A Study of Great Lakes Effects on Synoptic Processes by Using WRF Comparison Experiments

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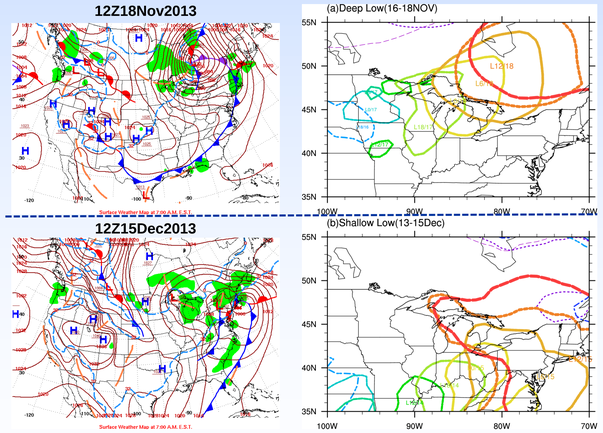
Introduction

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.

Synoptic Overviews



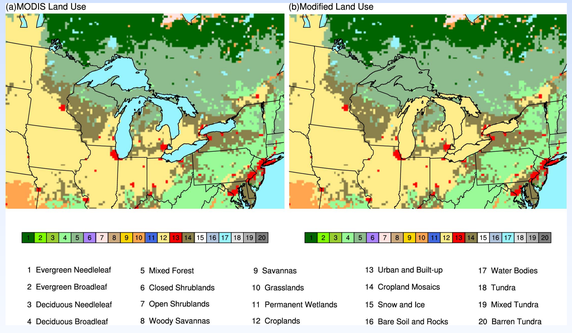
All low systems are not created equal. Did the Great Lakes perform the same way in two different scenarios? So how to **extract the Great Lakes' influence** in this two case? Here, the numerical simulations are conducted.

Experimental Designs

Cases	Deep Low	Shallow Low
Experiment	Integration Period (2013)	
	00Z16Nov~12Z19Nov	00Z13Dec~12Z16Dec
CONTROL	MODIS, NCEP Eta	
NOLakes	Modifed **Landuse+Vegetation+Soil**, NCEP Eta	
SSTLakes	MODIS, NCEP Eta , Updated **RTG SST**	

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

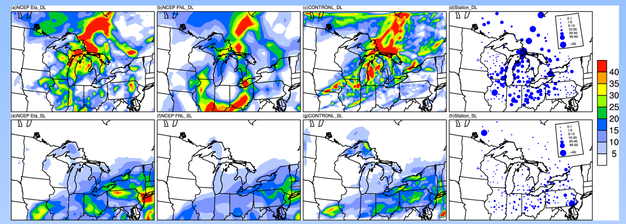
Modifications



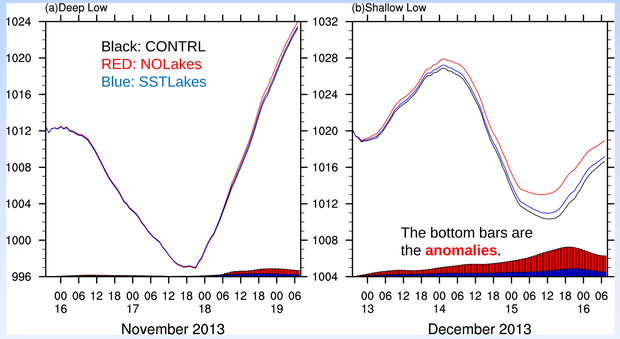
Variable Description	Variable Name	CONTROL-MODIS	NOLakes- Modified	
			Superior	Others
Land use	LU_INDEX	Water Bodies (17)	Mixed Forest (5)	Cropland (12)
Vegetation fraction	VEGFRA	0%	20%	25%
Soil category fraction	SOILCTOP	Water (14)	Sandy Loam (3)	Silt Loam (4)
	SOILCBOT			

Results

Model Validation----Precipitation

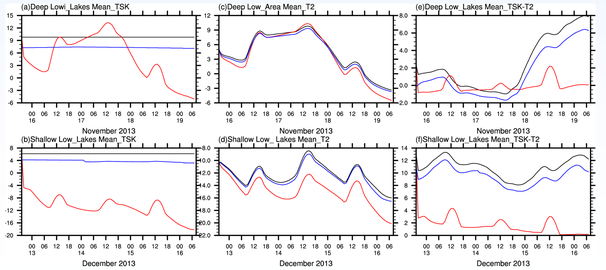


Storm Evolutions----Sea Level Pressure

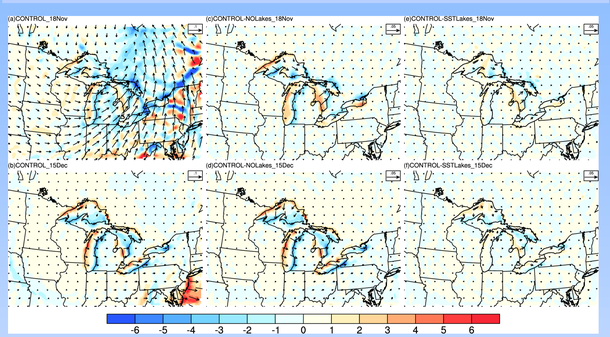


The Great Lakes responded differently in these two scenarios.

Surface Process---Temperature

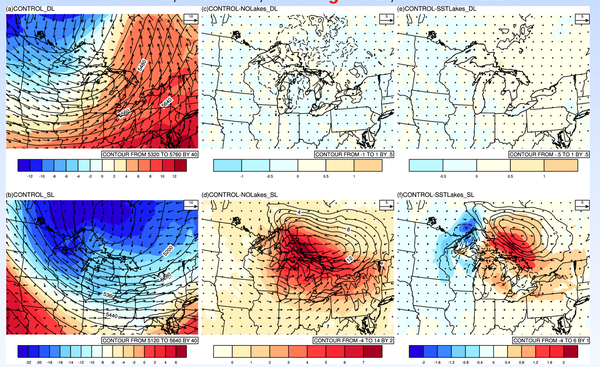


Surface Process---Humidity



Local-Background flow interaction

Vector: U, V at 10 m; **Shading**: T850; **Contour**: Z500



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.