GLOMAP code consolidation activity

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BACKGROUND AND INTRODUCTION

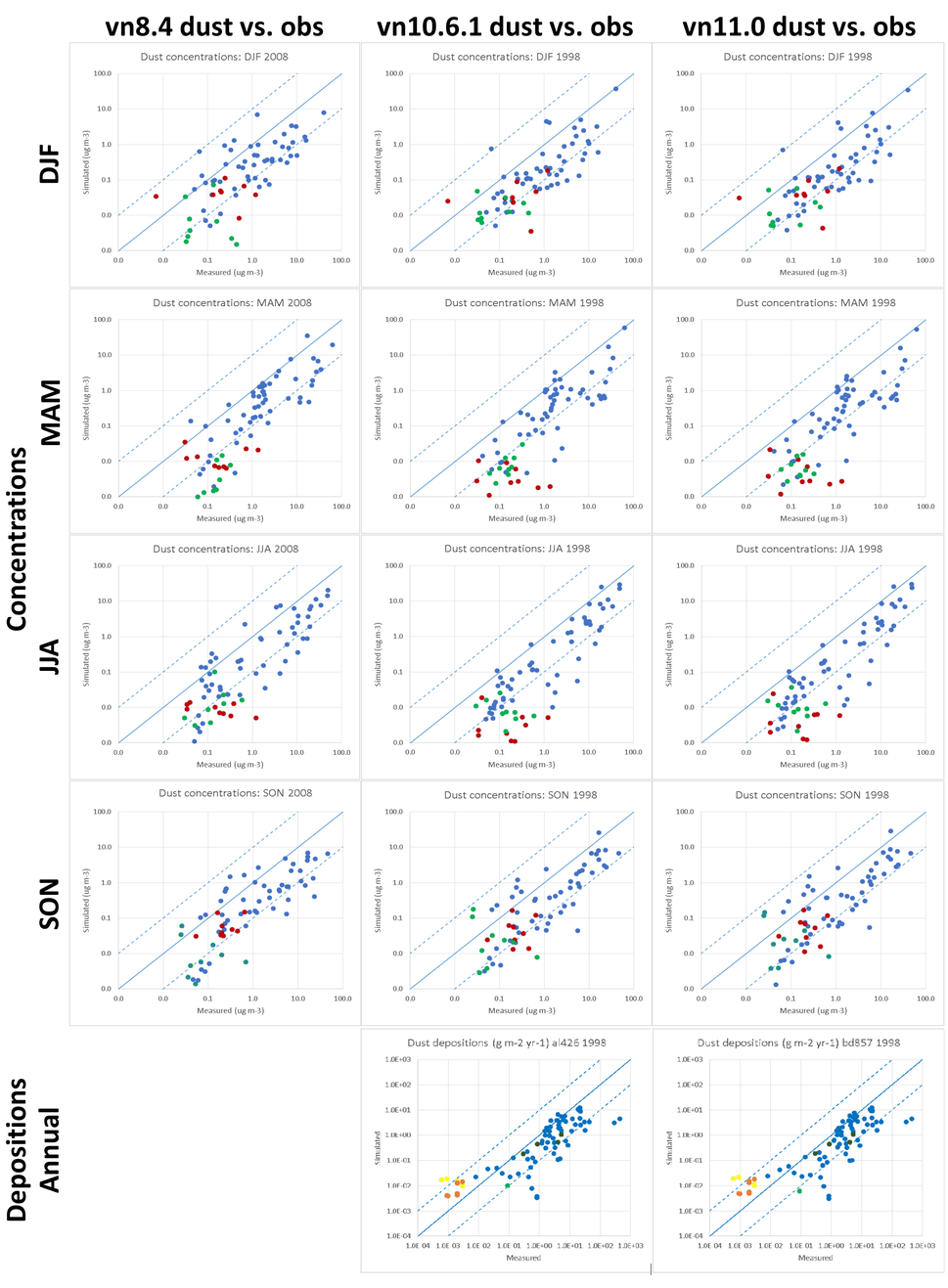
- **GLOMAP-mode** aerosol microphysical scheme (Mann et al., 2010, GMD) has been included in various UM-UKCA versions including UKESM1, which is recently released.
- However, UKESM1 and latest versions of UM-UKCA (vn11.x) do not include all the newer features, modifications and bug-fixes implemented and validated in lower versions of the models such as vn7.3 and 8.4 and other platforms such as TOMCAT (CTM) and C-IFS (ECMWF model).
- In this activity we have been adding these model developments back into UM-UKCA vn11.0 and vn11.3.

GLOMAP CODE EVOLUTION ON DIFFERENT PLATFORMS

GLOMAP version	Main additional features	TOM CAT	UM-UKCA vn7.3	UM-UKCA vn8.4	C-IFS	UM-UKCA vn11.0	Additional FCM branches	Routines additionally modified
7newprim	Separate routine for primary emissions	√	RJ3	RJ4	√	**RJ5**		
7newprim +dust	Dust in modal scheme and its ageing					**√**	vn11.0_dust_ageing	**ukca_prim_du**: Whole routine added by switch (not by branch) **ukca_aero_ctl**: Ageing of dust only modes turned on
8.0	Aerosols in stratosphere and troposphere			√		**√**	vn11.0_updateGLOMAPtoDhomse14ACP	**ukca_aero_step**, **ukca_calcnucrate**: mask_evap added **ukca_conden**: accounts for evaporation of sulfate aerosol in stratosphere **ukca_remode**: Mode merging treated differently
8.0+dust	Dust in modal scheme and its ageing			√				
8.1	Cloud ice threshold for scavenging			√		**√**	vn11.0_ACID_PRUF_GASSP vn11.0_UKCA_icescavupd_fromJMscav vn11.0_ukca_glomap_bugfix_SECORGorgNPF	**ukca_calcnucrate**: Only a fraction of secondary organic material is used in Metzger nucleation **ukca_aero_ctl**, **ukca_aero_step**, **ukca_impc_scav**, **ukca_main1-ukca_main1**, **ukca_rainout**: Cloud ice threshold for scavenging is introduced. **ukca_aero_step**: Bug-fix included
8.2	MSP (meteoric smoke particles) interactions			√	√	**√**	vn11.0_GLOMAPmode6matchMSPfromWACCM	**ukca_calc_coag_kernel**: Control on insoluble-insoluble coagulation added **ukca_coag_coff_v**: Coagulation efficiency added **ukca_coagwithnucl**: Control on intra- and inter-coagulations added **ukca_conden**: Condensation of H2SO4 added **ukca_ddepaer_incl_sedi_mod**, **ukca_ddepaer_mod**, **ukca_impc_scav**, **ukca_rainout**: Dry and wet depositions of H2SO4 from mode 6 added **ukca_aero_ctl**, **ukca_aero_step**, **ukca_ageing**, **ukca_calcminmaxndmdt**: include associated changes
8.3	Improvement in evaporation of H2SO4 off MSPs			√	√	**Planned**		
9.0	HyDiS (Hybrid dissolution solver) for nitrate and ammonium aerosols	√*	√			**Under development**		* HyDiS have been added on version 4 of GLOMAP on TOMCAT (Benduhn et al., 2016, GMD)

MODAL DUST SIMULATIONS

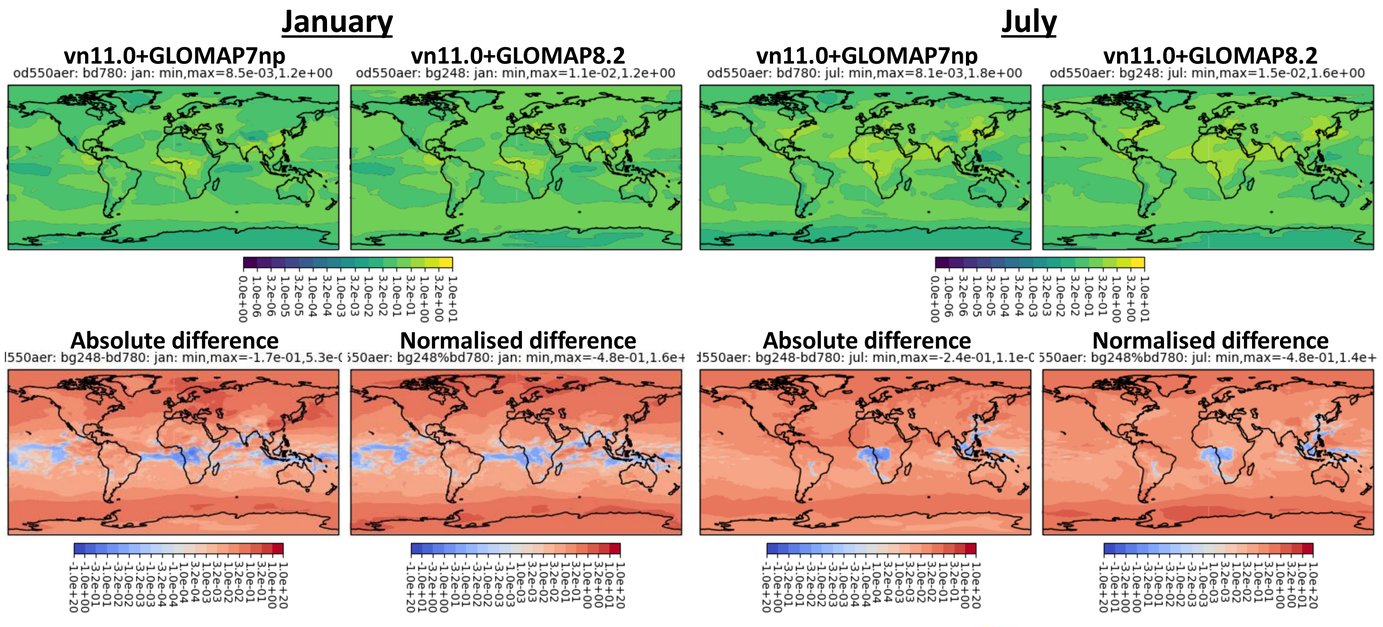
- Dust concentrations and total (dry+wet) depositions at surface observation sites are **very** similar between **vn10.6.1** and **vn11.0**.
- They are somewhat different from **vn8.4** but still similar in general.
- Simulations tends to underestimate observed dust concentrations (AeroCom; Huneeus et al., 2011) especially over remote marine regions.
- Simulated dust depositions are at about the right magnitude.
- They capture general features in observations.
  - Correlation coefficients between simulated and measured concentrations and depositions are all in the 0.80–0.82 range.



SIMULATED AOD

- AOD at 550 nm simulated in **UM-UKCA vn11.0** with **GLOMAP vn7newprim** (release job 5.0) and With **GLOMAP vn8.2** are compared.
- Differences are –0.2~0.5 (–50~160%) in January and –0.2~0.1 (–50~140%) in July.
- AOD is increased in mid- to high-latitude regions especially in the winter hemisphere.
  - One reason for this is the **cloud ice threshold** that is introduced to suppress nucleation scavenging in mixed phase clouds.
- AOD is increased in the Saharan outflow region.
  - Dust simulated in different ways: **bin** vs. **modal** schemes.
- AOD is reduced in the rain belt along ITCZ. This suggests increased scavenging in warm clouds. But why?
  - **Internal mixing between dust and soluble material** may have…
    - let dust act as CCN?
    - reduced particle number and increased cloud droplet sizes, rainfall and scavenging?
  - Nucleation of sulphate may have become less effective due to the change in **Metzger nucleation scheme**. This may have…
    - reduced particle number and increased cloud droplet sizes, rainfall and scavenging?

(Note these are **nudged** simulations so the atmospheric circulations should not be affected.)



UKESM

GLOMAP mode