ESA Sea level CCI

Meeting minutes

Annual Review 1 (29-30 Jan 2015)

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Participants:

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CGI :

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DTU: Ole Andersen (OA), Per Knudsen (PK)

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GFZ: Sergei Rudenko (SR)

NERSC: Johnny Johannessen (JJ)

UOH: Martin Scharffenberg (MS)

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European Space Agency

1. Executive summary

This section provides the reader with an executive summary of the minutes. Detailed minutes of the meeting can be found in section 3 and a list of acronyms is available in section 4.

1.1. SL_cci phase II status

- The first year of the SL_cci phase II project has been completed and no major issue has been listed. The temporal extension of the current v1.1 SL_cci ECV time series has been extended and the ECV now covers the period 1993-2013. Two options to the baseline have been accepted, including three partners.
- Next year will be quite busy because it will be the end of technical development for WP2. Within WP3 and 4 the plan is to make another ECV extension (adding the year 2014 with the same standards). The assessment of the product is ongoing and the deliverables have to be updated.
- All developments in WP2 have to be finished by end of June so that we have time to validate them. This is the important date this year.

- On-going discussions on the future of the CCI project (CCI 2) and the Copernicus Climate Change Service have been presented by ESA (JB) to the partners. The CCI has coordinated as much as possible with the European commission and ECMWF over the last year. ESA is very interested in ECMWF's definition of operational ECVs and will like ECMWF to be involved in the frame of the CCI 2 program. The calendar is currently at stage 0 proof of concept and this will go on from the end of this year till the end of 2016.

  JB: We are very happy that ECMWF will take care of this service. You can download from the website the presentation of the CCCS and you can see the architecture. There is a distributed approach and they will work with all the suppliers. We will do the research part of the service and collaborate with all the partners. ESA has a long track record of working with ECMWF. We can propose a CCI2 which will support putting into operations operational ECVs and refining existing ECVs. Mark Doherty, the chief of the program is also interested in driving the CCI2 to enhance cooperation with ECMWF. We are hoping the European Commission will invest in us to continue the research.

  MA: The SL_cci can continue in CCI2 with the part concerning the development and maybe the production for Copernicus.

  JB: It will probably not be moved on. ECMWF will have this distribution approach. ECMWF will be the operational sea level producer. The majority of the team will be interested in how we will shape CCI 2 as we continue Sea Level because we have more data / missions (Sentinels, SWOT, Cryosat (SAR mode, LR mode etc). I expect that the Copernicus part is more cranking the handle of the CCI production. I expect that we design CCI 2, it's the role of Anny to lead us to the future, decide what we'll do in the next phase. We should write that up in the next year and propose to the commission.

  AC: I think what definitely we should work on is to have a set of ECVs (Sea Level, Ice sheet Glaciers, SST) not produced independently but coherent with each other for the topic of the Sea Level closure budget and climate change. We have to work together with the other teams. This will be the main discussion at the ISSI workshop next week (http://www.issibern.ch/workshops/sealevelbudget/). The future should not be defined in terms of "SL" ECV but in terms of "a set of ECVs" for this topic. The definition of the work is to be done together with these teams.

- ESA will launch the CCI toolbox call for development:
  JJ: Regarding the CCI toolbox, when is it coming as an Invitation to Tender? Is this also now recognising the fact that we don't want to see one toolbox per ECV but have something common across all ECVs?

  JB: It will be coming in the first quarter of 2015 (March/April). The approach is to have 1 final toolbox and not 1 per ECV. The wealth in the toolbox is to be able to work with several ECVs at a time. It has to be a toolbox capable of manipulating all the ECVs we are producing.

- The data portal is currently under review (proposals were received in November 2014). The successful proposal is expected to begin in Q1 of 2015.
- A new call for "Living Planet" fellowships will be launched in 2015 (May/June).
- The COP21 meeting will be held in Paris.

1.2. Progress of the WPs

The partners have presented their work related with the different work packages. In general, JB insists on the fact that all contributors should add more details to the slides so that they could be understood later without oral comments.

- WP1: the synthesis of the user requirements has been updated including a focus on the sea level in the Arctic Ocean and in coastal areas. The cooperation between the SL_cci team and the CMUG is encouraged. In addition, the contributions of the SL_cci team to the System Engineering and Data Standard Working Groups have been described.

- WP2: new altimeter algorithms are developed in order to improve the calculation of the altimeter sea level. These new corrections will be validated and the best one will be selected and included in the reprocessed V2.0 SL_cci ECV which is planned to be produced in 2016.
  The different partners involved in this work package have presented their work. However, IsardSAT team has not been able to attend the meeting. JB would have liked to have more visibility on their achievement over the last year of the project. He would like to have a few slides covering their activity and their future work.
  The impact of external contributions of the project are analyzed (orbit solutions, ocean tide corrections,…). Within this WP, new orbit solutions are developed. More details on the orbit calculation, the gravity field and the estimation of the center of mass would be appreciated. It is suggested to organize a dedicated session on this subject within a future meeting.
  The improvement of the sea level calculation in coastal areas is discussed. This leads to the question that to which extent the physical processes that drive the sea level evolution in the open ocean also affect the sea level in coastal areas?
  The improvement of the atmospheric corrections required for the altimeter sea level estimation is presented. The work performed on this latter subject has led to significant improvements during phase I of the project, in particular concerning the regional mean sea level trends.
  Some work focuses on the sea level estimation in the Arctic Ocean and on the improvement of the mean sea surface. In addition, the raw altimeter instrumental measurements have been processed so that it is possible to distinguish the ocean measurements, the ice-covered regions and the areas free of ice. This allows the observation of the temporal evolution of the spatial coverage of ice-covered areas (animations/movies available). This constitutes significant achievements.
  The options tasks (WP2700) related to new altimeter retracking techniques for climate-quality sea level observations in the coastal zone and simultaneous retracking of multiple waveforms has been presented. The objective is to assess if we can better process the coastal altimeter waveforms which are affected by the proximity of the land.

- WP3: the work required for the delivery of the temporal extension of the SL_cci ECV has been presented. This includes the preparation of the altimeter database: ie update all altimeter algorithms for all the available missions over the extended period and validate the evolutions. To sum up:
  - Altimetry databases have been updated until the end of 2013
  - The FCDRs product v1.1 are now available for all the missions to the users in SL_cci ftp site
  - The next altimeter database extension to include 2014 is planned for the end of this year
  - Only 1 altimeter mission is available in SL_cci from mid-2013 onwards (Jason-2) : no data in high latitudes (66 deg) after mid-2013
  - In altimetry database version 2.0, others altimetry missions will be integrated (see slide #24 for details). Probably not possible to integrate Sentinel-3 and Jason-3 but we would like to include SARAL/Altika for example. The CryoSat-2 altimeter ocean measurements should be integrated in the computation of the reprocessed V2.0 ECV. The choice of which CryoSat-2 data to be used should be made after the March 15 CS-2 workshop. The most important issue is to have the validated sea level measurements calculated over all the periods. The stability is not the primary criterion as Jason-2 will be used as a reference.

- WP4: the different processing steps of the SL_cci system of production have been presented. They lead to the computation of the ECV. The computation, the validation and the delivery of 1 additional year of the ECV time series requires a significant amount of work. In addition to the production, the Product User Guide was updated when the data was produced. The data was also delivered, disseminated and promoted on the website.
  The comparison with AVISO products has shown that there are not strong differences in global trends but significant discrepancies appear at regional scales. Some small scales signals can be observed in the map of the sea level trend differences (Tropical Instability Waves signatures and small scale patterns in most parts of the ocean). This is due to the different methods of computation of AVISO and CCI products (i.e. monthly interpolation vs monthly average of daily interpolation). As these small scale differences are related with a difference of method, we are not interested in reducing these differences.
  The next step will be to update the PVIR.
  An additional temporal extension of the current version of the ECV will be released at the end of 2015. At the end of this year, a selection meeting will be organized (end November 2015, to be confirmed) so that the best altimeter algorithms will be selected. This will lead to the production of the V2.0 reprocessing of the SL_cci ECV planned in 2016. The SARAL/AltiKa as well as the CryoSat-2 altimeter ocean measurements should be integrated in the computation of the V2.0 ECV. As previously mentioned, the most important issue is to use validated dataset.

- WP5: the quality assessment of the SL_cci ECV product is performed by several partners within the Climate Research Group. The validation of the CCI product is made via assimilation in ocean models, comparison with model outputs globally as well as regionally in the tropics and in the Arctic Ocean. Discussions focus on how to include other ECV product (SST_cci for instance) in the quality assessment experiments.
  The science leader highlights the fact that we are interested in having the same results with the use of sea level products derived from other international groups. This is performed within the sea level closure budget approach which is an additional technique to assess the quality of the product. Overall, we demonstrate that the best closure of the sea level budget is obtained with the SL_cci data (among 6 different products).
  The ECV product is also evaluated thanks to a regional sea level validation (in the Mediterranean Sea and the German Bight) and comparison with in-situ measurements.
  The altimetry error budget is characterized at different climate scales. A confidence envelope error of the global mean sea level has been determined.
  The sensitivity of the MSL calculation changing the orbit of the reference mission has been analyzed using Sentinel-3 instead of Jason missions: it shows that it is not possible to meet user requirements for global trend if we use Sentinel-3. It is important to remain consistent in the errors we commit to minimize sources of uncertainty. The different sampling of oceanic variability –induced by the difference of ground tracks- prevents from meeting regional trend User Requirements. The recommendation is to conserve the historical TOPEX/Jason ground track to compute MSL time series and MSL trend maps.

- The work performed during 2014 has been largely promoted with updates of the website, two newsletters, presentations in international conferences and the publication of several peer-reviewed papers, including a publication presenting the achievements of the phase I project (>2000 downloads within 3 months).

2. List of actions from the meeting

The action items raised in this meeting are summarised here:

No	Description	Affectation	Open Date *(mmddyyyy)*	Deadline *(mmddyyyy)*	Closed date *(mmddyyyy)*	State	Comments
54	ESA/CLS/LEGOS/CRG to discuss the possibility of organising a workshop dedicated on Sea Level with the CMUG.	CLS	01/29/2015	05/28/2015		Open	
55	CF to check December SEWG minutes regarding DOI convergence.	CGI	01/29/2015	01/29/2015	02/05/2015	Closed	Email sent with SEWG minutes attached.
56	CF to send the Sentinel data requirements document to ESA	CGI	01/29/2015	01/29/2015	02/05/2015	Closed	Email sent with requirements.
57	CLS to redo the plot on the SL_cci database extension slide #12, with calculation just over the North Sea.	CLS	01/29/2015	05/05/2015		Open	
58	Decide which CryoSat-2 data should be used in ECV V2 after CS-2 QWG (end of March 15). Contact Jérôme Bouffard and Pierre Femenias to resolve this action		01/29/2015	05/05/2015		Open	
59	The team should communicate about the 2008 anomaly in the SL_cci ECV time series to the users but also to the data providers (agencies, JPL).	CLS/UoP/LEGOS	01/29/2015	05/05/2015		Open	
60	PML to compare smoothing with a very simple smoother, 63 samples running average and show before and after smoothing results.	PML	01/29/2015	05/05/2015		Open	
61	OA to send AC a link and the data for the Arctic based on altimetry	DTU	01/29/2015	05/05/2015	01/29/2015	Closed	Mail sent from OA to JJ, AC et al.
62	TUD to update the slides (renaming the SL_cci v1.1 product to V1.1)	TUD	01/29/2015	05/05/2015	02/23/2015	Closed	Updated Slides sent to CGI
63	Michaël A. to send to the team the link to the OSTST 2014 POD presentations on the subject.	CLS	01/29/2015	05/05/2015		Open	

64	SR to organise a working session with people involved in the POD group	GFZ	01/30/2015	07/07/2015		Open	
65	Interested partners to prepare a proposition / write a CCN on extra tasks before summer to be addressed to CLS and ESA (Jérôme B.).	GFZ	01/30/2015	06/30/2015		Open	
66	SR to provide paper with details about where the improvement is coming from for TOPEX.	GFZ	01/30/2015	05/05/2015		Open	
67	MA to provide UoPorto with the latest Envisat WTC version	CLS	01/30/2015	05/05/2015		Open	
68	All partners to provide one slide to summarize the main message of their presentations	All	01/30/2015	03/20/2015		Open	
69	WP leaders are encouraged to submit an abstract for the sentinel-3 workshop (deadline is Feb. 8th)	All	01/30/2015	02/08/2015	02/08/2015	Closed	
70	Posteriori action: SL_cci should submit abstract to Our Common Future Under Climate Change, International Scientific Conference, 7-10 JULY 2015 Paris, France. Session: "Assessing Climate Observations"	CLS	03/03/2015	03/10/2015		Open	
71	All partners who have submitted abstracts to send the title of abstracts and location to CGI, cc Jérôme + Bruno, JFL. Any work done concerning CCI should be sent so that it can be advertised on the website.	All	01/30/2015	05/05/2015		Open	In progress
72	Team to send all abstracts / papers / publication to CGI so that it can be added to the website.	All	01/30/2015	02/28/2015		Open	
73	CGI to remind the team every 3 months to provide updated publications by sending existing lists of publications so that the team can complete it.	CGI	01/30/2015	Quarterly		Open	
74	CGI to send an email to the team with the existing list of publications and ask to add new/missing publications.	CGI	01/30/2015	05/05/2015	02/08/2015	Closed	Publications list sent by email
75	CGI to add the description of webpages in the website statistics for the monthly	CGI	01/30/2015	02/16/2015	02/16/2015	Closed	Added to Feb MPR

	report.						
76	CGI/CLS to monitor the cumulative number of downloads of the ECV data instead of the number of requests for access and provide the regional distribution of the requests for access.	CGI/CLS	01/30/2015	Monthly		Open	
77	CGI to add IUGG as upcoming event to website.	CGI	01/30/2015	01/30/2015	02/03/2015	Closed	Event added to website
78	CGI to add a link to sentinel workshop actual website on the meeting and promote abstract deadline extended to Feb 8th.	CGI	01/30/2015	01/30/2015	02/03/2015	Closed	Extended abstract publicised
79	IsardSAT to provide a few slides on their activity within the project and their future work.	IsardSAT	01/30/2015	03/06/2015		Open	
80	CLS/ESA/LEGOS/CGI to define the dates of PM+Selection Meeting and AR2 before the Progress Meeting of May 2015.	CLS/ESA/LEGOS/CGI	01/30/2015	05/05/2015		Open	

3. Annex 1: Detailed minutes of the meeting

Actions listed in the previous section are underlined in bold red font.

Some important messages are in bold blue font.

3.1. Meeting Objectives & Agenda (JFL)

Start 9.20 (CET)

JFL introduced the meeting and presented the agenda.

3.2. SL-CCI Phase II Status (JFL)

3.2.1. ESA status of the CCI program (JB)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/276

- The idea of the CCI was to use the ECVs to realise the full potential from the long-term global EO archives that ESA and its member states has established over the last 30 years. The work performed is for the United Nation Framework Convention on Climate Change. This year, the COP21 meeting will be held in Paris and there will be the 6th collocation before that.
- The CCI is responding to some requirements and is trying to get all the member states working together. Some main achievements include:
  - The creation of a European EO Climate Science community
  - Facilitating the scientific cooperation between the Climate Observing and Modelling Communities
  - Development of a protocol for Climate Quality Algorithms Evaluation in an international context (14 groups working together).
  - The delivery of fully Error Characterised Climate Data sets, first for many ECVs
- The provision of up to date validated scientific datasets to support International Climate Policy and decision making.
- There are almost 90 contributing national entities (detailed in slide #5).
- Future achievement include:
  - The generation of peer reviewed publications in high impact scientific journals (>170 publications),
  - Paving the way for the ECV component of the Copernicus climate change service. Currently assessments are ongoing for the continuation into a CCI2 program. We'd like to provide contribution to the coordinated response to GCOS. Adding new ECVs for example lakes.
  - Facilitating the Sea Level Closure Budget by strengthen dialogue between Glaciers, Ice Sheets and Sea Level research communities,
  - Further enhancing European Research Communities presence in IPCC Assessments. Slides #6-7 provide more details.
- Most ECVs were present at the 5th CCI Collocation (20-22 October 2014, ESRIN, Frascati). The focus of discussions was on two main points:
  - Steps needed to make the SL_cci ECV operational. The next step was to enhance working relationships.
  - Key research questions that link multiple ECVs. All science leaders were given more scope to structure the meeting. Inputs will be taken forward during phase 2 for the next collocations.
  - Cross ECV research topics that link to closing the Sea Level budget were discussed. A meeting is being organised by Anny Cazenave (Sea_Level_cci) with the other six CCI projects, plus external participants on the topic, to be held at ISSI-Bern, 2-6 February 2015. Other research topics include the carbon cycle and data-model comparisons, to be led by CMUG. Slides #8-9 provide more details.

- Some project features like the visualisation tool for the CCI continue to be developed. An exhibition version which will be useful at conferences like UNESCO in Paris in July and a public version. The public version is a new requirement which is very popular with scientists and can be adapted to each ECV. See slide #10 for more details.
- The data portal is currently under review (proposals were received in November 2014). The successful proposal is expected to begin in Q1 of 2015.
- Living planet fellowships had 9 selected (4 from UK, 2 Germany, 1 spain, 1 France, 1 Finland) . Due to the success of the 2014 call, a new call will be launched in 2015. Calls will now be launched yearly. See slide #12 for more information.
- **AC enquired as to when the call will be released. JB mentioned it will be release in May/June.**
- The three late starting ECVs (Soil_Moisutre, Sea_Ice and Ice_Sheets) have finished and their data is available through the ESA site. The main achievements of these ECVs in phase 1 are
    - Sea Ice's Ice Concentration product is calculated using the most accurate algorithm, based on a detailed algorithm intercomparison study.
    - Soil Moisture has 35 years of soil moisture data. Based on high inclination radar echoes from scatterometers, we'd like to see SMOS data coming soon inn the climate era.
    - Ice sheets products have much better quality.
- The Fire project has completed phase 1, with all deliverables approved and their product available on the Fire website. ESA is now launching the SOW for Fire to start and initiate their phase 2 in the months to come.
- All the remaining CCI projects are progressing well and working within phase 2. For some projects such as cloud and aerosol, this involves broadening the data sets. See slide #15 for more details.
- For all ECVs, there has been more focus on cross-ECV interactions. The collocation output is that there is much more interaction than before partly because this is phase 2 and the products are more mature. ESA continues work to ensure cooperation with international partners. There WGClimate European Stake Holder meeting was held in Geneva with the climate working group and an attempt was made to link each ECV to the GCOS requirement. We're looking at what's missing to satisfy the GCOS requirement in terms of ECVS. The CCI had a dedicated session at the climate symposium in October (Darmstadt). The science leader for sea level was present. We're also going to be involved in the climate from space week in March 2015. More details on international cooperation can be found on slides #17-18.
- In terms of the Copernicus Climate Change Services; The CCI has coordinated as much as possible with the European Commission and ECMWF over the last year. ESA is very interested in ECMWF's definition of operational ECVs and would like ECMWF to be involved in the frame of the CCI 2 program. The calendar is currently at stage 0 proof of concept and this will go on from the end of this year till the end of 2016.
- In the coming year ESA will launch the CCI toolbox call for development. The 4 late starting CCI projects will Kick Off for Phase 2. The data portal is expected to KO in the next months. The next CMUG will be held 26-28 May 2015 in Sweden; CCI will be promoted at the 'Our Common Future under Climate Change' conference on 7-10 July 2015 in Paris. The abstract deadline is 2nd of March. The 6th collocation meeting is expected in Q3 of 2015 in ESRIN. ESA is continuing the promotion of the ECV by participating in different conferences and workshops. ESA is working to ensure good cooperation with Eumetsat and the European Commission.
- Slide #22 details the programme schedule.
- Slide #23 shows the CIC products time coverage. This details what other ECVs have supplied during phase 1 and also shows what is expected to be obtained by the end of phase 2.

Questions/Comments

MA: What is your take about the relationship between the SL_cci project and the Copernicus Climate Change Service?

JB: We are very happy that ECMWF will take care of this service. You can download from the website the presentation of the CCCS and you can see the architecture. There is a distributed approach and they will work with all the suppliers. We will do the research part of the service and collaborate with all the partners. ESA has a long track record of working with ECMWF. We can propose a CCI2 which will support putting into operations operational ECVs and refining existing ECVs. Mark Doherty, the chief of the programme is also interested in driving the CCI2 to enhance cooperation with ECMWF. We are hoping the European Commission will invest in us to continue the research.

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AC: I think what definitely we should work on is to have a set of ECVs (Sea Level, Ice sheet Glaciers, SST) not produced independently but coherent with each other for the topic of the Sea Level closure budget and climate change. We have to work together with the other teams. This will be the main discussion at the ISSI workshop next week. The future should not be defined in terms of "SL" ECV but in terms of "a set of ECVs" for this topic. The definition of the work is to be done together with these teams.

JB: ESA counts a lot on what will go on in the ISSI Bern workshop next week. The output of the ISSI workshop is important in order to tell us how to organise the CCI2, with the comment that all the ECVs have to be coherent and consistent with each other.

AC: the ISSI Bern workshop next week is not a big workshop (40 participants).

JB: you can go to the ISSI website (http://www.issibern.ch/workshops/sealevelbudget/) and see the programme and participants. There is an opportunity for us to participate with people going there. Anyone is welcome to contribute.

JJ: Regarding the CCI toolbox, when is it coming as an Invitation to Tender? Is this also now recognising the fact that we don't want to see 1 toolbox per ECV but have something common across all ECVs?

JB: It will be coming in the first quarter of 2015 (March/April). The approach is to have 1 final toolbox and not 1 per ECV. The aim of the toolbox is to be able to work with several ECVs at a time. It has to be a toolbox capable of manipulating all the ECVs we are producing.

3.2.2. Project management and work progress status (CLS/CGI)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/277

- Phase 2 of the CCI includes different work packages, see slide #4 for details of these. All the WPs are in progress. The technical development will happen this year. Last December there was the release of the first extension of the ECV covering 2010-2013. At the end of this year, 2014 will be added onto the ECV and there will be the reprocessing of the ECV to produce version 2. The processing of the ECV will stop in the summer so that the evaluation and selection of algorithms to be used in the production of the ECV can be performed next November. The reprocessing with V2 of the ECV will be performed before the end of the project in 2016.
- Regarding contractual aspects, some options have been accepted by ESA. 2 options were accepted in May; 1 with TUD has started. The other option with NOC/PML had a change in schedule. The CCN has been finalised and signed for this option.
- The next milestone of the payment plan is next month (Feb 2016). All partners are requested to send their invoices to CLS ASAP.
- The PMP lists all details of the project and has been updated regularly since last year, adding details of phase 2 KO, options added, WP descriptions and new personnel. System Engineering has had a key personnel change. Dates and list of publications of the team have equally been added. The PMP is available on the ftp site.
- Concerning deliverables; phase 1 of the project ended in 2013 and all phase 1 deliverables have been accepted by ESA. Phase 2 of this year has had several deliverables provided (see slides #11-12 for details). Some documents are still under review by ESA. RRDPs have been produced and are available on the ftp. They will be uploaded to the website pending ESA approval.
- Regarding meetings, we are at the first annual review today. There are quarterly progress meetings and CMUG meetings. All 2014 meetings have been completed. The next progress meeting will be on the 5th of May. Attendance at the next CMUG from the climate research group needs to be discussed. There will also be a Selection meeting to select the algorithms that will be used for reprocessing of the ECV. The idea is to

meet in November around the same time as the progress meeting. Tomorrow we can decide in the conclusion and fix the date and location for the selection meeting. The next collocation meeting may be at the end of 2015 but it has to be confirmed by ESA.

- Regarding actions, lots of actions were closed in the last year and a summary of open actions will be provided later.

In conclusion, next year will be quite busy because it will be the end of technical development for WP2. Within WP3 and 4 the plan is to make another ECV extension (adding the year 2014 with the same standards). The assessment of the product is ongoing and the deliverables have to be updated.

MA: by end of June all developments in WP2 have to be finished so that we have time to validate them. This is the important date this year.

Questions/Comments

MS: when is the next CAR due?

JFL: before next summer (KO+15) i.e. summer 2015.

3.3. Requirements management and SL_cci system (WP1, WP3)

3.3.1. User requirements presentation (NERSC)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/278

- The URD has been updated on a regular basis over the year. There are 3 main tasks concerning the URD:
  - These include continuing to review and update the URD and participate in CMUG meetings.
- The latest version of the URD issued in October includes input from NOC which will be presented shortly. The intention is to update the URD after each annual review, so there will be a new version next month or so. The promotion of views by other groups notably the climate modelling projects is also an activity performed in this WP.
- Slide #4 shows the status of requirements for global and regional Sea Level. There has been no change to this over the last year. New requirements on Arctic Ocean level and coastal have been introduced and these can be seen in slide #6. The Arctic must be compliant with the coastal. More details on how the target accuracy and stability numbers were achieved will be provided by NOC.
- There is consideration for sea level where the requirements are not defined. There is currently no substance on the coastal requirements. For the participation to CMUG, a good response to the numbers estimated is required. See slide #7.
- Task 1300 has been identified to manage participation to CMUG meeting. The plan is to split attendance to these meetings with UOH, ECMWF and NERSC. The next CMUG Meeting will be at SMHI in Sweden 26-28 May 2015. Participation to the ISSI workshop in Bern, 2-6 February 2015 is also planned.

Questions/Comments

AC: Regarding the CMUG, it is not clear what can be done as most of the CMUG work concerns other ECVs and there's very little about sea level. What is our position with respect to this problem? We have to decide what we can do to be more constructive in the CMUG.

BM: To date we don't have room in the CMUG to come with data compared to models and we rely more on the data than the model. There is no request from CMUG to have data to constrain the model, they do it the other way round i.e. use the model to constrain data. The difficulty is that models provide sea level information which is not directly comparable with sea level altimeter observations. Also sea level is not easy to compute. It needs to be computed offline.

JJ: Maybe we can think about inviting the CMUG modelling group to a specific meeting about sea level. Have a parallel working group on that topic. We can take an action and talk about it next week. The idea is proposed to organize a dedicated workshop with CMUG on the sea level.

Action: ESA/CLS/LEGOS/Climate Research Group to discuss the possibility of organising a workshop dedicated on Sea Level with the CMUG.

3.3.2. User requirements presentation – Coastal Zones (NOC)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/304

- A survey was done is in May 2014 with the help of about 40 altimeter specialists. The experts were selected from the coastal altimetry community. People from 14 different countries in total were chosen. There was a questionnaire presenting the GCOS and sea level requirements from phase 1 with around 12 questions requiring thought. We asked about accuracy in cm, stability from one year to another and stability over longer time periods. These 3 questions were asked for local and global products. The local product is about 10-15 cm in size, the global is the average around the entire world coast. Two values were requested; 1 threshold (minimum) and a target value (goal). 15 responses were received with the results are summarised in slide #6.. The range, which is included in square brackets shows the lack of consensus in this field.
- All numbers are in the updated URD. Numbers do not change much when looking at long term stability (over 10 years).
- The target values have been added to the summary tables of the URD. This can be seen in table 14 - synthesis of sea level requirements gathered by the sea level CCI project.
- These are the numbers from the survey. In the next 2 weeks, we could try to update the tables with a few more replies after this workshop if there is scope. Then produce a note which could be a contribution to sea level from coastal requirements.

Questions/Comments

Paolo C. wishes to contribute to the global SL budget analysis (participation to the book following the ISSI Bern meeting 2-5 Feb. 2015).

JB: The note should be explicit on what type of applications can be done within the range and what cannot be done. What can be done if we reach these numbers?

AC: What are these numbers based on? e.g. long term drift is for what application? Why do people need such accuracy? The purpose of *global* mean sea level studies is to understand the physical processes (ocean /atmospheric circulation) that drive the sea level changes. These physical processes affecting the coastal sea level changes are different.

PC: These accuracies are required for the global mean sea level at the coast. the idea is to understand to which extent the global processes that impact the global ocean affect the coastal areas. The populations living there are affected. The goal is to “close the chain of knowledge” starting from the earth system to the population at the coast.

AC: For global mean, it is necessary to understand the processes that are causing the global mean. We may need global mean to constrain the climate model. Which particular application?

PC: The numbers are really useful to understand the processes of global change. In the coastal zones, it is not to understand the processes but confirm the impact. On one side you have the processes on the other you have society. The impact of the processes on society is what we look at.

GQ: The local coastal has clearer benefits than the global coastal.

PC: It has a very powerful mediatic impact. At the moment we know SL is rising at 0.2mm/year. Looking at the regional impact is covered by the coastal (local) for which we need less stability and accuracy.

JJ: It could be useful to say ‘global mean coastal’

BP: How are satellite instrumental errors taken into account in the estimation of the global coastal average of the sea level?

PC: we are looking at screening and filtering the high rate data and error rate in the coastal zone looking at not rejecting too much data but preserving a meaningful signal. We look at where we draw the line and what data quality criteria we setup. That’s the objective of the WP 2030 i.e. look at the coastal instrumental impact

BP: These kinds of metrics are very rough averaging different situations.

3.3.3. System Evolution and System Engineering (CGI)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/279

- In contrasts to phase 1 this is a reasonably small task because the system is already up and running. At CGI we are focusing on the system specification documenting evolution from Phase 1 to phase 2, addressing key issues in phase 2. Slide #3 provide details on tasks involved in WP3000 including SEWG and DSWG involvement.
- There are 2 main deliverables: The SSD (CGI owner, continuation of phase 1 document), & SVR (CLS owned). Both documents have been updated and submitted with minor updates for phase 2.
- The SEWG's main objective is to all different System Engineering within different ECVs to discuss common issues, concerns and applications across the various ECVs. This led to mitigation of risk in phase 1, sharing resources in phases 2 and common knowledge exchange. There is a good range/coverage between terrestrial, oceanographic and atmospheric ECVs.
- CGI has been involved in coordinating meetings, managing the mailing list and file repositories and liaising with CCI DSWG. A total of 5 meetings took place in 2014. Some key issues raised in 2014 DSWG/SEWG meetings are summarised on slide #8. One final activity within 2014 was the SL_cci team questionnaire for QA4ECV. The QA4ECV was to develop a quality assessment system for various ECVs.
- Moving forward, there will be continued SL_cci consortium activity in the SEWG, Supporting the SEWG & DSWG activities throughout Phase II. There will also be preparation of and submission of Year 2 and Year 3 deliverables, namely SSD, SVR and PUG.

Questions/Comments

JB: Is it possible to have a copy of the sentinel data requirement document sent to ESA?

CF: Yes will send the document after this meeting. Each ECV team provided a summary of their requirements to ESA at Harwell. At the moment the documents are individual for each individual ECVs. They are investigating how to consolidate them into one.

JB: I am interested to see whether we have different or additional requirements. I doubt there will be different changes with supplying the data to different ECVs. It will be good to see a copy of the document

JB: There was a discussion in SL_cci and in the SEWG about the DOI, has there been any other discussion on the DOI or is the action on me?

JFL: it has been discussed in the SEWG, in September.

JB: the issue was how we can build the DOI stream and do we need to re-issue the DOI every time we add a byte to the dataset.

BML: The action I have now is for the DOI for DataCite (www.datacite.org). There were some guidelines sent after the SEWG September meeting on the DOI (see the minutes).

JB: can we use the DOI to reference data without storing them anywhere? We'll try to converge on this maybe next month and will gather something from CF from the SEWG. The question how we generate the DOI remains.

Action: CF to check December SEWG minutes regarding DOI convergence.

Action: CF to send the Sentinel data requirements document to ESA

3.4. SL_cci ECV Production (WP4)

3.4.1. Preparation of the altimetry database [2011-2013], CLS

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/280

- In phase 1 we produced version 1 of the ECV from 1993-2010. The first action of phase 2 was to extend the product till 2013 without any correction using the same standards used in the 1st phase. The main steps performed to extend the altimetry database and the validation results for the additional 3 years will be highlighted. The first sets of results concern the wet tropospheric GPD correction and the second set of results regard the atmospheric corrections from ECMWF.

- Slide #4 shows the extension of database for Envisat Jason-1 and Jason-2. Slide #5 shows the main steps to extend the altimeter database. The main one concerns the acquisition of the altimeter level 2 products and also the acquisition of the altimeter correction not included in this level 2 products. The other main step is the sea level calculation on a valid set of data called editing. The FCDR products have then to be validated and provided to the users.
- The altimeter database was updated with all the correction detailed in slide #6 e.g. ocean tide model with GOTV8, GOTV10, &FES2012 correction. Orbit corrections from CNES were also used.
- After computing the correction, it is necessary to convert all these external auxiliary data with an internal format to update the altimetry database. The next step is to update the database for all this missions. All the algorithms need to be computed in parallel because of the large quantity of data. Once the database has been updated, validation activities proceed to ensure that the algorithms are well calculated. The new RRDP calculated will be presented later. It is important to monitor all there steps carefully to prevent any errors.
- The results of this activity are detailed on slide #9. 6 new error RRDP reports for all periods 1993 onward and the last 3 years were provided. All reports are available on the ftp and CCI website.
- We checked that there is no change between new and old difference. The blue patch at the end of the graph (see slide #10) is to focus on the extensions. The next plot on slide #11 shows the error reduction. It is more important to have an homogenous correction over the whole period

AC: Did you compute the trend of this difference? Other groups may use one of these two corrections and this could explain the difference in trend between some GMSL products.

MA: This is the monitoring of the mean difference between the operational reanalysis, other slide is the error calculated. To calculate the error we use the cross over point and this does not impact the calculations. The operational model is slightly better in terms of performances at cross overs. In the framework of the CCI project working at climate scale we made the choice to keep it homogenous.

- Slide #12 shows homogeneity i.e. very small differences in coastal areas. For the global product it is more homogenous. For climate scales this small degradation has no impact.

JB: can you tell which one is better in the coastal area?

MA: Yes, using a formula, (we look at homogeneity of descending tracks and homogeneity of sea level). The correction which provides the best homogeneity at tracks crossovers is the best one.

JB: It would be nice to redo the plot with the calculation just over the North Sea - SL_cci database extensions slide. Have you discussed of these comparisons (ERA Interim versus ECMWF operational) with ECMWF people?

MA: Yes, discussions have occurred between CLS and ECMWF during the preparation of the Legeais et al. 2014 paper on this subject: Paul Poli from ECMWF has been included in the acknowledgement of this SL_cci paper. In addition, complementary results on this subject will be published very soon by Loren Carrère (CLS).

PC: Some of the work been suggested is the subject of WP2320, the most efficient way of doing this is that we liaise so that we make sure we get hold of all the different sets of corrections.

JF: We should send a recommendation of the spatial resolution. I would say 0.25 would be appropriate. When you go from ¼ to 1/8 of a degree you can see differences. ¼ is the minimum.

JB: we should provide our requirements as needed and not degrade the requirements.

Action: CLS to redo the plot on the SL_cci database extension slide #12, with calculation just over the North Sea.

- Slide #13 shows the Dry tropospheric Correction (Era interim vs. op. ECMWF fields). There are no differences in the last period so the correction on our altimetric database is good. The wet troposphere model is not used in the sea level calculation but it is used in the radiometric correction (see slide #16). There are stronger differences as expected at the end of the period. The error reduction is the same at the end of the period. Some analyses were done with the Wet Troposheric Correction provided by JF. The summary of the impact of the correction provided by JF is summarised in slide #20.
- For Envisat, at cross overs we can see that we reduce the error in WTC in tropical areas so it is an improvement. The evolution of this improvement over time can also be seen. On average the improvement is between 1 and 2 cm square which is important. The radiometer used in AVISO products was used so it is a composite correction. See slide #21 for plots.

PC: Can you provide information on this composite correction?

MA. The composite is based as the GPD correction, based on the radiometer of the GDR product, close to the coast it not the radiometer correction but it the model correction.

- For Jason-1, we show the local trend differences with the GDP correction. It can be seen that all the coastal areas have significant differences with the GDP correction. It is not easy to show it is an improvement. The impact is quite signification, 1mm/year along the coast which is close to requirements described by Paolo. See slide #22 for plots

JJ: It has distinct positive and negative values

MA: JF can comment on this result

PC: Why do we have the tropical yellow band?

JF: I cannot remember for Jason-1 but for In TOPEX there are very clear implementation problems. There are sets of passes where the composite has been adjusted to an invalid radiometer correction and you can see jumps. These jumps change the regional SL trend.

MA: The Jason-1 level 2 product is not a good product. There are some problems but very soon a new product will be released. We observe these differences but it is difficult to demonstrate it is an improvement. We are more confident in the work performed by JF than the level 2 correction.

- For J-2 the plot is the same but the differences are lower despite the fact they still exists. The scale is not the same. We have to investigate the differences. The differences are largely lower than requirements described by Paolo.
- **To conclude:**
- **Altimetry databases have been updated until 2013**
- **The FCDR product v1.1 are now available for all the missions to the users in SL_cci ftp site**
- **The next altimeter database extension to include 2014 is planned for the end of this year**
- **Only 1 altimeter mission is available in SL_cci from mid-2013 onwards (Jason-2) : no data in high latitudes (66 deg) after mid-2013**
- **In altimetry database version 2.0, others altimetry missions will be integrated (see slide #24 for details)**
- **Probably not possible to integrate sentinel 3 and J-3 but we would like to include SARAL/Altika for example.**

Questions/Comments:

MA: What products are used for Cryosat-2?

PC: Processing only started in 2014, I'm not aware of any plans to go back in time. This is a question for ESA. Will there be reprocessed ocean products from Cryostat for the first 4 years of the mission?

JB: We don't know yet if the ESA products will be candidate to the V2 SL_cci: a CryoSat-2 QWG meeting will occur in March. More details should be obtained from Jérome Bouffard and Pierre Femenias.

PC: We don't know the quality in terms of stability of CS2. The noise in the data is very low as expected but I cannot comment on trend and stability. It terms of the accuracy they are good products but in terms of stability the periods available are too short to comment.

MA: The main mission will be Jason-2 in this case, in fact the sea level provided by Cryosat will be adjusted to the sea level provided by Jason-2 i.e. CS-2 mission will be treated as a "secondary" mission in the SL system of production. **The most important issue is to have the validated sea level measurements calculated over all the periods.** The stability is not the primary criterion. This kind of product already exists but it is an internal product performed by CNES (Cryosat Processing Prototype - CPP). Currently it is this database which is used in the AVISO product. Currently it is possible for us to use this altimetry database if it is not possible to use IOP/GOP product. We may need prior authorisation for ESA (requested by CNES) to use the GOP like other PIs. More details should be obtained from Jérôme Bouffard and Pierre Femenias. In AVISO the delayed products have been used

Action: decide which CryoSat-2 data should be used in ECV V2 after CS-2 QWG (end of March 15). Contact Jérôme Bouffard and Pierre Femenias to resolve this action.

JB: This action should be solved by the time of the quality working group on 17th of March. We want to know before June which product datasets to use for Cryostat 2. Analysis of pros and cons of each datasets should be performed. If we don't have reprocessing done in May/June, then it's not a candidate because we don't have the data. We

need a scientific or logistic pros and cons list (e.g. data not available) to decide in March on what we can use. The quality working group in March output will help make a decision.

BM: Question on the level 3 altimeter data made available for the Climate Research Group: these L3 data are corrected from remaining HF aliased signals, so when compared with tide gauges measurements, should we correct the tide gauges data with this same correction?
JFL: This should be discussed (real need, expected effect?)

YF: yes for real time

3.4.2. Production of the ECV (CLS)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/281

- After the database is ready, this input data is used to produce sea level maps and associated ocean indicators. There will be a reprocessing of the dataset at the beginning of 2016. In this presentation, an overview of the data processing (the SL_cci and DUACS system) and a description of the SL_cci ECV & validation shall be given.
- Since 1998 the CNES/CLS DUACS system has been generating high quality merged gridded products for multipurpose applications. Starting with L2, we compute L3 followed by L4. It is then possible to compute L5 indicators based on the L4 maps. Slides #5-16 show the steps followed in achieving L5 Ocean Indicators starting with level 2 measurements.

OA: Is the editing done as part of DUACS? Is CLSS MSS 01 still used?

JFL: The production of the SL uses the DUACS system. The editing is different.

YF: The editing is very close as in AVISO. It is a system used as part of AVISO and as part of this project. CLS MSS is not used as part of the CCI project.

BM: In long wavelength do you only include the orbit reductions?

JFL: yes. The along track measurement provided to LEGOS are corrected for these measurements.

- For the long wave step in L3 production (slide #7), the use of a reference mission is crucial when we merge the different satellites. Next step is to reduce aliased HF signals. In the Mediterranean Sea, along track measurements show some biases at large scale but also at small scale close to the coast. This step is used to reduce that. The last step is to reduce the remaining noise. This leads to L3 along track altimeter data ready to be assimilated in ocean models. This has been provided to the climate research group.

BM: We can't compare these products because you've removed the HF signal which is typical of coastal areas. We will need to do the same if we want to compare with the tide gauge record. We would need something else to compare to the tide gauge record. We might need something dedicated or need to apply the same correction so we need to know what has been done.

MA: I'm not completely sure but you are right. What additional information do you expect with the L3 products compared to the L2 products?

BM: At least the Orbit error correction, which is signification in terms of trends. This needs to be thought of.

- L4 Mapping is detailed in slide #11. The goal of the mapping procedure is to construct a regular-gridded data set merging along-track SLA from different altimeter missions, taking into account the errors due to the measure's imperfections. The multimission merging is based on an **optimal interpolation** using an *a priori* knowledge of the covariance of the sea level and the measurement errors.
- Slide #12 shows the global maps of sea level anomalies.

JJ: Is the information/numbers about the correlation wavelength in time and space available?

JFL: Yes at this step we use temporal and spatial wavelengths. It's not mentioned in the PUG but we could find this information.

- In slide #15 and in the SL Animation, the left plot shows temporal evolution and the right plot shows monthly evolution. The movie is available on the project website. Slide #16 details the computation of the SL_cci ocean indicators.

- For validation, a comparison between SL v1.1 and AVISO was performed. The trend is very similar and the trend differences are almost zero. The y axis trend goes from -4 to + 4 mm per year. In 2008 when we change from Jason-1 to Jason-2 there is an anomaly. The Jason-1 JMR input is used for the computation of the wet trop correction. Slide #18 provides more information on the anomaly.

MA: It is not a problem in the correction provided by JF. JF's correction is based on the Jason-1 enhancement product and there is a problem in the correction provided by the GDR product. The JPL provided 2-3 years ago a replacement product to correct the anomaly in the red curve. After this, another product was distributed by the JPL to improve the coastal areas. While improving the coastal areas an anomaly has been detected. It is a 1mm anomaly but for studies in relationship with the closure budget this 1 mm is a problem. This anomaly was propagated over all the Jason-2 period.

AC: I will show this afternoon by a totally independent approach that there is a problem in all GMSL products at this date.

MA: It is not a big problem but it is difficult to detect this kind of problem. This will be solved by the end of June. JPL will provide a new product, the GDRE version in Feb/march. JPL is aware of this anomaly.

JF: if the problem is still there in the new version it might be an issue.

- Slide #20 shows trend diff between AVISO/SL_cci data. Large scale differences can be seen and these are related to the altimeter standard differences. There are also some small scale differences that can be seen mostly everywhere in slide #21. We can show that these differences are related to the mesh grid differences between SL and AVISO data but they are mainly related to mapping and averaging techniques which are different. For SL we performed monthly interpolations as opposed to AVISO which uses daily interpolation. See slide #22 for mapping/averaging techniques.
- **In conclusion, in addition to the production, the PUG was updated when the data was produced. The data was also delivered, disseminated and promoted on the website. The comparison with AVISO products has shown that there are not strong differences in global trends but significant discrepancies appear at regional scales. The next step will be to update the PVIR and prepare for the next extension planned for the end of the year.**

BM: Question on the comparison of GMSL curves from different group. Is this an intention of the project to do this international comparison exercise?

JFL: This will be the focus of WP5 this afternoon.

BML: Are we sure where the problem is in the WTC and can we fix it?

JF: I'd like to make the comparison with the final product.

MA: We plan to discuss with JF after the meeting this afternoon. I think now the problem is the error on the JPL product input data that we use in the calculation.

BML: Does reprocessing make sense?

MA: For V1.1 is it impossible as is a lot of work to do that and it might not be useful. We have detected this anomaly because we also work with Anny. This kind of anomaly is likely to happen between TOPEX A and TOPEX B, between TOPEX B and Jason-2. To correct this does not depend on the work performed on the CCI project but the work performed by the spatial agency to reprocess this product. We can use this reprocessing in the CCI project. We don't need this for the extension because in the extension we've only planned to reprocess the last year.

AC: We should let other groups reprocessing altimeter data know that we have detected the problem and provide an explanation. All 5 groups can then put a warning advertisement to the users on their sites. We have seen for several years that at this particular period the SL budget could not be closed. Nobody knew why. Now there seems to be an explanation. On our side as I will show this afternoon we were sure that the altimetry data was the cause of this discrepancy not the thermal expansion etc.

Action: the team should communicate about the 2008 anomaly in the SL_cci ECV time series to the users but also to the data providers (agencies, JPL).

JF: This is the kind of error detected when comparing different products but the issue is deeper than that. It happens in the 2 Jason's radiometers. Sometimes there are clear jumps which may come from just one channel. They have ways to identify and correct these. What happened here is that you see on different products the jumps.

JPL should work on the calibration of the radiometer. JPL and AVISO should both do same. There could be more problems like the one identified in Jason-1.

MS: Do you know how to proceed with communication about this error? What will be a useful hint on how to include that error in our work? We should not communicate that all anomalies are due to that error.

MA: We will think on the best way to do so. Perhaps more discussions in tomorrow afternoon's conclusions.

3.5. Option task description by NOC and PML

3.5.1. WP2700 – New retracking techniques for climate-quality sea level observations in the coastal zone (NOC)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/283

- These options constitute work to be completed by NOC and PML. WP 2700 is about retracking techniques for climate-quality sea level observations in the coastal zone. The objective is to go in coastal zone and see whether we can better track the waveforms. This WP consists of 2 series of WPs grouped into sets shown on slide #3. The first group is dealing with the assessment and recommendation on coastal retrackers, working on single waveforms. Each waveform is in isolation which is what all operational retrackers do. For the other group 2D retracking is performed. We will apply our technique to ERS1/ERS2 and Envisat as well as Jason1/2. We expect that this should be relevant to the other missions as well. We expect to learn something on how to retrack Cryostat 2 and Altika etc.
- There are 2 cascades of tasks. In the first task which concerns the single waveforms we preselect families of representatives for each class of retracker. We will generate the sample time series and compare with the SL product. Slide #4 details the workplan and deliverables. Graham/Andrey will give more details about the 2D work.
- For comparison, we will take time series from the representative retracker of each family and compare against products, we look at temporal evolutions of main SL product, we will also try to assess the errors as a function of distance from coast. More details can be found in slide #7.

Questions/Comments:

OA: Question about the families of retracker. Does the sub waveform give you the parameters as well?

Paolo: Yes, if you modulate the width of the sub waveform you will get all the information you need on the 3 parameters.

JJ: Is this one single waveform from one single tracker

PC: Yes this is one single waveform used as an example. These are the validation regions where we will do the validation on a set of tide gauges in the north of Europe and in the south east of Australia. We will produce the time series on those regions.

3.5.2. Simultaneous retracking of multiple waveforms (PML)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/282

- Tracking efficiency improvement is done by considering a batch of waveforms and applying the retracker to the whole batch of waveforms simultaneously. We also need to have some assumptions on our parameters along track. We have a quadratic function to describe the variation of these parameters. Considering multiple waveforms provides several advantages despite its complexity. These advantages are detailed in slide #4
- We start with the open ocean data (we haven't tested coastal data yet with our method but it will be done once the method is tested). The block diagram used for our retracking is shown on the slide #5. We need to do 2 correction stages before retracking. We need to compensate for range variation introduced by the

tracker and compensate for the amplitude variation of the signal. These 2 signals allow for correction of our wave form. The next stage is the application of the standard Brown tracker to have an initial guess of our parameters (sigma-nought, wave height etc). Then we fit our wave forms to the model; for the ocean model we use Brown waveform model.

- Slide #6 shows an illustration of how the tracker works. The blue part corresponds to the open ocean.
- In slide #7, the blue dots correspond to the output of the brown retracker and the crosses correspond to the 2D retracker. The 2D retracker produces quite a smooth output. Data was obtained for a batch of 21 waveforms. Slide #8 is another example for a wider window. The question is how to choose the number of waveforms in each batch. If we increase the number, we have greater suppression in the output and some small scale variation. Another question is how to choose the processing step. We cannot process the data by moving one waveform along track because we have high computational expenses. If the step is too big we will have steps introduced in the output (discontinuity). We partly solved this problem by using overlapping windows i.e. waveforms which overlap along track.
- **In conclusion, a new 2D retracker has been developed that appears to produce smoother estimates over the ocean. In the near future a quantitative comparison with the 1D Brown retracker will be done. We will try to use different optimisation algorithms and compare the results with tide gauge measurements in cooperation with NOC. Slide #10 provides more details on future work.**

Questions/Comments:

PT: The shift of the waveform in the analysis windows is due to the reflection of the surface and also due to the tracker on-board. It is not possible to correct for the motion of the tracker. If you cannot correct completely you introduce errors.

AK: Residual errors can be considered as noise, so long as we use quadratic function. We can smooth them out.

PT: Why are you using a parabolic function for signal and wave height?

GQ: We want some simple calculation of the change in signal or change in wave height.

AK: there are lots of factors which affect the output and it is difficult to say which ones have a bigger effect. We can reduce the number of parameters which describe our function but it is also a matter of compromise. We need to compare this with alternative retrackers.

GQ: We are trying to map a 2D surface. You have different bins and different waveforms and we can't move the waveform. There might be ways to implement this differently.

OA: There might be more important parameters to fit in. I can see that you have reduced the noise, but it will be nice to see the same plot taking the Brown fit averaging 10 waveforms.

JB: The quantitative comparison is very good and it will be nice to compare smoothing as you did with a very simple smoother, 63 samples running average. Show before and after smoothing.

Action: PML to compare smoothing with a very simple smoother, 63 samples running average and show before and after smoothing results.

3.6. Assessment of output products by Climate users (WP5 – Part 1)

3.6.1. Assessment by the Climate Research Group (UOH)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/284

- The GECCO2 assimilation approach is targeted at quantifying changes in SL-data through the CCI effort. It involves the assimilation of the SL_cci ECVs as constrains jointly with other available ECVs over the ocean and in situ data. Slide #2 provides more details on the description of the assimilation approach. The assimilations performed in phase 2 are detailed in slide #3. In phase 2, assimilations were performed using the V0 product from AVISO. We have assimilated V1 and we will assimilate V1.1 of the SLC_ECV jointly with other new ESA ECVs .

- Slide #4 details assimilations that have been completed in phase 2. With cross-comparison, it will be possible to check all the useful information from all these products and whether there are improvements or not.
- Preliminary results for the SL_cci annual meeting are shown from slide #5 onwards. In the plot on slide #6, the more blue there is, the more improvement there is. We see improvements for both satellites in general. There is more blue colour for V1 than V0 which shows improvements for both satellite series.
- On slide #10 (Ratio comparison), the data set deemed better is on top.
- **Preliminary conclusions: The SL data for constructing GMSL have been improved for V1.1 compared to V0. The question to the team is what will be other possible other ECVs to implement? Maybe some melting from the glaciers and include that in the calculations somehow.**

BM: We propose to remove the trend from ice from satellite altimetry to assimilate this dataset. It will include indirectly the use of the ECV from glaciers and ice sheets.

AC: You compare the AVISO product with new SL_cci. Why is there still so much discrepancy with the Colorado university SL data? Is it possible for you in the future to compare the CCI product data with Colorado university data because there are 2 groups of products one AVISO-NOA-CSIRO and CCI, one is Colorado and JPL Goddard. We still don't know which group is the best and it will be interesting to see the same kind of comparisons but with additional SL products (Colorado, Goddard, AVISO, CSIRO)

MA: The problem is that for example, the University of Colorado provides only the Global MSL (maps may be available in the future).

JJ: Could you comment more on the improvement which is good in the equatorial tropical regions but degrades as we go into high latitude south. Is there a deficiency in the GECCO model?

BM: At which scale do you expect your model to follow the observations?

MS: The model has its resolution and this is the limit of the model. It will be different if we do a model interpolation and this will introduce even more errors in some regions or a less good improvement in some regions.

3.6.2. Assessment by the Climate Research Group (ECMWF)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/285

- ECMWF is planning to begin work this year and will present some ideas on what they plan to do. Slide #1 shows what other models will be used for comparison with the new SL_cci product. At the moment we have an operational ORAS4. The plot on slide #1 shows the comparison of monthly sea surface maps of OAP5 with AVISO.
- Slide #2 details some questions we may ask regarding what kind of products will be available for validation. E.g. first is monthly mean gridded product which can be used to calculate inter-annual variability of the sea-level trends as global map, against model simulation and reanalysis. Secondly, daily mean maps could be used to evaluate the sea-level instantaneous variability and tropical instability waves. Finally, if there's going to be along track data, then we'd like to use it for offline diagnostics of statistics at observation space.
- Slide #3 details a focus study ECMWF would like to do. ECMWF hopes to do improvements in the Arctic sea-level from SL_cci phase 2, and validate against model (simulation and reanalysis). ECMWF would also like to do some study on global sea level changes and its attribution budget (SSH, steric-height from model/objective analysis, EBP from GRACE)

Questions/Comments:

BM: The last part is what is done by LEGOS in WP5 (the "sea level budget" approach). I don't understand where the model enters in the budget. Isn't it a little bit self-consistent because you're already using GRACE to constrain thermal expansion?

HZ: If you assimilate different SSH, we should see some difference.

BM: we could work with the 3rd part of WP5 and deliver some data from GRACE

AC: Why is this correlation between the reanalysis and the data (between ORAP5 and AVISO) so low in high latitude particularly the southern ocean? Is it because the model is wrong in this region and gulfstream region?

HZ: I think the model has difficulties in the ocean. The gulfstream area could be wrong; the position in our system has been shifted slightly. That's one of the reasons.

AC: ORAS4 2015 was mentioned. Is it a new version of ORAS4 and is it available?

HZ: ORAS4 is producing data in near real time. The data is available in our systems. I will get Magdalena informed of the question so she can respond.

BM: Are you aware of a T and S bias of the Med outflow in the Atlantic? You don't expect any improvement on ORAS5?

HZ: Yes we are aware, we are working on it and hopefully we can have some improvements in the north Atlantic.

JFL: This morning we were talking about the difference between SL_cci ECV and AVISO and we discussed the signal that can be seen at small scales in the map of the sea level trend differences (Tropical Instability Waves signatures and small scale patterns in most parts of the ocean). Some discussions occurred in the past on this subject with Magdalena B. As mentioned this morning, this is due to the difference in method of computation of AVISO and CCI products (i.e. monthly interpolation vs monthly average of daily interpolation). As the small scale differences observed on the map of sea level trend differences are related with a difference of method, we are not interested in reducing these differences. Check the presentation of this morning (slides #21 and #22) and we can further discuss.

3.6.3. Assessment by the Climate Research Group (NERSC)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/286

- At NERSC we are using the SL V1.1 to inter-compare against the simulations with Norwegian Earth System model (NorESM). We also assess TOPAZ re-analyses and last we assess assimilation experiment using the NorESM reanalyses and prediction (NorCMP). The intention is that we will, by the end of the year, see how we can take benefit of CCI SL in a reanalysis.
- The maps on slide #4 show that overall consistency between the SL_cci and DTU data is in the same places but there are slight differences in the magnitudes.

JJ: is the colour difference down to the resolution?

OA: DTU's is based on data and needs to be averaged a bit more

- Slide #5 shows that there are lots of differences between the CMIP5 vs ESA CCI models and their observations. None of the models have a great agreement with CCI and DTU. A jump (~7 cm) in the sea level averaged in the Arctic in 2003 with only ERS/Envisat from the DTU dataset can be seen.

AC: What is TOPAZ? Is it the ocean component of the coupled climate model?

JJ: No, the ocean model in NorESM and in TOPAZ it is Mycom. It is forced with that assimilation and both have the Sea Level model on top.

MS: There is no input from Jason?

JJ: This is all ERS and Envisat.

OA: But the ERS and Envisat are fitted to the same orbit as Jason.

- Slide #9 shows the NorESM vs ESA CCI. DTU is in green, CCI in blue, AVISO in black and Noresm in red. In SPG there is bias and some periods don't fit. Slide #11 shows the NERSC will be working with.
- Monarch model / Nicolas Koldunov et al. 2015 shows a thermo and halosteric contribution in the Arctic.

BM: Is NorESM forced with the observed atmospheric field (Thermo-and halosteric contributions slides)

JJ: yes

AC: the fresh water increases due to more precipitation?

JJ: it is river flow increasing in winter and not melting in summer. (see slide #14)

- From slide #17, we can claim that the SPG is better assimilated. There's not good correlation between SSH model and observation in the higher latitudes. It's a question on how the model can cope with such a big change.
- Slide #18 shows GRACE data from Greenland. From mid-2012 there was no loss of mass. This data will change the amount of fresh water coming into the high latitude water and as such sea level.
- **In Summary, the assessment of sea level changes at high northern latitudes seas and in the Arctic Ocean by comparison of SL_cci products and NorESM fields has been performed. The assessment using re-analyses from TOPAZ & the inter-comparison of thermosteric and halosteric anomalies in the in-situ observations and in the NorESM simulations have equally been done. A few things have not started yet and won't be till the other aspects are mature. Plenty of this will come into a meaningful report at the end of the year. More details are available on slide #19.**

Questions/Comments:

AC: Is the data for the Arctic based on altimetry published?

OA: Yes, it is published and downloadable. Will send a link and also provide the data.

Action: OA to send AC a link and the data for the Arctic based on altimetry

3.7. Assessment of output products by Climate users (WP5 – Part 2)

3.7.1. WP5200 - Error characterization: Evaluation through Sea Level Closure Budget (LEGOS)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/287

- We address the question of accessing the SL_cci product. The closure budget approach is to look on one side at the SL data and compute components. We can then see if the equation shown in slide 2 is verified. We have looked not only at the CCI product but other products detailed on slide #4. For each product, there are some differences. It is difficult to evaluate the CCI product because there are errors everywhere in the components i.e. GMSL etc.
- The Graph on slide #5 shows the GMSL computed from the 5 groups plus the CCI product in the black curve. For the steric data shown in slide #6, differences can also be seen. In slide #7, it can be seen that the agreement for GRACE is better but nothing is said on the accuracy of this product.
- In slide #9, we look at the residuals considering the different SL products. There are large differences between the different residuals. There are 3 groups of results, 1 group AVISO-NOAA-CSIRO data and the other group if CU-GFSC and Goddard data.

AC responded to JFLs question saying there is an anomaly in the thermosteric data of ORAS4 and halosteric data (big negative anomaly) which is probably an artifact of the model and doesn't affect the steric component.

- The first result in slide #12 shows that the best correlation is with ESA CCI GMSL. More comparisons are shown from slide #13 onwards.

MA: We tried to look at the altimetry data and at the moment I don't understand the problems in the data. We take an action to do more investigations

AC: We had attributed 1 error into GMSL (issues with the data).

- **With this kind of approach we are able to attribute to the residual time series an uncertainty contribution from GMSL. To summarize:**
- **The trend of the residual time series related to AVISO and NOAA data cannot be attributed to the deep ocean because the trend (>2000 m) is much too large.**
- **We suspect in 2008 there is a link from Jason1 to Jason2 and a bias between the 2 missions. This needs to be investigated more deeply.**
- **Overall, best closure of the sea level budget is obtained with the CCI data.**

JFL: where does CCI GMSL come from? Is it the average of the monthly maps?

AC: It was the mean of the gridded data. 66 degrees north-south.

JJ: You consider that there are no errors in GRACE data?

AC: We don't know yet. What we've started to do is to compare the GRACE data with the sum of the mass component. At this time it is less obvious in our residual time series that there is an error from GRACE.

3.7.2. Regional Sea level validation – option (TUD)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/288

- There are two main WPs included in this is option: WP1100 (Water Mass Budget) and WP1200 (In-situ validation against geodetic data).

AC: In the SL slide #11, what is the difference between CCI V1 and V2? Why do you consider 2 versions?

LFM: the sea level plot shows CCI V1.0 and V1.1.

JFL: CCI V1.1 includes Jason-2 and Envisat reprocessed data.

JB: It could be good to decide to use SL_cci v1.1 (only one of the products) and call it V1.1 instead of V2 so that everyone knows what it is.

Action: TUD to update the slides (renaming the SL_cci v1.1 product to V1.1)

- Results are detailed for WP1100 from slide #6-14 and for WP1200 from slide #19-21. In WP1200 daily solutions are completed by approximately 60% i.e. 2008-2011. After completion of all daily solutions 2008-2014 TUD will compute mean daily coordinates and velocities for the network and vertical rates for the tide gauges. TUD starts in 2008 as only BORJ, HELG and HOE2 station data is available before that. On day 150 of year 2008, TGKN data begins to be recorded and is the first in the German Bight collocated with a TG
- **In conclusion, for WP1100, the sea level from altimetry agrees well with steric/hydrology-corrected GRACE in MED Sea. The remaining differences are to be explained by errors in GRACE, ocean model and hydrology. For WP1200, preliminary work with in CryoSat-2 has been described in a paper almost accepted for publication.**

Questions/Comments:

JB: May be we can say that the main differences can be explained also in the altimetry in the conclusion. Anny has more confidence in the GRACE model.

AC: At the global scale the model is not so bad but a local scale there is low resolution.

LFM: The sea level computed as the sum of steric and mass components involves various observed or modelled quantities. These are: (a) GRACE satellite gravimetry data, (b) land hydrology total water storage to correct for continental hydrological leakage in GRACE data, (c) thermo-steric part due to Temperature and (d) halo-steric part due to Salinity from databases or ocean models.

Therefore the error of this sea level estimation depends on the error of all these four parts.

On the other side, when we derive sea level directly from satellite altimetry as in the CCI ECV, the error involved is the error related to altimetry alone.

3.7.3. Evaluation of the CCI data against TG records (DTU)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/289

- The plot on slide #3 is the global errors. In this investigation we don't put on the GIA (Glacial isostatic adjustment) correction. This is the global SL_cci trend over the CCI period. In slide #2 DTU has averaged the monthly CCI with V1.1. In slide #4 for Lerwick, the left plot is data from tide gauge and the right plot is data from CCI averaged over 100 km. The right plot shows a smaller variance.

AC: Why don't you extrapolate the gridded data to the side?

OA: This could be done but might not change the results.

- It is wrong to do a direct comparison with the CCI product in the Baltic Sea. The GIA is not accurate enough, closer to 6-7mm. Slide #6 shows there's a big scatter in the Baltic sea. In slide #8 (Ny Alllesund), the tide gauge goes down by 7mm. We have to be careful doing these assessments. The bottom line of this investigation is that it is important to look carefully into this.

PC: Do you have GPS information for any of these tide gauges?

OA: yes it is available

- In slide #8 (Russia), GIA is 2.4mm in the wrong direction. In slide #9 (Prudhoe Bay in north Alaska), there are big differences.

JFL: The altimetry data should also be corrected of the GIA effect?

AC: It can be done but it's much lower than the GIA at the tide gauge.

OA: my conclusion of this is that there is a problem in the CCI data.

- **Slide #12 shows the percentage of CCI data in the Arctic from 0-100. the CCI coverage is reduced in the Arctic**

CLS: this is not related with the editing of the L2 data and it has nothing to do with the MSS CNES/CLS01: it is related with the maps of covariance and noise used for all altimeter missions as input information for the optimal interpolation.

BM: How do you correct for the elastic response of the crust to the melting of glaciers in Alaska?

OA: I don't. It is not so bad in Prudhoe bay.

BM: Your main diff in your product with respect to CCI and AVISO is mean sea surface?

OA: That is one of the things. I also allow substantially more data in my CCI than the CCI allows because by some editing of the data, a lot of the data is rejected. The use of the radiometer correction in ice water rejects a lot of the data.

MA: Tomorrow morning there will be an hour's long discussion about the improvement of SL_cci in the arctic.

JB: The annual review is the moment to get a lot of knowledge. The slides are not detailed enough. We should add more info in the slides before uploading them to the archive. Having good slides with more words on it is important so that we don't misinterpret anything.

PC: The comparison between SL_cci and tide gauges is important because we find a lot of errors. For each point around the tide gauge you could look at the sea level rise in that particular point.

YF: This map is the old version of AVISO/DUACS and not the reprocessed version from last year (spatial coverage of CCI map).

OA: yes

3.7.4. Altimetry Error Budget at climate scales (CLS)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/290

- In the 1st phase of the project we defined the error of the altimetry SL measurements. We define the error of SL separating spatial scale, temporal scales and we compare this error with user requirements summarised in slide #1.
- After discussing with users, it is important to provide to users the instantaneous error of the GMSL time series. So in phase to we tried to release a confidence envelope to evaluate the error of the GMSL. Work is ongoing and preliminary results will be provided.
- The approach used is to generate a set of GMSL time-series that a priori have equivalent qualities by tuning identified parameters. These choices are made to design the GMSL set requires exhaustive preliminary studies. To make these choices we have to conduct a lot of studies before. Also the dispersion of all these time series will draw confidence envelops which will need to be adapted according to analyses' objectives.
- The methodology is illustrated in slides #5-10. We have identified 4 uncertainties families. The 1st is the standards we used to calculate the GMSL. We have also have identified the data selection, the average

grids and the error to link the altimetry missions. There is a strong correlation between altimetry and coastal distance in data selection. For the average mesh grids we have already performed studies with people at LEGOS to look at the sensitivity of the method and if we use 1/1 degrees we don't obtain the same results if we use 3/3 digress. For missions linking we change our strategy by small differences e.g. we link altimetry missions together in the middle of the verification phases and then we change the window/period to calculate the bias between the missions. After generating all these GMSL time series we obtain more than 18000 time series produced using different statistical approaches. It is a time consuming computation. It is the GMSL time series not the grids.

- Using all these time series we were able to calculate the envelope error for the GMSL shown in slides #11-12 from Jason-1 to Jason-2 missions. This kind of information is useful for the users in particularly for studies on the MSL closure budget.
- Slide #13 is an overview of the error after de-trending the GMSL trend. It can be seen that the envelope error is not constant in time.

JJ: Is the error picking up what Anny describe in 2007-2008

MA: Yes, we will analyse that in more details.

- **In slide #14, it can be seen that both official CCI GMSL curves are within the error envelop. Slide #15 shows the repartition of the error. Most of the error is due to the choice of the standards to calculate the SL. The data selection has a strong impact as well and this could be higher if we refine our analysis. The mesh grid has a low impact as well as the window to link the data.**
- **In Conclusion, this approach is a complementary approach to estimate altimetry errors in agreement with former studies. We would like also to calculate this error at smaller basin scales e.g. the Mediterranean Sea. The error could be refined by taking into account altimeter instrumental instabilities and extended to other missions e.g. TOPEX, Envisat, ERS with TOPEX being the priority. This study has been described in V2.0 of the CECR, this study was also presented at OSTST and collocation.**

Questions/Comments

PC: Perhaps try to avoid the word 'confidence' in naming these parameters because confidence is a clear quantity in statistics. Your method is very valuable because it shows at the end of the day that the official curve is in the middle of all the possible ranges. But that is very much a qualitative value. I don't think this has too much of a quantitative value because the various models and standards won't be totally independent from each other and you use all possible models. You don't know that adding different standards will change the curve. Only when all the standards have been tested can we make it quantitative.

MA: We have confidence in these altimetry standards, we only use 2 orbit solutions equivalent in terms of quality.

PC: In real terms it will be a measurement of the uncertainty in the model (confidence) but I am not convinced that this has been measured.

BM: Does the CCI project endorse one of the requirements of OSTST to provide error trends at regional scale & if yes will you provide a map by the end of the CCI project?

MA: We plan to do this work with an approach based on the modeling of the error and after we can use inverse methods to calculate the error. We need to think on the approach. Our objective is to do that by the end of June.

BM: It is right that you didn't try to identify all kind of systematic errors that are not taken into account. Many errors won't make it into the envelope. There is room to enlarge the envelope?

JB: It is important to make sure you refer to all the work we've done in the round robin, to say these were guiding our choices and we used the candidates of the Round Robin in order to generate new solutions. This will justify the choices made and the statistical analysis scale.

MA: In addition to this work we have to identify the potential systematic errors that we did not take into account in this study. It could be interesting.

Day 1 ended at 17.45 CET. Day 2 started at 9.00 CET

3.8. Introduction of day 2

MA introduced the meeting and presented the agenda for the second day. A large part of the second day is dedicated to WP2.

3.9. Technical Investigations (WP2 – Part 1)

3.9.1. New external contributions (CLS)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/291

- For the moment, 2 orbits have been evaluated; one for Jason-1 and another for Jason-2. The ocean tide correction has also been evaluated. Jason-1 solution will be ready for end of April and Jason-2 for end of March so everything should be ready for June target.
- Some technical improvements with respect to CNES GDR-D include a new gravity field, calibrated semi-empirical Solar Radiation Pressure model on the solar panels and Reduction of the South Atlantic Anomaly Doris station downweighting.
- Slide #7 shows there is no improvement on the long term evolution but hemispheric differences can be seen and we know it is an improvement. On the mesoscale the improvements can be seen in Australia.
- Other technical improvements with respect to the CNES GDR-E include a new gravity files and other detailed in slide #11.

BM: This adjustment of C31 and S31 is because they want to have something consistent with GPS?

SR: There was a presentation at the OSTST meeting, about sensitivity study for main satellites including Jason-1/2. They showed that these coefficients are most sensitives for theses satellites. There are also some other coefficients and it will vary depending on the coefficient used.

AC: Is the GOCE data used in this new model?

SR: Yes

- For the Ocean Tide correction; At the moment for CCI ECVs we are using GOT4V8 model. The new solution is designed to decrease the 60day signal. Slide #19 shows the GMSL with TOPEX and Jason-1/Jason-2 using the GOT4v10 ocean tide correction. You see a low noise on the TOPEX in sea level and the noise is stronger on Jason-1/Jason-2 MSL. If we use the GOTv4v8 solution, the noise is reduced on the Jasons and if you use the last correction the noise is very small but there is a stronger error on the TOPEX.
- Slide #23 shows the Jason-1 MSL with the GOTv4.8 model. In the Atlantic Ocean the signal is very noisy. Using GOTv4v10 there is a good improvement on Jason-1/Jason-2 SLA.
- We still have to work with CNES GDR-E products and that will take some months. We have to check if there is a new GSFC orbit. On the propagation correction there will be new products (detailed in slide #27) and we have to check if there will be new external corrections which we can use.
- **In conclusion, the quality of ECV will benefit from these standards but we still have to do some work on other orbits and corrections, integrate them in our database and test them to be ready for the June deadline.**

Questions/Comments

AC: For the other groups you know which orbits are used in the Colorado time series for e.g. and what is the difference in terms of orbit contribution for their orbits and yours?

MA: For the Colorado university group for TOPEX we use the same orbit and for Jason-2 as well. For Jason-1 we used different orbits. For the GMSL time series the impact is very low, lower than 0.1mm/yr with no impact at interannual scale. At regional scale the impact is very important.

SR: You will also get GFZ contribution

LZ: Yes but that's not an external contribution.

MA: Sergei will provide this orbit solution by the end of June, and we will compare it with the CNES orbit solution and we will select the best one. Sometimes the difficulty is to identify which orbit is the best one. This is a difficulty we faced in phase 1 and we will also have it in phase two. We need to do analysis with external groups.

Questions on the details of the calculation of the GDR-D orbit, the gravity field evolution and the modelisation of the center of mass. Several people would be interested in some details on the processing of the GDR-E orbit solution. MA pointed out that some answers can be found in the Olivier et al. OSTST 2014 oral presentation.

Action: Michaël A. to send to the team the link to the OSTST 2014 POD presentations on the subject.

3.9.2. New orbit solutions (GFZ)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/292

- This presentation will provide a description of new developments on precise orbit determination and show new results for Envisat, TOPEX and Jason-1. A list of publications last year based on this work shall be provided and a description of some trends and additional activities that can be performed on precise orbit determination in the second project phase if we have time shall be detailed.
- 7 different tropospheric reflection models were tested and these are detailed in slide #4. From detailed analysis it was found that the best results can be obtained using Vienna mapping function 1. In phase 1, we used release 4 and now there's a new release available with better spatial resolution and longer time span of the AOD1B model. We found that better orbit quality can be obtained using release 5 compared to release 4 (RL04) so we used release 5 in phase 2. In addition we computed the orbit of Envisat by using, additionally to SLR, also DORIS data and denser parameterization from 12.04.2012 till 12.06.2012. We tested geopotential model EIGEN-6S2.extended.v2 for Envisat and Jason-1.
- Another activity within phase 2 last year was computation of Jason-1 orbits. We computed 10 versions of orbits called CCI01 to CC10 (detailed in slide #5). The first one was derived used the old EIGEN-GL04S and version 2 using time gravity ocean models with drift. We tested 7 different tropospheric refraction models for corrections of DORIS observations. Based on these results and tests we computed the CCI10 orbit that uses the best models from the tested ones.
- Slide #6 shows the major difference in orbit models for phase 2 in comparison with phase 1. This is up to now and we are going to perform some additional tests so the models might change by the end of June when we get new orbits. The main differences are shown in blue.
- Slide #7 summarises orbit modelling changes for new orbits (Version 8) in comparison with old orbits (version 6). The major changes were done for Envisat, Jason-1 and TOPEX.
- Slide #8 shows the results. Results will be shown for each satellite starting with Envisat. In the left plot, the blue dots show the old orbits for phase 1 and the red show orbits for phase 2. There's a reduction of SLR (3% reduction improvement SLR RMS fits). Also improvements in DORIS SLR RMS fit of about 2.4 reduction improvement.
- The plots on slide #9 show values of radial arc overlap. We compute 2 days that have radial arc overlaps. By using improved standards we obtain improvements of radial cross-track overlap and along track. The main conclusion is that the orbit improvement reduction can be seen in the red plots below the blue ones.
- For TOPEX/Poseison (slide #10), for 13 years i.e. the whole mission, there is an improvement in SLR RMS and DORIS RMS but they are not as large as Envisat because TOPEX's orbit is higher than Envisat's. There are also improvements for TOPEX residuals. Slide #11 shows improvements for orbit radial cross track and along track overlaps. In slide #12, for the Jason-1 orbit, there is a reduction improvement in the mean RMS values of about 4.4%. This comes from using new tropospheric corrections and also other contributions. Slide #13 shows a reduction of radial arc overlap by 17% and along-track overlaps. Based on these results and phase 1 results, 2 peer review publications were published. 2 papers are in prep based on the test of tropospheric correction models and new versions of products. These are detailed in slide #14
- **We presented results at international conferences shown in slide #15. Until end of June we will compute Jason-2 orbits. We are also going to look at attitude modelling of Jason-1/2 satellites. Until now we have used centre modelling but now we will use attitude modelling. We will also do some tests and use of some other background models for precise orbit determination for TOPEX/Poseidon, Jason-1 and Jason-2 that will become available by June 2015. We will compute until end of June TOPEX, Jason-1/2 for the whole mission of each satellite and we will provide them to CLS for analysis by end of June 2015. Based on these tests that we've performed now it will be possible to compute a new orbit of**

Envisat and ERS-1/2. It is not included in the list of products for phase 2 but we can do that if they can be useful for our project.

MA: No problem from our side to test this orbit solution. Is it possible for you to provide Jason-1 orbit solution before June (by April)? Because there is a GDR-E reprocessing project and in the framework of this project we will analyse the impact of the CNES GDR-E orbit and it could be a good opportunity to analyse the GFZ orbit as well. If we test GFZs orbit solution in September it could be too late to provide the information on GFZs orbit being better to CNES and NASA. We prefer the final version of the orbit solution for 1 satellite if possible.

SR: We try to provide consistent orbits based on the same models. It will be better for the project when we provide consistency. It is not possible to provide the orbits earlier; they will only be available by end of June.

- Based on the planned future activities we have and taking into account that orbit is one of the contributions in sea level, it is important to have as best orbits as possible and try to improve the orbit quality. We looked through possible sources of orbit errors. From our point of view the major contributions to radial orbit errors are contributions from gravity field modelling – GRACE observations after 2002 have improved. An additional activity is to study the orbit radial error, testing errors coming for latest time variable gravity.

BM: Do you use ECMWF field in computing time variable gravity fields? Are you using ERA-Interim? Is it based on the same fields as the ones used for atmospheric corrections?

SR: They are derived from observations from GRACE and from SLR satellites

AC: How do they model these time variable coefficients? This is for the high frequency tide but you also have the low frequency tide.

BM: The high frequency is based on the ERA-Interim, is there a consistency between both?

AC: The time variable part of the gravity field, how it is different form one model to another? Is it the main factor improving the orbit?

SR: It is described in the first peer reviewed paper shown on slide #14. I will send a pdf of the paper.

JF: You mainly adjust Jason-2?

SR: Not only, using SLR observations you can adjust up to degree 4 or 5.

AC: You have periodic and non-periodic variations which are not linear.

SR: HF variation models are computed using ECMWF models.

AC: We need to discuss these models sometime. Maybe the models are all wrong. I'm sure there are systematic errors that are not accounted for.

MA: 2 papers exist on this subject, 1 from Sergei and 1 from Alexander K. We need to plan a discussion and iterations with people involved in the POD group.

SR: I will suggest planning such a discussion: review of time gravity field modelling at our next meeting. Perhaps during the selection meeting in November and we can invite Alexander for a discussion.

JB: It will be nice to have a 1 hr discussion within the CCI. Making sure that the CCI input is present in the POD workshops. We could think of a next event which may not just be CCI like the collocation where we have an opportunity to have a POD splinter. So we should think of being able to bring something that has been already digested in a POD panel in 1 hr. See what these people are concerned about and what the challenges are.

Action: SR to organise a working session with people involved in the POD group

- There are some additional activities to be considered. Another contribution to radial orbit errors is the contribution to Eigen reference frame because the orbits are computed in the reference frame. It is known for GPS and DORIS that companion has the second largest error. The various tasks to be investigated are listed in slide #17. We know that there are different versions of EOT and FES models not mentioned here. What will be the contribution to errors of ocean tides from these different models? This is the third additional task that might be performed on this project. Depending on funding availability we can start these activities in October 2015 or start them next year. It is the impact on the orbit for 60 day signals.

JB: It is a good proposal, I noted you have 3 tasks that you will like to do. We could include in this task also a point in future like organising a workshopfor climates for organisations like COSPAR etc. It will be good for the concerned people to meet (within an existing meeting) for 1-2 hours to discuss of these specific technical details. The workshop will led by Sergei. We should put these extra tasks in a request and I will send it Mark Doherty and see if we can get extra funds by October 2015. We should have this ready by the end of May/June so that it can be processed before the summer vacation. If not, the collocation will be an opportunity.

Action (interested partners): prepare a proposition / write a CCN before summer to be addressed to CLS and ESA (Jérôme B.).

JF: Results on TOPEX for 1st half and 2nd half of the mission, did they degrade?

SR: the reduction means improvement, its RMS fit. DORIS provided an improvement.

Action: SR to provide paper with details about where the improvement is coming from for TOPEX.

3.9.3. WP2300: Improvement of the sea level in coastal area (NOC)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/293

- The rationale for this work is that we will look at the impact. Looking at global sea level allows not only to analyse the processes but to also translate processes into impact on society. The CCI is completed only when we manage to link to the processes to the impact. In WP 2300 we focus on improving the screening, filtering and correction of data in the coastal zones. Slide #4 details sub WPs and their focuses. We will do this work for several ERS, Envisat, TP, Jason-1/2 series. We apply screening and corrections to many missions.
- We will also focus for the validation on 2 regions, 1 in the north hemisphere and 1 in south eastern Australia shown in slide #6. In slide #7, Wet Tropospheric GPD improvement vs other corrections can be seen. There is a variance which is a big improvement.
- In WP2320 we will work on the screening corrections in coastal areas. We are evaluating all the corrections from phase 1 in the coastal areas except Wet Tropospheric Correction that has a different work package. Evaluation is by comparison with TGs in RegA and RegB, with correlations as function of coastal distance and coastal proximity parameter. We should also identity most signification contributors to error budget. We will also work on the specific aspects of screening and filtering, again by comparison with TGs, looking in particular at the correct recovery of sea level trends.
- The output will be the time series detailed in slide #9 including recommendations of screening and filtering. Formally, this goes into an internal report to contribute to the ATBD (D2.1).
- Slide #10 shows an extra WP where we look at TRSL which is the sum of the global mean rise plus the regional variability plus the local vertical land motion. This is an important parameter. Slide #11 is an example, where the blue dots are the tide gauges that are linked with the GPS stations which are our first choice.
- **The final question in the coastal altimetry group is can we reliably compute the curve shown in slide #13 and the rate for the global coastal zone?**

Questions/Comments:

AC: I agree with the answer No. What is your opinion about that?

PC: In the end we will probably agree, if we don't agree we need to think about the processes. Regionally there may be differences, globally of course.

AC: If you average all coastal zones in a radius of 200km, we found that with conventional altimetry there is no difference.

PC: We may have the answer but we will provide the link on the processes and how they impact on the 10-15km.

JB: People want to know locally and this is the regional part and we need a map with information. If we do the global value without coastal data, you extrapolate what we know and we say the answer is the same. If we do that work with that data and then the only question answered is; is there a contribution to the global value coming from a signal periodic at a long time at the coast?

AC: The sampling along the coast line is already more or less representative of the global value.

JB: The amplitude of the signal over the whole coastline, the global coastline is what I would like to know.

PC: The SL indicator is not only SL height but also the amplitude and the phase of the signal so we will provide that too. Perhaps there is not much science about computing global means at the coast but it has mediatic value.

LFM: Will you compute absolute or relative global mean?

AC: This is absolute.

BM: Will you only look at region A and B? You will never get the global coastal MSL in this project?

PC: We will look at the corrections impact in screening over those 2 regions. I didn't explicitly put the final calculations for the global mean in the proposal.

JB: We should discuss additional data that we will use in the round robin. Another CCN perhaps.

3.9.4. Improvement of atmospheric corrections (UoP)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/294

- The main goal is to provide the improved WTC for 8 missions. In phase 1 it was 6. I will briefly summarize revisited corrections for the 6 missions we computed in phase 1, we submitted results in a paper recently. I will also provide the results for CryoSat and SARAL/AltiKa and what we want to do next.
- For the 6 missions we mainly revisited the criteria we used to detect the invalid points that need to be updated because for the other points we mainly take the onboard corrections. We submitted this in a paper recently.
- For Envisat; – this is the new Envisat correction with reprocessing by CLS version 2.1. We also use not only the SLA variance but we also use the along track. In the left plot on slide #5, we compute in orange the difference between the GPD and complete correction. These are differences in v1.1 SL. In blue the SLA variance at crossovers and in orange it is along-track. On the right plot, for Envisat we see an increase in SLA variance. This doesn't happen for any other missions. It looks like there is something wrong on the radiometer correction for all versions.
- On slide #6, we plot the map of the variance differences. On the right are differences with respect to the model. On the top right plot, crossover differences are shown.

Action: MA to provide UoPorto with the latest Envisat WTC version

AC: These plots for Envisat; what is curios is that where you have strong signals either dark blue or red, it coincided with the pattern of the regional sea level trend seen in altimetry.

MA: The tropospheric content is very well correlated with the sea level content for the steric component.

AC: why because this is an atmospheric effect?

MA: You see the improvement in the radiometer is higher in terms of variability of the atmosphere. The more the variability in the atmosphere, the better the radiometer.

JF: we show a relative and not absolute variance.

- On slide #7; the top left plot shows the variance differences in function of latitude. It shows a negative variance difference with respect to the WTC. Confirming that the composite version has strong contaminations. You can see the increasing variance on the top right plot. Bottom right plot is the plot for Envisat because when you add the whole globe and include the high latitude there is a hug increase in variance. When you remove the high latitudes you have the usual plots and the GPD is better.
- Slide #8 shows the results for TOPEX. The main diff with respect to phase 1 is that you cannot see the strong differences in some cycles where we found some issues in the replacement products we used. For TOPEX the improvement is stronger in the second part of the mission. You can see decreasing variance is higher in the first part than the 2nd part on the right plot.
- Slide #9 shows plots of the maps of SLA differences at crossovers (GDP for TOPEX slide).

BM: How can you explain the regional sea Level trends?

JF: It is a mixture between the anomalies that are not corrected in the original products and errors in the implementation of composite correction for TOPEX. I have plots of some passes where you can see the composite correction jumps.

MA: In the open ocean the only contribution is the anomaly of the TOPEX correction. It is not the composite correction.

JF: I disagree, I will show some plots later.

- Slide #10 shows the results. The latitude plots for TOPEX can be seen. Green means phase A and blue is phase B. The correction is better in phase A. The bottom plots show the variance differences.
- Slide #11 shows the summary results for CryoSat-2 which we presented at OSTST. Variance differences are shown in blue and orange. This correction is different from the other. It is called the Dcomb correction where we don't have radiometer anymore. This correction mainly uses the data from a set of imaging radiometers that are available and GNSS data. Whenever there are no observations it just takes the model. The pink plot shows the % of observations which is pretty high. Some cycles have 100% coverage. Globally there is a reduction of variance. The bottom map is the map of the differences. Globally there is a reduction. There is also some ice contamination.

Question: Regarding the yellow parts above Norway. It is quite consistent to what was said before about that was happening, the content of WTC is low and when you improve it you degrade the model.

JF: Our experience says that above and below second latitudes we should just use model

- Slide #12 shows the maps for CryoSat in function of latitude and distance form coast. Regarding the difference with respect to the model you have a general agreement apart for the 2 latitudes. The second plot shows the difference in variance as a function of distance from the coast.
- Slide #13 shows the maps for SARAL. The variance reduction is shown on the first plot on the left. According to these results the Dcomb corrections seem to improve slightly the on board radiometer correction. The right map is when we show the variance difference in SLAs at crossovers.
- On slide #14, the left map is the equivalent map in terms of latitude and the right map is the map as function of distance from the coast. Slide #15 shows the GPD for ERS1/2 and Envisat. You can see that for ERS-1 there are consistent results, reduction with respect to composite and model. Close to the coast improvement is small. Slide #16 shows the results for ERS-1/2 and Envisat. Slide #17 summarizes the equivalent results for TP, Jason-1/2. For Jason-1 you still have some improvement although less and for Jason-2 there is even smaller improvement. With respect to the model Jason-1/2 are quite good.
- **We now plan until the end of phase 2 to focus on long term consistency corrections. We will inter compare carefully the radiometer datasets for the onboard radiometers, we will also use imaging radiometers and GNSS and models. Prepping for this inter-comparison we decided to reprocess a set of GNSS stations to be confident that our solutions were compared using the same methodology getting rid of effects like ITRF. We chose 60 stations. We have completed one network and the analyses are ongoing. See slide #21.**

JF: Our plots show that whenever you do an analysis between +/-55 and you include the whole globe you get different results. This correction is independent corrections and it can be very valuable to inter-compare with other missions.
JB: this presentation should have a conclusion slide to sum up the presentation

Action: All partners to provide one slide to summarize the main messages of their presentations

3.9.5. WP 2420 - Improvement of atmospheric corrections thanks to new atmospheric reanalyses (CLS)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/295

- The goal is to look in phase 2 at dry, wet and dynamic atmospheric corrections for all missions using a new atmospheric model reanalysis. In phase 1 there were nice improvements using ERA-Interim with respect to the operational model. ECMWF advised to use the Japanese reanalysis as ECMWF's won't be ready on time. The progress status of this task is detailed in slide #24.
- The next steps are to look at this Japanese reanalysis and see if there is scope for re-computing using that model or not.

3.10. Technical Investigations (WP2 – Part 2): Improvement of the sea level in Arctic

3.10.1. DTU contribution

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/297

- There are 4 subtasks in this WP shown in slide #2. WP2210 is the new sea level estimation in the Arctic. We suggest continuing with the product presented in the last days. Using a times series for ERS-1/2 and Envisat from the first phase and we would like to extend that to CryoSat. We are in the process of taking the year 2011 and consolidating the data. We are still performing evaluations. We have found issues with physical retracking in the Arctic Ocean as well as with the empirical retracker and we don't yet have answers on which is better. The output product will be produced in 2015 and we will take all data till the end of 2014.
- There's been a lot of focus on how to get more data in the Arctic. We thought about doing SL reconstruction from SL. We can use CryoSat because it has better spatial coverage than the other satellites. With these experimental products we used 4 years of CryoSat data and created the 9 spatial modes for the data, then took Envisat back in time. So we effectively reconstruct SL where there is no data.
- We did it for a track that comes to Greenland (an Envisat track). Slide #5 shows that the black ones are the good data then they turn into the data that are rejected because they're bad. The red pikes are the reconstruction.
- WP 2230 is the improvement in the MSS in the arctic. We are still working on this. We went from DTU10 and added a year of CryoSat to derive DTU13. We start to see small issues in our MSS. What is wrong is that we used ICESat to complement our mean surface which were not good enough for proper MSS. We are trying to solve that going back in MSS and taking out ICESat and using ERS-1/2 and CryoSat. The problem with CryoSat is the Beaufort Gyre. Now we are finalizing the new MSS we will present at the Sentinel workshop in June.
- For WP2240, we tried to improve the ocean tides in the arctic. The best way to do that is not to compute an ocean model. We prepared the empirical constituent in the arctic for CryoSat and ERS-1 and we let other teams run that. We teamed up with Noveltis (Mathilde Cancet), Delft TU (M. Neeije and Ann-Theres Schultz) and Florent Lyard to "make a better product". We will deliver tidal coefficients to them for the Arctic as input into FES2015/2016.

Questions/Comments:

JF: What kind of model are you using for the constraints? On the old missions which model do you use?

OA: We use the default on CryoSat-2 based on ECMWF. We substituted the radiometer correction with the ECMWF operational. Replacing with ERA-Interim was not particularly good in the arctic.

JF: It is important to start using ERA-Interim. It covers the whole period.

MA: Which data do you plan to deliver by the end of June for these 3 tasks?

OA: The extended time series in the arctic is the first product, then we'll add the MSS, and we'll put in the empirical tidal model.

3.10.2. CLS Contribution

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/298

- We will cover the general processing scheme, talk about waveform classification, talk about results of this method, present an introduction of the next retracking step we are currently working on and then conclude. PML will then present their work on classification.
- WP2220 aims at proposing new sea level estimations in the Arctic Ocean through the re-processing of the ENVISAT measurements. To do that we start from scratch from the measurements and we have to separate waveforms from the ocean and waveforms from sea ice. We have to retrack these waveforms to estimate the geophysical information, then edit and average. The goal was to compare CLS and PML results on the classification.
- At CLS we use a neural waveform approach. We have to define all classes of waveforms we want to keep. We have identified 12 classes of waveform shapes shown in slide #5.

AC: Except for the first waveforms, to what kind of surfaces do these examples correspond?

JCP: The answer will be shown a few slides later

- Our method is that we classify every single 20Hz Envisat waveforms, so we put a class on every waveform. We use a neural network algorithm to classify the waveforms. We use geometrical parameters to classify the shape of the waveforms. We have 2 different neural networks seen on slide #6.
- Slide #7 shows 3 maps representing the classifications along 3 periods. Among all the classes the main waveform classes present on these maps are the 4 classes. Class 4 and 6 are mainly linked to the sea ice measurements. Sea ice is detected by our classification and can be discriminated from the ocean.
- If we can detect easily the transition between ocean and sea ice and if we can easily detect the sea ice measurement, we can compute the sea ice extent. We can see how the transition between ocean and sea ice is well defined in slide #8. We can compute the sea ice extent from all measurement we have classed in sea ice. We have computed the sea ice extent with the Envisat period and our classification applied to the sea ice period only keeping the sea ice classes. If we compare the sea ice extent with an external product we have a good agreement with their data.
- In slide #9 is shown in red the percentage of ocean waveforms in the Arctic above 60deg latitude. We have the variation for Envisat 2003-2011. In in blue, the peaky waveforms, purple the sea ice waveforms composed by class 4, 5 and 6. The variation of sea ice, leads and ocean can be seen.
- To look at seasonal variation we can compute the percentage of ocean waveforms per grid box. A movie of the percentage of ocean data per grid box is included in the presentation. The blue on slide #10 is presenting sea ice and the magenta is presenting the ocean. Only tracks from 1 satellite, Envisat, are shown.
- In slide #12 you can see that patterns of leads concentration logically evolve with sea ice melting. We can see some regions with no leads inside. The leads will give us the points to estimate SL in these points. Without leads we are not able to estimate SL in these regions. This is an issue we have to check.
- The next step to improve the Arctic SL is to process all the selected measurements. In the plot on slide #13, ocean, sea ice measurements can be seen and the leads as well. We have to improve the retracking of the selected measurements. We have to edit outliers and corrupted data, we have to account for the penetration for freeboard in the Ku band especially, applying of the most adapted corrections and MSS, filtering and averaging the data along track or in the gridded product and filling potential gaps.
- At CLS we have studied a lot retracking algorithms with different projects for many years. To have a SL estimation we have 2 solutions: have 2 algorithms, 1 for ocean and 1 dedicated to lead bias. If we use this we manage bias between estimates. The other option is to have 1 algorithm for all measurements. We have developed at CLS a new algorithm called IceNew. We have already evaluated performances over ocean in the frame of the PEACHI project and we have had good performances. It is an interesting retracker and we are evaluating this solution of sea ice currently.
- **In conclusion, we have developed a classification of the RA-2 waveforms based on a Neural Network approach over the entire ENVISAT period. We have computed sea ice coverage as well. Many issues are currently under investigation to compute an improved Arctic sea level. We are doing the same thing in parallel for the Altika data in the frame of a different project.**

Questions/comments:

JB: There is a lot of material for this annual review which is good. When you try to discriminate from lead measurements do you use the range?

JCP: In this classification No.

JB: I would advise that you try to get some SAR data from different spacecraft.

CLS: Legos did some work on comparison with SAR data. It is very difficult because it moves very fast and the SAR has an incident angle of 40 degrees so comparisons are difficult.

JB: Not with Envisat, use RadarSat for example and other satellites. Just to demonstrate that it is the leads and not the melt pools.

AK: Question on using range for classification. There is a problem with accuracy of measurement, actual height is about 30cm. Envisat measurement accuracy for each wave form is a similar range and you won't see the difference in height easily with Envisat measurements.

JB: The paper by Seymour Laxon provides good input on using range.

MA: The 20yrs Envisat altimetry database acquired represent 15TeraBytes of data so it is lots of work to process this altimetry database. 20Hz.

3.10.3. PML contribution

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/296

- At PML we use an alternative approach to estimate SSH in the Arctic. We are also using Envisat data. The method is based on classifying waveform into 3 classes: leads, sea ice and open ocean. It is challenging to discriminate between waveforms from the ice and Open Ocean because both have diffuse scattering mechanism and similar forms. So we use maps of ice concentration to discriminate between ice and open ocean. If we have a 100% water class then we consider waveforms from this area as waveforms from open water described by the Browns model. Discrimination between sea ice and leads is also done. Waveforms from leads will have much higher peakiness values compared with waveforms from ices. Leads have a sigma-nought of about 40 dB and sea ice has about 10 dB signal power/strength. For leads retracking, we use the empirical waveform model which uses the impulse function to describe leading edge. For ocean retracking we use the standard brown model. Then we combine these measurements to estimate SSH. This is the general approach. We can improve results of classifying waveforms and we can apply more efficient retrackers to improve accuracy.
- To improve classification we consider different sources of information provided by Envisat ASAR data and also provided by MERIS. More details can be found in slide #4
- In slide #5, we produced lead concentration maps for different periods in 2009; Jan, Feb, Mar, April, May and June from left to right. At this stage we would suggest not to use measurements taken in summer to make sure results are accurate. We also tried a similar approach for retracking our measurements using the extended Brown model similar to CLS. Instead of using different retrackers for leads and flows we tried to use a general model which can be applied to both cases based on the extension of the Brown approach. We can get a model that will describe surface with different properties by substituting sigma-nought and into the equation shown in slide #8.
- In slide #9, we see that by using this model we can get rid of the bias used in classification. Slide #10 shows that approximately 20cm difference can be seen for leads, but not for floes.
- The work currently I progress is detailed in slide #11. We're currently comparing our results with CLS's.
- Slide #13 shows that parabolic waveforms track can produce 2 effects, first is waveforms anomalies and the second is called off nadir hook effect when the estimated range change following the hyperbolic shape. It is a well-known effect in river altimetry. When we do the tracking of leads we need to take these effects into account. In slide #14 we can see that when we move away from the max signal power our range slightly changes following the hyperbolic shape. If we consider waveforms along track we can see reflection of leads as spikes of the signal in the 2D signal. In slide #15 we can see that maximum of waveform shifts a bit away from the centre position as we move away from the maximum of signal along-track.
- **In conclusion, as long as measurement information comes from the specular reflection observed at the maximum of signal along-track, it will be redundant to do retracking on each waveform and instead we can detect the max specular reflection from leads and we can do retracking on this form alone instead.**

Questions/Comments

OA: The end of this investigation was that we should have 2 products to make a Round Robin. You should have a SL product by June?

MA: The idea is to compare the different products and approaches and to merge them.

3.10.4. Comparison of CLS and PML solutions for measurement classification

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/299

- Two different approaches have been used: the CLS approach and the PML approach. The description of both approaches can be seen in slide #4. All waveforms are classified using the CLS approach and not in the PML approach but we cannot say if one approach is better than the other.

- We can say that we have good agreement on ocean measurements. A lot of data is rejected by PML in the classification and not in the CLS side. Data classified as bad on the PML side is mainly located over Sea Ice (i.e. measurement classed as sea ice by CLS) – see side #5. The CLS classification identifies more sea ice wave forms as shown in slide #6. All data classified as sea ice by PML are classified equally at CLS so there is good agreement at this point as shown in slide #7. In slide #8 it can be seen that there is good agreement between CLS and PML patterns. CLS classification found more leads in the circled region than the PML one.
- In slide #9, there is approximately 70% agreement on lead classification shown in blue. The red points are disagreements.
- **In conclusion, there are 2 different approaches and one cannot say which is better because the main goal is to improve the SL measurement so it doesn't matter if we use a lot of points or if we use only confident points. The CLS approach identifies more sea ice measurements than the PML approach. There is good agreement on data classified as "ice floe" by the PML. Almost the same regions are detected with a similar proportion of lead measurements except in one region at high latitudes. Nearly 70% of data are identified as leads by both classifications. It will be interesting to perform the same comparison after the retracking step to sea which value of the SL we can find on both sides.**

GQ: We also need to do comparison of classification for May (comparison was done for Feb). It would be interesting.

3.11. Impact of loss of ENVISAT and Sentinel-3 preparation (WP2500)

3.11.1. Impact of loss of Envisat on the MSL evolution (NOC)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/300

- In a simple way we want to describe what is the impact of having lost Envisat for some time on the MSL. You will see that there is space for discussion towards the end because I need feedback from the SL_cci team on the best scenarios to run for this experiment. The main aim is to analyse the impacts of loss of continuity on the 35-day track (in October 2010) on MSL evolution. The questions to focus on are summarized in slide #3.
- EPPA has been developed at NOC and this allows to generate any number of constellations. You can specify parameters for errors in the various components and it will predict the SSH error or a combination of errors. Slide #4 provides more info. This tool will be used for sampling and reconstruction the SL evolution. An EPPA example is shown in slides #6-7. We've been using this code on the output from NEMO in the Gulf Stream. When you combine the data over a period of 6 hours you end up with an error variance shown on the plots in slide #7.
- The strategy in detail to be implemented in this WP is firstly to take the time series of the real ocean. Secondly we do a validity check i.e. sample the surface with the validity tool and then compute the ECV indicators. Thirdly we sample again the real altimetric surface according to a few different scenarios. In this scenario we want to reproduce the loss of the 35 day mission with reinstatement after 3 years with/without phase C Envisat in the middle. For each one of these scenarios we compute the ECV SL indicators and we compare them to see the impact. Finally we would redo these experiments to complete the assessments but this time starting from a dataset independent from altimetry so we will use a realistic high resolution model.
- Some Points For discussion are: which real altimetry surface should we adopt? Which scenarios should we run in details? And which model shall we use for the sampling of the model?
- In terms of which map time series to sample for this experiment, the obvious choice is the AVISO quarter degree one day maps. It's got very high time resolution. There is no 7 day product available. It's been shown many times that in terms of GMSL rate you get virtually the same as the CCI one. The main difference comes from the atmospheric fields but it seems to affect the TP/Poseidon MSL after that. One question is as a reference for this experiment should we take the 2 satellite product or the multi-satellite product? The 2 satellite product is preferable because it is more homogenous. The team can have a look at the slides later and we can re-discuss this in a weeks' time before we start with the experiment and select the most meaningful scenarios. The other option is to look at the SL_cci quarter degree monthly.

PC: Is there an intermediate product with higher resolution?

MA: No

Pc: We will stick to both as the reference base maps to sample the experiments

- Which scenarios should we run? We can run the 10d+35d scenarios but to make it more realistic we can restart it in 35d in Mar 2013, and you've got the 3rd scenarios trying to fill the gap with phase C on Envisat. We can run all 3 scenarios.

JFL: what is the output?

PC: Amplitude, phase, ECV and main periodic sequence. All scenarios can be run for lat +/-66.

- Finally we would like to redo these experiments from a model which has realistic SLR rates and also has places where SL goes up and down. The model could be the NEMO run 1978-2010 and it can be extended past 2010 so that we see the impact of the loss of the Envisat mission or we can shift it in time to see what would be the impact of losing Envisat at some particular point in time. It is global coverage. I am suggesting running the experiment over the north Atlantic only. There are a number of nuances or changes we can do in this scenario so feedback would be useful.

JFL: which is the band of latitude used to compute GMSL?

PC: +-66. We will run all the scenarios for that latitude but we should also compute full latitude scenarios.

JFL: The goal is to assess the impact of losing one mission and not the GMSL deficiency i.e. we don't want to compare with the product.

PC: So for comparison we stick to +/-66. But we can provide additional computation.

3.11.2. Sensitivity of the MSL calculation changing the orbit of the reference mission: Sentinel-3 instead of Jason missions (CLS)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/301

- WP2520 is about the sensitivity of the MSL calculation changing the orbit of the reference mission: Sentinel-3 instead of Jason missions. We have completed this study. Two reports have been delivered to ESA and a paper currently is in progress which concerns the global impact of the reference missions.
- Slide #3 shows the GMSL for TP, Jason-1 and Jason-2. The advantage of using these 3 missions is that they have the same orbit and there are calibration phases between the 3 which allows us to compute the relative bias between the 3 missions. In a few months there will be the launch of Jason-3, so if we lose a satellite, what will be the accuracy of the MSL relative bias between Jason-2/3 and Sentinel-3? What will be the impact of this bias on SL trend and finally what is the impact of the oceanic variability sampling of sentinel-3 on the long term evolution? We answer these questions first for GMSL and then for regional MSL.
- There are 2 scenarios shown in slide #7. One reference scenario with a calibration phase for Jason-1/2, Jason-2/3 and a working scenario. In one case you have a calibration phase and in the other there is no calibration phase. With the calibration phase, the 2 satellites observe the same ocean at the same time so SSH errors are positively correlated such that when you calculate relative bias, these errors are cancelled. We tried to estimate the relative bias uncertainty and decompose this into these 2 impacts shown on slide #8 (SSH errors and oceanic variability impact).
- We used the GLORYS model and interpolated it on Jasons ground track and sentinel-3 ground tracks. We were able to compute a lot of relative biases and with 2 standard deviations we obtain the figure 0.9 which we associate to the relative bias. More information on the figures calculated can be found in the report produced. See slide #9 for details.
- Slide #10 shows the impact on GMSL plot. The estimate of the trend has an uncertainty, the more Jason-2 points the more uncertainty rises, at some points the estimation is more accurate because there are more points and uncertainty decreases.
- Slide #11 shows the impact of relative bias on SL trend estimation plot. Between linking Jason-2 and Jason-3 or Jason-2 and sentinel-3 the uncertainty on trend is doubled. The impact of sentinel-3 and the fact that this method is a good approach to measure the impact of the relative bias uncertainty are the 2 messages we can take from this.

JB: Here there are 2 curves, blue and red curves, is there a scenario with sentinel-3 and Jason-3 together? Suggest not to show the sentinel-3 part of the curve. It is a bit misleading to have these curves till 2035. You could have dotted lines continuing. We should put this in a paper so it can be reviewed.

BM: What is the effect of increasing the period of validation?

MA: Probably the number for J3 could be lower.

BM: So you could propose an optimal period of cross validation?

MA: This study has been done and the minimum length of the verification phase is about 100days (10 Jason cycles)

- If we take just the max of blue and red in the previous slide we have the following figures summarized in the table on slide #12.
- Now looking at impact of space time sampling which is different for sentinel-3 satellites with respect to TOPEX orbit on slide #14, we notice that the trend is 0.05mm/year which is low with what we've seen before.
- The kinds of scenarios we have are shown in slide #15. The message here is that changing the historical ground track has a really strong impact on the trend uncertainty.
- Now looking a regional SL trends. We perform the same analysis as in the north Atlantic. The impact of the relative bias is stronger when you look at a region.
- Concerning the long term evolution impact of space time sampling; Local effects change in time. We did the same thing as GMSL but computed the map of the trend, and plotted the difference of the 2 maps of SL trends shown in slide #19. Locally, the trend uncertainty is close to 2-3mm/yr. On the GMSL we saw that the impact of the trend was reduced compared to the relative bias uncertainty but here it may have a large effect. The impact of space time sampling is very strong which is a surprise
- **In conclusions, it is not possible to meet user requirements for global trend if we use sentinel-3. It is important to remain consistent in the errors we commit to minimize sources of uncertainty. The different sampling of oceanic variability –induced by the difference of ground tracks- prevents from meeting regional trend User Requirements. The recommendation is to conserve the historical TOPEX/Jason ground track to compute MSL time series and MSL trend maps.**

BM: It is essentially on the western boundary regions that we have these differences. Since they don't have the same time of passage they don't have the same variability and the trends computed are dominated by inter month variability. Maybe we should remove these western boundary regions because the user requirements don't target them. Either change the user requirement or make it clearer if they want long term changes then the western boundaries should not be targeted.

MA: Agreed because when we compute the map of GMSL trend we do not use mono-mission but we use multi-mission to obtain a good map.

3.12. Outreach and promotion

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/302

Conferences

- The project has been promoted at lots of international conferences some of which are shown in slide #3. Next week there is the meeting in Bern related to SL closure budget. There are 2 meetings in Bern. 1 related to SL measurement in the Arctic ocean (Mid June) with people from this group and some people from the Sea Ice group, some students and some people from CNES and LEGOS not involved in the CCI.

ESA and Univ. of Porto are not aware of the ISSI Bern international team related with the climatological aspects of water vapor over the altimeter era (Bruno Picard).

CLS: questions on this subject should be addressed to Bruno Picard (bpicard@cls.fr). This subject is independent of the work performed within CCI.

AC: next week it is a workshop with different CCI projects and the other meeting is international teams selected in response to the call last year that are invited to make proposals at ISSI to work on emerging problems. The meetings have different purposes. Once the team is selected, it is supported for 3 years including 1 meeting a year.

The new call was released last week so this is a good opportunity to submit proposals. The European Commission is in charge of this.

JFL: There should be another team on the other long term estimation of the water vapor and the estimation of the SL trend.

JB asked to be informed by all about the ISSI Bern teams related to altimetry, including the water vapor one.

Action: CLS to inform ESA (JB) about all ISSI Bern teams related to altimetry where the team members are participating.

AC: For 3 years we always presented at the AGU, EGU etc almost the same abstract. We should do things differently now because what is important is to add other users who are more familiar with University of Colorado data and other who will usually use different products. What we should do now is try to demonstrate that the CCI products are better than other existing products. We should think about that and not keep using the same abstracts.

JB: The step by step reasoning of demonstrating why the CCI is better in a presentation is something we need to show in presentations.

AC: we need to find a mechanism to attract other international colleagues so that they use our product. We should show that we compare the different products available, demonstrate that CCI ECV is the best and enhance the cooperation between groups. It is important to promote cooperation and discuss together the way the products are calculated, in terms of accuracy.

JB: Now we have to tell the whole word that the CCI product is useful and it is being used. Talking of abstracts, we need to agree on what will be displayed for Sentinel-3 workshop. Before mid-week everyone has submitted what they want to submit and that we have a good visibility. WTC will submit something. The deadline has been extended for 1 more week. There can be an abstract of various topics e.g. sentinel 3 inclusion etc.

Action: WP leaders are encouraged to submit an abstract for the Sentinel-3 workshop (deadline is Feb. 8th)

Action (a posteriori): SL_cci should submit abstract to Our Common Future Under Climate Change, International Scientific Conference, 7-10 JULY 2015 Paris, France. Session: "Assessing Climate Observations"

SR: The title of presentation on CCI should be changed. The title has been the same at all 2014 conferences. We should also submit abstracts to the IUGG, 28-29 June. There will be a session on sea level observations and modeling. Abstracts deadline is 8 Feb.

Note: list of presentations at AGU is not complete.

Action: All partners who have submitted abstracts to send the title of abstracts and location to CGI, cc Jérôme + Bruno, JFL. Any work done concerning CCI should be sent so that it can be advertised on the website.

BM: Would be useful to track the list of publication on SL_cci not from the team i.e. external people using CCI data.

Action: team to send all abstracts / papers / publication to CGI so that it can be added to the website.

Note: a search of web of science using CCI as keywords will get all publications from the team and also external

Action: CGI to remind the team every 3 months to provide updated publications by sending existing lists of publications so that the team can complete it.

Newsletters

- 2 newsletters published in 2014, the next newsletter should be this year (2015). Perhaps end of year after the algorithm selection meeting.

AC: May be some Arctic results shown here by CLS and DTU could be something new that can be presented in the next newsletter. Add new results.

JFL: before next summer we will try to publish something

Publications

- The list of publications can be found on the website. Slides #5-7 lists the 2014 publications and conference proceedings.

Action: CGI to send an email to the team with the existing list of publications and ask to add new/missing publications.

- Slide #8 shows the download rate of the Ablain et al. paper on SL.

Website

- An overall refresh of the website was performed at the beginning of phase 2. There has been lots of communication on the availability of new products, regular upload of deliverables as well as the updated list of publications and presentations/posters from the team at external meetings and conference. The calendar has been updated with upcoming events and the website has been recently transferred to be hosted at CGI.
- Slide #10 shows the statistics on the access of the website.

BML: For the monthly report, include the comment on the description of the pages on the website. i.e. node 1 is not representative

Action: CGI to add the description of webpages in the website statistics for the monthly report.

Product dissemination

- The product is accessible via the unique email address info-sealevel@esa-sealevel-cci.org. ESA has been included in this mailing list. It is managed by the altimetry service desk at CLS. For the promotion of the SL extensions in last December, there were web news, newsletters and emails sent to ESA and other CCI teams.
- Slide #12 shows the cumulative number of access requests to SL_cci ECV.

BML: Do we have a plot of actual data access? This is just the plot of people asking for the data?

JB: Perhaps we have fewer requests for access than actual product downloads.

BML: We should record the number of downloads

AC: It will be interesting to get the geographical distribution of the requests for access.

Action: CGI/CLS to monitor the cumulative number of downloads of the ECV data instead of the number of requests for access and provide the regional distribution of the requests for access.

SR: there's a meeting missing from website. The 26th General assembly (IUGG) in Prague at the end of June. The deadline for abstract submission has been postponed to 8th of Feb. There will be a session on sea level observation modelling 28-29 June.

Action: CGI to add IUGG as upcoming event to website.

3.13. Open actions

JB: re-launch action #35.

For actions number #9 and #35, JFL to send the required info to ESA. i.e. updated list of users. Once the mail has been sent, action #35 can be closed and action #9 can be only closed when at least one user answers.

Action #16: BM and AC (LEGOS) to contact other groups like Steve Nerem, see their motivation and see if they are ready to trial. Then the best approach can be decided. We need at least Steve Nerem's group and the NOAA group. AC and BM to initiate the process i.e. contact the relevant people.

Action #18: Wait for input from Bruno (ESA)

Action #19: Can be closed.

Action #41: JFL to check minutes of PM3 to progress this action

Action #51/52: 51 remains open as a reminder for regular updates. Add IUGG meeting to website. Action #52 can be closed.

Action: CGI to add a link to Sentinel workshop actual website on the meeting and promote abstract deadline extended to Feb 8th.

3.14. Wrap-up and conclusions (CLS/LEGOS/ESA)

Slides can be found at http://www.esa-sealevel-cci.org/webfm_send/303

The conclusions of the meeting and the associated main messages are summarized in the "Executive summary" section of this document (section 1).

IsardSAT team has not been able to attend the meeting. JB would have liked to have more visibility on their achievements over the last year of the project. He would like to have a few slides covering their activity and their future work.
Action: IsardSAT to provide a few slides on their activity within the project and their future work.

Discussions:

MS: How do we deal with the know error in the product?

JFL: Discuss how to take into account global envelope of confidence?

MA: could be an action for a future discussion

Next meetings:

The next meetings are as follows:

- PM#4 on 5th May
- CMUG#5 26-28th May, SMHI (LEGOS, CLS, UoH)
- PM#5 on 7th July
- Collocation: 29 Sept.- 1st Oct, ESRIN (LEGOS, CLS, one from CRG, CGI?)
- PM#6 + Selection Meeting: Toulouse / ESRIN End of November

Proposition to organise PM6 + selection meeting on 25-27 November 2015. The first morning could be dedicated to a Precise Orbit Determination discussion (session to be organized by Sergei R.). The date of the AR2 should be determined (Feb. 2016 perhaps).

JB: The annual meeting should be linked to a big milestone so the date should be fixed based on deliverables. i.e. all deliverables submitted prior to annual review.

JFL: Other discussion points were to organise a POD discussion detailed in slide #5. This is an open question, should we organise a discussion session?

MA: perhaps Sergei can organise it and it can be in Toulouse during the selection meeting. We can easily invite Alexander Couhert from CNES.

SR: We can start the PM6 2 hrs earlier before noon to accommodate this meeting.

Action: CLS/ESA/LEGOS/CGI to define the dates of PM+Selection Meeting and AR2 before the Progress Meeting of May 2015.

Several suggestions were made for an abstract title to be presented at external conferences by the SL_cci team. Suggestions included <<SL_cci ECV products: a unique accurate data time series to describe the sea level evolution at climate scales>> , <<Climatic SL variation from altimetry products>>. It was mentioned that we should promote the aim of the product to convince people to try the product. State that it is for climate studies and looks at long time scales. Other title ideas included << New SL product for climate studies>>, << Is the SL_cci product the best ever?>> & << CCI's the best climate record?>>.

Meeting adjourned 16.12 CET

4. List of acronyms

PVIR	Product Validation and Intercomparison Report
GPD	GNSS Path Delay
RRDP	Round Robin Data Package
FCDR	Fundamental Climate Data Record
GMSL	Global Mean Sea Level
SPG	SubPolar Gyre
NorESM	Norwegian Earth System model
DOI	Digital Object identifier
IOP/GOP	Intermediate/Geophysical Ocean Product
ATBD	Algorithm Theoretical Baseline Document
CAR	Climate Assessment Report
SSD	System Specification Document
SVR	System Verification Report
SEWG	System Engineering Working Group
QA4ECV	Quality Assurance for Essential Climate Variables
DSWG	Data Standards Working Group
PUG	Product User Guide
ORAS4	Ocean ReAnalysis System 4
ORAP5/OAP5	Ocean ReAnalysis Products 5 / Ocean Analysis Products 5
EBP	Equivalent Bottom Pressure
MSS	Mean Sea Surface
EPPA	Error Prediction Program for Altimetry
JMR	Jason-1 Microwave Radiometer
TRSL	Total Rise of Sea Level
SLA	Sea Level Anomaly