P8.4 **High Resolution GOES Sounder Ozone Estimates**

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1. INTRODUCTION

The Sounder onboard the Geostationary Operational Environmental Satellite series (GOES-8, GOES-9, GOES-10, GOES-11, and GOES-12) provides data that allows the estimation of total column and profile ozone amounts. Recent work has allowed this work to proceed at the full sensor resolution of 10 km (single field-of-view/SFOV) at sub-satellite point as opposed to the previous standard of 30 km. This improved resolution allows for the resolution of fine scale features in the ozone field that may indicate mesoscale airmass exchange related to clear air turbulence and other dynamic processes such as tropopause folds. Fine scale features have been examined to parameterize the quality of the detailed features seen in GOES Sounder ozone imagery. Results from this work apply to applications of GOES Sounder ozone as well as guiding improvements to that algorithm and development of future ozone algorithms for geostationary IR sensors such as the next generation of the GOES Sounder, the Hyperspectral Environmental Suite (HES), and GOES Imager, the Advanced Baseline Imager.

2. OZONE ESTIMATE METHODOLOGY

The ozone regression technique used with GOES Sounder data is a simple linear regression against a profile database. Validation against the Total Ozone Mapping Spectrometer (TOMS) has shown that the statistical regression yields better results than a physical retrieval that uses the regression as a first guess. Simulations have also indicated that regression extracts all of the available total column ozone information from broadband sensors like GOES and the proposed Advanced Baseline Imager (ABI), while hyperspectral instruments such as the proposed Hyperspectral Environmental Suite (HES) have more information than the regression is able to extract. Table 1 shows simulation results of a noise sensitivity study. Decreasing the amount of noise in the simulation impacts how much information is lost due to noise. GOES Sounder and ABI, which both have broad spectral responses, show little sensitivity to noise, whereas HES shows continual improvement down to the zero noise level.

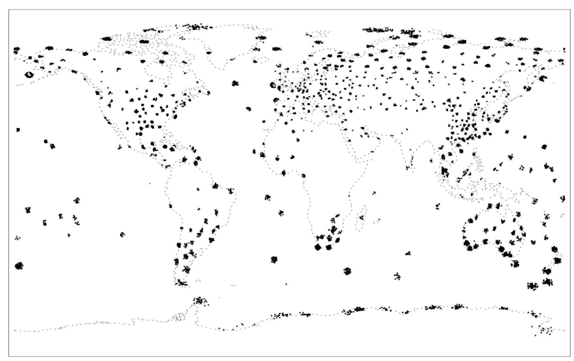

Figure 1: Locations of the NOAA88b profiles

For the GOES Sounder the regression is performed on all of the infrared bands. Table 2 lists the bands used (as well as those for ABI and HES). The regression is performed using the NOAA88b dataset containing 7,547 collocated temperature, moisture, and ozone profiles to simulate observed brightness temperatures which are then used as predictors along with other pieces of information, such as the time of year and latitude. The locations of the NOAA88b profiles are shown in Figure 1. The regression produces a profile that is then integrated to produce a total column ozone value.

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Multiplier	HES		ABI		GOES Sounder	
	RMSE (DU)	%RMSE	RMSE (DU)	%RMSE	RMSE (DU)	%RMSE
0	6.3 DU	1.8%	23.5 DU	6.8%	16.0 DU	4.9%
1/5 (5x5)	10.3 DU	2.9%	25.1 DU	7.2%	16.1 DU	4.9%
1/3 (3x3)	12.0 DU	3.5%	25.7 DU	7.4%	16.1 DU	5.0%
1 (1x1)	15.7 DU	4.6%	26.9 DU	7.7%	17.0 DU	5.2%

Table 1: Simulations of accuracy as a function of noise. A change in accuracy with a change in noise suggests the level of utilization of the input data by the regression.

Satellite	Bands used in ozone regression
GOES Sounder	4.45, 4.53, 4.58, 6.5, 7.0, 7.5, 9.7, 11.0, 12.1, 12.7, 13.4, 13.7, 14.1, 14.4, 14.7 µm
ABI	3.9, 6.15, 7.0, 7.4, 8.5, 9.7, 10.35, 11.2, 12.3, 13.3 µm
HES	8.3 µm to 15.3 µm (~685 cm-1 to ~1150 cm-1) (hyperspectral)

Table 2: Bands used in ozone regression on various platforms.

3. SFOV OZONE ESTIMATES

The noise study in Table 1 indicated that SFOV ozone with GOES would not be adversely affected by noise as opposed to the old standard of spatially averaging 3x3 fields-of-view. In practice, that remains true, the ozone estimates are not adversely impacted by the lack of spatial averaging. The largest issues with SFOV ozone are the quality of cloud detection and classification and circumstances that lie outside of the training dataset. In the case of cloud detection and classification, incorrectly labeling cloudy regions as clear typically leads to underestimates of total column ozone.

Figure 2 illustrates an example of SFOV ozone. The high ozone region (green and red) is associated with a synoptic-scale cyclone. Generally speaking, the ozone increases towards the center of rotation of the cyclone. The region labeled B indicates a deviation from this pattern that is collocated with low clouds streaming off of Lake Michigan. The clouds were inadvertently classified as clear in this particular version of the retrieval, leading to a local low in ozone that correlates very well with the clouds. There is no way to know for certain if this feature is real as there is no readily available validation data for this time period, but its shape and correlation to a low altitude feature (whereas ozone is at a high altitude) makes the validity of the ozone at that location suspect.

Overall the absolute accuracy of the total column ozone estimates from the GOES Sounder

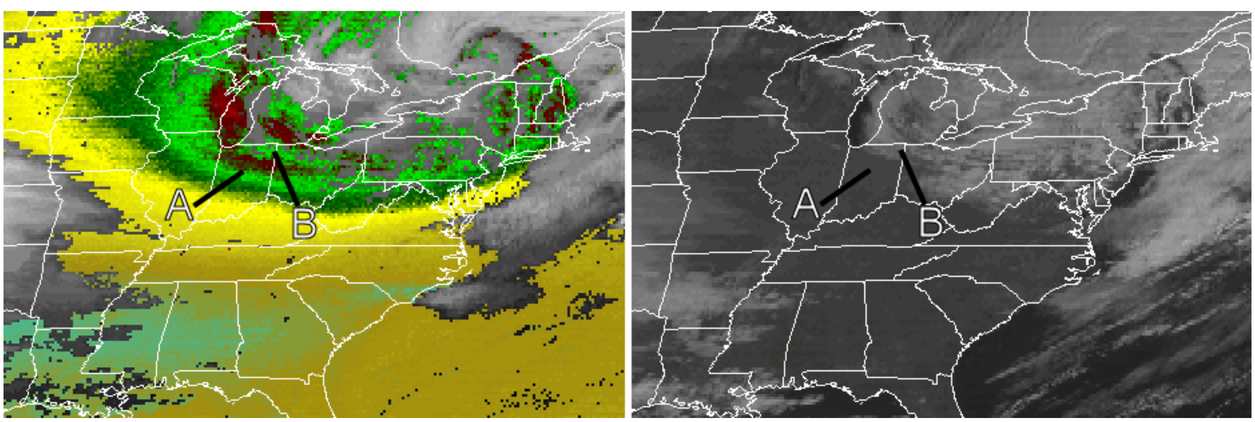

Figure 2: 13 November 2003, 14:46 UTC. Comparison between GOES-12 Sounder SFOV ozone estimates and Sounder visible data. Ozone values increase from cyan to yellow to green to red. The region labeled A indicates an ozone feature consisting of high total column ozone. Region B, just to the north of A, shows lower ozone, a potentially exciting feature that unfortunately corresponds to low lake-effect clouds streaming off of Lake Michigan. Such correlations indicate the ozone regression's requirement for good cloud detection and classification. There is no way of knowing from this data if region B is a real feature, though it is extremely unlikely to be anything but an artifact.

is around 5-7%. That accuracy is valid for clear-sky conditions. In the case of misidentified cloudy scenes, the accuracy appears to fall off dramatically, thereby stressing the need for accurate cloud typing.

Figure 2 also illustrates satellite noise as reflected by the GOES SFOV ozone estimates. Banding, visible as light horizontal lines, is visible in some locations. Random noise, a light speckling, also makes an appearance. Both sources of noise can be reduced and future versions of the algorithm will reflect that correction.

4. CONCLUSION AND THE FUTURE

GOES SFOV ozone estimates show promise for the identification of relatively small-scale features in the ozone field. However, care must be taken to correctly classify the scene. Partly cloudy scenes that are classified as clear pose a large source of error for the SFOV ozone estimates. Partly cloudy scenes may be salvageable in some cases if cloud fraction and temperature can be successfully estimated, thereby allowing an estimate of the clear-sky radiance. The SFOV ozone algorithm will also come to benefit from a larger training set and noise reduction. Once these enhancements have been fully integrated, further study of small-scale ozone features can commence.