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P1.46Case Studies of Warm Season Cutoff Cyclone Precipitation Distribution

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1. Introduction

Forecasting heavy precipitation associated with warm-season cutoff cyclones presents a particularly challenging forecast problem in the northeastern U.S. These challenges arise in part from physiographic features that modulate the distribution of precipitation and severe weather, and the rapid changes in the character of precipitation due to the evolution and motion of the cutoff cyclones.

2. Climatology

Previous research (Novak et al. 2002; Smith et al. 2002), provides a climatology of six primary closed low tracks for the entire U.S for the period 1980 -2000. For this research, the focus will be primarily on the northeastern U.S. and for the warm season months of June to September. Figures 1a-d are part of a monthly climatology of daily precipitation due to cutoff cyclones over the Northeast. For each day that a cutoff cyclone passed through a specified domain, the precipitation associated with it was averaged into a daily amount.

The second climatology, a climatology of monthly tracks, is derived from plotting 500 hPa gridded geopotential height analyses (at 30 m intervals) from the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis at six hour intervals (0000, 0600, 1200, and 1800 UTC) (Kalnay et al. 1996; Kistler et al. 2001). These plots were for the months of June to September, for the period 1980-1998. For the purposes of this research, a cyclone was considered cutoff when a geopotential height minimum was surrounded by at least one closed contour. From analyzing these closed cyclone tracks, a set of common paths and origins was created for each month for the Northeast. These paths and origins will be further analyzed in conjunction with a monthly climatology of precipitation derived from the NCEP Unified Precipitation Dataset (UPD).

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3. Case Studies

Four case studies of cutoff cyclones that produced significant damage from severe weather and flooding across the Northeast are being analyzed using the 40 km Eta initialized dataset from NCEP/NCAR. These cases include a Northwest Hudson Bay category of a closed low that, from 3 July to 5 July 1996, produced many flash floods in New York and New Jersey. The last two cases were Great Lakes category closed lows, one from 18 July to 19 July 1996, which produced flash flooding in Pennsylvania and several significant tornadoes. The other was from 29 July to 2 August 1996, which caused flooding in New York City and Long Island. Precipitation plots were also made for each day of each case using the UPD.

In this poster presentation emphasis will be placed on the case of 30 June to 1 July 1998, featuring a cutoff low that tracked through the Great Lakes. It produced significant severe weather in the Midwest and many parts of the Northeast. Severe weather included flash floods in Vermont, New York, and Rhode Island, along with three tornadoes on Long Island, New York (Fig. 2a). The disturbance that evolved into this cutoff originated north of Minnesota. It then traveled across the northern Great Lakes and through northern Maine.

The cutoff low featured a strong upper-level (250 hPa) jet on its equatorward side and a strong lower-level (850 hPa) jet on its eastern side. The heaviest rain fell along the New York and Pennsylvania border and in isolated pockets in the vicinity of significant orographic features such as the Adirondack Mountains of New York. The low-level jet enhanced the precipitation, which fell along the Pennsylvania and New York border (Fig. 2b). A vorticity maximum was centered at the base of the 500 hPa trough, which, as the cutoff intensified, broke into two separate maxima. Synoptic and mesoscale analyses will be used to relate the severe weather and heavy precipitation to orographic features, lower- and upper-level jet interactions, and to the structure, shape, and track of the evolving cutoff. Precipitation plots following the cutoff cyclone track will be assessed to determine how heavier precipitation falls relative to the track, e.g. to the left or right.

4. Conclusions and Future Work

Research in progress encompasses the continuing use of the Unified Precipitation Dataset (UPD) climatology to compare rainfall distributions associated with cutoff cyclones and their associated tracks. There will be a continuation on the preparation and investigation of each of the case studies. Emphasis will be placed on precipitation distribution relative to terrain and understanding the role of lower- and upper-level jet interactions. Radar data will be obtained and evaluated for each of the cases along with soundings from selected upper-air stations. Sounding data will provide information on the atmospheric stability and CAPE, as both of these measures may be relevant to the heavy rainfall problem. Composites will be further analyzed to study how speed and direction of movement of the cutoff lows affect precipitation distributions.

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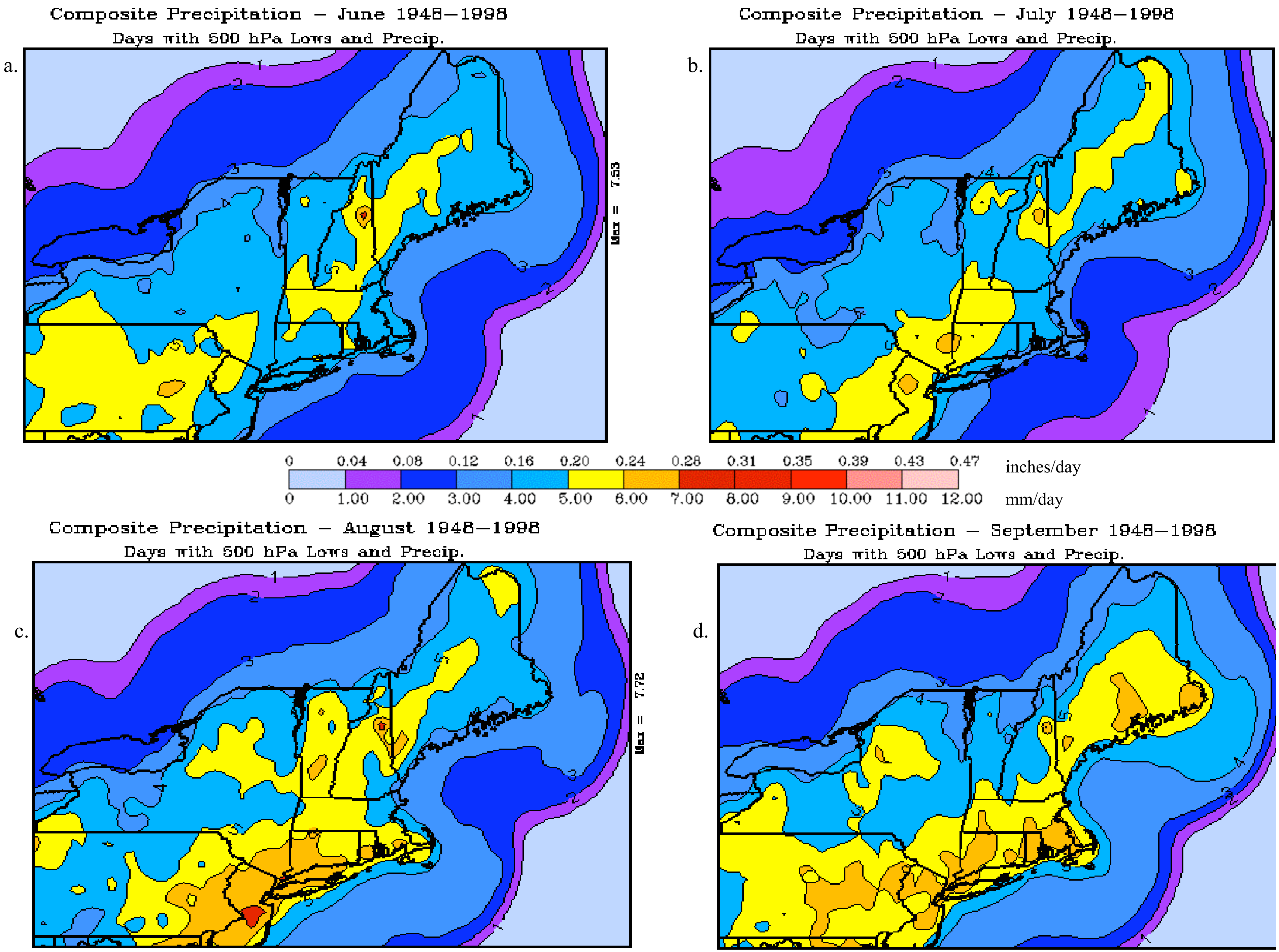

Fig. 1. (a) Average daily precipitation for June when a 500 hPa cutoff low is present. (b) Average daily precipitation for July when a 500 hPa cutoff low is present. (c) Average daily precipitation for August when a 500 hPa cutoff low is present. (d) Average daily precipitation for September when a 500 hPa cutoff low is present.