Two synoptic events in late 2013 are studied with regard to the Great Lakes' effects on low systems by using WRF Model. The first case is a deep low (DL) from 16-18 Nov (a Midwestern tornado outbreak); the other is a shallow low (SL) from 13-15 Dec (a broad snowfall in the Northeastern America). For the two processes, the Noah LSM in WRF is initialized in three different configurations: the CONTROL runs with real MODIS land use, the NOLakes runs in which the lakes are replaced by terrestrial land, and the SSTLakes runs with updating high-resolution sea surface temperature analysis.

**Introduction**

Two synoptic events in late 2013 are studied with regard to the Great Lakes' effects on low systems by using WRF Model. The first case is a deep low (DL) from 16-18 Nov (a Midwestern tornado outbreak); the other is a shallow low (SL) from 13-15 Dec (a broad snowfall in the Northeastern America). For the two processes, the Noah LSM in WRF is initialized in three different configurations: the CONTROL runs with real MODIS land use, the NOLakes runs in which the lakes are replaced by terrestrial land, and the SSTLakes runs with updating high-resolution sea surface temperature analysis.

**Experimental Designs**

<table>
<thead>
<tr>
<th>Cases</th>
<th>Deep Low</th>
<th>Shallow Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>Integration Period (2013)</td>
<td></td>
</tr>
<tr>
<td>CONTROL</td>
<td>MODIS, NCEP Eta</td>
<td></td>
</tr>
<tr>
<td>NOLakes</td>
<td>Modified Landuse+Vegetation+Soil, NCEP Eta</td>
<td></td>
</tr>
<tr>
<td>SSTLakes</td>
<td>MODIS, NCEP Eta, Updated RTG SST</td>
<td></td>
</tr>
</tbody>
</table>

NCEP Eta (6 hourly, 40 km, North America);
NCEP FNL (6 hourly, ~100 km, Global) (for comparison with NCEP Eta);
NCEP RTG SST (Daily, ~8 km, Global);
Gauged Precipitation (Great Lake area)

All low systems are not created equal. Did the Great Lakes perform the same way in two different scenarios? So how to extract the Great Lakes' influence in this two case? Here, the numerical simulations are conducted.

**Results**

**Model Validation---Precipitation**

**Storm Evolutions---Sea Level Pressure**

The Great Lakes responded differently in these two scenarios.

**Surface Process---Temperature**

WRF performs well in simulating both the DL and SL.
Lake-air temperature gradient induces vertical heat flux; lake-land roughness contrast contributes to moist convergence.
The Great Lakes' effect generally strengthens the low system near the surface but is sensitive to the background flow.
This effect becomes much more significant for the development of the shallow low and extends to a higher level, tilting downwind.

**Conclusions**

- WRF performs well in simulating both the DL and SL.
- Lake-air temperature gradient induces vertical heat flux; lake-land roughness contrast contributes to moist convergence.
- The Great Lakes' effect generally strengthens the low system near the surface but is sensitive to the background flow.
- This effect becomes much more significant for the development of the shallow low and extends to a higher level, tilting downwind.