THERMOSPHERIC NIGHTTIME MSTIDS OBSERVED BY AN ALL-SKY IMAGER AT COMANDATE FERRAZ ANTACTICA STATION (62 S)


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Outline

- Ferraz station at King George Island
- All-Sky airglow imager
- Wave Activity over Ferraz Station
- Summary
Partial view of **King George Island**, that is located about 200 km North of the Antarctic Peninsula

(62.1°S, 58.4°W)

Source: 1º Helicopter Squadron for General Employment (Esqd HU-1), Brazilian Navy
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Punta Plaza facility (meteor radar and All-Sky camera)
Ferraz Station - Punta Plaza Site

Source: J. V. Bageston
Observing Gravity Waves at Ferraz

A new all-sky airglow imager with three filters (OH NIR, OI 557.7 and 630.0 nm) was installed at Ferraz Antarctic Station in 2014.
Wave Activity in Mesosphere Region

[Graph showing zonal and meridional components over UT Time on 09/05/2016]
Wave Activity in Mesosphere Region

CF 10/05/2016 OH

Zonal (W - E)

Meridional (S - N)

UT Time
Wave Activity in Ionosphere Region
Wave Activity in Ionosphere Region
Are these waves related to OH emission?

OI Filter used has a Band Wide of 20 Å
How to ruled out OH Contamination?

So, no wave was propagating at the mesosphere to NW direction!
We used the well known Cross Spectrum Analysis

**Horizontal Wavelength**

\[ \lambda_h = \frac{2\pi}{\sqrt{k^2 + l^2}} \]

**Observed Phase Velocity**

\[ c_{obs} = \frac{2\pi}{\sqrt{k^2 + l^2}} \frac{\Delta \phi_{(k,l)}}{360°} \frac{1}{\Delta t} \]

**Observed Period**

\[ \tau_{obs} = \frac{\lambda_h}{c_{obs}} \]

**Prop. Direction**

\[ \varphi_{(k,l)} = tg^{-1} \left\{ \frac{Im \, C_{(k,l)}}{Re \, C_{(k,l)}} \right\} \]
Now we applied the method to all observed cases!
Overall Results

- **Horizontal Wavelength**: 27 waves, $\lambda_h \sim 75-200$ km
  - Number of Events: 8 to 1
  - Minimum: 0, Maximum: 8

- **Phase Velocity**: $c_{\text{obs}} \sim 75-175$ m/s
  - Number of Events: 8 to 1
  - Minimum: 0, Maximum: 8

- **Period**: $\tau_{\text{obs}} \sim 10-50$ min
  - Number of Events: 15 to 0
  - Minimum: 0, Maximum: 15

The diagrams show the distribution of events based on horizontal wavelength and phase velocity, with a peak around 75-200 km and 75-175 m/s, respectively. The period shows a concentration around 10-50 minutes.
So, what kind of waves are they?

When wave structures are observed in the ionospheric parameters, they are called traveling ionospheric disturbances (TIDs).

Depending on the size of the TID, they can be called small scale (SSTID), medium scale (MSTID) or large scale (LSTID).

<table>
<thead>
<tr>
<th>Type</th>
<th>Period (min)</th>
<th>Wavelength (km)</th>
<th>Phase Velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSTID</td>
<td>Few minutes</td>
<td>$\lambda \leq 100$ km</td>
<td>$c \leq 200$ m/s</td>
</tr>
<tr>
<td>MSTID</td>
<td>$5 \leq \tau \leq 60$ minutes</td>
<td>$\lambda \leq 1500$ km</td>
<td>$100 \leq c \leq 700$ m/s</td>
</tr>
<tr>
<td>LSTID</td>
<td>$30 \text{ min} \leq \tau \leq \sim$ hours</td>
<td>$\lambda &gt; 1000$ km</td>
<td>$300 \leq c \leq 1200$ m/s</td>
</tr>
</tbody>
</table>
Comparison with other OI 630 nm observations
**62°S**

- **Horizontal Wavelength**
  - $\lambda_h \sim 75-200$ km

- **Present Results**
  - $\tau_{obs} \sim 10-50$ min
  - $c_h \sim 75-175$ m/s

- **Number of Events**
  - 2 years

- **Number of Waves**
  - 27 waves

**22°S**

- **Wavelength**
  - $\lambda_h \sim 90-140$ km

- **Observation Time**
  - $\tau_{obs} \sim 10-30$ min
  - $c_h \sim 80-150$ m/s

- **Number of Events**
  - 2.5 years

- **Number of Waves**
  - 48 waves

**7°S**

- **Wavelength**
  - $\lambda_h \sim 100-200$ km

- **Observation Time**
  - $\tau_{obs} \sim 10-35$ min
  - $c_h \sim 30-180$ m/s

- **Number of Events**
  - 10 years

- **Number of Waves**
  - 98 waves
One of the most important mechanisms that has been pointed out as being effective for generation of MSTIDs is the Perkins instability (Perkins, 1973).
TID’s Propagation Direction

Perkins instability Mechanism

NH

Equator

SW

NW

SH
Looking closely in the wave Propagation Directions
-Not related with the Perkins instability process.

-Not directed linked by waves generated in the troposphere.

-Waves may be generated at the bottom site of the ionosphere region.

(Paulino et al., 2016)
Cloud Top Brightness Temperature (CTBT) with temperatures below -45°C.

Winter

Cold front and tropospheric jet stream
Summary

- Around 27 MSTIDs were observed in 2 years (2015 e 2016) at the Brazilian Antarctic Station;

- The main MSTID’s characteristics:
  - $\lambda_h \sim 75 - 200$ km
  - $\tau_{obs} \sim 10 - 50$ min
  - $c_{obs} \sim 75 - 175$ m/s

- Similar wave parameters were found at S.J. Cariri (7°S) and Cachoeira Paulista (22°S);

- According to MSTID’s propagation direction they seem be generated by the Perkins Instability Mechanism, however more investigation should be done.
Obrigado!

Perguntas?