Aliasing problems in gravity field recovery and possible solutions

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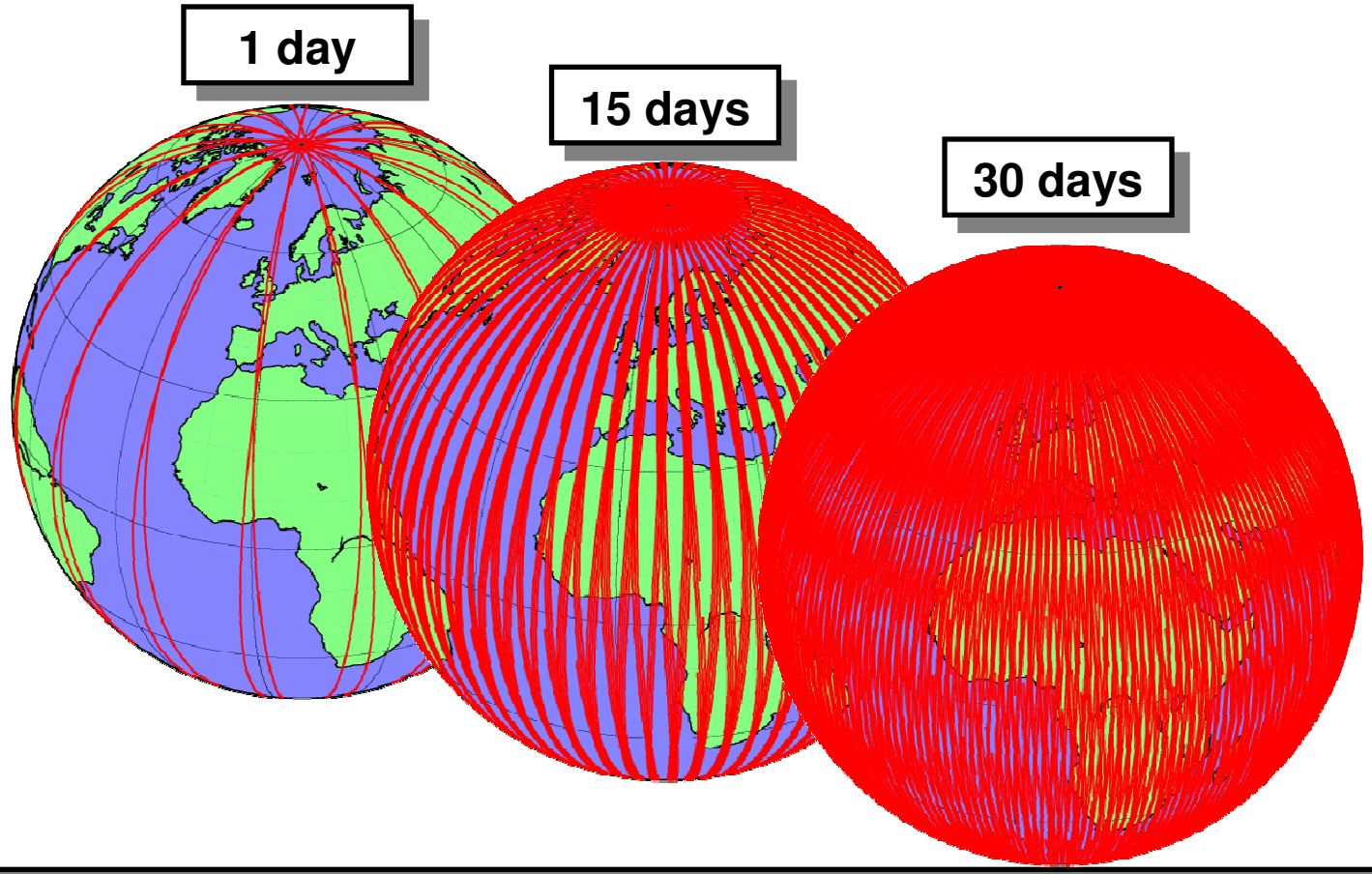
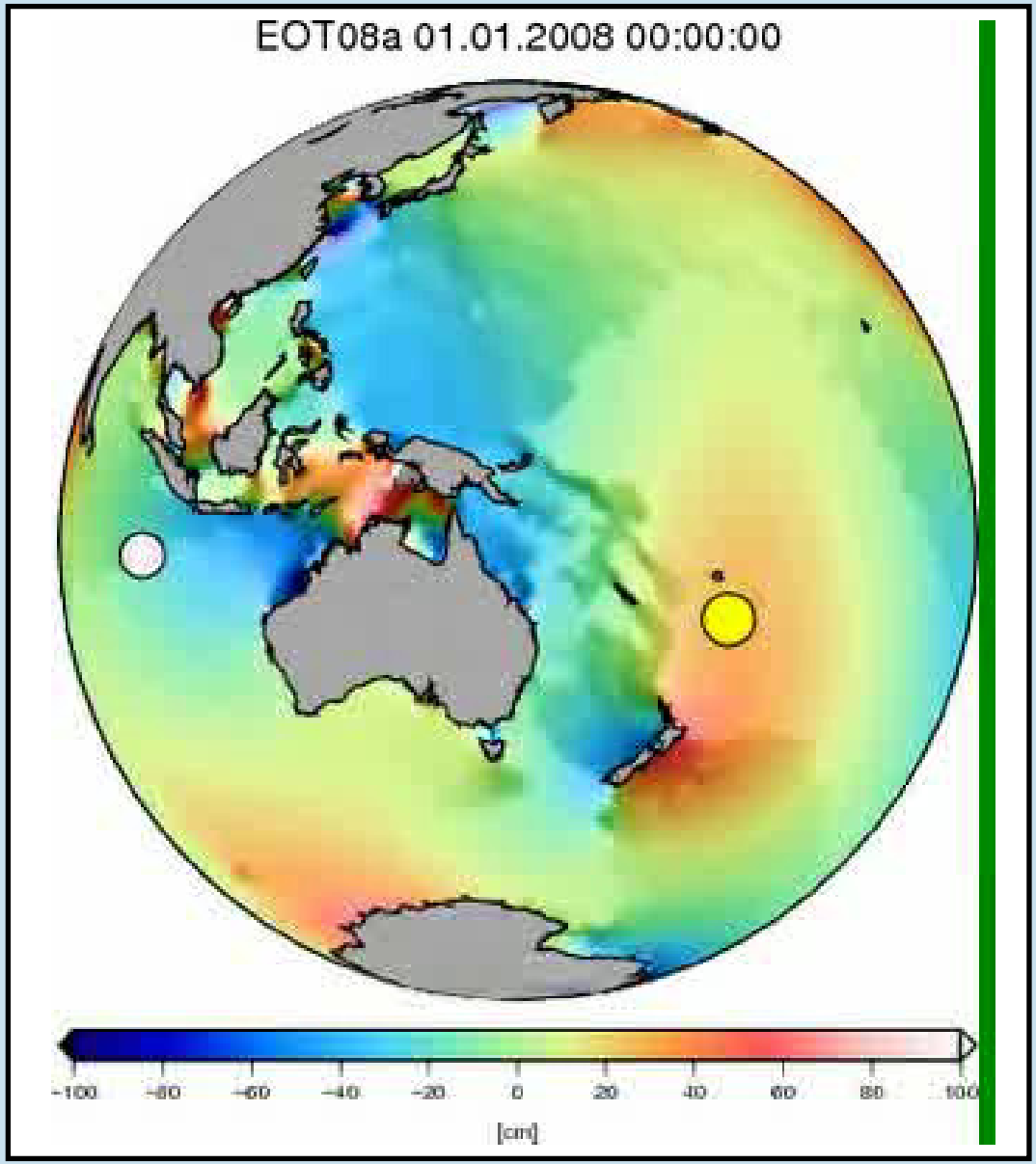
2. While the gravity field changes continously,
   it takes time to collect satellites data



GRACE and ocean tides



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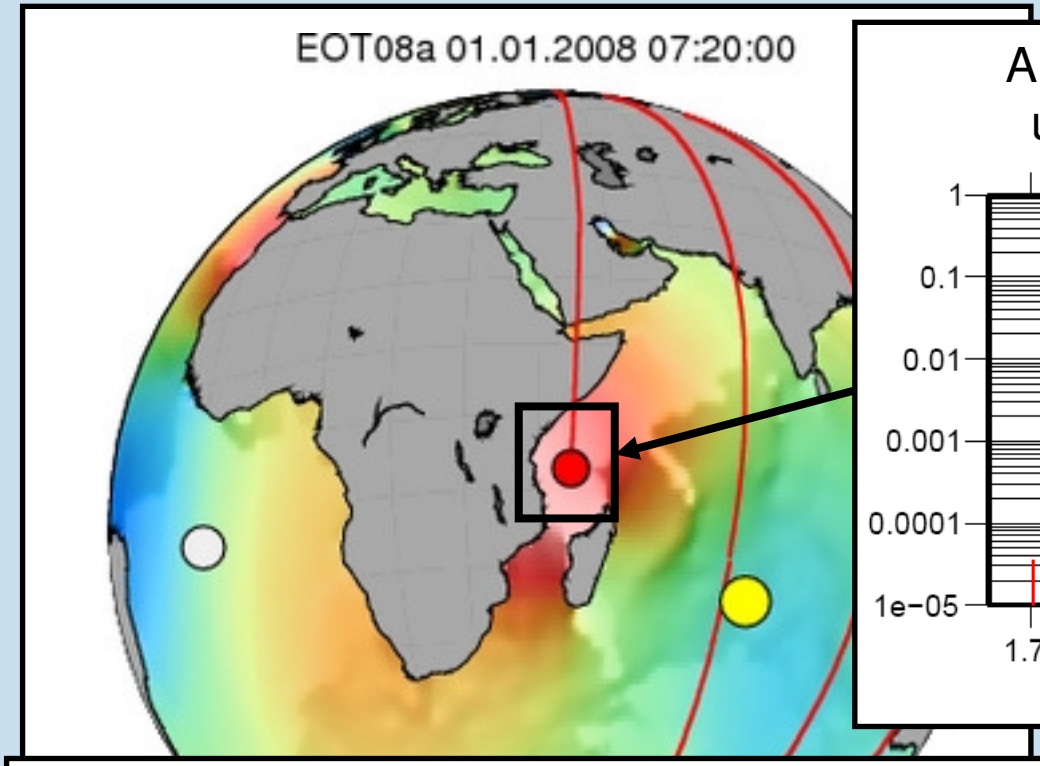

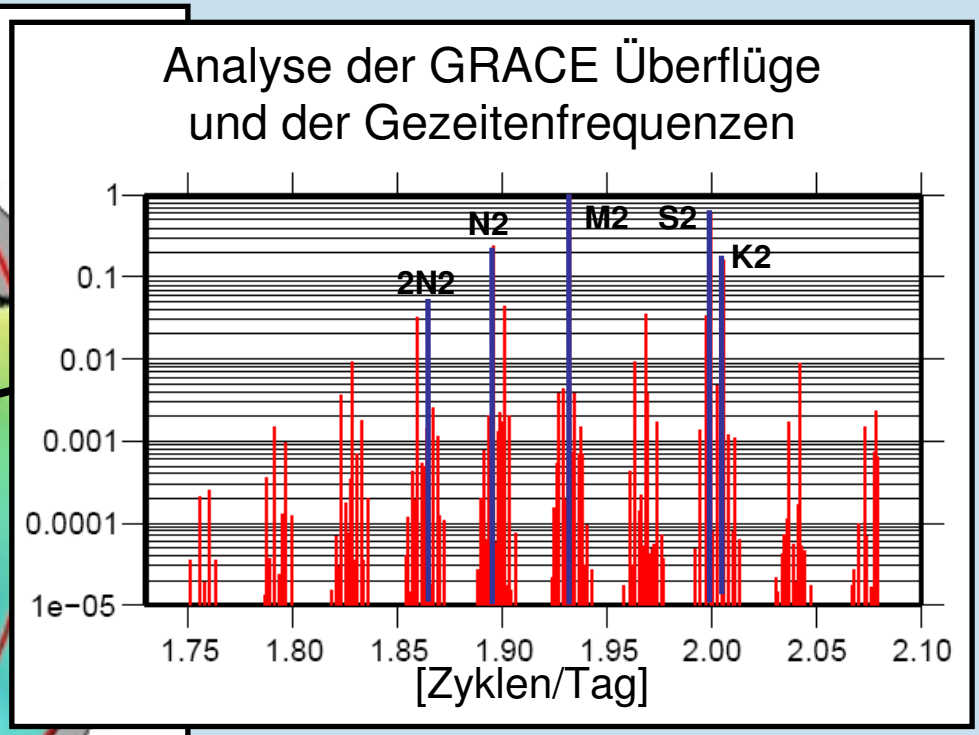

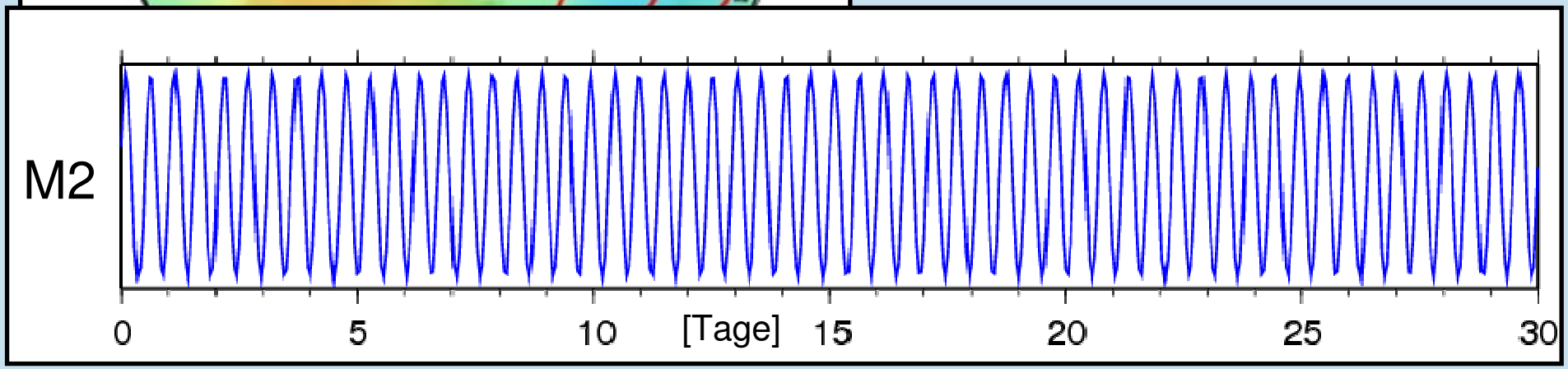

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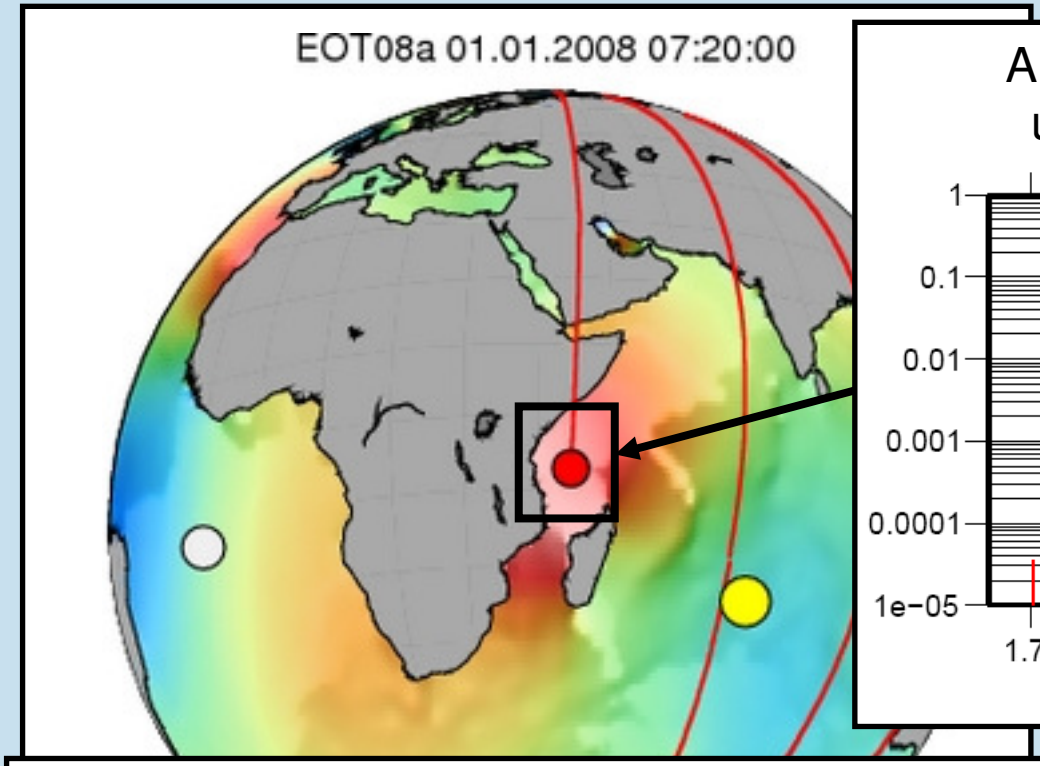
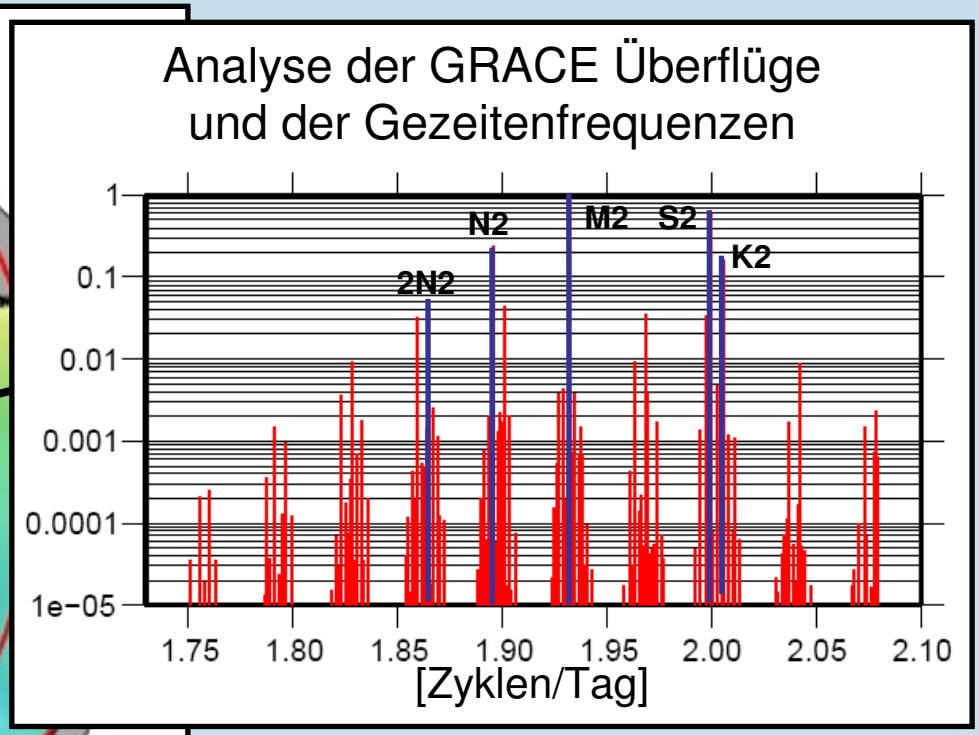
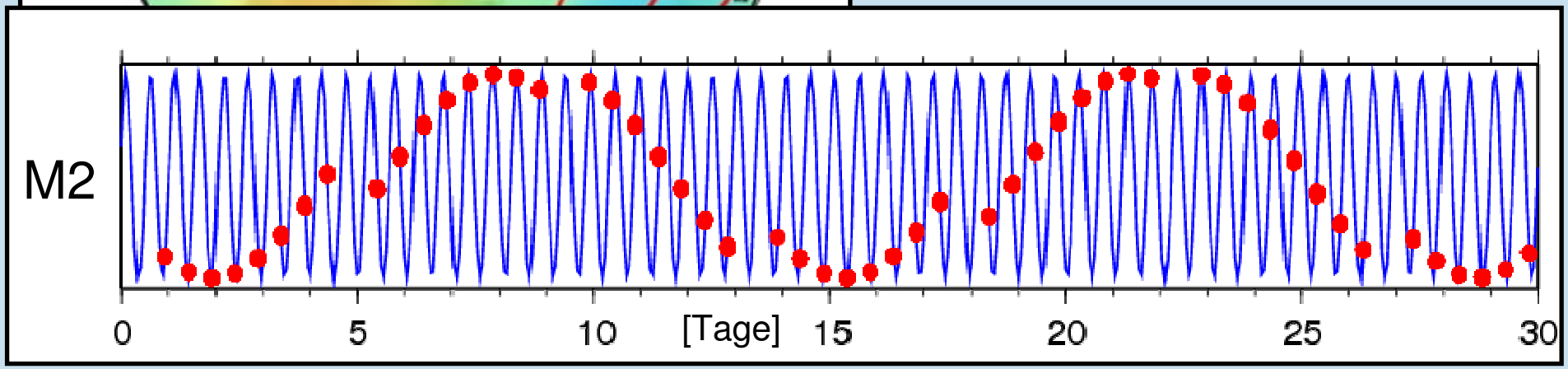
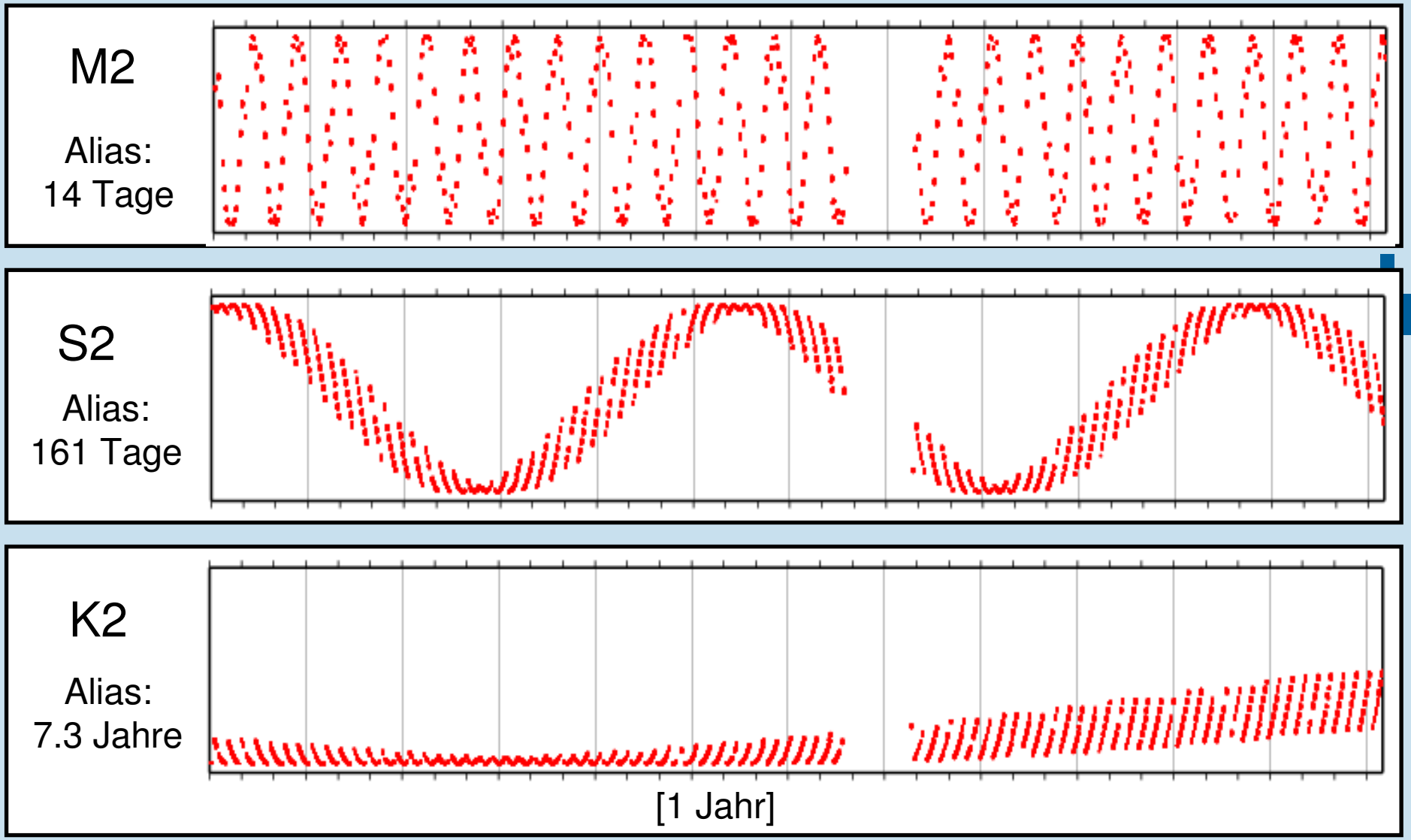






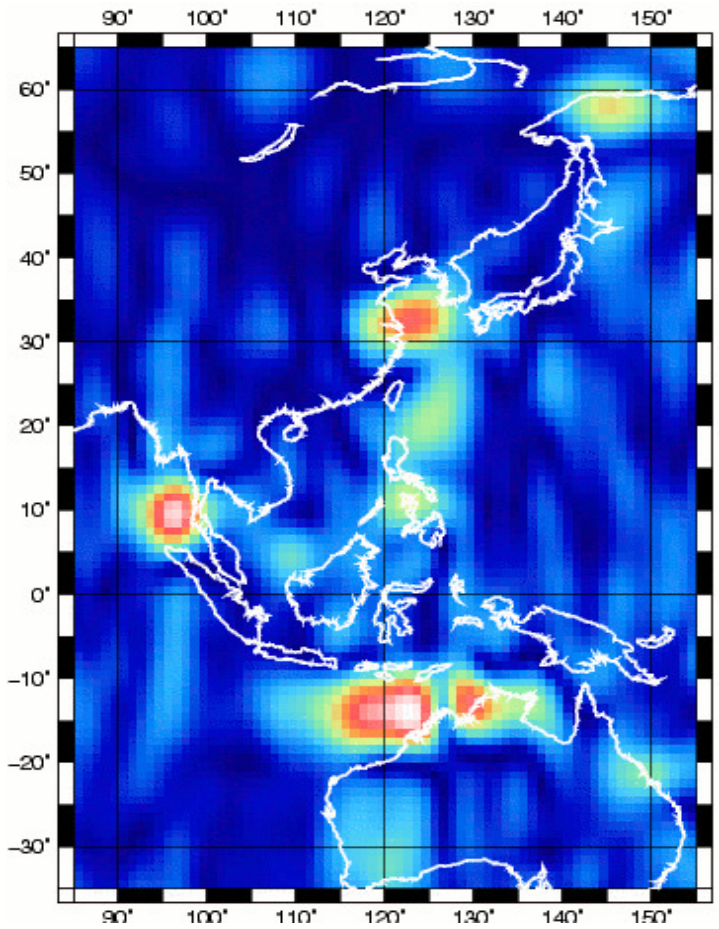
GRACE Aliasing Perioden



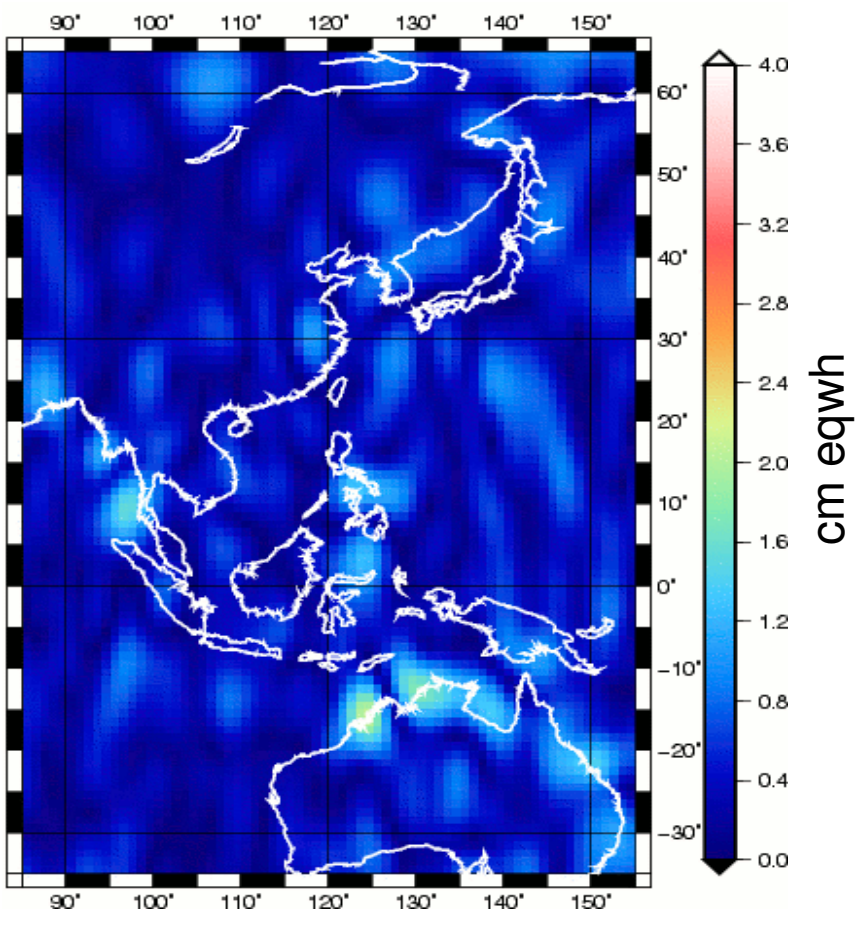
Monthly solution: EOT08a vs. FES2004

Amplitude of 161 day fit signal (S2 alias) from 64 monthly GRACE solutions

FES2004 as background



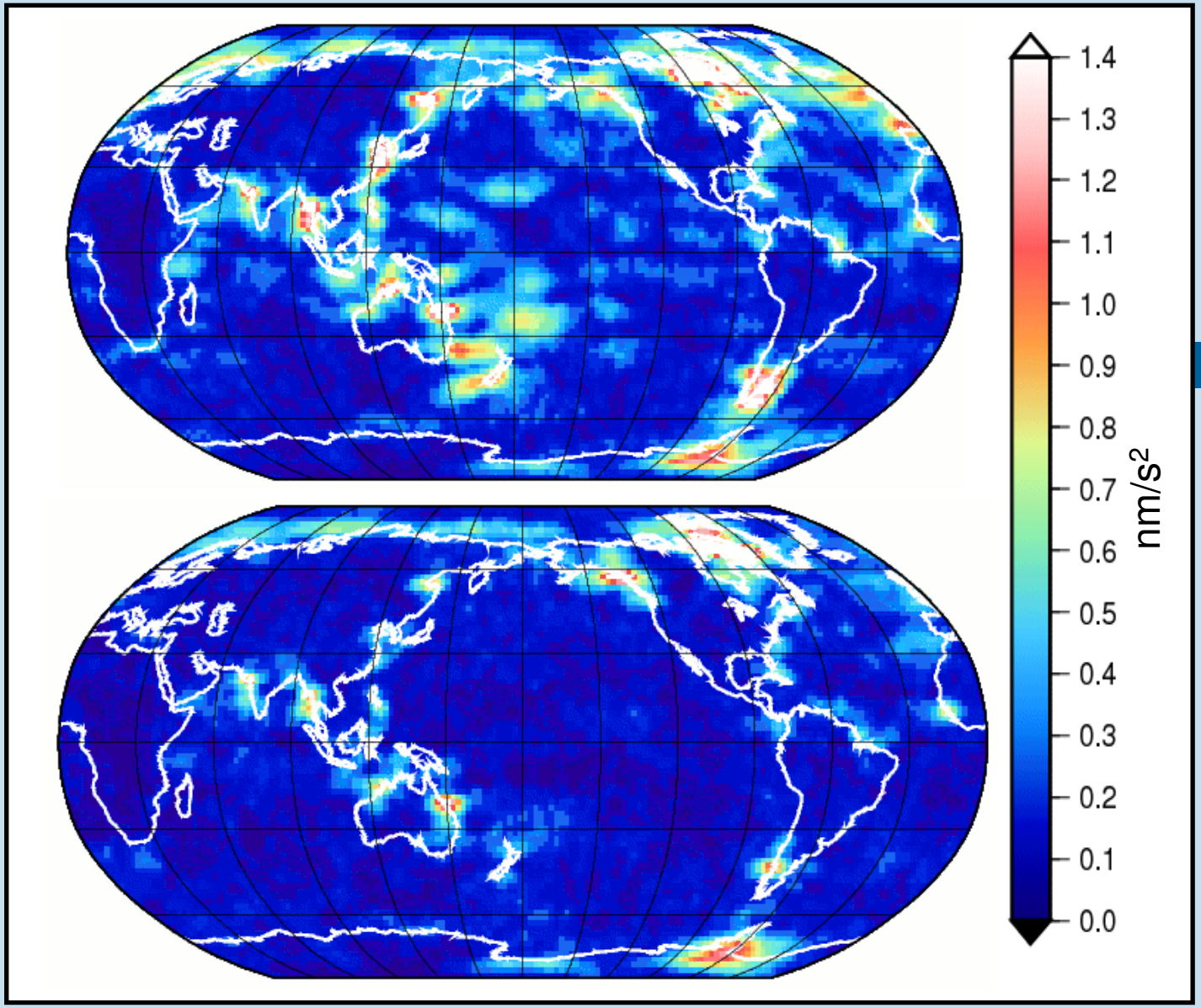
EOT08a as background



Range acceleration residual analysis – M2

FES2004

EOT08a



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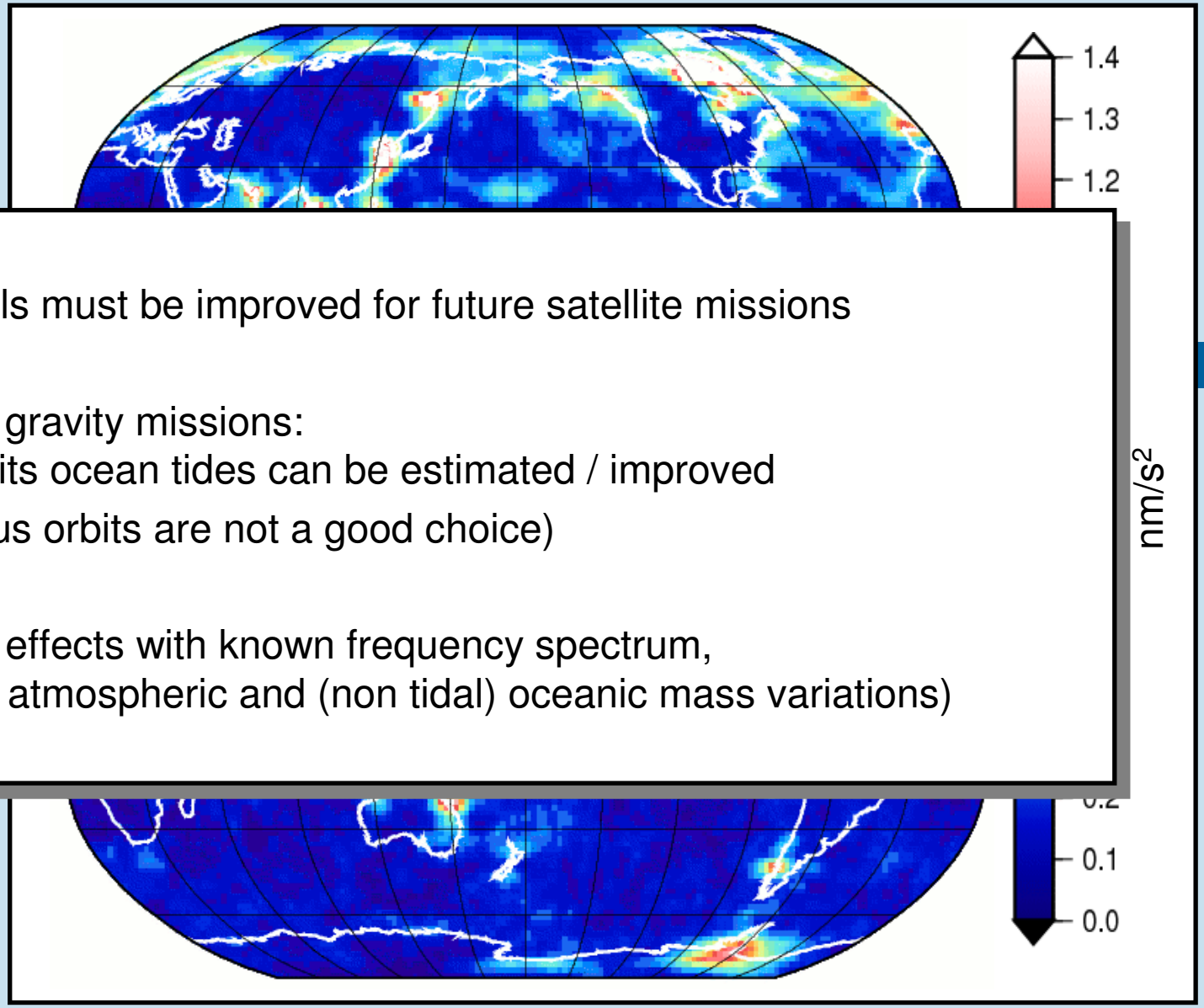


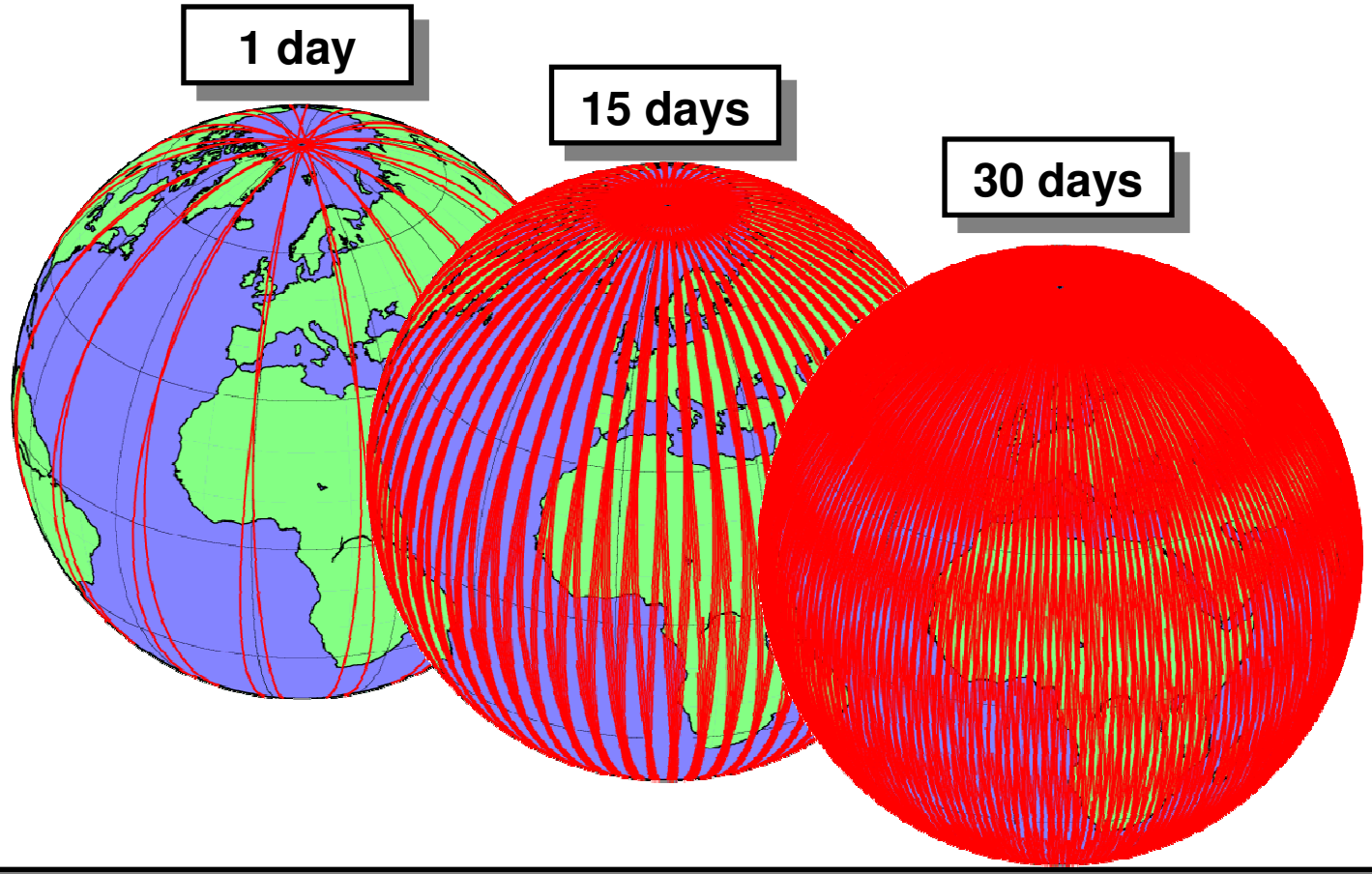
- Ocean tide models must be improved for future satellite missions

- Potential for new gravity missions:
  with tailored orbits ocean tides can be estimated / improved
  (sun synchronous orbits are not a good choice)

- Only possible for effects with known frequency spectrum,
  (not an option for atmospheric and (non tidal) oceanic mass variations)

GRACE

While the gravity field changes continously,
it takes time to collect satellites data



GRACE

While the gravity field changes continously,
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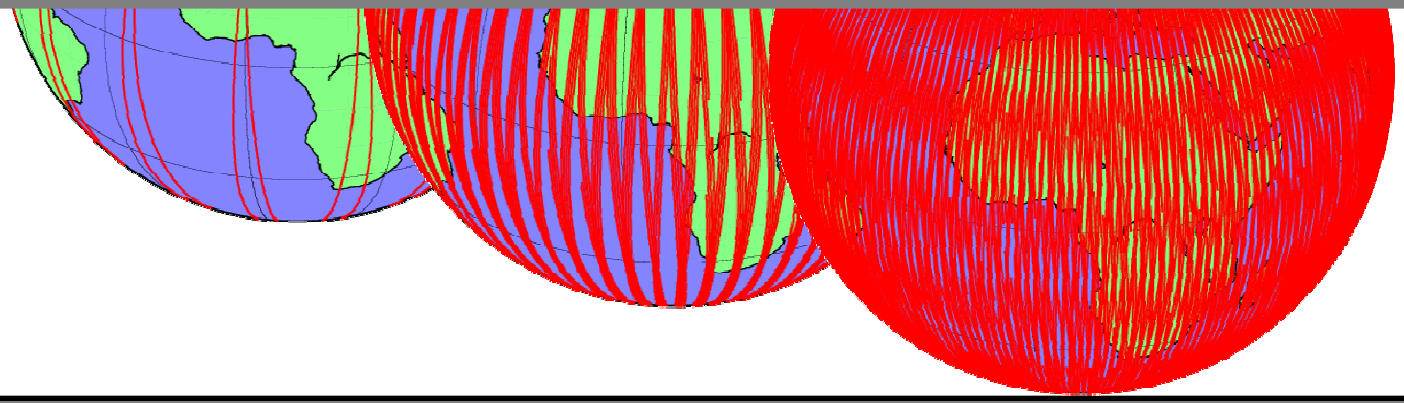
Common solution:

- Reduce high frequency signal by models,
  e.g. atmosphere and ocean dealiasing model (AOD1B)

- Estimate mean solution over a certain time span,
  e.g. monthly means



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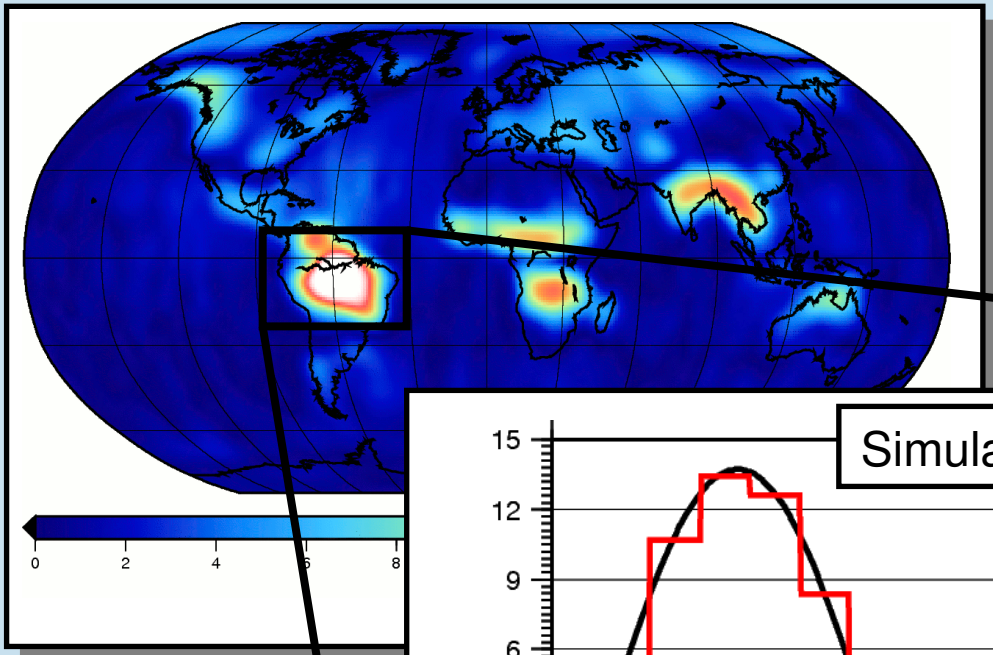
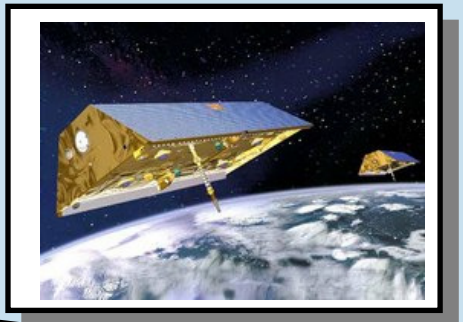
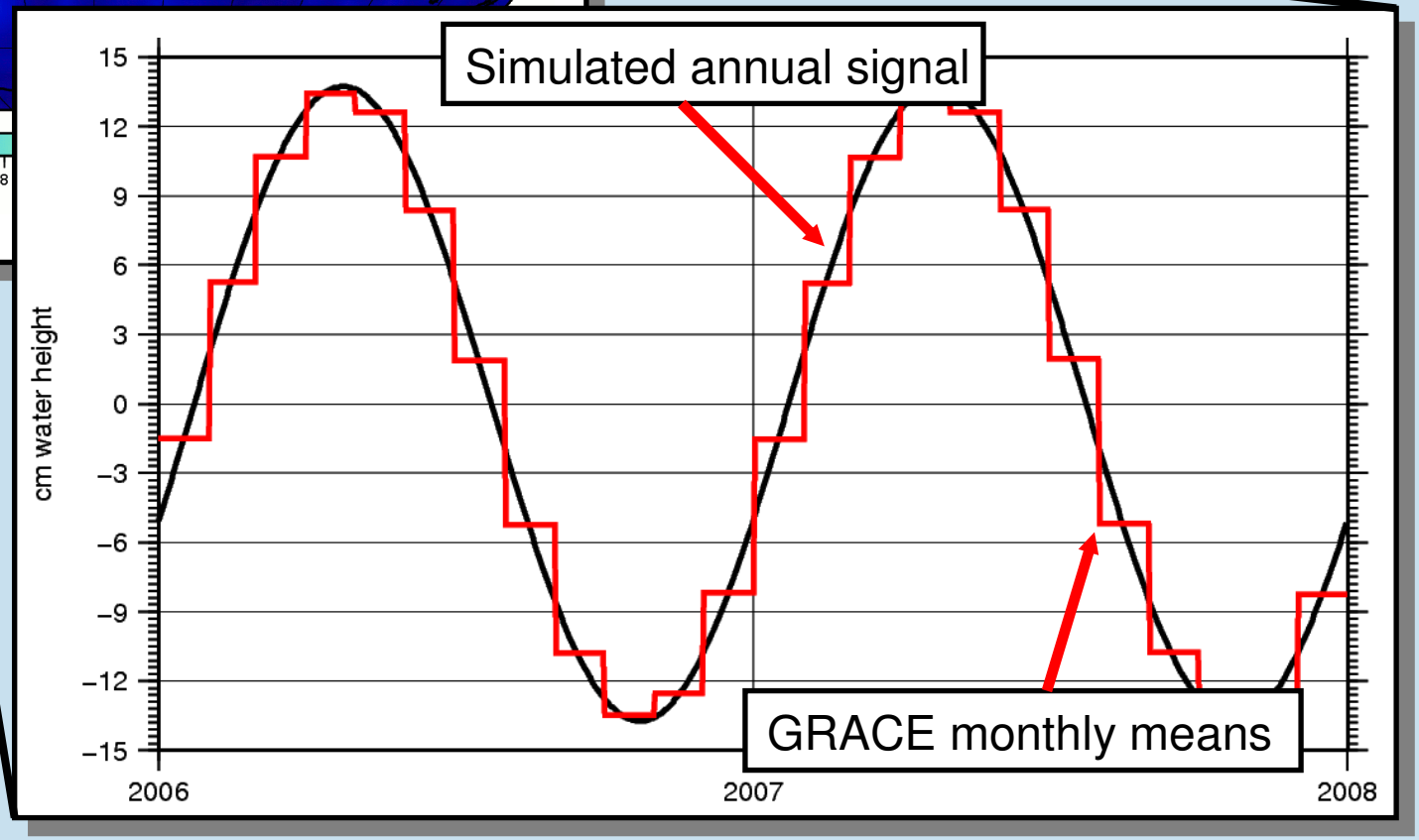
Question:

What means high frequency in terms of monthly means?

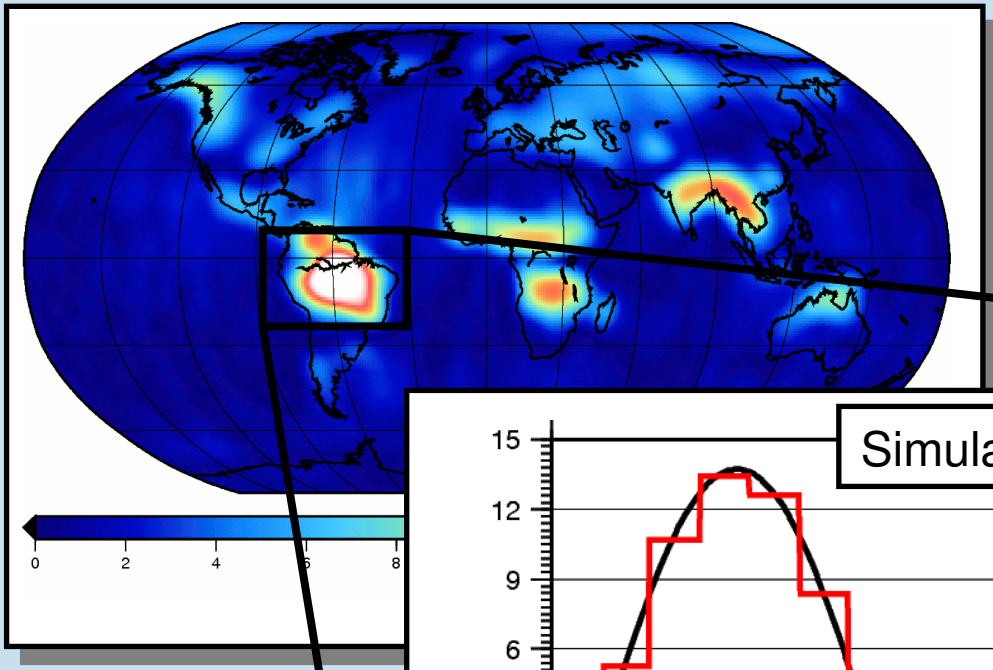
Simulation


0
2
4
6
8




Simulated annual signal
GRACE monthly means
cm water height
15
12
9
6
3
0
−3
−6
−9
−12
−15
2006
2007
2008

Simulation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4
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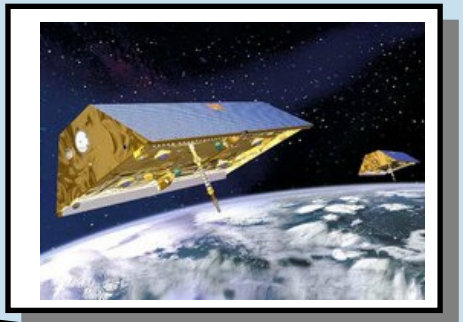
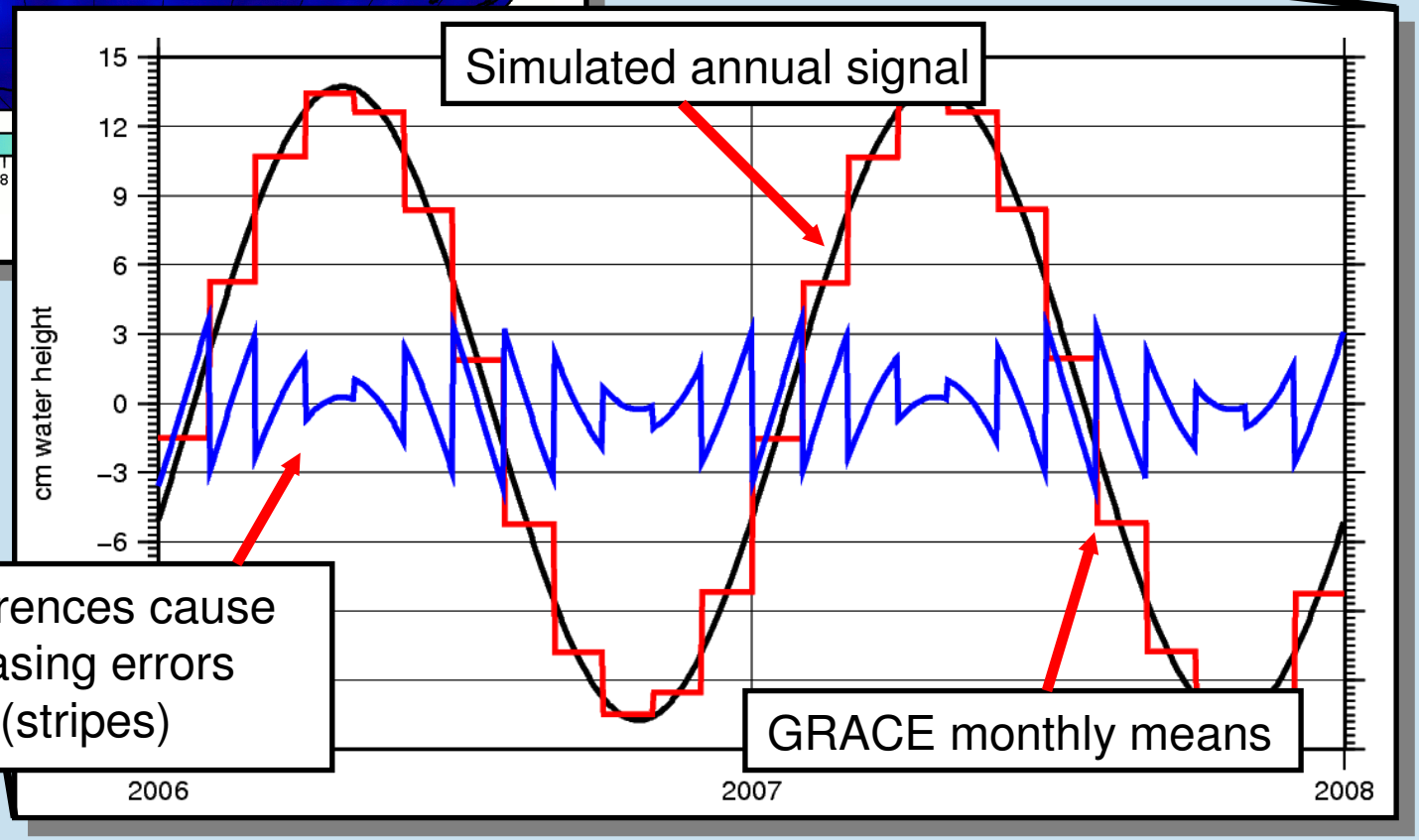
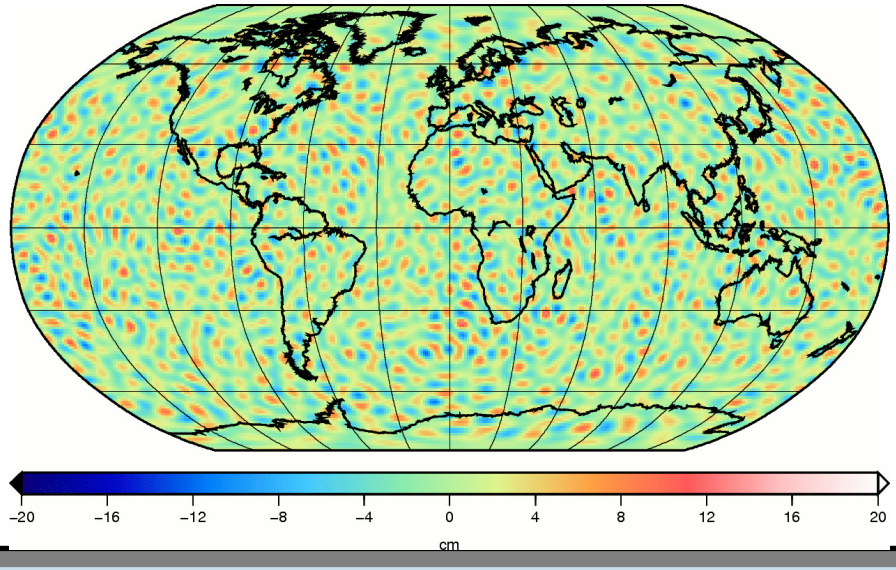



Simulated annual signal
15
12
9
6
3
0
−3
−6
cm water height
2006
2007
2008
Differences cause aliasing errors (stripes)
GRACE monthly means

Simulation (1 month, n=60, eq. water height)

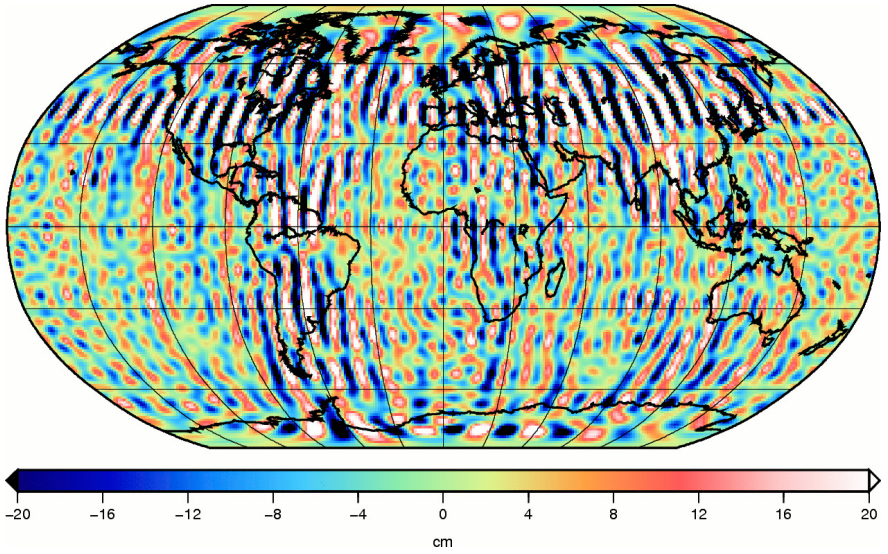
Errors in the solution without annual signal:

Basline accuracy is reached

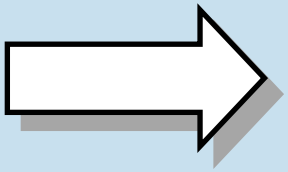


Errors in the solution with annual signal:

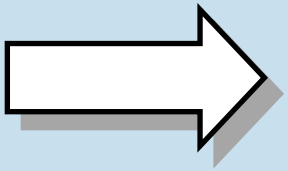
Well known stripping pattern



Even long-periodic signals cause aliasing errors in monthly mean fields

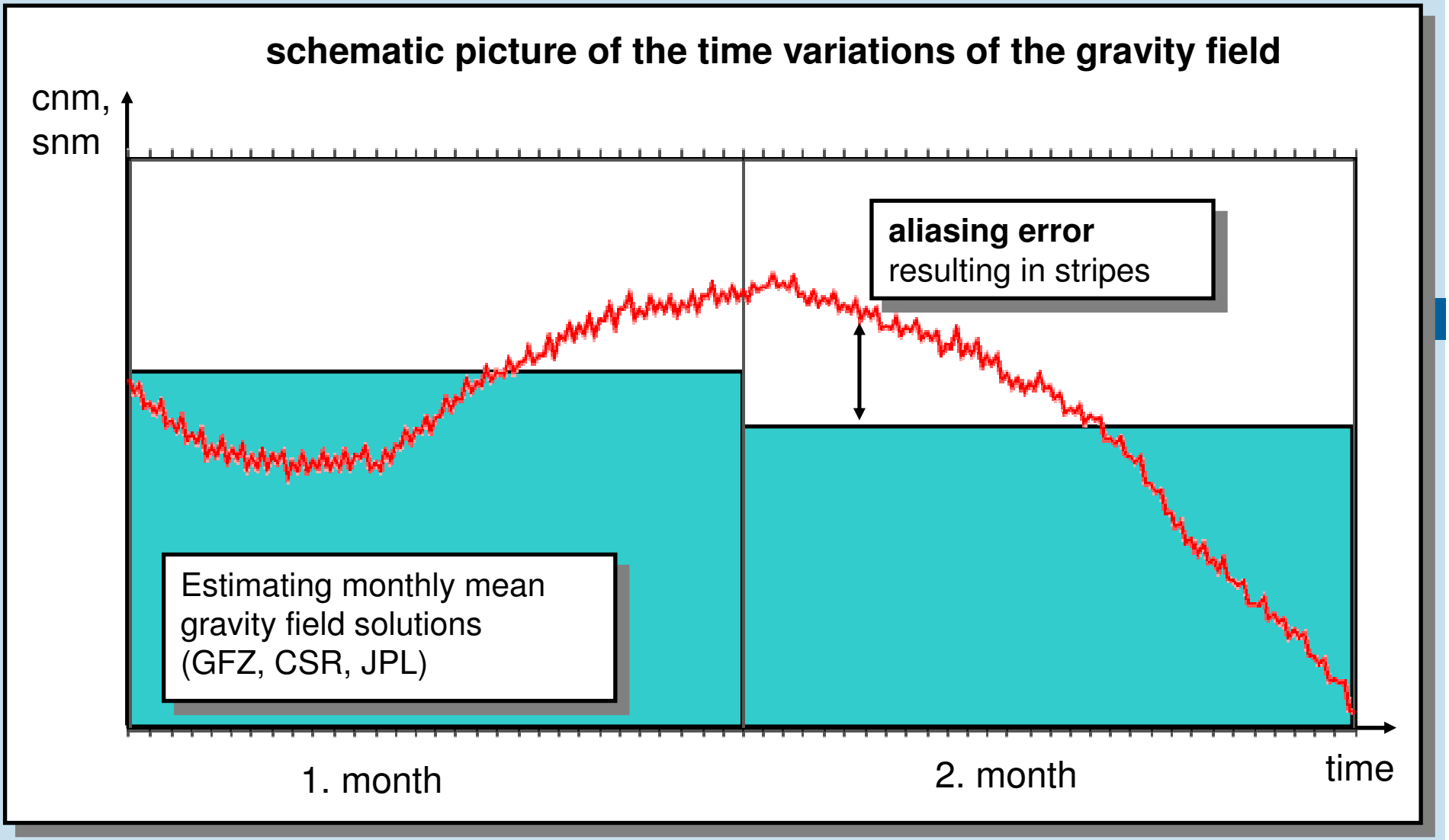


Time-step representations are not an optimal choice



Other ideas necessary to exploit the increased accuracy of new missions

Representation of the time variability



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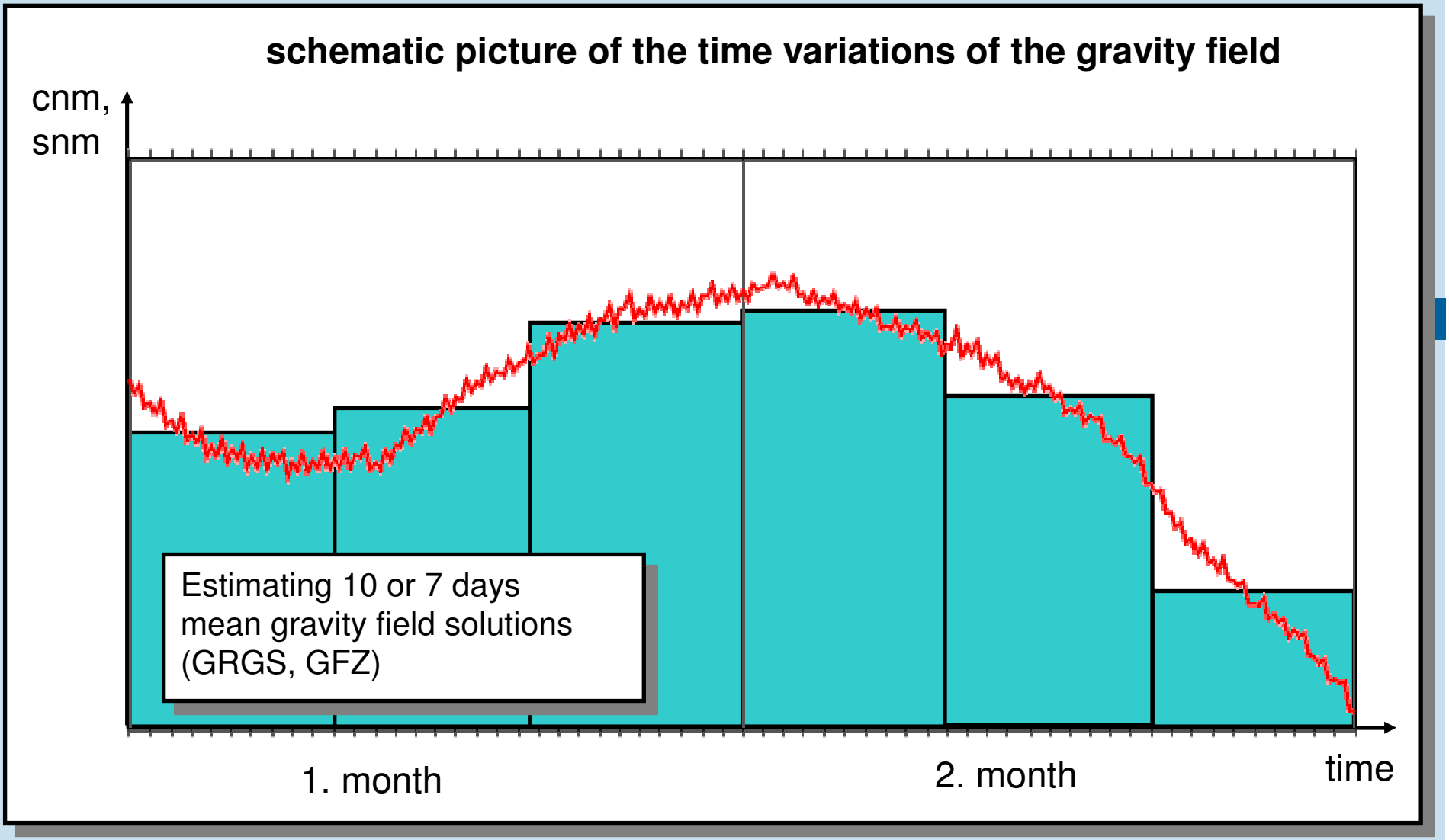

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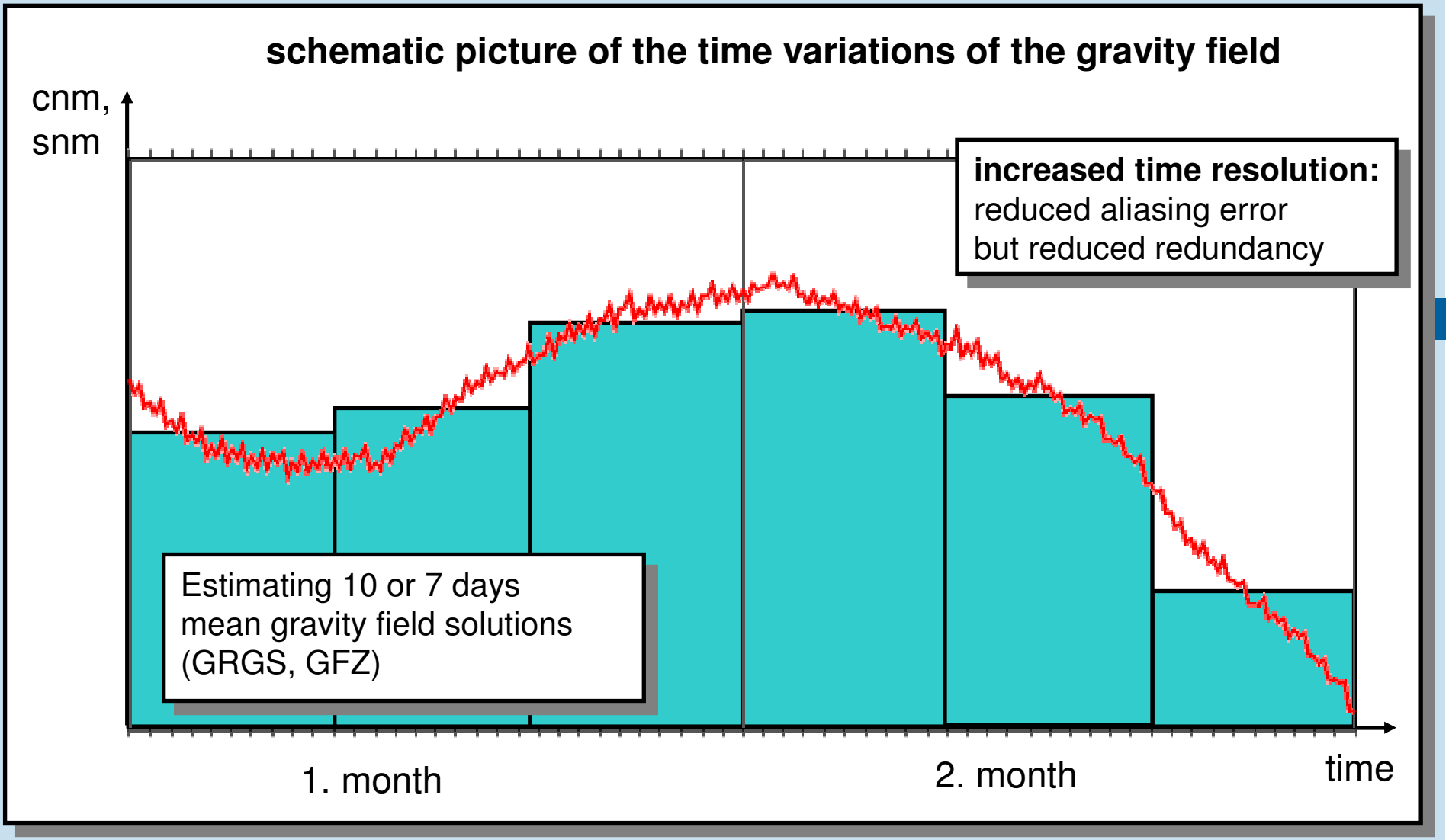

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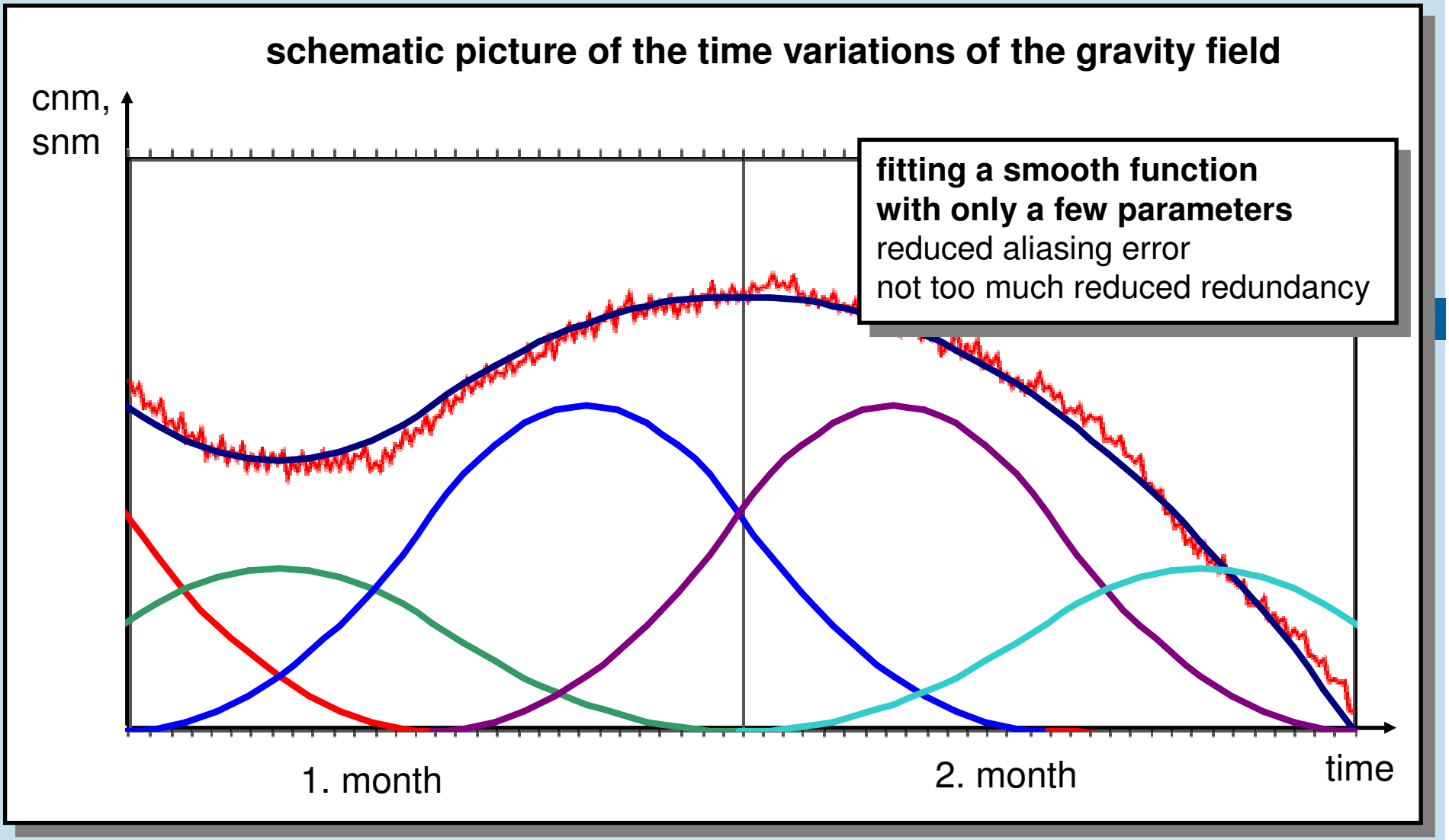
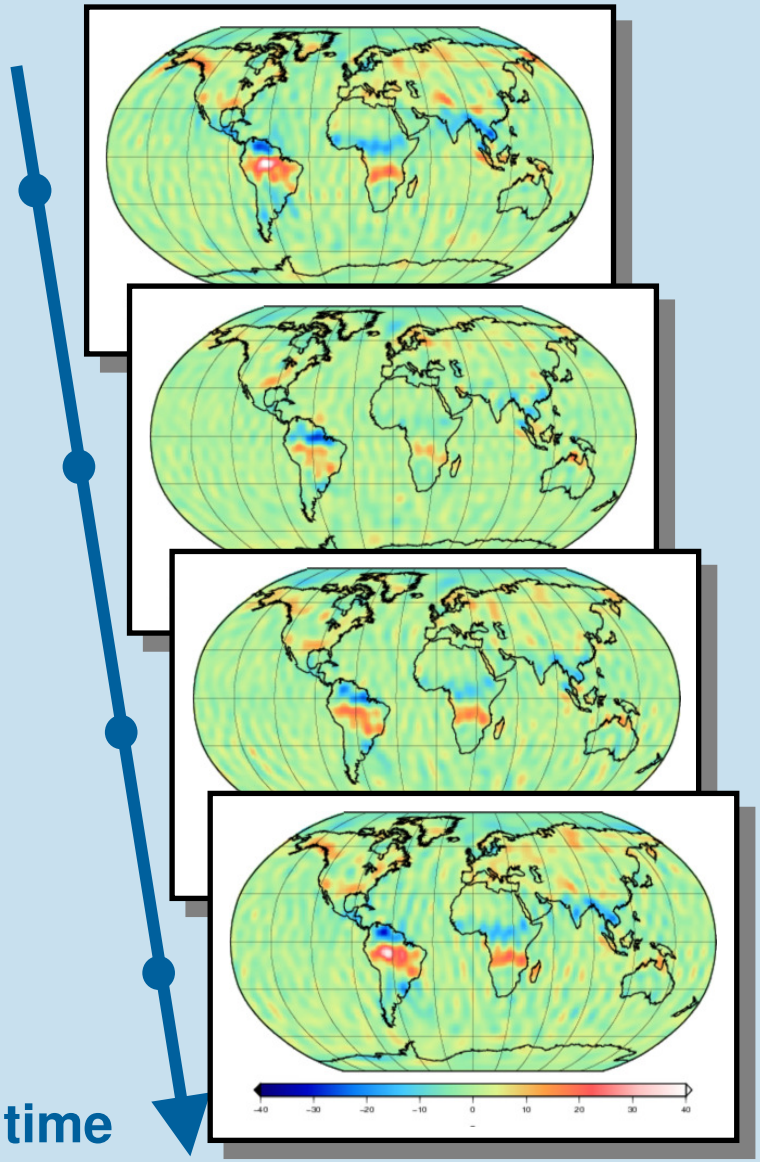


Dynamic process



Description of the time variable gravity field as dynamic process

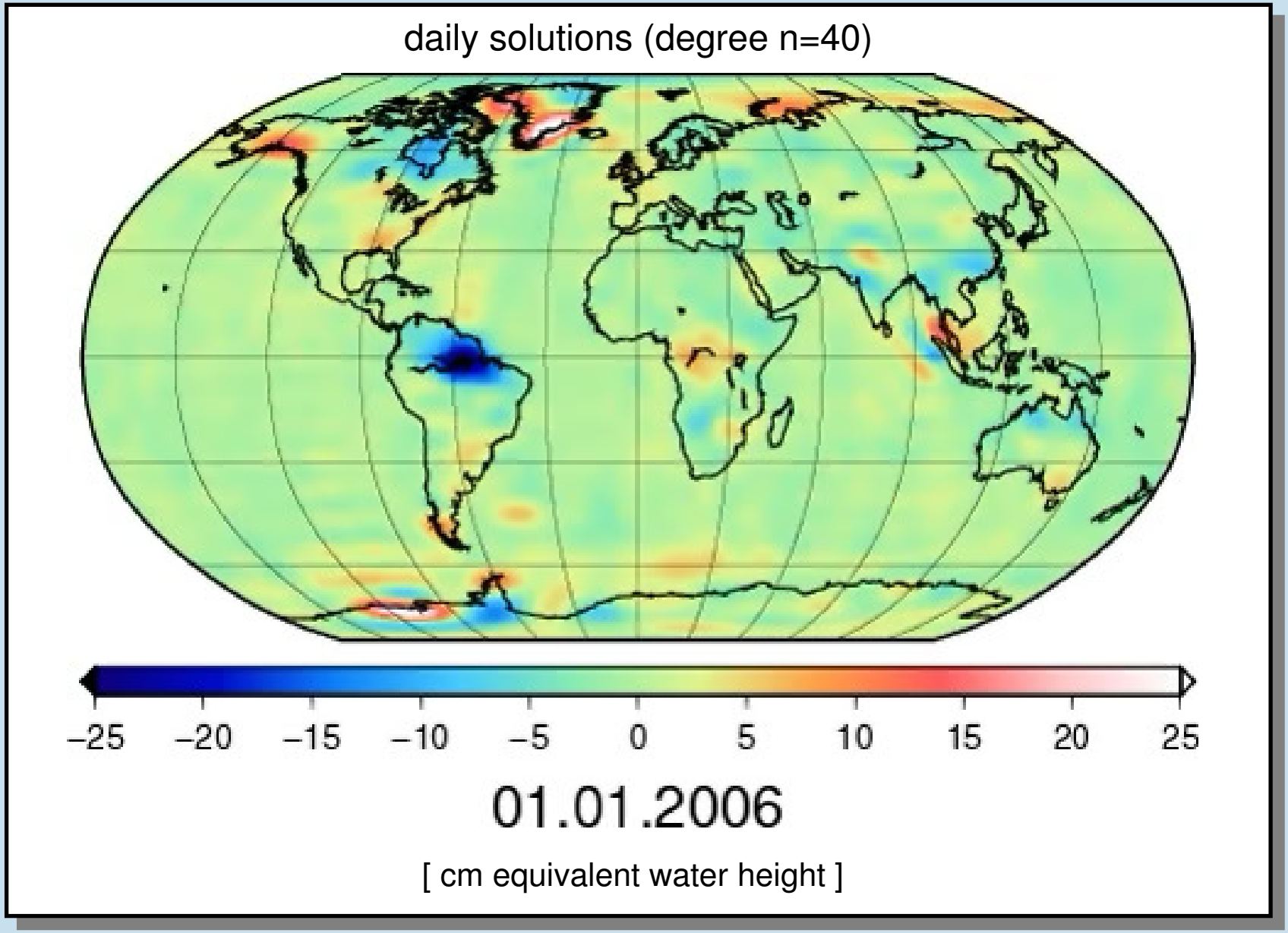
Current state is determined by previous states, state change is constrained by physics (prediction)

If physics is not exactly known, correlations can be derived by models

Current state is controlled by observations

→ Kalman Filter

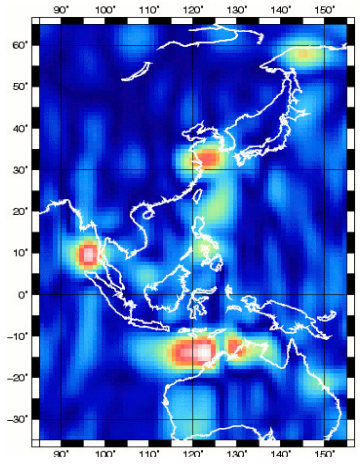
Kalman filter



Conclusions

- background models must be improved
  for future satellite missions

- Potential for new gravity missions:
  with tailored orbits ocean tides can be estimated / improved
  (sun synchronous orbits are not a good choice)



Even long-periodic signals cause aliasing errors
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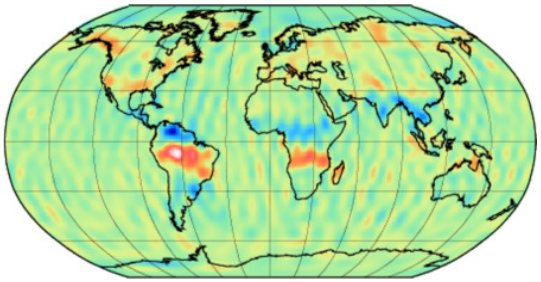

=> Block mean representations are not
an optimal choice

First ideas:
- Smooth representations in time by quadratic splines
- Description of the time variable gravity field as dynamic process

Further investigations necessary