



estec

European Space Research
and Technology Centre
Keplerlaan 1
2201 AZ Noordwijk
The Netherlands
T +31 (0)71 565 6565
F +31 (0)71 565 6040
www.esa.int

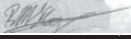


AGREEMENT / MEMORANDUM OF UNDERSTANDING

Work Agreement - EarthCARE Cal/Val AO Project [AOID]

Prepared by	Rob Koopman
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Author Rob Koopman  <small>Digitally signed by Rob Koopman DN: cn=Rob Koopman, o=European Space Agency, ou=ESCP, email=Rob.Koopman@esa.int, serial=99736400, c=NL</small>	Date 26-04-2017
Approved By	Date of Approval
D. Maeusli  <small>Digitally signed by D. Maeusli DN: cn=D. Maeusli, o=ESA, ou=ESCP-FRAG, email=dmaeusli@esa.int, serial=201736400234614, c=NL</small>	
A. Lefebvre  <small>Alain Lefebvre 2017.06.12 01:53:25 +02'00'</small>	

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1 INTRODUCTION

In this template, the explanatory text that is to be replaced with text that applies specifically to the work agreement between the PI and ESA is printed in blue.

1.1 Background: the EarthCARE mission

Earth Explorer Missions are part of the Earth Observation Envelope Programme (EOEP). They are missions led by the European Space Agency to cover primary research objectives. The EarthCARE Mission has been approved for implementation as the third Earth Explorer Core Mission. The mission is implemented in collaboration with Japanese Aerospace Exploration Agency who provides one of the core Instruments.

The EarthCARE mission has been specifically defined with the basic objective of improving the understanding of cloud aerosol-radiation interactions to include them correctly and reliably in climate and numerical weather prediction models. Specifically, the scientific objectives are:

- The observation of the vertical distributions of atmospheric liquid water and ice on a global scale, their transport by clouds and their radiative impact.
- The observation of cloud distribution ('cloud overlap'), cloud-precipitation interactions and the characteristics of vertical motions within clouds, and
- The retrieval of profiles of atmospheric radiative heating and cooling through the combination of the retrieved aerosol and cloud properties.
- The observation of the vertical profiles of natural and anthropogenic aerosols on a global scale, their radiative properties and interaction with clouds.

EarthCARE meets these objectives by measuring simultaneously the vertical structure and horizontal distribution of cloud and aerosol fields together with outgoing radiation over all climate zones. More specifically, EarthCARE will measure:

- Properties of cloud fields:
 - Cloud boundaries (top and base height) including multi-layer clouds.
 - Height resolved fractional cloud cover and cloud overlap.
 - Occurrence of ice liquid and super-cooled cloud layers.
 - Vertical profiles of ice water content and effective ice particle size and shape.
 - Vertical profiles of liquid water content and effective droplet size.
 - Small scale (1 km or less) fluctuations in these cloud properties.
 - Vertical velocities to characterise cloud convective motions and ice sedimentation.
 - Drizzle rain rates and estimates of heavier rainfall rates.
 - Narrow-band and broadband reflected solar and emitted thermal radiances at the top of the atmosphere.
- Properties of aerosol layers:
 - The occurrence of aerosol layers, their profile of extinction coefficient and boundary layer height, and



- The presence of absorbing and non-absorbing aerosols from anthropogenic or natural sources.

EarthCARE consists of the Space Segment, the Launcher Segment and the Ground Segment. The Space Segment is composed of the satellite including the following instruments:

- Cloud Profiling Radar (CPR)
- ATmospheric LIDar (ATLID)
- MultiSpectral Imager (MSI)
- BroadBand Radiometer (BBR)

The CPR is developed and procured by JAXA and delivered to ESA in the context of the ESA/JAXA cooperation for EarthCARE.

With both new sensor technology and retrieval approaches, there is the need to carefully assess the quality and validity of the generated data products before releasing them to the wider user community. This is even more relevant for the specific case of EarthCARE where the ultimate objective is to enable synergistic retrievals. The Announcement of Opportunity (AO) for the Calibration and Validation of EarthCARE is aimed at assessing and reducing the uncertainties in the EarthCARE measurements, by thoroughly assessing all aspects of instrument performance and stability, accuracy and suitability of the data processing, and comparison with independently acquired measurements.

1.2 Scope of the Document

This document describes the agreed project activity to be executed by [PI institute] in the context of the Project [AOID] for EarthCARE Calibration and Validation. It also describes the exchange of datasets between the European Space Agency and [PI institute] in the context of this project. A subset of the contents of this document will be copied into the EarthCARE Validation Plan, together with information from the equivalent documents from all other accepted proposals to the EarthCARE Calibration and Validation Announcement of Opportunity.

1.3 Applicable and Reference Documents

1.3.1 Applicable Documents (ADs)

[AD 1] Terms and Conditions for the Utilisation of Data under the ESA Category-1 scheme (<https://earth.esa.int/files/terms>)

[AD 2] Earth Explorers Data Policy (<https://earth.esa.int/web/guest/-/revised-esa-earth-observation-data-policy-7098>)

[AD 3] EarthCARE Correlative Data Protocol, EC-CO-ESA-SYS-0885



1.3.2 Reference Documents (RDs)

[RD 1] EarthCARE Mission Requirements Document, EC-RS-ESA-SY-012 v5.0

[RD 2] EarthCARE System Requirements Document, EC-RS-ESA-SY-001 v1a

[RD 3] EarthCARE Validation Definition Document, EC-RS-ESA-SYS-0906

[RD 4] EarthCARE Cal/Val Announcement of Opportunity, EC-PL-ESA-SYS-884

[RD 5] Proposal [AOID] by [Principal Investigator] to the EarthCARE Cal/Val AO

1.4 Objective(s) of the Activity

Specific objectives for this section are to be derived from the information in the AO proposal, in particular the section on “contribution to mission objectives”. **Generic** examples of objectives are:

- assessment of methods/algorithms for instrument calibration
- assessment of proposed methods/algorithms for external calibration
- independent estimates of achievable localisation and co-alignment errors
- independent determination of instrument stability
- comparison of geophysical products (cloud, aerosol, precipitation, and radiation properties) with independent ground-based, airborne or satellite measurements, including consideration of representativity errors
- impact of auxiliary information used in the processing (temperature, backscatter data bases, ...)
- comparison with other space-borne sensors (at level 1 and level 2)
- characterisation of major error sources and their dependencies on secondary parameters (e.g. solar zenith angle, land-sea error dependency, etc.)

error budget compilations

2 WORK DESCRIPTION

This chapter addresses the tasks that are to be executed

2.1 Plan and Perform Correlative Measurements

This section describes the correlative (independent) measurements of geophysical parameters. Each data source involved (e.g. ground-based instrument, airborne instrument, satellite sensor, model) is to be characterised in terms of location, time of operation (e.g. continuous & autonomous, operator during overpasses of EarthCARE, campaigns), geophysical parameters, their resolution and sampling distance, and accuracy and precision.

2.2 Process Correlative Data

This section should describe any data processing that the principal investigator performs on (raw) data, in order to derive geophysical data



2.3 Correlative Data Upload

In order to maximise intercomparison results extraction from the overall dataset, and enable independent verification of intercomparison results, all correlative data are to be uploaded to the ESA atmospheric Validation Data Centre (EVDC) for which an extension is planned to host EarthCARE correlative data. The specific datasets to be uploaded are described in Section 4.1. To protect the correlative data owner/Principal Investigator, all parties with entitlement to access his/her data on the EVDC will be required to sign the Correlative Data Protocol [AD-3]. These parties are:

- Principal Investigators of Accepted Cal/Val AO proposals
- Instrument calibration teams under ESA contract
- Level 1 and Level 2 algorithm developers under ESA contract

The agreement to upload his/her correlative data entitles the Principal Investigator to reception of pre-launch EarthCARE test data, and post-launch preliminary EarthCARE data (i.e. prior to public release).

2.4 Access EarthCARE Data

The Principal Investigator will use the following EarthCARE datasets in order to meet his project objectives. [This section is to be completed by detailed data requirements, in terms of instruments, product level, geographical coverage, etc.](#)

2.5 Perform Intercomparison Analysis

[This section should describe the intercomparison methods applied by the Principal Investigator and his team.](#)

2.6 Plan and Execute Validation Rehearsal

At about 4 months prior to launch, a validation rehearsal will be held. Prior to the rehearsal the Principal Investigator should have all tools and resources in place and prepare an observation schedule based on a simulated scenario provided by ESA. During the rehearsal he/she is to perform (or simulate, the case of expensive airborne instrumentation) correlative observations corresponding to this scenario and upload the resulting data products in agreed format to the EVDC.

ESA will make simulated EarthCARE data available (corresponding to the simulated scenario, TBC), which the Principal Investigator is to download and ingest into his intercomparison tools. The simulated analysis results are to be exchanged within the EarthCARE Calibration and Validation Team (made up of all the Principal Investigators of accepted AO proposals) in the context of the Validation Rehearsal Review, and any difficulties encountered are to be reported to ESA.



3 RESOURCES

3.1 Personnel

This section should list [AOID] project personnel allocated to the tasks

3.2 Hardware

This section should list [AOID] project hardware resources to be allocated to the project

3.3 Software

This section should list [AOID] project software resources (tools) to be allocated to the project

3.4 Funding

This section is used to describe the funding sources of the Principal Investigator for [AOID] project, see also [RD 5]

4 DELIVERABLES AND ESA-FURNISHED ITEMS

4.1 [AOID] Correlative Dataset deliverables

This section should contain a list of correlative datasets to be uploaded by the Principal Investigator, and latency (time between measurement and upload) for preliminary and consolidated data upload.

As far as reasonable, the correlative dataset to be uploaded should adhere to the GEOMS standard for correlative data. At the ESA atmospheric Validation Data Centre (EVDC) and the NASA Aura Validation Data Center (AVDC) numerous conversion support tools are available, and an EVCD conversion helpdesk is planned (TBC). The datasets will be protected by the EarthCARE Correlative Data Protocol [AD-3].

4.2 [AOID] project Assessments / Analyses

This section should list the outputs of the methods defined in section 2.5. As a matter of principle, all correlative datasets used to obtain the analysis results of the project should be uploaded (see also Section 2.3 and 4.1), in order to support exchanges within the ECVT and with the Algorithm Development Teams.

Publications of analyses are addressed in [AD-3]. If the Principal Investigator declares any further Proprietary Information, a Non-Disclosure Agreement will be agreed between the ESA and the Principal Investigator (see also section 4.4.3).



4.3 Reporting

The Principal Investigator will delivery quarterly progress reports via email during all phases of the project, describing status of preparation, status of funding, status/readiness/changes of/to instrumentation, preparation status of campaigns, progress on / readiness for data conversion, suitability of ESA tools/test data received thus far, progress with analysis methods/tools, and a list of open issues/problems/questions to ESA.

The Principal Investigator will present his/her project at the ESA Validation Workshop, and his/her intercomparison methodology at the joint ESA-JAXA Validation Workshop. Reporting at additional *ad hoc* meetings may be requested on best effort basis.

The Principal Investigator will report on the Validation Rehearsal, as part of the Rehearsal Results Review. At present it is not known if this is an online/internet review or a workshop.

The Principal Investigator will provide a detailed report of all his/her Commissioning Phase findings at the Preliminary Validation Results Review.

The Principal Investigator is invited to publish calibration/validation results in scientific literature and at workshops, provided that he/she adheres to the EarthCARE correlative data protocol [AD-3]

4.4 Items provided by ESA

4.4.1 *EarthCARE Datasets*

This section is to capture the preliminary and consolidated EarthCARE data deliveries that are agreed between ESA and the Principal Investigator. These are derived from the AO proposal after verification by ESA for feasibility.

4.4.2 *Other ESA Datasets*

This section documents the other ESA datasets to be made available through the AO mechanism. Please refer to Chapter 7 of [RD-4] for examples of datasets.

4.4.3 *Proprietary Information*

This section documents the proprietary information (if any) to be provided to the Principal Investigator. In case there are items defined in this section, the Agency and the Principal Investigator will sign a Non-Disclosure Agreement prior to delivery can take place to the Principal Investigator.

4.4.4 *Tools*

This section lists the tools that ESA will make available. At present ESA has tools available that are not yet adapted to EarthCARE. An assessment of ESA tools is ongoing in order to



arrive at a suite of tools suitable for EarthCARE validation, in particular overpass planning, collocation detection and intercomparison. This section is to document the tools that ESA provides to the Principal Investigator.

4.4.5 Information exchange with algorithm teams

ESA will act as interface between the Principal Investigator and the ESA algorithm teams.

4.4.6 Other ESA information

This section can be used to describe further information that ESA provides to the Principal Investigator to facilitate his/her work. Examples are prior information on EarthCARE calibration planning (in support of planning of under flights), or processor setting changes during commissioning fine tuning.

5 SCHEDULE AND MILESTONES

The detailed schedule specific to the project is to be placed here, in the context of the higher level milestones below:

As work agreements are individual to each AO project a definitive kick-off date cannot be set at present.

Project Kick Off	March/April 2018	Consolidated Work Agreement
1 st Validation Workshop (combined w. Science)	May/June 2018	Project Introduction Presentation
Pre-launch ESA-JAXA validation workshop	February 2019	Project Methodology Presentation
Validation Rehearsal	March 2019	Datasets
Validation Rehearsal Review / Validation Readiness	June 2019	Analyses, Rehearsal Reports
Launch	August 2019	
Preliminary Validation Results Review	February 2020	Datasets, Analyses, Reports
Long-term Validation Phase	February 2020 until End-of-Mission	Datasets, Analyses, Reports



6 SIGNATURES

For [PI Institute]

Date

Name

Function

Function

For the European Space Agency

Date

Name

Function