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ESTIMATION OF THE GRAVITY CHANGES INDUCED BY THE OCEAN MASS VARIATIONS

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Introduction

The recent progresses of the precise gravity measurements using superconducting gravimeters(SG) and absolute gravimeters enable us to observe very weak gravity signals induced by the various kinds of dynamic processes in and on the Earth. Because gravity changes reflect actual mass movements, the data of gravity measurements give us useful information to understand the dynamic processes of the Earth. In our previous work, we estimated the gravity changes induced by the sea level variations. Although the results obtained suggested that the gravity effects due to the ocean variation reaches 2 to 3 micro Gals, the amount was still too small to be detected clearly by actual gravity observations so far.

Recently, we have found a clear evidence of the gravity effects of the sea level variations in the annual gravity changes observed by superconducting gravimeters. It is considered that main sources of the annual gravity changes are the effects of solid tide, ocean tide and polar motion. However the gravity values predicted from these effects do not explain the observed values, and the residuals can be explained by the SSH effects. Furthermore, there is a possibility to estimate a steric coefficient which is the ratio of SSH divided by SST(Sea Surface Temperature) variations.

This fact suggests that the gravity observations give constraints about the ocean mass transportation. The same idea is in the several satellite gravity missions which are now under planning and some of them will soon be realized. Thus we also estimated the gravity effects of the SSH variations at the satellite orbit height level. Although the spatial coverage of the satellite gravity measurements are much superior than the ground measurements, the ground measurements are still important because of their high precision and temporal sampling rate. We will show the gravity effects, which are caused by the same SSH variations, both at ground and at the satellite orbit level.

The same investigation has been carried out for gravity effects of the atmospheric pressure and soil moisture variations as well.

Data Handling (Ocean)

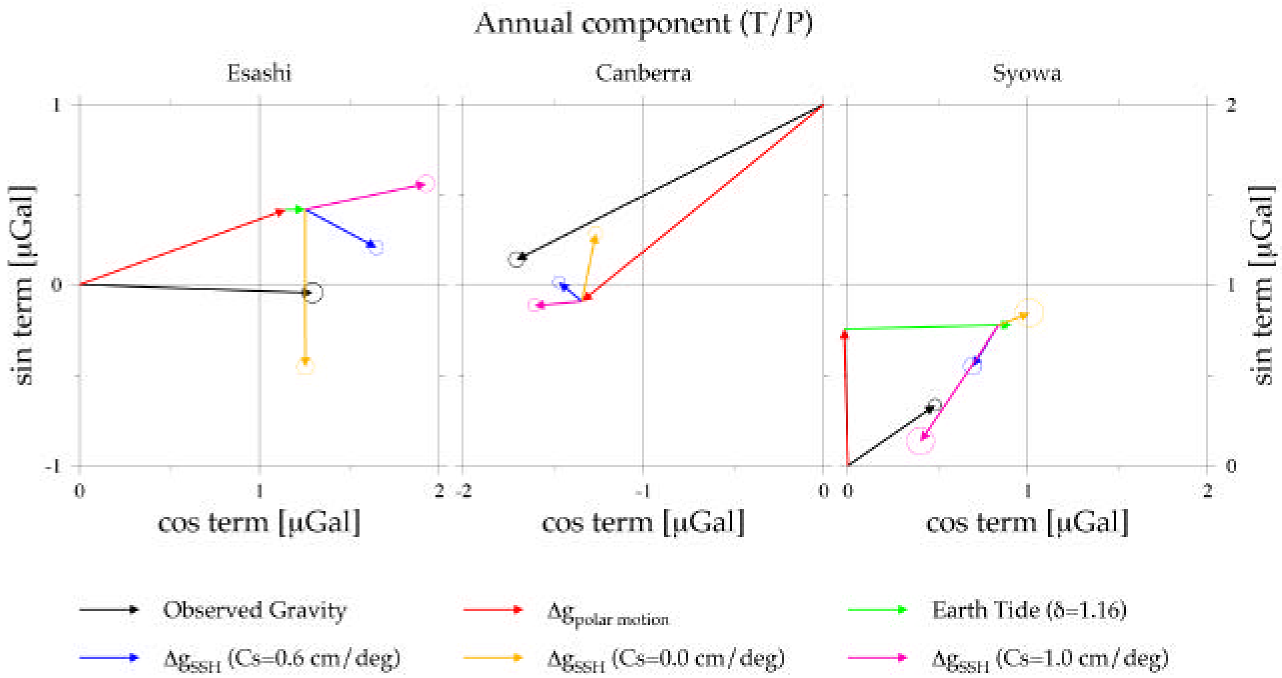
- *Estimation of mass changes*
  - POCM SSH and SST data sets are employed.
  - Steric parts of the SSH variations are removed using the SST data with constant coefficient of 0.6 cm/deg.
  - Mass conservation is attained so as the total ocean mass after the steric correction to be constant.
- *Calculation of Gravity*
  - Newtonian and loading effects of SSH variations are evaluated by a computer program "GOTIC"
  - Gravity effects are calculated on land areas at 5 deg x 5 deg grids.
- *Verification using SG data*
  - Annual component of the SSH effects are compared with SG data.
- *Calculation of Geoid*
  - SSH variations are expanded into spherical harmonic coefficients upto 96 degrees.
  - The effects on the Geoid heights are calculated using elastic Love numbers.

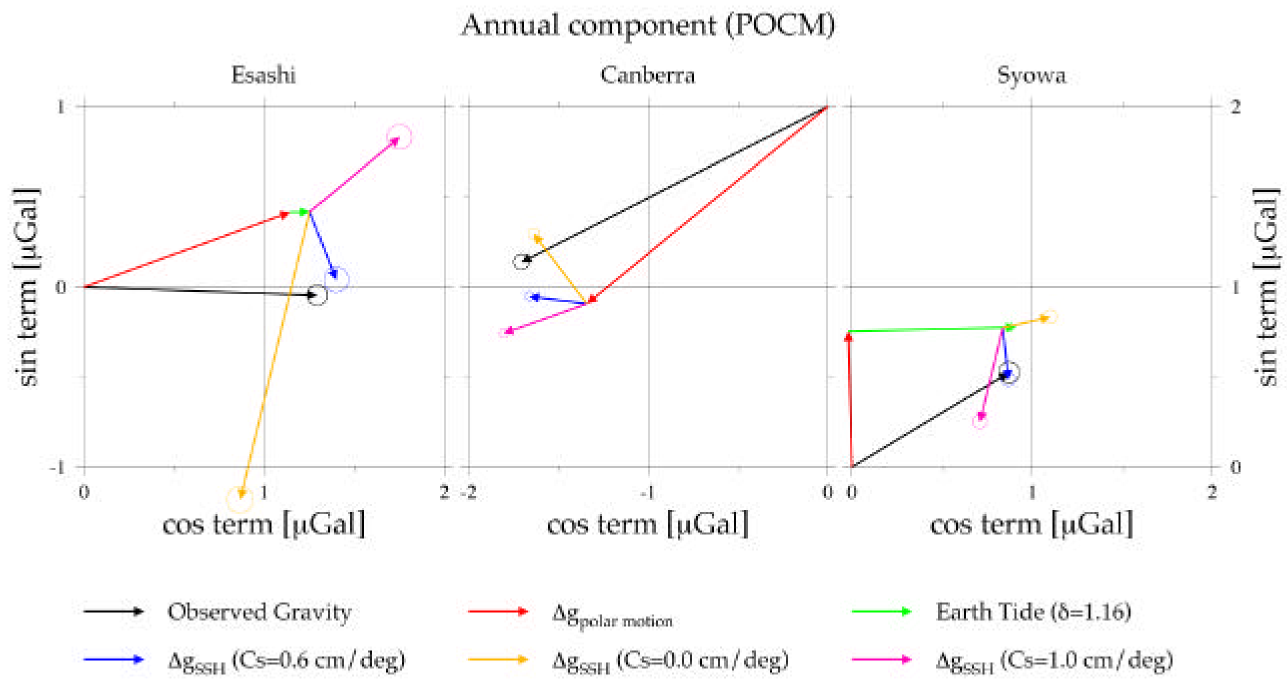
Data Handling(Others)

- *Surface Pressure*
  - NCEP/NCAR reanalysis CDROMs from 1978 to 1997 (20 years) are employed
  - Monthly average are employed to calculated the effects of long term variations
  - Every 6 hours data in 1995 are employed to calculated the short term effects.
  - Effects of the Geoid heights are calculated using spherical harmonic expansion technique with elastic Love numbers.
  - Both IB and NIB cases are evaluated.

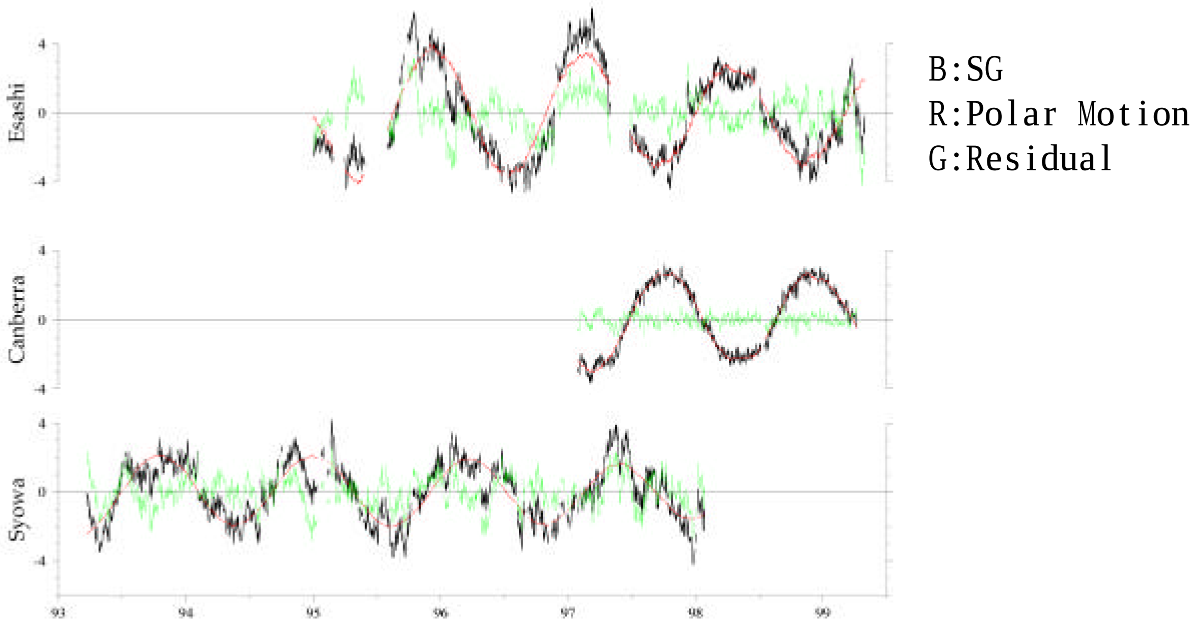
- *Soil Moisture*
  - Monthly average values of 200 cm soil moisture data from NCEP/NCAR reanalysis CDROMs (1978 - 1997) are employed.
  - The soil moisture data are converted to the equivalent water thickness using a constant depth of 65cm.
  - Mass conservation i s attained so as to the excess mass is uniformly distributed in ocean.
  - The same procedure is employed for the calculation of the Geoid heights variations.

Effects of the SSH Variation on The Annual Gravity Changes

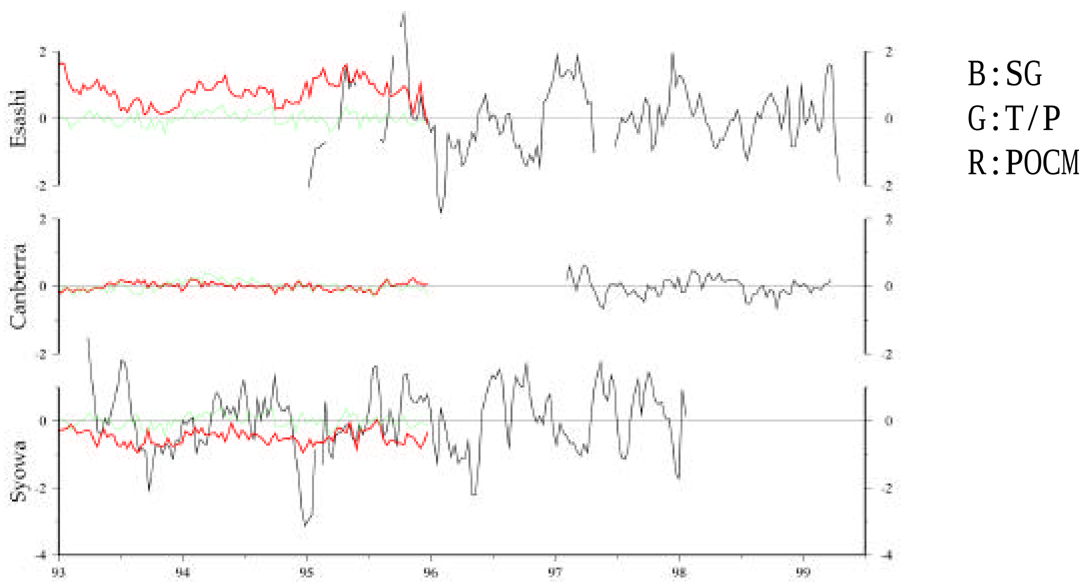




SSH Variation & Gravity Changes

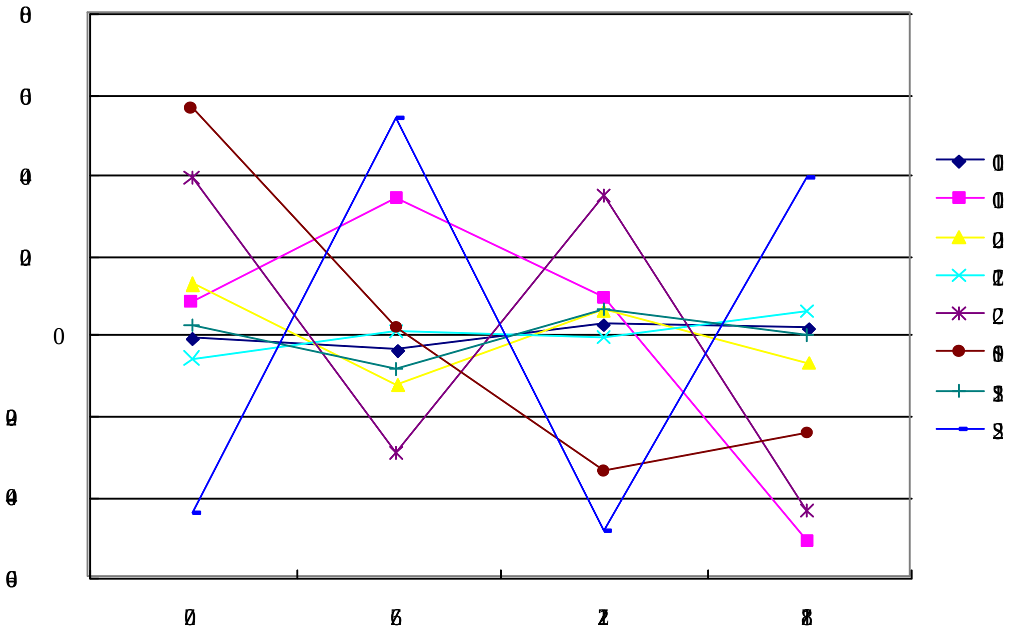


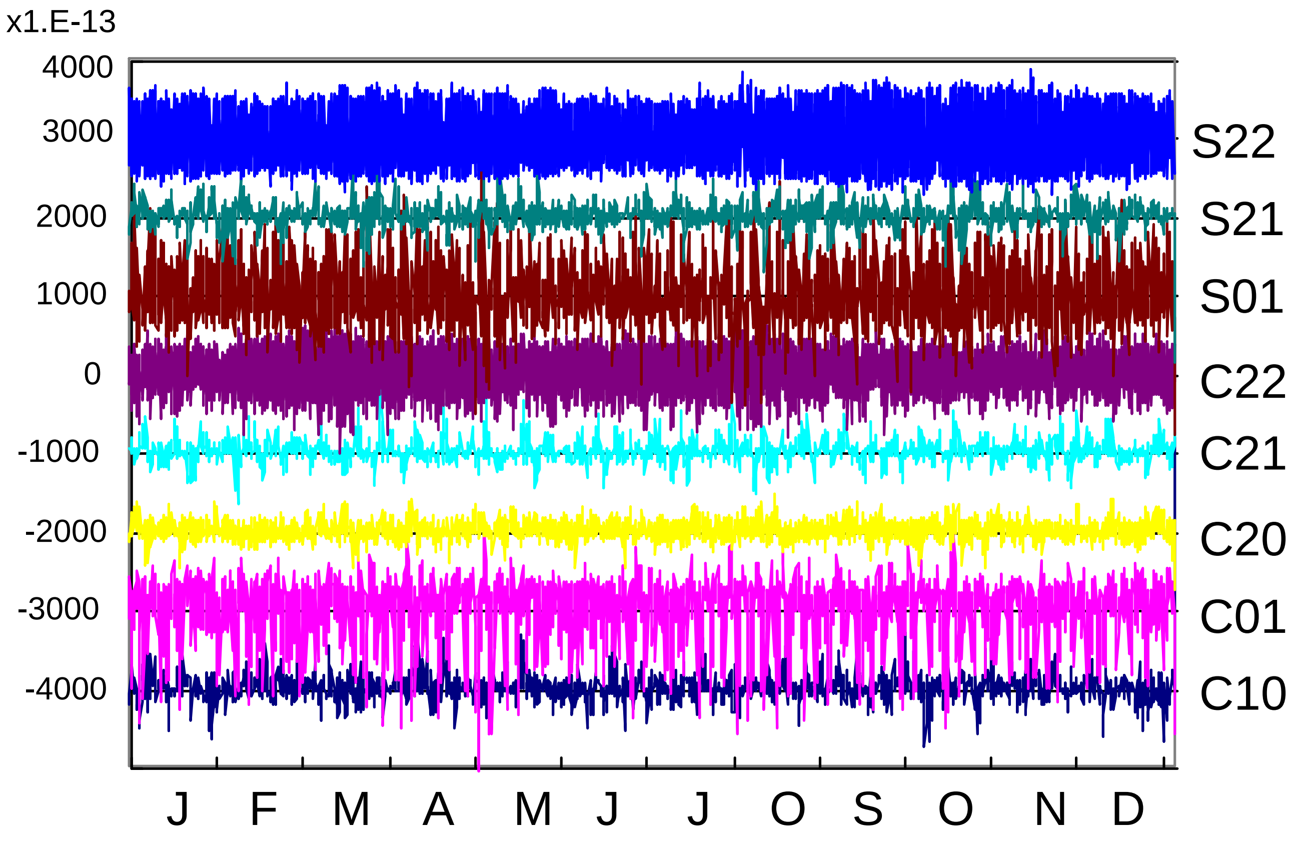
Gravity Changes due to Chandler polar motion



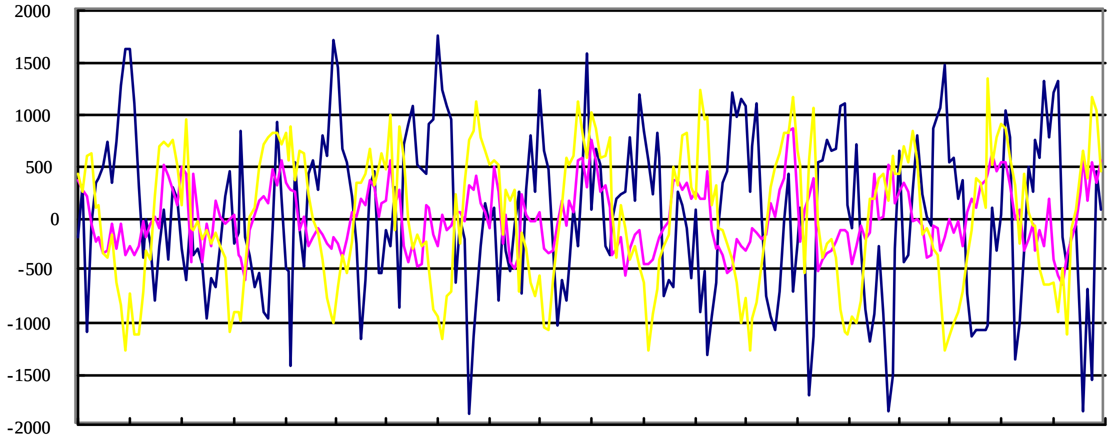
Residual Gravity Changes and Ocean effects

Time Variations of the Spherical harmonic coefficients (atmospher -short period)

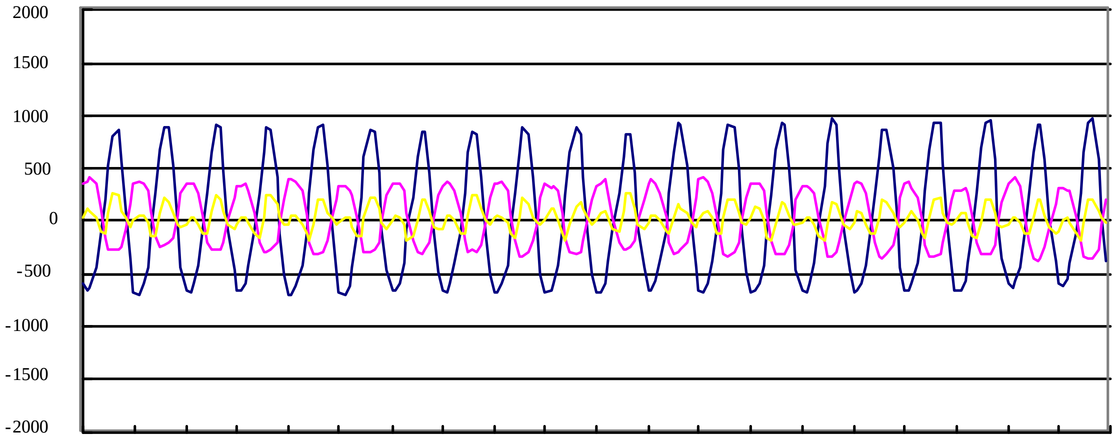




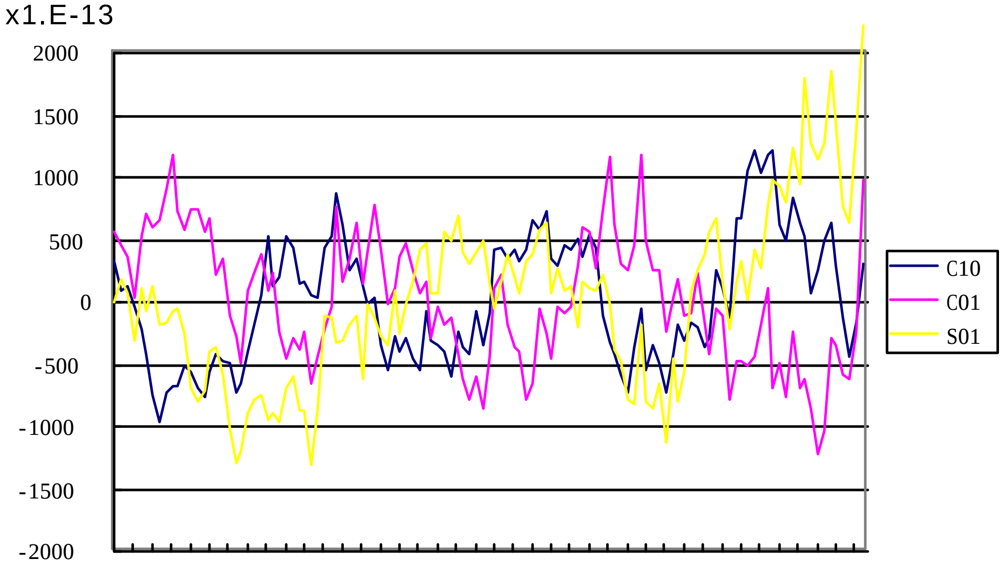
Time Variations of the Spherical harmonic coefficients (Long period)



Atmosphere (IB) 1978-1997

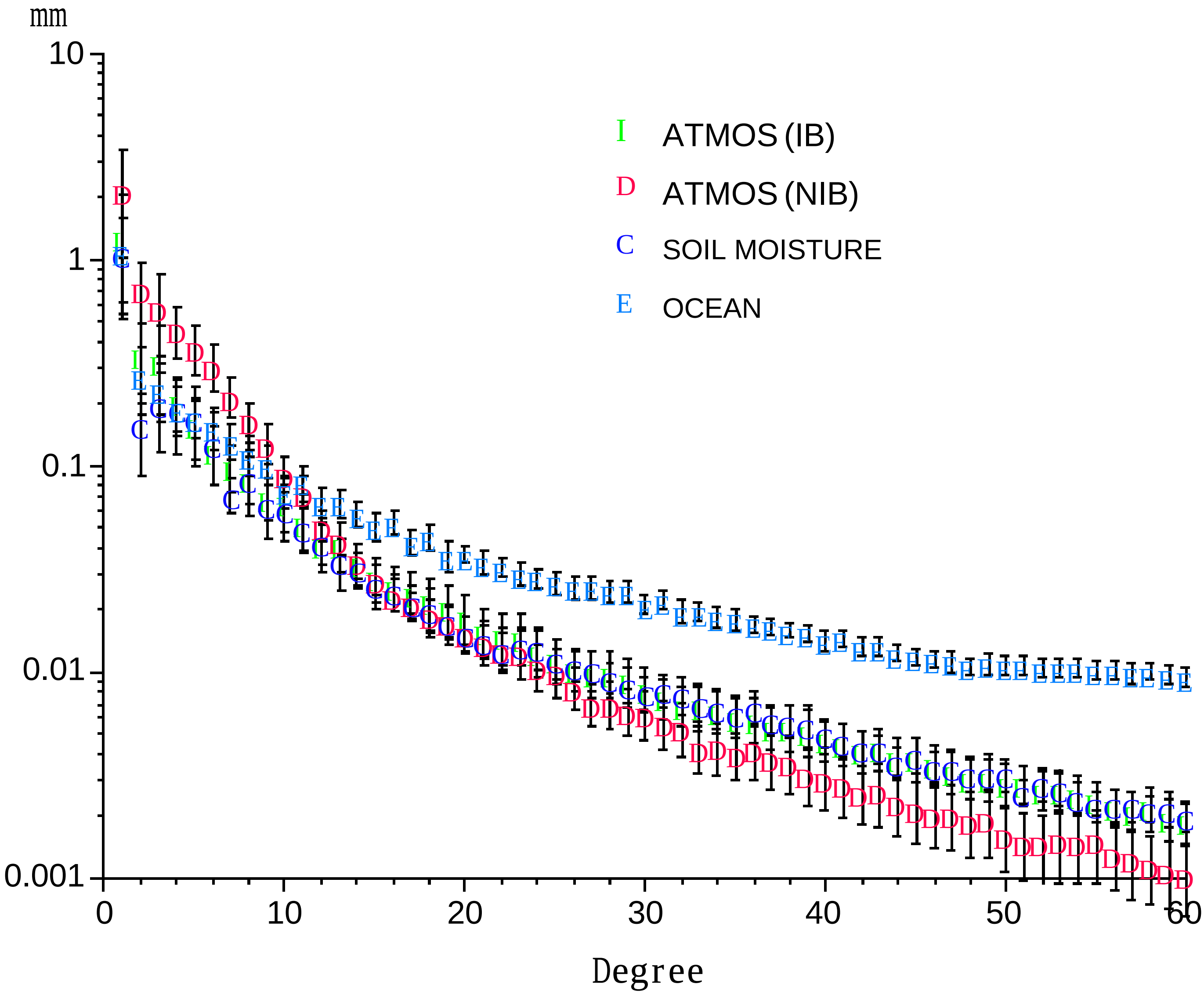


Soil Moisture 1978-1997



Ocean 1992.10-1995.12

Degree amplitudes



Degree amplitudes of the varying geoid signals