9.9 MIDDLE ATMOSPHERE MEASUREMENTS OF SMALL-SCALE ELECTRON DENSITY IRREGULARITIES AND ION PROPERTIES DURING THE MAC/EPSILON CAMPAIGN

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Rocket payloads designed to measure small-scale electron density irregularities and ion properties in the middle atmosphere were flown with each of the three main salvos of the MAC/Epsilon campaign conducted at the Andoya Rocket Range, Norway, during October to November 1987. Fixed-bias, hemispheric nose tip probes measured small-scale electron density irregularities, indicative of neutral air turbulence, during the rocket's ascent; and subsequently, parachute-borne Gerdien condensers measured the region's polar electrical conductivity, ion mobility and density. One rocket was launched during daylight (October 15, 1052:20 UT), and the other two launches occurred at night (October 21, 2134 UT; November 12, 0021:40 UT) under moderately disturbed conditions which enhanced the detection and measurement of turbulence structures. A preliminary analysis of the real-time data displays indicates the presence of small-scale electron density irregularities in the altitude range of 60 to 90 km. Ongoing data reduction will determine turbulence parameters and also the region's electrical properties below 90 km.

TABLE 1 MAC/Epsilon Campaign--Penn State Experiments

Launch Date--Time (Flight No.)	Probe	Measurements	Launch Conditions
15 Oct. 1987--1052:20 UT	Nose Tip	I_e, $\Delta N_e/N_e$	Daytime
(30.038)	Gerdien Condenser	$\sigma_\pm$, $k_\pm$, $N_\pm$	Disturbed
	Booms	E field	
	Rigid Electrode	I_{Max}	
21 Oct. 1987--2133:40 UT	Nose Tip	I_+, $\Delta N_+/N_+$	Nighttime
(31.066)	Booms	E Field	Disturbed
21 Oct. 1987--2134:00 UT	Nose Tip	I_e, $\Delta N_e/N_e$	Nighttime
(30.036)	Gerdien Condenser	$\sigma_\pm$, $k_\pm$, $N_\pm$	Disturbed
	Booms	E field	
	Rigid Electrode	I_{Max}	
28 Oct. 1987--0021:00 UT	Nose Tip	I_e, $\Delta N_e/N_e$	Nighttime
(31.067)	Booms	E field	Disturbed
	Blunt	$\sigma_\pm$	
12 Nov. 1987--0021:40 UT	Nose Tip	I_e, $\Delta N_e/N_e$	Nighttime
(30.037)	Gerdien Condenser	$\sigma_\pm$, $k_\pm$, $N_\pm$	Disturbed
	Booms	E field	
	Rigid Electrode	I_{Max}	

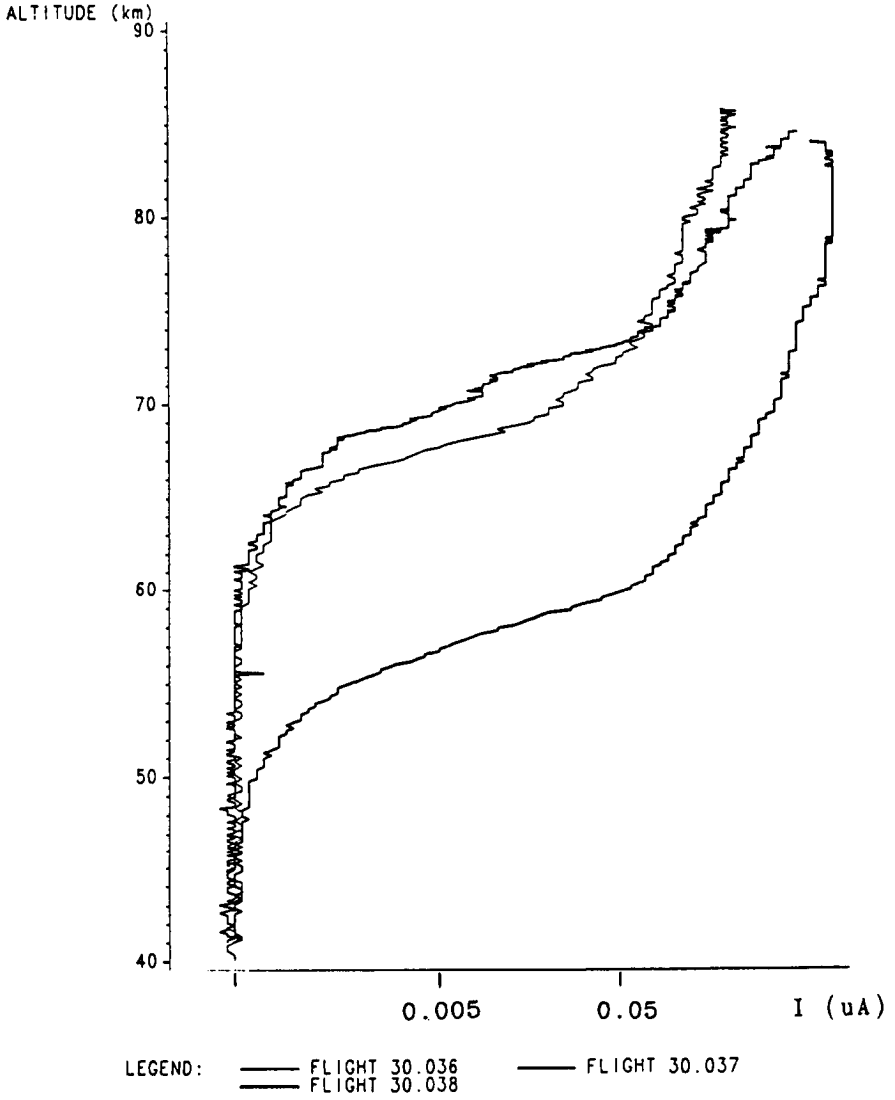

Figure 1. Nose tip probe electron current measurements for flights 30.036, 30.037 and 30.038. The different currents, for the same altitude, are indicative of relative electron concentrations. The electron number densities are the largest for the daytime flight 30.038 (salvo 1). In comparing the two nighttime current profiles, the electron concentration for salvo 2 (flight 30.036) was larger below 73 km and smaller above that altitude. Large scale ($\geq$ 1 km) wave-like structures are noticeable in the electron current measurements, particularly at altitudes above 70 km.

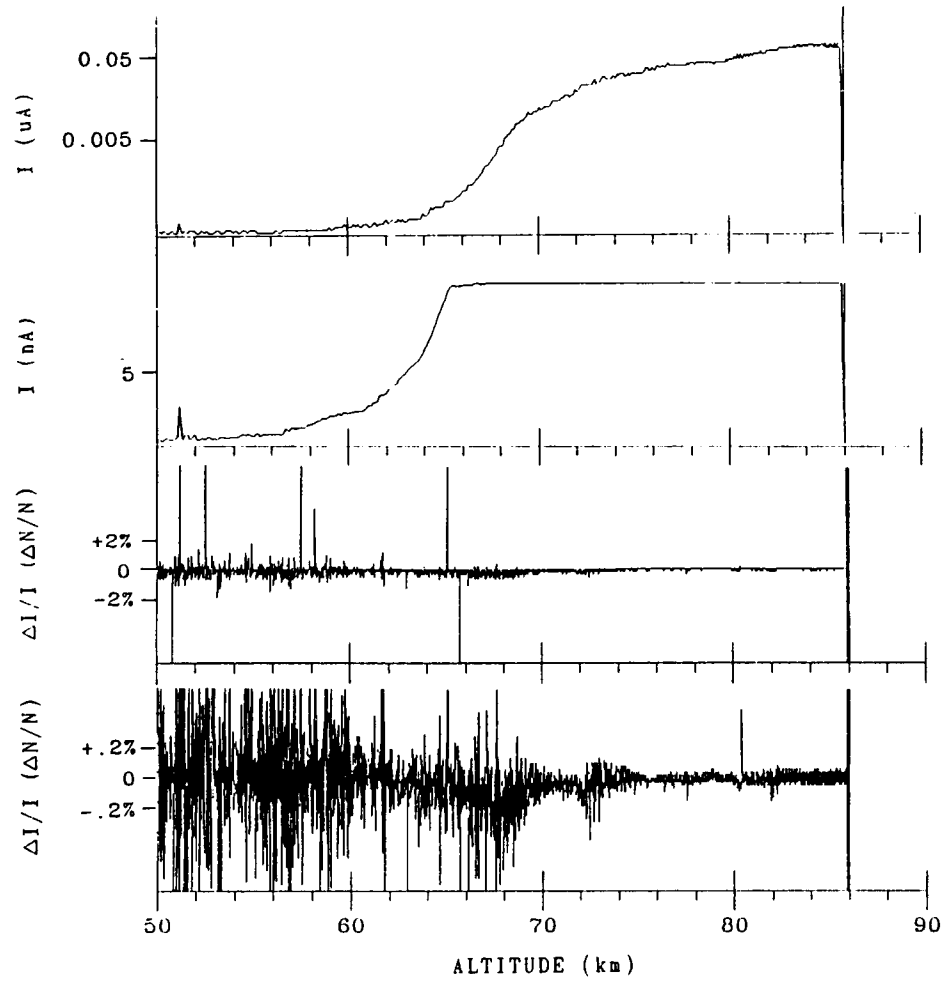

Figure 2. Nose tip prove dc and ac (amplified) electron current measurements for flight 30.036 (salvo 2). The dc electron current measurements (upper two panels) indicate the presence of free electrons at altitudes above approximately 64 km. Noticeable ac current variations (electron density fluctuations) at 68 km and 72-74 km indicate possible regions of small-scale turbulence. A power density spectrum for the small-scale electron density irregularities at 74 km showed a slope of – 5/3 for frequencies of 10 - 200 Hz, indicating turbulence in the inertial subrange. A spectral index of – 7 at higher frequencies, indicative of the viscuous range, also was determined.

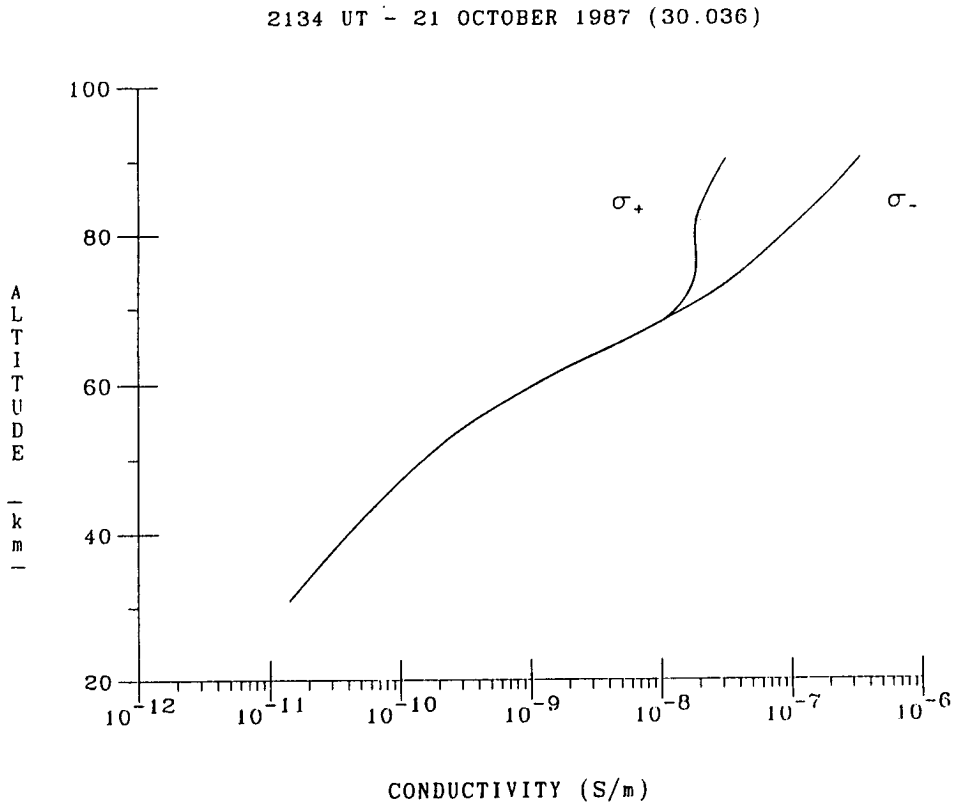

Figure 3. Profiles of positive and negative electrical conductivity obtained for flight 30.036 (salvo 2) by a parachute-borne Gerdien condenser. The altitude dependence for conductivity indicates the presence of auroral ionization sources above approximately 50 km (supported by the energy deposition measurements of Goldberg et al.) The relatively larger negative conductivity values above 65 - 70 km signifies the region where free electrons are present, which is consistent with the nose tip probe data of Figures 1 and 2.