



Geodetic Earth System Research at TU Dresden

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and the Geodetic Earth System Research working group



GEOWorkshop

Wrocław University of Environmental and Life Sciences

28 March 2019



The Geodetic Earth System Research working group



Geodetic Earth System Research

Use geodetic techniques to analyse Earth system processes

GNSS, satellite
altimetry, gravimetry

Sea Level and Mass Balance

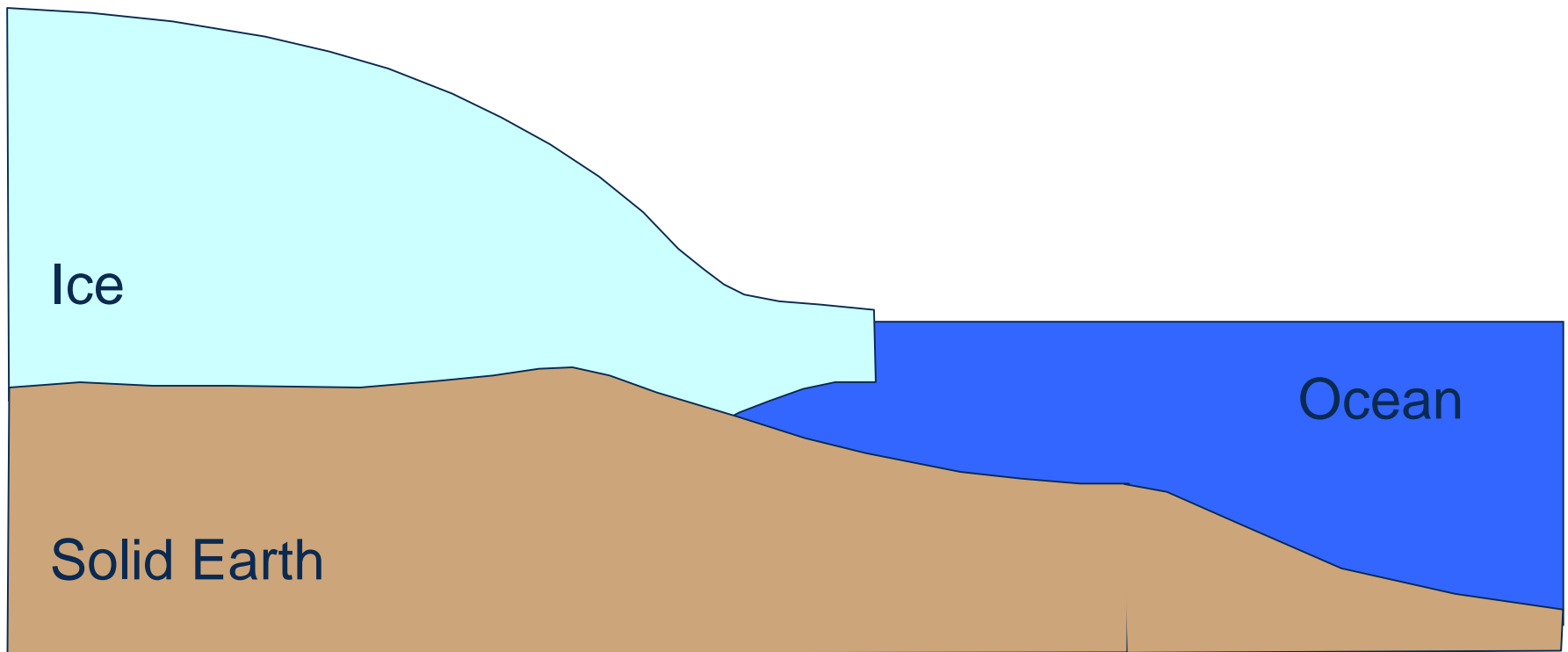
with focus on polar regions

including field observations





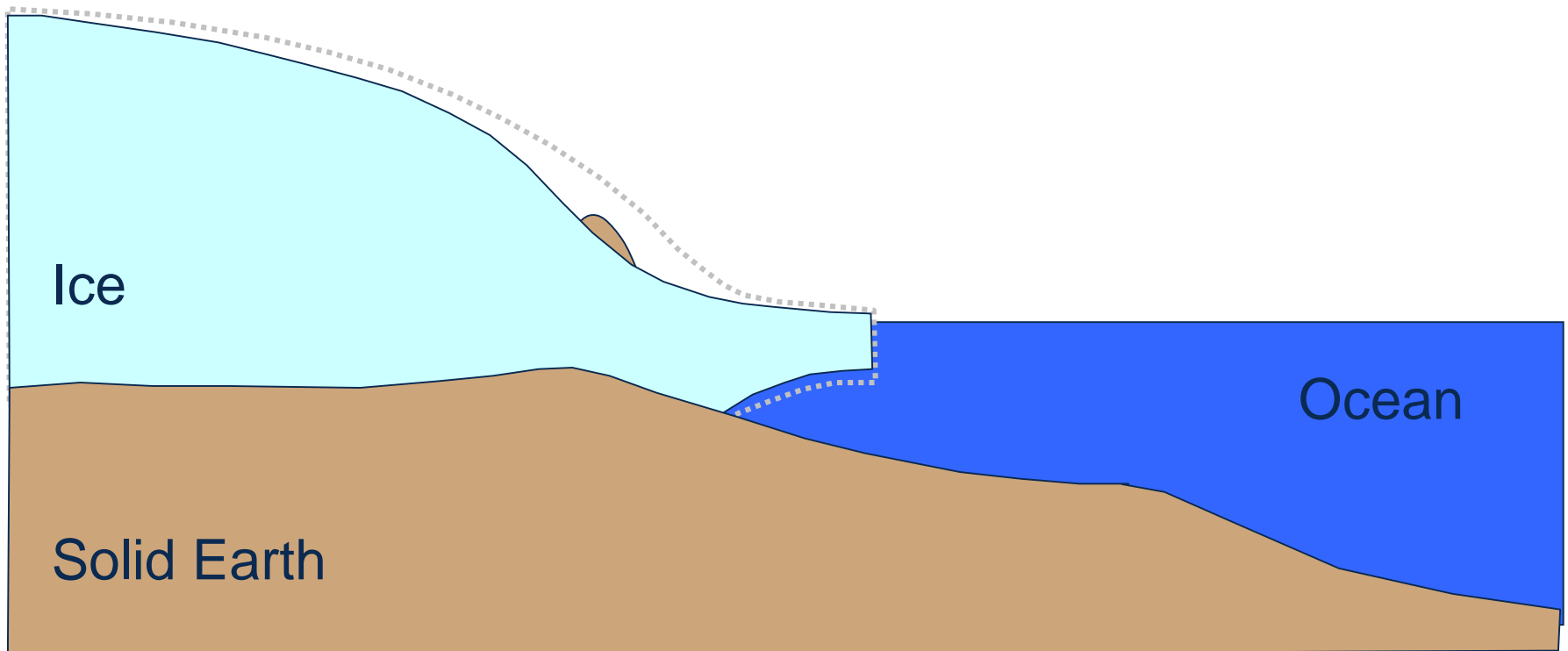
Earth system processes and Geodesy





Earth system processes and Geodesy

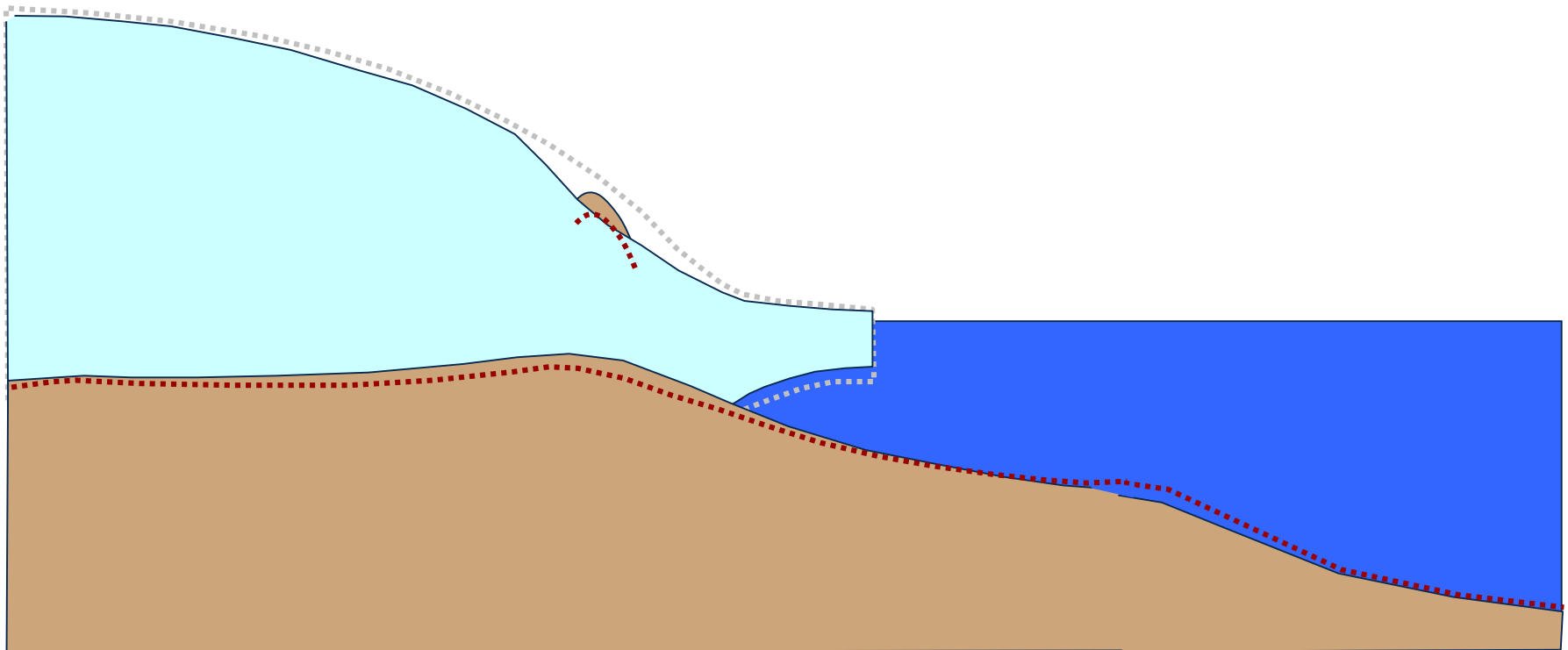
- Geometry





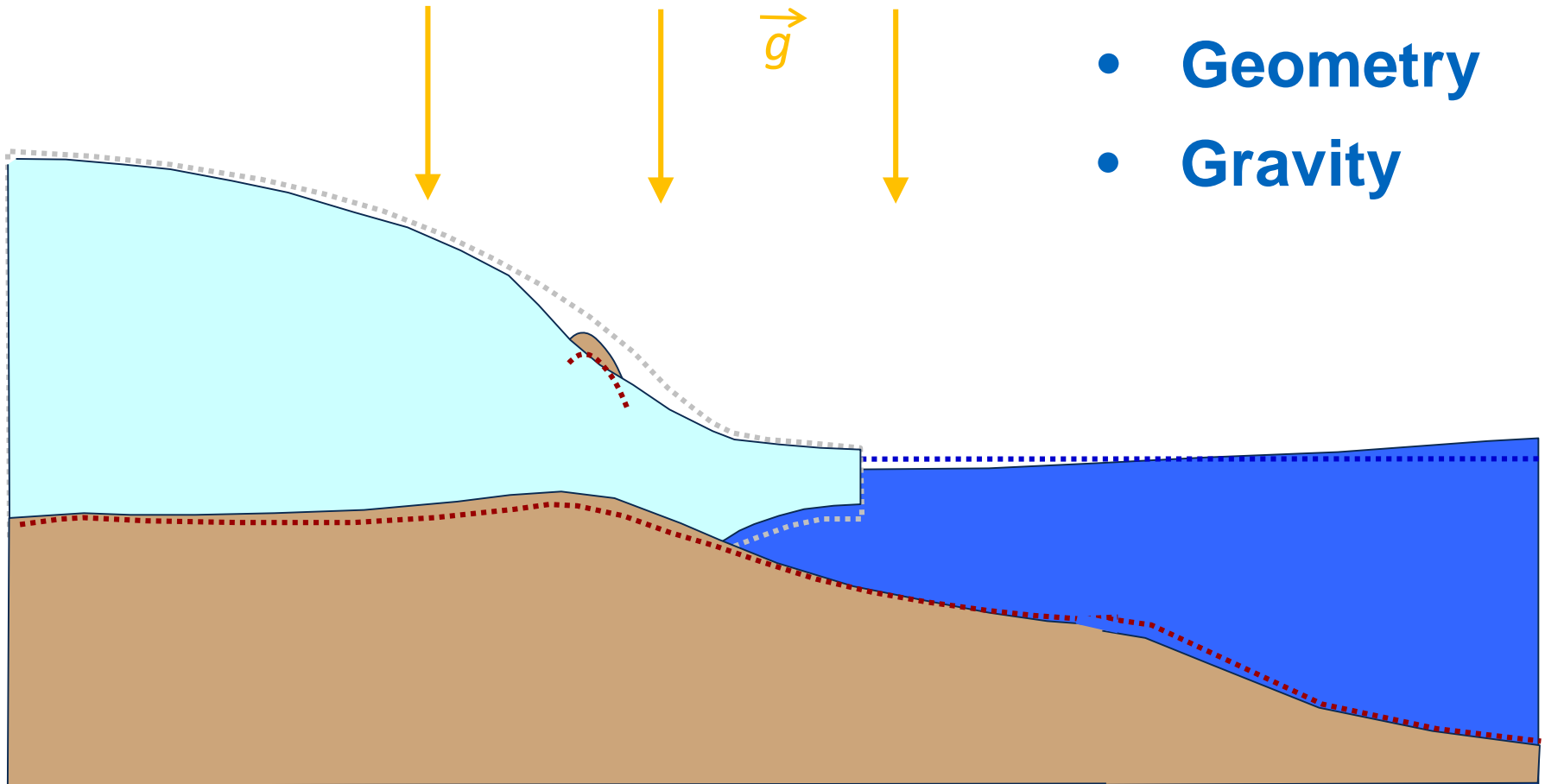
Earth system processes and Geodesy

- Geometry



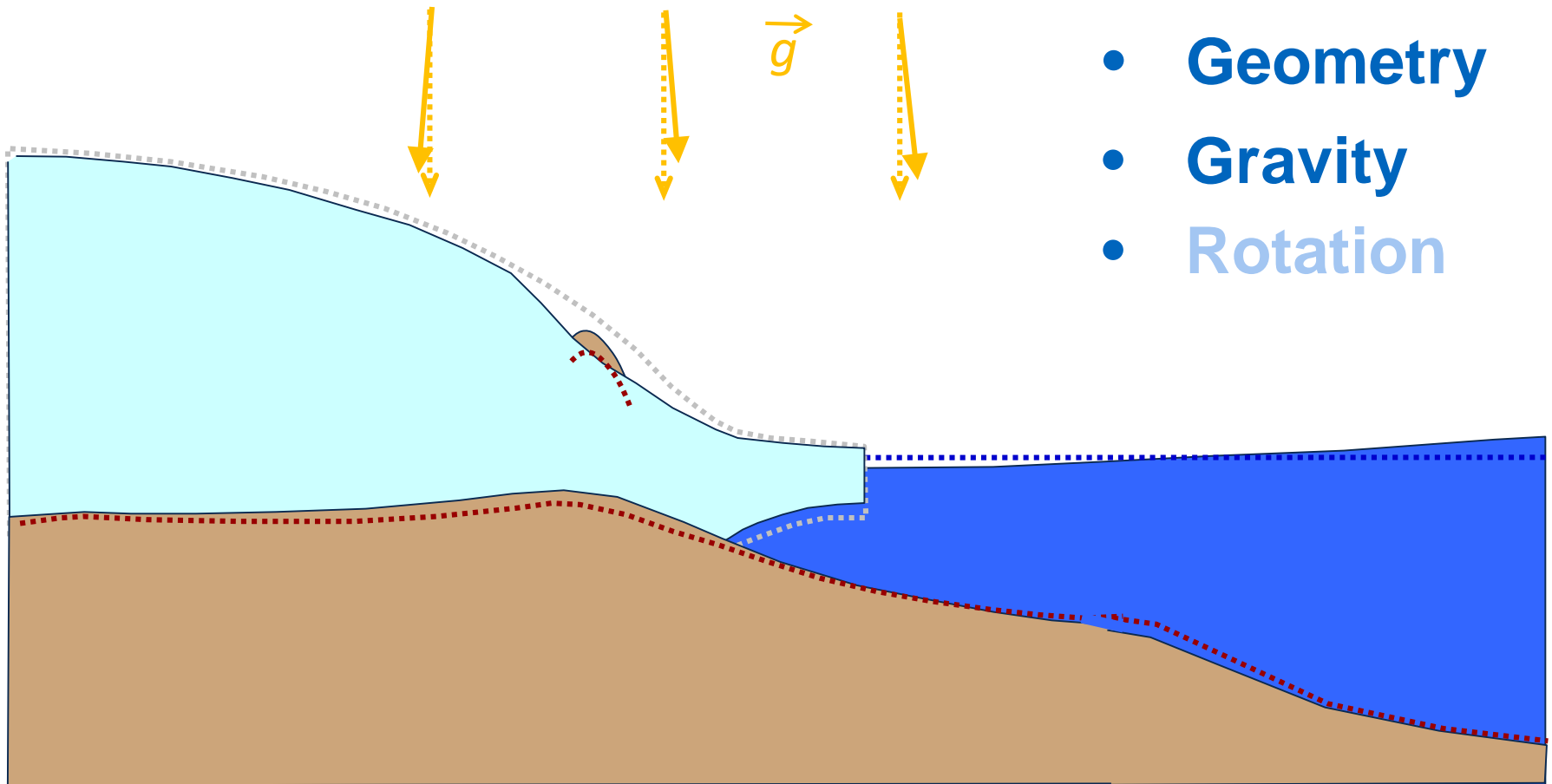


Earth system processes and Geodesy

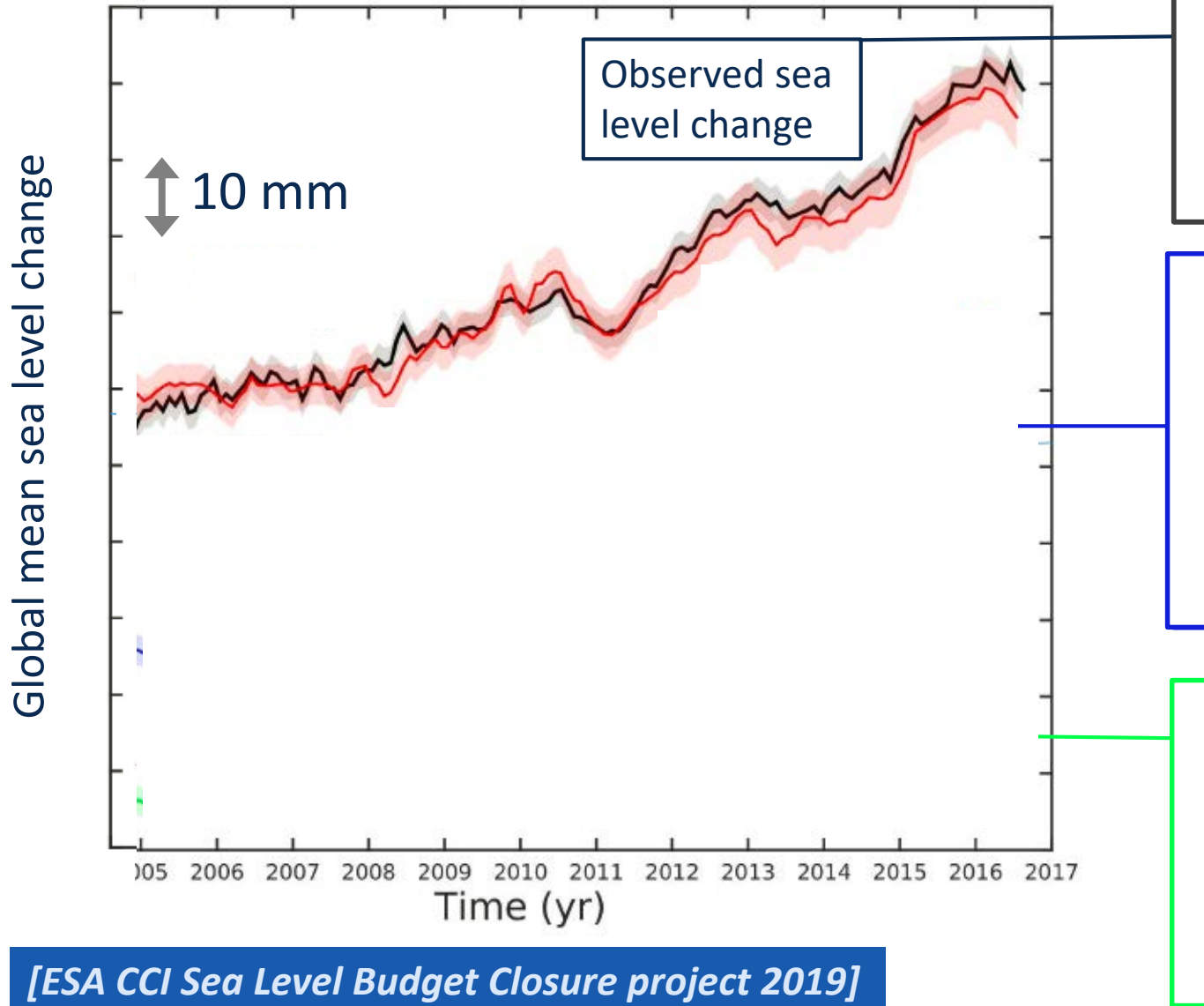




Earth system processes and Geodesy

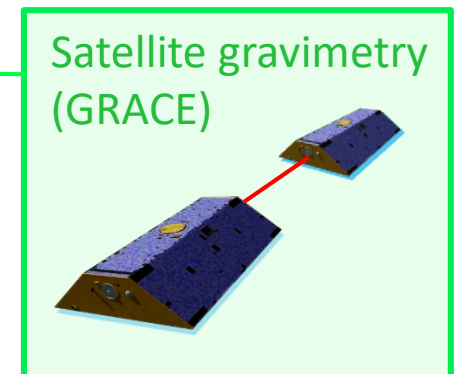
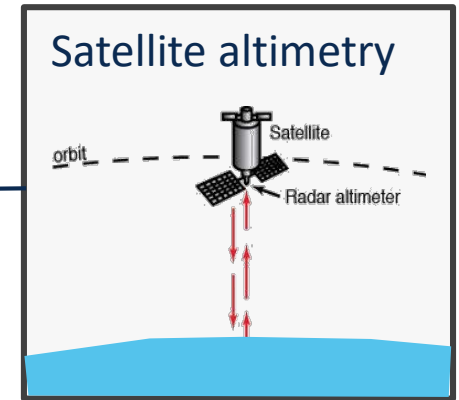
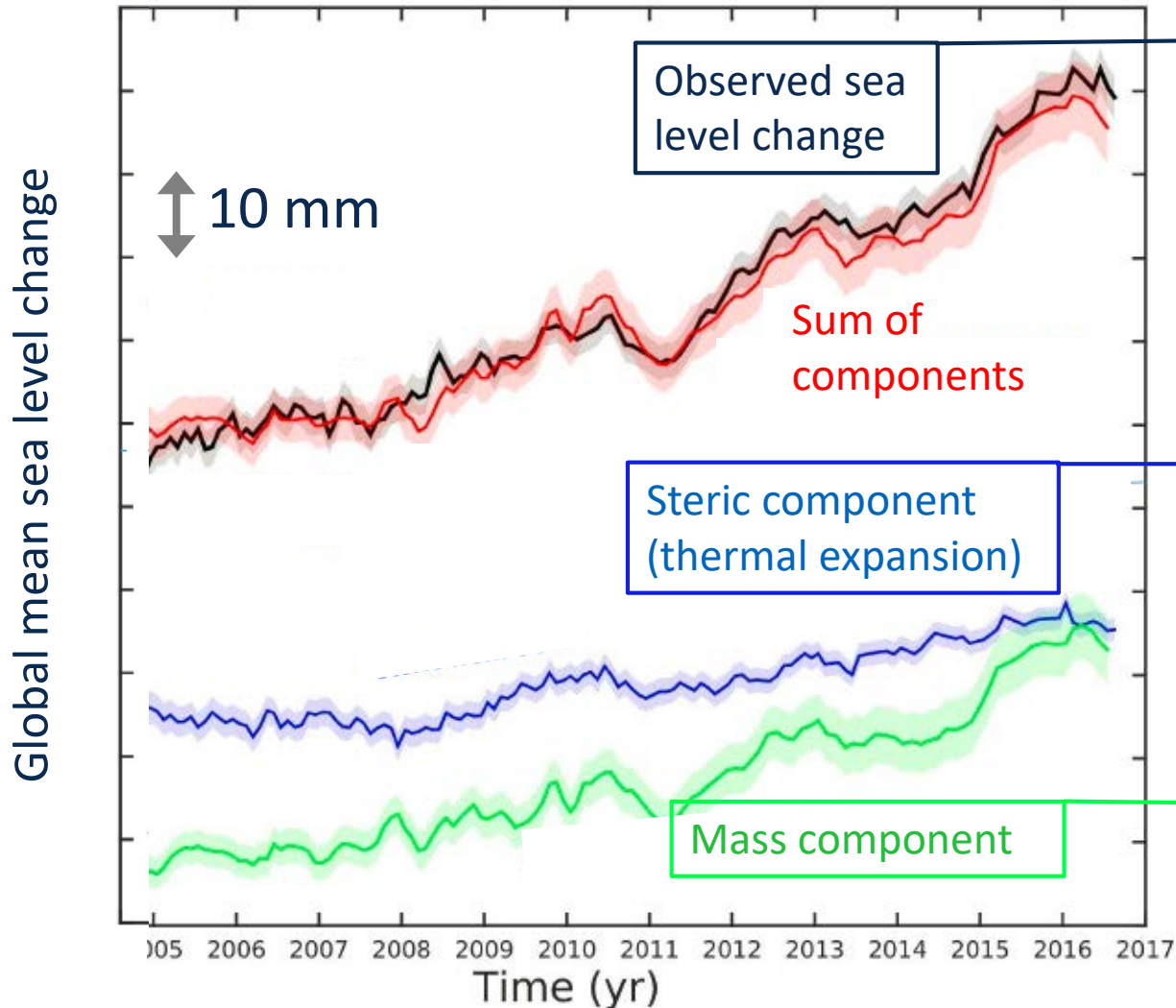


Sea level budget



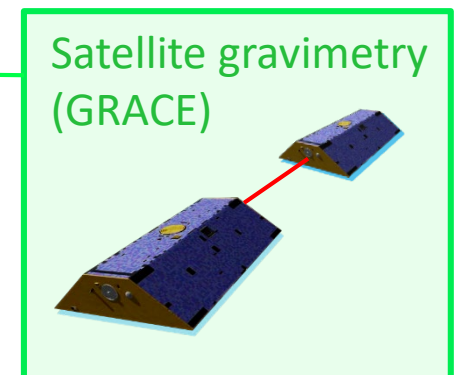
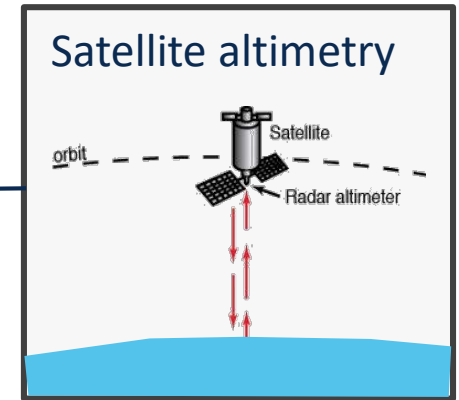
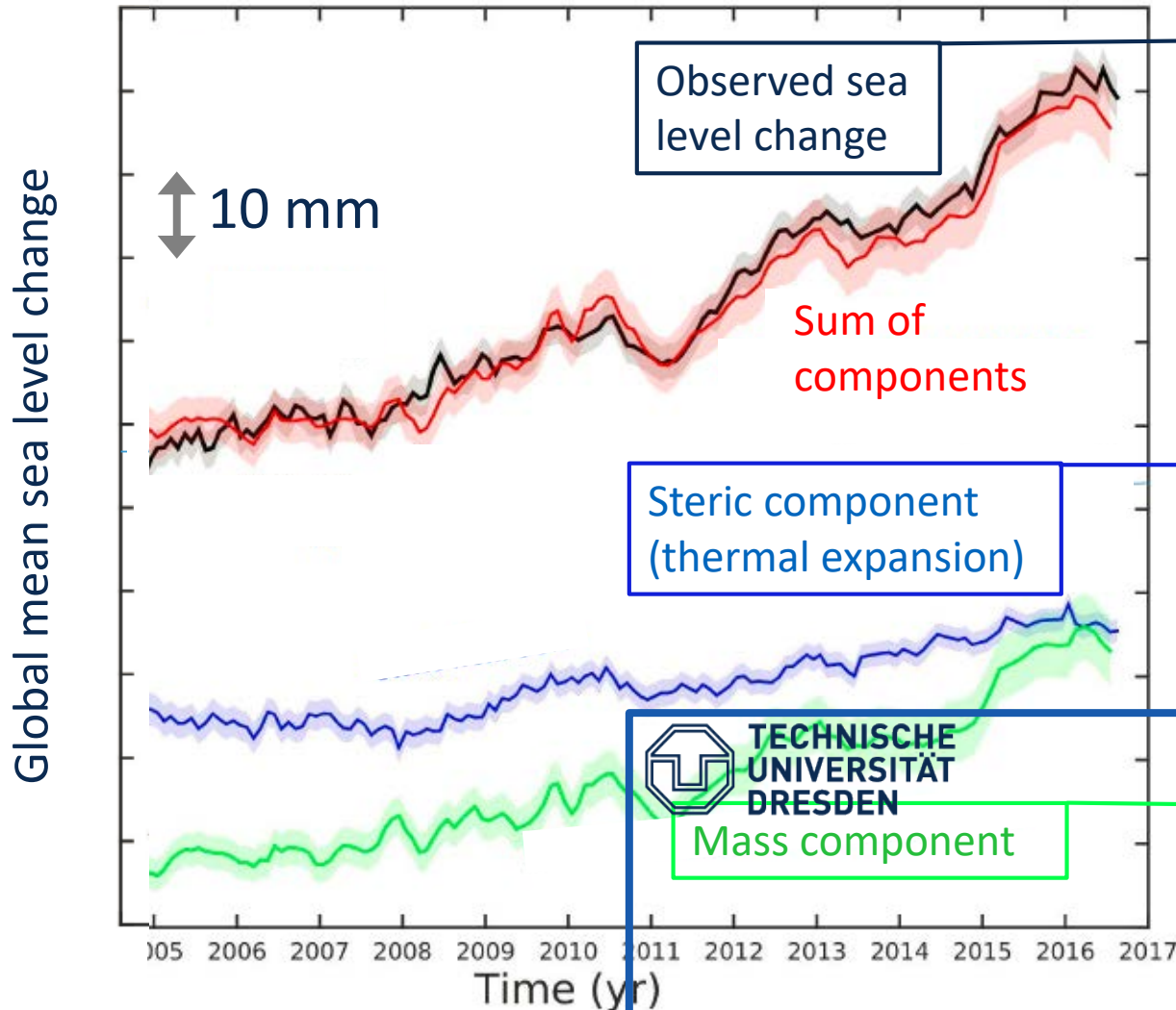
[ESA CCI Sea Level Budget Closure project 2019]

Sea level budget



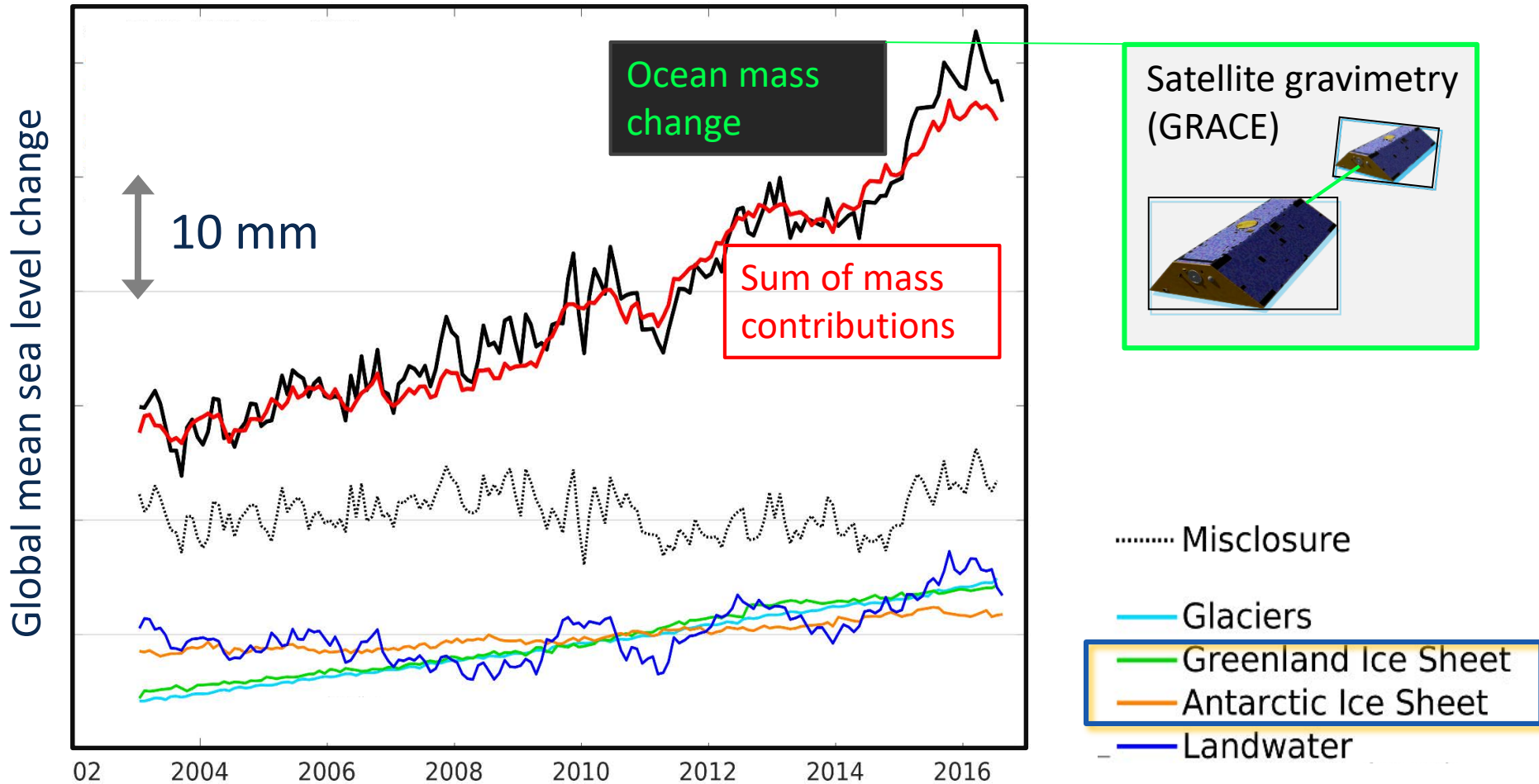
[ESA CCI Sea Level Budget Closure project 2019]

Sea level budget



[ESA CCI Sea Level Budget Closure project 2019]

Ocean mass budget



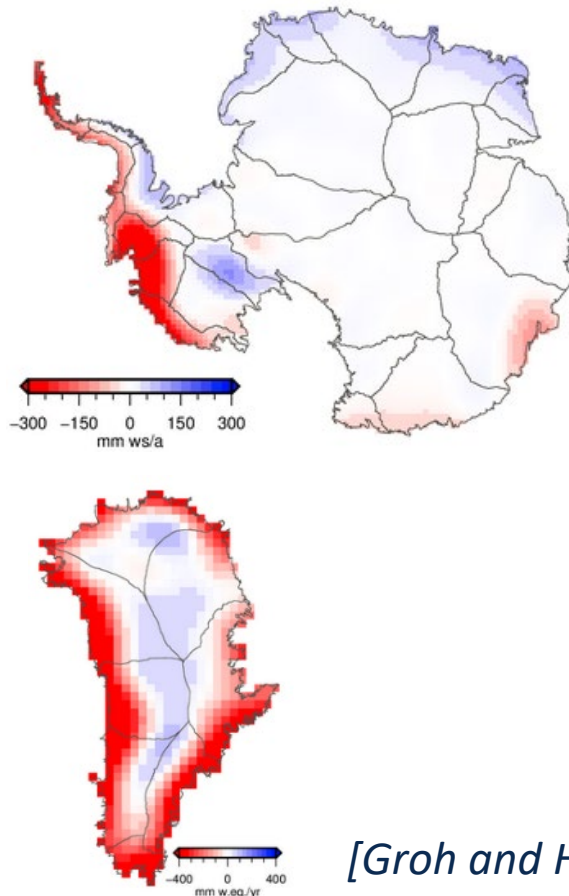
[ESA CCI Sea Level Budget Closure project 2019]

- Geometry
- Gravity

Satellite gravimetry for ice sheet mass balance

- Products developed and provided within ESA Climate Change Initiative (CCI) projects

Ice mass trends 2002-2016
[kg m⁻² yr⁻¹]



[Groh and Horwath 2016]

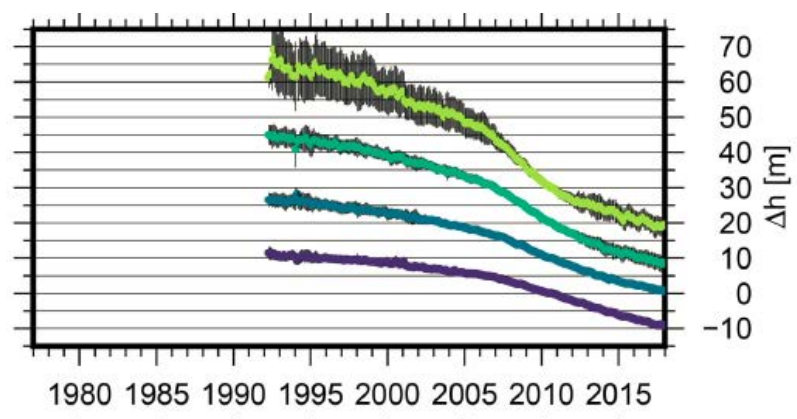
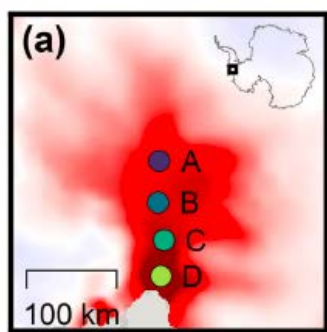
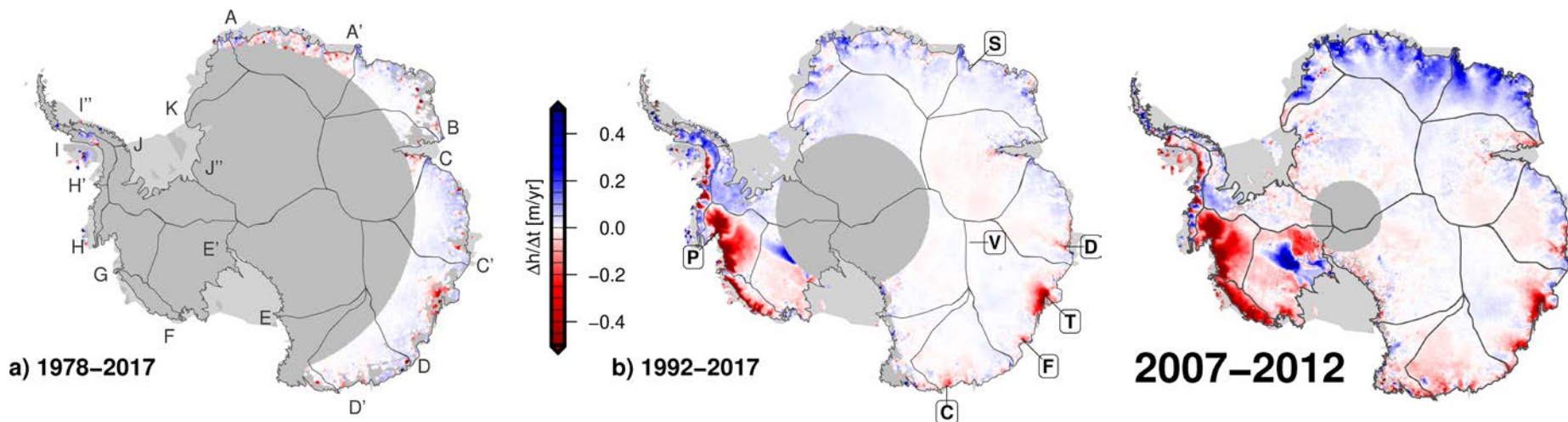
Interactive data portal data1.geo.tu-dresden.de
(in collaboration with Chair of Geoinformatics)

The figure displays two screenshots of the interactive data portal data1.geo.tu-dresden.de. The top screenshot shows the 'GMB Basin Product' interface, which includes a map of Antarctica and a 'Select a drainage basin' dropdown menu. The bottom screenshot shows the 'GMB Basin Product' interface, which includes a map of Antarctica and a 'Select a basin aggregation' dropdown menu. A line graph titled 'GIS09 - Greenland Ice Sheet' shows ice mass trends from 2004 to 2016, with a color scale from -2640 (red) to 1650 (blue). The graph shows a clear downward trend in ice mass over the period.

5000 visitors
350 downloads

Satellite altimetry for ice sheet mass balance

- Geometry
- Gravity



[Schröder et al. 2019: Four decades of Antarctic surface elevation changes from multi-mission satellite altimetry. *The Cryosphere*] → EGU highlight article



Geodetic Earth System Research

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GNSS, satellite
altimetry, gravimetry

Sea Level and Mass balance

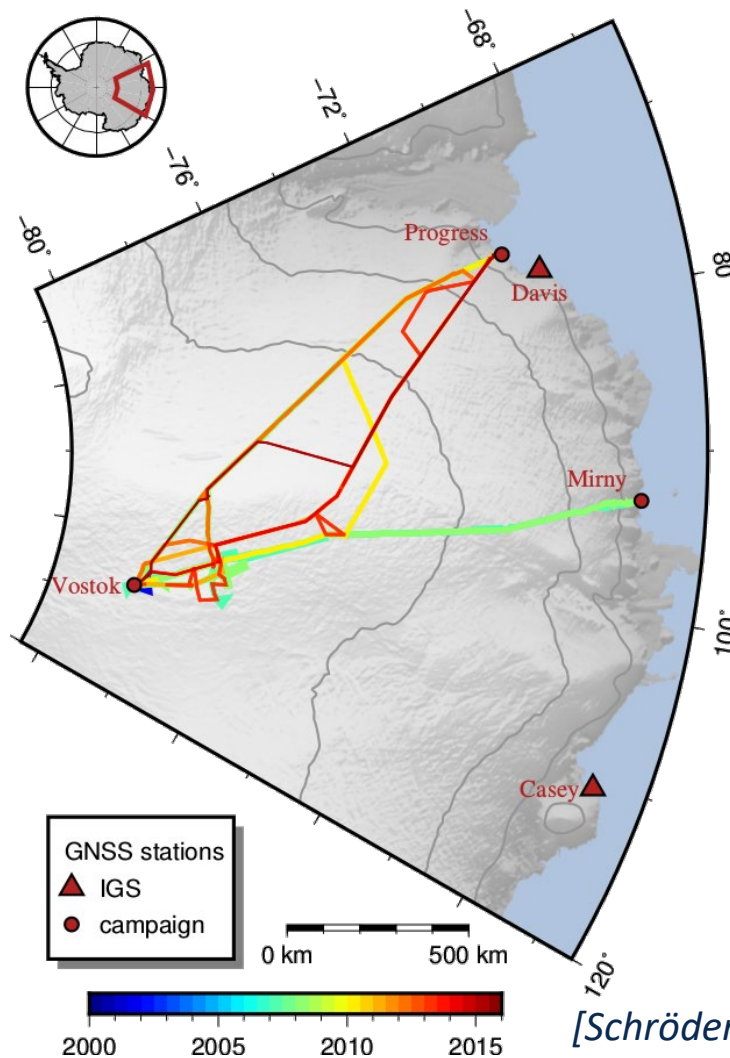
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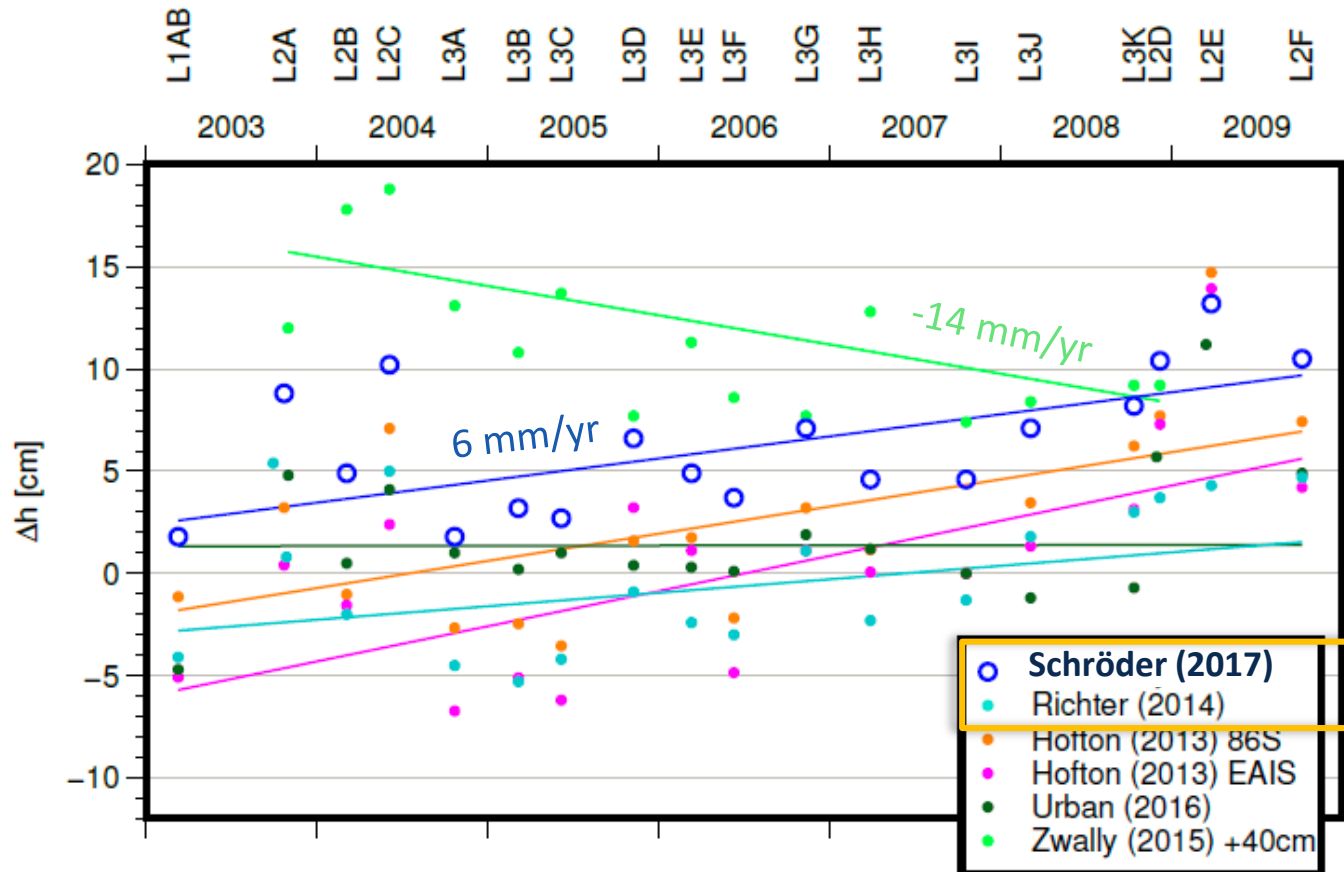
Kinematic GNSS traverses on the Antarctic Ice Sheet ...

- 30,000 km profiles acquired during 9 Russian Antarctic Expeditions 2001-2015



[Schröder et al. 2017,
The Cryosphere]

Kinematic GNSS traverses on the Antarctic Ice Sheet used for Calibration / Validation of satellite altimetry

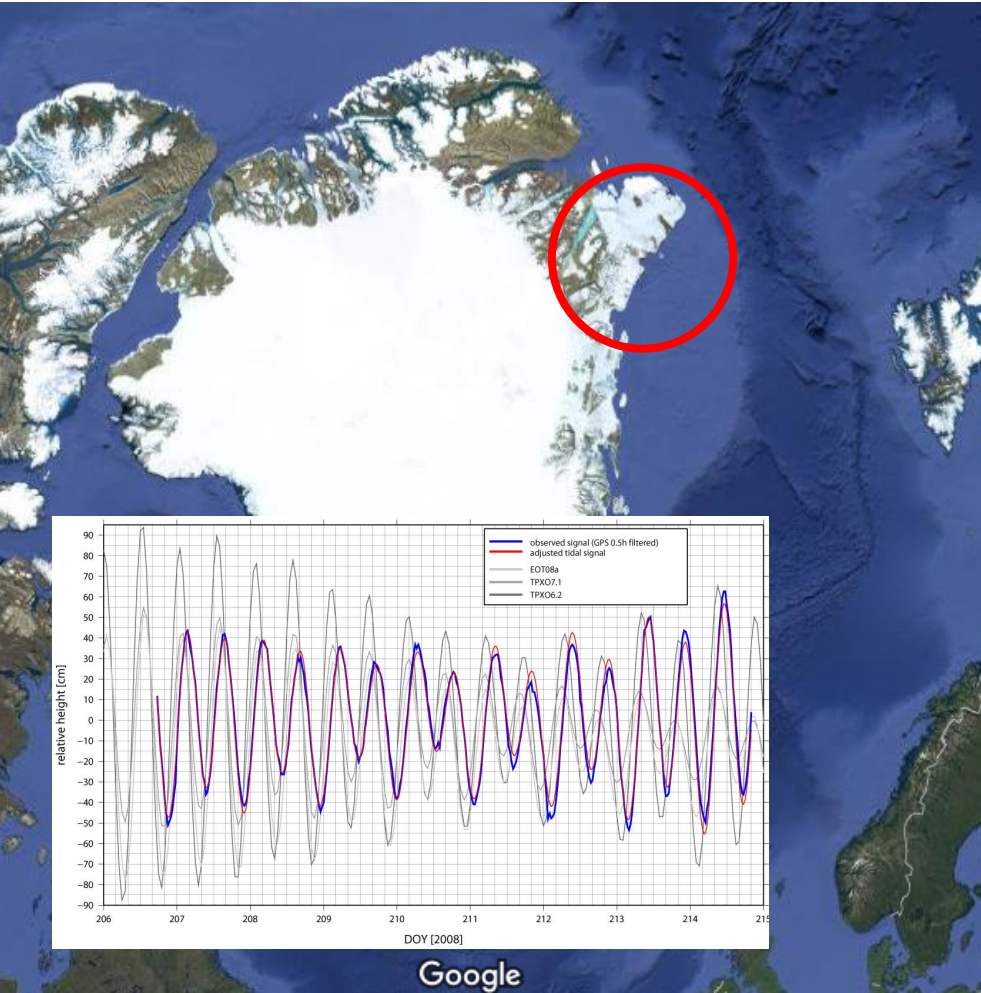


TU Dresden

- ICESat laser altimeter campaign biases according to different calibration studies
- have significant effect on ice mass balance results

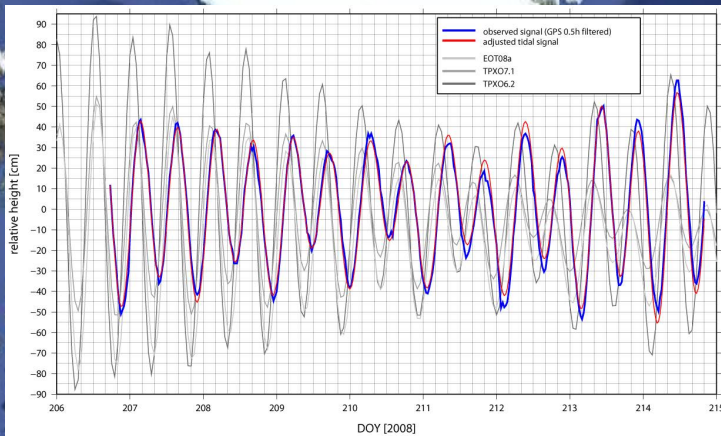
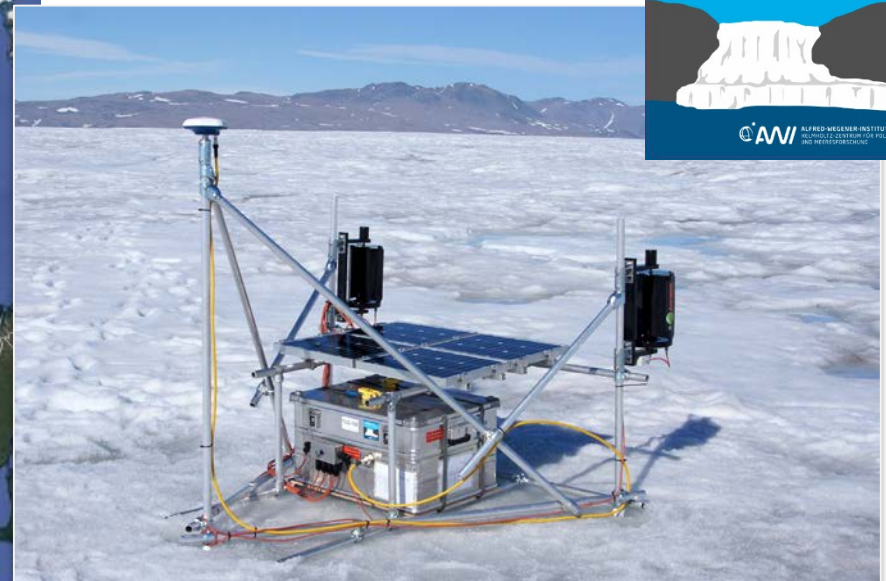
[Schröder et al. 2017,
The Cryosphere]

GNSS on floating glacier tongue in Greenland to observe tidal effects

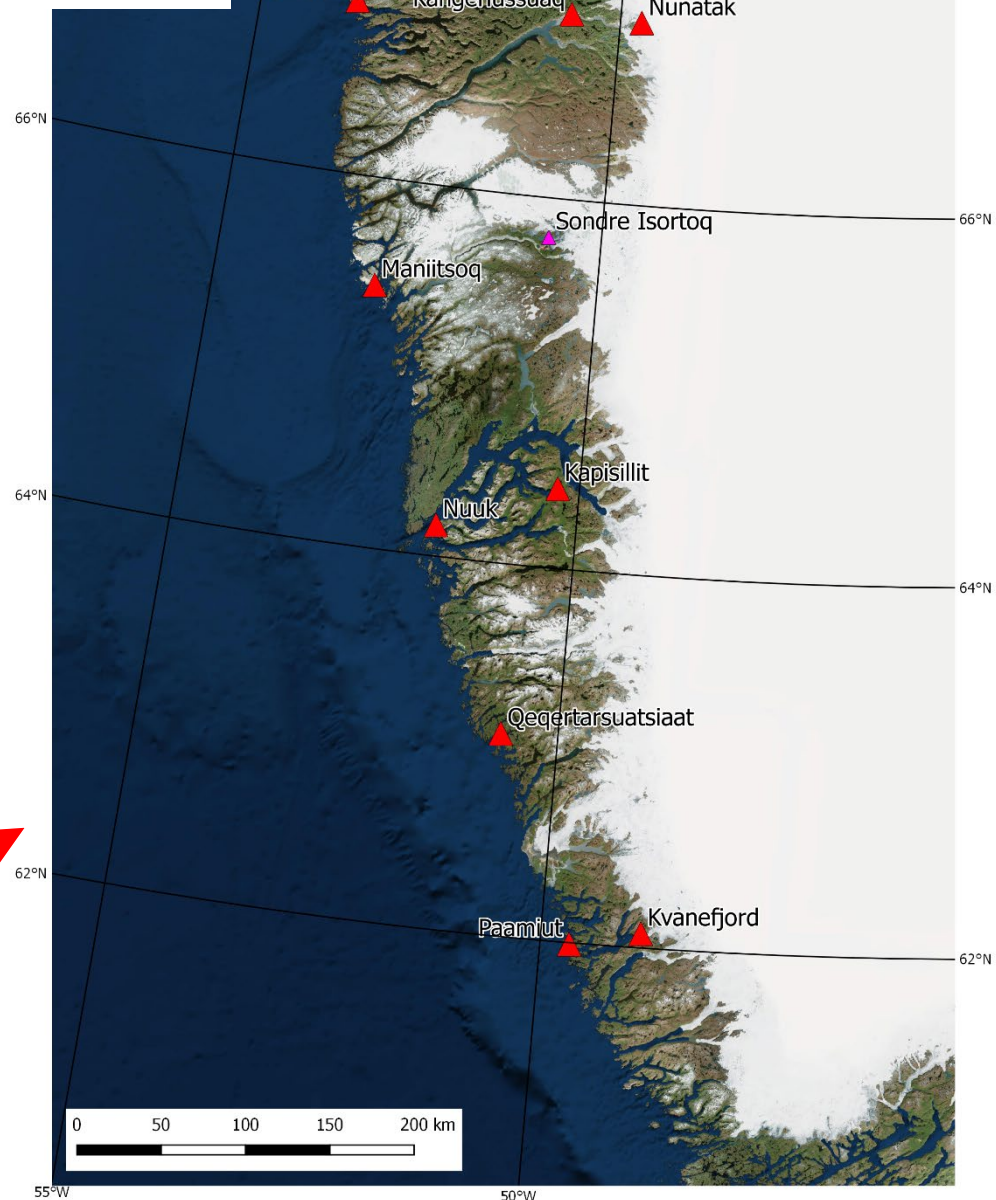


iGRIFF
79°N GLACIER
EXPEDITION
UNVEILING ICE-OCEAN INTERACTION

AWI ALFRED-WEIGER INSTITUT
FÜR KONTINENTALER PERMAFROST UND
HOCHGEBIRGSFORSCHUNG



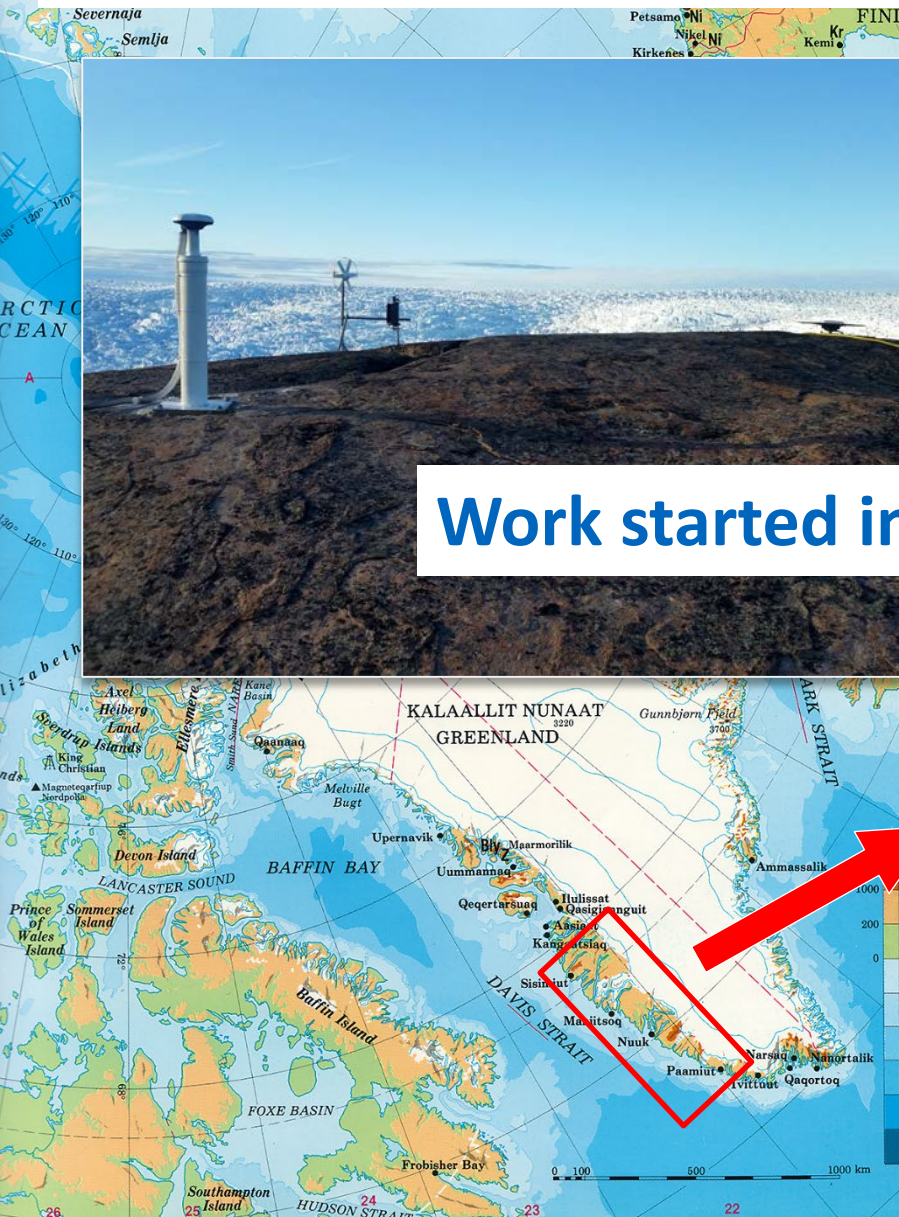
GNSS on bedrock in Greenland to observe crustal deformation



GNSS on bedrock in Greenland to observe crustal deformation



Work started in 1995.



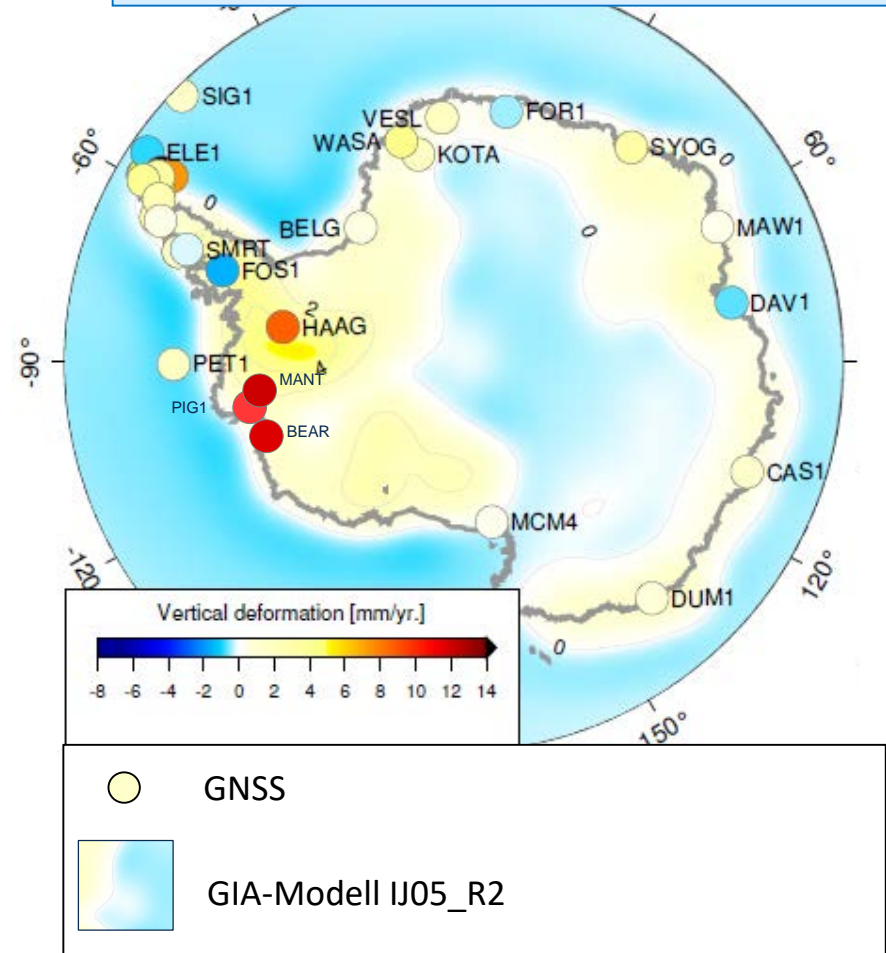
GNSS for Glacial Isostatic Adjustment in Antarctica

Setup of campaign measurement



(c) TU Dresden, Institut für Planetare Geodäsie

Vertical deformations (TU Dresden station and other stations)

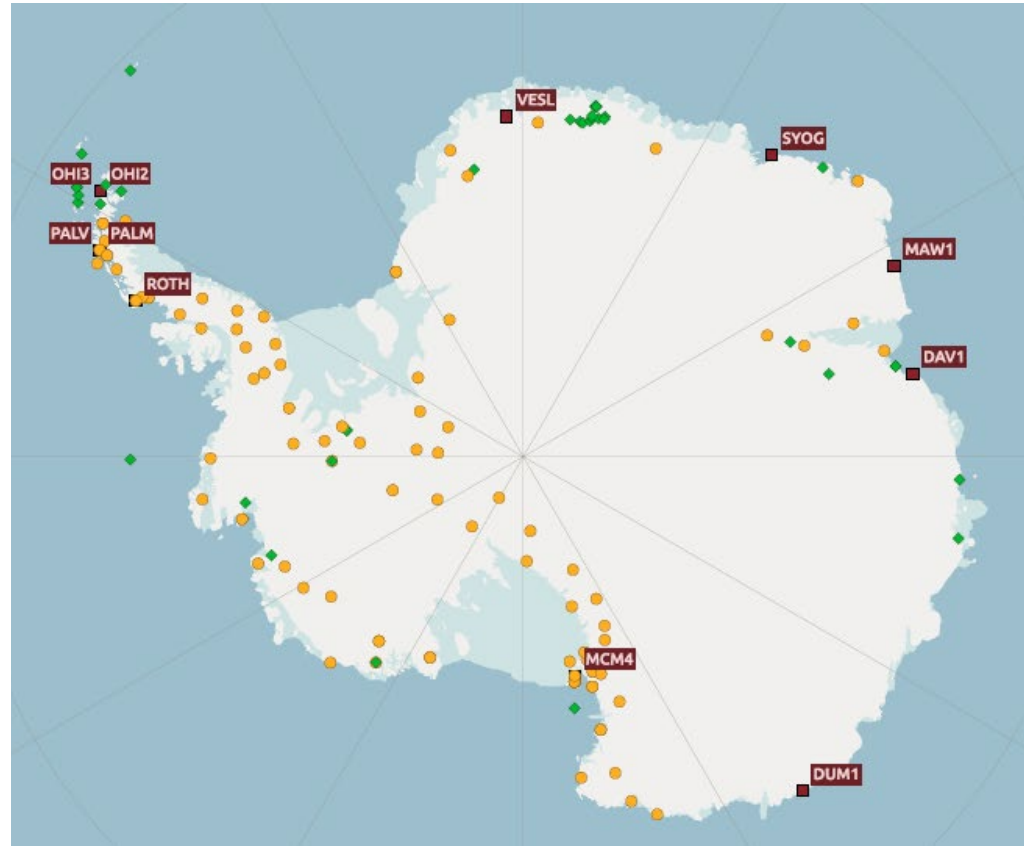


[Rülke et al. 2014]

GNSS Activities in the framework of SCAR (Scientific Committee on Antarctic Research)

- Host of the SCAR GNSS database (data1.geo.tu-dresden.de)
- GIANT REGAIN
(Geodynamics in Antarctica based on Reprocessing GNSS Data Initiative):
→ Consistent reprocessing of all available GNSS data on rock

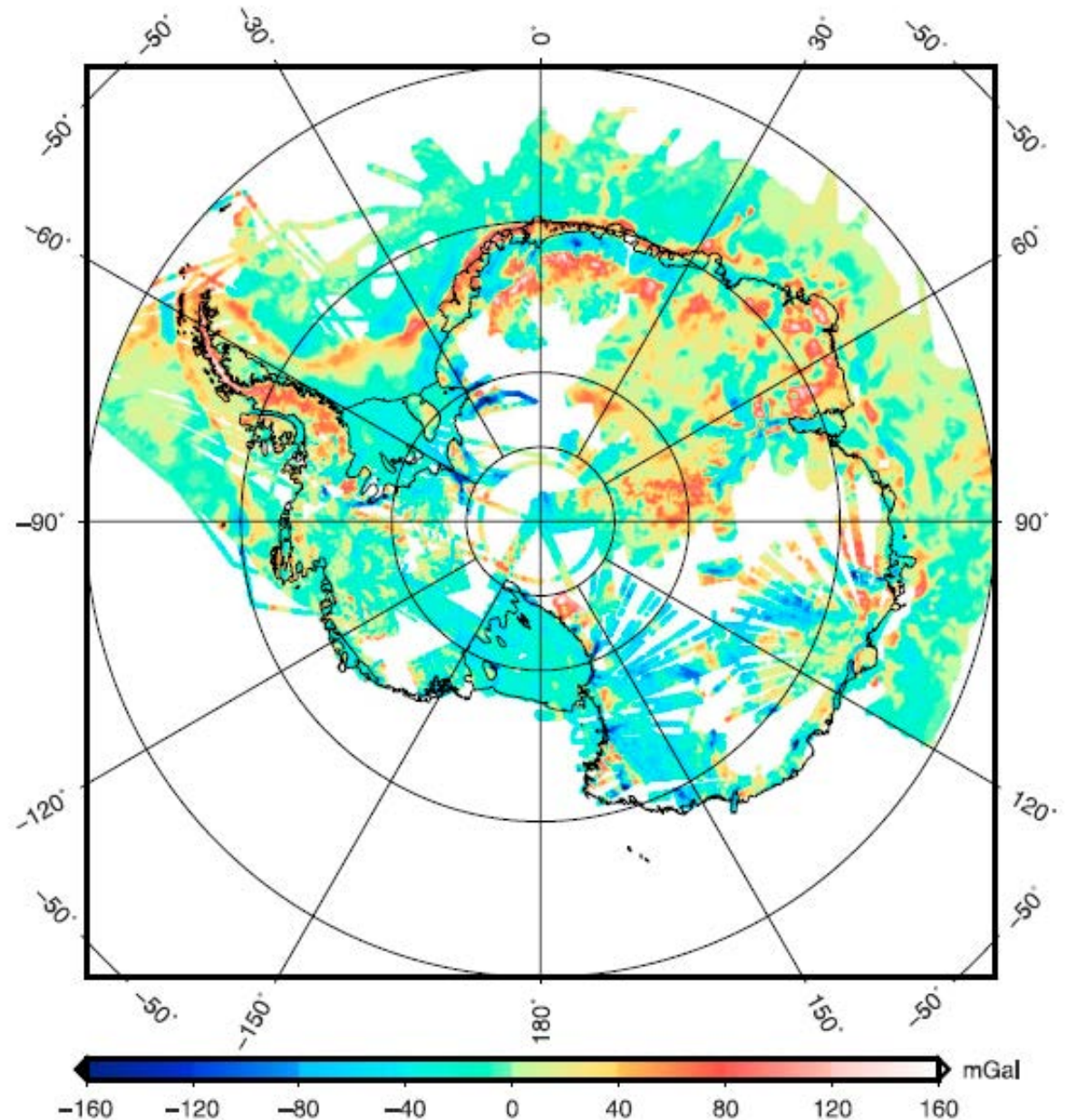
[Scheinert et al. 2018]



Antarctic gravity field

Free-air gravity anomalies:
First compilation of
the Antarctic Gravity
Field project

[*Scheinert et al. 2016*]



Geodetic Earth System Research at TU Dresden: Summary 1

GNSS

Satellite
altimetry

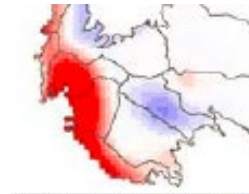
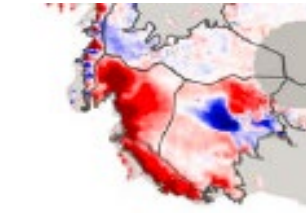
Satellite
gravimetry

Airborne measurements/
sat. remote sensing

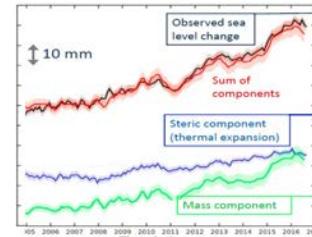
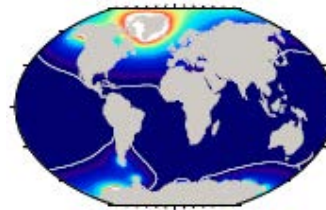
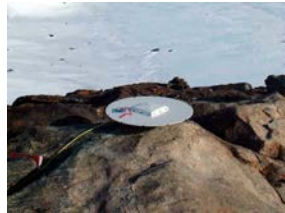
Ice sheet mass
balance



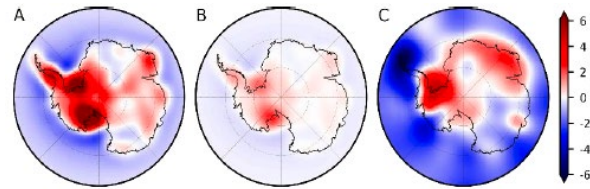
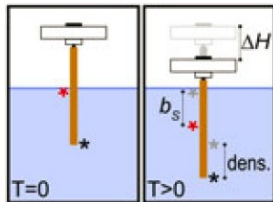
Sea level and
global mass
redistribution



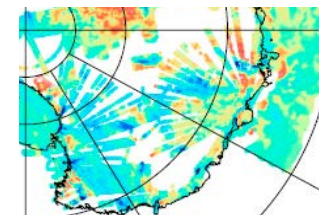
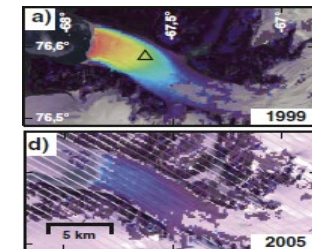
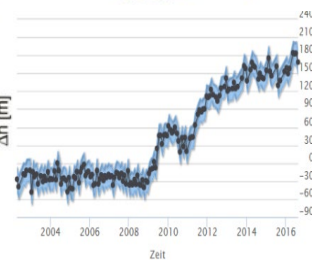
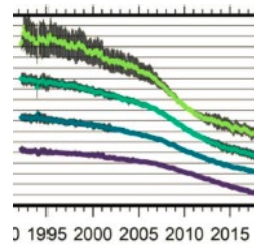
Glacial
isostatic
adjustment



Ice sheet
process
studies

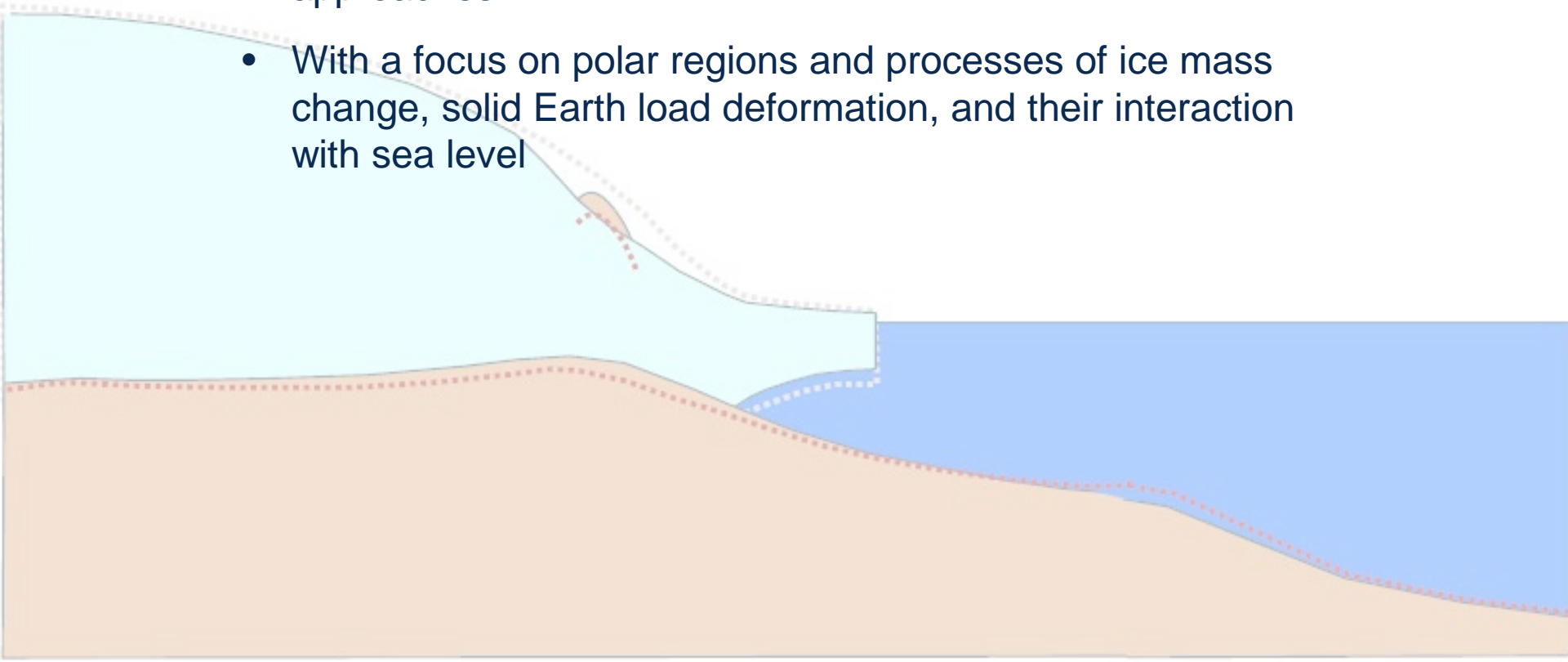


Antarctic
gravity field &
earth structure



Geodetic Earth System Research at TU Dresden: Summary 2

- Deliver facts on the Earth system from geodetic observations, as a prerequisite for understanding
- Combine satellite observations, fieldwork and geophysical/glaciological modeling in interdisciplinary approaches
- With a focus on polar regions and processes of ice mass change, solid Earth load deformation, and their interaction with sea level



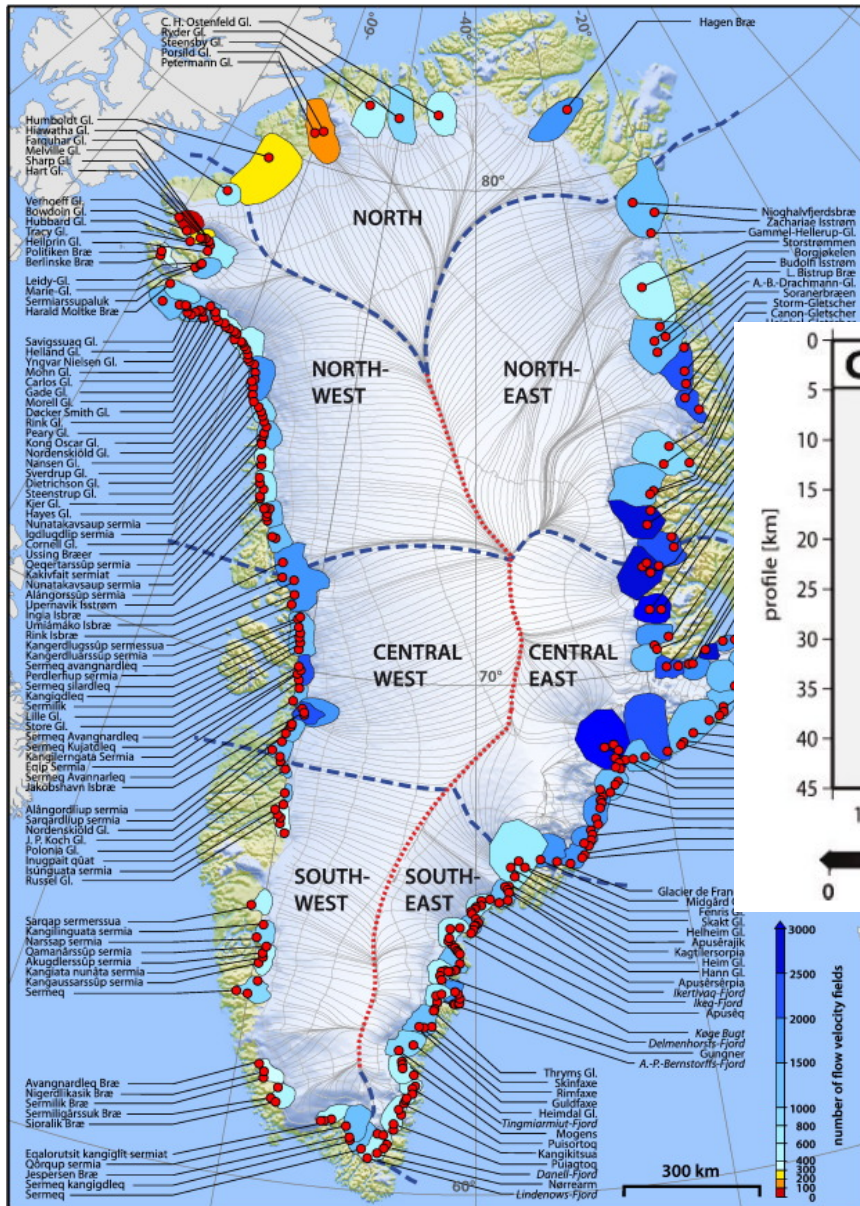


**TECHNISCHE
UNIVERSITÄT
DRESDEN**

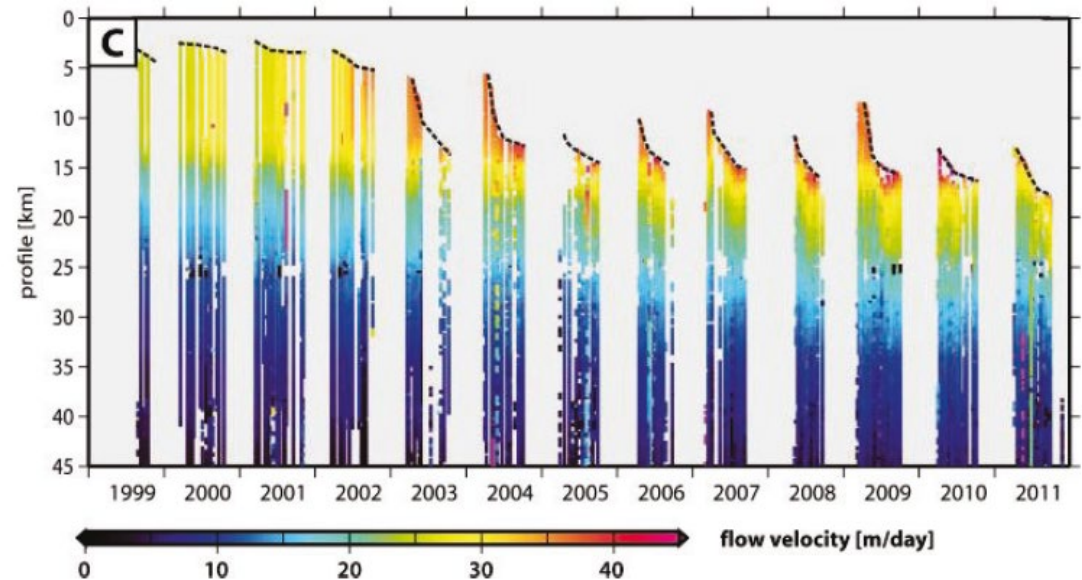
Faculty of Environmental Sciences, Department of Geosciences, Institut für Planetare Geodäsie



Glacier flow velocity fields from Landsat imagery



- available at data1.geo.tu-dresden.de (developed in collaboration with the Chair of Geoinformatics)



[Rosenau et al. 2015, Scheinert et al. 2016]

Gezeitendynamik

kinematische GNSS-Messung (24.06. – 01.08.2008)

GNSS-Station NIOG auf dem schwimmenden Gletscherteil
Gletscherteil zeigt Ozeangezeiten
(Modellprädiktionen nur nahe der Front möglich)

