Horizon 2020

Call: H2020-MSCA-IF-2017

(Marie Skłodowska-Curie Individual Fellowships)

Topic: MSCA-IF-2017

Type of action: MSCA-IF-EF-ST

(Standard EF)

Proposal number: 798094

Proposal acronym: ALPACA

Deadline Id: H2020-MSCA-IF-2017

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How to fill in the forms?

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

Proposal ID **798094** *Acronym* **ALPACA**

1 - General information

Topic	MSCA-IF-2017
Call Identifier	H2020-MSCA-IF-2017
Type of Action	MSCA-IF-EF-ST
Deadline Id	H2020-MSCA-IF-2017

Acronym	ALPACA
Proposal title	Assimilation of lidar profiles for aerosol forecasting

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months	24
Scientific Area	ENV

Please select up to 5 descriptors (and at least 3) that best characterise the subject of your proposal, in descending order of relevance.

Descriptor 1	*Atmospheric chemistry, atmospheric composition, air pollution, indoor air quality*
Descriptor 2	*Earth observations from space/remote sensing*
Descriptor 3	*Meteorology, atmospheric physics and dynamics*
Free keywords	*data assimilation, aerosols, LIDAR, aerosol optical depth, Kalman filter, atmospheric composition, atmospheric modelling, model uncertainty, observation uncertainty*

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Abstract

Operational aerosol forecasts largely rely on data assimilation techniques, whose main observational source of information is satellite-derived aerosol optical depth, a column integrated quantity. Consequently, the information about the vertical profile is predominately propagated from the numerical model and not from the assimilated observations. While the assimilation of LIDAR vertical profiles could largely improve aerosol analyses and forecasts, several key unresolved aspects hinder their positive impact and operational implementation. ALPACA identifies and tackles these difficulties with the goal of developing the full potential of LIDAR assimilation in aerosol analyses and forecasts. We will use a state-of-the-art multiscale atmosphere-chemistry model (MONARCH), an ensemble-based data assimilation system (LETKF), and satellite LIDAR data (CALIOP and LIVAS dust products) to 1) resolve the inconsistencies among LIDAR and aerosol optical depth observations in the context of aerosol data assimilation; 2) propose and investigate novel meteorological and aerosol model parameter perturbations to better represent the forecasting uncertainty, specifically focusing on the vertical structure; 3) investigate vertical localization, which has a pivotal, yet poorly studied, role in the assimilation of vertical profiles; and 4) test the assimilation of a single species (dust) using LIVAS products for the first time. Taking advantage of the multiscale nature of the model, our developments will be tested using both regional and global model configurations. The results of ALPACA are expected to strongly impact the aerosol data assimilation research field, and to improve the aerosol analyses and forecasts that are used in other research areas, and public and private sectors in fields such as climate, biogeochemistry, public health and solar energy production.

Remaining characters 123

Has this proposal (or a very similar one) been submitted to a Horizon 2020 Marie Skłodowska-Curie Individual Fellowship call, with the same supervisor and future host institution (and partner organization for Global Fellowships)? ○ Yes ◉ No

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Declarations

1) The applicant (future beneficiary) declares to have the explicit consent of all partner organisations (if applicable) on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The applicant (future beneficiary) hereby declares:

- it is fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- it has the financial and operational capacity to carry out the proposed action.	☒

The applicant (future beneficiary) is only responsible for the correctness of the information relating to his/her own organisation. Where the proposal to be retained for EU funding, the applicant (future beneficiary) will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection
The assessment of your grant application will involve the collection and processing of personal data (such as your name, address and CV), which will be performed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the purposes and means of the processing of your personal data as well as information on how to exercise your rights are available in the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Detection and Exclusion system of the European Commission (EDES), the new system established by the Commission to reinforce the protection of the Union's financial interests and to ensure sound financial management, in accordance with the provisions of articles 105a and 108 of the revised EU Financial Regulation (FR) (Regulation (EU, EURATOM) 2015/1929 of the European Parliament and of the Council of 28 October 2015 amending Regulation (EU, EURATOM) No 966/2012) and articles 143 - 144 of the corresponding Rules of Application (RAP) (COMMISSION DELEGATED REGULATION (EU) 2015/2462 of 30 October 2015 amending Delegated Regulation (EU) No 1268/2012) for more information see the Privacy statement for the EDES Database).

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List of participants

#	Participant Legal Name	Country
1	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION	Spain

Proposal ID **798094** *Acronym* **ALPACA** *Short name* **BSC**

2 - Administrative data of participating organisations

Future Host Institution

PIC	***Legal name***
999655520	*BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION*

Short name: BSC

Address of the organisation

Street Calle Jordi Girona 31

Town BARCELONA

Postcode 08034

Country Spain

Webpage www.bsc.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no
Academic Sector ..... yes

Legal person ..... yes

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Department(s) carrying out the proposed work

Department 1

Department name: Earth Sciences Department ☐ not applicable

☐ Same as organisation address

Street: Jordi Girona, 29

Town: Barcelona

Postcode: 08034

Country: Spain

If the location of the Department carrying out the proposed work is not the same as the location of the Host Institute, please note that although the proposal submission system calculates the budget of the project based on the location of the Host Institute, the budget of the project for the grant agreement will be calculated by using the country coefficient of the location of the Department carrying out the proposed work.

Proposal ID **798094** *Acronym* **ALPACA** *Short name* **BSC**

Researcher

The name and e-mail of the Researcher and Supervisor are read-only in the administrative form, only additional details can be edited here. To give access rights and contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Last Name*	ESCRIBANO	Last Name at Birth	
First Name(s)*	Jeronimo	Gender*	(•) Male ( ) Female
Title	Dr.	Country of residence*	France
Nationality*	Spain	Nationality 2	Chile
Date of Birth (DD/MM/YYYY)	27/09/1985	Country of Birth*	Argentina
		Place of Birth	Cordoba

Contact address

Current organisation name	Centre national de la recherche scientifique (CNRS)
Current Department/Faculty/Institute/ Laboratory name	Institut Pierre Simon Laplace

☐ Same as organisation address

Street	4 place Jussieu		
Postcode/Cedex*	75252	Town*	Paris
Phone	+33144272313	Country*	France
Phone2 / Mobile	*+xxx xxxxxxxxx*		
E-Mail*	jeronimo.escribano@lmd.jussieu.fr		

ORCID ID	0000-0001-9682-7624	
Researcher ID		*The maximum length of the identifier is 11 characters (ZZZ-9999-2010) and the minimum length is 9 characters (A-1001-2010).*
Other ID	*Please enter the type of ID here*	*Please enter the identifier number here*

Qualifications

University Degree giving access to PhD	Date of award (DD/MM/YYYY)	26/10/2012
Doctorate	Start date (DD/MM/YYYY)	22/10/2013
Doctorate	Date of (expected) award (DD/MM/YYYY)	09/03/2017
Full time research experience	Number of months	59

(Measured from the date when a researcher obtained the degree entitling him/her to embark on a doctorate, either in the country in which the degree was obtained or in the country in which the researcher is recruited, even if a doctorate was never started or envisaged.)

Place of activity/place of residence (previous 5 years - most recent one first)

Indicate the period(s) and the country/countries in which you have legally resided and/or had your main activity (work, studies, etc) during the last 5 years up until the deadline for the submission of the proposal. Please fill in this section without gaps, until the call deadline (14/09/2017).

Period from	Period to	Duration (days)	Country
22/10/2013	14/09/2017	1424	France
01/02/1987	21/10/2013	9760	Chile
	Total	11184	

Proposal ID **798094** *Acronym* **ALPACA** *Short name* **BSC**

Supervisor

The name and e-mail of the Researcher and Supervisor are read-only in the administrative form, only additional details can be edited here. To give access rights and contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name*: **Carlos** Last name*: **Pérez**

E-Mail*: **carlos.perez@bsc.es**

Position in org.: Atmos. Composition Group Leader/AXA Prof. on Sand and Dust Storms

Department: Earth Sciences Department

[ ] Same as organisation address

Street: Jordi Girona, 29

Town: Barcelona Post code: 08034

Country: Spain

Website:

Phone: +34934134050 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	*Last Name*	*E-mail*	*Phone*
Dorota	Chmielewska	dorota.chmielewska@bsc.es	+34934134082

Proposal ID **798094** *Acronym* **ALPACA**

3 - Budget

Is the Researcher eligible for family allowance? (•) Yes ( ) No

Participant Number	Organisation Short Name	Country	Country Coefficient	Number of Months	Researcher Unit Cost			Institutional Unit Cost		Total
					Living Allowance	Mobility Allowance	Family Allowance	Research, training and networking costs	Management and Overheads	
1	BSC	ES	0,976	24	108921,60	14400,00	12000,00	19200,00	15600,00	170121,60
Total				24	108921,60	14400,00	12000,00	19200,00	15600,00	170121,60

Partner Organisation from Third Country does not sign the Grant Agreement, does not recruit the researcher and does not directly claim costs from the action. The entire EC contribution is transmitted to the Host organisation located in Members States or Associated Countries.

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4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	○ Yes ◉ No	
Does your research involve the use of human embryos?	○ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	○ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA		**Page**
Does your research involve personal data collection and/or processing?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS		**Page**
Does your research involve animals?	○ Yes ◉ No	
6. THIRD COUNTRIES		**Page**
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	○ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	○ Yes ◉ No	
Do you plan to import any material - including personal data - from non-EU countries into the EU?	○ Yes ◉ No	
Do you plan to export any material - including personal data - from the EU to non-EU countries?	○ Yes ◉ No	
In case your research involves low and/or lower middle income countries, are any benefits-sharing actions planned?	○ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	○ Yes ◉ No	

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7. ENVIRONMENT & HEALTH and SAFETY		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	○ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	○ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff?	○ Yes ◉ No	
8. DUAL USE		**Page**
Does your research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	○ Yes ◉ No	
9. EXCLUSIVE FOCUS ON CIVIL APPLICATIONS		**Page**
Could your research raise concerns regarding the exclusive focus on civil applications?	○ Yes ◉ No	
10. MISUSE		**Page**
Does your research have the potential for misuse of research results?	○ Yes ◉ No	
11. OTHER ETHICS ISSUES		**Page**
Are there any other ethics issues that should be taken into consideration? Please specify	○ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

How to Complete your Ethics Self-Assessment

Proposal ID **798094** *Acronym* **ALPACA**

5 - Call specific questions

Eligibility Researcher (future fellow)

1. Were you in the last 5 years in military service? ○ Yes ◉ No

Other Questions

1. For communication purposes only, the European Commission REA asks for permission to publish the name of the researcher (future fellow) should the proposal be retained for funding. Does the researcher (future fellow) give this permission? ◉ Yes ○ No

2. Some national and regional public research funding authorities run schemes to fund MSCA applicants that score highly in the MSCA evaluation but which cannot be funded by the MSCA due to their limited budget. In case this proposal could not be selected for funding by the MSCA, do the researcher and supervisor consent to the European Commission disclosing to such authorities the results of its evaluation (score and ranking range) together with their names and contact details, non-confidential proposal title and abstract, proposal acronym, and host organisation? ○ Yes ◉ No

3. Is there a secondment in Member States or Associated Countries envisaged in Part B of this proposal? ◉ Yes ○ No

In which sector is the secondment in Member States / Associated Countries foreseen?

☒ Academic ☐ Non Academic

Do you already know the organisation to which this secondment will be? ◉ Yes ○ No

Name: Vrije Universiteit Amsterdam

Country: Netherlands

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Extended Open Research Data Pilot in Horizon 2020

If selected, applicants will by default participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions.

However, participation in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. After the action has started, participants will formulate a Data Management Plan (DMP), which should address the relevant aspects of making data FAIR – findable, accessible, interoperable and re-usable, including what data the project will generate, whether and how it will be made accessible for verification and re-use, and how it will be curated and preserved. Through this DMP projects can define certain datasets to remain closed according to the principle "as open as possible, as closed as necessary". A Data Management Plan does not have to be submitted at the proposal stage.

Furthermore, applicants also have the possibility to opt out of this Pilot completely at any stage (before or after the grant signature). In this case, applicants must indicate a reason for this choice (see options below).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be penalised for opting out.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	○ Yes	◉ No

Further guidance on open access and research data management is available on the participant portal: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm and in general annex L of the Work Programme.

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

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MARIE SKŁODOWSKA-CURIE ACTIONS

Individual Fellowships (IF)
Call: H2020-MSCA-IF-2017

PART B

“ALPACA”

Assimilation of Lidar Profiles for Aerosol foreCAsting

This proposal is to be evaluated as:

[Standard EF]

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Part B-1 List of participating organisations

Participating organisations	Legal Entity Short Name	Academic (tick)	Non-academic (tick)	Country	Dept./ Division / Laboratory	Supervisor	Role of Partner Organisation
Beneficiary							
Barcelona Supercomputing Centre	BSC	x		Spain	Department of Earth Sciences	Dr. Carlos Pérez García-Pando	
Partner Organisation							
Vrije Universiteit Amsterdam	VU	x		The Netherlands	Earth and Climate Cluster, Faculty of Science	Dr. Nick Schutgens	Hosting secondment

1. Excellence

1.1 Quality and credibility of the research/innovation action (level of novelty, appropriate consideration of inter/multidisciplinary and gender aspects)

Introduction, state-of-the-art, specific objectives and overview of the action

Atmospheric aerosols are a key component of the Earth system. They modify the energy budget by interacting with radiation and perturbing clouds, and they are an important source of nutrients for the terrestrial and marine biosphere. Aerosols can also adversely affect human health. Thus, it is crucial to understand, quantify and predict their global distribution and variability along with their interactions in the environment. The spatial and temporal distributions of aerosols can be estimated by optimally combining observations and numerical models through data assimilation (DA) techniques. The resulting fields are representations of the aerosol states in the model variables called *aerosol analyses*. These analyses are crucial for aerosol forecast production, as they are used as initial conditions for the numerical model integrations leading to the forecast. Long-term and consistent analyses (*aerosol reanalyses*) are useful for investigating aerosol variability, trends, impacts and climate feedbacks, and they are produced with the same DA techniques[1].

A key uncertainty in current models is the representation of the aerosol vertical structure[2]. At present, most operational aerosol forecast systems rely on the assimilation of (column-integrated) aerosol optical depth (AOD) from satellite-bone instruments (e.g. MODIS, *see list of acronyms at the end of part B1*). Consequently, the information about the vertical profile is mainly propagated from the numerical model and not from the assimilated observations. In the last decade, only a few studies have investigated the assimilation of vertical aerosol profiles from LIDAR instruments, both satellite-based (e.g. CALIOP) and ground-based (e.g., European EARLINET network and Asian AD-NET network), showing the potential of vertical profiling to improve the four-dimensional representation of aerosols in analyses[3,4,5] and forecasts[4,5].

The goal of this proposal is to tackle key unresolved difficulties in the assimilation of vertical aerosol information that hinder potentially large improvements in aerosol analyses and forecasts. The proposed research will be undertaken using the Multiscale Online Non-hydrostatic Atmosphere CHemistry model (MONARCH; previously known as NMMB/BSC-CTM[6]) designed and developed by Dr. Carlos Pérez García-Pando (the supervisor of this proposal) and his research group at BSC, in close collaboration with partners at other institutions such as NOAA and NASA. For the aerosol data assimilation MONARCH uses the local ensemble transform Kalman filter (LETKF)[7,8], which is an ensemble-based scheme enhanced by Nick Schutgens (acting secondment of this proposal) for aerosol treatment[9]. In an ensemble system, the ensemble mean is considered the best estimate of the actual state of the system, and the spread of the ensemble is an indication of its uncertainty. In contrast to the variational approach (e.g., 4D-Var[1]), the Kalman filter approach allows more flexibility in the choice of the forward model version, in the added perturbations and in the choice of the state vector (the model fields that are analysed). This flexibility allows a (comparatively) less costly development and testing of new DA configurations, as the coding of multiple adjoint (and tangent linear) models is avoided. Another very attractive feature of ensemble-based techniques is the flow-dependence of the uncertainty (i.e. it evolves with atmospheric flow). These advantages will be exploited in our project.

A major difficulty preventing the operational assimilation of aerosol LIDAR profiles (e.g., at ECMWF, Angela Benedetti, personal communication) is the presence of unresolved conflicting biases between different types of observations (i.e., LIDAR versus satellite AOD). To avoid the problem, some studies have adopted shortcuts such as rescaling the column-integrated extinction of the LIDAR observation to match the model first-guess[4]. **Our project will design and test upfront quality control checks to identify and resolve inconsistencies among observations.**

[1] Benedetti, A., et al., 2009. J. Geophys. Res., 114, D13205; Lynch, P., et al., 2016. Geosci. Model Dev., 9,1489–1522; Buchard, V., et al., 2016. Atmos. Env. 15(10), 125, 100–111; Cuevas, E., et al., 2015. Atmos. Chem. Phys, 15(8), 3991–4024; Inness, A., et al., 2013. Atmos. Chem. Phys, 13(8), 4073–4109
[2] Koffi, B., et al., 2012. J. Geophys. Res., 117, D10201; Koffi, B., et al., 2016. J. Geophys. Res. Atmos., 121, 7254–7283
[3] Sekiyama, T., et al., 2010. Atmos. Chem. Phys., 10, 39–49
[4] Zhang, J., et al.,2011. Geophys. Res. Lett., 38, L14801
[5] Wang, Y., et al.,2014. Atmos. Chem. Phys., 13,12031–12053
[6] Pérez, C. et al., 2011. Atmos. Chem. Phys., 11, 13001–13027; Badia, A. et al., 2017. Geosci. Model Dev., 10, 609–638
[7] Di Tomaso, E., et al., 2017. Geosci. Model Dev., 10, 1107–1129
[8] Hunt, B. R., et al., 2007. Physica D, 230, 112–126; Miyoshi, T. and Yamane, S, 2007. Mon. Weather Rev., 135, 3841–3861
[9] Schutgens, N. A. J., et al., 2010. Atmos. Chem. Phys., 10, 2561–2576; Schutgens, N. A. J., et al., 2013. Atmos. Meas. Tech., 6, 2455–2475

Another recurrent problem is the frequent inconsistency between the observed aerosol plumes and the simulated ones[10] due to temporal and spatial errors in the emission and in the underlying dynamical meteorological fields. To optimally combine the simulated aerosol fields with observations it is crucial to accurately estimate the forecasting uncertainty, which in the case of an ensemble-based scheme, such as LETKF, is derived from the ensemble of model states at the assimilation time and evolves during the forecast. This uncertainty is underrepresented in current systems, particularly in the vertical, because perturbations of the ensemble members are typically applied only to the aerosol source strengths. It has been recently shown that combined aerosol source and meteorology ensembles are necessary to produce sufficient spread in outflow regions[11]. **Our project will investigate whether meteorological and other model parameter perturbations may allow a better representation of the forecasting uncertainty, specifically focusing on the vertical structure.** To our knowledge, this hasn't been assessed before. Our hypothesis is that these new perturbations will affect the 3-dimensional structure of background covariances, and hence the way in which information from an observation is spread in the vertical.

Our project will also study vertical localization, which has a pivotal, yet poorly studied, role as the observation influence might erroneously cover both the boundary layer and the free troposphere.

Research methodology and approach

The methodology is designed to reach the scientific objectives by first preparing the model and the observations for the LIDAR assimilation **(i)**. Then, the ensembles will be studied and designed **(ii)**, tuned and executed **(iii)** and the results will be evaluated and validated **(iv)**. The simulations will be done with two different model configurations: a regional high-resolution (0.1º by 0.1º) dust-only model configuration, and a global model configuration including all aerosols (1.4º by 1º). MONARCH contains advanced chemistry and aerosol packages, and is coupled online with the Non-hydrostatic Multiscale Model (NMMB), which allows for running either global or high-resolution regional simulations. The regional dust model version provides operational forecasts at the SDS-WAS Regional Center and the BDFC for a regional domain comprising Northern Africa, Middle East and Europe. The global aerosol model version contributes to the ICAP Multi Model Ensemble[12]. The work plan is described below:

(i) Observation handling: We will first develop an accurate and flexible observation operator that simulates LIDAR signals based on the aerosol simulated by MONARCH. Then we will prepare the native LIDAR observations for ingestion into the DA. The DA system will assimilate vertical profiles (either attenuated backscatter measurements together with depolarization, or derived extinction coefficients) from the CALIOP instrument. For the assimilation in dust-only simulations, we will use the LIVAS dust dataset, which provide dust extinction coefficient profiles at 532 nm derived from CALIOP measurements based on the particle linear depolarization ratio and a more suitable LIDAR ratio value for dust[13]. Preparations include quality checks, regridding and reformatting before they can be ingested by the LETKF. A close-to-optimal configuration for the representativeness error will be chosen and added to the instrument error given by the data providers. For aggregated aerosol satellite retrievals (used with coarse resolution global simulations in order to match model resolution and avoid the assimilation of sub-grid features), we will use the representativeness errors estimated by the spatial sample variance of the original retrievals, and assume uncorrelated observation errors[14]. For denser observations (used in fine resolution regional experiments), representativeness errors can be larger and correlated. We will test methods such as variance inflation[15] to account for these errors and the unrepresented correlation structure.

Other observations (surface concentration measurements, ground-based LIDAR observations from EARLINET and MPLNET, and AOD from AERONET) will similarly need regridding and reformatting to easily use them for evaluation purposes. Additionally, assimilated observations will be thoroughly evaluated and compared to the set of independent and more accurate ground-based observations, and between each other (in AOD space), in order to detect possible systematic biases as a function of the season, surface characteristics, AOD magnitude and meteorology. This will help designing the strategy for applying strict quality control procedures on the assimilated observations, and for tackling the challenging problem of conflicting biases between types of observations.

(ii) Ensembles: We will design and implement new perturbations of the meteorology and aerosol parameters in the model ensemble. An accurate estimation of forecasting uncertainty will be key in order to optimally combine

[10] Escribano., J., et al., 2016. J. Geophys. Res. Atmos., 121, 8549–8566; (Hendrik Elbern, personal communication)
[11] Rubin, J., et at., 2016. J. Geophys. Res. Atmos., 122, 4967–4992
[12] Sessions, W., et al., 2015. Atmos. Chem. Phys., 15, 335–362; International Cooperative for Aerosol Prediction (http://icap.atmos.und.edu)
[13] Amiridis, V., et al., 2015. Atmos. Chem. Phys., 15, 7127–7153
[14] Zhang, J., et al., 2008. J. Geophys. Res., 113, D10208
[15] Whitaker, J.S., et al., 2008. Mon. Wea. Rev., 136, 463–482

the simulated aerosol fields with observations. Forecasting uncertainty, expressed in terms of background-error covariances, has in fact the crucial role of spreading observation increments in space (horizontally and vertically), across model variables (multivariate analysis) and producing statistically consistent increments between neighbour grid points. In the LETKF this uncertainty is mainly driven by the spread of the ensemble members. Therefore, an adequate representation of the horizontal and vertical uncertainty in the model ensemble is central to the assimilation of LIDAR signals. In addition to the common perturbations (aerosol source strength and source parameters) already implemented in the BSC-DA scheme, the meteorological perturbations will be produced using the Global Ensemble Forecast System (GEFS) meteorological analyses provided by NCEP. These are available for 20 ensemble members, four times per day. Used as initial conditions for the MONARCH runs, they will help spreading aerosols both horizontally and vertically to areas that are not reached by the standard run, which is expected to help in correcting errors due to the transport. Additional uncertainty in the vertical will be explored through perturbations of model parameters (e.g., parameters in the boundary layer scheme), perturbations in the aerosol scheme (e.g., wet and dry deposition schemes) and in the aerosol emissions (e.g., injection height and vertical distribution of biomass burning). The chosen set of parameter perturbations (and their magnitude) have to fulfil, at least, two criteria: (i) the ensemble members have to be physically plausible, and (ii) the spread in the vertical and the horizontal should ideally cover the error of the standard run compared to available observations.

(iii) Simulations: We will perform two sets of simulations. First, we will work with seasonal dust simulations over the BDFC regional domain assimilating dust AOD[7] and dust vertical profiles from the LIVAS[13]/CALIOP product. This simulation has the aim of testing the assimilation specifically for one aerosol component (dust) over a domain and configuration, at a relatively high spatial resolution, currently used to provide operational dust forecasts for WMO. Secondly, an assimilation of the CALIOP profiles and total AOD in a global simulation at a coarser horizontal resolution will be run. The latter simulation will include all the aerosol types, and timely fits within the ICAP collaborative effort on tackling the assimilation of both columnar and vertical profiling information for all the main aerosol species modelled. For both sets of simulations we will perform the associated reference simulations without assimilation. This will be used not only for evaluation purposes, but also to understand whether and where the assimilated observations produce a reduction of ensemble spread.

The configuration of different localization schemes will be tested. Localization can improve background covariance estimates by removing spurious elements among distant grid points, which arise from sampling errors introduced by finite ensemble size. In the LETKF it is performed through R-localization, i.e. the localization is performed in the observation error covariance matrix (R), making the influence of an observation on the analysis decay gradually toward zero as the distance from the analysis location increases. Localization in the vertical has a pivotal role as the observation influence may cover both the boundary layer and the free troposphere. For this reason, LIDAR DA can produce wrong analysis increments in the mixed layer (Ed Nowottnick, personal communication). As a remedy, an anisotropic vertical localization function will be tested.

The ensemble perturbations are expected to represent well the actual error structures. However, due to limited ensemble size or missing model processes, it is common to obtain underestimated covariances, which has a detrimental effect on the analysis: an under-representation of the background uncertainty might translate into giving a lower weight to the observations with respect to the background. In some cases, this can lead to filter divergence[16]. This may also be true after our new design of perturbations targeting the vertical structure. As a remedy, background covariances can be increased by increasing the deviation of the ensemble members with respect to the mean by a tunable parameter. Different tuning techniques will be tested, with particular attention to vertical covariance structures.

(iv) Evaluation and validation: The simulations will be compared with independent observations (described in (i)) and specific DA diagnostics will be computed, such as statistics on first-guess and analysis departures, comparison between the analysis root mean square error and ensemble spread, and ensemble rank histograms[17]. The former will assess the overall quality of the DA product, and the latter will help detecting possible biases in the DA system and evaluating the DA system performance. The validation tasks will build upon existing tools and the experience of the host and secondment institution in the evaluation of simulated AOD[18] and dust aerosol vertical structure[19]. A set of parameters (i.e. aerosol load, surface concentration, and aerosol vertical profiles) will be identified for scoring the analysis and short-term forecast performance. As a side product of the assimilation

[16] Anderson, J. L., 2007. Tellus A, 59: 210–224
[17] Anderson, J. L., 1996. J. Climate, 9, 1518–1530
[18] Basart, S., et al., 2012. Atmos. Chem. Phys., 12, 3363–3392; Schutgens, N. A., et al., Atmos. Chem. Phys., 16, 1065–1079
[19] Binietoglou, I., et al., 2015. Atmos. Meas. Tech., 8, 3577–3600

system, assimilation runs perform also an analysis-initialised forecast (the first-guess), whose validation provide an assessment of the impact of data assimilation on the short-term aerosol forecast.

Originality and innovative aspects of the research programme

This project contributes to the advancement of the aerosol DA research field by using a state-of-art assimilation system (LETKF), a sophisticated chemical weather prediction system (MONARCH) and observations whose potential has not been fully exploited yet by the research and operational community.

The project advances a variety of key aspects related to the assimilation of vertical aerosol information. The successful harmonization of the assimilation of AOD and LIDAR observations in a DA system will be one of the most innovative aspects of the project. This will allow to effectively take advantage of the current and future instruments of the Earth observing system (e.g., sunphotometers and LIDAR networks worldwide, Copernicus program). Other innovations include our attempt to properly represent the forecast uncertainty in the vertical based on a new design of the ensemble and the thorough study of the vertical localization. The project will be a pioneer in expanding the design of the ensemble perturbations (both meteorological and aerosol physical parameterization) in order to better control the vertical and horizontal variability of the analysed aerosol. This will be achieved drawing from the extensive experience built up, during the last 25 years, in the field of numerical weather prediction.

To our knowledge, this will also be the first attempt to assimilate LIDAR products (LIVAS) exclusively for dust applications, which will showcase the benefit of having specific observational constraints on a model individual aerosol component, compared to merely relying on the model background when such a constraint is not available. The latter solution is operationally adopted in all aerosol forecast centres, but error-prone due to incorrect model aerosol attribution.

The approach proposed will result in a high-quality DA system, providing better aerosol analyses and forecasts than current capabilities. It will also provide key insights on the model processes and parametrizations, as we will be able to assess the characteristics and sources of the errors by studying the sensitivity to perturbations, analysis increments and observation impact. Therefore, the approach proposed will provide an innovative framework for future model developments.

The outcome of this project will have implications not only in the DA research field, but also in a large variety of fields where aerosol analyses and reanalyses are used, as climate studies, biogeochemical studies and public health research.

The interdisciplinary aspects of the action

Aerosol DA combines the study of atmospheric aerosols (chemistry and physics), and the use of numerical models (mathematics and computer science) by using a wide range of applied mathematics tools, such as optimization, linear algebra, probabilities and statistics. Additionally, data assimilation does an extensive use of measurements and laboratory studies. This project will require the interaction with atmospheric scientists (both for the dynamics and composition aspects of the atmosphere), with modellers working on the physical parametrisation schemes, with observation retrieval experts, with computer scientists for an efficient implementation of the code, and also with end-users of aerosol analysis and forecasts (e.g. by the regional centre of WMO hosted by BSC, http://sds-was.aemet.es/). Moreover, aerosol research draws also on other branches of science such as chemistry and biology, for their composition, formation via gas reactions, and emission from plants and sea. Because of the large amount of data and the complexity of the atmospheric models, there is a strong link between DA, high performance computing (HPC) and more generally, information technology (IT).

Explain how the high-quality, novel research is the most likely to open up the best career possibilities for the experienced researcher and new collaboration opportunities for the host organisation(s).

The proposed project will enhance the ongoing collaboration between the BSC and Vrije Universiteit Amsterdam (VU). This project will allow deepening the collaboration of the BSC and the experienced researcher (ER) with recognised institutions and other leaders in the aerosol DA field, such as the participants of the ICAP initiative from the all the major world-wide aerosol forecasting centres (ECMWF, NOAA, NASA, MeteoFrance, JMA and others). As a result of this collaboration the ER will have the chance of opening work perspectives in the future, in a variety of institutions, as for example numerical weather prediction centres (CAMS/ECMWF).

The ER has extended experience in variational DA methods and will provide this complementary perspective to the host institution. The ER will benefit from the training on ensemble-based DA methods, advanced observation handling, and both global and regional modelling and forecasting. This will expand his employment possibilities to work on other related fields, such as numerical weather prediction, satellite retrievals, or even engineering applications. Also, the ER will enlarge his publication record with high quality publications, as well as increase his

autonomy by taking on responsibilities to plan and manage research activities, both on a day-to-day and long-term basis.

The ER will demonstrate his capacities of leading an innovative and timely project on aerosol DA that will surely help expanding his professional network and increase his visibility and recognition in the research and operational communities.

1.2 Quality and appropriateness of the training and of the two way transfer of knowledge between the researcher and the host

The BSC will provide training to the ER in relevant topics associated to this project. The training includes some areas where the host institution has a remarkable expertise, such as the use and development of global and regional numerical models (NMMB-MONARCH model), the forecast and analysis validation of meteorological and atmospheric composition model simulations against observations, parallel programming in atmospheric models, quality assurance of satellite aerosol observations and ensemble-based data assimilation methods. Moreover, the vast experience of the host on mineral dust modelling and dust related processes will be a key element of the training. From the secondment with N. Schutgens, the transfer of knowledge on Kalman filter and representativity of observations and models will strengthen the ER competences on the research field.

In addition to the continuous *training-through-research* considered in this proposal, the training program considers several other management and communication skills. The fellow will benefit from some remarkable training activities organised periodically (and according to a personalised plan) by the Human Resources department of the host institution. These training activities involve training in advanced scientific writing and proposal writing for competitive funds, research program management, team leadership and management, conflict resolution, training for gender issues in research teams, training in outreach skills and activities, and ethics in research (among others). The training will be complemented with *on-the-job* training of proposal writing and supervision activities.

On the other hand, the acquired experience of the ER on aerosol modelling, aerosol observations from satellites and aerosol data assimilation will enrich the local group. The strong background in applied mathematics of the ER will contribute with an analytic point of view for technical and scientific problems that could arise in the research group. For example, in his PhD, the fellow has proposed a novel approach by exploiting the mathematical properties of the cost function in a DA system to improve the performance of the optimization sub-problem (in speed, accuracy, and stability of the numerical solution).

1.3 Quality of the supervision and of the integration in the team/institution

Qualifications and experience of the supervisors

This project will be supervised by Dr. Carlos Pérez García-Pando (BSC) and comprises a secondment of 4 months (in total) with Dr. Nick Schutgens (VU).

Dr. Carlos Pérez García-Pando is Ramón y Cajal Researcher, AXA Professor on Sand and Dust Storms (SDS) and Head of the Atmospheric Composition group at BSC composed by 12 researchers. His research focuses on understanding the physical and chemical processes controlling atmospheric aerosols, and evaluating their effects upon climate, ocean biogeochemistry, air quality, and health. He is also a model developer with a large experience in HPC and operational forecasting. Between 2009 and 2016 he worked at the NASA Goddard Institute for Space Studies and Columbia University, where he served as PI and co-PI in competitive research projects funded by the U.S. Department of Energy, NASA and NOAA, with collaborators at NOAA/National Centers for Environmental Prediction, NOAA/Geophysical Fluid Dynamics Laboratory, Princeton University and Cornell University. Aside of his significant research achievements related to dust-radiation interactions, dust-mineralogy, and dust effects on health, he led an international multi-institutional initiative to develop a unique unified (regional and global) prediction model for weather, atmospheric aerosols, and chemistry that today provides operational forecasts widely used by the international scientific community, weather services, companies, and air quality managers. Dr. Pérez García-Pando's work has resulted in ~55 peer-reviewed papers (h-Index: 28, i10-Index: 46, citations: 3186, source: Google Scholar), 20 chapters in books/proceedings/reports, 150 contributions to conferences/workshops/seminars (26 as invited speaker) and the edition of a book of proceedings. He organized an international conference and a workshop on SDS. He participated in 27 international (US and EU) and national projects (in 6 of them as PD, PI or co-PI). He co-advised 3 PhD students, 3 Master students, and 1 Postdoc. His work was highlighted among others by NASA and the European Centre for Medium-Range Weather Forecasts (ECMWF), and covered by international media such as The Guardian. Dr. Pérez García-Pando was recently awarded with an AXA Chair to support an ambitious mineral dust research program at BSC.

After obtaining a PhD in astrophysics (1998), Dr. Nick Schutgens moved to atmospheric science. Since 2006 his main interest is aerosols and their impact on the environment, in particular climate. He is a modeller with a strong affinity for using remote sensing data. He has worked 13 years abroad at the University of Tokyo and the University of Oxford. He now works at the Vrije Universiteit Amsterdam (with Prof. dr. Guido van der Werf) on modelling biomass burning aerosol. His expertise includes data assimilation, aerosol process analysis, observational representativity and model evaluation. He developed an ensemble Kalman filter now used by Japanese and Spanish institutes for data assimilation studies. He was the scientific project manager for the development of CIS (www.cistools.net) to help researchers collocate, analyse and visualise diverse datasets in the atmospheric sciences. He leads an international AEROCOM project on model evaluation in the context of uncertainties in remote sensing retrievals.

Hosting arrangements

The experienced researcher will be integrated in the Earth Sciences Department at BSC (BSC-ES), specifically in the Atmospheric Composition group led by Dr. Pérez García-Pando. BSC-ES includes four groups (*Atmospheric Composition (AC), Climate Prediction, Computational Earth Sciences, and Earth System Services*) comprising ~60 employees, including scientific, technical, and support staff. The excellence of the department is illustrated by its high publication rate with more than 150 papers – several of very high impact – in the past 5 years, the participation and/or coordination of EU-FP7, H2020, and national projects (e.g. IS-ENES2, QWeCi, SPECS, PREFACE, EUCLEIA, S2S4E, InDust COST Action, DustClim) and the close collaboration with the industrial sector. The AXA Chair on Sand and Dust Storms led by Dr. Pérez García-Pando is transversal within BSC-ES. Therefore the ER will benefit both from scientific exchange within the AC group and from synergies with the other groups. BSC-ES also hosts (together with the Spanish Weather Service, AEMET) the WMO SDS-WAS NA-ME-E Regional Center (http://sds-was.aemet.es/), which coordinates research and operational communities to enhance the ability of countries to deliver timely and quality SDS forecasts, observations, information, and knowledge to users.

As demonstrated by the long list of past and ongoing projects, BSC-ES and Dr. Pérez García-Pando, have a large active network of collaborations with over 50 institutions worldwide. The groups also work closely with private companies, especially in the fields of agriculture, transportation, and energy, that access the operational air quality and dust products made available online. By working with Dr. Pérez García-Pando at BSC-ES, the ER will benefit from existing networks and will have the possibility to contribute to and participate in future projects.

The ER will have full access to the near real-time online documentation maintained at BSC-ES, which includes detailed information on past and ongoing projects, publications, meetings, codes, etc. This guarantees the instant exchange of information about activities within the department, including the MSCA, fastens the adaptation of the ER and maximizes opportunities for collaboration with other members of the department. Group meetings are held approximately weekly by the AC group, two-weekly by the AXA Chair, and monthly by the department. Seminars within the AC group and department-wide additionally foster interaction and scientific exchange within and between the groups. The fellow will participate of group and department meetings regularly, and he will present his work at least 2 times a year during the action. One-to-one meetings with the supervisor will occur at least once every two weeks. Dr. Enza di Tomaso, an expert on aerosol data assimilation at the AC group, will closely co-supervise and collaborate with the ER at BSC.

Furthermore, BSC is committed to the principles of the *European Charter for Researchers* and *The Code of Conduct for the Recruitment of Researchers*, and has been awarded the *Human Resources Excellence in Research* logo in 2015, proofing it a favourable working environment.

1.4 Capacity of the researcher to reach or re-enforce a position of professional maturity/independence

The ER has shown his capacity to work in a range of problems related to atmospheric composition. He has worked on the evaluation of emission inventories in cities by using datasets of measured gas concentrations; in the critical analysis of aerosol satellite retrieval products over bright surfaces; in the analysis of LIDAR signals and the synergetic retrieval of AOD and aerosol properties; in aerosol and atmospheric modelling; in regional dust emission estimation by using DA techniques for wide range of satellite aerosol products and, more recently, in the exploratory study of shortwave radiance data assimilation for aerosol estimation. The ER skills and knowledge in numerical modelling, atmospheric and aerosol sciences, and DA techniques makes him an outstanding candidate to carry out this project.

This proposal includes the use and enhancement of an ensemble-based scheme for aerosol data assimilation in which the ER has less experience compared to his extensive knowledge of variational-based methods. The use of ensemble, localization and the Kalman filter approach will allow the ER to broaden his knowledge in atmospheric

composition DA, through the familiarization and mastering of different techniques, methods and approaches to the DA problem. This fellowship will strengthen the position of the ER as a DA expert, but also enhance his knowledge in the characterization of observation and model uncertainty. The capacity of mastering several techniques will allow him to look for innovative solutions and take the best choice in the implementation of the DA system to fulfil the objectives of this proposal, with a consequent positive impact also on his future career.

During his career, the ER has demonstrated his capacity to identify scientific and technical problems and to propose his own solutions. This project will encourage the researcher to continue and strengthen his professional independence while he works closely with the BSC-ES team.

The training given by the BSC on scientific and management aspects will enrich the ER competencies and will allow him to work as a successful independent scientist. Practical training actions, as participating in the writing process of collaborative publications and project proposals, or the co-supervision of students will contribute to the development of the fellow's maturity as researcher. Additionally, the ER will have the opportunity of collaborating with recognized institutions and researchers within the established BSC collaboration networks, which are fundamental for the evolution of a young scientist.

2. Impact

2.1 Enhancing the potential and future career prospects of the researcher

The ER will take advantage of the fellowship to expand his knowledge in several fields related to his main research interest. The current familiarity of the fellow with the variational approach to DA will be complemented with ensemble-based techniques. This will provide the fellow with a more complete perspective on the atmospheric composition DA problem in particular, and DA in general. After the completition of this fellowship the ER will have enough tools to evaluate the pros and cons of each of these approaches for future applications or projects related to atmospheric composition DA, and he will be able to implement, analyse and improve these systems.

The training in regional numerical modelling, model validation and verification will further broaden the ER knowledge on these key subjects for aerosol modelling. Even though the fellow had worked extensively in aerosol numerical modelling, the use of a highly parallelized non-hydrostatic model with relatively high spatial resolution will permit the fellow to have deeper insights into this topic. Currently, there is a lack of scientists with strong IT skills in numerical weather prediction and climate modelling, and the ER will be highly qualified in these topics. In addition, the ER will gain experience on model and observation representativity in the context of data assimilation. The secondment will contribute to this training that will be materialised with the use of localised aerosol observations (such as LIDAR or AERONET AOD) in the DA system.

The above-mentioned skills and knowledge are clearly transferable to future projects of the ER. In particular, the familiarity with the two most used and advanced methods for atmospheric DA will be highly valuable and will surely boost the ER career. Kalman filter methods are used in a variety of fields (e.g. ballistics, medical technology, seismology, visual recognition and tracking, etc.) besides atmospheric sciences, and the acquired ER skills will broaden his employability in the academia and industry.

The training on project preparation and management provided by the host will certainly give new tools to the ER to pursue his career, in the preparation and implementation of future high quality projects, either in the public or in the private sector. Dissemination and communication activities will help increasing the visibility and the publication record of the fellow's work in the atmospheric sciences research community. In the managing aspects, the fellow will be able to demonstrate the capacity of leading a research project integrally. The acquired knowledge will put the ER in a beneficial position to find a job in high-impact projects and world leading institutions, as for example in the Copernicus Atmosphere Monitoring Service.

From a more personal perspective, although the ER has the Spanish nationality, this fellowship will give him the opportunity to live in Spain for the first time, and to enrich his cultural and professional background and networks.

2.2 Quality of the proposed measures to exploit and disseminate the action results

Dissemination: The outcomes of this project will impact the aerosol and DA research field, as well as the users of the BSC aerosol forecast system. The major scientific findings and achievements will be published in renowned and high impact peer reviewed scientific journals on atmospheric science, as ACP, JGR, GMD or GRL. The work and findings will be disseminated in the research community through presentations in appropriate conferences and meetings such as the AGU fall meeting, EGU annual meeting, and the IGAC biannual meeting. This will benefit other DA users (non-aerosol DA or NWP DA users) and LIDAR users (e.g., in the preparation of future instruments' exploitation as for example from the ESA's Earth Explorer mission). The fellow will also present and discuss the project outcomes in more specific venues (e.g. Copernicus/CAMS annual general assembly,

AEROCOM meetings) and team meetings, such as the annual ICAP meeting, where given its nature and objectives, the action's results can influence the research and operational forecasts worldwide.

Exploitation: The results from the proposed work will be immediately and straightforwardly exploited for the benefit of European citizens and air-quality and climate researchers globally. The impact will be mostly done through the operational forecast of the SDS-WAS Regional Center. The improvement of the data assimilation system will impact positively the quality of dust and aerosol forecasts of the BSC (https://dust.aemet.es/), extending the outcomes of this project to all the users of this operational product. Currently, the BSC products are employed by a wide range of users, including international organizations, profit and non-profit companies, individuals and government institutions. This operational capability directly informs European and international legislators' work to develop air quality policy and regulations.

2.3. Quality of the proposed measures to communicate the action activities to different target audiences

Communication of research results and public engagement will be a key focus of the proposed work. The ER has a strong history in presentation of research results at scientific conferences. Additionally, BSC has dedicated staff and several operational programs in place that will help the ER to communicate his activities to other researchers, students, and the general public. First, important results and milestones will be published in the BSC newsletter for communication to the general public. Existing routes of communication at BSC (website, brochures, presentations, etc.) will also be employed to communicate project information, progress and results. Specific details of the communication through these channels will be developed in conjunction with BSC staff as part of WP1. The ER will further participate in MareNostrum (see section 3.4) open days at BSC, for students and the general public, and professional tours, which exceed 5000 visitors per year. The BSC operates as a PRACE Advanced Training Centre with a mission to provide training and education related to utilization of European supercomputing resources, including for environmental simulation. The ER will participate in the PRACE training program modules related to atmospheric modelling. Finally, results will be presented approximately once a year as part of the BSC Research Seminar Lecture series.

3. Quality and Efficiency of the Implementation

3.1 Coherence and effectiveness of the work plan

The work plan contains 5 work packages (WP) and each package contains, at most, 4 tasks (T). WP1 refers to the management and communication activities, while the other 4 are detailed in the methodology (section 1.1). WP1 includes the Career Development Plan (that will be updated every 6 months and will be elaborated under the supervisor's and Human Resources department guidance), the periodic bi-weekly meetings with the supervisor and research teams, the preparation of talks and presentation in scientific and non-scientific activities, the writing of deliverables (D), milestones (M) and publications, and the management coordination and related activities. The detail of the work plan and the Gantt chart is the following:

WP1: Management and communication [M1-M24]
WP2: Observation handling [M1-M6]
T2.1: LIDAR observation operator
T2.2: Preparation of LIDAR observations
T2.3: Observational error estimates
T2.4: Preparation of observations for validation
M2.1: Set of observations and bias quantification prepared for DA. [M5]
WP3: Design of the ensemble [M7-M12]
T3.1: Implementation of meteorological perturbations (derived from GEFS)
T3.2: Test and analysis of parameter perturbations
M3.1: Choice of the set of parameters perturbations [M11]
WP4: Simulations [M11-M19]
T4.1: Assimilation-free simulations
T4.2: Test and evaluations regarding the localization scheme
T4.3: Test and evaluations regarding the inflation of the background covariance matrix
M4.1: Choice of background covariance matrix tuning strategy and localization scheme [M15]
T4.4: Perform assimilations
M4.2: Publication on ensemble design and localization for LIDAR assimilation (OSSE) submitted [M18]
WP5: Evaluation and validation [M7-M24]
T5.1: Evaluation of (internal) DA skills
T5.2: Evaluation of analysed fields and forecasts against observations

M5.1: Publication on dust simulation submitted [M24]
M5.2: Publication on global simulation submitted [M24]

Deliverables:
D1.1: Career Development Plan [M1, M7, M13, M19, M24]
D1.2: Mid-term report of the action [M12]
D1.3: Final report of the action [M24]
D2.1: Report on the observations [M5]
D3.1: Report on the design of the ensemble [M12]
D4.1: Report on the regional dust simulation [M19]
D4.2: Report on the global simulation [M19]
D5.1: Report on the global and regional evaluation and validation [M24]

Training: Training events are scheduled according to the BSC training program: scientific writing [M2], how to make effective presentations [M6], time management [M11]; and at least 3 more trainings are planned for the second year (not yet scheduled by BSC): gender issues in research, scientific communication and outreach and proposal writing.

Communication: communication activities are organised periodically at the BSC (visits of students, science fairs). Documentation about the project (for non-specialists) will be also produced and disseminated (brochures, website).

Secondment: A secondment in the the Vrije Universiteit Amsterdam (VU) is proposed. The collaboration with Nick Schutgens will contribute to the methodological treatment of the LIDAR information in the DA system (WP2), the tuning of the DA system and the preparation of the idealised LIDAR assimilation simulations (WP4). Nick Schutgens is expert in aerosol data assimilation and observational representativity. Past and current collaborations with the BSC-ES group have been highly productive.

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP1																								
WP2																								
WP3																								
WP4																								
WP5																								
Deliverable	D1.1				D2.1		D1.1					D1.2 D3.1	D1.1						D1.1 D4.1 D4.2					D1.1 D1.3 D5.1
Milestone					M2.1						M3.1				M4.1			M4.2						M5.1 M5.2
Secondment																								
Training																								
Dissemination and exploitation													EGU conf.			ICAP meeting		IGAC conf.						

Table 1: Gantt Chart

3.2. Appropriateness of the allocation of tasks and resources

WP1 is dedicated to the preparation of documents, presentations and talks during the action. The BSC staff will support the financial, legal and managing activities of this WP. **WP2** covers the compilation of observations that will be used for the assimilation and validation. The LIDAR, satellite and ground-based observations that will be used are publicly available and are already stored at BSC. Bias quantification and quality check will be the most time-consuming activity; we estimate that this work can be done in 5 months. **WP3** will use computational tools (numerical model and LETFK) and infrastructure available at the BSC. In particular, the perturbed meteorological initial conditions (GEFS) for the numerical model are currently available at the BSC storage. The assigned 6 months to this WP is in agreement with the quantity of sensitivity simulations and tests required for the choice of the perturbed parameters. **WP4** will perform the actual data assimilation. The computing time and access to the HPC facilities is provided by the host institution, and no external resources are needed. Because the workflows to run the model and the DA system are already available at BSC, the time assigned to this task (9 months) is appropriate. **WP5** will evaluate the simulations throughout the project period once all the observations have been compiled and prepared, from M7 to M24. The final evaluation, analysis (WP5) and publications (WP1) of the results will be performed in the last 5 months.

3.3 Appropriateness of the management structure and procedures, including risk management

Management procedures: A qualified project manager will support the researcher in all the legal, financial and administrative arrangements needed and will work in close contact with Education, Human Resources and Communications departments for all training arrangements and dissemination and outreach activities. Finances of the project will be managed according to MSC funding rules signed at the grant agreement and will follow the established processes at the host organization, which has considerable experience in managing such projects. The ER will work in close contact with the supervisor and the staff, who will review the progress of the work through progress reports compiled as part of WP1. This, together with the meetings with the supervisor, will allow the evaluation of the progress against the work plan, and increase assistance in a timely manner if the necessity arises.

Risk management: ES-BSC provides an ideal infrastructure to carry out the proposed research that maximizes the potential for success while minimizing the administrative and research risks. It provides state-of-the-art high-performance computing infrastructure and personnel, computational and multidisciplinary science knowledge resources, a large, well respected international scientific network, and experience in the administration of European Union projects. Two areas of potential research-related risk have been identified: **1)** Difficulties in finding the localization parameters for LIDAR observations: the expertise of Dr. Nick Schutgens will be crucial to overcome this risk; a range of options are available for the choice of the localization scheme and parameters; an exhaustive exploration will be done supported by discussions with collaborators from ICAP members; **2)** Unavoidable biases between LIDAR and AOD observations in the DA system: a range of options are available to constrain LIDAR profiles to observed or simulated AOD; there will be a periodic exchange of ideas in this topic with external researchers (e.g., ECMWF, CAMS, ICAP members). If unexpected risks arise during the project, further contingency planning will be carried out as part of WP1.

3.4 Appropriateness of the institutional environment (infrastructure)

BSC is the National Supercomputer Facility in Spain, hosting unique HPC facilities (MareNostrum 4 – 13th fastest supercomputer worldwide and 3rd fastest in Europe in June 2017; MinoTauro – traditional CPU cores combined with GPU accelerators) and technical support (Computational Earth Sciences group – technicians providing advice on HPC facilities). The combination of outstanding HPC facilities and high-quality user support constitutes an excellent infrastructural basis. The ER will get access to all key research facilities, infrastructure, and equipment. He will get office space and supplies within BSC-Earth Sciences department, Edificio Nexus II, Jordi Girona Street 29, Barcelona. The high-performance capabilities and the close collaboration with the Computer Sciences department of BSC allow increasing the spatial/temporal resolution and to run ensemble simulations of atmospheric modelling systems, both to improve our knowledge on dynamic patterns of atmospheric constituents in complex terrains and atmospheric interactions/feedbacks of physico-chemical processes, and to allow data assimilation applications. Furthermore, BSC has extensive subscriptions to all relevant online journals, allowing immediate access to a comprehensive range of scientific literature. During the secondment at VU, the ER will be hosted by the Earth and Climate Cluster of the Faculty of Science. He will get space and will have at his disposal all the necessary resources and infrastructures needed in order to reach the scientific and training objectives of ALPACA. The secondment host is committed to provide to the applicant full access to available databases stored in their repositories, and in-house developed software for observation processing and data assimilation developments.

List of acronyms: ACP: Atmospheric Chemistry and Physics; **AD-NET**: Asian dust and aerosol lidar observation network; **AEROCOM**: Aerosol Comparisons between Observations and Models; **AERONET**: Aerosol Robotic Network; **AGU**: Americal Geophysical Union; **AOD**: Aerosol optical depth; **BDFC**: Barcelona Dust Forecast Center; **BSC**: Barcelona Supercomputing Center; **BSC-ES**: Earth Sciences Department at BSC; **CALIOP**: Cloud-Aerosol Lidar with Orthogonal Polarization; **CAMS**: Copernicus Atmosphere Monitoring Service; **CIS**: Community Intercomparison Suite; **DA**: Data assimilation; **EARLINET**: European Aerosol Research Lidar Network; **ECMWF**: European Centre for Medium-Range Weather Forecasts; **EGU**: European Geosciences Union; **ER**: Experienced researcher; **GEFS**: Global Ensemble Forecast System; **GMD**: Geoscientific Model Development; **GRL**: Geophysical Research Letters; **ICAP**: International Cooperative for Aerosol Prediction; **IGAC**: International Global Atmospheric Chemistry; **IT**: Information technology; **JGR**: Journal of Geophysical Research; **JMA**: Japan Meteorological Agency; **LETKF**: Local ensemble transform Kalman filter; **LIDAR**: Light detection and ranging; **LIVAS**: LIdar climatology of Vertical Aerosol Structure for space-based lidar simulation studies; **MODIS**: Moderate Resolution Imaging Spectroradiometer; **MONARCH**: Multiscale Online Non-hydrostatic Atmosphere CHemistry model; **MPLNET**: NASA Micro-Pulse Lidar Network; **NASA**: National Aeronautics and Space Administration; **NCEP**: National Centers for Environmental Prediction; **NOAA**: National Oceanic and Atmospheric Administration; **NMMB**: Non-hydrostatic Multiscale Model; **OSSE**: Observing system simulation experiment; **SDS-WAS**: WMO Sand and Dust Storm Warning Advisory and Assessment System; **VU**: Vrije Universiteit Amsterdam; **WMO**: World Meteorological Organization; **WP**: Work package.

Part B-2 Section 4 - CV of the Experienced Researcher

Name: Jerónimo José ESCRIBANO ALISIO
Nationalities: Spanish, Chilean, Argentinian
Date and place of birth: Cordoba, Argentina, 27/09/1985
Place of residence: Paris, France

The main scientific interest of the Experienced Researcher (ER) is atmospheric composition data assimilation, in particular aerosol data assimilation. This field combines a variety of research disciplines and it has a significant impact upon multiple environmental and human dimensions. The ER has a solid background on applied mathematics (mathematical engineering), and MSc and PhD studies on atmospheric sciences.

The ER has previously worked on statistical evaluations and analyses of emission inventories of gaseous compounds, analytical and modelling analyses of aerosol retrievals from satellite, and over the last years he has been involved mainly in aerosol data assimilation and numerical modelling. During his PhD, the ER implemented and evaluated a dust emission scheme into the LMDZ atmospheric model and improved the associated aerosol module. He also designed and implemented a variational data assimilation system, and performed an exhaustive analysis of the data assimilation products and methods. Special emphasis was given to the error uncertainty balance problem, bias correction, cost function minimization methods and to the description of the observational uncertainties within the DA system. The ER has worked with a range of aerosol-related observations including (CALIOP/CALIPSO) LIDAR measurements, and aerosol optical depth, both satellite-based (MODIS, MISR, SEVIRI, PARASOL) and ground-based (AERONET). More recently, the ER has been working in the CAMS43 project (of the Copernicus Atmosphere Monitoring Service, ECMWF/European Commission), where he is in charge of the exploratory study for the assimilation of short-wave satellite measured radiance for aerosol DA in the IFS model. This implies dealing with radiative transfer models and collaborating with the development teams in Europe and the US. He is also participating in a collaboration project that aims to quantify the information content of AERONET stations within the network in terms of AOD and AAOD (absorption AOD), to be used in AOD data assimilation.

Education

- March 2017: PhD at the Laboratoire de Météorologie Dynamique (LMD/IPSL), Université Pierre et Marie Curie, France. Thesis title: "Regional inversion of desert dust sources", under the direction of Olivier Boucher (LMD/CNRS) and Frédéric Chevalier (LSCE/CEA).
- October 2012: MSc. Meteorology and Climatology at the Department of Geophysics, University of Chile, Chile.
- October 2012: Mathematical Engineering at the Department of Mathematical Engineering, University of Chile, Chile.
- July 2010: Bachelor in Engineering Sciences, major in Mathematics. Department of Mathematical Engineering, University of Chile

Professional experience

- March 2017 to the present: Post-doctoral researcher at the Institut Pierre Simon Laplace (IPSL, Paris, France) in charge of the radiance aerosol data assimilation aspects of the CAMS43 project, part of the Copernicus Atmosphere Monitoring Service (ECMWF/European Commission).
- October 2012 – October 2013: Research assistant at the Center for Climate and Resilience Research – CR2 (Santiago, Chile), working on LIDAR and ceilometer aerosol inversions and supporting field campaigns.
- January – April 2011: Visiting student at CCST/CPTEC INPE (São Jose Dos Campos, SP, Brazil), working on regional atmospheric and aerosol modelling.
- December 2009 – March 2010: Research internship at the Center for Mathematical Modelling (UMI CNRS 2807, Santiago, Chile), working on the treatment of satellite sulphur dioxide observations for source inversions and data assimilation.

Teaching activities:

Teaching assistant at the University of Chile:

- Atmospheric Pollution (theory and practice), Autumn 2010, 2011, 2012, Spring 2011. Department of Geophysics. Prof. L. Gallardo
- Numerical Analysis in Partial Differential Equations (practice), Spring 2011, Department of Mathematical Engineering, Prof. A. Osses.
- Statistics (practice), Spring 2007, Autumn 2009. Department of Mathematical Engineering.
- Statistics (theory), Fall 2008, Spring 2008. Department of Mathematical Engineering. Prof. N. Lacourly
- Optimization (theory), Spring 2007, Department of Industrial Engineering

Awards

Top score in math test in the National Selection Test for University admission, Chile, 2003.

Languages

Spanish: Mother tongue
English: Advanced (C1), spoken and written
French: Elementary (A2/B1)
Portuguese: Beginner

Computer skills

Linux and HPC user, programming and scripting languages (Fortran, Python, Matlab, bash, Latex, C)

Publications

Escribano, J., Boucher, O., Chevallier, F., and Huneeus, N. (2017). Impact of the choice of the satellite aerosol optical depth product in a sub-regional dust emission inversion. *Atmospheric Chemistry and Physics*, 17(11): 7111–7126, doi: 10.5194/acp-17-7111-2017. 1 citation.

Escribano, J., Boucher, O., Chevallier, F., and Huneeus, N. (2016). Subregional inversion of North African dust sources. *Journal of Geophysical Research: Atmospheres*, 121(14):8549–8566, doi:10.1002/2016JD025020. 1 citation.

Hourdin, F., Gueye, M., Diallo, B., Dufresne, J.-L., Escribano, J., Menut, L., Marticoréna, B., Siour, G., and Guichard, F. (2015). Parameterization of convective transport in the boundary layer and its impact on the representation of the diurnal cycle of wind and dust emissions. *Atmospheric Chemistry and Physics*, 15(12): 6775–6788, doi: 10.5194/acp-15-6775-2015. 6 citations.

Escribano, J., Gallardo, L., Rondanelli, R. and Choi, Y.-S. (2014). Satellite retrievals of aerosol optical depth over a subtropical urban area: the role of stratification and surface reflectance. *Aerosol and Air Quality Research*, (14) 596–607, doi:10.4209/aaqr.2013.03.0082. 7 citations.

Gallardo, L., Escribano, J., Dawidowski, L., Rojas, N., Andrade, M.F. and Osses, M. (2012). Empirical evaluation of vehicle emissions inventories for carbon monoxide and nitrogen oxides for Bogotá, Buenos Aires, Santiago and São Paulo. *Atmospheric Environment*, (47):12-19, doi: 10.1016/j.atmosenv.2011.11.051. 26 citations.

Publications (in preparation)

Benedetti, A., Reid, J., Baklanov, A., Basart, S., Boucher, O., Brooks, I., Brooks, M., Colarco, P., Da Silva, A., Cuevas, E., Escribano, J., Huneeus, N., Kazadzis, S., Kinne, S., Knippertz, P., Laj, P., Marsham, J., Menut, L., Mona, L., Rémy, S., Sekiyama, T., Tanaka, T., Terradellas, E., Wiedensohler, A. Observation requirements for global operational aerosol prediction. *To be submitted.*

Conferences

Poster: Gallardo, L., Henríquez, A., Escribano, J., Huneeus, N., Osses, A. and Rémy, S. Quantifying information content and gaps in the AERONET network in South America. *14th Science Conference of the International Global Atmosphere Chemistry (IGAC) Project*. Breckenridge, CO, USA, September 2016.

Poster: Escribano, J., Boucher, O., Chevallier F. and Huneeus, N. Subregional inversion of North African dust sources. *LEFE-CHAT workshop on mineral dust*, Créteil, France, March 2016.

Poster: Escribano, J., Boucher, O., Chevallier F. and Huneeus, N. Inversion of aerosol sources over the Sahara desert using satellite observations, *European Geophysical Union (EGU) general assembly*, Vienna, Austria, April 2015.

Oral presentation: Escribano, J., Boucher, O., Chevallier F. and Huneeus, N. Inversion of dust source over Sahara. *MACC-III General assembly*. Reading, United Kingdom, January 2015.

Poster: Escribano, J., Boucher, O., Chevallier, F., and Huneeus, N. Inversion of aerosol sources over the Sahara Desert using satellite observations. *13th Symposium of the International Commission on Atmospheric Chemistry and Global Pollution (ICACGP), 13th Science Conference of the International Global Atmosphere Chemistry (IGAC) Project*. Natal, Brazil, September 2014.

Oral presentation: Escribano, J., Rondanelli, R. and Choi, Y.-S. Satellite retrievals of aerosol optical depth over a subtropical urban area: the role of stratification and surface reflectance. *MACC-II Open Science Conference*, Brussels, Belgium, January 2014.

Poster: Escribano, J., Gallardo, L., Rondanelli, R., Choi, Y.-S. The effects of boundary layer height and surface reflectance on the relation between aerosol optical depth and mass concentration over Santiago. *12th Open Science Conference of the International Global Atmosphere Chemistry (IGAC) Project*. Beijing, China, September 2012.

Poster: Escribano, J., Carvajal, P., Gallardo, L., Rondanelli. Remote vs. in situ observations of aerosols over the Santiago basin: representativity and trends. *2nd Conference of the Brazilian Association for Aerosol Research*. Rio de Janeiro, Brazil, August 2011 .

Poster: Gallardo, L., Escribano, J., Ross, C., Osses, M. and Dawidowski, L. Empirical evaluation of vehicle emissions of carbon monoxide and nitrogen oxides in Santiago, Chile and Buenos Aires, Argentina. *12th Symposium of the International Commission on Atmospheric Chemistry and Global Pollution (ICACGP), 11th Science Conference of the International Global Atmosphere Chemistry (IGAC) Project*. Halifax, Canada, July 2010.

Poster: Gallardo, L., Escribano, J. And Ross, C. Empirical evaluation of vehicle emissions of carbon monoxide and nitrogen oxides in Santiago, Chile. *South American Emissions, Megacities and Climate (SAEMC) Final Meeting*, Buenos Aires, Argentina, May 2010.

Poster: Macías, F., Escribano, J., Osses, A. and Gallardo L. An algorithm to estimate the source of sulfur dioxide. *International Center for Pure and Applied Mathematics (CIMPA) Summer School Inverse Problems and Applications - Workshop on Inverse Problems and Applications*. Santiago - Valparaiso, Chile, January 2010.

Oral seminar: "The effects of boundary layer height and surface reflectance on the relation between aerosol optical depth and mass concentration over Santiago". *Ewha Womans University*, Seoul, Korea. September 2012.

Funding

- Copernicus Atmosphere Monitoring Service, implemented by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the European Commission.
- OSIRIS project from MEDDE/INSU, France.
- France-Chile ECOS project C14U01.
- GENCI projets t2014012201, t2015012201 and t2017012201.
- South American Emissions. Megacities and Climate (SAEMC) project, funded by the Inter-American Institute for Global Change Research (IAI) CRN II 2017 which is supported by the US National Science Foundation (Grant GEO-0452325).

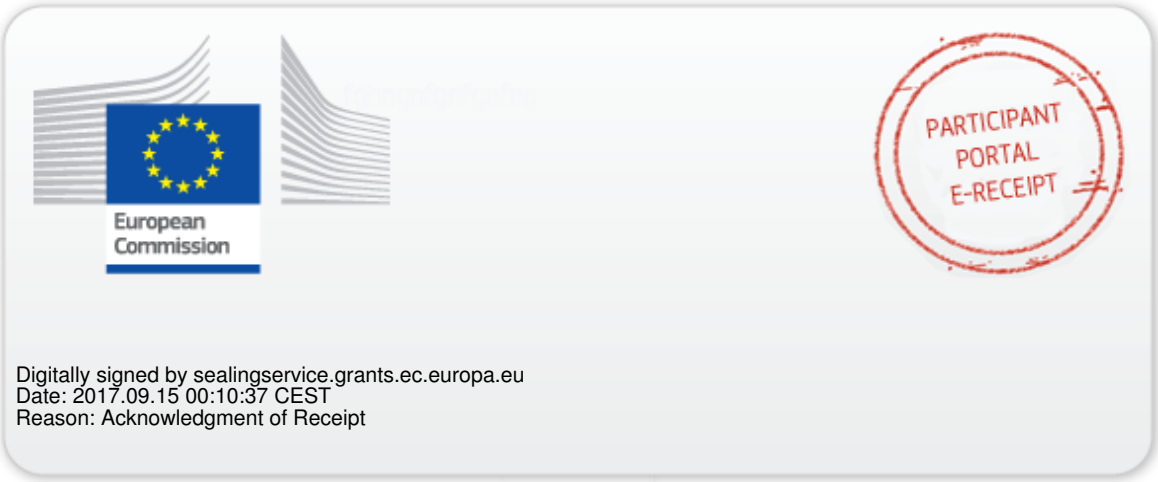
Part B-2 Section 5 - Capacity of the Participating Organisations

Beneficiary: Barcelona Supercomputing Center – Centro Nacional de Supercomputación	
General Description	Established in 2005, the **Barcelona Supercomputing Center (BSC)** serves as the national supercomputing facility in Spain. BSC hosts 1 of the 6 European Tier-0 supercomputers and is among the best supercomputing centres in the world. BSC strives to be a first-class research centre in scientific fields that demand high-performance computing (HPC) such as Life Sciences, Earth Sciences, and Engineering. BSC has brought together a critical mass of first-rate researchers, HPC experts and cutting-edge HPC technologies to foster multidisciplinary scientific collaborations and innovations. Between 2013 and 2017, BSC has recruited 86 pre-doctoral students, 111 Postdocs and Senior Scientists, 132 technical support staff and 47 management staff members, 255 from Spain, 71 from EU countries and 50 from outside Europe. BSC counts more than 470 staff members from around 42 countries. Recruitment is based on principles of merit, transparency, competition and gender balance, and the centre has been awarded with the badge of Human Resources Excellence in Research (HRS4R) in 2015. The applicant will be enrolled at the **BSC Earth Sciences Department (BSC-ES).** The ES department is structured around four groups, with more than 65 employees, including technical and support staff. It is a highly productive scientific entity that has published more than 135 research articles in peer-reviewed journals over the last four years (2014-2017), including 103 in prestigious high-impact journals (publications of the department: https://earth.bsc.es/wiki/doku.php?id=publications:_publications). It is expected that the BSC-ES will increasingly play in the next few years a significant role in the national and international scenes, according to its size and resources.
Role and Profile of key persons (supervisor)	**Dr. Carlos Pérez García-Pando** (supervisor) is Ramón y Cajal Researcher, AXA Professor on Sand and Dust Storms, and leader of the Atmospheric Composition group at BSC-ES. He is a leading expert in dust and more generally aerosol research and has vast experience in the development of Earth-system models. **Dr. Enza di Tomaso** (co-supervisor) is a researcher in the Atmospheric Composition group at BSC-ES. She is an expert on ensemble-based data assimilation, and is in charge of the data assimilation developments and projects developed by the group.
Key Research Facilities, Infrastructure and Equipment	BSC hosts and manages a range of HPC systems, including MareNostrum 4, with 148,176 cores and 13.7 Pflops capacity. Additionally, BSC manages Minotauro, a Sandy Bridge's cluster with NVIDIA GPUs, providing more than 100 TFlops.
Independent research premises?	Yes. All key research facilities, infrastructure, and equipment will be available for the fellow.
Previous Involvement in Research and Training Programmes	Until September 2017, BSC has been involved in more than 150 completed projects (inter alia: 41 individual grants/fellowships/personnel support; 9 EU-FP6; 51 EU-FP7; 13 EU other funding scheme projects (e.g. ESA, Copernicus) and many National projects) e.g. IS-ENES, APPRAISAL, FIELD_AC, PRACE 1lP, PRACE 2iP, Mont-Blanc, ScalaLife, OPTIMIS, PELE, RISC) and many private contracts. BSC also participated in the MC ITN project (SCALUS: FP7-PEOPLE-ITN-2008-238808) and three Marie Curie IEFs (EEPPIBM: FP7-PEOPLE-2012-IEF-327899, MatComPhys: FP7-PEOPLE-2011-IEF-302320 and MDRAF: FP7-PEOPLE-2013-IEF-622662).
Current involvement in Research and Training Programmes	**Collaborations with universities**: BSC closely collaborates with Universidad Politècnica de Catalunya (UPC) including a joint Master degree in Environmental Engineering. **Excellence Programs and Networks:** Severo Ochoa Excellence Programme (Research seminars series); RES training sessions; NVIDIA CUDA/GPU excellence center (PUMPS summer school); PRACE Advanced Training Center; HiPEAC (ACACES summer school, Computing system weeks and HiPEAC conferences) and H2020-EINFRA-Centers of Excellence for computing applications. **Research Fellowships**: BSC is currently awarded with 6 early-stage postdocs (4 Juan de la Cierva and 2 Beatriu de Pinós), 12 seniors (5 Ramón y Cajal, 3 I3 and 6 ICREA) and is supporting 4 MSCA ITN and 5 MSCA-IF. Noteworthy, three of these MSCA-IF are currently conducted at BSC-ES (NeTNPPAO, ACRoNNIM, SPFireSD), which will host the proposal on hand. In addition, BSC is the main beneficiary of a MSCA COFUND program for postdoc fellows, which foresees the implementation of a training programme (STARS; H2020-MSCA-COFUND-754433). **Projects:** Total of 111 ongoing projects are funded by the European Commission (FP7, Horizon 2020, Copernicus, COST Action): e.g. Euroserver, DEEP, PRIMAVERA, EUDAT, PRACE 3IP; 37 at BSC-ES (4 EU-FP7, 21 EU-H2020, 12 EU-Other) and 8 National Projects.
Relevant Publications and/or research/innovation products	(1) *NMMB/BSC-Dust forecasts:* http://dust.aemet.es (2) *Pérez et al. (2011),* Atmospheric dust modeling from meso to global scales with the online NMMB/ BSC-Dust model – Part 1: Model description, annual simulations and evaluations, *Atmos. Chem. Phys.*, 11, 13001–13027 (3) *Pérez García-Pando et al. (2014),* Soil dust aerosols and wind as predictors of seasonal meningitis incidence in Niger, *Environ. Health Perspect.*, 122 (7), 679–686 (4) *Pérez García-Pando et al. (2016),* Predicting the mineral composition of dust aerosols: Insights from elemental composition measured at the Izaña Observatory, *Geophys. Res. Lett.*, 43, 10520–10529 (5) *Di Tomaso E., Schutgens N.A.J., Jorba O., Pérez García-Pando C. (2017),* Assimilation of MODIS Dark Target and Deep Blue observations in the dust aerosol component of NMMB-MONARCH version 1.0, *Geosci. Model Dev.*, 10, 1107–1129

Partner Organisation: Vrije Universiteit Amsterdam	
General Description	The Earth and Climate Cluster of the Faculty of Science from the Vrije Universiteit Amsterdam (VU; 23,000 students, over 4,400 scientific publications, and 265 doctoral theses in 2015) specialises in understanding past, present, and future climate changes and their impact on terrestrial and oceanic environments. The part of the cluster relevant to this proposal focuses on global aerosol, using a combination of Earth models, remote sensing datasets and statistical tools (data assimilation) to better understand aerosol forcing of climate and aerosol impact on the environment.
Key Persons and Expertise (supervisor)	**Dr. Nick Schutgens** (supervisor) is an expert in data assimilation and the use of remote sensing data in evaluating and improving global aerosol models. He has worked for 13 years abroad, at the universities of Tokyo (Japan) and Oxford (UK). He is closely involved in AEROCOM, an international community of global aerosol modellers. **Prof. dr. Guido van der Werf** leads the climate and carbon cycle group and has developed the Global Fire Emissions Database (GFED) together with colleagues from the US (NASA and University of California, Irvine).
Key Research Facilities, Infrastructure and Equipment	VU has a supercomputer facility that will be available for this project, although it is likely the fellow will prefer remote access to the BSC facilities. VU offers access to an extensive library network and licenses for geospatial and other software. VU also provides a range of facilities to help integration of international scholars.
Previous and Current Involvement in Research and Training Programmes	Within the faculty several groups have led or are involved in previous MC traineeships and other research programmes. Nick Schutgens has supervised 1 MSc student, 4 PhD students and 4 junior postdocs (not related to MC). Guido van der Werf was recipient of an ERC Starting Grant on fire emissions between 2011 and 2016. In the first period of Horizon 2020, VU Amsterdam has acquired 60 grants across all pillars and priorities, among which 32 as coordinator. A total of 20 Marie Curie grants were obtained in 2014-2016. The research group currently has one large Vici grant (1.5M, 2017-2022, van der Werf) from the Netherlands Organisation for Scientific Research (NWO) on emissions from fires. The group is currently also involved in the Netherlands Earth System Science Center (NESSC) and the Monitoring Atmospheric Composition & Climate (MACC) project. In addition, the group manages several smaller NWO grants.
Relevant Publications and/or research/innovation products	(1) *Schutgens N.A.J., Miyoshi T., Takemura T., Nakajima T. (2010)*, Applying an ensemble Kalman filter to the assimilation of AERONET observations in a global aerosol transport model, *Atmos. Chem. Phys.*, 10, 2561–2576 (2) *Schutgens N.A.J., Miyoshi T., Takemura T., Nakajima T. (2010)*, Sensitivity tests for an ensemble Kalman filter for aerosol asimilation, *Atmos. Chem. Phys.*, 10, 6583–6600 *(3) Dai T., Schutgens N.A.J., Goto D., Shi G., Nakajima T. (2014)*, Improvement of aerosol optical properties modeling over Eastern Asia with MODIS AOD assimilation in a global non-hydrostatic icosahedral aerosol transport model, *Environmental Pollution* 195, 319–329.

Part B-2 Section 6 - Ethical Issues

The fellow is aware and will comply the Charter of Fundamental Rights of the European Union and the European Convention on Human Rights and its Supplementary Protocols, and no potential ethics issues has been identified in this proposal.



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