Crustal Deformation Study of the Charlevoix Seismic Zone in Quebec

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Tectonic Plates
Charlevoix Seismic Zone - CSZ (intraplate)
Seismic activities in CSZ

- Possibly due to post-glacial rebound and/or to a meteoric impact
Meteoric impact

- About 350 millions years ago
Post-glacial rebound

- Last glacial era:
  - 70,000 - 10,000 years ago
  - Max.: 18,000 years ago
  - 2 - 3.5 km of ice thickness

http://palaeo.gly.bris.ac.uk/Palaeofiles/Pleistocene/
Measured post-glacial rebound in Canada

Comparison with precise geodetic levelling
Variation of benchmark altitudes
Measured geodetic points
- GPS campaigns of 1991 and 2005
2005 GPS campaign – Field observations

2013-05-13
## GPS campaigns comparison (1991 vs 2005)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Year</th>
<th>1991</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
<td>20-27 September</td>
<td>21-27 July</td>
</tr>
<tr>
<td>Number of stations</td>
<td></td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>IGS Stations</td>
<td></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Session duration per station</td>
<td></td>
<td>2 x 5 hours</td>
<td>&gt; 48 hours</td>
</tr>
<tr>
<td>Interval</td>
<td></td>
<td>10 seconds</td>
<td>30 seconds</td>
</tr>
<tr>
<td>Number of satellites</td>
<td></td>
<td>4-6</td>
<td>7-10</td>
</tr>
<tr>
<td>Baseline length</td>
<td></td>
<td>30-50 km</td>
<td>30-50 km</td>
</tr>
<tr>
<td>Mask angle</td>
<td></td>
<td>0°</td>
<td>5°</td>
</tr>
<tr>
<td>Antenna</td>
<td></td>
<td>Ashtech dual-frequency</td>
<td>Ashtech choke ring dual-frequency</td>
</tr>
</tbody>
</table>
BERNESE software

Precise orbits and sat. clocks

A-priori coordinates

RINEX files

Receiver clock error

Single difference processing

Cycle slip corrections

Float L3 double difference processing

Ambiguity resolution for L1 and L2

Fixed L3 double difference processing

1991

Velocity calculation

2005

Initialisation

Pre-processing

Processing
GPS horizontal velocities

15+/−0.5mm/yr
Comparison of horizontal velocities with other studies

Horizontal velocities relative to the N-A plate
Comparison of relative horizontal velocities with other studies

GPS vertical velocities
Comparison of vertical velocities with other studies

Conclusions and further works

- The number of common geodetic points was limited between the 1991 and 2005 campaigns
- The quality of the observations of the 1991 GPS campaign was not as good as the 2005 campaign
- Since 2005, the Charlevoix network is resurveyed every 2 years
Acknowledgments

- Stéphanie Bourgon & CRG-GPS group