Summary report from the HARMONIE/ALADIN working days on surface and soil assimilation, met.no Oslo, 16-20 March 2009

Participants:
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Agenda:
An agenda for the presentations and discussions during the working week is included as Appendix I. Presentations given are available at
http://www.netfam.fmi.fi

Reports from sub-group discussions:
Several issues, important for the planning and further development of the HARMONIE and ALADIN forecasting systems, were dealt with in sub-groups during the working week. Sub-group 1 treated the conversion of soil variables between the ECMWF, SURFEX and HIRLAM models (see Appendix II), subgroup 2 treated CANARI spatial interpolation developments (see Appendix III) and also the need for more long term developments of spatial interpolation techniques (see Appendix IV), subgroup 3 treated the planning of a summer-time convection Comprehensive Impact Study (CIS, see Appendix V) and, finally, sub-group 4 treated the Observations for HARMONIE data assimilation (see Appendix VI).

Main recommendations from the working week:

(1) For the further development of the HARMONIE and ALADIN soil data assimilation, most emphasis should be spent on the soil assimilation within the SURFEX software framework, utilizing CANARI as a pure spatial interpolation tool (for T2m, RH2m, SST, sea ice fraction and snow). For the soil assimilation, OI should initially be applied, but should be replaced by EKF as soon as possible.

(2) Joint algorithms (and subroutines) for the conversion between the ECMWF (H.TESSEL), ISBA-2L, ISBA-3L, ISBA-DF and HIRLAM multi-layer soil scheme variables should be developed in accordance with Appendix II. The physical conversion should be applied on the native grid, in case of ECMWF data a Gaussian grid. The interpolation should be carried out in conservative variables, the same as used by the conversion, for example, soil water index. Orography differences should be taken into account for soil temperature, as well as for the distribution of soil water on solid and liquid forms and possibly also for snow variables.

(3) The CANARI spatialization software should be improved in several aspects, see Appendix III.

(4) In order to avoid duplicate work, all HARMONIE researchers are strongly encouraged to work within the HARMONIE mini-sms system and to submit modifications and bug-fixes to the reference system ("trunk" version).

(5) Work should be initiated for an introduction of Bufr2odb in the observation pre-processing in order to get closer to the ECMWF solution and to avoid unnecessary intermediate formats.

Suggested List of actions as a consequence of the working week recommendations:

(a) Recommendation (1) has the consequence that HIRLAM urgently must introduce (develop) and test the interface to (the online) SURFEX also for the ALARO (highest priority), ALADIN and HIRLALD physical parameterizations options in HARMONIE.
(b) Meteo-France (Jean-Francois Mahfouf) will provide source codes and scripts for the surface and soil assimilation, based on the combined use of CANARI and SURFEX. HIRLAM will need to modify and introduce the source codes and scripts into the HARMONIE-miniSMS framework. Extended tests and validations will follow.
(c) The CANARI spatialization software will be improved in several aspects, for example, use of a reduced ODB data set, tuning of error statistics, use of vertical correlations, adjustment of background profiles to the station heights, reduced weight for stations influenced by the sea and revival of the snow analysis.
(d) Meteo-France will provide a subroutine CPREP1.f90 for the soil variable conversions (recommendation 2).
(e) Implement the "901+927(FULLPOS)" file conversion in HARMONIE to be used as a reference. Update with the latest 901 changes and separate the file handling from the variable conversion (CPREP1.f90). Overpassing of the ARPEGE climate file and the need for global fields.
(f) The HARMONIE software package GL needs to improved with respect to: soil variable conversion in accordance with recommendation 2 (CPREP1.f90), use of input Gaussian grid for ECMWF data and avoiding smoothing along coastlines.
(g) Modify the prep_surfex routine to handle conversion from ECMWF and HIRLAM soil variables in accordance with recommendation (2).

Questions on staff resources and time schedule for the future actions:

It is certainly not the task of the working week to decide of future development actions and allocation of staff resources for these actions. Here we will just list some cruciual question and some indications of available staff resources:

- We need a time schedule for the implementation of SURFEX in HARMONIE with ALARO Physics (Action (a)).
- We need a time schedule for the delivery of scripts and source codes from Meteo-France (Actions (b), (d) and (e)).
- Maria Diez and Mariken Homleid are prepared to work with actions (b) and (c). Other met.no persons may also contribute, in particular with the scripting and miniSMS work. Beatriz Navascues is also willing to help Maria with action (c). A working week at met.no or INM for task (b) and (c) would probably help to accelerate the work.
- The required development of GL would probably most efficiently be carried out by Ulf Andrae.

Remaining open issues

1. There is a need for a more long term development of spatial interpolation techniques, taking the hetereogeneity and an-isotropy of surface and the soil into account. At present it was not possible to agree on a single joint effort. Meteo-France and NILU will investigate Ensemble Kalman Filtering techniques, and within the HIRLAM and ALADIN communities there is also an interest to develop variational techniques based on a wavelet representation of error covariances. This issue is of joint interest for the HIRLAM and ALADIN communities.

2. It is not obvious, for the moment, whether one should put emphasis on retrieval products or radiances from satellites for soil and surface assimilation. Following the example of atmospheric data assimilation, we will start with retrieval products and gradually, if needed, introduce also the retrieval algorithms into the soil and surface assimilation process.

Appendix I

Agenda for the NetFAM working days on surface and soil data assimilation for the HARMONIE/ALADIN forecasting system

Monday 16 March in meeting room VIA

10.00 – 11.45
Session 1: Status of ALADIN/HARMONIE with regard to the surface and the soil
10.00 – 10.45 Jean-Francois Mahfouf - Strategies for introduction of SURFEX, including data assimilation, in ALADIN and AROME. Joint HIRLAM/ALADIN plans.
11.00 – 11.30 Ulf Andrae - Status of the SMHI HARMONIE systems with particular emphasis on the surface and the soil and on GL conversions from ECMWF/HIRLAM to HARMONIE

11.45 – 13.00 Lunch

13.00 – 15.00
Session 2: Discuss and start to develop techniques for a proper conversion of soil and surface variables in the ECMWF model to the soil and surface and soil variables in HARMONIE/SURFEX model (ISBA to start with).
13.00 – 13.30 Roger Randriamampianina and Mariken Homleid – Validation of a trial to make correct conversions of ECMWF soil model variables to the HARMONIE ones.
13.45 – 14.15 Jean-Francois Mahfouf – Some thoughts on a proper (flux-consistent) conversion of ECMWF soil model variables to the SURFEX ones.
14.30 – 15.00 Formation of a subgroup (rapporteur J.-M. Mahfouf) to design algorithms for a proper conversion of soil and surface variables from the ECMWF/HIRLAM ones to the HARMONIE/SURFEX ones

15.00 – 15.30 Coffee

15.30 – 16.15
Session 3: Learn the CANARI coding structure in order for HIRLAM staff to make real contributions in the field of land soil temperature and moisture, sst, sea ice, lake and snow assimilation.
15.30– 16.15 Francoise Taillefer – Overview of the CANARI data assimilation, methods and computer code

Session 4: Validate the present HARMONIE surface and soil assimilation based on CANARI to make certain that everything is carried out correctly.
16.30 – 16.50 Maria Diez – Validation of the CANARI 2m temp and humidity analysis and the OI soil variable assimilation.
17.00 – 17.20 Mariken Homleid – Validation and improvement of the CANARI SST and sea ice assimilation, with some comments also on lake data assimilation

Tuesday 17 March

09.00 – 10.30 Work in subgroups in meeting rooms VIA and met.no
Subgroup 1 on soil/surface variable conversion (Rapporteur J.-F. Mahfouf)
Subgroup 2 on CANARI development (Rapporteur Mariken Homleid)

Subgroup 3 on Summer time convection CIS (Rapporteur Reima Eresmaa, to be arranged later during the week))
Subgroup 4 on Observations for HARMONIE 3D-Var (Rapporteur Magnus Lindskog)
Note: Subgroups 3-4 have subjects outside the soil/surface working week)

10.30 – 11.00 Coffee
11.00 - 12.00 Continued work in subgroups
12.00 – 13.00 Lunch

Session 5: Report on progress and make a detailed plan for HIRLAM (and ALADIN) staff contributions in HARMONIE/ALADIN surface and soil assimilation (using CANARI and SURFEX as the framework) in meeting room VIA

13.00 – 13.30 Jean-Francois Mahfouf - The simplified EKF for soil data assimilation
13.40 – 13.50 Han The (given by Jelena Bojarova and Nils Gustafsson) : An adaptive UKF as an alternative to simplified EKF
13.50 – 14.20 Sam-Erik Walker/William Lahoz: NILU EnsKF ideas for soil assimilation
14.20 – 14.35 Suleiman Mostamandy – A literature review on snow information data assimilation
14.35 – 15.00 Coffee
15.00 – 15.15 Nils Gustafsson - Naïve ideas on Lake data assimilation
15.15 - 15.35 Jure Cedilnik Analysis of the LandSAF albedo product for NWP

16.00 – 17.00 Practical exercise – Installation of SURFEX EKF in meeting room Castellanus

Thursday 19 March

13.00 – 17.00
Session 6: Hands-on exercise in soil data assimilation with SURFEX including EKF and OI (lead by J.-F. Mahfouf) in meeting room Castellanus

Friday 20 March
Final session in meeting room VIA
09.00 – 11.30 Reports from sub-groups including discussions

Appendix II: Report from WG on conversion issues.

J.-F. Mahfouf (rap.), U. Andrae, S. Gollvik, V. Odegaard, J. Onvlee, L. Rontu

April 14, 2009

1 Objectives

- Provide guidance on data conversion of prognostic variables from the ECMWF (H-TESSEL) and HIRLAM land surface schemes to the HARMONIE land surface scheme (ISBA-2L), but also (if possible) for other land surface schemes (ISBA-3L, ISBA-DF, HIRLAM multi-layer) - Such guidance should also be useful to the SNRWP ET on surface aspects and interoperability.
- Allow cold start of the surface variables for the HARMONIE system
- Reduce as much as possible intermediate steps (interpolations) from the native grid to the target grid

2 Current conversion tools

Do we know exactly how they proceed ? Documentation available ?

- E901 + E927 : ECMWF GRIB file => ECMWF FA file => HIRLAM FA file (correct handling of LSM)
- Mini SMS - GL conversion : ECMWF/HIRLAM lat/lon rotated => initial/boundary FA file (unrealistic smoothing along coastlines). Non conserving interpolation (to be changed). Erroneous translation of variables.
- PREP_SURFEX : ECMWF GRIB file => initial LFI file / HIRLAM GRIB file => initial LFI file (available in v4.8 and cy35t2 but not tested ?)

3 Recommendations

Proposal for a two step approach as follows (even though discussions took place about the relevance in inverting the order):

ECMWF variable	ISBA variable	Importance
Skin temperature (T_{sk})	Surface temperature (T_s)	3
Soil temperature - Layer 1 (T_1)	Surface temperature (T_s)	3
Soil temperature - Layer 2 (T_2)	Mean surface temperature (T_2)	2
Soil temperature - Layer 3 (T_3)	Mean surface temperature (T_2)	2
Soil temperature - Layer 4 (T_4)	N.A.	3
Snow depth - snow density	Snow water equivalent	1
Soil water/ice content - Layer 1 (θ_1)	Superficial soil (liquid/ice) moisture (w_g)	2
Soil water/ice content - Layer 2 (θ_2)	Mean soil (liquid/ice) moisture (w_2)	1
Soil water/ice content - Layer 3 (θ_3)	Mean soil (liquid/ice) moisture (w_2)	1
Soil water/ice content - Layer 4 (θ_4)	Mean soil (liquid/ice) moisture (w_2)	1
Interception reservoir	Interception reservoir	4
Snow albedo	Snow albedo	4

Table 1: Correspondence table of soil prognostic variables from ECMWF H-TESSEL to SURFEX ISBA 2-L. The importance is estimated from the "memory" of each variable ; how long an error in the initial conditions will persist ?

- First step : perform physical conversion on the native grid - extract ECMWF data on gaussian grid instead of LAT/LON grid to reduce inconsistencies (even for limited area models) - do we need to extract global fields ? - In this step climatological fields from the target grid are needed on the native grid (from high resolution data bases - pb of lakes in the current ARPEGE data base at 5 km - what about ECOCLIMAP ?)

- Second step : horizontal interpolation from the native grid to the target grid - it is also recommended that interpolation is performed on "conservative variables" (e.g. SWI) already used in the physical conversion.

- Provide modified subroutine `CPREP1.F90` to HIRLAM as soon as possible

Recommendations are only provided for physical conversions :

- Use ancillary data (soil/vegetation) in order to rescale prognostic variables using physical constraints.

- Perform the conversion for root zone soil moisture (in volumetric units - accounting for soil textures) using SWI and vegetation fraction (since in summer, evapotranspiration from vegetation in H-TESSEL and ISBA is proportional to SWI).

- The use of R_{smin}/LAI scaling is not recommended in a first stage (even though interesting in summer it seems potentially dangerous in winter since it is not anymore a relevant parameter controlling surface evapotranspiration)

- Account for the orography difference (vertical interpolation) for the soil temperature interpolations and also for improved partition of frozen and liquid soil water reservoirs (proposal from P. Le Moigne).
- Perform step 1 on total soil moisture (liquid+ice) and split the two contributions on the target grid when the soil temperatures have been interpolated (use ECMWF analytical soil temperature dependency function).

4 Remaining issues

- Check with ECMWF (G. Balsamo) about the existence of two snow reservoirs in H-TESSEL
- How to initialize soil tiles in the target model (since ECMWF does not have tiles in the soil ?) - and also surface tiles not present in the native model (towns ? lakes ?)
- For the ISBA-3L the simplest option is to make $w_3 = w_2$. Would the use of θ_4 be useful ?
- Which suggestions can be given for the HIRLAM multi-layer soil scheme - conversion from one vertical soil discretization to another ?
- Which suggestions can be given for horizontal interpolation (LSM constraints) - is FULL-POS sufficient ?
- Other actions to be taken ?
- On which interpolation tool should we focus for improved conversions ?

5 Formulas

5.1 Soil wetness index

$$SWI = \frac{\theta - \theta_{pwp}}{\theta_{cap} - \theta_{pwp}} = \frac{w - w_{wilt}}{w_{fc} - w_{wilt}}$$

5.2 Superficial soil moisture

Empirical conversion since bare soil evaporation formulations between ECMWF and SURFEX are too different (no evident analytical correspondence even under certain assumptions).

$$\frac{\theta_1}{\theta_{cap}} = \frac{w_g}{w_{fc}} \tag{1}$$

5.3 Root zone soil moisture

ECMWF SWI :

$$SWI_{IFS} = \frac{c_H SWI_H + c_L SWI_L + (LSM - c_H - c_L) SWI_{BS}}{LSM}$$

where LSM is the land fraction in the grid; c_H and c_L are the fraction of low and high vegetation in each grid box; SWI_H and SWI_L are weighted averages of the soil moisture content over the 4 layers according to the root-depth profile of the high and low vegetation surfaces, and $SWI_{BS} = (\theta_1 - \theta_{pwp})/(\theta_{cap} - \theta_{pwp})$ corresponds to the bare soil part of the grid.
ISBA SWI:

$$SWI_{ISBA} = veg \times SWI(w_2) + (1 - veg) \times \frac{w_2}{w_{sat}}$$

alternative formula :

$$SWI_{ISBA} = veg \times SWI(w_2) + (1 - veg) \times \frac{w_g}{w_{sat}}$$

where w_g is derived from Equation (1).

5.4 Soil temperatures

ISBA soil temperatures cannot be associated to "physical layers" (limitation of the force-restore method), so simple formulations can be proposed :

$$T_s = T_{sk}$$

$$T_2 = (T_1 + T_2 + T_3)/3$$

Appendix III

Report from subgroup 2 on CANARI developments

The group had a short plenary session and identified these areas for further discussion:

1) Technical details related to the setup and performance of the current version of CANARI in HARMONIE
2) Implementation of EKF in HARMONIE
3) Snow analysis with CANARI
4) Developments of surface analysis – ideas for longer term plans

After a short presentation by Francois Taillefer on CANARI namelists etc, the group splitted into two, one with focus on short term plans (1-3 above):
Francois Taillefer, Maria Diez, Suleiman Mostamandy, Mariken Homleid (rapporteur)

and one discussing ideas for longer term developments :
Nils Gustafsson, Ekaterina Kourzeneva, Jure Cedilnik, Tomislav Kovcic, Kalle Eerola, Priit Tisler, William Lahoz (rapporteur)

Short term plans

1. Improve the current setup and performance of CANARI in HARMONIE

1.1 Build new OBD for CANARI (MH)

- with only SYNOP observations
- with time window +/- 0.5 h (instead of 6 hours for 3DVAR)

1.2 For T2m and RH2m analysis (MD)

- tune the error statistics, e.g. evaluate HIRLAM setup
- if possible, replace the present very simple correction for orography differences in the observation operator by introducing the SPAN solution
- introduce vertical dependency in the correlations, to reduce the influence from non-representative observations, in analogy with what is already implemented for snow depth
- consider also reduced weight (or no weight) to non representative stations in coastal regions

Tecnical details related to specification of error statistics, quality control, searching strategies and ODB are summarized in APPENDIX A.

2. Implementation of EKF in HARMONIE

Maria Diez will in cooperation with Jean-Francois Mahfouf implement the Extended Kalman Filter for soil variable data assimilation together with CANARI for T2m and RH2m analysis in HARMONIE.

3. Snow analysis in CANARI

The snow analysis in CANARI was implemented and tested by Lora Gaytandjieva in 2000. It has however not been run operationally. The snow analysis in HIRLAM is running operationally with good performance, a potential improvement should come from more observations, e.g. pseudo observations from satellite data.

The idea is to
- test and study the performance of the current CANARI setup
- introduce potential improvements from HIRLAM
- introduce satellite data

To be discussed:
- HIRLAM (span) uses a snow density field to produce the 1. guess, what about CANARI?

Appendix III-A

Tecnical details related to quality control, specification of error statistics, searching strategies

Recommondation: Read the output from CANARI (RunCanari) carefully to see which values are actually used.

a) Quality control
NACOBS
OROLIM – max obs altitude for a SYNOP to be used (default 10000m)
ORODIF – max diff allowed between SYNOP altitude and corresponding model orography (default=10000m)

b) Specification of observation and background error statistics

catrma.F90 – fill covariance matrix (between all observation points)
cacova.F90 - fill covariance vector (between one gridpoint and observation points) according to LCORRF specified in NCALORI

NALORI
LCORRF - (default .FALSE.) – control type of error correlation function
LCORRF = .FALSE. – exp(-0.5*d^2/r^2)
LCORRF = .TRUE. - exp(-0.5*|d|/r)

function/qastat.h – definition of function for horizontal correlation, which is Gaussian:

FRHT2D2(PD2,POR) = EXP (-0.5*PD2/POR)

NAM_CANAPE
REF_S_T2: model error standard dev. for T2m
REF_S_H2: model error standard dev. for 2m relative humidity
REF_S_SN: model error standard dev. for snow
REF_A_T2: horizontal length scale for T2m
REF_A_H2: horizontal length scale for 2m relative humidity
REF_A_SN: horizontal length scale for snow

cabiyo.F90 – initialization of observation error standard deviation
! SYNOP
ECTERO(NSYNOP,1,2,1) = 1.4_JPRB - T2m
ECTERO(NSYNOP,1,4,1) = 0.10_JPRB - RH2m
ECTERO(NSYNOP,1,6,1) = 5.0_JPRB - snow

Comment: Observation standard deviations specified in ODB are at the moment overridden by the values specified in cabiyo, but this will be changed in a future version of CANARI.

c) Searching strategies for QC and OI

ODB – separate databases for 3DVAR and CANARI

ODB for CANARI:

- only synop observations
- time window +/- 0.5 hour (instead of 6 hours for 3DVAR)

Changes in
oulan - extract observations from MARS and produce an ascii file
bator - build ODB

Comment: At the moment there are more than 62000 lines of the following error message in RunCanari:

no boite lue = 4 sur 4 KTYPO = 1 KMXGSL = 700 Lat. = 49.22 Lon. = 11.10 *** Debordement dans CASGRA ***

Telling that there are to many observations compared to the KMXGSL – max . no of observations of each type – specified in namelist NADOCK by NMXGBA

Appendix IV

Report on subgroup on future prospects for HIRLAM, including treatment of observations, 18 March 2009

Rapporteur: William Lahoz

This subgroup met on Tuesday 17 March 2009, and considered the following issues:

1. Spatial interpolation of land surface observations;
2. Potential improvements to CANARI;
3. Assimilation of radiances.

The results of this discussion, organized by issue, are as follows:

1.Spatial interpolation

Initially, many of the land data assimilation efforts within HIRLAM (or HIRLAM-related activities), e.g., at Météo-France and NILU, will involve a 1-D (vertical) treatment. This is because, first, land surface processes are (to first order) vertical and, second, to build up expertise starting from a simpler set-up. However, there is a desire to eventually move to a 3-D set-up, perhaps via an intermediary 2-D stage. The subgroup discussed ways in which 2-D and 3-D effects could be incorporated via spatial interpolation from a 1-D set-up.

A key aspect of the land surface that any spatial interpolation should take account of is the heterogeneity (or anisotropy) of the land surface. For example, orographic effects should be included. Three methodologies were identified and discussed: (i) wavelets; (ii) Ensemble Kalman filter (EnKF); and (iii) recursive filters. We discuss these in turn.

Wavelets. They are designed to handle anisotropic structures. Efforts related to HIRLAM include complex-valued wavelets in ALADIN 3D-Var, and 2-D wavelets at the SMHI, next generation MESAN system (T. Landelius, and A. Deckmyn in Belgium). The SMHI-MESAN set-up involves tuning parameters.

A possible solution is to set up a PhD project to introduce wavelets into a simpler version of the models available (this may require more work than anticipated). A suggestion would be a PhD supervised by Nils Gustafsson, with possible collaboration from elsewhere (perhaps NILU).

EnKF. The idea is that through the development of the background error covariance matrix, **B**, horizontal correlations in the model would be taken account of. The EnKF is the NILU approach to land data assimilation and the suitability of this approach for spatial interpolation will be tested.

Recursive filters. The work of, e.g., Jim Purser (NOAA) was mentioned. This idea remains on the table, but currently is given lower priority than wavelets and the EnKF.

Finally, spatial interpolation activities should also take account of developments to couple the land surface to the atmosphere. Currently, for reasons of expediency and simplicity, the land data assimilation efforts at, e.g., Météo-France and NILU, involve external land surface models, with no feedback to an atmospheric model. The use of simple models (as mentioned above, developing such simple models may be harder than anticipated) for this task would be desirable.

2.Potential improvements to CANARI

A number of potential improvements to CANARI were identified. These include treatments of 2m temperature information and orography effects. It was mentioned that the way forward is to implement HIRLAM (SPAN) solutions in CANARI. It was identified that resources (manpower, money) needed to implement these improvements are scarce. Nevertheless, a few possibilities involving Met.No, HIRLAM, Météo-France and SMHI were identified: make use of the expertise/experience of Mariken Holmleid (Met.No) and Maria Diez (INM/HIRLAM); and make use of the reanalyses effort to be undertaken by Météo-France and SMHI (e.g. based on a recently submitted EU proposal).

Other improvements to CANARI identified concerned the adaptation of the data assimilation system to account for bias correction and the observational and model errors. The ideas of Dee and da Silva (bias correction), and Desroziers (tuning observational and model errors) were mentioned and discussed. NILU intend to apply these ideas in their land data assimilation developments.

It was emphasized that complete consistency between the land and atmosphere, e.g., fluxes between the soil surface and the upper air, is paramount. Nils Gustafsson provided a brief outline of an idea to use two cost functions, one for the soil (relatively more non-linear) and another for the atmosphere (relatively less non-linear), and use loops and an iterative technique (akin to outer/inner loops in 4D-Var), together with a joint solver to perform the assimilation. Issues such as the treatment of boundary layer and the surface, and time-scales appropriate for linearity, would have to be investigated. This approach was perceived to be worth considering, but unlikely to be developed in the near future. Developments at Météo-France (Mahfouf, Lemoigne, Bouyssel) could help move forward with this approach.

3.Assimilation of radiances

The benefit of assimilating radiances rather than retrievals has long been recognized in the NWP community. Thus, it is natural to move toward the implementation of radiance assimilation for the land surface. Such a development is likely to allow better use of land surface observations, and benefit NWP activities, including the assimilation of atmospheric satellite observations where weighting functions are affected by the land surface. The assimilation of land surface radiances, however, is at a very early stage, not implemented operationally and, if at all performed, done so in a research mode. The various problems to be overcome include the development of a reasonable radiative transfer model and mapping between observed radiances and model quantities.

The land data assimilation activities at, e.g., Météo-France and NILU, will involve retrievals for the foreseeable future. Nevertheless, it was deemed worthwhile to explore ways to develop the capability for radiance assimilation for the land surface. Possible ways forward include the use of passive control variables (i.e., do not contribute to the update of the background), and the use of Satellite Application Facility (SAF) products and algorithms. The experience / expertise of the Met.No remote sensing section could be used. A joint PhD project involving Met.No and NILU was identified as a possible way of getting resources to address the assimilation of radiances for the land surface- this will be explored, but a likely start date is 2-3 years into the future.

Appendix V

Notes from meeting on convective scale Comprehensive Impact Study (CIS)

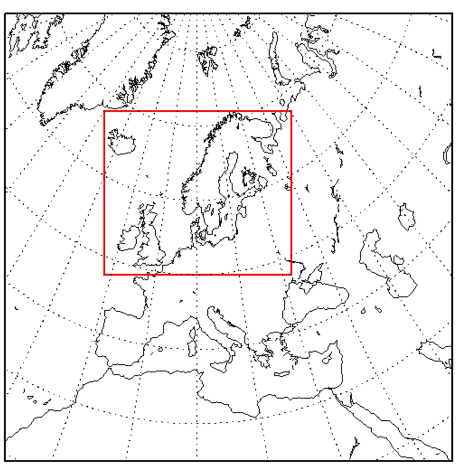
Oslo, Norway, 19 March 2009

Participants:

Reima Eresmaa, Nils Gustafsson, Jeanette Onvlee, Magnus Lindskog (rapporteur), Roger Randriamampianina, Kirsti Salonen, Jelena Bojarova ('observer')

General

Learning from the Atlantic scale CIS the results should be carefully checked at an early stage. In addition, in a first step experiments should be run on a 'Scandinavian area' (see figure below) significantly smaller than the large European area aimed for at a later stage. The purpose of this initial reduction of the domain is both to reduce computational requirements in this test phase and to have an area with radar wind data available at an early stage. Also the area should be far enough south so that SEVIRI satellite data is available and expected to have an impact. GPS data should be taken from Germany, England and France (these 3 processing sites have highest quality) and subdivided into boxes to avoid redundancy of GPS data. The time period over which the convective scale CIS experiment should be run is 1 June-15 July, 2007, where the first 14 days represent a warming up period. Bias corrections should be applied for GPS and SEVIRI data, utilizing a RCR run. Bias correction based on RCR-forecasts from same season the year before or the month before the experiment (preferred by Reima, based on later discussions). No bias correction is initially planned for radar data. A control run with HIRLAM 4D-Var utilizing conventional types of observations, and satellite data as in the Atlantic scale CIS, will be carried out with settings as described below. In the complementary runs SEVIRI clear + cloud not-effected radiances, radar radial winds and GPS ztd will be used. Details on the combination of observations to be used in the complementary runs are to be decided later (ASM meeting in May).



Control run settings

  - 'Scandinavian area' reaching to North of the Alps, see figure above. 10 km horizontal resolution and 60 vertical levels.
  - HIRLAM 4D-Var with two outer loops (6 times horizontal resolution and 3 times horizontal resolution, respectively). Standard simplified physics to be used (no large scale condensation)
  - HIRLAM reference structure function to be used (60 vertical levels, from 15 km RCR area based on 36-12 h forecast differences).
  - Specific humidity control variable to be used.
  - 6 h assimilation cycle for 1 June- 15 July 2007.
  - Up to 30 h forecasts at 00 and 12 for 8 June- 15 July.
- Observations from Atlantic scale CIS in control run (ATOVS AMSU-A and AMSU-B radiances, GEO and MODIS AMVs, SEAWINDS scatterometer winds)

Additional Observations

Additional data to be used are radar radial winds, GPS ZTD, SEVIRI cloud free and cloud not affected radiances.

Radar radial winds:

  - Collect hourly radar radial wind raw data from Sweden, Finland and possibly the Netherlands.
  - Dealiasing and generation of superobservations.
  - Tuning of observation errors and QC.
- Monitoring of radar quality.

GPS ZTD:

  - Collect horly data processed in Germany, England and France.
  - Look into bias correction (not VarBC), rules for station selection, possibly thinning.
- Bias correction for independent month (month before experiment utilizing RCR run).

SEVIRI radiances

  - Collect hourly cloudfree radiances and non-cloudeffected radiances, (aim cloudy radiances).
  - Tuning of qc and error statistics.
- Bias correction for independent month (same as for GPS ZTD) utilizing RCR run.

Code merging and platform

Code modifications needed for radar radial wind and GPS submitted to trunk. Reima will then create stable branch from that to be used for control run. After that the relatively extensive SEVIRI code modifications will be added to a copy of the settings for the control run. All runs will be carried out at ECMWF hpce supercomputer.

Actions and time-frame

- Submit changes needed for radar radial winds and GPS ZTD to trunk (Kirsti, Reima, 1 April 2009).
- Preparation of settings and area for control run (Reima, 15 April, 2009).
- Carry out 1 month of HIRLAM 4D-Var control run (Reima, to be finnished at ASM in mid-May, 2009).
- Collection and preparation of data (radar radial wind, GPS ZTD, SEVIRI) for bias correction period, and experiment period (Kirsti, Reima, Martin, Magnus, ASM mid-May, 2009).
- Update copy of settings for control run with SEVIRI needed code (Martin and Magnus, ASM in mid-May, 2009).
- Investigate performance and quality of control run (all, ASM in mid-May, 2009).
- Meeting on CIS at ASM to decide on additional observation runs (all).
- Bias correction for GPS ZTD and SEVIRI (Reima, Martin, Magnus, 15 June, 2009).
- Investigation of radar radial wind quality (Kirsti, 15 June, 2009).
- Test assimilation runs with radar radial winds, GPS ZTD, SEVIRI radiances included (15 June, 2009).
- Carry out runs with additional observations in different combinations to be decided (all, autumn, 2009).
- Analyze results (all autumn-winter, 2009)
- Extension of experiment to larger domain (all, 2010).

Appendix VI:

Report from subgroup 4

OBSERVATIONS FOR HARMONIE DATA ASSIMILATION

Magnus, Roger, Jeanette, Ole, Mats, Antonio

OSLO WS ON SURFACE AND SOIL DATA ASSIMILATION
16-19 March, 2009

Topics that were discussed

- *General procedure for HARMONIE DA work*
- *Which observation types/variables to use and how*
- *Observation pre-processing*
- *Format issues*
- *Bias correction*
- *Blacklist/Monitoring*
- *Tuning of errors and QC*
- *shuffle_odb problem*
- *Observation assimilation studies*

General procedure for HARMONIE DA work

All HARMONIE researchers strongly encouraged to work within HARMONIE mini-sms system.

Submit modifications/bug-fixes to 'trunk'

Observations to be used (3D/4D-Var)

Default (set to .true. in HARMONIE reference system) :
Conventional types of observations:
synop, ship, dribu, airep, temp, pilot, amdar, acars

(type of variables to be used may need modification after studies through assimilation experiments+ based on experiences from ALADIN/HIRLAM)

Non-default (set to .false. in HARMONIE reference system) :
ATOVS AMSU A/B, HIRS, IASI, AMV/MODIS METEOSAT, Wind-profilers, SEVIRI (need to be pre-processed locally), GPS ZTD (underway), ASCAT (not yet fully pre-processed), binary cloud info (preprocessed), radar wind- profiles, Radial wind reflectivities (to be pre-processed), approach radar (T,u,p) (to be pre-processed)

Observations to be used (Surface assimilation)

At present :
SYNOP T2m, RH2m, SST

In future:
Lake temperature, ice, Satellite based soil moisture observations

Observation pre-processing

Present situation in LACE: Hungary pre-process and provides obsoul-files, seviri in grib. The future plan is to have local pre-processing at each institute.

HARMONIE observation pre-processing mainly utilizes BUFR as input format for observations. BUFR data are mainly processed by OULAN (for conventional data) and BATOR (for satellite data). BATOR requires flag setting lmfbufr=.false. (the default setting uses MF BUFR).

HARMONIE observation pre-processing works fine with ECMWF bufr data and ECMWF tables.

Further HARMONIE work regarding utilization of local bufr data/tables is needed. This require a combined effort from HARMONIE experts and experts from individual institutes.

Work for an introduction of Bufr2odb to get closer to ECMWF solution and to avoid unnecessary intermediate formats. (BUFR-> ODB)

Format issues

Make sure that standard data formats to be exchanged can be handled as input and preprocessed:

BUFR for most observation types,
hdf5 for radar radial winds/reflectivities,

At present binary format is used for binary cloud information and, grib or binary for SEVIRI.

Bias correction (3D/4D-Var)

Variational bias correction as default (in line with LACE plans). Allow for flexible use (for example to allow for daily cycle of biases) and provide bias correction files as starting points (10 day warming up needed). Prepared for AMSUA/B; HIRS, IASI, SEVIRI

Bias correction of other observations: Solutions often available in IFS.

Radar reflectivity is important examples but need to be handled separately

Keep in system the off-line bias correction

Blacklisting/Monitoring (3D/4D-Var)

At present LACE/HARMONIE partners are using Meteo France blacklist file. (mf_blacklist.b , LISTE_NOIR_DIAP (sometimes updated), LISTE_LOC (blacklist for short period in case of operational run). In HIRLAM essentially no blacklisting is done.

Monitoring is important and a flexible system do exist (Advanced visualization system available but need some local preparation. Simpler one in reference harmonie.). Extend existing monitoring system to allow for time-series of departures at individual stations. Exchange monitoring information from national runs.

→ Possibility of carrying out reference run on coarser resolution.

Tuning of errors and QC

Further work on investigation/tuning of observation/background errors and tuning of fg-check is needed.

Modifications should be introduced in HARMONIE branch.

Introduction of VarQC is not felt important until positive impact of VarQC has been clearly demonstrated in HIRLAM framework.

HARMONIE Shuffle_odb problem

Shuffle_odb is not working properly in HARMONIE system. From time to time it fails for still unknown reasons. More often it fails with a large number of processors in assimilation. In HARMONIE npool= number of processor. Changing number of pe usually 'cure' the problem.

In Croatioa NPOOL is set less than the number of processors and no problem with shuffle_odb has been experienced.

In HARMONIE we should try NPOOL < number of processors but also find the reason for failure and solve the problem.

HARMONIE observation assimilation studies

Extensive HARMONIE assimilation experiments is planned and will be beneficial for several aspects of the HARMONIE system (such as recommended observation usage, stability, qc)

Assimilation experiments will be carried out within EUCOS framework and for local HARMONIE setups at individual institutes.

EUCOS impact studies will be coordinated with HIRLAM Comprehensive Impact studies and a huge observation data base (containing for example COPS data) will be prepared and made available.