COASTALT

Development of Radar Altimetry Data Processing in the Oceanic Coastal Zone

ESA/ESRIN Contract No. 21201/08/I-LG

WP1 – Task 2.1. Report on User Requirements for Coastal Altimetry Products

VERSION 1.1 (accepted & final), 13 October 2008

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EUROPEAN SPACE AGENCY (ESA) REPORT

CONTRACT REPORT

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Abstract

This document is compliant with WP1 Task 1.2 User Requirement Evaluation of the COASTALT proposal. The present document aims to:

- analyze and synthesize the completed questionnaires and surveys for product requirements;
- assess the feasibility of achieving the minimum user requirements;
- produce an achievable product requirement definition and analysis document for evaluation by ESA. This will be in the form of recommendations for the planned coastal altimetry products;
- incorporate any changes and suggestions as a result of the review by ESA, which integrates the main recommendations from the CNES/PISTACH[1] Project with the findings of the present survey.

[1] PISTACH = **P**rototype **I**nnovant de **S**ystème de **T**raitement pour les **A**pplications **C**ôtières et l'**H**ydrologie, a project funded by CNES and led by CLS Toulouse, France

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Abbreviations and Definitions

ADT	Absolute Dynamic Topography
ASIRAS	SAR/Interferometric Radar Altimeter System
BUFR	Binary Universal Form for the Representation of meteorological data
CIOSS	Cooperative Institute for Oceanographic Satellite Studies
CNES	Centre National d'Etudes Spatiales
CNR	Consiglio Nazionale delle Ricerche
ECMWF	European Centre for Medium-Range Weather Forecast
ESA	European Space Agency
HDF	Hierarchical Data Format
IMEDEA	Institut Mediterrani d'Estudis Avançats
MDT	Mean Dynamic Topography
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
OPeNDAP.	Open-source Project for a Network Data Access Protocol
SAR	Synthetic Aperture Radar
SSH	Sea Surface Height
SLA	Sea Level Anomaly
SST	Sea Surface Temperature
SWH	Significant Wave Height

1 Introduction

The COASTALT project aims to develop a new product that maximises the use of altimetric measurements near the coast. The requirements for such a product are not predetermined but have to be decided by the COASTALT team in collaboration with ESA and after consultation with the potential users of the project. This report describes the collection of the users' views on the basis of a questionnaire that has been developed and distributed by COASTALT, and presents some recommendations on the definition of the new product.

1.1 Methodology

During the first two months of the COASTALT project the WP1 team designed and distributed a questionnaire to gather feedback from a wide pool of users interested in the optimum exploitation of radar altimetry in the coastal zone. A list of key users was defined in collaboration with the PISTACH (CNES project) team. The PISTACH project has similar aims to COASTALT and it was felt that duplication of efforts was not efficient and would burden the user community unnecessarily, thus it was agreed with the PISTACH team that the people contacted by them would not be contacted again by COASTALT. The questionnaire was distributed by email. In addition, the questionnaire was distributed to the participants of the first CIOSS/NOAA Coastal Altimetry Workshop in Silver Spring[2], MD, 5th to 7th February 2008, in which COASTALT participated. The returned questionnaires have been analyzed and the results of the analysis, as well as recommendations on the definition of the new products, are provided in this document.

This report includes information provided by the PISTACH team where it was of assistance for this survey.

1.2 Questionnaire

The COASTALT questionnaire was designed by the WP1 team (Starlab, NOCS and CNR) on the basis of the PISTACH questionnaire, with some modifications. The questionnaire is attached at the end of this document, under Annex I. Its structure is briefly explained hereafter.

The questionnaire is divided in various sections each with a different objective. The initial section establishes the **user profile**, with particular reference to his/her involvement in coastal work and to previous use of altimeter data. The second section is application oriented; which **kind of application** the user has in mind for altimetry data (for current and/or prospective work), and which parameters are of interest to him/her.

The next sections provide the basis for the COASTALT team to know current products in use and future products requirements. These sections involve: first a **product characterization** in terms of spatial/temporal sampling and data delivery time requirements, and, second, **accuracy** and **precision requirements**. A simple explanation of the concepts of *accuracy* and *precision* was provided at the end of the questionnaire.

[2] http://cioss.coas.oregonstate.edu/CIOSS/altimeter_workshop.html

Finally, the user is questioned about his/her requirements in terms of **auxiliary data** (including other remote sensing data and a mean dynamic topography) and on the preferred data format and distribution. He/She is also asked to provide his/her affiliation and e-mail address for a mailing list that will form the core of the Science Working Team in Coastal Altimetry (task 7.2 in the COASTALT Project).

NOTE: a later analysis with updated figures is available in the presentation by Dufau and Martin-Puig at the 2nd Coastal Altimetry Workshop: http://www.coastalt.eu/pisaworkshop08/pres/01-PISTACH-COASTALT-CAW-V4-CMP.pdf

2 Questionnaire Analysis

2.1 User Profile

A total of twenty questionnaires were received, in addition to the thirty three gathered by the PISTACH project, which distributed the survey at an earlier stage. The names of the experts who have replied to the COASTALT questionnaire, their institutions and country are provided below:

- Saleh Abdalla, ECMWF (UK)
- J.-J. Benjamin, Universitat Politècnica de Catalunya (Spain)
- Andrey Kostianoy, Institute of Oceanology, Russian Academy of Sciences (Russia)
- A. S. Unnikrishnan, Physical Oceanography Division. National Institute of Oceanography India (India)
- Charles Colkoen, ARGOSS (The Netherlands)
- M. Ravichandran, Indian National Centre for Ocean Information Services (India)
- Dominique Durand, Norwegian Institute for Water Research (Norway)
- Viorel Malciu, National Institute for Marine Research - development "Grigore Antipa". (Romania)
- Damia Gomis, IMEDEA (Spain)
- Oceanographic Applications Group, Consiglio Nazionale delle Ricerche (CNR) (Italy)
- Y. K. Somayajulu, National Institute of Oceanography India (India)
- Johnny Johannessen, NERSC (Norway)
- Ted Strub, Oregon State University (USA)
- Sarantis Sofianos, University of Athens (Greece)
- Sergey Stanichny, Marine Hydrological Institute (Russia)
- Frank Aikman, Chief, Marine Modeling and Analysis Programs (MMAP), NOAA, Silver Spring (US)
- Bill Emery, University of Colorado, Boulder (US)
- Mohan Karyampudi, Earth System Science Interdisciplinary Center, University of Maryland (US)
- Daniel Conley, University of Plymouth (U.K.)
- François Soulat, Mercator (France)

Mailing addresses may be found in annex III.

Although the number of returned questionnaires is not large, they cover a wide range of countries mostly European, but also from other continents.

To better understand the user needs, their answers have been classified by institution type. Six different institution categories have been defined: public research institution, private research

institution, public operational institution, private operational institution and mixed institutions (operational and research) public and private. The previous classification will allow the interpretation of the results under various criteria. For example, it will allow the understanding of the user needs by sector (public or private) and it will also allow differentiating user needs for research and operational purposes. For clarity a graph representation of the results is provided for each question. A table with all the questionnaires/interview results is also attached at the end of the document in Annex II.

The questionnaire accepts multiple answers for most of the questions. The total number of answers (100% in a pie chart) that is going to be accounted is not related to the total number of received questionnaires, since for many of the questions users have responded with more than one choice.

In some of the questions the results of the COASTALT questionnaire have been merged with the results of the similar questionnaire carried out by the PISTACH project. Where this has been done it is explicitly mentioned. In Annex II a table with all the results, COASTALT and PISTACH, is provided.

2.1.1 Working institute /enterprise

Most of the questionnaires received were from oceanographers at public research institutions.

Analyzing in detail the different sectors of the users who have collaborated, the total distribution per institution type is:

- Operational public: **1**
- Research public: **11**
- Operational private: **1**
- Research private: **0**
- Operational + Research public: **5**
- Operational + Research private: **2**

For the analysis, in order to identify the specific needs this distribution can be grouped in:

- Total Research: **18**
- Total Operational: **9**
- Total Public: **17**
- Total Private: **3**

Most of the questionnaires come from the public sector; the private sector is undersampled with only three replies. However, we will need to consider these three questionnaires representative the whole sector in the absence of any contradictory evidence.

2.1.2 Specific study of the coastal ocean

This section provides the analysis of answers to the questions: “How do you study the coastal zone?”, and “have you already used altimetry products for your studies?” included in the questionnaire.

All collaborators had previous experience with altimetry products, with a 100% “yes” response to the second question. Therefore, the results hereafter detailed correspond to an experienced community of users, as expected from the distribution list defined.

Figure 2-1 shows the percentage of different data types used daily by our collaborators, merged with the result of PISTACH project. Some users restrict to one single data type. Others use more

than one source of information for their research and/or operational applications. In total, the distribution of data is:

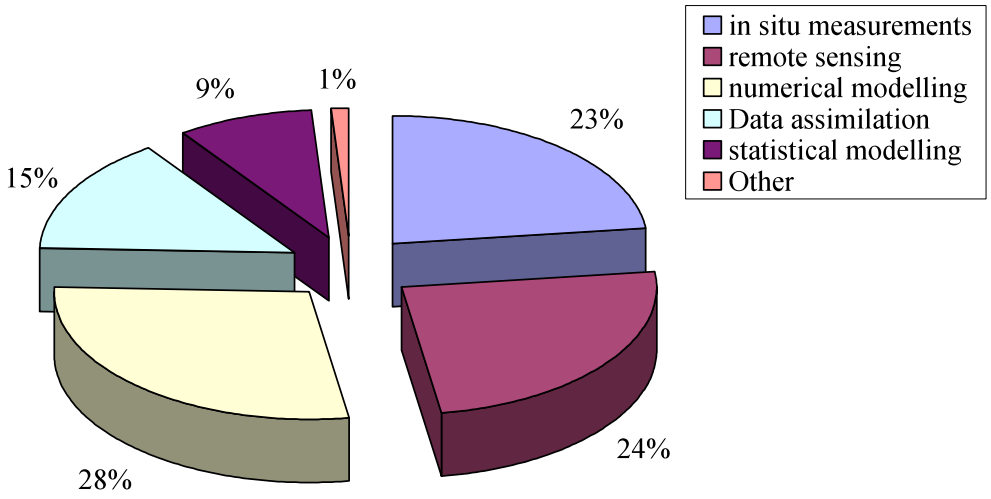


Figure 2-1- Types of data used to study the coastal ocean

The main activities undertaken by users of altimetry data are well defined. The broad headings of numerical modelling, remote sensing and in situ measurements are the most popular of the users' activities. Statistical methodologies like statistical modelling and data assimilation cover the remaining share. **It is important to notice that modelling as a whole covers a large share of the activities of our pool of users**. One questionnaire has been marked as other. In addition, one of the members of the COASTALT community reported problems related to the resolution when moving from Deep Ocean to coast.

Between the COASTALT individual results and the PISTACH ones there is no statistical difference with these samples; both surveys showed similar tendencies with very small differences. While in PISTACH the most chosen application was numerical modelling, in COASTALT it has been remote sensing data, but the differences are not significant, so we should consider the first three applications to have equivalent interest.

This part of the survey clearly identifies the character of the main user activities. Nevertheless, we must remind that the private sector is under-sampled by the survey.

2.1.3 Time length and delivery time of altimetry data

This section analyzes two related User Profile questions: "*Do you consider your work to be: Real time, near real time, delay mode or climate related*" and "*How long are your usual databases?*". Clearly faster relaying of the data to the user would indicate a need for a product that can be provided very quickly, with little time for quality checks. The length of the used databases would determine whether the effort could be concentrated in segments of the existing data or whether the effort should cover the totality of available data, or at least establish a priority for reprocessing of the existing data archives.

2.1.3.1 Measurement to Result time delay

There is no single preferred delay mode. It appears that real time applications are now less popular, with only 14% of the questionnaires claiming such a need. The preferences for near real-time, delayed and climate related modes are almost equally distributed.

Figure 2-2, representing just the COASTALT replies, summarizes the type of work currently carried out by our users. The biggest percentage of our collaborators' work is near real time, followed by delayed mode; both imply a certain delay between data reception and production of results. Climate related analysis, which implies long-term studies, is in third place, but given the number of responses, the order is not significant and the three first applications should be considered as equally representative of users' key applications. Real time experiments are less usual among the community at the moment. However, as it will become clearer from some of the later questions, the users feel that real time applications of coastal altimetry are potentially important, and it is one of the challenges for altimetry to be able to provide real time or near-real time data in the coastal area.

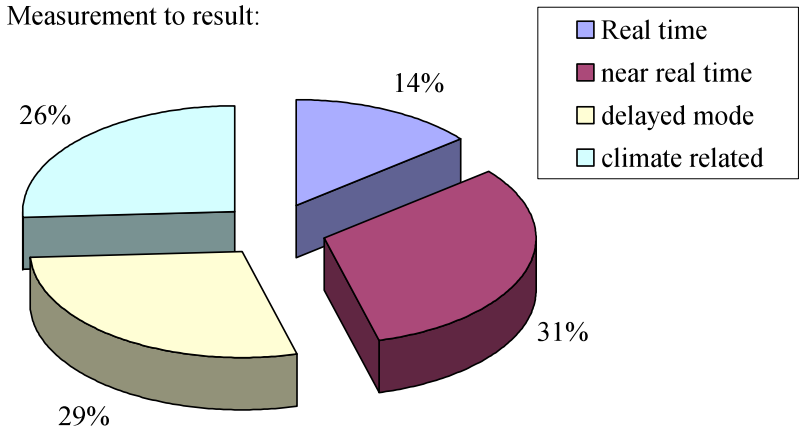


Figure 2-2.- Measurement to result time delay

2.1.3.2 Length of used datasets

Our users' datasets temporal lengths have been classified in 5 different types:

- Day long or shorter
- Between 1 day and 1 month
- Between 1 month and 1 year
- Between 1 year and 10 years
- Longer than 10 years and as long as possible

The COASTALT community responses are provided in the following graph:

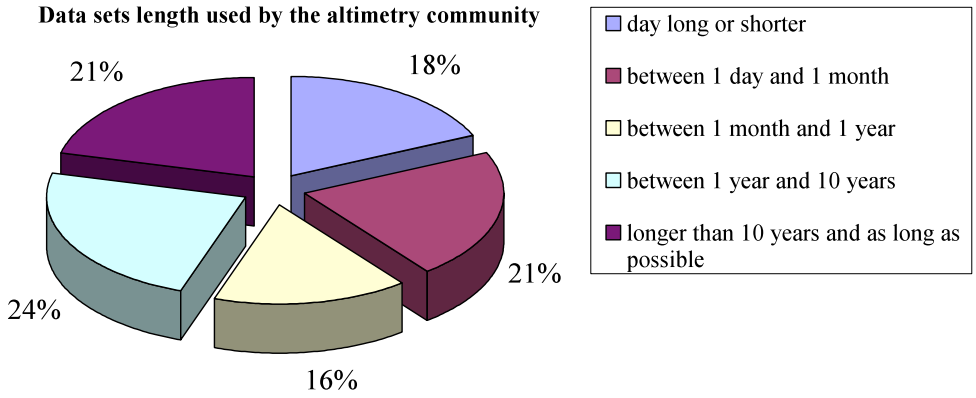
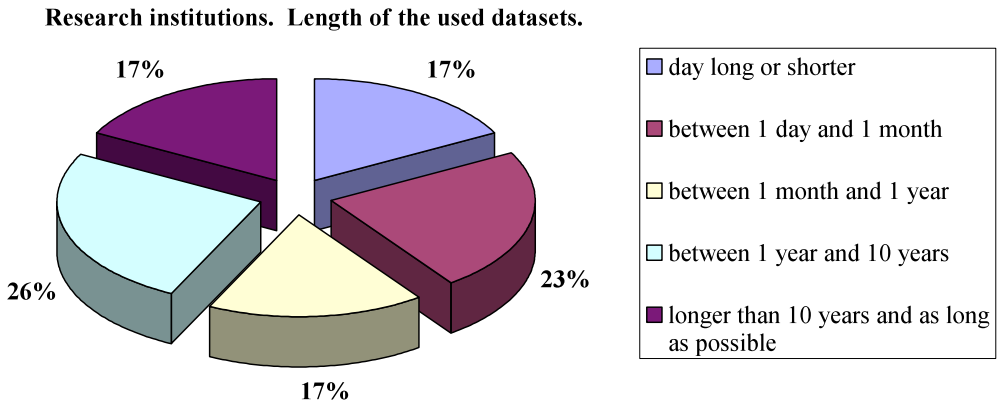


Figure 2-3- Length of the datasets used by the altimetry community

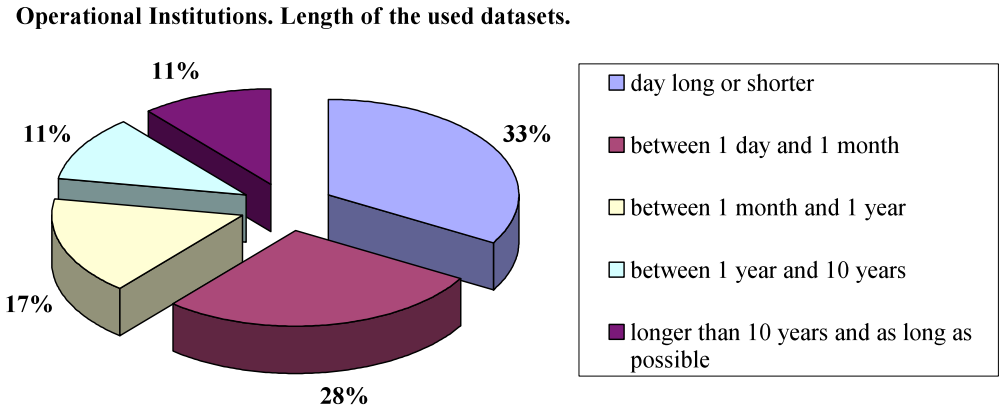
Again there is no preferred length. One can notice that datasets of up to one year would apparently cover approximately half of the users' needs. This indication may be the basis for a pilot reprocessing of the existing data.

Datasets with temporal length between one year and ten years are mostly used for coastal analysis followed by data sets longer than ten years and between one day and one month. In any case the distribution of the chosen length of the dataset is quite balanced as the graphic reveals.

Datasets lengths are strongly related to the final application of the study that our collaborators do. For this reason the previous figure is repeated for research institution and operational institutions in Figure 2-4.



a)



b)

Figure 2-4 – Temporal length of the data sets for research (a) and operational (b) institutions.

Longer datasets (longer in time) are more frequently used among the research institutions as illustrated in Figure 2-4 a). Operational institutions tend to use shorter (shorter in time) data sets. Operational institutions rely more frequently on real time or almost real time services.

In addition to the previous results, an illustration of the results classified by user type is provided below:

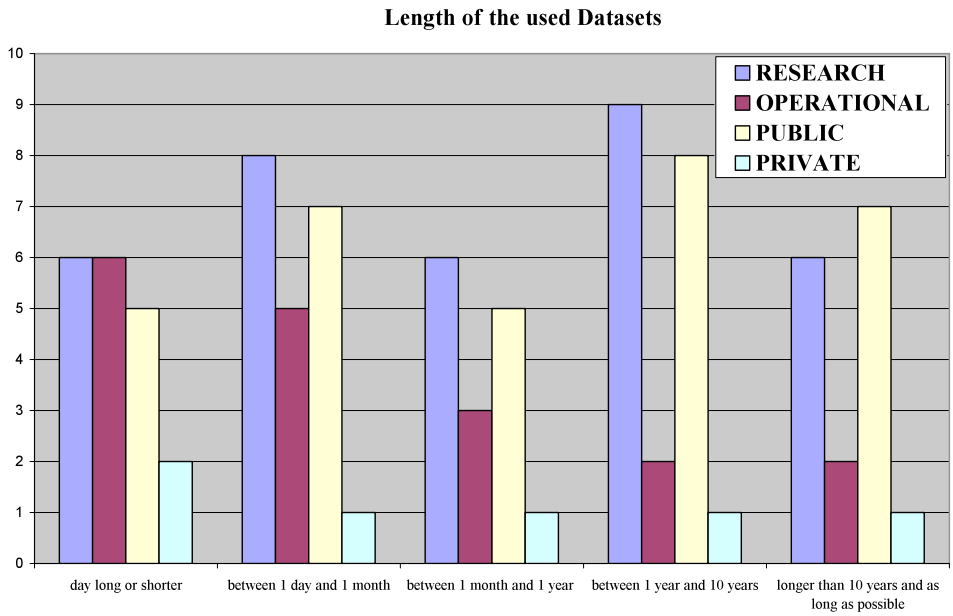


Figure 2-5: Datasets length classified by user type

The previous figure confirms what was expected, i.e. that operational institutions are more interested in shorter delays in receiving the data.

2.2 User /Sector Applications

In this section, all the figures provide the merged results from PISTACH and COASTALT community answers.

2.2.1 Observation Zone

This section provides an analysis of the responses to the question: *"Are you using data from: Near shore, coastal zone, Open ocean"*.

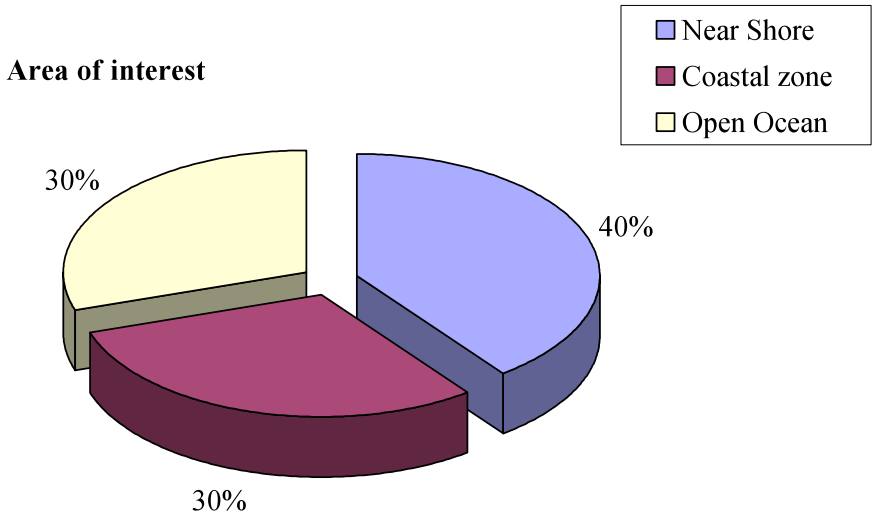


Figure 2-6: Areas of Interest

Figure 2-6 shows that experts have no clear tendency for any of the provided options. All three are almost equally studied.

2.2.2 Distance to the shoreline

This section summarizes the answers to the question *"What distance from the shoreline?"* which complements the previous subsection.

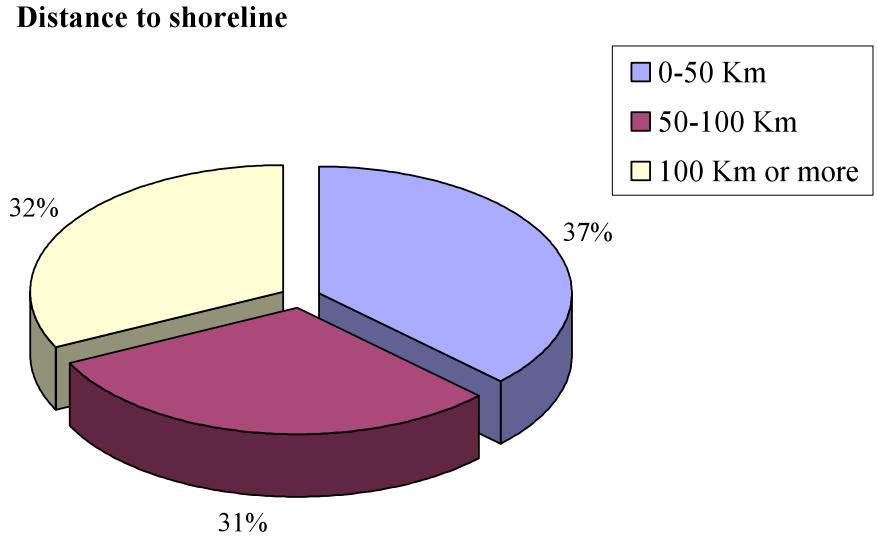


Figure 2-7- Distance to the shoreline

The previous figure indicates that the area of interest of two thirds of the users is included in the strip extending a hundred kilometres from the coast. Some of the users indicated that the specific preference was around one to five kilometres from the coast. There is not a clear divergence between the individual PISTACH or COASTALT results or the merged ones.

2.2.3 Purpose of the altimetry product

The last question in the survey to better understand the work/application needs of the user relates to the final purpose of the altimetry products achieved within their work/application. The answers to the question: "*Purpose of the altimeter product*"; are provided in the following graph:

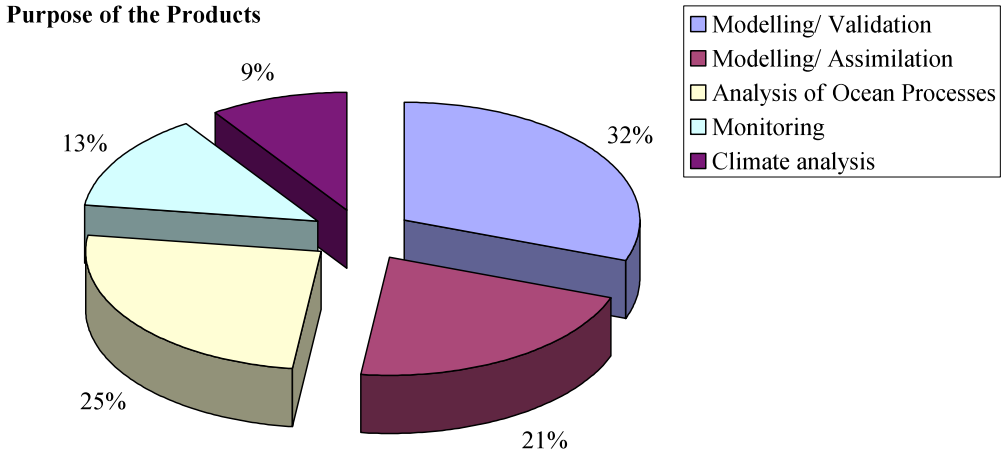


Figure 2-8.- Purpose of the altimetry products

Figure 2-8 reveals that three sectors presently dominate the use of altimetry data. The established uses of model validation, model assimilation and as a diagnostic for oceanic processes are the three uses. **As already noted in the comments to figure 2.1, modelling as a whole is an important market for coastal altimetry.** Monitoring and climate analysis are the product purposes that, although not negligible, are less popular. It is worth noting that these represent areas where the altimetric products have clear room for improvement in the future: real-time monitoring by producing faster products and climate related research by ensuring continuity of consistent measurements.

2.3 Parameters Used

In this section the results presented correspond again to the merged outputs of PISTACH and COASTALT surveys.

2.3.1 Physical process under study

The physical processes were classified in six different categories:

- Sea Level Anomaly
- Absolute Dynamic Topography
- Sea Surface Height (SSH)
- Waves (Sea State answers in PISTACH)
- Geoid
- Wind (Sea State answers in PISTACH)

The answers of the community to the question: "*Which physical processes do you study*" are shown in the following figure. Note that more than one answer was possible per community member.

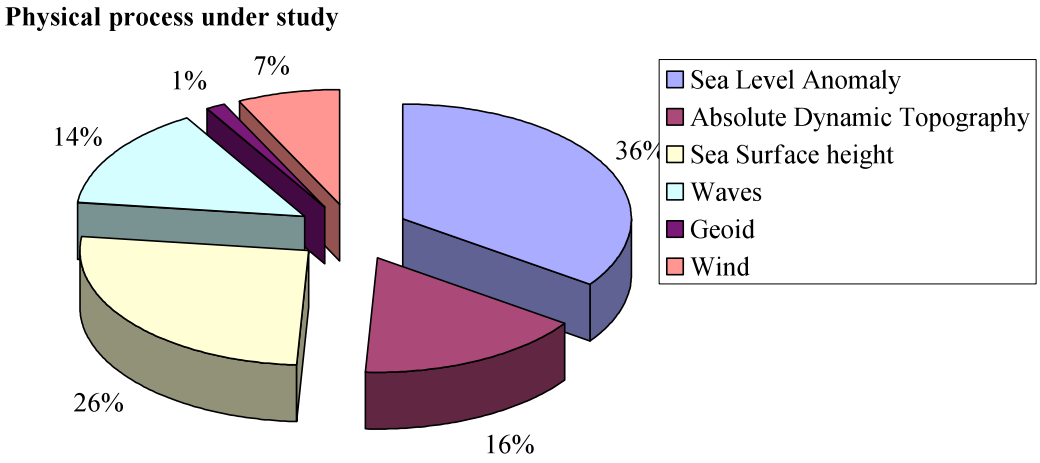


Figure 2-9.- Physical process under study.

As the figure shows the two physical parameters more used among the coastal altimetry community are the Sea Surface height (SSH) and the Sea Level Anomaly (SLA). Following these two Absolute Dynamic Topography (ADT) and Waves are the third and forth most studied with almost the same percentage followed by the wind. It must be noticed that wind and waves together cover a non-negligible share, thus supporting the production of wind and wave coastal altimetry products. The least studied by the coastal altimetry community responding to these surveys is the Geoid, but this is because virtually all people contacted are oceanographers not geodesists (we know from the geodetic community that the coastal geoid is an important topic). Free space was left in the questionnaire for additional physical processes of interest to the community, and parameters as ocean colour, pressure, currents, coastal topography or bathymetry were suggested.

2.3.2 Frequently used parameters

This section analyzes the answers provided in question two of the "used parameters" section in the questionnaire. The percentages illustrated in Figure 2-10 refer to the question: *"Which of the following parameters do you use? Give a score using 4 (very important to you) to 1 (marginal). Put 0 where you do not use a parameter at all".*

The parameters classification provided to the collaborators in the questionnaire was:

- Wind Speed
- Salinity
- Temperature
- Surface elevation
- Significant Wave Height (SWH)
- Other …

Figure 2-10 provides a percentage distribution of the community interests in each of the parameters. The percentage below has been obtained as the sum of scores for a parameter, divided by the overall sum of scores

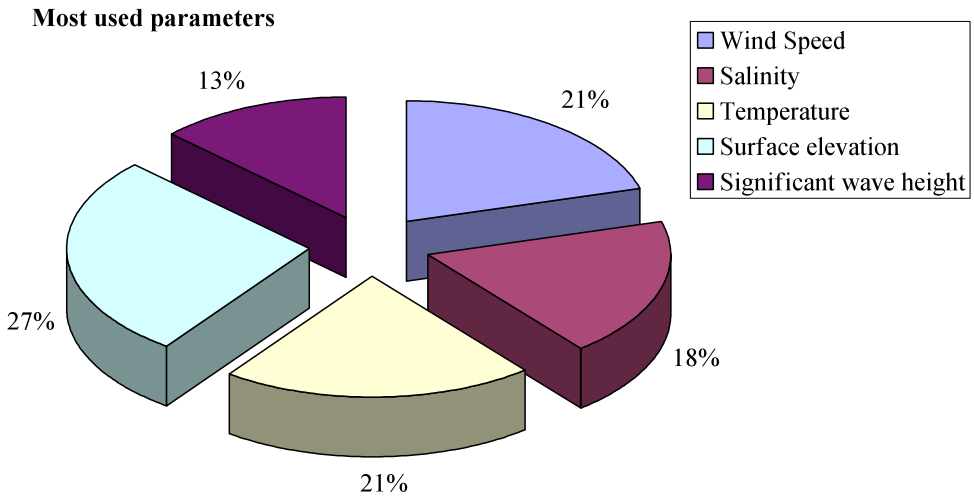


Figure 2-10.- Most used parameters

Surface elevation, or sea level, is the most popular of the different parameters. The others are, however, close to it in percentage of use and interest and are almost equally important.

Currents were also added as an additional parameter by some users, since they were not included in the original range of options.

2.4 Products Characterization

The users were asked to provide information on their presently preferred product and, in addition, on the characteristics they wished the new product to have. In this way the necessary improvements in the present products are to be identified. These results cannot be merged with the ones provided by the PISTACH questionnaires since the nature of the questions is different. Thus the results here are based on the 20 COASTALT replies.

Note that some of the subsections hereafter may differ in total number of responses. This is due to the fact that not all the COASTALT users responded to all the questions in these subsections, or more than one answer was provided.

2.4.1 Along track frequency sampling

The most commonly used frequency sampling by the community is 1 Hz. However, the preferred one is 20 Hz. Additional comments recommend keeping the 1 Hz frequency as complementary to the desired 20 Hz. Only one community member was interested in the 1800 Hz. In the PISTACH survey this question was asked in a different way, but the results still indicate that the preference of the PISTACH sample is clearly 20 Hz, and that the 1 Hz should be retained as indicated in the COASTALT results.

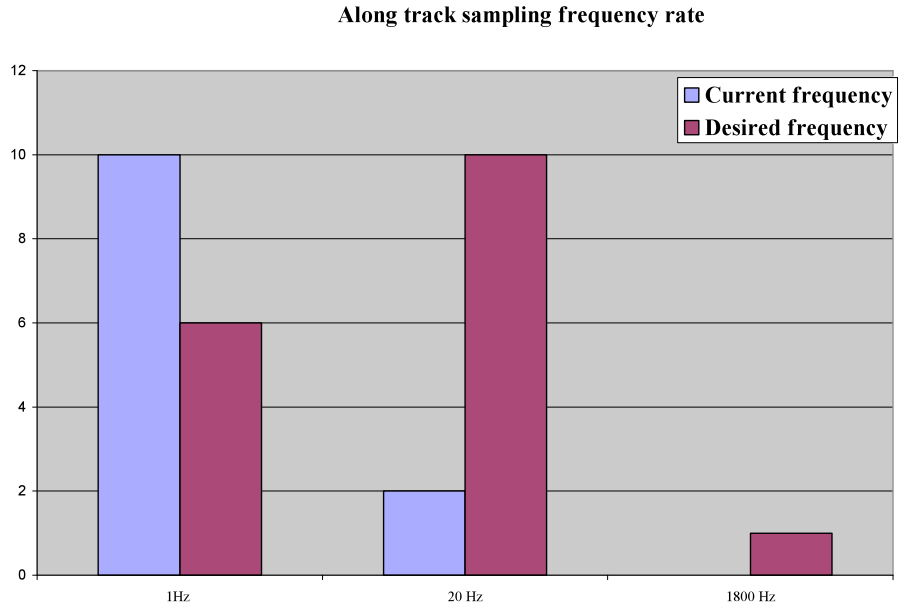


Figure 2-11.- Along track sampling frequency

2.4.2 Spatial resolution (Along track)

For the spatial resolution the choice is very clear for all the community: they are interested in the smaller spatial resolution provided in the questionnaire. No smaller resolutions were specified in the field left for additional comments.

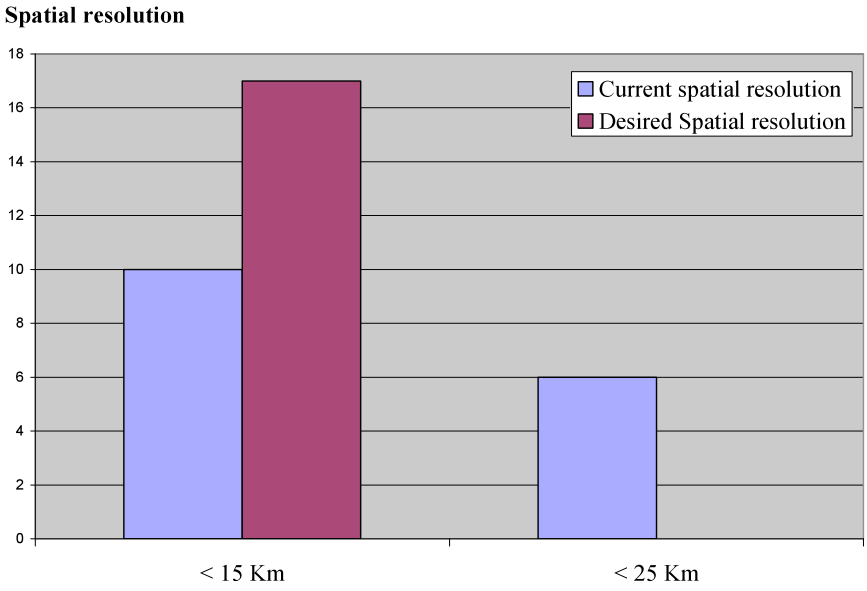


Figure 2-12.- Spatial resolution accuracy

2.4.3 Data delivery delay versus accuracy

In terms of accuracy versus delivery delay the choice is also clear. Nowadays most of the user community has access to delayed time accurate data, but they would favour access to near real time data (even if of lower accuracy) or even to real time data. This is to some extent surprising, as most of the users have not declared themselves as operational entities and neither are they using near real time nor real time data as yet (see Figure 2-2.- Measurement to result time delay). **We can conclude that the replies to this question clearly highlight a potential market for near real time and real time coastal altimetry.**

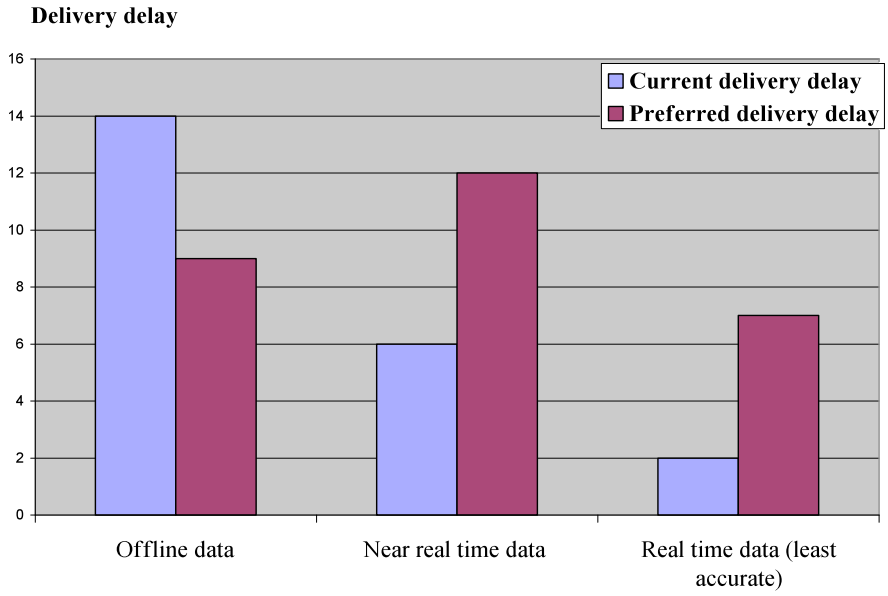


Figure 2-13.- Delay delivery vs data accuracy

2.5 Accuracy Requirements

Three questions in the questionnaire referred to product accuracy. The questions focused on: accuracy for height measurements, accuracy for SWH, and Radiometric accuracy. All the people interviewed were requested to specify the accuracy of these parameters currently used, and the desired accuracy of these parameters in the new products to be released under this project. The analysis of the responses is provided hereafter.

2.5.1 Accuracy for Height Measurements and SWH

In terms of accuracy for height measurements and SWH the preferences are: users prefer the products to have the best accuracy possible; better than three centimetres accuracy for height measurement and better than five per cent of SWH. In practise this will only be possible with delayed time products for sea surface height; however, the underlying message from the users is that accuracy is an important issue and effort should be put into improving it.

One surprising results is that a majority of users consider the present products to have an accuracy better than 3 cm, which is certainly questionable in marginal seas and when approaching the coast. This suggests that users tend to overrate the capabilities of current altimeter data in the coastal area, and calls for better information to the users, including a rigorous explanation of the error budget.

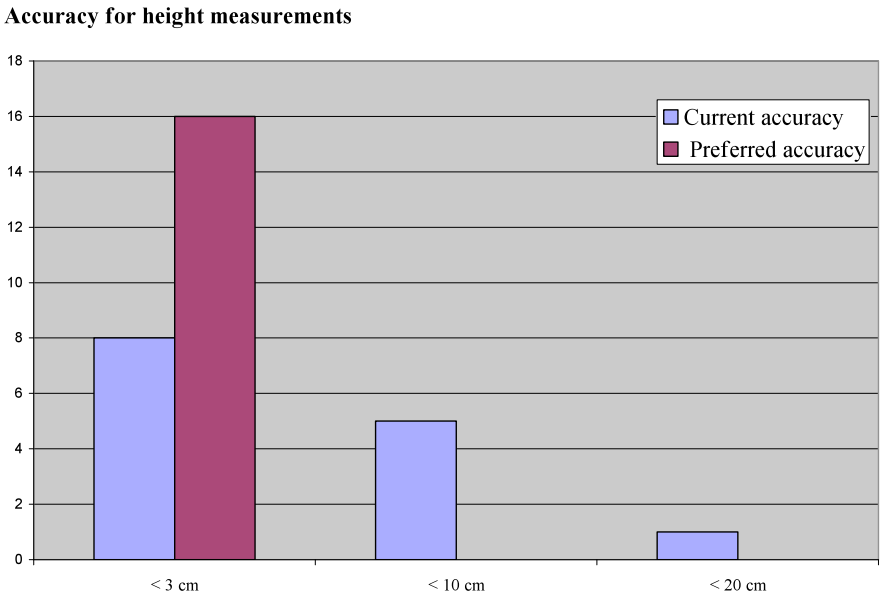


Figure 2-14.- Accuracy for height measurements

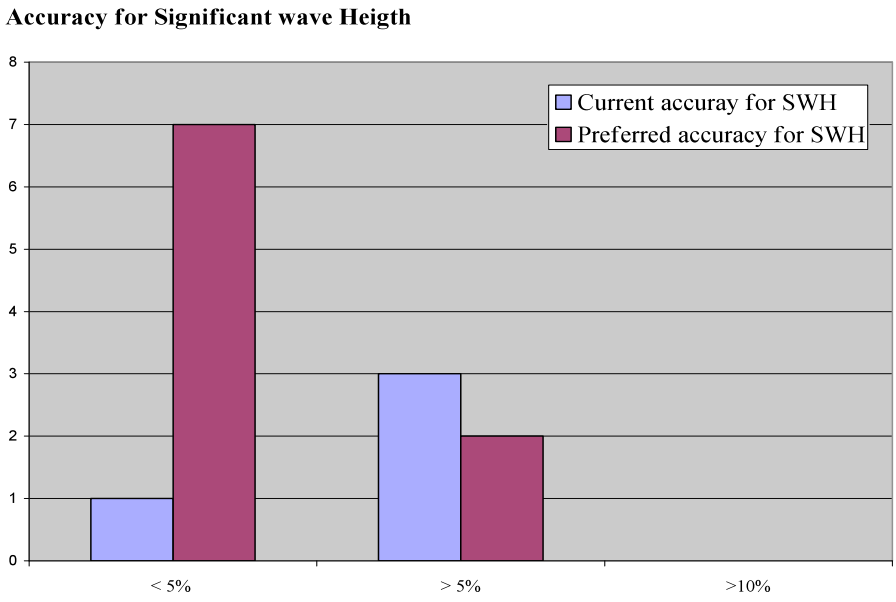


Figure 2-15.- Accuracy for SWH

2.5.2 Radiometric Accuracy

Several users have neither responded to this question, nor provided us with any additional preference. The tendency of those who have responded is equally distributed as far as the desired accuracy is concerned. Half of the people who responded prefer a radiometric resolution better

than 0.2dB, while the other half prefer a radiometric resolution better than 0.5dB. Currently, more tend to work with radiometric accuracy less than 0.5dB.

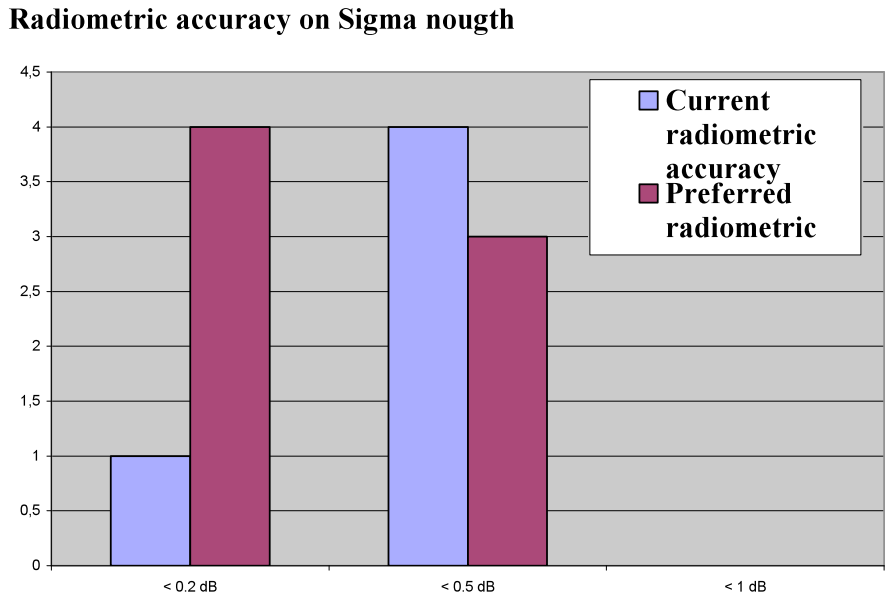


Figure 2-16- Radiometric accuracy

2.6 Precision Requirements

The same parameters as in the previous section have been analyzed for precision. No precision requirements have been asked to the PISTACH sample.

2.6.1 Precision for Height Measurements and SWH

Similar results to the accuracy analysis are shown in Figure 2-17 and Figure 2-18 compared to their equivalents in the previous section.

The majority of the users interviewed are satisfied with the current precision of the present system for height measurements. Again, this calls for better information to the users, including a rigorous explanation of the error budget as discussed in §2.5.1.

In the case of SWH, most users would like to have improved products with precision better than 5%.

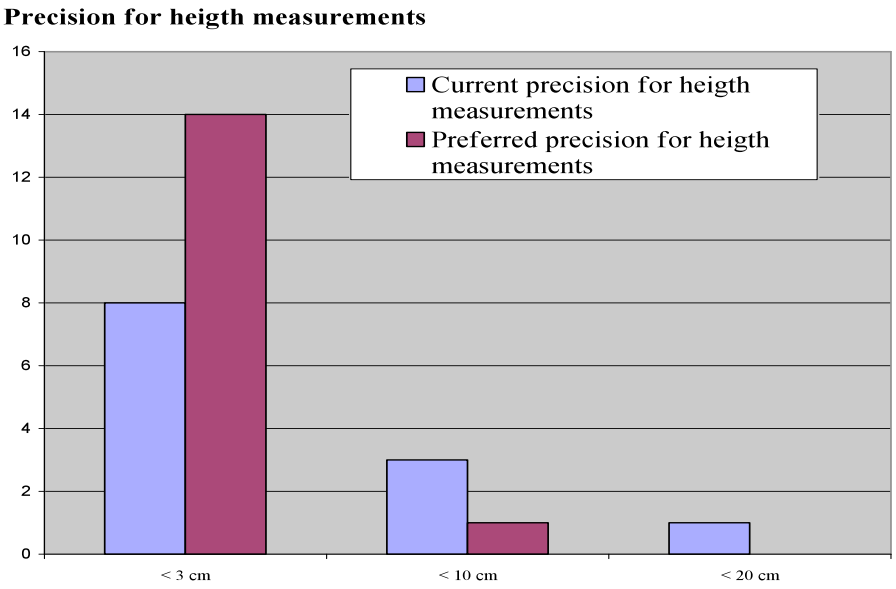


Figure 2-17.- Precision for height measurements

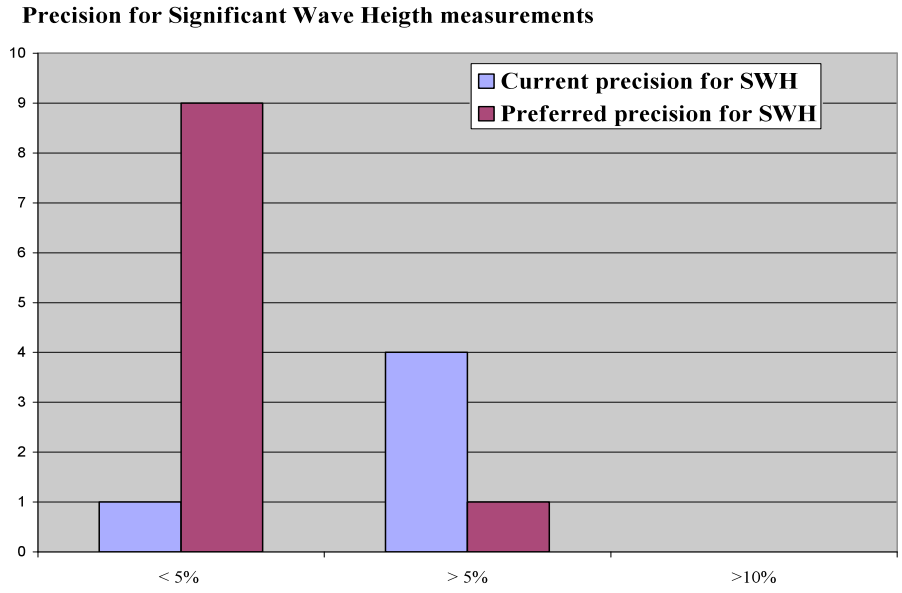


Figure 2-18.- Precision for SWH measurements

2.6.2 Radiometric precision of sigma-0

The results provided in Figure 2-19 are not highly significant since only six questionnaires responded to this question. From those six; two of them expressed their preferred radiometric resolution while the question about the current radiometric precision was left blank. Note that those questions about precision and accuracy have been left blank by a large part of the community, specially the questions referring the current parameters.

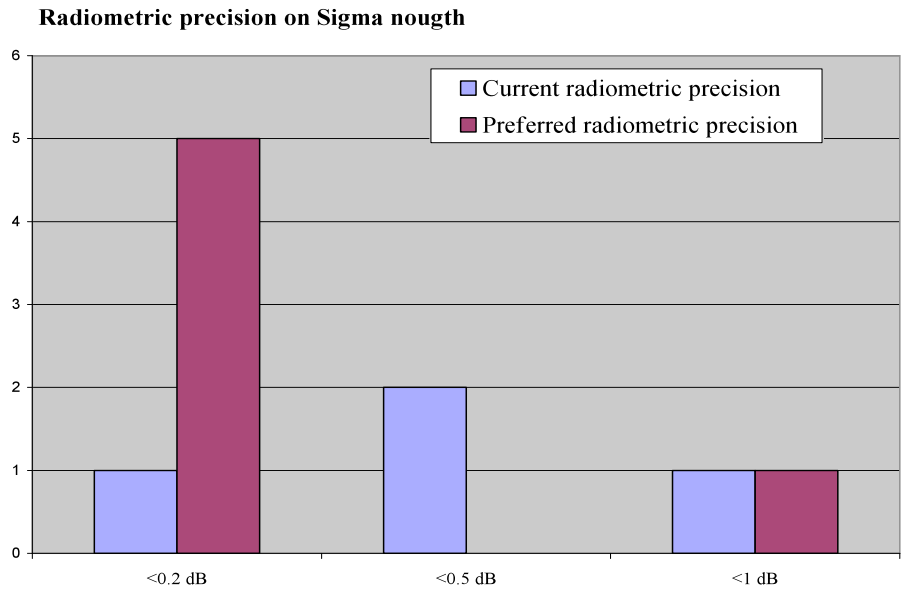


Figure 2-19.- Radiometric precision

2.7 Auxiliary Data

As auxiliary data the users were asked for:

- Supplementary data required for the new product
- Complementary information needed
- Need of mean dynamic topography
- Other remote sensing data products synergic to their altimetry work
- Need of altimeter data
- The need of data in several coastal areas
- Additional comments and suggestions

Some of the questions can be merged with the PISTACH results. Where this is done it will be indicated.

2.7.1 Required supplementary data

Five different options were provided to the users. As supplementary data they could chose between:

- Raw data
- Quality controlled data
- Data with global quality flags
- Data with specific quality flags
- Other

No response to the "other" was provided. Most users showed a strong interest in quality-controlled data. The second most popular option was the specific quality flags, followed by data with global quality flags and raw data. This is consistent with users being interested in using the data on an "as is" basis for direct studies of the output quantities or for assimilation into models, without many of them interested in reprocessing the data.

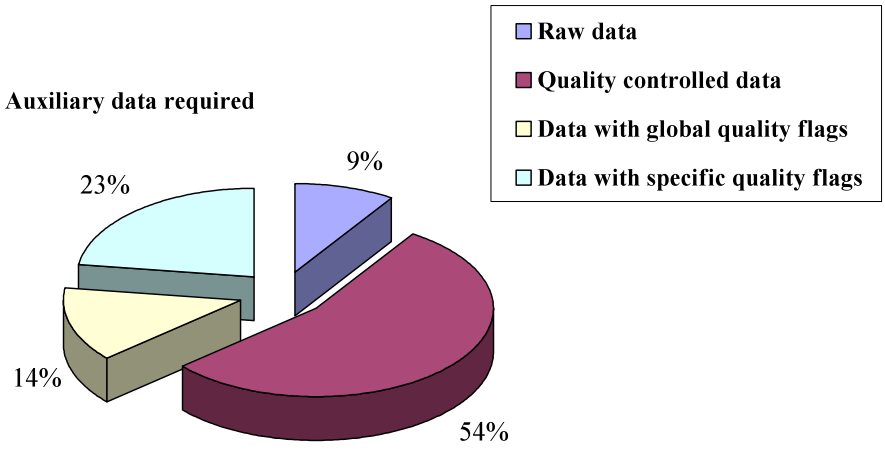


Figure 2-20.- Auxiliary data required

2.7.2 Complementary Information Needed

Different complementary information options were specified in the questionnaire:

- HF fields to correct altimeter data
- Applied Atmosph. Corrections
- Applied Geophysical corrections
- Instrumental corrections
- Other

Applied atmospheric and geophysical corrections are of major interest by the altimetry community, as could be expected. HF fields and instrument corrections with equal percentage follow the previous two. This calls for a distribution of coastal altimetry data in the form of records (CGDRs – Coastal Geophysical Data Records) having all the additional fields, as an evolution of the currently available GDRs.

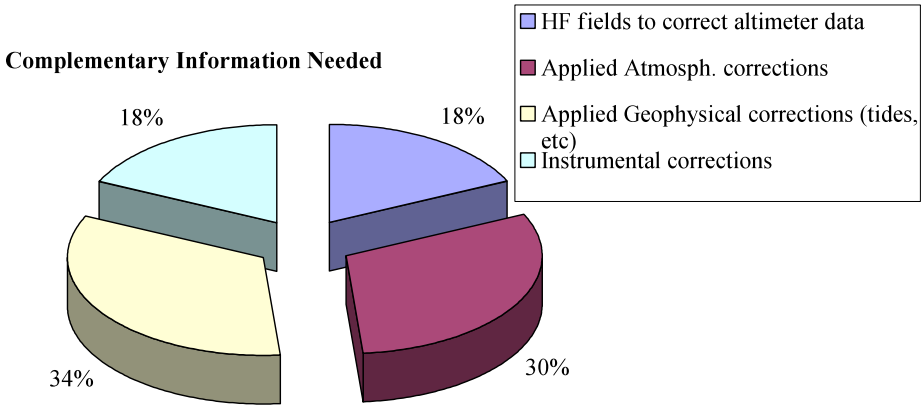


Figure 2-21.- Use of the auxiliary data

2.7.3 Need for a Mean Dynamic Topography (MDT) to Reference Data

Most research institutions need a MDT to reference data. Operational institutions do not consider a MDT as important for their work.

Concerning the public and private segmentation, in this case it is very similar to the research and operational segmentation, due to the fact that the majority of research centres are public while most operational centres are private.

The result can be compared to the one gathered in PISTACH, where no segmentation of the users was done. In that case, 77% of the community answered positively to the question while 19% responded in the negative. Four percent are not sure whether they require the MDT or not.

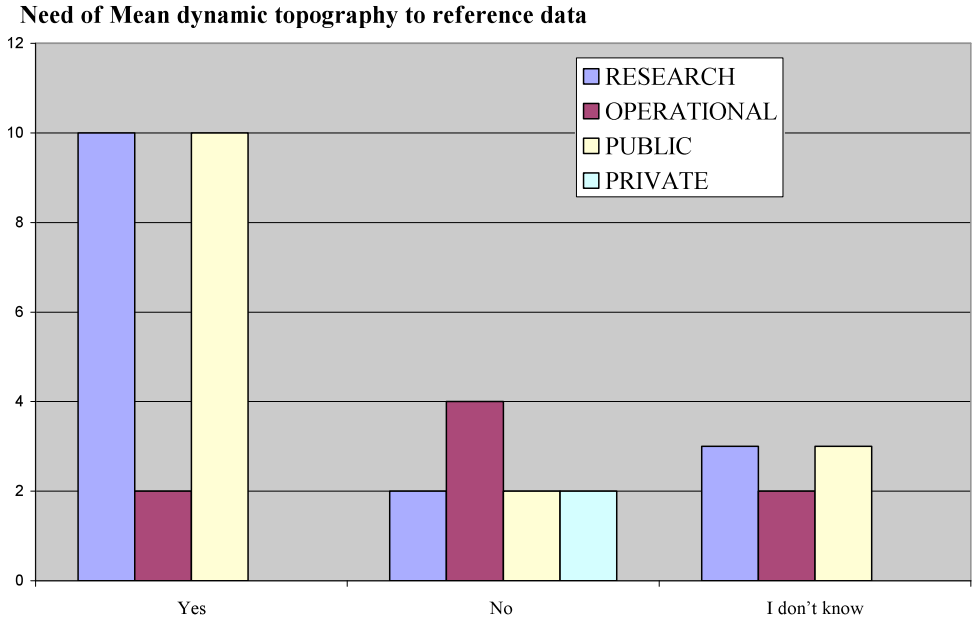


Figure 2-22.- Need for a MDT to reference data

2.7.4 Additional Remote Sensing data Products Synergic with Altimetry Applications

Altimetry data are sometimes interpreted in synergy with other remote sensing products. The questionnaire included as options those products most commonly used by the altimetry community. This question was also included in the PISTACH survey and the results presented here are the COASTALT/PISTACH merged ones. The options available were:

- Synthetic Aperture Radar (SAR)
- Optical
- Infrared
- Other

All seem to be of significant interest to the altimetry community. Optical data seem to be slightly more used (or more desired) than the other two, but the percentage of interest is not much larger and the difference may not be significant. Again, PISTACH and COASTALT present the same tendencies.

No response to the "other" field was provided.

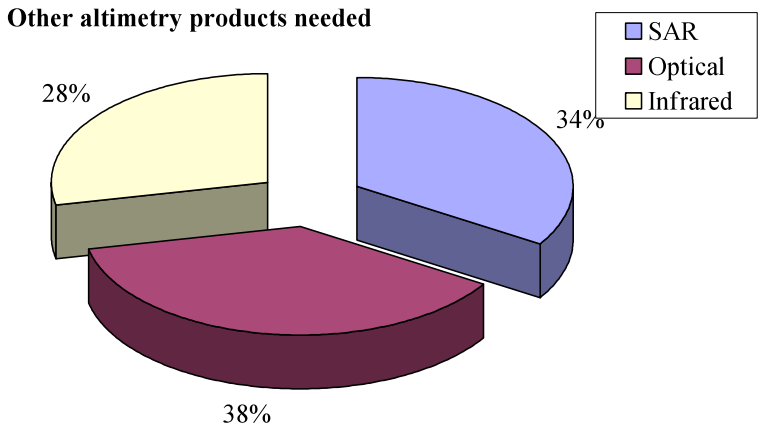


Figure 2-23.- Other remote sensing data products needed

2.7.5 Need for Altimeter Data

This pie diagram is the result, again, of the merged results of both user surveys. All users who replied make use of altimetry data over the coastal ocean. This result was expected because the selected users were mainly coastal scientists. None of them focuses on open ocean applications only. But many do work on the open ocean, and only one fifth restrict their research to coastal ocean only. However, one can compare this result with that in Figure 2.7 to discover that the definition of 'coastal' by the users is quite broad, as a good percentage of them do not go closer than 50 km from the coast at present.

Additionally, (and not provided in a graph but it can be found in the final results table included at the end of this document) most of the experts who replied study more than one coastal location.

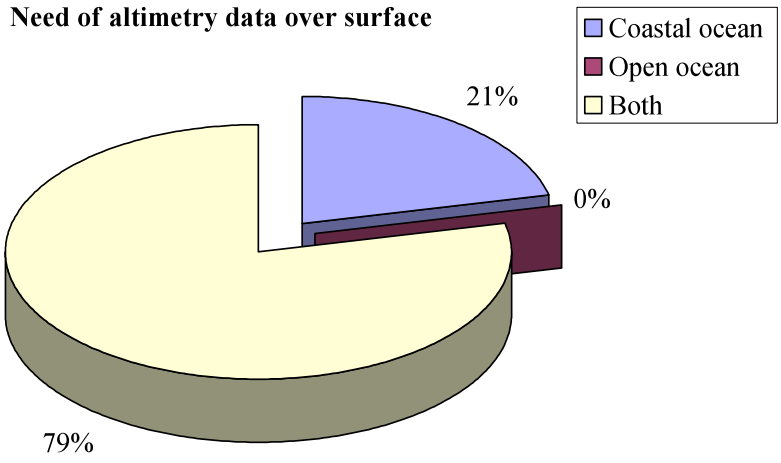


Figure 2-24 .- Need for altimetry over the surface distributed by zones

2.8 Data Format and Distribution

The data format is an important characteristic to be considered in a product description phase. Three different questions were asked to the collaborators:

- What data format do you use?
- What delivery mode is easier for you?
- How often do you need the altimeter dataset to be updated?

In this case, the nature of the question was the same in COASTALT and PISTACH, but the PISTACH community expressed just the preferred mode, so it will not be helpful to merge both results. However, the preferred data format and delivery mode for the PISTACH community will be discussed.

2.8.1 Data format used and preferred

Four popular data format options were given to the community, plus any additional possible answer:

- NetCDF
- ASCII
- Binary
- HDF
- Other

The most frequency used data format is NetCDF, and it is also the preferred one. The second mostly used format is ASCII. Other formats, as HDF or binary, are less required. In addition, another format not listed previously, like BUFR[3], was specified by the collaborators.

The preferred format for the PISTACH community was also NetCDF followed by ASCII.

[3] The Binary Universal Form for the Representation of meteorological data (BUFR) is a data format maintained by the World Meteorological Organization which belongs to the category of *table-driven code forms*, where the meaning of data elements is determined by referring to a set of tables that are kept and maintained separately from the message itself.

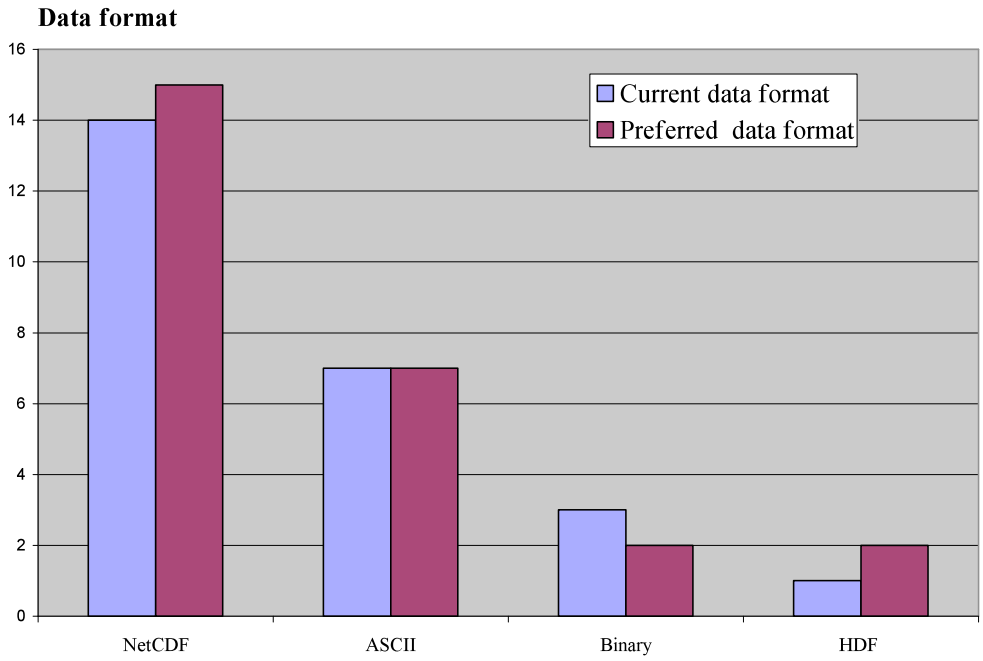


Figure 2-25.- Data formats

2.8.2 Delivery mode used and preferred

ftp is nowadays the most common delivery mode among the coastal community. The preferred mode for future delivery is *OPeNDAP* followed by the possibility to upload the data directly into the program from remote servers, and *ftp*.

DVD is the least commonly used format among the community. The delivery delay time compared to the other options may be the cause of the low interest of the community. The *GTS* [4]delivery mode was suggested by one user.

Note that more than one option could chosen by the interviewed experts.

The preferred delivery mode for the PISTACH community was also ftp, followed by *OPeNDAP* and remote server.

[4] For more details on GTS, the Global Telecommunication System used in meteorology, see http://en.wikipedia.org/wiki/Global_Telecommunications_System. Note that EUTMETSAT have also recently proposed a system called EUTMETCAST and based on standard Digital Video Broadcast (DVB) technology – see http://www.eumetsat.int/HOME/Main/What_We_Do/EUMETCast/index.htm

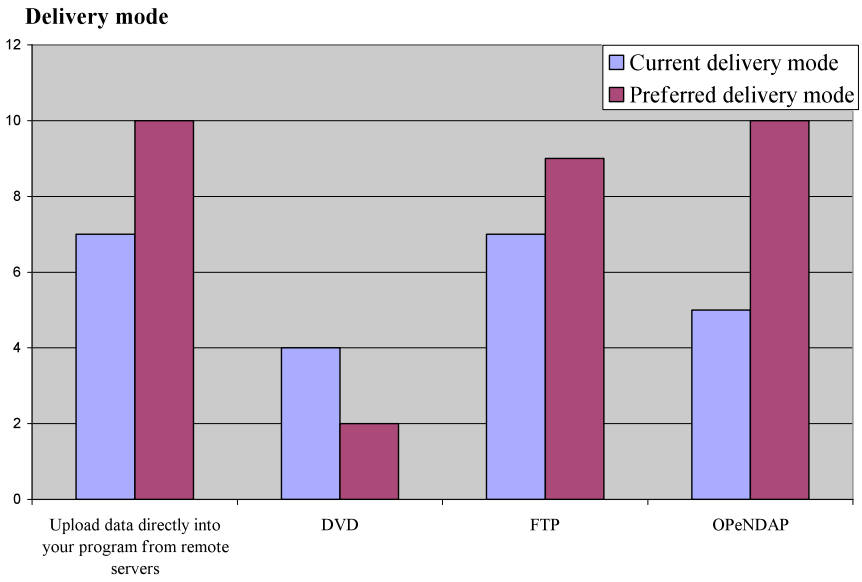


Figure 2-26. - Delivery Mode

2.8.3 Needed latency of data.

Looking at both distributions, current and preferred, it emerges from Figure 2-27 that the majority of the users would prefer the altimeter dataset to be updated daily, while nowadays this is not the case and most datasets are updated less frequently. This requirement by the users is consistent with the development of near-real time data supported by the questions above.

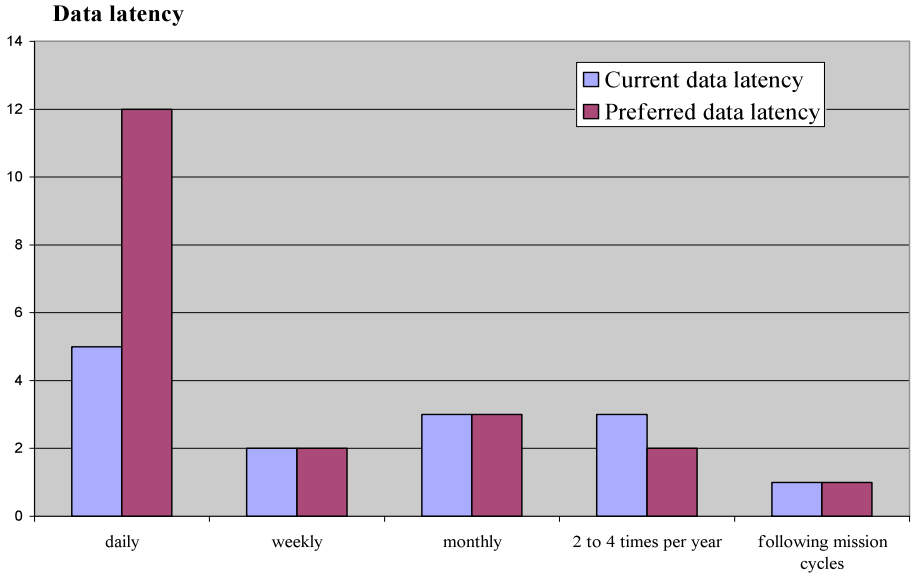


Figure 2-27.- Altimeter Dataset Update time

Research centres are mostly interested in daily upload of the datasets, and so are operational institutions. Some users prefer data to be updated less frequently regardless of whether they are

research or operational. Most probably those not requiring frequent updates are mainly focusing on climatic research.

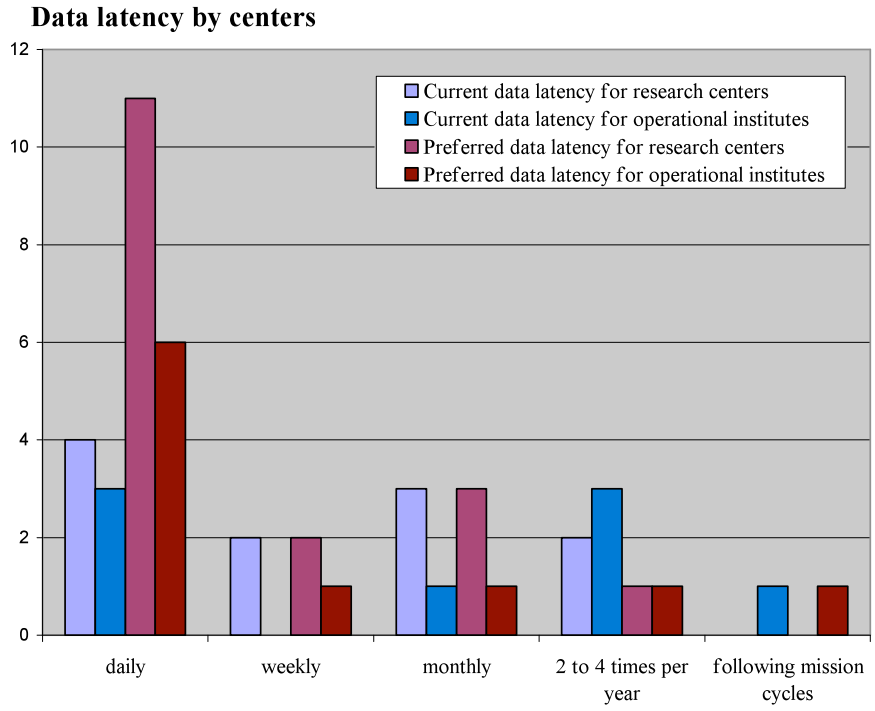


Figure 2-28.- Data Upload time analysis per centres

3 Questionnaire Summary

3.1 Questionnaire Main Conclusions

After the survey we can conclude that we have valuable information to draw the user requirement for the new altimetry product. Twenty institutions responded to the COASTALT questionnaire while a further thirty three responded to the PISTACH questionnaire. It has to be taken into account that the major proportion of both the COASTALT and PISTACH communities are public research institutions. The public institutions working on operational products are well represented in both communities, but there is a lack of participation from the private sector: just 8% of both communities represent private industry.

The integration of the results of PISTACH project and COASTALT project has been very useful in providing a more consistent analysis. **The COASTALT results in all cases have confirmed the indications drawn from the PISTACH sub-sample and can be seen as an independent validation of the PISTACH survey, and vice versa.**

As a general indication, we can say that remote sensing data are used as a valuable tool alongside modelling and data assimilation for the purposes of research or operational services. These applications are of varying natures, with Near Real Time and delayed mode studies being more common among the community. The length of the datasets needed/used depends on the application. In the case of operational services, some of them near-real-time, the data required in most of the cases is one day long or shorter, while for research studies the dataset more requested is between one and ten years.

For the observation zone there is no clear preference among near shore, coastal zone and Open Ocean, and in consequence the typical distance to the shoreline varies in a balanced way.

The answer about the purpose for the altimetry products reveals that for the research community the main focus is on the analysis of ocean processes, while the operational community tends to require altimeter data more for model validation or assimilation into models.

The physical processes most frequently studied in the community are the Sea Surface height and the Sea Level Anomaly, and as it can be foreseen, the most frequently used parameter is the Surface elevation. It is important to highlight that wind and wave parameters are of great interest for operational forecasting centres. Currents where also suggested despite not being an option in the initial list.

The analysis of the current and preferred accuracy and precision requirements for different classifications of users has been very helpful; in many occasions the current product does not satisfy clearly the user in terms, for instance, of the accuracy of the SWH or the radiometric accuracy on sigma nought.

Concerning required supplementary data, the community prefers quality controlled data for its purposes, complementing the altimetric information in most cases with Optical, SAR or infrared data equally.

Finally, preferred formats among the community are NetCDF and ASCII while ftp and OPeNDAP are the most desirable delivery options. The preferred latency of data is the best achievable (~daily) for the whole the community, independently of the nature of the centre.

4 Product Requirements Definition

4.1 Strategy for Product Requirement Definition

The outcome of the COASTALT and PISTACH surveys has to be a list of **recommendations** (below) for the definition of the new product, i.e. a list of characteristics that the new product should have. To draft this list of characteristics we, COASTALT partners, have decided to follow a *supervised* approach: rather than deriving the recommendation solely from the raw, results of the COASTALT and PISTACH questionnaire, we **interpret** these results on the basis of our previous (10-year) experience in the field. We believe that this approach will prove the most successful in that it 'filters' the results of the questionnaire, moderating some indications that could be biased due to incomplete familiarity of the users with the existing or planned products, as well as to incomplete (or difficult to find) information/documentation.

A good example of how we interpret the results in order to draw recommendations would be the precision issue: a non-negligible share of the users believe that the current SSH product available for the coastal environment has a precision better than 3 cm. For these users, therefore, there would be little scope to improve the product precision. However, a quick informal survey between few expert altimetrists does immediately show that this is a very optimistic – and unrealistic - view. We therefore conclude that precision improvement **is** a requirement, even if it is being overlooked by some (actual or potential) users. Another example is on data formats: although some replies would still favour ASCII over NetCDF, experienced users can testify that metadata (easy to add to NetCDF – not so easy to account for in simple ASCII files) are often essential to many applications, so our recommendation goes definitely towards NetCDF as the format to adopt.

4.2 Recommendations For the Coastal Altimetry Product(s)

We recommend that products will:

- **be** provided **along-track**;
- include **not only sea surface height, but also significant wave height and wind speed** which will constitute a very valuable asset to coastal managers and modellers (see 2.3.1 and Figure 2-9.- Physical process under study.);
- include **both the 1 Hz posting rate and the maximum posting rate** compatible with an acceptable signal-to-noise ratio; the upper boundary on this is obviously **18 Hz** for Envisat (see Figure 2-11.- Along track sampling frequency)
- include data **as close to the coast as possible**, even when none of the main estimated parameters (height, significant wave height and wind) are considered reliable;
- **initially be developed as a delayed product,** but with a processing chain **compatible with the delivery of near-real-time** (with daily distribution) **and real-time data**, as there is a clear requirement for those (see Figure 2-13.- Delay delivery vs data accuracy);
- put in place all those **improvements in corrections (including local corrections) and retracking** so that **accuracy and precision are optimized**;

- provide the users with **an error budget** and clear documentation on the characteristics and limitations of the products
- as far as the height measurement is concerned, provide not only the SSH, but also **anomaly and mean value**, and **a coastal MDT where possible** (Figure 2-22.- Need for a MDT to reference data);
- Provide **quality flags** together with **all the separate corrections** (see Figure 2-20.- Auxiliary data required and Figure 2-21.- Use of the auxiliary data);
- be **easy to merge across missions**, with a common correction scenario that should make possible the cross-calibration of Sea Surface Height, wind and wave information from Envisat with those from other altimetric missions;
- the product must be in **NetCDF format** (Figure 2-1- Types of data used to study the coastal ocean) and **distributed both via FTP and OPeNDAP**;
- however **DVD distribution should be retained** for the benefit of those users with bandwidth constraints

4.3 Geographical Domain of Application

A final recommendation concerns the definition of the global region over which the coastal altimetry reprocessing is to be applied. One important issue is that in COASTALT and PISTACH the reprocessing is expected to follow a **sequential approach**, i.e. it is done not on single track-points but on sizeable track segments. This approach aims to exploit the along-track correlation of geophysical parameters and corrections for the purpose of maximizing the improvement in precision. As a consequence, reprocessing must start some distance from the coast and/or the shelf. Other (complementary) needs are:

- the reprocessing must include all shelf areas, where tides are problematic
- the reprocessing must include some specific basins such as Mediterranean Sea, Gulf of Mexico, etc

Based on the requirements above, the PISTACH project has drafted some recommendation for a coastal reprocessing domain that COASTALT endorses in full. **The coastal domain is defined as:**

- **all track segments with distance from the shoreline <200 km; AND**
- **all track segments with distance from the shoreline between 200 and 400 km and bathymetry shallower than 5000m; AND**
- **all continental shelves including the shelf slopes; AND**
- **all marginal, enclosed and semi-enclosed seas like Gulf of Mexico, Mediterranean Sea, etc**

The domain is illustrated in Figure 4-1 below.

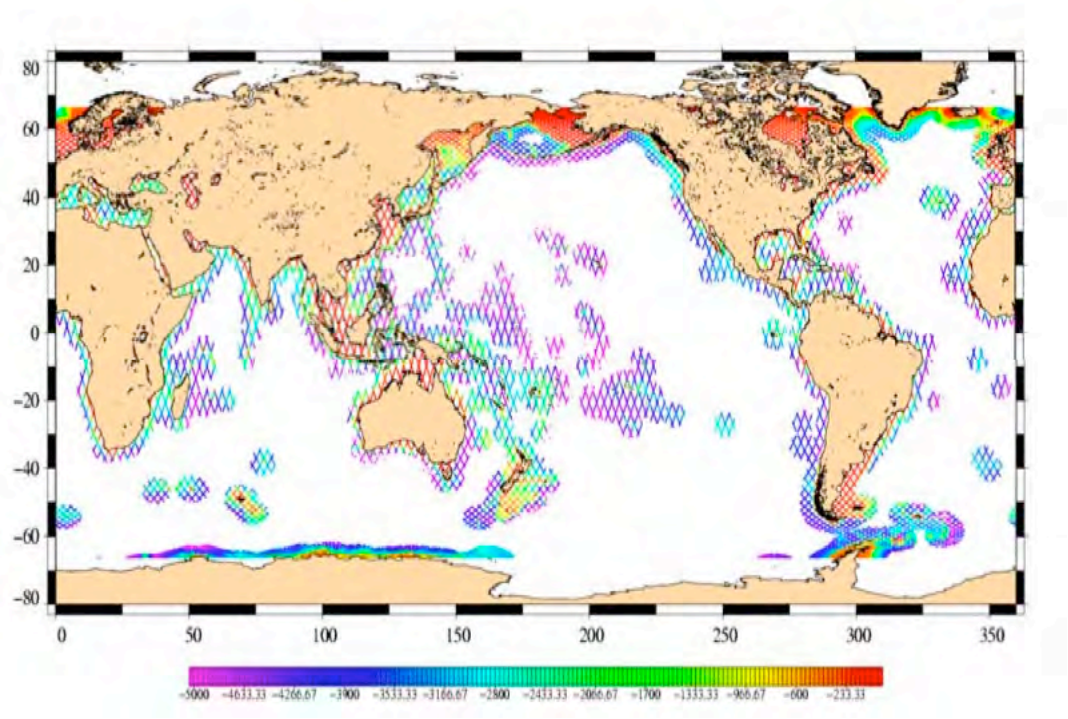


Figure 4-1.- Geographical domain for coastal altimetry reprocessing in PISTACH and COASTALT (figure from PISTACH based on Jason-1 tracks; the colour indicates depth)

The wide extent of the coastal band defined above, and the adoption of a common format and common correction scenario indicated in 4.2 will ensure that **coastal altimetry data can be used seamlessly in extension of the current open ocean product**, as also requested in the ESA ITT Statement of Work.

5 Annex I – COASTALT Dossier / Questionnaire

COASTALT

NEW COASTAL ALTIMETRY PRODUCTS

In the framework of the COASTALT Project, ESA is paving the way to one or more new coastal radar altimeter products. The main objective of COASTALT is to define, test and prototype these new products. Then ESA will apply the resulting knowledge to the routine generation and distribution of such coastal products from Envisat, as well as to the reprocessing of the ERS archives close to the coast.

We need your help to define these new products, which will move coastal altimetry towards an OPERATIONAL status

With this questionnaire we aim to gather a feedback from oceanographers, marine scientists, and coastal researchers in order to match the improvements planned for these new products with your expectations.

At the end you are also given the option to subscribe to the Coastal Altimetry Science Working Team mailing list if you wish.

An introduction to altimetry products is attached as an annex to this questionnaire.

We thank you for contributing to the novel field of coastal altimetry by answering these questions. Please, do not hesitate to contact us if you need any additional information.

Best Regards,

Starlab COASTALT project team.

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QUESTIONNAIRE

(Please note that several questions allow more than one answer – check all those that apply)

USER PROFILE						
Working institute/enterprise	Operational (Public)	Research (Public)	Operational (Private)	Research (Private)		Other
Specify name: …… ……						
How do you study the coastal ocean	in situ measurements	remote sensing	numerical modelling	Data assimilation	statistical modelling	Other
Specify data product and model…… ……						
Have you already used altimetry products for your studies	yes	no				
Please specify data product and parameter used: …… ……						
Problems encountered: …… ……..…… …… ……..						
Do you consider your work to be:	Real time	near real time	delayed mode	climate related		
How long are your usual datasets?	day long or shorter	between 1 day and 1 month	between 1 month and 1 year	between 1 year and 10 years	longer than 10 years and as long as possible	

USER SECTOR/APPLICATIONS					
Are you using data from:	Near Shore	Coastal zone	Open Ocean		
To complement the previous question, what distance from the shoreline?	0-50 Km	50-100 Km	100 Km or more	Other	
Purpose of the altimeter products	Modelling/ Validation	Modelling/ Assimilation	Analysis of Ocean Processes	Monitoring	Climate analysis
Other important specifications: …… …… …… …..……					

Table 1.- User profile questions

PARAMETERS USED						
Which physical processes do you STUDY?	Sea Level Anomaly	Absolute Dynamic Topography	Sea Surface height	Waves	Geoid	Wind
Which of the following parameters do you USE? Give a score using 4 (very important to you) to 1 (marginal). Put 0 where you do not use a parameter at all	Wind Speed	Salinity	Temperature	Surface elevation	Significant wave height	Other (specify ……)
Other physical process/ parameter/ contents that could be evaluated with altimetry data: …… …… ……						

Table 2.- Used parameters related questions

PRODUCT CHARACTERIZATION				
Along-track frequency sampling	1Hz	20 Hz	1800 Hz	Other (pls. specify)
Which one do you use currently?				
Preferred/desired for the new product				
Spatial resolution (along-track)	< 15 Km	< 25 Km	Other (pls. specify)	
Which one do you use currently?				
Preferred/desired for the new product				
Data delivery delay vs accuracy	Offline data (most accurate)	Near real time data	Real time data (least accurate)	
Which one do you use currently?				
Preferred/desired for the new product				

Table 3.- Product characterization related questions

ACCURACY REQUIREMENTS				
Accuracy for HEIGHT measurem.	< 3 cm	< 10 cm	< 20 cm	Other (pls. specify)
Current product				
Preferred/desired for the new product				
Accuracy for Signif. Wave Height (SWH)	< 5%	< 10%	< 20%	Other (pls. specify)
Current product				
Preferred/desired for the new product				
Radiometric Accuracy (=on σ_0 measurement)	< 0.2 dB	< 0.5 dB	< 1 dB	Other (pls. specify)
Current product				
Preferred/desired for the new product				

PRECISION REQUIREMENTS				
Precision for HEIGHT measurem.	< 3 cm	< 10 cm	< 20 cm	Other (pls. specify)
Current product				
Preferred/desired for the new product				
Precision for Signif. Wave Height (SWH)	< 5%	> 5%	>10%	Other (pls. specify)
Current product				
Preferred/desired for the new product				
Radiometric precision (=on σ_0 measurement)	<0.2 dB	<0.5 dB	<1 dB	Other (pls. specify)
Current product				

Preferred/desired for the new product				

Table 4.- Accuracy and Precision requirements related questions

AUXILIARY DATA					
Supplementary data required for the new product:	Raw data	Quality controlled data	Data with global quality flags	Data with specific quality flags	Other
Specify:……					
Complementary information needed for:	HF fields to correct altimeter data	Applied Atmosph. corrections	Applied Geophysical corrections (tides, etc)	Instrumental corrections	Other
Specify:……					
Need of Mean Dynamic topography (MDT) to reference data?	Yes	No	I don't know		
Which other remote-sensing data products would be synergistic to your applications?	SAR	Optical	Infrared	Other (specify .....)	
For which application/product? :……					
Need of altimeter data over.	Coastal ocean	Open ocean	Both		
Do you need altimetry data in several coastal locations?	Yes	No, just one			

Comments/ suggestions: …… ……..…… …… ……

Table 5.- Auxilliary data related questions

DATA FORMAT AND DISTRIBUTION						
What data format do you use?	NetCDF	ASCII	Binary	HDF	Other	Other
Current						
Preferred/desired for the new product						
What delivery mode is easier for you?	Upload data directly into your program from remote servers	DVD	FTP	OPeNDAP	Other	Other
Current						
Preferred/desired for the new product						
How often do you need the altimeter dataset to be updated?	daily	weekly	monthly	2 to 4 times per year	following mission cycles	Other
Current						
Preferred/desired for the new product						
REMARKS						

Other comments and suggestions:……..……..……..…
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Table 6.- Data format and distributions related questions.

THE COASTAL ALTIMETRY SCIENCE WORKING TEAM (COASTALT SWT)

As part of COASTALT, we intend to establish a Coastal Altimetry Science Working Team (COASTALT SWT). The SWT will initially take the form of a simple mailing list but we envisage that we will hold meetings (preferably to coincide with related events such as the Ocean Surface Topography Science Team meetings).

If you are interested in joining the COASTALT SWT please indicate so below:

Your name .....

e-mail .....

Do you want to be added to the COASTALT SWT mailing list?	YES	NO

Questionnaire Annex: Altimeter products

Parameters that can be measured with altimetry

An altimeter on board a satellite measures the distance (range) between the reflecting surface and the satellite by processing the time delay between emission of the radar pulse and reception of its echo (waveform). The measurements are taken along the ground track, i.e. the projection of the altimeter orbit on the Earth's surface.

When the surface is water, (usually) the derived elevation of the surface is called Sea Surface Height (SSH). It is referenced to an ellipsoid and can be deduced from the range measurement by using a positioning system and knowing the orbit of the satellite. SSH is composed of two parts: a variable oceanic part, the Absolute Dynamic Topography (ADT), and a geophysical constant, the Geoid.

The measure of the Geoid at small scale is not known with enough accuracy; therefore the separation of SSH into ADT+ Geoid cannot be done. The SSH is instead decomposed into a mean (time-invariant) component, the Mean Sea Surface (MSS) and a Sea Level Anomaly SLA which takes into account the variation of height around the MSS due to the variability of the ocean dynamics (eddies, fronts, mean sea level change, tides, …).

$SSH = MSS + SLA = Geoid + ADT$

The MSS contains then both the Geoid and the permanent part of the ADT called the Mean Dynamic Topography MDT, which is due to the stationary part of the ocean currents. Its knowledge permits to bypass the Geoid to study the ADT of the ocean

$ADT = MDT + SLA$

which can then be used to compute absolute geostrophic currents.

Other parameters that can be estimated from the altimeter waveforms are the **significant wave height (SWH),** derived from the slope of the leading edge of the echo waveform, and the normalized radar cross-section **sigma0 (σ^0), which can be directly related to wind speed.**

Available products

Several levels of altimeter products are available: from Level 0 to Level 4 data depending on its processing stage.

- Level 0 corresponds to raw data received without any extra processing.
- Level 1 corresponds to positioned and timed raw data.
- Level 2 applies some corrections to level 1 data to rise above the instrumental and geophysical measurement errors (atmospheric perturbations, tides etc...). Level 2 data are given along-track separately for each mission. They are also called Geophysical Data Records (GDR).
- Level 3 data come from a data processing chain including multi-mission calibration and validation (SLA, SSH, ADT).
- Level 4 data refer to gridded products (as opposed to along-track), multi-mission intercalibrated.

A note on *accuracy* and *precision* of altimetric measurements

We assume that the altimeter's measurements are sample values from probabilistic distributions. Then *accuracy* is the relationship between the mean of measurement distribution and its "true" value, whereas *precision*, also called reproducibility or repeatability, refers to the width of the distribution with respect to the mean. The following figure illustrates these concepts graphically:

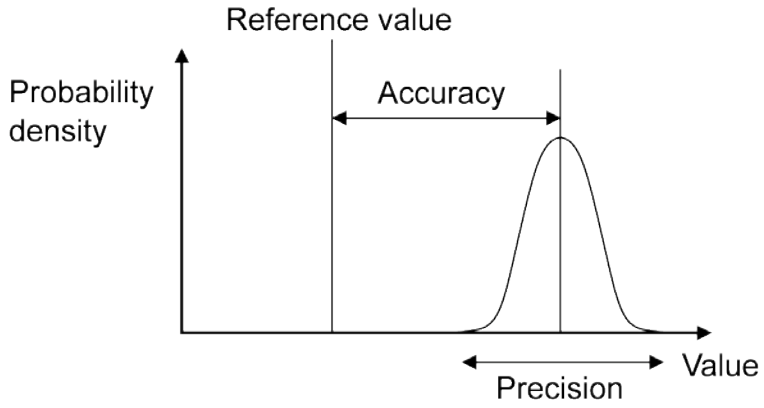

Figure 5-1: Accuracy and precision in altimetric measurements; illustration representation of concept

Different applications may have different requirements in terms of accuracy and/or precision. For instance, the estimation of the rate of global sea level rise from altimetry requires accuracy, but not necessarily precision given the huge numbers of measurements available to compute the mean rate. Instead, studies of El Niño require *both* accuracy (to discriminate the anomalous raised or lowered SSH value with respect to the mean) *and* precision, while the detection of fronts or bathymetric features requires only precision.

6 Annex II Questionnaire Results

USER PROFILE						
Working institute/enterprise	**Operational (Public)**	**Research (Public)**	**Operational (Private)**	**Research (Private)**	**R+ Operational (Public)**	**R+ Operational (Private)**
	1	11	1	0	5	2
Specify name:						
How do you study the coastal ocean	**in situ measurements**	**remote sensing**	**numerical modelling**	**Data assimilation**	**statistical modelling**	**Other**
Research (Public)	5	8	4	1	1	
Operational (Public)			1	1		
R+ Operat.institution (Public)	5	5	5	4	4	
R+ Operat.institution (Private)	1	1	1		1	
Operational (Private)		1	1	1		
Research (Private)						
PISTACH	8	5	11	5	1	1
total research	11	14	10	5	6	
total operational	6	7	8	6	5	
total public	10	13	10	6	5	
total private	1	2	2	1	1	
TOTAL	**11**	**15**	**12**	**7**	**6**	**0**
total + total pistach	**19**	**20**	**23**	**12**	7	**1**
% total research	0,6875	0,875	0,625	0,3125	0,375	
% total operational	0,857142857	1	1,142857143	0,857142857	0,714285714	
% total public	0,833333333	1,083333333	0,833333333	0,5	0,416666667	
% total private	0,5	1	1	0,5	0,5	
% total	**0,95**	**1**	**1,15**	**0,6**	**0,35**	4,05
Specify data product and model.....						
Have you already used altimety products for your studies	**yes**	**no**				
Research (Public)	8	1				
Operational (Public)	1					
R+ Operat.institution (Public)	2	2				
R+ Operat.institution (Private)	1					
Operational (Private)	1					
Research (Private)						
total research	11	3				
total operational	5	2				
total public	11	3				
total private	2	0				
TOTAL COASTALT	**13**	**3**				
Do you consider your work to be:	**Real time**	**near real time**	**delayed mode**	**climate related**		
Research (Public)	2	5	5	6		
Operational (Public)		1				
R+ Operat.institution (Public)	2	3	4	1		
R+ Operat.institution (Private)	1	1	1	1		
Operational (Private)		1		1		
Research (Private)						
total research	5	9	10	8		
total operational	3	6	5	3		
total public	4	9	9	7		
total private	1	2	1	2		
total	**5**	**11**	**10**	**9**		
How long are your usual datasets	**day long or shorter**	**between 1 day and 1 month**	**between 1 month and 1 year**	**between 1 year and 10 years**	**longer than 10 years and as long as possible**	
Research (Public)	1	3	3	7	6	
Operational (Public)					1	
R+ Operat.institution (Public)	4	4	2	1		
R+ Operat.institution (Private)	1	1	1	1		
Operational (Private)	1				1	
Research (Private)						
total research	**6**	**8**	**6**	**9**	**6**	
total operational	**6**	**5**	**3**	**2**	**2**	
total public	**5**	**7**	**5**	**8**	**7**	
total private	**2**	**1**	**1**	**1**	**1**	
TOTAL COASTALT	7	**8**	6	9	8	

USER SECTOR/APPLICATIONS						
Are you using data from:	Near Shore	Coastal zone	Open Ocean			
Research (Public)	6	9	9			
Operational (Public)		1	1			
R+ Operat.institution (Public)	5	4	2			
R+ Operat.institution (Private)	1	1	1			
Operational (Private)	1	1	1			
Research (Private)						
PISTACH	16	6	8			
total research	12	14	12			
total operational	7	7	5			
total public	11	14	12			
total private	2	2	2			
TOTAL COASTALT	**13**	**16**	14			
total + total pistach	**29**	**22**	22			
Spatial Scale. Distance to the shoreline	0-50 Km	50-100 Km	100 Km or more	Other		
Research (Public)	5	6	6			
Operational (Public)				water deepth in excess of 50		
R+ Operat.institution (Public)	5	2				
R+ Operat.institution (Private)	1	1				
Operational (Private)	1	1	1			
Research (Private)						
PISTACH	10	8	12			
total research	11	9	6	0		
total operational	7	4	1	#VALUE!		
total public	10	8	6	0		
total private	2	2	1	0		
TOTAL	**12**	**10**	**7**	**0**		
total + total pistach	**22**	**18**	**19**	**0**		
purpose of the altimetry products	Modelling/	Modelling/	Analysis of	Monitoring	Climate analysis	
Research (Public)	4	2	8	6	5	
Operational (Public)	1	1				
R+ Operat.institution (Public)	5	4	2	2	1	
R+ Operat.institution (Private)	1		1			
Operational (Private)		1		1		
Research (Private)						
PISTACH	12	8	8	1	1	
total research	**10**	**6**	**11**	**8**	**6**	
total operational	**7**	**6**	**3**	**3**	**1**	
total public	**10**	**7**	**10**	**8**	**6**	
total private	**1**	**1**	**1**	**1**	**0**	
TOTAL	**11**	**8**	11	9	6	
total + total pistach	**23**	**16**	19	10	7	

PARAMETERS USED						
Which physical processes do you STUDY?	Sea Level Ano	Absolute Dyn	Sea Surface	Waves	Geoid	Wind
Research (Public)	8	4	7	3		1
Operational (Public)				1		1
R+ Operat.institution (Public)	2	1	3	2	1	1
R+ Operat.institution (Private)			1	1		
Operational (Private)	1		1			
Research (Private)						
PISTACH	13	6	6	3		2
total research	10	5	11	6	1	2
total operational	3	1	5	4	1	2
total public	10	5	10	6	1	3
total private	1	0	2	1	0	0
TOTAL COASTALT	**11**	**5**	12	7	**1**	
total + total pistach	**24**	**11**	18	10	**1**	**5**
Which of the following parameters do you USE? Give a score using 4 (very important to	**Wind Speed**	**Salinity**	**Temperatur e**	**Surface elevation**	**Significant wave height**	**Other**
Research (Public)	20	20	27	30	10	4
Operational (Public)	2				4	2
R+ Operat.institution (Public)	16	12	13	16	9	
R+ Operat.institution (Private)		4		4	4	
Operational (Private)	1		1	4	1	
Research (Private)						
PISTACH	8	6	7	8	1	
total research	36	36	40	50	23	
total operational	19	16	14	24	18	
total public	38	32	40	46	23	
total private	1	4	1	8	5	
TOTAL COASTALT	**39**	**36**	41	54	**28**	
total + total pistach	**47**	**42**	48	62	**29**	**6**
						backscatter
Other physical process/ parameter/ contents						
Specify:.....						

PRODUCT CHARACTERIZATION				
Along-track frequency sampling	**1Hz**	**20 Hz**	**1800 Hz**	Other (pls. specify)
Which one do you use currently?				
Research (Public)	6			
Operational (Public)	1	1		
R+ Operat.institution (Public)	2			
R+ Operat.institution (Private)		1		
Operational (Private)	1			
Research (Private)				
PISTACH				
total research	8	1	0	0
total operational	4	2	0	0
total public	9	1	0	0
total private	1	1	0	0
TOTAL COASTALT	**10**	**2**	0	0
total + total pistach	**10**	**2**	0	0
Preferred/desired for the new product				
Research (Public)	3	6		
Operational (Public)	1	1		
R+ Operat.institution (Public)	2	2		
R+ Operat.institution (Private)			1	
Operational (Private)		1		
Research (Private)				
PISTACH				
total research	5	8	1	
total operational	3	4	1	
total public	6	9	0	
total private	0	1	1	
TOTAL COASTALT	**6**	**10**	1	
total + total pistach	**6**	**10**	1	
Spatial resolution (along-track)	< 15 Km	< 25 Km	Other (pls. specify)	
Which one do you use currently?				
Research (Public)	6	3		
Operational (Public)	1			
R+ Operat.institution (Public)	2	2		
R+ Operat.institution (Private)		1		
Operational (Private)	1			
Research (Private)				
PISTACH				
total research	8	6	0	
total operational	4	3	0	
total public	9	5	0	
total private	1	1	0	
TOTAL COASTALT	**10**	**6**	0	
total + total pistach	**10**	**6**	0	
Preferred/desired for the new product				
Research (Public)	9			
Operational (Public)	1			
R+ Operat.institution (Public)	5			
R+ Operat.institution (Private)	1			
Operational (Private)	1			
Research (Private)				
PISTACH				
total research	15	0	0	
total operational	8	0	0	
total public	15	0	0	
total private	2	0	0	
TOTAL COASTALT	**17**	**0**	0	
total + total pistach	**17**	**0**	0	
Data delivery delay vs accuracy	**Offline data**	**Near real**	**Real time**	
Which one do you use currently?				
Research (Public)	8	3	1	
Operational (Public)			1	
R+ Operat.institution (Public)	5	1		
R+ Operat.institution (Private)		1		
Operational (Private)	1	1		
Research (Private)				
PISTACH				
total research	13	5	1	
total operational	6	3	1	
total public	13	4	2	
total private	1	2	0	
TOTAL COASTALT	**14**	**6**	2	
total + total pistach	**14**	**6**	2	
Preferred/desired for the new product				
Research (Public)	6	6	3	
Operational (Public)			1	
R+ Operat.institution (Public)	2	4	2	
R+ Operat.institution (Private)		1		
Operational (Private)	1	1	1	
Research (Private)				
PISTACH				
total research	8	11	5	
total operational	3	6	4	
total public	8	10	6	
total private	1	2	1	
TOTAL COASTALT	**9**	**12**	7	
total + total pistach	**9**	**12**	7	

ACCURACY REQUIREMENTS				
Accuracy for HEIGHT measurem.	**< 3 cm**	**< 10 cm**	**< 20 cm**	**Other (pls. specify)**
Current product				
Research (Public)	6	2		
Operational (Public)				
R+ Operat.institution (Public)	1	3		
R+ Operat.institution (Private)			1	
Operational (Private)	1			
Research (Private)				
PISTACH				
total research	7	5	1	0
total operational	2	3	1	0
total public	7	5	0	0
total private	1	0	1	0
TOTAL COASTALT	**8**	**5**	1	**0**
total + total pistach	**8**	**5**	1	**0**
Preferred/desired for the new product				
Research (Public)	9			
Operational (Public)				
R+ Operat.institution (Public)	5			
R+ Operat.institution (Private)	1			
Operational (Private)	1			
Research (Private)				
PISTACH				
total research	15	0	0	0
total operational	7	0	0	0
total public	14	0	0	0
total private	2	0	0	0
TOTAL COASTALT	**16**	**0**	0	**0**
total + total pistach	**16**	**0**	0	**0**
Accuracy for Signif. Wave Height (SWH)	**< 5%**	**> 5%**	**>10%**	Other (pls. specify)
Current product				
Research (Public)				
Operational (Public)	1			
R+ Operat.institution (Public)		2		
R+ Operat.institution (Private)		1		
Operational (Private)				
Research (Private)				
PISTACH				
total research	0	3	0	0
total operational	1	3	0	0
total public	1	2	0	0
total private	0	1	0	0
TOTAL COASTALT	**1**	**3**	0	**0**
total + total pistach	**1**	**3**	0	**0**
Preferred/desired for the new product				
Research (Public)	2	1		
Operational (Public)	1			
R+ Operat.institution (Public)	3	1		
R+ Operat.institution (Private)	1			
Operational (Private)				
Research (Private)				
PISTACH				
total research	6	2	0	0
total operational	5	1	0	0
total public	6	2	0	0
total private	1	0	0	0
TOTAL COASTALT	**7**	**2**	0	**0**
total + total pistach	**7**	**2**	0	**0**
Radiometric Accuracy (=on s0 measurement)	**< 0.2 dB**	**< 0.5 dB**	**< 1 dB**	**Other (pls. specify)**
Current product				
Research (Public)	1	1		
Operational (Public)				
R+ Operat.institution (Public)		2		
R+ Operat.institution (Private)		1		
Operational (Private)				
Research (Private)				
PISTACH				
total research	1	4	0	0
total operational	0	3	0	0
total public	1	3	0	0
total private	0	1	0	0
TOTAL COASTALT	**1**	**4**	0	**0**
total + total pistach	**1**	**4**	0	**0**
Preferred/desired for the new product				
Research (Public)	3			
Operational (Public)	1			
R+ Operat.institution (Public)		2		
R+ Operat.institution (Private)		1		
Operational (Private)				
Research (Private)				
PISTACH				
total research	3	3	0	0
total operational	1	3	0	0
total public	4	2	0	0
total private	0	1	0	0
TOTAL COASTALT	**4**	**3**	0	**0**
total + total pistach	**4**	**3**	0	**0**

PRECISION REQUIREMENTS				
Precision for HEIGHT measurem.	**< 3 cm**	**< 10 cm**	**< 20 cm**	**Other (pls. specify)**
Current product				
Research (Public)	6	1		
Operational (Public)				
R+ Operat.institution (Public)	1	2		
R+ Operat.institution (Private)			1	
Operational (Private)	1			
Research (Private)				
total research	7	3	1	0
total operational	2	2	1	0
total public	7	3	0	0
total private	1	0	1	0
TOTAL COASTALT	**8**	**3**	1	**0**
total + total pistach	**8**	**3**	1	**0**
Preferred/desired for the new product				
Research (Public)	8			
Operational (Public)				
R+ Operat.institution (Public)	4	1		
R+ Operat.institution (Private)	1			
Operational (Private)	1			
Research (Private)				
total research	13	1	0	0
total operational	6	1	0	0
total public	12	1	0	0
total private	2	0	0	0
TOTAL COASTALT	**14**	**1**	0	**0**
total + total pistach	**14**	**1**	0	**0**
Precision for Signif. Wave Height (SWH)	**< 5%**	**> 5%**	**>10%**	**Other (pls. specify)**
Current product				
Research (Public)	1			
Operational (Public)		1		
R+ Operat.institution (Public)		2		
R+ Operat.institution (Private)		1		
Operational (Private)				
Research (Private)				
total research	1	3	0	0
total operational	0	4	0	0
total public	1	3	0	0
total private	0	1	0	0
TOTAL COASTALT	**1**	**4**	0	**0**
total + total pistach	**1**	**4**	0	**0**
Preferred/desired for the new product				
Research (Public)	3	1		
Operational (Public)	1			
R+ Operat.institution (Public)	4			
R+ Operat.institution (Private)	1			
Operational (Private)				
Research (Private)				
total research	8	1	0	0
total operational	6	0	0	0
total public	8	1	0	0
total private	1	0	0	0
TOTAL COASTALT	**9**	**1**	0	**0**
total + total pistach	**9**	**1**	0	**0**
Radiometric precision (=on s0 measurement)	**<0.2 dB**	**<0.5 dB**	**<1 dB**	**Other (pls. specify)**
Current product				
Research (Public)	1	1		
Operational (Public)				
R+ Operat.institution (Public)		1		
R+ Operat.institution (Private)			1	
Operational (Private)				
Research (Private)				
total research	1	2	1	0
total operational	0	1	1	0
total public	1	2	0	0
total private	0	0	1	0
TOTAL COASTALT	**1**	**2**	1	**0**
total + total pistach	**1**	**2**	1	**0**
Preferred/desired for the new product				
Research (Public)	3			
Operational (Public)	1			
R+ Operat.institution (Public)	1			
R+ Operat.institution (Private)			1	
Operational (Private)				
Research (Private)				
total research	4	0	1	0
total operational	2	0	1	0
total public	5	0	0	0
total private	0	0	1	0
TOTAL COASTALT	**5**	**0**	1	**0**
total + total pistach	**5**	**0**	1	**0**

AUXILIARY DATA					
Supplementary data required for the new product:	Raw data	Quality controlled data	Data with global quality flags	Data with specific quality flags	
Research (Public)	1	7	2	4	
Operational (Public)				1	
R+ Operat.institution (Public)	1	3	1		
R+ Operat.institution (Private)		1			
Operational (Private)		1			
Research (Private)					
PISTACH					
total research	2	11	3	4	
total operational	1	5	1	1	
total public	2	10	3	5	
total private	0	2	0	0	
TOTAL COASTALT	**2**	**12**	3	**5**	
total + total pistach	**2**	**12**	3	**5**	
Complementary information needed for:	HF fields to correct altimeter data	Applied Atmosph. corrections	Applied Geophysical corrections (tides, etc)	Instrumental corrections	Other
Research (Public)	4	5	5	2	
Operational (Public)		1		1	
R+ Operat.institution (Public)	2	2	4	2	
R+ Operat.institution (Private)		1	1	1	
Operational (Private)		1	1		
Research (Private)					
total research	6	8	10	5	0
total operational	2	5	6	4	0
total public	6	8	9	5	0
total private	0	2	2	1	0
TOTAL COASTALT	**6**	**10**	11	**6**	**0**
total + total pistach	**6**	**10**	11	**6**	**0**
Need of Mean Dynamic topography (MDT) to reference data?	**Yes**	**No**	**I don't know**		
Research (Public)	8		1		
Operational (Public)		1			
R+ Operat.institution (Public)	2	1	2		
R+ Operat.institution (Private)		1			
Operational (Private)		1			
Research (Private)					
total research	**10**	**2**	**3**		
total operational	**2**	**4**	**2**		
total public	**10**	**2**	**3**		
total private	**0**	**2**	**0**		
TOTAL COASTALT	**10**	**4**	**3**		
total + total pistach	**10**	**4**	**3**		
Which other remote-sensing data products would be synergistic to your applications?	SAR	Optical	Infrared	**Other (pls. specify)**	
Research (Public)	5	5	6		
Operational (Public)	1				
R+ Operat.institution (Public)	3	3	1		
R+ Operat.institution (Private)		1	1		
Operational (Private)					
Research (Private)					
PISTACH	9	11	7	3	
total research	8	9	8	0	
total operational	4	4	2	0	
total public	9	8	7	0	
total private	0	1	1	0	
TOTAL COASTALT	**9**	**9**	**8**	**0**	
total + total pistach	**18**	**20**	**15**	**3**	
Need of altimeter data over.	**Coastal ocean**	**Open ocean**	**Both**		
Research (Public)	2		7		
Operational (Public)			1		
R+ Operat.institution (Public)	3		2		
R+ Operat.institution (Private)	1				
Operational (Private)			1		
Research (Private)					
PISTACH	4	0	26		
total research	6	0	9	0	
total operational	4	0	4	0	
total public	5	0	10	0	
total private	1	0	1	0	
TOTAL COASTALT	**6**	**0**	**11**	**0**	
total + total pistach	**10**	**0**	**37**	**0**	
Do you need altimetry data in several coastal locations?	Yes	No, just one			
Research (Public)	7				
Operational (Public)					
R+ Operat.institution (Public)	4	1			
R+ Operat.institution (Private)	1				
Operational (Private)	1				
Research (Private)					
PISTACH					
total research	12	1	0	0	
total operational	6	1	0	0	
total public	11	1	0	0	
total private	2	0	0	0	
TOTAL COASTALT	**13**	**1**	**0**	**0**	
total + total pistach	**13**	**1**	**0**	**0**	

DATA FORMAT AND DISTRIBUTION					
What data format do you use?	NetCDF	ASCII	Binary	HDF	Other
Current					
Research (Public)	8	3	1	1	
Operational (Public)					**BUFR**
R+ Operat.institution (Public)	5	3	2		
R+ Operat.institution (Private)	1				
Operational (Private)		1			
Research (Private)					
PISTACH	18	7	5	0	0
total research	14	6	3	1	0
total operational	6	4	2	0	
total public	13	6	3	1	0
total private	1	1	0	0	0
TOTAL COASTALT	**14**	**7**	**3**	**1**	**0**
total + total pistach	**14**	**7**	**3**	**1**	**0**
Preferred/desired for the newproduct					
Research (Public)	8	3	1	1	
Operational (Public)	3	2	1		**BUFR**
R+ Operat.institution (Public)	3	1		1	
R+ Operat.institution (Private)	1	1			
Operational (Private)					
Research (Private)					
PISTACH	18	7	5	0	0
total research	12	5	1	2	0
total operational	7	4	1	1	
total public	14	6	2	2	0
total private	1	1	0	0	0
TOTAL COASTALT	**15**	**7**	**2**	**2**	**1**
total + total pistach	**15**	**7**	**2**	**2**	**1**

What delivery mode is easier for you?	Upload data directly into your program from remote servers	DVD	FTP	OPeNDAP	Other
Current					
Research (Public)	5	2	5	2	
Operational (Public)					**GTS**
R+ Operat.institution (Public)	2	1	1	3	
R+ Operat.institution (Private)		1			
Operational (Private)			1		
Research (Private)					
PISTACH					
total research	7	4	6	5	0
total operational	2	2	2	3	#VALUE!
total public	7	3	6	5	0
total private	0	1	1	0	0
TOTAL COASTALT	**7**	**4**	**7**	**5**	**1**
total + total pistach	**7**	**4**	**7**	**5**	**1**
Preferred/desired for the newproduct					
Research (Public)	6	2	5	3	
Operational (Public)					**GTS**
R+ Operat.institution (Public)	3		3	5	
R+ Operat.institution (Private)	1			1	
Operational (Private)			1	1	
Research (Private)					
PISTACH	5	2	18	5	
total research	10	2	8	9	0
total operational	4	0	4	7	#VALUE!
total public	9	2	8	8	0
total private	1	0	1	2	0
TOTAL COASTALT	**10**	**2**	**9**	**10**	**0**
total + total pistach	**10**	**2**	**9**	**10**	**0**

How often do you need the altimeter dataset to be updated?	**daily**	**weekly**	**monthly**	**2 to 4 times per year**	**following mission cycles**	**Other**
Current						
Research (Public)	2	2	2			1
Operational (Public)					1	
R+ Operat.institution (Public)	2		1	1		
R+ Operat.institution (Private)				1		
Operational (Private)	1			1		
Research (Private)						
total research	4	2	3	2	0	
total operational	3	0	1	3	1	
total public	4	2	3	1	1	
total private	1	0	0	2	0	
TOTAL COASTALT	**5**	**2**	**3**	**3**	**1**	
total + total pistach	**5**	**2**	**3**	**3**	**1**	
Preferred/desired for the newproduct						
Research (Public)	6	1	2	1		1
Operational (Public)					1	
R+ Operat.institution (Public)	4	1	1			
R+ Operat.institution (Private)	1					
Operational (Private)	1			1		
Research (Private)						
PISTACH						
total research	11	2	3	1	0	
total operational	6	1	1	1	1	
total public	10	2	3	1	1	
total private	2	0	0	1	0	
TOTAL COASTALT	**12**	**2**	**3**	**2**	**1**	
total + total pistach	**12**	**2**	**3**	**2**	**1**	

7 Annex III Contact List

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