Environment Canada | Environnement Canada

Status of radiance assimilation at the Canadian Meteorological Center

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INTRODUCTION : Many important upgrades to the operational Global Deterministic and Ensemble Prediction System (GDPS & GEPS) at Environment Canada were implemented since ITSC-19 :

Changes to Deterministic Prediction Systems - November 2014

- Assimilation approach based on Four-Dimensional Ensemble-Variational data assimilation 4DEnVar (Buehner et al., 2015)
- Resolution increase of the analysis increment horizontal grid from 0.9 x 0.9 deg. to 0.45 x 0.45 deg.
- Background error covariances surface to ~40hPa: Average of NMC method and 4D ensemble covariances from 256 ensemble members every hour over assimilation window
- Assimilation of IASI from Metop-B (on May 2014)
- Increase in the number of channels assimilated for AIRS (87 to 142) and for both IASI (62 to 142).
- Assimilation of ground-based GPS data from North America.

EXPECTED END-2015

- Assimilation of CrIS and ground-based GPS data over Europe (E-GVAP network).
- Use of a non-diagonal radiance observation error covariance matrix, taking interchannel correlation into account (See poster session 5b from Louis Garand) .

Changes to Ensemble Prediction System - November 2014

- Ensemble size is increased from 192 to 256 members (analysis steps) (Houtekamer et al. 2014)
- The resolution of the EnKF analyses, the trial fields and the medium-range forecast is increased to 50 km (800x400 grid points) from 66 km (600x300 grid points)
- The time step of the model (trial and forecast) was reduced from 20 minutes to 15 minutes
- The position of the model top raised to 1.45 hPa (from 1.78) for better match with the highest temperature level in GEPS
- Provides the GDPS with an ensemble of trials to estimate the flow-dependent background error covariance for the 4DEnVar (Buehner et al. 2014 a and b; Buehner et al. 2013a)
- GPS-RO observations above 1 km (instead of 4 km in previous version) are assimilated
- Three additional parameters are now perturbed in the trial-field and medium-range forecast model configurations
- Assimilation of stratospheric humidy (for 4D-EnVar).

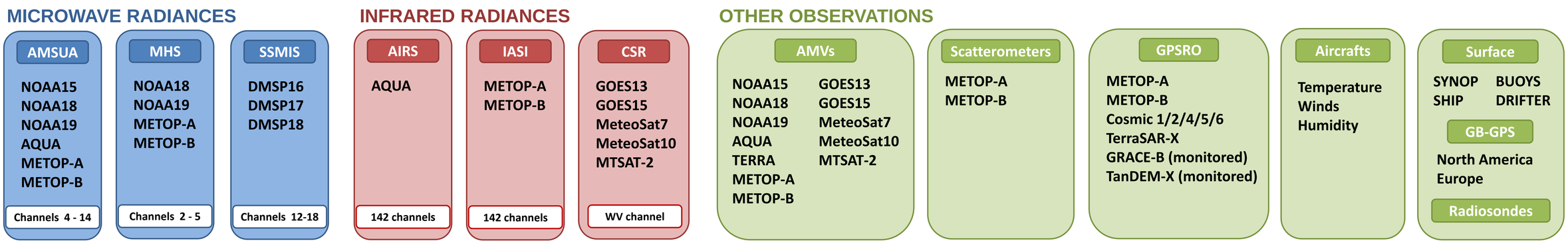
Common changes to Deterministic & Ensemble Prediction System - November 2014

- Satellite radiance bias correction improvement: Coefficients computed from Obs-minus-analysis from a 3DVar analysis that does not include radiances
- RTTOV updated from version 8.7 to version 10.2
- Improved treatment of radiosondes observations : Estimated of horizontal drift from winds and ascent time difference, selection of observations according to model levels (Laroche and Sarrazin 2013).
- Static bias correction for aircraft temperature and change in the selection of observation (now based on model levels)

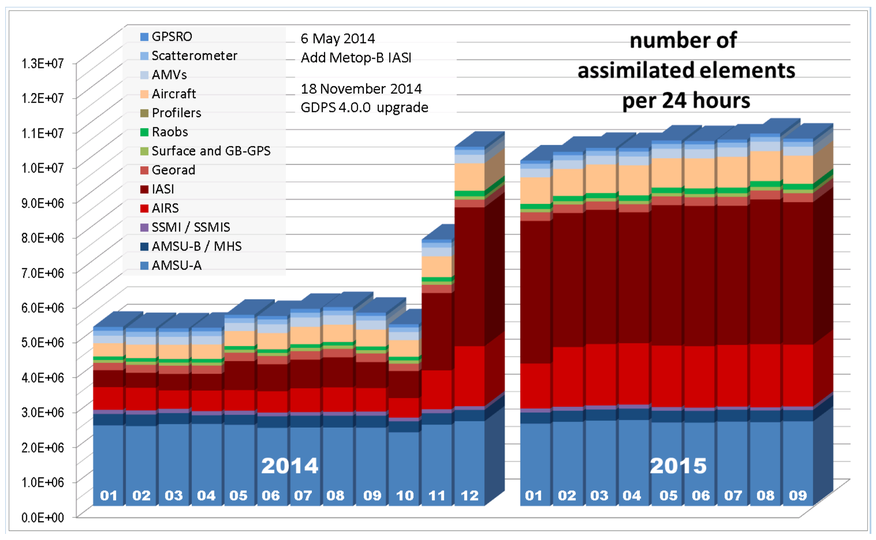
EXPECTED END-2015

- Assimilation of ATMS (See poster session 11b from Stephen Macpherson).

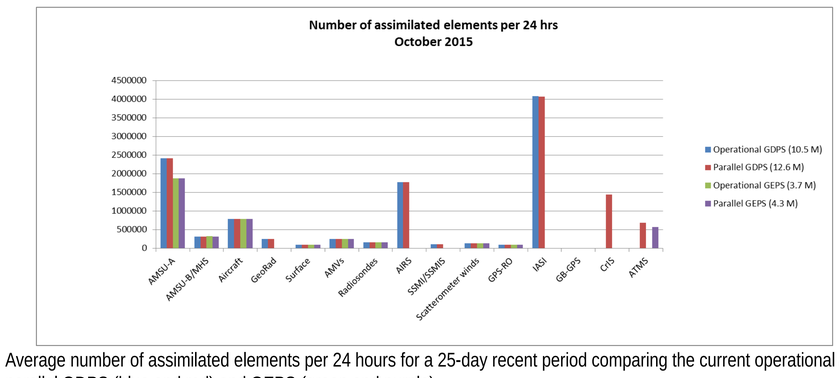
CURRENT OBSERVATIONS ASSIMILATED



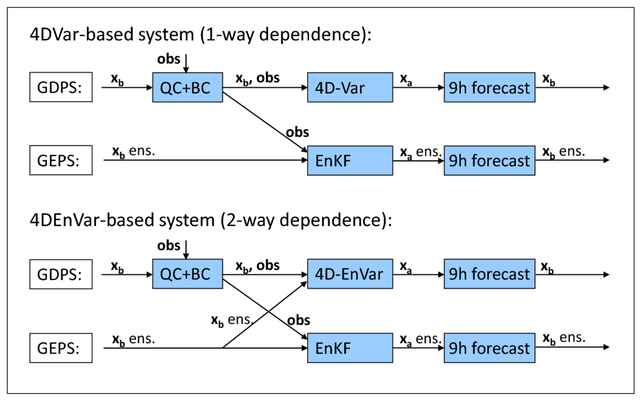
Number of observation assimilated



Average number of assimilated elements in the global deterministic systems per 24 hours for each month since January 2014.



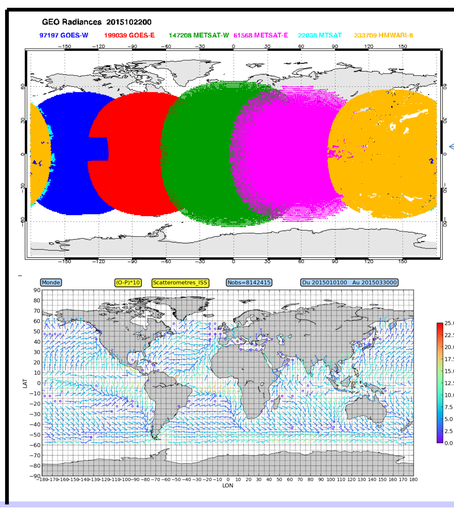
Average number of assimilated elements per 24 hours for a 25-day recent period comparing the current operational and parallel GDPS (blue and red) and GEPS (green and purple).



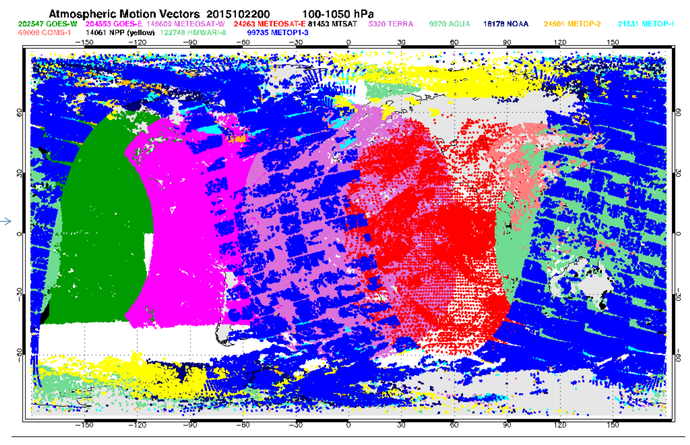
Dependencies between the deterministic and ensemble prediction systems (GDPS and GEPS) in the (top) previous 4DVar-based system and (bottom) new 4DEnVar-based system. Note that QC refers to quality control and BC to bias correction, both applied to the observations before assimilation in both systems. The vectors x_b and x_a refer to the background and analysis states, respectively, and ens. refers to the EnKF ensemble of either background or analysis states. (Buehner et al. 2015)

cm-1	Spectral bands	2008 4DVar		2011 4DVar		2014 EnVar	
		AIRS	IASI	AIRS	IASI	AIRS	IASI
650-770	T sounding (peak higher than 80mb)	0	0	0	0	0	0
	T sounding (80mb < peak < 150mb)	0	0	0	0	28	30
	T sounding (peak lower than 150mb)	20	0	20	43	34	45
770-980	Surface, low peaking T, RH sounding	6	0	6	19	12	19
980-1070	Ozone sounding	0	0	0	0	0	0
1070-1310	Surface and cloud properties	4	0	4	0	8	6
1310-2035	Water vapor & temperature sounding	33	0	33	0	32	33
2035-2175	CO column amount	0	0	0	0	0	0
2175-2250	Temperature sounding (N_2O band)	9	0	9	0	13	9
2250-2420	Temperature sounding (CO_2 Band)	15	0	15	0	15	0
2420-2700	Surface and cloud properties	0	0	0	0	0	0
	Total volume assimilated (Million/day)	**87** **0.7**	**0** **0**	**87** **0.7**	**62** **0.5**	**142** **1.8**	**142** **2.0**

Assimilated IR hyperspectral observations



Currently Monitored and Planned



AMVs
- Dual Metop Wind product
- NPP VIIRS
- Himawari-8

FUTURE PLANS

- Assimilation of CSR from Himawari-8, AMVs from SNPP and Himawari-8, Scatterometers from RapidScat.
- Assimilation of additional channels from CSR.
- Increase thinning resolution from 150km to 125km globally or over the extratropics only.
- Assimilation of infrared radiance observations with sensitivity to land surfaces (See Session 10a oral presentation from Louis Garand).

REFERENCES:

- Houtekamer, P. L., Bin He, and Herschel L. Mitchell. “Parallel Implementation of an Ensemble Kalman Filter.” Monthly Weather Review 142, no. 3 (March 2014): 1163–1182. doi:10.1175/MWR-D-13-00011.1.
- Laroche, S., and R. Sarrazin, 2013: Impact of radiosonde balloon drift on numerical weather prediction and verification. Wea. Forecasting, 28, 772–782.
- Mark Buehner, Ron McTaggart-Cowan, Alain Beaulne, Cécilien Charette, Louis Garand, Sylvain Heilliette, Ervig Lapalme, Stéphane Laroche, Stephen R. Macpherson, Josée Morneau, Ayrton Zadra. (2015) Implementation of Deterministic Weather Forecasting Systems Based on Ensemble–Variational Data Assimilation at Environment Canada. Part I: The Global System. *Monthly Weather Review* **143**:7, 2532-2559.

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