Impact of change in AOD1B on RL04 monthly GSM products

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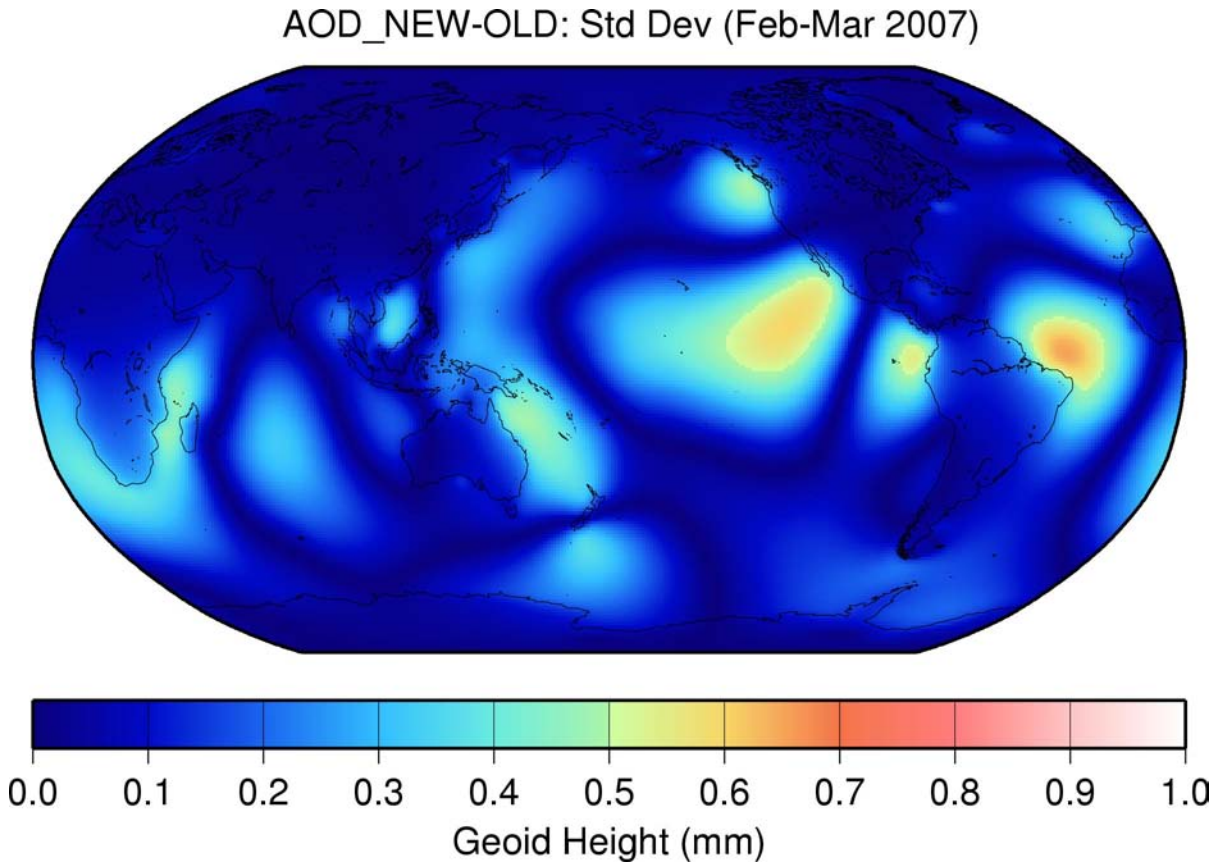
Feb 21, 2008

GRACE Technical Note 06

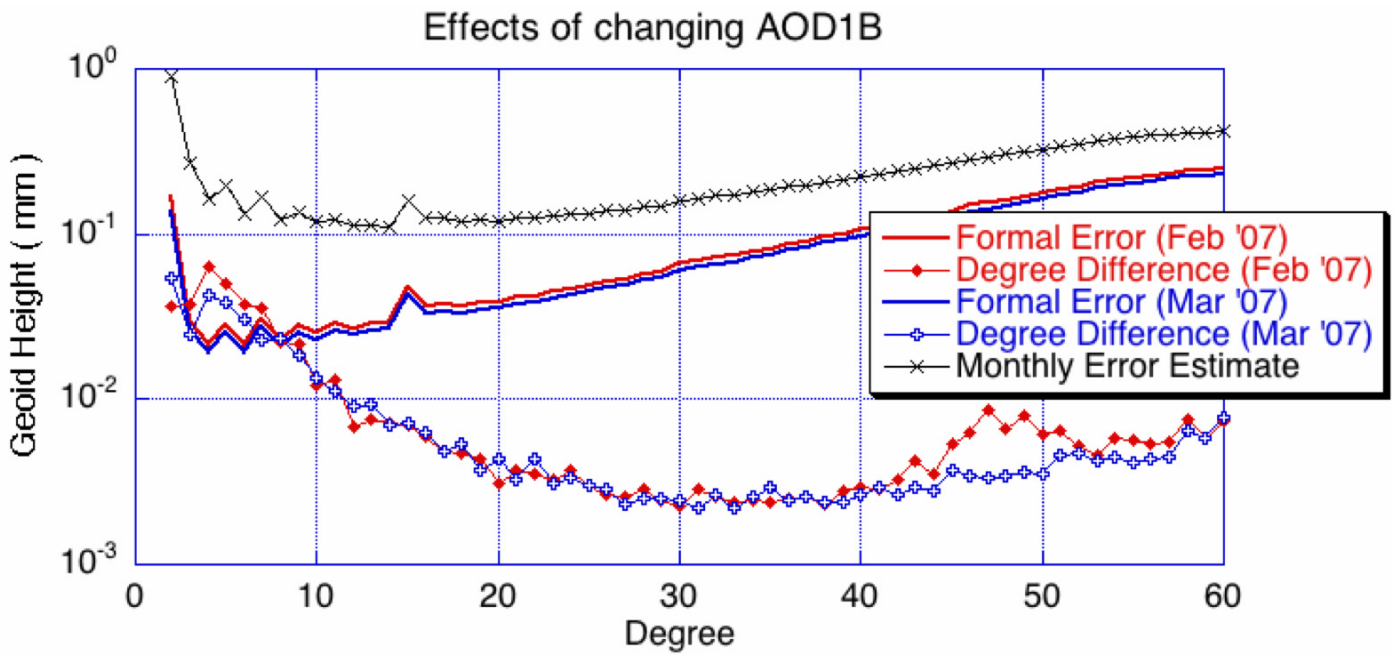
Background

- A combination of gravity field changes due to atmospheric variations and non-tidal oceanic variations is modeled as a part of background gravity field models in GRACE data processing. This model is delivered in the so-called AOD1B products.
- Between Jun 23, 2006 and Sep 20, 2007, the ocean component of the AOD1B was forced by a surface pressure field that had the S2 atmospheric pressure removed twice, by mistake.
- Since an error in the background model affects the estimated monthly gravity fields delivered in the GSM-2 data products, the SDS centers re-created the Level-2 data products all 16 months between June 2006 and September 2007.
- This note summarizes the impact on the Level-2 products as a result of this re-processing. We recommend that users replace the previously released products with the re-processed products. The following products are affected: AOD1B, GSM-2, GAC-2 and GAD-2.
- References:
  - Level-2 Product User Guide
  - AOD1B Product Description Document
  - Level-2 Data Product Release Notes from each center
  - SDS Newsletters October 07 till January 2008



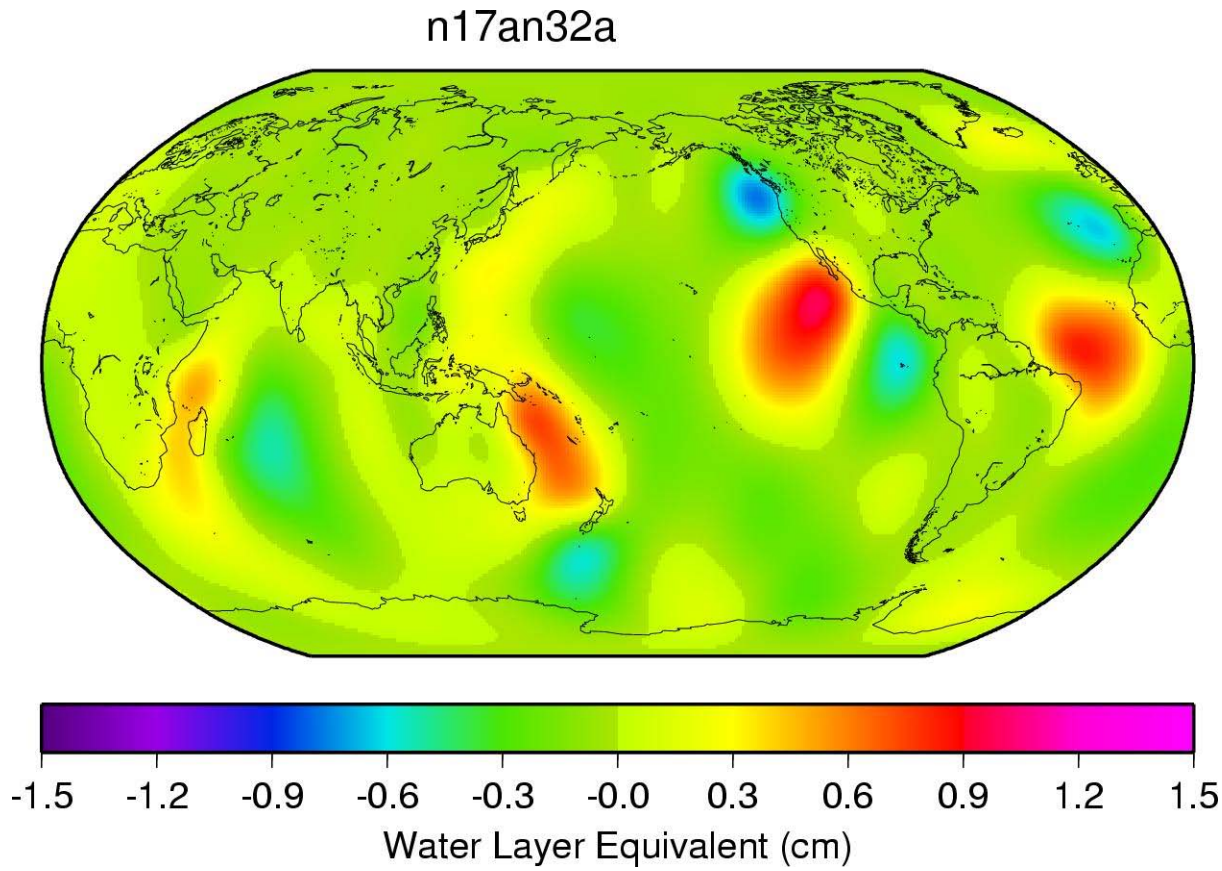
This image shows the standard deviation of the time-series of geoid height changes due to the differences between the incorrect and the correct AOD1B products - over 60 days of February and March 2007. The maps were drawn using the 6-hr, degree/order 100 “GLO” time-series within the AOD1B product, and do not include terms of harmonic degrees 0 and 1. Therefore, this map shows the size and geographic distribution of the change in the energy of the background gravity field model used for GRACE processing as a result of this correction.

As may be expected, the change in energy is large over the oceans.



This image shows the degree statistics of the changes in two monthly solutions (CSR-RL04 solution for Feb and Mar 2007) as a result of correcting the background AOD1B model. The X-axis is the harmonic degree, and the Y-axis is the root-sum-square of geopotential harmonic differences, expressed in units of mm of geoid (upon multiplication by a mean Earth radius of 6378136300 mm). The black crosses represent an upper-bound error estimate for a typical month, obtained by examining residuals relative to seasonal model fits to monthly solutions. The solid red (blue) lines show the formal errors for the Feb (Mar) 2007 solutions. The red (blue) symbols show the degree difference variances for Feb (Mar) 2007 solutions done with incorrect and correct AOD1B models.

For further illustration, the next page shows these differences in map form.

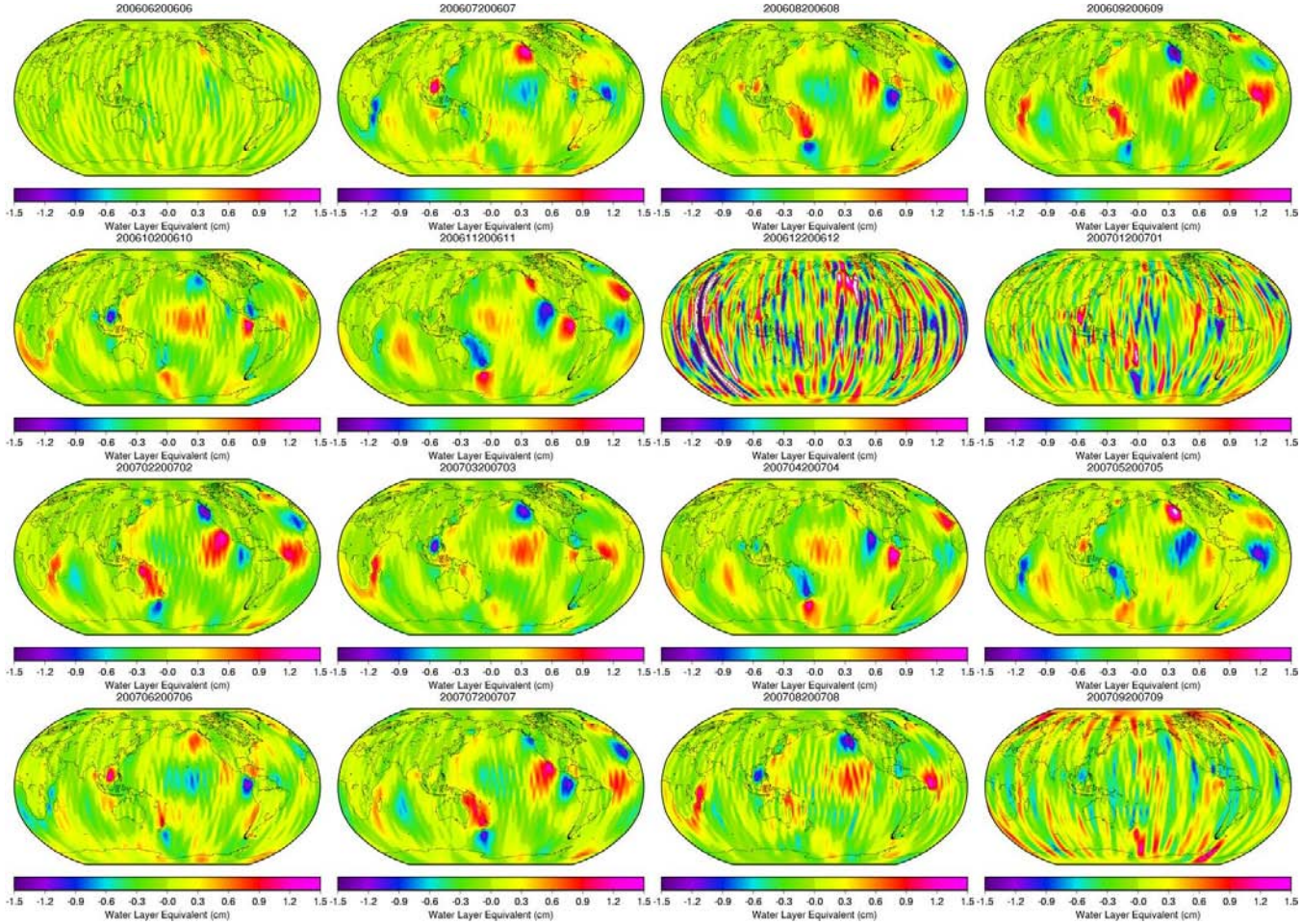


This map shows the water-layer equivalent of the difference between the old and the new GSM-2 products for Feb 2007, caused by the change in the background AOD1B model. Note the generally small amplitude changes over land; and the higher amplitude, large-spatial-scale changes that occur over the same oceanic regions where the background AOD1B model changed with a large standard deviation.

The 60x60 monthly GSM fields were differenced, and plotted with 750-km Gaussian smoothing. Degree-2 differences are included within this comparison.

Jun ‘06

Sep ‘06



Jun ‘07

Sep ‘07

This montage shows the change in the solutions - in equivalent water layer height - for the 16 CSR RL-04 re-processed months - starting from June 2006 at top left-hand corner, moving to the right to Sep ‘06 at the end of the first row, and then continuing down and to the right until Jun ‘07 at the bottom left, and finally, Sep ‘07 at bottom right.

In order to exaggerate the change, the maps are drawn to 300-km smoothing - note that this level of smoothing is not generally used to extract mass-flux changes without some de-striping.

Once again, with the exception of Dec ‘06, Jan ‘07 and Sep ‘07, the changes are larger over the oceans. The exceptional months do not support signal extraction at such a high spatial resolution.

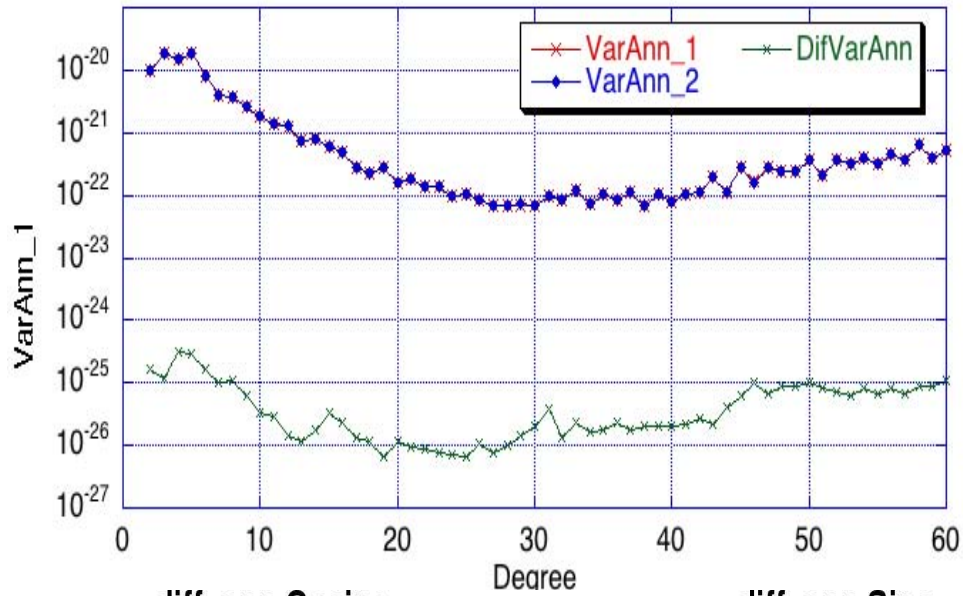
Change to Annual Fit

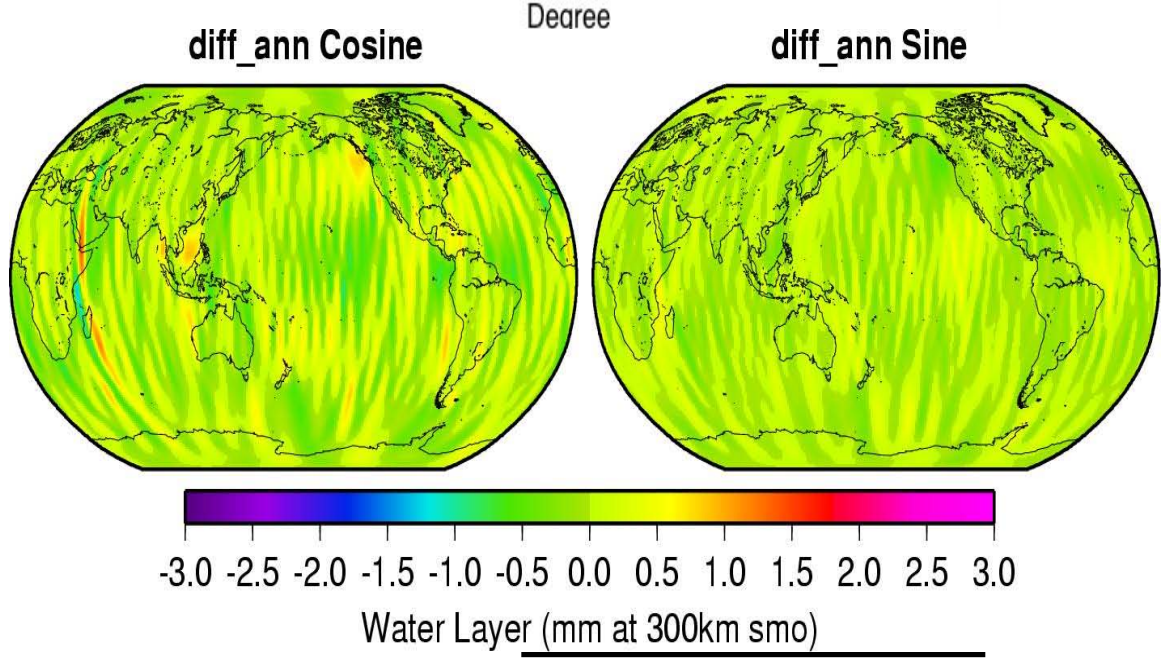
The top-right image shows the degree variance (sum-squares) of the amplitudes of an annual cycle fit to the 66 monthly CSR-RL04 solutions (from Apr 2002 to Dec 2007). Two fits are done - one using the previously released RL04 solutions, and another with the 16 months between Jun '06 and Sep '07 replaced with the re-processed fields.

The green line shows the degree variance of the difference between the two fits to the annual sinusoid.

The water-layer equivalent map of the annual cosine and sine amplitudes of the difference is shown in the lower panel, drawn to degree 60, with 300-km Gaussian smoothing.

The changes to the annual cycle from this re-processing are therefore no more than 1-mm water layer amplitude - well below the estimates of error at 300-km resolution.





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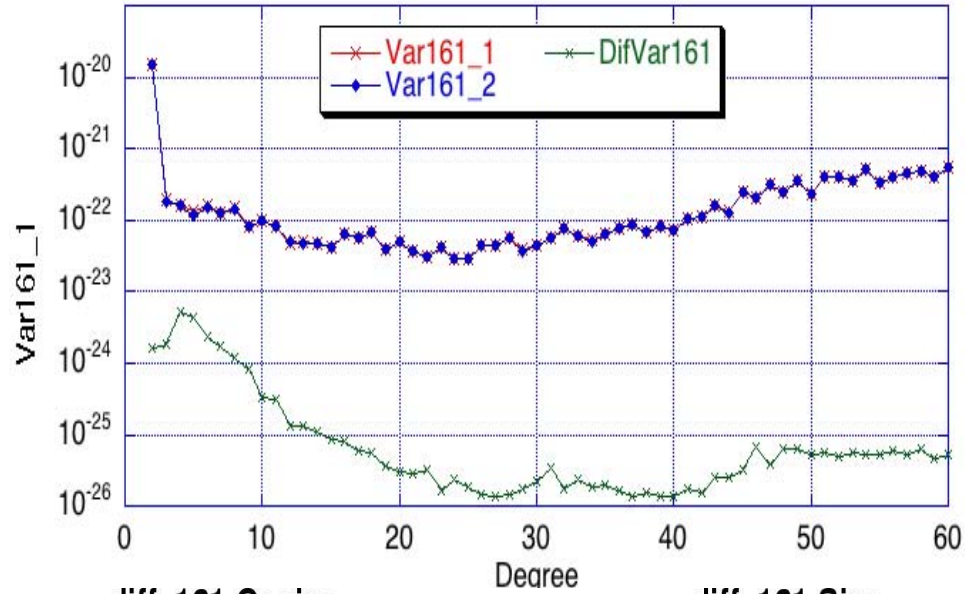
Changes to 161-day fit

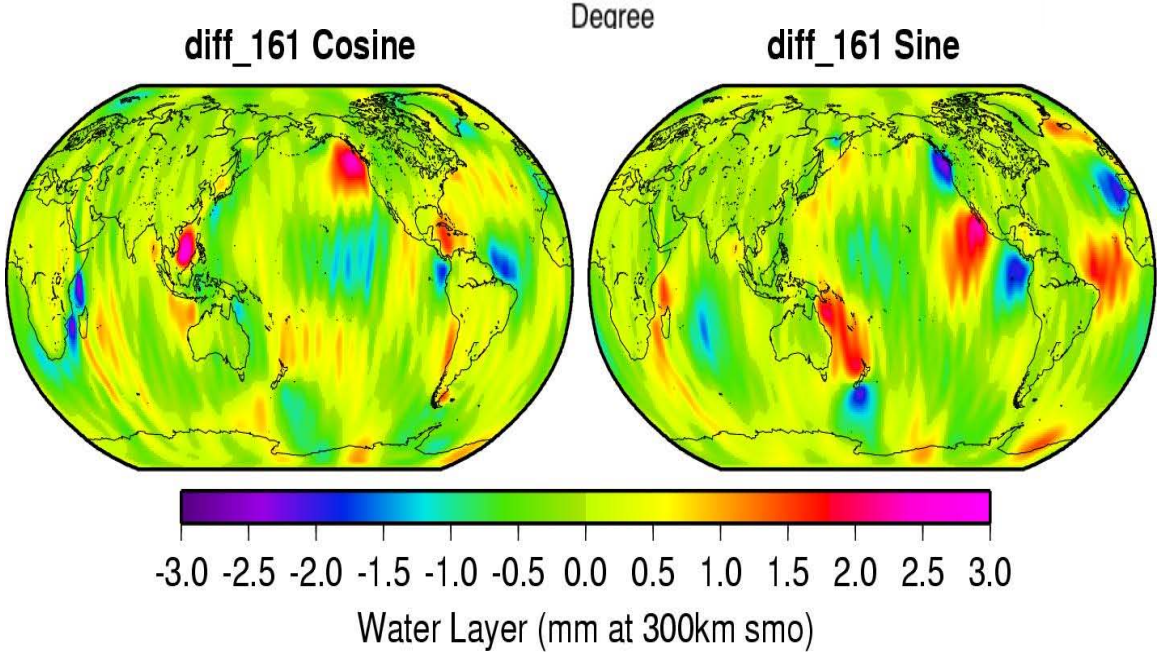
The top-right image shows the degree variance (sum-squares) of the amplitudes of 161-day (S2-Alias) fit to the 66 monthly CSR-RL04 solutions (from Apr 2002 to Dec 2007) - with and without the new fields.

The green line - showing the degree variance of the difference between the two fits - is now a larger fraction of the 161-day signal.

The water-layer equivalent map of the annual cosine and sine amplitudes of the difference is shown in the lower panel, drawn to degree 60, with 300-km Gaussian smoothing.

The approximately 1-cm changes in the span of 16 months between Jun '06 and Sep '07 (shown in the earlier montage) has altered the 161-day fit over the mission duration by several mm of water-layer equivalent.





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Conclusion

- The change in AOD background model over the 16 months has altered the signal over the oceans in these months by up to 1-cm water-layer equivalent, and over large spatial extent.
- Unlike low-frequency changes to the background models, this perturbation in the GRACE estimate cannot be restored by studying the summed quantity (GAC+GSM) or (GAD+GSM) - as is the common practice among oceanographic users.
- The change in signal over land areas is notably smaller.
- We recommend that users replace the 16 monthly solutions between Jun ‘06 and Sep ‘07 with the re-processed solutions that were delivered in February 2008 (please see Release Notes).