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CASE STUDIES OF MAJOR DST-6 SOUNDING IMPACTS WITH THE GLAS MODEL

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ABSTRACT

Two case studies of DST-6 sounding impacts are presented. In each of these cases, major improvements to the GLAS model's forecasts of specific synoptic features resulted from including satellite-sounding data in the initial analysis.

INTRODUCTION

A detailed subjective evaluation of the impact of satellite-derived temperature soundings on synoptic forecasts with the high resolution (2½°lat.x3°long.) version of the GLAS GCM has been carried out for eleven of the forecasts from the February 1976 DST period. Following the procedures of Atkins and Jones (1975), qualified weather forecasters were asked to judge the relative utility of prognostic charts generated from SAT and NOSAT initial conditions, without actually knowing which forecasts had utilized satellite-derived sounding data. This evaluation showed the overall impact of the satellite data assimilation to be modest and beneficial, supporting the conclusions of our statistical evaluation (Ghil et al., 1978) and revealed no cases in which major negative impacts occurred. Two cases in which major improvements to GLAS model forecasts resulted from the inclusion of satellite-derived temperature soundings will be presented in the following sections.

72-h Forecast from 0000GMT, 19 February 1976

This was a case in which a significant improvement to the predicted displacement of an intense winter storm occurred in the latter half (36-h period) of the forecast period. The initial conditions for this forecast showed a moderately intense low pressure system, associated with an upper level short wave trough, located off the northwest coast of the U. S. As this system moved inland, a new low developed along an already existing stationary front and became the dominant feature by 1200GMT on 19 February. During the next 24 h, the cyclone moved southeastward and intensified, after which time it recurved and then accelerated toward the northeast. The storm produced heavy snow, blizzard, or near-blizzard conditions in Colorado, Kansas, Nebraska, Iowa, Michigan, and

Wisconsin. Tornadoes or severe thunderstorms were reported in Kansas, Oklahoma, Texas, Arkansas, Missouri, Illinois, Louisiana, and Mississippi. The majority of the severe weather occurred toward the end of the forecast period after recurvature of the cyclone to the northeast.

Fig. 1a and 1b depict the 72-h sea-level pressure prognoses, and predicted track of this cyclone, for the SAT and NOSAT cases, respectively, while the corresponding analysis and observed track is depicted in Fig. 1c. Fig. 1d shows the NMC operational 72-h forecast.

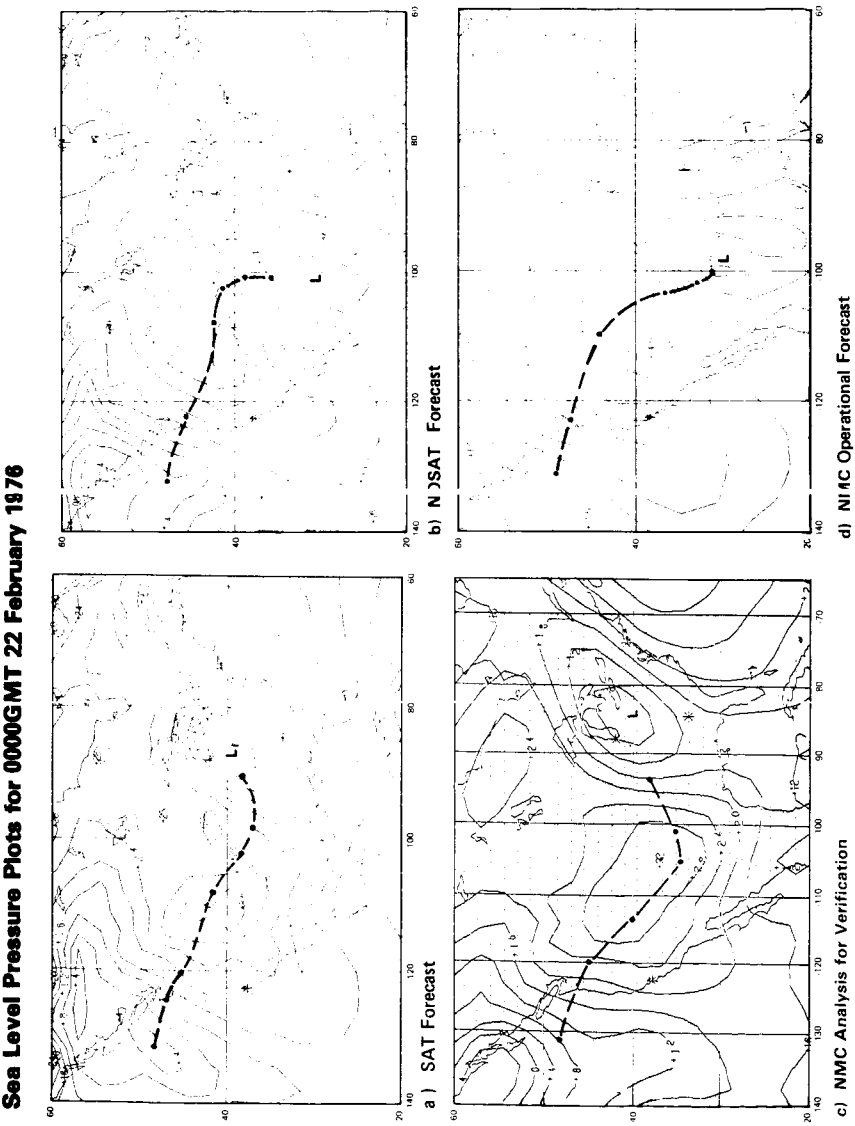

Fig. 1a shows the 72 h forecast from SAT initial data at 0000GMT 19 February 1976. Fig. 1b the corresponding NOSAT forecast. Fig. 1c shows the verification analysis (operational NMC analysis), and Fig. 1d the NMC operational 72 h forecast. Dots represent past positions of low at 12 h intervals.

A comparison of these charts reveals the very significant improvement in the model prediction that included satellite-sounding data. During the first 36 h of the forecast, only slight differences exist between the SAT and NOSAT sea-level prognoses as both predict the intensification and southeastward movement of the low. After 36 h, however, major differences in the predicted track are evident. The NOSAT system forecasts the low to move south-southeastward, while the SAT system forecasts the low to continue southeastward for 12 h and then recurve to the northeast such that the 48, 60, and 72-h forecast positions of the low are in excellent agreement with observations.

Since most of the severe weather associated with this low occurred during the last 30 h of the forecast, it is clear that significantly improved local weather forecasts could have resulted from the use of the SAT prognoses in this situation. In order to investigate this point further, the SAT and NOSAT predictions of local convective instability and destabilization by differential equivalent potential temperature advection were compared. It was found that a 51 percent reduction in RMS errors of convective instability and a 22 percent reduction in RMS errors of differential advection occurred in the prediction which included satellite sounding data.

An evaluation into the nature of the impact in this case has been partially completed. Results from this study indicate that differences in the initial thermal advection patterns off the west coast of the U. S. between SAT and NOSAT analyses amplified with time as the cyclone moved inland and contributed significantly to the differing displacements after 36 h. The effects of additional initial state differences are also being investigated.

72-h Forecast from 0000GMT, 11 February 1976

In this case, a weak cyclone formed along a stationary front in southwest Canada, moved southeastward while intensifying during the first 40 h of the period, and then recurved to the east-northeast. While the predicted tracks of this low are similar for both the SAT and NOSAT systems, major differences in the intensification of this low were evident on all prognoses after 36 h. In each case the SAT system forecast a more intense cyclonic circulation in better agreement with observations.

Fig. 2a and 2b depict the 72-h sea-level pressure prognoses for the SAT and NOSAT cases, respectively, while the corresponding analysis is depicted in Fig. 2c. Fig. 2d shows the NMC operational 72-h forecast.

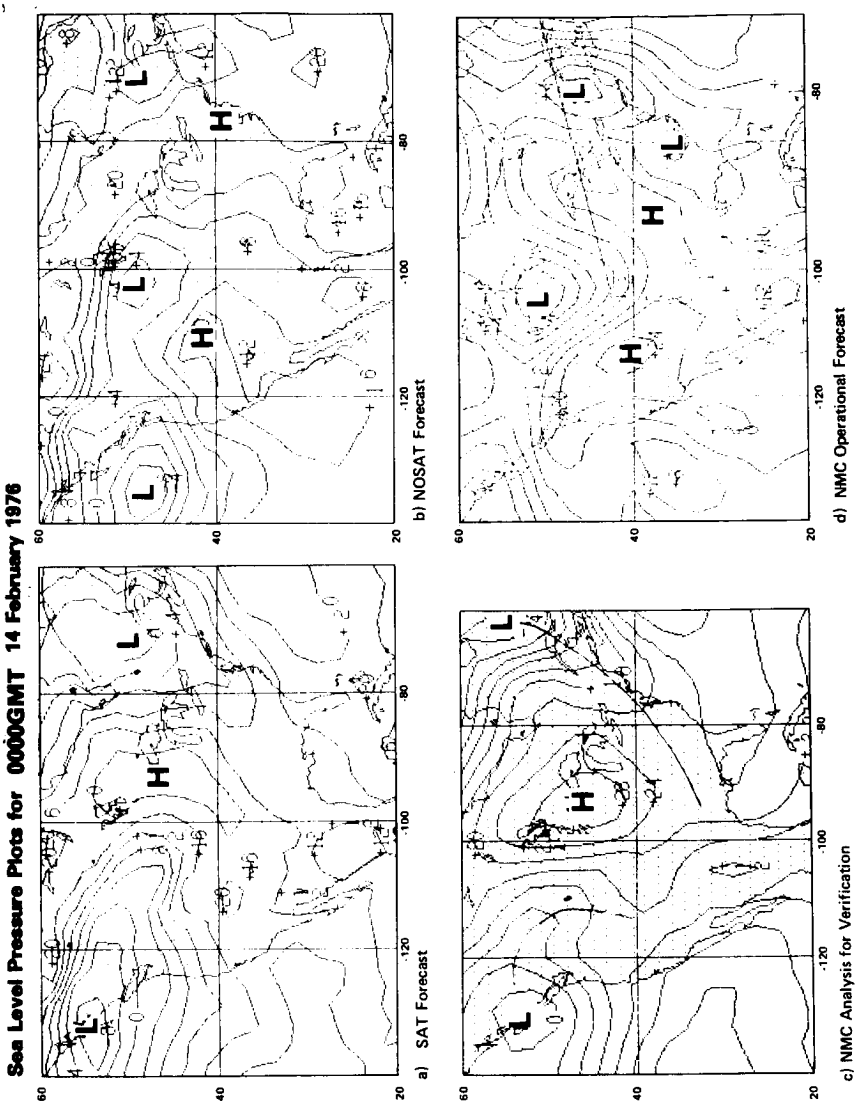

Fig. 2a shows the 72 h forecast from SAT initial data at 0000GMT 11 February 1976; Fig. 2b the corresponding NOSAT forecast; Fig. 2c shows the verification analysis (operational NMC analysis), and Fig. 2d the NMC operational 72 h forecast.

A comparison of these figures reveals that the SAT prognoses is substantially better than the NOSAT in its prediction of the cyclonic circulation over southeastern Canada and the northeastern U. S., as well as the anticyclone approaching the Great Lakes and the pressure trough extending southeastward from southwest Canada. Improvements relative to the NMC prognoses are also evident.

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