

The authors present modifications of the Tiedtke convection scheme and apply and evaluate these in the 4 km nested runs over Taiwan. I like the presentation of the manuscript as the modifications are presented and evaluated step by step for case studies followed by a general evaluation, the manuscript is also well written in general. I also broadly agree with these modifications (see below) and the discussion of the convective features related to model deficiencies.

The authors thank Dr. Peter Bechtold for his encouraging and helpful comments. Our point-by-point responses are provided below and marked in blue text.

Specific comments:

- SCA: yes the mass flux scaling should definitely be applied before applying the CFL criterium. Could you mention what model time step you use? Also in the CFL criterium computation it might be better to use for very small time steps eg $dp/(g*\max(dt,300))$

The time step used in our TGFS nested simulations is 225 seconds. We appreciate the suggestion to compute the CFL criterion as $dp/(g* \max(dt, 300))$, which helps prevent excessive updraft mass flux when using small time steps. We plan to evaluate this refinement in future model developments.

- Cloud top criterium: yes the convective cloud top height is definitely overestimated in the original version, you might also want to test an additional criterium on the cloud top height that has been introduced in the German weather service (DWD) and ECMWF, ie for the updraught to continue in the vertical $dT/dz < -3.e-3$ and $Buo > -2$

Thank you for pointing out the criteria used in DWD and ECMWF. We conducted a sensitivity test by introducing the overshooting limiter you suggested into the TGFS nested model. The experiment using the overshooting limiter was conducted with the southwesterly flow case discussed in section 5.2 and denoted as OSL.

As shown in Fig. R1, compared to CUP, OSL shows a reduction in heavy rainfall, particularly along the southwestern coast of Taiwan. In addition, the vertical cross-sections of hydrometeor mixing ratios (for ice, snow and graupel) indicate that the cloud top in OSL is indeed lowered (Fig. R1d). On the other hand, compared to TOP in this study (which uses a revised criterion for defining cloud tops), OSL similarly

achieves the goal of lowering convective cloud tops; however, the rain band in OSL does not shift as far offshore (Fig. R1c) as seen in TOP (Fig. 6e) and observation (Fig. 6a). This is likely due to the revised criterion (TOP) leads to a higher restriction than the OSL approach, resulting in a lower cloud top (around 16 km in Fig. 8g) than OSL (around 17 km in Fig. R1d). Consequently, TOP generates less compensating subsidence, creating a more favorable environment for new updraft to form in the upstream region (farther from the coast), as discussed in Fig. 10.

Nevertheless, we agree that the approach you suggested introduces a thermodynamic constraint dependent on the environmental thermal structure, which is more physically robust. Therefore, we will continue to assess this approach across different cases and weather regimes.

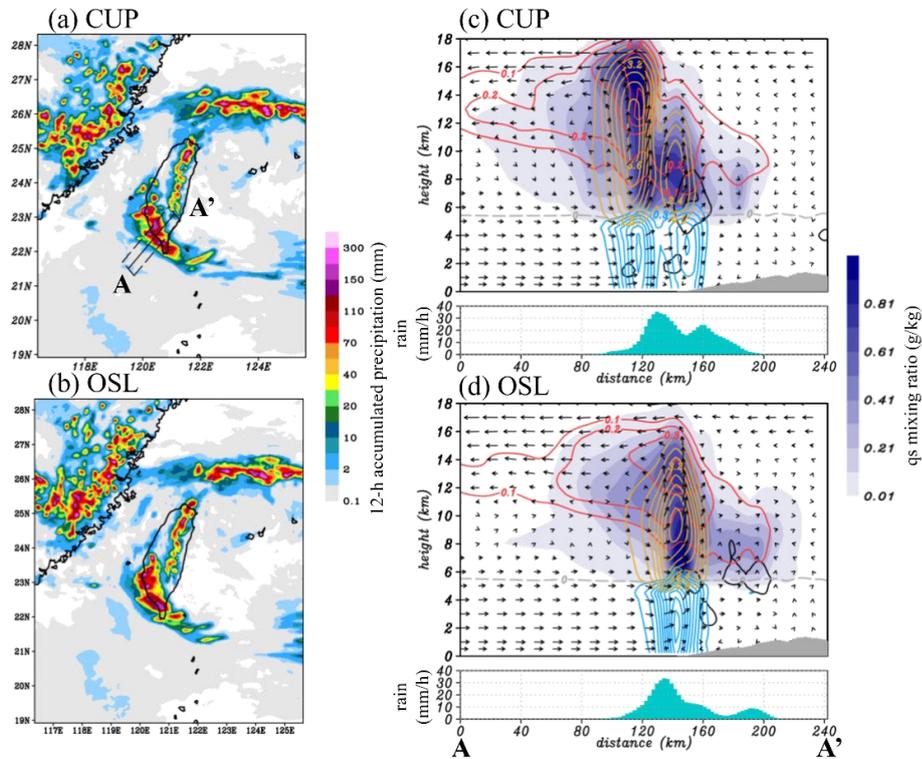


Figure R1: The 48–60-h accumulated precipitation forecasts from the (a) CUP and (b) OSL experiments, and the vertical cross sections along the A-A' line in Fig. a of hydrometeor mixing ratios (g kg^{-1}) and along-section vertical circulations (vectors; 50 m s^{-1}) for (c) CUP and (d) OSL at 50-h forecasts. The cross sections are computed by averaging along the short axis of the dashed box denoted in (a). Gray shading represents the averaged terrain height. Different contour colors represent the mixing ratios of cloud water (black; 0.2 g kg^{-1} interval), rain water (blue; 0.3 g kg^{-1} interval), cloud ice (red; 0.1 g kg^{-1} interval), and graupel (yellow; 0.8 g kg^{-1} interval), while the purple shading denotes the snow mixing ratio (g kg^{-1}). The greenish-blue histogram denotes the rain rate (mm h^{-1}).

- Entrainment modification: Here I find it less convincing, you say it further reduces “convection” but the results show more light precipitation indicating more widespread light convection. Indeed, when looking at your formula it appears that for $z=100$ m you get entrainment rates of 10^{-3} m^{-1} which is similar to the original, but for $z=500$ m (a typical cloud base height) it is 2×10^{-4} which is already much smaller than the original (Note also you say d_1 is non-dimensional but it has units m^{-1}).....??? At least in your conclusions you seem not to have adopted this version for operations.

We thank Dr. Peter Bechtold for this insightful comment and for carefully checking the formula. Yes, the unit of d_1 in Eq. (5) should be m^{-1} rather than non-dimensional. We will correct this in the revised manuscript. Regarding the increase in light precipitation, we agree that the entrainment is decreased when replacing Eq. (3) with Eq. (5), and the statement in our manuscript was imprecise. A lower entrainment rate allows the parameterized convection to consume more environmental instability and moisture. The “reduction in convection” mentioned in our manuscript should refer more precisely to the suppression of unrealistic grid-scale heavy rainfall events, achieved by a greater contribution from subgrid-scale processes to stabilize the environment. Accordingly, the production of widespread light precipitation is a consequence of this more active convection scheme. We will revise the relevant description in Section 3.4 and the discussion on CRH to clarify this mechanism.

You also discuss in detail - a discussion which is welcome - reasons for having precipitation bands sometimes too far offshore compared to observations. Then you mention at the end that this problem is even more widespread in winter over a relatively warm sea. Indeed, this problem is shared by all global modelling centres employing a convective parametrization. The reasons are as you broadly mentioned the interaction between heating and the circulation (forming a quasi stationary near coast circulation, having updraught and downdraught in the same grid cell and the lack of advection. We could largely address this problem in the upcoming operational version at ECMWF (cycle 50r1, April 2026) by handing over a significant amount of convective precipitation to the large-scale cloud scheme where it is advected and evaporated (no publication available)

Thank you for sharing this valuable information that handing over convective precipitation to the large-scale cloud scheme helps address the offshore precipitation bias in winter. We have also conducted studies on this issue, and found that in addition

to the convection and cloud microphysics schemes, the boundary layer scheme may also play an important role. The forecasted boundary layer instability and the resulting Froude number affect the low-level onshore wind speed, which in turn strongly influences the distribution and intensity of offshore rain bands.