Laboratoire de Morphodynamique Côtière et Continentale

RÉGION NORMANDIE

UNION EUROPÉENNE
Fonds européen de développement régional

Alderney Race surface hydrodynamics measured by HF radar

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ANR AGENCE NATIONALE DE LA RECHERCHE

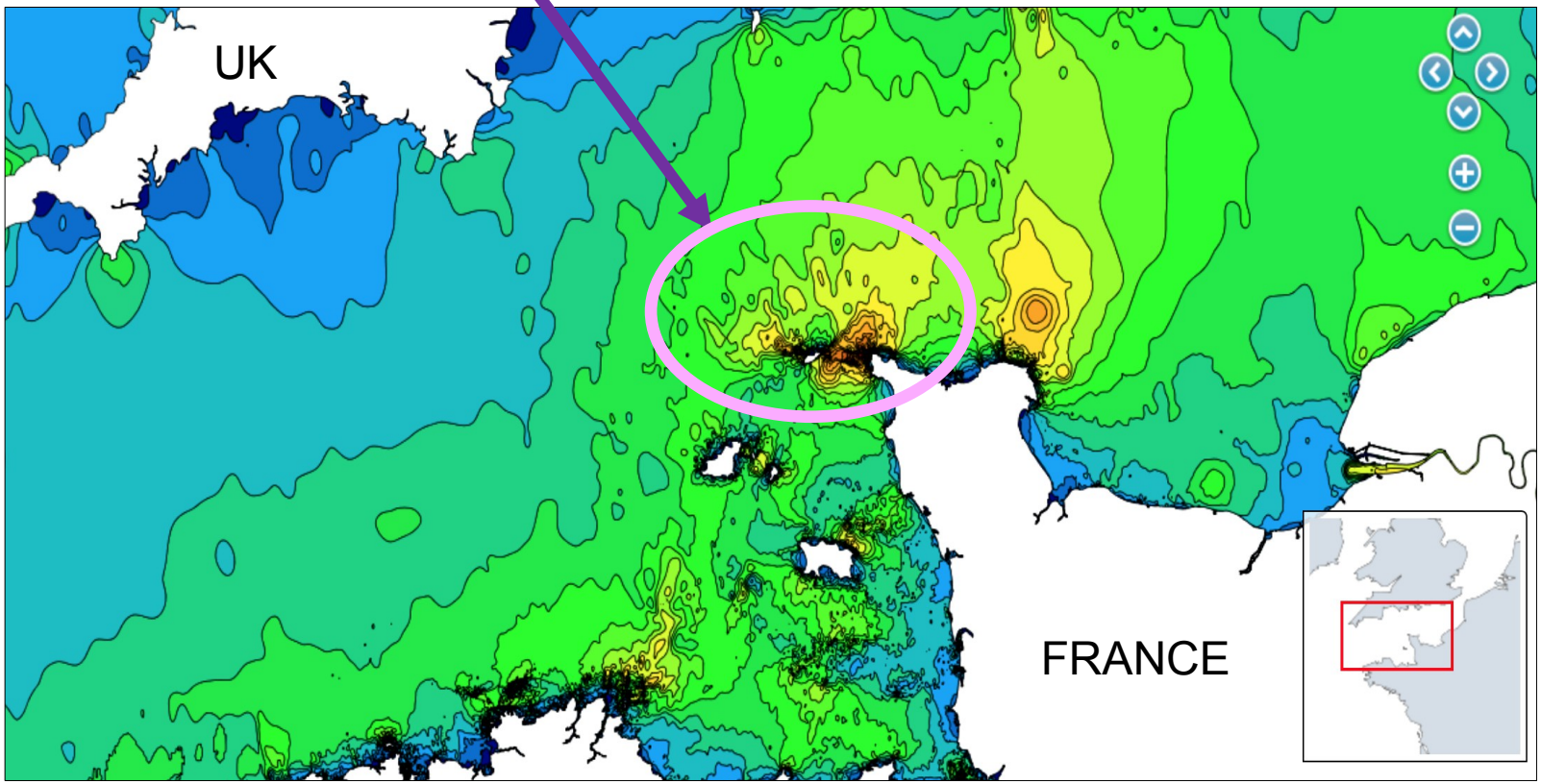
FRANCE ENERGIES MARINES

UNICAEN université de Caen Basse-Normandie

INVESTISSEMENTS D'AVENIR

Alderney Race

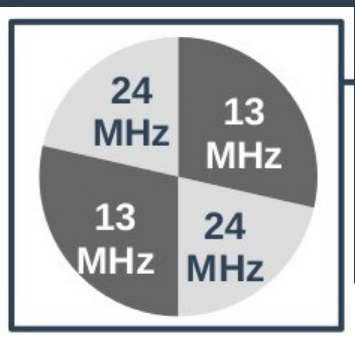
Alderney race has the **largest tidal stream energy potential** in Europe (between the La Hague Cape and the Alderney island)



http://data.shom.fr

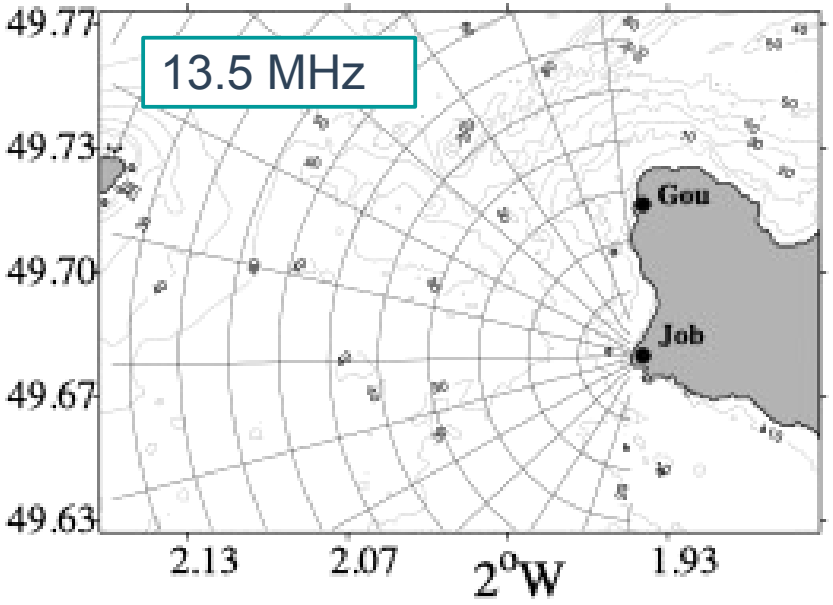
- Shallow to intermediate waters : **20 to 60 m depth**
- **Mega-tidal** environnement: tidal range up to 10m
- **Tidal asymetry**
- **Extreme tidal current** reaching to 5 m/s
- **Marine turbulence** with a lengthscale of 10-15m
- **Ocean waves**: wind-waves and swell

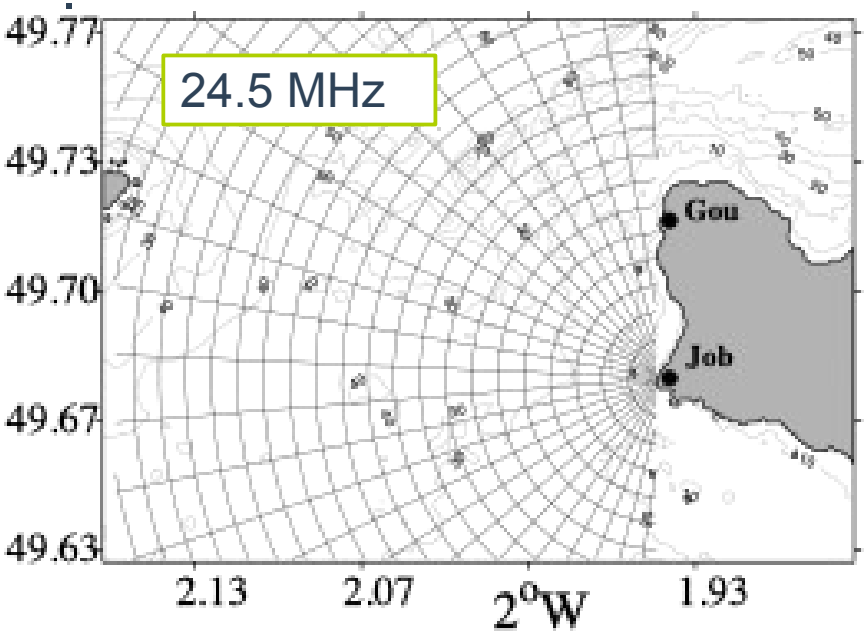
HF radar characteristics



	13.5 MHz	24.5 MHz
Bandwidth (kHz)	100	200
Range resolution (m)	1500	600
Azimuthal resolution (deg)	14	7
Grid spacing (m)	500 x 500	

- HF radar capable of operating at **two frequencies**, **13.5** and **24.5** MHz.
- Different spatial resolution.
- Different penetration depth.

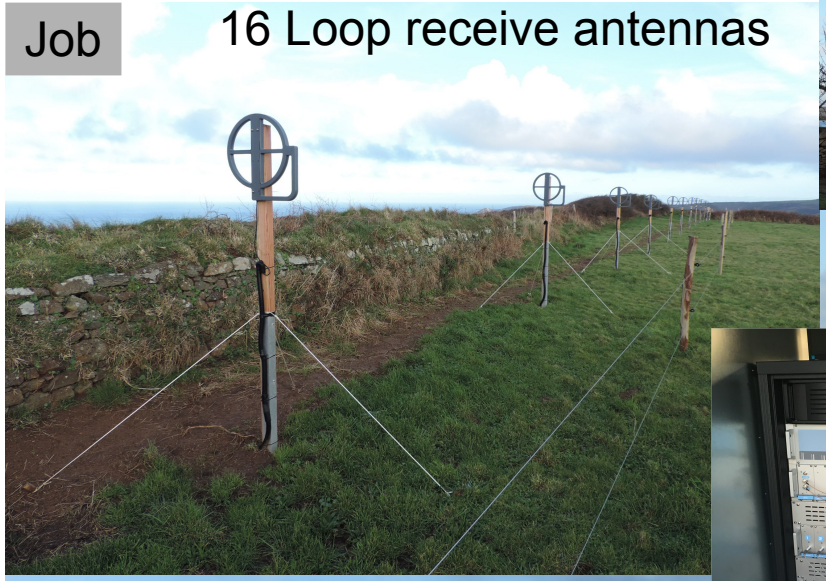




HF radar sites

Job

16 Loop receive antennas

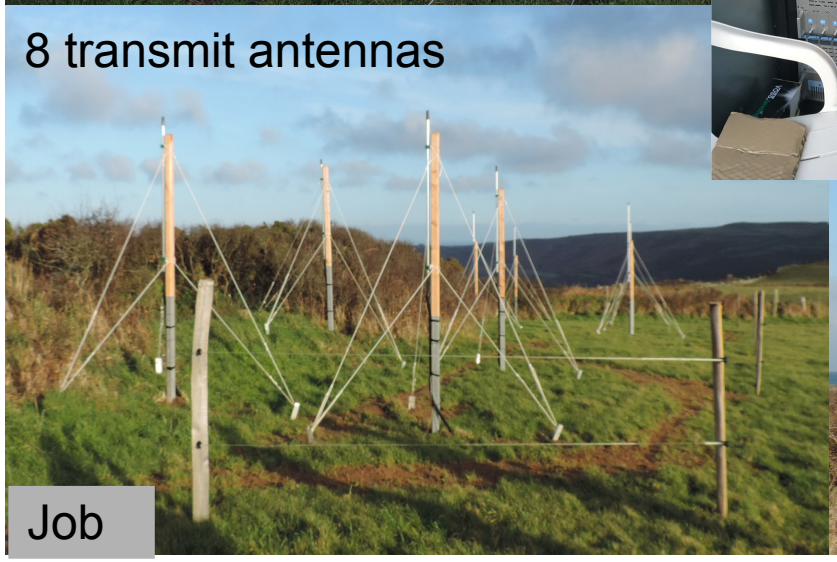


HF radars:
40 antennas, 2 radar electronics,
2 containers, ~50 kms of cables

16 receive antennas

Gou

8 transmit antennas

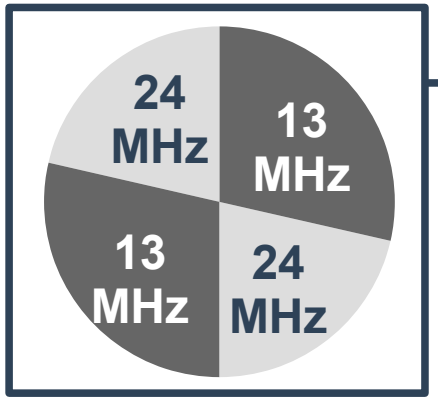


Job

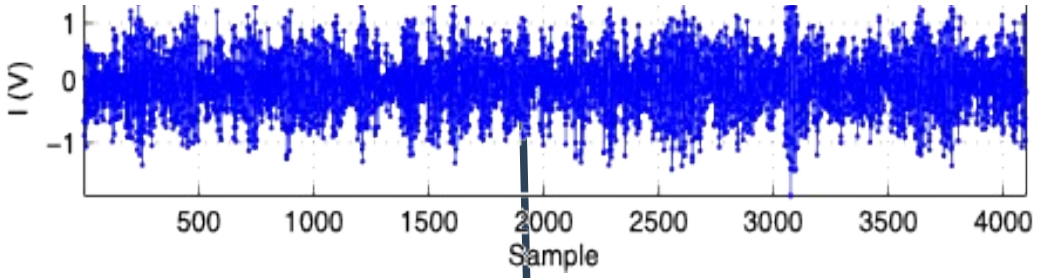
8 transmit antennas

Gou

Acquisition/Processing chain



Range resolution



Angular resolution

Direction finding (MUSIC)

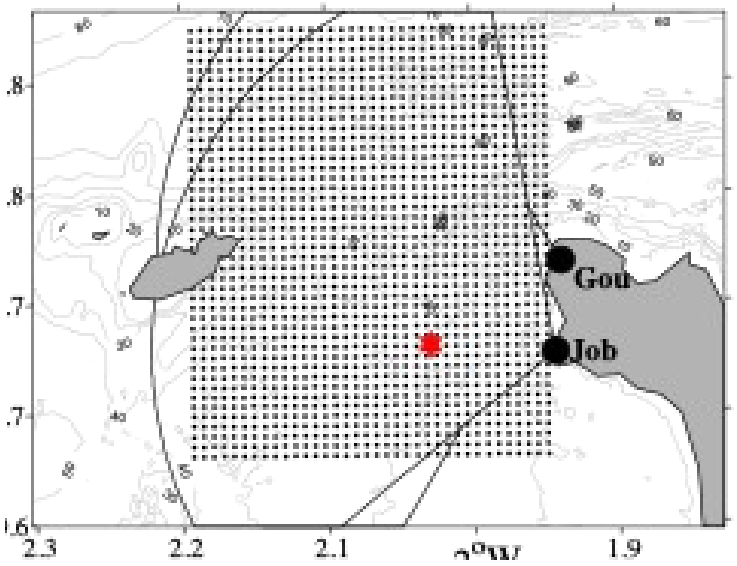
- Eigenfunction analysis of signal covariance matrix
- High resolution
- Irregular grid coverage

Beamforming

- Digital beam steering
- Lower resolution
- Good grid coverage

Surface current

DINEOF
2dVar

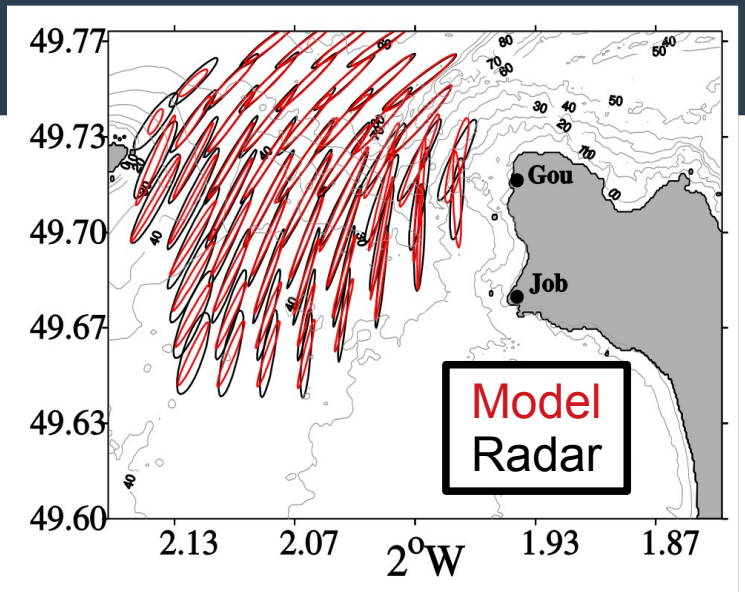


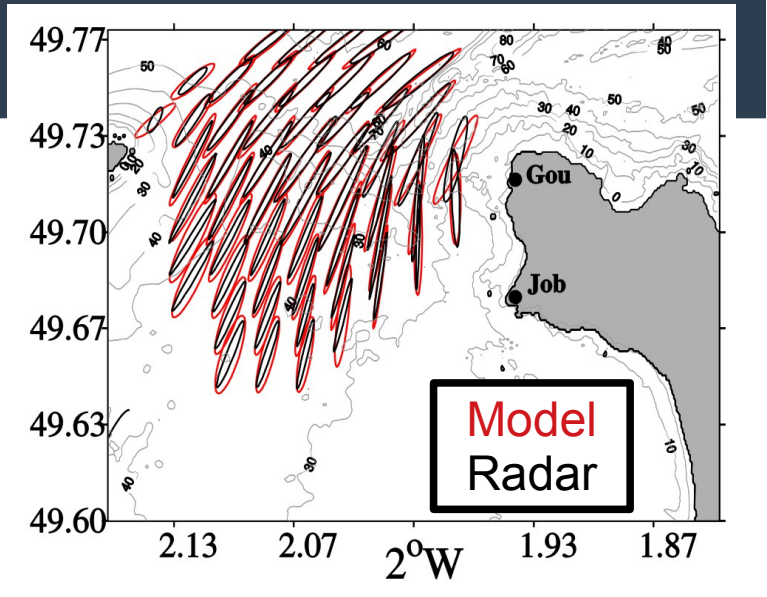
Waves

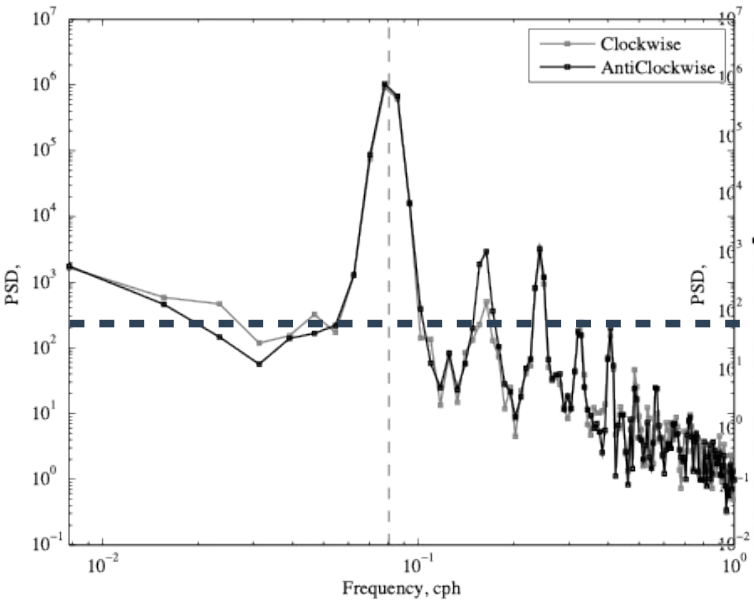
Semi-empirical relation Between 2nd order Doppler and **1D wave spectrum**

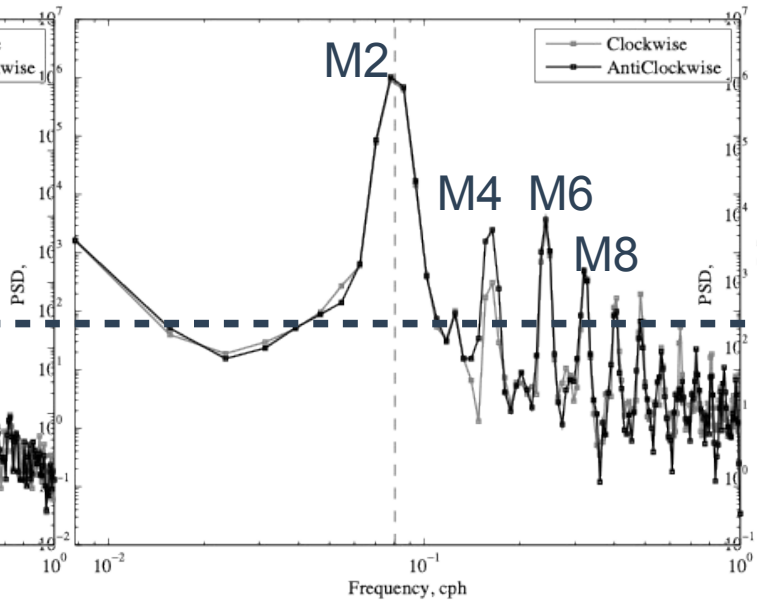
Numerical inversion equation relating 2nd order Doppler and **directional wave spectrum**

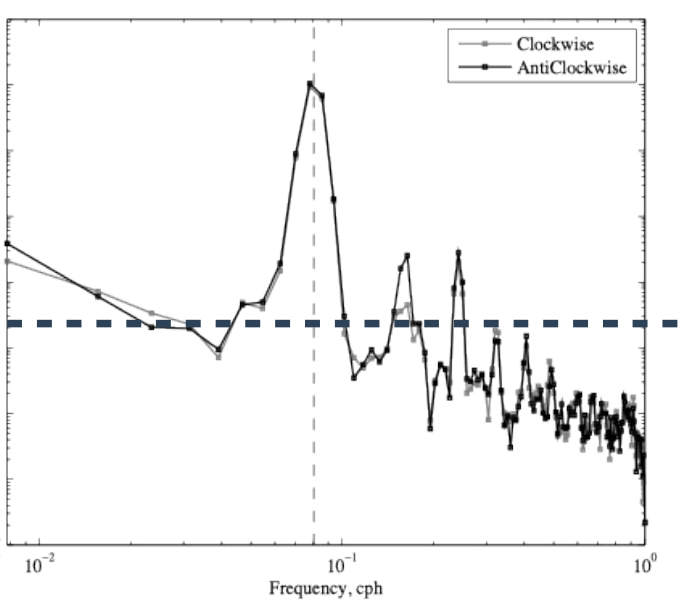
Current ellipses & Rotary spectra









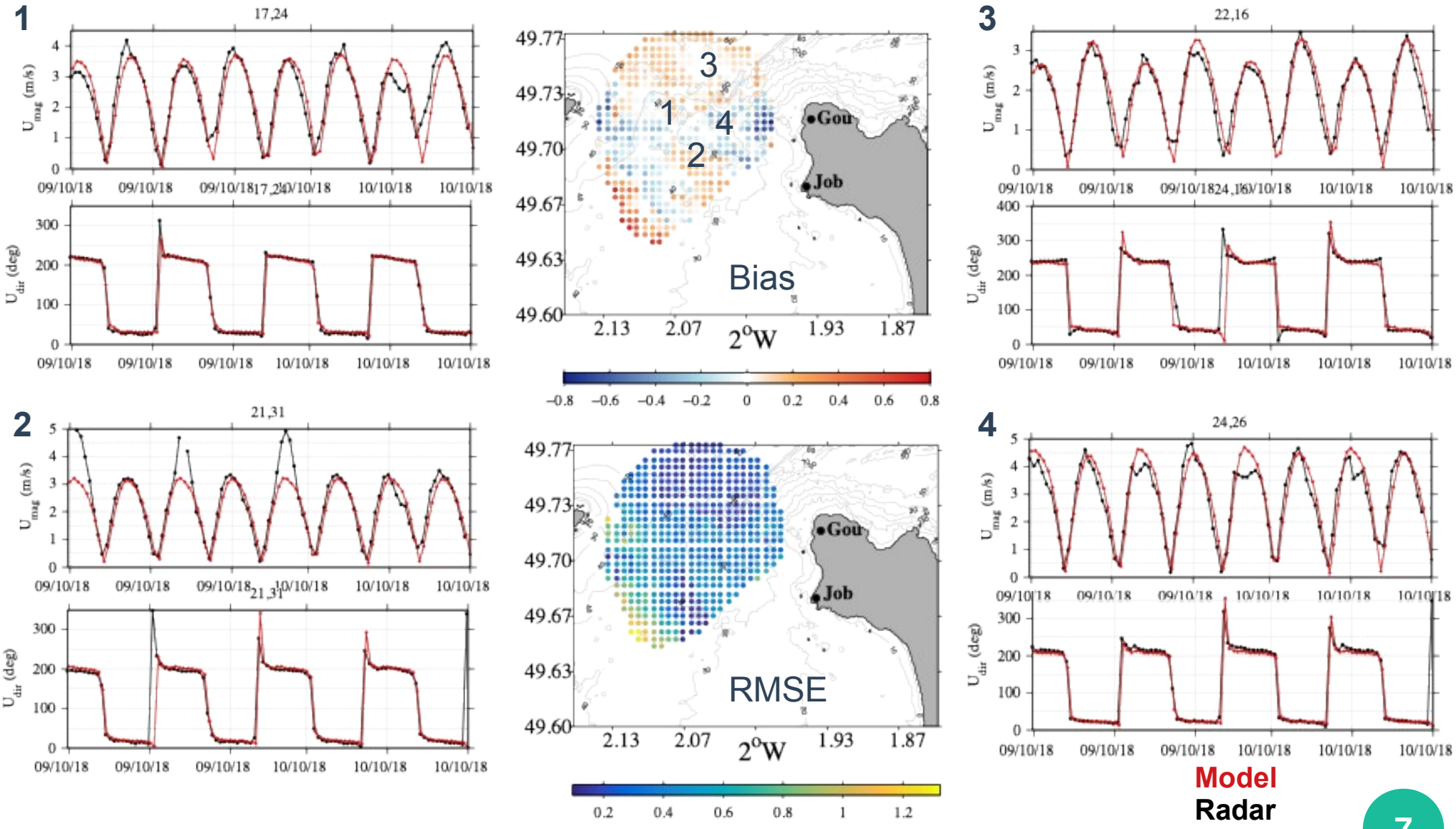


13.5 MHz

Model

24.5 MHz

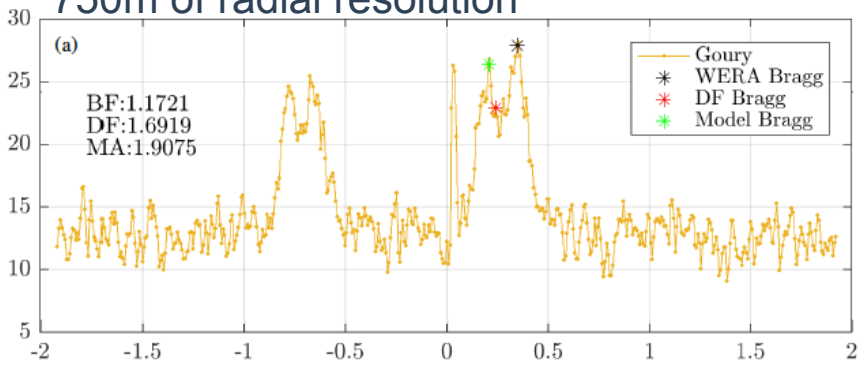
Time evolution of surface currents
(24 MHz/Spring tide)



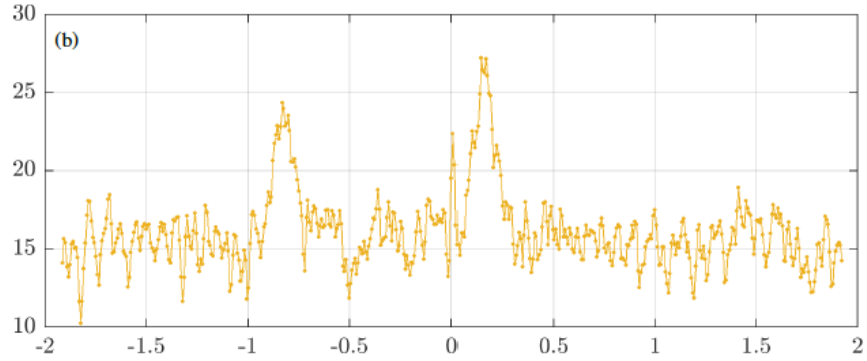
Possible improvements

High resolution measurements with a bandwith of 750 kHz, nov. 2020
(Radial resolution : 200m, Angular resolution : unchanged, Frequency : 24.5 MHz)

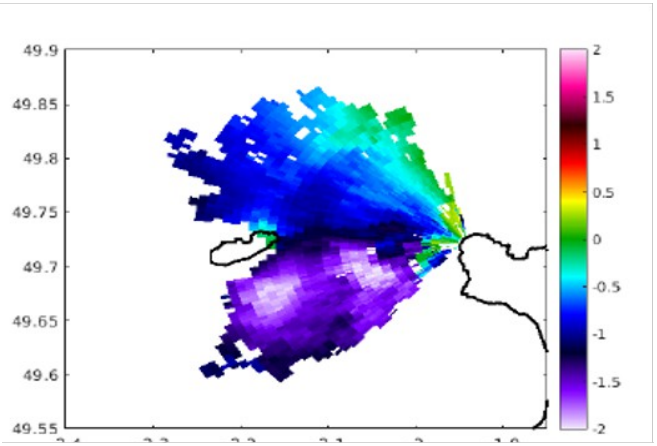
750m of radial resolution

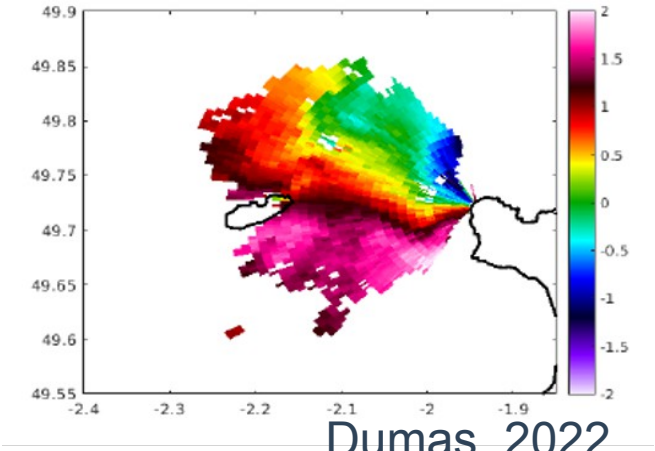


200m of radial resolution



New Direction Finding techniques based on antenna groups
(with D. Dumas and C.-A. Guérin)





Dumas, 2022

Summary

- Why use HF radars for this site ?

* Alderney Race is very difficult to instrument with in-situ materials.
* Hydrodynamic measurements are essential for the development of tidal energy.

- **HF radars from WERA** technologies are relatively **expensive**: ~500 keuros

LERA radars are cheaper but are not yet suitable for beginners: this is perhaps the future.

- HF radars in Cotentin are devoted to help the **development of tidal energy**
=> They will be used in the FloWatt project (2023-2028) aiming at implement 7 tidal turbines in Alderney Race.

- **Data** are available **on request.**

- Data are easily accessible from the **Ifremer ftp (SISMER).**

- Our post-processing tools are open source.