

## **Pre-Existing Technology for GLOMAP-mode**

This PET document continues the free non-exclusive software license granted to CNRS/HYGEOS and ECMWF for the first 2 phases of CAMS43 (Apr16 to Mar19, Apr19 to Aug22), continuing here for the CAMS2\_35 period (Sep22 to Feb25), re: the “reference” versions of the GLOMAP-mode source-code.

### 1) GLOMAP-mode version 5

This is the original “first fully documented” version of GLOMAP-mode, as described in the Geoscientific Model Development paper by Mann et al. (2010), evaluating global aerosol properties simulated based on its implementation within the TOMCAT offline 3D chemistry transport model (Chipperfield, 2006).

This v5 of GLOMAP-mode was Implemented into a perforce branch of the ECMWF Integrated Forecasting System during the 1<sup>st</sup> phase of MACC, with simulated global aerosol properties in the reference run b0vk (at IFS cycle CY36R2) presented in Deliverable Report D\_G\_AER1.8 (Woodhouse et al., 2011).

TOMCAT-GLOMAPmode v5 results submitted to AeroCom (A2-CTRL-2006) in October 2009.

### 2) GLOMAP-mode version 6R

This is the revised “GLOMAP-bin re-calibrated” version of GLOMAP-mode, as described in the Atmospheric Chemistry and Physics paper by Mann et al. (2012). The letter “R” refers to the re-calibration of some key parameters used in the modal scheme (e.g. the geometric standard deviation for the soluble accumulation mode). These were adjusted following benchmarking of the simulated global particle size distribution against parallel simulations within TOMCAT of the sectional GLOMAP-bin scheme (Spracklen et al., 2005, 2008).

TOMCAT-GLOMAPmode v6R results submitted to AeroCom (A2-CTRL-2006) in August 2011.

### 3) GLOMAP-mode version 7newprim

This version includes an initial set of changes required to enable the scheme to be applicable to simulate aerosol properties across the stratosphere and troposphere, as described in Dhomse et al. (2014a). This v7newprim was the version of GLOMAP implemented in the IFS at the end of MACC-II, as described in Deliverable Reports D\_62.3 (Woodhouse et al., 2013) and D\_62.5 (Woodhouse et al. (2014) within reference simulation b0zg at IFS cycle CY38R1 as lodged into the IFS trunk at CY40. This version of the code was also implemented in the “merged branch” at v7.3 of the UK Met Office Unified Model (MetUM), as used by Bellouin et al. (2013), Kipling et al., (2013), West et al. (2014), Turnock et al. (2015) and as lodged back to the MetUM trunk at v8.2.

The “newprim” extension to the version number refers to the way primary emissions in the model were refactored to provide fluxes via an emissions pre-processor routine “ukca\_mode\_ems.F90”. In so-doing the primary emissions routines were separated from the rest of the GLOMAP code, with 2 distinct interface routines developed, one for the emissions and one for the other parts of the code. Alternative versions of these interface routines are now implemented in TOMCAT, the MetUM and in the ECMWF IFS.

This CY40 trunk code was used for the “stand-alone” (b1e3, b1fv) and “coupled to C-IFS” (b1ft) IFS-GLOMAP CY40R3 runs as in MACC-III Deliverable report D62.4 (Mann et al., 2015).

#### 4) GLOMAP-mode version 8

The initial version of version 8 of GLOMAP-mode (v8.0) is to include the code-changes required to simulate aerosol properties across the stratosphere and troposphere, as described in Dhomse et al., (2014b). In 2016, the v8.4 release job 4 (RJ4.0) of the UKCA-UM composition-climate model (Abraham et al., 2015) was updated to provide these Dhomse14 code updates via a dedicated FCM branch and has now also been added to the UM v11.0 for lodging back to the UM trunk and for use in UKESM1. An interim GLOMAP v8.1 version includes improvements to some tropospheric aerosol processes (as described in Yoshioka et al., 2019), and then to the main GLOMAP v8.2 version for further improved stratospheric aerosol properties (enacting heterogeneous nucleation of meteoric-sulphuric particles) GLOMAP-mode version, as applied for UM-UKCA simulations in Zanchettin et al. (2016), Brooke et al., (2017), Marshall et al. (2018), Timmreck et al. (2018), Marshall et al. (2019), Dhomse et al. (2020), Antuna Marrero et al. (2020) and Clyne et al. (2021). A further evolved GLOMAP v8.3 includes improved meteoric-sulphuric particle interactions.

In CAMS phase 1, this GLOMAP v8.3 was provided to CNRS and the GLOMAP codebase in C-IFS was upgraded from v7newprim to GLOMAP v8.3, leading to the two stratospheric aerosol deliverable reports during the recent CAMS43 2<sup>nd</sup> phase (e.g. Mann et al., 2021).

#### 5) GLOMAP-mode version 9 (with coupling to HyDiS v1.0)

This is a version of GLOMAP currently in development within the MetUM for use in UKESM which combines the functionality of version 8 with also option to apply as the “nitrate-extended version of GLOMAP-mode”, the main component of which is a new hybrid dissolution code “HyDiS” which is comprehensively described in Benduhn et al. (2016), with results from benchmark testing in the GLOMAP box model and validation of global aerosol properties in the version 4 of GLOMAP-mode in TOMCAT. This version of GLOMAP can be made available for the IFS during CAMS2-35 as part of the GLOMAP code progression.

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