

Propagation of atmospheric model errors to gravity potential harmonics

- Impact on GRACE De-Aliasing -

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Introduction

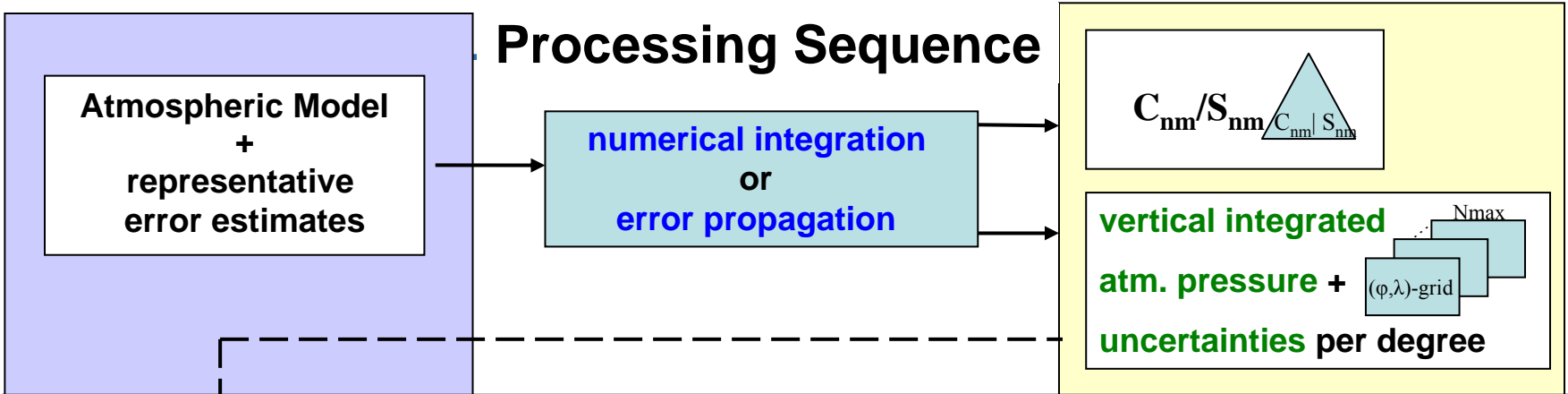
- GRACE is still under the performance projected before launch
- the de-aliasing process seems to be one of the main remaining uncertainty source in the GRACE data analysis

GOAL:

Improvement of the de-aliasing process by taking model uncertainties into account!

(this presentation: *atmospheric model*)

Processing Sequence



Atmospheric De-aliasing – Fundamental Formulas

$$T_v = (1 + 0.608S)T \quad \implies \quad H_{k+1/2} = H_s + \frac{1}{g} \sum_{j=k+1}^{N_{level}} R_{dry} T_v \ln \frac{P_{j+1/2}}{P_{j-1/2}}$$

$$P_{k+1/2} = a_{k+1/2} + b_{k+1/2} P_s$$

$$C_{nm} = -\frac{a^2(1+k_n)}{(2n+1)Mg} \iint_{Earth} \left[\int_{P_s}^0 \left(\frac{a}{a-H_{k+1/2}} + \frac{\xi}{a} \right)^{n+4} dP \right] P_{nm}(\cos\theta) \cos m\lambda \sin\theta d\theta d\lambda$$

$$S_{nm} = -\frac{a^2(1+k_n)}{(2n+1)Mg} \iint_{Earth} \left[\int_{P_s}^0 \left(\frac{a}{a-H_{k+1/2}} + \frac{\xi}{a} \right)^{n+4} dP \right] P_{nm}(\cos\theta) \sin m\lambda \sin\theta d\theta d\lambda$$

Error-Propagation of the uncertainties in the atmospheric input parameters S, T, P_s, H_s on the inner integral I_n (centre of mass of the atmospheric column)

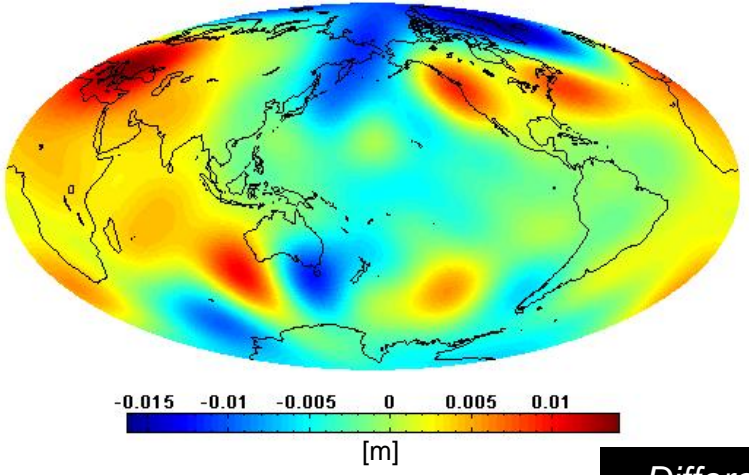
Conventional vs. New Approach (I)

	Numerical Integration	Least Squares Adjustment
Input	Atmospheric parameter (T, S, P _s , H _s)	Atmospheric parameter (T, S, P _s , H _s) + representative error estimates
Output	Atmospheric potential coefficients C _{nm} /S _{nm}	atmospheric potential coefficients C _{nm} /S _{nm} + error estimates

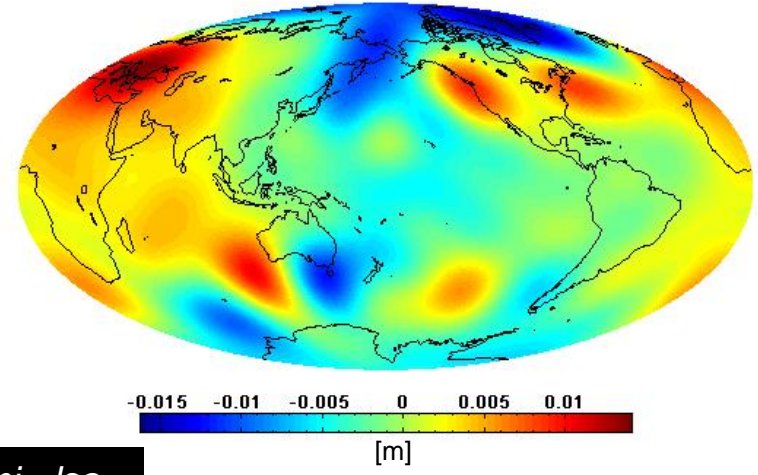
Notice: the „new“ de-aliasing coefficients will slightly differ from the present ones!

Conventional vs. New Approach (II)

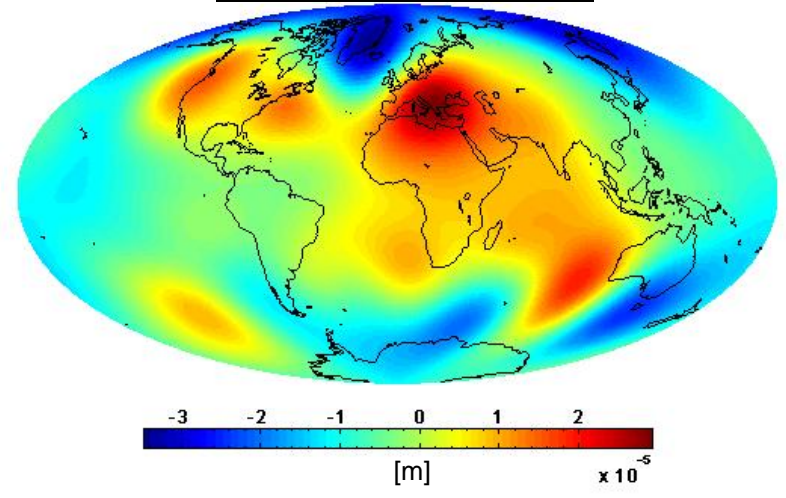
numerical integration (ni)



least squares adjustment (lsa)



Difference ni - lsa

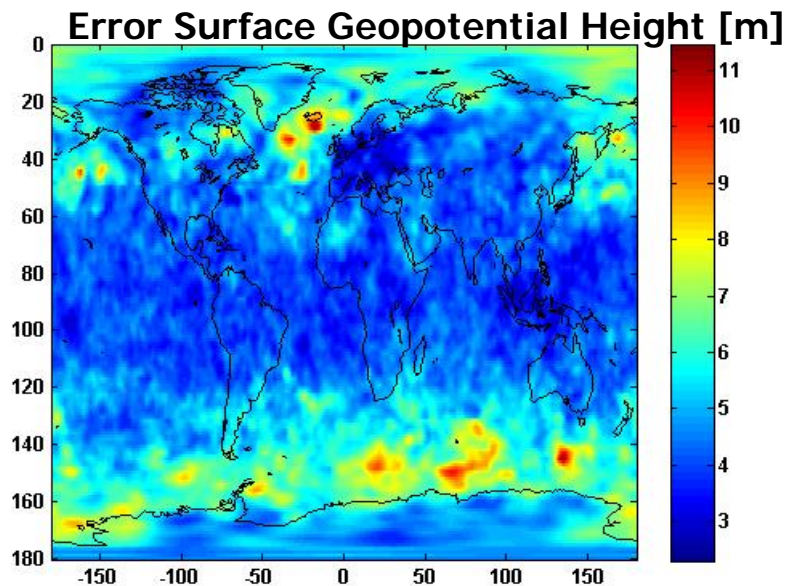
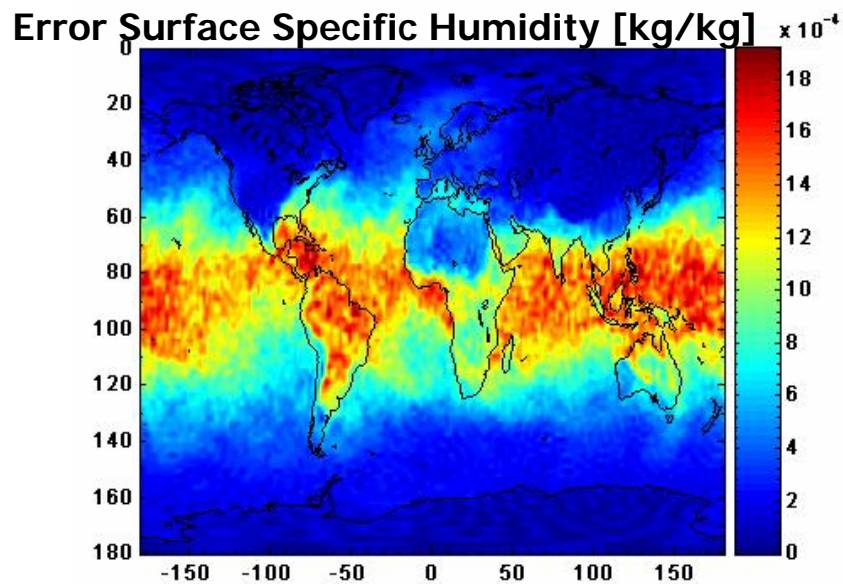
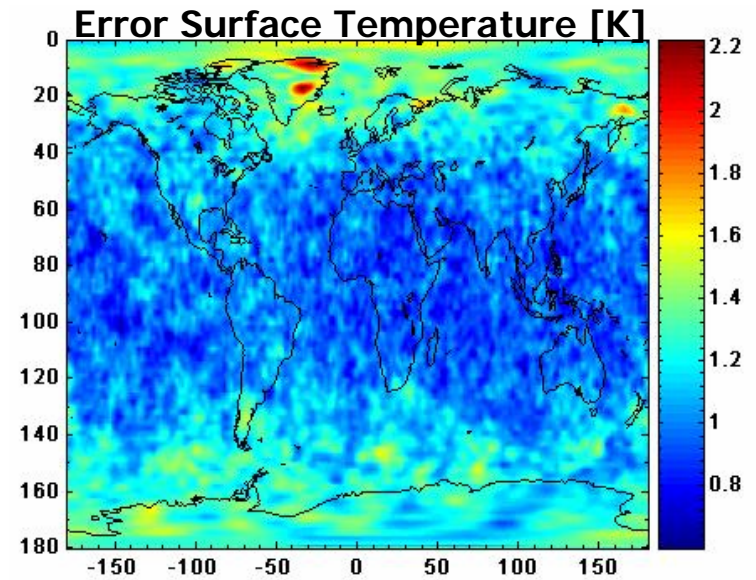
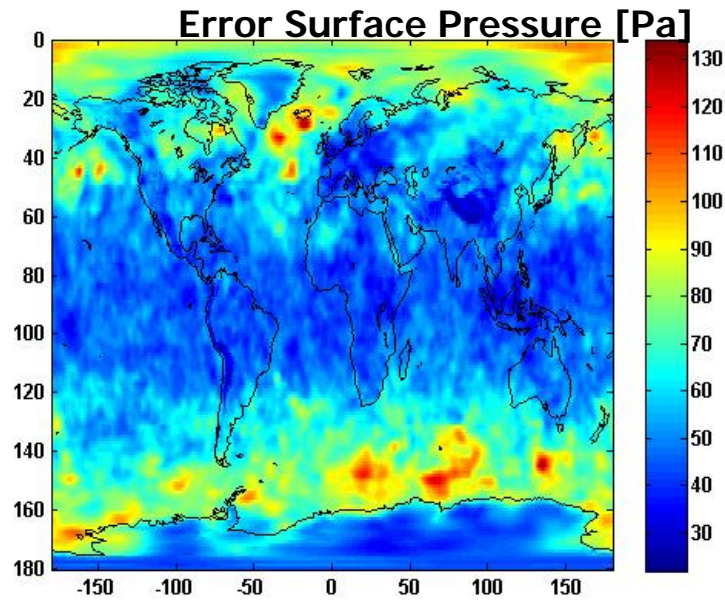


Differences between the two approaches maximum 0.04 mm geoid

Input parameters are regarded as error-free in both approaches!

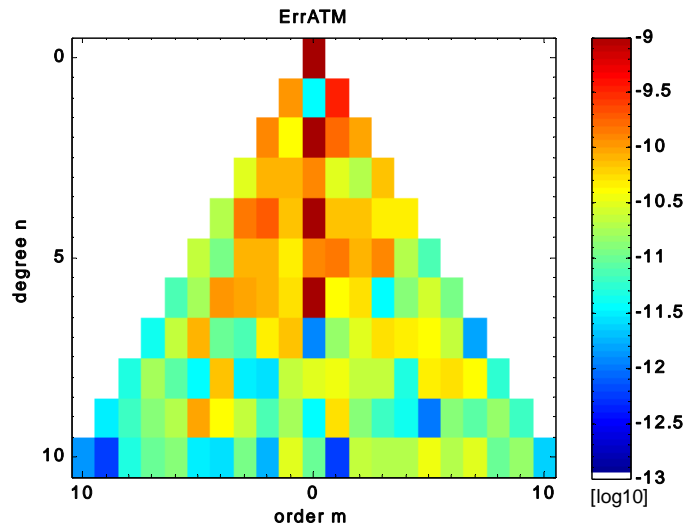
$$N_{\max}=10$$

ECMWF Model Errors

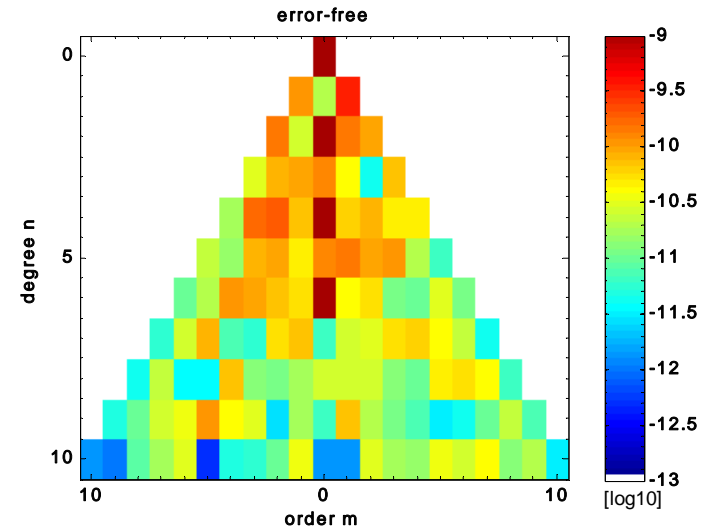


Results: „New“ Atmospheric De-Aliasing Product (I) –

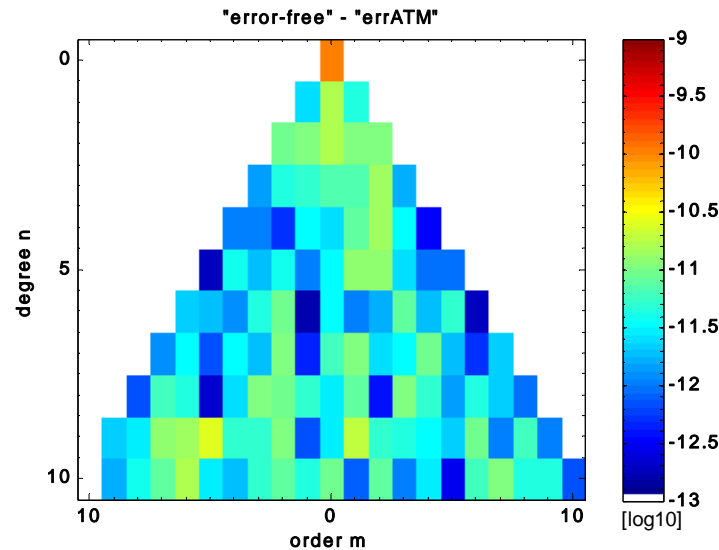
Case 1: „full-error“: uncertainties of all atm. parameters are taken into account



Case 2: „error-free“: atm. parameters are regarded as error-free

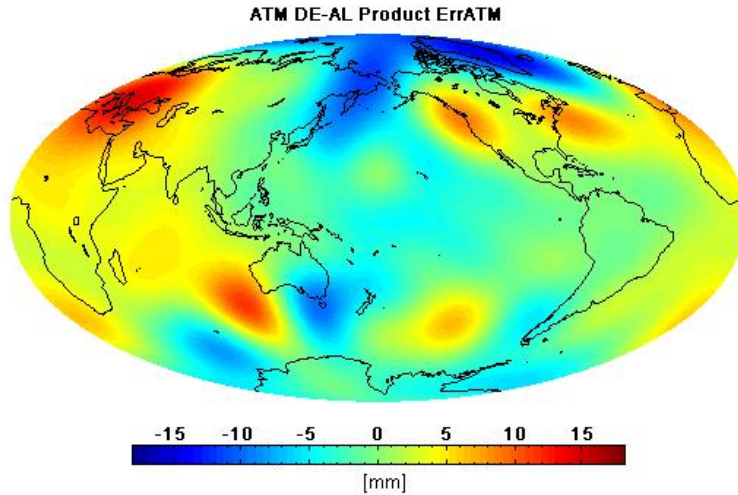


Difference between „error-free“ and „full-error“ - case



— Results: „New“ Atmospheric De-Aliasing Product (II) —

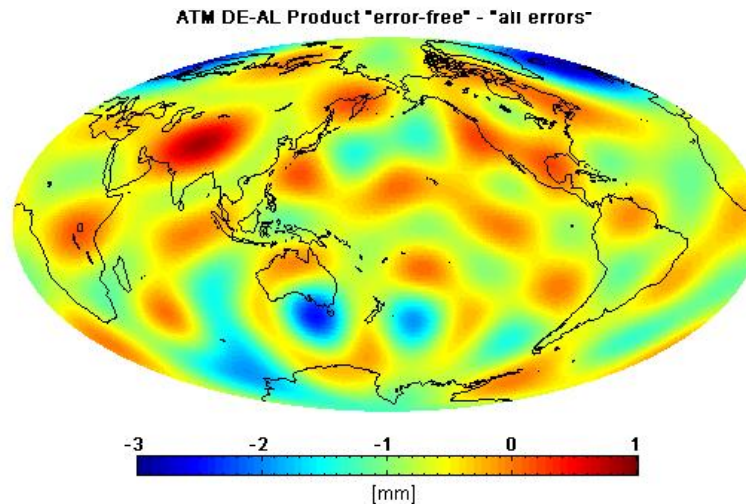
Case 1: „full-error“: **uncertainties of all atm. parameters** are taken into account



Case 2: „error-free“: **atm. parameters** are regarded as **error-free**



$N_{max}=10$

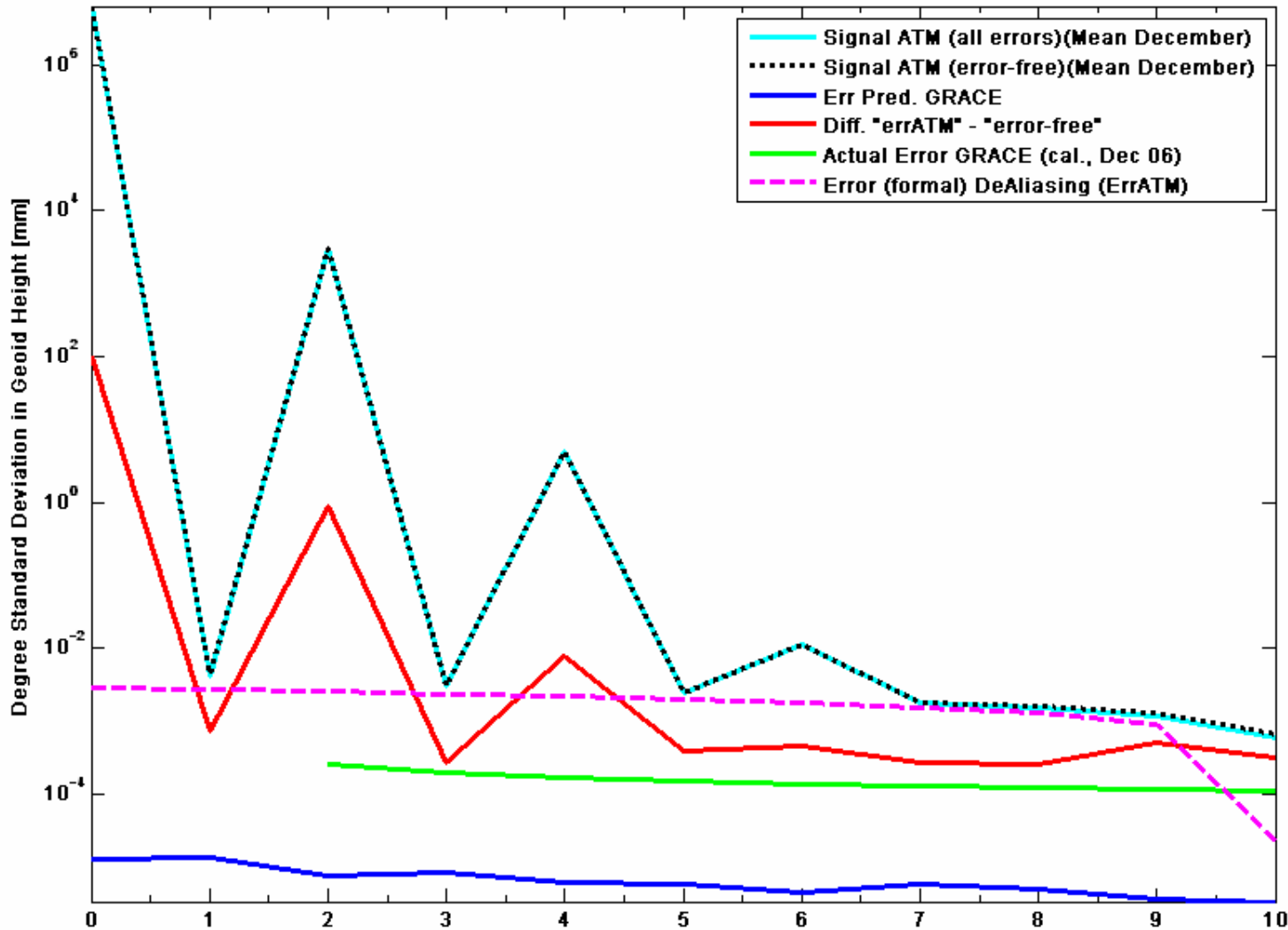


Difference
between „error-free“
and „full-error“ - case
in the [mm]-domain!!

→ **GRACE is sensitive to atmospheric model uncertainties!**

— Results: „New“ Atmospheric De-Aliasing Product (III) —

Degree Standard Deviations in Geoid Height [mm]



Atmospheric model uncertainties do have impact on GRACE de-aliasing product!

Conclusions & Outlook

Until now:

- input parameters for atmospheric de-aliasing are regarded as error-free!
- AOD1B product consists of C_{nm}/S_{nm} without any accuracies

It is shown:

Uncertainties in atmospheric models have significant impact on GRACE de-aliasing product ([mm]-domain)!

Therefore:

- representative error measures for atmospheric and oceanic parameters have to be determined
- „new“ de-aliasing product will consist of C_{nm}/S_{nm} and **their accuracies**
- **error propagation should be tested in the standard GRACE – de-aliasing process → Impact on monthly GRACE gravity field solutions?**

Thank you for your attention!