Modelled Diurnal Oscillations around Saint Pierre and Miquelon Islands

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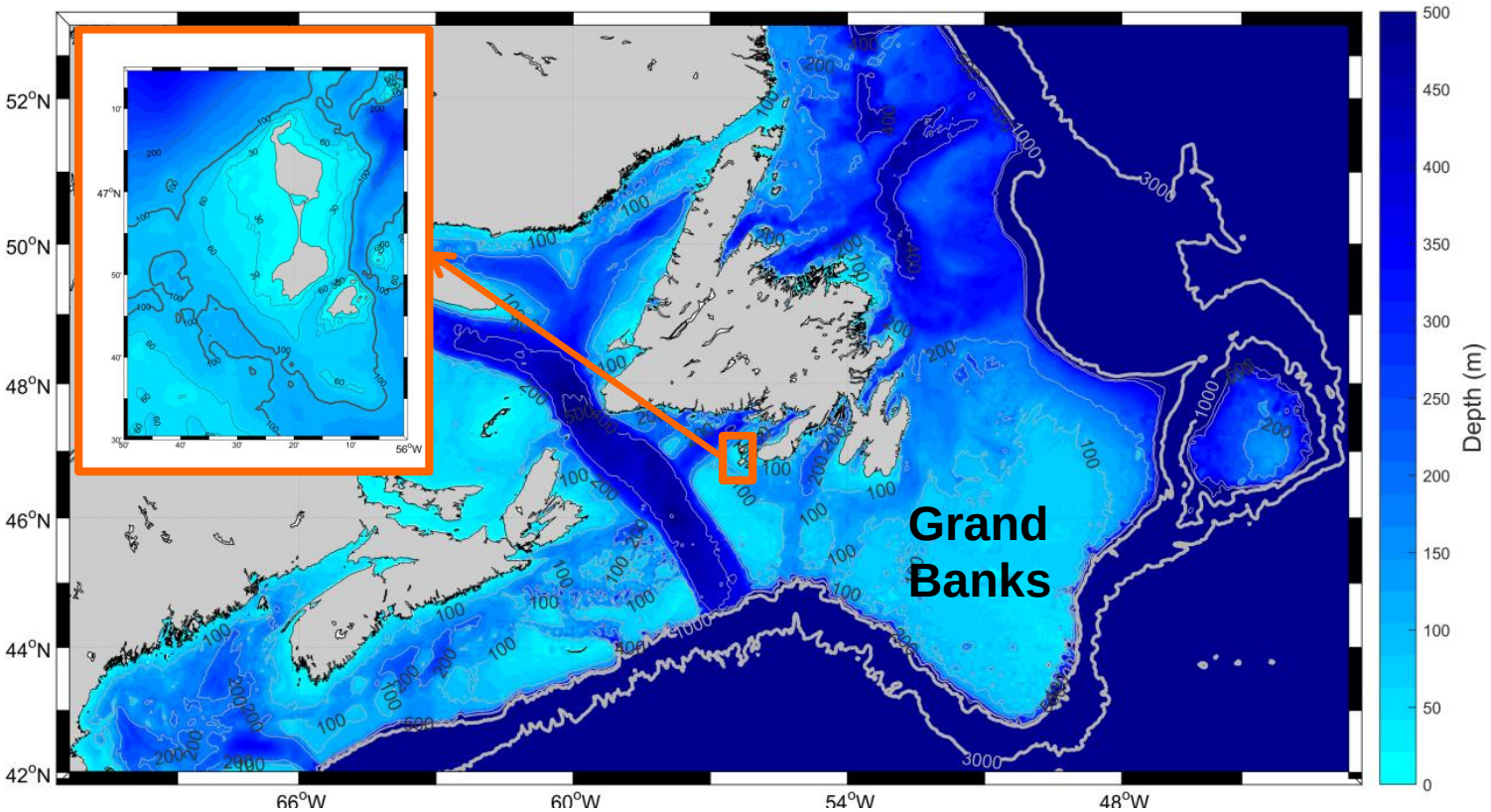
Plan

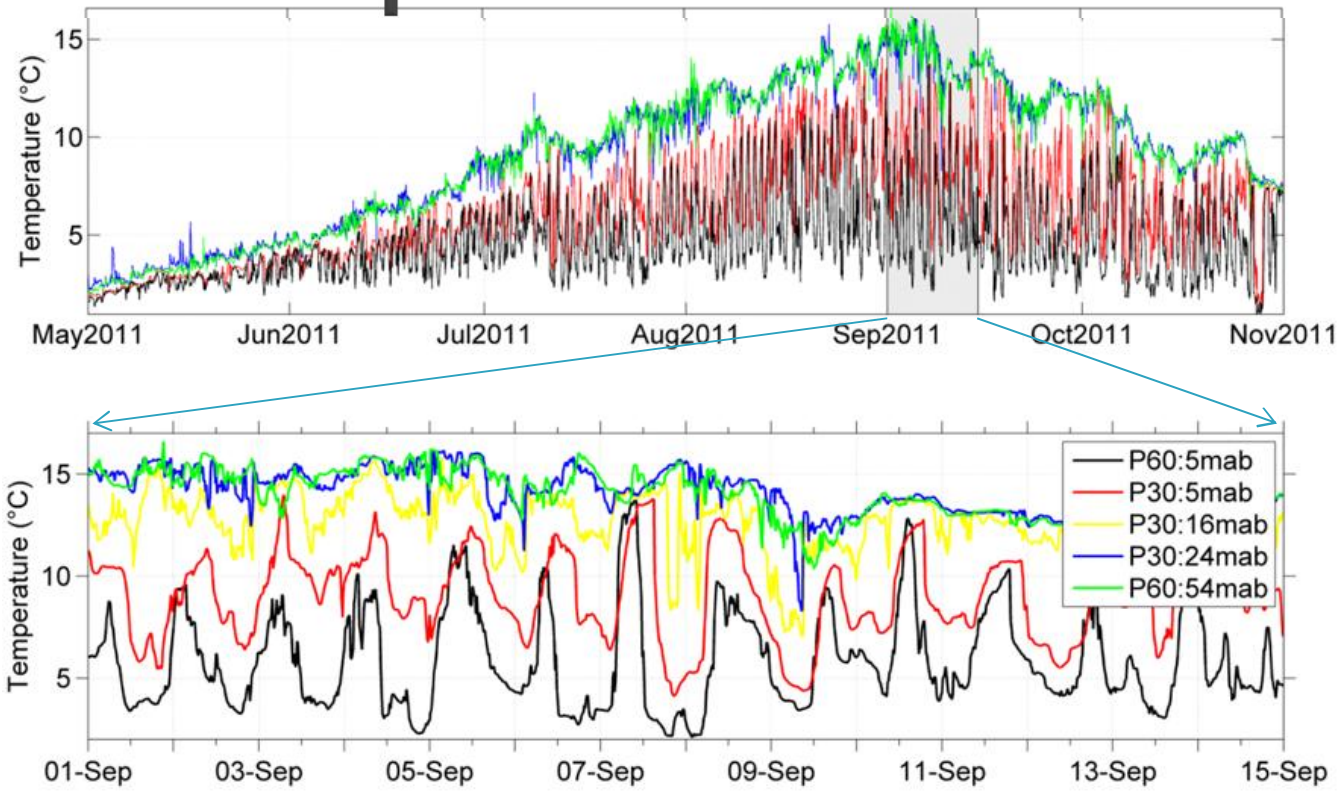
- Physical setting
- Measurements in the water column
- Modelling experiments
- Preliminary results
- Perspectives

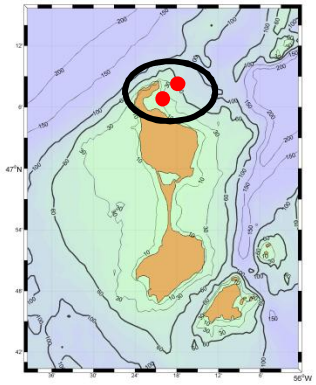
Area of study



- Seasonal stratification
- Semi-diurnal tide on the sea levels
- Diurnal anomaly of the current around Grand Banks and near Saint Pierre and Miquelon (SPM) (Xu and Loder 2004)

First temperature measurements (2011)

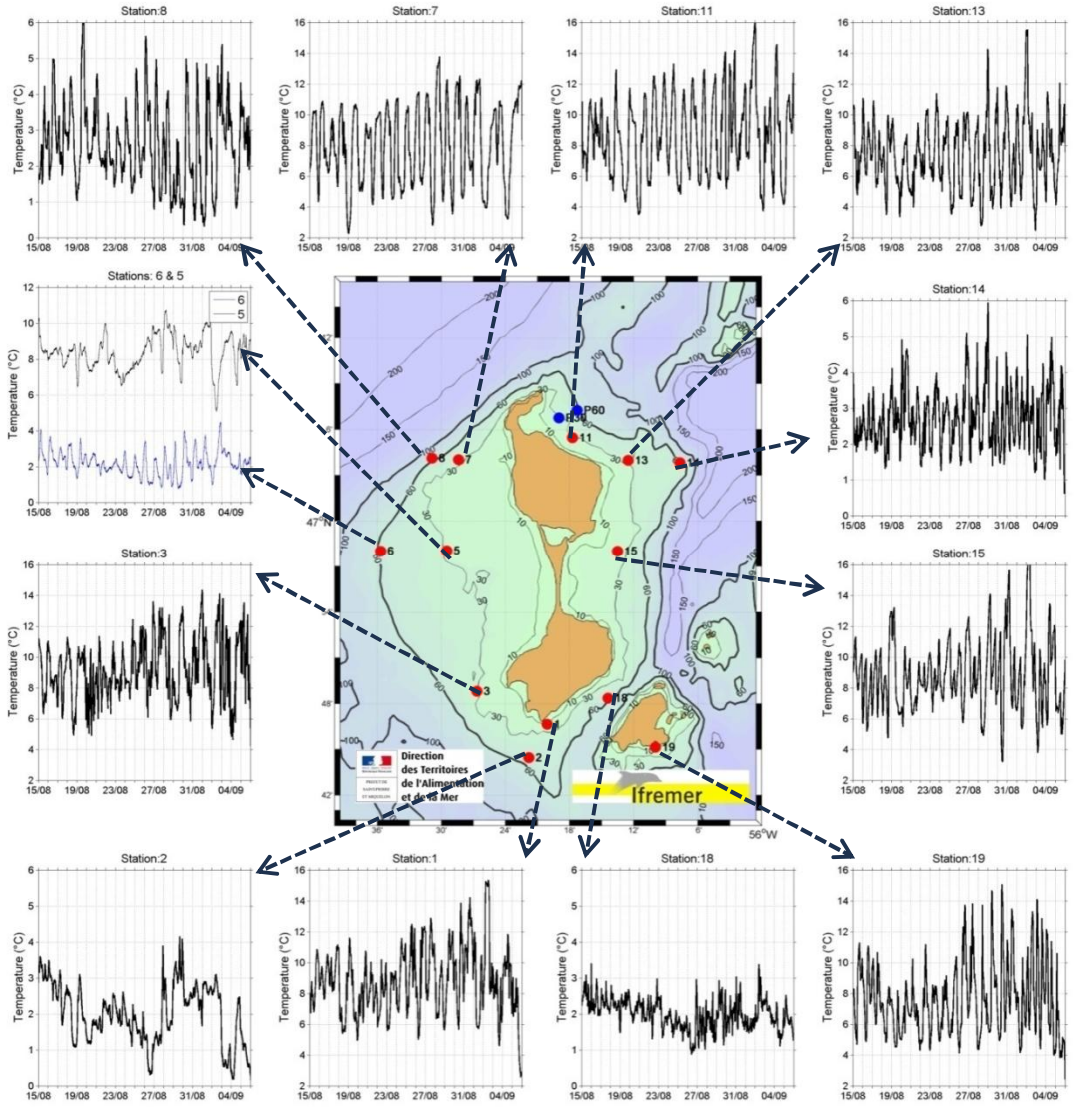




- Two thermistor moorings P30 (30m) and P60 (60m) in Miquelon Bay:
  - Surface temperature (blue & green curves) -> **seasonal cycle**
  - Near bottom temperature (red (30m) black (60m) curves): **Strong Diurnal oscillations during stratified period**
  - Amplitude reaching 11.5°C.

Lazure Pascal, Le Cann Bernard, Bezaud Marion (2018). **Large diurnal bottom temperature oscillations around the Saint Pierre and Miquelon archipelago**. *Scientific Reports*, 8(1), 13882.

Bottom temperature measurements on the shelf around the archipelago (2015)

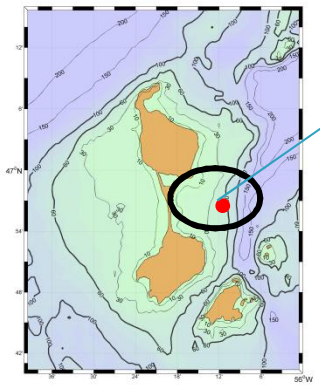


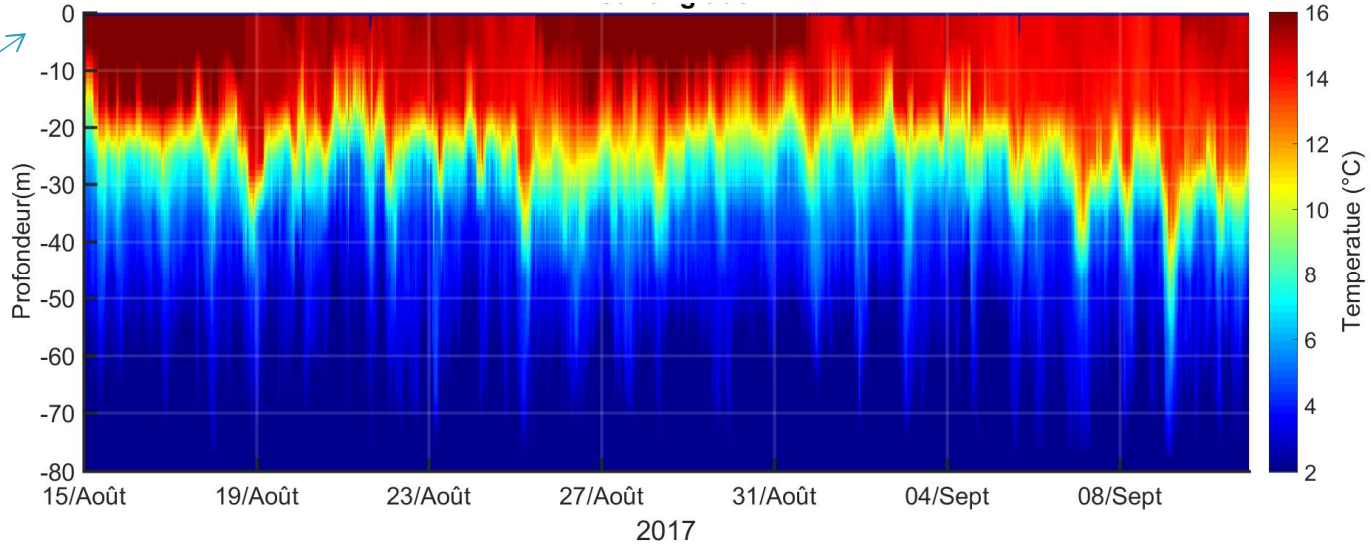
- 13 moorings at **30 and 60 m depth** (15/08 – 04/09/2015):
  - Bottom temperature oscillations.
  - Large range of temperature.
  - Dominant Periodicity : **diurnal** (01 tidal component ~26h)
  - ω < f (=2.pi/17h) subinertial oscillations

Recent publication (based on observations) :
- **nearly resonant for island-trapped waves**
-Clockwise propagation
-**Evidence of an azimuthal mode 2 pattern** (2 wavelengths)

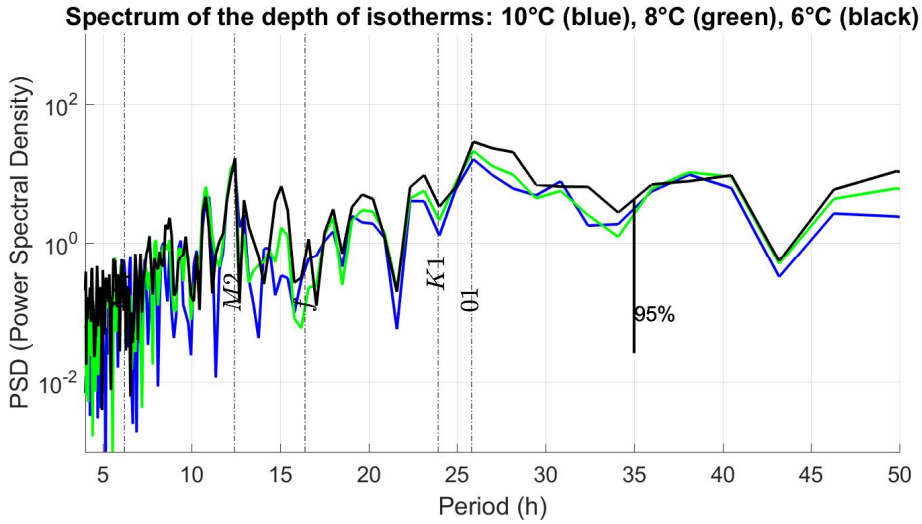
(Lazure et al. 2018)

Recent measurements (2017)
Time evolution of the vertical structure of temperature

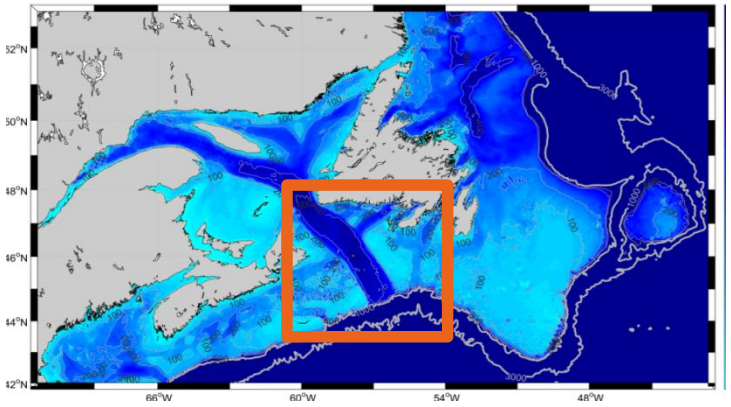


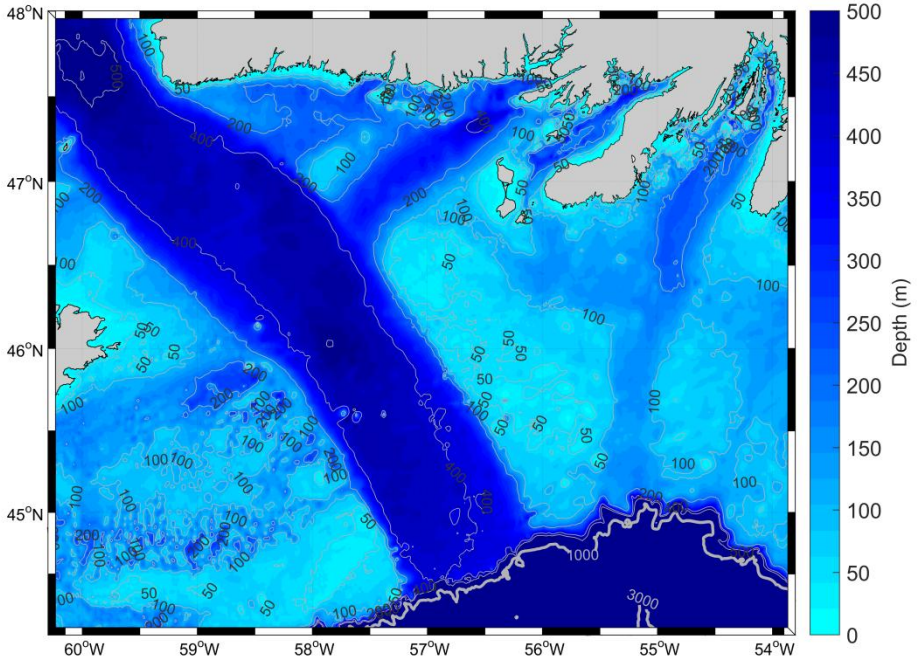


- Summer stratification
- Vertical range reaching 20 m.
- diurnal oscillations of the isotherms

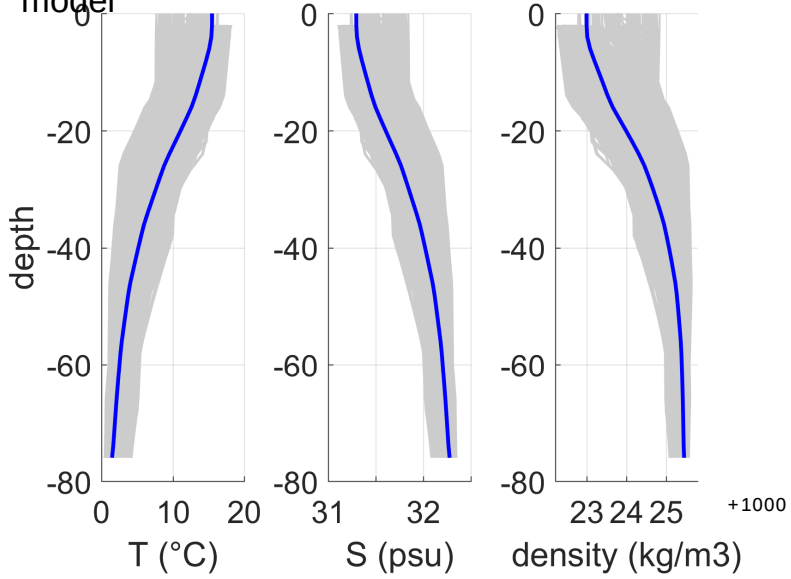


Model configuration



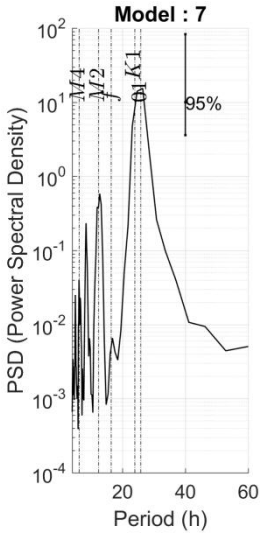


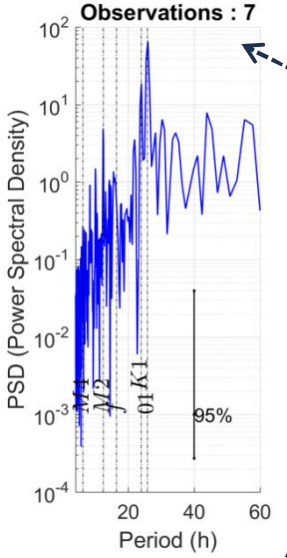
- 2D regional model (resolution ~2km)
  - Open boundary condition FES 2004 (Lyard 2006).
- Barotropic tide validated (with tide gauges and ADCP).
- 3D local model (resolution ~500 m 30 sigma levels)
  - Schematic stratification
  - Open boundary conditions provided by regional model

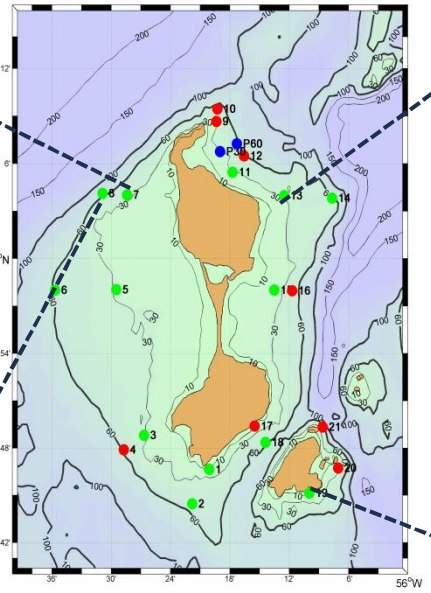


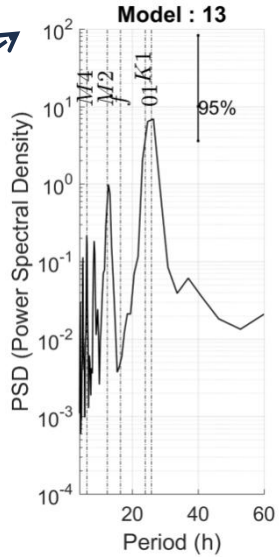
- Modelling strategy (MARS model)
  - Run **without meteorological forcing**
  - Realistic tide ->good agreement with data (sea levels).
  - **For CTW investigation : simulation with O1 tidal component only**

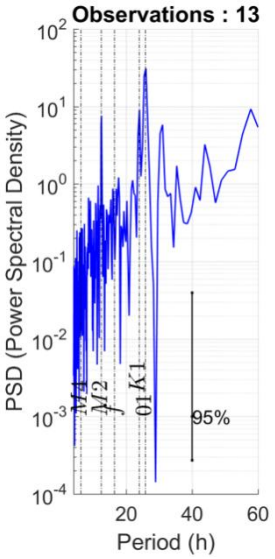
Bottom temperature spectra Observations/ modelling (realistic tide)

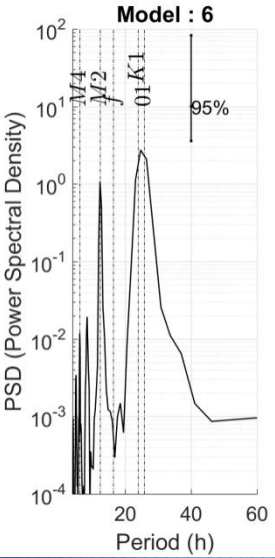


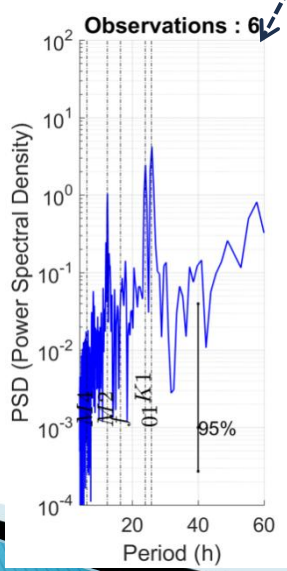


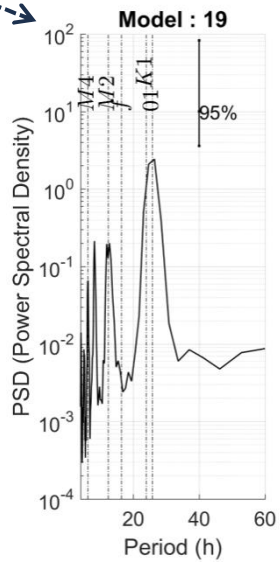


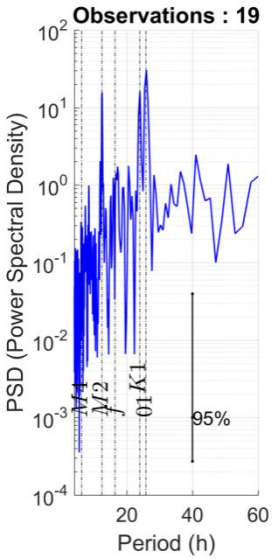












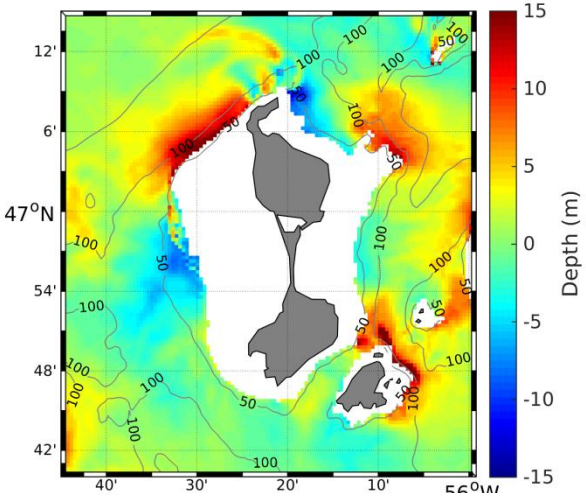
Dominance of O1 component, intensification of M2 component along the eastern side.

Model reproduces well the bottom temperature spectra.

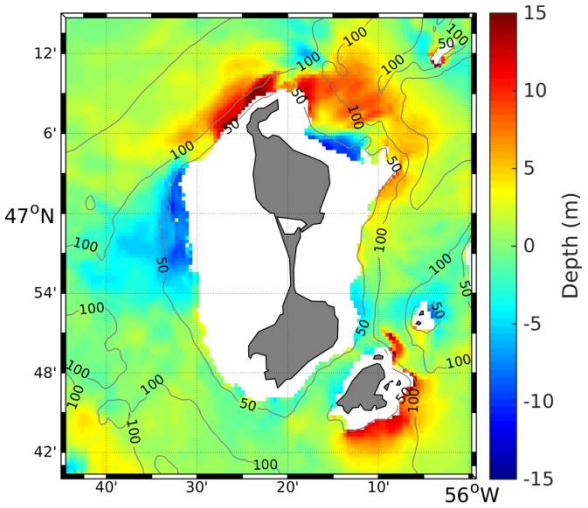
Preliminary results (O1 only) : isotherm 6°C depth anomaly

- On one cycle of O1 (26h).
- Mean depth of the 6°C isotherm = 35 m

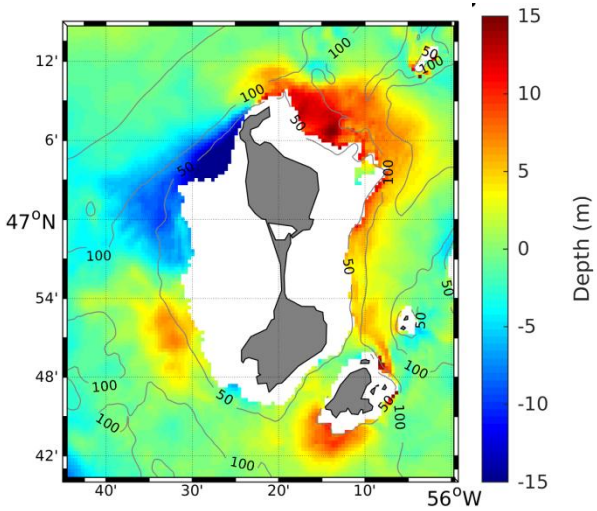
t = 1h



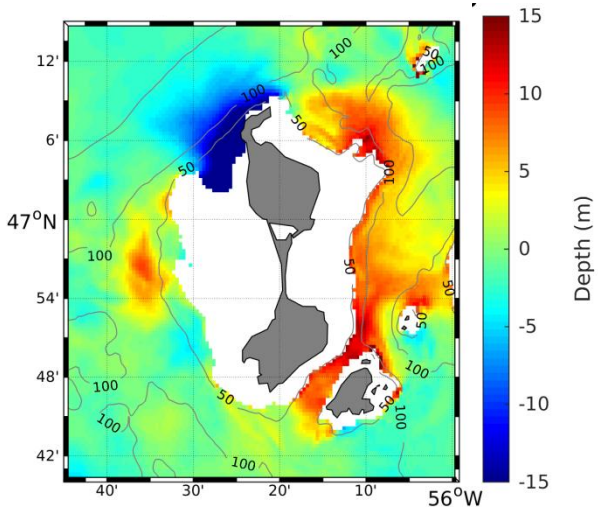
t = 7h



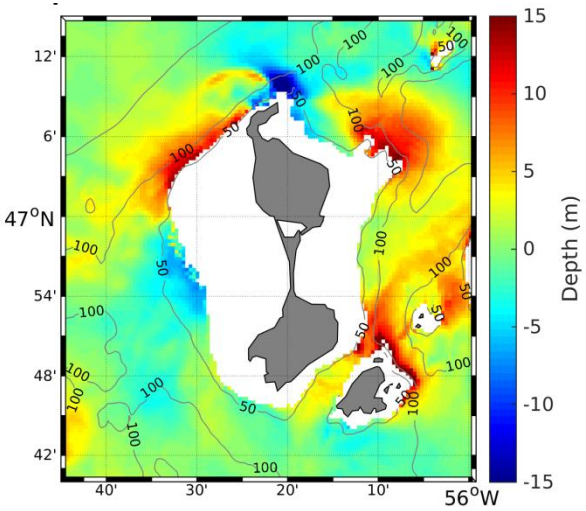
t =13h



t = 19h

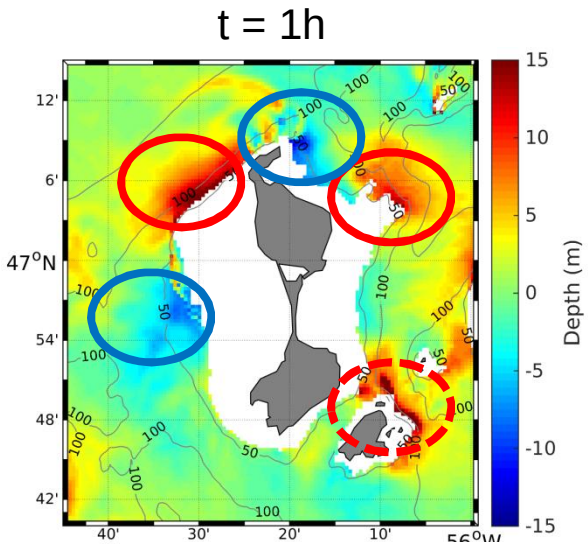


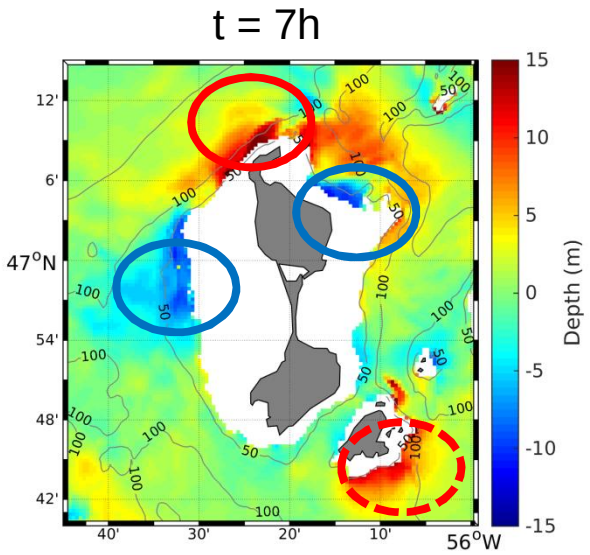
t = 25h

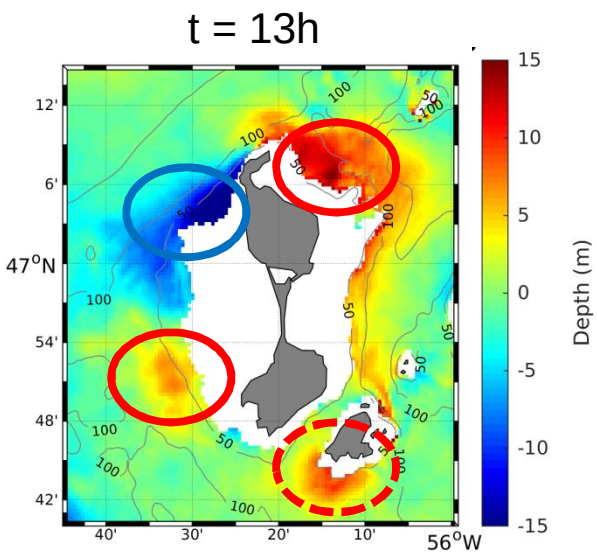


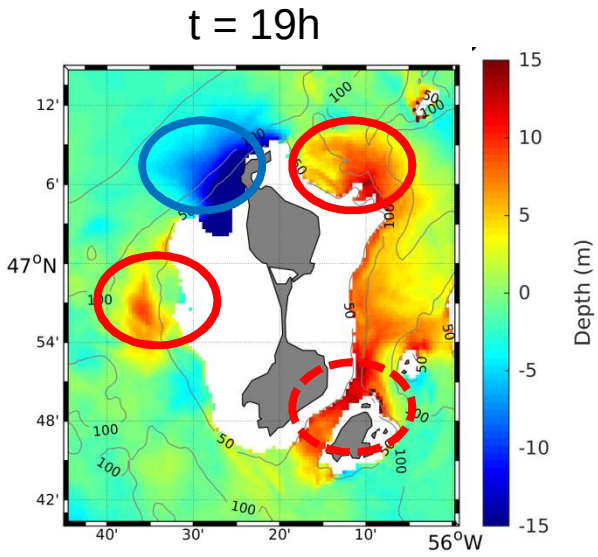
Preliminary results (O1 only) : isotherm 6°C depth anomaly

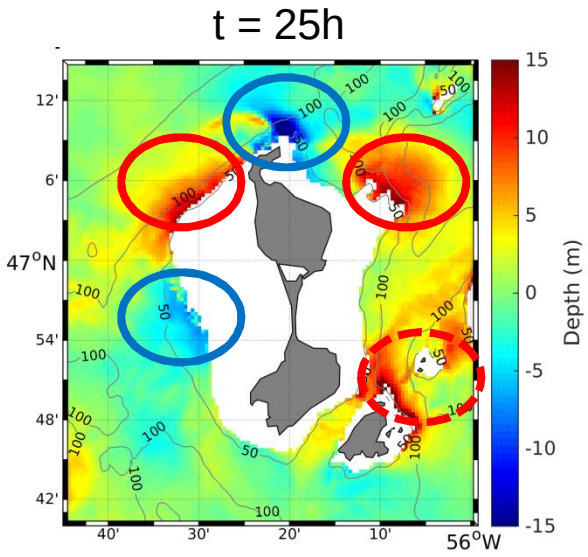
- Propagation clockwise
- Azimuthal mode 2



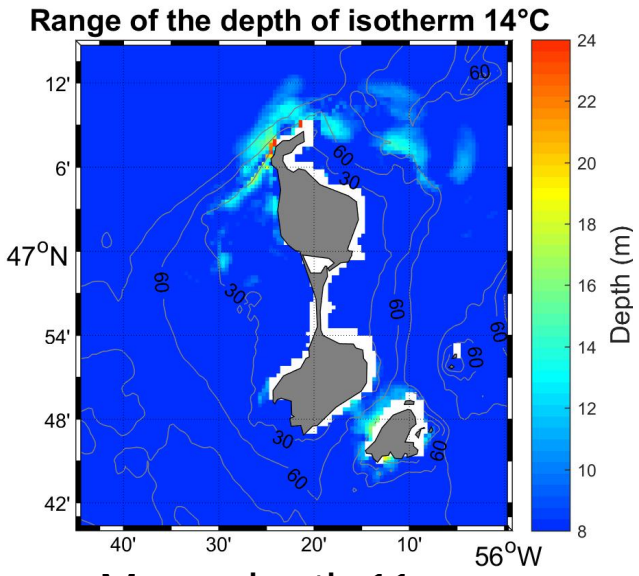




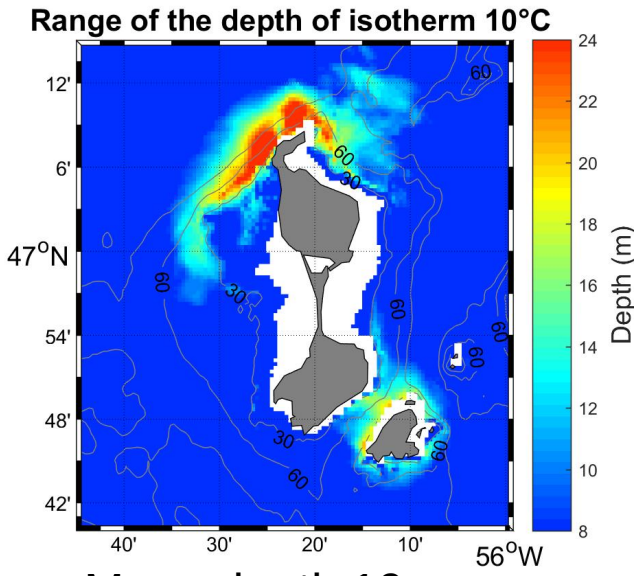




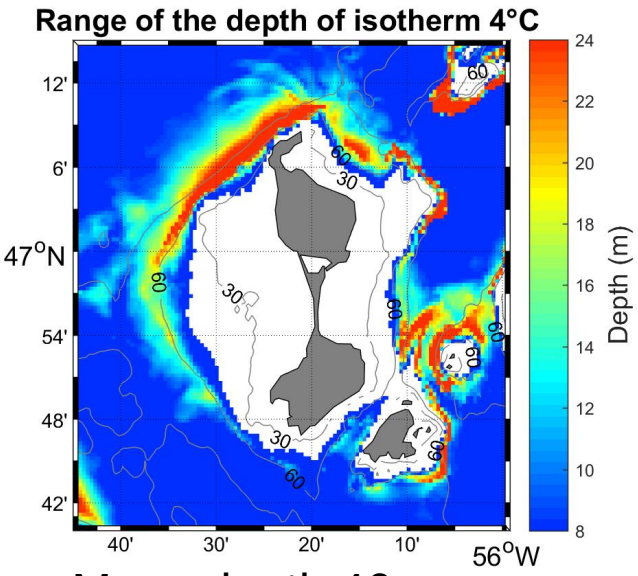
Preliminary results (O1 only) : Isotherms oscillations range



Mean depth 11m



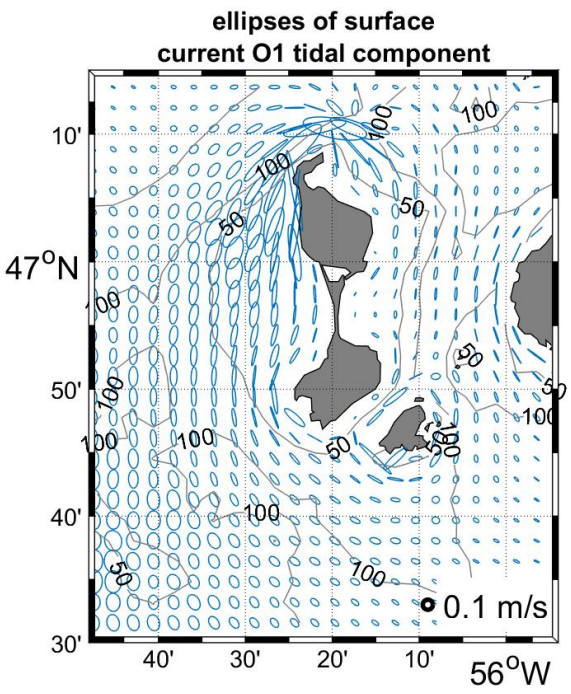
Mean depth 19 m

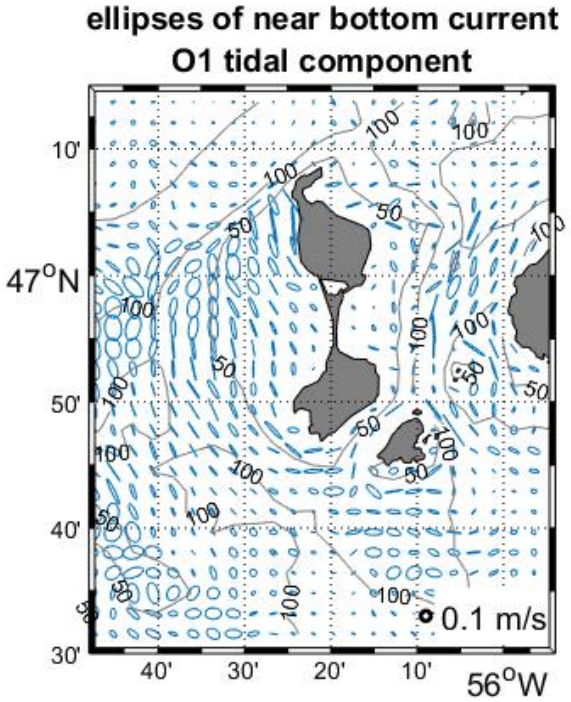


Mean depth 46 m

- Immersion range (max depth – min depth)
- Intensification near the bottom.
- Amplification north west of Miquelon

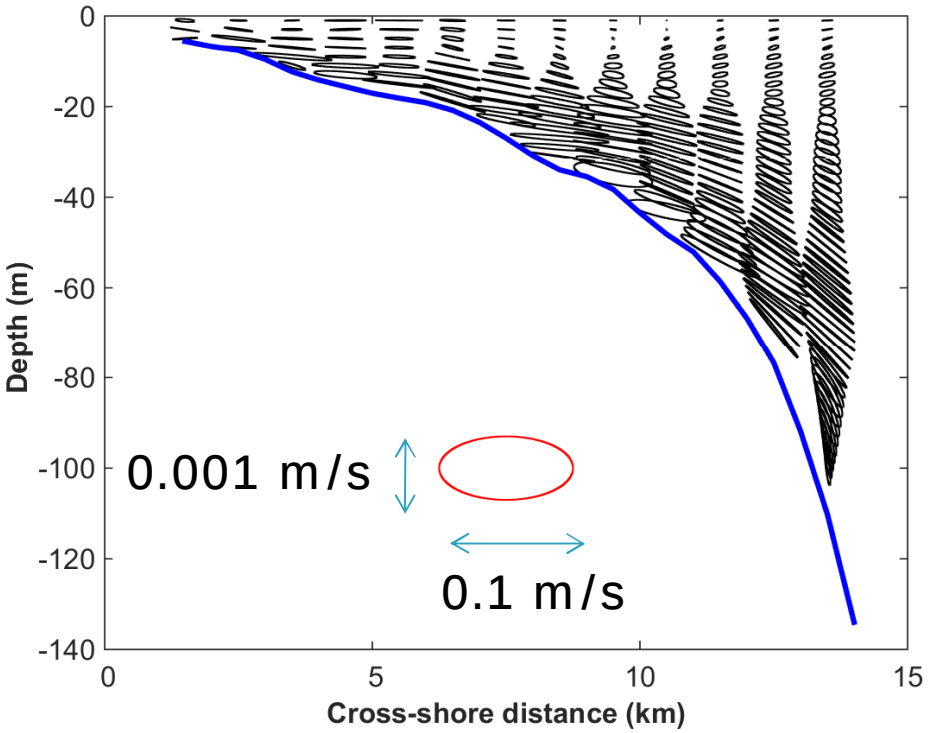
Preliminary results (O1 only) : Bottom and surface current



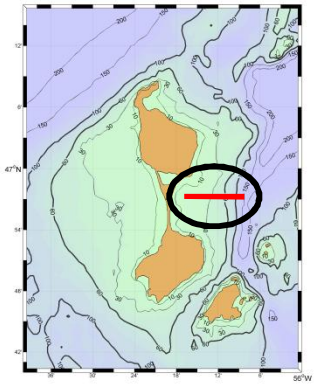


- Surface current :
  - Amplification on western side SPM
  - North intensification
- Bottom current:
  - Amplification north west SPM

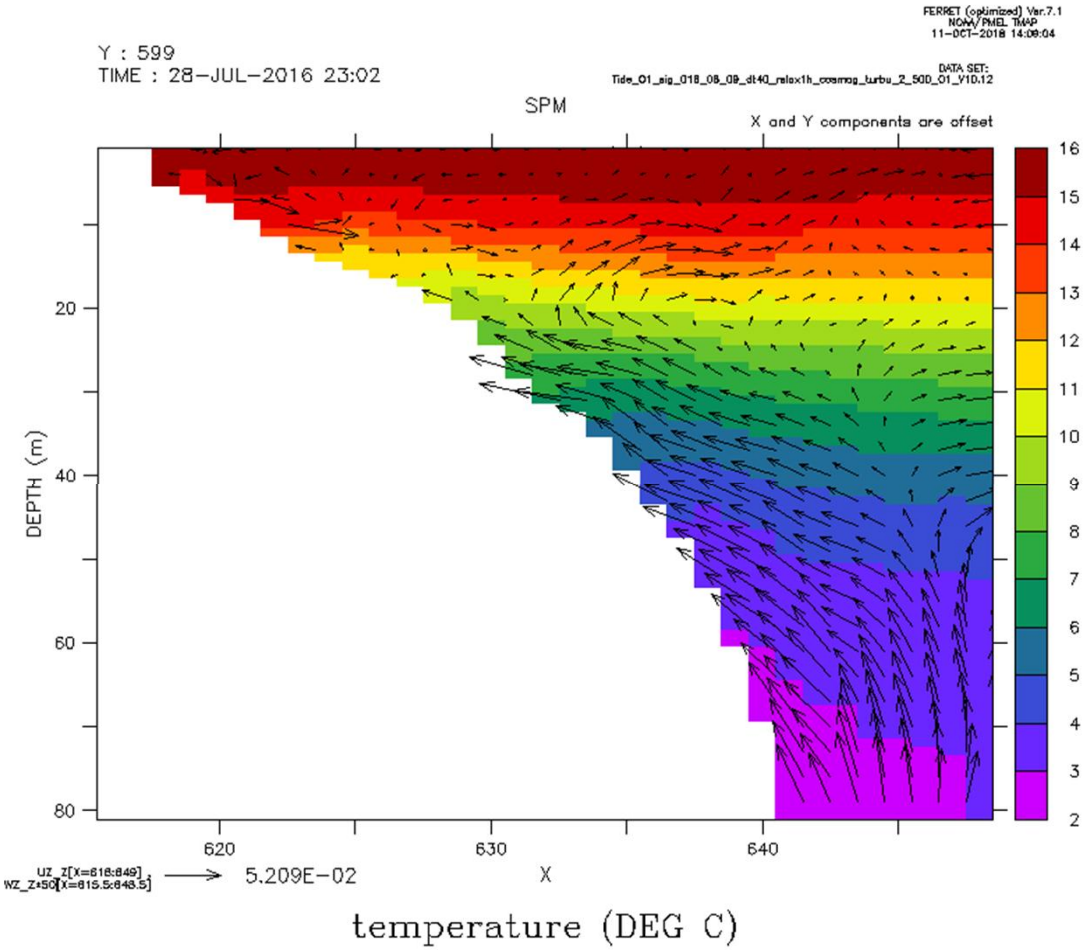
Preliminary results (O1 only): cross shore dynamics

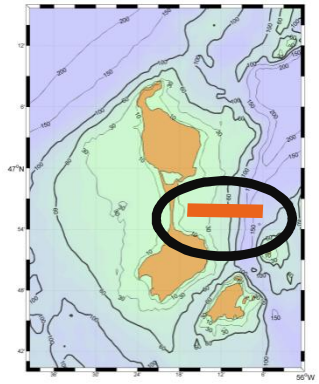


- Near bottom amplification
- Up and down sloping of bottom water



Dynamics on a transect





- Up and down sloping of bottom water
- Strong vertical shear of cross shore current

Conclusion and perspectives

- Conclusion
  - Diurnal oscillations are propagating around the islands. -> hypothesis of a CTW (Lazure et al 2018)
  - Modelling results consistent with observations.
  - Clockwise propagation 6°C isotherm depth anomaly
  - A bottom intensification -> isotherm oscillations and cross shore current.

- Perspectives
  - Improve the stratification for boundary condition & bottom layers distribution.
  - Find the location and mechanism of the generation of the diurnal oscillations.
  - Investigate the impact of the seasonal stratification on these oscillations.
  - Meteorological impact on the system.

Thank you for your attention !!

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