The UK's Geophysical Equipment Facility

Alex Brisbourne, SEIS-UK

Orfeus Observatory Coordination Workshop

Lisbon, May 2011

With contributions from Alan Hobbs, Nick Harmon and Tim Henstock

Geophysical Equipment Facility
NATURAL ENVIRONMENT RESEARCH COUNCIL

OBIC

SEIS U.K.

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Talk Structure

- Introduction to the facility
  - Onshore seismic
  - Offshore seismic
  - Non-seismic
- Data management by SEIS-UK
- Recent developments
  - Satellite modem State-of-Health
  - Understanding current induced noise on broadband ocean bottom seismometers using CFD
- GEF within the “AlpArray” concept
- Summary

A 3-Node Facility

GEF is a 3-node facility of NERC, the UK's *Natural Environment Research Council*.

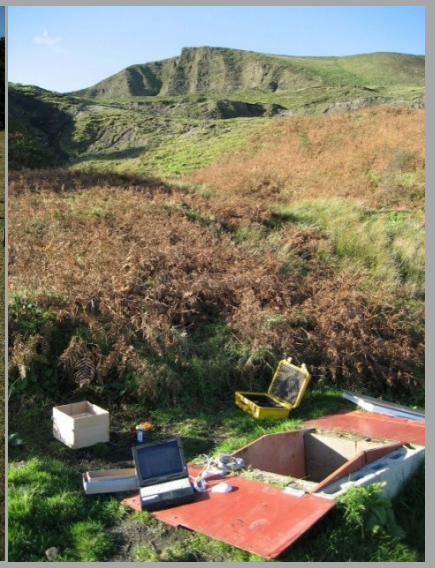
SEIS-UK is based at the University of Leicester and supports onshore seismic data acquisition;

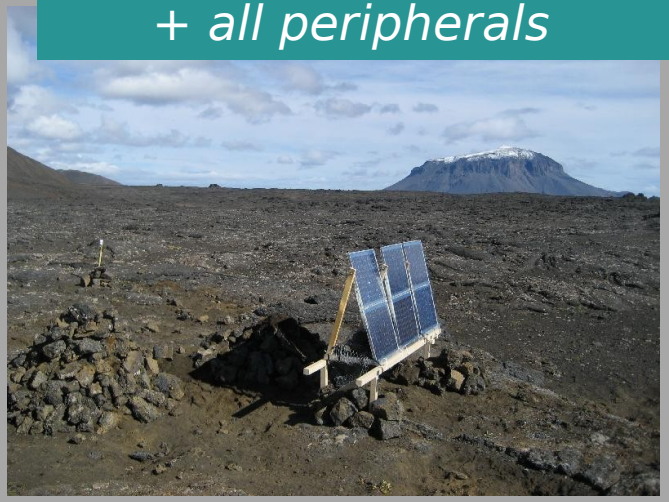
OBIF, based at the Universities of Durham and Southampton, supports multi-sensor seabed instrumentation, including seismology;

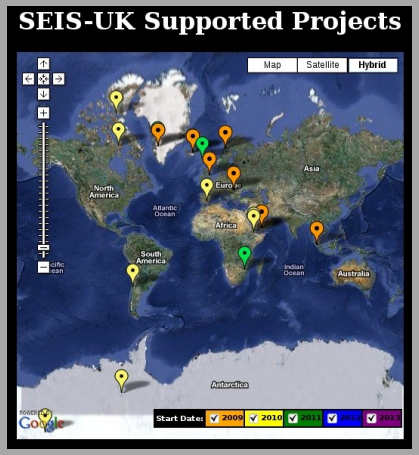
Onshore Seismic

Established in 2000, now with:

- 29 x CMG-3TD with DCM
- 15 x CMG-3T with NMX Taurus
- 20 x CMG-40TD with DCM
- 45 x CMG-ESPDC
- 110 x CMG-6TD
- 20 x High Frequency systems
- 28 x LE-3Dlite
- *+ all peripherals*



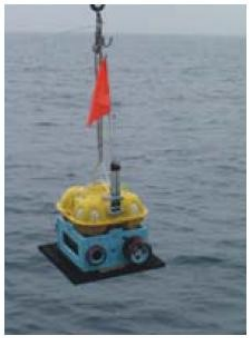




UK marine instrumentation

- 50 instruments capable of 4C seismic recording, mixture of LC-2000 and modified LC-4x4
- 9 of the LC-4x4 based systems can be equipped with differential pressure gauge
  - Recording time up to 9 months possible with standard pressure tubes and flotation using DPG and short period geophones
  - Development of 4-C broadband using Trillium compact sensors (120s max period) in progress
- Data converted to SEGY, miniSEED etc
- 14 instruments have low-noise amplifiers for EM

Type	Available	Sensor Type	Max. Depth	Max. Endurance
LC2000-2	18	Vertical L22 Geophone, HTI-90-U Hydrophone	6000m	280 days
LC2000-4	8	Gimballed 3-component L22-8 geophone, HTI-90-U Hydrophone	6000m	140 days
LC4×4	24	Gimballed 3-component L22-8 geophone, HTI-90-U Hydrophone	6000m	320 days
LC4×4-LD	10	Gimballed 3-component L22-8 geophone, Differential Pressure Gauge	6000m	320 days
LC2000-EM	14	12m Dipole with AIS Ag-AgCl sensors	6000m	60 days

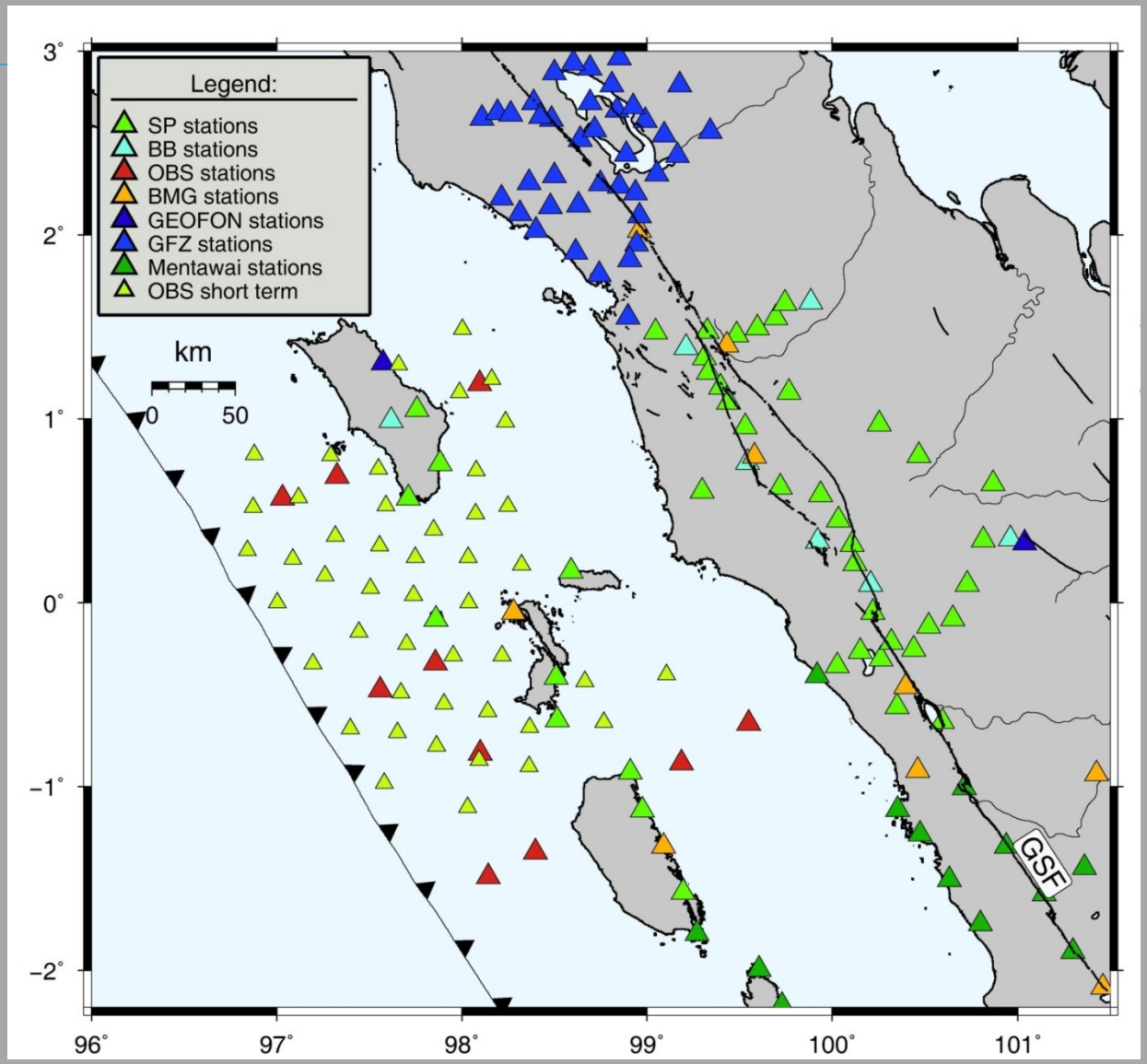


Typical deployments

- Marine experiments (active or earthquake source)
- Combined land/marine arrays eg using SEIS-UK, such as Sumatra
- Rapid response if instruments not committed elsewhere (eg Chile)

Example - Sumatra

- Onshore-offshore recording, 9 month DPG combined with short-term array for analysis (see Lange et al., EPSL



Onshore GNSS

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Leica Geosystems GX1230 Receivers

- Dual frequency geodetic receivers
- Optional Glonass reception
- Static and cm level RTK operation
- Choke-ring antenna option
- 23 receivers available for loan

Leica Geosystems SR530 Receivers

- Dual frequency geodetic receivers
- Static and cm level RTK operation
- Choke-ring antenna option
- 8 receivers available for loan

Static and R TK

Slide courtesy of Alan Hobbs, GEFE

Ground Penetrating Radar

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3 Systems Available

Sensors and Software Pulse EKKO Pro

· 3 transmitter powers up to 1000V
· 25, 50, 100, 200 and 500 MHz antennas
· Multi-channel option

Sensors and Software Pulse EKKO 100

· 400 and 1000V transmitters
· 25, 50, 100, and 200 MHz antennas

Sensors and Software Pulse EKKO 1000

· 225, 450, 900, and 1200 MHz

Glaciology; shallow structure; archaeology; geomorphology; water table etc

Slide courtesy of Alan Hobbs, GEFE

Geomagnetic

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Geonics Protem

- Digital receiver
- TEM-47 transmitter
- 3D receiver coil
- Multi-turn 5x5m transmitter loop
- Single turn loops up to 100x100m
- Supplied with Interpex IX1D software
- *acquifers; groundwater contamination; saltwater intrusion; fault m*

Slide courtesy of Alan Hobbs, GEFE

Seismic Data Management and Archive

Part of NERC's Terms and Conditions state that data must be archived at publicly available data centre

Obtain unique network code from FDSN

www.fdsn.org/getcode.html

Record in proprietary format

Use instrument manufacturer's software to convert to Steim-1 miniseed

Populate all miniseed headers at conversion

This then allows for independent verification of meta-data upon completion as the dataless volume is produced separately

Dataless seed generated with make_dlsv of Winfried Hanka

Seismic Data Management and Archive

Use a simple / flat file structure for archive

> Project Directory > Day Directories > Component-Day files

Maintain GPS/SOH data separately

All station quality control is carried out by users in the field immediately after data download e.g. GPS checks; mass positions; continuity

Use PASSCAL utilities and/or qmerge for miniseed data manipulation

Use GOAT at IRIS to verify data format conversion

Produce GOAT text file which is ftp'd to IRIS (uses seed2sync utility)

View data continuity/gaps/overlaps via web interface

Use miniseed2dmc to ship data to DMC

Future developments in data management?

Stations xml vs dataless

SeisComP3 file structure; ArcLink

EIDA node

Archive format of GPS and SoH

Recent Developments at GEF – 1

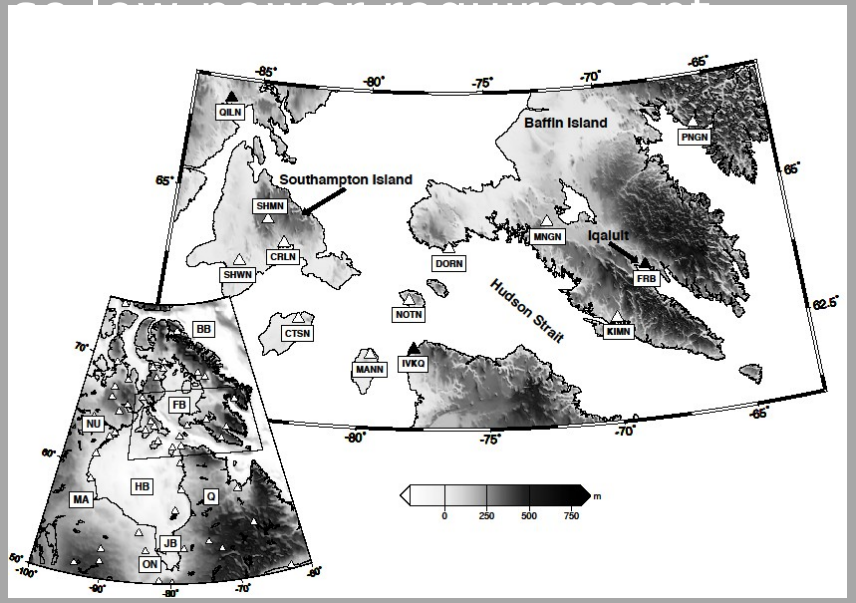
State-of-Health Telemetry for remote high-latitude onshore experiments

Onshore broadband seismic systems deployed by Bristol University as part of the HuBLE experiment studying crust and mantle structure beneath Hudson Bay

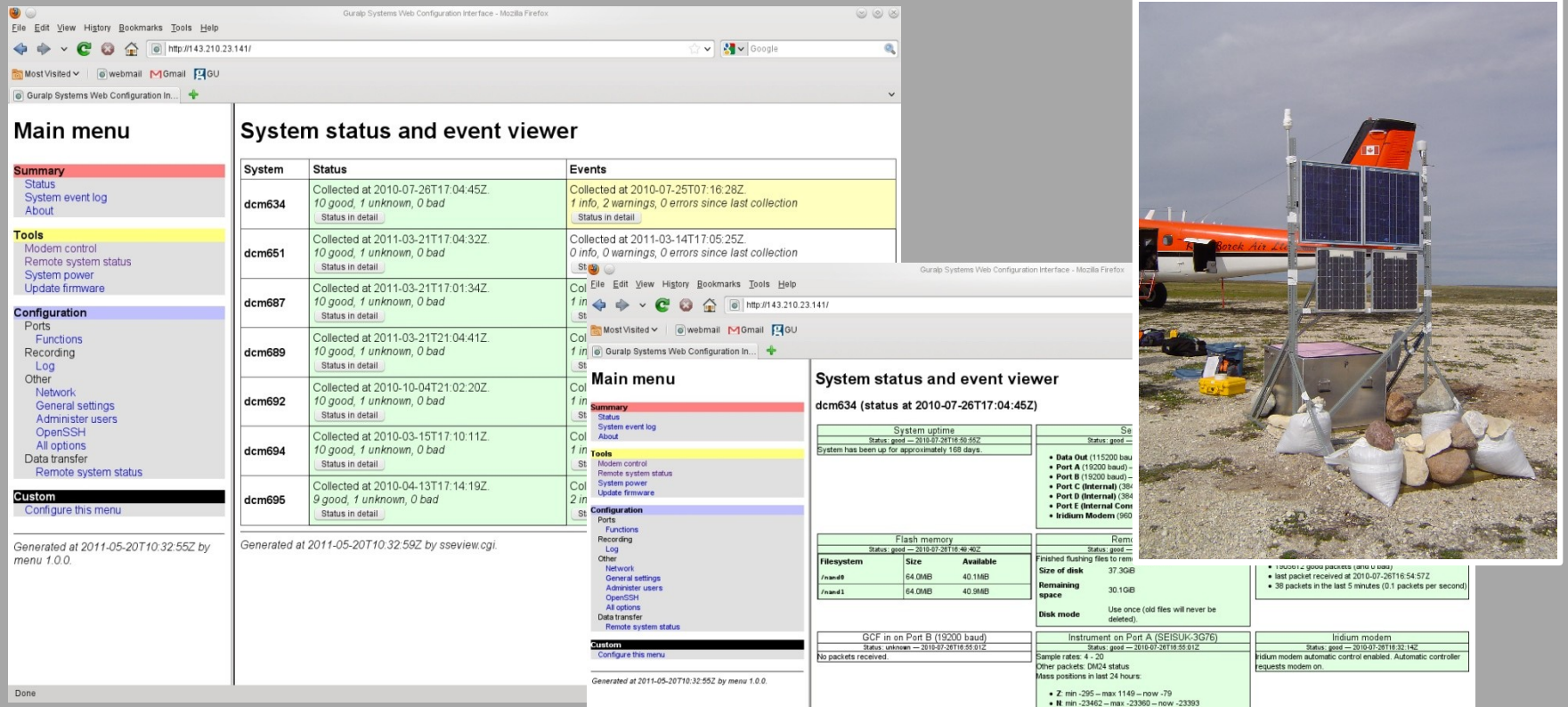
Extremely remote: Annual visits to stations only

High latitude: long dark winter so low power requirement

- *6 x CMG-3TD with Iridium modem equipped DCM data logging units*
- *Modem on twice per week for 8 hours in low-power mode*
- *Base station at SEIS-UK making weekly automatic calls for SoH package*
- *2-way communication possible to resolve issues*



Iridium Modem SoH



The CMG-DCM also supports standard networking protocols and hardware, currently in use in Chile and Serbia where existing infrastructure and power are available

Recent Developments at GEF – 2

Understanding current induced noise on broadband ocean bottom seismometers using CFD

Thomas Spenkuch, Nicholas Harmon, Stephen Turnock

NERC Technology Proof of Concept Project

In the process of acquiring Trillium Compact sensors for BB package

Motivation

Free-fall ocean bottom seismometers are subject to ocean bottom currents, resulting in tilting of the instruments.

Tilting significantly degrades the fidelity of the horizontal components, reducing the usefulness of the instruments.

Turbulent inflow of the currents is likely the primary cause of

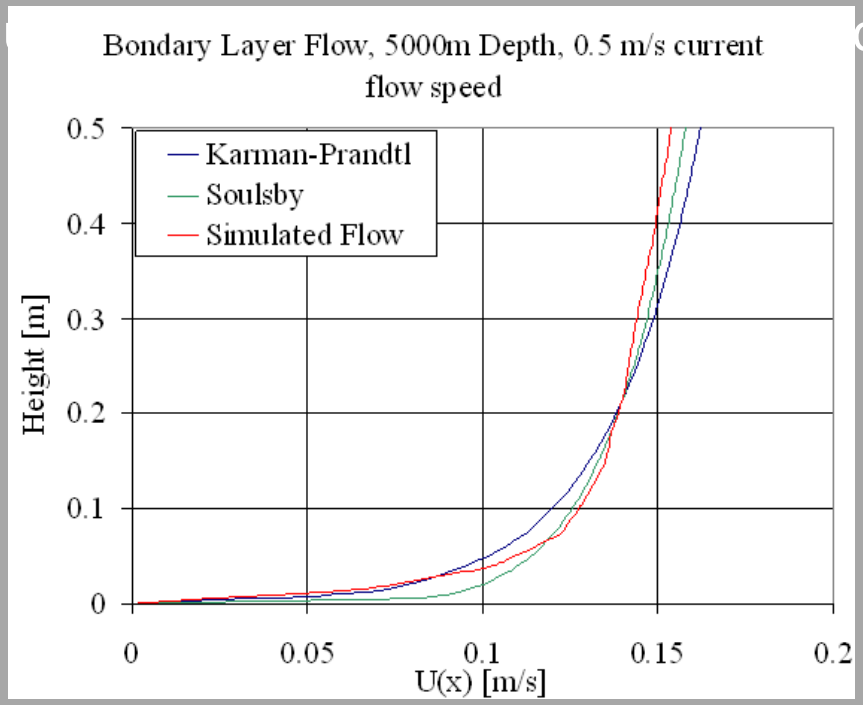
Deep Sea Floor Currents

Current experiences friction with the seabed turbulent boundary layer

Water column close to the seabed is dominated by boundary layer

Velocity forms a logarithmic profile

C depth



Karman-Prandtl equation:

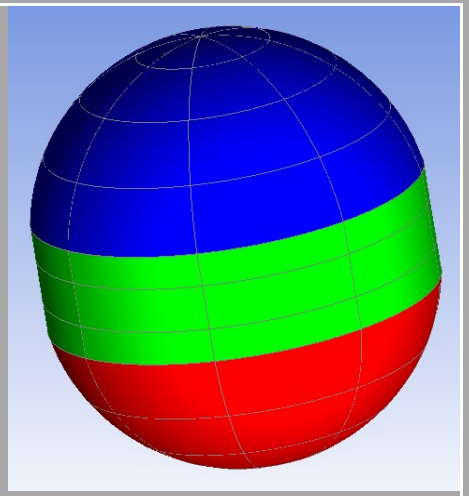
$$U(z) = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_0}\right)$$

Empirical formula by Soulsby:

$$U(z) = \left(\frac{z}{0.32 \cdot h}\right)^{1/7} \cdot \overline{U}$$

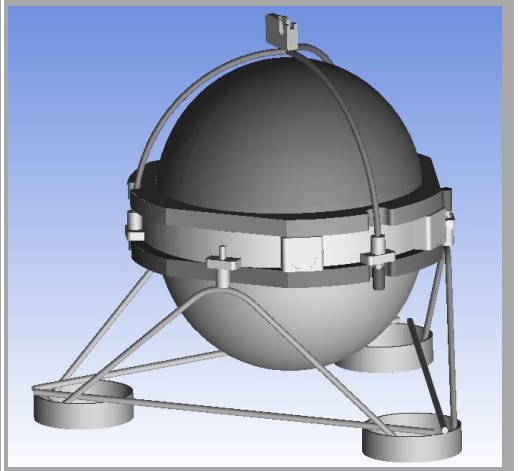
Shapes of Interest

Stretched Sphere

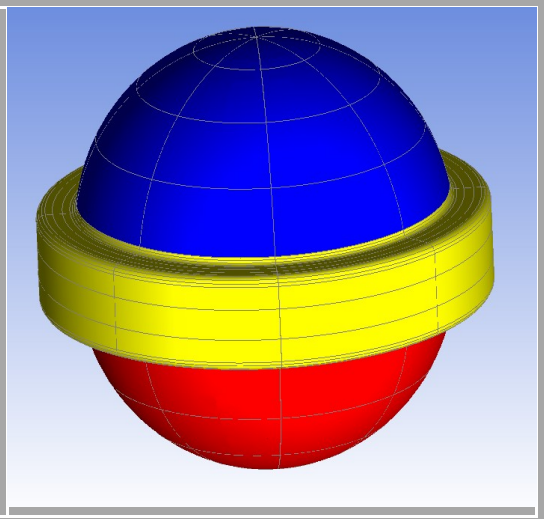


Scripps Institution of Oceanograpy (SIO) *

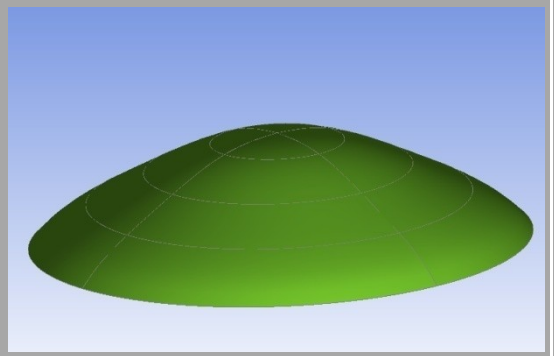
Full Sensor Package



Stretched Sphere + Ring



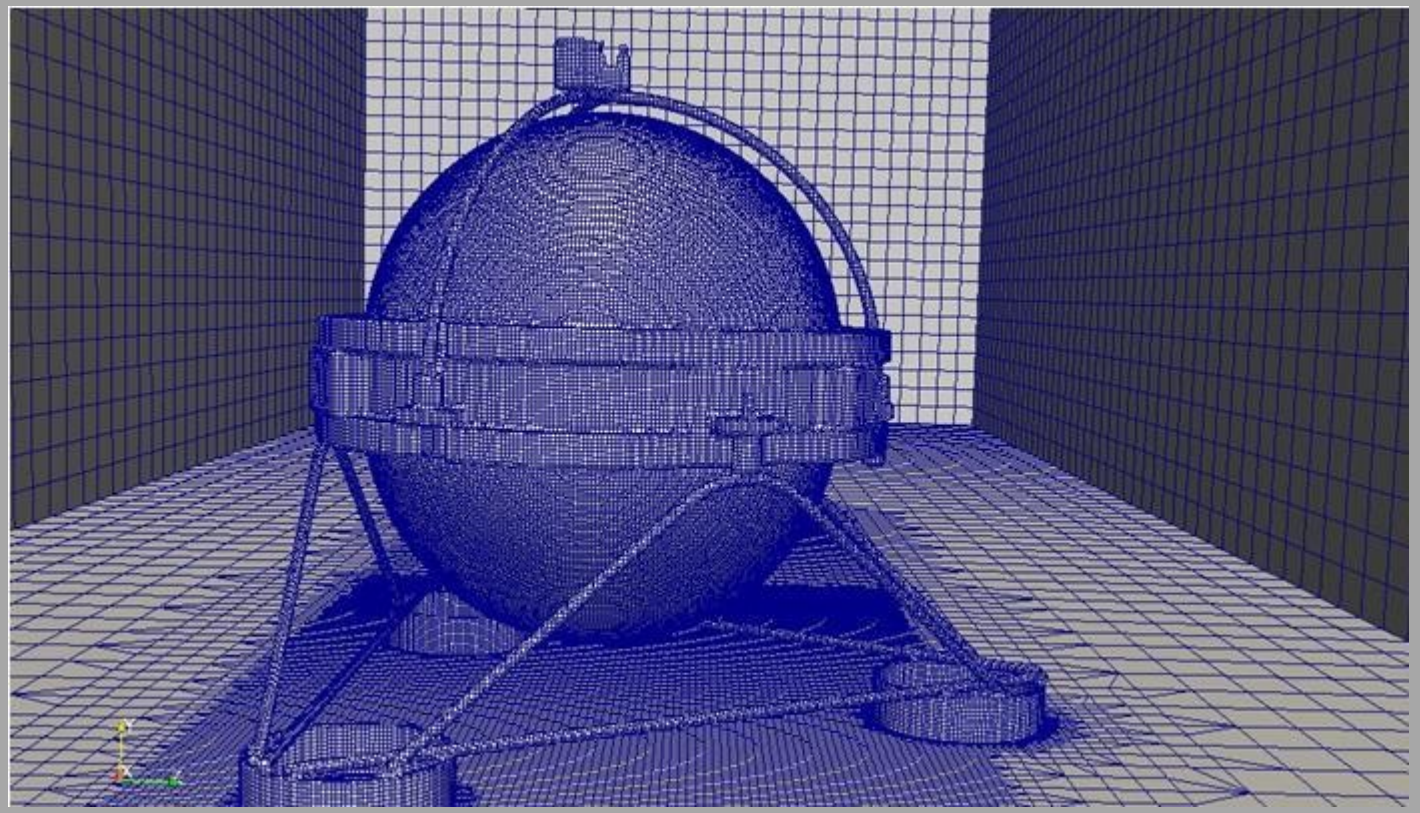
Horseshoe Crab



* CAD drawing provided by Jeff Babcock and Martin Rapa

Meshes – Full package

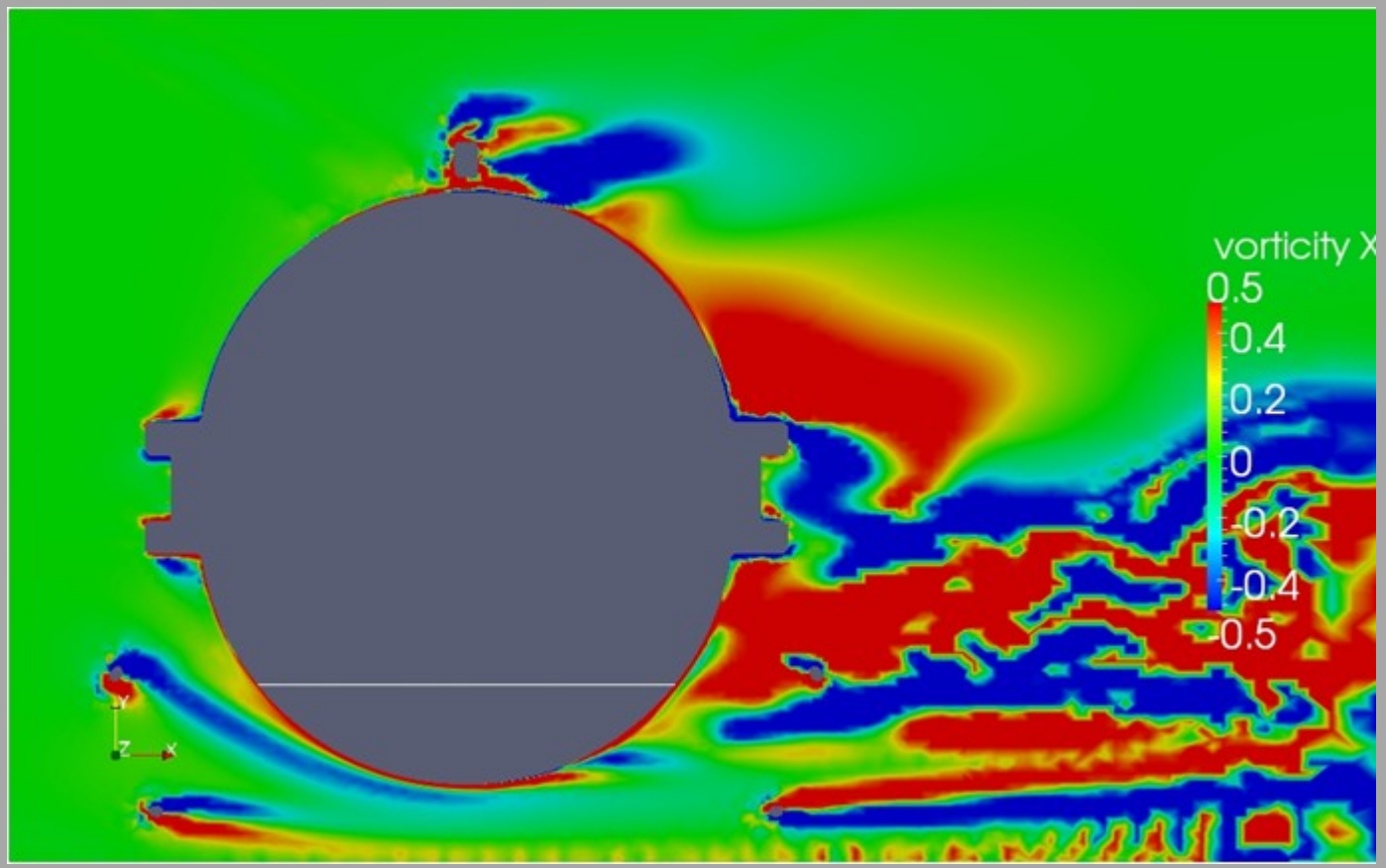
Mesh quality	Number of cells
Medium	2.10 mio



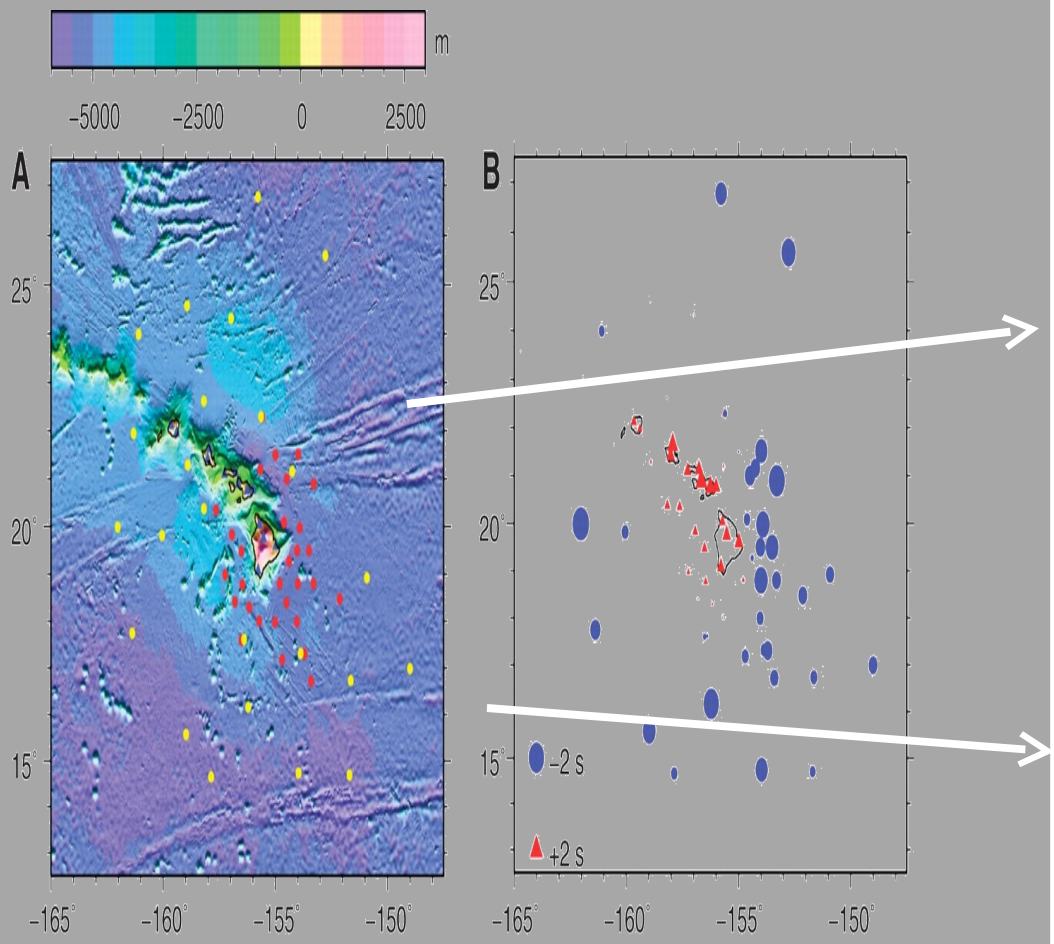
Results – Full Package

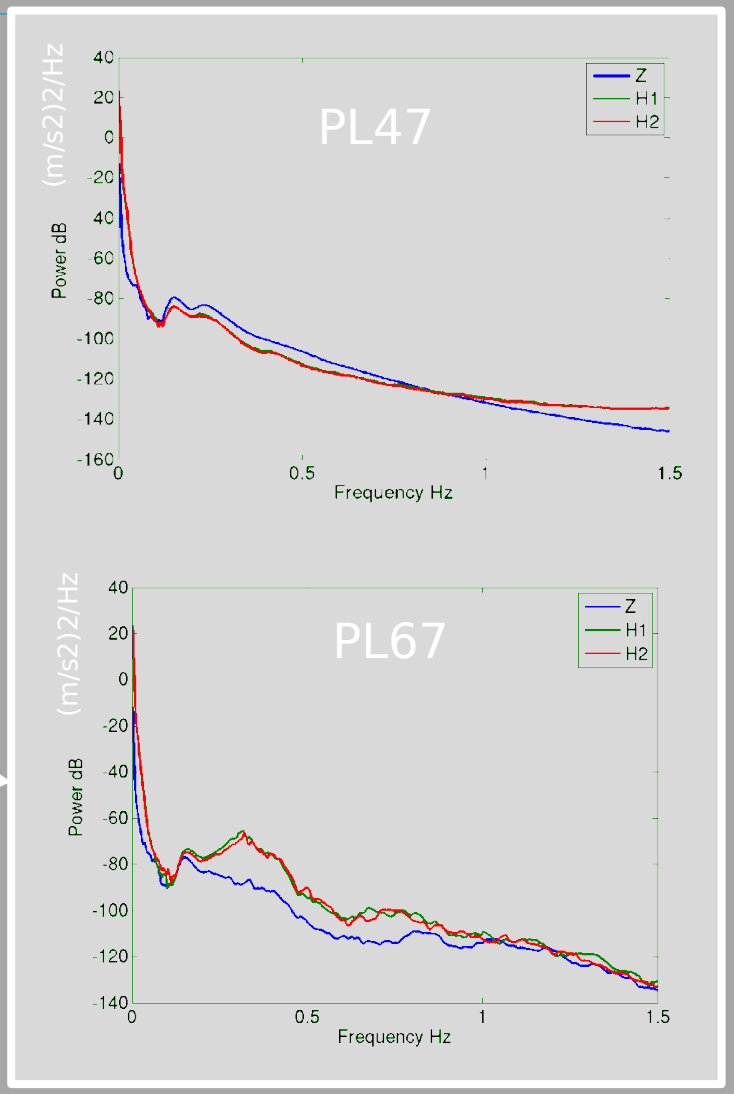
Vorticity contour plot: 3 different flow times t=42.8s, 48.8s, 80.8s

- Curl of the velocity field (vortex identifier) $\vec{\omega} = \nabla \times \vec{u}$



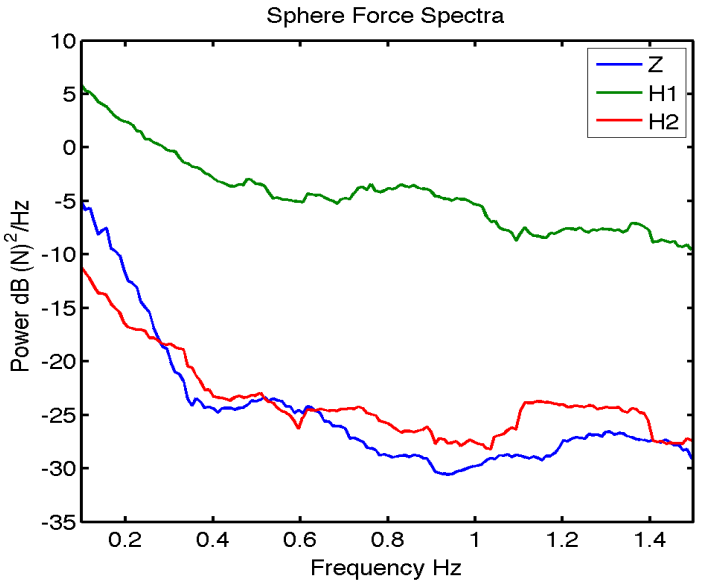
PLUME SIO Trillium 240 Seismometers

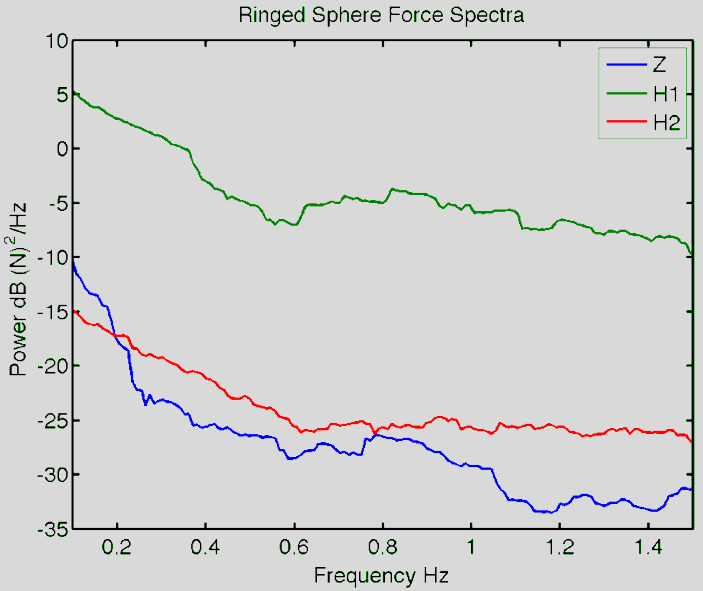


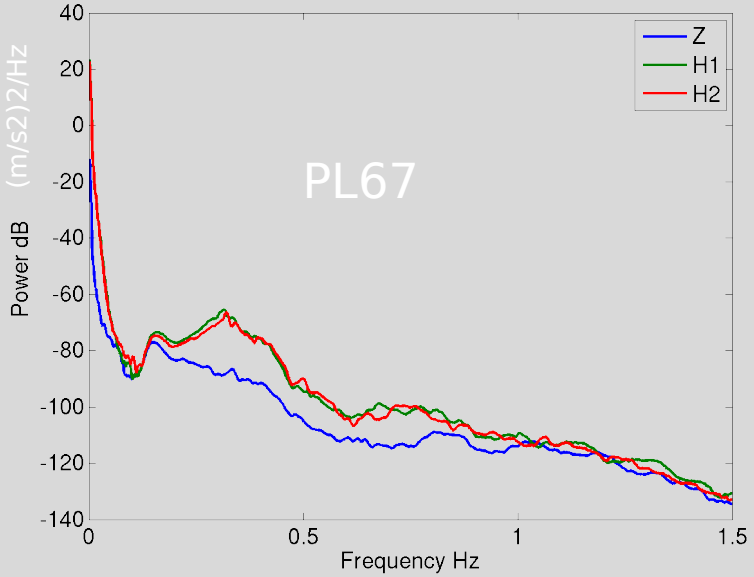


C J Wolfe et al. Science 2009;326:1388-1390

Results - Spectra





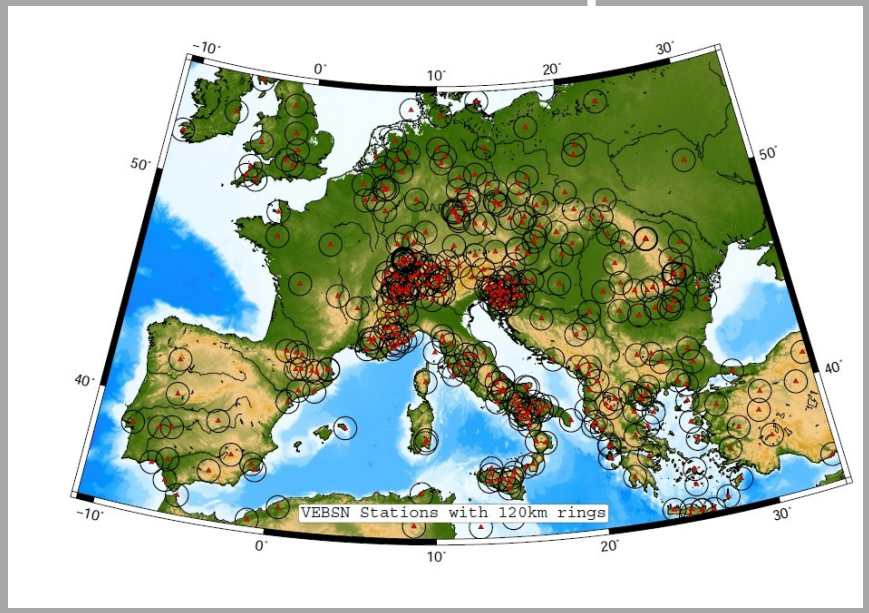


GEF and the “AlpArray” Concept

GEF cannot just decide to participate in projects such as AlpArray:

All loan applications are reviewed by the NERC GEF Steering Committee and must

Initially loans of 2



investment for equipment

Summary

GEF is a 3-node facility supporting all aspects of geophysical data acquisition for scientific research

The UK's onshore and offshore facilities are slowly synchronising their data products

Offshore broadband data acquisition is a near-future goal of OBIF

Participation of GEF in a AlpArray project is possible with UK PI involvement

Contact details (email/web):

seis-uk@le.ac.uk www.le.ac.uk/seis-uk

gef@nerc.ac.uk gef.nerc.ac.uk