The distribution of marine OpenData via distributed data networks and Web APIs.

The example of ERDDAP, the message broker and data mediator from NOAA

Dr. Conor Delaney

Who Am I?

- Developed the GIS based system used by the English Environment Agency to assess the impact of pollution discharges into the seas off the west of England

- Developed the software systems used by Irish Government to develop shellfish aquaculture

- Led the marine work package of the FP7 project ENVIROFI, which looked at converging of Future Internet technologies and marine science data

- Currently working the Maritime unit of JRC helping them exploit marine science OpenData

Maritime Affairs Unit of the JRC

The Maritime Affairs Unit is part of the Institute for the Protection and Security of the Citizen (IPSC) of the European Commission's Joint Research Centre and provides technical & scientific support to EU policies.

Our unit works with:
- Fisheries and Aquaculture
- Maritime Safety and Security
- Transport Safety and Security

The Blue Hub is an in-house platform to perform research in the fields of maritime surveillance and Maritime Situational Awareness.

9 April 2014   GeoMaritime, London   3

Maritime Situational Awareness

The BlueHub is a Consumer of Marine Science Data

Illegal immigration

Maritime Safety

Maritime Security

Illegal fishing

Maritime Traffic

Piracy

Oil pollution

Marine Data Distribution – Properties

- Range of Scales in data size from individual animal observations to meteo/ocean model output and sea bed scans (Big Data)

- International effort to produce data and general agreement that much of this data should freely available or indeed be OpenData

- Traditional target audience for this data has been the scientific and the domain expert community

- Current "Big Data + Cloud" is generating both interest in data sources and new processing capability

- There is an OpenData push coming from governments (being adopted by JRC) who recognize that data can have a life beyond its primary audience and can possibly generate commercial activity

Marine Data Distribution – The Portals

- **Web Portals** have been a successful strategy for the collation, collection and sharing of marine science data and knowledge

- The target audience tends to be scientists and experts

- The types of portals tend to fall into of these categories:

  - **Data Discovery Portal**: This uses various techniques (Web GIS for example) to find data which can then be downloaded

  - **Data Display**: Data display in a Web GIS to display data from a number of sources which can be download or display and combined with other data in WEBGIS

  - **Online GIS**: This allows data discovery and analysis in a sophisticated WEBGIS. Data is downloaded to Cloud Storage.

Data Portals for Data Discovery

Data Discovery Portal: This uses various techniques
(Web GIS for example) to find data which can then be
downloaded

Typical Workflow:

- **Navigate** to a central
  website (portal)
- **Query** the data presented
  (e.g. either via web GIS,
  Query or catalogue)
- User **logs in**, selects data
  and starts a process that
  downloads data to their
  computer for further
  processing

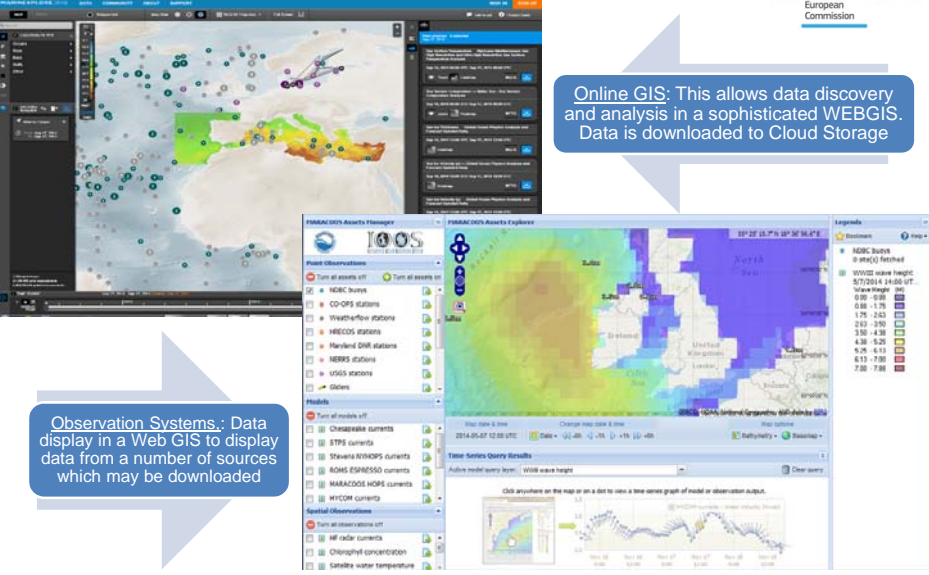This has been very successful
and useful workflow

9 April 2014   GeoMaritime, London   Joint Research Centre   7

Data Portals for Data Display and Analysis

Online GIS: This allows data discovery
and analysis in a sophisticated WEBGIS.
Data is downloaded to Cloud Storage

Observation Systems,: Data
display in a Web GIS to display
data from a number of sources
which may be downloaded

9 April 2014   GeoMaritime, London   Joint Research Centre   8
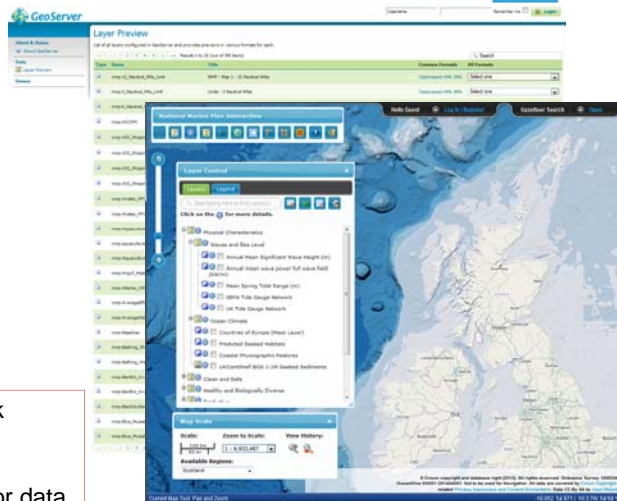
4

Marine Atlas (In this case Scotland)

National Atlas of Sea

* Consumer of data from NODCs

* Publishing the results of analysis on primary data

* Making the data catalogue available to others

Marine Strategy Framework Directive:

Will increase the demand for data

How to Best Publish the Primary Data?

* It would better to avoid large data transfers

* Data should be published at source by the producer thus ensuring data is always up to date

* Data should be easy to access

* It should be possible to query the Data

* Data should be available in a number of different formats

* Technologies used to promote interoperability e.g. OCC

* Technologies should expose a WEB API

WEB Architecture – New Paradigm

- **New developement paradigm aimed at constrained devices:**
  - Tablets and mobile phones:

    - Lower processing power and limited on device storage
    - Mobile Internet...user is paying for the data download

  - The WEB Browser is the OS!

    - WEBGL enables GPU accelerated usage of physics and image processing in browser
    - JSON, JQuery, JavaScript and AJAX for browser based applications
    - OGC is enabling geospatial interoperability
    - Web Services = data + analysis = information.

Distributed Data Networks – USA Strategy

National Oceanographic Data Center has implemented interoperable data technologies to enhance the use of oceanographic data in the NODC archives **e.g.**

OPeNDAP Hyrax Server
http://data.nodc.noaa.gov/opendap/
Users of the DAP standard can subset datasets, transform data into ASCII, and access the metadata embedded in a file in several ways.

THREDDS Data Server (TDS)
http://data.nodc.noaa.gov/thredds/
Thematic Realtime Environmental Distributed Data Services (THREDDS) Data Server (TDS) is a web server that provides metadata and data access for scientific datasets, using OPeNDAP, OGC WMS and WCS, HTTP

However these technologies are still in the realm of the Earth Science, requiring:
- Domain knowledge for the data
- Domain knowledge for the data standards are protocols

ERDDAP- WEB API by NOAA

ERDDAP (the Environmental Research Division's Data Access Program).
Developed to provide a WEB API to the existing distributed data network.

- **message broker**: it receives data request (via html) and converts them into formats used by other data servers
- **queries** data at source archives and returns the result of the query
- **data mediator:** it converts sophisticated marine science data formats and converts them formats more familiar to web/software developers
- **leverages** (among other things): NetCDF, THREDDS,OGC and OPenDAP (DAP) and the existing distributed data network
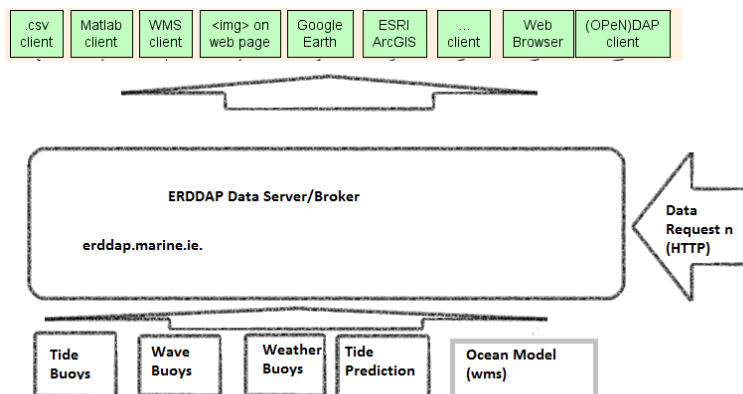- Creates a **catalogue** of data being published at remote data centers

WEB API…?

Here is simple illustration of how a MI ERDDAP
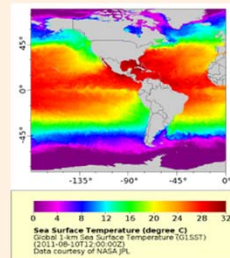
Example: Gridded Data

Gridded data, graphs, and maps can be requested via specially formed, RESTful, OPeNDAP URLs.

The URL specifies everything: dataset, response file type, subset:

http://coastwatch.pfeg.noaa.gov/erddap/griddap/jplG1SST.html
?sst[(2011-08-10T12:00:00)][(-80):100:(80)][(-180):100:(0)]

- Special file types: .html (Data Access Form), .graph (graphical form), .fgdc, .iso19115

- Data file types: .asc, .csv, .das, .dds, .dods, .esriAscii, .htmlTable, .json, .mat, .nc, .ncHeader, .odvTxt, .tsv, .xhtml

- Image file types: .geotif, .kml, .smallPdf, .pdf, .largePdf, .smallPng, .png, .largePng, .transparentPng

- If time is last, you will get the latest data.

Sea Surface Temperature (degree C)
Global 1-km Sea Surface Temperature (G1SST)
(2011-08-10T12:00:00Z)
Data courtesy of NASA JPL

The M6 Ocean Weather Buoy

1. http://mda.marine.ie/erddap/tabledap/

2. IWBNetwork.largePng

3. ?time,AirTemperature

4. &station_id=%22M6%22

Irish Weather Buoy Network
(station_id="M6")
Data courtesy of Marine Institute
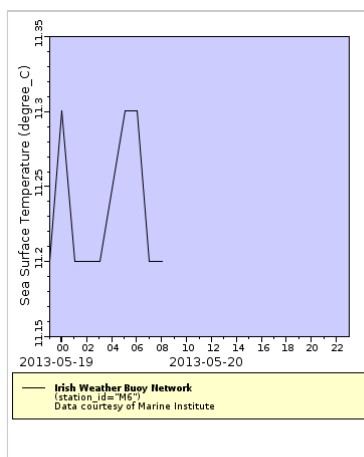
Located about 400km west of Galway city.

Atmospheric Pressure | Air Temperature | Wind Speed
Wave Height | Sea Temperature

The Atlantic Ocean Buoy is a Platform for a number of sensors. You can select a sensor via the radio buttons.

The Sea State Dashboard

9 April 2014 — GeoMaritime, London — 17

The BlueHub

20 October 2014 — GeoMaritime, London — 18

9

Building the Maritime Situational Picture

SHIP REGISTER

identifier	name	flag	Type	length
247300100	SIDER	ITA	CARGO	250

COOPERATIVE SHIP POSITIONS *(AIS, VMS, LRIT)*

NON COOPERATIVE SHIP POSITIONS *(VDS)*

VESSEL TRACKING

FUSION ALGORITHM

MARITIME SITUATIONAL PICTURE
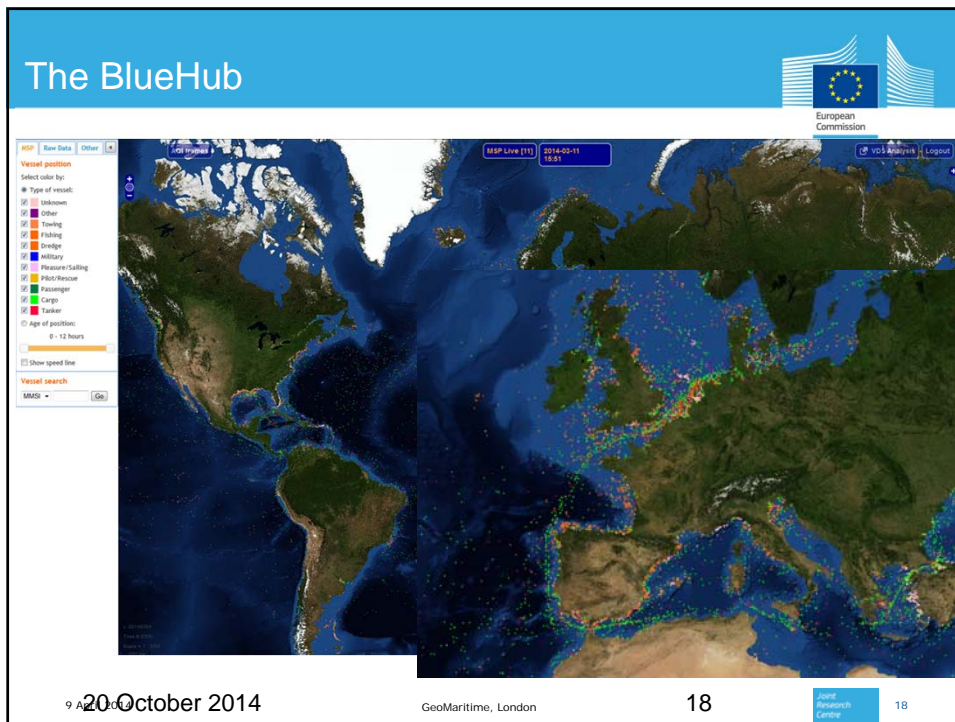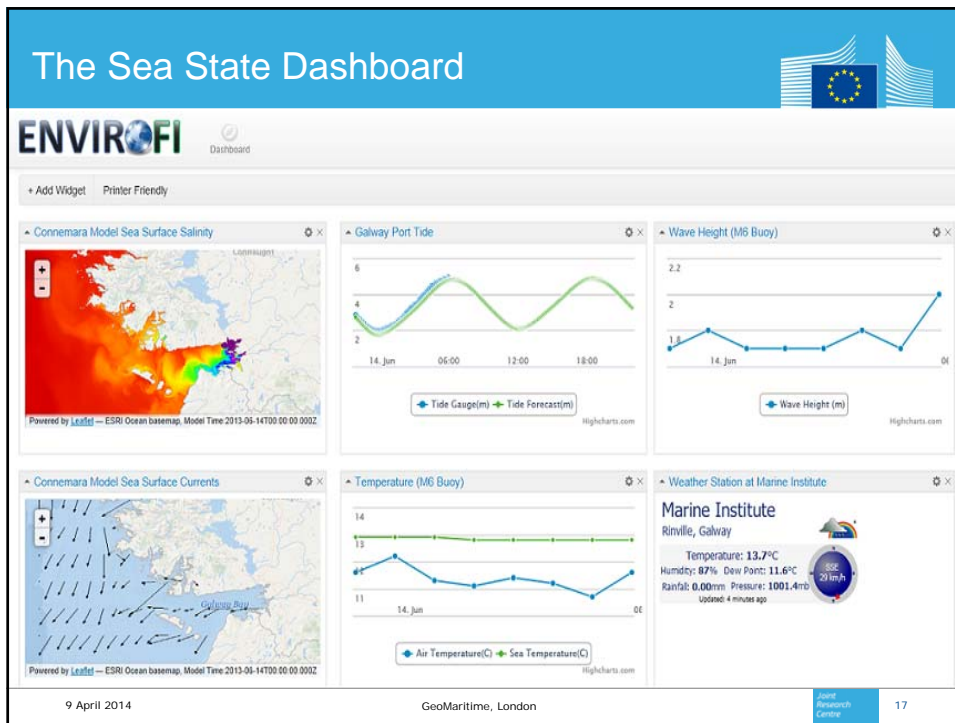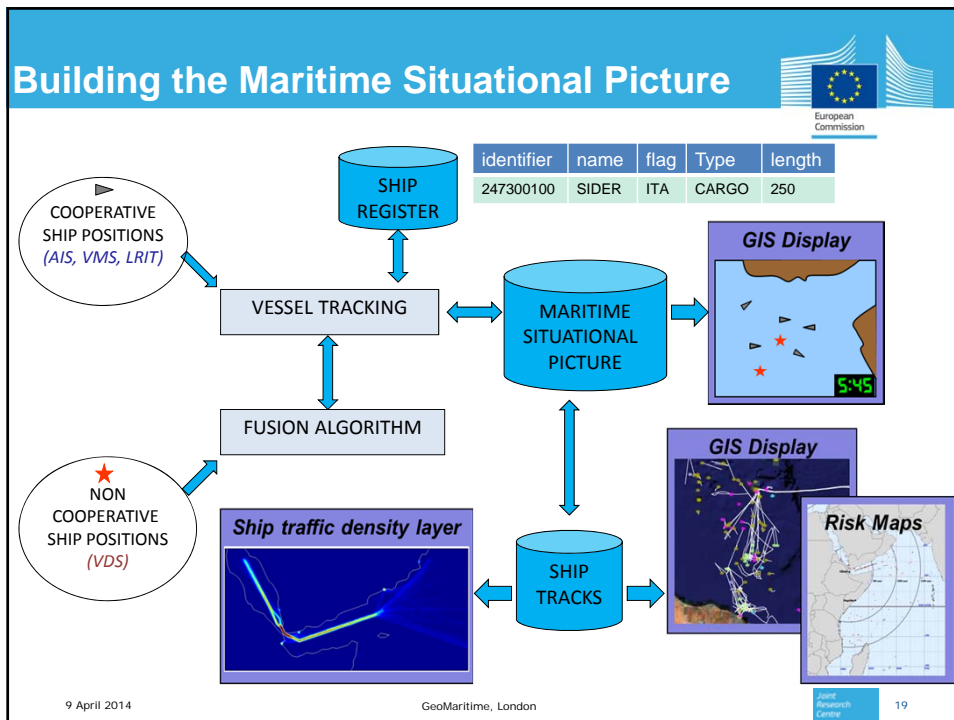
GIS Display

5:45

GIS Display

Risk Maps

Ship traffic density layer

SHIP TRACKS

9 April 2014 · GeoMaritime, London · 19

BlueHub Data Sources (some of them)

- **Reporting data**
  - LRIT (ships >300 GT) – EU Flags
  - AIS (ships > 300 GT + many smaller)
    - Coastal AIS – MSSIS
    - Satellite AIS – exactEarth, LuxSpace/OrbComm, FFI (NORAIS, AISSat-1)
  - VMS (fishing ships) – few EU Flags
  - – Continuous data stream, update minutes – hours
  - Incident reports – IMB, ReMISC Sana'a

  Commercial
  Institutional
  Partners exchange

- **Observations (non-cooperative)**
  - Satellite radar (medium & large ships) – ENVISAT, RADARSAT-2, TerraSAR-X, CosmoSkymed
    - SAR = Synthetic Aperture Radar
  - – Infrequent snapshot images

- **Auxiliary**
  - Ship registers
  - Coastline maps

  Cooperations with:
  EMSA, EUSC, NURC, Italian Coast Guard, EU Flag States, ESA, US Navy, SPAWAR, FFI (NO), DLR (GE), GD (US), …

9 April 2014 · GeoMaritime, London · 20

10

Maritime Domain Awareness ERDDAP

- Embracing and using OpenData from the marine science community
- Using ERDDAP has a key resource for finding and using data
- Exploring the concepts of light weight Apps to deliver targeted marine domain awareness
- Actively developing thematically based ERDDAP servers

1) NOAA/NCEP Global Forecast System (GFS) Atmospheric Model (wind speed and direction)
2) NOAA WaveWatch III (NWW3) Global Wave Model (Global Wave forecast)
3) Near Real Time Geostrophic Currents (Global)

http://mda.marine.ie/erddap/index.html

9 April 2014   GeoMaritime, London   21

Maritime Domain Awareness

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Title	Sum-mary	FGDC, ISO, Metadata	Back-ground Info	RSS	Institution	
data			graph	M	Biloxi_ms (Digital Elevation Models, biloxi ms)	?	F I M	background	RSS	NOAA NGDC	
data			graph	M	Chlorophyll-a, Aqua MODIS, NPP, DEPRECATED OLDER VERSION (1 Day Composite)	?	F I M	background	RSS	NOAA CoastWatch	
data			graph	M	Chlorophyll-a, Aqua MODIS, NPP, Global, Science Quality (8 Day Composite)	?	F I M	background	RSS	NOAA CoastWatch	?
data			graph	M	Currents, Geostrophic, Aviso, Global (1 Day Composite)	?	F I M	background	RSS	NOAA CoastWatch	?
data			graph	M	Distance from Nearest Coastline: 0.01-Degree Grid	?	F I M	background	RSS	NASA GSFC	
data			graph	M	East Atlantic SWAN Wave Model	?	F I M	background	RSS	Irish Marine In	?
data			graph	M	GHRSST Global 1-km Sea Surface Temperature (G1SST), Global, 0.01 Degree, Daily	?	F I M	background	RSS	NASA JPL	
data			graph	M	GHRSST Level 4 AVHRR_OI Global Blended Sea Su ... perature Analysis, Global, 0.25 Degree, Daily ?	?	F I M	background	RSS	NOAA/NESDIS/NCDC	
	set	data	graph		IBTS Trawl Surveys	?	F I M	background	RSS	Marine Institute	
data			graph	M	Irish Marine Institute Connemara Model CONN2D	?	F I M	background	RSS	Irish Marine In	?
data			graph	M	Irish Marine Institute Connemara Model CONN3D	?	F I M	background	RSS	Irish Marine In	?
	set	data	graph		Irish National Tide Gauge Network	?	F I M	background	RSS	Marine Institute	
	set	data	graph		Irish Wave Buoys	?	F I M	background	RSS	Marine Institute	
	set	data	graph		Irish Wave Buoys 30 Min	?	F I M	background	RSS	Marine Institute	
	set	data	graph		Irish Weather Buoy Network	?	F I M	background	RSS	Marine Institute	
data			graph	M	MeteoGalicia - Model Roms - Galicia (ROMS METEO)	?	F I M	background	RSS	NOAA NESDIS CWC	?
	set	data	graph		MI Tide Prediction	?	F I M	background	RSS	Marine Institute	
	set	data	graph		MI Wave Forecast at buoy locations	?	F I M	background	RSS	Marine Institute	
data			graph	M	Model Monthly Means	?	F I M	background	RSS	Irish Marine In	?
data			graph	M	Navy Global Environmental Model (NAVGEM), 0.5 degree, 10 m Wind	?	F I M	background	RSS	FNMOC	
data			graph	M	Navy Global Environmental Model (NAVGEM), 0.5 degree, Pressure MSL	?	F I M	background	RSS	FNMOC	
data			graph	M	Navy Operational Global Atmospheric Prediction System (NOGAPS), 1 degree, 10 m Wind	?	F I M	background	RSS	FNMOC	
data			graph	M	Navy Operational Global Atmospheric Prediction System (NOGAPS), 1 degree, Pressure MSL	?	F I M	background	RSS	FNMOC	
	set	data	graph		NDBC Standard Meteorological Buoy Data	?	F I M	background	RSS	NOAA NDBC, Coas	?
data			graph	M	Near Real Time Geostrophic Currents	?	F I M	background	RSS	CoastWatch Cari	?
	set	data	graph		NOAA NDBC SOS - currents	?	F I M	background	RSS	NOAA NDBC	
	set	data	graph		NOAA NDBC SOS - sea_floor_depth_below_sea_surface	?	F I M	background	RSS	NOAA NDBC	
	set	data	graph		NOAA NDBC SOS - sea_water_salinity	?	F I M	background	RSS	NOAA NDBC	
	set	data	graph		NOAA NDBC SOS - sea_water_temperature	?	F I M	background	RSS	NOAA NDBC	
	set	data	graph		NOAA NDBC SOS - waves	?	F I M	background	RSS	NOAA NDBC	
	set	data	graph		NOAA NDBC SOS - winds	?	F I M	background	RSS	NOAA NDBC	
	set	data	graph		NOAA NOS SOS, EXPERIMENTAL - Air Temperature	?	F I M	background	RSS	NOAA NOS	
	set	data	graph		NOAA NOS SOS, EXPERIMENTAL - Barometric Pressure	?	F I M	background	RSS	NOAA NOS	

9 April 2014   GeoMaritime, London   22

For Example: The BlueHub
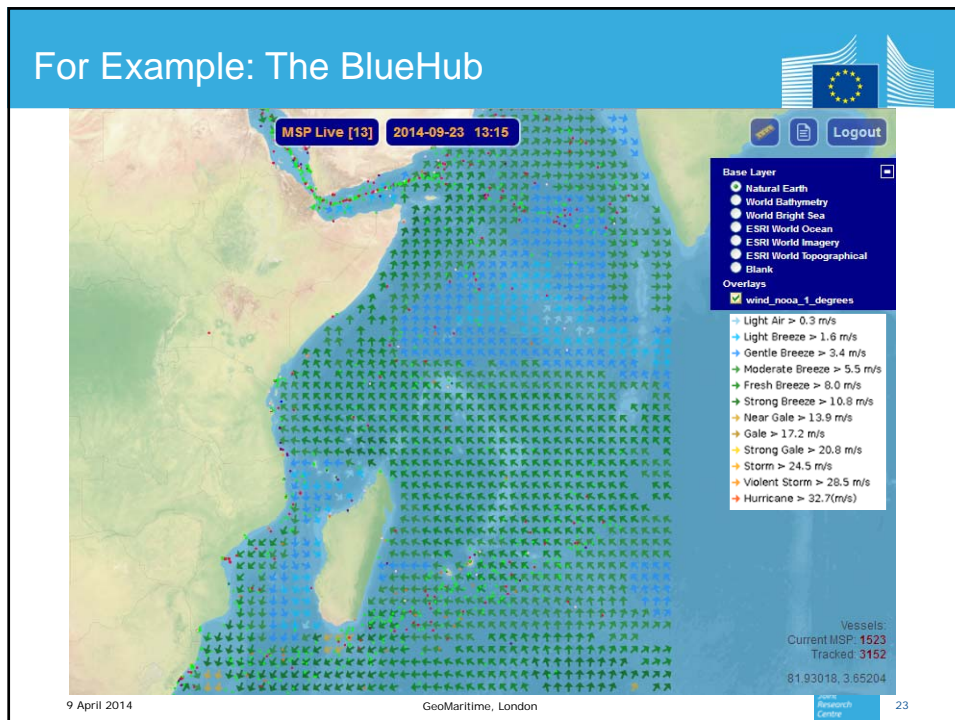
ERDDAP Possibilities…..

- It could complement EMODnet providing an alternative route to data, that would meet the needs of software developers (for example)

- Provide a EMODnet catalogue that could used as a basis of other catalogues. For example the MDA catalogue is constructed using Marine Science data that could be useful for the Maritime Domain http://mda.marine.ie

- If EU NODCs published via ERDDAP it would help establish a distributed data network with the data being published and maintained at source. For example http:// erddap.marine.ie

- Global NODCs published via ERDDAP ad-hoc catalogues could be constructed to suit international needs