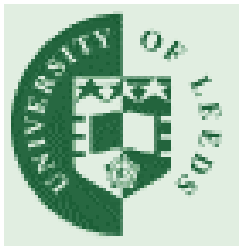
The UK Chemistry and Aerosols Project (UKCA)



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What is UKCA ?

¥ UKCA is a joint NCAS— Met Office programme funded by NCAS, GMR and DEFRA for three years (started mid-2004)

¥Initiating project partners are Hadley Centre, Cambridge and Leeds Universities

Objective of UKCA

¥ To build and evaluate a new UK community atmospheric chemistry-aerosol model suitable for a range of topics in climate and environmental change research

Why do we need UKCA ?

¥ Scope of current chemistry and aerosol models is insufficient for Earth System modelling

¥Synergy resulting from Met Office and NCAS partnership

¥To encourage wider community research in this area

Main Products of UKCA

¥ A flexible global model for chemistry-aerosol-climate studies

- ¥Troposphere and Stratosphere
- ¥Coupled chemistry, aerosols and climate

¥A 100 year validated, demonstration run

¥A model suitable for community use as part of the UM system

New Features

- Coupled chemistry, aerosols and climate model
- Based on new dynamics
- Combined troposphere-stratosphere chemistry
- Improved aerosol microphysics and chemistry
- Capability to interact with surface, radiation and biosphere
- Modular structure

Main UKCA Work Packages

- Tropospheric model development
  - HadGAM at N48L38
  - Tropospheric chemistry schemes
- Stratospheric+tropospheric model
  - HadGAM at N48L60
- Aerosols
  - New aerosol species and microphysics
  - Aerosol chemistry

Current Participants

¥ Chemistry: Glenn Carver, Olaf Morgenstern, John Pyle (Cambridge), Bill Collins, Colin Johnson, Fiona O Connor (Met Office)

¥Aerosols: Nicolas Bellouin, Jim Haywood, Jamie Rae (Met Office), Ken Carslaw, Graham Mann (Leeds)

¥L60 Dynamics: Andrew Bushell, Neal Butchart (Met Office), Lesley Gray (Reading), Scott Osprey (Oxford)

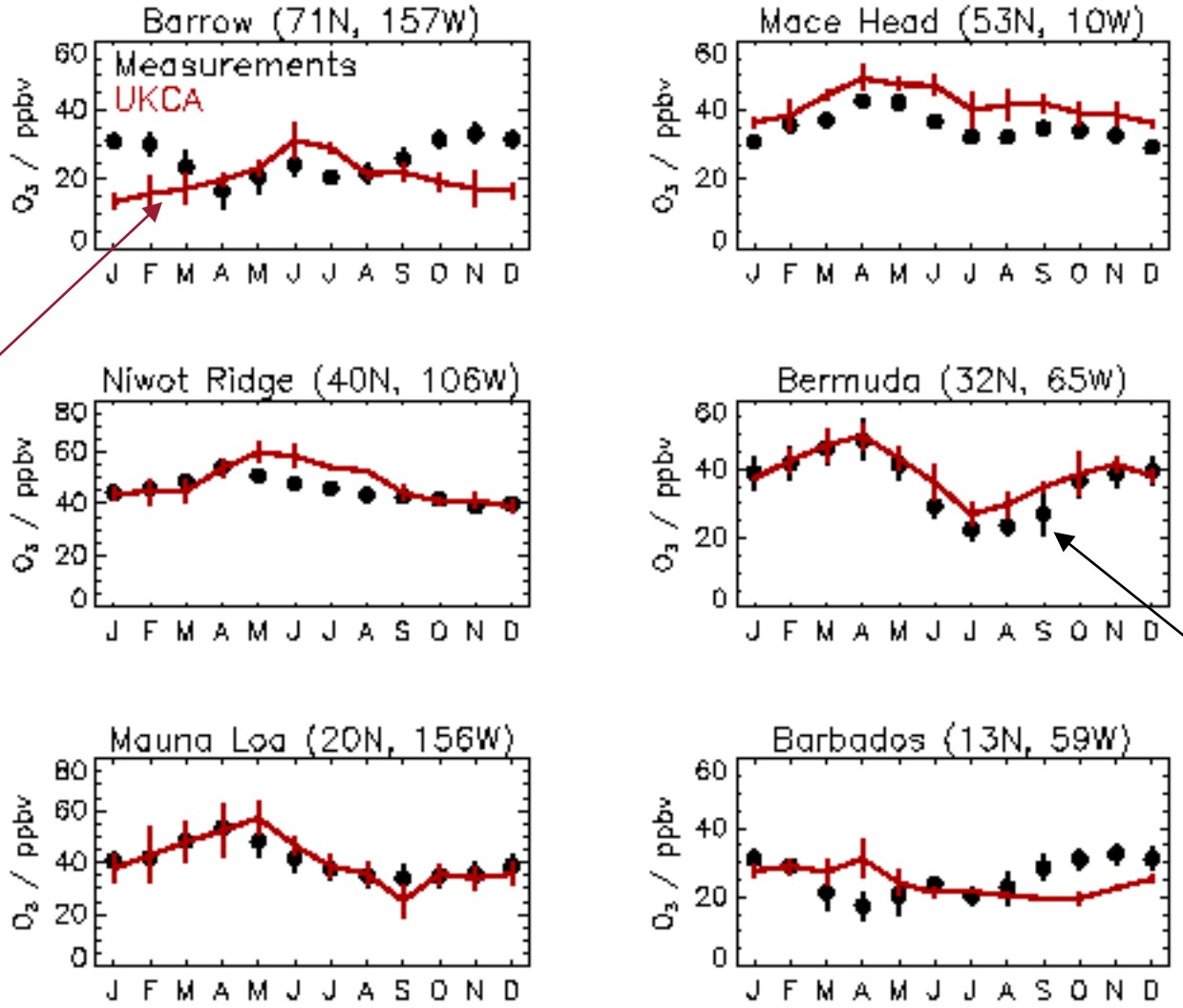
UKCA Chemistry Schemes

	TOMCAT L38	TOMCAT/ WA L60	MOZART-2 L38	UM_CAM (strat) L60
Tracers	24	45	43 (in ASAD)	25
Species	44	71	67	43
Ethane, propane	Relatively explicit	Relatively explicit	Slightly simplified	none
Isoprene	None	None	NCAR	none
Other NMVOCs	none	none	butane, _-pinene, alcohols, alkenes	none
Stratosphere	Prescribed	Compre-hensive	Prescribed	Compre-hensive

UKCA Tropospheric Chemistry

- ¥ CH4-CO-NOx-HOx-NMHCs chemistry scheme
- ¥ 24 Tracers and 46 Species
- ¥ Prescribed photolysis rates and upper boundary
- ¥ Surface, aircraft, and lightning emissions
- ¥ Wet and dry deposition
- ¥ ASAD chemical solver

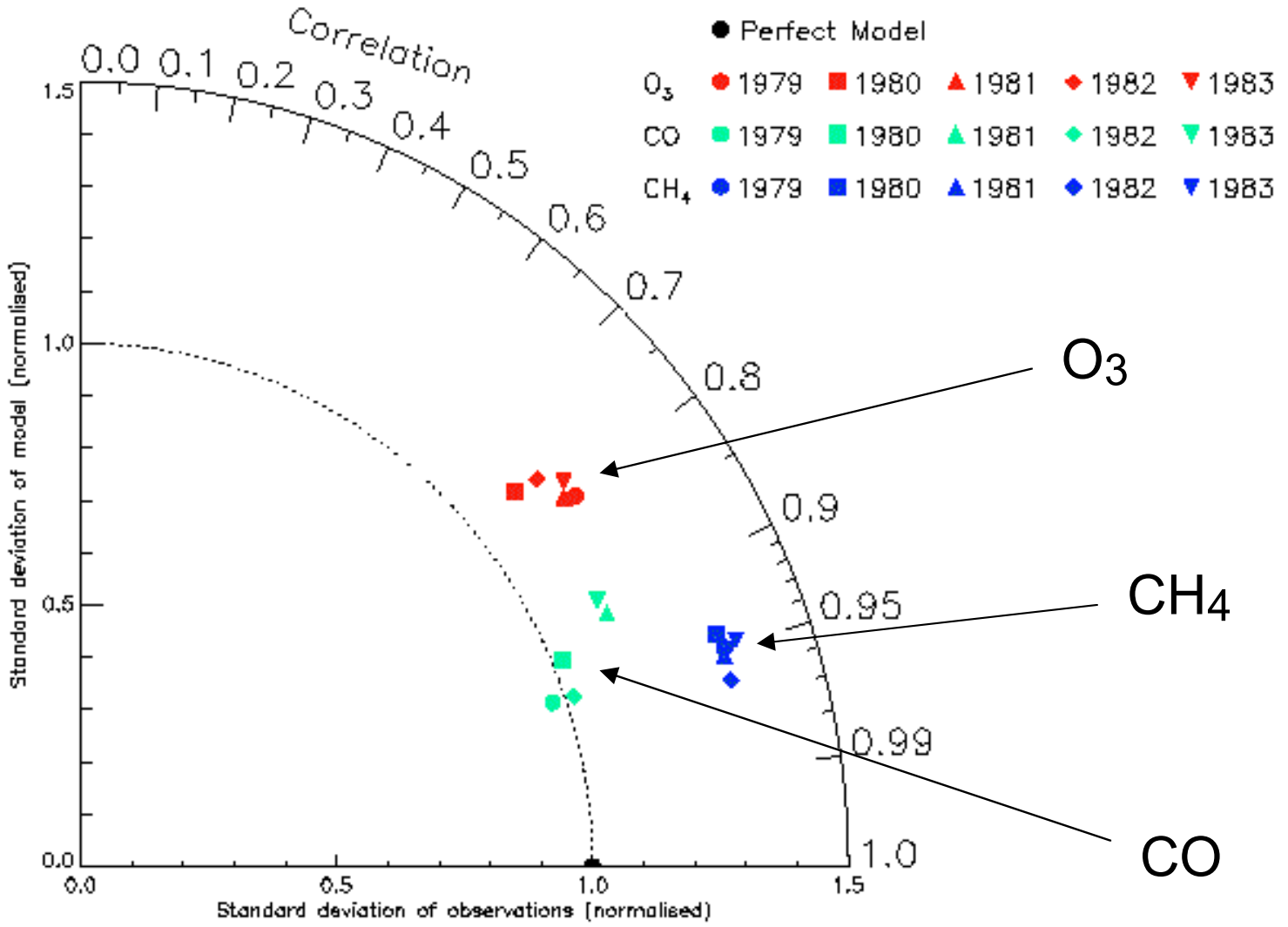
Comparison with CMDL Surface Ozone



UKCA
5-yr mean

Obs

Taylor Diagram for Surface Comparisons



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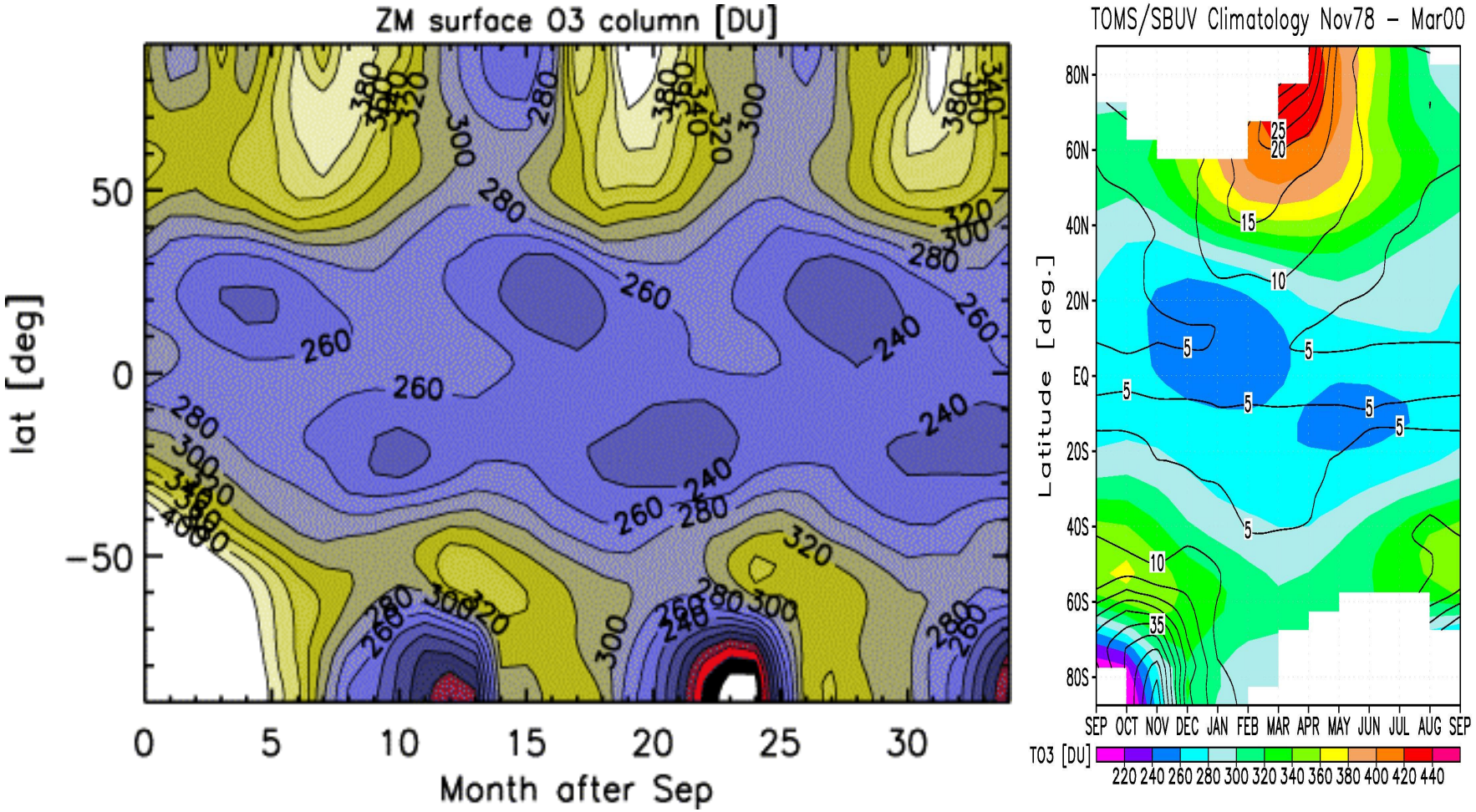
Trop-Strat chemistry

- Tropospheric chemistry package incl. emission & deposition
- Merged TOMCAT/SLIMCAT photolysis (*Future: Fast-J*)
- Stratospheric radical reactions
- Stratospheric halogen (Cl/Br) chemistry from UM_CAM (P. Braesicke) + 10 source gases
- Heterogeneous PSC chemistry
- Denitrification + dehydration
- Here: UM 5.5 N48L60 (top: 85 km)

Total ozone in 35-months simulation



Monthly-mean total ozone (DU) in (left) UKCA. (right) TOMS/SBUV climatology.

Aerosol part of UKCA sub-model

UKCA-mode aerosol scheme incorporates

- dynamically evolving aerosol size distributions with particle number as a prognostic variable,
- a multi-component aerosol system with internally mixed modes
- binary nucleation of new sulfate aerosol
- prognostic sea salt mass per particle

Initial configuration of UKCA-mode

Mode name	Size range	Composition	Soluble?
nucl-sol	r < 5 nm	SU	Yes
Aitken-sol	5 < r < 50 nm	SU, BC, OC	Yes
accum-sol	50 nm < r < 500 nm	SU, BC, OC, SS, DU	Yes
coarse-sol	r > 500 nm	SU, BC, OC, SS, DU	Yes
Aitken-ins	5 < r < 50 nm	BC, OC	No
accum-ins	50 nm < r < 500 nm	DU	No
coarse-ins	r > 500 nm	DU	No

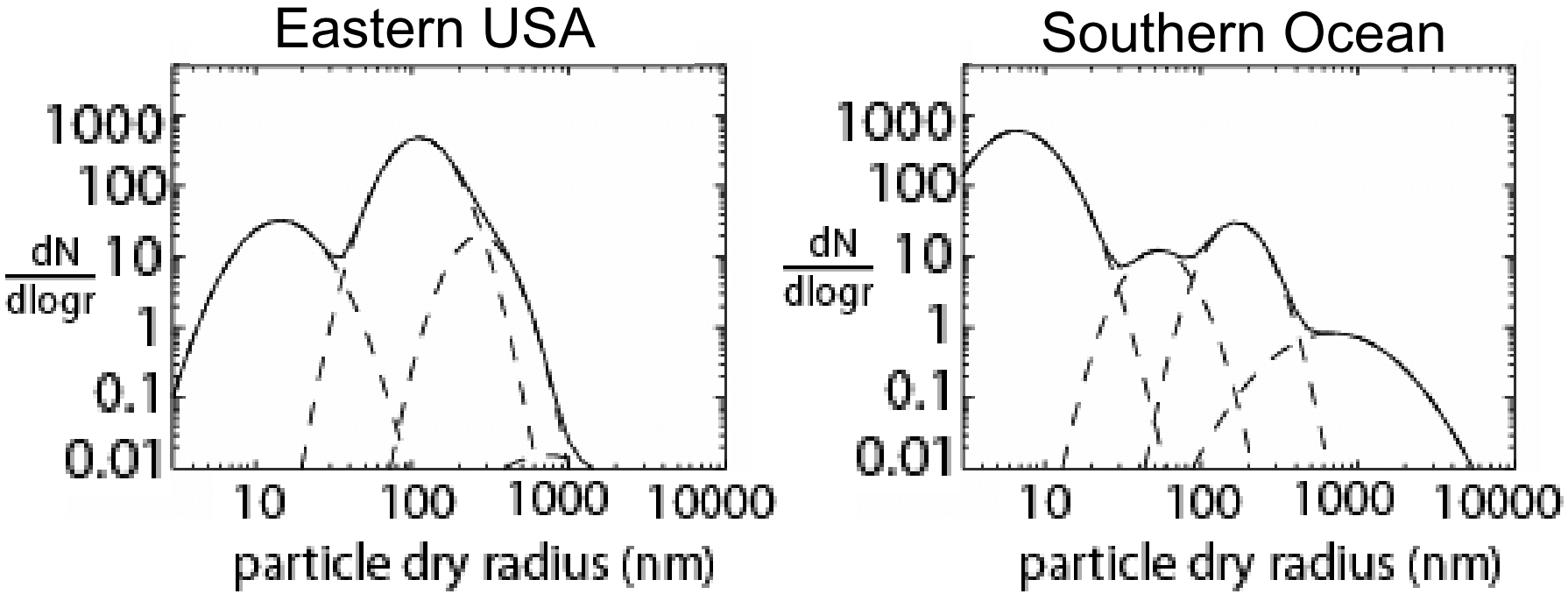
Initially UKCA-mode to follow M7 model (Vignati et al., 2004; Stier et al., 2005).
SU=sulfate, BC=black carbon, OC=organic carbon, SS=sea salt, DU= dust.

¥Subsequent versions of UKCA-mode will include more complete multi-component system

¥aerosol chemistry including nitrate and ammonium

¥secondary organic aerosol incorporated following scheme development via QUEST project

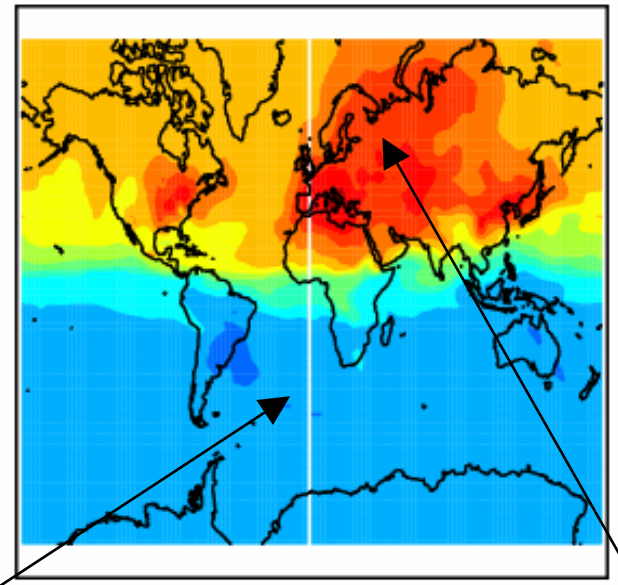
Size distributions from sulfate-and-sea-salt only global UKCA run within TOMCAT (T42L31).



Variation of aerosol size, composition and mixing state feeds into UM radiation scheme.

Dynamically varying size of aerosol particle modes

soluble Aitken mode



$\bar{r}$ (nm)

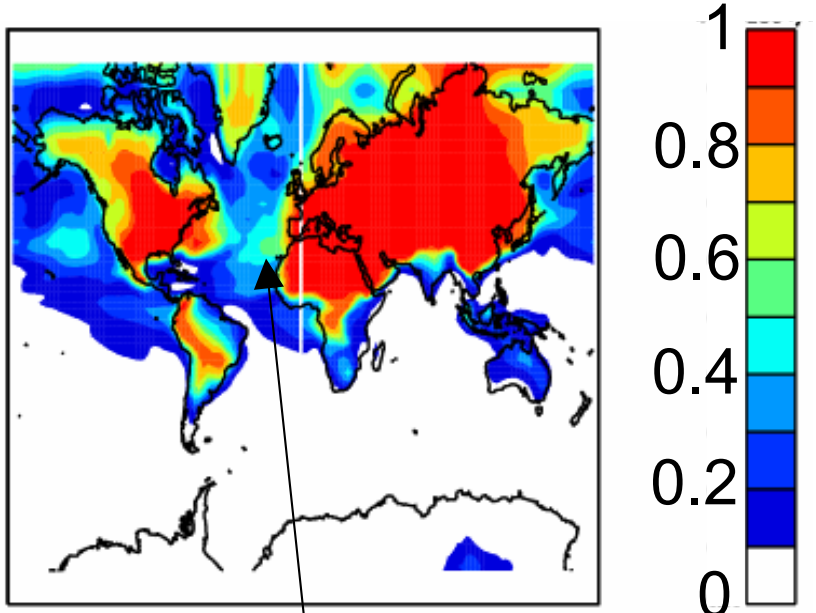
150
120
90
60
30
0

larger Aitken mode particles in polluted continental MBL

smaller Aitken mode particles in clean SH MBL

Dynamically varying composition within internally mixed modes

accum. mode SU mass fraction



Internally mixed accum. mode composition varies

Ongoing Work

- Improve L60 model temperature bias and GWD
- Different chemical schemes (aerosol chemistry)
- Further evaluation of trop-strat chemistry
- Add dust and carbon to new aerosol scheme
- Implement aerosol sub-model in HadGAM1
- Sensitivity Tests
- UKCA Description and Validation paper

Complementary activities (1)

¥ QUEST is funding three modelling consortia - one on chemistry/aerosols with emphasis on surface emissions (esp biogenics) and deposition but including developments in chemical mechanisms and SOA (also surface/ocean).

¥ QUEST aims to develop an ESM based on HadGEM

Complementary activities (2)

¥Need to include earth system components in climate models

¥Hadley Centre is building a new model: **HadGEM2**

- ¥Start September 2005
- ¥Tuned version by June 2007

¥Ecosystems:

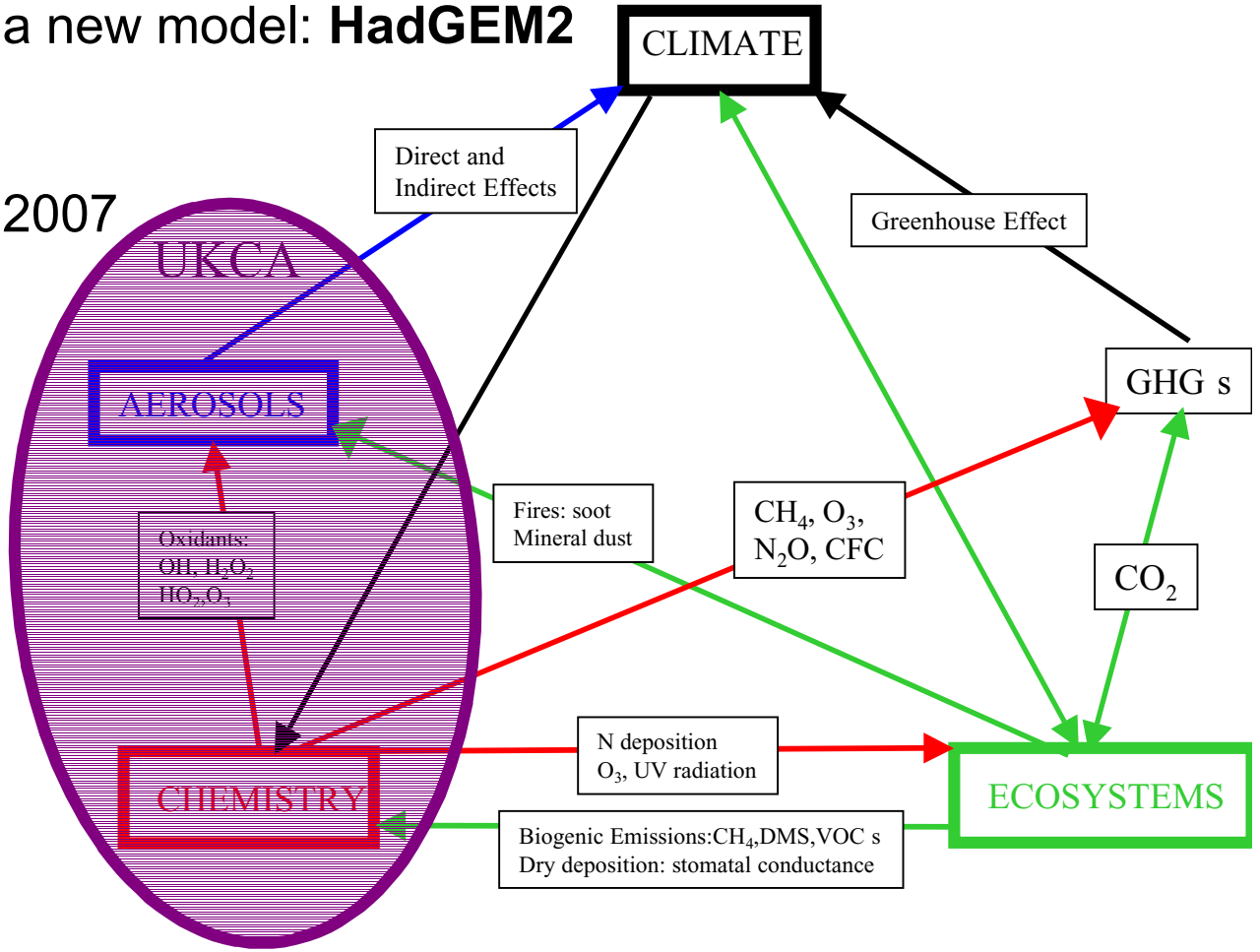
- ¥TRIFFID,
- ¥diat-HadOCC

¥Chemistry & aerosols:

- ¥UKCA*

(Joint Met Office/NCAS)

*not necessarily all components



Release strategy

¥ Phased release starting early 2006
¥ Linked to UM releases
¥ Coinciding with submission of papers
¥ Code of conduct including feedback, collaboration, possible co-authorship etc..
¥ Documentation and std control run

Further information

¥Website

http://www.ukca.ac.uk/

Under development. Will provide details of model, how to get it, documentation, UKCA presentation etc.

¥Mailing list

ukca-announce@atm.ch.cam.ac.uk

To subscribe send an email to majordomo@atm.ch.cam.ac.uk with the text **subscribe ukca-announce** in the body of the message.

The end