

# Scientific activities at EUMETSAT for the proposed EPS-Aeolus programme

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**Abstract:** EPS-Aeolus is the EUMETSAT proposed program to follow-up the successful Earth Explorer Aeolus launched by ESA in 2018. EPS-Aeolus will exploit Aeolus-2 satellites designed by ESA. This paper presents the scientific aspects of the future system, focusing on the scientific studies and the current user requirements.

Studies focused on the expected benefits of a future EPS-Aeolus system, by testing the added value of simulated data in Numerical Weather Prediction (NWP) systems. The two impacts estimation studies showed consistent improvement in the forecasts, expected to be roughly twice as large as the improvement brought by the assimilation of ESA's Aeolus data.

The user requirements are based on recommendations from ESA's Aeolus Science Advisory Group and EUMETSAT's EPS-SG requirements.

## 1. Introduction

In complement to the presentation of the program, this paper will describe the scientific activities around the proposed EPS-Aeolus programme at EUMETSAT.

The scientific requirements are compiled in an End User Requirement Document (EURD). Evolutions of the requirements compared to Aeolus will be presented. Improvements to several key performances will be outlined.

In preparation for the EPS-Aeolus program, EUMETSAT funded three studies, to estimate the impact foreseen for the future mission. Two studies focused on the assessment of forecast improvement for the future EPS-Aeolus system, based on the actual Aeolus impact and simulations of Aeolus-2 data quality. A third one aimed at studying the improvement in NWP forecast brought by the addition of a cross-polarization measurement capability, which was not available on Aeolus.

Additionally, an instrument data simulator study started, with the aim to adapt the Aeolus simulator to provide realistic Aeolus performance, configure it to simulate EPS-Aeolus performance and plan the evolution into a fully representative EPS-Aeolus instrument data simulator.

## 2. Scientific studies

EUMETSAT funded two activities related to the impact of Aeolus-2 on future weather forecast systems.

The first one funded KNMI to update the configuration of the LIPAS simulator [1] to be representative of actual Aeolus and planned Aeolus-2 performance. KNMI then provided the properly configured simulator to NOAA, who used it in an OSSE. Results were presented at conferences [2].

The second study is an Ensemble Data Assimilation (EDA) experiment involving the two proposed programmes of EUMETSAT, EPS-Aeolus and EPS-Sterna, and was performed by ECMWF [3]. EPS-Sterna is a proposed programme of EUMETSAT, that would exploit a constellation of small satellites carrying microwave sounders. The small satellites would be based on the prototype of the Arctic Weather Satellite mission of ESA.

Both impact studies provide consistent results and suggest that, in an otherwise stable configuration, the observations from EPS-Aeolus would bring an improvement about twice as large as the one brought by Aeolus information. Figure 1 shows the percentage change in the zonal wind EDA spread relative to the baseline experiment values given on pressure levels for real Aeolus (blue dots), simulated Aeolus (solid blue) and simulated

Aeolus-2 (black). The statistics are computed for the period July 8-28, 2019. The error bars represent the 95% confidence interval. The impact on meridional winds, geopotential height and temperature (not shown) are of similar magnitudes.

The EDA also underlines the very complementary nature of EPS-Aeolus and EPS-Sterna, as the combined impact reached 93 % of the sum of impacts if missions are considered separately.

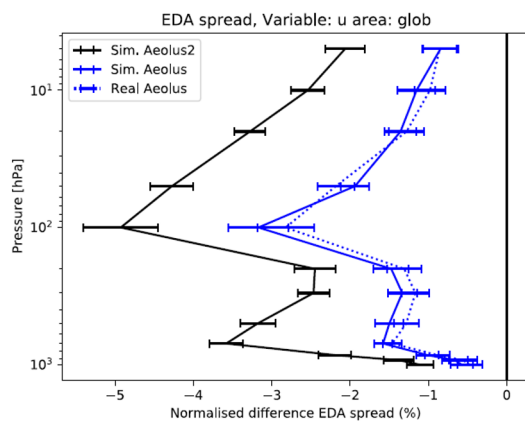


Figure 1. Change in EDA spread for zonal wind from [3].

A third study focused on a new feature planned for Aeolus-2: the implementation of a cross-polarization channel, which is especially useful for the observation of aerosols and ice clouds. This study, named ADD-CROSS, investigated the impact on Numerical Weather Prediction (NWP) of adding the cross-polarization information. Note that this added channel was not implemented on Aeolus. The team from the National Observatory of Athens performed extensive work to simulate Aeolus-like cross-polarization observation from CALIPSO data (among others: matching Aeolus resolution, conversion to 355 nm). The simulated observations were then assimilated by ECMWF in the CAMS model. The study focused on a 1-month period in September 2021, for which observation made during the JATAC campaign [4] were available. In a setup with “interactive aerosols”, ADD-CROSS demonstrated the impact on the main NWP variables (temperature, pressure, wind...) of assimilating the more complete “full” backscatter, i.e. co-plus cross-polar, instead of the only simple co-polar backscatter that was available from Aeolus data.

Such a cross-polarization observation capability is being studied and its implementation will be confirmed soon.

Additionally, a study to evolve the Aeolus End-to-End Simulator (E2S) and the performance of the preliminary EPS-Aeolus instrument architecture has started.

After the program approval by EUMETSAT members states, further activities will focus on the processor development including prototypes designed to test the algorithms and feed the development of operational processors. These activities will seek to involve teams from the Aeolus DISC, to take the knowledge on board and reuse as much as possible from the successful Aeolus mission.

### 3. End user requirements

The End User Requirements Document is the EUMETSAT document capturing the high-level user needs. We will focus here on the observational performance requirements.

Among the improvements compared to Aeolus, we can cite, for instance a particular focus on the random error (or observation noise) and on the bias. Both error components act together to decrease the impact of the data through its assimilation in NWP models [5].

Timeliness is also a critical element affecting the impact in NWP assimilation [6] and it should be improved with respect to Aeolus.

### 4. References

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