Monitoring and diagnosis of analysis results

HARMONIE SYSTEM TRAINING WEEK
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Structure

- Introduction
- Automatically produced daily monitoring plots
- Some other daily diagnostics easily produced
- Diagnostic tools to apply once and to redo every now and then when modifying your forecasting system
- Potential improvements
What to look at to monitor/diagnose the data assimilation system?

• Observations utilized for each data assimilation cycle
• Quality of different observation types and individual observations
• Impact of different observations on the analysis (and forecasts)
• Functionality and tuning of bias correction and quality control
• General functionality of data assimilation system
• Pre-scribed statistics for background and observation errors
• ...?
General

• Quite a lot of monitoring results are automatically produced for each data assimilation cycle and others can easily be derived.
• Most of the diagnostics tools have their origin in HIRLAM and are adopted to use in HARMONIE.
• There is still room for improvements and extensions, in particular monitoring of satellite data and surface data assimilation.
Illustration of monitoring results available each data assimilation cycle

Results from Ulfs experiment alaro_36h14_mixbc

Platform: ecgate/c1a
Domain: SCANDINAVIA_5.5
PHYSICS: ALARO
SURFACE: SURFEX
DA: Surface and upper-air data assimilation
Period: 1-31 January, 2010
Illustration of plots from each data assimilation cycle

Raw data on ecfs:

• `ec://snh/harmonie/alaro_36h14_mixbc/YYYY/MM/DD/HH//logfiles.tar`
  (HM_Date_YYYYMMDDHH.html)

• `ec://snh/harmonie/alaro_36h14_mixbc/YYYY/MM/HH/DD/odb_stuff.tar`
  (odb_can.tar, odbvar.tar, odb_ccma.tar, VARBC.cycle)

• `ec://snh/harmonie/alaro_36h14_mixbc/YYYY/MM/DD/HH/
  UA (FA): ICMSHANAL+0000, MXMIN1999+0000 (ANAB1999+0000), ICMSHHARM+0006`

SURFEX (Ifi): AROMOUT_.0000.lfi, AROMOUT_.0006.lfi

On ecgate:

$HOME/hm_home/alaro_36h14_mixbc/sms/config_exp.h: OBSMONITOR=obstat:obtime

• `hm_home/alaro_36h14_mixbc/archive/extract/WebgraF`
  placed on

$SCRATCH/hm_home/alaro_36h14_mixbc/archive/extract/WebgraF.tar
  -cvf WebgraF.tar WebgraF ( -> WebgraF.tar)

bring WebgraF.tar (gzipped) to a file-system of your institute

Intermediate useful files that are stored:

$SCRATCH/hm_home/alaro_36h14_mixbc/archive/extract

ecma_amsu_YYYYMMDDHH.gz, ecma_conv_YYYYMMDDHH.gz, ccma_YYYYMMDDHH.gz
Displaying monitoring results using the WebgraF web-interface on SMHI file system:

cd /data/proj/hirfou/uandrae/4magnus/
ftp ecaccess.ecmwf.int, followed by get WebgraF.tar, followed by tar –xvf WebgraF.tar
Observation usage timeseries

Obstype
- AMDAR-Aircraft
- AIREP-Aircraft
- AMDAR-Aircraft

Number of AMDAR-Aircraft observations at 00 UTC

No. of Obs:
- 600
- 1200
- 1800
- 2400

Date:
- 26/12
- 02/01
- 09/01
- 16/01
- 23/01
- 30/01
- 06/02
HARMONIE usage maps and departures of conventional observations

Obstype: airep_t
Date: 2010020100
HARMONIE usage maps and departures of conventional observations

Plottype: Map
Obstype: Departure
Date: 2010020100
Observation fit statistics for 2010010400

AIREP

Radiosonde
HARMONIE daily time-series of satellite bias correction

Date: 2010012600
HARMONIE maps of amsua departures and bias-correction

Satellite
- NOAA15
- NOAA16
- NOAA18
- NOAA19
- METOP

Channel
- 6
- 7
- 8
- 9
- 10

Type
- ob(raw)-fg
- ob-fg
- ob-an
- bcorr

Date
- 2010013100
NOAA-19 ASMSU-A bias and bias correction 2010013100

ob (raw)-fg

ob -fg

ob-an

biascorr
How to derive and plot information of Cost function minimization

On ecgate go to $SCRATCH, then

```bash
ecp ec:/snh/harmonie/alaro_36h14_mixbc/YYYY/MM/DD/HH//logfiles.tar
.tar –xvf logfiles.tar Date_harmonie.log
grep -i ‘grepcost – iter’ HM_Date_2010010312.html | awk '{print $4,$6,$7}' > out.dat
``` - >

```
more out.dat
``` - >

```
0 288235.563138
0.000000000000 1560.13110649 0.000000000000
1 1389.98178552 9.10205729598
2 1279.04101911 26.4942541088
3 1218.49069048 37.8142691175
...
999 935.646296242 169.685692755
```

Remove first and last line and plot column 1 against, 2 (jb), 3(Jo) and (2+3) J
Cost as function of number of iterations in the minimization

\[ J = J_b + J_o \]
How to generate plot sof analysis increments from each data assimilation cycle

Raw data on ecfs:
• ec:/snh/harmonie/alaro_36h14_mixbc/YYYY/MM/DD/HH/
  UA (FA): ICMSHANAL+0000, MXMIN1999+0000 (ANAB1999+0000), ICMSHHARM+0006
  SURFEX( lfi): AROMOUT_.0000.lfi, AROMOUT_.0006.lfi

Convert to grib and plot (analysis increments) difference files:

Temp anincr 200 hPa (tenth of K)  T2m anincr 200 hPa (K)

MXMIN1999+0000(T)- ICMSHANAL+0000(T)  ICMSHANAL+0000 (T)-ICMSHHARM+0006(T-6)

Also take a look at plot tg1,tg2, wg1,w2 analysis increments from surfex files
Also plot the background fields and analysis increments themselves. Example of analysis increment och background field.

Temperature at i 200 hPa

**Unit: tenths of Kelvin**

**Unit: Kelvin**
Some diagnosis that to do once and repeat when changing characteristics of data assimilation and modelling system

- Diagnosis of background error statistics using jbdiagnose and single observation impact studies.
- Tuning of background error standard deviations (REDNMC)
- Tuning of first guess check rejection limits
Impact of one single AMSU-A channel 7 observation in HARMONIE 3D-Var. Observation time at 20080212 12 UTC, 0 degree longitude, 60 degree latitude. Observed value 1 K warmer than corresponding background value.

Vertical cross section of temperature increments (K) at the beginning of the assimilation time window.

http://cimss.ssec.wisc.edu/itwg/itsc/itsc17/posters/7.22_randriamampianina.pdf

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/SingleObs

Single Observation Impact Experiments

- Positive
- Negative
Tuning of background error standard deviations

- Desroziers et al. (2005) presented methodology for diagnosing background and observation error variances from statistics of observation minus analysis and observation minus background equivalent. This statistics is contained in stored ccma_YYYYMMDDHH.gz files. Utilize a couple of months of these files.

- There is ongoing work to introduce this methodology into HARMONIE reference system.
Illustration of results from Desroziers method utilized to estimate \( \text{sigmab/sigmao} \) from statistics of \( (y-\text{Hxb}), (y-\text{Hxa}) \) 
(from Jana Sanchez Arriola)

Vertical profile of \( \text{sigmab/sigmao} \) for temp_T

![Vertical profile of sigmab/sigmao for temp_T](image)
"Objective" Tuning of BgQC and VarQC

(following Andersson and Järvinen, QJR, 1999)

Derive histograms \(f\) of ob-bg and ob-an

Transform histograms according to:

\[
\hat{f} = \sqrt{-2 \ln\left[\frac{f}{\max(f)}\right]}
\]
Data from 14 days experiment

Transformed Histogram

Histogram

Data from 1 day experiment

Surface pressure innovation histograms (Pa)

HIRLAM EXAMPLE

DRIBU

Accepted VarQC rej

BgQC rej
Potential improvements

• Extend the monitoring tool to cover more types of satellite observations as well as new types high resolution observations.
• Introduced various automatically produced monitoring plots for surface data assimilation.
• Automatic generation of plots for cost function minimization and analysis increments.
• Make sure on-going developments will be introduced into the reference system.
• Monthly averages of various statistics?
• New types of monitoring and diagnostics?