MESOSCALE ANALYSIS OF A CAROLINA COASTAL FRONT

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Abstract. During the Intensive Observation Period (IOP) 7 (22 February 1986) of the Genesis of Atlantic Lows Experiment a persistent coastal front was observed along the Carolina coast in the eastern United States. An intensive baroclinic zone, associated with the cold air damming to the east of the Appalachian Mountains, and the warm marine atmospheric boundary layer over the Gulf Stream, resulted in a northeasterly low-level geostrophic wind maximum near the coast.

Two convergence zones were observed, one near the shore and the other near the western edge of the Gulf Stream. The convergence zone near the coastline was relatively weaker than that near the Gulf Stream. The differential surface thermal forcing caused enhanced convergence associated with the frontogenesis, and a meso-low was observed over the offshore front. The terms in the frontogenesis equation are estimated, and the diabatic term is found to be larger than the frontogenetic confluence term along the shore.

Key words: GALE, Coastal front, Atmospheric boundary layer, Gulf Stream, Mesoscale analysis, North Carolina

1. Introduction

Strong thermal gradients occur during winters off the coast of the Carolinas (eastern U.S.) due to the presence of the Gulf Stream with sea-surface temperatures (SSTs) of about 298 K. The adjacent coastal waters, on the other hand, have SSTs typically in the range of 279 K to 282 K and the land has surface temperatures varying from 273 K to 283 K depending on the time of the day. Such large horizontal variations in the surface temperatures cause sharp gradients in the surface turbulent heat fluxes. These strong gradients in heat fluxes enhance mesoscale circulation and the associated convergence. One such mesoscale convergence usually observed during winters in this region is the Carolina coastal front. Since these fronts are surface induced, they are shallow with a typical height less than 1000 m.

The importance of the Gulf Stream heating in the evolution of these coastal fronts has been studied by several investigators (Bosart, 1975; Riordan, 1990; Holt and Raman, 1990, 1992; Huang and Raman, 1990, 1992; Doyle and Warner, 1990, 1993). Other process that occur during coastal frontogenesis are cold air damming along the Appalachian Mountains (Richwein, 1980), convective rainbands along the Gulf Stream (Huang and Raman, 1992) and low-level jets (Doyle and Warner, 1993).

The purpose of this paper is to document the mean structure of the marine boundary layer during a coastal frontogenesis and the development of a meso-low observed offshore of the coast of Carolinas on 22 February 1986. For the present

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