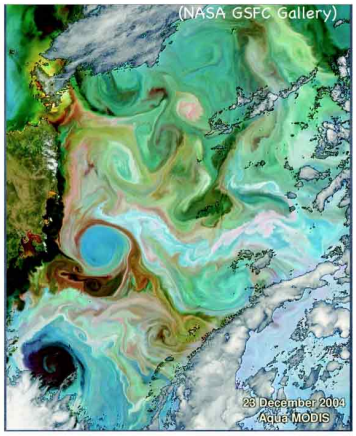
Wavemill: a New Mission for High-Resolution Mapping of Total Ocean Surface Current Vectors

A. Martin[1], C. Gommenginger[1], B. Chapron[2], J. Marquez[3], S. Doody[4], G. Burbidge[4], B. Dobke[4], D. Cotton[5].

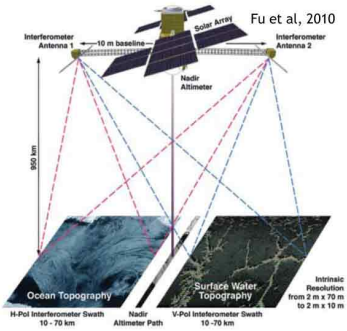
[1]National Oceanography Centre, UK; [2]IFREMER, Fr; [3]Starlab, Sp; [4]Airbus D & S, UK; [5]SatOC, UK.

Mission Objectives — Sample Submesoscale Dynamics

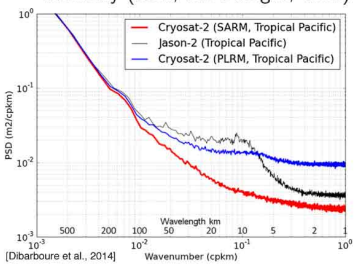
- Vertical transports and Ocean Biology, role of small scale
  - 50% of the vertical transport of ocean biogeochemical properties takes place at scales < 100km (Lapeyre and Klein, 2006)
  - Ageostrophic circulation resulting from perturbation of circular eddy flow lead to upwelling velocity ≈10 m/day (Martin & Richards, 2001) — Ekman pumping ≈0.5 m/day
  - Eddy/wind interactions amplify eddy-induced upwelling (McGillicuddy et al., 2007)
  - Submesoscale processes along the periphery of eddies induce vertical velocities several times larger than those due to eddy/wind interactions (Mahadevan et al., 2008)
- Small scale impact on large scale ocean (Levy, Klein, et al. 2010)
  - large scale circulation
  - Meridional heat transport
  - Thermohaline circulation
  - restratification and mixed layer depth
  - biogeochemistry on basin scale



Complementarity with SWOT and Sentinel-3



- Complementarity between high-resolution : SSH (SWOT) & total currents (Wavemill)
- Sentinel-3 : Synergy with SST, ocean colour & high-res. SAR altimetry (SSH, wave height, wind)



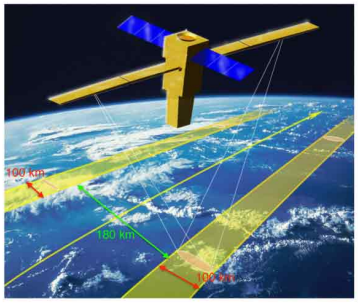
Mission Challenges

- Data intensive
- Power contraints
- Orbit choices
- Sampling strategy & coverage
- Polarisation & incidence angle options
- Currents + winds retrieval

Wavemill

Concept

- Along-Track Interferometry SAR
- Ku-band
- Two 100km swath
- Two Squinted beams
  - to derive 2D surface map



Objectives

- Derive Total Surface Current Velocity Vector

  Total meaning : geostrophic + ageostrophic currents. Ageostrophic include tide, Stokes drift, wind drift, Ekman current
  - at 1km (coastal 500m)
  - with an accuracy of 5cm/s
- Derive Ocean Wind Vector
  - at 1km resolution
  - accuracy < than 2m/s and 20°
- Derive Swell spectrum

Measuring Ocean Surface Currents from Space

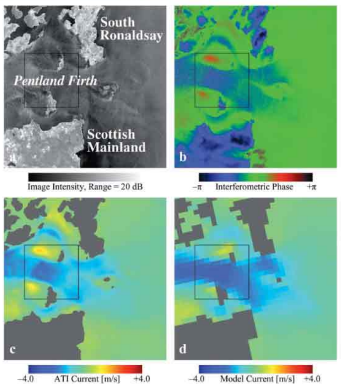
What is available ?

- IR SST & Ocean color
  - only if there is no clouds and strong and trackable features
- Altimetry
  - derive geostrophic current
  - at time scale about 1 week
  - at space scale higher than 50km (conventional) or about 10–25km (SWOT, COMPIRA)
- SAR
  - Doppler Centroid shift — Envisat (Chapron et al., 2005) and Sentinel-1
  - Along-Track Interferometry — Tandem-X (Romeiser et al., 2013)

  ⇒ Surface motion at 1km of resolution

  ⇒ Only component perpendicular to the track

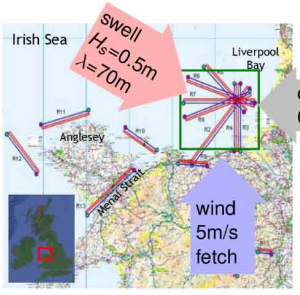
[Romeiser et al., 2013]
Orkney Islands
Tandem-X
ATI SAR



- Participation to Earth Explorer 9
- Building the Science Team ⇒ email : *cg1@noc.ac.uk*

Wavemill Airborne Proof-of-Concept — Wind-wave influence on the Doppler signal — Theory, Data & Model

- Dual beam Along-Track SAR interferometry
- Flight, the 26th of October 2011, VV-pol, 25°–45°



Data

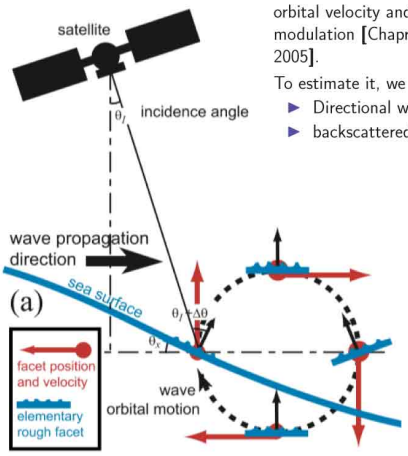
- In situ directional wave spectrum (up to $\lambda = 5$m)
- ADCP current at 2-4m below the surface
- MetOffice Wind (1.5km ; 1h)

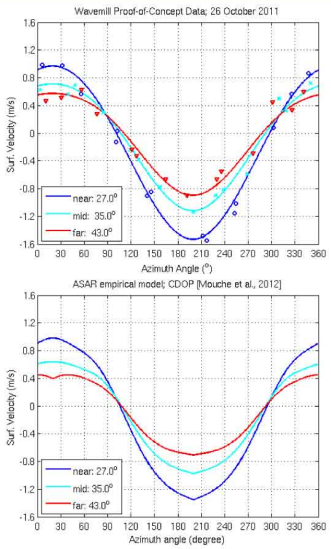
Wave artefact surface velocity — Theory

Line-of-sight velocity is sensitive to correlation between wave orbital velocity and wave tilt modulation [Chapron et al., 2005].

To estimate it, we need :

- Directional wave spectrum
- backscattered GMF





admartin@noc.ac.uk