Optimizing Lake Surface Temperatures and Ice Coverage For High Resolution Lake Effect Snow Forecasts

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Introduction

- “Legacy Approach”
  - Threat Maps
  - Flowcharts
  - 12 km NAM
  - Pattern Recognition
  - BUFKIT

- Demand for improved spatial/temporal evolution (NDFD)

- Can we improve upon these tools with high resolution local modeling?
Local Modeling of LES

- Demonstrated successes on the Eastern Lakes
  - Ballentine et al. (1998)
  - Arnott et al. (2007)

- Known Biases with single-band LES
  - Ballentine and Zaff (2007)
  - Arnott (2010)

- Is there potential added benefit from a high-resolution simulation at APX?

- What are the impact of varying SST/Ice analyses on high resolution LES simulations?
APX Local WRF

- **Two Nests**
  - 12km Outer
  - 4km Inner
- **Run at 00/12Z**
  - Length: 36 hour
- **IC/BCs: Previous GFS**
- **CP Scheme**
  - Outer: KF
  - Inner: None
- **Microphysics: Lin et al.**
- **PBL: Yonsei**
- **Operational Availability:** T+2hr (~02/14Z)
APX Local WRF - continued

00Z Simulation
- NASA SPoRT Great Lakes SST (sstsport)
- NASA SPoRT Great Lakes Ice (icegl)

12Z Simulation
- NCEP 1/12° global high res SST data
- NCEP 1/12° global high res ice coverage
Model Assessment

- Seasonal
  - Avoid daily “flukes”

- Part Verification:
  - WRF/COOP Compare

- Part Comparison:
  - SPoRT/NCEP Comparison
Study Specifics

- **Period:** 12/4/2010-2/26/2011
  - 59 Simulations
  - WRF Verification: 12-36 Hour Forecast (12Z-12Z)
    - Match COOP Observation Time
  - SST/Ice Compare:
    - Variables
      - Max T/Min T/ Liquid Precipitation

![Diagram](image-url)
WRF/COOP Compare – Max T

GAYM4 Max T

Max T (°F)

-10 0 10 20 30 40 50 60


GAYM4
LOCAL WRF
GAYM4-WRF
**WRF/COOP Compare – Liquid Precipitation**

**GAYM4 Liquid Precipitation**

- **Totals:**
  - GAYM4: 4.11”
  - WRF: 4.13”

- **0.1”:**
  - POD: 0.58
  - FAR: 0.30

The graph shows the liquid precipitation over time, with a peak on 1/16/2011.
WRF Verification - Summary

- Max Temperature Climatology represented well
  - No systematic biases
- Less Min Temperature Skill
  - Quite persistent warm bias
  - Especially for the coldest (radiational cooling) nights
    - BOIVER indicates overnight high wind speed bias
- Liquid Precipitation
  - Climatology (pattern) fit reasonably well
  - Too much precipitation for higher end events
  - Large wet bias over Eastern U. P. (not shown)
SPoRT/NCEP Comparison

- Demonstrate comparison (NCEP vs. SPoRT initialization) of:
  - Model QPF
  - Ice Coverage
  - SST (point)
    - Lake Superior
    - Lake Michigan
QPF Comparison

Average Difference: +0.005” (SPoRT)
Sum Difference: +0.46” (SPoRT)

12 Hour Liquid Precipitation Forecast – GAYM4

Date

QPF (in)

20101204  20101219  20110103  20110118  20110202  20110218

SPoRT
NCEP
Ice Coverage Comparison

Domain Averaged Ice Coverage

Average Difference: +0.07 (SPoRT)
Lake Superior Temperature Comparison (47.25N, 86.5W)

Average Difference: +0.09C (SPoRT)
Lake Michigan Temperature Comparison
(45.25N, 86.25W)

Average Difference: +0.29°C (NCEP)

QPF
Average Difference: +0.006” (NCEP)
Sum Difference: +0.18” (NCEP)
Summary

- Demand for increased spatial/temporal resolution for NDFD
- Performed seasonal verification/comparison
  - Reduces influence of “flukes”
- Verification
  - Modeled MaxT climatology well
  - Less skill with MinT
    - Warm bias with radiational cooling
  - Mixed QPF results
    - Good at Gaylord
    - QPF too high for “high-end” events, and at Sault Ste. Marie
Summary - continued

- QPF
  - SPoRT > NCEP
- Lake Ice Coverage
  - SPoRT > NCEP
- Lake Superior SST
  - SPoRT > NCEP
- Lake Michigan SST
  - NCEP > SPoRT
    - Dominated by ~one month period
**Preliminary Conclusions**

- What led to higher QPF in SPoRT Runs?
  - Identical setup outside of SST/Ice
  - Warmer lake waters on Superior and on Michigan for > ½ the time?
  - Does warmer lake temperature “outweigh” greater ice coverage?
Future Work

- Collaboration with NASA SPoRT
  - Microphysics/PBL sensitivities
  - Expand current SPoRT/NCEP comparison work?

- Evaluate second season with operationally-available local WRF data
  - Does it benefit the forecast process?
Acknowledgements

- NASA SPoRT
  - Collaboration on ICE/SST Product
- Rob Rozumalski
  - WRF EMS Developer
- GrADS
Extra Slides
WRF/COOP Compare – Liquid Precipitation

TCMM4 Liquid Precipitation

Totals:
TCMM4: 5.18”
WRF: 7.33”
WRF*: 5.43”

0.1”:
POD: 0.71
FAR: 0.33
WRF/COOP Compare – Liquid Precipitation

SSMM4 Liquid Precipitation

Totals:
SSMM: 2.54"
WRF: 6.92"

0.1”:
POD: 0.86
FAR: 0.70
NASA SPoRT

NCEP 1/12°
National Ice Center Analysis January 20th

- Fits well with forecaster observations during this period