credit: NASA/Astronaut Ron Garan

Canadian Space Agency
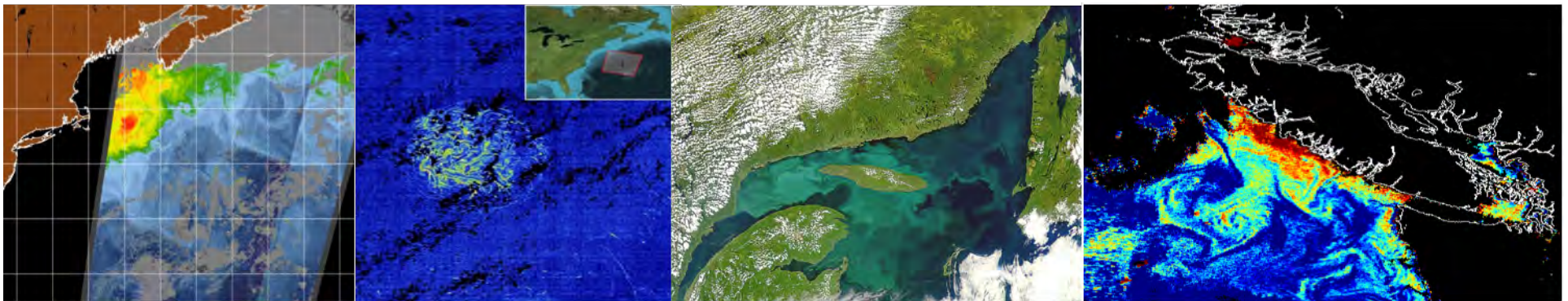## *Report on Ocean Colour Activities*
Martin Bergeron
Susanne E. Craig
Canadian Space Agency (CSA)

International Ocean Colour Science Meeting, 15-18 May 2017, Lisbon, Portugal

Canadian Space Agency Interest in Ocean Colour

- **To enable end-users to exploit ocean colour data** in support of fisheries management, ecosystem protection, coastal zone management, safety & national security, environment & climate.

- **National Co-ordination through NetCOLOR**
  - Canadian ocean colour co-ordination body (Chair: Susanne Craig);
  - Supported by CSA & MEOPAR (Canadian funding body);
  - Facilitates co-ordination of research efforts, training of young scientists, development of ocean colour applications for societal benefit.

- **International Co-ordination through IOCCG;**

- **Canadian Space Strategy (June) to be followed by a Long Term Implementation Plan**

Canadian Ocean Colour Activities – Arctic

Marcel Babin, Université Laval
Canada Excellence Research Chair (CERC) in Remote Sensing of Canada's new Arctic Frontier

| Sentinel North
Harnessing the power of light for the benefit of human health, the environment, and sustainable development in the North

Scientific Directors: Marcel Babin & Yves De Koninck

- CAD $98M, 7 years to Université Laval;
- To optically sense environment & health in the North;
- New miniature sensors for marine environment (e.g. UAVs);
- Activities started late 2016.

Canadian Ocean Colour Activities – Lakes & Nearshore

NSERC Canadian Lake Pulse Network
PI: Yannick Huot, Sherbrooke University

- Study of 680 lakes in 11 ecozones;
- Assess health of Canadian lakes (stressors & biogeochemical functioning;
- Forecast future changes;
- Develop new observational approaches – **remote sensing.**
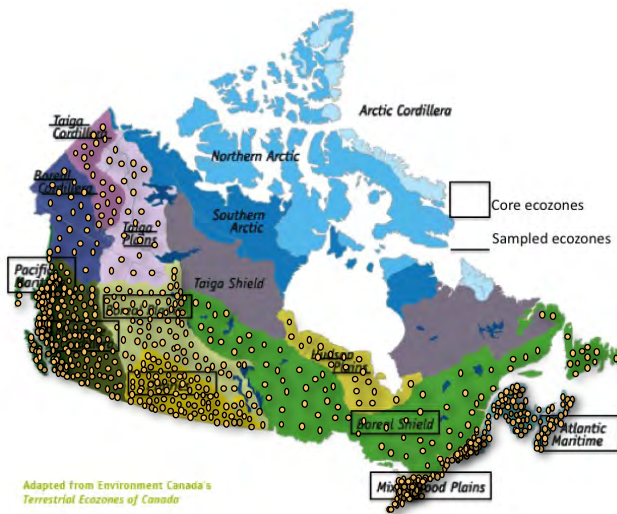
Distribution of lakes in the study

Environment & Climate Change Canada (ECCC)
Caren Binding, Yi Lou

Water Quality
- Early detection, monitoring & forecasting of HABs;
- Understanding biogeochemical processes (DOM, whiting events, sediment…);
- Support of logistically difficult field science.

% Days (May-Oct) Max Chlorophyll
0   10   30   40   50

HICO
Aug 19, 2013

ALD620
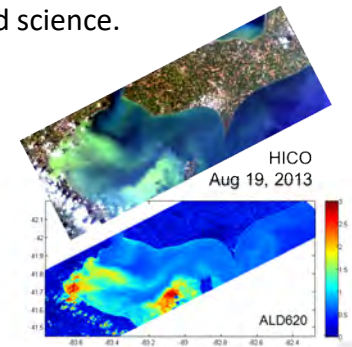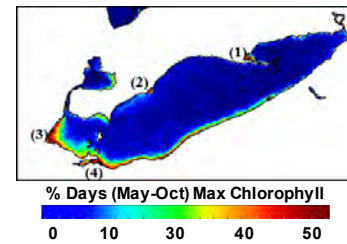
Marine & Ice Services
- Integrated Satellite Tracking of Pollution (ISTOP);
- Differentiating oil from algae, oil slick thickness;
- Coastal & inland lake ice detection.

VIIRS shows solid fast ice & the gradient in thickness & concentration

Oil slick and algae in MODIS imagery

Canadian Ocean Colour Activities - Coastal

Maycira Costa, University of Victoria, SPECTRAL Remote Sensing Laboratory

- Autonomous data acquisition from ferries – Ferry Ocean Colour Observation Systems (FOCUS);
- In situ above-water R_{rs} for satellite validation & model development: Sentinel-3, MODIS & VIIRS;
- Chl phenology & salmon health;
- Bloom initiation.
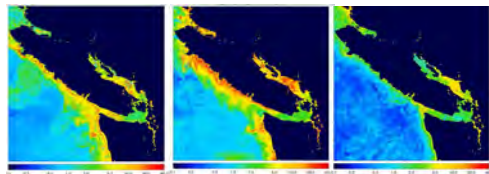
*Bloom Initiation Salish Sea 2002-2016*

Susanne Craig, Dalhousie University

- NASA PACE Science Team –algorithm development for optically complex waters;
- Project scientist North Atlantic Aerosols & Marine Ecosystems Study (NAAMES) – phytoplankton trace gases & atmospheric chemistry;
- Harmful algal blooms;
- Glider studies of bio-optical properties.
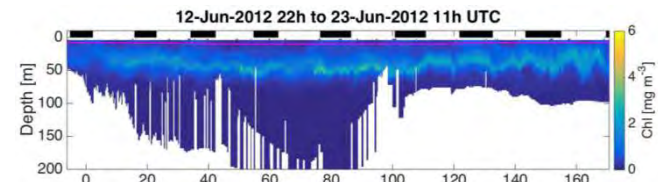
Chl fluorescence glider transects across the Scotian Shelf. *Ross et al., 2017, JMS, 172, 118-127*
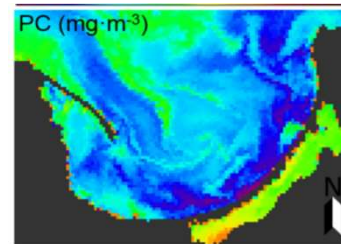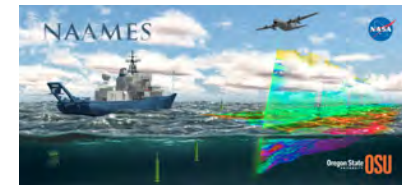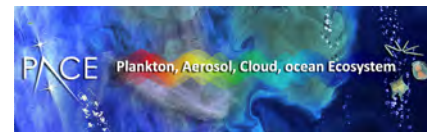
Phycocyanin concentration in the Baltic Sea. *Soja-Woźniak et al., 2017, Remote Sensing, 9, 343*

Canadian Ocean Colour Activities – Technology & Science

Technological Innovation

Marlon Lewis, Seabird Scientific/Dalhousie University

- Co-Investigator: Design and fabrication of profiling hyperspectral radiometers for vicarious ocean colour calibration/validation.


HYPERNAV float

SEA-BIRD SCIENTIFIC

OC for Monitoring and Operational Science

Fisheries & Oceans Canada, Bedford Institute of Oceanography, Emmanuel Devred

- Bio-optical documentation of coastal and pelagic environment;
- Archive and distribution of OC and SST products;
- Phytoplankton ecology in support of ecosystem-based approach to fisheries management;
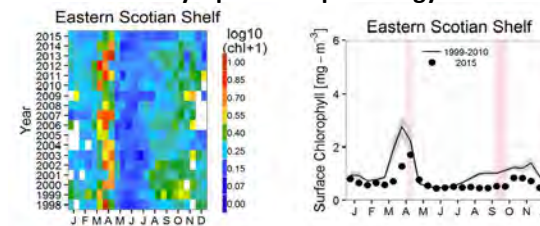- Coastal water transparency, harmful algal blooms.

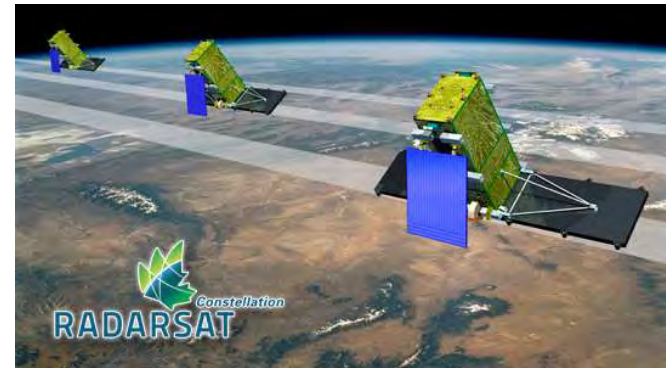**Absorption budget for NW Atlantic**
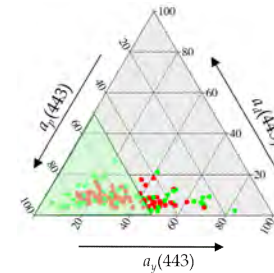
Processing of OC data products
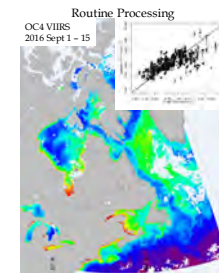
Phytoplankton phenology

Canadian Space Agency Satellite Missions

RADARSAT Constellation Mission (RCM)
- Flagship satellite mission: 3-satellite configuration;
- Daily access to 90% of the world's surface;
- Launches in 2018;
- SAR Data Continuity beyond RCM being considered.

Future Mission: Coastal Ocean Colour Imager (COCI)
- The COCI Mission addresses the need for observations of coastal & aquatic systems, and their response to climate- and anthropogenically-driven forcers, at a ***spatial, spectral & temporal resolution not currently available from existing sensors***
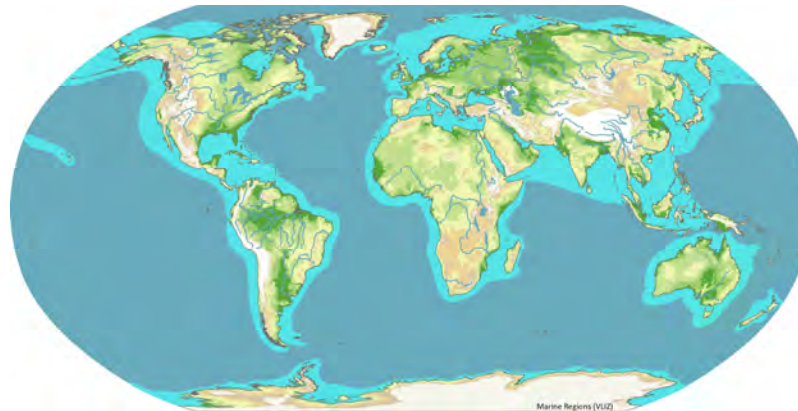
~150+ M km² of land area, 300 M km² of imagery (Excluding Antarctica)

Global coastal & inland areas of interest

Coastal Ocean Colour Imager (COCI)

- Designed to sample coastal oceans, estuaries & lakes, globally at 100m scale;
  - In collaboration with NRL - Builds on HICO heritage

- Hyperspectral coverage of the entire Canadian territory (including land) every 8 days;

- Revisit time of <3 days over Canadian waters;

- Including dedicated atmospheric payload;

- Low stray light, glint & polarization sensitivity;

- Phase 0 complete.

PARAMETER	VALUE
Swath width (@675 km altitude)	240 km
GIFOV at nadir (@675 km altitude)	100 m × 100 m
Ground Sampling Distance at nadir (GSD)	Across-track: 100 m Along-track: Sampled at 50 m then binned to 100 m
Spectral range	360 nm to 910 nm
Spectral sampling interval (raw)	1.25 nm
Spectral sampling interval (4 bins)	5 nm
Peak SNR (PACE LTypical, for 10 nm sampling, 100 m × 100 m)	900 :1 @ 450 nm
Estimated Enveloppe (excluding gimbal)	HSI: 37 cm × 80 cm × 112 cm DHCU: 23 cm × 33 cm × 17 cm
Estimated mass (excluding gimbal)	HSI: 57 kg DHCU: 19 kg
Estimated power (excluding gimbal)	45 W OAP
Data rate when imaging (100 m and 5 nm assuming 2:1 compression)	169 Mbits /s

Products	Examples
Core Optical Variables	Radiometric quantities, IOPs, AOPs
Phytoplankton Pigment Concentrations	Chl, accessory pigments, carotenoids
Phytoplankton Characteristics	Phyto C, taxonomic/functional groups, Chl fluorescence
Particle Population Characteristics	SPM, POC, PIC, PSD
Photobiochemical Characteristics	DOC, CDOM fluorescence, MAAs, phycobiliproteins
Production	NPP, NCP, nutrients
Fluxes & Ecosystems	C export, air-sea CO_2 exchange, land-ocean material exchange
Ice	Sea ice, ice on/off, iceberg
Bathymetry	Bathymetry
Dynamics	Plumes, effluents, waves, sea state
Bottom Type Analysis	Bottom type & composition
Surface Pollutants	Oil, toxic chemicals
Shore & Littoral Zone Analysis	Beach characterization, coverage, soil type
Vessel Analysis	Ship detection & identification

COCI Next Steps

- Breadboarding activities underway
  - Full spectrometer breadboard including the procurement of FPAs;
  - Technology development to continue for 18-24 Months.

Canadian National Research Council Falcon aircraft

- Airborne demonstration campaigns
  - Two aircraft campaigns planned to perform a technology demonstration ITRES-built instrument (WISE) developed under the Space Technology Development Program (STDP);
    - Representative of expected performance of COCI instrument.
  - Deployment platform: Falcon / Twin Otter aircraft;
  - Expected to take place in 2018 and 2020. Call for proposals Sept 2017;
  - Located in 2 priority regions identified by Users & Science Team based on relevance to Canadian researchers and partners.

- Partnership being sought for cost-effective access to space.

Invitation to attend the Earth Observation Summit

The Earth Observation (EO) Summit 2017 brings together in one exceptional event the 38th Canadian Symposium on Remote Sensing (CSRS), the 17th Congress of the Association Québécoise de Télédétection (AQT), the 11th Advanced SAR (ASAR) Workshop and the 51st Workshop of the Association de Géomatique Municipale du Québec (AGMQ). This EO Summit 2017 is an international event to be held in Montréal from 20 to 22 June 2017. It aims to assemble several communities interested in Earth Observation (EO), its technologies, its applications and its societal benefits.