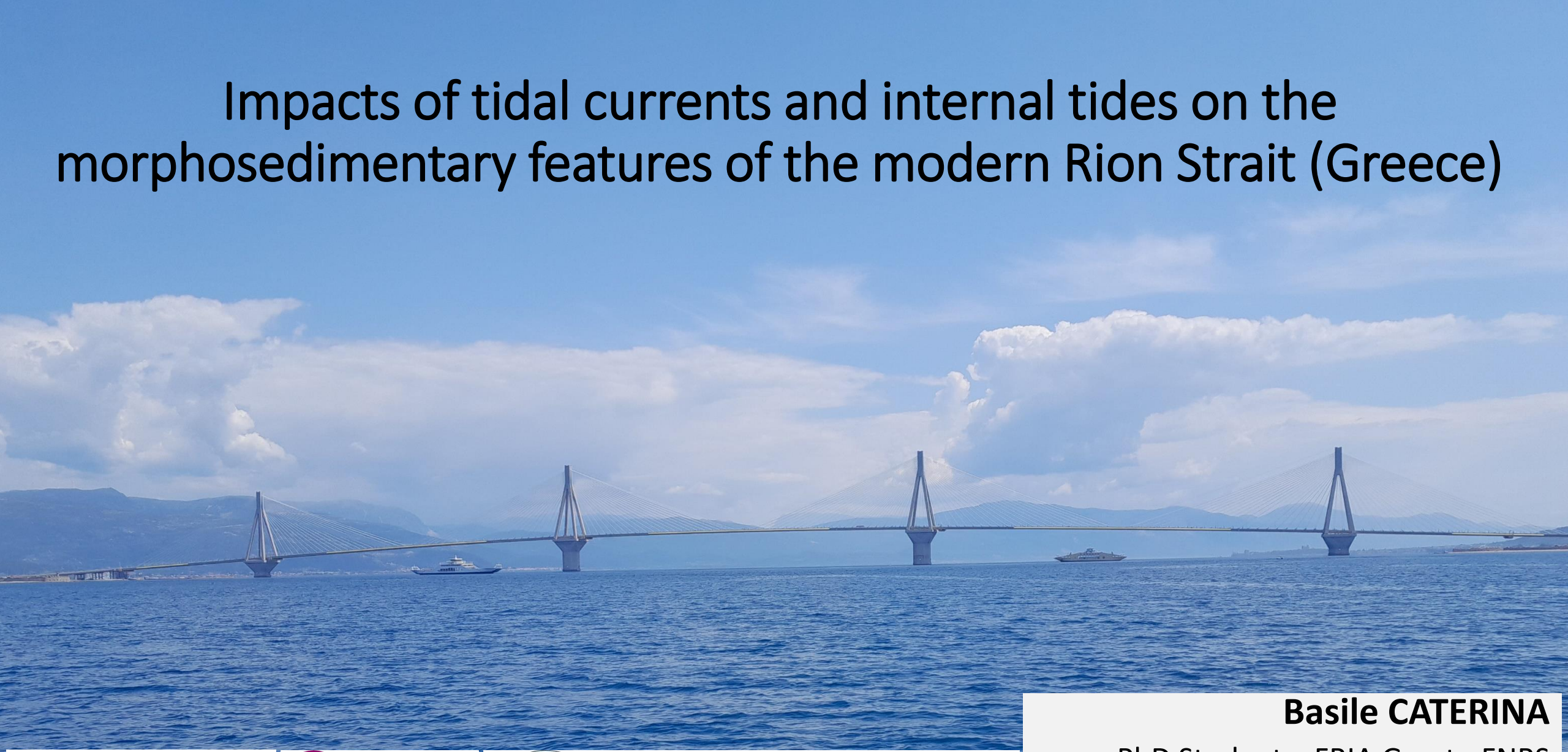
Impacts of tidal currents and internal tides on the morphosedimentary features of the modern Rion Strait (Greece)



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RCG 2023

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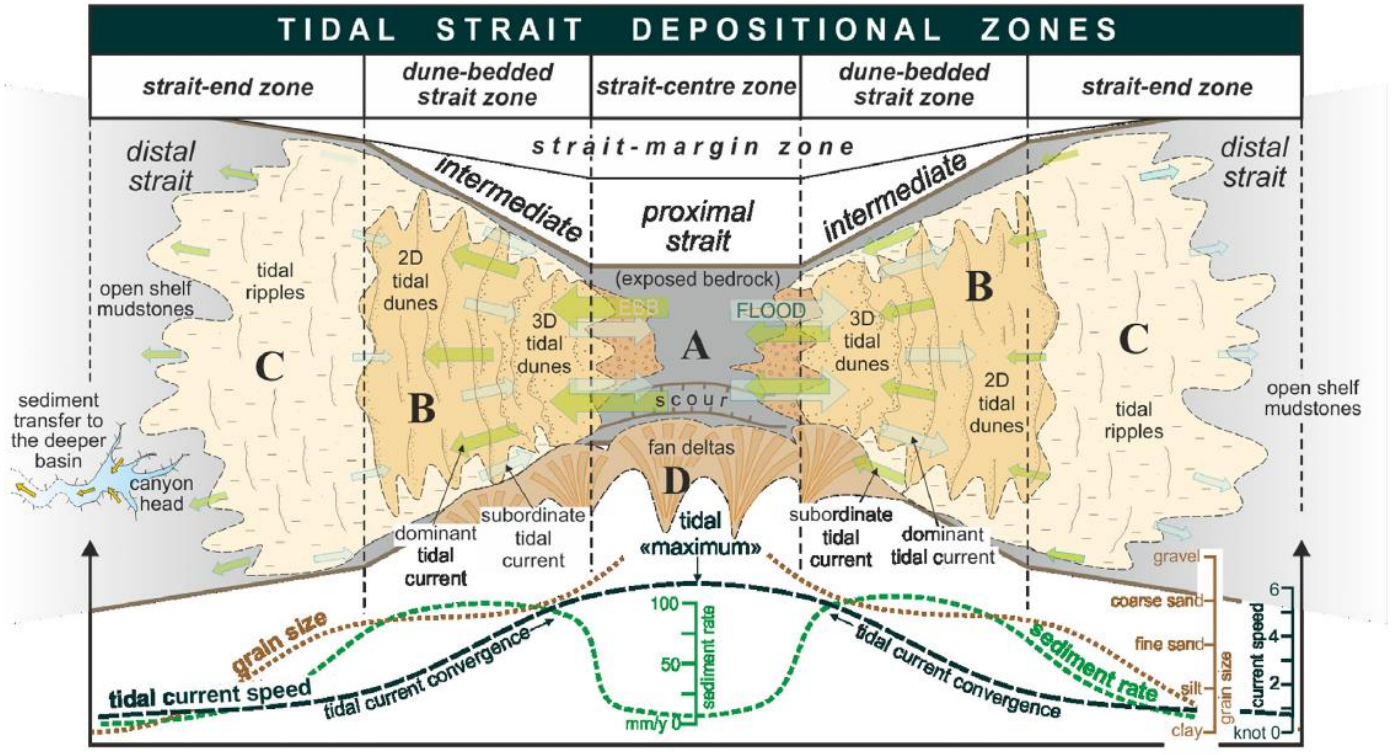
CAPPADOCIA, TÜRKİYE 12-14 September 2023

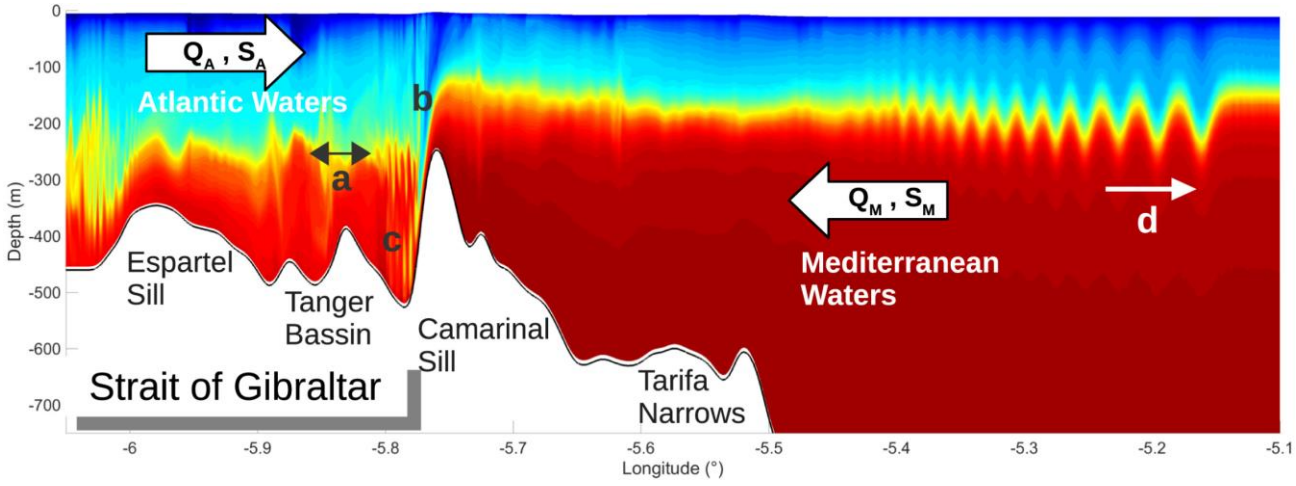
"Geoheritage and Geodiversity"

Tidal straits: dunes and tidal currents



Theoretical depositional model in a tidal strait from Longhitano et al., 2013

- Tidal depositional model: dunes near the sill and erosion in the sill
- Internal tide and internal waves with bathymetric thresholds



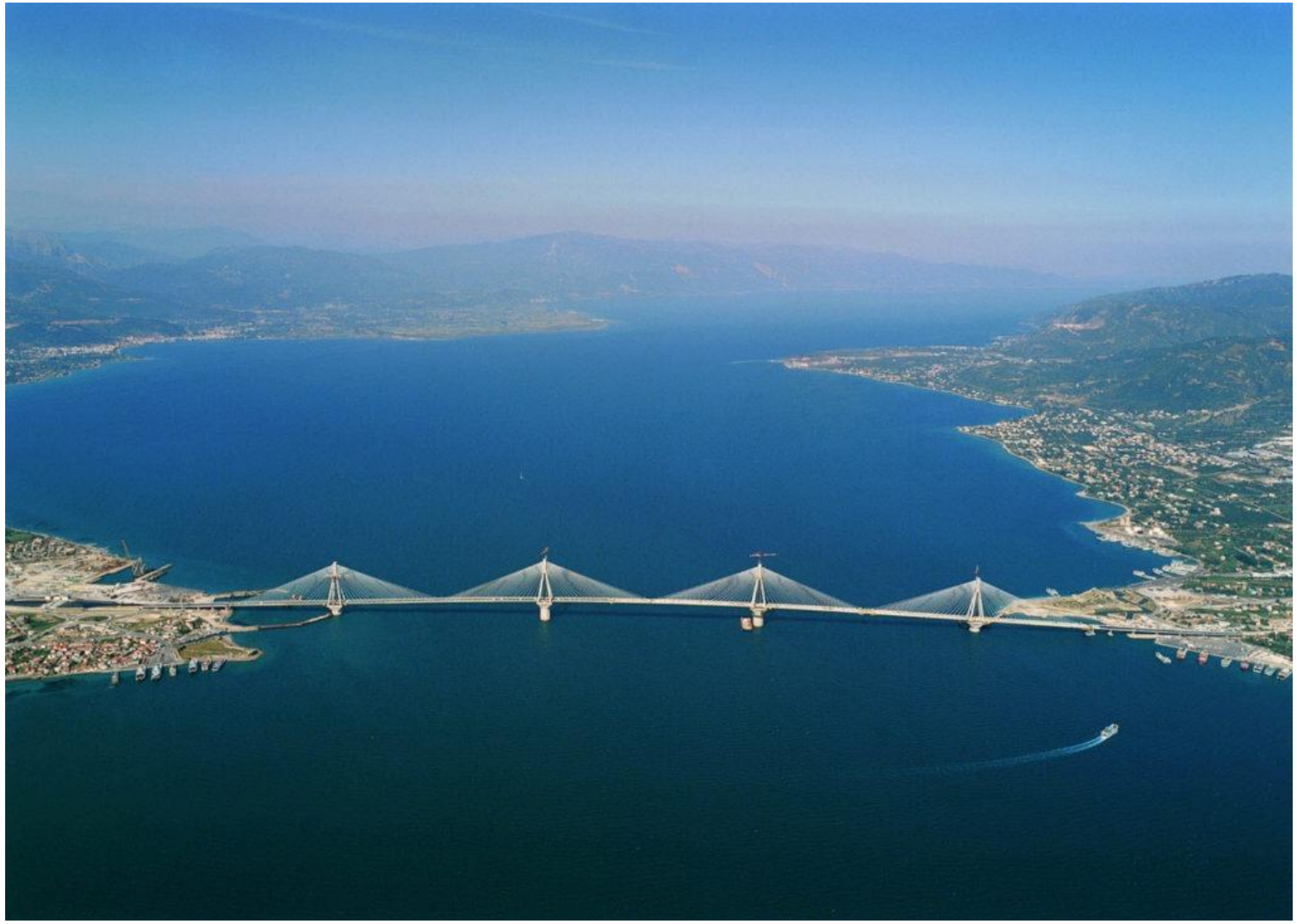
Internal wave in Gibraltar Strait (Hilt et al., 2022)

Connection of 2 different basins

- Patras Gulf: “wide” and shallow (~150 m depth)
- Corinth Gulf: “narrow” and deep (~900 m depth)
- Tidal strait dynamics in a microtidal context

Localization of the study area

Rion strait: small but still mysterious



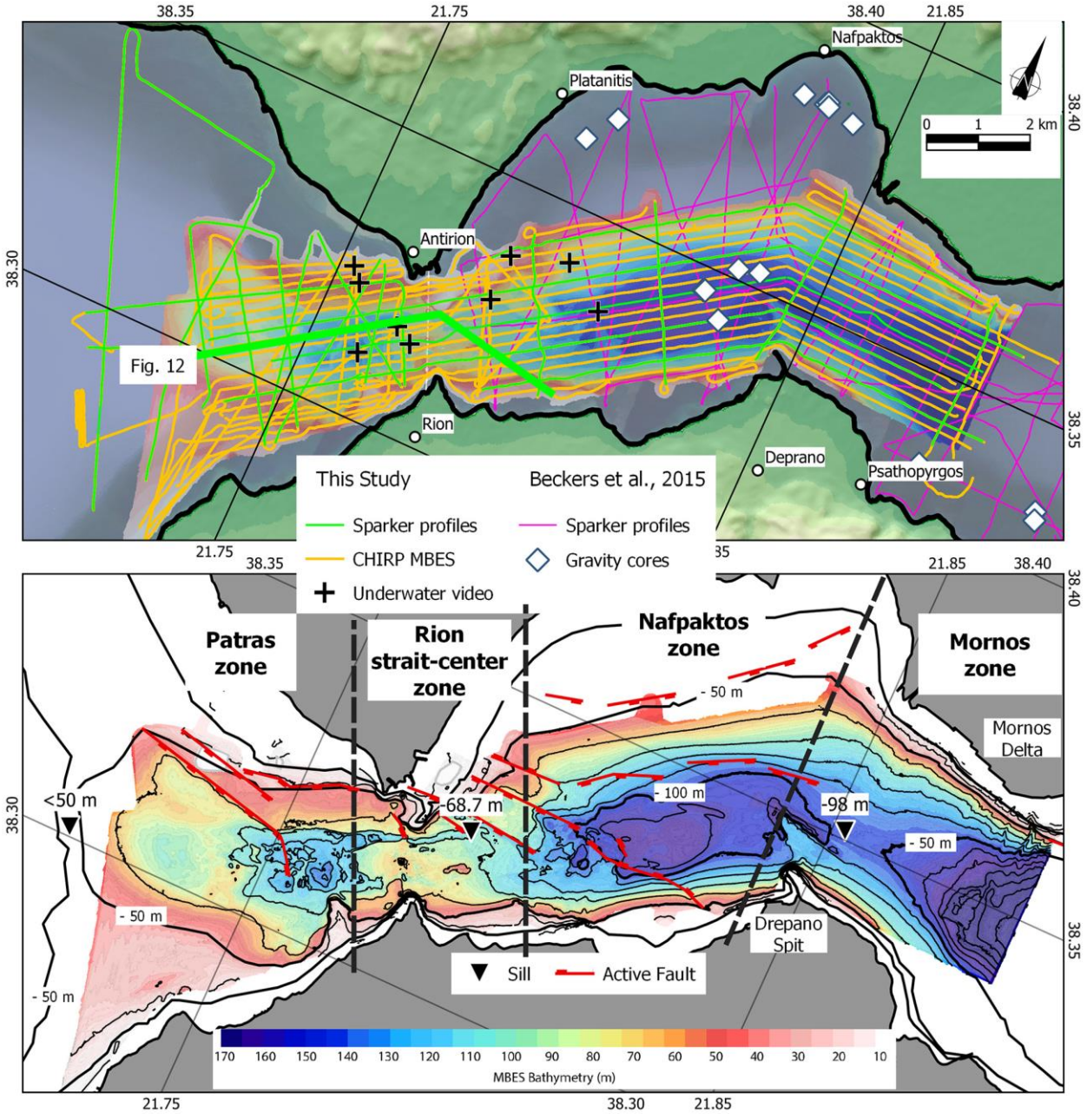
GEFYRA/NIKOS DANIILIDIS

- 2.5 km opening
- 70 m depth for the sill

→ Currents & circulation?

→ Deposits & morphology?

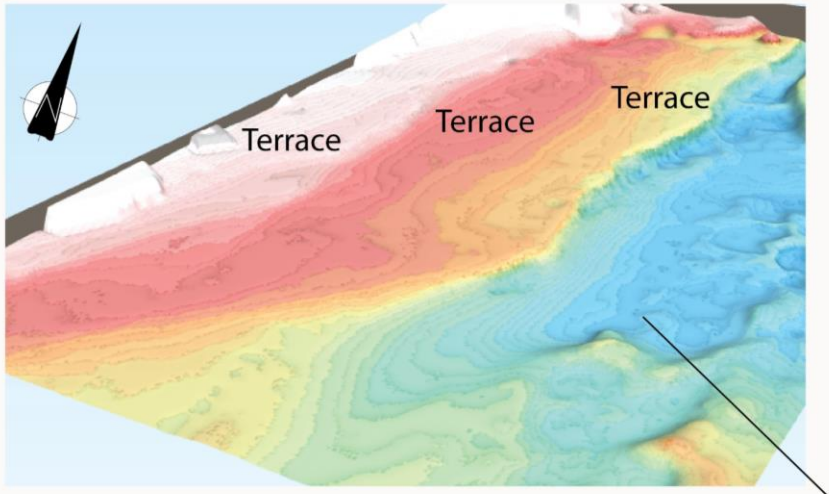
Measure currents and observe morphologies



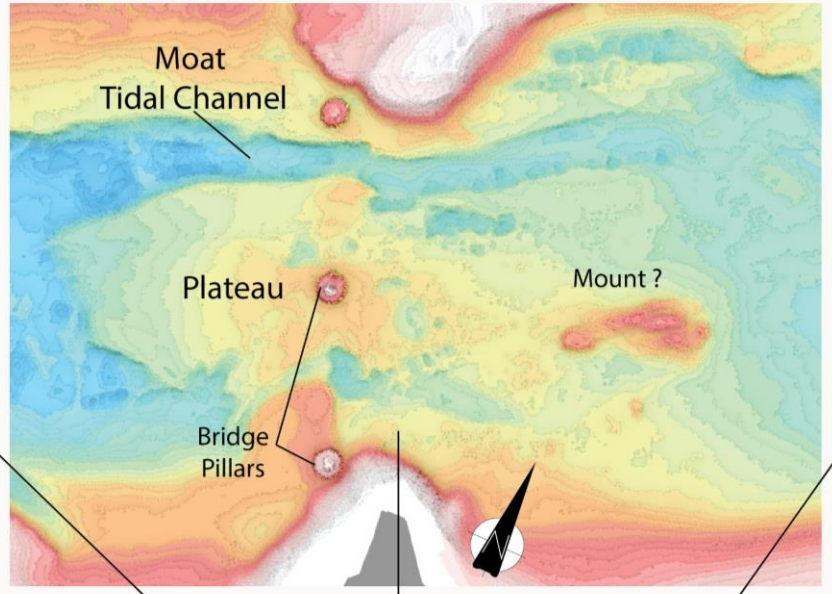
- Currents:
  - In-situ: CTD, ADCP
  - Remote sensing: CMEMS database, Landsat
- Morphologies:
  - Seismic profiles (CHIRP and Sparker)
  - MBES (High resolution bathymetry)

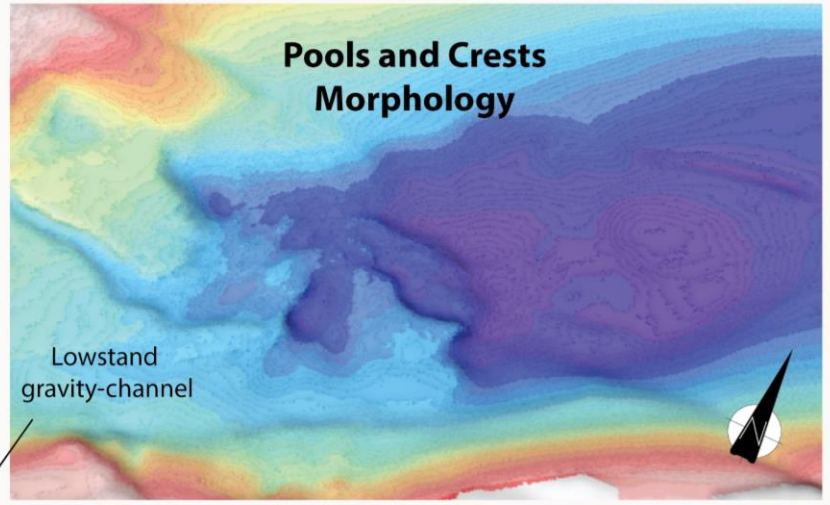
Map of all the transects with seismic and ADCP data. Fault and high-resolution bathymetry map of the Rion-Antirion strait (Rubi et al., 2022)

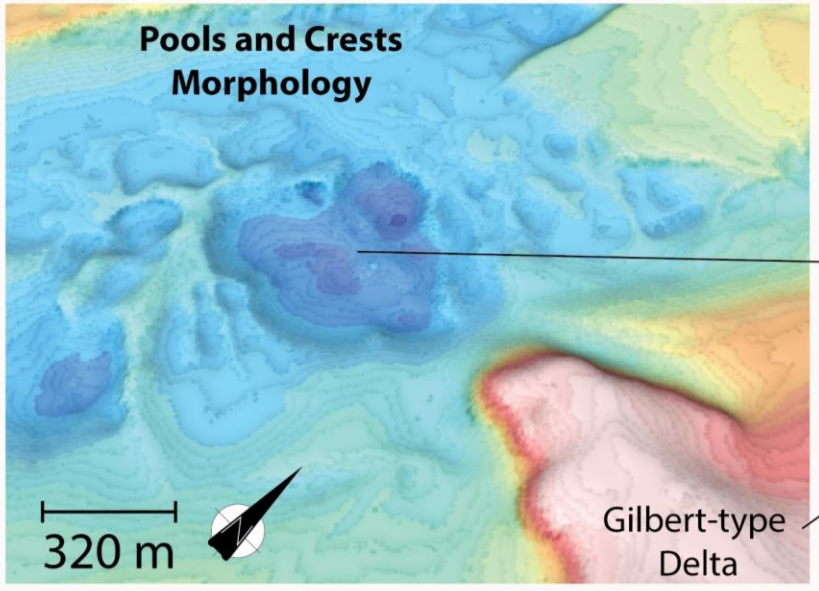
No dunes… too much erosion

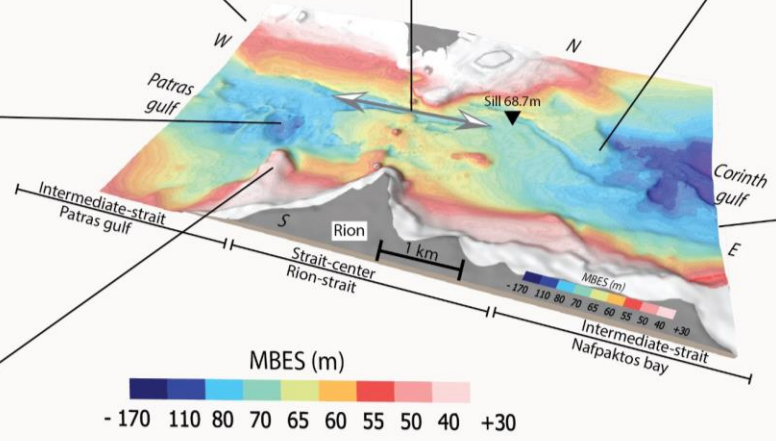


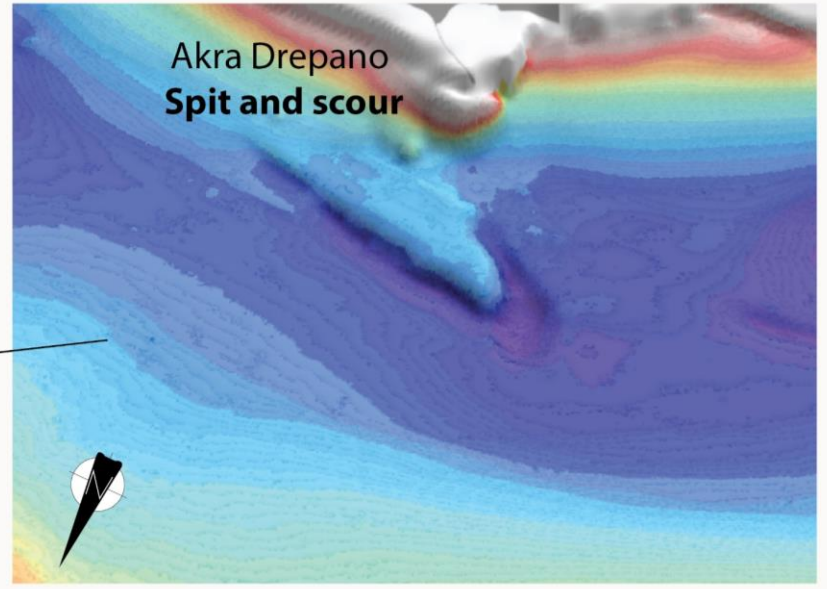
West Patras Gulf
Intermediate Strait



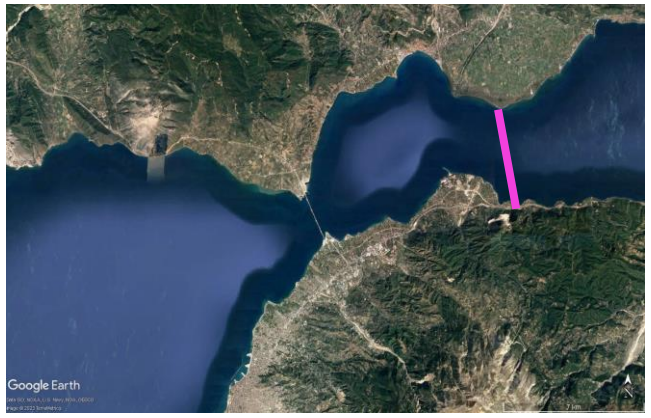


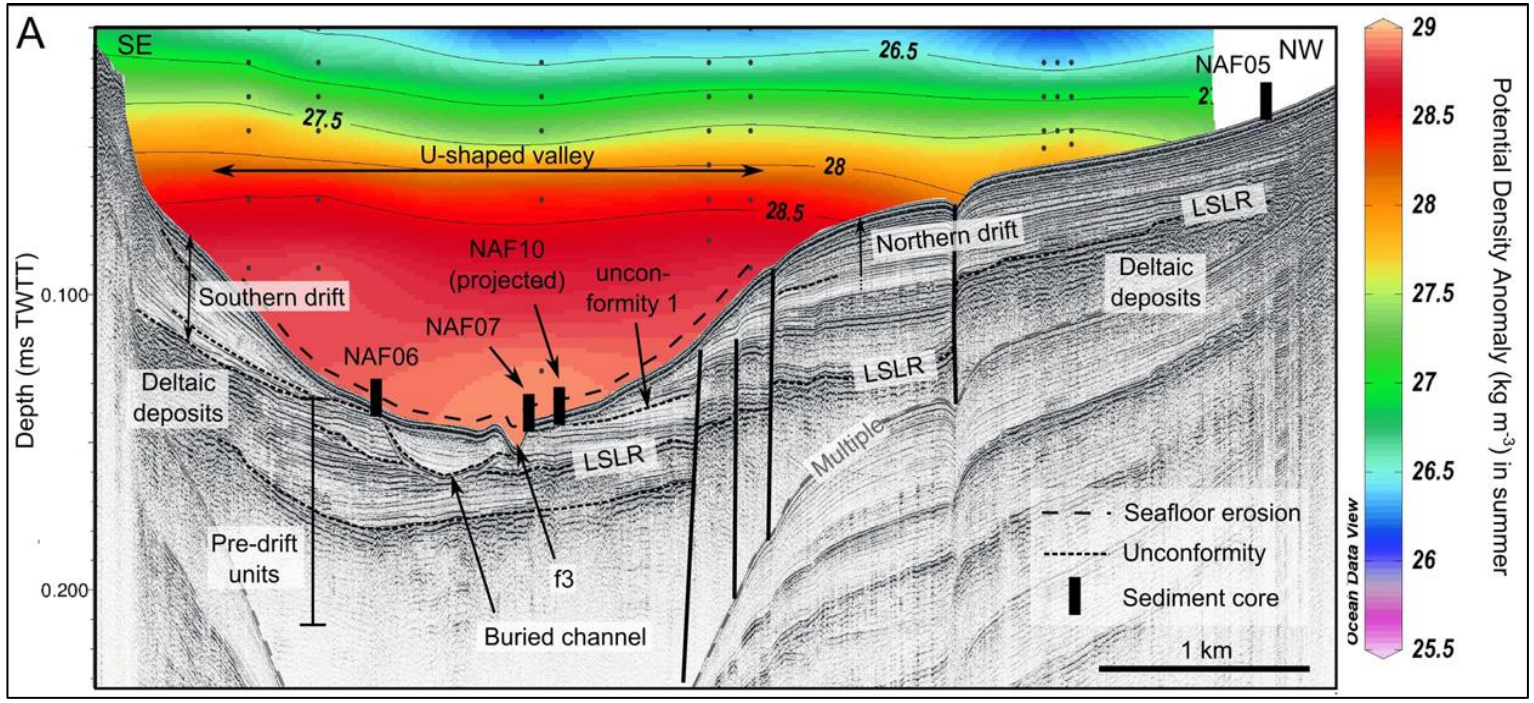






Plastered drifts on the slope





Density of the water displayed above seismic data in front of Nafpaktos area (Beckers et al., 2016)

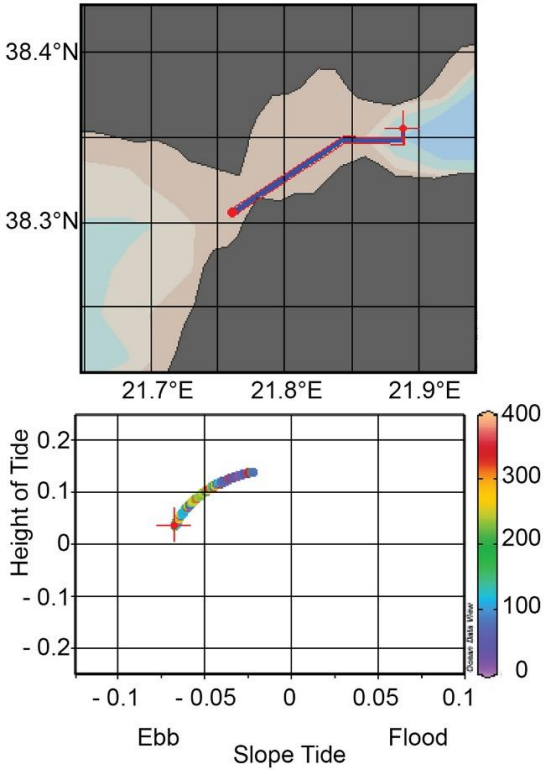
- Outside of the strait
- Deposits on the slope
- Erosion at depth

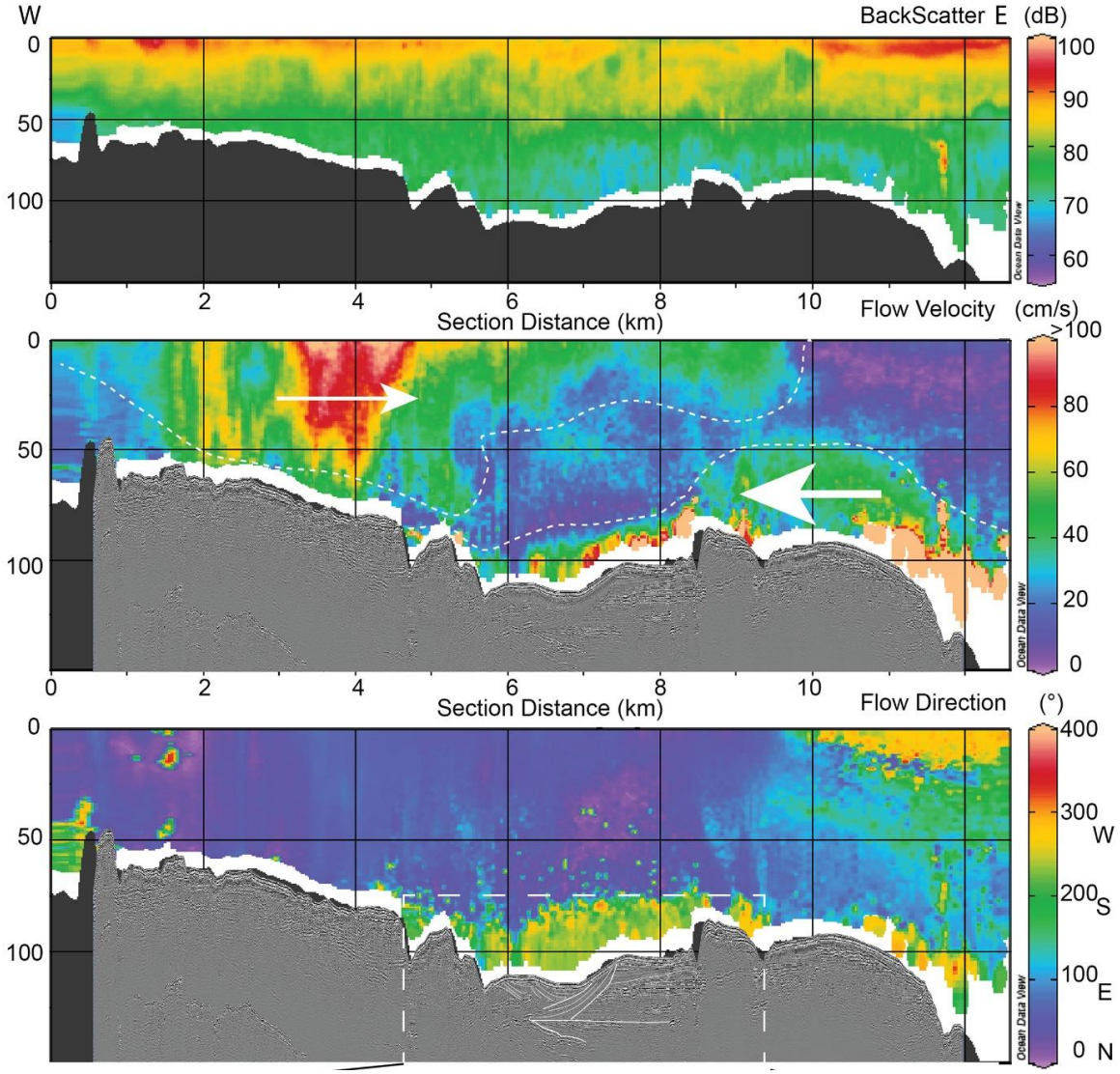
Evidence of an internal tide

Ebb tide

- Surface: towards Corinth Gulf

- Bottom:
  - internal tide due to a bathymetric threshold
  - High-velocity flow (up to 4m/s)



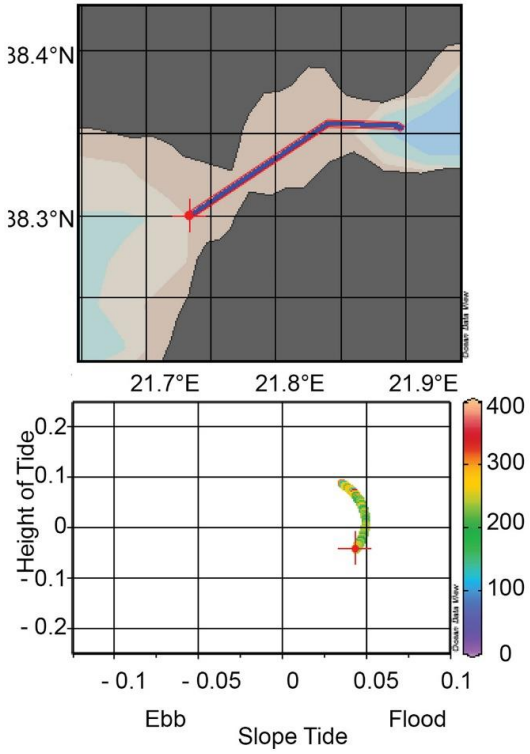


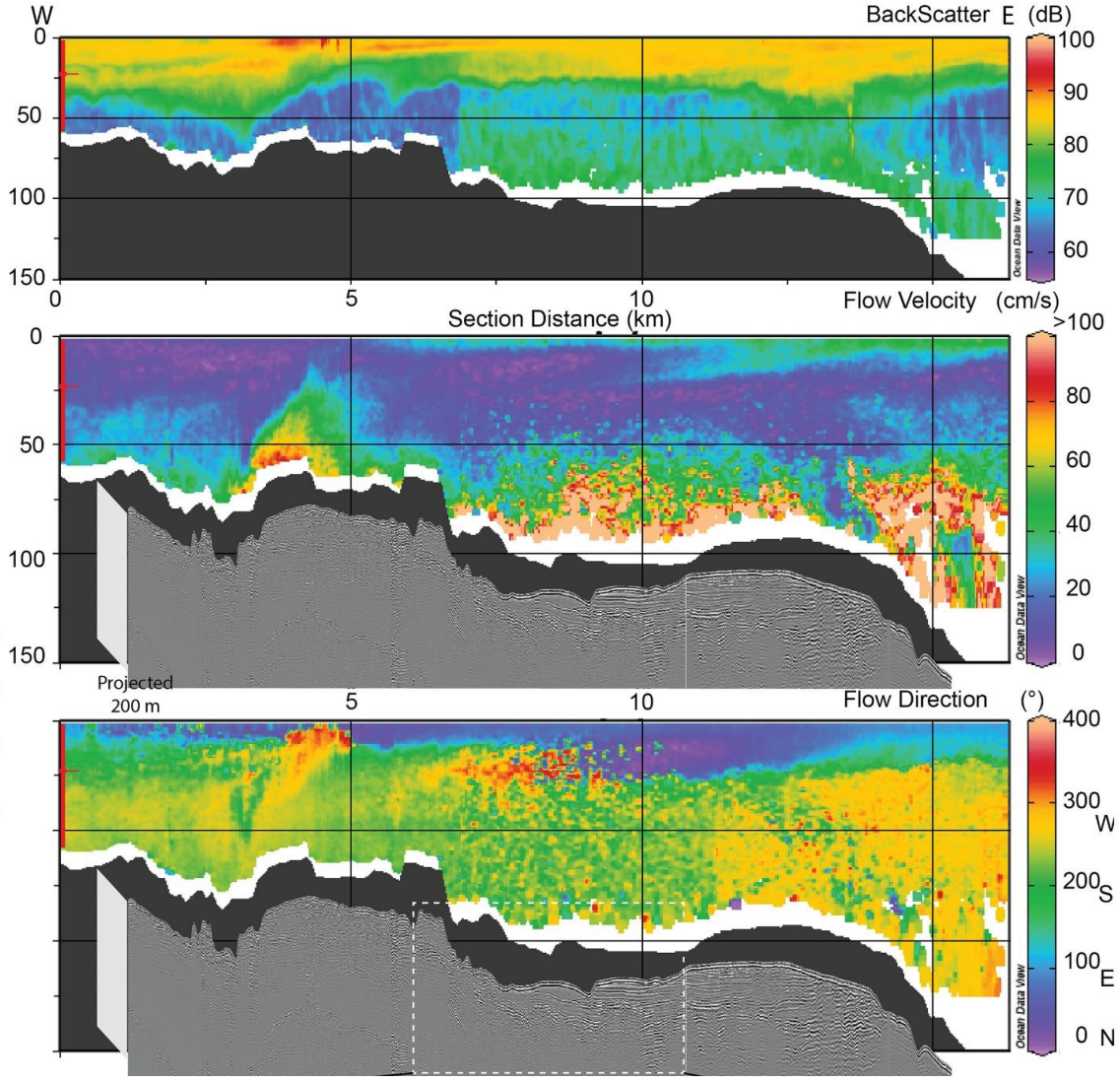
ADCP measurements during ebb tide on a longitudinal section in the Rion-Antirion Strait (Rubi et al., 2022)

Evidence of an internal tide

Flood tide

- Bottom currents overflow the sill
- Surface tide enhance the “bottom” tide

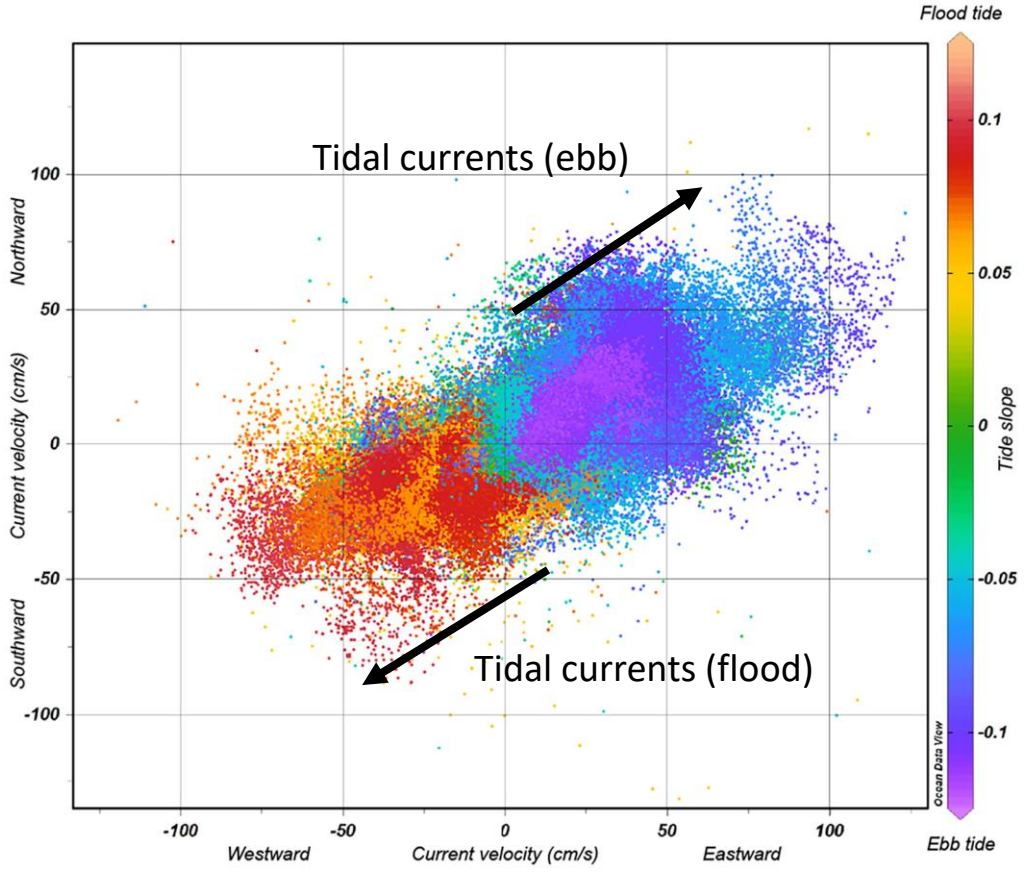




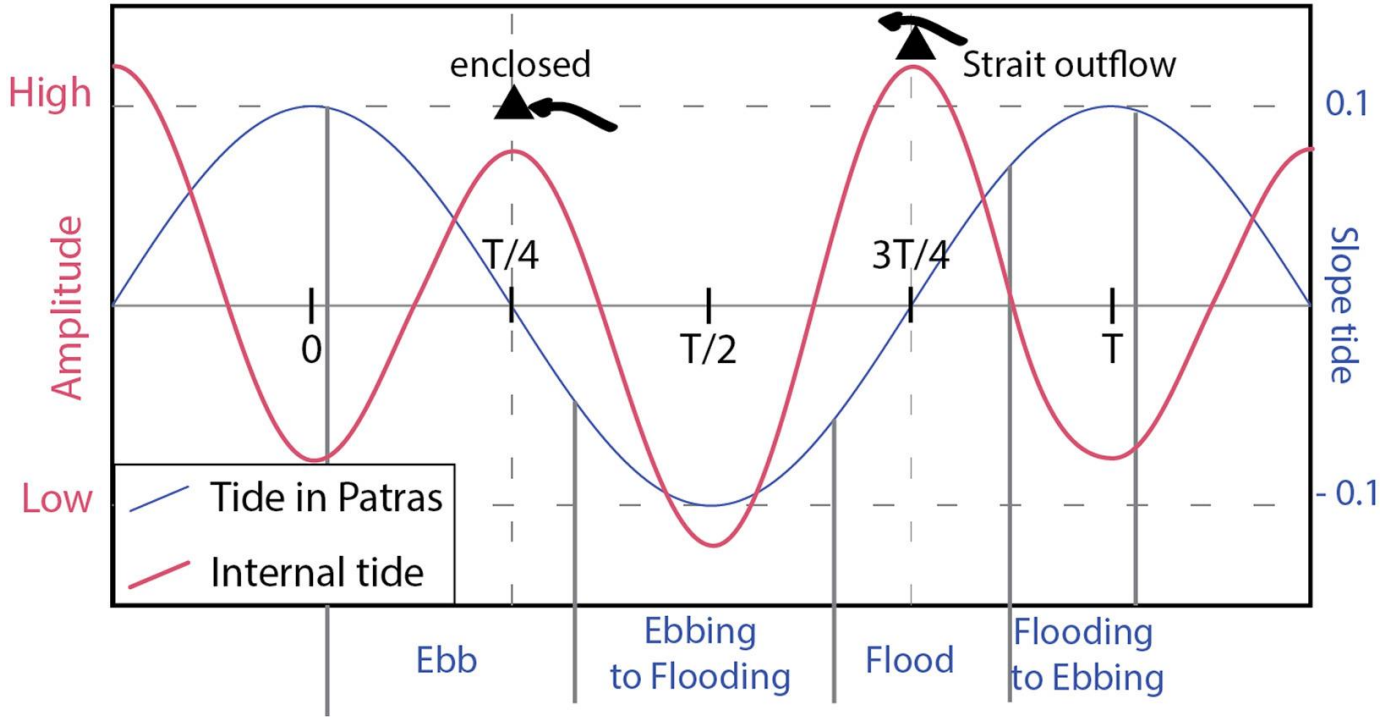
ADCP measurements during flood tide on a longitudinal section in the Rion-Antirion Strait (Rubi et al., 2022)

Tidal amplitude and direction

- 2 different frequencies in the tides: surface vs bottom

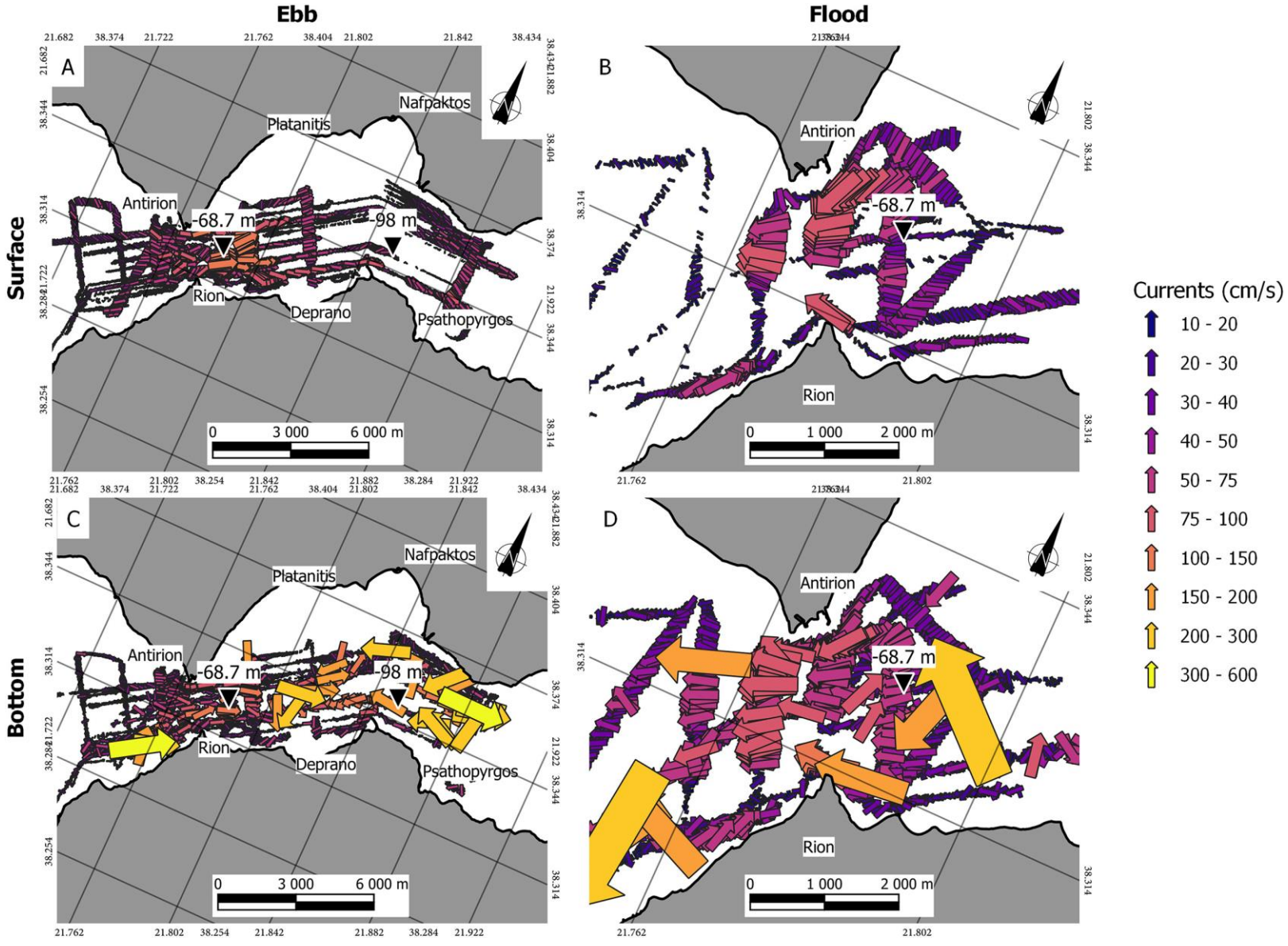


Main surface current direction & velocity vs tide slope based on ADCP data (Rubi et al., 2022)



Tidal amplitude and direction of the currents (Rubi et al., 2022)

High velocity current dynamics at the bottom



How does the internal tide work here?

- First path for answer:
  - During ebb, the bottom flow is limited to Corinth
  - Still during ebb, surface water from Patras are heating, enhancing the internal wave at the interface
  - During flood, the rising tide allow the overflow of the internal tide over the sill
- Second path for answer:

  ROMS modelling

Current velocity during ebb and flood phases, at the surface and at the bottom based on ADCP data (Rubi et al., 2022)

Regional Oceanographic Modelling System

- Forcings: Bathymetry (GEBCO), Oceanography (CMEMS), Winds (ECMWF), Tides (TPXO)
- Actual conditions verified through satellite data/in-situ measurements

Technical details

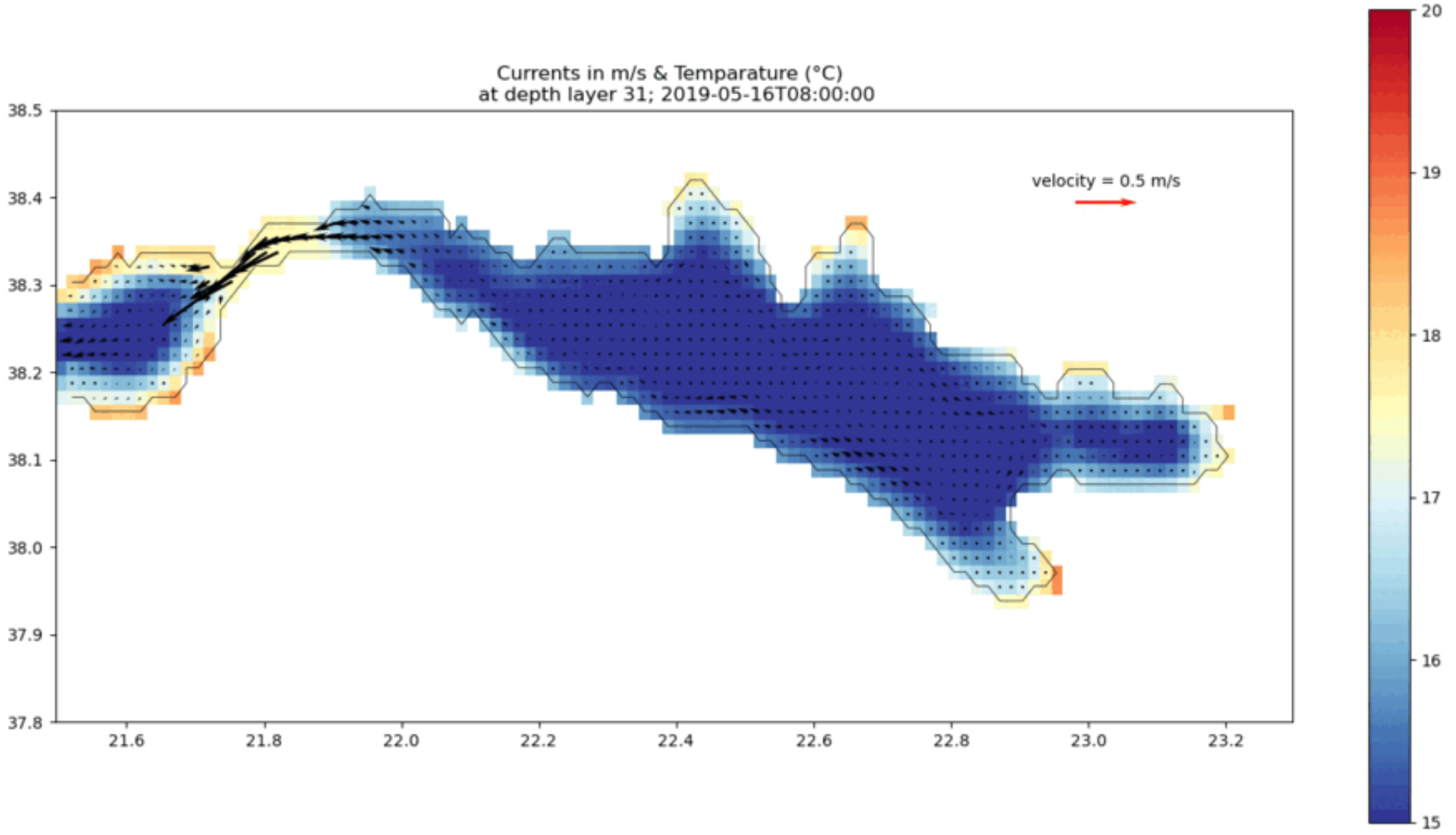
- Reduced bathymetry for the Corinth Gulf (4,4); High Resolution bathymetry for the strait (1,1) ~450 m
- Corrected bathymetry (HR bathymetry)
- Forcing at the boundaries → only 1 open at West (Ionian Sea)
- Masks : lakes and Aegean Sea
- May 2019 and 1 year (01/01/2019 to 01/01/2020)
- Adaptative depth: 32 layers

Tidal currents at depth: funnel effect

- From bottom to top

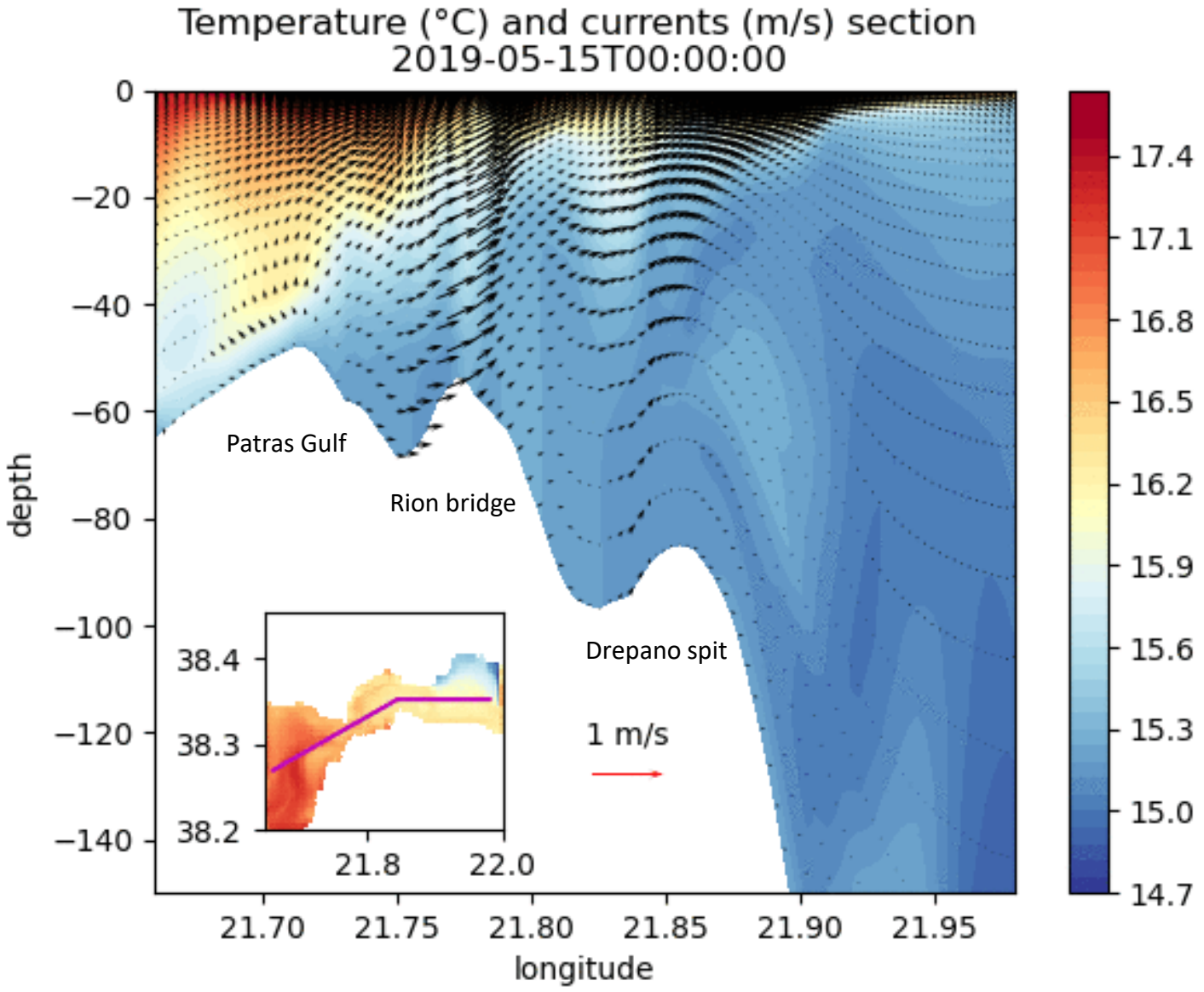
→Stronger currents appears at mid-depth in the strait !

→Funnel effect from the shape of the 2 Gulfs



Tidal currents in the strait

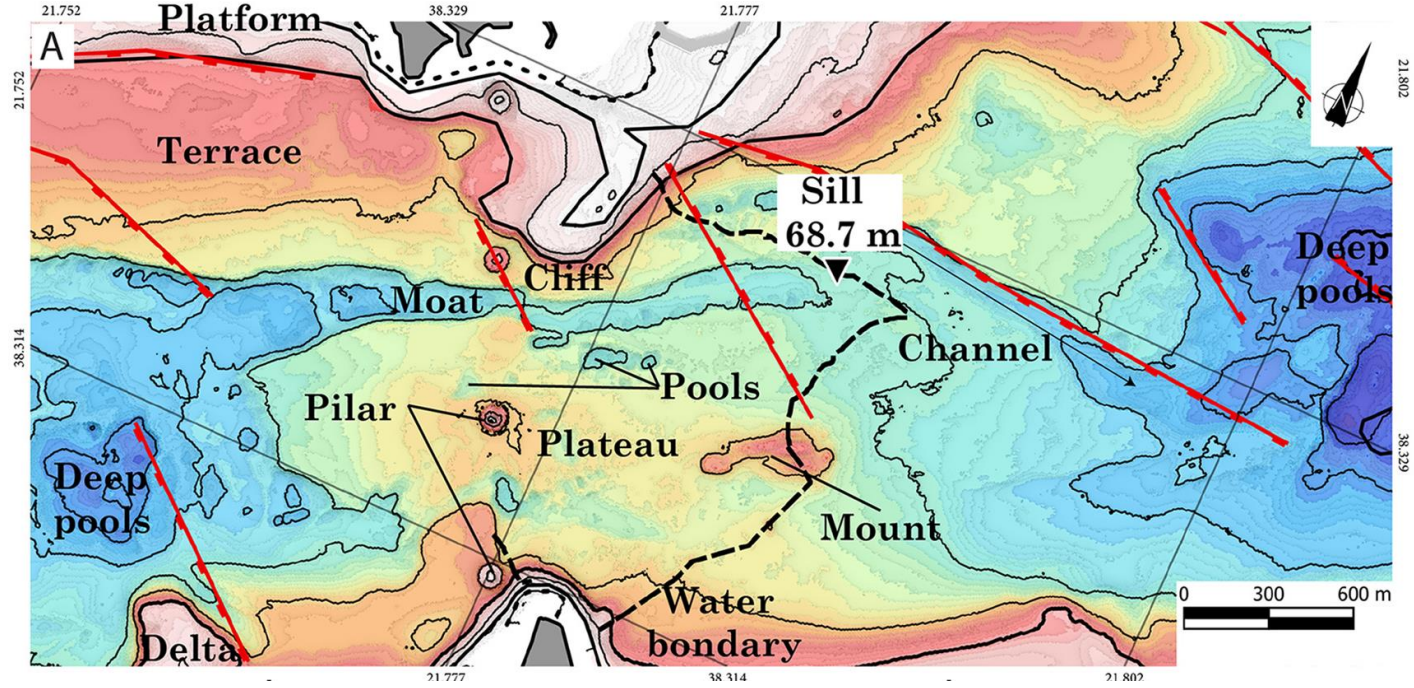
- “High” resolution bathymetry (~450 m/pixel)
- Funnel effect
- Strongest currents at the bottom of the Rion-Antirion bridge explain the erosion
- Differences in phases between surface and bottom tidal currents

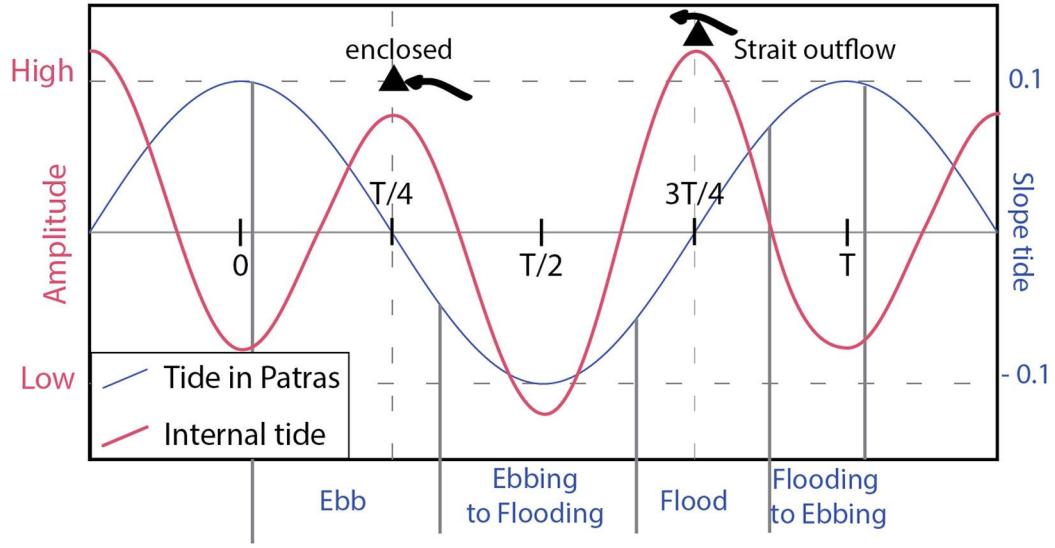


Erosion & internal tides

Reminders:

- No dunes but **erosive** features
- Active hydrodynamism & funnel effect: velocities > **1m/s**
- **Internal tides** frequency ≠ tide frequency
- Investigations for the origin of these internal waves





Interpreted bathymetry around Rion-Antirion strait & Amplitude of the tide and internal tide in the Strait (Rubi et al., 2022)

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Thank you for your attention

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