Transparency and Quality Assurance Procedures in Physics Based SDB Production

Role of SDB, and future directions

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Role of SDB

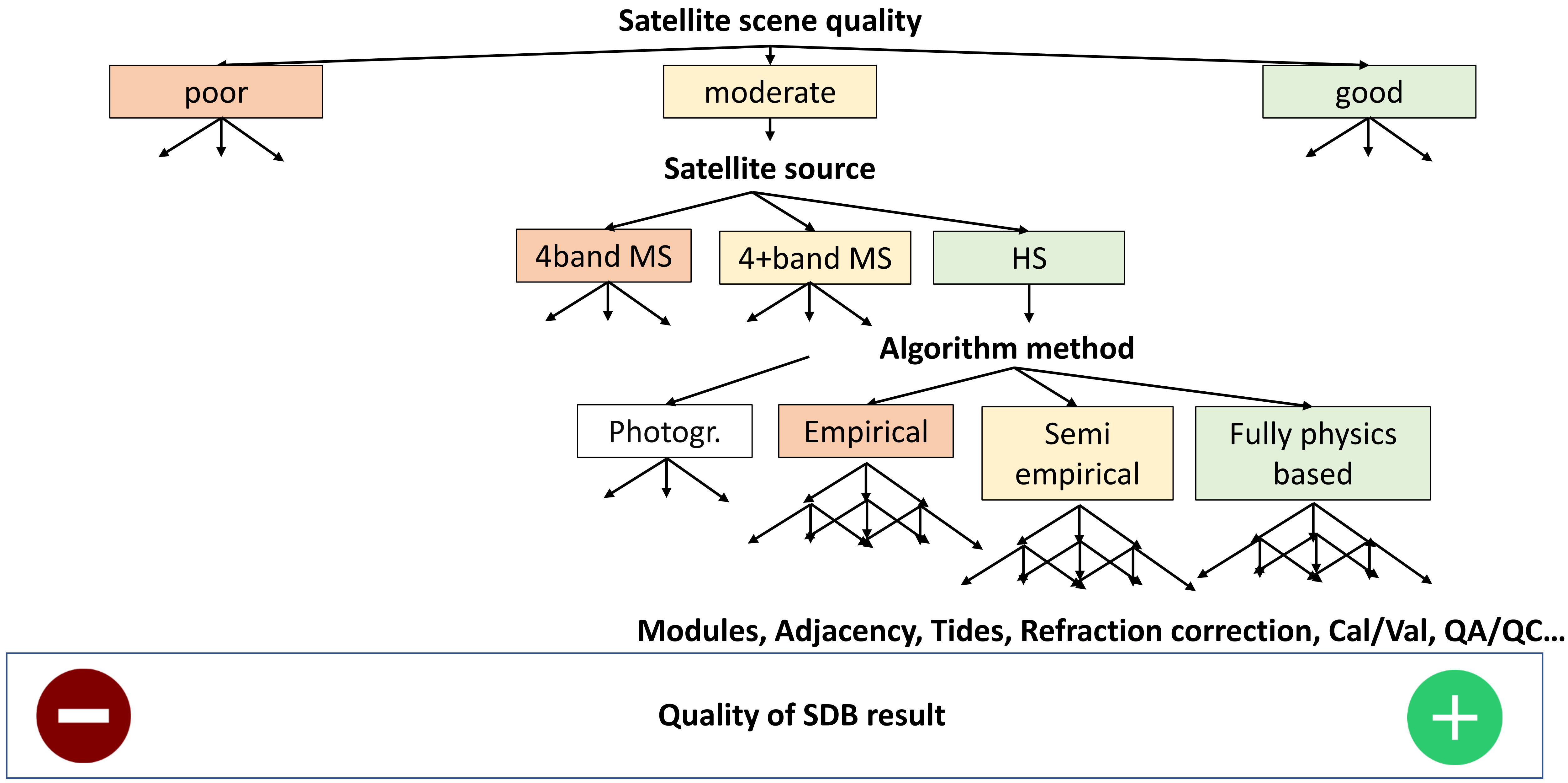
Reconnaissance

various SDB approaches depending on quality requirements

Independent mapping capability

for unsurveyed, outdated or remote areas
for highest quality requirements, independent level of confidence
=> fully physics based approach

Diversity of SDB solutions



QA/QC requirements when calibrating SDB data

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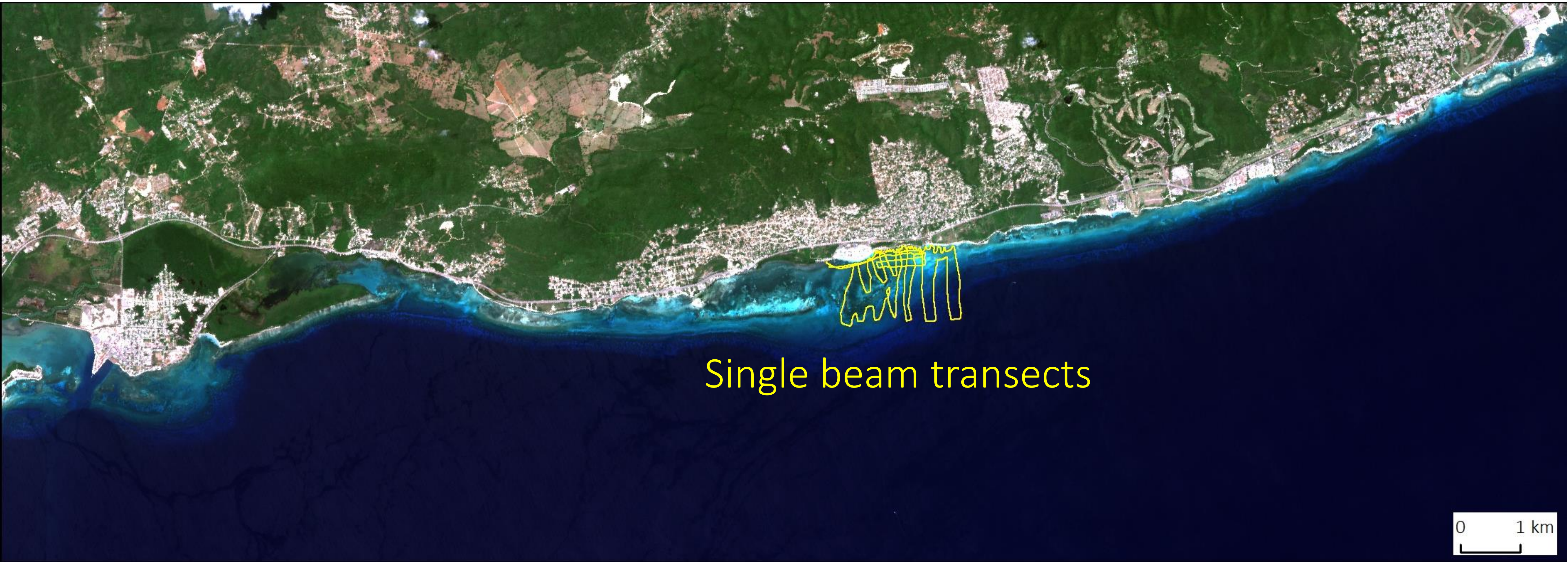
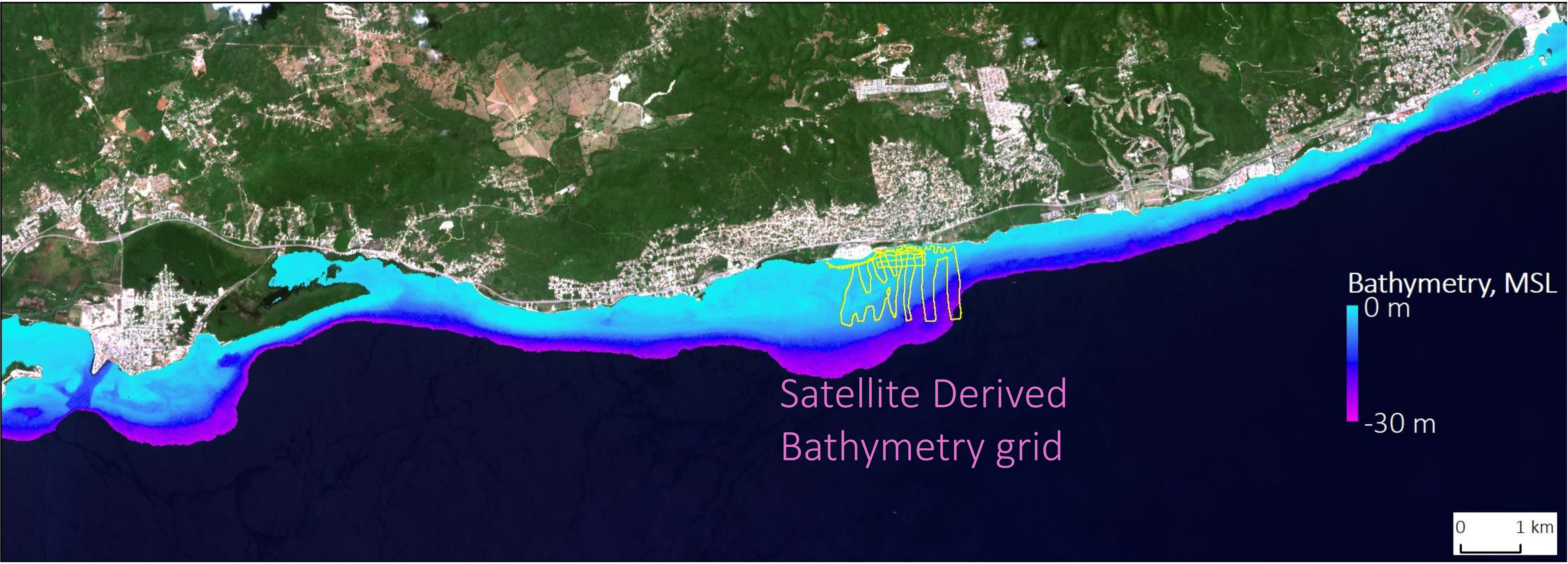


QA/QC requirements when calibrating SDB data



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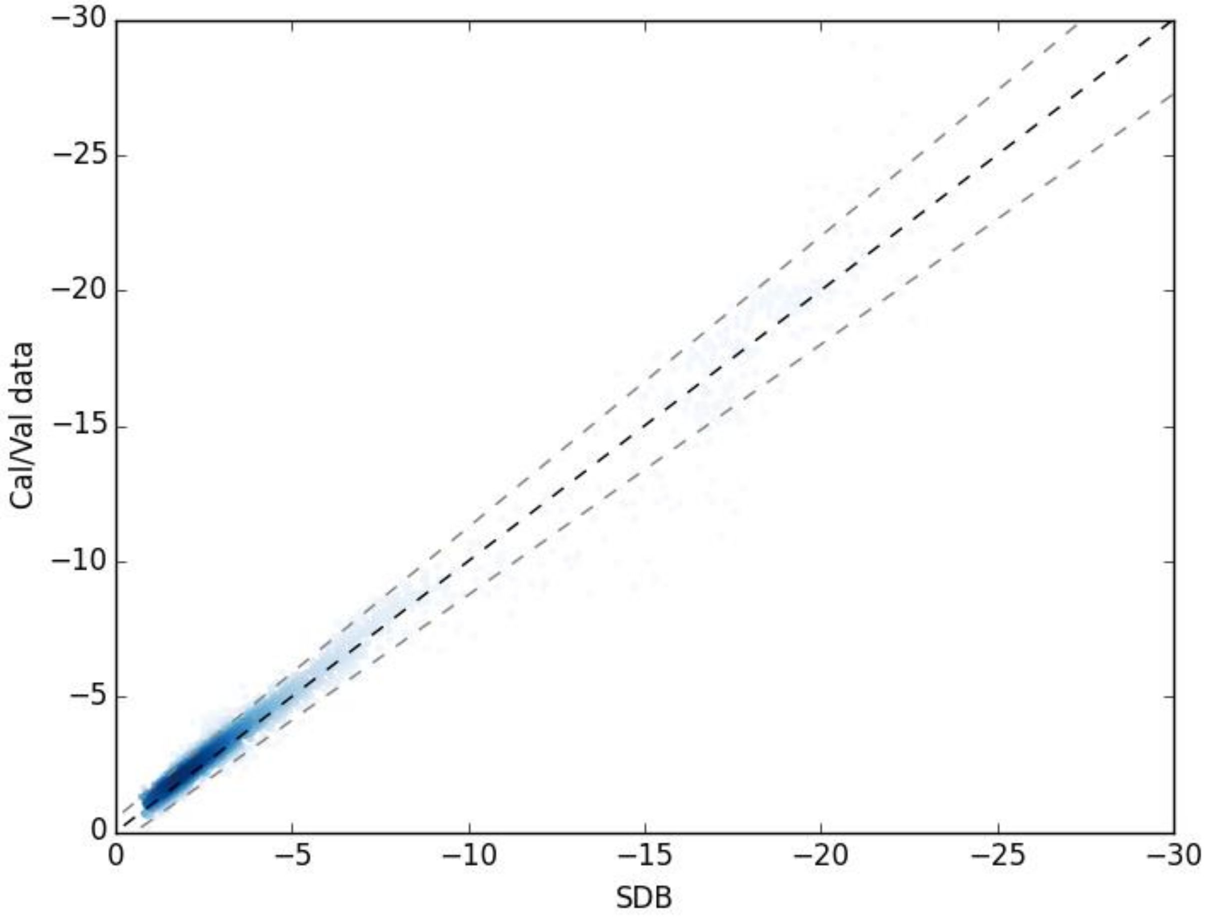
QA/QC requirements when calibrating SDB data



90% of SDB data within 50cm accuracy compared to single beam transects

QA/QC requirements when calibrating SDB data

QA/QC processing steps

- **Pre-processing**

  Selection of appropriate satellite and airborne sensors,

  Selection of appropriate recording / environmental condition (geometry, season, ..)

- **Post-processing:**

  Tidal effects

  Horizontal displacement with water depth through water refraction

  Data cleaning: Manual / semi-automated interpretation

  Cal/Val process if in-situ data are accessible

  Creation of ISO conform metadata

QA/QC processing steps

- **Image data processing: corrections and QC procedures**

  Classification of area of interest into land, cloud, water, breaking waves, ….

  Correction of effects of atmosphere

  Correction of effects of adjacency effects

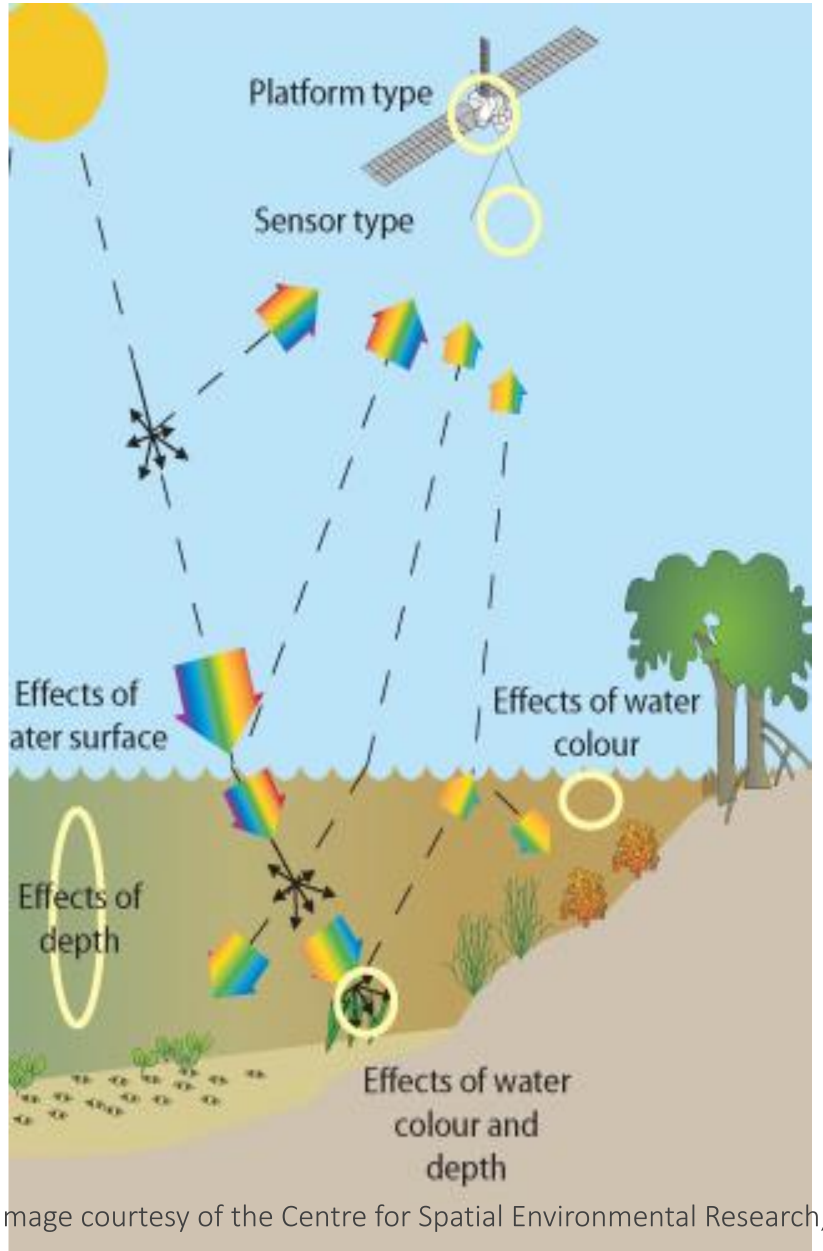
  Correction of effects of sunglitter

  Correction of effects of water absorbers and backscatter

  Coupled seafloor albedo and water column thickness calculation

  Error propagation, uncertainty processing

EOMAP’s physics based solution



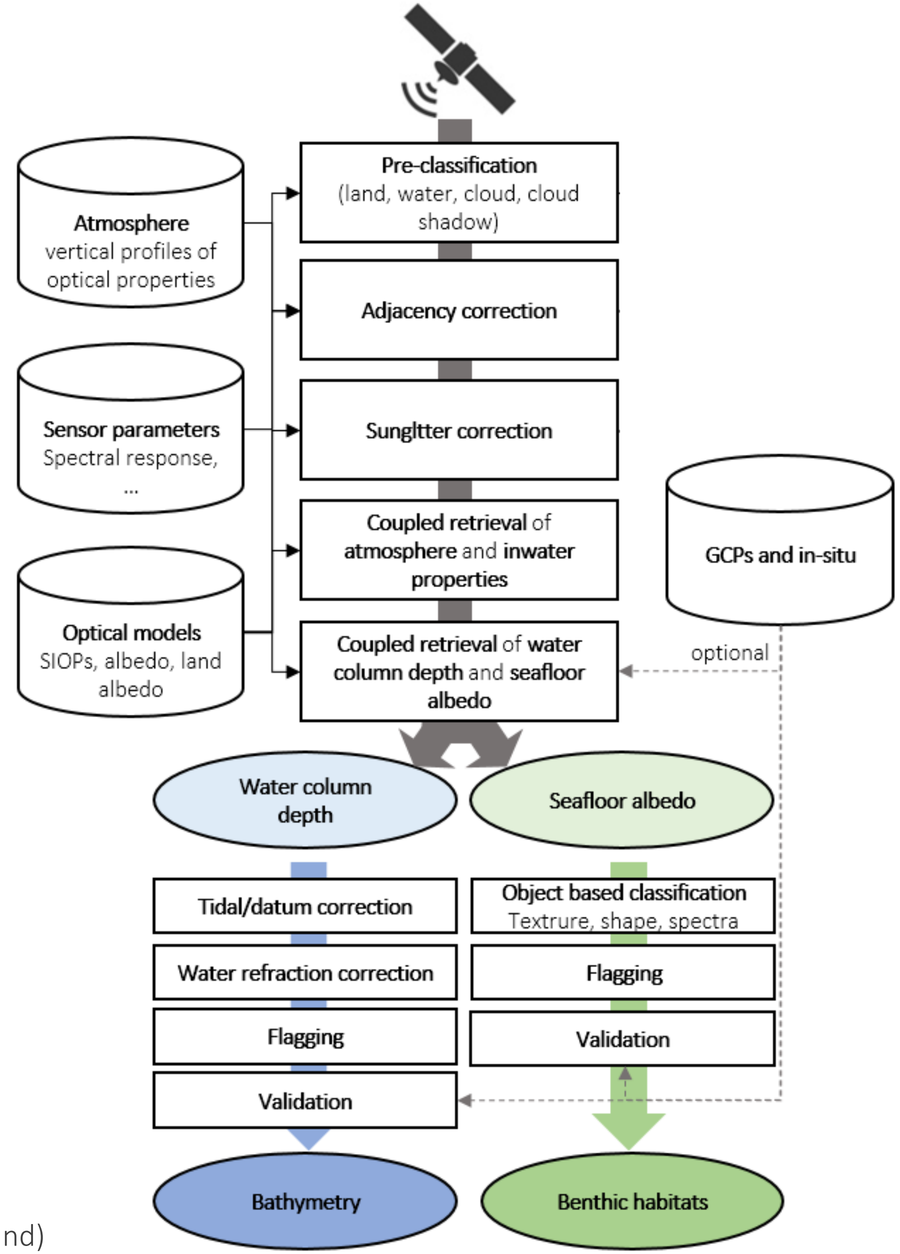


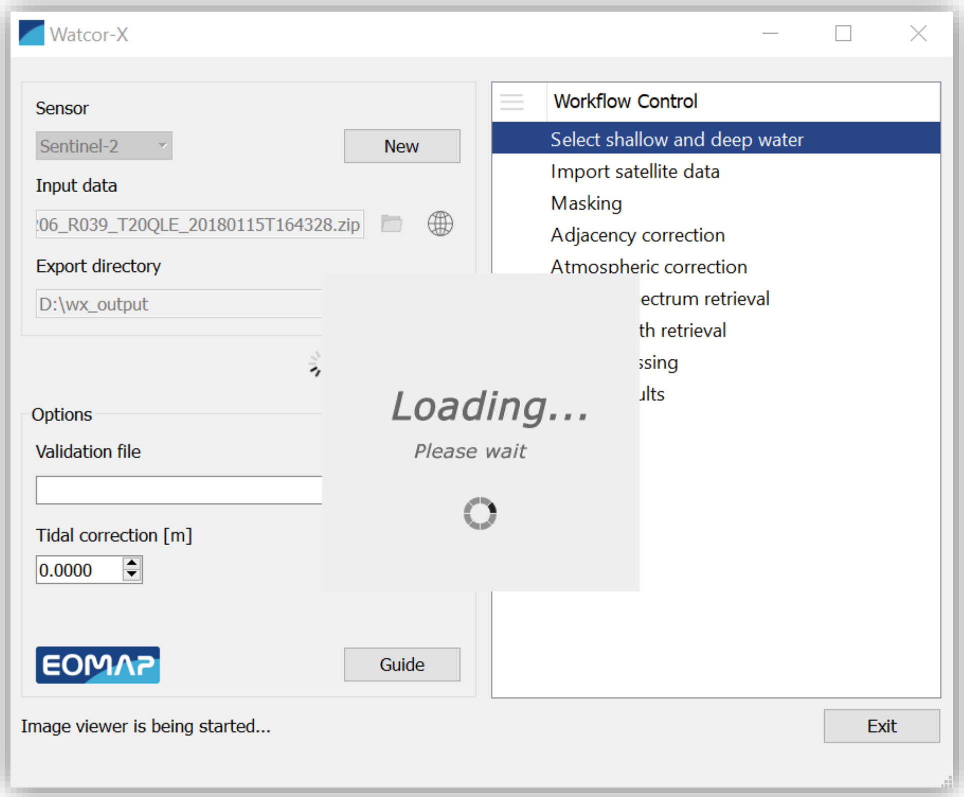
Image courtesy of the Centre for Spatial Environmental Research, University of Queensland)

Impact of QA corrections in an automated state-of-the art workflow

Objective to demonstrate capabilities:

Independent site assessment

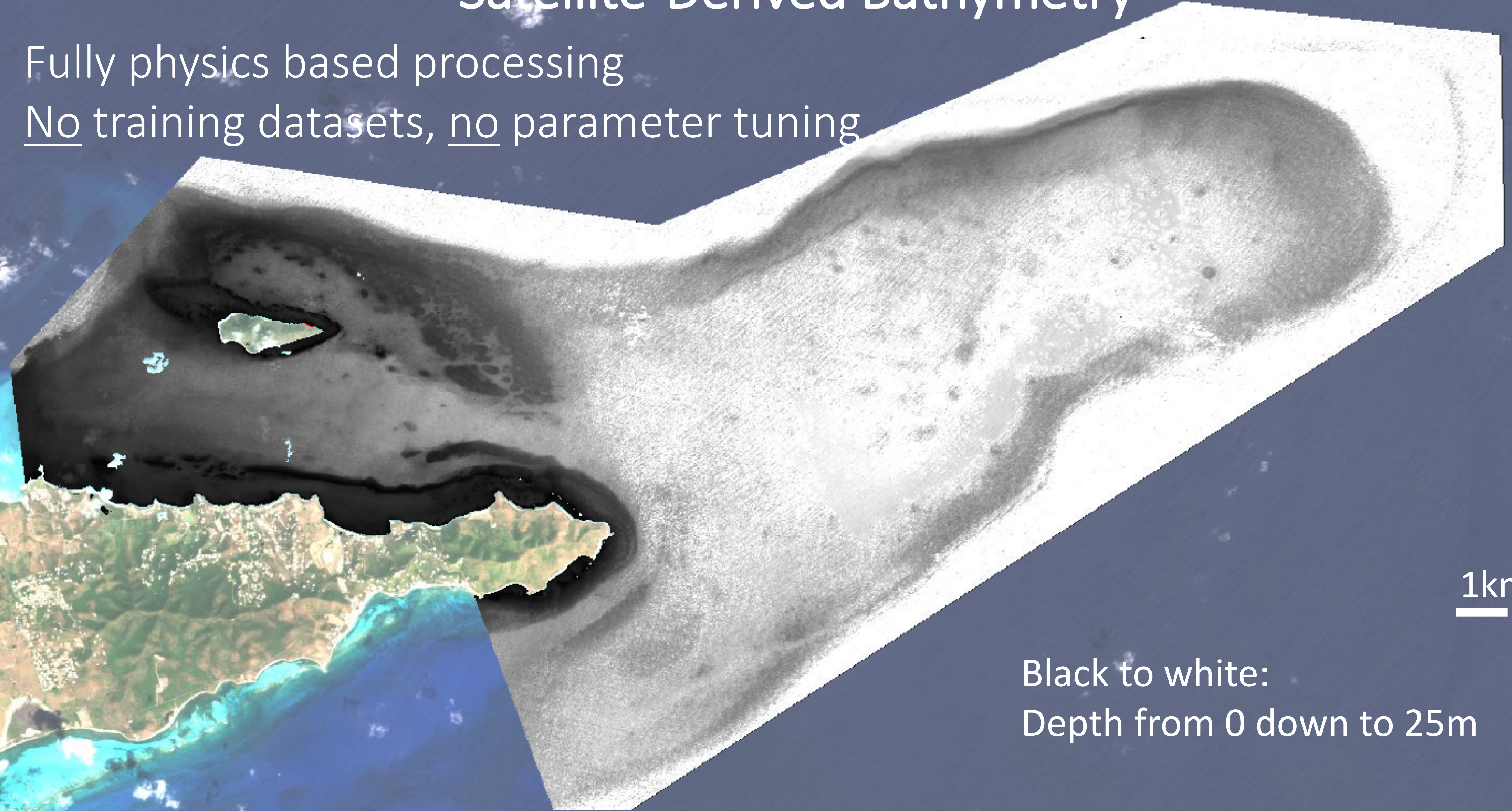
Independent level of confidence provision
Transparency in SDB production mechanisms



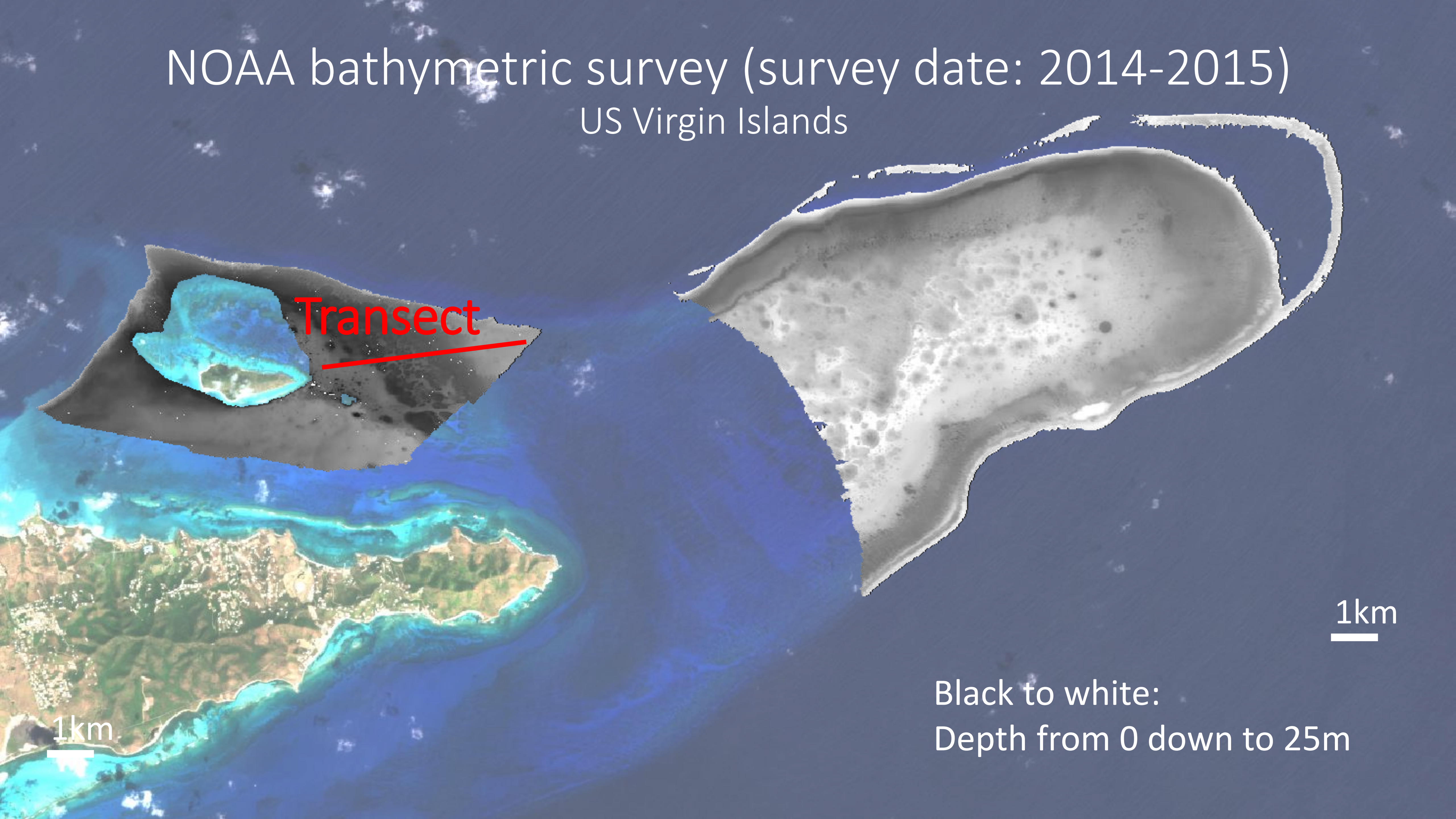
Satellite-Derived Bathymetry

Fully physics based processing

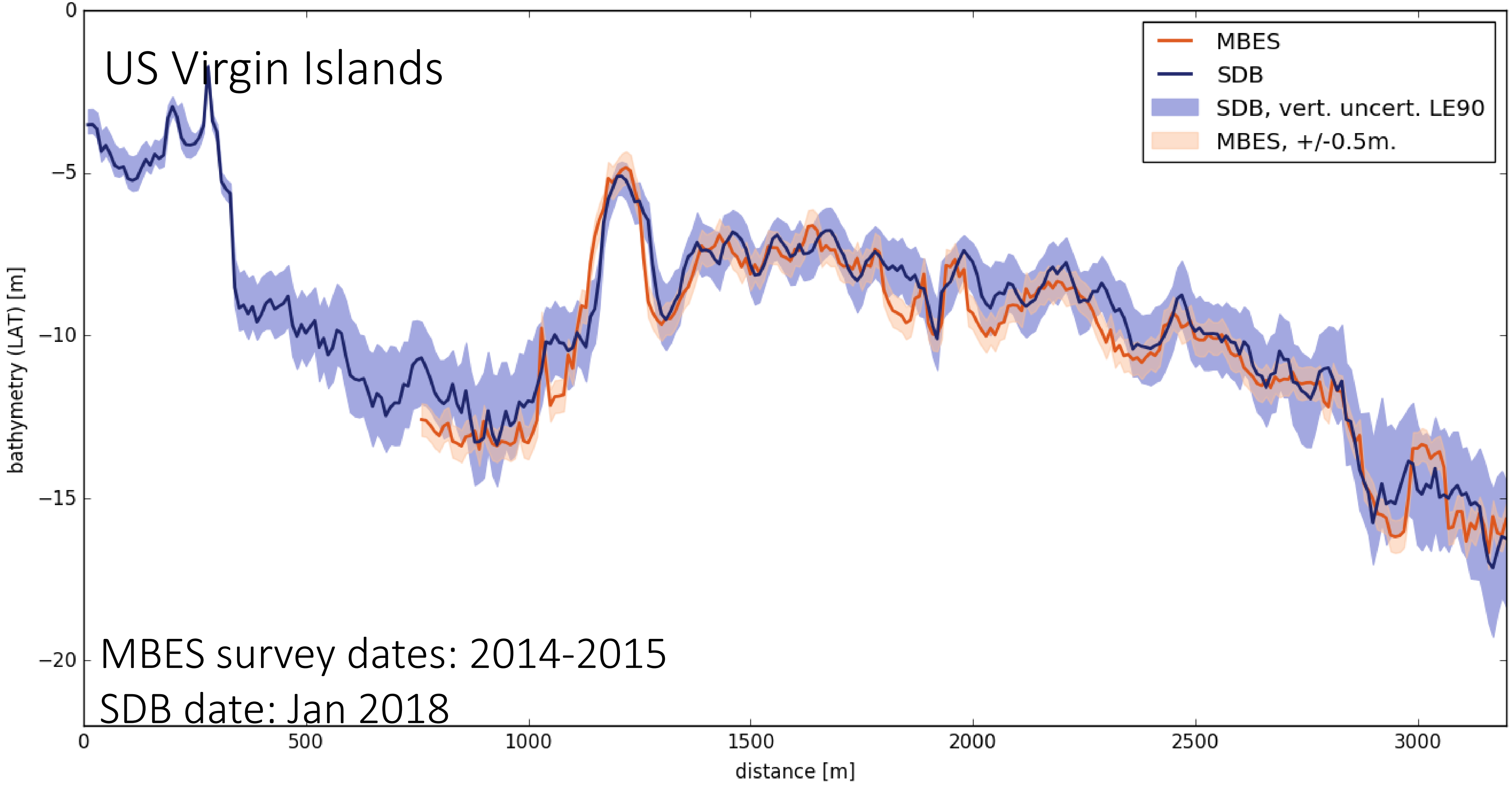
No training datasets, no parameter tuning



Black to white:
Depth from 0 down to 25m

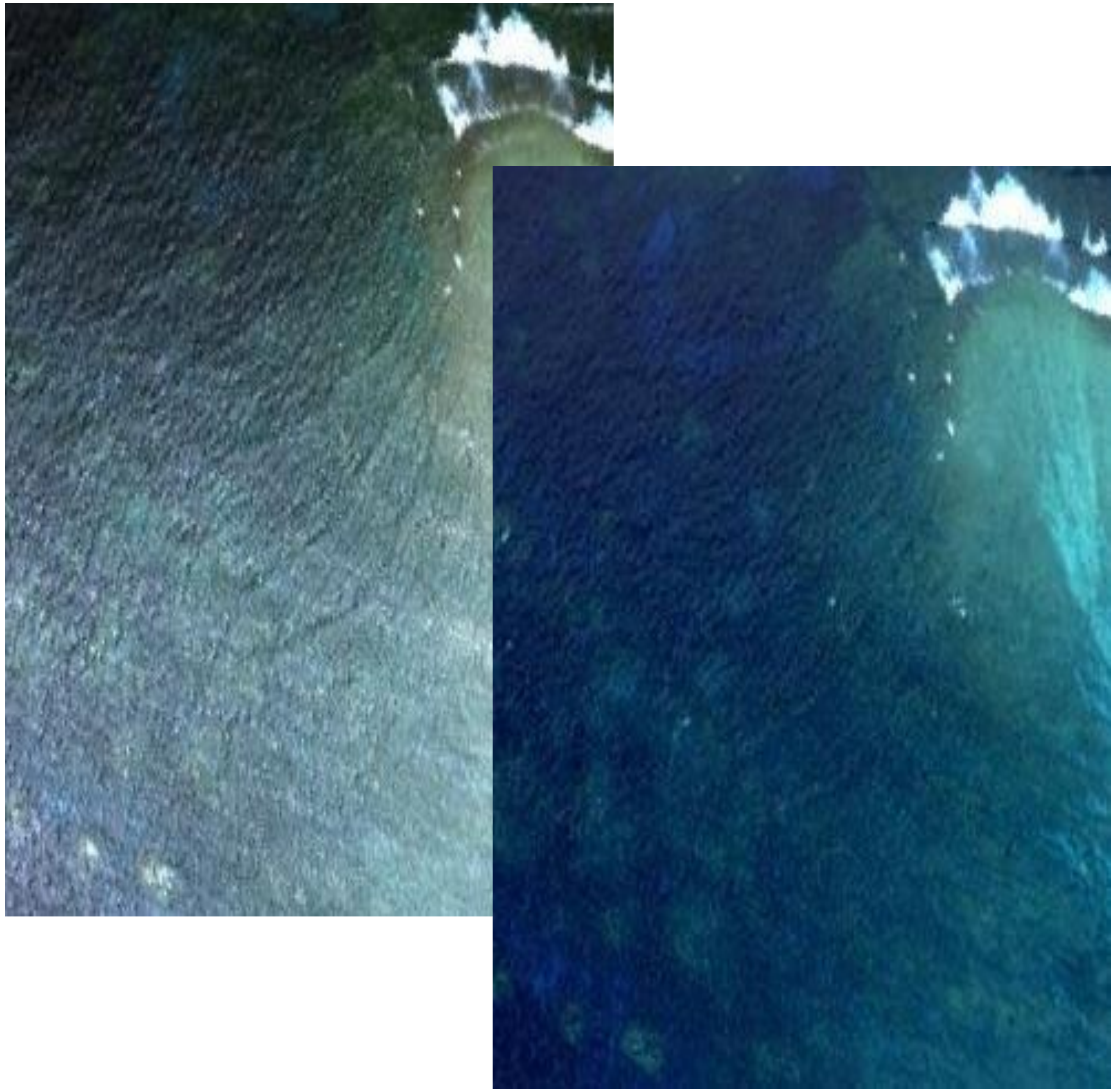

NOAA bathymetric survey (survey date: 2014-2015)
US Virgin Islands
Transect
1km
1km
Black to white:
Depth from 0 down to 25m

SDB and MBES transect



Fully physics based processing, <u>No</u> training datasets, <u>no</u> parameter tuning

Impact of corrections in an automated workflow (Watcor-X)



Impact of corrections executed in a transparent physics based automated production workflow:

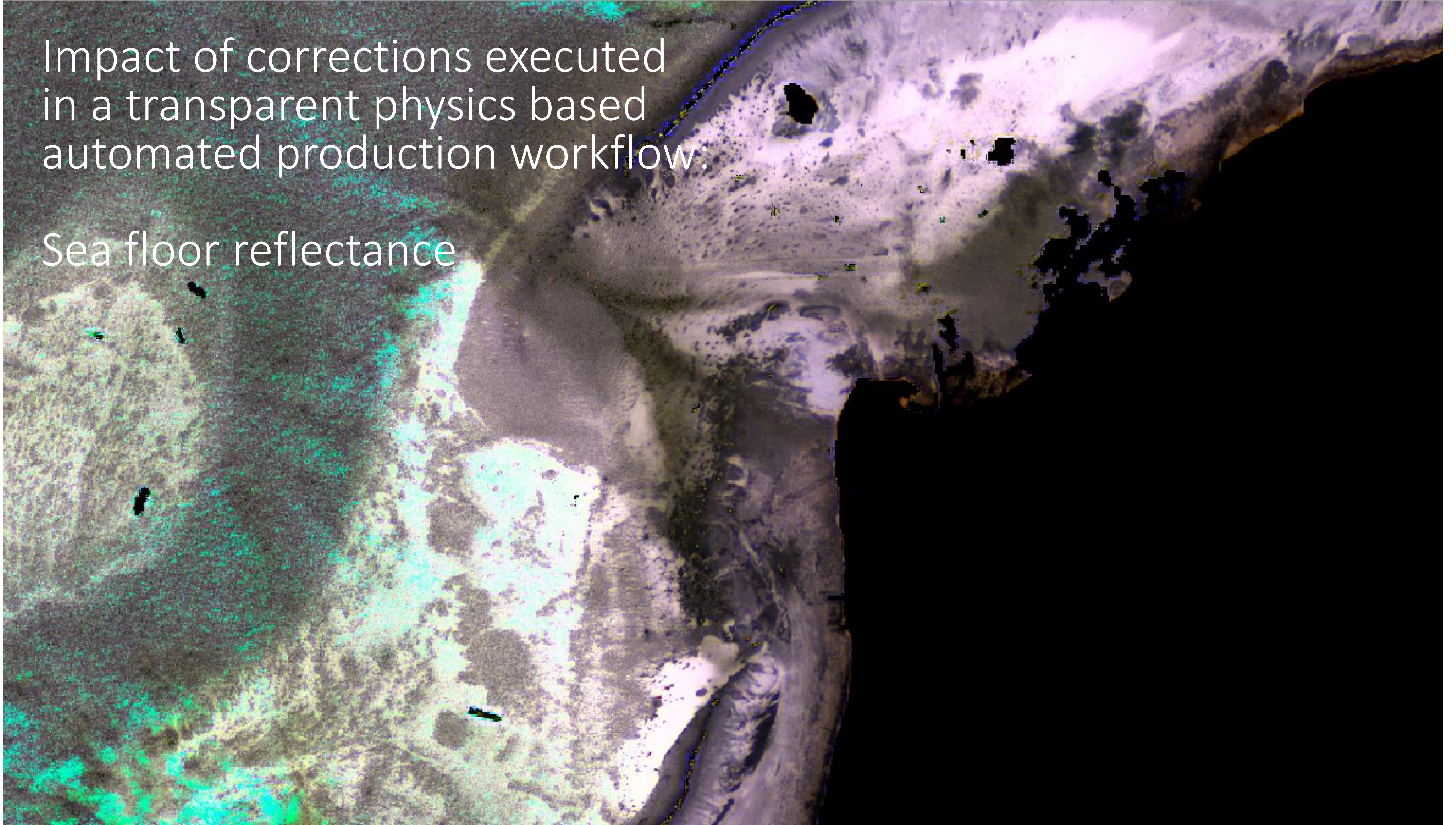
Raw image scene, including clouds, haze, …

Impact of corrections executed in a transparent physics based automated production workflow:

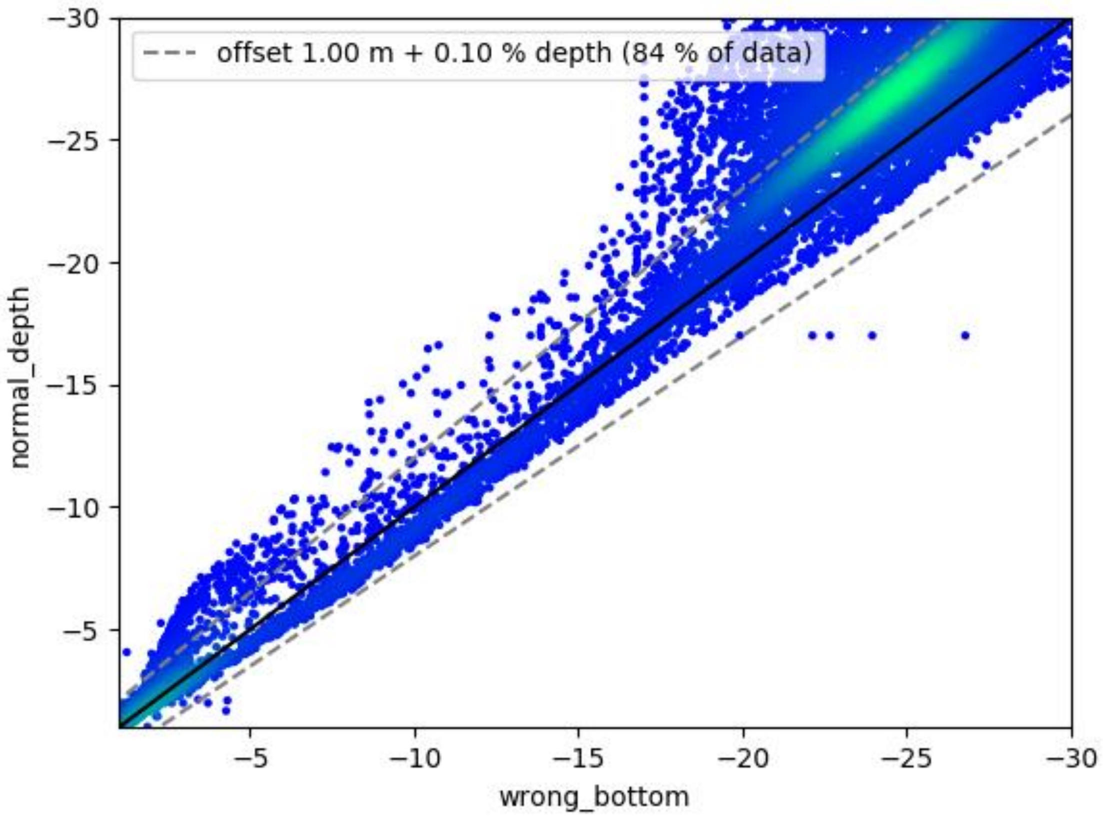
Subsurface reflectance

Impact of corrections executed in a transparent physics based automated production workflow:

Sea floor reflectance



Impact of restricted/wrong bottom reflectance model on depth retrieval

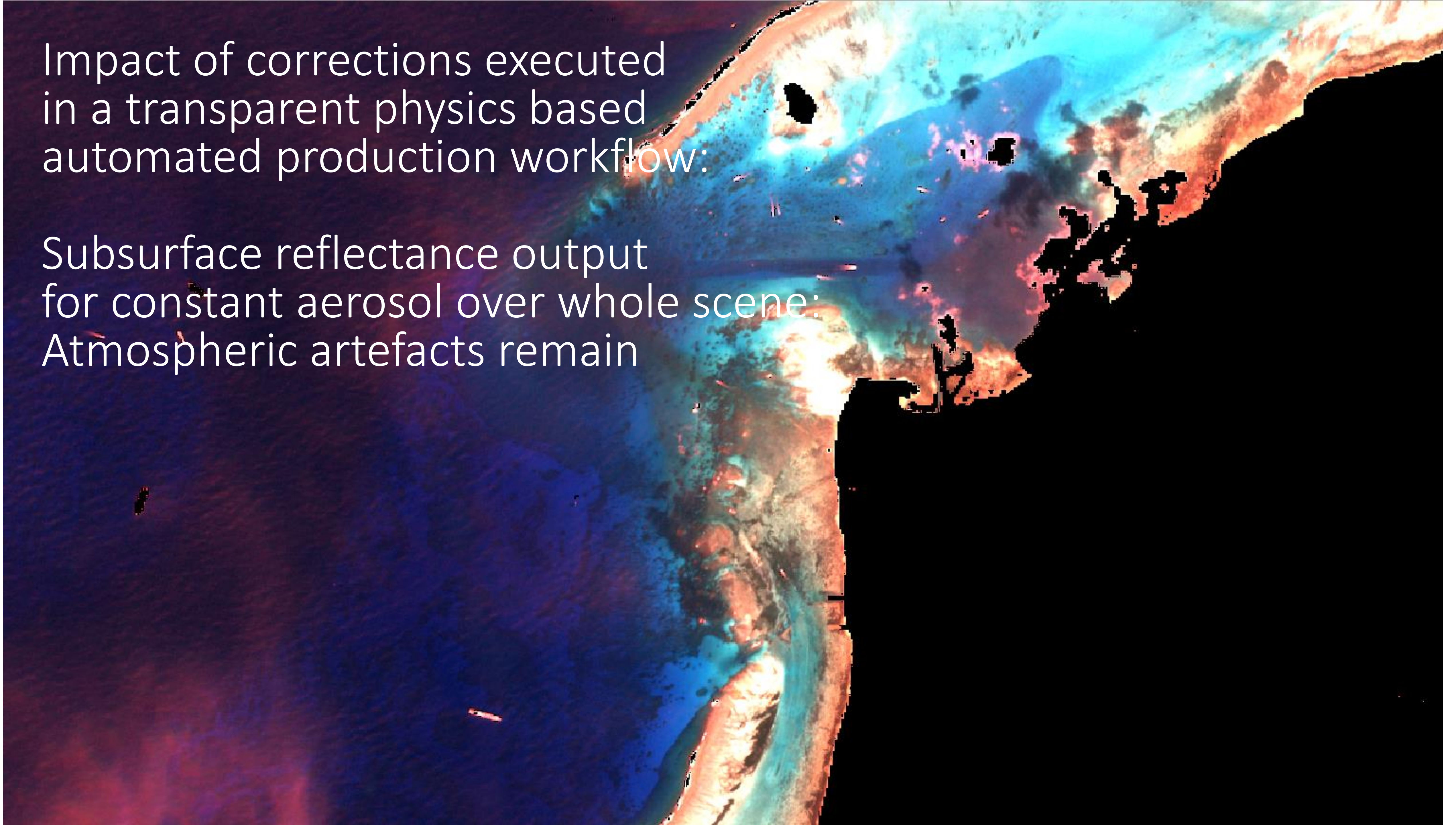


Impact of corrections executed in a transparent physics based automated production workflow:

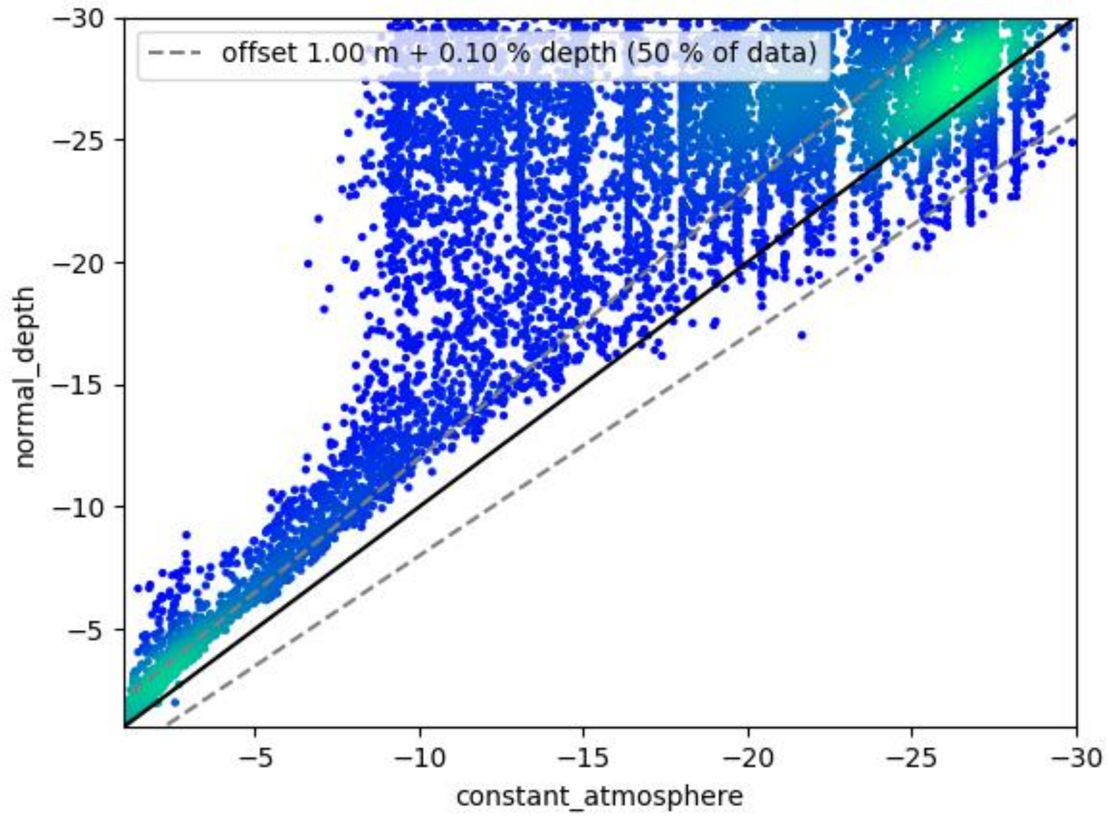
Subsurface reflectance output for pixelwise variable aerosol retrieval

Impact of corrections executed
in a transparent physics based
automated production workflow:

Subsurface reflectance output
for constant aerosol over whole scene:
Atmospheric artefacts remain



Impact of variable aerosol retrieval versus constant AC correction on depth retrieval



Fully automated SDB processing with Watcor-X (version 2018)

Results from shore to -15m depth for different regions in comparison to Zones Of Confidence (ZOC)

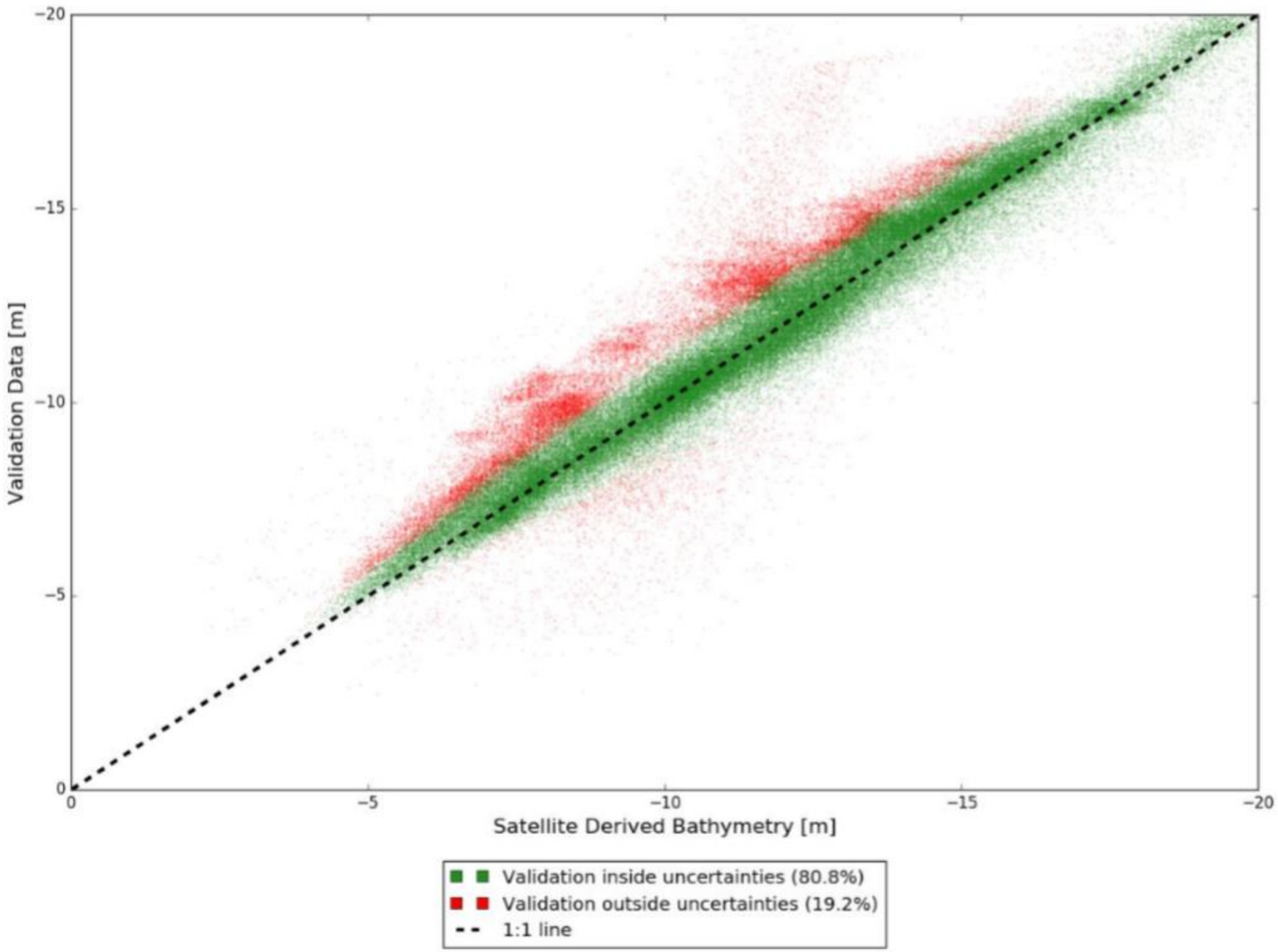
Area	ZOC A	ZOC B	ZOC C
Puerto Rico	53%	76%	95%
St Croix	36%	64%	96%
St. Thomas	20%	38%	71%
Jeddah	18%	35%	85%

Vertical uncertainty, CI95:
ZOC A: 0.5m + 1% depth
ZOC B: 1.0m + 2% depth
ZOC C: 2.0m + 5% depth

Datum der Szene	1	2	Klasse
2018 02 17	85%	93%	1B
2018 08 11	71%	84%	1B
2018 03 29	81%	91%	2
2018 03 19	69%	92%	2
2017 12 24	33%	53%	2
2017 12 29	56%	71%	2
2018 02 02	61%	78%	2

… and impact on scene suitability

Forecast of uncertainty in an automated processing workflow



Autonomous SDB capability
Limitations on environmental conditions

Parameters	Impacts	Ideal conditions	Insufficient conditions
Water clarity	Maximum depth, vertical uncertainties, object detection	Secchi Disc Depth > 15m	Secchi Disc Depth <5m
Spatial distribution of water clarity	Full seafloor search, maximum depth, vertical uncertainties, object detection	Water clarity in simlar ranges within or the study site	Highly heterogeneous water clarity
Seafloor	Full seafloor search, vertical uncertainites	Sediment, coral or hardbottom surfaces with none to moderate vegetation	Dense Kelp forest, very dark (often vulcanic) rocks
Seastate	Vertical uncertainties, object detection	No to little seastate and resuspension of materials	Strong wave interactions
Tides	Vertical uncertainties	Tidal heights are homogenous for the site	Varying and unknown spatial distribution of tidal heights

Autonomous SDB capability
Specifications for satellite recordings

Parameters	Impacts	Ideal specs	Insufficient specs
Satellite sensors	Maximum depth, vertical uncertainties, noise	8band WorldView-2, Sentinel-2, hyperspectral sensors	WorldView-1, IRS,….
Geometry	Sunglint	Sun and sensor in similar azimuth and angle	If >5% reflectance is returned from the water surface
Cloud & haze	Full seafloor search, vertical uncertainites, object detection	No cloud or haze	

Quality assurance for SDB products

Sensors

Data analytics

Production workflow

How to reflect all this in:

Standards ?
Risk management ?
Tendering requirements ?
Fostering improvements & innovation?
Knowledge dissemination & Capacity building?

Future directions to improve SDB

Multi-image processing, algorithms improvements

Improving concepts for integrated approaches

Online processing capabilities and portals

Transparency in SDB production, quality forecasts, uncertainty

Introductions	At IHO / Regional Commission meetings, CBSC meeting
Understanding & **Exchange**	SDB forum, SDB day 2018/2019
Training	SDB production and integration training (e.g. EOMAP HQ 2019, Indonesia 2020) eLearning: Online processing course & support
Certification	Qualification levels for hydrographers for SDB generation, integration, charting

THANK YOU

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