1. INTRODUCTION

A suite of products has been developed and evaluated to assess hazards presented by convective downbursts to aircraft in flight. In the current generation of Geostationary Operational Environmental Satellite (GOES) (11-12), the existing suite of GOES microburst products employs the GOESounder to calculate risk based on conceptual models of favorable environmental profiles for convective downburst generation. Pryor and Elrod (2001) outlined the development a Geostationary Operational Environmental Satellite (GOES) sounder-derived wet microburst severity index (WMSI) product to assess the potential magnitude of convective downbursts, incorporating CAPE as well as the vertical theta-e difference (TeD) between the surface and mid-troposphere. In addition, Pryor (2006a) developed a GOES Hybrid Microburst Index (HMI) product intended to supplement the use of the GOES WMSI product over the United States Great Plains region. The HMI product infers the presence of a convective boundary layer (CBL) (Stull 1988) by incorporating the sub-cloud temperature lapse rate as well as the dew point depression difference between the typical level of a warm season Great Plains convective cloud base and the sub-cloud layer. Based on validation of the GOES WMSI and HMI products over the Oklahoma Panhandle during the 2005 and 2006 enhanced convective seasons, Pryor (2006a) noted an inverse proportionality between WMSI and HMI values for convective wind gusts of comparable magnitude. The statistically significant negative correlation between WMSI and HMI values likely reflects a continuum of favorable environments for downbursts, and underscores the relative importance of thermal and moisture stratification of the boundary layer in the acceleration of convective downdrafts.

2. CASE STUDIES: 29 March 2007 Downbursts

During the evening of 28 March 2007, strong downbursts were observed over the Oklahoma Panhandle. Downburst wind gusts of 45-55 knots were recorded by the Goodwell and Beaver, Oklahoma mesonet stations at 2005 and 0350 UTC 29 March 2007, respectively. Late afternoon (2200 UTC 28 March 2007) Geostationary Operational Environmental Satellite (GOES) Microburst Windspeed Potential Index (MWPI) imagery indicated elevated values along and to the east of the dryline that was located over the western Oklahoma Panhandle. Elevated MWPI values indicated favorable boundary layer thermodynamic conditions for convective downbursts most likely resulting from the presence of the dryline (Scheafer 1986). The dryline established favorable conditions for downbursts by enhancing vertical circulation and hence, the depth of the convective boundary layer.

GoES MWPI product images at 2200 UTC 28 March 2007 and at 0000 UTC 29 March 2007, respectively, display the development of convective storm activity over the Texas and Oklahoma Panhandles. The 2200 UTC image indicates elevated values (plotted in red and orange) along and to the east of the dryline. The 0000 UTC image displays cloud-to-ground (CG) lightning activity near the time of downburst occurrence at Goodwell (45 knots at GOES UTC). Noteworthy is a lack of lightning in the vicinity of Goodwell at the time of downburst occurrence as well as decreased CG lightning flash density associated with convective storms near the dryline. A meteogram from the Goodwell mesonet station, reflected downburst occurrence by displaying a sharp peak in wind speed at approximately 055 UTC. Atkins and Wakimoto (1991) related this peak in wind speed to downburst observation at the surface by mesonet stations. Interesting to note was an increase in MWPI values downstream of the convective storm activity through the evening in the region of downburst occurrence. Thus, MWPI product imagery indicated favorable environmental conditions for downburst occurrence associated with the convective storm clusterm as it tracked through the Oklahoma Panhandle during the evening of 28 March.

10 April 2007 Downbursts

During the afternoon of 10 April 2007, strong downbursts, associated with convective storms initiated by an upper-level disturbance, were observed over the western Oklahoma Panhandle. The first and strongest downburst wind gust (44 knots) was recorded by the Kenton mesonet station where the highest MWPI value in the panhandle was indicated over an hour earlier at 2000 UTC. Strong surface winds and solar heating of the boundary layer after the passage of a cold front resulted in the development and evolution of a deep convective mixed layer through mid-afternoon, establishing favorable conditions for downburst generation. Favorable environmental pre-conditioning for downbursts was apparent in 2000 UTC MWPI imagery with the highest risk value located over Cimarron County, Oklahoma. The GOES sounding from Clayton, New Mexico at 2000 UTC in Figure 6 echoed a favorable environment for downbursts by displaying an inverted V profile, similar to the type A profile as described by Wakimoto (1985). This event demonstrated a strong correlation between MWPI values and observed convective surface wind gusts.

3. METHODOLOGY AND VALIDATION

Data from the GOES HMI and MWPI were collected over the Oklahoma Panhandle for downburst events that occurred on 29 March and 10 April 2007. The first, a downburst that initiated against conventional surface data, was generated by Man computer Interactive Data Access System (McIDAS) and then archived on an FTP server. The Oklahoma Panhandle was chosen as a study region due to the wealth of surface observation data provided by the Oklahoma Mesonet (Brock et al., 1995), a thermodynamic environment typical of the High Plains region during the warm season, proximity to the dryline, and relatively homogeneous topography. Correlation between GOES MWPI values and observed surface wind gust velocities was computed to assess the significance of a linear relationship between observed downburst wind gust magnitude and MWPI values. Validation based on these events over the Oklahoma Panhandle indicated a strong correlation (r = 0.83) between MWPI values and observed surface convective wind gusts. As exemplified in the case studies, the GOES MWPI product demonstrated utility in the short-term prediction of downburst magnitude. Future validation effort will focus on upcoming warm season (June-August) downburst events that occur over the High Plains, specifically the Oklahoma Panhandle region.

4. REFERENCES


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