A New Model of the Mean Albedo of the Earth: Estimation and Validation from the GRACE Mission and SLR Satellites.

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Abstract

Estimates of the albedo of the Earth have evolved over time but converged over the past 2000-2015. Second, we analyse what is the set of data leading to the lowest residual mean square level in orbital propagation scenarios, by using data from MED gondola satellites (Lages-1, tracked by the IERS network) and the two GRACE satellites. We give an example of an evaluation carried out over eight years (2004-2021).

1. Albedo modelling

• The mean value of albedo in Stephens model of 0.30 is slightly different from the current estimate from CERES observations [6]. According to CERES, ECMWF (Energy Budget Adjusted Fluxes) data, the global, annual mean all-sky reflected flux is 99.7 W m⁻² (equivalent to a global albedo of 0.293) [2].

2. Validity of the new models: an analysis

• From Fig. 3, it appears that the difference (bottom) are on a very low (mm) level for most of the stations when comparing CERES and Stephens; bifor other such datasets (T2C and TCR0), the differences have a significant level (cm). These differences can be correlated to the difference between the grids that are significant as well (not shown here).

3. Perturbation due to albedo on Lages-1

As an example of the kind of effect induced by the change of the albedo modelling, we computed the orbit of Lages-1 for a period of 30 days using the various albedo models:

• following the IBS Analysis Steering Committee (ASC) guidelines;
• testing the impact of the choice of the grids initializing the albedo/IR effects.

• In Fig. 3, it appears that (i) the difference (bottom) are on a very low (mm) level for most of the stations when comparing CERES and Stephens; bifor other such datasets (T2C and TCR0), the differences have a significant level (cm). These differences can be correlated to the difference between the grids that are significant as well (not shown here).

4. Perturbation due to albedo on GRACE

The radial correction strategy, originally applied on CHAMP, is adapted to handle the albedo and infrared effects on the GRACE satellites. In the treatments, the degraded measurement along the radial axis (X) is finally replaced by a combination between the STIR measurement along the tangential axis (Y) projected on the radial axis (by application of the “lift / drag” ratio) and the radiation pressure models. This procedure makes it possible to deduce the lift information from the Y axis of the accelerometer:

\[ \text{Ratio (lift / drag)} = \frac{Y}{X} \]

5. Conclusions and prospects

• The comparisons using GINS to calibrate the albedo models based on GRACE results as reference show that our new Mean model based on ECMWF grids provide the lowest level of RMS, on each of the tested orbits.

• GRACE satellites: using radial correction strategy provides a direct precise comparison of albedo models

• The origin of seasonal and average values differences that appear between the various sets has to be clarified.

References


References

• GRACE release 04 (RL04) is one of CNES gravity model products based on accelerometer, GPS and SLR measurements;

• Second bulletin files have been updated from RL04b orbits;

• From Fig. 5, it appears that the difference in tangential and normal axis components is negligible comparing with radial component;

• It is not that far from the Stephens model, our mean model based on ECMWF grids gives the best fit with accelerometer RMS values, as shown in Fig. 6.