



Exploiting Maritime Spatial Data Infrastructure

Michael Quin
Craig Pitman

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Spatial Data Is Very Valuable to Government

and to everybody...



**Port
Management**

Conservation

Land Management

Science/Modeling

Congestion

Crime

Defense/Security

Emergency Management

Pollution

Water

Agriculture/Forestry

Business Efficiency

Natural Resources

Biodiversity

Economic Recovery

Global Warming

Human Health

Energy

Oceans

Land Use

Population

Education

Public Safety

Development

Logistics

Facility
Management

Urbanization

Humanitarian
Relief

Law Enforcement

National Security

Environmental Protection

✓ *Improving Planning, Management, and Decision Making . . .*

Marine SDI

Definition

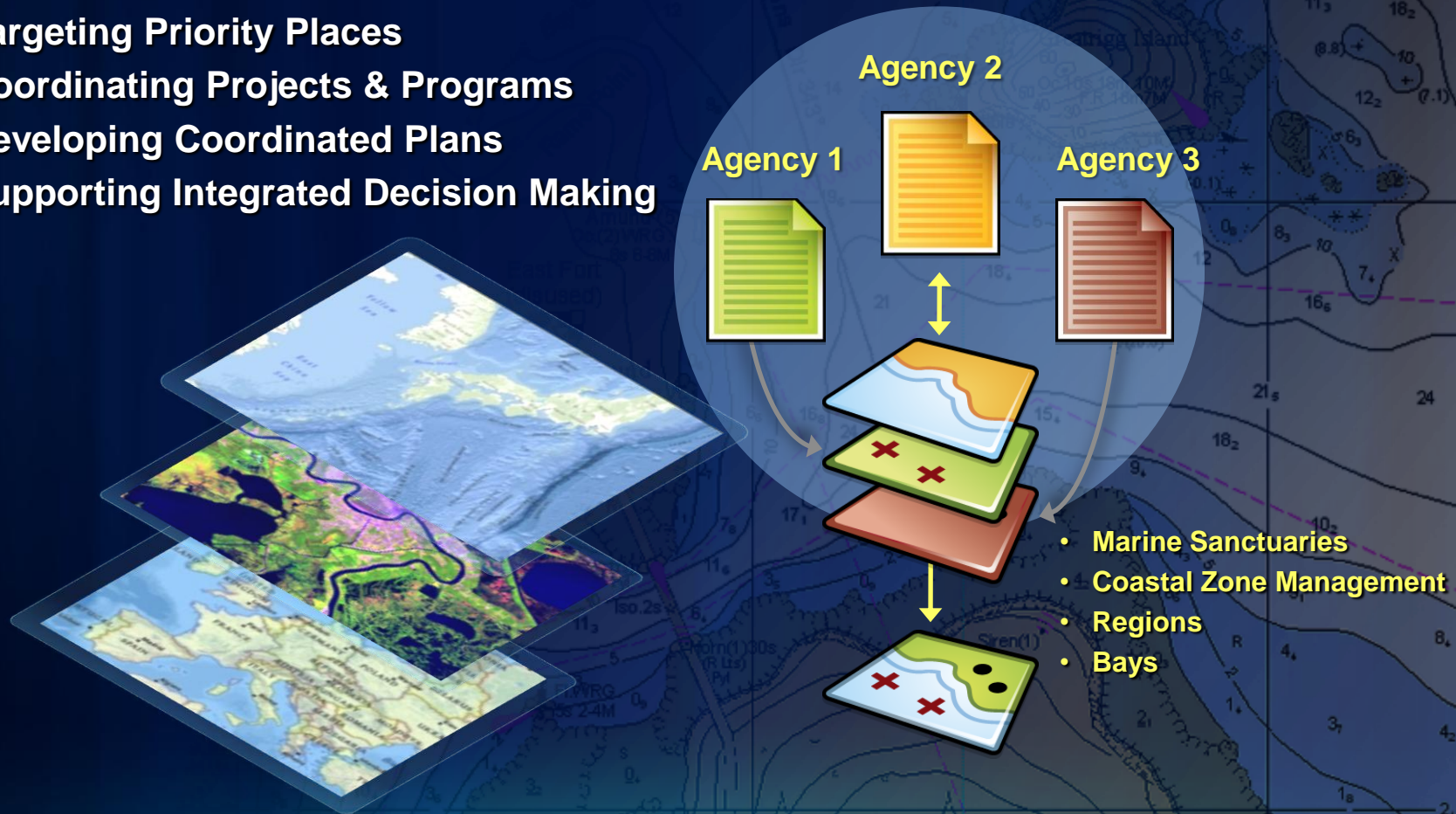
- *“MSDI is the component of an SDI that encompasses marine geographic and business information in its widest sense. This would typically include seabed topography (bathymetry), geology, marine infrastructure (e.g. wrecks, offshore installations, pipelines and cables), administrative and legal boundaries, and areas of conservation, marine habitats and oceanography.”*

(IHO Pub. C-17, Spatial Data Infrastructures “The Marine Dimension”. Guidance for Hydrographic Offices. Ed. 1.1 February 2011).

Maritime Systems Supporting Place-Based Policies

Increasing the Impact of Government Programs & Projects

- Targeting Priority Places
- Coordinating Projects & Programs
- Developing Coordinated Plans
- Supporting Integrated Decision Making



Using Geography & GIS as a Framework for Integrated Problem Solving

What Does it Take to Build a MSDI

- Core Data
- Data models
- Enterprise Geographic Information System
- People and Resources
- Governance and Standards



Broad Practice of Enterprise IT.....

Common Marine Data Types

Marine Points

Instantaneous Points

Feature Points

ID
X,Y
Z

Examples:
marker buoy,
transponder,
other fixed,
geography

Instant Subtype

ID
X,Y
Z or ΔZ
 $m_1...m_2$
t

Examples:
CTD, XBT, SVP casts at
ΔZ, fish density, tide
gauge, etc., at surface
or a single Z

Location Series Subtype

ID
ΔX,Y
ΔZ
 $m_1...m_2$
 $t_1...t_2$

Examples:
telemetry, bird/
mammal
sighting, ship
mounted ADCP

Time Series Point

Time Series

ID
X,Y
Z or ΔZ
 $m_1...m_2$
 $t_1...t_{infinity}$

Examples:
current meter,
moored ADCP at
ΔZ, obs. buoy,
hydrophone,
OBS at single Z

Marine Lines

Profile Line

ID
X,Y
 M_1,M_2
 $Z_1,Z_2...$

Examples:
for abstracting data from,
building profile from,
measuring change along...
seismic reflection,
bathy profile,
cross section,
sed. transport line

Time Duration Line Track

ID
 $X_1,Y_1,X_2,Y_2...$
 M_1,M_2
 $Z_1,Z_2...$
 $m_1,m_2...$
 $t_1,t_2...$

Examples:
transit ship track,
ROV or sub track,
algal bloom trawl,
ADCP tracks,
ARGO drifter

Feature Line

ID
 $X_1,Y_1,X_2,Y_2...$
 M_1,M_2

Examples:
cable, pipeline, sea
wall, ocean front, EEZ
or
legal boundaries NOT
enclosing an area

Survey Subtype

Examples:
aerial coastal
survey, lidar,
SCUBA/free swim obs.

Sounding Subtype

Examples:
single beam
bathy

Shoreline

shoreline type,
VDatum

Marine Areas

Feature Area

ID
 $X_1,Y_1,X_2,Y_2...X_1,Y_1$
Z
m

Examples:
Marine boundaries
(e.g., sanctuary, MPA),
habitats,
patches, lava
flows, clipping,
masking

Time Duration Area

ID
 $X_1,Y_1,X_2,Y_2...X_1,Y_1$
Z
m
 $t_1...t_n$

Examples:
No-take
zones,
oil spills,
harmful algal
bloom

Marine Rasters/Grids/Meshes

Regularly Interpolated Surfaces

$row_1, col_1...row_n, col_n$
 $Z_{r,c1}...Z_{r,cn}$
multipoint

Examples:
multibeam bathy,
sidescan, lidar,
SST, climatology,
scientific mesh,
"re-analyzed"
products
(images such as
GeoTIFF, BIL, etc.)

Irregularly Interpolated Surfaces

$row_1, col_1...row_n, col_n$
 $Z_{r,c1}...Z_{r,cn}$
multipoint

Examples:
TINs, bathymetry,
sidescan, lidar,
scientific mesh for
finite element
model, etc.

Mesh Volume

ID
 X_1,Y_1,Z_1,X_2,Y_2,Z_2
 $...X_1,Y_1,Z_1$
m or $m_1...m_n$
t or $t_1...t_n$
ncols,nrows,nlayers
in scientific mesh,
multipatch

Examples:
model of plume,
front, warm core,
trawl abundance

Derived or Placeholder

**Animations:
Movies,
Video**

X_1,Y_1,Z_1,X_2,Y_2,Z_2
 $...X_1,Y_1,Z_1$
 $t_1...t_n$

Examples:
U/W video footage,
outputs from atm. or
circulation models
that are animated &
georegistered so
other data may be
overlain

ACRONYMS—definitions

ADCP—acoustic doppler current profiler
ARGO—array for real-time geostrophic oceanography
BIL—band interleaved by line (for remotely sensed images or grids)
CTD—conductivity, temperature, depth
EEZ—exclusive economic zone

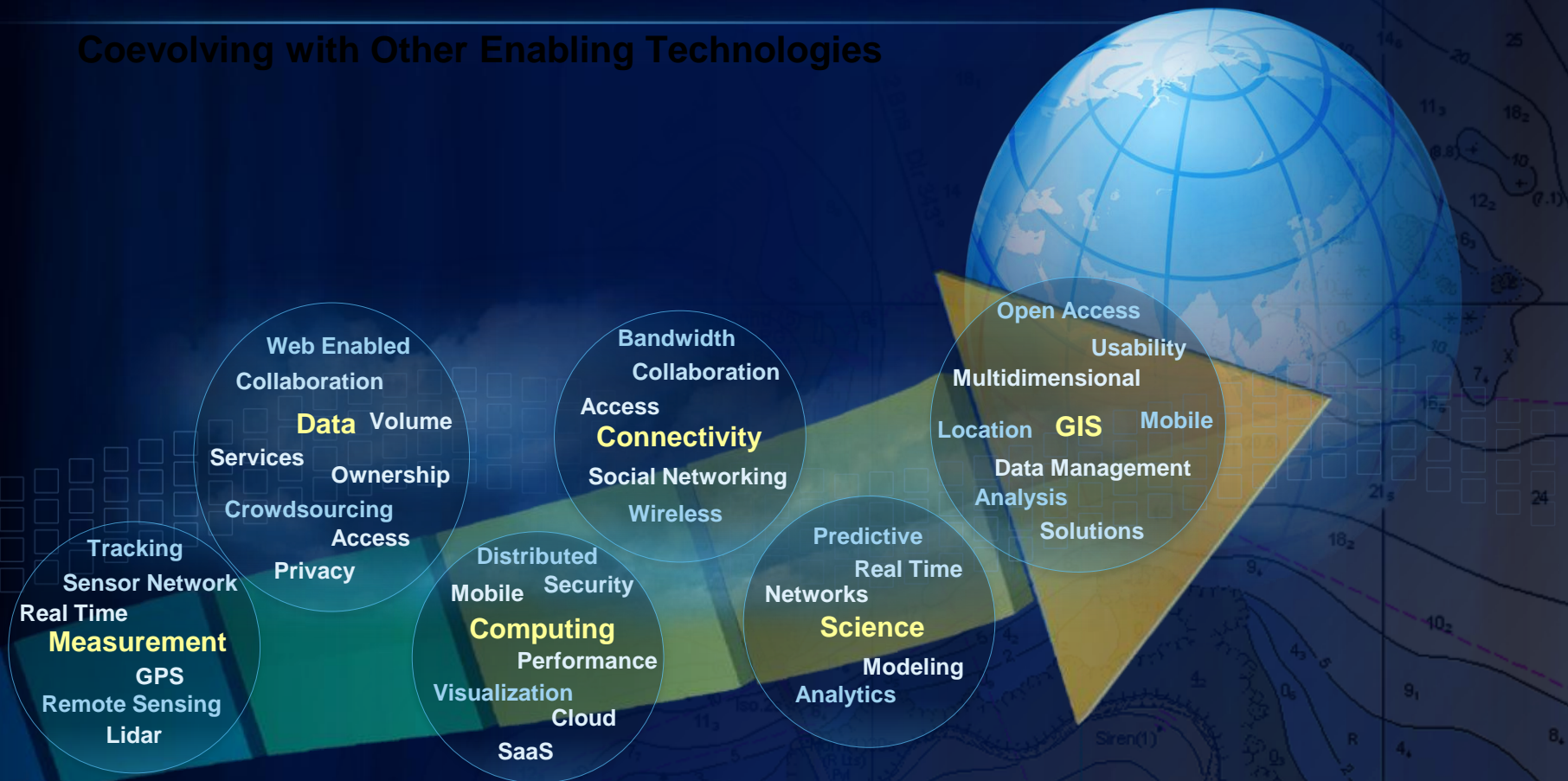
GeoTIFF—georeferenced tagged image file format
LIDAR—light detection and ranging
MPA—marine protected area
OBS—ocean bottom seismometer

ROV—remotely-operated vehicle
SCUBA—self-contained underwater breathing apparatus
SST—sea surface temperature
SVP—sound velocity profile

TIN—triangulated irregular network
U/W—underwater (also often refers to "underway")
VDatum—vertical datum
XBT—expendable bathythermograph

Definition of Enterprise Is Always Moving Rapidly

Coevolving with Other Enabling Technologies



Spatial Data Is Following Moore's Law.....

A New NSDI Engagement Pattern Is Emerging

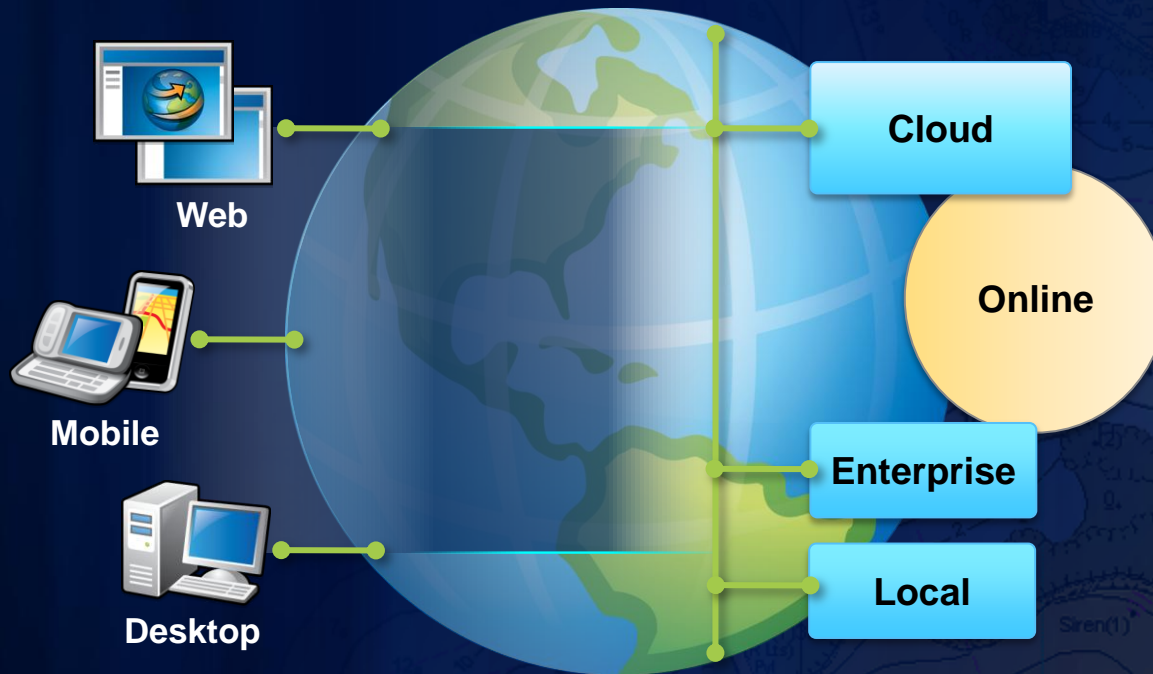
Making GIS Accessible to Everyone



... Virtually Anywhere and on Any Device

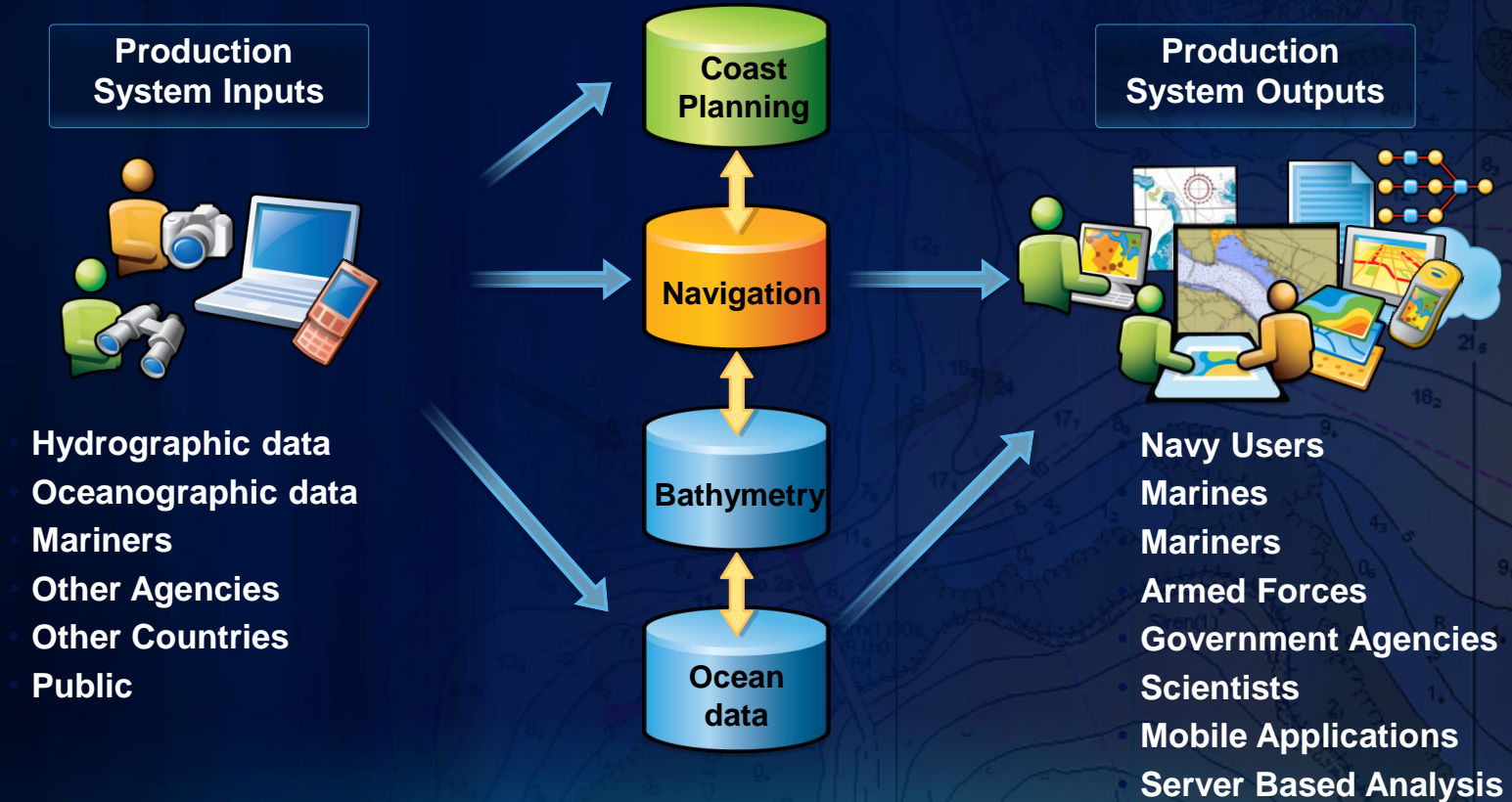
MSDI Engagement through Information Systems

Three main levels in a System for Geographic Information



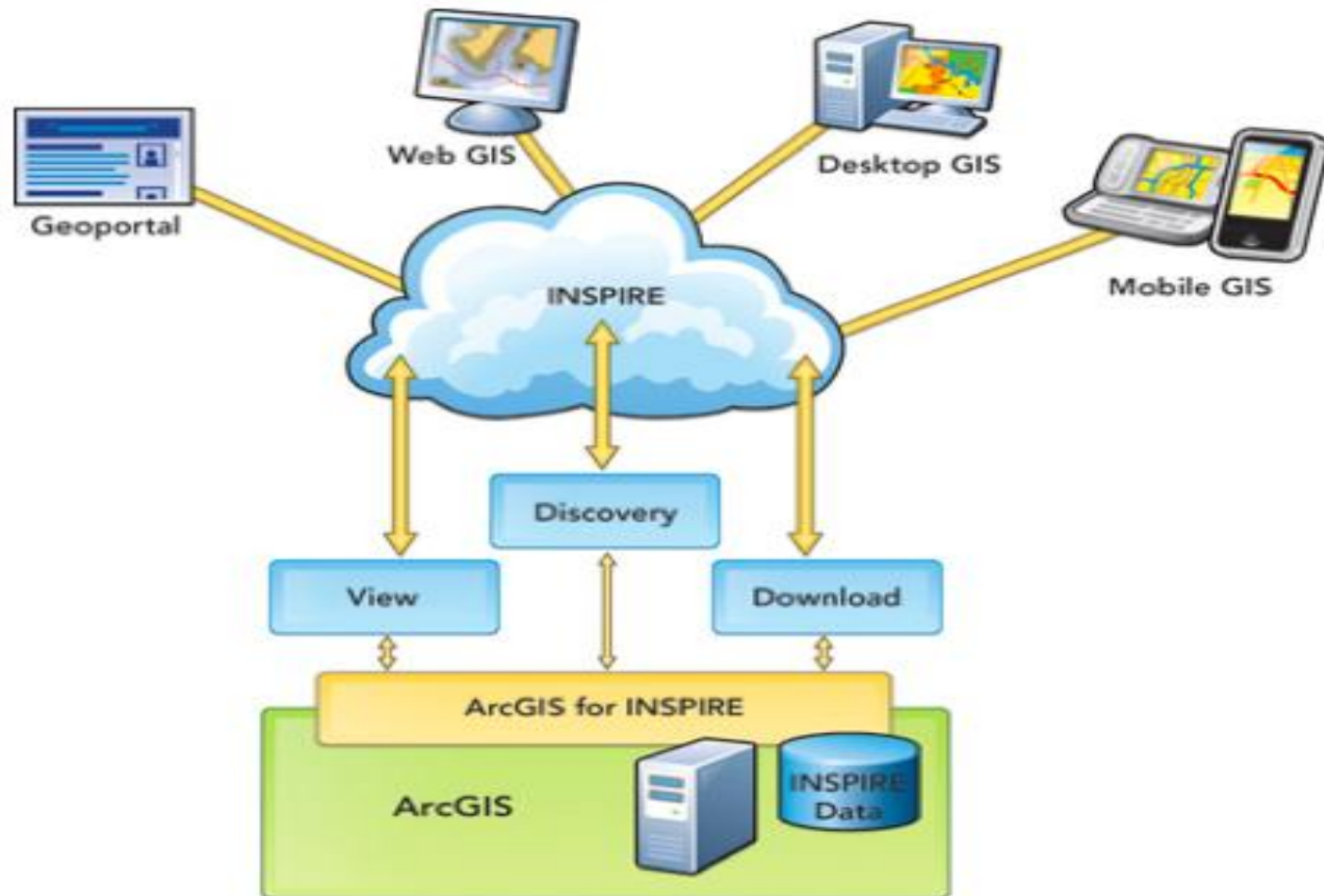
Convergence of Marine Spatial Data Infrastructure

Marine Data and Information System



...Interoperability, flexibility and scalability

European Inspire NSDI



Standardizing GIS System to Support Government NSDI

ArcGIS Online: Cloud computing

ArcGIS Online



Maps and Apps for Everyone

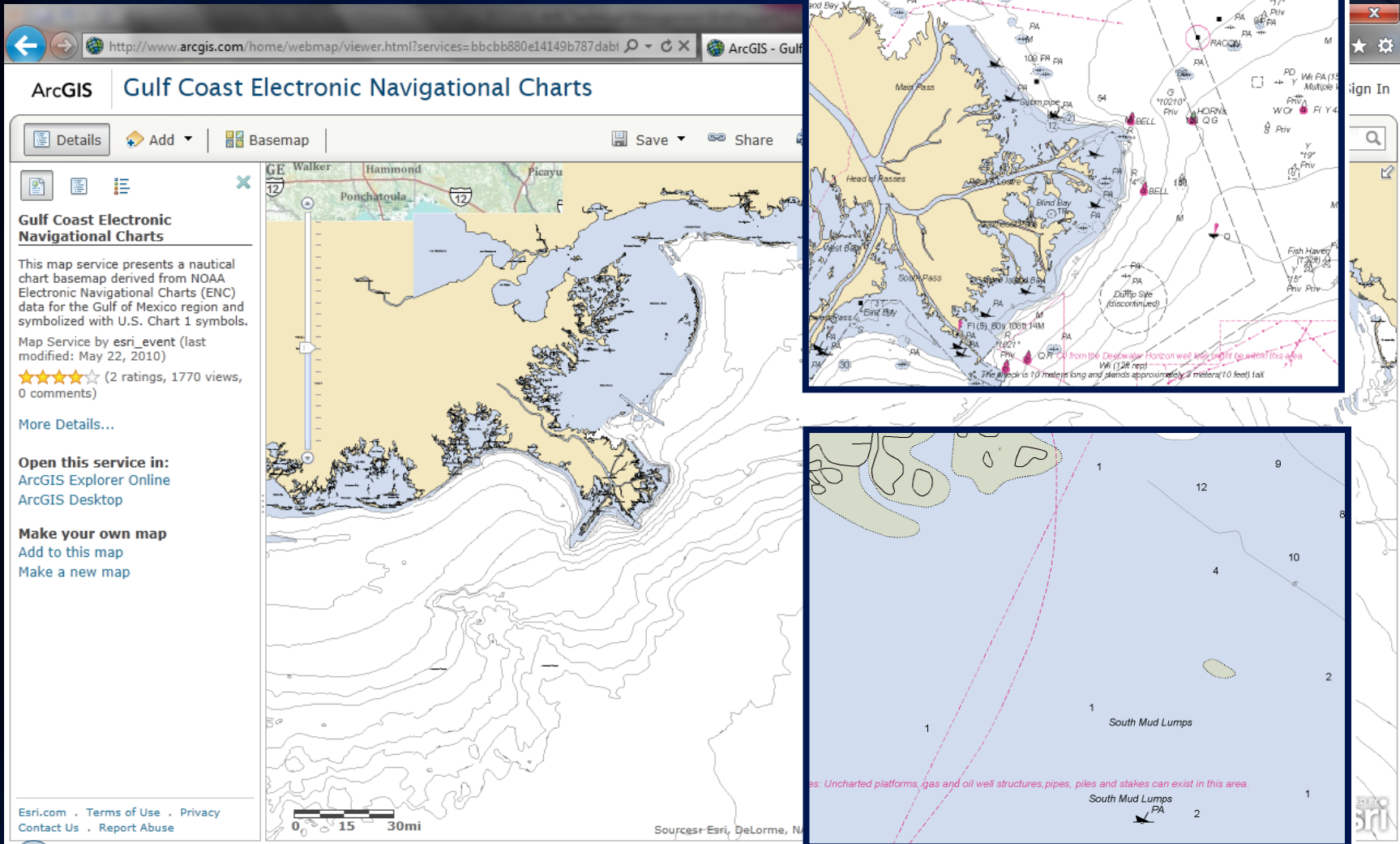
Easy online discovery, access,
visualization, and dissemination of
geospatial information.

VIEW NOW >

- Map Products
- Web Apps
- Web Services
- Ocean Basemap

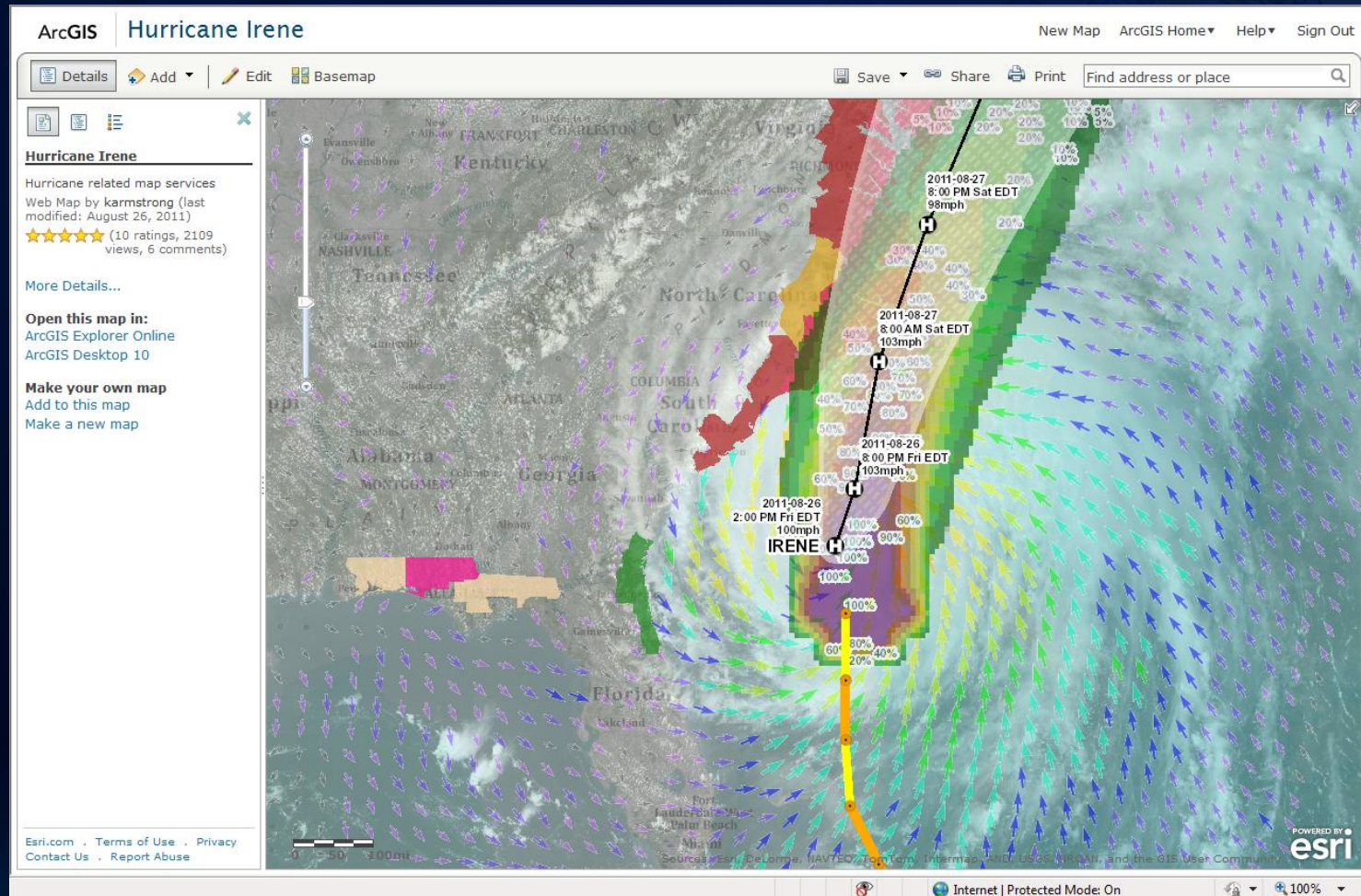
Volunteer Geographic Information and Crowd Sourcing.....

Maritime Online – Nautical Chart Service (coming soon)



Hurricane Irene (Aug-26-2011)

METOC Observations and Forecast Models



Maritime Online – St. John BIOMapper

Biogeography Integrated Online Mapper

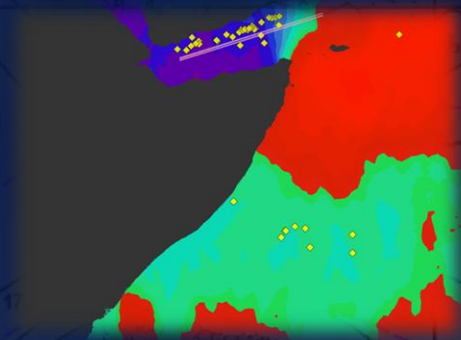


Benthic Habitat Mapping off St. John, U.S. Virgin Islands National Park and Virgin Islands Reef National Monument



Solving Problems with Unified MSDI

Solving Piracy with MSDI



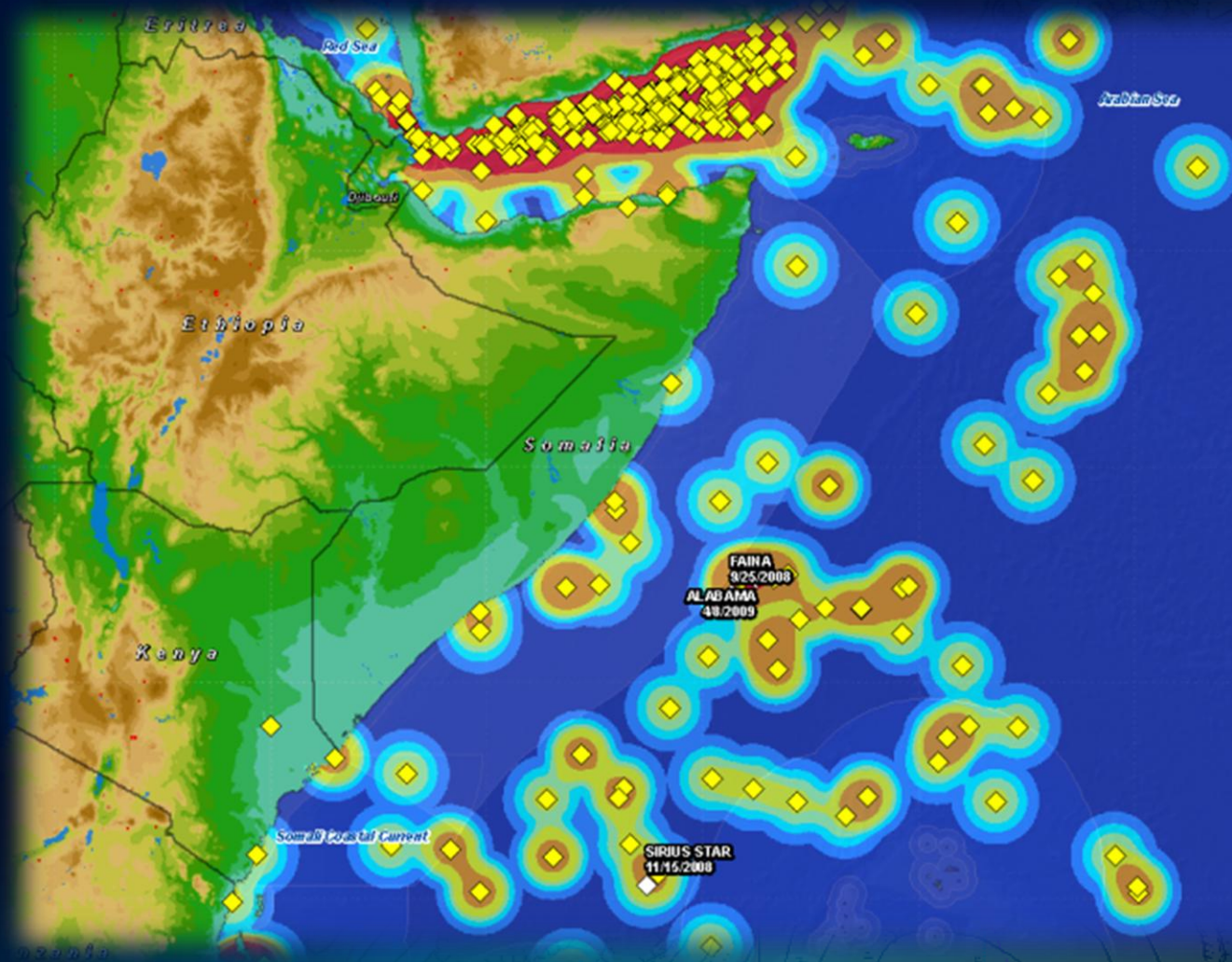
Briefing – 30 Years of Piracy

Making Sense of in Chaos of data



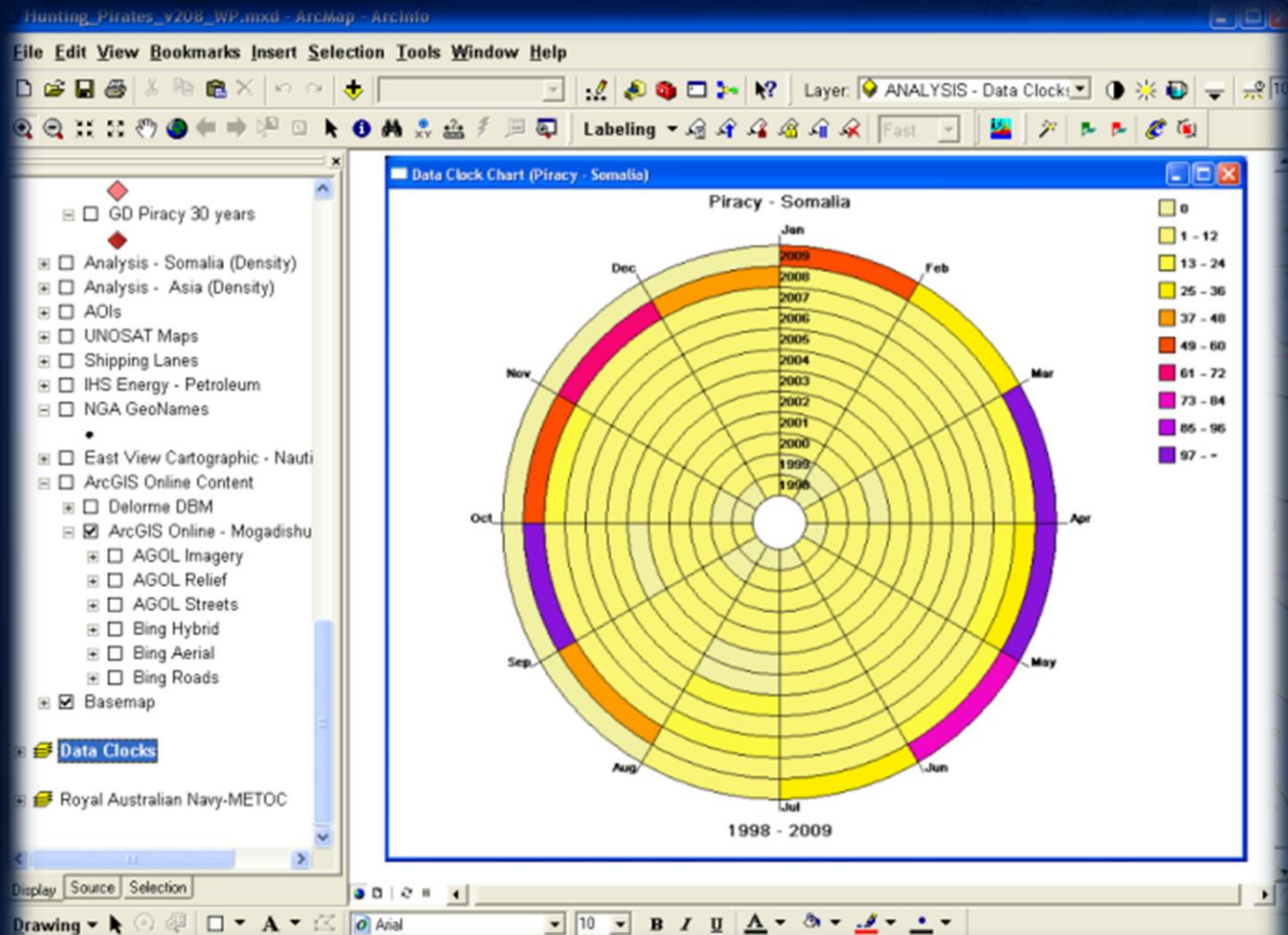
2008 - 2009 Pirate Attacks

Density Analysis & High Profile Attacks

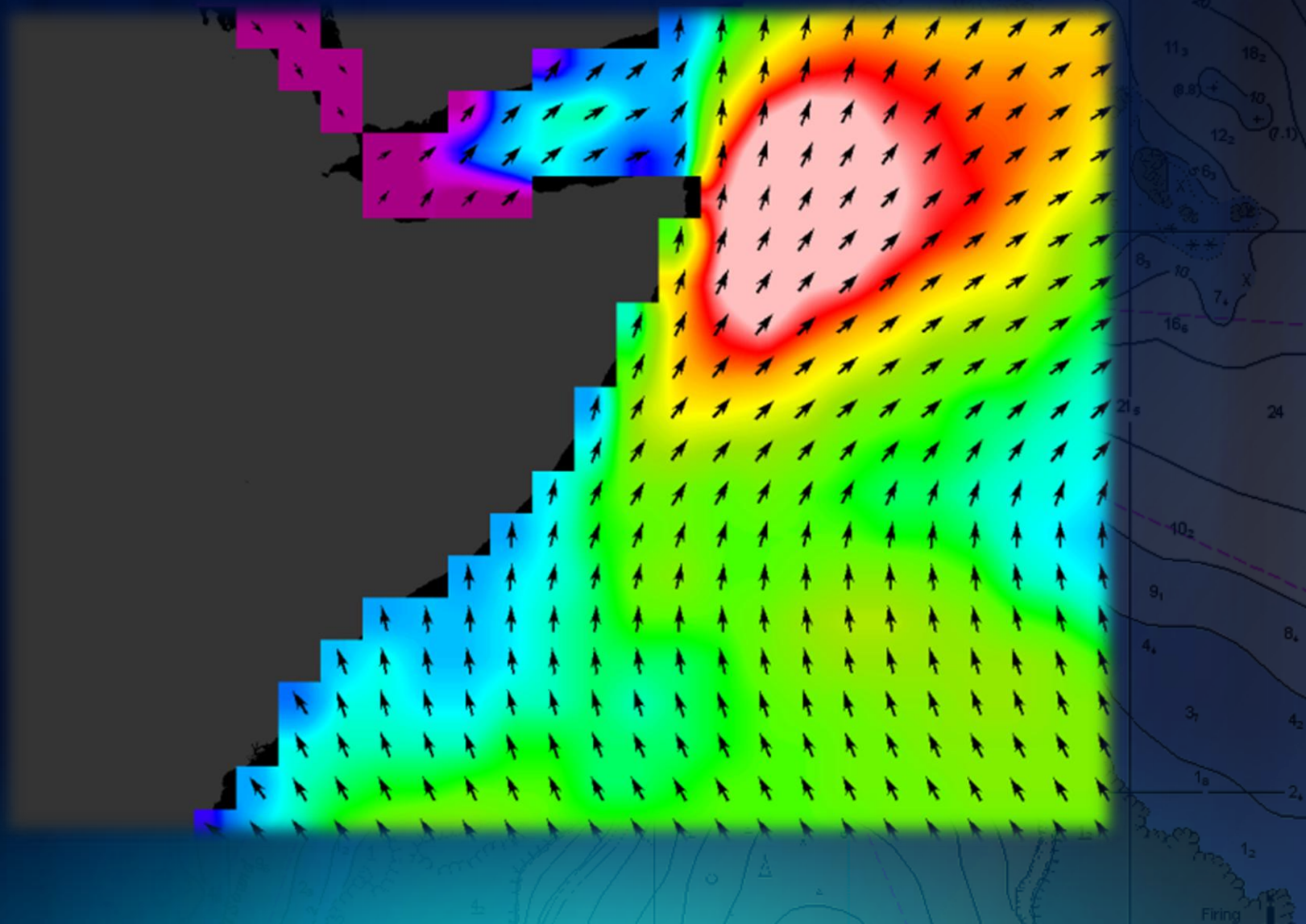


Attacks by Month and Year (Seasonal Patterns)

Tracking Analyst Data Clock

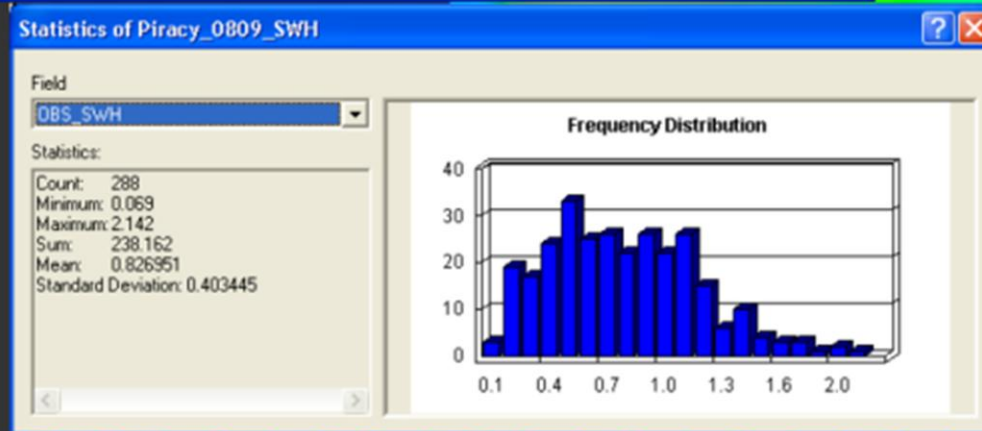
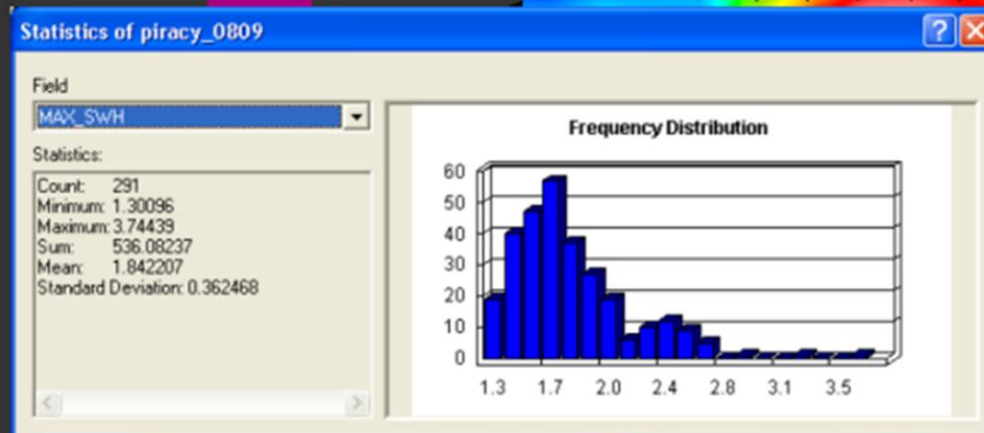


Royal Australian Navy METOC Collaboration



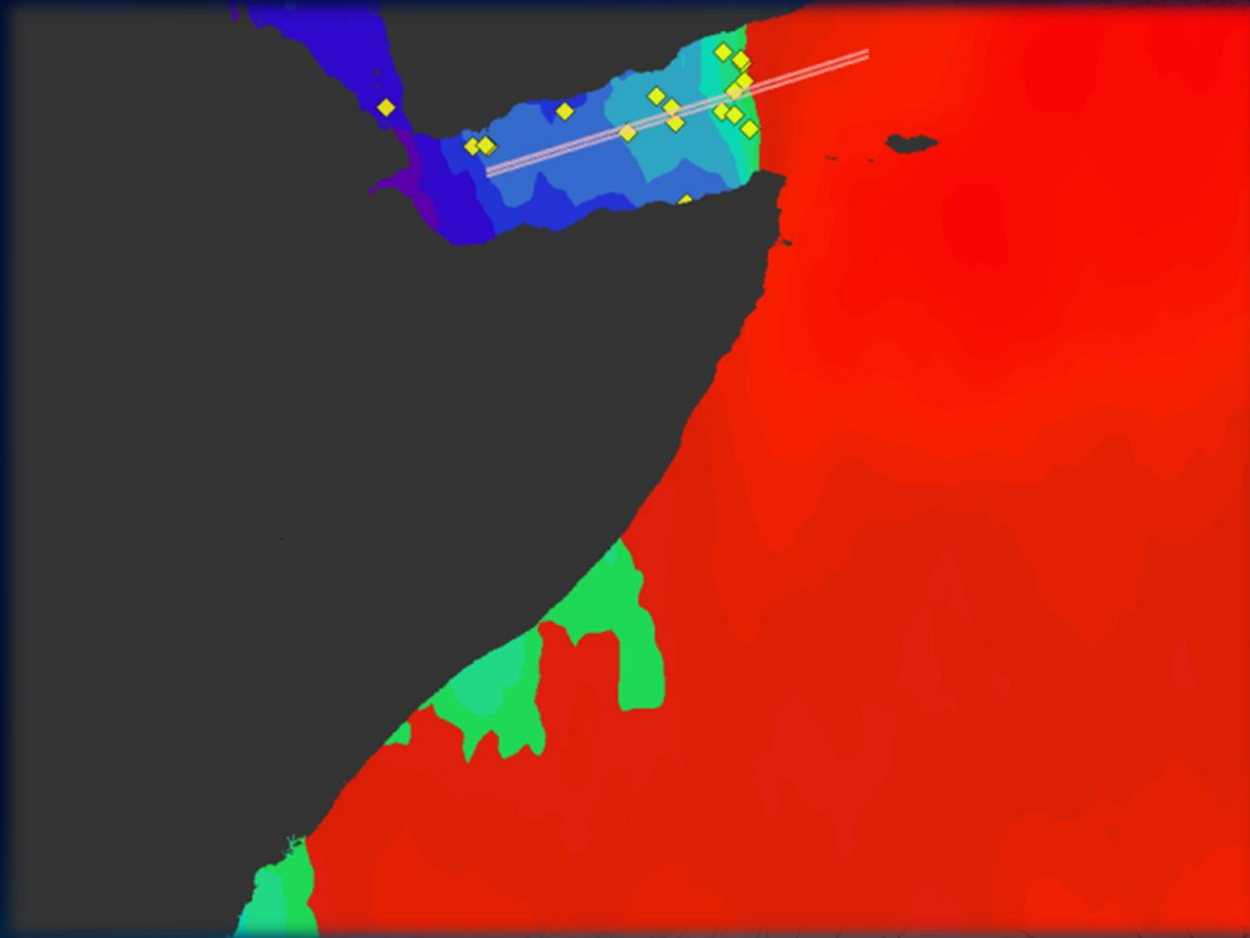
Analysis of Wave Conditions

Overlay of Pirate Attacks with Maximum and Observed Wave Heights



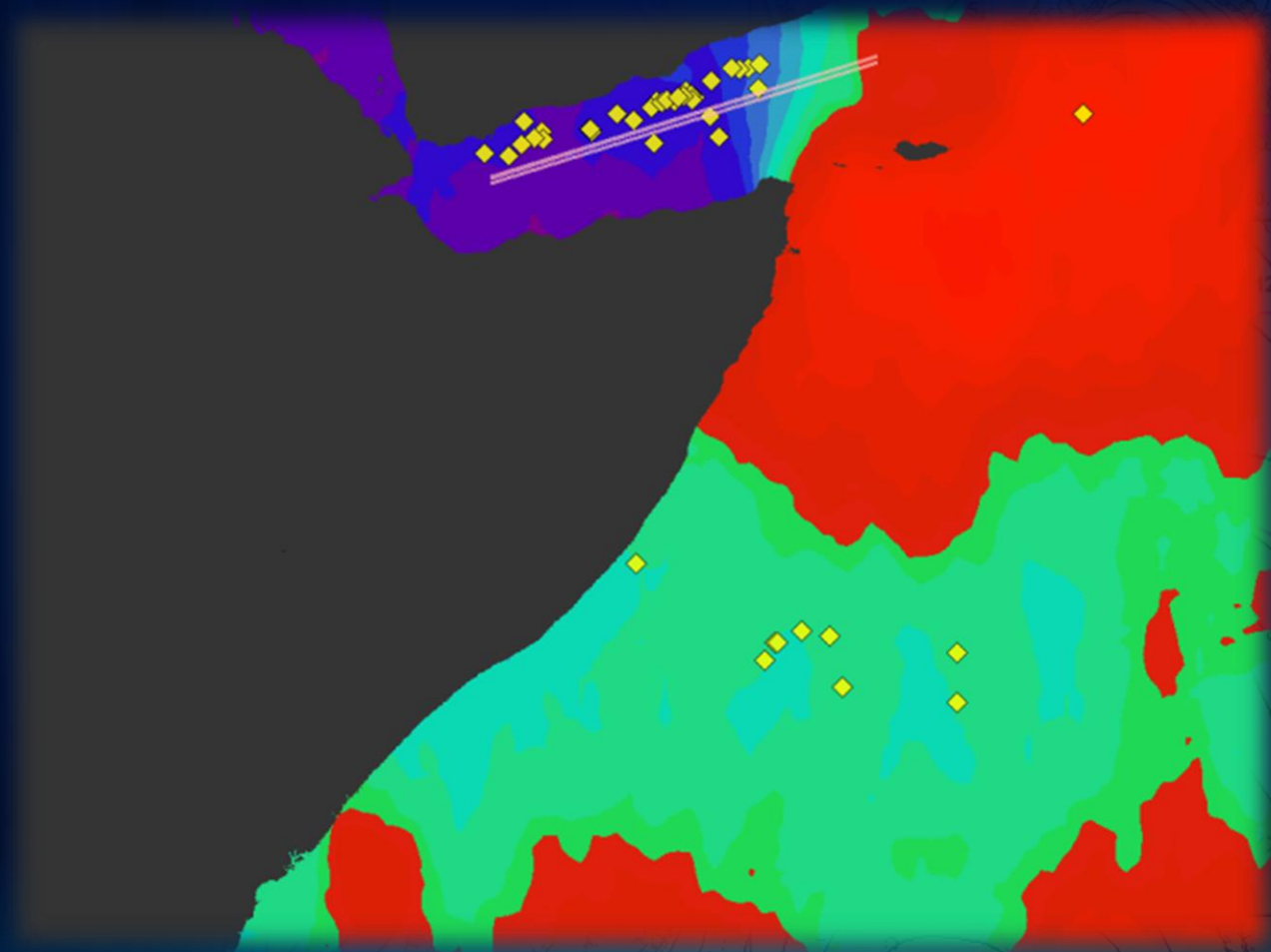
Likelihood of Attack – August

Areas Greater than 2.8m Monthly Significant Wave Heights (Red) = Unlikely Attacks



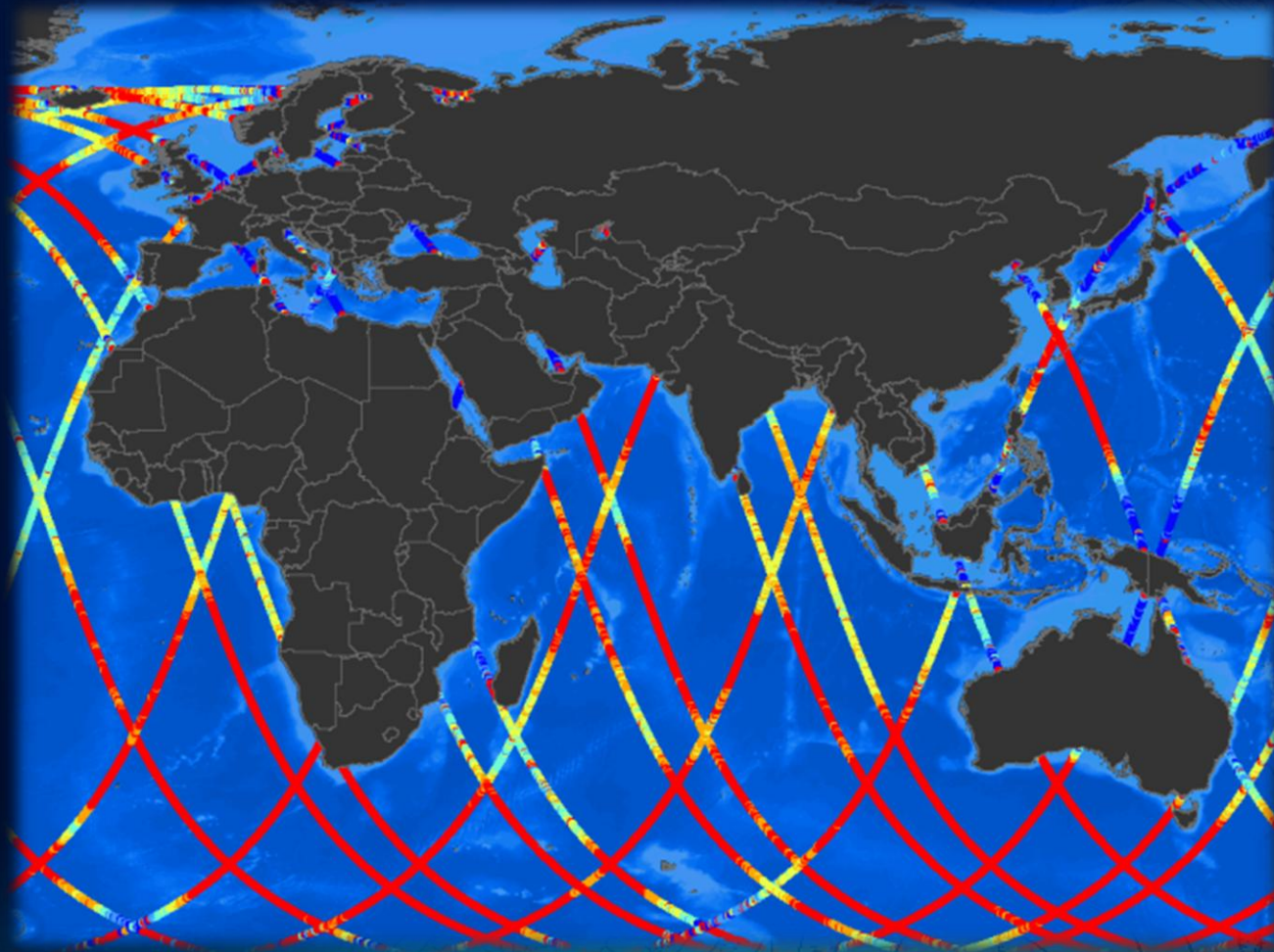
Likelihood of Attack – September

Areas Greater than 2.8m Monthly Significant Wave Heights (Red) = Unlikely Attacks



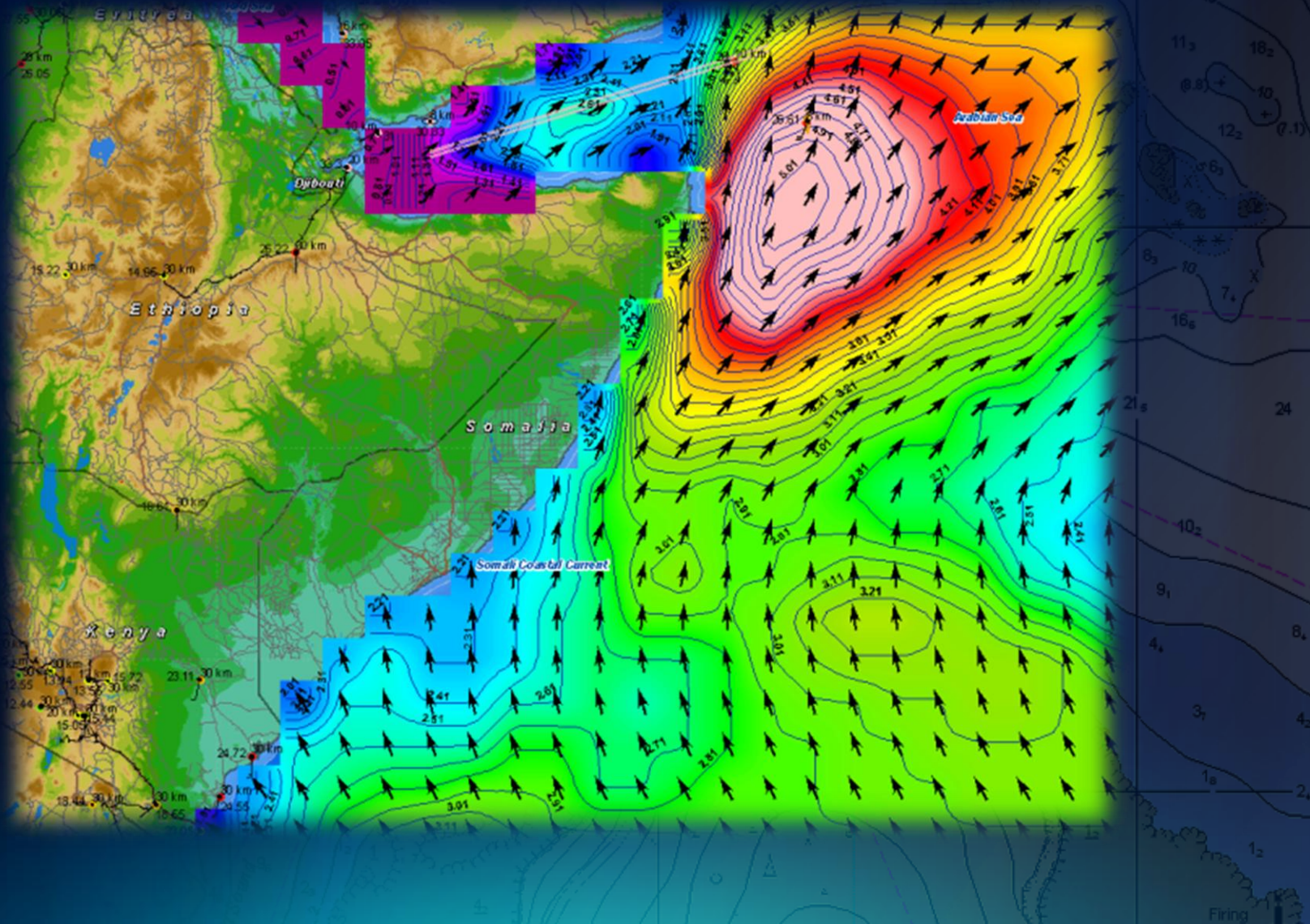
Wave Heights (2 Hours Ago)

Near Real Time – Jason Satellite

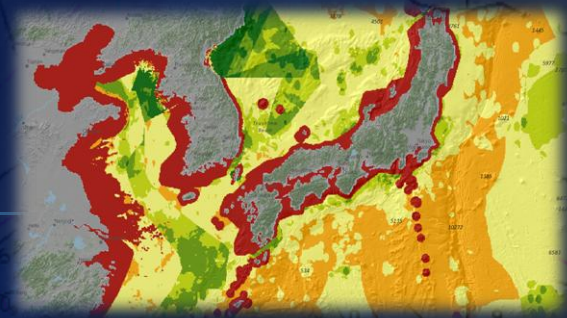


Daily Wave Models Supporting Safe Passage

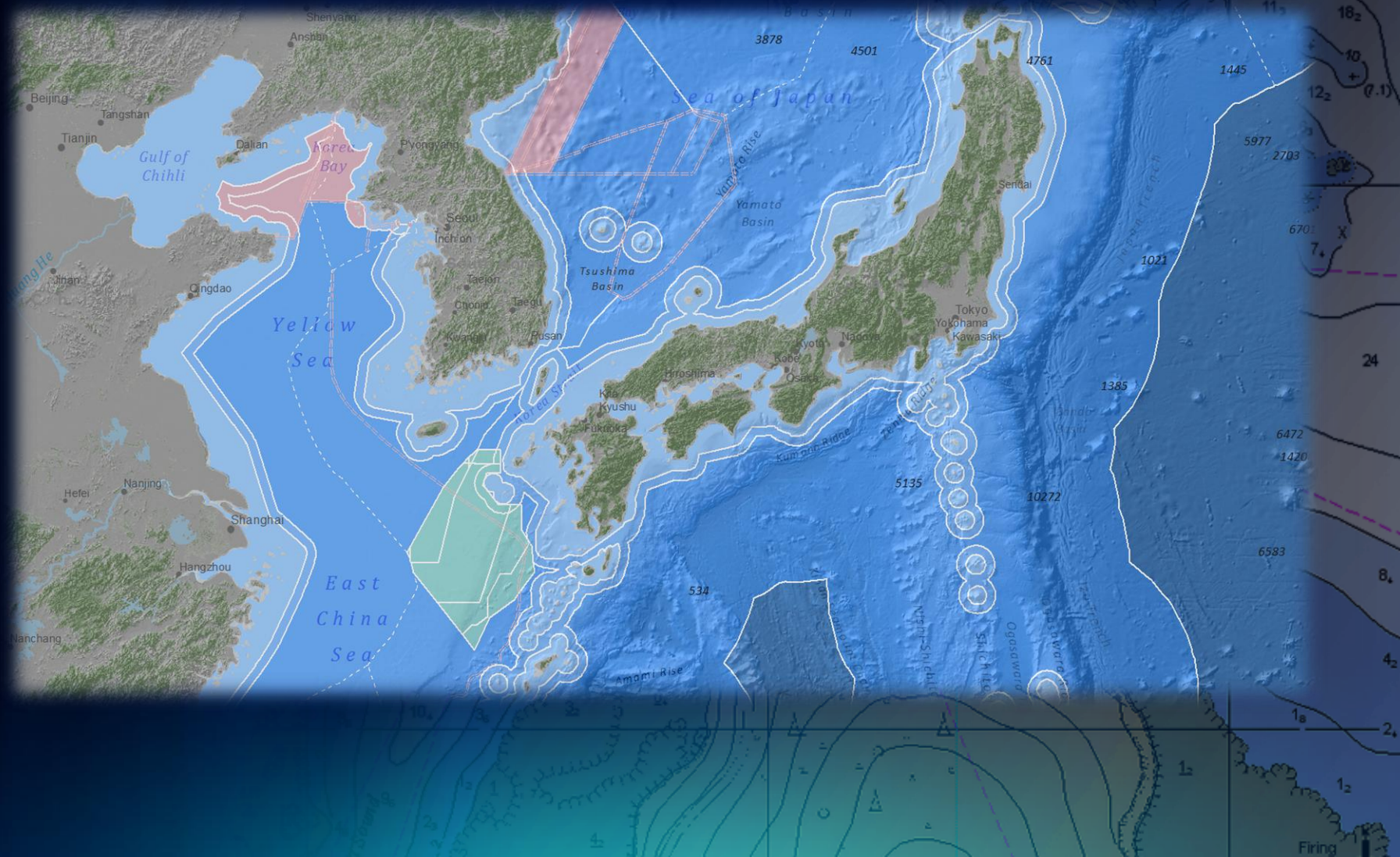
Forecasting Daily Events



Solving Problems in Undersea Warfare

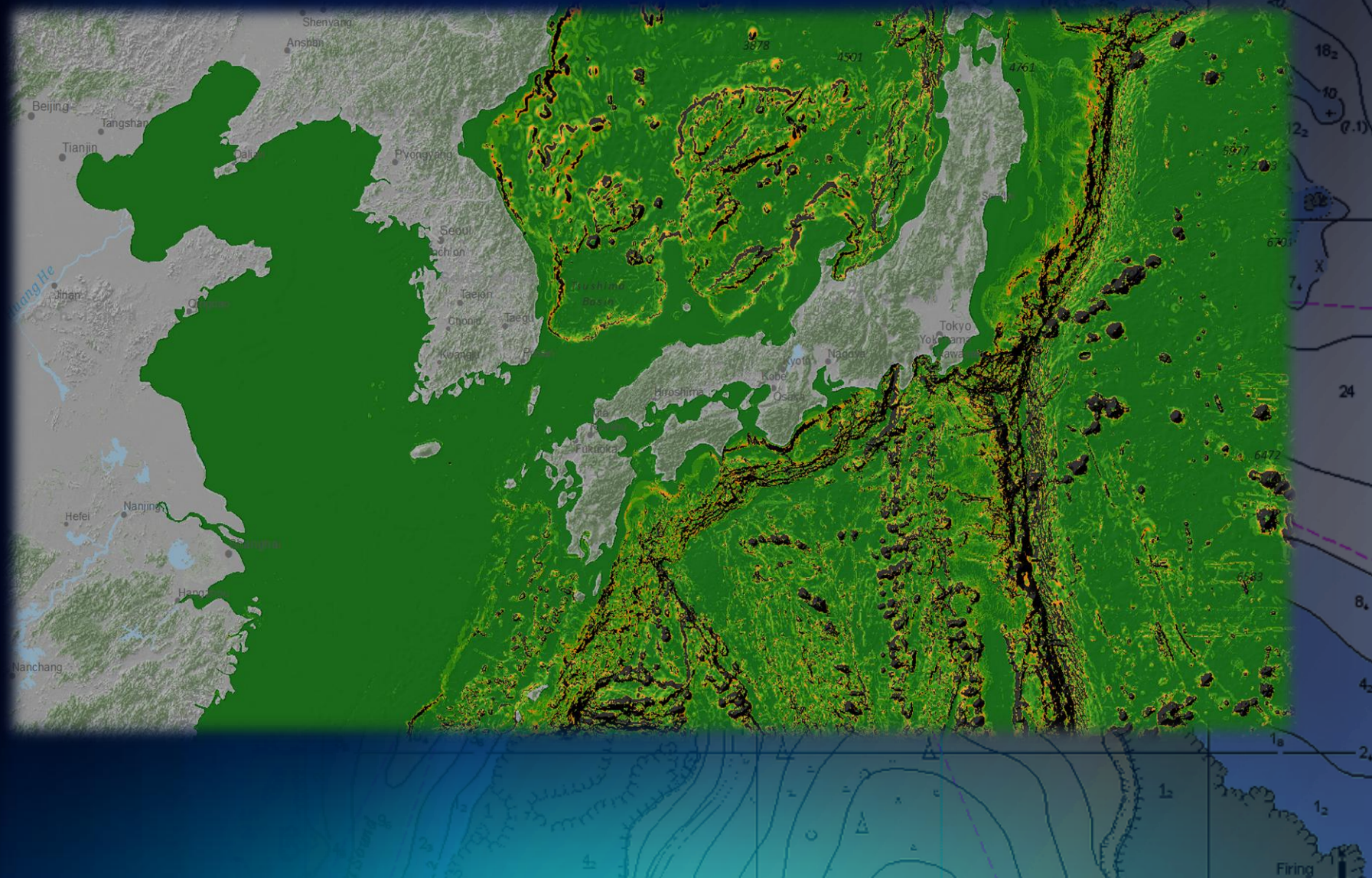


International Boundaries and Disputed Territories

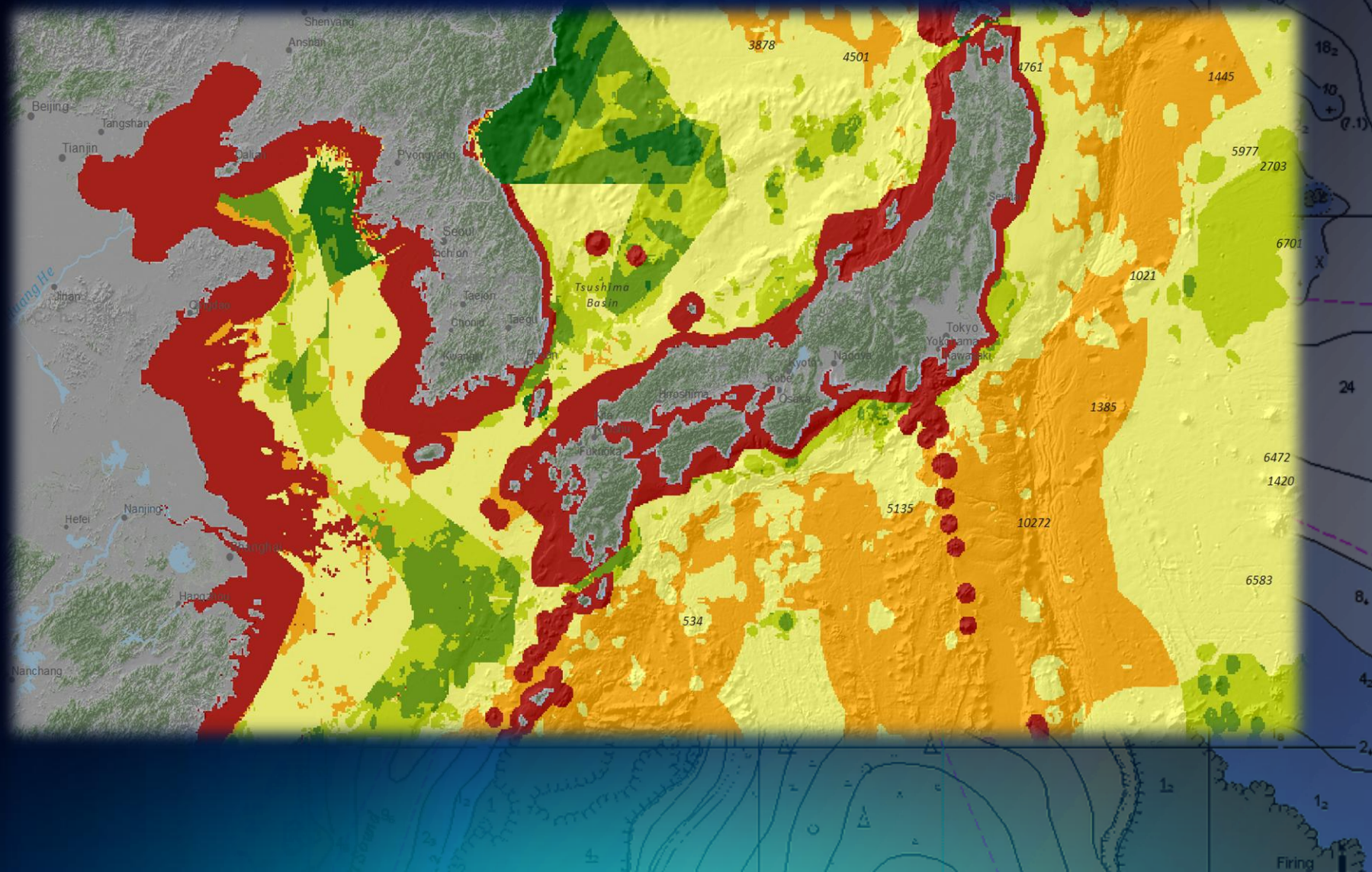


Nautical Charts and Bathymetry

Ocean Sediment and Slope



Models for Predictive Analysis through Fusion



Deploying Interoperable Systems for Problem Solving

Supporting Individuals, Groups, and Organizations



**Integrating and
Synthesizing Information
from Many Sources**



**Facilitating
Communication
and Collaboration**



**Breaking Down Barriers
Between Institutions,
Disciplines and Cultures**

Maritime Collaboration “Unity of Action”



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Maritime