
Ocean tide loading in East Antarctic GNSS stations

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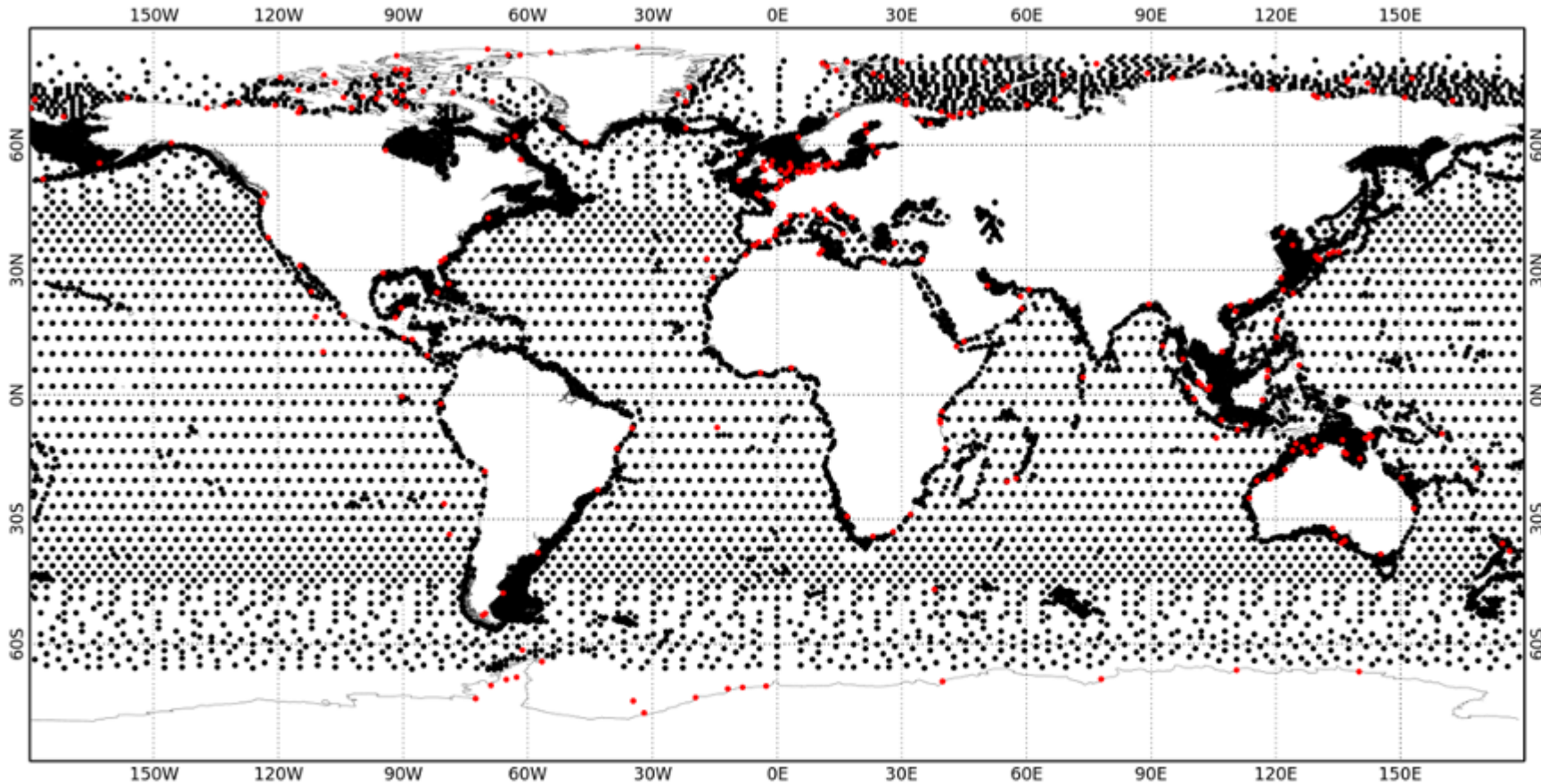
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Introduction

- Ocean tide loading (OTL)
 - Elastic response of the solid Earth
 - Vertical and horizontal crustal displacements up to several cm
 - Corrected from GNSS
- Why Antarctica is challenging
 - Sparse in-situ observations and incomplete high-latitude altimetry

Introduction



Example of assimilated observations used in FES2022 from https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/hdbk_FES2022.pdf

Figure 8: localization of the data assimilated in the FES2022 tidal solution: altimeter data in black and tidal gauges in red.

Introduction

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- Why Antarctica is challenging
 - Sparse in-situ observations and incomplete high-latitude altimetry
 - Uncertain bathymetry and grounding line geometry
 - Large ice shelves and complex coastal/ice-shelf tides
- We assess 6 tide models (both newer and legacy) to test how corrections reduce vertical scatter and tidal-band power

Study area



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Data description

GNSS data

- GNSS data from 2012–2017
- 30s sampling
 - Filtering and spike removal
- GPS + GLONASS

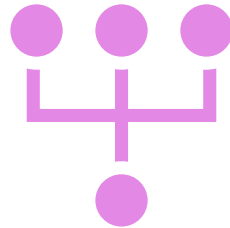
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Tide models

Model	Model type	Grid/resolution	Antarctic relevance
FES2004	Global hydrodynamic	1/8° global grid	Legacy global model with limited Antarctic coastal constraints
FES2014b	Global hydrodynamic	1/16° global grid	Improved bathymetry/coastal resolution, ice shelf draft corrections in some sectors
FES2022b	Global hydrodynamic	1/30° global grid	Improved polar/coastal resolution and bathymetry
TPXO10-Atlas-v2	Global inverse barotropic	1/6° global + 1/30° regional patches	Includes polar patches and CryoSat-2 assimilation
GOT5.5	Global empirical	1/8° global grid	Improved treatment of polar regions
CATS2008v2023	Regional inverse barotropic	Native 2 km polar stereographic grid, reprojected to 1/30°	Includes ice shelf cavities, grounding lines, and flexure corrections

What was done?

We will have a poster on
LoadDef vs. SPOTL at TIGER



Processing pipeline

GNSS processing with PRIDE PPP AR
(Geng et al., 2019)

OTL deformation with LoadDef (Martens et
al., 2019)



GNSS – model comparisons

Focus on vertical component

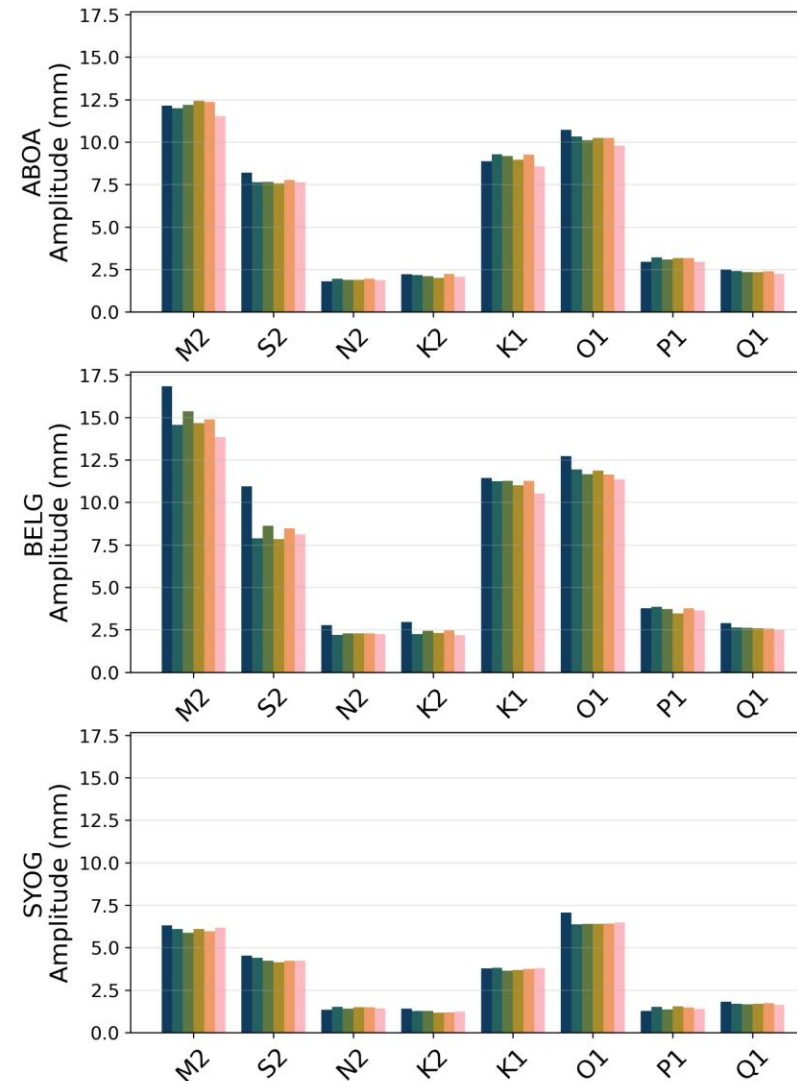
Variance reduction

Spectral power reduction

Differences between tide models



- Mean absolute amplitude difference ~0.24 mm
- Max amplitude difference 3.16 mm



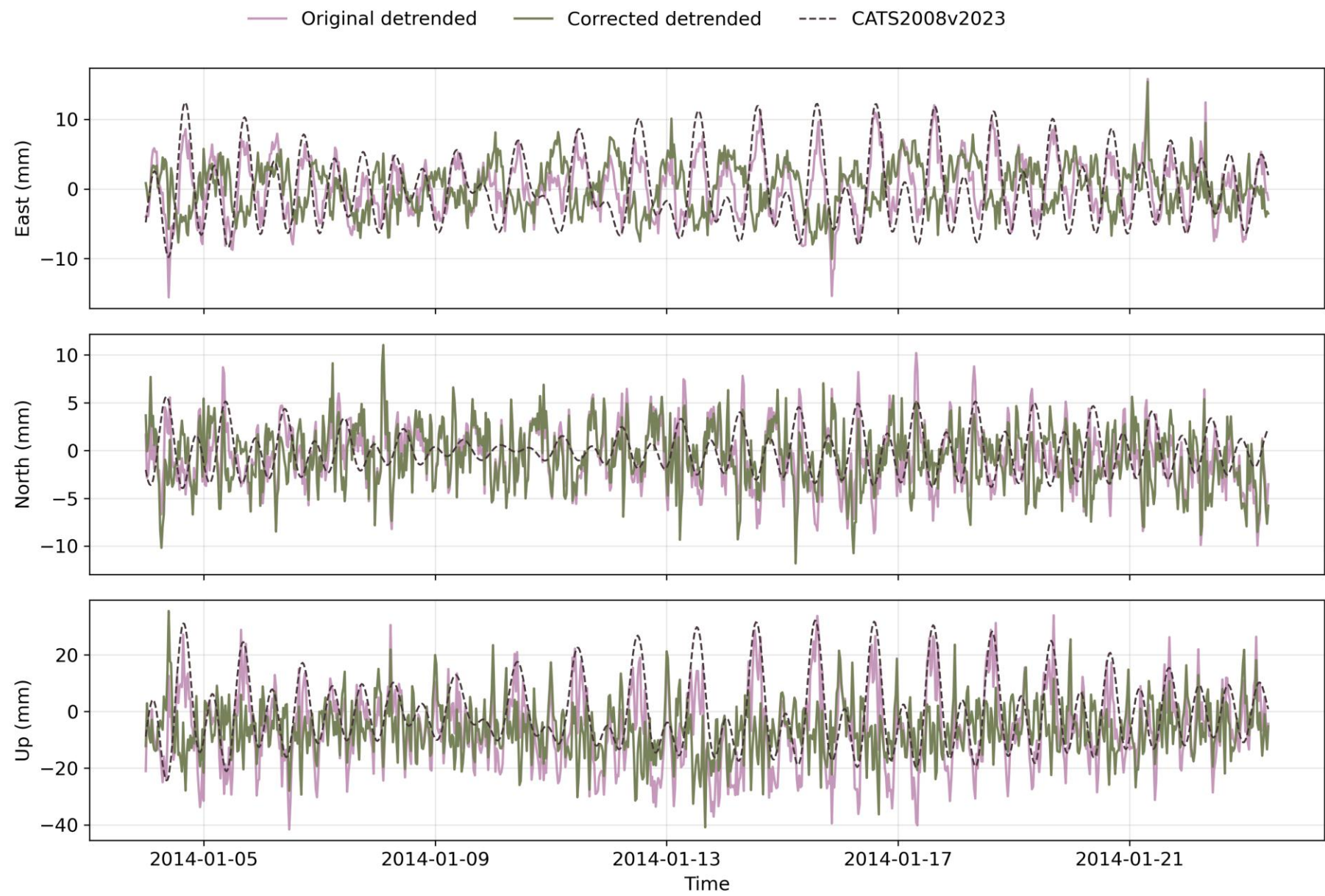
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Effect of corrections

Station ID	“Best” model	RMS (%)	VR (%)	Semi-diurnal (%)	Diurnal (%)
ABOA	CATS2008v2023	16.9	31.0	87.5	74.6
BELG	CATS2008v2023	12.6	23.5	83.8	55.8
DAV1	FES2004	13.9	26.4	45.6	63.1
MAW1	FES2004	13.9	26.1	31.8	64.4
NONS	CATS2008v2023	7.8	15.0	50.8	57.8
SYOG	CATS2008v2023	17.6	32.2	75.7	68.8
VESL	CATS2008v2023	10.6	20.1	75.7	68.8

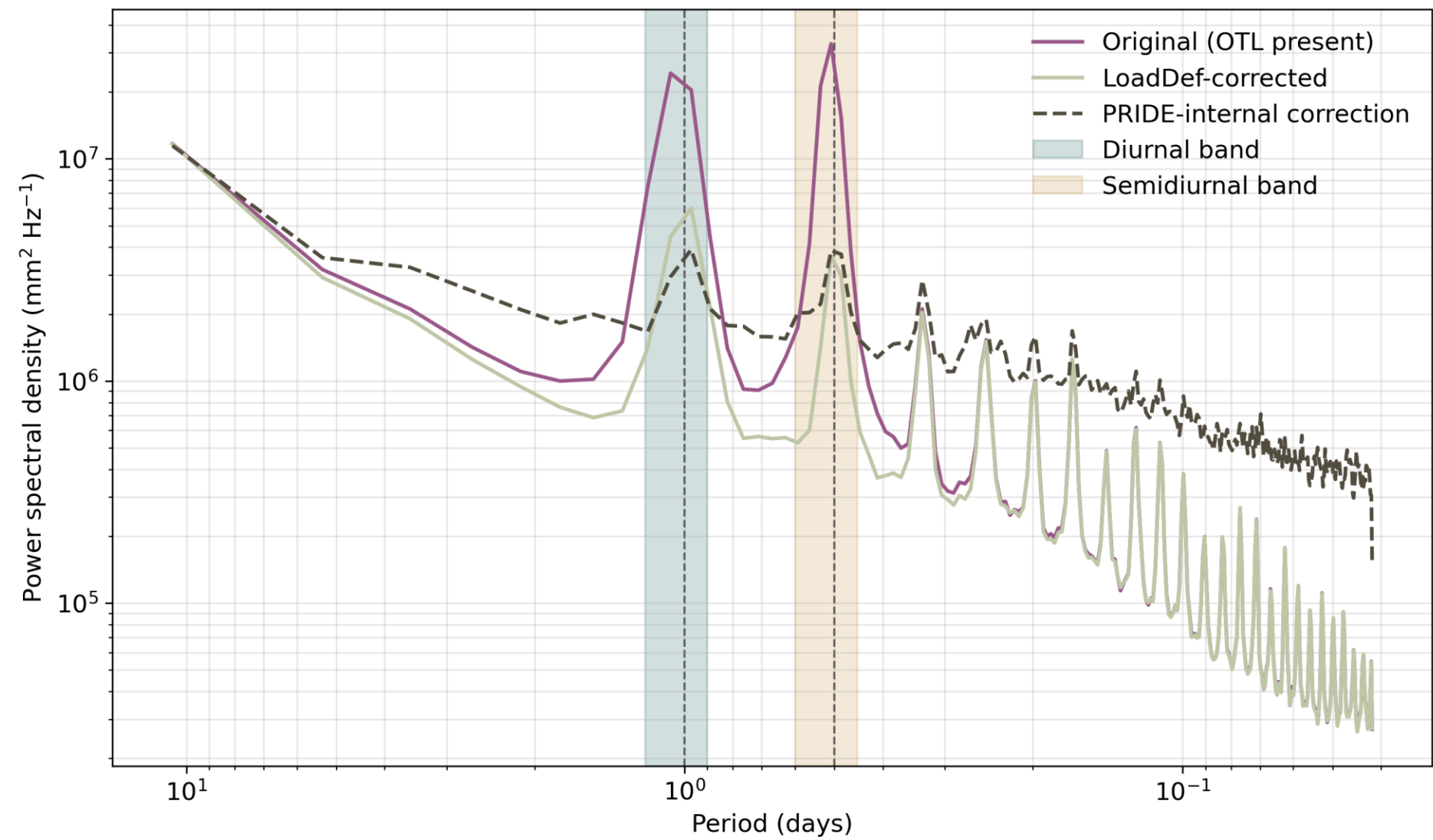
Inter-model differences in RMS and VR reduction are generally small, up to 2 %, at stations. However, differences are larger in semidiurnal (>11 %) and diurnal (>8 %) reductions.

ABOA GNSS + OTL



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ABOA vertical PSD



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Conclusions

1. Mean inter-model amplitude differences are <1 mm, but can reach >3 mm in some regions



Conclusions

2. Corrections have largest effect near coasts, grounding lines, and ice shelf edges

ABOA (20km from grounding line),
BELG (1 km from grounding line),
SYOG (island)

3. Station-to-station variability is larger than the differences among most model combinations

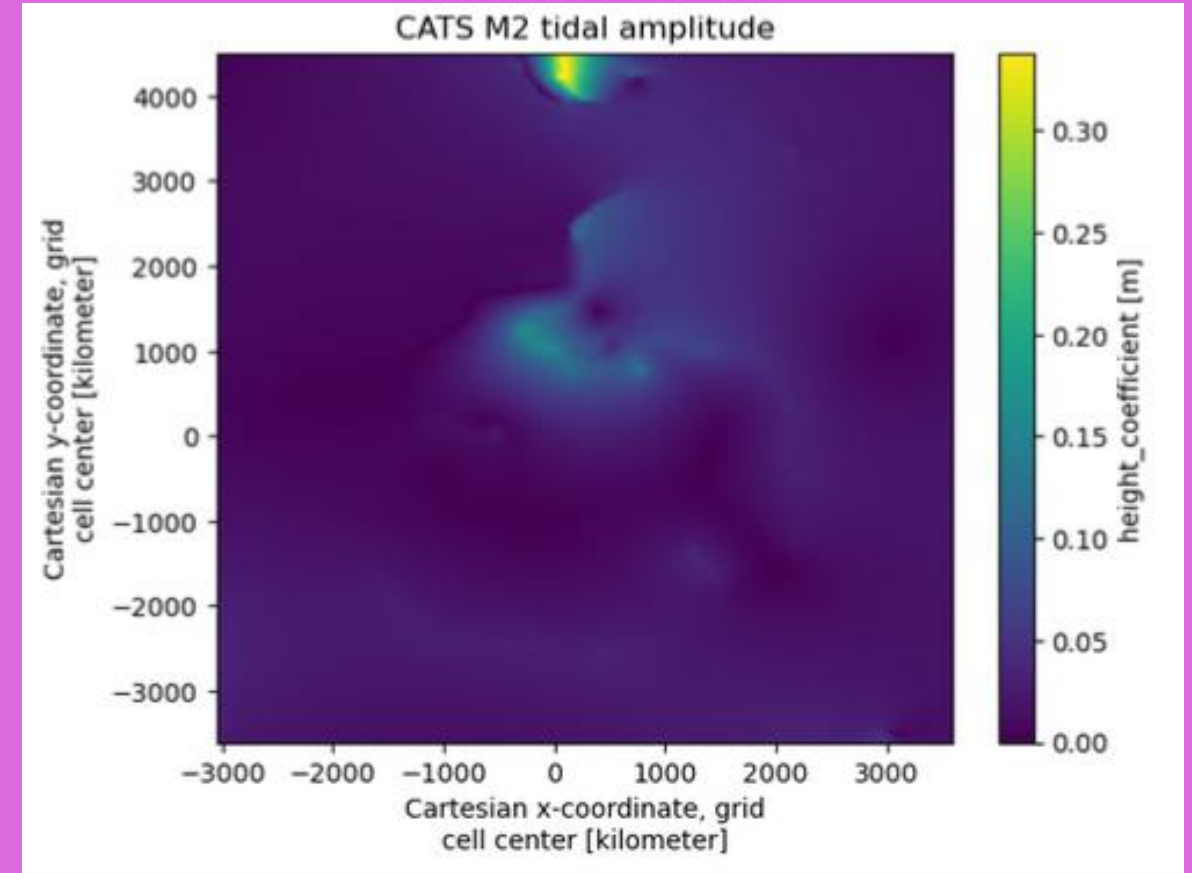


Conclusions

4. Regional CATS2008v2023 is most consistent, with the global FES2004 model remaining competitive

Newer or higher resolution models don't automatically yield "better" results

Performance limited by sparse observations and uncertain bathymetry, grounding line geometry, and sub-ice-shelf cavities



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Kiitos
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