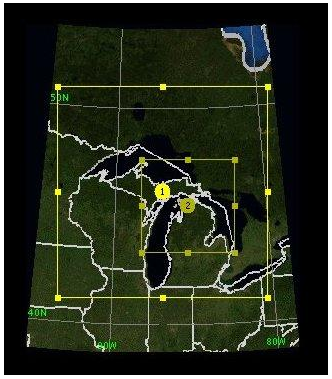
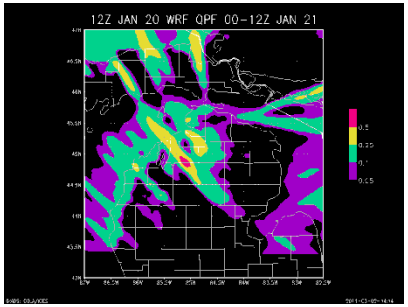
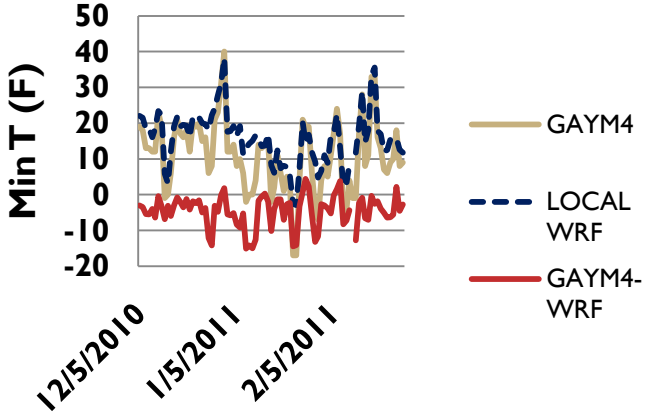
Optimizing Lake Surface Temperatures and Ice Coverage For High Resolution Lake Effect Snow Forecasts







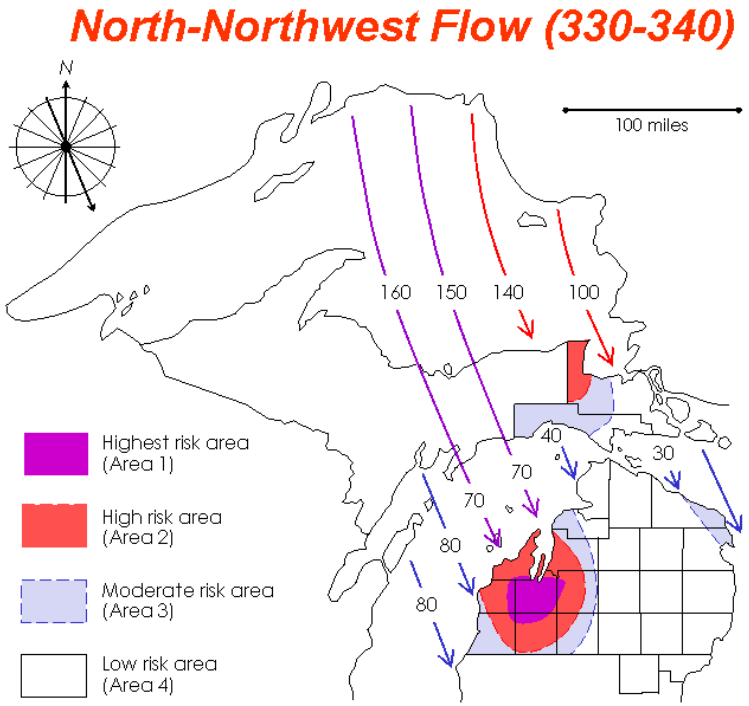
Justin Arnott

Science and Operations Officer

NWS Gaylord, MI

Introduction

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



- Demand for improved spatial/temporal evolution (NDFD)

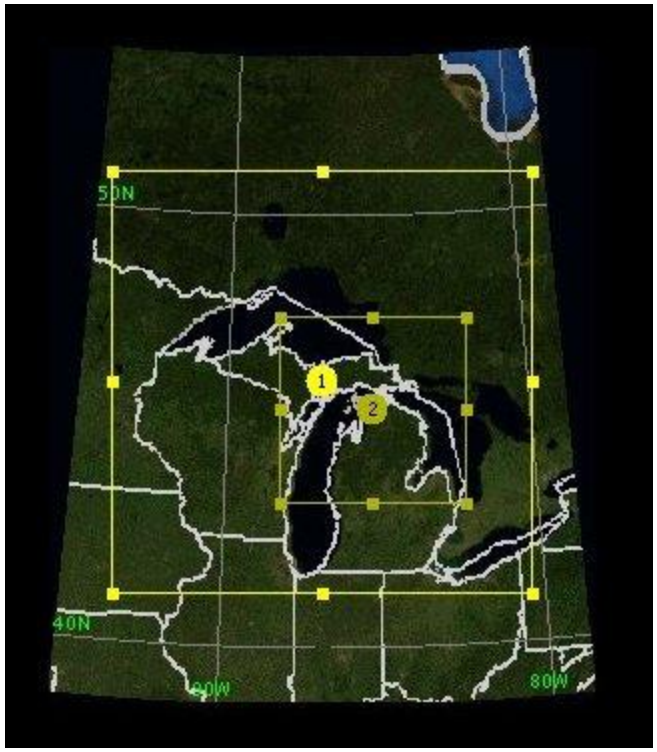
- Can we improve upon these tools with high resolution local modeling?

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

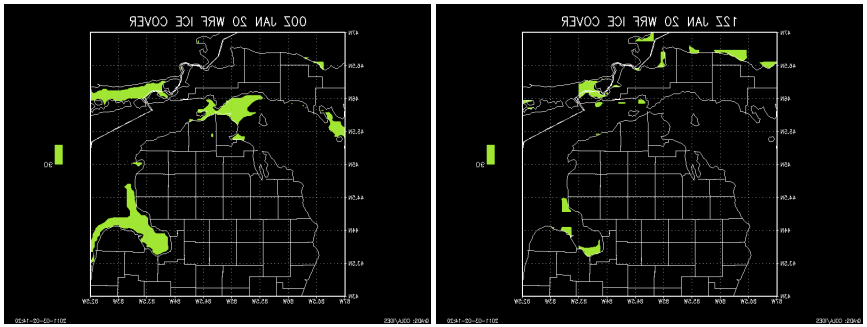
- NASA SPoRT Great Lakes SST (sstsport)
- NASA SPoRT Great Lakes Ice (icegl)

12Z Simulation

- NCEP 1/12° global high res SST data
- NCEP 1/12° global high res ice coverage

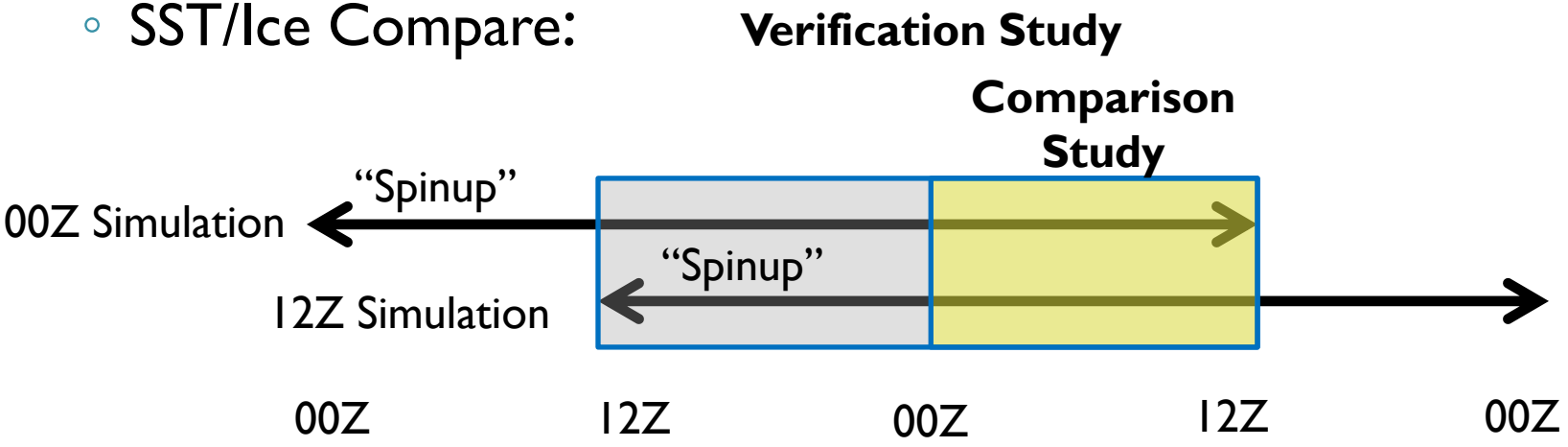
Model Assessment

- Seasonal
  - Avoid daily "flukes"
- Part Verification:
  - WRF/COOP Compare
- Part Comparison:
  - SPoRT/NCEP Comparison



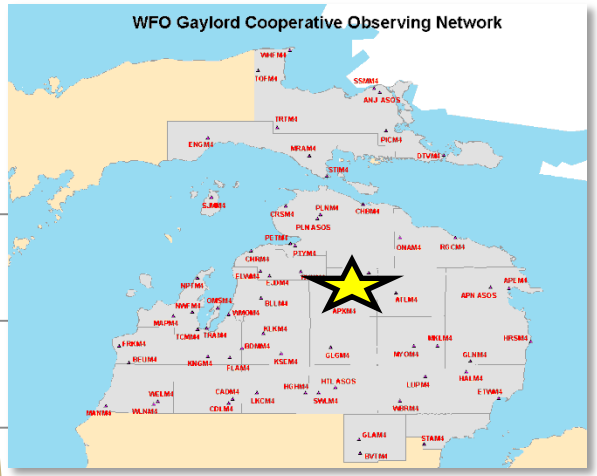
Study Specifics

- Period: 12/4/2010-2/26/2011
  - 59 Simulations
  - WRF Verification: 12-36 Hour Forecast (12Z-12Z)
    - Match COOP Observation Time
  - SST/Ice Compare:

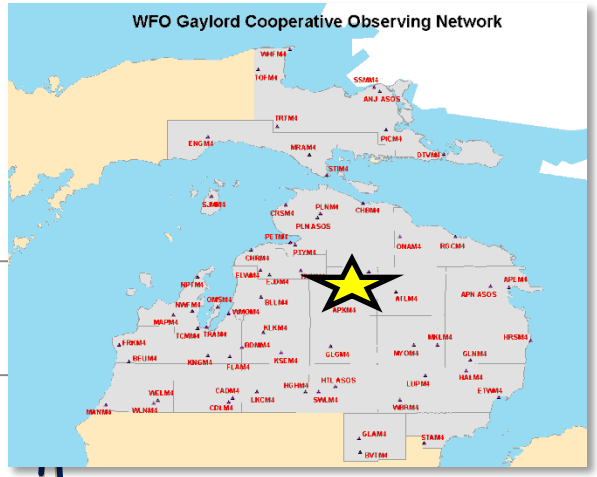


- Variables
  - Max T/Min T/ Liquid Precipitation

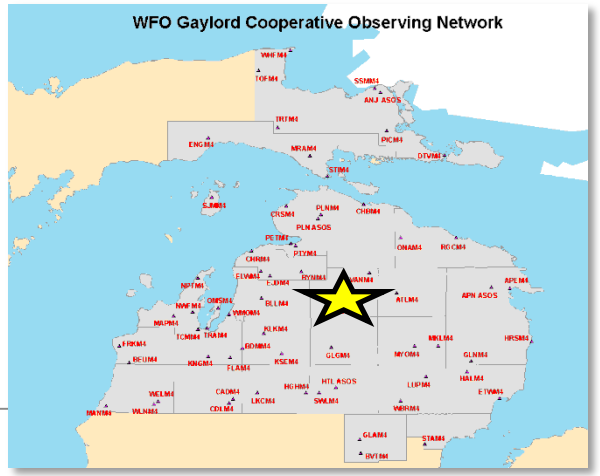
WRF/COOP Compare – Max T



WRF/COOP Compare – Min T



WRF/COOP Compare – Liquid Precipitation



GAYM4 Liquid Precipitation

Totals:
GAYM4: 4.11”
WRF: 4.13”

0.1”:
POD: 0.58
FAR: 0.30

Liquid Precipitation (in)

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

12/5/2010
12/12/2010
12/19/2010
12/26/2010
1/2/2011
1/9/2011
1/16/2011
1/23/2011
1/30/2011
2/6/2011
2/13/2011
2/20/2011
2/27/2011

GAYM4
LOCAL WRF

WRF Verification - Summary

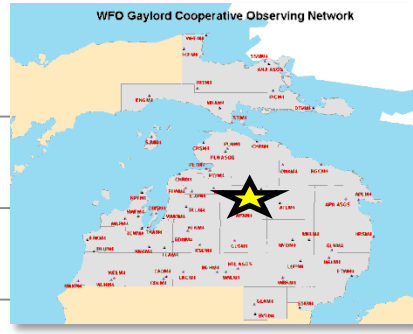
- Max Temperature Climatology represented well
  - No systematic biases
- Less Min Temperature Skill
  - Quite persistent warm bias
  - Especially for the coldest (radiational cooling) nights
    - BOIVER indicates overnight high wind speed bias
- Liquid Precipitation
  - Climatology (pattern) fit reasonably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

SPoRT/NCEP Comparison

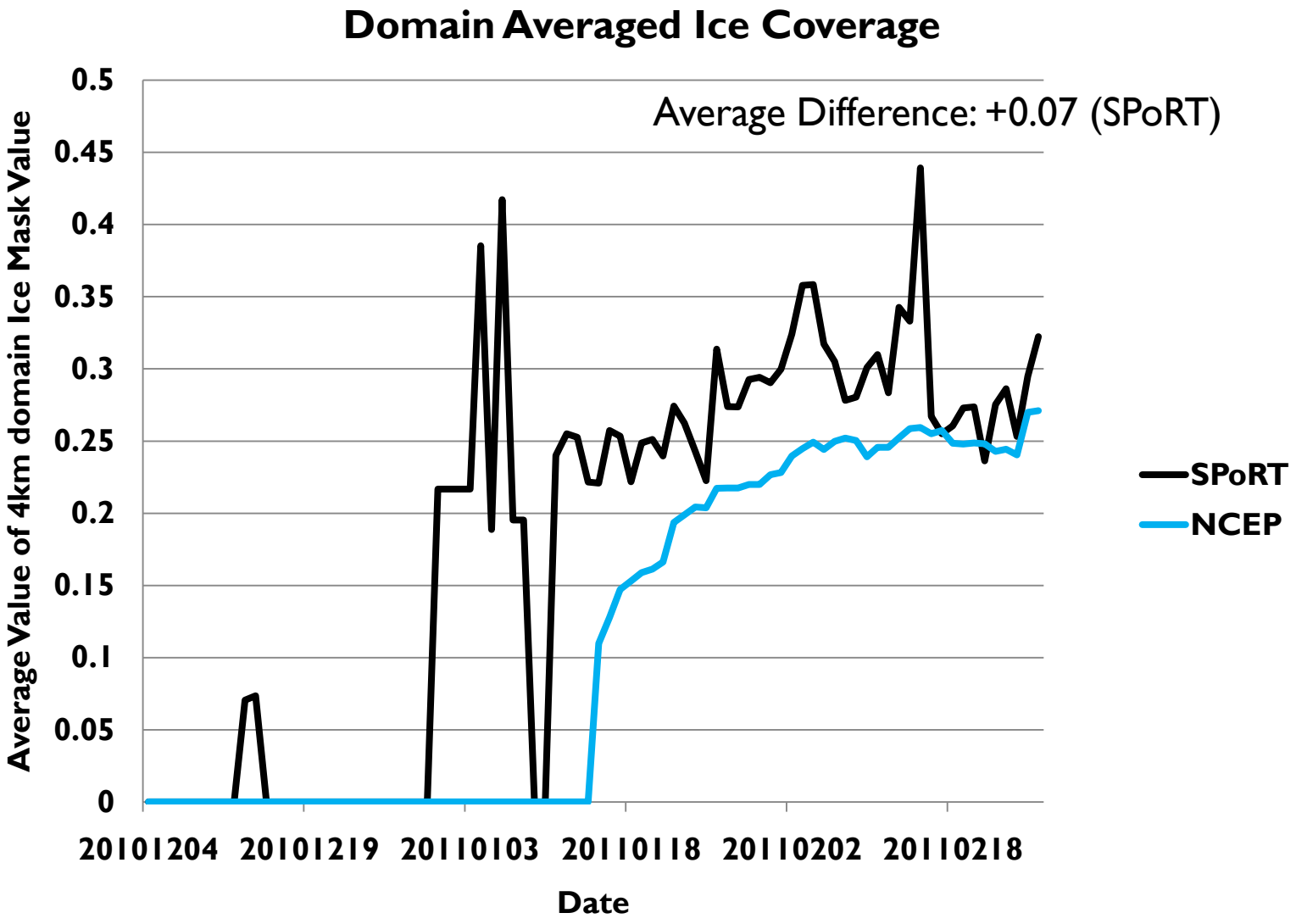
- Demonstrate comparison (NCEP vs. SPoRT initialization) of:
  - Model QPF
  - Ice Coverage
  - SST (point)
    - Lake Superior
    - Lake Michigan

QPF Comparison

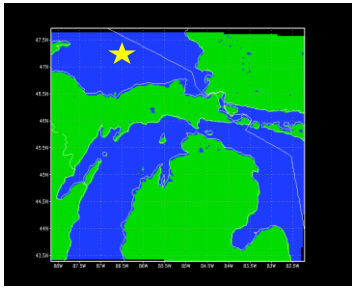
Average Difference: +0.005" (SPoRT)
Sum Difference: +0.46" (SPoRT)

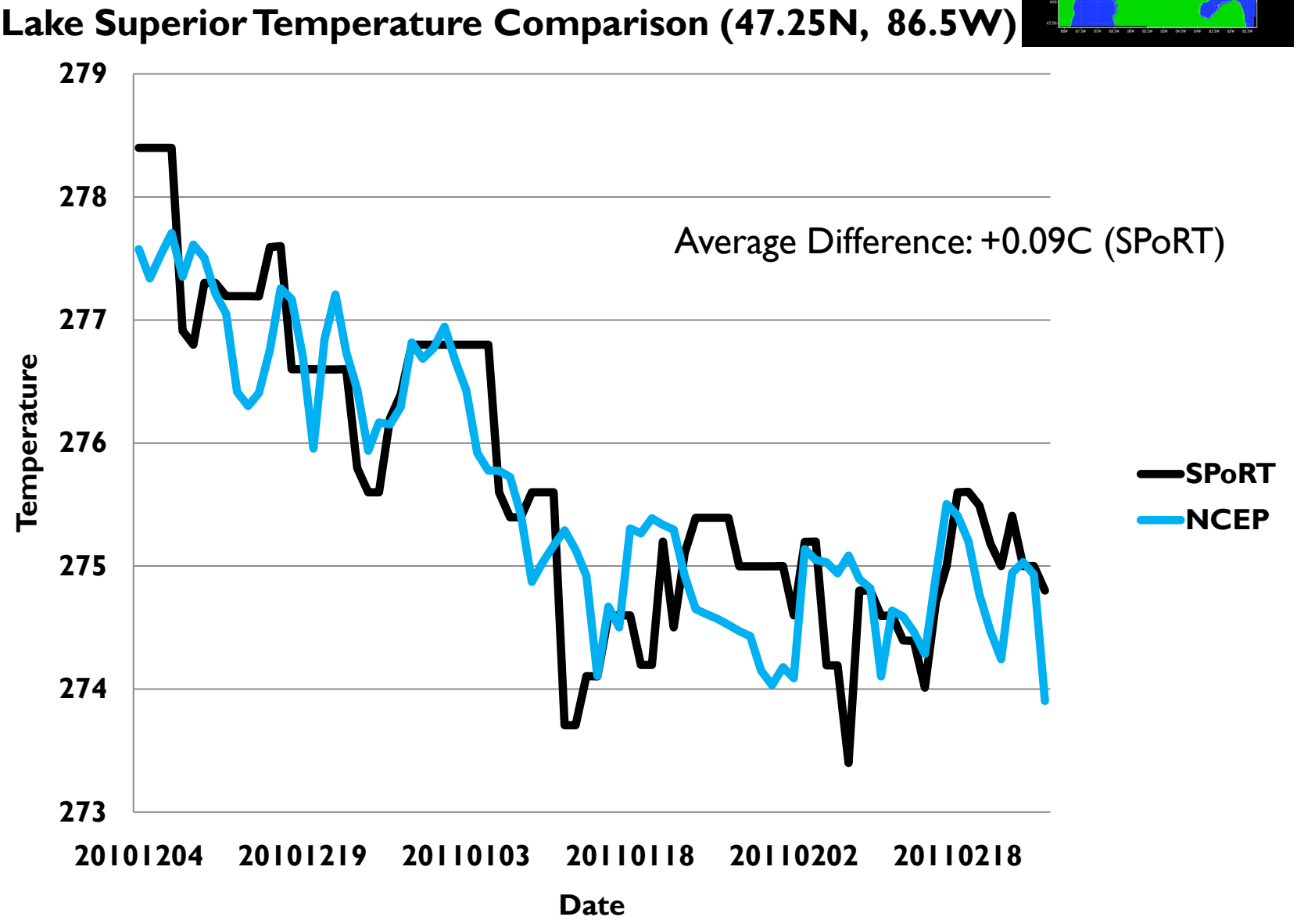


Ice Coverage Comparison

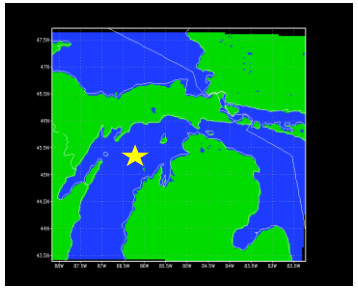


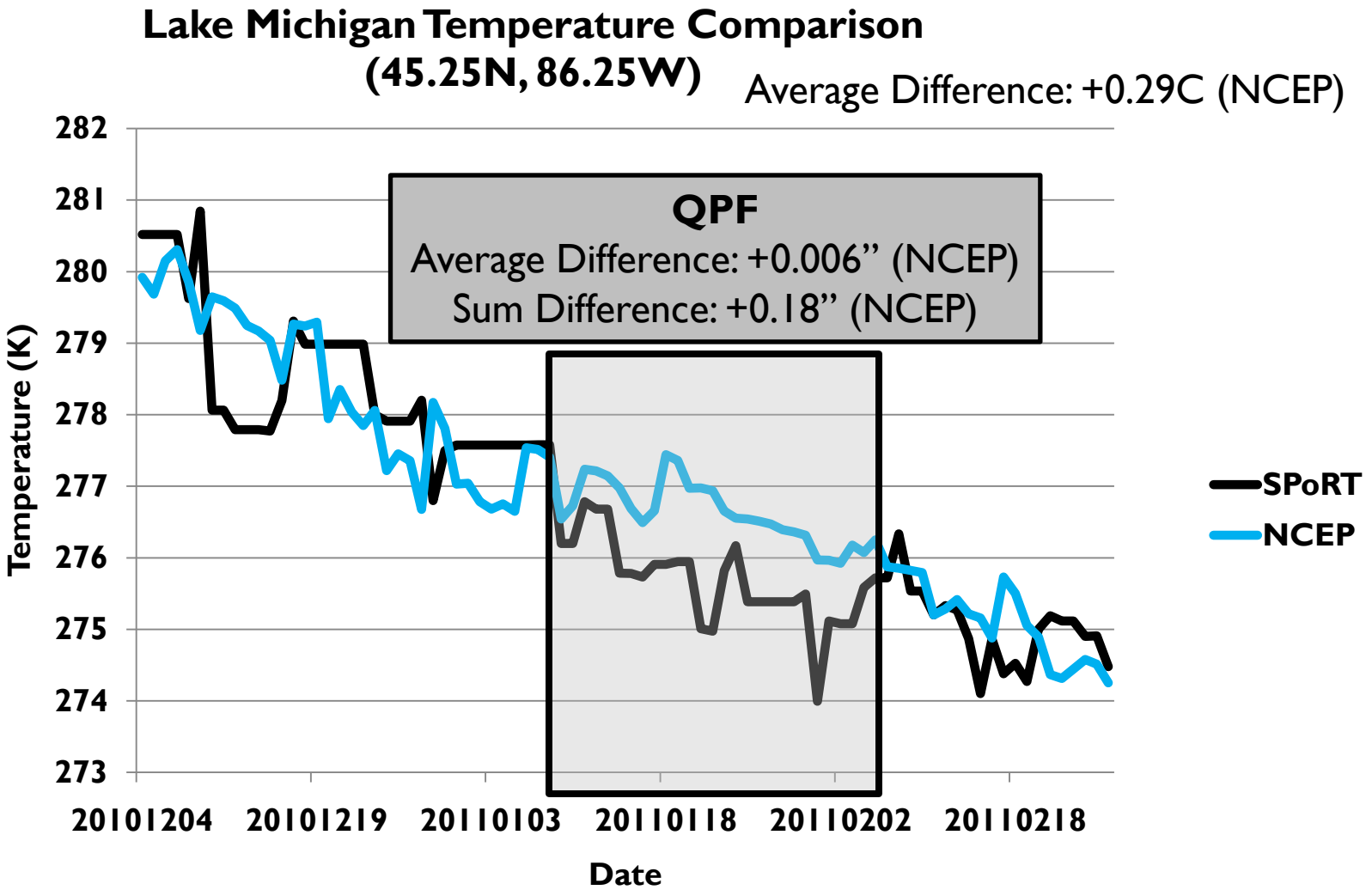
SST Comparison – Lake Superior





SST Comparison – Lake Michigan





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?

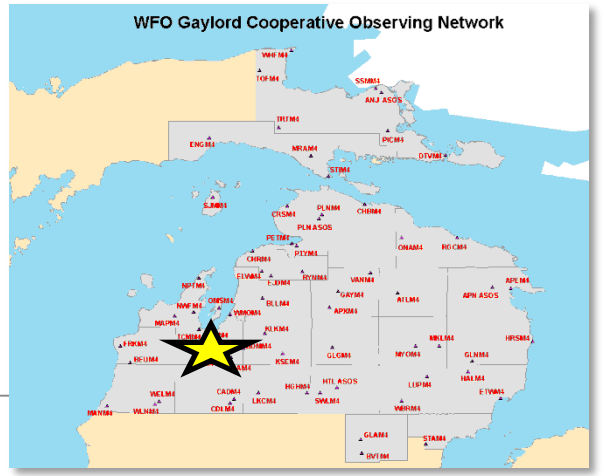
- Evaluate second season with operationally-available local WRF data
  - Does it benefit the forecast process?

Acknowledgements

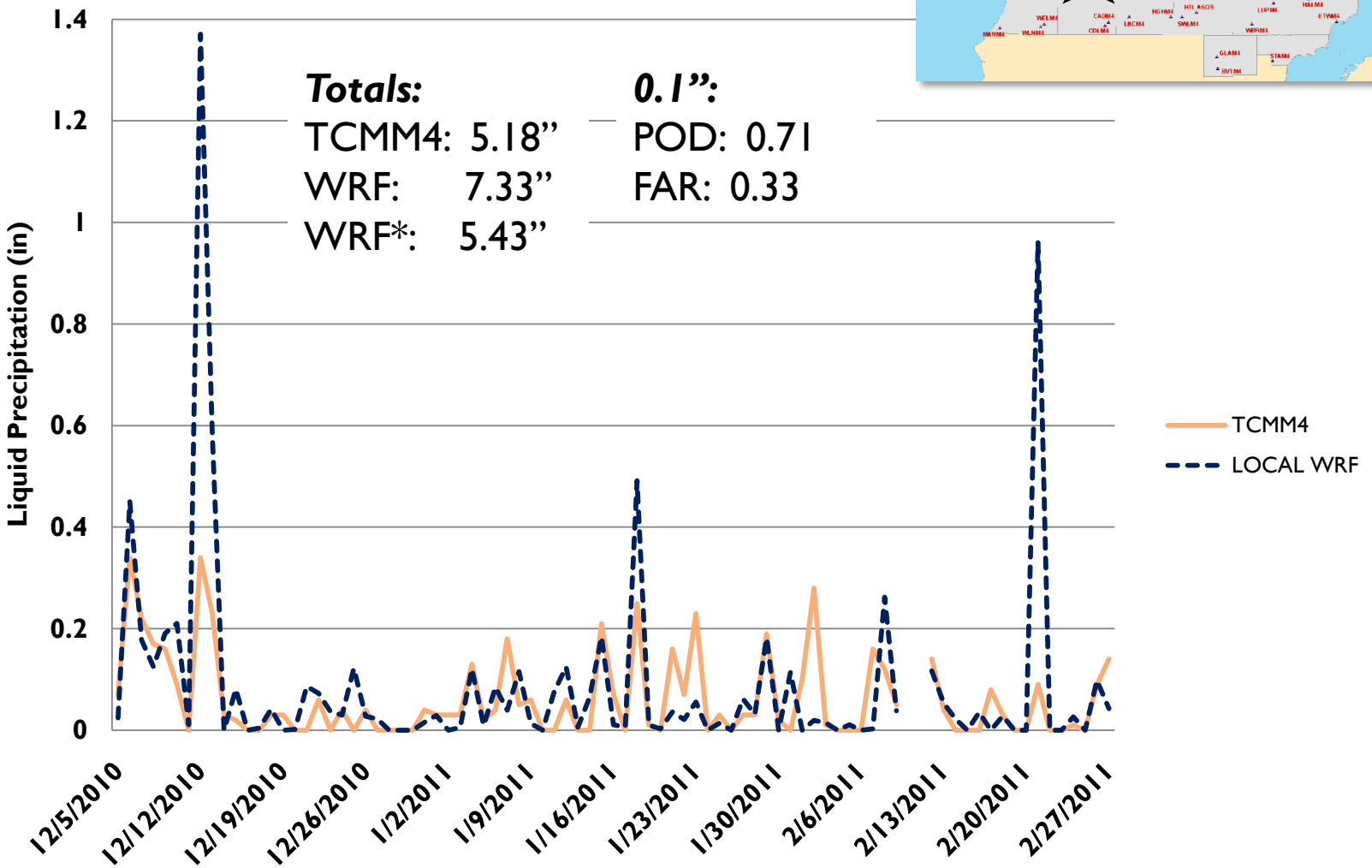
- NASA SPoRT
  - Collaboration on ICE/SST Product
- Rob Rozumalski
  - WRF EMS Developer
- GrADS

Extra Slides

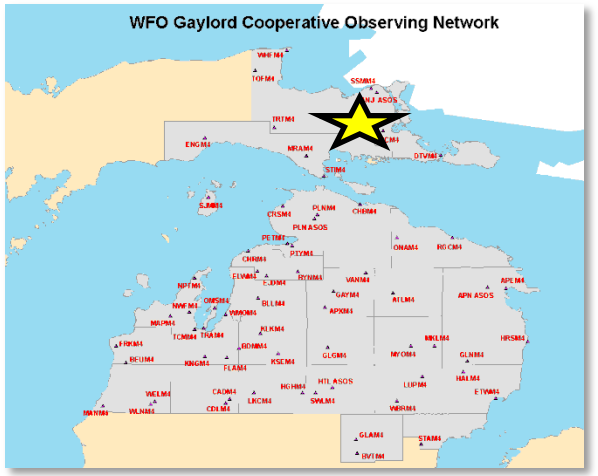
WRF/COOP Compare – Liquid Precipitation



TCMM4 Liquid Precipitation



WRF/COOP Compare – Liquid Precipitation



SSMM4 Liquid Precipitation

Totals:
SSMM: 2.54”
WRF: 6.92”

0.1”:
POD: 0.86
FAR: 0.70

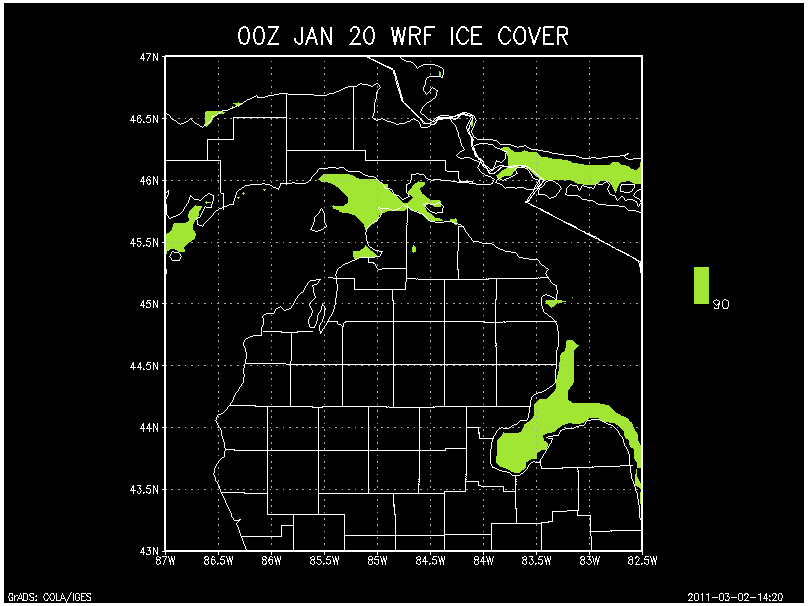
Liquid Precipitation (in)

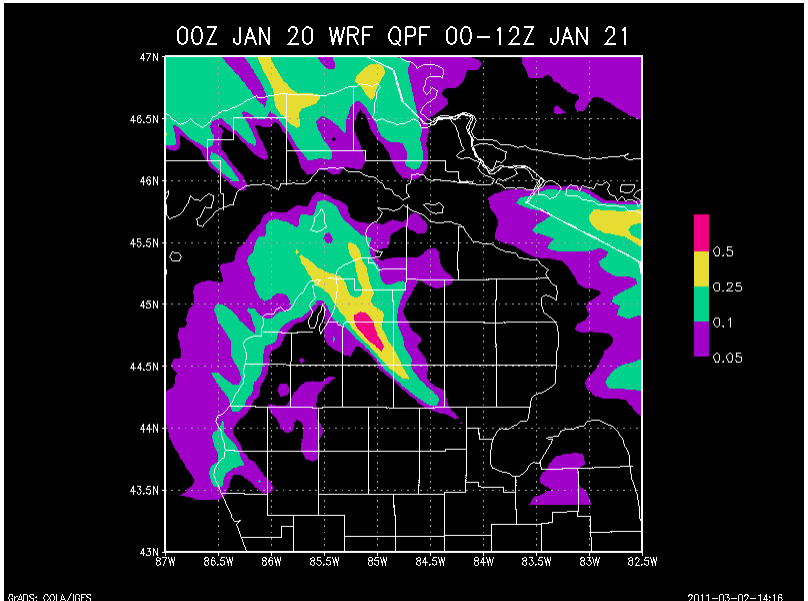
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

12/5/2010
12/12/2010
12/19/2010
12/26/2010
1/2/2011
1/9/2011
1/16/2011
1/23/2011
1/30/2011
2/6/2011
2/13/2011
2/20/2011
2/27/2011

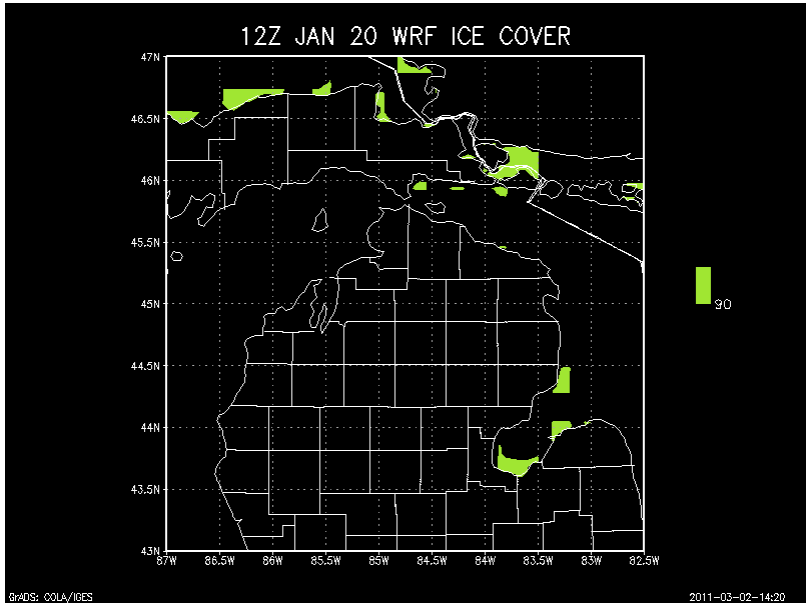
ANJ
LOCAL WRF

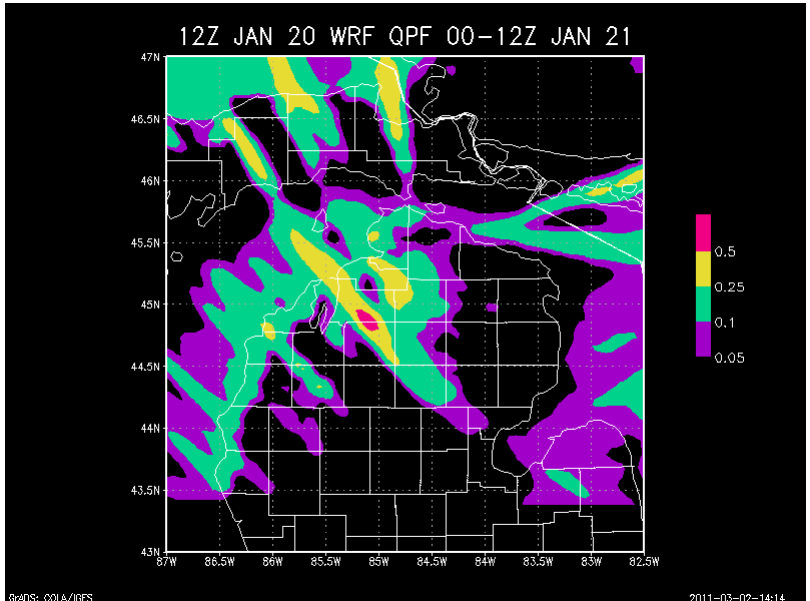
NASA SPoRT





NCEP 1/12°





National Ice Center Analysis January 20th

- **Fits well with forecaster observations during this period**