



FI oceanografija: oris ob 25-letnici SZGG

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Morska biološka postaja*

*b) Univerza v Ljubljani, Fakulteta
za gradbeništvo in geodezijo*





1995

Strokovno srečanje Slovenskega združenja za geodezijo in geofiziko

ZGODOVINA SLOVENSKE GEODEZIJE IN GEOFIZIKE

1. DEL

ZBORNİK PREDAVANJ

SLOVENSKO ZDRUŽENJE ZA GEODEZIJO IN GEOFIZIKO

Ljubljana, 1995

Začetki oceanografije na Slovenskem

Vlado Malačič*

Vsebina

V prispevku je sprva opisan pregled nekaterih del v dvajsetem stotetju, ki nekako sodijo v oceanografijo in so pomembna tudi za slovenski del Tržaškega zaliva. Večji poudarek je na predstavitvi opravljenega dela v zadnjem desetletju. Omenjeni so hidrografski pregledi Tržaškega zaliva, ki sodijo v opisno oceanografijo, ter analitična in numerična dela, ki sodijo v fizikalno oceanografijo. Slednja zaenkrat zgolj opisujejo lastna nihanja Jadranskega morja, odziv morja na vsiljevanje s potujočim valom zračnega tlaka ter plimovanje in vetrni tok v Tržaškem zalivu. Predstavljeni so odprti problemi, vezani predvsem na residualno gibanje in gostotni tok, ki so podlaga za nadaljnje delo.

Pregled do osemdesetih let

Zgoščen zgodovinski pregled del, ki sodijo v oceanografijo, je bil opisan že drugje (Malačič, 1993a), zato bo tukaj podan le povzetek nekaterih ugotovitev, ki so bile objavljene pred več kot desetimi leti. Večji poudarek bo na delih, opravljenih od 1985 naprej, pa še ta bodo opisana zgolj zaradi predstavitve oceanografije, ki je pri nas mlada veda.

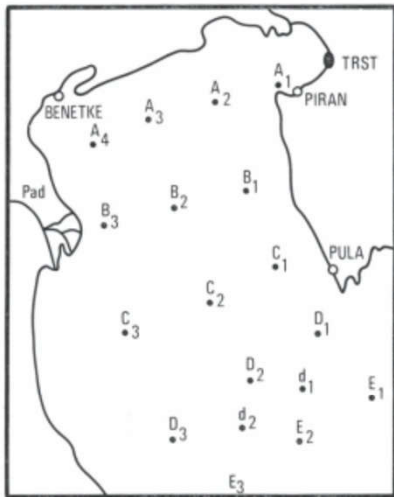
Leta 1819 je Trgovska in navtična akademija v Trstu objavila meteorološka opazovanja za potrebe pomorske meteorologije, od leta 1869 pa so objavljeni zapisi meritev nivoja gladine morja, ki jih je izvajal observatorij v Trstu, danes imenovan Istituto Talassografico. Zaradi skrbnega vzdrževanja in rednega umerjanja mareografa v obdobju enega stoletja je za podatke nivoja gladine v Trstu znano, da so zanesljivi. Na podlagi harmonične analize časovnih nizov redno izdajajo mareografske tablice, ki so za praktično rabo primerne tudi za naše področje. Za podroben opis nivoja gladine v okviru natančnosti meritev zadostuje sedem plimskih komponent (Ferraro et al., 1993), od teh štiri poldnevne (M2, S2, N2, K2) in tri dnevne za (K1, O1 in P1), od katerih sta

* dr., Morska postaja Piran, Fornače 41, 66330 Piran



1965, Bernot in Štirn

Geografski zbornik XXVIII, 1988

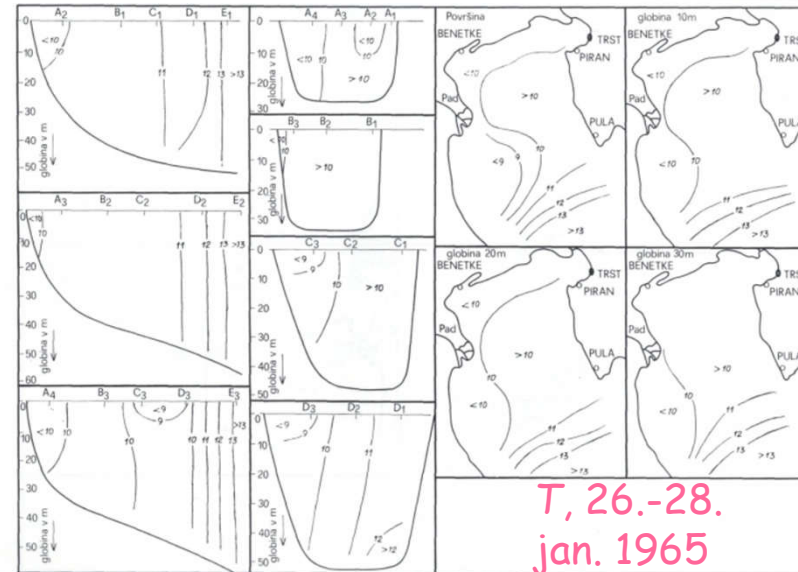


F. Bernot,
Geografski
zbornik,
1988

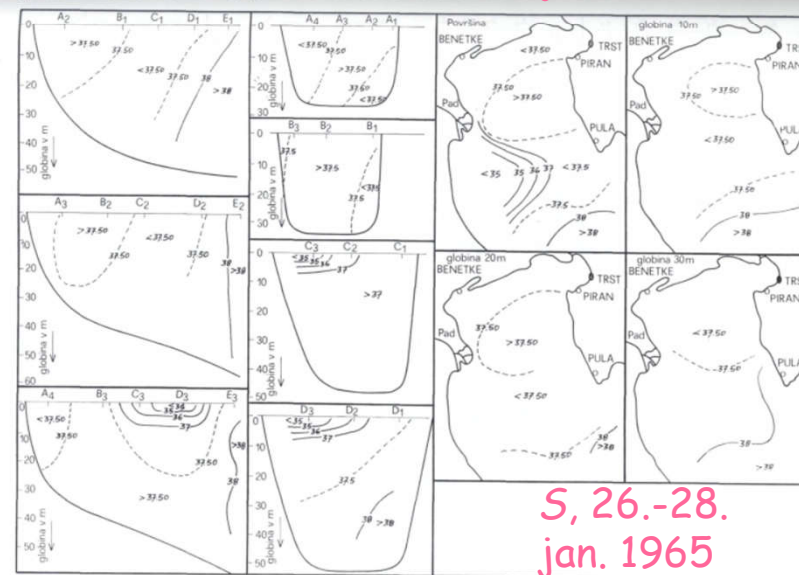
Sl. 1. Razpored postaj na severnem Jadranu.
Fig. 1 Map of the stations in the region of the North Adriatic.

dolžnih profilov s petimi prečnimi preseki, na t. i. postajah (sl. 1), bile opravljene sistematične fizikalno-kemične in biološke meritve ob naslednjih terminih in z naslednjimi ladjami:

1. med 26. in 28. januarjem 1965 — M/L Argonavt I;
2. med 25. in 27. februarjem 1965 — M/L Argonavt I;
3. med 24. in 28. marcem 1965 — M/L Argonavt I;
4. med 7. in 9. majem 1965 — M/L Argonavt I;
5. med 26. in 27. majem 1965 — M/L Argonavt I;
6. med 28. junijem in 6. julijem 1965 — M/L Argonavt I;
7. med 6. in 8. avgustom 1965 — M/L Zlatorog;
8. med 15. in 17. septembrom 1965 — M/L Zlatorog;
9. med 13. in 30. decembrom 1965 — M/L Rašica, kasneje preimenovana v M/L Argonavt II.



T, 26.-28.
jan. 1965



S, 26.-28.
jan. 1965

Sl. 3. Vertikalni in horizontalni preseki slanostnih razmer (v ‰) severnega Jadrana med 26. in 28. jan. 1965.
Fig. 3. Vertical and horizontal profiles of salinity condition (in promiles) of the North Adriatic from 26. to 28. of January 1965.



1991, Meritve slanosti s prevodnostjo

European Commission

Ecosystems research report No 32 THE ADRIATIC SEA

Proceedings of the workshop
'Physical and biogeochemical processes in the Adriatic Sea'
Portonovo (Ancona), Italy
23 to 27 April 1996

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T. S. Hopkins,
A. Artegiani, G. Cauwet, D. Degobbis, A. Malej

Secretariat: R. M. Landotti

Local organiser
CNR-Istituto di Ricerca sulla Pesca Marittima (IRPEM)

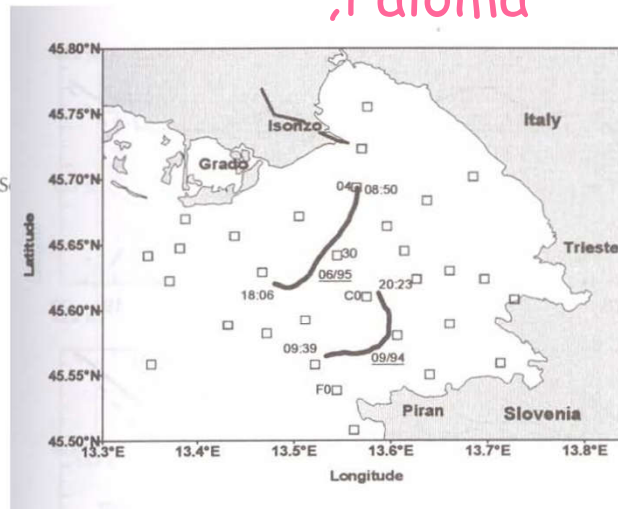
Directorate-General for Research

1999

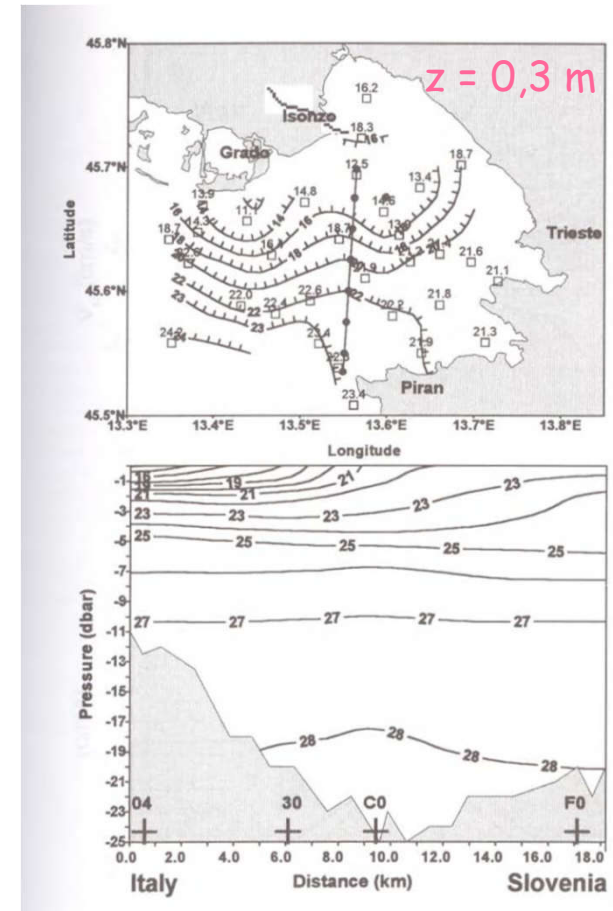
EUR

30. jan. 20

EU projekt
,Paloma'



Sledenje površinski vodni
masi
8. sep. 1994, 5.-9. jun. 1995



8. jun. 1995,
višek gostote
[kg/m³]

SZGG 25 let



1991, Meritve slanosti s prevodnostjo



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Journal of Marine Systems 55 (2005) 47–66

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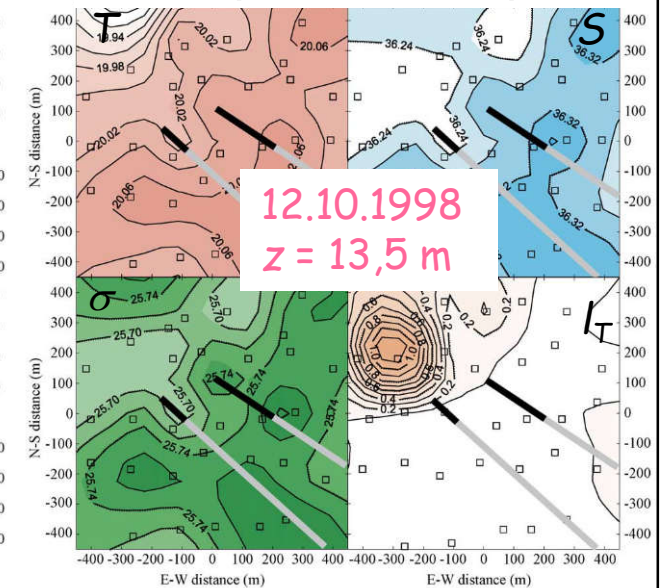
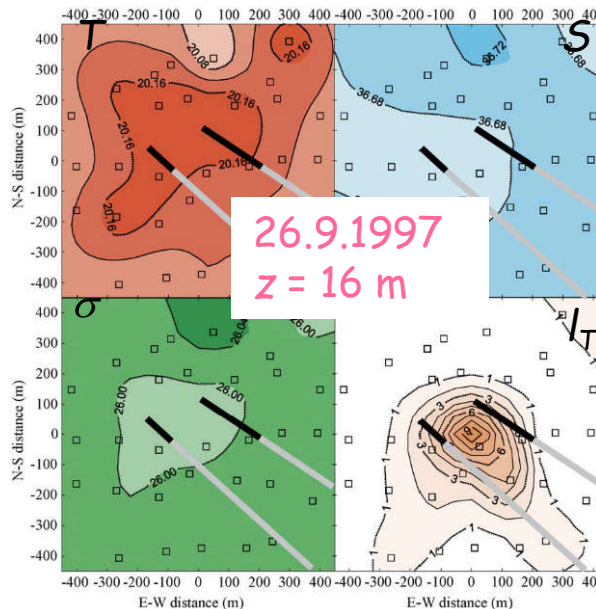
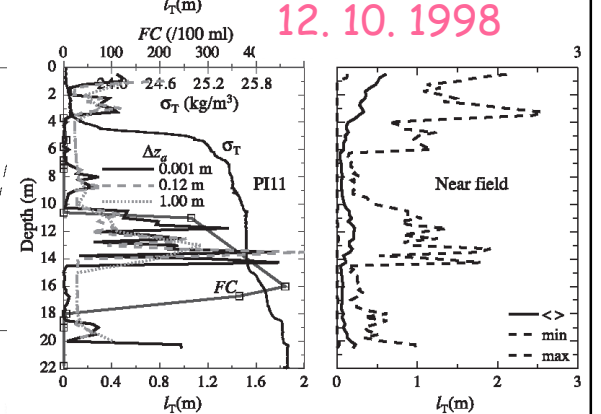
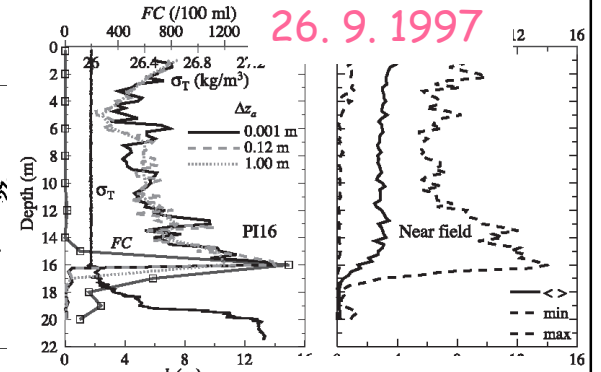
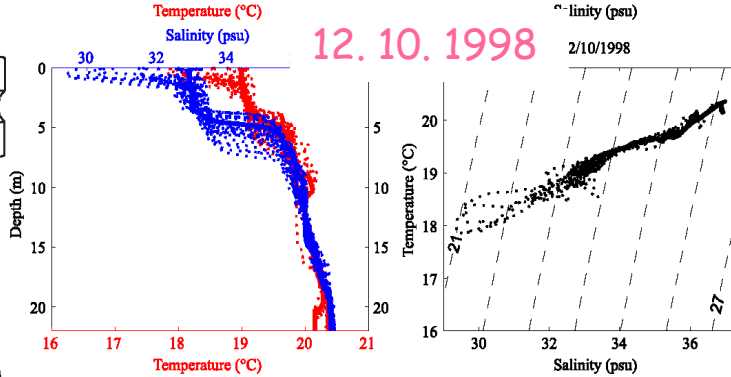
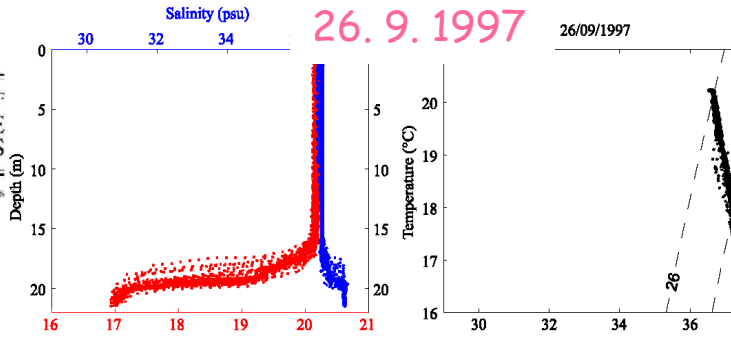
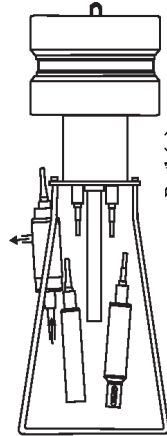
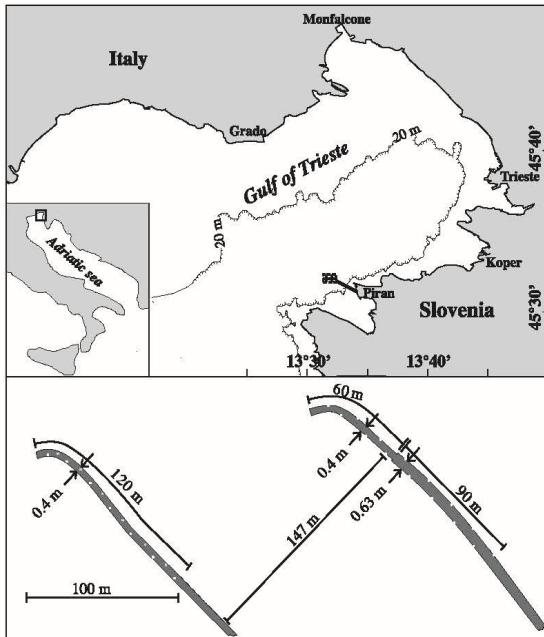
Initial spread of an effluent and the overturning length scale near an underwater source in the northern Adriatic

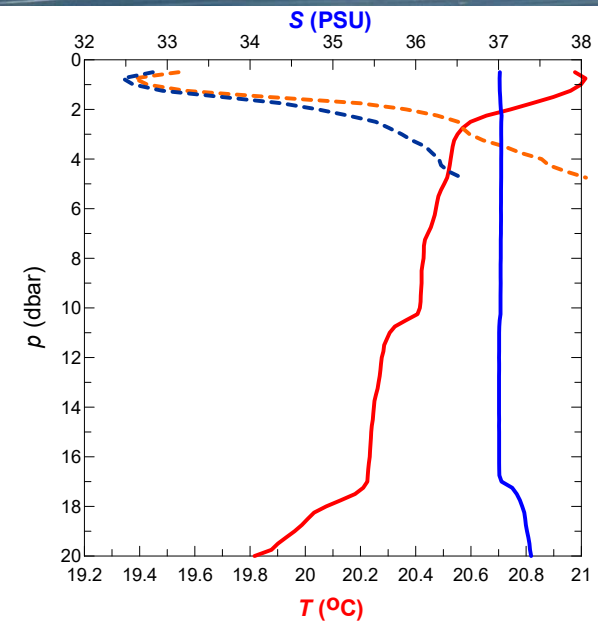
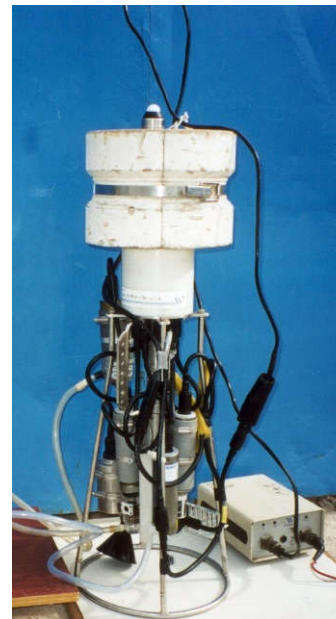
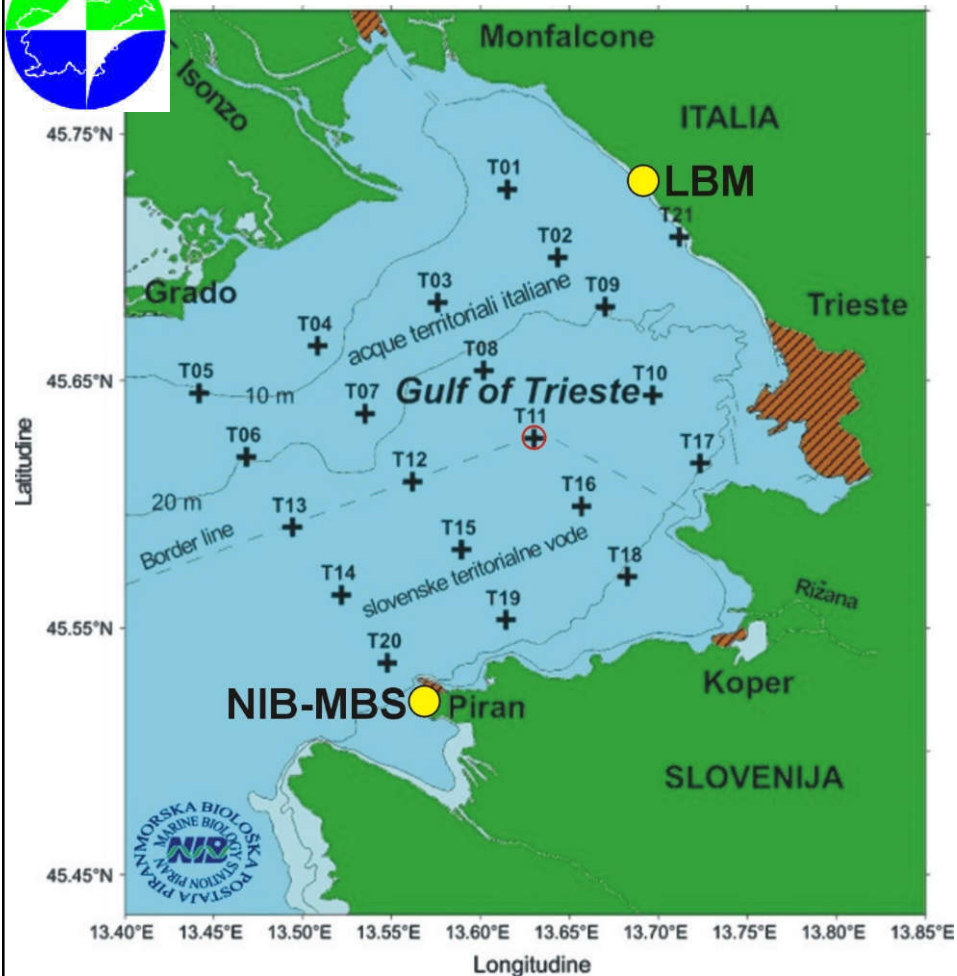
Vlado Malačič*

Marine Biology Station, National Institute of Biology, Piran, Slovenia

Received 21 February 2004; accepted 9 July 2004

Available online 6 October 2004





ADRICOSM
Oktober 2002 - september 2003:
NIB.MBS & LBM: 37 križarjenj
- termohaline lastosti TS zaliva
- podatki za *prognostični model* Jadranskega morja
(INGV Bologna)

V. Malačič, M. Celio, C. Comici



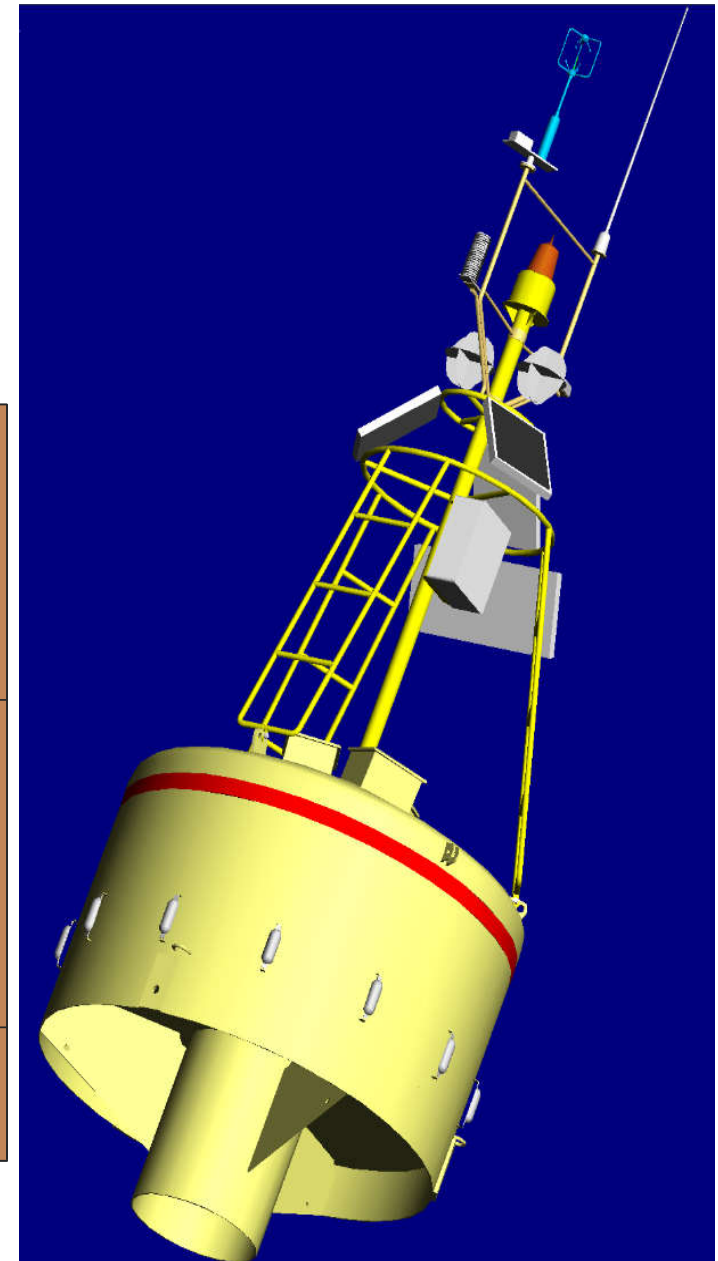
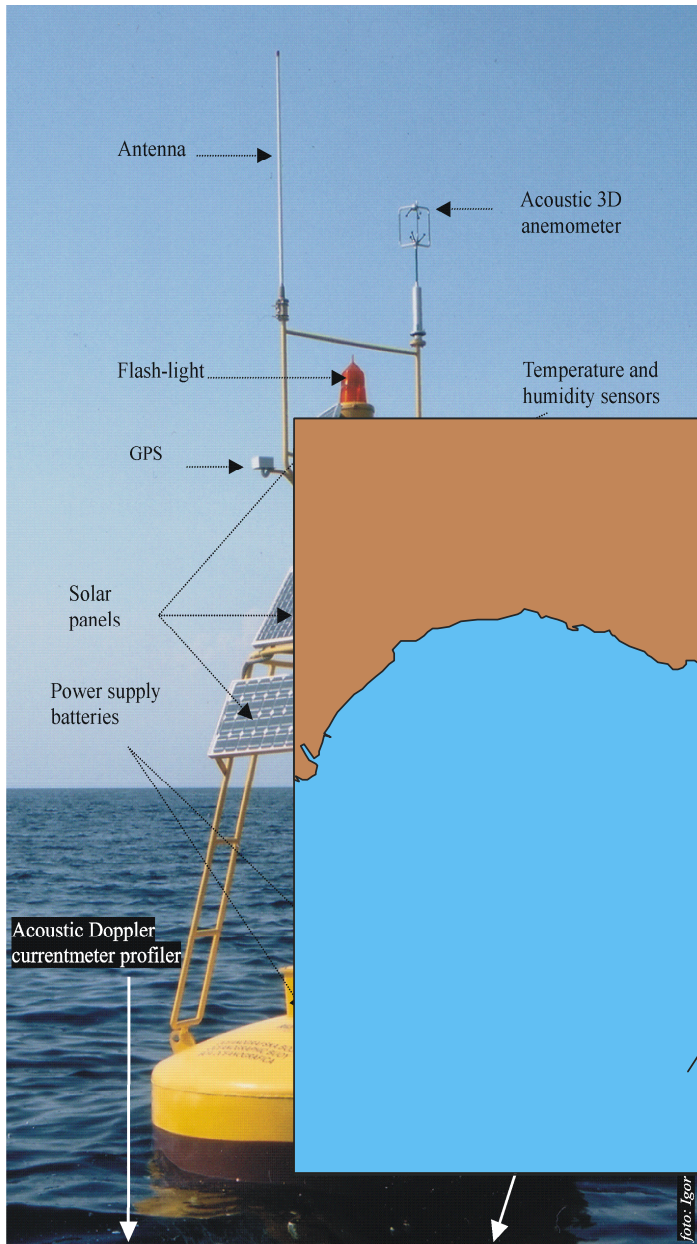
Obalna oceanografska boja Piran (COSP)

o dec. 2001

o sep. 2002- dec. 2006

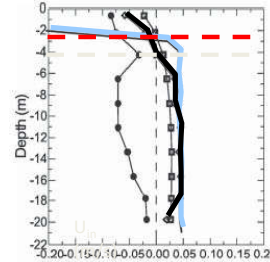
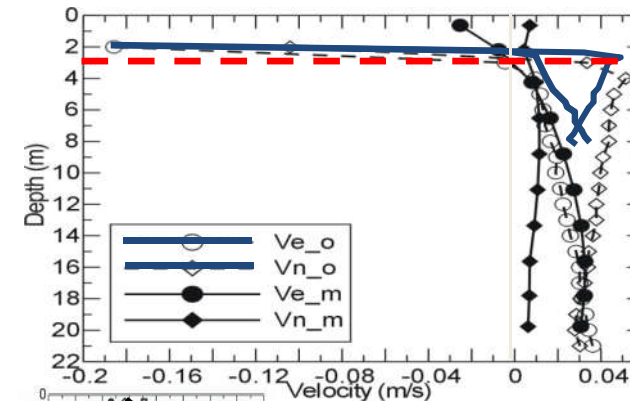
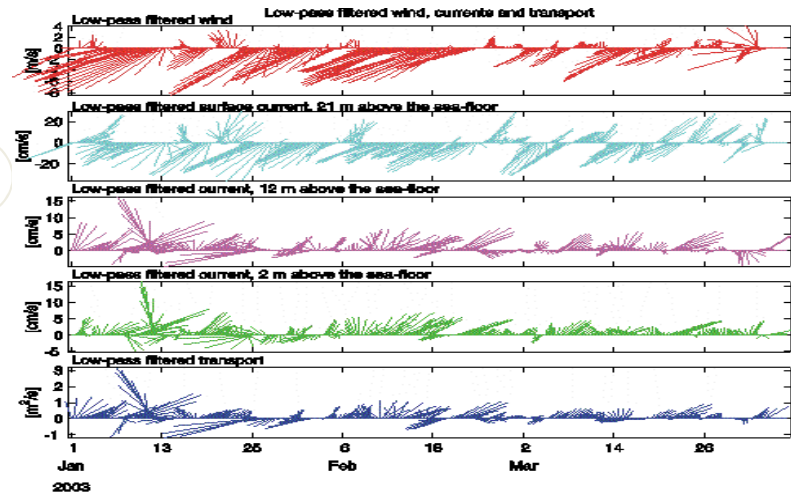
o jan. 2007

o sep. 2008: Vida





Primerjava modelskih rezultatov cirkulacije z meritvami morskih tokov



5-15 Jan 2003

$$\langle U_w \rangle = 8.9 \pm 6.0 \text{ m/s} \Rightarrow$$

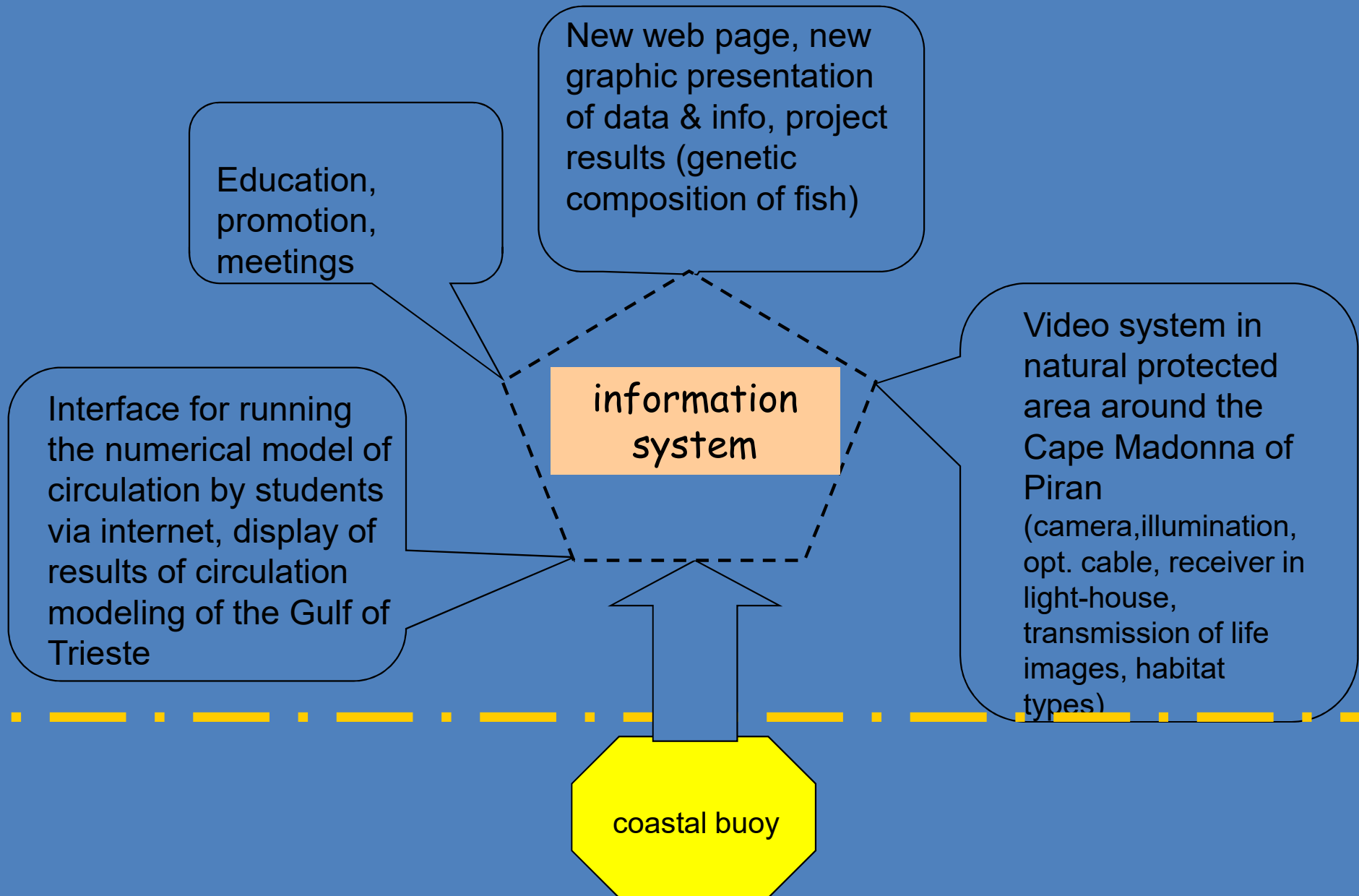
$$\tau = 1.36 \cdot 10^{-4} \text{ m}^2/\text{s}^2 = 8.7 \cdot \tau_{\text{mod}}$$

ADRICOSM
project
model
NAPOM



Information System About the state of Marine Environment in the Gulf of Trieste (ISMO)

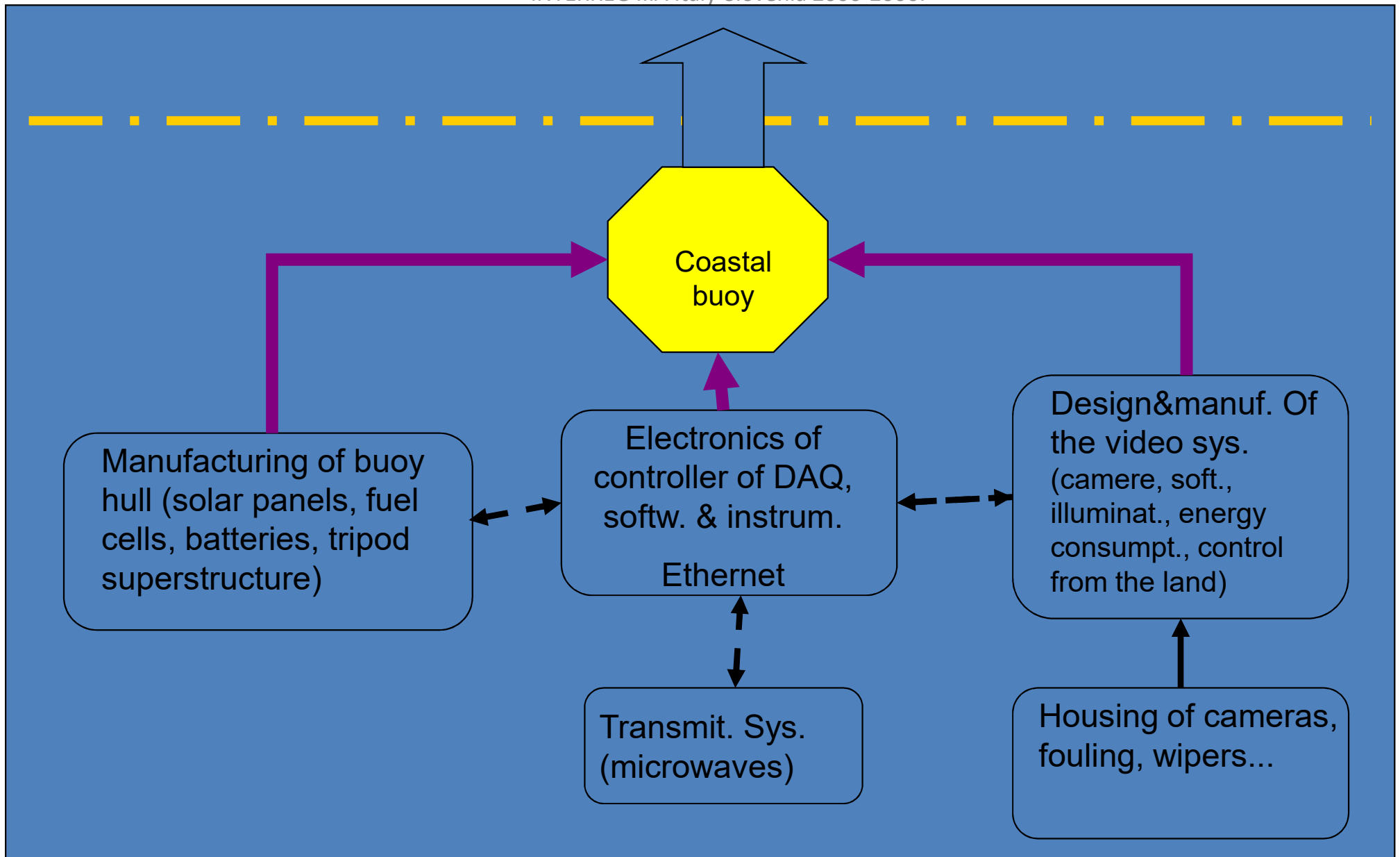
INTERREG IIIA Italy-Slovenia 2000-2006:





Information System About the state of Marine Environment in the Gulf of Trieste (ISMO)

INTERREG IIIA Italy-Slovenia 2000-2006:





Znotraj Vide

- Krmilna elektronika
- Gorivna celica na metanol
- Tri skupine Li akumulatorjev, LiFePO₄ skupaj 1200 Ah + sončni paneli



Boja Vida



'VIDA'

<http://www.nib.si/mbp/en/oceanographic-data-and-measurements>

SZGG 25 let

- Vida od 2007 (INTERREG project ISMO), before COSP od 2002
- 2.5 m diameter, 5 m višina, masa 2,5 tone, iz nerjaveče pločevine. Tritočkovno sidrana z betonskimi bloki

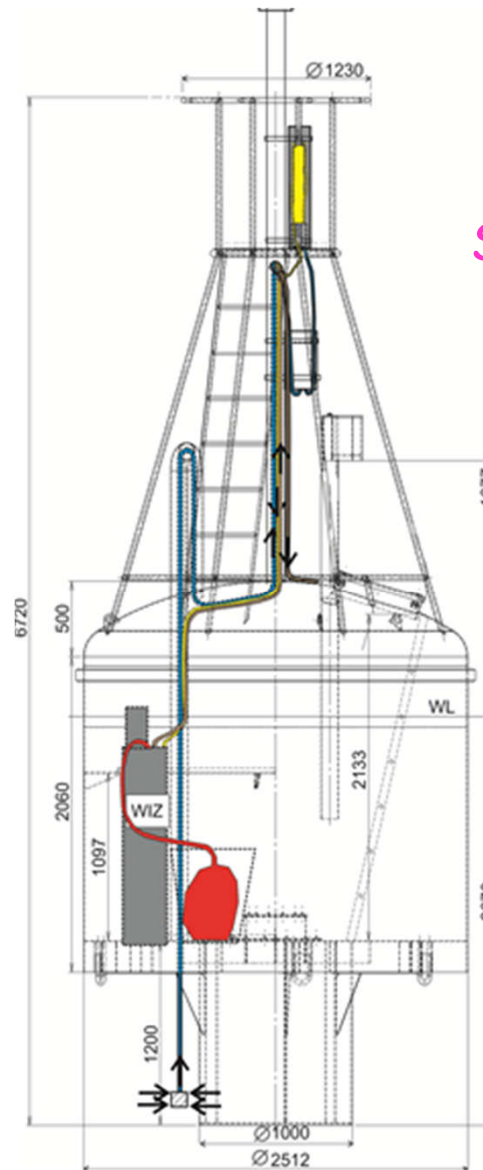
| Proizvajalec, instrument | Količina | Višina nad/pod gladino (m) | Perioda vzorčenja (s) | Število meritev / časovno enoto | Kontrola kvalitete ¹ |
|--|-----------------------------|----------------------------|-----------------------|---|---------------------------------|
| VAISALA, HMP 45A | zračna temperatura in vlaga | 5,0 | 10 | 6 / minuto | DA |
| Gill Instruments, WindMaster Pro Ultrasonic Anemometer | Hitrost in smer vetra | 5,0 | 0,1 | 10 / sekundo | DA |
| Xsens Technologies, MTI XSENS KOMPAS | 3D kompas | 5,0 | 0,1 | 10 / sekundo | NE |
| LICOR, LI-190SL-50 | PAR | 4,4 | 0,23 | 4,26 / sekundo | NE |
| SeaBird, SeaBird 16plus SEACAT | Slanost in temperatura | -2,5 ± 0,2 | 300 | 1 / 5 minut | NE |
| Wet labs, ECO Chlorophyll Fluorometer Chlorophyll-a (FL-CHL) | koncentracija klorofila | -2,0 ± 0,2 | 300 | 1 / 5 minut | NE |
| AANDERAA DATA INSTRUMENTS, Oxygen optode 4835 | kisik | -22,5 ± 0,5 | 60 | 1 / minuto | NE |
| Nortek, Akustični tokomer AWAC 600kHz z NIP | Tokovi | -2,5 ± 0,5 | 1 | 600 v prvih 10 minutah polurnega intervala | NE |
| Nortek, Akustični tokomer AWAC 600kHz z NIP | Valovi | -22,5 ± 0,5 | 1 | 1024 v naslednjih 1024 sekundah polurnega intervala | NE |
| Nortek, Akustični tokomer AWAC 600kHz z NIP | Temperatura | -22,5 ± 0,5 | 1 | 600 v prvih 10 minutah polurnega intervala | NE |

Komunikacija z Vido

- GSM
- Mikrovalovni ethernet (.Wi-Fi) link (GHz) na 5,2 km vidni oddaljenosti

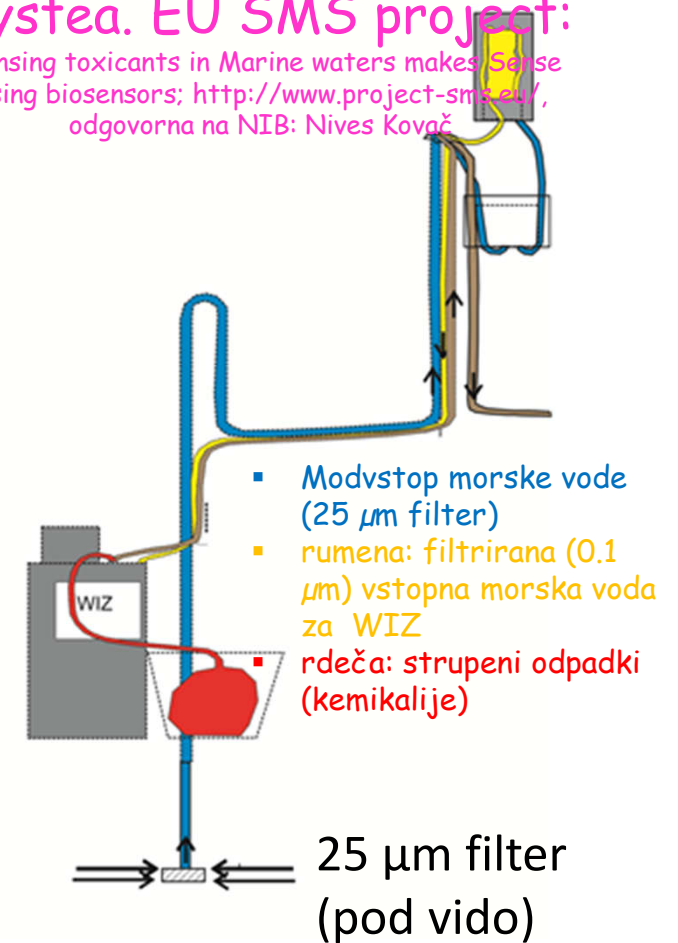


Boja Vida, EU projekt SMS dec. 2013-aug. 2017



Postavitev hidravlične napeljave za WIZ sondo (hranilne snovi) podjetja Systema. EU SMS project:

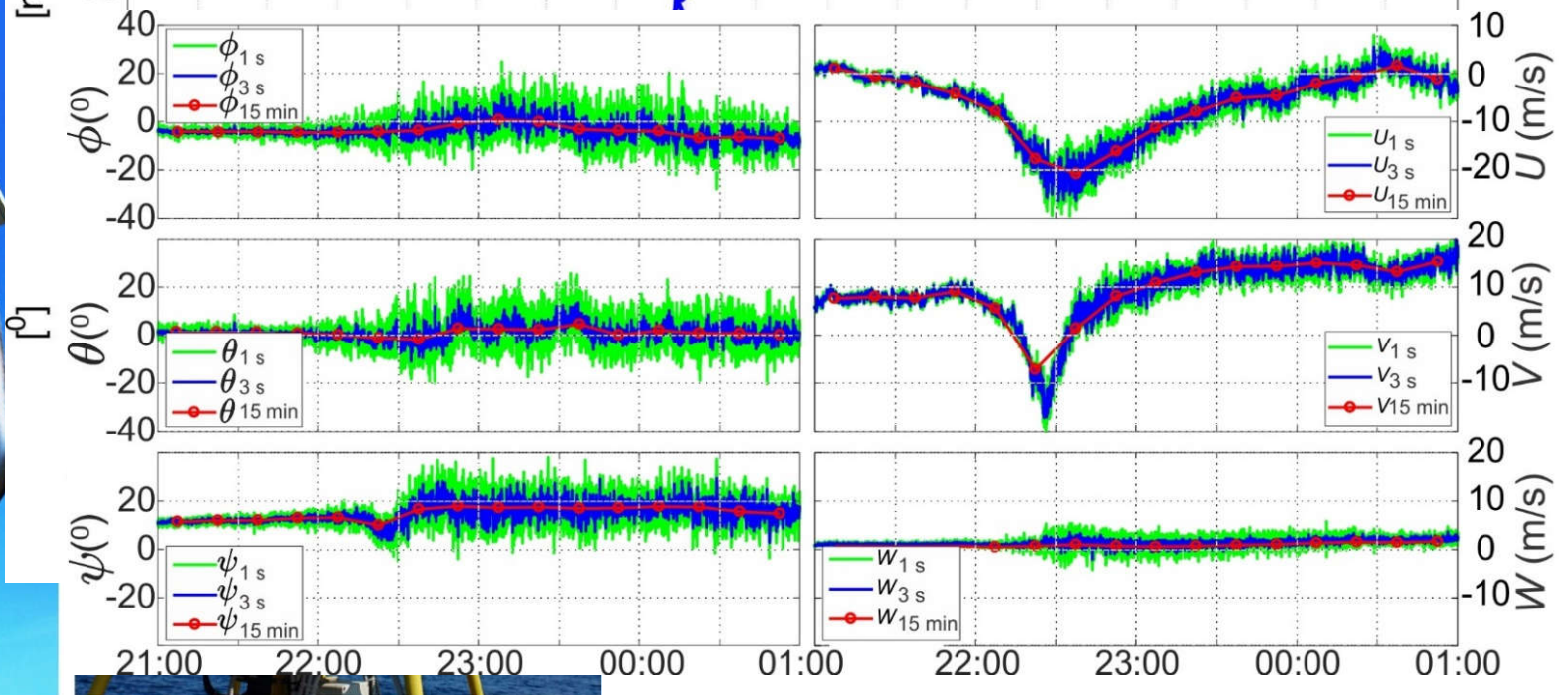
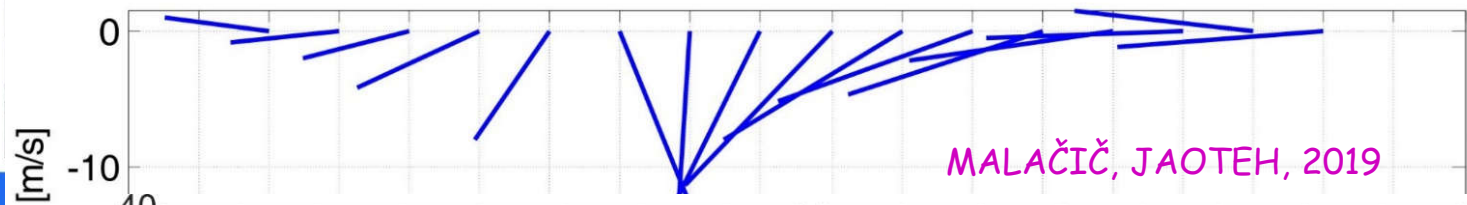
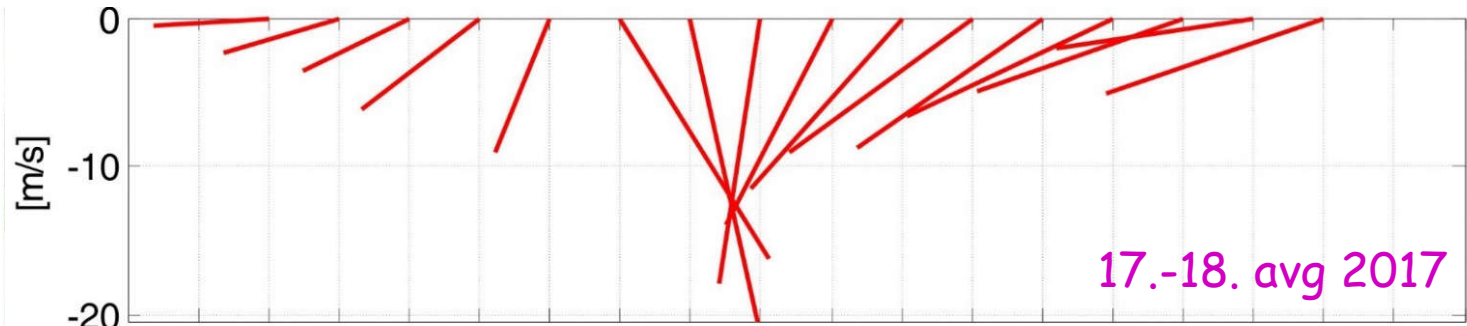
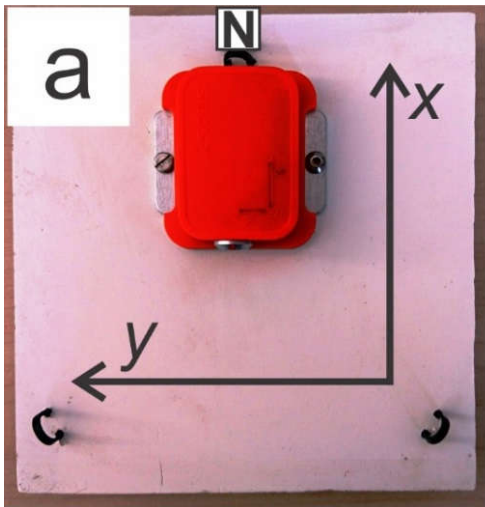
Sensing toxicants in Marine waters makes Sense using biosensors; <http://www.project-smi.eu/>, odgovorna na NIB: Nives Kovač

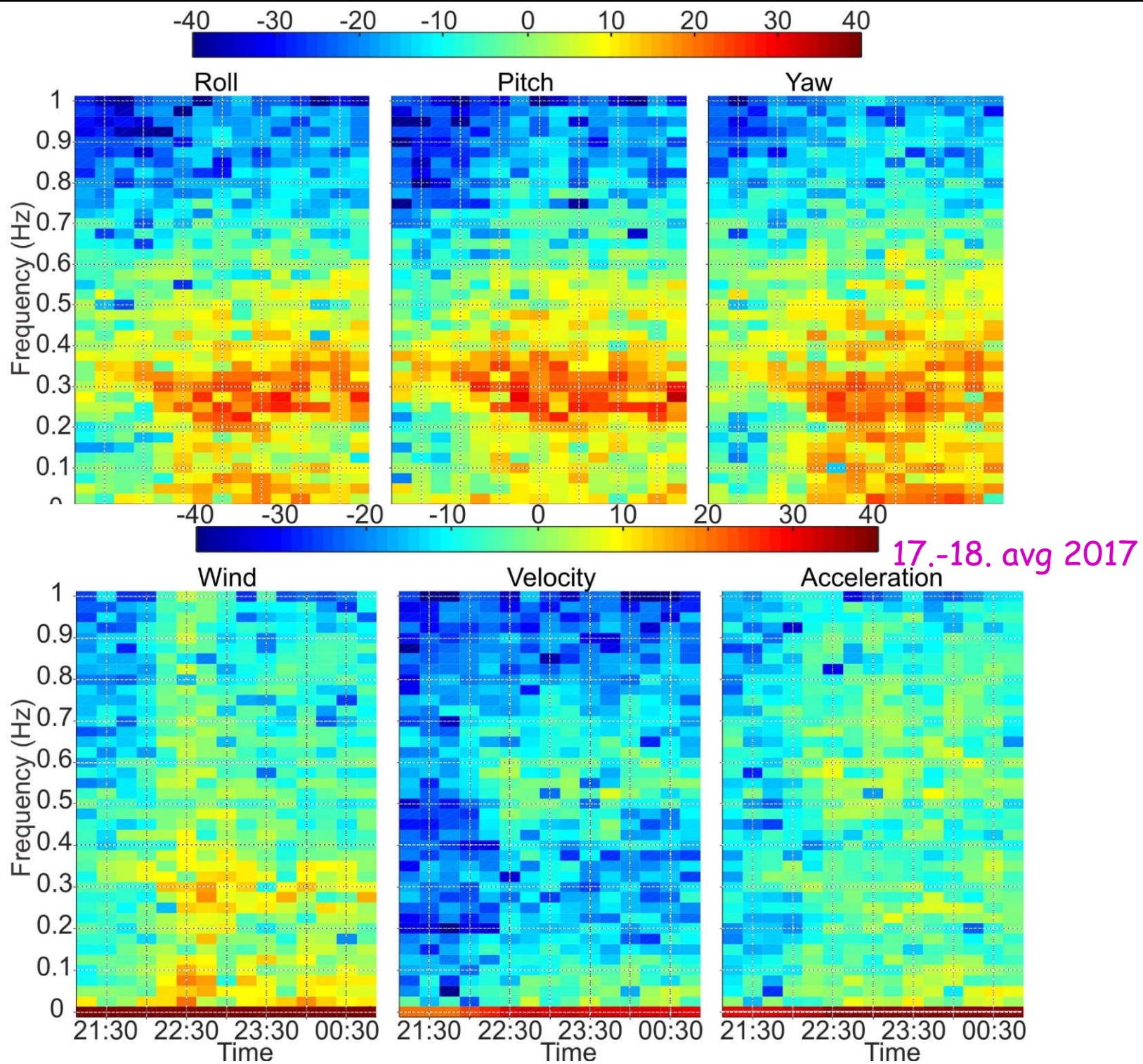




Dela na kompasu na Vidi 17. maja 2017

Analiza in testiranje





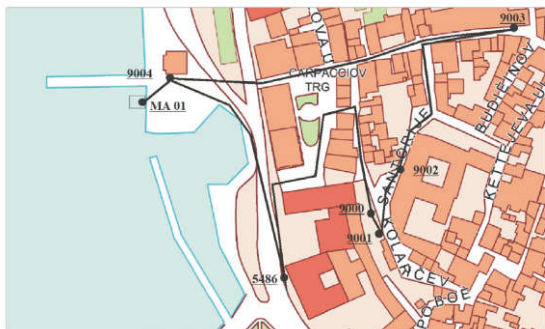


ARSO

Mareografska postaja Koper



Mareografska postaja Koper



Nivelmanska mreža mareografske postaje Koper (vir: DPK-1000 GURS)
Benchmarks of the tide gauge Koper (source: DPK-1000 GURS)

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE

Prognozirano plimovanje morja
Tide tables
2019

Jadransko morje – Koprski zaliv
Adriatic Sea – The Bay of Koper

Izdajatelj / Publisher:

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Agencija RS za okolje / Slovenian Environment Agency

Vojkova 1b, Ljubljana

Spletni naslov: www.arso.gov.si

e-naslov: gp.arso@gov.si

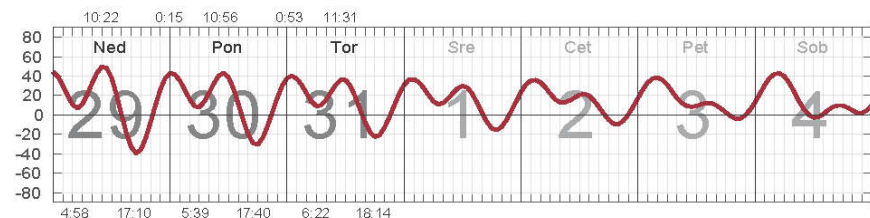
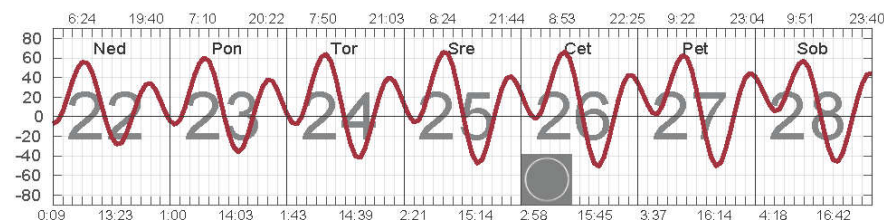
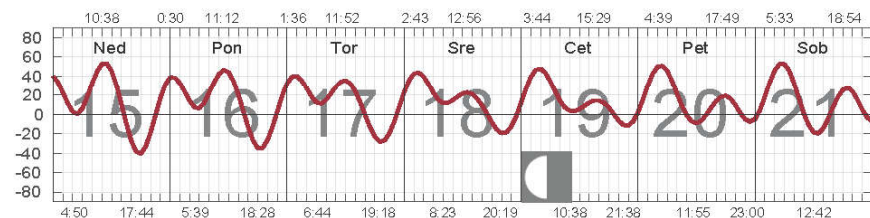
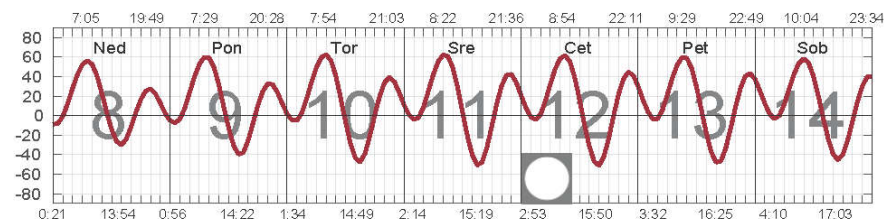
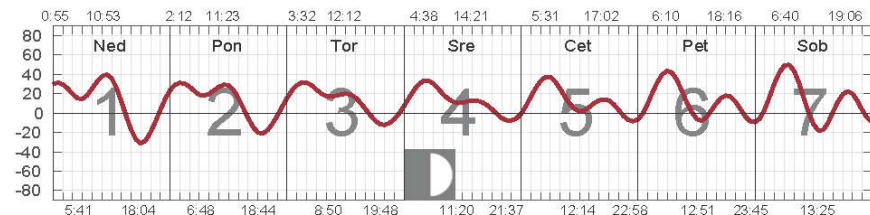
Januar 2019

<http://www.arso/vode/morje>

Avtorji / Authors:

Matjaž Ličer, Anja Fettich, Maja Jeromel

December



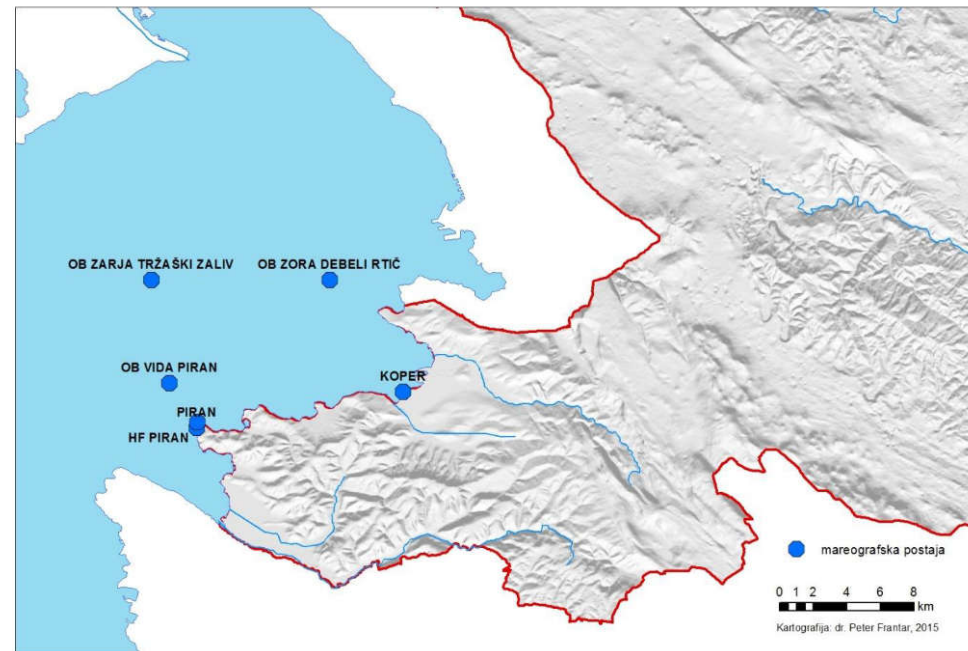


Program hidrološkega monitoringa površinskih voda za obdobje 2016–2020

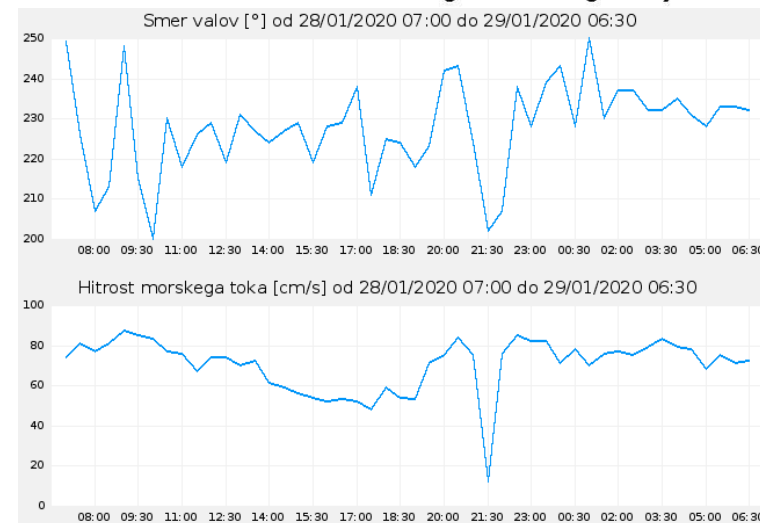
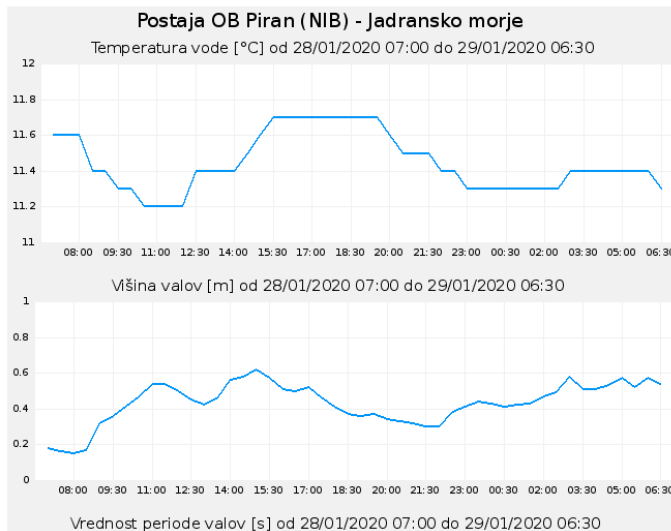


ARSO

Zora in Zarja



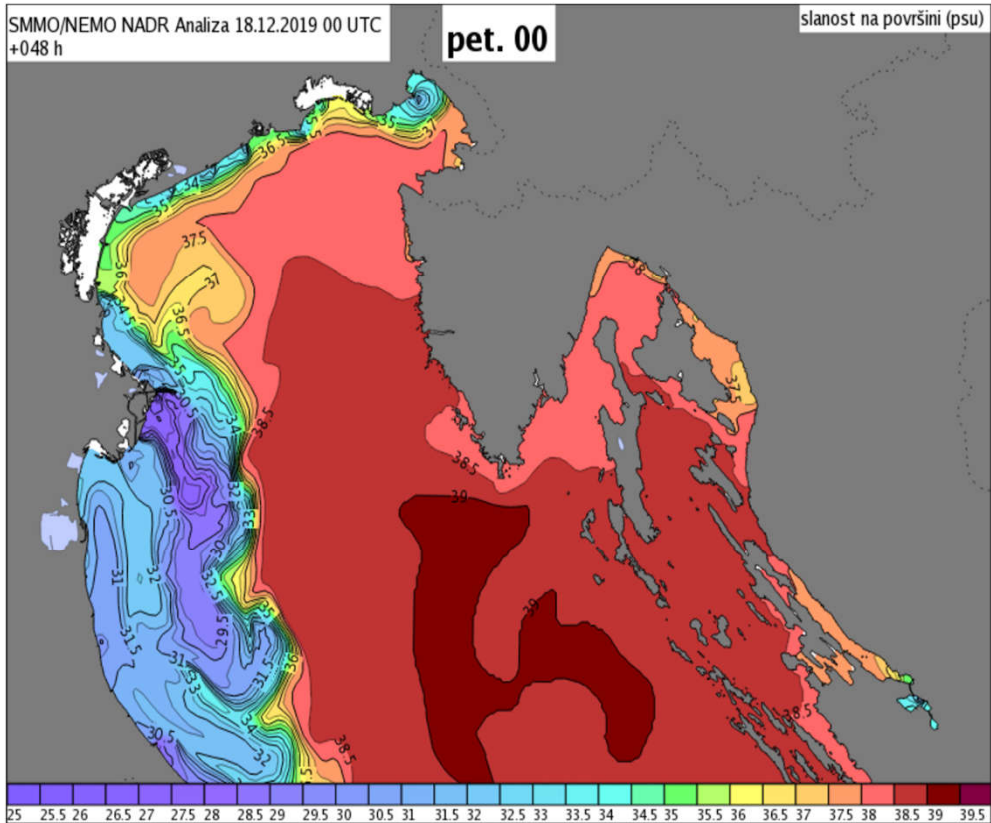
Slika 2: Merilna mesta hidrološkega monitoringa morja



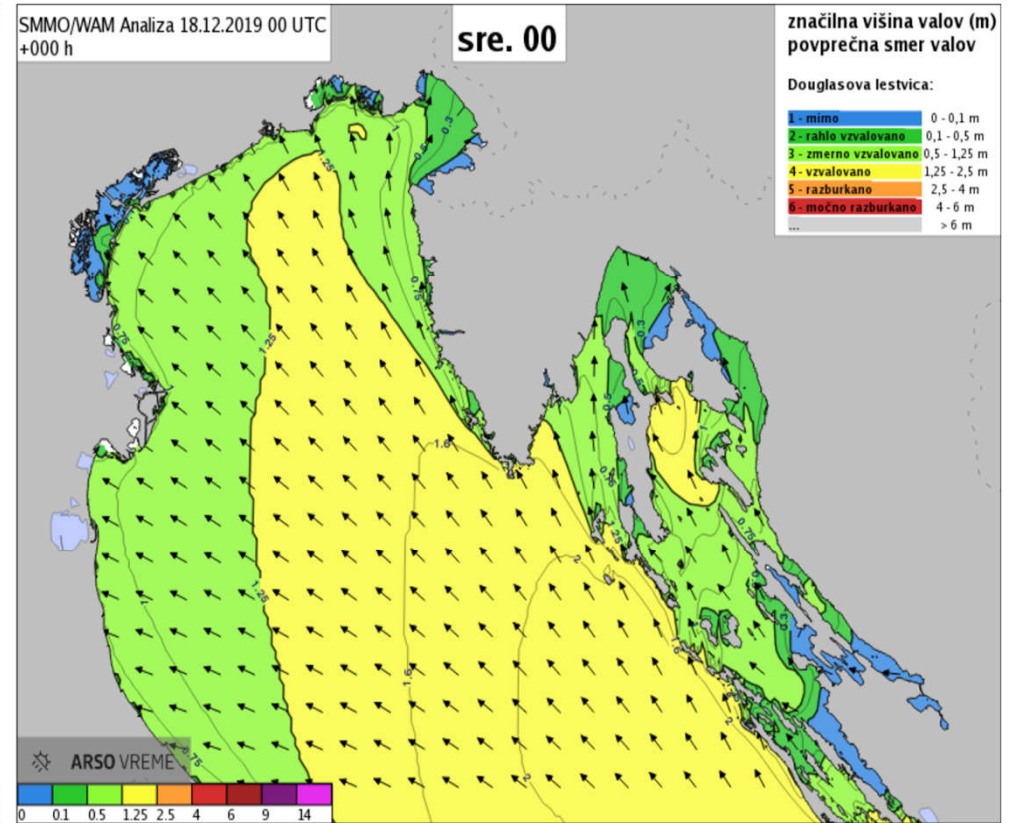


ARSO

Simulacije cirkulacije in valov



NEMO:
S pri gladini 20. dec. 2019



WAM:
pov. valovi 18. dec. 2019

M. Ličer, NIB



Numerično modeliranje cirkulacije FGG, UNI-LJ

XXIII Congress of the International Association for Hydraulic Research
Ottawa, August 21-25 1989

THREE DIMENSIONAL MODELLING OF CURRENTS IN THE NORTHERN ADRIATIC SEA

Rudi Rajar
University of Ljubljana, FAGG, Yugoslavia

1. DESCRIPTION OF PROBLEM

The Adriatic Sea is a relatively closed gulf of the Mediterranean. The Koper bay and Piran bay lie in its northeastern part (SW of Trieste) and are very shallow, the depths being below 20 meters (Fig. 1).

Because of growing industrial and touristic development, the water quality in the whole northern Adriatic, and especially in the two above mentioned bays is seriously endangered.

To simulate different existing or planned situations of diffusion of pollutants, a hydrodynamic mathematical model for simulation of current velocities was made. Later on water-quality model will be made and by combined model it will be possible to find ecologically and economically optimal solutions.

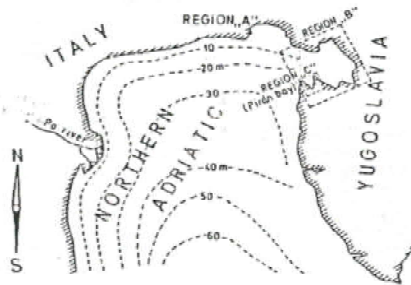
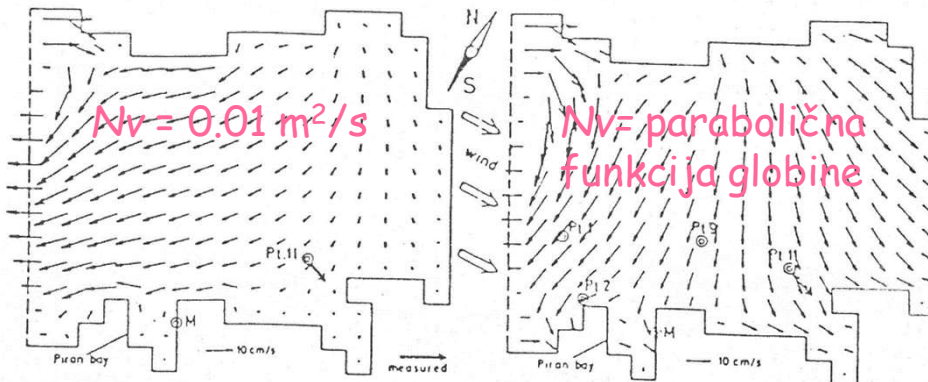


Fig. 1 Situation



OCEANOLOGICA ACTA · VOL. 23 - N° 7

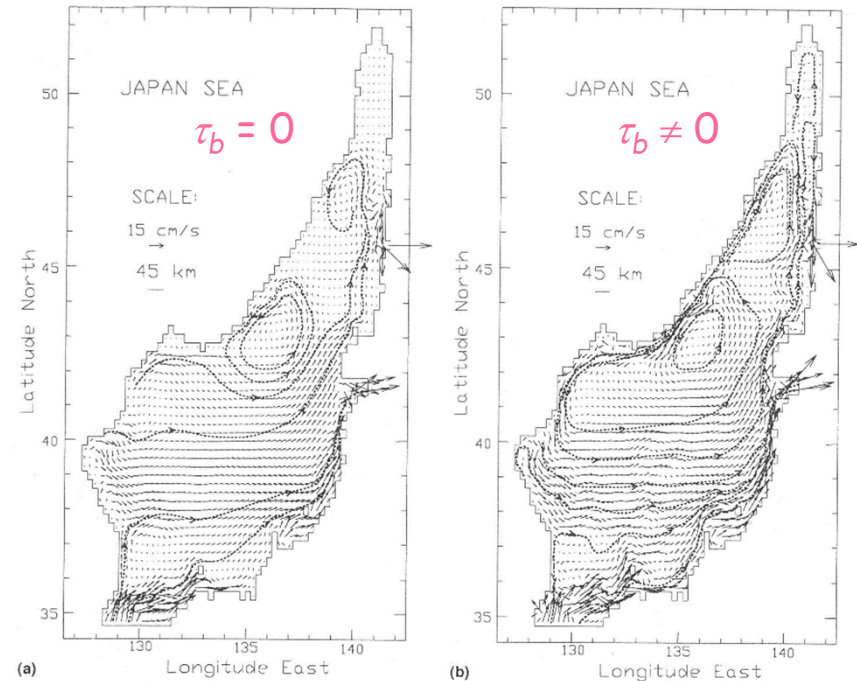


Modelling of circulation and dispersion of radioactive pollutants in the Japan Sea

Matjaž ČETINA^a, Rudi RAJAR^{**}, Pavel POVINEC^b

^a Faculty of Civil and Geodetic Engineering, University of Ljubljana, Hajdrihova 28, 1000 Ljubljana, Slovenia

^b International Atomic Energy Agency, MEL, Monaco



Tok v pov. plasti (0-10 m),
brez vetra



Numerično modeliranje cirkulacije FGG, UNI-LJ



Transactions on Ecology and the Environment vol 14, © 1997 WIT Press, www.witpress.com, ISSN 1743-3541

Calibration of a 2D mercury transport and fate model of the Gulf of Trieste

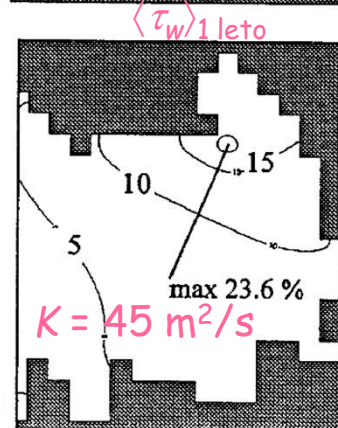
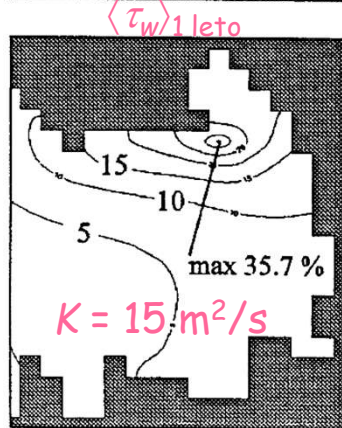
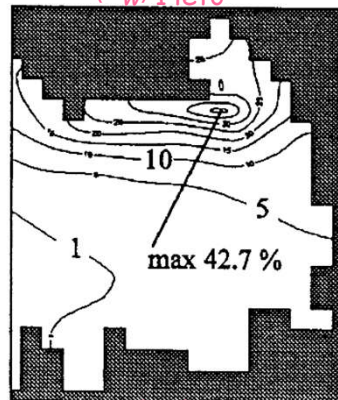
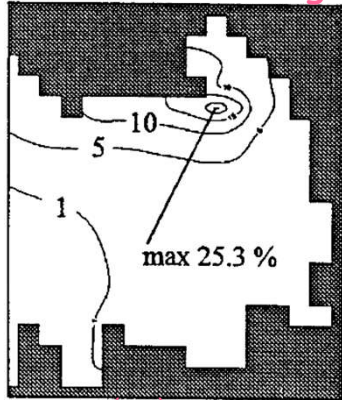
Andrej Sirca & Rudi Rajar

University of Ljubljana, Faculty of Civ. and Geodetic Engineering,
Hydraulics Division, Hajdrihova 28, 1000 Ljubljana, Slovenia

EMails: asirca@fagg.uni-lj.si, rrajar@fagg.uni-lj.si

1 leto urne homog. τ_w

1997



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journal homepage: www.elsevier.com/locate/envres



2013

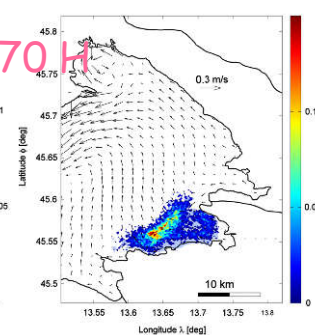
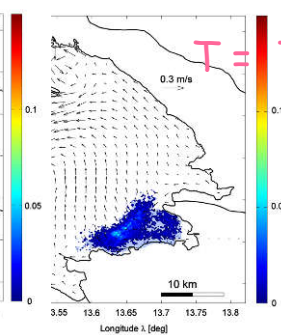
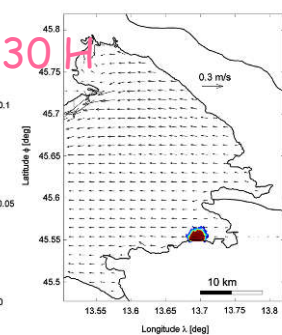
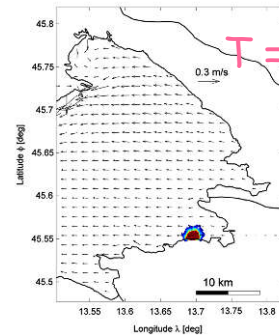
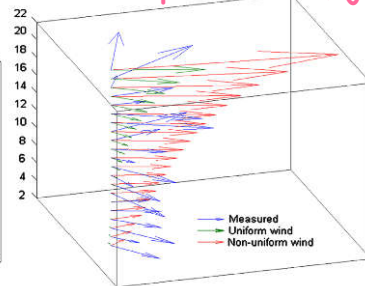
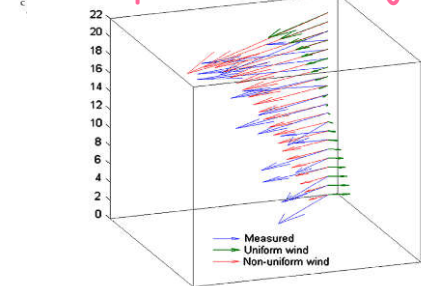
High-resolution pollutant dispersion modelling in contaminated coastal sites



Vanja Ramšak^a, Vlado Malačič^b, Matjaž Ličer^b, Jože Kotnik^c, Milena Horvat^c, Dušan Žagar^{a,*}

Tok pod Vido, burja

Tok pod Vido, jugo



Izhlapevanje nafte

Brez izhlapevanja

Izhlapevanje nafte

Brez izhlapevanja



NIB+OGS+
Dartmouth
(NH, USA)

Plimovanje na Jadranu

Poldnevni valovi: Kelvinov val; ploski kanal

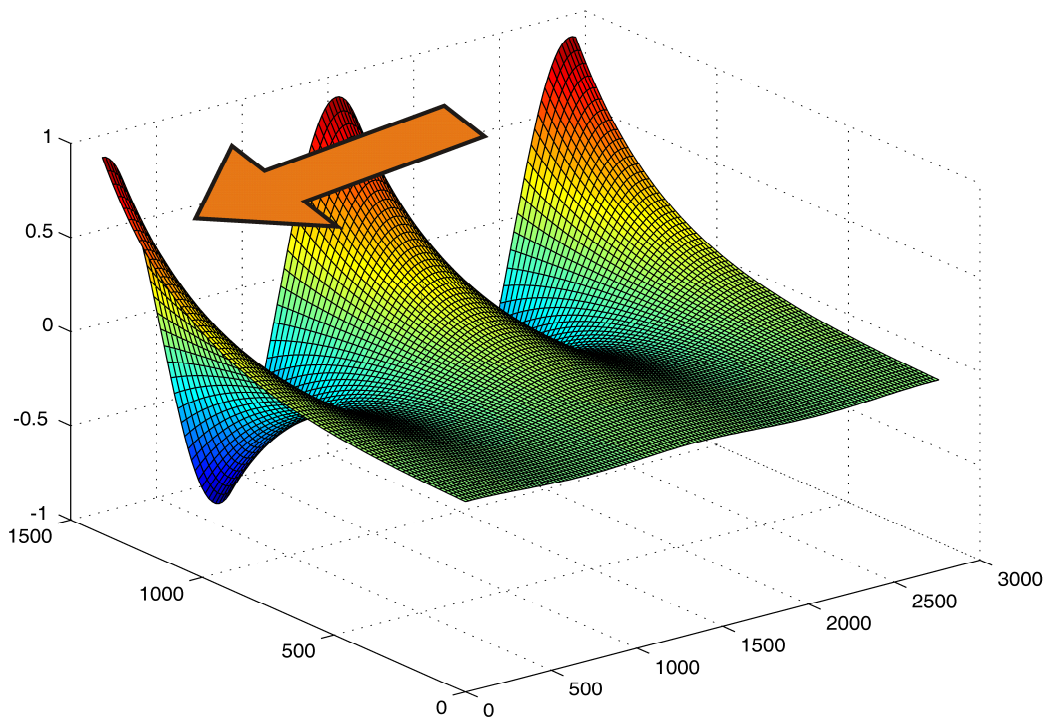
$$V = V_{10}(y - ct)\exp(x/R) + V_{20}(y + ct)\exp(-x/R), \quad \eta = \sqrt{\frac{H}{g}}V_{10}(y - ct)\exp(x/R) - \sqrt{\frac{H}{g}}V_{20}(y + ct)\exp(-x/R).$$

$$V_1 = V_{10} \cos(ly - ct)\exp(x/R); V_2 = V_{20} \cos(ly + ct)\exp(-x/R)$$

Val, ki potuje v smeri negativne osi y :

$$\eta = A_0 \cos(ly + ct)\exp\left(\frac{L - x}{R}\right)$$

$$v = A_0 \sqrt{\frac{g}{H}} \cos(ly + ct)\exp\left(\frac{L - x}{R}\right)$$



V kanalu, ki se razteza vzdolž
vznoorednika od $x = 0$ do $x = L$

$$\eta = A_0 e^{-x/R} \cos$$

$$v = \frac{g}{fR} \left[-A_0 e^{-x/R} \right]$$

Za i

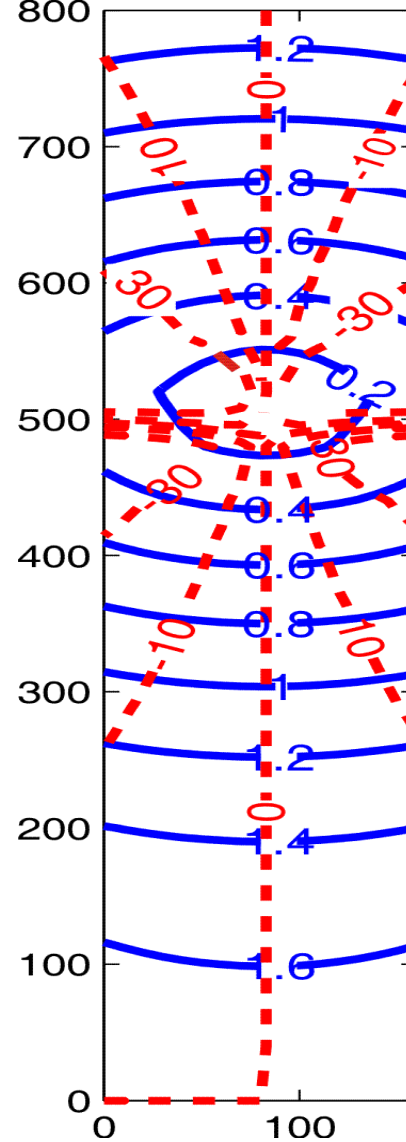
$$\eta = Z_0$$

$$Z_0 = \sqrt{A_0^2 e^{-2x/R}}$$

$$V_0 = \frac{g}{fR} \sqrt{A_0^2 e^{-2x/R}}$$

$$\tan \varphi_Z = -\frac{1}{A}$$

$$\tan \varphi_V = -\frac{1}{A}$$



$$-\omega t + \phi)$$

$$\cos(ly - \omega t + \phi)$$

lanje:

$$\cos(\omega t - \phi_V)$$

$$\frac{R \cos(2ly + \phi)}{-L/R \cos(ly - \phi)}$$

$$l + \phi)$$

$$+ \phi)$$

$$y + \phi)$$

$$y + \phi)$$

Malačič
in sod.
(2000)



Plimovanje na Jadranu

Dnevni valovi: topografsko-gravitacijski val; 'ozek' kanal

$$u=0: \quad fv = g\eta_x; \quad v_t = -g\eta_y; \quad \eta_t + (vH)_y = 0.$$

$$(\eta, v) \propto \exp(-i\omega t): \quad \frac{\omega^2}{g}\eta + (H\eta_y)_y = 0. \quad \eta = \eta_0 \exp(\sigma(y)) \Rightarrow H(\sigma_{yy} + \sigma_y^2) + H_y\sigma_y + \frac{\omega^2}{g} = 0,$$

Blage (,linear.‘) sprem. $\eta(y) \Rightarrow \sigma_{yy} \ll \sigma_y^2: H\sigma_y^2 + H_y\sigma_y + \frac{\omega^2}{g} = 0 \Rightarrow \sigma_y = -\frac{H_y}{2H} \pm \left(\frac{H_y^2}{4H^2} - \frac{\omega^2}{gH} \right)^{1/2} = \sigma_{y1} \pm \sigma_{y2}$

$$\eta_1 \propto e^{-\ln(H/H_0)/2} = (H_0/H)^{1/2}$$

$$H = H_0(1 - ay)^2, \quad H_0 = 571 \text{ m}, \quad a = 1/(935 \text{ km})$$

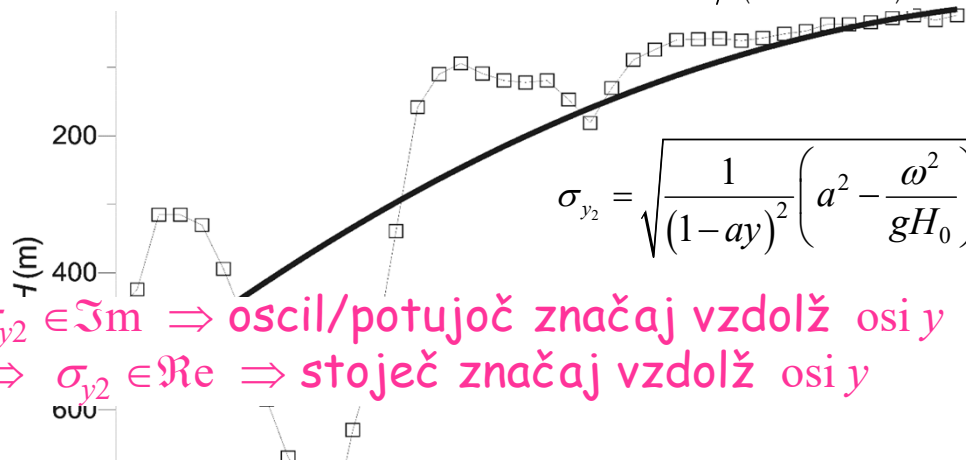
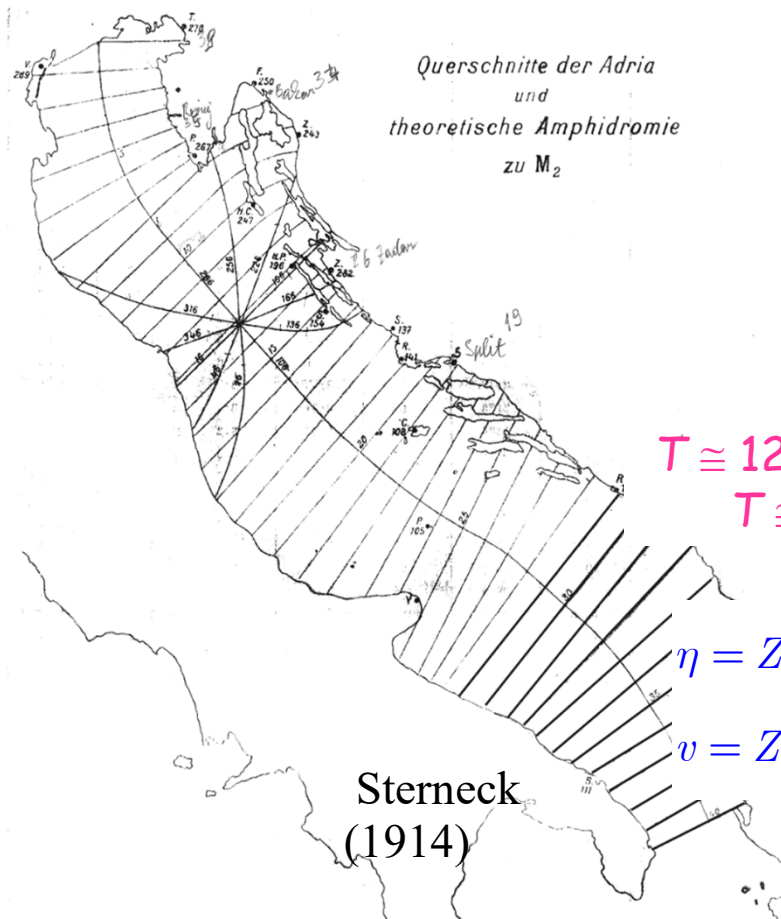
$$\sigma_{y2} = \sqrt{\frac{1}{(1-ay)^2} \left(a^2 - \frac{\omega^2}{gH_0} \right)}$$

$T \cong 12 \text{ h} \Rightarrow \sigma_{y2} \in \Im \text{m} \Rightarrow \text{oscil/potujoč značaj vzdolž osi } y$
 $T \cong 24 \text{ h} \Rightarrow \sigma_{y2} \in \Re \text{e} \Rightarrow \text{stoječ značaj vzdolž osi } y$

$$\eta = Z_0 \Re \left\{ e^{-i\omega t} e^{-ik(y)x} e^{\sigma(y)} \right\} = Z_0 (1 - ay)^{-1 + \sqrt{1 - \omega^2/(ga^2H_0)}} \cos[\omega t + k(y)x]$$

$$v = Z_0 a \frac{g}{\omega} (1 - ay)^{-2 + \sqrt{1 - \omega^2/(ga^2H_0)}} \left(1 - \sqrt{1 - \omega^2/(ga^2H_0)} \right) \sin[\omega t + k(y)x].$$

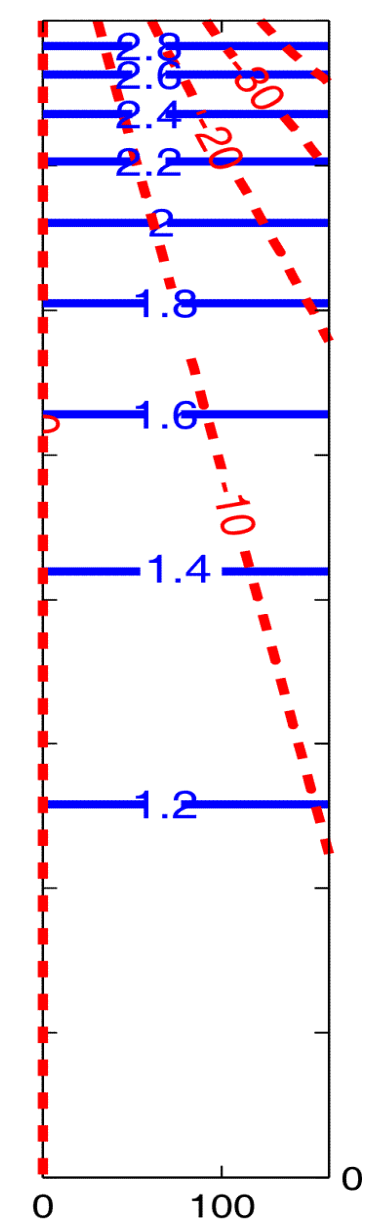
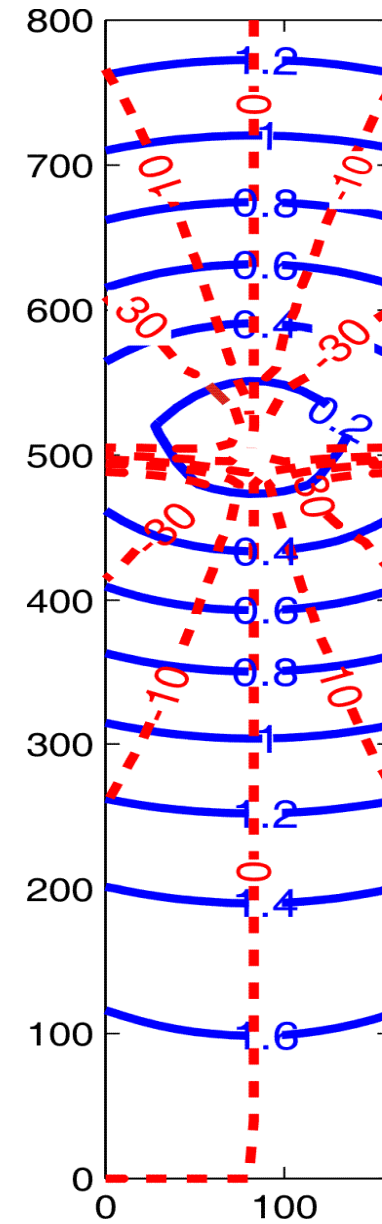
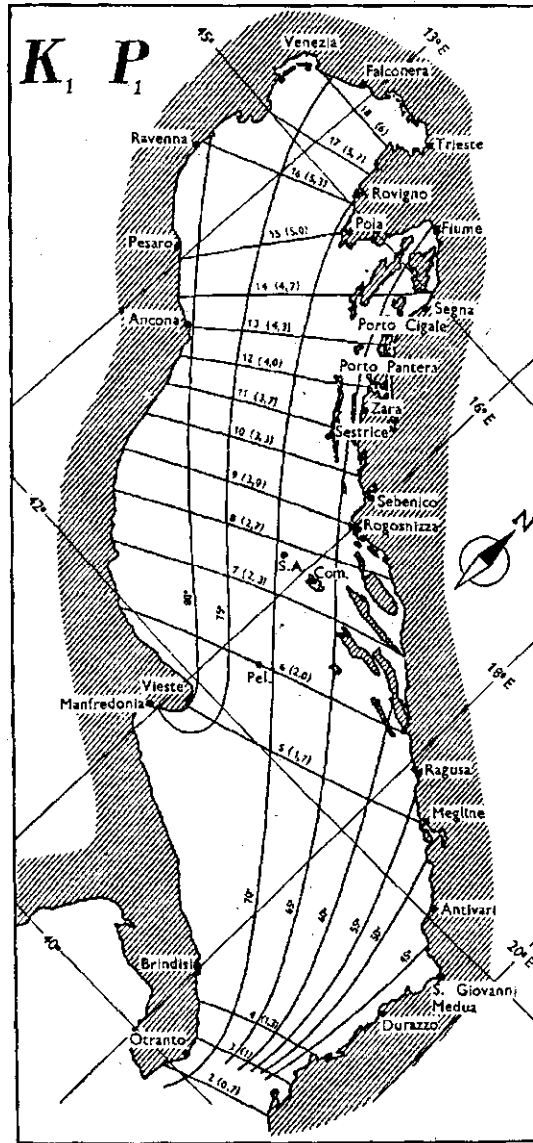
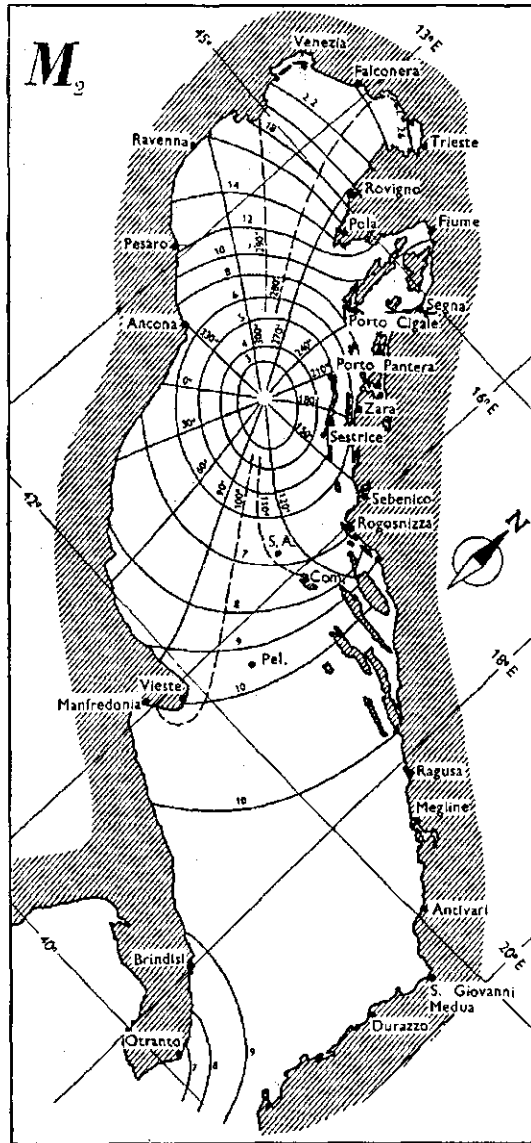
Malačić, Viezzoli
& Cushman-Roisin
(2000)





Plimovanje na Jadranu

Primerjava analitičnih modelov z meritvami

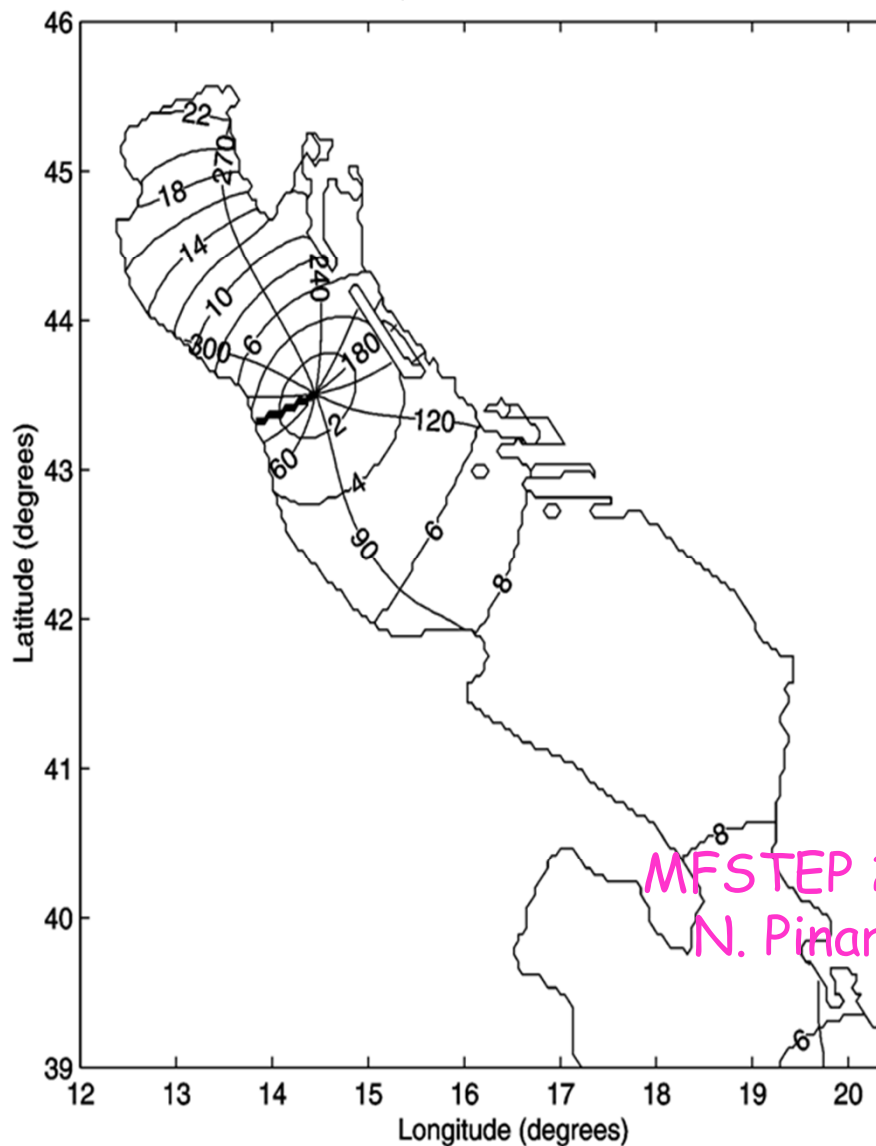


SZGG 25 let

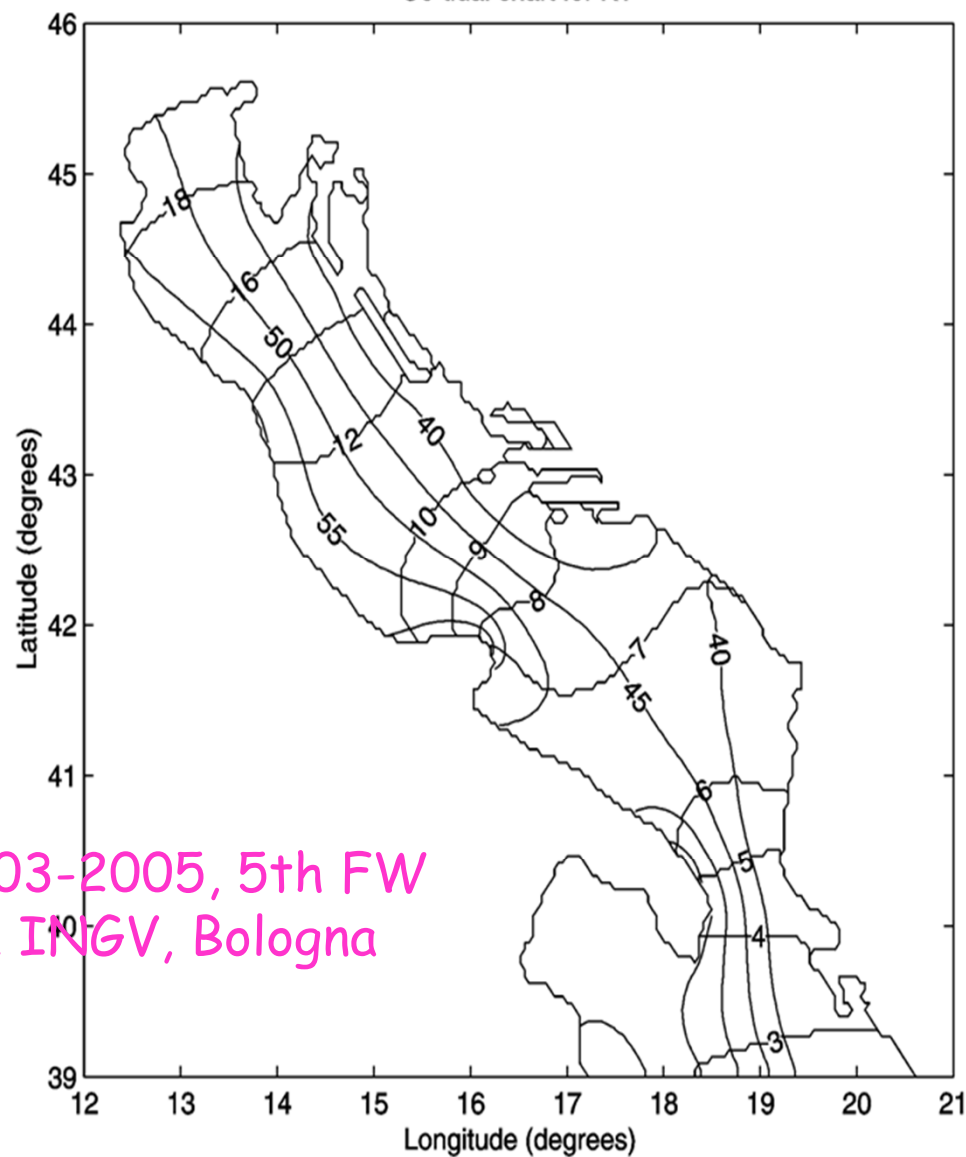


Numerično modeliranje plimovanja

Co-tidal chart for M2



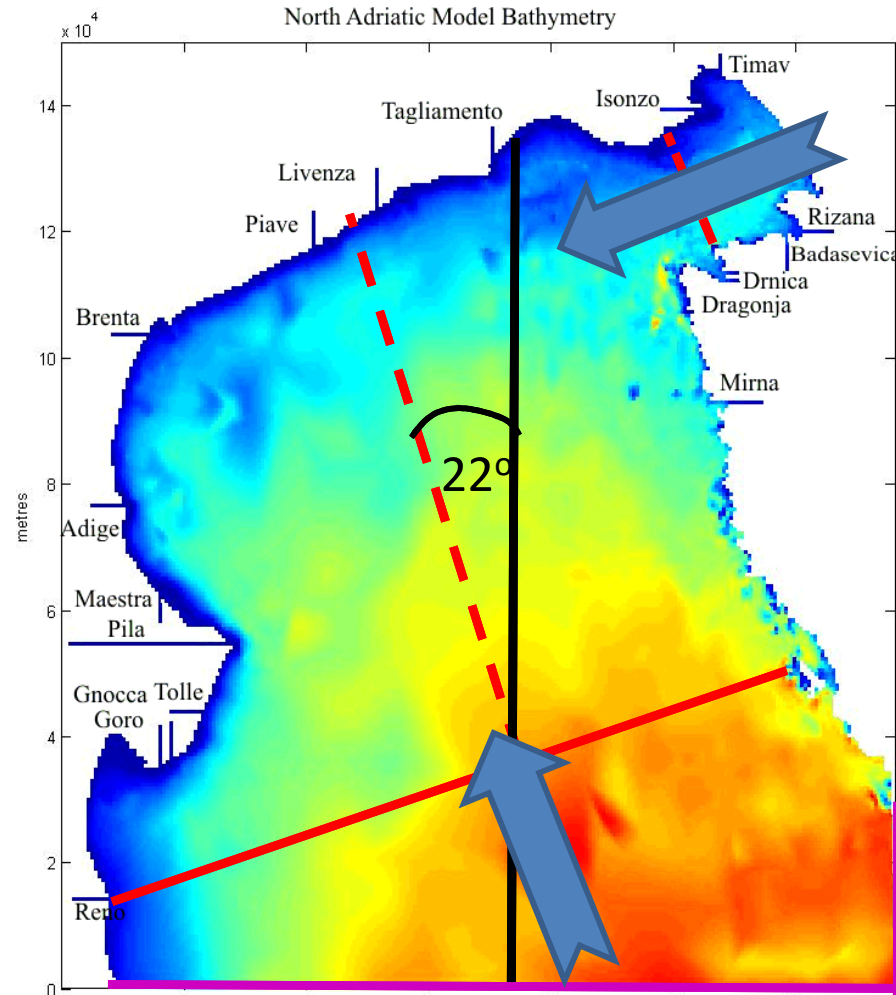
Co-tidal chart for K1



MFSTEP 2003-2005, 5th FW
N. Pinardi, INGV, Bologna



North Adriatic Princeton Ocean Model



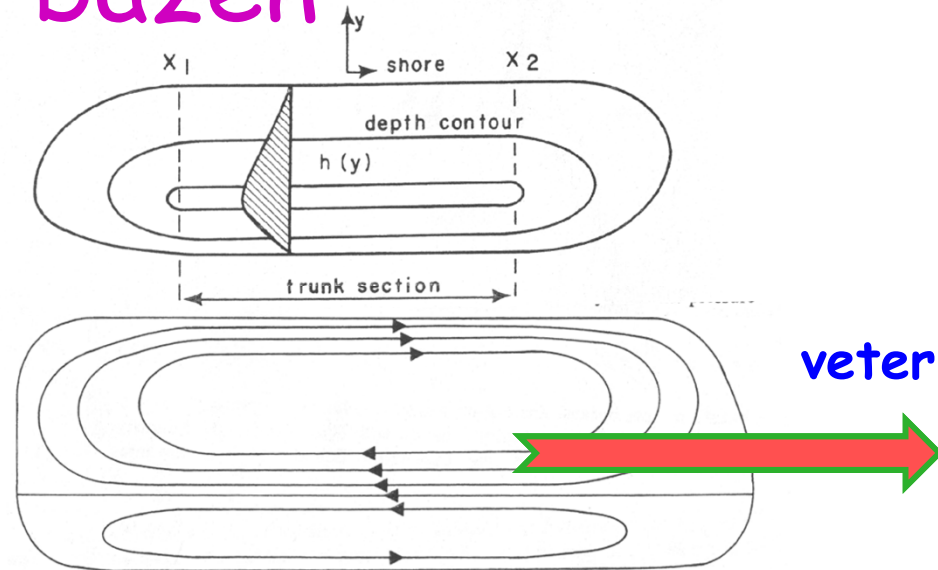
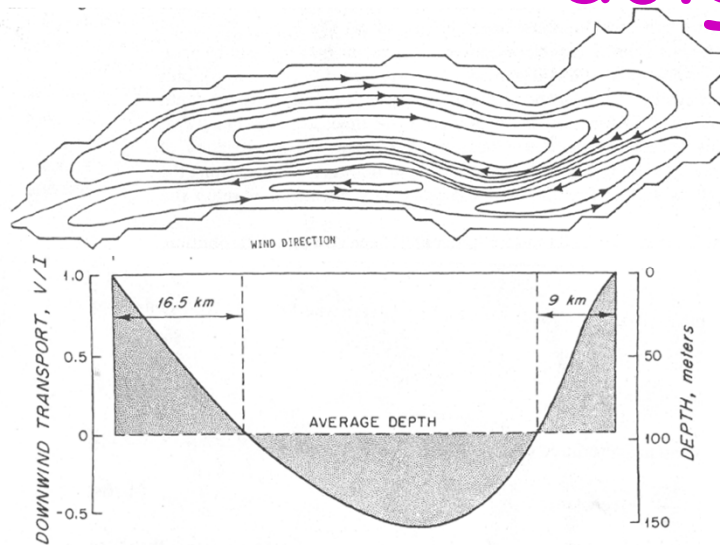
OPERATIVEN od decembra 2009

Teče na ARSO (Ličer M.). Ugnuzden v ADRIPOM, 2017

POM zamenjan z NEMO (CMEMS, Coriolis)



Transport. teorija, dolgi bazen



'za podolgovate bazene': Csanady, G. T. 1982. Reidel comp.

Vzdolžni transport U , prečni V , $H(x,y)$; vet. sila $F = \text{const.}$, Coriolis = 0, trenje = 0:
 $\partial U / \partial t = -g H \partial \eta / \partial x + F$; $\partial V / \partial t = -g H \partial \eta / \partial y$; $\partial U / \partial x + \partial V / \partial y = \partial \eta / \partial t$. Iz mirovanja \Rightarrow

naj: $U = At$; $V = Bt \Rightarrow A = -g H \partial \eta / \partial x + F$; $B = -g H \partial \eta / \partial y$;

$\partial A / \partial x + \partial B / \partial y = 0$. Znotraj bazena transport || isobaram $\Rightarrow B = 0 \Rightarrow \partial \eta / \partial y = 0$. Ni

prečnega transporta: $\int A dy = 0$ preko širine $b \Rightarrow \partial \eta / \partial x = Fb / gS$; $S = \int H dy = 0 \Rightarrow$

$$U = Ft [1 - (Hb/S)] \Rightarrow \int U dt = [1 - (Hb/S)] \int F dt \propto [1 - (H/H_{pov})]$$

$\Rightarrow \langle U \rangle > 0$ or $\langle U \rangle < 0$ odvisno od $H > H_{pov} = S/b$, ali $H < H_{pov}$.

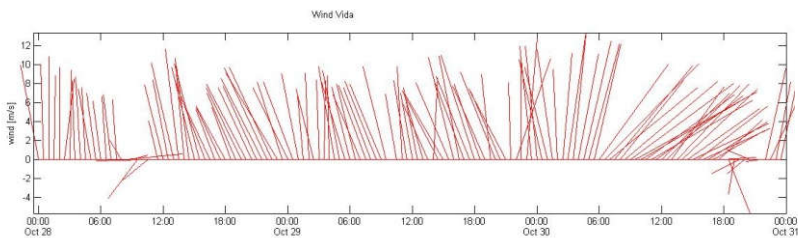
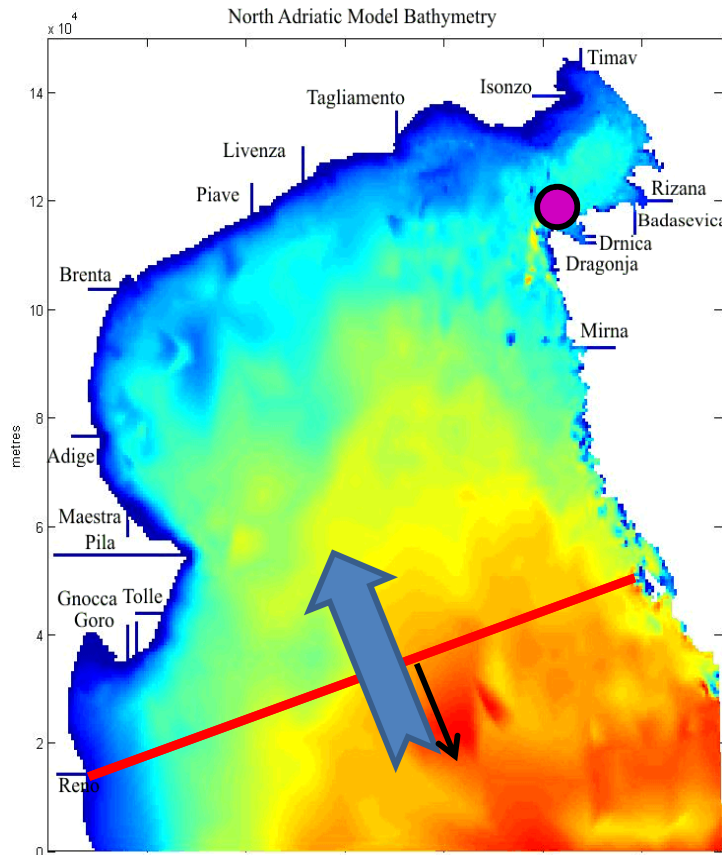
Pri obali (plitko): $\langle U \rangle \uparrow \uparrow V_{\text{vet}}$; osrednji del (globok) $\langle U \rangle \uparrow \downarrow V_{\text{vet}}$.



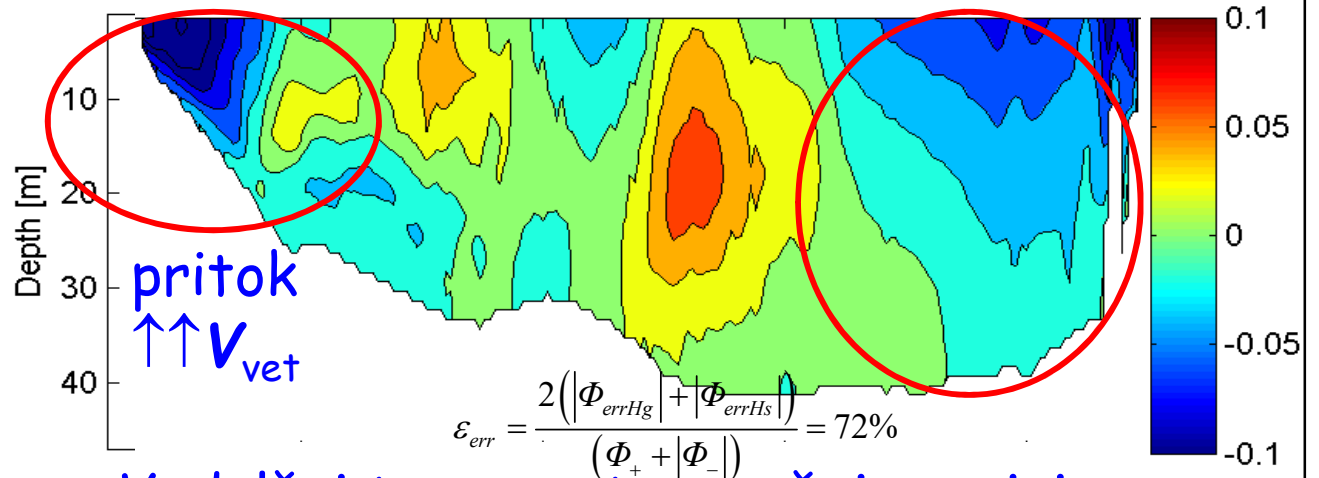
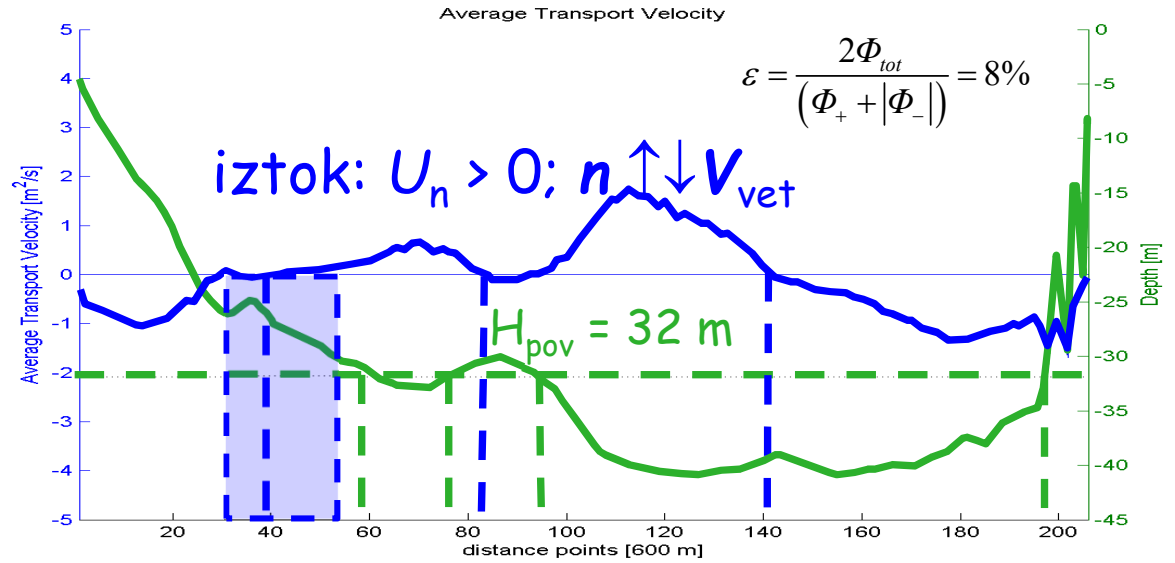
NAPOM - Jugo

Šibka stratifikacija

28-30 okt. 2008



Veter na boji Vidi



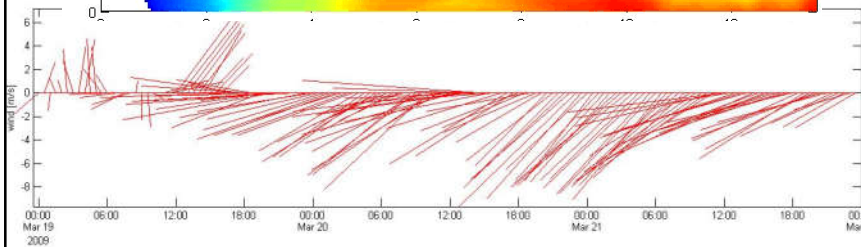
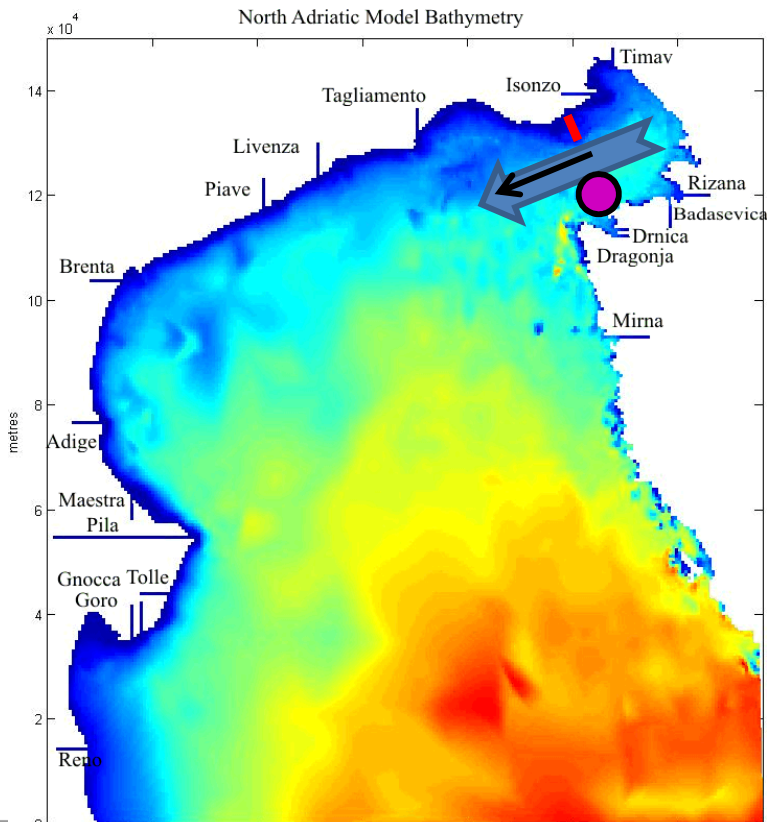
Vzdolžni transport v prečni ravnini



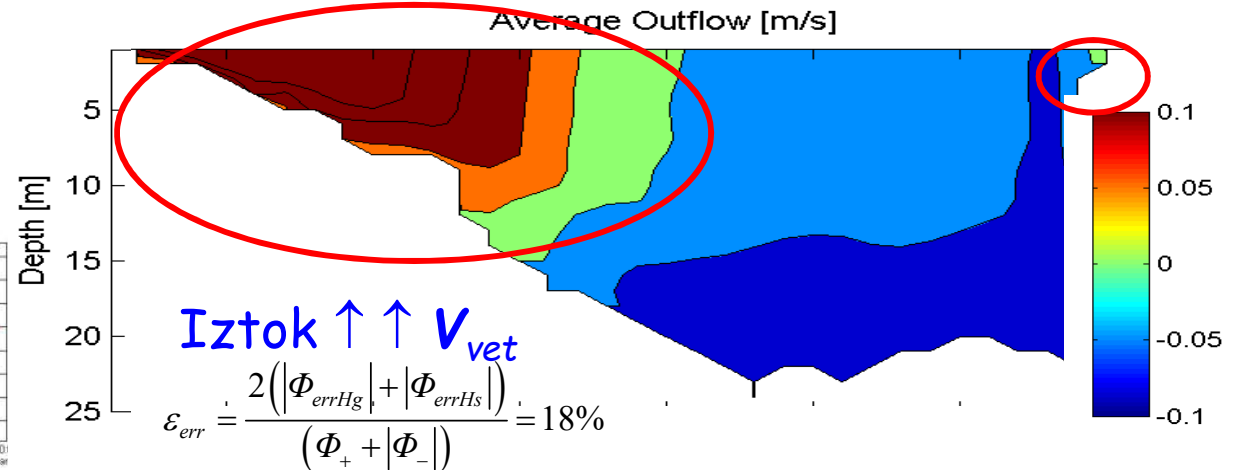
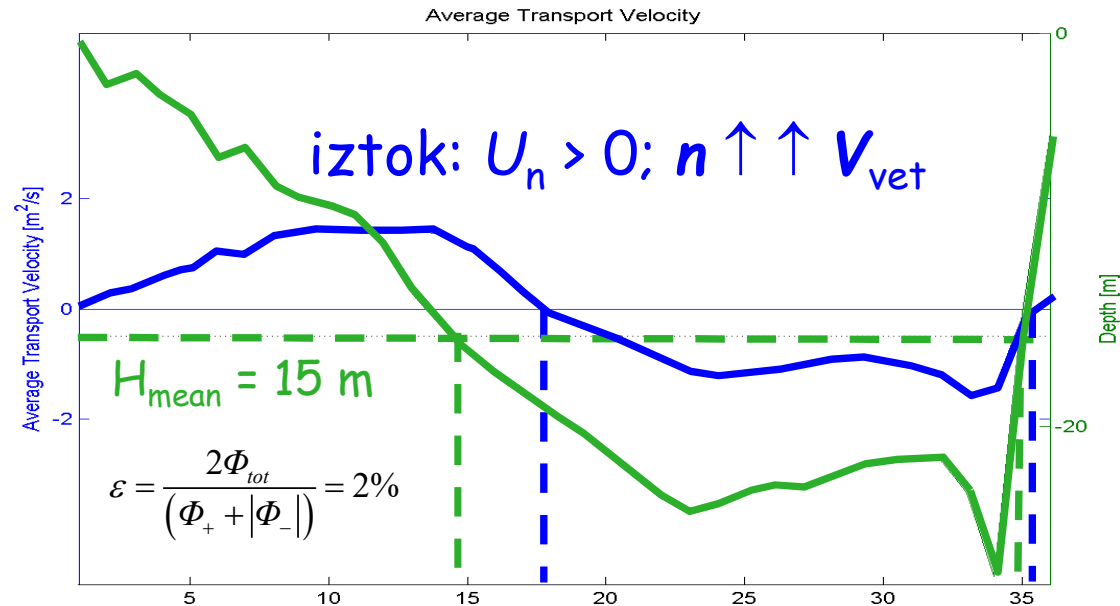
IZHODIŠČE: NAPOM - burja

Šibka stratifikacija

19.-21. marec 2009



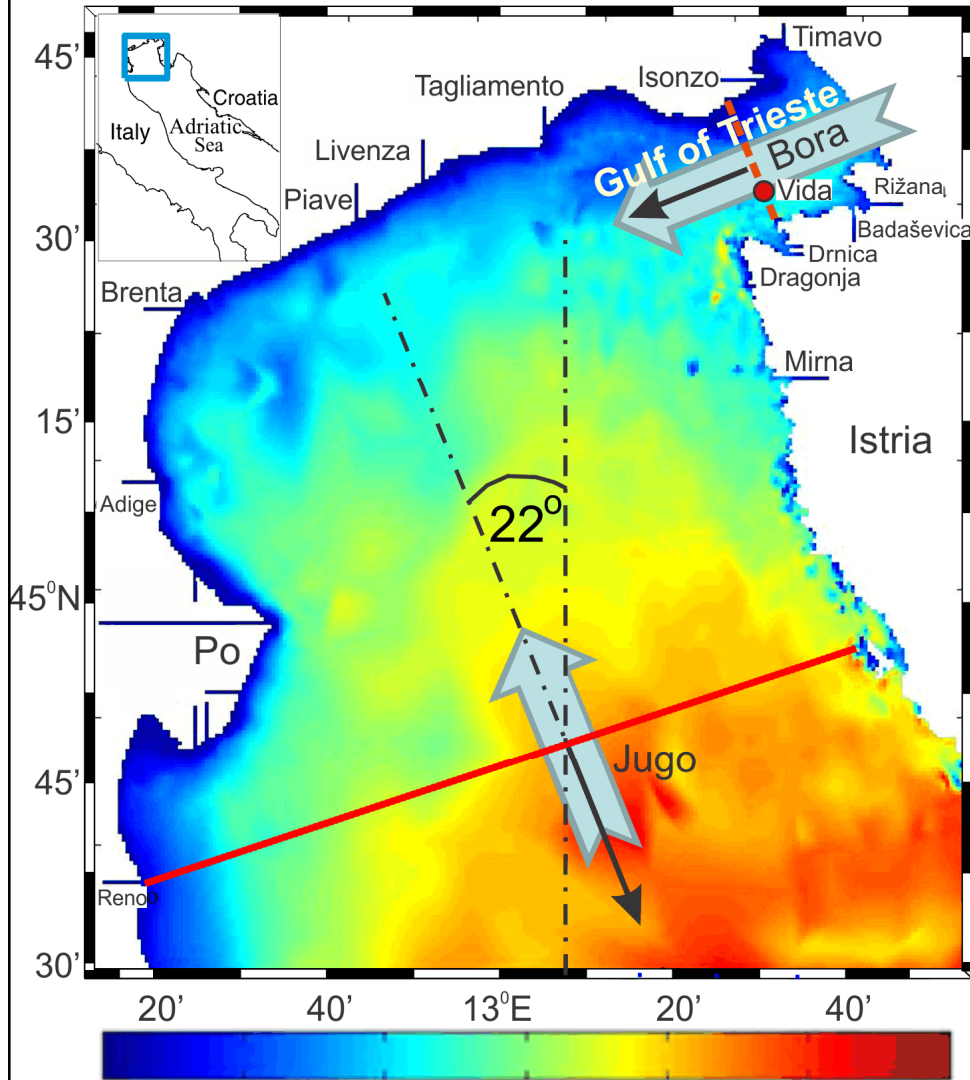
Veter na Vidi



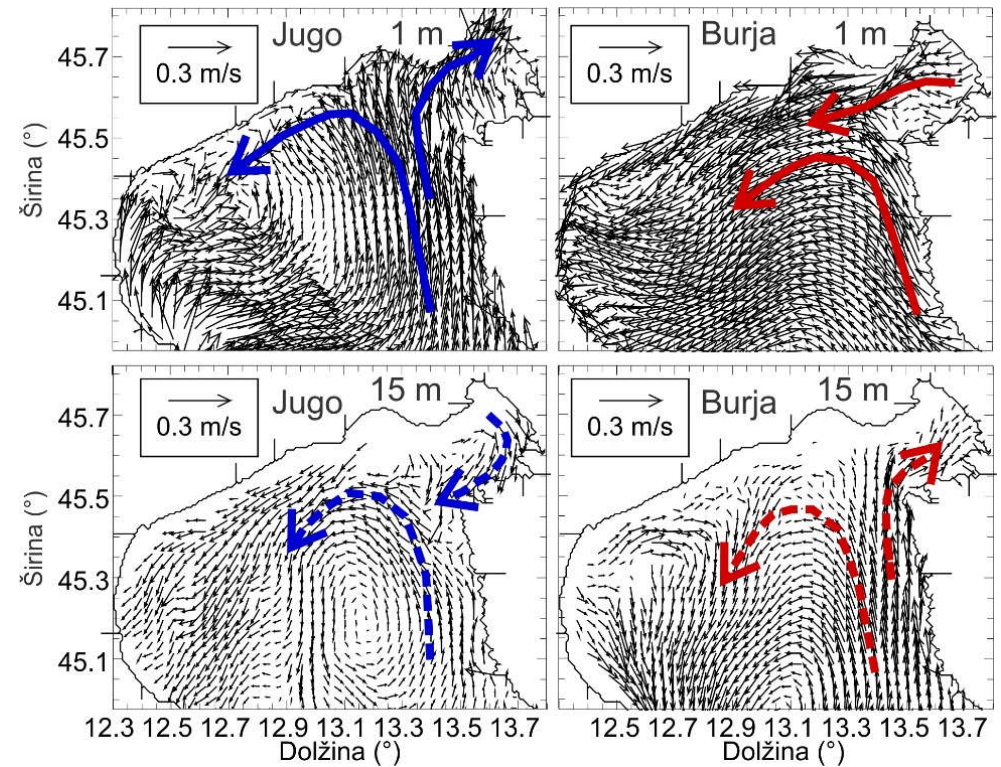
Transport prečno na Tržaški zaliv
Malačič, Petelin in Vodopivec, JGR 2012



MODELSKI REZULTAT



Malačič V., Petelin B., Vodopivec M., 2012,
JGR (C), 117, C06032



NAPOM

Northern Adriatic Princeton Ocean Model



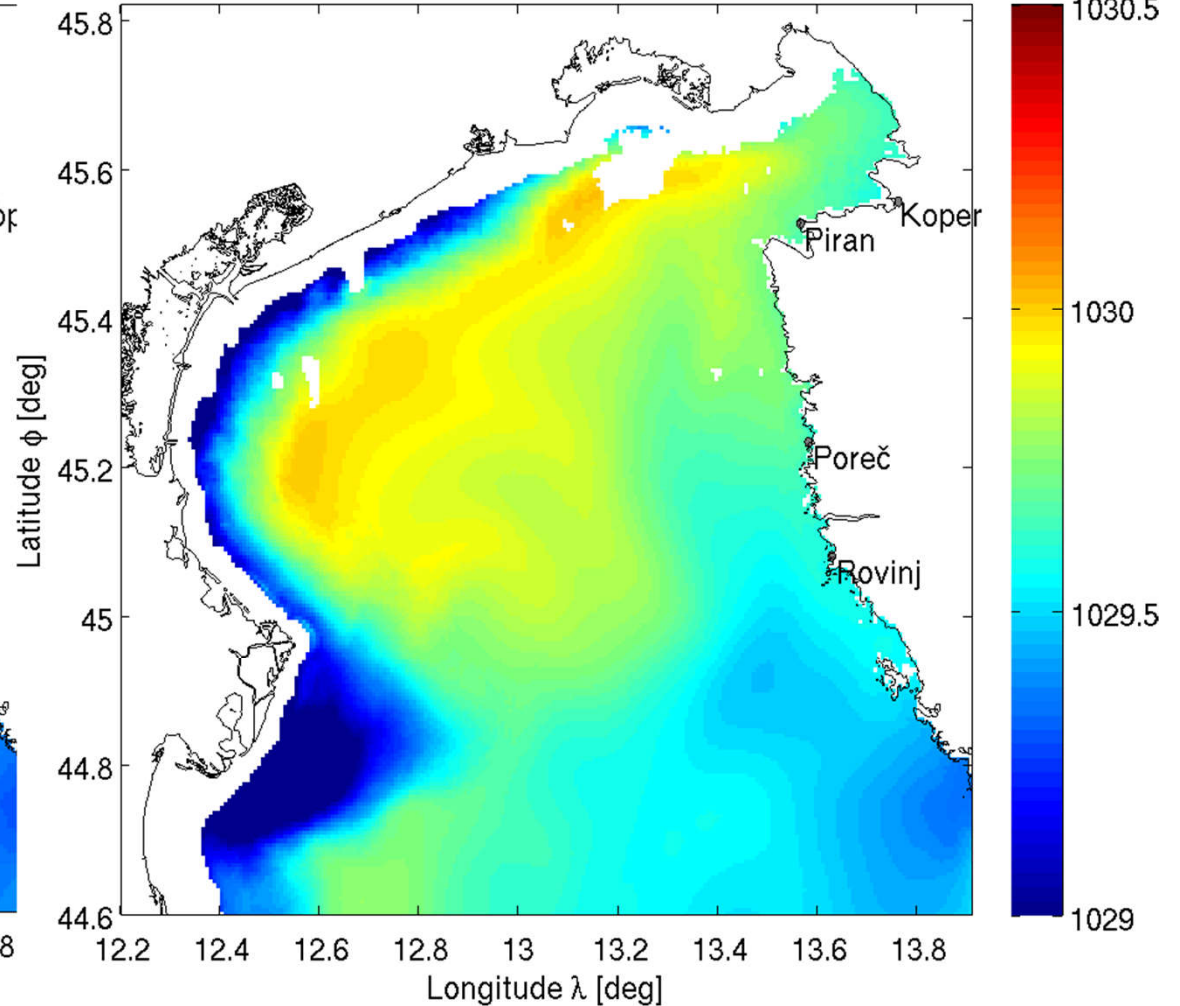
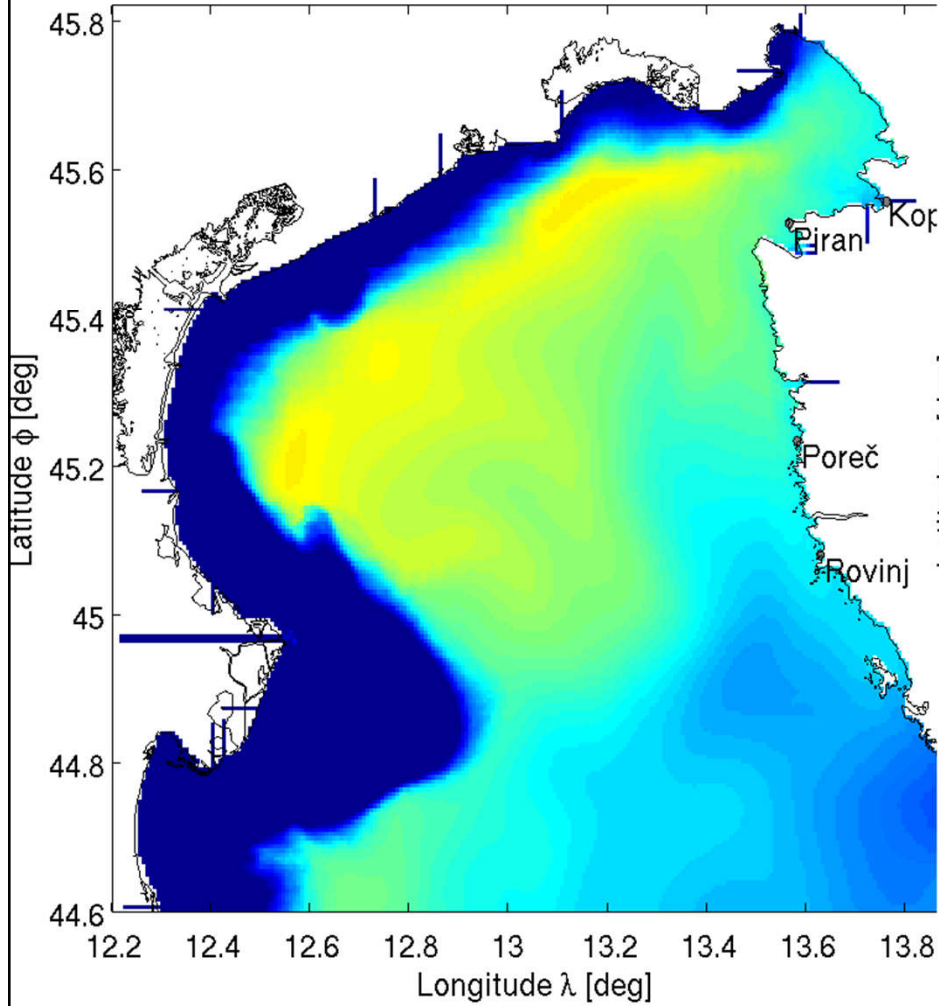
27 jan.-16 feb. 2012: σ

1.5 m

15 m

NAPOM density [kg/m³] at depth 01 m at 2012-01-27 00:00

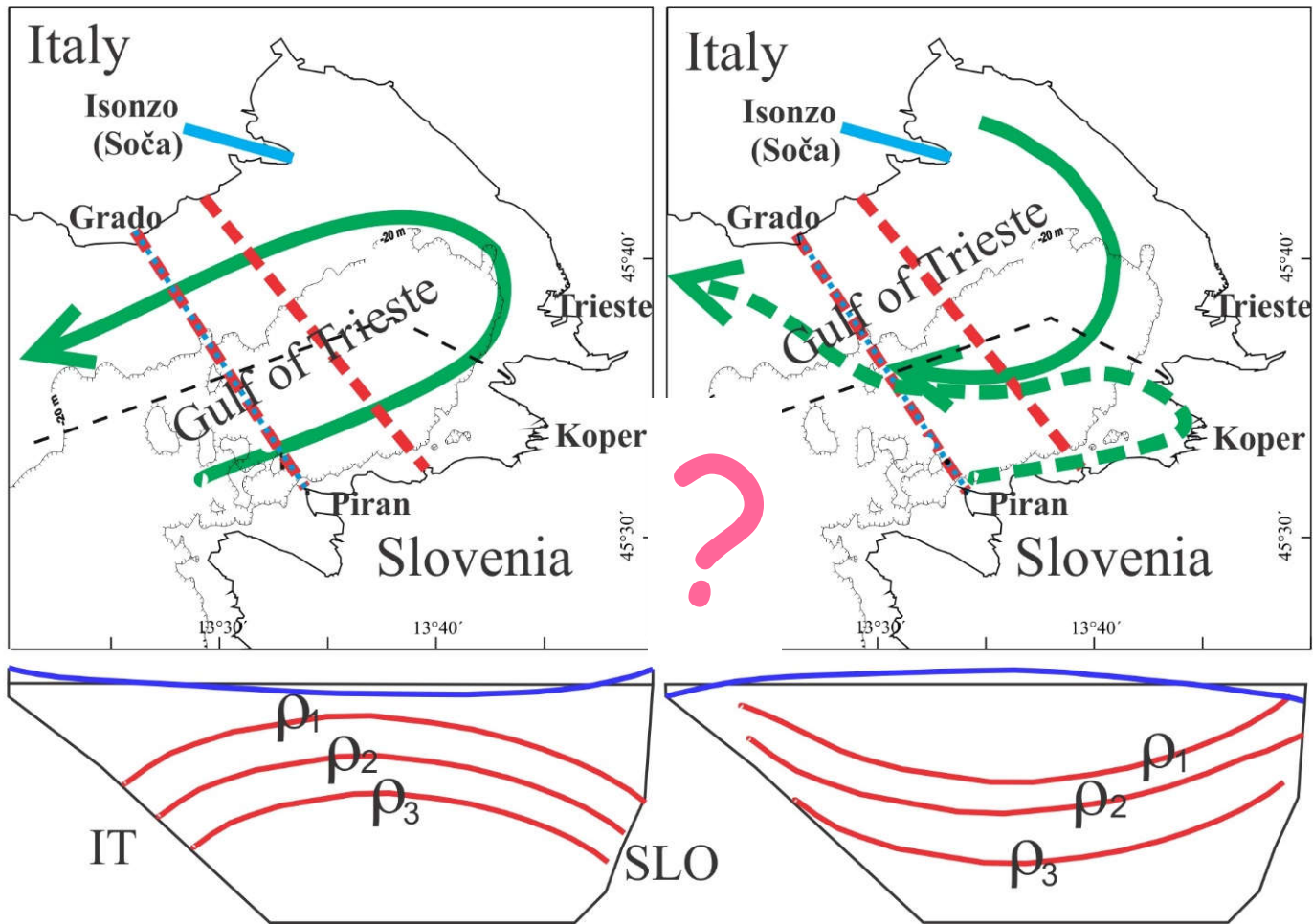
NAPOM density [kg/m³] at depth 15 m at 2012-01-27 00:00



(M. Vodopivec & M. Ličer)



Kaj pa, ko ni vetra?



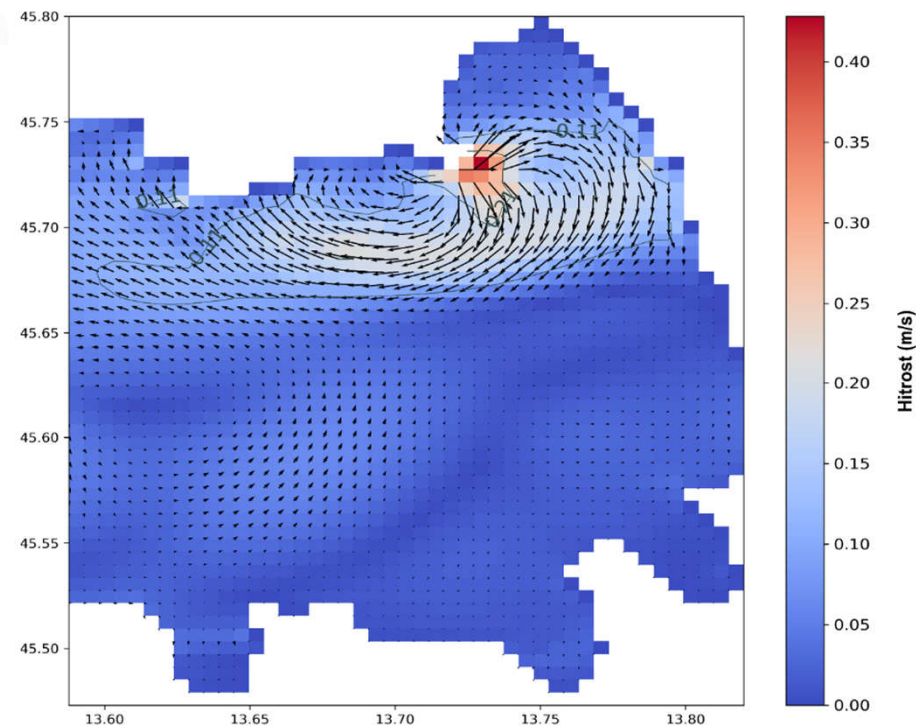
Malačič &
Petelin,
JGR 2009



Kaj pa, ko ni vetra?



Malačič &
Petelin,
Kluwer, 2001

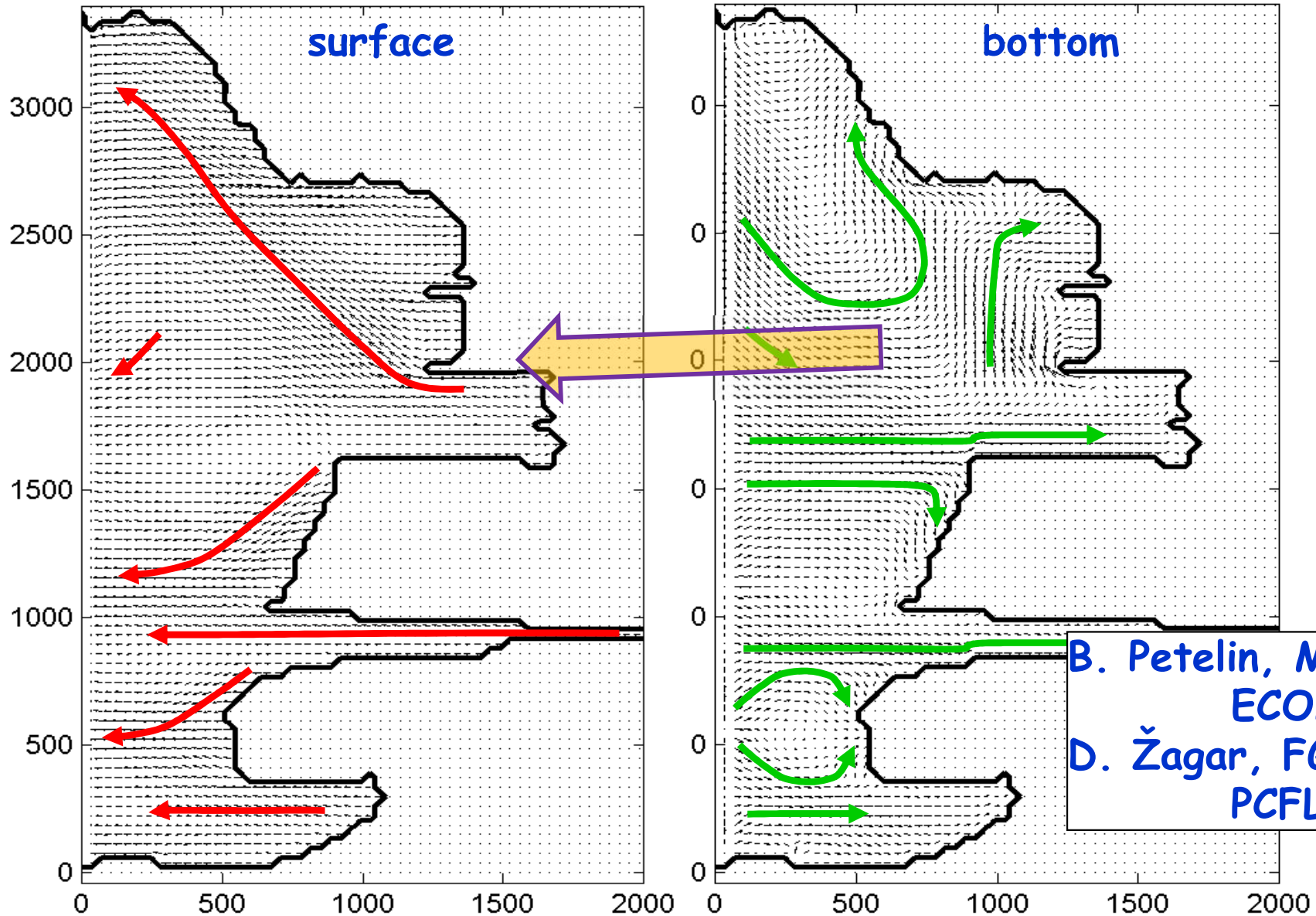


Umer B., Malačič
V. & Žagar D.
2019, EGU



Cirkulacija odprtih zalivov in transport sedimenta

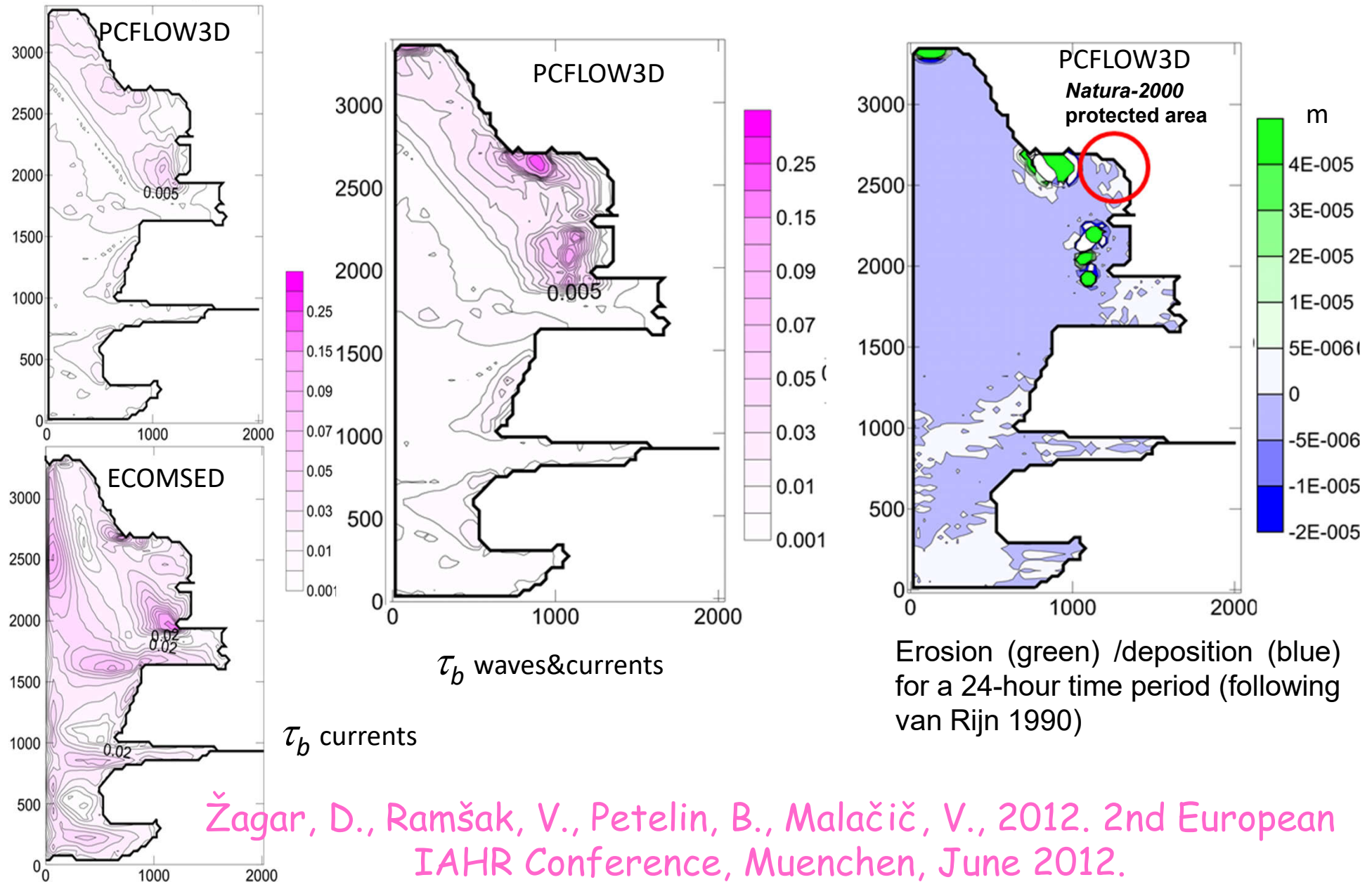
Burja 15 m/s, 88 stopinj - morski tokovi na površini Burja 15 m/s, 88 stopinj - morski tokovi na dnu





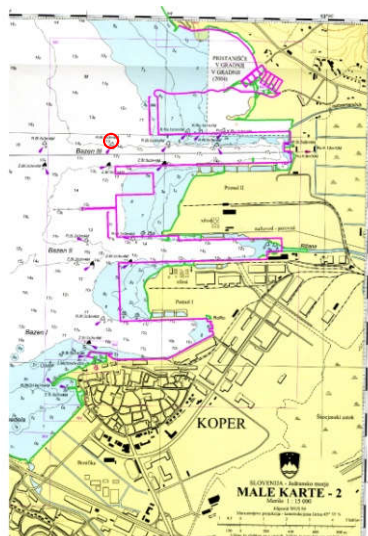
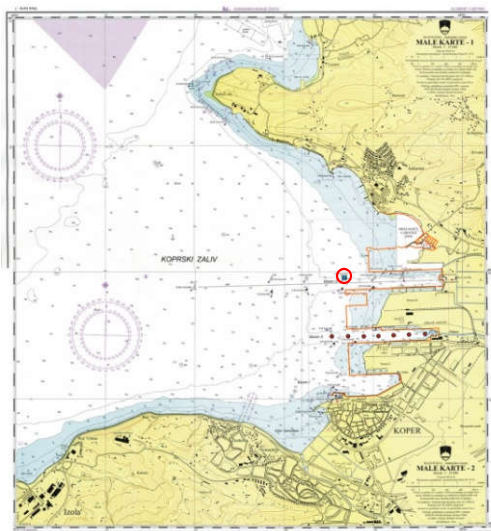
IZHODIŠČE:

Depozicija/resuspenzija ob burji v Koprskem zalivu





Enoletne meritve tokov v Koprskem zalivu



13° 43,6213' E

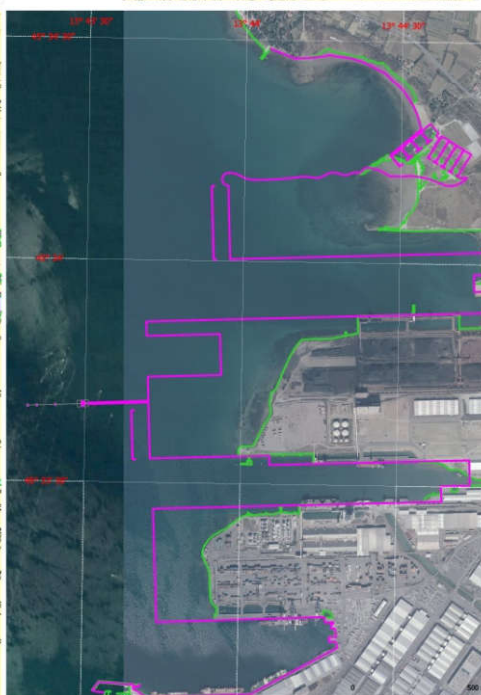
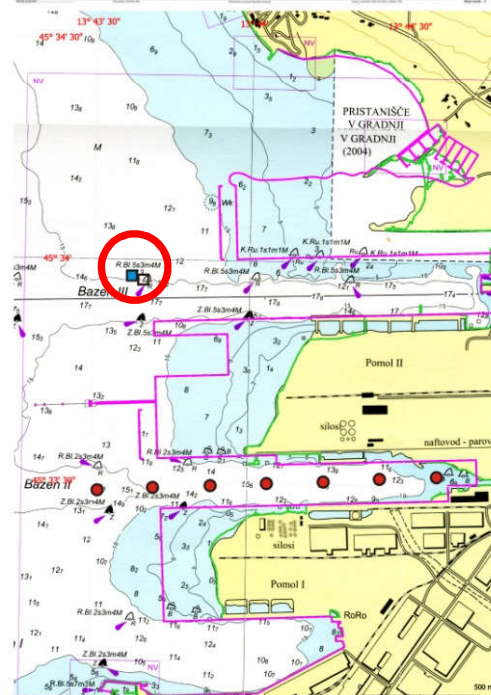
45° 33,9638' N

19. dec. 2008 - 28. apr. 2009

1. maj 2009 - 7. sep. 2009

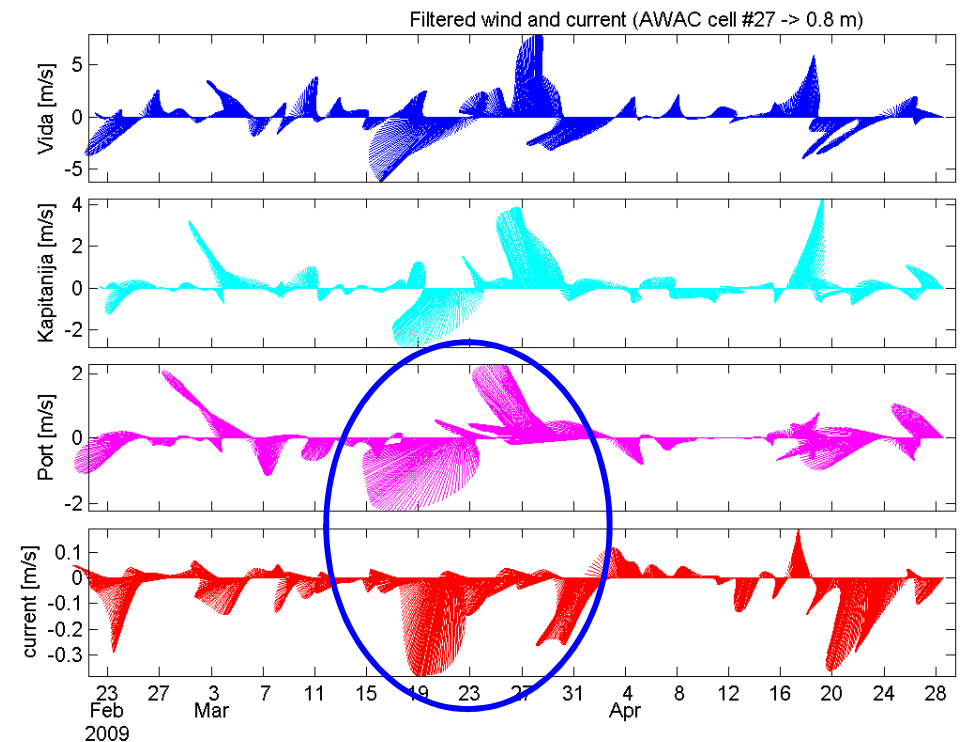
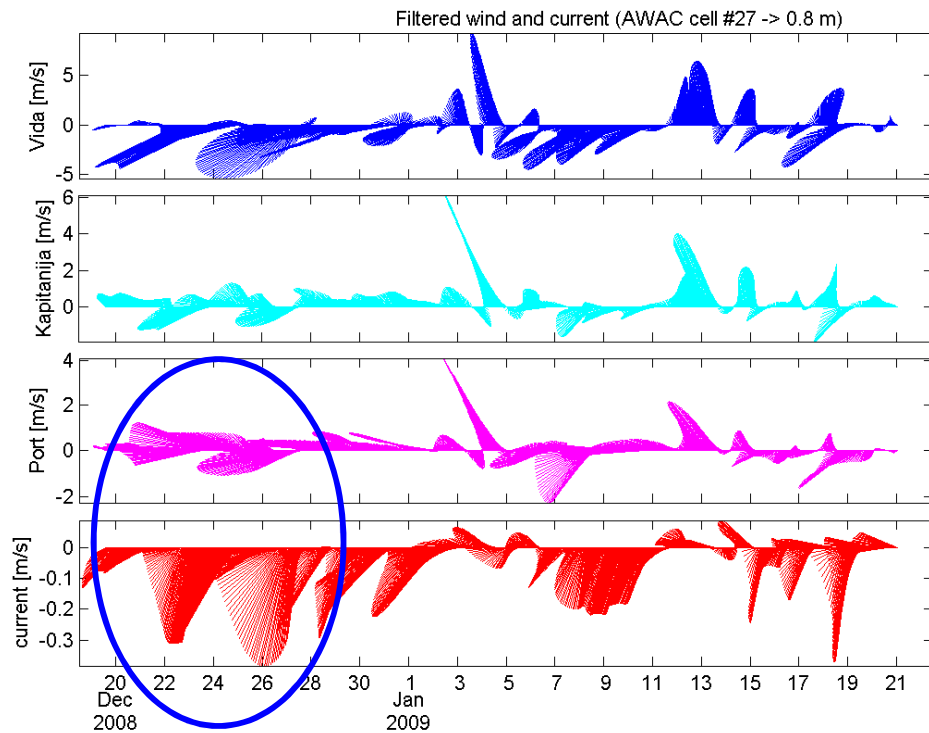
13. sep. 2009 - 21. dec. 2009

Devet dni podat. vrzeli





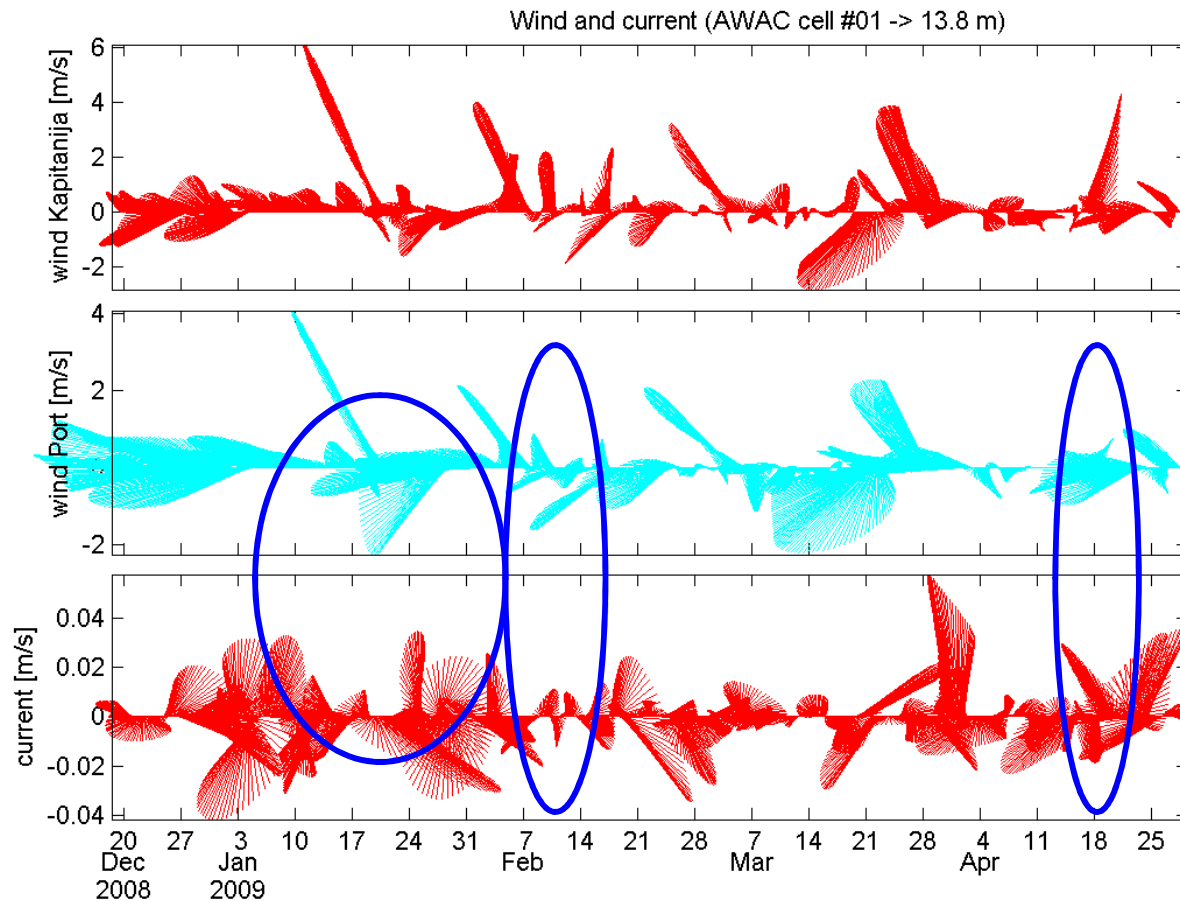
Enoletne meritve tokov v KP zalivu površinski tokovi



Filtrirani vetrovi na Vidi (zgoraj), na mareograf. postaji v Kopru ('Kapitanija'), v Luki Koper ('Port'). Spodaj rdeče: površinski tok v globini 0.8 m. 72 h nizkopasovni filter (Pugh, 1982). Levo: dec. 2008 - feb. 2009. Desno: feb.-apr. 2009.



Enoletne meritve tokov v KP zalivu, pridneni tokovi



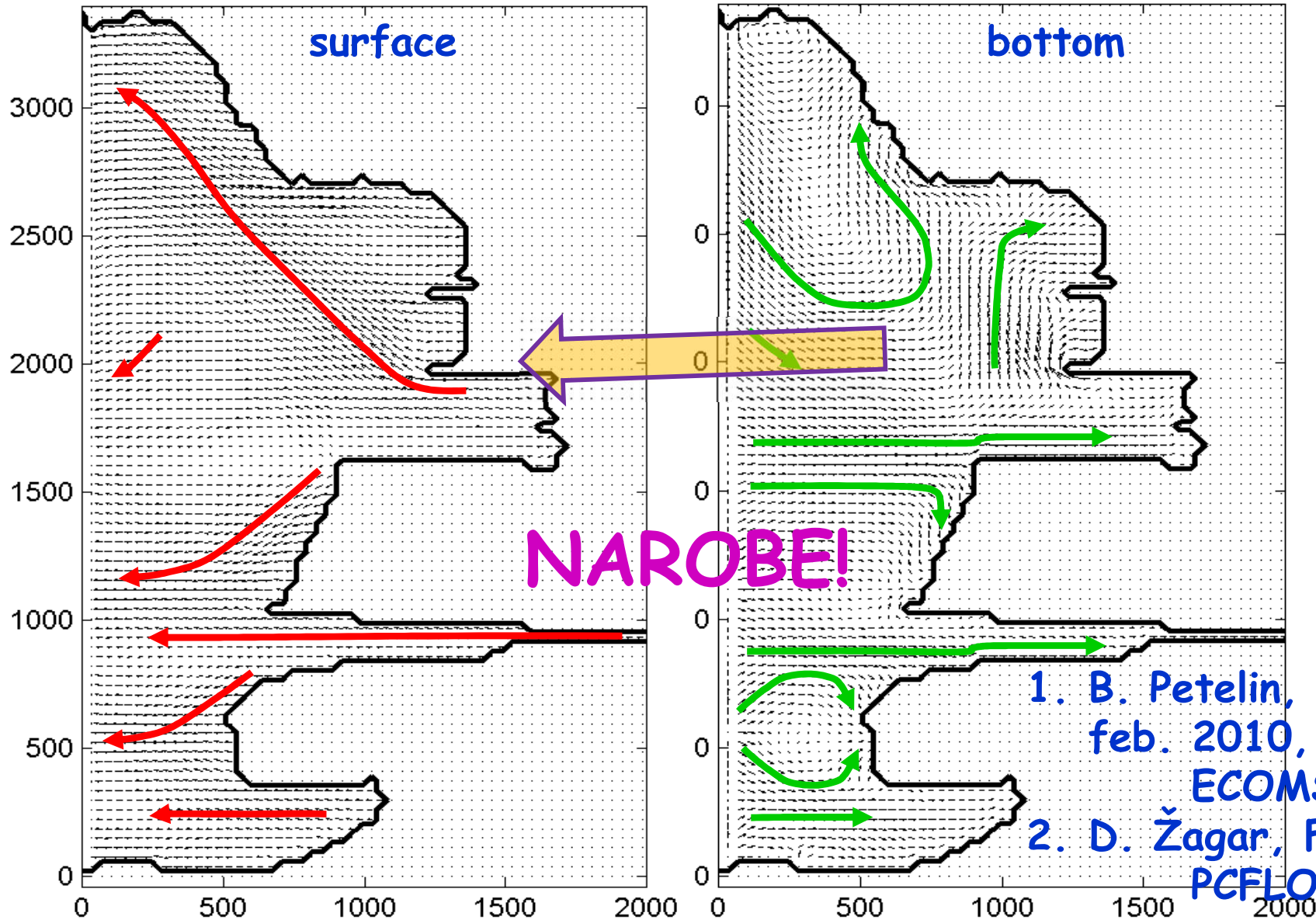
Vetrovi na mareograf.
Postaji (zgoraj,
'Kapitanija'), v Luki
Koper
(sredina, modro).
Spodaj: tokovi v
globini 13.8m, blizu
mor. dna.



Simulacije vetrne cirkulacije ob burji

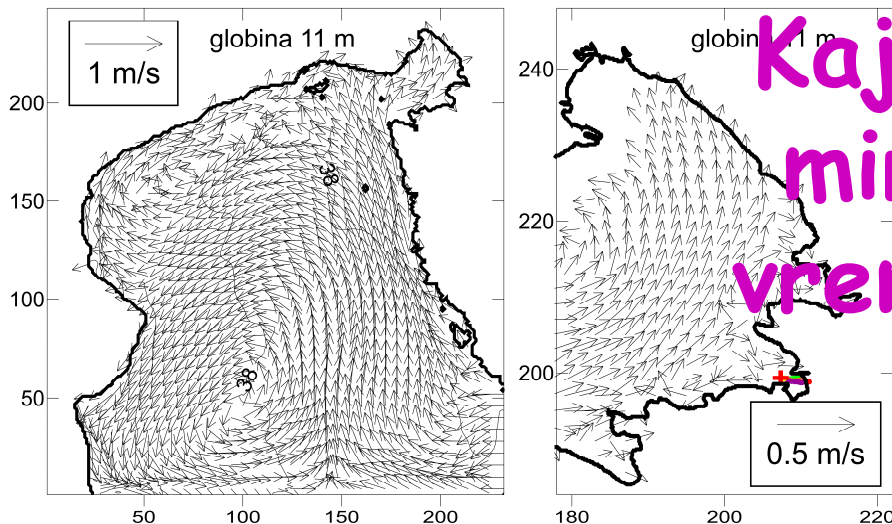
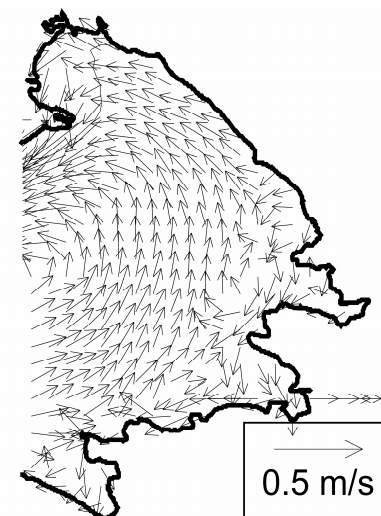
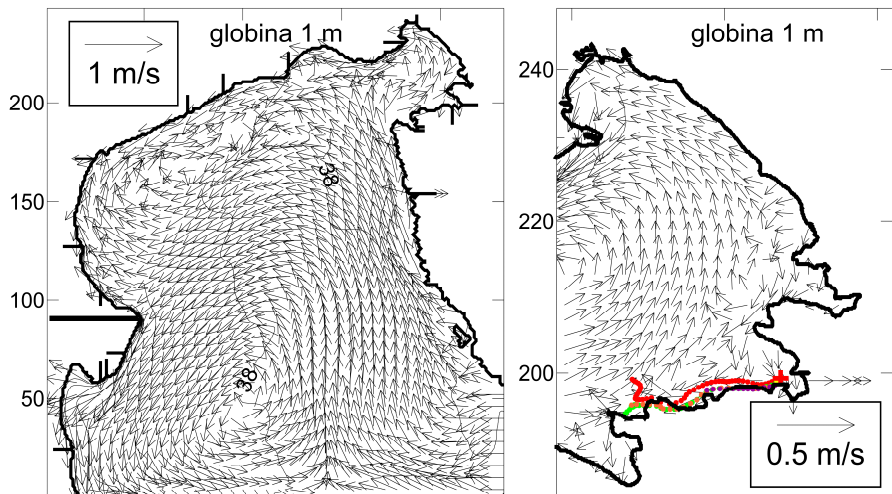
Burja 15 m/s, 88 stopinj - morski tokovi na površini

Burja 15 m/s, 88 stopinj - morski tokovi na dnu

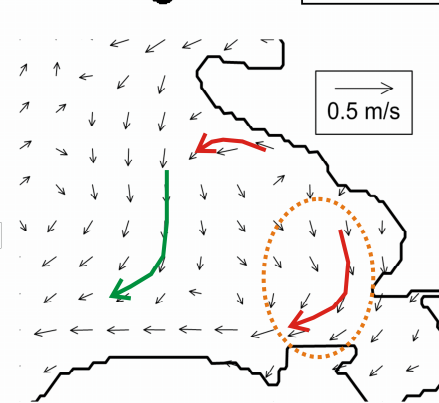
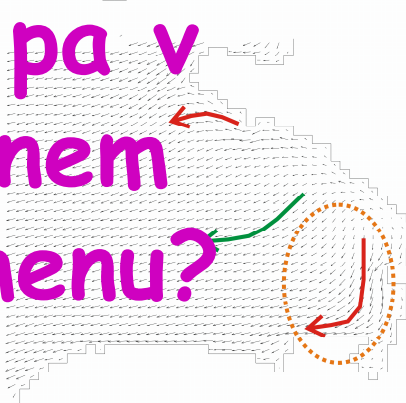


Simulacije vetrne cirkulacije

Tokovi 64 ur od 19.3.2009 0:00



Kaj pa v mirnem vremenu?



B. Petelin, MBP, 2010

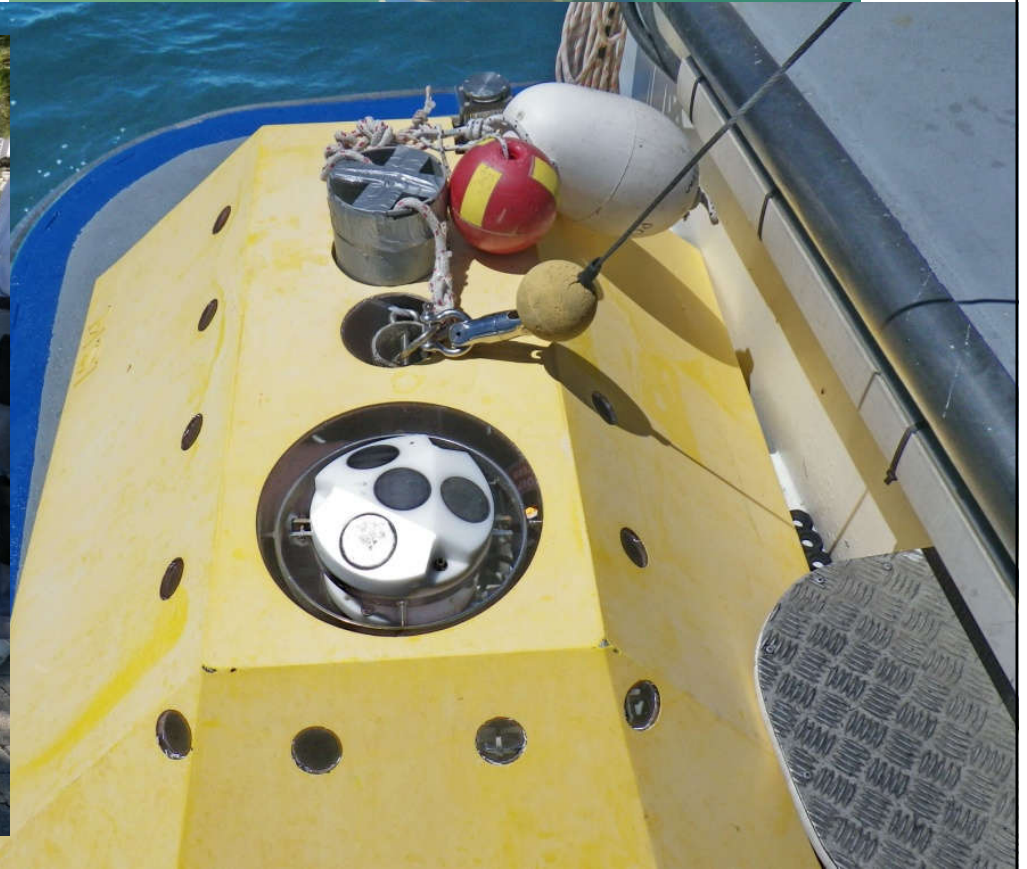
D. Žagar, KMTE, FGG, UNI-LJ, 2010

B. Petelin, MBP, 2010



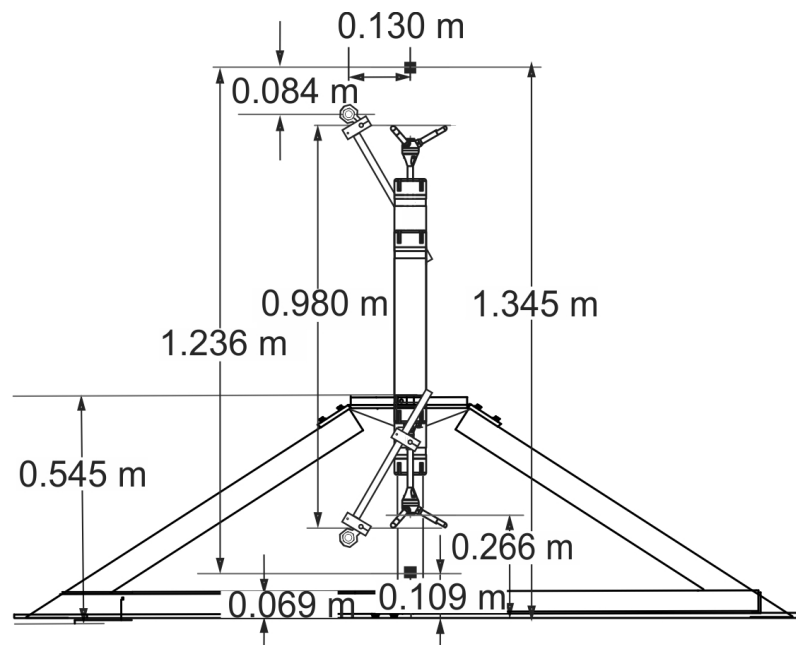
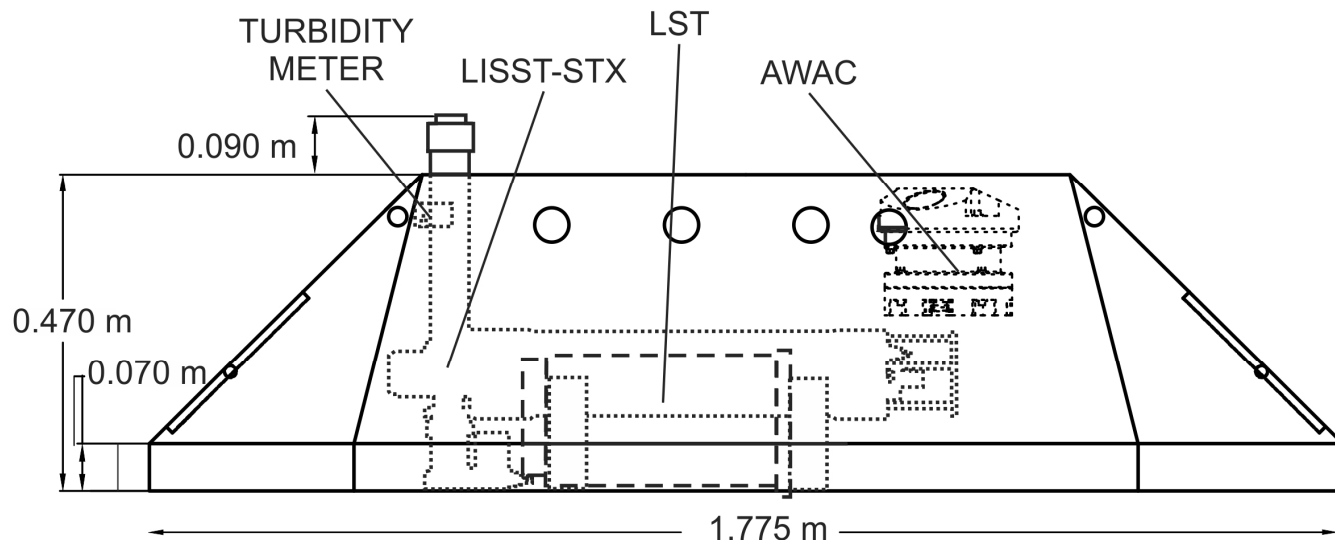
Eksperimentalno delo







Instrumenti na morskem dnu





Radarske meritve površinskih tokov (25 MHz) v Tržaškem zalivu





Radarske meritve površinskih tokov (25 MHz) v Tržaškem zalivu

<http://www.nib.si/mbp/en/oceanographic-data-and-measurements/other-oceanographic-data/hf-radar-2>





Radarske meritve površinskih tokov (25 MHz) v Tržaškem zalivu

JOURNAL OF GEOPHYSICAL RESEARCH: OCEANS, VOL. 118, 1 18, doi:10.1002/2013JC009261, 2013

Surface circulation in the Gulf of Trieste (northern Adriatic Sea) from radar, model, and ADCP comparisons

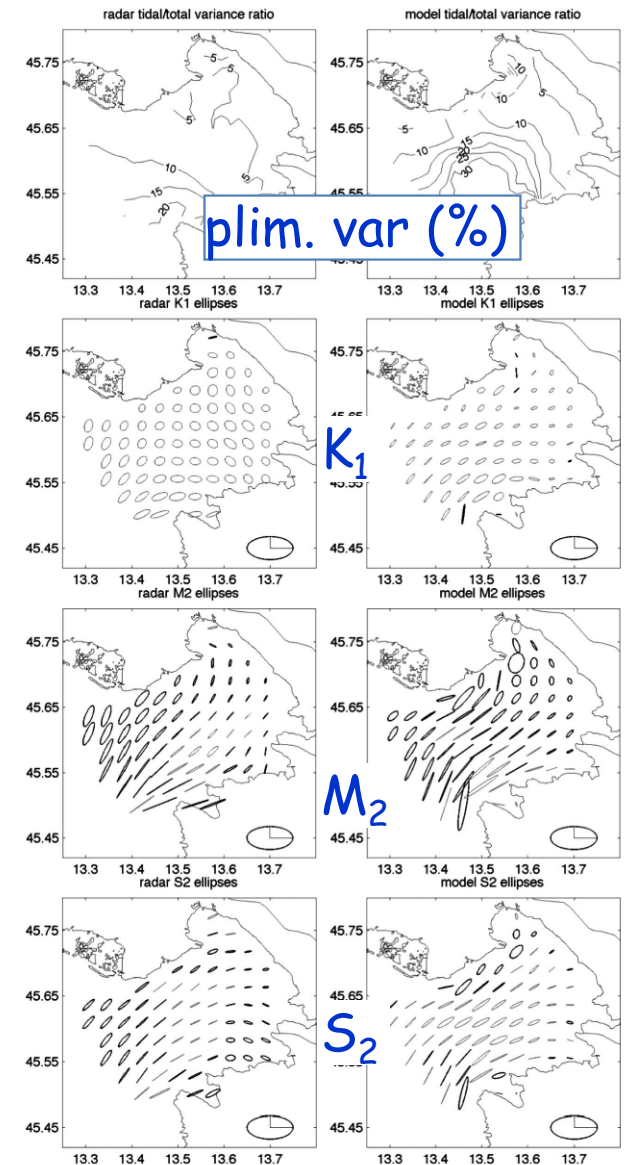
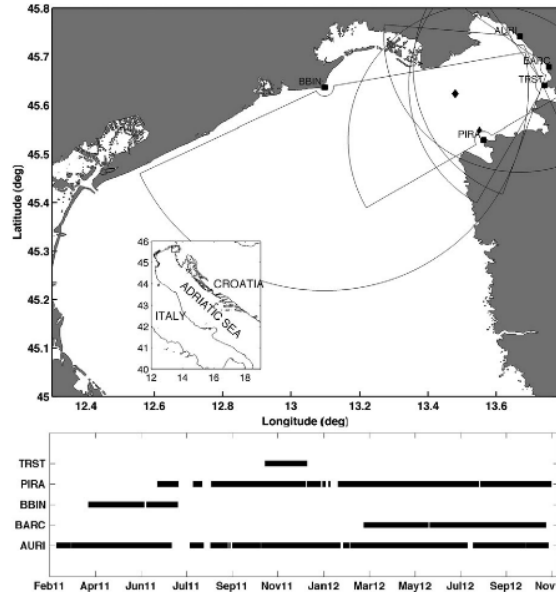
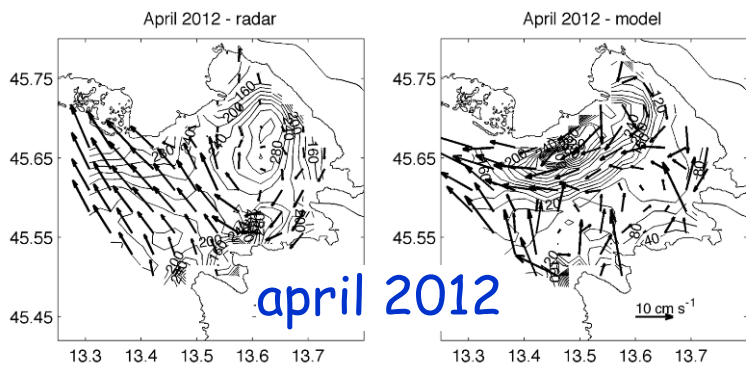
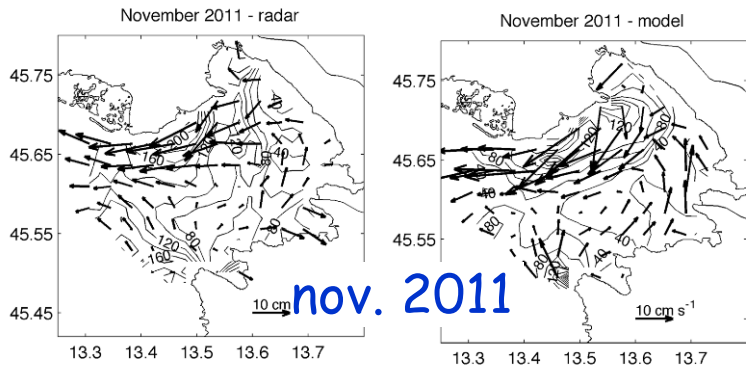
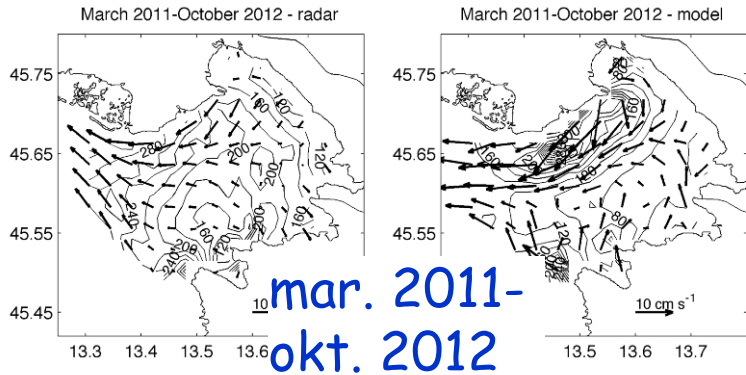
Simone Cosoli,¹ Matjaž Ličer,² Martin Vodopivec,² and Vlado Malačič²

radar

model

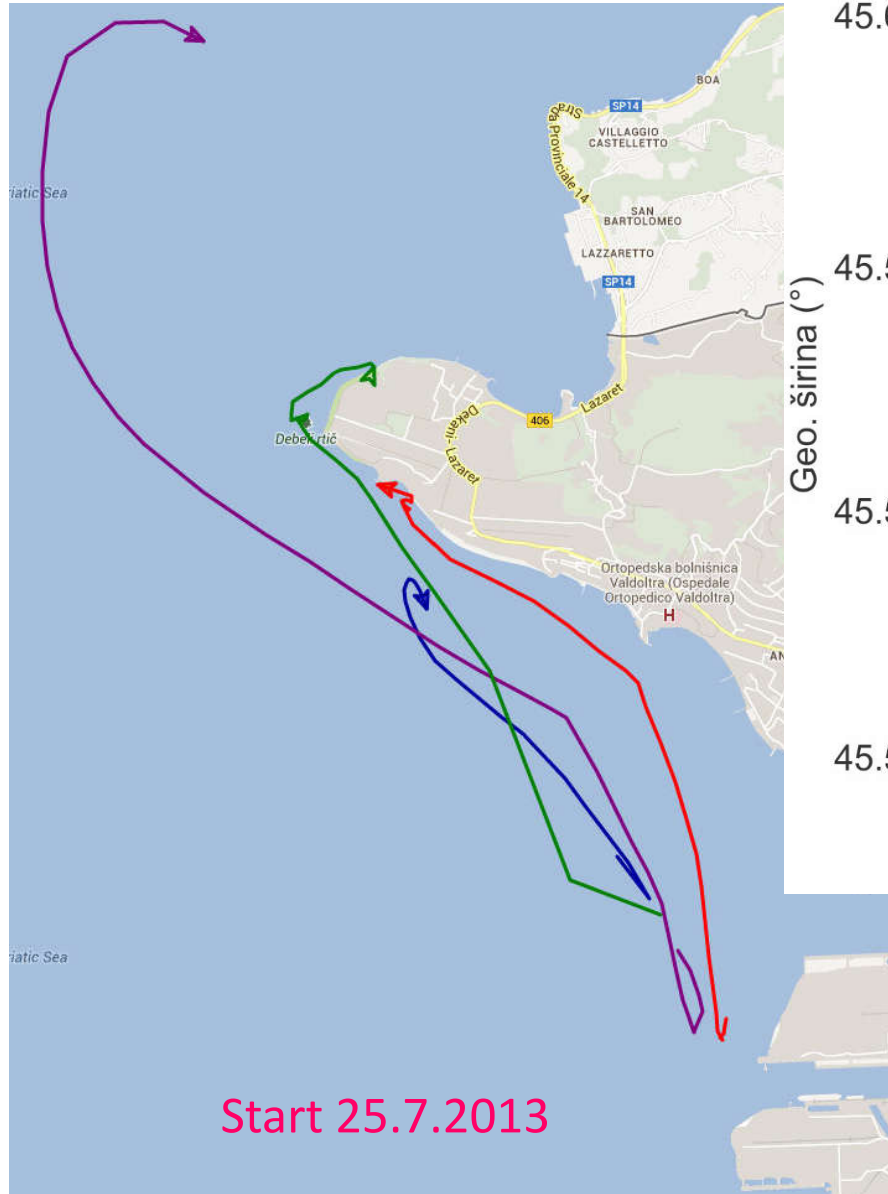
radar

model



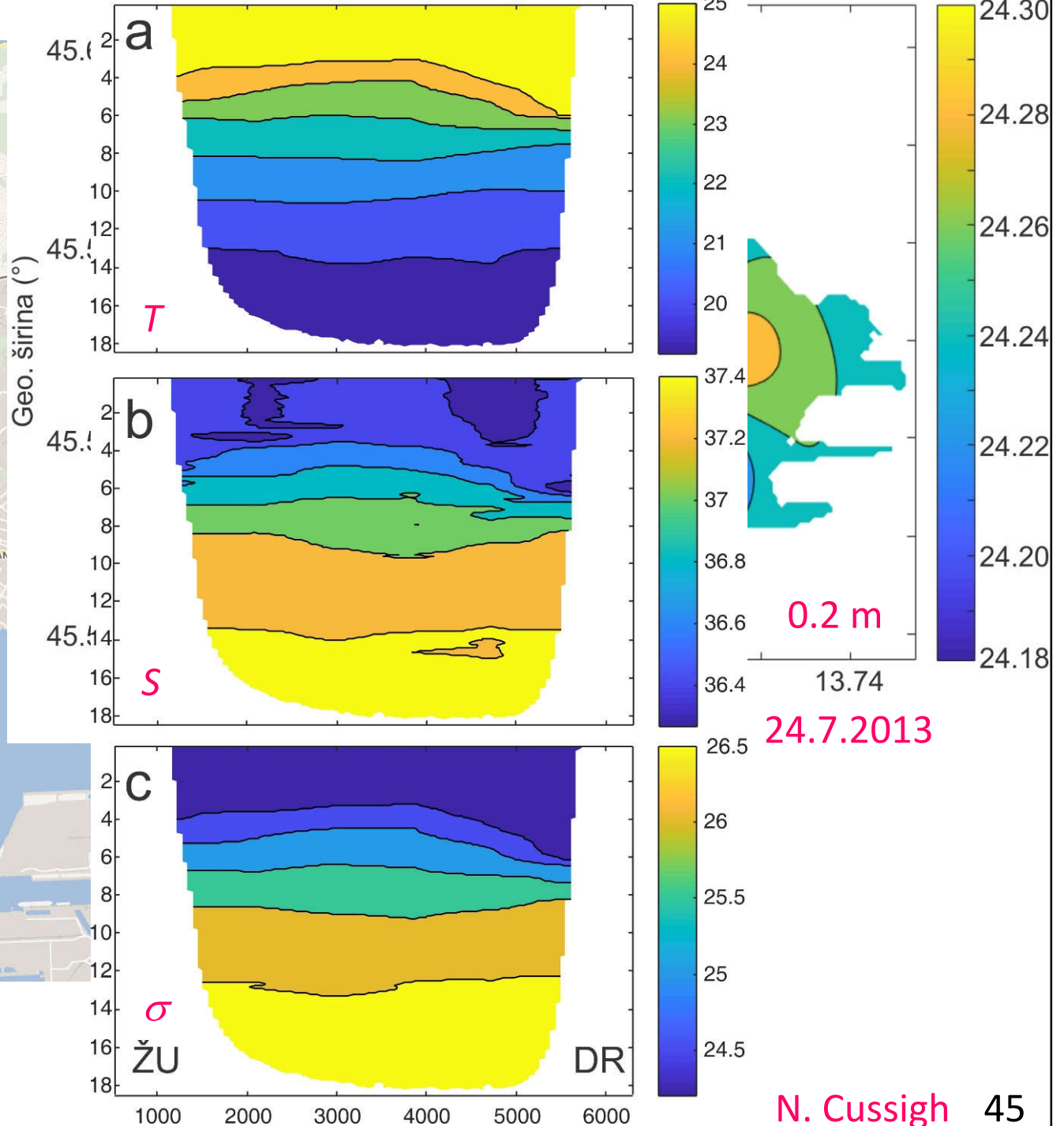


Kaj pa v mirnem vremenu?



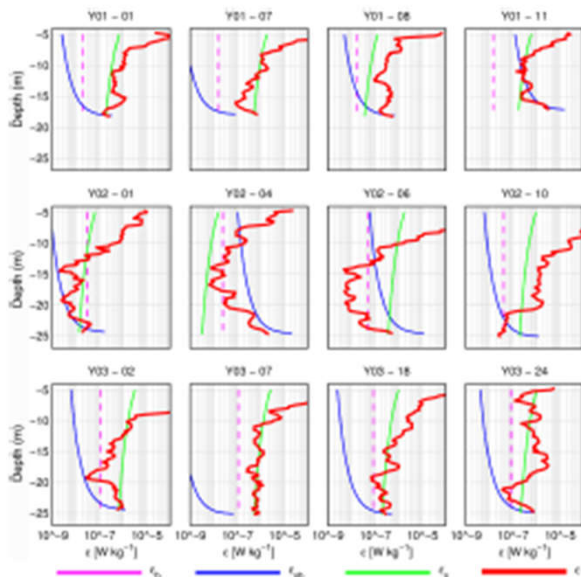
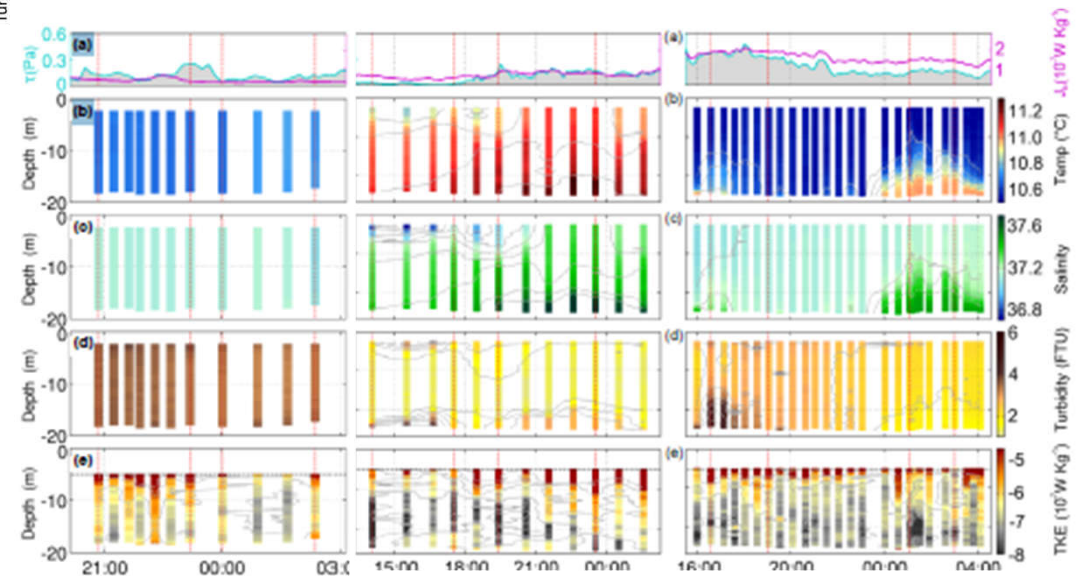
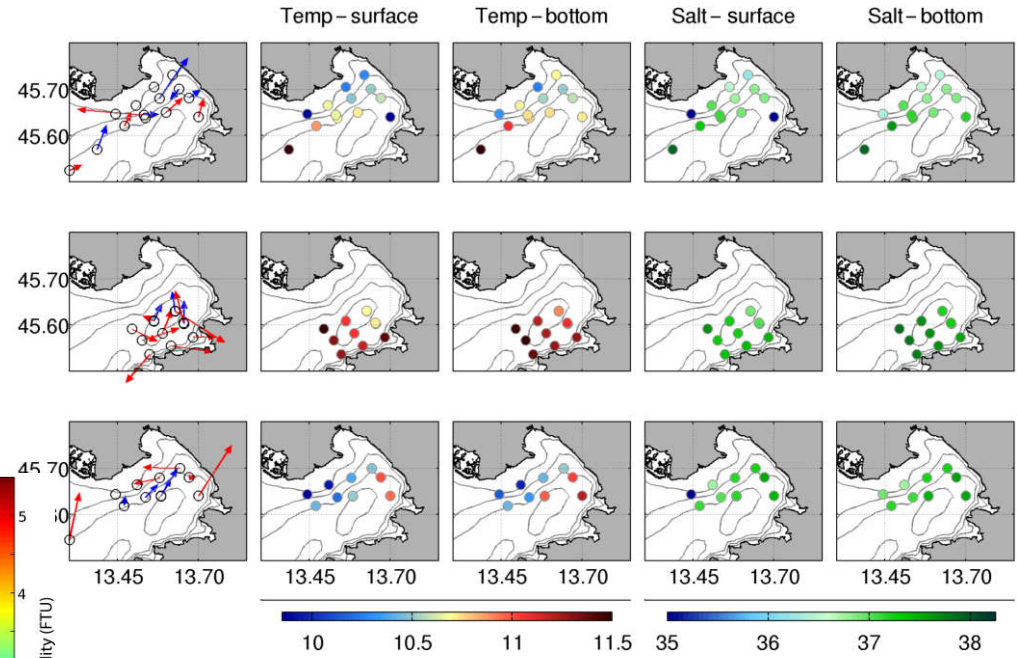
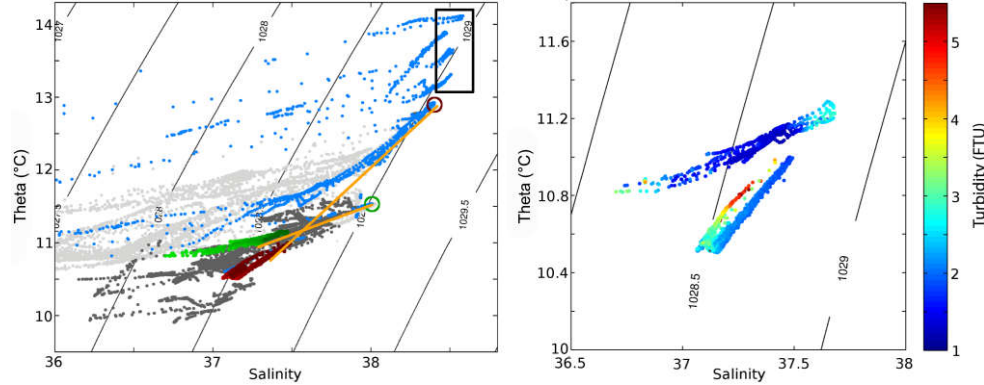
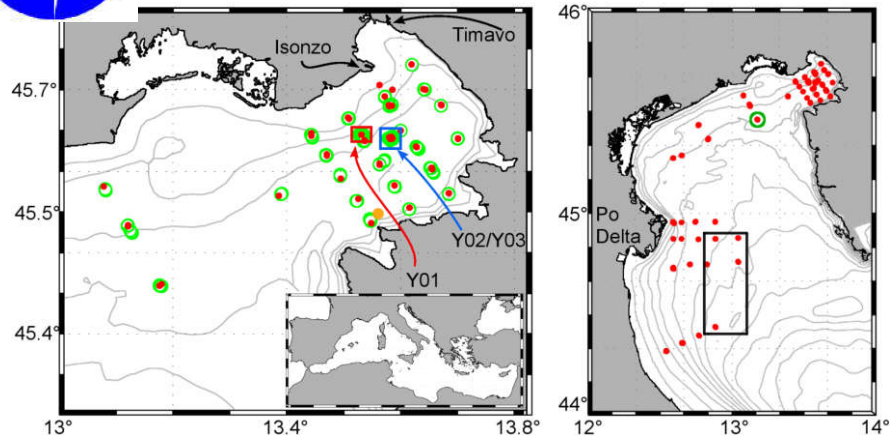
Start 25.7.2013

Software: D. Deželjin ,
hardware: F. Henigman





Turbulenca: Carpet 2014 križarjenje



Falcieri in sod. 2016, *Ocean Sci.*, 12, 433-449