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Sub-seasonal and seasonal prediction service for tyre companies in Finland

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10th Arctic Climate Forum, October 26-27, 2022



EuroGEO



GROUP ON
EARTH OBSERVATIONS



Motivation

- Winter tyres must be used from 1 November to 31 March if the weather and road surface conditions require it
 - time of winter tyres' installation varies from year to year
- Tyre companies and tyre change garages rely on short-term weather forecast
- Tailored sub-seasonal and seasonal forecasts would facilitate the preparedness of tyre companies and public, and assist safety driving

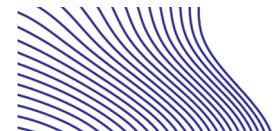


The screenshot shows a news article from Yle. The header includes the Yle logo and navigation links: Uutiset, Areena, Urheilu, Menu. The article title is "Winter's sudden onset causes tyre change rush". The text states: "Winter arrived to southern Finland in a hurry last Wednesday, leading to even longer queues at tyre changing garages in the capital area last week. A manager who's worked at a Helsinki tyre shop for the past 12 years said that last week was the busiest that he could remember." Below the text is a photograph of a dark blue car in a tyre shop with several workers and stacks of tires. The image credit is "Image: Antti Mikkola / Yle". The date is "6.11.2016" and it was updated on "7.11.2016 18:03".



been very busy at his the tyre shop where he works. Last Monday.

as the busiest day," he said on Friday, saying that the schedule for a tyre change would be later next week.



Cars queuing for winter tyre change in Espoo, 1.11.2016

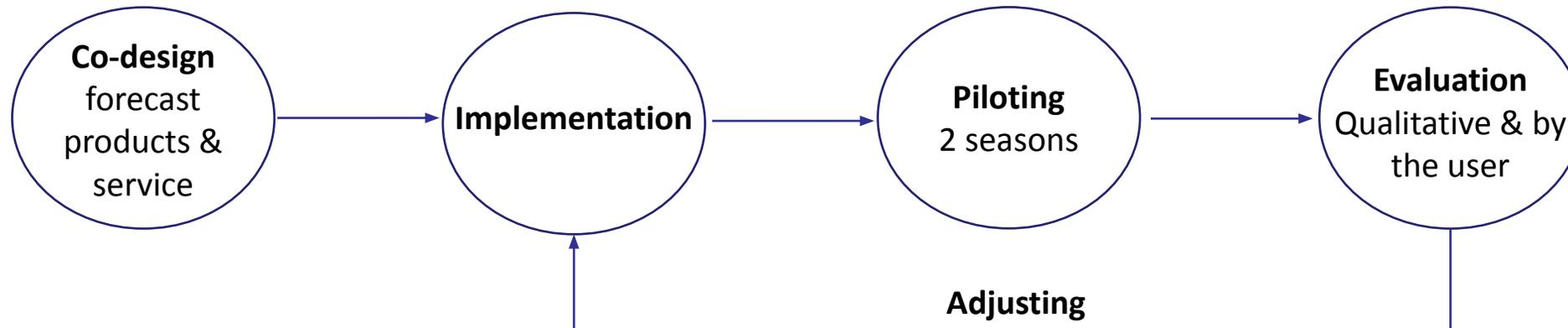


Objective

To **create an operational user-oriented climate service** providing tailored sub-seasonal and seasonal predictions for winter tyre season and safety driving conditions → sustainable in the long run

To **assess the applicability of sub-seasonal and seasonal forecast products** for transportation sector

Co-production of the service through an iterative strategy



User engagement was a key aspect in service production

WE ARE VIANOR – SAFE JOURNEYS!

THE LARGEST TIRE AND CAR SERVICE CHAIN IN THE NORDICS
170 own service centers & 140 partners

FULL RANGE OF TIRES, TIRE & CAR SERVICES AND SOLUTIONS

SUSTAINABILITY AND SAFETY ALL THE WAY
people environment safety

100% OWNED BY NOKIAN TYRES
Nordic conditions and our long history have shaped our skills and thinking

COMMITTED TO SERVE
EASY RELIABLE FRIENDLY

Customer promise:
YOU CAN CONCENTRATE ON WHAT'S IMPORTANT TO YOU.

VIANOR

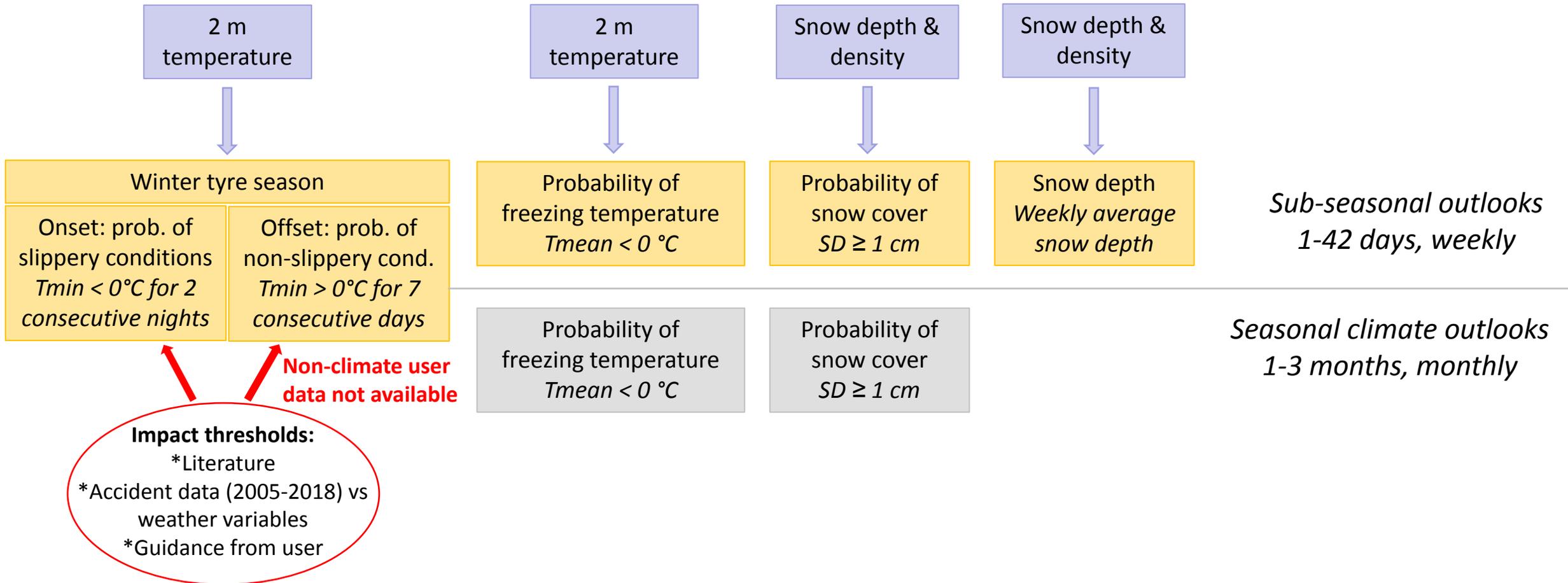
How can Vianor utilize the climate information in their business and what are the benefits?

- S2S forecasts would allow to better prepare operations for the high season
 - season management and seasonal workers
 - customer communications on time of tyre change
 - marketing activities
- Add value to Vianor's B2C and B2B customers for a safe journey and better customer experience

Dynamical engagement of Vianor through scoping workshop, periodic meetings, mail exchanges, service demonstration:

- Assess Vianor's needs => sub-seasonal forecast preferred over seasonal
- Select and co-design of tailored forecast products (sub-seasonal and seasonal outlooks)
- Design the visualization and delivery => simple visualization through maps
- Testing the service and providing feedback during and after the pilot season

Essential climate variables → Tailored sub-seasonal and seasonal outlooks



Data sources and production of sub-seasonal and seasonal outlooks

Sub-seasonal forecast data: ECMWF EPS

- ✓ re-forecasts (2000-2019) from MARS
- ✓ real time forecasts fetched through ECMWF dissemination
- ✓ time-range 46 days, updated twice a week
- ✓ 51 ensemble members, spatial resolution 0.4°

ERA5 reanalysis (2000-2019) from C3S CDS: for evaluation and calibration

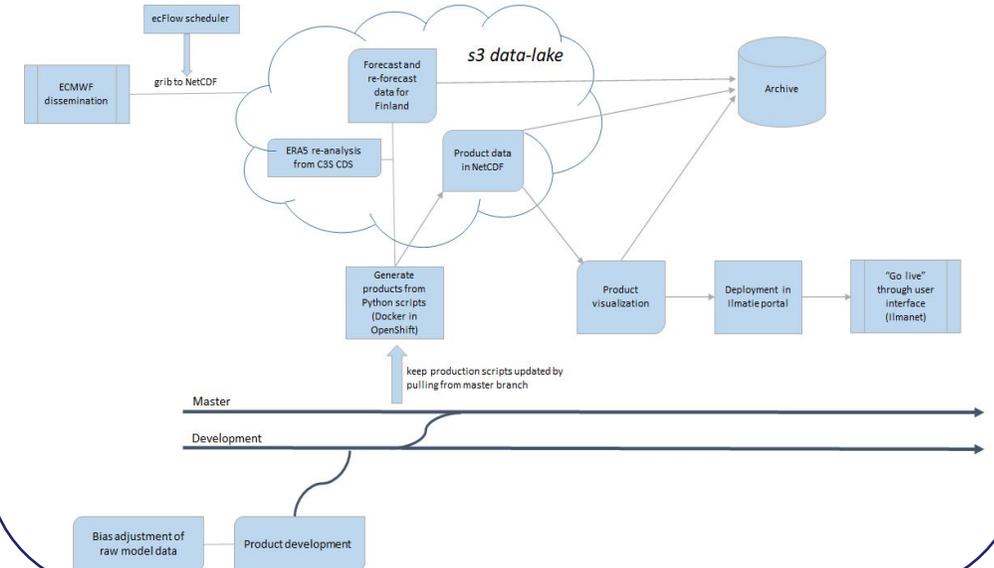
Gridded observational data (2000-2019) for pilot evaluation

Seasonal forecast data: ECMWF SEAS5

- ✓ re-forecasts (2000-2019) from MARS, spatial resolution 0.25°
- ✓ real time forecasts from C3S, spatial resolution 1°
- ✓ 51 ensemble members, updates on 13th of every month

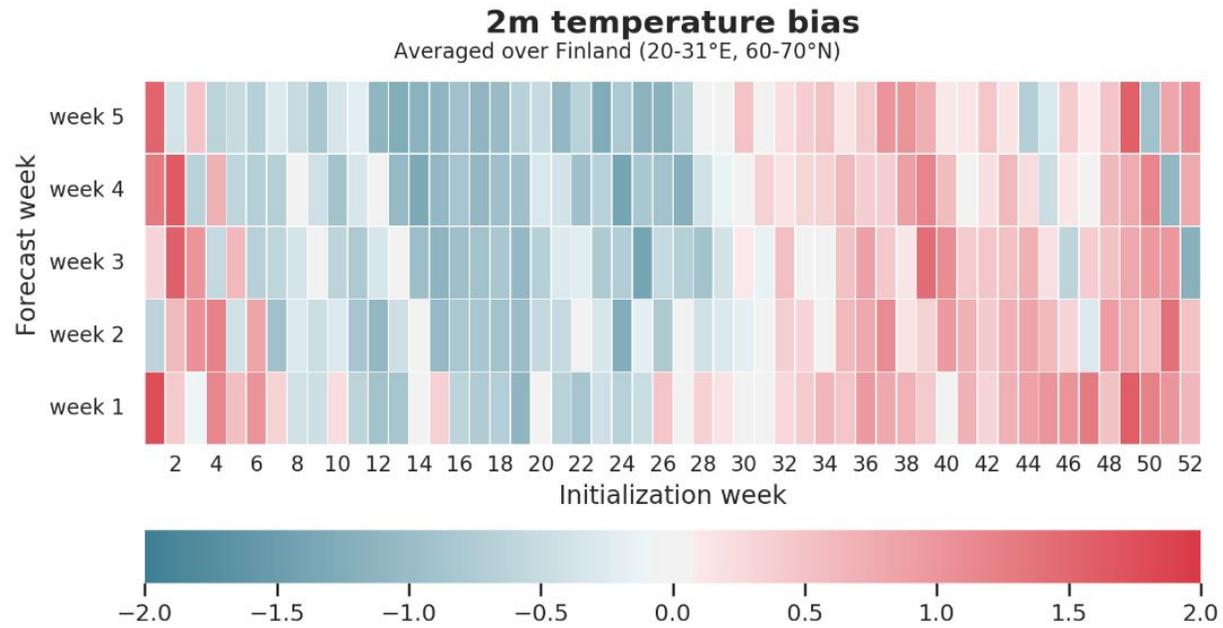
ERA5 reanalysis (2000-2019) from C3S CDS: for evaluation and calibration

Operational service set up and running on FMI server, disseminated on Ilmanet platform (FMI)



Service runs on WEkEO platform (Copernicus DIAS service), disseminated on FMI web-portal:
<https://seasonal.fmi.fi/e-shape/vianor/>

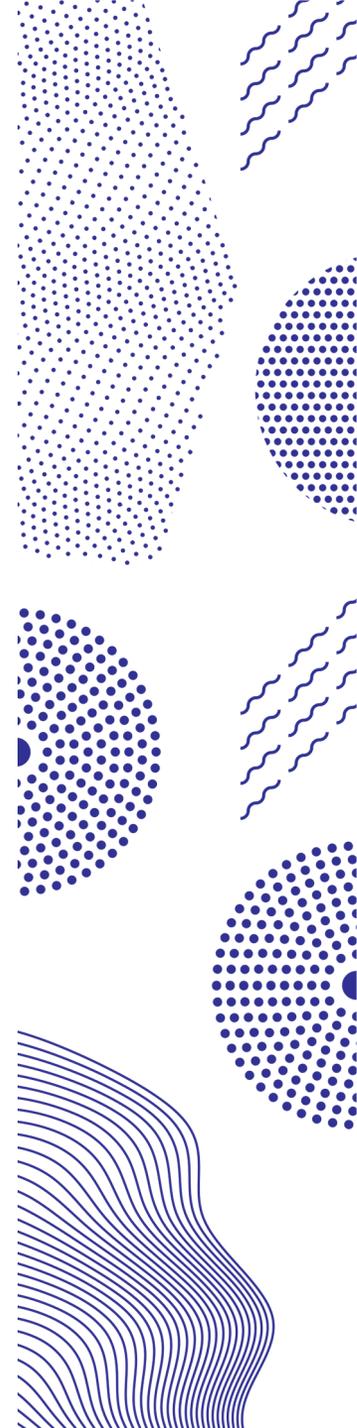
The prediction skill of raw sub-seasonal and seasonal forecasts data is assessed and improved through bias correction



ECMWF EPS 2m temperature re-forecasts compared to ERA5 reanalysis (2000-2019)

There is a strong **warm bias during autumn and winter**, **cold bias during spring**

All the variables are quality assessed and systematic errors from the raw model data are reduced through post-processing before producing the forecast products



Forecast quality assessment and bias adjustment (1)

Sub-seasonal forecast data

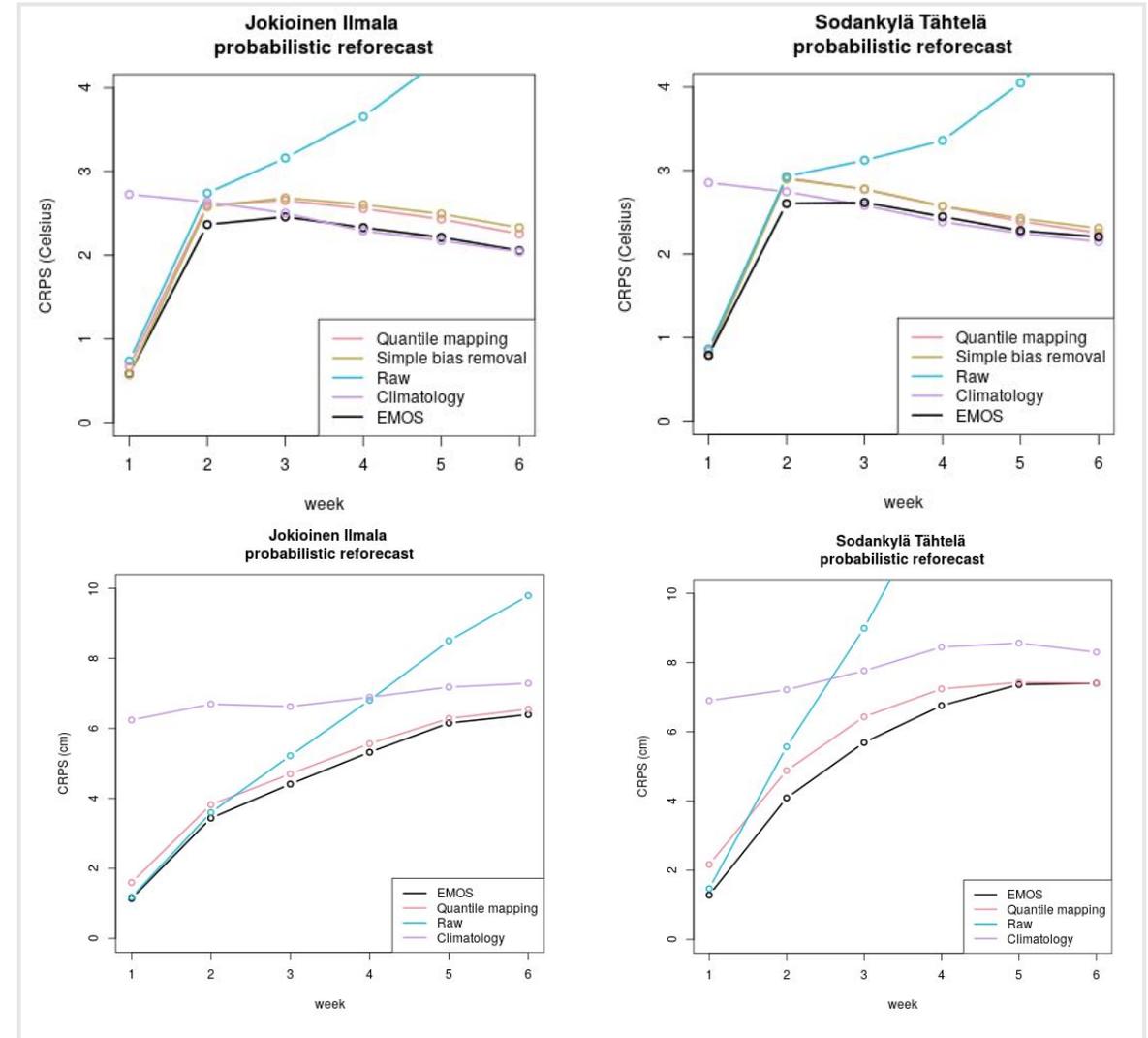
Bias adjustment methods used to remove model errors: simple bias removal, empirical quantile mapping and EMOS

Forecast evaluation: CRPS and RMSE (for 7 locations)

Temperature forecasts generally have skill up to 2 weeks
→ mean bias removal applied in production

Snow forecasts generally have skill up to 4-6 weeks
→ quantile mapping applied

Skill scores for the raw forecasts and applied bias adjustment methods



Forecast quality assessment and bias adjustment (2)

Seasonal forecast data

Skill assessment using original spatial resolution (0.25°)

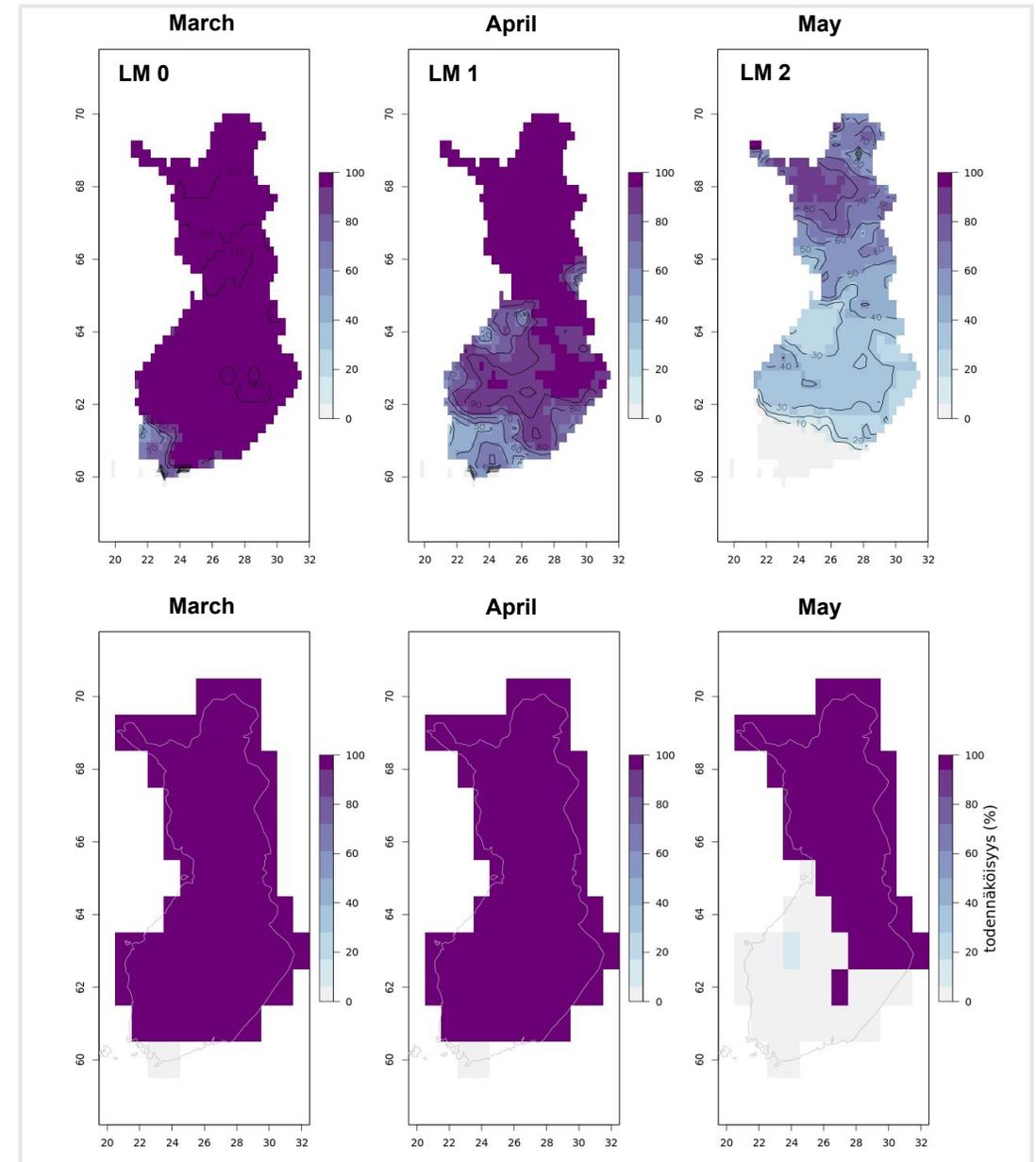
Bias adjustment methods tested: empirical quantile mapping, variance, EMOS and scaling (for T2m)

Forecast evaluation: CRPS (aggregated for all grids)

EMOS applied in production for **2m temperature** and **snow depth**

Forecasts of the probability of snow corrected with EMOS from MARS data (top) and CDS data (bottom)

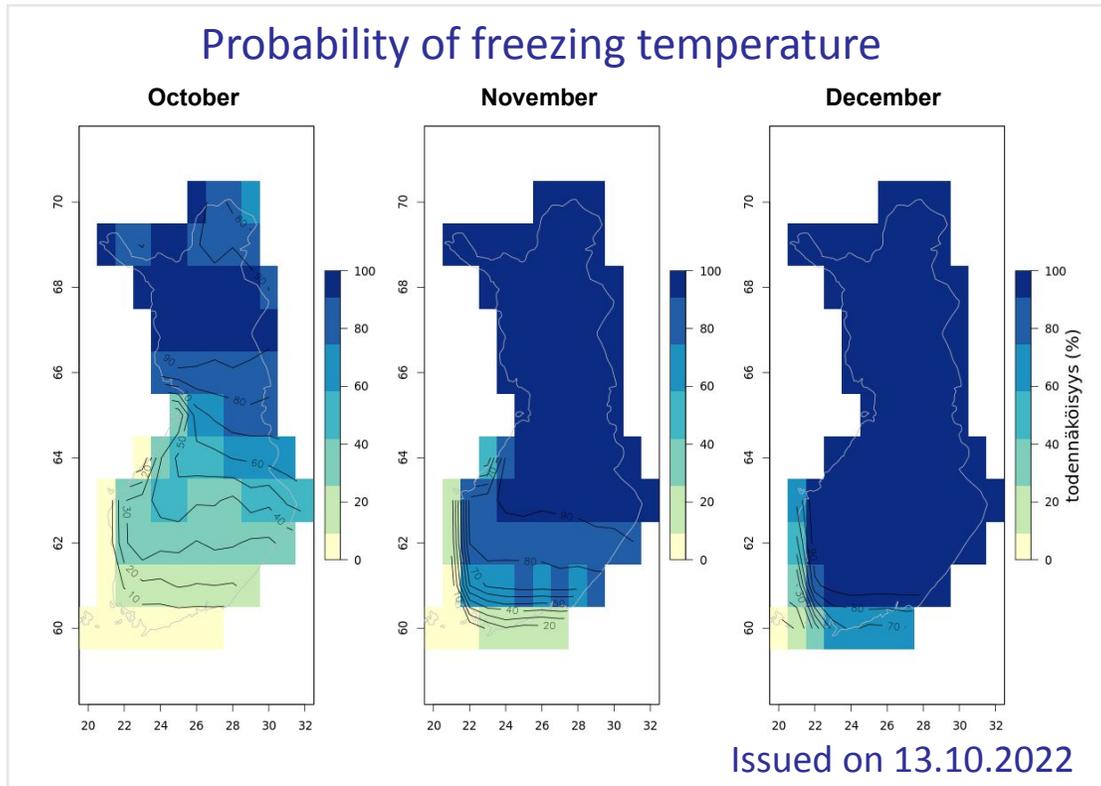
→ reduced spatial resolution of CDS data influences the quality of snow forecast



Seasonal climate outlooks produced and disseminated on FMI web-portal

Released in Jan 2021: <https://seasonal.fmi.fi/e-shape/vianor/>

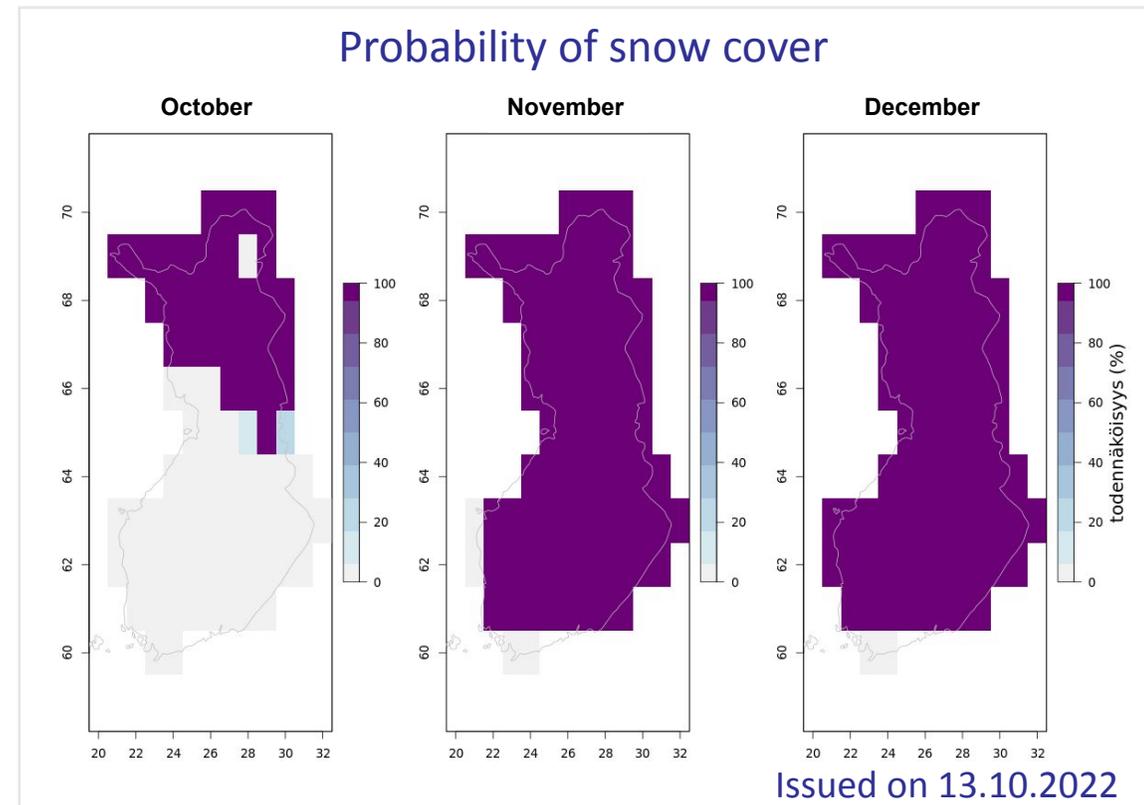
Probability of freezing temperature



The **freezing temperature seasonal climate outlook** predicts the likelihood of monthly mean temperature at 2m height being below 0°C for three months ahead through three monthly forecasts. Values over 80% suggest very high probability.

The **snow cover probability seasonal climate outlook** predicts the likelihood of at least 1 cm of monthly mean snow depth for three months ahead through three monthly forecasts. Values over 80% suggest very high probability.

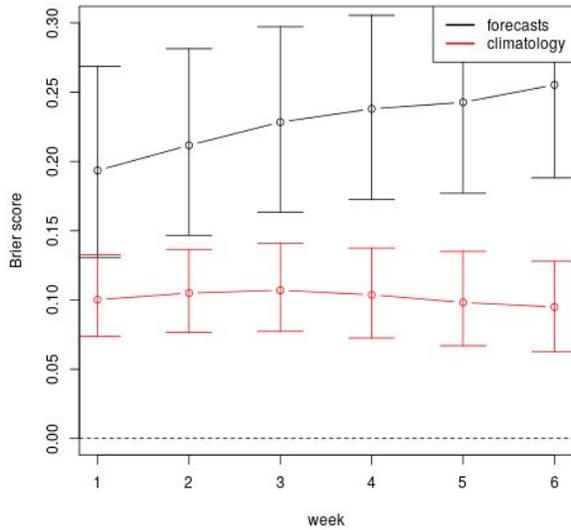
Probability of snow cover



Updates on the 13th of each month.

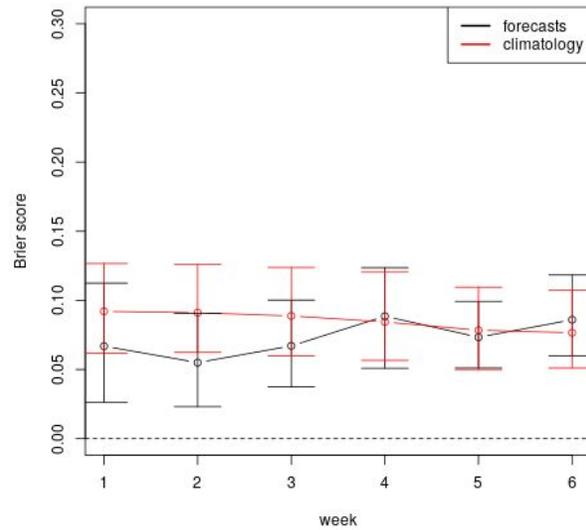
Evaluation of sub-seasonal outlooks from pilot seasons 2020-2021 and 2021-2022

Probability of freezing temperature
Jyväskylä



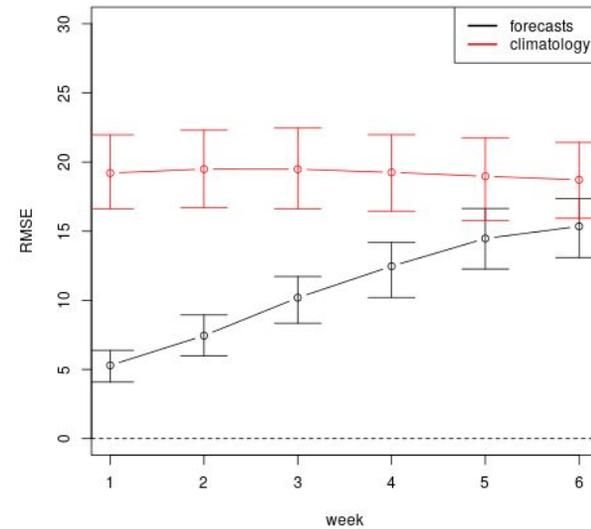
Climatology beats forecast

Probability of snow cover
Jyväskylä



Forecast performed well, larger amounts of snow are underestimated

Snow depth
Jyväskylä



Evaluation against
observations and climatology

Verification scores:
Brier score, reliability and
RMSE

Climatology = 20 years of
gridded observational data

Barriers in winter tyre season outlook verification: lacking user data on the time of tyre change
→ no reference data to validate the criteria applied and evaluate the product

User feedback and uptake of the service

Vianor has planned the usage of the tool in different situations, but the forecast products were not tested in operational work

“Useful tool, but we must understand better the reliability of the forecasts and how to utilize it.”

“Including the service to Vianor’s operational workflow is challenging. The needed development to link the forecast products wasn’t possible to the current economical situation.” → Unpreparedness/lack of resources for needed technical development

“Skill of forecast not good enough, for operational work high probabilities needed for 4-5 weeks ahead and more regional information”. → Limitations of forecast quality / resolution

“No business case found for utilizing the tailored climate information.”

Summary and lessons learned

- 1.** Prediction skill of sub-seasonal temperature and snow improved with post-processing, but the skill of temperature is still limited to week 2-3, better predictability for snow → promising results for snow-based products
- 2.** Prediction skill of seasonal temperature and snow also improved with bias adjustment, snow has better skill → coarse-resolution snow forecasts from CDS might not be as useful as the full-resolution forecasts
- 3.** Reliability of sub-seasonal forecast models needs further improvement to meet business expectations
- 4.** Although Vianor won't utilize the sub-seasonal and seasonal outlooks, the service could be valuable for other users from transport sector → transferred to FMI's Customer Service for further marketing
- 5.** Building the trust in the products and increase their uptake takes time



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More about the service:

Vajda A., Hyvärinen O., Rantanen M., Tack A., Silvennoinen M.: Seasonal preparedness pilot – Sub-seasonal and seasonal prediction service for tyre companies, FMI's Climate Bulletin: Research Letters, vol 4, issue 1, DOI: <https://doi.org/10.35614/ISSN-2341-6408-IK-2022-02-RL>

Link with the e-shape showcases and pilots:

<https://e-shape.eu/index.php/showcases/pilot7-5-seasonal-preparedness>

<https://helpdesk.e-shape.eu/>

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