# Determination of local covariance functions for the prediction of Bouguer gravity anomalies at the Brazil-Argentina Border

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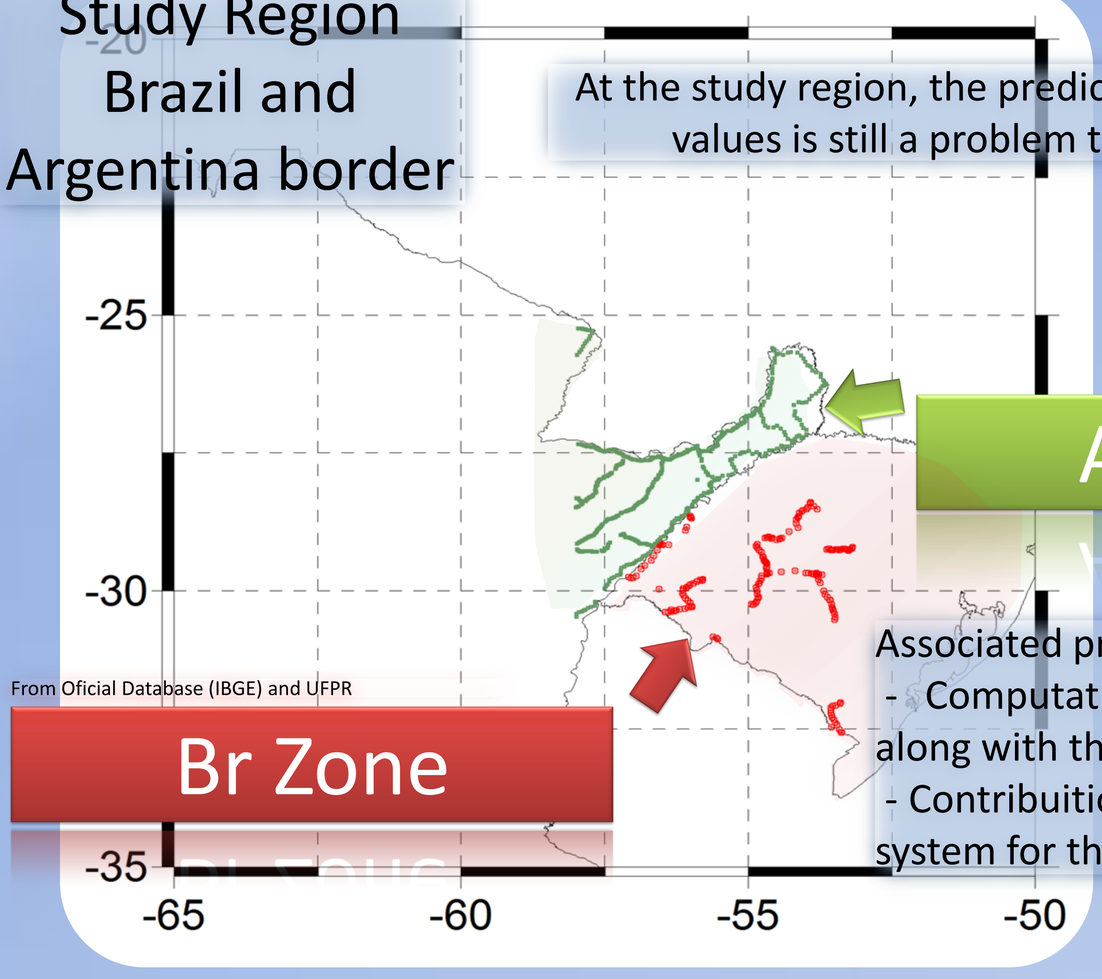
## Study Region
## Brazil and Argentina border



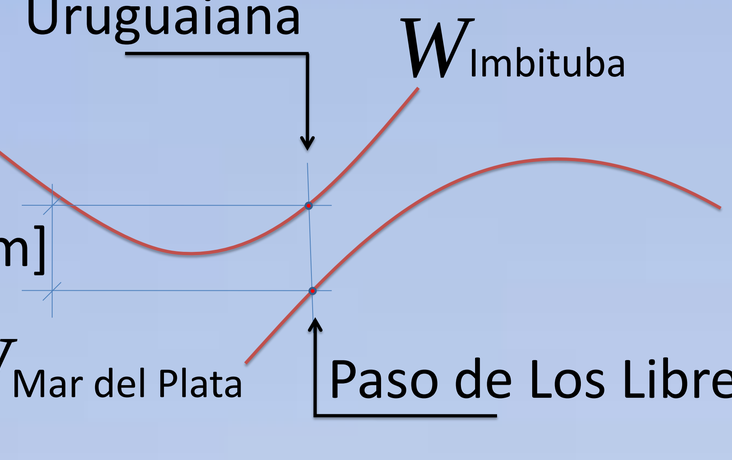

From UNLP and IGN database

From Oficial Database (IBGE) and UFPR

At the study region, the prediction of gravity values is still a problem to solve...

Associated problems:
- Computation of geopotential numbers along with the leveled lines/nets;
- Contribuition to an only Vertical reference system for the whole South America.

The argentine heights were shifted to put both systems in the same reference




*This difference was estimated after a few campaigns realized at the region. To this study, it was considered the same value for all over the region

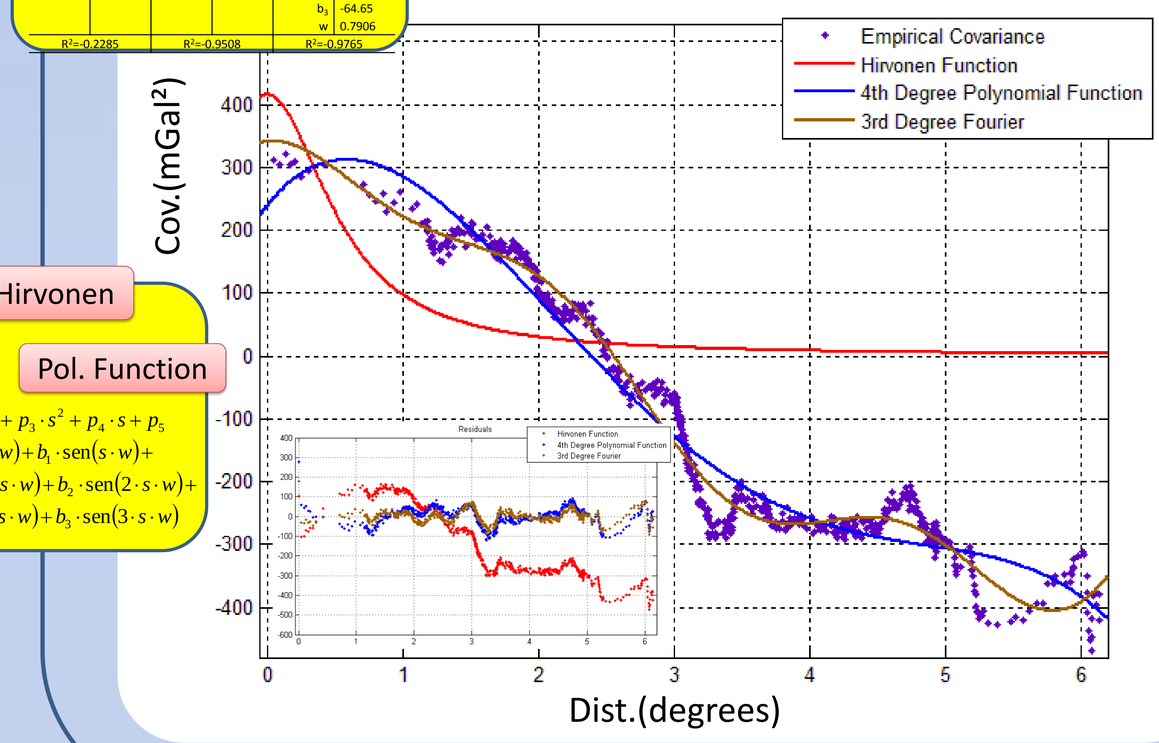
Since there is not an specific local covariance function to predict gravity anomalies at the border between Brazil and Argentina, it was generated a local covariance function from Bouguer gravity anomalies in the LSC context. The anomalies were calculated from official gravity database of Brazilian Institute of Geography and Statistics (IBGE). The work region is at the Rio Grande do Sul State. Gravity data was also provided by the National Geographic Institute (IGN - Argentina).

To integrate the heights of both systems, it was applied a shift of 0.7193 cm to the argentine heights based on extensive field determinations at the study region done by the LARAS group (See also presentation in this meeting). A determination was carried out over benchmark PFA 1XA (P. de Los Libres, Argentina) in Brazilian and Argentine systems.

After the computation of empirical covariance function, some tests were realized. The best results were founded by using a 4th degree polynomial function and a 3rd degree function. The residuals can be seen in the figure at the right side. It was reserved 10 per cent of points for checking.

Also, it was observed a significant difference between the results obtained by the Hirvonen's formula. Particularly the $C_0$ coefficient founded was 415,3 against the coefficient 337 founded on the literature.

| Hirvonen | | 4th degree Pol. Function | | 3th degree Fourier Function | |
|---|---|---|---|---|---|
| $C_0$ | 415.3 | $p_1$ | -4.56 | $a_0$ | -48.56 |
| d | 0.5548 | $p_2$ | 66.42 | $a_1$ | 268.4 |
| | | $p_3$ | -278.5 | $b_1$ | 198.4 |
| | | $p_4$ | 264.6 | $a_2$ | 85.14 |
| | | $p_5$ | 240.3 | $b_2$ | 12.27 |
| | | | | $a_3$ | 35.7 |
| | | | | $b_3$ | -64.65 |
| | | | | w | 0.7906 |
| $R^2$=-0.2285 | | $R^2$=-0.9508 | | $R^2$=-0.9765 | |




Hirvonen

$$COV_1 = \frac{C_0}{\left(1+\left(\frac{s}{d}\right)^2\right)}$$

Pol. Function

$$COV_2 = p_1 \cdot s^4 + p_2 \cdot s^3 + p_3 \cdot s^2 + p_4 \cdot s + p_5$$

Fourier

$$COV_3 = a_0 + a_1 \cdot \cos(s \cdot w) + b_1 \cdot \text{sen}(s \cdot w) + a_2 \cdot \cos(2 \cdot s \cdot w) + b_2 \cdot \text{sen}(2 \cdot s \cdot w) + a_3 \cdot \cos(3 \cdot s \cdot w) + b_3 \cdot \text{sen}(3 \cdot s \cdot w)$$

$$X = \left(A^T A\right)^{-1} \cdot A^T l$$

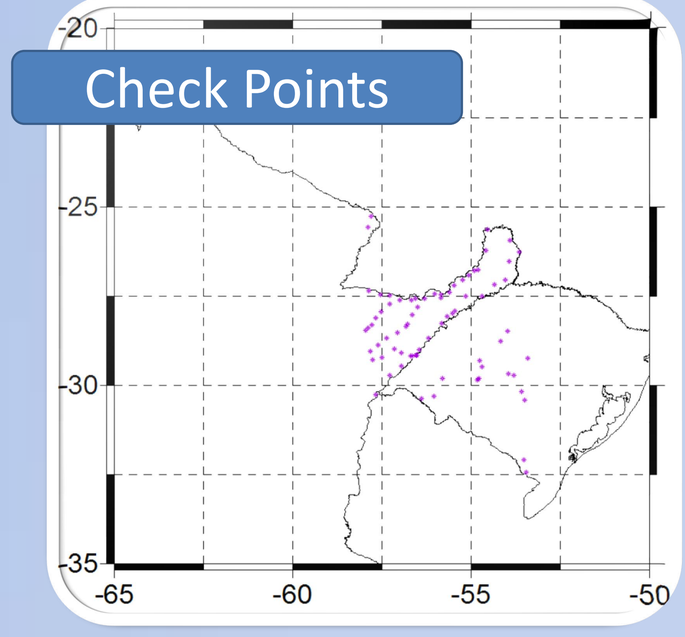
## Results

After applying a 2 sigma filter, the prediction results show a RMS of 1.146 mGal for the 4th degree polynomial function. Doing the same procedure, the 3rd degree Fourier function provides 2.295 mGal. Two and four points were removed for the first and second situation, respectively.

Even though the Fourier function seems to be more adequate for the representation of a complex phenomenon, the polynomial function showed improved results. It is suggested the use of the 4th polynomial function presented for the prediction of gravity anomalies and from them gravity values along with leveling lines in the studied region.

All the programs and routines developed are available at http://www.laras.ufpr.br.

## Check Points




It is pertinent to mention that neither polynomial function nor Fourier function fulfill the positive-definite conditions related to the covariance functions when the subject is the prediction problem. However, the Hirvonen function (a positive-definite function) delivers the worst results

Due to the difficulties presented above, the results from non-positive-definite functions should be subject of further instigation.

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