FORTE

NASA EARTH VENTURE SUBORBITAL MISSION

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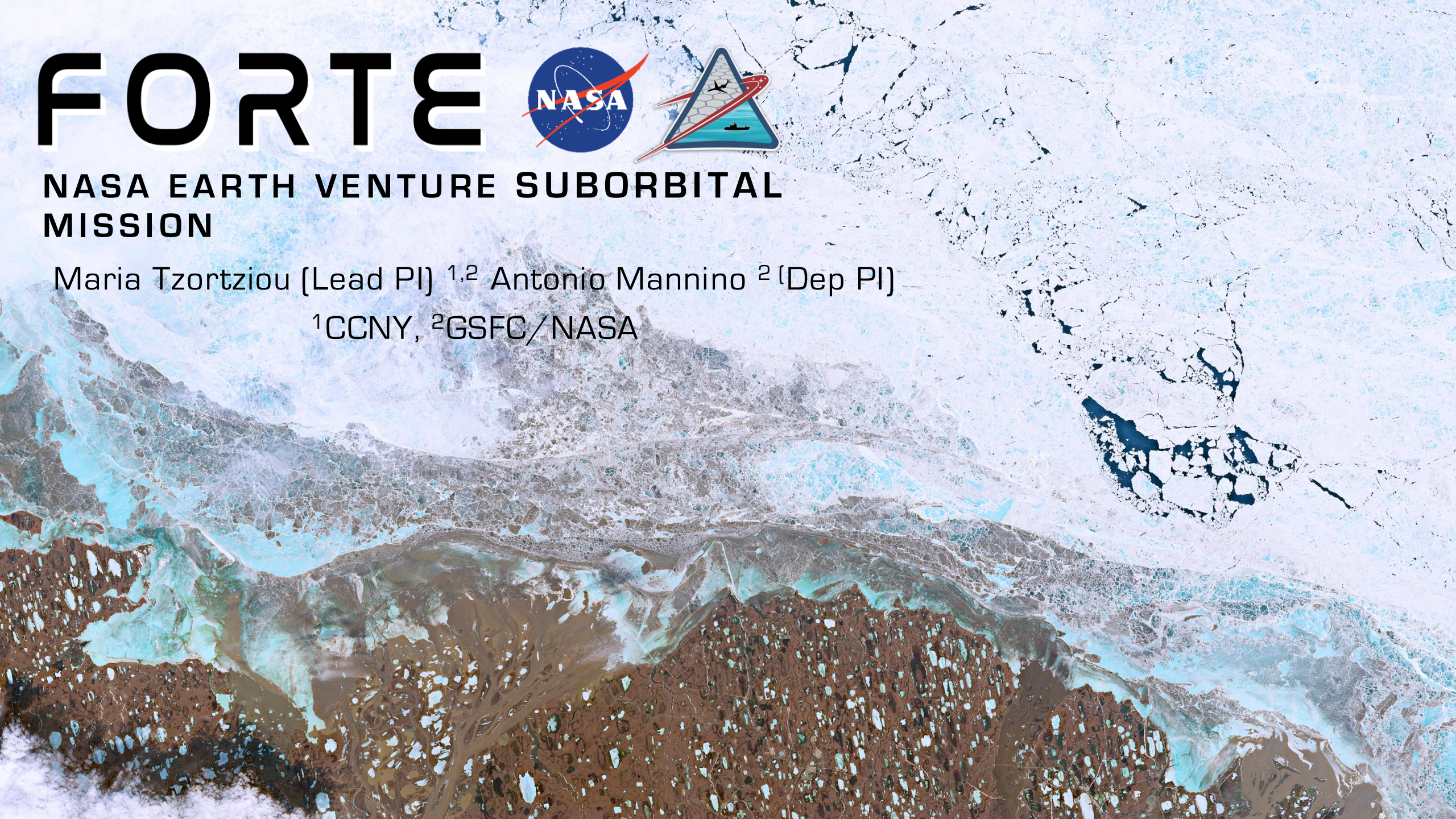


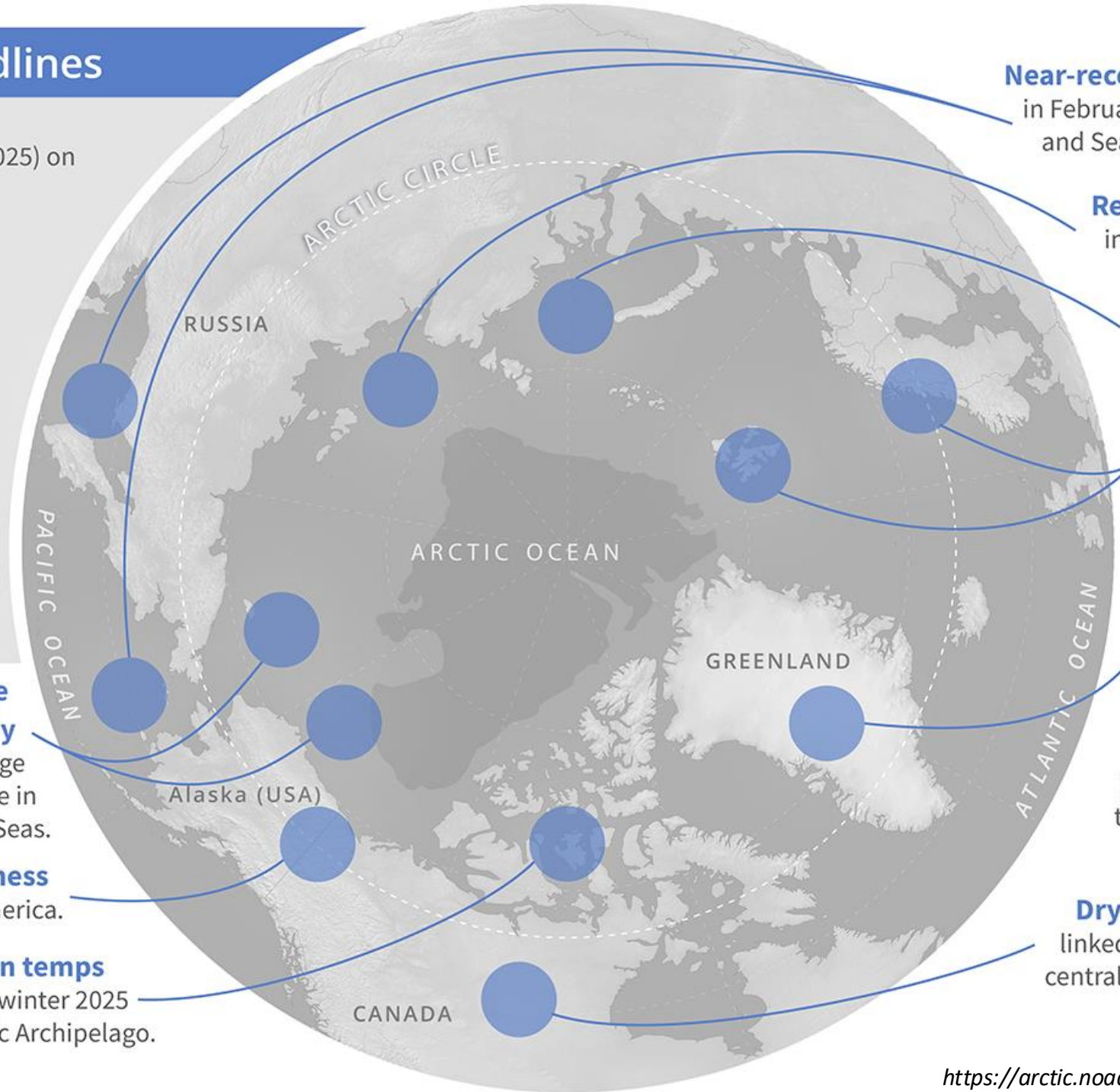
2025 Arctic-wide headlines

Record setting temperatures:
Warmest water year (Oct 2024–Sep 2025) on record.

Extreme precipitation:
Highest annual amount for Oct 2024-Sep 2025 and wettest spring on record.

Large swings in snow cover:
Peak seasonal snowpack was above average Arctic wide, while June experienced rapid snow loss.

Record low winter sea ice:
The lowest annual maximum extent in the 47-year satellite record observed in March.



Near-record low sea ice extent
in February and March in Bering Sea and Sea of Okhotsk.

Record low sea ice extent
in May in Laptev Sea.

Warmest sea surface temperatures on record
in August in Kara Sea.

Glacial thinning largest on record
during mass balance year of 2023/24 in Arctic Scandinavia and Svalbard.

Greenland temperatures
above average in spring with records at Summit Station in May, while summer temperatures close to average.

Dry summer conditions
linked to forest fires in central Canada.

Lower-than-average primary productivity
aligned with higher-than-average summer sea ice coverage in Chukchi and Beaufort Seas.

Record high tundra greenness
observed across North America.

Record autumn temps
in 2024 that persisted into winter 2025 in Canadian Arctic Archipelago.

https://arctic.noaa.gov/report-card/report-card-2025/

The Challenge

Accelerating changes - **in Arctic ocean and land resources, river flows, biodiversity, extreme events, erosion, and infrastructure** - are of key concern to **local communities, industrial development, and economic prosperity in the region and globally.**

Yet, the **coastal Arctic – this dynamic and transitional *continuum* of ecosystems that connect land to sea - remains largely unexplored and unchartered**, due to the remoteness, harshness, and extreme conditions that characterize this region.

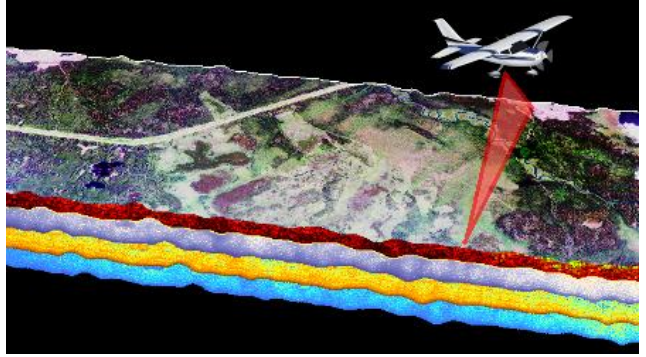
Advanced, multi-disciplinary, multi-platform observing technologies are key enablers for exploring this rapidly changing frontline.

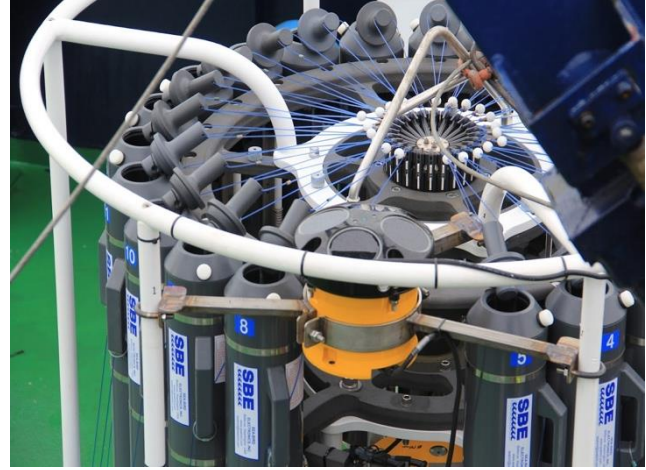
The Mission

FORTE is a recently selected NASA Earth Venture Suborbital (EVS-4) Mission that will apply **cutting-edge ocean observing technologies and state-of-the-art models** to explore the remote and rapidly transforming ecosystem of the coastal Alaskan Arctic and how environmental change is impacting this region *and beyond*.

Key elements in FORTE:

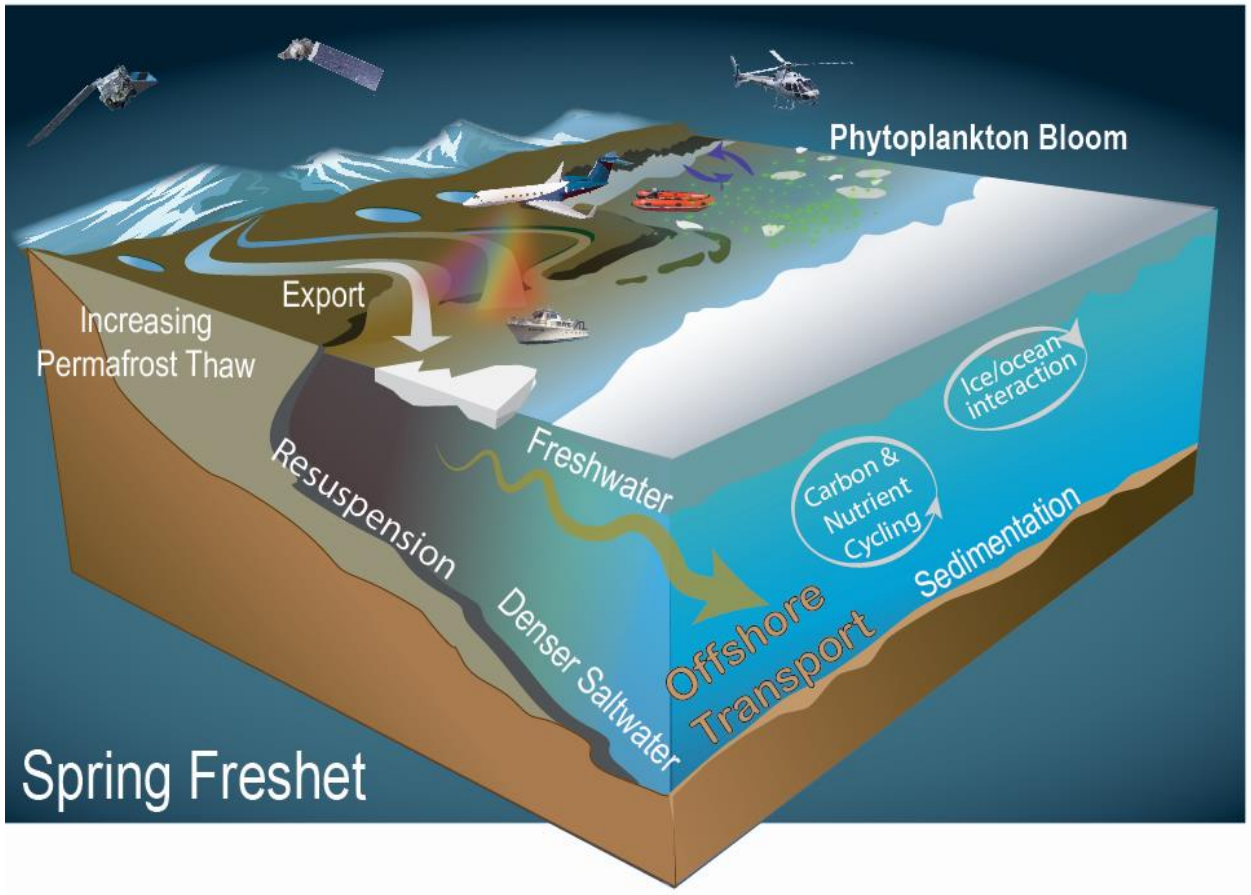
- Novel airborne & satellite **remote sensing technologies**
- Critical measurements from **high-tech research vessels**
- **Numerical Models and AI Tools**
- Helicopter deployments of teams and instruments into ***conditions rarely measured***
- **Autonomous** surface, underwater, airborne platforms
- International and local **collaborations**

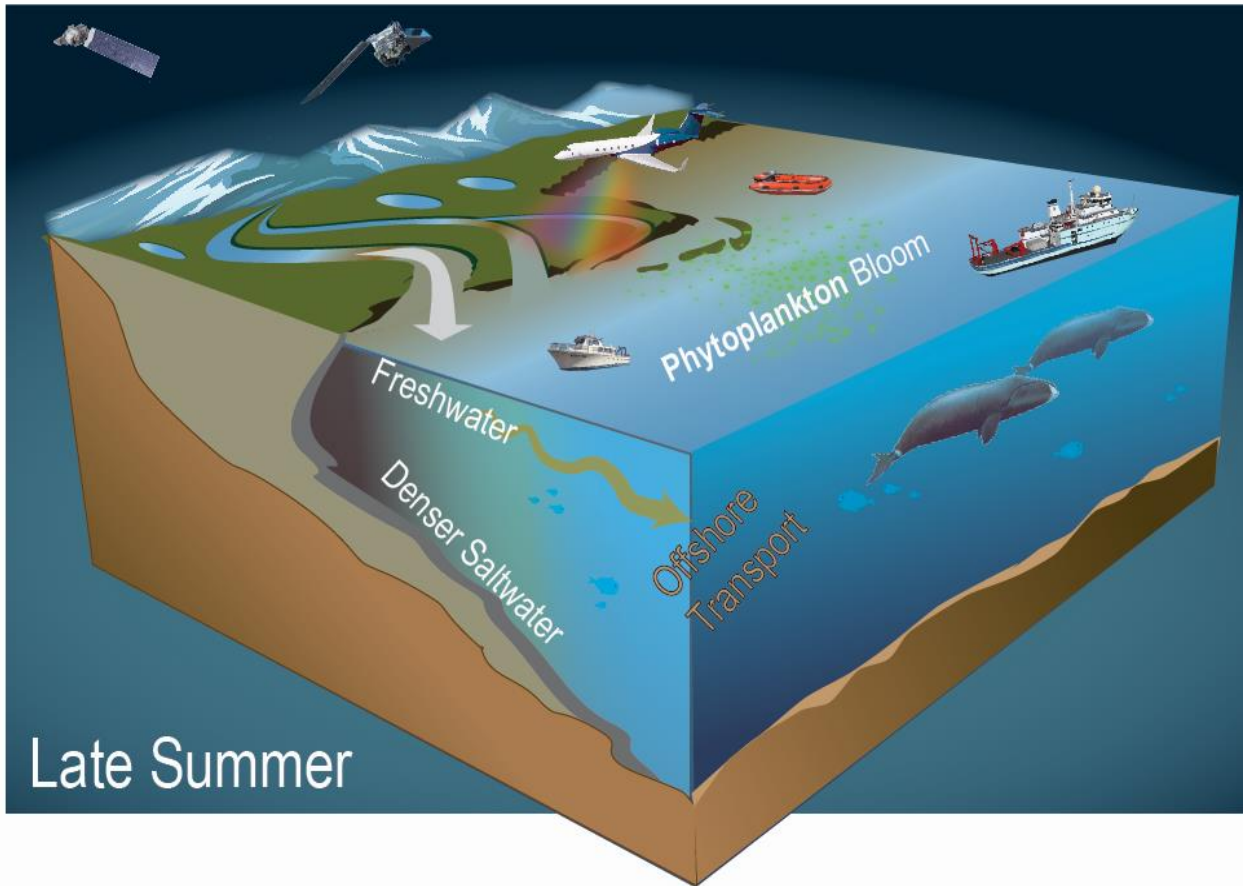




Overarching Questions in FORTE

How do nearshore Arctic ecosystems, from ***lower watersheds to coastlines and adjacent seas****, respond to* ***changes in the mobilization, magnitude, composition, and seasonality*** *in land-ocean fluxes (freshwater, heat, carbon, sediment and nutrients)* ***and what are the implications for local marine resources, coastal communities and industries, as well as larger scale ocean processes?***





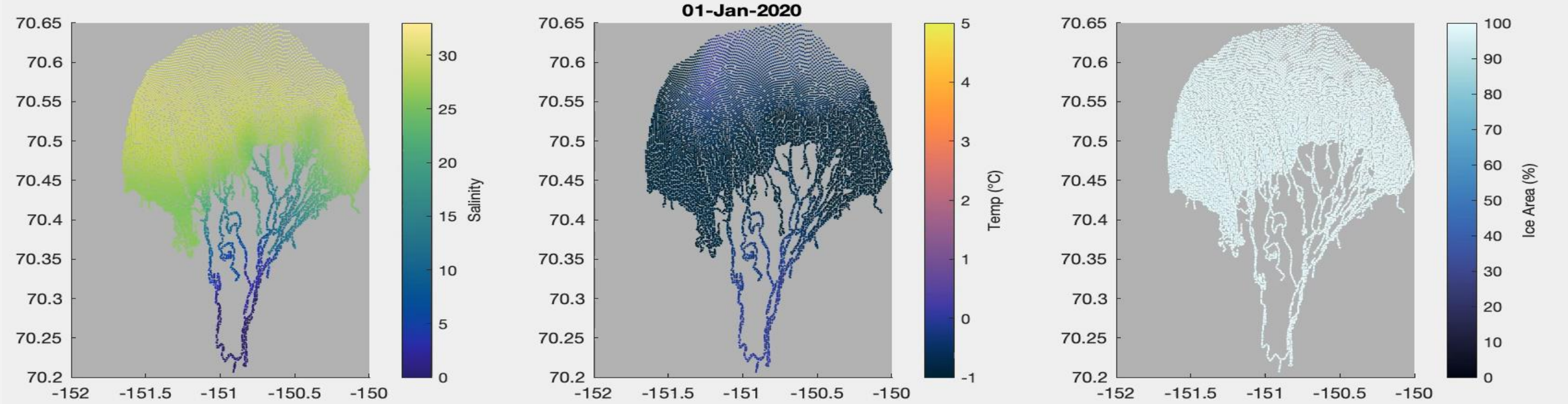
Overarching Questions in FORTE

The primary driver of Arctic coastal function is **seasonality, sharp temporal transitions, and spatial heterogeneity.**

Yet, how seasonality, biogeochemical fluxes, and ecological responses change in the **Arctic's smaller rivers** that account for more than **40% of riverine discharge** into the Arctic Ocean, remain not well characterized.

FORTE focuses on this dynamic continuum of Alaska's northernmost ecosystems – eroding coastlines, rivers, deltas, and estuaries – that connect land to sea.

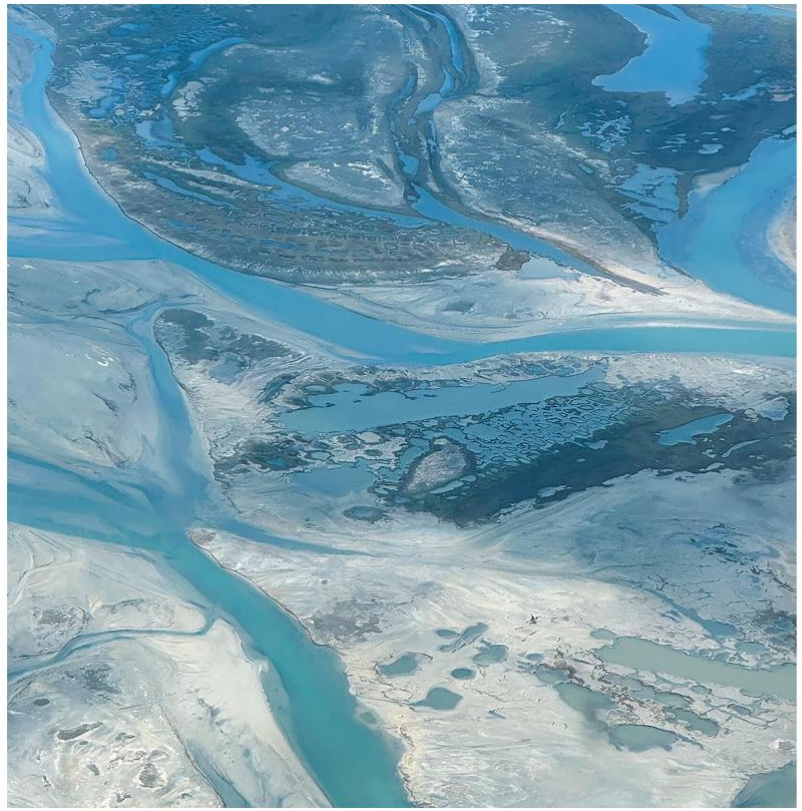
Colville River Salinity, Temperature, and Ice Area, Jan 2020 – Sep 2022



Hydrodynamic model results from CBS-FVCOM Model (Clark et al.)

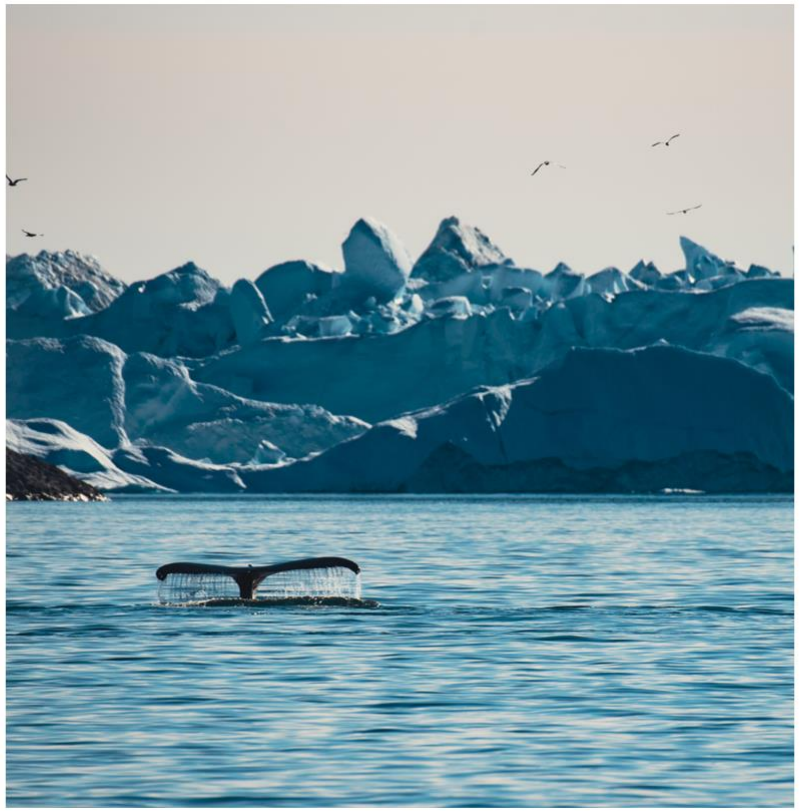
RESEARCH AREA #1

The **impact of warming and increased Arctic river discharge on river plumes, coastal erosion, water quality,** and the spatiotemporal transitions between sources and sinks of carbon and nutrients **– from land to sea.**



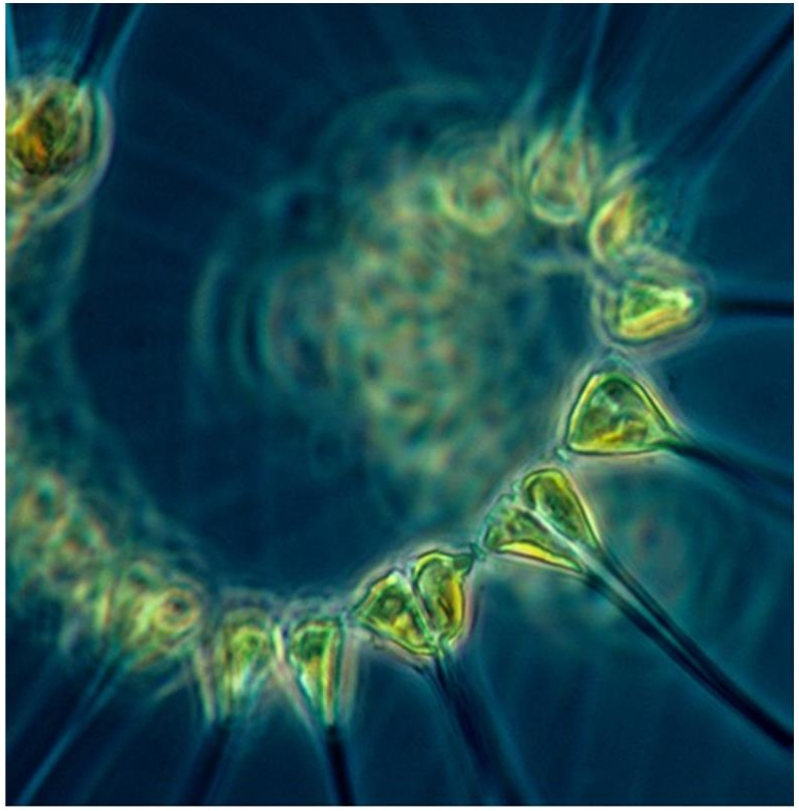
RESEARCH AREA #2

Changes in the **relative importance and interaction of coupled physical and biogeochemical processes** in transforming Arctic land-ocean fluxes as environmental conditions change **— from surface waters to the deep Arctic Ocean.**



RESEARCH AREA #3

The **response of phytoplankton populations** to a changing Arctic, as well as the growing risk of harmful algal blooms and their impacts on biodiversity, marine resources, and food security **– from the base of the food web to higher trophic levels**.



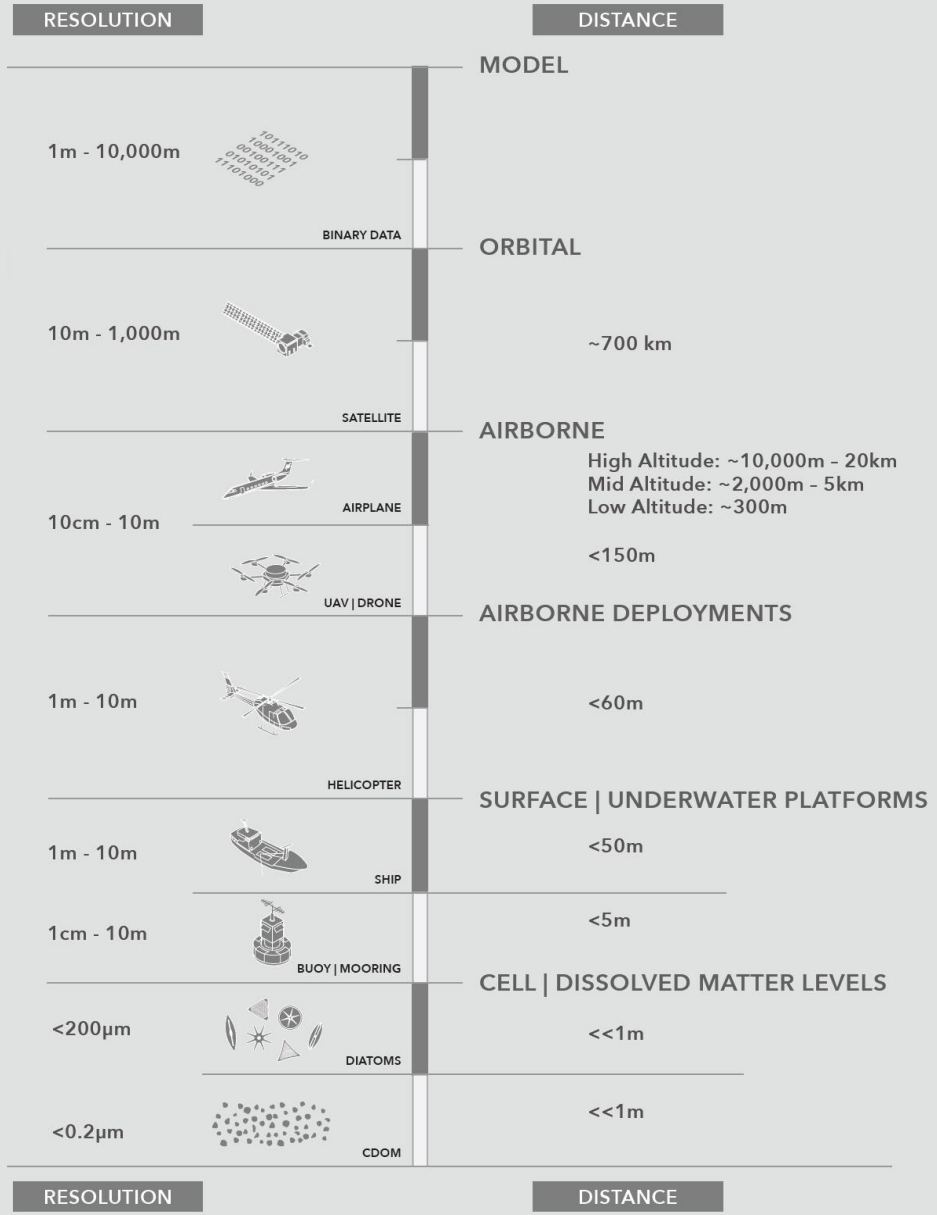
FORTE : Integration of observations - from the micro to the ecosystem scale

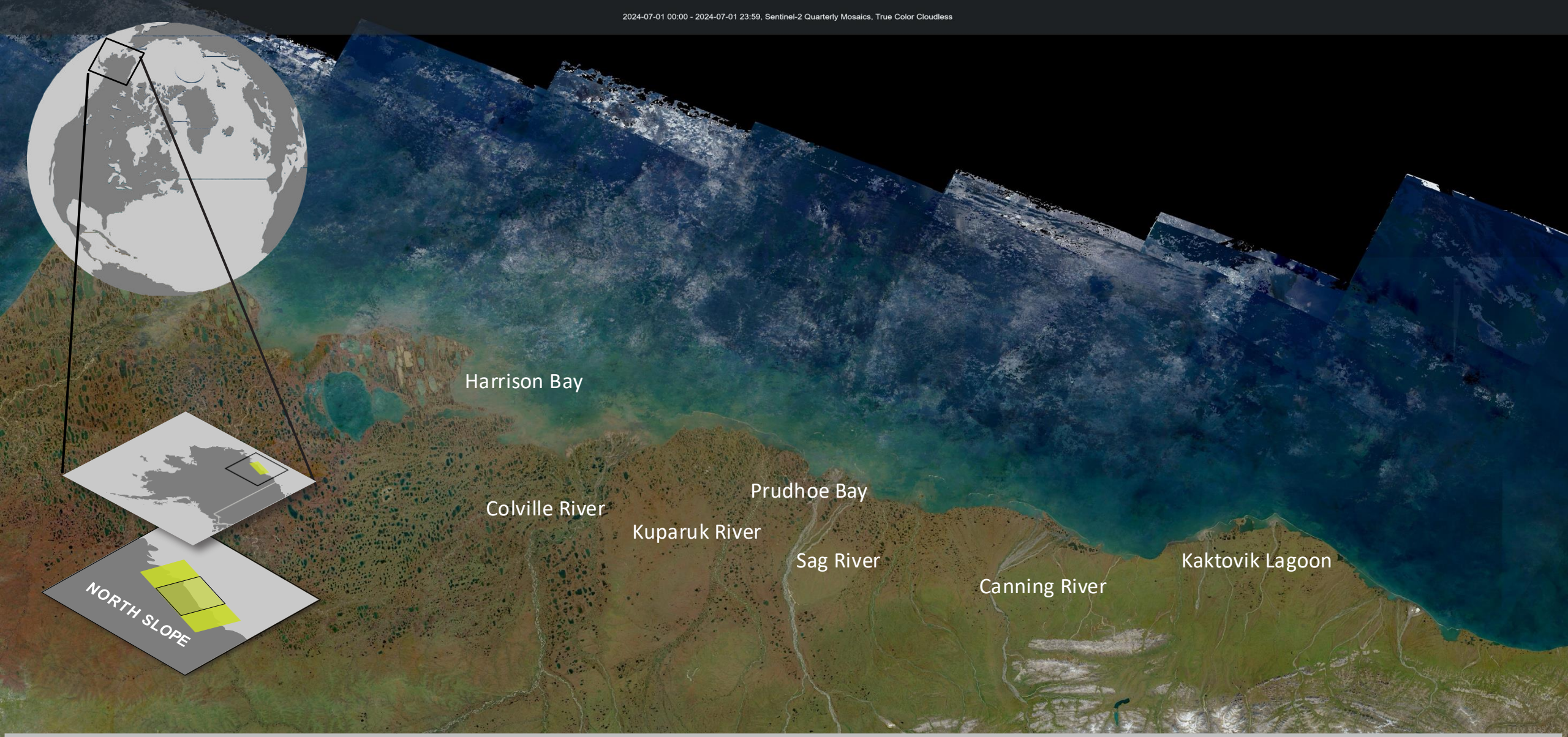
RESOLUTION		DISTANCE
	MODEL	
1m - 10,000m	BINARY DATA	
	ORBITAL	
10m - 1,000m	SATELLITE	~700 km
	AIRBORNE	High Altitude: ~10,000m - 20km Mid Altitude: ~2,000m - 5km Low Altitude: ~300m
10cm - 10m	AIRPLANE	
	UAV | DRONE	<150m
	AIRBORNE DEPLOYMENTS	
1m - 10m	HELICOPTER	<60m
	SURFACE | UNDERWATER PLATFORMS	
1m - 10m	SHIP	<50m
1cm - 10m	BUOY | MOORING	<5m
	CELL | DISSOLVED MATTER LEVELS	
<200µm	DIATOMS	<<1m
<0.2µm	CDOM	<<1m
RESOLUTION		DISTANCE

FORTE : Integration of observations, disciplines and expertise

FORTE Science Team

Airborne– AVIRIS	Hydrological Connectivity	Modeling-ECCO FORTE
Niklas Urs Bohn	Anastasia Piliouras	Dustin Carroll
Regina Eckert	Katherine Lininger	Raphael Savelli
Evan Greenberg	**Coastal Ice/Hydrology**	Stephanie Dutkiewicz
Danie Jensen	Tamlin Pavelsky	Charles Miller
Kelly Luis	Sarah Cooley	Vincent Le Fouest
David Thompson	**DOM transformations**	Dimitris Menemenlis
Charles Miller	Robert Spencer	Michael Rawlins
Michael Eastwood	Anne Kellerman	Clement Bertin
Robert Green	**DOM, Carbon, Optics, RS**	**Modeling-ECCO-SEDLIGHT**
Airborne-UAV	Maria Tzortziou	Vincent LeFouest
Wesley Moses	Kyle Turner	Freshwater/DOC Export
Gia Lamela	Josh Harringmeyer	Michael Rawlins
Trina Merrick	**Particles, Optics, RS**	**Local Partners**
Ivan Savelyev	Antonio Mannino	Phillip Toney
Ahmed El-Habashi	Matthew Kehrli	Teresa Richardson
Moorings/Buoys	Austin Grubb	**International Partners**
Jim Thomson	**Phytoplankton, NPP**	Bennet Juhls
Moorings, PM, NCP/GPP	Joaquim Goes	Pier Paul Overduin
Lauren Juranek	Helga Gomes	Gesine Mollenhauer
Emily Eidam	Jinghui Wu	Hajo Eicken





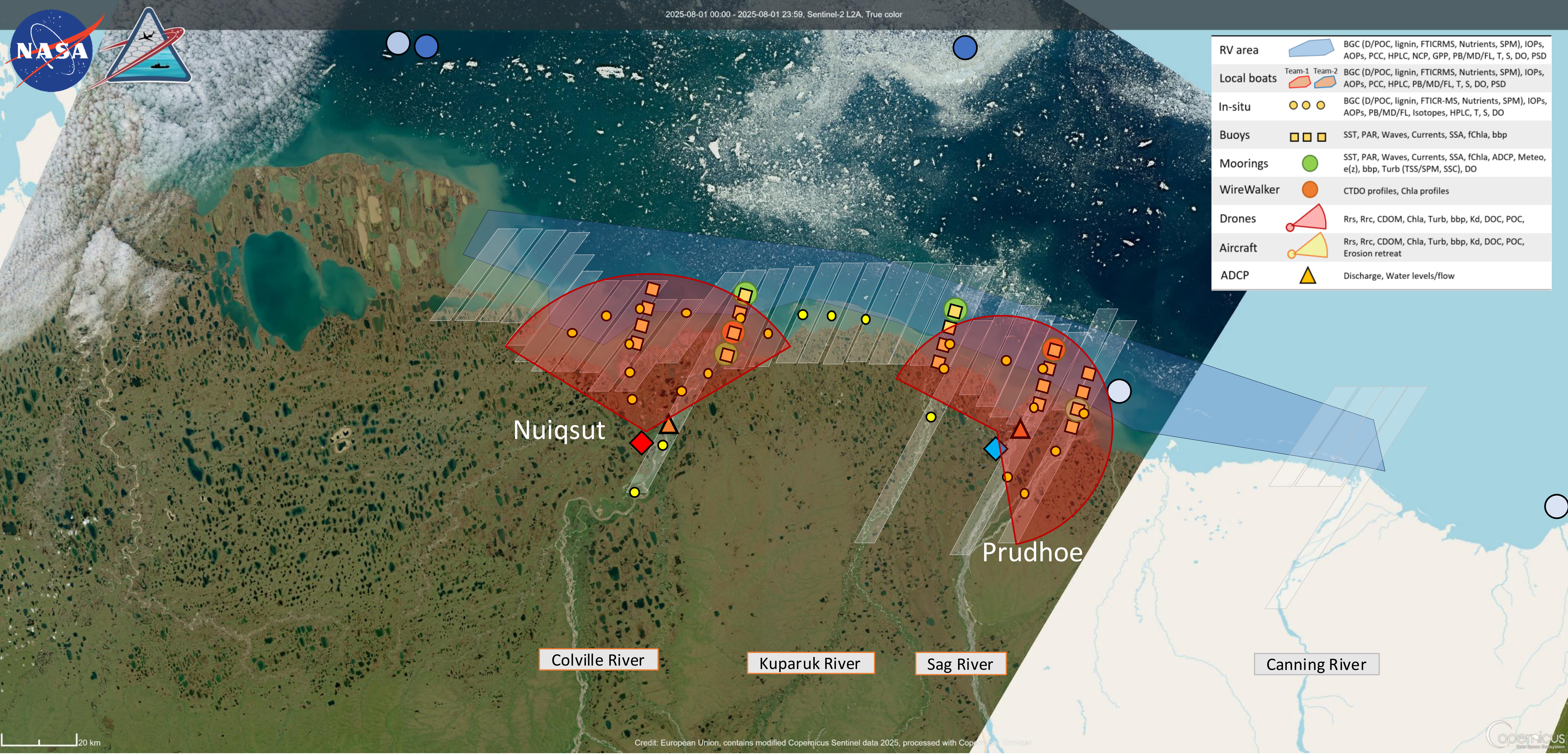
Study Domain: Focus on the **four largest river systems that drain North Alaska: Colville, Kuparuk, Sag, Canning**

Time period: Measurements **from spring freshet to late summer**; (first moorings in Sept 2026), 2027 and 2028

Timeline: 2026: 1st year of projects, **2027-2028: fieldwork**, 2029: synthesis

2024 - 2025

June																July																August																	
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30



2027

Month	Days
June	2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30
July	2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30
August	2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Phase I (3 weeks)	Phase II (3 weeks)	Phase III (3.5 weeks)	Phase IV

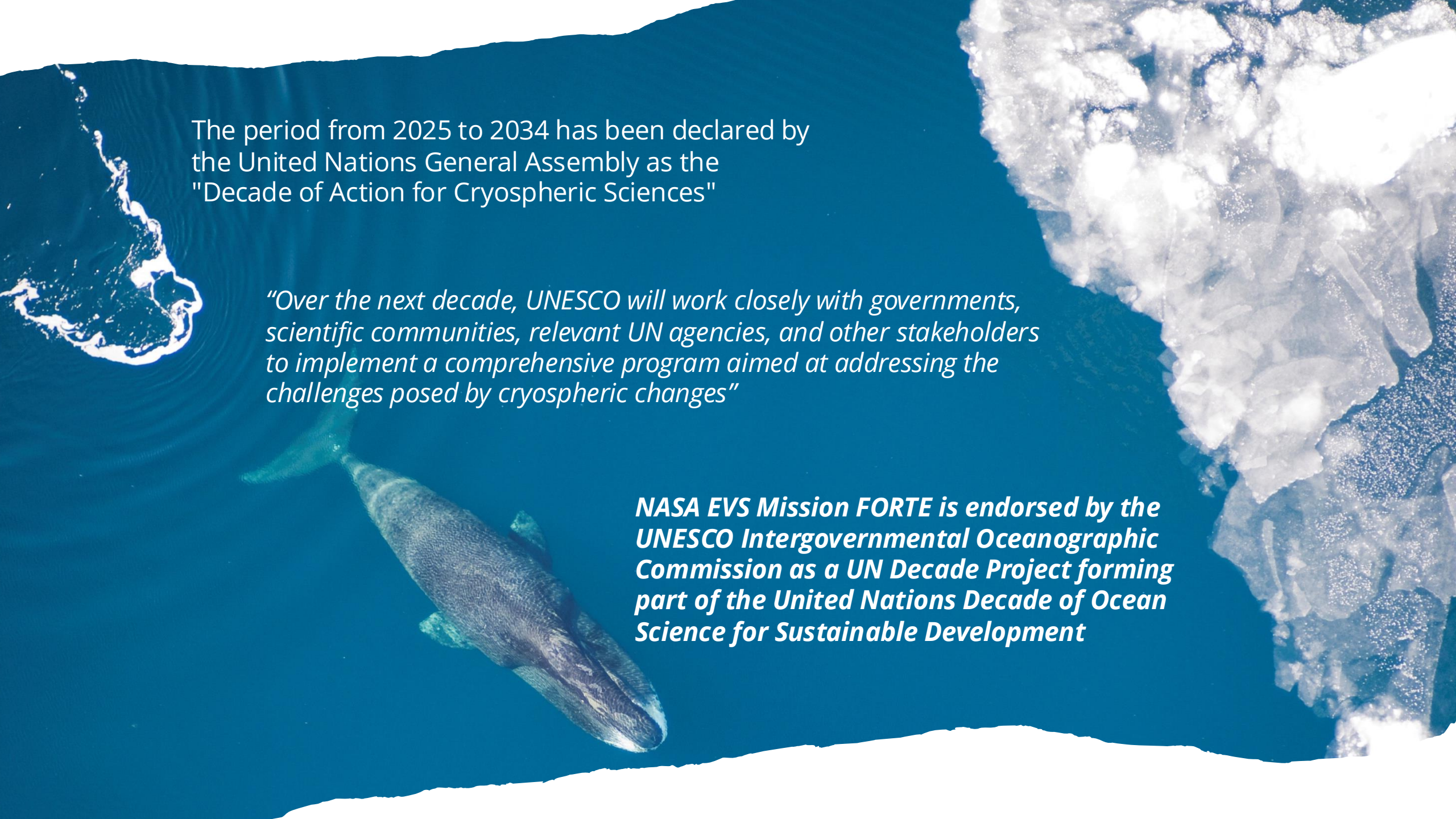
Partnerships: from local to global

FORTE is founded on strong collaborations with local, regional, and international partners

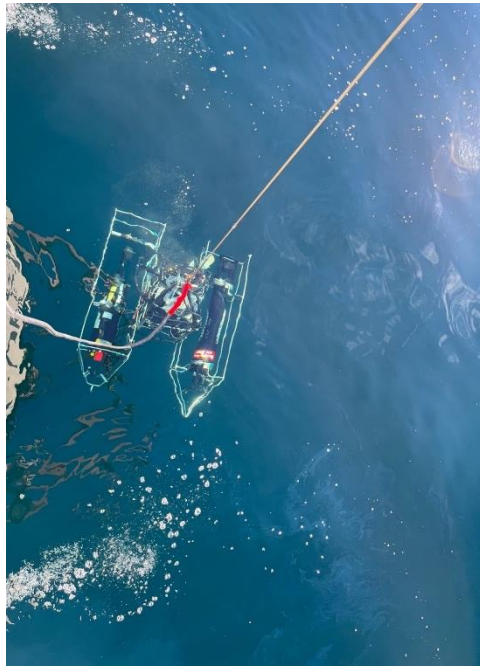
- **Native Village of Nuiqsut**, Alaska
- **North Slope Borough** (NSB), Alaska
- **Universities:** City University of New York; Columbia University; Duke University; Florida State University; La Rochelle Université; Massachusetts Institute of Technology; Oregon State University; Pennsylvania State University; San Jose State University; University of Colorado, Boulder; University of Massachusetts, Amherst; University of North Carolina, Chapel Hill; University of Washington, Seattle
- **Research Centers and Institutes**: Alfred Wegener Institute; Ctre Nat de la Recherche Scientifique; Goddard Space Flight Center, NASA; Jet Propulsion Laboratory, NASA; Naval Research Lab
- **OceanX** nonprofit ocean exploration
- **NASA Missions and Programs** (ABOVE, Arctic COLORS, FRESH)
- Beaufort Lagoon Ecosystem **NSF BLE-LTER program**
- DOE-supported **InteRFACE and HiLAT** projects
- **US-Navy, US Coast Guard, NOAA** efforts in Alaska
- **WHOI** - Woods Hole Oceanographic Institution
- **IARPC** - Interagency Arctic Research Policy Committee
- **IASC - International Arctic Science Committee** - Coastal Beaufort Sea 2027 Coordination Hub (NASA FORTE, Arctic PISCES, Arctic PULSE, Beau Pair, and REVISIT)
- **Polar Knowledge Canada**
- **NASA's GLOBE** Program
- **NASA's** EarthRISE Developers Academy
- **Letters to the Sea** Initiative
- UNESCO's **Environmental DNA (eDNA) Expeditions**

The period from 2025 to 2034 has been declared by the United Nations General Assembly as the "Decade of Action for Cryospheric Sciences"

“Over the next decade, UNESCO will work closely with governments, scientific communities, relevant UN agencies, and other stakeholders to implement a comprehensive program aimed at addressing the challenges posed by cryospheric changes”



NASA EVS Mission FORTE is endorsed by the UNESCO Intergovernmental Oceanographic Commission as a UN Decade Project forming part of the United Nations Decade of Ocean Science for Sustainable Development



https://cce.nasa.gov/forte/

Projects started in Spring 2026 | FORTE Deployments: September 2026-August 2028







M. Tzortziou Lead PI | A. Mannino Deputy PI | S. Nicholas | P. Griffith | D. Hodkinson | B. O'Connor | Project & Data Management Team | L. Lorenzoni NASA HQs