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Great Lakes Wave Prediction System: From Refined to Probabilistic Forecasts

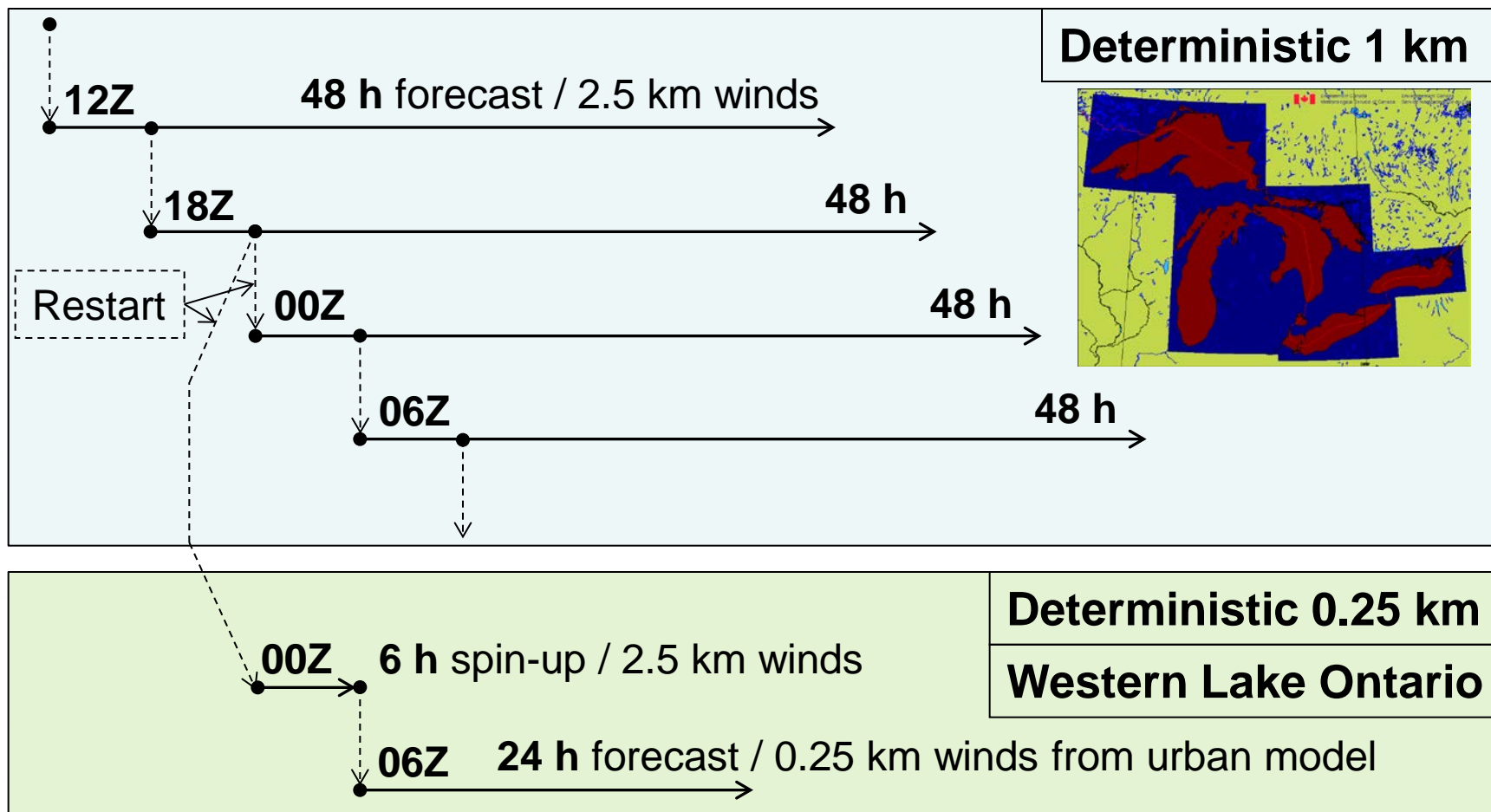
Natacha B. Bernier, **Benoit Pouliot**,
J.-H.G.M. Alves, M. Lépine,
S. Peel, and P. Pellerin

14th Wave Workshop, November 2015

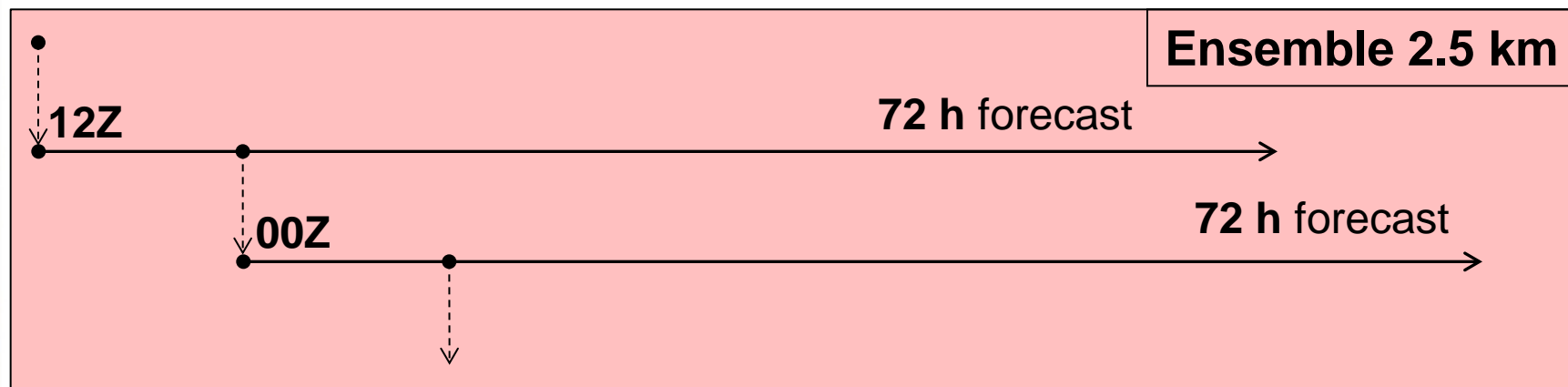
Motivation

- **2015 Pan and Parapan Am Games were held in the Toronto area in July and August**
- **Public and private sectors required accurate forecasts with adequate lead times (e.g. for activation of emergency measures, rescheduling sailing events)**
- **Only available Canadian wave guidance over the Great Lakes was available 3-hourly at coarse resolution (approx. 5km)**
- **Can we provide better guidance, including realistic estimates of uncertainty?**

Methodology



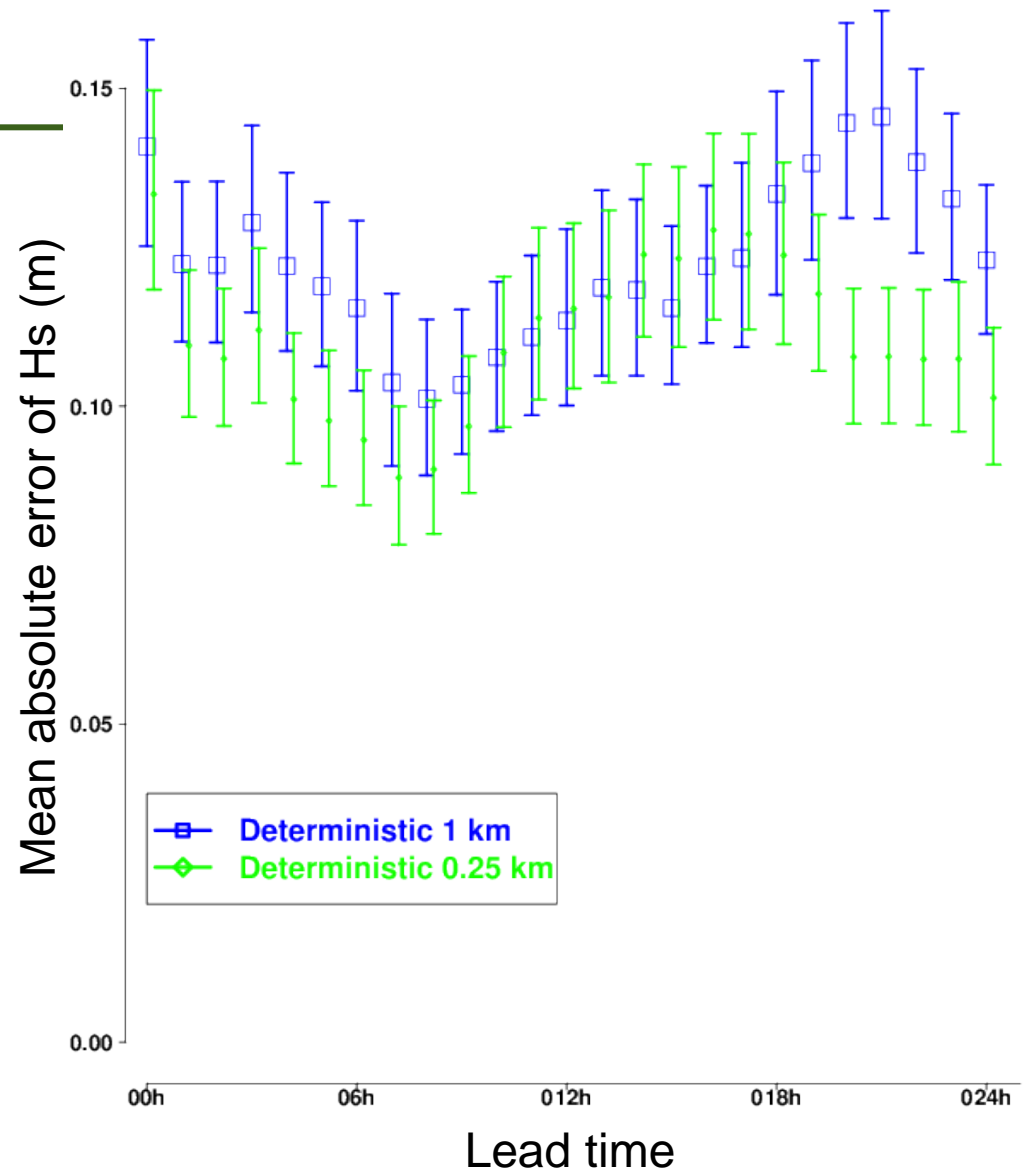
Methodology



- One control plus 20 members
- Member by member cycling allows persistence of spread
- Driven by atmospheric regional ensemble at 15 km
- Range to increase with atmospheric ensemble upgrades

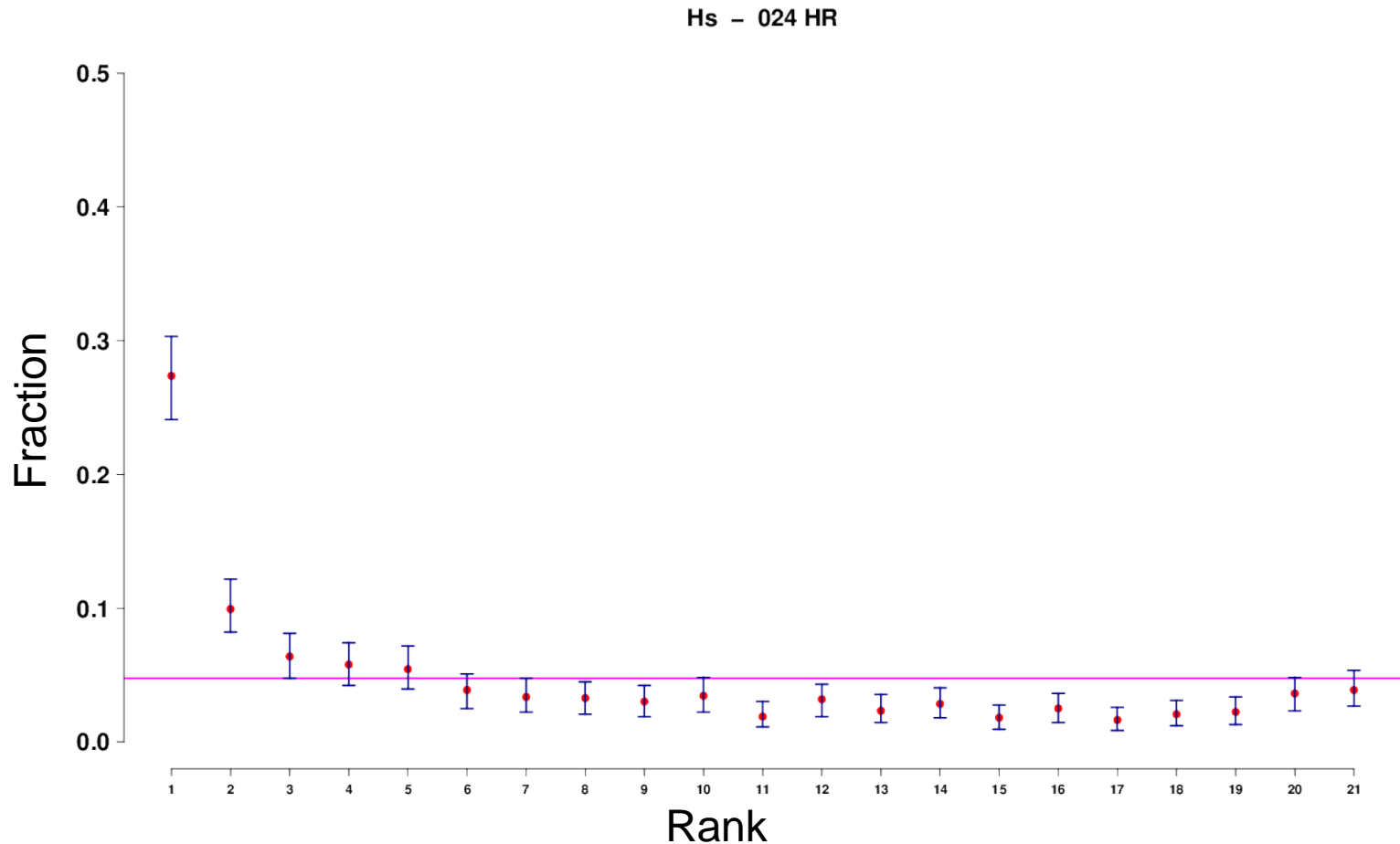
Statistics - Deterministic

- MAE of Significant Wave Height (H_s)
- June 27 to August 31 2015
- 4 buoys of West Lake Ontario
- High bias in summer



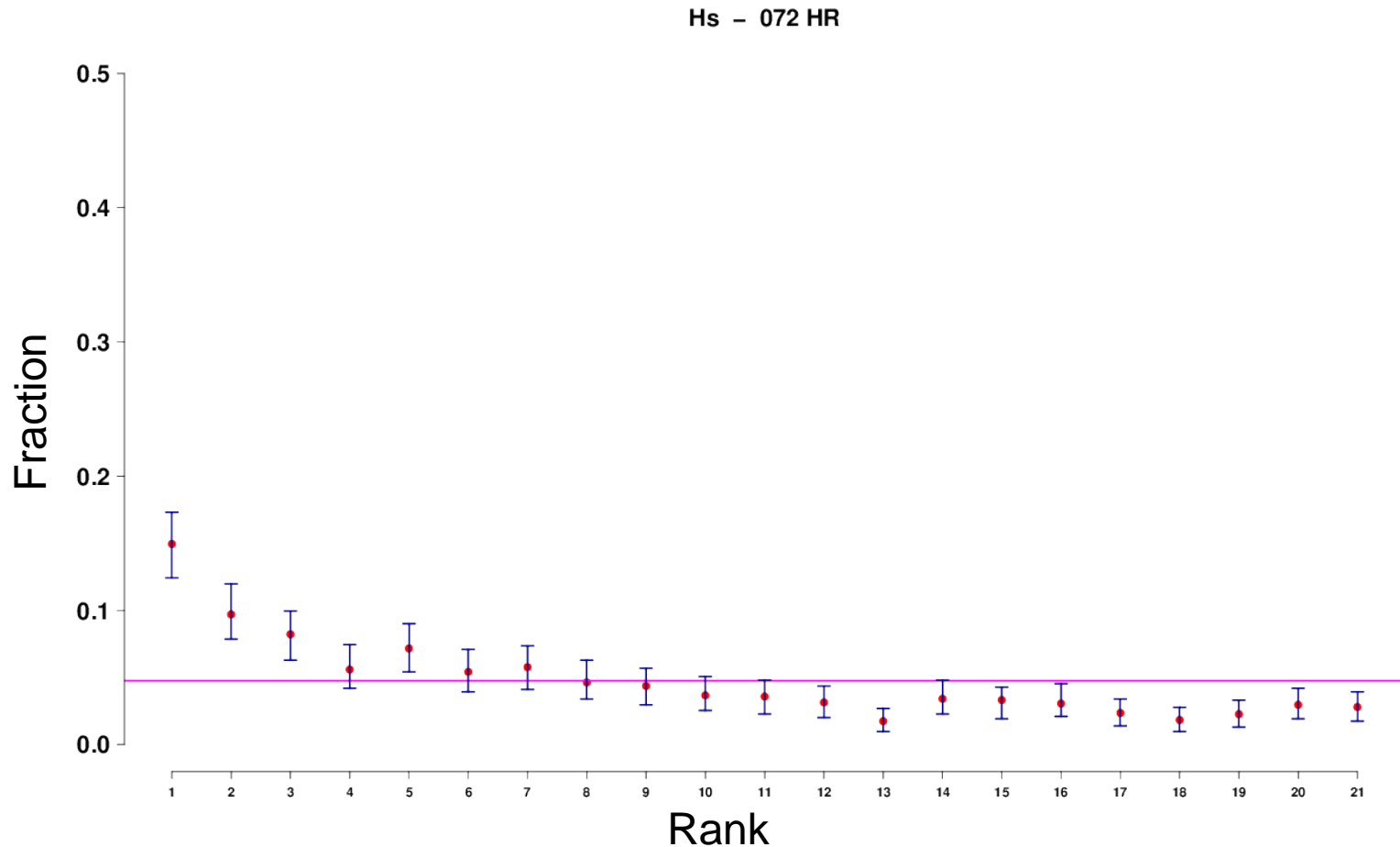
Statistics - Ensemble

Rank histogram of Hs for JJA 2015: lead time 24 hours



Statistics - Ensemble

Rank histogram of Hs for JJA 2015: lead time 72 hours

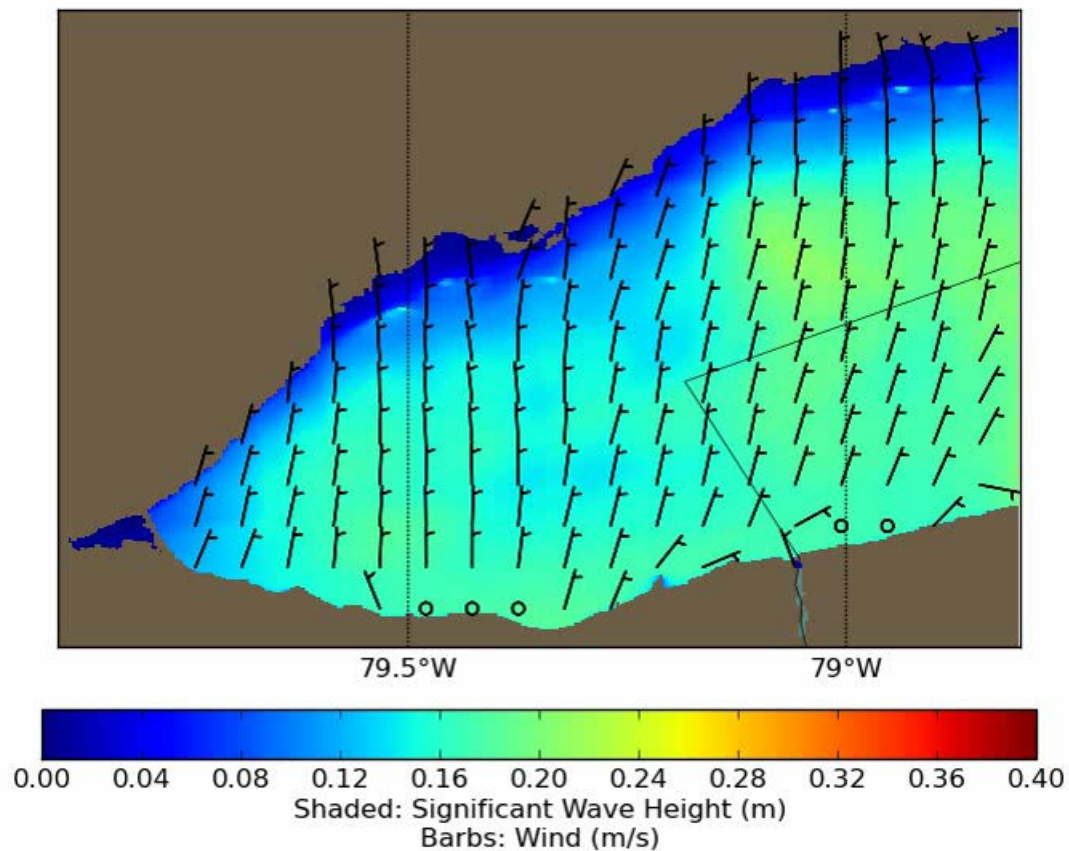


Lake Breeze

PANAMDWPS init. 2015070206

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Forecast valid 2015-07-02 12:00 UTC



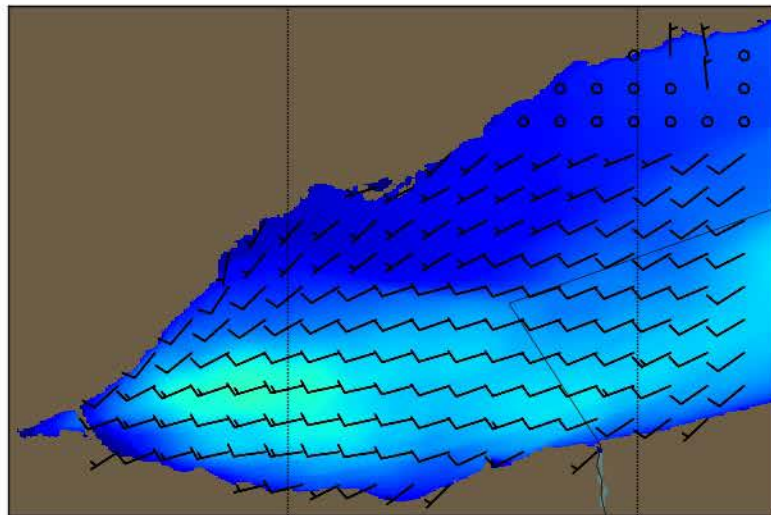
Squall Line

Deterministic 0.25 km

PANAMDWPS init. 2015080206

Environment Canada

Forecast valid 2015-08-02 12:00 UTC

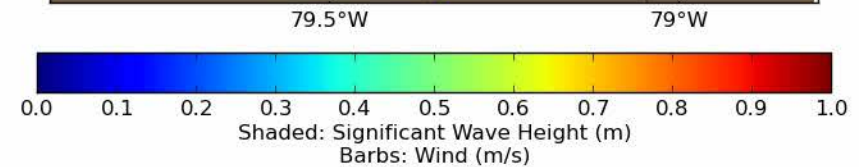
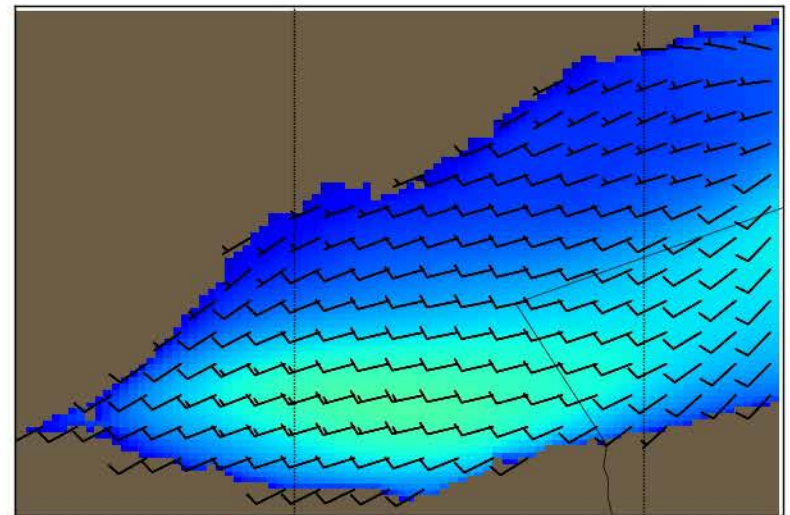


Deterministic 1 km

GLDWPS_ont1p0km init. 2015080206

Environment Canada

Forecast valid 2015-08-02 12:00 UTC



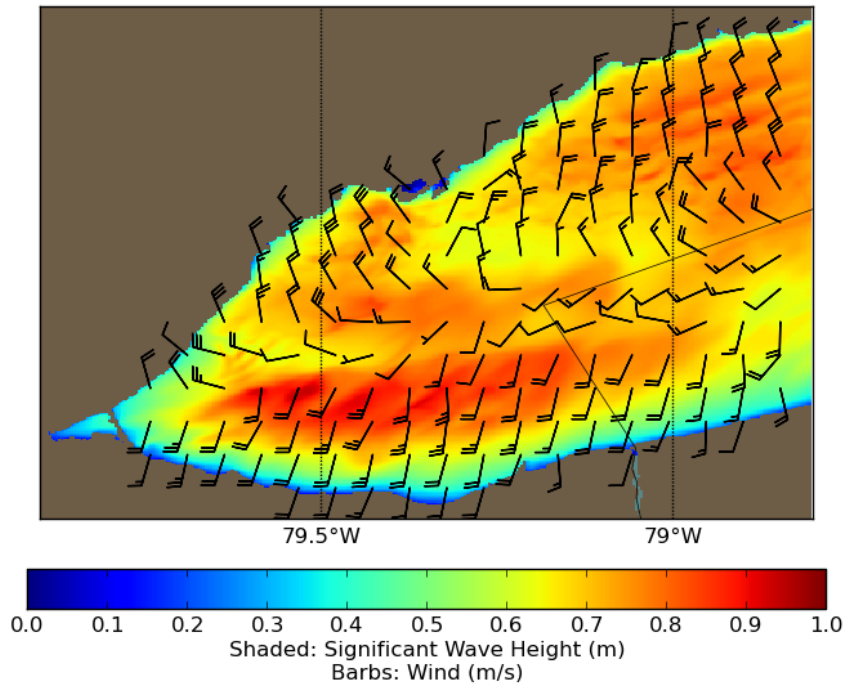
Squall Line

Deterministic 0.25 km

PANAMDWPS init. 2015080206

Environment Canada

Forecast valid 2015-08-03 01:00 UTC

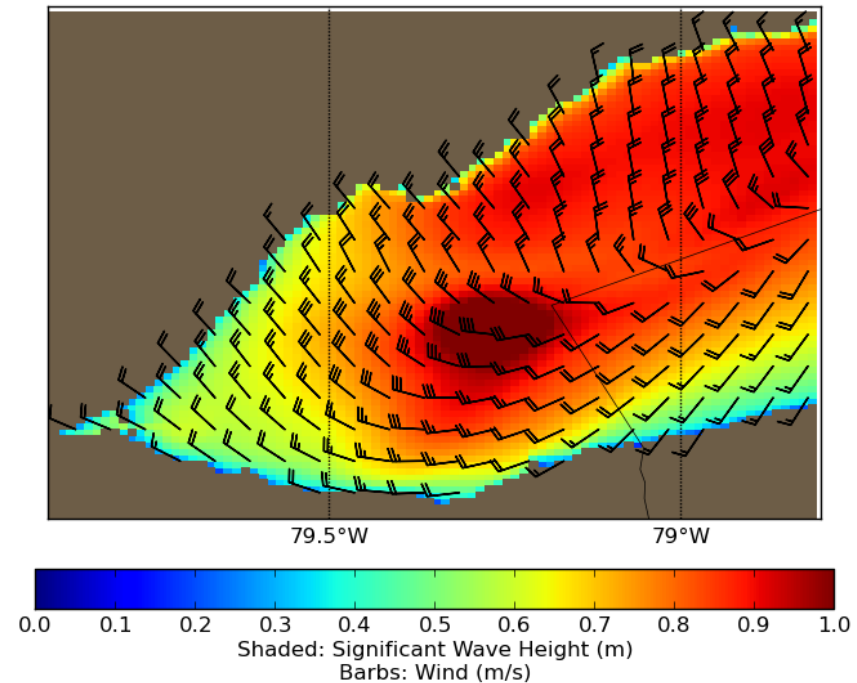


Deterministic 1 km

GLDWPS_ont1p0km init. 2015080206

Environment Canada

Forecast valid 2015-08-03 00:30 UTC



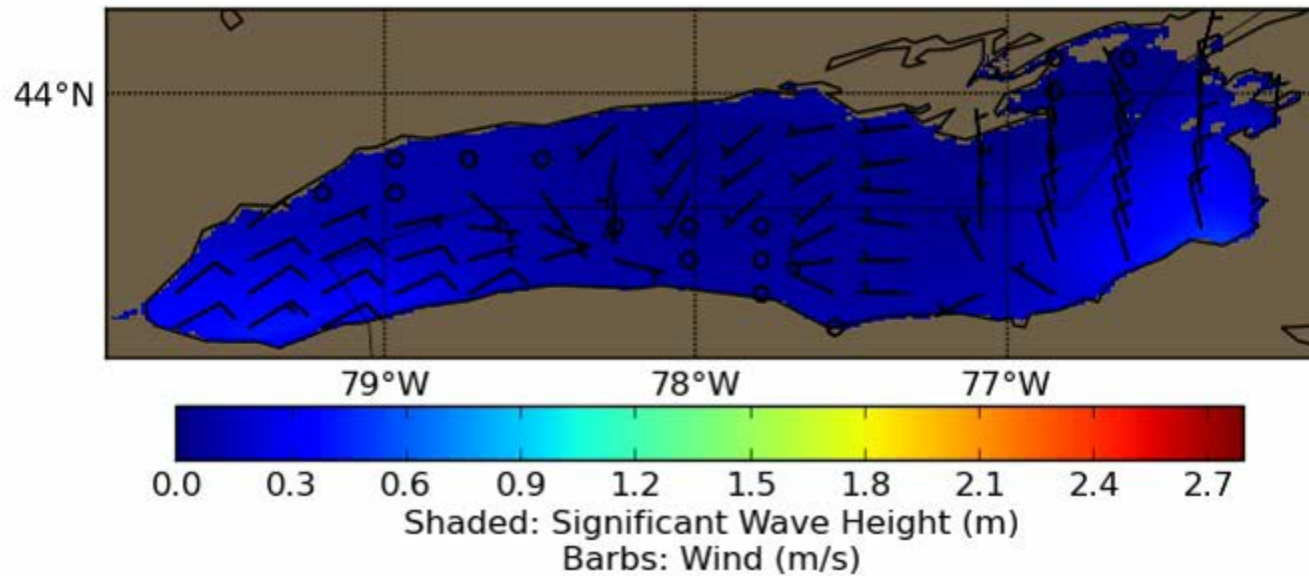
Extratropical Low

Deterministic 1 km

GLDWPS_ont1p0km init. 2015062700

Environment Canada

Forecast valid 2015-06-27 00:00 UTC



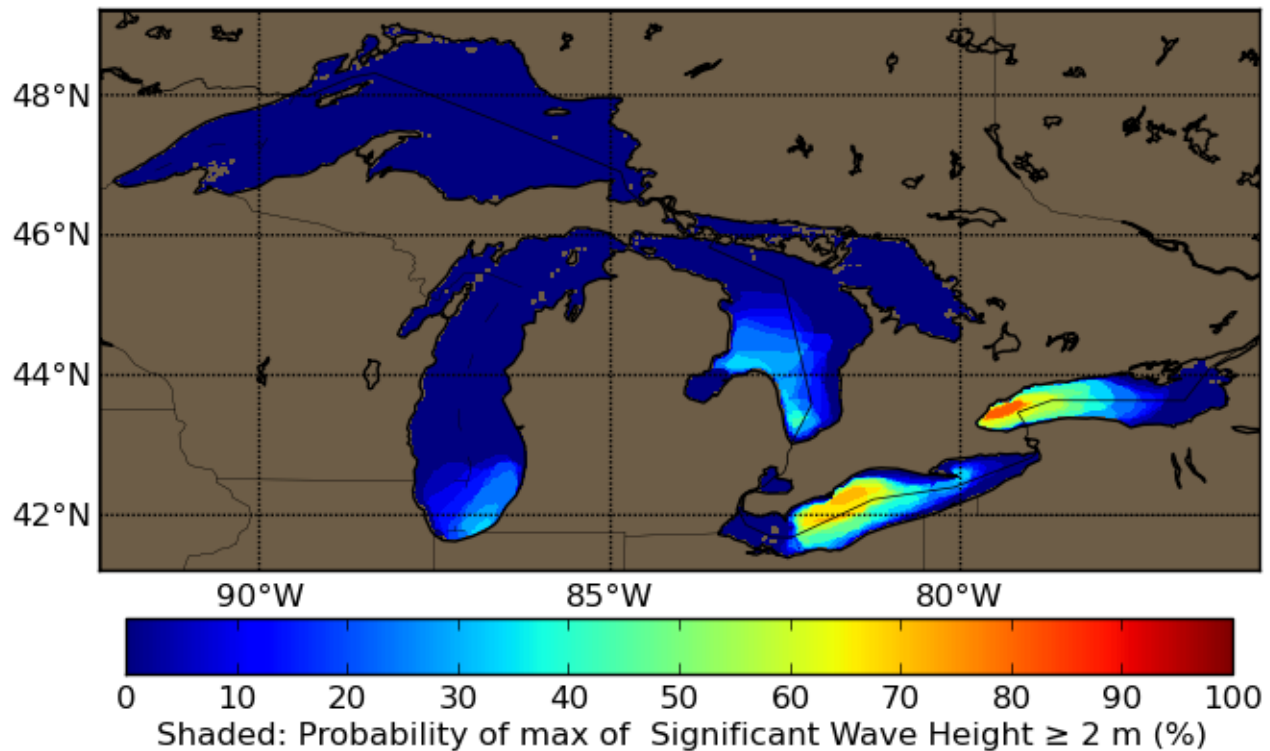
Probabilistic Forecast

- Probability of max $H_s \geq 2\text{m}$ over lead time 48 to 60 h

GLEWPS init. 2015062600

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Ensemble Forecast for 12 hours from 2015-06-28 00:00 to 2015-06-28 12:00 UTC



Probabilistic Forecast

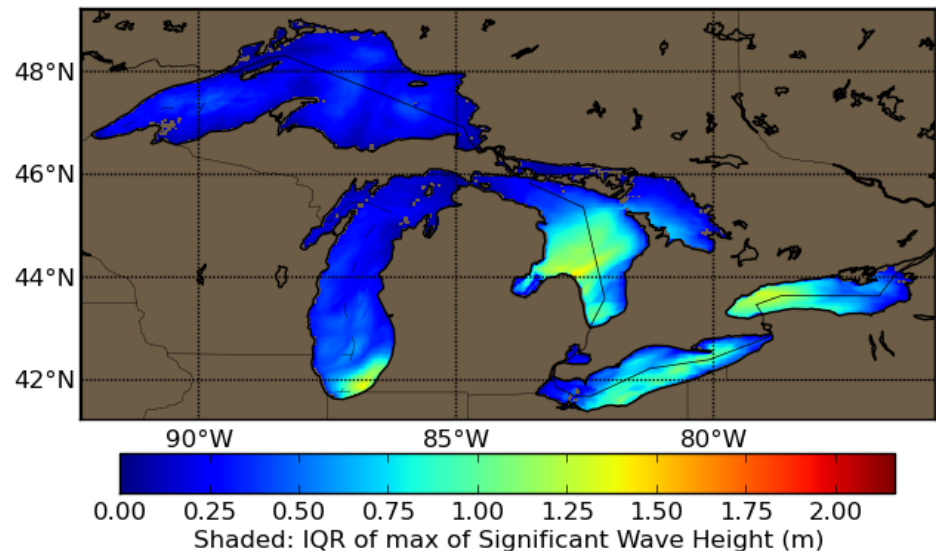
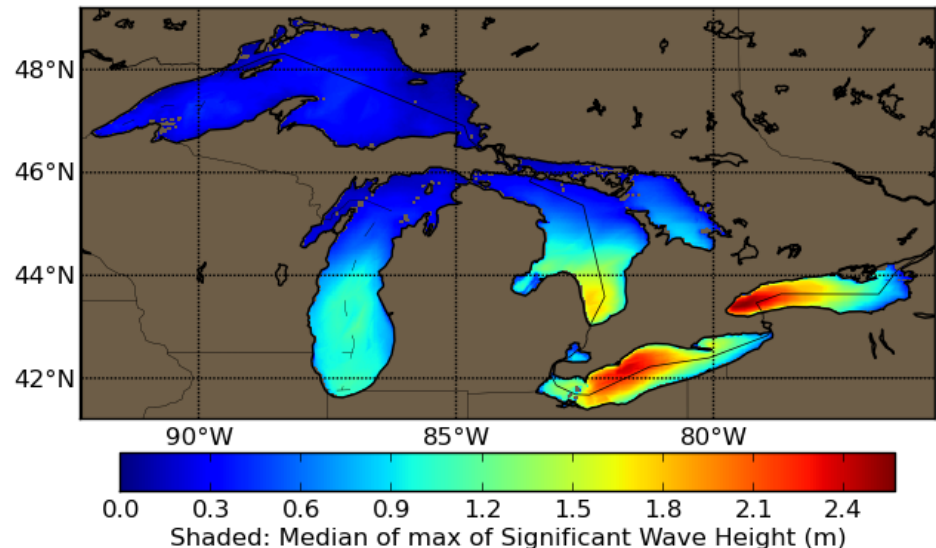
GLEWPS init. 2015062600

Environment Canada

Ensemble Forecast for 12 hours from 2015-06-28 00:00 to 2015-06-28 12:00 UTC

- Median of max Hs
- Spread of max Hs
- Lead time 48 to 60 h
- Through 36 hours:
6-hourly intervals
- Past 36 hours:
12-hourly intervals

Modified from Bernier and Thompson 2015



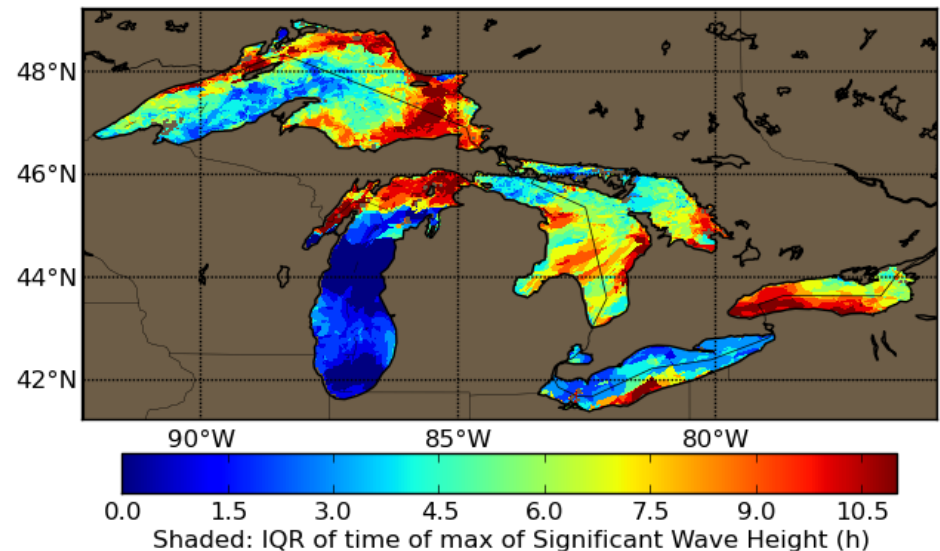
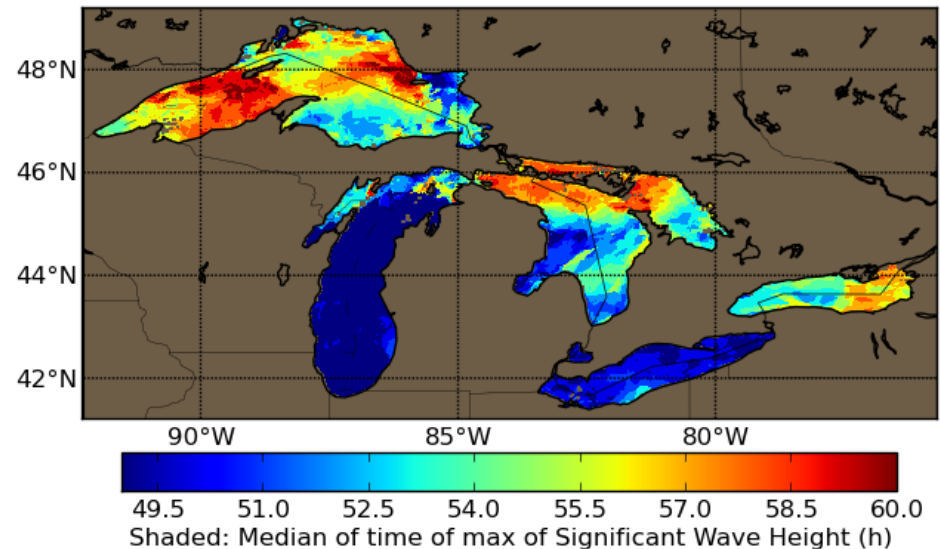
Probabilistic Forecast

GLEWPS init. 2015062600

Environment Canada

Ensemble Forecast for 12 hours from 2015-06-28 00:00 to 2015-06-28 12:00 UTC

- Median of time of max Hs
- Spread of time of max Hs
- Lead time 48 to 60 h



Discussion

- **Developed a suite of wave models for the Great Lakes**
- **Systems are used as a basis for upgrades**
- **In support of forecasting for Pan Am and Parapan Am**
- **Positive feedback from Canadian & American forecasters**
- **High resolution adds value**
- **Presentation of probabilistic forecast information is important**

Future Work

- **Use of incremental-analysis update for better pseudo-analysis**
- **Longer range ensembles once atmospheric ensembles updated**
- **Coupling with atmosphere**
- **Coupling with ice model**
- **Coupling with currents**

