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Demeter observations during the March 29, 2006 solar eclipse

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Solar eclipses are rare events that have always been of particular interest to ionospheric researchers because they offer an opportunity to study the dynamical response of the ionosphere to a known variation of the solar radiation. Decreases of the electron density in the F2 layer and of the Total Electron Content (TEC) are standard features observed following the maximum of solar obscuration. However a few previous studies conducted in the topside ionosphere have shown that, above the F-peak, the effects of solar eclipses are far more complex and variable, strongly depending on a number of intricate processes associated with the location and characteristics of the eclipse, with the transport and heating of plasma along magnetic field lines, possibly even with disturbances in the neutral atmosphere.

On March 29, 2006 a total solar eclipse occurred over a long path from Brazil to Africa and ending over Mongolia at sunset with the greatest eclipse observed at 10.10 UT in Lybia. Plasma measurements were provided by instruments on DEMETER at an altitude of $\sim$ 720 km during orbit 9254 around the time of greatest eclipse in a longitudinal sector 10˚ to 20˚ west of the point of greatest eclipse. In the northern hemisphere ionosphere magnetically conjugate to DEMETER, the instantaneous solar obscuration was equal or higher than 10% between 10.08 and 10.24 UT with a maximum of $\sim$ 50% close to 10.14 UT. When considering the eclipse conditions during the hour preceding this orbit both the northern and the southern conjugate ionospheres were

subject to eclipse conditions with the maximum of solar obscuration occurring at a eccentric dipole latitude of $\sim 10^\circ$ and reaching about 25% in the south and 35% in the north. One of the main difficulties encountered during this study was to determine for each ionospheric parameter the base line that should represent the variations of this parameter along the orbit in a "normal" ionosphere in absence of eclipse. This stems from the high variability of the low latitude ionosphere in the longitude sector where DEMETER measurements were performed close to the South Atlantic Anomaly. This was done in our case by taking into account on one hand the 2 orbits that encompass the "eclipse orbit" on March 29, about 1.40 hour apart from it and free from eclipse effects, and, on the other hand, the orbits closest in longitude to the "eclipse orbit" but on the 2 days that encompass the eclipse day, March 28 and March 30. The observations show a clear thermal effect with a noticeable decrease of the electron and ion temperatures over a fairly extended eccentric dipole latitude range from about 30° to -10° eccentric latitude. The variation of the electron density is fainter and thus less simple to analyze due to the difficulty in determining a reliable base line. To allow a better understanding of the ionospheric variations we have also performed a modelling of the ionosphere with the help of the 2D SAMI2 code introducing in the code realistic eclipse conditions. The SAMI2 code allows to model the dynamics of the ionosphere in a magnetic meridian along closed plasmaspheric magnetic field lines. Applied to the DEMETER conditions of observation, the model reproduces very well the decrease in electron and ion temperatures and predicts a decrease in the electron density on DEMETER at positions conjugate to the eclipsed northern ionosphere.