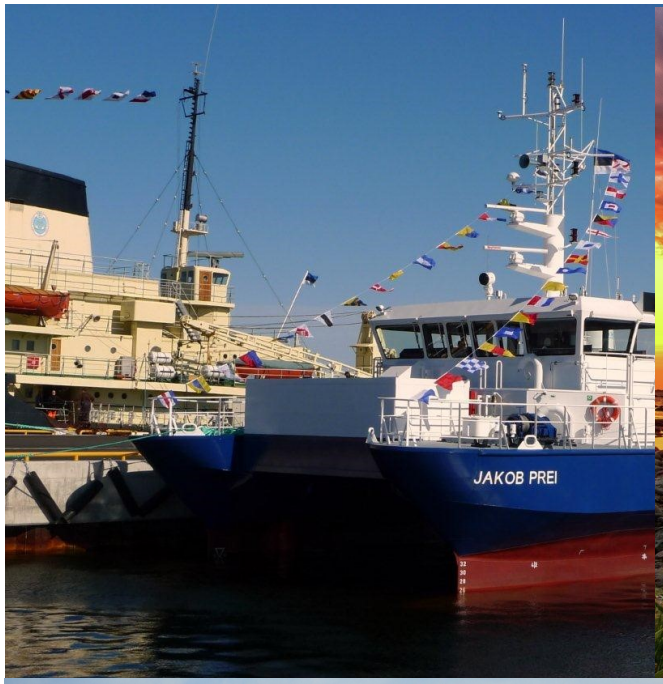
UNIVERSITY OF TARTU
1632

# Physics based methods in satellite derived bathymetry

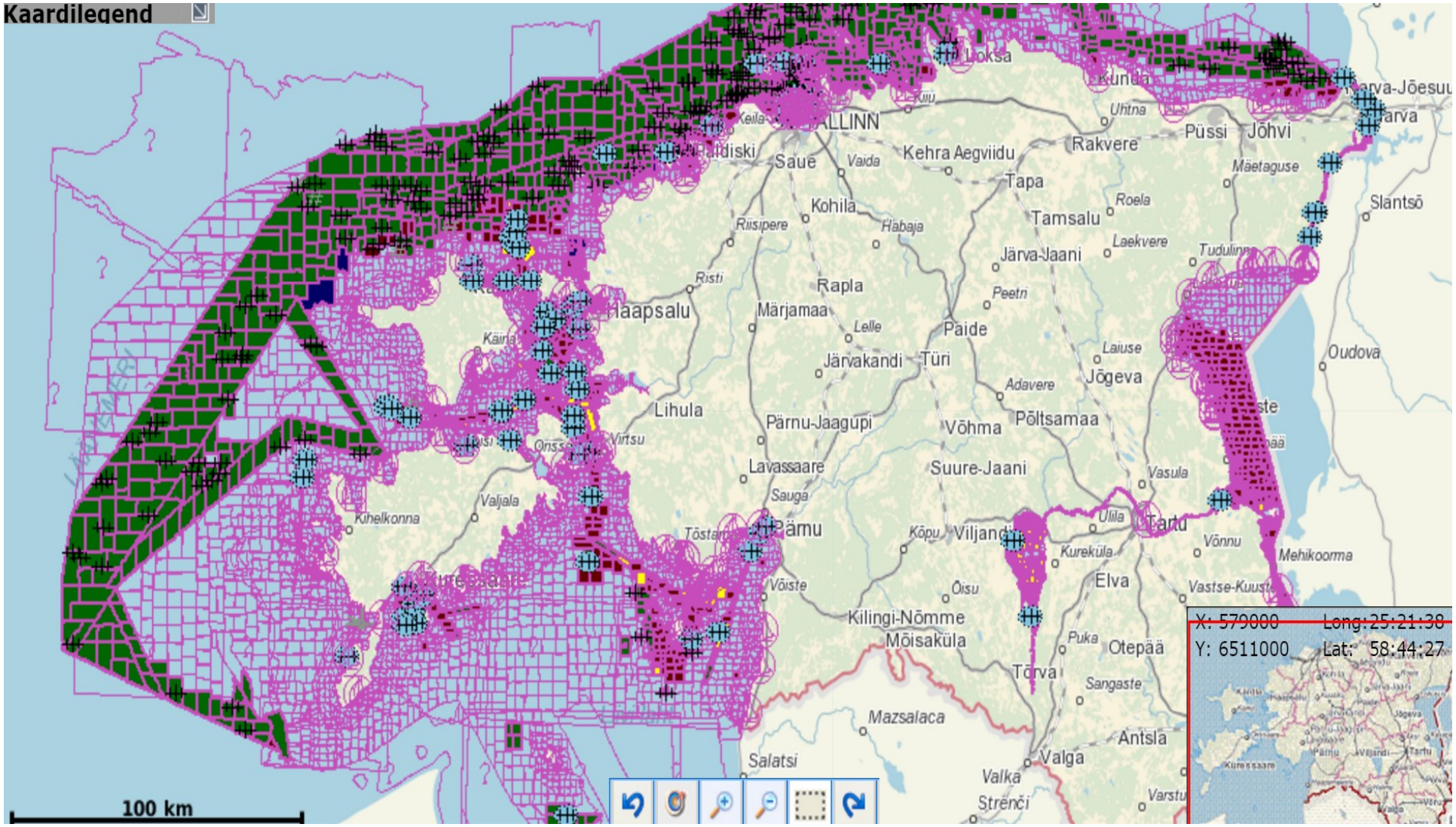

## Tiit Kutser

**Estonian Marine Institute**

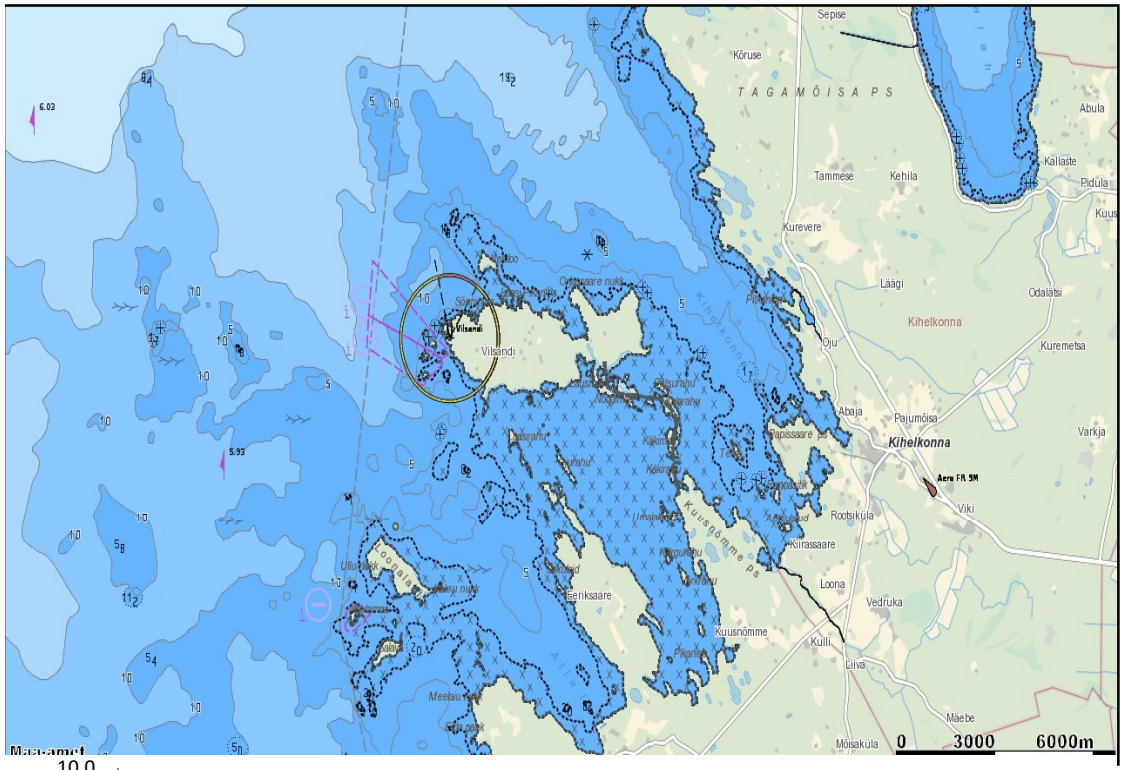

JAKOB PREI

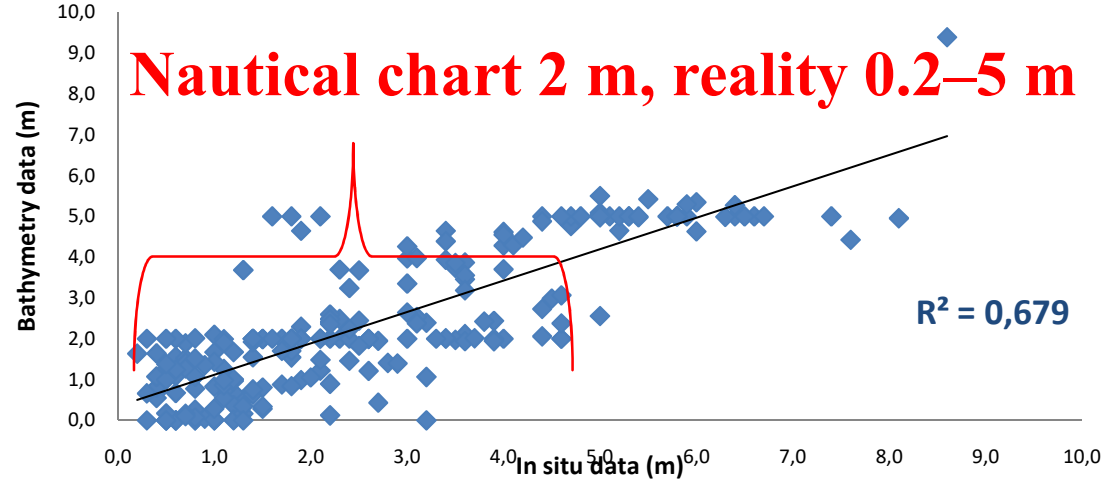

Gert Vardja
www.gertvardja.ee

# Estonian coastal waters mapped with sonar



# Nautical charts in Estonia

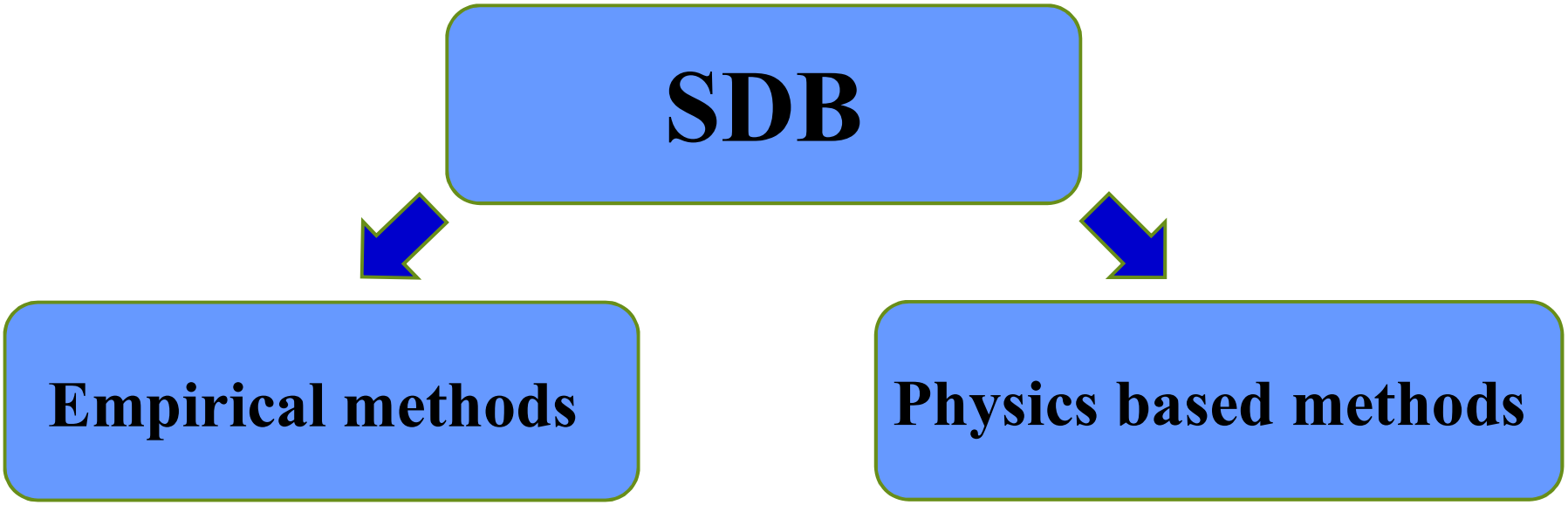



* Very shallow areas mapped before 1953

* A single storm and ice can change bathymetry

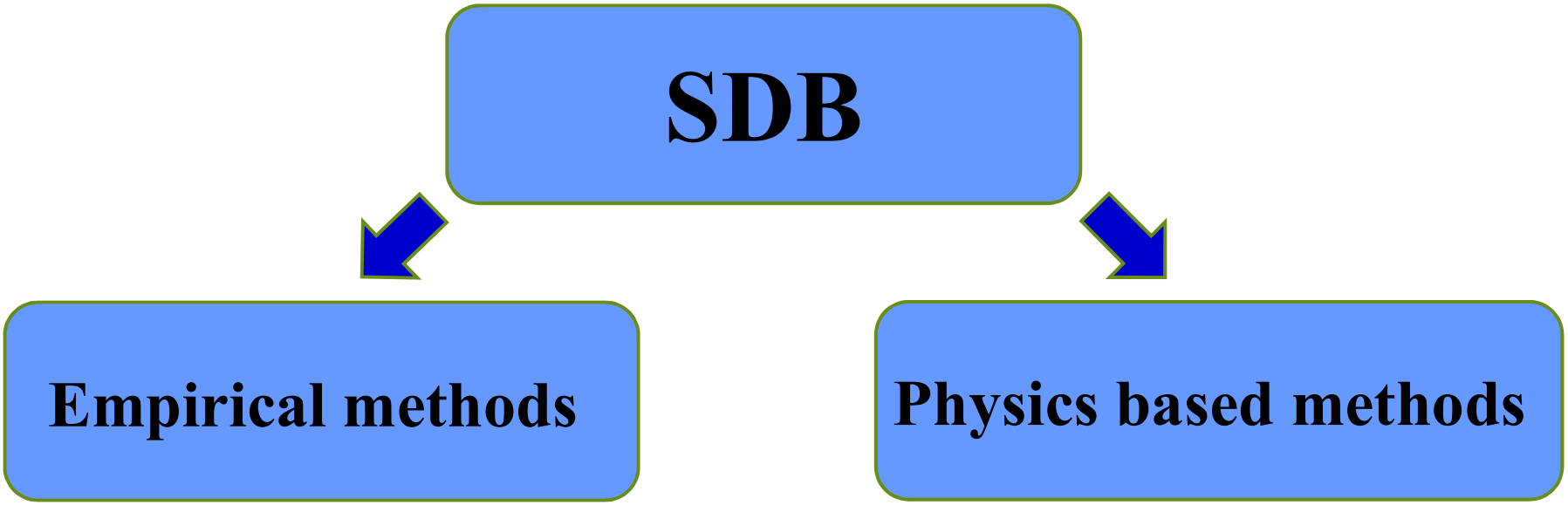
* Large areas inaccessible by hydrographic ships




**Band ratios and their combinations**

**Use full reflectance spectra and models**

* **SAMBUCA, BOMBER Lee et al. inversion type**
* **Spectral libraries (LUT) with methods like SAM**
* **Neural Networks**
* **Machine learning**




+ computationally fast

- Either bottom reflectance or depth has to be known to estimate the other parameter

- Instrument specific

- Lots of *in situ* data needed

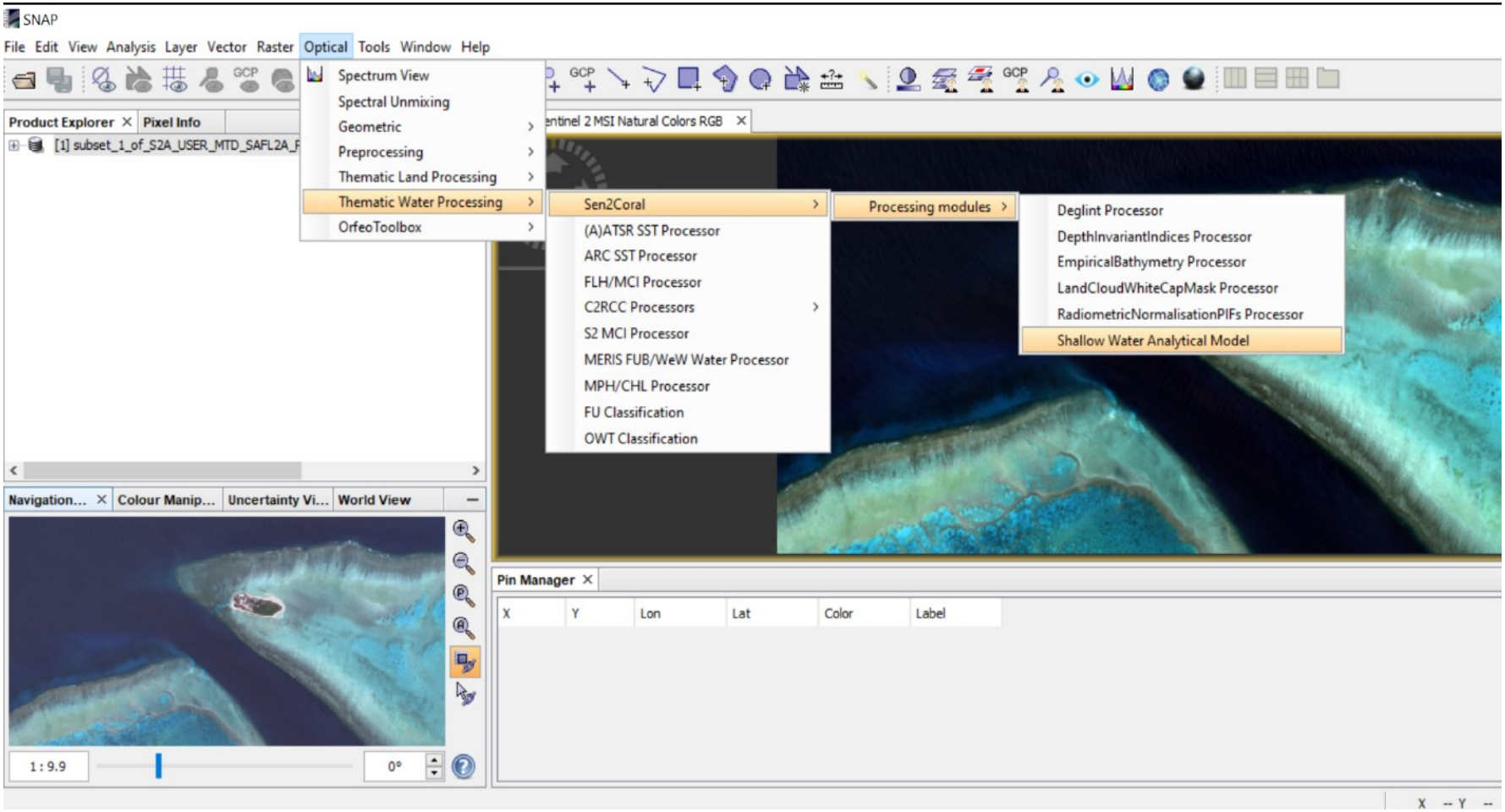
- Many methods are slow

+ Depth and bottom type retrieved simultaneously

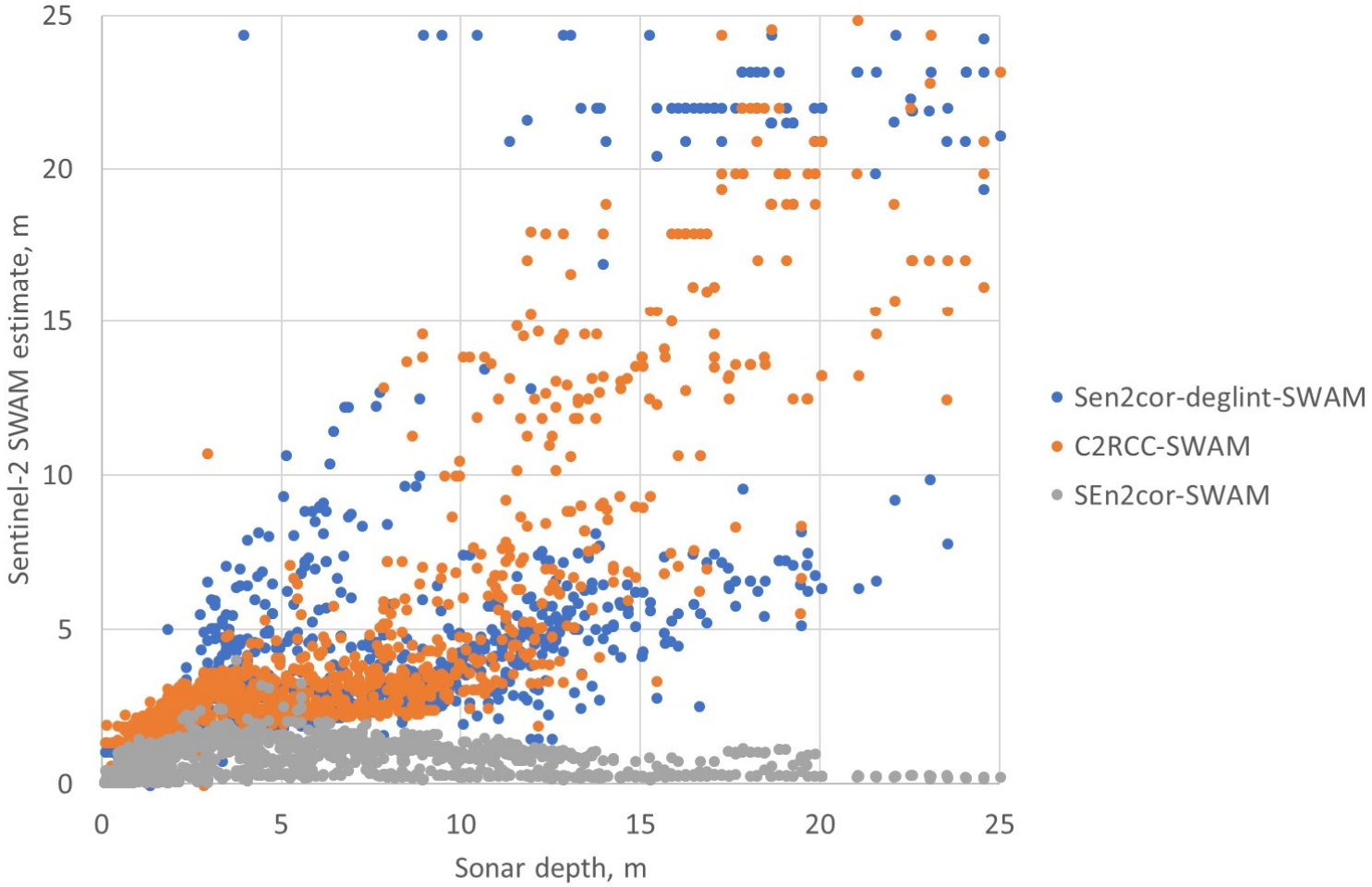
+ Universal from sensor point of view

+ No *in situ* data needed after optical properties for the model are defined

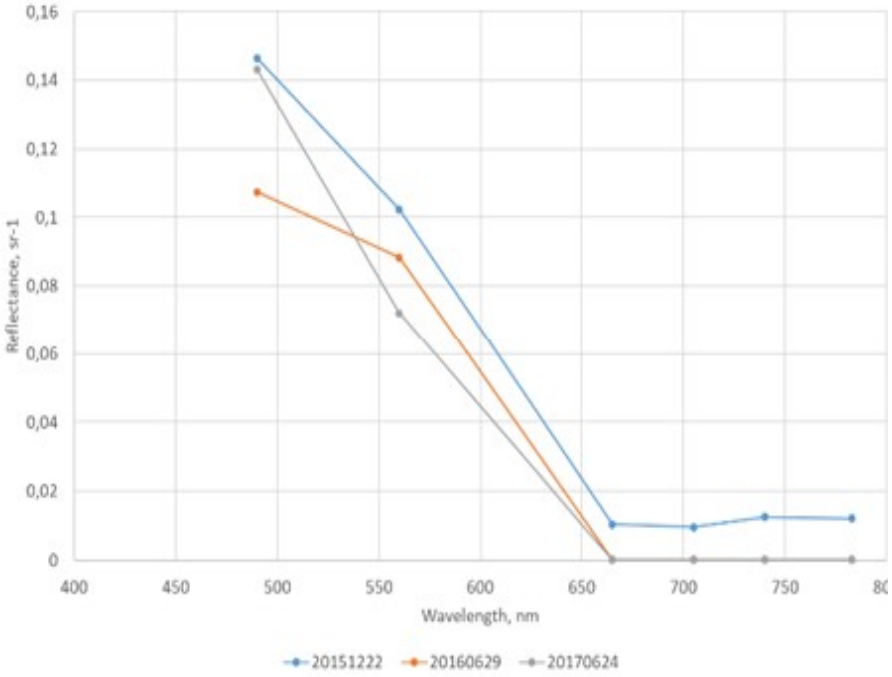
# Depth Invariant Indices and SWAM available in SNAP

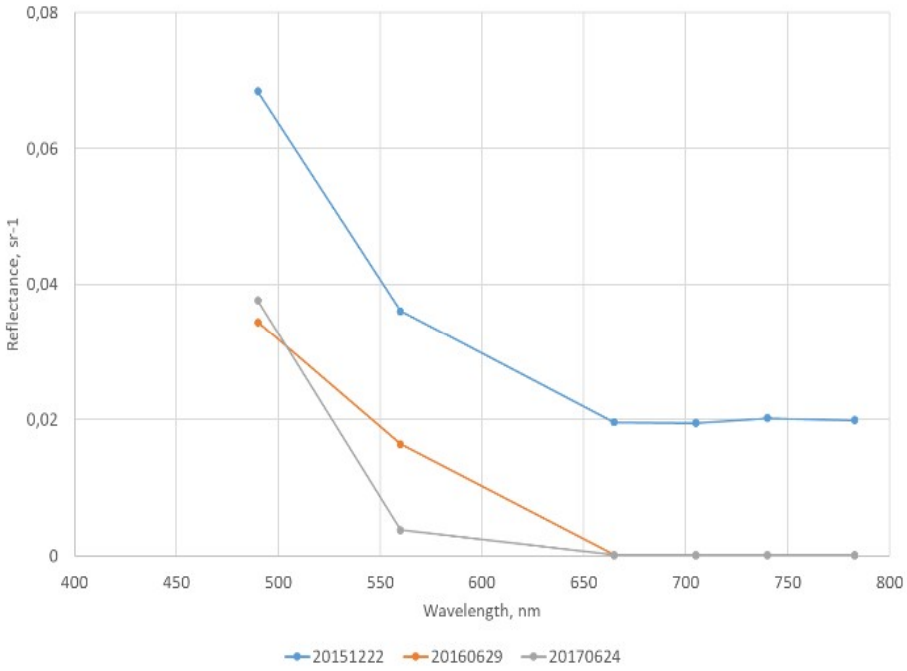


# Analytical methods very sensitive to image quality



# Glint and residual signal
# Sen2cor atmospheric correction

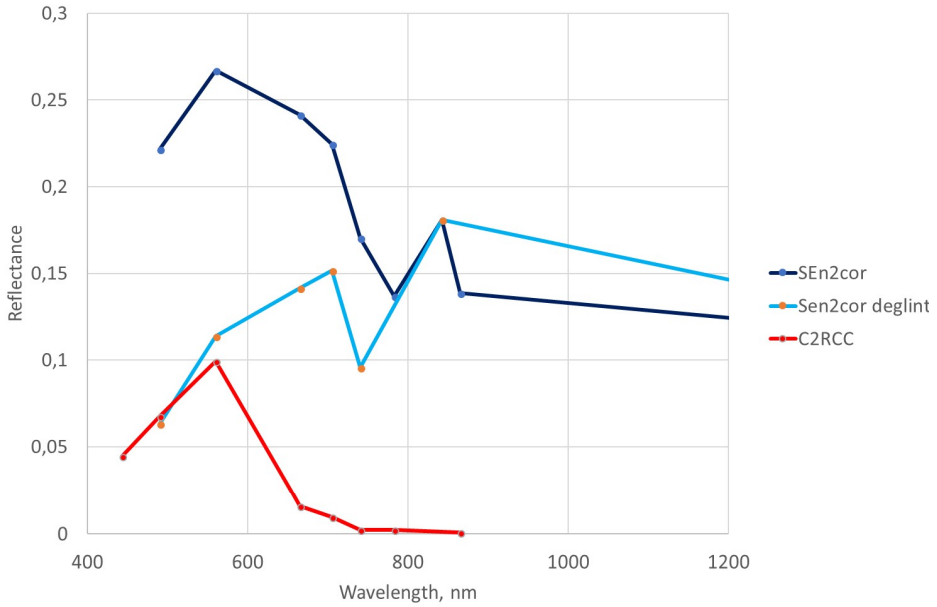


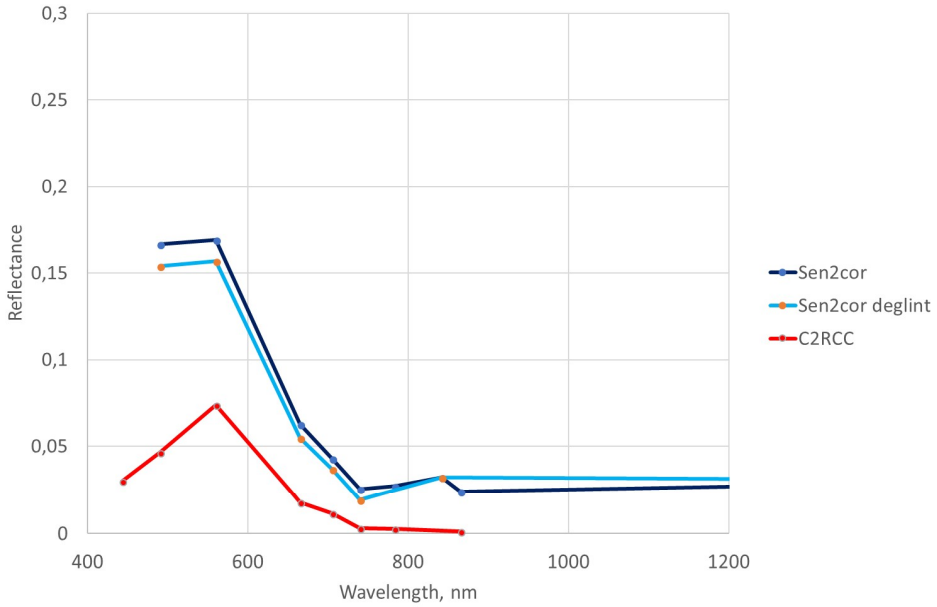



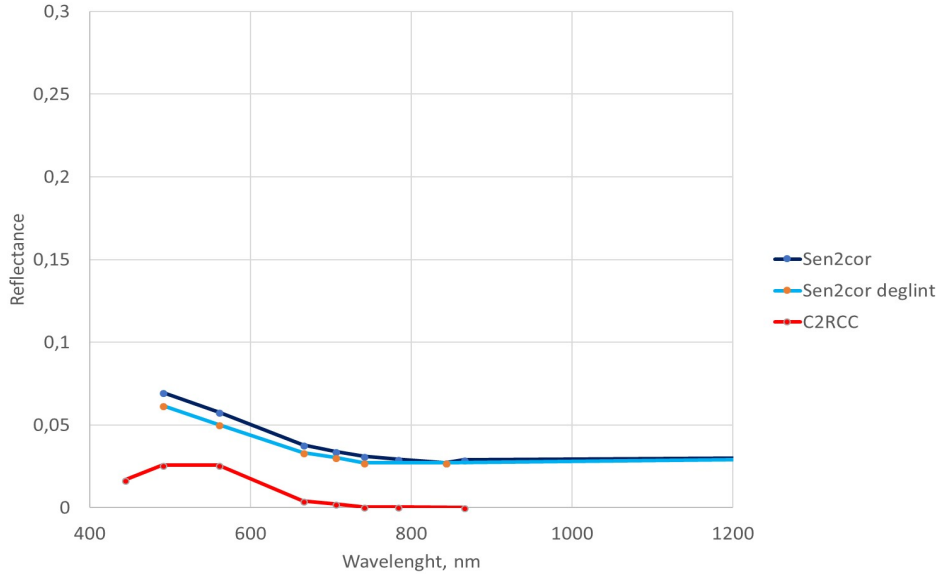

**Bright sand in few meter deep water**

**Deep water**

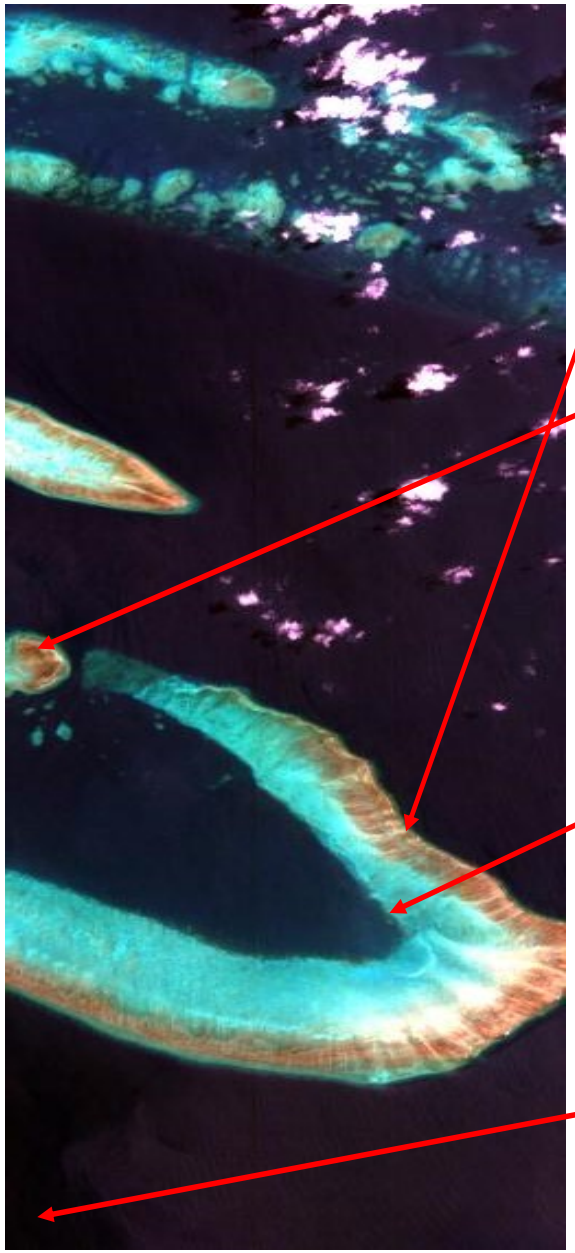
# Glint removal

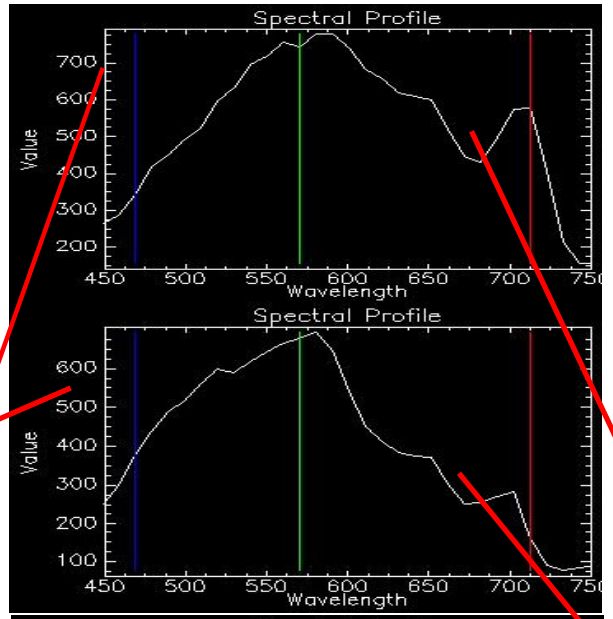


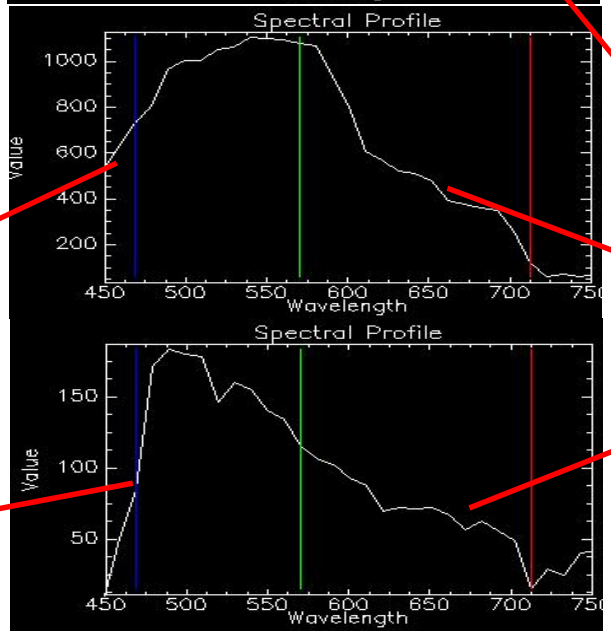



# Spectral shape matching

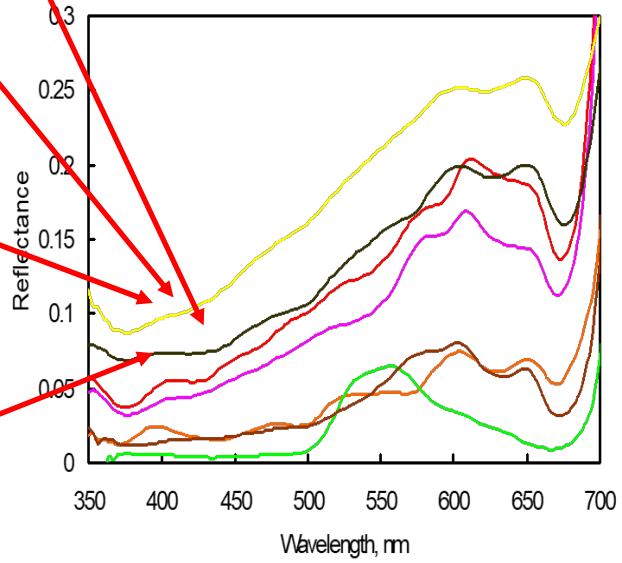





**Modelled spectral library**

**Different bottom types at diferent depths**



# ”Classical“ image processing

**Top-of-atmosphere image**

↓

**Atmospheric correction**

↓

**Water processing**

**(Water level spectral library + SAM)**

↓

**Map**

## ”Alternative“

## image processing

**Top-of-atmosphere image**

↓

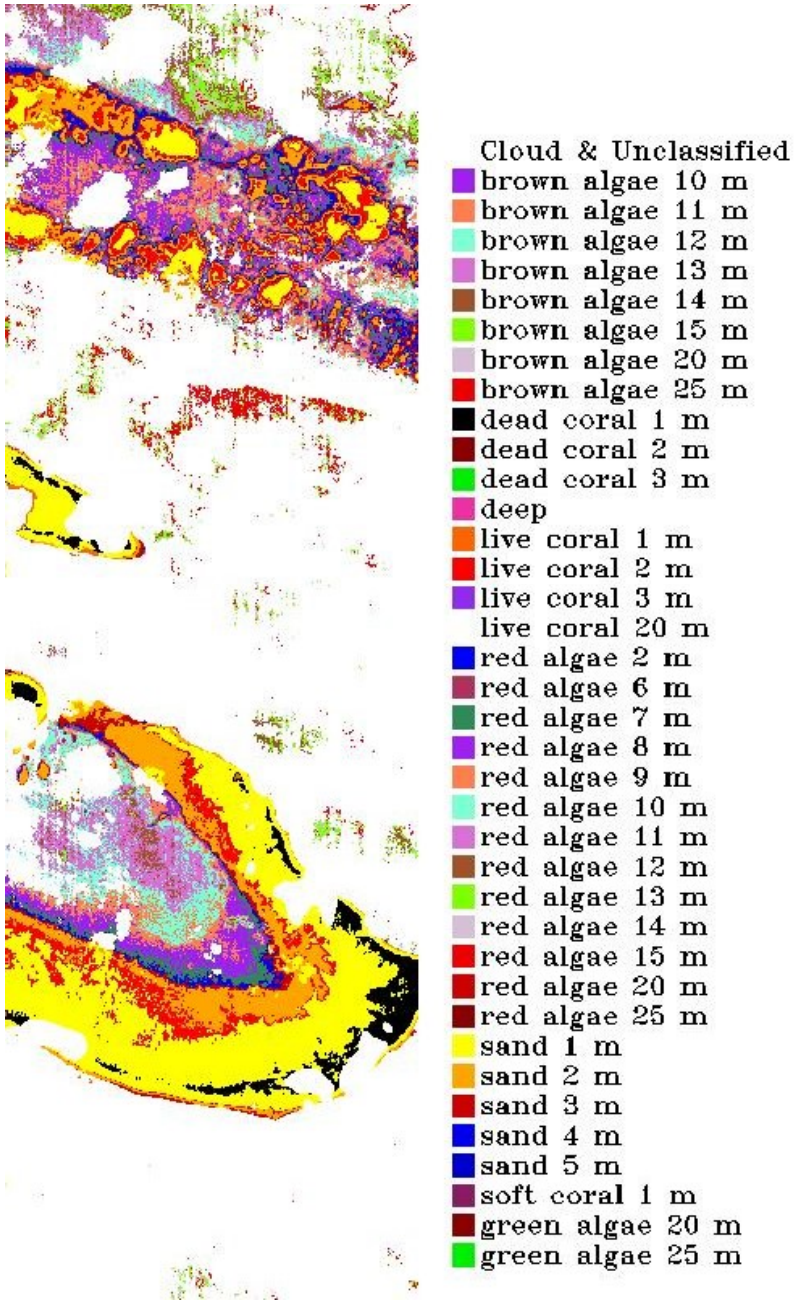
**Water processing**

**(TOA spectral library + SAM)**

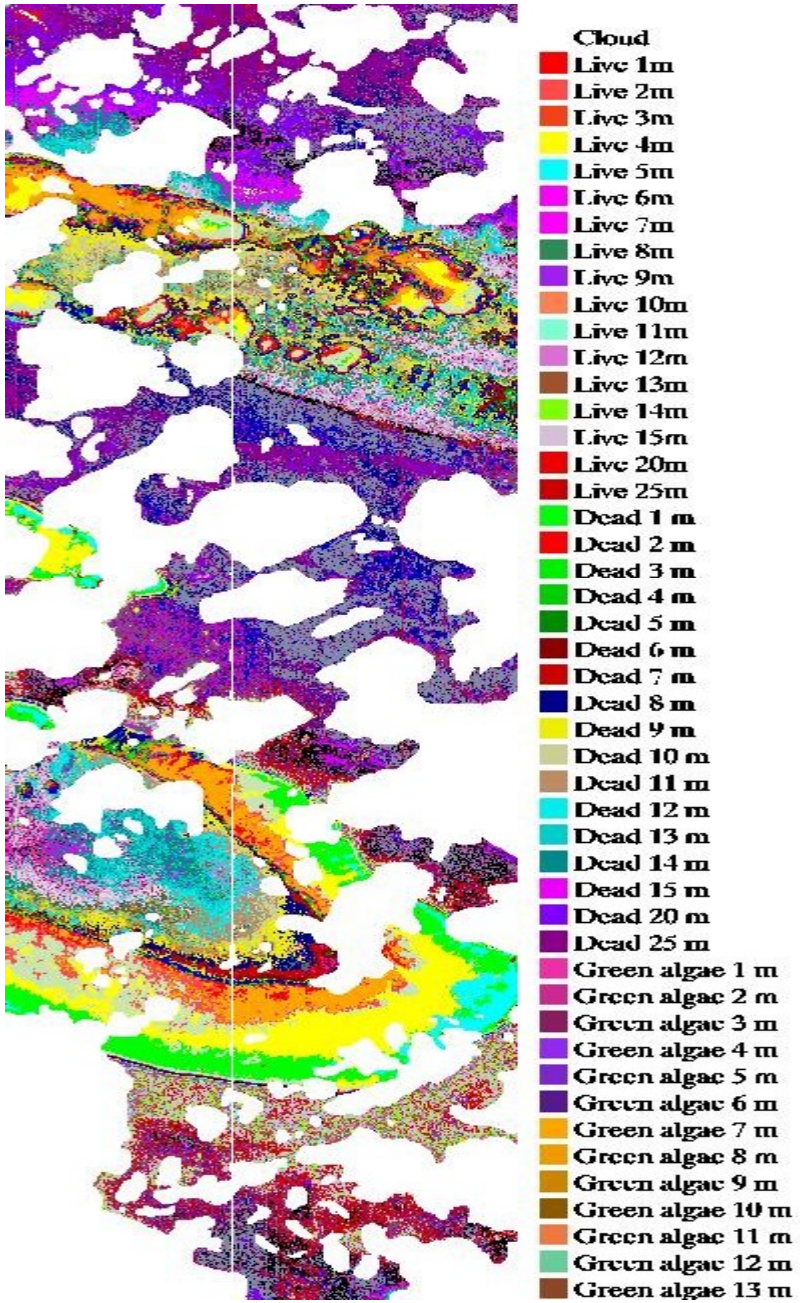
↓

**Map**

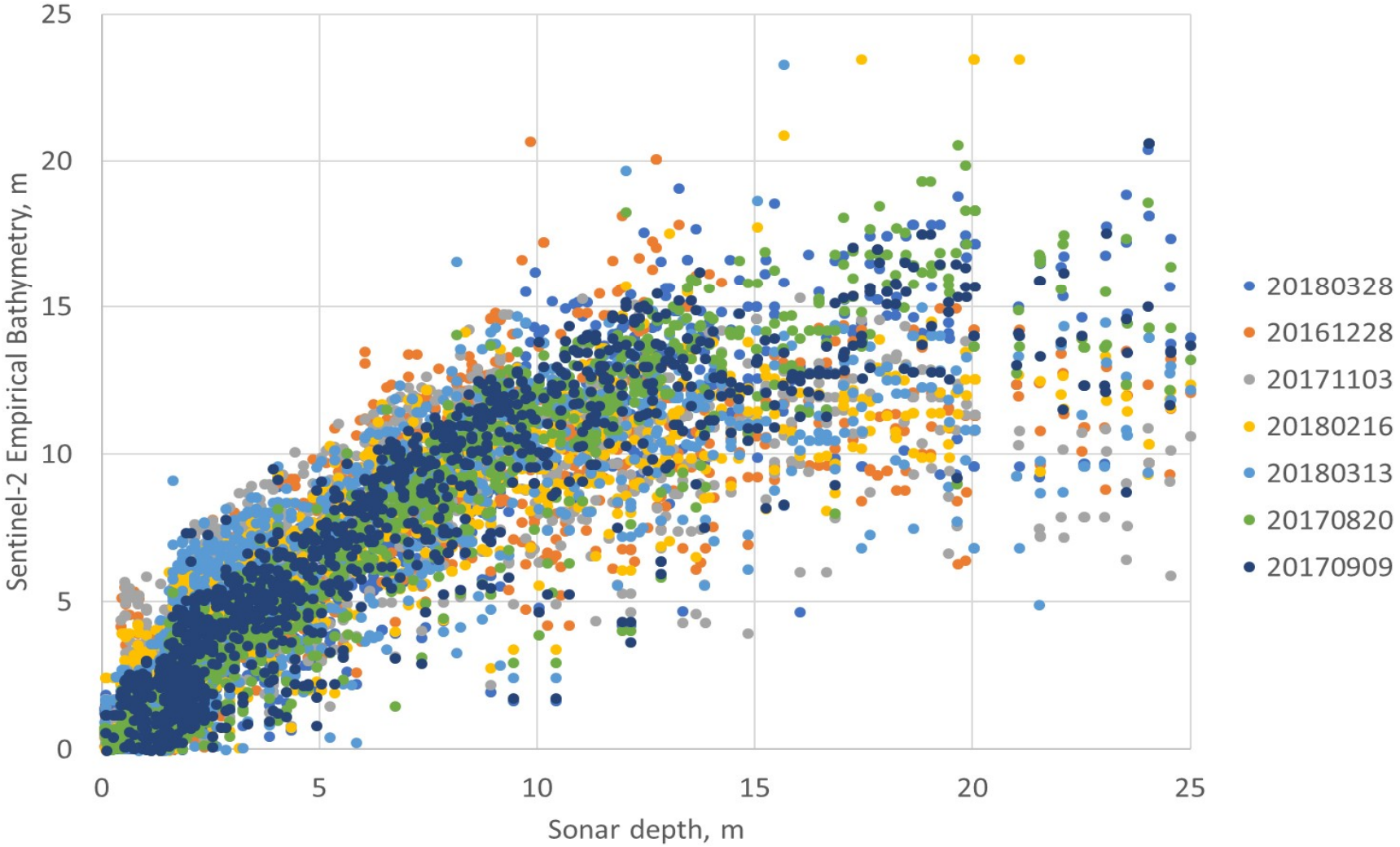
# Classical



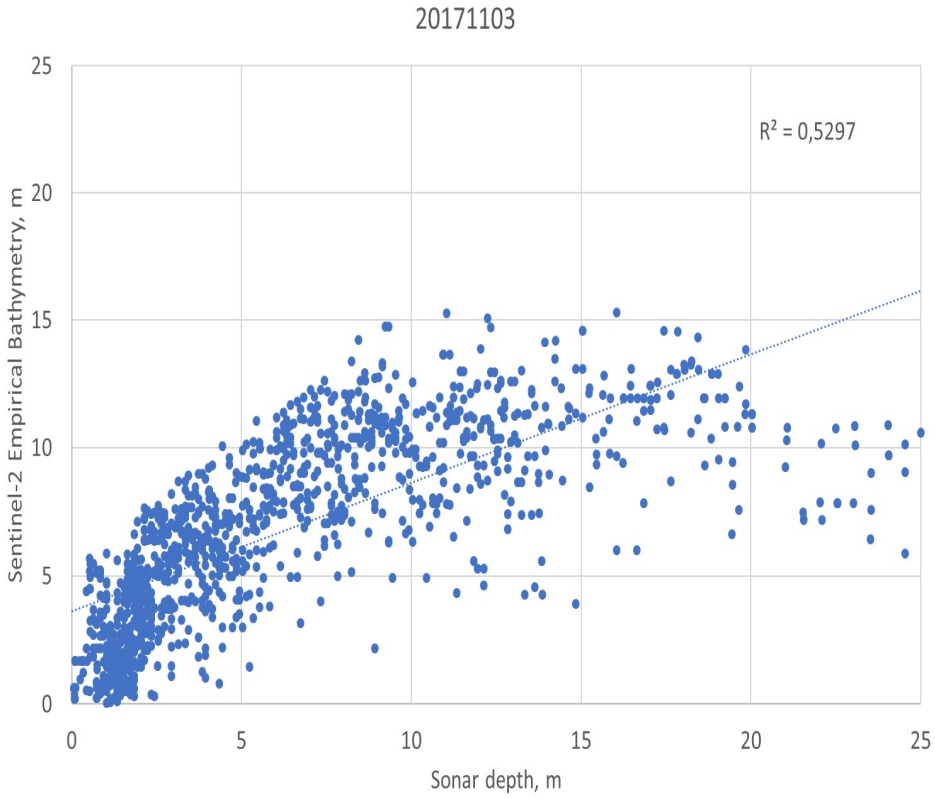

# Alternative

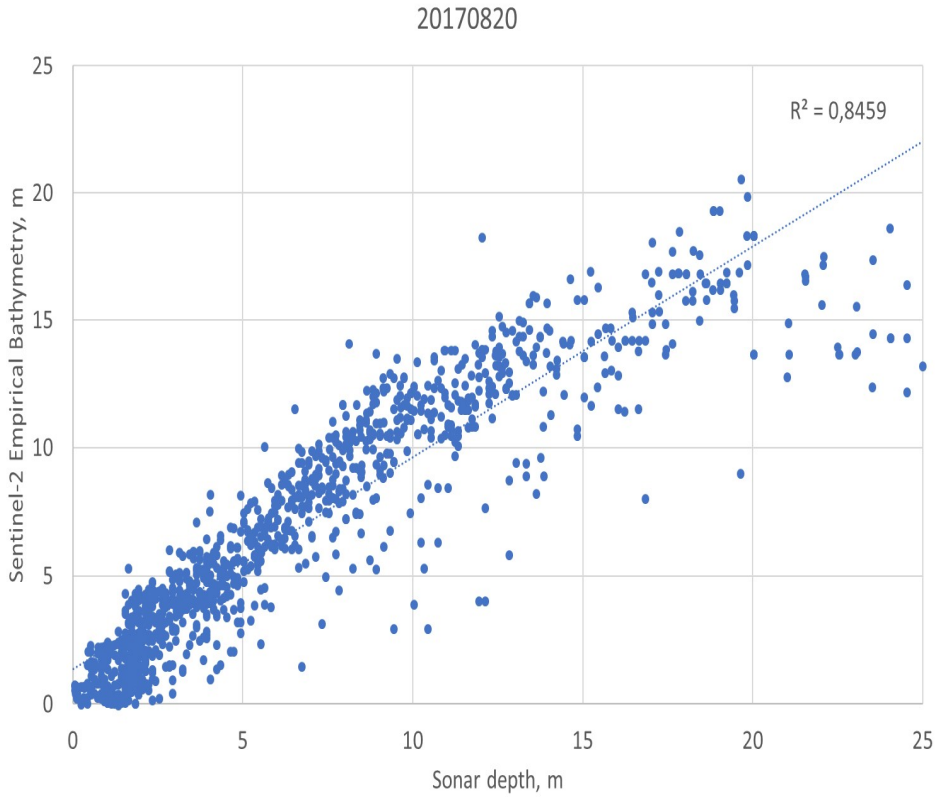


# Empirical methods also sensitive to image quality



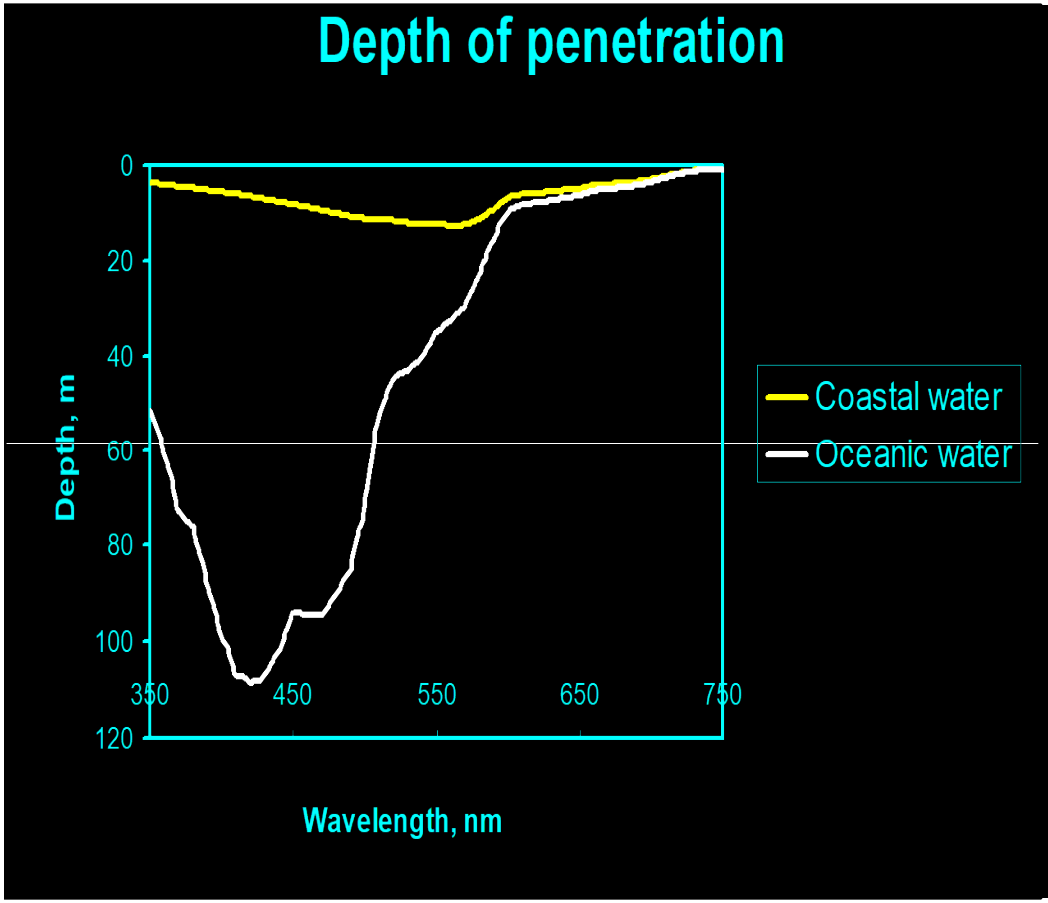
# Lizard Island, Sentinel-2
# Different dates

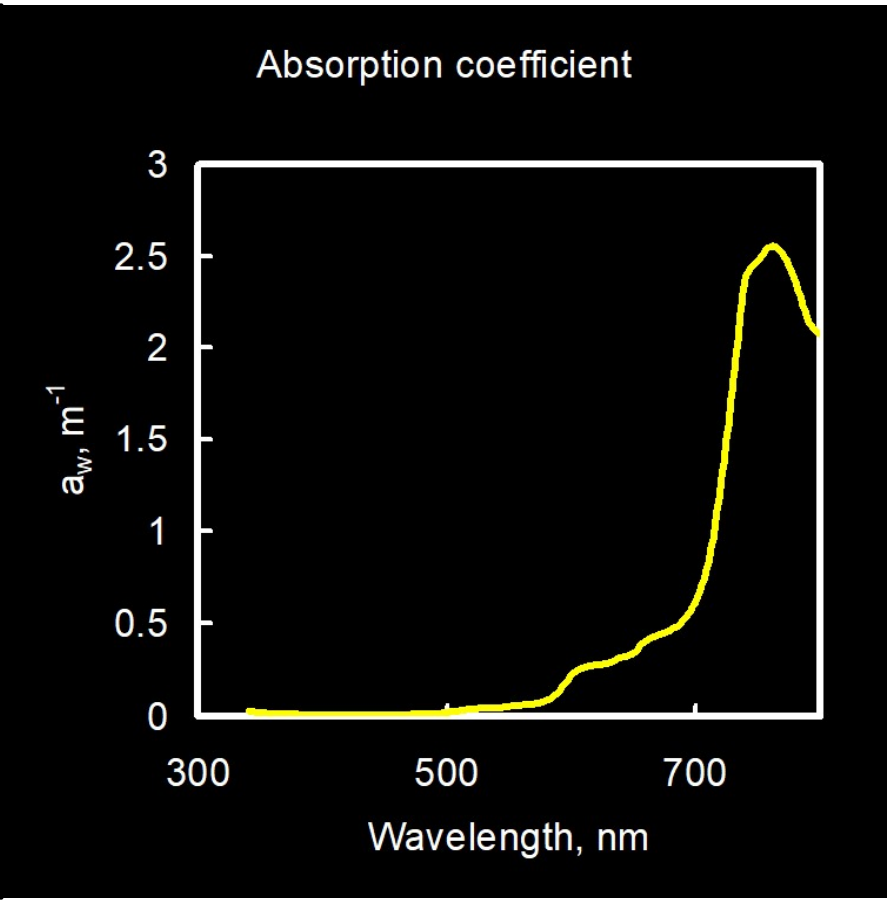



**Exactly the same 1341 points**

# Reminder




**Depth esimates much more accurate in 5-7 m deep water**

**Little change in water depth = large change in reflectance**

# Conclusions

* Physics Based Methods have advantage in the locations where little or no *in situ* data is available
* PBM very sensitive to errors in input data (e.g. atmospheric correction, glint)
* Methods using only the shape of reflectance data (e.g spectral library + SAM) should be less sensitive to input data quality

# Conclusions

* Working with top of atmosphere reflectances (i.e using forward model instead of inverse) is probably better than „classical“ approach
* Machine learning and other new methods should be tested

UNIVERSITY OF TARTU
1632

# Thank you for your attention!