An overview of the ionospheric research at INPE, Brazil

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and all the staff, pos-docs, students, and collaborators at the

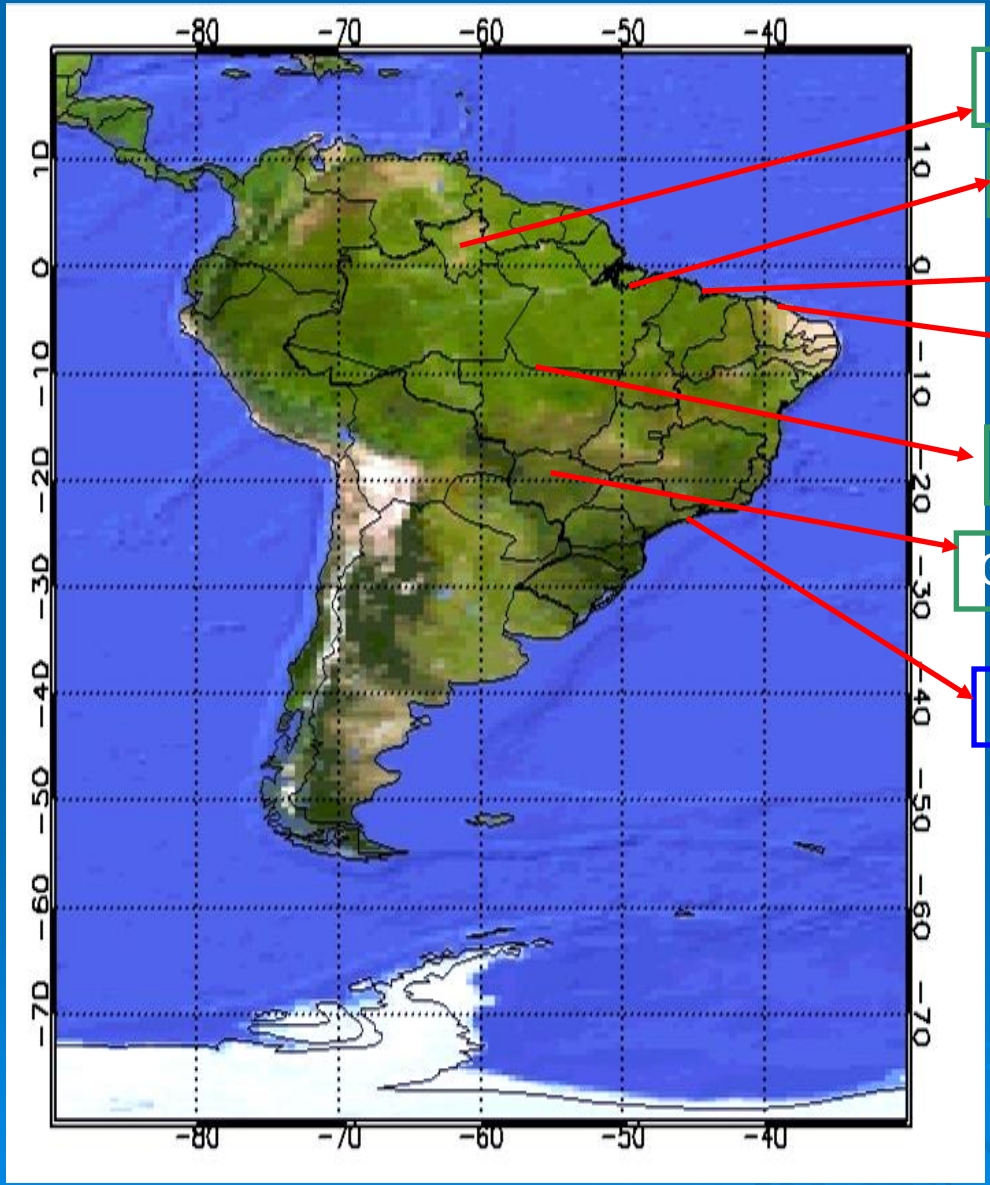
Ionospheric group at INPE

INTRODUCTION

- The National Institute for Space Research (INPE) has celebrated its 50th anniversary this year (2011). Since its beginning INPE has developed ionospheric research using ground-based instruments and payloads onboard of sounding rockets. So it is not incorrect to say that the ionospheric research in Brazil is also celebrating its half-centenary. During this time period important studies were conducted by the ionospheric group at INPE that evidenced the peculiarities of the ionospheric region over the Brazilian region. Some of these results will be presented in this talk.

- Payloads on board of sounding rockets – continues to be an important research activity
- Research using Polarimeters (to measure TEC), Riometers (to measure cosmic noise absorption) and VLF receivers (to study the low ionosphere)
- Ionosondes – long time series (almost 40 years from some stations) – continues to provide important data (digital instruments) for research
- VHF radars
- Scanning photometers and all sky imagers – detection of plasma bubble
- GPS receivers for TEC and scintillation studies

Digisondes in Brazil



Boa Vista

Belém

São Luiz

Fortaleza

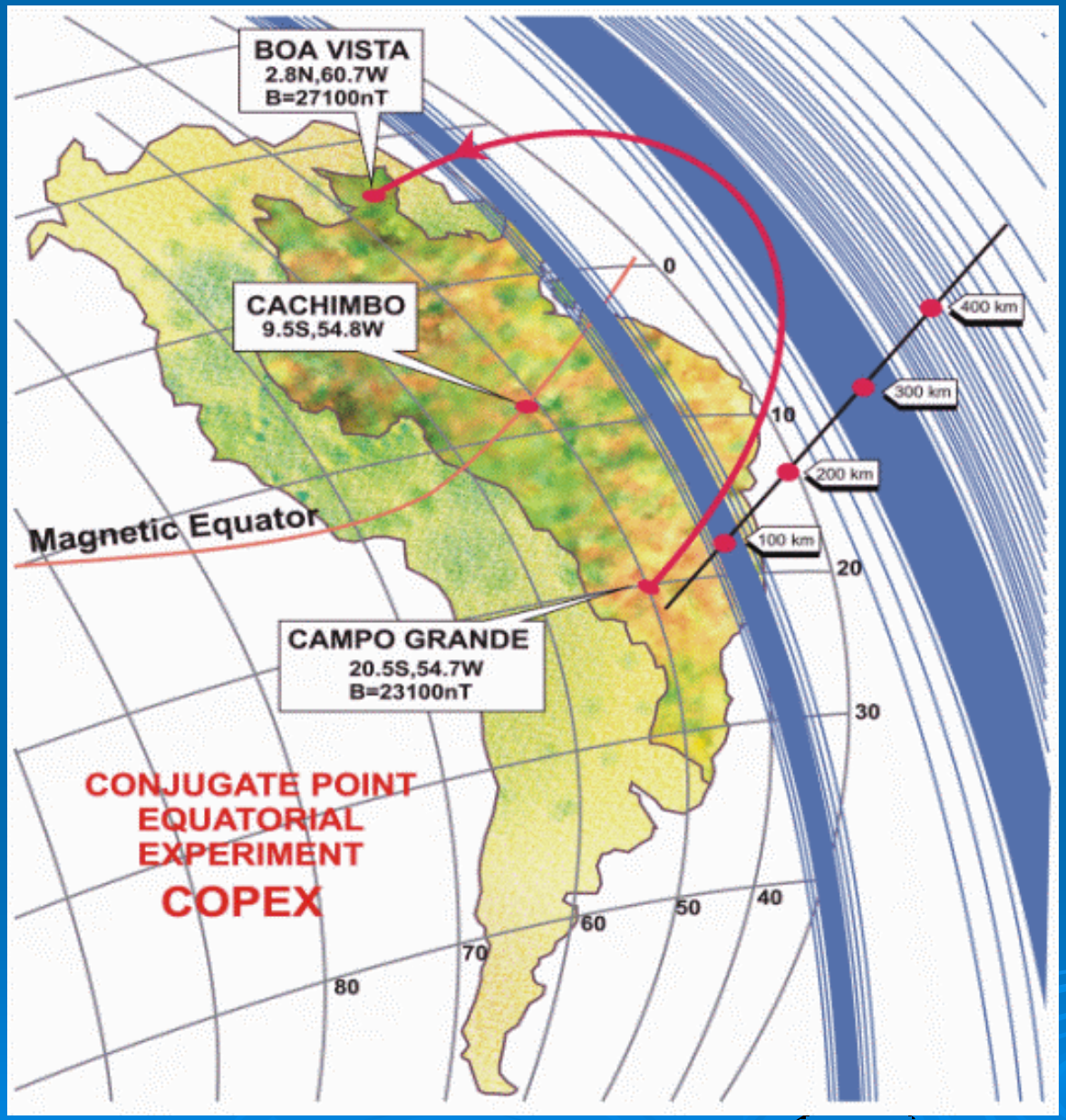
Alta Floresta

Campo Grande

Cachoeira Paulista

In operation

To be installed


BOA VISTA
2.8N,60.7W
B=27100nT
CACHIMBO
9.5S,54.8W
Magnetic Equator
CAMPO GRANDE
20.5S,54.7W
B=23100nT
CONJUGATE POINT
EQUATORIAL
EXPERIMENT
COPEX
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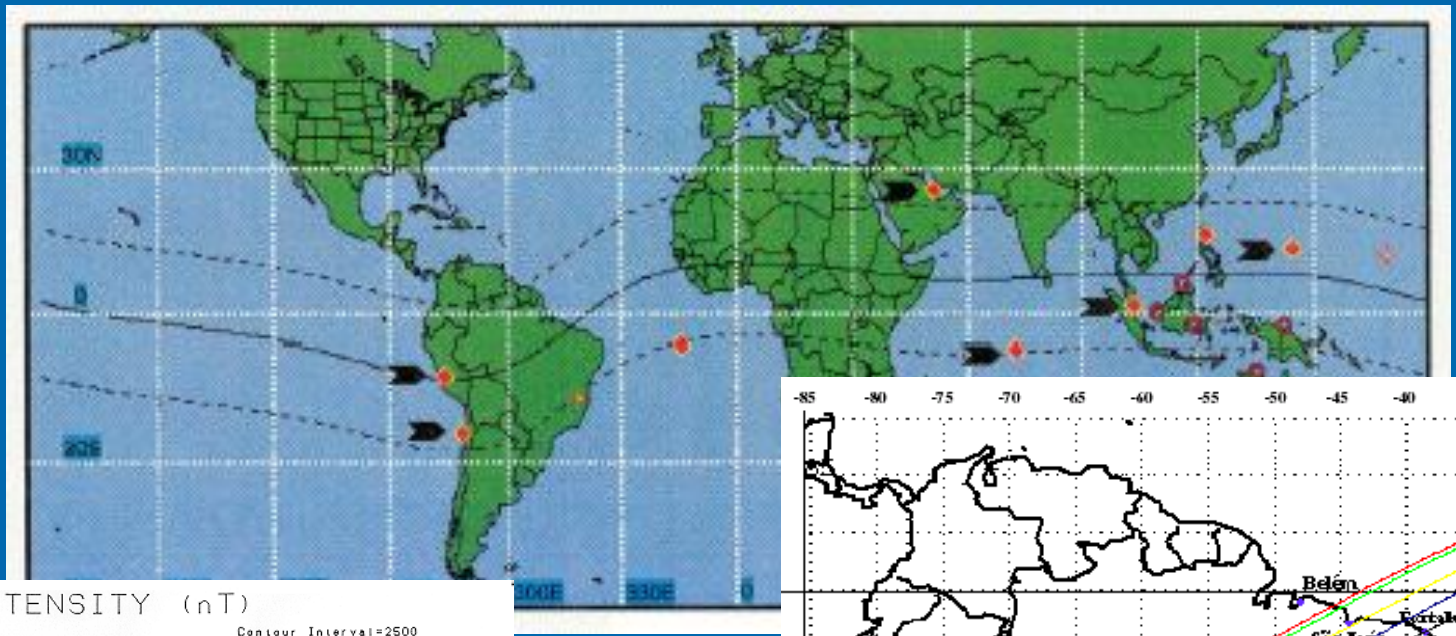
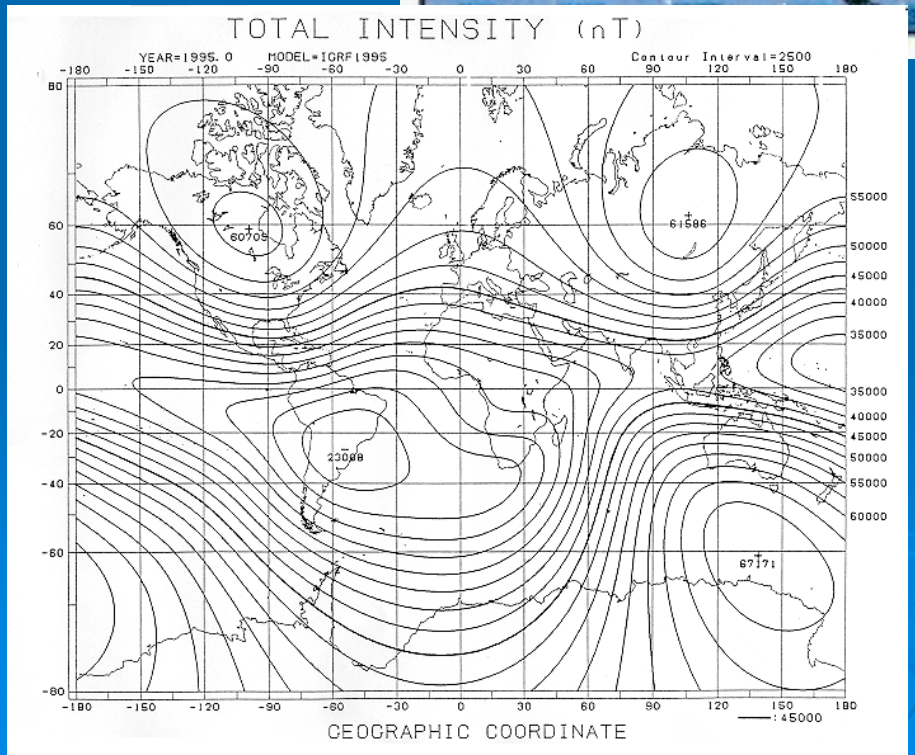
40
50
60
70
80
400 km
300 km
200 km
100 km




TOTAL INTENSITY (nT)
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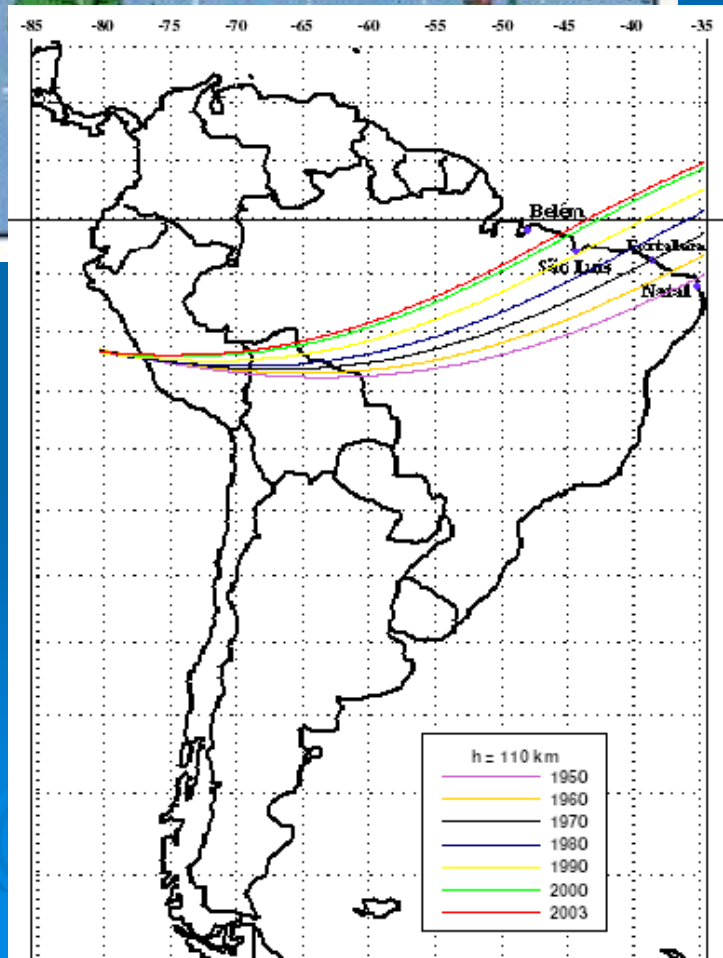
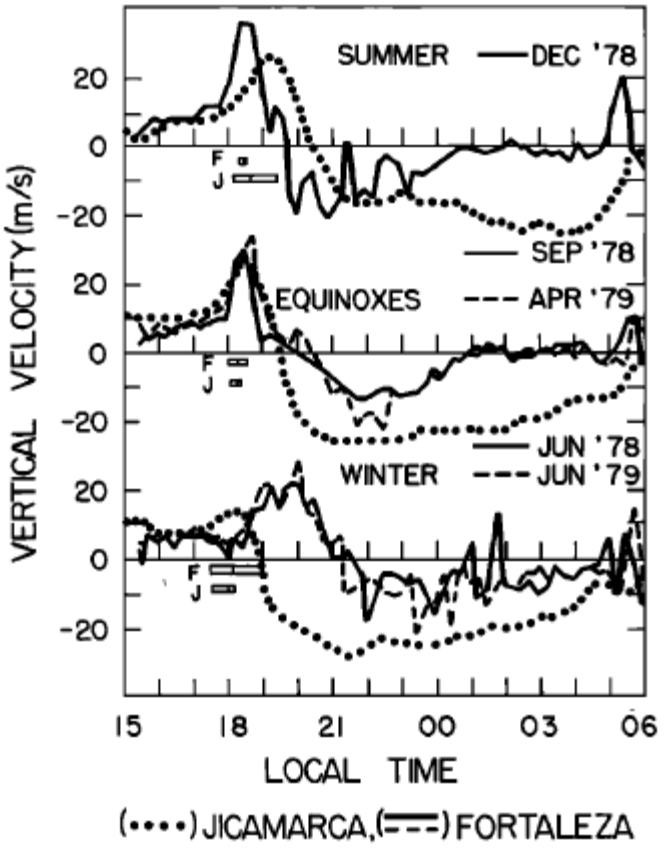
CEOGRAPHIC COORDINATE
: 45000

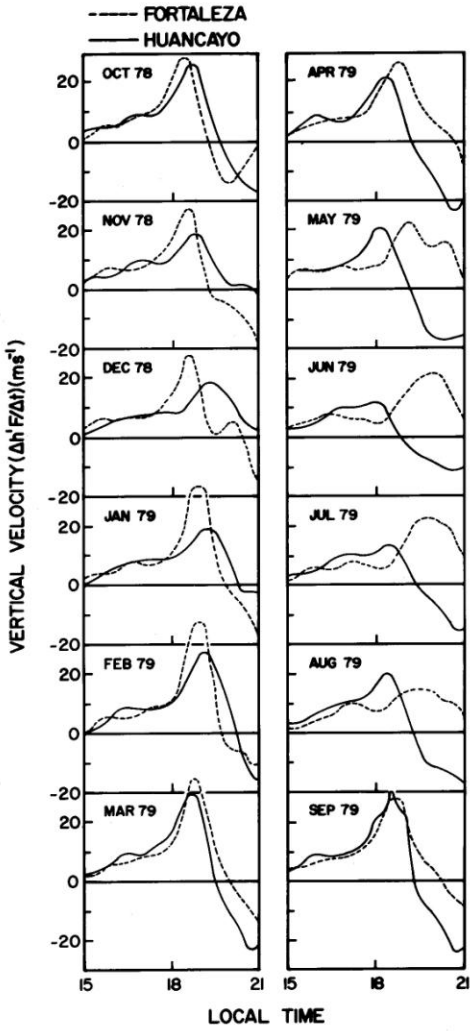

Belém
São Luís
Fortaleza
Natal
h = 110 km
1950
1960
1970
1980
1990
2000
2003

Abdu et al., Magnetic declination control of the equatorial F region dynamo electric field development and spread F, JGR, 86, A13, 11,443-11,446, 1981

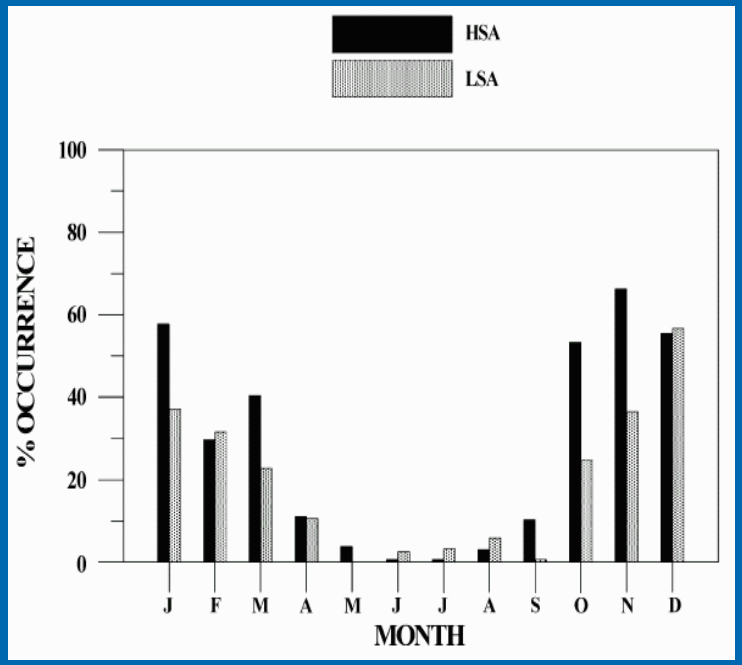
Abstract. We have carried out a cor
study of the evening prereversal enhanc
the equatorial F region vertical ioni
drift velocities (V_z) over Fortaleza (
Brazil, and Jicamarca (12°S, 77°W), Peru, two
magnetic equatorial stations in the American
zone. The results show profound dissimilarities
in the seasonal trends in the times and widths of
the V_z prereversal peak, which reflect in the
spread F characteristics as well, at the two
stations. The dissimilarities are shown to be
arising mainly from the difference in the
magnetic field declination angles that causes
differences in the conjugate E region sunset
durations and, hence, in the F region
polarization electric field development rates at
the two stations.

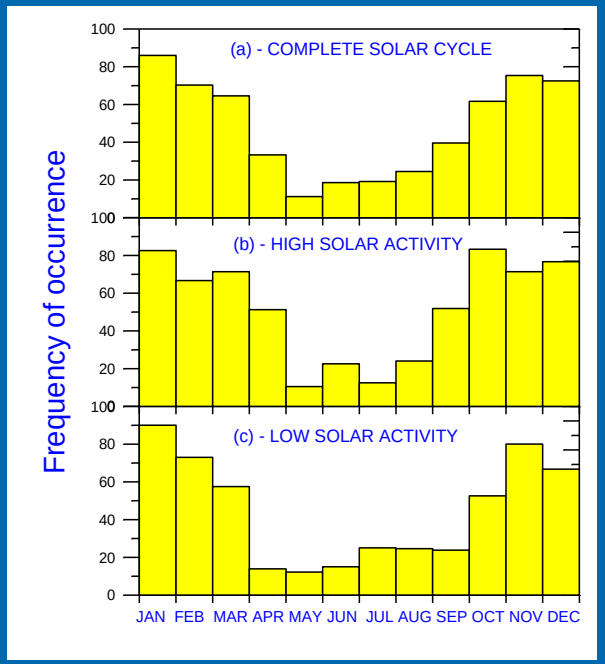


Batista et al., JGR, 1996



Plasma bubble occurrence over Cachoeira Paulista





HSA – High Solar Activity (March/89 - October/91)

LSA – Low Solar Activity (September/94 - January/98)

All sky imager - (Sahai et al., 1999)

All sky scanning photometer - (Sobral et al., 2002)

F region plasma drift for the Brazilian region (Batista et al., JGR, 1996)

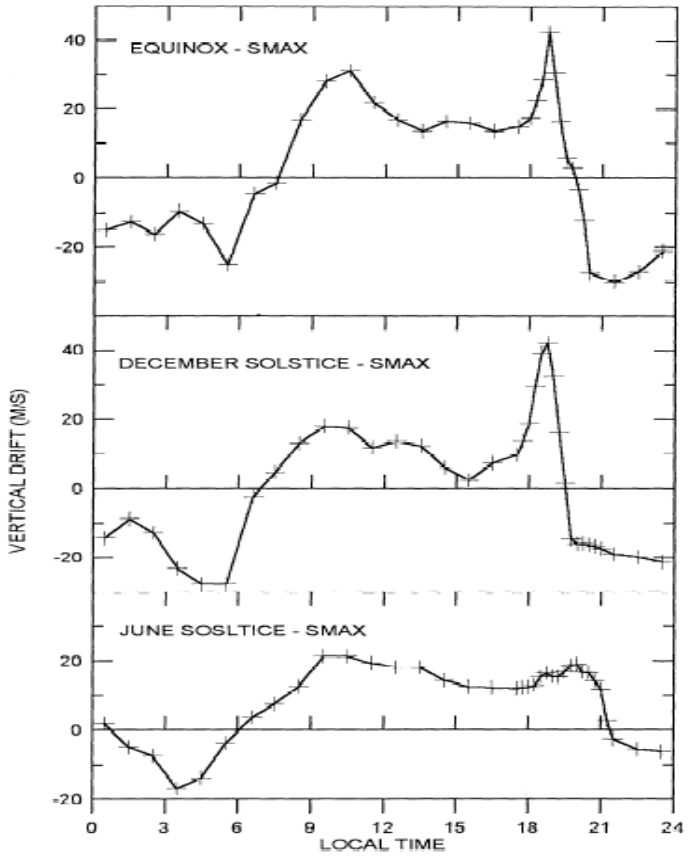


Figure 1. *F* region vertical plasma drift model for the Brazilian equatorial region during high solar activity periods.

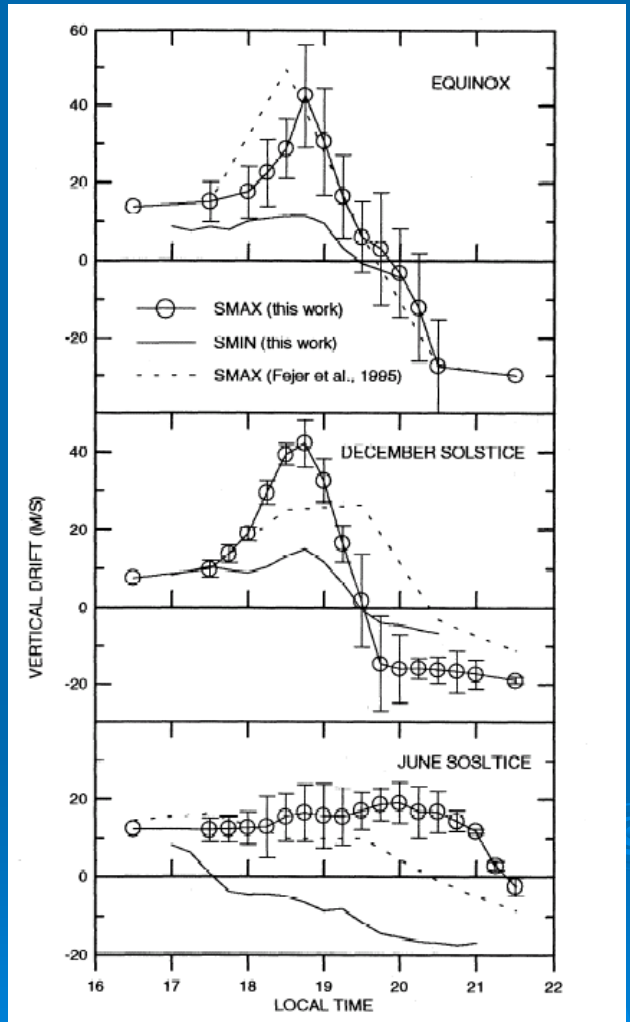


Figure 2. *F* region vertical plasma drift model around sunset for the Brazilian equatorial region during high and low solar activity periods, as compared with satellite measurements.

Cases of extreme prereversal enhancements during magnetic storms

Batista et al, JGR, 1991

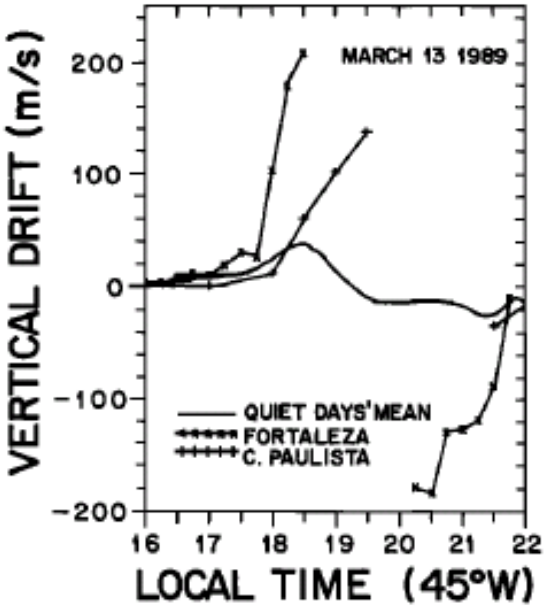
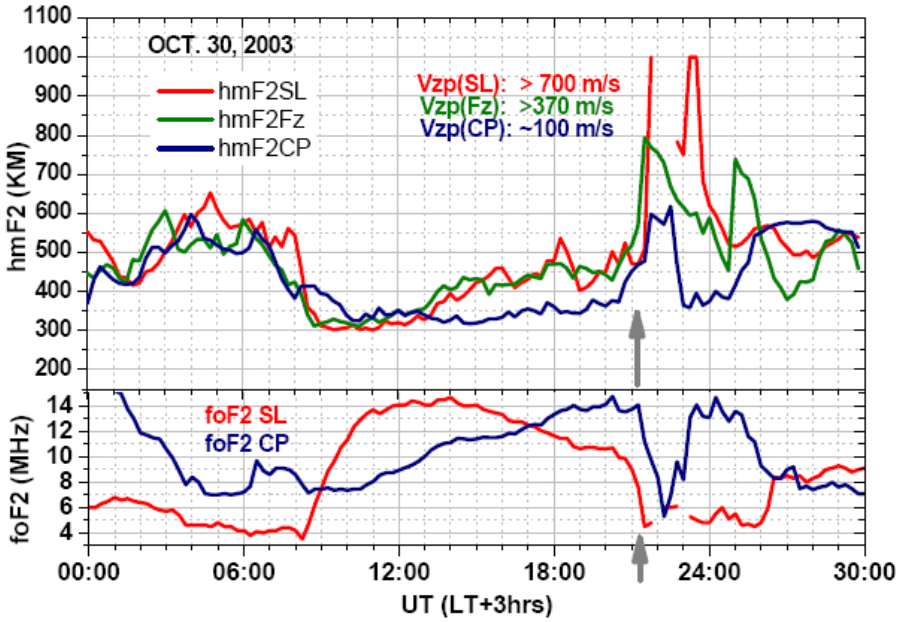
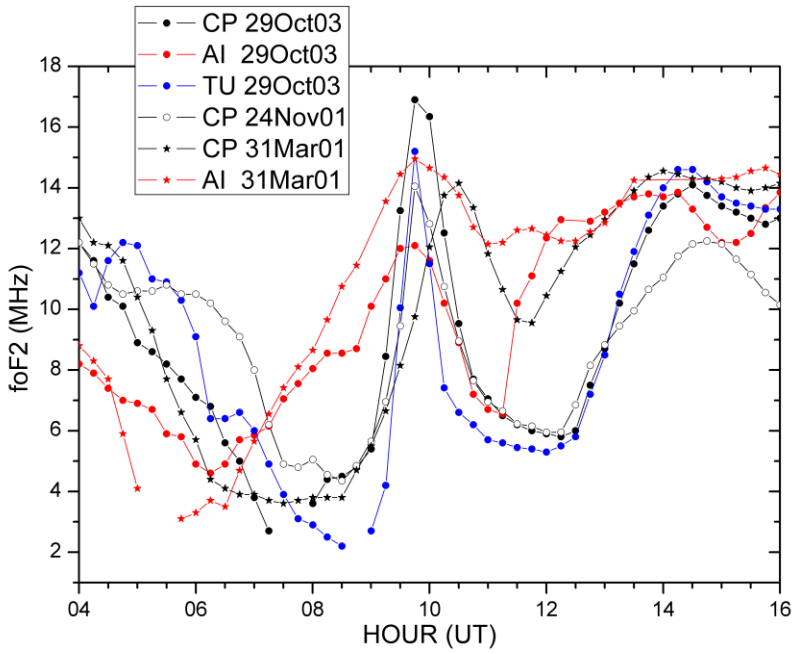


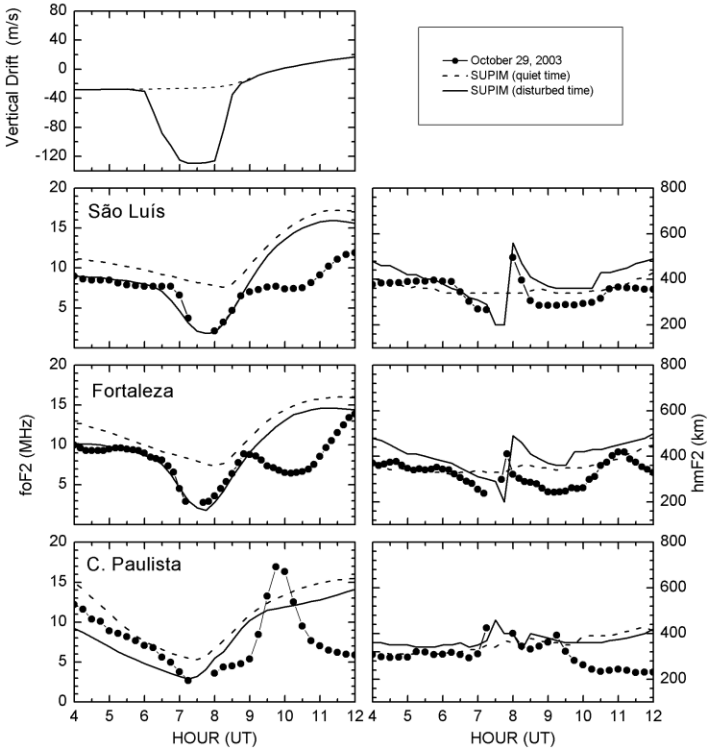
Fig. 3. Vertical plasma drift inferred from ionograms over Fortaleza (crosses) and Cachoeira Paulista (plusses) around local sunset on March 13, 1989. The full line represents the quiet time vertical drift over Fortaleza.

Abdu et al., JGR, 2008

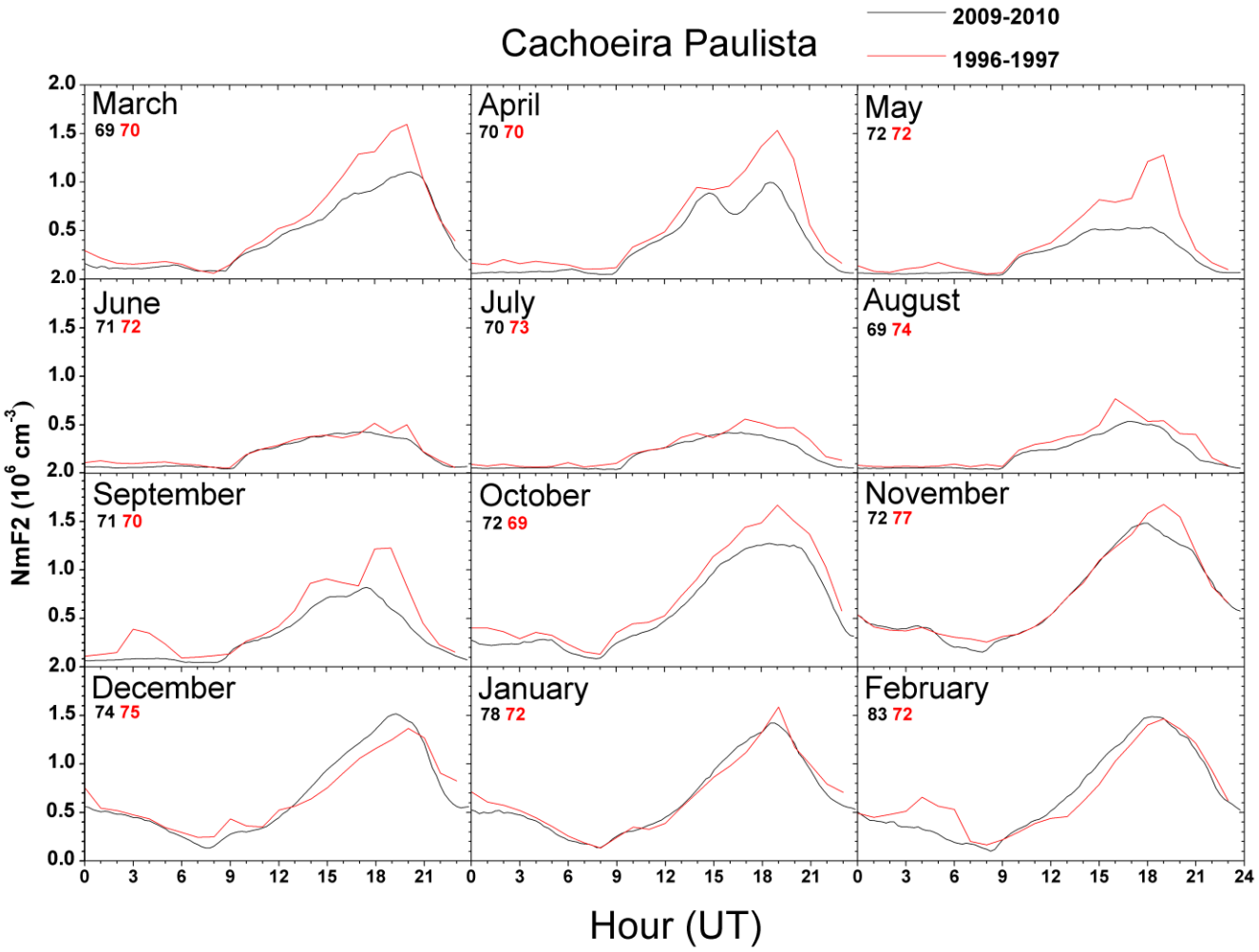


Simulation of the effect of an westward intensified electric field From: Batista et al., JGR, 2006





The ionosphere under the extremely prolonged low solar activity of solar cycle 23/24

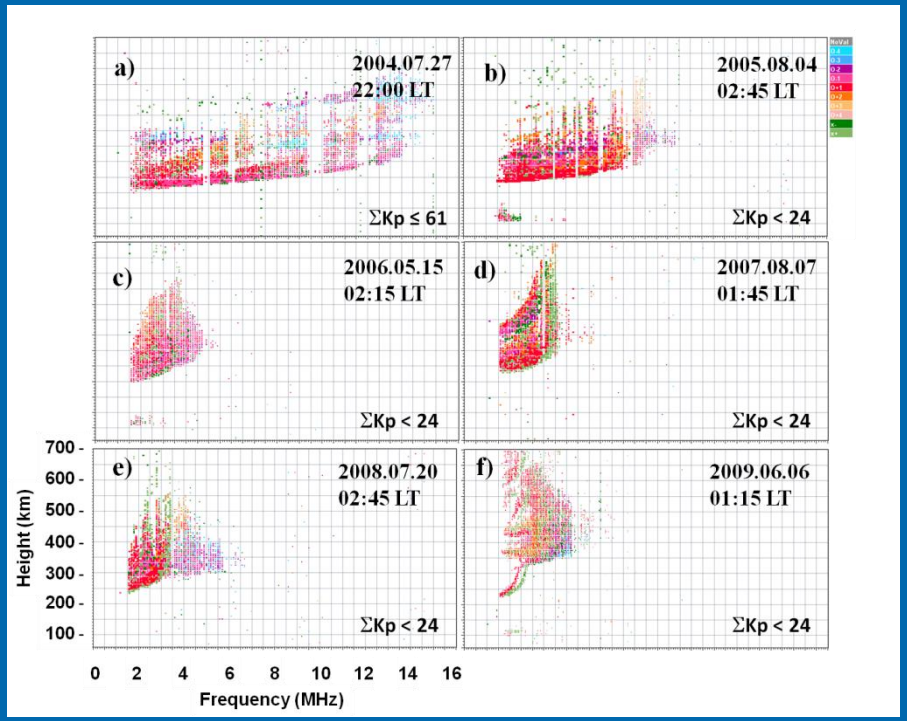


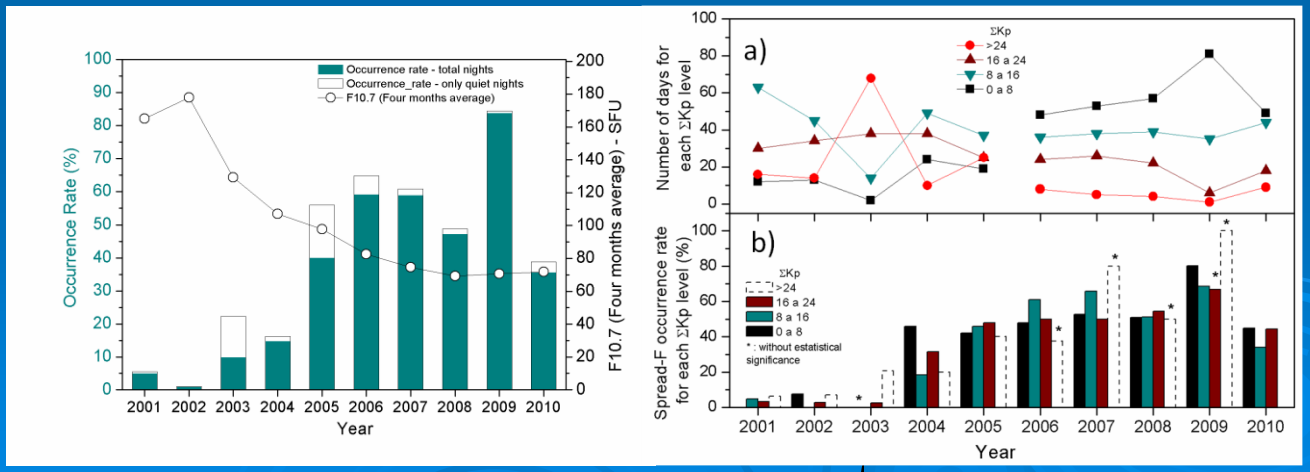
NmF2 variation at daily peak (19-20 UT)

Mar 31%
Apr 37%
May 63%
Sep 51%
Oct 25%

F10.7(09) > F10.7(96) but NmF2(09) < NmF2 (96)

Candido et al., JGR 2011



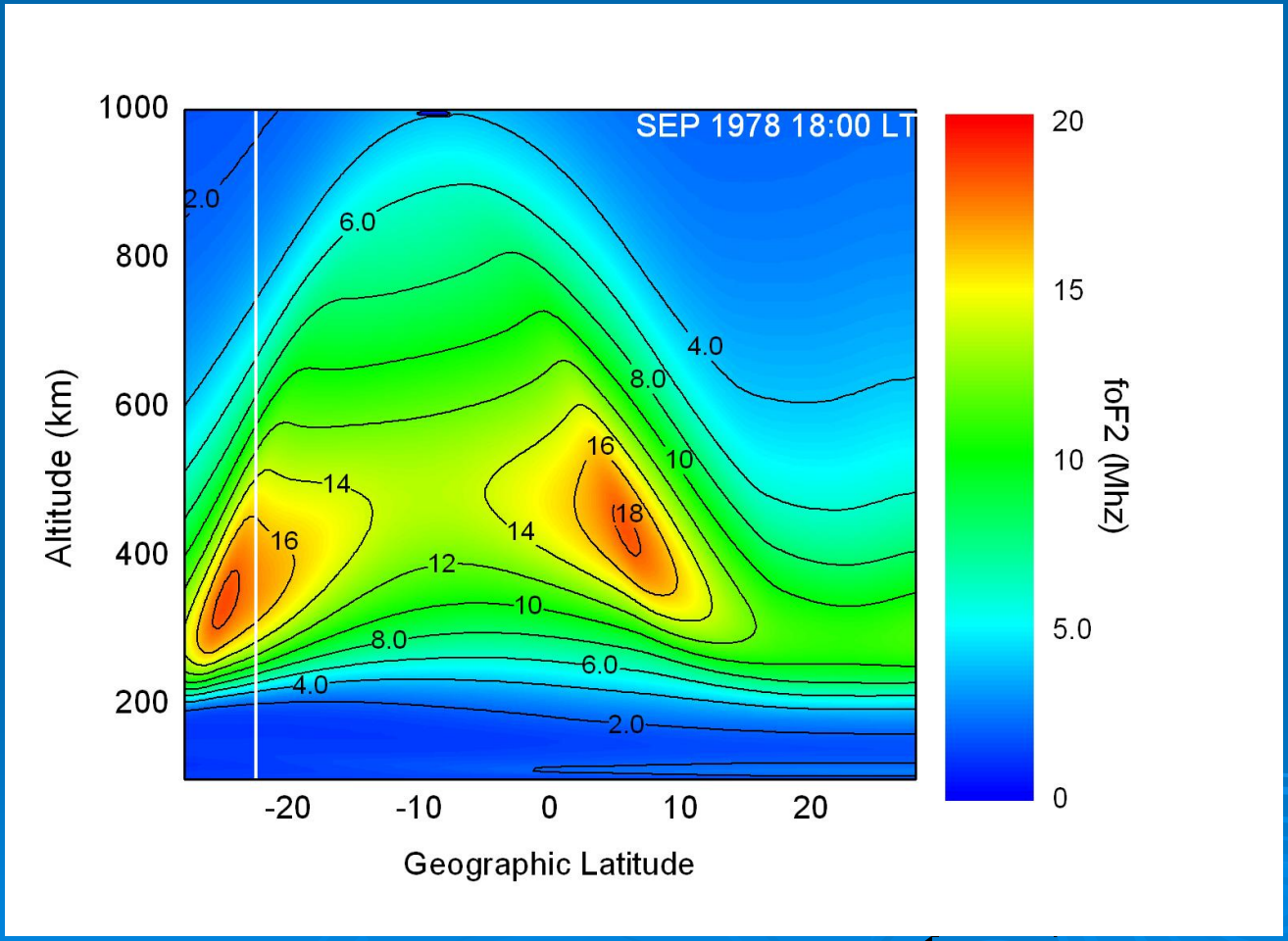


Model results

Equatorial ionization anomaly simulation
High solar activity

Sequence
September 1978, 1989, 2002
1800 LT

Northward movement of the anomaly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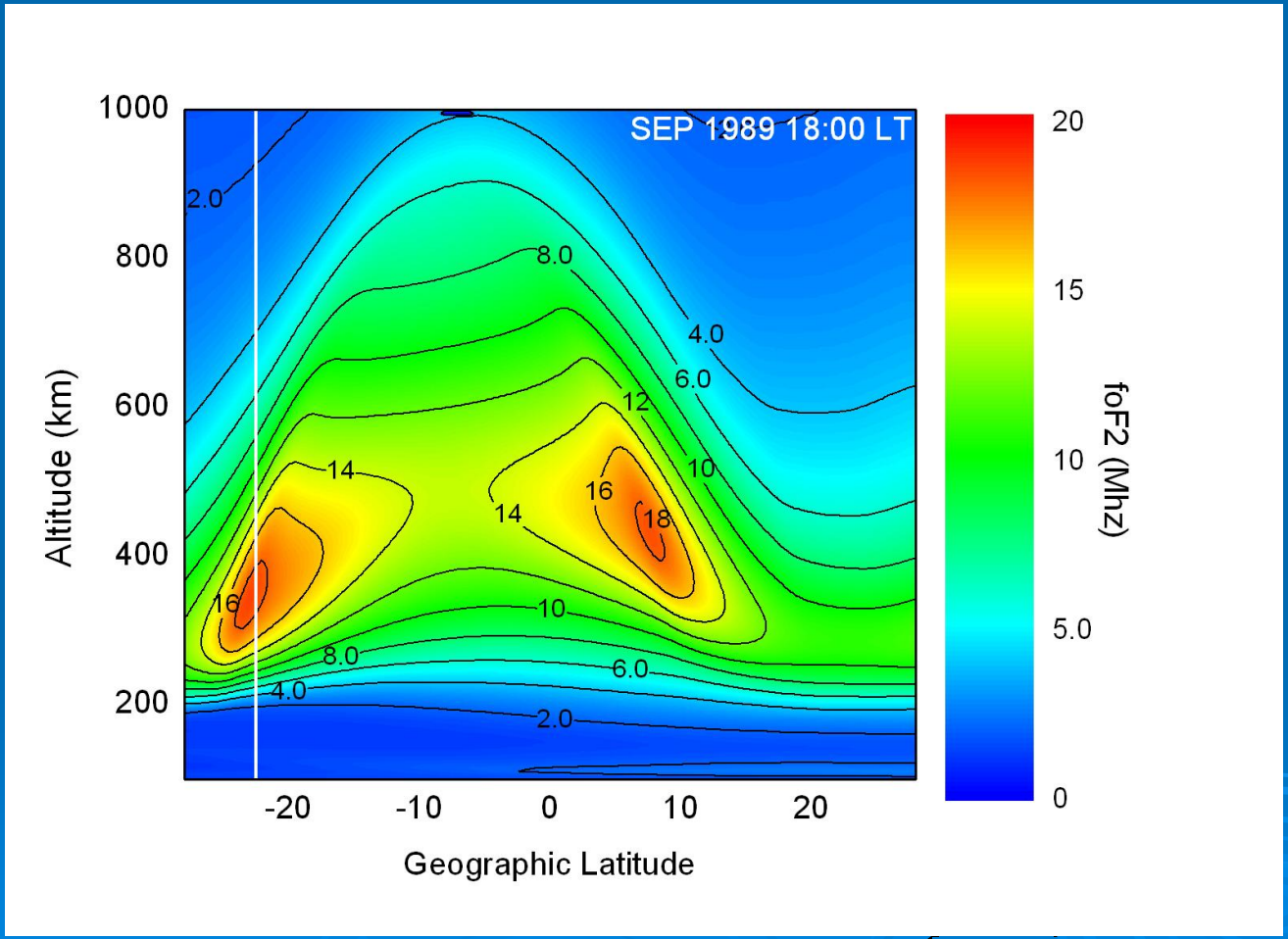
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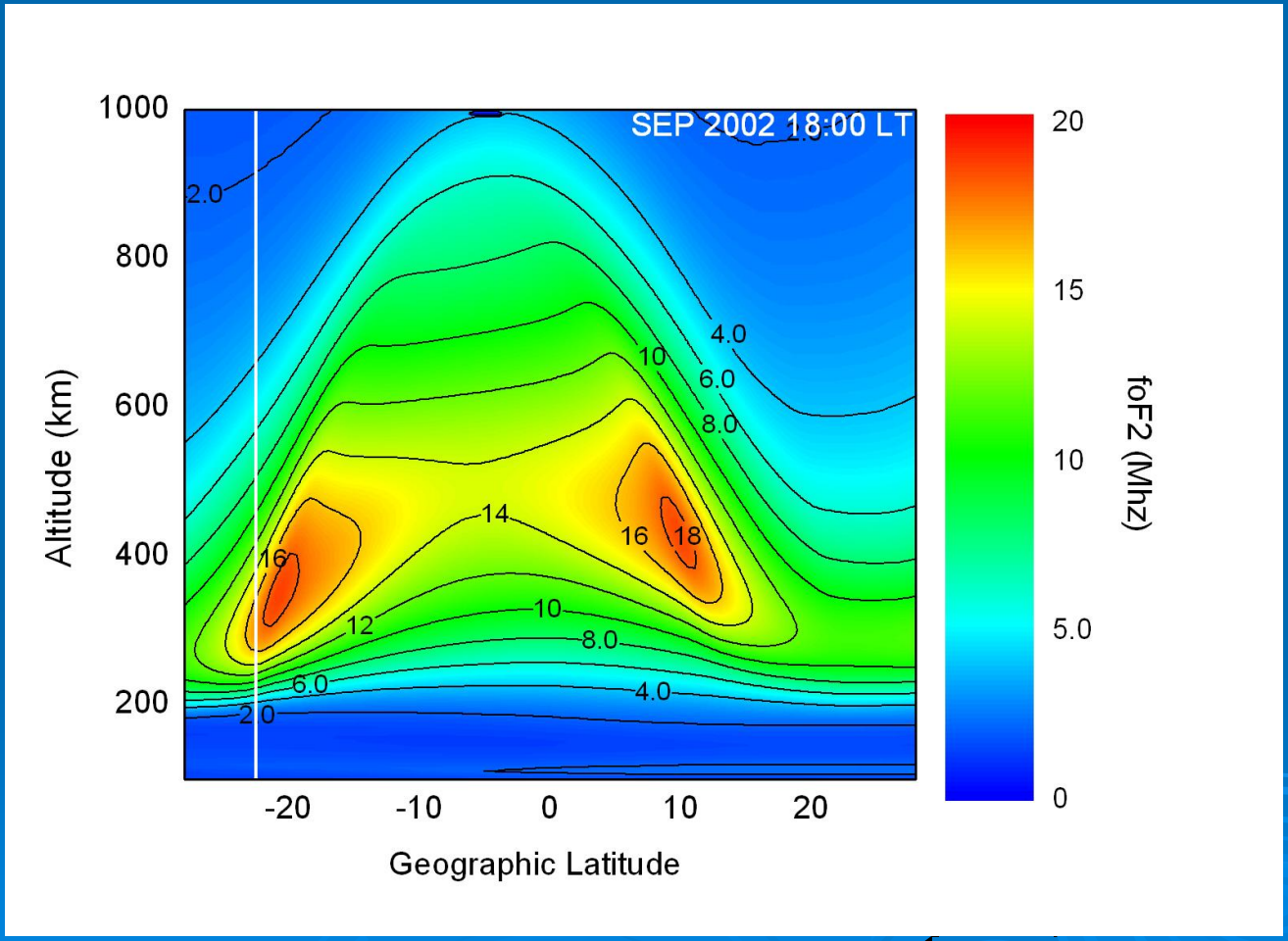
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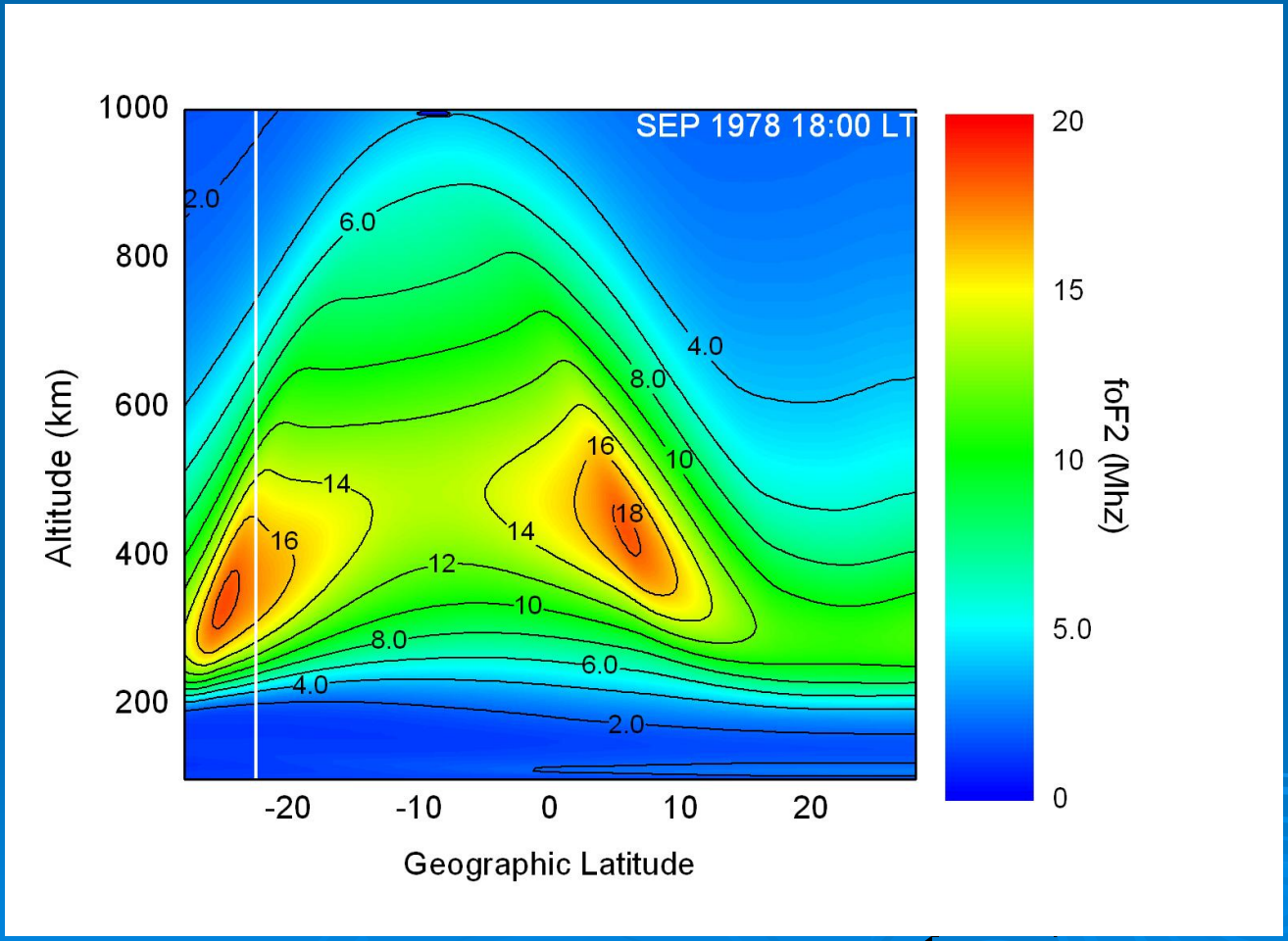
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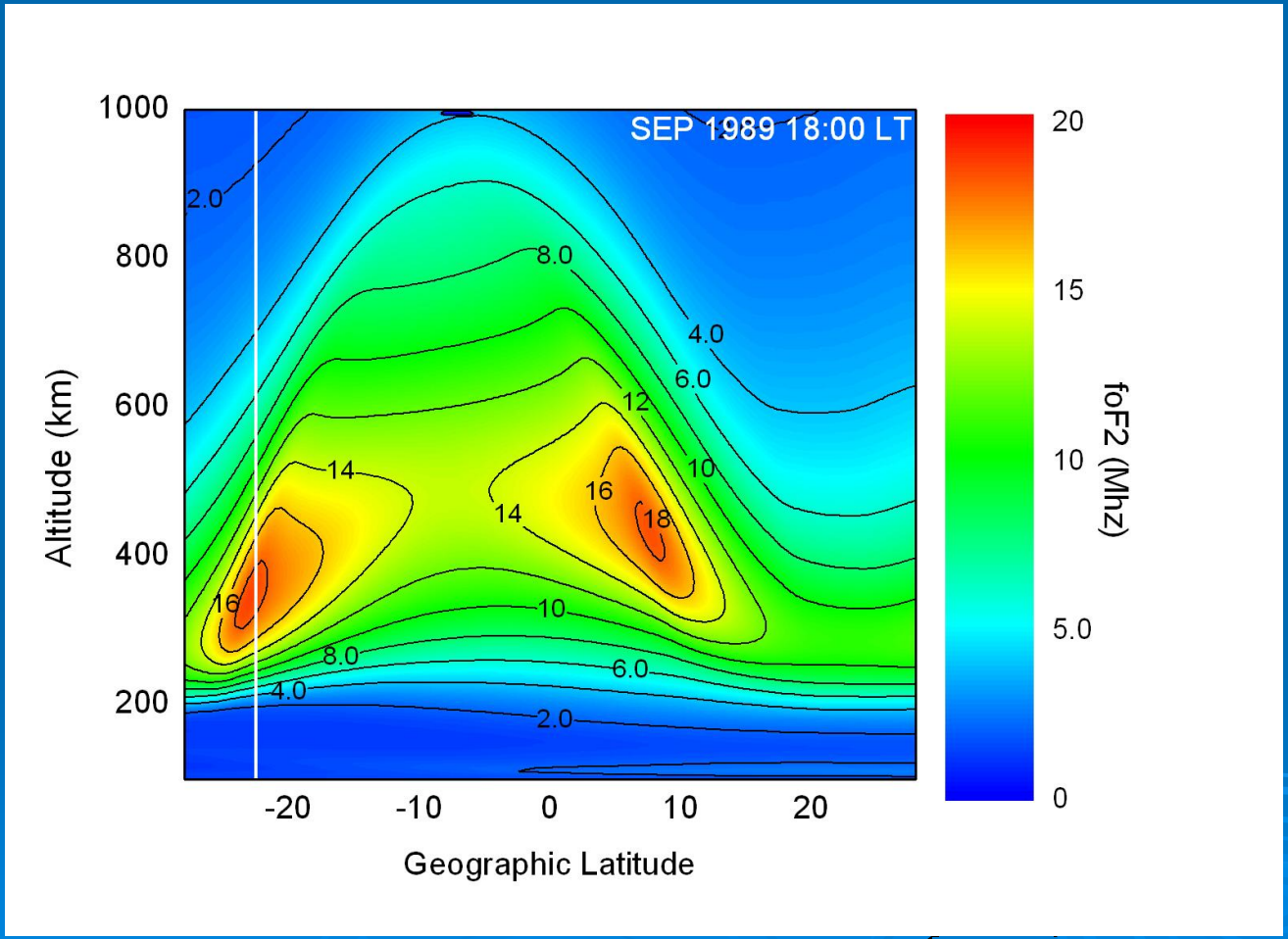
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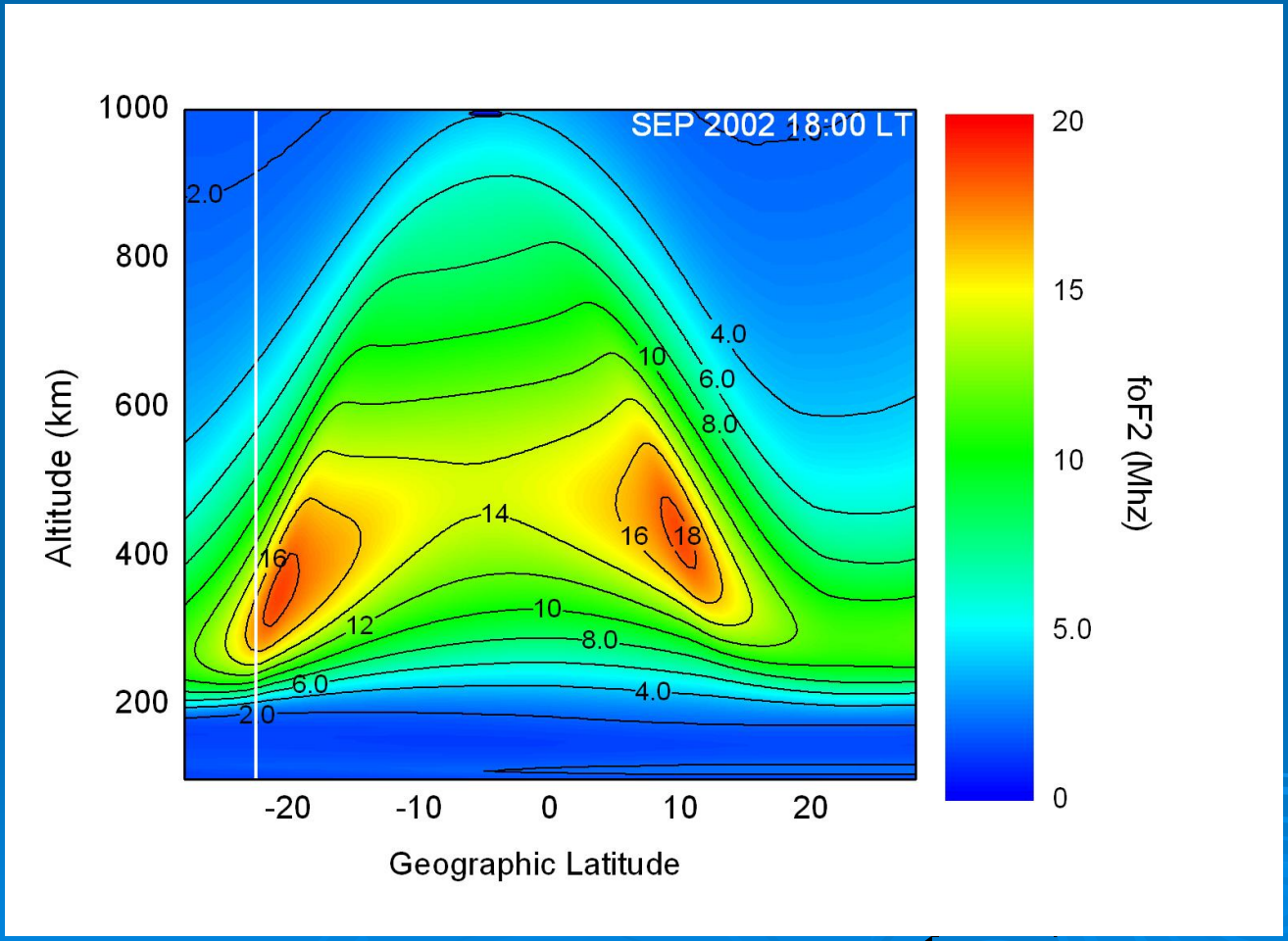
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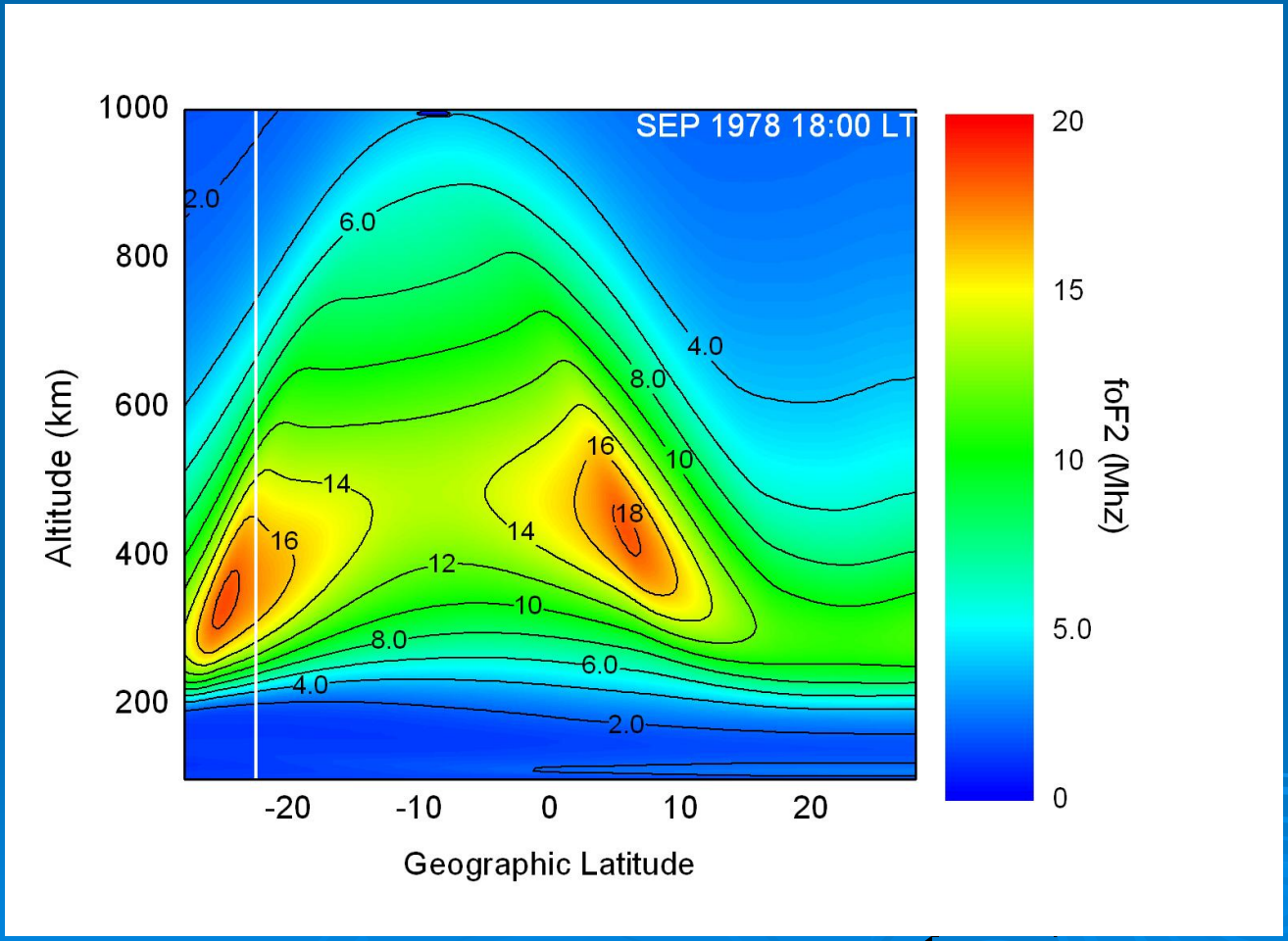
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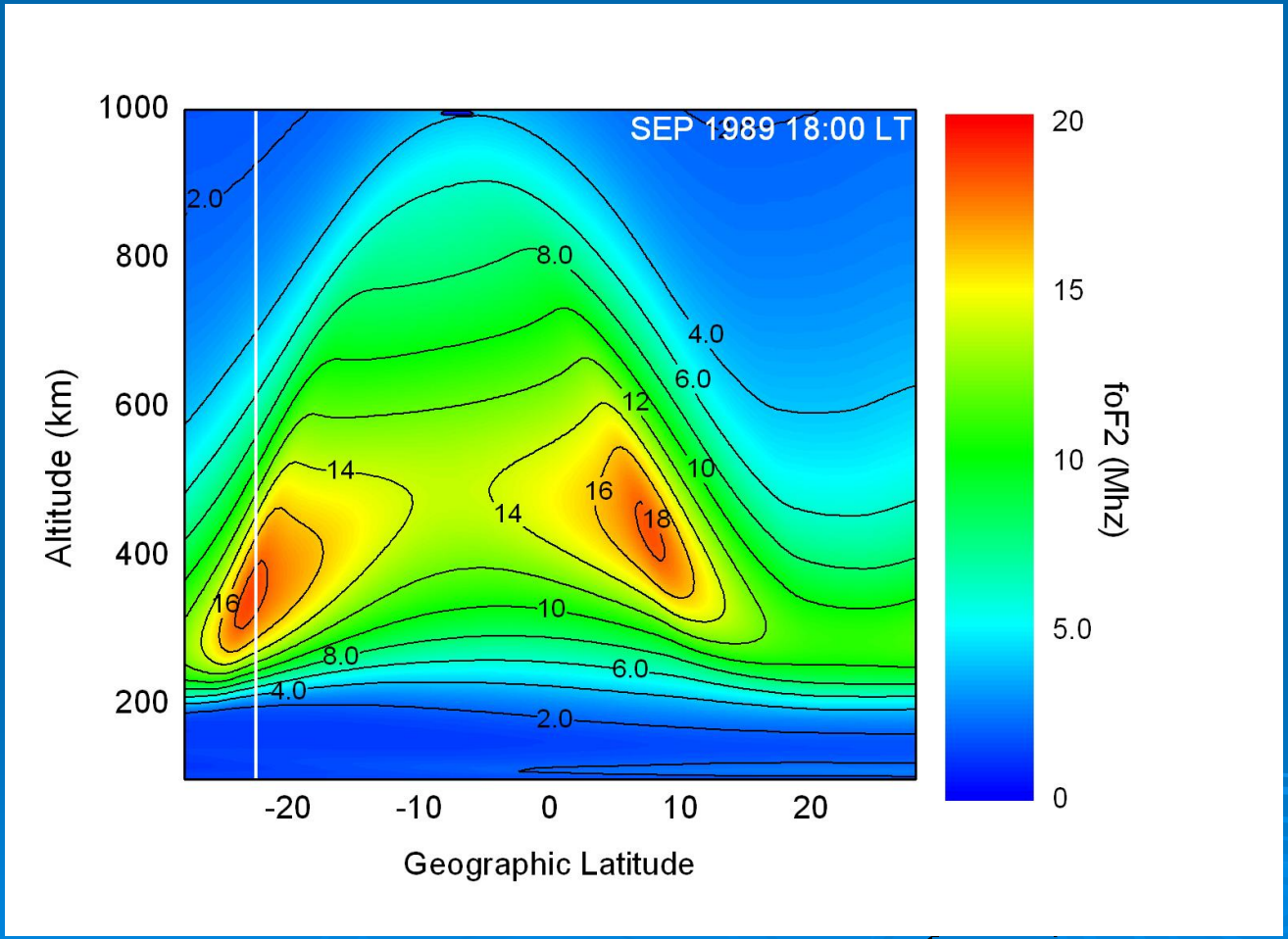
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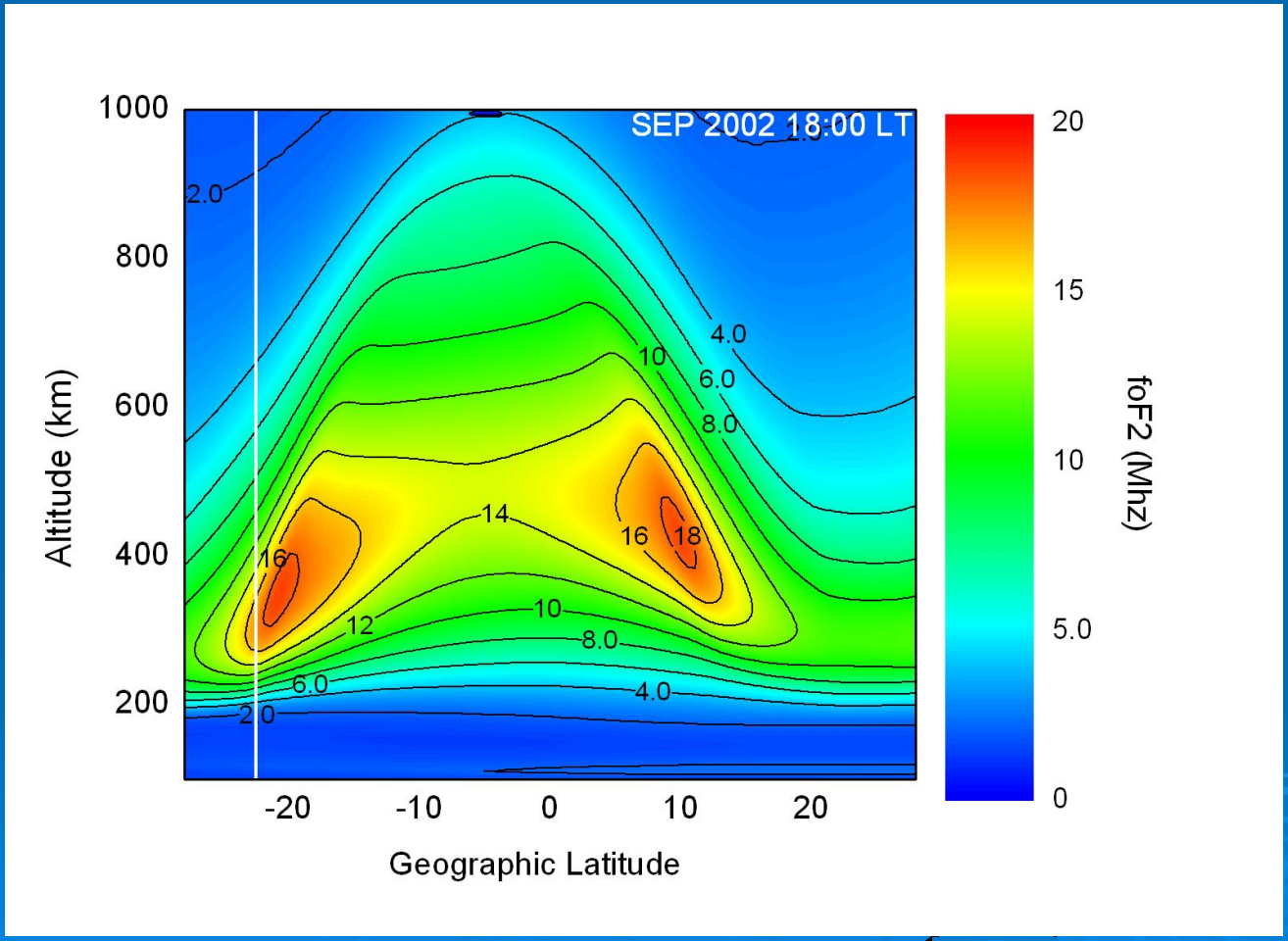
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TEC maps calculated using SUPIM-INPE

(http://www.inpe.br/climaespacial/)