UkrRIS activities to improve navigation in sea-river shipping area

https://ukrris.com.ua/

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RIS Workshop in Geneva 23-rd of June 2016

CONTENT

Introduction

1. Ships blinking mark on the IENC during the message transmission by VHF;
2. Water mark and printing way of information, which is transmited by VHF;
3. RIS technology for VHF information reflection in ERI or NTS messages;
4. Dynamic chart modeling (DCM) in estuary Danube:

- Theoretical aspects;
- Trial aspects;
- Dynamic prediction of IENC;
- Evaluation

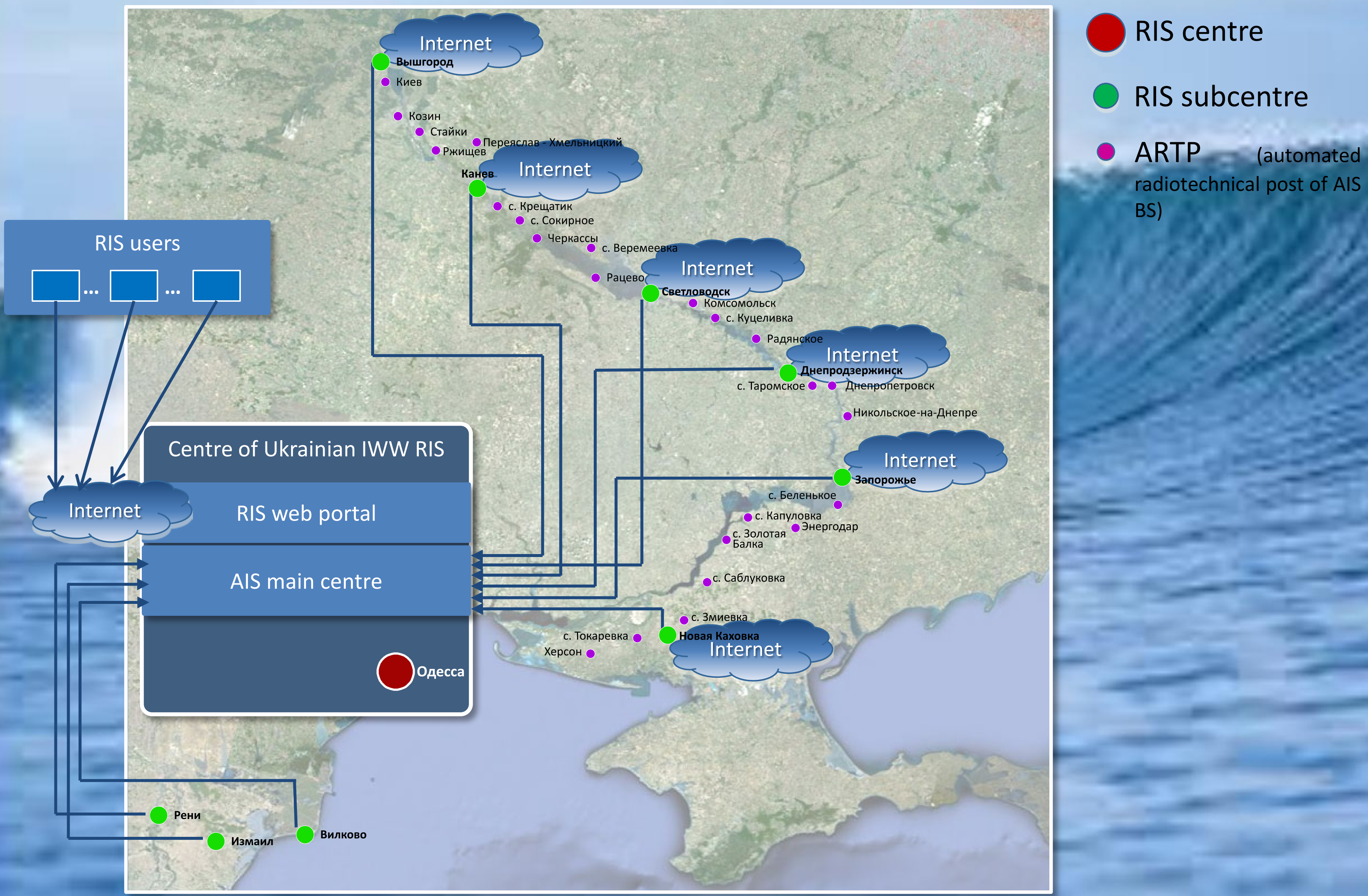
5. Study course “navigator behavior recommendation in suddenly change of hydro- meteorological conditions”

Conclusion

Introduction

1. In time of UkrRIS operational we made decision that RIS development can to be advance. Some of ideas the deal solutions we considering in this presentation.
   Take into account that safety of navigation is relevant part of RIS tasks, we try to point out in this point especially in the estuary of the Danube, where we face challenges, for instance, with recognize of VHF in order to radiotelephone transmission information.
2. Second part is dynamic components of IENCs which is really regardless in real time ongoing vessels. In this reason we considering the dynamic model at sea/river surface & sea/river bottom up to date for safety navigation in shallow water .
3. Third part is development of new study course “navigator behavior recommendation in suddenly change of hydro- meteorological conditions” in shallow water regard to Dynamic chart in real time.

UkrRIS Structure



Web portal structure

River information services are implemented as individual pages accessible to users of the portal information services.

Service FAIRWAY

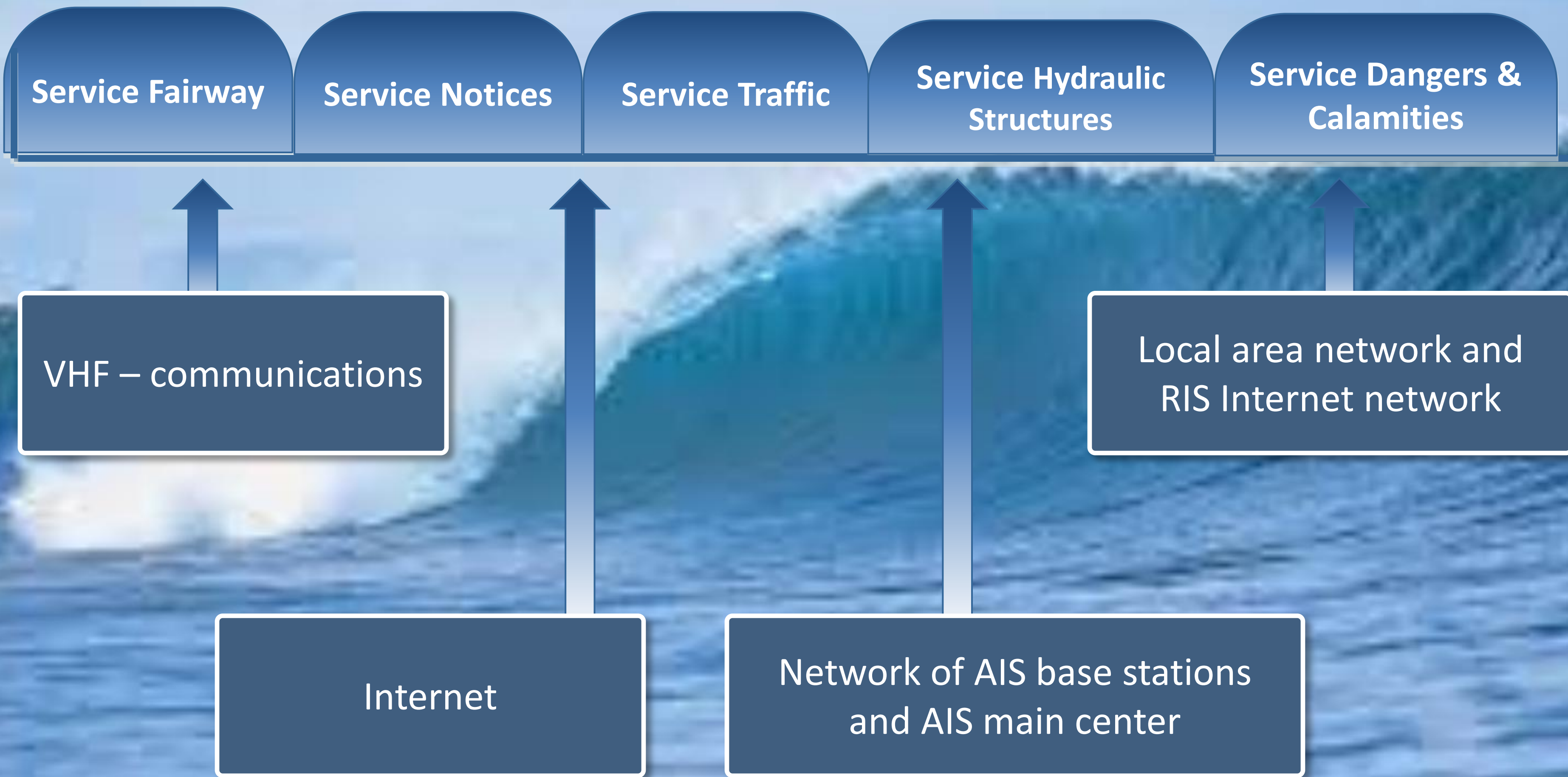
Service NOTICES

Service TRAFFIC

Service HYDRAULIC STRUCTURES

Service DANGERS & CALAMITIES

Technical solutions used by RIS services



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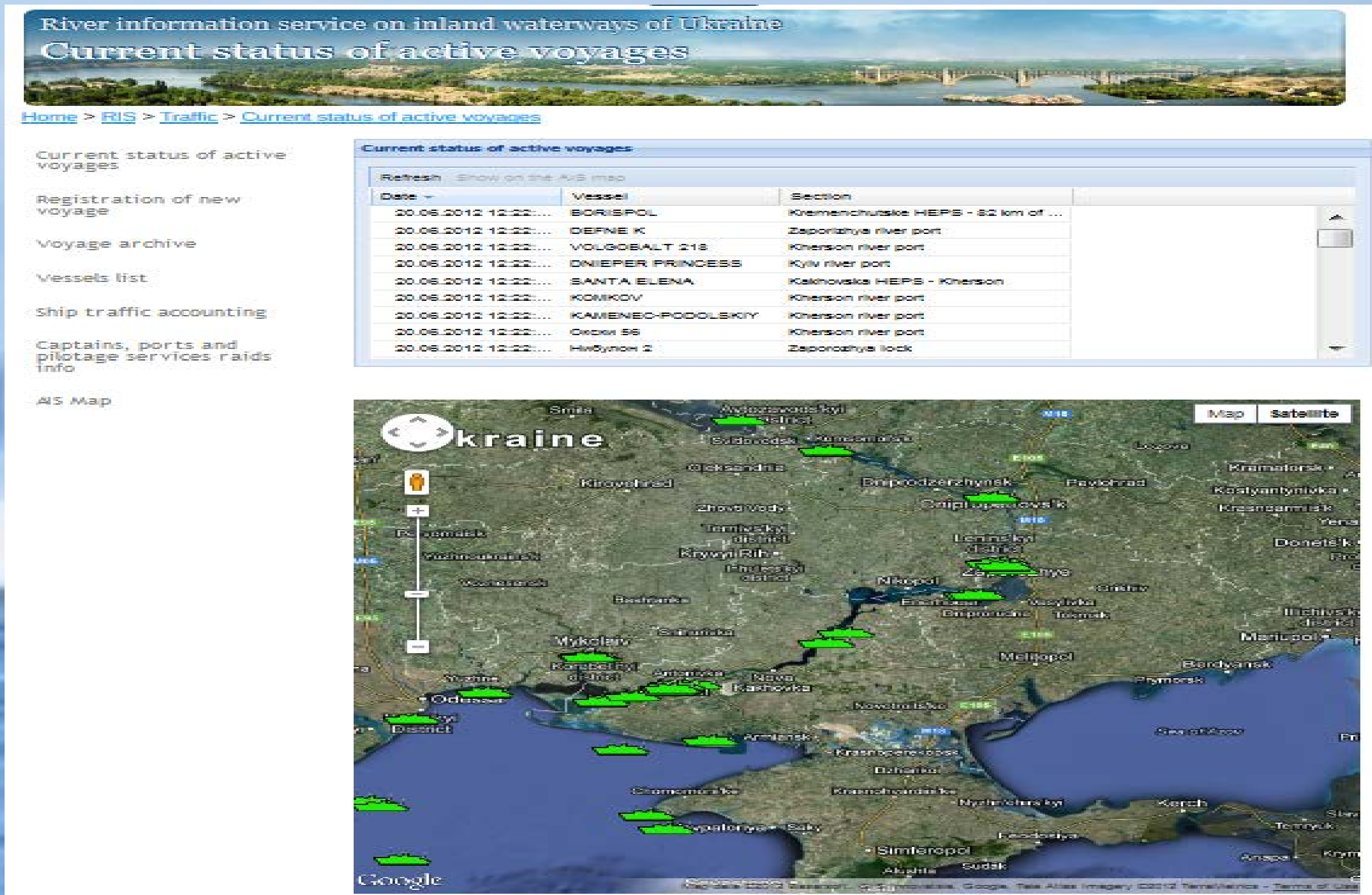
Service «Traffic» at web portal



Actual vessel location (dispatcher data)

Part 1

1. Marking the transmitting vessel on IECDIS

VHF/ATIS – ECDIS/AIS integration allows marking of the transmitting vessel on electronic chart by blinking mark

Inland ECDIS (Edition 2.3)

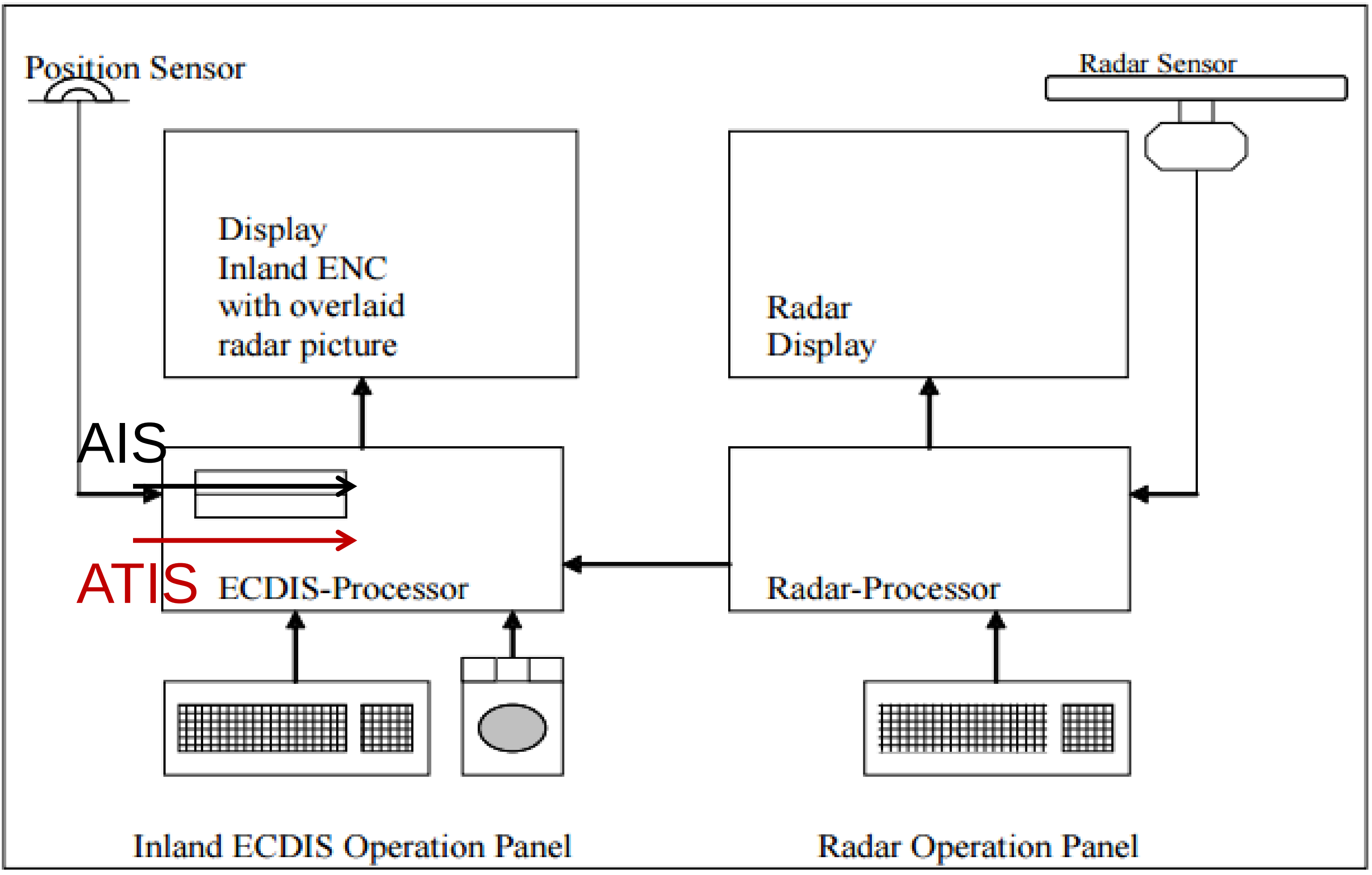
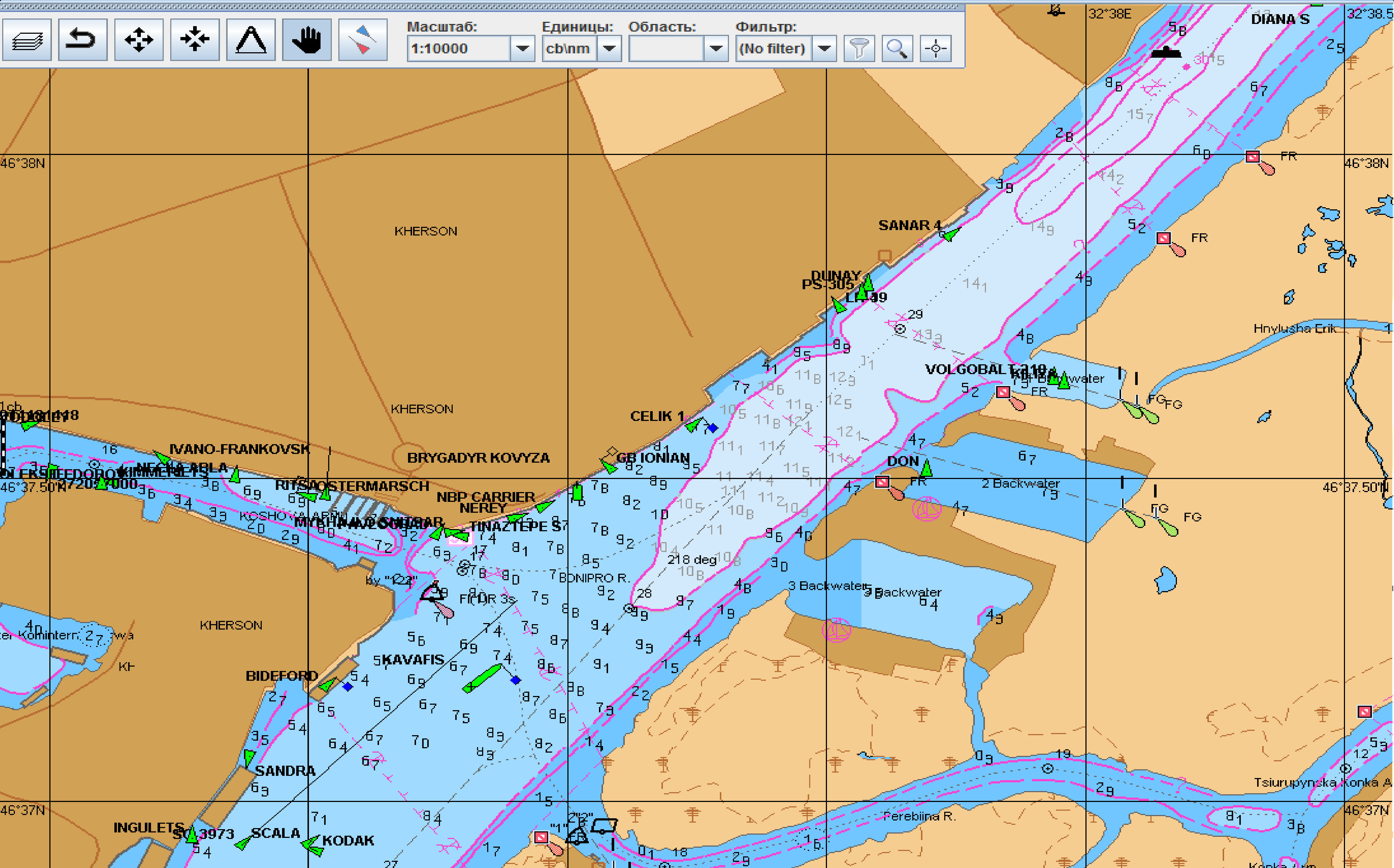


Fig. 2: Inland ECDIS equipment, self-sufficient system with connection to radar

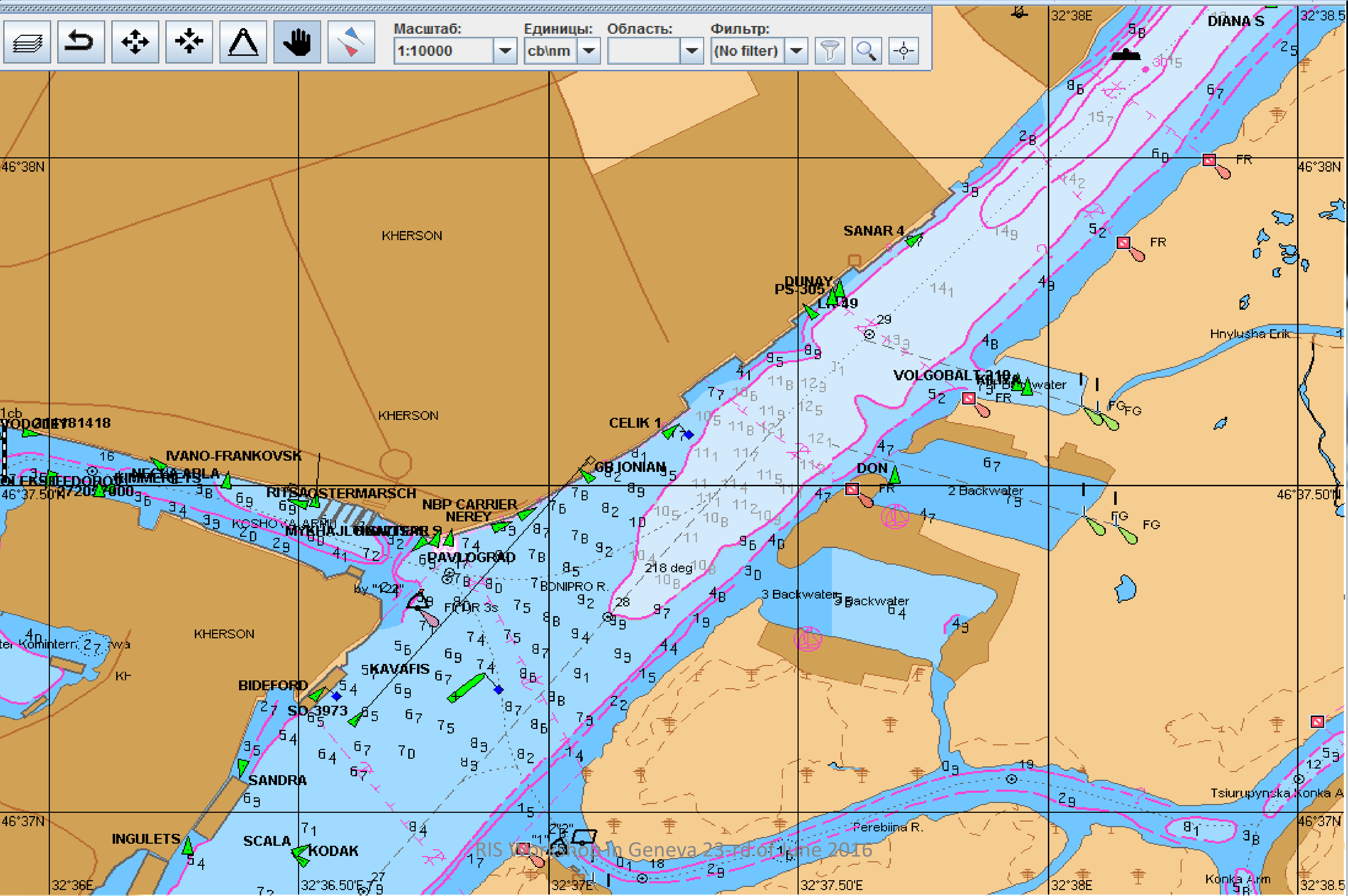
The range of operation for AIS and VHF/ATIS is the same, therefore in IECDIS charts AIS&ATIS marks are harmo-nized

VHF/ATIS – ECDIS Integration (1)

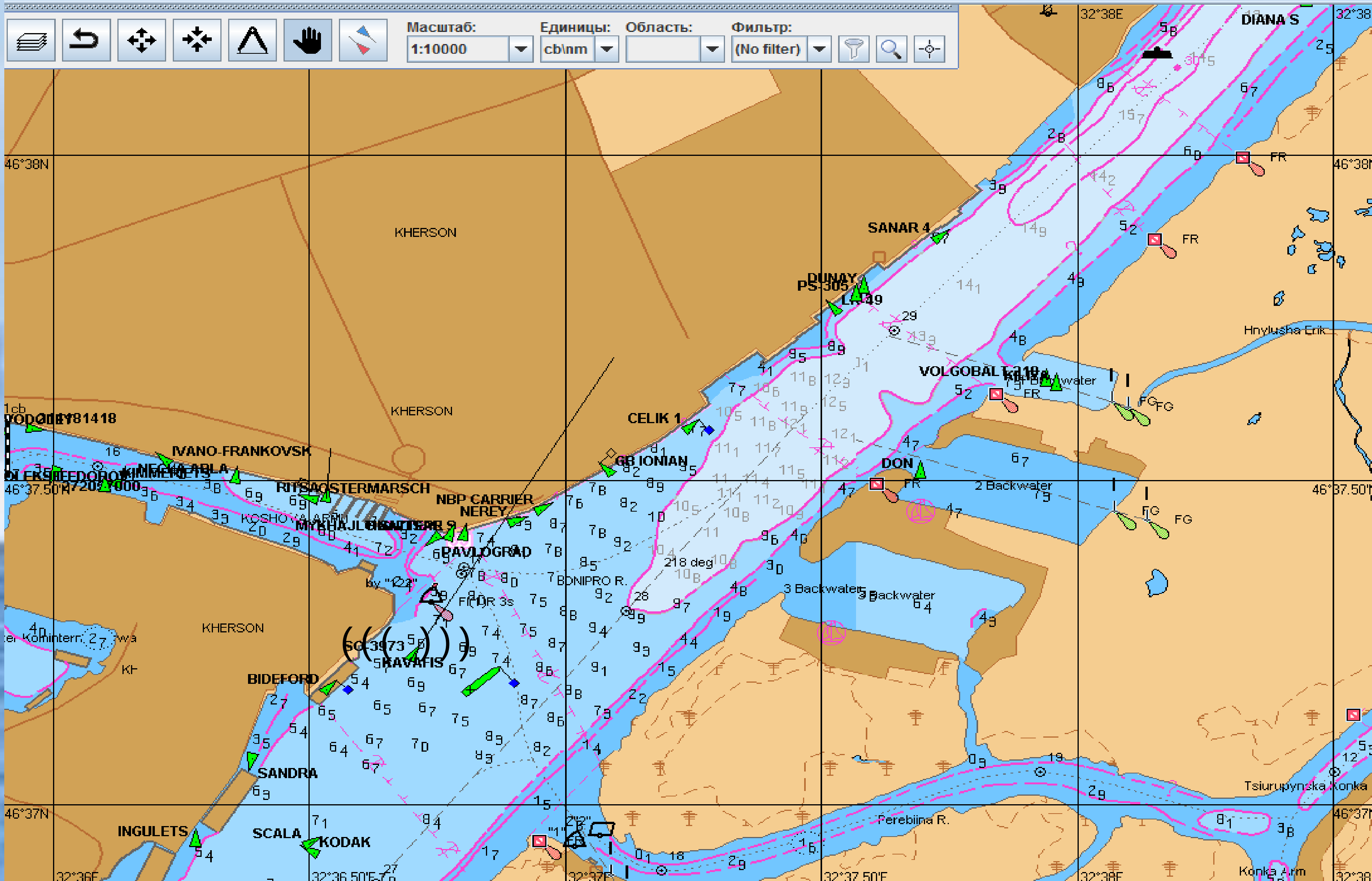


VHF/ATIS – ECDIS Integration (3)

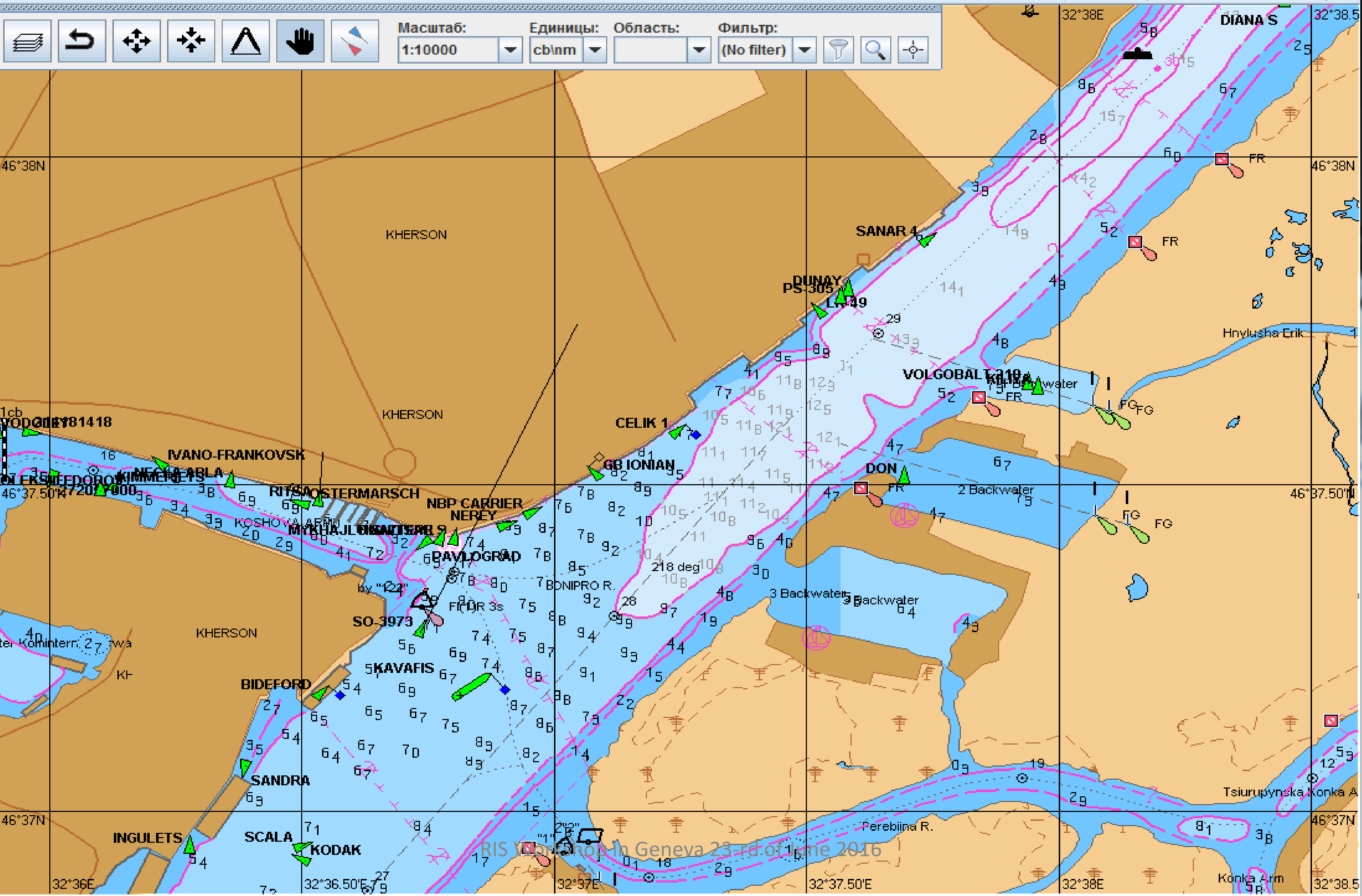
VHF/ATIS - ECDIS Integration (4)



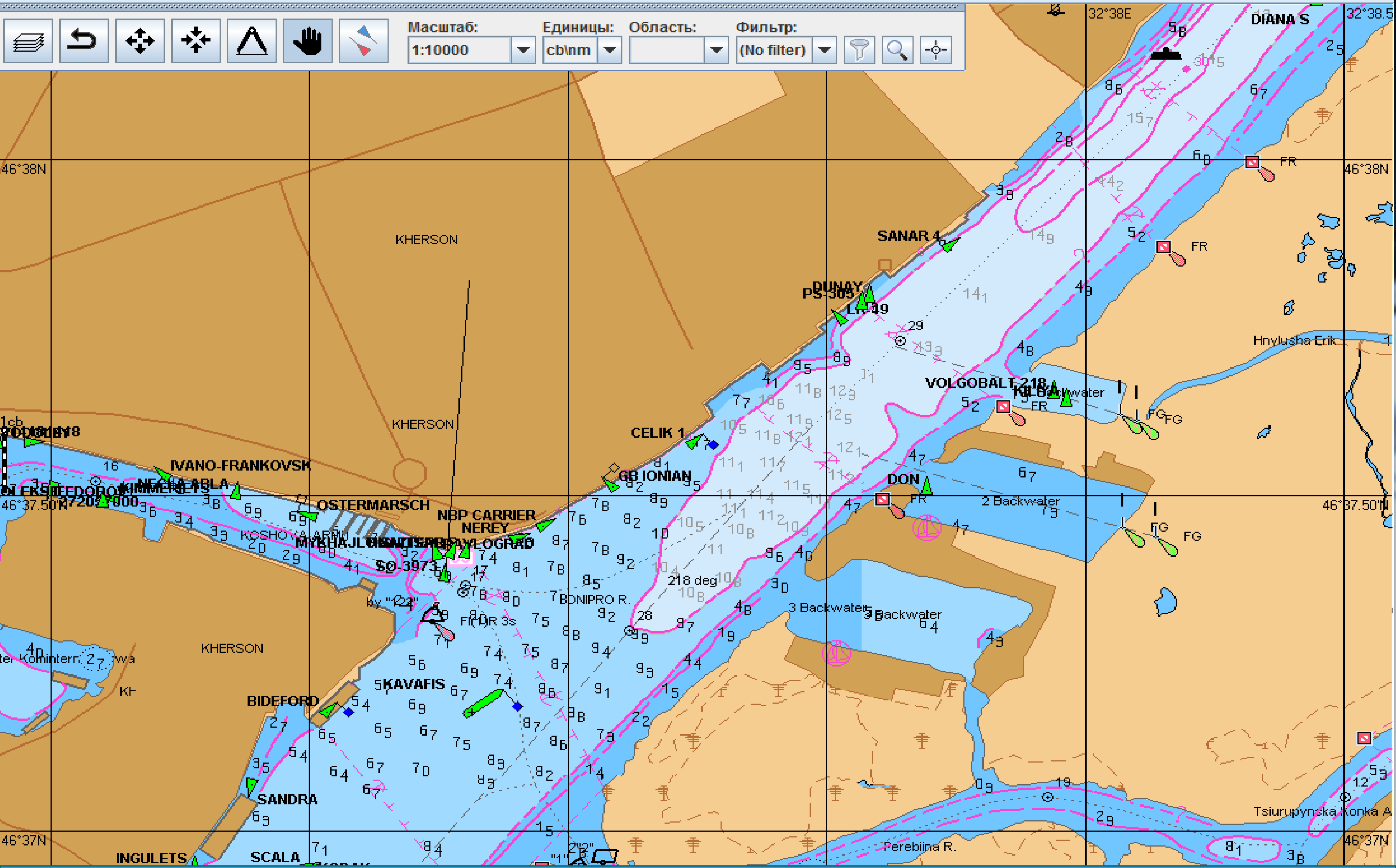
VHF/ATIS – ECDIS Integration (5)



VHF/ATIS – ECDIS Integration (6)



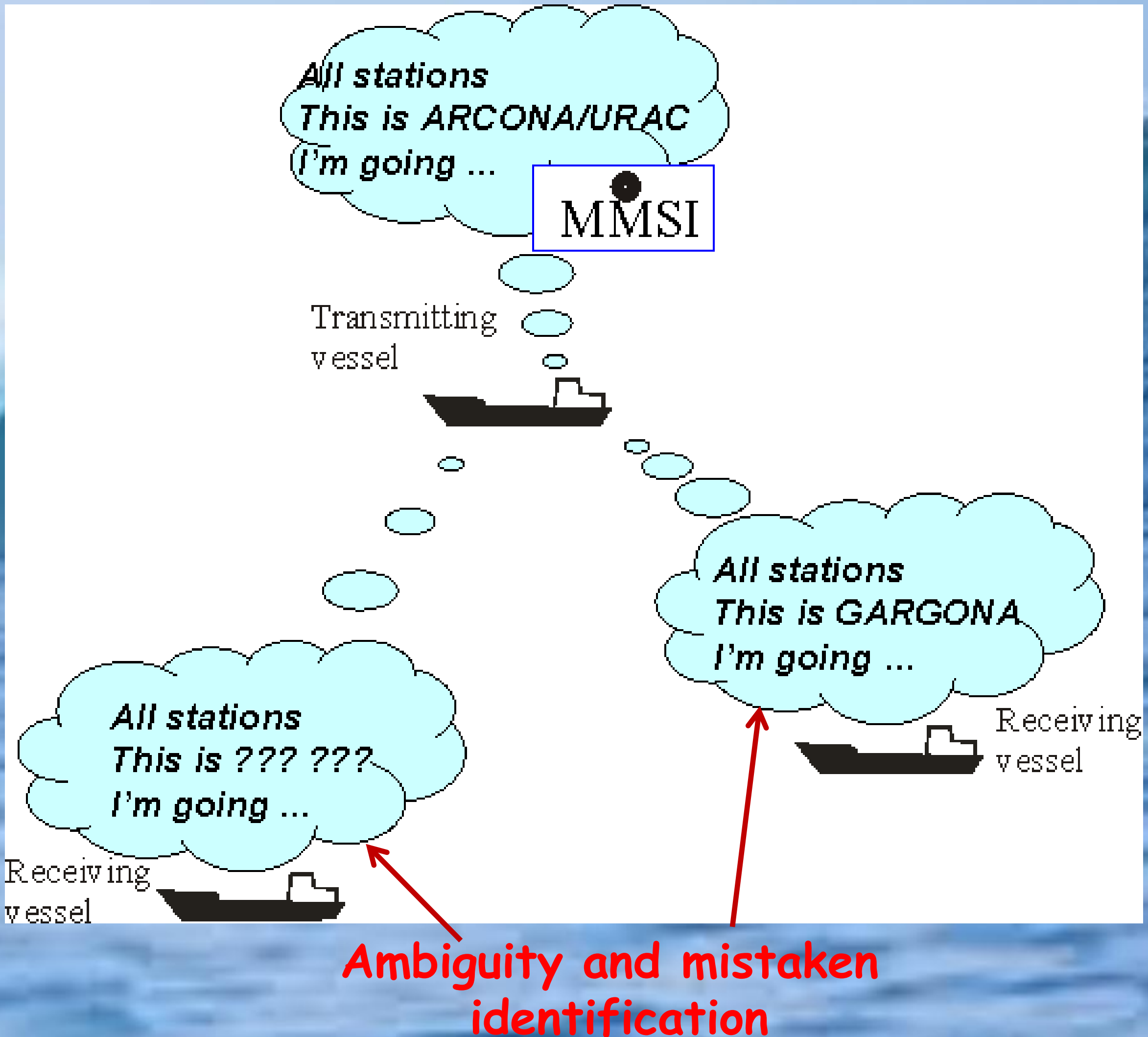
VHF/ATIS – ECDIS Integration (7)



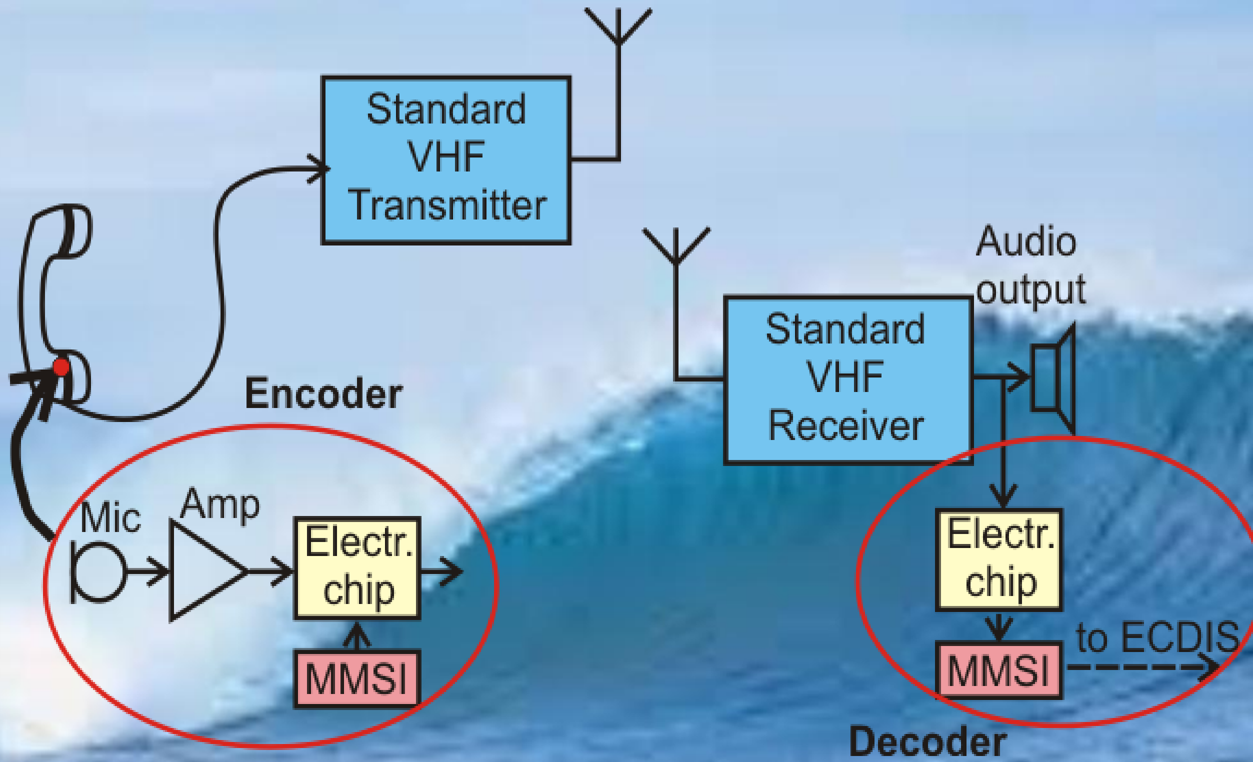
2. Application of audio watermarking (AWM) technology in marine/river VHF radiotelephony

The Proposed Solution: Audio Watermarking

MMSI
(Maritime Mobile Identification Number)
is **embedded directly into audio signal.**
It allows realising **Automatic Identification** of transmitting station



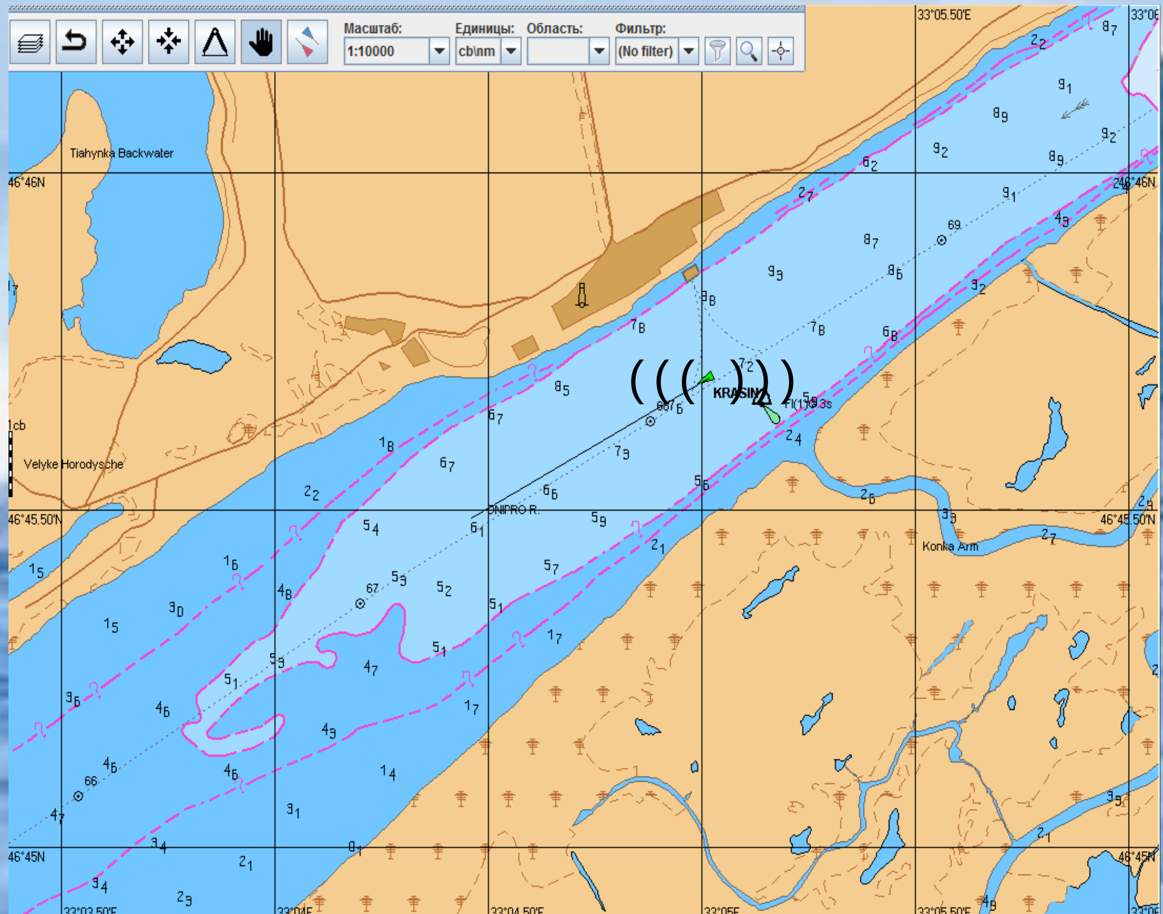
Practical Realization



Application in VHF telephony for Automatic Identification. Electronic Chip is necessary just for seagoing vessels which going to come in the river ports. For river vessels there is the ATIS equip.

Another application of Audio Watermarking: Subtitle for on-line R/Telephony

THIS IS KRASIN   I'M HEADING   TO THE OLD BERTH



*Speech recognition is necessary at the transmitting part

3.Using AWM in NtS and ERI

NtS

RIS index

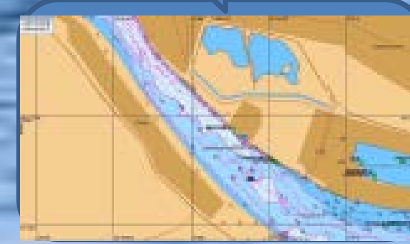
encoding

IENC

IMAGE/symbol

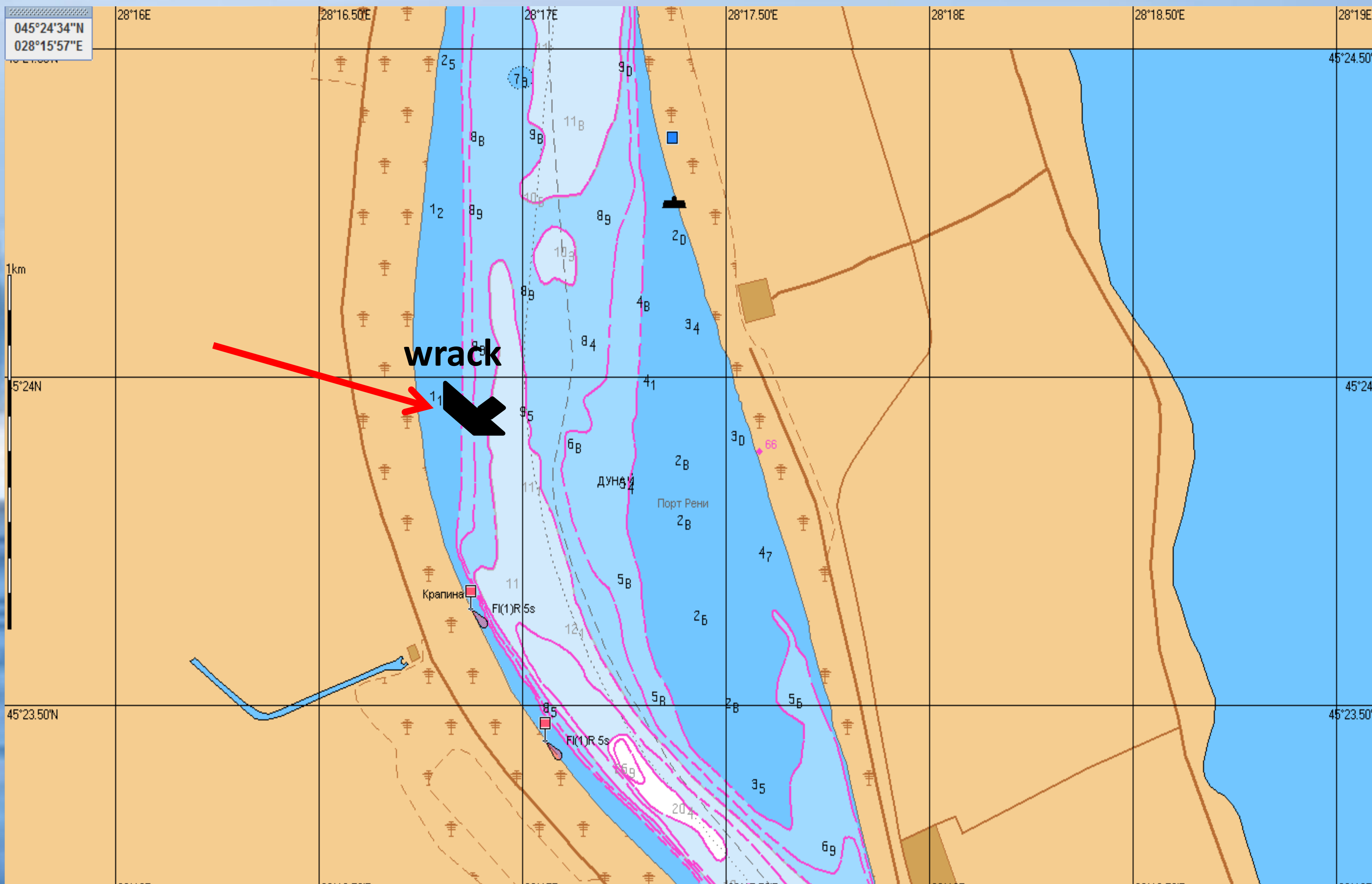
Sunken small craft on the right side of the fairway at the Danube, river-km 66

AWM



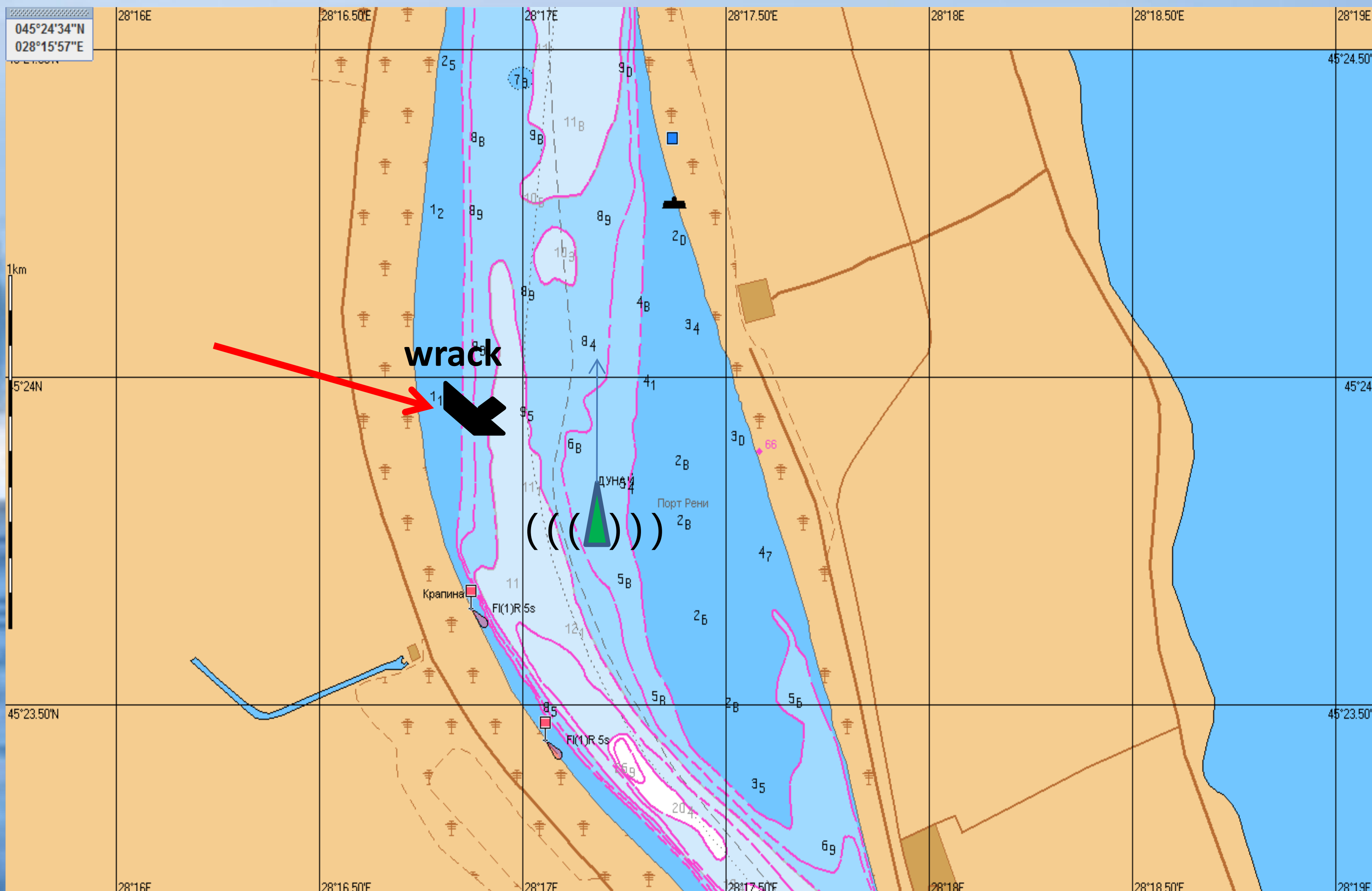
Notices to Skipers

Sunken small craft on the right side of the fairway at the Danube, river-km 66



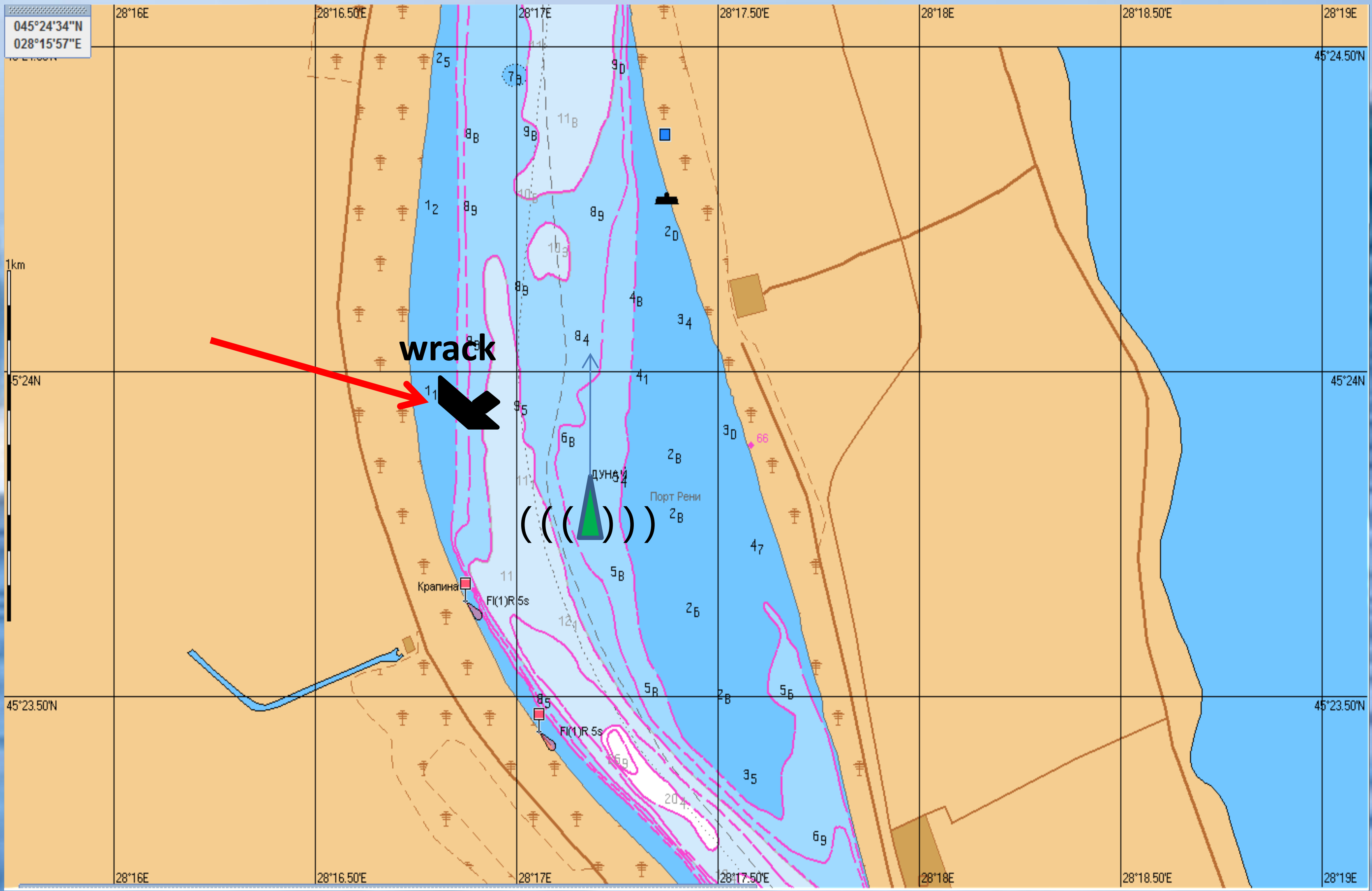
Notices to Skipers

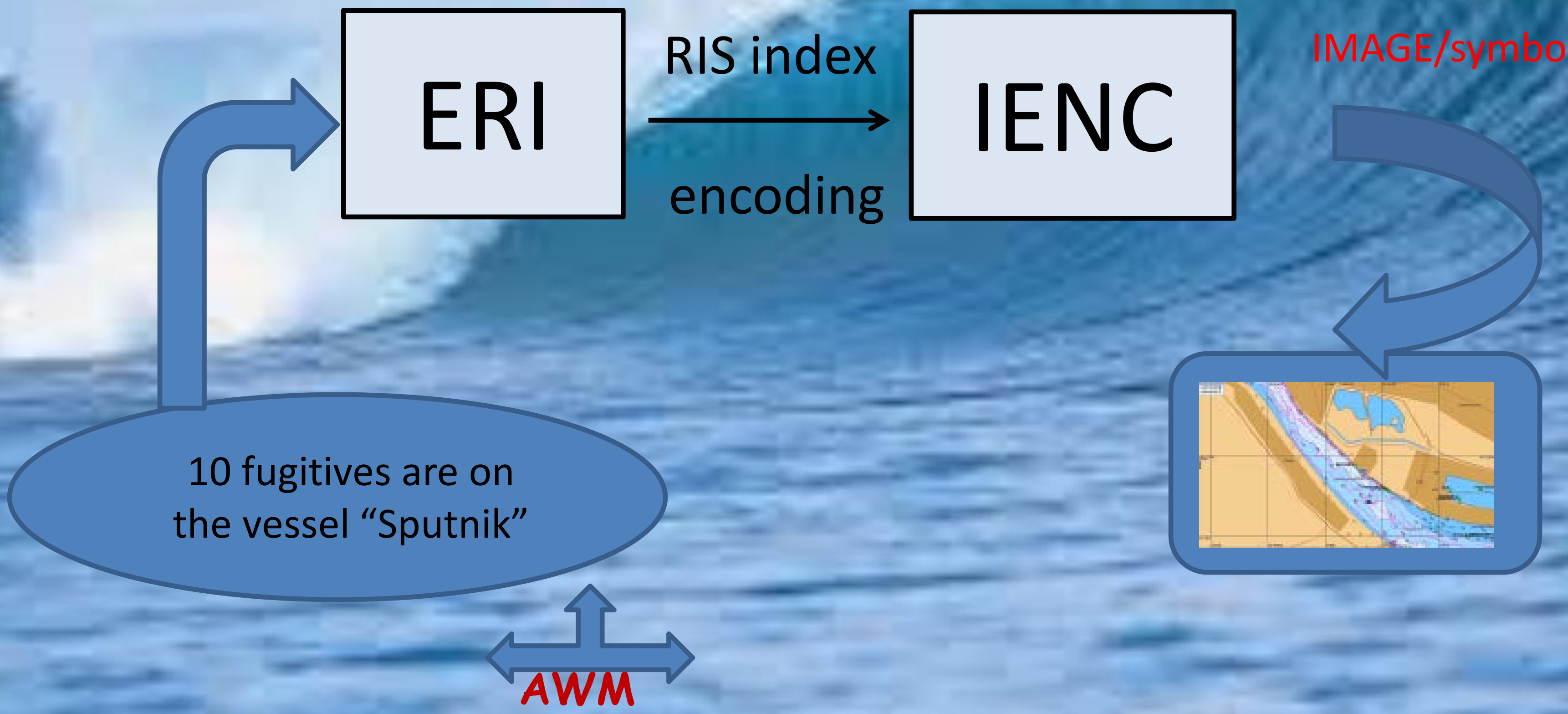
Sunken small craft on the right side of the fairway at the Danube, river-km 66



Notices to Skipers

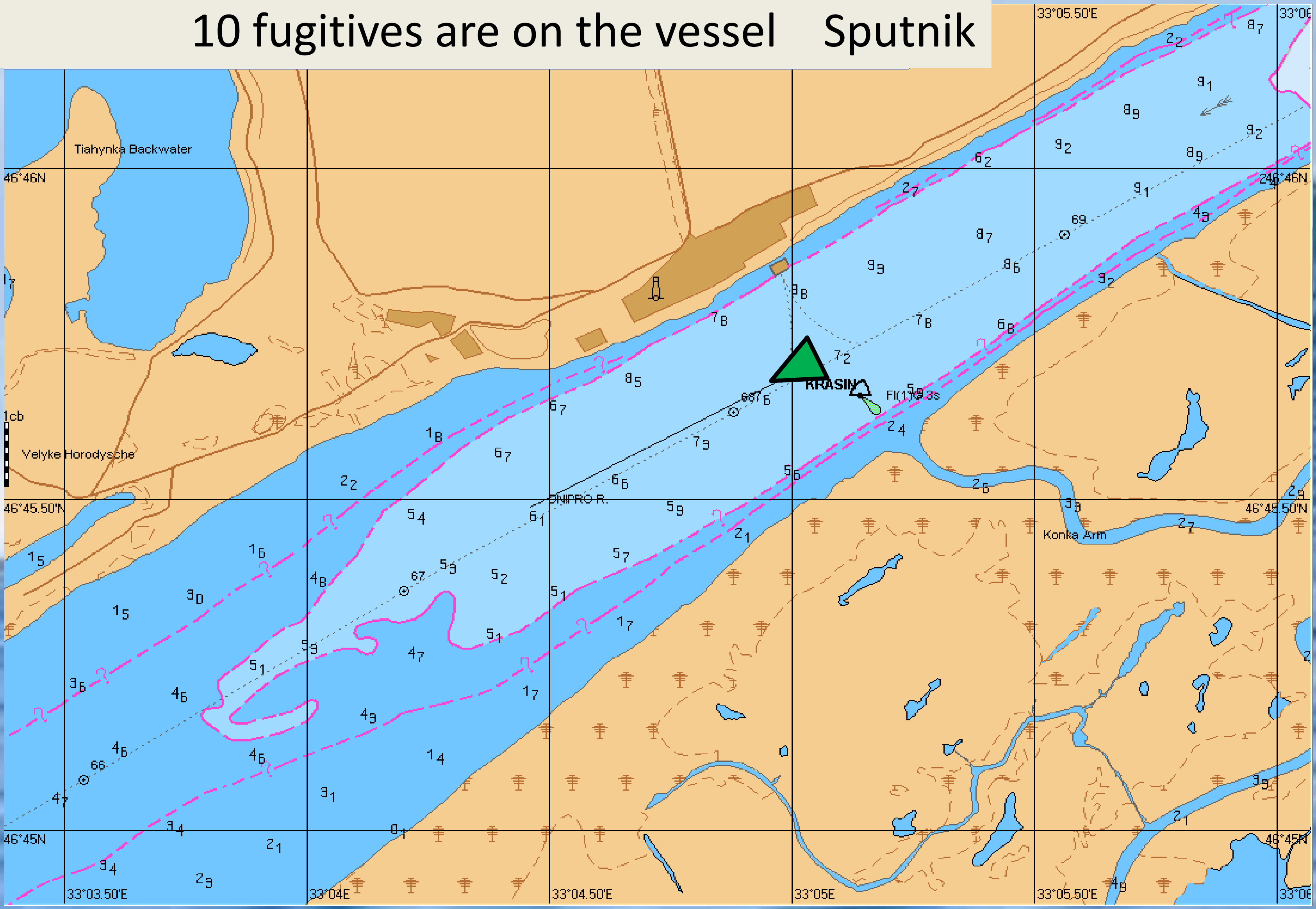
Sunken small craft on the right side of the fairway at the Danube, river-km 66




ERI
RIS index
encoding
IENC
IMAGE/symbol
10 fugitives are on the vessel "Sputnik"
AWM

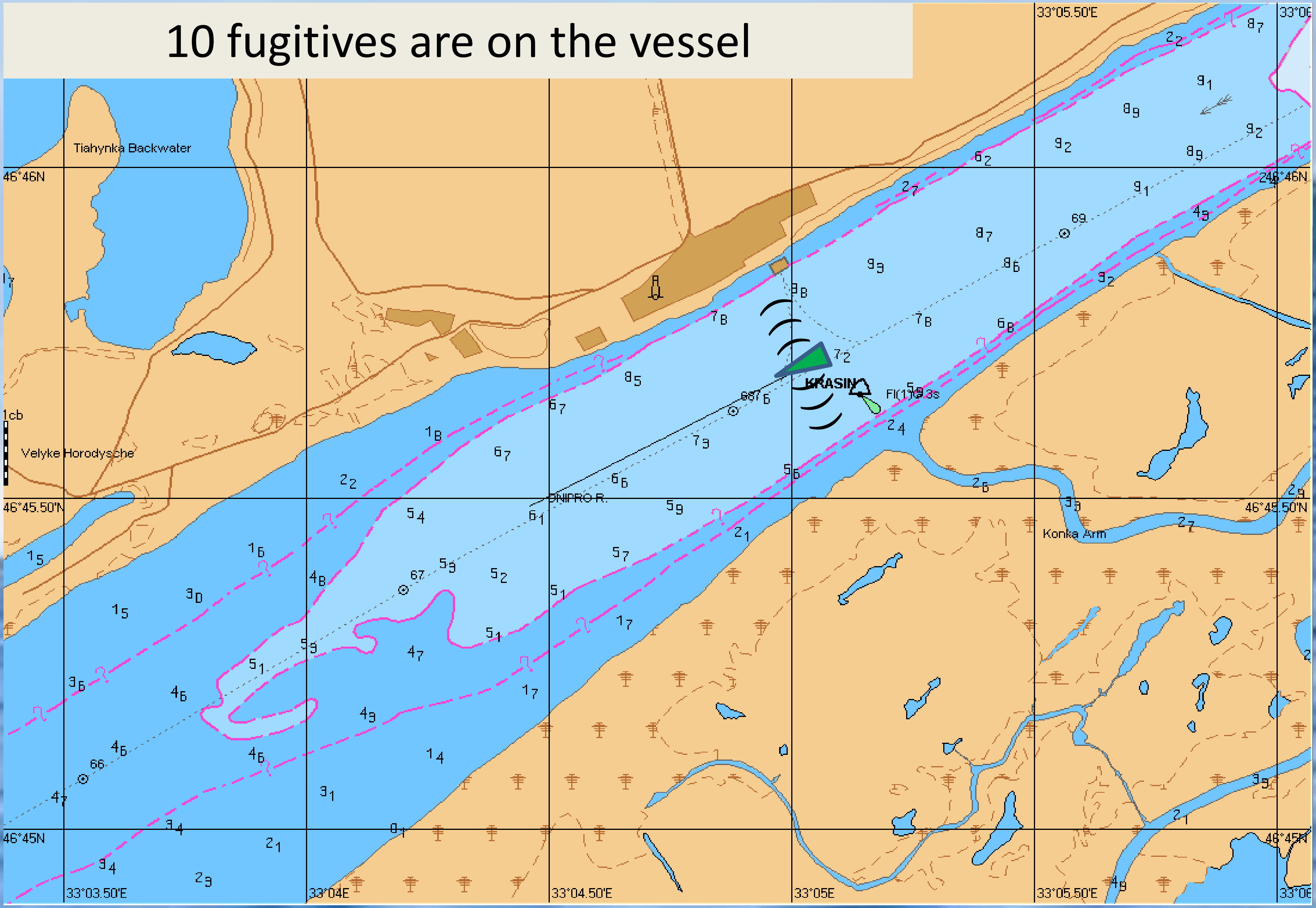
ERI

10 fugitives are on the vessel Sputnik



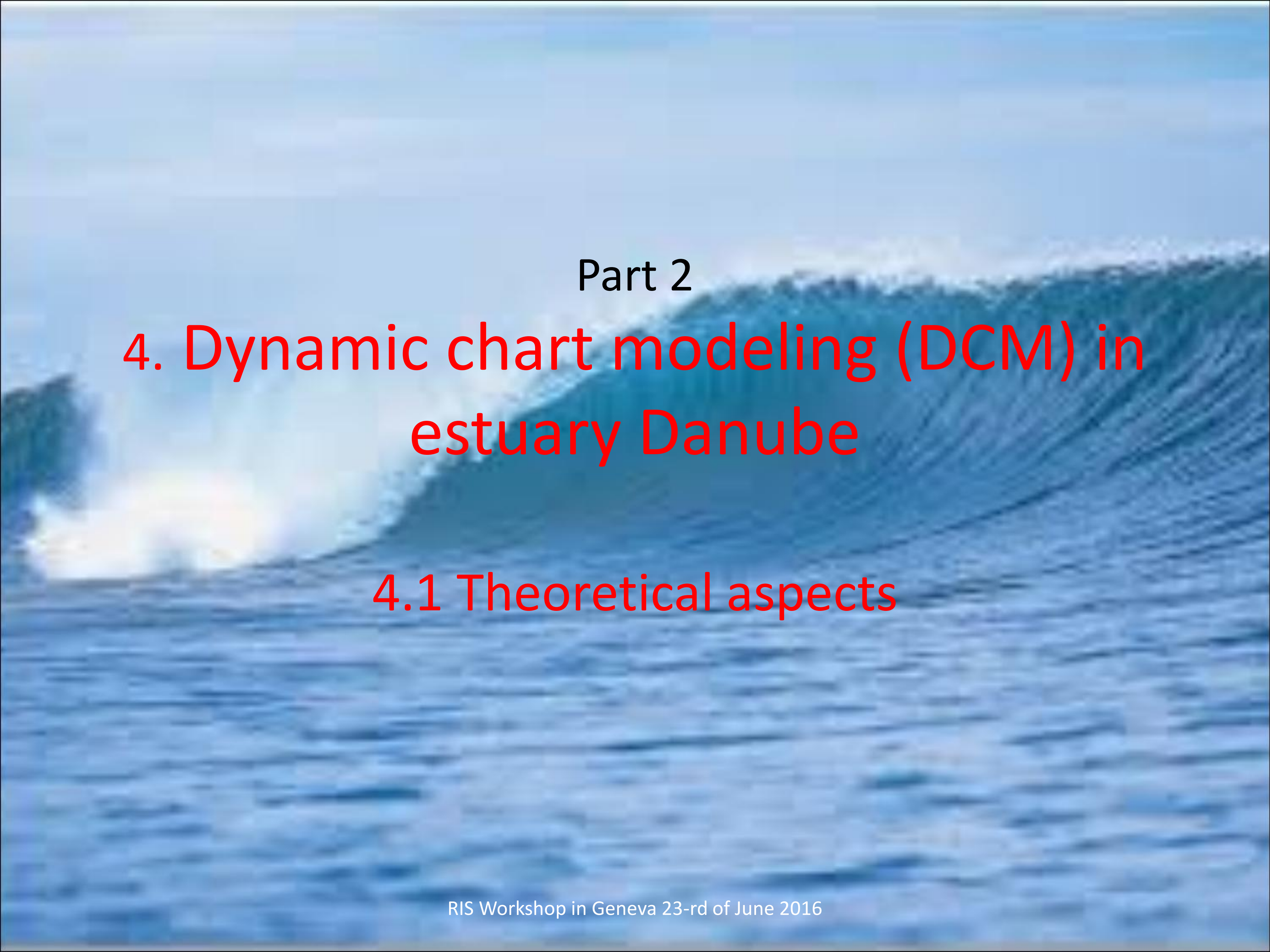
ERI

10 fugitives are on the vessel



Summary to the 1-st part

1. The display of the information in harmonized and effective way increases the overall awareness of the information improving the situational awareness as well as reducing the mistakes made transferring information from paper outputs. The information display must bring all the key information together.
2. It is necessary to integrate received navigational information via communication equipment into the integrated navigation system in a harmonized and agreed way and simplify addressed VHF communication for navigators.
3. ECDIS modernization would release a navigator from routine procedures and from handling abstract data, replacing them with understandable actions on standard user interface – ECDIS display.
4. The proposed modernization retains in operation all standard communication equipment and ECDIS functions and provides full compatibility with other equipment commonly used and integrated with ECDIS.



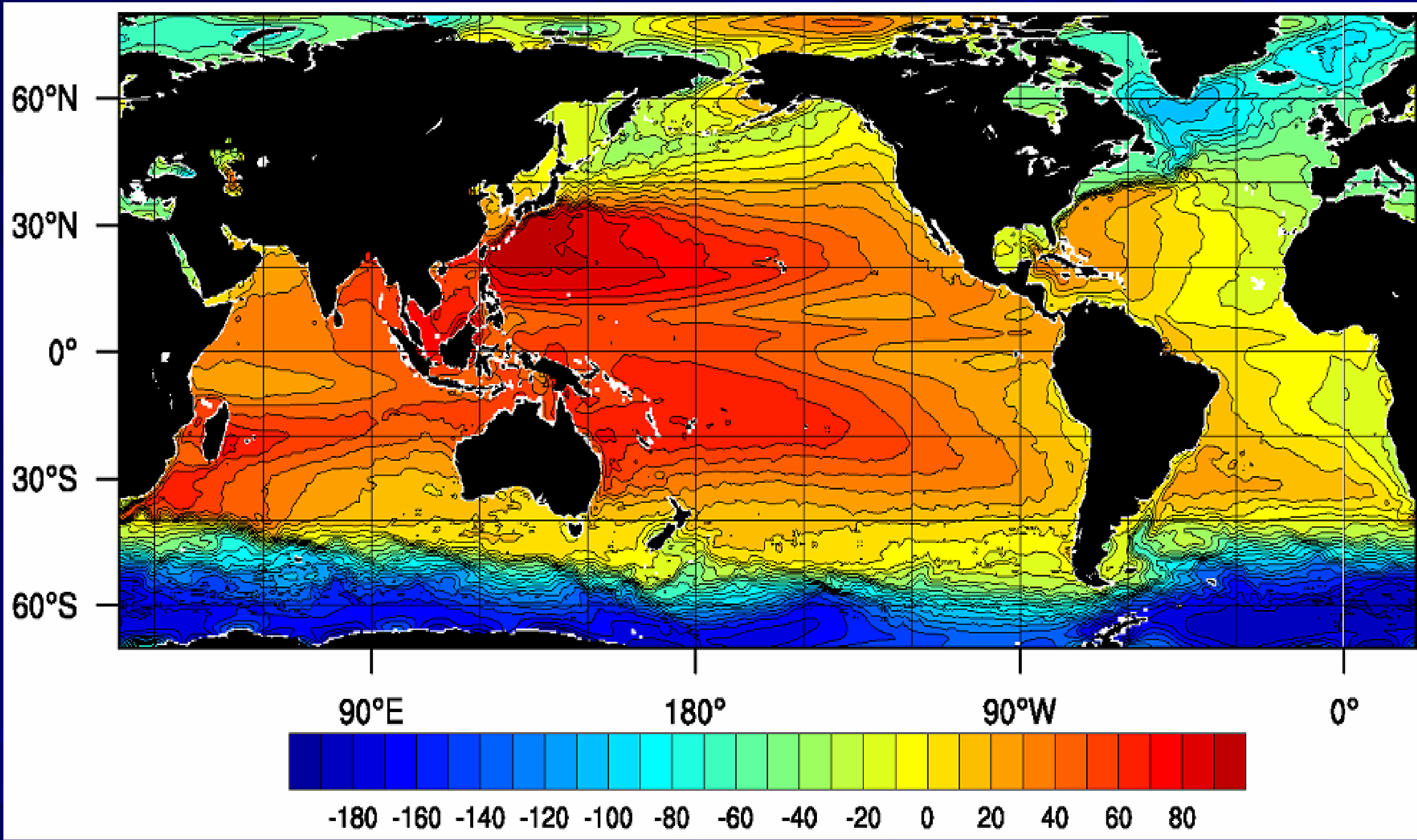
Part 2

4. Dynamic chart modeling (DCM) in estuary Danube

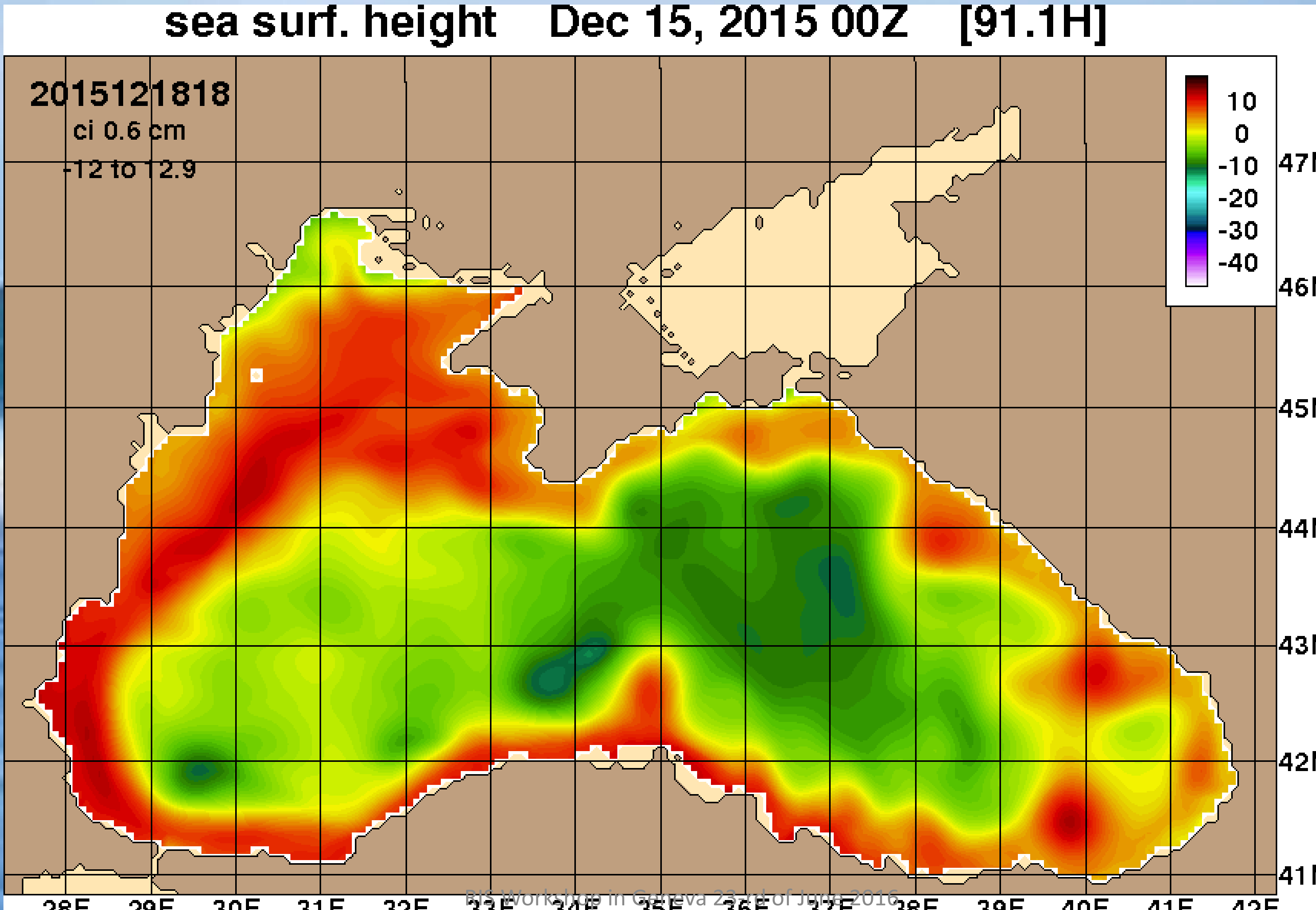
4.1 Theoretical aspects

Mean Sea Surface Evaluation

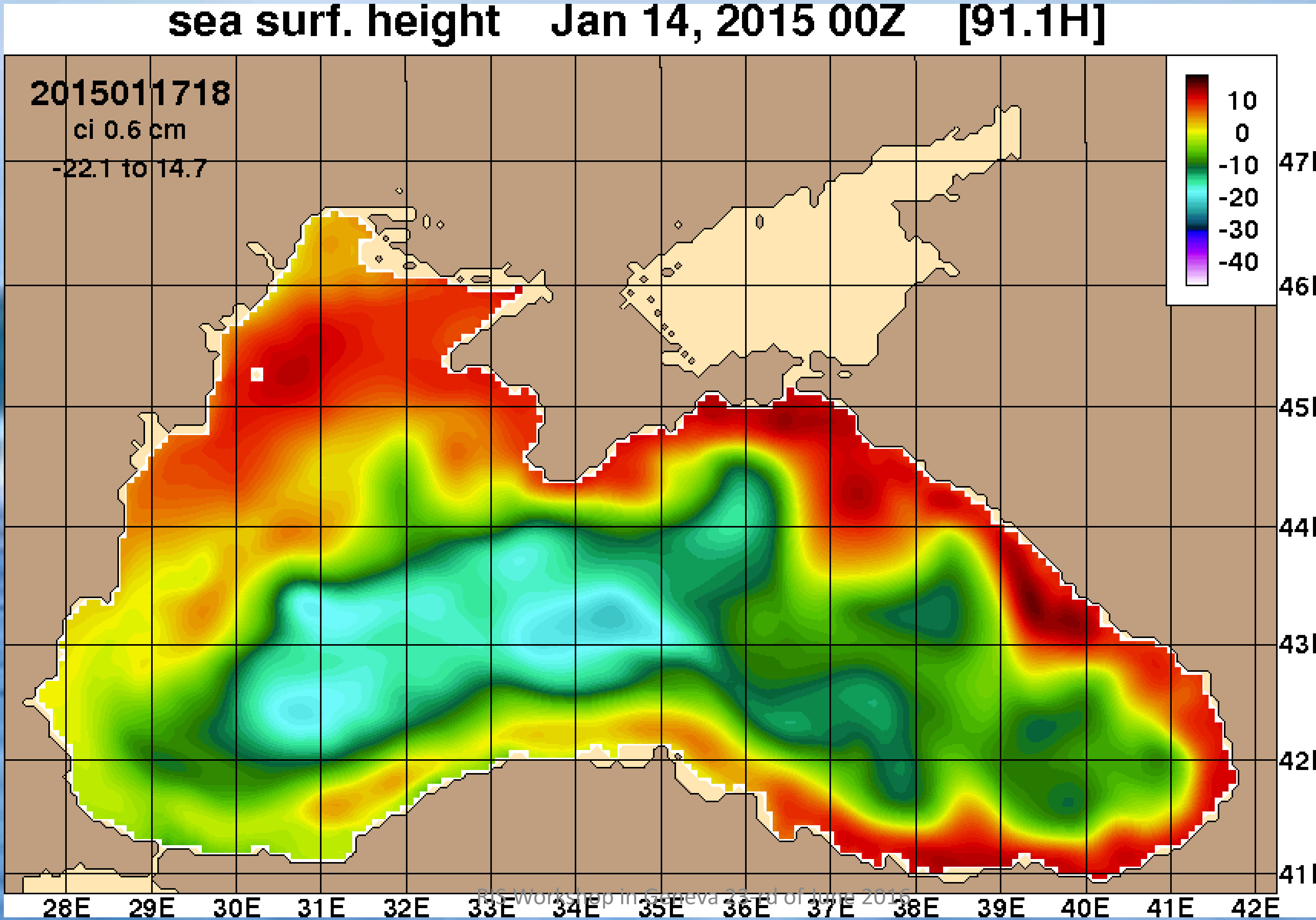
1992-2002 Mean dynamic ocean topography (0.5°)



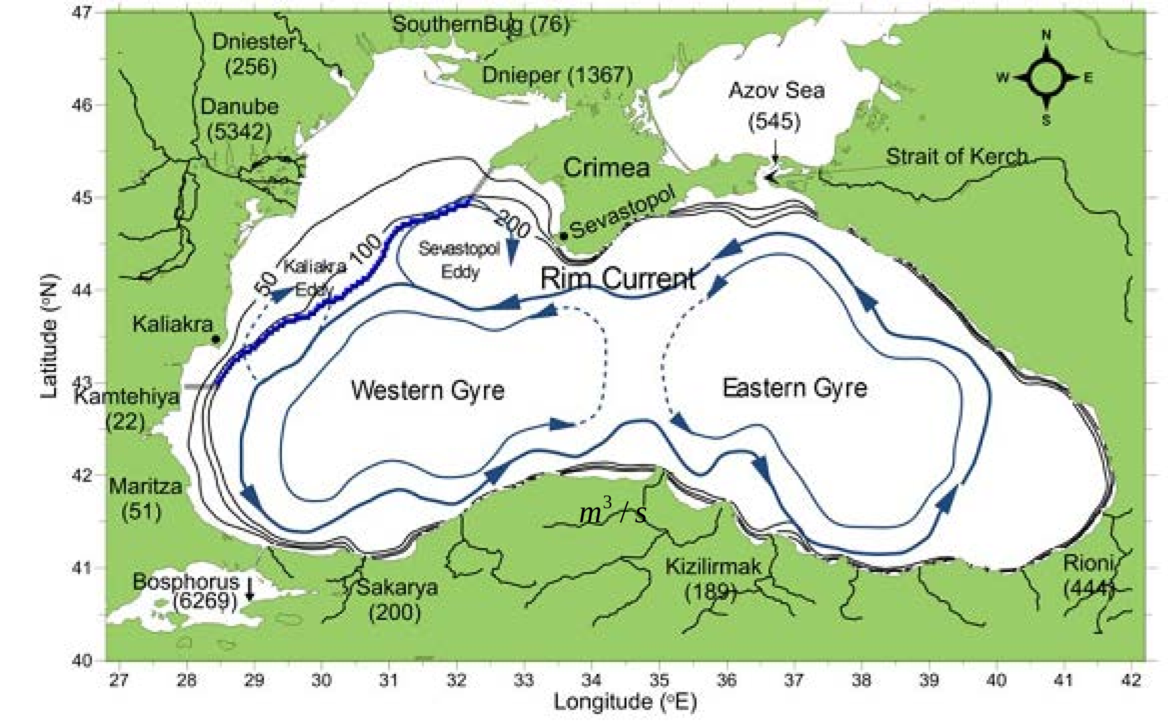
Black sea surface dynamic 1



Black sea surface dynamic 2



Estimates for the Black Sea based on remotely sensed data are significantly higher; up to 40% of shelf waters could be replenished during the summer season by a single mesoscale eddy [Shapiro et al., 2010].



Geographic setting, main rivers, and topographic features of the Black Sea with solid contours representing bathymetry. The annual mean runoffs of the main rivers and discharges via the Kerch and Bosporus straits are shown in the parentheses (units: m^3/s). The boundary enclosing the north-western shelf (the ‘‘fence’’) is composed of the shelf break following the 200 m isobaths (line of blue squares) and two short segments connecting to the coast (gray squares) at the two ends of the line formed by blue squares. Schematic of the Rim Current, main gyres, and anticyclones eddies are indicated by arrows, modified from that of Oguz et al. [2014].

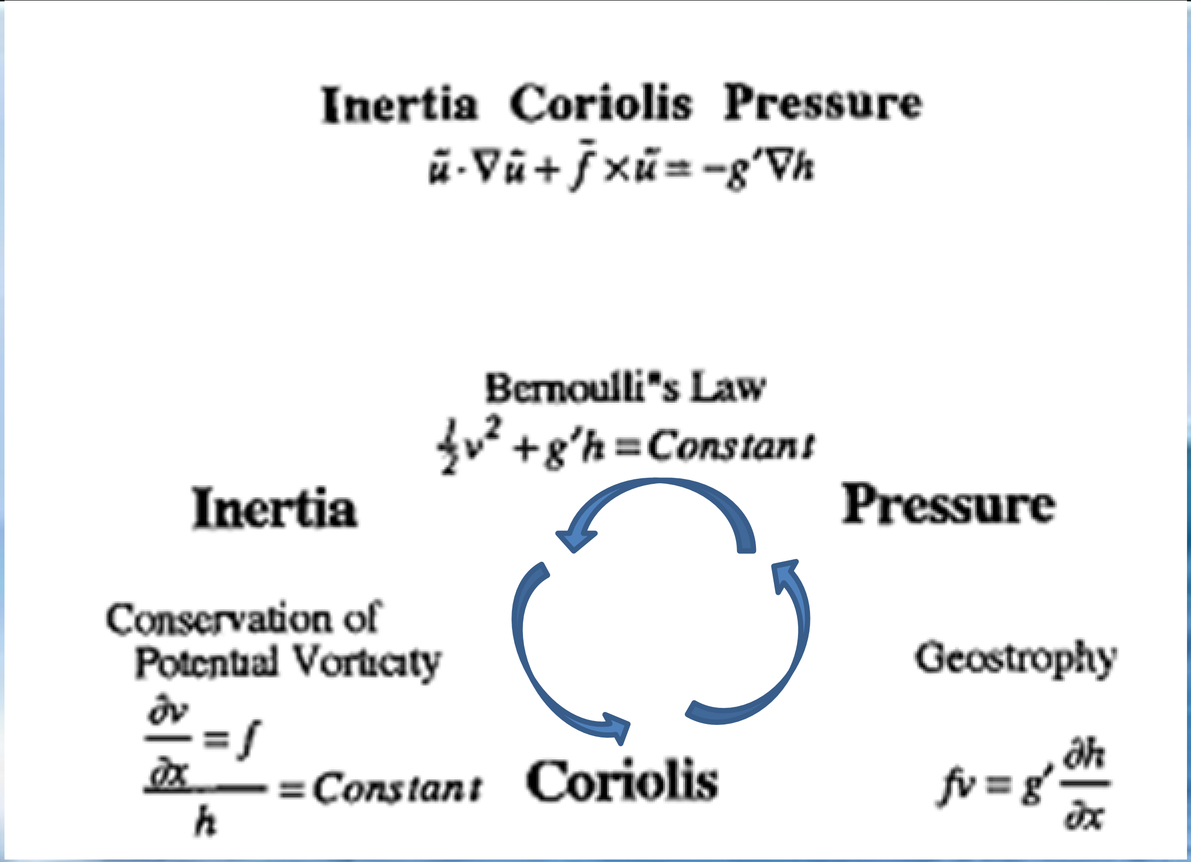


Figure 1. Diagram showing the three forces exerted on a fluid element and how dynamic relations are derived from these three forces.

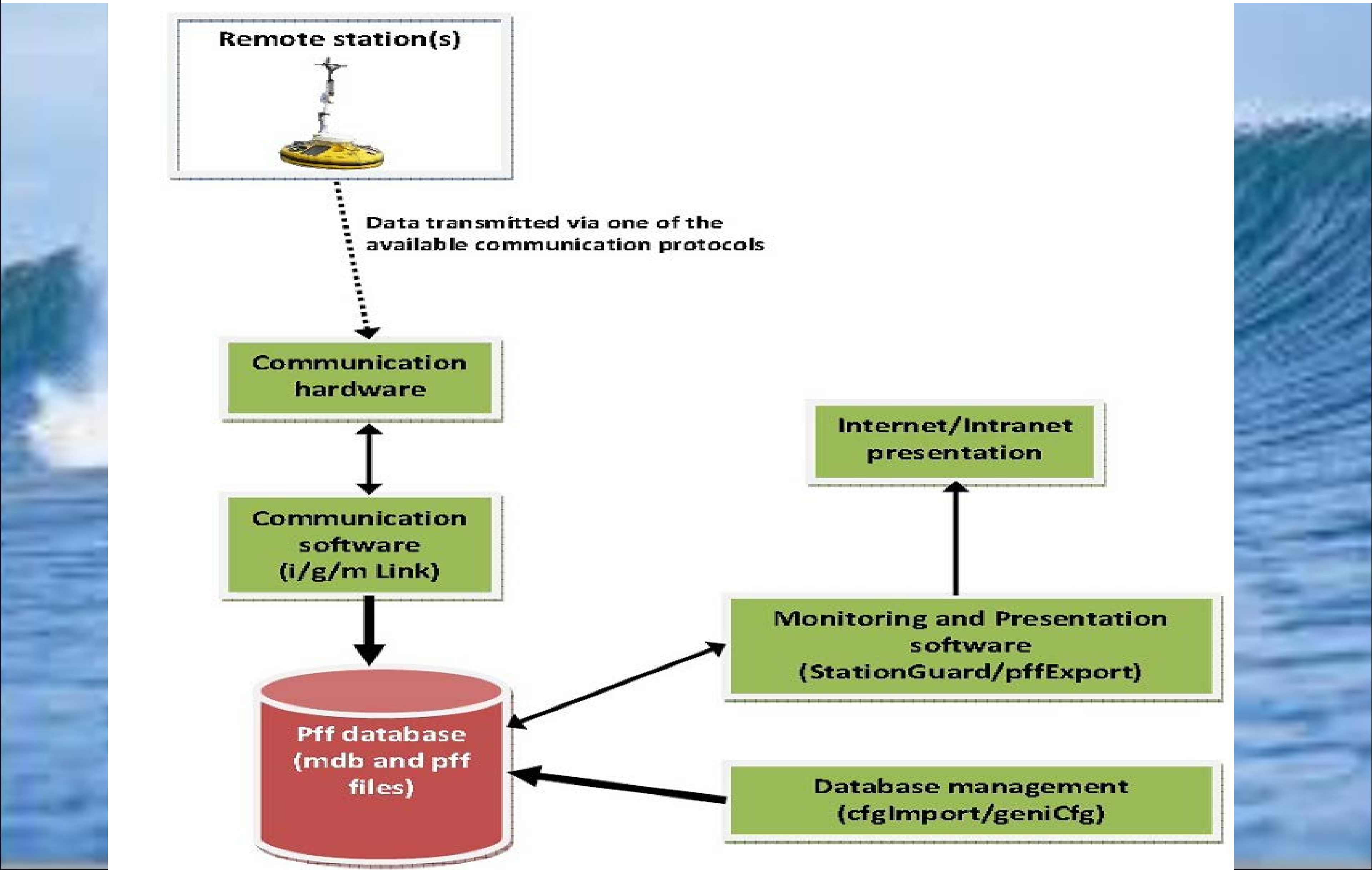
4.2 Trial aspects
Hydro meteorological boy in Danube estuary

Communication options:

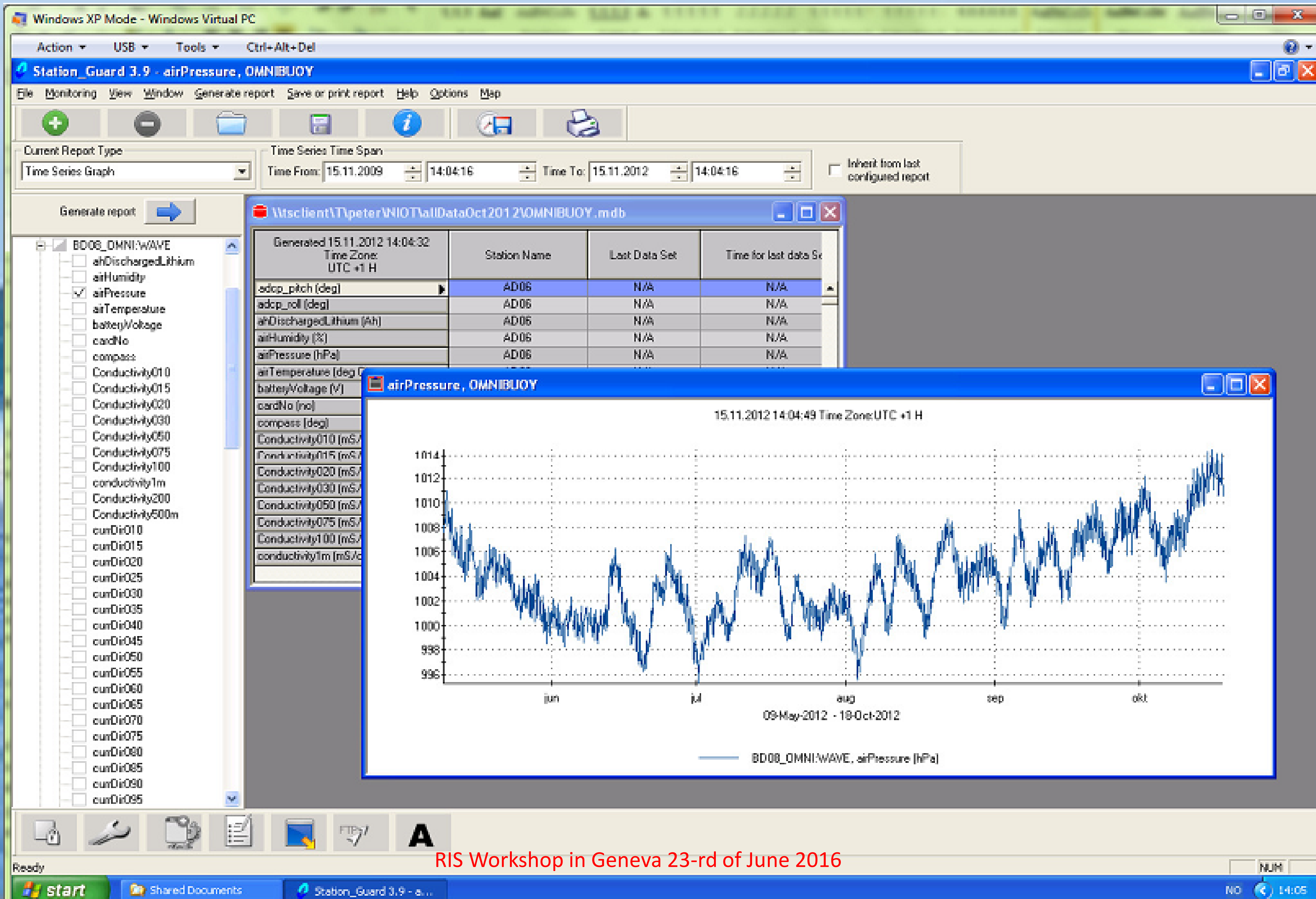
- Inmarsat-C satellite (geostationary)
- IRIDIUM (low orbit satellite)
- 10/100base-TX Ethernet (TCP/IP)
- WLAN
- Serial line (proprietary or PPP protocol) over any of the serial ports
- GSM telephone
- GPRS
- UHF/VHF radio

Parameter
Directional wave sensor
Surface current
Wind speed/direction sensor
Surface temperature and salinity
Air pressure sensor
Air temp/humidity sensor
Visibility
GPS unit
Flash light
Options
Option: Current profiler
Option: Argos tracker
Option: AIS unit

The measured parameters are packed into a binary string together with message id, time tag and several buoy house hold parameters, comprising the buoy message in PFF format. PFF is the acronym for Packed File Format. The binary format ensures minimum satellite traffic cost.



Hydro meteorological data



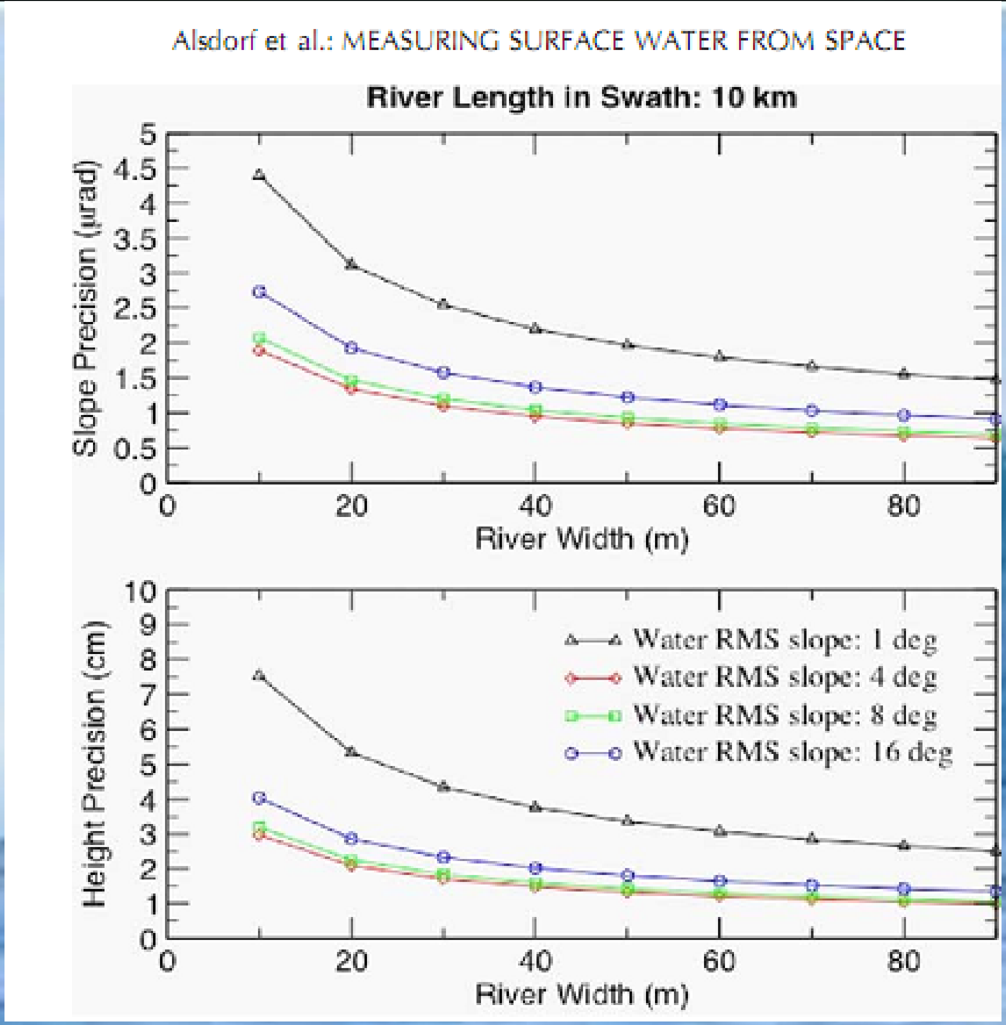


Figure 2. Height and slope precision of the interferometer. Height and slope estimates. Precision depends on water brightness and the length and width of the imaged water body.

• Whitehead: TOPOGRAPHIC CONTROL OF STRAIT FLOW

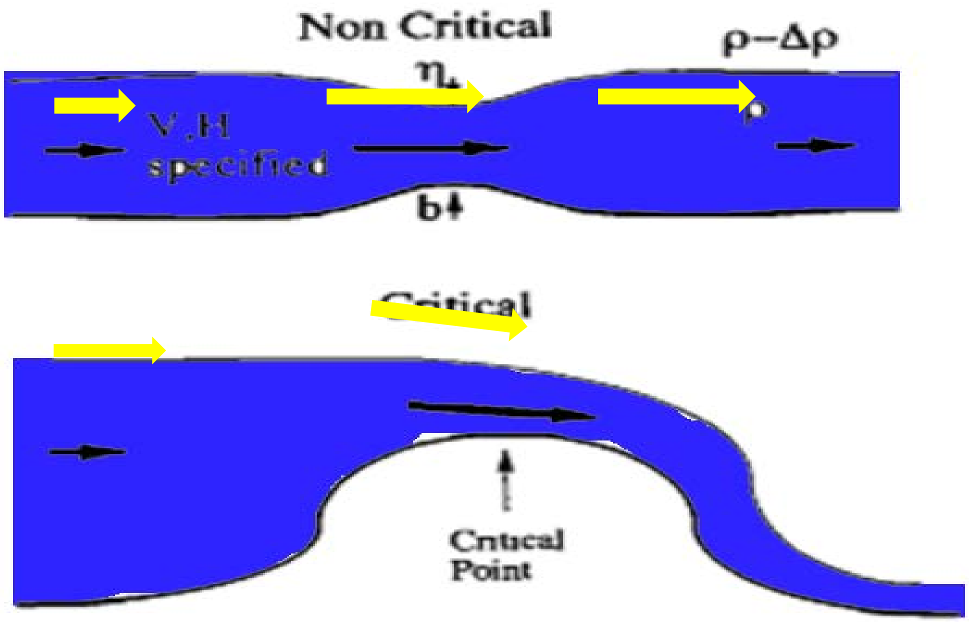


Figure 3. Sketch of an idealized flow of fluid along a channel with downstream velocity **V** and depth **H**, and the adjustment to a slowly increasing bottom **b**.

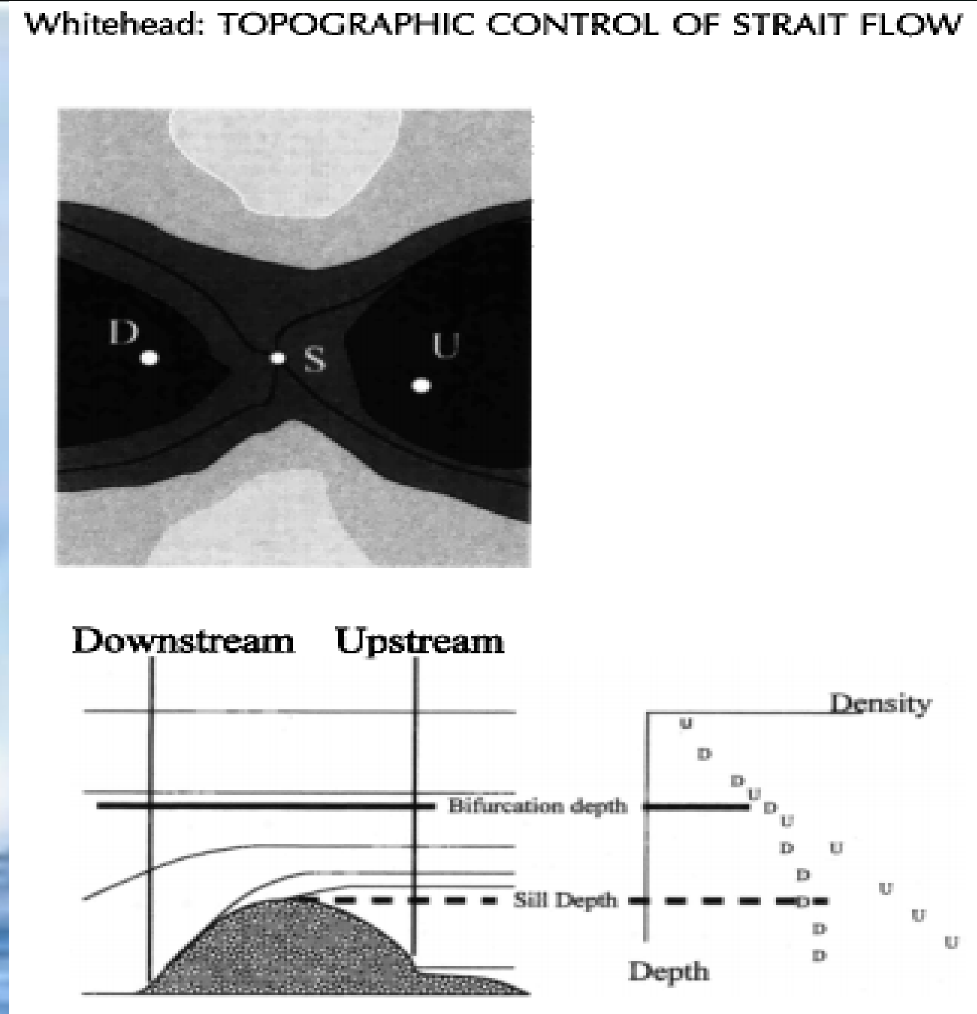


Figure 4. Map view sketch of a typical saddle point region (top). The darkest regions are deepest, and progressively lighter regions are shallower. One isobath connects between the two basins and the connection point defines a saddle point. A vertical section from one basin to the other (bottom, left) typically has asymmetry of density contours below a fixed depth but none above sill depth. We denote the basin with denser water as "upstream" (U) and the other "downstream" (D). On the bottom right the bifurcation depth between U and D.

The top section of this fig.4 shows a schematic top bathymetric view of a sill region, with deepest bathymetry darkest and shallower regions progressively lighter. A prominent topological feature of a sill region is the saddle point (S), which separates two unconnected deep basins (black). Note, however, that this point also separates two shallower ridges (lightly stippled). If these extend around and surround the upstream basin above that saddle point depth, then that sill is the deepest connection for the dense deep water at sill depth between the two basins. Experience has shown that flow of deep water between the two basins will most likely be found in the vicinity of that saddle point. There is one depth whose contours (thick black lines) intersect at S. We thus label two stations located on either side of S as U for upstream and D for downstream. This difference from flatness begins at the level where the two density versus depth curves taken at U and D split apart, or bifurcate, as shown on the right. The upstream region (U) contains denser fluid below the bifurcation depth than downstream (D) since U contains undiluted deep water below sill depth and D contains deep water mixed with less dense overlying water. To estimate Ap/p, we will select at least two density profiles from conductivity-temperature-depth (CTD) or bottle data, one upstream and one downstream of the sill that correspond to U and D in our sketch. The profiles must extend to the depth of the sill. The greatest density difference between upstream and downstream at or above sill depth will be used for the value of Ap. The sill depth is found from bathymetric charts. The bifurcation depth is subtracted from the sill depth to determine hu. The width of the opening at the bifurcation depth will be used to determine L, and this width is determined through the use of bathymetric charts.

As was mentioned before, the four parameters f, ha, Ap/p, and L are used to predict flux, but uncertainty in each contributes uncertainty to the flux prediction. The value of ha is produced from information of bifurcation depth, which is typically determined from a number of CTD casts, so that scatter from currents, eddies, and even distance from the sill produces variation up to ~50 m from what is expected to be a true long-term value. Second, sill depth is uncertain. Third, the result is sensitive to h a raised to a power greater than 1. The resulting uncertainties in flux prediction are presently as large as the uncertainty of the direct estimate of flux from extensive current meter data sets. Finally, frictional effects should move the critical point to a region downstream of the sill. In spite of these limitations to both prediction and measurements, results indicate that the control dynamics may play a role in the flow through the passageway , since the parameters span a wide range of values.

Regional Ocean Modeling System (ROMS; http://www.myroms.org).

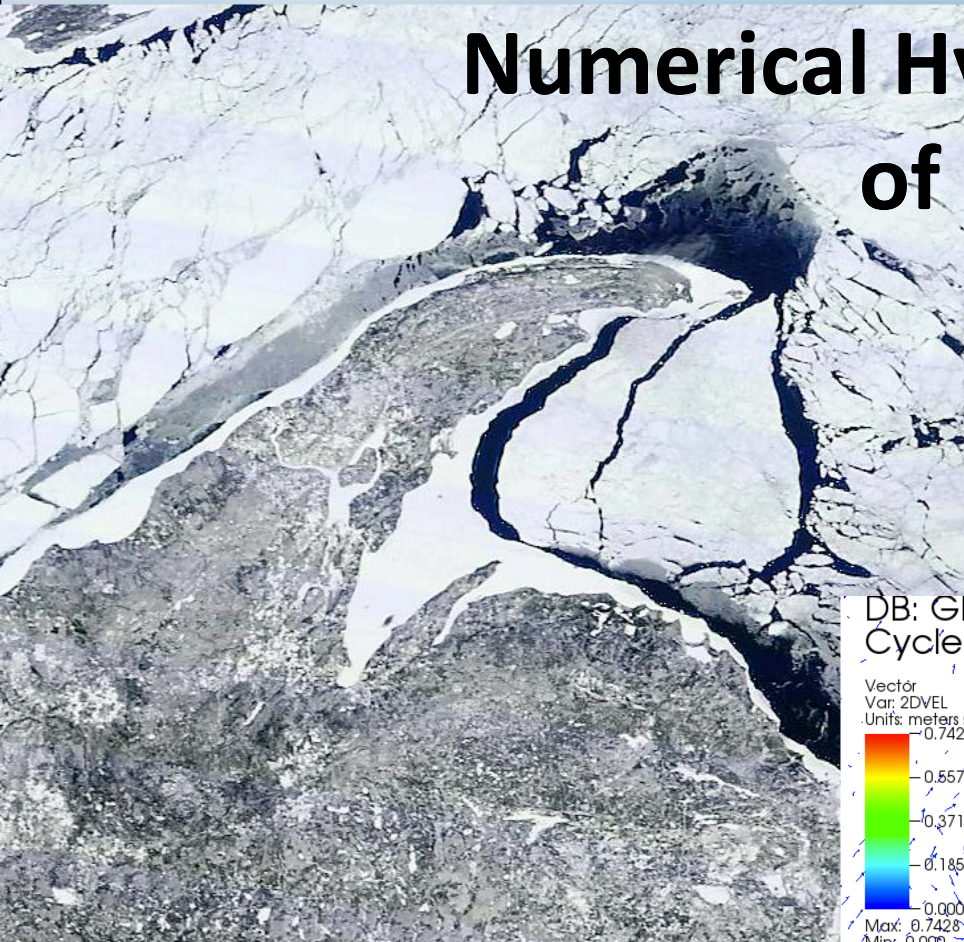
1. The exposure of the shelf instability and failure of the outer shelf and slope, generating gravitational slide and array transport ationof sediments toward the deep-sea part of the basin .
2. The measurements elevation of the water surface (***h***), its slope (***∂h/∂x***), and temporal change (***∂h/∂t***). Advances in remote sensing hydrology, particularly over the past 10 years and even more recently, have demonstrated that these hydraulic variables can be measured reliably from orbiting platforms. Radar altimeters have a rich, multidecadal history of successfully measuring elevations of the ocean surface and are now also accepted as capable tools for measuring h along orbital profiles crossing sea-river water area.

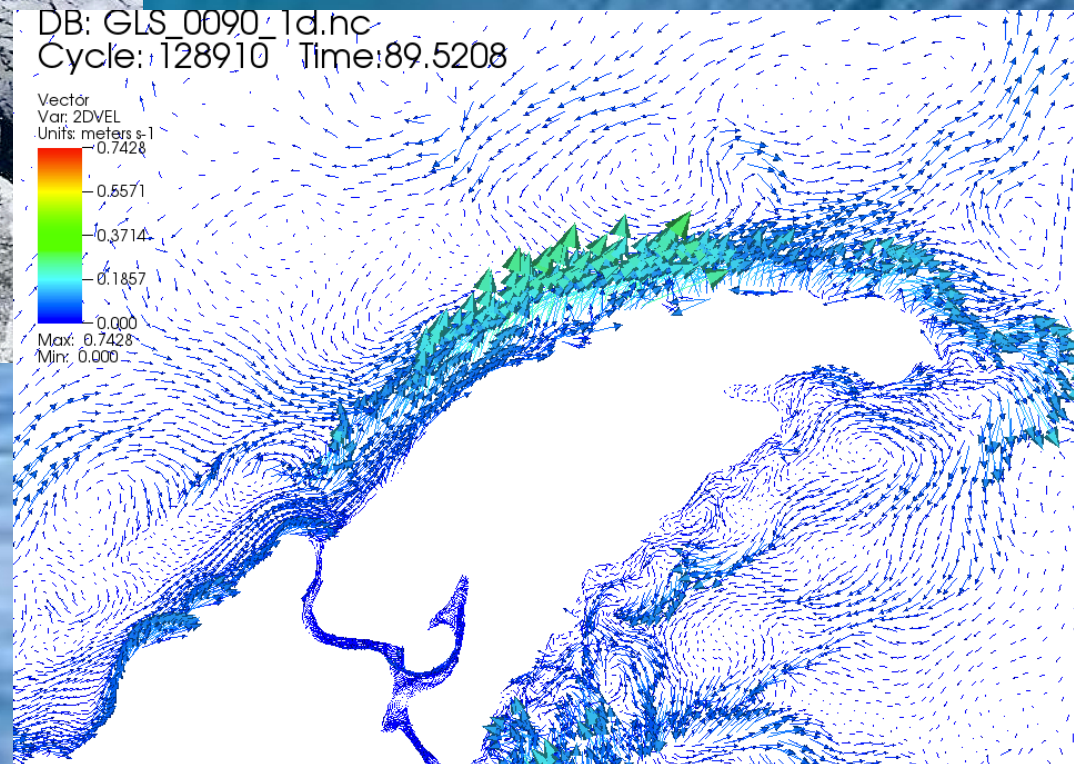
Rather than an intrinsic measurement, water slopes are derived from elevation measurements collected by altimeters or by SRTM. Altimetric methods use the distance between orbits with the measured **h** values to calculate $\partial h/\partial x$; thus there is an inherent time lag between **h** acquisitions that is built into the slope calculation or gradually developing flood waves.

Oceanic surface elevations have been routinely measured since the early 1990s using radar altimetry onboard the satellites. The launch of the Ice, Cloud and land Elevation satellite has now made spaceborne lidar altimetry available for terrestrial water bodies (2 cm and 5.6 cm wavelengths, respectively). Height resolutions of radar altimetry over river surfaces are ~5 cm at best and are more typically ~50 cm , but with increased averaging over large lakes (>100 km^2), accuracies improve to 2–3 cm.

Current technology allows a satellite mission to charts the elevations of surface waters across the globe and to derive storage changes in lakes, reservoirs, and wetlands and the discharge of rivers.

Numerical Hydrodynamic Modeling of Fluid/Sediment Motion

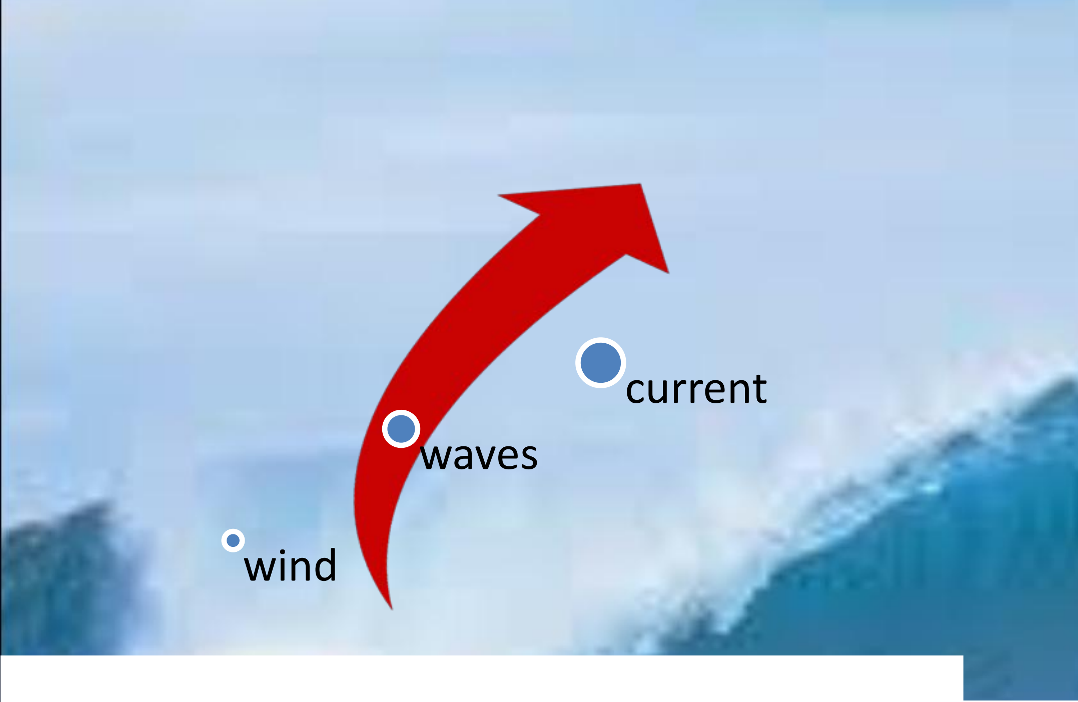


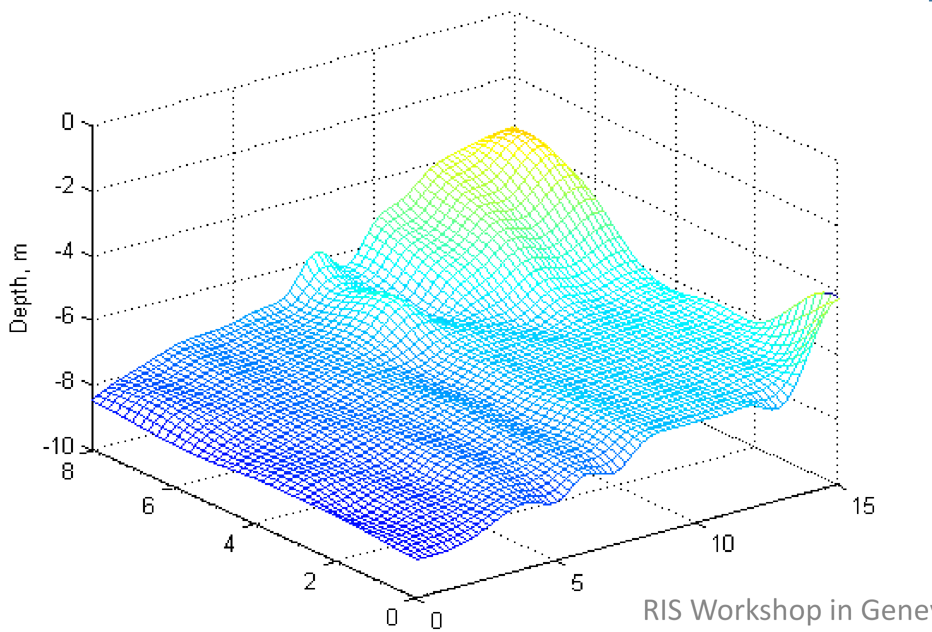


Regional Ocean Modeling System (ROMS; http://www.myroms.org).

Depth contours dynamic in chart

2013-2016 years observations





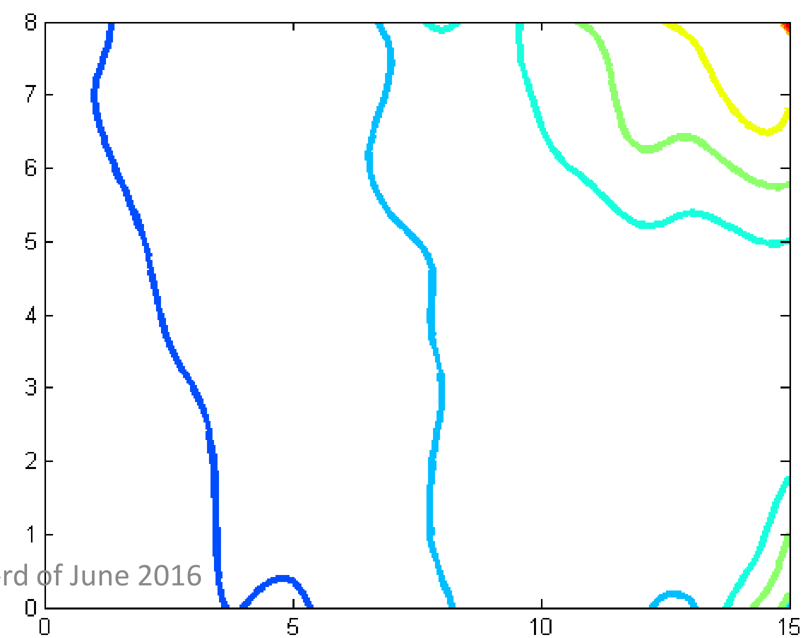
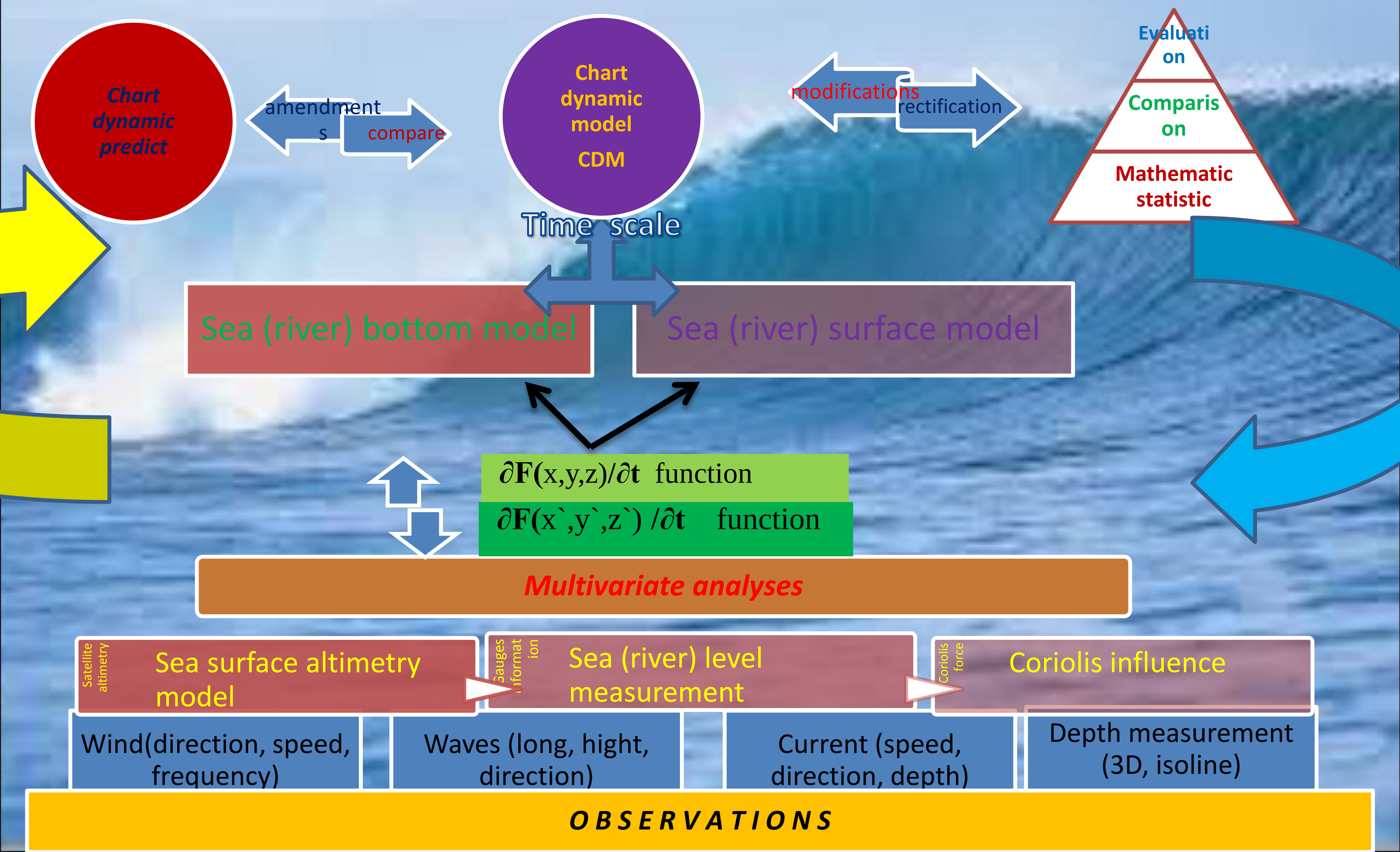
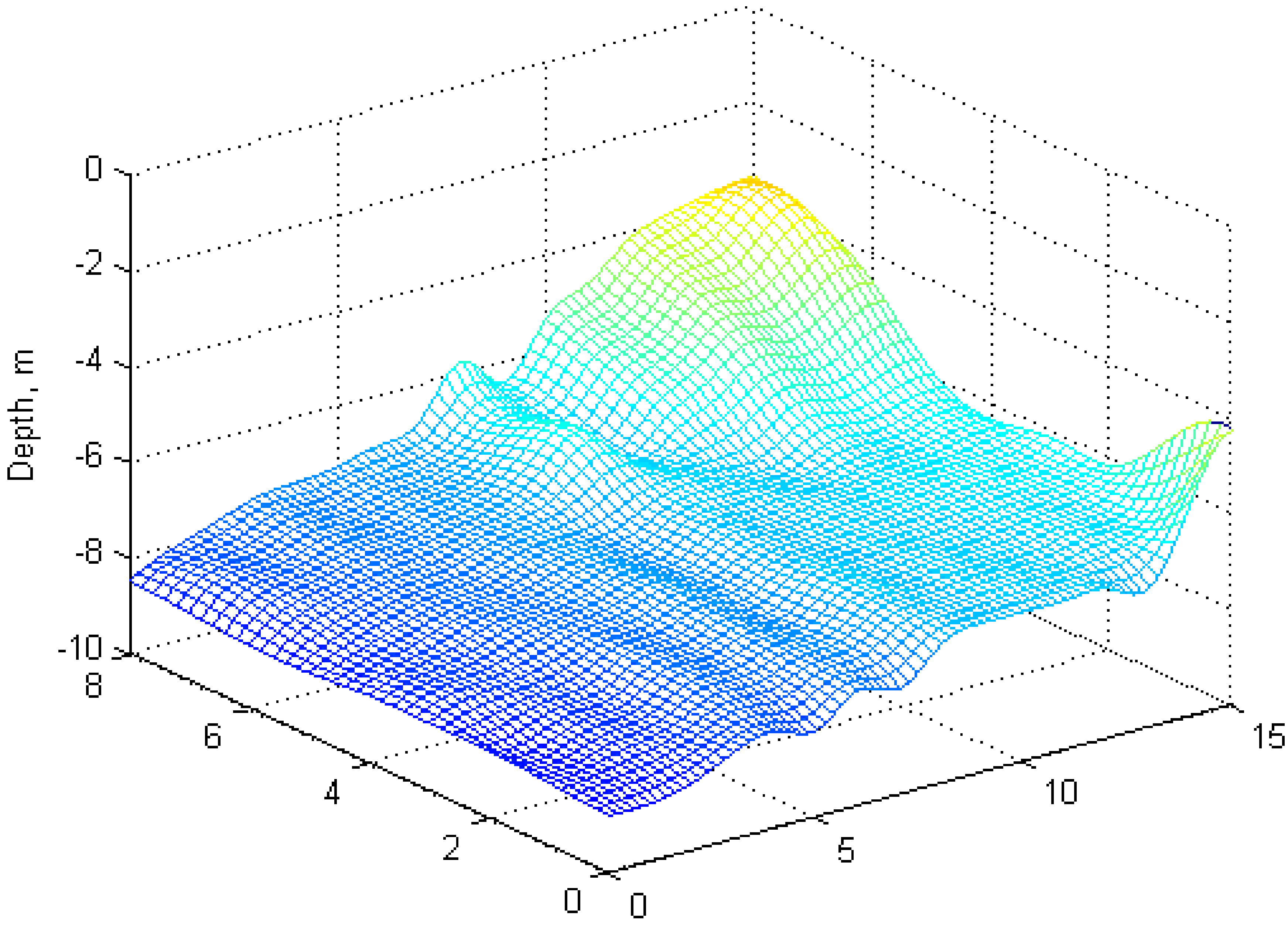
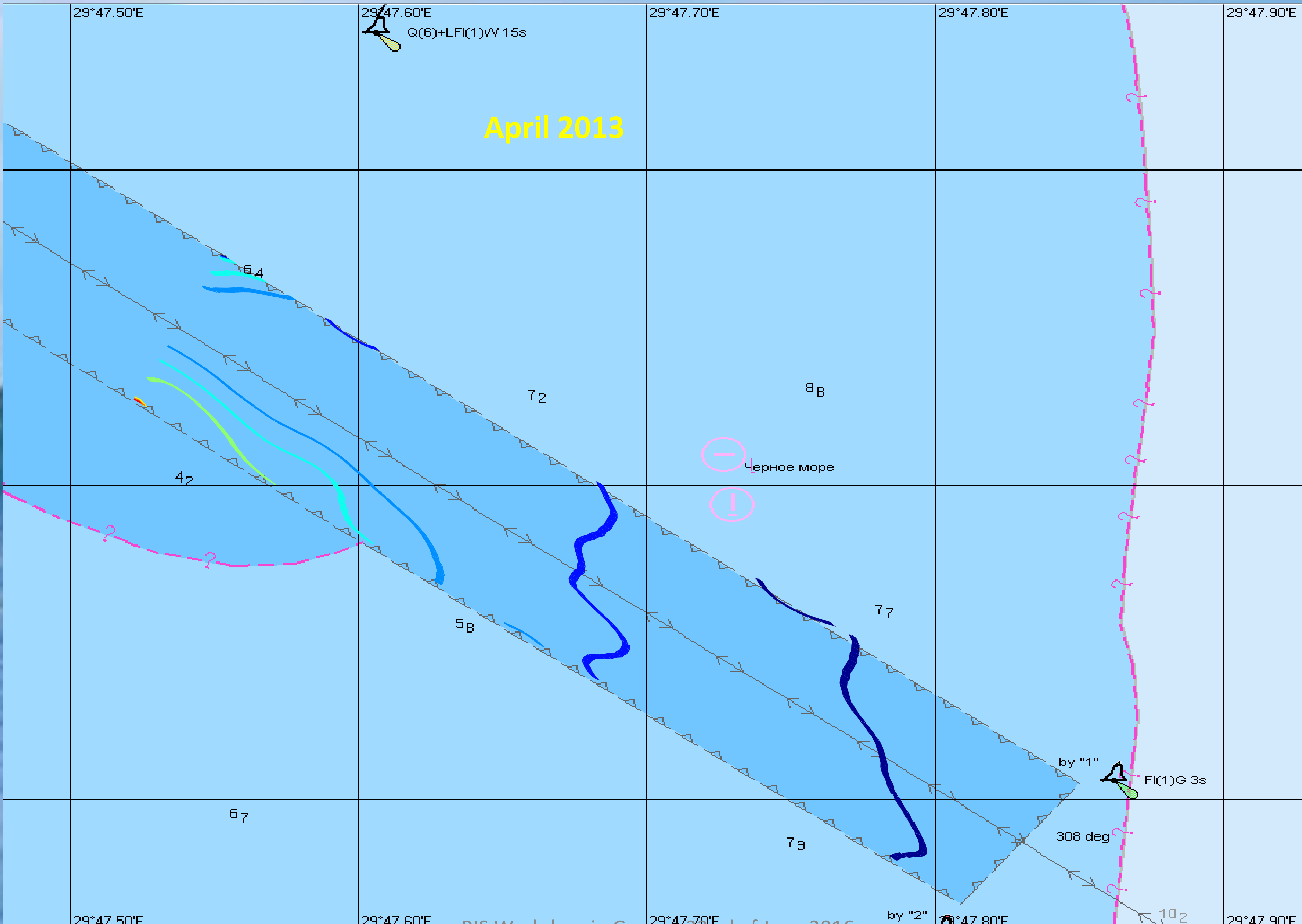


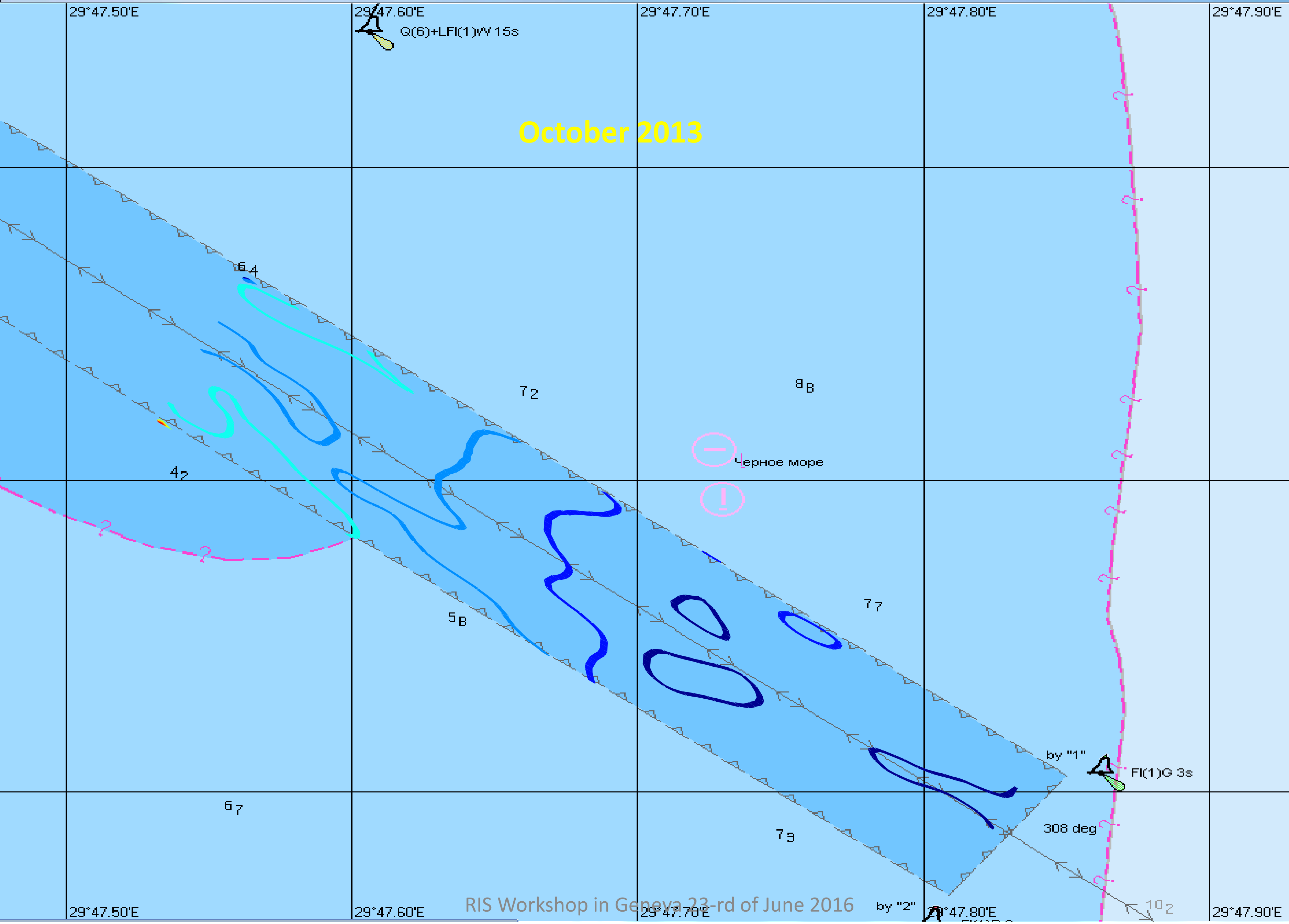
CHART DYNAMIC MODEL

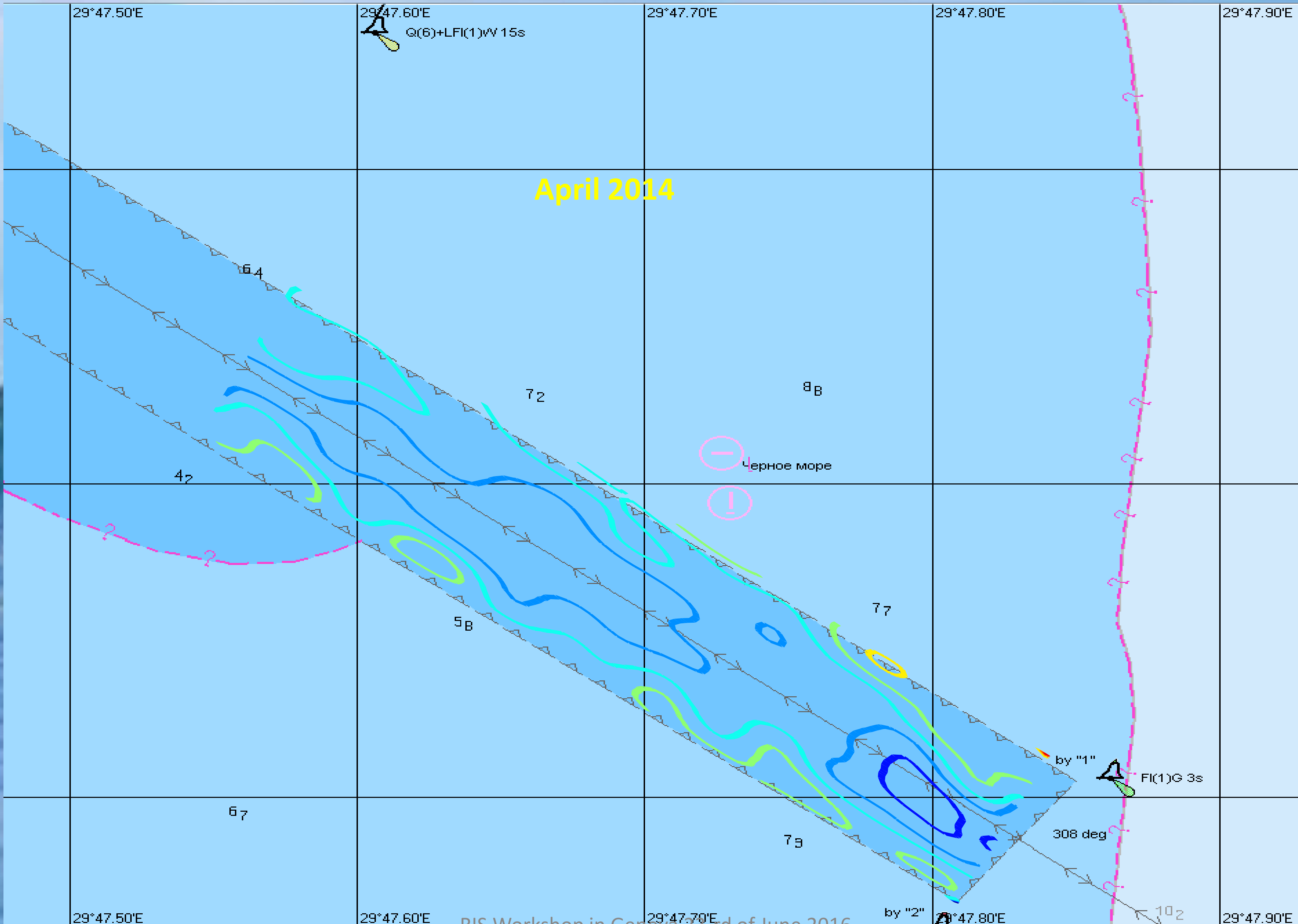




Depth, m
0
-2
-4
-6
-8
-10
8
6
4
2
0
0
5
10
15


April 2013
29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
Черное море
by "1"
Fl(1)G 3s
308 deg
by "2"
29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E


29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
October 2013
Черное море
by "1"
Fl(1)G 3s
308 deg
by "2"



April 2014
29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
Черное море
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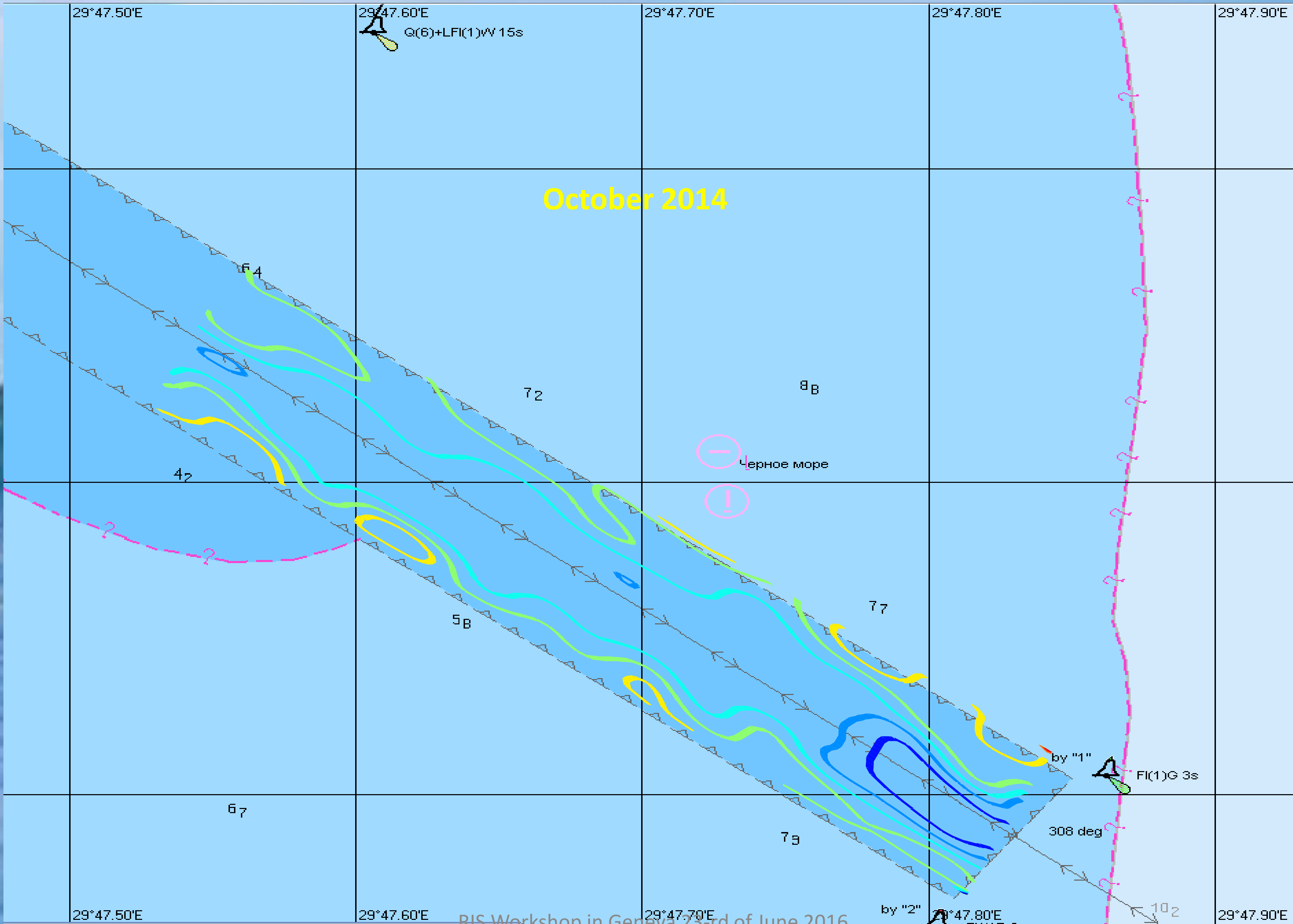
308 deg
by "2"


29°47.50'E
29°47.60'E
29°47.70'E
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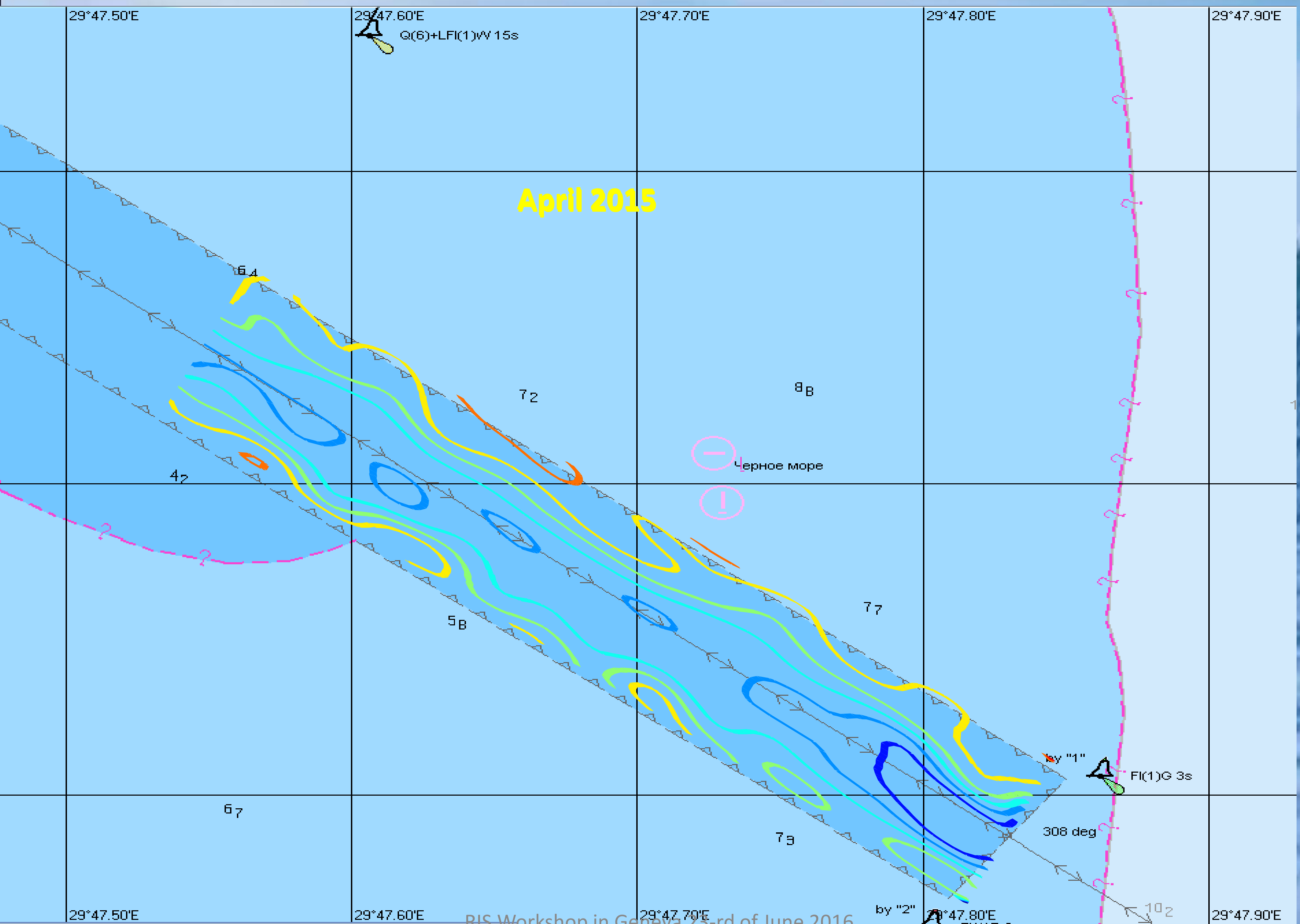
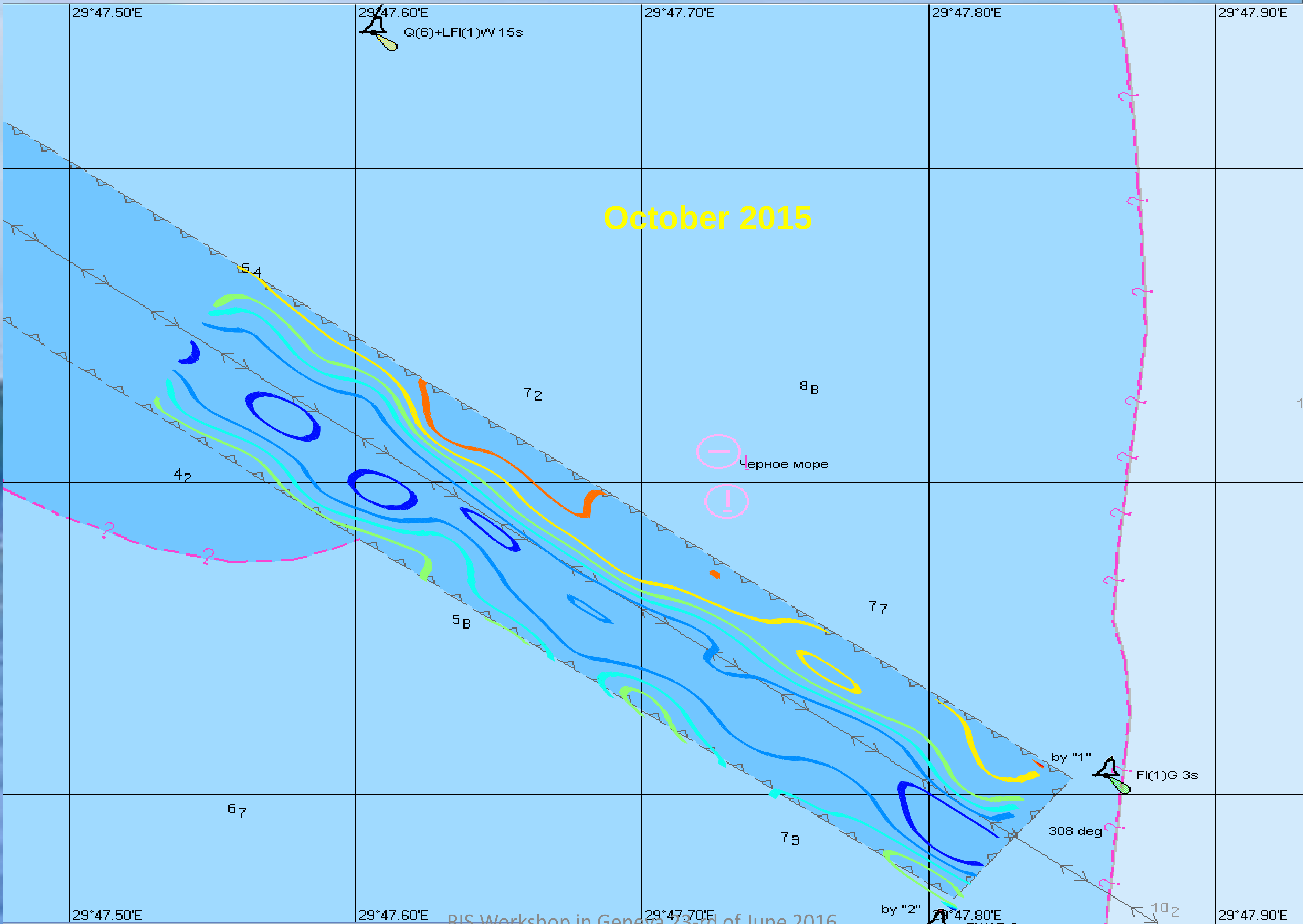
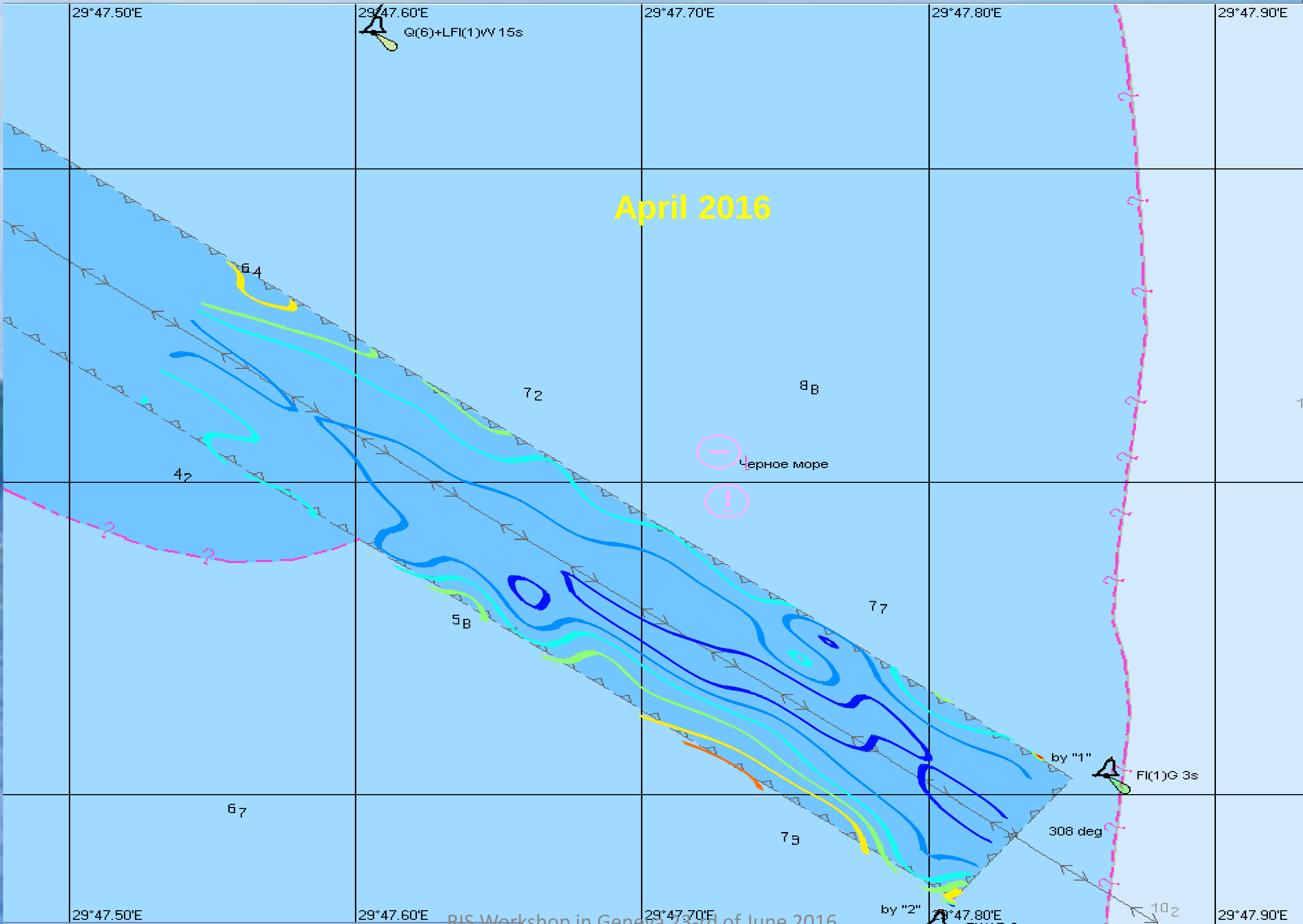
Q(6)+LFl(1)W 15s
October 2014
Черное море
by "1"
Fl(1)G 3s
308 deg
by "2"

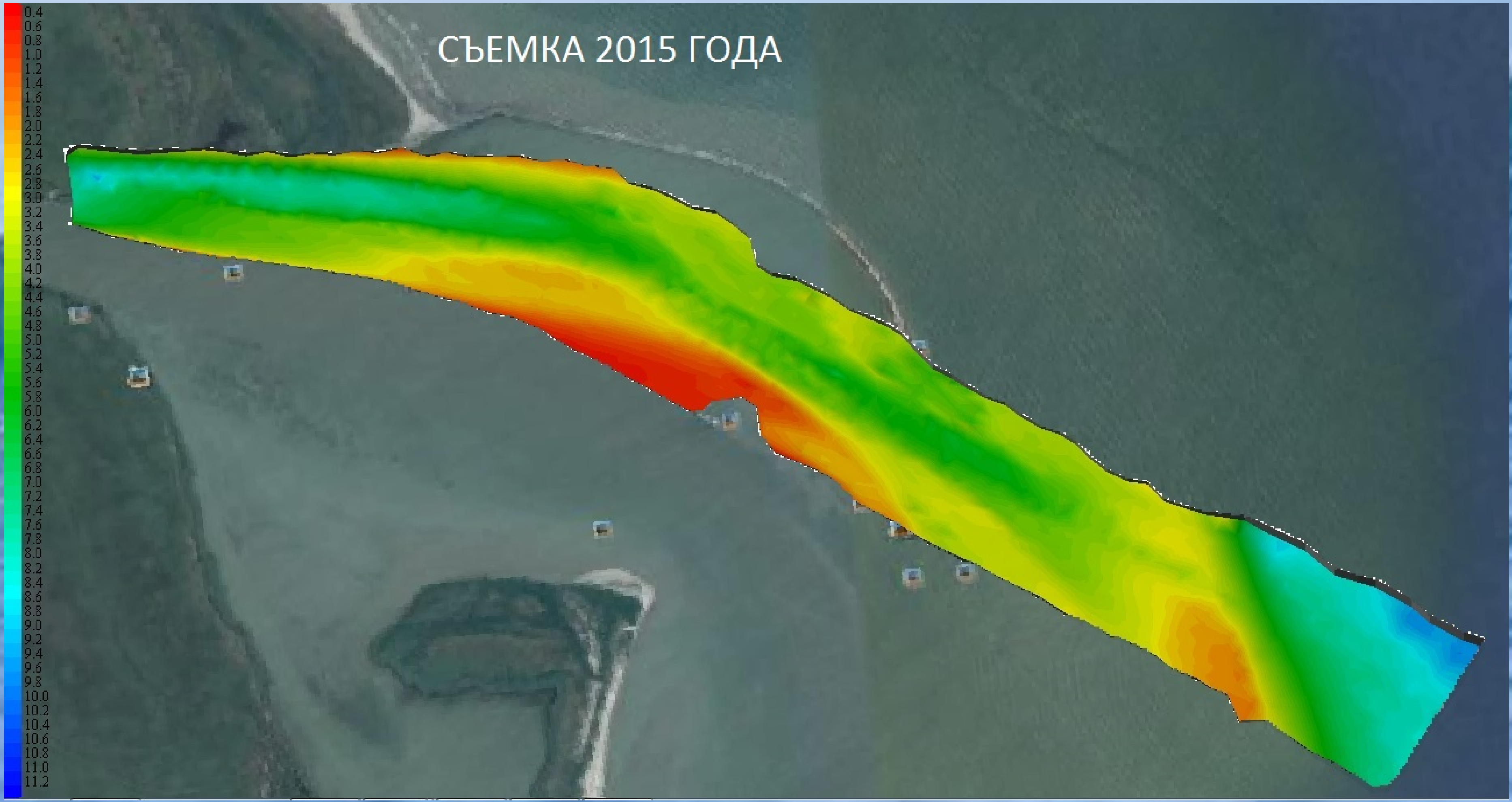

29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
April 2015
64
72
8B
42
Черное море
5B
77
by "1"
Fl(1)G 3s
67
73
308 deg
by "2"
102

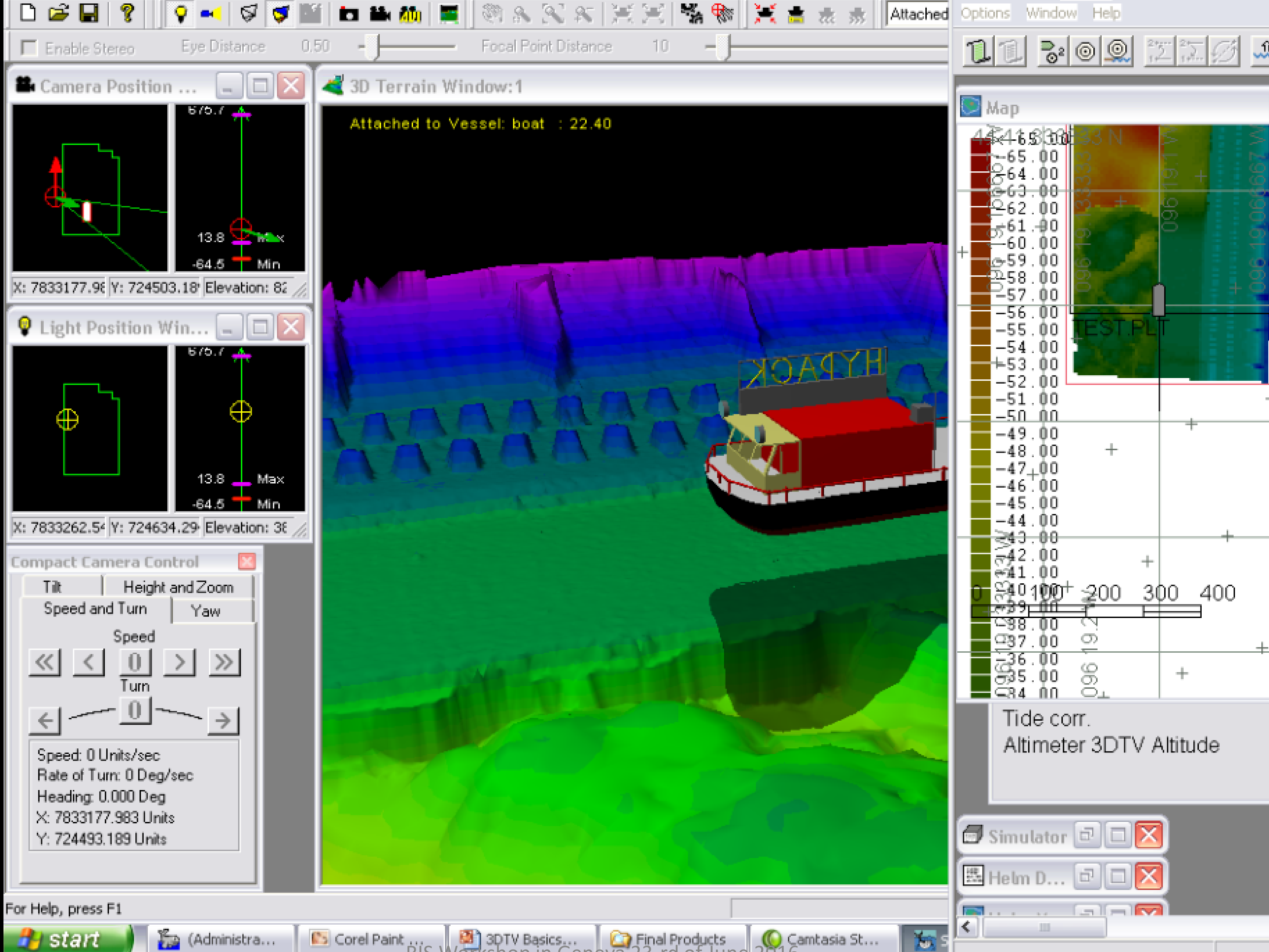


29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
October 2015
Черное море
by "1"
Fl(1)G 3s
308 deg
by "2"


29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
April 2016
6 4
7 2
8 8
4 2
Черное море
5 8
7 7
by "1"
Fl(1)G 3s
6 7
7 9
308 deg
by "2"
10 2

Visualisation




Enable Stereo
Eye Distance
0.50
Focal Point Distance
10
Attached
Options
Window
Help
Camera Position ...
3D Terrain Window:1
Attached to Vessel: boat : 22.40
Map
TEST.PLT
HYPACK
X: 7833177.98
Y: 724503.18
Elevation: 82
Light Position Win...
X: 7833262.54
Y: 724634.29
Elevation: 38
13.8
Max
-64.5
Min
Compact Camera Control
Tilt
Height and Zoom
Speed and Turn
Yaw
Speed
Turn
Speed: 0 Units/sec
Rate of Turn: 0 Deg/sec
Heading: 0.000 Deg
X: 7833177.983 Units
Y: 724493.189 Units
Tide corr.
Altimeter 3DTV Altitude
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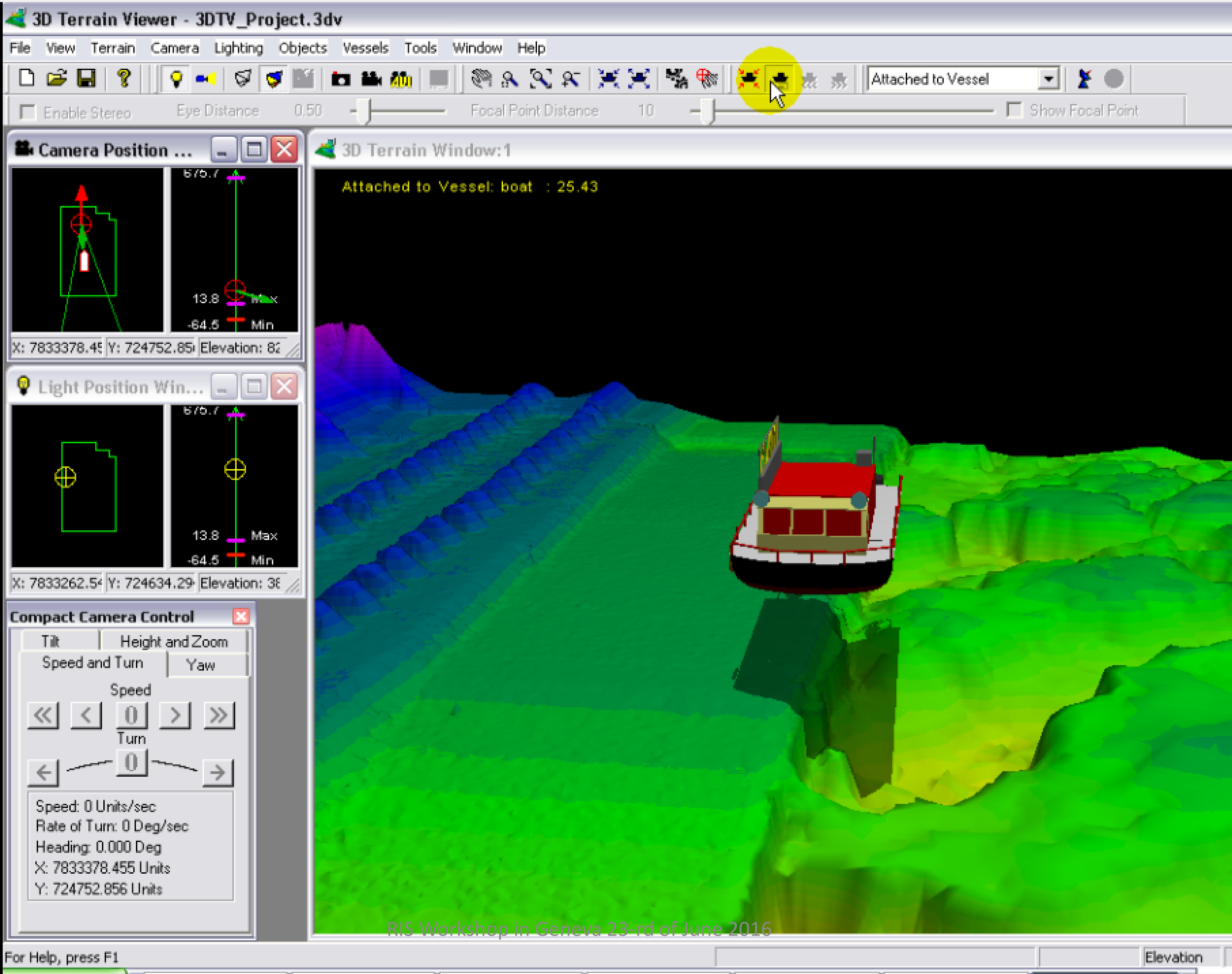
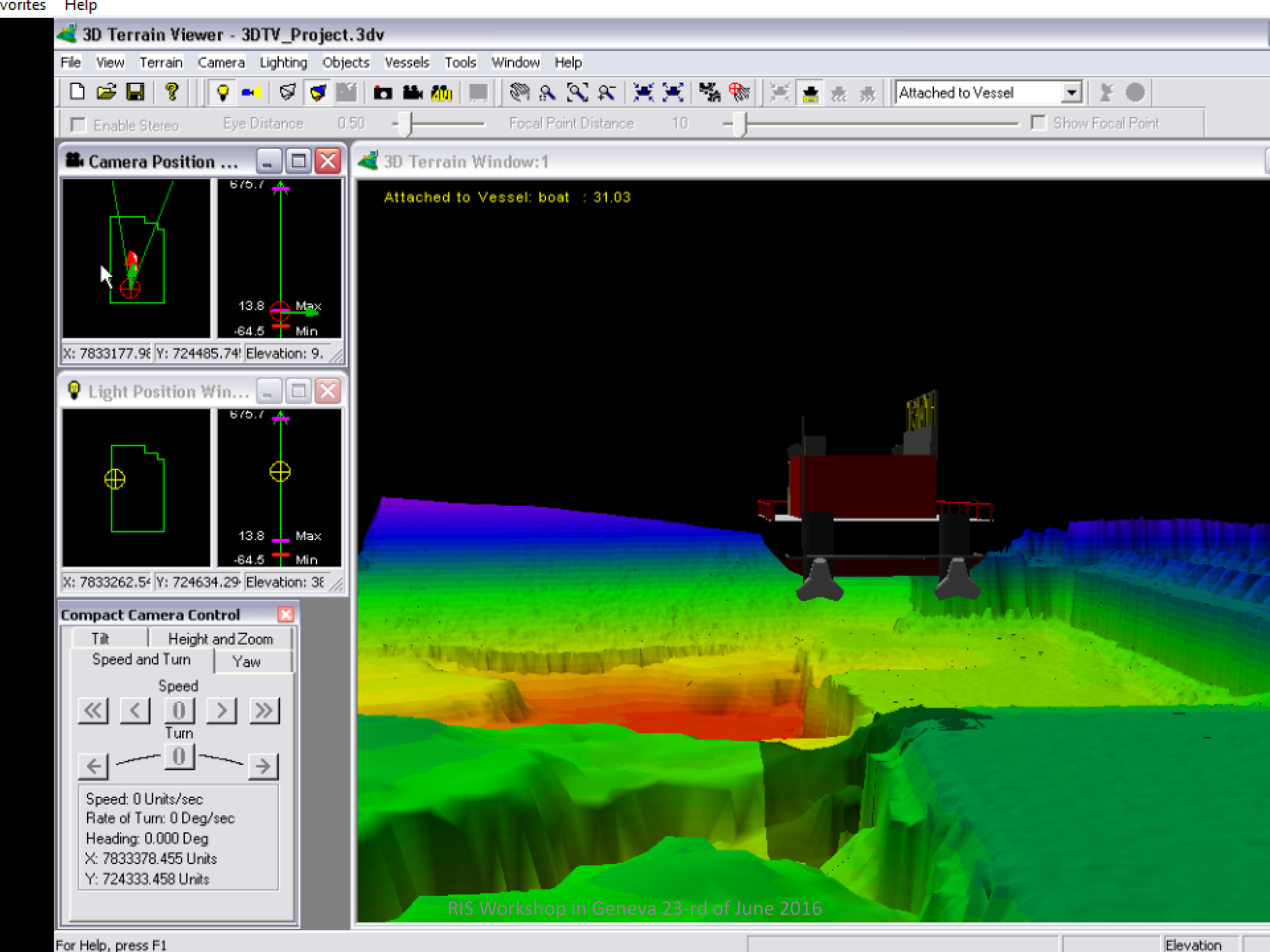
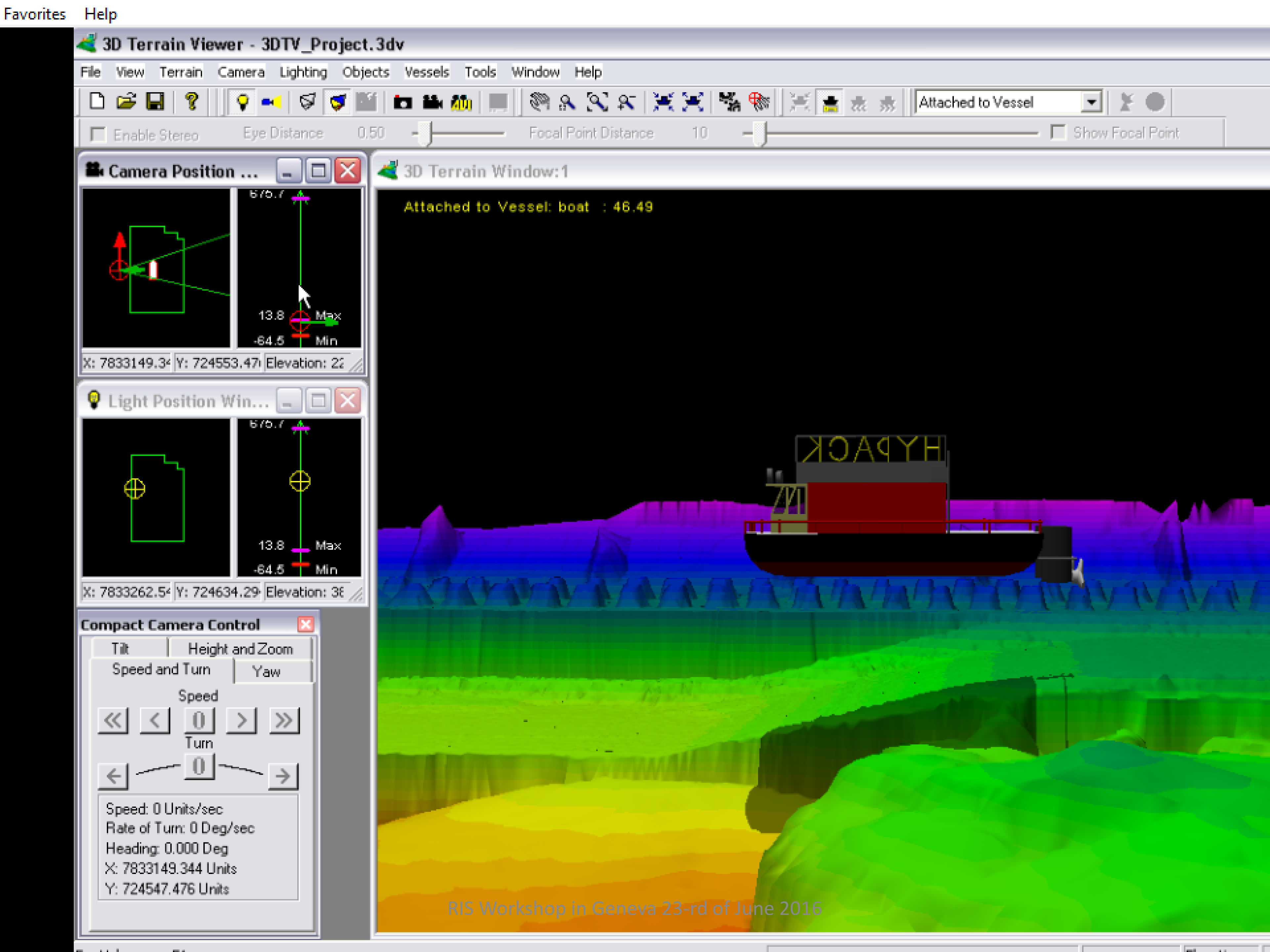
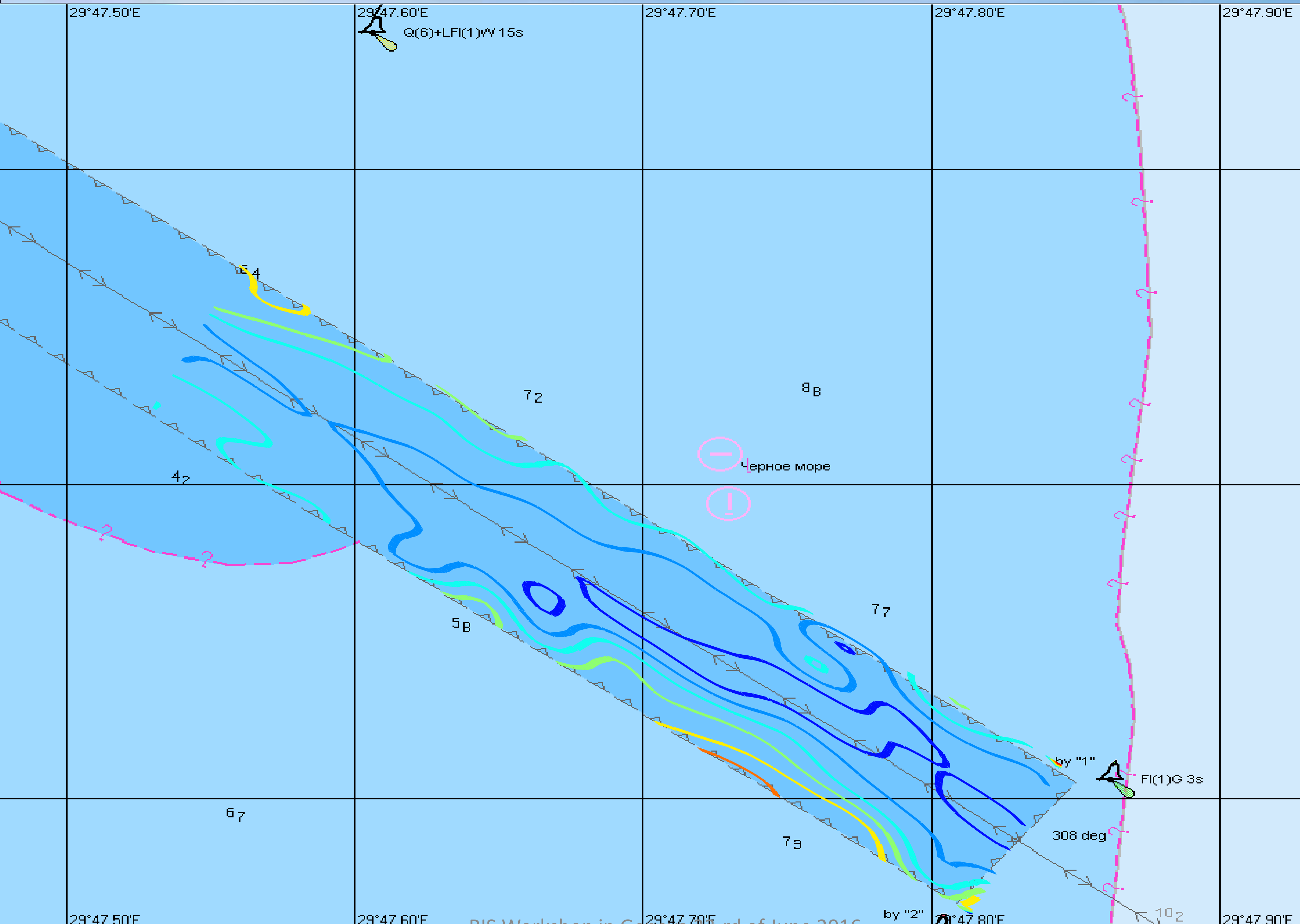
For Help, press F1
start
(Administra...
Corel Paint ...
3DTV Basics...
Final Products
Camtasia St...

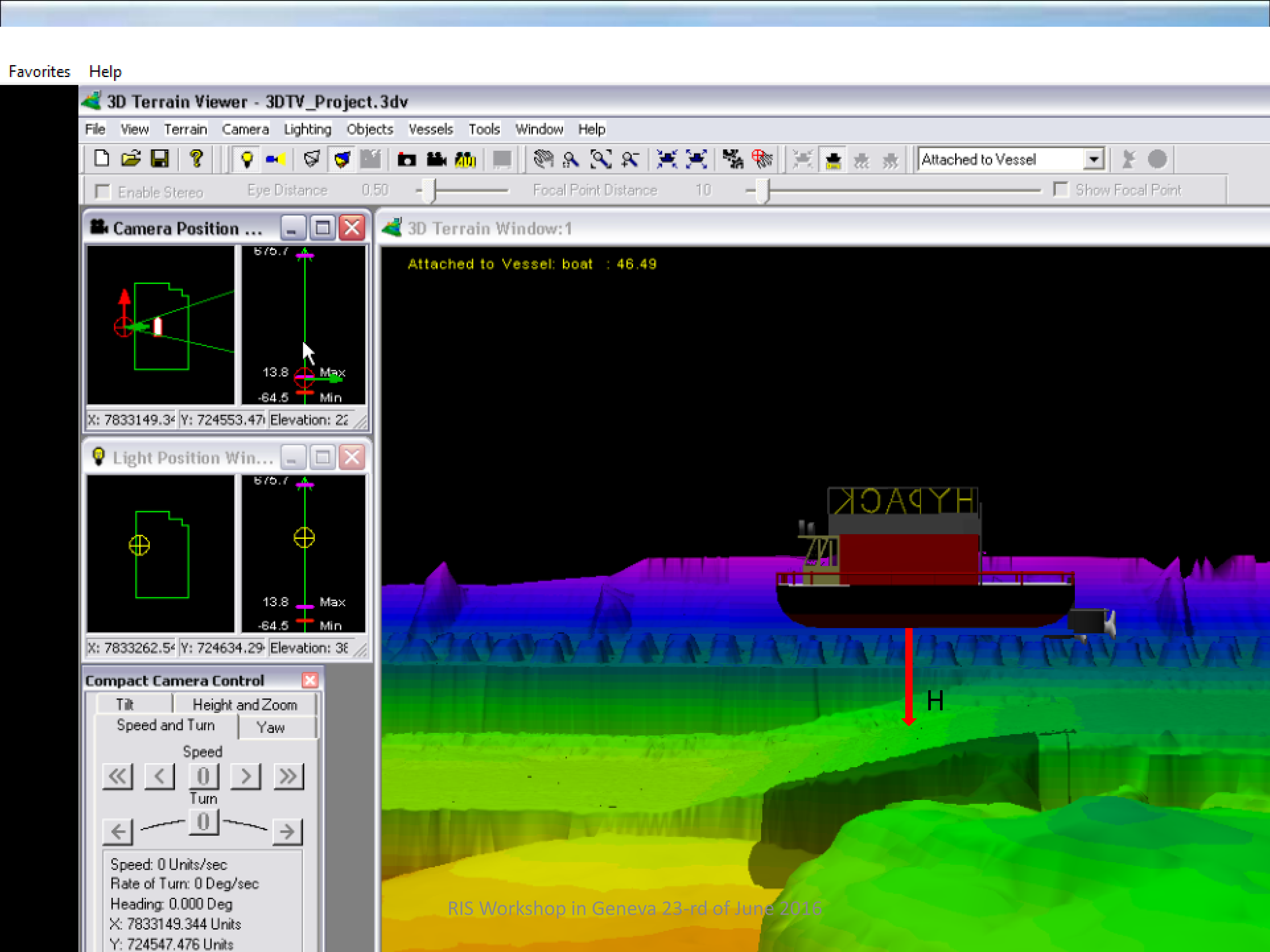

3D Terrain Viewer - 3DTV_Project.3dv
File View Terrain Camera Lighting Objects Vessels Tools Window Help
Attached to Vessel
Enable Stereo
Eye Distance 0.50
Focal Point Distance 10
Show Focal Point
Camera Position ...
X: 7833378.45 Y: 724752.85 Elevation: 82
Light Position Win...
X: 7833262.54 Y: 724634.29 Elevation: 38
13.8 Max
-64.5 Min
Compact Camera Control
Tilt
Height and Zoom
Speed and Turn
Yaw
Speed
Turn
Speed: 0 Units/sec
Rate of Turn: 0 Deg/sec
Heading: 0.000 Deg
X: 7833378.455 Units
Y: 724752.856 Units
3D Terrain Window:1
Attached to Vessel: boat : 25.43
For Help, press F1
Elevation



RIS Workshop in Geneva 23-rd of June 2016


Favorites Help
3D Terrain Viewer - 3DTV_Project.3dv
File View Terrain Camera Lighting Objects Vessels Tools Window Help
Attached to Vessel
Enable Stereo
Eye Distance 0.50
Focal Point Distance 10
Show Focal Point
Camera Position ...
13.8 Max
-64.5 Min
X: 7833149.3 Y: 724553.47 Elevation: 22
Light Position Win...
13.8 Max
-64.5 Min
X: 7833262.5 Y: 724634.29 Elevation: 38
Compact Camera Control
Tilt
Height and Zoom
Speed and Turn
Yaw
Speed
Turn
Speed: 0 Units/sec
Rate of Turn: 0 Deg/sec
Heading: 0.000 Deg
X: 7833149.344 Units
Y: 724547.476 Units
3D Terrain Window:1
Attached to Vessel: boat : 46.49
HYPACK
RIS Workshop in Geneva 23-rd of June 2016


29°47.50'E
29°47.60'E
29°47.70'E
29°47.80'E
29°47.90'E
Q(6)+LFl(1)W 15s
Черное море
by "1"
Fl(1)G 3s
308 deg
by "2"


Favorites
Help
3D Terrain Viewer - 3DTV_Project.3dv
File View Terrain Camera Lighting Objects Vessels Tools Window Help
Attached to Vessel
Enable Stereo
Eye Distance
0.50
Focal Point Distance
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Show Focal Point
Camera Position ...
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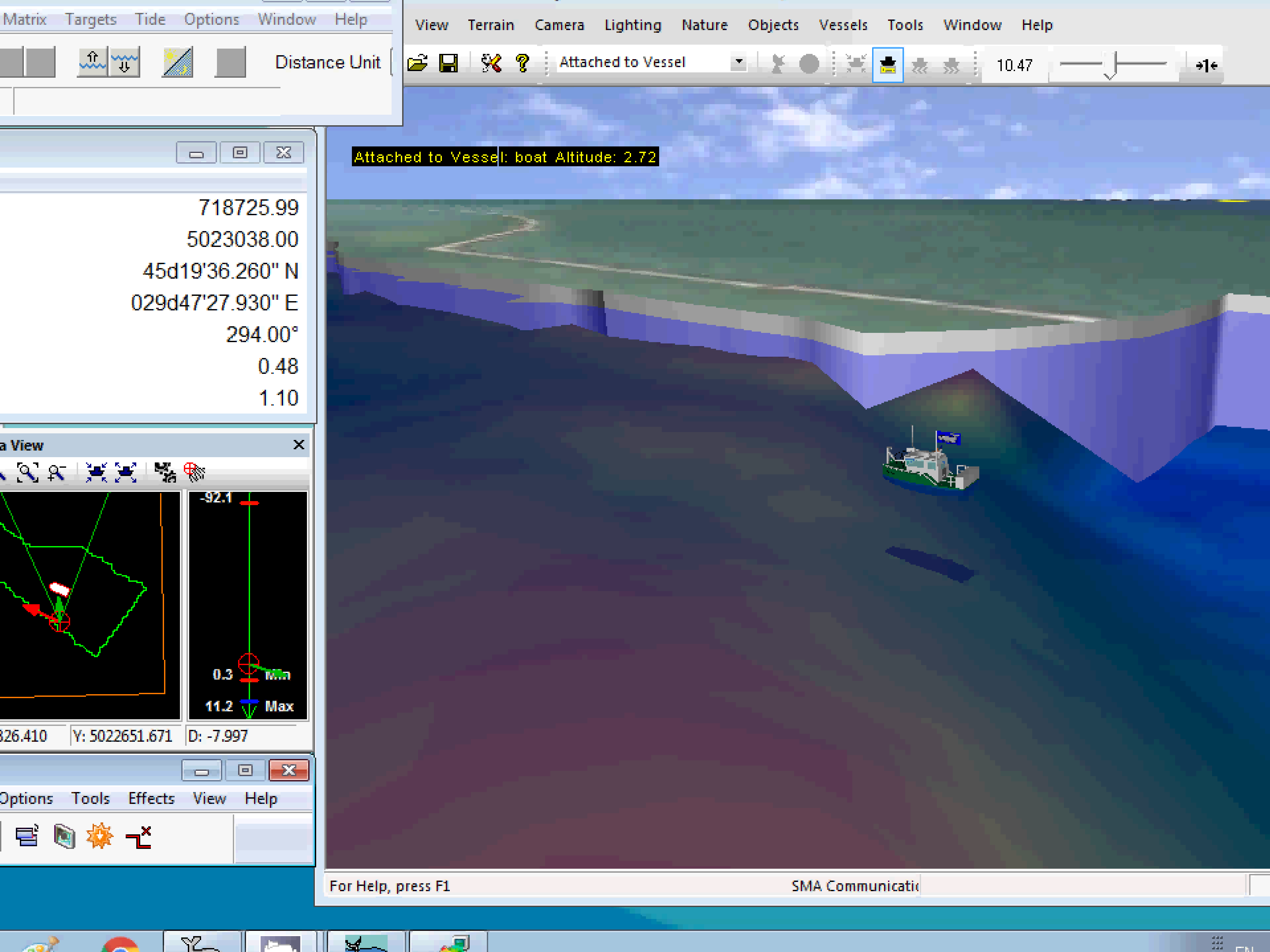
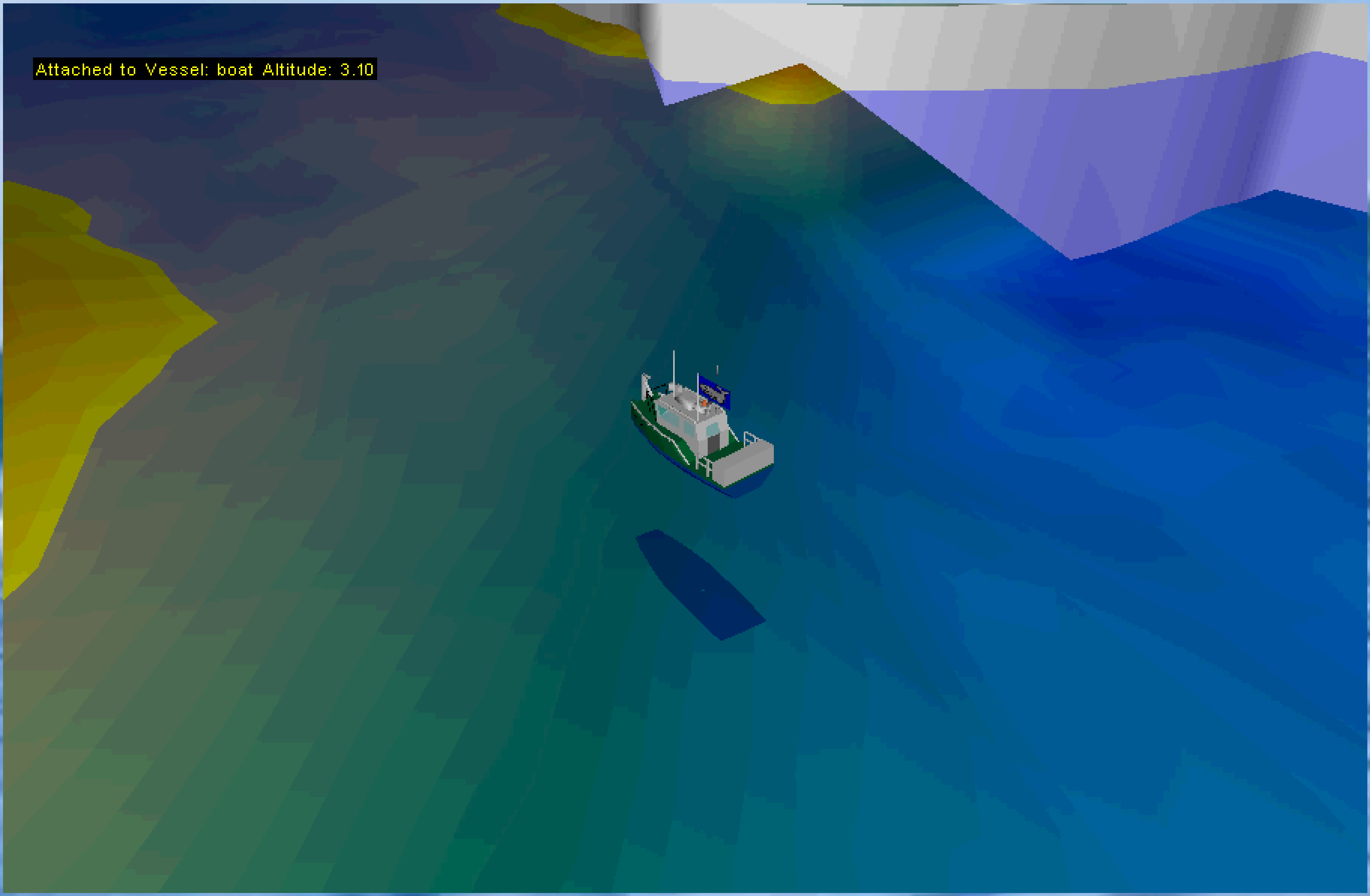
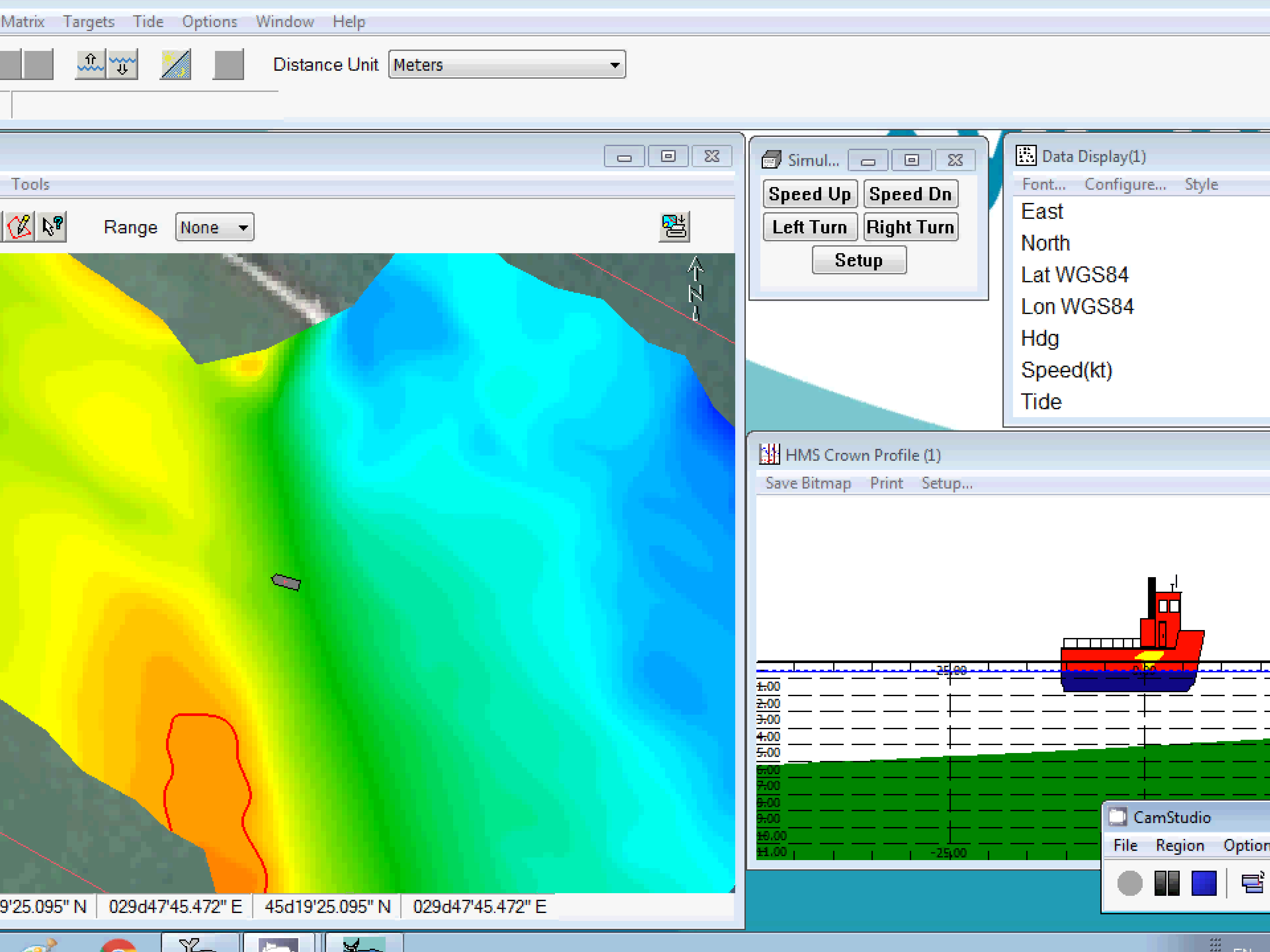
13.8
Max
-64.5
Min
X: 7833149.34
Y: 724553.47
Elevation: 22
Light Position Win...
675.7
13.8
Max
-64.5
Min
X: 7833262.54
Y: 724634.29
Elevation: 38
Compact Camera Control
Tilt
Height and Zoom
Speed and Turn
Yaw
Speed
Turn
Speed: 0 Units/sec
Rate of Turn: 0 Deg/sec
Heading: 0.000 Deg
X: 7833149.344 Units
Y: 724547.476 Units
3D Terrain Window:1
Attached to Vessel: boat : 46.49
H



Matrix Targets Tide Options Window Help
Distance Unit
View Terrain Camera Lighting Nature Objects Vessels Tools Window Help
Attached to Vessel
10.47
Attached to Vessel: boat Altitude: 2.72
718725.99
5023038.00
45d19'36.260" N
029d47'27.930" E
294.00°
0.48
1.10
a View
-92.1
0.3
11.2 Max
326.410
Y: 5022651.671
D: -7.997
Options Tools Effects View Help
For Help, press F1
SMA Communicati


Attached to Vessel: boat Altitude: 3.10


Matrix Targets Tide Options Window Help
Distance Unit
Meters
Tools
Range
None
Simul...
Speed Up
Speed Dn
Left Turn
Right Turn
Setup
Data Display(1)
Font... Configure... Style
East
North
Lat WGS84
Lon WGS84
Hdg
Speed(kt)
Tide
HMS Crown Profile (1)
Save Bitmap Print Setup...
1.00
2.00
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9.00
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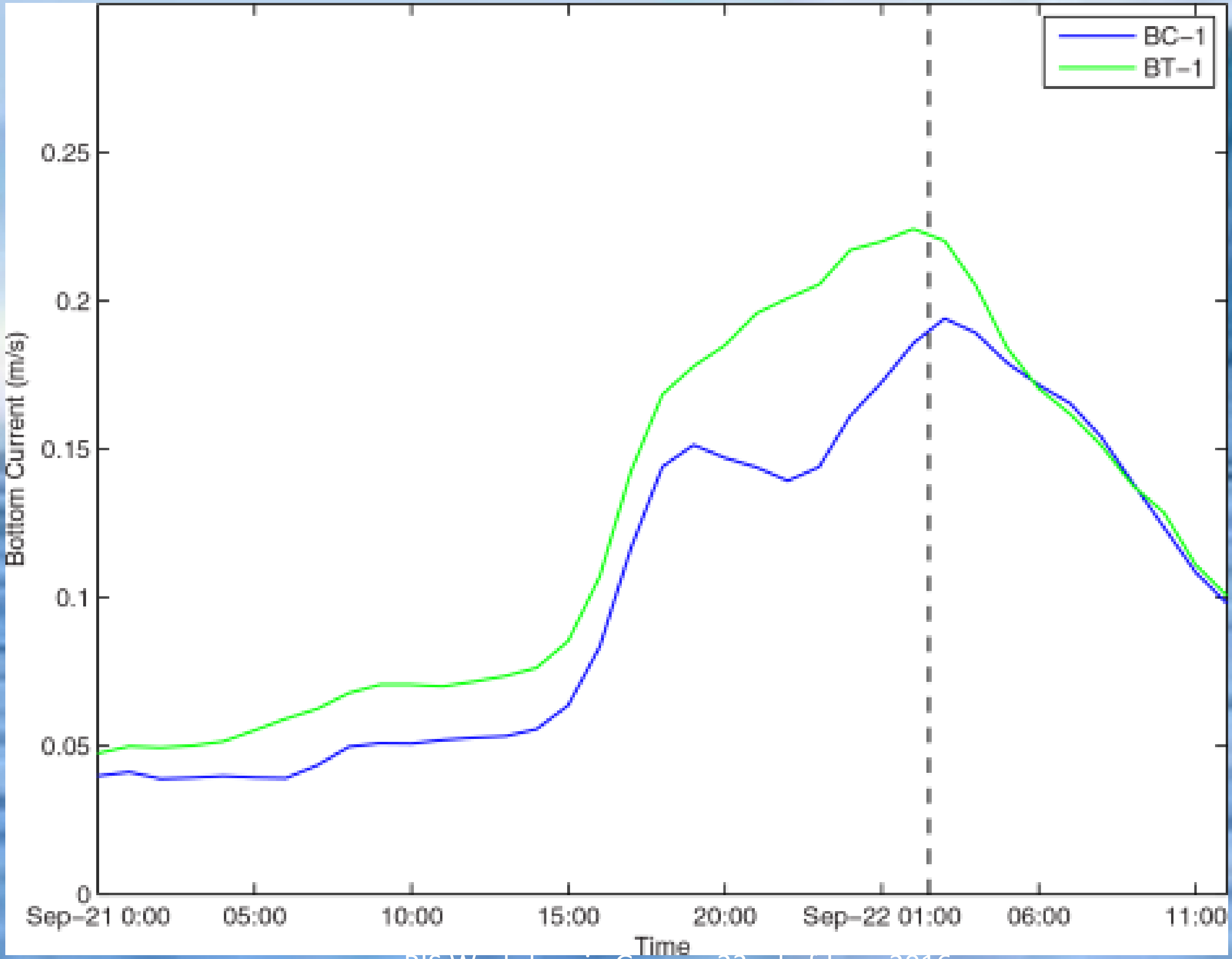
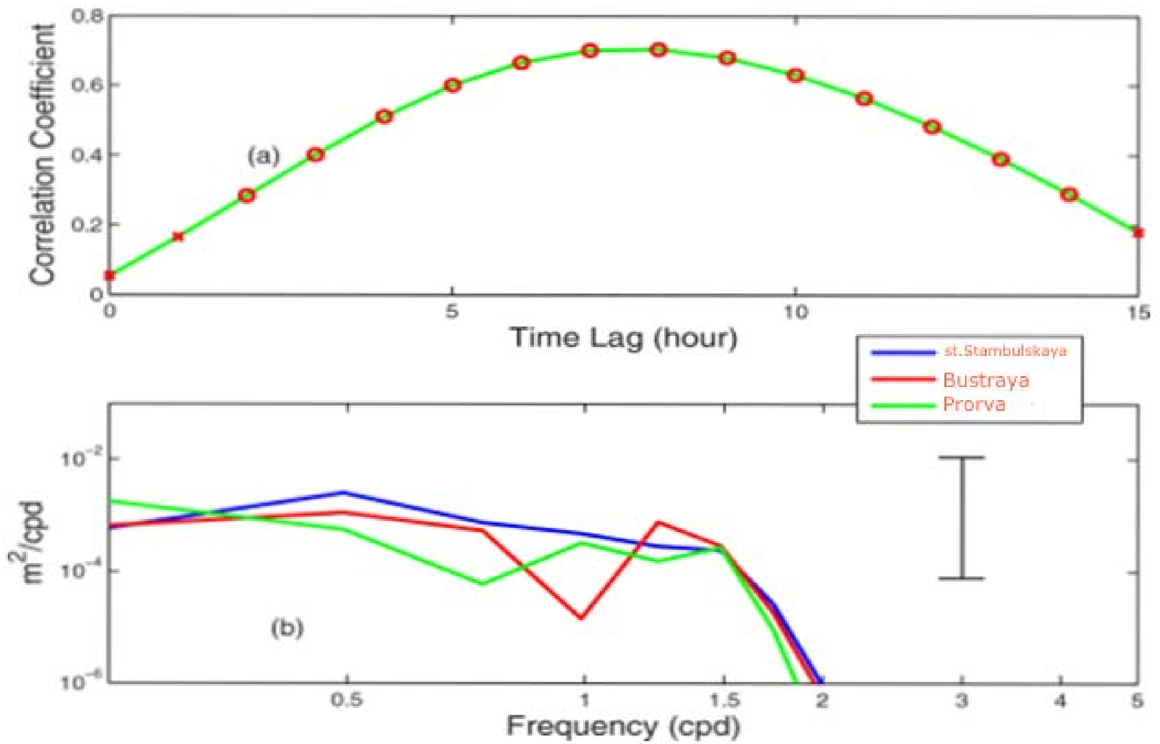
CamStudio
File Region Option
9'25.095" N
029d47'45.472" E
45d19'25.095" N
029d47'45.472" E

4.4 Evaluation

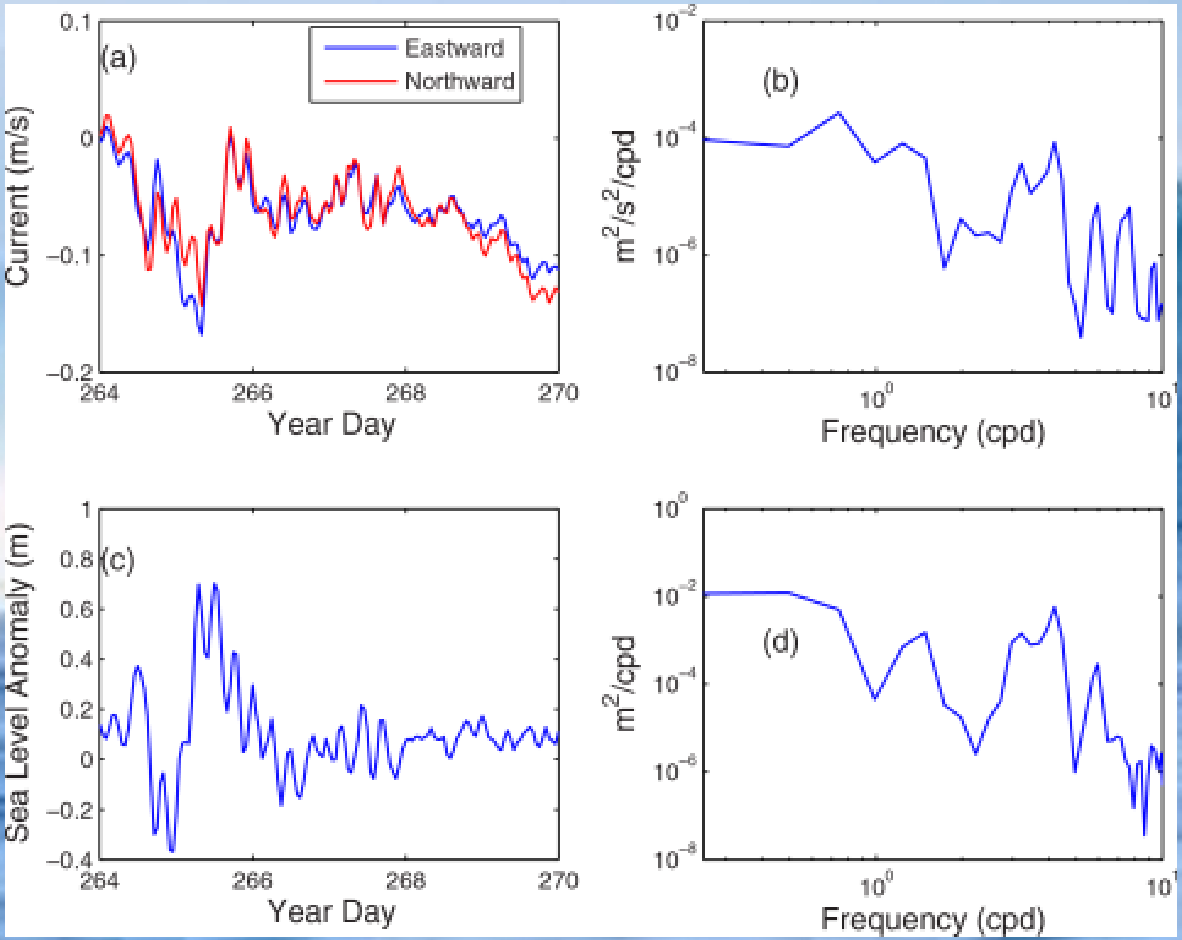
Black sea responses over the Danube estuary: A modelling study model BC-1 & BT-1





(a) Lagged correlation coefficients (open circles: significantly different from zero at the 99% confidence level; cross: insignificant) between the gauge sea level anomalies at St. Starosmbulskoe and Bystroe arms, with the latter lagging the former. (b) Power spectral density of the gauge sea level anomalies at St. Stambulskoe Prorva and Bystroe arms, along with the 95% confidence interval (vertical bar).

Black sea responses to surface modelling: A modelling study



(a) Vertically averaged current at a location indicated in Figure and (b) its power spectral density of the total current speed.
(c) Sea level anomaly and (d) Power spectral density.

EDUCATION AND TRAINING PROGRAMME FOR PROFESSIONALS FOR INLAND NAVIGATION VESSELS

Speciality: **Navigation**

Discipline: **Vessel handling**

Necessary content knowledge: **In-depth knowledge**

Module course: **“Navigator behavior recommendation in case the suddenly change of hydro-meteorological conditions”**

1. General

In case when critical hydro-meteorological conditions of navigation is very fast altered (for instant, ice phenomena, flood, shallow water and strong wind) under which navigation is hampered, the boatmasters shall strictly **observe** special temporary requirements of the competent authorities of the countries introduced on the sections of their responsibility according to article 1.22 of the Basic rules of navigation on the Danube (BRND). Special temporary requirements of the competent authorities are timely and sufficiently notified to the crews of the vessels and shipping companies by means of RIS in a form of "Notices to skippers“ or VHF technology as was mention before.

2. Ice phenomena

In case of ice phenomena that do not allow vessels to continue their journey, the boatmasters, apart from a strict compliance with the temporary requirements of the competent authorities and Special River Administrations, shall take all measures necessitated by the circumstances to prevent imminent danger, in particular:

- when passing close to big ice floes and ice fields;
- to avoid entering into the ice field;
- if the vessel has yet entered a dangerous zone;
- following the collision with the ice;
- boatmasters of the vessels shall maintain continuous communication with the vessels operating in the ice zones;

- if the vessels pass a natural canal or a canal made in the ice by the icebreaker;
- when passing a lock;
- if, according to "Notice to skippers", the conditions of the open brash ice, up to
  10 cm and over in thickness, are expected;
- all vessels getting trapped in the middle of the ice field, in case of a threat to remain blocked or to block the way to other more solid vessels.

3. Flood

When navigating in flood conditions, the boatmasters shall take all measures necessitated by the circumstances to prevent danger, in particular:

- to comply strictly with the articles of "Local rules of navigation on the Danube (Special provisions)" concerning restrictions of navigation or its prohibition in case of high water levels as well as exceeding of the highest navigation level (HNL);
- to comply strictly with the notices to skippers regarding the passage regime with a limited speed on the specific section;
- to pass under the bridges only in case of sufficient clearance and conditions defined by "Local rules of navigation on the Danube (Special provisions)" and "Notices to skippers";
- to undertake manoeuvres and meeting with the vessels at night only after preliminary agreement on the meeting conditions via radiocommunication;

If "Notice to skippers" does not require the concrete passage speed on the concrete section, then it shall be such as not to cause intense wave disturbance, damaging a shoreline and floating equipment moored on the shore.

4. Shallow water

When navigating in shallow water conditions, the boatmasters shall take all measures necessitated by the circumstances to prevent danger, in particular:

- when approaching a shallow water section or ford, to reduce in advance and gradually speed of the vessel to the value which provides a stable steering;
- to undertake meeting and overtaking only when there is enough fairway width for such manoeuvres, while reducing in advance speed to the value that provides stable steering;
- to avoid drastic speed increase;
- to ensure strictly the recommended minimum safety clearance (minimum underkeel clearance).

5. Strong wind

In case of strong wind, which complicates or obstructs navigation, the boatmaster shall strictly observe special temporary requirements of the competent authorities and Special River Administrations and, to ensure safety, manage navigation according to "Notices to skippers" and navigation conditions in the critical sector, and, when navigation is stopped or announced to be interrupted, shall timely and in a proper manner bring the vessels to a safe berth and inform the competent authorities thereon.

6. Requirements for anchoring and mooring equipment

When berthing the vessel on a narrow section of the riverbed, in shallow water and in places, where both winds blowing in one direction and rapid flow prevail, to ensure safety, double mooring cables and, when anchoring, two anchors, if any, and stern anchor, should be used.

CONCLUSION

1. The proposed innovation is based on additional connection ECDIS to communication equipment in the frame of existing conventional installations. This proposal is fully compatible with the direction of bringing all the key information together on the base common standard interface – ECDIS, which simplifies action of OOW and provides further development of means of communication and navigation and implementation of modern digital technology in navigation.

   All of these advantages can be realized only after the adoption of corresponding amendments to ECDIS performance standards.

2. Autonomous Surface Vehicle (ASV) and Autonomous Underwater Vehicle (AUV) advanced technology has matured in recent years and is readily available to development IECDIS dynamic charts. Both ASVs and AUV are capable of producing automated bathymetric and water surface quality dynamic charts.

3. Certain predict of dynamic in IECDIS charts will allow us to avoid possible trouble during the navigation.

4. New training course will give navigators behavior modeling when suddenly change hydro-meteorological conditions that should enhanced safety of navigation.

Thank You!

Questions ?