4th Antarctic Gravity Wave Instrument Network

Historical background of all-sky airglow observations at
Comandante Ferraz Antarctic Station and small-scale gravity
waves climatology

José V. Bageston; Gabriel A. Giongo; Cristiano M. Wrasse; Paulo P. Batista; Delano Gobi; Hisao Takahashi

National Institute for Space Research (INPE), Brazil
Contact: bageston@gmail.com / jose.bageston@inpe.br
São José dos Campos-SP, Brazil – April 25, 2018
Outline

- Motivations for gravity wave observations at Commandant Ferraz Station;
- Geographical location of Ferraz Station
- Historical on the MLT instrumentation at Ferraz Station;
- Gravity Waves observed at Ferraz Station (62.1°S, 58.4°W);
  - All-Sky airglow observations and its statistics;
  - Small scale gravity waves: Examples/Morphologies, wave parameters and propagation directions;
  - Case studies of mesospheric fronts;
- Future plans for MLT researches at Ferraz Station;
- Conclusions and Acknowledgments;
Motivations

- High GWs activity around the Antarctica Peninsula and South America;

Motivations

- Effects of Gravity Waves in the MLT winds structure;

Mesospheric wind disturbances over King George Island (Ferraz Staion) due to gravity waves.

**Source:** Quian Li et al., 2013 (JGR: Atmospheres). doi:10.1002/jgrd.50577
Motivations

➢ A new airglow imager with 3 airglow filters was installed at Ferraz in 2014;

➢ Possibility of reactivate of the Ferraz meteor radar in 2019;
Motivations

- Relationship between GWs observed in the Antarctic Peninsula and in the South America and possibility of GWs observation in the summer time (monitoring NLC occurrence) from the ground;

- Strong engagement between the ANGWIN members;

Source: https://en.wikipedia.org/wiki/Research_stations_in_Antarctica
Geographical location of Ferraz Station

(A) Antártica

(B) Península Antártica

(C) Porção da Ilha Rei George

(D) Estação Antártica Comandante Ferraz (EACF), em 28 de Agosto de 2007

EACF (62.1°S, 58.4°W)
Surrounding of Ferraz station

Source: 1º Helicopter Squadron for General Employment (Esqd HU-1), Brazilian Navy
MLT Instrumentation at Ferraz
MLT Instrumentation at Ferraz

2007
2010-2011

2014-present
The first all-sky airglow imager was installed in March 2007, but before that an OH photometer (2000-2003) and OH CCD imager for rotational temperature (2004) has been operated at Ferraz.

In 2008 none GW observations were conducted at Ferraz since the previous imager has return to Brazil for change the CCD (it was calibrated for usage in a temperature system);
After change the CCD in the all-sky system at INPE-SJC (yearly 2009), a technician returned to Ferraz and installed this other all-sky CCD camera, but some problem occurred in the CCD shutter (even that during tests at INPE-SJC such problem did not appeared). So, again there were none useful all-sky airglow images.

After brought the CCD back to SJC, a new CCD was used instead of the previous one. After checking for similar problems this new CCD returned to Ferraz in 2010, and operated in a good shape until February 2012.

<table>
<thead>
<tr>
<th>Year</th>
<th>Observed Nights</th>
<th>Usefull Nights</th>
<th>SSGW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>87</td>
<td>44</td>
<td>241</td>
</tr>
<tr>
<td>2010</td>
<td>81</td>
<td>31</td>
<td>74</td>
</tr>
<tr>
<td>2011</td>
<td>123</td>
<td>52</td>
<td>149</td>
</tr>
<tr>
<td>Total</td>
<td>291</td>
<td>234</td>
<td>464</td>
</tr>
</tbody>
</table>
After the fire accident at the main Ferraz station (Feb., 2012), the Punta Plaza region (MLT instruments) stayed without power until Jan., 2014.

In Feb., 2014 a post-doctorate guy went to Ferraz and a new high performance all-sky airglow imager was installed, which operates with three filters: OHNIR; OI557.7 and OI630.0.

However, after almost three months of operation, a problem occurred in the power transformer near the shelter where the instruments were operates. Then, the new airglow imager could obtain only 6 partially cloudy nights among 21 observed nights, and just 4 gravity waves were identified.

From 2015 to 2017 no problem occurred, but this year (2018) the electric cables that connect the main station to Punta Plaza broken twice.
Statistics of GWs at Ferraz Station

Statistics of observations during the winter time for all observed years

<table>
<thead>
<tr>
<th>Year</th>
<th>Observed Nights</th>
<th>Usefull Nights</th>
<th>SSGW</th>
<th>MSGW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>87</td>
<td>44</td>
<td>234</td>
<td>31</td>
</tr>
<tr>
<td>2010</td>
<td>81</td>
<td>31</td>
<td>88</td>
<td>4</td>
</tr>
<tr>
<td>2011</td>
<td>123</td>
<td>52</td>
<td>136</td>
<td>36</td>
</tr>
<tr>
<td>2014</td>
<td>21</td>
<td>6</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>2015</td>
<td>228</td>
<td>101</td>
<td>104</td>
<td>22</td>
</tr>
<tr>
<td>2016</td>
<td>**</td>
<td>**</td>
<td>15*</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>291</td>
<td>234</td>
<td>585*</td>
<td>146</td>
</tr>
</tbody>
</table>

Only a few days in August 2016 were analyzed;

A quick view in the data from 2016, it seems that a similar number of GWs to 2015 can be identify;

The 2017 data were sent by mail in an external hard disc, but we could not see these data yet.
Statistics of GWs at Ferraz Station

Statistics of observations during the winter time for all observed years

![Bar chart showing number of events per year from 2007 to 2017. The chart indicates a peak in 2008 with 234 events, followed by years with 88, 136, 104, and 15 events respectively. The total events are 585.](chart.png)
Examples of Small-Scale Gravity Waves

Simultaneous band events

LUME/INPE EACF

01:53:18 LT 18/08/2007

17/08/2007 LUME/INPE - EACF
Examples of Small-Scale Gravity Waves

07 Dec 2011

**Observation of a mesospheric front in a thermal-doppler duct over King George Island, Antarctica**

J. V. Bageston, C. M. Wrasse, P. P. Batista, R. E. Hibbins, D. C Fritts, D. Gobbi, and V. F. Andrioli
Atmos. Chem. Phys., 11, 12137-12147, https://doi.org/10.5194/acp-11-12137-2011, 2011
Examples of Small-Scale Gravity Waves

28 Jan 2011

**Case study of a mesospheric wall event over Ferraz station, Antarctica (62° S)**


Examples of Small-Scale Gravity Waves

Pulse or Solitary front

Wave-wave interaction

LUME/INPE EACF

03:33:09 LT  14/05/2007

Examples of Small-Scale Gravity Waves
Examples of Small-Scale Gravity Waves

Mesospheric front observations by the OH airglow imager carried out at Ferraz Station on King George Island, Antarctic Peninsula, in 2011
Gabriel Augusto Giongo, José Valentin Bageston, Paulo Prado Batista, Cristiano Max Wrasse, Gabriela Dornelles Bittencourt, Igo Paulino, Neusa Maria Paes Leme, David C. Fritts, Diego Janches, Wayne Hocking, and Nelson Jorge
Examples of Small-Scale Gravity Waves

27 Feb 2018
**Mesospheric front observations by the OH airglow imager carried out at Ferraz Station on King George Island, Antarctic Peninsula, in 2011**
Gabriel Augusto Giongo, José Valentin Bageston, Paulo Prado Batista, Cristiano Max Wrasse, Gabriela Dornelles Bittencourt, Igo Paulino, Neusa Maria Faes Leme, David C. Fritts, Diego Janches, Wayne Hocking, and Nelson Jorge
Examples of Small-Scale Gravity Waves

Mesospheric front observations by the OH airglow imager carried out at Ferraz Station on King George Island, Antarctic Peninsula, in 2011
Gabriel Augusto Giongo, José Valentin Bageston, Paulo Prado Batista, Cristiano Max Wrasse, Gabriela Dornelles Bittencourt, Igo Paulino, Neusa Maria Faes Leme, David C. Fritts, Diego Janches, Wayne Hocking, and Nelson Jorge
Examples of Small-Scale Gravity Waves
Wave parameters and prop. directions


* Only a few events were analyzed for 2016 (August), it's missing the most part of the data
Wave parameters and prop. directions

~ 62% of the total of events

Autumn (Feb-May)

Events: 128

Winter (Jun-Aug)

Events: 361

Spring (Sep-Oct)

Events: 96
Wave parameters and prop. directions

**128 GWs** Autumn (Feb-May)

**361 GWs** Winter (Jun-Aug)

**96 GWs** Spring (Sep-Oct)
Case Studies of Meospheric Fronts (2011)

Mesospheric front observations by the OH airglow imager carried out at Ferraz Station on King George Island, Antarctic Peninsula, in 2011

Gabriel Augusto Giongo, José Valentin Bageston, Paulo Prado Batista, Cristiano Max Wrasse, Gabriela Dornelles Bittencourt, Igo Paulino, Neusa Maria Paes Leme, David C. Fritts, Diego Janches, Wayne Hocking, and Nelson Jorge
Case Studies of Meospheric Fronts (2011)

Event 1
- 5 hours before the GW
- 4 hours before the event
- 240 km away from Ferraz
- SABER and AURA soundings

Event 2
- 3 hours before the GW

Event 3

Event 4
Case Studies of Meospheric Fronts (2011)
Case Studies of Mesospheric Fronts (2011)
SUMMARY

- We have been observe gravity waves from Ferraz station since 2007, and even considering the problems, we still obtain good data;
- We could observed almost 600 small-scale gravity waves during 4 years;
- Medium-scale gravity waves also were characterized for 5 years;
- It were found 6 cases of mesospheric fronts, which were characterized in term of their parameters and propagation condition;
- Two cases of mesospheric fronts could be linked to tropospheric sources, and one case was likely absorbed by the local wind;
- The characterization of the mesospheric gravity waves in terms of the intrinsic parameters will be conducted by using the meteor radar from KSS/KOPRI.
Future Plans for the MLT Researches in Ferraz

- Rebuild/rewire the meteor radar → Probably David Fritts (GATs Inc.) will obtain some support from the USAP-NSF for the next year;
- We have plan to continue to observe NLC at Ferraz (we did not see yet the data from the last summer) and Rothera;
- Expand the NLC network: Ushuaia (Argentina) or Punta Arenas (Chile);
- From March, 2012 until now we don’t have mesospheric winds observations from the Ferraz meteor radar. So, we have been contacted and obtained mesospheric winds from the King Sejong Station;
- Continue the analysis of the previous observed gravity waves: search for medium-scale waves; apply ray-tracing to previous observed waves and analyze the new NLC images;
The new Brazilian Antarctic Station

The new Ferraz Station will be ready in 2019!

Thank you very much for your attention!
MUITO OBRIGADO PELA ATENÇÃO!