# Arctic-COLORS — Coastal Land Ocean Interactions in the Arctic

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***Arctic-COLORS is a proposed NASA Field Campaign project that aims to improve understanding and prediction of land-ocean interactions in the rapidly changing Arctic coastal zone, and assess vulnerability, responses, and feedbacks of coastal ecosystems, communities, and natural resources to current and future pressures.***

## Why the Coastal Arctic?

- Significant increase in summer SST ast 50 years
  - Substantial reduction in sea ice coverage and ice season length.
- Increasing Primary Productivity and changing food web dynamics
- Permafrost is thawing
  - 1672 Petagrams of organic carbon stored in Arctic permafrost globally (feedbacks to climate)
- Changing flows in Arctic rivers
- Substantial Coastal Erosion
  - 17-20 m/yr in most exposed Beaufort sites
  - 0.3 m/yr in Chukchi Sea sites
- Ocean acidification of Arctic seas
- Extreme biophysical changes
- Arctic ecosystems shifting from benthic- to pelagic-dominated
- Consequences for Arctic wildlife and human populations

## Why NASA?

- Remote sensing (RS) from satellite and airborne platforms are essential for capturing the spatial and temporal variability of the Arctic coastal study domain (past and present).
  - NASA has the satellites, airplanes, airborne sensors and RS data processing and distribution capability to enable Arctic-COLORS.
- The development/parameterization and robustness of models necessary to address the goals of Arctic-COLORS will be accelerated with NASA remote sensing observations.
- Synergies with ABoVE and other NASA field campaign and modeling programs.

### Science Team

| Name | Institution | Name | Institution |
|---|---|---|---|
| **Carlos Del Castillo** | NASA GSFC | **David Kirchman** | U. Delaware |
| **Marjorie Friedrichs** | VIMS | **Diane Lavoie** | Fisheries & Oceans Canada |
| **Peter Hernes** | UC-Davis | **Bonnie Light** | U. Washington |
| **Antonio Mannino** | NASA GSFC | **James McClelland** | U. Texas / MSI |
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| **Joseph Salisbury** | UNH | **Irina Overeem** | U. Colorado |
| **Maria Tzorziou** | CCNY | **Chris Polashenski** | U.S. Army Corps of Engineers |
| **Matthew Alkire** | U. Washington | **Michael Rawlins** | U. Massachussetts |
| **Marcel Babin** | U. Laval | **Rick Reynolds** | Scripps/ UCSD |
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| **Eddy Carmack** | Fisheries & Oceans Canada | **Robert Striegl** | USGS |
| **Lee Cooper** | UMCES/ CBL | **James Syvitski** | U. Colorado |
| **Susanne Craig** | Dalhousie University | **Suzanne Tank** | U. Alberta |
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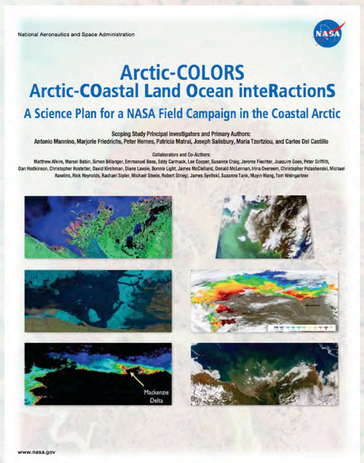
| **Joaquim Goes** | Lamont-Doherty | **Tom Weingartner** | U. Washington |
| **Peter Griffith** | SSAI/ GSFC | Paula Bontempi | NASA HQ |
| **David Kirchman** | U. Delaware | | |

**Potential Partners** (to be explored further):

- Canada (Polar Knowledge, Sentinel North, etc.)
- Other NASA Programs, NSF, NOAA, BOEM, USGS, etc.
- International partners (Pan-Arctic: EU, Japan, Korea, etc.)

**REVISED Science Plan submitted Jan. 2018**




**Science Plan currently in Peer Review**

## Overarching Science Goal

**To quantify the coupled biogeochemical-ecological response of the Arctic nearshore system to rapidly changing terrestrial fluxes and ice conditions.**

## Science Themes

I. **Effect of land on nearshore Arctic biogeochemistry**
(rivers, thawing permafrost, coastal erosion)

II. **Effect of ice on nearshore Arctic biogeochemistry**
(snow, landfast ice, sea ice)

III. **Effects of future change (warming land and melting ice) on nearshore Arctic biogeochemistry**
(seasonal and interannual first, then future scenarios /predictions)

## Science Questions

**I. Effect of land on nearshore Arctic biogeochemistry**

- How do freshwater carbon, nutrient, and sediment fluxes to the coastal zone change as a result of:
  - changing riverine and groundwater inputs?
  - passage through estuaries and gradients?
  - coastal erosion and thawing permafrost?
- How do these changing fluxes affect nearshore Arctic biogeochemical and ecological processes?
- How has the relative magnitude of inputs from rivers and coastal erosion changed across the nearshore Arctic seasonally and interannually?

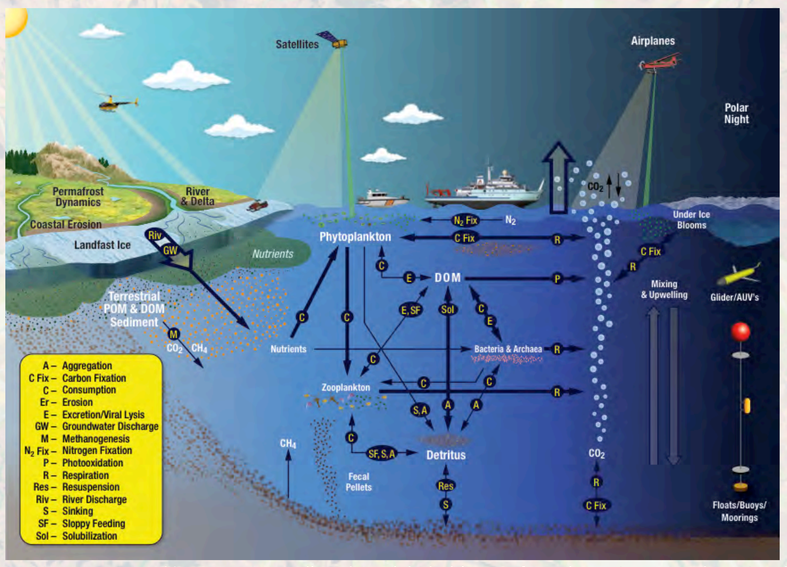
**II. Effect of ice on nearshore Arctic biogeochemistry**

- How does flow alteration/channeling by morphological ice conditions impact terrestrial fluxes into, and attenuation within, the nearshore Arctic?
- How does the coastal snow/ice cover impact nearshore Arctic biogeochemical processes by controlling rates of mixing and by modulating light availability?
- How does the timing of sea ice formation/retreat, duration of sea ice cover and ablation, snow accumulation, and the morphology of the coastal ice zone influence nearshore Arctic biogeochemical and ecological processes?

**III. Effects of future change (warming land and melting ice) on nearshore Arctic biogeochemistry**

- On seasonal and interannual timescales, how will changing land (Question 1) and melting ice (Question 2) impact nearshore Arctic biogeochemical and ecological processes?
- On interdecadal timescales, how will changing land (Question 1) and melting ice (Question 2) impact nearshore Arctic biogeochemical and ecological processes?

## Integrative Observational Approach

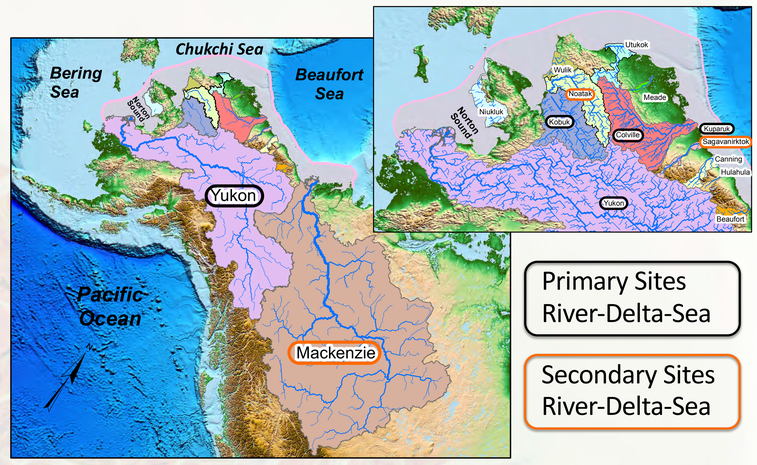



Processes represented by arrows as well as those labeled (permafrost dynamics, coastal erosion, landfast ice, etc.) will be examined at the interface of river estuaries and deltas with the coastal ocean. Larger and thicker arrows and text represent the higher priority processes and biogeochemical state variables.

## Where? When? What?

### *WHERE?*

From the Yukon Delta to the Mackenzie Delta, from the head of tidal influence to the coastal shelf (pink-shaded coastal region on map)




### *WHEN?*

The proposed timeline for Arctic-COLORS is 2021-2031,
(i) to overlap with NASA's ocean color mission PACE, and
(ii) to overlap with 3rd phase of NASA's ABoVE program to benefit from ABoVE's results and possible follow-on activities, thus linking processes in the Arctic coastal oceans and terrestrial ecosystems.

### *WHAT?*

**Intensive sampling and process experiments** will be conducted **from river mouths to near-shelf** of the Yukon, Mackenzie and a select number of small rivers (Map 1) plus coastal erosion sites.

**Core process measurements** will include: Primary production, assimilation/grazing, community respiration, aggregation/ flocculation, photochemical and bacterial transformation of organic matter.

**Complete seasonality: continuous year-round measurements** with floats, buoys, moorings, AUVs, satellites, … weather and ice permitting. Intensive process studies during key months (plus airborne remote sensing)

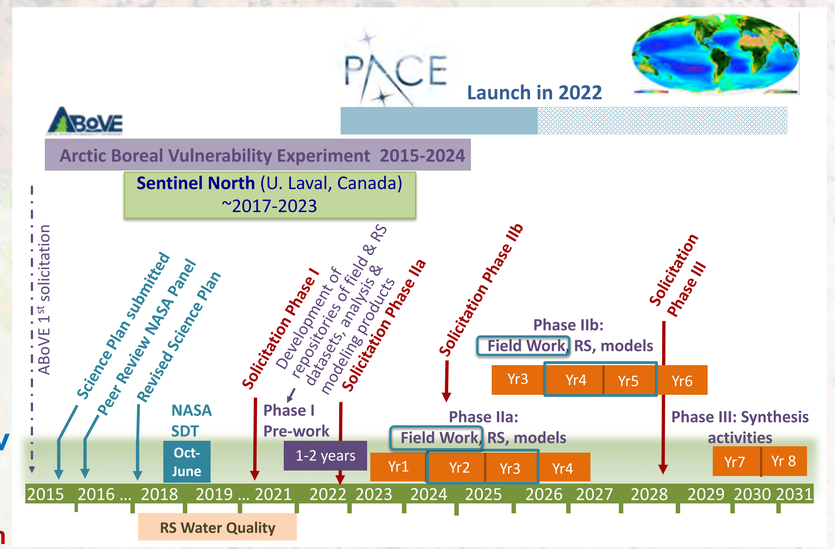
**Survey studies** undertaken along and across the continental shelf to
(1) Assess spatial heterogeneity across different shelf regions,
(2) Determine interactions and teleconnections between the outer shelf and shallow shelf regions occupied during the process studies,
(3) Evaluate model simulations across temporal and spatial scales,
(4) Permits scaling up using remote sensing observations

*Timing*: July-August and September-October

| Early March | May-June | July | September | October |
|---|---|---|---|---|
| • End of winter condition | • Peak river discharge<br>• Ice breakup<br>• Under ice blooms | • Under ice blooms<br>• Increasing biological & photochemical activity | • Max open water/min sea ice<br>• Low river discharge<br>• Pre-conditioning of systems prior to winter<br>• Peak respiration late Sept-early Oct | • Freeze-up period |

- Diverse approaches proven to be effective in the Arctic for **year-round measurements and sampling**
  - Ice camps, ATVs, sleds (lower river, delta, landfast ice)
  - Small boats and small ships (lower river to nearshore)
  - Medium and large icebreakers (nearshore to outer shelf seas)
    - Deployable small vessels for shallow-water & near ice work
  - Helicopter-enabled sampling
  - Moorings, floats, buoys, gliders and other autonomous vehicles
  - Airborne and satellite remote sensing

## Notional Observational Program Timeline




| Scoping Study Timeline | 2014 | | | | 2015 | | | | 2016 | | | | 2017 | | | | 2018 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Town Halls & Presentations | | | | | | | | | | | | | | | | | | | | |
| Scoping Study Workshops | | | | | | | | | | | | | | | | | | | | |
| Refine Science Questions & Plan | | | | | | | | | | | | | | | | | | | | |
| Drafting of Scoping Study Report | | | | | | | | | | | | | | | | | | | | |
| Posting of Draft Report - 30 days | | | | | | | | | | | | | | | | | | | | |
| Submission of Report to NASA | | | | | | | | | | | | | | | | | | | | |
| NASA Posting of Report - 30 days | | | | | | | | | | | | | | | | | | | | |
| NASA Review Panel | | | | | | | | | | | | | | | | | | | | |
| Revision of Science Plan | | | | | | | | | | | | | | | | | | | | |
| Science Plan Submission to NASA | | | | | | | | | | | | | | | | | | | | |
| NASA Review Panel 2nd round | | | | | | | | | | | | | | | | | | | | |
| SDT Develops Implementation Plan | | | | | | | | | | | | | | | | | | | | |

**Programmatic questions & feedback are referred to**
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