13B.4

Discrete Propagation and Initiation of Tropical Oceanic Convection

Robert G. Fovell[1]* and Robert A. Houze, Jr.[2]
[1]UCLA and [2]University of Washington

1. Introduction

Over tropical oceans precipitating clouds occur in ensembles in which phenomena ranging from shallow isolated cells to large mesoscale convective systems form, move, and dissipate in a bewildering variety of complex patterns. A fundamental part of understanding the behavior of these ensembles is determining how the clouds regenerate themselves and propagate. Precipitating convective storms typically generate subcloud cold pools, which often play a key role in storm maintenance by providing a lifting mechanism for warm, moist air. Although this ascent tends to be punctuated into individual convective cells, this has become known as continuous propagation, the continuity being provided by the cold pool's persistence. Yet, new cells are often seen to initiate *ahead* of established convection (Houze, 1977, *MWR*), implying a mechanism other than cold pool lifting is operating. Some of these cells subsequently merge with the established convection while others remain independent. In either case, the convection can be thought of as propagating in a discrete fashion, a common occurrence in the tropics (e.g., Kingsmill and Houze, 1999, *QJRMS*).

2. Possible discrete initation mechanisms

Several possibly cooperative mechanisms may be involved in the discrete initiation of convection. First, Mapes (1993, *JAS*) pointed out that latent heating by a storm can excite a low frequency gravity wave environmental response which can accomplish lower tropospheric lifting away from any cold pool. In numerical studies of organized midlatitude storms, Fovell (2002, *QJRMS*) found this response to make the storm's near-field inflow environment more convectively favorable, and its role in discrete propagation of a nocturnal squall line was discussed by Fovell and Kim (2003, *10th Meso. Proc.*). Second, Tompkins (2001, *JAS*) showed that moist, high CAPE bands of boundary layer air form at the cold pool boundary of a precipitating storm and remain after the pool decays. Convection can be retriggered from this air after surface fluxes remove the convective inhibition (CIN), a process that takes time. Third, cold pools present obstacles to the flow, and can cause convergent ascent in their wakes, away from the cold pool itself.

The Tompkins mechanism implies air in newly developed convection may be directly traceable to older storms but, due to the time needed for CIN removal, the new clouds will not necessarily appear near already established ones. In contrast, the other two mechanisms suggest new clouds are more likely to occur in the vicinity of active convection. We are inspecting MM5 simulations made over the western tropical Pacific for evidence of these mechanisms. The domain is triply nested with an inner 4 km nest centered on Kwajalein, Marshall Islands. Kwajalein is a venue of concentrated study of precipitating cloud ensembles because of its research quality S-band radar and the KWAJEX field campaign conducted there in 1999. The innermost nest is 920 x 920 km; only a portion of this domain will be shown.

3. Results

Figure 1 shows selected fields from a fairly typical simulation. At 1830Z, precipitating systems labeled **1** and **2** are seen in the southern and eastern portions of the subdomain, propagating northward and westward, respectively. By 1930Z a number of new clouds have appeared in the vicinity of the two systems. Among these, the clouds labeled **C** and **D** probably resulted from cold pool lifting. That cannot explain the appearance and location of clouds **A** and **B**, however.

The remaining panels show clouds **A** and **B** generated cold pools of their own by 2030Z but were eventually incorporated into system **1** approaching from the south. More new clouds have formed by 2130Z, some – such as the two marked **E** – residing well ahead of the two systems. All of the discretely generated clouds developed over "hot spots" consisting of local surface θ_e maxima. The clouds labeled **E**, for instance, appear along finger-shaped extrusions of the $\theta_e = 352$K contours that stretch to the northwest ahead of system **2**.

The θ_e hot spots coinciding with clouds **A** and **B** could be traced back in time at least 5.5 hrs. Figure 2 presents conditions existing at 1600 and 1300Z, the broken dashed lines enclosing hot spot positions at those times. Consistent with the Tompkins mechanism, the local maxima can be traced back to the cold pool boundaries of convection long since decayed. However, convection does not spring from these spots until they reach the vicinity of storm **1**, hours after any CIN has vanished. It is probably not coincidence that the new clouds formed from these favorable patches when they reached the vicinity of active convection. Future work will focus on examining the Mapes and convergence mechanisms and comparing these model results to observations.

Acknowledgments. This work was supported by NSF grant ATM-0139284.

---

*Corresponding author address: Robert Fovell, UCLA Atmospheric Sciences, Los Angeles, CA 90095-1565. E-mail: rfovell@ucla.edu.

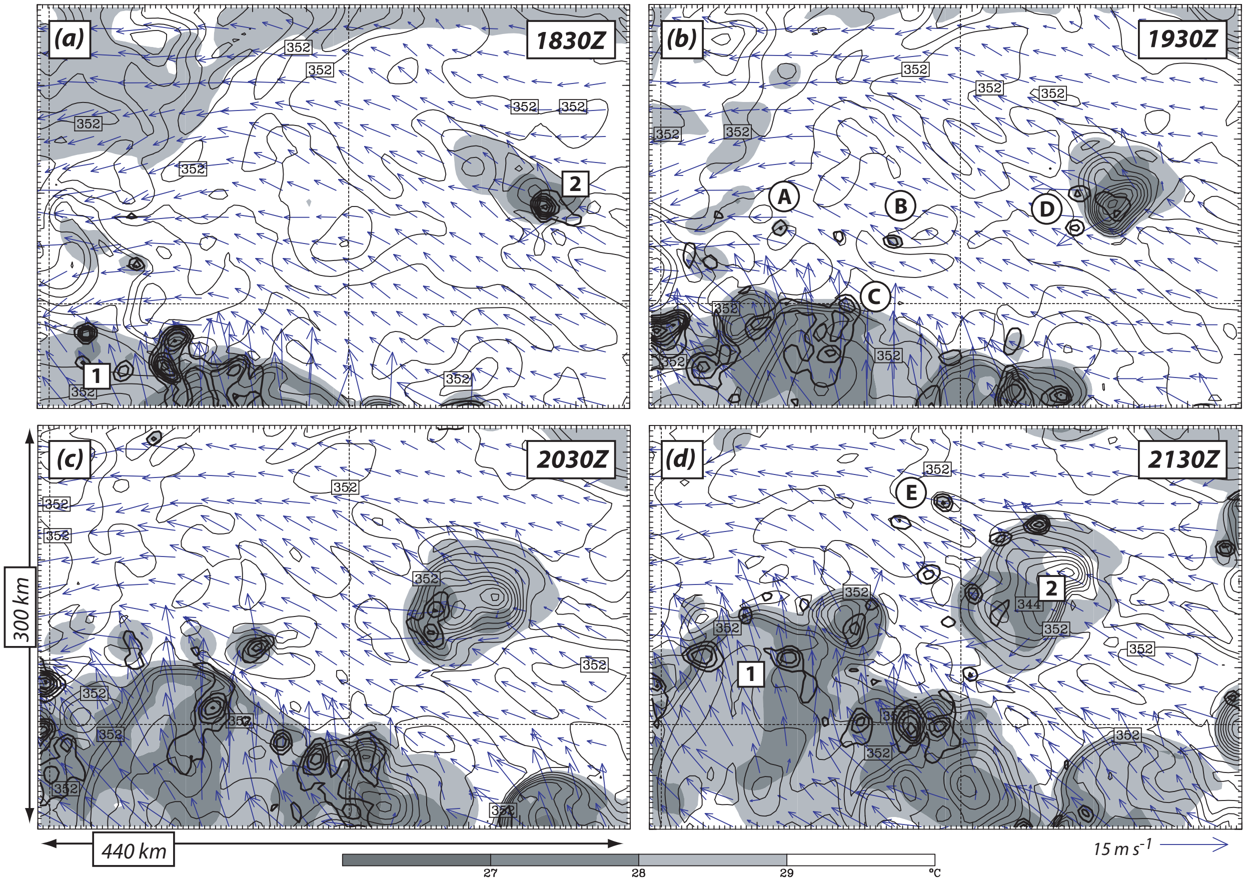

Fig. 1: Surface temperature (shaded), θ_e (thin 2 K contours) and integrated condensate (thick 2 mm contours) fields, with 10 m vector winds for a typical Marshall Islands simulation.

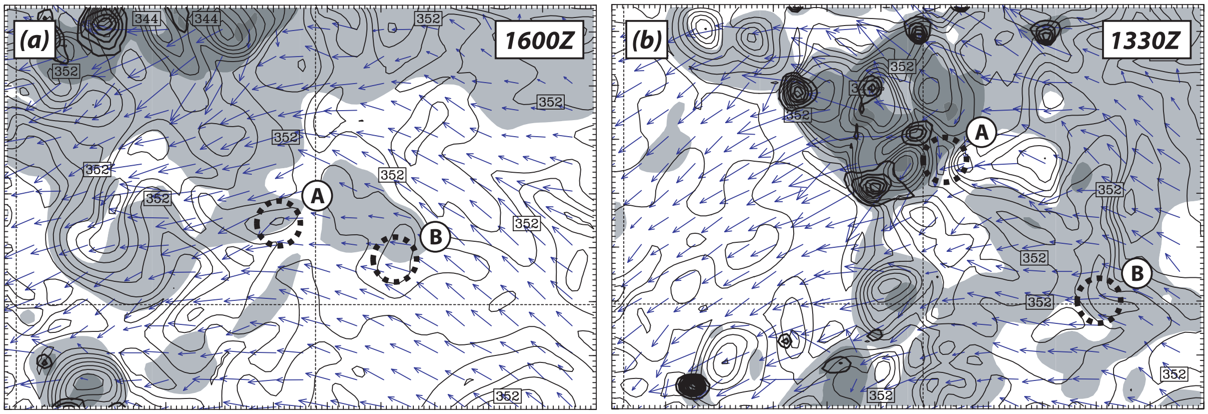

Fig. 2: As in Figure 1, but for two earlier times in the simulation.