The Role of the Great Lakes in the 10-11 February 2005 Northwest Flow Snowfall Event in the Southern Appalachian Mountains

P3.4

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1.) Motivation & Background

- Identified as a significant forecast challenge by National Weather Service (NWS) forecasters
- Main issues include total accumulations, spatial extent, variability
- Climatology studies (Perry and Konrad 2004-2007) provide excellent motive and identify a "Great Lakes Connection" (GLC)
- Perry et al. (2007) found that 47.1% of 191 NWFS events (1975-2000) displayed a GLC
- GLC events associated with greater lower tropospheric moisture, greater snowfall totals

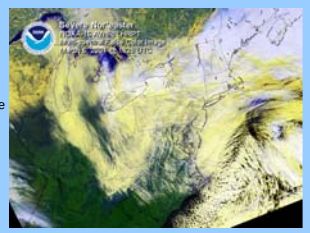

Figure1: Visible satellite image from 1826 UTC, 6 March 2001

- Present study: **Quantify** and **evaluate** the role of the Great Lakes in NWFS events for select cases via model experiments
- When lakes are removed, influence on the stability and moisture of the upstream airmass?
- Effect on Froude (F_r) number?
- F_r quantifies interaction of air flow and mountain barrier, F_r=U/NH
- Expect reduced F_r without the lakes
- Effect distribution, amount of precipitation

3.) 10-11 February 2005 Event Overview

Figure 3: 72 hour HYSPLIT backward trajectory ending at 12 UTC 10 February

Figure 4: 72 hour HYSPLIT backward trajectory ending at 21 UTC 10 February

Figure 5: NEXRAD composite base reflectivity from 12 UTC 10 February

Figure 6: NEXRAD composite base reflectivity from 21 UTC 10 February

- Example of a "post-frontal" event where lower-tropospheric winds behind a departing cold front became northwesterly across the southern Appalachians
- Event began at 09 UTC on 10 February and lasted roughly 24 hours ending around 09 UTC on 11 February
- Storm total snowfall amounts ranged from 1" to 5" with an event maximum of 8.1"
- Backward air parcel trajectories (Figs. 3, 4) reveal that this event has a GLC as defined by Perry et al. (2007)

4.) Results

- Removal of the Great Lakes in LKNOFLX results in a drier and more stable upstream airmass, and less NWFS precipitation (Fig. 7)
- 20-25% less NWFS precipitation occurs in the LKNOFLX experimental run compared to the CTRL
- 950-850 hPa layer averaged F_r (Fig. 8) from a point half-way between the Great Lakes and the southern Appalachians shows that F_r is decreased in the LKNOFLX run
- When averaged over the entire event: LKNOFLX=0.99, CTRL=1.39
- Lower F_r in LKNOFLX shows that the lakes act to increase F_r and enhance air flow over southern Appalachians

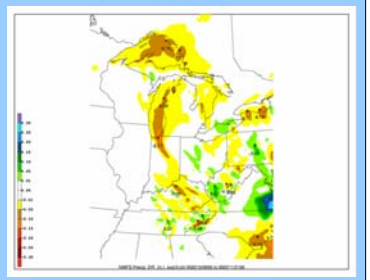

Figure 7: NWFS precipitation difference, LKNOFLX - CTRL

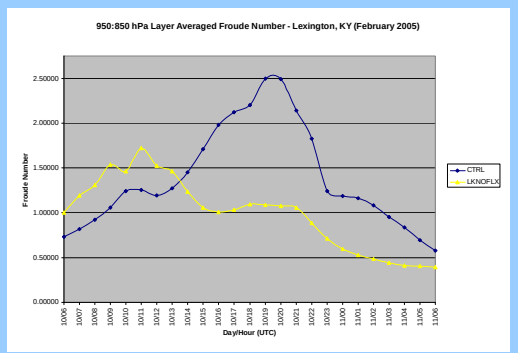

Figure 8: 950:850 hPa layer averaged Froude number at Lexington, KY

2.) Methodology: Case Selection and Experimental Setup

- Select a NWFS event with a GLC and produce a model simulation using the Weather Research and Forecast (WRF-ARW, Version 2.1.2)
- Compare the full-physics control run (CTRL) to an experimental run (LKNOFLX) that sets the surface fluxes of heat and moisture to zero over the Great Lakes
- Model runs initialized several days prior to the beginning of the NWFS to preclude any preconditioning of the lower tropospheric airmass by the Great Lakes
- Model details:
  - Domain (Fig. 2) - 150x150, 24km grid spacing
  - North American Regional Reanalysis (NARR) data used as initial and boundary conditions
  - Lin et al. microphysics, Yonsei University (YSU) PBL, Betts-Miller-Janjic (BMJ) convective scheme

Figure 2: WRF Domain

5.) Conclusions and Future Work

1. The role of the Great Lakes is to moisten and destabilize the lower-tropospheric airmass upstream of the southern Appalachians.
2. Results emphasize that forecasters in the southern Appalachian region should remain cognizant of upstream conditions over the Great Lakes, and consider parcel trajectories when forecasting NWFS events.

Future Work

- Construct a F_r classification scheme of the NWFS events in the Perry et al. (2007) dataset
- Continued development of forecast methodologies for NWFS events