Extracting coral reefs features from data

Alex Giménez-Romero

UNIT OF
EXCELLENCE
MARÍA
DE MAEZTU

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  - Water flow around atolls
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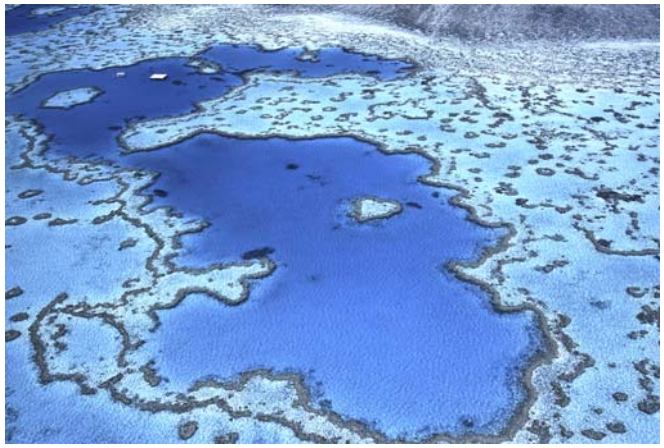


Aerial shot of the bleaching coral reefs of Great Barrier, images from CGTN

INTRODUCTION

- Large-scale detection and monitoring of coral reefs
  - Can we identify corals from satellite images?
  - Can we map and monitor coral reefs continously?

- Spatial structure of coral reefs
  - Do corals form spatial patterns?
  - Is there a typical atoll size?

- Environmental conditions in coral reefs
  - How do currents flow around atolls?
  - Typical values of temperature, salinity, etc.
  - How are the fluctuations or the seasonality of these values.

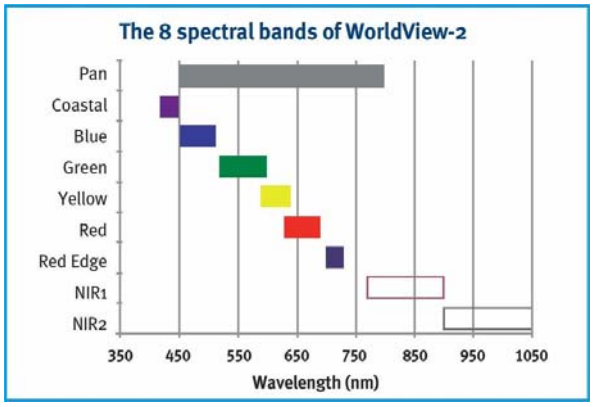
- Idea: Different benthic objects absorbe and reflect light with different patterns

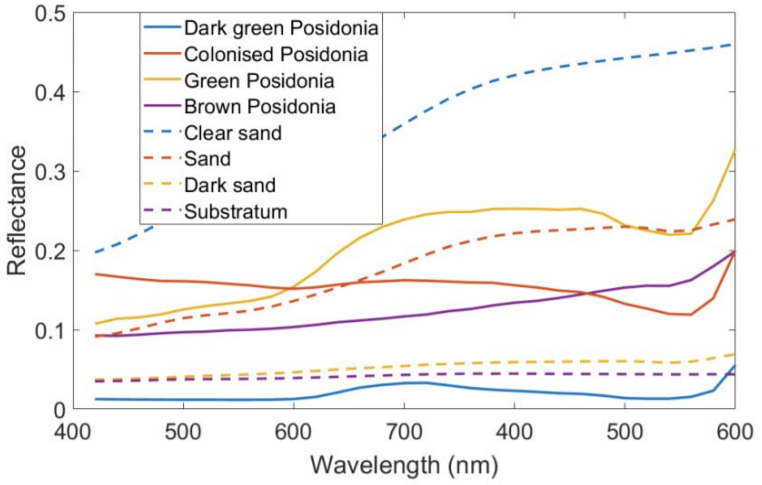
→ Each object can be associated with a given spectrum

- Artificial Intelligence can be used to identify this patterns and build predictive models

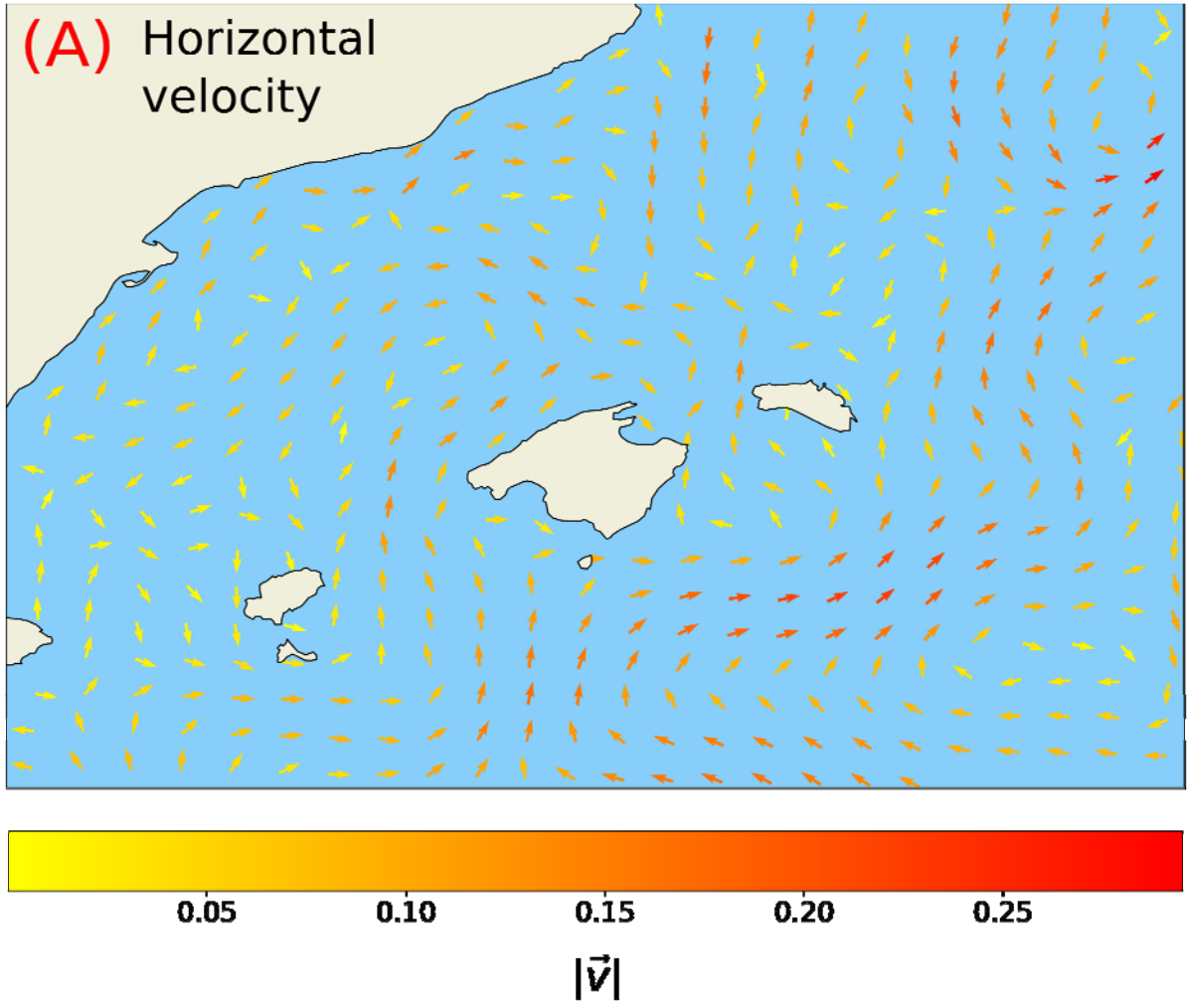
→ The models learn the spectrums of each object

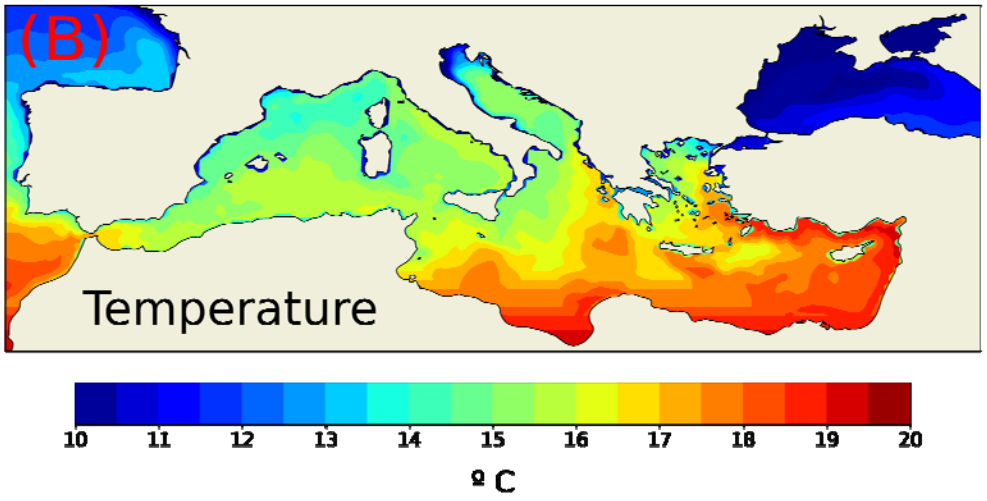
- Hyperspectral data can be obtained with satellites, planes, drones, etc.

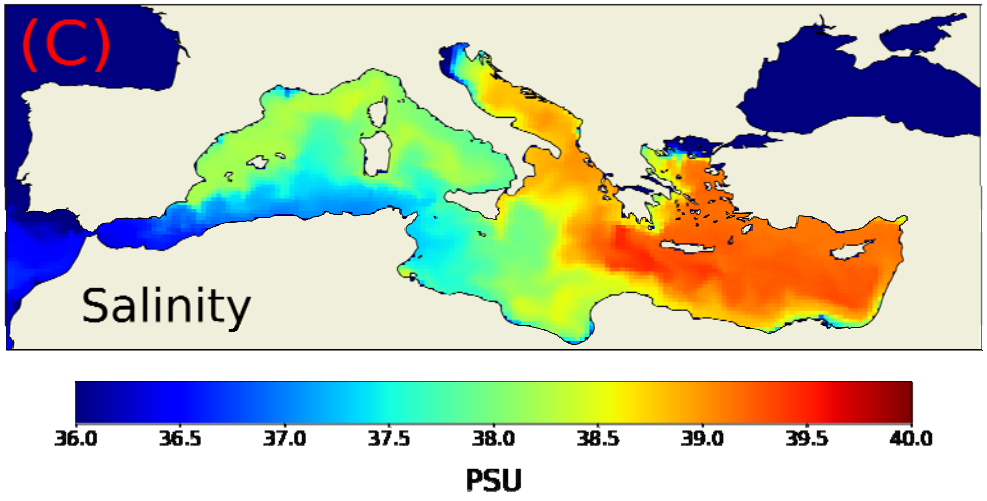




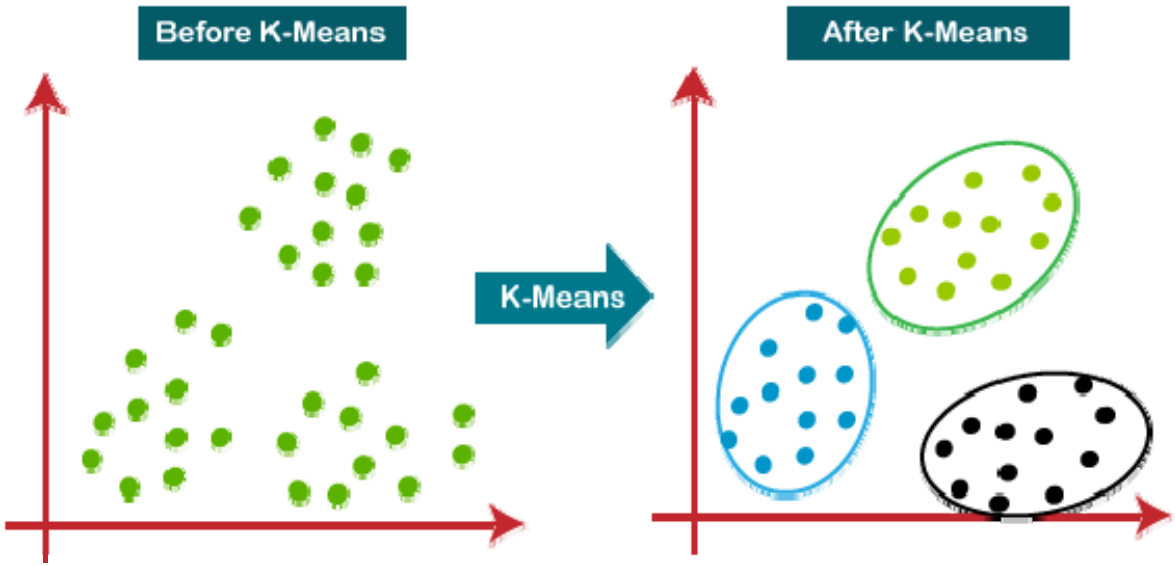
Guillaume, Mireille et al. (2020). Mapping Benthic Habitats by Extending Non-Negative Matrix Factorization to Address the Water Column and Seabed Adjacency Effects. Remote Sensing.


(A) Horizontal velocity
0.05
0.10
0.15
0.20
0.25
$|\vec{v}|$

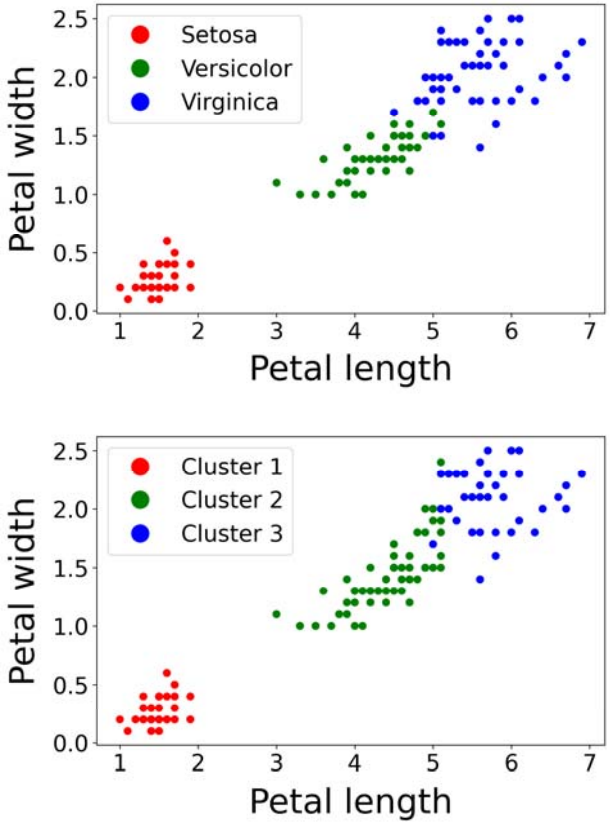

(B)
Temperature
10
11
12
13
14
15
16
17
18
19
20
ºC


(C)
Salinity
36.0
36.5
37.0
37.5
38.0
38.5
39.0
39.5
40.0
PSU

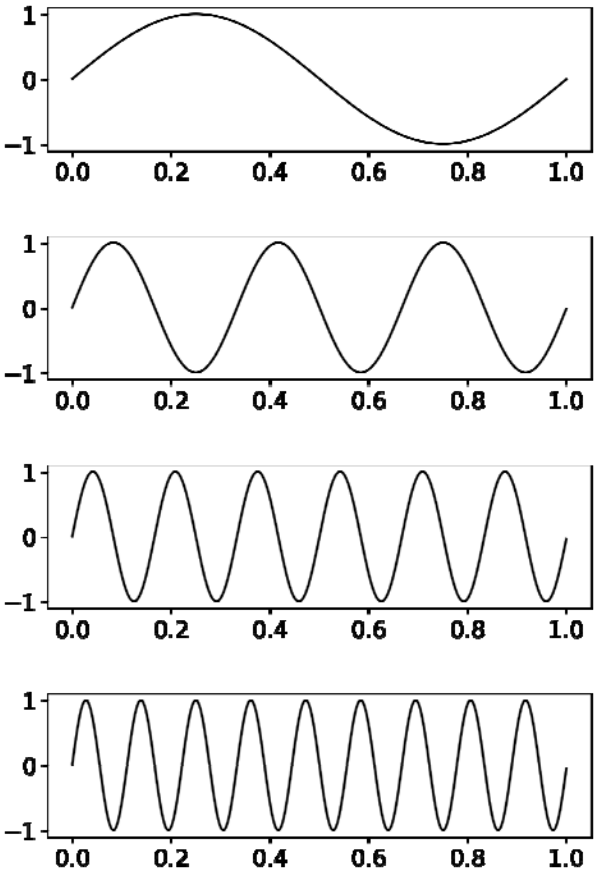
Abstract idea



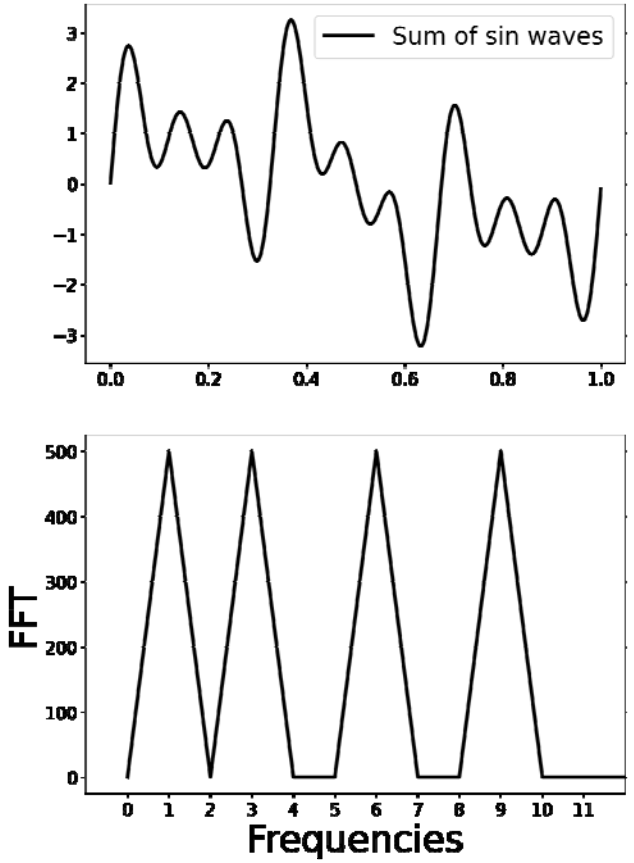
Most famous example

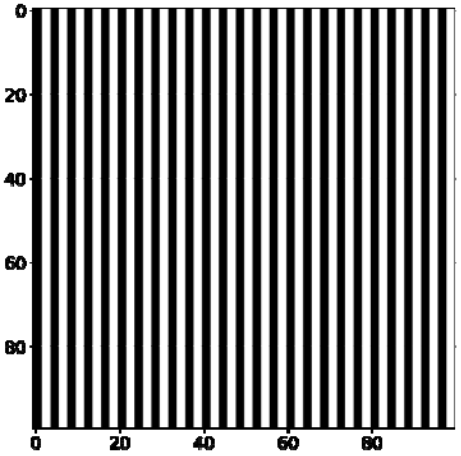


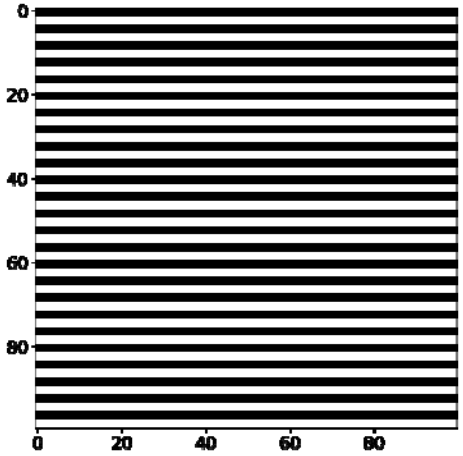
Sine wave functions with different frequencies

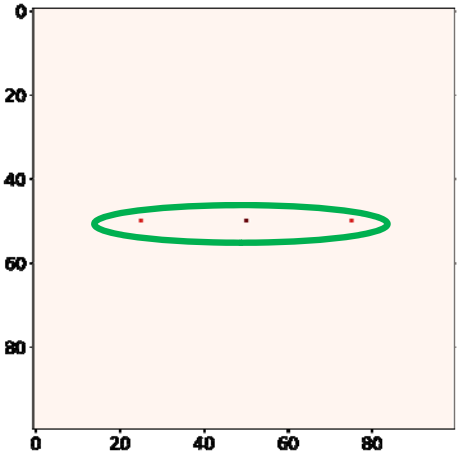


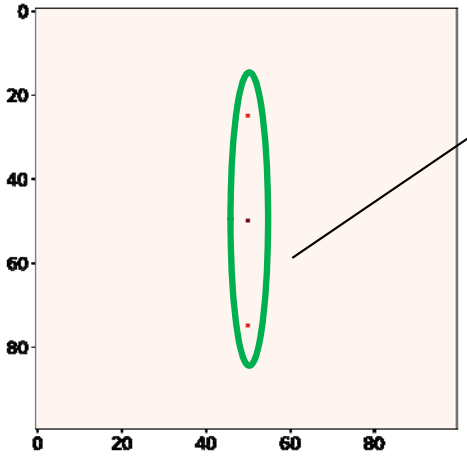
FFT to find the frequencies of the sum wave

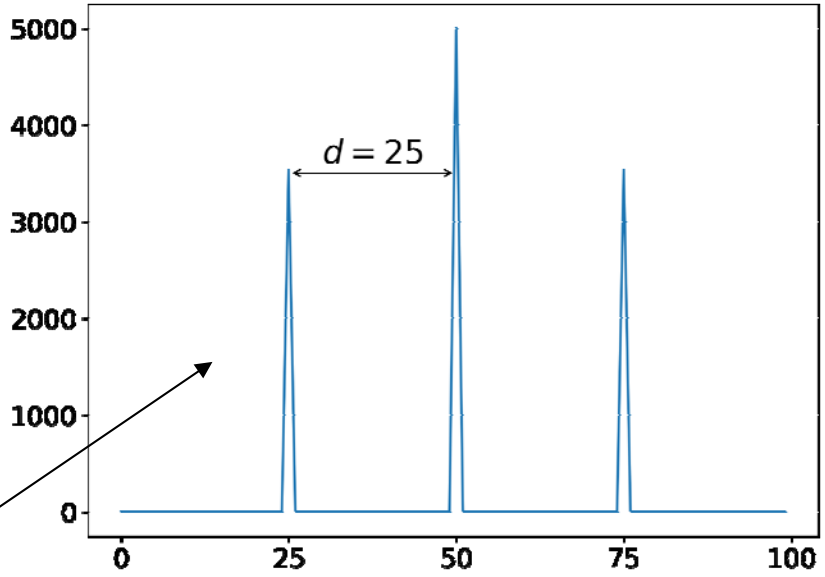








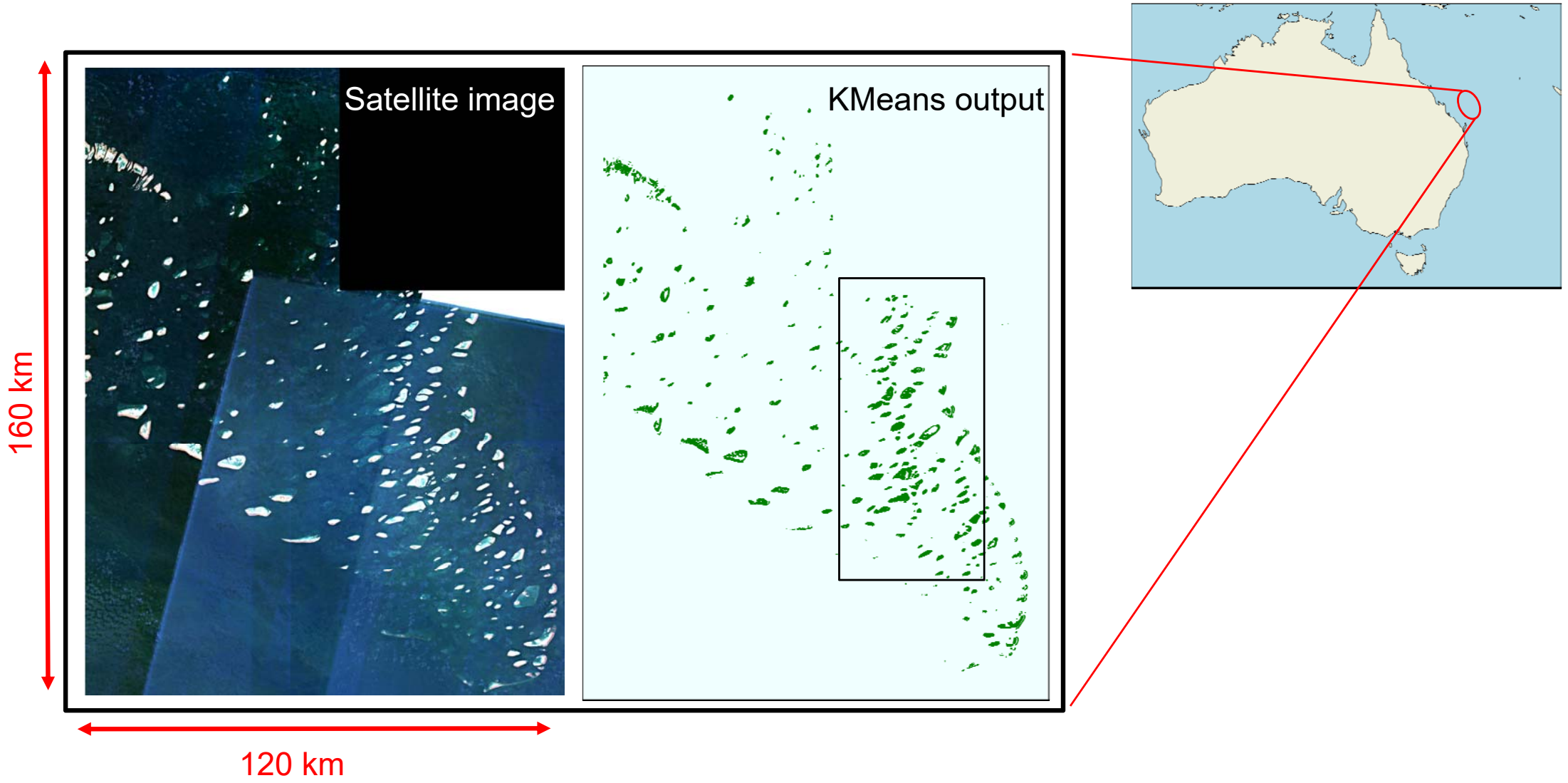




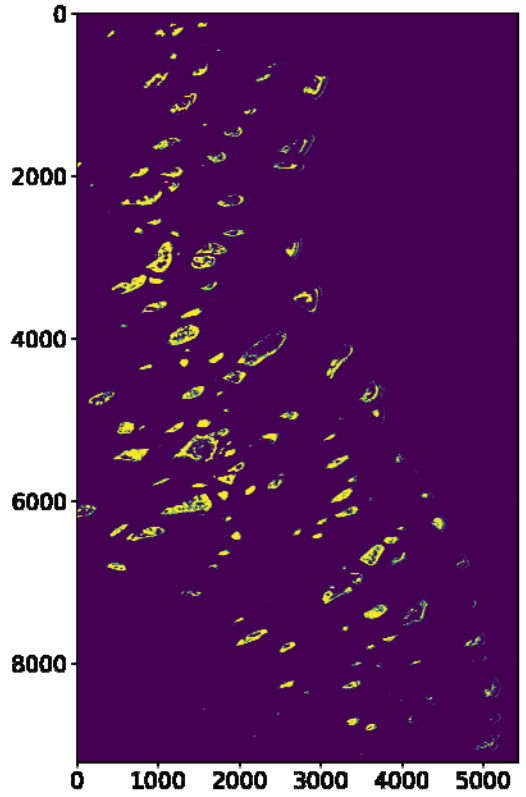
$$l_{pattern} = \frac{L}{d}$$

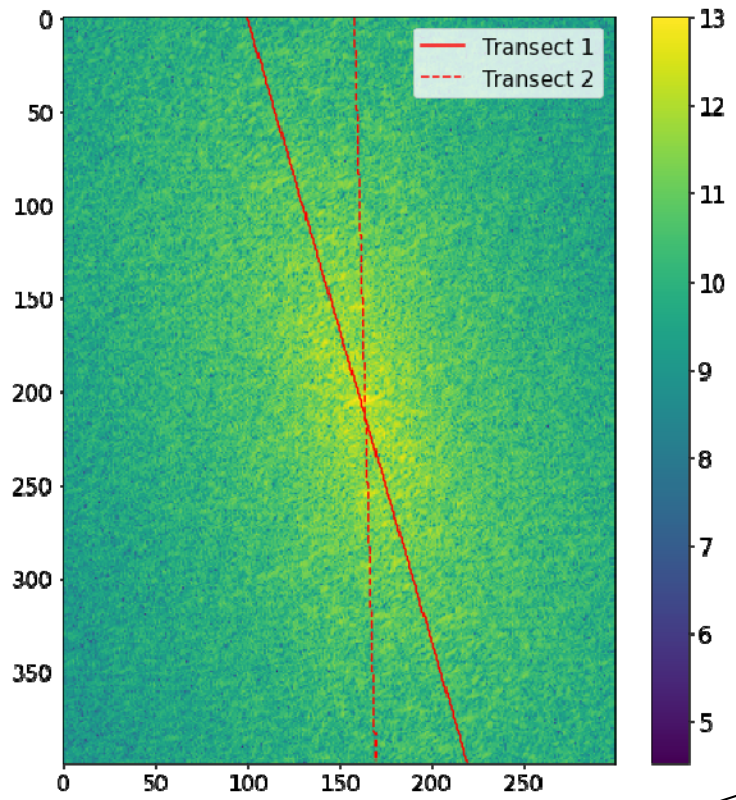
RESULTS

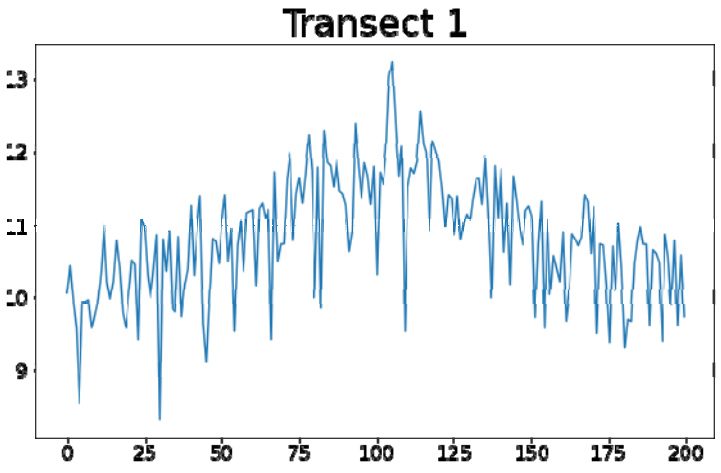
CORAL IDENTIFICATION FROM SATELLITE IMAGES *

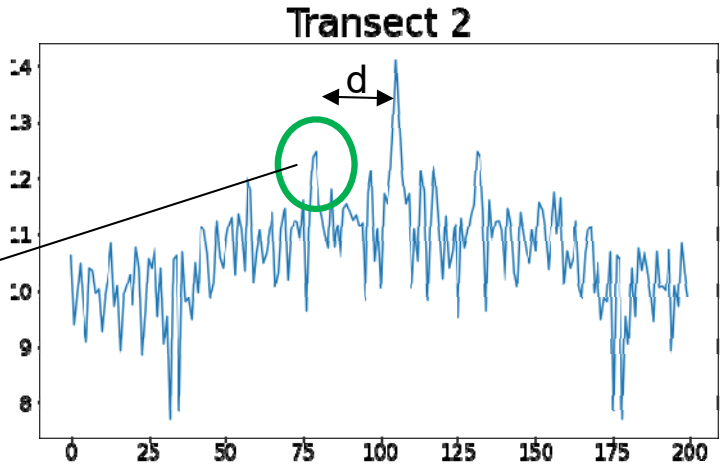


CORAL REEFS SPATIAL PATTERN



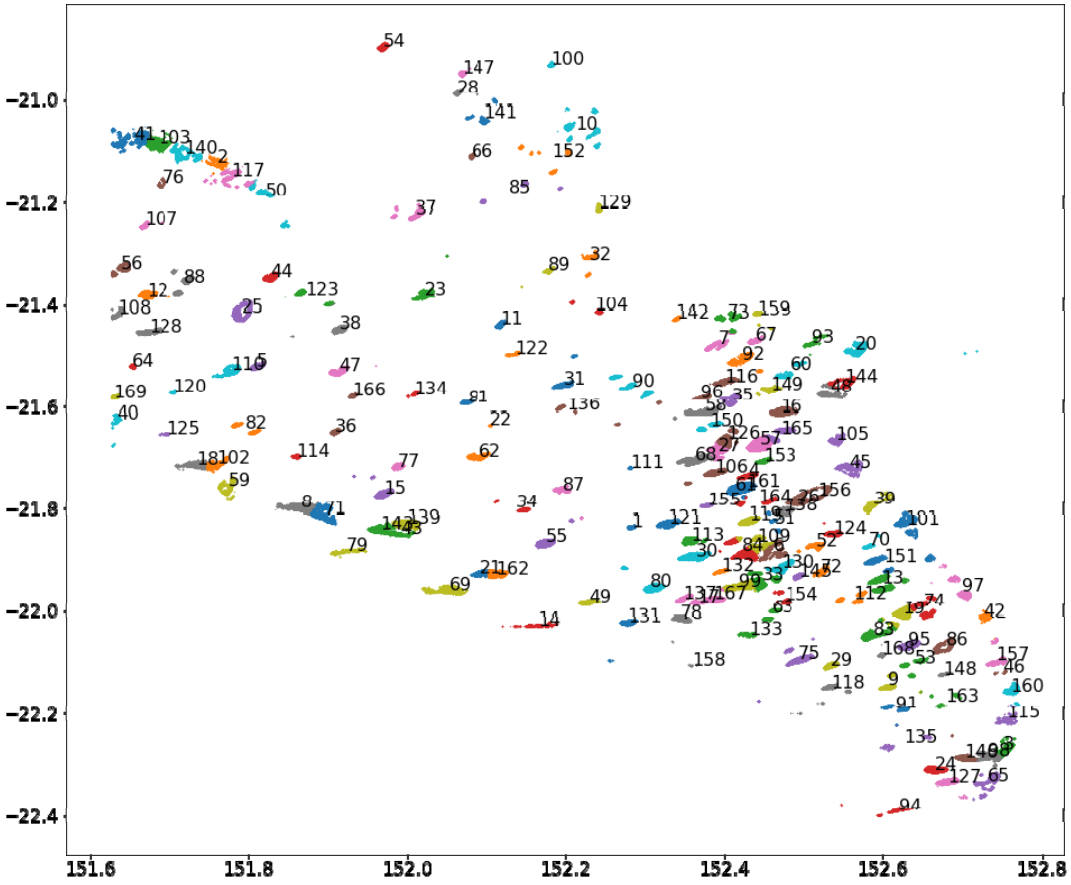


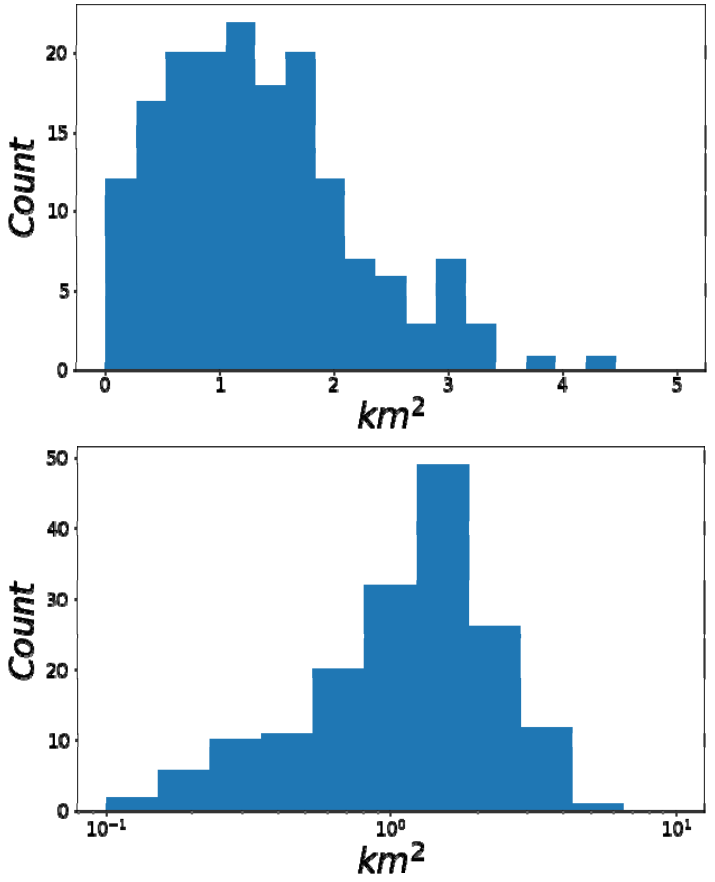




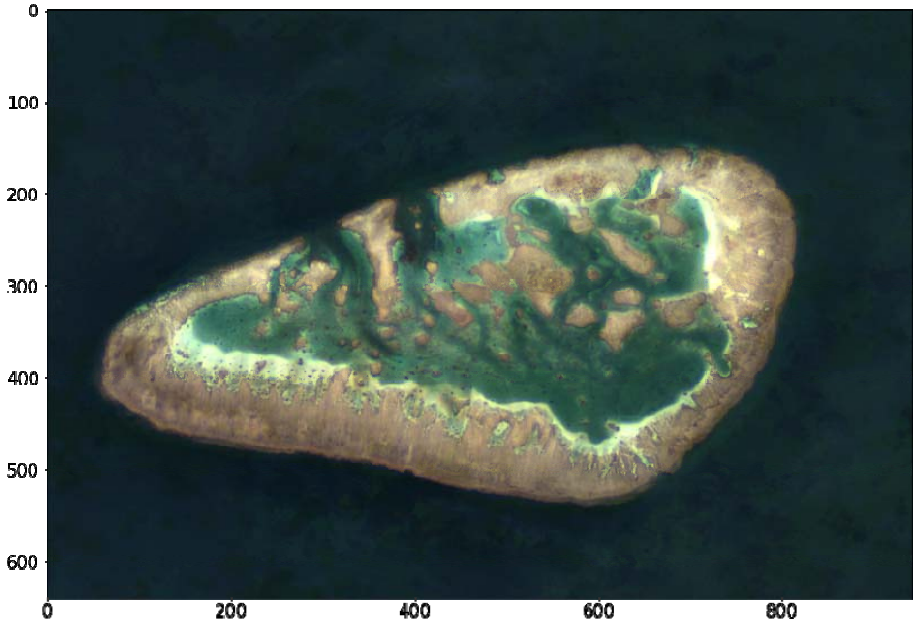
$$l_{pattern} = \frac{L}{d} \approx 2\,\mathrm{km}$$

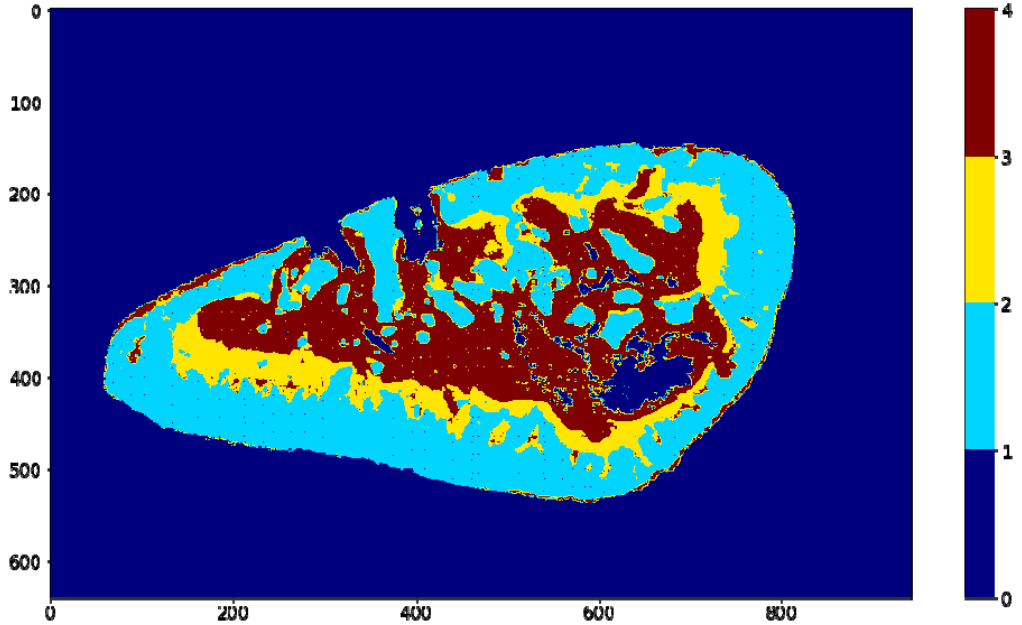
KMeans clustering using lat-lon values of identified coral pixels to compute the size distribution of atolls





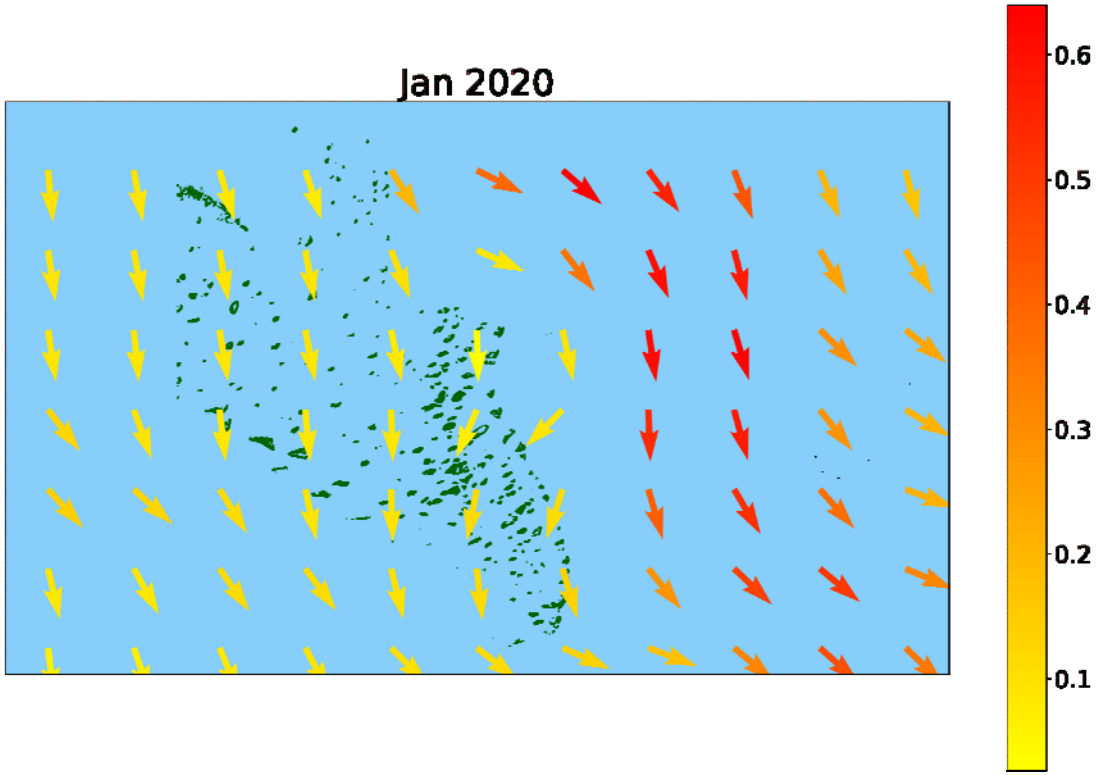
AI can be used to classify different benthic and geomorphic classes of coral reefs





Recently, a large collaboration of scientists, technologists and conservationists has allowed to map the world's coral reefs and produce the *Allen Coral Atlas:* https://allencoralatlas.org/

Data from ORAS5 database can be used to study the flow of water around atolls



- Coral reefs can be identified and classified from hyperspectral images like satellite imagery
    - This identification allows to extract several spatial features of coral reefs
- Reanalysis datasets with global coverage allow to determine the environmental conditions at wich coral reefs are subject
- All the extracted features can be combined with models to address how are coral reef formed and desing conservation plans

THANK YOU

for your attention