

Aerosol Properties PRocesses And InfluenceS on the Earth's climate (APPRAISE)

IMPLEMENTATION PLAN

Contents

1. Summary
2. Overall Programme Objectives
3. Summary of Science Plan
4. Work Plan
 - 4.1. Science Components
 - 4.1.1. Description of Core Activities
 - 4.1.1.1.CP1a
 - 4.1.1.2. CP1b
 - 4.1.1.3.CP2
 - 4.1.1.4.CP3
 - 4.1.1.5. CP4
 - 4.1.2. Description of Consortia
 - 4.1.2.1.ADIENT
 - 4.1.2.2.ACES
 - 4.1.2.3.APPRAISE ICE
 - 4.2. Management Components
 - 4.2.1. Science Co-ordinator (SC)
 - 4.2.2. Programme Advisory Group (PAG)
5. Use of facilities
 - 5.1. The FAAM Aircraft
 - 5.2. Chilbolton
 - 5.3. UFAAM
 - 5.4. BADC
6. Timeline, Milestones and Deliverables
7. National and International Links
 - 7.1. QUEST
 - 7.2. EUCAARI
 - 7.3. EUSAAR
 - 7.4. SOLAS
 - 7.5. Virtual Institute Aerosol Cloud Interaction (VI-ACI)
 - 7.6. OP3
8. Knowledge Transfer and External Communication
9. Website
10. Progress Monitoring and Reporting
11. Appendices

1. Summary

Aerosol Properties, PRocesses And Influences on the Earth's Climate (APPRAISE) is a UK NERC (Natural Environment Research Council) directed programme designed **to improve our ability to quantify the effects of atmospheric aerosol particles on the Earth's climate system**. The APPRAISE programme aims to investigate and understand the underlying properties of airborne particles that affect the lifecycle of aerosol particles and are responsible for their effect on radiation and cloud formation. The programme will also tackle the formation and transformation of particles in the atmosphere to establish and quantify key pathways in the lifecycle of particles in the atmosphere. The scientific objectives of APPRAISE are described in full in the APPRAISE Science Plan, which is the principal planning document for the programme (<http://www.nerc.ac.uk/research/programmes/appraise/resources.asp>).

Within the Science Plan, the areas of research that APPRAISE will fund have been defined. The Science Plan also includes an initial implementation plan which sets out the structure of the programme, its management, knowledge and links across the NERC, UK and international community.

This document, the Implementation Plan, aims to define the strategy by which the objectives of the Science Plan will be achieved. It also provides a timetable for activities within the APPRAISE programme. **Note that this is a “living document” and should be consulted regularly, as it will be up-dated periodically.**

There are two principal methods for achieving the scientific aims of the APPRAISE programme. Targeted consortia will be used to address three key broad scientific problems in the area. These will be supported by a small number of core activities which are focused on filling current gaps in the UK science community in areas necessary for delivery of APPRAISE science in the consortia. The consortia are to be supported in response to Announcement of Opportunity (AO) calls, whereas the core activities will be awarded in response to a targeted tendering exercise. Inter-disciplinary collaboration between APPRAISE scientists will be encouraged through a series of science workshops and annual meetings.

The coordination of the programme will be through the Science Coordinator (SC), in conjunction with the APPRAISE Programme Advisory Group (PAG). The SC and PAG will act as a focus for the programme and will facilitate communication and promote national and international collaboration.

The exploitation and communication of the results of the programme will be realised through the programme's plans for Knowledge Transfer. Each consortium will develop its own KT with project partners. The overall programme KT will be managed through the UK Atmospheric Aerosols Network (UKAAN), which will be part supported by APPRAISE for the duration of the programme. UKAAN is also supported in part by the National Centre for Atmospheric Science (NCAS). Its role in APPRAISE will be to bridge the gap between the research and user/stakeholder communities, a role it has maintained since it began as an NERC supported KT network in 2004. Dissemination of data within the programme and to the wider community is described in the APPRAISE data management plan (see <http://badc.nerc.ac.uk/data/appraise>) and subject to the APPRAISE data policy (see details below). The primary aim of the APPRAISE data

policy is to enable access to APPRAISE data and to maximise the exploitation of the results.

APPRAISE is a major contributor to the NERC Science Plan in the area of developing the understanding of aerosol and cloud processes on climate. APPRAISE pre-dates the new NERC strategy yet is highly relevant in a number of the new research themes, particularly in the Climate System and Earth System themes but also in Natural Hazards and Environment, Pollution and Human Health.

2. Overall Programme Objectives

APPRAISE is a major 5 year scientific programme that will run from 2005-2010 (with science beginning in summer 2006 – see section 6). APPRAISE will seek to tackle key research challenges that include understanding and quantifying:

- (i) the direct effect of aerosols on the Earth's radiation budget, via scattering and/or absorption of radiation;
- (ii) the influence of aerosols on cloud properties and hence indirect effect on climate and influence on the hydrological cycle;
- (iii) the role of aerosols in feedback processes between land, the biosphere and climate.

To reduce these uncertainties a much-improved understanding of the atmospheric aerosol lifecycle and better representations of this in climate simulations are needed.

The main aims of APPRAISE are to:

- Provide a focus for UK research in the key area of aerosols, clouds and climate over the next 5 years
- Deliver improved knowledge on aerosol and cloud properties, processes and impacts through detailed field and laboratory measurements
- Use process models to develop parameterisations for use by global and regional transport and climate models.
- Test and demonstrate the climatic importance of key aerosol and cloud processes through a coordinated hierarchy of models linking process scales to global climate models through transport models
- Identify and quantify key biosphere-atmospheric aerosol couplings at the process scale and so provide improved data from which to develop parameterisations.
- Deliver a coordinated internationally leading activity in the APPRAISE area

Through reaching the above aims APPRAISE will also contribute to meeting the challenges of the new science themes. For example by using targeted process studies we can improve and expand observations that can be used to validate climate models a key challenge of the Climate System theme. Similarly, the process studies in ACES and OP3 are directly relevant to understanding another key challenge “Understanding the forces and feedbacks that drive the Earth System.”

3. Summary of Science Plan

The APPRAISE programme seeks to significantly develop knowledge of the impact of aerosols on our climate by conducting basic scientific research on key processes involved in the lifecycle of the aerosols in the atmosphere. The programmes approach will be

through an integrated hierarchy of laboratory studies, field and global observations, process models, regional models and global/climate models, providing interconnected tools for use in the three key science areas below. APPRAISE will provide co-ordination and exploitation of expertise across an internationally renowned science community. The mechanism for delivery is through consortia grants, supported by a core programme of key strategic scientific activities.

The Consortia are targeted in the following three areas:

- The Direct Impacts of Aerosol on Climate
- Aerosol Cloud Interactions and Climate
- Aerosol coupling in the Earth System

To achieve its overall objectives, add value to the consortia activities and provide a strategic vision for aerosols research, APPRAISE is supporting several key scientific areas that provide underpinning science to the programme. These are specifically targeted at areas not covered by NCAS II and other NERC institutes and facilities, though they will work closely with these frameworks. The target research areas are:

- Formation Pathways and Properties of Organic Aerosols
- Improved Representation and Validation of the Radiative Properties and Impacts of Aerosols and Clouds
- Development of a Global Model to Investigate Key Aerosol and Cloud Processes
- Improved Coupling of In Situ Cloud Measurements with Novel Model Schemes

4. Work Plan

The strategic Implementation plan included in the Science Plan (web reference) provides general guidance on the main structures and mechanisms that will deliver APPRAISE science, and includes the overall aims and objectives of each of the consortia and core activities. The work plan seeks to provide a summary of what the individual funded components of APPRAISE will do specifically and how they meet the programme's aims.

4.1 Science Components

4.1.1 Description of Core Activities

4.1.1.1 CP1a: Formation Pathways and Properties of Organic Aerosols (PI Dr John Reid, University of Bristol)

Researchers at the Universities of Bristol, Cambridge, Manchester and East Anglia are undertaking collaborative laboratory and theoretical work to investigate the pathways of formation and properties of organic aerosol. They are seeking to develop an improved description of secondary organic aerosol production, based upon experimental studies of particle aging, association and accretion reactions in the condensed phase and the kinetics of mixed component particle growth. This will be coupled with a thermodynamic model of gas/aerosol partitioning of organic compounds incorporating theoretical methods of predicting vapour pressures. Further, they are developing a framework for assessing the

role of organic compounds on the properties of atmospheric aerosol. A major contributor to this framework will be new experiments, using both single particle and ensemble techniques that will define the equilibrium properties of mixed inorganic/organic aerosols including their water uptake, freezing properties and the behaviour of mixed phase particles. Experiments will seek to reconcile measurements made on single particles, using optical and electrostatic traps, with ensemble aerosol flow tube studies, and with larger scale chamber studies. At all points, reference will be made to theoretical predictions with, for example, an extension of the Aerosol Inorganics Model to incorporate the organic components studied in this work.

The programme of research is divided into four work packages extending over three years. The hygroscopicity and aging of organic aerosol (Milestone 1) will be examined in year 1. Year 2 will focus on an examination of the freezing temperatures of mixed component organic/inorganic/aqueous aerosol (Milestone 2) and the kinetics of mixed particle growth (Milestone 3). In the final year, research will concentrate on examining the equilibrium partitioning of organic components between the condensed aqueous and organic phases (Milestone 4).

The formation of such a versatile team from four institutions, coalescing around Core Programme funding from APPRAISE, provides a unique opportunity to address many of the key issues in the role of organics in atmospheric aerosols using a broad base of novel laboratory experiments and state-of-the-art theory.

4.1.1.2 CP1b : Investigating the Composition of Organic Aerosols: Low Molecular Weight and Heterogeneous Reaction Products. (PI -Dr Alastair Lewis, University of York)

The processes occurring during the formation and ageing of secondary organic aerosol (SOA) are currently very poorly understood. Recent evidence from smog chamber studies has shown that the photo-oxidation of gas-phase organic species may lead ultimately to the formation of macromolecules (oligomers and polymers up to 1000 Da) in aerosols. This is now proposed as being the key mechanism by which VOCs are incorporated into the aerosol phase. This research proposes the use of aerosol samples and data from historical and future smog chamber experiments in combination with novel state-of-the-art analytical molecular characterisation methods to:

- Determine the key low molecular weight monomer building blocks for a series of anthropogenic and biogenic organic species using comprehensive gas chromatography with mass spectrometric detection.
- Resolve the molecular structures of oligomeric compounds formed via heterogeneous reactions of monomers using high performance liquid chromatography coupled to tandem mass spectrometry.
- To propose chemical pathways and parameterisations for the formation of macromolecules based on observed reagents and products.

A series of smog chamber experiments will be carried out at the University of Manchester as part of the APPRAISE consortium ACES. These specially tailored experiments will investigate the formation of secondary organic aerosol from biogenic precursors. These novel experiments will be performed under atmospherically relevant conditions in contrast with previous studies. External collaborations with Dr John Wenger (University College Cork, Eire) and Dr George Marston (University of Reading)

will allow additional studies to investigate the effect of functionality on secondary organic aerosol formation. Strong links have been established with consortia projects and samples collected as part of the OP3 project (additional work funded by ACES) and during APPRAISE-ICE will allow extension of laboratory techniques to the field.

Early generation semi-volatile organic compounds in organic aerosol will be identified using comprehensive two-dimensional gas chromatography coupled to time of flight mass spectrometry. The formation and structure of oligomer species through heterogeneous aerosol reactions will be investigated using liquid chromatography coupled to an ion-trap mass spectrometer. Chamber experiment outputs will be collated by Dr Hamilton and distributed to ACES partners and will also seek to contribute results from the chamber experiments to the database of the EU EUROCHAMP (Integration of European Simulation Chambers for Investigating Atmospheric Processes: <http://www.eurochamp.org/>) project, which makes data available from the wider chamber community in Europe.

4.1.1.3 CP2 Improved representation and validation of the radiative properties and impacts of aerosols and clouds. (PI - Dr Eleanor Highwood, University of Reading)

This core post funding will deliver on all 3 APPRAISE core deliverables (2.1-2.3) through the development of:

- a hierarchy of radiative transfer models (including a “benchmark” radiative transfer model for comparison with GCM schemes) and single scattering models which will utilise new measurements and understanding concerning composition of aerosols and clouds, will be validated against laboratory and in-situ measurements of aerosol radiative properties and which will provide radiative properties suitable for use across the APPRAISE community.
- A quantitative assessment of the sensitivity of these radiative transfer models to the remaining uncertainties in aerosol and cloud properties
- Access to and consistent additional processing of existing UK sunphotometer data from Plymouth Marine Laboratory and Cardington, including an intercomparison of these instruments with the new UK AERONET¹ site at Chilbolton. Facilitation of the positioning of the University of Cambridge lidar at Cardington to give profiles of water vapour, ozone and aerosols when it is not used on the FAAM² aircraft.
- Community available software for the derivation of aerosol radiative and microphysical properties from FAAM aircraft data such as could be used both on existing data from past campaigns and with future campaigns.

Activity will be in three main areas.

- 1) Scattering and radiative transfer models: Recent developments in both radiative transfer modelling and in measurement of aerosol microphysics, composition and radiative properties now suggest it is timely to develop both a conceptual framework through which the new information (e.g. from Aerosol Mass Spectrometers, filters analysis, lidar, AERONET sites, laboratory measurements of refractive indices etc) can be utilised in determining aerosol and cloud radiative properties as used in GCMs, and also a “benchmark” radiative transfer model to

¹ Aerosol Robotic Network

² Facility for Airborne Atmospheric Measurements

which the range of simplified models can be compared. We will make novel measurements of the phase function and asymmetry parameter of mineral dust and contribute existing measurements of ice crystals using electro dynamic levitation techniques. We will incorporate recent laboratory measurements of dust, volcanic ash and aerosols containing black carbon. We will calculate radiative properties of multi-component aerosol by a variety of different methods and, through their use in the radiative transfer models we will assess the sensitivity of the radiative forcing to this uncertainty. The widely used Edwards and Slingo (1996) radiation code will form part of the model hierarchy. Some further work on the bench-mark model is required to build on the inclusion of scattering and cloud treatment; to make the interface between model components more seamless; and to examine the dependence of the results on the spectral resolution of the output from RFM and dependence on the number of streams used in DISORT.

- 2) Sunphotometer intercomparison: The planned intercomparison of both Plymouth Marine Laboratories and the Met Office sunphotometers with the AERONET equipment at Chilbolton will take place in June 2007. In addition to the initial comparisons proposed, these instruments will be joined by further sunphotometers (from BAS and MSSL) and an experimental lidar from LidarTechnologies, adding considerable value to the APPRAISE campaign and providing a test ground for work in the APPRAISE consortium ADIENT. This will focus on ensuring the consistency of aerosol optical depth and size distribution information.
- 3) Data base of optical properties: Together with the UKAAN co-ordinator, the PDRA employed by this core activity will develop a database that can be accessed via the web by the UK aerosol community and will adapt software previously developed under NERC projects (e.g. DODO) to produce specific aerosol radiative property information from e.g. FAAM data at the BADC (for example, some corrections to scattering data are wavelength dependent and depend on the type of aerosol so corrections derived for dust in DODO may not be appropriate for other aerosol types).

4.1.1.4 CP3 The Development of a Global Model to Investigate Key Aerosol and Cloud Processes (PI - Professor Ken Carslaw, University of Leeds)

This core activity has 2 objectives:

1. To provide a global aerosol transport model that is capable of:
 - carrying the main aerosol types,
 - dealing with complex mixing states
 - acting as a key stage in the hierarchical testing of aerosol processes in APPRAISE
- 2 The coordination of the hierarchical model development, interfacing with other modelling effort in the UK

A major aim is to compare and ultimately improve UKCA in the Unified Model

- carrying the main aerosol types,
- dealing with complex mixing states
- acting as a key stage in the hierarchical testing of aerosol processes in APPRAISE

In this core post, sectional (GLOMAP-TOMCAT) and modal (UKCA-TOMCAT) global aerosol chemical transport models are to be developed with the capability of dealing with the major aerosol types and complex aerosol mixing states. Of the two aerosol schemes, UKCA carries approximately 20 tracers whereas GLOMAP carries more than 100. Essentially the microphysical processes are the same. The UKCA is ideal for multi-year simulations, whereas GLOMAP is ideal for detailed process studies (where size distribution is key) of the order of months.

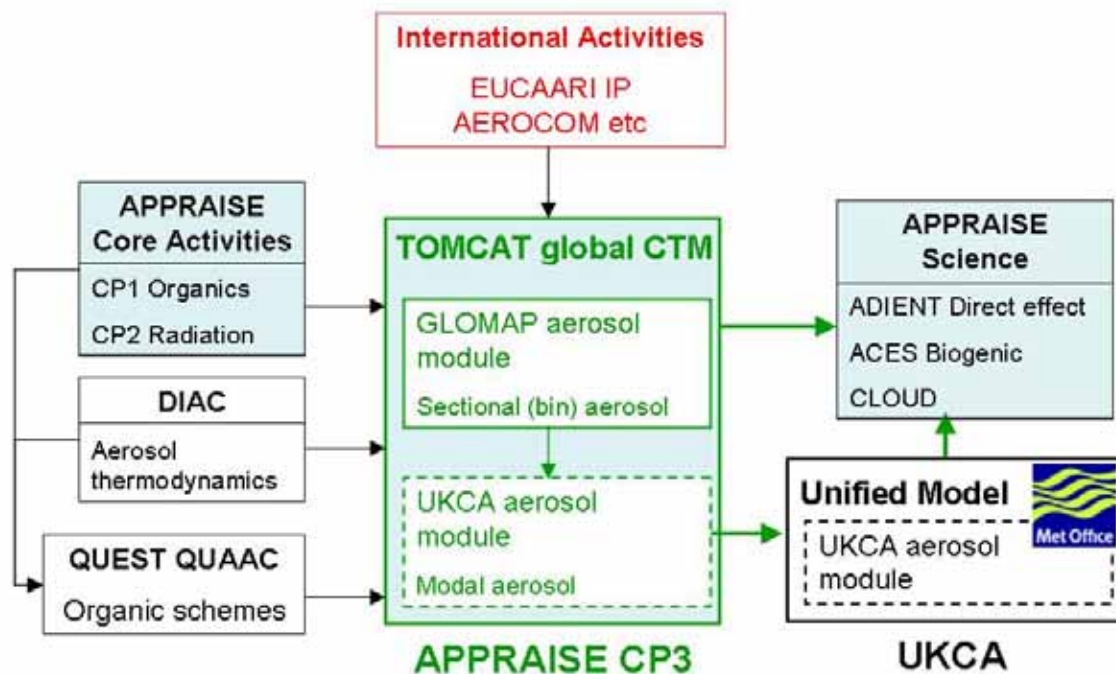
These models will be used for evaluating the understanding of large scale aerosol microphysical, chemical and radiative properties against observations, and for developing and testing parameterized schemes that capture the key processes, but which are simple enough to be incorporated into global and regional climate models.

For GLOMAP-TOMCAT key model developments include:

- improved treatment of secondary organic aerosol
- calculation of aerosol thermodynamics for inorganic/organic mixtures
- treatment of additional particle types
- multi-stage grid nesting down to 10x10 km.

Standard model diagnostics will be developed to allow comparison with a wide range of aerosol instrumentation.

The linkages between Core Post 3, other core posts, APPRAISE science and other national and international work are illustrated in the figure below.



4.1.1.5 CP4: A Next-Generation Model Framework for the Investigation of the Impact of Aerosol Properties on Mixed-Phase Cloud Processes (PI - Professor Thomas Choularton, University of Manchester)

This core activity aims to develop a next-generation model of the interaction of aerosol with mixed phase cloud, dealing with key processes much more explicitly than is presently possible. The model will be based on the latest version of the Met Office Cloud Resolving Model (CRM) and utilise the range of detailed aerosol models being developed through NCAS-Composition. The model will be a tool for exploitation within and enhancement of the successful APPRAISE consortium in the clouds area. The new model will also be a tool for the development of aerosol-ice / mixed phase cloud treatment in UKCA.

The specific milestones within the project are:

1. To produce a new state of the art parcel model with explicit microphysics capable of being driven by observed dynamics or dynamics calculated from the CRM (January 2008, with continued development to the end of year December 2009). This model will be used to guide development of the CRM and test the end product model (From January 2008 to December 2009)
2. To improve the parameterisation of cloud microphysics using the 2 and 3 moment scheme within the Met office Cloud Resolving Model (December 2008)
3. To produce a CRM with Explicit bin Cloud Microphysics with improved treatment of the aerosol and microphysics (December 2009)

The key uncertainties in understanding cloud / aerosol interactions can be broadly categorised into two classes. First class of uncertainties require development of a mechanistic understanding of the detailed microphysical and chemical processes contributing to cloud / aerosol interactions. The second group of uncertainties requires direct coupling of an adequate description of this mechanistic understanding into a realistic dynamical framework to explore the feedbacks between the detailed processes and the dynamics. There are therefore two aspects to the project:

- A state of the art explicit microphysics parcel model will be developed in order to quantify the impacts of aerosol properties on cloud microphysics. Dynamical fields obtained from the Met Office Cloud Resolving Model using parameterised microphysics will drive this. Comparison of the results using the parameterised microphysics from the CRM and the new parcel model will lead to improvements in the microphysical treatment in the CRM.
- A detailed aerosol and cloud microphysics module will be built into the Met Office Cloud Resolving Model. This new model will couple the aerosol effect on mixed-phase microphysics with the latent heat, water loading and dynamics of the CRM. The aerosol and cloud particle microphysics will include new schemes for ice formation developed in 1. This will be a 2 step process one involving improvement of the parameterisations of the microphysics with the CRM the second developing a CRM with explicit bin microphysics.

The main outcome of this activity will be a novel direct treatment of cloud/aerosol interactions in cloud resolving models including explicit aerosol and cloud microphysics that is based on an improved knowledge of the interaction of clouds and aerosol especially mixed phase clouds.

4.1.2 Description of Consortia

4.1.2.1 *Appraising the Direct Impacts of Aerosol on Climate (ADIENT)*

The overarching objective of ADIENT is to quantify the direct effect of aerosols on the Earth's radiation budget. The direct effect of atmospheric aerosol has been addressed in a number of earlier studies, however the properties of anthropogenic aerosol over the UK have not been fully characterised, certainly in comparison to other aerosol types. ADIENT will fill this gap by making comprehensive measurements of aerosol size, chemistry, and radiative impact on a) the scale of individual plumes, b) the UK budget of aerosol, and c) regional aerosol variability across Europe. In ADIENT these measurements will be exploited to characterise the physical, chemical and optical properties of anthropogenic pollution aerosol. A hierarchy of models will be used to quantify aerosol transformations and to assess the radiative impacts of anthropogenic pollution aerosol from the scale of single city plumes to the European scale. Finally, the project will augment the new measurements with existing aircraft, ground based and satellite data to describe the aerosol distribution and optical properties on regional and global scales for a ten-year period. This description will be used to place the radiative impact of the UK pollution aerosol into a regional and global context by comparing the radiative forcing from key aerosol regions.

The project will deliver:

- new FAAM measurements of the physical, chemical and optical properties of aerosol over the UK and Europe,
- a comprehensive description of the spatio-temporal evolution of anthropogenic aerosol, in particular the single scatter albedo,
- an assessment of the radiative impact of anthropogenic aerosol,
- a comprehensive description of the physical properties of key aerosol types,
- an assessment of the aerosol radiative forcing split into the natural and anthropogenic contribution both regionally and globally.

An important consequence of the project will be the confrontation of existing aerosol models with a combination of new and existing in situ, ground and satellite based aerosol measurements on a range of spatial scales. This will be the most exacting test of UK aerosol models to date and provides the mechanism for an improvement in model accuracy.

4.1.2.2 *Aerosol Coupling in the Earth System (ACES)* -

This is a consortium project headed by Dr Gordon McFiggans at the University of Manchester involving the Universities of Edinburgh, Leicester, Lancaster and York, Imperial College London, and the Centre for Ecology and Hydrology.

The ACES project will entail both process investigations and impact studies. The process investigations are to improve fundamental understanding of the processes involved in the formation of biogenic secondary organic aerosol (BSOA). This will be achieved through three different but complementary approaches:

- chamber studies
- field studies (Malaysian Borneo)

- process model development

Models of atmospheric chemistry and transport will then be used to assess the impacts and uncertainties of BVOC emissions and BSOA formation on chemical and physical properties of aerosols on a regional scale.

ACES will be split into four work packages

WP1: Chamber studies of BVOC emissions and BSOA formation

- 1.1 Leaf-scale emissions studies (Plant physiology and BVOC emissions from representative tree species under controlled conditions)
- 1.2 Single precursor BSOA production studies (Plant physiology and BVOC emissions from representative tree species under controlled conditions)
- 1.3 BSOA from precursor ensembles (Use of emissions ensemble from plant chamber as a feed for Manchester chamber. Comparison with synthetic ensemble)

WP2: Field measurement studies

- 2.1 Enhanced characterisation of OA components including primary emissions
- 2.2 In-canopy BVOC precursor and OA flux characterisation
- 2.3 BVOC precursor and OA flux characterisation above oil palm plantation

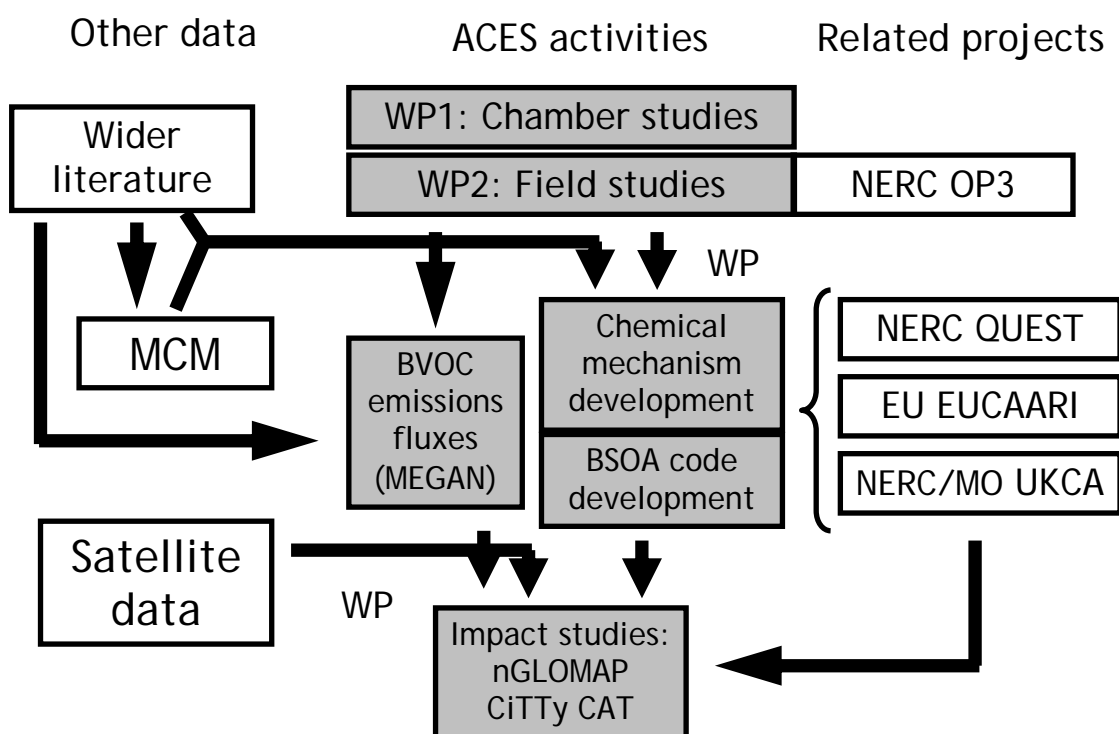
WP3: Development of BSOA formation mechanisms

- 3.1 Development of detailed gas-phase degradation mechanisms
- 3.2 Property estimation and development of gas-aerosol partitioning code
- 3.3 Mechanism evaluation using chamber data
- 3.4 Mechanism reduction

WP4: Modelling of Impacts and Uncertainties

- 4.1 Quantifying impact/uncertainty of BSOA/BVOC on regional atmospheric composition

ACES has several links with other programmes as detailed in the figure below.



4.1.2.3 Aerosol Interactions in Mixed Phase Clouds (ICE)

This consortium (led by Professor Tom Choullarton at the University of Manchester) aims to determine the nucleating ability of specific ice nuclei and the initiation and development of ice in mixed phase clouds. It seeks to determine how aerosol particles control the cloud microphysics, precipitation and dynamics in mixed phase clouds and will assess the type and phase partitioning of absorbing material above below and within clouds and the role of this material in ice nucleation. The ICE Consortium will reduce the uncertainty in the contribution of indirect radiative forcing by better understanding of the role of aerosols in the microphysics of mixed phase cloud.

The principal method of addressing these objectives will be through a combination of laboratory studies, modelling studies integrated with a series of aircraft flights and ground-based measurements made at Chilbolton. The flights will be performed in association with the Chilbolton radars and lidars to investigate the glaciation processes and the scavenging of black carbon in mixed phase layer clouds (supercooled stratocumulus, and mid-level layer clouds together with convective clouds as the opportunity arises). They will be supported by ground-based measurements at Chilbolton of the aerosol size distribution and composition together with the hygroscopic properties of the aerosol with an intensive campaign in January and February 2009. Airborne measurements in mountain wave clouds will also be performed in association with EUCAARI

A key and novel part of the proposed work is that samples of aerosol will be collected so that the ice nucleating ability of similar aerosols can be examined in the AIDA cloud chamber at Karlsruhe (see section 7). Studies will also be performed investigating the ice nucleation properties of various organic compounds, including various kinds of soot, and refractory material. The effects of coatings on the aerosol will also be investigated.

The integration of the chamber studies, ground based aerosol, airborne aerosol and cloud microphysics together with measurements from the radar will be performed using a new aerosol cloud model being developed jointly at Manchester and Leeds, in collaboration with the University of Helsinki. This model development is already funded through an APPRAISE core post (4.1.1.4).

4.2 Management Components

4.2.1 Science Coordinator (SC)

The Programme Science Coordinator (Dr Keith Bower) is a part-time position, held within an HEI, the University of Manchester. The primary role of the post is to develop the programme plan and delivery strategy, including this plan, a data management plan and a knowledge transfer strategy. The SC is working to ensure coordination between the different science components of APPRAISE, in particular making sure that the core activities are successfully coupled to the consortia programmes. The SC, together with

the Programme Advisory Group (PAG), will organise workshops to facilitate this interaction across the programme in addition to the large annual meetings.

The SC administers the awards process, feeding back information to unsuccessful candidates and, where necessary, negotiating modifications to the work plan and/or finances of successful applications. The SC is also responsible for the monitoring and reporting on behalf of the whole programme, including annual reporting and the completion of output performance measures (OPMs). In addition, the SC is to maintain an overview of the scientific progress made against the Programme Objectives. This document forms part of the structure for that process. In addition the SC ensures liaison across all APPRAISE participants and will foster the development of an APPRAISE community. A list of the APPRAISE participants and their affiliations is provided in appendix 1.

4.2.2 Programme Advisory Group

The PAG advises on the direction and integration of the Programme science and recommends award of research funds. The PAG has a role in the implementation of the data management strategy and for transferring the programme outcomes to the wider community, through knowledge transfer and other data communication strategies. The membership of the PAG is provided in Appendix 2. Together with the SC, they promote the programme and play a coordination role in knowledge transfer and data management. Lastly, following completion of the programme and the production of the final report they will be responsible for the post programme evaluation.

4.2.3 NERC Swindon

The SC and the PAG will be assisted by the Programme Manager Dr Ned Garnett who is located in the Swindon Office, following the departure of Dr Tracy Henshaw. NERC, Swindon provide day to day administrative support for the programme and act as the secretariat for the PAG. They are coordinating the peer review process and post award grant maintenance and will assist with the planning of Programme workshops.

5. Use of NERC facilities

5.1 FAAM Aircraft

The FAAM aircraft facility plays a central role in the implementation of APPRAISE science. In total 255 flight hours will be used by APPRAISE; 145 of these will be used by ADIENT, 110 by ICE APPRAISE; of these 60 hours will be used in conjunction with the EUCAARI EU6 project. The ICE APPRAISE activities will largely be based around Chilbolton (see below) and will be closely coordinated with the facility. The main intensive flying periods for ICE APPRAISE will take place in December 2007 and in January and February 2009, the latter being supported by a major ground based deployment at the Chilbolton site. A fraction of the ICE APPRAISE flying will be in collaboration with EUCAARI and will involve a limited number of flights to study the

microphysics of wave clouds formed over the Alps during the EUCAARI aircraft intensive when the FAAM aircraft will be based in Oberpfaffenhofen, Germany.

The ADIENT flight programme will be partly based in the UK and will focus on studying the physical, chemical and optical properties of pollution aerosol downwind of major pollution sources such as London. The radiative properties of the aerosol will also be measured and the radiative budget assessed. A second type of mission will also be carried out that will develop on the Polluted Troposphere programme, AMPEP, that assessed the UK budgets of gases and aerosols using flights conducted around Britain. This work will extend this through an assessment of the radiative properties of the aerosols. The flying will include overflights of sun photometers and a ground based LIDAR situated at a location on the east coast of the UK. Approximately, 75 flight hours will be taken up in these activities.

ADIENT will be closely integrated into the EUCAARI Framework 6 Integrated Project (see section 7.2) and will be a major contributor to that programme. 50 aircraft flying hours are being dedicated to a multi-aircraft intensive in May 2008 based at Oberpfaffenhofen, Munich. The EUCAARI programme is providing the support for the major detachment and some flying hours, predominately to support in situ measurements of aerosol chemical and physical properties. The DLR Falcon will undertake joint flying operations with the FAAM aircraft and will be fitted with a LIDAR. The two aircraft will conduct survey type missions investigating aerosol properties across Europe, the Falcon using remote sensing to survey the flight path and the FAAM aircraft to provide detailed in situ measurements. ADIENT will add to these activities by the addition of more flying hours and an additional suite of radiation instrumentation that will also allow column assessments of the radiative properties to be made over key strategic sites such as the EUSAAR and AERONET networks.

5.2 Chilbolton

Chilbolton observatory hosts a powerful array of instruments for observing mixed-phase clouds that will be operated during the flights of the FAAM aircraft in ICE-APPRAISE. The scanning 3-GHz Doppler/polarization radar will be used to provide the larger-scale context for the aircraft measurements; its 0.28° beam means that the clouds are sampled with unrivalled resolution. A number of vertically pointing radars and lidars operate near-continuously at Chilbolton, and will be used both when the aircraft flies directly overhead, and for continuous monitoring of the clouds and aerosol. The UFAM 35-GHz cloud radar may be used to derive ice water content, and during case studies is supplemented by the 94-GHz cloud radar to obtain accurate ice particle size. The lidar ceilometer can locate the presence of supercooled liquid water, and previously has been used to calculate a climatology of supercooled water over Chilbolton. When unobscured by low cloud, the dual-frequency microwave radiometer provides an estimate of the liquid water path of mixed-phase clouds. By late summer 2006 these measurements will be complemented by two new continuous-operation lidars. The UV polarization lidar will be much more sensitive to ice clouds than the ceilometer, and will be able to determine cloud phase unambiguously using its depolarization channel. The 1.6-micron Doppler lidar will measure the vertical velocity of cloud and aerosol particles, particularly in the boundary layer.

These measurements will be used to build up a climatology of aerosol and mixed-phase cloud properties over Chilbolton, both to support the interpretation of the aircraft case studies, and to study effect of aerosol on cloud statistically. The long-term monitoring capability of Chilbolton has recently been enhanced by the addition of a CIMEL sun photometer, providing aerosol optical depth in cloud-free daytime periods. In combination with the lidar backscatter profile, this can be used to derive the aerosol extinction profile. ICE-APPRAISE will utilize all these facilities in both its intensive aircraft activities and as part of a long term operation.

5.3 UFAM

The UFAM instrument suite will be utilized significantly by the APPRAISE programme. The major aerosol and cloud instruments such as the ground and aircraft based Aerosol Mass Spectrometer; the ground and aircraft based Cloud Particle Imager; the Differential Mobility Particle Sizer; and the UFAM aerosol mobile laboratory will all be used in support of the APPRAISE programme. Furthermore, UFAM staff will be available to maintain the facilities on behalf of the programme.

5.4 BADC

NERC's designated data centre for APPRAISE is the British Atmospheric Data Centre (BADC). An APPRAISE data management plan has been set up to establish a coherent approach to data issues during the programme. Its objective is to ensure that:

- Appropriate data support is provided to the scientists within APPRAISE.
- Data are made available to collaborators within APPRAISE in a timely fashion.
- Distribution conditions protect the individuals' rights to publish their own work.
- Potentially scientifically valuable data are kept for the long-term.
- A high quality documented APPRAISE archive is created.
- Data and documents are eventually distributed to the broader scientific community.

A data protocol will ensure appropriate usage and recognition of data and providers. It contains conditions for data access and publication and all applicants to the data will be required to abide by the protocol.

A website has been set up for APPRAISE at the BADC, which will be the gateway to all APPRAISE data: <http://badc.nerc.ac.uk/data/appraise/>. This page will include links to all relevant documentation and external sites and will be updated as the programme unfolds.

6. Timetable, Milestones and Deliverables

APPRAISE funding began in 2006 for the core projects and 2007 for the consortia.

Detailed timelines including milestones and deliverables of the core projects and the three consortia, ACES, ADIENT and ICE-APPRAISE, are given in appendices below.

7. National and International Links

7.1 QUEST

QUEST (Quantifying and Understanding the Earth System) is a major NERC programme that aims to deliver a step-change improvement in scientists' ability to predict environmental change, to assess the implications for the sustainable use of resources, to seek action-oriented research outputs, and to inform decision-making. One of the main elements in QUEST is studying the role of surface processes on atmospheric oxidizing capacity and aerosol loading. It will do this by building on an existing Met Office/NERC initiative to develop a new community model, UKCA, to study the interaction between climate and atmospheric composition. New chemistry and aerosol schemes are being developed for inclusion in the model. Schemes are also being developed to describe (interactively wherever possible) surface emissions of reactive trace gases and deposition processes. The QUEST Aerosol and Atmospheric Chemistry (QUAAC) activity develops the model formulation and also provides improved emissions databases and parameterisations. However, there is no testing of the model schemes, nor probing of the parameterisations in the model. APPRAISE activities are focussing on the development of knowledge of aerosol processes and properties (see OP3 linkages below). Hence, there is an excellent opportunity for synergy between these two programmes and this will be promoted within the APPRAISE programme.

7.2 EUCAARI

The European Integrated project on Aerosol Cloud Climate and Air Quality Interactions, EUCAARI, is the main EU programme on aerosols and clouds and will be the main focus for aerosol research activity in Europe for the next 5 years. The programme started in early 2007. EUCAARI brings together the leading European research groups, state-of-the-art infrastructure and key players from third countries to investigate the role of aerosol on climate and air quality.

The objectives of EUCAARI are

- Reduction of the current uncertainty of the impact of aerosol particles on climate by 50% and quantification of the relationship between anthropogenic aerosol particles and regional air quality, and
- Quantification of the side effects of European air quality directives on global and regional climate, and provide tools for future quantifications for different stakeholders.

EUCAARI will also contribute to technological developments in aerosol measurements, enhancing future experiments and air-quality monitoring networks. The project is organized into four scientific elements designed to maximize the integration of methodologies, scales and ultimately our understanding of air quality and climate. New ground-based, aircraft and satellite measurements will be integrated with existing data to produce a global consistent dataset with the highest possible accuracy. A European measurement campaign will be designed around simultaneous multi-station observations, Lagrangian aircraft measurements and carefully selected "super-sites". A hierarchy of models will be developed based on the results of the laboratory and theoretical investigations. The models will be used to interpret the measurements and will be integrated in regional air quality and global climate models. The result will be measurable

improvements in the project's climate and air quality models. The outcomes (scenarios, recommendations, models, harmonized datasets and new knowledge) will be disseminated to authorities, policy makers, the research community, industry, instrument designers, and the EU-ESA Global Monitoring for Environment and Security (GMES) Program.

Clearly, there is considerable synergy between APPRAISE and EUCAARI. Joint Aircraft Measurement Campaigns are planned in both the ADIENT and Clouds consortia. Links between the ACES consortium and EUCAARI are described (in the OP3 section) below and involve the feeding in of mechanism enhancements from ACES to the multicomponent partitioning module under development within EUCAARI WP1.4 (coordinated by ACES PI Gordon McFiggans).

The APPRAISE SC will encourage Core Project leaders and the consortia PIs to identify further linkages between their projects and EUCAARI so that interactions between the two programmes can be maximized. To date, activities linking APPRAISE and EUCAARI have included the invitation to Prof. Markku Kulmala, the head of the Aerosols Group at the University of Helsinki (home institute of the EUCAARI Project Office) to participate as a keynote speaker at the APPRAISE Kick Off meeting held at the University Of Reading in June 2007. It was agreed at this meeting that a wider dialogue between APPRAISE and EUCAARI was desirable and would be generated through joint workshops and invitations to each other's activities. The chair of the PAG and the PI of CP1 are both members of the EUCAARI Steering Committee and so are contact points for both programmes. Although APPRAISE has already formulated a data policy agreement, a joint EUCAARI-APPRAISE workshop on data issues was considered desirable with the goal of formalizing a common data sharing policy between the two programmes in the near future. The EUCAARI policy is for the immediate exchange of data between associated partners. An invitation was extended from Markku Kulmala to APPRAISE participants to attend the EUCAARI meeting in November (19-23) 2007. It is the intention of both programmes to hold a Joint Science Meeting (preliminarily scheduled for November 2009 in Manchester or Leeds).

7.3 EUSAAR

Another EU integrated project that APPRAISE shares links with is the European Supersites for Atmospheric Research (EUSAAR) programme. The objective of EUSAAR is the integration of measurements of atmospheric aerosol properties performed at a distributed network of 20 high quality ground-based stations (supersites) across Europe. This integration contributes to a sustainable reliable operational service in support of policy issues on air quality, long-range transport of pollutants and climate change. Networking activities will ensure most efficient use of available resources by

- Harmonisation and validation of current measurement of particle optical, physical and chemical properties
- Centralisation of validated measurements in a common database accessible to all users
- Good practice techniques and protocols disseminated within and outside the project

An important goal of EUSAAR is to improve accessibility to European monitoring data and to provide users with better tools to extract information from archiving systems. The advanced aerosol database is hosted and maintained by NILU and is based on the already existing EMEP database. The first version of the official database will open in September 2007.

The EUSAAR networking activities are complemented by 3 joint research activities (JRA) aimed at developing future tools for aerosol monitoring and dissemination of information. These developments are to be achieved through transnational coordinated research projects sharing experience, know-how and human capital, as offered by the proposed infrastructure. Each one of the JRAs supports and improves the implementation of one or more of the networking activities.

The objectives of the (11) trans-national access activities (TNA) are to promote scientific excellence ("mobility of experts") and access of research scientists, in particular inexperienced users, to the high quality EUSAAR infrastructures (supersites). Scientific users are the engineers or scientists who need the support of an advanced research station to conduct research in environmental sciences such as atmospheric dynamics, cloud microphysics, atmospheric chemistry, climate studies, remote sensing atmosphere, and atmospheric radiative transfer.

Many of the members of the APPRAISE team of researchers have already been participants in projects occurring at EUSAAR sites. In addition to these links, members of the EUSAAR network were invited to participate at the APPRAISE Kick Off meeting, where discussions of common data policies and access to each others data bases were initiated.

7.4 SOLAS

The NERC Surface Ocean-Lower Atmosphere programme (UK SOLAS) provides the main national contribution to international SOLAS (www.solas-int.org). Funded at the level of ~£11 m over 2005-10, UK SOLAS supports 24 research grants, three service-based contracts and an additional two CASE studentships. The programme's Science Plan is given at www.nerc.ac.uk/research/programmes/solas together with other basic information. The overall goal is to advance understanding of the mutual interactions between the atmosphere and the oceans, focusing on chemical exchanges that affect ocean productivity, atmospheric composition and climate.

UK SOLAS interests potentially relevant to APPRAISE include: i) ocean production of DMS, iodocarbons and other trace gases involved in particle formation; ii) sea-spray studies under a range of wind conditions to parameterise sea salt aerosol production; iii) atmospheric processes affecting dust and nutrient inputs to the ocean, and their subsequent biogeochemical effects; iv) establishment of an observatory (with international partners) on the Cape Verde islands for time series studies on the tropical marine atmosphere subject to both oceanic and continental influences (details at www.york.ac.uk/capeverde); and v) global-scale data synthesis and modelling, with emphasis on air-sea fluxes, aerosols and relevant atmospheric chemistry.

There are several senior researchers involved both in UK SOLAS and APPRAISE. Thus it is expected that synergies will naturally develop, and can be encouraged - for mutual benefit.

7.5 The VIACI Helmholtz Virtual Institute for Aerosol Cloud Interaction

A significant and important part of the ICE APPRAISE Cloud consortium activities will be the laboratory experiments carried out at the AIDA (Aerosol Interaction and Dynamics in the Atmosphere) chamber facility at the Forschungszentrum Jülich in Karlsruhe, Germany, to investigate the Ice Nucleating properties of various aerosol classes and samples under a range of controlled but atmospherically relevant conditions. AIDA has recently been assigned membership of the “Helmholtz Virtual Institute” network in Germany, as a “Virtual Institute for Aerosol and Cloud Interactions” (VI-ACI). This collaborative work at the AIDA chamber thus provides important linkages with the Helmholtz Virtual Institute network in Germany and its national and international partners.

The Helmholtz Virtual Institutes are a successful instrument to pursue the goals to which the Helmholtz Association has committed itself within the framework of the Pact for Research and Innovation. The Helmholtz Virtual Institutes comprise a network of around 77 virtual institutes sponsored for a three-year term with the involvement of almost 170 partners from 52 universities. The Helmholtz Association’s Assembly of Members recently passed a motion to uphold this funding measure, and a further call for proposals for a total of 10 new virtual institutes will follow in 2008.

In general, a Virtual Institute brings together major qualitative and quantitative research capacities from one or more universities and one or more Helmholtz Centres, supported by its own management structure, and so creates a centre of excellence with international standing and attractiveness to researchers in a key area of research. In a Virtual Institute distinguished research groups concentrate their efforts pursuing concrete strategic research goals. This serves to create a new cooperation quality strengthening scientific excellence and increasing international competitiveness. The number of institutions participating should arise from the work in question and should normally be between three or four. Foreign partner institutions should also be involved.

More information on VIACI in particular and Helmholtz Virtual Institutes in general can be found at (http://imk-aida.fzk.de/viaci_engl) (for information in English click on the link "What is a Helmholtz Virtual Institute?" and then on "Unterlagen der Ausschreibungsrunde 2007 - englische Version ")

7.6 OP3.

The OP3 or “Oxidant and Particle Photochemical Processes above a South-East Asian tropical rain forest” project is a NERC funded consortium project (<http://www.es.lancs.ac.uk/op3/index.html>) involving 23 PIs and co-PIs from 8 UK institutions (7 UK Universities: Lancaster, Leicester, Cambridge, York, Leeds Manchester and East Anglia, and the NERC Centre for Ecology and Hydrology, Edinburgh). Its objectives are (i) to understand how emissions of reactive trace gases

from a tropical rain forest mediate the production and processing of oxidants and particles in the troposphere, and (ii) to better understand the impact of these processes on local, regional and global scale atmospheric composition, chemistry and climate. Consortium partners include the Malaysian Meteorological Department, the Universiti Malaysia Sabah, Yayasan Sabah and a team of internationally-recognised research leaders in the field from the USA and Europe. The project will also contribute to the activities of the EC Network of Excellence "ACCENT".

OP3 will carry out field measurements within an undisturbed part of the Borneo rainforest at the Malaysian Meteorological Service's Global Atmospheric Watch station at Bukit Atur, and the Royal Society supported Danum Valley Field Centre, in Sabah, Malaysia. Two four week intensive measurement campaigns will be undertaken in April-May and June-July 2008. The latter period will also utilize the NERC FAAM research aircraft.

OP3 will address five key questions:

- 1). What are the rates of transfer and the speciation of organic compounds emitted from this tropical forest region?
- 2). How are these biogenic reactive compounds chemically processed in the near and intermediate field?
- 3). How do these emissions contribute to the formation of longer-lived intermediate products?
- 4). To what extent does the regional biogenic emission control the secondary aerosol budget and its hygroscopic and radiative properties?
- 5). What are the effects of these biogenic emissions on global chemistry and climate?

OP3 will deploy a range of state of the art measurement systems to quantify and speciate the fluxes of biologically produced reactive compounds from the forest canopy and underlying soils to the boundary layer. These will be compared with those from other forest locations to evaluate the ability to estimate fluxes using emission models. Earth observation systems will be used to assess the representativeness of measured fluxes to the wider region. OH/HO₂/RO₂/NO₃/halogen measurements, combined with constrained box models, will provide a means of understanding the in situ chemistry. VOC ratios, coupled with chemical-transport models and in situ OH measurements, will be used to understand the timescales of transport and transformation from the source region. Measurement of the concentrations of oxygenates, coupled with detailed chemical trajectory models and 3-D mesoscale chemistry-transport models, will be used to enhance the understanding of the role of these compounds in the chemistry of the upper troposphere. Of particular interest to APPRAISE will be the measurements of the composition of the organic fraction of the submicrometre aerosol and how this relates to the photochemical processing of the gas phase VOC precursors. Measurements of highly time resolved aerosol composition, coupled with detailed organic analysis for key markers and organic functionality, will provide a detailed knowledge of the aerosol chemistry. This will enable improved understanding of an, as yet poorly understood, important aerosol source that may well control cloud droplet number in an area where large convective cloud activity is prevalent. An assessment will be made of how biogenic emissions from Borneo impact the global atmosphere in contrast with the roles of Amazonia and Africa. An important question is how these impacts will change under land-use and climate change scenarios. A state of the art climate model with detailed tropospheric chemistry will be used to assess the effects of changing emissions.

The APPRAISE ACES consortium (4.1.1.2) has strong links to OP3 and is adding significantly to the project with a focus on developing our understanding of the oxidation pathways and phase partition of SOA leading to aerosol production. ACES aims to: (i) to improve our understanding of the fundamental processes involved in the formation of aerosols from the chemical processing of natural hydrocarbons emitted from forested regions of the world: (ii) to assess the impact of those aerosols on atmospheric composition, climate and rainfall: and (iii) to assess the impact of changes in land use on the above processes and impacts. This will be achieved using a combination of experimental studies in laboratory chambers, observational studies in a tropical forested region, and assessment studies using numerical models of the atmosphere

Specific ACES–OP3 linkages are listed below. They include joint linkages to previously mentioned programmes and institutes described in the earlier sections above :

- The ACES field measurements are collocated with, occur simultaneously to and supplement the field measurements made within the NERC OP3-Danum2008 consortium project between March and July 2008. The main PI of OP3, Nick Hewitt, is a partner in ACES and the ACES PI, Gordon McFiggans, has been co-opted onto the OP3 Scientific Steering Committee.
- QUAAC / UKCA - The mechanism developed within ACES will build upon those developed within 2 UK QUEST funded programmes. The QUAAC Aerosol & Atmospheric Chemistry (QUAAC) chemical scheme will be based on the Combined Reactive Intermediates mechanism (CRIMech) also developed within. The aerosol scheme will be abbreviated, for incorporation into the UK Chemistry & Aerosol (UKCA) model developed in collaboration with the Met Office. The reduced ACES scheme will develop the CRIMech paradigm, tailoring the intermediates to most readily preserve the condensable intermediates in the Master Chemical Mechanism (MCM) rather than to preserve ozone formation potential, in addition to incorporating the additional degradation mechanisms. ACES investigator Mike Jenkin is funded within QUEST and Gordon McFiggans and Nick Hewitt are partners in QUAAC.
- EUCAARI - The scheme developed within QUAAC forms the basis for the multicomponent partitioning module under development within EUCAARI WP1.4. The module is an extension of that developed for QUAAC, incorporating a more detailed consideration of the organic components. The performance of the thermodynamic treatment within the module will be validated against benchmark code within EUCAARI. The mechanism enhancements within ACES will feed into the EUCAARI framework to enable an enhanced treatment of BVOC oxidation and partitioning. Gordon McFiggans coordinates EUCAARI WP1.4.
- APPRAISE organic aerosol activities aim to conduct a number of fundamental laboratory studies of aerosol properties within the experimental programme of the University of Manchester Aerosol Chamber. These include the ACES WP1 chamber studies. Analytical techniques developed at the University of York within the activity will be deployed within the chamber experiments in ACES WP1 and the field measurements in ACES WP3. Ally Lewis and Jacqui Hamilton are involved in both ACES and the organic aerosol activity, while Gordon McFiggans is a partner in the organic aerosol activity and is responsible for the University of Manchester Aerosol Chamber programme.

- Joint CEH / UMan studentship - A 1-dimensional canopy model incorporating BVOC oxidation and SOA formation is under development within a joint studentship supervised by Eiko Nemitz (CEH) and Gordon McFiggans. This will be deployed within ACES with an aim to reproduce in-canopy organic oxidation and partitioning to aerosol.

8. Knowledge Transfer and External Communication

The Knowledge Transfer (KT) mechanisms of APPRAISE are more fully described in the Programme KT document. Only a brief overview is provided here. Each of the consortia has their own KT plans in place, and will directly feed their findings to the end user community through these links. Funded Consortia PI's have provided a list of their projects main KT activities and these will be listed in an Annex to the Programme KT document. It has been agreed that the overall KT for the programme will be managed by the UK Atmospheric Aerosols Network (UKAAN). The network has to date been part supported through an NERC KT network award and the National Centre for Atmospheric Science (NCAS) Composition Directorate. The NERC KT network funding finishes soon but APPRAISE will provide continuity of funding for the activities of UKAAN to continue and be tailored to meet the needs of APPRAISE for the duration of the programme.

UKAAN has already forged links between major UK research institutions in the area of aerosol research and major stakeholders such as the Met Office, the Environment Agency and DEFRA and learned societies such as the Institute of Physics, the Royal Society of Chemistry, the Aerosol Society and the Royal Meteorological Society. It hosts a series of workshops to highlight the state of knowledge in a particular area and seeks to provide papers on the forthcoming science strategy to deliver on key aims for the UK in the area of aerosol science over the coming years.

Further External Communication will be delivered through special sessions at international conferences, the annual national APPRAISE conferences, dedicated workshops that will involve key stakeholders, and integration with international programmes such as EUCAARI and SOLAS. All workshop reports and summaries will be available through the APPRAISE website.

9. The APPRAISE Website

<http://www.nerc.ac.uk/research/programmes/appraise/>

In addition to the NERC APPRAISE website above a separate independent website was set up in 2007 at <http://ncasweb.leeds.ac.uk/appraise> to advertise the main aims and highlight the main activities and science results from the Programme. This site is hosted NCAS with input from UKAAN and is remote from Swindon. The website will provide a focal point for the programme and will be used to advertise forthcoming events, report on the progress of the consortia and core activities and will be updated as and when new information on the programme becomes available. It will host workshop and conference presentations, meeting minutes and titles, and abstracts of published papers. The NERC

APPRAISE website will still be used for all formal announcements for the programme, but will not carry additional material described.

10. Progress Monitoring and Reporting

The progress of the programme will be monitored continually by the SC and formal reports will be requested annually (with summary updates at 6 monthly intervals) from each of the Core Activities and Consortia. The reports will be posted on the APPRAISE website and will be discussed by the PAG at their annual meetings. Where clear problems are identified the SC and members of the PAG will discuss with the PI of the CA or the Consortia how the problems can be rectified and deliver the science over the lifetime of the programme. It is anticipated that the research highlights from the programme will be included on the Programme web site.

As stated, written reporting will be carried out annually and a final report will be necessary from each of the funded components. It will be the responsibility of each PI to deliver their own report to the SC and the responsibility of the SC to compile their reports, summarise them and identify the main outputs. Responsibility for the overall programme final report lies with the SC.

Appendices

Appendix 1: List of participants

Title	First Name	Surname	Organisation	Email
	Judith	Agnew	CCLRC	J.L.Agnew@rl.ac.uk
Dr	U	Baltensperger	Paul Scherrer Institute	urs.baltensperger@psi.ch
Dr	Michael	Bane	The University of Manchester	michael.bane@manchester.ac.uk
Professor	Alan	Blyth	University of Leeds	blyth@env.leeds.ac.uk
Dr	Oliver	Boucher	Meteorological Office/ Hadley Centre	olivier.boucher@metoffice.gov.uk
Dr	Keith	Bower	The University of Manchester	k.bower@manchester.ac.uk
Dr	Helen	Brindley	Imperial College London	h.brindley@imperial.ac.uk
	Dominique	Butt	NERC	
Professor	Kenneth	Carslaw	University of Leeds	carslaw@env.leeds.ac.uk
Professor	Thomas	Choularton	The University of Manchester	T.W.Choularton@manchester.ac.uk
Professor	Hugh	Coe	The University of Manchester	hugh.coe@manchester.ac.uk
Dr	Sarah	Cornell	University of Bristol	sarah.cornell@bris.ac.uk
Dr	Tony	Cox	University of Cambridge	rac26@cam.ac.uk
Mr	Jonathan	Crosier	University of Manchester	j.crosier@manchester.ac.uk
Dr	Zhiqiang	Cui	University of Leeds	zhiqiang@env.leeds.ac.uk
	Amy	Foxton	NERC	
Dr	Martin	Gallagher	The University of Manchester	MARTIN.GALLAGHER@MANCHESTER.AC.UK
Dr	Don	Grainger	University of Oxford	r.grainger@physics.ox.ac.uk
Dr	Paul	Griffiths	University of Cambridge	ptg21@cam.ac.uk
Miss	Kate	Hanford	University of Bristol	Kate.Hanford@bris.ac.uk
Professor	HC	Hansson	Stockholm University	HC@itm.su.se
	Claudia	Hawke	NERC	
Dr	James	Haywood	Meteorological Office	jim.haywood@metoffice.com
Dr	Tracey	Henshaw	NERC	
Dr	Eric	Achterberg	University of Southampton	eric@noc.soton.ac.uk
Dr	James	Allan	The University of Manchester	james.allan@manchester.ac.uk
Professor	M	Bailey	NERC Centre for Ecology and Hydrology	mbj@ceh.ac.uk
Dr	Christine	Braban	University of Cambridge	cfb32@cam.ac.uk
Mr	Phillip	Brown	Meteorological Office	phil.brown@metoffice.gov.uk
Dr	Rachel	Burgess	The University of Manchester	rachel.burgess@manchester.ac.uk
Professor	Martyn	Chipperfield	University of Leeds	martyn@env.leeds.ac.uk
Dr	Simon	Clegg	University of East Anglia	s.clegg@uea.ac.uk
Professor	Ian	Colbeck	University of Essex	COLBI@ESSEX.AC.UK
Dr	Paul	Connolly	The University of Manchester	p.connolly@manchester.ac.uk
	S	Davies	University of Leeds	s.davies@see.leeds.ac.uk
Professor	Mike	DePledge	Plymouth Marine Laboratory	mhd@pml.ac.uk
Dr	A	Dudhia	University of Oxford	dudhia@atm.ox.ac.uk
Dr	Deborah	Fish	DSTL Porton Down	djfish@dstl.gov.uk
Dr	John	Foot	Meteorological Office	john.foot@metoffice.gov.uk
Dr	Kim	Hampton	Hovemere Ltd	khampton@hovemere.com
Professor	Roy	Harrison	University of Birmingham	r.m.harrison@bham.ac.uk
Professor	Charles	Hewitt	Lancaster University	n.hewitt@lancaster.ac.uk
Dr	Eleanor	Highwood	University of Reading	e.j.highwood@reading.ac.uk
Dr	Robin	Hogan	University of Reading	r.j.hogan@reading.ac.uk
Professor	Anthony	Illingworth	University of Reading	a.j.illingworth@reading.ac.uk
Dr	Michael	Jenkin	Imperial College London	m.jenkin@imperial.ac.uk
Professor	Roderic	Jones	University of Cambridge	rlj1001@cam.ac.uk
Dr	Madhavi	Karumudi	University of Reading	sws04km@met.rdg.ac.uk
Professor	Paul	Kaye	University of Hertfordshire	P.H.Kaye@herts.ac.uk

Dr	Brian	Kerridge	CCLRC	b.j.kerridge@rl.ac.uk
	Charles	Kilburn	BADC	C.A.D.Kilburn@rl.ac.uk
Dr	Martin	King	Royal Holloway, Univ of London	m.king@gl.rhul.ac.uk
Dr	Rob	Kinnersley	Environment Agency (Solihull)	rob.kinnersley@environment-agency.gov.uk
Professor	Markku	Kulmala	Helsinki University	markku.kulmala@helsinki.fi
Dr	Angus	Mackenzie	Lancaster University	r.mackenzie@lancaster.ac.uk
Dr	Graham	Mann	University of Leeds	gmann@env.leeds.ac.uk
Dr	James	McQuaid	University of Leeds	j.mcquaid@see.leeds.ac.uk
Dr	Laura	Mitchem	University of Bristol	Laura.Mitchem@bristol.ac.uk
Professor	Stephen	Mobbs	University of Leeds	stephen@env.leeds.ac.uk
Dr	Paul	Monks	University of Leicester	p.s.monks@le.ac.uk
Dr	Eiko	Nemitz	NERC Centre for Ecology and Hydrology	en@ceh.ac.uk
Dr	Clive	Oppenheimer	University of Cambridge	clive.oppenheimer@geog.cam.ac.uk
Professor	Anthony Guy	Orpen	University of Bristol	guy.orpen@bristol.ac.uk
Dr	Paul	Palmer	University of Edinburgh	pip@ed.ac.uk
Dr	Justin	Peter	University of Leeds	jpeter@env.leeds.ac.uk
Dr	Daniel	Peters	University of Oxford	dpeters@atm.ox.ac.uk
Dr	Gavin	Phillips	NERC Centre for Ecology and Hydrology	gjph@ceh.ac.uk
	Francis	Pope	University of Cambridge	fdp21@cam.ac.uk
Dr	Caroline	Poulsen	CCLRC	c.a.poulsen@rl.ac.uk
Professor	Colin	Prentice	University of Bristol	colin.prentice@bristol.ac.uk
Dr	Jeremy	Price	Meteorological Office	jeremy.price@metoffice.com
Professor	John Adrian	Pyle	University of Cambridge	john.pyle@atm.ch.cam.ac.uk
Dr	Jonathan	Reid	University of Bristol	j.p.reid@bristol.ac.uk
Professor	Keith	Shine	University of Reading	k.p.shine@reading.ac.uk
Dr	Richard	Siddans	CCLRC	r.siddans@rl.ac.uk
Professor	Anthony	Slingo	University of Reading	as@mail.nerc-essc.ac.uk
Dr	Timothy	Smyth	Plymouth Marine Laboratory	tjism@pml.ac.uk
Dr	Dominick	Spracklen	University of Leeds	d.spracklen@see.leeds.ac.uk
Dr	Gareth	Thomas	University of Oxford	gthomas@atm.ox.ac.uk
Dr	Martin	Todd	University College London	m.todd@geog.ucl.ac.uk
Dr	David	Topping	The University of Manchester	david.topping@postgrad.umist.ac.uk
Dr	Susan	Turner	The University of Manchester	fiona.turner@manchester.ac.uk
Dr	Zbigniew	Ulanowski	University of Hertfordshire	z.ulanski@herts.ac.uk
Dr	Louisa	Watts	NERC/BADC	lw@nerc.ac.uk
Dr	Ann	Webb	The University of Manchester	ann.webb@manchester.ac.uk
Dr	Chris	Westbrook	University of Reading	c.d.westbrook@reading.ac.uk
Professor	Andrew	Whiteley	NERC Centre for Ecology and Hydrology	aswhi@ceh.ac.uk
Dr	Martin	Williams	DEFRA (Dept for Env, Food & Rural Affair)	Martin.Williams@defra.gsi.gov.uk
Dr	Paul	Williams	The University of Manchester	paul.i.williams@manchester.ac.uk
Dr	Phil	Williamson	University of East Anglia	p.williamson@uea.ac.uk
Mr	Charles	Wrench	CCLRC	C.L.WRENCH@RL.AC.UK
Mr	Kevin	Wyche	University of Leicester	kpw5@le.ac.uk
Apologies				
Dr	David	Fowler	CEH	dfo@ceh.ac.uk
Dr	Jacqueline	Hamilton	University of York	jfh2@york.ac.uk
Professor	Alastair	Lewis	University of York	ac15@york.ac.uk
Dr	Gordon	McFiggans	The University of Manchester	g.mcfiggans@manchester.ac.uk
Professor	M	Pilling	University of Leeds	M.J.PILLING@CHEMISTRY.LEEDS.AC.UK

Appendix 2: PAG members

Prof Urs Baltensperger	- Paul Scherrer Institute (Switzerland) (CHAIR)
Prof Hugh Coe	- Manchester University
Dr Jim Haywood	- The Met Office
Dr Eleanor Highwood	- Reading University
Prof Mike Pilling	- University of Leeds
Prof John Pyle	- University of Cambridge
Prof Tony Slingo	- University of Reading (ESSC)
Dr Martin Williams	- DEFRA

NERC Management Team

Dr Keith Bower,	- University of Manchester (Science Coordinator)
Dr Ned Garnett	- NERC (Programme Manager)
Dominique Butt	- NERC (Programme Administrator)
Amy Foxton	- NERC (Programme Administrator)
Dr Rachel Burgess	- University of Manchester (Assistant to SC)

Appendix 3: Programme Timeline

