Geophysical Research Abstracts
Vol. 12, EGU2010-12332, 2010
EGU General Assembly 2010
© Author(s) 2010

Gravity waves as a causal mechanism for transition from closed to open cellular convection in the remote South East Pacific

Grant Allen (1), Geraint Vaughan (1), Paul Connolly (1), Peter Cook (1), Patrick Minnis (2), Thomas Toniazzo (3), and Hugh Coe (1)

(1) University of Manchester, SEAES, Manchester, United Kingdom (grant.allen@manchester.ac.uk), (2) NASA Langley Research Center Science Directorate, Hampton, VA, USA, (3) University of Reading, United Kingdom

The formative mechanisms of so-called Pockets of Open Cells (POCs), observed as cell-like (openly-convecting) cloud-free areas embedded in remote marine stratocumulus sheets, are currently the subject of intense speculation and scientific interest. These structures can act to modulate the thermodynamic and radiative properties of large areas of the Marine Boundary Layer (MBL), as well as modifying the composition of the remote MBL through the washout of already scarce particulate matter (CCN). Moreover, the important potential climate impact of these structures, through their radiative properties, is not represented in climate or regional-scale models.

The necessary conditions, or "tipping point" for the transition between the metastable closed and open cell dynamic states is also the subject of much speculation and has been observed by aircraft to be linked to the scavenging of available CCN by drizzle, with consequent feedback on the underlying convective dynamic of the cloud.

This work discusses observations of satellite-retrieved cloud bulk properties during October 2008, which clearly illustrate the propagation of several gravity waves in the MBL, emanating from a trough at 30 degrees South, off the coast of Chile. The waves are manifest by their modulation of cloud top height by up to 500 metres peak-to-trough, with propagation perpendicular to the mean flow. Analysis of satellite imagery indicates the waves have a period of approximately one hour and a wavelength of around 55 km.

The "opening up" or formation of POCs in the wake is observed as wave trains traverse the Pacific Ocean. The POCs formed appear stable and subsequently advect with the mean flow. We demonstrate here, with the aid of a parcel model, that simulated gravity waves are able to effectively induce drizzle through their effect on MBL and cloud dynamics, thus scavenging available CCN and initiating the transition to open cell convection. We do not suggest that gravity waves are a ubiquitous mechanism for all POCs observed in the South East Pacific (or elsewhere), but that gravity waves are one way to induce drizzle formation; with drizzle formation being the likely necessary action for POC formation through CCN scavenging. Furthermore, the period, wavelength and amplitude of the gravity waves are shown here to be critical to whether cloud droplets are precipitated.