→ CLIMATE CHANGE INITIATIVE

fire_cci Newsletter

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It is generally accepted that between 25% and 40% of greenhouse gas emissions are related to fires. Emissions resulting from fires are therefore a highly relevant factor in climate change .

In this issue:

Dr. Emilio Chuvieco, scientific leader of the project talks about the opportunities and challenges associated with fire_cci

Dr. Emilio Chuvieco, has worked with remote sensing of fire events for 25 years. He has, for example, coordinated projects relating to fire risk evaluation and post-fire assessment. Here he explains the key tasks and main benefits of the project.

As could be clearly seen during the 2010 summer in Russia, fires can affect property and the health of people across large areas. But what role does fire play in climate change research?

Fire has important regional implications, as could be seen in recent years in Russia, Australia, California and Greece. Such extreme fire seasons have had severe impacts on lives and properties. But fires are also a global issue, since they appear in a wide range of ecosystems. About 30% of the global land mass is affected by fire to some extent. Fires can occur periodically, in line with climatic cycles or annually in some tropical savannas.

Fires affect global climate change as they influence global carbon budgets and greenhouse gas emissions. Especially with regard to deforestation, the use of fire is very important in the tropical regions and also has an impact on biodiversity. Fires have very important implications with regard to greenhouse gas emissions. Estimates vary, but there is a general consensus that between 25% and 40% of emissions are related to fire. So, fire has a very important role in relation to greenhouse gas budgets. Fire-related emissions are therefore a highly relevant factor in climate models.

Fire_cci science leader Dr. Emilio Chuvieco (University of Alcalá de Henares)

Fires are also affected by global change, and global warming is expected to change fire regimes in many parts of the world.

What are the recent trends in fire activity and how are fire regimes changing globally?

Fire is a natural process. Many types of vegetation are actually adapted to fire and need fires for their natural processes. But the positive or negative impacts are very much associated with the adaptation of actual fire regimes to natural fire regimes.
Traditional fire regimes are affected by climate cycles: when the climate becomes warmer, fire seasons tend to be longer, fire severity increases and fires appear in new areas. This is what we are observing in recent decades, in particular in terms of the occurrence of severe fire seasons and the occurrence of fires in areas that are not adapted to cope with them, such as rainforests. A number of scientific papers have recently emphasised the relation between earlier snowmelt and an extension of the fire season, especially in boreal forests.

What are the actual scientific questions relating to fire that need answering?

There are many open scientific questions to answer concerning global fire activities. The first one would be the actual extent of fire activity and how much area is really affected by fire. There is still considerable uncertainty in this respect. The amount of biomass actually consumed in an area can vary considerably depending on the pre-fire biomass and the fire behaviour. In other words, the biomass actually consumed by fires is not known very accurately.
Another question relates to the combustion efficiency, which is the ratio of CO_2 to CO or other carbon compounds released during a fire. This factor influences the type of emissions derived from fires and also the effect of the emissions on atmospheric chemistry.
One of the goals of the Fire_cci is to provide more precise estimations of burned area and to determine what uncertainties exist with regard to current global burned area products. We want to know how these uncertainties affect the products planned for generation in the project and how these uncertainties can be eliminated or at least reduced.

What is the current situation in the burned area data sector?

There are a number of fire databases in existence in developed countries, but most countries do not have reliable fire statistics.
Some global burned area datasets exist as well, but these have a very wide range of estimates carried out in different ecosystems. For estimates, there is also a scale dependency, as shown for example in a recent study by one of our collaborators. There is also a varied range of estimates relating to the amount of gas emissions, with different levels of spatial resolution.
In addition, we do not have long and reliable historical time series of global burned areas, which makes the analysis of changes in fire regimes more difficult. We have data for some countries but large areas of the world have very little information available. Even countries that have good fire statistics gathered using ground survey means still have a lot of inconsistencies, e.g. in terms of fire coordinates.

What are the main goals that you want to achieve in the fire_cci project?

We will redefine user needs relating to global burned area products, particularly climate modellers' needs but also the needs of users from other communities, for example in the field of deforestation or civil protection agencies. Once the data are processed, climate modellers will test the burned area products output by the project in a set of climate and vegetation models.
The project aims to develop methods for generating long-term and reliable global databases of burned areas. The project will rely on European sensors, mostly at coarse resolutions: A(A)TSR on board the ERS and Envisat, VEGETATION on board the SPOT-4 and 5 and Envisat-MERIS data.
The pre-processing part of the project is very important as we cannot rely on general pre-processing chains. This is because we will be looking at very low radiance levels where we need to be sure that there are no mix-ups with water, clouds, snow and topographic shadows.
We need to be very strict with regard to geometric correction as well. This will involve some challenges but we hope that we can collaborate with other projects in the CCI programme that have similar goals.
For the algorithm development part of the project we will make use of new approaches based on the synergic use of thermal and reflectance data. For MERIS data, for example, there is currently no algorithm available that has been tested globally, so we are going to develop algorithms for the other sensors and compare our results with results from already existing products. Our results will be compared with existing algorithms in the round robin exercise. The best approach identified in the round robin exercise will then be implemented in the processing chain.

What is the structure of your project team?

Our team consists of 10 partners, all with long experience in their respective fields of activity. I will lead the team's scientific activities, with support from a project manager from GAF AG, Germany who will provide project management expertise. This particular configuration will ensure that we combine scientific excellence with industrial project management skills.
In addition to the coordinating partners, the consortium is organised into three groups.
The Earth observation science team consists of experts in algorithm development and data pre-processing (atmospheric and geometric correction, cloud-snow-water masking). They include the German aerospace center (DLR), the Instituto Superior de Agronomia in Portugal, the Instituto Nacional de Investigaciones Agrarias in Spain, the University of Leicester in the UK, and our group at the University of Alcalá, also in Spain.
As the aim is to implement the methods operationally, the project also includes a systems engineering group, lead by GMV, an industrial company located in Madrid. As the planned outcome of the project is a preoperational production chain that will become operational in the second phase of the climate change initiative following the fire_cci project.
Finally, the project also includes a climate modellers group consisting of high level French and German institutes, which will be responsible for the the identification and definition of user requirements and

assessment of the burned area products generated during the project.
The team will also interact with an external board, the Climate Modelling User Group (CMUG), which will also be accessible to other projects in the ESA CCI programme.
The different groups can call on strong international connections to other algorithm developers, validation experts and end-users in order to achieve high quality project results.

What is the planned project evolution?

The first actions in the fire_cci will be the gathering of user requirements for a burned area product and the determination of product specifications for the output from the project.
In parallel, the project team will initiate acquisition of data for algorithm development and validation.
Once the data has been collected, pre-processing activities will start, with a particular focus on geometric and atmospheric correction. Algorithms for atmospheric correction, water, cloud and snow masking as well as topographic shadow correction will be developed and refined.
Geometric correction is very important for burned area detection, as some of the algorithms are based on change detection. So, we need to be sure that the pixels are in the same place throughout the time series.
We will then move on to the development of burned area algorithms and also the adaptation of already existing algorithms. Using a round-robin approach, we will choose the best algorithms offering the optimal results for various ecosystems.
We will then progress to the production of global BA for five years and also validation of that product.
The outputs will be used for testing in dynamic vegetation models and fire emission models.

What are the known requirements for burned area products?

The GCOS requirements for this variable are quite stringent. It is recommended to have a five percent accuracy with a spatial resolution of 250m, a daily temporal resolution and a 5% stability level. Today's existing products have a best accuracy in the range of 20-25%. The above requirements are therefore not very realistic at the present stage and will be updated in the User Requirements Document to be generated at the beginning of the project. We will try to do our best to get as close as possible to the GCOS requirements.
A user requirements analysis will also be carried out using data gathered from climate modelling partners involved in the project and from a user requirements questionnaire.

Is there a need for product validation and assessment?

There are several global burned area products already available, but these differ considerably in terms of output in different ecosystems. These products more or less agree that the approximate global burned area is 3.7 million square kilometres, but the estimates vary in different regions and years. A systematic validation has not yet been performed, although previous projects have included some formal validation, mostly coordinated by the CEOS Land Product Validation team. Part of that team is working in our consortium.
Those validation efforts have observed a large variety of accuracies in different ecosystems and different continents. There is thus a need to investigate the relationship between accuracy and controlling factors such as land cover, climatic conditions, fire size and fire conditions.
When comparing different global burned area products, one see considerable overestimates and underestimates depending on the particular ecosystem. There is not a consistent trend of one product overestimating or underestimating all the time, but outputs are very ecosystem specific in terms of accuracy.
This is something we need to work on in order to provide climate modellers with data that is reliable enough for their activities.

What is the idea behind the round robin exercise?

In the round robin exercise, we will test and compare different burned area algorithms.
It is plannedWe plan to develop two main components for the round robin exercise:
i) a data package will be provided to everybody interested in developing or testing burned area algorithms, so that data can be used in a standard way by these parties, and ii) we will also code different burned area algorithms that have already been published, in order to compare their performance with the algorithms developed and refined during the course of the project.
The algorithm testing will be done using a comprehensive software system that will be developed and which will be easily accessible to the scientific community.

What are the production targets for the project?

We are interested in the temporal consistency of the time series. 10 sites, each with a size of about 500 x 500 km, have been selected for the production of a time series covering a time span from 1995 to 2009. This will demonstrate the consistency of the processing chain as well as the burned area product outputs.
We will also produce global coverages for five years in order to show that the processing chain is semi-operational. Obviously we need to assemble a lot of data for that, but we are confident that this will be possible.

How do you plan to validate the burned area products?

There is a strong focus in the project on product validation, as most of the products are not properly validated from a statistical point of view.
We will generate our own reference data from higher resolution satellite images (mostly Landsat TM/ETM+) and will gather as many reference sites as possible. These will be derived from national forest services, particularly in Canada, the US and European countries in which fire perimeters are available.
In order to generate reference data for our study sites and the global product, we plan to use about 600 Landsat images for validation. Pre and post fire conditions will be used to determine the time of a fire occurrence.
We will follow the standard methods specified by GCOS and the CEOS Land Product Validation Group regarding the metrics and factors controlling accuracy in order to better understand how these factors influence the actual accuracy. We will identify omission and commission

errors as well as the proportion of burned areas detected by the low and high resolution sensors.
There will also be a phase involving a comparison of products. Our product will be compared with other products that are already available, mostly derived from MODIS but also from previous ESA projects. We will use standard metrics to compare the products and identify which perform best in different ecosystems.

What are the benefits of the fire_cci project for other projects of the CCI programme?

There are a number of activities that are common to all or at least some of the other projects that are running in parallel in the climate change initiative. We have analysed our tasks and found that synergies can be generated especially with regard to the gathering of user requirements, as well as in terms of data pre-processing, validation efforts and the assessment of our product by climate modellers.
The structure of the CCI programme will also foster these synergies through the involvement of the Climate Modelling User Group (CMUG). A number of collocation working periods with other project teams and meetings with CMUG will lead to the establishment of solid scientific coherency, as well as allowing consolidation of common approaches and mobilisation of the multi-disciplinary scientific expertise available within the various project teams.

Milestones and events

Fire_cci activities – review and outlook

The three-year project Fire_cci has officially started on September 1st 2010. Since then a number of events have taken place.

PAST EVENTS

Living Planet symposium in Bergen

The Living Planet symposium took place in Bergen (Norway) from June 28th to July 2nd 2010. The science leader of Fire_cci Dr. Emilio Chuvieco was invited by ESA to introduce ECV Fire Disturbance to a diverse audience of top-level scientists and decision makers from all over the world.
You can revisit the climate change session of the Living Planet symposium and see the presentation of Fire_cci at:
http://www.esa.int/esaMI/Living_Planet_Symposium_2010/

Kick-off meeting in Alcalá de Henares

The kick-off meeting in Alcalá de Henares was held on September 9th-10th 2010. The main goal of the meeting was to get all parties involved at one table in order to reaffirm the roles and responsibilities. Furthermore, the general approach and the timeline of the project have been outlined and confirmed. Open questions have been discussed and answered.

First collocation meeting

The first collocation meeting took place at the ESA/ESRIN offices in Frascati, Italy on September 15th-17th 2010. The working meeting brought together key personnel from all CCI projects, the climate modelling user group (CMUG) and ESA. Issues of common interest were discussed and agreements were made.

The purpose of the collocation meeting was to,
- orient all CCI project teams to the same common objectives
- activate interactions between the different CCI project teams
- define Guidelines that are common to all CCI projects

The minutes on the collocation meeting can be seen online at:
http://earth.eo.esa.int/workshops/esa_cci/intro.html

Future project milestones

The Firc_cci started its activities immediately after the kick-off meeting in Italy. The first task was to gather user requirements information from potential users of a burned area product working in the field of climate modelling and earth observation. For that matter a questionnaire has been disseminated to selected parties and can be viewed and filled out online at:
http://www.esa-fire-cci.org/content/take-part-tell-us-what-you-need
(A first evaluation of answers can be read in the following article).

In parallel, data acquisition has been started for the satellite data to be used for developing and improving burned area algorithms. Furthermore, data archives have been tested for high resolution data to be used for product validation.

Upcoming Events

- **ESA side event on the COP in Cancun (Mexico)**
  29 November - 10 December 2010
  Emilio Chuvieco will present the Fire_cci project.
- **ECV-CMUG interaction meeting**
  14th -16th March 2011, at ECMWF, Reading (United Kingdom)

fire cci

Project parameters

Establishing high quality basic data for fire_cci products

User Requirements Questionnaire

The burned area product will be a critical input to scientists working with atmospheric and vegetation modelling at regional and global scales. The interest of a user requirements questionnaire is to obtain a burned area product that best fits their needs in order to improve the utility of the product. Accordingly, the questionnaire focuses on several key issues such as product characteristics (e.g. spatial resolution, temporal resolution for each type of product), accuracy and quality control, metadata and quality flags, data format and dissemination mechanisms.

Up to November 2nd 2010, a total of 43 answers to the questionnaire have been received, 14 were from the EO community, 15 were from the modelling community, 5 were from the data assimilation community and 9 were from other areas of expertise. Based on these responses a preliminary evaluation was performed as quick survey to check if the general idea of the product appears to be what the users need. The following conclusions could be drawn:

- Product type: from the several examples presented in the questionnaire the ones that were found to be extremely useful (i.e. that had the maximum score in a scale of 0 to 10) were burned patches, annual fires (with fire start and end time included) and burned pixel, annual synthesis (with time label), both with 30.2% of the answers.
- Product accuracy and quality control: the ideal product is one presenting an accuracy in burned area of 95%, with omission and commission errors not greater than 5%, with a geolocation of 100 m, a temporal accuracy of 1 day and a temporal stability (in % per annum) of 95%.
- Additional answers were related to the product type, format, metadata and dissemination means.

The full analysis of the user requirements will be included in a deliverable of the project and will form the basis for the product specification, which will guide the production of the burned area data delivered in this project.

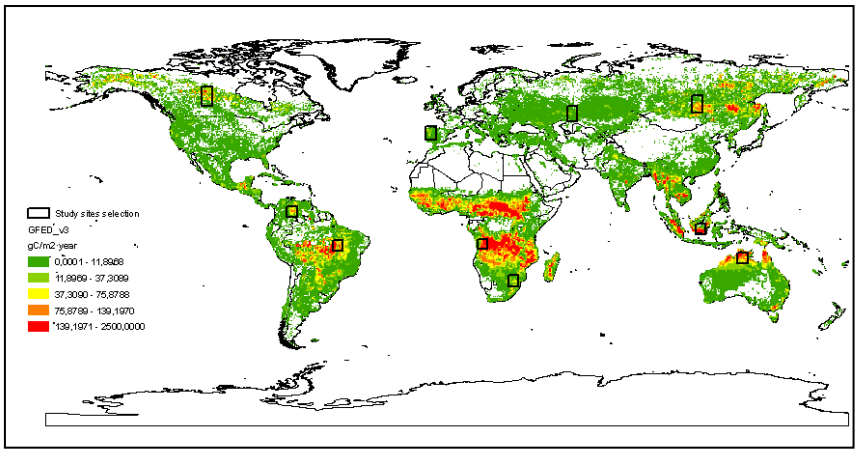


Figure 1: Study sites over the estimation of carbon emissions per square meter and year from GFEDv3 database.

Study Sites

Ten study sites have been selected for algorithm development, covering a large diversity of fire characteristics under different vegetation types and climates. Some of the regions that are problematic in existing burned area products (Borneo, Kazakhstan & Brazil) were selected as well in an attempt to improve accuracy in those regions. In figure 1 the spatial distribution of the study sites can be observed, with the carbon emission levels caused by forest fires as background.

Reference data

Reference data for algorithm development and validation of the burned area maps is being obtained for the different study areas. Where available, fire perimeters available from local experts or national forest services are also being used. When no fire perimeters are available, medium resolution satellite imagery (e.g. Landsat, CBERS,...) will be used for generating burned areas. A semi-automatic burned area detection algorithm is being used in this case, with a posterior visual verification of the results. An extensive database of fire perimeters is under construction, which will be available for future projects as well.

Input data

Satellite input data of VEGETATION, (A)ATSR and MERIS have been ordered for the ten study sites. DLR is working on the pre-processing of the imagery to deliver high quality input data. Within three months the first four full dataset should be delivered so that algorithm developers can start parameterising the different algorithms. Within six months from now imagery for all study area will be pre-processed.

GAF AG introduces the project website

Adhering to the principles of openness and transparency

Fire_cci
Project manager
Richard Theis, GAF

Are you a climate modeller interested in global burned area products covering a long time series? Are you an Earth observation scientist working with algorithms designed specifically for the detection of burn scars on the Earth's surface? Are you a participant in one of the 11 climate change initiative projects?
Then you might be interested in information about the Fire_cci project provided on the web.

The Fire_cci project is supported by a dedicated project website providing all the relevant information in an open and transparent manner. The project website is specifically designed to support:

- Project awareness and promotion
- External user participation and support
- Data dissemination
- Project coordination and monitoring

The project website hosts a wide range of information for interested external parties/users, the project team and also ESA.
The structure of the website allows easy identification of content relevant for all manner of visitors.

One of the main goals of the project website will be to promote the fire_cci project to the user community and to invite them to participate by using the generated algorithm, tools and datasets.

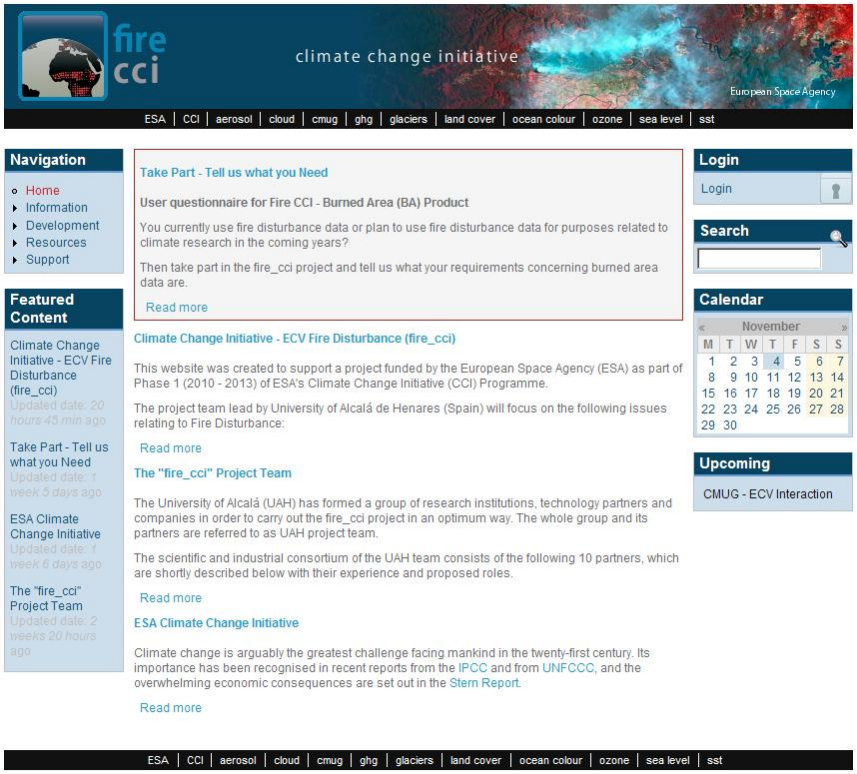
The project website provides an introduction to the Climate Change Initiative in general and also the specific requirements of the fire_cci part of the programme.

Features of the project website

A regular newsletter will be disseminated via the website containing information of interest to climate modellers interested in participating in the project as well as other interested parties.
A news section will provide all interested parties with regular updates; this will include information about the availability of new documents and data as well as about the updating of existing content. Furthermore, an RSS feed will inform the user community about news and website modifications.
Several different tools will be provided on the project website in order to allow the scientific community to participate in the fire_cci project. At the beginning of October, a user requirements questionnaire was sent to a list of potential users of burned area products in order to obtain feedback concerning their needs and requirements. The questionnaire has also been made available online via links on the project website.

The dates and details of upcoming events will be provided in the project calendar that forms part of the website.
Frequently asked questions (FAQ) will be generated and continuously updated to include common user questions.

An important component of the fire_cci project will be the round-robin exercise. The project website will enable all interested parties to easily take part in this. The website will also provide detailed instructions for using the necessary data sets, as well as describing the validation protocols, describing the use of the algorithms and publishing the final results of the exercise.



Fire_cci website at www.esa-fire-cci.org

A document repository will be established to publish all technical documents created during the project lifetime. Furthermore, the project website will become the access point for all the data sets created during the project. New data will be added as it becomes available. Especially the round-robin data package will provide a valuable opportunity for Earth observation scientists to participate in the development of new and improved algorithms for burned area detection.
The website will be dynamic and will evolve during the course of the project.

Discover and take part in the Fire_cci activities at www.esa-cci-fire.org.

Set-up of the fire_cc team

International scientific and technological expertise

The scientific and industrial consortium of the UAH team consists of the following 10 partners, which are shortly described below with proposed roles in the project. University of Alcalá de Henares, Spain (UAH) is the lead partner and the scientific coordinator of the activities of its partners. Project management is performed by a GAF project manager. Specific groups of partners are set-up to address specific tasks:

Science Leader

UAH - University of Alcalá de Henares (Spain)
Environmental Remote Sensing Research Group: Fire Disturbance and Earth Observation Science Expertise and Scientific Lead in the Fire_cci project.

Project Manager

GAF AG, Munich (Germany)

Applied Earth observation and GIS expertise, project management, product validation and website administration of the Fire_cci project.

Climate Research Group

The climate research group consists of IRD, JÜLICH and LSCE. This group of internationally recognized experts involved in understanding climate dynamics are responsible to ensure that the fire_cci meets the requirements of the Climate Research Community. This group will gather requirements from the wider community in terms of observational climate data and contribute to the preparation of a detailed 'user requirements document'. They will as well:

- review and comment key project deliverables from an end-user and modeller perspective.
- liaise with the wider international research community in the exploitation and integration of fire_cci products within specialised models.
- undertake necessary steps to integrate fire_cci products within specialised models.
- assess the trends and consistency of these products, examine the impact of such datasets on results from specialised models and provide the necessary feedback.
- publish the results of the project in internationally recognised, peer-reviewed scientific journals and through specialised community newsletters.

IRD (CNRS) – Centre National de la Recherche Scientifique (France)
Climate modelling expertise

JÜLICH – Forschungszentrum Jülich GmbH (Germany)
Global modelling Group: Atmospheric modelling expertise

LSCE – Le Laboratoire des Sciences du Climat et l'Environnement (France)
Biogeochemical Cycle Group
Climate modeling expertise

Earth Observation Team

The earth observation (EO) team engaged in the project is made up by DLR, INIA, ISA and UL. The members of this team in the project

- are at the forefront of developing methodologies and next generation algorithms required for generating high quality climate relevant data sets.
- have already developed, demonstrated and validated pre-cursor systems.
- will orient their future research activities to support the CCI initiative.

The role of the EO science team is to:

- review and improve existing, and implement new high-performance, algorithms necessary to produce long term data products meeting, or approaching the specific GCOS performance requirements for the fire_cci
- develop formal scientific specification of algorithms, prototype software, and reference data products, which can be passed, in a second programme phase, to industry for integration within operational systems.
- generate data products demonstrating the feasibility of achieving performance as close as possible to the GCOS requirements.
- validate the derived products and provide recommendations for future algorithm developments to meet the GCOS performance requirements.
- develop a formal protocol for the Round-Robin algorithm inter-comparison and validation exercise.
- actively participate in the Round-Robin inter-comparison and validation exercises and provide a conclusive Round-Robin Report.
- select the best performing and most suitable algorithms in agreement with the wider EO science community.
- publish the results of the project in internationally recognised, peer-reviewed scientific journals and through community newsletters.

DLR

DLR – Deutsches Zentrum für Luft- und Raumfahrt (Germany), Applied Remote Sensing Cluster
Earth observation scientific expertise, system engineering expertise.
Level 1 Pre-Processing.

GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN · INIA Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

INIA – Instituto Nacional de Tecnologia Agraria y Alimentaria (Spain)
Remote Sensing Research Group: Fire and Earth observation scientific expertise.

Hinc patriam sustinet
Instituto Superior de Agronomia
Universidade Técnica de Lisboa

ISA - Instituto Superior de Agronomia (Portugal) Department of Forestry
Burned area mapping, Global burned area algorithms.

University of Leicester

UL – University of Leicester (United Kingdom)
Fire Disturbance and Earth Observation Science Expertise.

System Engineers

The system engineers have previous expertise in requirement definition and specification of large EO data processing and product delivery systems, in terms of software, hardware, archiving and throughput. Knowledge of the latest related technologies like GRID or CLOUD computing.

The system engineers will:

- identify the requirements and the technical specifications for a complete end-to-end ECV processing chain by analysing the system prototype in an operational context.
- interact closely with the EO science team and Climate Research Group to ensure that any specification is 'fit for purpose'.
- conduct trade-off analysis between different system concepts based on the priorities of:
  - low operational cost
  - reprocessing capability
  - modularity
- address the need for establishing data service systems that ensure ongoing accessibility to the climate data sets into the future as well as the required capacity to update these data sets periodically.

gmv INNOVATING SOLUTIONS

GMV AEROSPACE & DEFENCE (Spain)
GMV will provide system engineering expertise.

Contact details:
For more information concerning the Fire_cci project you are invited to visit the project website:
www.esa-fire-cci.org

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