

# Thomas Frederikse

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## Appointments

- NASA Jet Propulsion Laboratory, Earth Science department** **2018 - present**  
JPL Postdoctoral fellow
- Utrecht University, Institute for Marine and Atmospheric research** **2017 - 2018**  
Postdoctoral fellow

## Education

- PhD: Physical and Space Geodesy, Delft University of Technology** **2013 - 2018**  
Thesis: Sea-level changes on multiple spatial scales: estimates and contributing processes.  
[🔗 Thesis repository](#)  
Awarded cum laude (top 5% of PhD candidates from Delft University of Technology)
- MSc: Applied Physics, Delft University of Technology** **2011 - 2013**  
Thesis: Simulations and explanation of large-scale cloud structures during a Cold Air Outbreak.
- BSc: Applied Physics, Delft University of Technology** **2007 - 2011**

## Publications

### In press, under review, in preparation

1. Dangendorf, S., Frederikse, T., Chafik, L., Klinck J., Ezer, T., & Hamlington, B.D.: Model-tested reconstruction reveals large-scale ocean circulation control on coastal sea level. *Under review*
2. Harvey, T.C, Hamlington, B.D., Frederikse, T., & Nerem, R.S. Drivers of Recent Coastal United States Relative Sea Level Trends. *Under review*
3. Frederikse, T., Adhikari, S., Dangendorf, S., Gehrels, R., Landerer, F.W., Marcos, M., Slangen, A.B.A., & Wöppelmann, G. Constraining 20th-century sea-level rise in the South Atlantic Ocean. *Under review*
4. Hakuba, M. Z., Frederikse, T., & Landerer, F.W. Space geodesy suggests larger Earth Energy Imbalance than in-situ observations. *Under review*

### Published

1. Frederikse, T., Landerer, F., Caron, L., Adhikari, S., Parkes, D., Humphrey, V. W., Dangendorf, S., Hogarth, P., Zanna, L., Cheng, L., & Wu, Y.-H. (2020). The causes of sea-level rise since 1900. *Nature*, 584(7821), 393–397. doi:10.1038/s41586-020-2591-3
2. Hamlington, B., Frederikse, T., Thompson, P., Willis, J., Nerem, R., & Fasullo, J. (2020). Past, Present and Future Pacific Sea Level-Change. *Earth's Future*. doi:10.1029/2020EF001839
3. Larour, E., Caron, L., Morlighem, M., Adhikari, S., Frederikse, T., Schlegel, N.-J., Ivins, E., Hamlington, B., Kopp, R., & Nowicki, S. (2020). ISSM-SLPS: Geodetically compliant Sea-Level Projection System for the Ice-sheet and Sea-level System Model v4.17. *Geoscientific Model Development*, 13(10), 4925–4941. doi:10.5194/gmd-13-4925-2020
4. Frederikse, T., Buchanan, M. K., Lambert, E., Kopp, R. E., Oppenheimer, M., Rasmussen, D. J., & van de Wal, R. S. W. (2020). Antarctic Ice Sheet and emission scenario controls on 21st-century extreme sea-level changes. *Nature Communications*, 11(1), 390. doi:10.1038/s41467-019-14049-6

5. Hamlington, B. D., Piecuch, C. G., Reager, J. T., Chandanpurkar, H., Frederikse, T., Nerem, R. S., Fasullo, J. T., & Cheon, S.-H. (2020). Origin of interannual variability in global mean sea level. *Proceedings of the National Academy of Sciences*, 201922190. doi:10.1073/pnas.1922190117
6. Hamlington, B. D., Gardner, A. S., Ivins, E., Lenaerts, J. T., Reager, J., Trossman, D. S., Zaron, E. D., Adhikari, S., Arendt, A., Aschwanden, A., Beckley, B. D., Bekaert, D. P., Blewitt, G., Caron, L., Chambers, D. P., Chandanpurkar, H. A., Christianson, K., Csatho, B., Cullather, R. I., DeConto, R. M., Fasullo, J. T., Frederikse, T., Freymueller, J. T., Gilford, D. M., Giroto, M., Hammond, W. C., Hock, R., Holschuh, N., Kopp, R. E., Landerer, F., Larour, E., Menemenlis, D., Merrifield, M., Mitrovica, J. X., Nerem, R. S., Nias, I. J., Nieves, V., Nowicki, S., Pangaluru, K., Piecuch, C. G., Ray, R. D., Rounce, D. R., Schlegel, N.-J., Seroussi, H., Shirzaei, M., Sweet, W. V., Velicogna, I., Vinogradova, N., Wahl, T., Wiese, D. N., & Willis, M. J. (2020). Understanding of Contemporary Regional Sea-level Change and the Implications for the Future. *Reviews of Geophysics*. doi:10.1029/2019RG000672
7. Hamlington, B. D., Frederikse, T., Nerem, R. S., Fasullo, J. T., & Adhikari, S. (2020). Investigating the Acceleration of Regional Sea-level Rise During the Satellite Altimeter Era. *Geophysical Research Letters*. doi:10.1029/2019GL086528
8. Frederikse, T., Landerer, F. W., & Caron, L. (2019). The imprints of contemporary mass redistribution on local sea level and vertical land motion observations. *Solid Earth*, 10(6), 1971–1987. doi:10.5194/se-10-1971-2019
9. Jevrejeva, S., Frederikse, T., Kopp, R. E., Le Cozannet, G., Jackson, L. P., & van de Wal, R. S. W. (2019). Probabilistic Sea Level Projections at the Coast by 2100. *Surveys in Geophysics*. doi:10.1007/s10712-019-09550-y
10. De Roode, S. R., Frederikse, T., Siebesma, A., Ackerman, A. S., Chylik, J., Field, P., Fricke, J., Gryscha, M., Hill, A., Honnert, R., Krueger, S., Lac, C., Lesage, A. T., & Tomassini, L. (2019). Turbulent transport in the Gray Zone: A large-eddy model intercomparison study of the CONSTRAIN cold air outbreak case. *Journal of Advances in Modeling Earth Systems*. doi:10.1029/2018MS001443
11. Hamlington, B. D., Cheon, S. H., Piecuch, C. G., Karnauskas, K. B., Thompson, P. R., Kim, K.-Y., Reager, J. T., Landerer, F. W., & Frederikse, T. (2019). The Dominant Global Modes of Recent Internal Sea Level Variability. *Journal of Geophysical Research: Oceans*, 124(4), 2750–2768. doi:10.1029/2018JC014635
12. Chafik, L., Nilsen, J. E. Ø., Dangendorf, S., Reverdin, G., & Frederikse, T. (2019). North Atlantic Ocean Circulation and Decadal Sea Level Change During the Altimetry Era. *Scientific Reports*, 9(1). doi:10.1038/s41598-018-37603-6
13. Adhikari, S., Ivins, E. R., Frederikse, T., Landerer, F. W., & Caron, L. (2019). Sea-level fingerprints emergent from GRACE mission data. *Earth System Science Data*, 11(2), 629–646. doi:10.5194/essd-11-629-2019
14. Frederikse, T., & Gerkema, T. (2018). Multi-decadal variability in seasonal mean sea level along the North Sea coast. *Ocean Science*, 14(6), 1491–1501. doi:10.5194/os-14-1491-2018
15. Vermeersen, B. L., Slangen, A. B., Gerkema, T., Baart, F., Cohen, K. M., Dangendorf, S., Duran-Matute, M., Frederikse, T., Grinsted, A., Hijma, M. P., Jevrejeva, S., Kiden, P., Kleinherenbrink, M., Meijles, E. W., Palmer, M. D., Rietbroek, R., Riva, R. E., Schulz, E., Slobbe, D. C., Simpson, M. J., Sterlini, P., Stocchi, P., van de Wal, R. S., & van der Wegen, M. (2018). Sea-level change in the Dutch Wadden Sea. *Netherlands Journal of Geosciences*, 97(03), 79–127. doi:10.1017/njg.2018.7
16. Simon, K. M., Riva, R. E. M., Kleinherenbrink, M., & Frederikse, T. (2018). The glacial isostatic adjustment signal at present day in northern Europe and the British Isles estimated from geodetic observations and geophysical models. *Solid Earth*, 9(3), 777–795. doi:10.5194/se-9-777-2018

17. Slobbe, D. C., Sumihar, J., Frederikse, T., Verlaan, M., Klees, R., Zijl, F., Farahani, H. H., & Broekman, R. (2018). A Kalman Filter Approach to Realize the Lowest Astronomical Tide Surface. *Marine Geodesy*, 41(1), 44–67. doi:10.1080/01490419.2017.1391900
18. Frederikse, T., Jevrejeva, S., Riva, R. E. M., & Dangendorf, S. (2018). A Consistent Sea-Level Reconstruction and Its Budget on Basin and Global Scales over 1958–2014. *Journal of Climate*, 31(3), 1267–1280. doi:10.1175/JCLI-D-17-0502.1
19. Kleinherenbrink, M., Riva, R., & Frederikse, T. (2018). A comparison of methods to estimate vertical land motion trends from GNSS and altimetry at tide gauge stations. *Ocean Science*, 14(2), 187–204. doi:10.5194/os-14-187-2018
20. Frederikse, T., Riva, R. E. M., & King, M. A. (2017). Ocean Bottom Deformation Due To Present-Day Mass Redistribution and Its Impact on Sea Level Observations. *Geophysical Research Letters*, 44(24), 12, 306–12, 314. doi:10.1002/2017GL075419
21. Kleinherenbrink, M., Riva, R., Frederikse, T., Merrifield, M., & Wada, Y. (2017). Trends and interannual variability of mass and steric sea level in the Tropical Asian Seas. *Journal of Geophysical Research: Oceans*, 122(8), 6254–6276. doi:10.1002/2017JC012792
22. Riva, R. E. M., Frederikse, T., King, M. A., Marzeion, B., & van den Broeke, M. R. (2017). Brief communication: The global signature of post-1900 land ice wastage on vertical land motion. *The Cryosphere*, 11(3), 1327–1332. doi:10.5194/tc-11-1327-2017
23. Dangendorf, S., Marcos, M., Wöppelmann, G., Conrad, C. P., Frederikse, T., & Riva, R. (2017). Reassessment of 20th century global mean sea level rise. *Proceedings of the National Academy of Sciences*, 114(23), 5946–5951. doi:10.1073/pnas.1616007114
24. Frederikse, T., Simon, K., Katsman, C. A., & Riva, R. (2017). The sea-level budget along the Northwest Atlantic coast: GIA, mass changes, and large-scale ocean dynamics. *Journal of Geophysical Research: Oceans*, 122(7), 5486–5501. doi:10.1002/2017JC012699
25. Frederikse, T., Riva, R., Kleinherenbrink, M., Wada, Y., van den Broeke, M., & Marzeion, B. (2016). Closing the sea level budget on a regional scale: Trends and variability on the Northwestern European continental shelf. *Geophysical Research Letters*, 43(20), 10, 864–10, 872. doi:10.1002/2016GL070750
26. Frederikse, T., Riva, R., Slobbe, C., Broerse, T., & Verlaan, M. (2016). Estimating decadal variability in sea level from tide gauge records: An application to the North Sea. *Journal of Geophysical Research: Oceans*, 121(3), 1529–1545. doi:10.1002/2015JC011174

## Invited presentations

1. The causes of sea-level rise since 1900  
Sea-level seminar series, National Oceanography Centre, Liverpool, UK, 2020
2. From local to global: can we use our understanding of local sea-level changes to better constrain our estimates of global-mean sea-level changes over the last century?  
US CLIVAR webinar, 2019 (📺 YouTube)
3. Combining tide-gauge observations with estimates of spatial sea-level variability to improve reconstructions and to close the contemporary global and regional sea-level budget.  
EGU General Assembly, 2018
4. Decoding observed sea-level change: do we understand what's happening at the sea surface?  
Institute for Marine and Atmospheric Physics colloquium series, Utrecht University, 2018

5. Closing regional sea level budgets with geodetic observations  
Netherlands Centre for Coastal Research Symposium 'Regional sea level change', 2017
6. Contemporary sea level changes: how much and why?  
Delft geoscience student association seminar series, 2017
7. Explaining trends and variability along the Northwestern European shelf.  
European Climate Research Alliance Sea-level workshop, Bergen, Norway, 2016
8. Large eddy simulations of the development of mesoscale structures during a cold air outbreak  
Buys Ballot Boundary Layer and Turbulence workshop, 2013

## Funding

<b>NASA sea-level change science team</b>	<b>2020 - 2024</b>
Attributions of past regional sea level variations and projection of future sea level changes.	
	\$600k/yr, CO-I
<b>NASA sea-level change science team</b>	<b>2020 - 2024</b>
From grounding lines to coastlines: an integrated approach to barystatic sea-level projections.	
	\$450k/yr, CO-I
<b>Delft University Climate Institute</b>	<b>2013</b>
Precipitation control on mesoscale cloud cellular organization.	
	€3k, Recipient

## Awards and recognition

2017 Department of Geoscience & Remote Sensing Outstanding Paper Award  
 2017 Department of Geoscience & Remote Sensing Outstanding Poster Award  
 2018 Buys Ballot National Research School Best Poster Award  
 2019 Department of Geoscience & Remote Sensing Outstanding Paper Award  
 2021 JPL Outstanding Postdoc Presentation Award

## Ongoing and past projects

<b>NASA Sea Level Change Science Team</b>	<b>2018 - present</b>
Member of the 2020-2024 NASA Sea Level Change Science Team (N-SLCT). Co-investigator for two projects: 'Attributions of past regional sea level variations and projection of future sea level changes' (PI: Tong Lee) and 'From grounding lines to coastlines: an integrated approach to barystatic sea-level projections.' (PI: Eric Larour)	
<b>Towards a Unified Sea Level Record</b>	<b>2018 - present</b>
Contributing to an international effort, led by Sönke Dangendorf (Old Dominion University) and Marta Marcos (University of the Balearic Islands), to understand the differences between multiple global sea-level reconstructions and how 20th-century changes should be interpreted in the light of long-term proxy records. This project is sponsored by the International Space Science Institute, Bern, Switzerland. <a href="#">↗</a> Website	
<b>IAG-ICCC Joint Working group on Regional sea level and vertical land motion</b>	<b>2020 - present</b>
Member of the working group 'Regional Sea level and vertical land motion' of the Inter-Commission Committee on "Geodesy for Climate Research", which is part of the International Association of Geodesy (IAG). With this group we are working on a consistent set of data sets for sea-level science and function as a source of information for fellow scientists on how to use and combine observational data sets in a geodetically consistent way. <a href="#">↗</a> Website	

**IPCC Special Report on the Ocean and Cryosphere** **2018 - 2019**

Contributing author to chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities of the IPCC Special Report on the Ocean and Cryosphere. For this report, I computed all changes in future extreme sea levels. [↗ SROCC Chapter 4](#)

**Sea-level rise, subsidence and morphodynamics in the Dutch Wadden Sea** **2018**

I contributed to the report ‘Sea-level rise, subsidence and morphodynamics in the Dutch Wadden Sea’, which has been written by the Dutch Waddenacademie to foster our understanding of how the fragile ecosystem of the Dutch Wadden Sea will react to sea-level changes and land subsidence and to project its impacts for 2030, 2050, and 2100. I was responsible for estimating past changes from tide-gauge observations and for determining the role of ocean mass changes and geodynamics.

## Teaching

**Jet Propulsion Laboratory summer internship program** **2019-2020**

Co-supervising Thomas Harvey, graduate student from University of Colorado for two consecutive internship programmes.

**Delft Sea Level Summer School** **2019**

Presented the lecture ‘A crash course in using tide gauges to study sea level’ at the 2019 Delft Sea Level Summer School.

**Mechanics** **2016 - 2018**

Teaching assistant for 1st-year undergraduate course Mechanics, class size of about 100 students. Designed homework exercises and the final exam, gave tutorials and plenary lectures.

**Oceans, Sea Level, and Bathymetry.** **2015 - 2018**

Teaching assistant for graduate course Oceans, Sea Level, and Bathymetry, class size of about 25 students. Designed homework exercises and the final exam, gave tutorials and plenary lectures.

**Physics of the Earth and Atmosphere.** **2014 - 2016**

Teaching assistant for graduate course Physics of the Earth and Atmosphere, class size of about 25 students. Designed homework exercises and supervised the tutorial sessions.

## Academic Service

Session convener for ‘Coastal Subsidence: Natural versus anthropogenic drivers’ at the 2019, 2020, and 2021 EGU General Assembly.

Reviewed manuscripts for: Nature, Nature Communications, Geophysical Research Letters, Journal of Geophysical Research - Oceans, Earth and Planetary Science Letters, Journal of Climate, Earth System Dynamics, Progress in Oceanography, Frontiers in Marine Sciences.

## Media

The 2020 sea-level budget study got picked up by many media outlets, including:

- Climate change: Dams played key role in limiting sea level rise [↗ BBC](#)
- Record Ice Loss in Greenland Is a Threat to Coastal Cities Worldwide [↗ Bloomberg](#)

The changes in extreme sea levels I computed for the IPCC SROCC report have been picked up as the main conclusion of the whole report in various media:

- The World’s Oceans Are in Danger, Major Climate Change Report Warns. [↗ New York Times](#)
- Extreme sea level events ‘will hit once a year by 2050’. [↗ The Guardian](#)

Selection of the media coverage of ‘Ocean Bottom Deformation Due To Present-Day Mass Redistribution and Its Impact on Sea Level Observations’:

- If the sea floor is sinking, are we safe from sea level rise? [↗](#) New Scientist
- Climate Change Is Causing the Seafloor to Sink. [↗](#) Gizmodo
- Rising waters sink seafloors. [↗](#) EARTH magazine
- Is climate change causing the seafloor to SINK? Scientists claim weight of water pouring off melting ice sheets is making the oceans heavier and squashing the planet. [↗](#) Daily Mail

Coverage of 'Antarctic Ice Sheet and emission scenario controls on 21st-century extreme sea-level changes' in the Dutch media:

- Honderd keer hoger overstromingsrisico voor tropische kusten in 2050. (Hundred-fold increase in flood risk for tropical coasts in 2050.) [↗](#) Nu.nl
- De kans op extreme waterstanden neemt de komende-eeuw fors toe. (The odds of extreme water levels will increase massively this century.) [↗](#) Scientias

In 2019, I commented about a sea-level report presented to the Dutch national government in two leading Dutch newspapers:

- Door de golven de zeespiegelstijging niet zien. (Unable to see sea-level rise because of the waves.) [↗](#) NRC Handelsblad
- Zijn alle voorspellingen over de stijging van de zeespiegel overdreven? (Are all projections of sea-level rise too high?) [↗](#) Volkskrant

Selection of other newspaper and radio interviews:

- Langere dagen door klimaatverandering (Days become longer due to climate change) [↗](#) BNR News-radio
- De zeespiegel stijgt steeds sneller: Welke problemen levert dat op? (Sea levels are rising faster and faster: what problems does that cause?) [↗](#) Nu.nl

Fact checker for [↗](#) Climate Feedback

Designed one of the questions for 'De Nationale Wetenschapsquiz' (The National Science Quiz), an annual popular scientific television quiz, which attracted 600.000 viewers. [↗](#) Nationale Wetenschapsquiz

## **Skills**

Languages: Dutch (native), English (fluent, level C1 on European CEFR scale), German (basic proficiency)

Programming and model development experience in Python, Julia, matlab, C++, Fortran, OpenMP.