**Geoscientific
Model Development
Discussions**

Interactive comment on "A quasi chemistry-transport model mode for EMAC" *by* R. Deckert et al.

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In this paper Deckert and co-authors present a new configuration of the EMAC global chemistry-climate model, called quasi chemistry-transport model mode (QCTM). In this mode all feedbacks between chemisty and dynamics are removed, thus allowing for a better quantification of chemical sensitivities.

In my opinion the paper is technically sound and generally well written. I consider the presented material well suited for Geoscientific Model Development. I therefore recommend publication after minor revisions. Specifically, I would like the authors to consider the following points:

i. In the introduction the authors explain the problem of diverging meteorological states

in coupled simulations and how this interferes with the analysis of responses to chemical perturbations. The QCTM is proposed as a means to simulate identical meteorological sequences despite the perturbed chemistry. Another well-known way to produce similar sequences of meteorological variability is 'nudging'. In fact the results presented in this paper are themselves based on simulations in which the tropospheric dynamics is nudged toward ECMWF reanalysis fields. I therefore recommend including a short discussion of the nudging method and of its limitations compared to QCTM.

ii. In section 4.2 the authors state that the differences in the simulated mesospheric temperature climatologies obtained in fully coupled and uncoupled modes (Fig. 5a) may be due to differences in the simulated resp. prescribed ozone climatologies. The latter is based on the ozone climatology by Fortuin and Kelder (1998), which according to the original paper extends only up to 0.3 hPa. The authors should clarify in the text how they have extrapolated this ozone climatology to the top of their model (0.01 hPa) and to what extent the chosen method has affected the simulated temperature differences in the mesosphere.

iii. The captions to figures 6 and 7 have been interchanged. Also the references to these figures in section 4.2 have been mixed up.

iv. In section 2 it is mentioned that "two blocks in North-South direction are combined for an improved load balancing with respect to the distribution of day and night grid-boxes". Can the authors please clarify in the text how this is done?

v. In section 3.1 the five options for I_H2O_TENDENCY are not well explained. For instance, why is it mentioned for all options that the H2O tracer is defined? It is also not clear if the tracer is always defined in the whole atmosphere or for some options only in the stratosphere and mesosphere. If the first is the case, it should be mentioned how the initialization is done in the troposphere (from specific humidity). Further, for the option "I_H2O_TENDENCY=1" an offline oxidation source is not "added" but is replacing an existing representation. The authors should also better explain how the

synchronization takes place and clarify when the H2O mixing ratios (tendencies) are updated from the specific humidity (tendencies) or vice versa. As for QCTM only the option "I_H2O_TENDENCY=2" is relevant, the description of the other options is better placed in an appendix. In any case, I propose to rewrite this part and clarify the above.

vi. The ordering of the subsections of section 3 is not logical. It makes more sense to start with the submodels RAD4ALL and H2O, and then describe HETCHEM and PSC.

vii. In my opinion subsection 3.4 is excessively long given the little attention on PSC coupling in the evaluation section. Please consider shortening the description of the PSC submodel and leave out any details that are less relevant for understanding the chemistry-climate couplings.

viii. In section 4.1 the authors state that the anomalies "tend to spread farther for the monthly averaging". I have the impression that this is a wrong interpretation caused by the difference is contours between figures 3b and 3d. Please clarify.

ix. In section 4.2 it is mentioned that CFC-11 and CFC-12 are treated differently. Please explain the reason for this.

x. In section 4.2 it is stated that "the removal of non-H2O radiative feedback artificially compensates for the tropospheric deviation in temperature". Please clarify to what extent the differences in tropospheric temperatures between (fully or partially) coupled and uncoupled simulations are also reduced by the applied nudging.

Some additional minor technical points:

1. In the abstract (line 10) change "clouds (b). Offline" to "clouds (b), and offline".

2. In the abstract (line 18) there seems to be a double space before "Toggling".

3. Page 2191, line 11: change "After a few time steps" to "After a number of time steps".

4. Page 2191, lines 15 and 18/19: change "statistical expectation values" to "time

averages".

5. Page 2191, line 15: change "are hardly" to "may be hardly".

6. Page 2191, line 28: change "latter" to "the latter".

7. Page 2191, line 28: change ", or," to "or".

8. Page 2192, line 20: remove quotation marks around "setup".

9. Page 2193, line 9/10: Without further information it quite meaningless to mention the number of submodels a model consists of. Please remove this sentence.

10. Write either "sub-models" or "submodels" throughout the paper.

11. Page 2194, line 21: The "CPL namelist" is introduced without explanation what "CPL" stands for.

12. Correct "heterogenous" to "heterogeneous" (several times).

13. Page 2196, line 8: according to Table A1 "L_COUPLE_H2O=2" should be "L_COUPLE_H2O=F".

14. Page 2196, line 17: correct "CFC-I2" to "CFC-12".

15. Page 2199, line 25/26, "Yet, the water vapor tendencies remain unaffected": I presume the author mean here the "specific humidity tendencies" in the ECHAM5 core model. Please clarify.

16. Section 4 (page 2200, lines 13, 15 and 22; page 2201, lines 2, 4 and 9); caption to figure 3 (lines 2 and 7): Please add "simulation" after "sensitivity" and "reference".

17. Page 2200, line 22: change "the perturbation" to "the perturbation in emissions".

18. Page 2201, line 5: change "constant factor" to "constant percentage".

19. Page 2203, line 17: change "would increase" to "would have to increase".

20. Page 2204, line 26: change "CH4 degradation plays a minor role there" to "CH4 degradation plays a minor role in the water vapor budget there"

21. In the conclusion (line 14), change "quasi chemistry-transport mode, QCTM" to "quasi chemistry-transport model mode, QCTM".

22. Page 2207, line 6: change "both, QCTM and " to "both QCTM and".

23. Page 2208, line 13: remove "poor-in-noise" (unknown expression).

24. Table 1: Please specify the ECMWF re-analysis that was used.

25. Caption to figure 2: change "(a), offline, and (b), online" to "(a) offline, and (b) online".

26. Caption to figure 5: change "Mean annual-mean" to "Annual-mean".

27. Caption to figure 8: I have the impression that "versus coup_full" should be "versus decoup_full". Please correct.

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