

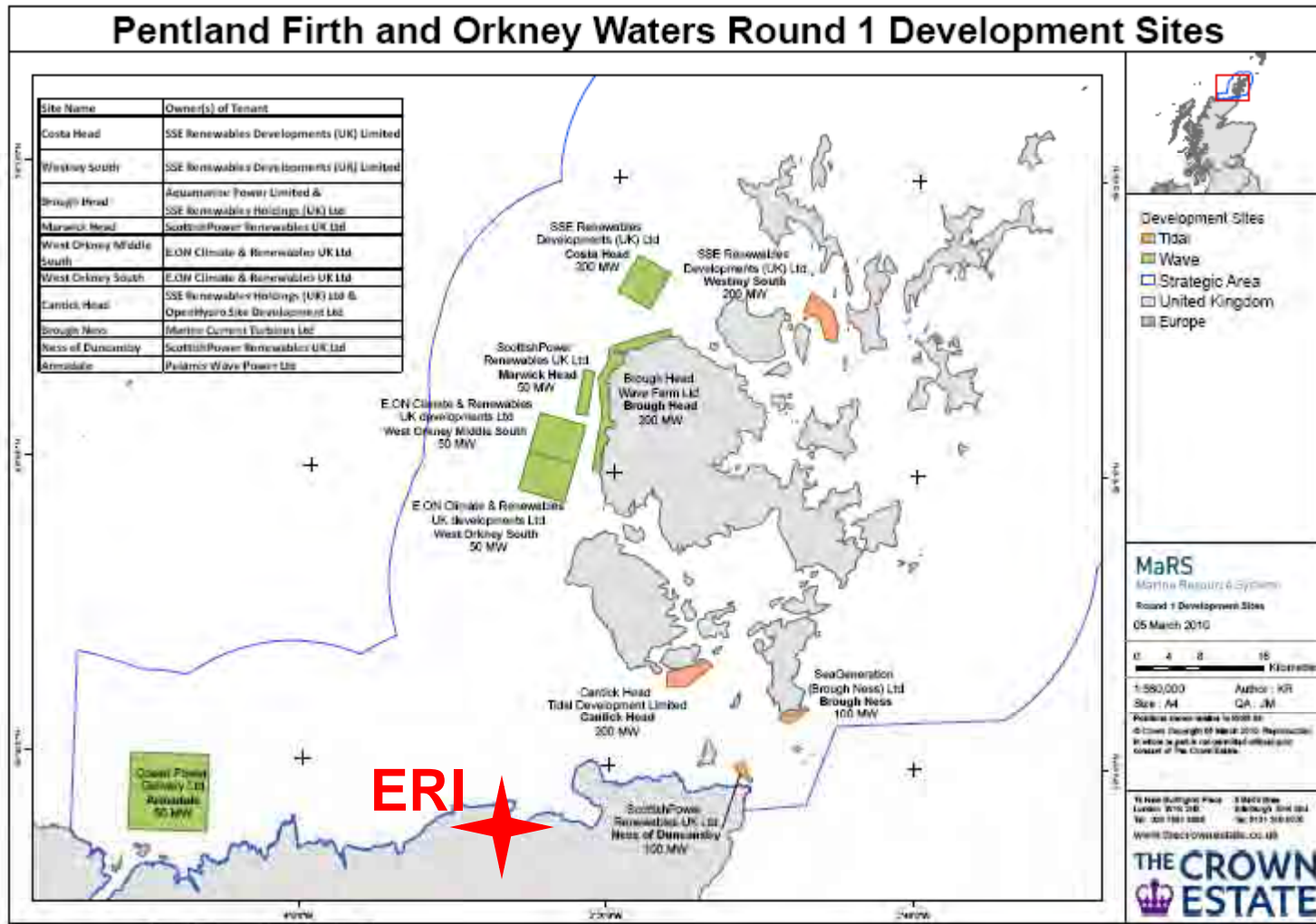
Towards determining the exploitable resource of a real tidal channel; The Inner Sound of Pentland Firth

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Gold Rush?



<http://www.thecrownestate.co.uk/newscontent/92-pentland-firth-developers.htm>

Building capacity in the region



Strategic Research Development Grant



- Predict environmental impacts of wave & tidal devices
- Address key roadblocks in developing the UK marine renewables sector

SuperGen marine



- Provide next generation of leaders in marine energy research
- Provide industry a dynamic & enduring R&D base in the locality

Offshore Renewable Energy Conversion platforms – Coordination Action (OREC-CA)



MaREE: A capacity building project



- **Builds on:** Existing expertise in marine & environmental sciences
Current activity and partnerships
Unique resource potential of the region
- **Focus** Environmental issues related to marine renewable energy + the socio-economic aspects
- **Aims** Establish academic leadership in the H&Is in a sector that contributes to Government's renewable energy targets

To develop a sustainable programme of applied and fundamental research (+ associated KE and commercial activity)
 - Underpinned by strategic partnerships

Resources and risks

Dr. David Woolf

Theme lead



Research staff: Dr. Peter Bowyer
Dr. Lonneke Godijn-Murphy
Dr. Tariq El-Geziry *

Technicians: Soeren Hoejlund
Yen-Fu Chen
Dr. Jason McIlvenny

PhD researchers:

M. Easton - An integrated modelling framework for EIA of large-scale arrays

J. Dufaur *- Meteorological forcing of current & sea level anomalies in Pentland Firth

G. Marchi *- Tidal races in the Pentland Firth as an obstacle to tidal stream energy development

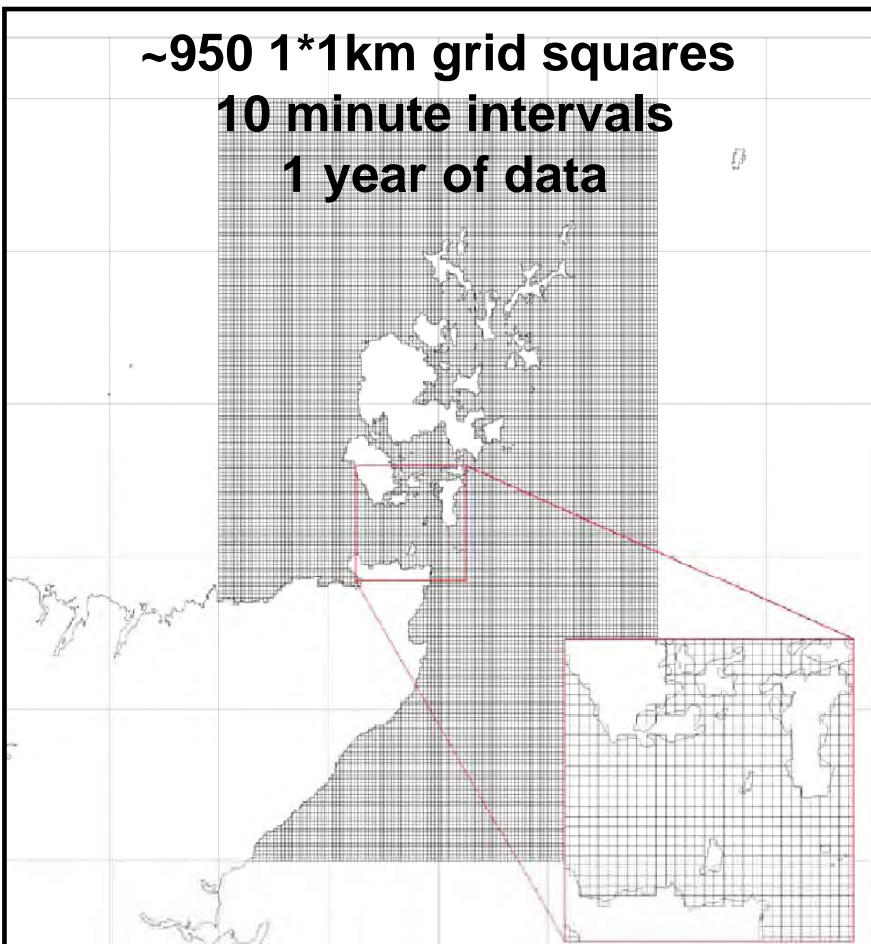
- Tidal resource assessment / Wave climate assessment
- Modelling device-environment physical interaction
- Weather windowing
- Satellite, radar, acoustics and buoys data, GIS /modelling

Outline of Tidal Stream Research

- Analysis and GIS Mapping of Low Resolution Model (POLPRED Orkney Model)
 - Lora Jane Dillon, 2006-7
- Underway ADCP Surveys
 - Lonneke Goddijn-Murphy, 2009
- High Resolution Modelling
 - Matt Easton, 2009 - (*see also PG presentation*)
 - Peter Bowyer, 2010 -
- Remote Sensing Methods

The POLPRED Model

Proudman Oceanographic Laboratory



1/120° lat by 1/60° long

58°N to 59°40'N

04°00'W to 02°00'W

Temporal or Spatial

Level of tide

Speed of current

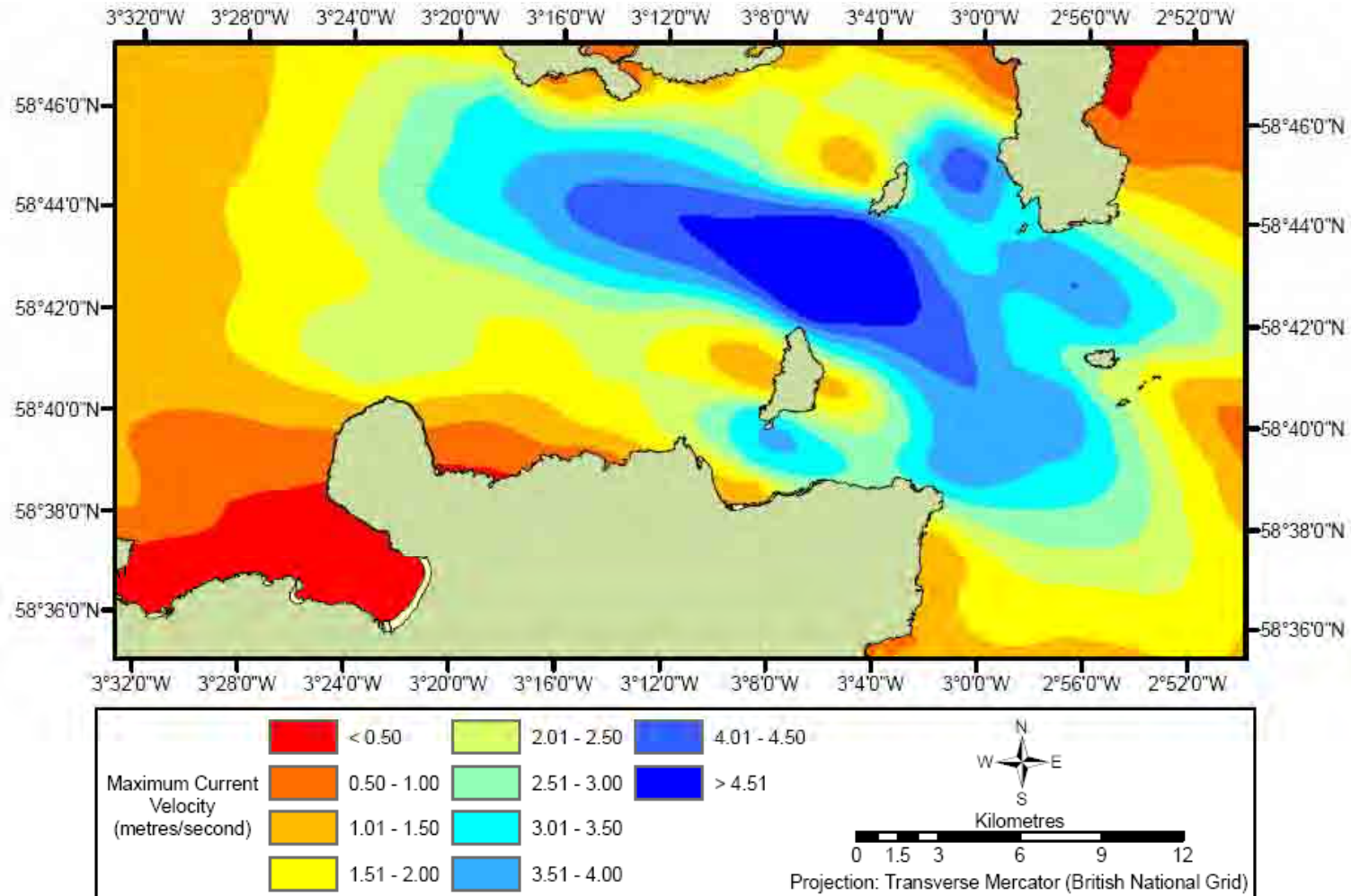
Direction

Tidal Diamonds

Long term statistics

Particle tracking

Modelled Tides (POLPRED)

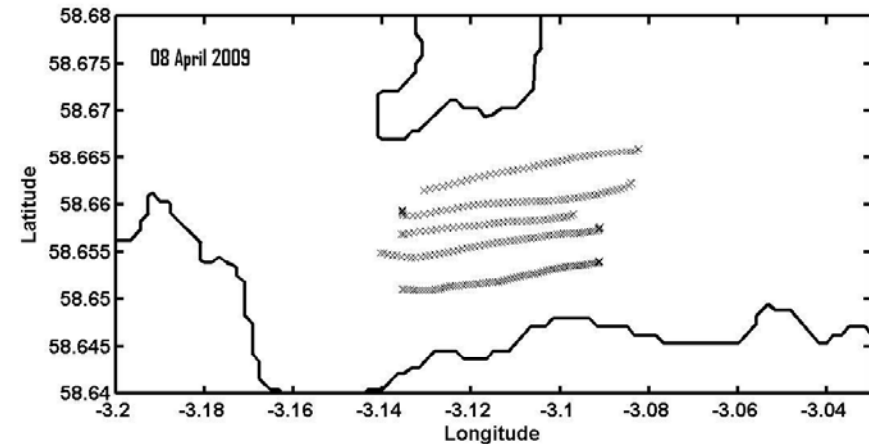


MSc Project of Lora Jane Dillon. POLPRED 1/120 x 1/60 "Orkney Model" under license from POL.

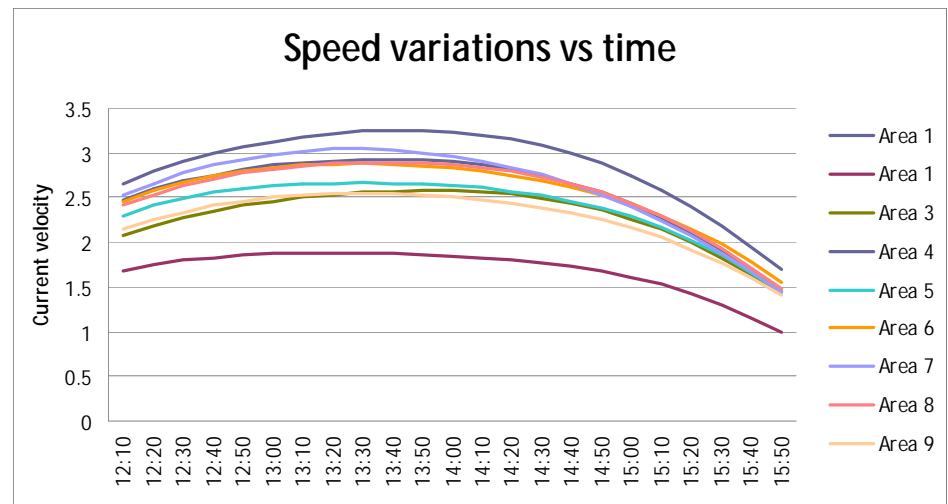
Boat Survey and Analysis



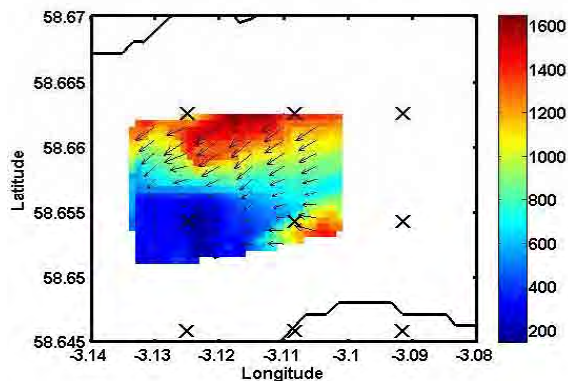
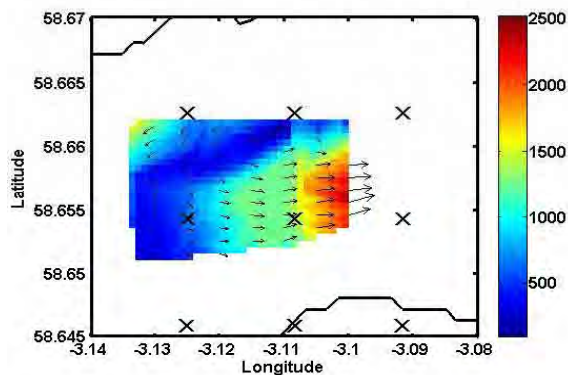
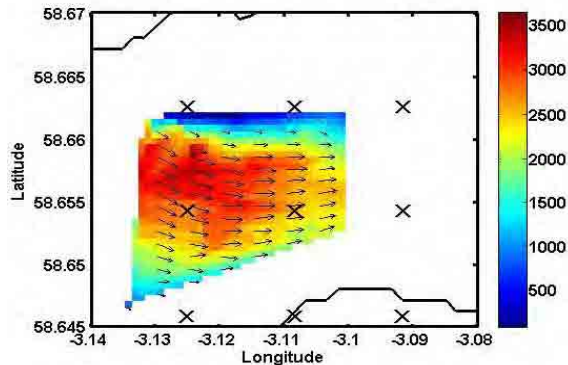
Underway ADCP surveys



Matching data on survey tracks (above) to low-resolution model data (below)

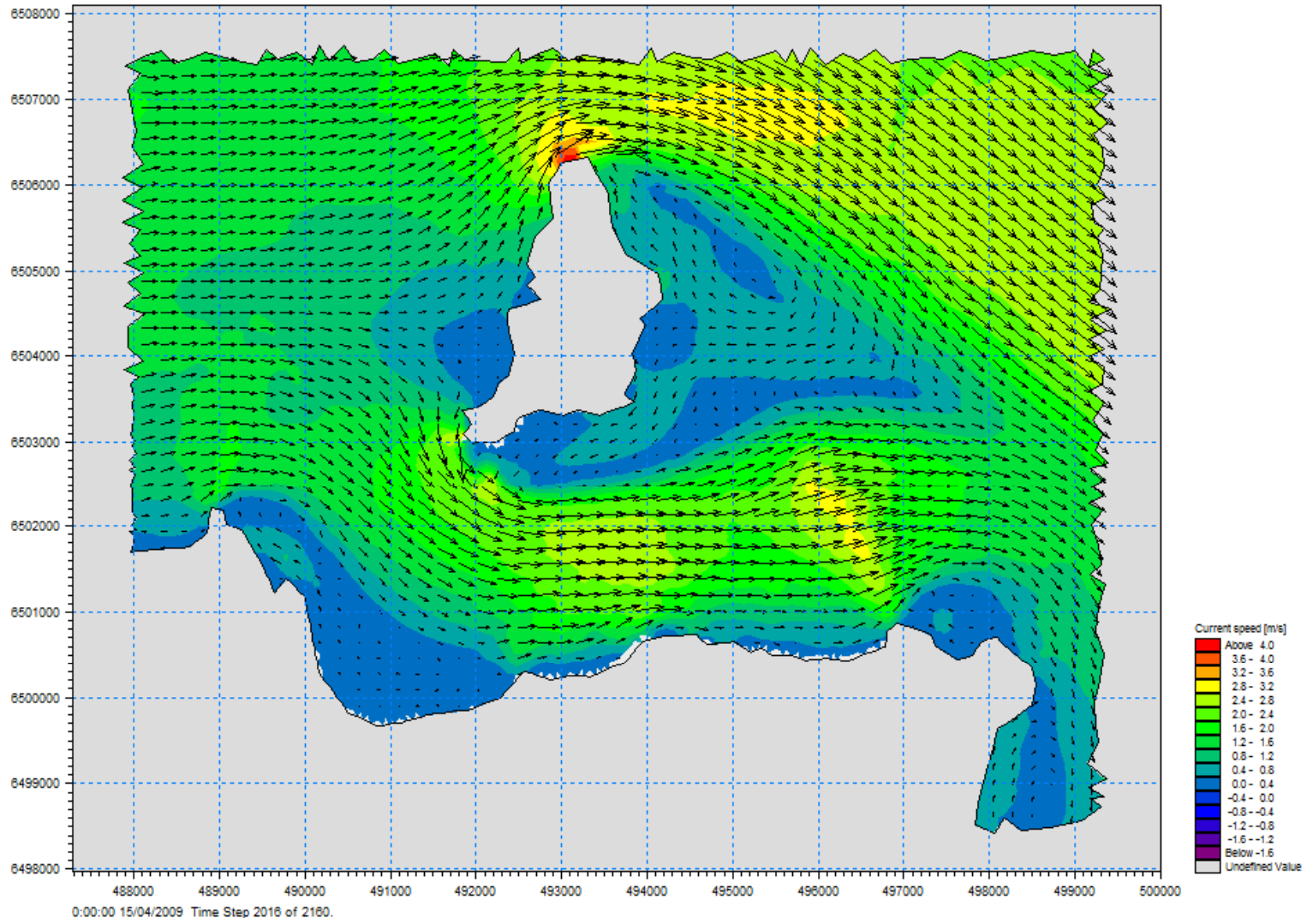


Detailed Characteristics of the Tidal Stream Resource

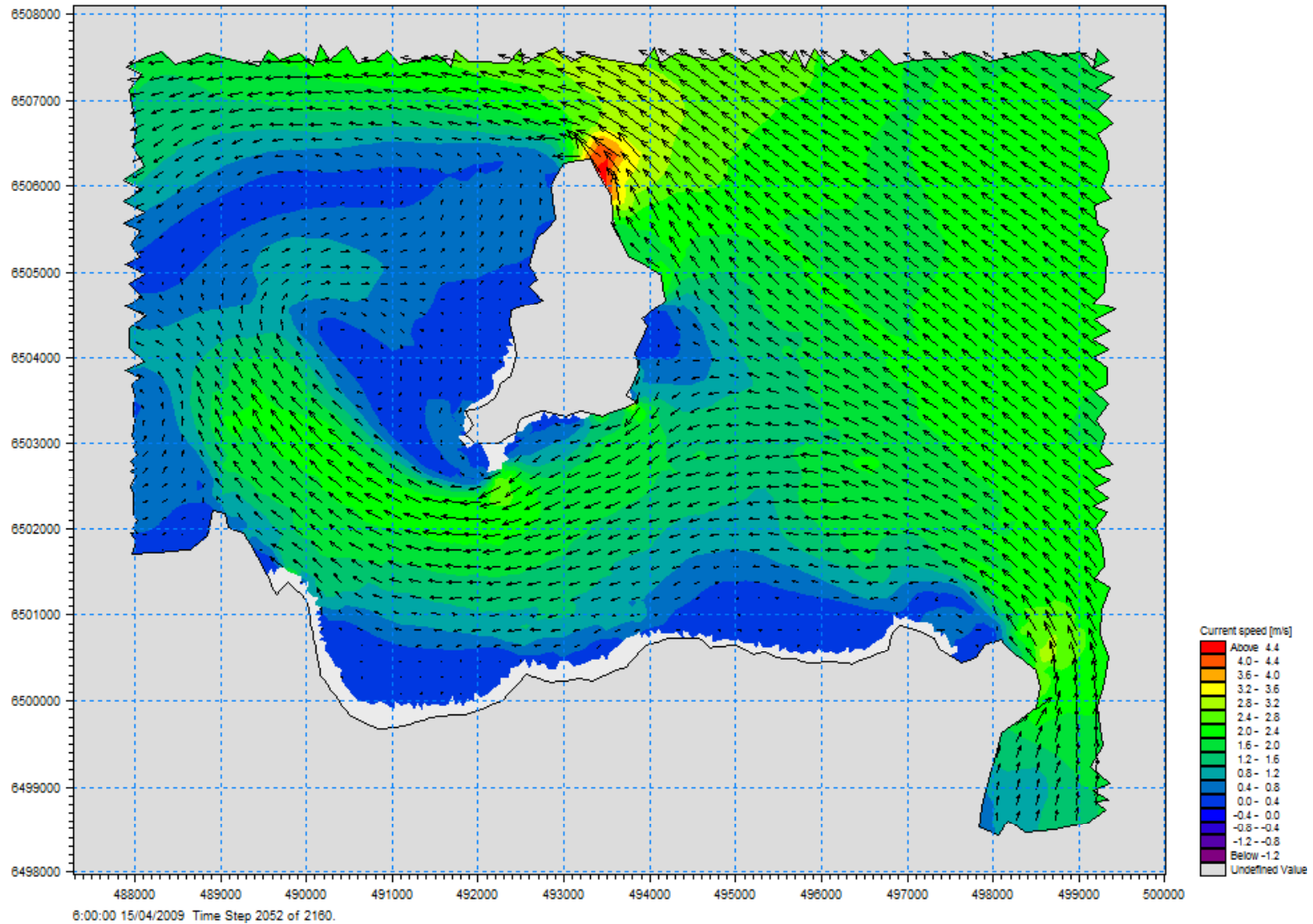


- Current strengths can vary over distances of only 100 metres
- Flood and Ebb Streams can be asymmetric
 - In Strength
 - In Position
 - In Direction
- “Bi-directionality” of tidal currents is rare
 - Asymmetry
 - Tidal ellipses
 - Eddies
- Vertical shear is mainly (but not always) restricted to near the sea bottom

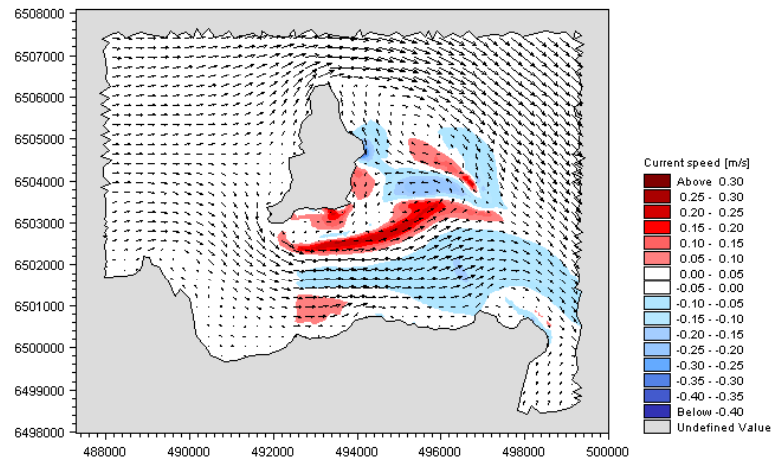
Inner Sound on Flood



Inner Sound on Ebb



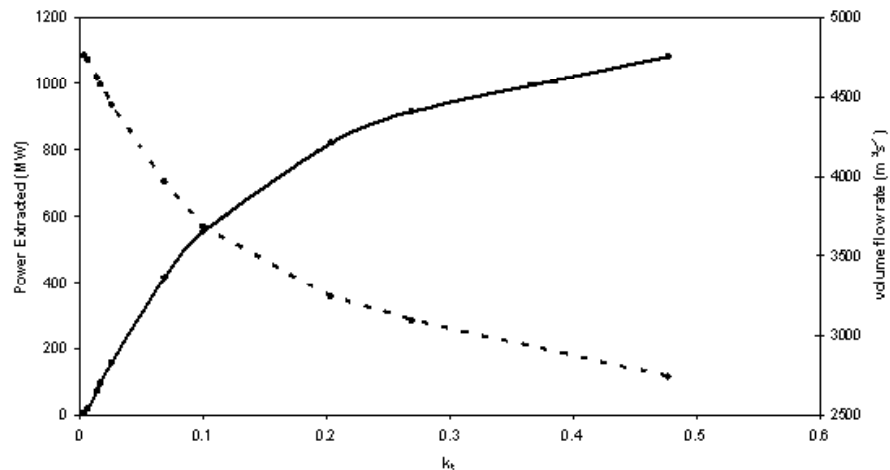
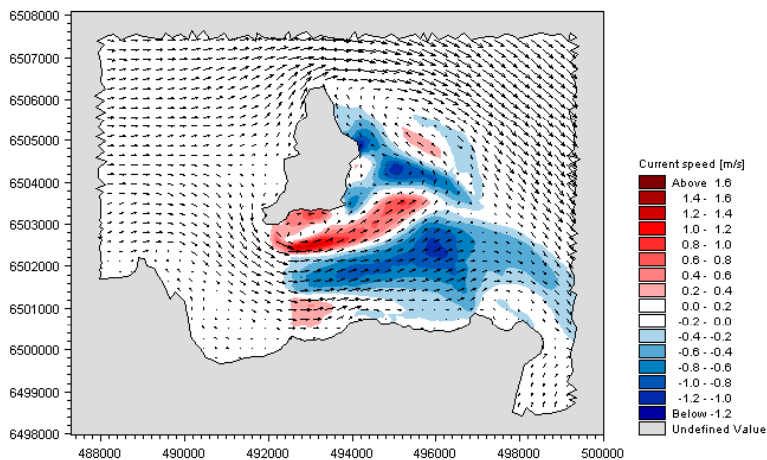
How are the hydrodynamics altered by introducing energy extraction?



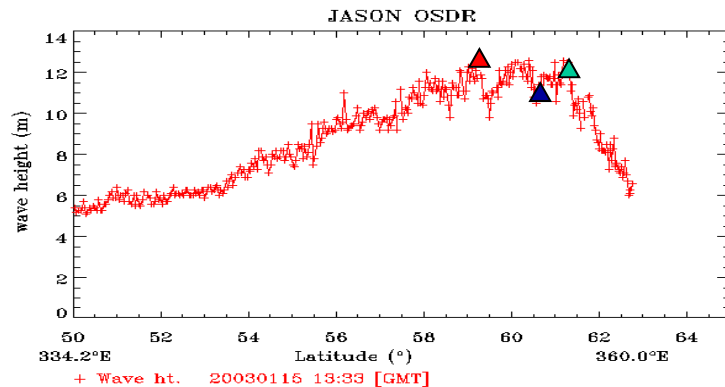
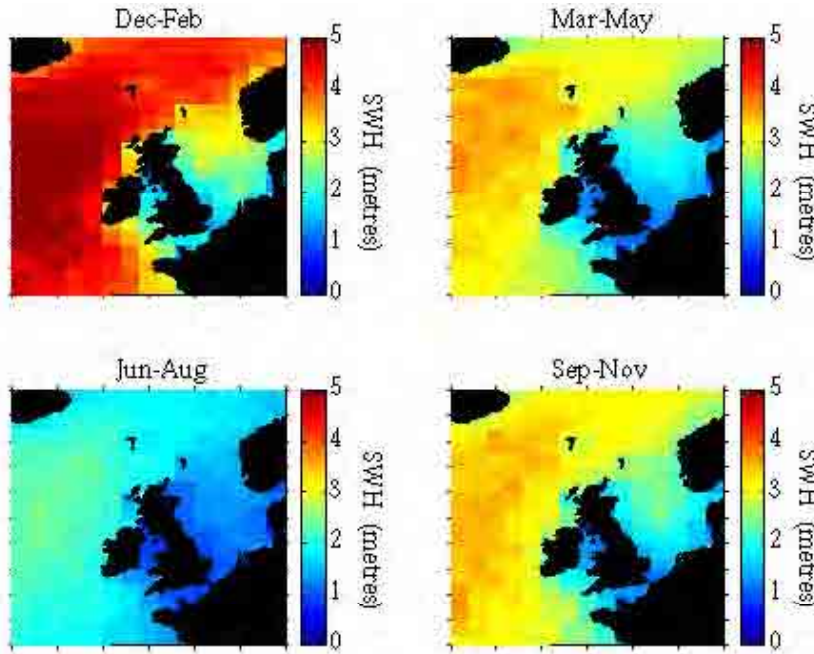
If we introduce a tidal fence, significant current anomalies are inevitably introduced

Large anomalies result from GigaWatt-scale extraction, with diminishing returns

Currents → Sedimentation Dynamics
→ Habitat → Ecology

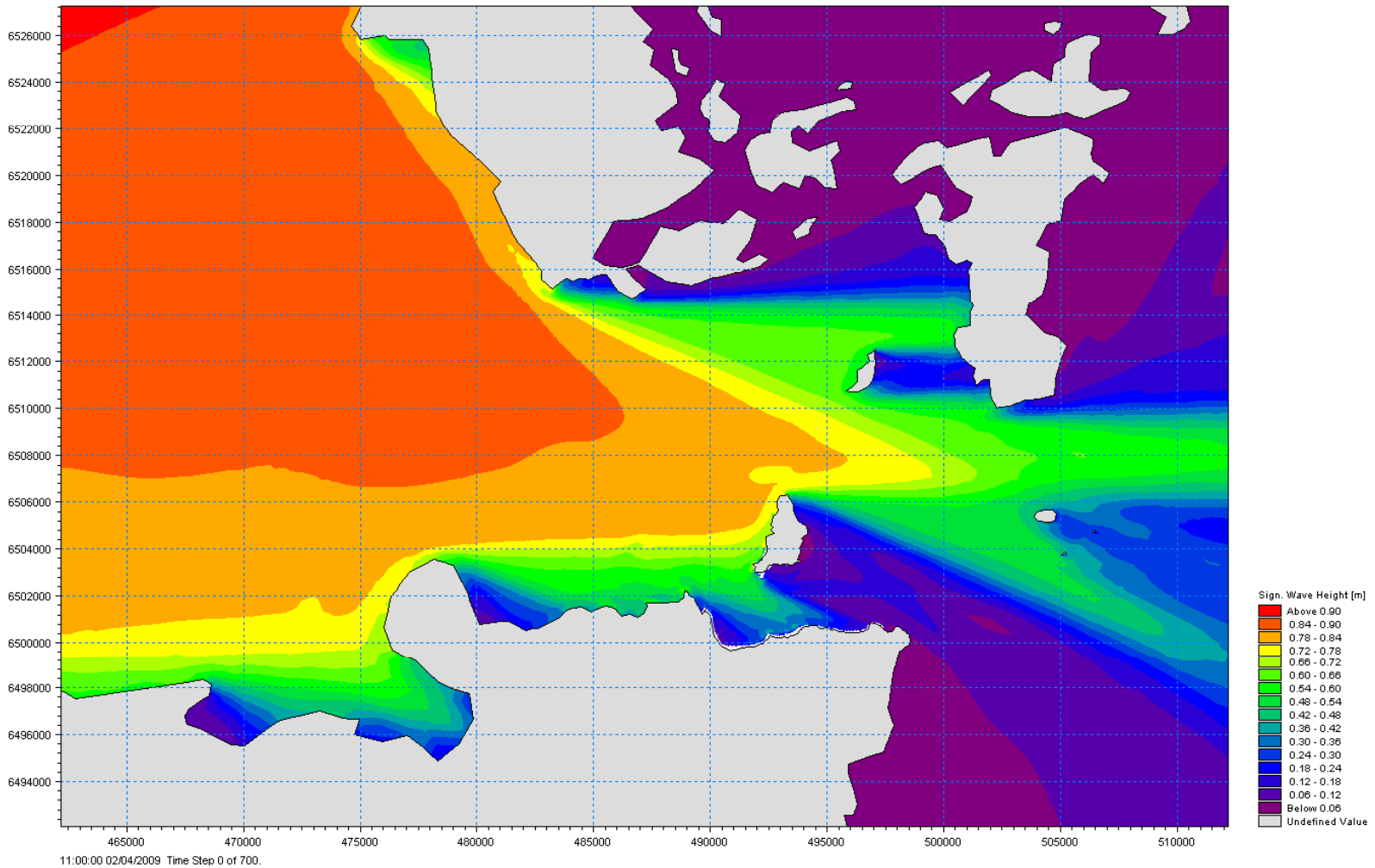


Wave Climate



- Offshore wave climate can be effectively measured by satellite altimetry
- At sites such as Pentland Firth, there is a complex interaction of waves with bathymetry and currents
- Validated wave model output is essential data for exposed tidal energy sites such as the Pentland Firth

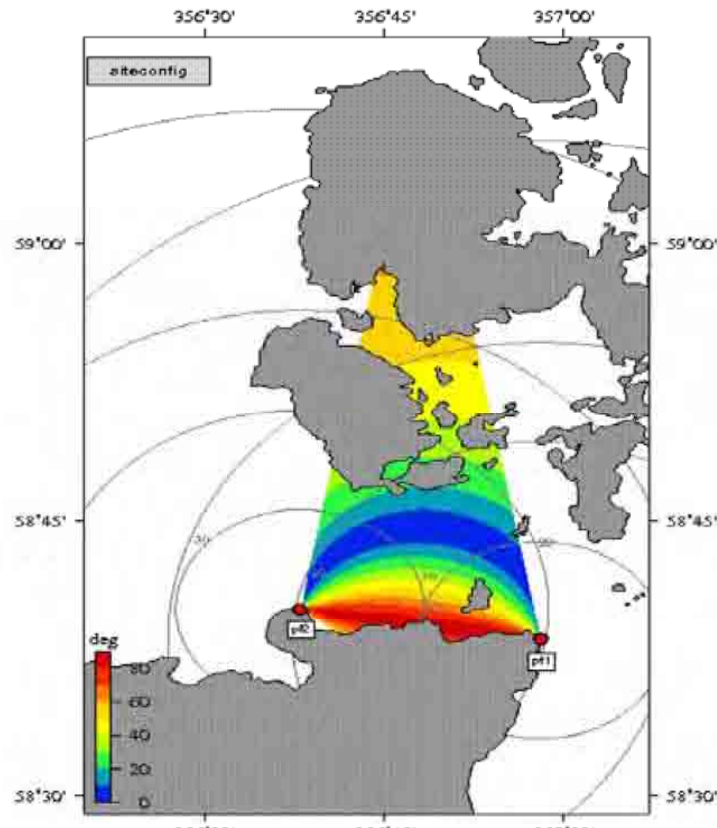
Wave Modelling



Simple case of a uniform 1 metre sea propagating from the western boundary

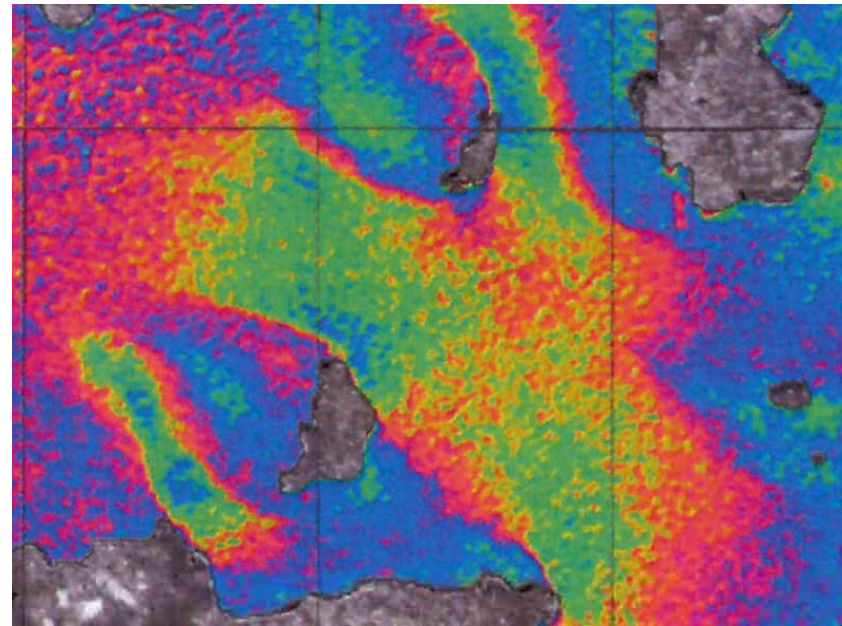
Remote Sensing Methods

Coastal HF Radar



“RASCAL PF”; Courtesy Lucy Wyatt and Jon Side
N.B. Waves also!

SAR Along Track Interferometry



Radial Velocity by SAR ATI (X-SAR / SRTM). N.B. one colour cycle equates to a difference in velocity component of 4m/s. From Runge et al. (2004)

Obstacles and Solutions

- Finite Limit on Extraction
- Complicated Current Characteristics
- Tidal Races and Severe Turbulence
- Severe Wind and Wave Climate
- Ecology Sensitive to Large-Scale Hydrodynamics
- Modelling (flows and waves)
- New Measurement Technologies (e.g. for Tidal Races)
- Validation
 - Point (e.g. fixed ADCP)
 - Boat Survey
 - Remote Sensing
- Co-ordinated physical and ecological studies