The first three months of operation of the GUTTA-VISIR system for ferries

G.Mannarini | Fondazione CMCC

Opatjia, Croatia | 09 March 2022

Outline

- Introduction
- Overview of GUTTA-VISIR (GV)
- Measuring the impact of GV
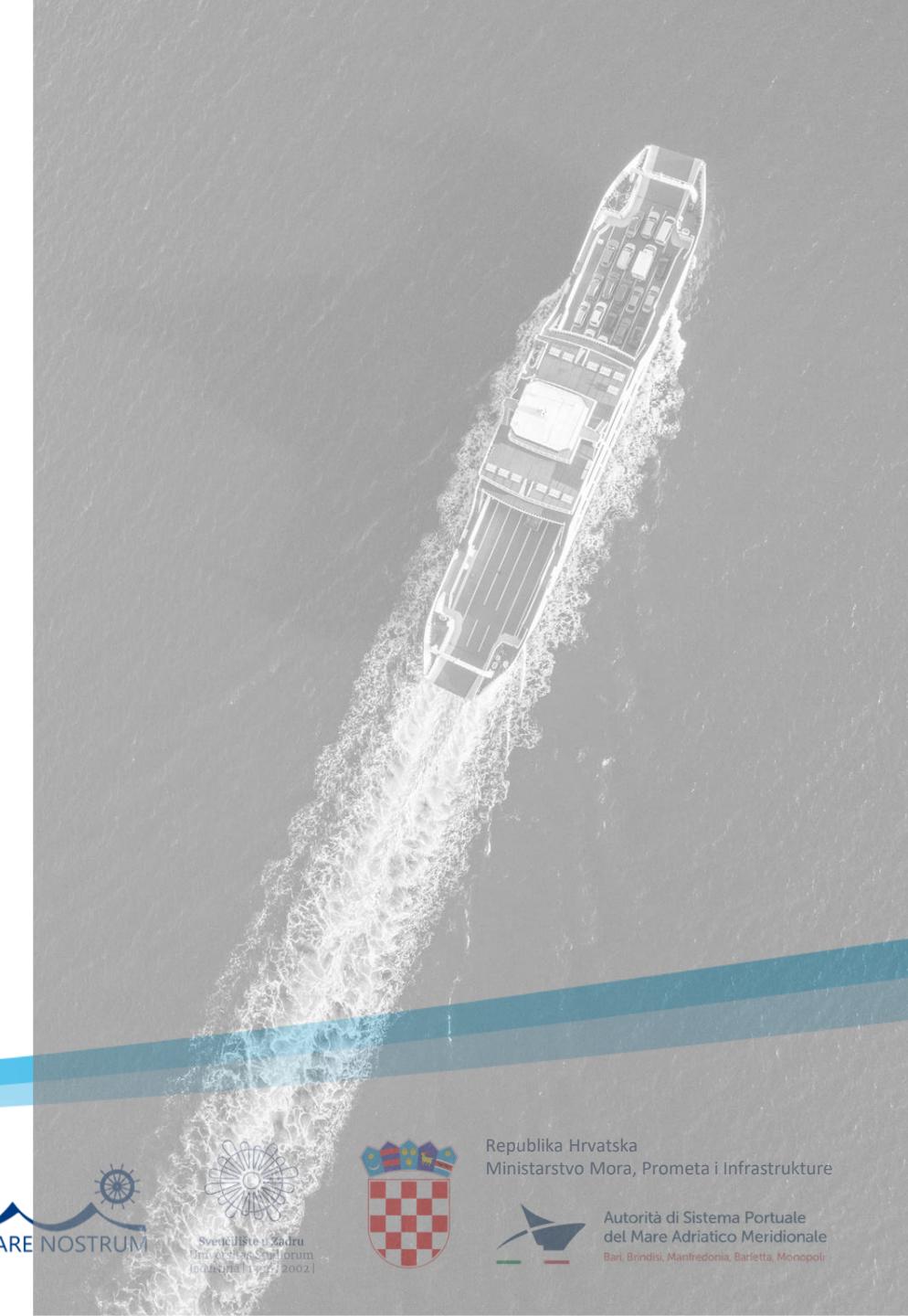
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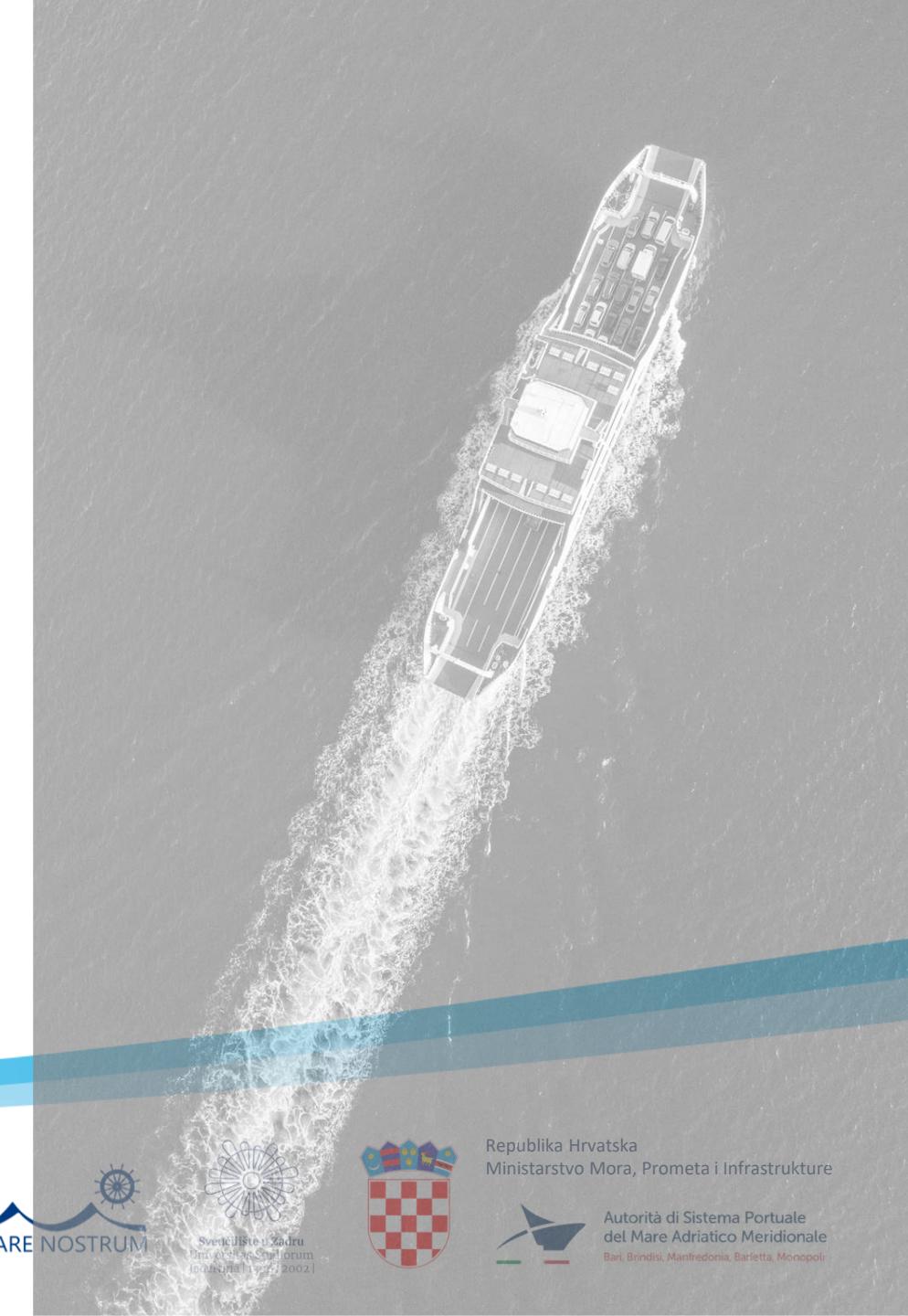
Overcoming the climate externality

Candidate metrics to be embedded into cost of a maritime transportation service:

CO_2

- Absolute quantity
- Climate-change relevant
- Likely to be used for EU-ETS (s. fitFor55)
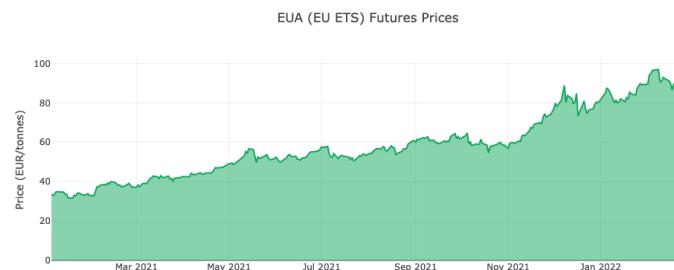
CII = CO_2/ton-mile

- Normalized quantity
- Allows comparisons among vessels/services
- Subject to artifacts (sail longer for given emissions will reduce CII)
- Will be used by IMO (cf. MEPC-76) starting from 2023
- May flow into a Market-Based-Measure by IMO

EUA (EU ETS) Futures Prices

Years	
2020	1.0%*
2021	1.0%*
2022	1.0%*
2023	2.0%
2024	2.0%
2025	2.0%
2026	2.0%
2027	
2028	
2029	
2030	

ISWG-GHG 8/WP.1/Rev.1
ISWG-GHG 8/J-6/Add.1
MEPC 76/WP.1/Rev.1

Ferries and efficiency

Interviewed:
- Head of ferry line
- Ferry shipping managers
- Scheduling departments
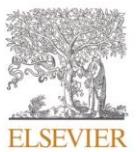
Energy efficiency in ship operations - Exploring voyage decisions and decision-makers

René Taudal Poulsen [a,*], Martin Viktorelius [b], Hanna Varvne [c], Hanna Barbara Rasmussen [d], Hannes von Knorring [e]

[a] Copenhagen Business School, Department of Strategy and Innovation, Copenhagen, Denmark
[b] Linnæus University, Faculty of Technology, Kalmar, Sweden
[c] University of Gothenburg, Department of Business Administration, Gothenburg, Sweden
[d] University of Southern Denmark, Centre of Maritime Health and Society, Esbjerg, Denmark
[e] DNV, Gothenburg, Sweden

① Route choice
- ferries are tailor-made ships on specific routes, for many years
- no pronounced head- or backhauls
- customers expect a certain frequency, even during the low season
- public procurement contracts for subsidized ferry routes

② Speed choice
- schedule adjustments are unfeasible because of the logistical requirements of freight transport
- schedule reliability dictates service speeds and often undermines energy efficiency
- arrive early in port, to leave enough time for the complex cargo operations

③ Voyage execution
- punctual departure important for energy efficiency measures
- constant speed during a voyage, to save fuel
- trim optimization and cargo planning/loading: closely related challenges
- minimize the use of thrusters
- optimize the use of auxiliary engines

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Scientific basis
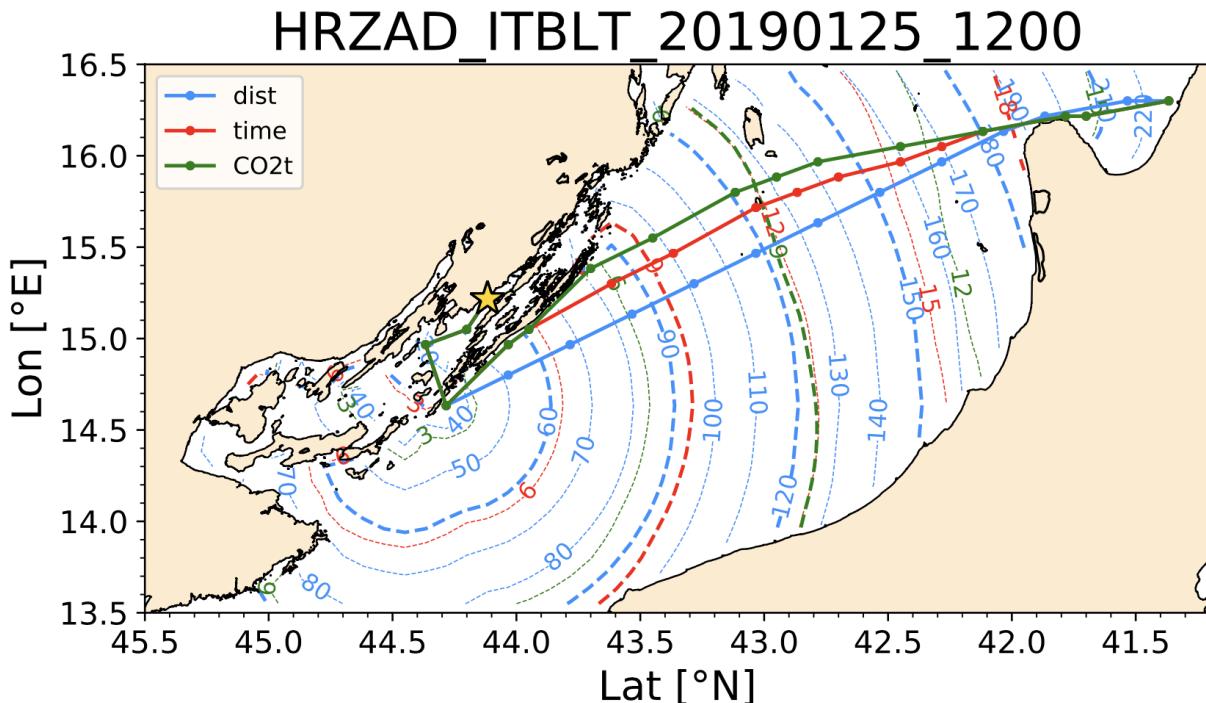
Gianandrea Mannarini [1,*], Lorenzo Carelli [1], Josip Orović [2], Charlotte P. Martinkus [3] and Giovanni Coppini [1]

https://www.mdpi.com/2077-1312/9/2/115

HRZAD_ITBLT_20190125_1200

- VISIR updated for computing least-CO_2 routes
- Ferry seakeeping and emissions from Unizd's simulator
- New python code (validated vs. VISIR-1 in matlab)
- Use of CMEMS metocean forecasts
- New visualization with isolines
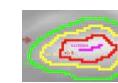
Interreg Italy - Croatia GUTTA
European Regional Development Fund
EUROPEAN UNION

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

MARE NOSTRUM

Sveučilište u Zadru
Universitas Studiorum
Jadertina | 1396 | 2002 |

Republika Hrvatska
Ministarstvo Mora, Prometa i Infrastrukture

Autorità di Sistema Portuale
del Mare Adriatico Meridionale
Bari, Brindisi, Manfredonia, Barletta, Monopoli
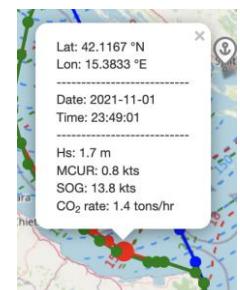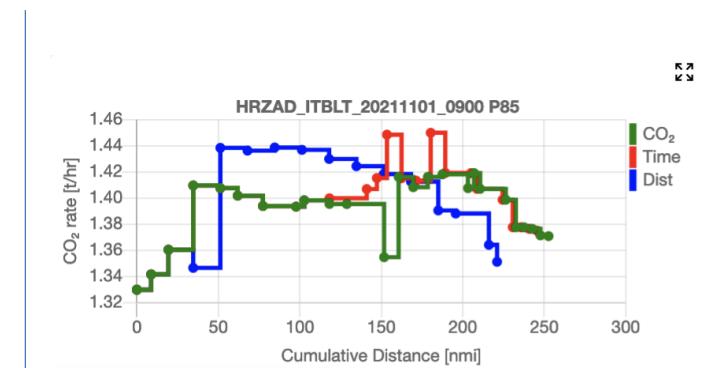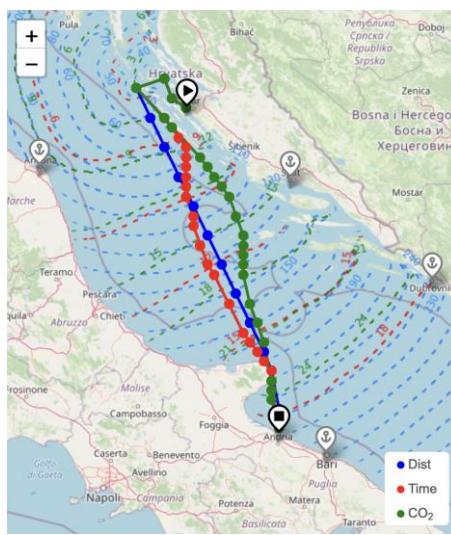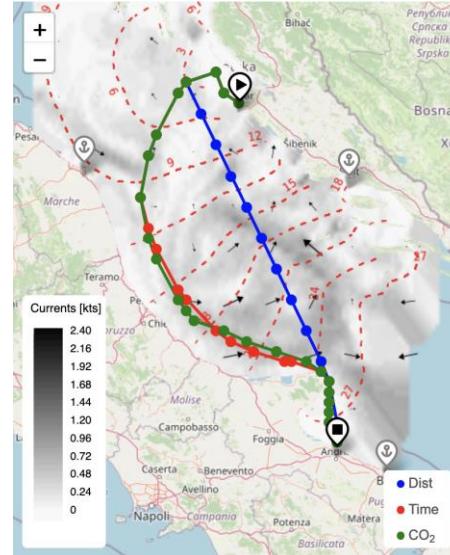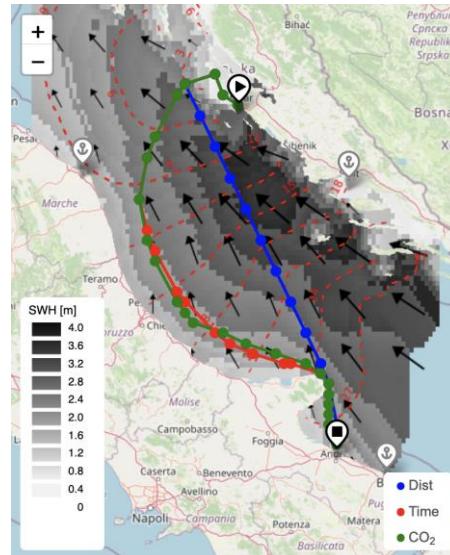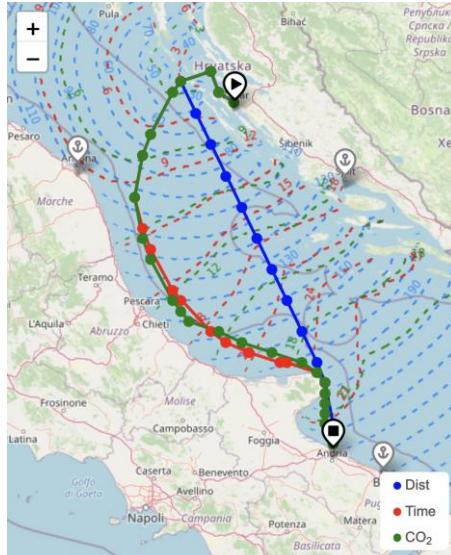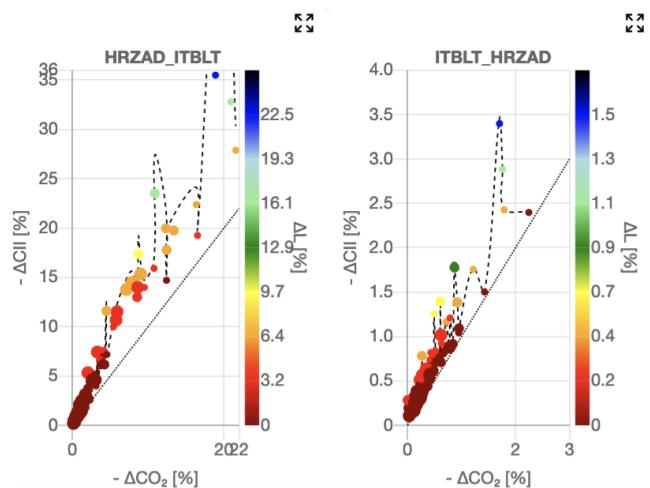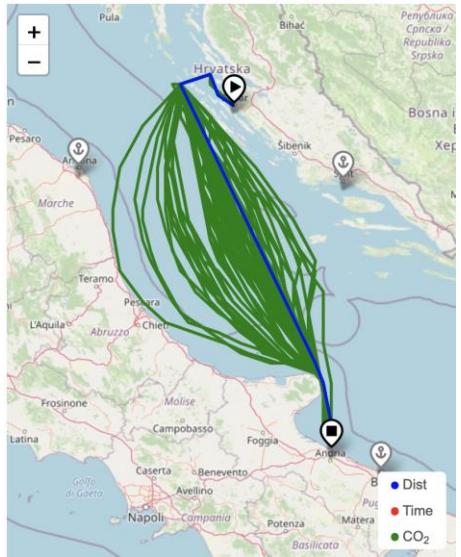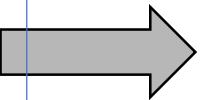
From a real ferry to the end user's device

①

L = 125 m
P_{ME} = 4,000 kW

②

installed at the University of Zadar
(Croatia)

③ rough and head seas ➔
speed loss & CO_2 emissions increase

a)

④ VISIR-2 cmcc

weights on graph

shortest paths

post-processing

www.visir-model.net

⑤ Route computation and visualization are parallelized

30 x

⑥ User browses results on own device

Some exemplary routes

UI functioning

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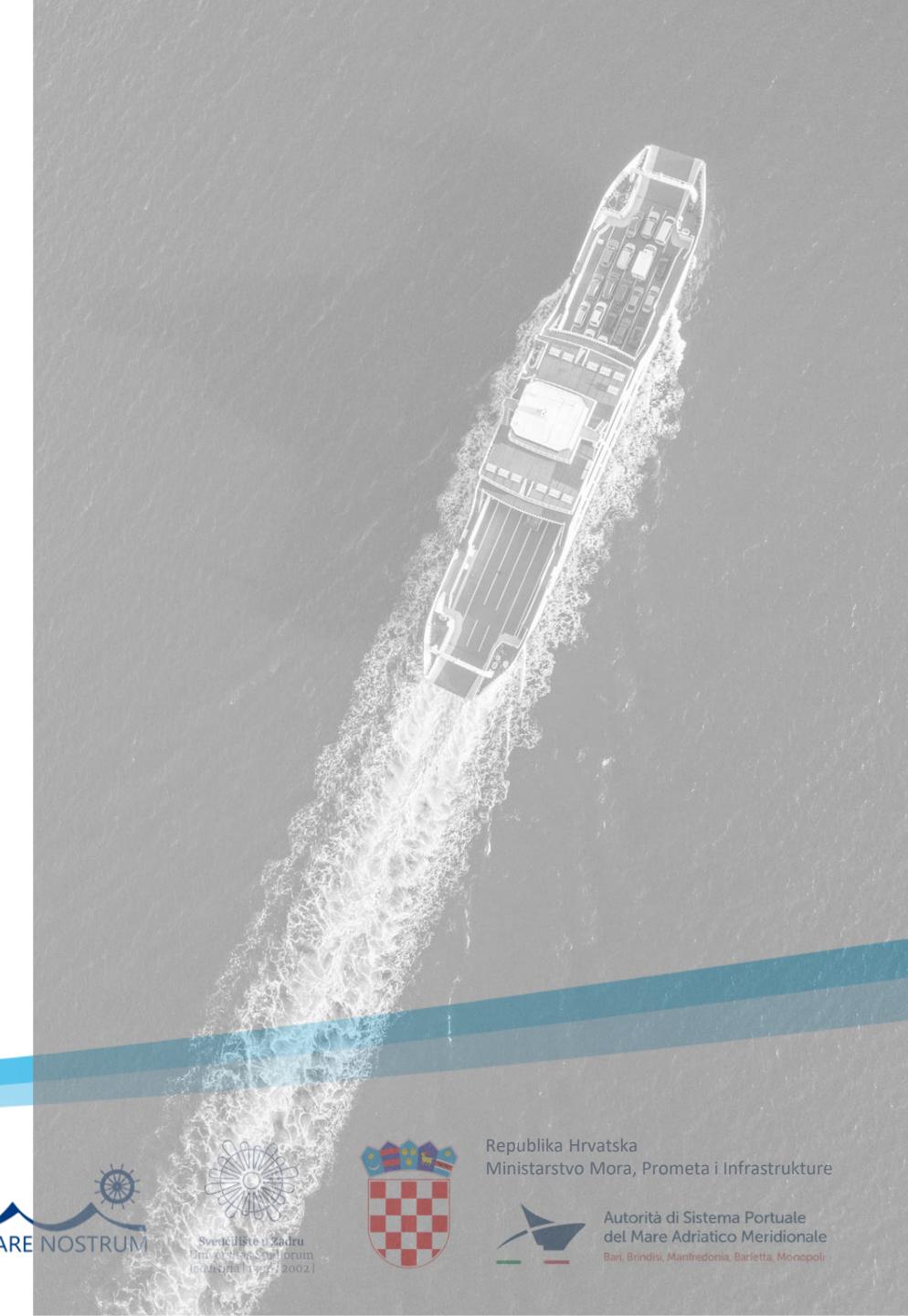
(15 x 2) routes operationally optimized

ITAOI_HRRJK

ITRAN_HRZAD

ITAOI_HRZAD

ITAOI_HRSPU

ITAOI_HRDBV

ITBLT_HRZAD

ITBRI_HRSPU

ITBRI_HRDBV

ITBDS_HRDBV

ITBRI_MEBAR

ITBDS_MEBAR

ITBRI_ALDRZ

ITBDS_ALDRZ

ITBDS_GRIGO

ITBDS_GRGPA

GUTTA routes
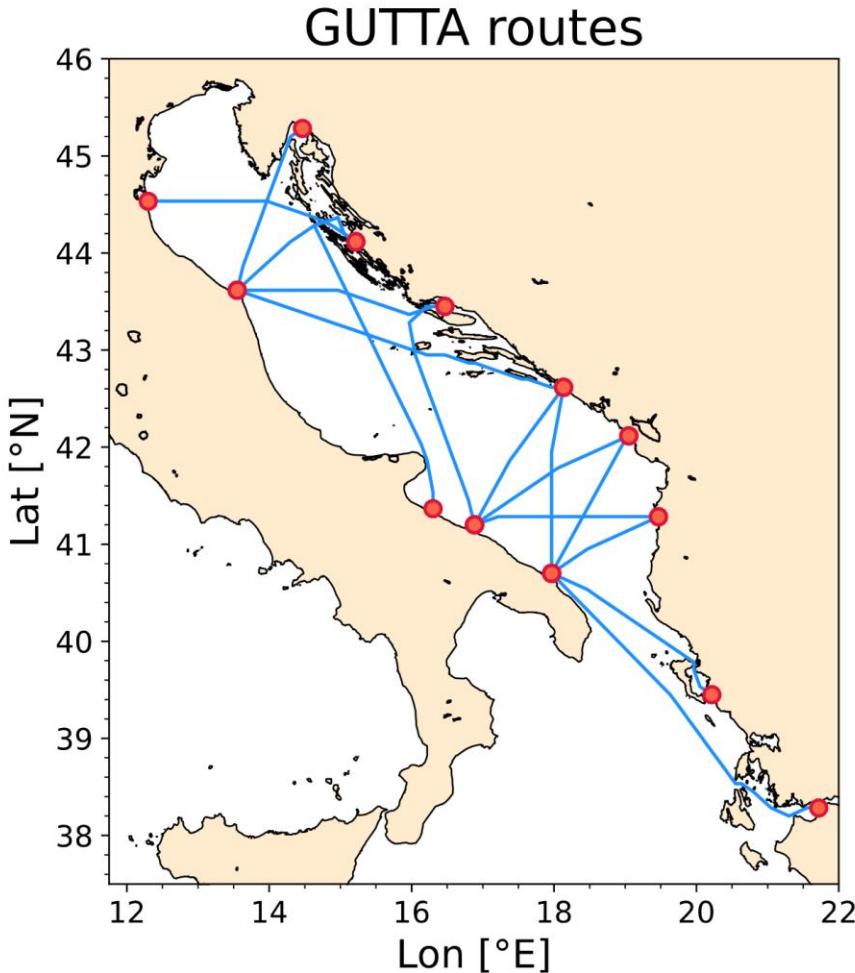
HRRJK_ITAOI

HRZAD_ITRAN

HRZAD_ITAOI

HRSPU_ITAOI

HRDBV_ITAOI

HRZAD_ITBLT

HRSPU_ITBRI

HRDBV_ITBRI

HRDBV_ITBDS

MEBAR_ITBRI

MEBAR_ITBDS

ALDRZ_ITBRI

ALDRZ_ITBDS

GRIGO_ITBDS

GRGPA_ITBDS

Route bundles

14 Dec 2021
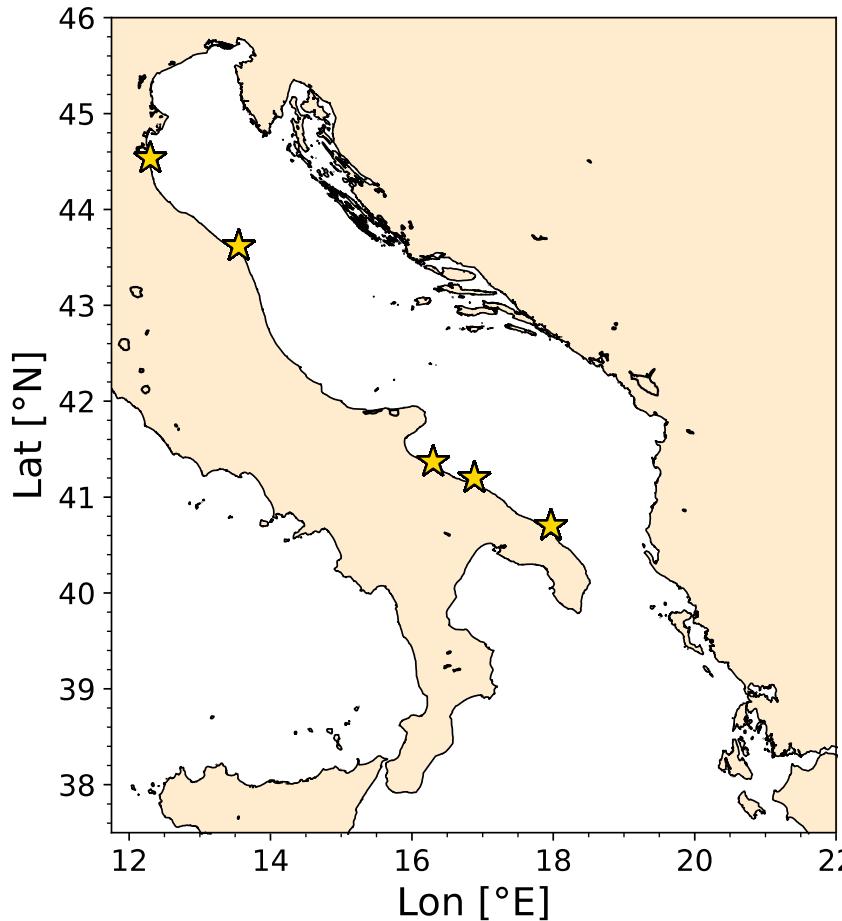
As departure date
and time are changed,

bundles of optimal
route arise

05 Nov 2021 — Eastbound

05 Nov 2021 — Westbound
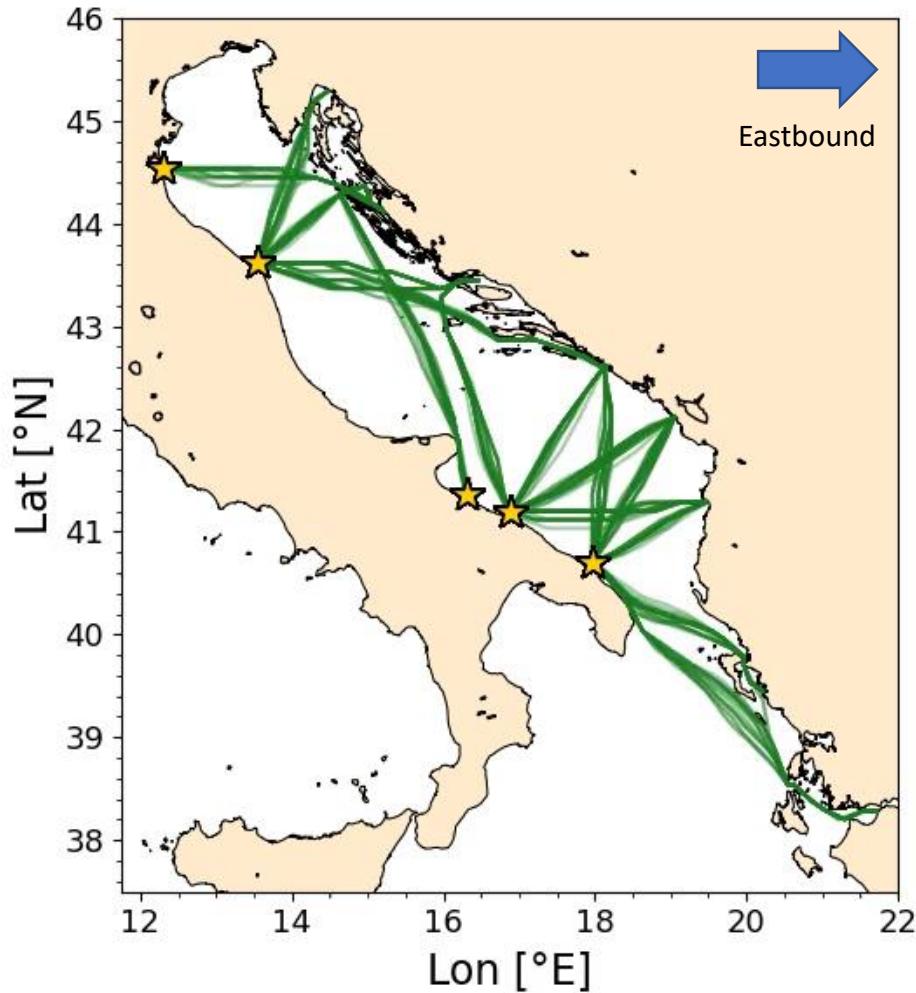
Animated bundles since GV in operation
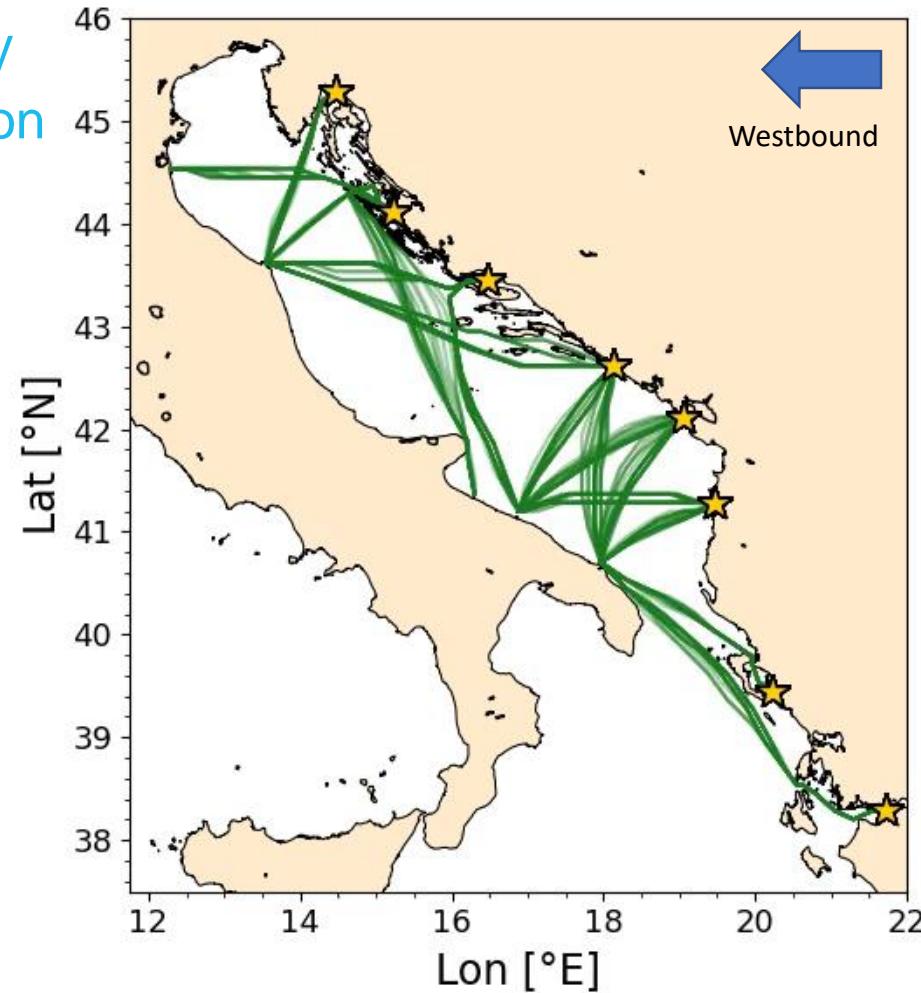
Statistical distribution of CO$_2$ savings

For any ordered route (ITBLT-HRZAD different from return voyage), iteration on:

- Departure dates/times
- Engine loads

Engine load of 70%

ITBRI_HRSPU 70

#outliers = 90 out of 735

CO2t savings [%]

median
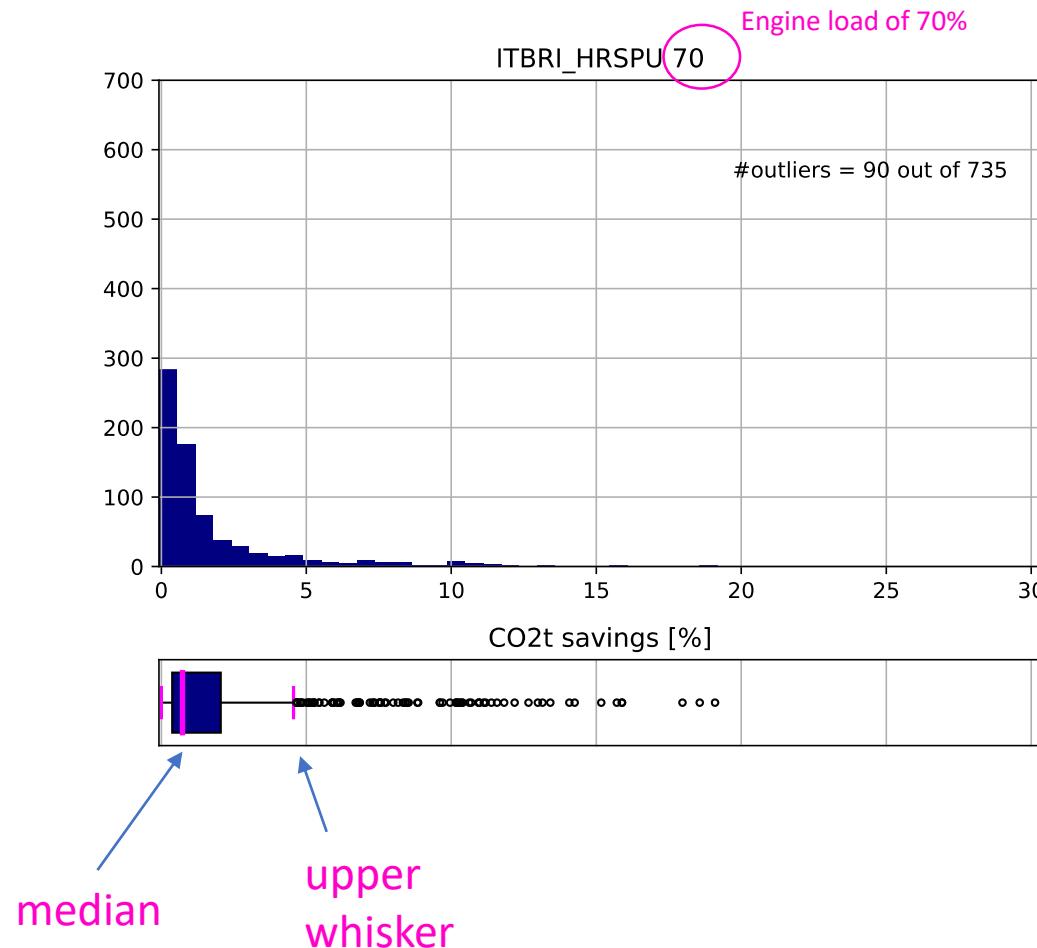
upper whisker

Nearly exponential distribution of CO$_2$ savings:

Larger savings: outliers

Consider:
- Median
- Upper whiskers

Filter by:
- East/Westbound routes
- Engine load

Eastbound routes -statistics

Nov 5th - Feb 4th

CO2t savings [load 70%]
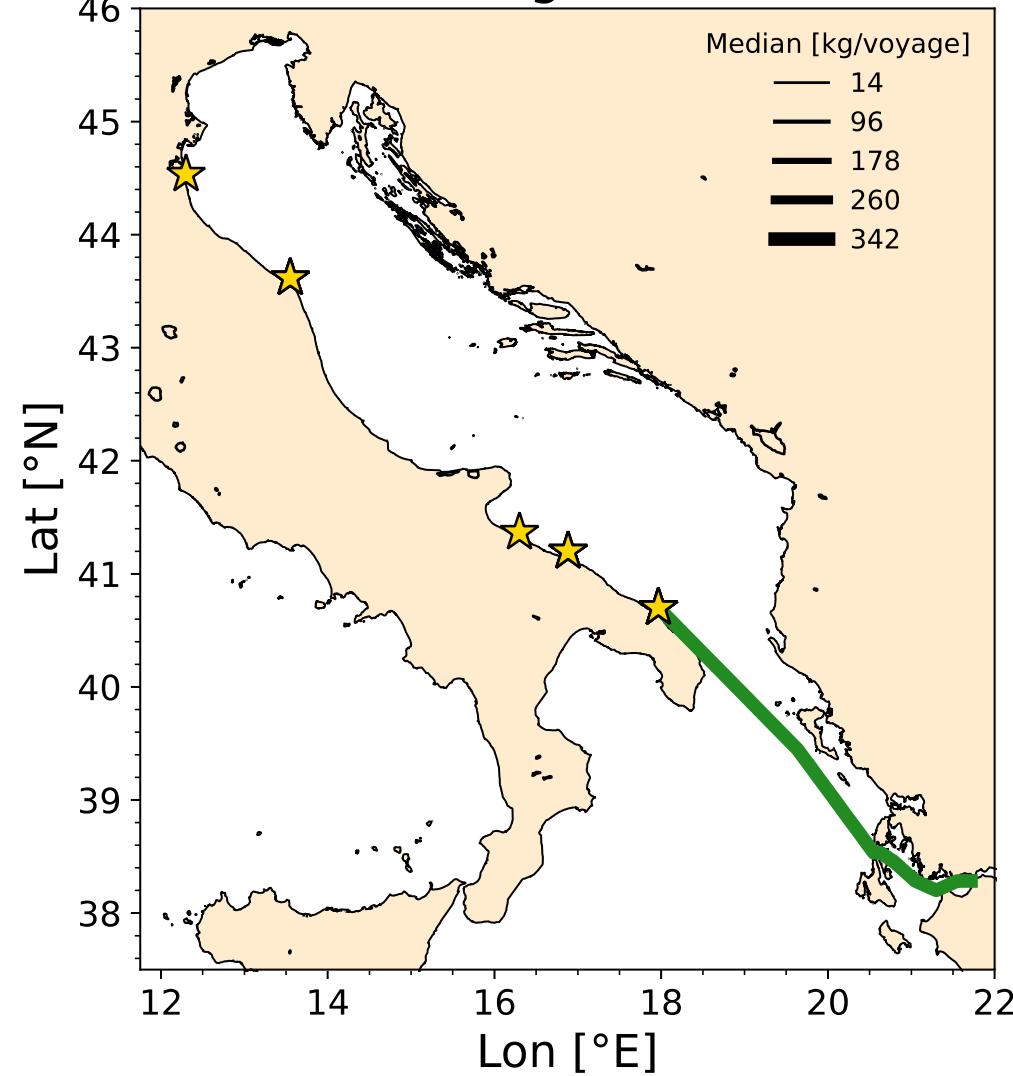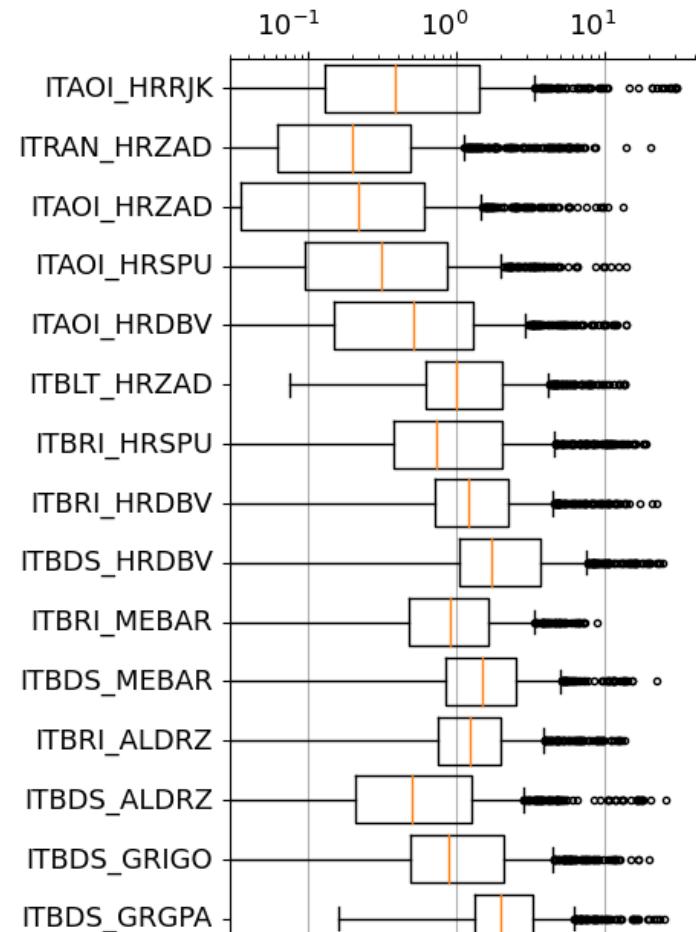
Westbound routes -statistics

Nov 5th - Feb 4th

CO2t savings [load 70%]
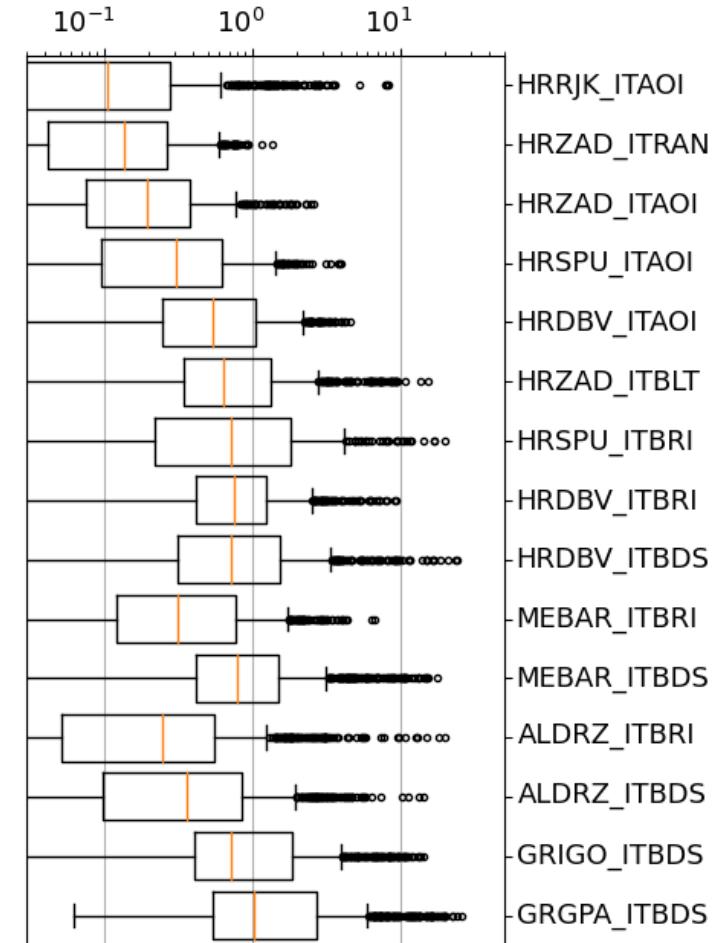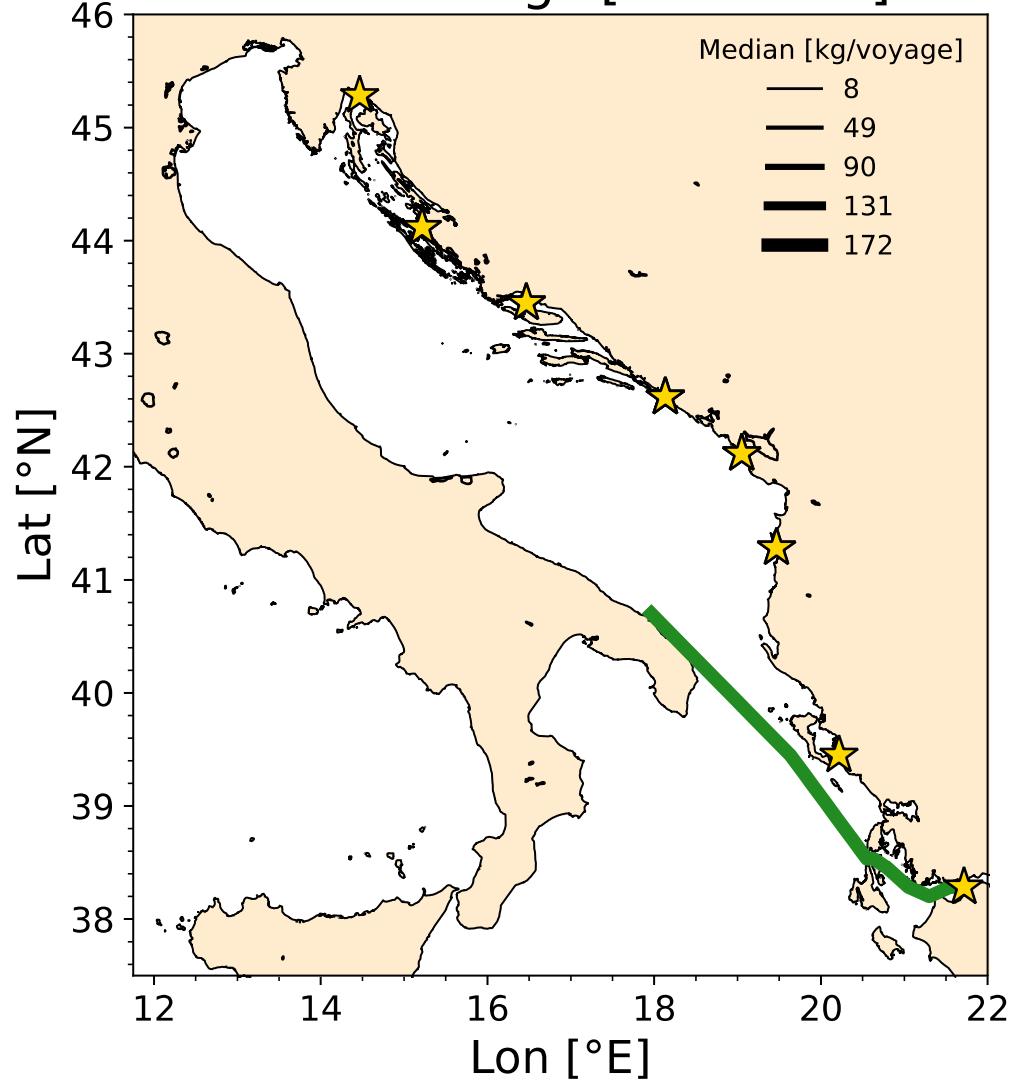
Annual CII savings

15 routes west- (east)-bound on odd(even) days for a 3 months period

	70%	85%	100%
CII % savings	1.17	0.63	0.39

Median values:

| CII	units	engine load		
		70%	85%	100%
AER	g/(t*mile)	16.7	21.9	28.7
EEOIpax	g/(pax*mile)	169	221	291
LmDIST	g/(m*mile)	54.1	70.8	93.0
CgDIST	g/(GT*mile)	4.83	6.32	8.30

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Annual CO$_2$ savings

15 routes west- (east)-bound on odd(even) days for a 3 months period:

first 3 months of GV
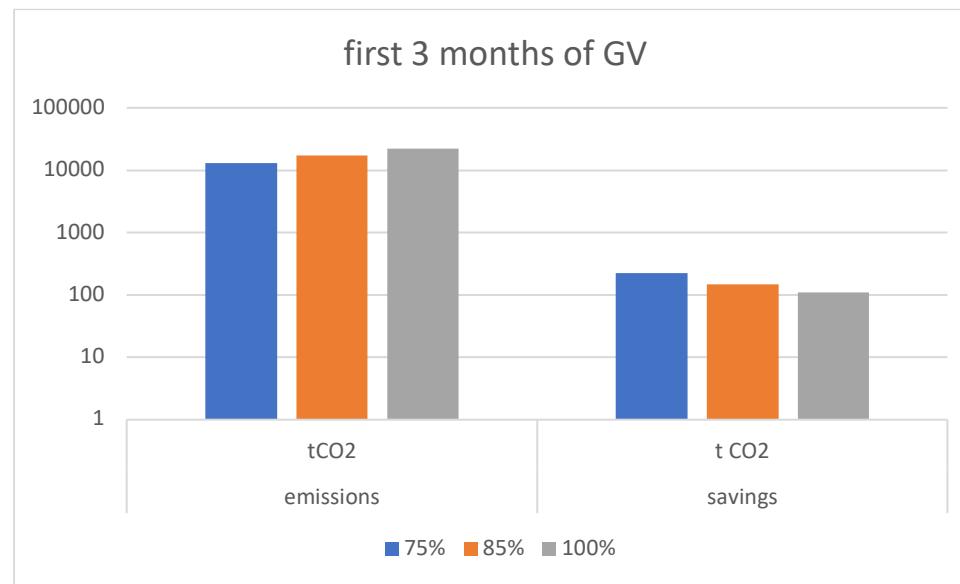
IMO#	Name	Engine load [%]	annual emissions [t CO$_2$]	Savings [t CO2]	EU-ETS value of the savings [EUR]
-	UniZd ferry on 15 days/ any other day	70	52,652	888	89-45 kEUR
		85	68,293	591	59-30 kEUR
		100	89,316	435	44-22 kEUR
7230599	MARKO POLO	-	12,155	-	-
7615048	DUBROVNIK	-	11,479	-	-
7602120	AURELIA	-	11,470	-	-
9021485	ZADAR	-	8,757	-	-
-	4 ferries above	-	43,860	-	-

EMSA \ THETIS-MRV

EU Carbon Permits (EUR) 58.32 -6.78 (-10.41%)

STOP WAR #stopwar

War in Ukraine

58.320

May   Jul   Sep   Nov   2022   Mar

1D 1W 1M 6M 1Y 5Y 10Y 25Y 50Y All

Conclusions & Outlook

GUTTA-VISIR

- A technological platform for assessing CII savings from routing, while minimizing CO_2 emissions

- Operational pre-computation from metocean forecasts:
  - 0-waiting time for the end-user
  - many routes (3510 / twice a day)

- Statistics for first 3 months:
- Large savings are statistically rare
- CII savings between 0.4 and 1.2%
- Mean CO_2 savings (0.5-2%), depending on engine load
- 500-1,000 tCO_2 could be saved yearly in the Adriatic Sea

- Feedback from users and maritime stakeholders needed:
  https://www.gutta-visir.eu/other/feedback

Thanks