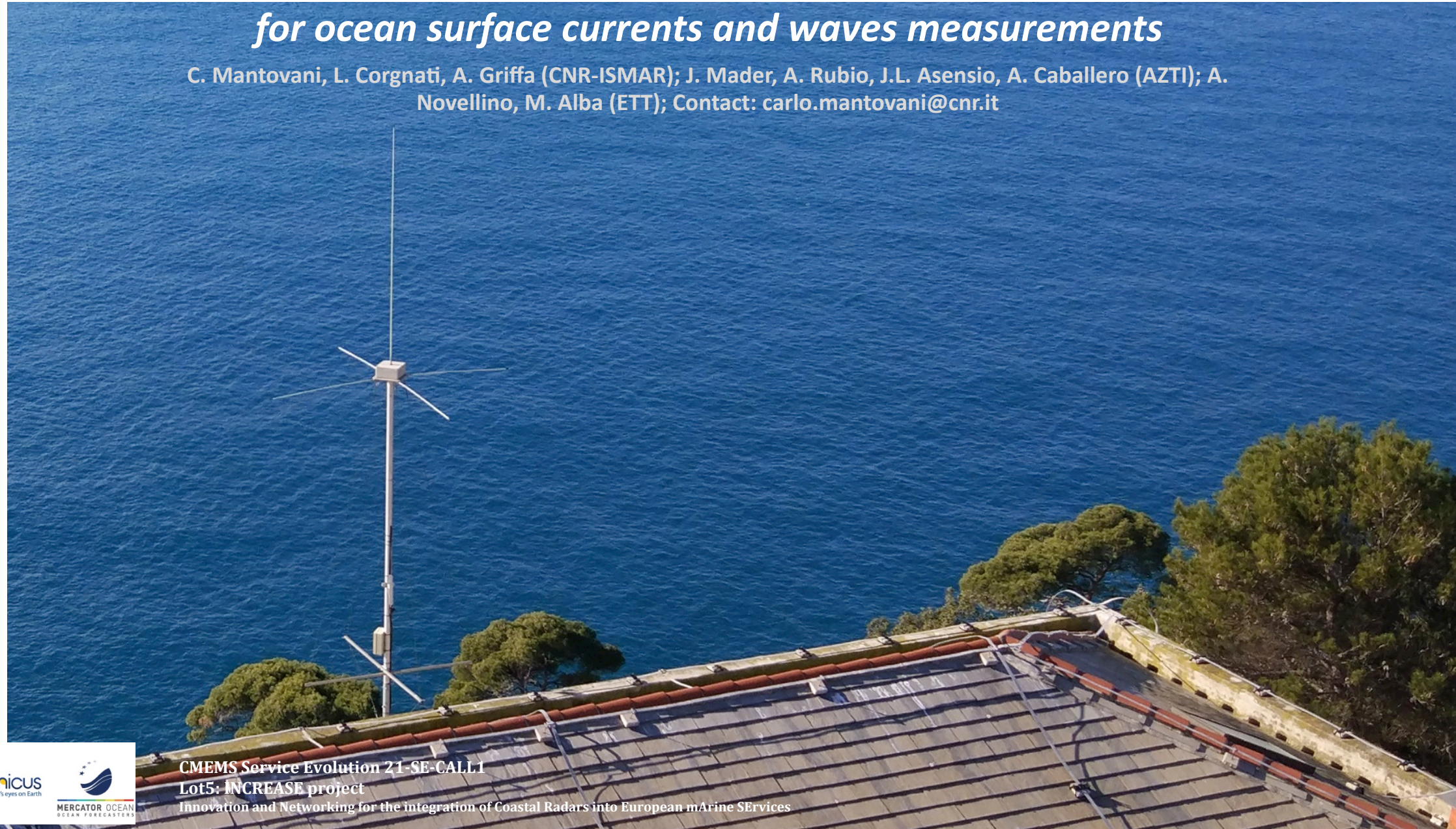
Introduction to HF radar technology

for ocean surface currents and waves measurements

C. Mantovani, L. Corgnati, A. Griffa (CNR-ISMAR); J. Mader, A. Rubio, J.L. Asensio, A. Caballero (AZTI); A. Novellino, M. Alba (ETT); Contact: carlo.mantovani@cnr.it



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Lot5: INCREASE project
Innovation and Networking for the integration of Coastal Radars into European mArine SErvices

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Brussels,

26 September 2017

DAY 2 Session

9:00-13:00

HF Radar in Europe

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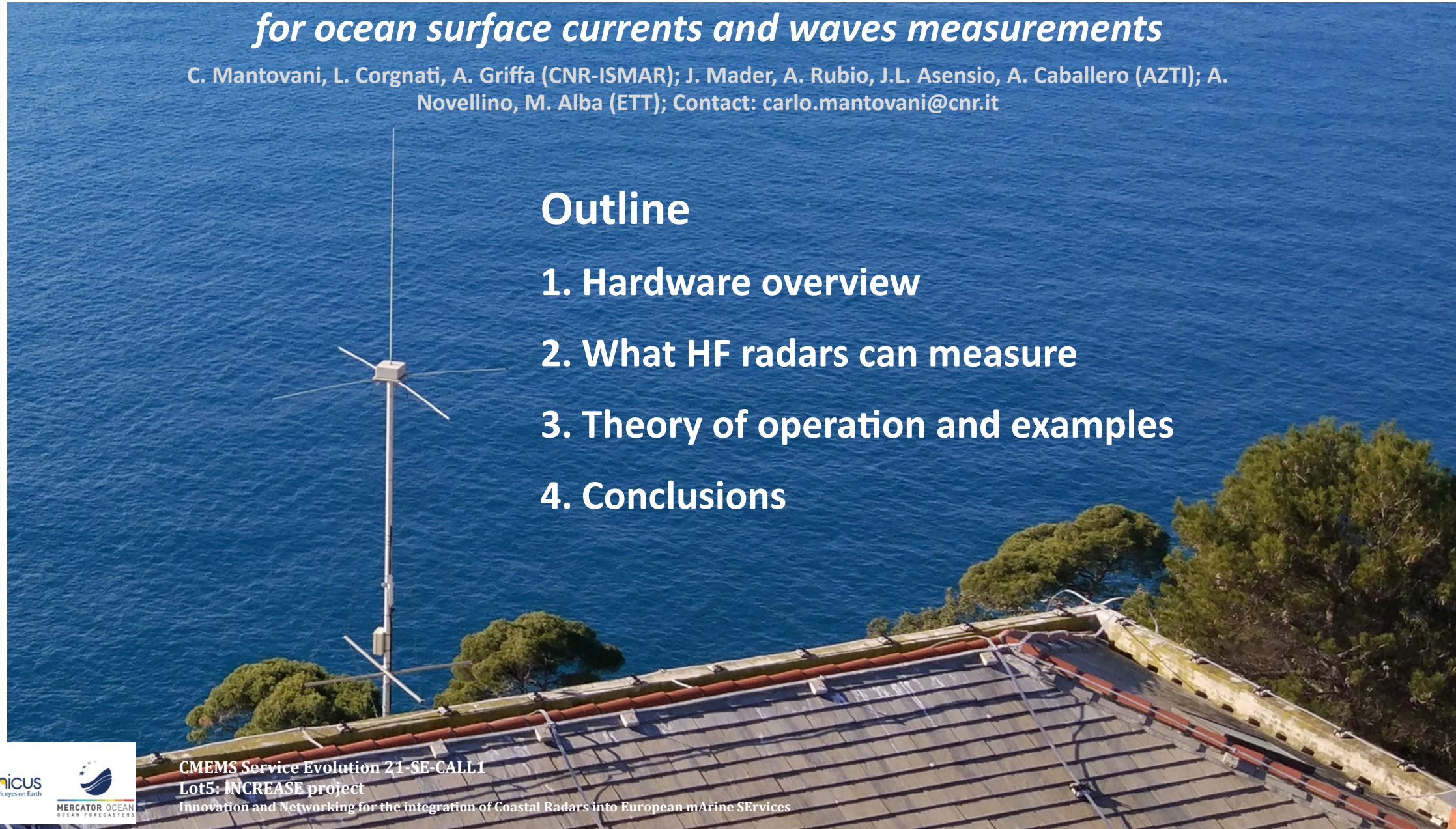

Outline

1. Hardware overview
2. What HF radars can measure
3. Theory of operation and examples
4. Conclusions

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HF Radar in Europe

Hardware overview

- Land based remote sensing instrument
- HF = High Frequency (from 3 to 30 MHz)
- One receiving and one transmitting station (plus electronics)
- different antennas configurations (depending on frequency and signal processing technique)

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Hardware overview

From University of Hamburg

4-element square array receiver

Introduction to HF Radar technology

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Hardware overview

From University of Hamburg

16-element linear array receiver

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Hardware overview

From CNR-ISMAR

Compact transmitting and 3-element receiving antenna

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What HF Radars can measure

- Ocean surface* currents velocity over wide areas (thousands of square Km) with high temporal and spatial resolution

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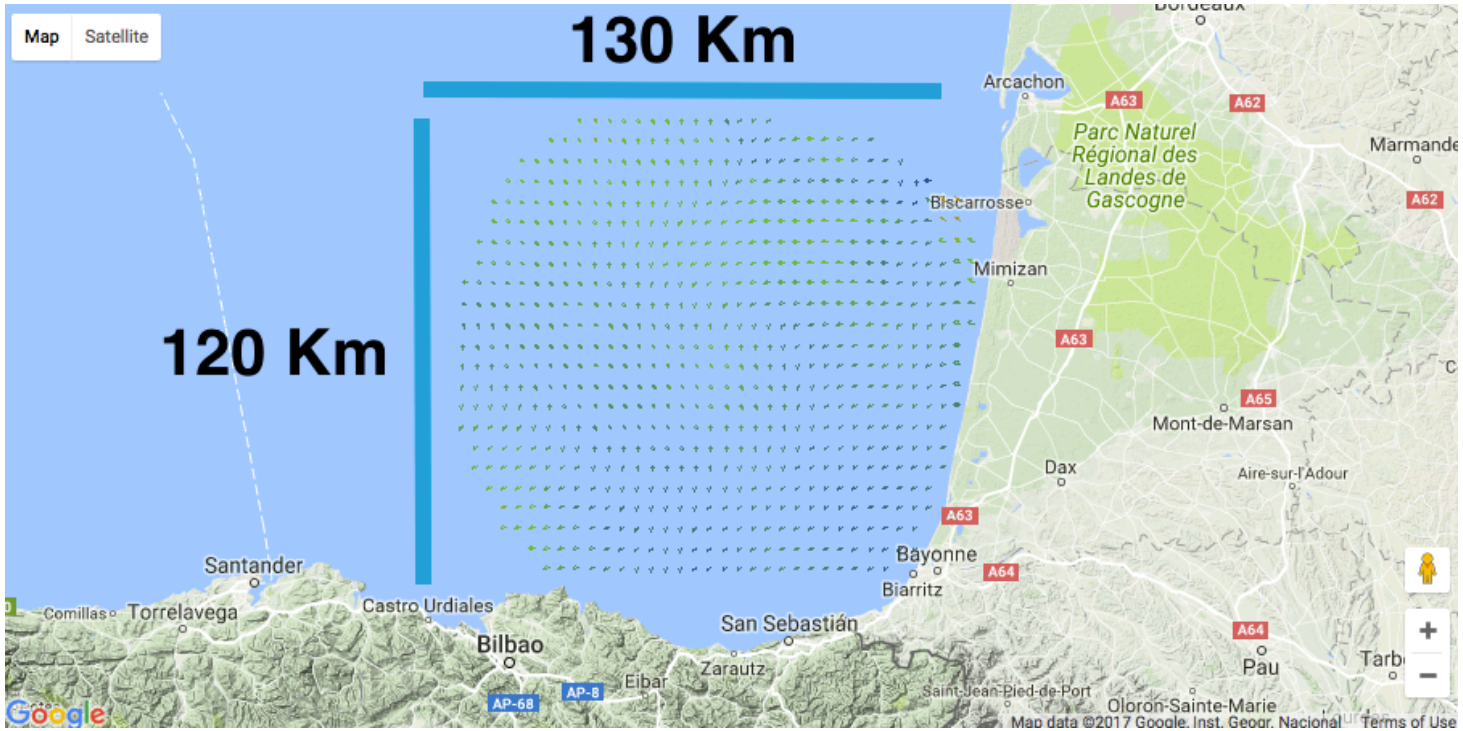

* = from 0,5 to 2m depth depending on frequency

Bay of Biscay, from Basque Operational data acquisition system. **Map obtained from 2 HF radar systems measurement**

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What HF Radars can measure

- Significant wave height, period and direction

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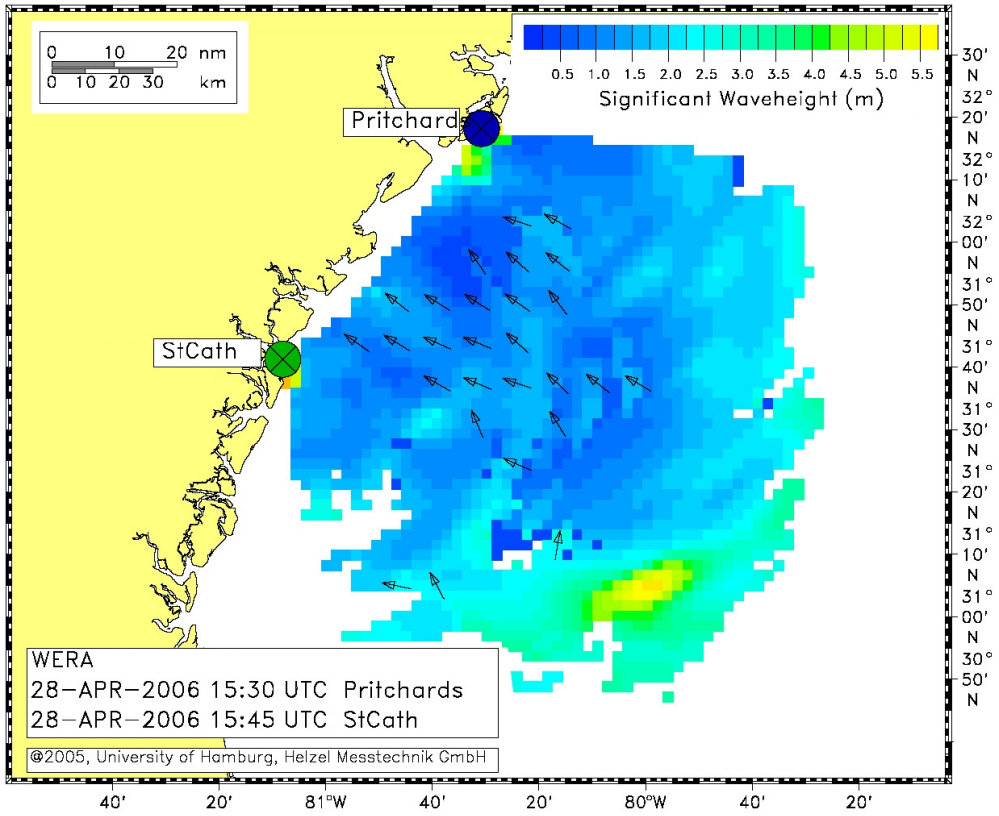


From Prof. Dana Savidge at SKIO and Prof. Rich Styles at USC

Theory of operation

THE

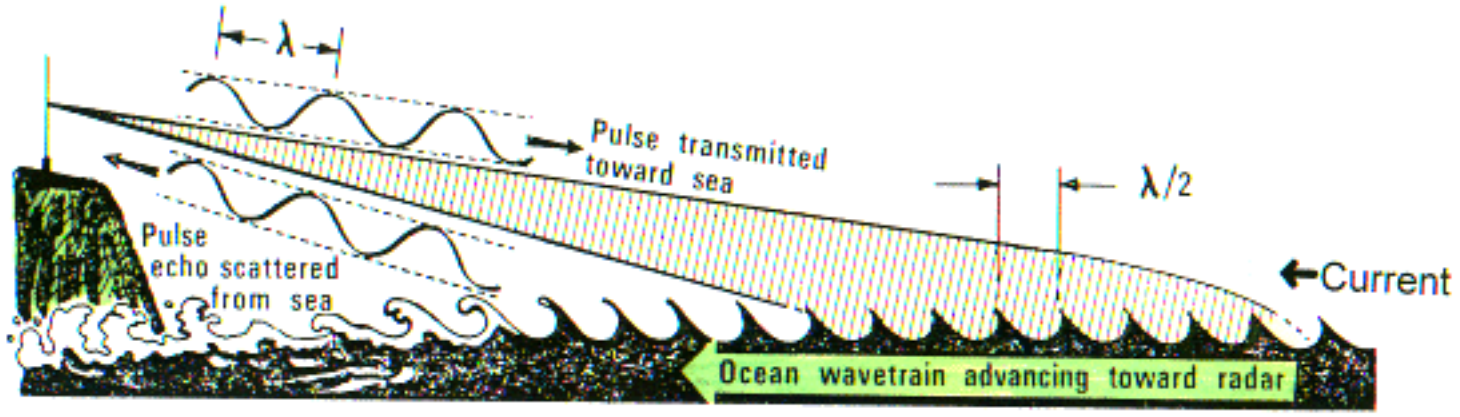
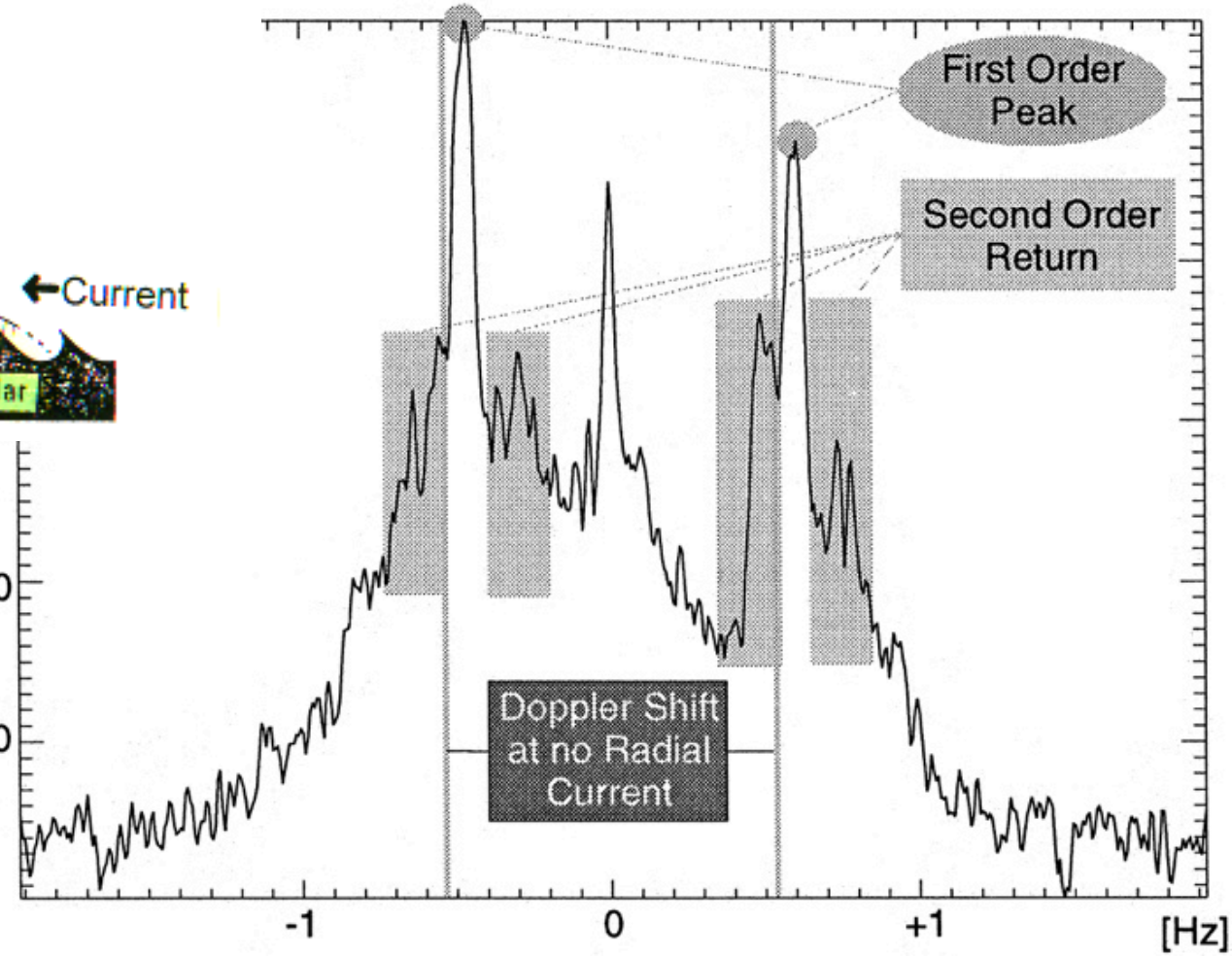


Image from marine.rutgers.edu



Gurgel K-W et al, Coastal Engineering 37 1999. 201–218

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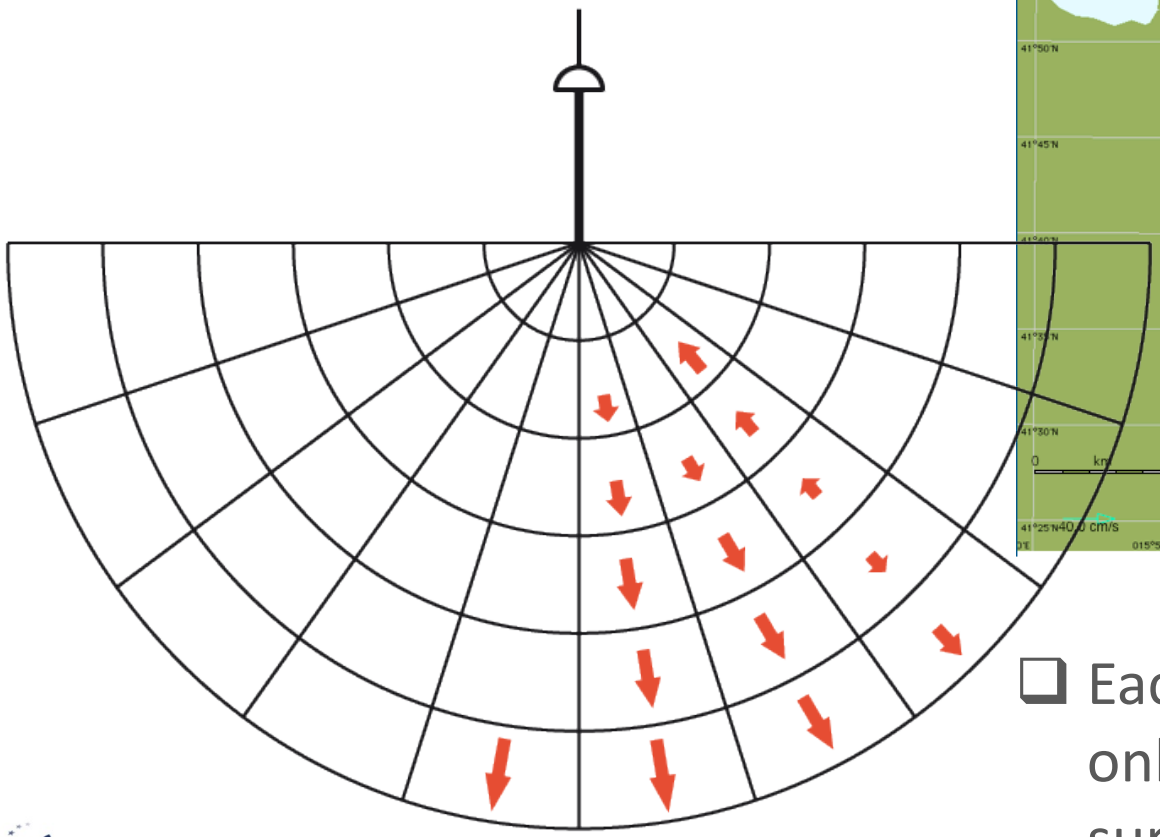

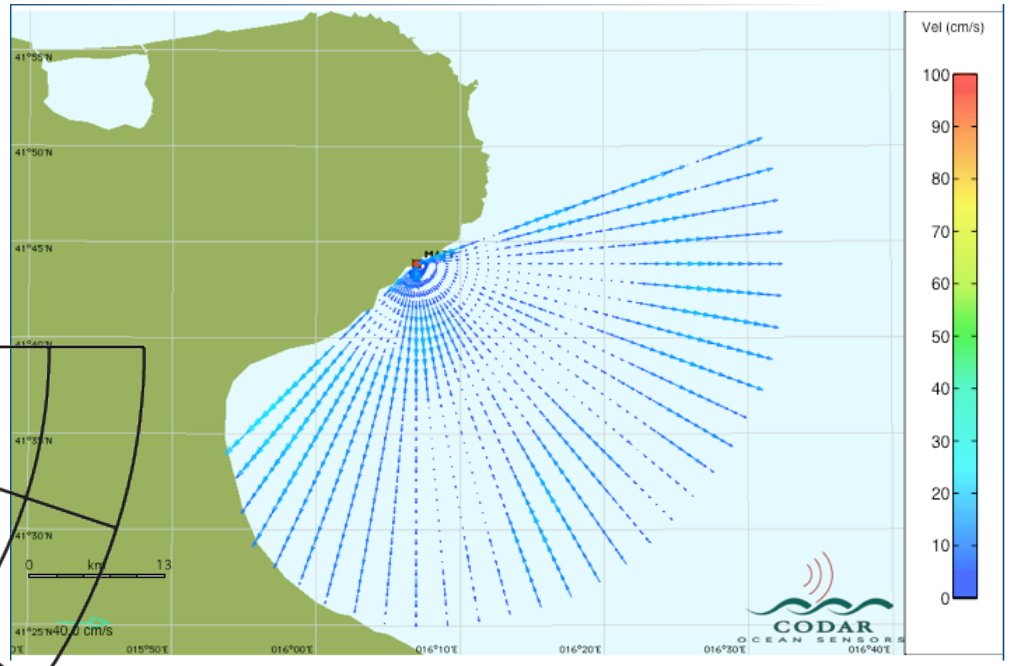

- Each HF radar system can measure only the radial component of the surface velocity

Copernicus Europe's eyes on Earth

MERCATOR OCEAN OCEAN FORECASTERS

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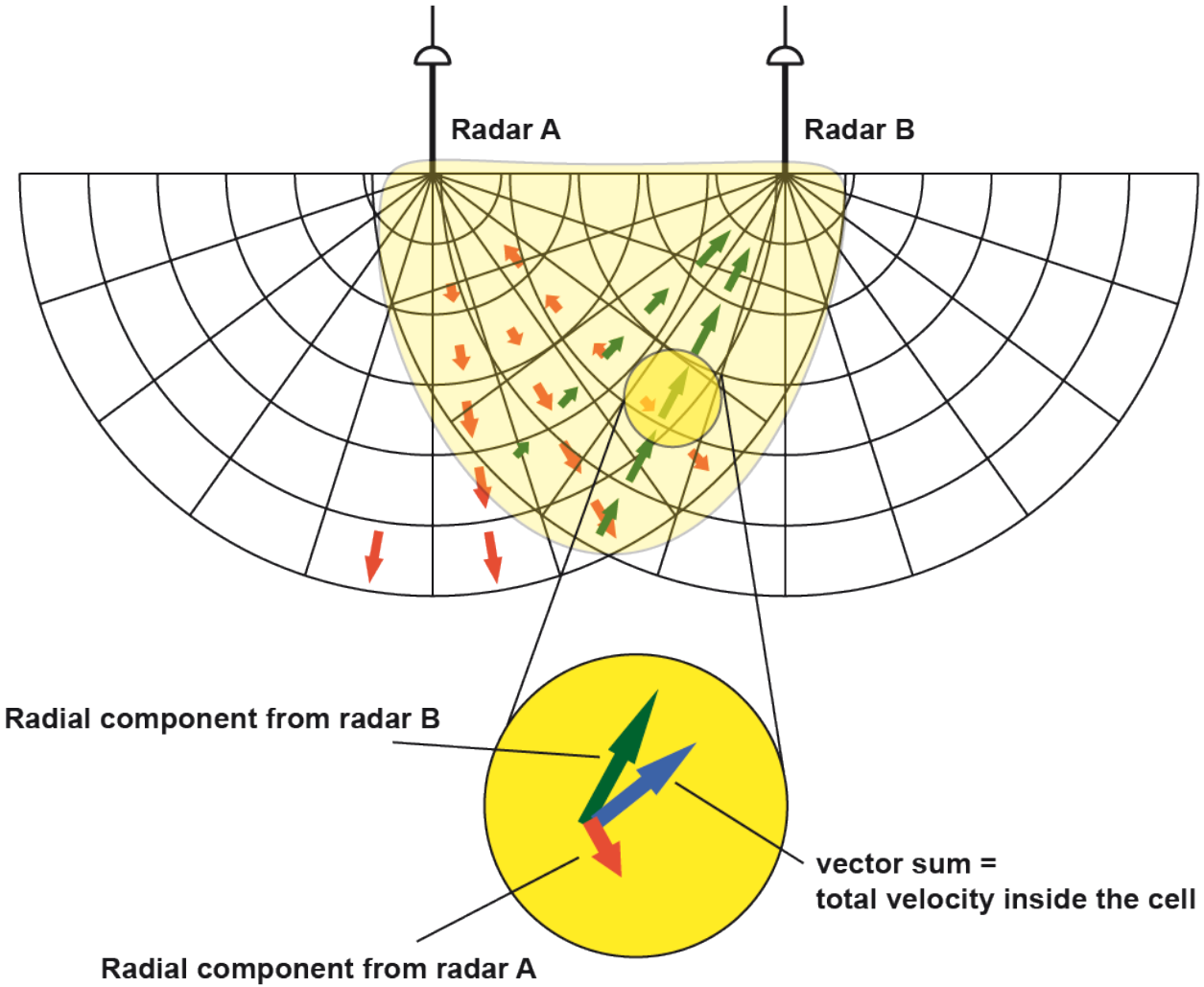

Two or more radial maps overlapping are combined to provide total velocity map.

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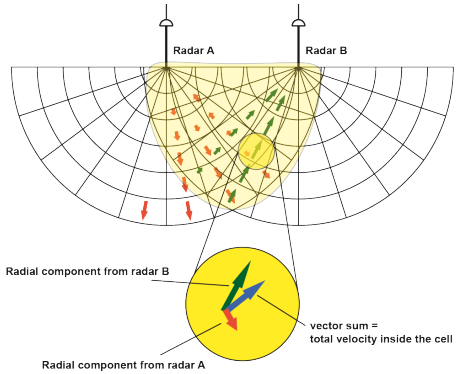

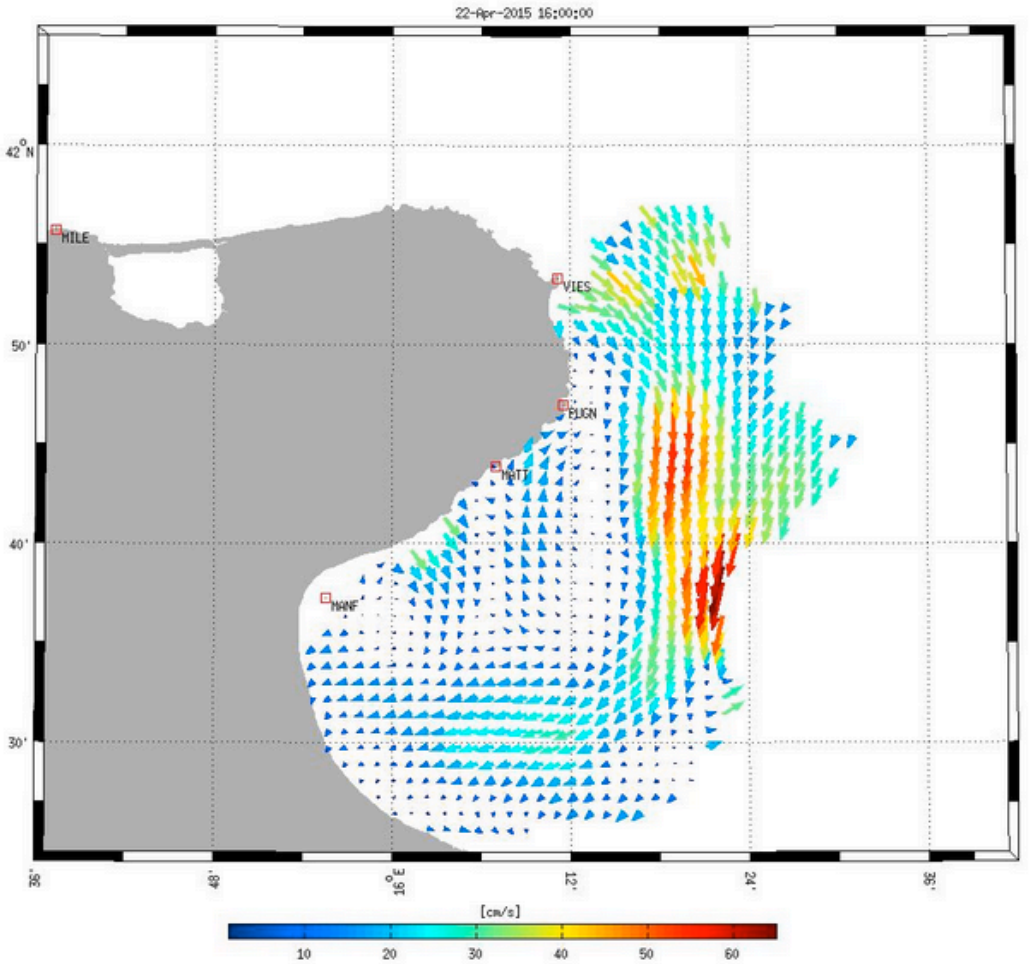

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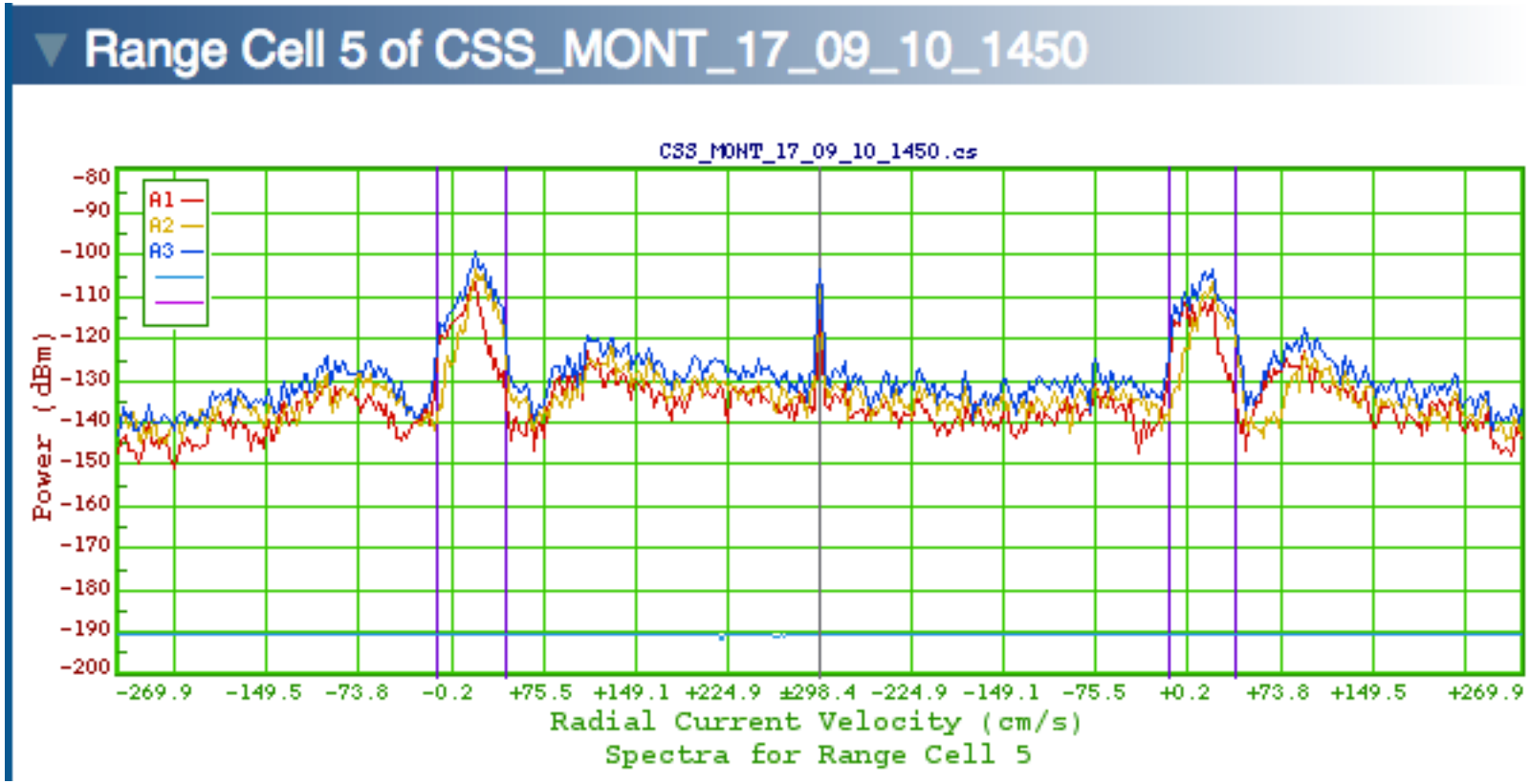

Example of doppler spectrum from range cell at 5Km distance

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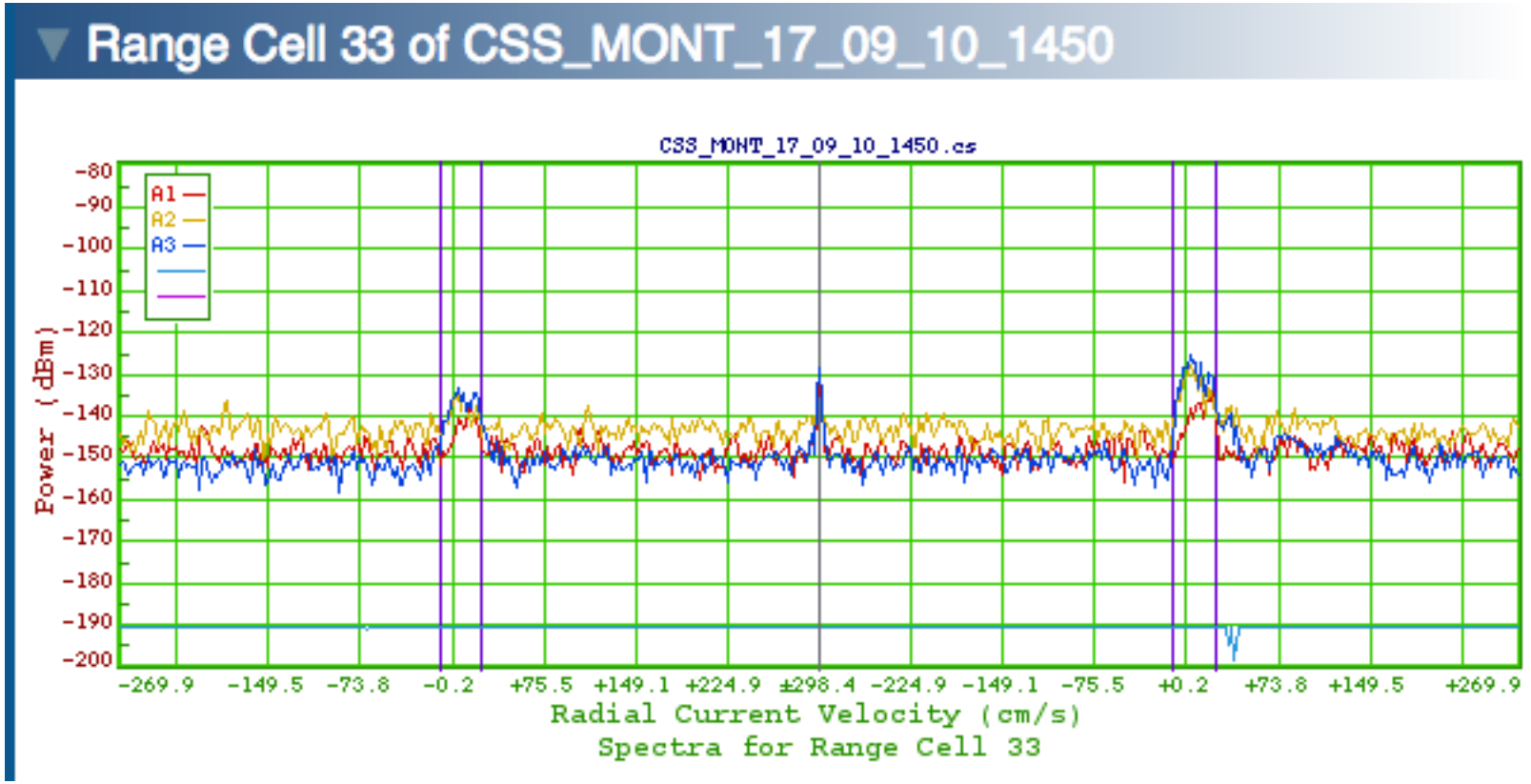

Example of doppler spectrum from range cell at 33Km distance

Attenuation of sea echo from longer distances

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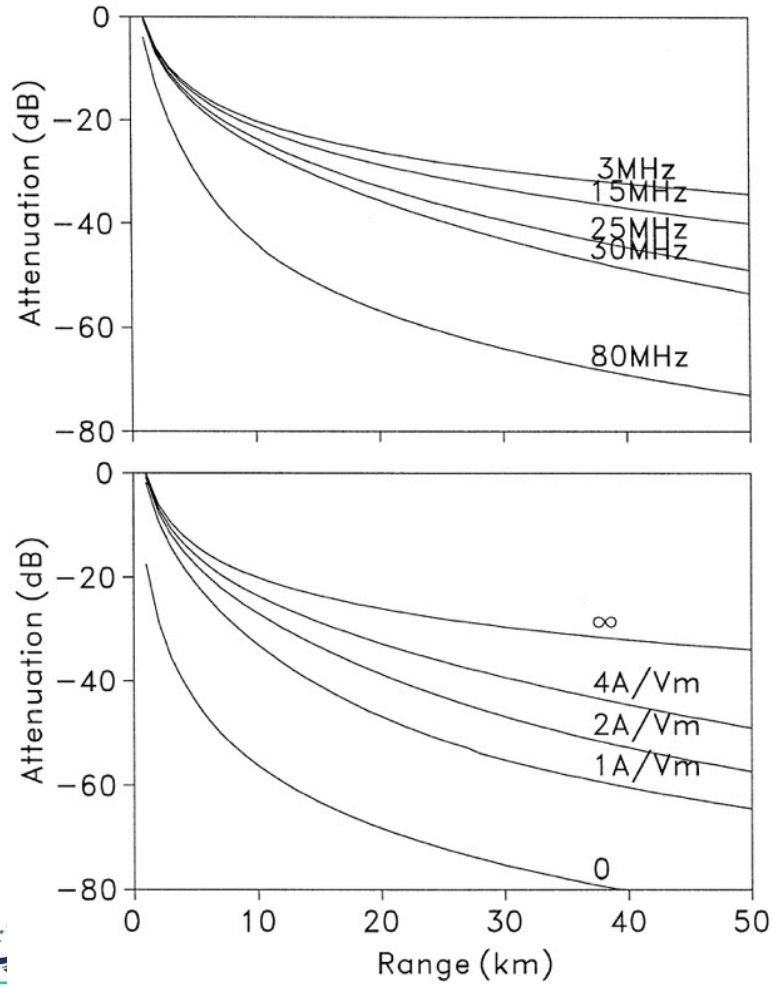

Signal strenght of sea echo VS distance at different frequencies

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Theory of operation

Radar Frequency (MHz)	Radar Wavelength (m)	Ocean Wavelength (m)	Ocean Wave Period (s)	Depth of Current[1] (m)	Typical Range[2] (km)	Typical Resolution[3] (km)	Typical Bandwidth (kHz)	Upper $H_{1/3}$ Limit[4] (m)
5	60	30	4.5	2	175-220	6-12	15-30	25
12	25	12.5	2.5	1-1.5	60-75	2-5	25-100	13
25	12.5	6	2	.5-1	35-50	1-3	50-300	7
48	6	3	1.5	<.5	15-20	.25-1	150-600	3

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Conclusions

Some advantages:

- ❑ Land based –> low maintenance cost
- ❑ Continuous monitoring of the sea state in automated way
- ❑ Wide area covered

Some limitations:

- ❑ Radio frequency bands are busy -> radio interferences
- ❑ Possible gaps in space and time due to bad S/N ratio
- ❑ Only surface measurements

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