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Canada

Status of Operational Satellite Data Assimilation at Environment Canada

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Introduction

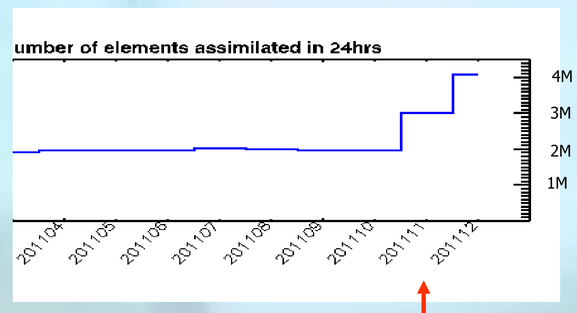
- On November 16, 2011, Environment Canada has implemented a major upgrade to the Canadian Meteorological Center analysis and forecast suites. The upgrades include new data sources for assimilation.
  - IASI : 62 channels, sensitive to temperature below 150hPa;
  - SSMIS : 7 SSMI-like channels from DMSP-16, sensitive to temperature, humidity and surface wind speed (over oceans);
  - CSR : all 5 geostationnary satellites (previously 2 GOES satellite), one water vapor channel assimilated;
  - AIRS : assimilate upper level channels previously blacklisted within 30° of both poles;
  - Humidity data from aircraft.
- Other improvements include :
  - Reduced horizontal thinning for all satellite radiance observations (250km → 150km)
  - New sea-surface temperature analysis (Global 0.2 deg; Brasnett 2008)
  - Reduced background errors near the model top
  - Improved QC for AMV's and unified radiance bias correction scheme
- In what follows, what refers to the former operational control is in blue and the new operational system is in red.

Assimilation setup

- Observing network
  - Surface (SYNOP/SHIP/BUOYS/DRIFTER)
  - Radiosonde (TEMP/PILOT)
  - GPSRO (COSMIC. METOP, GRACEA, TERRASARX)
  - Aircraft (temperature, wind, humidity)
  - AMV's (Geo and Polar)
  - Wind profiler (USA)
  - Scatterometer (METOP-2 Ascat)
  - AMVs (Geo and Polar)
  - GOES-E/W (water vapor channel)
  - Meteosat7-9 (water vapor channel)
  - MTSAT-2 (water vapor channel)
  - NOAA15-16-18-19 & METOP-2, AQUA (AMSUA, AMSUB/MHS)
  - DMSP16 SSMIS (7 SSMI-like channels)
  - AIRS (87 channels, all assimilated globally)
  - IASI (62 channels)
- GEM Model characteristics
  - Model top at 0.1 hPa (63km)
  - 33km resolution (800 x 600) L80
- Data assimilation
  - 4D-Var, T108 (240x120)
  - analysis resolution 33km (800 x 600)

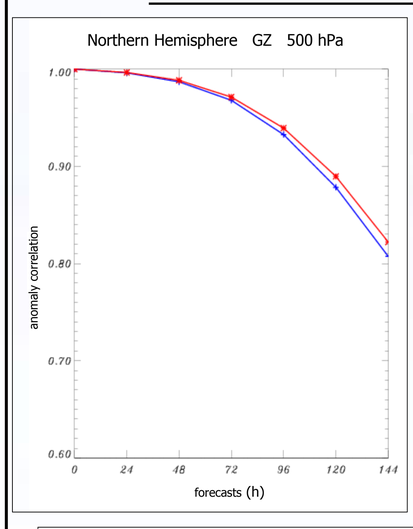
Number of channels per spectral bands

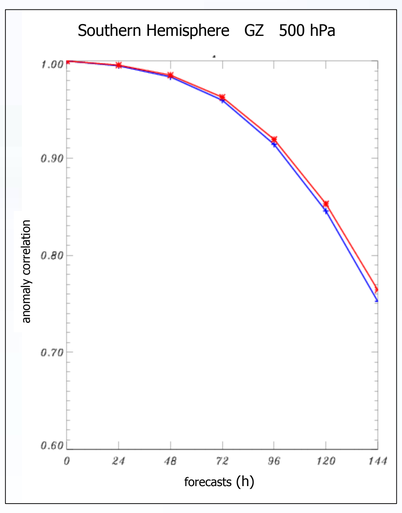
cm^{-1}	Spectral bands	AIRS	IASI
650 – 770	Temperature Sounding (CO_2 Band)	20	43
770 – 980	Surface and cloud properties	6	19
1000 – 1070	Ozone sounding	0	0
1070 – 1150	Surface and cloud properties	4	0
1210 – 1650	Water vapor temperature sounding	33	0
1650 – 2100	Water vapor temperature sounding	0	0
2100 – 2150	CO column amount	0	0
2150 – 2250	Temperature sounding	9	0
2350 – 2420	Temperature sounding (CO_2 Band)	15	0
2420 – 2700	Suface and cloud properties	0	0



Operational Implementation of New and Additional data 16 November 0600 UTC

Parallel Run Verification : January - March 2011



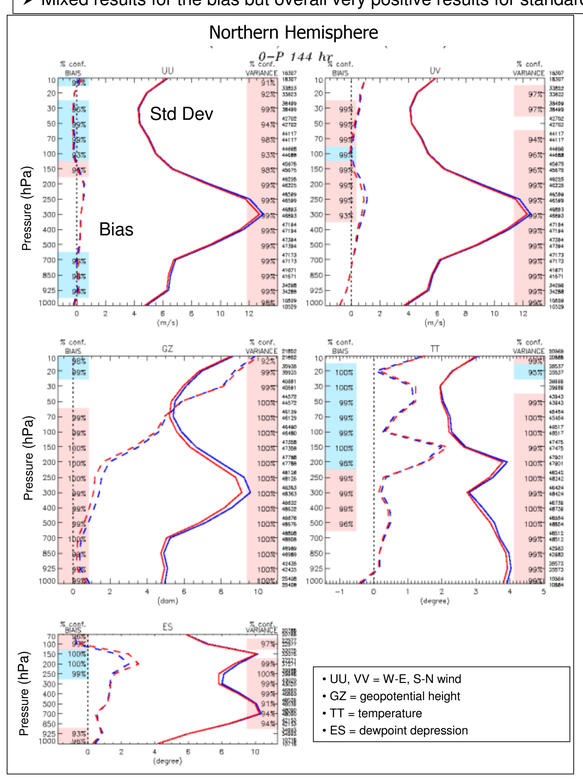


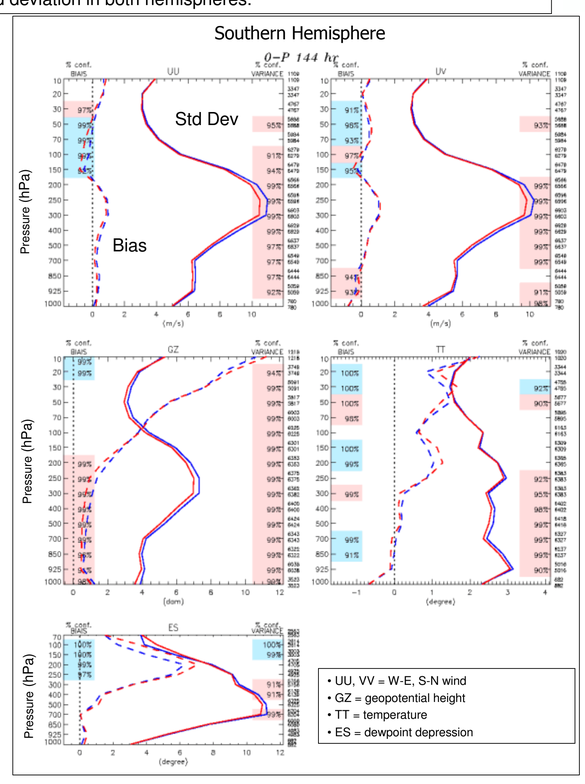
Verification of 1-6 day forecasts against analysis: Anomaly correlation for 500 hPa Geopotential Height (GZ)

- Higher correlation is better
- Positive impact on both hemispheres forecasts
- Gain of about 6 hours predictability in NH and 3 hours in SH at day 5
- Verification for 65 days

Verification of 6 day (144 hr) forecast (P) against radiosonde observations (O) for Northern and Southern Hemisphere

- Significance level (%) of bias and Std Dev O-144hr differences are shaded (red = experiment is better, blue = control is better)
- Mixed results for the bias but overall very positive results for standard deviation in both hemispheres.

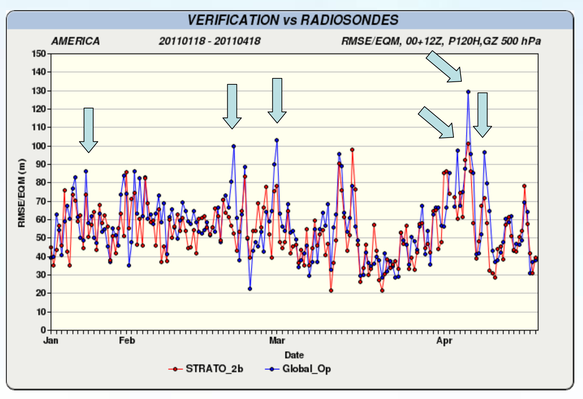




Parallel Run Verification : time series January to June 2011

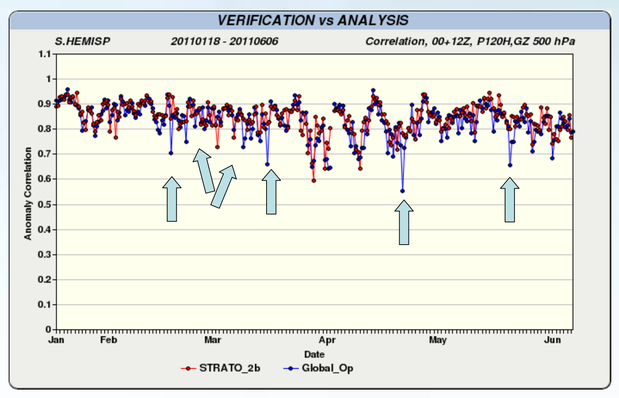
GZ 500 hPa 120 h RMS N.H.
cases RMS > 80: **OPS: 20 PAR 10**

Arrows show occurrences of busts that were greatly reduced in comparison to operational



GZ 500 hPa 120 h A.Corr. S.H.
cases ACOR < .75: **OPS: 29 PAR 15**

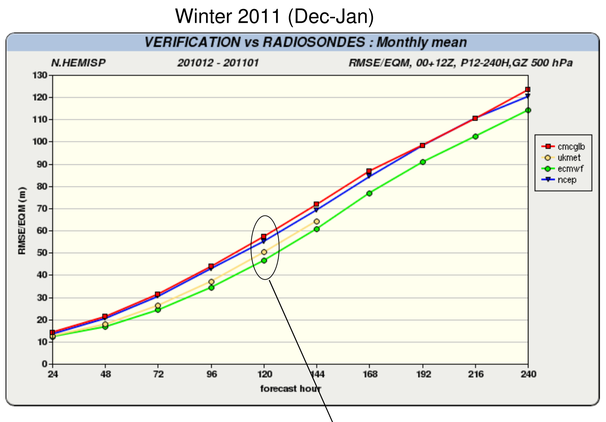
Arrows show occurrences of busts that were greatly reduced in comparison to operational



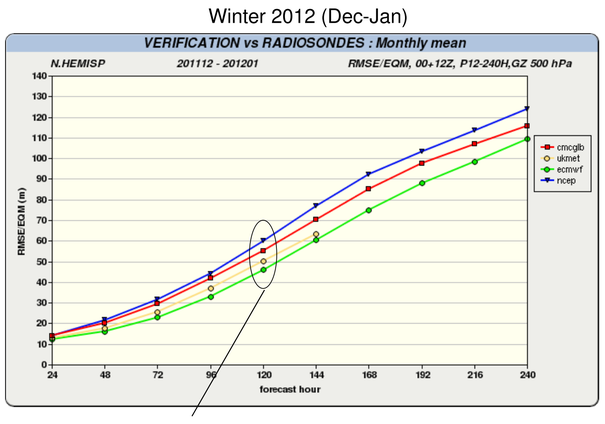
Comparison with other Centres : Winter 2012 to Winter 2011

MSC NCEP UK-Met ECMWF

Winter 2011 (Dec-Jan)



Winter 2012 (Dec-Jan)



N. H. Forecast errors (RMS) at Day-5 (120-hr)

Winter 2011	Winter 2012
57.3 m	59.9 m
55.2 m	55.3 m
50.3 m	50.3 m
46.6 m	45.9 m

2.0 m error reduction represents about 4-h of gain in forecast skill in the medium range forecasts.

Courtesy of S. Laroche

Concluding remarks

- Results show that the assimilation of the new data sources (IASI, SSMIS, CSR) as well as reduced thinning of radiances, therefore doubling the amount of data assimilated, has an overall very positive impact on the analyses and forecasts of the EC global 4D-Var system for both hemispheres.
- This upgrade was operationally implemented at CMC on November 16, 2011 for the global and the regional deterministic prediction systems.
- Changes to Satellites (e.g. GOES, MTSAT) occurred during the parallel run and will be incorporated after the migration to the IBM P7 computers. Data from DMSP F17 and F18 and AVHRR polar winds will also be incorporated.
- EnKF (GEPS) has 100-km grid, lid at 2 hPa: assimilates AMSU-A ch.4-11 and AMSUB ch.2-5 but thinning remained at 250-km; no AIRS / IASI

In the Works

- RDPS to be upgraded to 4D-Var T200, 10-km grid by Summer 2012.
- GDPS to be upgraded to 25-km grid, 4D-Var T180 by Fall 2012. GEPS grid (EnKF) to 66-km grid (from 100-km) with multi-scale algorithm, same thinning as GDPS.
- Work is underway for NPP (ATMS and CrIS) initially using simulated data and RTTOV-10. Data from Metop-B to be incorporated later in 2012.
- Assimilation of bending angle instead of refractivity for GPS-RO, and GB-GPS (ZWD).
- Improved assimilation of aircraft and radiosonde data (full 4D trajectory).
- Additional AIRS and IASI channels, reduced radiance observation errors and possible further reduction in horizontal thinning.
- New 3D-Var Global sea-ice analysis.
- New unified assimilation system for GDPS and GEPS (En-Var and EnKF).