Consistent algal bloom spatial extent modelling using MERIS, MODIS, and OLCI sensors
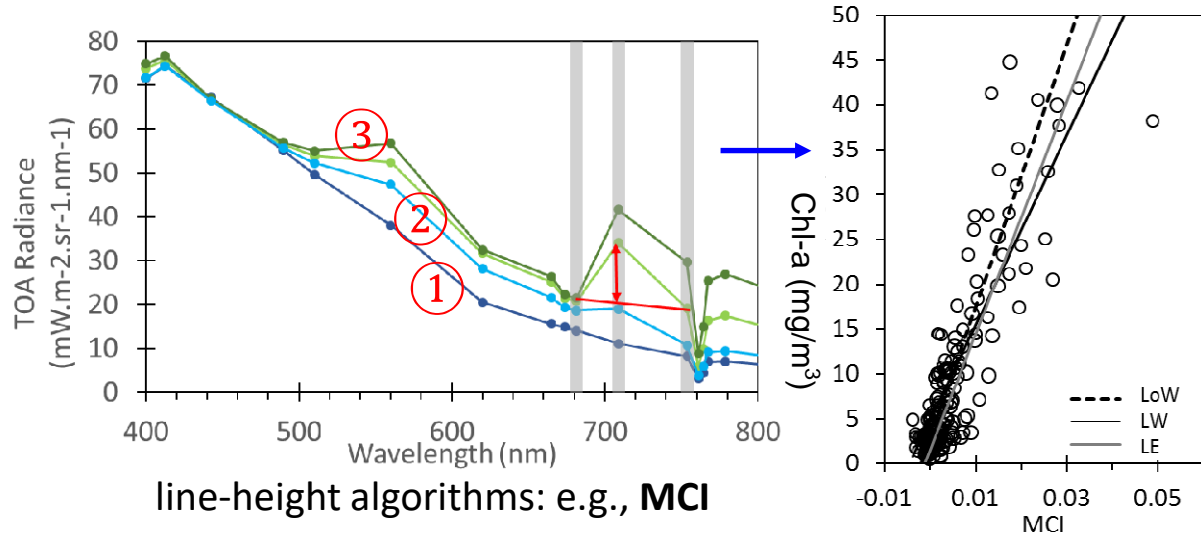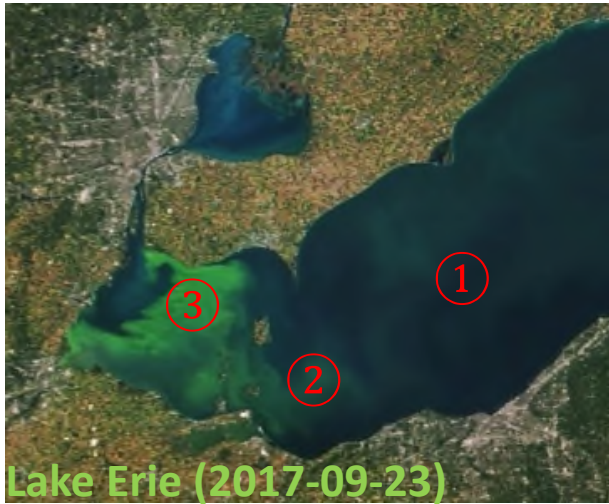
Chui Zeng and Caren Binding

*Environment and Climate Change Canada (ECCC)
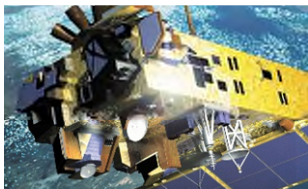Burlington, Ontario*

chuiqing.zeng@canada.ca

Lake of the Woods, 14 Aug 2019
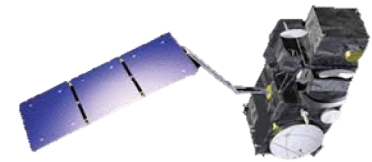
Remote sensing of algal bloom

Lake Erie (2017-09-23)

line-height algorithms: e.g., **MCI**

- Line-height algorithms for complex inland water systems (e.g., MCI)
- Algal bloom: chlorophyll-a concentration (*chl-a*) >=10 mg/m^3
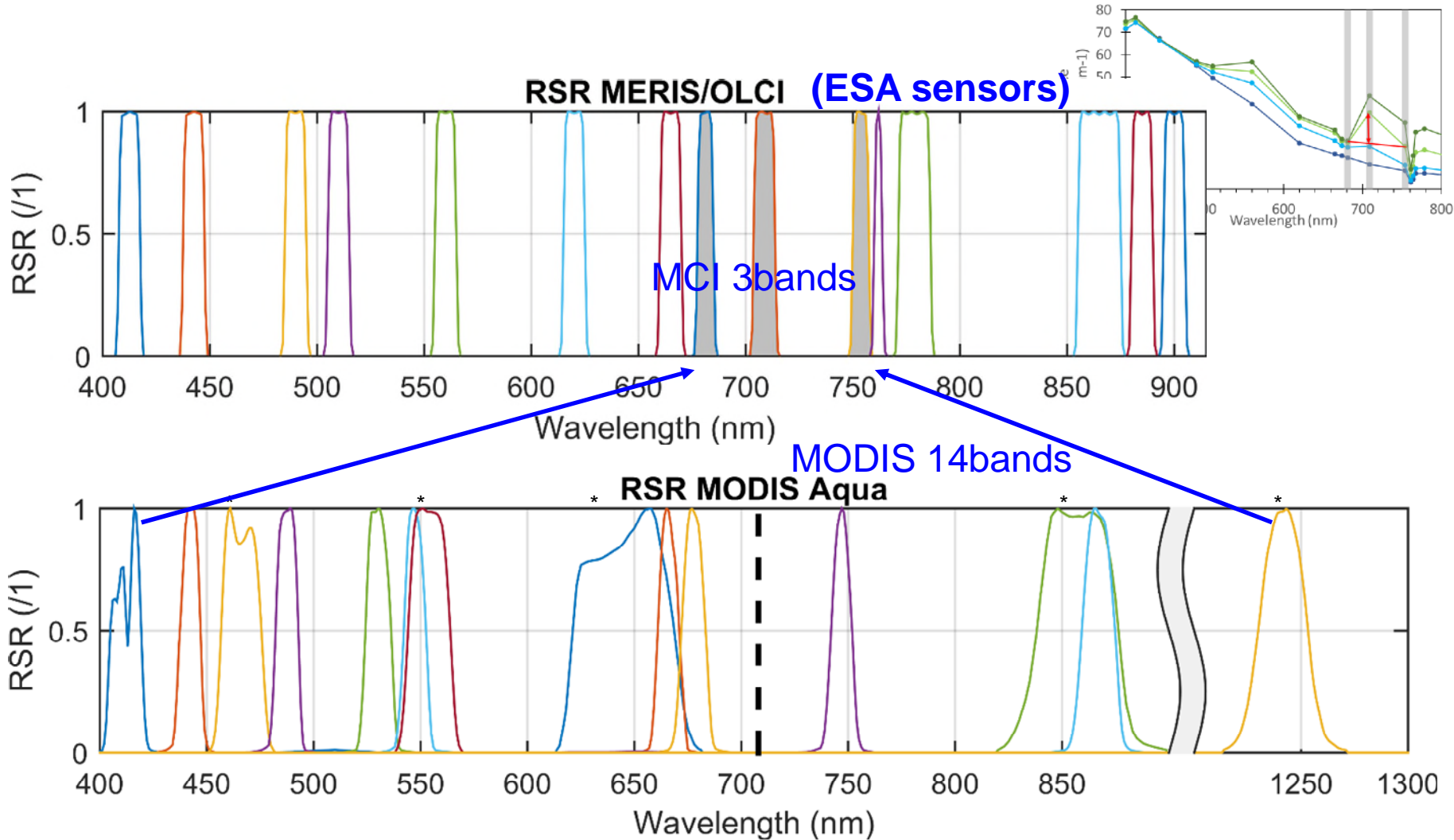- **Limitation: sensor observation gap (2012-2015)**

(ESA sensors)

| 2002 | MERIS | May2012 | ? | 2016 | OLCI | present |

| 2002 | MODIS | present |

Envisat MERIS   MODIS Aqua   Sentinel-3 OLCI

ESA: European Space Agency

RSR MERIS/OLCI **(ESA sensors)**

MCI 3bands

MODIS 14bands

RSR MODIS Aqua

RSR: relative spectral responses

MODIS shortage:

- missing the key band for MCI at 708nm
- coarse spatial resolution (1km v.s. ESA 300m)

→ Neural network (NN) model to "predict" 708nm

MODIS NN training
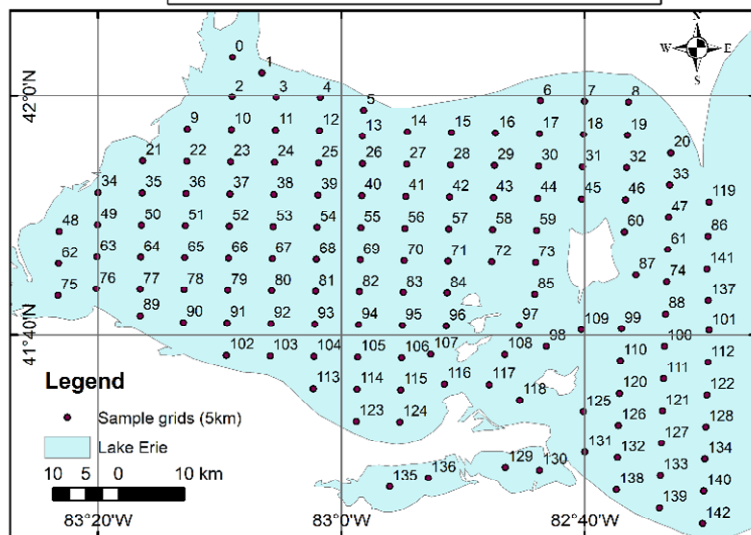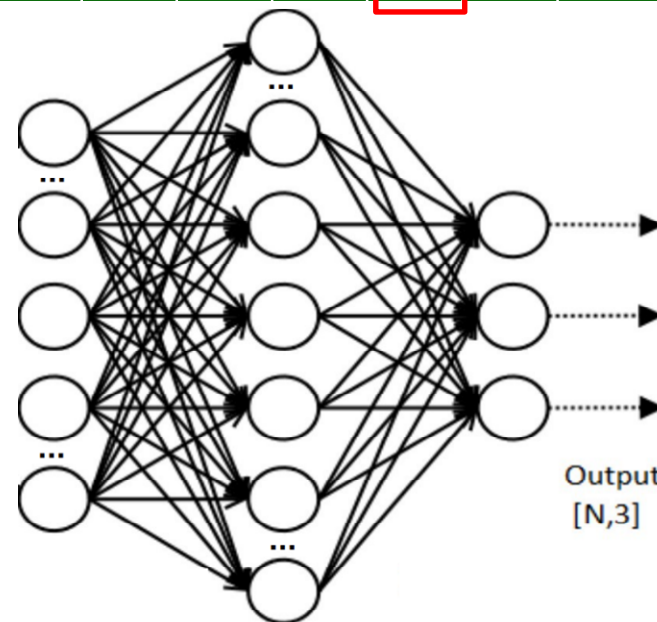
- Western Lake Erie (WLE); 143 grid points
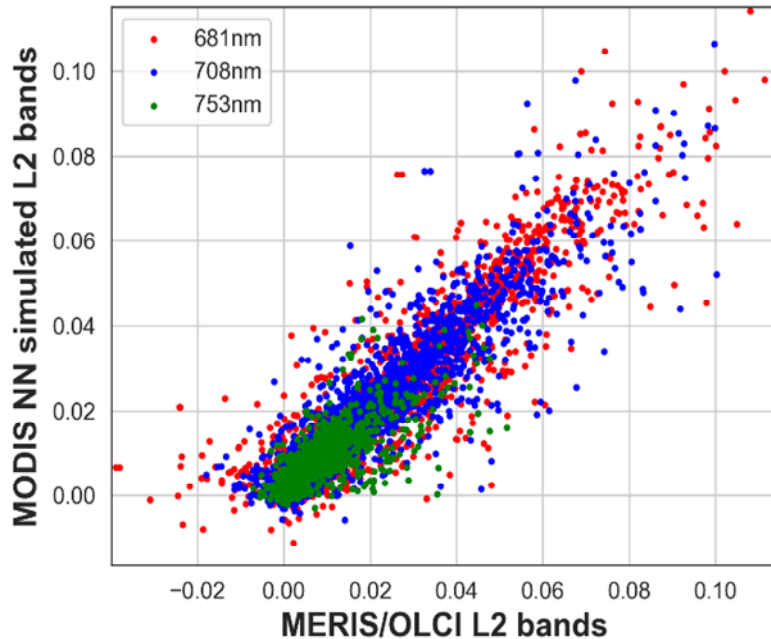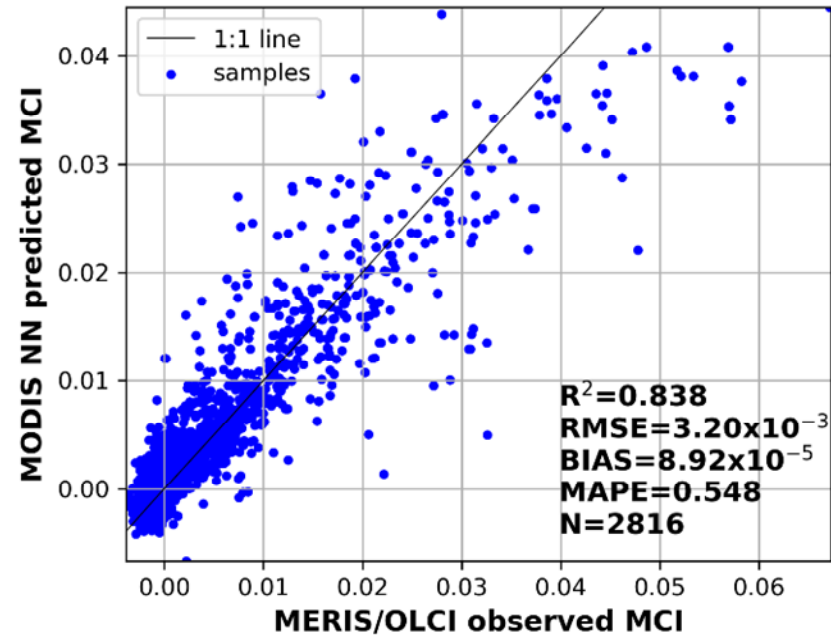- MODIS ρ_s : 39,086 and 40,226 samples in 2011 and 2017
- MERIS/OLCI L2: 16,099 and 12,091 samples; *matched 10k+*

MODIS NN training performance

(a) per band comparison
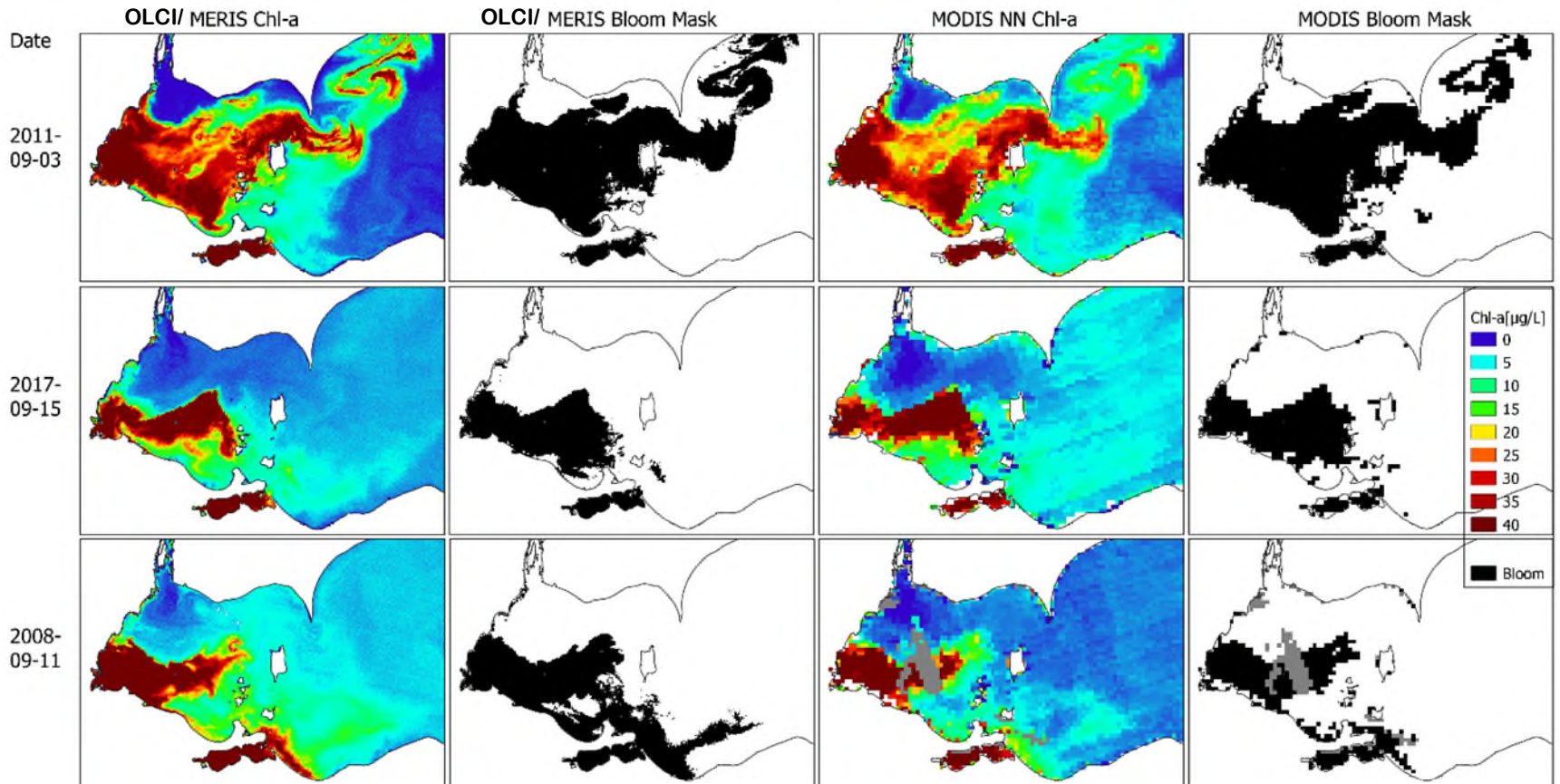

(b) derived MCI comparison

70% training + 30% test; different technical parameters experimented.

e.g., NN output: per band(x3) outperforms direct MCI (x1)

MODISNN also outperforms other MODIS chl models: MODIS 488/555, MODIS 748/667 and MODIS CI to be consistent with MERIS/OLCI MCI
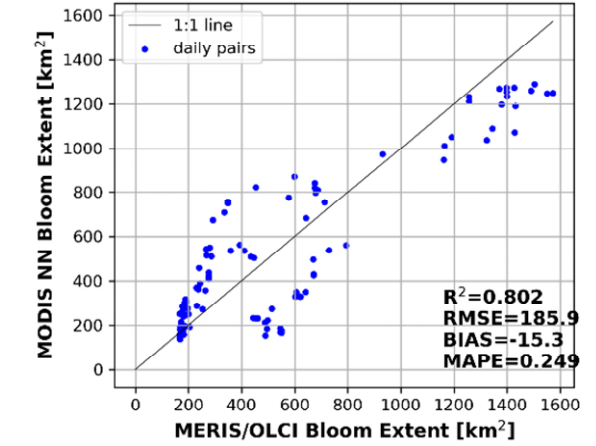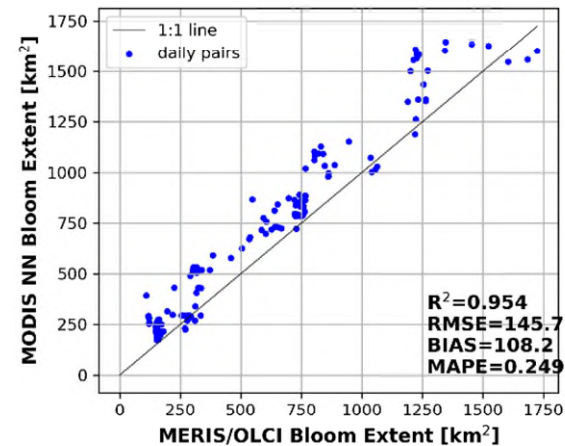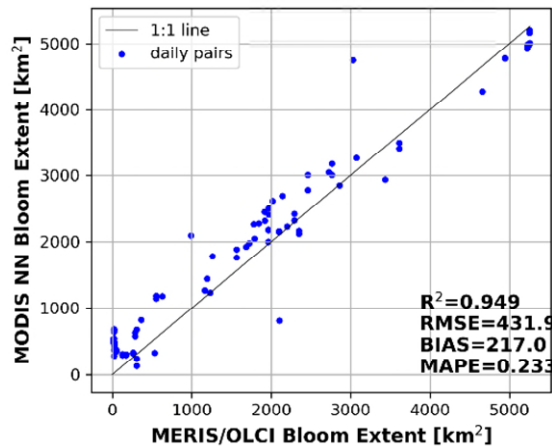
Saturated pixel processing? Mixed pixel along shore? …

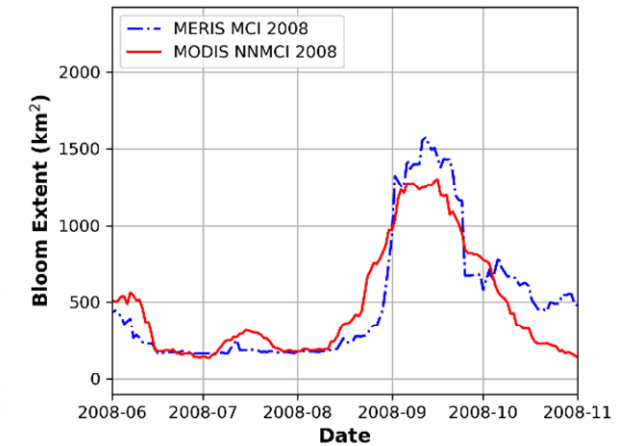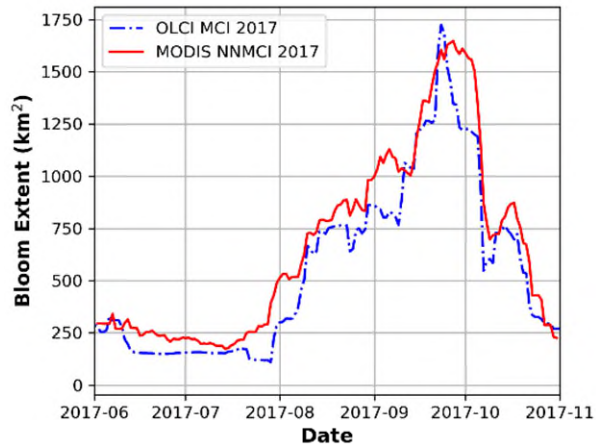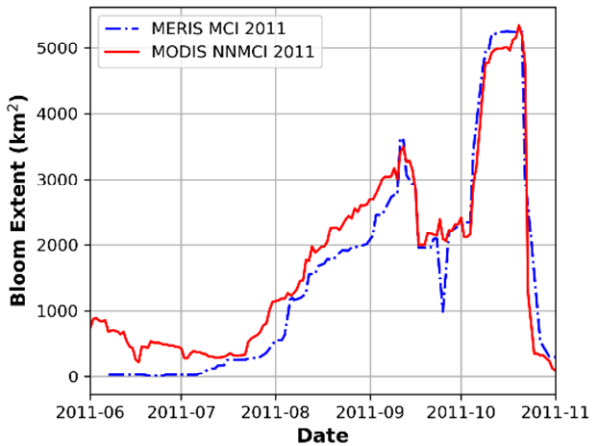# Result examples

Chlorophyll maps and bloom (*chl-a*>=10mg/m^3) extent masks

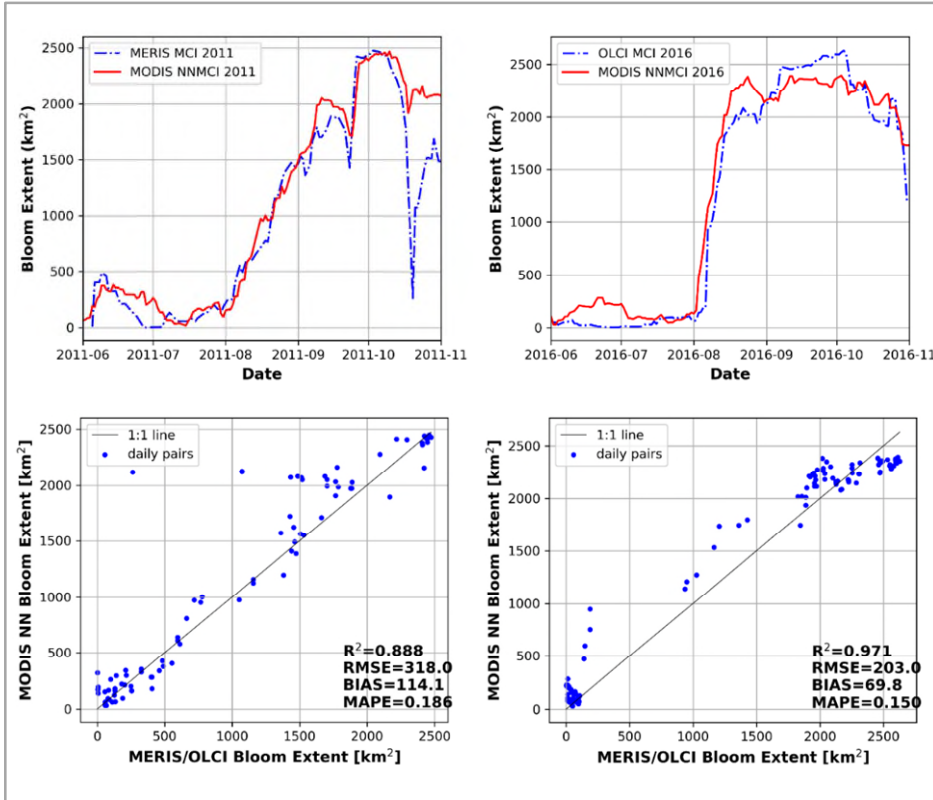spatial pattern, *observation time diff, spatial resolution*

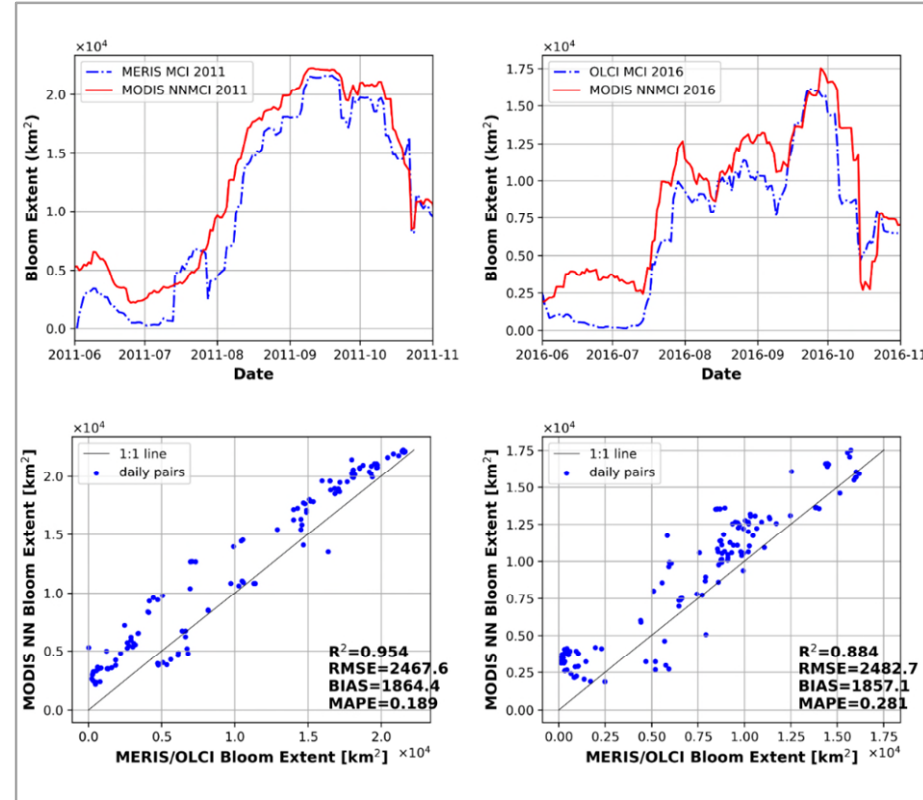# Bloom extent series comparison

Top: rolling 14 day averaged bloom extent compared between MODIS NN and MERIS/OLCI
Bottom: the scatter plot of the top row.

Bloom extent discrepancy caused by:
sensing time difference, MODIS image distortion (geometric and radiometric), etc

NN model transferability
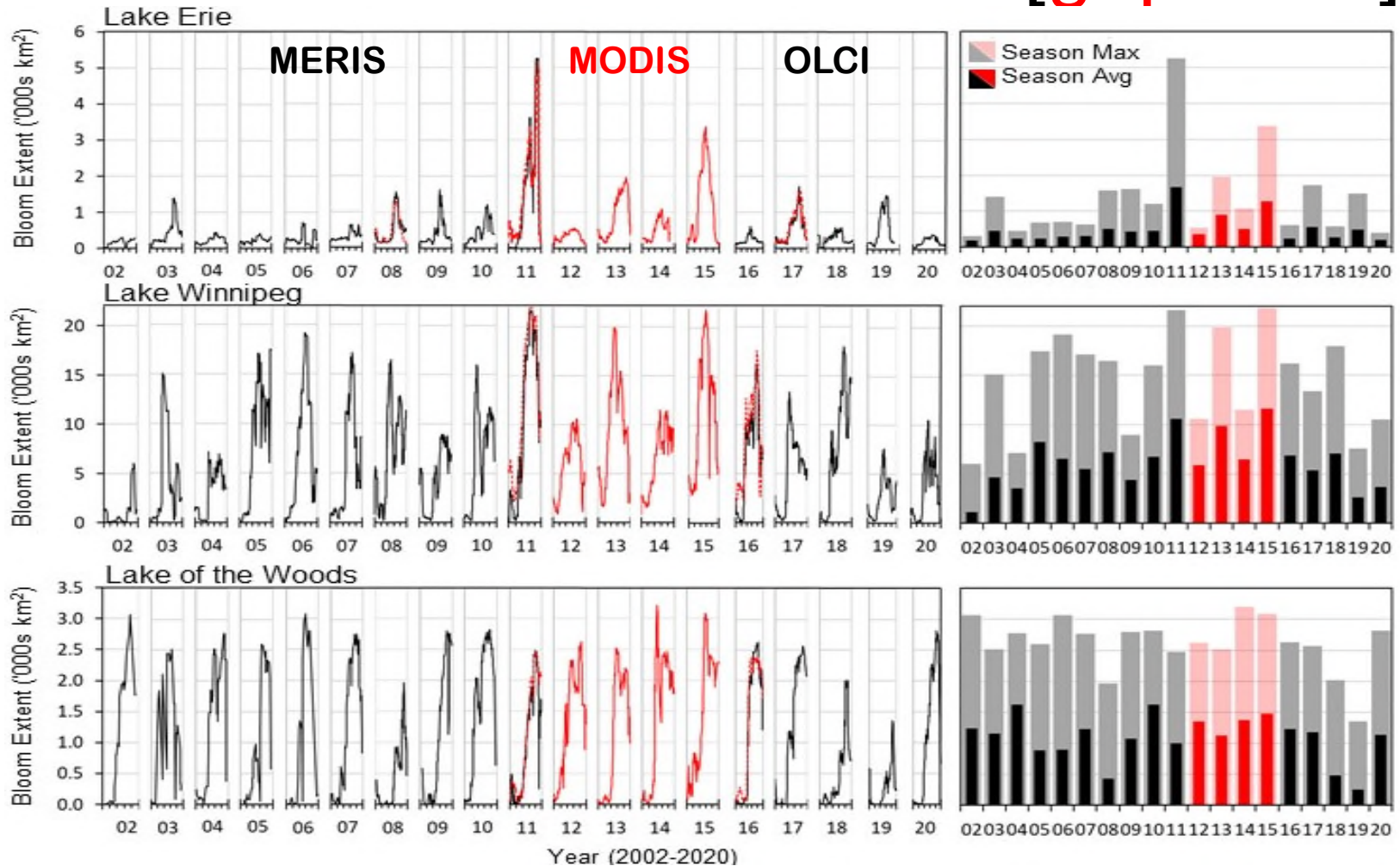

Lake of the Woods   Lake Winnipeg

NN model is consistent when transfer to other Canadian lakes
Each lake was trained separately

Time series of bloom extent [gap filled]

- Continuous bloom observation 2002-2021
- As a data source to support water management and science

Summary

- Observation gap of ESA sensors: MERIS (<2012) & OLCI (>2016)

- MODIS Aqua neural network (NN) to fill the sensing gap

- Performance evaluation from different perspectives

- Time series of algal blooms started from 2002

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**a manuscript with details of this work is under revision **