ATOVS assimilation in the regional configuration of the Canadian unified system

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1. Introduction

The incremental formulation of the Canadian operational 3DVAR assimilation system allows for quasi-simultaneous implementation of improvements developed for the global data assimilation in the regional framework. After the ATOVS AMSU-A channels were successfully assimilated in the new Canadian Meteorological Center (CMC) global assimilation system (Chouinard et al., 2002), it was straightforward to do the same for the 24 km resolution regional model. A brief description of the regional assimilation cycle is presented along with significant positive impact on specific regional meteorological parameters, such as precipitation. Also, in the process of issuing timely high resolution NWP forecasts over Canada, the availability and coverage of data are crucial. It is reported that this concern is adequately addressed even when the replacement of level-1d AMSU-A data by level-1b sets implies relying operationally on the Internet network instead of the GTS for data transfer.

2. Unified analysis code

The short-range regional forecast model GEM (Global Environmental Multiscale) (Côté et al. 1998) has a 24 km horizontal resolution over North America and 28 eta levels in the vertical. It is run twice daily (00 and 12UTC) for 48 hour forecasts. This regional GEM grid configuration, operational at CMC since September 15 1998, is shown on Fig. 1. The initial conditions are obtained from a 3DVAR analysis procedure (Laroche et al. 1999). The incremental implementation of the variational assimilation algorithm allows for ingestion of trial fields at different resolutions horizontally and vertically while the analysis of the increments remains on a common internal grid. Thus the same analysis code can be used for both global and regional analysis. It is only the information from the trial field for the calculation of the innovations that differs. The regional analysis with higher resolution topography has better data visibility than the global one, e.g. ships in coastal areas or surface data over mountains. Note that a maximum data reception delay of about 1.5 hour ensures timeliness of the resulting forecast. In contrast to a continuous global assimilation cycle, the regional cycle runs only two loops of 6 hour assimilation before launch of the 48 hour regional forecast. Then

a new 12 hours cycle, also called spinup, starts. It is the global analysis that initiates the cycle. A schematic view of this procedure can be seen in Fig. 2.

The implementation of a unified analysis program in January 2001 for both global and regional applications allowed for an instantaneous benefit in the regional system of algorithmic changes or development of new data sets for the global mode instead of the typical 6 months delay. This is well illustrated in the history of recent operational changes in both global and regional forecasts systems presented in Table 1.

3. Results

The impact of these implementations were all beneficial at various degrees to the regional model's output variables. What is most important is that the precipitation forecasts were also improved. An example is shown in Fig.3, where one can see the significant bias reduction for all forecast precipitation classes compared to SYNOP rain gauges when the regional analysis went to eta levels and assimilated direct radiances instead of retrieved thickness and also aircraft winds. Moreover, the increase of the threat score (the number of correct quantitative precipitation forecasts divided by the total number of occasions on which that event was forecast and/or observed) for this 3 weeks fall case is considered significant. However no clean conclusion can be taken for high classes given the small number of verification samples.

4. Internet data reception

On June 7, 2001 ATOVS-1d mapped and filtered cloud satellite data were replaced by less processed ATOVS-1b set in the operational data stream. In the process, TOVS data from the NOAA-14 platform were replaced by NOAA-16 ATOVS. Level 1d data was received by GTS feed, whereas now CMC gets level 1b data on an FTP server at NESDIS through the Internet network. The AAPP package is used to decode the 1b data. The data amounts have increased due to the inherent higher resolution of level 1b, but even with thinning still done at 250 km a ~3.5 overall increase in volume presented to the analysis resulted from this change. It was noted that level 1b data arrived earlier than level 1d, which is crucial for regional run cutoff at T+1h40. However a dedicated link from the data producers (NESDIS) to CMC remains in the plans, even if our experience with the overall reliability of this current data access setup shows that it is as good as any other operational link. A major event like the ''ice-storm'' of January 1998 would have greatly affected CMC's assimilation system as the Internet access was down for nearly a week.

5. Conclusion

Any new development in global data assimilation framework has to be tested in the regional world. But the workload is significantly reduced by a unified analysis algorithm, allowing for quicker improvements of the forecast. This was the case for the direct assimilation of AMSU-A ATOVS radiances in CMC's regional system. Note that this approach might not be optimal as operational mesoscale forecasts become a reality. The fact that CMC's operational ATOVS level-1b access relies on the Internet network with earlier accessibility and a good reliability is quite encouraging for the probable future evolution of the GTS.

6. References

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Côté, J.; S. Gravel, A. Méthot, A. Patoine, M. Roch and A.N. Staniforth. 1998. The operational CMC/MRB global environmental multiscale (GEM) model: Part I-Design consideration and formulation. *Mon. Weath. Rev.* **120**: 1373-1895.

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Implementation	Global	Regional	Satellite Data
Analysis done on 28 model levels instead of standard pressure levels	June 2000		NOAA-14 SATEM
Assimilation of TOVS, ACARS and AMDARS	September 2000		NOAA-14 RTOVS MSU(2-4) NOAA-15 ATOVS-1d AMSU-A (land: 9-10, ocean: 6-10)
Both above changes with implementation of **unified** analysis code		January 2001	Same as above
Assimilation of ATOVS-**1b**	June 2001	June 2001	NOAA-15 and NOAA 16 ATOVS-1b AMSU-A
ISBA surface scheme		September 2001	
Parametrized low level blocking + correction to gravity wave drag	December 2001		
Assimilation of T, Ps instead of Geopotential + Variational QC	December 2001	December 2001	extra AMSU-A channels peaking below 500 hPa (land: 6-10, ocean: 3-10)

Table 1. Recent operational implementation history at CMC/MSC.

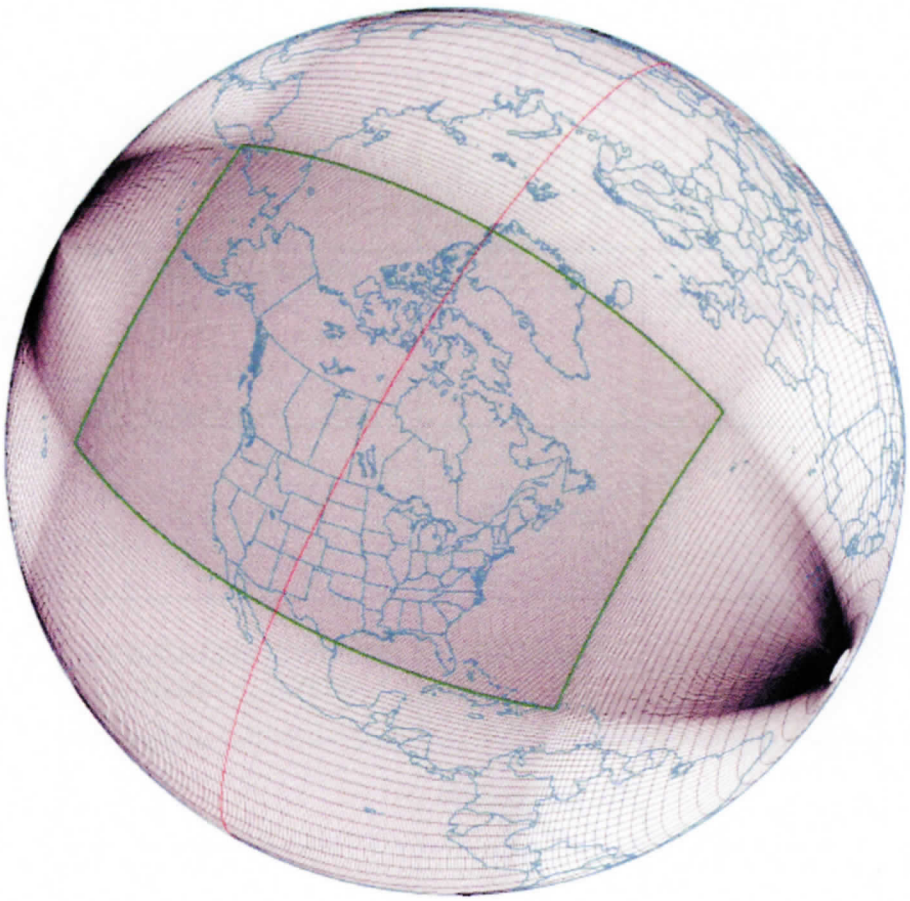

Figure 1. GEM grid for CMC operational regional model.

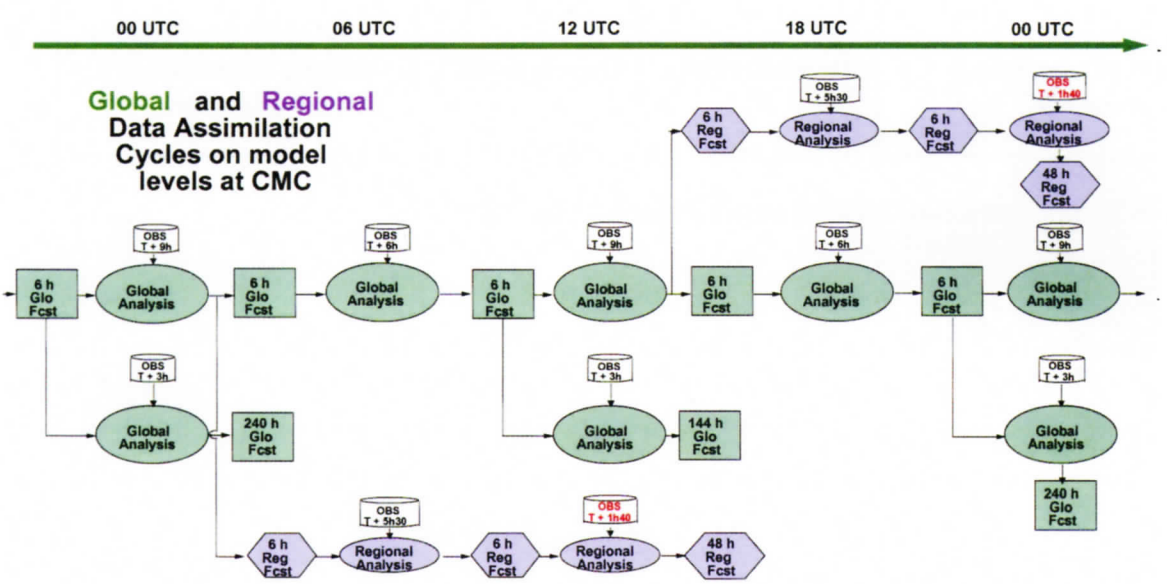

Figure 2. CMC's operational global and regional data assimilation cycle configurations.

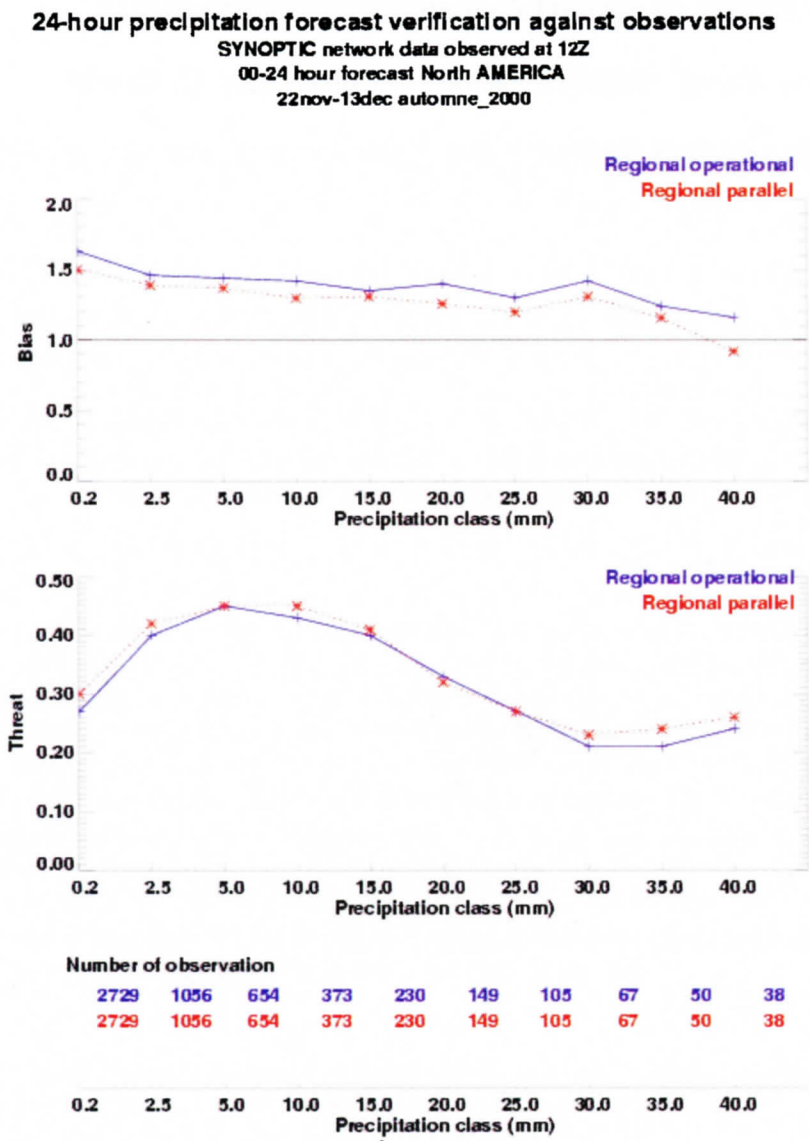

Figure 3. Comparative bias and threat scores for the 24 hour precipitation forecast of regional model fed with old analysis on pressure levels and NOAA/14 SATEMS (operational) and new assimilation on eta levels with assimilation of ATOV radiances and ACARS winds implemented January 2001 (parallel).

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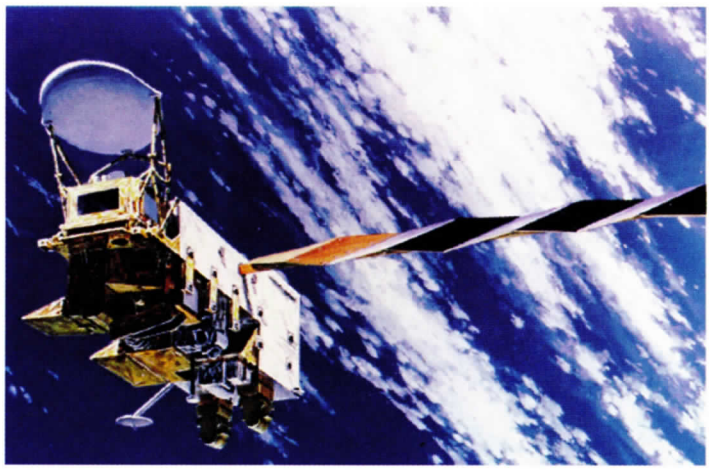

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