



Weather forecasting during Arctic expeditions: Experiences from ARTofMELT

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Sofia Hellstrand, Uppsala University
The ARTofMELT Science Team
Swedish Polar Research Secretariat,
captain Mattias Petersson and the crew of *Oden*



Atmospheric Rivers and the onset of Arctic Melt

We wanted to know:

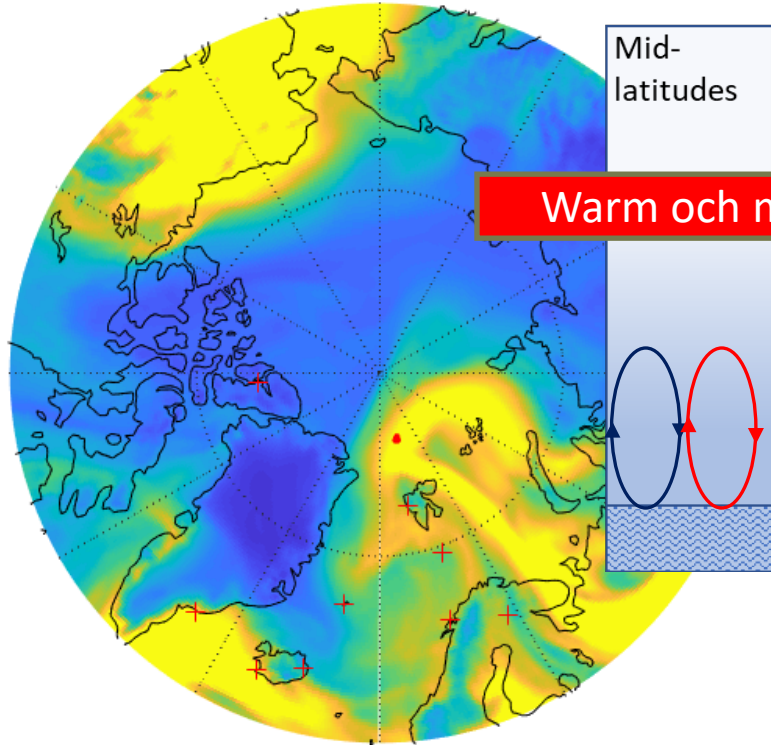
- What is the impact of atmospheric rivers on the surface energy budget in spring?
- Can an atmospheric river trigger the annual melt onset?
- How is surface melt first manifested, and how does it play out in time?
- What processes are key for starting the melt?

Atmospheric rivers and the onset of Arctic Melt

Episodic intrusion of warm and moist air from the south & air mass transformation

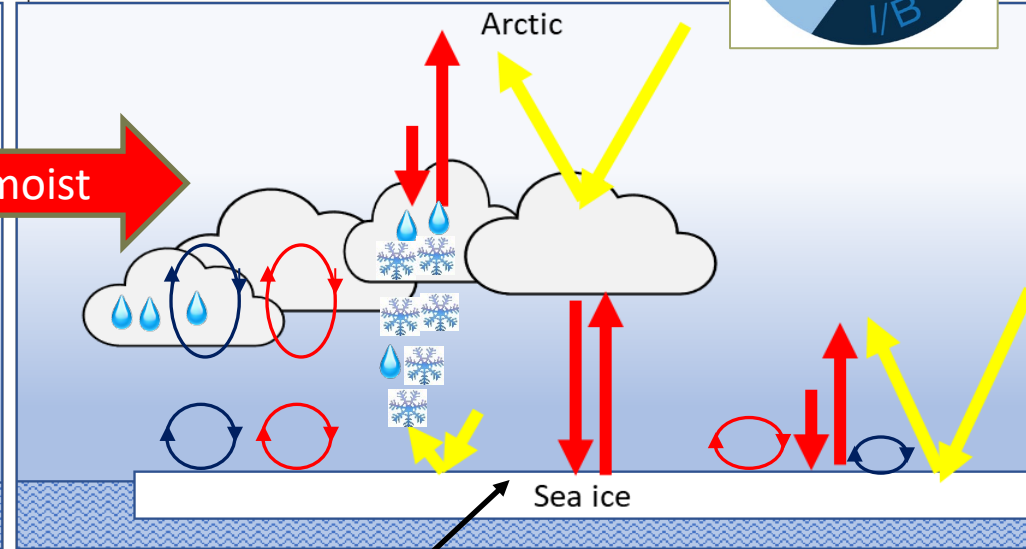
2020-04-16 00:00

Integrated water vapor



Mid-latitudes

Warm och moist

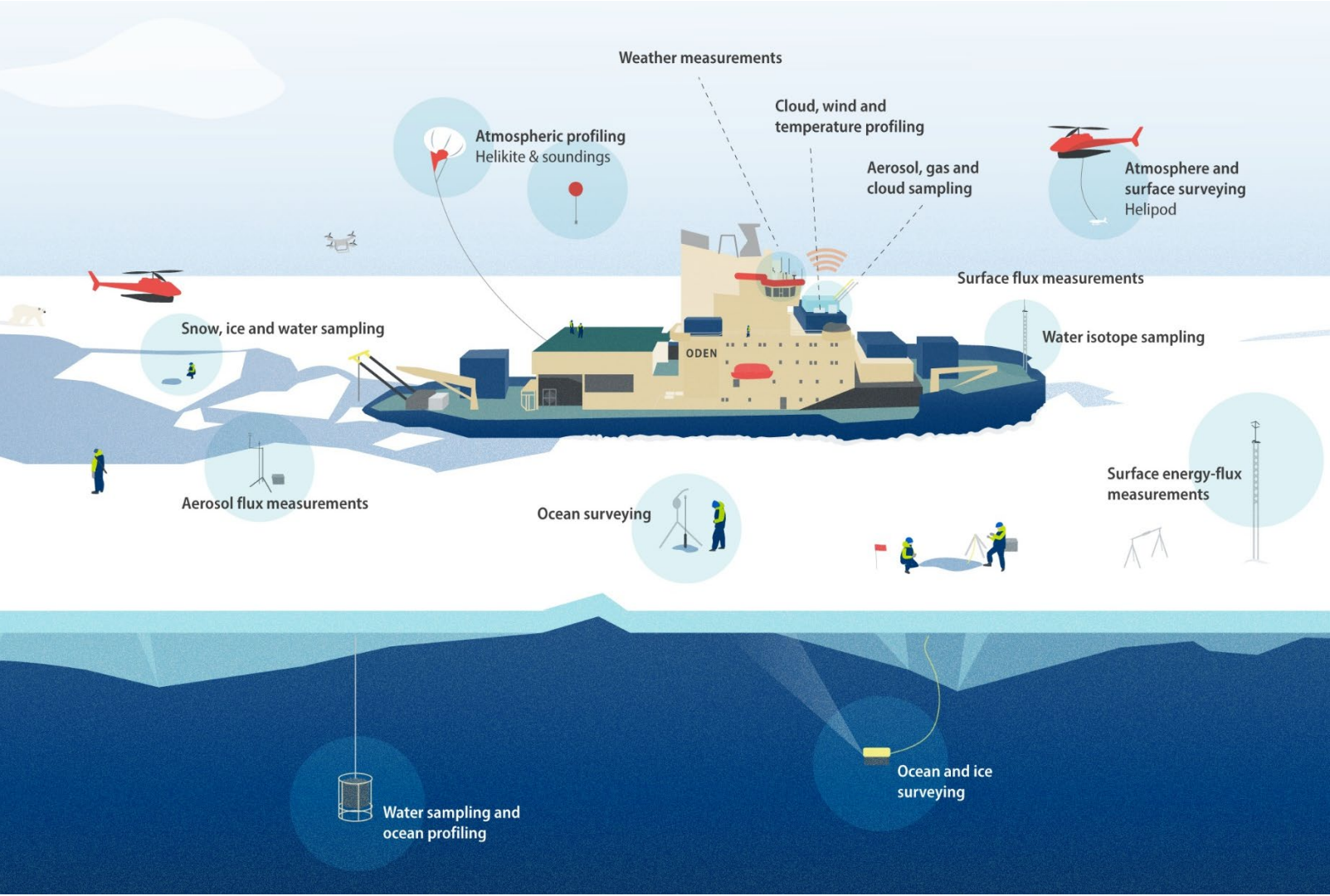


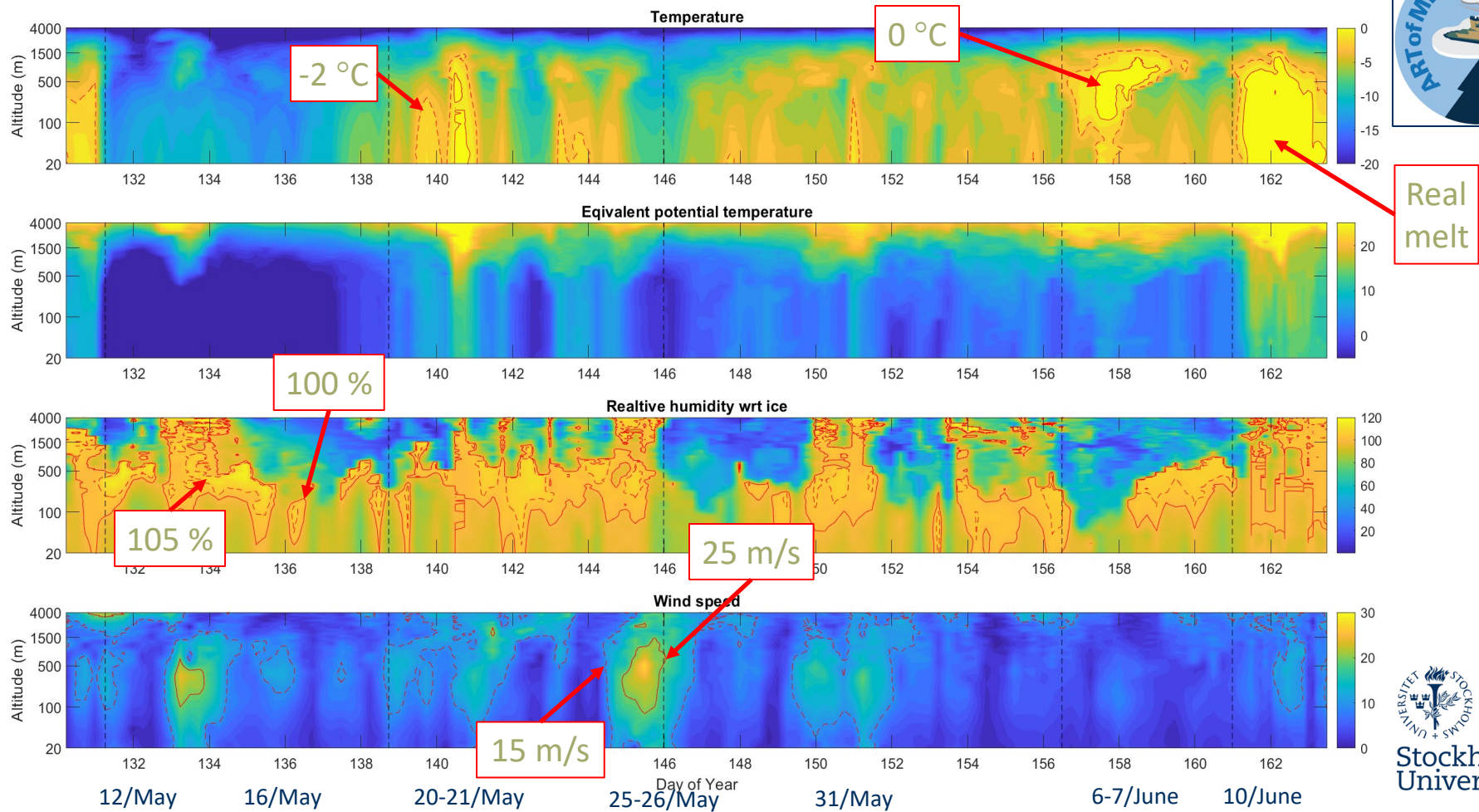
Arctic

Sea ice

Surface energy budget...





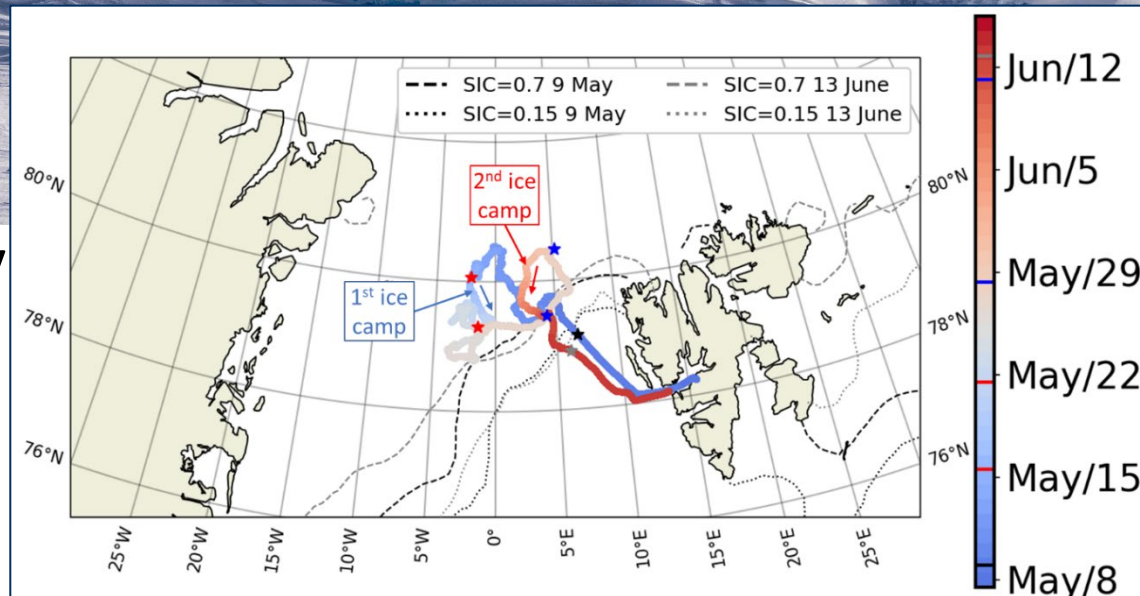


What we needed...

- Advance notice on the arrival of “warm air intrusions” for where to navigate; NB, bandwidth using Iridium (pre-Starlink) was limited

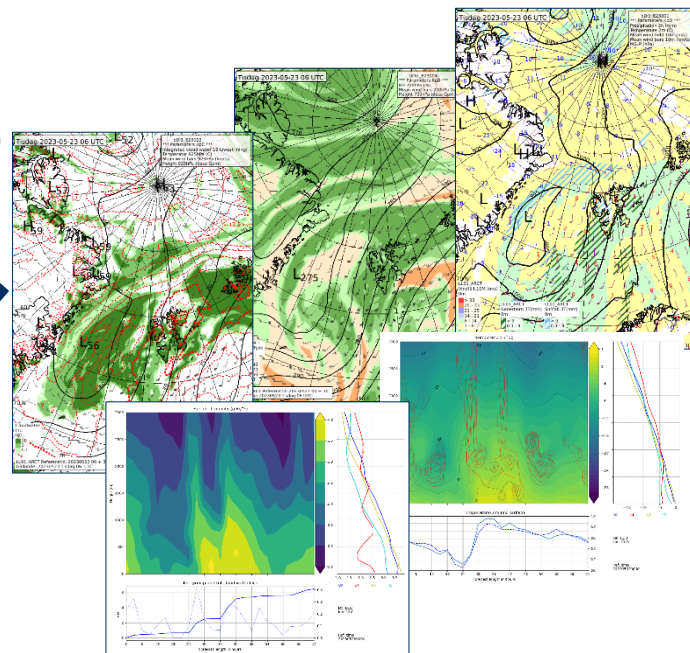


Unexpectedly
difficult ice!



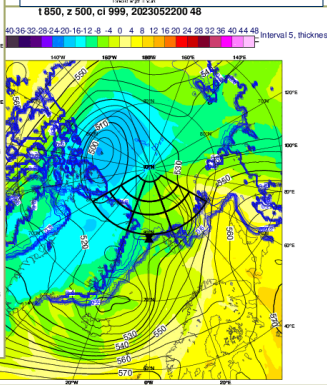
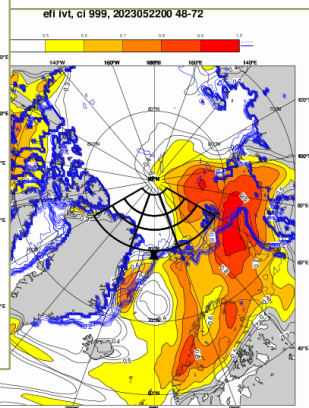
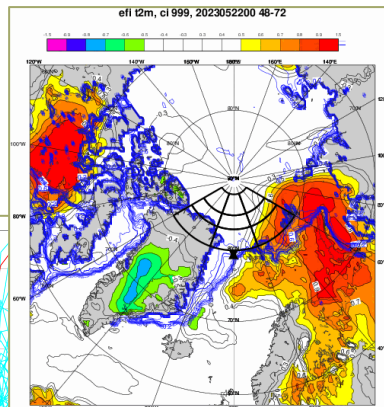
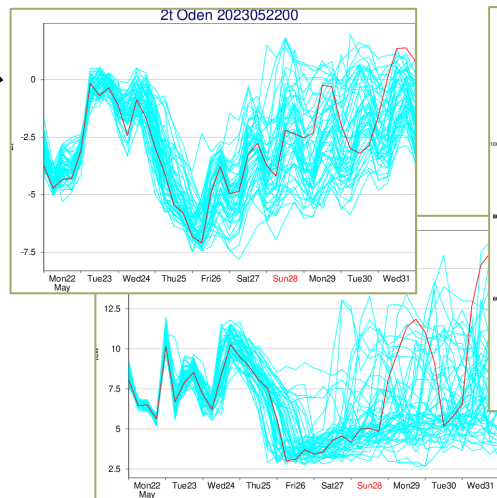
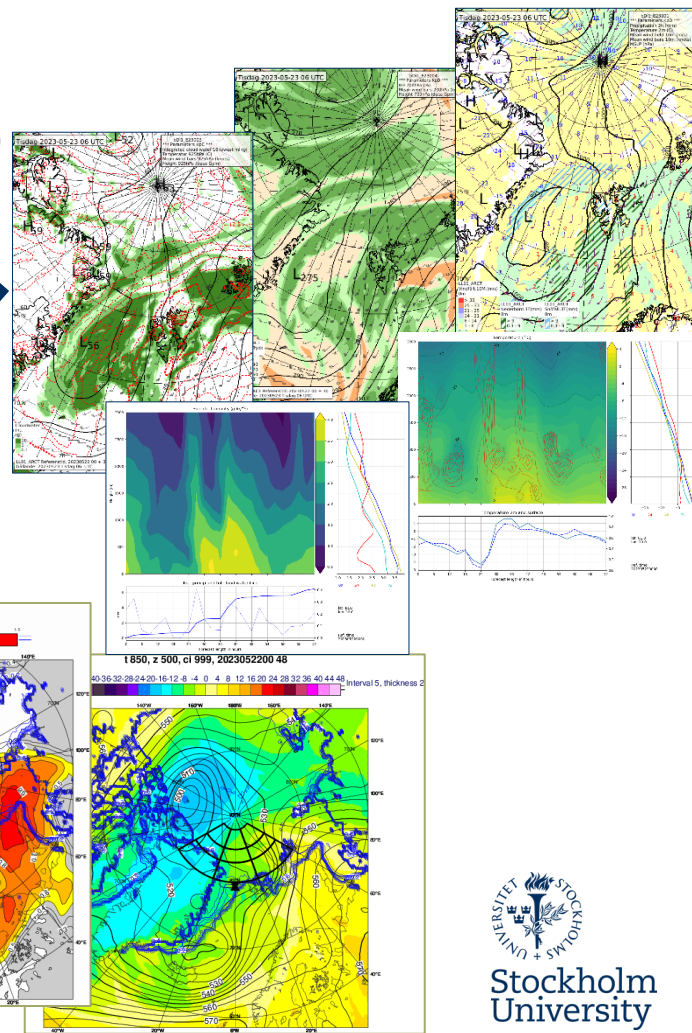
What we needed, what we had...

- Advance notice on the arrival of “warm air intrusions” for where to navigate; NB, bandwidth using Iridium (pre-Starlink) was limited
- For this we had:
 - Deterministic forecast from ECMWF through SMHI and Arome Arctic from Met Norway for daily planning (also operational meteorologist available; NB mostly for navigation and helicopter operations)



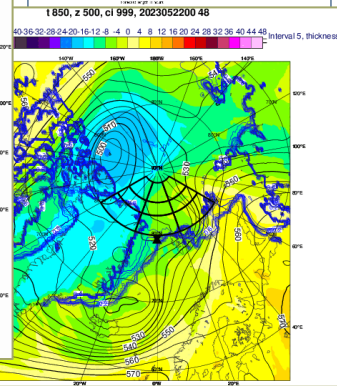
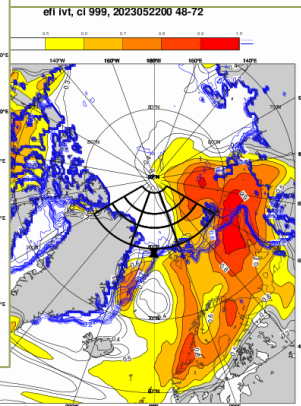
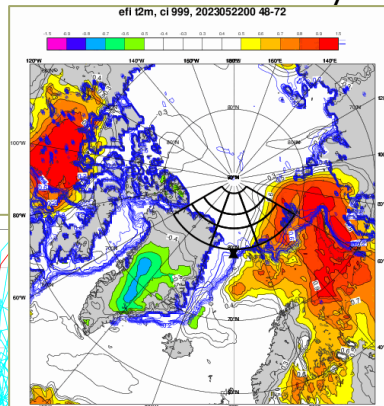
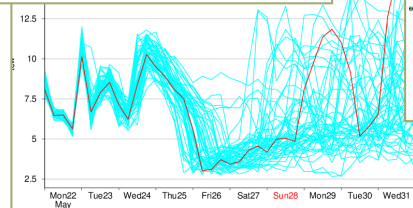
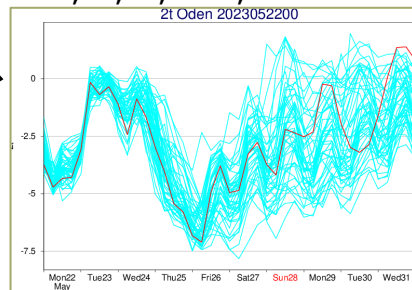
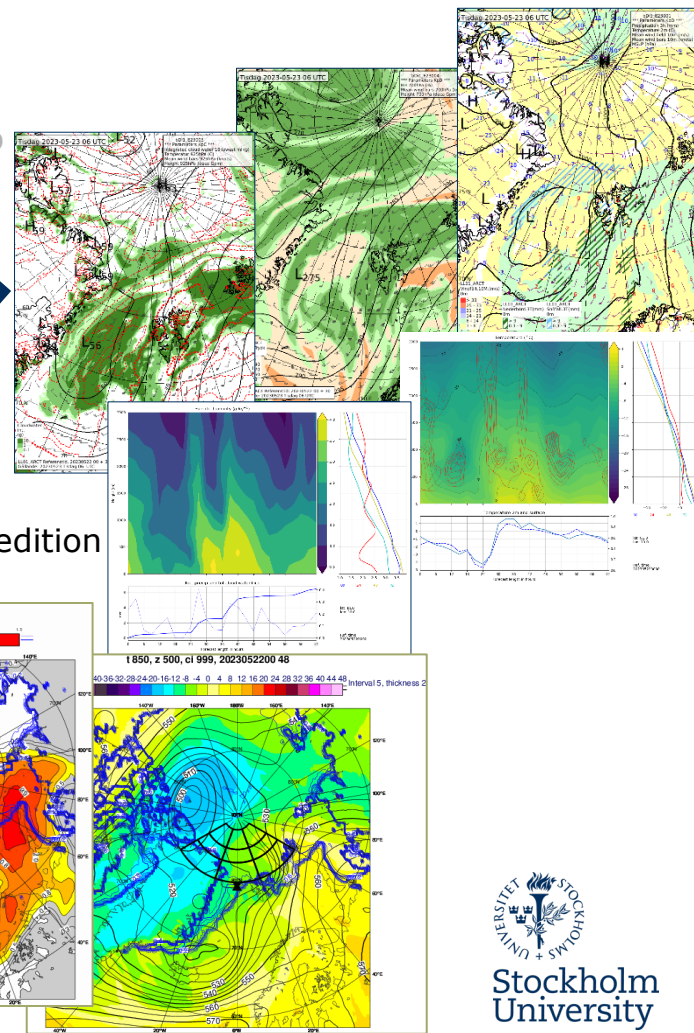
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 - ECMWF ensemble forecasts for Oden’s position and averages and EFI for select variables for area for day 2, 5 & 7.



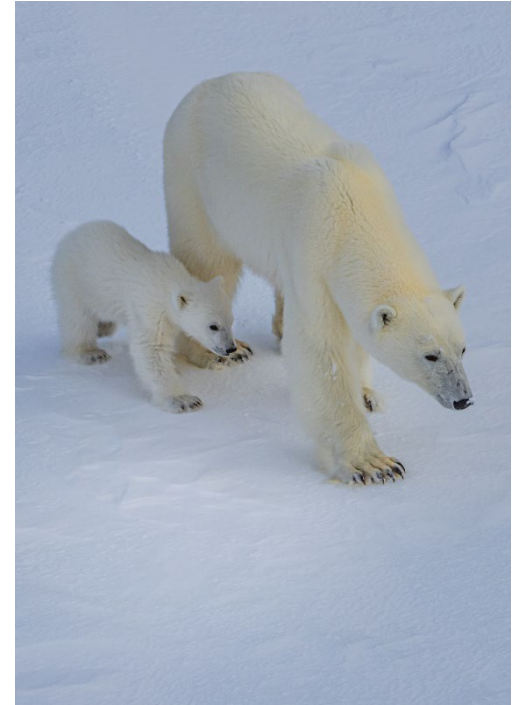
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- For this we had:
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 - ECMWF ensemble forecasts for Oden’s position and averages and EFI for select variables for area for day 2, 5 & 7.
 - Established a virtual forecast office issuing text forecast for day 1, 2, 3, 4-5, 6-7 and outlook for next week. Dry run before expedition



What we needed, what we had – and how it worked

- Advance notice on the arrival of “warm air intrusions” for where to navigate; NB, bandwidth using Iridium (pre-Starlink) was limited
- For this we had:
 - Deterministic forecast from ECMWF through SMHI and Arome-Arctic from Met Norway for daily planning
 - ECMWF ensemble forecasts for Oden’s position and averages for select variables for area for day 2, 5 & 7.
 - Virtual forecast office issuing text forecast for day 1, 2, 3, 7 and an outlook for next week. Dry run before expedition
- Daily planning cycle:
 - Day N-1, 17 UTC: Work package leader meeting...
 - Day N, 07 UTC: Steering group meeting, deterministic forecasts ftp → plan of the day
 - Day N, 08.30 UTC: All hands briefing (after breakfast)
 - Day N, 10 – 11 UTC: Ensemble forecast and outlook available, decision time!
 - Alternative 1: Work proceed, cycle repeats...
 - Alternative 2: Work on ice interrupted, all onboard by 18 UTC and ship is moved

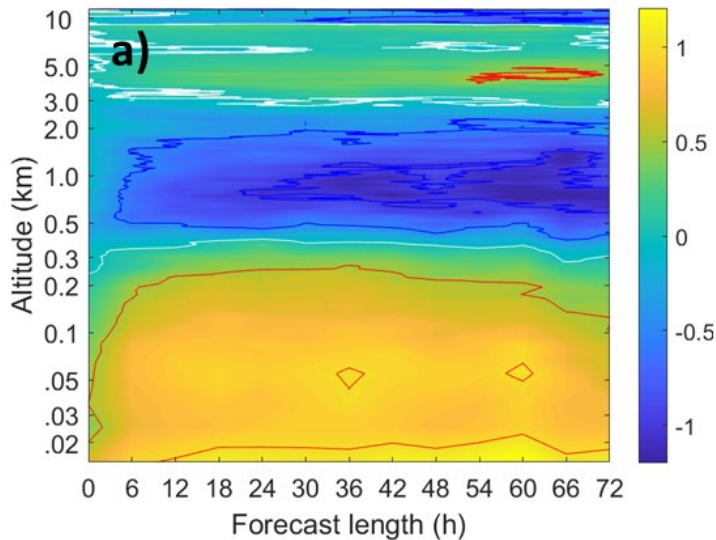


What we needed, what we had – and how it worked

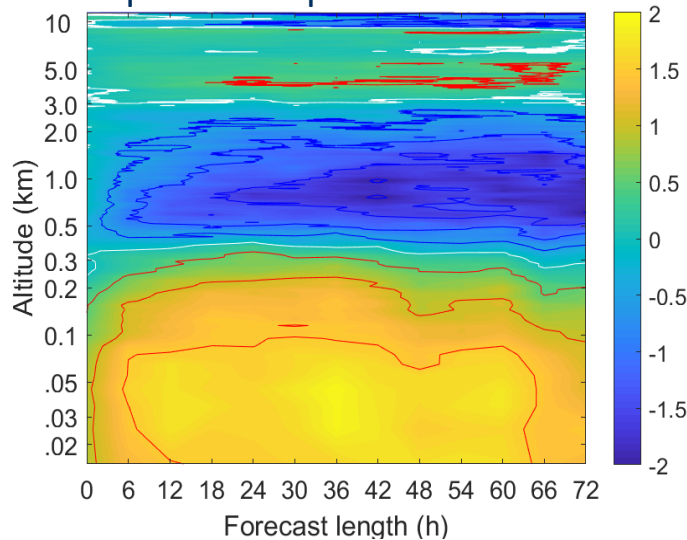


The Arctic Ocean 2018 detour (mid-Aug to mid-Sept, 2018)

Temperature error



Eq. Pot. Temperature error



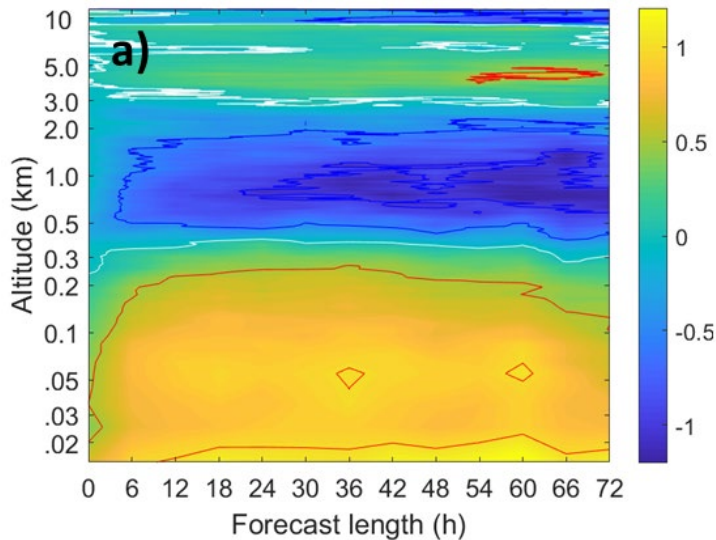
Tjernström et al. 2021

What we needed, what we had – and how it worked

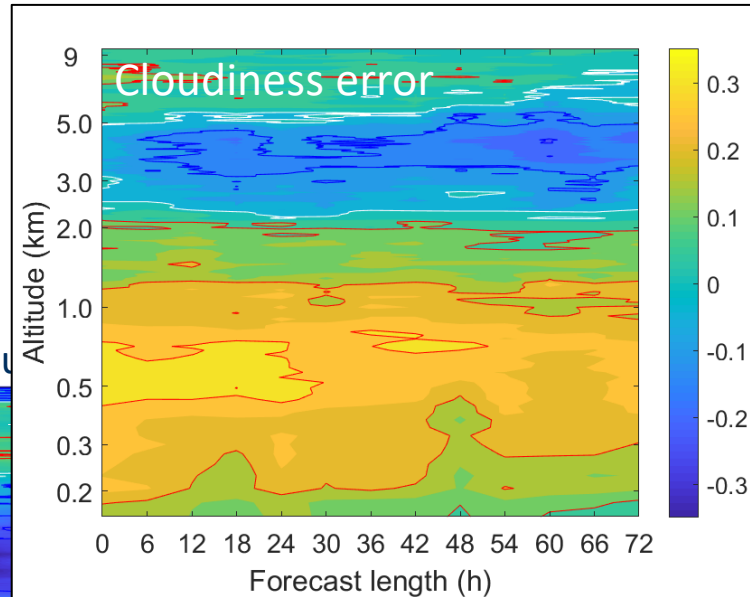
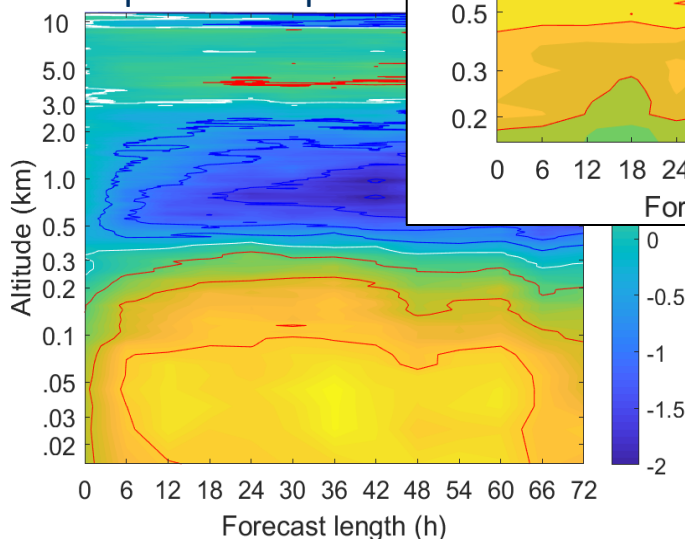


The Arctic Ocean 2018
detour

Temperature error

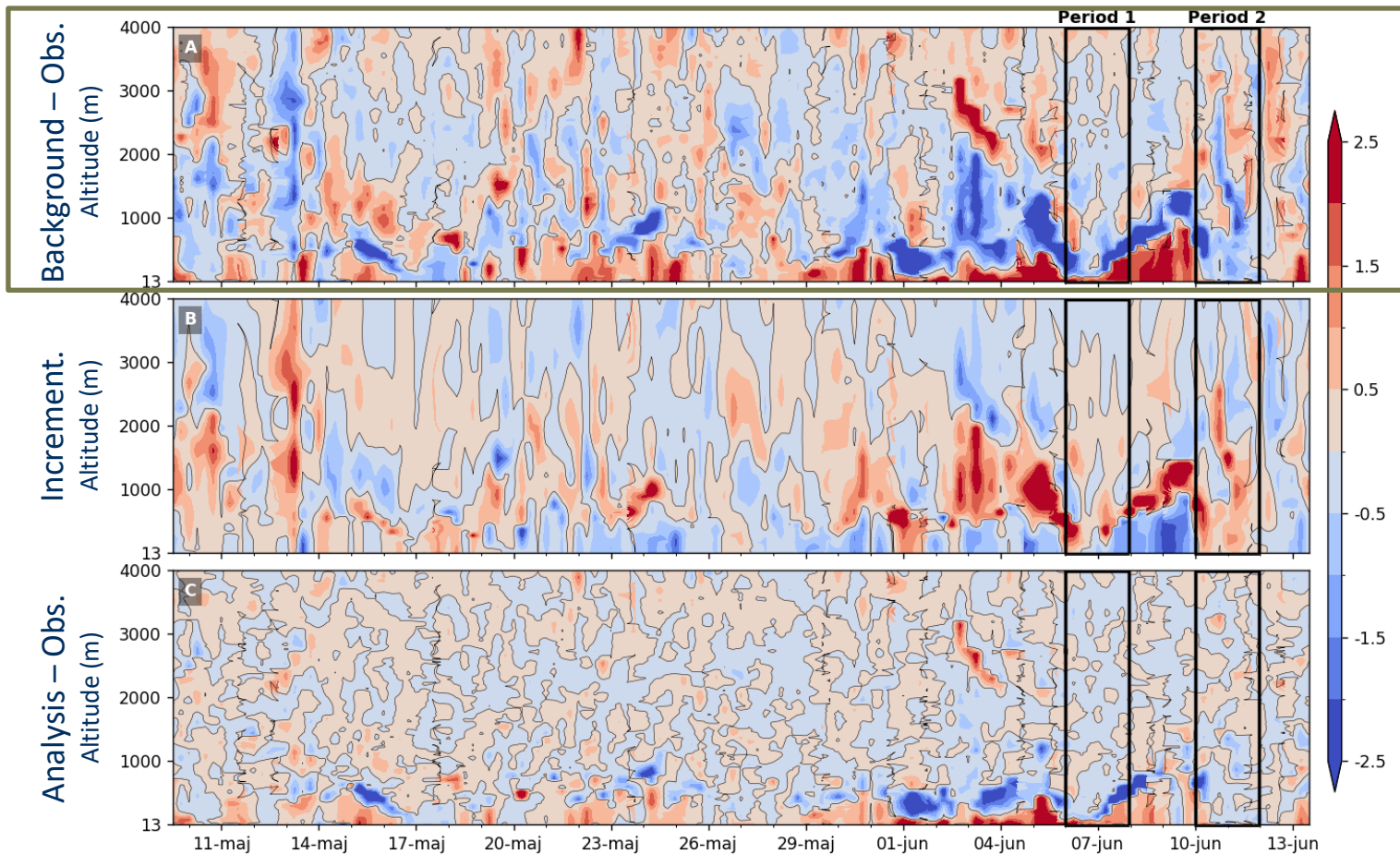


Eq. Pot. Temperature

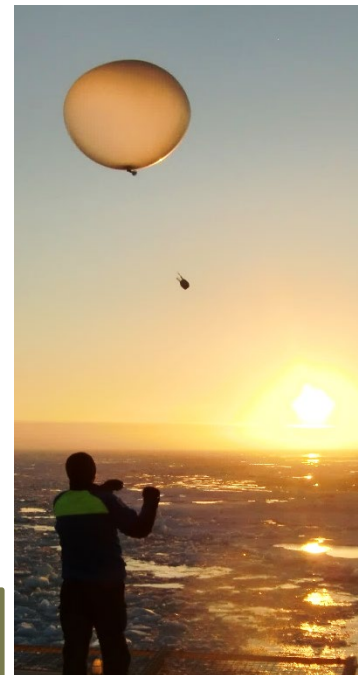
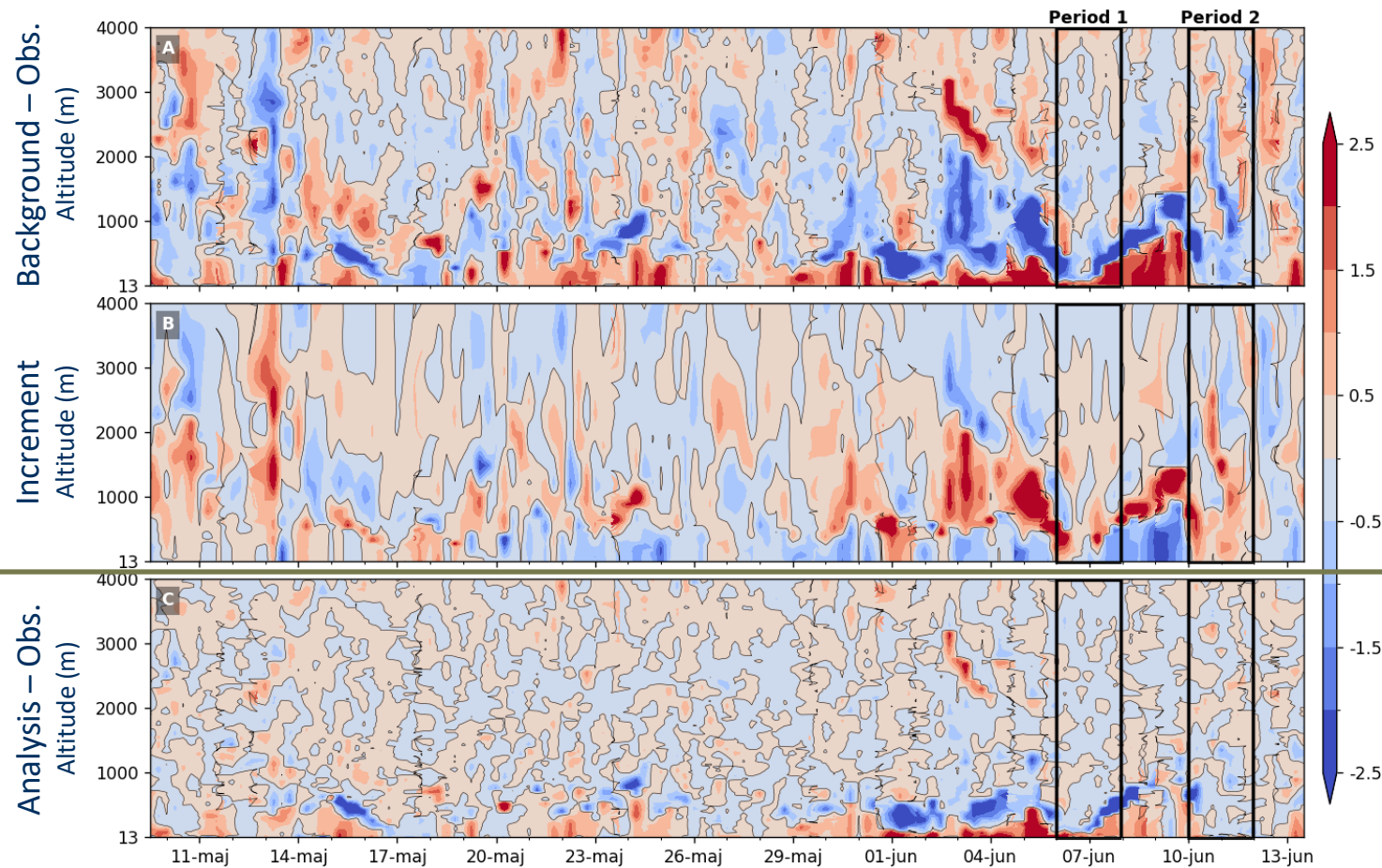


Tjernström et al. 2021

Results from ARTofMELT: Data assimilation



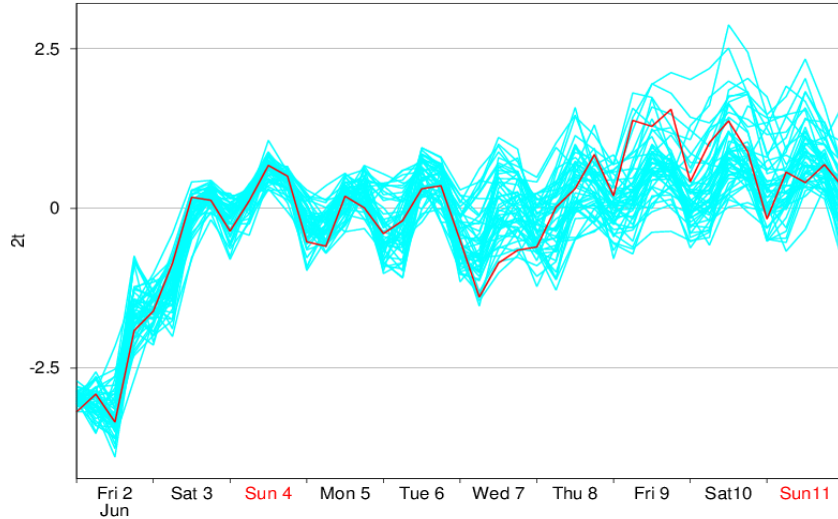
Results from ARTofMELT: Data assimilation



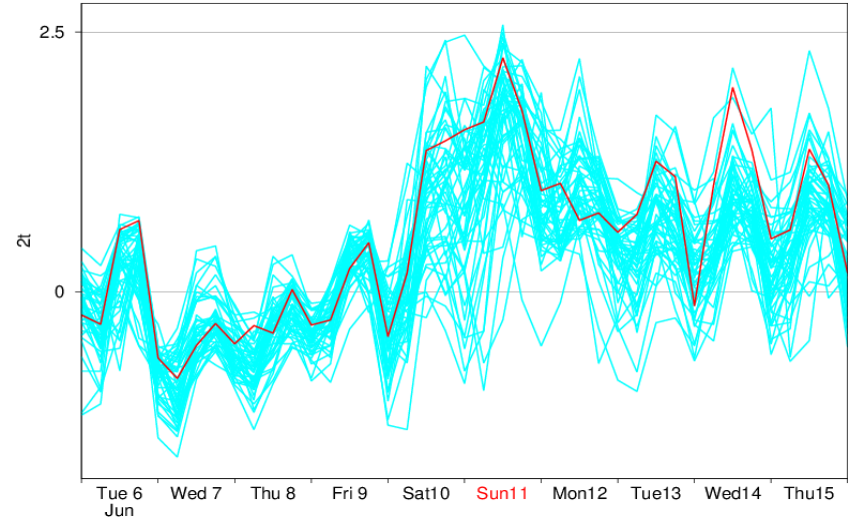
Forecasts at the time...

The forecasts at the time

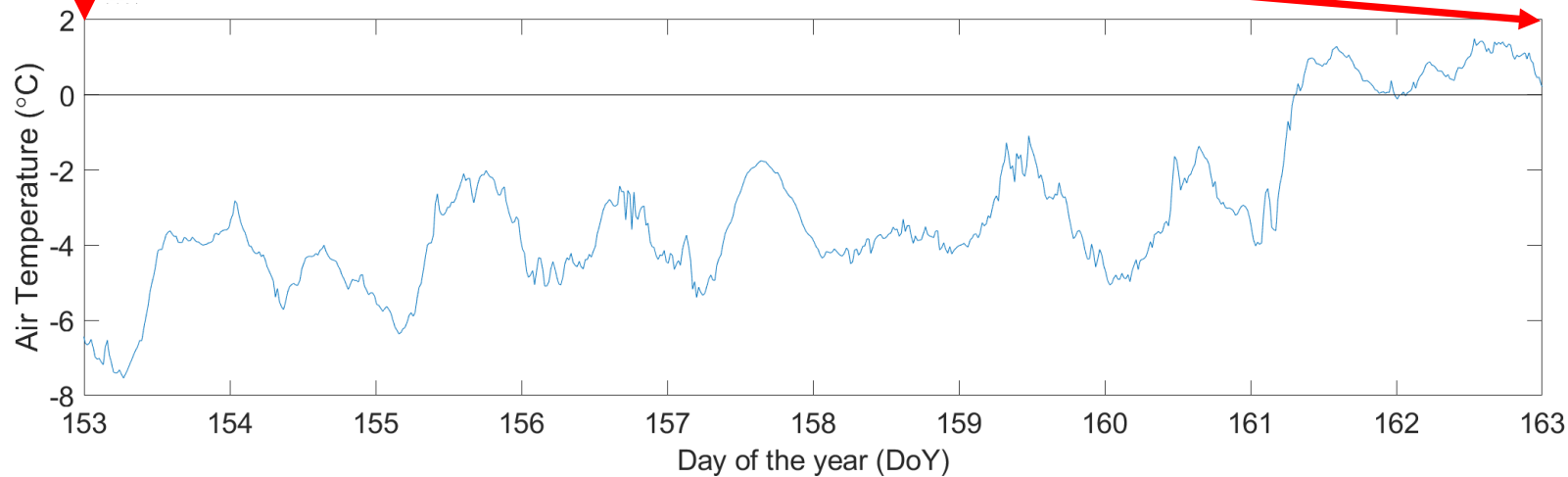
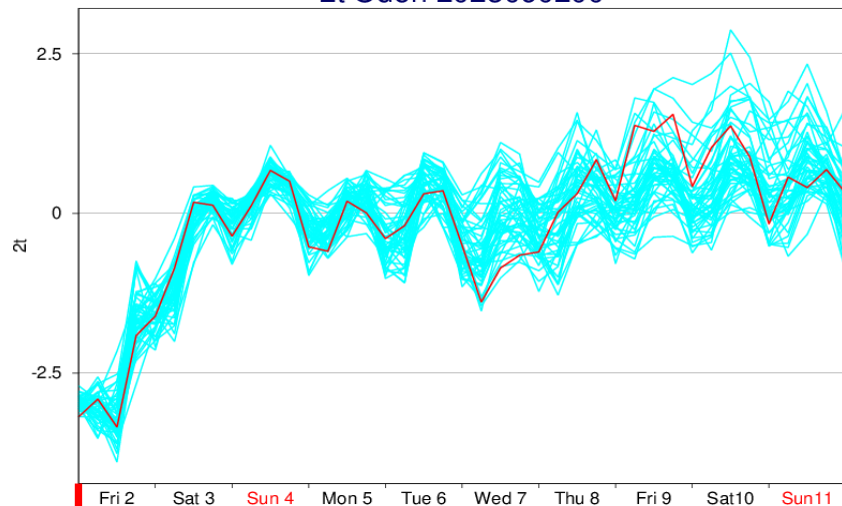
T2m issued Friday 2 June



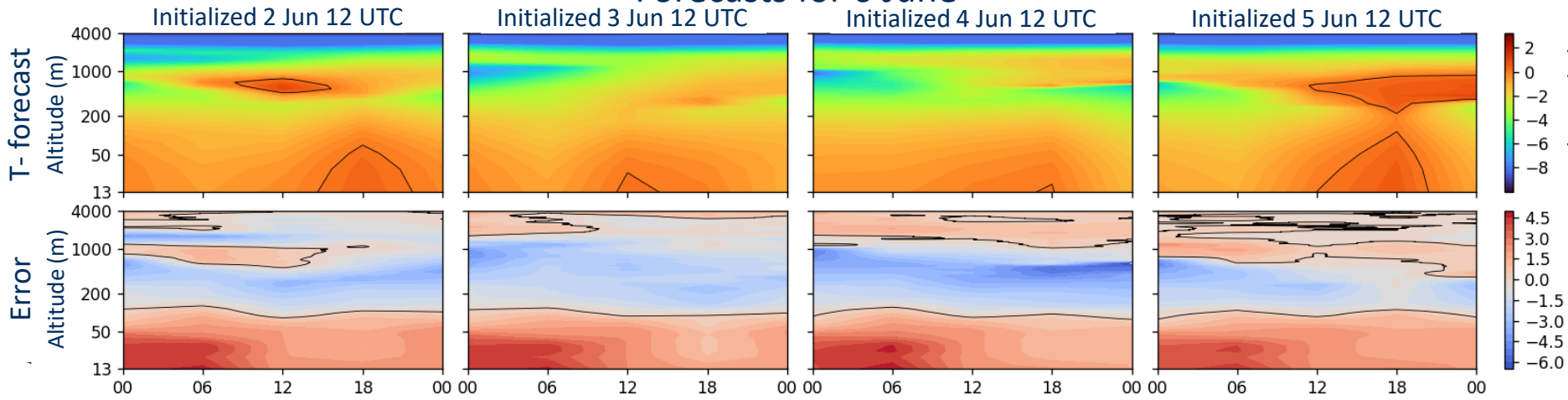
T2m issued Tuesday 6 June



2t Oden 2023060200

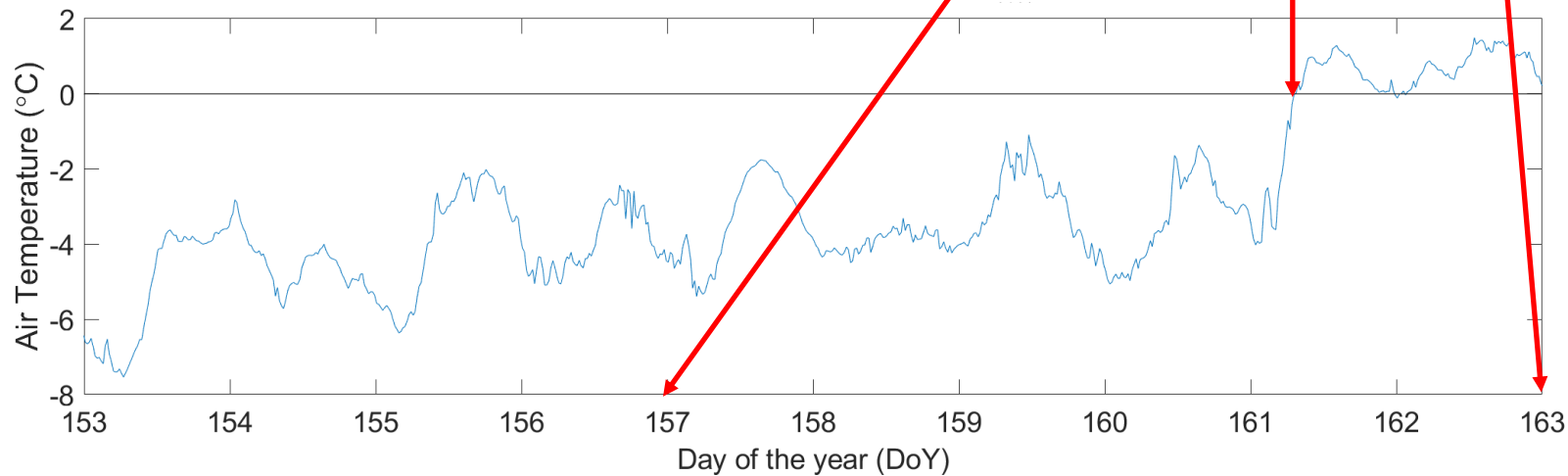
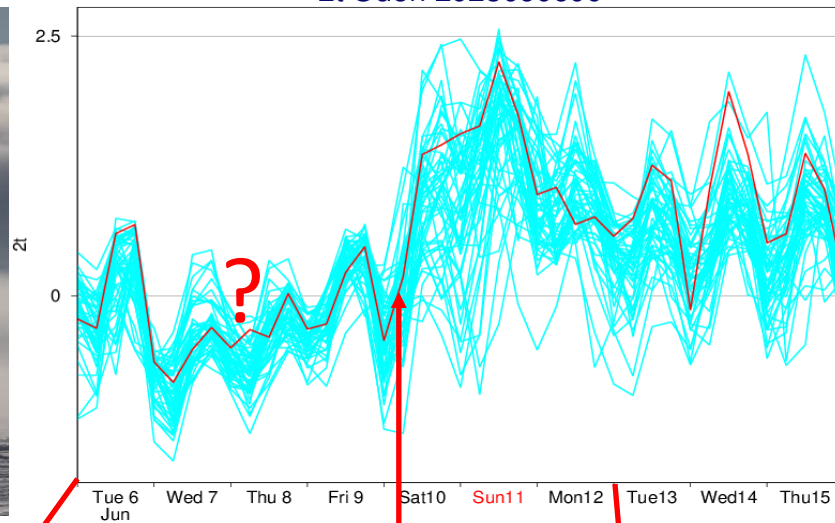


Forecasts for 6 June

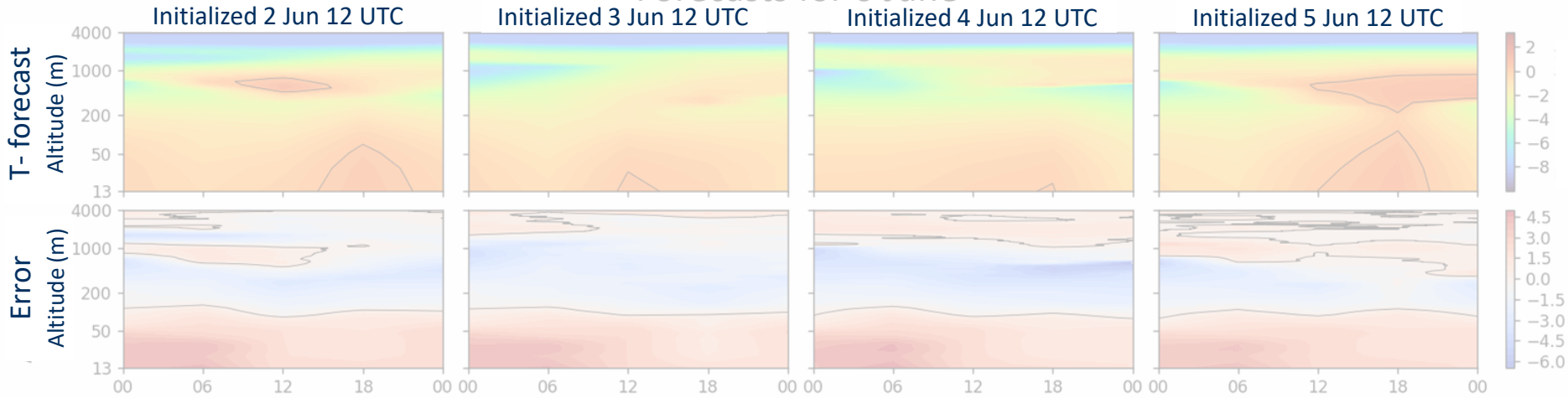




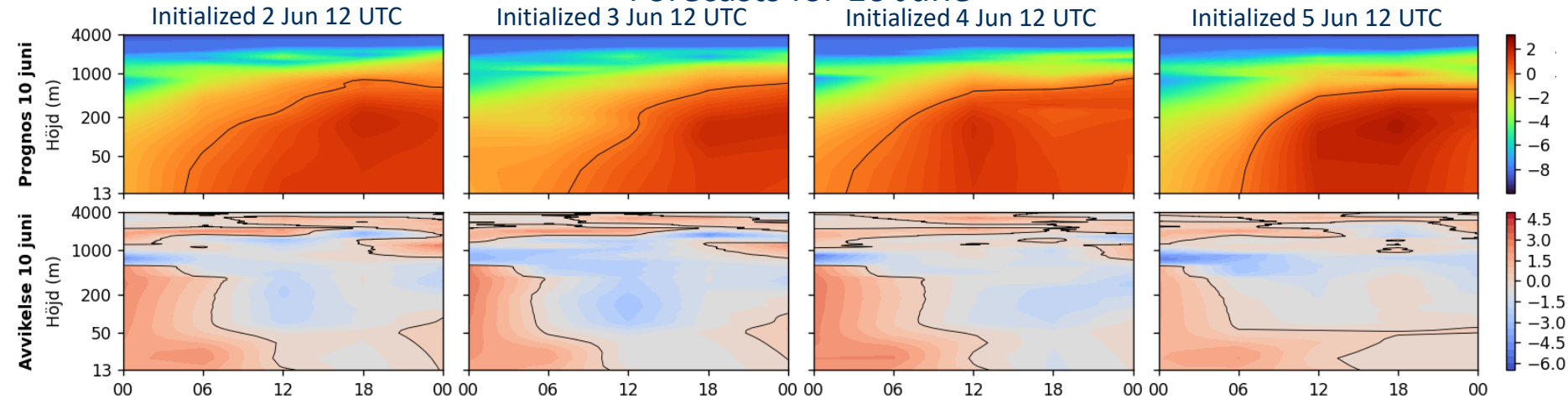
2t Oden 2023060600



Forecasts for 6 June

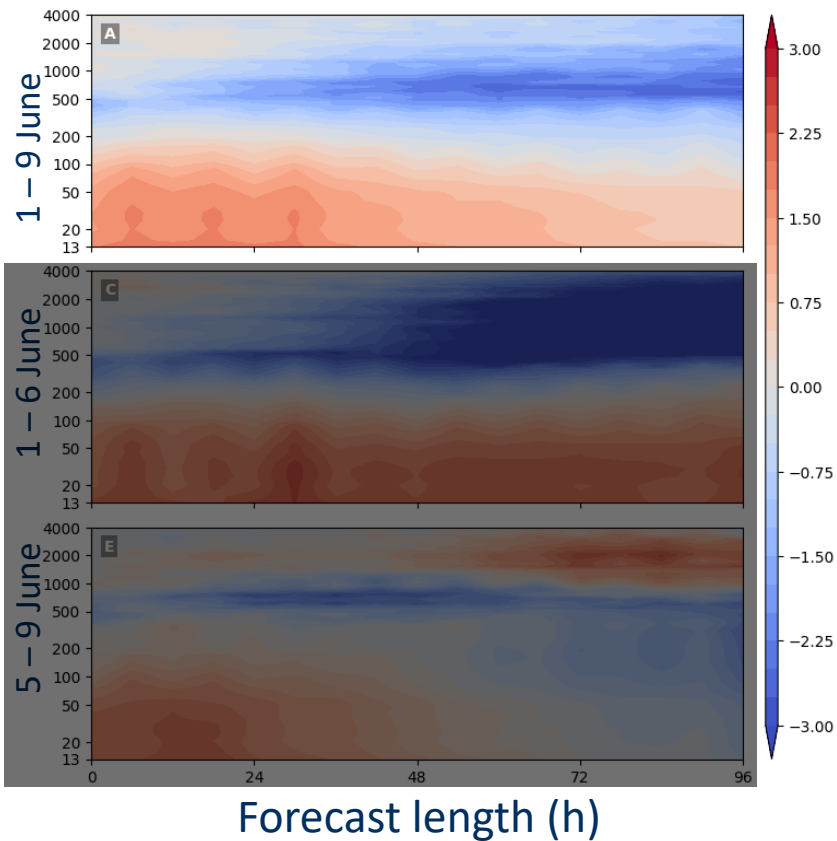


Forecasts for 10 June

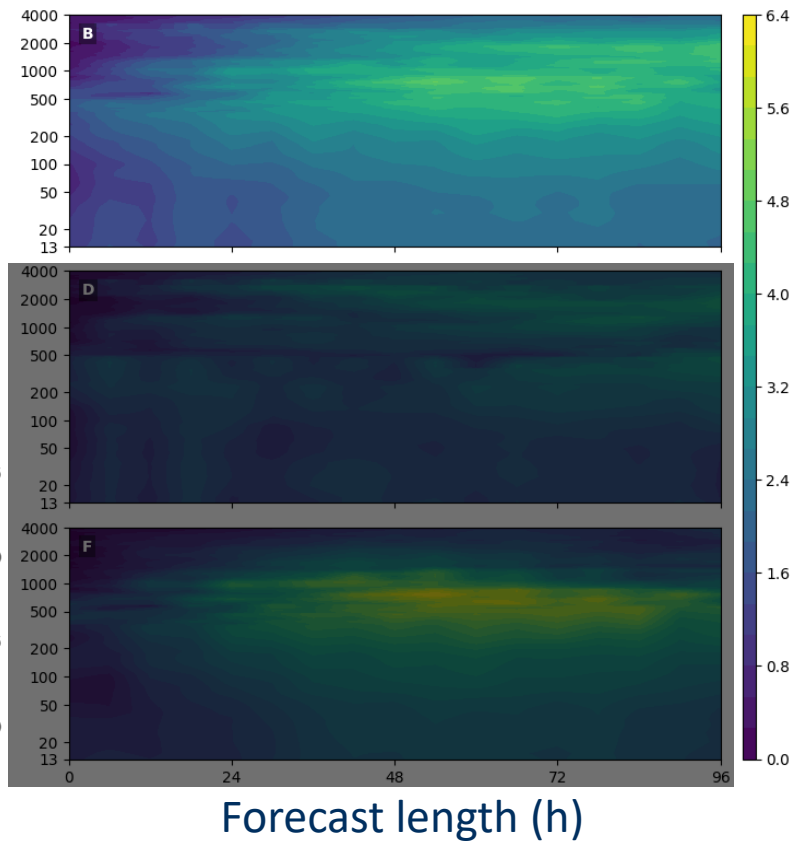


Results: Forecast error

Error



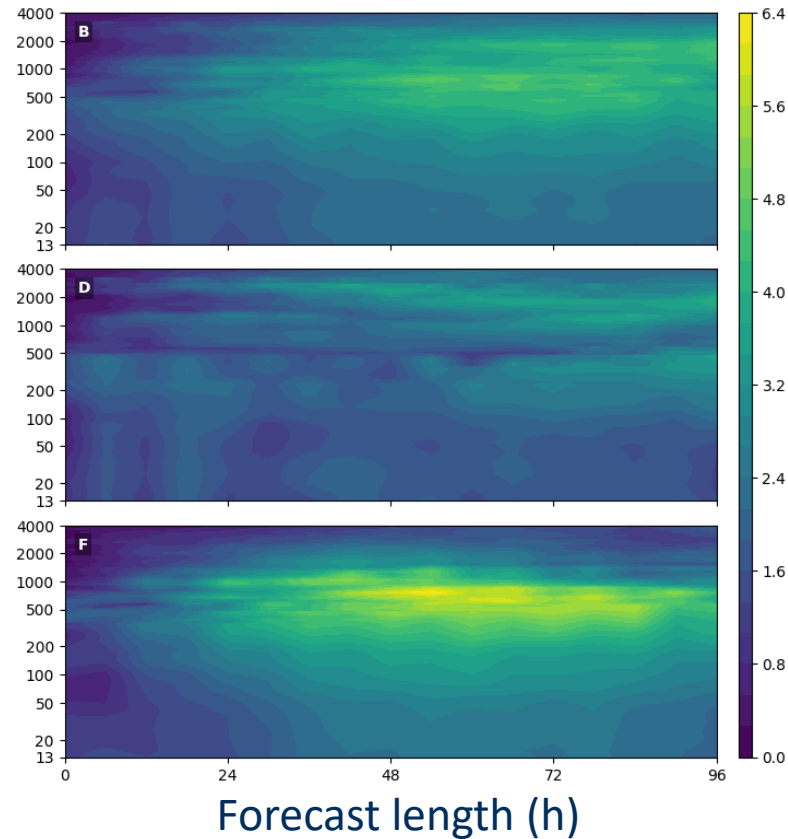
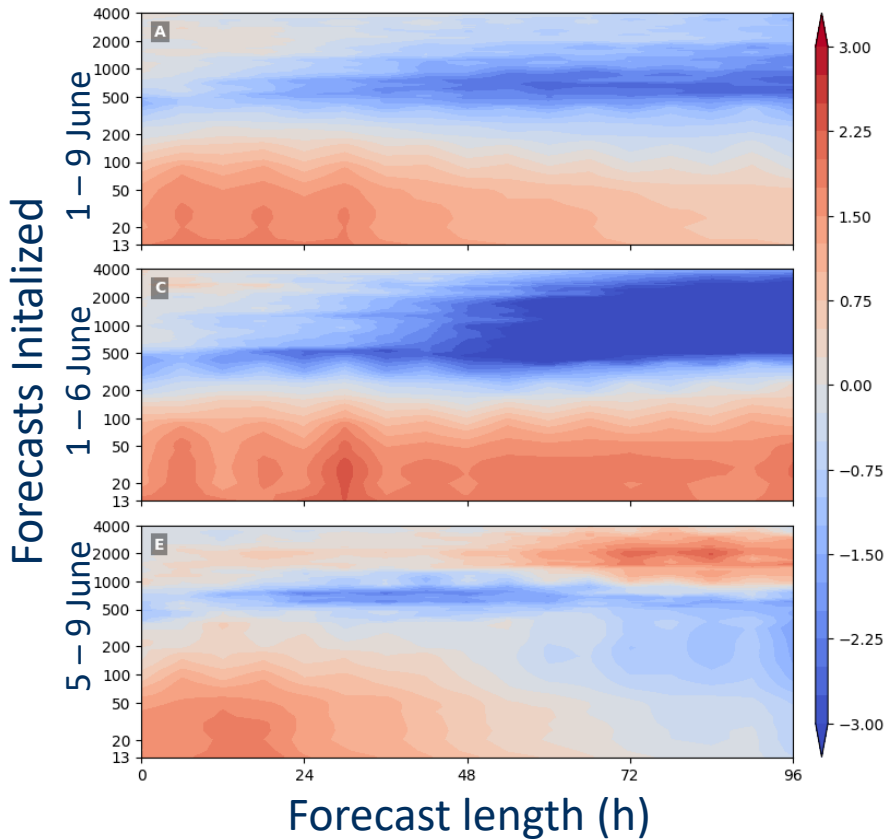
Standard deviation



Results: Forecast error

Error

Standard deviation



Summarising comments

- A well prepared, rehearsed and organized forecasting and outlook routine contributed to a better field campaign
- Assimilating campaign observations improved the local forecast
- A more extensive evaluation remains, but:
 - systematic warm boundary-layer, cold upper-layer bias, persists from previous experiences
 - problems resolving the boundary-layer inversion
 - a problem with the diurnal cycle also persists
- On the wish-list: Sea-ice forecast, especially divergence/convergence!



A polar bear is standing on a vast, flat expanse of snow and ice. The bear is facing right, with its head slightly turned towards the viewer. Its fur is a light cream color, and its black nose and mouth are visible. The ground is covered in a thick layer of snow with some small ice patches and tracks. In the upper right corner, there is a blue speech bubble containing the text "Thanks for your attention!".

Thanks for your attention!