



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

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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

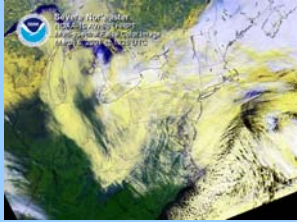


Figure 1: Visible satellite image from 1826 UTC, 6 March 2001

- 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

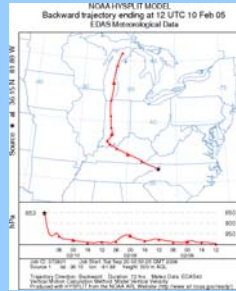


Figure 3: 72 hour HYSPLIT backward trajectory ending at 12 UTC 10 February

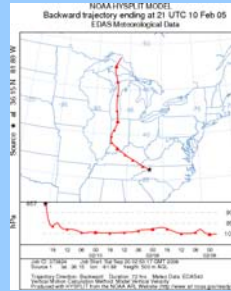


Figure 4: 72 hour HYSPLIT backward trajectory ending at 21 UTC 10 February

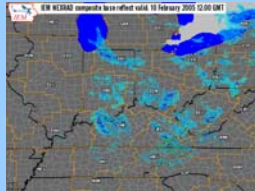


Figure 5: NEXRAD composite base reflectivity from 12 UTC 10 February



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

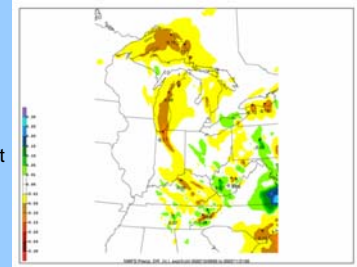


Figure 7: NWFS precipitation difference, LKNOFLX - CTRL

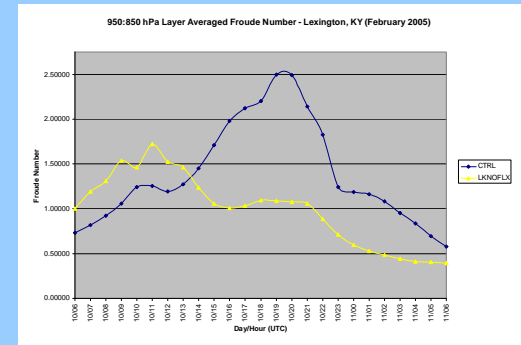


Figure 8: 950-850 hPa layer averaged Froude number at Lexington, KY

## 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

- The role of the Great Lakes is to moisten and destabilize the lower-tropospheric airmass upstream of the southern Appalachians.
- 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