9.7 ROCKET MEASUREMENTS OF ELECTRON DENSITY IRREGULARITIES DURING MAC/SINE

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Four Super Arcas rockets were launched at the Andoya Rocket Range, Norway, as part of the MAC/SINE campaign to measure electron density irregularities with high spatial resolution in the cold summer polar mesosphere. They were launched as part of two salvos: the turbulent/gravity wave salvo (3 rockets) and the EISCAT/SOUSY radar salvo (one rocket). In both salvos meteorological rockets, measuring temperature and winds, were also launched and the SOUSY radar, located near the launch site, measured mesospheric turbulence. Electron density irregularities and strong gradients were measured by the rocket probes in the region of most intense backscatter observed by the radar. The electron density profiles (8-4 on ascent and 4 on descent) show very different characteristics in the peak scattering region and show marked spatial and temporal variability. These data are intercompared and discussed.

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**INSTRUMENTATION**

**DC PROBE:** ON ALL FOUR SUPER ARCAS ROCKETS  
**TECHNIQUE:** COLLECTION OF DC ELECTRON CURRENT OF ISOLATED TIP HELD AT FIXED +3-VOLT BIAS POTENTIAL WITH RESPECT TO ROCKET SKIN.  
**MEASUREMENT:** HIGH RESOLUTION (SPATIAL TO ABOUT 10 CM) OF ELECTRON CURRENTS PRESUMED APPROXIMATELY PROPORTIONAL TO ELECTRON DENSITY.

**RF PROBE:** ON TWO OF FOUR SUPER ARCAS ROCKETS  
**TECHNIQUE:** THE ROCKET BODY IS SPLIT (ISOLATED) AND FED AS A DIPOLE ANTENNA WHOSE RF ADMITTANCE AT 3 MHz IS TELEMETERED TO THE GROUND.  
**MEASUREMENT:** LOW RESOLUTION ELECTRON DENSITY PROFILES.

MAC SIME SUPER ARCAS ROCKETS  
**SUMMARY**

<table>
<thead>
<tr>
<th>ROCKET NO.</th>
<th>SALVOE</th>
<th>LAUNCH DATE/TIME</th>
<th>APOGEE</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>NASA 15.244</td>
<td>TURBULENT</td>
<td>DAY 195 14 JULY 87</td>
<td>95.4 km</td>
<td>GOOD DC PROBE ASCENT &amp; DESCENT</td>
</tr>
<tr>
<td>S-SA 1/L</td>
<td>GRAVITY WAVES</td>
<td>1000 L.T. (0800 UT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA 15.245</td>
<td>TURBULENT</td>
<td>DAY 195 14 JULY 87</td>
<td>96.1 km</td>
<td>GOOD DC PROBE ASCENT &amp; DESCENT</td>
</tr>
<tr>
<td>S-SA 2/H</td>
<td>GRAVITY WAVES</td>
<td>1129 L.T.</td>
<td></td>
<td>GOO</td>
</tr>
<tr>
<td>NASA 15.247</td>
<td>TURBULENT</td>
<td>DAY 195 14 JULY 87</td>
<td>92.5 km</td>
<td>GOOD DC PROBE ASCENT &amp; DESCENT</td>
</tr>
<tr>
<td>S-SA 3/II</td>
<td>GRAVITY WAVES</td>
<td>1455 L.T.</td>
<td></td>
<td>GOOD RF PROBE ASCENT &amp; DESCENT</td>
</tr>
<tr>
<td>NASA 15.246</td>
<td>EISCAT/SOUSY</td>
<td>DAY 196 15 JULY 87</td>
<td>97.7 km</td>
<td>GOOD DC PROBE ASCENT &amp; DESCENT</td>
</tr>
<tr>
<td>S-SA 4/L</td>
<td></td>
<td>1432 L.T.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MS1' radar**

\[
\sigma = \frac{2\pi c k_B (T_s + \alpha T_c)}{P_2 A_0 a^2 F_i} \left( \frac{r}{\Delta r} \right)^2 \frac{S}{N} \quad \text{Boislet and Gage [1980]}
\]

\[
\sigma = 1.15 \times 10^{-17} \frac{S}{N} \text{ m}^{-1} \quad \text{Poker WGT}
\]

\[
\sigma = C \quad \frac{S}{N} \text{ m}^{-1} \quad \text{Souby}
\]

**Rocket**

\[
\sigma(k) = -n \left( \frac{\pi}{8} \right) k^2 \frac{f_p^4}{4f^4} \left( \frac{S_0(k)}{N_i^2} \right) \quad \text{Reynold and Smith [1984]}
\]

**Poker**

\[
\frac{S}{N} = \frac{3.91 \times 10^{-11} (-n) N_i^2 V_R (\Delta N_e)^2}{2\pi} \quad \text{where:}
\]

\[
n = \text{Slope PQD} \quad \text{PQ = Electric Density} \quad \text{GPG = Geopotential}
\]

**Souby**

\[
\frac{S}{N} = C \quad (-n) N_i^2 V_R (\Delta N_e)^2 \quad \text{where:}
\]

\[
C = \text{Power at } f_o \quad \text{PQDR = Power at } f_o
\]
Figure 3.