Covering the GOCE mission polar data gaps - a simulation using gravity gradients and ground gravity.

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Presentation GOCE MAG Jan. 2001.

File: H:\CCTWP\polargap.wpd, date: 2000-12-22

The selected orbit of the GOCE mission creates gaps in the data coverage at the poles. These gaps may however be covered using other data-types such as ground or airborne gravity data. In order to study the influence of adding such data simulations have been performed computing the error-estimates of the spherical harmonic coefficients using different data-combinations.

Least-squares collocation has been used to determine the error-estimates of (correction to) spherical harmonic coefficients as described in (Tscherning, 2000).

Initially a 1 degree approximate equal area data-coverage using T_{zz} at 300 km altitude was used. This resulted in 41000 observations, and a normal-equation (upper triangular) matrix of size 6 GB. It was, however, found that for the type of simulation presented here, a 2-degree coverage was sufficient. This correspond to 12000 observations. The resulting error-estimates are shown in Fig. 1. As in other simulations the increase of the error for the near-zonal coefficients is very significant.

The ground data may be used to calculate upward continued gravity gradients at satellite altitude. Two simulations have then been made, where first the North pole and then the South Pole was filled, see Fig. 2 and 3. We see that in order to really obtain a reduction, data at both poles are needed.

Least-squares collocation permit the combination of data of different types. Simulations were therefore made using ground gravity converted to 2 degree-equal area means and 1 degree equal area means. (In reality point data at 20 km and 10 km altitude was used). The 2-degree gravity data gave a slight improvement, but it was first when the 1 degree data was used that error-estimates similar to the ones obtained using gravity gradients were obtained, see Fig. 4 and 5. Data error estimates of 0.2 mgal standard deviation were used, but this value plays only a minor role. It is the data-coverage which determines the error-estimates.

Conclusion: Gravity data in the Arctic is available and should be used to improve the GOCE solution. A further improvement equivalent to a complete data coverage with gravity gradients is possible if the Antarctic is also covered.

Reference:

Tscherning, C.C.: Computation of spherical harmonic coefficients and their error estimates using Least Squares Collocation. Accepted Journal of Geodesy, 2000.(Also in E2M report).

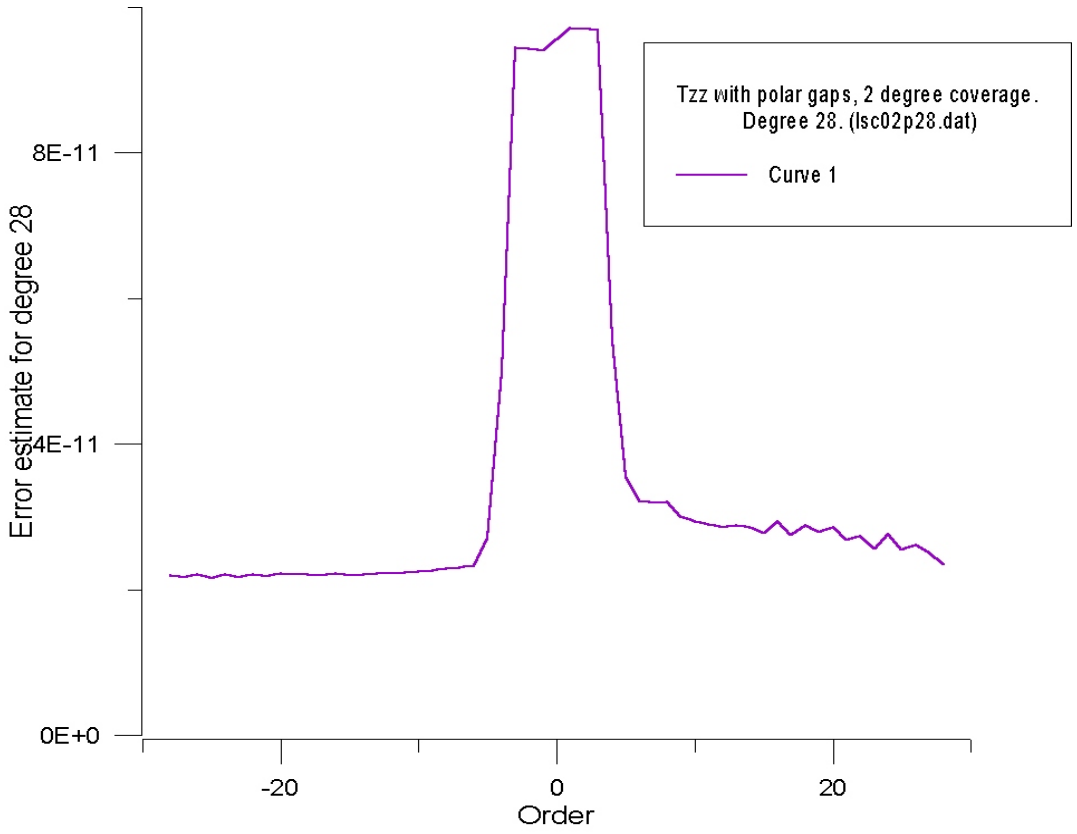

Tzz with polar gaps, 2 degree coverage.
Degree 28. (lsc02p28.dat)
Curve 1
Error estimate for degree 28
8E-11
4E-11
0E+0
-20
0
20
Order

Fig 1.

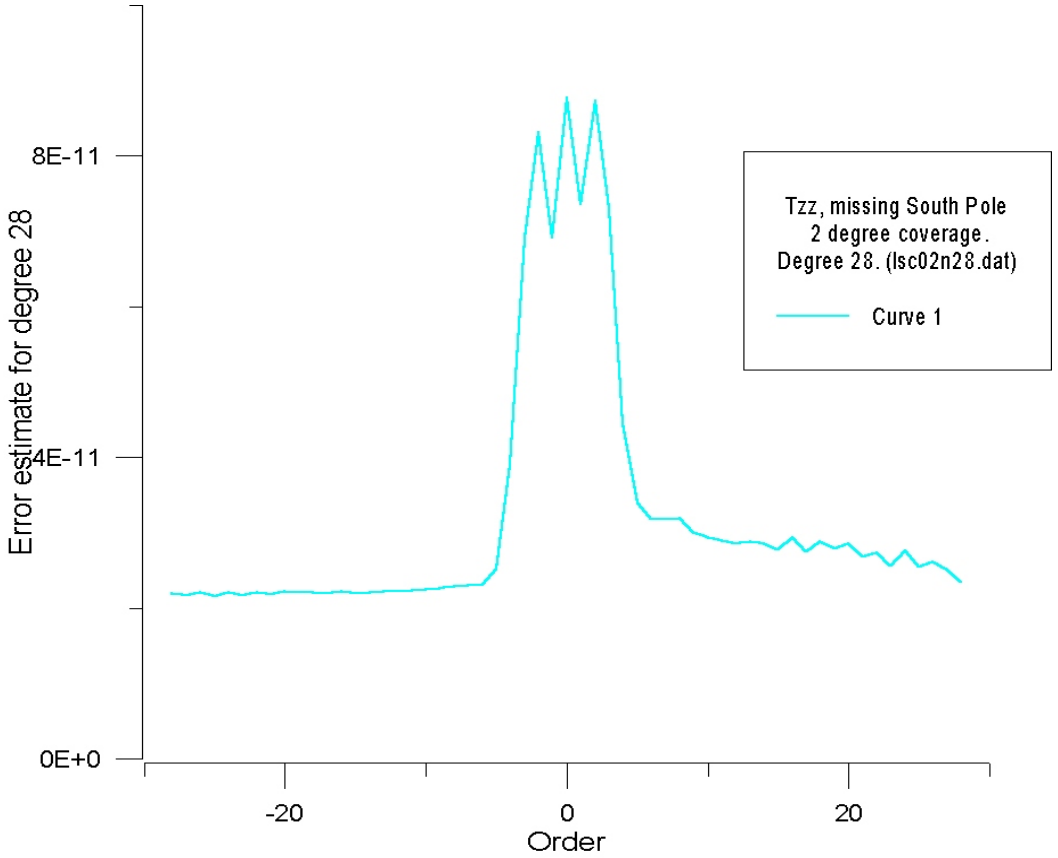

Tzz, missing South Pole
2 degree coverage.
Degree 28. (lsc02n28.dat)
Curve 1
Error estimate for degree 28
8E-11
4E-11
0E+0
-20
0
20
Order

Fig. 2.

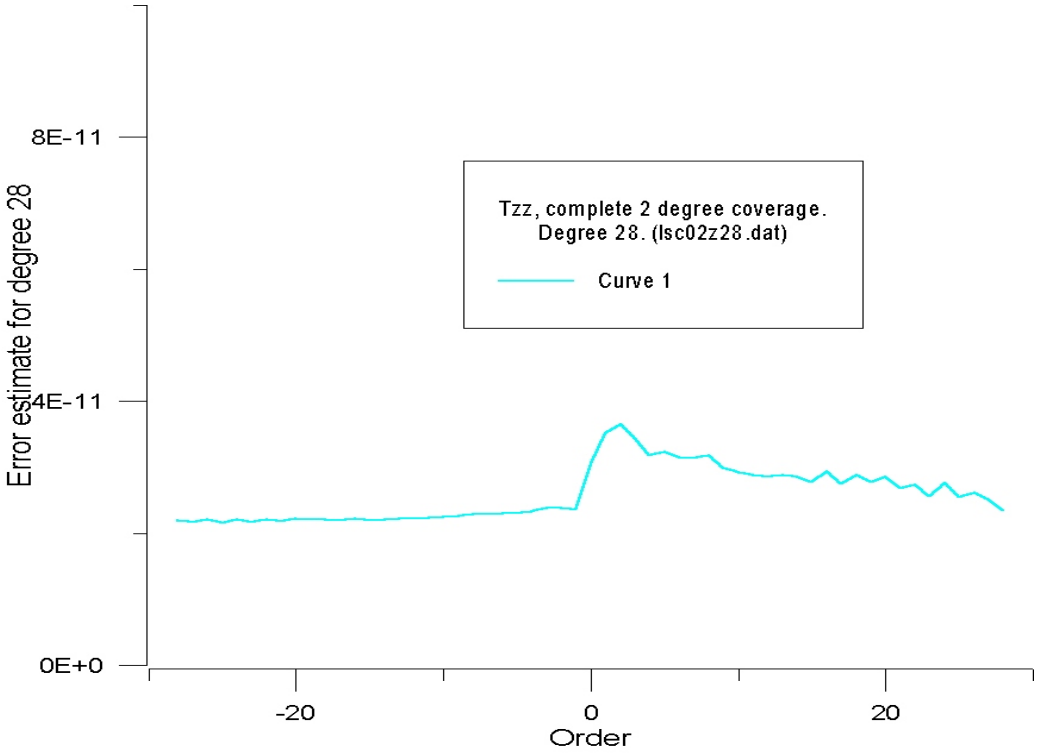

Tzz, complete 2 degree coverage.
Degree 28. (lsc02z28.dat)
Curve 1
Error estimate for degree 28
8E-11
4E-11
0E+0
-20
0
20
Order

Fig. 3.

Fig. 4.

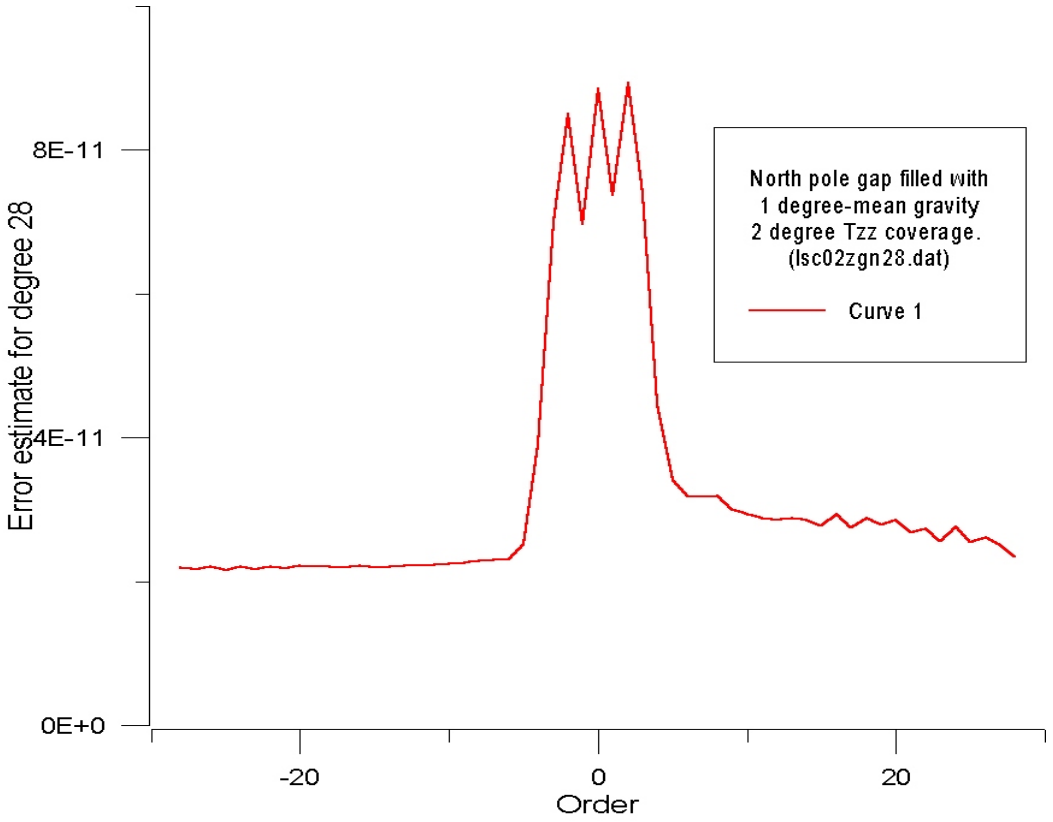
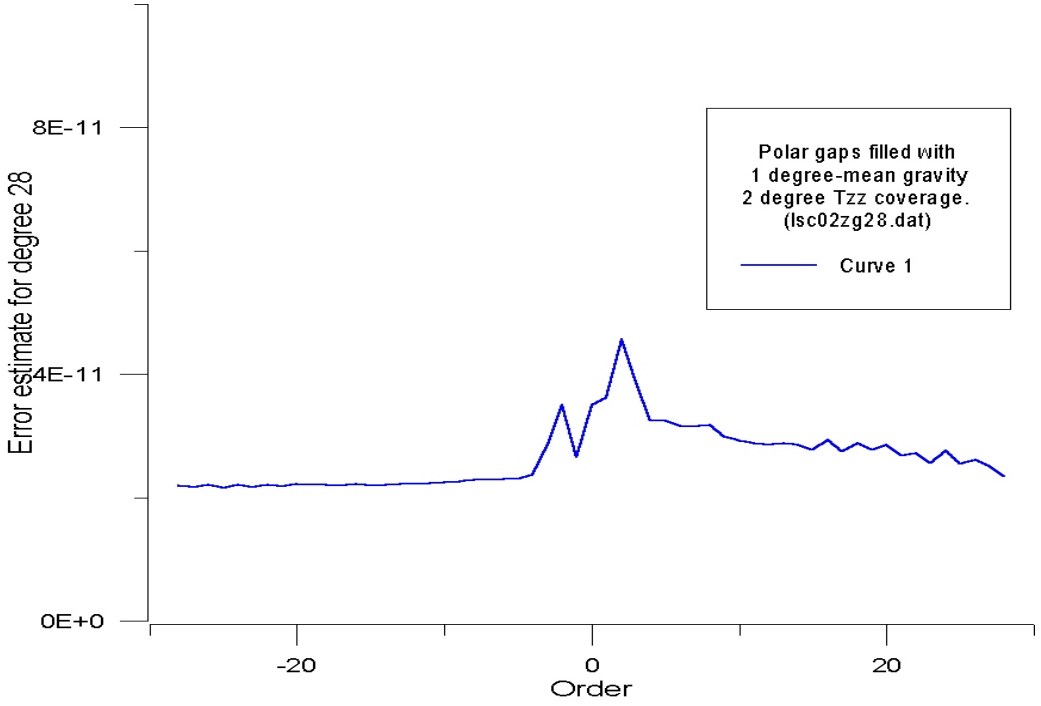

8E-11
4E-11
0E+0
Error estimate for degree 28
-20
0
20
Order
North pole gap filled with
1 degree-mean gravity
2 degree Tzz coverage.
(Isc02zgn28.dat)
Curve 1

Fig. 5.


8E-11
4E-11
0E+0
Error estimate for degree 28
-20
0
20
Order
Polar gaps filled with
1 degree-mean gravity
2 degree Tzz coverage.
(Isc02zg28.dat)
Curve 1