CMA SHIPS

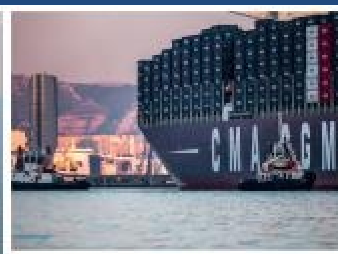
CMA CGM Group

Container Ships Consumption Models

Ship Efficiency 2015 by STG: 5th International Conference, Hamburg

Jean-Baptiste BOUTILLIER - Sadok MALLEK

Hamburg, 28/09/2015



Excellence in Shipmanagement

CMA SHIPS

▪ Content

1. Introduction

▪ The group presentation

CMA CGM, a leading world wide shipping group

Led by its founder, Mr Jacques R. Saadé, CMA CGM is the world’s third largest container shipping company.

CMA CGM Group is today a global enterprise operating on all the world’s shipping routes and offers the full range of logistics and transportation services to its customers.

From its base in Marseille, the CMA CGM Group is present in more than 160 countries through its network of over 655 agencies, with more than **20,000 employees worldwide (4,500 in France).**

▪ The group presentation

2014 Key figures

16.7 billion Revenue in USD	12.2 million Volume transported in TEUs	445 Vessel fleet
1.648M Fleet's slot capacity in TEUs	655 Offices worldwide	400 Ports of call in 160 countries
170 Shipping lines	20,000 Employees worldwide	4,500 Employees in France

▪ CMA Ships presentation

CMA CGM

- MARITIME
  - CMA CGM
  - ANL
  - DELMAS
  - MacAndrews
  - كوماناف COMANAV
  - CNC
  - USL U.S. LINES
- ACTIVITES PORTUAIRES
  - TERMINAL LINK
  - CMA TERMINALS
- INTERMODAL
  - GREENMODAL TRANSPORT
  - TCX
  - PROGECO CONTAINER MANAGEMENT
- ACTIVITES SUPPORT
  - CMA CGM LOGISTICS
  - CMA SHIPS
  - CMA SYSTeMS

CMA Ships

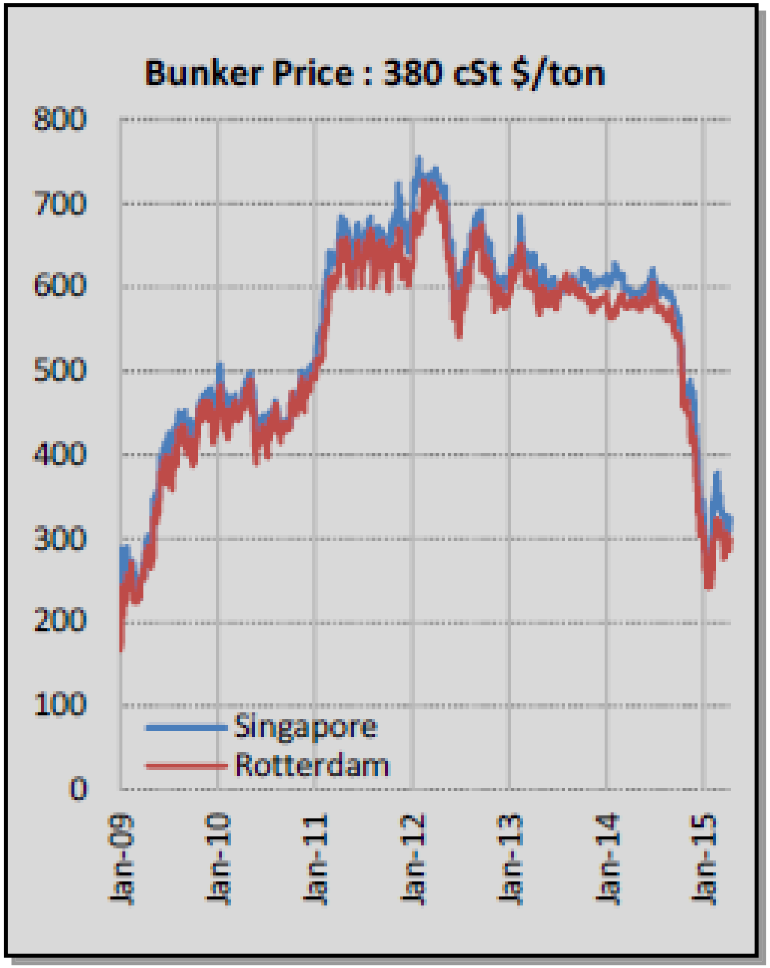
- Wholly owned subsidiary of CMA CGM group.
- Mission: managing all fleet related operations of the group owned and bare boat chartered vessels (116 vessels).

* The implementation of the transaction is subject to the prior clearances from the relevant competition authorities; until then OPDR and CMA CGM remain competitors

▪ Global context

- ➢ Huge variations of the fuel price.
- ➢ Strong pressure of the energy cost on the group results.
- ➢ New regulations. eg :**E**nergy **E**fficiency **D**esign **I**ndex **(EEDI).**

CMA CGM commitment

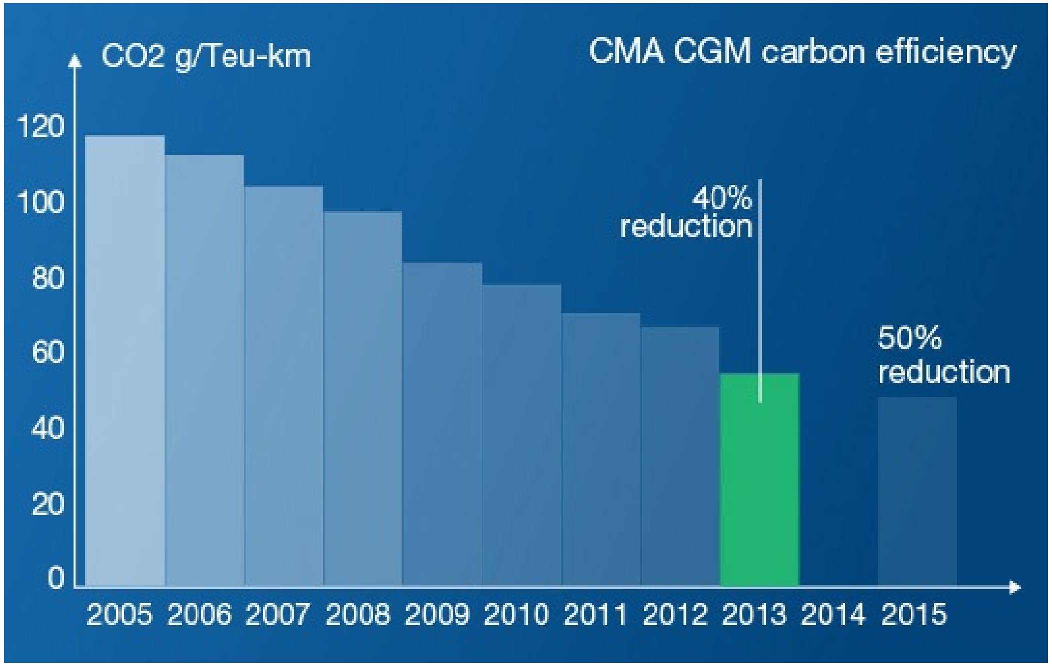


(Source: Alphaliner)

▪ CMA CGM commitment in CO_2 reduction:

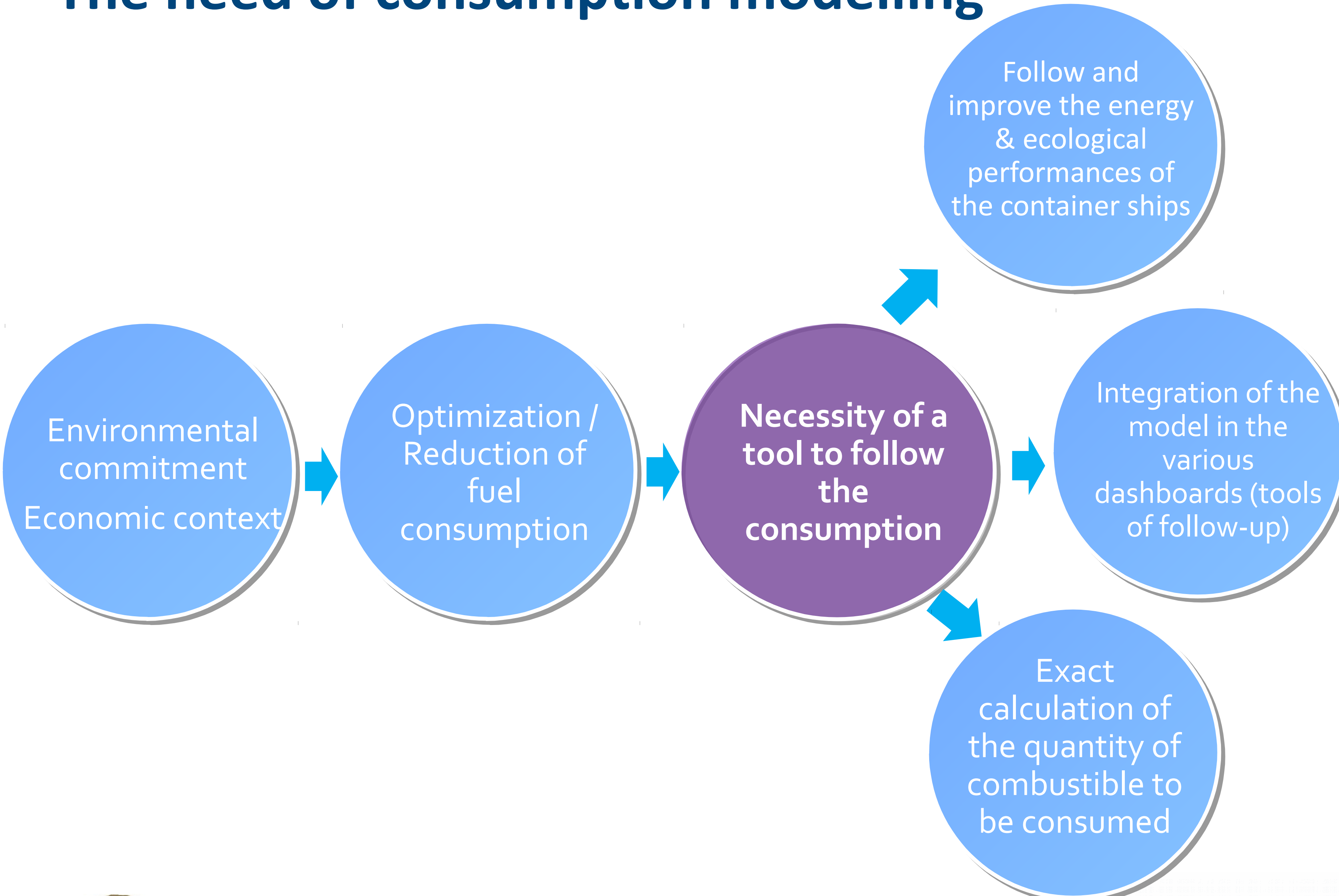
CMA CGM has established three major strategic areas of focus:

- ✓ **Energy, Climate Change, and Air Quality**
- ✓ **Oceans, Marine Environment, and Biodiversity**
- ✓ **Innovations, Solutions, and Sustainable Transport Services**



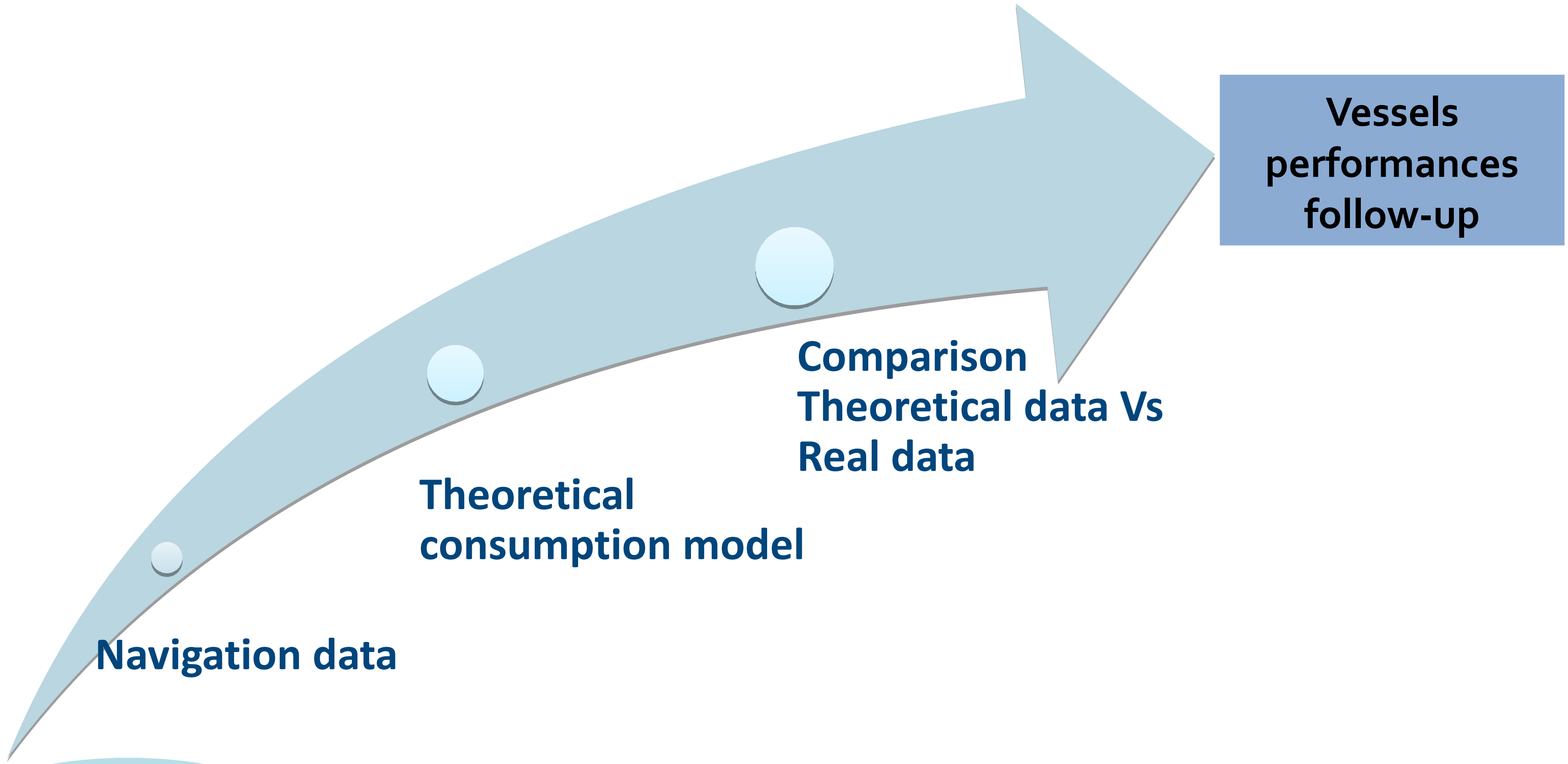
CMA CGM set itself the ambitious goal of reducing CO2 emissions by 50% per container per km by 2015. **In 2013, CMA CGM carbon efficiency has improved by 40%**, one of the sector's best performances.

▪ The need of consumption modelling



2. Presentation of the model developed

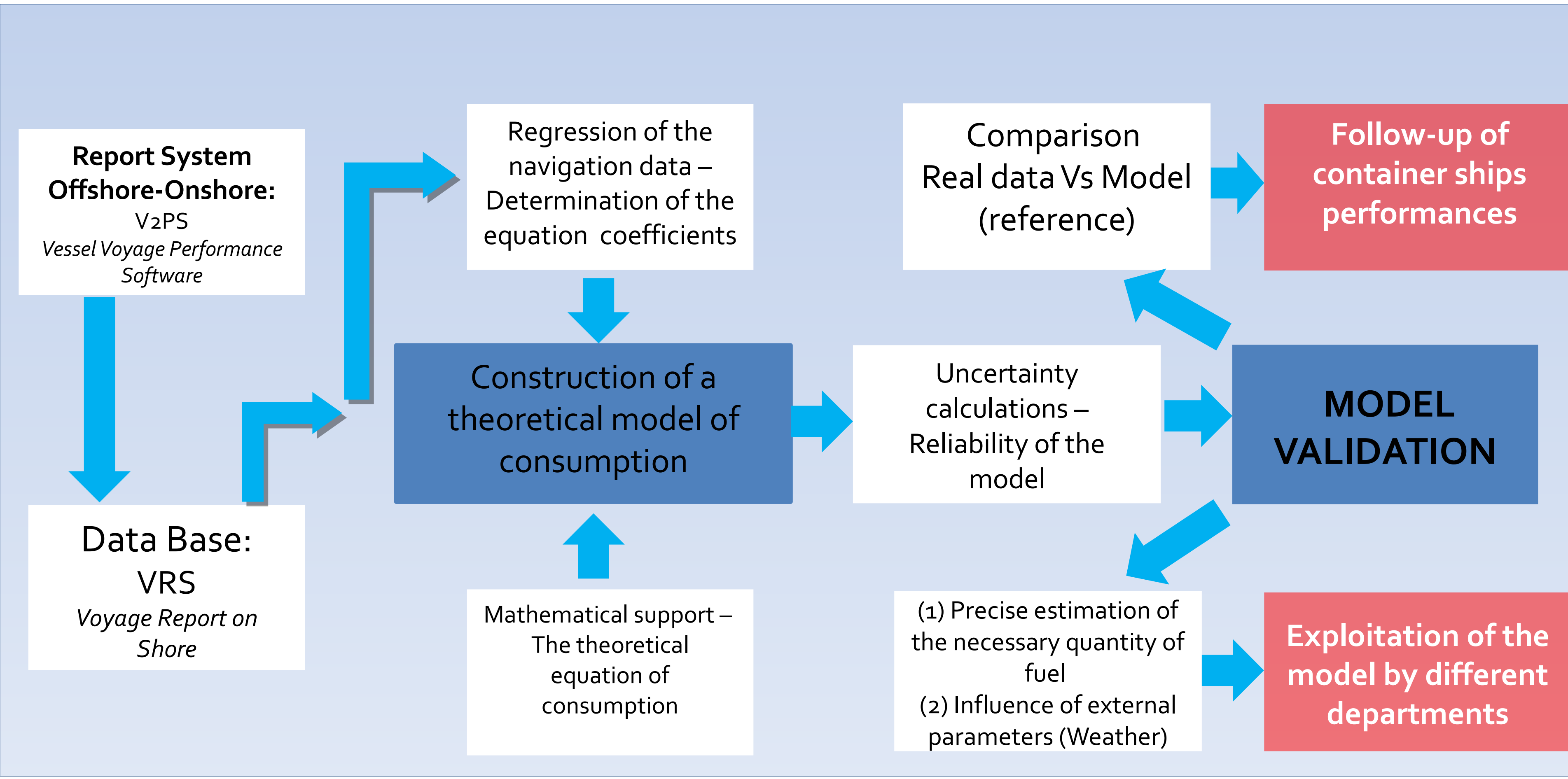
▪ The approach



BIG DATA

Hydrodynamic studies: Ship resistance
Econometric / Statistical analysis vs analytic study
Setting the parameters

▪ Methodology



▪ The preliminary Model development

Preparation of navigation data

- Data export from VRS
- Data cleansing

Application of the regressions

- Definition of variables then launch of regressions

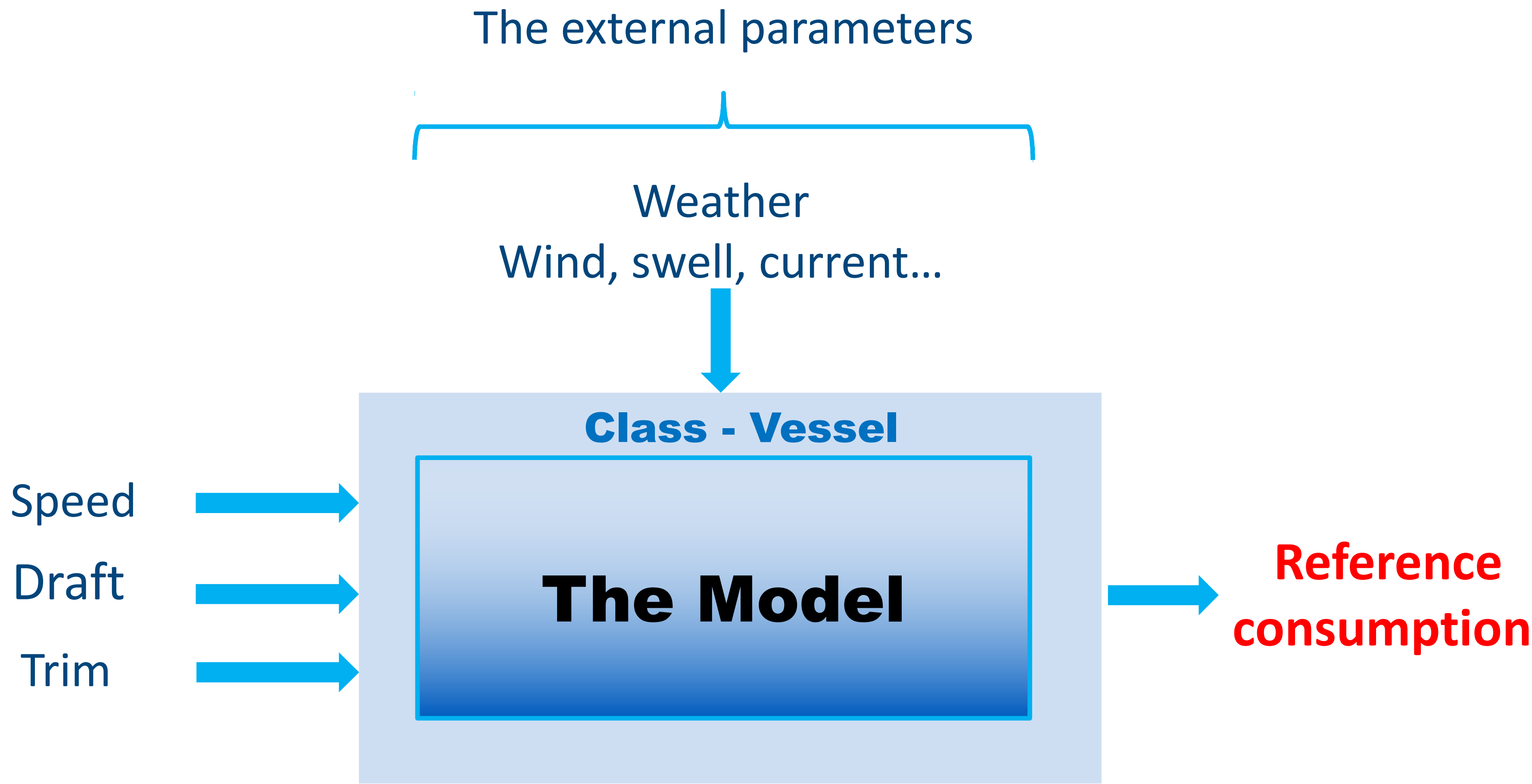
The theoretical approach

- Theoretical equation of consumption – Mathematical support

Analysis and interpretation of the regressions

- Matching : Theoretical model support with Regressions results
- Validation of the calculations

▪ The model parameters



▪ The parameters selected

The consumption = Function of

- *Speed*
- *Draft*
- Trim
- Wind speed
- Wind sector
- Vessel condition (Hull & Engine)

Continuous variables (Speed, Draft)

(First regression)

Discrete variables (Trim, Wind speed, Wind sector, Vessel condition)

(Second regression)

External conditions → Wind speed, Wind sector

▪ The theoretical approach

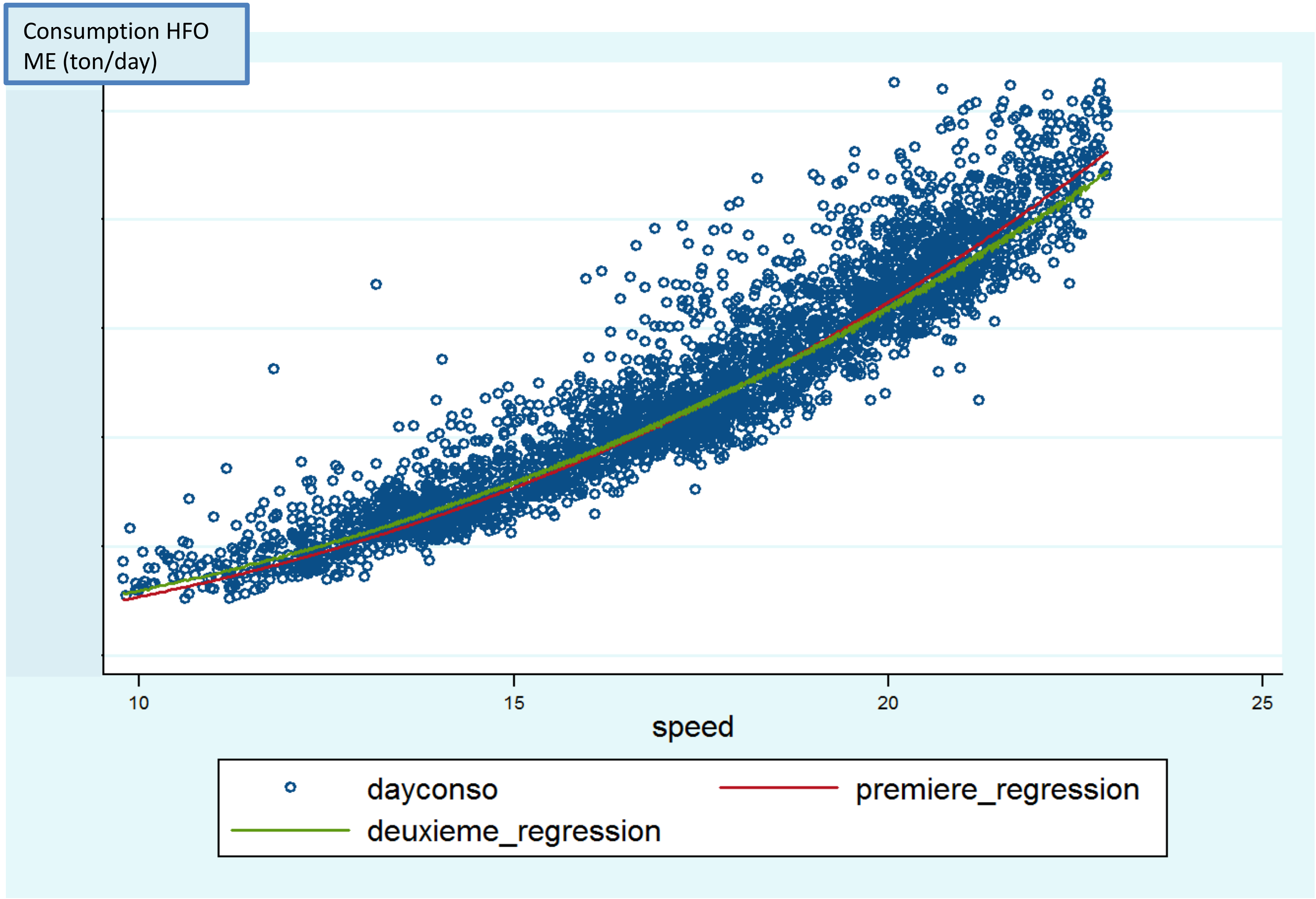
$$Consumption = \beta * (Speed)^{\alpha}$$

$$\ln(C) = \ln\beta + \alpha \ln Sp + \varepsilon$$

$$\mathbf{\ln C = \alpha \ln(Sp) + \gamma \ln(D) + \varepsilon'}$$

▪ The results of regressions

13800 TEU Class – CMA CGM LAPEROUSE



• Jean-Baptiste BOUTILLIER
• Sadok MALLEK

▪ The results of regression

Source	SS	df	MS
Model	666.255205	16	41.6409503
Residual	49.0267477	3340	.014678667
Total	715.281952	3356	.213135266

Number of obs	=	3357
F(16, 3340)	=	2836.83
Prob > F	=	0.0000
R-squared	=	0.9315
Adj R-squared	=	0.9311
Root MSE	=	.12116

ldayconso	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lspeed	2.416784	.012799	188.83	0.000	2.391689	2.441879
ldraft	.0486282	.0202928	2.40	0.017	.0088406	.0884157
bystern	.0105157	.0052602	2.00	0.046	.0002022	.0208292
bybow	-.0452146	.0065239	-6.93	0.000	-.0580058	-.0324235
wind_speed_2	.0292606	.0056636	5.17	0.000	.0181562	.040365
wind_speed_3	.0507822	.0060141	8.44	0.000	.0389906	.0625738
wind_speed_4	.0914604	.0070638	12.95	0.000	.0776107	.1053102
wind_speed_5	.2004761	.0082036	24.44	0.000	.1843914	.2165607
wind_dir_1	.0419107	.006404	6.54	0.000	.0293545	.0544669
wind_dir_2	.0384713	.0063797	6.03	0.000	.0259627	.0509799
wind_dir_4	-.0700084	.006826	-10.26	0.000	-.083392	-.0566248
wind_dir_5	-.0960802	.0060287	-15.94	0.000	-.1079005	-.0842598
vespucci	.0306051	.0066608	4.59	0.000	.0175455	.0436647
colomb	.0232977	.0066293	3.51	0.000	.0102997	.0362956
cortereal	.0149423	.0068068	2.20	0.028	.0015963	.0282883
magellan	.0102133	.0067275	1.52	0.129	-.002977	.0234037
_cons	-2.30559	.0510389	-45.17	0.000	-2.405661	-2.205519

α_i

$$Consumption = \left(1 + \sum_i (e^{\alpha_i} - 1)\, x_i\right) * e^{(constant + \alpha_{speed} * \ln(speed) + \alpha_{draft} * \ln(draft))}$$

▪ Final equation of the consumption

$$\text{Consumption} = \exp^{(\text{Constant} + \alpha_{\text{speed}} * \ln(\text{speed}) + \alpha_{\text{draft}} * \ln(\text{draft}))} *$$
$$(1 + \beta_{\text{trim}} + \beta_{\text{wind\_speed}} + \beta_{\text{wind\_sector}} + \beta_{\text{vessel}})$$

3. Model improvements

Model improvements

- Update of input data
  (Evolution of the daily reports , updating the vessels list)

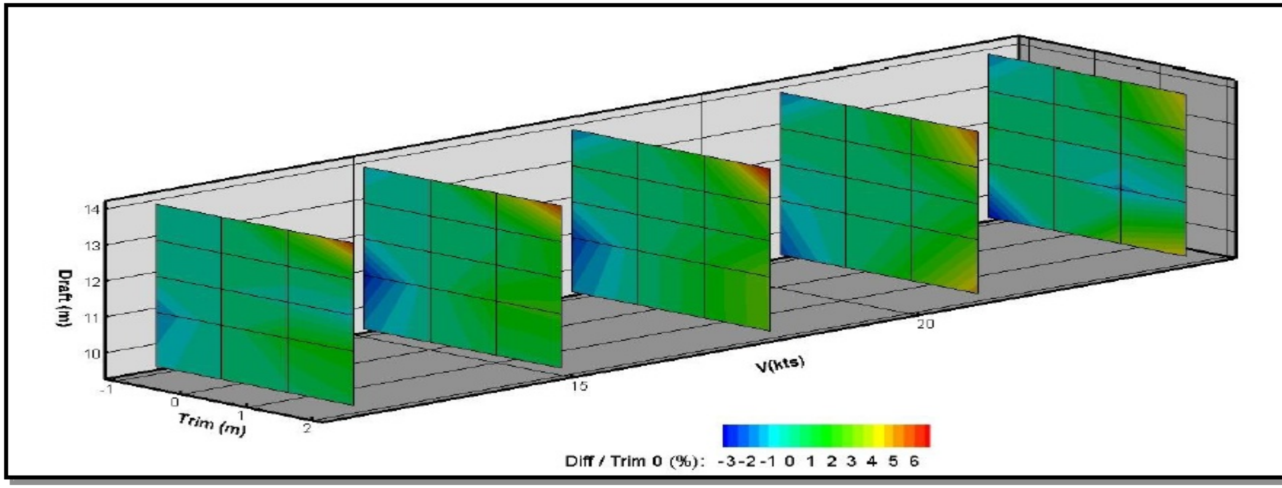
- Modification of the existent filters
  (Navigation duration, Extreme value of the speed and the consumption)

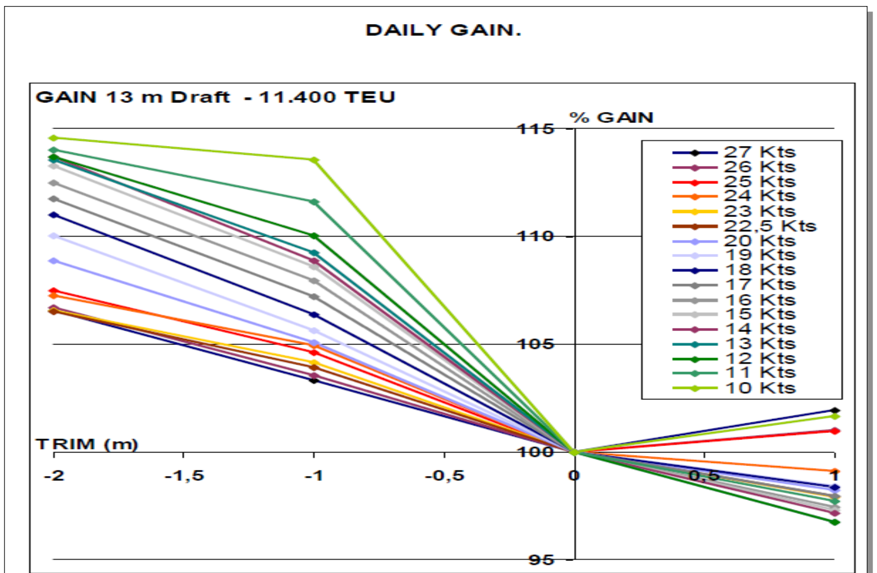
- Application of new filters
  (Trim, speed range according to container ships class)

- the reference values
  (vessel, trim)

Improve the reliability / robustness of the model

▪ Trim Optimization





The optimal trim depends on speed and draft.

▪ Trim optimization

- For the old model, the trim takes a fixed coefficient independent of speed & draft.

→ Discretization of the trim parameter (depending on speed & draft range).

→ Exploitation of the numerical calculations (CFD) and the model tests results to obtain a theoretical coefficient for the trim.
(Correlation: Developed Model – Numerical calculations)

▪ Development of a tool to present the results

- Storing the regression results (Equation coefficients)

- Presenting the results as consumption curves.

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM LAPEROUSE	Class 13800	14	Even Keel	3	Travers

Vessel:
16000
CMA CGM JULES VERNE
CMA CGM A VON HUMBOLDT
CMA CGM MARCO POLO

13800
CMA CGM LAPEROUSE
CMA CGM AMERIGO VESPUCCI

Draft (m):
12,5
13
13,5
14
14,5
15
15,5
16

Trim:
Choisir the TRIM

1m By Bow
Even Keel
1m By Stern
2m By Stern

Wind Force (Bf):
Choisir WIND FORCE (bf)

0
1
2
3
4
5

Wind Sector:
Choisir WIND SECTOR

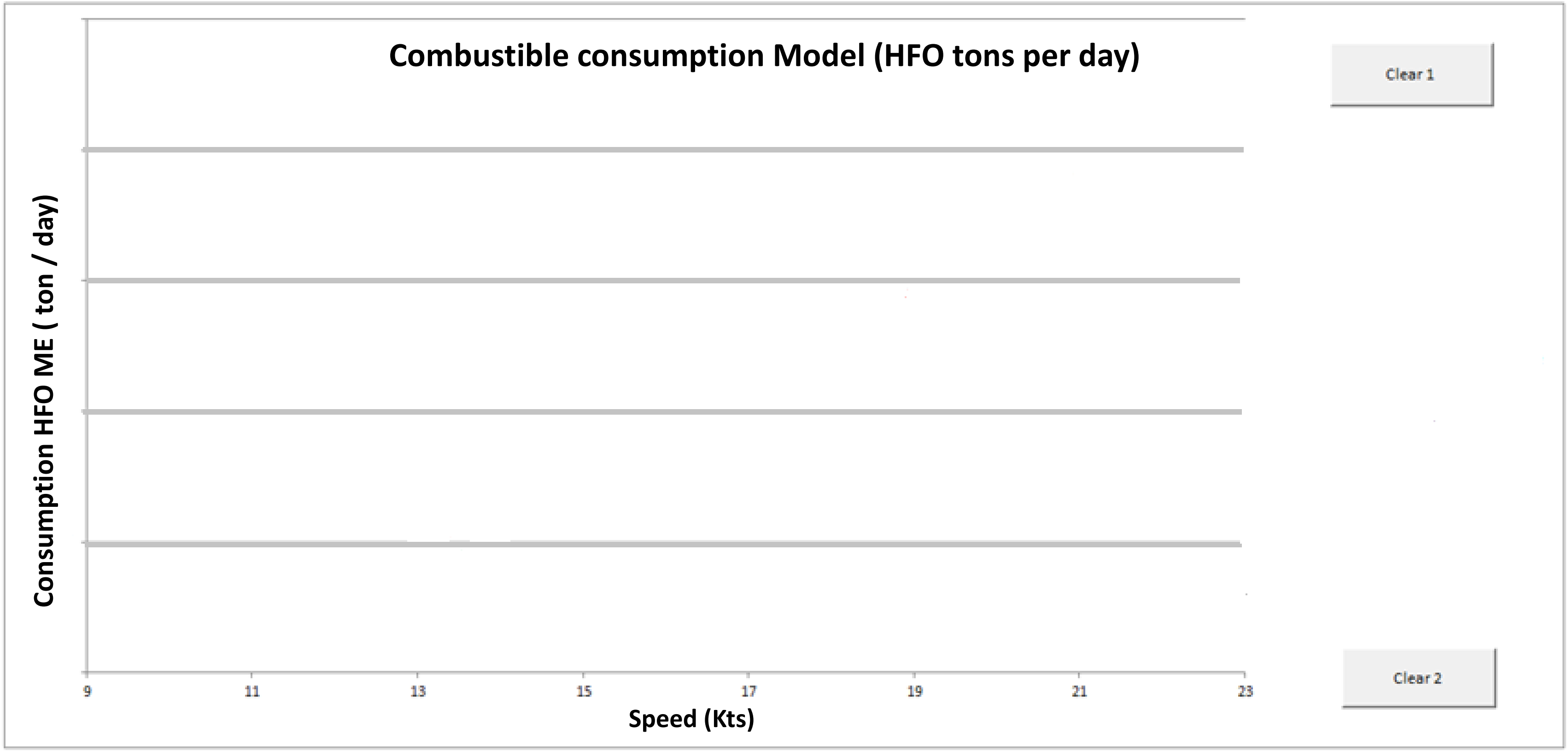
3/4 arrière
3/4 Face
Arrière
Face
Travers

▪ Presentation of the results

Run Calcul--New Model--1

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM JULES VERNE	Class 16000	16	1m By Stern	3	Travers

Run Calcul--Old Model--1



Run Calcul--New Model--2

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM MARCO POLO	Class 16000	13	1m By Bow	5	Arrière

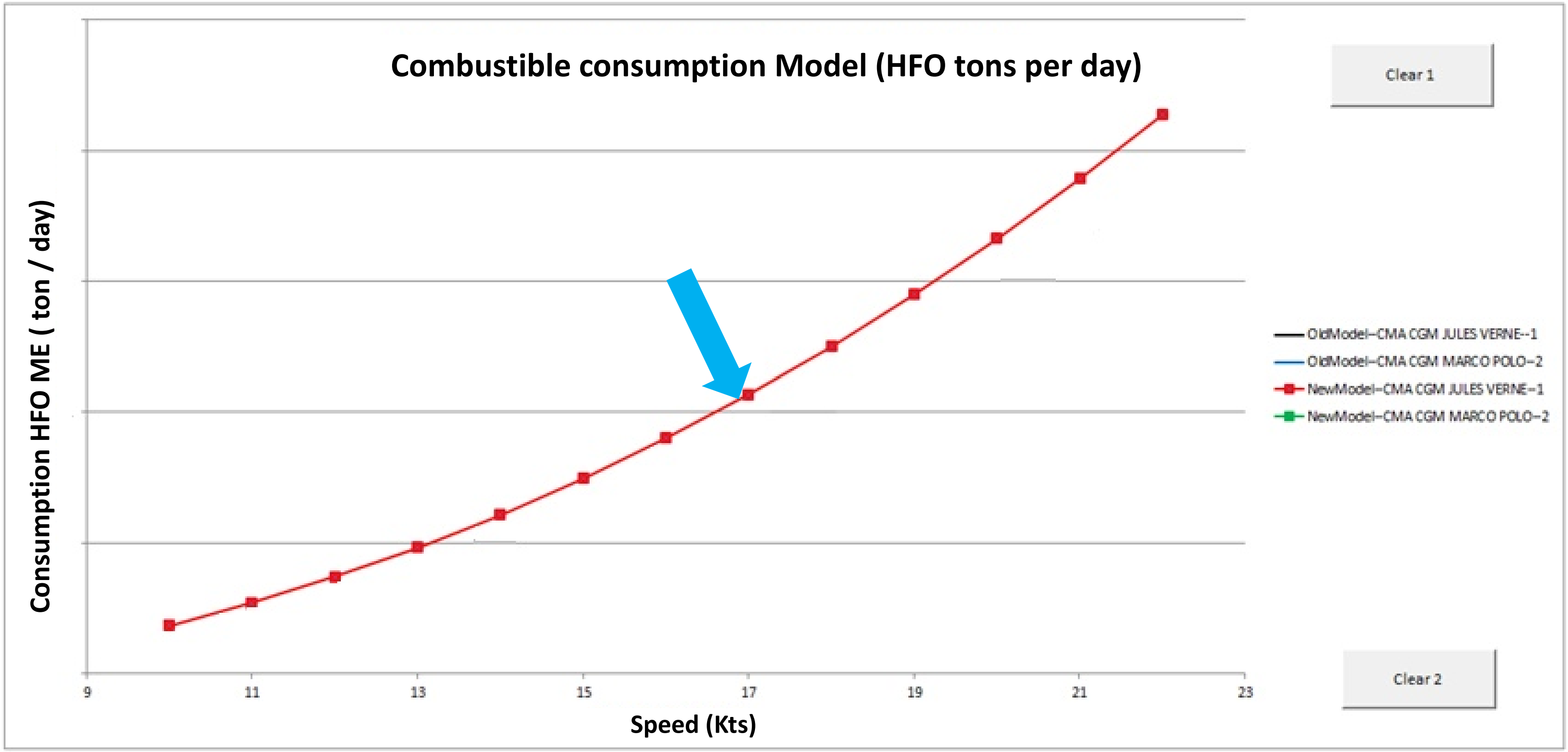
Run Calcul--Old Model--2

Presentation of the results

Run Calcul--New Model--1

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM JULES VERNE	Class 16000	16	1m By Stern	3	Travers

Run Calcul--Old Model--1



Run Calcul--New Model--2

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM MARCO POLO	Class 16000	13	1m By Bow	5	Arrière

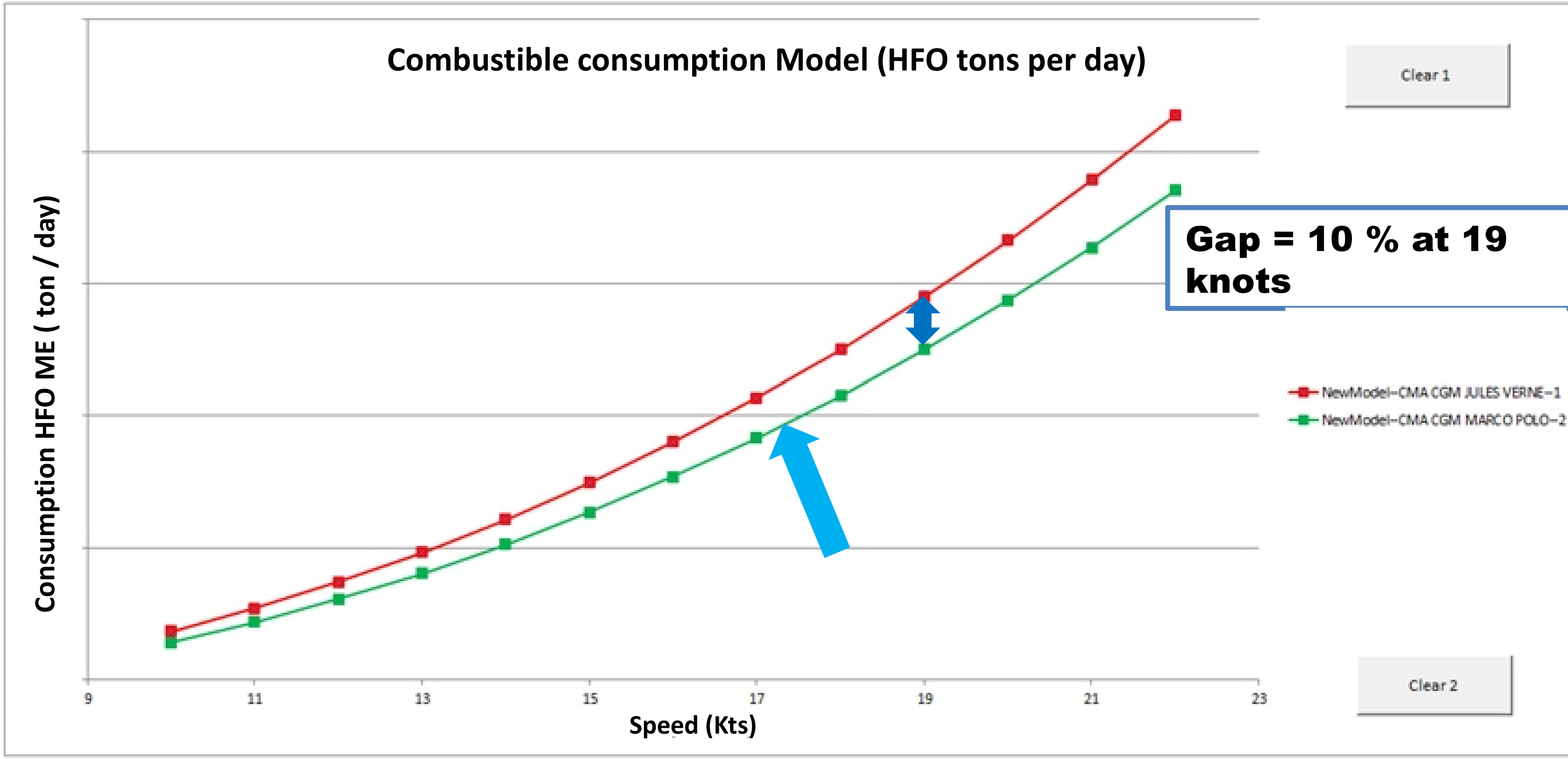
Run Calcul--Old Model--2

▪ Presentation of the results

Run Calcul--New Model--1

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM JULES VERNE	Class 16000	16	1m By Stern	3	Travers

Run Calcul--Old Model--1



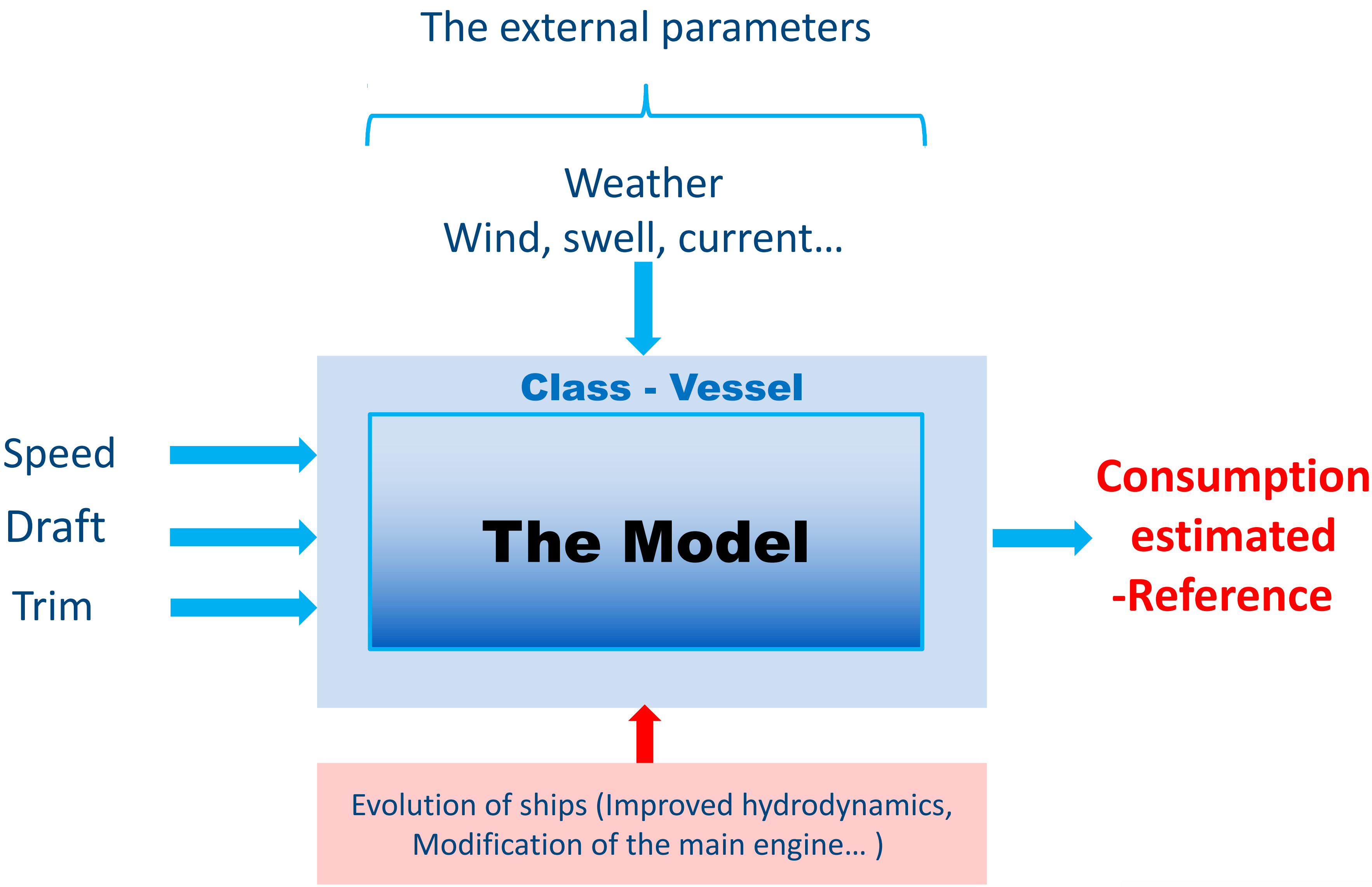
Run Calcul--New Model--2

Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM MARCO POLO	Class 16000	13	1m By Bow	5	Arrière

Run Calcul--Old Model--2

4. The follow-up of the container ships performances

▪ Inclusion of the evolution of ships



▪ Solutions for existing fleet to reduce consumption

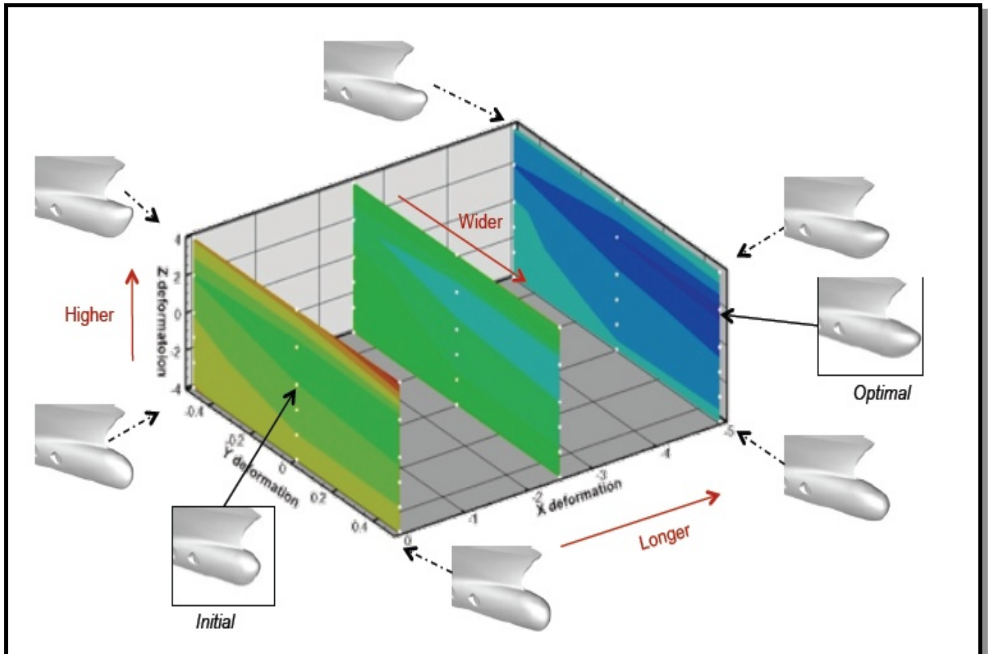
- The Slow Steaming
  (Decreasing the navigation speed)

- Installation of a Turbo-Charger Cut Out
  (Deactivation of a Turbo-Charger / Low load running)

- The Dry Dock

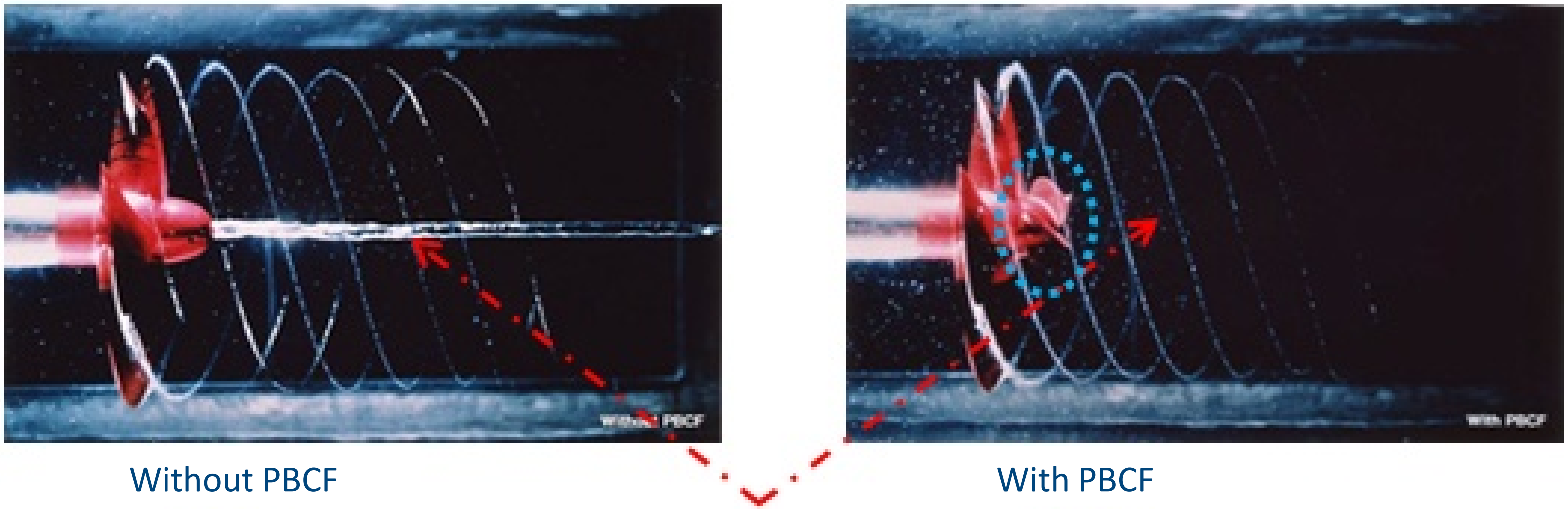
▪ Solutions for existing fleet to reduce consumption

Bulbous bow modification



▪ Solutions for existing fleet to reduce consumption

Propeller Boss Cap Fins (PBCF)



Without PBCF

With PBCF

▪ And next ? Global optimization concept !

Three areas to adjust the vessel hydrodynamics performances and the propulsion efficiency to the actual and future operation profiles.

The propeller:
It makes the vessel moving. Its design is dependent of the vessel and her operation profile.

The main engine:
It's tuning is linked to the propeller and the operation profile.

The bulbous bow:
Front part of the vessel. The entire water flow along the hull is dictate by this part.

- Adapted bulbous bow for slow steaming operation

Less power needed thanks to the adapted bow for the same operation (first saving)

- Less power needed = different propeller

Less power needed for the same operation thanks to the new bow and new propeller (second saving)

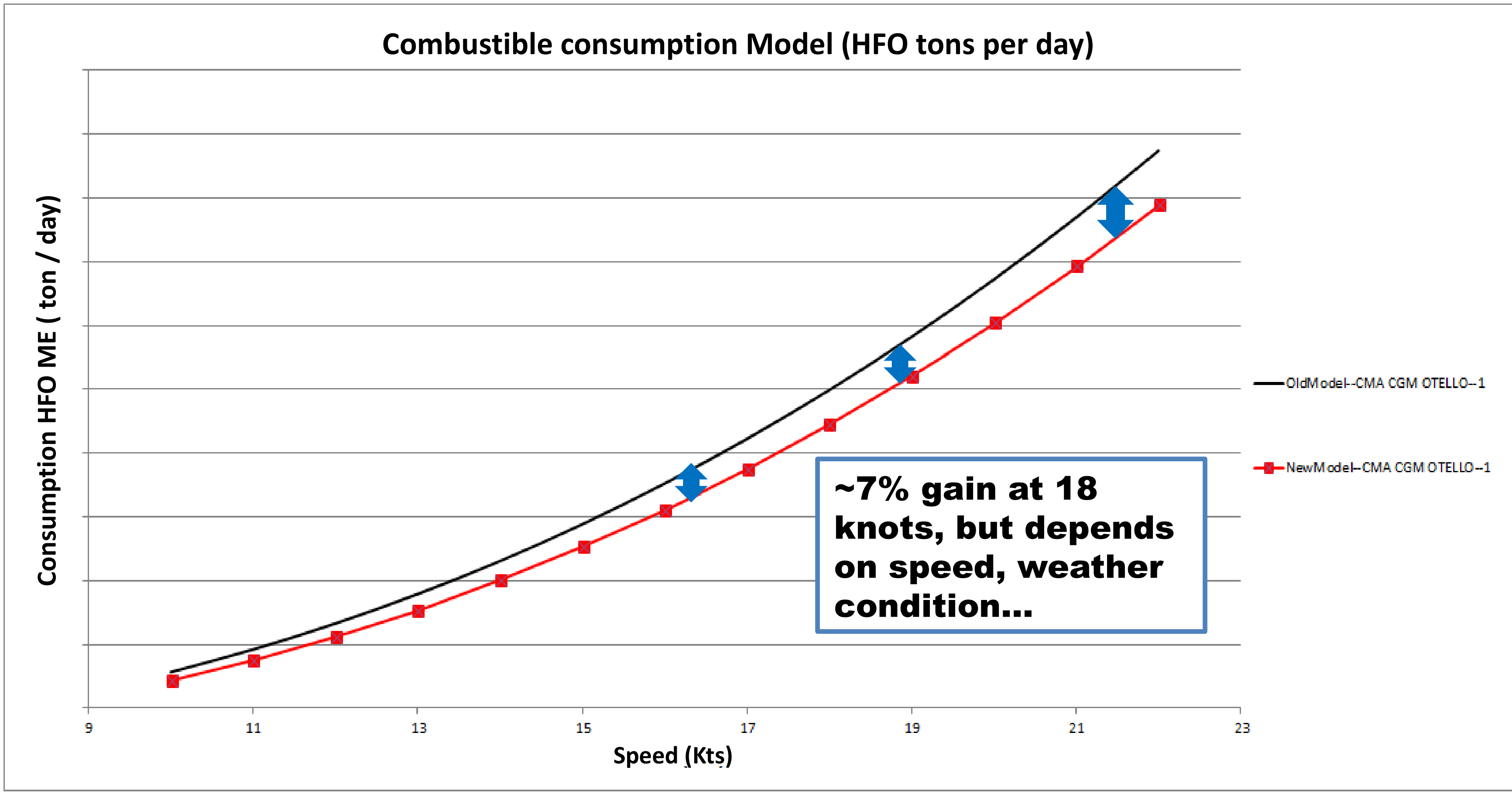
- Less power required = Main Engine can be adapted

Combined Fuel saving

▪ The follow-up of the performances

Example: CMA CGM OTELLO - Bow modification

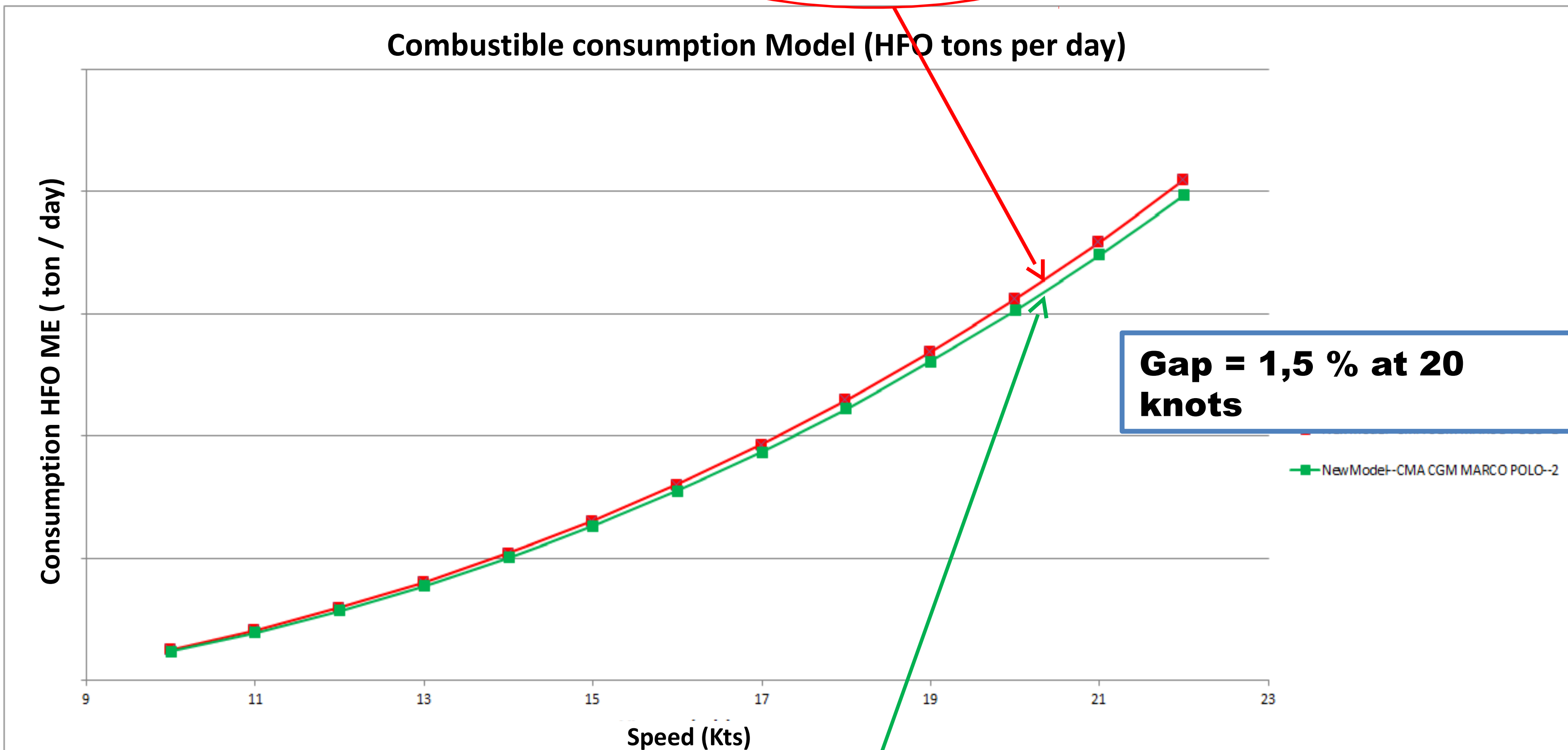
Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM OTELLO	8500 OTELLO	13	Even Keel	3	Travers



▪ The follow-up of the performances

Example: CMA CGM MARCO POLO – Optimal configuration for Draft & Trim

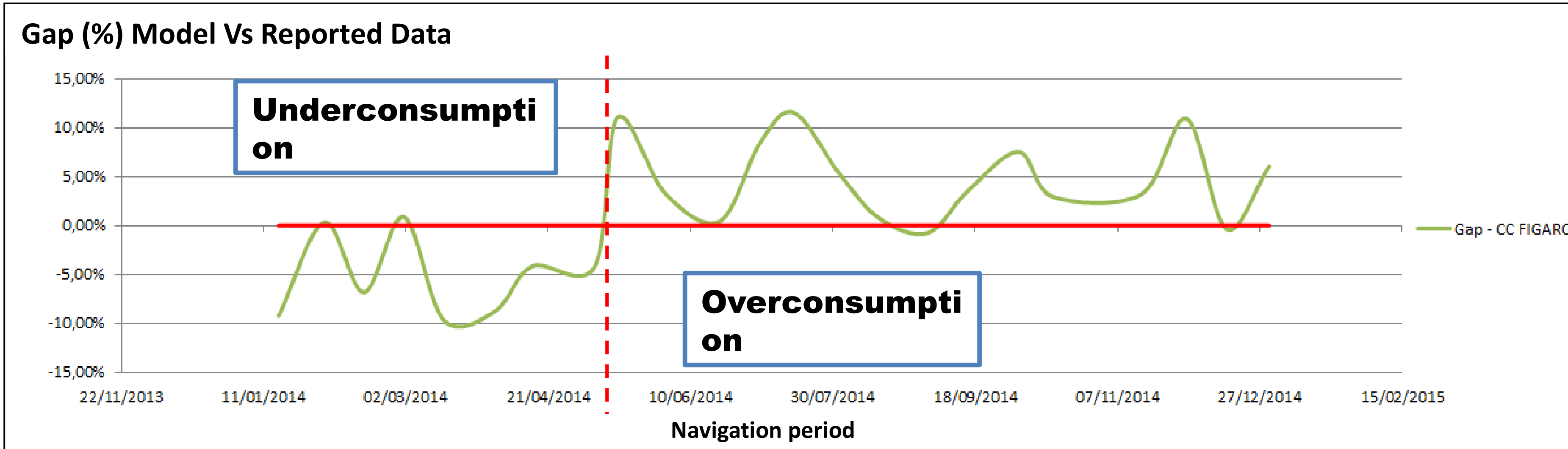
Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM MARCO POLO	Class 16000	14	2m By Stern	3	Travers

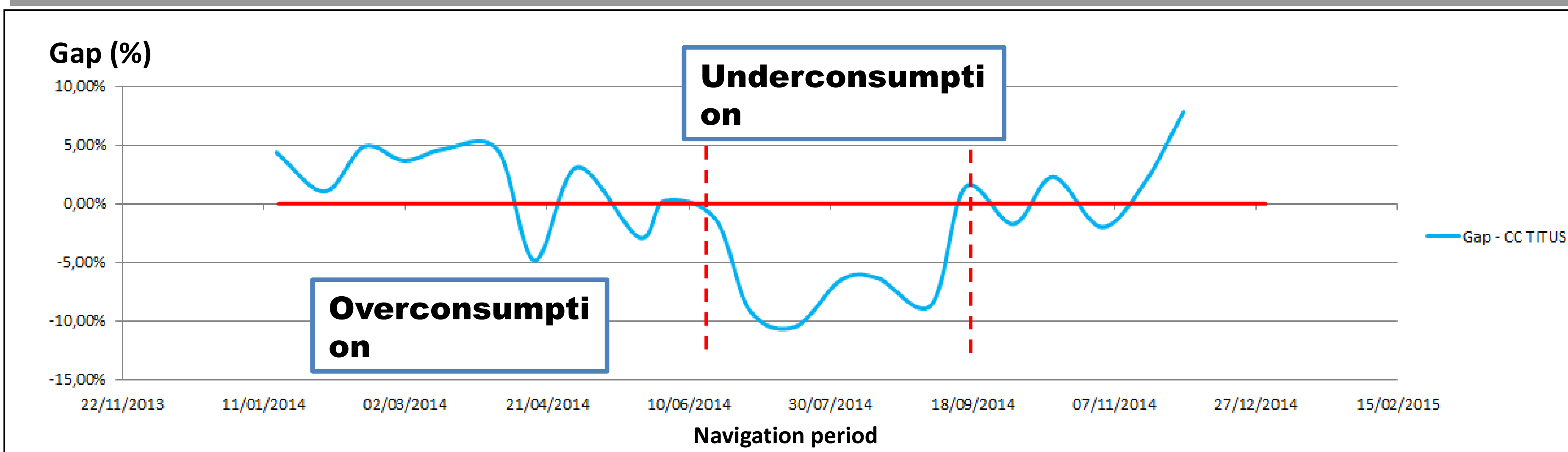


Vessel	Class	Draft (m)	Trim	Wind Force (Bf)	Wind Sector
CMA CGM MARCO POLO	Class 16000	16	1m By Bow	3	Travers

▪ The follow-up of the gap (Model Vs Reported)

The period of over/underconsumption can coincide with a specific crew …

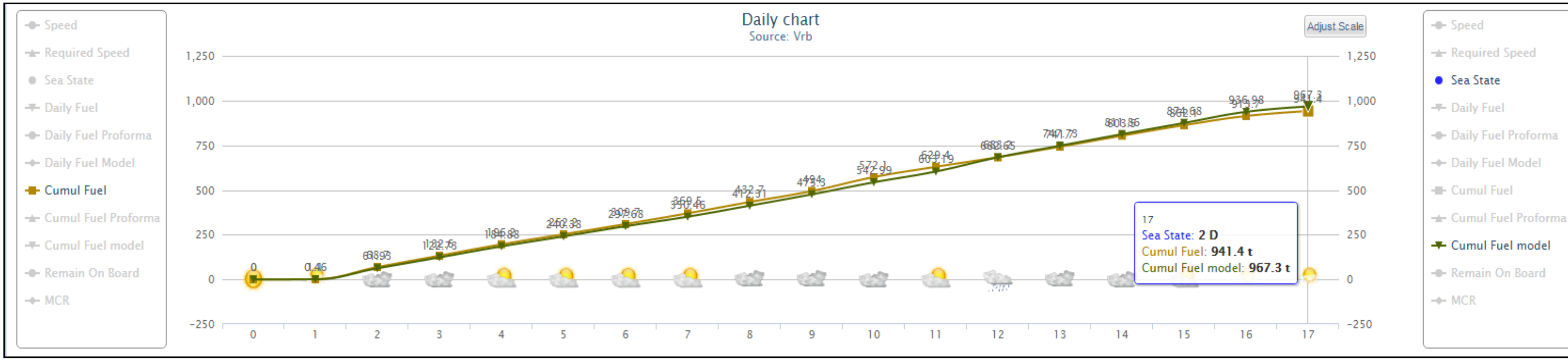


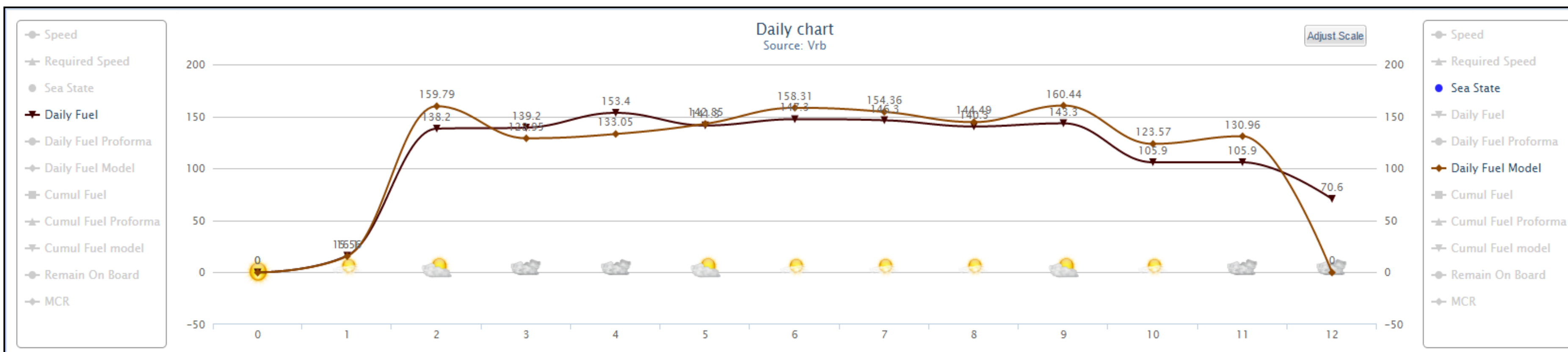


▪ Industrialization of the model

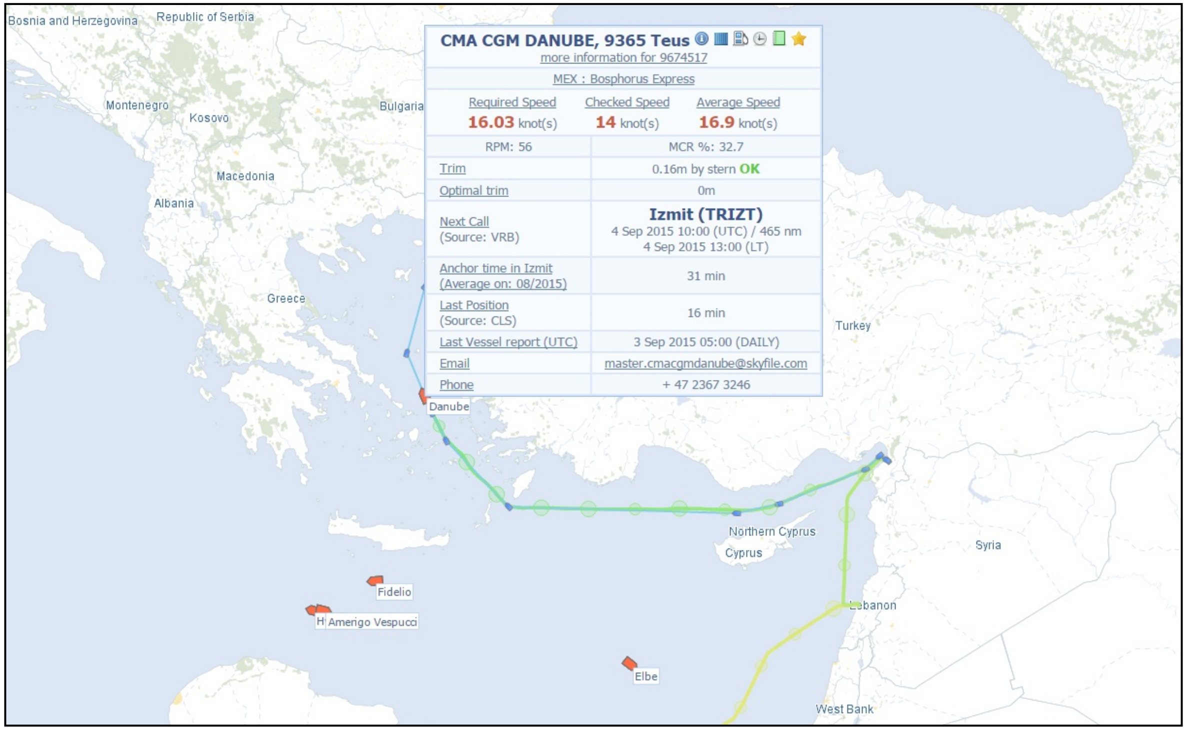
➢ Integration of the models in the dashboards

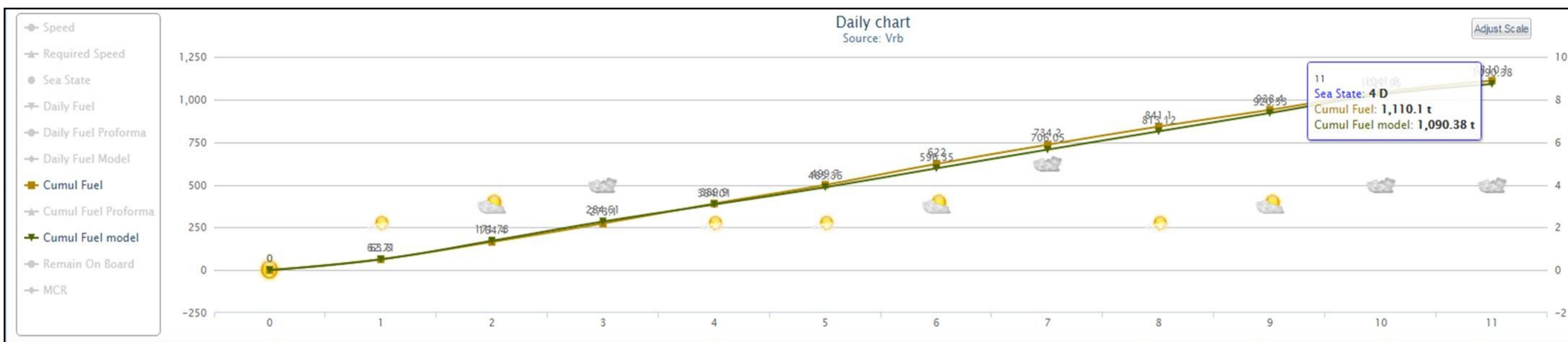
➢ Automation of modelling (ongoing)





▪ Industrialization of the model





5. Conclusion and outlook

▪ To conclude

- The Model limits are related to quality and amount of data(especially for small vessels).
  (Improving the quality of reports – Increasing frequency – Installing new instrumentation for a better collect of weather data)
  ➔ Ongoing Project: Automatic Collection Data

- The model is implemented in several dashboards

- Maintaining and improving the model
  (Automation of modelling)

- Integration of the model in other projects: Fleet Center, Lines, Bunkering, Chartering…

➔ **Simplicity, ease of use and portability.**

Trust our solutions and our passion…

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Sailing ahead with passion
since 1978
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