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CEDA Central Dredging Association
AdSP MTS

WORKSHOP SULLA VALUTAZIONE DEGLI EFFETTI FISICI DOVUTI ALLA MOVIMENTAZIONE DEI SEDIMENTI IN AREE MARINO-COSTIERE: STRUMENTI E METODOLOGIE DI APPROCCIO

WORKSHOP SUR L'ÉVALUATION DES EFFETS PHYSIQUES CONSÉQUENTS À LA MANIPULATION DES SÉDIMENTS DANS LES ZONES MARINES CÔTIÈRES: INSTRUMENTS ET MÉTHODES D'APPROCHE

WORKSHOP ON THE ASSESSMENT OF PHYSICAL EFFECTS RELATED TO SEDIMENT HANDLING IN MARINE AND COASTAL AREAS: TOOLS AND SHARED APPROACHES

MONITORING OF METEO, HYDRODYNAMIC AND WATER QUALITY DATA IN COASTAL AREAS

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CoNISMa

CoNISMa Consorzio Nazionale Interuniversitario per le Scienze del Mare

La cooperazione al cuore del Mediterraneo
La coopération au cœur de la Méditerranée

Regione Autònoma de Sardigna · Regione Autonoma della Sardegna · ISPRA · Sistema Nazionale per la Protezione dell'Ambiente · ARPAL · Provincia di Livorno · Var Le Département · Université de Toulon · Collectivité de Corse

INTRODUCTION

✓ WHY is monitoring necessary?

1. Knowledge of the main physical processes typical of the target costal site (cyclic and recursive)
2. Continuous information on ordinary state of target costal site, but also during accidents and special scheduled operations ➡ possibility of intervention
3. Calibration and validation of numerical models ➡ forecasting and future scenarios
4. Support for local authorities in coastal planning, management and in situ decision-making

INTRODUCTION

✓ Where is monitoring needed most?

1. Areas exposed to strong anthropic pressure due to urbanization, heavy industry, touristic and commercial ports, military naval dockyard...
   ➡ Highly vulnerable (urban, industrial discharges, naval traffic)
2. Areas with naturalistic value, precious ecosystems and environmental heritage
3. Areas exposed to natural hazards including flooding, storm impacts, sea-level rise, coastal erosion or sediment deposit
4. Coastal basins and inlets, especially sensitive to human activity and climate change because of their semi enclosed shapes and lagoon characteristics


DAL MERCANTILE PANAMENSE «EAST CASTLE» ORMEGGIATO IN PORTO SONO FUORIUSCITE 30 TONNELLATE DI CARBURANTE

Chiazza di nafta in Mar Grande Paura a Taranto

«Per un errore». Cozze a rischio

GIGANTE CON ALTRI SERVIZI ALLE PAGINE 2 E 3 >>

MAR GRANDE Si cerca in tutti i modi di arginare la chiazza di carburante

- Nicastro: il disastro è stato scongiurato
  RIZZO A PAGINA 3 >>
- Città in ginocchio fra polveri e gas
  COLUCCI A PAGINA 3 >>
- Tuonano i Verdi «Fatto gravissimo»
  A PAGINA 3 >>

TARGET AREA

✓ **Mar Grande and Mar Piccolo basins (Ionian Sea)**

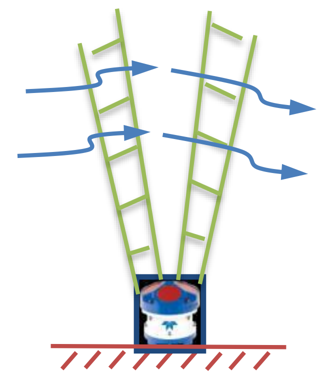
- Mar Grande (max depth ~35m)
  Mar Piccolo (max depth ~15m)
- joined by two channels
- Mar Grande borders two openings are present: NW 100m and SW 400m
- complex topography
- vulnerable (urban, industrial discharges, naval traffic)

MEASURING STATIONS

✓ **Mar Grande meteo-oceanographic station (St. O)**

- from Dec 2013, (40°27.6'N and 17°12.9’E), h~26m
- equipped with:

Weather system: ultrasonic sensor for wind; barometric pressure sensor; temperature/humidity probe (at 1.5m above surface)



Bottom mounted ADCP: current speed and direction along vertical (bins 0.50m). Transducer at 0.50m above seafloor, upward facing. Pressure sensor.

Multidirectional Wavemeter: Depth cells are array of sensors to detect wave magnitude and direction

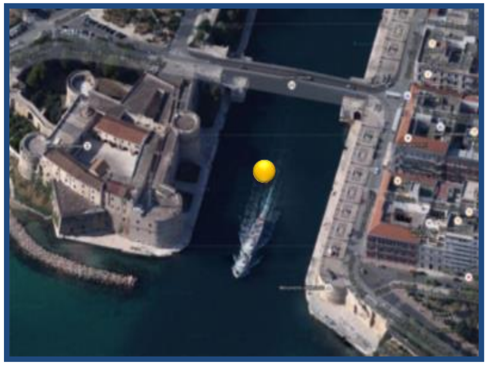
Water quality sensor: CTD (Conductivity Temperature Depth) Sensor of BOD, Fluorimeter, Sensor for Turbidity and Chlorophyll. At 5m from surface.

Data are hourly-averaged
Sampling rate 5Hz

MEASURING STATIONS

✓ **Mar Piccolo station in Navigable Channel (St. N)**

- from May 2014, (40°27.6'N and 17°12.9’E), h~12m
- equipped with:



Bottom mounted ADCP

Wavemeter

Ultrasonic tide gauge

Acoustic frequency of both ADCPs 600KHz
Velocity accuracy 0.3%
Tide gauge resolution 1mm; accuracy ±1cm

Settled in frame of Flagship Project RITMARE,
with funds from PON R&C 2007-13 provided by MIUR

System managed by research unit of Coastal Engineering Laboratory (LIC) of Polytechnic University of Bari, DICATECh

www.michelemossa.it/stazionemeteo.php
www.michelemossa.it/stazionemeteo2.php

MEASURING STATIONS: data acquisition and transmission

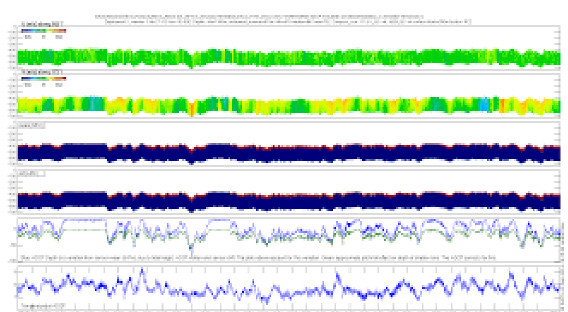
1. Data are processed in real time by LISC datalogger.

2. Marlin software connects to datalogger to take measured data, to process on site and give them back

3. Communication with remote systems by means of cellular modem 3G, connected to datalogger, sending data on the internet web.

Modem 3G

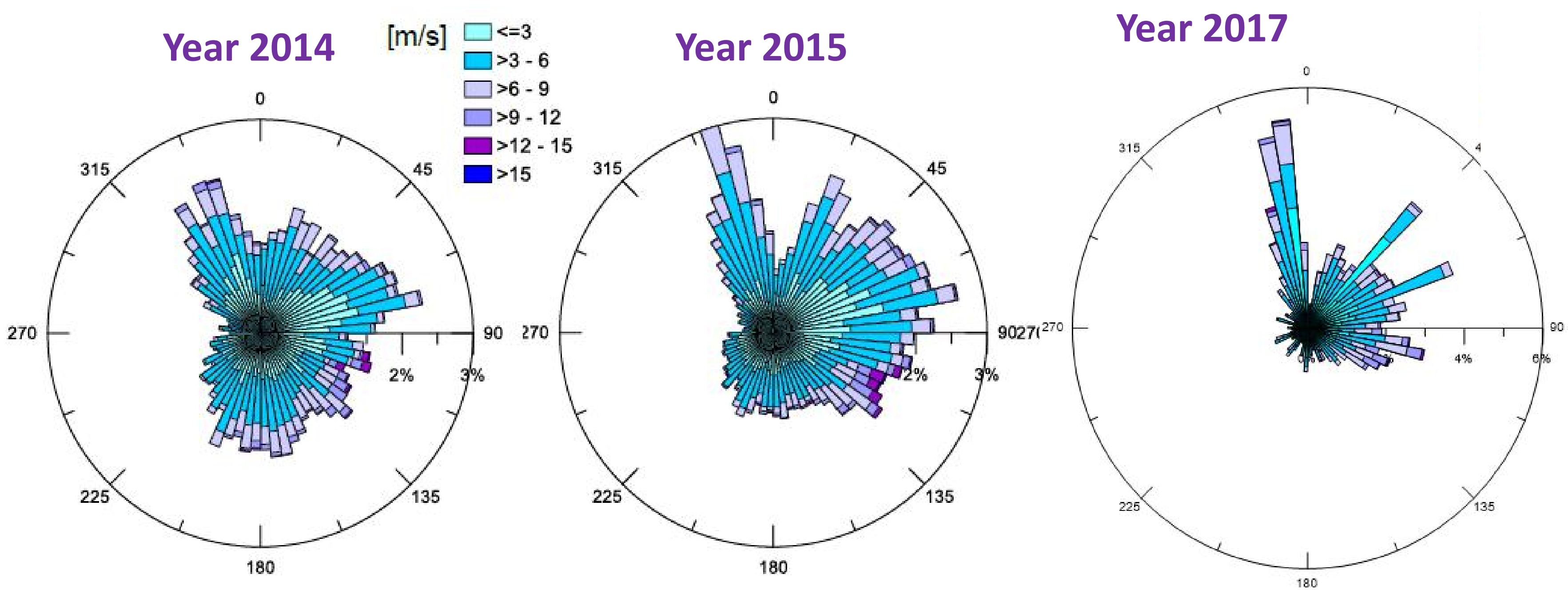
4. Communications towards remote systems is managed by software ROCS, calling datalogger, to download acquired data and to check or change acquisition parameters.



DATA ANALYSIS with classical and well known procedure

MAR GRANDE St. O: Winds (incoming direction shown)

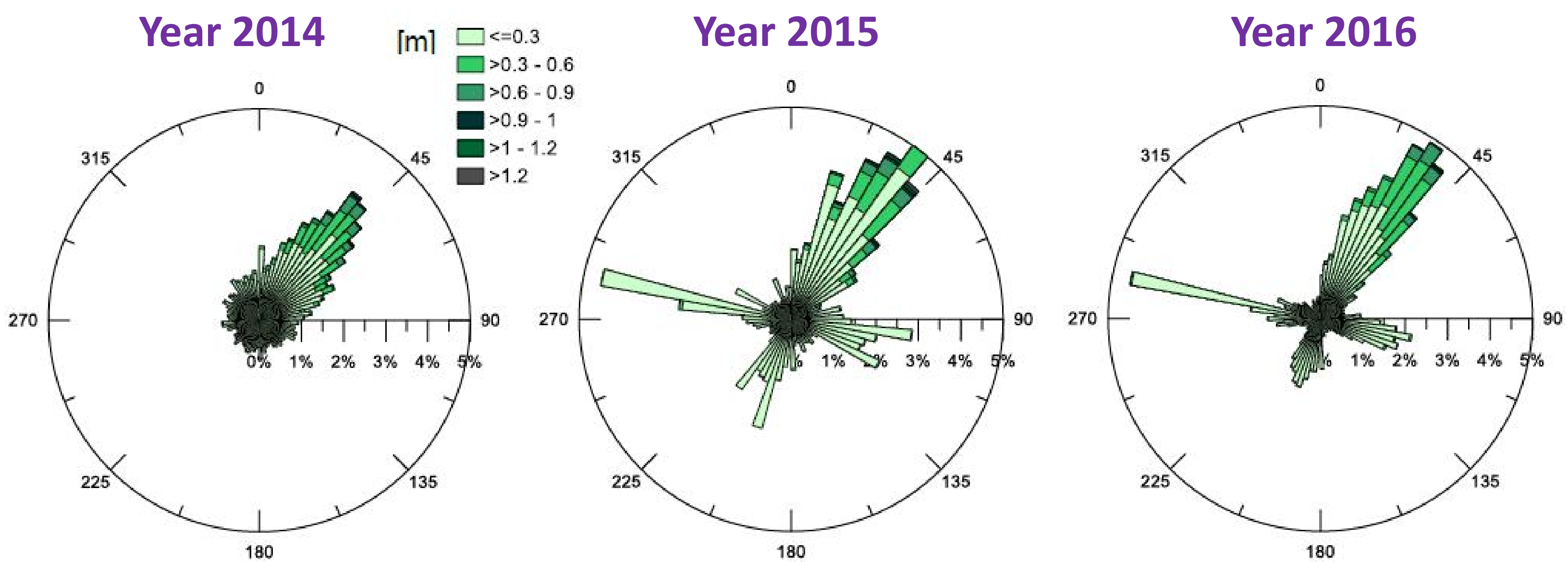
- ✓ Annual rose plot: winds from NNW most frequent, max ~9m/s
  moderately frequent spanning clockwise from NNE to E
  most intense Sirocco winds (12-15 m/s), but less frequent.
- ✓ Distribution confirmed annually



DATA ANALYSIS

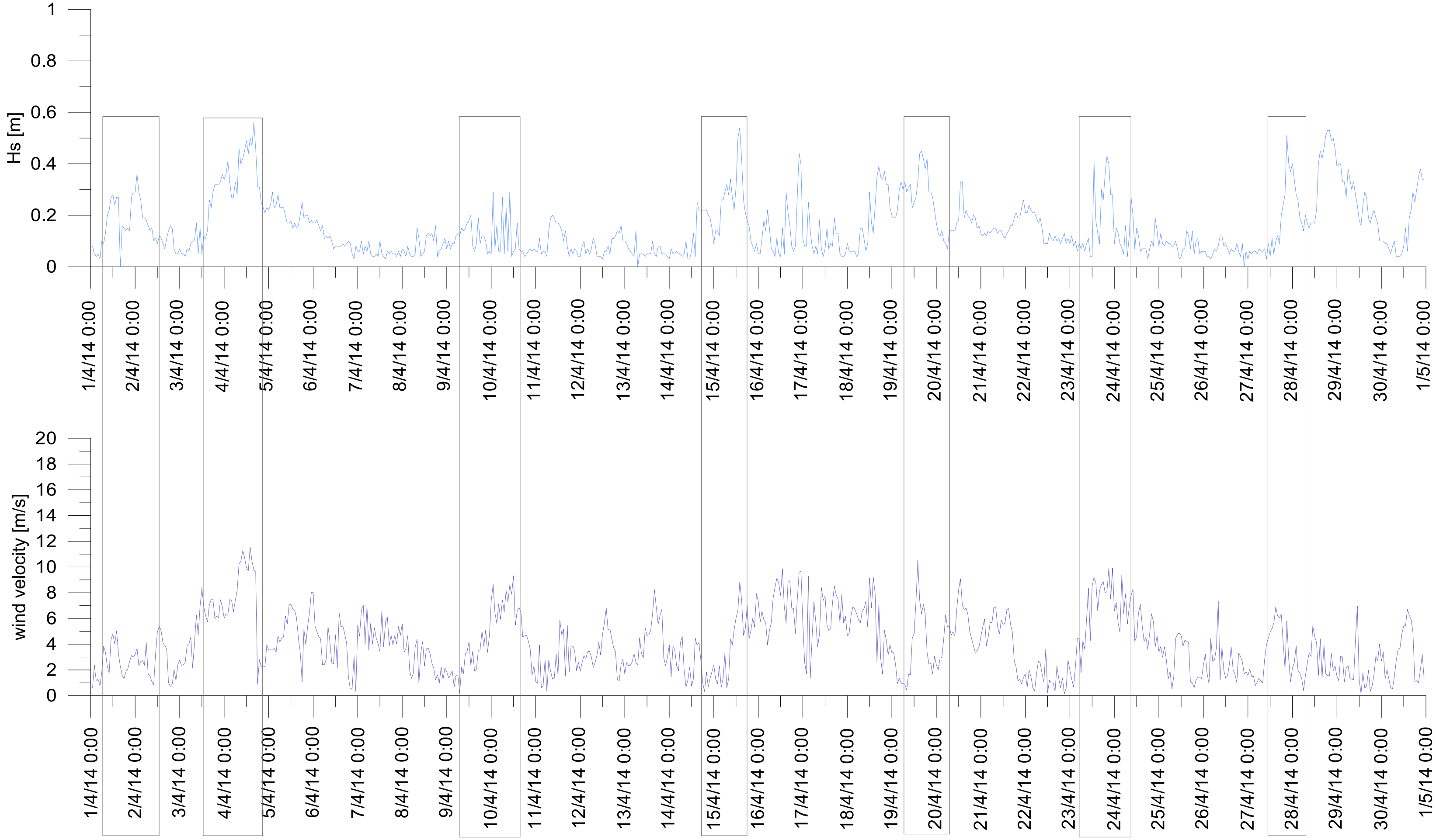
MAR GRANDE St. O: Waves (propagation direction shown)

- ✓ Shape of basin and location of St. O → wind waves rare due to short fetches and dominant landward winds. Basin dominated by swell waves, entering from the SW opening and propagating inside.
- ✓ Confirmed by annual polar plots of the significant wave heights *Hs* → most frequent and highest waves from SW, consistently with opening.
- ✓ Annual typical behavior



DATA ANALYSIS – time series

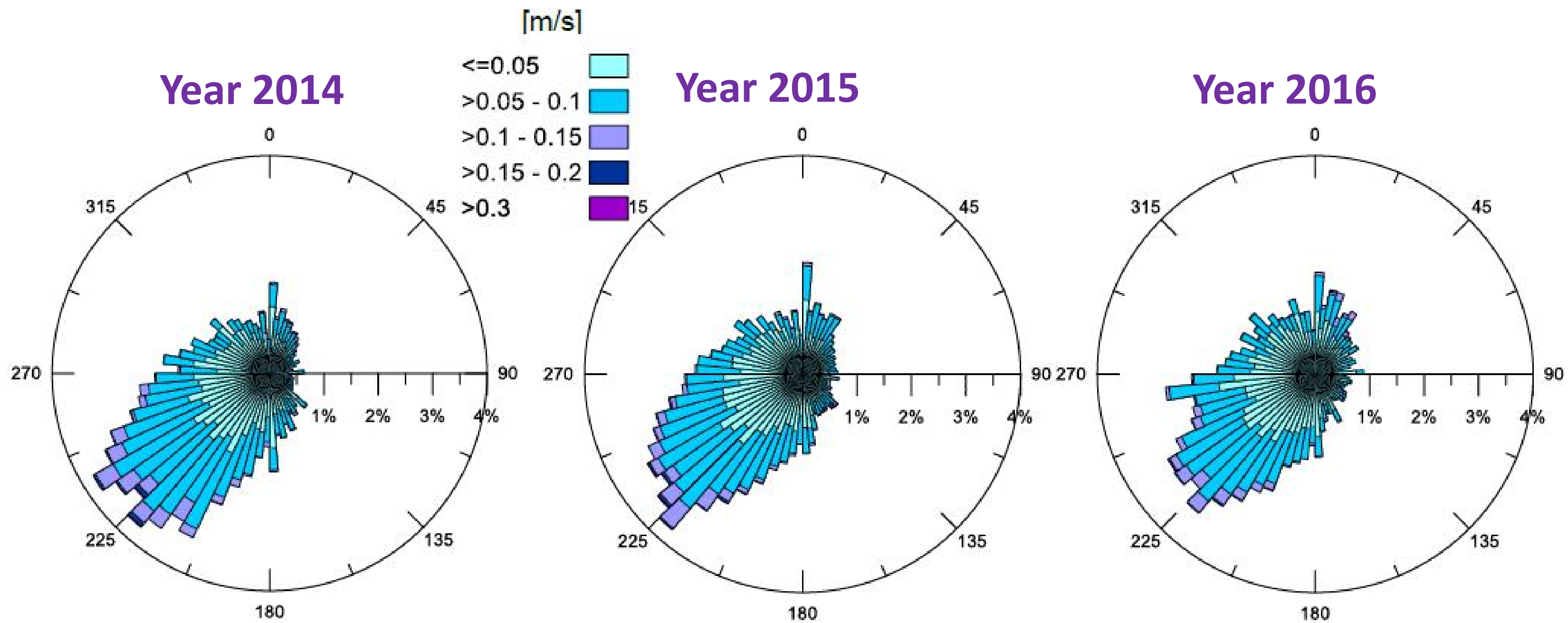
MAR GRANDE St. O - Waves and wind direct comparison



DATA ANALYSIS

MAR GRANDE St. O: Currents (propagation direction shown)

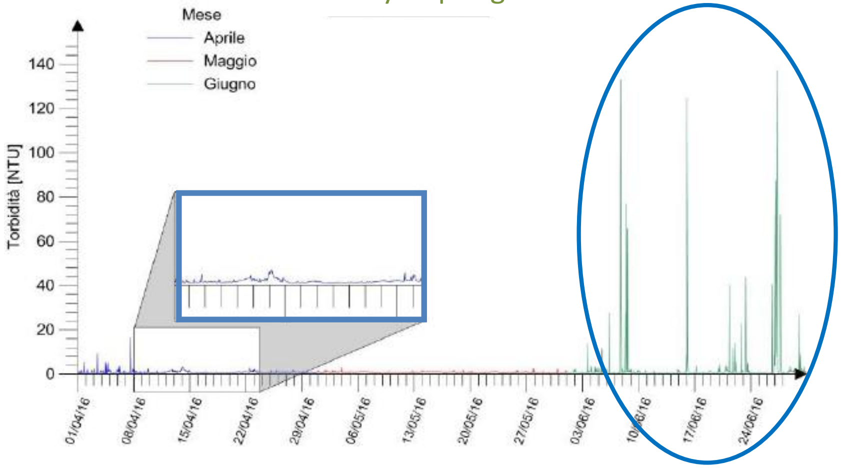
- ✓ Typical annual behavior of bottom currents
- ✓ Bottom velocities converge towards SW, flowing outside
- ✓ Annual surface currents propagating clockwise (S to N), affected by moderate winds



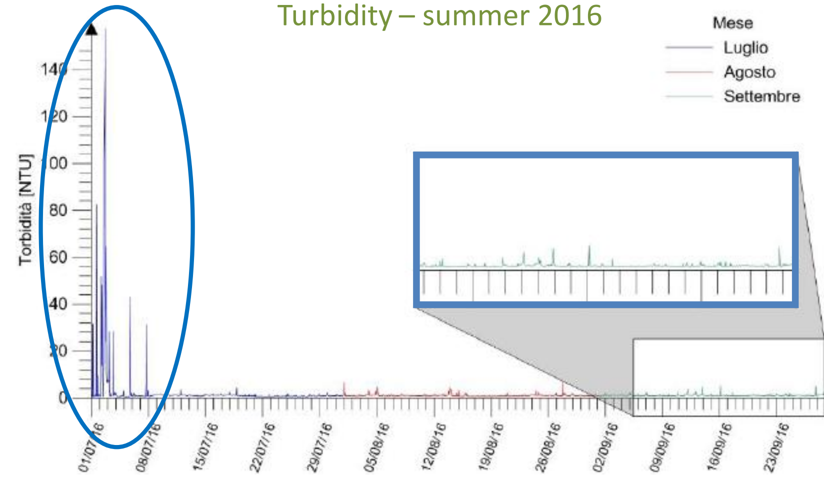
DATA ANALYSIS MAR GRANDE St. O: Scalars

✓ Consistent seasonal behavior

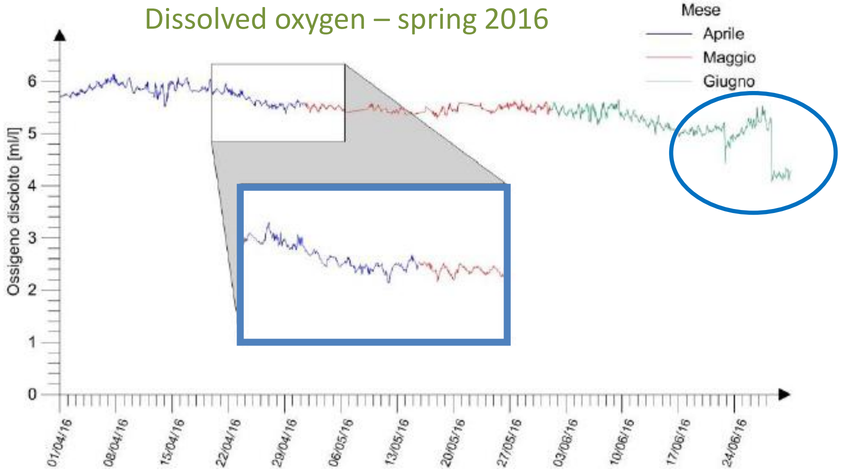
Turbidity – spring 2016



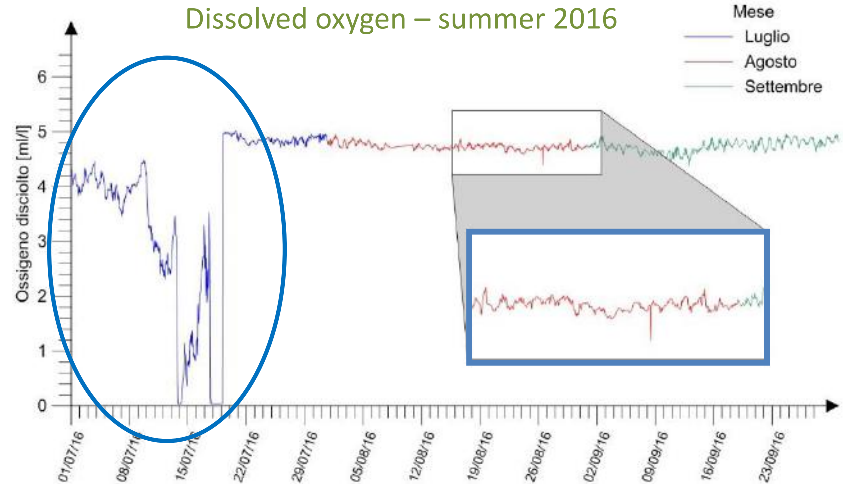
Turbidity – summer 2016



Dissolved oxygen – spring 2016



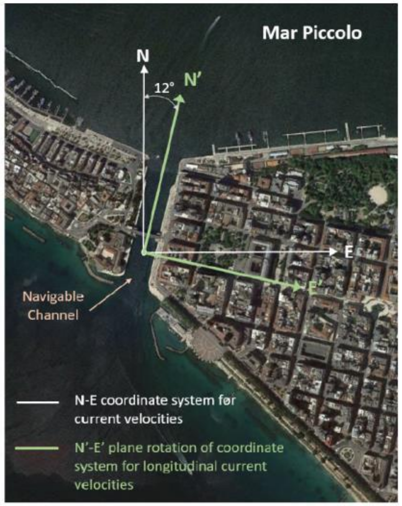
Dissolved oxygen – summer 2016

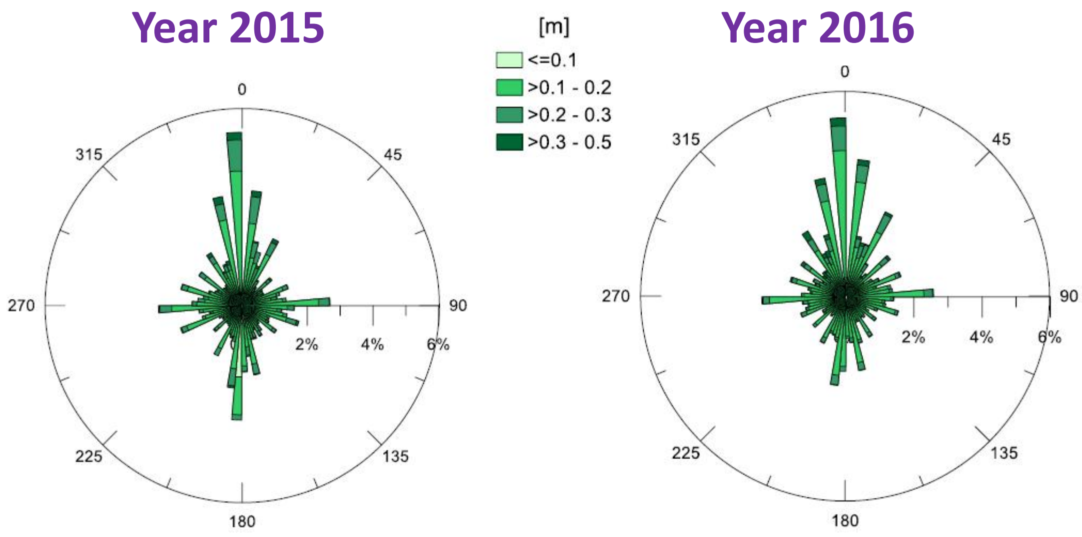


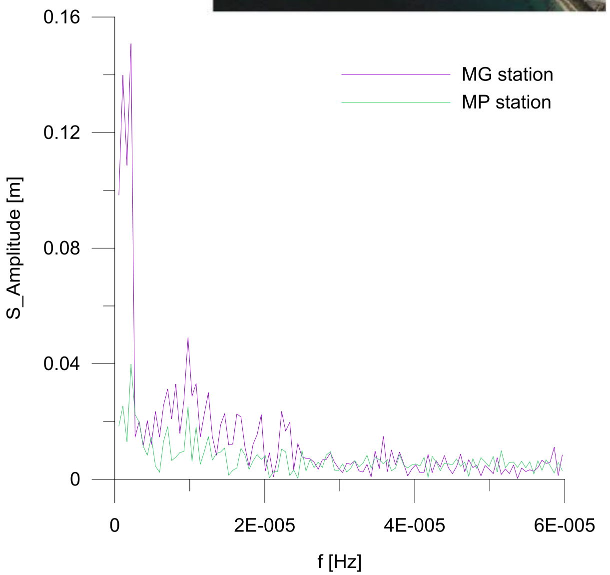
DATA ANALYSIS

MAR PICCOLO St. N: Waves

- ✓ Polar diagrams: annual ***Hs*** lower than in MGrande (max ~0.6m)
- ✓ smoothed swells from external basin.
- ✓ Propagation ~ orientation of Channel





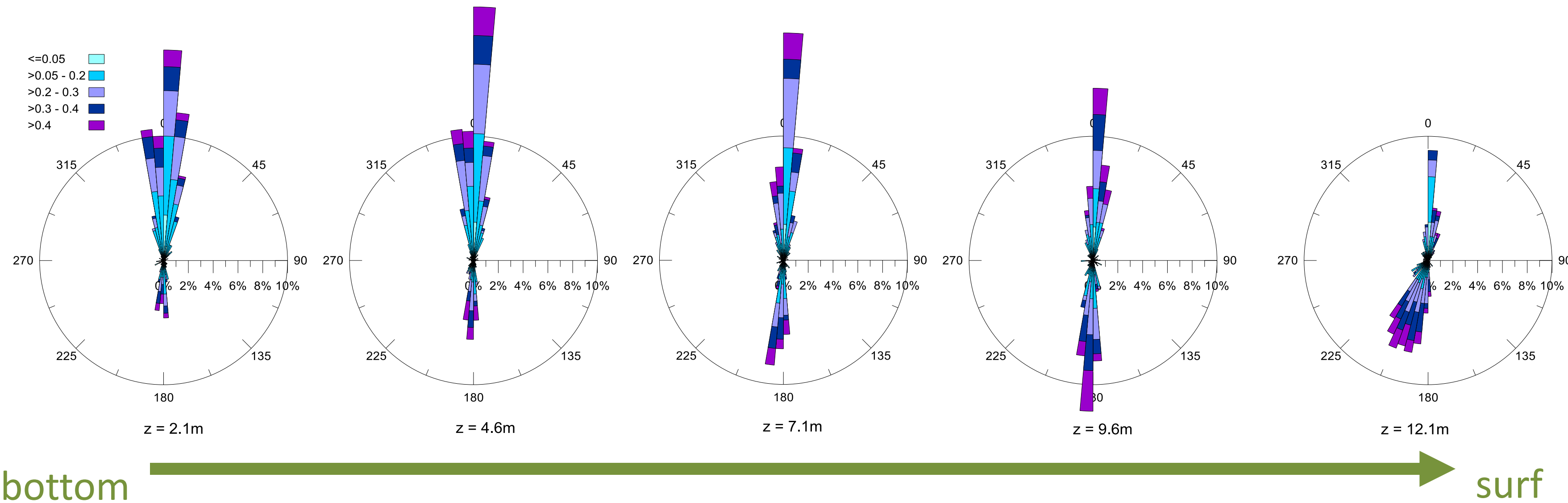


Amplitude spectra Hs at St. O and St. N in Nov 2015

DATA ANALYSIS

MAR PICCOLO St. N: Currents

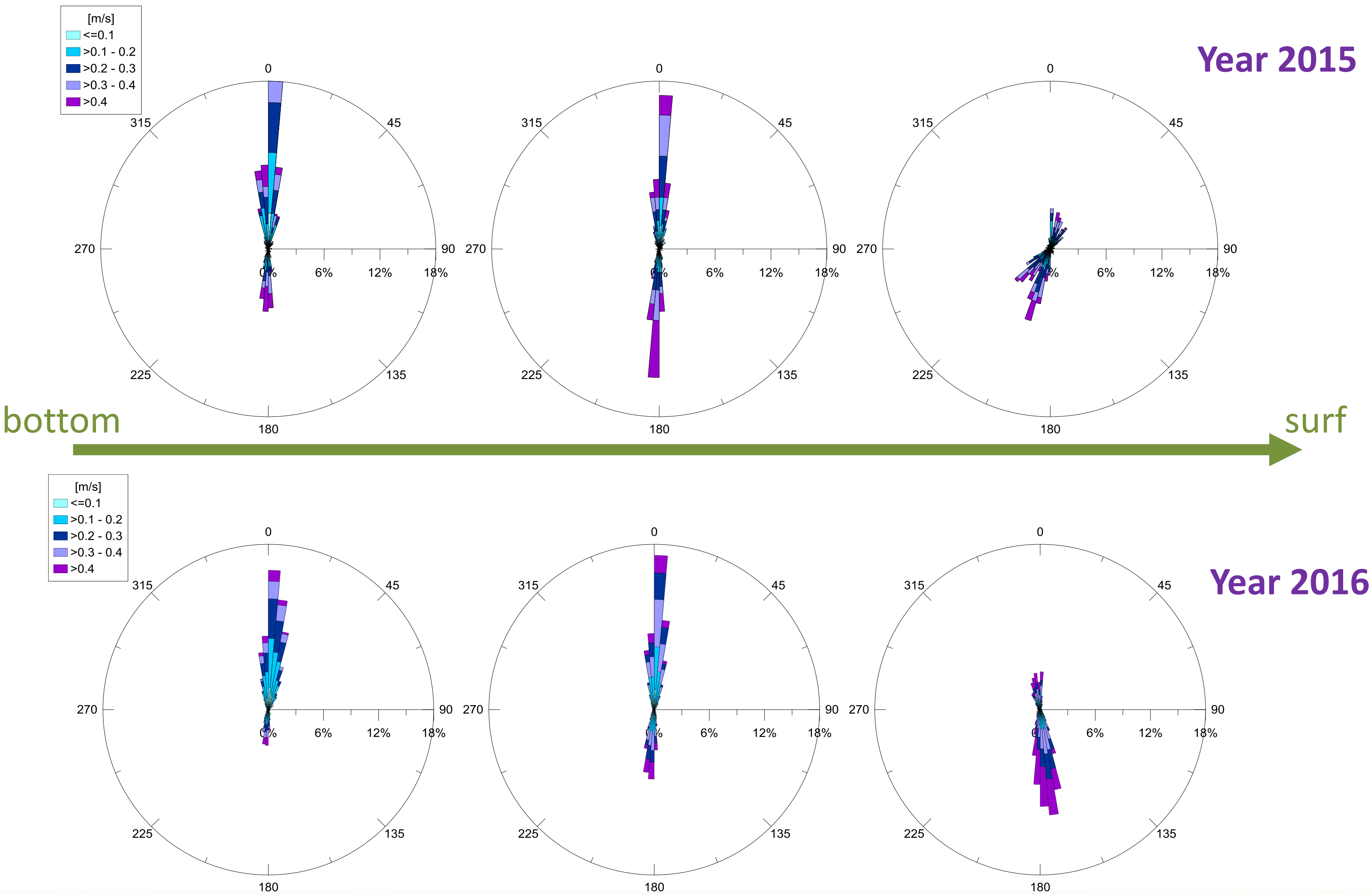
✓ Typical monthly behavior, at different depths: → case September 2015



- near bottom current inflowing towards Mar Piccolo with 0.05-0.3m/s
- at intermediate depths: both inflowing and outflowing currents
- near surface dominant SSW outflows, with higher intensities (>0.4m/s)

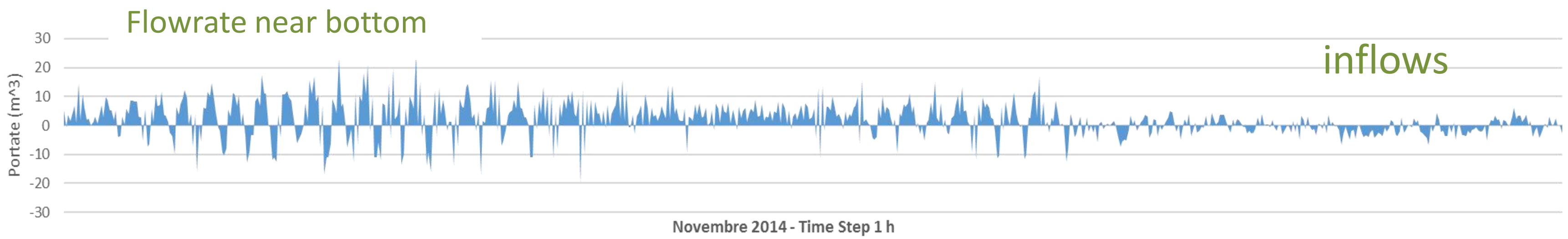
DATA ANALYSIS MAR PICCOLO St. N: Currents

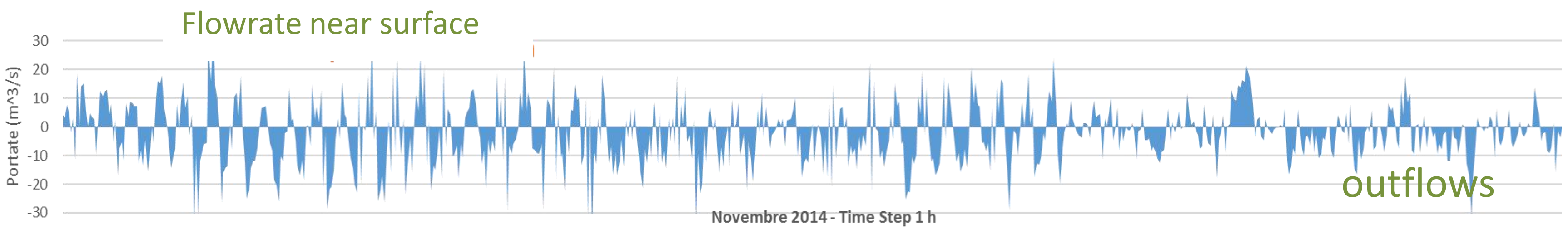
✓ Typical annual behavior



DATA ANALYSIS

MAR PICCOLO St. N: Currents





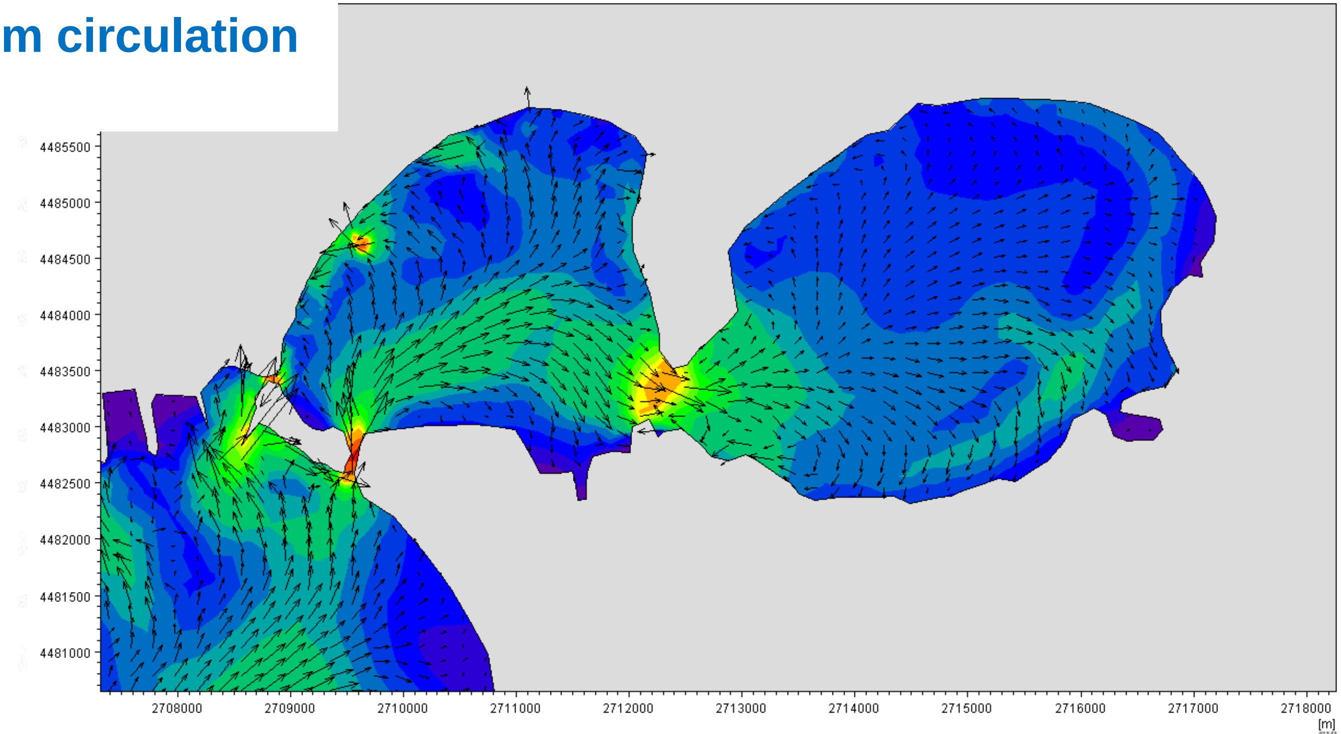
DATA ANALYSIS MAR PICCOLO St. N: Currents

1. double circulation in channel, **inflowing** towards Mar Piccolo **in deeper layers** and **outflowing** in **most superficial** ones

2. during whole year, **inflowing rate prevails on the outflowing one**

Consistent with results of **numerical modelling SHYFEM 3D** and **MIKE 3D** (DHI)

Annual bottom circulation Map - 2014



- De Pascalis F, Petrizzo A, Ghezzo M, Lorenzetti G, Manfè G, Alabiso G, Zaggia L, Estuarine circulation in the Taranto Seas, Env. Science and Poll. Res., 9, 2015)
- DHI (2016)

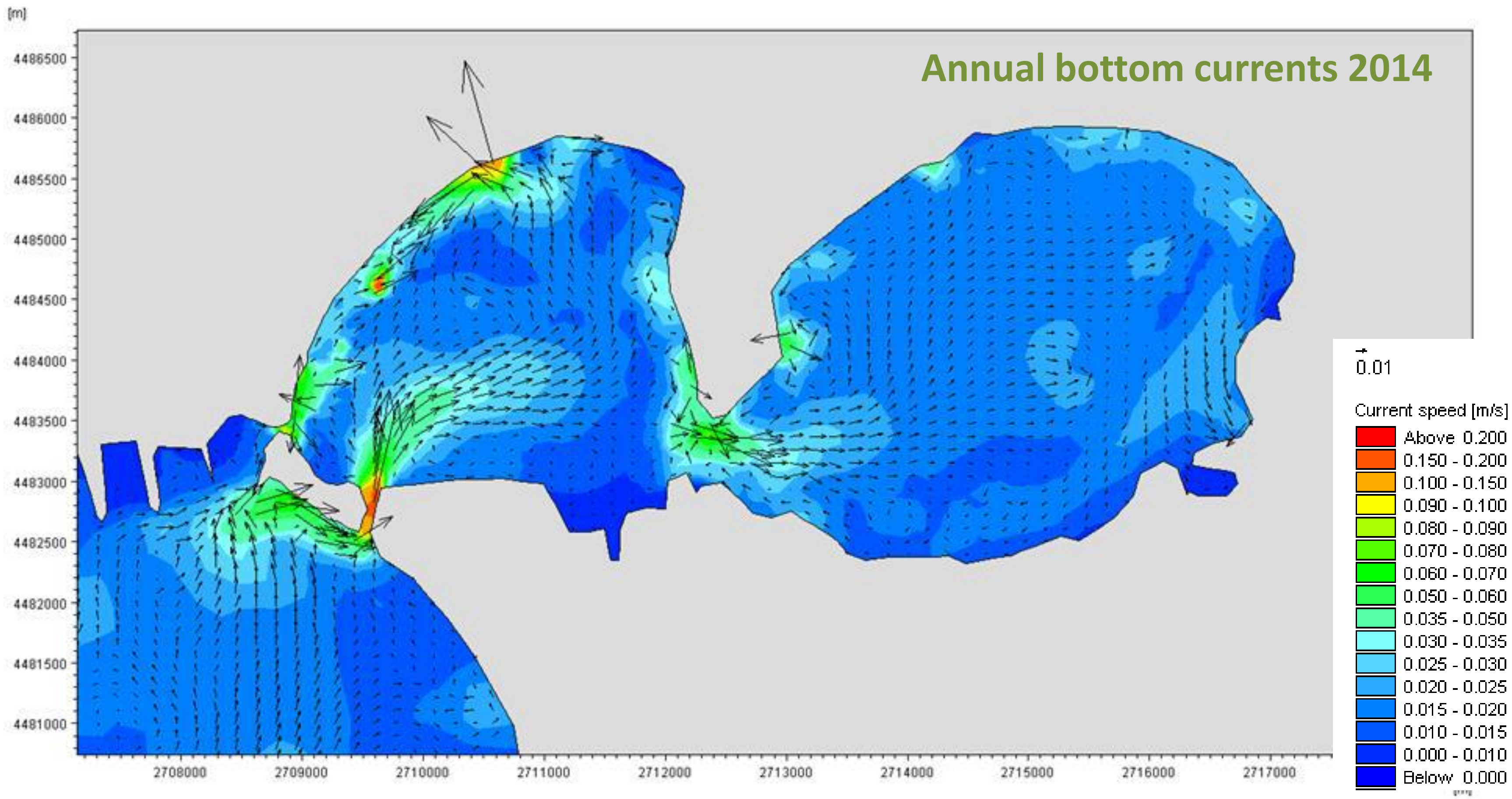
NUMERICAL MODELLING

✓ **HOW can we use data for modelling?**

1. Calibration: choosing parameters such as wind drag coefficient, bottom roughness, coefficients in the turbulence closure model (coeff Smagorinsky)
2. Validation: based on measured input data (winds, tide, waves i.e. radiation stresses, thermoaline gradients) we make comparisons of output (currents) with measured currents
3. Once simulated a reliable hydrodynamic state in the basin, we can add further processes, such as sediment transport (also due to dredging) or oil spilling
4. Provide scenarios and forecasting

NUMERICAL MODELLING

✓ **Case of bottom sediment transport (MIKE 3HD, DHI)**



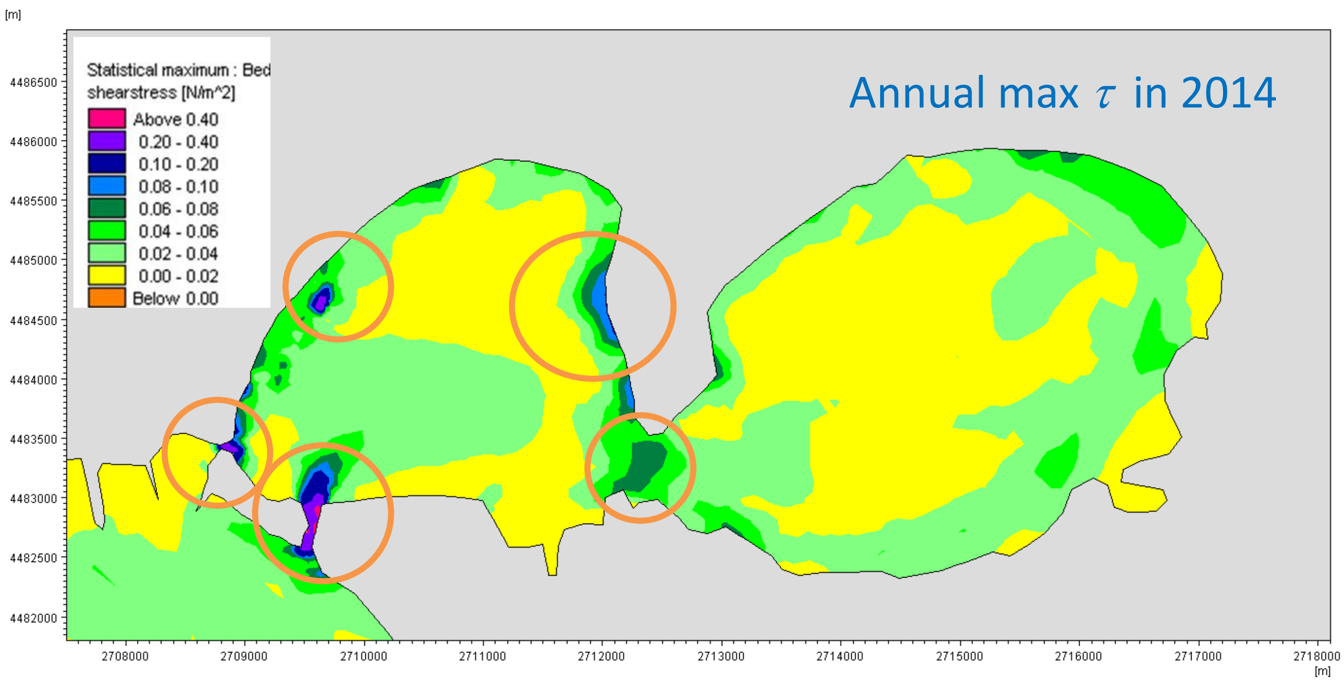
NUMERICAL MODELLING

✓ Case of bottom sediments

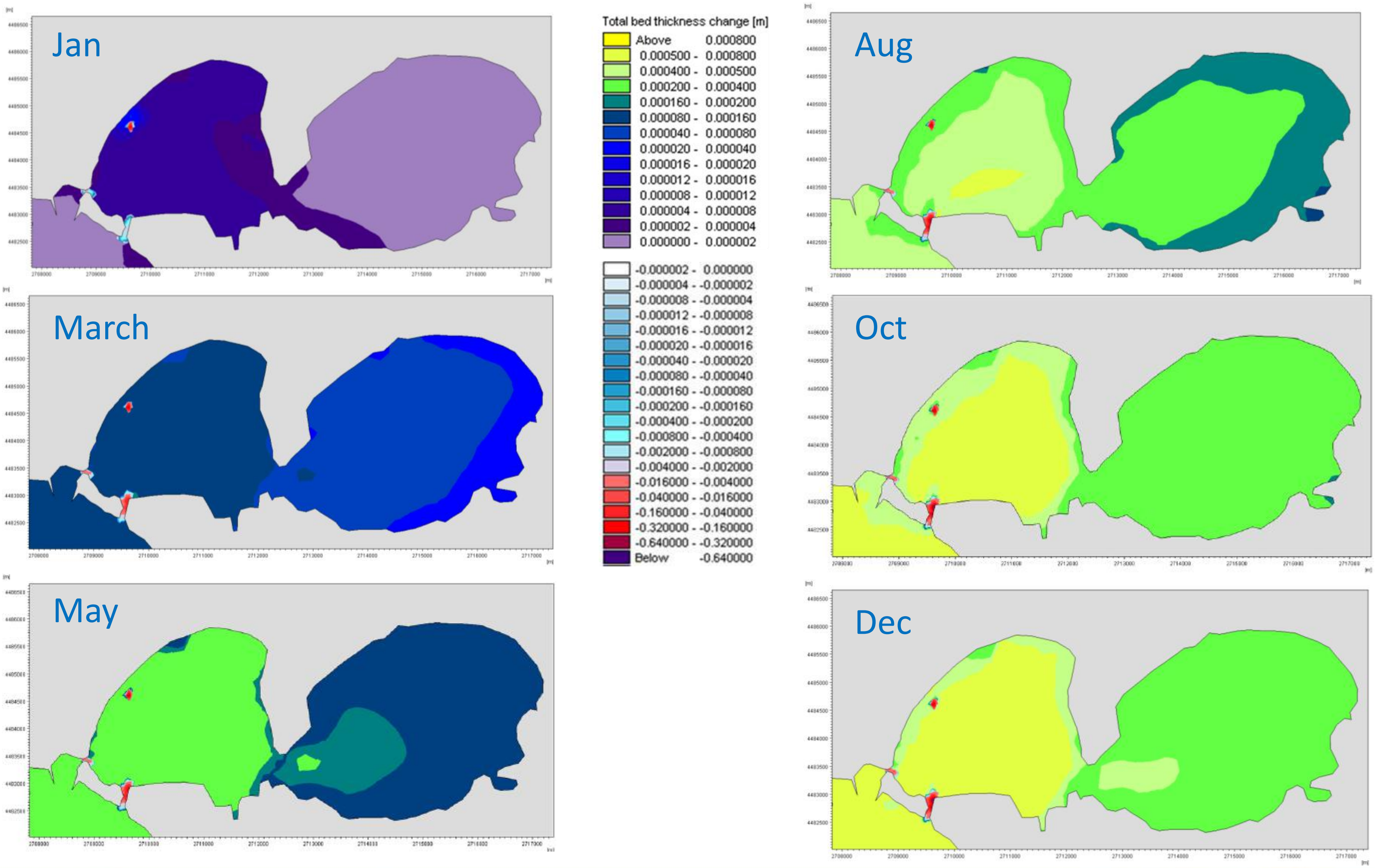
From bottom velocities we compute annual maxima tangential stresses τ at bottom:

$$U_b = \sqrt{\tau / \rho}$$

Where τ exceeds critical value computed for clay-silt bottom, we map erosion



NUMERICAL MODELLING Case of bottom sediments: annual evolution trend

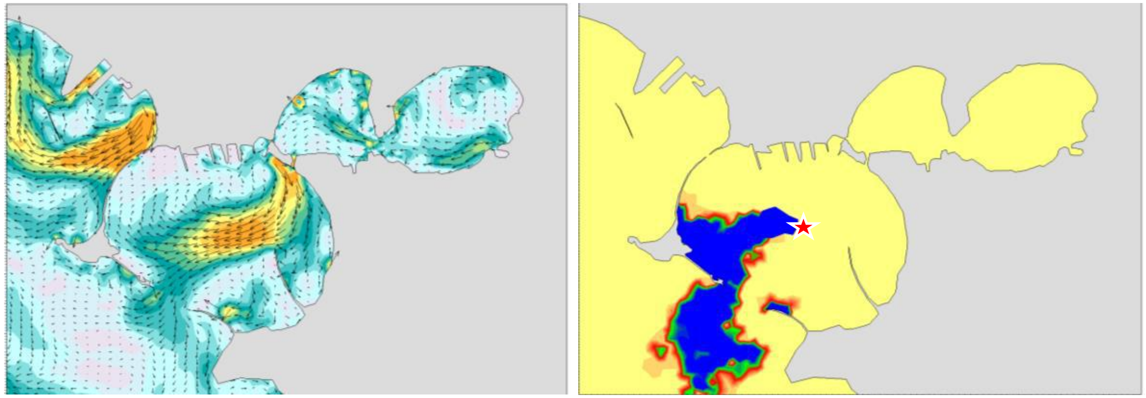


NUMERICAL MODELLING Case of hypothetical oil spilling

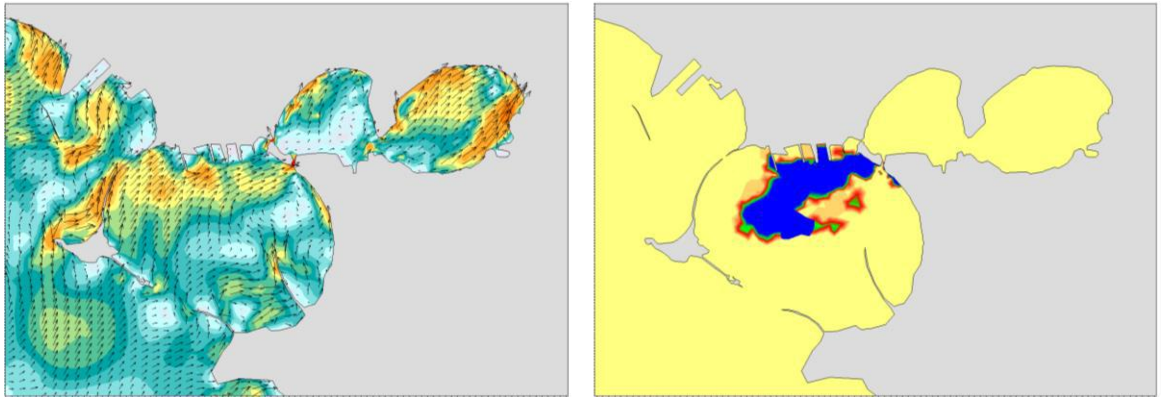
Continuous leakage of oil over a period 3 days, starting on:
12 Dec 2015 at 08:00
12 July 2015 at 08:00

- total mass of oil released is 519 tons (rate of 2 kg/s)
- oil type is crude oil

Staring from calibrated hydrodynamics in both seasons, spilling module added



3rd day Dec.



3rd day July

CONCLUSION

- ✓ Monitoring of characteristic items is essential to detect physical trends typical of costal site
- ✓ Provided continuous information on ordinary state and also real-time information during accidental events
- ✓ Possible calibration and validation of hydrodynamic numerical models, thus obtaining reliable circulation patterns to be used as input for successive simulations, i.e. transport and dispersion of sediments and/or contaminants
- ✓ Providing future scenarios and forecasting, thus supporting local authorities in coastal planning, management and in situ decision-making
- ✓ Joint use of high-quality field data and numerical models is profitable, if we use high quality and trustworthy field data

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ONGOING COOPERATIONS

ARPA PUGLIA
Università Roma La Sapienza
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GRAZIE PER L'ATTENZIONE