

## Al in Routine Production of Regional Sea Ice Charts – Evolution, Challenges, Recommendations

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# BIG DATA IS HERE ③



### **Regional Ice Charting Timeline – Data and Analysis**

Pre mid-90's :	Aircraft, low res optical (NOAA), passive microwave Paper, MBYTES, analyzed manually
Mid- to late 90s $\rightarrow$ :	Aircraft, Synthetic Aperture Radar (Radarsat-1), low res Paper, MBYTES, analyzed manually
Early to mid-00's → :	Synthetic Aperture Radar (Radarsat-1, Envisat), optical FEW GBYTES, analyzed manually
Late 00's → :	Synthetic Aperture Radar (Radarsat-1, Radarsat-2, Env GBYTES, analyzed manually
Mid-10's → :	Synthetic Aperture Radar (Radarsat-2, Sentinel-1, Cosr Sentinel-2) FEW 10s of GBYTES, analyzed manually
Late 10's → :	Synthetic Aperture Radar (Radarsat-2, Sentinel-1, Cosr Sentinel-2) Several 10s of GBYTES, analyzed manually
2020's → :	HELP !

- optical (NOAA), passive microwave
- (NOAA, MODIS), passive microwave
- visat), optical (NOAA, MODIS)
- moSkyMed, TerraSAR-X), optical (MODIS,

moSkyMed, TSX, PAZ), optical (MODIS,



## Towards Smart Production (1)

### **DMI Ice Service - Status 2024**

#### GOOD:

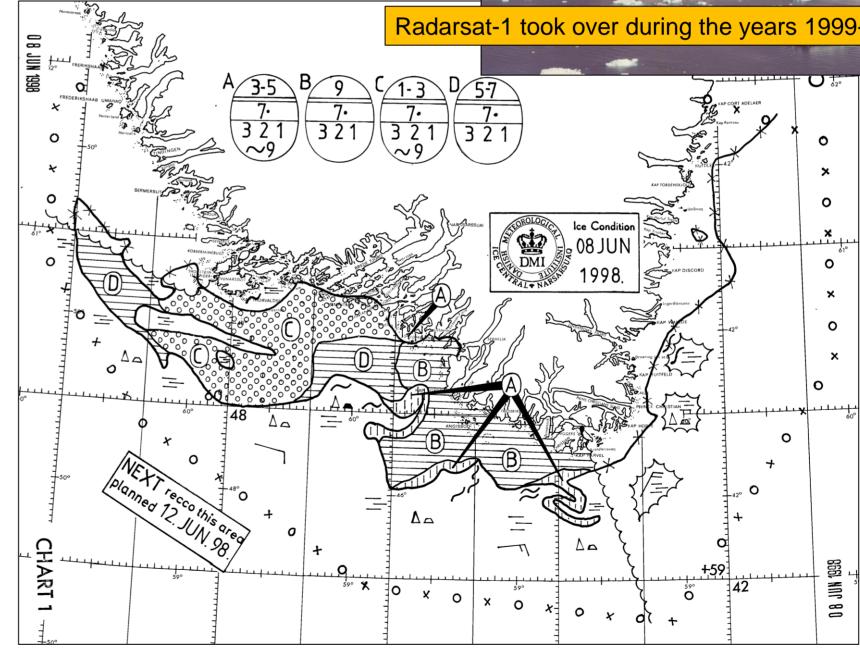
- Improved SAR capability (coverage, resolution, update frequency, delivery time, noise level, continuity)
- SAR Satellites are backup for each other
- Targeted products and services to marine community
- More SAR satellites coming
- Passive microwave data phased out

#### **CHALLENGES:**

- Staff day time only
- Analyst hours stable (budget)
- Sea ice analysis time
- Regional priorities follow shipping
- Limited tools to aid analysts finding and managing data
- Production is not linked to high resolution sea ice models

#### **FUTURE NEEDS:**

- Sub-daily updates (more satellites coming online)
- Ice products delivered fast (~1 hour or less)
- High resolution ice information near shore
- Ice thickness (include L-band?)
- Icebergs in sea ice (include L-band?)
- Sea ice analysis exported to high res sea ice model
- New ice products (drift, compression, snowcover...)
- New ice services  $\rightarrow$  Advisory, consultancy, decision support





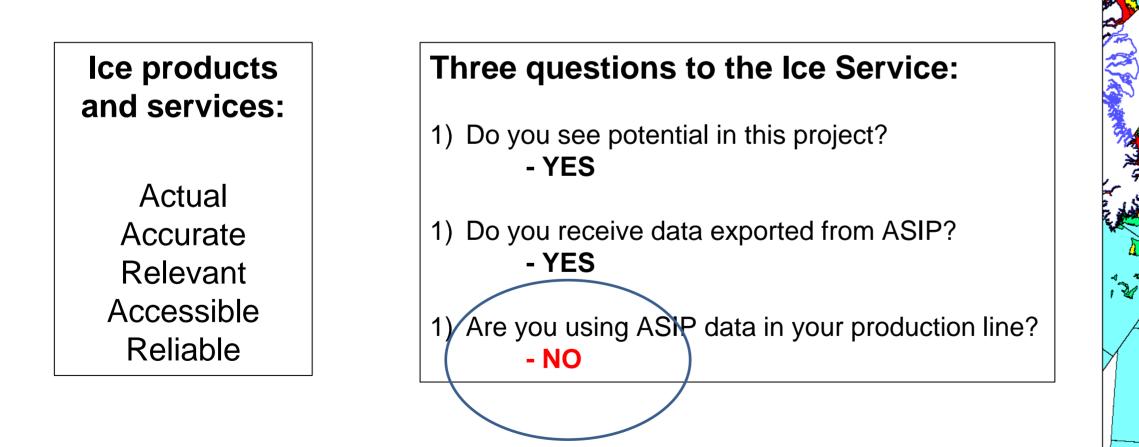
Radarsat-1 took over during the years 1999-2001

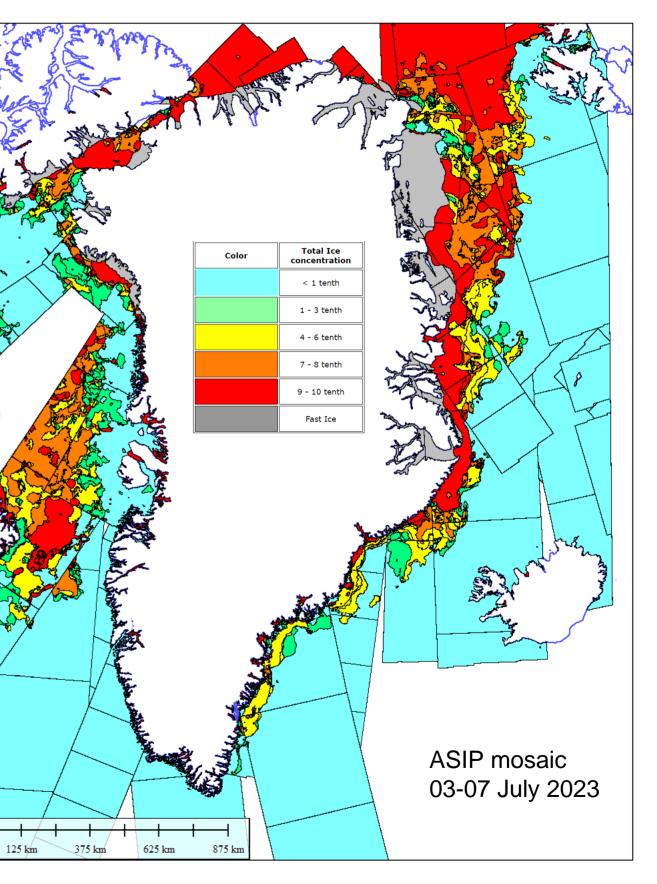


## Towards Smart Production (2)

DMI Science Project "Automatic Sea Ice Products (ASIP)" started in 2017:

- Artificial intelligence
- Take advantage of large daily Sentinel-1 data volumes
- Training data extracted from DMI regional ice charts
- Automated processing
- Export to SIGRID3 (and other formats)

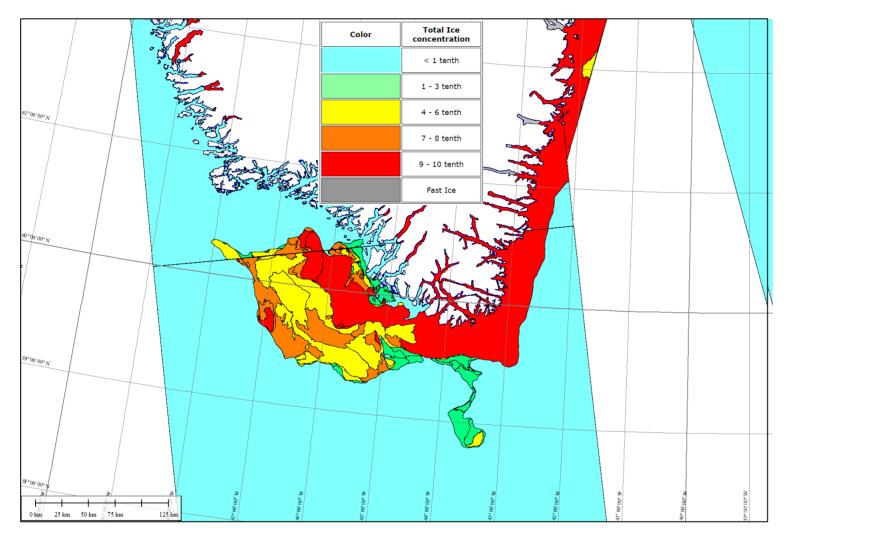


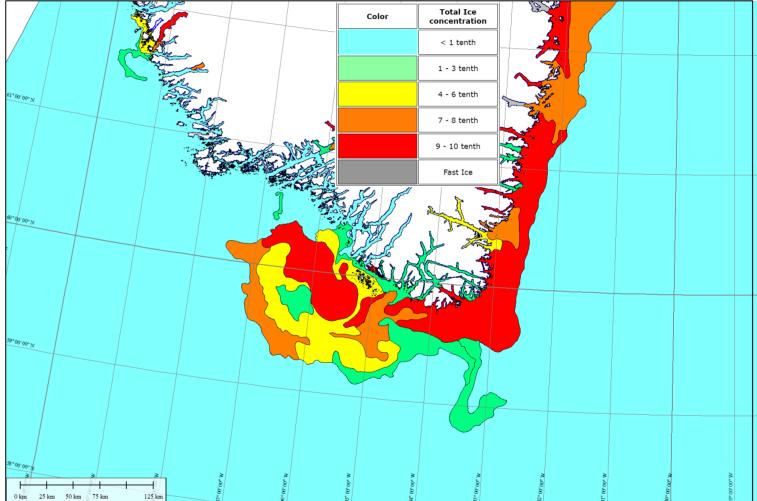




## Towards Smart Production (3)

### Many excellent examples on succesful AI sea ice mapping





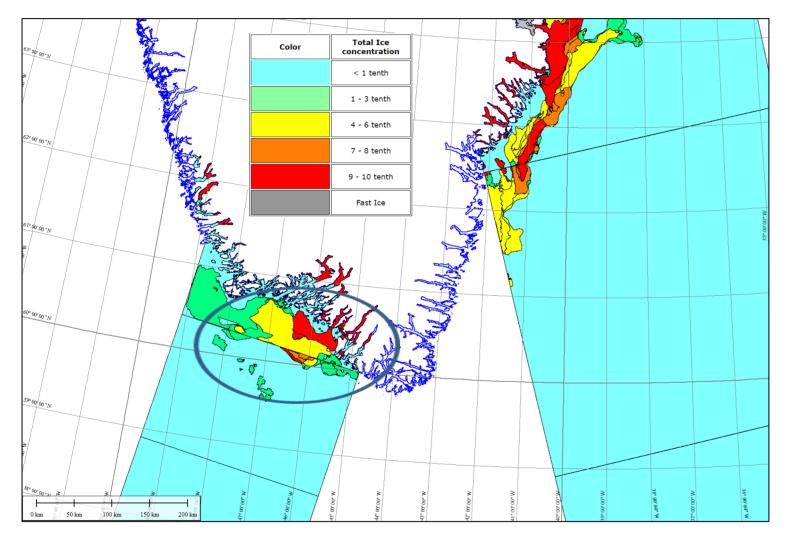
ASIP 15 June 2024 2030 UTC

ICE SERVICE Sea Ice map 15 June 2024 2030 UTC



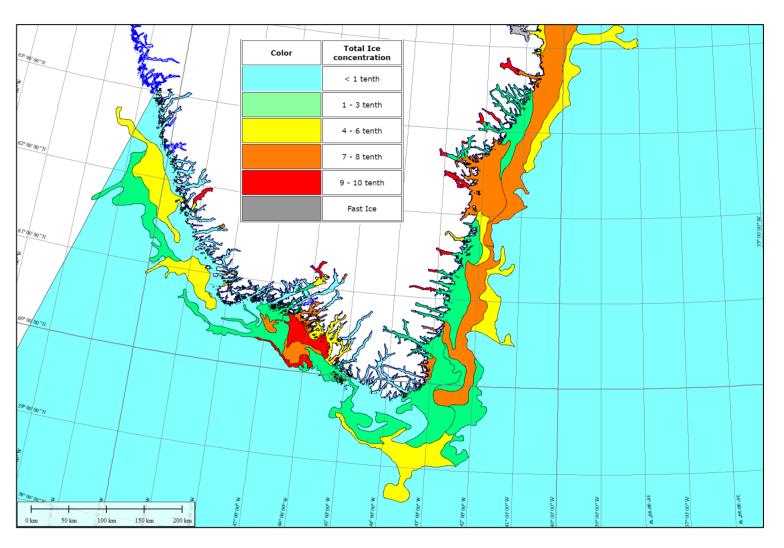
## Towards Smart Production (4)

### What are we missing in the Ice Service? Satellite coverage going into AI, frames side by side



ASIP 01 July 1200 UTC - 02 July 2359 UTC 2024

Available ~ 1 hour after satellite data download



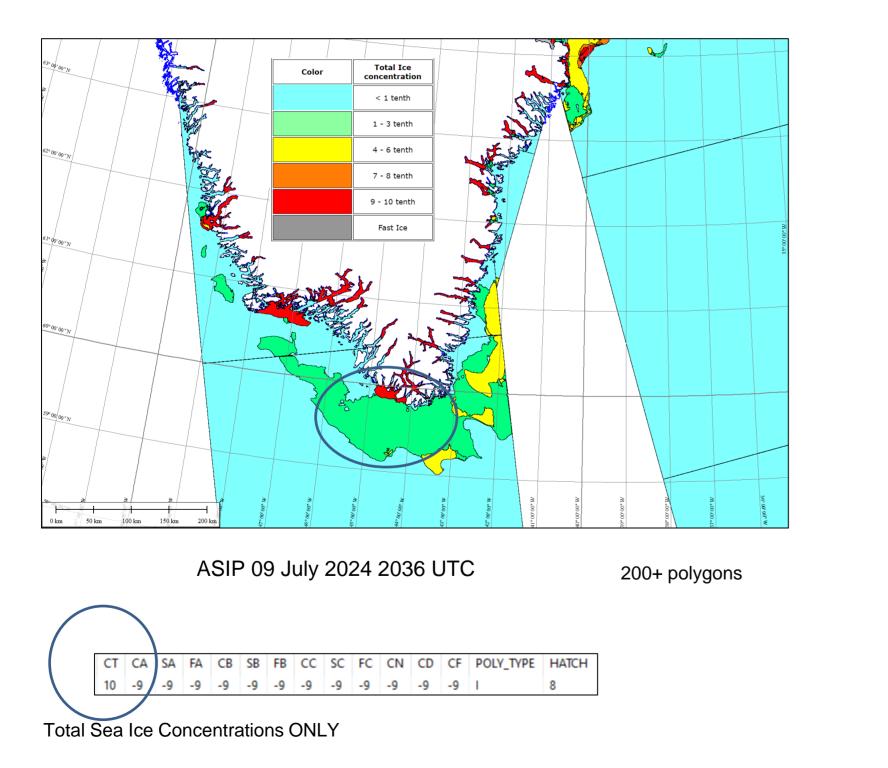
#### ICE SERVICE Sea Ice map 02 July 2024 0930 UTC

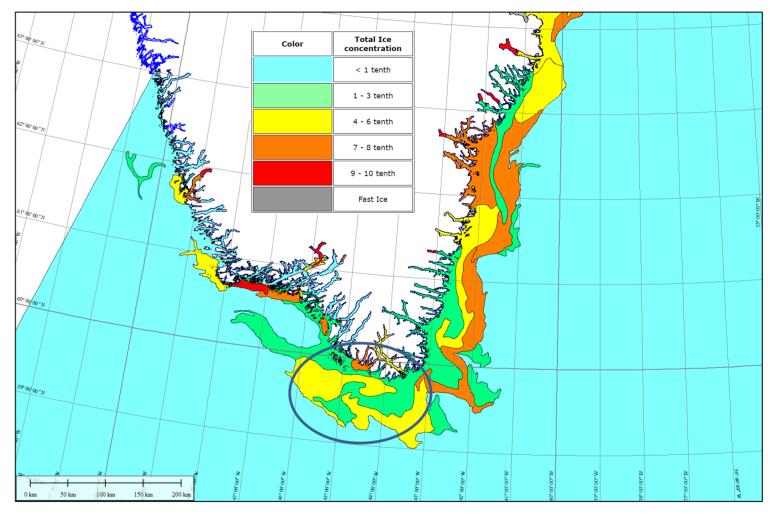
Available: 02 July 2024 1352 UTC



## Towards Smart Production (5)

### What are we missing in the Ice Service? Low Concentration confidence, ice thickness, floe size





Ice Service Sea Ice map 09 July 2024 2030 UTC

СТ	CA	SA	FA	CB	SB	FB	CC	SC	FC	CN	CD	CF	POLY_TYPE	HATCH
40	-9	95	2	-9	-9	-9	-9	-9	-9	98	-9	19	1	7

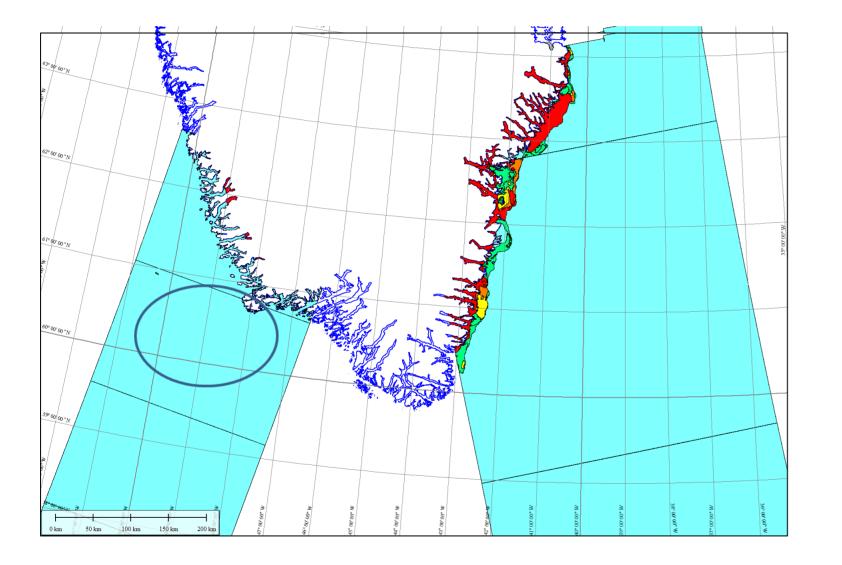
54 ice polygons

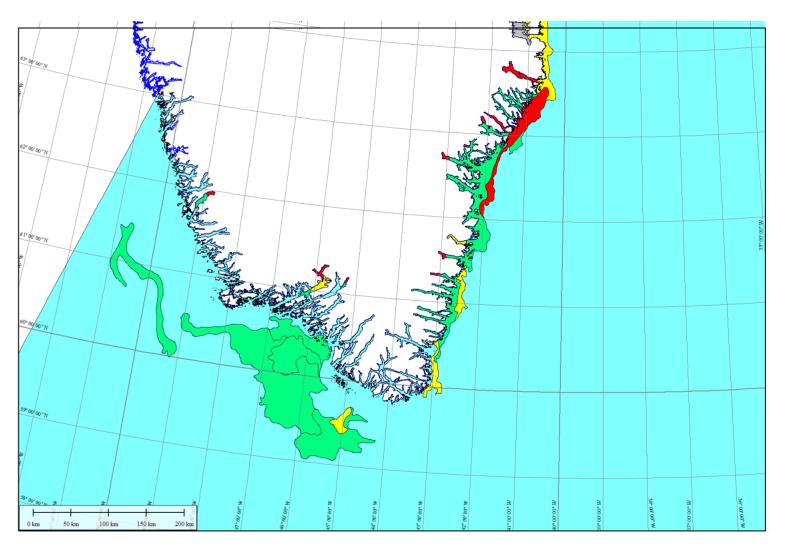
Total sea ice concentration, stage of development, flow size available



## Towards Smart Production (5)

What are we missing in the Ice Service? 1/10 of sea ice is very different from open sea / bergy waters. **Can ASIP be the future** <u>authoritative</u> product?





ASIP 19 July 2024 0935 UTC

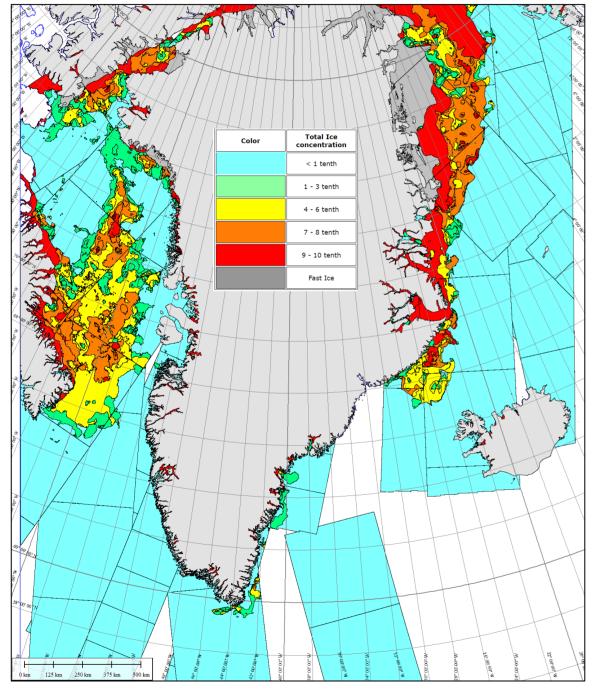
### 1/10 (or more) of ice **NO GO** for non ice classed ships

Sea Ice map 19 July 2024 0930 UTC

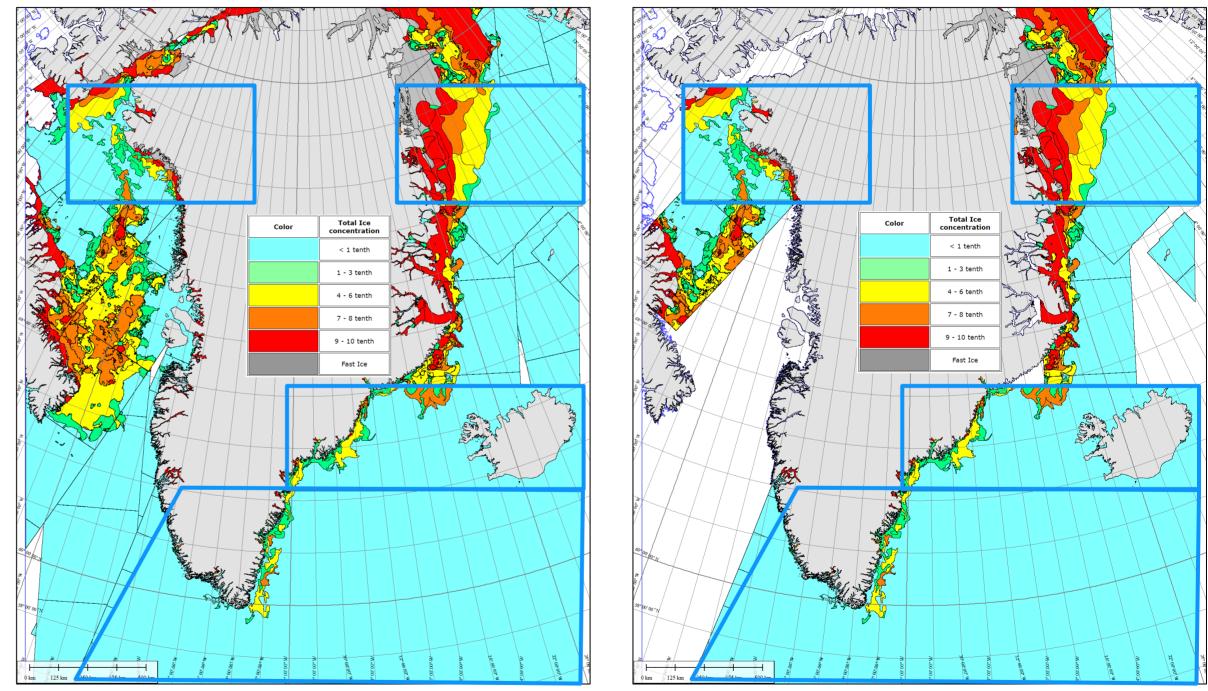


## Towards Smart Production (7)

### What are we missing in the Ice Service? Methodology for merging ASIP / manual SIGRID3 files



ASIP 4 days mosaic (ONLY) for 14-18 July 2023



ASIP 4 days mosaic for 14-18 July 2023, with 18 July 2023 Ice Service sea ice analysis overlayed (blue boxes)

ASIP 1 day mosaic for 18 July 2023, with 18 July 2023 Ice Service sea ice analysis overlayed (blue boxes)



### Towards Smart Production Using Al Routinely

### **Recommendations:**

### **To Science**

- 1) Keep up the good work !
- 2) Add more data from NRT satellites
- 3) Make sea ice thickness (SoD) available
- 4) Include Operations in development program
- 5) Limitations of technology

### **To Management**

- a) From demonstration project to full implementation
- b) Vision, plan, resources
- c) Ice analyst role, from producer to advisor
- d) International coordination, partnerships

### BIG DATA is here, but CLIMATE CHANGE is also here

## Ice products and services:

Actual Accurate Relevant Accessible Reliable