REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: …………………………The Netherlands……………………..…

Principal Investigator[1]**:** ……………………...Jason Edward Williams…………………...

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Other researchers: …………………………………………………………………..……

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Project Title: ……..Investigation of aerosol feedbacks on decadal timescales…..

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If this is a continuation of an existing project, please state the computer project account assigned previously.	**SPNLWILL** ________________
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2012
Would you accept support for 1 year only, if necessary?	YES ☒ NO ☐

Computer resources required for 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	200000	200000	
Data storage capacity (total archive volume) (gigabytes)	100	100	

An electronic copy of this form ***must be sent*** *via e-mail to:* *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date):

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Continue overleaf

[1] The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: ……………………… Jason Edward Williams ………………

Project Title: ….. Investigation of aerosol feedbacks on decadal timescales ……

Extended abstract

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.

It is well established that biofuel use (BF) and biomass burning (BB) in the Asian Subcontinent has a large scale regional effect on local air quality, radiative forcing and trace gas concentrations over China, South-East Asia, India and the Indian Ocean via direct emissions of both gaseous pollutants and aerosol particles (e.g. Leileveld et al., Science, 2001; Ramanathan et al., Science, 2010). It has also been shown that the resident lifetime of e.g. Black Carbon (BC) particles is sufficiently long that they can be transported large distances, impacting on e.g. the relatively pristine Arctic (Jacobsen, JGR, 2010). Therefore in order to accurately simulate the atmospheric composition in any large-scale 3D global chemistry transport model requires an accurate description of such emissions and their interaction with photolysing light (via direct absorption and scattering). This perturbs photo-chemical reaction cycles which influence tropospheric ozone and perturb the lifetimes of methane, a rapidly increasing greenhouse gas. Due to the long atmospheric lifetime of CO2 it has recently been argued that a more realistic strategy for curtailing the increase in global temperatures on the short term is to focus on the mitigation of BC by the introduction of abatement strategies in the tropics and Asian sub-continents, where BF is commonly used for cooking, the use of two-stroke diesel engines is ubiquitous and BB practises occur throughout the region. Therefore it is relevant to investigate the effects that such mitigation approaches will have on air quality and regional atmospheric composition in the Northern Hemisphere (NH) via the application of a large-scale CTM.

This project uses the 3D global chemistry transport model TM5 (Huijnen et al, GMD, 2010). It will use a version of TM5 which has recently been updated with both an online photolysis routine (Williams et al**,** GMD, 2012), which allows the direct introduction of perturbations in the Aerosol Optical Depth (AOD) on photolysis rates of trace gases, and the inclusion of the M7 parameterized aerosol scheme (van den Burgh et al, ACP, 2010). The TM5 model is also capable of making direct comparisons against a host of different measurements by the use of an online interpolation routine which uses the latitude, longitude and altitude of e.g. flight tracks thus improving the statistical robustness of the comparisons. The aims take the form of three main components:

(i) Update of the modified Carbon Bond Mechanism v4: TM5 currently employs a rather crude but efficient chemical mechanism for tropospheric photochemistry which was developed over a decade ago (Houweling et al, JGR, 1998). Many other CTMs now have much more extensive schemes allowing them to explicitly introduce a range of Volatile Organic Compounds (VOCs) for which global emission inventories are now readily available. A more advanced mechanism based on the Carbon Bond philosophy has now been developed (CBM-Hybrid) which allows the explicit description of all C1-C3 VOCs, the segregation of isoprene and terpenes and higher compounds such as aldehydes and ketones. Tests have shown that this mechanism has the potential to improve the global distribution of e.g. CO and O3. This mechanism will be introduced into TM5 and coupled with the online photolysis scheme, in order to allow a more accurate description of gasphase tropospheric chemistry. It is envisaged that this will be completed by the end of 2012**.**

(ii) Decadel Hindcast experiments concerning BF and BB for 1999-2009: The updated version of TM5 developed in part (i) will be used to investigate the regional and global effects of BF and BB gaseous and particulate emissions on tropospheric composition in the NH. Here datasets such as those available from EDGAR 4.0 and GFEDv3 (van der Werf et al, ACP, 2010) which include BC and Organic Carbon (OC) emissions will be coupled to the M7 aerosol parameterization for the calculation of AOD. Coupling of the AOD into the online photolysis scheme is currently ongoing in a separate project, which allows the effects of additional absorption and scattering on tropospheric photo-chemistry to be accounted for. The performance of the M7 module for BC and sulphate has recently been investigated (von Hardenburg, ACPD, 2012), where finding suggest that transport to the arctic is somewhat under-predicted. The influence of the additional BC transported to the arctic from regional BB in e.g. Russia will be a focus of this part of the project, where a pre-requisite of quantifying effects is realistic global distribution. Comparison of the gaseous tracer distributions against a host of different atmospheric measurements (e.g. MOZAIC, ozone-sondes, ground-based flasks) will be used to quantify the effect of introducing additional AOD on model performance. Moreover, analyses of the chemical budget will be used to assess the effects on e.g. the atmospheric lifetimes of both CO and methane. The model will be driven with the ECMWF ERAinterim meteorological analyses fields which provide e.g. consistent temperature, pressure and water-vapour fields which are important for calculating the correct oxidation capacity of the troposphere. It is envisaged that these two decadal simulations will be completed by the end of 2013 and the results subsequently analysed.

(iii) Future experiments concerning BF and BB for 2030 and 2050: Here we aim to use the TM5 model for future simulations for the years 2030 and 2050. The use of meteorological fields from the EC-Earth earth system model (Hazlager et al, BAMS, 2010) in TM5 is currently being developed in a number of separate research projects based at ECMWF allowing changes in meteorology due to a changing climate to be accounted for. Here we will perform 4 simulations: 2 for 2030 and 2 for 2050. Using future emission inventories which are becoming readily available (e.g. Lamarque et al, ACP, 2010) we will assess the impact on future air quality from both estimated BF and BB activity using the version of TM5 validated in part (ii). A realistic mitigation scenario will be implemented and the resulting changes in surface concentrations and global air quality will be subsequently assessed. It is envisaged that these yearly simulations will be completed at the end of 2014. If there is some delay due to unforeseen problems in either parts (i) or (ii) then a focus will be placed on 2030 where confidence in the meteorological fields from ECEarth will most likely be higher.