Research Executive Agency

7th Framework Programme for Research, Technological Development and Demonstration

Marie Curie Intra-European Fellowships for Career Development (IEF)

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7th Framework Programme for Research, Technological Development and Demonstration

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A1: Summary

Proposal Number	622662	Proposal Acronym	MDRAF

General Information

Proposal Title	Effects of Mediterranean desert dust outbreaks on radiation, atmospheric dynamics and forecasting accuracy of a numerical mesoscale model

Are you applying for this grant in order to resume a career after a break? ○ yes ◉ no

If so, for how long have been inactive in research? _____ months

Marie Curie action-code	MC-IEF	Scientific Panel	ENV
Duration in months	24	Call identifier	FP7-PEOPLE-2013-IEF
Keywords (up to 200 characters)	satellite, dust, Mediterranean, modeling, atmospheric dynamics, radiative effects, optical properties, feedback mechanisms, radiation, climate, dynamic meteorology, synoptic meteorology,NMMB/BSC-CTM		

Descriptor 1	V202
Descriptor 2	V203
Descriptor 3	V214

Abstract (up to 2000 characters)

The main objective of the proposed project (MDRAF) is to describe the 3D structure of Mediterranean desert dust outbreaks and study their effects on radiation and atmospheric dynamics by means of numerical modeling (NMMB/BSC Chemical Transport model-NMMB/BSC-CTM). Moreover, the meteorological feedbacks and the forecasting accuracy of NMMB/BSC-CTM when dust effects are considered will be assessed. The study region covers the broader Mediterranean basin and the analysis extends over the period 2002-2012. For the identification of desert dust outbreaks, an objective and dynamic algorithm will be set up where as initial conditions various aerosol optical properties derived by MODIS-Aqua, EP-TOMS and OMI platforms will be used. Additionally, satellite (CALIPSO) and ground (EARLINET) measurements providing the vertical profile of dust loads will be also analyzed. The accuracy of algorithm's outputs will be evaluated against optical (AERONET) and physical (PM10) measurements. At the next step, the direct radiative effect (DRE) will be estimated at the top of atmosphere, into the atmosphere and at surface for the shortwave (SW), longwave (LW) and net (SW+LW) radiation. The induced radiative effects are expected to affect the vertical atmospheric heating profile leading to a modification of the atmospheric dynamics. For this purpose, it will be studied how dust DREs affect the temperature vertical structure, the surface temperature and sensible/latent heat fluxes, stability/instability conditions, the convective available potential energy (CAPE), clouds and precipitation formation. Also, the possible feedbacks induced by dust particles affecting thus their production/removal rates as well as the atmospheric circulation patterns related with their transport processes will be also examined. At the final stage of the project, the forecasting accuracy of the NMMB/BSC-CTM will be examined for several atmospheric parameters, locally and spatially, when dust effects are considered.

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Has a similar proposal been submitted to a Marie Curie Action under this RTD Framework Programmes?	○ Yes	◉ No
Does this proposal include any of the sensitive ethical issues detailed in the Research Ethical Issues table of Part B?	○ Yes	◉ No

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A2: Participants

Proposal Number	622662	Proposal Acronym	MDRAF	Participant Number	1

Information on organisations

If your organisation has already registered for FP7, enter your Participant Ident. Code	999655520
Organisation Legal name	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION
Organisation short name	BSC

Administrative data

Street name	Calle Jordi Girona	Number	31
Town	BARCELONA	Postal Code/Cedex	08034
Country	ES		
Internet homepage	www.bsc.es		

Status of your organization

Certain types of organisations benefit from special conditions under the FP7 participation rules.
The Commission also collects data for statistical purposes. The guidance notes will help you complete this section.

Please 'tick' the relevant box(es) if your organisation falls into one or more of the following categories

Non-profit organisation	(•) Yes	( ) No
Public body	(•) Yes	( ) No
Research organisation	(•) Yes	( ) No
Higher or secondary education establishment	( ) Yes	(•) No
International organisation	( ) Yes	(•) No
International organisation of European Interest	( ) Yes	(•) No
Joint Research Center of the European Commision	( ) Yes	(•) No
Entities composed of one or more legal entities [European Economic Interest Group (Unité mixte de reserche) / Enterprise groupings]	( ) Yes	(•) No
Commercial Enterprise	( ) Yes	(•) No

Main area of activity (NACE code)	72

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1. Is your number of employees smaller than 250? (full time equivalent)	○ Yes	◉ No
2. Is your annual turnover smaller than € 50 million?	◉ Yes	○ No
3. Is your annual balance sheet total smaller than € 43 million?	◉ Yes	○ No
4. Are you an autonomous legal entity?	◉ Yes	○ No

You are NOT an SME if your answer to question 1 is "NO" and/or your answer to both questions 2 and 3 is "NO". In all other cases, you might conform to the Commission's definition of an SME. Please check the additional conditions given in the guidance notes to the forms

Following this check, do you conform to the Commission's definition of an SME? ○ Yes ◉ No

Contact point of the host organization

Scientist in charge (For the co-ordinator (participant number 1) this person is the one who the REA will contact in the first instance)

Family Name	Baldasano		
First Name(s)	Jose Maria		
Title	Prof.	Gender	◉ male ○ female
Position in the organisation	EARTH SCIENCES DEPARTMENT DIRECTOR		
Department/Faculty/Institute/Laboratory name/...	Earth Sciences - Air Quality		
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Fax +		E-mail	santiago.gasso@bsc.es

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Town	Barcelona	Postal Code/Cedex	08034
Country	ES		

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Authorised representative to sign the grant agreement or to commit the organisation for this proposal

Family Name	Valero Cortés				
First Name(s)	Mateo				
Title	Prof.	Gender	(•) male	( ) female	
Position in the organisation	Director				
Department/Faculty/Institute/Laboratory name/...	Directors				
Phone1	+ 34	934134053	Phone2	+	
Fax	+		E-mail	mateo.valero@bsc.es	

Is the address different from the legal address? (•) Yes ( ) No

Street name	Jordi Girona, Edificio Nexus II, 1a Planta	Number	29
Town	Barcelona	Postal Code/Cedex	08034
Country	ES		

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A3: Participants

Proposal Number: 622662 Proposal Acronym: MDRAF

Information on the researcher

Family Name: Gkikas

Family Name at Birth: Gkikas

First Name(s): Antonis

Title: Dr. Gender: (•) male ( ) female

1st Nationality: EL 2nd Nationality:

Date of birth (DD/MM/YYYY): 11/12/1979

Location of origin (Country): EL

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Country: EL

Phone1: + 30 2651008735 Phone2: +

Fax: +

E-mail: agkikas@cc.uoi.gr

Qualifications

University Degree	Date of award (DD/MM/YYYY)	28/04/2004
Doctorate (in progress)	Date of award (DD/MM/YYYY)	
Doctorate	Date of award (DD/MM/YYYY)	04/02/2013
Full time postgraduate research experience	Number of months	60
Other Academic qualifications	Date of award (DD/MM/YYYY)	

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

Indicate the period(s) and the country/contries in which you have legally resided and/or had your main activity (work, status, ..) during the last 5 years up until the deadline for the submission of the proposal. The 5 years prior to the deadline should be covered.

Period from	Period to	Duration (days)	Country	
14/08/2008	14/08/2013	1827	EL	Remove

Total 1827

Add Row

Have you submitted or are you in the process of submitting another proposal for the Marie Curie Actions: IEF, IOF, IIF or CIG, or have you previously benefited of Community funding under Marie Curie Actions

○ Yes ◉ No

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A4: Budget

Proposal Number 622662 Proposal Acronym MDRAF

FUNDING REQUEST

Main Phase		
Year	Full-time person-months	Type B Fixed-amount Fellowship (Y/N)
1	12	N
2	12	N

Mobility allowance

Are you eligible for the family-related mobility allowance? ○ Yes ◉ No

Post-graduate Research Experience of the applicant at the deadline of the call. 4-10 years

STARTPAGE

PEOPLE
MARIE CURIE ACTIONS

Marie Curie Intra-European Fellowships (IEF)
Call: FP7-PEOPLE-2013-IEF

PART B

"MDRAF"

B1 RESEARCH AND TECHNOLOGICAL QUALITY

B1.1 Research and technological Quality, including any interdisciplinary and multidisciplinary aspects of the proposal

Annually, the Mediterranean basin is affected by transported dust aerosol loads that originate in North African and Middle East deserts, which have been identified as the major dust source areas worldwide (e.g. Washington et al., 2003). This transport reveals both spatial and temporal characteristics driven mainly by the prevailing synoptic conditions as well as by the production and removal rates of mineral particles. In many cases, these loads are recorded at high concentrations (outbreaks or episodes or events) revealing also a wide geographical extent that affects in many ways large parts of the Mediterranean. In order to describe the Mediterranean desert dust outbreaks' features, many researchers have used combinations of ground or satellite retrievals or model techniques in an inter-disciplinary approach to the problem. Nevertheless, each one of the aforementioned methods presents advantages or disadvantages concerning measurement accuracy, spatiotemporal representation as well as theoretical assumptions. For example, ground measurements of aerosol optical properties are more accurate than the satellite retrievals or model outputs but their main limitation is that they are representative only locally. On the contrary, satellite measurements provide a wide view of the aerosol burden but their accuracy is affected by several factors such as clouds, surface reflectance and assumptions in their retrieval algorithms. Due to the development of modern and advanced sensors, especially after 2000, the accuracy of satellite measurements has increased rapidly leading many scientists to use them in aerosol research. The implementation of model tools can be also characterized as an appropriate method in aerosol studies but the accuracy of their outputs is strongly determined by the quality of their initial conditions and the considered theoretical background.

As already mentioned above, the Mediterranean is affected by desert dust outbreaks originated primarily in the Sahara desert and secondarily in the Middle East. More specifically, its eastern parts are more affected in winter and spring, the central ones in autumn and the western parts in summer (e.g. Gkikas et al., 2009). Additionally, the intensity of desert dust outbreaks is higher near to the North African coasts decreasing towards northern latitudes. Nevertheless, in the case of intense low-pressure systems, the transport range can reach to the Arctic regions (Barkan and Alpert, 2010). On a seasonal basis, dust outbreaks are more intense in the dry than in the wet period (Moulin et al., 1998) of the year attributed to the seasonality of production (e.g. Sharav cyclones) and removal mechanisms (e.g. precipitation) strength.

The longitudinal shift of dust transport activity is determined mainly by the prevailing synoptic conditions (Gkikas et al., 2012). In addition, it has been established that the phase of North Atlantic Oscillation (NAO) is a determinant factor for dust abundance in the Mediterranean (e.g. Pey et al., 2013). The relation between the atmospheric circulation and desert dust transport in the Mediterranean has been studied by many researchers in the past (e.g. Meloni et al., 2008). In all these studies it has been reported that massive dust loads are transported towards the Mediterranean when cyclonic conditions prevail. Moreover, under these atmospheric conditions, strong southerly winds prevail as well as updraft air motions, uplifting thus desert dust particles at high altitudes into the troposphere. Based on lidar measurements, desert dust particles can be recorded up to 10 km into troposphere (Gobbi et al., 2000) while the higher concentrations are found between 1.5 km and 6.5 km (e.g. Mona et al., 2006). However, under desert dust episodes conditions, the main dust aerosol burden is recorded at around 3 km (Kalivitis et al., 2007).

The description of desert dust episodes characteristics has been the subject by many researchers in the past. In these works, different measurements have been used derived by ground, satellite and model databases. More specifically, the regime of desert dust episodes on a climatological basis has been presented from Toledano et al. (2007) and Meloni et al. (2007) for El Arenosillo (2000-2005) and Lampedusa (1999-2005), respectively. On the contrary, many scientists (e.g. Gómez-Amo et al., 2011) focused their interest on the description of specific desert dust outbreaks in the eastern, central and western Mediterranean. In all the above works, ground measurements of aerosol optical properties derived by the AErosol RObotic NETwork (AERONET) or vertical profile concentrations derived by the

European Aerosol Research Lidar Network (EARLINET) have been used. Recently, Pey et al. (2013) described the characteristics of African dust outbreaks, over the period 2001-2011, based on ground PM_{10} concentrations measured at different locations in the Mediterranean. The incorporation of analysis by the atmospheric chemistry community is a welcome multi-disciplinary component in the study of dust episodes. Satellite observations are able to provide a wide view of aerosol optical properties which is very important in cases of desert dust outbreaks. According to existing knowledge, many researchers have used satellite data only for specific cases and not on a climatological basis. A first approach to describe the frequency, intensity and duration of Mediterranean desert dust episodes for a relatively long period (2000-2007) was made by Gkikas et al. (2013). Finally, desert dust outbreaks have been also studied by the implementation of model tools (e.g. Santese et al., 2010).

Desert dust aerosols comprise one of the most important climatic agents since they interact both with shortwave (SW) and longwave (LW) radiation leading to a perturbation of the Earth-Atmosphere system's radiation budget. This perturbation can be made either directly (through scattering and absorption) or indirectly (via modification of cloud properties) or semi-directly (cloud dissipation due to radiation absorption by aerosols). Among the three processes, describing the interaction between aerosols and radiation, the most studied is the direct radiative effect (DRE) although the uncertainty of the estimated calculations remains high. Regarding the uncertainty of indirect and semi-direct aerosols effects, these are even higher since the feedback mechanisms between aerosols and clouds are more complicated and not well represented until now.

Dust aerosols interact directly with the incoming solar radiation through scattering and absorption while they absorb and emit longwave radiation. Among the two spectrum ranges, the effect of desert dust aerosols has a negative sign (cooling) in the shortwave (SW) and a positive sign (warming) in longwave (LW) radiation, while due to the higher impact on SW radiation the net (SW+LW) effect is negative (cooling). A part of the incoming solar radiation is absorbed by the desert dust aerosol layer causing atmospheric warming and surface cooling. The overall effect of mineral particles at the top of the atmosphere, in most cases, is negative (cooling) since surface cooling is higher than atmospheric warming. Therefore, dust aerosols lead to planetary cooling (e.g. Xia and Zong, 2009) or warming (e.g. Papadimas et al., 2012), depending also on the surface albedo (e.g. Osborne et al., 2011). It is important therefore to study the dust radiative effect under episodal conditions where it is expected to reach a maximum. In contrast to other dust affected areas (e.g. Atlantic Ocean), the number of studies dealing with the estimation of dust DRE in the Mediterranean is limited. In most of them, the DREs have been calculated based on ground measurements or model techniques either for specific dust episodes or for the SW spectrum range.

The induced perturbation of the radiation field by mineral particles leads to a redistribution of the energy into the Earth-Atmosphere system and thus it is expected to cause modifications on atmospheric dynamics. More specifically, it is well known in the literature that dust can affect components of the hydrological cycle (e.g. Mallet et al., 2009), cloud properties (e.g. Huang et al., 2006), precipitation (e.g. Rosenfeld et al., 2001), sea surface temperature (e.g. Foltz and McPhaden, 2008) and spin down monsoon circulation (e.g. Lau et al., 2006). A comprehensive analysis of dust aerosol effects on the radiation field is crucial since their inclusion in numerical weather models substantially improve the accuracy of forecasting products. Clearly, a study of the impact of dust episodes on climate requires multi-disciplinary expert knowledge from several different subject areas.

In order to assess the impact of desert dust outbreaks on atmospheric dynamics, the implementation of model techniques by MDRAF it is hoped that will provide a novel and possibly the unique solution. Based on model simulations, it can be clarified which factors will have the greatest impact on various atmospheric processes, hence increasing the forecasting accuracy of numerical weather models. Also, the investigation of positive and negative feedbacks induced by deserts dust outbreaks will help in our understanding of their precise role in the Earth-Atmosphere system. It is certain that many questions must be answered about the connection of desert dust aerosols with meteorology and the proposed project aims to address this point by building on the broad inter-disciplinary and multi-disciplinary foundation now present. It is also expected that a scientific base will be established to extend further our knowledge about how desert dust outbreaks are related with possible climatic changes.

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B1.2 Appropriateness of research methodology and approach

In the present section, the main objectives of the proposed project are presented. In each one of them, the features of the Mediterranean desert dust outbreaks, their impact on the radiation field and atmospheric dynamics, their feedbacks and the accuracy of a numerical mesoscale model, are analyzed. The main objectives of the proposed project are:

1. *Description of the 3D spatial and temporal characteristics of the Mediterranean desert dust outbreaks in relation to climatology*

For the identification of desert dust episodes, over the period 2002-2012, an objective and dynamic algorithm will be developed. The basic features of such an algorithm are presented in Gkikas et al. (2009; 2013). Nevertheless, an updated version of the algorithm will be used. As initial conditions to the algorithm, various satellite aerosol optical properties provided at 1°x1° spatial resolution and on a daily basis will be used. More specifically, the aerosol parameters which have been selected describe the load via the aerosol optical depth (AOD), the size of aerosol particles (Ångström exponent, α), the contribution of fine particles to the total load (Fine Fraction, *FF*), the aerosols absorptivity (Aerosol Index, *AI*) and their mean size in the whole atmospheric column (Effective Radius, r_{eff}). In brief, the algorithm firstly identifies cases, in each pixel, where AOD_{550nm} is higher than computed thresholds, which have been calculated from the mean and standard deviation values, over the study period. At the second phase, the α, FF, AI and r_{eff} are used for the identification of desert dust episodes by setting appropriate upper or lower thresholds depending on the parameter. Apart from the coarse resolution aerosol data (1°x1°), fine resolution data (10km x 10km) are going to be analyzed in order to give a better representation of the spatial patterns of desert dust outbreaks. For the description of the vertical structure of desert dust episodes, a synergistic use of CALIOP/CALIPSO retrievals will be made providing information (e.g. extinction coefficient) at different altitudes into the atmosphere. The algorithm's identification/classification is going to be evaluated against: (i) aerosol optical properties derived from AERONET stations located in the Mediterranean, (ii) vertical measurements of the aerosol load derived by the EARLINET network, (iii) ground measurements of PM_{10} concentrations and (iv) dust model outputs (from the DREAM model). Summarizing, in the first part of the project the main characteristics of the Mediterranean desert dust outbreaks such as frequency, intensity and duration at different spatial and temporal scales are going to be studied. In addition, for a first time, the 3D structure of desert dust episodes in the whole Mediterranean basin will be presented on a climatological basis.

2. *Direct radiative effects induced by desert dust outbreaks*

In the second part of the proposed project, the dust DRE under desert dust episodal conditions is going to be estimated. For this purpose, specific desert dust outbreaks revealing either massive loads or wide spatial extent are going to be selected as study cases based on the results obtained in the previous objective. The direct radiative effect of desert dust aerosols on radiation is going to be computed based on NCEP (National Centers for Environmental Prediction) non-hydrostatic Multiscale Model (NMMB/BSC-Dust/CTM model) which is a further evolution of Non-hydrostatic Mesoscale Model (WRF-NMM). The full description of the model is provided by Pérez et al. (2011), Haustein et al. (2012) and Spada et al. (2013). Briefly, the NMMB/BSC Dust model is a new unified atmospheric model for a broad range of spatial and temporal scales. In its simulations several WRF (Weather Research and Forecasting) parameterizations schemes are used for the treatment of turbulence in the planetary boundary layer (PBL) and in the free atmosphere, the surface layer scheme, the NCEP NOAH land surface model or the LISS (Land Ice Sea Surface) model, the GFDL (Geophysical Fluid Dynamics Laboratory) longwave and shortwave radiation, the Ferrier gridscale clouds and microphysics, and the Betts-Miller-Janjic convective adjustment scheme.

For each study case, two model runs will be made. In the first run, desert dust aerosols are included (the "with" case) into the simulations, while in the second run mineral particles are absent (the "without" case). By subtracting these two runs (i.e. with-without) the direct effect on radiation induced by dust aerosols can be computed. The DRE calculations are going to be made at the surface, in the atmosphere, and at the top of the atmosphere - providing information about the perturbation of the radiation budget

into the Earth-Atmosphere system. In addition, DREs calculations are going to be also made for the shortwave (SW), longwave (LW) and the whole (SW+LW) spectral range. This disaggregation is made in order to analyze the effect of desert dust aerosols in the solar and the terrestrial radiation as well as their net effect.

3. Effects of desert dust outbreaks on atmospheric dynamics

There is a strong relation between induced dust radiative effects and modifications of atmospheric dynamics. For this purpose, the main aspect of the third part of the proposed project is to study and analyze the modification of atmospheric dynamics resulting from desert dust outbreaks. More specifically, the following are going to be studied:

- The variations of the vertical heating profile induced by the dust radiative effects.
- How these variations affect the stability/instability conditions at different altitudes into the troposphere.
- How clouds' physical (e.g. coverage) and optical properties (e.g. cloud optical depth) are modified by the induced dust radiative effects.
- The variations in the number of cloud condensation nuclei.
- How the spatial and temporal features of precipitation are affected by the induced dust radiative effects as well as its initiation time and amount.
- The effect on the convective available potential energy (CAPE), which is a measure of how much energy is available to produce very strong updrafts.
- The effect on the surface temperature as well as on the sensible and latent heat fluxes.

4. Feedback between prevailing synoptic conditions and the 3D spatial distribution of dust

Previous studies have shown that the interaction between aerosols and radiation can affect meso-scale or even larger atmospheric circulation patterns. Based on this concept, the modification of the pressure fields at different levels into troposphere will be studied. This is crucial since the transport pathways of dust aerosol particles are determined by the prevailing synoptic conditions. Therefore, MDRAF will investigate how the 3D spatial features of the aerosol burden can be modified by such conditions as it is expected that there will be modifications in atmospheric circulation patterns.

5. Forecasting ability of a numerical mesoscale weather model

In the last part of the proposed project, the main goal is to investigate how dust aerosols can affect the forecasting efficiency of a meso-scale meteorological model (NMMB/BSC-Dust model) for a short period (1-3 days). More specifically, the model outputs are going to be surveyed and compared against reanalysis data as well as with meteorological parameters (e.g. temperature), derived by ground station measurements by applying statistical methods (e.g. contingency tables). In the last part of the proposed project the main aim is to describe how well the position, strength and propagation of synoptic systems can be forecasted into the study region when aerosol effects are considered in model runs.

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B1.3 Originality and innovative nature of the project and relationship to the 'state of the art' of research in the field

The description of desert dust outbreaks in the broader area of the Mediterranean basin has been studied by many researchers. Nevertheless, in these works the analysis has been restricted either to a

specific location or to isolated cases. In the frame of the proposed project, an objective and dynamic algorithm will be developed providing information about desert dust outbreaks characteristics (frequency, intensity, duration) for the whole Mediterranean basin. The synergistic and inter-disciplinary use of satellite and ground aerosol optical retrievals intensifies substantially the usefulness of the results - providing for the first time complete information about the 3D structure of Mediterranean desert dust outbreaks. Additionally, it is very important that the analysis will be performed over a relatively long period (about 10 years), thus providing robust results. Until now, knowledge about the vertical structure of the Mediterranean desert dust outbreaks has been mainly based on locally restricted ground lidar profiles.

In the literature there are studies describing the direct radiative effect of dust aerosols in the Mediterranean but these are either at a local scale or for the SW spectrum only. In addition, only a few studies have used a radiative transfer model for the estimation of dust DREs in the Mediterranean area. One of the MDRAF objectives is to describe the effect of desert dust outbreaks on the solar and terrestrial radiation. The analysis will be presented at different levels of the Earth-Atmosphere system as well as for the broader Mediterranean basin revealing the spatial patterns of DREs.

At present, there is a lack of knowledge in the field of feedback mechanisms affecting the variations of dust aerosol loads as well as their transport processes. MDRAF aims to describe the effect of desert dust outbreaks on the atmospheric dynamics in detail. More specifically, it will study which are going to be the modifications on stability/instability conditions, on cloud physical and optical properties, on precipitation and other atmospheric parameters (e.g. surface temperature). It is expected that MDRAF results are going to add significant knowledge on these scientific issues since the existing number of works is limited.

According to Pérez et al. (2006), the consideration of dust radiative effects into numerical weather models improves the accuracy of their outputs. Based on this, in the last part of the proposed project the accuracy of NMMB/BSC-Dust model forecasting outputs for a short period (1-3 days) will be examined. This analysis will be made for the primary atmospheric parameters (e.g. temperature) hoping that it will provide insight into how dust radiative effects affect the forecasting efficiency of a numerical weather model. This diagnostic control could be the basis for a future development and update of existing schemes integral to the NMMB/BSC-Dust model.

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B1.4 Timeliness and relevance of the project

In the frame of the proposed project, many aspects about the Mediterranean desert dust outbreaks will be presented in order to extend existing knowledge, add innovative information and answer to questions about their effects on weather and climate. The selection of the Mediterranean basin as a study region can be characterized as ideal, since it is one of the most dust affected areas of the planet, threatened by desertification in its southern parts (Intergovernmental Panel on Climate Change, 2007), highlighting the possible climate changes in the future. One of MDRAF's objectives is to establish a climatological database describing the main characteristics of Mediterranean desert dust outbreaks. Such results can be used in order to investigate the impact of desert dust episodes on human health, air quality of populated areas as well as in the produced energy by photovoltaic parks. Considering the EU priorities for saving money, through better assessment of health risks (pollution), natural hazards (extreme events) or energy exploitation (photovoltaics), it is clear the demand of a comprehensive analysis about dust aerosols' regime, especially under episodes conditions.

Another innovation that MDRAF provides is the description of the 3D structure of desert dust outbreaks for the whole Mediterranean basin, by a synergistic use of satellite and ground aerosol retrievals. The NMMB/BSC-Dust model will be used for the estimation of SW and LW DREs providing their spatial features improving on existing approaches that are restricted either to specific locations or to isolated desert episodes. A main objective of the proposed project will be the analysis of desert dust aerosols effects on atmospheric dynamics. In contrast with other dust affected areas of the planet, such as the Atlantic Ocean and E. Asia, in the Mediterranean, the level of knowledge on the effect of dust

aerosols on atmospheric dynamics is still low. Only a small number of studies have been presented trying to clarify the effect of dust aerosols on weather in general and there are still many questions to be answered. MDRAF aims to contribute substantially to this, enriching the existing knowledge through a comprehensive analysis of the induced impacts on atmospheric dynamics by mineral particles. Nowadays, many activities of European residents such as agriculture, transport and tourism, associated with social and economical impacts, depend strongly on weather conditions. For this reason, the improvement of the forecasting ability of numerical weather models is an essential issue in atmospheric sciences. This will be the target of the last part of the MDRAF project. Based on these results, model's schemes can be updated and improved, and can be adapted by other similar mesoscale models.

The proposed project will give to the applicant the opportunity to continue to build on his research activity in this field and to gain the appropriate scientific knowledge needed for his participation in future projects related to atmospheric and dust modeling studies. Furthermore, the mobility provided by a Marie Curie IEF will give to the fellow the chance to collaborate with expert scientists in the field of dust/atmospheric modeling to improve his existing skills, and also to share his expertise with the host institute. At the end of the project, the applicant will be able to bring back to his country new expertise in the atmospheric/dust modeling field and with his CV being greatly strengthened.

B1.5 Host research expertise in the field

The Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC-CNS) is one of the most developed research institutes in Europe in the field of atmospheric sciences, especially in atmospheric and dust modeling, with specialised expertise in the fields of Deep Computing, Computer Architecture and Life Sciences.

The applicant will work under the supervision of Dr. José María Baldasano who is the director of the Earth Sciences Department at the BSC-CNS. Dr. Baldasano is an expert in the field of air quality modeling, mineral dust modeling, atmospheric modeling and global and regional climate modeling. Under his supervision, a group of scientists and researchers is currently working on meso-scale meteorological and dust modeling. The group is highly experienced on these issues working with several mesoscale models such as MEMO, MM5, WRF and NMMB applied to complex and very complex regions as well as to different domains. In addition, the research staff of the BSC-CNS Earth Sciences Department has enriched experience in lidar measurement techniques, collaborating with certificated laboratories in Europe and the United States as well as participating in the European project EARLINET.

From 2002, the BSC and the Mediterranean Center on Insular Coastal Dynamics (ICoD) of the University of Malta established an operational dust forecast model (DREAM) in the frame of the EARLINET project. DREAM provides daily dust forecasts for the Euro-Mediterranean, Sahara-Sahel and East Asia domains. The model developments are made at the Earth Sciences department of BSC-CNS based on evaluation analyses of their forecast products against ground and satellite data. In order to further increase the model's accuracy, the group is working on the inclusion of dust radiative effects into its simulations.

Since 2008, the group, in collaboration with National Centers for Environmental Prediction (NOAA/NCEP/EMC) and other research institutions (NASA Goddard Institute for Space Studies, University of California, Irvine) has worked on the development of NMMB/BSC Chemical Transport Model (NMMB/BSC-CTM). The NMMB/BSC-CTM model provides online chemical weather forecasts at sub-synoptic and meso-scale resolutions and is a powerful tool in air quality modeling. Its development was based on the NMMB/BSC-Dust model which was designed and developed at the BSC, and provides short to medium-range dust forecasts for both regional and global domains. Currently, the NMMB/BSC-Dust model is in pre-operational status and provides operational dust forecasts over North Africa, Middle East-Europe regions (http://www.bsc.es/earth-sciences/mineral-dust/nmmbbsc-dust-forecast/).

Both models, BSC-DREAM8b v2.0 and NMMB/BSC-Dust, are participating in the SDS WAS (Sand and Dust Storm Warning Advisory and Assessment System) Regional Center for Northern Africa, Middle East and Europe. SDS-WAS is a project developed under the umbrella of the World Meteorological Organization (WMO) to improve capabilities for more reliable sand and dust storm forecasts. Two nodes have been established in Spain and China for the Northern Africa-Middle East-Europe and Asia domains, respectively. The group at BCS-CNS is pivotal in the operation of the Spanish node. The wealth of experience of the host

institute and its leading role in the field makes it a perfect choice for the applicant and the successful outcome of MDRAF.

B1.6 Quality of the group/scientist in charge

The proposed project will be accomplished under the supervision of Dr. Baldasano who will be the scientist in charge (SIC). The other members of the MDRAF project will be Dr. Gassó, Dr. Jorba and Dr. Basart. For each member of the project, a short curriculum vitae is presented below:

Dr. JOSÉ M. BALDASANO RECIO is full professor of Environmental Engineering at Technical University of Catalonia (UPC). He was the coordinator of UPC PhD programme in Environmental Engineering from 1992 until 2007 (this programme was the first in Spain in this specialty). His R+D activities are focused on air quality modeling, waste management and environmental impact assessment.

He is member of the Editorial Board and referee of numerous international scientific journals. He is author of more than 260 publications in scientific and technical journals; more than 270 communications and 160 invited contributions in congress; 60 conferences; and co-editor and author of 19 books on environmental subjects. He has been supervisor of 19 PhD dissertations. He has been a cochairman of 5 international conferences in environment topics. He has been a consultant and adviser of more than 70 companies and administrations. He has been award: "Rey Jaime I" for Environmental Protection, 1997 on "Waste Treatment".

At present, he is the Director of the Earth Sciences Department at Barcelona Supercomputing Center (BSC).

DR. SANTIAGO GASSÓ-DOMINGO is Air quality Group Manager at BSC, and also Professor in the Project Engineering Area of UPC since 1996. At present, from 2012, he is the Director of the Department of Project Engineering (UPC). He has about 20 years of R&D experience, and has been involved as coordinator in several competitive national and international projects. He has more than 30 technical reports, 100 communications in international congresses, and 40 articles published in JCR indexed journals, as well as referee of international scientific journals. His R&D activities are orientated to: Air emissions, air quality, environmental management systems and environmental decision-making. He is responsible of the research group of Environmental Modeling and Technology of the UPC. Also he is coordinator, from 2007, in this university, of the doctorate program in Environmental Engineering (Excellence award from the Spanish Ministry of Education and Science). Honor Award of the Rafael Escolá Prize corresponding to the XIII National Conference for Project Engineering, AEIPRO (Seville). Member of the Project Management Institute (PMI) and Spanish Association of Project Engineering (AEIPRO).

DR. ORIOL JORBA is the Meteorological Modeling Group Manager of the Earth Sciences Department of the Barcelona Supercomputing Center – Centro Nacional de Supercomputación since 2008. He is co-author of 30 research papers and has more than 60 contributions in international conferences. He has participated in national (IMMPACTE, CALIOPE) and European research projects of the FP7 program (IS-ENES, IS-ENES2, FIELD_AC).

DRA. SARA BASART is junior researcher in the Earth Sciences Department of BSC. She is mainly interested in desert dust modeling and in atmospheric aerosol characterization using ground-based and satellite remote sensing observations of the atmospheric composition (lidar and sunphotometric techniques). She has more than 15 publications in peer-reviewed scientific journals, 40 in conference proceedings, various scientific and technical reports. She has participated in more than 10 national, European and international projects and experimental campaigns. Currently, she is working in the development, evaluation and analysis of the NMMB/BSC-DUST model predictions (http://www.bsc.es/earth-sciences/mineral-dust/nmmbbsc-dust-forecast/model-description/). Sara Basart is responsible of maintenance and operation of the desert dust predictions at the BSC website (http://www.bsc.es/projects/earthscience/) and of the Barcelona AERONET site (http://aeronet.gsfc.nasa.gov/). She is involved in the research activities in the model evaluation and model intercomparison within the framework of the Dust Storm Warning Advisory and Assessment System Programme (SDS-WAS; http://sds-was.aemet.es/).

B2 TRAINING

B2.1 Clarity and quality of the research training objectives for the researcher

The applicant's CV shows that he is highly experienced in aerosol research based on satellite and ground measurements. Nevertheless, his participation in the proposed project will not only enhance his existing knowledge, but will be of major benefit to his acquisition of new and specialised, high-level knowledge in the field of radiation studies as well as atmospheric dynamics and dust modeling. This transition will be ensured by his participation in the proposed project and following a training schedule organized by the host institute (BSC) that takes advantage of its experience on these issues. The overall objective of the training program is the transfer of knowledge from the host group to the applicant in the field of advanced atmospheric and dust modeling. The acquisition of expertise in the following scientific topics has been pin-pointed as principal training objective:

Atmospheric-Dust modeling

- Emission processes
- Transport in the atmosphere
- Cloud processes
- Dry and wet deposition

Mineral dust aerosol radiative feedbacks

- Optical properties of mineral dust aerosol
- Radiative transfer model for SW and LW
- Direct effect of mineral dust aerosol
- Meteorological feedbacks

A proper training in these areas will be essential to the success of the project, and will greatly benefit the professional scientific updating of the applicant's knowledge-base through him acquiring competence in atmospheric modeling and aerosol radiative processes. Indeed, a further understanding on the role of radiative effects of mineral dust on meteorology, and how such processes affect the overall emissions of mineral dust along with their feedbacks will represent the basis for a solid future research path in climate studies. Over the training period, the applicant's scientific profile will be upgraded substantially meaning that he will be able to play a more central role in cross-disciplinary projects. In addition, experience of relaying information to scientists in different multi-disciplinary and inter-disciplinary fields will also improve his technical communication skills.

B2.2 Relevance and quality of additional research as well as of transferable skills offered with special attention to exposure to the industry sector, where appropriate

The Barcelona Supercomputing Center (BSC) is dedicated to providing high-quality postdoctoral training to future scientific leaders. It draws upon its experience in developing specific technical and scientific skills, as well as the complementary skills required for efficient research execution and communication. Researchers work with human resources and supervisors to develop and execute an individual Career Plan, which draws upon the experience of the BSC and the needs of the researcher. The training objectives in the plan are monitored and updated regularly in meetings undertaken with the supervisors, discussing research progress and identifying potential difficulties and ways of overcoming them. The objectives are met through various mechanisms including on-the-job training, seminars and workshops. The BSC and the Spanish weather service (AEMET) organize courses in the Atmospheric chemistry modeling and atmospheric aerosols topics.

Critical appraisal and continued exposure to new technological and scientific developments. This includes both learning the state of the art by keeping up with the literature and attending conferences, and developing literature search and management skills, ensuring this continues through to an independent research career. The BSC has extensive subscriptions to all relevant online journals, allowing immediate access to a comprehensive range of scientific literature. Further exposure is gained in the regularly seminars series organised by the BSC Earth Sciences Department, the Environmental Engineering PhD

program (awarded with Excellence Mention by the Spanish Ministry of Education, Culture and Sport) of the Universitat Politécnica de Catalunya (UPC) and the NA-ME-E Regional Center. Particular focus will be made to absorbing this information critically but fairly, furthering the ability to spot potential flaws in future research projects and maximizing the quality of scientific output. Critical appraisal skills will be further developed in the host laboratory journal meetings.

The researcher will develop scientific communication skills, taking a leading role in the preparation and publication of manuscripts and undertaking oral and poster presentations at relevant international conferences. The Earth Sciences Department Seminar series alternates between invited speakers and internal speakers, and postdoctoral researchers are expected to present their work. These skills will also be developed by delivering presentations in the weekly group meeting, and taking part in the scientific sessions and activities of the Earth Sciences Department.

Developing the art of grantsmanship and professional writing. In the highly competitive world of research, proficiency in writing clear grant applications is essential. During the time with the host, the applicant will take part in writing and reviewing grant applications and attending grant application sessions covering proposal preparation and writing, and finding sources of funding.

Developing management, leadership and interpersonal skills. Research requires cooperation between lab members and collaborators, often across cultures and disciplines. Without proper management and leadership to coordinate research, time and effort can be wasted and research environments can be intimidating. Interpersonal skills are required for diffusing disputes and handling personal and professional issues with sensitivity. Developing these skills aids in the harmonious and efficient running of future independent research positions and seeing projects through to the end. These skills will be developed in the BSC management workshops, covering supervision, leadership and motivational skills, budgeting of time, money and intellectual effort, understanding the goals of researchers in different stages of their careers, and professionally dealing with issues arising in work and personal life. These skills will also be developed by taking a role in mentoring postgraduate researchers in the Department. Researchers are given the opportunity to help in the organisation of conferences, of which the BSC usually hosts one or two each year. The researcher will coordinate the collaboration between the scientists at the BSC and the NA-ME-E Regional Center, gaining experience working as part of a team, managing time and setting research priorities.

Exposure to the industry sector. One of the main objectives of BSC-CNS is to proactively transfer technology to industry, both as an objective in itself in terms of dissemination of scientific output, and also with the intention to generate industrial returns. Increasing emphasis is being placed by BSC-CNS management on fomenting and facilitating interactions with industry at all levels, from direct R&D collaborations, to educational activities such as providing technical seminars, and staff exchanges with private industry R&D laboratories. A number of important agreements have been signed and existing collaborations strengthened and expanded (i.e. Gas Natural, IDOM, SGS). This exposure will aid in identifying future research directions of commercial value and prepare the researcher for potential collaborations with industry.

B2.3 Measures taken by the host for providing quantitative and qualitative mentoring/tutoring

The BSC has a great capacity for training, and trains dozens of postdoctoral researchers each year. In particular, the BSC has or is supporting the following early-stage postdoctoral fellowships: 2 Marie Curie IEF, 3 Marie Curie ITN, 7 Juan de la Cierva (2 ongoing) and 3 Beatriu de Pinós fellowships. Senior postdoctoral fellowships include 7 Ramón y Cajal (1 ongoing), 4 I3m and 4 ICREA fellowships. The BSC also offers in-house programming and high performance computing courses for code optimisation and efficiency, including PRACE training courses (http://www.training.prace-ri.eu/). The BSC also organises technical workshops and scientific conferences related to the topic of the proposed research. Currently BSC is organizing the "*European Earth System and Climate Modeling School*" in collaboration with Max Planck Institute. Additionally, the researchers of BSC are encouraged to participate in international workshops and seminars dealing with the evaluation of aerosol measurements as well as Earth's system monitoring and modeling.

B3 RESEARCHER

The fellow, Gkikas Antonis, was born in Athens, Greece, on 11th December 1979. His BSc title was received in 2004 from the Technological Educational Institute of Crete, Greece in the field of Natural Resources and Environmental Engineering (Grade: 7.3 out of 10) [BSc thesis title: *Weather forecast atmospheric models*]. His MSc title was received in 2007 from the University of Ioannina, Department of Physics in Meteorology, Climatology and Atmospheric Physics (Grade: 8.56 out of 10) [MSc thesis title: *Aerosol optical properties in the broader area of the Mediterranean basin*]. During his PhD studies (2008-2012) he worked at the Laboratory of Meteorology, Department of Physics, University of Ioannina. His PhD dissertation dealt with the study of aerosol episodes in the Mediterranean basin [PhD title: *Study of aerosol episodes over the broader area of the Mediterranean basin based on contemporary satellite data*] (Grade: Excellent). From 2006, he has worked in 7 research scientific projects, participated as a co-author in 9 publications in peer-reviewed scientific journals and 25 scientific conference proceedings (7 National and 18 International). From 2012, he has been working as a Postdoctoral Researcher in the Laboratory of Meteorology (University of Ioannina) and is also collaborating as an external cooperator with the National Observatory of Athens, the University of Aegean and the University of Crete. In addition, he has participated as a reviewer in four scientific journals (Natural Hazards and Earth System Sciences, Atmospheric Chemistry and Physics, Atmospheric Environment, Advances in Meteorology). His main scientific interests lie in the field of aerosol and radiation studies as well as synoptic meteorology. During his education phases and research activities, the fellow has acquired a significant knowledge of computer operating systems (e.g. Windows, Linux), programming languages (e.g. Fortran, IDL) and software packages (e.g. SPSS, Origin). In 2003, he worked for six months, on weather observation and forecasting, at the weather office of the airforce military base in Souda (Chania, Crete).

B3.1 Research experience

In the present section of the proposal, a list of the research projects where the applicant participated is presented below:

- **1/11/2006 – 31/12/2007**: «Weather Risk Reduction in the Central and Eastern Mediterranean – RISKMED», (http://www.riskmed.net), Research Assistant, University of Ioannina.
- **4/11/2008 – 24/11/2008**: «Weather Risk Reduction in the Central and Eastern Mediterranean – RISKMED», Research Assistant, University of Ioannina.
- **1/3/2008 – 31/12/2009**: «Study of aerosol optical properties in Epirus and the northwestern Greek area based on high resolution contemporary satellite measurements», Research Assistant, University of Ioannina.
- **1/6/2011 – 31/12/2011:** «Aerosol and Cloud Influence on the global surface UV irradiance retrieved from satellite sensors (ACI-UV)», Research Assistant, National Observatory of Athens.
- **1/10/11 – 31/5/2012: «**LIFE+PM^3**»**, Research Assistant, University of Crete.
- **1/2/2012 – 30/4/2012: «**Aerosol and Cloud Influence on the global surface UV irradiance retrieved from satellite sensors (ACI-UV)**»**, Research Assistant, National Observatory of Athens.
- **1/8/2012 – 31/12/2013: «**Lidar Climatology of Vertical Aerosol Structure for Space-Based Lidar Simulation Studies – LIVAS», Post Doctoral Research Assistant, National Observatory of Athens.
- **20/11/2012 – 31/5/2013:** «Production of students' educational tools dealing with natural hazards», Post Doctoral Research Assistant, University of Ioannina.
- **1/11/2012 – present:** «Identification of sources and physicochemical properties of fine and ultrafine suspended particles affecting the climate of Greece», Post Doctoral Research Assistant, University of Aegean.

B3.2 Research results including patents, publications, teaching etc., taking into account the level of experience

The applicant, during his educational stages and research activity has been involved in the writing of manuscripts and is first author in 3 out of 9 of his peer-reviewed publications. He has prepared several high quality posters for international meetings on aerosol science and is first author in 14 out of 25

national and international conference proceedings. Below is a list of the research studies where the applicant has contributed:

Publications in peer-reviewed scientific journals

1. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: «**Aerosol events in the broader Mediterranean basin based 7-year (2000 – 2007) MODIS C005 data**», Ann. Geophys., 27, 3509-3522, 2009.
2. Hatzianastassiou, N., **A. Gkikas**, N. Mihalopoulos, O. Torres, and B. D. Katsoulis: **«Natural versus anthropogenic aerosols in the eastern Mediterranean basin derived from multiyear TOMS and MODIS satellite data»**, J. Geophys. Res., 114, D24202, doi:10.1029/2009JD011982, 2009.
3. A. Bartzokas, V. Kotroni, K. Lagouvardos, C.J. Lolis, **A. Gkikas**, and M.I. Tsirogianni: «**Weather forecast in north-western Greece: RISKMED warnings and verification of MM5 model**», Nat. Hazards Earth Syst. Sci., 10, 383–394, 2010.
4. A. Bartzokas, J. Azzopardi, L. Bertotti, A. Buzzi, L. Cavaleri, D. Conte, S. Davolio, S. Dietrich, A. Drago, O. Drofa, **A. Gkikas**, V. Kotroni, K. Lagouvardos, C.J. Lolis, S. Michaelides, M. Miglietta, A. Mugnai, S. Music, K. Nikolaides, F. Porcù, K. Savvidou, and M.I. Tsirogianni: **«The RISKMED project: Philosophy, methods and products»,** Nat. Hazards Earth Syst. Sci., 10, 1393–1401, 2010.
5. E.E. Houssos, C.J., Lolis, **A. Gkikas**, N. Hatzianastassiou, A. Bartzokas: **«On the atmospheric circulation characteristics associated with fog in Ioannina, north-western Greece»,** Int. J. Climatol., 32: 1847–1862. doi: 10.1002/joc.2399, 2012.
6. **A. Gkikas**, Houssos, E.E., N. Hatzianastassiou, A. Bartzokas: «**Synoptic conditions favouring the occurrence of aerosol episodes over the broader Mediterranean basin**», Q.J.R. Meteorol. Soc., 138: 932–949. doi: 10.1002/qj.978, 2012.
7. G. Athanasssiou, N. Hatzianastassiou, **A. Gkikas**, C. Papadimas: «**Estimating aerosol optical depth over the broader Greek area from MODIS satellite**», Water Air Soil Pollut., 224:1605, doi: 10.1007/s11270-013-1605-2, 2013.
8. Amiridis, V., Wandinger, U., Marinou, E., Giannakaki, E., Tsekeri, A., Basart, S., Kazadzis, S., **Gkikas, A.**, Taylor, M., Baldasano, J., and Ansmann, A.: **«Optimizing Saharan dust CALIPSO retrievals»**, Atmos. Chem. Phys. Discuss., 13, 14749-14795, doi:10.5194/acpd-13-14749-2013, 2013.
9. **Gkikas, A.**, Hatzianastassiou, N., Mihalopoulos, N., Katsoulis, V., Kazadzis, S., Pey, J., Querol, X., and Torres, O.: «**The regime of desert dust episodes in the Mediterranean based on contemporary satellite observations and ground measurements**», Atmos. Chem. Phys. Discuss., 13, 16247-16299, doi:10.5194/acpd-13-16247-2013, 2013.

Publications in national conference proceedings

1. N. Hatzianastassiou, **A. Gkikas**: **«A multi-year study of aerosol optical thickness in Greece»**, 8th Conference Meteorology, Climatology and Atmospheric Physics, p. 48-59, Athens, 24 – 26 May 2006.
2. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: **«Study of aerosol episodes in the greater Mediterranean basin using MODIS-Terra satellite data»**, 9th Conference Meteorology, Climatology and Atmospheric Physics, p. 601-608, Thessaloniki, 28 – 31 May 2008.
3. A. Bartzokas, V. Kotroni, K. Lagouvardos, C.J. Lolis, **A. Gkikas** and M.I. Tsirogianni: «**The RISKMED project**», 9th Conference Meteorology, Climatology and Atmospheric Physics, p. 163-170, Thessaloniki, 28 – 31 May 2008.
4. **A. Gkikas**, N. Mihalopoulos and N. Hatzianastassiou: «**Characteristics of dust aerosol events in the Mediterranean basin based on a synergistic use of 7-year (2000-2007) satellite data**», 10th Conference Meteorology, Climatology and Atmospheric Physics, p. 623-630, Patra, 25 – 28 May 2010.

5. V. Minias, **A. Gkikas**, C.D. Papadimas and N. Hatzianastassiou: «**Aerosol optical properties in north-west Greece during the 8-year period 2000-2008 based on high resolution MODIS-Terra data**», 10th Conference Meteorology, Climatology and Atmospheric Physics, p. 1142-1149, Patra, 25 – 28 May 2010.
6. M. Koras-Caracca, **A. Gkikas**, C.D. Papadimas and N. Hatzianastassiou: **«Aerosol size over the broader Greek area based on satellite and ground measurements»**, 11th Conference Meteorology, Climatology and Atmospheric Physics, (COMECAP2012), Athens, 30 May – 1 June 2012.
7. **A. Gkikas**, E. Mastrapostoli, F. Stamatoukou and N. Hatzianastassiou: **«Extreme spatial and temporal variability of surface air temperature over Europe during 1950-2010»**, 11th Conference Meteorology, Climatology and Atmospheric Physics, (COMECAP2012), Athens, 30 May – 1 June 2012.

Publications in international conference proceedings

1. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: «**Aerosol events in the Mediterranean basin during the 7-year period 2000 – 2007 based on MODIS – Terra data**», Vol. 10, EGU2008-A-10280, 5th General Assembly of the European Geosciences Union, Vienna, Austria, 13 – 18 April 2008.
2. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: «**Study and characterization of aerosol episodes in the Mediterranean basin for the 7-year period 2000 – 2007 based on MODIS data**», European Aerosol Conference, Abstract T06A115O, Greece, Thessaloniki, 24 – 29 August 2008.
3. N. Hatzianastassiou, N. Mihalopoulos, **A. Gkikas**, O.Torres, B. D. Katsoulis: «**The role of megacities on aerosol optical thickness in the Eastern Mediterranean basin based on TOMS and MODIS satellite data**», 7th International Conference on Air Quality - Science and Application (Air Quality 2009), p. 856-859, Istanbul, 24-27 March 2009.
4. **A. Gkikas,** N. Hatzianastassiou, N. Mihalopoulos, O.Torres, B. D. Katsoulis: «**The role of natural and anthropogenic particles in the eastern Mediterranean basin aerosol levels based on multi-year TOMS and MODIS satellite data**», M15.52/29204, p. 167, Our warming planet, IAMAS-IAPSO-IACS MOCA-09, Joint General Assembly, Montreal, Canada, July 19 – 29, 2009.
5. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: «**Variability in aerosol properties, sources and events in the Eastern Mediterranean basin based on satellite observations**», Protection of the Environment, p.198-205, Greece, Corfu, 5 – 7 July 2010.
6. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: «**Direct radiative effect of extreme desert dust episodes in the Mediterranean basin**», International Aerosol Conference, Finland, Helsinki, 2F3, 29 August – 3 September 2010.
7. Papadimas, C., **A. Gkikas**, N. Hatzianastassiou: «**Desert dust optical properties over the Saharan desert and Arabian Peninsula based on Deep Blue MODIS data during the period 2003-2007**», International Aerosol Conference, Finland, Helsinki, P2K48, 29 August – 3 September 2010.
8. **A. Gkikas**, E.E. Houssos, A. Bartzokas, N. Hatzianastassiou: **«Synoptic conditions favouring the occurrence of strong aerosol episodes over the broader Mediterranean basin»**, 12th Plinius Conference on Mediterranean Storms, Greece, Corfu, 1 – 4 September 2010. (Plinius12-102, Abstracts: p. 36)
9. **A. Gkikas**, N. Hatzianastassiou, N. Mihalopoulos: «**Direct effect of extreme aerosol episodes on atmospheric solar radiation in the broader Mediterranean basin and potential links with atmospheric dynamics**», Geophysical Research Abstracts, Vol. 13, EGU2011-12581, EGU General Assembly 2011, 2011.
10. M. Korras Carraca, **A. Gkikas** and N. Hatzianastassiou: «**Comparison of MODIS Deep Blue aerosol single scattering albedo and asymmetry parameter with AERONET for northern**

Africa, Middle East and Europe», European Aerosol Conference, EAC 2011, 4-9 September 2011, 2011.

11. **A. Gkikas**, E. E. Houssos, C.J. Lolis, A. Bartzokas, N. Mihalopoulos, N. Hatzianastassiou: «**Atmospheric circulation characteristics favouring the development of desert dust storms in the Mediterranean**», 13th Plinius Conference on Mediterranean Storms, Plinius13-70, Savona, Italy, 7-9 September 2011.
12. **A. Gkikas**, E. E. Houssos, A. Bartzokas, N. Mihalopoulos, N. Hatzianastassiou: «**Atmospheric circulation patterns associated with intense dust outbreaks over the Mediterranean basin**», Atmospheric Composition Change the European Network (ACCENT), Air quality and climate change: Interactions and Feedbacks, 3rd Urbino Symposium, Urbino, Italy, 13-16 September 2011.
13. **A. Gkikas**, E. E. Houssos, C.J. Lolis, A. Bartzokas, N. Mihalopoulos, N. Hatzianastassiou: «**The regime of dust episodes over the Mediterranean basin from contemporary satellites**», 6th International workshop on sand/duststorms and associated dustfall, 7-9 September 2011, Athens, Greece.
14. M. Korras-Carraca, **A. Gkikas**, C.D. Papadimas, and N. Hatzianastassiou: «**Saharan and Arabian Peninsula dust optical properties from MODIS Aqua Deep Blue over 2002-2010**», 6th International workshop on sand/duststorms and associated dustfall, 7-9 September 2011, Athens, Greece.
15. N. Mihalopoulos, S. Kleanthous, G. Kouvarakis, **A. Gkikas**, E. Vasilliadou, C. Theodosi, C. Zoubali, N. Hatzianastassiou: «**Interannnual variability of dust over the Eastern Mediterranean**», 6th International workshop on sand/duststorms and associated dustfall, 7-9 September 2011, Athens, Greece.
16. S. Kazadzis, N. Kouremeti, **A. Gkikas**, A. Arola, I. Ialongo, A. Bais, A.M. Siani, T. Koskela, M. Janouch, and J.M. Villaplana: «**Solar UV irradiance calculations with the use of satellite-based cloud, ozone and aerosol retrievals**», International Radiation Symposium (IRS) 2012, Dahlem Cube, Berlin, Germany, 6-10 August 2012.
17. M. Taylor, S. Kazantzis, A. Tsekeri, **A. Gkikas** and V. Amiridis: «**Calculation of aerosol microphysical properties by neural network inversion of ground-based AERONET data**», European Aerosol Conference, Spain, Granada, 2 – 7 September, 2012.
18. **A. Gkikas**, N. Hatzianastassiou, S. Kazadzis, V. Amiridis, S. Basart, E. Marinou, J.M. Baldasano: «**Optical properties and radiative impact of intense dust outflows in the Mediterranean basin, based on a synergistic use of satellite, ground-based measurements and modeling**», European Aerosol Conference, Spain, Granada, 2 – 7 September, 2012.

B3.3 Independent thinking and leadership qualities

The applicant has gained significant knowledge in aerosol and radiation studies as well as in synoptic meteorology during his educational stages and research activity. In his MSc and PhD dissertations he worked on the analysis of satellite and ground measurements of aerosol optical properties, the direct effect of aerosols on solar radiation and the objective classification of atmospheric circulation patterns related with the occurrence of aerosol episodes. According to his CV, he was co-author in 9 research studies published in high quality peer reviewed scientific journals. In all of them, he contributed both to data analysis as well as in the interpretation of the results. Also, he was a first author in 14 out of 25 national and international conference proceedings. In addition, the fellow has participated in several research projects offering him the opportunity to collaborate with experienced scientists as well as to prove his independent thinking and ability to manage and lead various scientific issues. His contribution at different stages (data analysis, interpretation of the results and contribution to the writing of the assessment reports) of the research projects has built his experience which is required for the coordination of the proposed Marie Curie-IEF project. Also, the fellow during his PhD studies, in the Laboratory of Meteorology (University of Ioannina), has contributed to the guidance and learning of graduate and postgraduate students. This project will greatly increase and reinforce the fellow's expertise in aerosol and radiation studies, and help him make the transition to his chosen research field of dust and atmospheric modeling. Finally, the proposed project will permit the applicant to develop and make an

important step forward in his career via the new experience that will be gained working at a high level institute like the BSC and the strong host group.

B3.4 Match between the fellow's profile and the project

The applicant during his research career and educational phases has gain significant knowledge in aerosol research. In his MSc dissertation, he worked on the decoding and analysis of aerosol optical properties derived from different satellite databases in order to describe the aerosols' regime over the Mediterranean. Also, he analyzed aerosol data derived from AERONET stations in order to validate the accuracy of satellite measurements. At his PhD dissertation, he continued his occupation with satellite and ground aerosol retrievals, improving his knowledge level on handling and analyzing datasets of aerosol and atmospheric parameters provided at various spatial and temporal scales. More specifically, he developed an objective and dynamic algorithm for the identification of different aerosol episodes types in the Mediterranean. Also, he worked on the classification of atmospheric circulation patterns favoring the occurrence of aerosol episodes based on multivariate statistical methods. In the last part of his PhD, he used a radiative transfer model to compute the induced direct radiative effect, under various aerosol episodes conditions, for specific locations.

Apart from the educational phases, the fellow has participated in several scientific research projects. During RISKMED project, he worked on the development of an early warning system of severe weather events in Epirus (NW Greece) and the validation of a numerical mesoscale model (MM5) outputs. The applicant worked for two years on a research project funded by University of Ioannina, which its objective was the description of aerosol burden regime in the broader area of Epirus, over the period 2000-2008. The analysis was based on satellite data, taken by MODIS-Terra database, provided at fine spatial resolution (10km x 10km). During the LIVAS project, the applicant worked on the intercomparison, over the North African deserts and Europe, of aerosol retrievals derived by MODIS-Aqua and CALIPSO platforms, both flying in the NASA's A-Train satellite constellation. His contribution to the ACI-UV project was to decode aerosol and cloud parameters derived by MODIS database, at fine and coarse spatial scales. These data used as initial conditions to an RTM in order to estimate aerosol and cloud effects on UV radiation. Also, the applicant participated in LIFE+PM3 project (http://www.life-airquality.eu/) working on the comparison of satellite retrievals against surface measurements of PM_{10} concentrations. At the present time, he is participating in THALIS project where its scientific target is to assess the effect of fine and ultrafine particles on the climate of Greece.

The fellow's CV proves his experience in aerosol studies and data analysis of ground and satellite retrievals provided at different spatial and temporal scales. Based on the above, the applicant's profile matches with the project objectives under which he will acquire a significant knowledge level in atmospheric and dust modeling. In addition to this participation in the proposed project will give him the opportunity to be at a major institute like BSC allowing him to collaborate with a scientific group of experts on these issues.

B3.5 Potential for reaching or reinforcing a position of professional maturity

The success of the proposed project is ensured by the quality of the host institute, the applicant's knowledge level and the innovative approach of the research study. The applicant's placement at the BSC will offer him the opportunity to be trained on dust and atmospheric modeling. The training that he will acquire will be at the highest level since the host institute is established as one of the top laboratories in Europe and globally with regard to atmospheric and dust modeling. During the proposed project, it is expected that as a researcher the applicant will improve his knowledge level and build on existing skills already possessed. Over the project period, it is expected also that he will acquire new and advanced complementary competencies crucial for the mature stages of a young scientist. It is also important to be mentioned that there are many advantages to be gained from such a period of mobility - in the sense that the fellow will be stimulated by a new environment and will have the possibility to make new scientific contacts both in the host institution and via established scientific collaborations. At the end of the program, the applicant will have acquired strong competencies that will help him to work as an independent scientist in the field of satellite aerosol research, atmospheric and dust modeling with an

enhanced publication record. Hopefully, his improved skills will help him to achieve his appointment in an academic or research position in his country or elsewhere in Europe. Summarizing, the applicant's skills and knowledge level, which will be gained by his participation in the Marie Curie IEF fellowship, will provide him to be equipped to work on future projects dealing with:

- Aerosol research based on satellite, ground and modeling measurements
- Atmospheric dynamics
- Atmospheric and dust modeling studies
- Interaction between aerosols and radiation
- Climate change studies

B3.6 Potential to acquire new knowledge

Until now, the applicant has participated and contributed in several scientific projects working mainly on the analysis of satellite aerosol optical properties provided at different spatial and temporal scales. Furthermore, he has participated in 9 refereed papers published in high quality and of wide acceptance by the scientific community journals. He has been primary author or a principal contributing author in many papers and conference proceedings - proving his ability to lead a project and a team of experts. In general, his main research activity was in the field of aerosol studies, satellite remote sensing, radiation and synoptic meteorology. He was involved in the decoding and handling of satellite measurements provided from local to global scale, the impact of aerosols in the radiation field and the objective classification of atmospheric circulation patterns related with the occurrence of aerosol episodes in the Mediterranean. During his PhD, he developed an objective and dynamic algorithm for the identification and classification of aerosol episodes according to their type. Algorithm's outputs have been validated against AERONET retrievals and surface measurements of PM_{10} concentrations. Additionally, the algorithm's outputs have been evaluated against active satellite sensors (CALIPSO) providing the vertical structure of aerosol load as well as against dust model outputs (DREAM). His potential for learning and adaptation provides the background to the motivation of this fellowship which is to enable the fellow to acquire new knowledge and expertise in the field of atmospheric and dust modeling.

The success of the proposed project will give the applicant the opportunity to work for the first time outside of his country (Greece) at an institute having extensive experience in the fields of atmospheric and dust modeling. The mobility gained by the fellowship will give him the opportunity for a comprehensive transfer of knowledge, collaboration with experienced scientists, and dissemination of his own expertise. The fellow's intention is to acquire fundamental knowledge on atmospheric and dust modeling since the BSC institute scientific group has expertise in these issues. It is expected that from this fellowship the scientific profile of the applicant will be upgraded substantially and will help him in his future career steps. More specifically, he will be able to transfer the gained knowledge to younger scientists or scientific research teams working either in his home country or at a new research location. Apart from his scientific evolution, the fellow during the training period will enrich his computer skill level by working on modern and advanced platforms, and will be able to broaden his knowledge on programming codes.

The SIC, Dr. Baldasano, has full experience in guidance of young scientists since he had been supervisor of 19 PhD dissertations. Also, his extended research experience is proved by his participation in many scientific projects as well as by the very high number of publications in peer reviewed journals and conference proceedings. At present, he is the Director of the Earth Sciences Department at Barcelona Supercomputing Center (BSC). His main research activities lie in the field of air quality modeling, mineral dust modeling, atmospheric modeling and global and regional climate modeling.

B4 IMPLEMENTATION

B4.1 Quality of infrastructures/facilities and international collaborations of host

Early in 2004 the Ministry of Education (Spanish Government), Generalitat de Catalunya and Technical University of Catalonia (UPC) took the initiative of creating a National Supercomputing Center in Barcelona. The Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC-CNS) is the National Supercomputer Facility in Spain. Established in 2005, it has inherited the tradition of the well-known CEPBA, Institute in Parallel Computing in Europe, also including MareNostrum, one of the most powerful Supercomputer in Europe.

The Earth Sciences Department (ES-BSC) was established with the objective of carrying out research in Earth system modeling, initially focusing on atmospheric physics and chemistry. The group directed by Dr. José María Baldasano, coming from the Environmental Modeling Laboratory of the Technical University of Catalonia (LMA-UPC) has as main topics of research: air quality modeling, mineral dust modeling, atmospheric modeling and global-regional climate modeling. The group has a wide experience in mesoscale meteorological modeling in complex and very complex regions. The group has used mesoscale models MEMO, MM5, WRF and NMMB applied in the Barcelona Geographical Area, the Iberian Peninsula, the Western Mediterranean Basin and Europe. Also, has developed several emission inventory models for anthropogenic and biogenic emissions in the area of Catalonia: developed the model LEM/EIM for the city of Barcelona (in 1995) and the model EMICAT2000 for Catalonia, also has been developed the EMIVAL2000 for the area of Valencia and the high resolution emission model HERMES for Spain (in 2008). The group has a wide experience with air quality models photochemical mechanisms that take into account photochemical interactions of the different species of pollutants. Several studies of the dynamics of air pollutants within the Western Mediterranean Basin have been carried out with CMAQ and CHIMERE models.

Furthermore, the group has a wide experience in the applications of lidar techniques, participating in environmental campaigns of measurements with lidar, collaborating with Los Alamos National Laboratory (LANL), New Mexico (USA), ERLAP (European Reference Laboratory of Air Pollution), Environmental Institute, JRC-ISPRA European Commission, and participating in the European project EARLINET.

From 2002, the Mediterranean Center on Insular Coastal Dynamics (ICoD) of the University of Malta, established dust operational forecasts with the DREAM system within the EU-funded project EARLINE. In this context, LMA (currently the ES-BSC) and ICoD intensely collaborated in the development of the dust model. Currently, model operations in the Euro-Mediterranean region, Sahara-Sahel region, and East Asia, and model developments have been transferred to the Earth Sciences department of BSC. Recent works of the group have focused on the validation of the model with lidar observations, sun-photometer data and satellite imagery, and further improvements with the inclusion of dust radiative effect has shown a way to improve numerical weather prediction results through feedbacks between aerosol concentration and meteorology. The current operational version is the BSC-DREAM8b v2.0 model that includes updates in the dry and wet deposition schemes as well as the inclusion of a "preferential source" mask in its emission scheme (http://www.bsc.es/projects/earthscience/BSC-DREAM/). Work is currently underway to maintain daily operational forecasts of mineral dust for North Africa, Middle East, Europe and East Asia based on the updated version of BSC-DREAM8b v2.0; and provide the mineral dust components to the air quality forecasting system CALIOPE.

Since 2008, the group develops a new online chemical weather prediction system, NMMB/BSC Chemical Transport Model (NMMB/BSC-CTM), intended to be a powerful tool for research and to provide experimental efficient global and regional chemical weather forecasts at sub-synoptic and mesoscale resolutions. This system is being developed in conjunction with the National Centers for Environmental Prediction (NOAA/NCEP/EMC) and other research institutions (NASA Goddard Institute for Space Studies, University of California, Irvine). NMMB/BSC-Dust is an online multi-scale atmospheric dust model designed and developed at BSC-CNS and it is the first step towards the development of the NMMB/BSC-CTM. The dust model is fully embedded into the Non-hydrostatic Multiscale Model NMMB developed at NCEP and is intended to provide short to medium-range dust

forecasts for both regional and global domains. Currently, the NMMB/BSC-Dust model is in pre-operational status and provides operational dust forecast over North Africa- Middle East-Europe and global regions (http://www.bsc.es/earth-sciences/mineral-dust/nmmbbsc-dust-forecast/). The NMMB/BSC-Dust model is participating in the International Cooperative on Aerosol Prediction (ICAP) model inter-comparison initiative. Work is presently ongoing for implementing an operational version, and evaluating the operational system for mineral dust forecast model NMMB/BSC-Dust, as well as the application of assimilation techniques and use of satellite data to improve mineral dust simulations.

In this context the ES-BSC group hosted the Northern Africa-Middle East-Europe (NA_ME-E) Regional Center of the World Meteorological Organization (WMO) for the Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). SDS-WAS is a project developed under the umbrella of the World Meteorological Organization (WMO) to improve capabilities for more reliable sand and dust storm forecasts. At present two nodes are established: the Northern Africa-Middle East-Europe Node (hosted by Spain) and the Asian Node (hosted by China). A consortium of the Meteorological State Agency of Spain (AEMET) and the Barcelona Supercomputing Center (BSC-CNS) manages the Regional Center, hosted by Spain (http://sds-was.aemet.es/).

Both models, BSC-DREAM8b v2.0 and NMMB/BSC-Dust, are participating in the SDS WAS Regional Center for Northern Africa, Middle East and Europe.

The potential usefulness of the experimental dust forecasting was recognised by WMO, resulting in a recent proposal to nominate the consortium of BSC-CNS and AEMET to host the first CBS Regional Specialized Meteorological Center with activity specialization on Atmospheric Sand and Dust Forecast (RSMC-ASDF). This center is requested to build and maintain a web portal to provide forecast products, related information, verification results and services on the internet. Approved the 22 of May of 2013 by the Executive Council of WMO in the 65th Session (Geneva, Switzerland). The prediction dust transport model to be used will be NMMB / BSC-Dust developed by Earth Science department.

Additionally, the group has coordinated a national initiative that aims to develop an air-quality forecasting system for Spain under the umbrella of the CALIOPE project (www.bsc.es/caliope/) funded by the Environmental Ministry of Spain. The aim of CALIOPE stands for delivering air-quality related products with very high resolution (1 km for hot spot regions, 4 km for Spain, 12 km for Europe, 1 hr-temporal resolution) useful to a wide range of users for reducing the impacts of air pollution on human health. A partnership of four research institutions composes the CALIOPE project: the Barcelona Supercomputing Center (BSC), the CIEMAT, the Earth Sciences Institute 'Jaume Almera' (IJA-CSIC) and the CEAM Foundation. This consortium deals with both operational and scientific aspects related to air quality monitoring and forecasting. Under this project, the group has developed a linkage between WRF model and CHIMERE. This will allow the CHIMERE users to take advantage of the new developments produced in the WRF model. Extensive evaluation campaigns have been undertaken in order to evaluate the CALIOPE modeling system. Presently the CALIOPE system is a dairy operational service of air quality forecasting (48 hr) with very high resolution for Europe (12 x 12 km), the Iberian Peninsula 4 x 4 km), with high spatial resolution nesting for Andalusia (1x1 km), Canary Islands (2x2 km) and Barcelona (1x1 km). CALIOPE enables public and private agencies to monitor the effect of existing pollution sources (industry, traffic, natural sources) and to model the impact of potential changes (new roads, factories, legislation, etc.). Further investigations of the reliability of the CALIOPE air quality system in reproducing pollutants observation, and the improvement in the pollutants simulation by the application of a Kalman Filter based post-process have been carried out (http://www.bsc.es/caliope). CALIOPE is possible because of the development of a very detailed and disaggregated emission inventory for air pollutants for Spain with a high spatial resolution of 1km^2 and a temporal resolution of 1 hour. In order to apply the inventory the Earth Science Department has developed the High-Elective Resolution Modeling Emissions System version 2.0 (HERMES v 2.0) model and software which is running on the MareNostrum, which represents an improved and updated version of the previous model HERMES 2004. The update of this emission inventory is a critical work to maintain the capability of air quality forecasting (http://www.bsc.es/caliope/es/emisiones).

The previous results of the group highlight its expertise in air quality modeling from local to global scales and data assimilation techniques. Also it should be noted that from year 1998 until the last call in

2009, the group has been awarded as Quality Research Group (2009-SGR-338) by the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) of the Generalitat de Catalunya.

The internationalisation of the research activity is guaranteed by the participation of the group in EU-funded projects (e.g., FIELD-AC, IS-ENES, MACC, EARLINET, Excellence Network of the 6th EU Framework Programme on Atmospheric Pollution and Climate Change, ACCENT). Additionally, the group maintains active collaborations with international groups and scientists of recognized prestige such as the Computational Sciences Laboratory of the University of California (Irvine, EEUU) directed by Dr. Donald Dabdub; Dr. Slobodan Nickovic of the World Meteorological Organization; Dr. Zavisa Janjic of the National Centers of Environmental Predictions, USA; the Department of Atmospheric Chemistry of the Max Planck Institute for Chemistry, Germany (Dr. Jos Lelieveld), the Norwegian Meteorological Institute (Dr. Leonor Tarrasón) and the National Center for Atmospheric Research, EEUU (Dr. Rolando García).

The experience gained in these research fields has resulted in numerous publications in international magazines, proceeding in national and international congresses, participation in national and international projects, participation in expert groups and other activities.

B4.2 Practical arrangements for the implementation and management of the research project

MDRAF will take place at the BSC as the host institute providing the applicant with the necessary infrastructures and resources to guarantee the success of the project. Since MDRAF has been planned as an individual project, any management problems are expected to be quite minor. The BSC secretariat services will be responsible for handling the financial and practical arrangements of the project and have vast experience of handling similar EU-funded research projects for early-stage researchers. All technical requirements such as computing needs, software programs and so on will be handled by the BSC technical personnel who have full experience in dealing with large-scale, international research projects.

The scientist in charge (SIC) Dr. Baldasano, has extensive experience in managing research projects and in supervising postdocs. At the present time, he has a permanent position at BSC working as Director of the Earth Sciences Department. During the project, the applicant will work under the SIC's supervision and will collaborate with other researchers and scientists, working at the BSC in the field of atmospheric sciences. Any assistance or support needed in making contact with personnel at both the EU and national level will be provided by the BSC secretariat.

The host will take care of issues concerning the training of the fellow during the project period, and the appropriate management of the project. Additionally, the host will ensure that the fellow will be provided with all the available data or model outputs required for the attainment of each of the project's objectives. Aside from technical issues, the fellow in collaboration with the SIC, will prepare the assessment reports presenting the evolution of the project as well as its overall achievements in the final report. The host will facilitate that results obtained during the different phases of the proposed project will be presented in conference proceedings and peer reviewed scientific journals.

The host has the overall responsibility to ensure that the contract is followed in every respect and that the researcher is operating as defined by the Grant Agreement. The SIC will be the single contact person for any liaison with the EU Commission. In addition, the host institute will take care of any unforeseen problems that may arise during the work, and will try to solve any possible conflict or difficulty.

B4.3 Feasibility and credibility of the project, including work plan

The proposed project (MDRAF) is scheduled to last 24 months and is separated into 8 phases which are described in the present section of the proposal. Each phase of the project is further divided into sub-sections comprising the steps which are required for its accomplishment. The description of the phases as well as of their sub-sections is described below, while in Table 1 the timeline of MDRAF is presented.

Phase A: Decoding of the raw satellite data derived by MODIS-Aqua, EP-TOMS, OMI and CALIPSO databases (*Months 0-3*)

- Decoding of aerosol optical properties derived by MODIS-Aqua database (Collection 051 or Collection 006) provided at fine (10km x 10km) and coarse (1˚x1˚) spatial resolution. **(A1)**
- Decoding of Aerosol Index (AI) measurements derived by EP-TOMS and OMI databases provided at fine (13km x 24km) and coarse (1.25˚x1˚ for EP-TOMS and 1˚x1˚ for OMI) spatial resolution. **(A2)**
- Decoding of the vertical profiles of extinction coefficient and aerosol typing derived by CALIPSO database provided at 5 km spatial resolution. **(A3)**

Phase B: Description of Mediterranean desert dust outbreaks characteristics based on an objective and dynamic algorithm (*Months 0-6*)

- Implementation of the algorithm (described in Section B1.2) for the identification of desert dust episodes over the broader area of the Mediterranean basin, for the period 2002-2012. **(B1)**
- Analysis of the algorithm's outputs for the description of frequency, intensity and duration of Mediterranean desert dust outbreaks at various temporal and spatial scales. **(B2)**
- Sensitivity analysis of the input parameters in order to clarify which will be the impact on algorithm's classification method. **(B3)**
- Sensitivity analysis of cloud contamination effect in order to study the modifications of the algorithm's outputs. **(B4)**
- Evaluation of the algorithm's outputs against: (i) AERONET aerosol retrievals derived by stations located across the Mediterranean basin, (ii) PM_{10} surface concentrations derived by Airbase (http://acm.eionet.europa.eu/databases/airbase/), EMEP (www.emep.int/) and EUSAAR (http://www.eusaar.net/) databases and (iii) Dust REgional Atmospheric Model (BSC-DREAM8b) outputs. **(B5)**

Phase C: Description of the 3D structure of the Mediterranean desert dust outbreaks based on a synergistic use of MODIS-Aqua and CALIPSO retrievals (*Months 7-9*)

- Regridding of raw CALIPSO retrievals, provided at 5km spatial resolution, into 1˚x1˚ gridded format in order to be compared against algorithm's outputs. **(C1)**
- Intercomparison of algorithm's outputs with the CALIPSO vertical profiles of extinction of coefficient and aerosol typing in order to present the 3D structure of the Mediterranean desert dust outbreaks. **(C2)**
- Interpretation of the above results through geographical distributions and regional means at different temporal scales (months, seasons, years). **(C3)**
- Evaluation against lidar ground measurements provided by EARLINET stations and Dust REgional Atmospheric Model (BSC-DREAM8b) outputs. **(C4)**

Phase D: Training period over the NMMB/BSC Dust model environment (*Months 7-12*)

- Training and acquiring experience in the operational implementation of the NMMB/BSC Dust model. **(D1)**

Phase E: Estimation of the direct radiative effect (DRE) induced by the Mediterranean desert dust outbreaks (*Months 10-15*)

- Selection of the Mediterranean desert dust outbreaks which will be the study cases. **(E1)**
- Estimation of the DRE induced by the Mediterranean desert dust outbreaks on the shortwave (SW), longwave (LW) and net (SW+LW) radiation. **(E2)**

- Estimation of the DREs at the top of the atmosphere, in the atmosphere and at the surface. **(E3)**
- Interpretation of the results according to the produced geographical distributions as well as to their averaged values on a regional scale. **(E4)**

Phase F: Impact on atmospheric dynamics induced by dust radiative effects (*Months 13-18*)

- Impact on the vertical heating rate profiles induced by desert dust outbreaks. **(F1)**
- Impact on the stability/instability conditions at different altitudes into the atmosphere. **(F2)**
- Impact on the cloud physical and optical properties. More specifically, are going to be examined how desert dust outbreaks affect the clouds' spatial coverage, cloud condensation nuclei, vertical extension, initiation/dissipation processes and optical properties. **(F3)**
- Impact on the spatial and temporal features of precipitation. More specifically, are going to be studied how desert dust outbreaks affect the precipitation's amount, spatial patterns and initiation time. **(F4)**
- Impact on the convective available potential energy (CAPE). **(F5)**
- Impact on the sensible and latent heat fluxes. **(F6)**
- Impact on the surface temperature. **(F7)**

Phase G: Feedback mechanisms (*Months 19-21*)

- Investigation of the modification on the atmospheric circulation patterns when dust radiative effects are considered into the model simulations. **(G1)**
- Impact of these modifications on the dust transport mechanisms and aerosol burden over the broader Mediterranean basin. **(G2)**

Phase H: Forecasting efficiency of NMMB/BSC model (*Months 22-24*)

- In this phase of the proposed project is going to be studied the accuracy of NMMB/BSC model's forecast outputs when dust radiative effects are considered into the simulations. **(H1)**
- Validation of the numerical NMMB/BSC outputs for the primary weather parameters (e.g. temperature, precipitation) against measurements taken by meteorological stations or other databases (e.g. ECA&D). **(H2)**
- Comparison of the predicted spatial patterns for basic meteorological parameters (e.g. temperature, precipitation) against reanalysis data derived by NCEP/NCAR Reanalysis Project or other databases. **(H3)**

According to the timetable of the project, two reports will be prepared presenting the results from the first year and the overall achievements of MDRAF, respectively. A main concern of the fellow as well as of the SIC Dr. Baldasano is the dissemination of the results to as many as possible interested researchers and to the scientific community in the field of atmospheric sciences. This notification of the MDRAF's achievements will be made through special lectures, seminars at the host organization, and shorts visits to other groups, presentations in national and international conferences as well as publications in peer reviewed journals of high impact in the field of atmospheric sciences.

Table 1: Timetable of MDRAF

	Months							
Phases	**0-3**	**4-6**	**7-9**	**10-12**	**13-15**	**16-18**	**19-21**	**22-24**
A	A1-A3							
B	B1-B2	B3-B5						
C			C1-C4					
D			D1	D1				
E				E1-E2	E2-E4			
F					F1-F3	F4-F7		
G							G1-G2	
H								H1-H3
Reports				√				√√

√ Intermediate report
√√ Final report

B4.4 Practical and administrative arrangements and support for the hosting of the fellow

For many years, BSC has been participating in research projects funded by the EU acquiring the appropriate and required knowledge in management of such a large scale projects. Moreover, due to these international collaborations, many scientists, researchers and students at different educational levels have been hosted in BSC. Based on the above, the host institute has a secretariat with an evolved infrastructure to support in the provision of work space, facilities, computer access and resources. Prior to arrival, the secretariat assigns all the requirements which are needed by the fellow during his working period in the BSC institute.

The financial and practical management of the project will be dealt by the BSC secretariat services, which have ample experience in managing research projects including those funded by the EU. The technical part of the project, including any special computing needs and programs, will be managed by the BSC technical and scientific personnel which has extensive experience in dealing with large-scale, international research projects and which can provide any necessary computer and software tools.

Dr. Baldasano is the director of the Earth Sciences Department at BSC. In the proposed project he will be the scientific of charge being the supervisor of the fellow. He has full experience in managing and supervising scientific groups since during his academic career and research activity he has participated in many projects. In addition to the periodical assessments presenting the achievements of the project will be headed by the SIC while the other members of the project will also contribute. The applicant will work in close collaboration with the SIC and the other members of the MDRAF's scientific group. Also, the applicant will be able to interact with other researchers at the BSC working in the field of atmospheric sciences. Any assistance or support needed in making contact with personnel at EU and national level will be provided by the BSC secretariat. The applicant will have full access to the data needed during the project phases, provided by BSC through Dr. Baldasano.

B5 IMPACT

B5.1 Impact of competencies acquired during the fellowship on the future career prospects of the researcher, in particular through exposure to transferable skills training with special attention to exposure to the industry sector, where appropriate

The conceptual framework of this project is particularly consistent with the fellow's research profile and strongly related to his specific scientific concerns. The applicant's CV shows that he has extensive experience in aerosol studies while his knowledge level in the field of radiation studies and synoptic meteorology can be characterized as adequate. The proposed project will give him the opportunity to enrich and update his existing skills and competencies in many aspects and will support his transition to the field of the atmospheric and dust modeling. His research experience will help him to adapt and assimilate the new knowledge which is expected to be acquired by the proposed project. This will be ensured by his collaboration with the SIC as well as with other scientific staff of BSC who have expertise in the fields of atmospheric and dust modeling. In addition, the collaboration of the BSC with other institutes and its participation in international networks will give to the fellow the opportunity to have contact with other scientists and researchers in this field. This will be crucial for a researcher entering into mature stages of his research career. The project will enable the fellow to build up knowledge and proficiency together with an unprecedented acquisition of new scientific competencies that will include:

- Improving of fellow's expertise in the field of aerosols and radiation studies as well as dynamic and synoptic meteorology.
- Deepened knowledge in the construction and implementation of algorithms for the identification of aerosol particles of different nature based on a synergistic use of various satellite and ground measurements.
- Improving his existing knowledge on the evaluation methods and techniques of satellite retrievals against ground measurements.
- Acquisition of new proficiencies in atmospheric and dust modeling.
- Mastering computer skills at a high level working on cluster machines and supercomputers.

Apart from expected scientific achievements, the fellow, at the end of the project, will acquire project management skills and experience of independent thinking. More specifically, his participation in a large scale project like this, will give the applicant the opportunity to progress to more senior scientific positions such as principal coordinator status with the competences required to ensure the successful management and handling of scientific, technical or other issues that are required. At the end of the project, the applicant will be able to work either as an independent researcher, be able to collaborate with other scientific groups back to his country, and/or participate in other international fellowships. The fellow's participation in the proposed project will lead him to share and transfer knowledge with the host institute and vice versa. An additional potential benefit for the applicant by his participation in MDRAF is the opportunity that working at the BSC provides for supervising students at high educational level as well as younger researchers and scientists working on the fields of aerosol, radiation and atmospheric modeling studies. The new work conditions offered to the applicant by his collaboration with the host institute will undoubtedly help the fellow to acquire generic competencies:

- Flexible work skills among different research communities
- Independent and innovative thinking
- Organization skills including project management (scientific objectives, budgeting)
- Tutoring skills through the supervision of a graduate student.
- Broadening of personal contacts network.

In summary, the participation of the fellow in the proposed project will have a diverse range of positive impacts on his scientific and professional profile, and allow him to achieve a level of mature standing in the future as an effective and productive European scientist.

B5.2 Contribution to career development, or re-establishment where relevant

The fellow's previous research experience has been mainly focused on aerosol and radiation studies as well as on synoptic meteorology. In the framework of MDRAF, it is expected that the applicant will enrich substantially his existing knowledge and skill level. The proposed project offers to the fellow a unique opportunity to broaden considerably both his scientific profile and the range of his research experience.

The main scientific objectives of MDRAF focus on a detailed description of Mediterranean desert dust outbreaks based on a synergistic use of satellite and ground measurements, their direct radiative effects and their impact on the atmospheric dynamics. The fellow's scientific and research experience is relevant to the first two objectives. His involvement in the proposed project will allow him to strengthen these competences and to acquire competence in the third. The fellowship will offer a unique chance to the fellow to make the transition to an upper scientific level, complementing his research profile, and equipping him with the skill base required to advance his career in the future.

The host institute is undoubtedly an expert in the field of atmospheric modeling as indicated by its international collaborations, its participation in scientific networks and its multiyear experience on atmospheric sciences. This fact intensifies the opportunities given to the fellow to acquire new and innovative expertise in the course of MDRAF project. Over the training period, the fellow will have the opportunity to interact with experts in atmospheric modeling at the BSC and acquiring appropriate advanced training through collaborations, lectures and seminars. The benefits of the proposed training period at the BSC from a long-term perspective would be invaluable.

B5.3 Benefit of the mobility to the European Research Area

The fellow has resided in Greece during his educational stages and research activities. The Marie Curie IEF will provide the fellow the opportunity to work in a new environment and to interact with scientists and researchers who are experts in the field of atmospheric modeling. The mobility that the fellowship engenders will enable the fellow to create new collaborations with other researchers from different countries and expand his professional prospects in Europe. The BSC institute offers him a unique opportunity, at the right time of his career, to work alongside experienced researchers in the field of atmospheric modeling. Through this collaboration, he will receive training and knowledge at a very high level and enrich substantially his profile. Furthermore, the skills and experience in remote sensing of aerosol particles that he will bring to the host institute, will allow for a transfer of knowledge between the fellow and the host institute that has the potential to generate high impact research results.

B5.4 Development of lasting cooperation and collaboration with other countries

The fellow, at the present time is working as a postdoctoral researcher in the Laboratory of Meteorology at the University of Ioannina (Greece) and collaborating with the National Observatory of Athens (NOA) and the University of the Aegean. Through the proposed project, the applicant will have the opportunity to build a new collaboration with the host institute as well as with other researchers or institutes which are involved in other projects with BSC. The Marie Curie IEF fellowship is an ideal way to establish a new relationship between the host and the university where fellow comes from. Also, there are likely to be increased possibilities for the creation of new consortiums involving collaborators of both the fellow and the host institute.

B5.5 Contribution to European excellence and European competitiveness regarding the expected results

According to the work plan and the objectives of the proposed project, it is expected that MDRAF will generate new, important and innovative information about the characteristics and the impacts of Mediterranean desert dust outbreaks demonstrating thus the excellence of the European researchers on these issues. Our knowledge about the characteristics and structure of Mediterranean desert dust outbreaks is limited. The introduced methods and techniques in the framework of the proposed project are hoped that will raise the European scientific impact on aerosol and modeling research, in terms of global aerosol community. MDRAF will expand substantially existing knowledge and will provide innovative

information at the European level. The innovative approach of a synergistic use of satellite and ground measurements will provide for the first time information about the 3D structure as well as the characteristics of desert dust outbreaks for the whole Mediterranean basin over a relatively long time period. As a European product, the latter will raise the profile of EU research excellence in the field, will reflect on EU excellence in dust and atmospheric modeling and will raise also the competitiveness of the EU globally. The satellite retrievals obtained by MDRAF will set a new standard for the investigation of desert dust outbreaks since they are able to cover broad regions with high accuracy. Synergistic use of the satellite and ground aerosol retrievals worldwide will enhance the quality and the usefulness of the results. Potentially, these tools can be adapted and applied in other regions of the planet affected by dust transport. It is envisaged also that the algorithms' outputs can be used to clarify for example the impact of massive dust loads on air quality and health in European highly-populated areas.

A significant contribution of the MDRAF project will be the investigation of the direct effect of desert dust outbreaks. At this part of the project, it is expected that the results will clarify how mineral particles affect the solar, terrestrial and net radiation at different levels into the Earth-Atmosphere leading to a perturbation of its energy budget. The implementation of the NMMB/BSC model offers the opportunity to extend the analysis over the whole Mediterranean basin. These new features will update previous works that have been mainly restricted to specific locations or to individual study cases. In the literature, there are many studies describing the impact of desert dust loads on the atmospheric dynamics. Nevertheless, these studies refer to dust affected areas of planet such the Atlantic Ocean while for the Mediterranean and the European continent there is a lack of knowledge. MDRAF aims to focus on this issue by describing the effect of desert dust outbreaks on the precipitation, clouds formation, instability/stability conditions and other atmospheric processes. Such an extensive analysis is estimated that will set the scientific background where future studies rely on it and further extend it. The last objective of the proposed project is to investigate which will be the impact of desert dust outbreaks to the forecasting accuracy of a numerical mesoscale model. This is crucial since it is well known that the weather conditions are totally related with social, economic and other human activities. Apart from the accurate prediction of atmospheric processes at short- and medium range temporal scales it is very important to clarify, if that is possible, which will be the impact of desert dust outbreaks at higher timescales (climate). The selection of the Mediterranean as study region is characterized as ideal since it has been identified by IPCC as a threatened area associated to the possible future climate changes.

Apart from all the relevant information, the deliverables and end-products of this project will contribute to European excellence and competitiveness by demonstrating that European centers like the host institute BSC can be pioneer in aerosol and atmospheric modelling research. Also, collaborations between European researchers coming from different countries will establish new consortiums able to respond to new and demanding challenges on weather and climate studies. By this point of view, the scientific prestige of European research centers and universities will be substantially upgraded attracting scientists/researchers outside from the European continent. Additionally, according to our experience, Europe's relatively small nations have achieved much more by acting together than they might have done if working alone, and have nurtured scientific competence in most if not all member states. A large number of aerosol studies have been funded by the EU over the last decades (e.g in CORDIS website 434 projects related to the topic are accounted). Many synergies can be found with current ongoing FP7 work programmes for collaborative projects (e.g. challenge 6.1 in FP7-Environment Workprogramme 2013 part of the research aims to further explore atmospheric processes, pollutants, GHG emissions). This is expected to continue in future programmes as aerosol impacts on the Earth's climate is a major and still highly uncertain parameter, e.g. in HORIZON 2020 this topic is expected to be tackled as part of following societal challenge: Climate action, resource efficiency and raw materials. High impact projects like MDRAF will help to ensure that Europe can meet the challenges of the 21st century where the quality of the environment affects everyday life and the impact of aerosols on climate change, air quality and other fields is high in public conscience. MDRAF is expected to provide significant added value in the field of aerosol research - highlighting the role of the European scientific community in these fields.

B5.6 Impact of the proposed outreach activities

One of the main interests of the fellowship is to disseminate the achievements and the results of the proposed project to as many users as possible. For this reason, the fellowship has planned to publish and announce during the progress of the projects' phases, results that could be of potential interest to citizens, researchers, scientists or other users. This will be done via construction of a project web page, the issuing of press releases, and the publishing of key results in peer-reviewed scientific journals. The occurrence of desert dust outbreaks in the Mediterranean can potentially have a significant impact on human health. In particular, citizens are greatly concerned about air quality in urban and populated areas, possible adverse health effects, the impact of weather conditions on social/economical activities like tourism, and climate change. Therefore, citizens will be keen to be informed about the potential effects of mineral particles on their daily life. One of the aims of MDRAF therefore is to communicate to the public, the important role that aerosol research has on environmental policy-making decisions. Apart from planned public outreach activities, the fellow intends to present the project's results to students entering or following tertiary education courses in related fields so as to engage with them and attract their attention of the importance of aerosol science studies. Finally, the achievements of MDRAF will be presented to the scientific community through participation in large, international conferences and publications in high-impact peer reviewed journals. The fellow will also present his work internally at the BSC and at other institutes/universities to foster interaction with other scientists and to get important feedback from experts in the field. The main outreach activities for the public, students and researchers/scientists are presented below:

Public

- Creation of a website providing a technical and non-technical description of the project
- Through the website the users will be able to be informed for several issues about MDRAF as well as to have access to the results
- Providing non-technical description about the role of aerosols in weather and climate
- Providing non-technical description about the effect of aerosols in human health
- Providing non-technical articles describing the physical and optical properties of desert dust aerosols, how can be transported and which are the processes responsible for their removal
- Inclusion of the project information in several dissemination activities of BSC (e.g. BSC website)
- Help with open tours of the MareNostrum supercomputer infrastructure, which is housed in the beautiful Torre Girona chapel adjacent to the BSC laboratories, e.g. in regular outreach activities such as 48 Open House Barcelona.

Students

- Visit schools and universities giving lectures about the role of aerosols in the atmosphere
- Help with MareNostrum supercomputer infrastructure school visits (e.g. in 2012, the BSC was shown to more than 160 Spanish school classes)
- Organizing meetings in the BSC, where young students and researchers interested in atmospheric sciences could visit and be informed by the scientific group of the MDRAF about aerosol research

Researchers/Scientists

- Publication of MDRAF results in scientific journals
- Participation in national and international conferences
- Lectures and seminars at the BSC presenting the progress of project to the local scientific staff or visitors scientists/researchers (e.g. within Severo Ochoa Excellence Center programme)
- Short visits to other institutes/universities presenting the progress and the aspects of the project

At the end of the project, the fellow will organize an open day at the BSC where the scientific group involved in MDRAF will present the results of project. The main achievements of the project will be presented to students, researchers and scientists and thus facilitate a two-way interactive discussion about the wider implications of MDRAF and the potential for building on the foundation it creates.

B6 ETHICS ISSUES

	Research on Human Embryo/Foetus	YES	Page
	Does the proposed research involve human Embryos?		
	Does the proposed research involve human Foetal Tissues/Cells?		
	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**X**	

	Research on Humans	YES	Page
	Does the proposed research involve children?		
	Does the proposed research involve patients?		
	Does the proposed research involve people not able to give consent?		
	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**X**	

	Privacy	YES	Page
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical convinction)?		
	Does the proposed research involve tracking the location or observation of people?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**X**	

	Research on Animals	YES	Page
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**X**	

	Research Involving Developing Countries	YES	Page
	Is any material used in the research (e.g. personal data, animal and/or human tissue samples, genetic material, live animals, etc.): a) Collected and processed in any of the ICPC countries?		
	b) Exported to any other country (including ICPC and EU Member States)?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	**X**	

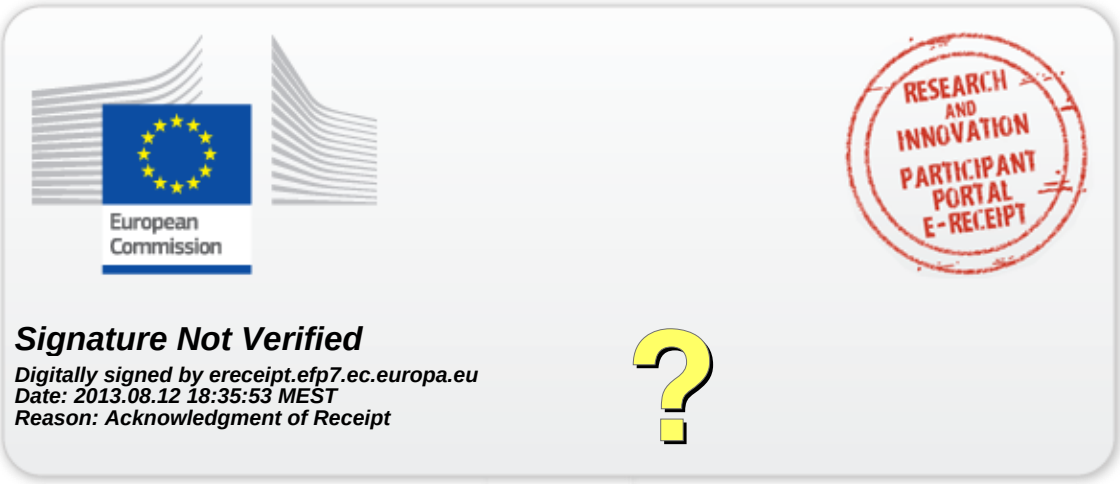
ENDPAGE

PEOPLE
MARIE CURIE ACTIONS

Marie Curie Intra-European Fellowships (IEF)
Call: FP7-PEOPLE-2013-IEF

PART B

"MDRAF"



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