

PROJECT TITLE: TOPVOYS

PRIORITY AREA: PA5 - Safety and security

SUBTOPIC: PA5: ICT tools for monitoring and optimization of maritime operations (e.g. routing following best weather conditions), PA5: Decision support systems, PA5: Improve operations such as dynamic positioning systems, docking and mooring systems, automation of processes, optimized routing, handling of goods, subsea intervention

PROJECT START DATE: June 2018

PROJECT MID-TERM DATE: December 2019

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PROJECT WEBSITE: <http://topvoys.nersc.no/>

PROJECT DURATION: 36 months

TOTAL REQUESTED FUNDING: 1.186.000 €

TOTAL COSTS: 1.740.000

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INTERNATIONAL COOPERATION

1. Have there been any change in the consortium composition during the second half of the project?

- Yes
 No

At CSIR a new scientist has replaced Dr. M. Krug in the project.

2. If your project had not received MarTERA funding would you have undertaken it anyway?

- Yes
 No

3. Do you apply for another grant, additional funding?

- Yes, with the whole consortium.
 Yes, with part of the consortium.
 No

We plan to look for opportunities for other grants both at EU level and at national level. Note also that another ESA funded project named World Ocean Circulation (WOC) is ongoing with

OceanDataLab Nansen Environmental and Remote Sensing Center and CMA-CGM as partners.

PROGRESS REPORT

1. Main results, conclusions and fulfilment of objectives (1/2 page)

The aim is to advance and implement analyses tools and decision support system for voyage optimization securing reduction in fuel consumption and emissions. A new tool aiming at providing value-added surface current product has been developed. This product is calculated from available forecasts and measurements.

The testing and evaluation of the tool have consisted in validating a new metric (based on identification of surface currents that are crossing sea surface temperature (SST) fronts) performance in a hindcast mode for different areas (Agulhas Current and the Arabian Sea). The first step consists in identification of regional areas and periods for which models represent significantly different current fields and where available in-situ observations (surface drifters or ship-based WatchReport) enable model assessments and discrimination. The second step then focuses on verification and whether the choice of the best product would have been the same using only satellite-based SST observations of mesoscale features and meandering fronts.

The comparison of the different products in terms of quality and reliability (metric values, scores) forms the basis for the selection of the best optimized route. The routing accounts for the metric values retrieved from the comparison between model-based velocity fields, satellite-based SST frontal locations and surface drifter data (when available). Near real time satellite data and in-situ data of the surface current and sea surface temperature fields are used for assessment of the model-based surface current field for ship routing. It has been demonstrated that synoptic satellite-based SST maps of surface frontal structures provide highly important evidence of meandering currents and eddies which are proxy for the surface currents dynamics. As such they allow assessment and validation of the quality of the model-based surface current products. Moreover, regular use of a wave ray-tracing model with different surface currents are run for simulations of possibly occurrences of extreme waves invoked by wave-current interaction. In so doing a reliable traffic-light system is provided by which the metric values for the pre-selected ship routes build on regular near real time updates of: (i) rapidly changing currents associated with meandering ocean fronts and eddies; and (2) likelihood of crossing seas leading to wave energy focusing and presence of dangerous waves. The work is still in progress for further testing in the Agulhas Current region and in the North Atlantic centered to the Gulf Stream region.

2. Did the project progress according to plan?

Yes

No

Comment (if no): Partly. Delays have been encountered due to the pandemic situation that prohibited onboard testing and assessment of the routing optimization. A no-cost extension was granted in the autumn of 2021 for termination of the project in April 2022.

Note that for the French partners, it has recently been agreed by the French Funding Authority

that the work may be extended to May 18, 2022, the final report itself, for the French partners' WP, being delivered by September 18, 2022. A similar request for extension will therefore be forwarded by the Norwegian partners to that the latest findings and achievements can be incorporated in the final report.

3. If you have marked "No" above, please comment on how you proceeded to improve the efficiency of the project coordination;

The project extension followed by a progress meeting at ACTIMAR in Brest (France) in November 2021 allowed us to agree and implement an updated work plan.

4. Were the coordination and organization of the project efficient?
- Yes
- Partially
- No
5. Is the contribution of each partner clearly identifiable?
- Yes
- Partially
- No
6. Was the schedule for completion of the project consistent/realistic?
- Yes
- Partially
- No
7. Was the collaboration between partners effective?
- Yes
- Partially
- No
8. Problems in the implementation of the work plan

In case you had any problem with the implementation of the work plan, please select the reason(s) that may explain the problems:

- Difficulties in recruiting personnel
- Poor communication between project partners
- Change of one project partner
- One or more partners underperforming
- Experimental/technical difficulties
- Other, please specify:

Comments (if applicable):

This international project has suffered from the regulations, restrictions and constraints imposed by the Corona pandemic on travels, exchange of scientists, running of training courses and planned visits onboard selected ships operated by CMA-CGM and Grieg STAR. Moreover, the rotation of personnel has also slightly affected the efficiency and progress of the project.

PROJECT OUTCOMES

Please indicate which crosscutting sectors would also benefit from the results of the project:

In accordance with the Priority Areas specified under the MarTERA program the cross-cutting sectors that would benefit from results of the project resides within: PA 3 - Automation, sensors, monitoring and observations and PA 5 - Safety and security.

1. Scientific outputs

Please indicate the publications resulting from the project activities, details on patents licenses corresponding to results from the project, the know-how, any other spin-offs from the project, any partnerships, etc. If the publication is accessible on-line, indicate the DOI or the website address.

List of results from the jointly conducted work					
Type of result	Number	Authors, title, year, issue/editor (if applicable)	Partner(s) involved	Open Access: Yes/NO (if applicable)	Website address (if applicable)
Peer review papers*	1	Johannessen, J.A., A. Perrin, L. Gaultier, S. Herledan, C. Pouplin, F. Collard, J.P.Maze, M. Dussauze, J. Rapp, R. Fanebust, S. Andersen, O. Franks & R. Meyer (2021), Tools for Optimizing Performance of VOYages at Sea, TransNAV International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 15, No. 1, March 2021.	NERSC, ODL, ACTIMAR, CMA-CGM, Grieg STAR, NMU, CSIR		DOI: 10.12716/1001.15.01.25 https://www.transnav.eu
Books or book chapter		1. 2. n.			
Publications co-authored by R&D and industrial partners		1. 2. n.			
PhDs delivered as part of the project					

<p>Conference proceeding/presentations</p>	<p>5</p>	<p>1) SPACEPORT Norway Conference, Stavanger, Norway, 22-24 May 2018. 2) MARTERA ERA-NET COFUND, Kick-off meeting, Paris, France, 15-16 October 2018. 3) Atlantic Workshop, Southampton, England, 23-25 January 2019. 4) World Ocean Circulation User Consultation Meeting, ESA-ESRIN, Frascati, Italy, 21-22 February 2019. 5) MarTERA Cofund Program midterm meeting, Trondheim, Norway, 24-25 September 2019.</p>	<p>NERSC, ODL, ACTIMAR, CMA-CGM, Grieg STAR, NMU, CSIR</p>		
<p>Patent applications</p>					
<p>International patent</p>					
<p>EU patent</p>					
<p>National patent</p>					
<p>Licenses</p>					
<p>New collaborative projects</p>					

Other	<p>Johannessen, J.A., A. Perrin¹, L. Gaultier, S. Herledan, C. Pouplin, F. Collard, J.P.Maze, M. Dussauze, J. Rapp, R. Fanebust, S. Andersen, O. Franks & R. Meyer (2021), TOPVOYS: Tools for Optimizing Performance of VOYages at Sea, MarTERA News Letter, November 2021.</p>	<p>NERSC, ODL, ACTIMAR, CMA-CGM, Grieg STAR, NMU, CSIR</p>	<p>YES MarTERA Newsletter</p>	<p>https://www.martera.eu/news</p>
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2. Innovation oriented results

2.1 Improvement of the competitiveness by incorporating any of the following solutions

Please mark with an X the corresponding option, if there is more than one, add a row to the table below for each identified solution.

Development of materials with better performance or lower cost	
Development of supplies with better performance or lower cost	
Development of components with better performance or lower cost	
Development of design strategy with better performance or lower cost	X
Development of models with better performance or lower cost	X
Development of more modern and efficient equipment at low cost	
Development of electronic components and specific software for its incorporation into the final product and the improvement of its benefits	
Design developments that make the product or its packaging more functional and attractive	
Other:	

2.2 Detail for each partner the major development(s) of the project:

Development	Partner (name)	Details
Product	Actimar	Merged (expertized) and blended (automated) surface current products.
Method	Actimar	Spatialization and combination of errors between numerical models and in situ observations.
	CSIR	Use of AIS data from the sailing routes around southern Africa.
	ODL/Actimar	Validation using satellite-based surface current and SST fronts. SST frontal detection algorithm used to assess and rank the quality of the surface current products derived from models and from satellites.
	NERSC	Software package for Integration of tools (GeoSPaaS and SynTool/SEAScope)
Model		
Process		
Service	Actimar	Provision of daily surface current forecast with a confidence index
	NMU/SAIMI	Disseminate the findings of the TOPVOYS research project to the South African and international shipping companies which rounds the southern African continent. Additionally make the results available via publication of the research results in professional Maritime magazines and recognized maritime and scientific research journals.
Equipment		
Prototype	OceanDataLab	Conversion routines implemented to add support in SEAScope for all required remote-sensing products (except microwave), Mercator ocean model currents, CMEMS Coriolis surface drifter data with drogue at 15m and Actimar's outputs
	NERSC	Implemented GeoSPaaS search engine for distributed databases and data repositories with subsequent downloading capabilities and delivery of relevant information products and data in compatibles file-format to SEAScope
	ODL/Actimar	Algorithm for Confidence Index of surface current information, Actimar's package Actiroute for the production and delivery of the service
New organizational method		

New marketing concept or strategy		
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Other, please specify:

2.3 Indicate the technical/operational characteristics of the technological development implemented, emphasizing the innovative component thereof:

Integration of near real time satellite data into ship routing services is innovate and demonstrated to advance the provision of reliable routing information with quality flags.

2.4 Specify which are the components or characteristics of the proposed solution that can be considered distinctive/original/innovative with respect to the current technology and specifically, in relation to the state of the art of the marine-maritime sector

It adapts to the productive specificities of the sector at local/regional level (topography, production system -intensive/extensive/to scale-, available resources, etc.)	
Responds to a new productive problem, for with there are no solution implemented at the local/regional level	
Replaces a technology that currently needs to be imported	X
Solve a current problem with a new methodology/technology and generate positive effects on the environment	X
It allows to use the available resources efficiently	X
Other:	

3. Relations with stakeholders (end-users, policy makers, authorities etc.)

3.1 Who are the identified stakeholders of the project?

Shipping companies in general and especially CMG-CGM and Grieg STAR.

3.2 Have you actively approached or been approached by any companies or stakeholders during the project for exploitation of your project results?

Yes, we have been actively approached

Yes, we have been approached

No

Comment: The TOPVOYS publication in the NAVSTAR Journal has sparked a lot of interests and request for more information about the method and products. The findings and results are also being inquired in the ongoing ESA funded WOC project.

3.3 Have you invited policymakers/authorities to project related events/networking?

Yes

No

Comment:

4. Further exploitation and dissemination activities of results (workshops, conference to socio-economic actors, lectures...) (if applicable)

The project has been presented and discussed at the following meetings, workshops and conferences:

- SPACEPORT Norway Conference, Stavanger, Norway, 22-24 May 2018.
- TOPVOYS project meeting, Brest, France, 11-12 October 2018.
- MarTERA ERA-NET COFUND, Kick-off meeting, Paris, France, 15-16 October 2018.
- Atlantic Workshop, Southampton, England, 23-25 January 2019.
- World Ocean Circulation User Consultation Meeting, ESA-ESRIN, Frascati, Italy, 21-22 February 2019.
- TOPVOYS project meeting, GRIEG Star, Bergen, Norway, 27 March 2019.
- TOPVOYS project meeting, CSIR, Cape Town, South Africa, 2 May 2019.
- TOPVOYS project meeting, CMA-CMG, Marseille, France, 12 August 2019.
- MarTERA ERA-NET Co-fund Program midterm meeting, Trondheim, Norway, 24-25 September 2019.
- TOPVOYS project meeting, ACTIMAR, Brest, France, 2-3 December 2019.
- On-line TOPVOYS Project Meeting, 10 February 2021
- TOPVOYS Project Meeting, ACTIMAR, Brest, France, 22 November 2021.

5. Transnational implementation of results

High

Moderate

Minor

Comment:

6. Did you achieve any result that would not have been possible without the consortium?

No

Yes. Please, specify:

Connection between the tools developed by NERSC, ODL, Actimar.

7. Outreach activities towards the general public (if applicable)

8. Did your research already have other unexpected impacts?

High

Moderate

Minor

Not applicable

Comment:

CONTRIBUTION TO OVERALL AIMS OF ERA-NET MarTERA

In this part of the questionnaire, we ask you to assess your contribution to overall aims of this ERA-NET.

The overall goal of the ERA-NET Cofund MarTERA is to strengthen the European Research Area (ERA) in maritime and marine technologies as well as Blue Growth.

Please, indicate in the bullet list of challenges below your contribution(s) to MarTERA Research Areas:

Contribution of your project in each of the MarTERA Research Areas:

1. **Environmentally friendly maritime technologies:** Reduction of emissions and underwater noise, waste and ballast water management, innovative propulsion systems, advanced technologies for the use of new fuels, detection and response capacities to oil spills and marine pollutions, voyage optimization, on-board power, vessel efficiency and energy management, technologies for sensitive regions etc.

Substantial

Moderate

Minor

Not at all

Comment:

2. **Development of novel materials and structures:** Novel materials, biofouling and corrosion prevention, development of technologies for economic and environmental sustainable renewable energy from sea; technologies for detection and removal of munition; new vessel design; development, monitoring, maintenance and dismantling of maritime structures etc.

Substantial

Moderate

Minor

Not at all

Comment:

3. **Sensors, automation, monitoring and observations:** Sensor developments; underwater technologies for inspection, intervention, monitoring and control; development of intelligent and cost efficient systems and devices; path planning, guidance, navigation and control methodologies for marine vessels, including multiple cooperative vehicles (incl. swarm technologies) etc.

Substantial

Moderate

Minor

Not at all

Comment:

4. **Advanced manufacturing and production:** Top quality, globally competitive and environmentally friendly products; optimization of production; automation of production; intelligent/innovative interacting components; human computer interaction and Augmented Reality etc.

Substantial

Moderate

Minor

Not at all

Comment:

5. **Safety and security:** Individual safety concepts harmonized with navigational requirements; intelligent predictive maintenance systems; ICT tools for monitoring and optimization of maritime operations; hinterland connection to inland waterways ; early warning and accident management systems; evacuation and rescue concepts etc.

Substantial

Moderate

Minor

Not at all

Comment:

HUMAN RESOURCES INVOLVED

Academic level	Number of persons involved in project activities	Gender (F/M)
Master degree	5	4/1
PhD degree	9	7/2
Post-doc		
Graduation degree	1	0/1
Undergraduate		

6. Following the end of the project, do you expect new positions to be linked to the project (hired by one of the partners for example?)

- Yes
 Partially
 No

Comment:

7. Following the end of the project, do you expect new positions to promote the experience gained from the project?

- Yes
 Partially
 No

Comment:

FINANCIAL STATUS

1. Use of resources

Partner	Budget requested	Budget used (in %) Per end of 2021	Comment
Actimar	149 keuro	90%	10% left to be used by the end of the project.
OceanDataLab	295 keuro	75%	25% left to be used by the end of the project.

CSIR	100 keuro	not reported	
NERSC	478 keuro	90%	10% left to be used by the end of the project.
CMA-CGM	50 keuro	90%	10% left to be used by the end of the project.
Grieg Star AS	60 keuro	72%	28% left to be used by the end of the project.
SAIMI	54 keuro	not reported	

2. Describe if there were any deviations from the budget and justify:

The deviation of the budget is entirely connected to the no-cost extension of the project.

ADDITIONAL COMMENTS TO THIS REPORTING

1. Free comments from the coordinator

General comments at the coordinator's discretion, on the state of project progress, interaction between partners.

The project has been very interesting to coordinate, although challenging due to the restrictions and constraints imposed by the Corona pandemic. The latter has caused some delays and lack of opportunities to execute specific tasks such as tool testing and assessment onboard vessels at sea. However, novel methods have been developed leading to promising findings and results for ship voyage optimization leading to possible reduction in fuel consumption and emission. The methods are currently being tested for ship voyages passing the Arabian Sea and waters around Southern Africa. The findings and achievements will be presented in the Final Report.

2. Free comments from partners

General comments from the other partners if appropriate.

Actimar: The project helped us developing and improving new services for ship routing, from combinations of available operational forecasts and different satellite and in-situ observations. Improved current fields are delivered along with more robust confidence index. Some part of the service is automated, but improvement has still to be made to achieve a full-automated service.