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DOCUMENT

External Calibration and Validation of the Aeolus Mission

Announcement of Opportunity, 2018 call reopening

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1 LIST OF ACRONYMS

Aladin	Atmospheric Laser Doppler Instrument
AO	Announcement of Opportunity
ATBD	Algorithm Theoretical Baseline Document
ACV	Aeolus Calibration and Validation
ACVT	Aeolus Calibration and Validation Team
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation
CAL/VAL	Calibration and Validation
EarthCARE	Earth Cloud, Aerosol and Radiation Explorer
ESA	European Space Agency
NASA	National Aeronautics and Space Administration
IODD	Input Output Data Definition
NWP	Numerical Weather Prediction
PI	Principal Investigator
TBD	To Be Determined



2 INTRODUCTION

ESA's Earth Explorer missions are developed in direct response to priorities identified by the scientific community. Carrying novel technologies, each satellite in the series is developed to improve our understanding of how the planet works as a system and the impact that human activity is having on natural Earth processes. By providing timely and accurate profiles of the world's winds along with information on aerosols and clouds, the Aeolus mission (hereafter called Aeolus) will not only advance our understanding of atmospheric dynamics, but will also provide much-needed information to improve weather forecasts. This state-of-the-art mission will also contribute to climate research.

The Aeolus satellite carries a single instrument – a Doppler wind lidar called Aladin. This sophisticated instrument is designed to probe the lowermost 30 km of the atmosphere to provide profiles of wind, aerosols and clouds along the satellite's orbital path. Comprising a powerful laser, a large telescope and a very sensitive receiver, Aladin is the first wind lidar in space. The laser system emits short powerful pulses of ultraviolet light down into the atmosphere. The telescope collects the light that is backscattered from air molecules, particles of dust and droplets of water. The receiver analyses the Doppler shift of the backscattered signal to determine the wind speed at various altitudes below the satellite.

It goes without saying that accurate weather forecasts are important both for commercial activities such as farming, fishing, construction, transport, energy exploitation and, of course, for generally planning our daily affairs. Although weather forecasts have advanced considerably in recent years, meteorologists urgently need reliable global wind-profile data to improve the accuracy of forecasts even further. Currently, wind information is either derived from temperature observations and is hence low resolution, or is measured directly but does not cover the whole globe. The World Meteorological Organization has, therefore, identified the lack of global direct wind profile measurements as one of the major deficits in the current Global Observing System. By filling this gap, Aeolus will improve weather forecasts and climate modelling along with considerable socio-economic benefits. In particular, better forecasts of extreme weather events will be of importance. Reliable knowledge of Earth's wind fields will also advance our knowledge of atmospheric energy, water, aerosol and chemistry cycles.

Long-term records of aerosol and cloud properties are needed to further our understanding of climate change. NASA's CloudSat and CALIPSO satellites currently supply data on these important variables, but these missions have already well exceeded their goal mission lifetime. The further provision of aerosol and cloud information from Aeolus will help bridge the gap until ESA's dedicated cloud, aerosol and radiation mission, EarthCARE, is launched.

This novel sensor technology and retrieval approaches require a careful assessment of the quality and validity of the generated data products before releasing them to the user community. Therefore, ESA released a first Announcement of Opportunity (AO) in 2007 calling for Calibration and Validation (CAL/VAL) proposals for Aeolus. The AO called for a thorough calibration and validation of the instrument and data products. This shall be achieved through a thorough assessment of all aspects of the instrument performance and stability, the accuracy and suitability of the data processing, and comparisons with independently acquired measurements. Sixteen proposals were received world-wide, including a number of proposals being a composite of numerous joint national efforts. Ground-based and airborne CAL/VAL activities were proposed, using independent wind and atmospheric sensing systems. Further activities included Aeolus measurement assimilation and product monitoring.



Since 2007, the Aeolus project has faced a number of delays due to challenges in the hardware development. An important change to the measurement baseline is the change from burst to continuous mode operation. This means that the laser is now operated continuously with 50 Hz pulse repetition rate instead of being switched on once every 200 km for 50 km with a pulse repetition frequency of 100 Hz. With the delivery of the first flight laser in December 2013, the Aeolus project has reached an important milestone allowing the resuming of the CAL/VAL preparation through this AO delta-call in 2014. During the 2014 delta-call, 17 proposals were received and recommended by ESA. In 2018, it was decided to reopen the Aeolus CAL/VAL AO call and to keep it open during the mission life-time. This document is applicable to the 2018 Aeolus CAL/VAL AO call reopening.

3 CALL OBJECTIVES

The principal means to provide estimates of uncertainty is by comparison to independent ground-based, airborne or satellite-based measurements, and detailed investigations of the retrieval methods applied to the target satellite measurements.

The European Space Agency is therefore announcing this reopening of the Aeolus CAL/VAL AO call:

- to invite new groups to participate in Aeolus CAL/VAL throughout the mission lifetime

Specific areas in which the contribution of the participants is sought are:

- validation using other satellite, airborne or ground-based experiments providing independent measurements of wind profiles, clouds and aerosols;
- experiments to assess accuracy, resolution, and stability of the Aeolus instrument Aladin;
- assessment and validation of the Aeolus retrieval and processing

More details about the Aeolus scientific CAL/VAL requirements are given in [RD 2], which acts as a guide for the definition of the CAL/VAL proposal activities.

Accepted CAL/VAL teams will have access to Aeolus data products starting at Level 1b up to Level 2b, including auxiliary data. Furthermore, during the satellite commissioning phase data access will be limited to these teams.

Funding of the activities solicited through this AO shall be covered by national/institutional resources. There will be no funding available via the Agency.

The Agency anticipates that this AO will stimulate the response from a wide cross-section of the international science community with experience in conducting field experiments and campaigns measuring winds and atmospheric optical properties, and in geophysical research using remote sensing data. One outcome of the AO process and its implementation is to connect groups with field and remote sensing expertise, respectively. The AO is open to groups and individuals; group responses are particularly welcome. The invitation is open to scientists worldwide.



The following (non-exhaustive) list of areas for investigation, as identified in [RD 2], is expected:

- assessment of methods / algorithms for instrument calibration
- assessment of the effectiveness of the “geophysical corrections”:
 - atmospheric correction (cloud, aerosol, backscatter,...)
 - sun (day-light, eclipse)
 - importance of ground targets
- assessment of localisation error, in particular bias and harmonics (e.g. by comparison with islands or other well behaved landmarks)
- assessment of instrument stability
- comparison of wind products with ground-based or airborne measurements (e.g. radiosondes)
- comparison of wind products with ground-based or airborne measurements, considering scale issues (‘representativity’)
- impact of auxiliary information used in the processing (temperature, backscatter data bases, ...)
- comparison with other space-borne sensors
- analysis of “mixed background measurements”: crossing lakes / rivers over land, coastal areas / islands over ocean
- assessment of major error sources
- error budget compilations

Principal Investigators (PI’s) whose proposals are accepted will be invited to become members of the Aeolus Calibration and Validation Team (ACVT) activities. Members of the ACVT may expect to participate in some, or all, of the following activities:

- Integration of their proposed work within a wider scientific and technical framework, and the establishment of collaboration between specialists.
- Participation in the establishment of detailed validation planning well in advance of the launch.
- Participation in post-launch data product and retrieval algorithm validation, and on-going monitoring of satellite performance and data quality.
- Support to the Agency in the planning and execution of special satellite operations in conjunction with ground experiments.
- Support to the Agency in the definition, in the light of post launch experience, of reprocessing algorithms to be applied to the Level 1b, Level 2a, and 2b data.
- Support to ESA in dedicated ACV meetings and workshops.
- Participation in pre-launch rehearsal activities

Members of the ACVT will be expected to play an active role in the validation of data products. A description of their proposed contribution and experience shall be specified in responses to this AO.

During the Aeolus operational phase (phase E2), science teams can at any time access Aeolus data through the ESA EO Portal (<https://eoportal.org/web/eoportal> and <http://aeolus-ds.eo.esa.int/>). Regular CAL/VAL and Science Workshops will be held through-out Phase E2.



4 AO DELTA-CALL DOCUMENTATION AND DATA PACKAGE

In support of the Aeolus mission user community, documents have been prepared to provide a detailed description of the mission, the instrument data acquisition, processing and products. Documents relevant to this AO are:

- The Aeolus Science Report [RD 1]
- Aeolus scientific CAL/VAL requirements [RD 2]
- Aeolus Scientific Calibration and Validation Implementation Plan [RD 3]
- The Aeolus Mission Requirements Document [RD 4].
This document contains a description of the scientific context of the mission, the scientific and measurement objectives, and an outline of the satellite system and data products. This document contains information of general interest,
- The Aeolus System Requirements Document [RD 5]
This document translates the (scientific) Mission Requirements into (technical) requirements as orbit and attitude, instrument performance, operability, etc.
- The Aeolus Level 1b (calibrated wind measurements), Level 2a (atmospheric optical properties products), and Level 2b (quality controlled temperature and pressure corrected wind measurements) Algorithm Theoretical Baseline Documents (ATBDs) [RD 6-8],
- The Level 1b, Level 2a, and Level 2b Input Output Data Definition documents (IODDs) [RD 9-11].

Furthermore, Aeolus L1b, L2a and L2b simulated sample products are made available on <http://aeolus-ds.eo.esa.int>. The Aeolus L1 and L2 data product documentation (Algorithm Theoretical Basis Documents (ATBDs), and Input/Output Data Definition documents (IODDs)) are available on the ESA Aeolus AO Web site (see Chapter 6).

5 ACTIVITY ORGANIZATION

Following the evaluation of the responses to the AO and the confirmation of the selected proposals, the ACVT will be established. The Team, in conjunction with the Agency, will plan and execute the calibration, validation and on-going monitoring of the Aeolus satellite system and data products.

Prior to the satellite launch, the ACVT will play an important part in the evolution of the Aeolus Scientific CAL/VAL Implementation Plan [RD 3], which identifies the Aeolus calibration and validation activities, the groups responsible for their implementation, their schedule, organization and coordination.

The Aeolus Scientific Calibration and Validation Plan [RD 3] contains the overall CAL/VAL schedule and its state of readiness will be reviewed 3 months before launch at a dedicated CAL/VAL Readiness Review.



During the commissioning phase that immediately follows the launch, the ACVT will provide a first assessment of the data products, and report on instrument calibration activities where these have been performed. The reporting is foreseen to take place during the first Aeolus CAL/VAL workshop six months after launch. It may also be requested to support the check-out of the satellite-ground segment system. Where possible, the ACVT will also be asked to provide preliminary results via written reporting as an input to the Commissioning Phase Review, which will be held after completion of the commissioning phase.

During the mission phase that follows, the ACVT will continue to support the validation of the data products, investigations of retrieval algorithms and on-going monitoring of the instrument system and data products. They will support the Aeolus CAL/VAL Workshops, where the first workshop will be held 6 months after launch followed by yearly CAL/VAL workshop throughout the mission lifetime.

An important outcome of the Aeolus CAL/VAL Workshops will be consolidated recommendations by the ACVT for updates and optimization of the Level 1b, 2a and 2b data retrieval and reprocessing. The reprocessing of the entire data set is foreseen in the mission planning as Aladin is a new sensor. Past experience shows that with new sensors, retrieval algorithms may be greatly improved in the light of experience gained in using the data. Evaluation of the performance of retrieval algorithms is also greatly helped by comparison to co-located ground-based and air-borne observations. It is for this reason that the two activities of algorithm design and validation are integrated within the activities solicited by this AO.

It is anticipated that some validation activities, together with on-going system and data monitoring, will continue throughout the mission lifetime, nominally 3 years after launch.

6 GUIDELINES FOR THE PROPOSAL PREPARATION AND SUBMISSION

The proposal can only be submitted in electronic form using the ESA AO Web site in a pre-defined format. Detailed submission guidelines are available at: '<http://earth.esa.int/files/AeolusCalValguidelines>'.

Please note that a pre-requisite for the proposal submission is to be registered at ESA Earthnet which means to have an active ESA EO-SSO account. In case you have not yet registered at Earthnet, please follow the procedure described at <https://earth.esa.int/web/guest/general-registration>. Further details are given in the link to the “AeolusCalValguidelines” above.

There is no submission deadline for this open call, and ESA assessments of the proposals will be organized when new proposals are submitted.

7 PROPOSAL EVALUATION

7.1 Evaluation Procedure

Proposals received in response to this Announcement of Opportunity will be reviewed by panels composed of:



- Aeolus Project (phase D/E1)
- Aeolus Mission Manager (phase E2)
- Aeolus Phase E2 Data Quality Manager
- Aeolus Campaigns Manager
- Aeolus Mission Scientist

7.2 Evaluation criteria

The following criteria will be used in the evaluation of the proposals:

- relevance of the proposed project to the objectives of the Aeolus calibration, validation and/or retrieval activity,
- contribution to the objectives of the Aeolus calibration, validation and/or retrieval activity,
- background and experience of the proposers,
- feasibility and probability of success, and
- credibility of proposed funding.

8 DATA AVAILABILITY

In support of the validation and algorithm development activities, the Agency will make Aeolus data available to the investigators selected in response to this AO during the Aeolus commissioning phase (Phase E1) and in phase E2. In addition, data from other ESA Earth Observation satellites and so-called Third Party Missions are available via the ESA EO Portal upon registration. Should remote sensing data from other Earth Observation missions be necessary for the proposed CAL/VAL work, then the proposal must clearly specify whether the team has guaranteed (free) access to the data during the project duration. During Phase E1 and early part of phase E2 (before the first official release of the Aeolus data), Aeolus data access will be restricted to Members of the ACVT.

Details of the Aeolus data products available to ACVT Members are described in the algorithm theoretical baseline documents (ATBD's) [R7-9] and Input Output Data Definition documents (IODDs) [RD 9-11].

As part of the proposal submission, applicants are requested to indicate their needs for satellite data products in terms of geographical areas but also data volumes. However, it is recognised that at this early stage in the mission, detailed understanding of the data products, and detailed campaign plans may be lacking. Consequently ACVT Members will be required to refine their data requirements as part of the planning activity, also taking account of any constraints arising from the capabilities of the data processing and distribution facility.

The provision of data to ACVT Members under this AO will need to satisfy the general ESA terms and conditions covering Earth Observation data which are available at '<http://eopi.esa.int>' under 'ESA Data Policy'. It is necessary for ACVT members to satisfy these conditions (which are drawn up in agreement with ESA member states). It should be noted in particular that no data supplied in the framework of this AO may be transferred, sold or given to third parties other than approved co-investigators, without the written authorisation of the Agency. Prior to receiving data, ACVT Members will need to provide:



- confirmation of the funding of the project, where appropriate;
- confirmation of their acceptance of the terms and conditions for receiving the data;
- confirmation of agreement to the allocated data quantities and delivery conditions.

The Level 2b data will be available in both Earth Explorer (EE) and BUFR format, whereas Level 1 and 2a data will be available in EE format only. Specification can be found in [RD 9-11] for EE and [RD 12] for BUFR format.

9 REPORTING

The progress and accomplishments of the proposals selected through this Announcement will be monitored by ESA. All selected projects will be required to submit periodic progress reports (every 6 months) describing the status of their project and to prepare a final report at the end of the project period, in accordance with a given format to be defined by the Agency. Recommendations for improvements in the system, e.g. processor updates, would be of particular importance. PI's may also be asked to present results or part of their results at a limited number of specialised workshops to be organised by the Agency.

A key aspect of this Opportunity is that none of the Aeolus phase E1 data or products, used or produced in the framework of any of the tasks, nor the scientific results derived thereof, shall be disseminated to external entities prior to approval by the Agency. Commissioned Data, made available during Phase E2 of the mission, can however be freely used under the standard ESA conditions noted on the ESA EO portal.

Confidentiality can be requested when the proposal is submitted and should be supported by adequate justification. Confidentiality will be guaranteed during the course of the evaluation process. The Agency, however, retains the right to, under any circumstances, use project data products at its discretion for any further data processing and/or data exploitation purposes.

Results of projects must also be provided in computer readable form to be defined by the Agency, so that they may be made available to other users.

10 AO TIME TABLE

- Release of the call (Opening of Submission Website): **1 October 2017**
- Closing of the call (Closing of Submission Website): **no closure date**
- Notification of the evaluation results to PI's: **2 months after submission**
- Start of ESA data delivery to accepted PI's: **To be determined (expected about 8 weeks after launch, but will be announced per email and on Aeolus wiki page on <http://wiki.services.eoportal.org> (page still to go live))**
- Projects completion (Final reports): **Launch + 3 years (to be confirmed)**
- ACVT Workshops: **annually throughout the mission starting 6 months after launch, dates TBD.**



11 REQUEST FOR INFORMATION

Further information regarding this Announcement may be found on the Web site dedicated to the Aeolus Announcement of Opportunity (<https://earth.esa.int/aos/AeolusCalVal>).



12 REFERENCE DOCUMENTS

The following documents provide valid background information for the activities solicited through this Announcement.

- [RD 1] Aeolus Science Report, ESA Reference number: SP-1311, 2008. Available on http://www.esa.int/Our_Activities/Observing_the_Earth/The_Living_Planet_Programme/Earth_Explorers/Aeolus
- [RD 2] Aeolus Scientific Calibration and Validation Requirements, ESA Reference: AE-RS-ESA-GS-005, issue 1.0.
- [RD 3] Aeolus Scientific Calibration and Validation Implementation Plan, version 1.0.
- [RD 4] Aeolus Project, Mission Requirements Document, ESA Reference: AE-RP-ESA-SY-001, version 1.3 (Draft).
- [RD 5] Aeolus Project, System Requirements Document, ESA reference: AE-RS-ESA-SY-001, version 3.1.
- [RD 6] Aeolus, Algorithm Theoretical Basis Document (ATBD), Level1B Products, Document Reference: AE-RP-DLR-L1B-001, Issue 4.3.
- [RD 7] L2A Product, Algorithm Theoretical Basis Document (ATBD), Document number: AE-TN-IPSL-GS-001, Issue 5.5.
- [RD 8] Aeolus Level-2B algorithm theoretical baseline document, Document number: AE-TN-ECMWF-L2BP-0024, Issue 3.0.
- [RD 9] Aeolus Level 1b Processor and End-to-End Simulator, Input/Output Data Definitions Interface Control Document, Document reference: ADM-IS-52-1666, Issue 4.08.
- [RD 10] Aeolus Level 2a Processor Input/Output Data Definition, Document number: AE-IF-DLR-L2A-004, Issue 3.5.
- [RD 11] Aeolus Level-2B/2C Processor Input/Output Data Definitions Interface Control Document, Document number: AE-IF-ECMWF-L2BP-001, Issue 3.0.
- [RD 12] L2B BUFR Converter Software User Manual, AE-TN-KNMI-BUFR-001, version 1.0.

All documents are available on the ESA AO web site (see chapter 6).