



Australian Government

Geoscience Australia



Evaluating the Effect of Atmospheric Gravity and the Annual Gravity Field Variation on Lageos Orbits

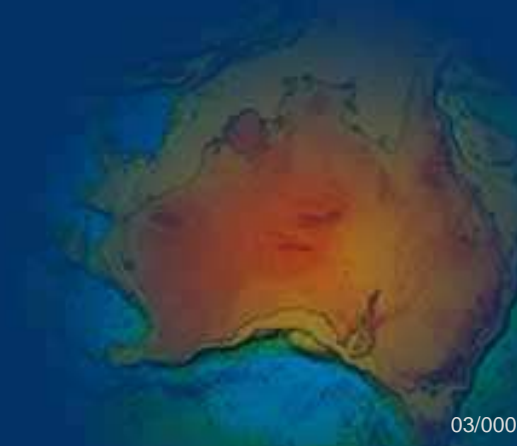
Ramesh GOVIND (Geoscience Australia)

Frank LEMOINE (NASA/GSFC)

Nikita ZELENSKY (SGT)

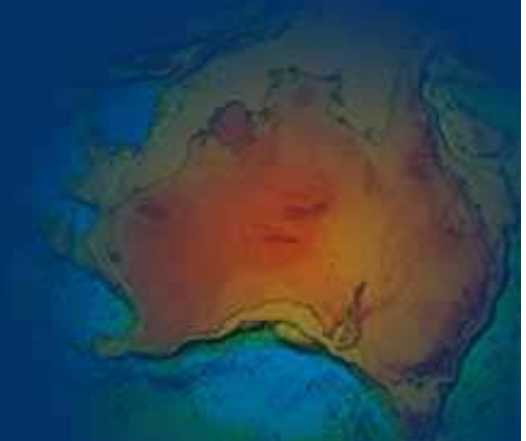
Scott LUTHCKE (NASA/GSFC)

**ILRS Fall Workshop
25th September 2007
Grasse**



Overview

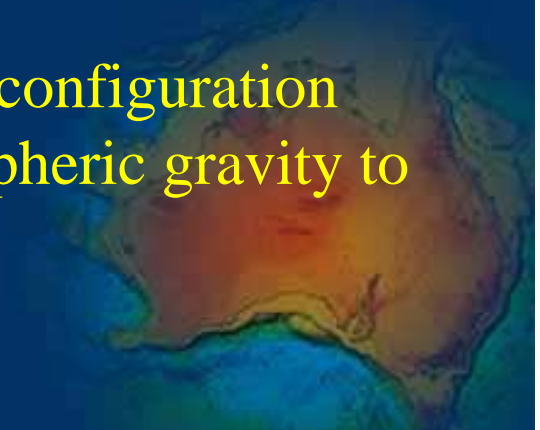
- Introduction
- Atmospheric Gravity
 - Lageos-1, spectrum, geographical correlation
 - Lageos-2, spectrum, geographical correlation
- Annual Gravity Field Variation
 - Lageos-1, spectrum, geographical correlation
 - Lageos-2, spectrum, geographical correlation
- Atmospheric Gravity
 - Geocentre Motion
- Annual Gravity Field Variation
 - Geocentre Motion
- Summary of Results



Introduction

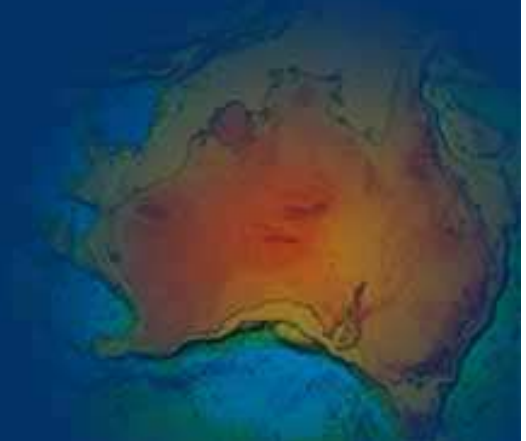
Lageos-1 and Lageos-2 computations 2002 – 2007.5

- Case01
 - Geodyn0511
 - IERS2003 Conventions for Earth and Ocean Tides
 - GGM02C + time varying gravity
 - Standard modelling
 - Standard parameter estimates
- Case02
 - Added Atmospheric Gravity to the Case01 configuration
 - Case01-Case02 gave contribution of atmospheric gravity to the Lageos solutions



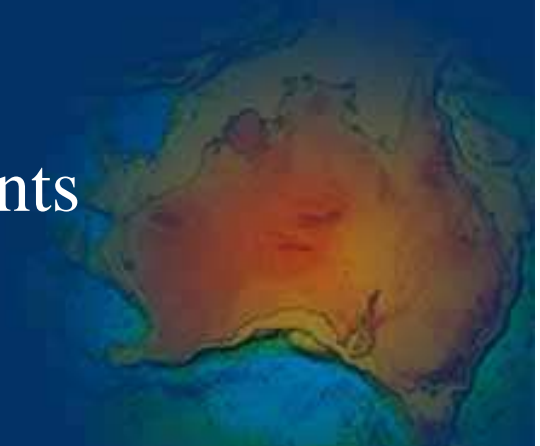
Introduction

- Case03
 - Added Atmospheric Gravity to Case02 configuration
 - Case02-Case03 gave contribution of annual variable gravity to the Lageos solutions
- Analysis
 - Orbit spectrum of the differences
 - Geographical Correlation
 - Geocentre Motion

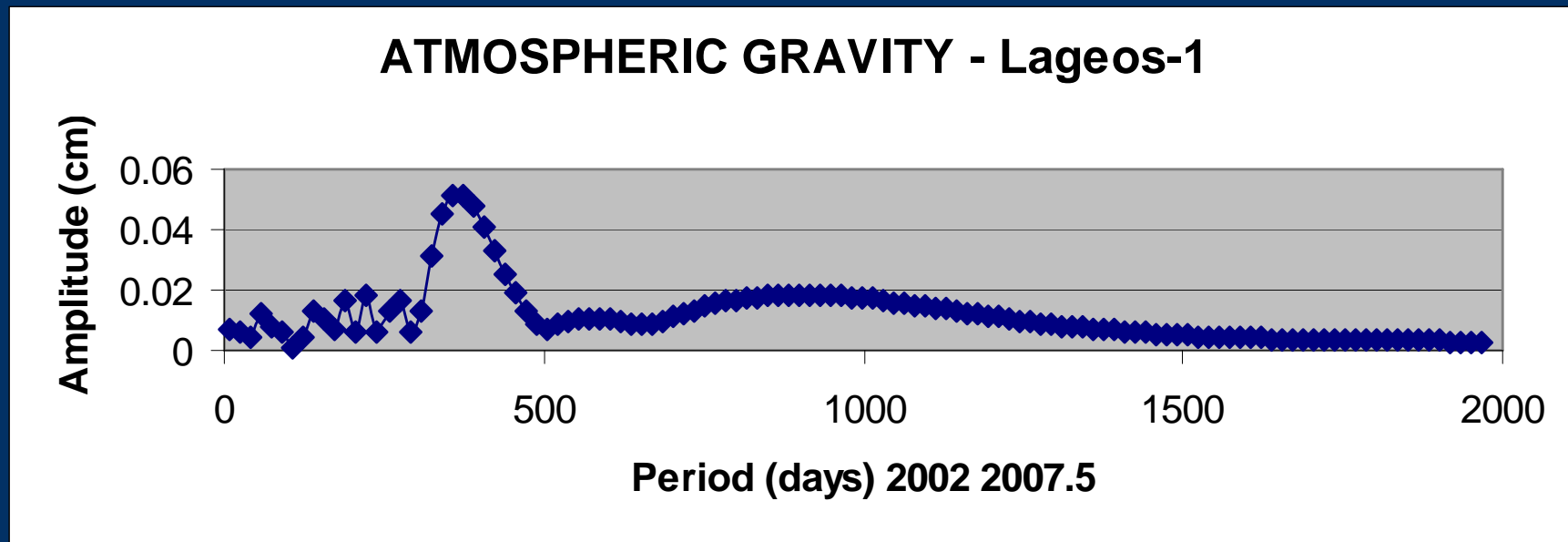


ATGRAV and Annual Gravity Field Variation

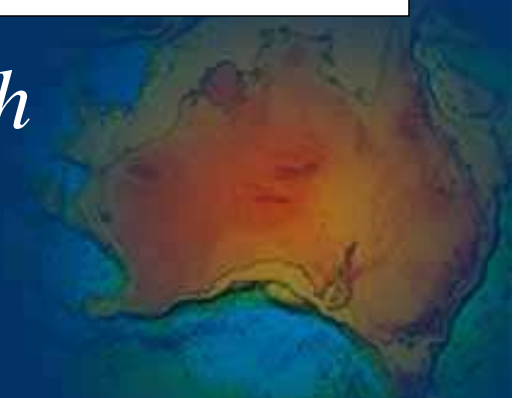
- Atmospheric Gravity
 - NCEP 6-hourly data files
 - 50 X 50 spherical harmonic coefficients
 - Compiled by Petrov.
- Annual Gravity
 - Grace GGM02C solution
 - 20 X 20 spherical harmonic coefficients



ATGRAV Lageos-1 orbit spectrum



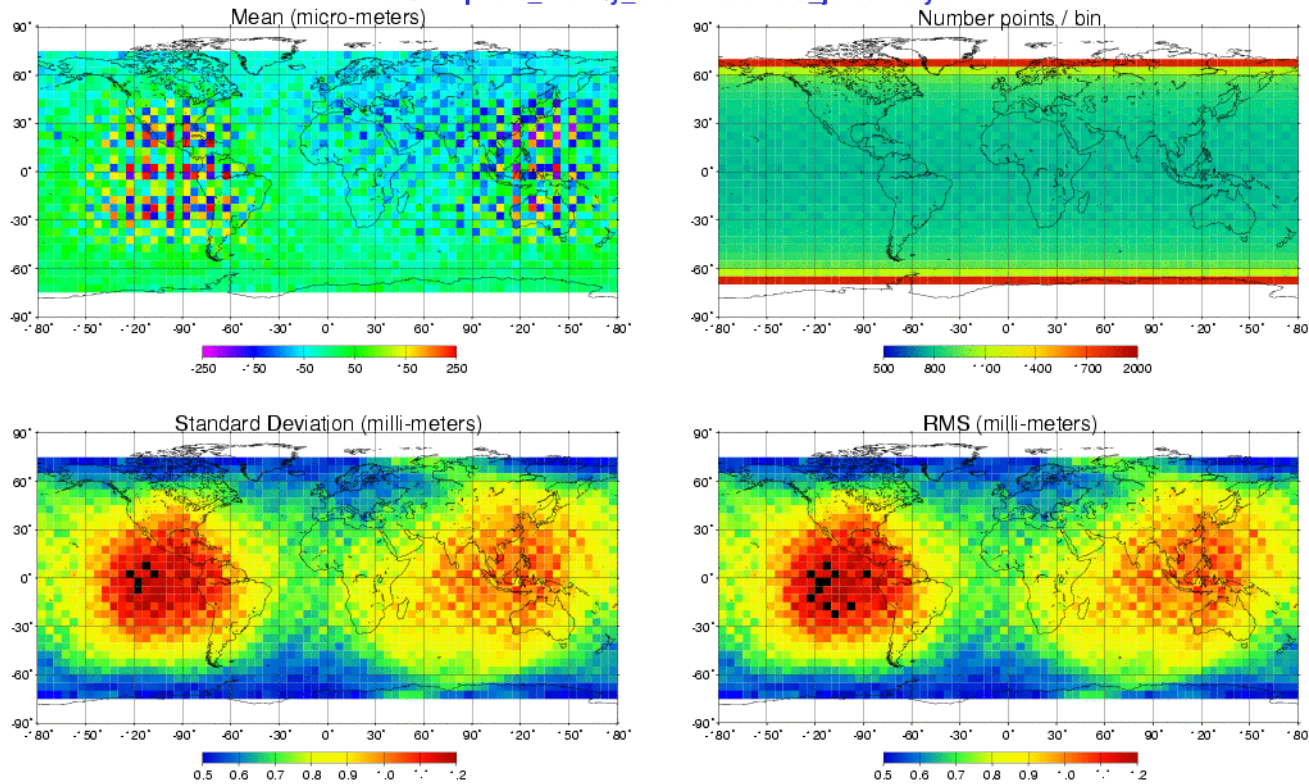
*Annual Period dominant with
0.5 mm amplitude*



ATGRAV Lageos-1 Radial Orbit Differences Geographical Correlation

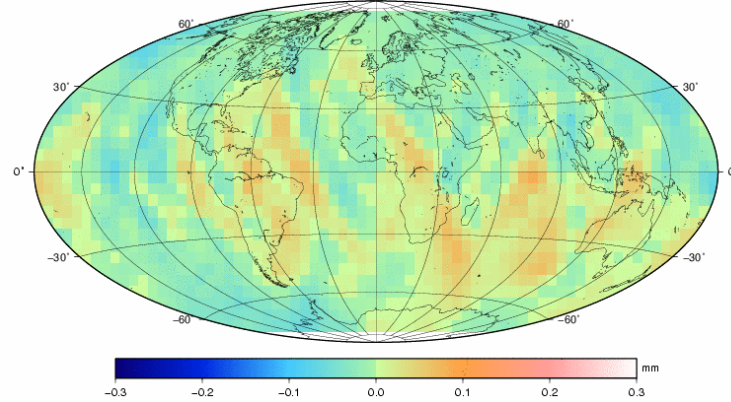
LAGEOS1 radial orbit differences 5x5 degree latitude/longitude bins

Atmosphere_Gravity_nomodel-model_jan02-may07

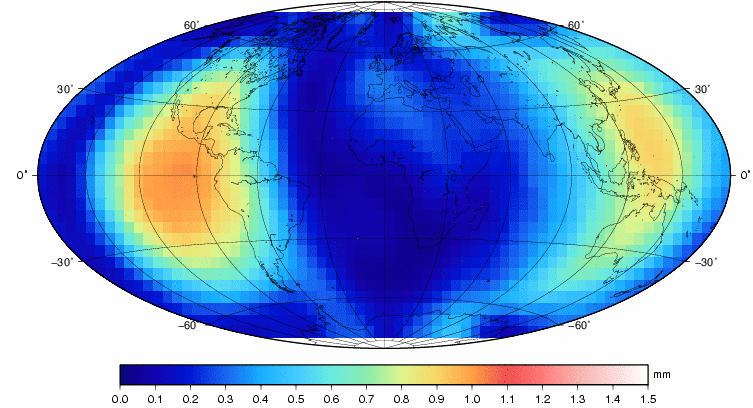


ATGRAV Lageos-1 Radial Orbit Differences

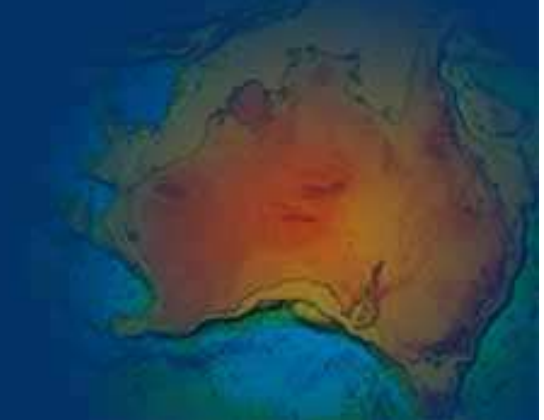
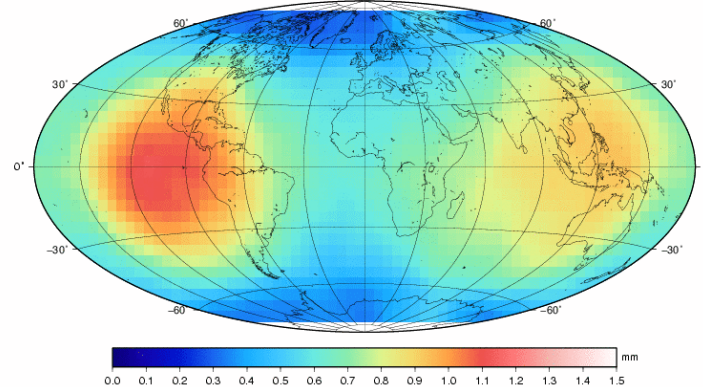
Lageos Mean Radial Diff. (020106-070107); gdn0511_1-gdn0511_2



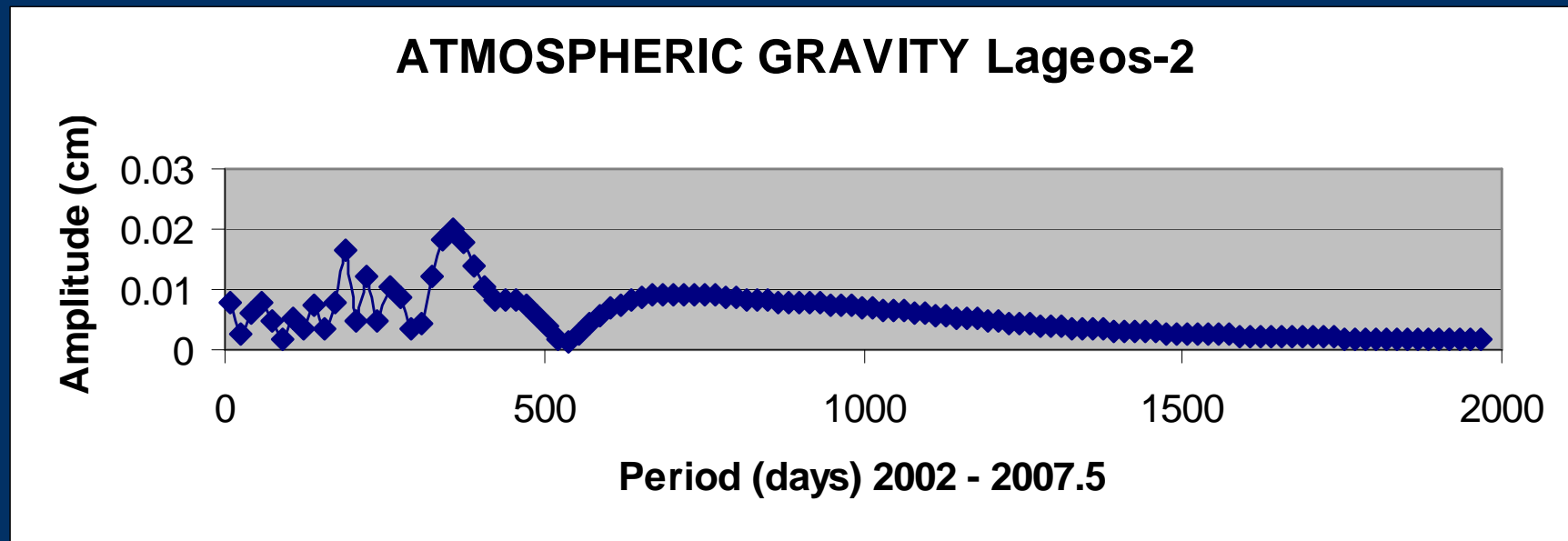
Lageos Radial Diff. (020106-070107) Annual Amp.; gdn0511_1-gdn0511_2



Lageos RMS Radial Diff. (020106-070107); gdn0511_1-gdn0511_2



ATGRAV Lageos-2 orbit spectrum



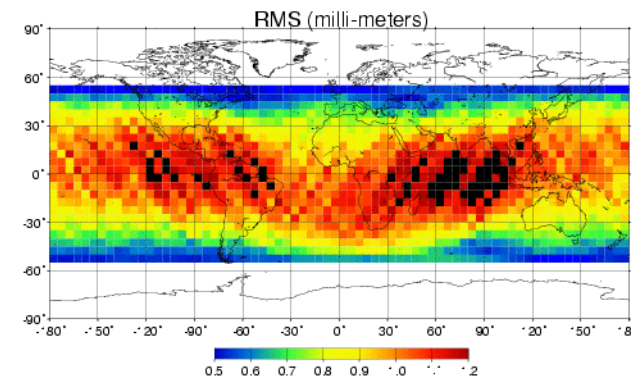
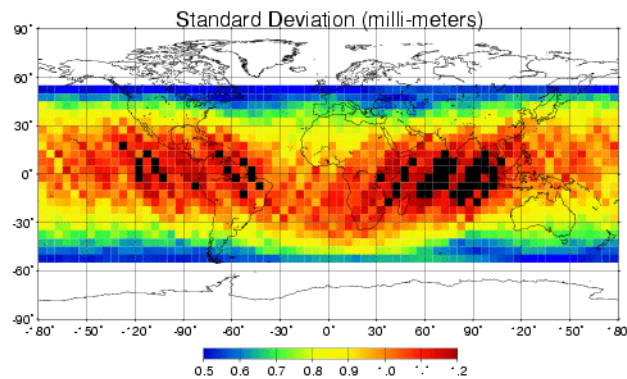
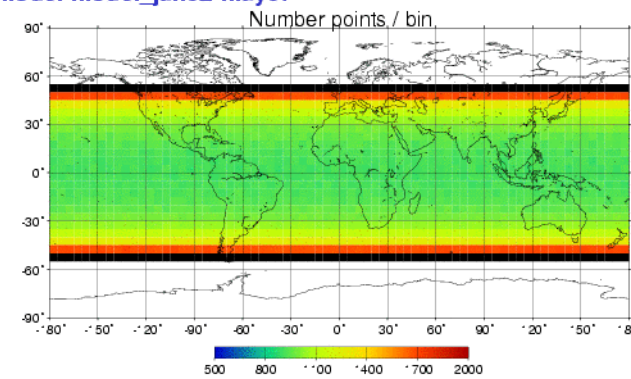
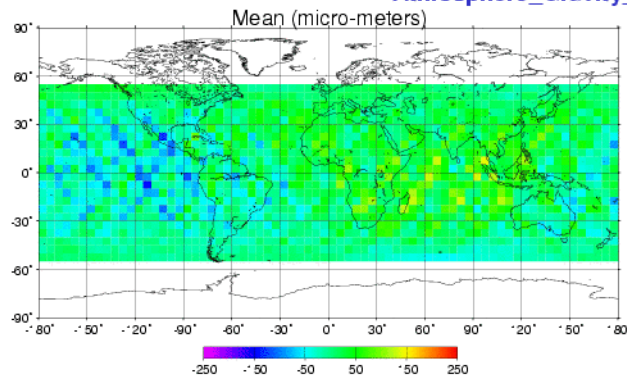
*Annual Period dominant with 0.2 mm amplitude and half-yearly
with a 0.15 mm amplitude*



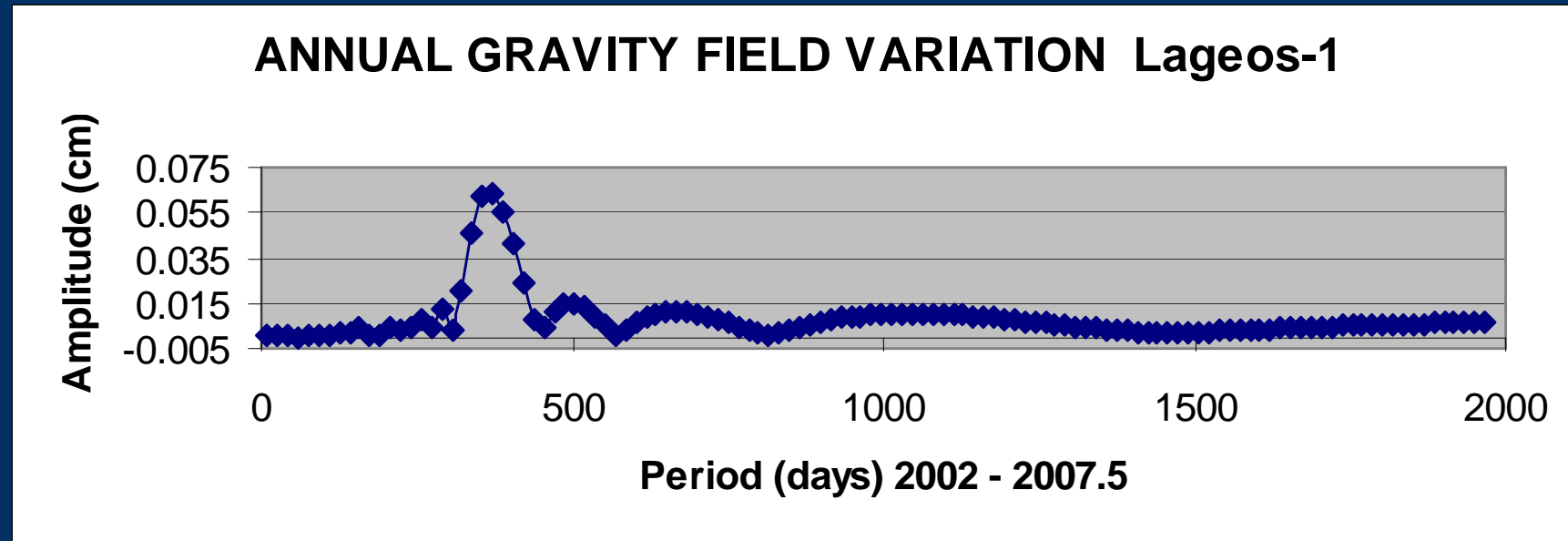
ATGRAV Lageos-2 Radial Orbit Differences Geographical Correlation

LAGEOS2 radial orbit differences 5x5 degree latitude/longitude bins

Atmosphere_Gravity_nomodel-model_jan02-may07



Annual Gravity Lageos-1 orbit spectrum

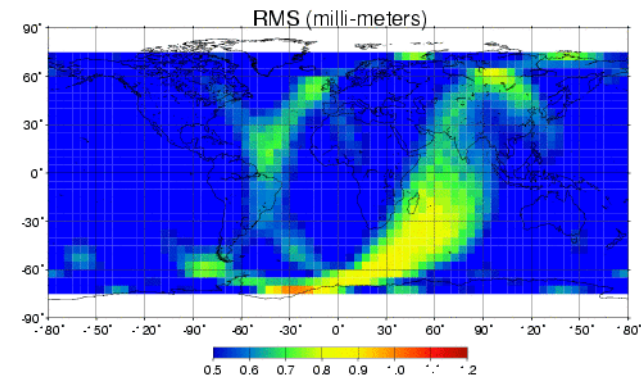
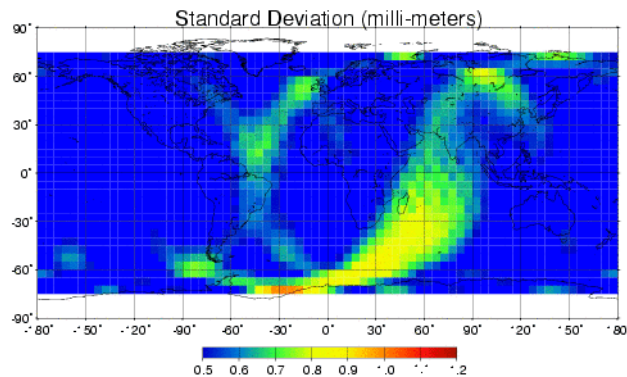
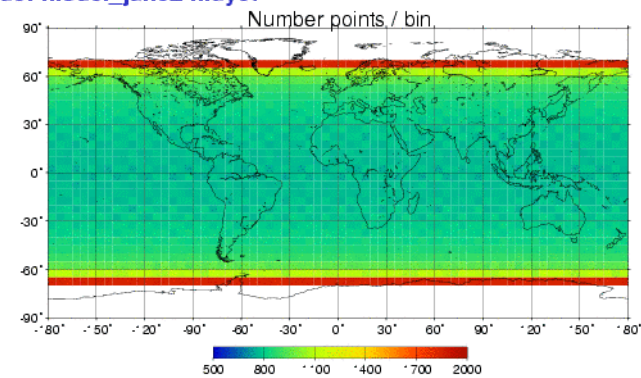
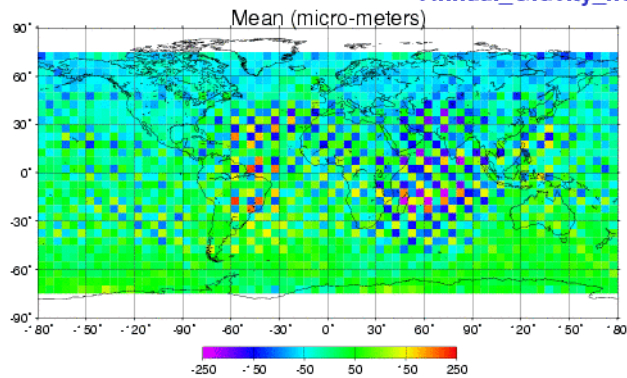


Annual Period dominant with 0.6 mm amplitude

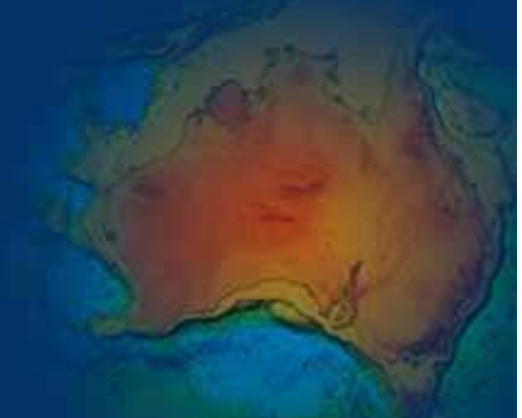
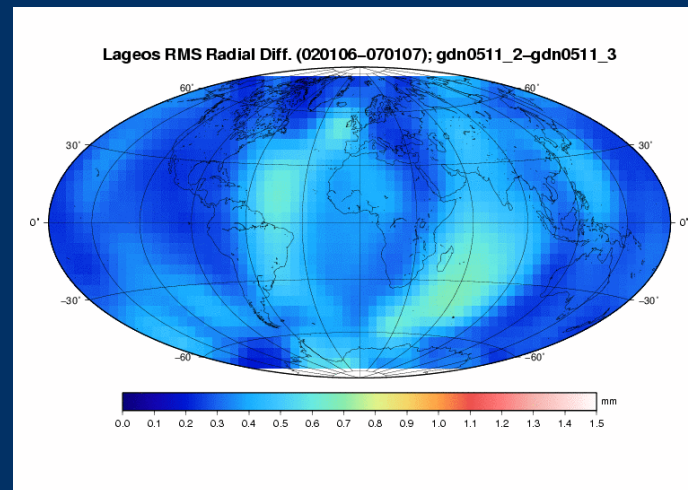
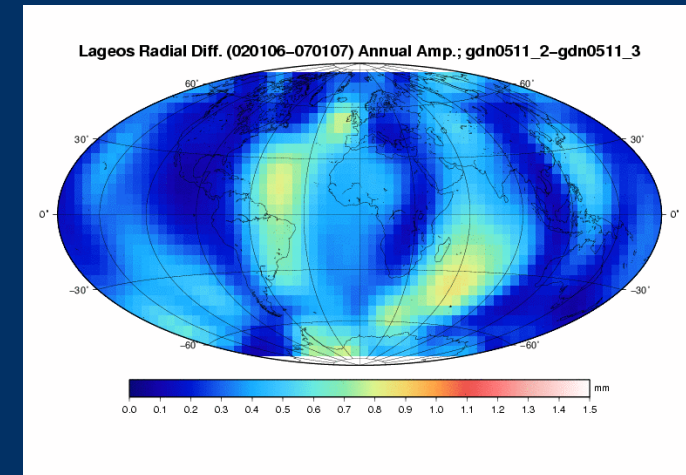
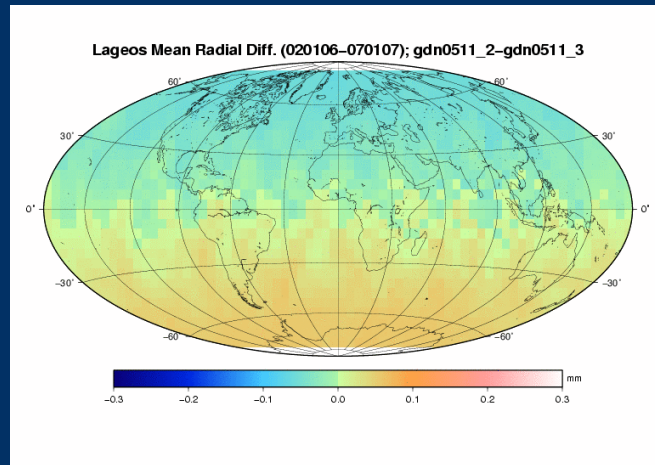
ANNGRAV Lageos-1 Radial Orbit Differences Geographical Correlation

LAGEOS1 radial orbit differences 5x5 degree latitude/longitude bins

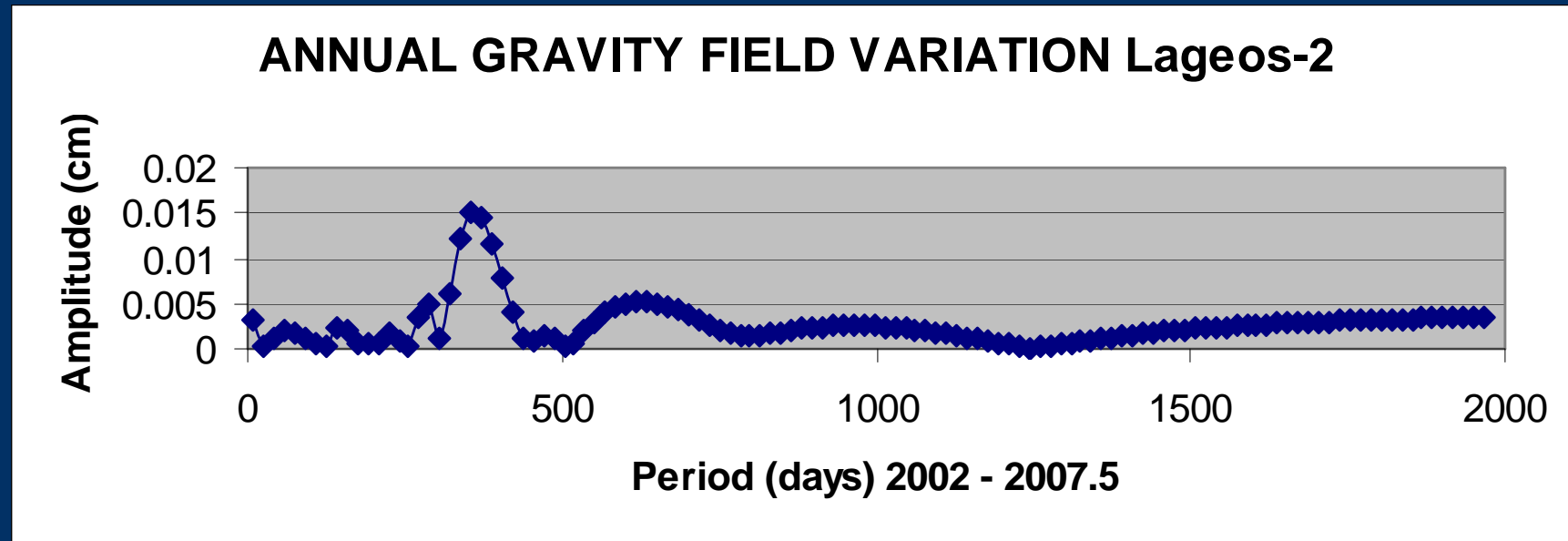
Annual_Gravity_nomodel-model_jan02-may07



ANNGRAV Lageos-1 Radial Orbit Differences



Annual Gravity Lageos-2 orbit spectrum



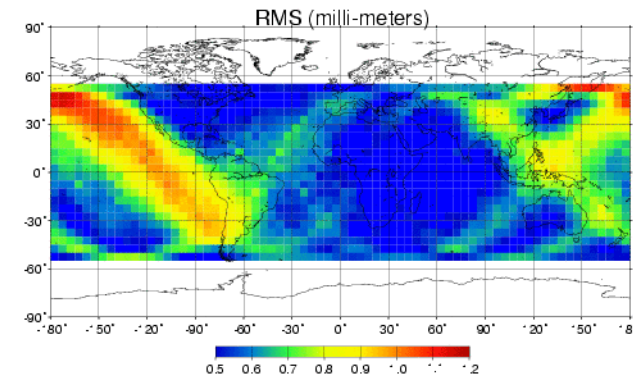
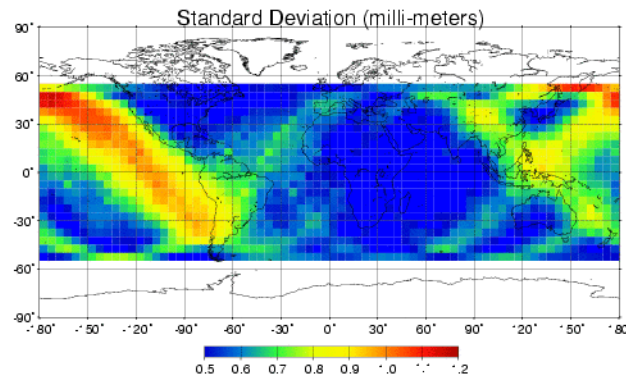
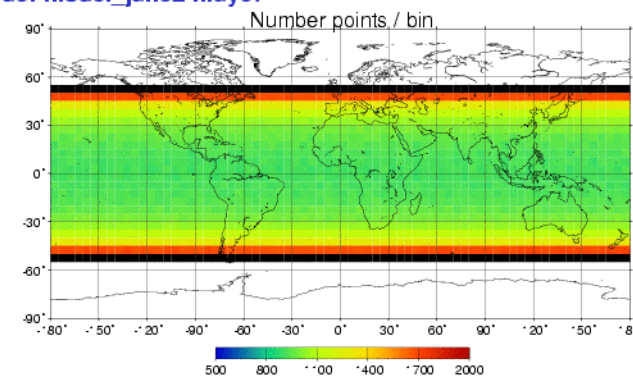
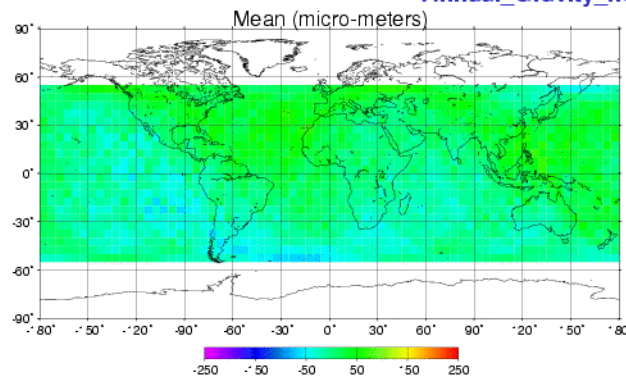
Annual Period dominant with 0.15 mm amplitude



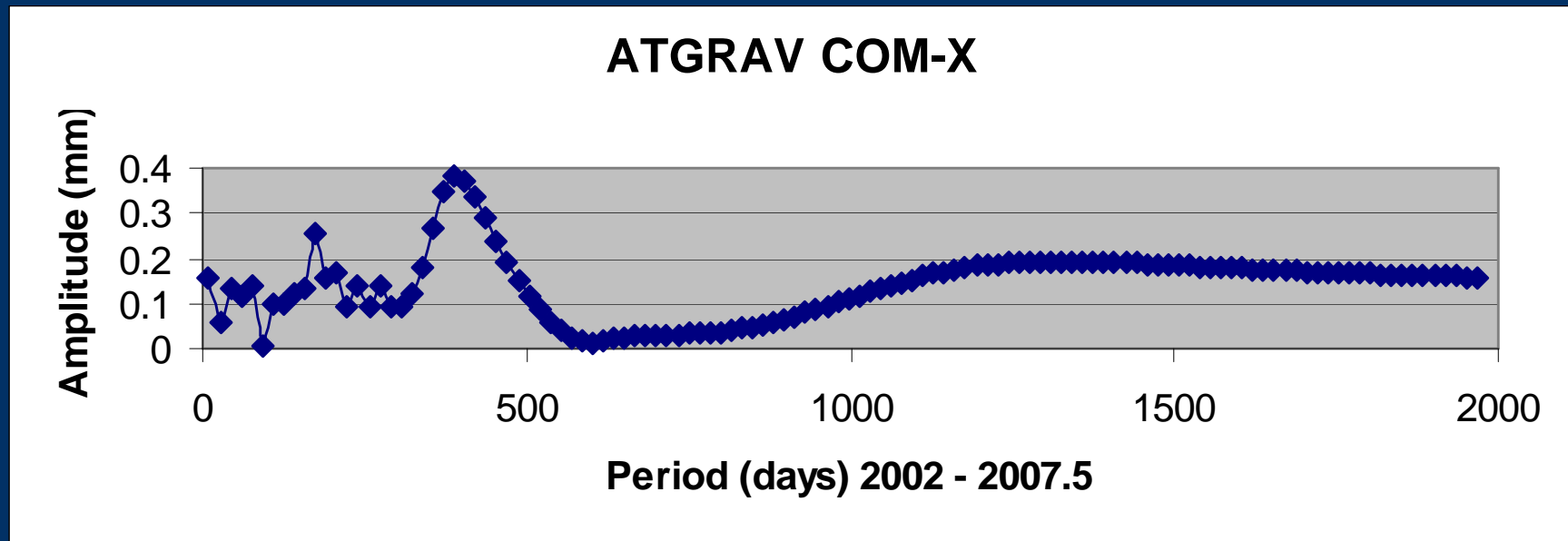
ANNGRAV Lageos-2 Radial Orbit Differences Geographical Correlation

LAGEOS2 radial orbit differences 5x5 degree latitude/longitude bins

Annual_Gravity_nomodel-model_jan02-may07

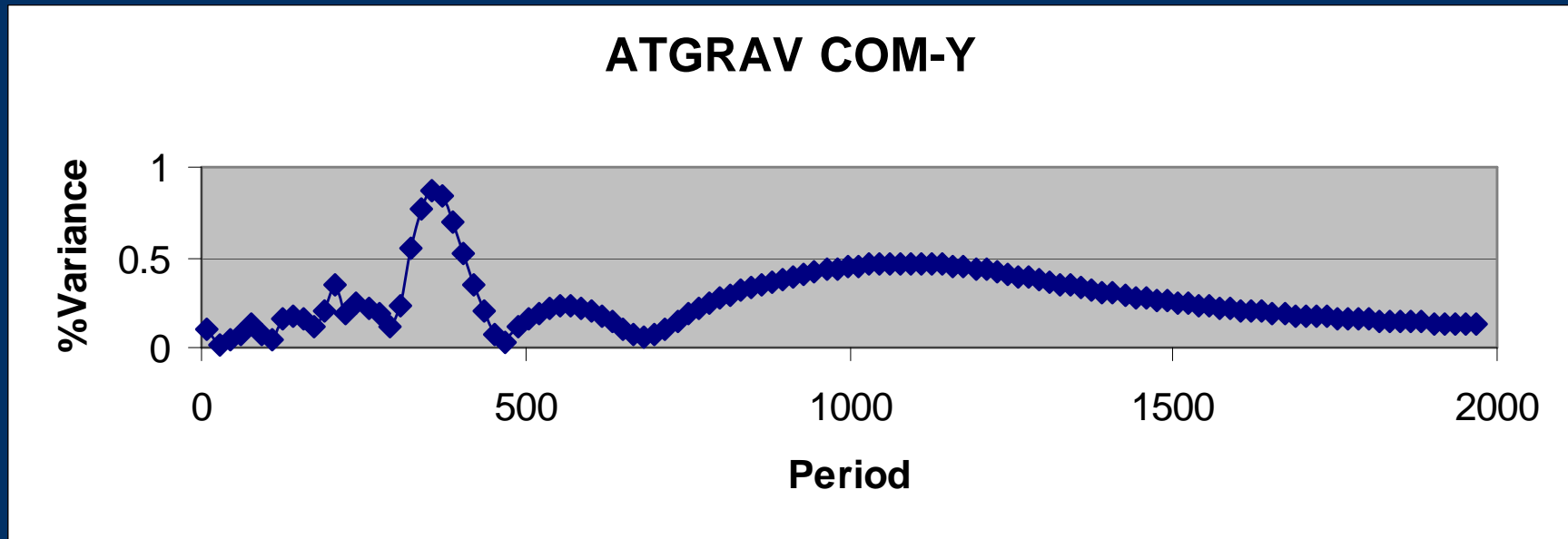


ATGRAV – COM-X (Differences)



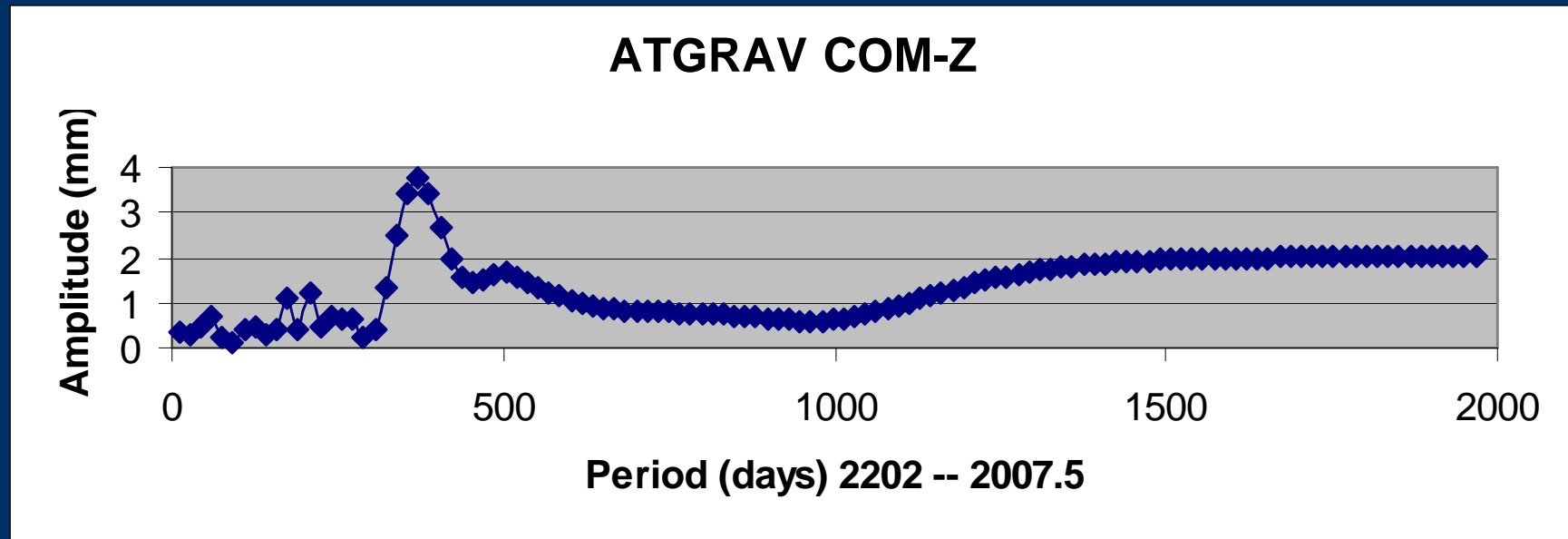
Annual Period dominant with 0.4 mm amplitude

ATGRAV – COM-Y (Differences)



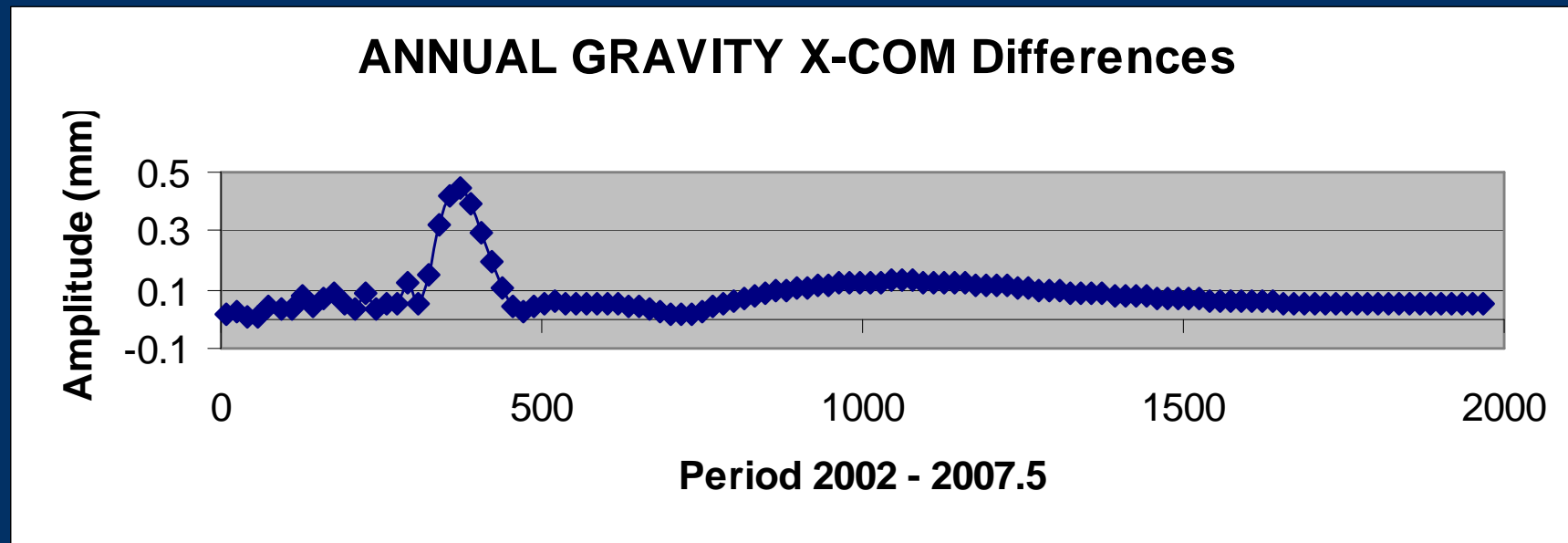
Annual Period dominant with 0.9 mm amplitude

ATGRAV – COM-Z (Differences)



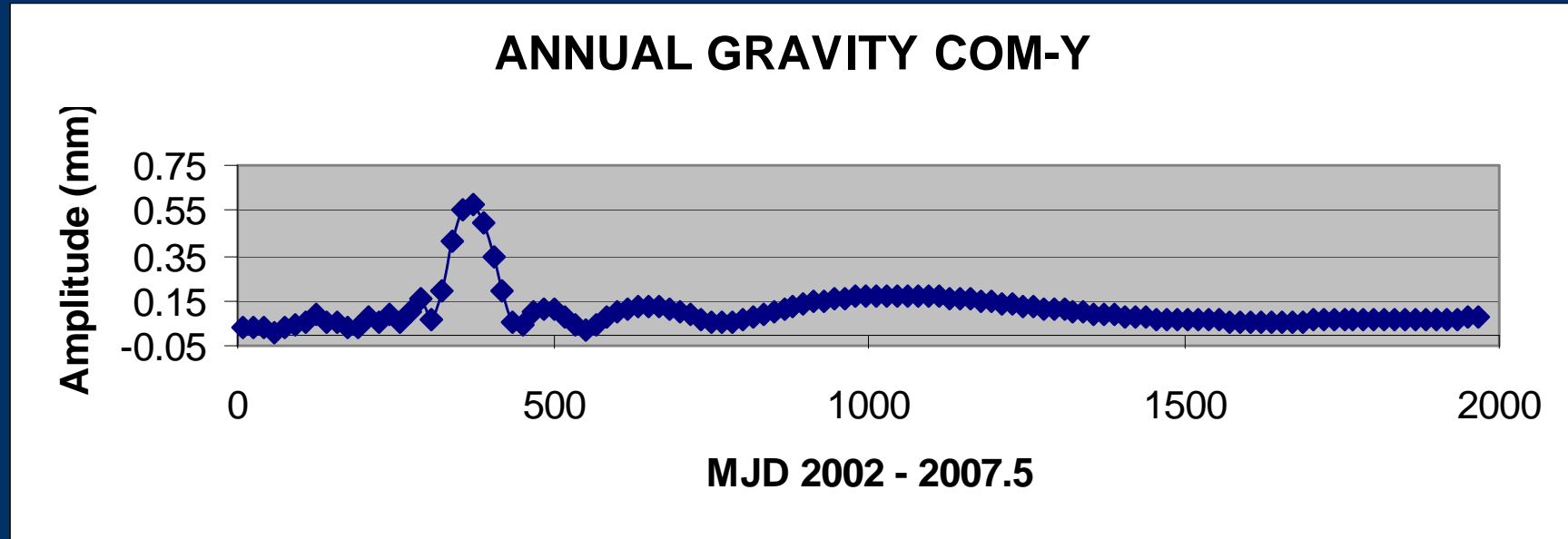
Annual Period dominant with 3.8 mm amplitude

ANNUAL GRAVITY COM-X (Differences)



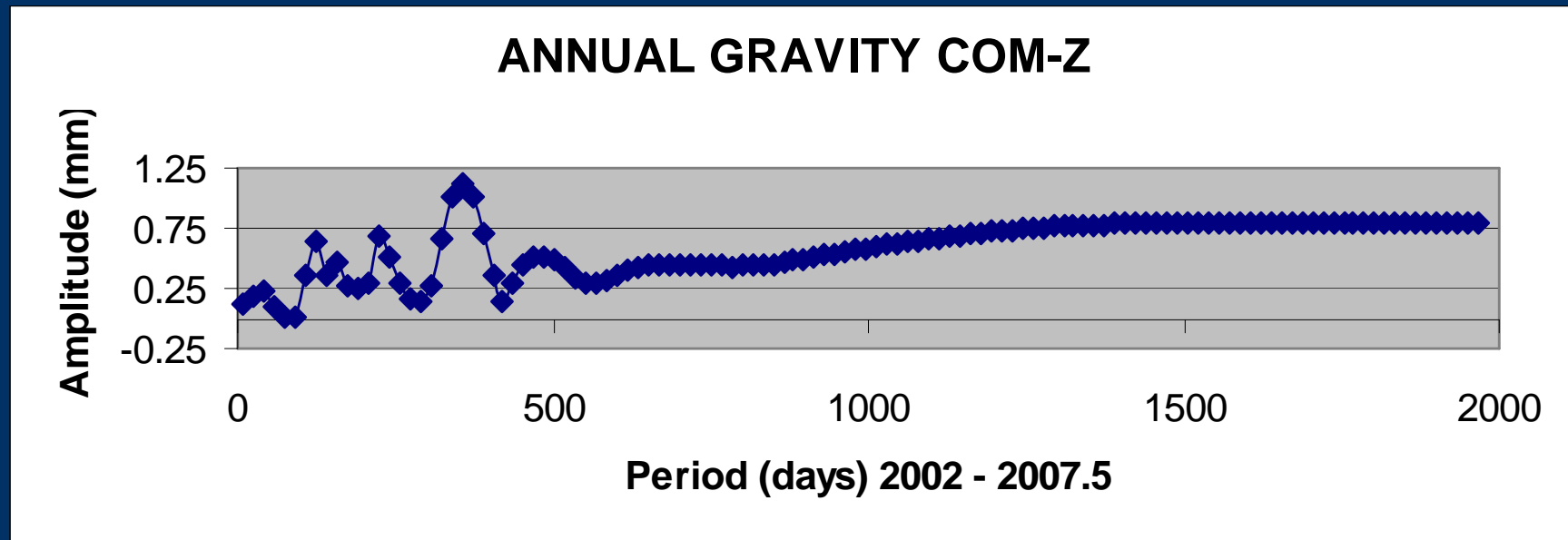
Annual Period dominant with 0.4 mm amplitude

ANNUAL GRAVITY COM-Y (Differences)



Annual Period dominant with 0.6 mm amplitude

ANNUAL GRAVITY COM-Z (Differences)

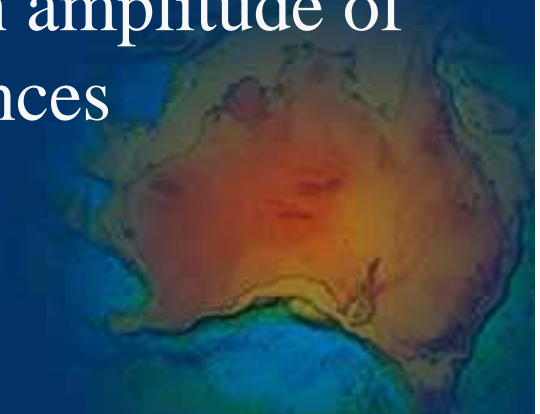


Annual Period dominant with 0.6 mm amplitude

RESULTS SUMMARY

Lageos orbits

- Atmospheric Gravity
 - Lageos-1
 - From the application of the NCEP 6-hourly ATGRAV, the effect on Lageos-1 orbits is 1 - 1.2 mm radial having a total effect of about 5 mm 3D.
 - Dominant Period is annual with an amplitude of 0.5 mm for the radial orbit differences



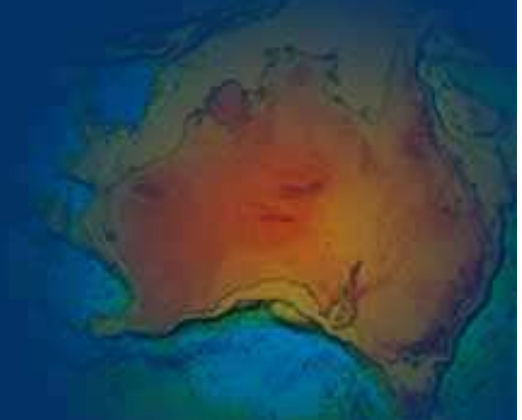
RESULTS SUMMARY

Lageos orbits

–Lageos-2

- Dominant Period is annual with an amplitude of 0.15 mm.

The only difference between the two satellite orbits being the inclination



RESULTS SUMMARY

Lageos orbits

- Annual Gravity Field Variation
 - Lageos-1
 - Dominant Period is annual with an amplitude of 0.6 mm for the radial orbit differences
 - Lageos-2
 - Dominant Period is annual with an amplitude of 0.2 mm and a secondary period of half-year with an amplitude of 0.15 mm

Inclination ?



RESULTS SUMMARY

Lageos orbits

- For the 20 X 20 time varying harmonics gravity harmonics from GRACE (annual – representing land hydrology), the radial orbit signal is about 1 mm – having a total 3-D effect of 5 – 6 mm.
- Alternate annual terms determined by other centres need to be used to confirm these results.
- In regions, where the annual gravity contributions are larger for both Lageos-1 and Lageos-2, the RMS of the mean block differences are also larger. This may imply a lack of adequate tracking data for GRACE. However, this is more pronounced for Lageos-1



RESULTS SUMMARY

Lageos orbits

- In regions where the atmospheric gravity contributions are larger, the RMS of the block mean radial orbit differences are also larger – this may imply that there is a lack of atmospheric pressure data for input inot the NCEP model. However, the study should be re-done with other models such as ECMWF.



RESULTS SUMMARY

Earth's Centre of Mass

- Atmospheric Gravity
 - Annual period in all components with an amplitude of 0.4, 0.9 and 3.8 mm for X, Y, Z respectively.
- Annual Gravity Field Variation
 - Annual period in all components with an amplitude of 0.4 mm, 0.6 mm and 0.6 mm in all components.

Total annual periodic effect of ATGRAV + ANNGRAV is 4.5 mm for the Z-Component.

