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DOCUMENT

Sixth CCI Collocation Meeting Report

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Reference	EOP-SEC
Issue/Revision	0.0
Date of Issue	
Status	Draft

APPROVAL

Title Sixth CCI Collocation Meeting Report	
Issue Number 0	Revision Number 0
Author Catherine Downy & Anne Stefaniak	Date
Approved By	Date of Approval

CHANGE LOG

Reason for change	Issue Nr.	Revision Number	Date

CHANGE RECORD

Issue Number	Revision Number	Reason for change	Date	Pages	Paragraph(s)

DISTRIBUTION

Name/Organisational Unit

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1 SCOPE

This document summarises the outcomes of the sixth Collocation meeting of the ESA Climate Change Initiative, held at ESRIN, Frascati, Italy on the 29th September – 1st October 2015.

The collocation meeting brought together representatives of all fifteen CCI project teams. The main focus of this collocation meeting was to assess the current achievements of the CCI programme thus far including exploitation of the data and consider future evolution of the project with ECVs to be incorporated as part of CCI+.

The output of the collocation meeting is recorded within this report as a collective assessment of the status of the CCI and a series of key actions, as formulated by the collocation participants, drawing upon the collective expertise of all CCI project teams.

This report is intended to assist the CCI teams to pursue their projects and generate operational ECV data products in a consistent manner during Phase 2, as explicitly required by GCOS.

2 INTRODUCTION

The CCI programme objectives and scope are described in the document, “ESA Climate Change Initiative: Description [EOP-SEP/TN/0030-09/SP]”.

The work to be carried out on each ECV is specified in the Statement of Work for the CCI, “ESA Climate Change Initiative Phase 2 Statement of Work” [CCI-PRGM-EOPS-SW-12-0012].

The project scope and team composition for each of these projects is described in the document “ESA CCI Projects Description” and key documents can be found on the CCI website: cci.esa.int

At the time of the 6th Collocation meeting the following fourteen ECV projects were in place:

GCOS ECV	CCI Project	Science Leader
A.6	Cloud_cci	Deutscher Wetterdienst (<i>R.Hollmann</i>)
A.7	Ozone_cci	BIRA-IASB (<i>M. Van Roozendael</i>)
A.8	Aerosol_cci	DLR / FMI (<i>T. Popp / G.De Leeuw</i>)
A.9	GHG_cci	U.Bremen IUP (<i>M. Buchwitz</i>)
O.1	Sea_Ice_cci	NERSC, (<i>S. Sandven</i>)
O.2	Sea_Level_cci	LEGOS-CNES (<i>A. Cazenave</i>)
O.3	SST_cci	U. Edinburgh (<i>C. Merchant</i>)
O.4	Ocean_Colour_cci	Plymouth Marine Laboratory (<i>S. Sathyendranath</i>)
T.2.1	Glaciers_cci	U. Zurich (<i>F. Paul</i>)
T.2.2	Greenland_Ice_Sheet_cci	DTU Space (<i>R. Forsberg</i>)
T.2.2	Antarctic_Ice_Sheet_cci	U. Leeds (<i>A. Shepherd</i>)
T.5.1	Landcover_cci	Université Catholique de Louvain (<i>P. Defourny</i>)
T.9	Fire_cci	U. Alcalá (<i>E. Chuvieco</i>)
T.10	Soil_Moisture_cci	TU Vienna (<i>W. Wagner</i>)

Through a separate ITT, the cross-cutting project, the ‘Climate Modelling Users Group (CMUG)’ was set up with the aim of ensuring integrated feedback between the ECV projects and the global climate modelling community. The CMUG provide a structured forum for guiding the ECV projects on the use of the data sets, discussing intercomparison methods, error characterisation, etc. and helping the projects to achieve the set performance targets for each ECV.

Each CCI project team typically includes experts from ten or more research organizations, including a Science Leader and a Project Manager, and contains three sub-groups. The sub-groups are organised into: specialist scientific expertise in EO; a Climate Research Group, including climate modellers; and system engineering experts.

Each science leader will ensure the overall scientific integrity of the project throughout the project. The science leader will also ensure that each CCI project maintains effective working links to the appropriate international climate science programmes, initiatives and projects, and to other CCI project teams. Each science leader is directly supported by a project manager who ensures communication within the project team, maintenance of schedule, tracking of actions, deliverables and reporting to ESA.

The projects are at varying stages. The CCI project deliverables for Phase 1 and Phase 2 have been specified in accordance with the “Guideline for the Generation of Satellite-based Datasets and Products meeting GCOS Requirements” (GCOS-129, March 2009). All completed documents and data products can be found on the project websites, accessible via the main CCI programme homepage.

3 UPDATE ON THE CCI PROGRAMME

3.1 Activities within the CCI Programme

An update on the progress of the CCI programme was given by Maurice Borgeaud. Phase one of the CCI programme is now complete with many ECVs working on Phase 2 which will be completed by 2017/2018. The programme is currently looking ahead at the CCI+ programme which will likely evolve with new ECVs, including data from the Sentinels potentially starting at the beginning of 2018. Many of the current ECVs have developed standardized global multi-mission ECV time series with the inclusion of more cross-ECV projects. The CCI Visualisation Tool is now fully functioning and the CCI app is currently being developed. The Living Planet Symposium 2016 is currently being organized and is planned to incorporate CCI projects within the various sessions.

3.1.1 COP 21

The CCI programme is preparing promotional material for the 21st Conference of the Parties (COP 21), where many countries are aiming to get a global agreement on climate change. ESA participates in the COP meetings with an observer status and will have a delegation at COP 21. There will be an ESA side event on “Supporting National Forest Monitoring with Earth Observation” on the 3rd December with the potential for another one with the European Commission. There will also be a small exhibit inside the UNFCCC compound at Le Bourget. There will also be articles on space and climate in the official RTCC magazine distributed at COP 21 and interviews on RTCC TV.

From 5-6 December, at 10:00 to 20:00 there will be an allocated area to host the CCI Visualisation Tool during COP21 at the Grand Palais. One of the animations showing the CCI data sets will be shown in the ESA ‘data cube’ at the Champs-Élysées in Paris. There will also be a resources page on the CCI website.

Key messages from ESA:

- Satellite observations provide vital information to politicians on the extent of climate change, climate mitigation and adaptation (e.g. rising sea levels, Cryosat year ice loss monitoring).
- Space Agencies worldwide are contributing, via CEOS, towards the delivery of a global observation system for climate.
- Satellite observations have enabled major advancements in climate science and models and are a key component to the IPCC assessments.
- ESA, Eumetsat and the European Union have invested heavily in a new generation of operational satellites (Copernicus, meteorological) to support climate action over the coming decades.
- Research satellites are providing the insights into climate change processes and help improve climate models.

- The free and open data policy will ensure that developed and developing countries have equal access to precise, timely and global information.

3.1.2 CCI Open Data Portal

The CCI Open Data Portal aims to provide a central point of harmonised access to mature ECV datasets. The project has been running since May 2015 and has developed a FTP site, which is currently available with Phase 1 and early Phase 2 data. The portal will update all CCI websites to a standard format providing free and open access to data and documentation. For those who optionally register their details when downloading the datasets, automatic email updates providing information on updated datasets and new issues will be sent. The CCI Open Data Portal will be consistent with the C3S and GCOS initiatives. The portal will provide a central data archive and metadata catalogue. Improvements will also be made to the CCI programme website with all documents and data access in one central point consistent across the CCI project team sites.

R1: Input is required from the CCI project teams to communicate with the data portal team to develop consistent websites

3.2 Coordination with other activities

The CCI programme has been responding to GCOS requirements with a coherent contribution from European participations. The programme has also been active in CEOS WGClimate collaboration working to link each of the ECV inventories to the GCOS requirements. The Climate Office presented the CCI Visualisation Tool and work to the Department of Energy and Climate Change who were very interested in the material developed for COP-21. The CEOS working Group will be chaired by Europe and meetings have been held with EUMETSET to accommodate this with ESA will chair for the first half followed by EUMETSAT. A four year implementation plan ins being prepared and will be presented at the CEOS plenary in November.

In addition, ESA and NASA have agreed a second phase of the successful mission IMBIE to go ahead. It was cited 21 times in the IPCC 5 assessment report and over 360 citation in peer reviewed literature. The next phase will include annual assessments for 2016, 2017 and 2018.

3.3 Feedback from the Science Leaders and System Engineers

Current plans include to work on joint project papers with the potential for papers to contribute to the special issue in Remote Sensing titled 'Climate satellite data records and applications' to be published in autumn 2016 (Deadline 01.01.2016). A paper on uncertainty will also be submitted to BAMS.

Obs4MIPS - Some points have been raised regarding security issues blocking the easy submission of data to the CCI Open Data Portal. Issues were also raised regarding the spatial resolution of the data.

The Sea Ice project will now focus on R&D based on the AMSR data while OSI-SAF will focus on the SSMI data in agreement with EUMETSAT.

The System Engineers had a long discussion on DOIs, which is being supported by the Open Data Portal team. Sentinel data is ready to start being included into various projects. However, the large data sizes are a concern for some. Other issues addressed include data formats, metadata and masks. Some suggestions included to support Obs4MIPS through the CCI Open Data Portal. There is a need to decide on an agreement for CCI wide principles for constructing DOIs with support from the CCI portal.

R2: Collaboration is required to work on joint papers to contribute to the Remote Sensing Special Issue

R3: Decisions on an agreement for CCI wide DOI construction is recommended

4 ECVS: WHAT IS OPERATIONAL AND WHAT STILL REQUIRES R&D?

4.1 Copernicus Climate Change Services (C3S)

Plans for the new Copernicus department (CAMS) to be based at ECMWF were presented by Dick Dee. The service will combine operational ECV data sets including CCI ECVs. Questions arose regarding the success of CCI ECVs as proof of their success. The service will combine a climate data store, sectoral information system and evaluation and QC section. Outreach and dissemination will also be included in the service elements. C3S will fund production aspects rather than research and will therefore only incorporate CCI ECVs once operational.

4.2 View from the projects

Operations are inherently embedded within the research; however, for the purposes of funding, operational and R&D are categorized separately. Feedback from each of the projects will be put forward to C3S.

Soil Moisture - Maturity matrices can help define what is operational. Products are moving closer to operational in Phase 2. R&D includes requests for higher resolution data with inclusion of new sensors.

Fire – The sensors currently being used were not originally developed for burnt area mapping. The products are currently meeting GCOS requirement but not at the 15% accuracy and therefore still needs R&D. There is a need for higher resolution data to include the importance of small fires.

Landcover – Some MERIS and ASAR products are already operational including the land cover and global water body map. R&D still includes modeled annual change for water body maps including the incorporation of Sentinel 2 data.

Ice Sheets Antarctica – Some products will be operational straight away using processes developed by Ice Sheets Greenland. R&D includes the incorporation of new sensors and missions and the ability to automate grounding line detection which is being investigated.

Ice Sheets Greenland – Phase 2 will include both science based and operational practices. As part of the project improvement to the resolution of SEC would like to be incorporated.

Ocean Colour – Open waters, IC-CCI and chlorophyll area already considered operational. R&D includes optically complex waters including coastal and river outflows. Now need to include new sensors and important to stay up to date.

Sea Level – Some aspects are already operational, however, now need to work on historical data and new sensors and system development with R&D.

Sea Surface Temperature – Need improvements from a variety of sources. Ongoing R&D includes extending the time series backwards to 1980 with the inclusion of passive data.

Sea Ice – Main SIC product is now operational with R&D focusing on the SSMI data. Near-real time data with a 1-month delay is being developed. R&D includes improvements to accuracy, sea ice snow depth, and uncertainties. SI drift will start next year.

Glaciers – Some aspects operational but R&D is ongoing and could therefore continue in both CCI+ and C3S but there is a high demand for further R&D with all products.

GHG – There is a strong link and cooperation between R&D and operational. Based on the criteria GHG is now operational but R&D is needed to further improve the algorithms and solve future problems including the addition of new sensors.

Ozone – Constantly need reprocessing to include new data but the products are now generally matures and close to being operational. The inclusion of Sentinel 5 Precursor data will require specific R&D.

Aerosols – Some products are now operational and responding to GCOS requirements. R&D is focused on consistency and extending the time series.

Clouds – Will be operational by the end of the project providing regular CDR updates however processing is not yet finished. Need to use long-term data with the inclusion of heritage sensors and future sensors.

Overall many of the projects already maintain a number of operational ECVs; however, they need to be regularly reprocessed to incorporate new data, including Sentinel data, and to extend the time series. Work is currently continuing on finding the best possible algorithms and processes with the data.

R4: A more formal coordination between CCI Ocean ECVs and the Copernicus Marine Service and Climate Service should be established. In particular for the reprocessing of ocean ECVs.

5 CCI OPEN DATA PORTAL AND TOOLBOX

5.1 Topics

DOIs – The Open Data Portal will provide DOIs to CCI data on the central archive. STFC-CEDA can assign DOIs to data in the archive. This will include links to publications, documentation, and web pages from the landing page of the website. The DOI indicates that the data is stable (not going to be modified) and complete (not going to be updated). Users must acknowledge use of the data and cite any relevant dataset DOIs.

Obs4MIPS – Observations for Model Intercomparisons is an activity to make observational products more accessible for climate model intercomparisons. It will produce a curated set of observations that are recommended for use in major climate modeling initiative like CMIP5/6. It is a key goal of the CCI programme to provide high quality data for climate modeling. So far some ECVs have started the submission process including aerosol, but most haven't with the majority committed to doing this in Phase 2. The data portal will help this process with ocean colour doing a trial run in September/ October 2015. The data portal team will create a rollout schedule to provide technical support to ECVs and work out what the ECVs need to do to the data for submission. The portal will provide the metadata and publish and maintain the converted dataset on the ESGF and Obs4MIPs index. They will also produce a tech note describing the products and comply with technical/ format requirements. The data must be CF-compliant with one variable per file in NetCDF v3 format.

Website support – The data portal team will be responsible for maintaining and improving the CCI website such as it becomes the web front end to the portal. They will guide and achieve a consistent style and content across the CCI team sites. Comments/ questions/ interaction is very much welcome to help shape the support required.

CCI Open Data Portal Evolution – There is a suggestion for flagship datasets to aid simplicity for users; should the teams identify which of their products should be the flagship datasets? In addition the team will provide quicklooks for all aggregated CCI ECV products with small picture files (JPEG, PNG).

Beyond the CCI Open Data Portal – Possible future data exploitation platform and the portal team are collecting requirements from the community including interviews and an online survey. May result in no action, adapting or developing existing systems, or a new system to be built.

R5: Feedback is required to the CCI Data Portal Team

6 CCI ACHIEVEMENTS

CCI achievements were discussed for each of the projects. A summary of the main points from each project is detailed. Data from each project has been incorporated into the CCI Visualization Tool and will also be developed with the iPad version.

CMUG – Data has been analysed for each of the CCI projects with the exception of the CMUG SST, however, some inter-comparison studies between ocean colour and SST have been undertaken. Data comparison from previous ESA projects has also been incorporated including comparisons between Globcover and Landcover highlighting obvious differences. Results are available on the website with the next CMUG meeting planned for April 2016 in Munich.

Cloud – Phase 2 is in full operation including incorporation of heritage AVHRR data. Some work has begun looking at multi-ECV investigations correlating the ENSO index with cloud fraction anomalies. Work is progressing on satellite simulator in order to evaluate models with satellite observations. Questions arose regarding the drift in cloud cover for AVHRR data requiring orbital drift correction.

Ozone – Data is now freely available to the public on the website combining multi sensor data. The data has been implemented in the WMO Ozone assessment report (2014). Work is ongoing to analyse regional and long-term trends. Currently over 30 publications in peer-reviewed journals.

Aerosol – Issues have arisen with the project regarding validation and use of comparative datasets. Missing or incomplete data is also influencing the data. Now have 2 Living Planet Fellows working with the aerosol data.

Greenhouse Gases – Data is currently available on the website and will continue to be updated and re-processed. The next version is due in April 2016. CO₂ monthly fields are sparse and need good algorithms to reduce the uncertainty of the land-sink.

Sea Ice – Work is now focusing on the AMSR data whereas the SSM/I data is being developed by EUMETSAT OSISAF. Big improvements on the uncertainty estimations with pixel scale uncertainty values. The next phase will improve the resolution of the data from 2010. Work is ongoing with the ice thickness data along with the development of an Antarctic SIT product.

SST – Data is available and work is ongoing to produce 0.1 K accuracy and minimize biases. CCI SST is being incorporated into a number of projects including H₂O₂ EUSTACE, LST, and a switch from the use of HadISST to CCI data with a key benefit of improved AVHRR products. Gaining wider user base.

Ocean Colour – Provides daily to monthly composites from 1977 to 2013 with over half a million files currently downloaded by users. Potential for a cross-ECV project with Aerosol looking at chlorophyll concentration and AOD on a global scale.

Glaciers – 3 data products are currently available. Data input has been developed into the Randolph Glacier Inventory / GLIMS, and the most downloaded paper in cryosphere history (Gardelle et al., 2013). Potential for collaboration within the sea level budget project with Ice Sheets and Sea Level.

Land cover – Next data release this year including some fixes for lichen and local area. User downloads show relatively few downloads for the uncertainty data. Glacier outlines from the CCI project already form part of the land cover product.

Soil Moisture – CCI data has been incorporated in the NOAA Climate.gov State of the Climate in 2014 information. There are currently over 1800 users with a large majority based in the US.

Ice Sheets –(Greenland) – Five data products have been produced including a time series of calving fronts for over 20 major outlet glaciers. Included water equivalent data. Current data users include glaciologists, ice sheet modelers, national authorities and stakeholder and the general public.

Ice Sheets (Antarctica) – Not currently in the data production phase but the round robin is underway with initial products to be generated with existing algorithms from Ice Sheets –Greenland. Investigating methods of automating grounding line location.

Fire – Data is now available dating back to the early 1980's. Data downloads from 41 researchers in 19 countries. Phase 2 will include the generation of small fire database which account for 27% of all burnt areas.

Sea level – The next data release is due soon with an extension available next year. User numbers have significantly increased for 1 year. A full reprocessing is planned in June 2016 covering 1993 – 2014. Further developments are needed in the Arctic ocean and coastal areas.

All projects have developed better algorithms and gained a better understanding of the uncertainties and inconsistencies within the data. Work is ongoing throughout Phase 2 and will continue to extend the time series and improve the algorithms and data products.

7 IMPROVING EXPLOITATION OF CCI DATA

One of the aims of the meeting was to aid discussion on ways to improve the exploitation of CCI data. This was split into various sections including exploitation of the cryosphere, GHG and fire data, and feedback from the Living Planet Fellowship workshop.

Points that arose included a funding hiatus which could be resolved with the integration of multi-ECV projects. More papers should be coming out with reference to the use and exploitation and development of the CCI projects in accordance with the production of complete time series. A new Nature journal on datasets and cross-cutting issues in research should be addressed with regard to the CCI data including projects such as the sea level budget and global carbon cycle. Many cross-ECV projects are being carried out within the Living Planet Fellowships exploiting and highlighting the use of the data.

Questions as to whether CMUG can do more to independently validate the data sets and whether other climate researchers should be included in CMUG were also discussed. Other datasets CCI is in competition with should be compared to evaluate models and force high resolution modeling in Phase 2.

The use of trailblazer users has been tested but has high overheads engaging with users and is time consuming with little input from data users. Suggestions for the Living Planet Fellows to support the trailblazing were raised. Links between CMUG and the CRG's may also prove to be a useful connection that will demonstrate the merits of the models.

The LPF workshop highlights some issues regarding the ease of accessibility of the CCI data. In future this should be easier with the CCI Data Portal and will significantly reduce the issues, which previously arose; including restricted access, no standard download and dealing with error covariance's with different grids.

Many of the LPF projects are multi-ECV and working alongside CCI project teams. The 2015 Living Planet Fellowship call has been successful and new candidates will be appointed soon.

8 UNCERTAINTIES AND CONSISTENCIES

Feedback from the session on uncertainties and consistencies were provided by Chris Merchant and Adam Povey. Error propagation approaches to uncertainties have practical limitations to be faced but the distinction between the two had improved. Different types of uncertainties and characterization of uncertainties vary depending on the temporal and spatial scales. Calculating uncertainties for a long-time series is a challenging task and needs to be provided when adding new data including new sensors. Sentinel 3 data is likely to be difficult to work with through error propagation.

Consistency is an issue within the ocean colour project requiring inclusion of data from other ECVs (SST/SICCI) within missing data due to the impact of aerosol correction of water. The sea ice edge is an important region for investigating biomass blooms. First need to identify the inconsistencies. Discussions as to whether consistency can be estimated including known unknowns and unknown unknowns along with discussions regarding whether estimating errors through estimation or error propagation was better.

9 CCI+ THE EVOLUTION OF THE PROGRAMME

9.1 GCOS update

An update from GCOS was provided by Pascal Lecomte. The current activities not only cover the atmosphere, land and ocean, but add to the definition of cryosphere, hydrosphere and the importance of global cycles. Land surface temperature will become a new ECV in the future phase of CCI+ (to be decided after the ministerial in December 2016). GCOS is focused on ECVs at the global scale but there is also a requirement for more regional scale data.

9.2 Sentinels update

Sentinel 1: The open data flow was created last year with data being used by the Marine and Emergency Copernicus Services. A full coverage of Europe is provided every 12 days including the central Arctic. Sentinel 1B is under development and due for launch March - May 2016.

Sentinel 2 has been launched and initial images have been received (July 2015) from the multi-spectral instrument. Data can be available up to 24 hours after acquisition.

Sentinel 3 is due to be launched on 10th December 2015 and is ready for launch with some minor problems to address. Cooperation with EUMETSAT in the operations phase which will pass over to EUMETSAT once it is fully operational. Data access will be the same as for Sentinel 1 and 2 via the Sentinel data hub. This will be a rolling archive with the most recent data. Sentinel 3B is due to be launched 18 months after 3A (~June 2016).

9.3 CMUG science perspective

CMUG plan to continue work with CCI+ using modeling assessments of new and updated CCI ECVs. This will include assessment of CCI data against external user requirements including C3S. Global assessment of ECVs may help aid cross-ECV investigations (e.g. Fire, SM and Biomass) and consistency between ECVs. CMUG will help promote cross-ECV studies and the use and reliability of CCI data with reference to research needs identified in IPCC AR5. Modeling enables gaps in the data to be filled however there is still a need to account for external user requirements. Collaboration is ongoing with other projects and initiatives including Clic.

Copernicus are not undertaking research and development and this will be covered by CMUG. Focus will be on new areas of expertise including cryosphere.

10 POTENTIAL NEW ECVS

Potential ECVs have been identified with reference to the CCI+ programme. Guest speakers were invited to introduce the following ECVs as potential projects in accordance with the CCI programme.

10.1 Lakes

Lakes are an important component of the water cycle with water volume relating to river runoff, precipitation, evaporation and outflow. Lake volume and temperature change is an indicator of climate change and global warming. Most models do not currently include them as part of the global hydrological cycle but they are important to include on a global scale in GCMs. Monitoring of lakes will aid better representation of prediction of the hydrological cycle. There are multiple lake parameters measurable from space (lake level, area, volume, surface water temperature, ice formation and break-up and ice duration). GCOS has already shown an interest selecting 79 lakes to be monitored in 2020 with SWOT.

10.2 Ozone and aerosol precursors

Precursors to support existing aerosol and ozone ECVs including short-lived trace gases, air pollutants and precursor emissions to better quantify tropospheric ozone and secondary aerosols. Develops on from the ESA DUE GlobeMISSION. Tropospheric ozone and secondary aerosols including transport between the stratosphere and troposphere will be covered. It is important to account for secondary formation of aerosols including nucleation growth into aerosols calculated as nanometers and smaller. They are important as they inform us about trends in pollution and whether policies are effective. Instruments to use include OMI, GOME-2, SCIAMACHY and others.

10.3 Sea state

Sea state, or ocean waves, is usually defined by the elevation spectrum and whitecap properties. The waves exclude tsunami's and are generated by winds. They can be measured using altimeters since 1993 based on the Globwave project as precursor and including Sentinel 1A data. The wave climate community is now part of IPCC. More work is needed on extremes including tropical storms and the interaction with other ECVs (e.g. sea ice). The ECV will include ocean waves, swell and wind speed. It is important for the shipping and oil/ gas industry and is not currently in GCOS information.

10.4 Biomass

Biomass analyses will address key science questions including land use change, ecological processes, climate-carbon coupling earth system model evaluation. Biomass is linked through the global carbon cycles including fossil fuel burning, biomass burning and land-use change flux. The biosphere acts as an important carbon sink with deforestation an important influence on this carbon sink. Biomass is 50% carbon but is difficult to measure. The ECV would cover net primary production, biomass growth, removals from fire etc. incorporating Sentinel data.

10.5 Land surface temperature

LST is a key variable in the land atmosphere transfer and describes the surface state. It is a different variable to surface air temperature and plays a different role; however, the variability in LST and SAT are closely linked. It is a key parameter for evaluating Earth System Models and would provide higher resolution

information on air temperature estimated using surface skin temperature from satellites. To meet climate user needs for long, homogeneous, sub-daily, <0.05 degree resolution with split uncertainty components using a combination of available sensor types are required.

10.6 Snow and albedo

Snow and albedo is an important component to understand, sea ice with open water and ponding has different albedo up to 1.8 – 3.6 times increased in absorption. Increased albedo in high latitudes results in increased melt rates. The Greenland Ice Sheet is absorbing more energy increasing surface melt. People are interested and want to know what's happening, hence there is a call for the data. The ECV can be developed on from GlobSNOW, however, this did not cover albedo. Snow surface temperature is important from H2020 EUSTACE. There is a need for more data including snowline, snow mass balance on land ice, and in mountain regions, on sea ice and lake ice and melt rates. Applications include change detection, transient climate model evaluation and data assimilation into melt models (DMI HIRHAM5).

10.7 ECVs in the stratosphere

The new definition of stratospheric ECVs includes high-vertical resolution ozone, water vapour, aerosol, transport tracers and temperature from the upper atmosphere to the stratopause. Long-lived GHGs in the stratosphere affect both local temperatures and surface climate. GHGs from tropospheric sources are destroyed in the stratosphere, affect chemistry and impact the natural abundance of the ozone layer. Stratospheric aerosol is considered in total radiative forcing calculations and is important to understand interannual variability; contributing up to a quarter to the hiatus in global warming as indicated by the IPCC. We need them to understand climate variability, trends and mechanisms that drive them. Ground based observations are limited in spatial and temporal coverage and require global satellite based data.