Modeling spatio-temporal variability of algal blooms using MODIS imagery of inland waters

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Objectives

This study is part of a project aiming to monitor past, present and future chlorophyll-a of inland waters using MODIS imagery downscaled to 250 m spatial resolution (MODIS-D-250). The objectives of my PhD study are:

1-To develop a **cloud mask** for water bodies (inland, coastal, and open ocean) based on a linear discriminant analysis algorithm using MODIS-D-250.
2-To establish a **regional portray** of algal bloom occurrence in Southern Quebec using a geospatial database describing bloom **phenology** (e.g. starting date, duration, intensity).
3-To develop a statistical model to **evaluate the predisposition** of lakes in developing algal blooms according to their physiographic and climatic characteristics.

1- From MODIS imagery to chlorophyll-a
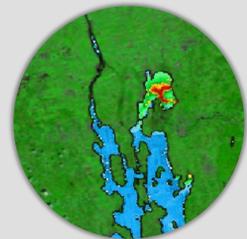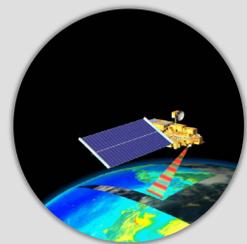
From 2000 to 2016

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①	**Downloading MODIS Level 1B product**	
②	**Pre-processing steps:** (1) Downscaling bands 3-7 from 500 m to 250 m spatial resolution (2) Re-projection (3) Atmospheric correction	Trishchenko (2006)
③	**Land mask:** Distinguishing water pixels from mixed (land-water) pixels	El Alem (2014)
④	**Cloud mask:** Detecting cloud/haze over water bodies containing optically active components	Ratté-Fortin (2017)
⑤	**Chl-a concentration:** Estimation at 250 m spatial resolution	El Alem (2014)

## 2- Algal bloom portray in southern Quebec

Spatial trend:

- The highest relative **frequency** of blooms is seen on lakes of the South-West shore of the St. Lawrence river, east of Montreal city.

Temporal trends:

- There is a significant increase in algal bloom **frequency** and **extent** in the majority of lakes in southern Quebec.

- Although not significant, there was an increase in the **duration** of blooms between 2000 and 2016 in the majority of lakes in southern Quebec.
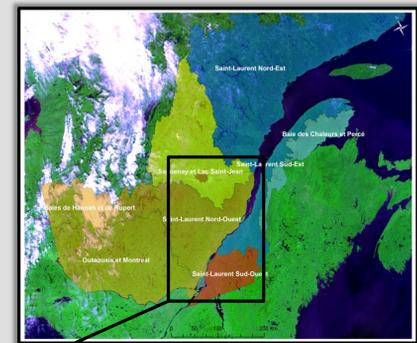
Temporal trends in algal bloom frequency between 2000 and 2016
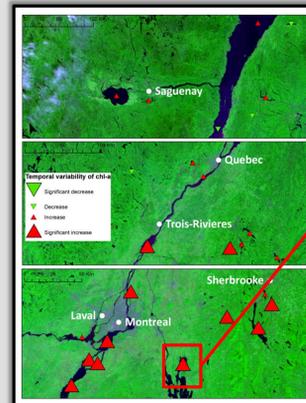
Results for the specific case of Missisquoi Bay of Lake Champlain: temporal trends in phenologic variables
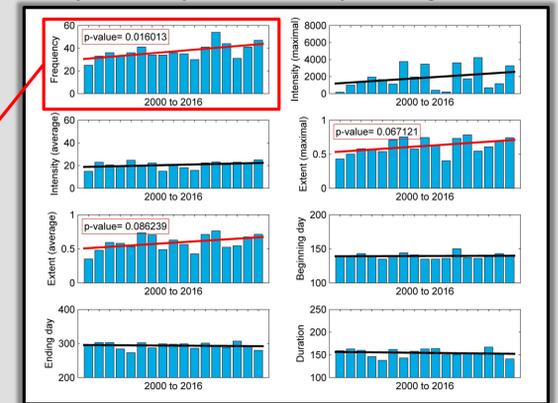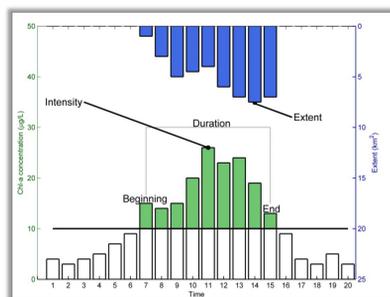

3- Links between algal blooms and physiographic, anthropic and climatic characteristics

A statistical model (copulas) will be developed to investigate the relationships between algal bloom **phenology** and **environmental characteristics**.

Phenologic database: Spatial = 1903 lakes, Temporal = 2000 to 2016

1) **Beginning:** Threshold used : $\frac{10\mu g}{L}$ (WHO, MSDEFCC)
2) **Duration:** Number of days between beginning and the ending days.
3) **Intensity:** Maximal concentration value between beginning and ending days.
4) **Extent:** Maximal extent between beginning and ending days.
5) **Frequency:** Number of bloom episodes per year.

Multivariate frequency analysis

Environmental database:

Temperature

Lake morphology
Watershed morphology

Precipitation

Land use

Demography
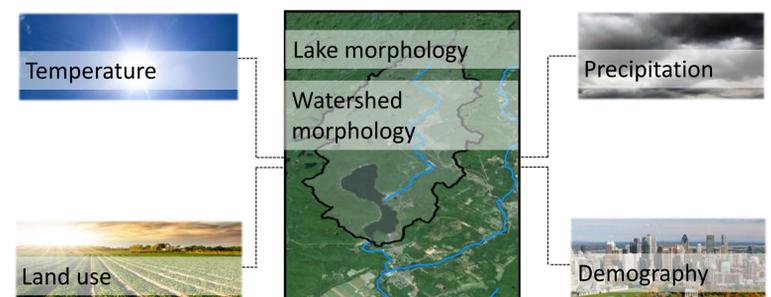
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