1. INTRODUCTION

The morning glory is a dramatic low-level roll cloud or series of roll clouds observed around the southern part of the Gulf of Carpentaria in northern Australia. These roll clouds occur in the early hours of the morning with their passage accompanied by a sudden wind squall (10 – 15 m s\(^{-1}\)) and a pressure jump of the order of 1 – 2 hPa. Although morning glories form at all times of the year, they are far more frequent during the dry season months of September to mid-November, the average during this period being about one every two days. For further details see the review by Reeder and Smith (1998).

Northeasterly morning glories, which form over Cape York Peninsula, are believed to be generated through the collision of the east and west-coast sea breezes, (e.g. Clarke 1984). Recently, Porter and Smyth (2002) have suggested that the disturbance forms through the resonant interaction of the west-coast sea breeze and the topography. The aim of this study is to clarify the mechanism by which morning glories are generated, through a series of very high-resolution numerical modelling experiments.

2. THE NUMERICAL MODEL

The numerical model used in the present study was originally described in detail by Clark (1977). It is formulated in terms of terrain following height coordinates and employs the non-hydrostatic, anelastic form of the equations of motion. The finite difference approximations are second order in both space and time. All calculations are done in two dimensions. The horizontal grid spacing is 200 m, and there are 60 unevenly spaced levels in the vertical, with the lowest level at 2 m and the highest level at 15 km. The model domain is 640 km wide, with a strip of land 440 km wide located between two 100 km wide bodies of water. The model is initialised at sunrise using an early morning sounding from Willis Island, and imposing a 5 m s\(^{-1}\) easterly geostrophic flow.

![Figure 1: Control experiment. Potential temperature, shaded in 1 K increments, showing the two sea breezes at 2100 LST, with a 40 km gap between the plots. The peninsula is located from \(x = 100 \text{ km}\) to \(x = 540 \text{ km}\).](image)

Table 1 lists the Froude number, \(Fr = c/c_e\), where \(c\) is the phase speed of the waves created immediately after the east-coast sea breeze rides over the west coast sea breeze, and \(c_e\) is the speed of the east-coast sea breeze, indicates whether or not a morning glory develops, and if so, how many waves are present at 0100 LST. The num-
ber of waves produced depends on the stability of the west-coast sea breeze and the strength of the east-coast sea breeze.

The inclusion of orography representative of Cape York Peninsula does not change the overall result with a morning glory forming in much the same way as in the case without orography. The main difference is that the sea breezes meet earlier when orography is included. An isolated hill on the west coast is considered also with westward propagating waves of smaller amplitude being generated by the west-coast sea breeze alone. However, the amplitude of these waves is much smaller than the morning glory that results from the interaction of the east-coast and west-coast sea breezes.

## REFERENCES


