Ship-borne VHF Radar for Upper Atmospheric Research

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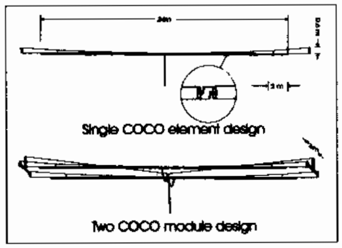
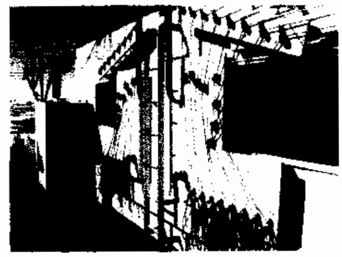
System Description

We have installed a VHF radar on board the Peruvian vessel BIC Humboldt Most of radar components are similar to those used by the JULIA system at Jicamarca (receiver, transmitter, acquisition/control system). However, as expected, the antenna design and installation is quite different.

The antenna consists of 6 COCO lines (21-m width). Each COCO element consists of 12 x 2 meter coaxial elements (24 m total). It is suspended from a ¼" low stretch Dacron sailboat guide line. Both are in turn suspended from a catenary line made also of Dacron. The catenary is tensioned (~60 lbs.) to remove any sag from the antenna line. The sag does not depend of the tension on the guide line, but a comparable tension is placed to keep the antenna from sagging in a transverse direction due to transverse winds. Each COCO element is fed at its center, with two short open stubs, one for each half, to tune it for 100 Ohm impedance. Two COCOs are fed in parallel, through two half-wavelength feeds, producing a 50 Ohm total impedance. The weight of the feed line is supported independently by a V shaped line in this center (see Figure 1). A set of winches and pulleys are used to regulate the tension of this Dacron lines (see Figure 2). A side view of the antenna is shown in Figure 3. In order to extend the antenna area beyond the beam of the ship, we have added four transverse structures to support additional COCO lines (see Figures 4 and 5).

Although the antenna area is small, this system is capable of observing coherent echoes coming from the upper atmosphere. We have successfully make observations of (a) polar mesospheric summer echoes (PMSE) in the Antarctic region, and (b) equatorial electrojet (EEJ) echoes at different latitudes. Examples of these observations are shown below.





PMSE Observations

PMSE observations using the Humboldt system have been made during the last two Peruvian Antarctic expeditions Antar IX and Antar X, in 1998 and 1999, respectively. See Figure 6 for the route followed on each expedition.

During Antar IX, the radar was calibrated by operating simultaneously with the fixed radar at the Peruvian Antarctic station (Machu Picchu). The system was then stowed and deployed back in the Rothera vicinity. It operated near Rothera for a week, monitoring the PMSE activity (e.g., Figure 7) while falling-sphere mesospheric temperature measurements were performed (Luebken et al., 1999). The system continued its operation while navigating back to Machu Picchu station, supporting open seas and relative winds up to 40 knots.

In the beginning of 1999, during Antar X, the Humboldt system was again used to monitor PMSE, this time to study their latitudinal dependence, from ~49°S to ~62°S. We observed the first PMSE ever recorded in the continental South America, at 54°44'S (Figure 10). Echoes were also received along the Drake passage (e.g., Figure 9). During this expedition, the system had its most demanding test, supporting sea-state conditions of 5 to 6, and winds up to 50-60 knots.

Figure 10.

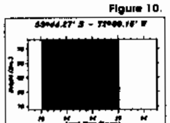


Figure 9.

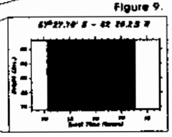
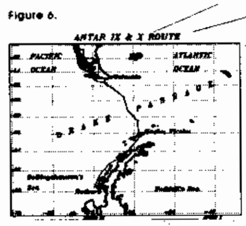
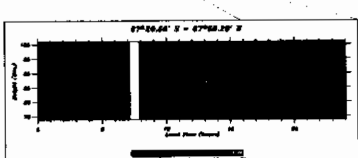


Figure 6.





Equatorial Electrojet Observations

The Humboldt system has been also used to make EEJ observations in May, 1998, these type of observations were performed South of the magnetic Equator, from ~7°S (see Figure 11). At the same time, the EEJ spectral and power measurements were made at Jicamarca using two antennas: one looking "overhead" and another looking obliquely 45° west at Jicamarca. An example at these concurrent observations is shown in Figure 12. In the top panel we show the echoes observed with the Humboldt system. The echoes observed from Jicamarca are shown in the middle and bottom panels, for the overhead and oblique echoes respectively. Note that the corresponding geomagnetic latitudes are also shown for the Humboldt observations.

Similar observations can be performed at northern geomagnetic latitudes to study in more detail the latitudinal characteristics and extent of the equatorial