

Anonymous Referee #1

General comments

1. *This paper documents the development of a module to describe organic aerosol composition and evolution in the atmosphere (ORACLE) within the ECHAM5/MESSy Atmospheric Chemistry (EMAC) model. The paper comprises a very comprehensive description of the module and is well written and clear; I would recommend its publication in GMD following clarification on the below very minor issues.*

We would like to thank the referee for the positive response. Below are our responses to the issues raised.

Specific comments

2. *Saturation vapour pressures of organic aerosol (in the nucleation mode) can reach as low as 10^{-2} to 10^{-3} $\mu\text{g m}^{-3}$ (Pierce et al., 2011), and recently Ehn et al. (2014) identified the production of extremely low-volatility organic compounds (ELVOCs) from the oxidation of biogenic VOCs. In ORACLE, the lowest volatility SOA generated from VOCs is $1 \mu\text{g m}^{-3}$. The authors explain that additional bins may be added by the user, but it may be worth mentioning that the current configuration does not account for the generation of oxidation products with extremely low volatility?*

Indeed ORACLE can be used to simulate the formation of extremely low volatility SOA (SOA-elv) with saturation concentration lower than $10^{-2} \mu\text{g m}^{-3}$, however, this should not be confused with the work of Pierce et al. (2011) and Ehn et al. (2014) who refer to the secondary organic compounds condensation on (or formation in) ultrafine aerosols (nucleation growth). Nucleation growth is far less understood than the partitioning of material between the condensed and gas phases and is not currently included in ORACLE. ORACLE is an equilibrium model and while partitioning and condensational growth can be accurately described in equilibrium for fine aerosols, the condensational growth of ultrafine aerosols demands a dynamical representation since the surface tension increases the effective saturation concentration of each SOA species in ultrafine particles and both the surface tension and the saturation vapor pressures of the organic molecules condensing on (or forming in) the ultrafine aerosol are largely unknown. Following the reviewers recommendation, in the revised manuscript we mention that the current configuration does not account for the generation of SOA-elv and we also refer to the limitations of ORACLE in simulating nucleation growth events of SOA-elv.

Technical comments

3. *p5474, line 27: There's a mismatch between the range of saturation vapour pressures covered by SVOCs in this sentence and in Figure 2, so (unless I misunderstood!) one of these needs correcting.*

SVOCs have saturation concentrations between 0.01 and $100 \mu\text{g m}^{-3}$. The range of saturation vapor pressures in Figure 2 starts from $10^{-1} \mu\text{g m}^{-3}$ since in this application we have

used only two surrogate species to describe the SVOCs with $C^* = 10^{-1}$ and $10 \mu\text{g m}^{-3}$. Nevertheless, even if it is not used in the current application, we have extended the range of SVOCs saturation concentrations to 10^{-2} in Figure 2 in order to be consistent with the theory.