

# **UKCA at vn6.6 of the Unified Model (DRAFT)**

Colin Johnson and UKCA team

13th<sup>th</sup> November 2007

## **Introduction**

UKCA has been ported to vn6.6 of the Unified Model and now operates from panels available in the UMUI. Details of how to do this are outlined below. Available features include the tropospheric chemistry, stratospheric chemistry and the MODE aerosol scheme. UKCA occupies section 34 of the UM, but as the transport of this section is not yet available, atmospheric tracer transport is being done in section 33. The stratospheric chemistry in this release is untested because a suitable L60 model at vn6.6 is not yet available. The MODE scheme has also not been fully tested because diagnostics were not output. This will be rectified at the next version using the UKCA diagnostics section.

## **Work completed for vn6.6**

- All diagnostic fields used by UKCA are now available as standard UM diagnostics and can be switched on in the UMUI.
- UKCA tropospheric chemistry, stratospheric chemistry, tropospheric with aerosol chemistry and the MODE aerosol scheme are all available.
- Oxidants from UKCA can be used in the UM sulphur cycle scheme instead of the ancillary file previously used.
- Radiative feedback using trace gases from UKCA is included.
- A version of the FAST-J photolysis scheme is included.
- Control features in the UMUI turn on the code, and a new panel for MODE has been added.
- A new STASH section (38) has been added specifically for UKCA diagnostics.

## **How to run UKCA at vn6.6**

To run UKCA it is necessary to turn on sections 33 and 34, and apply some hand edits to the umui output files. Details of how to do this are shown below.

## Testing UKCA at vn6.6

vn6.6 of the Unified Model was released on 2<sup>nd</sup> December 2007. Pre-release testing was done and a few compilation and corrections to the UMUI and STASHmaster\_A were done. See ticket #1142 for the blow by blow details of model testing. Job agbqn is for UKCA at vn6.6.3. This has been run for 6 months. This has some changes to u\_model relative to vn6.6.2, and again a branch was needed to correct UKCA for these changes (argcona.h and artcona.h replaced with modules). New control variables were inserted into cruntime.h in this branch to allow use of UKCA\_MODE from the umui.

Job agbqo is to test UKCA-MODE at vn6.6.3. This was unsuccessful as there is an array bound error which has proved hard to trace.

## Running UKCA at vn6.6

Job agsta (hadcj) runs the tropospheric chemistry model. This compiles and runs without any specific hand edits or branches for UKCA. This job uses the vsafe option for UKCA code.

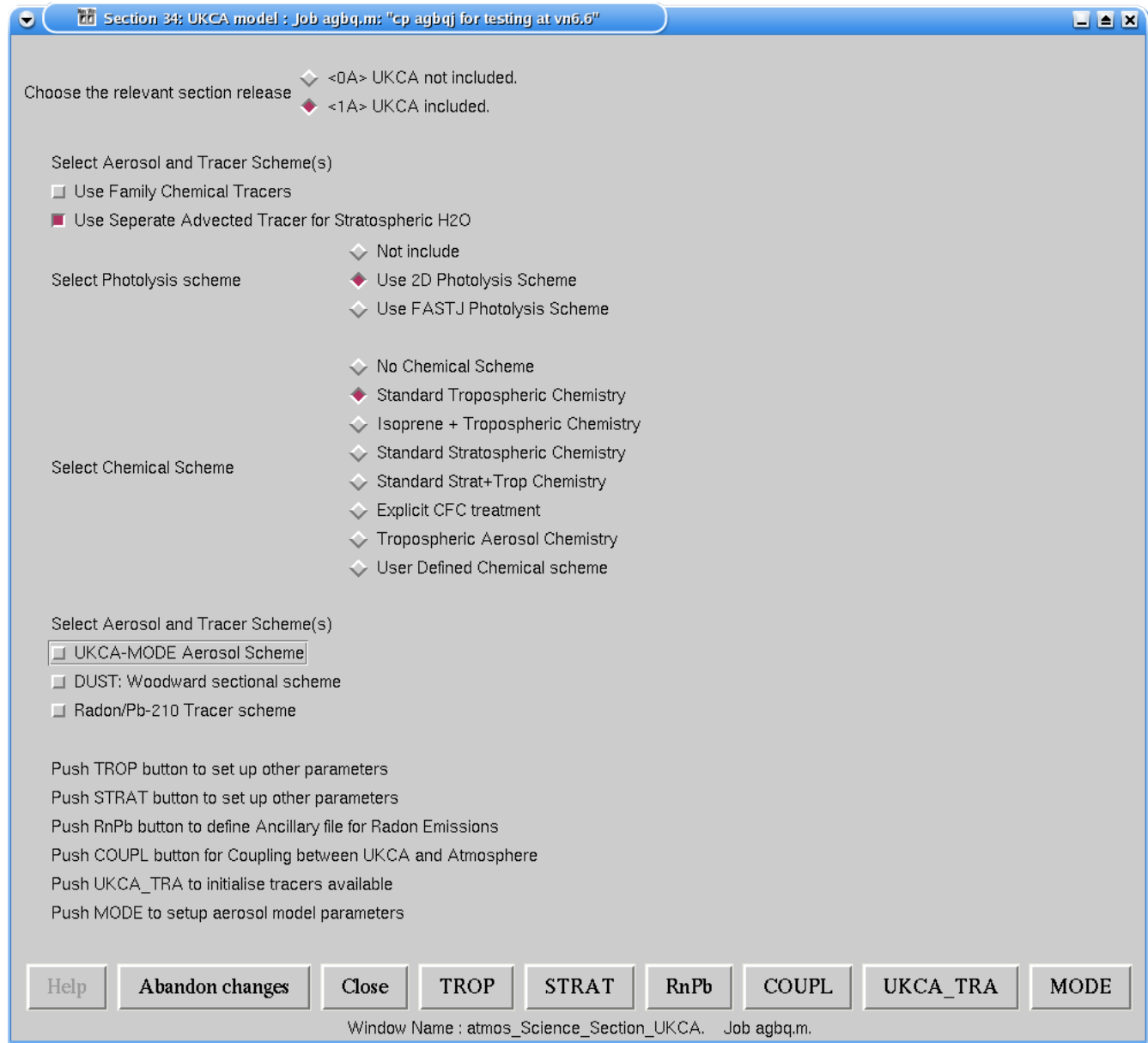
## Open Tickets

- [#818 Introduce functionality for UKCA/tracer lateral boundary forcing](#)
- [#835 Tracer system for section 34 \(UKCA\)](#)
- [#880 PUM - Create stub files for UKCA and ISCCP](#)
- [#1058 Add code to allow use of UKCA-MODE aerosols in radiation scheme](#)
- [#1078 Update of copyright statement in UKCA routines](#)
- [#1079 Update of copyright statement in Fast-j routines](#)
- [#1118 Improve vector performance of ukca\\_deriv, ukca\\_stratf, and possibly ukca\\_chemco](#)
- [#1142 6.6 Testing : UKCA](#)
- [#1147 UKCA Remaining Issues from Reviewers](#)
- [#1163 Put STOCHEM chemistry scheme into UKCA](#)
- [#1165 Update of UKCA to get bit reproducible results on different PE configurations](#)

## UMUI features

The main panel is shown below, this is accessed from Atmosphere=> Model Configuration > UKCA chemistry

Illustrations 1-3 show examples of the UKCA and tracer panels from vn6.6 of the UMUI. The tracer (section 33) panel is in use only until tracer transport is included for section 34. In this case tracer selection must be done manually, for example for tropospheric chemistry the first 26 tracers are required.



*Illustration 1: Main UKCA Panel*

As this release still uses section 33 for the tracer transport scheme, this scheme needs turning on. Note that boundary layer mixing of these tracers is not set, this is because this is explicitly done by UKCA for the chemical tracers when emissions are added. The number of tracers turned on depends on the scheme being used. This panel is accessed from Atmosphere => Model Configuration

=> Atmospheric tracers. A user stashmaster file is also needed to define these tracers, and the order of the tracers must be the same as defined in the chemistry module `ukca_chem1_dat.F90` for the appropriate case.

UKCA requires diagnostics to be set that are available at every timestep, and placed in secondary storage space. Please see job `agsta` (`hadcj`) which defines the package switch `U` for the required diagnostics.

User stashmaster files are also used to define the diagnostic fields from UKCA in section 33.

*Illustration 2: Tracer Panel*

**Atmospheric Tracers : Job agbq.m: "cp agbqj for testing at vn6.6"**

☒ Do you want to include tracers in the atmosphere?  
Mark the STASH tracer items to be included - these will have section 33 STASH numbers and STASHmaster entries.

The format of the left column is :-  
<ITEM(TRACER NO: CONVENTIONAL USE)>

For the right column you should enter:-

- 0 - Do not include
- 1 - Include from dump
- 2 - Configure from ancillary tracer file (file needs attaching & see help)
- 3 - Update from aerosol climatology (file needs attaching)

Tracers	
Tracers available	Select
1 (01: TRACER_1 )	1
2 (02: TRACER_2 )	1
3 (03: TRACER_3 )	1
4 (04: TRACER_4 )	1
5 (05: TRACER_5 )	1
6 (06: TRACER_6 )	1
7 (07: TRACER_7 )	1
8 (08: TRACER_8 )	1
9 (09: TRACER_9 )	1
10 (10: TRACER_10 )	1
Inert	Edit

☐ With boundary layer mixing of tracers

Number of atmospheric tracer levels

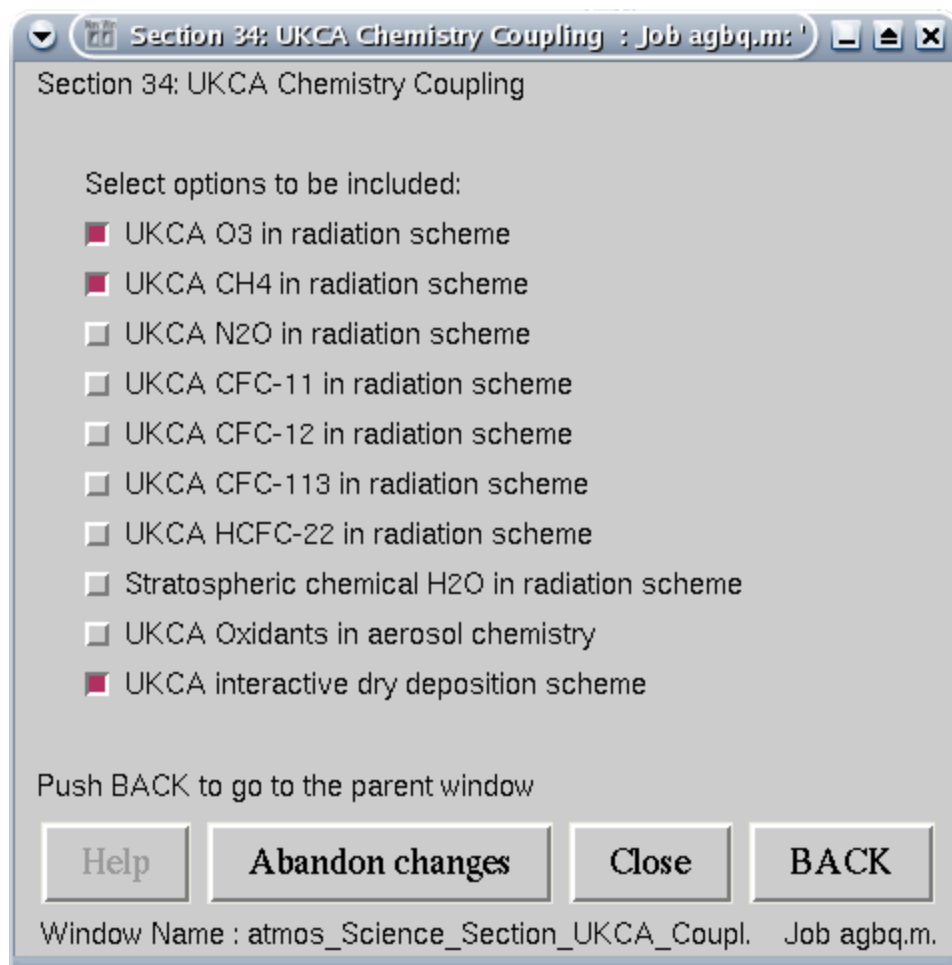
Chemistry is included. The number of tracer levels must equal the number of model levels

Push ANCIL to look at the ancillary file setting

**Help** **Abandon changes** **Close** **ANCIL**

Window Name : atmos\_Config\_Tracer. Job agbq.m.

*Illustration 3: UKCA Coupling Panel*



## Recommended Hand Edits and Branches

1. Hand edit (~hadcj/umui\_jobs/hand\_edits/MODE\_on) to change section definition from A34\_1A to A34\_1G in order to select the correct array sizes to run the MODE aerosol scheme.
2. Hand edit () to change section definition from A34\_1A to A34\_1C in order to select the correct array sizes to run the stratospheric chemistry scheme.

## APPENDIX 1: UKCA Logicals and Control Variables in RUN\_UKCA Namelist

Available at vn6.6	Name	Action/Comment
--------------------	------	----------------

Yes	L_ukca	Turns on UKCA
Yes, not tested	L_ukca_family	Selects family chemistry, requires change to tracers
Yes, not tested	L_ukca_advh2o	Use separate tracer for water vapour, requires change to tracers
Yes	L_ukca_phot2D	Use tabulated photolysis rates from 2D model
Yes, not tested	L_ukca_fastj	Use FAST-J for photolysis rates, currently only suitable for troposphere
Yes	L_ukca_chem	Use chemistry
Yes	L_ukca_trop	Tropospheric chemistry
No, not yet included	L_ukca_tropisop	Tropospheric chemistry with isoprene scheme
Yes, not tested	L_ukca_strat	Stratospheric chemistry
No, not yet included	L_ukca_wachem	'Whole atmosphere' chemistry
No, not yet included	L_ukca_strattrop	Stratospheric and tropospheric chemistry
Yes, not tested	L_ukca_stratcfc	Stratospheric chemistry with explicit CFC treatment
Yes, not tested	L_ukca_aerchem	Tropospheric chemistry with DMS and SO2 oxidation schemes
No, not yet included	L_ukca_user	User specified chemistry
Yes, not tested	L_ukca_mode	MODE aerosol scheme
Yes, not tested	L_ukca_dust	UM dust scheme
Yes, not tested	L_ukca_RnPb	Rn-222/Pb-210 scheme
Yes, not tested	L_ukca_O3budget	Turn on ozone budgeting
No, problem with wetland methane scheme in UM	L_ukca_qCH4inter	Turn on interactive wetland methane emissions
No, not yet included	L_ukca_isopinter	Interactive isoprene emissions
No, not yet included	L_ukca_terpinter	Interactive terpene emissions

Yes, not tested	L_ukca_budget2	Budget code for stratospheric chemistry
Yes, not tested	L_ukca_QF11F12MBR	Use emissions for CFC-11, CFC-12, and CH3Br
Yes, not tested	L_ukca_useUMUIvals	Use UMUI values for N2O and CFC emissions
Yes, not tested	L_ukca_NAT_sedi	Include NAT sedimentation
Yes, not tested	L_ukca_het_PSC	Do heterogenous chemistry on PSCs
Yes, not tested	L_ukca_H2O_feedback	Use oxidation source to feedback on dynamical H2O
Yes, not tested	L_ukca_ClBrcons	Apply conservation to Cl and Br species
Yes, not tested	L_ukca_useRO3	Use RO3 in photolysis scheme
Yes, not tested	L_ukca_useCO3	Use climatological ozone in photolysis scheme
Yes, not tested	L_ukca_userelaxO3	Use climatological ozone in photolysis scheme above 0.3 hPa
Yes, not tested	L_ukca_radO3	Use ozone from UKCA in radiation scheme
Yes, not tested	L_ukca_radCH4	Use methane from UKCA in radiation scheme
Yes, not tested	L_ukca_radN2O	Use N2O from UKCA in radiation scheme
Yes, not tested	L_ukca_radF11	Use CFC-11 from UKCA in radiation scheme
Yes, not tested	L_ukca_radF12	Use CFC-12 from UKCA in radiation scheme
Yes, not tested	L_ukca_radF113	Use CFC-113 from UKCA in radiation scheme
Yes, not tested	L_ukca_radF22	Use CFC-22 from UKCA in radiation scheme
No, not yet in use	L_ukca_radCH2O	Use chemical water vapour in radiation scheme
No, not in use	L_ukca_useoxid	See UM sulphur scycle



		scheme
Yes, obligatory	L_ukca_intDD	Use interactive dry deposition scheme – alternative scheme does not work correctly
Yes, not tested	I_MODE_SETUP=1	SO4 and SS in 4 soluble modes
Yes, not tested	I_MODE_SETUP=2	SO4, SS, BC, & OC in 5 modes
No, not yet in use	I_MODE_SETUP=3	SO4, SS, BC, & OC in 4 soluble modes
No, not yet in use	I_MODE_SETUP=4	SO4, SS, BC, OC, & SOC in 5 modes
No, not yet in use	I_MODE_SETUP=5	SO4, SS, BC, OC, & SOC in 4 soluble modes
Yes, not tested	I_MODE_SIZEPRIM=[1-4]	Defines size parameters for primary SO4, BC & OC emissions
Yes, not tested	I_MODE_NUCSCAV=[1-2]	Defines nucleation scavenging method: 1=as GLOMAP Spr05, 2=use scavenging coeffs
Yes, not tested	I_MODE_DDEPAER=[1-2]	Defines dry deposition: 1=as GLOMAP Spr05, 2=incl. sedi method
Yes, not tested	I_MODE_NZTS	No. of sub-steps for nucleation/ condensation
Yes, not tested	MODE_ACTDRYR	Minimum dry radius for activation to cloud droplet
Yes, not tested	L_UKCA_PRIMSU	Apply primary sulphate aerosol emissions
Yes, not tested	L_UKCA_PRIMSS	Apply primary sea-salt emissions
No, not yet in use	L_UKCA_PRIMBCOC	Apply primary BC and OC emissions
Yes, not tested	L_UKCA_SEDI	Include sedimentation, only in use for I_MODE_DDEPAER=2
Yes, not tested	L_UKCA_NUCL	Include nucleation

**Table 2. Diagnostic Fields Required by UKCA**

Section Item	Description	Time,Domain,Usage Profiles
0 406	EXNER PRESSURE AT THETA LEVELS	TALLTS, DALLTH, UPUKCA
0 407	PRESSURE AT RHO LEVELS AFTER TS	TALLTS, DALLRH, UPUKCA
0 408	PRESSURE AT THETA LEVELS AFTER TS	TALLTS, DALLTH, UPUKCA
0 409	SURFACE PRESSURE AFTER TIMESTEP	TALLTS, DIAG, UPUKCA
1 201	NET DOWN SURFACE SW FLUX: SW TS	ONLTSW, DIAG, UPUKCA
1 235	TOTAL DOWNWARD SURFACE SW FLUX	TALLTS, DIAG, UPUKCA
3 25	BOUNDARY LAYER DEPTH AFTER B.LAYER	TALLTS, DIAG, UPUKCA
3 60	RHOKH_MIX	TALLTS, DPBLALL, UPUKCA
3 61	RHO_ARESIST (RHOSTAR*CD_STD*VSHR)	TALLTS, DIAG, UPUKCA
3 62	ARESIST [ 1/(CD_STD*VSHR) ]	TALLTS DIAG UPUKCA
3 63	RESIST_B (1/CH - 1/CD_STD)/ VSHR	TALLTS DIAG UPUKCA
3 64	DTRDZ_CHARNEY_GRID	TALLTS DPBLALL UPUKCA
3 65	GRID-LEVEL OF SML INVERSION (kent)	TALLTS DIAG UPUKCA
3 66	Rho * entrainment rate (we_lim)	TALLTS DPFT UPUKCA
3 67	Fraction of the timestep (t_frac)	TALLTS DPFT UPUKCA
3 68	zrzi	TALLTS DPFT UPUKCA
3 69	GRID-LEVEL OF DSC INVERSION (kent)	TALLTS DIAG UPUKCA
3 70	Rho * entrainment rate dsc	TALLTS DPFT UPUKCA
3 71	Fraction of the timestep dsc	TALLTS DPFT UPUKCA
3 72	zrzi dsc	TALLTS DPFT UPUKCA
3 73	ZHSC Top of decoupled layer	TALLTS DIAG UPUKCA
3 74	Surface layer resist for dust div1	TALLTS DIAG UPUKCA
3 75	Surface layer resist for dust div2	TALLTS DIAG UPUKCA
3 76	Surface layer resist for dust div3	TALLTS DIAG UPUKCA
3 77	Surface layer resist for dust div4	TALLTS DIAG UPUKCA
3 78	Surface layer resist for dust div5	TALLTS DIAG UPUKCA
3 79	Surface layer resist for dust div6	TALLTS DIAG UPUKCA
3 209	10 METRE WIND U-COMP	TALLTS DIAG UPUKCA
3 210	10 METRE WIND V-COMP	TALLTS DIAG UPUKCA
3 217	SURFACE HEAT FLUX W/M2	TALLTS DIAG UPUKCA

3 462	STOMATAL CONDUCTANCE ON PFTS (M/S)	TALLTS	DPFT	UPUKCA
3 465	FRICTION VELOCITY	TALLTS	DIAG	UPUKCA
4 205	CLOUD LIQUID WATER AFTER LS PRECIP	TALLTS	DALLCL	UPUKCA
4 206	CLOUD ICE CONTENT AFTER LS PRECIP	TALLTS	DALLCL	UPUKCA
4 222	RAINFALL RATE OUT OF MODEL LEVELS	TALLTS	DALLCL	UPUKCA
4 223	SNOWFALL RATE OUT OF MODEL LEVELS	TALLTS	DALLCL	UPUKCA
4 227	RAIN FRACTION OUT OF MODEL LEVELS	TALLTS	DALLCL	UPUKCA
5 227	NOMINAL 3D CONVECTIVE RAINFALL RATE	TALLTS	DALLCL	UPUKCA
5 228	NOMINAL 3D CONVECTIVE SNOWFALL RATE	TALLTS	DALLCL	UPUKCA
15 218	PV on model theta levels	TALLTS	DALLTH	UPUKCA
17 205	DIMETHYL SULPHIDE EMISSIONS	TALLTS	DIAG	UPUKCA
30 453	Height at Tropopause Level	TALLTS	DIAG	UPUKCA