EUROGEO WORKSHOP 2023

ARCTIC PASSION

Sustainable Energy challenges in the Arctic

Mikko Strahlendorff

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

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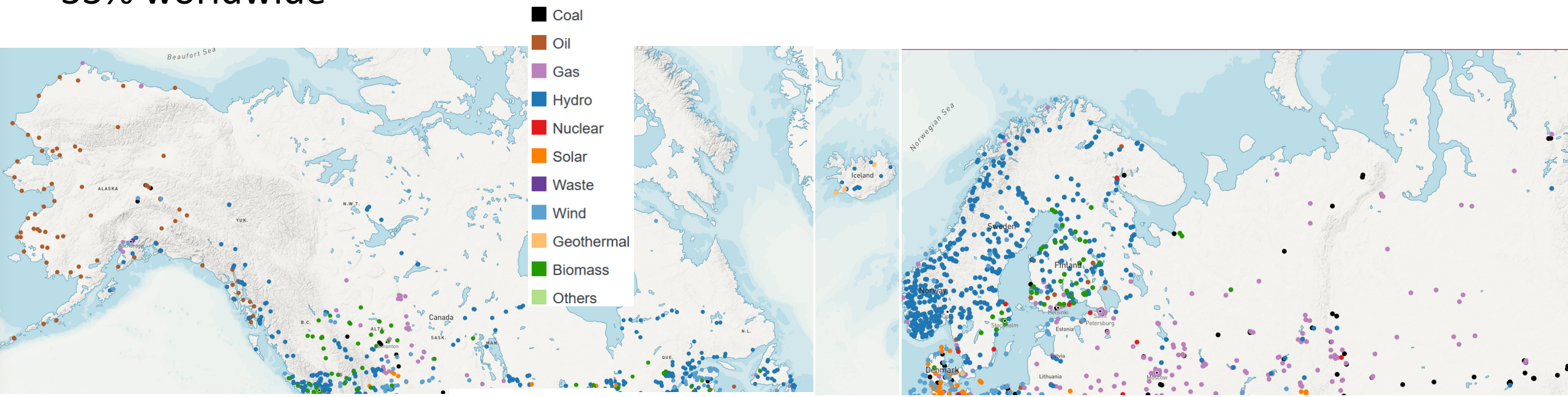
eurac research

Institute of Atmospheric Pollution Research
National Research Council of Italy

European Commission

Hydropower is often the Arctic export nr 3

- It can be the most important power source to balance the system that includes wind and solar as it can be regulated smoothly adapting to the production of the others
- Challenges in changing snow cover and large rains that overwhelm damns
- Biggest renewable that according to IEA for a carbon neutral world needs to grow 33% worldwide

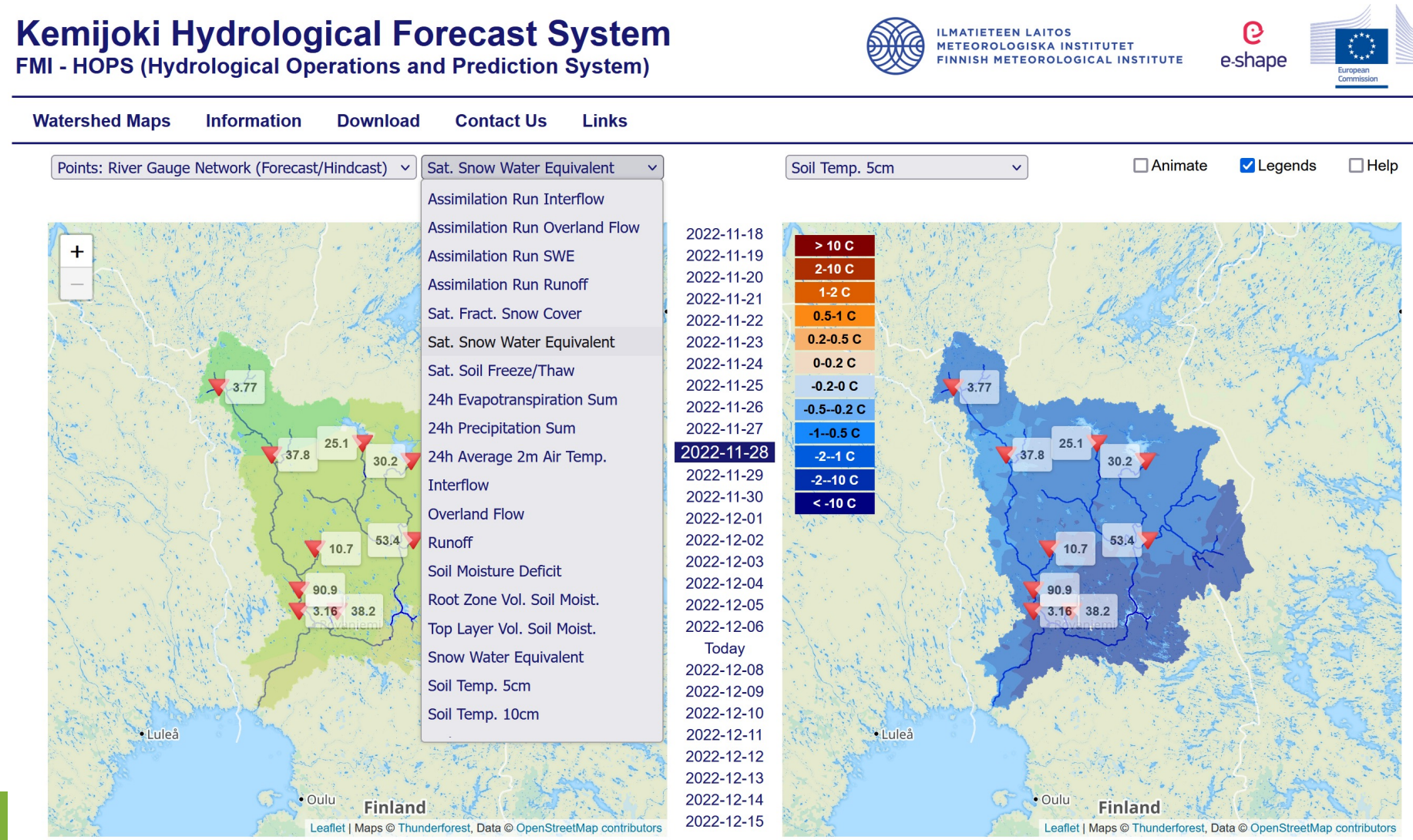


Energy plants by type on https://resourcewatch.org

https://hops.fmi.fi for seasonal snow power prediction

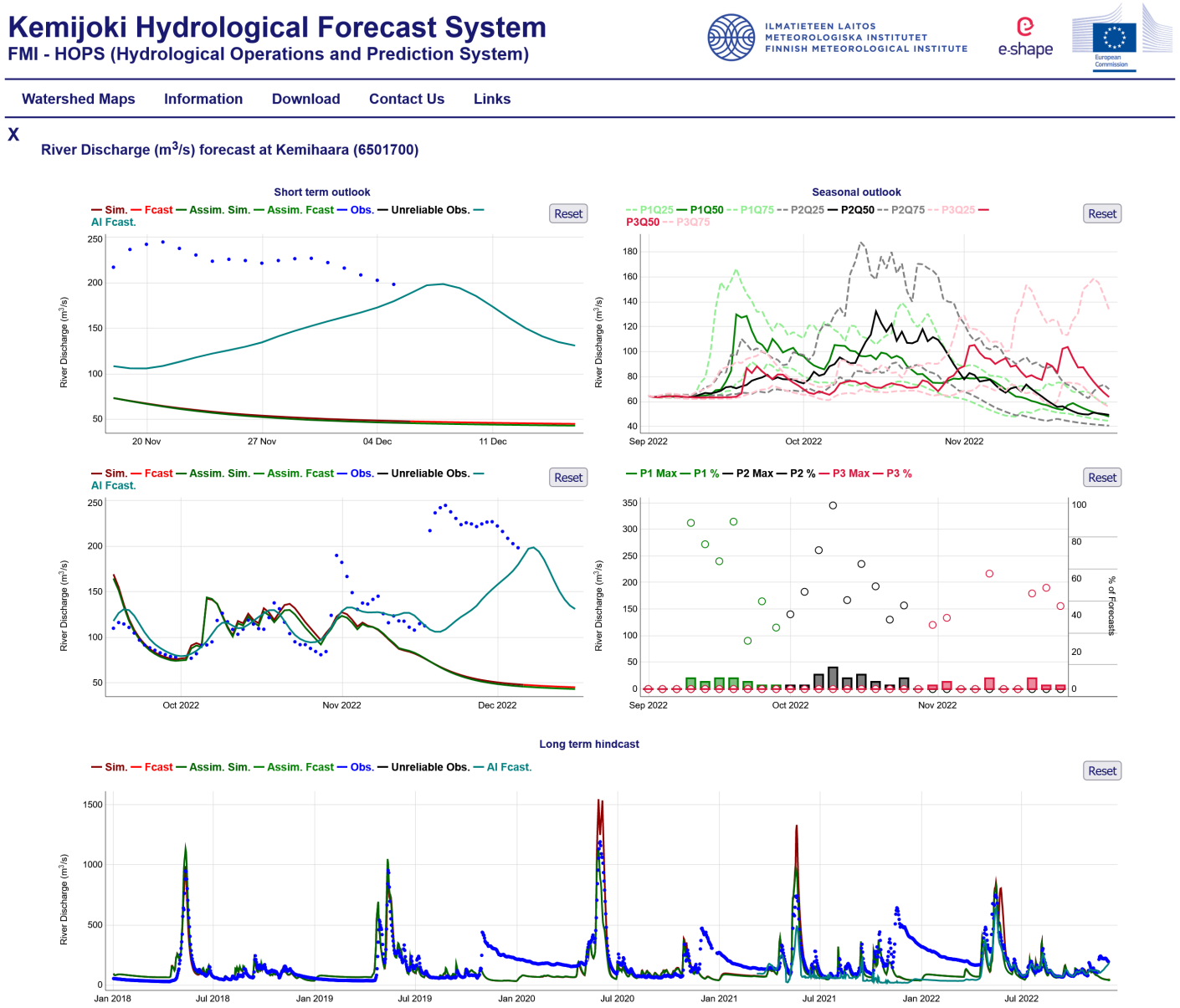
Jaakko Ikonen
Cemal Tanis

- Biggest hydropower operator in Finland with many dams on the same river system
- Observations on snow and weather are visualized
- Model analysis on soil conditions and river flow as well



Seasonal forecasts

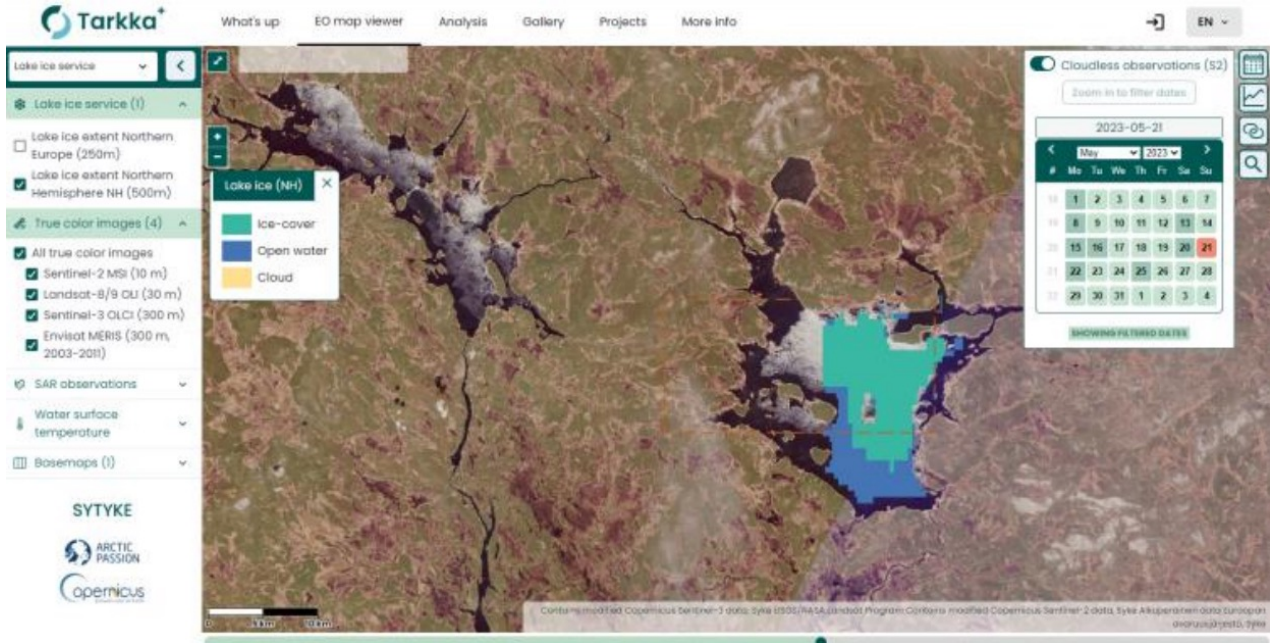
- Default time window is 20 days back and 10 forward based on NWP weather forecasts
- Clicking on river gauge stations the time window is expanded also to seasonal forecasts 3 months ahead based on ECMWF SEAS5
- Hindcasts are demonstrating how well the HOPS model has performed until now
- A very good new machine learning forecast is developing



Lake ice and river ice dams as challenges

- Copernicus S-1 SAR VH analysis for river and lake pixels reveals icejams

- Tarkka service for lake ice
- Copernicus lake ice product using hi-res EO, surface temperatures and S-1 SAR



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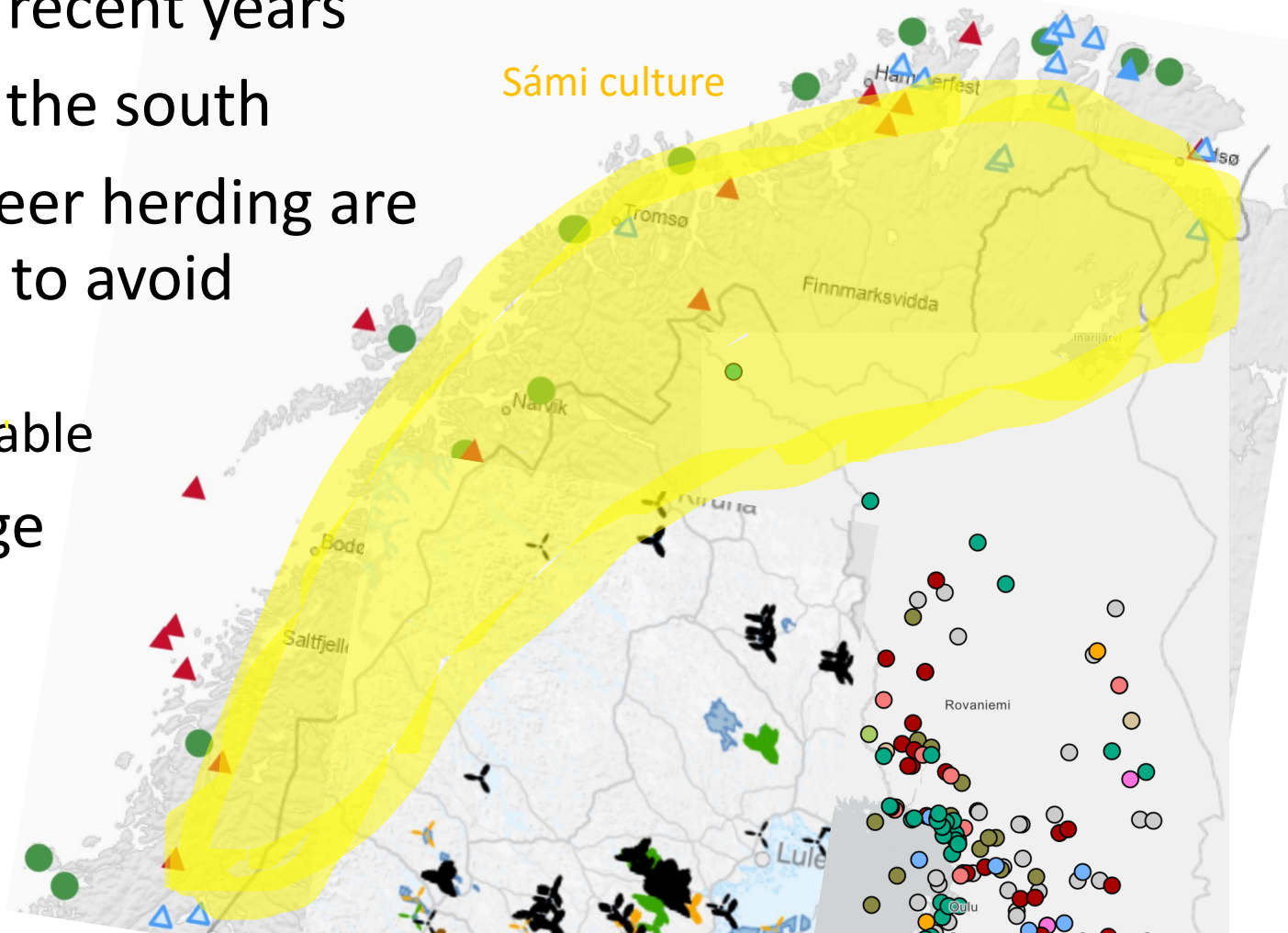
Wind power is increasing in the Nordics

- A boom has started already in recent years
- Arctic is selling wind power to the south
- Indigenous interests like reindeer herding are challenging as reindeers seem to avoid turbine vicinities
  - Courts have made wind parks liable
- Permafrost is another challenge
  - Seasonal thawing goes deeper



Permafrost change detection with EO

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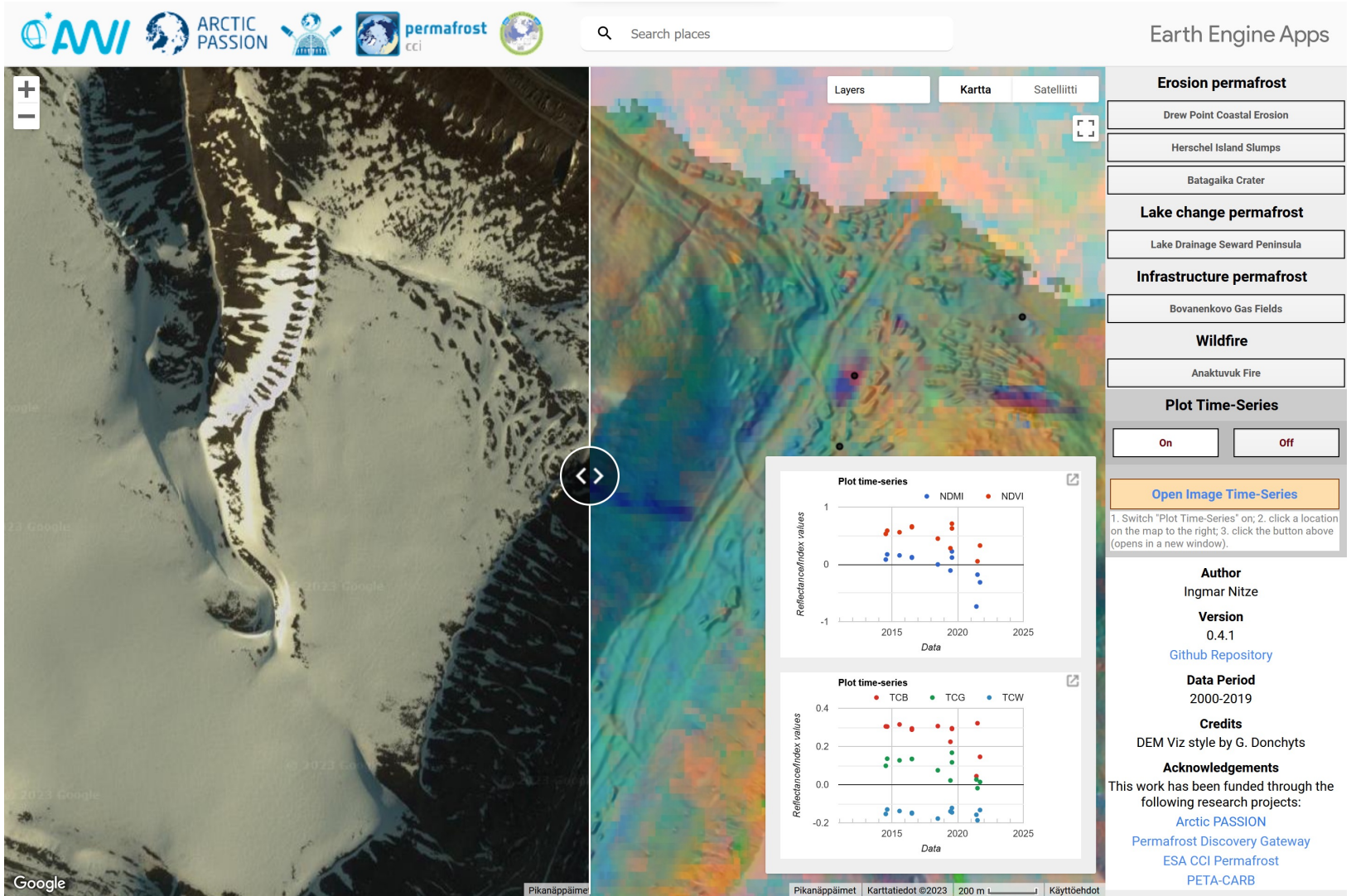
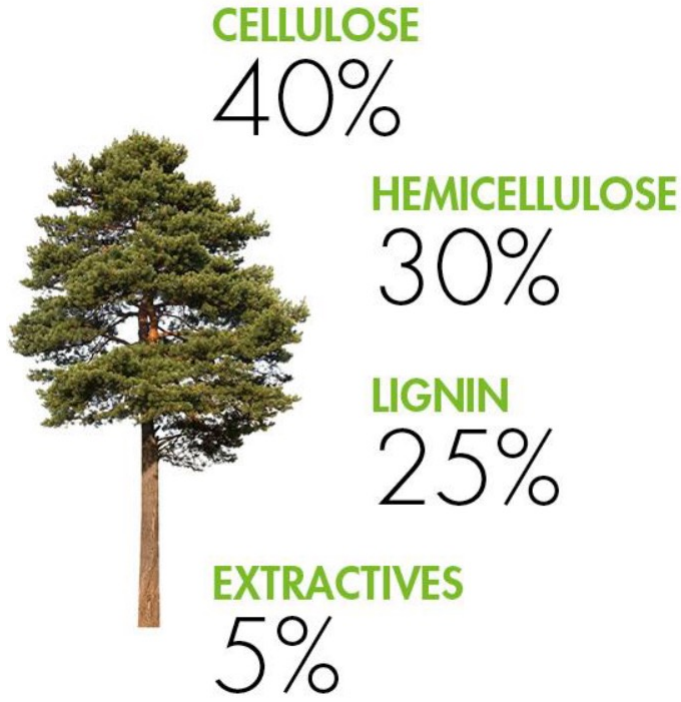
- Longyearbyen Svalbard
- Arctic Passion progress
  - Permafrost Share Arctic Variable
  - Practical application of permafrost monitoring
  - Co-design with local communities including Canadian indigenous and Svalbard municipality



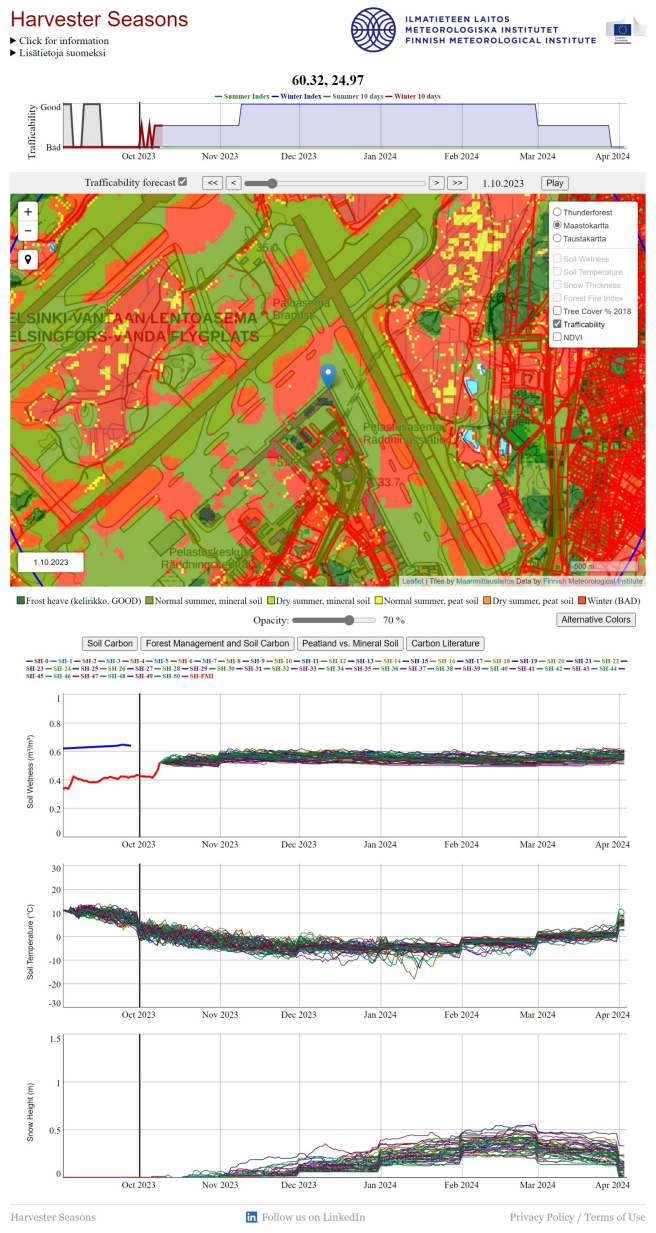
Arctic relies mostly on residential heat from wood burning

- Trees/Bioenergy is the prime source for heat and increasingly power in combined production
- Both residential and communal solutions are included, but industrial size production is connected to forestry-based biofactories for pulp, biofuels and lignin leading to non-fossil solutions: plastic, fibre,..
- Cooking is used so surplus energy is an easy gain
- Tree material is also a source for biofuels and a lot of chemicals



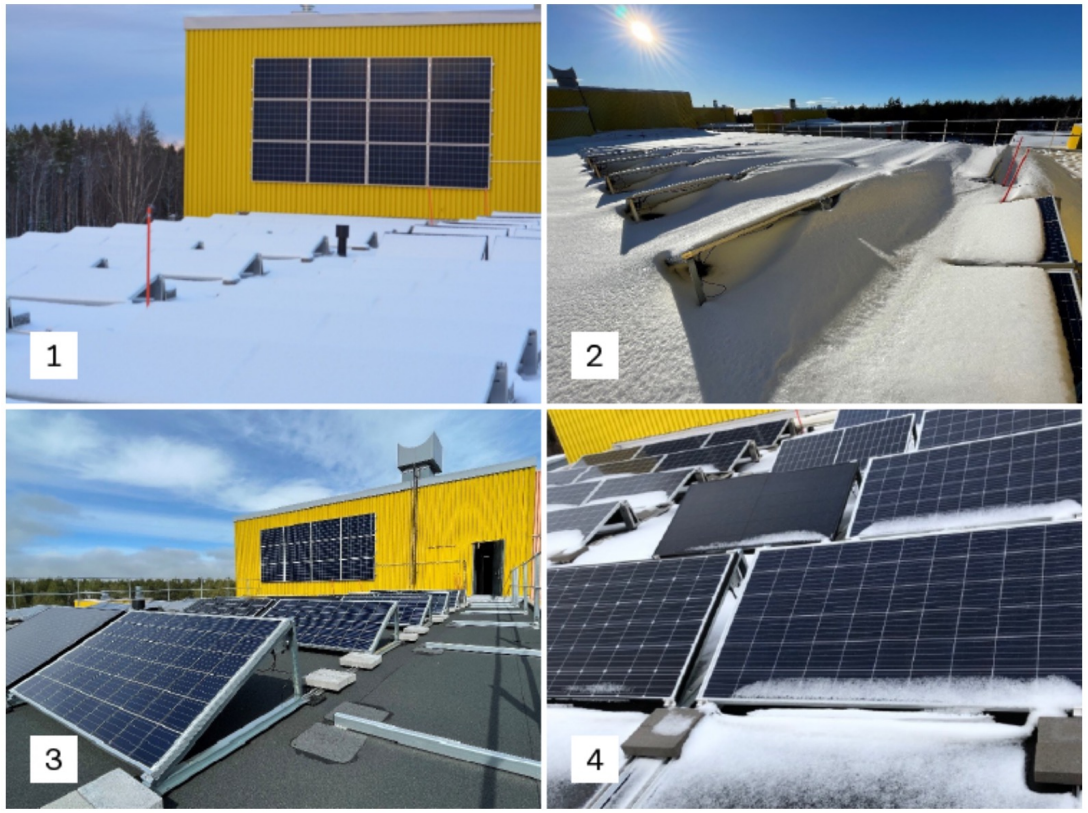
https://HarvesterSeasons.com

- Trafficability conditions and forecasts from weather and seasonal predictions
- Seasonal forecasts are based on 90% of ensemble members over/under a threshold for soil wetness, soil temperature and snow depth
- Downscaling to 16m in Finland and soon 30m in Europe is based on TWI and soil information
  - Finnish analysis is also including air-borne laser-scanning of ditches and
- Additional information is available for fireweather, NDVI and tree cover density
- Finnish forest industry is using the app for sustainable forestry and ensuring logistics for biofactory supply chains



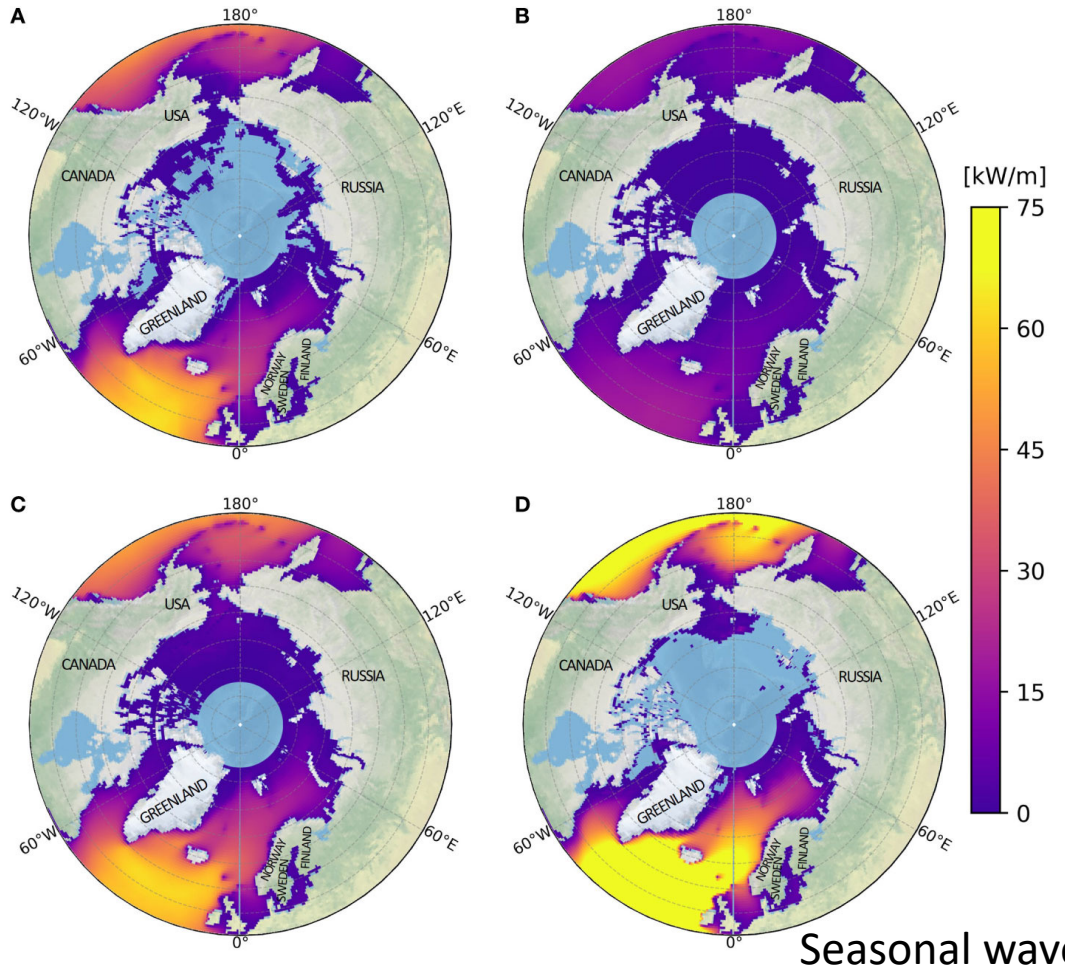
Solar power is used privately and being evaluated for larger production

- Solar is in the Arctic seasonally very variable with strong production in summer in even zero in winter
- Still residential solutions are using solar as a lot of housing is almost only used in summer
- Tilted panels are more productive, but snow removal needs solutions that don’t harm panels or their frames



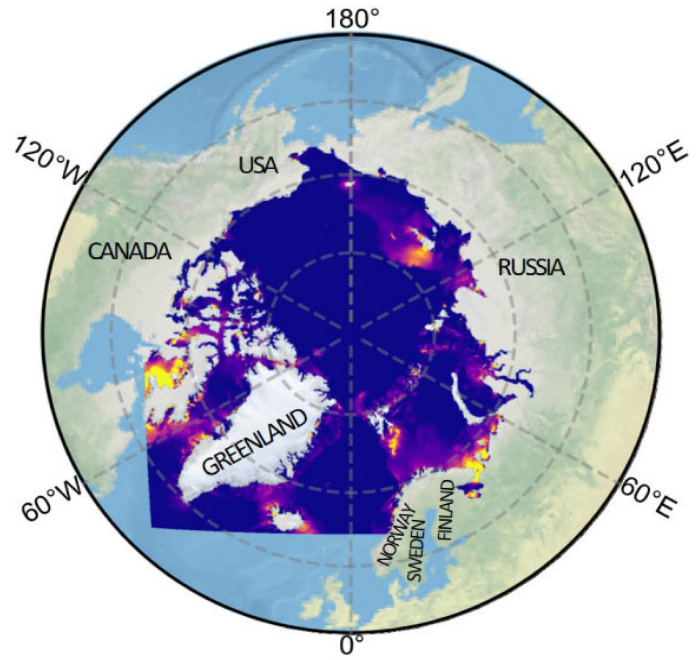
(1. Winter; 2. Spring; 3; Summer; 4. Autumn)

Arctic wave and tidal energy is scarse



Especially scientific observation networks are looking for energy from the marine environment, but solutions are not simple especially in combination with sea-ice.

Ruth Branch et al, Mar. Sci., 21 November 2022 Sec. Ocean Observation Volume 9 - 2022 | https://doi.org/10.3389/fmars.2022.970337



Maximum tidal velocity as calculated with the Tide Model Driver toolbox.

Seasonal wave power per unit crest length *J* calculated using WAVEWATCH III model output. Data are averaged from June 2014 to May 2019. **(A)** Spring: March-May, **(B)** Summer: June-August, **(C)** Fall: September-November, and **(D)** Winter: December-February

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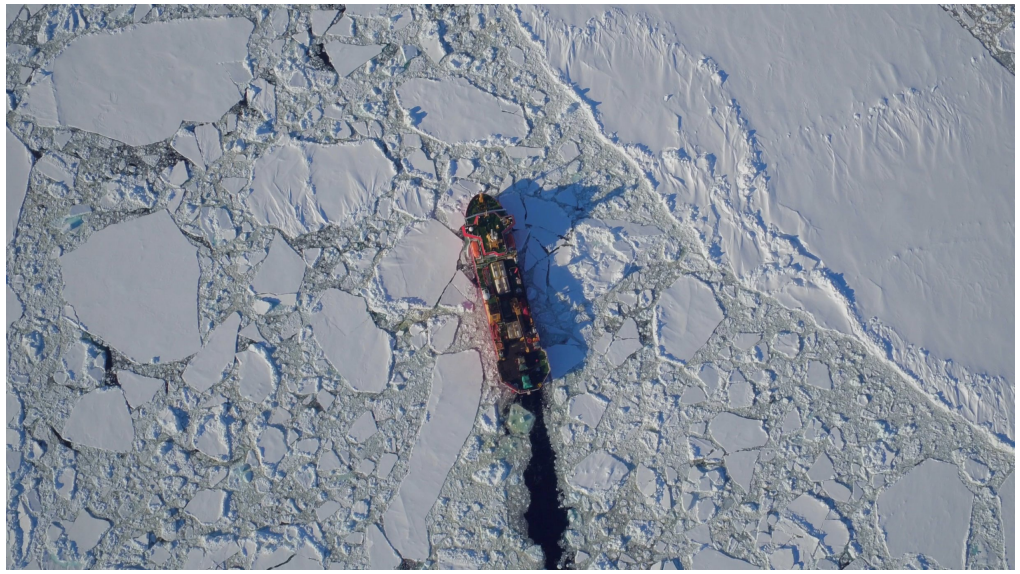
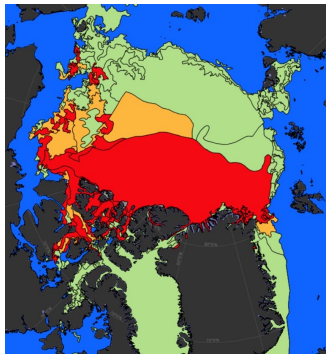
Pilot Service – Improving Safety for Shipping in the Polar Seas

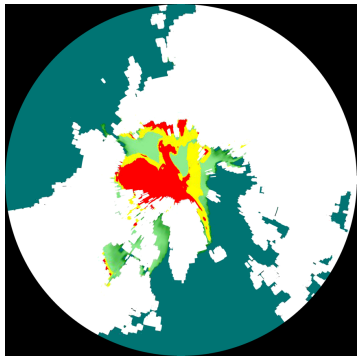
Andrew Fleming BAS and many from Univ Calgary, Univ Ottawa, Met Norway, FMI, DTU, DMI, AWI

- The pilot service aims to reduce the risk of a shipping incident by improving application of the International Maritime Organisation's (IMO) POLARIS risk assessment system.
- to improve understanding of POLARIS application and usefulness for all maritime operators in the Arctic.
- Developments are co-designed and developed with AC PAME, national ice services, ship owners and operators, insurers and marine safety organisations.



BAS ship RRS Ernest Shackleton navigating through heavy sea ice





examples of POLARIS risk assessment from ice chart (left) and POLARIS forecast (right).

The pilot service comprises three components.

- Historical analysis of shipping risk in the Arctic by comparing a record of ship movements with concurrent POLARIS risk assessments.
- Improving the delivery of current sea ice information to ships by combining position data from satellite AIS information.
- Assessing the usefulness of POLARIS forecasts based on sea ice forecasts.

polarview.aq/arctic

Conclusion

- Arctic is in Europe an energy exporter and the potential is comparable in many parts of the Arctic
- European projects Arctic Passion, e-shape, Destination Earth and national projects are developing concrete services for the challenges involved

- Forecasting renewables with ML and weatherforecasts is highly successful, Helsinki solar and all wind power in Finland per hour
- Very good predictions of electricity price as well