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LETTERS TO THE EDITOR

Comments on "Mesoscale cellular convection: is it convection?"

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Fiedler (1985) demonstrates the inadequacy of three convective instability theories in explaining the large aspect ratio of mesoscale cellular convection (MCC). As an alternative explanation, he suggests mesoscale entrainment instability (MEI), an instability resulting from the entrainment fluxes at the top of the mixed layer.

Fiedler uses the acronym MCC to designate "the cellular cloud pattern in marine strato-cumulus cloud decks", i.e. closed convection cells. In fact, "Mesoscale cellular convection" was first used by Hubert (1966) as a collective name for open as well as closed convection cells (see also Agee (1984) for some nice examples). Nowhere does Fiedler allude to the large differences between open and closed cells. Cloud cover in open cells may be only 10%, while Fiedler assumes 100% cloud cover. Since a coupling between entrainment and condensation of water vapour is definitely necessary for the occurrence of MEI (Fiedler, 1984, p. 98), it is very doubtful whether MEI can explain the existence, let alone the structure and large aspect ratio, of open cells. The conditional nature of latent heat release seems to be a much better candidate (Van Delden, 1985).

To me it even seems doubtful that MEI can explain the large aspect ratio of closed cells with a cloud cover close to 100%. This can be seen from eq. (3.22) (Fiedler, 1985) which gives the small-scale cut-off. According to this equation MEI occurs only when

$$k^2 < \frac{-C_T U_{10} - w_e + 6.3 \times 10^{-2}}{\bar{H} K} \simeq \frac{2.3 \times 10^{-5}}{K}$$

in typical AMTEX conditions. Here k is the horizontal wavenumber and K is the horizontal eddy diffusion coefficient. Fiedler assumes $K = 1000$ m^2/s, citing Sheu and Agee (1977). However, I could not find any estimate of the value of K in this paper. For the assumed value of K, Fiedler finds that the 30:1 aspect ratio mode has approximately the largest growth-rate. However, 1000 m^2/s seems to be a gross overestimate for K in the convective mixed layer. The choice is more appropriate in hurricane conditions (Ooyama, 1969, p. 17). Hubert (1966), Sasaki (1971), Agee and Chen (1973) and Krishnamurti (1975) assume values for K between 1 and 100 m^2/s. It can be seen from the above equation that by decreasing K by a factor 10–100, the small-scale cut-off wavelength is decreased by a factor 3–10. If the entire marginal stability curve shifts to smaller scales by the same factor, this would mean that the modes with aspect ratios between 10 and 3 would be the preferred modes.

In summary, I think the entrainment instability, found by Fiedler (1984), does not offer a satisfactory explanation for the large aspect ratios of closed cells, because he has to assume an unrealistic high eddy diffusion coefficient. MEI is irrelevant to open cells.

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