Contribution of non-tidal oceanic mass variations to Earth rotation determined from space geodesy and ocean data

Franziska Göttl, Wolfgang Bosch, Michael Schmidt, Florian Seitz

Deutsches Geodätisches Forschungsinstitut

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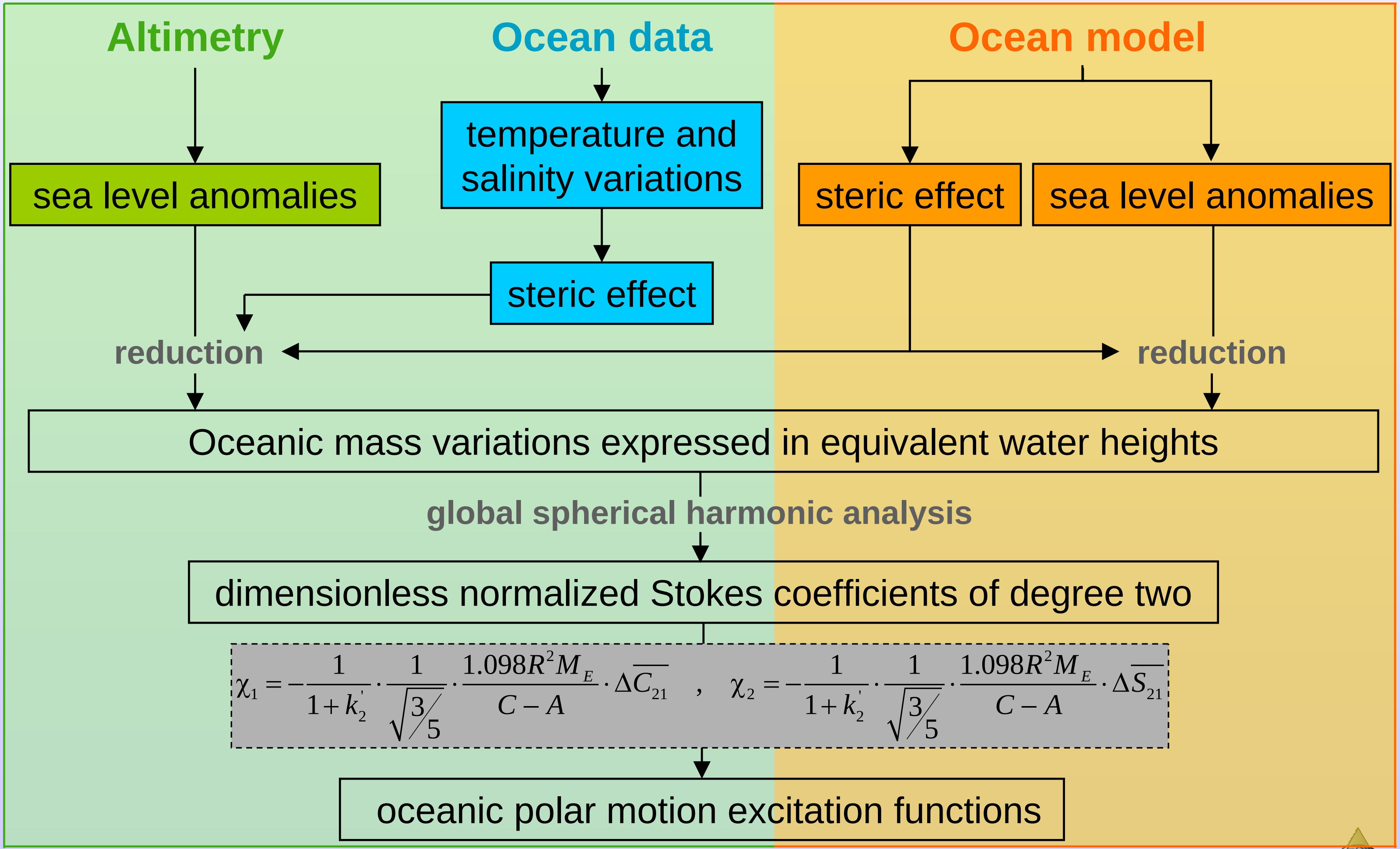
Motivation

- The motion of the rotation axis with respect to the Earth’s surface can be observed precisely from space geodetic techniques
- Underlying geophysical processes within and between the subsystems of the Earth that perturb the Earth rotation have to be separated for a better understanding of our planet
- Global mass displacements and movements can be estimated from terrestrial and space observations and from assimilated models

Can satellite altimetry estimate oceanic mass variations better than ocean models?

Calculation method



Data sources (1)

Altimetry

Sea level anomalies (SLA) from TOPEX/Poseidon extended mission

- Altimeter data: MGDR, Version C
- Consideration of environmental and geophysical corrections, including inverse barometer correction
- Mean sea surface of 2003 - 2005
- Monthly mean (time series)
- Roman Savcenko, Wolfgang Bosch (DGFI)

Ocean data

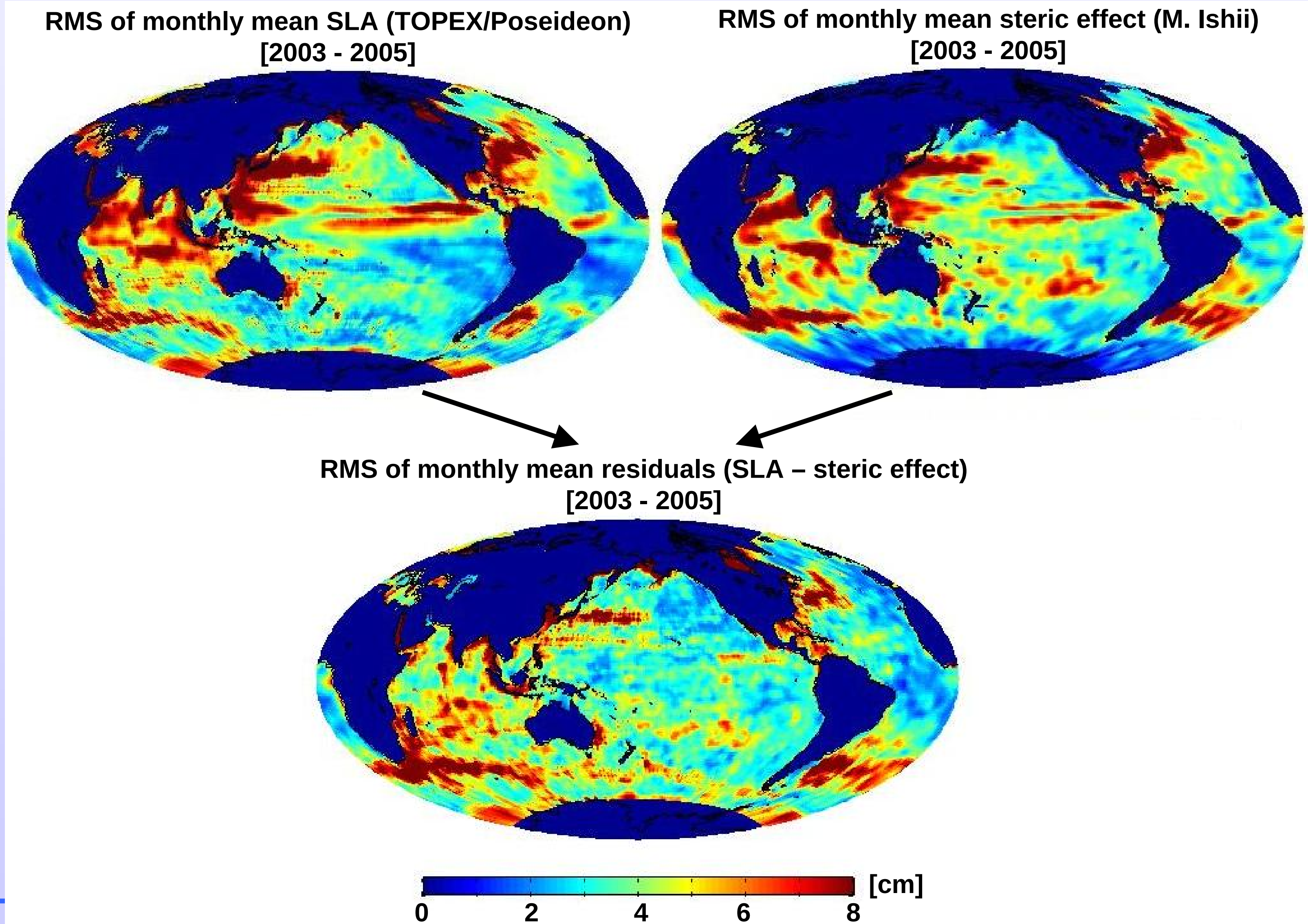
Temperature and salinity climatologies of the WOA05

- 24 depth level (0 - 1500m)
- long-period monthly mean (averages)
- http://www.nodc.nova.gov/OC5/WOA05

Temperature and salinity fields from Masayoshi Ishii

- 16 depth level (0 - 700m)
- monthly mean (time series)
- Masayoshi Ishii (Frontier Research Center for Global Change)

Data sources (2)



Data sources (3)

Ocean model

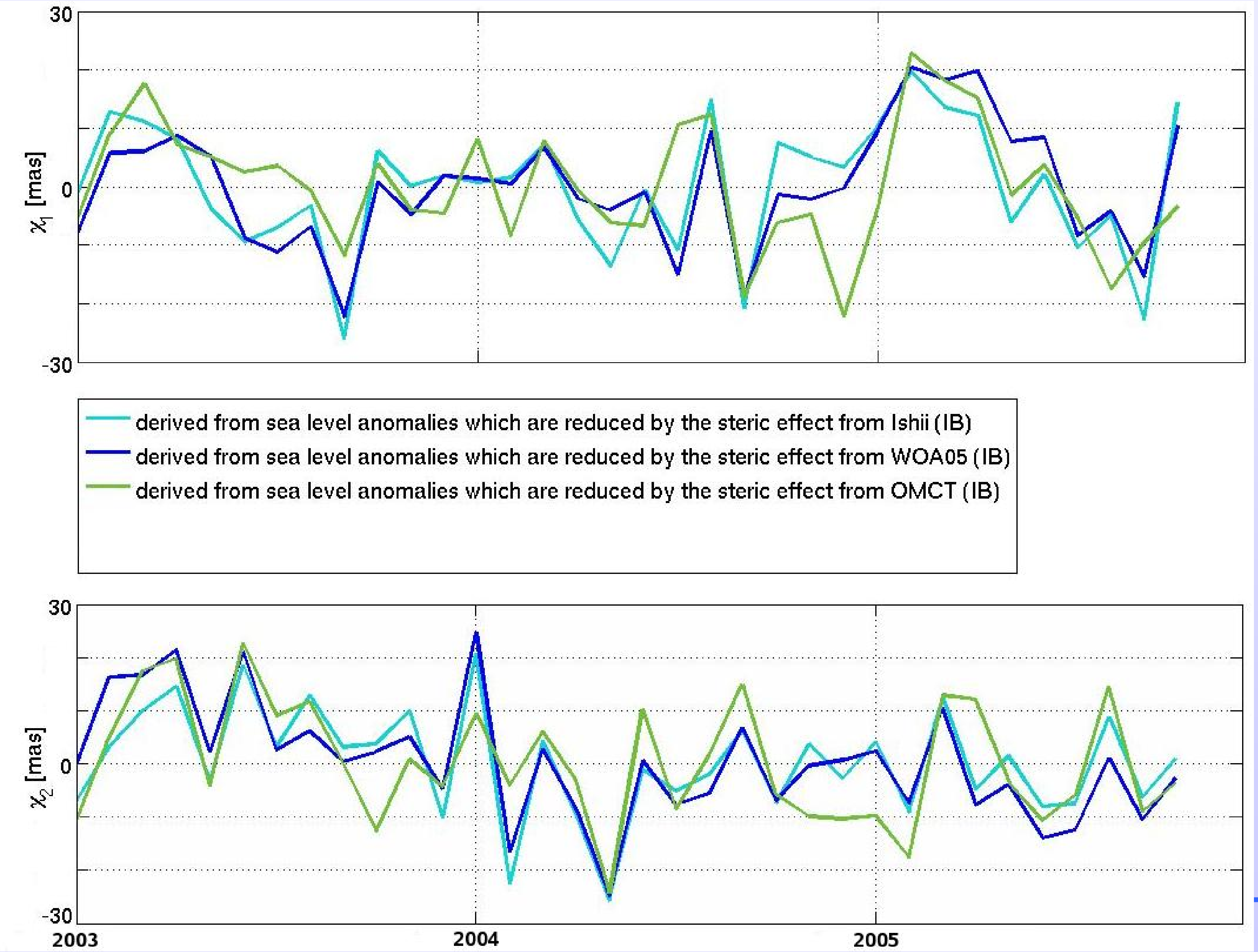
Oceanic excitation functions from baroclinic ocean model OMCT

- Forcing with ECMWF
  - wind stress
  - 2m-temp.
  - freshwater fluxes
- IB adoption
- Assimilation: no
- Mass conservation
- Monthly mean (time series)
- Maik Thomas (GFZ-Potsdam)

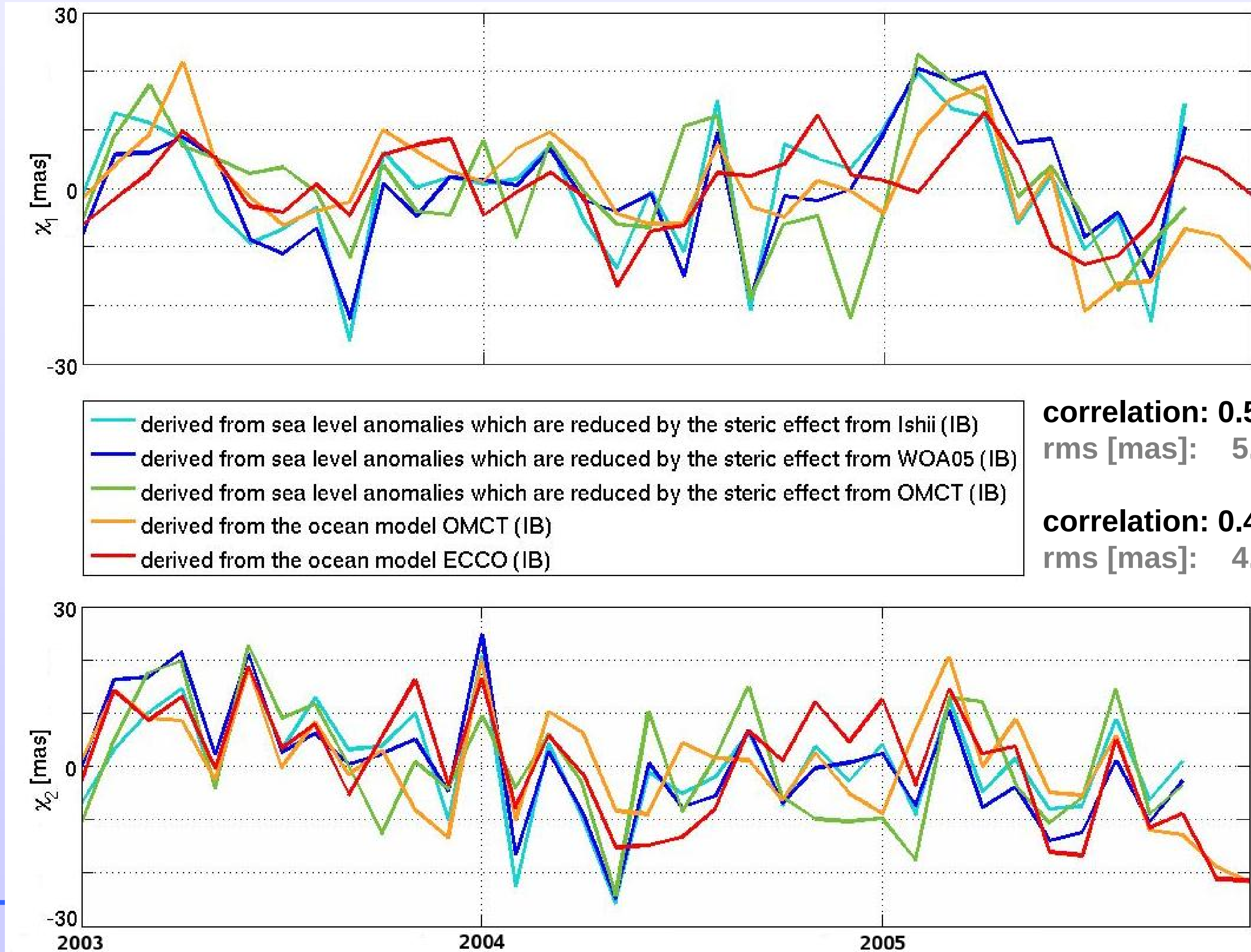
Oceanic excitation functions from baroclinic ocean model ECCO (kf049f)

- Forcing with NCEP reanalysis
  - wind stress
  - heat flux
  - freshwater fluxes
- IB adoption
- Assimilation: altimetry & XBT
- Mass conservation
- Monthly mean (time series)
- http://euler.jpl.nasa.gov/sbo/sbo_data.html

Oceanic excitations



Oceanic excitations - compare



correlation: 0.52 – 0.87
rms [mas]: 5.4 – 11.0

correlation: 0.47 – 0.90
rms [mas]: 4.7 – 10.5

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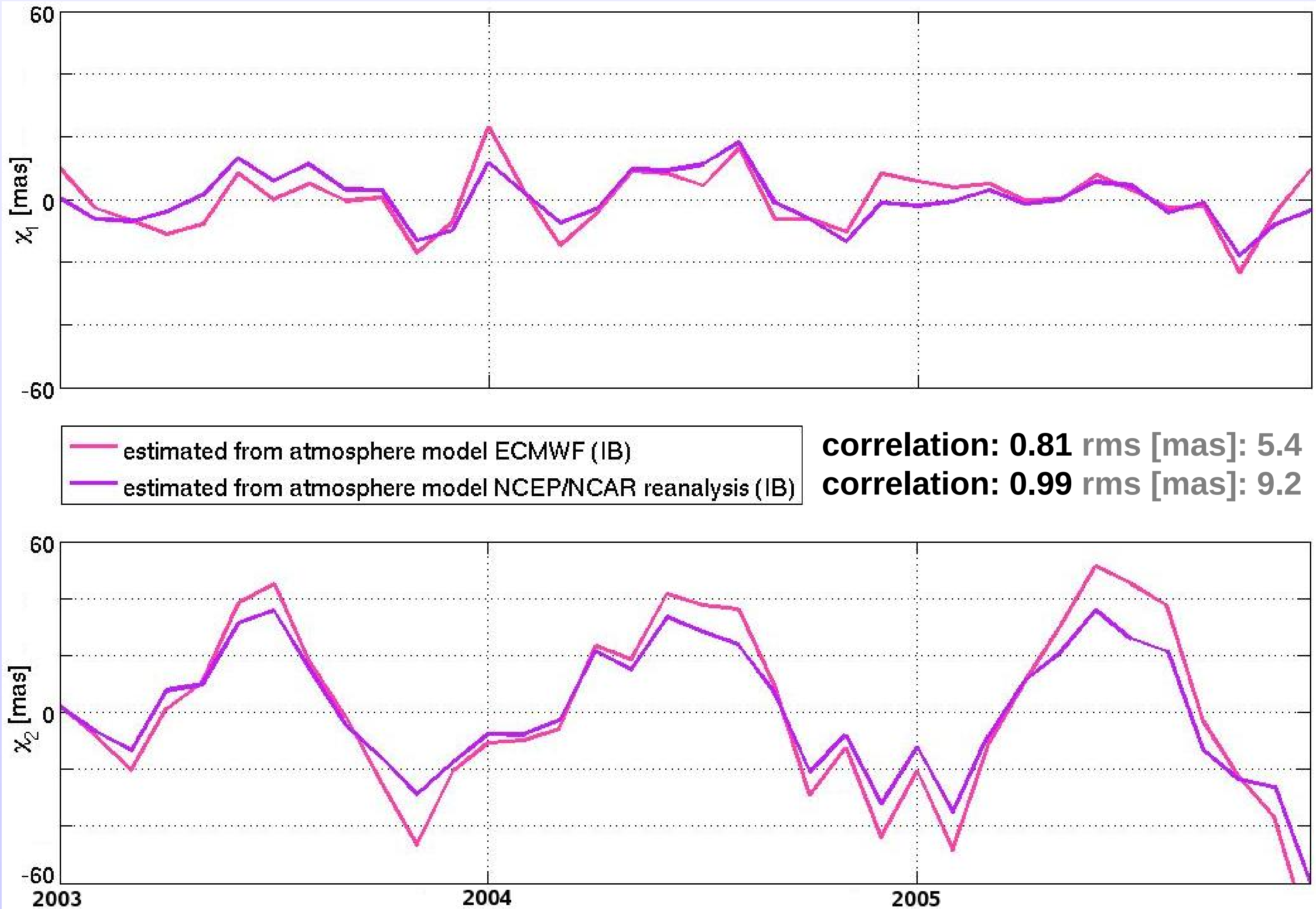
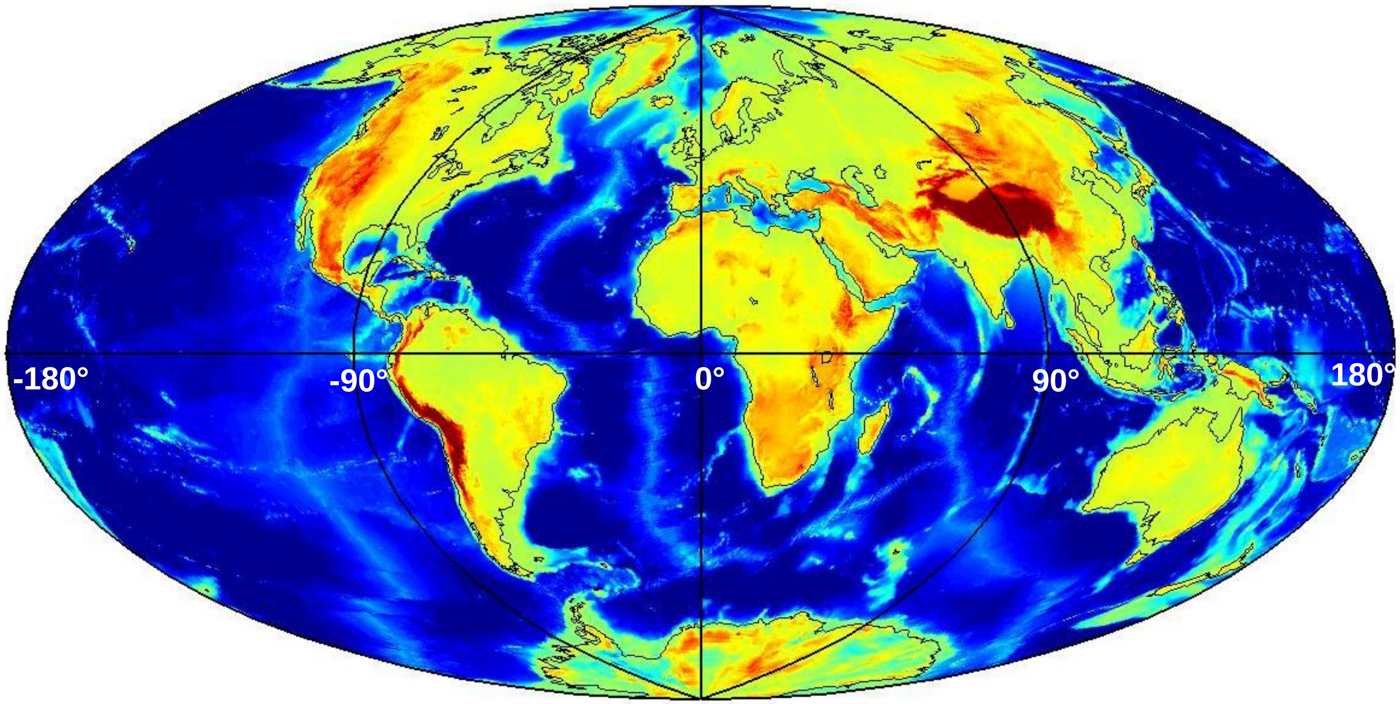
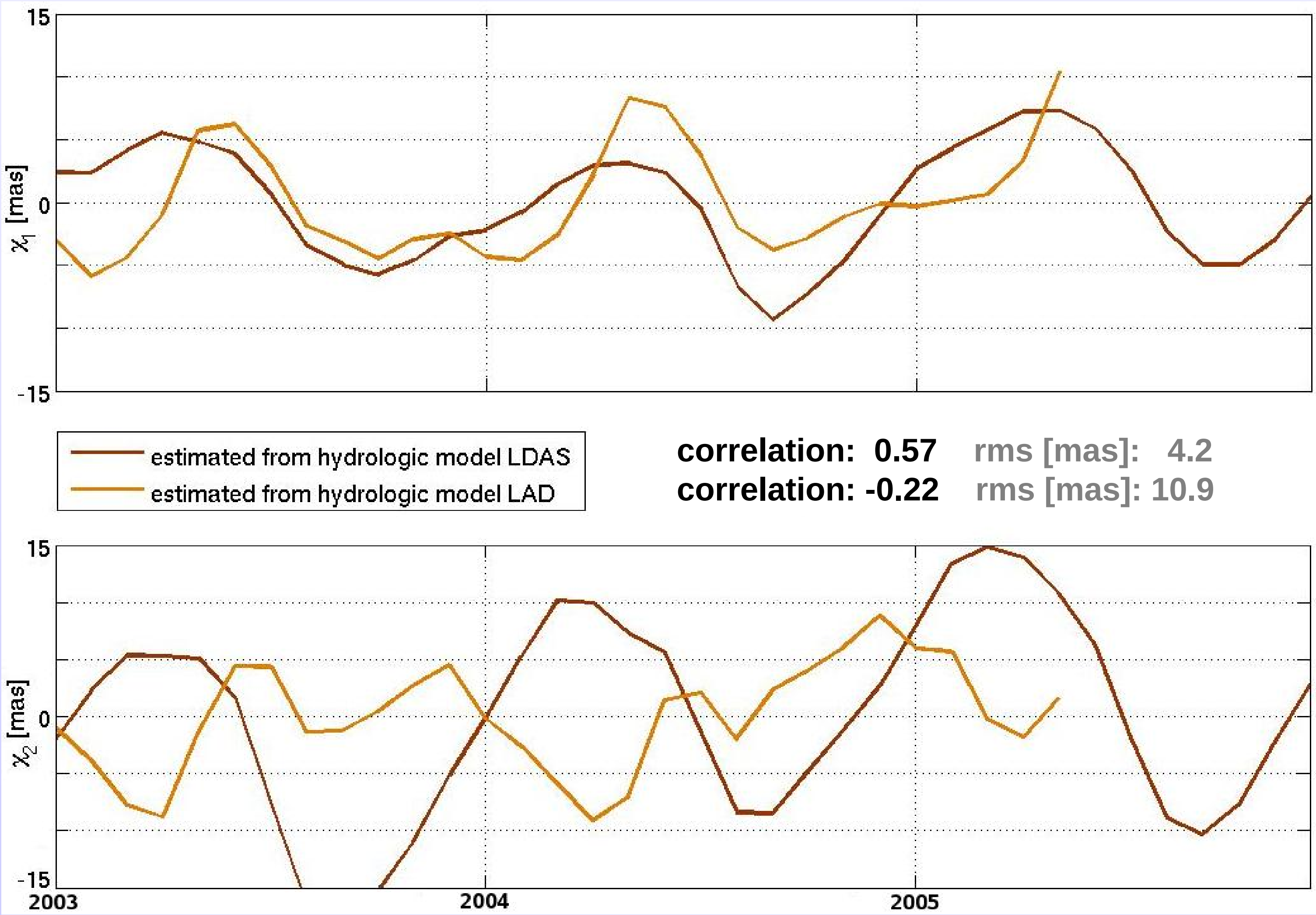
Atmospheric excitations



Land ocean distribution

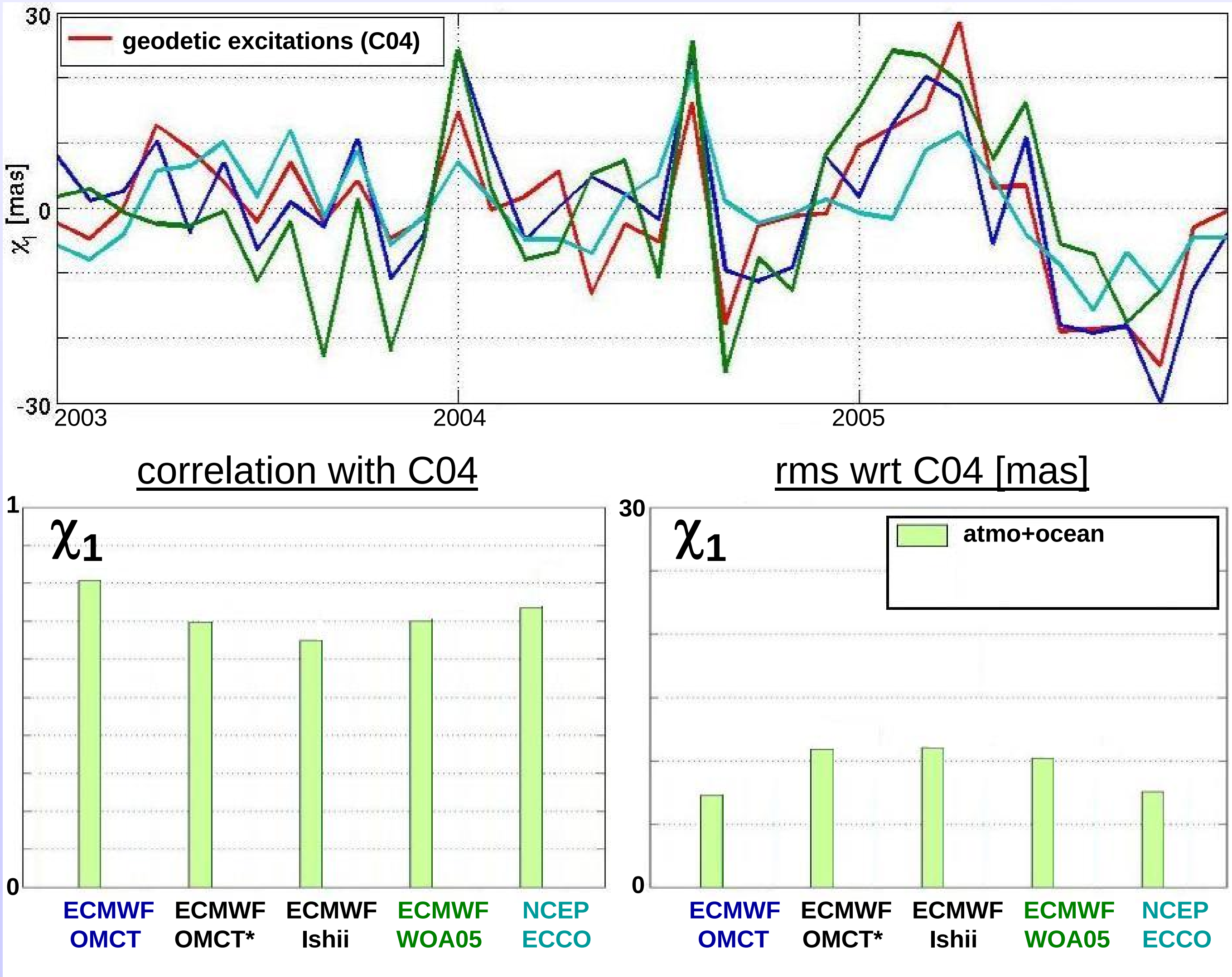


Hydrological excitations



correlation: 0.57 rms [mas]: 4.2
correlation: -0.22 rms [mas]: 10.9

Agreement w. geodetic excitations (C04)



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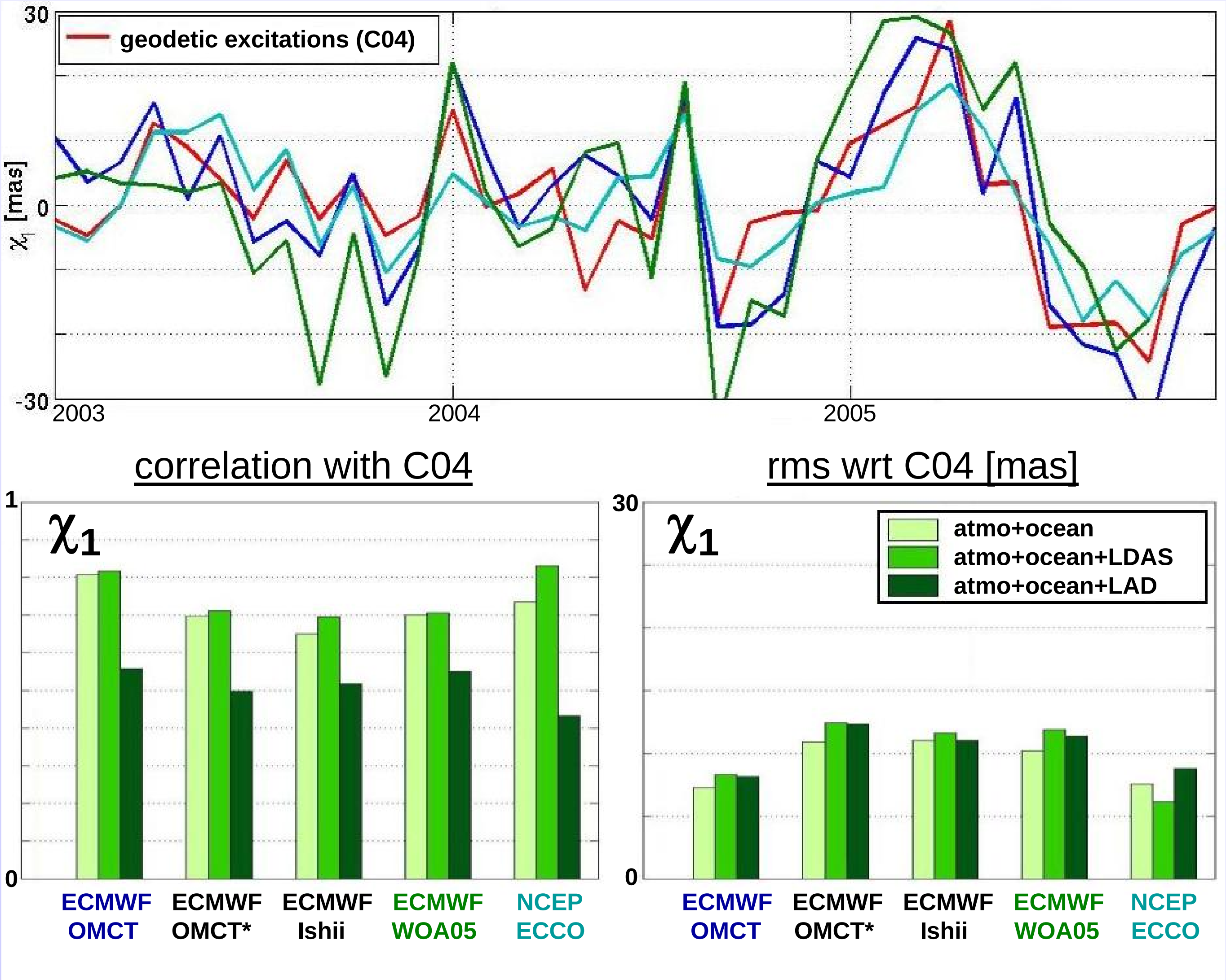

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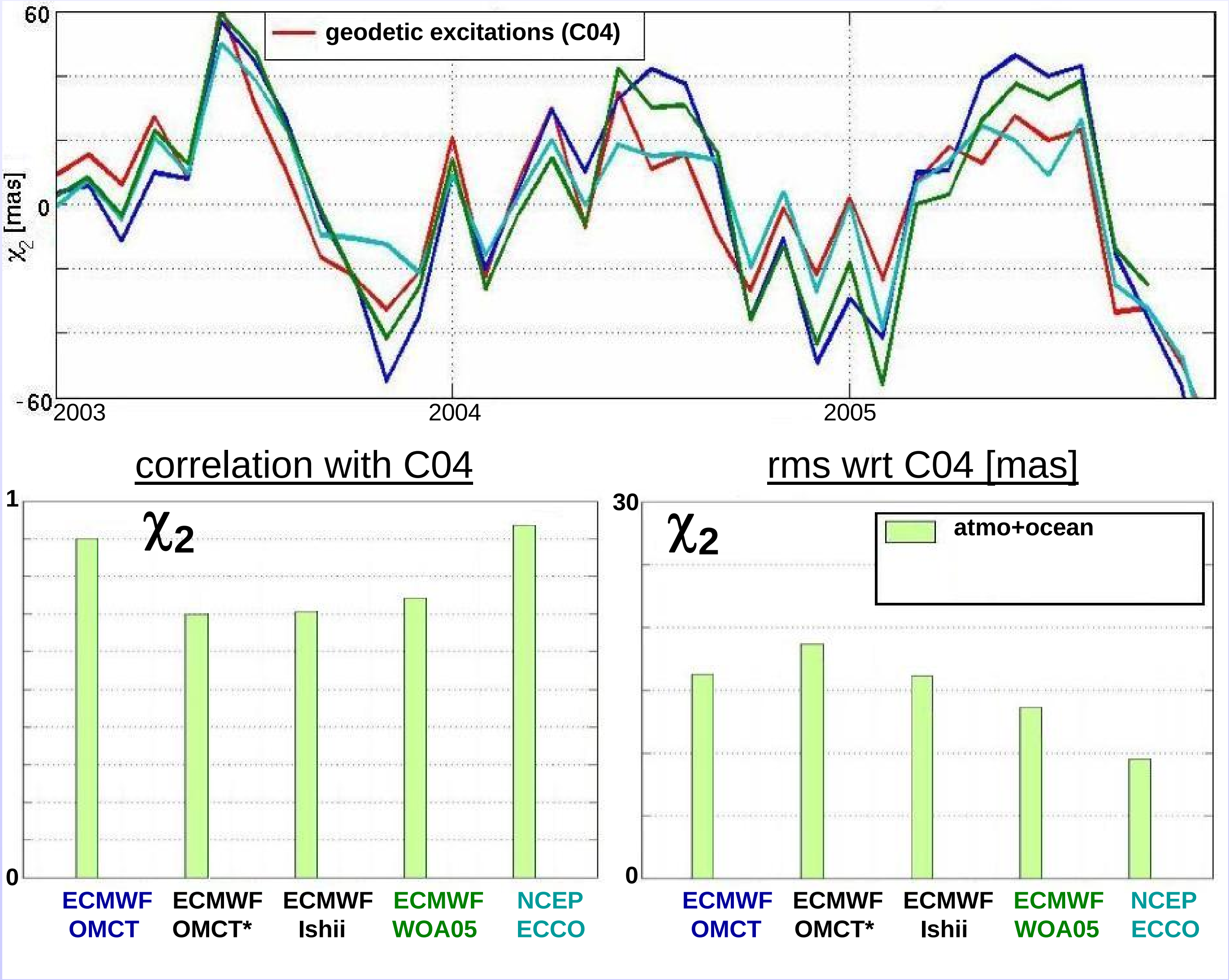
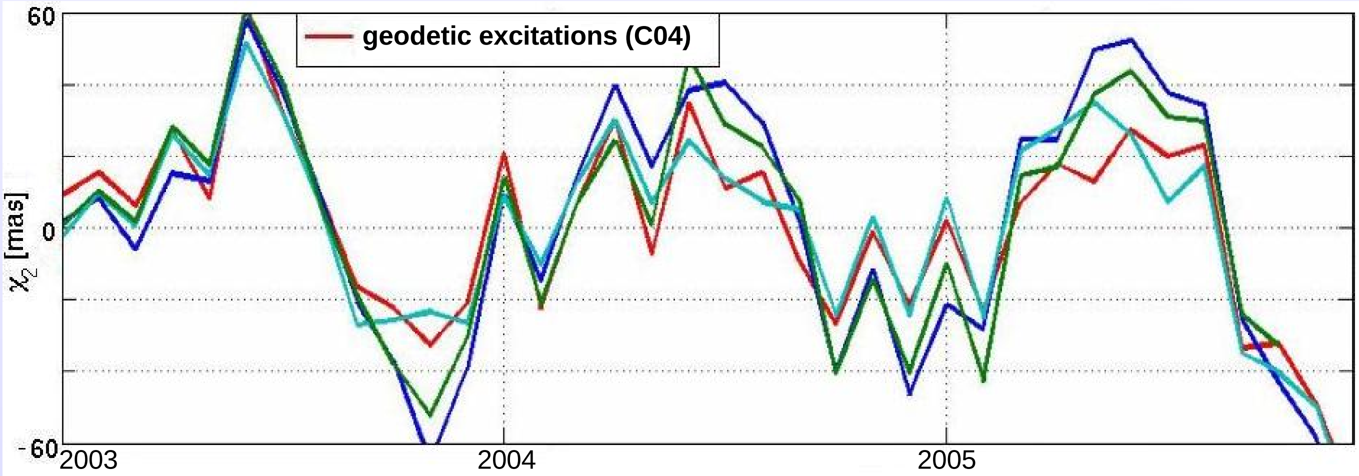
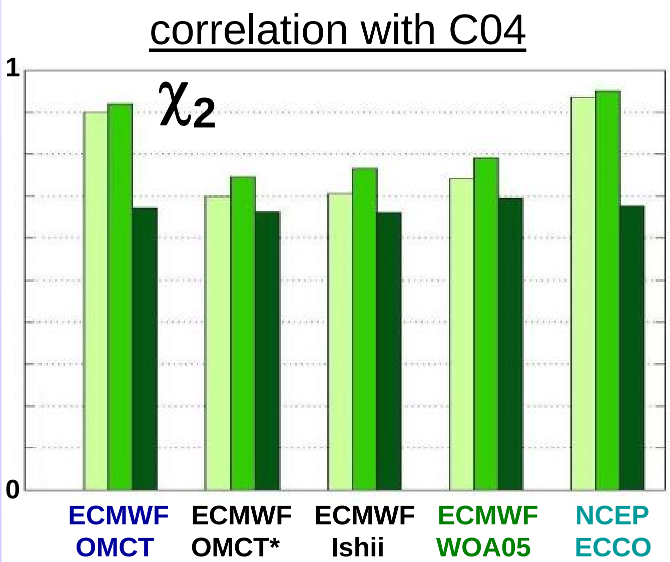
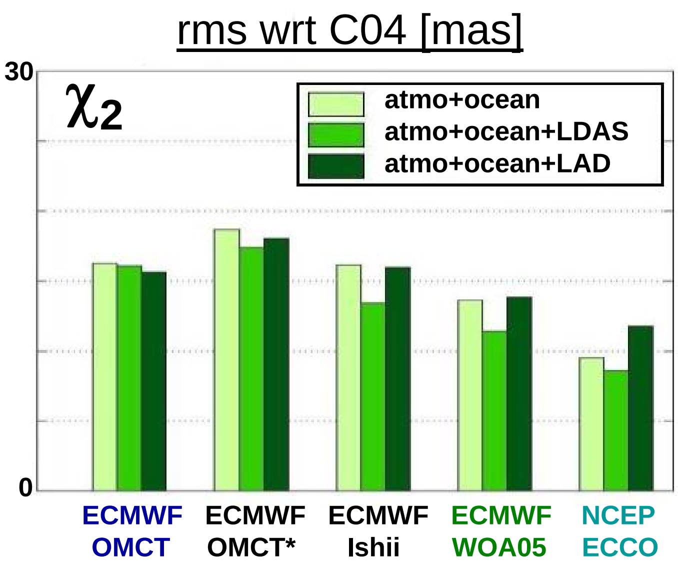


Agreement w. geodetic excitations (C04)







Conclusions and Outlook

Adding hydrological excitations from LDAS do mostly raise the agreement with geodetic excitations.

Assimilated-model-only polar motion excitations seem to be better than combined polar motion excitations.

- Assimilated-model-only solutions are consistent
  - Errors of atmospheric model are compensated by ocean model
- Combined solutions may be inconsistent
  - Classical IB adoption
  - Uncertainties of steric effect
  - Uncertainties of atmosphere model
  - Uncertainties of oceanic mass movements from ocean model

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Assimilated-model-only polar motion excitations seem to be better than combined polar motion excitations.

- Assimilated-model-only solutions are consistent
  - Errors of atmospheric model are compensated by ocean model
- Combined solutions may be inconsistent
  - Classical IB adoption (dynamic atmosphere correction)
  - Uncertainties of steric effect (new satellite mission SMOS)
  - Uncertainties of atmosphere model
  - Uncertainties of oceanic mass movements from ocean model

Thank you for your attention!

Agreement w. geodetic excitations (C04)