



# CYMS2 – AR

## Assessment Report



CLS-ENV-NT-23-0046

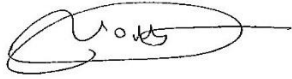
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## APPLICABLE DOCUMENTS/LISTE DES DOCUMENTS APPLICABLES

[SOP] - CLS-ENV-NT-20-0226 - Standard Operating Procedure (SOP) for SHOC in 2020-2021 - v1.2 - 30/11/2020

[ASM] - Assimilation of CYMS products by MET Norway - v1.0 - 20/09/2022

[EUR] - Collected end-user requirements - CLS-ENV-NT-22-0499 - v1.0 - 18/09/2022

[AR] - Assessment report - CLS-ENV-NT-23-0046 - v1.0 - 11/04/2023

[PUM] - Product User Manual - CLS-ENV-NT-20-0228 - v2.0 - 01/09/2022

[VAL1] - CyclObs Database - Validation report - Part 1: Main report - v1.0 - 21/05/2022

[VAL2] - CyclObs Database - Validation report - Part 2: Case study - v1.0 - 21/05/2022

[VAL3] - CyclObs Database - TC Vortex Analysis Product - v1.0 - 19/09/2022

[ASS] - Presentation of service evaluation, potential evolution, recommendations - CLS-ENV-NT-23-0045 - v1.1 - 14/04/2023

[FR] - Final Report - CLS-ENV-RP-23-0215 - v1.0 - 11/04/2023

# 1 Introduction

This document aims at assessing the end-users experience with CYMS and the impact in their tools/practices and perspectives on scientific and operational aspects.

This document is based on the exchanges with end-users performed as part of WP 230: “Assessment of end-user experience”.

The first section presents and analyses the results of an online questionnaire distributed to the end-users identified during the course of the CYMS project since its beginning.

The second section describes the CYMS usefulness from the perspective of end-users through 2 publications, an illustration by Météo-France La Réunion and WMO recommendations.

In the Appendix, the full answers to the questionnaire are available.



## 2 CYMS online form

### 2.1 Presentation

The CYMS online form was distributed after the CYMS Webinar that took place on 5<sup>th</sup> May 2022 to all end-users that have been directly or indirectly contacted during the course of the CYMS project, since its start with ESA in 2020.

The form is accessible through the following link: [CYMS 2022 online form](#).

It stayed open for one month and a total of 15 participations were gathered. This is to be compared to the participation to the first CYMS questionnaire, sent in 2021, to the Tropical Cyclone (TC) meteorological forecasters, which gathered 4 answers.

The higher participation is due to the wider audience reached during this project extension thanks to:

- The extension to more varied meteorological phenomena (including over Europe),
- The inclusion of more end-users (insurance, private companies...),
- An active communication effort through:
  - CYMS twitter account with more numerous followers. It is described in detail in [ASS] deliverable,
  - A preparatory end-user questionnaire targeting CMEMS users which collected more than 300 answers. It is described in detail in [EUR] deliverable.
  - CYMS Webinar, which reached more than 70 subscriptions and 39 participants. It is described in detail in [ASS] deliverable.

This form was prepared in collaboration with CLS and IFREMER.

It is also directly available below:



# Microsoft Forms

*Figure 1: Direct access to the online form*

## 2.2 Analysis

This sub-section describes the questions and the results from the online form.

A total of 15 answers were gathered.

The questions are presented one by one, after one another. The full answers are given in Tables format in the Appendix.

### 2.2.1 Question 1: Have you ever visualized or used the wind data provided by CYMS?

About half (53%) of the users have used or visualized the wind data provided by CYMS.

1. **CYMS** is an operational demonstration for the monitoring **extremes** over the ocean using **high-resolution** radar satellites to provide wind measurements over **Tropical Cyclones** and European extremes such as **Extra-Tropical Cyclones, Medicanes, Polar Lows**. It provides wind products in Near Real-Time and maintains a homogeneous reprocessed archive.

Have you ever **visualized** or **used** the wind data provided by CYMS?

As a reminder, previous information such as Webinar replay, data access, scientific references, data visualization, project news, can be found here: <https://www.esa-cyms.org/>.

[Plus de détails](#)



## 2.2.2 Question 2 & 3: regions and phenomena of interests

The end-users related to the new regions: European waters, others (Western Mediterranean Sea) and associated new phenomena are well represented: polar lows, katabatic winds, medicanes, extra-tropical storms.

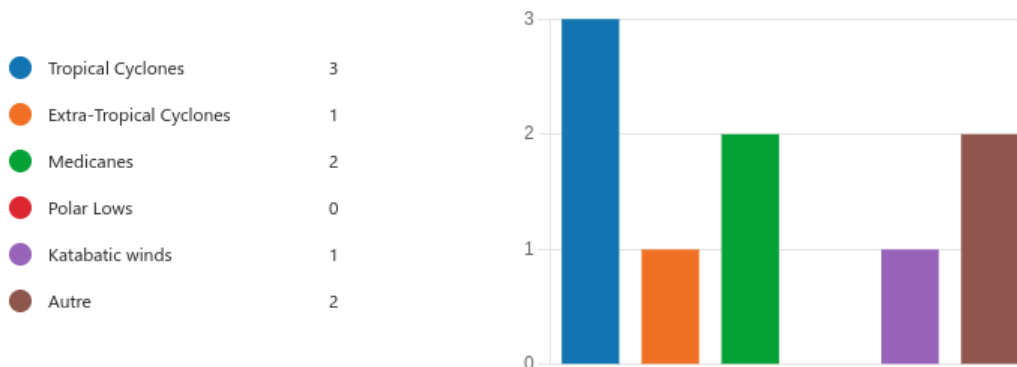
2. What is your **region** of interest ?

[Plus de détails](#)



3. For what meteorological **phenomena** have you been using CYMS products ?

[Plus de détails](#)





## 2.2.3 Questions 4, 5 & 6: CYMS visualization platforms

9 end-users indicate having used the CYMS platforms, 2 of which having using 2 or three of them.

The average score is 8/10 for the CYMS platforms, with very positive feedbacks.

Some end-users (end-user #15) advised for quicker display of SeeWater. Some for a one-click data download for a given TC (#6 with CyclObs) or for more easily accessible user guide (#8 with EODA).

4. Have you used CYMS **visualization platforms** ?

[Plus de détails](#)

- CyclObs: <https://cyclobs.ifremer.fr> 4
- EODA: <https://eoda.cls.fr/cyms> 4
- SeeWater: <https://datastore.cls.f...> 3



5. If yes, can you provide your **evaluation** on the platform(s) ?

[Plus de détails](#)

[Aperçus](#)

8  
Réponses

Dernières réponses

"Very user-friendly: 9 "

"7"

"7"

[Mettre à jour](#)

4 répondants (50%) répondu 7 pour cette question.

platform is easy  
lot of options 7  
user-friendly  
data  
8 quick  
Rate

6. How **useful** did you find it ? What possible improvements would you find useful ?

[Plus de détails](#)

 Aperçus

7

Réponses

Dernières réponses

*"Improve the speed of layers display."*

*"It can be quite useful. I am still learning to use it for practical applications ..."*

 Mettre à jour

3 répondants (43%) répondu **useful** pour cette question.






## 2.2.4 Questions 7 & 8: CYMS products

5 end-users indicate having downloaded CYMS data.

Whenever evaluated, the data content and format is judged as Good.

7. Have you **downloaded** CYMS products ?

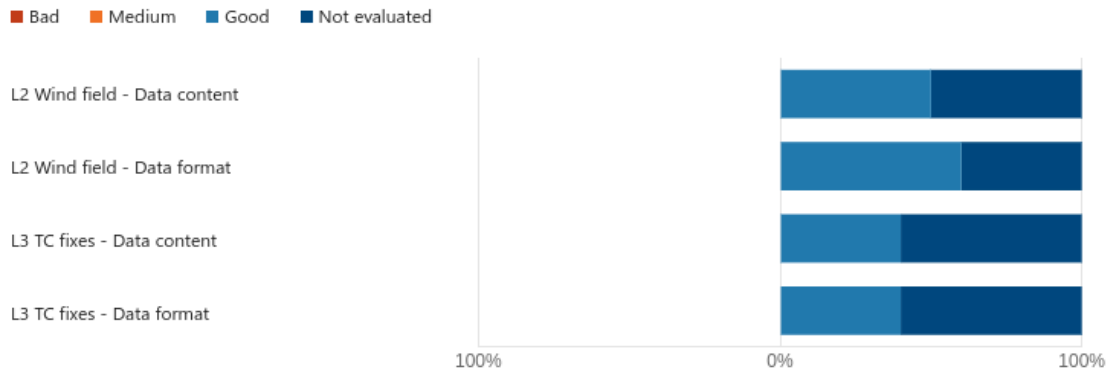
[Plus de détails](#)

	through Cyclobs	3
	through FTP	2
	Autre	1



8. If yes, can you provide **your evaluation** on the **products** you have used (L2 wind fields or L3 Tropical Cyclone wind radii Fixes) ?

[Plus de détails](#)



## 2.2.5 Questions 9: Other comments

Full answers are provided and commented in the Appendix (p 23).

The answers indicate either no additional comment, a great potential are the following answers:

- A request for change in the data format (wind speed and wind direction) to better meet the CF convention. They have been accordingly implemented in the currently provided CYMS products.
- A request to provided additional data format than just the NetCDF.
- A comment on the limited coverage of the Mediterranean Sea. This comment is in line with the one already identified and discussed in the recommendation's sections of document [ASS]. It highlights the limited coverage of S1 constellation alone at mid-latitude to monitor specific event of interest.

9. Do you have **other coments** on CYMS products ?

[Plus de détails](#)

6  
Réponses

Dernières réponses  
"No"  
"Sounds quite useful with great potential"

## 2.2.6 Questions 10: For which applications?

Full answers are provided and commented in the Appendix (p 24).

End-users are interested in:

- Assessing Medicane wind velocities through CYMS L2P products,
- Climate studies,
- Comparing Numerical Weather Prediction (NWP) analysis and forecasts against SAR-derived wind measurements, including over extremes.

- For Tropical cyclones analysis. In particular, for the North Indian Ocean region, the Indian RSMC indicates that: "It would be helpful if the wind products are provided from the early stages of Tropical cyclones or monsoon low-pressure systems. It helps in early detection and analysis during the genesis of such systems. If the frequency of availability of the wind products can be improved further from once a day available currently, it will help in detailed monitoring and better operational use".  
It is not clear to us whether this region is being monitored as closely by RS-2 and RCM as the other TC basins. As for S1, apart for the acquisitions performed by default in the coastal regions, SHOC is only rarely activated over this basin as TC as usually weaker. And if it is activated, the current procedure (cf. SOP) does not allow a very early monitoring. These recommendations are part of the ones gathered in the [ASS] deliverable.
- Using CYMS products for navigation control of large ocean going ships.

10. Can you detail for **which** application, **how** you have used CYMS products and how **useful** it proved ?

[Plus de détails](#)

 Aperçus

8

Réponses

Dernières réponses

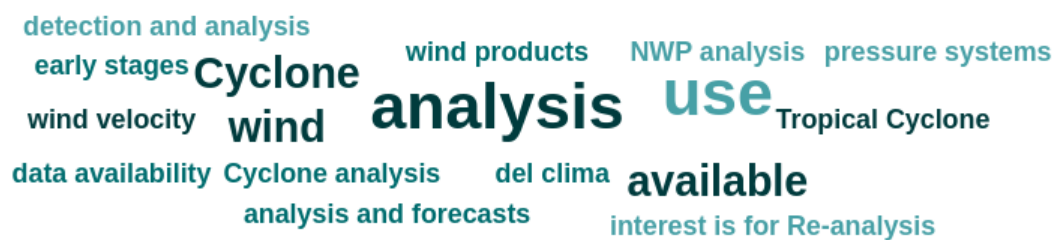
*"My interest is for Re-analysis of extreme meteorological situations "*

*"Not yet but intend to use for navigation control of large ocean going ship..*

*"visualise eventual cyclones on coastal regions "*

 Mettre à jour

3 répondants (38%) répondu **analysis** pour cette question. ...



## 2.2.7 Questions 11 & 12: End-users

The end-users participating to the questionnaire belong to the following entities: Liège University, ECMWF, BRGM, Federal University do Rio de Janeiro, University of Dhaka, ENSER, India Meteorological Department, SOCIB, Sea Gust

11. Finally, can you indicate your **name and affiliation** ?

[Plus de détails](#)

[Aperçus](#)

15  
Réponses

Dernières réponses

"Slim GANA / Sea Gust"

"Jayems"

"Nadia Mkhinini, FSB, Sea Gust, Tunisia"

3 répondants (20%) répondu **University** pour cette question.

A word cloud containing the following text: Baptiste Mourre, Bhubaneswar, University of Liège, Beisl - Federal, Shouvik, GANA / Sea, Mir, University de IIT, Rio Dey, Janeiro, Federal University, Carlos, Sea Gust, Luciano, Mola, Meteorological Department, and Majeda.

12. And eventually, can you indicate your **email** ?

[Plus de détails](#)

[Aperçus](#)

15  
Réponses

Dernières réponses

"slim.gana@sea-gust.com"

"d.jayems@gmail.com"

"n.mkhinini@gmail.com"

1 répondants (7%) répondu **ctroupin@uliegebe** pour cette question.

A word cloud containing the following email addresses: slimgana@sea-gustcom, mirsharifuldu77@duacbd, giovannadechiara@ecmwfint, davidemerli@enserit, djayems@gmailcom, ctroupin@uliegebe, bmourre@socibes, mdeoto@smngobar, sd58@iitbbsacin, and nmkhinini@gmailcom.

## 2.2.8 Questions 13: Additional comments

Participants provide either very general positive comment or indicate that they will further evaluate the product.

13. Do you have any **additional comments** to make ?

[Plus de détails](#)

 Aperçus

8

Réponses

Dernières réponses

"No."

"Thank you for the invitation! Much Appreciated!"

 Mettre à jour

2 répondants (25%) répondu **thanks** pour cette question. ...

not have time  
valuable information  
extreme events  
possibility of a webinar time  
assimilation system

cyclone data  
future study  
**No thanks**  
products are very useful  
invitation

products  
Good job

## 3 Additional contribution from end-users

### 3.1 Article 1 - JTWC

The following article presents the usefulness of CYMS data for JTWC meteorological forecasters:

Howell, B., Egan, S., & Fine, C. (2022). Application of Microwave Space-Based Environmental Monitoring (SBEM) Data for Operational Tropical Cyclone Intensity Estimation at the Joint Typhoon Warning Center, *Bulletin of the American Meteorological Society*, 103(10), E2315-E2322.

<https://doi.org/10.1175/BAMS-D-21-0180.1>

Below is the summary of the article:

“JTWC is now utilizing SAR, SMAP/SMOS, and AMSR2 derived SSW as additional data sources for real-time and post storm analysis. Previously, only sparse observations from ships, island weather stations, scatterometry sensors (50 kt and below), and application of the Dvorak technique were available for estimating TC intensity. The aforementioned Space-Based Environmental Monitoring (SBEM) Sea Surface Winds (SSW) derived intensity estimation methods now benefit the JTWC post storm best track review and as of 2020, the real-time storm analysis. These data are useful as they were shown (this study) to correlate with 2019 JTWC best track intensities and Dvorak CI estimates.

Importantly, over half the time in the 2019 BT review, these data resulted in small increases of the final intensities (<10 kt), though in a few cases these SBEM estimates provided support to make larger changes (>15 kt), particularly for intense (> 80 kt) TCs which lacked data other than traditional Dvorak-based fixes. **The value of these new satellite-based intensity estimates to an operational TC forecasting center cannot be overstated, as they provide an outstanding source of measured SSW data in otherwise data-sparse regions.** While these sensors contributed greatly to JTWC’s operational and post storm assessment of TC intensity, and changes were made to the post storm TC intensity records, the overall impact to the historical record is small, with 411 of the 425 post analysis adjustments being 10 kt or smaller, well within accepted uncertainty ranges for best track intensity estimates (e.g., [Landsea and Franklin 2012](#)). Overall, these methods lend valuable SSW and thus storm intensity estimations that are now trusted by JTWC to enhance storm intensity analysis, both in real time and during the post storm review process. Concerns about heterogeneity in the TC record are certainly valid from a research point of view, since the introduction of new datasets can alter the statistical characteristics of that record. However, it is worth pointing out that such heterogeneity is not new and is present throughout the historical record due to the appearance (and disappearance) of new satellite sensors, aircraft reconnaissance, etc., and therefore, researchers will always have to be cautious when incorporating data based on new sensors.”

A specific SAR example is also provided for TC Harold (2020):

“Tropical Cyclone 25P (Harold) provides an example of an intensity increase adjustment based on SAR data. On 0600 UTC 6 April 2020, the initial BT intensity was analyzed at 135 kt based on a PGTW Dvorak estimate of T7.0 (140-kt equivalent) and the near-concurrent ADT estimate of T6.5 (127 kt). Shortly thereafter, by 0940 UTC, ADT estimates increased to T7.4 (152 kt). Furthermore, data from a 0714 UTC SAR pass (Fig. 3a) depicted SSWs near 160 kt in the northeast quadrant of the system, with some higher values approaching 193 kt along the immediate coastline of Pentacost Island. The higher values approaching 195 kt were considered to be spurious and not representative of the TC intensity. The BT intensity at 0600 UTC 6 April was adjusted upward to 145 kt, partially to account for higher winds evident in the SAR data, which provided additional data to clarify that the BT intensity was on the higher end of the available (Dvorak and ADT) intensity estimates. **This example demonstrates the utility of SAR imagery as an additional data point for very intense systems.**”



## 3.2 Article 2 – NOAA and JTWC

This article presents the usefulness of CYMS data for NOAA meteorological forecasters:

Jackson, C. R., T. W. Ruff, J. A. Knaff, A. Mouche, and C. R. Sampson (2021), Chasing cyclones from space, *Eos*, 102, <https://doi.org/10.1029/2021EO159148>.

Below are the most striking parts, directly extracted from the article:

- In 2020, JTWC gained access to a new remote sensing tool, synthetic aperture radar, which provides highly detailed views of wind speed at the ocean surface under the tropical cyclones (depressions, storms, and hurricanes) as they travel and evolve.
- **A Uniquely Useful Tool:** Directly captured in the backscattered signals acquired with SAR are many of the well-known tropical storm features found in visible or infrared images, such as the eyewall, mesovortices (circulations within the eyewall), boundary layer rolls, outflow boundaries, and rainbands (Figure 1). **More important is SAR's unique ability to record the roughness of the ocean surface directly**, which allows for the creation of high-resolution 2D maps of surface wind speed that **significantly improve estimates of the eye location. The maps also improve estimates of other important storm parameters used by forecasters, including maximum wind speed, the radius of maximum winds** (the distance between a storm's eye and the band containing the strongest winds), and the distance and areal extent of winds at critical wind speed thresholds that define tropical depressions, tropical storms, and hurricanes (34, 50, and 64 knots, or 17, 25, and 33 meters per second, respectively).

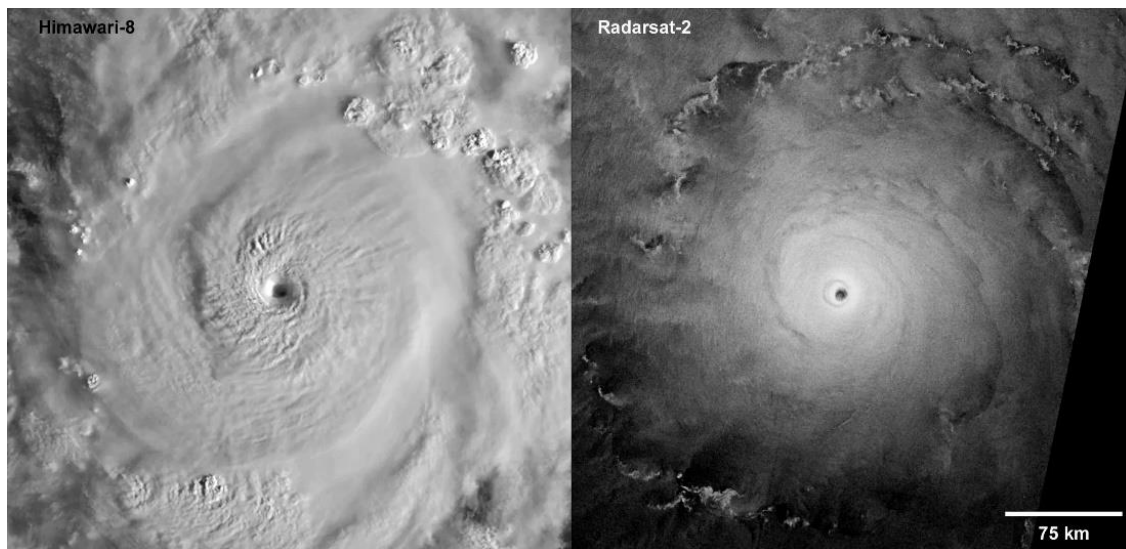


Figure 2: These two satellite images of Super Typhoon Goni over the Pacific Ocean were taken at almost the same time on 30 October 2020, when the storm was close to peak intensity with wind speeds exceeding 155 knots. The visible-light image from Japan's Himawari-8 satellite (left; 500-meter resolution) captures the reflection of sunlight from the cloud tops and shows transverse bands in the cirrus clouds, a sloping eyewall, spiral banding features circling more than 360°, and a clear eye (indicative of an intense tropical cyclone). The wide-swath SAR image acquired by the Radarsat-2 satellite (right; with 100-meter resolution) shows the radar backscatter return from the ocean surface and patterns from convection cells, rainbands, and outflow boundaries, along with spiral wind streaks. Credit: RADARSAT-2 Data and Products © MDA Geospatial Services Inc. 2020; Himawari-8 image courtesy of the Japan Meteorological Agency. Click image for larger version.

- The SAR-derived wind information fills an important role at JTWC because, since 1987, there has been no routine aerial reconnaissance in the area that JTWC is responsible for monitoring. And although satellite microwave radiometers have been providing direct measurements of extreme winds to JTWC since about 2017, **SAR is the only satellite sensor with sufficient spatial resolution to measure a storm's radius of maximum winds.**



- In 2020, for the first time, near-real-time SAR-based wind speed maps, eye position estimates, and derived wind fixes were **incorporated into operational forecasting at JTWC** through the center's Automated Tropical Cyclone Forecasting (ATCF) system [Sampson and Schrader, 2000].
- During Super Typhoon Goni, which struck the Philippines in October 2020, several timely acquisitions of SAR data over the storm were collected prior to its landfall. **These acquisitions helped JTWC fine-tune its storm wind estimates**, according to Cmdr. R. Corey Cherrett, the center's commanding officer at that time. He noted that **accurate analyses and forecasts helped to drive the evacuation of more than 350,000 people, potentially saving countless lives.**
- As the frequency of SAR acquisitions increased during the 2020 storm season, **JTWC began relying on SAR wind data in real-time tropical cyclone analysis, with great success.** Brian Howell, Best Track Officer at JTWC, and Typhoon Duty Officer Caitlin Fine compiled a 2019 and 2020 data set of subjective wind intensity estimates made by forecasters at the center along with concurrent SAR acquisition passes over storms. From this compilation, they found that the information provided by the SAR passes either reinforced or prompted adjustments to forecasters' subjective determinations. **In all cases, however, the SAR data have proved invaluable in both real-time and postseason analyses.**
- Last year (2020) was clearly a notable time in the development and use of SAR in characterizing tropical cyclones. JTWC, in collaboration with IFREMER, NRL, and NOAA, pioneered the incorporation of SAR-derived tropical cyclone wind data into forecast products in near-real time. The ability of SAR to produce quantitative, fine-resolution information about cyclone winds, eye locations, and other characteristics **represents a significant new tool that can assist in the forecasting of tropical storms.**
- **With the new capabilities provided by SAR and growing data streams from current and planned satellites, JTWC and other agencies tasked with forecasting tropical cyclones are better positioned than ever to help people and countries around the world prepare for these beautiful but destructive natural forces.**

### 3.3 RSMC MF La Réunion

This feedback was presented at the MAXSS international workshop, held on 3-5<sup>th</sup> May 2023 at IFREMER, Brest (FRANCE).

The main conclusions were presented by Sébastien Langlade, forecasters à MF La Réunion:

- Variety of sources, available over various platforms: The wide variety of the spaceborne observations over TC is a great advantage for forecasters analysis. **Yet, their use is being made difficult by the fact that all these data are available and viewable on various platforms which do not necessarily accumulate them all in a single interface.** An alternative would be that they are integrated in MF internal software but this is not foreseen at the moment.
- **The overall consistency of the SAR-derived products has been tested and improved using some new sensor-specific GMFs.**
- The quality of the SAR data can sometimes be very questionable for isolated situations. E.g., of Freddy on 08/03/2023 at 15:42 UTC indicates largely over-estimated Vmax (reaching 55 m/s) with respect to the Best Track data. This is seen on different sensors (RCM and Sentinel-1) thereby suggesting that this is not sensor-specific but rather attributed to the atmospheric conditions. In the present case, we suspect the rain contamination to be responsible for this over-estimation. One issue with the current contamination is that it could not be detected based on the currently implemented

heterogeneous filter. Additionally, under-going research based on the texture analysis using DNN (Deep Neural Network) methodologies are not foreseen to identify such effects. Other methodologies described in the literature based on the agreement between SAR observables are expected to be more promising (Zhao et al. 2023).

- The complexity of certain SAR acquisitions can require in-depth analysis of the situation by meteorological forecasters, who are not necessarily well formed to fully understand the reliability, the quality and the content of the SAR-derived measurements. **It is therefore important to setup a long-term loop of SAR tutorials and discussions** allowing for in-depth discussions on SAR measurements possibilities and limitations to describe meteorological situations of interest and to keep including end-users needs for the development of future products.

### 3.4 WMO recommendations

Below are the WMO recommendations for the remote sensing part following the International Workshop on Tropical Cyclone IWTC-10:

**“(3) Encourage continued investment in the planning, launch, and support of low-earth orbit satellite missions to sustain and improve spatial and temporal coverage of observations that capture TC size, structure, and intensity (e.g., microwave imagery, scatterometers, synthetic aperture radar) including low-cost missions such as CubeSats.**

Reasoning: Infrequent observations from the currently operational satellite constellations do not adequately meet forecaster needs. Many IWTC-X attendees commented on the usefulness of and/or otherwise expressed interest in synthetic aperture radar (SAR) observations with some concern expressed over loss of SAR from Sentinel. Consider collaborating with The Coordination Group for Meteorological Satellites (CGMS) with a near-term step to convey this recommendation to CGMS at the upcoming meeting in May 2023.”

## 4 Conclusion

This document has presented the end-users experience with CYMS and the impact in their tools/practices and perspectives on scientific and operational aspects.

**The first section** has presented and analysed the results of an online questionnaire distributed to the end-users identified during the CYMS project since its beginning. End-users belong to several communities, from public meteorological centers linked to WMO to private companies, not to mention research entities. Their implication varies greatly as well, depending on the TC coverage over their region of interest and the historical connections that, sometimes, started years before CYMS was initiated. Not all end-users have participated to the questionnaire but several of them are current data users and have presented their interest in CYMS data at MAXSS international workshop, held on 3-5<sup>th</sup> May 2023 at IFREMER, Brest (FRANCE): ECMWF, Reask. Earth and Descartes Underwriting.

Additional meteorological centers that could benefit from CYMS have also been identified and should be contacted future CYMS activities: Korean Meteorological Administration (KMA), National Meteorological and Hydrological Services (NMHS) in Philippine.

The questionnaire indicates a large interest of the end-users in continuing and starting to use CYMS products, for various applications and regions (Tropical Cyclone as well as European extremes). End-users' recommendations for CYMS products and visualization platforms are taken into account for future and already applied updates (e.g., data format). The growing interest in CYMS data is further testified by the increasing use of CYMS web portal, documented in the [ASS] document.

**The second section** describes the CYMS usefulness from the perspective of WMO end-users. It is a major achievement that SAR imagery is now used routinely for TC monitoring activities performed by WMO centers, including for their daily operations. These measurements are judged unique for meteorological forecasters and strongly contribute to better characterizing the TC parameters and evolution. Especially, feedbacks indicate that in the absence of SFMR measurements (only available along the US coastlines), CYMS products are a unique contribution for the estimation of Vmax by meteorological forecasters, but also for the TC structure observation (including wind radii, eye position and geometry).

While entities like Météo-France La Réunion have been included in TC monitoring with SAR at earliest stages, they now seem not to have the same level of use of the SAR data in their operational practices as other centers like NOAA and JTWC. This can be attributed to several reasons:

- Data timeliness for S1 CYMS products: they require that the data is made available within 3h after acquisition,
- Access to RCM (either archive or NRT) and RS-2 (archive) CYMS products is not possible via CYMS,
- SAR missions and some other relevant spaceborne measurements are not integrated in their forecasting analysis tool.

On the opposite, other users such as NOAA and JTWC have proven a solid use of the SAR measurements, have setup the necessary display and dissemination portals and have incorporated this information into their platforms (e.g., of disseminating platform from NESDIS: ([https://www.star.nesdis.noaa.gov/socd/mecb/sar/AKDEMO\\_products/APL\\_winds/tropical/index.html](https://www.star.nesdis.noaa.gov/socd/mecb/sar/AKDEMO_products/APL_winds/tropical/index.html))). On top of this, they are also processing the Sentinel-1 CYMS acquisition from Level-1 to Level-2 by themselves. The algorithms for estimating the wind maps and the FIX products are similar to those developed within CYMS. Yet, the level of maturity and robustness of their dissemination platform is high and now provides RCM and RS-2 acquisitions on top of S1 while CYMS can now only access to RS-2, and not for the NRT processing.

From the European point of view, it is therefore important to:

- Maintain a high-level of scientific expertise and data quality for CYMS products. This is further described in the recommendations section of the [ASS] deliverable,
- Ensure the access to RS-2 acquisitions in NRT as it was the case in the past and possibly add the capability to access to RCM,
- Ensure that all SAR products are made available within 3 hours after acquisition,
- Keep improving CYMS visualization and dissemination platforms.

Finally, scientific developments also confirm the interest in using CYMS products in NWP models for **validation** of the NWP model better parameterized for TC (presentation by Jean Bidlot et al. 2023 from ECMWF - MAXSS international workshop, 3<sup>rd</sup>-5<sup>th</sup> May 2023)

## Appendix A - Acronyms

BOM	Bureau Of Meteorology
BUFR	Binary Universal Form for the Representation of. meteorological data
CEMS	Copernicus Emergency Management Service
CMEMS	Copernicus Marine Environment Monitoring Service
CPHC	Central Pacific Hurricane Center
CYMS	CYclone Monitoring with Sentinel-1
EC	European Commission
ECEPS	ECMWF Global Ensemble Prediction System
ECMWF	European Centre for Medium-Range Weather Forecasts
FTP	File Transfer Protocol
GMS	Geostationary Meteorological Satellite
HK	Hong-Kong
HKO	Hong-Kong Observatory
HNPW	Humanitarian Networks and Partnerships Weeks
IMD	India Meteorological Department
JMA	Japan Meteorological Agency
KMA	Korean Meteorological Administration
LACy	Laboratoire de l'Atmosphere et des CYclones
MF	Météo-France
NASA	National Aeronautics and Space Administration
NCEP	National Center for Environmental Prediction
NetCDF	Network Common Data Form
NMS	National Meteorological Services
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
RSMC	Regional Specialized Meteorological Centres
RMW	Radius of Maximum Wind
SAR	Synthetic Aperture Radar
SWIO	South West Indian Ocean
TCWC	Tropical Cyclone Warning Centres
TC	Tropical Cyclone
UKMO	United Kingdom Meteorological Office
WMO	World Meteorological Organization
WWMIWS	Worldwide Met-Ocean Information and Warning Service

## Appendix B - References

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## Appendix C - Full questionnaire answers

ID	Have you ever visualized or used the wind data provided by CYMS?	What is your region of interest?	For what meteorological phenomena have you been using CYMS products?
1	Yes	Coastal regions ; European waters	Medicanes;
2	No		
3	No		
4	No		
5	Yes	Open Ocean ; Tropical regions;	Katabatic winds;
6	Yes	Tropical regions;	Tropical Cyclones;
7	No		
8	Yes	Tropical regions;	Tropical Cyclones;
9	No		
10	No		
11	No		
12	Yes	Coastal regions ; European waters ; Western Mediterranean Sea;	Mediterranean storm;
13	Yes	Coastal regions;	coastal cyclones;
14	Yes	Open Ocean ;	Tropical Cyclones;Extra-Tropical Cyclones;
15	Yes	Coastal regions;	Medicanes;

ID	Have you used CYMS visualization platforms?	If yes, can you rate them (from 0 to 10)?	How useful did you find it ? What possible improvements would you find useful ?
1	CyclObs	7	<p>maybe the visualisation on the map could be improved. I think you use the Python library "bokeh" in CyclObs; I'm wondering if something like Leaflet directly (<a href="https://leafletjs.com/">https://leafletjs.com/</a>) or via Python (<a href="https://github.com/python-visualization/folium">https://github.com/python-visualization/folium</a>) could provide users with a better interface, for example:</p> <ul style="list-style-type: none"> <li>- allowing them to change the basemap</li> <li>- displaying vectors or 'flow' (<a href="https://github.com/onaci/leaflet-velocity">https://github.com/onaci/leaflet-velocity</a>)</li> </ul>
2			
3			
4			
5	SeeWater	7	Seguimiento y evaluación
6	CyclObs	8	Not sure if I miss it, but it would be useful to have the option of downloading all the available data for one TC in a single step.
7			
8	EODA	8	The platform is very good. It can be made more user-friendly. It would be helpful if the webpage also contains brief details of each product and documentation or a video of the user guide.
9	EODA and Cyclobs		
10			
11			
12	EODA	Rate 8	The platform is easy to use and quick, with a lot of options to filter the data. The platform is very useful. We could not identify any critical failure.
13	EODA	7	
14	EODA, Seewater, CyclObs	7	It can be quite useful. I am still learning to use it for practical applications and how to get data on real-time basis. I still need to learn the type of data and format if can be used directly in my application.
15	SeeWater	Very user-friendly: 9	Improve the speed of layers display.



ID	Have you downloaded CYMS products?	L2 Wind field - Data content	L2 Wind field - Data format	L3 TC fixes - Data content	L3 TC fixes - Data format
1	FTP ;	Good	Good	Good	Good
2					
3					
4					
5	Cyclobs ;	Good	Good	Good	Good
6					
7					
8	Cyclobs ;	Not evaluated	Not evaluated	Not evaluated	Not evaluated
9					
10					
11					
12					
13	FTP ;	Good	Good	Not evaluated	Not evaluated
14	Cyclobs ;	Not evaluated	Not evaluated	Not evaluated	Not evaluated
15	No;	Not evaluated			

ID	Do you have other coments on CYMS products ?
1	For the variables 'wind_speed' and 'wind_from_direction', standard attributes exist and could be used in the netCDF files (it already implemented please discard this comment)
2	
3	
4	
5	No
6	
7	
8	Wind data provided in the netcdf format seems to be incompatible with open-source meteorological data visualization software like McIDAS-V. This limits its use.
9	
10	
11	
12	We were limited by the data availability for our particular applications. No satellite track was available off the north-western coast of Mallorca Island during the ~two day period with high winds and upwelling in November 2021 (storm Blas). During Calypso campaign in Feb-March 2021, no data was available over the sampling area. We wonder whether this is due to a too high wind threshold (calibrated based on wind strength in other regions of the world) or whether there was no tracks at all over the study area during this period.
13	
14	Sounds quite useful with great potential
15	No

ID	Can you detail for which application, how you have used CYMS products and how useful it proved ?
1	Just having a look at Medicane wind velocity
2	
3	
4	
5	Evaluación del clima
6	We have only visualised the data to be (visually) compared to NWP analysis and forecasts and to other available observations
7	
8	Used it for Tropical Cyclone analysis. It would be helpful if the wind products are provided from the early stages of Tropical cyclones or monsoon low-pressure systems. It helps in early detection and analysis during the genesis of such systems. If the frequency of availability of the wind products can be improved further from once a day available currently, it will help in detailed monitoring and better operational use.
9	
10	
11	
12	We explored the data but could not really use them due to the limitations of data availability over our study area.
13	visualise eventual cyclones on coastal regions
14	Not yet but intend to use for navigation control of large ocean going ships.
15	My interest is for Re-analysis of extreme meteorological situations

ID	Finally, can you indicate your name and affiliation?	And eventually, can you indicate your email ?	Do you have any additional comments to make ?
1	Charles Troupin, University of Liège	<a href="mailto:ctroupin@uliege.be">ctroupin@uliege.be</a>	nothing, thanks
2	Mir Shariful Islam, University of Dhaka	<a href="mailto:mirsharifdu77@du.ac.bd">mirsharifdu77@du.ac.bd</a>	I will use cyclone data in my future study.
3	Carlos Henrique Beisl - Federal University fo Rio de Janeiro	<a href="mailto:carlos.beisl@gmail.com">carlos.beisl@gmail.com</a>	
4	Shouvik Dey, IIT Bhubaneswar	<a href="mailto:sd58@iitbbs.ac.in">sd58@iitbbs.ac.in</a>	Good job.
5	Luciano Mola Majeda cartógrafo,geologo	<a href="mailto:molamajedaluciano@gmail.com">molamajedaluciano@gmail.com</a>	No
6	Giovanna De Chiara, ECMWF	<a href="mailto:giovanna.dechiara@ecmwf.int">giovanna.dechiara@ecmwf.int</a>	We think that these products are very useful and provide valuable information on extreme events. We would like to test them in our assimilation system but we did not have time to do this yet.
7	Matias De Oto Servicio Meteorologico Nacional	<a href="mailto:mdeoto@smn.gob.ar">mdeoto@smn.gob.ar</a>	Let me know if there is the possibility of a webinar to learn how to use these products.
8	Chinmay Khadke, India Meteorological Department	<a href="mailto:chinmaykhadke@gmail.com">chinmaykhadke@gmail.com</a>	
9	Davide Merli ENSER srl	<a href="mailto:davide.merli@enser.it">davide.merli@enser.it</a>	
10	Mir, Kyushu	<a href="mailto:mirsislam77@gmail.com">mirsislam77@gmail.com</a>	
11	Jessie Louisor/ BRGM	<a href="mailto:jessie.louisor@gmail.com">jessie.louisor@gmail.com</a>	
12	Baptiste Mourre	<a href="mailto:bmourre@socib.es">bmourre@socib.es</a>	
13	Nadia Mkhinini, FSB, Sea Gust, Tunisia	<a href="mailto:n.mkhinini@gmail.com">n.mkhinini@gmail.com</a>	
14	Jayems	<a href="mailto:d.jayems@gmail.com">d.jayems@gmail.com</a>	Thank you for the invitation! Much Appreciated!
15	Slim GANA / Sea Gust	<a href="mailto:slim.gana@sea-gust.com">slim.gana@sea-gust.com</a>	No.