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SSEC Publication No.96.02.S1.

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Annual Report for NOAA Grant NA36GP0481
Covering the period 10/1/95-2/29/96

This annual report summarizes the UW-Madison participation in the ASHOE/MAESA (Airborne Southern Hemisphere Ozone Experiment / Measurements for Assessing the Effects of Stratospheric Aircraft) field program, supported by NOAA Grant NA36GP0481. There were two separate activities supported by this grant; one activity supports the participation of the High resolution Interferometer Sounder (HIS) aboard the ER-2 aircraft in the data gathering campaign, and the other activity supports onsite forecasts of isentropic atmospheric structure and circulation in support of the ER-2 flights and modeling the global hydrologic cycle.

1. HIS field program participation during ASHOE/MAESA

The UW-Madison HIS instrument participated in all four phases of the dynamics and radiation field campaign aboard the ER-2 aircraft, the fourth and final phase occurred during the period covered in this report. The October HIS flights were included in order to characterize the polar vortex during the period of maximum ozone depletion. Table 1 summarizes the data gathering flights made from Christchurch, New Zealand (NZCH), primarily flying south into the polar vortex.

Summary of UW HIS Experiment Data Collection Flights during ASHOE/MAESA

Date	Launch – Return time	Flight Location	Mission
04/13/94	1930 - 0330 UTC	NZCH - 68S	Antarctic vortex
04/15/94	0052 – 0350 UTC	NZCH – 38S	Volcano overflight
06/05/94	2000 - 0200 UTC	NZCH – 68S	Antarctic vortex
06/08/94	2000 – 2100 UTC	NZCH – 45S	Test flight
08/08/94	2200 – 0620 UTC	NZCH – 69S	Antarctic vortex
08/10/94	2100 – 0430 UTC	NZCH – 67S	Antarctic vortex
10/03/94	2130 – 0530 UTC	NZCH – 68S	Antarctic vortex
10/05/94	2100 – 0445 UTC	NZCH – 65S	Antarctic vortex

HIS measurements taken during the final phase of ASHOE/MAESA used software developed under year 1 funding, applying the HIS radiance spectra to calculate temperature, moisture and ozone structure in the upper troposphere and lower stratosphere. HIS temperature and water vapor profile data were then used to validate the thermodynamic characteristics of data assimilation models that provide the global circulation patterns used to analyze the transport of the constituents associated with the Ozone depletion process. HIS temperature and moisture retrievals were also used to calculate atmospheric cooling rates, which were compared to cooling rates calculated using input from global forecast models. Results of the ASHOE/MAESA data analysis are provided in the final report.

2. Isentropic model forecast support during ASHOE/MAESA

Research over this five month period investigated the global hydrologic cycle with emphasis on the Southern Hemisphere circulation. The focus was to understand the underlying reasons for the relatively limited progress being made in the prediction of the atmosphere's hydrologic processes, cloudiness and energy exchange. The consensus of modelers utilizing σ coordinates is that with improved parameterization and increased resolution, the predictability of both weather and climate will improve. However, attempts to improve simulations through improving parameterizations have had limited success and the results from climate models with resolutions greater than T42 (or T63) do not demonstrate the expected improvements.

As a continuation of this effort, a second experiment examined the conservation capability of models to appropriately conserve properties. In a series of simulations, this experiment which is extremely pertinent to the hydrologic cycle compared the UW θ-σ and σ models, and the NCAR CCM2 abilities to conserve equivalent potential temperature (θ_e) during 10 day integrations under both dry and reversible moist adiabatic processes. Non-conservation of θ_e constitutes an error that seriously degrades a model's ability to simulate the full range of the atmosphere's hydrologic processes. The initial θ_e distribution from ASHOE IOP data was inserted as a trace constituent in each model. The models were then integrated to 10 days and conservation examined. The correlations remain higher in the UW θ–σ model than in the other two models. The results of these numerical experiments documented inherent advantages of modeling hydrologic processes in isentropic coordinates and demonstrated the potential for advancing the understanding and modeling of the hydrologic cycle, energy exchange and regional climate. Results from this experiment are presented in Zapotocny et al. (1996b).