARMONIE implementation and testing : Per Dahlgren (per.dahlgren@smhi.se))

=> Plans: to compare Jk and spectral blending techniques on 2.5 AROME domain with L65; work is done partially under MetCoOP (operational met.no-SMHI collaboration)

Development of the HARMONIE 3DVAR data assimilation system (III)

Implementation of the cloud mask initialisation in the HARMONIE forecasting system (cloud mask from nowcasting SAF, cloud top temperature from MSG, SYNOP cloud base height): specific humidity is changed after analysis keeping virtual potential temperature constant (Sibbo van der Veen, sibbo.van.der.veen@knmi.nl)

=> Further investigation of results (improved forecast quality of cloud cover, precipitation, upper air temperature, surface pressure; 2m T worse, possibly problems with radiation scheme)

Development of the HARMONIE 3DVAR data assimilation system (IV)

Towards data assimilation: 2D physical cloud properties are extracted from the MSG SEVIRI images (Kristian Pagh Nielsen, kpn@dmi.dk). Available products are integrated cloud water, cloud effective radius, cloud optical thickness
=> from April 2012 product is covering Faroe Islands, Great Britain, Benelux, Poland, the Baltic states, Finland and the countries in between. This area could well be made larger.

Development of the HARMONIE 3DVAR data assimilation system (V)

RUC: both 3h DA cycle and 1h DA cycle are available in harmonie- CY37h1(Magnus.Lindskog@smhi.se)
=> the climatological structure functions
derived from the +3h forecast error ensemble do not indicate any moisture spin-up problems; assimilation of remote sensing observations is crucially important; plans to test 1h DA cycle assimilating radar data (moisture spin-up problems are expected)

Redesign of the IFS FGAT scheme is highly desirable
=> the centered window approch as in HIRLAM seems to be more efficient; (looking for collaboration)

Theoretical study on the suitable scales for generation of super-observations and how to relate the effective model resolution (Tomas.Landelius@smhi.se et al)
=> the study is done using the HIRLAM 4D-Variational data assimilation system (so far some test have been carried for HIRLAM temperatures at 10 km resolution with the aim to apply the results on the SEVIRI radiances).

Flow-dependent data assimilation methods (I)

4D-Variational data assimilation scheme (Magnus.Lindskog@smhi.se et al) : ALARO 5.5 km outperforms 3DVAR

=> AROME 2.5km is in the early design state (stage1: implement SURFEX, ECMWF non-linear physics, ECMWF tangent linear physics; stage 2: replace ECMWF non-linear physics with AROME; proof of concept by end of 2013);

=> The aim: AROME 4DVAR scheme to be used as a reference developing advanced flow-dependent data assimilation techniques.

Flow-dependent data assimilation methods (II)

Develop EnsDA and LETKF techniques for the HARMONIE forecasting system
=> EnsDA (ready August 2012, jelenab@met.no et al);
=> LETKF (start autumn 2012, Pau Escriba, pescribaa@aemet.es)
=> Scientific coordination with MF is important (variance inflation, spatial filtering)

Implementation of the hybrid variational data assimilation scheme into the HARMONIE forecasting system
=> start autumn 2012 (jelenab@met.no et al)

Flow-dependent data assimilation methods (III)

Treatment of non-additive errors: first results are obtained

=> image warping technique to construct pseudo-observations + 4D-Variational assimilation of pseudo-observations (tomas.landelius@smhi.se et al)

=> field alignment technique (Carlos Gejio, cgeijog@aemet.es); in the current implementation signal from observations escapes within several time steps due to lack of balances in the initial state

=> Scientific collaboration with MF is important (transform techniques to account for flow-dependency)

Flow-dependent data assimilation methods (IV)

Design and implementation of the 4D-Ens-VAR

=> not started yet, potentially a very attractive scheme. The non-linear propagation of the ensemble members minims tangent-linear propagation of the analysis increment; no need to for tangent-linear and adjoint models (Nils Gustafsson & Jelena Bojarova)
=> MF is interested in this scheme as well (Loik Berre)

Important: all algorithmic scientific developments should take into account OOPS source code overhaul

LAM concept is introduced into the QC-toy model (Nils Gustafsson & Trygve Aspelien et al)

HIRLAM-B (Nils.Gustafsson@smhi.se) will participate in the OOPS scientific review (ready August 2012)

Hybrid Variational Data Assimilation scheme is planned to be implemented into the QC-toy model.

Designing new DA algorithms the close collaboration is important: one should avoid multiple realisations of the same basic idea.

COPE (Continuous Observation Preprocessing at ECMWF)

Aim is a complete re-design of the observation handling in the operational suite.
The observation pre-processing (appropriate data formats, QC, screening, thinning, black-listing and bias-correction) to be re-written in C++ and will be moved outside the IFS environment.
COPE is a collaborative project between ECMWF and Meteo-France where the HIRLAM community will invited participate as well (2 x0.5year work : Eoin.Whelan@met.ie; Frank Thomas Tveter franktt@met.no)
=> Probable result: complete rewriting of BATOR software;
=> At the moment on the design stage (contact person from MF Florence.Rabier@meteo.fr)

Radar data assimilation (I)

Radar radial winds and radar reflectivities are implemented technically at met.no, SMHI, DMI, AEMET, KNMI, METIE (MF algorithm is used to assimilate reflectivities); MF BUFR format is default in BATOR

=> MF experience assimilating radar data is much more positive than HIRLAM. One possible reason is the quality of the data.

=> Radar data assimilation is the central point of the extended radar data impact studies which are in preparation now (following schedule autumn this year; will probably be delayed)

=> Radar data exchange issue (different radar data formats from different radar data producers; different radar data quality)

Radar data assimilation (II)

CONRAD:

=> Local formats (NO,SE,NL,IRE) → MF-BUFR format

=> CONRAD-aemet has been used to exchange successfully radar data with MF

=> CONRAD-metie is extended to allow ODIM BUFR on output (some problems installing in ecgate)

=> CONRAD software to be merged with the branches and to be phased into CY37

(Contact person Martin.Ridal@smhi.se)

The careful documentation of the local implementation of the radar data may be find at https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/Conrad

Radar data assimilation (III)

BATOR – current MF pre-processing tool :

Local radar data → CONRAD → MF-BUFR → ODB

=> BATOR software extended on the local radar branch: harmonie-36h1_radar (allows polar coordinates; different scan strategies for different elevations; different volume sizes for different scan angles; different thinning for different gridtypes). Work is in the mature stage and is to be phased into harmonie-CY37h1

=> Plans: further upgrade BATOR software to allow HDF-5 format on input (ready autumn 2012). Work will not be phased into MF-BATOR software. MF prioritize COPE project instead of further BATOR development. COPE is a long term solution.

HIRLAM-B Contact person: Martin.Ridal@smhi.se

Common radar data QC software:

HIRLAM-B has not decided yet on the common QC software for operational radar data assimilation

HIRLAM-B has selected common BALTRAD QC Toolbox as the common radar data QC software for the extended radar data impact studies.
=> BALTRAD QC Toolbox is an intended common radar data QC toolbox for OPERA. HIRLAM-B will investigate BALTRAD QC Toolbox with regards to its functionality and possibility to install on the local platforms (KNMI, AEMET, SMHI, ecgate) HIRLAM-B contact person
Gunther.Hasse@smhi.se

ProRad is an open source radar data pre-processing software, including QC tools, developed at met.no

Other high resolution upper air observations

HIRLAM-B puts a dedicated efforts in the assimilation of high-resolution high-frequency observations. The aim is to construct the powerful meso-scale data system to be a basis for the short-range meso-scale ensemble prediction system. The HYMEX campaign will be used as a framework for scientific collaboration with MF (contact person at MF Nadja Fourier)

=> low peaking IASI channels (Tuuli.Perttula@fmi.fi)
=> water vapour sensitive IASI channels (Frank Tveter)
=> cloudy IASI radiances (Roger et al)
=> low level winds (Harald Schyberg et al, haralds@met.no)
=> scaterometer winds (Gert-Jan.Marseille@knmi.nl)
=> cloudy SEVIRI radiances (Siebren.de.Haan@knmi.nl et al)
=> ZTD GNSS (Jana Sanchez et al, jsancheza@aemet.es)
=> local “road” stations (Mats Dahlbom, mda@dmi.dk)
=> ATOVS radiances (Magnus.Lindskog@smhi.se et al)

Other high resolution upper air observations (II)

Main scientific topics to be addressed:

Variational Bias Correction algorithm for the remote observations (ATOVS, IASI, SEVIRI, GNSS) : formulation, implementation, performance

Surface conditions for RTTOV

Spin-up of moist balances

Balance conditions for hydrometer variables

Flow-dependent structure functions

Modelling of observation error cross-correlations/construction of superobservations

=> Scientific collaboration is highly desirable !

2. Surface data assimilation

2.1 Development of new spatialisation tool
2.2 Improved SURFEX interface
2.3 Soil data assimilation
2.4 Snow data assimilation
2.5 Sea-ice data assimilation
2.6 Lake data assimilation

Surface data assimilation (I)

Improved SURFEX interface (Trygve Aspelien. trygvea@met.no) is implemented in CY38t1, maybe backphased to CY37=>
Some plans on the "parallelization" of EKF scheme

Development of new spatialisation tool (MESCAN, Tomas.Landelius@smhi.se in close collaboration with MF): downscaling of T2m. RH2m is implemented in the euro4m branch of gl; downscaling of wind and rr24 is in progress => Plans: implementation of wavelets as a horizontal structure functions

Surface data assimilation (II)

Soil moisture data assimilation: comparison between EKF and OI-main scheme; assimilation of ASCAT soil moisture product (mdieazm@aemet.es)
=> manpower problems at the moment

Snow data assimilation: usefulness of the GLOBSNOW product as snow measurements in the NWP (Ekaterina.Kourzeneva@fmi.fi et al); local precipitation stations (Mariken Homleid, marikenh@met.no)
=> Plans: investigate other remote sensing products as (snow probabilities maps based on AVHRR and MODIS; LANDSAF product based on AVHRR and SEVIRI, NOAA/NESDIS snow cover extend)

Surface data assimilation (III)

Assimilation of sea-ice measurements: no active work yet
=> Plans: implementation of simple sea-ice model into HARMONIE (based on the HIRLAM experience), investigation of usefulness of sea ice cover and sea ice drift products; collaboration with MF on implementation of GELATO and possibly HIGHTSI (Mariken Homleid, marikenh@met.no)

Assimilation of lake temperatures: development of the EKF algorithm in progress (Ekaterina.Kourzeneva@fmi.fi et al)
=> Plans: design of algorithm for spatial interpolation of lake temperatures in CANARI, usefulness of MODIS lake temperature and ice cover measurements

Transversal issues

Forecast model and model error in relation to data assimilation and ensemble forecasting

Development of the verification methodology for both deterministic and ensemble forecasting in presence of phase-error (both time and location error)