



# SATELLITES, THE AUTONOMOUS SURVEYORS

Rapid assessment of storm-induced impacts to coastlines

Dr. Kim Knauer<sup>1</sup>, Knut Hartmann<sup>1</sup>, Edward Albada<sup>1</sup>,  
Lindino Benedet<sup>2</sup>, Morjana Signorin<sup>2</sup>

<sup>1</sup> EOMAP USA Inc / EOMAP GmbH

<sup>2</sup> Coastal Protection Engineering



EOMAP

# WHO IS EOMAP?



Private high-tech company



Focusing on satellite data analytics, IT solutions, webapps and API



Specialised on aquatic environments



International team of 50+ employees



Serving HOs, engineering, academia, costal zone managers...

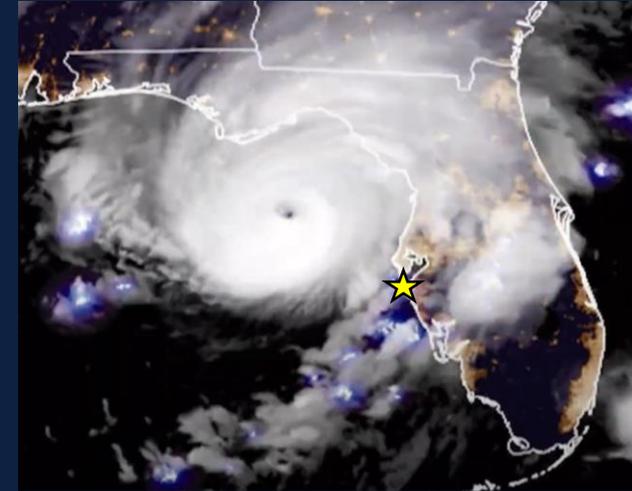


HQ in Germany  
with affiliates in  
USA, Australia,  
Indonesia, Dubai

# WHY MONITORING BEACHES?

- Severe damages to beaches by hurricanes
- Large annual expenses for beach nourishments
- Need for rapid assessment of volume losses immediately after storm event

Hurricane Idalia (2023)



Coquina Beach, Florida, post-Hurricane



# TRADITIONAL WAY OF SURVEYING BEACH NOURISHMENT

Beach profiles as a combination of:



Single beam by boat



Rod and level survey by foot

- Incomplete coverage
- Time delay in collection
- Expensive and time consuming



# SATELLITES



Back in time over decades



Data everywhere even for small water bodies



Multiple daily acquisitions



# SATELLITE-DERIVED BATHYMETRY (SDB)

## SPECIFICATIONS

### Source

Multispectral satellite data of 0.3-10m spatial resolution

### Methods

Physics based depth retrieval

### Depth

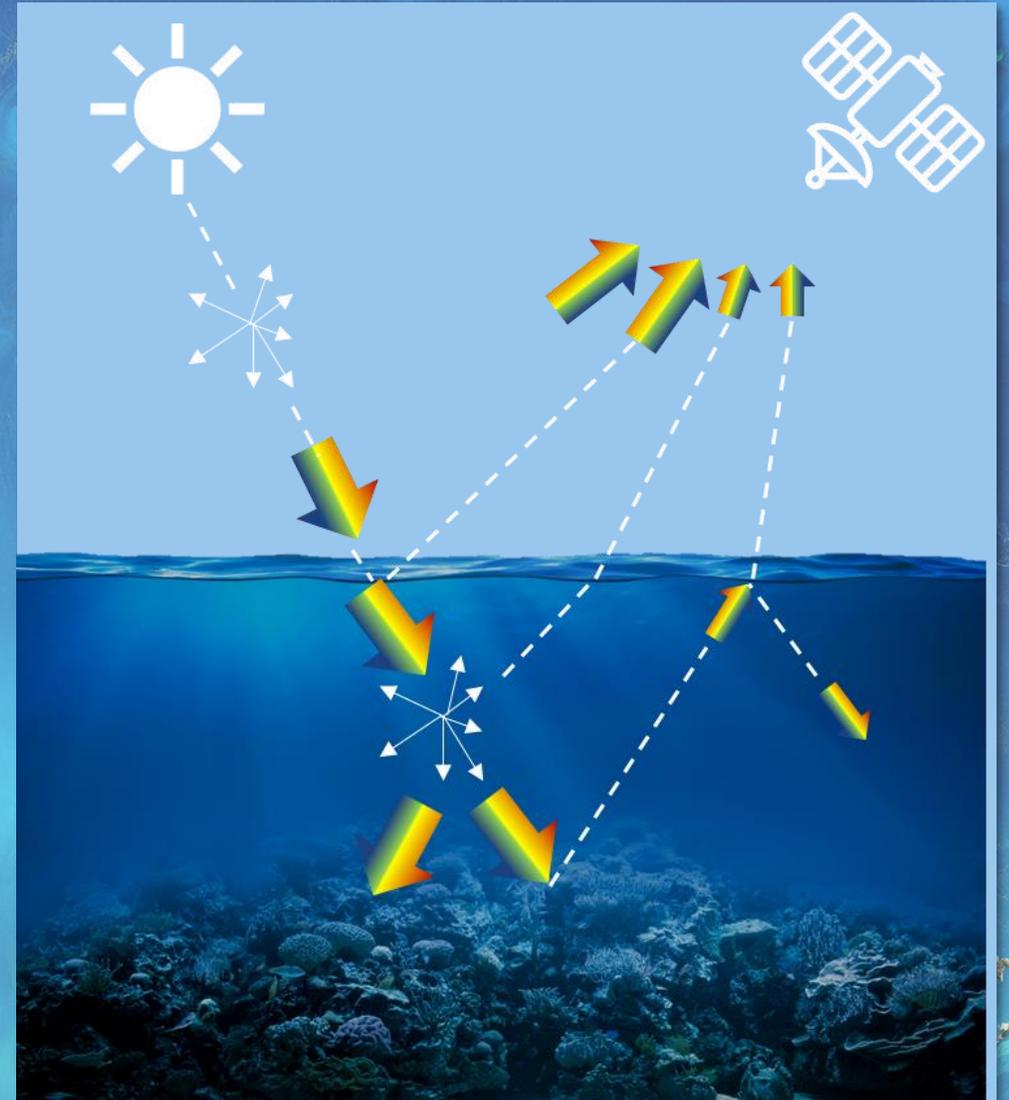
Shoreline to 1 to 1.2 Secchi Disc Depth

### Benefits

Global access, no mobilisation, verified quality and workflows, cost savings.

### EOMAP solution

bathymetric data provision, SDB software, Online Platform



# SATELLITE-DERIVED BATHYMETRY (SDB)

## SPECIFICATIONS

### Source

Multispectral satellite data of 0.3-10m spatial resolution

### Methods

Physics based depth retrieval

### Depth

Shoreline to 1 to 1.2 Secchi Disc Depth

### Benefits

Global access, no mobilisation, verified quality and workflows, cost savings.

### EOMAP solution

bathymetric data provision, SDB software, Online Platform



# COQUINA BEACH SURVEYS

## Topo-bathy survey

- December 2022 (pre-Idalia) and October 2023 (post-Idalia) at each transect line.

## Satellite-Derived Bathymetry

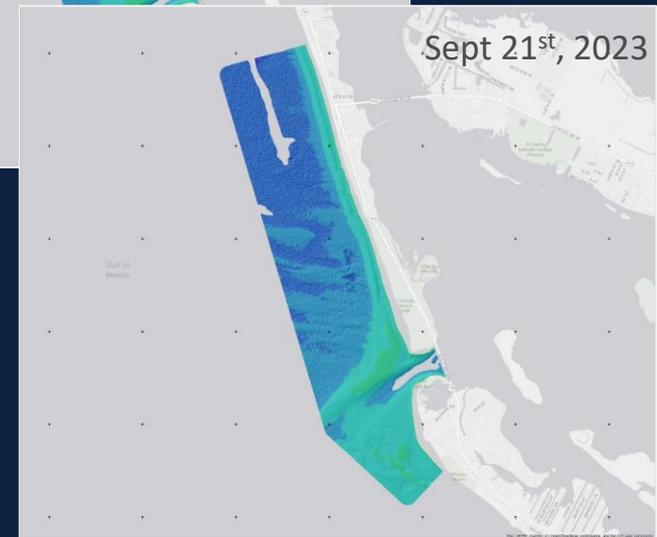
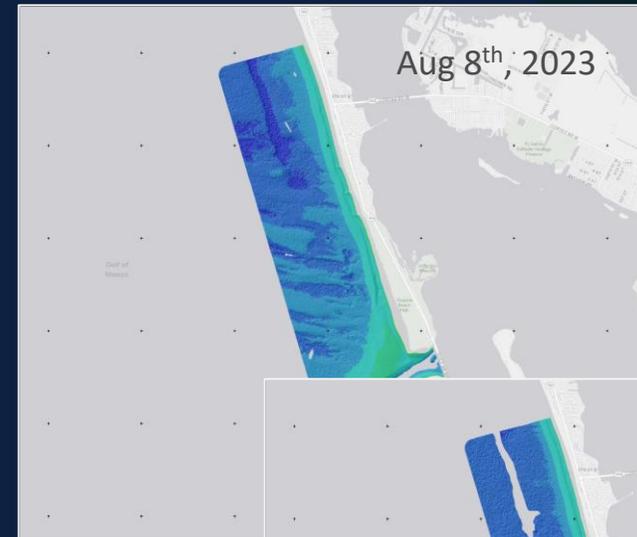
- December 2022 (pre-Idalia) and October 2023 (post-Idalia) from **Planet's Super-Dove satellites** with approx. 3m spatial resolution.
- Note: No local survey or training data were used in this process!

**Volume changes** from the landward survey limit to the depth of closure (-6m)

Topo-bathy survey



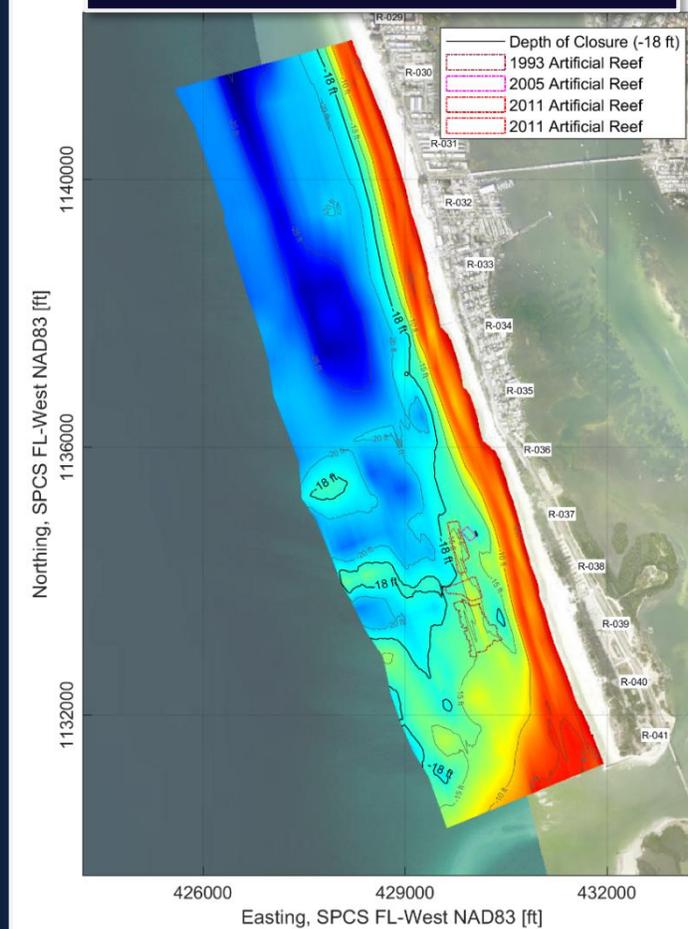
SDB



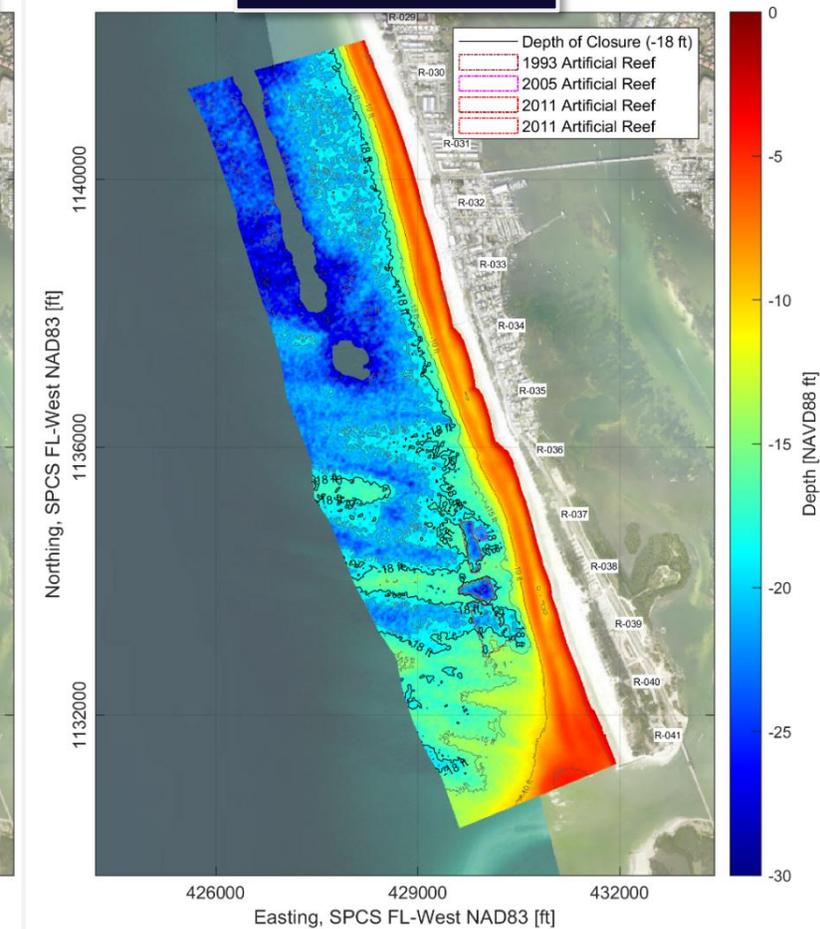
# COMPARISON ANALYSIS

- SDB creates **dense bathymetry grids from the shoreline** (0m MSL!) to deep areas consistently
- Hydrographic survey as interpolation of lines

Traditional Survey, Dec 2022

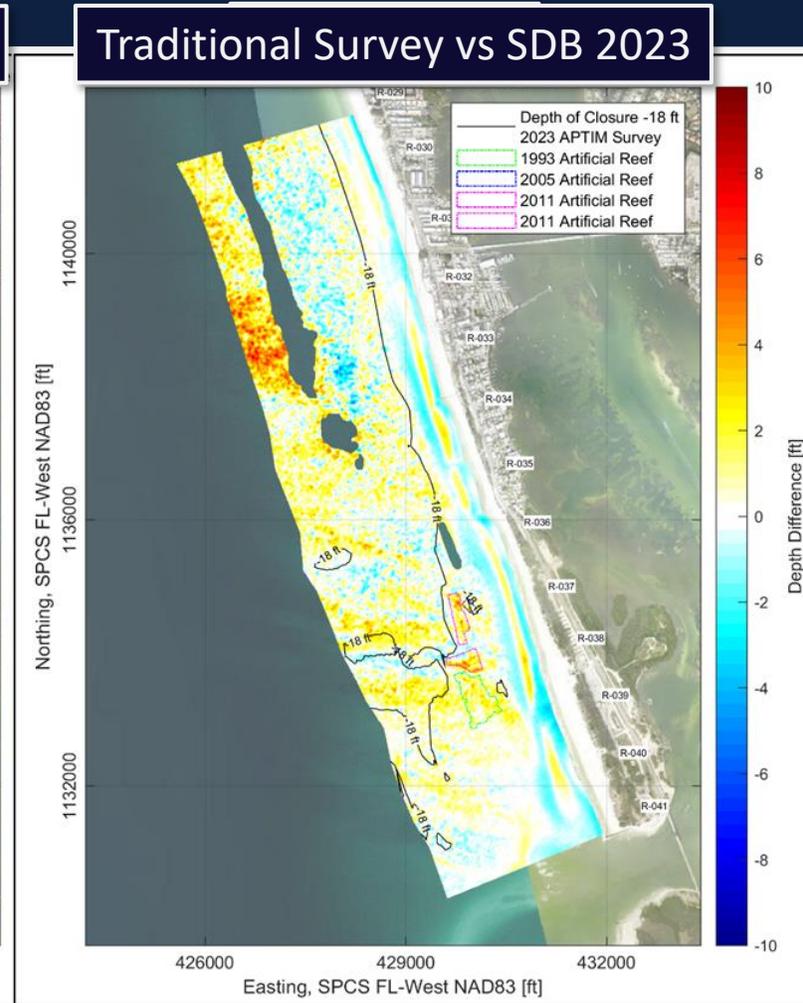


SDB, Dec 2022



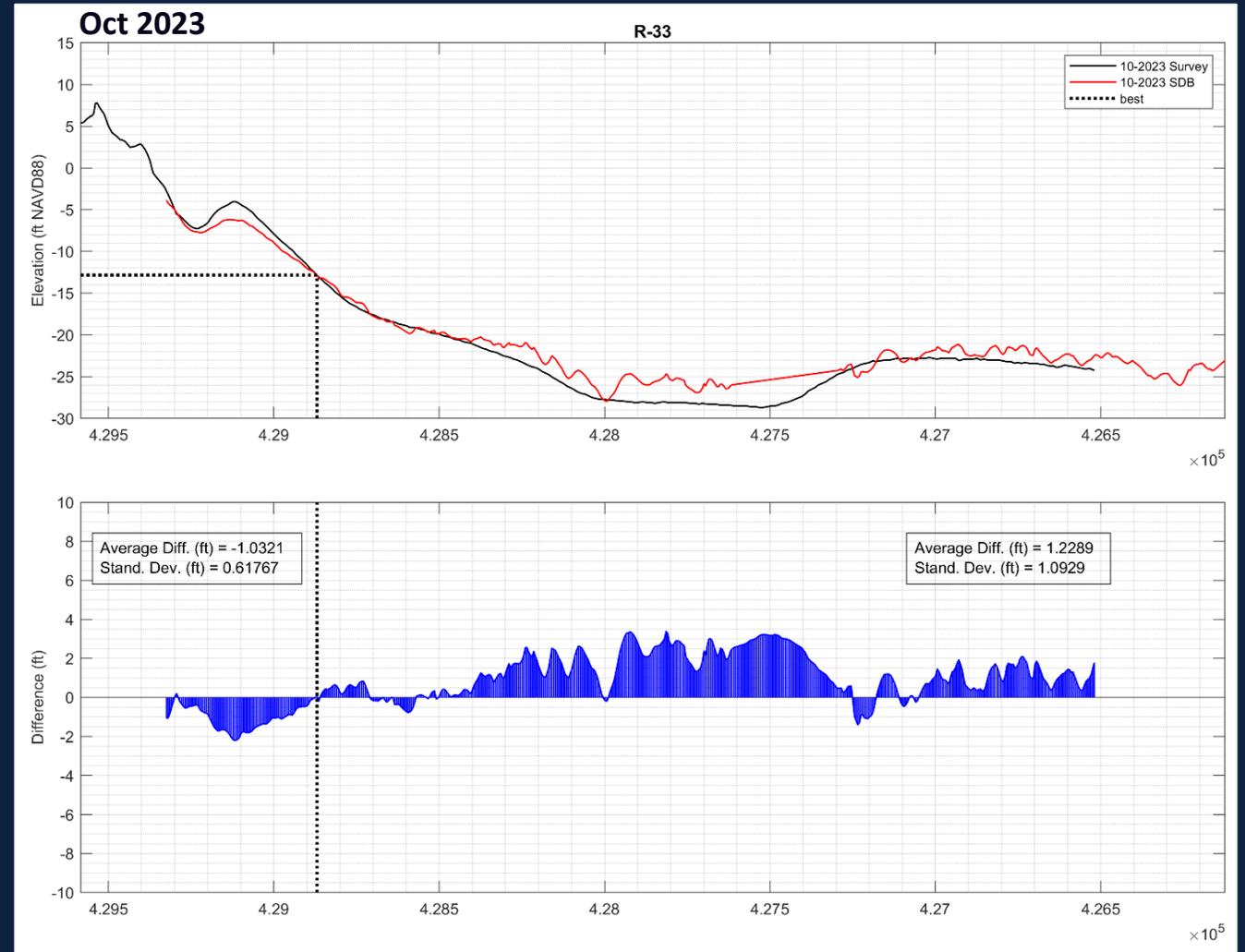
# COMPARISON ANALYSIS –DIFFERENCE PLOTS

- Similar trends in areas shallower than the depth of closure (DOC)
- Pattern of shoreline erosion and accretion at the nearshore bar
- Deeper than the DOC, a greater difference is observed between the datasets in 2023



# COMPARISON ANALYSIS - PROFILES

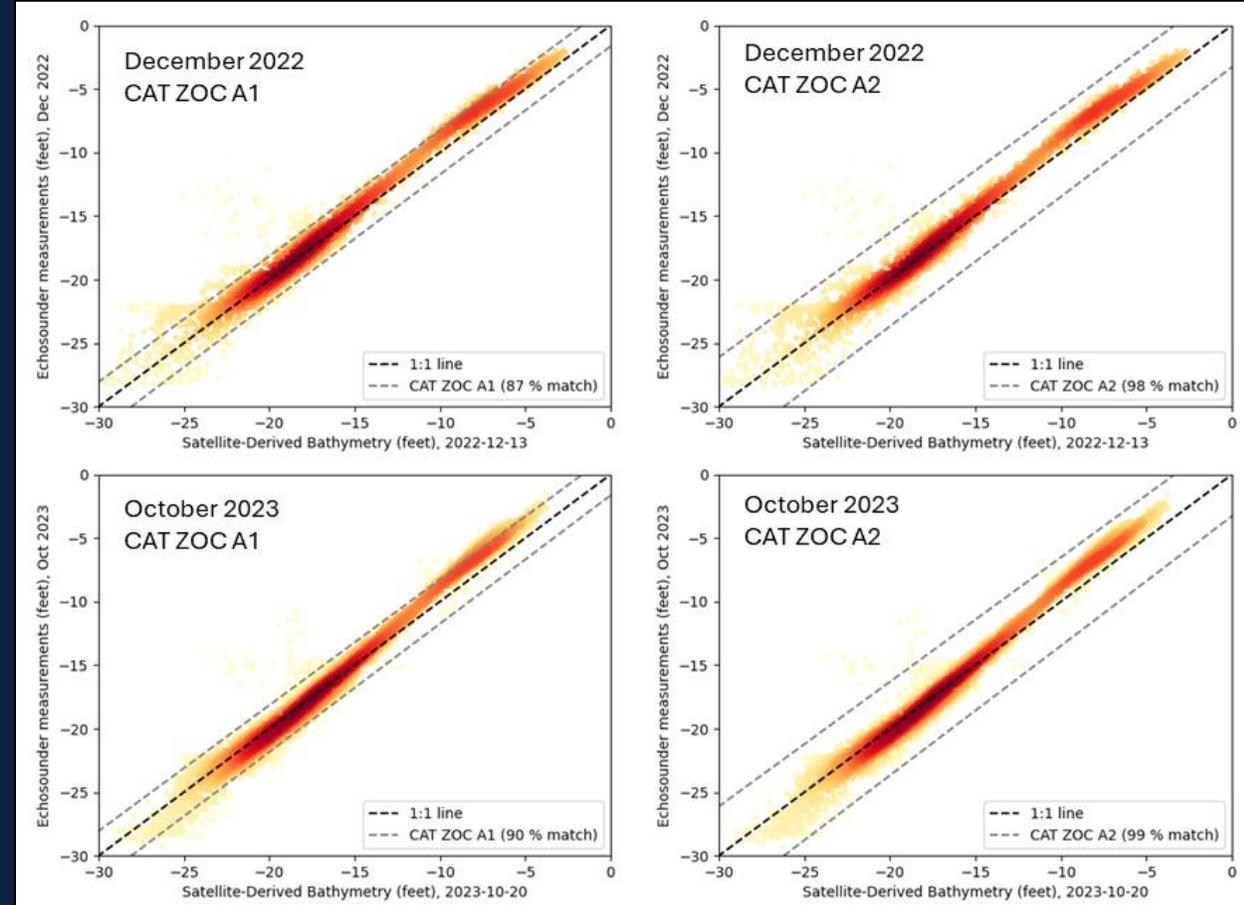
- SDB data extracted along the beach profiles
- **SDB captures the overall profile shape accurately**
- **Average difference approx. 30 cm** compared to hydrographic survey
- Shallower elevations: lower standard deviation
- Deeper elevation (> -6m): greater variability in difference between the hydrographic survey and SDB data



# COMPARISON ANALYSIS – STATISTICAL

- CATZOC (Category Zone of Vertical Confidence) used to evaluate vertical accuracies, which is a common measure for specifying uncertainties in charts
- *Nearly* achieved CATZOC A1
  - >95% of all data have 0.5m absolute and 1% relative uncertainties
- Achieved CATZOC A2
  - >95% of all data have 1m absolute and 1% relative uncertainties

Note: **SDB was processed without the use of training data**; further improvements in vertical accuracies can be achieved with post-processed calibration-validation routine from a few existing survey profiles



# COMPARISON ANALYSIS – VOLUME

- **Traditional survey** → Volume loss of **59,000 m<sup>3</sup>**
- **SDB survey** → Volume loss of **54,500 m<sup>3</sup>**
- Difference between datasets → 4,500 m<sup>3</sup>

## Notes:

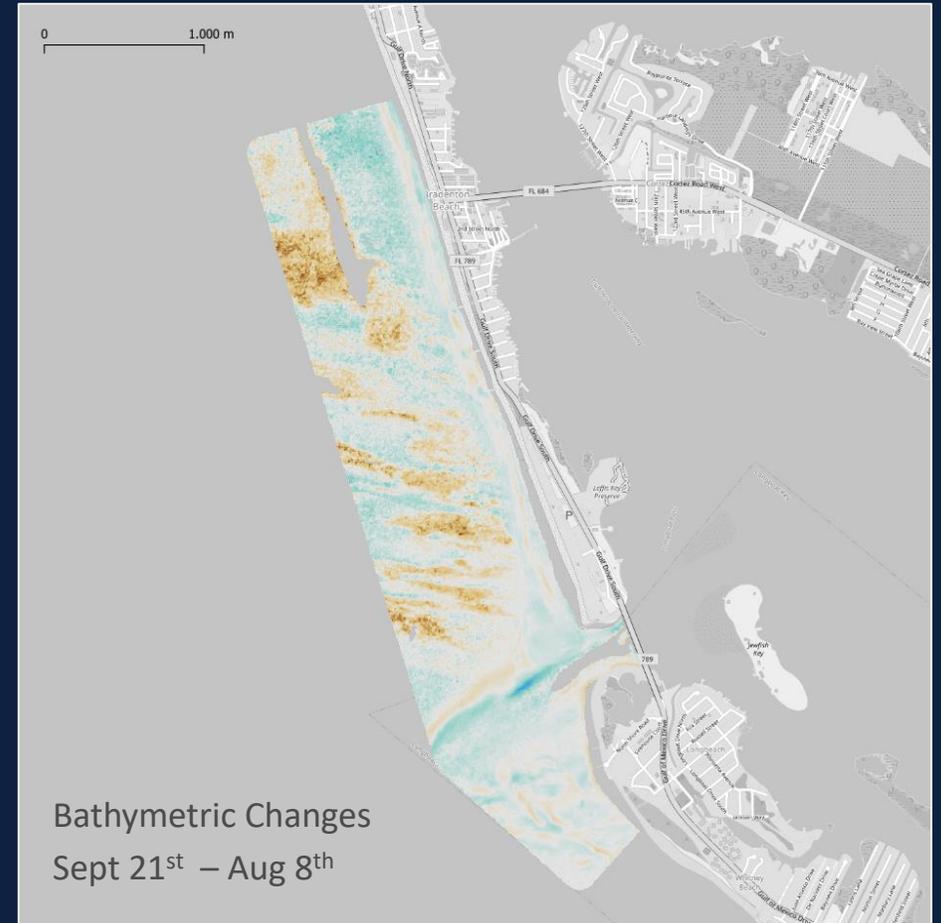
- comparison of volume change varied profile by profile
- SDB resolution captures intricate spatial changes, particularly between the traditional transects.

Profiles	Distance (ft)	Pre-Idalia (Dec 2022) to Post-Idalia (October 2023)					
		SDB		Hydrographic Surveys		Difference	
		Density (cy/ft)	Volume (cy)	Density (cy/ft)	Volume (cy)	Density (cy/ft)	Volume (cy)
T-30	1126	-2.3	-1,900	-5.0	-2,000	2.7	100
R-31	900	-1.1	-4,500	1.4	-900	2.5	3,600
R-32	966	-8.9	-10,400	-3.3	-1,900	5.6	8,500
R-33	951	-12.5	-15,200	-0.5	-8,600	12.0	6,600
R-34	1019	-19.5	-7,600	-17.5	-8,300	2.0	700
R-35	922	4.6	700	1.2	-900	3.4	1,600
R-36	521	-3.2	-4,200	-3.1	-2,000	0.1	2,200
R-36.5	506	-12.9	-4,000	-4.6	-2,700	8.3	1,300
R-37	440	-2.8	-2,800	-6.1	-3,300	3.3	500
R-37.5	440	-9.9	-1,900	-8.7	-4,200	1.2	2,300
R-38	464	1.4	-2,100	-10.5	-4,000	11.9	1,900
R-38.5	465	-10.4	-3,400	-6.7	-7,800	3.7	4,400
R-39	453	-4.3	400	-27.0	-6,800	22.7	7,200
R-39.5	453	6.2	3,700	-3.1	-6,000	9.3	9,700
R-40	429	10.3	-800	-23.3	-7,200	33.6	6,400
R-40.5	425	-14.1	-8,000	-10.3	-7,100	3.8	900
R-41	291	-23.5	-9,200	-23.0	-4,000	0.5	5,200
R-41+305		-39.9		-4.4		35.5	
<b>Study Area (R-30 to R-41+305)</b>	<b>10,774</b>	<b>-6.6</b>	<b>-71,200</b>	<b>-7.2</b>	<b>-77,700</b>	<b>0.6</b>	<b>6,500</b>

# SUMMARY

SDB has the potential to be a **valuable tool** in rapid post-storm disaster assessments for beaches:

- **Rapid** post-storm disaster assessment tool
- **Cost-effective and efficient**
- Ability to **go back in time**: baseline bathymetric surface pre-storm and rapid assessment post-storm from archives
- Detect subtle **spatial changes in high resolution**
- **Combination with satellite-derived DEM possible**



# SDB-ONLINE

sdb-online.eoapp.de

Cloud backend, fully scalable

Based on **physics based SDB**  
concept (RTE inversion)

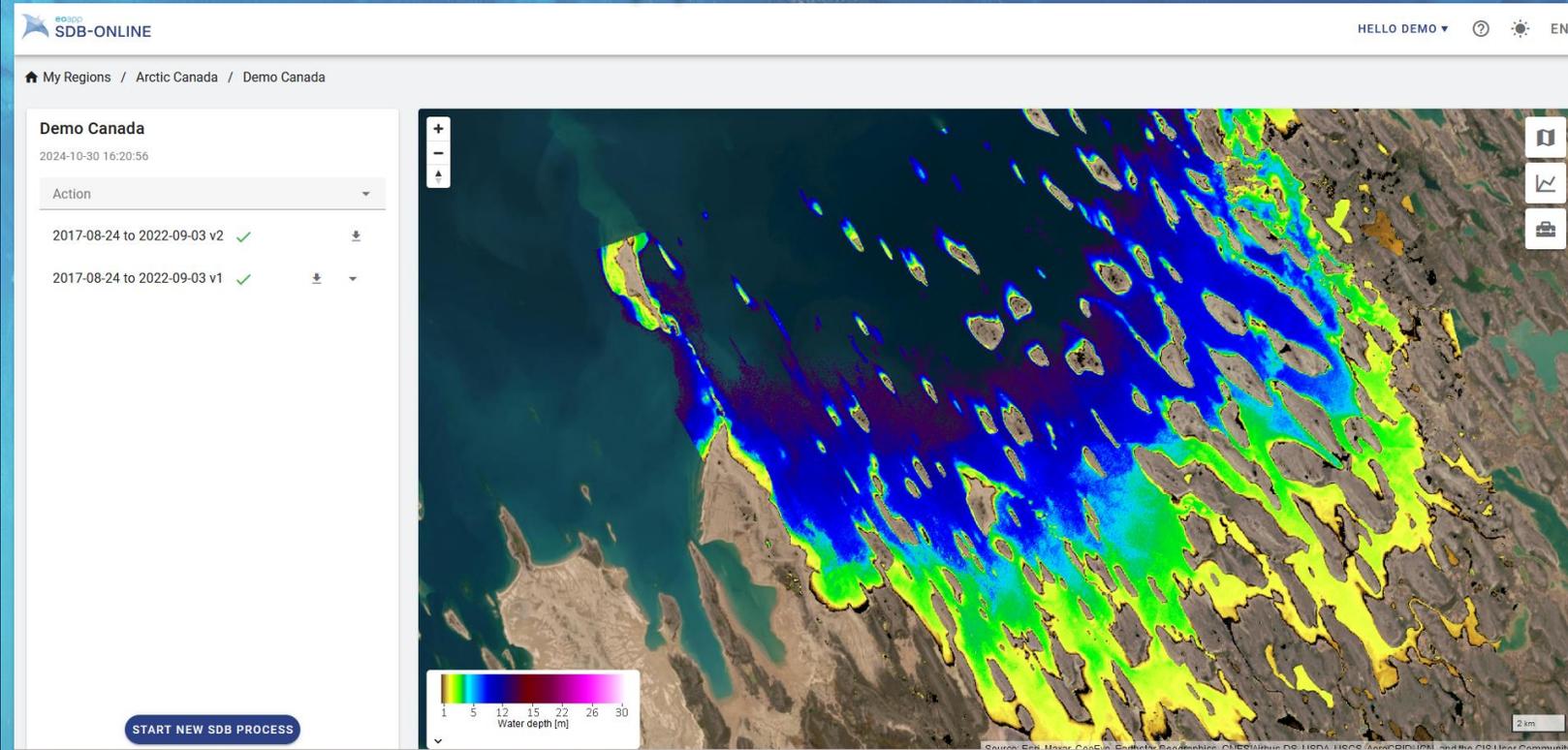
**Automatic** modus

**Multi-image** modus

**Webapp** user interface

**API** access

**10m** spatial resolution



# Thank you!

## EOMAP

Mail: [knauer@eomap.de](mailto:knauer@eomap.de)  
Internet: [eomap.com](http://eomap.com)

Germany (HQ)

USA

UAE



Indonesia

Australia