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Utö Atmospheric and Marine Research Station

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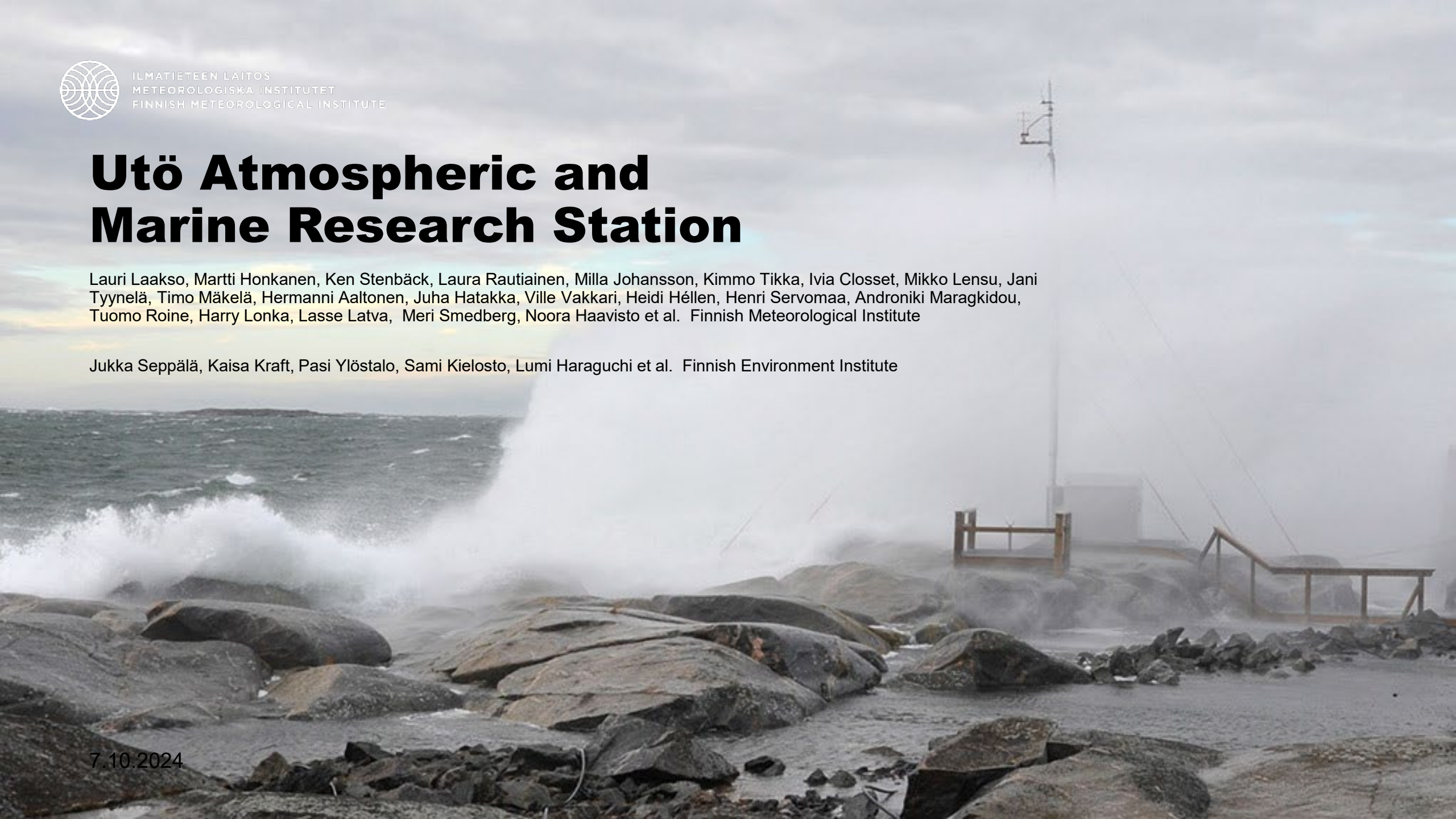
Jukka Seppälä, Kaisa Kraft, Pasi Ylöstalo, Sami Kielosto, Lumi Haraguchi et al. Finnish Environment Institute



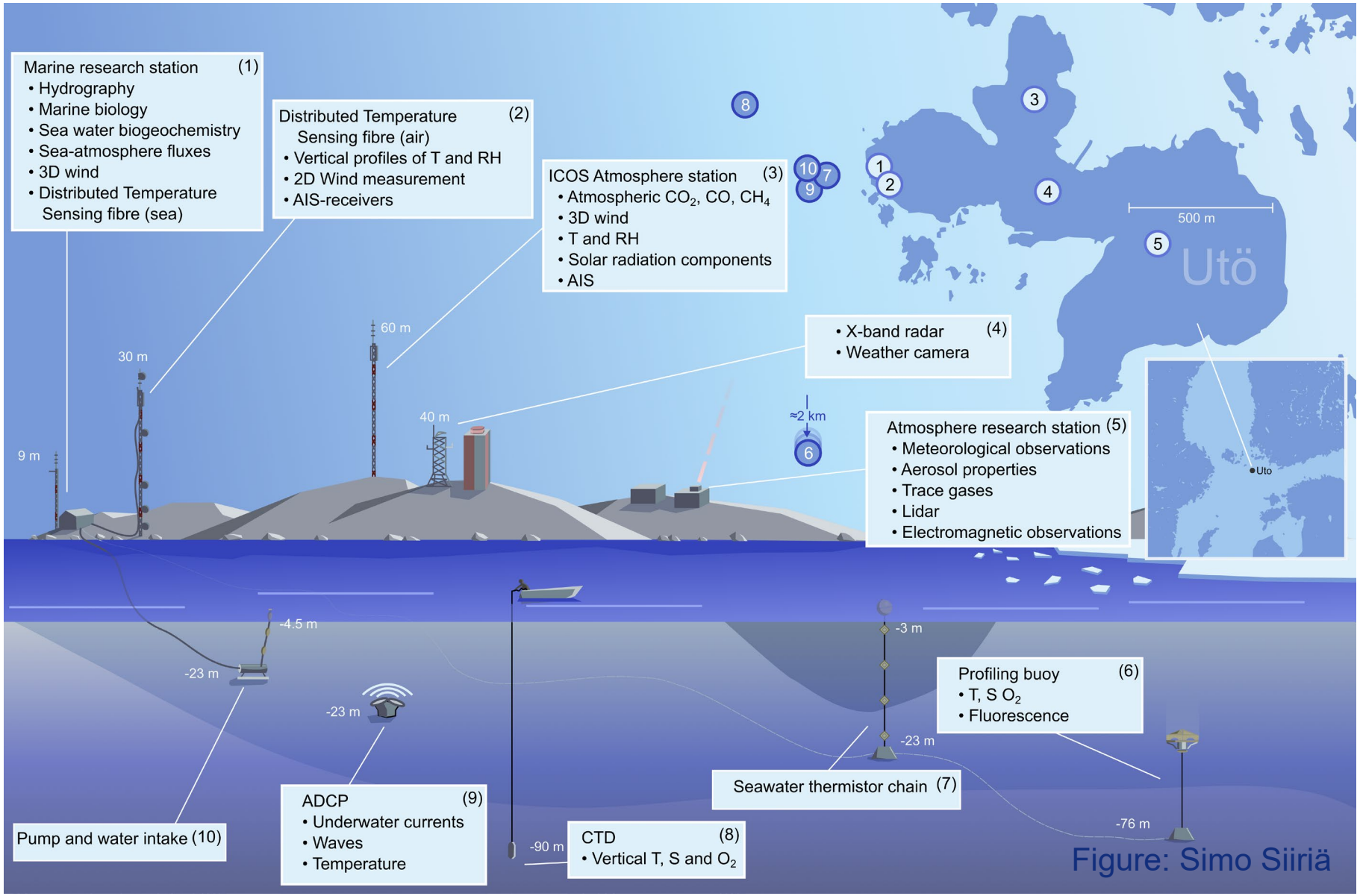
7.10.2024

Utön research station history

1881 → Meteorological observations
1900 → Sea water temperature and salinity profiles (0…100 m)
1980 → EMEP-air quality; HELCOM
2012 → ICOS-ERIC Greenhouse gases
2014 → FINMARI (Finnish Marine Research Infrastructure)
2015 → JERICO-coastal infrastructure
2017 → "WMO long-term observing station in the recognition of irreplaceable cultural and scientific heritage"
2020 → ACTRIS-ERIC
2021 → Radar and electromagnetic signal research facility
2024 → Solar energy research

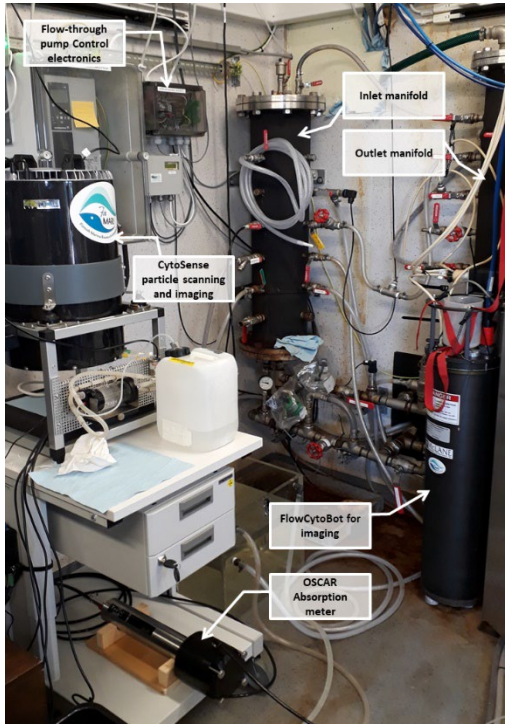
FMI: infrastructure, atmospheric measurements, aerosols, GHG's, oceanography, radar, defense
SYKE: Marine ecosystem, marine biology
Marine safety sector, industry, universities

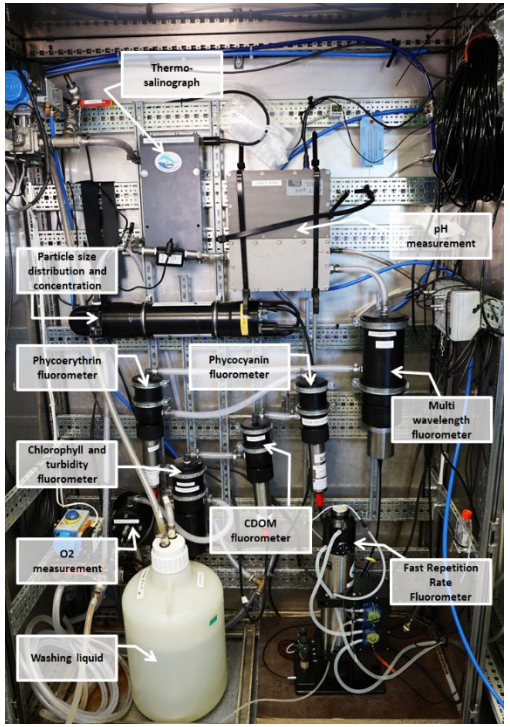
Utö observations



The operational marine ecosystem Flow-through system

Variable	Measured since
Temperature, salinity	2015->
Chlorophyll fluorescence	2015->
Turbidity	2015->
Phycocyanin fluorescence	2015->
Phycoerythrin fluorescence	2017 ->
Humic/organic-C fluorescence	2015->
Spectral fluorescence	2017 ->
Oxygen	2017 ->
pH	2016->
pCO2	2015->
Fluorescence induction, prim. prod.	2015-> occasionally
Backscattering	2017-> occasionally
Spectral absorption	2017-> occasionally
Phytoplankton imaging	2017->
Plankton flowcytometry	2021->
Bottle sampling for nutrients, Chl, DIC, alkalinity, optics, phytoplankton species, primary production, mixotrophy, organic matter degradation…	Since 2015, altogether approx. 250 sampling events



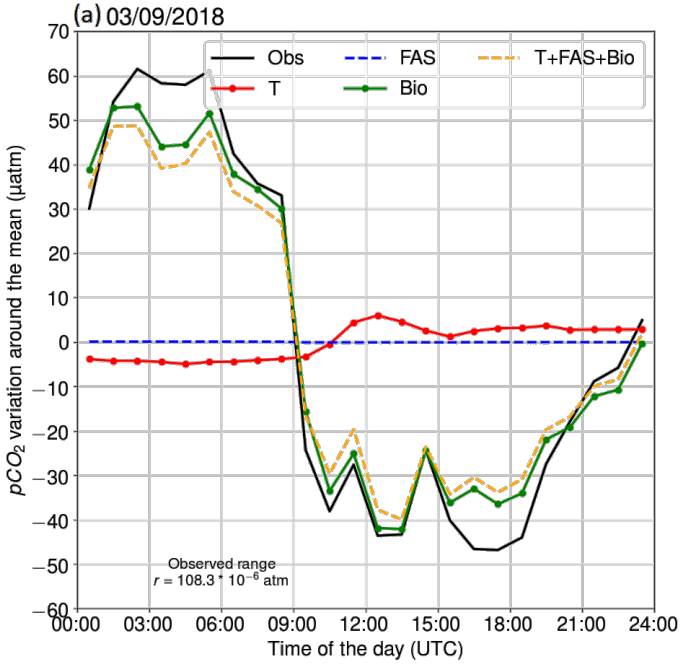


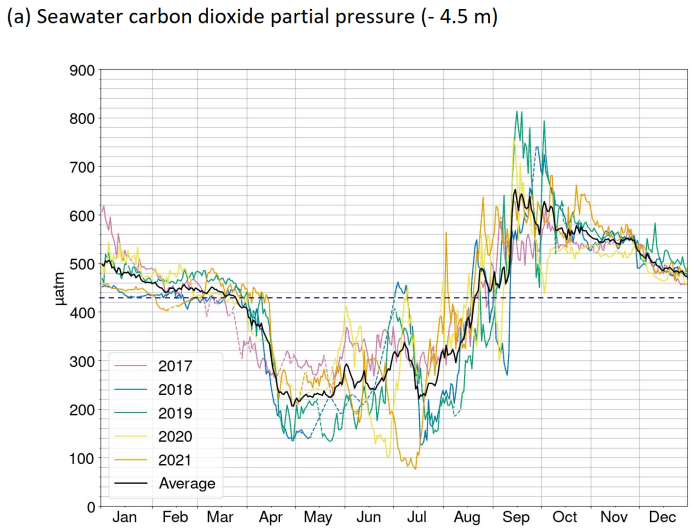
Flow-through setup

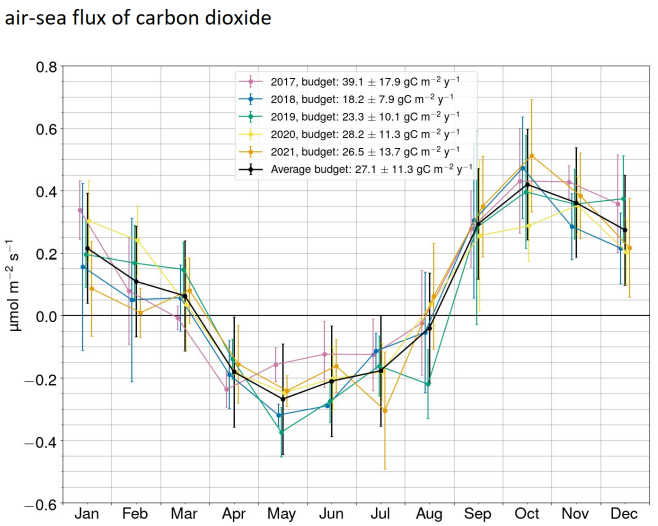
Pump at seabed

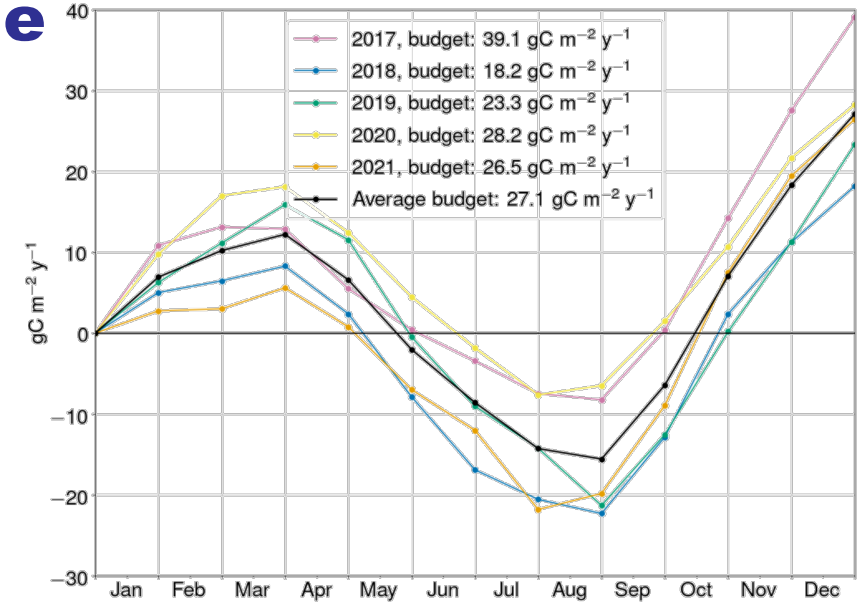
- Depth: -23 m
- Floating inlet 18 m
- Distance from shore 250 m
- Flow rate ~50 lpm
- Residence time ~5 min

Science highlights (1): Marine carbon cycle









- Carbon balance divided in components
- Impact of ecosystem quantified
- Archipelago Sea at Utö is a source of carbon dioxide

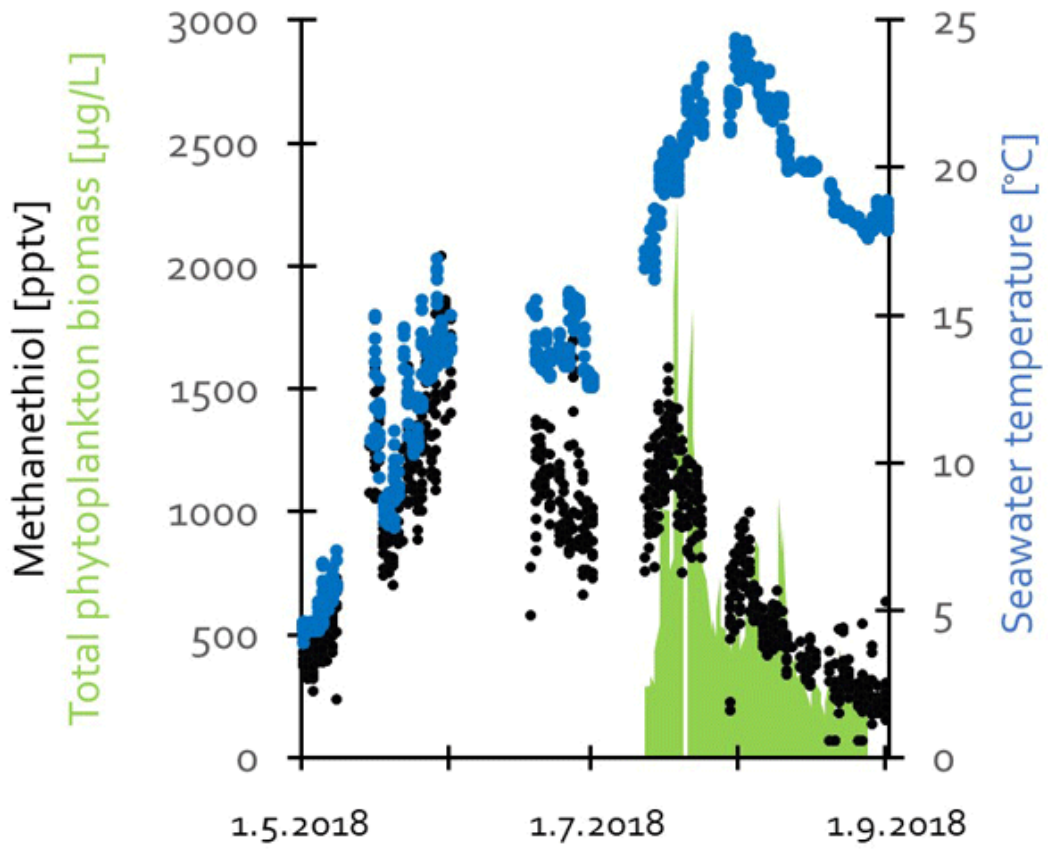
  → inflow of carbon from land ecosystems

More in Martti Honkanen's presentation!

Honkanen et al., 2018
Honkanen et al., 2021
Honkanen et al., 2024

Science highlights (3): BVOC's from marine ecosystem

- Capability to determine marine ecosystem species composition and BGC and atmospheric fluxes simultaneously
- New compound found **Methanethiol**
- New project 2025-28 combining observations at Utö and Cap Verde



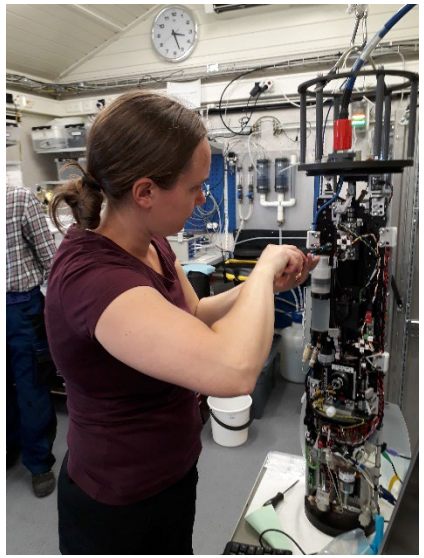
Hellén et al., 2024

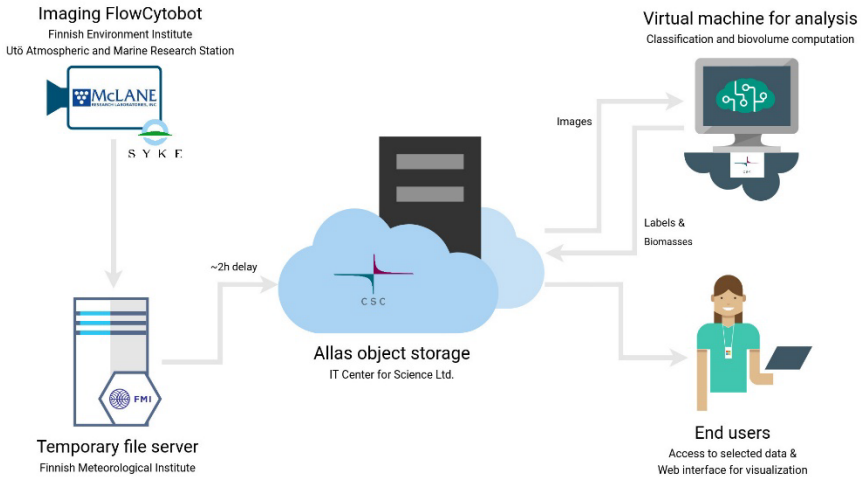
Science highlights (4): Phytoplankton species composition

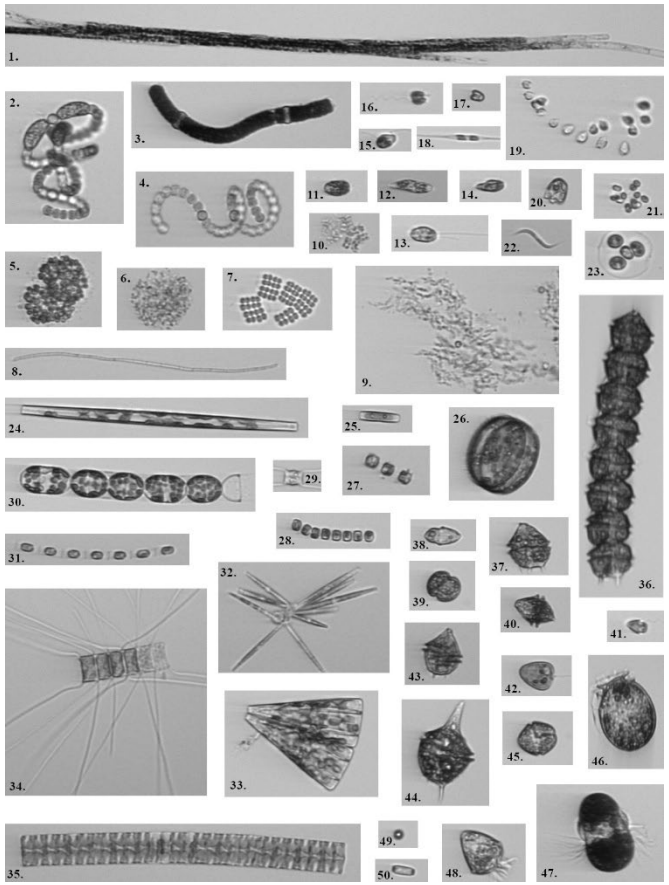
More in Kaisa Krafts's presentation!

Imaging Flow Cytobot, IFCB

- Takes images of phytoplankton cells and colonies (10-150µm)
- Takes a sample of 5ml with approx. 20 min interval
- The camera is triggered by chlorophyll-*a* or scatter
- Even as many as ~30 000 high resolution images / hour
- Data analyzed with CNN image recognition algorithm, approx. 50 taxonomic classes reliably recognized so far
- Online data stream created

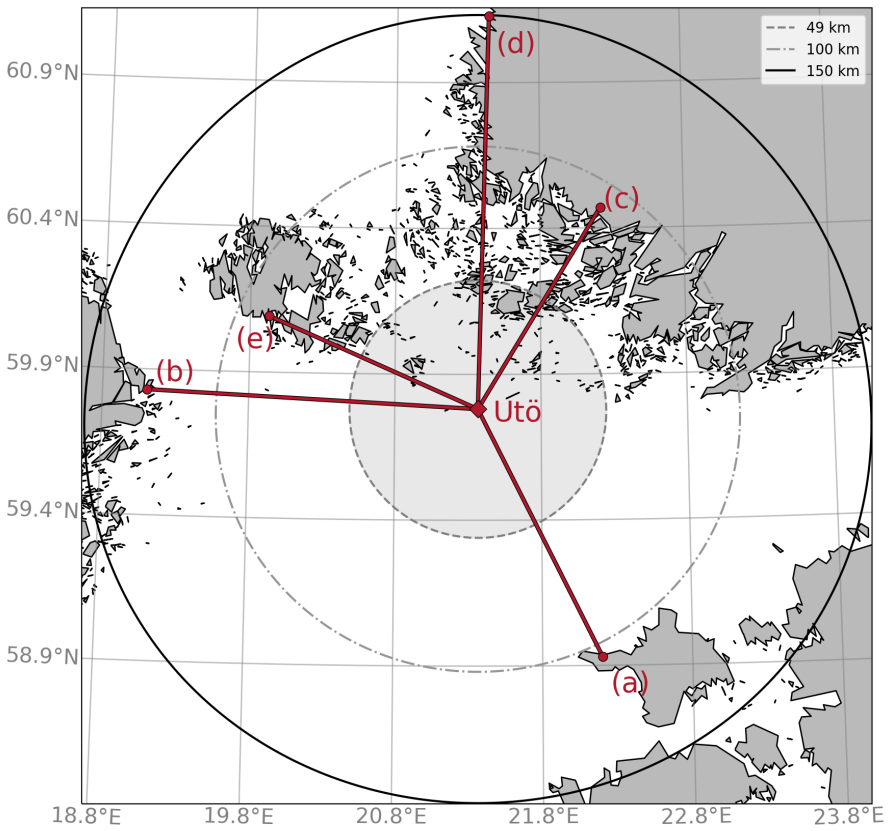


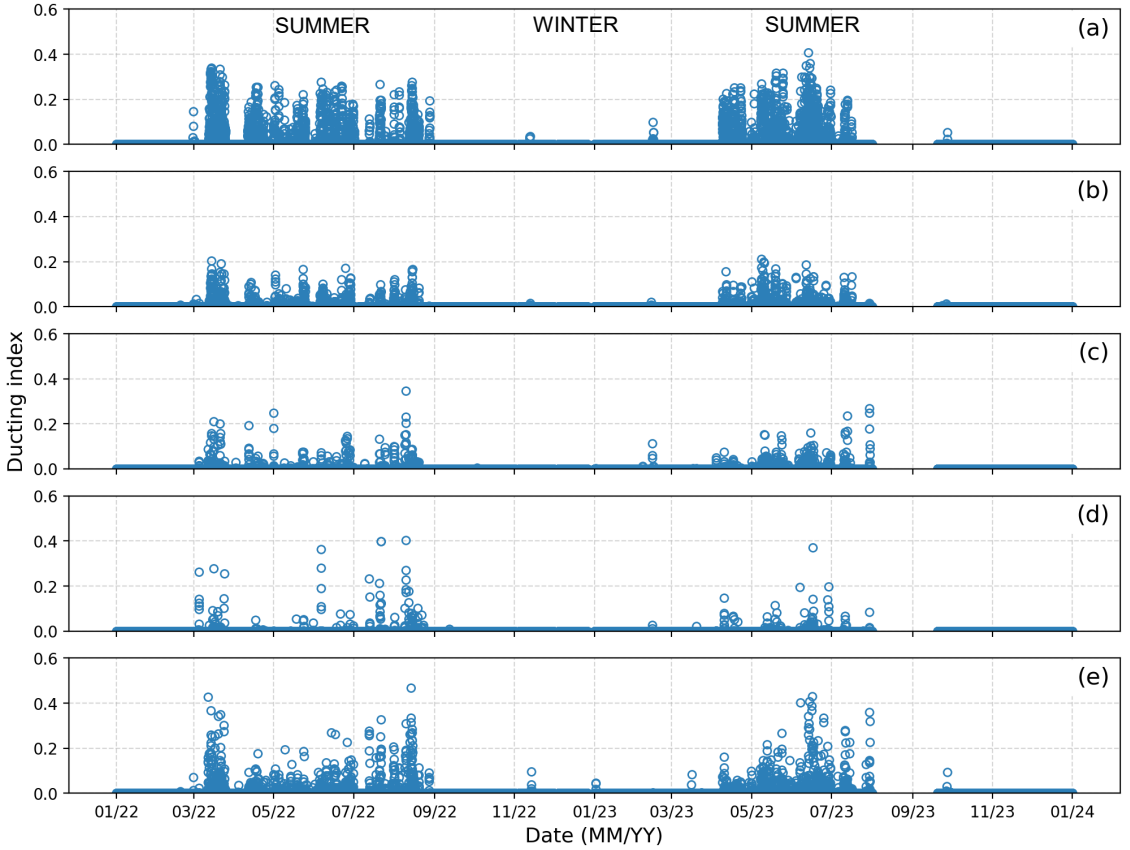




Kraft et al, 2021
Kraft et al, 2022
Kraft et al, 2024

Science highlights (5): Utö coastal surveillance radar



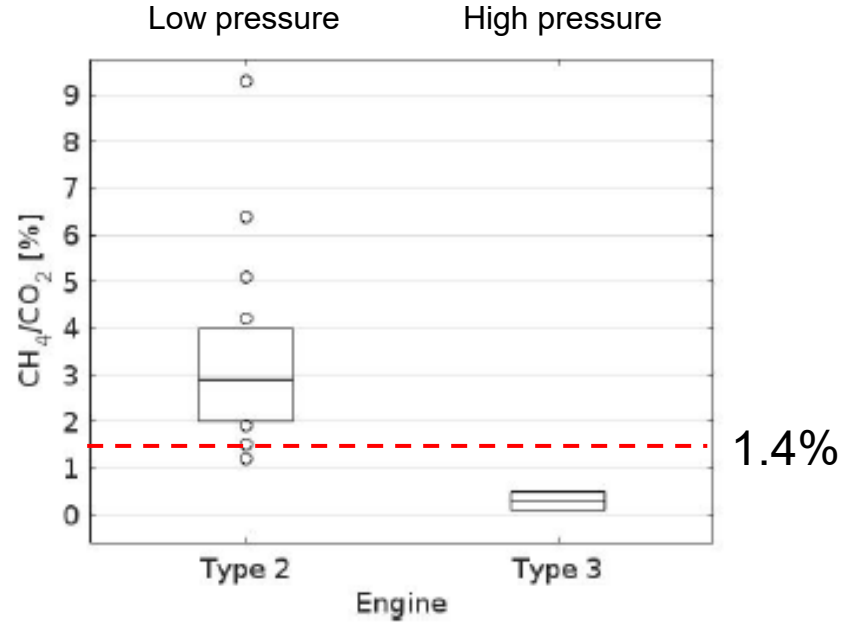


- Standard horizon range 49 km
- Utö X-band radar signal (~9.3GHz) duct 19 % of time (observed with radar)
- Atmospheric duct over the sea surface 36% of time (observed with a mast)
- Ducting most common during the spring and summer, and also over the sea ice
- Impacted by weather conditions and sea surface properties

Rautiainen et al., 2023
Rautiainen et al., 2024
Lensu et al., in prep

Science higlights (9): Shipping emissions (SECA, LNG)

- LNG-more harmful to climate than traditional shipping fuels

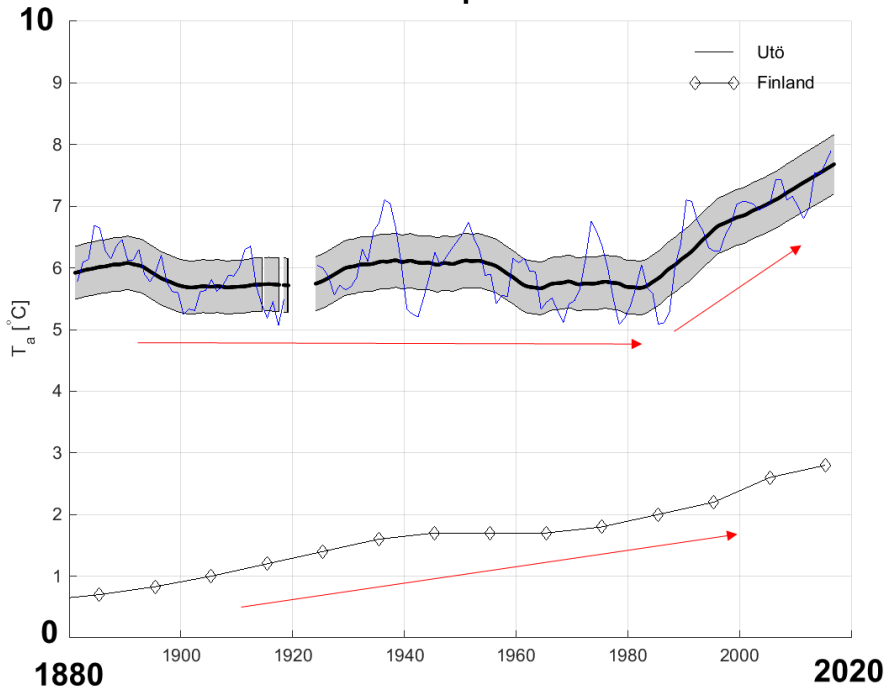


- Impact of SECA on SO2-concentrations measured at Utö
- Observable decrease, however
  - Adverse effects on marine ecosystem
  - Speeds up the climate change due to reduced marine cloud cover

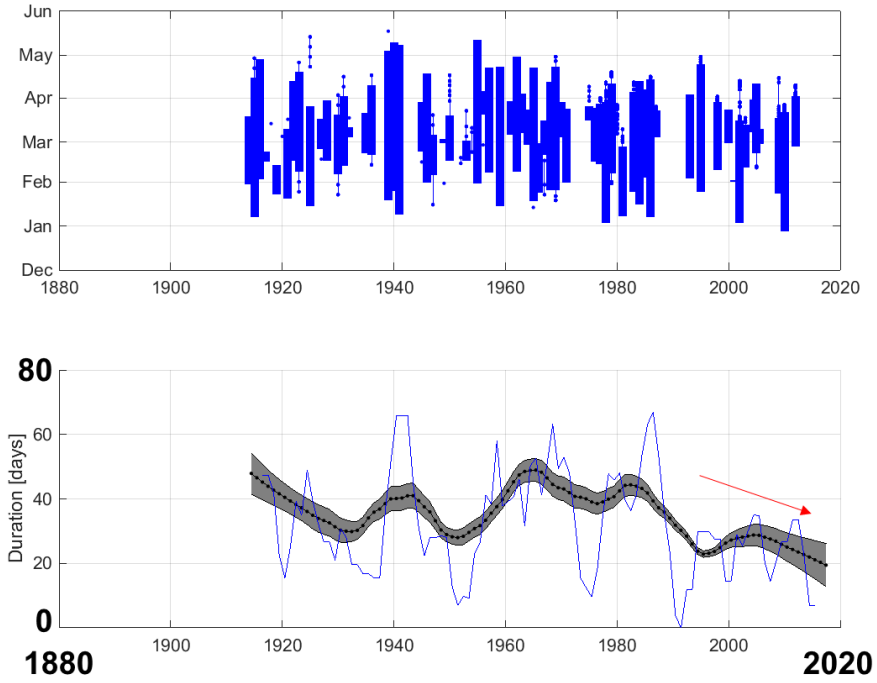
Grönholm et al., 2021
Seppälä et al., 2021
Maragkidou et al., 2024 (in review)

Science highlights (10): Long-term impacts of climate change

Air temperature



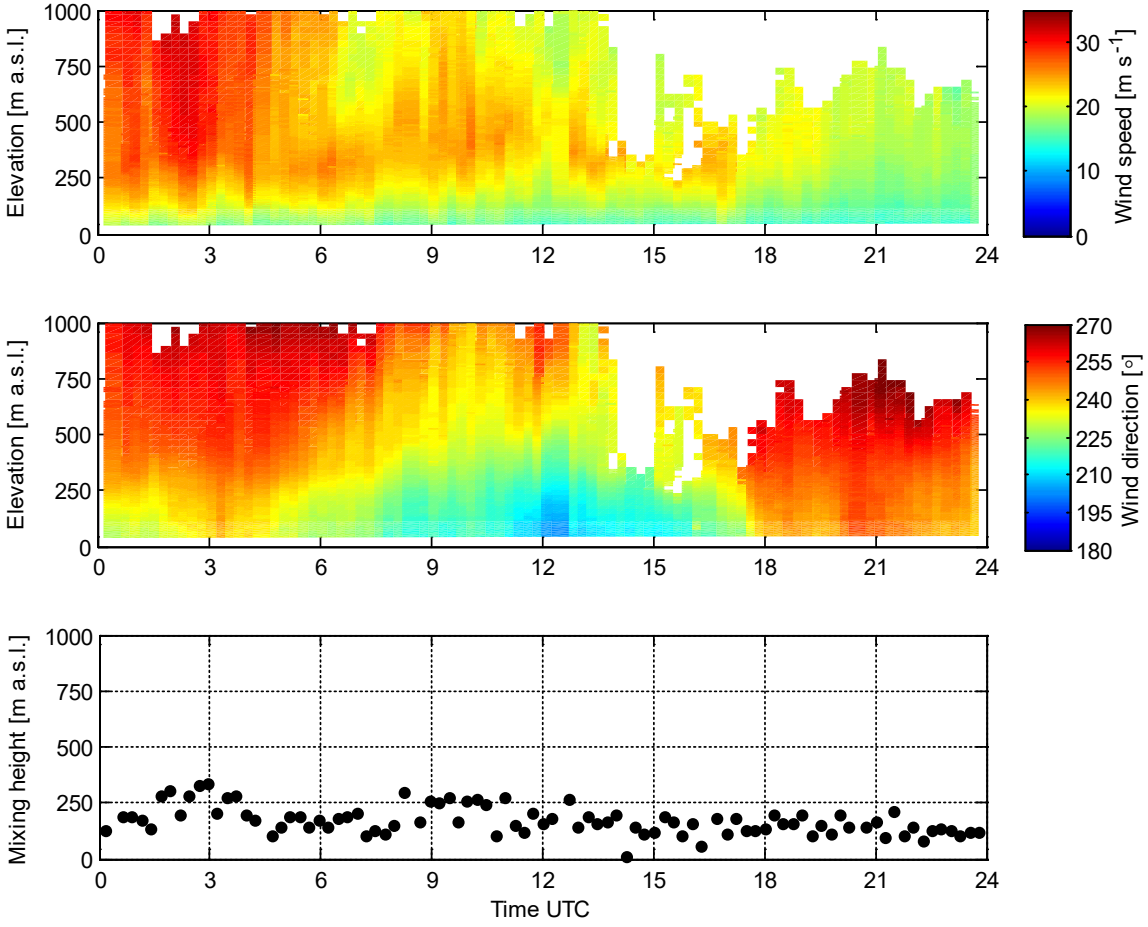
Sea-ice cover



- Climate significantly changed during the last 140 years
- Changes in sea-ice cover (- 50% since 1980) the main local driver

Laakso et al., 2018

Science higlights (11): Marine boundary layer dynamics



Wind speed 0…1000m
Low level jet above 150 m

- Extremely important for wind energy production

Wind direction: 90…180° change within few hundred meters.

- Just surface measurements not enough; torque on blades

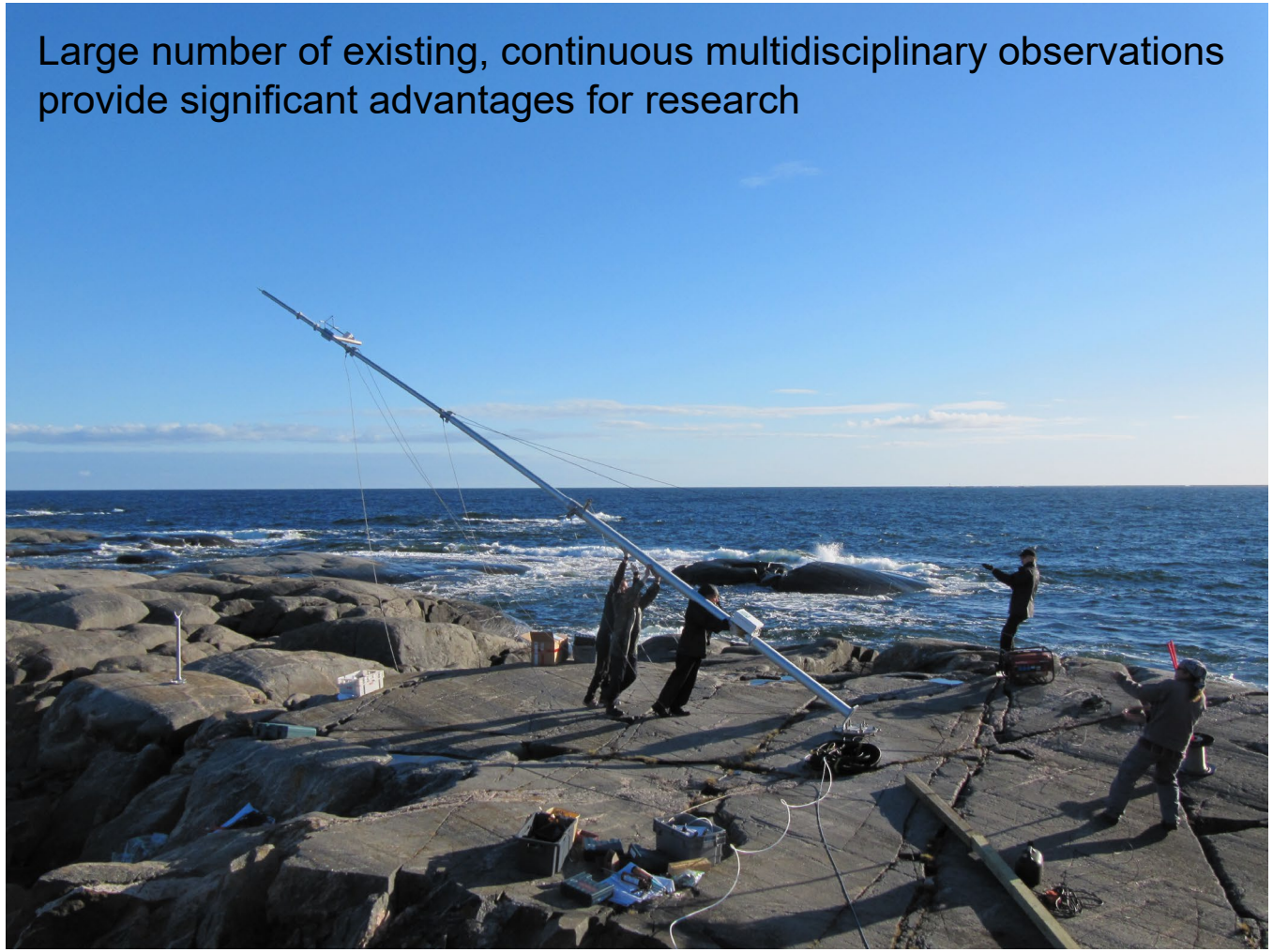
Marine boundary layer 100…200m

- Influence e.g. helicopters, visibility, wind energy etc

Tuononen et al, 2017;
Hämäläinen et al., 2020;
Hallgren et al., 2020, 2021

Utö offers possibilities for high-level multidisciplinary research in:

- Marine carbon cycle and BGC
- BVOC's from marine ecosystem
- Shipping emissions
- Marine ecosystem dynamics (species, taxonomy, optics)
- Waves and hydrodynamics
- Renewable energy
- Weather, marine and climate model development
- Aerosol research
- Atmospheric chemistry
- Greenhouse gases
- Climate change research



AQUARIUS TA

Call 1: 11 November 2024 – 20 January 2025
Call 2: 2 September 2025 – 28 October 2025