USE OF ATOVS RADIANCES IN THE GLOBAL MODEL AT BMRC.

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Summary: The Global Assimilation and Prediction System (GASP) at the Bureau of Meteorology Research Centre (BMRC) has previously shown good positive impact in the Southern Hemisphere and the Tropics, and neutral impact in the Northern Hemisphere, using one-dimensional variational retrievals (1DVAR) with TOVS radiances from the NOAA-11 and NOAA-14 satellites. We show that that inclusion of ATOVS radiances from NOAA-15 significantly increases the information content of the 1DVAR retrievals, and as result produces an improved analysis and consequently an improvement in the forecast scores.

1. INTRODUCTION

The 1DVAR system implemented within the GASP Optimal Interpolation (OI) data assimilation system, has several new features compared to previous 1DVAR systems used at other centres. It has latitudinally varying background error variances, while keeping a global correlation structure, and the retrieval error covariance is computed, enabling dynamic Purser type (Purser 1990, Eyre et.al. 1993) scaling to be applied to each retrieval, before assimilation in the OI system (Harris and Steinle, 1999). This method allows the information content of the retrieval itself to directly influence the weight given to the retrieval in the analysis. It also uses the first guess to compute air-mass radiance bias predictors, as well as having a latitudinally varying scan correction (Harris and Kelly 1999).

2. USE OF ATOVS RADIANCES

This system has now been applied to ATOVS radiances from NOAA 15, which the Bureau has been receiving from NESDIS since July 1999. The dynamic scaling method automatically adjusts to the higher information content of the ATOVS radiances, giving the retrievals higher weight in the analysis compared to those derived from NOAA-14. Since the ATOVS data, consisting of HIRS and AMSU-A radiances(AMSU-B is not used at present in GASP), consists of many more channels than the previous HIRS, MSU and SSU combination on previous NOAA satellites, the dynamic scaling factor calculations in the GASP/1DVAR system is able to automatically give the ATOVS retrievals more weight. Figure 1a and 1b show the difference in the size of the scaling factor Λ(see Harris and Steinle 1999), between 'Cloudy' soundings, those in which only HIRS 1-3 channels are used, plus MSU 2-4 and SSU 1-3 in the case of NOAA-14, and AMSU 3-14 in the case of NOAA-15 were used. The scaling factor Λ is in fact the ratio of the scaled (in the Lorenc/Purser sense) retrieval error and the background error, for the retrieved layer thickness values. Hence, the smaller the scaling factor, the lower the retrieval error, and so more information has been retrieved from the radiance measurements. The use of the AMSU channels particularly show a large reduction in the retrieval error in the stratospheric layers as well as in the lower troposphere, particularly in this case with the absence of the lower-level sounding HIRS channels. When the HIRS channels are included, as in the case of 'Clear' soundings, the effect is not as pronounced, but the extra information is still quite evident.

3. OBSERVATION FITTING STATISTICS

Using observation fitting statistics, it is possible to demonstrate the improvement in the six-hour first guess where ATOVS radiances have been used in an on-going analysis. Figure 2 shows the improvement in the bias and RMS error for radiosonde geopotential height observations, for a variety of different observation combinations, using either 1DVAR retrievals, or the NESDIS retrieval, for the Southern Hemisphere mid-latitudes. There is a quite noticeable decrease in the bias, particularly with respect to retrievals using the NESDIS product. In fact, as can be seen in Figure 2, the higher density NESDIS TOVS product at 125km (Expt 12b) has a larger bias around 300hPa than the lower density NESDIS SATEM product at 500km, suggesting a possible bias in the data. However, the two 1DVAR experiments 13a and 13b show a much smaller bias, with 13a possibly exhibiting a residual bias due to the SATEMS. The full 1DVAR experiment with both NOAA-14 and NOAA-15, experiment 13b has very little geopotential bias in this region. A similar, but less dramatic effect is seen in the tropics and Northern Hemisphere.

4. FORECAST VERIFICATIONS

The forecast verifications resulting from this series of experiments shows quite clearly the positive effect of both the 1DVAR for NOAA-14 with NOAA-15 SATEMS in experiment 13a, and the best result for the dual 1DVAR experiment 13b. These are with respect to the two NESDIS product assimilation experiments 12a and 12b, where the only difference between these experiments is the impact of the higher resolution ATOVS dataset as compared to the SATEM dataset.

5. SUMMARY

In summary, we have shown the positive benefit of the use of ATOVS data in the 1DVAR/GASP data assimilation system. The dynamic scaling factors have automatically given the ATOVS data higher weight in the analysis, which is beneficial given the higher information content. We have shown the improvement in both observation fitting statistics and forecast scores.

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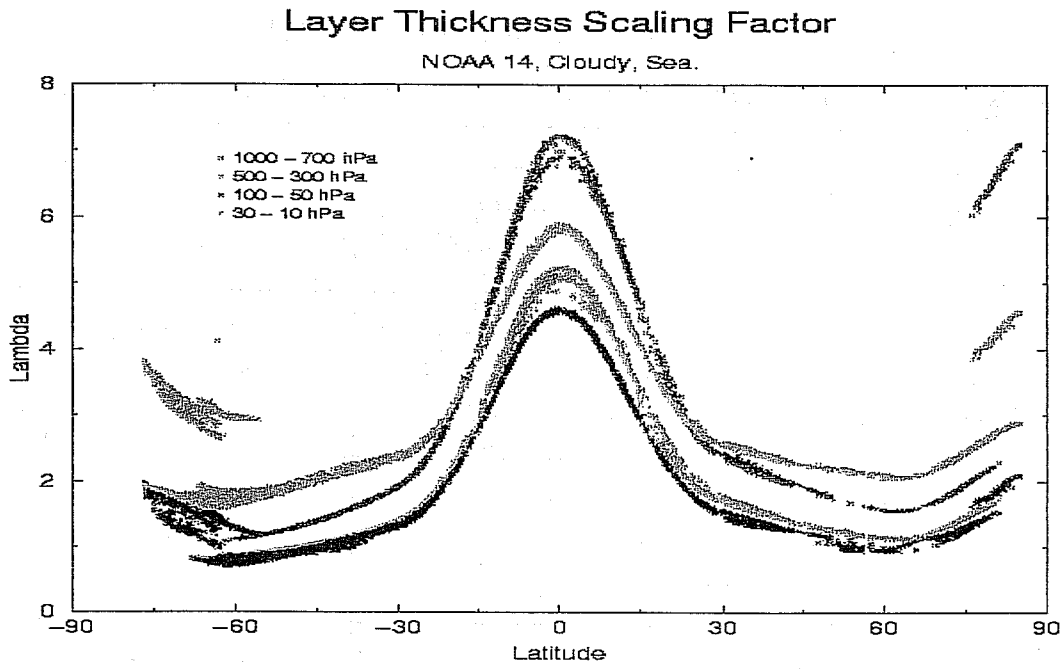

Fig 1a: Layer Thickness Scaling Factor, NOAA-14 Cloudy Retrievals.

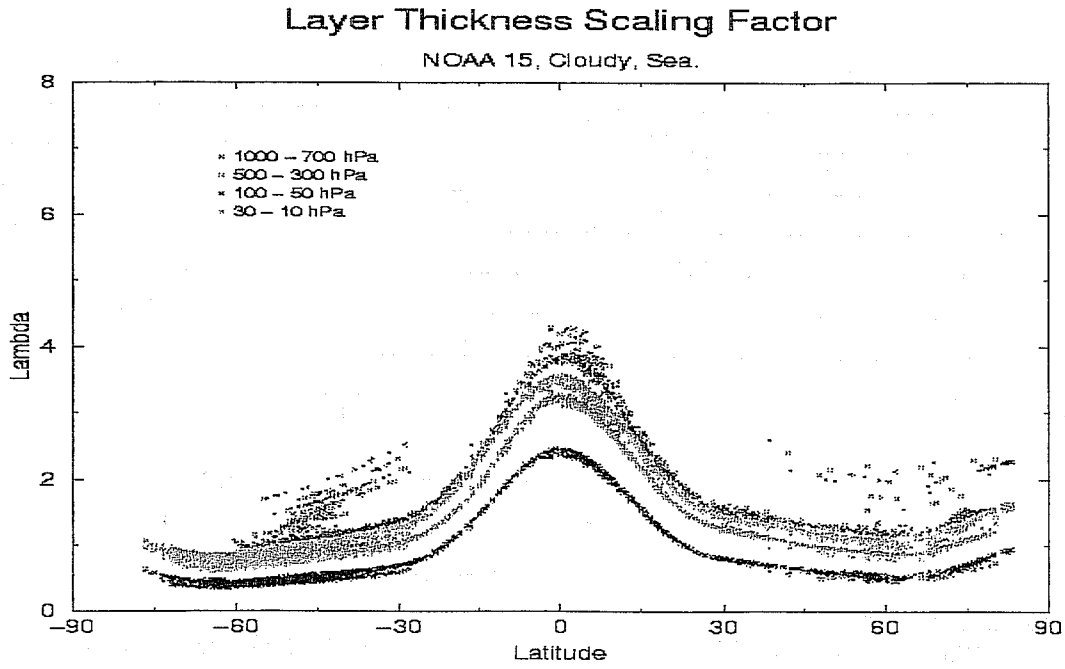

Fig 1b: Layer Thickness Scaling Factor, NOAA-15 Clear Retrievals

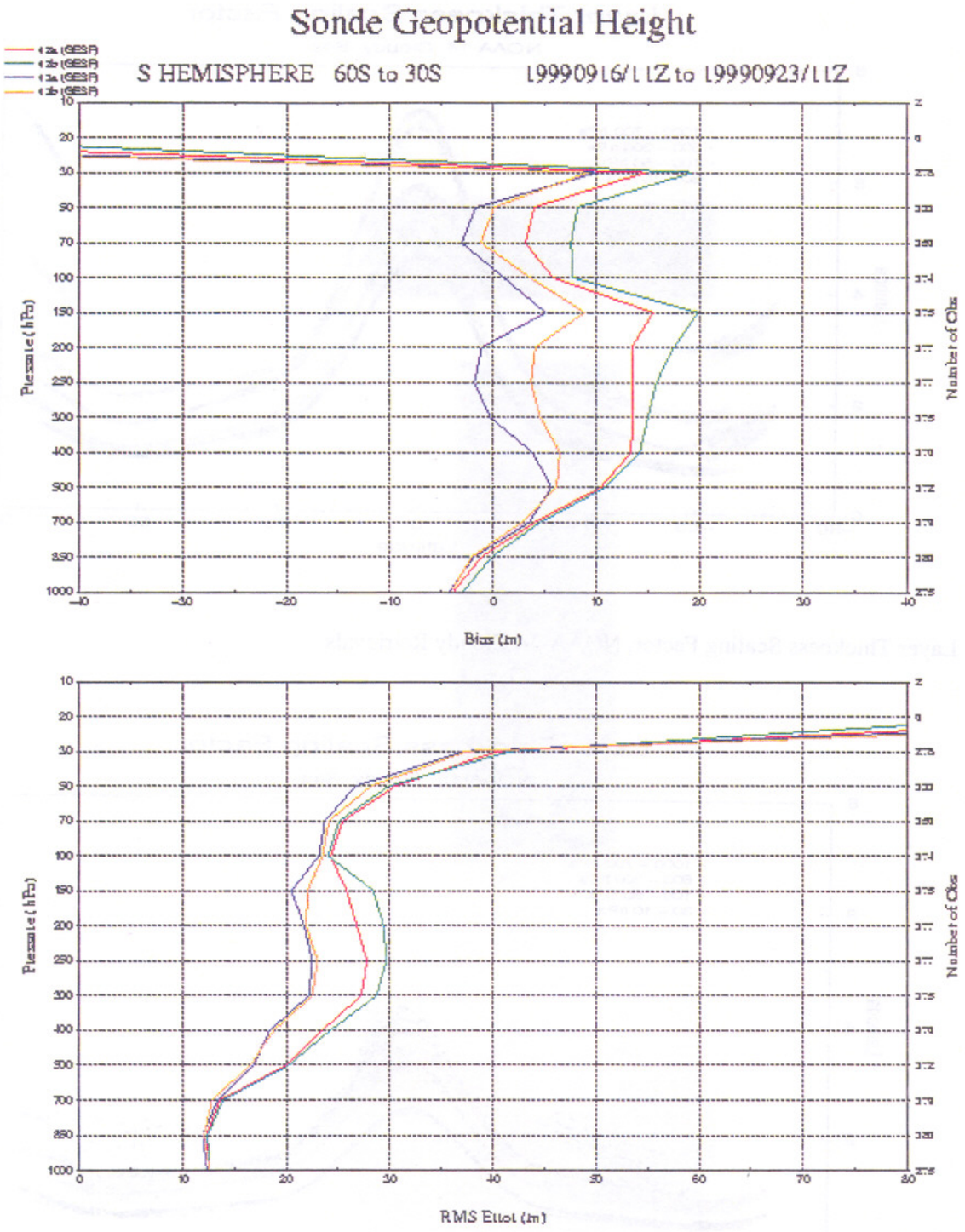

Fig 2: Observation Fitting Statistics

12a:	NOAA-14 NESDIS RTOVS +	NOAA-15 NESDIS SATEM
12b:	NOAA-14 NESDIS RTOVS +	NOAA-15 NESDIS ATOVS
13a:	NOAA-14 1DVAR +	NOAA-15 NESDIS SATEM
13b:	NOAA-14 1DVAR +	NOAA-15 1DVAR

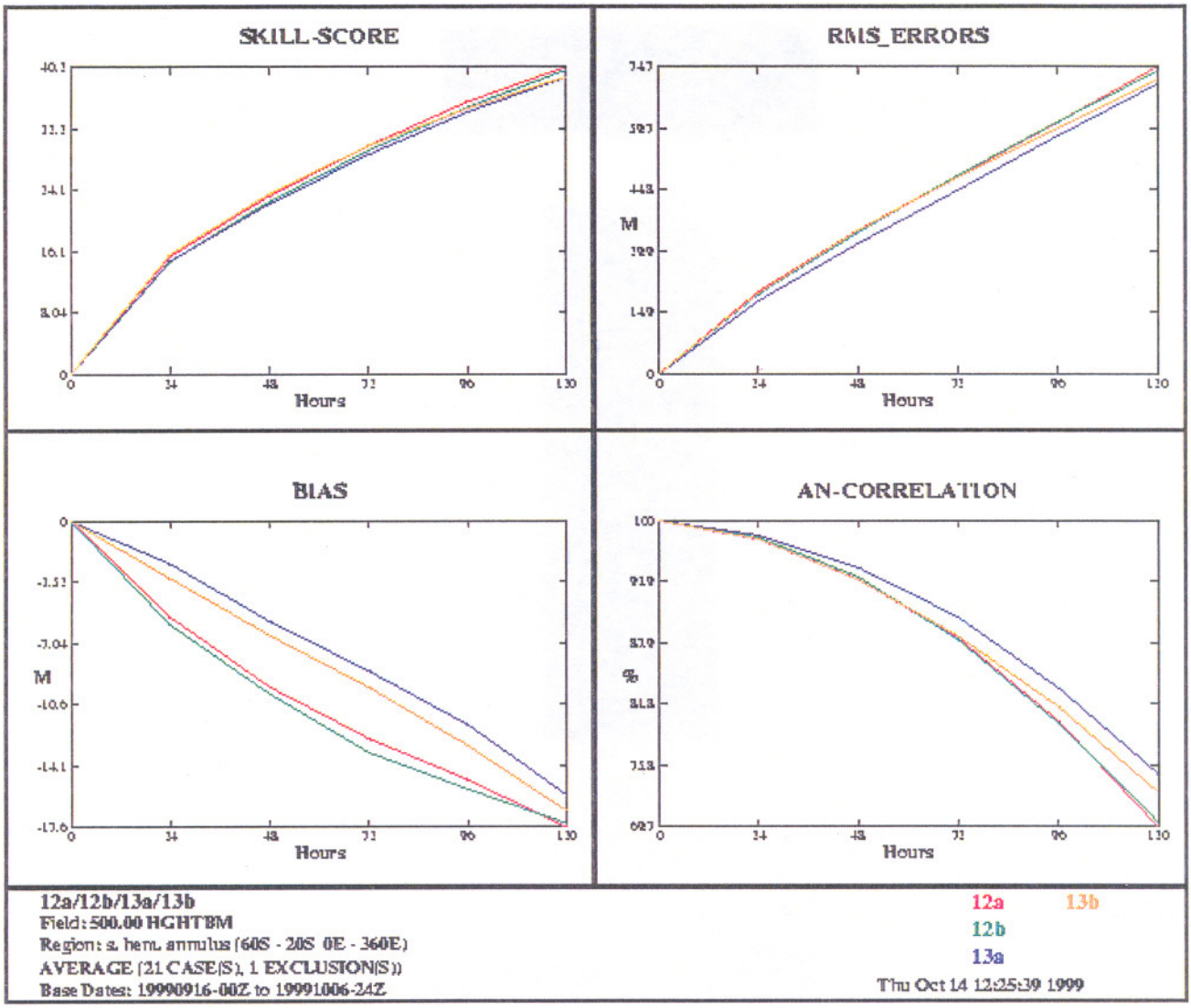

Fig 4: Forecast Scores for Southern Hemisphere Annulus (Legend as for Fig 3).