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T A B L E O F C O N T E N T S

1	CCI Programme Status	4
2	Cloud_cci (GCOS A.4) _____	8
3	Ozone_cci (GCOS A.7) _____	11
4	Aerosol_cci (GCOS A.8) _____	14
5	GHG_cci (GCOS A.9) _____	17
6	Sea_level_cci (GCOS O.2) _____	20
7	SST_cci (GCOS O.3) _____	23
8	Ocean_colour_cci (GCOS O.4) _____	25
9	Glaciers_cci (GCOS T2.1) _____	27
10	Landcover_cci (GCOS T.5.1) _____	30
11	Fire_cci (GCOS T.9) _____	33
12	Climate Modelling Users Group _____	35

1 CCI PROGRAMME STATUS

CCI Programme Status

The eleven teams that make up the Climate Change Initiative are all up and running, and the programme as a whole is starting to take shape. The 10 projects looking at Essential Climate Variables (ECVs) are developing interactions between each other and with the Climate Modelling Users Group (CMUG). International coordination is progressing constructively, both within Europe, and internationally through the recently established Committee on Earth Observation Satellites (CEOS) Working Group on Climate (WGClimate).

At the programme level, CMUG has adapted its work plan to analyse work done by the CCI teams; it is now stretched over 6 months, rather than confined to a single programme milestone.

ECV Projects Status

All CCI projects have now completed the process of gathering ‘user requirements’ from their respective communities. Each project surveyed various user groups to garner opinions on the most useful products they could produce with regards to their Essential Climate Variable. The results are now being finalised into a **User Requirements Document (URD)** for each project.

Each team has captured user requirements in a manner suited to their particular user community and ECV. The methods used include literature reviews, on-line user surveys and user workshops. The primary goal has been to ensure that the User Requirements Document encompasses the major applications for ECV data products (climate research *and* climate modelling), and represents the needs of the key user communities within Europe and internationally. To assure this, each URD is being reviewed by an international scientific body, to be identified by the World Climate Research Programme (WCRP) and the Global Climate Observing System (GCOS).

All CCI project teams have provided input into the ongoing **review of the GCOS ‘Satellite Supplement’**, with several CCI science leaders participating in person at meetings. It provides an overview of requirements on the accuracy, stability and resolution of satellite-based datasets, and is a fundamental source of requirements for the CCI programme. Engaging in the review meets one of the CCI programme objectives of providing feedback to GCOS on user requirements.

All teams have now defined their complete data requirements for the next three years in a **Data Access Requirements Document (DARD)**. Many teams have already acquired the Earth Observation (EO) data needed for the first year of their project. In a limited number of cases this has necessitated a change to the project due to the large volumes of data involved. Team members have been participating in Instrument Quality Working Groups to ensure the products are well linked to level 1B data generation and calibration/validation processes. Each team is acquiring the necessary in-situ data via team members who have the specific expertise and access to relevant international observation networks and databases. CMUG is providing coordinated access to the European Centre for Medium Range Weather Forecasting (ECMWF) and its climate re-analysis

data, and will ensure links to the EC-funded re-analysis projects, ERA-Interim and ERA-CLIM.

The teams are now well advanced with the **Product Specification Documents (PSDs)**, many of which are almost complete. This document is being produced with reference to the User Requirements Document and the GCOS requirements, and outlines in detail the ECV datasets that will be produced in the CCI project.

The **round-robin** algorithm evaluation and selection process is underway in most teams and should be delivering preliminary outcomes during the upcoming reporting period. The process will vary with each project but each will test algorithms (different algorithms applied to the same instrument and other algorithms applied to different instruments) to select the best performing one.

Detailed reports on each of the ten active ECV projects, and on CMUG, covering the above issues, are given in sections 2-12.

Scientific Cooperation

Scientific exchanges between the project teams have increased after an initial set-up period and the success of the programme-wide collocation meeting in September 2010. The Cloud_cci and Aerosol_cci projects are both directly relevant for several ECVs so have solicited input from other teams for their URDs. The Aerosol_cci team also organised three algorithm development workshops with several other CCI teams.

The first **CMUG integration meeting**, convened at ECMWF on 14-16 March 2011, brought together 2-3 experts from each CCI project, and was very useful in promoting these cross-project exchanges. The goal of the meeting was to jointly review the URDs from all teams and the preliminary Product Specification Documents, before they're finalised within the teams. The definitive requirements for ECMWF re-analysis data required by the projects were also established.

Another key aim of the CMUG meeting was to assess the extent to which the CCI teams expect to satisfy the user needs and the GCOS requirements, identified in the URDs. It was recognised that the overriding user requirement was for continuous and consistent, long-term ECV data records (from at least 1991 onwards) but that this may be unrealistic for some projects. This is because several CCI projects are (for scientifically sound reasons) currently focusing on a smaller sub-set of years for their data products. Therefore a requirement has now been identified for at least one "golden year" of complete data from all projects to be produced. The ESA executive has taken note of these conclusions and will investigate actions possible at the programme level to better satisfy this key user requirement during the initial three-year phase of CCI.

The added value of the CCI ECV data products was discussed with respect to what is currently available. It was concluded that, for clarity, CCI teams should make an explicit statement of this added value within the Product Specification Documents, and – importantly – within future public communications.

The **CCI Data Standards Working Group**, established following the first collocation meeting at

ESRIN, Italy, in September 2010, has been working actively to agree common data standards that will be applied for output data products generated by all CCI teams.

International Coordination for CCI

The initiation of the **CEOS Working Group on Climate** (WGClimate) provided a major impetus for the space agencies to produce a response to GCOS. ESA is actively contributing to WGClimate and participated in its Geneva meeting in February 2011.

Coordination of the CCI within Europe is progressing well. Following the tri-partite ESA-EC-EUMESAT meeting at Harwell in November 2010, ESA participated in an **EU-US meeting on space and climate** at the Joint Research Centre, ISPR, in March. EU participants included DG_Enterprise and Industry, DG_JRC, EEA, EUMETSAT and ESA. US participants included the Department of State, NOAA, NASA and USGS. Many common objectives were identified, including the importance of data continuity, calibration/validation and long term data preservation for climate observations. The importance of working through established international frameworks, such as CEOS and GEO (as well as WMO SCOPE), to deliver a coordinated response to GCOS, was re-affirmed. The outcome of this meeting will be channelled into the next EU-US dialogue on space in July 2011.

The EC has invited the ESA executive to participate in the third meeting of the Global Monitoring for Environment and Security (GMES) Climate Change expert group. ESA is also scheduled to present the CCI at a workshop on GMES Climate Change Services, to be held in Helsinki in June 2011.

Scientific Consultations for CCI

Several scientific consultation meetings have been held to prepare for two new CCI projects on **ice-sheets and soil-moisture** ECVs, to be implemented via the ESA Strategic Initiative (STRIN). These will be tightly coordinated with the rest of the CCI programme and technical progress reporting to PBEO/DOSTAG will be integrated within the CCI quarterly status reports.

A briefing on all EO exploitation projects planned within STRIN was held at the Norwegian Space Centre, Oslo, on 15 March 2011. Participants from twenty other centres around Europe joined the meeting online.

A dedicated user consultation meeting was held at DTU Copenhagen on 29 March in preparation for the start of the **ice sheets** ECV project. Experts on space-based and in-situ ice-sheet observations, ice-sheet models, and coupled climate models all participated. The coordinator of the EC-funded "ice2sea" FP7 project contributed significantly in identifying opportunities for scientific cooperation with the planned project.

Preparations for the **soil-moisture** ECV were initiated with a questionnaire to international EO experts on the topic. An overview of the technical requirements will be presented and discussed at the soil moisture session of the EUMESAT scatterometer conference in early April 2011. A more comprehensive set of user inputs will then be drawn from the WCRP WOAP (WCRP Observation and Assimilation Panel) meeting in ESRIN, at the end of April, which will discuss selected ECVs

in depth, including soil moisture.

The tenders for the projects Sea_Ice, Ice_Sheets, and Soil_Moisture, will be issued in Q2-2011. The aim is to have the new project teams in place for the next CCI collocation meeting in October 2011.

Programme Outreach

All CCI teams have now put their **project websites** on-line, and all User Requirements Documents have been made publicly available on completion. These will be followed by the Product Specification Documents, when finished.

The CCI executive made a public version of the latest CCI progress report, which is available on the CCI website. The aim is to facilitate international scientific and programmatic coordination by providing full visibility of CCI project activities to all potentially interested parties.

ESA participated in a hearing on **Space for Climate at the European Parliament** in February, in the presence of the EC Commissioner for Climate Action, Connie Hedegaard. Interventions were made by the ESA Director of Earth Observation Programmes, Prof. Volker Liebig, as well as Eumesat Director General, Dr Lars Prahm. A report on this event was issued on the [ESA news portal](#).

Next Steps

In the coming six months -

- CCI teams will issue version 1 of their Product Specifications Documents.
- CCI teams will start the round-robin algorithm evaluation and selection.
- CCI teams will continue to support the review of the GCOS Satellite Supplement.
- The ITTs for sea-ice, soil moisture, and ice-sheet ECVs will be issued.
- The second CCI collocation meeting will take place at ESRIN, October 12-14.
- ESA will continue to contribute actively to CEOS WG-Climate.
- ESA will continue European level coordination on climate ESA-EUM-EC.
- ESA will host the WCRP WOAP (18-21 April) and the MARCDAT II international meetings (May 02-06) at ESRIN.
- CCI teams will attend the WCRP Open Science Conference, Denver US, October 24-28.

2 A2.1 Cloud_cci (GCOS A.4)

Project Status

Overall the Cloud_cci project is progressing according to plan, with a short delay in the product specification having been recovered. Although the Round Robin formally closed on April 1st some results from participating teams are still due; these are expected in mid-April. This should not have a major impact on the Round Robin schedule.

An important new opportunity for international cooperation has arisen via the forthcoming EUMETSAT Cloud Retrieval Evaluation Workshop (CREW-3) in Madison, US, November 2011. This research activity aims to evaluate the strengths and weaknesses of the most important cloud property retrieval algorithms for passive imager instruments on board polar and geostationary satellites (SEVIRI, AVHRR, and MODIS). Members of the CREW-3 project attended the last Cloud_cci progress meeting, and subsequent harmonization of round-robin data sets; a common day of observation data is now planned in both projects. Cloud_cci project members will also participate in the CREW-3 workshop.

Data Requirements

Cloud CCI has documented its requirements on data in the final DARD v1.3, whilst all data have been gathered and collected for the Round Robin exercise. All satellite input data from AVHRR, MERIS and AATSR, for the processing of the Cloud_cci data sets covering the years 2007-2009, are available to the team. The pre-existing database of satellite data, to be used as input for the Cloud_cci products, is currently about 15 TB. The remaining needed level-1 swath based MODIS data for selected channels from the TERRA and AQUA satellites (expected data volume ~30 TB) will be downloaded from the MODIS archive as part of WP 3125 shortly.

User Requirements

For cloud properties, several compilations of user requirements are existing (e.g. from WMO) and Cloud_cci relied on them in the compilation of its user requirements. They address application areas and disciplines of NWP, climate research, climate modelling and nowcasting. As the products from Cloud_cci are focused towards climate research and the GCOS user community it is evident that data sets from Cloud_cci are not useful, per se, for all near real-time application and all climate process studies. The GEWEX Radiation panel co-chair reviewed the Cloud_cci documents resulting in no additional comments.

Cloud_cci user requirements are ambitious but an assessment based on already existing algorithms and data set shows that most of the requirements can be met with the existing capabilities of satellite instruments. The requested temporal resolution can currently not be met with the proposed instrument combination. However there is scope for possible cooperation or inclusion into other international activities (e.g. NOAA's CDR programme, WMO SCOPE-CM). The cross-cutting CCI requirements from other ECVs are still under discussion so it is not certain how and if they

can be met, as different instruments outside the scope of Cloud CCI are involved.

Cloud_cci participated in the on-going update of GCOS 107 and was therefore able to identify differences in requirements in its PSD, which Cloud_cci is able to update and fulfill. As the temporal requirements have not been changed/degraded, Cloud_cci will still not be able to satisfy them.

Products specification

The product specification document has been designed and agreed with the climate research team, which was part of team that responded to the GCOS long-term requirements. Based on the user requests, Cloud_cci will provide not only spatially and temporally averaged data sets, with an input from all available satellite instruments at that time, but also single instrument averaged data. This allows the user to investigate specific questions. Cloud CCI adopted the NetCDF CF standard which is consistent with the other ECV projects.

The added value of the Cloud CCI datasets is that for the first time a coherent single algorithm for multi-annual cloud data set, based on the latest instruments (e.g. MODIS and AATSR), as well as on the heritage AVHRR instruments will be provided. It will use the combination of different instruments and satellites to ensure a better temporal diurnal coverage and an increased accuracy as a comprehensive level 1 radiance characterization and inter-calibration of all instruments will be performed. In doing this, the AVHRR instruments are tied not only to MODIS but also to AATSR high accuracy measurements.

Scientific cooperation

Two members of the Cloud_cci science team attended the GCOS TD 107 redefinition workshop in Geneva. The main task of the workshop was a critical review of the current GCOS 107 document and its adaptation to the GCOS Implementation plan 2010 to reflect the current state of the science. Both participants took scientific responsibility for the section on ECV cloud properties.

Cloud_cci participated in the cloud mask workshop of Aerosols_CCI. Cloud_cci plan to use their expertise (detection of areas with high aerosol load) in the evaluation process of the round robin exercise. CMUG interactions led to a finer definition of the content, especially in the DARD. In the last progress meeting, in March 2011, CMUG was present as well as additional experts (e.g. on cloud validation over snow and high latitude area). A team member of CREW-3 also attended. This activity led directly to a harmonisation between both teams for the round robin data base. Through the scientific collaboration with EUMETSAT's CM (Climate Monitoring) SAF and the WMO SCOPE-CM pilot project No. 1 Cloud CCI has access to latest developments on level 1 radiance inter calibration of the AVHRR channels. In addition to this, a WMO SCOPE-CM pilot activity is particularly supporting the initial algorithm development within Cloud_cci. Furthermore, it is planned, that the key scientist of the WMO SCOPE-CM activity, will visit RAL and participate in the next progress meeting at the end of May to discuss a common ESA/PB approach on inter-calibration of MODIS, AVHRR and AATSR. Cloud_cci invited and encouraged other groups to participate e.g. in the Round Robin, although participation by other MODIS groups could not be achieved (due to their workload to release collection 6 of MODIS).

Next Steps

In the next 6 months the main activities are related to an evaluation of the Round Robin exercise to identify strengths and weaknesses of algorithms. In parallel with algorithm development, intercomparison/interaction will take place to ensure a throughout characterizations of level-1 radiance.

Cloud CCI will participate in the next WCRP/GCOS WOAP workshop in Frascati on “Evaluation of Satellite-Related Global Climate Datasets” and in the open review of the update GCOS satellite supplement.

Ongoing and planned conference contributions are:

- Overview presentation at EGU in April 2011.
- WCRP conference, October 2011, Denver: contributions are planned in order to present results on the round robin exercise as well as to provide an overview talk.
- The next progress meeting with a dedicated topic on the round robin exercise evaluation will be end of May in Berlin, Germany.

3 A2.2 Ozone_cci (GCOS A.7)

Project Status

At this stage of the project, the first task of producing the user requirements analysis and product specification document is nearly complete. No major problems have been encountered, although additional iterations have been necessary to reach a consensus on the respective content of the User Requirements and Product Specifications Documents. This was clarified after consultation with the CMUG and ESA, in particular during and following the CCI Project Integration Meeting (ECMWF, Reading, 14-16 March 2011). Final versions of the URD, PSD and DARD are to be delivered in the first week of April 2011. During this quarter, new opportunities for international collaborations have arisen from the link with activities of the WCRP core project SPARC (Stratospheric Processes and their Role in Climate). This will take place in the framework of the SPARC Data Initiative and in support of the recent IO₃C-SPARC initiative to develop a global, homogeneous, vertically resolved ozone data base that will serve the preparation of the next WMO/UNEP Ozone Assessment and the next IPCC Assessment (AR5).

Data Requirements

All data requirements have been defined and gathered into the DARD. The main issues identified concern the quality and homogeneity of the level-1 data sets from the UV nadir sensors GOME, SCIAMACHY, GOME-2 and OMI. The timely availability of level-1 data products that include the latest calibration and degradation corrections is critical. Likewise, the timely delivery of the version 6 of the GOMOS level-2 data product is essential for the project. 80% of the data needed for completion of the tasks scheduled in year 1 have been gathered.

User Requirements

The Ozone_cci URD is nearing completion; a final version that will have implemented the changes requested by ESA and the CMUG will be delivered by first week of April. User requirements have been gathered from GCOS, IGACO, WMO, CMUG and most importantly from a specifically targeted, international climate research community which aims to evaluate chemistry-climate models (CCMs) with particular focus on long-term numerical simulations. The main focus of scientific investigation is on ozone-climate connections and the coupling of the troposphere and the stratosphere in a changing climate, considering the depletion of the ozone layer in the past, and the expected recovery in future decades. Improved vertically resolved ozone data sets are also required for assimilation in numerical weather prediction systems with the aim of improving long-term reanalyses. As identified, ozone data product requirements essentially reflect the spatio-temporal resolutions of numerical models currently used and the different scales of the process to be investigated. The most challenging requirements are those on the accuracy and vertical resolution of the ozone profiles in the upper troposphere and lower stratosphere. Likewise requirements for data assimilation and numerical weather applications are close to “target” requirements and very likely will not be matched within this phase of the CCI. More generally, a full assessment of the adequacy of the user requirements cannot be provided at this early stage. Instead this will result

from a full analysis of the data products to be generated within the project.

Products specification

The specification of the Ozone_cci products follows the requirements identified in the URD. Ozone_cci end products are multi-sensors merged level-3 products, specified for total columns, vertical profiles from nadir sensors and vertical profiles from limb and occultation sensors. They consider the characteristics of European satellite instruments flown in the last 16 years, and focus in particular on the ESA-platforms since the mid-nineties. According to user requirements, all product data files are compliant with NetCDF Climate and Forecast (CF) convention for the data structure and with the INSPIRE standard for the metadata. Level-3 data sets following these specifications will be available both for individual instruments and for merged data products from multiple satellites. The major improvements compared to currently available ozone data sets are (1) the generation of consistent level-3 data sets based on the current most advanced level-2 algorithms (2) the delivery of these data in a CF-compliant NetCDF data file format that matches the needs of climate users. Such data are mostly needed to better understand atmospheric (physical, dynamical, and chemical) processes and to establish a more robust benchmark to assess the quality of already existing CTMs and CCMs. As already mentioned, the extent to which Ozone_cci products will (or won't) match user requirements in terms of accuracy, stability and resolution will be assessed in the course of the project. For this reason, the Ozone_cci PSD does not yet include a rigorous assessment of the level of compliance with the URD.

Scientific cooperation

The most active cooperation and interaction so far has occurred with the CMUG, in particular for the preparation of the first ECV integration meeting. This interaction has led to a better identification of the user needs, in particular as regards the needs for data assimilation in NWP models. Also fruitful discussions have taken place on the role and possible impact of ECMWF reanalysis data sets for the Ozone_cci project. Possible areas of collaborations with other ECV projects have been identified on scientific basis. This includes e.g. the possibility to use of cloud and tropospheric aerosol information in algorithmic studies to investigate the potential added-value on the accuracy of ozone products, in particular for tropospheric ozone retrievals. It was noted however that the scope of such activities should be matched to the available resources. Potential collaborations have also been identified that could make use of stratospheric aerosols developed in the Aerosol_cci project. Such data sets are of high relevance for limb-scattering retrievals, but also for climate modeling. As to the latter, the relations between SST and ozone or between polar ozone and ice have been identified as science topics of high interest for Ozone_cci.

Next Steps

The main activities planned in the next 6 months concern algorithmic developments in each of the three Ozone_cci EOSTs (Earth Observation Science Teams). Round-robin exercises will take place in EOST-3 to select a reference algorithm for MIPAS. Likewise in EOST-2, a round-robin is being prepared with the aim to build a reference nadir ozone profile algorithm having optimal performances at both stratospheric and tropospheric altitudes. Protocols have been established in interaction with validation teams. The following data sets will be produced: (1) data base for tasks 2, and (2) a first version of the Round-Robin data package. Regarding documentation, the Product Validation Plan will be finalized by month 9, and the System Requirement Analysis in month 12.

A first version of the ATBD will be produced by month 12.

4 A2.3 Aerosol_cci (GCOS A.8)

Project Status

The project is performing well, despite having accumulated a 6 week delay, although no major problems have been encountered. As Aerosol_cci kicked-off in July 2010, earlier than most other CCI projects, this delay has not affected coordination within the programme. Deliverables have been produced mostly according to schedule, and part of the delay is due to the time required to revise some poorly prepared initial versions. The project manager has subsequently tightened the implementation of the schedule for the production of documents.

Additionally, the team have identified a need to spend more time on the algorithm round robin due to the complexity of their approach and from a growing understanding of the opportunities in the algorithm work for better understanding uncertainties. A 3-month shift in the schedule for algorithm development would only have a minor impact on the system development tasks, and the overall 36-month project schedule would be maintained.

Three algorithm development workshops focusing on different aspects of aerosol retrieval (surface reflectance, cloud-clearing, aerosol models) have taken place, and internal working groups have discussed the main issues and are preparing technical notes on best practice.

Datasets needed for the round robin have all been acquired. The first prototype aerosol datasets have been generated based on initial and competing precursor algorithms. These original algorithms have been updated to a common product format (NetCDF) to include product uncertainty information, and are stored centrally in an ftp site hosted by ICARE. Validation tools have been set up and first test datasets have been analysed.

Based on user requests for a statistically significant evaluation the processing and analysis of case studies using several algorithm versions of the precursor algorithms (with improved/harmonised aerosol optical properties, cloud masking and surface treatment), the work plan was extended to include one full global dataset for 1 month (September 2008) with each algorithm version. This has also contributed somewhat to the 6 week delay.

Data Requirements

All data requirements have been defined conclusively, including necessary ECMWF data. A Category-1 proposal was submitted to ESA covering all ESA and third-party mission data requirements. All data needed for the processing in Phase 1 of the project has been acquired by the team. The Data Access Requirements Document has been revised three times, following detailed RIDs from ESA, and is now accepted.

User Requirements

The URD has been accepted. The collection of user requirements, however, is ongoing beyond the

formally accepted deliverable (URD v1.3) to incorporate further feedback from user groups such as the GMES project MACC.

User requirements were collected mainly through the key user body AEROCOM, which is a global network of the sixteen major climate aerosol modelling research groups. The URD includes input from AEROCOM (through informal discussions in the AEROCOM network), but also from MACC, the European GMES atmosphere service requiring datasets for data assimilation in re-analysis. Major user messages are: ease of use (format, lat-lon grid, documentation), specification of pixel level error, link accuracy with horizontal resolution and stability with temporal domain, provide information on absorption and aerosol composition. Application domains treated in the URD are model development, process studies, trend monitoring and data assimilation in re-analysis.

The user requirements collected by Aerosol_cci were externally distributed to CMUG, other ECVs and the WMO-GAW Science Advisory Group (SAG) for aerosols. This SAG is currently evaluating the requirements received from CMUG and Aerosol_cci together with the older GCOS collection of requirements. Aerosol_cci is working closely with the SAG to structure and harmonize the user requirements in order to feed them in the WMO Rolling Review of user Requirements for GCOS.

User requirements include some requirements that are not met, including vertical layering of aerosol optical depth and long-term datasets. Vertical layering cannot be fulfilled with the sensors available. Long-term datasets are not yet planned in Aerosol_cci, as the project focuses on the algorithm development, but the Level-1 datasets do exist to produce at least one decade of data, and generation of such long time series has been proposed in CCI options. User requirements for optical aerosol properties will be assessed and validation will show the capabilities and limitations of the algorithms, and will help target algorithm improvements.

Products specification

The Product Specification Document (PSD) is currently undergoing revision based on ESA feedback. The PSD includes an analysis matching the product specification with the user requirements. The Aerosol_cci data set will consist of a variety of products: Multi-spectral aerosol optical depth and aerosol type probability will be retrieved from several sensors and a synergetic multi-spectral approach. Additionally, a consistent UV absorbing aerosol index (AAI) and a stratospheric extinction profile gridded product at $2.5^\circ \times 10^\circ$ will be provided. These are the Level-2 products which form the basis for provision of Level-3 products consisting of one or more merged multi-spectral aerosol optical depth and aerosol type products. Furthermore a global “climatology” of aerosol type probability for the reference year will be provided. Each product will include a pixel-wise error characterisation, which is one major area of progress.

Requirements for accuracy, precision and stability will be implemented as far as possible. Only validation will show how far this can be achieved. The ongoing algorithm and module analysis and tests and the round robin exercise will provide deeper insight on the error budget and feasible uncertainty thresholds of the products – this will then build the basis for a refinement of the respective product specifications.

Adopted data standard and format is NetCDF v.4, CF v.1.4 consistent with other CCI projects.

Scientific cooperation

Interaction with NASA and EUMETSAT during algorithm workshops and specific working group activities has helped to assure consistency with activities outside Europe. Interaction with the other ECVs (clouds, ocean colour, land cover, fire, ozone) has led to better understanding of consistency requirements (e.g. with clouds), of respective ECV products and opportunities for interim data comparison as a means of validation and consistency testing. CMUG has supported harmonization of ECMWF data requirements analysis and identification of possible ECV inter-comparison activities. The interaction with CMUG and the other ECV projects is considered valuable and necessary to assure scientific consistency.

Next Steps

The next six months will first see final iteration of the PSD and then reprocessing and systematic validation of the test data sets with different algorithm versions to better understand the specific contributions to product uncertainties. The round robin exercise will be started with processing of four months of global data (one in each season) with all algorithms to be compared (including at their own cost potential external participants). Furthermore, system requirements will be formulated for aerosol product re-processing.

5 A2.4 GHG_cci (GCOS A.9)

Project Status

The GHG_cci project kicked-off on 1 September 2010, therefore this is the second Quarterly Status Report of the project. The GHG_cci project is proceeding as planned, with significant progress already being made. No major problems have been encountered so far.

In the timeframe this report covers the main achievements of the projects have been:

- Generating the first versions of key documents – User Requirements Document (URDv1), Data Access Requirements Document (DARDv1) and Product Specification Document (PSDv1). The first versions have been finalised during the reporting period as planned and are publicly available from the GHG_cci website (<http://www.esa-ghg-cci.org>).
- Generating a first version of the Round Robin Evaluation Protocol (RREP), which is also publicly available from the GHG_cci website.
- Preparing for and participating at the CCI Integration Meeting at ECMWF, 14-16 March 2011.
- Preparing for the 2nd Project Meeting (PM2) which will be held during EGU on 7 April 2011. CMUG has been invited.
- Updating the GHG_cci website.
- Algorithm development, data processing and evaluation of the resulting data products.

A detailed first comparison of all the data products generated with the GHG_cci ECV Core Algorithms (ECAs) has been initiated and very encouraging results have been obtained (to be presented at EGU and in PM2). Significant progress has also been made on the Additional Constraints Algorithms (ACAs). For example, a detailed comparison of the new methane profile data product retrieved from SCIAMACHY occultation measurements at IUP, Univ. Bremen, has been initiated with the MIPAS product of KIT. The first results will be presented at PM2. In addition, the following peer-reviewed publications of GHG_cci team members appeared during the reporting period (or at the end of the previous period):

- Butz, A., et al., CH₄ retrievals from space-based solar backscatter measurements: performance evaluation against simulated aerosol and cirrus loaded scenes, *J. Geophys. Res.*, 115, D24302, doi:10.1029/2010JD014514, 2010.
- Frankenberg, et al. Global column-averaged methane mixing ratios from 2003-2009 as derived from SCIAMACHY: Trends and variability, 116, D04302, doi:10.1029/2010JD014849, *J. Geophys. Res.*, 2011.
- Georgoulas A.K., et al. A case study on the application of SCIAMACHY satellite methane measurements for regional studies: the Greater Area of the Eastern Mediterranean, *International Journal of Remote Sensing*, 32(3), 787-813, doi:10.1080/01431161.2010.517791, 2011
- Reuter, M., et al. Retrieval of atmospheric CO₂ with enhanced accuracy and precision from SCIAMACHY: Validation with FTS measurements and comparison with model results, *J.*

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Data Requirements

A first version of the Data Access Requirements Document (DARD) has been compiled during the reporting period. It is available via the GHG_cci website. The GHG_cci team has access to all the satellite data it needs, e.g., to all SCIAMACHY and GOSAT data from launch to end of 2010. The GHG_cci team also has access to all relevant model data (e.g., TM5 from JRC and CarbonTracker from NOAA). TCCON data are also available and have already been used for initial comparisons. Parts of the data from 2010 are still needed and will be added to the database in the coming months. During the generation of the DARD a good working relationship with ECMWF has been established in order to define the ECMWF data needs, and how GHG_cci can access data sets.

User Requirements

A first version of the URD has been generated as planned (URDv1). It is publicly available from the GHG_cci website (<http://www.esa-ghg-cci.org>). The URD was positively evaluated by CMUG. It is expected that all requirements will be met with the possible exception of the accuracy requirements, which are very demanding (sub-percent for XCO₂ and XCH₄); even the threshold requirements are demanding (threshold meaning the “minimum useful” requirement). For the GHG-cci user the focus here is on “useful”, not on “minimum”. This means that even if the threshold requirements are not met, one cannot conclude that the data are useless. However, under these conditions it is unlikely that the data are very useful, all the time, for all locations. It has also been pointed out in the URD that what matters are the details of the spatial-temporal error structure, which cannot be well characterized using a single number or a small set of numbers. It has therefore been highlighted in the URD that the numerical values given in the URD only give an indication but should by no means be over-interpreted.

The availability of URDv1 has been announced to a large community (including the teams in the US teams in the US and Japan being part of the OCO and GOSAT science teams). The GHG-cci CRG (Climate Research Group) is considered a representative international user for the use of satellite CO₂ and CH₄ data products for regional surface flux inverse modelling. The process of establishing links to (other) international science bodies, most notably the Global Carbon Project (GCP) and IGBP, has been initiated. Initial comments on the URD from outside the CCI project have been obtained and will be considered for future updates. This is also true for the recommendations made by CMUG. CMUG especially would like to see the longer-term perspective added (the next 5 and 10 years). Also this will be added to the next version of the URD. Here it will be pointed out that there is high risk for significant EO data gaps, due to the very limited number of approved satellite missions with sensitivity to near surface GHG variations. In this context planned and proposed future European missions such as Sentinel-5P (CH₄ but not CO₂), MERLIN (CH₄ but not CO₂) and CarbonSat (CO₂ and CH₄) have an important role to play.

Products specification

A first version of the PSD has been generated as planned (PSDv1) and is publicly available from the GHG-CCI website. The GHG-CCI CRG has reviewed the PSD and initial CRG comments

have been included in the PSD. Additional comments have been provided after the submission of PSDv1. For example, the users would like to see the entire state vector in the product and not only parts of it. These comments will be considered for the next update. It is planned that the project will use NetCDF, as used by the other CCI projects. The detailed definition is still ongoing, including aspects such as CF naming conventions, but it is known that GHG-cci will benefit from adhering to these standards. The users, in particular, will benefit from more information being incorporated in the products, compared to what currently exists. The products will meet the user requirements on product content, although to what extent the products will meet other requirements, most notably the very demanding relative accuracy requirements, still needs to be assessed. GHG-cci is still at the beginning of the 2 year Round Robin phase, where algorithms are being improved.

Scientific cooperation

A strong link has been established and further strengthened during the reporting period with the EU project MACC (Monitoring Atmospheric Composition and Climate). MACC is considered to be one of the key users for the GHG data products to be generated within GHG-cci. Cooperation with other international projects and partners have also been further strengthened during the reporting period, for example with a new ECV related project in the US led by Dr. Susan Kulawik, JPL, which aims at producing a detailed characterization of satellite CO₂ retrievals including SCIAMACHY and GOSAT. It has been agreed to deliver the GHG-cci SCIAMACHY XCO₂ data product generated with the BESD algorithm (Reuter et al., 2011) for external evaluation and to exchange information on all relevant findings to see if the two projects reach consistent conclusions on the data quality.

Next Steps

During April – June 2011, i.e., month 8 – 10 of the GHG-cci project, the focus will be on further improving the GHG-cci retrieval algorithms, data processing, and analysis of the resulting data products. A major focus will also be the generation of the Product Validation Plan (PVP) which is due in month 9. Work on several other documents will also be carried out, most notably ATBDv0, and AIECARv0 (Algorithm Inter-comparison and Error Characterization and Analysis Report). Work has started on compiling the Data Base Task 2, which will contain a data base of validation data (due month 9). Available satellite retrievals will be part of the Round Robin Data Package (RRDP) (month 6-12 (initial version), to be continued after month 12).

Several abstracts on GHG-CCI (overall and specific topics) have been submitted to the EGU 2011 conference in Vienna and the International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-7) in Edinburgh. They have all been accepted for (oral and poster) presentation.

6 Sea_level_cci (GCOS 0.2)

Project Status

9 months after the starting date, the project has entered into a new phase with intense activity on three main topics. First, the work on the user requirements, a key issue in this project, continued with numerous exchanges, resulting in several upgrades of the User Requirements Document.

Secondly, activities on algorithm development have strongly intensified. For some algorithms, some issues still have to be resolved concerning the data requirement (property right, phasing with other projects) but for others, the preparatory activities are well advanced and development has started. Some of the proposed algorithms are promising, such as the new Envisat instrumental processing, which will have a major impact at a climate scale. The SLCCI will be the first opportunity to have an extensive scientific assessment.

Finally, work has commenced on the System Requirements, including elicitation of “business goals” from the CCI Statement of Work, a comprehensive and reasoned mapping from a system apt for re-use, namely DUACS, towards a Sea Level CCI operational system, and construction of a draft Requirements Baseline. Through the 6 first months of the project, the Sea Level CCI team has set up connection with other European altimetry projects, and communicated with the international altimetric and climate communities. This is a key element to fulfilling the ambitious objectives of this project.

Data Requirements

30 types of data are necessary to run the algorithms and to perform the inter-comparison and selection task: satellite and ancillary data from 6 altimeter missions (ERS-1, ERS-2, Envisat, Jason-1, Jason-2, T/P, GFO) as well as in situ data. Among all the input datasets retrieved, several issues were encountered which have induced a delay in the development planning. Moreover the availability of reprocessed Envisat dataset will not be phased with SLCCI WP2 planning any more, and some corrective actions had to be taken.

Strong efforts have been applied by the Sea-Level project in terms of coordination: several meeting and teleconferences with ESA and CNES were organised in order to allow the CCI to benefit from the optimal input data from the external projects. Among the data to be ordered, 2 kinds of deliveries were requested: a one shot delivery on the overall period of availability; and another for data (satellite, ancillary, ...) that are processed operationally. This will allow the generation of the most complete possible sea level ECV time series.

User Requirements

The synthesis of the user consultation and review of the requirements were presented at the 2nd Progress Meeting. The discussion organised during this meeting with all the partners and also a CMUG team member, led to several recommendations. It was recommended that input from the

community working on meso-scale and coastal signals be included in the URD. It was also emphasized that it is necessary to share common definitions for the terms of accuracy, precision and stability. A new version of the URD was updated and delivered to ESA on 4 March 2011. At PM2 it was also agreed that the URD might be updated in the 2nd phase of the project to catch the evolving views and requirements in the scientific user community. This would also bring special attention to the sea level requirements in the high latitude seas and the Arctic Ocean where the permanent and seasonal sea ice cover cause challenges in the altimeter based sea level processing.

The sea level URD was presented during the CMUG meeting in March. The document points out that the current user requirements cannot be met by the existing data. The opportunity exists for Sea_Level_cci to reduce this gap and to improve error characterisation. Feedback from the CMUG meeting was that user requirements should be better distinguished the current status of the altimetry. It was also noted that requirements for a regional signal need to be added. Consequently, the URD should explain more clearly how User Requirements were collected, and identify “target” and “achievable” requirements. A good link is assured to the on-going update of the GCOS satellite supplement, due to the deep involvement of the science leader in this activity.

Products specification

A first version of the PSD was delivered in March, and presented at the CMUG integration meeting, in order to demonstrate how the product specifications meet the needs of the sea level CCI climate research group. The requirements concerning the global and regional mean sea level applications, in terms of spatial resolution and length of the time data series have been taken into account. In comparison with sea-level products currently available, new information (crucial for climate studies) will be provided concerning the evolution of the time data series (such as the trend, the description of periodic signals...) and the errors associated. Work is ongoing to improve the PSD waiting for the next version of the URD where requirements will be improved.

Scientific cooperation

The Sea Level CCI Project is closely connected to international activities related to global and regional analyses of the climate system specifically activities within the WCRP, such as CLIVAR or CLIC. Both are concerned with the Arctic system and its changes. This concerns observations (CLIVAR/GSOP and OOPC), changes in the climate system (CLIVAR/AIP) and specifically sea level (CLIC). In February a joint WCRP/IOC workshop on regional sea level variations and drifts was held in Paris. During the workshop detailed discussions of regional sea level variability was held and the role of the Arctic and its hydrological cycle was highlighted for predictions of regional and global sea level.

The ESA CCI project on sea level has also cooperated with two EU projects, notably MONARCH-A (led by NERC) and MyOcean (led by Mercator-Ocean), either through direct collaborations such as envisioned with MONARCH-A or through the interface with MyOcean to discuss how high resolution sea level products should be delivered. The role played by CLS, as leader of the Sea-Level Thematic Assembly in MyOcean, ensures a good coordination between the two projects. The work of MONARCH-A is directly related to the CCI effort both with respect to altimetry, but also Arctic tide gauges. At the same time MONARCH-A is a candidate model for bringing several ECVs together in a joint use and evaluation.

The ECV Integration meeting was also a very good opportunity to reactivate the links with the other ECV teams and the modelling community, established at the 1st collocation meeting. Although the sea level ECV does not have direct linkage with other ECV projects, a potential synergy has been identified with the SST ECV. The correlation between those two ECV at low frequencies/long term will be useful for the ECV product assessment. It has to be noted that the ESA CCI on sea level will also cooperate with the soon to be launched CCI projects on sea ice, ice sheets, and glaciers.

One outcome from the collocation meeting and the CMUG meeting is that despite its relatively good maturity, the sea level ECV is not really used by the coupled climate models even for validation exercise. The ESA CCI program consequently represents a very good opportunity to enhance the use of the sea level ECV.

Next Steps

In 2011 Q2, most of the efforts will be dedicated on the development of the improved algorithms (WP2000). The first Round Robin data package will also be generated which will allow tuning the validation procedure, necessary steps to prepare the selection process at the end of year.

The CMUG meeting showed out that additional work is needed on the URD to better define the users requirements. The PSD will also be completed in the next months in line with the next URD version.

The System Requirements Document (SRD) is due for delivery in mid April 2011, against a stable and complete Requirements baseline. Effort will then commence on the design of the system, via a System Specification Document (SSD), which takes as its main input the SRD.

7 SST_cci (GCOS 0.3)

Project Status

The project remains broadly on schedule. Unforeseen delays (now resolved) have impacted data assembly by 2 months. However, other work has been brought forward, and the delay will be recovered later in the project.

Data Requirements

The DARD is now in final review and there are no known open issues. The project has gathered 95% of the data required, and all data is expected in hand by the end of April.

User Requirements

The SST_cci URD has already been approved and accepted, with 116 numbered user requirements identified. Over 100 climate users were surveyed, covering all geographies and relevant disciplines, including modelling and climate monitoring. The key messages from users were:

- A clear need for improved uncertainty information, which is being fully addressed by this project
- More stringent accuracy requirements than those in GCOS2006, which were the baseline for this project. These have been fed into the GCOS review process.

User requirements have been analysed in terms of the fraction of users satisfied by varying levels of stringency, a novel approach which has been commended by CMUG.

The SST_cci project will meet many of the requirements identified in the URD, but not all. For example, the new breakthrough requirements for accuracy and stability cannot be demonstrated with the present global observing system (and therefore not by this project), although significant progress towards them will be achieved. The project target of stability of 0.05 K/decade is a significant advance towards users' breakthrough requirement of 0.02K/decade, and probably represents the limit demonstrable with current (AATSR) and planned (SLSTR) satellite technology.

The project will deliver a 20-year SST climate data record, and the requirement for a 30 year SST climate data record is covered by an option proposal. Likewise, the objective of many users for sub-daily time resolution requires new research, also covered by an option proposal. As noted above, the more stringent accuracy, precision and stability requirements have been fed into the GCOS review process.

Products specification

The SST_cci Product Specification Document (PSD) is presently under ESA review. The GHRSSST community has been involved in PSD definition. The team expects to meet the user requirements for improved uncertainty information and spatial resolution. They do not expect to be

able to demonstrate the new breakthrough level requirements for accuracy precision or stability – however, the project will deliver considerable improvements on GCOS2006 with respect to those requirements. Data produced by the project will meet the SST community standard GDS2.0, will be CF compliant, will take account of CMIP5 where relevant, and will be NetCDF.

Scientific cooperation

The project team has interacted with other groups, including Ocean Colour and Cloud CCI projects, and with working groups within the GHRSSST community.

Next Steps

The major activities for the next 6 months are (a) the Round-Robin exercise, (b) continue algorithm development, and (c) preparations for product validation. The Round Robin exercise will be launched at the GHRSSST 12 International Science Team workshop in Edinburgh (early July 2011) and will run for 4 months.

The following deliverables will be addressed in the next 6 months:

- The Product Specification Document (PSD) has just been submitted for ESA acceptance.
- The final Data Access Requirements Document (DARD) has been circulated for review.
- The draft Product Validation Plan (PVP) has been circulated for review.
- The Data Base for Task 2 (DBT2) v1 is being compiled, having been delayed by unforeseen difficulties acquiring data from some sources. Most data has already been acquired, and the rest will be acquired in April 2011.
- The scope and content of the Algorithm Theoretical Basis Document (ATBD) v0 was discussed at a recent progress meeting and will be drafted in the next 6 months

The Round-Robin Data Package will be available for external users from July 2011. Openness is being assured by the following steps:

- The global SST community will be invited to participate in the Round Robin exercise
- Project documents are available on the SST_cci website (<http://www.esa-sst-cci.org>)
- The Science Leader maintains a blog describing progress and the issues being discussed (<http://sst-cci.blogspot.com/>)
- The Science Leader is hosting GRHSST 12 in July 2011 (<https://www.ghrsst.org/news/q/date/2011/03/24/second-announcement-ghrsstxii/>)
- The project team will be represented at International WCRP-GCOS workshop on the evaluation of satellite-related global climate datasets (<http://www.congrex.nl/11C06/>) and MARCDAT-3 (<http://icoads.noaa.gov/marcdat3/>) meetings.
- Project team members have attended several seminars by invitation.

8 Ocean_colour_cci (GCOS O.4)

Project Status

The Ocean Colour Climate Change Initiative project is on track, with the last progress meeting held in ESRIN on 12th and 13th January. The Round Robin exercise is being held during the month of April with the results to be discussed with ESA and the Science Team at the next progress meeting in Harwell, UK on 19th and 20th May. The schedule remains tight and weekly team telecons are taking place to ensure the team remain on track and any potential blocking issues are dealt with in a timely manner.

Data Requirements

The project's data requirements have been fully captured in the Data Access Requirements Document (DARD). All data for the first year of the project has been gathered and is now available for use within the Round Robin exercise. The team has been supporting ESA in their cooperation with NASA on the data exchange of NASA's MODIS/SeaWiFS archive and ESA's MERIS archive. The team has also been liaising with ECMWF and the DARD is likely to receive minor updates following discussion with ECMWF.

User Requirements

The User Requirements Document has been published and has been reviewed favourably by CMUG. It is also being reviewed by IOCCG, and the draft report is very positive. Final review is expected in April 2011. Approximately 100 users from Europe, Japan, USA, Canada, South America, China and India completed the on-line questionnaire and fall into two main categories: climate and ecosystem modelers, and those who use the data directly to study long-term (decadal scale) variability in the data, in relation to modulations in the forcing fields. The climate modelers use ocean colour data for validation of model outputs on the distribution of phytoplankton in the ocean. Primary production, information on major phytoplankton functional types, and data on the inherent optical properties of the ocean are also being used increasingly for climate research. The polling of the users has revealed that the requirements vary with application. A challenge would be to meet the diverse requirements of the different user communities. The survey has also revealed that all users place high value on reliable error estimates on a pixel-by-pixel basis. Mark Dowell, a member of the OC-CCI team as observer, participates in the GCOS updating process, ensuring smooth dialogue between the two processes.

Products specification

Ocean colour data are being used to generate standard products such as chlorophyll and inherent optical properties of oceanic waters that are at the heart of the OC-CCI project. At the same time, the user consultation process revealed wide interest in the community in new products that are emerging from ocean-colour data, such as information on phytoplankton size structure and community structure. The first version of the Product Specification Document, which has been finalized, recognizes the diverse user requirements as defined in the URD, and addresses how to meet as many of the requirements as possible within the OC-CCI project, while facilitating future

developments and incorporation of additional products and applications that fall outside the scope of the present project. The team was also involved with the first data standards teleconference and intend to integrate specifications with other ECVs in future versions of the document.

Scientific cooperation

The team attended the Aerosol workshop at DLR, Germany on 18th-20 January. It also attended the MERIS QWG at ESRIN on 4th March and will document the results in a specific calibration technical note that will be distributed to other ECV's. The Science leader presented the project's status at the latest IOCCG meeting in Dartington UK. The team also attended the CMUG meeting (14th- 16th March) at the ECMWF where coordination and synergies among various CCI projects were discussed. This included establishing links with the Earth System Grid project in the US and to produce data for a golden year or month that all ECVs will complete, allowing cross product comparisons. The team has submitted abstracts for presentation at MARCDAT-III and Remote Sensing and Photogrammetry Society meetings. Members of the OC-CCI team were very active participants at the Sentinel for Science meeting at ESRIN on 22 – 24 March.

Next Steps

The main activity for the next 6 months is the Round Robin algorithm selection process, the results of which will be discussed at the next progress meeting. External scientific experts have been invited to help review and foster the project's open and inclusive remit. Updates to the existing deliverables will be made to reflect the findings of the Round Robin exercise as well as the Product Validation and Algorithm Selection Report (PVASR), Error Characterization Document (ECD) and System Requirements Document (SRD).

9 Glaciers_cci (GCOS T2.1)

Project Status

The Glaciers_cci project is on schedule with respect to the project plan. Based on the demands for the forthcoming IPCC report, additional efforts are now being directed to the coordination of compiling a more-or-less complete global glacier inventory by the end of 2011, to have it readily available for the sea-level rise modelling community. It might be required to delay the work on This may mean there is a delay in finalising some of the document deliverables in order to realise these data products.

Data Requirements

Data requirements have been sent to the technical officer; apart from the requested ALOS PALSAR data, no special requirements exist. The work on the related deliverable 1.3 has started, but the document is still in a draft status (ToC with headlines). The baseline data for the project (Landsat scenes from glovis.usgs.gov with L1T geometric accuracy) are all available and will be processed on demand (i.e. after consultation with the responsible GLIMS (Global Land Ice Measurements from Space) regional centre) and as temporal resources permit. Data sets for the elevation change product from altimetry and velocity fields from optical and microwave data for year 1 are also available. Any further missing data sets will be gathered subsequently based on demands of the CRG (Climate Research Group) and the wider glaciological community.

User Requirements

The latest version of the URD considers the feedback from CRG and CMUG and has been submitted for formal review to the technical officer. The collected user requirements resulted from several documents provided by international organizations (GCOS, IGOS), the scientific community (journal papers, IPCC reports), and feedback from the CRG and the wider glaciological community (approached via GLIMS mailing list and Cryolist). We have feedback from about 25 users covering a wide range of disciplines (e.g. glacier mapping, GLIMS and WGMS as KSB, hydro/glacier/climate modelling community, end-users). The major message is: *'please get the global glacier inventory complete as soon as possible'*.

There are no principle conflicts between the different requirements, but products are needed in a variety of formats (e.g. glacier outlines in vector, raster and netCDF). As a couple of tools are available for format conversions, it seems feasible to serve the various needs. The URD has already been reviewed by the KSB WGMS and GLIMS but it is expected that the URD will further evolve through time. With the existing EO data the user requirements can likely be met. As data availability is subject to continuous modification, this statement could not be final, but at the moment no problems are expected. The team looks forward to the availability of the TerraSAR-X / TanDEM-X data.

In regard to the update of the GCOS satellite supplement, the team has expressed the important

need to clearly distinguish ECV Glaciers and Icecaps from the new proposed ECV Ice sheets. Some further comments (e.g. on determination of elevation changes for glaciers and icecaps from repeat DEMs) were also provided.

Products specification

For the PSD a detailed ToC with headlines and topics to be covered has been prepared. At this stage no substantial trade-offs in regard to the user requirements have to be made, as the product specifications as given by IGOS (2007) and CMUG deliverable 2.1 are largely driven by the technical specifications of the respective satellite sensors. It is, however, also clear that for the glacier area product, manual editing is required to meet the accuracy specifications in the URD. The selection of specific regions for product generation is basically user driven and has to be performed in close agreement with ongoing efforts. In this regard, the most valuable input by the users was the up-to-date feedback on currently ongoing data processing. This helped in coordinating the efforts and revising the key regions. A major demand expressed by all users is the fast completion of the global glacier inventory. The CRG (incl. the KSB) will be involved in reviewing the PSD.

For the PSD a detailed ToC with headlines and topics to be covered has been prepared. At this stage no substantial trade-offs in regard to the user requirements have to be made, as the product specifications as given by IGOS (2007) and CMUG deliverable 2.1 are largely driven by the technical specifications of the respective satellite sensors. It is, however, also clear, that for the glacier area product manual editing is required to meet the accuracy specifications in the URD. The selection of specific regions for product generation is basically user driven and has to be performed in close agreement with ongoing efforts. In this regard, the most valuable input by the users was the up-to-date feedback on currently ongoing data processing. This helped in coordinating the efforts and revising the key regions. A major demand expressed by all users is the fast completion of the global glacier inventory. The CRG (incl. the KSB) will be involved in reviewing the PSD.

Major improvements compared to the products currently available will be in the spatially more complete data set that will allow for a more precise calculation of the contribution of glaciers and ice caps to sea-level rise. Apart from spatial completeness, data completeness will also be enhanced by adding topographic attributes to already existing entries. The data standards will follow those specified for the GLIMS database and in GTOS (2009). The well-established shapefile format will be used for vector data and GeoTiff for raster data / images. Though these formats are not consistent with the netCDF format used by the other ECV projects or CMUG, they are shared by the hydrological and glaciological modelling community. This is currently more important as they will perform the climate change impact assessment studies. However, a conversion of final products to netCDF is possible.

Scientific cooperation

Cooperation with other projects and research groups was greatest for the coordination of ongoing and remaining work needed to complete the inventory in the GLIMS database. This work includes the regional centres of Alaska, Canada, and Norway, the projects ice2sea (EU FP7) and CryoClim (ESA), the KSBs GLIMS and WGMS, as well as the work for the next IPCC report (AR5).

The feedback from CMUG was of particular importance as it stressed the forthcoming interest of the climate modelling community in the generated data products. As a direct assimilation of (gridded) glacier information in GCMs is not yet possible, the focus is still on the downstream use of climate model data for hydrological/glaciological models. Nevertheless, the ECV integration meeting was particularly useful to coordinate activities with the Landcover_cci. Here it was decided that the glacier class in their product will be provided by Glaciers_cci. No immediate actions emerged from the CMUG meeting but the overall scientific cooperation helped to efficiently orient the project.

Next Steps

In the coming months the PSD and DARD will be finalized. The project will bring the Glaciers_cci website online and up-to-date and start with the preparations for the round robin experiments (e.g. data base set-up, algorithms, validation data). All data and results will be available online to ensure the openness of the process and the required scientific scrutiny.

10 Landcover_cci (GCOS T.5.1)

Project Status

At this moment, the CCI Land cover project is on schedule with respect to the project plan. No unforeseen problems have been encountered. The URD, DARD and PVP have been finalized; the writing of the PSD is in progress, the round-robin has been launched and algorithms are being developed by the consortium in the light of the URD and draft PSD.

Data Requirements

The last version of the DARD, delivered at the very beginning of March, is now complete. It details the datasets needed as essential input to perform the CCI Land Cover project but also all other products that could be considered to better reach the objectives of the project. Currently, all Cat-1 proposals introduced to ESA have been approved and most of the datasets have been (or are being) acquired. Strong efforts are still required for the SAR dataset and the SPOT 4 validation acquisitions. For the first one, agreement has been found between the consortium and the ESA G-POD platform to support the data processing. For the second one, archive data have been acquired and new acquisitions have been programmed.

User Requirements

The URD was finalized in February. A broad user consultation mechanism was set-up to actively involve different climate modelling groups:

- the “key users”, i.e. partners directly involved in the CCI-LC project (from MPI-M, LSCE, MOHC and CMUG);
- the “associated users”, i.e. users from the climate modeling community not directly involved in the CCI-LC project (a group of 85 users was approached, 15 of them participated);
- “the broad land cover data user community”, i.e. users not directly from climate modelers but the “climate concerned” (372 users participating to the survey, from all continents but mainly from Europe)

The consultation was achieved through surveys, which focused on 3 main ways land cover observations are used in climate models:

- as a proxy for several land surface parameters assigned by Plant Functional Types (PFTs);
- as a proxy for (tracking) human activities, i.e. land use affecting land cover;
- as datasets for validation of model outcomes (i.e. time series) or to study feedback effects.

Next to the surveys, strategic Earth observation documents for land cover were considered and a detailed literature review was carried out.

In general, there is quite a good match among the requirements coming from specific users and from the international institutions. The main findings of the analysis highlight that:

- Both **stable** LC data and a **dynamic** component are expected;
- Consistency** among the different model parameters is often more important than accuracy of

- individual datasets;
- Providing information on **natural versus anthropogenic vegetation**, tracking human activities and defining history of disturbance is of increasing relevance;
 - LC products should provide **flexibility** to serve different scales and purposes both in terms of spatial and temporal resolution;
 - The relative importance of **different class accuracies** varies significantly depending on which surface parameter is estimated;
 - Future requirements for temporal resolution refer to **intra-annual and monthly dynamics** of land cover including remote sensing time series signals;
 - More than 90% of the general land cover users find the **UN-LCCS** a suitable approach for thematic characterization; and this approach is also quite compatible with the PFT concept of many models;
 - Quality of LC products need to be **transparent** by using quality flags and controls, terms of spatial and temporal resolution and including information on the probability for the land cover class or anticipated second class or even the probability distribution function for each class (coming from the classification algorithm).

Most requirements could be addressed in the project. However, the accuracy and stability thresholds exceed the performances of the current land cover classification algorithms. The request for global land cover change information also remains a challenging issue considering the current algorithms and data and products consistency.

Products specification

A first version of the PSD was presented during the third progress meeting and discussed with users and ESA. Based on these comments, a second version was proposed, which provides a more extended description of the products. Most requirements expressed by the users are being addressed by the project. Overall accuracy of 80% and stability of 80-85% have been defined as realistic objectives for the project. Even if such figures are slightly lowered than those required, their achievements still represent a strong improvement with regard to the current products. With regard to the requirement of land cover change information expressed by the users, no specific land cover change product was proposed in the baseline proposal since it requires developing dedicated processing chains. Indeed, simple inter-comparisons of classification products are well known to highlight the land cover classification instabilities rather than the land cover change, the respective land cover accuracy being below the land cover change rate.

Surface reflectance and land cover products will be provided in the NetCDF-3 format. The format will be changed and products will be converted to NetCDF-4 in 2012. The land cover products will also be delivered in the GeoTiff format for specific users of the land cover community. As for the metadata, they will be conforming to the Geography Markup Language specifications. In this way, the CCI-LC project follows the CCI guidelines and should thus be consistent with the other ECV projects.

Scientific cooperation

During the last three months, the project was mostly involved with international LC and climate modeling communities (CMUG and GlobCover users) in order to complete the URD. The last

collocation meeting also offered to opportunity to ensure collaborations with the CCI-Cloud project (interactions for the cloud flag foreseen through the round-robin), to ensure strong interactions with the CCI-Fire project and with the other GlobSeries projects. This should definitely contribute to the land cover product construction at mid-term.

Next Steps

The next 6 months will be dedicated to the pre-processing and classification algorithms development and to the round-robin activity. In this respect, specific attention will be paid to the validation of all developed algorithms (by the consortium and by external round-robin participants) and to a robust and transparent selection of the “best” algorithms. In terms of deliverable, the “Product Specification Document” will be finalized and the “Round-Robin Data Package for inter-comparison and validation”, the “Algorithm Theoretical Basis Document – version 1” are expected to be provided. The “Detailed Processing Chain” and the “Input-Output Data Definition” are also planned.

11 Fire_cci (GCOS T.9)

Project Status

During the last quarter the main activities were the elaboration and completion of the User Requirements Document (URD), the Product Specification Document (PSD), the Data Access Requirement Document (DARD), the Product Validation Plan (PVP) and the first version of the Algorithm Theoretical Basis Documents (ATBDs I,II,III).

Constraints have been raised concerning the provision of data for algorithm development due to the vast amount of input data and the associated time consuming read-in procedures. Instantaneous and intensive effort has been made to extend, intensify and accelerate the transfer rate. Immediately taken actions comprised the upgrading of hardware devices and the prioritisation of study sites.

Data Requirements

The DARD was provided to ESA on the 2nd March and comments from ESA were received on 11th March. The DARD defines all necessary and available satellite input sources, validation and auxiliary data sets for execution of the Round Robin-exercise and the validation and comparison of the final output product. All input data are available at DLR for consecutive and iterative pre-processing procedures. The first packages of data have been provided to the EO project partners responsible for the algorithm improvement and development in order to initiate the Fire_cci project Task 2.

User Requirements

The URD was provided to ESA on 1st March and simultaneously to the Global Carbon Project and the IGBP AIMES Project. The formal review process by the Key Science Body is still pending. The specifications of the URD were identified by circulating a questionnaire to international climate-vegetation-atmosphere modelling and research groups and Earth observation communities followed by a detailed analysis of the user responses. The major applications of Burned Areas (BA) information within the multifaceted end-user communities are monitoring and modelling of carbon cycle, vegetation dynamics and atmospheric chemistry.

The ESA EO satellite mission data archive constitutes a long-term and consistent database for the extraction of information for the generation of global BA products meeting end-user community requirements. Most of the scientific user needs and requirements concerning product types, accuracy, traceability, and data format will be met in the final BA product.

Products specification

The PSD was provided to ESA on 1st March and simultaneously to the GOF-C-GOLD Fire Implementation Team. The formal review process by the Key Science Body is still pending. Based on the analysis of the URD the PSD represents the most critical BA product parameters and its

minimum acceptable accuracy, spatial and temporal resolution. Depending on the final product type the output format will be HDF5 for pixel-based products and NetCDF for grid products. The former are more common to the land community, while the latter is more generalized among the climate modellers, so a balance between the two was adopted. Tools for format conversion will also be provided.

In comparison to existing BA products the fire_cci BA pixel as well as the grid based products are composed of long-term and consistent time series, including detailed data and production traceability and error characterisation. In addition, integration of different sensors will be undertaken.

Scientific cooperation

From the beginning, within the ongoing pre-processing stage, DLR has been in contact with Cloud/Land Cover ECVs concerning long-term stability of the basic input satellite sensors. During the first CMUG Integration Meeting common baseline conditions as well as technical approaches and constraints were identified. In view of this it was deemed appropriate and necessary to intensify the exchange and sharing of information between other ECV teams, in particular, ECVs Cloud/ Land Cover.

Next Steps

In the next quarter the focus will be on augmentation of the pre-processing and provision of adequate and comprehensive data sets for the algorithm development and testing. Every effort will be made to achieve continuous and constant data output following the defined priority settings. A first draft of the agenda of the Round-Robin-Workshop was sent to project partners on 07/03/2011 for comments and suggestions and this will be finalised.

After receiving comments and recommendations on delivered documents all documents will be adapted, amended and issued as an updated version. These finalized documents will be published on the Fire_cci web site. Draft versions of the deliverables have been released on the ECV web site for public access to ensure transparency and to receive further feedback.

12 Climate Modelling Users Group

Project Status

In this reporting period, there has been progress over most of the CMUG project in line with the work plan. The “User Requirement Baseline Document” (URD) capturing the needs of the Climate Modelling and Reanalysis community has been consolidated following continuous discussion with modellers. The “Technical Note on User Requirements & Specifications” has however been delayed due to late delivery of input material by the CCI projects, such as the “Product Specifications” documents. The main event during this period was the “CCI Integration Meeting” (ECMWF, UK, 14-16 March) organised by CMUG and hosted by ECMWF. A brief description of the meeting objective and outcome is provided below.

Data Requirements

The requirements of the CCI projects for ECMWF Reanalysis data (e.g. ERA-Interim), in terms of parameters, observing cycle, time span and coverage, have been partially gathered and are documented within the “Data Access Requirement Document” (DARD) for traceability reasons. Most teams (but Fire and Glaciers) need some reanalysis data to support retrieval and round robin activities (e.g. Ozone, Specific Humidity, Water Vapour). Requirements of the SST and GHG teams have been finalised while the detailed requirements from the other teams are still under consolidation. Mechanisms are currently put in place by ECMWF in order to deliver the data over the internet. It has been advised to make use of a common Climate Data Operator package for interpolation of the ECMWF data at the satellite location in order to ensure some consistency in the procedures.

User Requirements

The CMUG URD addresses the needs of the Climate Modelling and Reanalysis Communities. Organisations operating global climate models and reanalysis are only a few in the world, due to the complexity and cost to operate comprehensive global climate models and state-of-the-art data assimilation systems for reanalysis. Hence, CMUG partners are well placed to provide these requirements as they operate three of the leading global climate models in Europe (e.g. Met Office / Hadley Center, MPI-M, Meteo France) and a widely used state-of-the-art Atmospheric Reanalysis (e.g. ECMWF ERA-Interim).

Requirements from the modelling communities have also been complemented through a questionnaire, sent to 56 selected experts from 46 international organisations. About 34 experts replied to the requirements survey, ensuring coverage of a dozen of climate models, representing a wide range of models complexity (regional and global) and their applications. The information was also refined following extensive discussions with modellers, at a dedicated CMUG meeting at the European Geophysical Union last year, with the IS-ENES consortium during their assembly, the CMUG Integration Meeting in March, and also through direct interactions with GCOS, at the occasion of the GCOS Atmosphere Observation Panel for Climate (AOPC) in February and the via

the visit by staff of the ESA Climate Office to the UK Met Office in March.

The needs of the communities have been articulated in terms of 4 categories: prediction, assimilation, model development, and trend monitoring. Not all the ECVs attract the same interest. For example, glacier is not well represented into global climate models, while clouds and aerosols are a major source of uncertainty and therefore require extensive observation to constrain the models.

The main message is that long-term “trend monitoring” has very stringent requirements on stability and time-span in order to capture relatively small climate signals. For example, several decades of data (e.g. for SST) would be necessary to extract meaningful climate signal. Also it seems that a significant part of the climate modelling community is more focussed on “model development”, which has requirements for process-study somewhat different from long-term monitoring, and therefore not always in line with GCOS requirements. There is also a strong requirement for a comprehensive characterisation of the error per sensor and per pixel (more difficult to quantify errors of merged products), and its spatial pattern (co-variance matrix), in particular for applications using assimilation (e.g. reanalysis). Finally, it is important to recognise that both low-level (e.g. Level 1) and high-level (e.g. Level 2/3) EO products are increasingly needed by these communities. Regarding joint requirements across ECVs, at least a “golden year” (see section 3) would be needed as a first step in order to bring a proper climate perspective to the data quality across ECVs.

Recognising the evolving needs of the community, CMUG will update the document as new information and needs become available.

Scientific cooperation

CMUG has been active in international cooperation. The CMUG team took part in the following meetings (outlined in the table below) with the climate research community (two of these with a dedicated CMUG presentation), to further build / consolidate links with CCI projects (e.g. GEWEX Clouds), relevant projects (e.g. Globalbedo), the IS-ENES climate modelling community and GCOS (e.g. AOPC).

CMUG has also continued interacting with CCI projects, also through participation in dedicated meetings (e.g. with SST in Exeter, with Ocean colour in Plymouth 17 January, with Aerosol in DLR 18-19 Jan, with Sea-Level in Toulouse on 20-21 January).

The main interaction with the team was achieved through the organisation by CMUG of the “CCI Integration Meeting” held at ECMWF, 14-16 March. The meeting was well attended with 44 experts from CMUG, ESA, all the CCI projects, and researchers from international organisations and projects.

The objectives of the meeting were to (i) check how ECV project URDs are consistent with the needs of Climate Research Groups in the context of CMUG needs and GCOS requirements, including source traceability, (ii) First look at ECV product specifications if available (and check that the proposed products will be of use by Climate Research groups in their applications), (iii) allow ECV teams to assess collectively how their projects address the integrated perspective for

Meeting	Dates	Location	Actions and outcome
GCOS satellite supplement expert meeting	10-12 Jan	Geneva	Informal representation of the CCI and CMUG.
GlobAlbedo project meeting	11-12 Jan	Hamburg	MPI-M hosted this meeting. The project products and timeline are in good alignment with the CCI activities and the usability of the GlobAlbedo data set in the scientific exploitation of cci_landcover data will be explored.
EUMETSAT CDOP-2	31 Jan	-	A link to ESA CCI initiative was encouraged for all EUMETSAT SAF's.
ILAMB meeting	24-26 Jan	Irvine, USA	Presentation on the CCI including progress and aims. ILAMB = International Land Model Benchmarking, see www.ilamb.org
IS-ENES	2-4 Feb	Hamburg	Informal interaction with delegates about CMUG and CCI.
GCOS-AOPC (delayed from April 2010)	7-11 Feb	Geneva	Gave a presentation on the CCI including CMUG.
GEWEX/ESA Due GlobVapour Workshop	8-10 Mar	ESRIN	Informal interaction with delegates about CMUG and CCI.

consistency between the ECVS to avoid gaps, (iv) discuss how to deal with uncertainties in products (how to capture and describe them for product users), (v) develop / finalise the ECV projects data needs for ECMWF reanalysis data.

The meeting included a mix of presentations by CCI teams but also by external experts addressing a variety of scientific challenges, such as Climate Modelling Needs (Marco Giorgetta, MPI), Reanalysis (Dick Dee, ECMWF), CMIP5 model assessment (Robert Ferrao, NASA-JPL), IS-ENES network (George Tselioudis, Academy of Athens), and SPARC Chemistry Model Assessment (Veronika Eyring, DLR).

During working group discussions, it was acknowledged that the datasets generated in the first phase of CCI cover limited time periods for most of the ECV projects. This implies that the “climate perspective” and “across-ECV” consistency check to be performed by CMUG will be difficult to fully achieve due to the lack of overlap between data sets. It was therefore recommended to identify a “golden year” for re-processing all ECVs. Other recommendations to ensure consistency were related to the use of common data, both from EO sensors (e.g. same Level 1 of ESA and Level 2 of non-ESA data across projects) and ancillary data (e.g. same procedure for interpolating ECMWF data on satellite level). It was also stressed that the CCI projects should clearly identify the added-value of their products compared to existing products in order to foster their exploitation.

Next Steps

The main activities of the next quarter, will be the participation of the CMUG team within:

- WCRP-GCOS Observation & Assimilation Panel (WOAP) meeting held in ESRIN (18-20 Apr). The meeting will produce a report on quality assessment of existing ECV satellite-related data sets, some of which addressed in CCI (such as Clouds, Sea-ice, Soil Moisture, SST).
- Annual Project Review at ESRIN (21 April)
- Visit to NASA-JPL in May to re-inforce links with the NASA initiatives, in particular with regards to CMIP5
- Continued discussion with IS-ENES, CCMVal.