

Current Status of AOD1B: RL05 and RL06

Henryk Dobslaw, Inga Bergmann-Wolf, Robert Dill,
Lea Poropat, Frank Flechtner

German Research Centre for Geosciences (GFZ)
Department 1: Geodesy
dobslaw@gfz-potsdam.de

AOD1B is an *a priori* background model fully independent from GRACE sensor data.

Purpose:

- AOD1B attempts to remove high-frequency non-tidal gravity signals at periods shorter than ~ 60 days from the GRACE sensor data in order to avoid temporal aliasing.
- AOD1B provides a priori information on atmospheric mass variability in order to aid the geophysical signal separation.

Requirements:

- AOD1B needs to be provided with very high temporal and spatial resolution to properly represent the atmospheric weather systems.
- AOD1B needs to be stable on time-scales from years to decades in order to avoid the introduction of spurious signals into the gravity fields.

Currently Maintained AOD1B Releases

RL05	RL06
since 1979; 6 hourly; d/o=100	since 1976; 3 hourly; d/o=180
ERA-Interim (1979 – 2000) op. ECMWF (since 2001)	ERA-40 (1976 – 1978) ERA-Interim (1979 – 2006) op. ECMWF (since 2007)
OMCT 1.0° forced with 6 hourly ECMWF data	MPIOM TP1L40 forced with 3 hourly ECMWF data
ATM; OCN; GLO; OBA	ATM (IB-corrected); OCN (additive inverse IB-corrected); GLO; OBA
S2 tide removed from OCN only; S2 and S3 partially aliased	12 frequencies removed from both OCN and ATM
artificial drift in OCN component; jumps in ATM component	residual decadal signals are in range of observed variability
update cycle: weekly	update cycle: daily

Available Documentation for RL06

GRACE 327-750

Gravity Recovery and Climate Experiment

Product Description Document
for AOD1B Release 06

(Rev. 6.1, September 14, 2017)

Henryk Dobslaw, Inga Bergmann-Wolf, Robert Dill,
Lea Poropat, Frank Flechtner

GFZ German Research Centre for Geosciences
Department 1: Geodesy



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A new high-resolution model of non-tidal atmosphere and ocean mass variability for de-aliasing of satellite gravity observations: AOD1B RL06

H. Dobslaw, I. Bergmann-Wolf, R. Dill, L. Poropat, M. Thomas, C. Dahle, S. Esselborn, R. König and F. Flechtner

Deutsches GeoForschungsZentrum—GFZ, Department 1: Geodesy, Telegrafenberg, D-14473 Potsdam, Germany. E-mail: dobslaw@gfz-potsdam.de

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SUMMARY

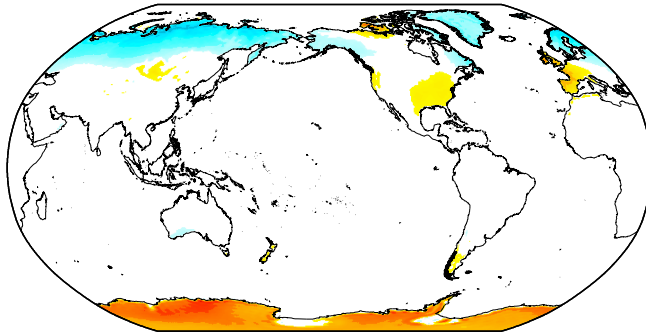
The release 06 (RL06) of the Gravity Recovery and Climate Experiment (GRACE) Atmosphere and Ocean De-Aliasing Level-1B (AOD1B) product has been prepared for use as a time-variable background model in global gravity research. Available since the year 1976 with a temporal resolution of 3 hr, the product is provided in Stokes coefficients up to degree and order 180. RL06 separates tidal and non-tidal signals, and has an improved long-term consistency due to the introduction of a time-invariant reference orography in continental regions. Variance reduction tests performed with globally distributed *in situ* ocean bottom pressure recordings and sea-surface height anomalies from Jason-2 over a range of different frequency bands indicate a generally improved performance of RL06 compared to its predecessor. Orbit tests for two altimetry satellites remain inconclusive, but GRACE *K*-band residuals are reduced by 0.031 nm s^{-2} in a global average, and by more than 0.5 nm s^{-2} at numerous places along the Siberian shelf when applying the latest AOD1B release. We therefore recommend AOD1B RL06 for any upcoming satellite gravimetry reprocessing effort.

Key words: Global change from geodesy; Loading of the Earth; Satellite gravity.

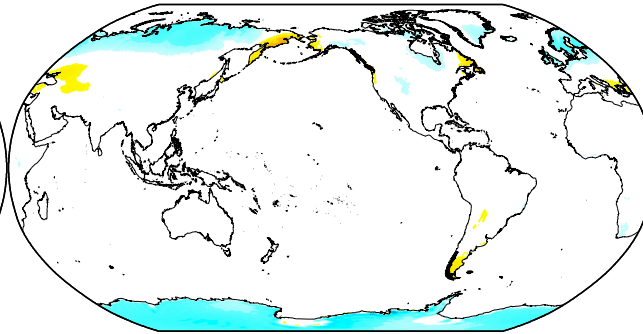
www.gfz-potsdam.de/en/esmdata

PDD Chapter 2: Surface Pressure Contributions

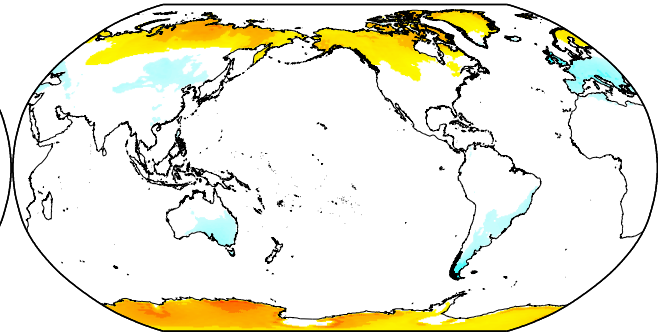
2007



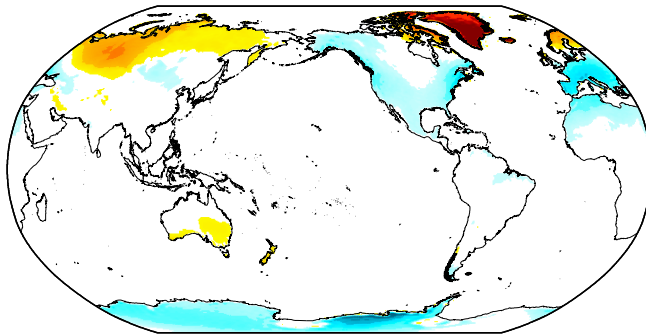
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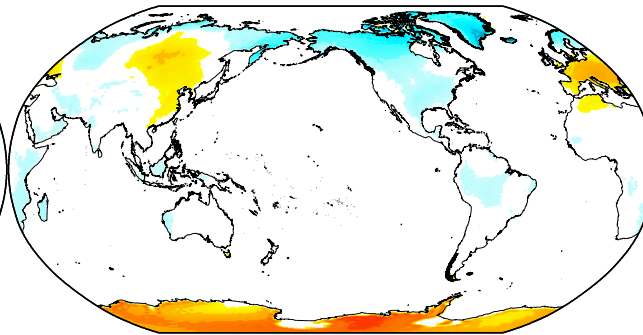
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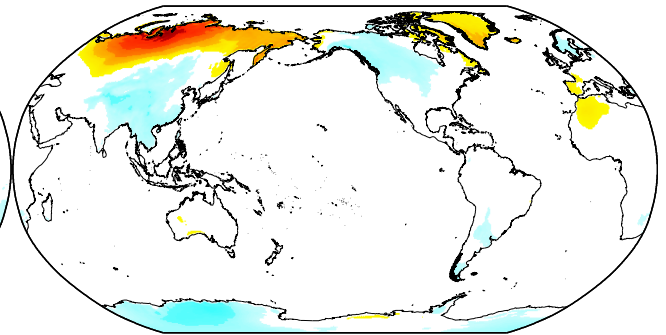
2010



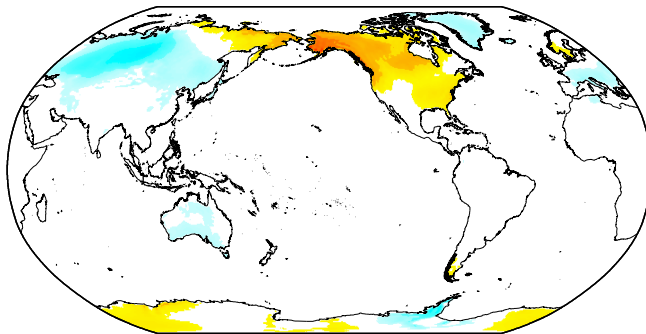
2011



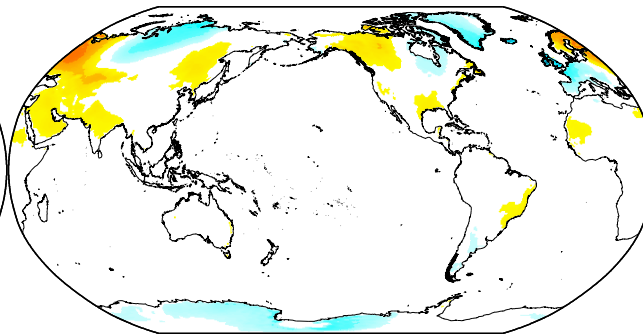
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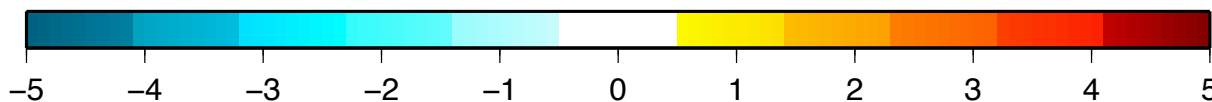
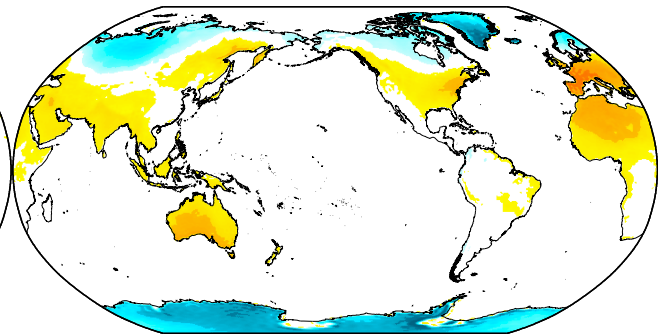
2013



2014



2015



PDD Chapter 2: 3 Hourly Tendencies in Surface Pressure

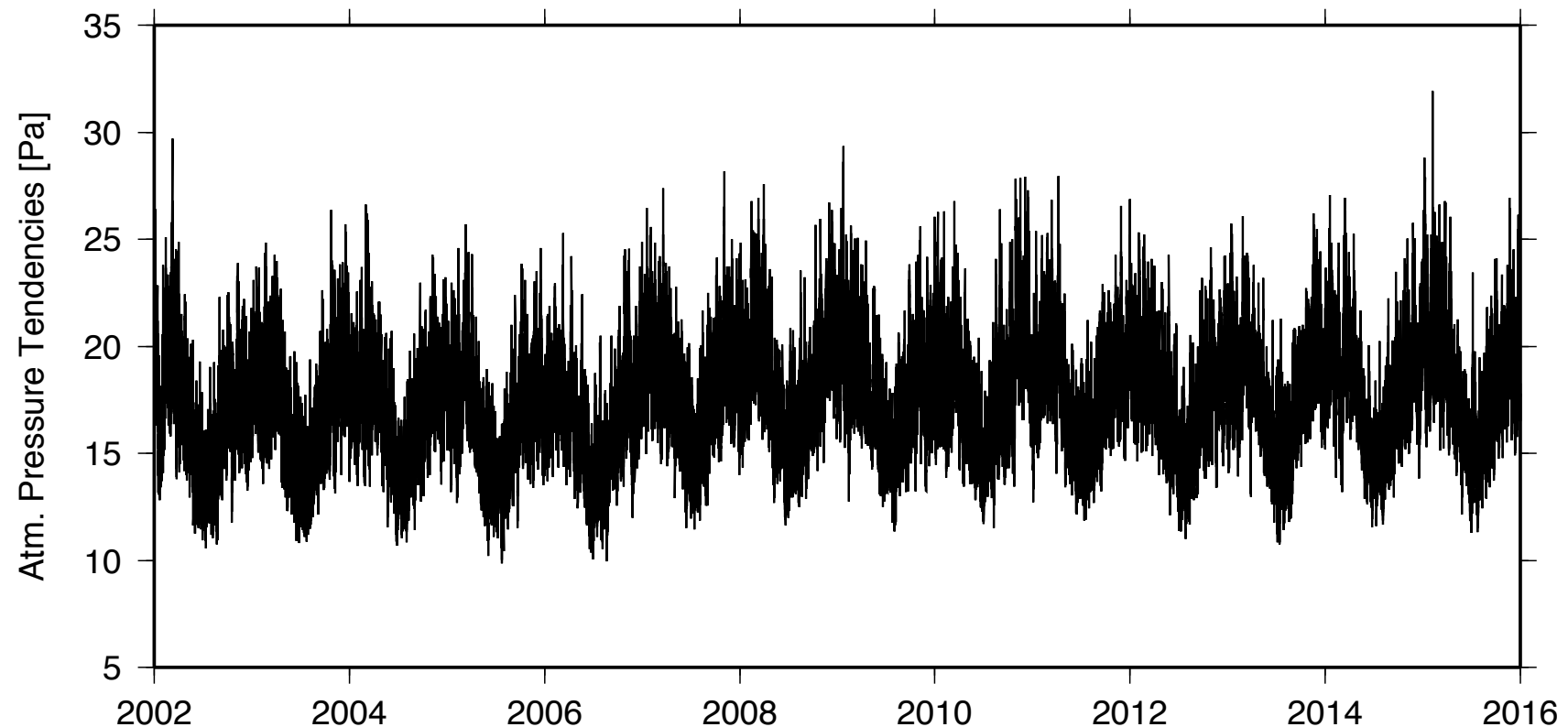
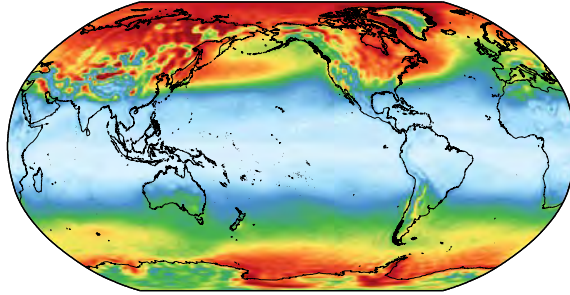


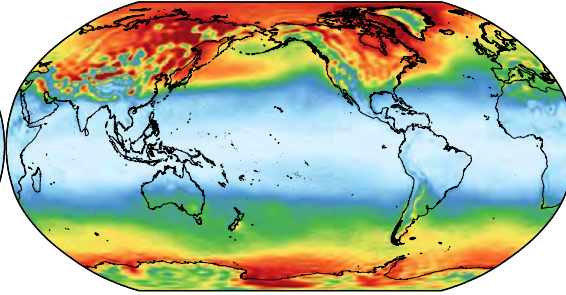
Figure 2.6: Area-weighted global mean of absolute values of 3 hourly tendencies of atmospheric surface pressure as included in AOD1B.

PDD Chapter 4: Upper-Air Density Anomalies

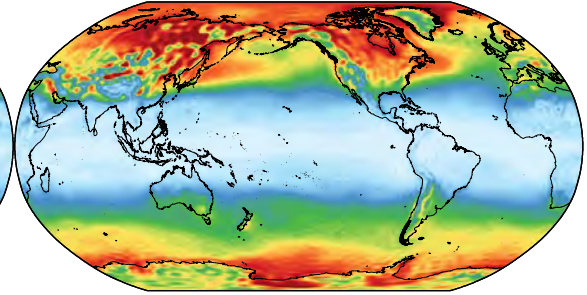
2007



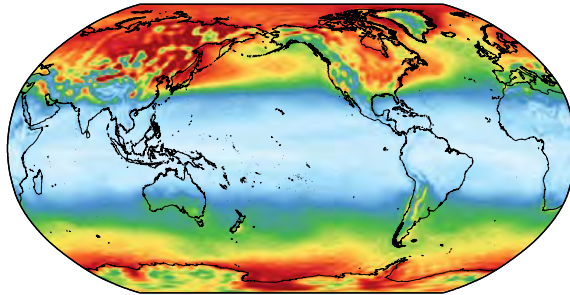
2008



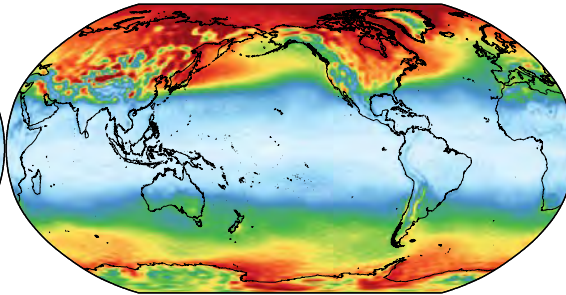
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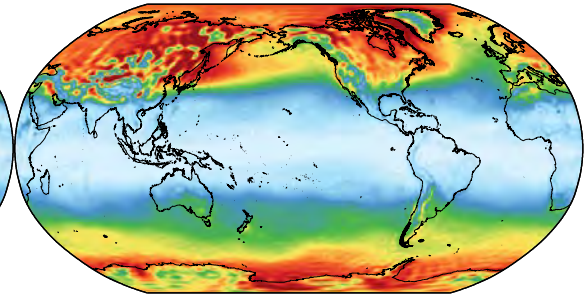
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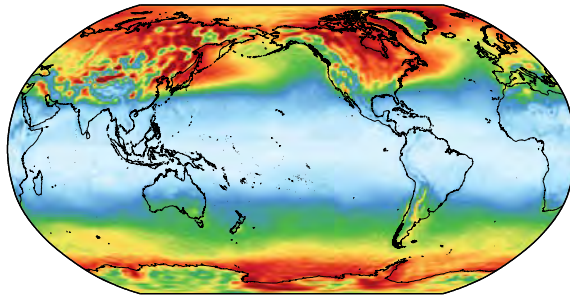
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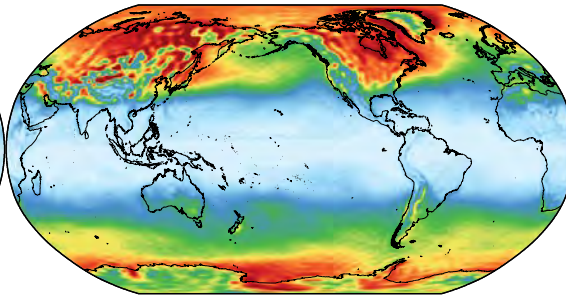
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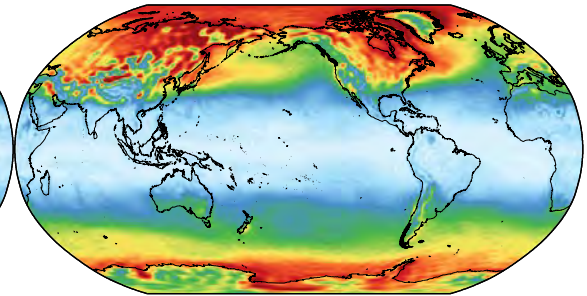
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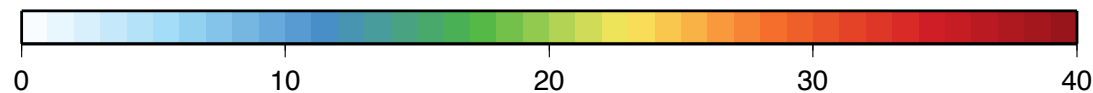
2014



2015

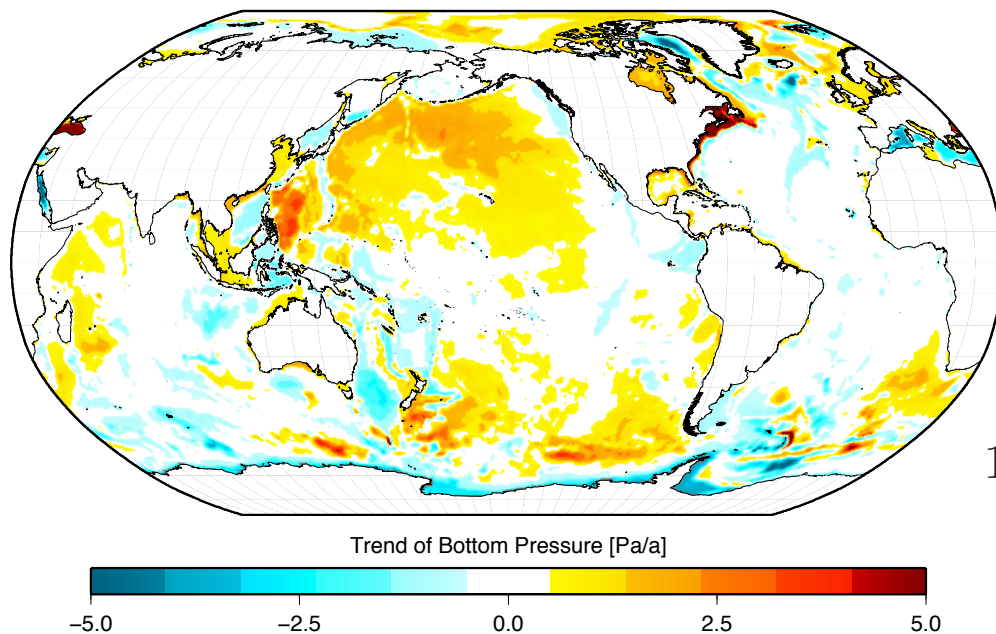


RMS variability of Upper Air Effects on Gravity [Pa]



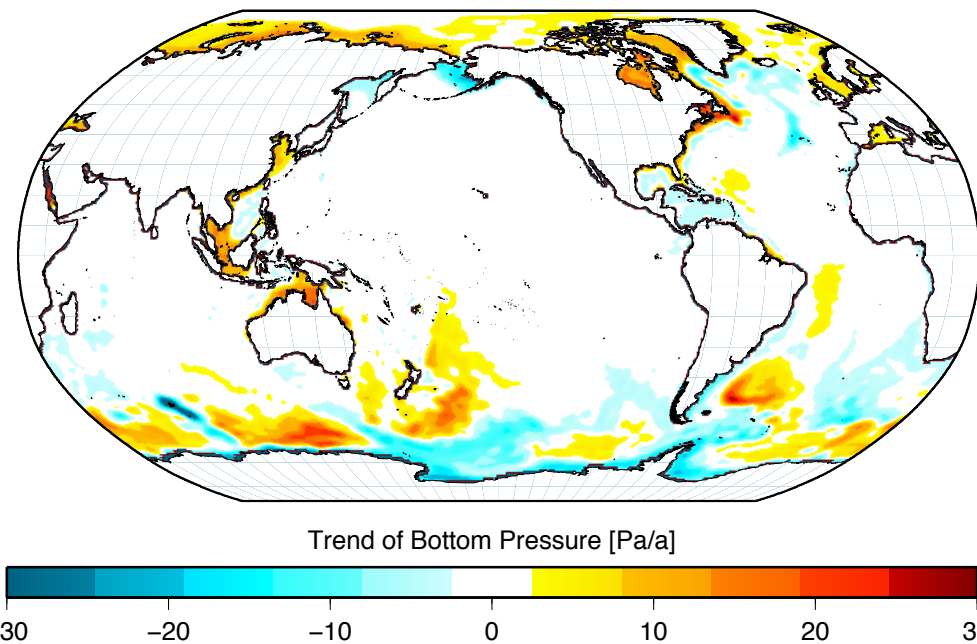
PDD Chapter 3: Ocean Contributions

460–499



Residual OBP trends in MPIOM
spin-up run (years 460 – 499)

1976–2015



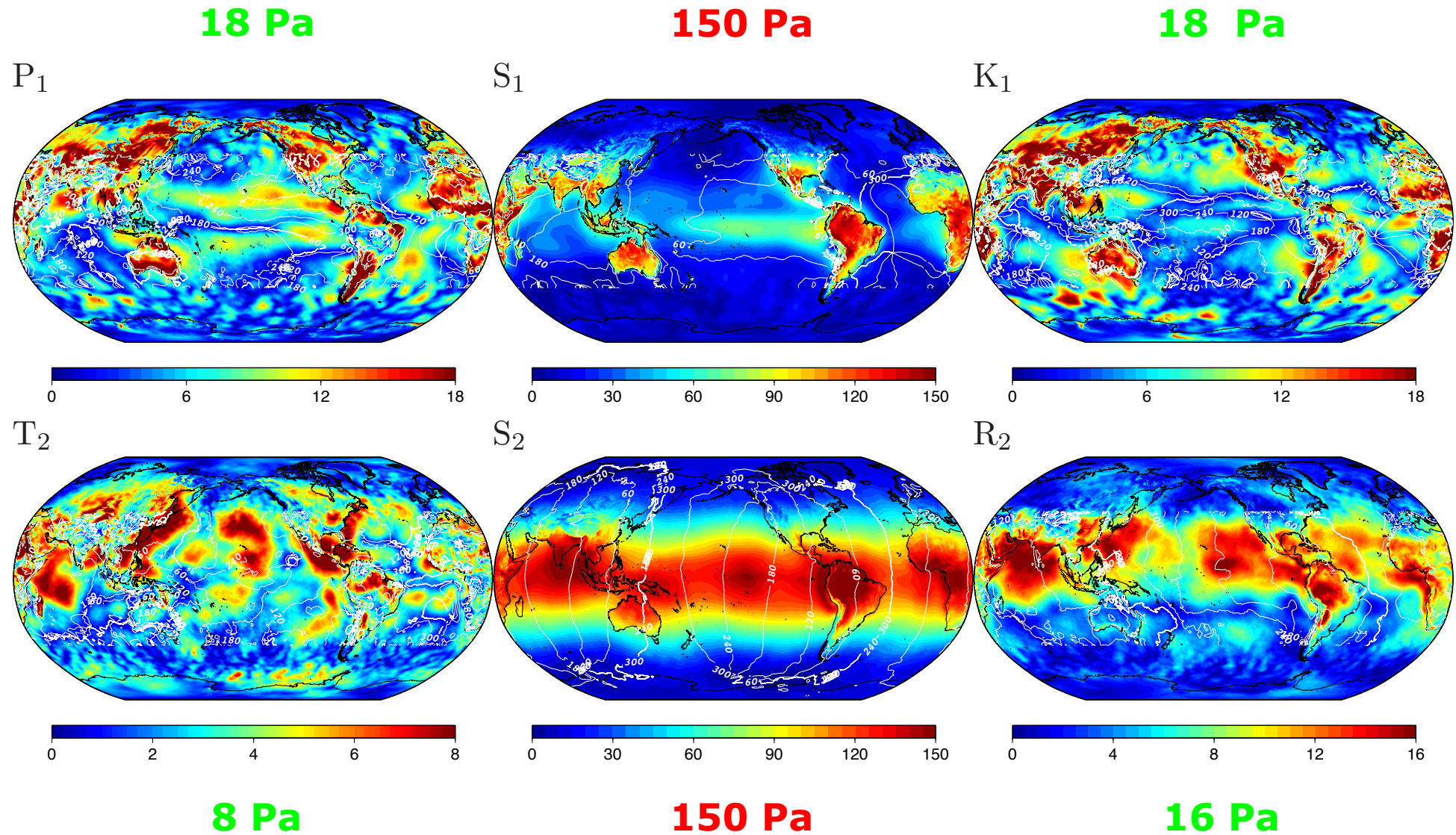
Residual OBP trends in AOD1B RL06
OCN component (1976 – 2015)

PDD Chapter 5: Fit and Remove 12 Frequencies

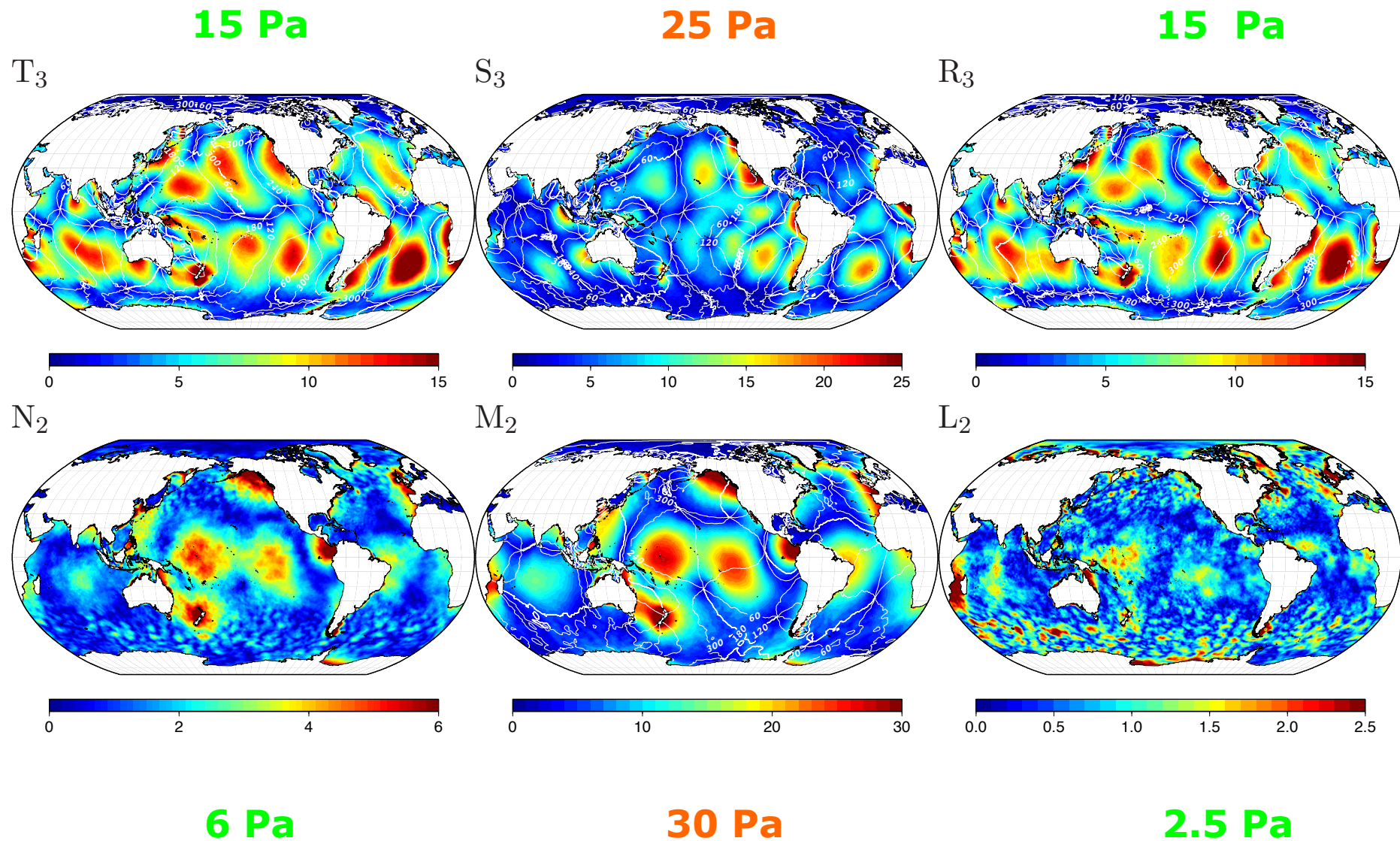
Table 5.1: Tidal constituents estimated and removed from the non-tidal AOD1B coefficients.

partial tide	Argument	Frequency ($^{\circ}\text{h}^{-1}$)
P_1	$t - h - 90^{\circ}$	14.9589314
S_1	$t + 180^{\circ}$	15.0000000
K_1	$t + h + 90^{\circ}$	15.0410686
N_2	$2t - 3s + 2h + p$	28.4397295
M_2	$2t - 2s + 2h$	28.9841042
L_2	$2t - s + 2h - p + 180^{\circ}$	29.5284789
T_2	$2t - h + p'$	29.9589333
S_2	$2t$	30.0000000
R_2	$2t + h - p' + 180^{\circ}$	30.0410667
T_3	$3t - h$	44.9589300
S_3	$3t$	45.0000000
R_3	$3t + h$	45.0410700

PDD Chapter 5: Atmospheric Tides



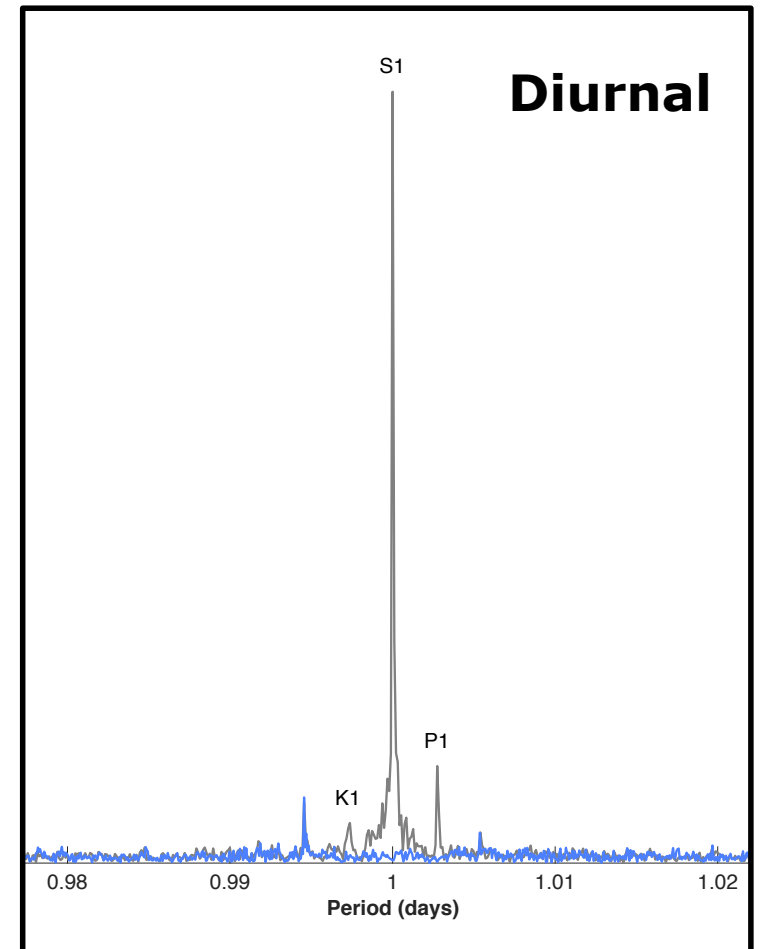
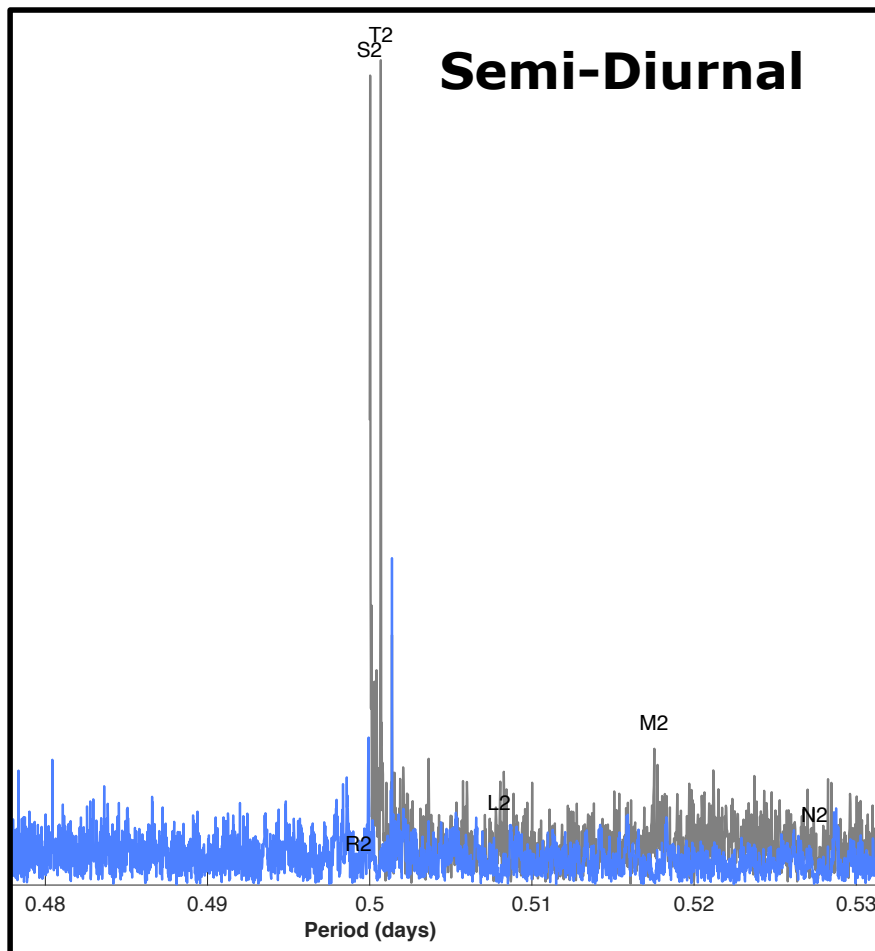
PDD Chapter 6: Ocean Response to Atmospheric Tides



Spectral Analysis of C20 from AOD1B (1976 – 2016)

AOD1B RL05

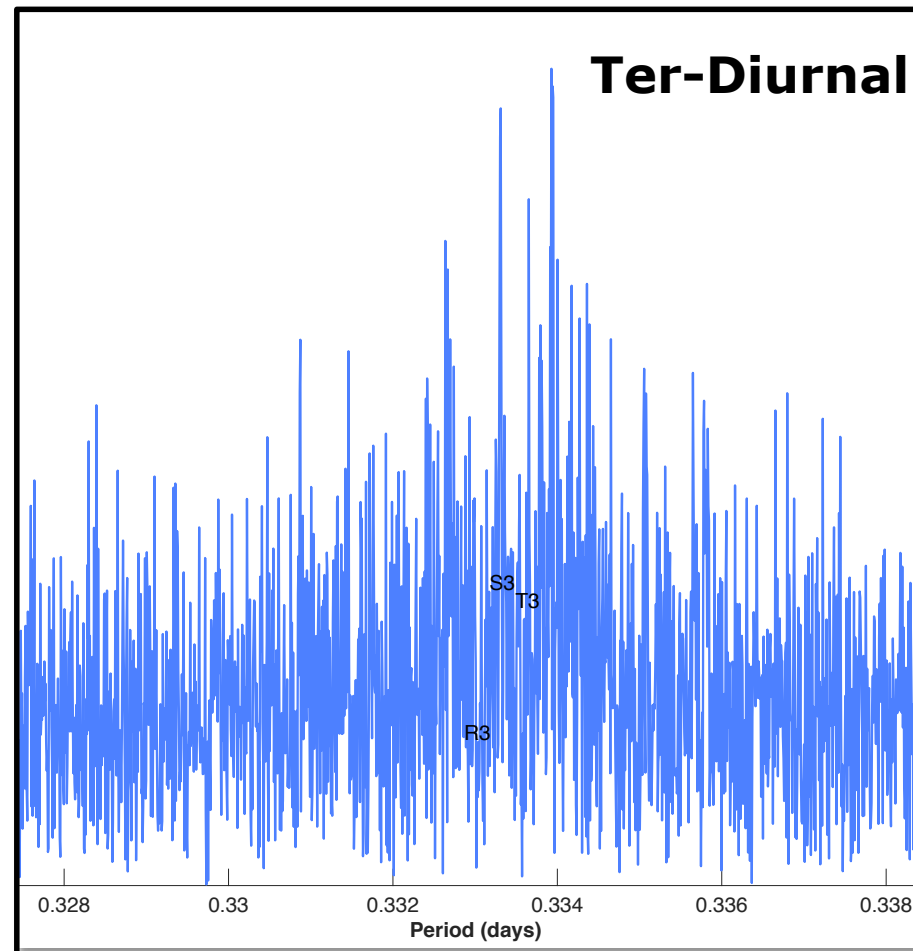
AOD1B RL06



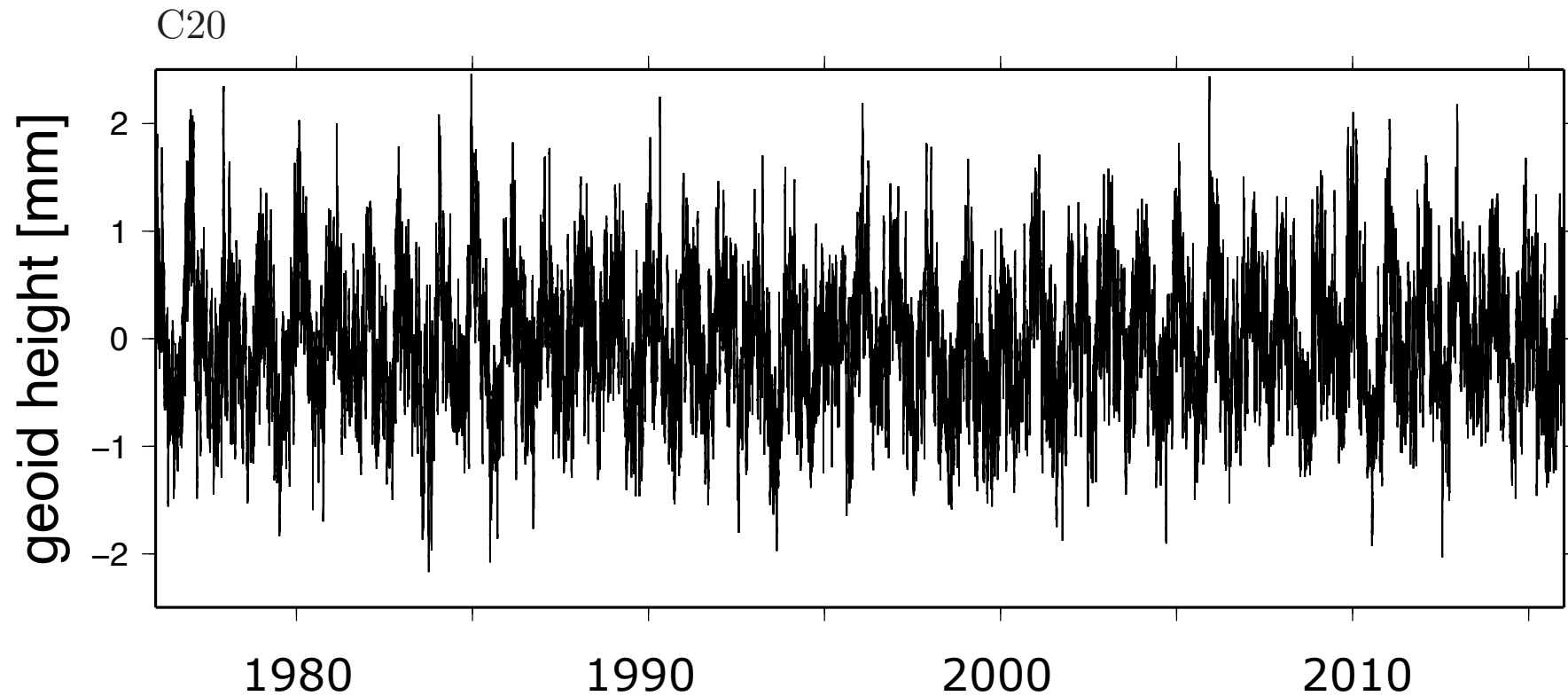
Spectral Analysis of C20 from AOD1B (1976 – 2016)

AOD1B RL05

AOD1B RL06

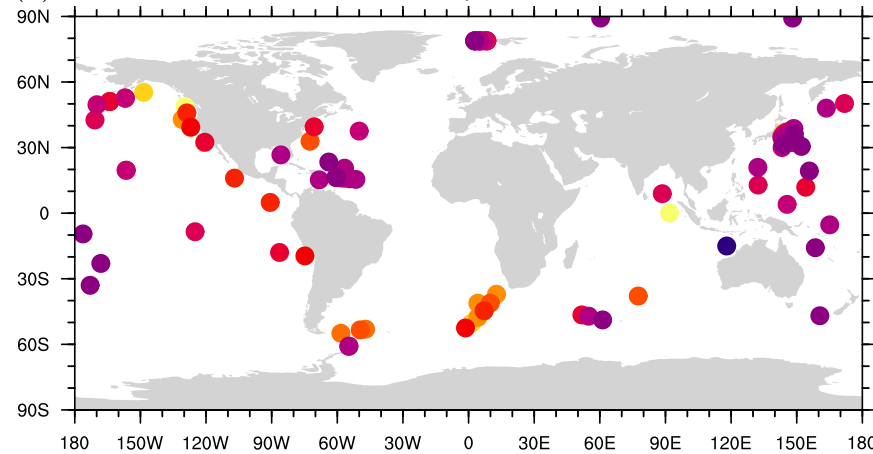


PDD Chapter 7: C20 Time Series GLO

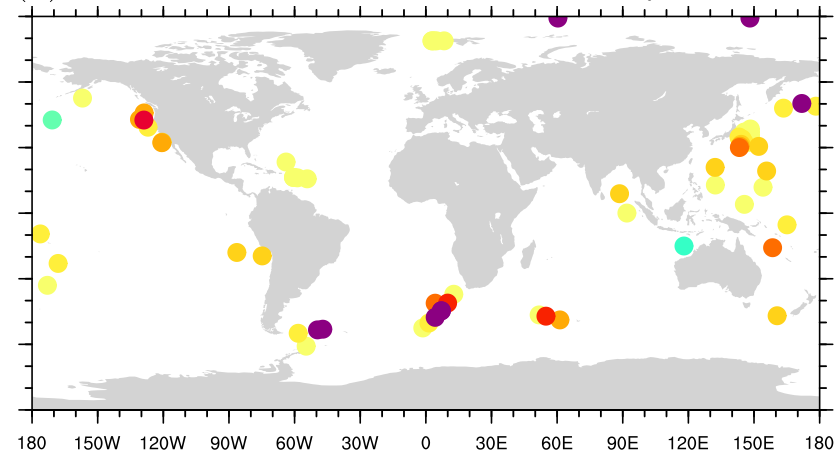


GJI-Paper: Validation Against in situ OBP Data

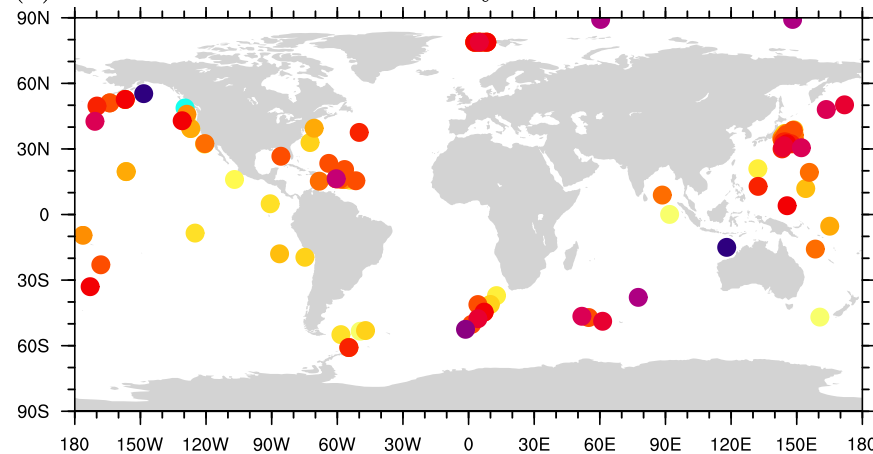
(c) AOD1B RL06: 3 – 10 days



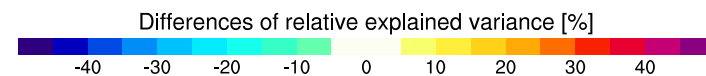
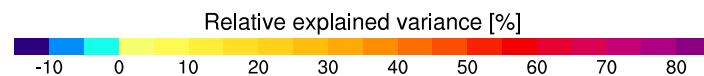
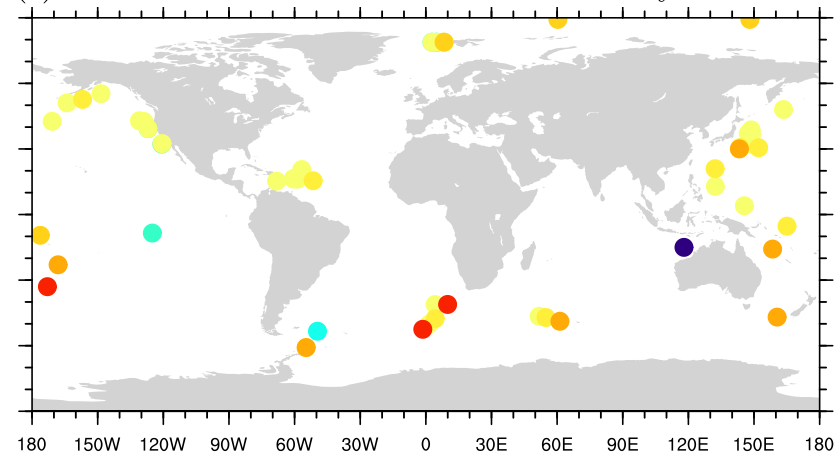
(d) Differences RL06 – RL05: 3 – 10 days



(e) AOD1B RL06: 10 – 30 days

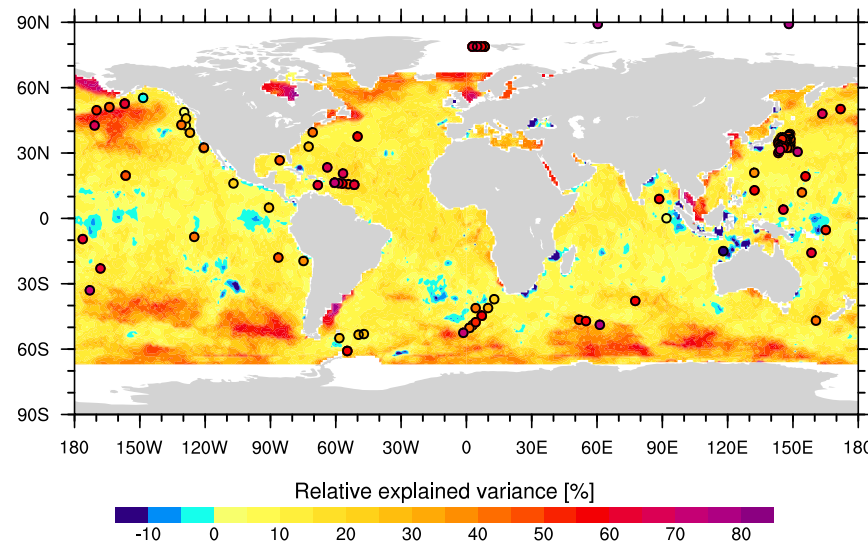


(f) Differences RL06 – RL05: 10 – 30 days



GJI-Paper: Validation Against Jason-2 SLA

(a) AOD1B RL06: 1 – 30 days



(b) Differences RL06 – RL05: 1 – 30 days

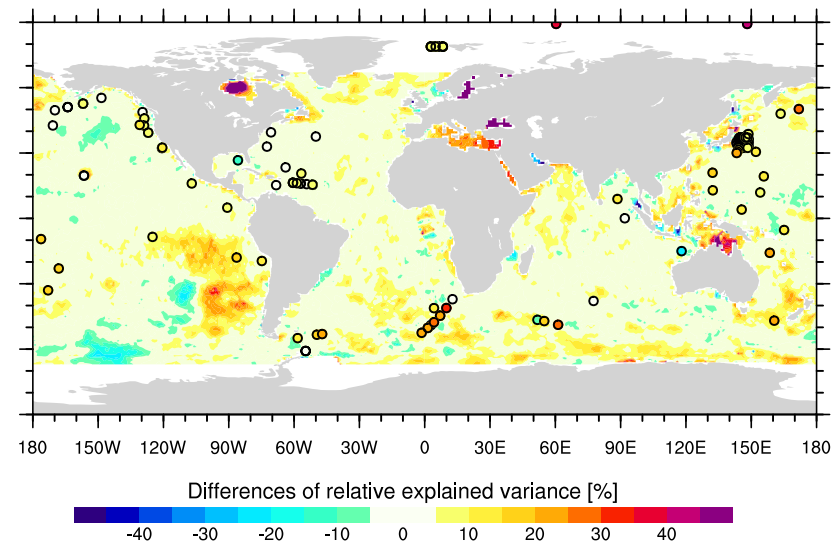


Figure 2. Relative variances (percent) of sea-level variability from Jason-2 over the period 2012–2015 explained by (a) AOD1B RL06, and (b) differences between relative variances explained by RL06 and RL05, each bandpass filtered for periods of 1–30 d. For comparison, corresponding results from *in situ* ocean bottom pressure observations consistently filtered for identical frequencies are shown as well (circles). Note that *in situ* data were used from the years 2004–2008, which differs from the Jason-2 data period.

GJI-Paper: Reduction of KBRA Residuals

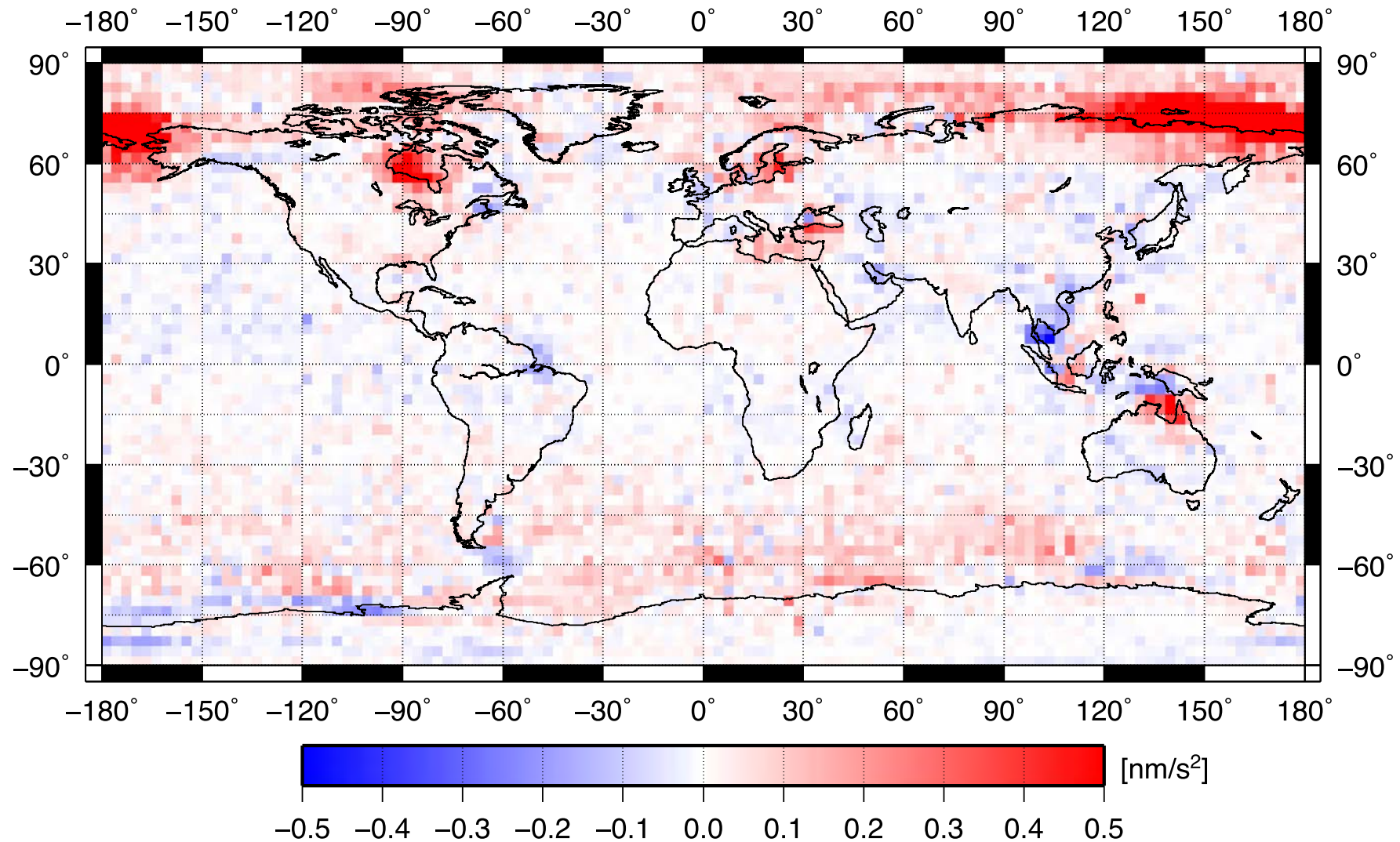
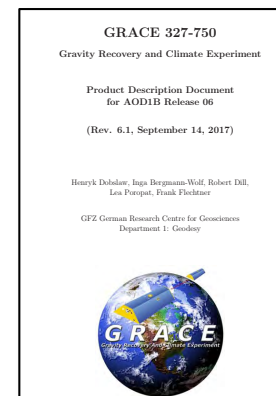
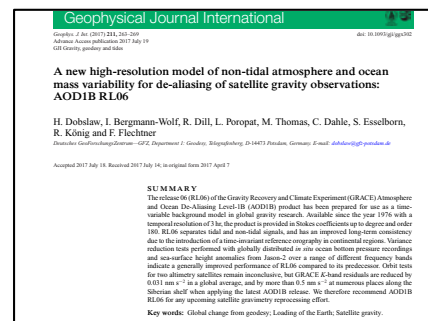


Figure 3. Reduction in GRACE *K*-band range acceleration residuals when replacing AOD1B RL05 with RL06 averaged over the year 2008.

Summary on AOD1B

- AOD1B RL05 and RL06 are currently routinely updated (weekly and daily, respectively)
- RL06 has an improved long-term consistency: posterior corrections to GSM fields (GAE, GAF) will be no longer necessary
- Separation between tidal and non-tidal signals in RL06: atmospheric tides need to be treated separately in Precise Orbit Determination



- Data and documentation for RL06 are publicly available:

www.gfz-potsdam.de/en/esmdata