



SPATIALLY EXPLICIT UNCERTAINTY IN MARINE REMOTE SENSING AND HOW TO USE IT FOR MODEL OPTIMIZATION

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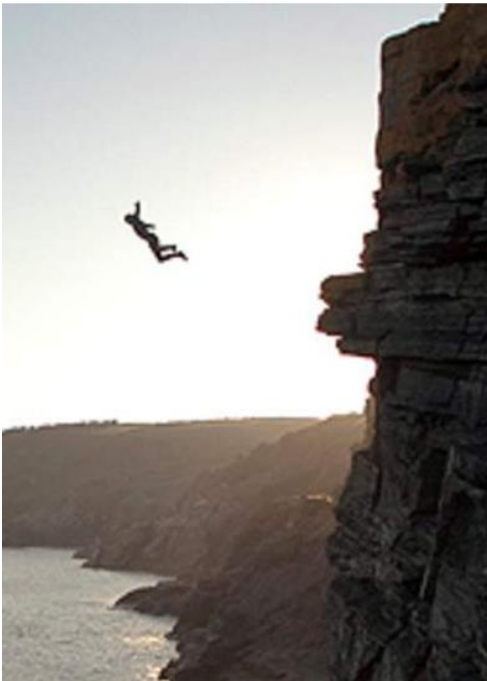
²European Space Research Center (ESRIN), European Space Agency (ESA). Via Galileo Galilei, Frascati, Italy.

³Institute of Geography and Geology, University of Würzburg, 97074 Würzburg, Germany

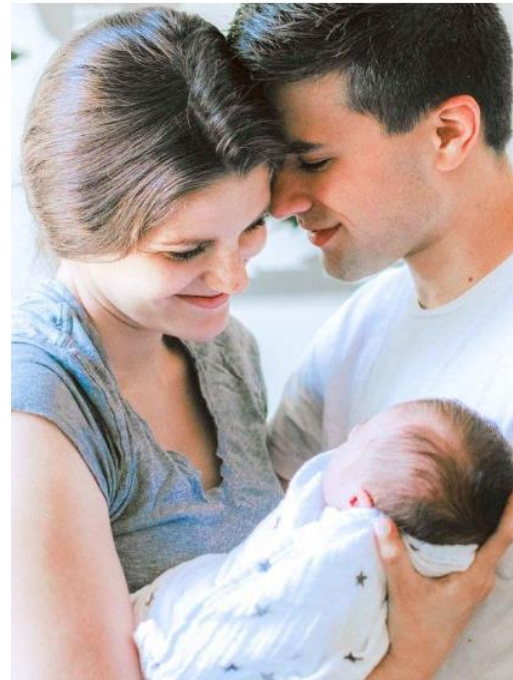
⁴Ocean Ledger, 18 Waincott Main 11975, NY, United States

⁵German Aerospace Centre, Remote Sensing Technology Institute (IMF), 82234 Wessling, Germany

What is Uncertainty?



Source: <https://news.sky.com/story/cliff-divers-100ft-plunge-caught-on-camera-10493099>

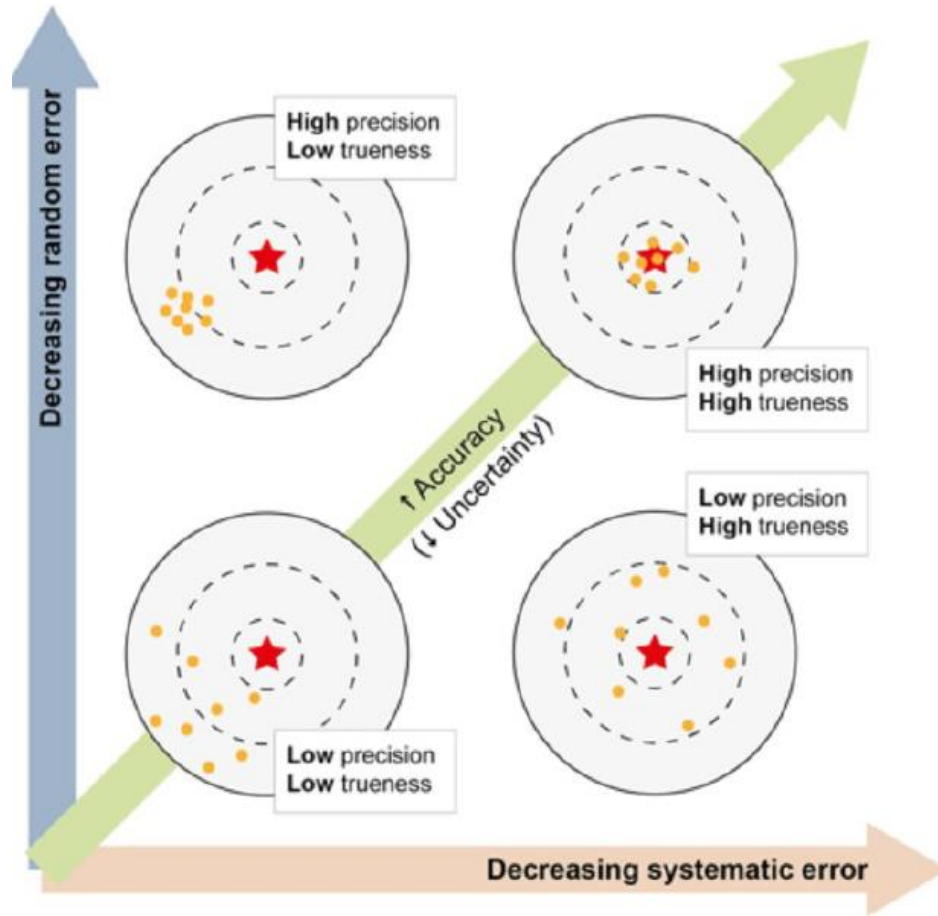


Source: <https://blog.zencare.co/communication-problems-new-parents/>



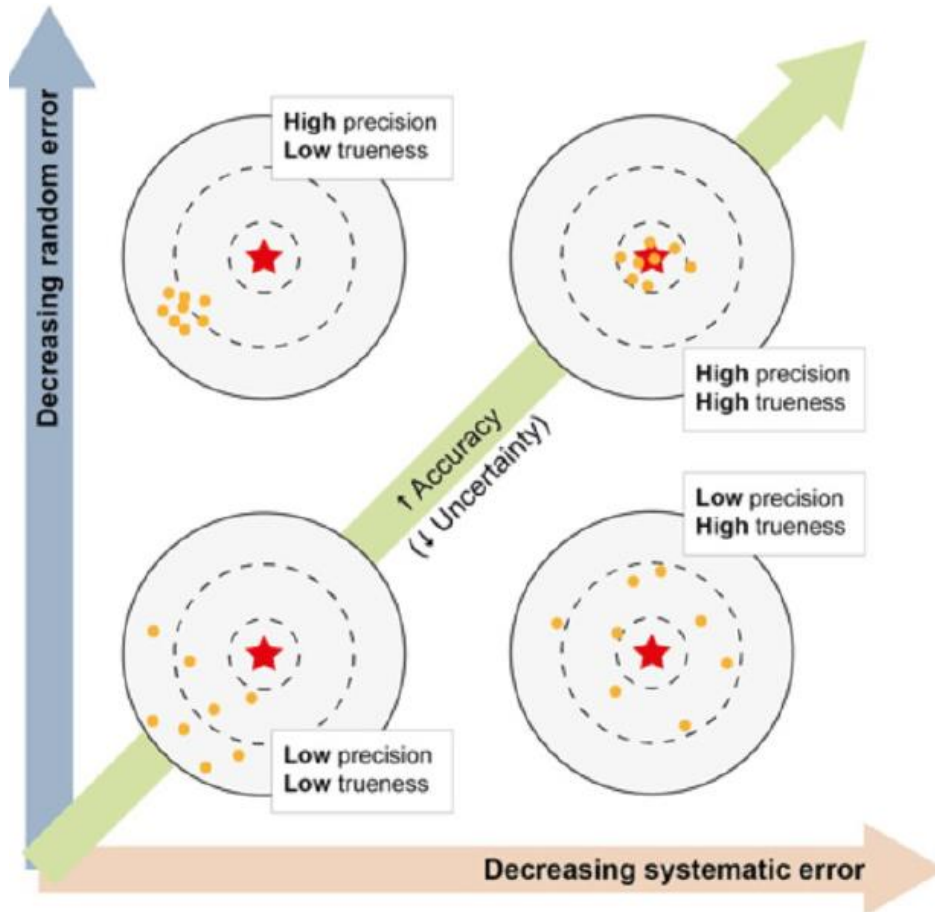
<https://www.theguardian.com/careers/phd-right-career-option>

Uncertainty of Measurement/ Model

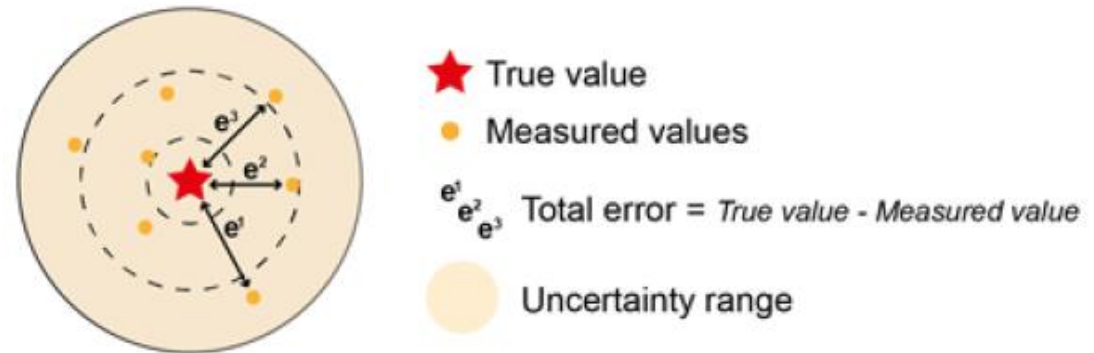


Pérez-Díaz, L., Alcalde, J., and Bond, C. E.: Introduction: Handling uncertainty in the geo-sciences: identification, mitigation and communication, Solid Earth, 11, 889–897, <https://doi.org/10.5194/se-11-889-2020>, 2020.

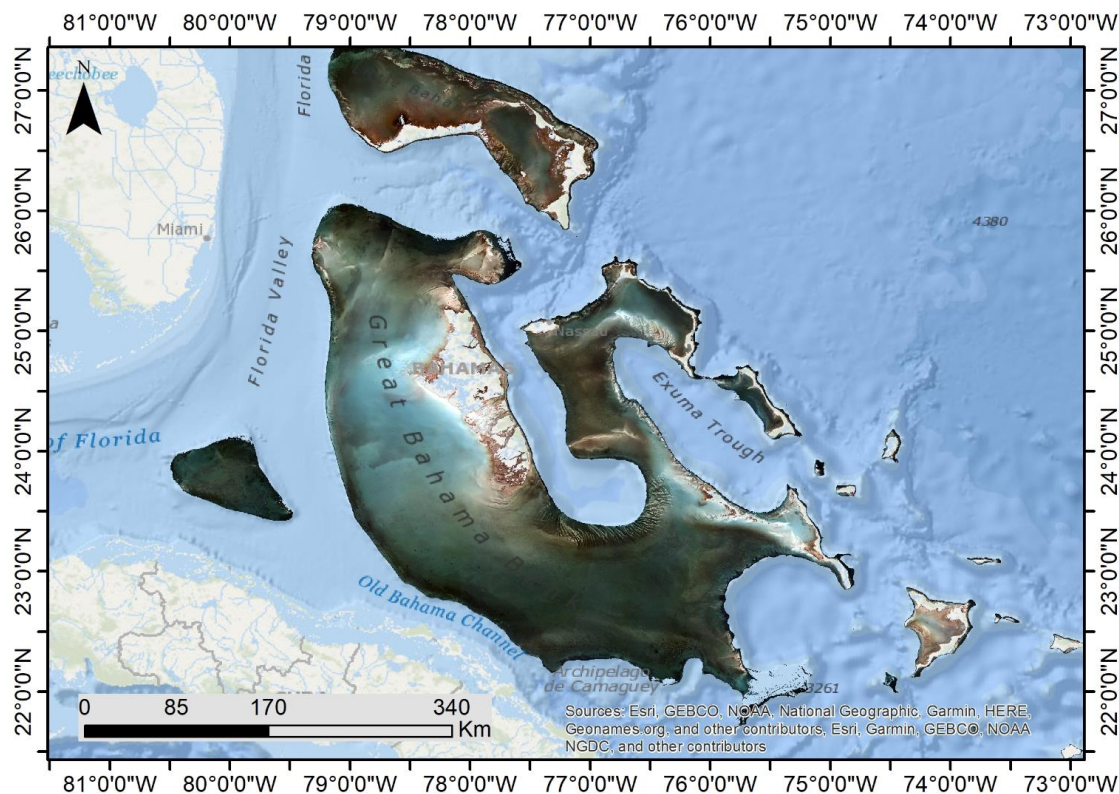
Uncertainty of Measurement (Spatially- constrained)



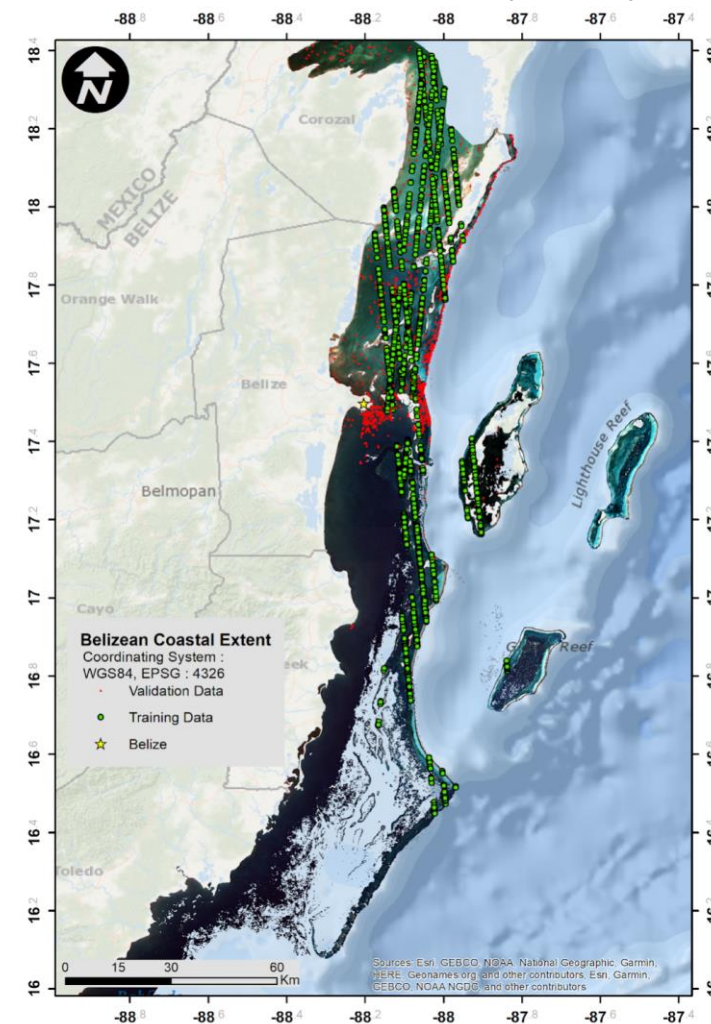
Uncertainty of Prediction (Not Constrained)



Benthic Habitat Classification

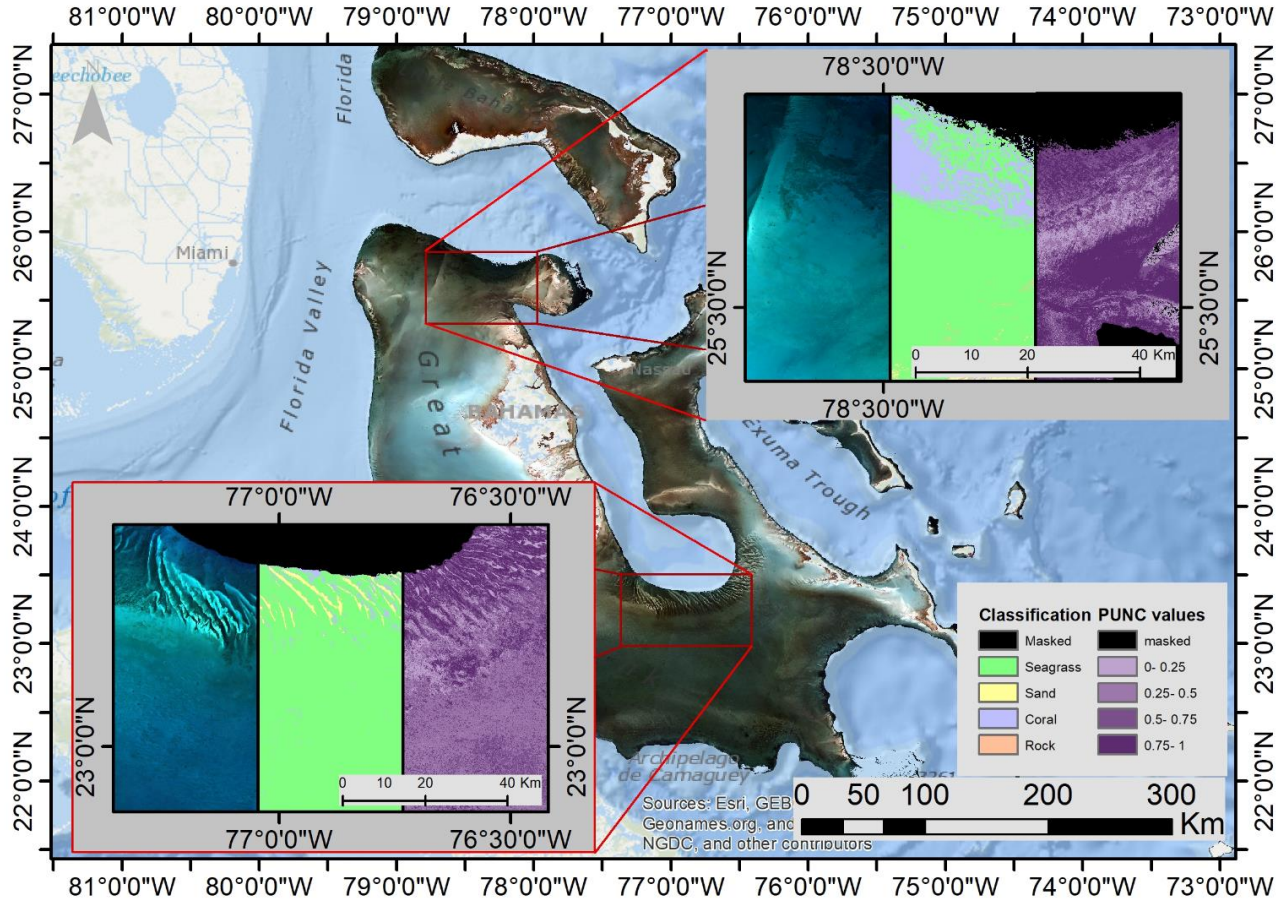


Satellite Derived Bathymetry

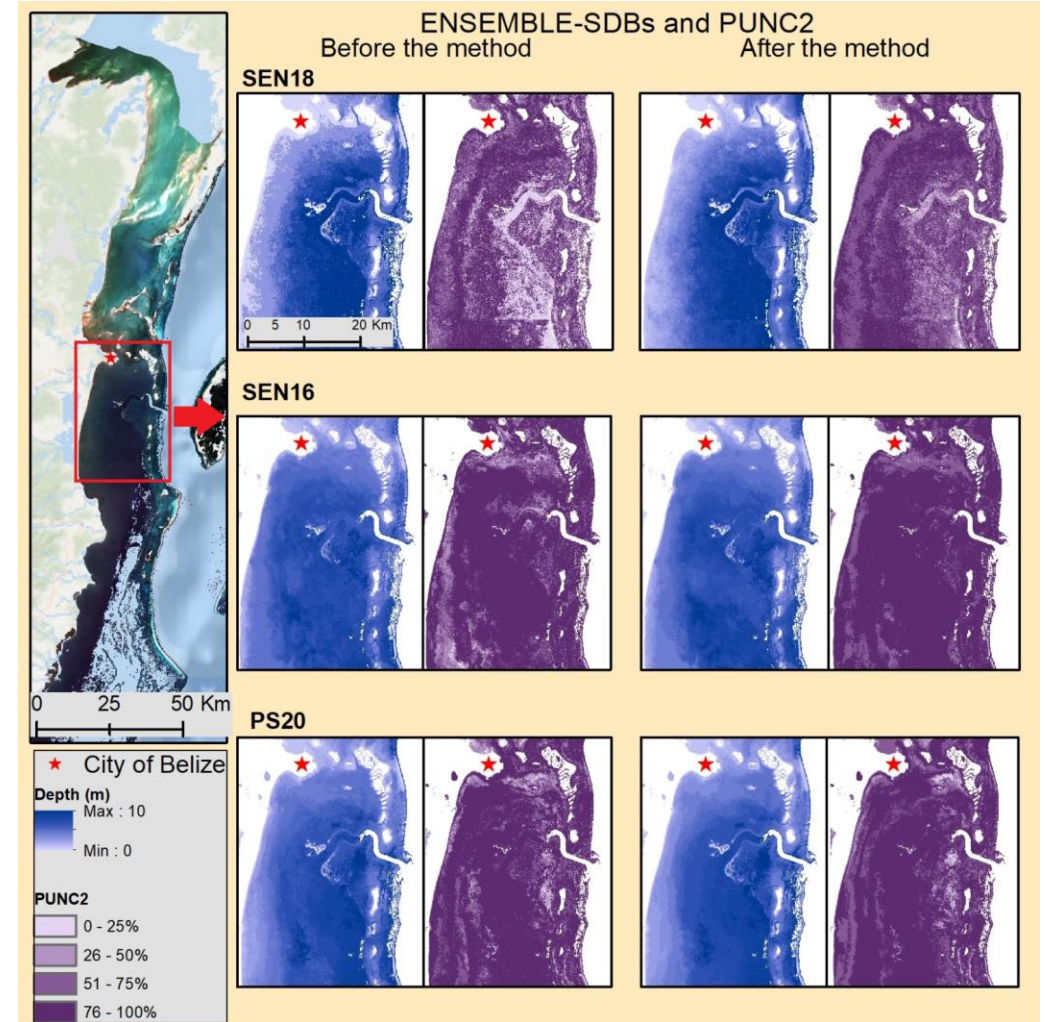


Study Region(s)	Satellite System	Time Range	# of Satellite Images / Composites	Task
The Bahamas	Sentinel -2	2017-2021	18881 images	Habitat Classification
Wakatobi Archipelago, Indonesia	PlanetScope	2015-2020	10 biannual composites	Habitat Classification
Belize	i) Sentinel -2 ii) PlanetScope iii) Planetscope	i) 2018-2021 (Sen18) ii) 2016-2019 (PS16) iii) 2020-2022 (PS20)	i) 876 images ii) 8 semester basemaps iii) 29 monthly mosaics	Satellite Derived Bathymetry (SDB)

Benthic Habitat Classification



Satellite Derived Bathymetry



Benthic Habitat Classification

The Bahamas

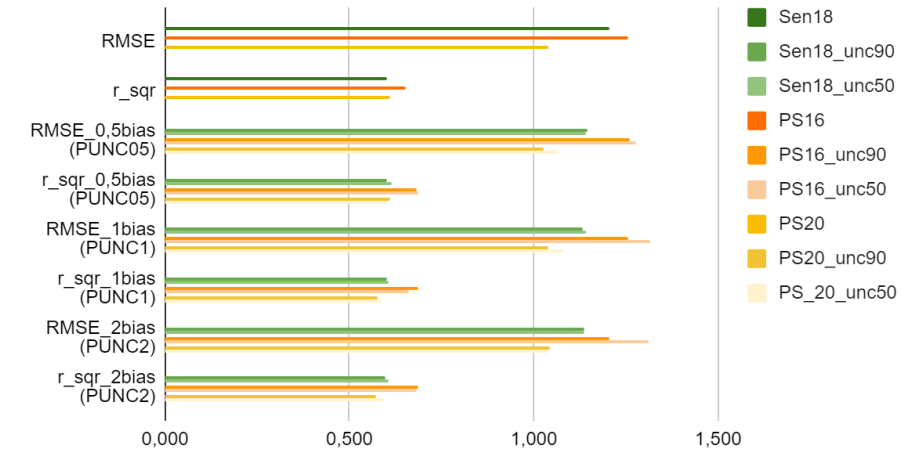
Classification model	Overall Accuracy [%]	User's accuracy (seagrass) [%]	Producer's accuracy (seagrass) [%]	User's accuracy (coral) [%]	Producer's accuracy (coral) [%]
Best Ensemble model	61.3	96.8	81	52.8	76.3
Second Best Ensemble model	61.2	97.6	80.7	52.6	74.7
Classification with All Data	59.8	60.4	52.3	35.5	30.3

Wakatobi

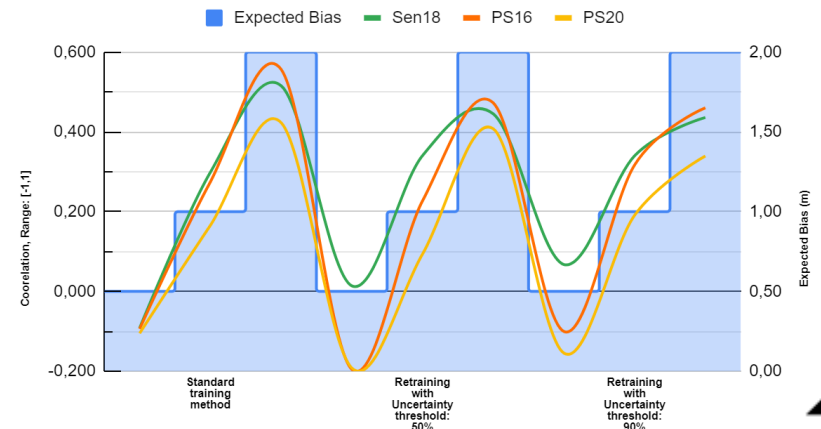
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Second Best Ensemble model	99.5	1	1	98.2	1
Classification with All Data	99.5	1	1	98.1	1

Satellite Derived Bathymetry

Bar Chart of RMSE and R² before and after retraining the models



Correlation of StdDev-PUNC



Benthic Habitat Classification

The Bahamas

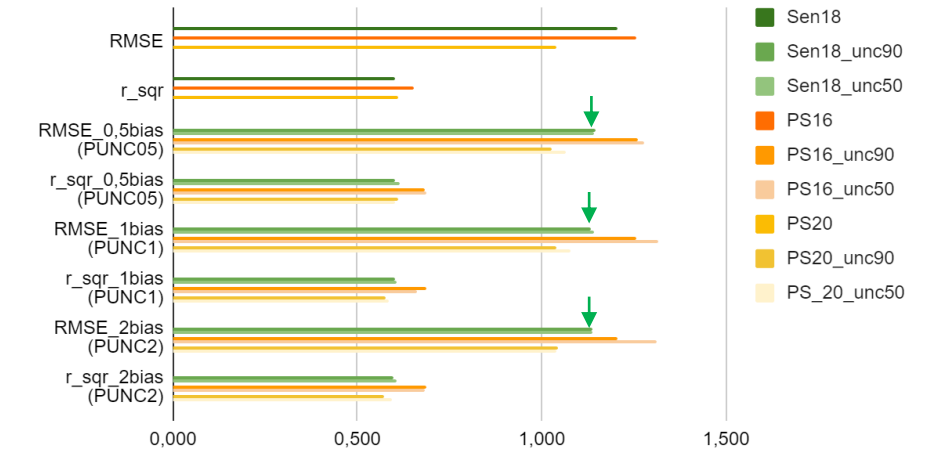
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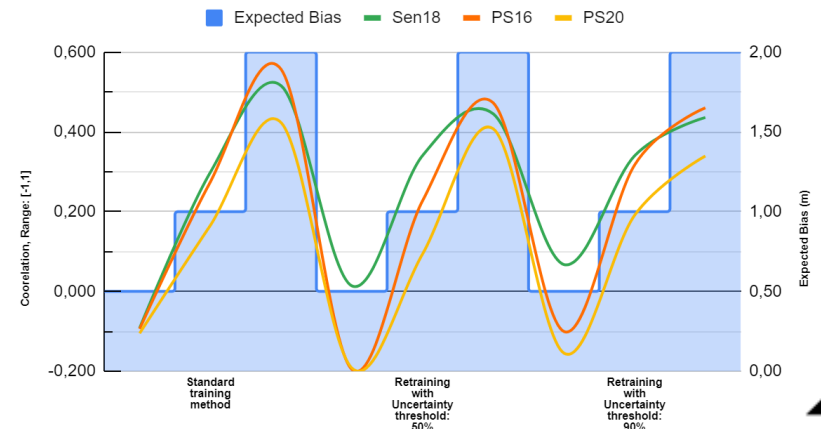
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A Cloud-based Framework for the Quantification of the Spatially-Explicit Uncertainty of Remotely Sensed Benthic Habitats

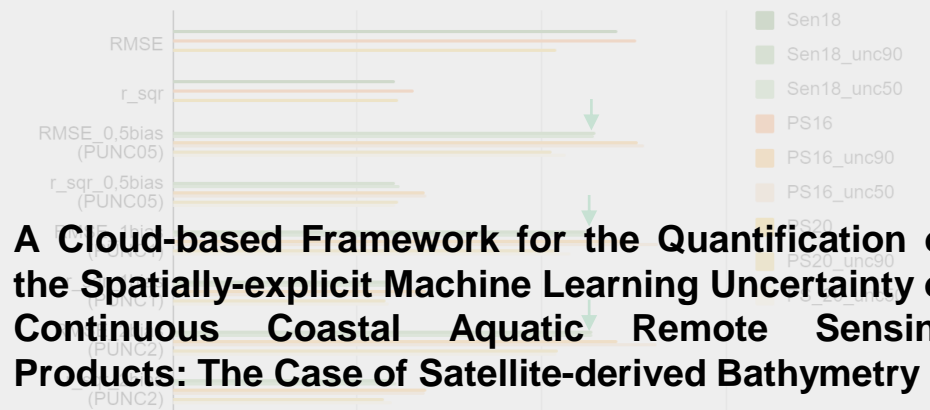
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Status: Under Review

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Satellite Derived Bathymetry

Bar Chart of RMSE and R² before and after retraining the models



A Cloud-based Framework for the Quantification of the Spatially-explicit Machine Learning Uncertainty of Continuous Coastal Aquatic Remote Sensing Products: The Case of Satellite-derived Bathymetry

Spyridon Christofilakos, Avi Putri Pertiwi, Andrea Cárdenas Reyes, Chengfa Benjamin Lee, Stephen Carpenter, Nathan Thomas, Dimosthenis Traganos, Peter Reinartz

Status: To be submitted by the end of the June '24

Correlation of StdDev-PUNC



- A per pixel quantifiable assessment of uncertainty Machine-Learning product is possible
- Model optimization based on uncertainty seems to work better on classification rather on SDB tasks

- A quantifiable assessment of uncertainty in a prediction is possible
- Model optimization based on uncertainty seems to work better on classification rather than SDB tasks

Future Prospects

- Further research & proof of concept is still needed
- Investigate DL procedures



THANK YOU FOR YOUR TIME