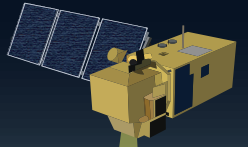




# Smarter sensors

Sea ice, cold temperatures, and a dynamic light regime pose challenges in data gathering. New technologies, however, can significantly improve our observational capacity and understanding of the Barents Sea. Different instrument-carrying platforms collect data in a coordinated manner across temporal and spatial scales. For example, hyperspectral imagers provide a common currency through different platforms for collecting biogeochemical data, detected as spectral reflectance per image pixel, providing optical fingerprints from large-scale ecosystems to organelle functions.

Satellites



Large-scale ecosystem

Spectral reflectance per image pixel

Species A  
Species B  
Species C



Small-scale ecosystem

UAVs

Hyperspectral imaging per image pixel

AUVs

Under-ice photomosaic

Populations & communities

Cells & organisms

Inside cells

Flow cytometry

Autotrophic

Mixotrophic

Heterotrophic

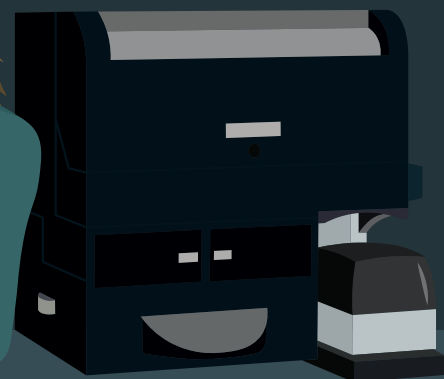
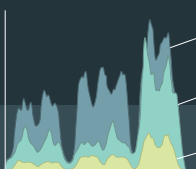
Microscopy

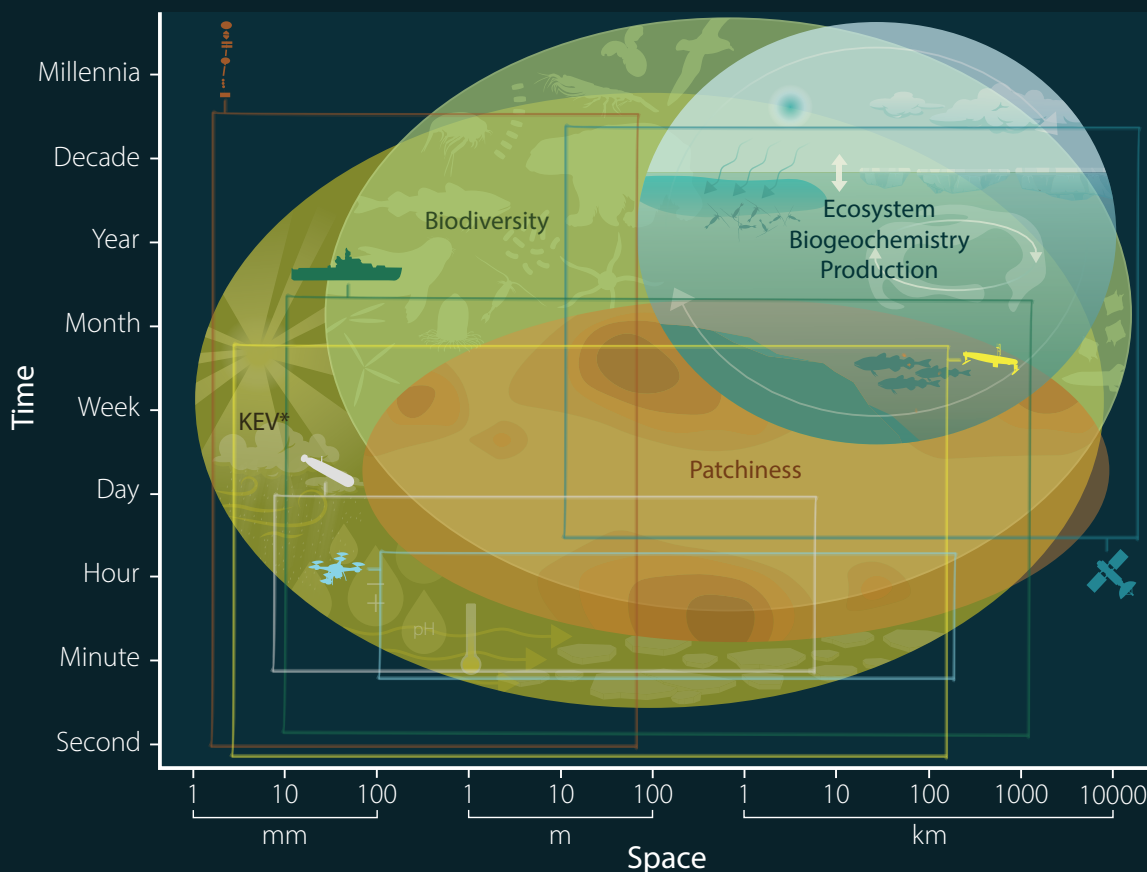
Sequencing

GTTACATAGGCCTAA  
TTAAGCGCGCATTTA  
GAGATTCTCATCGTA  
ACTCTTCATTCGAT

Bio-optical sensors in CytoSense

Size, length, cells per chain  
Structural complexity  
Number of chloroplasts





With information from all or a selection of platforms, we gain significantly more information (data) faster and at a lower cost across all time and space scales. This system provides cross-disciplinary information for sound decision-making.

\*KEV = Key Environmental Variables

## The observation pyramid

### Satellite



### Uncrewed aerial vehicles



### Uncrewed surface vehicles



### Ship



### Uncrewed underwater vehicles



### Fixed platforms



### Types of sensors

- Optical sensors
- Light sensors
- Electro-chemical sensors
- Acoustics sensors
- in situ* biological sampling

← Spatial coverage →

## RECOMMENDATIONS

To complement and optimize our current observational capabilities, new technology represents a promising future.

The observation pyramid can be used to identify, map, and monitor various biogeochemical variables of interest through a combination of smart sensors. We are now transitioning from relying on point measurements to providing data that covers large areas (space), and from seconds to decades (time). The instrument-carrying platforms comprise satellites, uncrewed aerial vehicles (UAVs), uncrewed surface vehicles (USVs), ships, uncrewed underwater vehicles (UUVs, e.g. autonomous underwater vehicles (AUVs) and gliders), and fixed platforms (buoys and landers).

Advances in such integrated systems can provide essential information on primary production, biodiversity, currents, stock assessments, and risk evaluation. This enables a comprehensive overview of the ecosystem's overall health, which is crucial for sound decision-making.