Guidance Notes on Cloud Condensate Tendency Diagnostics

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1. Overview

Cloud condensate tendency diagnosics (CCTD, hereafter) are source terms of the tendency equation for the non-convective cloud condensate in a climate model. They are used to help understand how the cloud condensate distribution is determined in the climate models. The CCTD are proposed as additional diagnostics for the CFMIP2 experiments to gain insight into the physical mechanisms responsible for cloud feedbacks (Bony et al 2009). This note briefly describes how to obtain the diagnostics for CFMIP2.

The CCTD are obtained by (i) evaluating the increments of cloud condensate at various physical processes in a climate model, and (ii) dividing the increments by a time step. For example, the source term related to autoconversion is evaluated by taking the difference in cloud condensate before and after the autoconversion calculation, and dividing the difference by a time step. The diagnostics have the units of kg/kg/s. Positive values indicate increasing tendencies of the cloud condensate.

Table 1 shows examples of the source terms requested for the CFMIP2, which are selected assuming the microphysical processes outlined in Fig.1. Since the representation of cloud microphysics in a model depends on the model structure, we expect that modeling groups select their own suite of diagnostics which suits their models best. Note that microphysical processes which are not directly related to the cloud condensate budget are omitted from Fig.1 or Table 1 (e.g., evaporation of rain).

2. How to prepare the diagnostics

The procedure of preparing the CCTD diagnostics can be summarized in three steps as follows.

Step 1

Define the source terms which are suitable for describing the cloud mass budget of your model. A schematic figure like Fig.1 will be helpful in this task. Category of the clouds considered in the mass budget may be cloud liquid, cloud ice, or cloud condensate (liquid plus ice). Other cloud categories may also be included as long as they are 'seen' by the radiation code. Please select the cloud categories which suit the model structure best.

Step 2

Select the variable names from the CMIP5 output list, which correspond to the source terms defined in the Step 1. If you cannot find the appropriate ones, please contact Mark Webb (mark.webb@ metoffice.gov.uk). In this case, new variable names may need to be proposed and added to the list.

Step 3

Add the source terms to the output list of your model when conducting experiments for the CMIP5 and CFMIP2. When submitting the output of the source terms (i.e. the CCTD variables), we recommend that a schematic figure like Fig.1 for your model is also sent to Mark Webb (mark.webb@ metoffice.gov.uk) by email for reference.

3. References

Bony S., M. Webb, B. Stevens, C. Bretherton, S. Klein, G. Tselioudis 2009: The Cloud Feedback Model Intercomparison Project: Summary of Activities and Recommendations for Advancing Assessments of Cloud-Climate Feedbacks.

Table 1 : Examples of the source terms requested for CFMIP2. CMIP5 variable names are also shown by parentheses. Shading indicates the variables which appear in both liquid water and ice budgets.

Cloud liquid water budget	Cloud ice budget
Condensation-Evaporation (tnsclwce)	Heterogeneous Nucleation (tnsclihenv)
Advection (tnsclwa)	Deposition-Sublimation (tnsclids)
	Evaporation of melting ice (−tnscliemi)
Homogeneous Nucleation (−tnsclihon)	Homogeneous Nucleation (tnsclihon)
Heterogeneous Nucleation (−tnsclihencl)	Heterogeneous Nucleation (tnsclihencl)
Bergeron-Findeisen Process (−tnsclibfpcl)	Bergeron-Findeisen Process (tnsclibfpcl)
Riming (−tnscliricl)	Riming (tnscliricl)
Accretion (tnsclwas)	Accretion (−tnsclwas)
Autoconversion (−tnsclwac)	Advection (tnsclia)
Accretion (−tnsclwar)	Icefall (tnscliif)
	Boundary-layer Mixing (tnsclibl)
	Melting (−tnsclimr)
	Riming (tnsclirir)

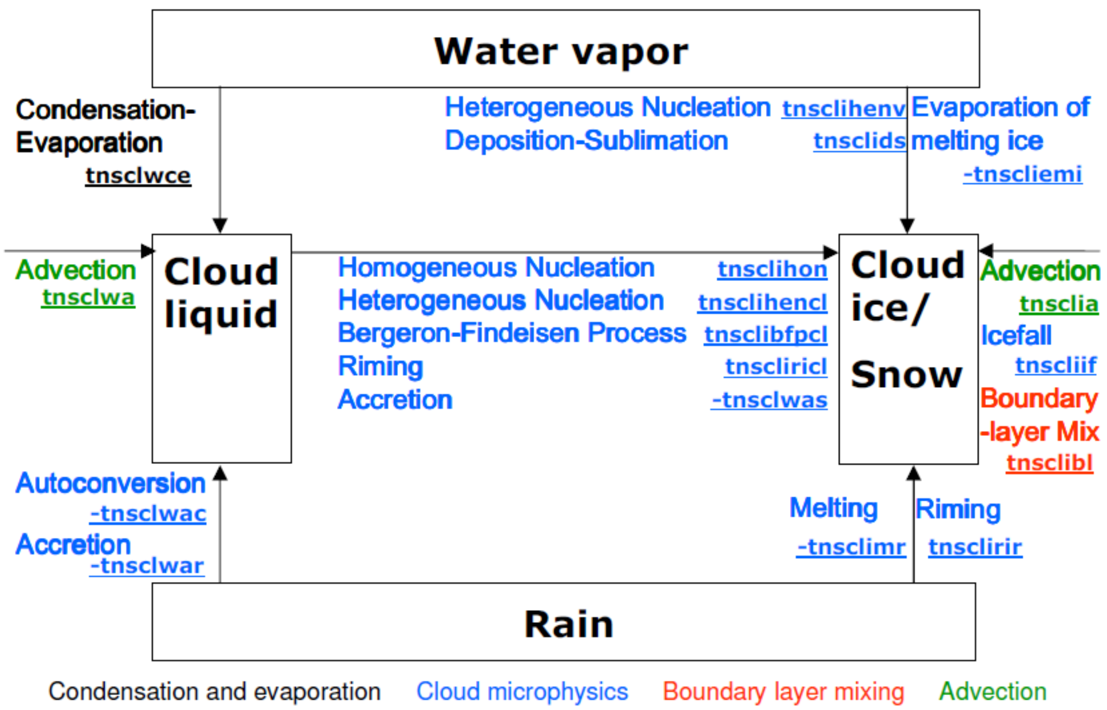

Figure 1: Schematic figure of the cloud scheme in HadGEM2 with CMIP5 variable names (underlined). Arrows indicate the direction of the mass flow represented by the positive values of the source terms.