Detecting Sea Ice Extremes from Satellites
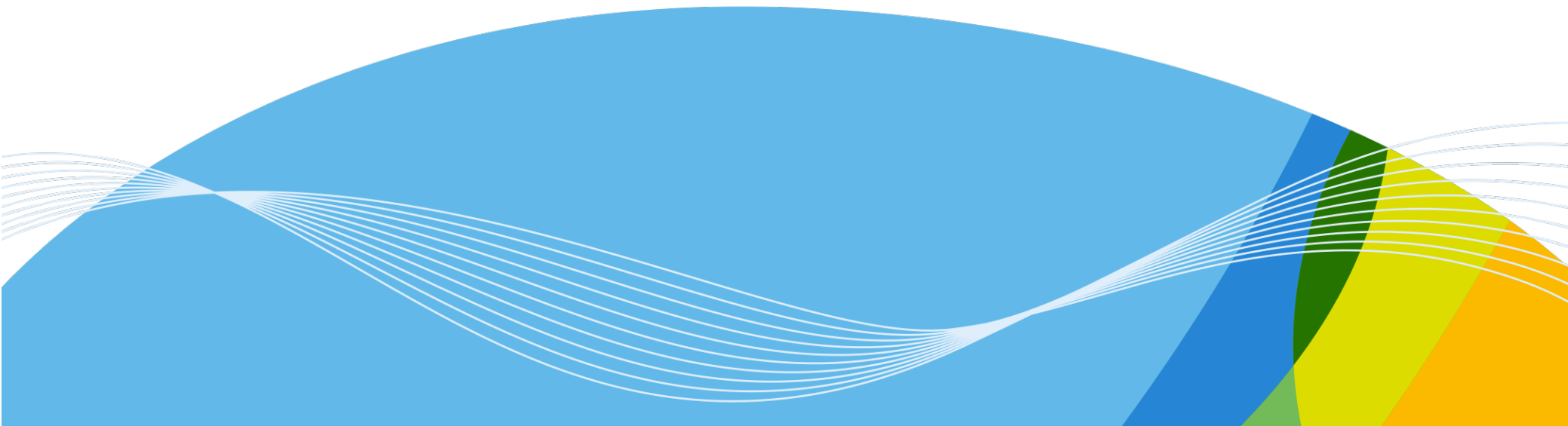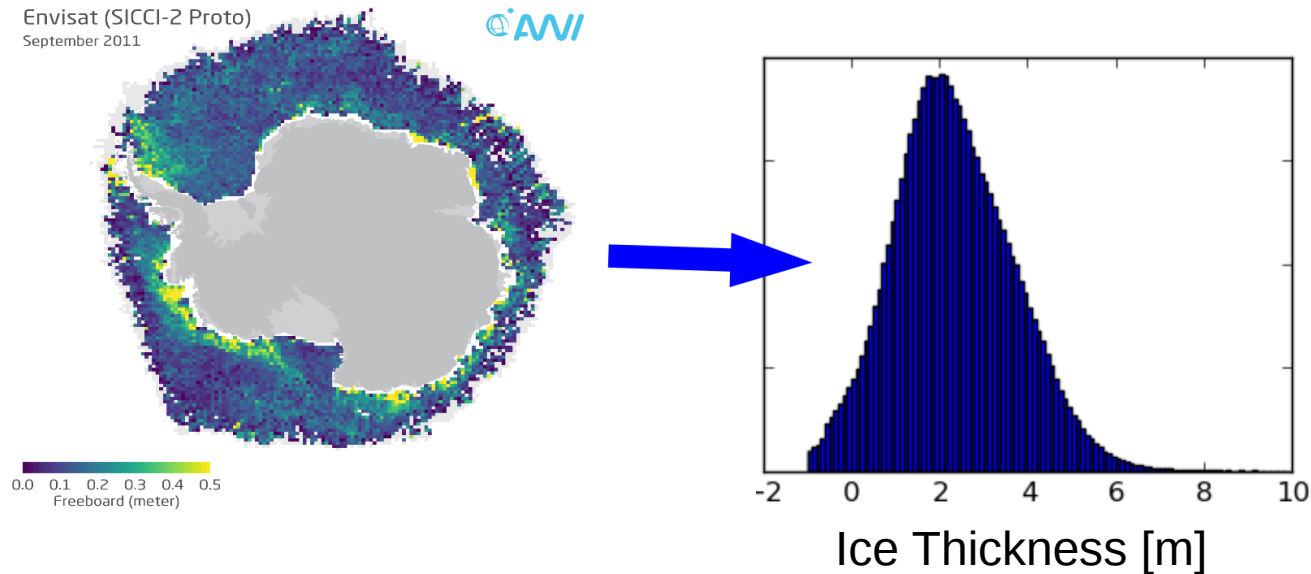
What is extreme?

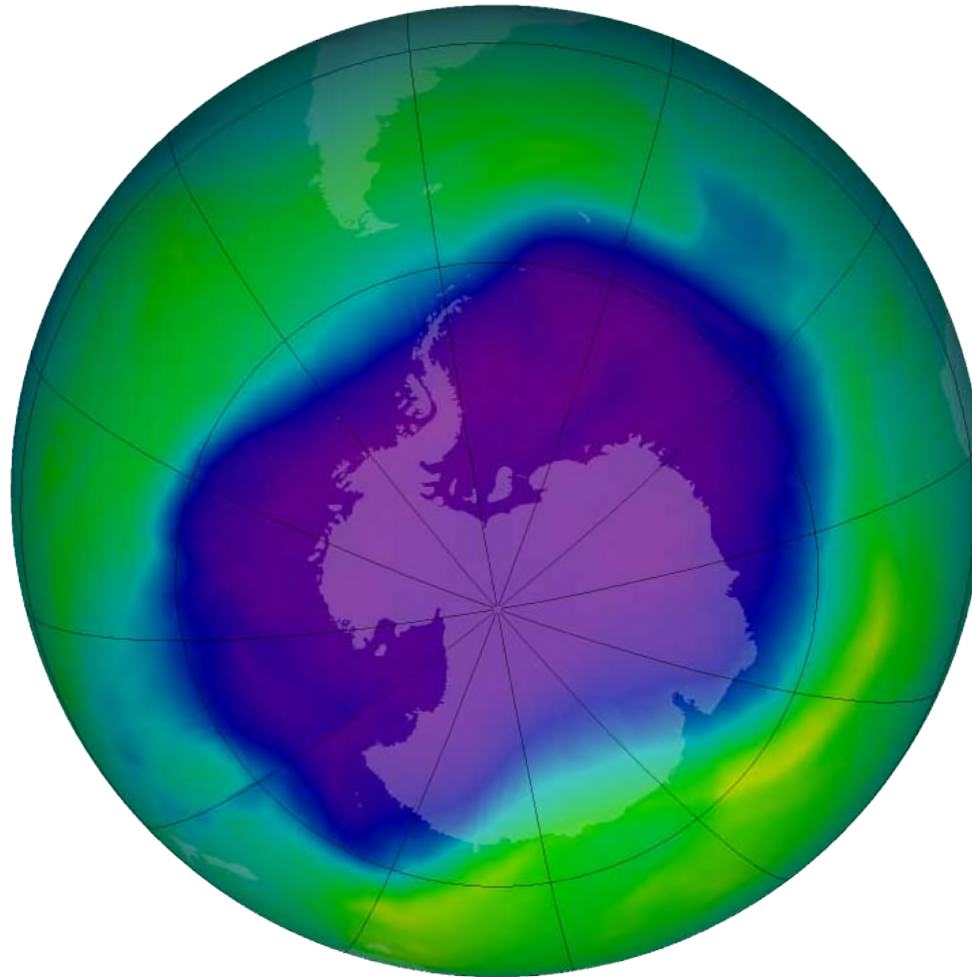- "Exceeding what is usual or reasonable; immoderate"

Note about satellites

- Satellite measurements are always noisy.

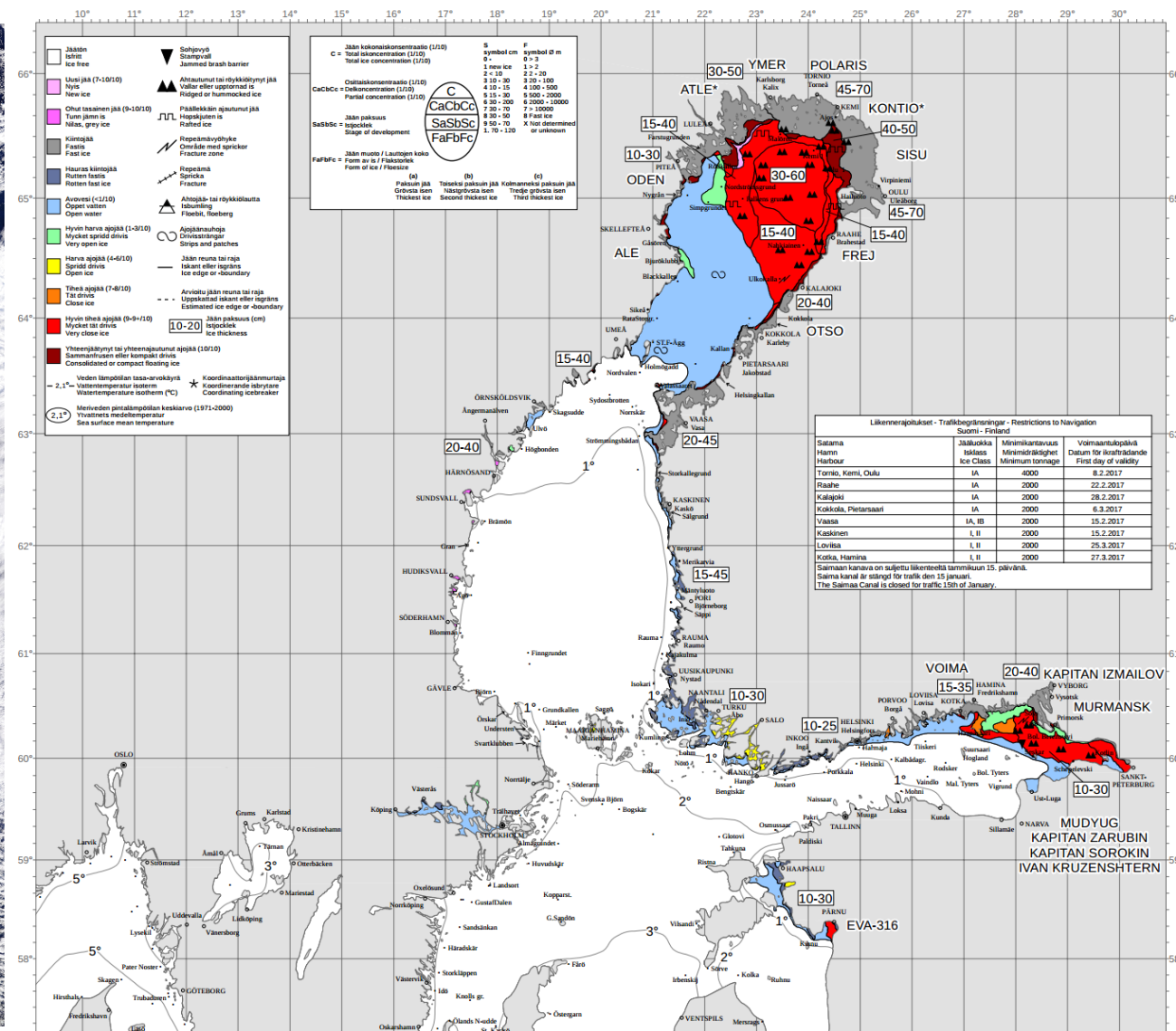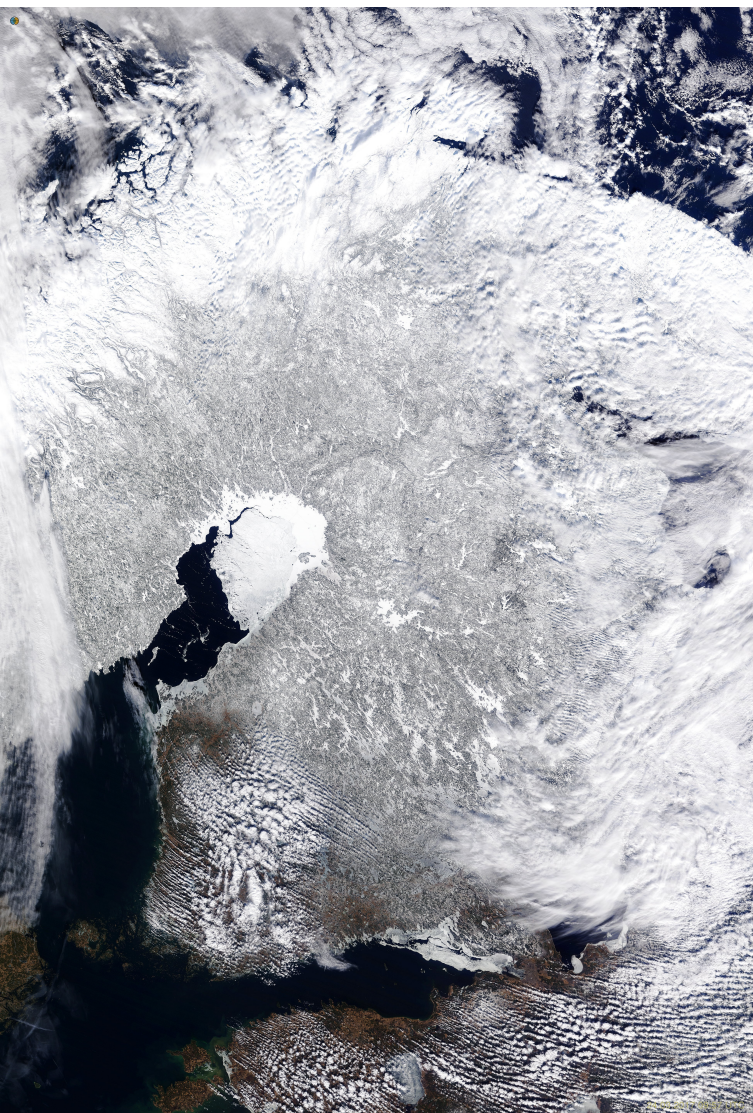- Thus, satellites excel at measuring the average and not the extreme!

Remember the ozone hole!

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Jääkartta   Iskarta   Ice Chart
N:o 120   27.3.2017

Legend:

Jäätön / Isfritt / Ice free

Uusi jää (7-10/10) / Nyis / New ice

Ohut tasainen jää (9-10/10) / Tunn jämn is / Nilas, grey ice

Kiintojää / Fastis / Fast ice

Hauras kiintojää / Rutten fastis / Rotten fast ice

Avovesi (<1/10) / Öppet vatten / Open water

Hyvin harva ajojää (1-3/10) / Mycket spridd drivis / Very open ice

Harva ajojää (4-6/10) / Spridd drivis / Open ice

Tiheä ajojää (7-8/10) / Tät drivis / Close ice

Hyvin siheä ajojää (9-9+/10) / Mycket tät drivis / Very close ice

Yhteenjäänyt tai yhteenajautunut ajojää (10/10) / Sammanfrusen eller kompakt drivis / Consolidated or compact floating ice

Sohjovyö / Stampvall / Jammed brash barrier

Ahtautunut tai röykkiöitynyt jää / Vallar eller upptornad is / Ridged or hummocked ice

Päällekkäin ajautunut jää / Hopskjuten is / Rafted ice

Repeämävyöhyke / Område med sprickor / Fracture zone

Repeämä / Spricka / Fracture

Ahtojää- tai röykkiölautta / Isbumling / Floebit, floeberg

Ajojäänuhoja / Drivissträngar / Strips and patches

Jään reuna tai raja / Iskant eller isgräns / Ice edge or ·boundary

Arvioitu jään reuna tai raja / Uppskattad iskant eller isgräns / Estimated ice edge or ·boundary

Jään paksuus (cm) / Isjocklek / Ice thickness

Veden lämpötilan tasa-arvokäyrä / Vattentemperatur isoterm / Watertemperature isotherm (°C)

Meriveden pintalämpötilan keskiarvo (1971-2000) / Ytvattnets medeltemperatur / Sea surface mean temperature

Koordinaattorijäänmurtaja / Koordinerande isbrytare / Coordinating icebreaker

Jään kokonaiskonsentraatio (1/10) / Total iskoncentration (1/10) / Total ice concentration (1/10)

Osittaiskonsentraatio (1/10) / Delkoncentration (1/10) / Partial ice concentration (1/10)

Jään paksuus / Isjocklek / Stage of development

Jään muoto / Lauttojen koko / Form av is / Flakstorlek / Form of ice / Floesize

	(a)	(b)	(c)
	Paksuin jää / Grövsta isen / Thickest ice	Toiseksi paksuin jää / Näststövsta isen / Second thickest ice	Kolmanneksi paksuin jää / Tredje grövsta isen / Third thickest ice

	S symbol cm	F symbol Ø m
	0 new ice	0 > 3
	1 new ice	1 > 2
	2 < 10	2 2 - 20
	3 10 - 30	3 20 - 100
	4 10 - 15	4 100 - 500
	5 15 - 30	5 500 - 2000
	6 30 - 200	6 2000 - 10000
	7 30 - 70	7 > 10000
	8 50 - 70	8 Fast ice
	9 50 - 70	B Fast ice
	1. 70 - 120	X Not determined or unknown

Restrictions to Navigation:

Liikennerajoitukset - Trafikbegränsningar - Restrictions to Navigation
Suomi - Finland

Satama Hamn Harbour	Jääluokka Isklass Ice Class	Minimikantavuus Minimidräktighet Minimum tonnage	Voimaantulopäivä Datum för ikraftträdande First day of validity
Tornio, Kemi, Oulu	IA	4000	8.2.2017
Raahe	IA	2000	22.2.2017
Kalajoki	IA	2000	28.2.2017
Kokkola, Pietarsaari	IA	2000	6.3.2017
Vaasa	IA, IB	2000	15.2.2017
Kaskinen	I, II	2000	15.2.2017
Loviisa	I, II	2000	25.3.2017
Kotka, Hamina	I, II	2000	27.3.2017

Saimaan kanava on suljettu liikenteeltä tammikuun 15. päivänä.
Saima kanal är stängd för trafik den 15 januari.
The Saimaa Canal is closed for traffic 15th of January.

Space-borne observations for detecting and forecasting sea ice cover extremes
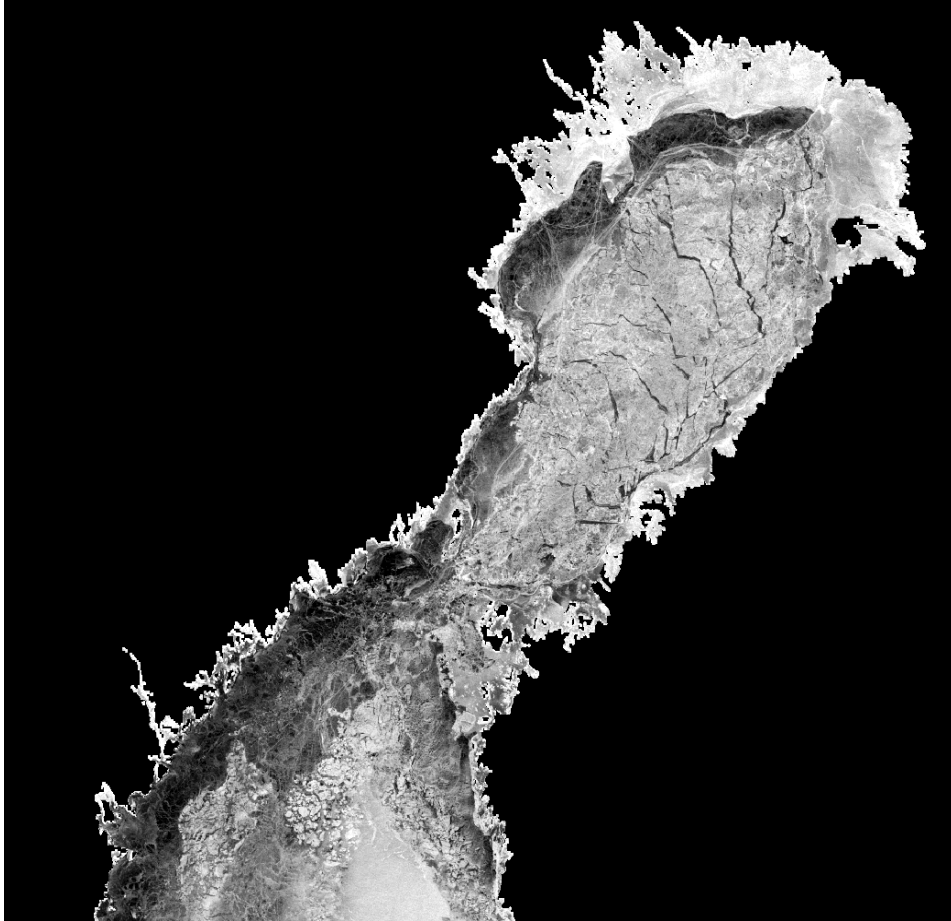
SPICES SAR classification

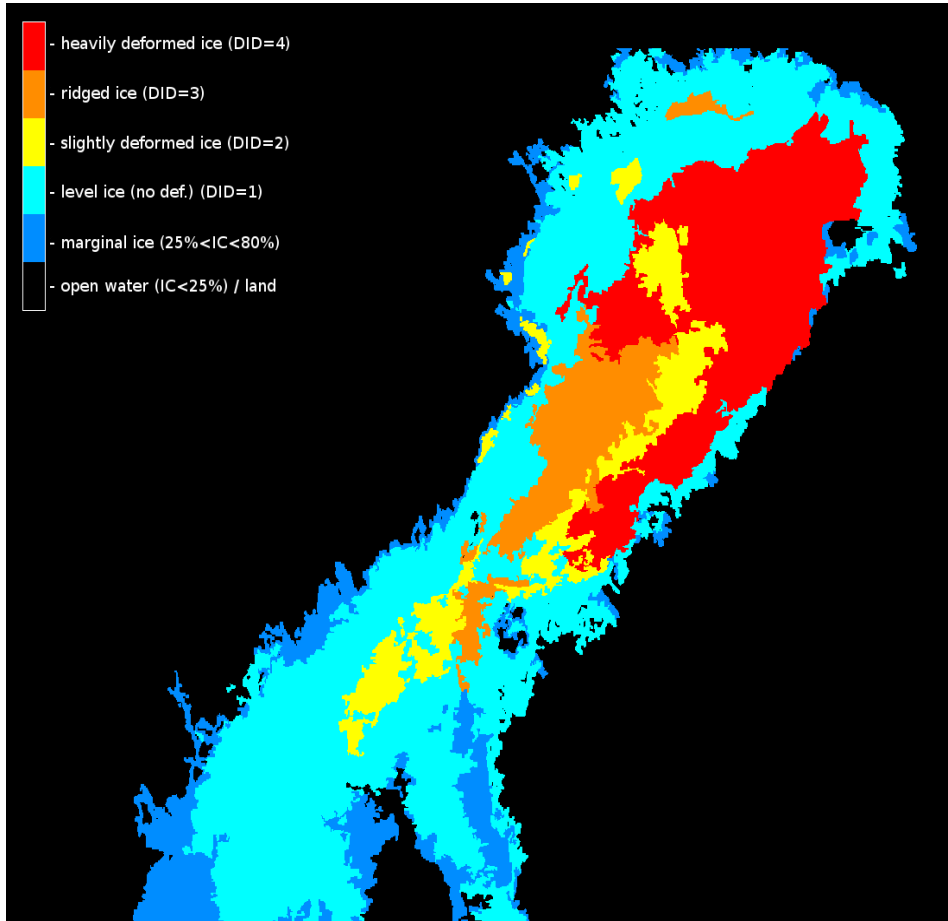RadarSat-2 SAR HH

DID estimated (Random Forest Classifier)

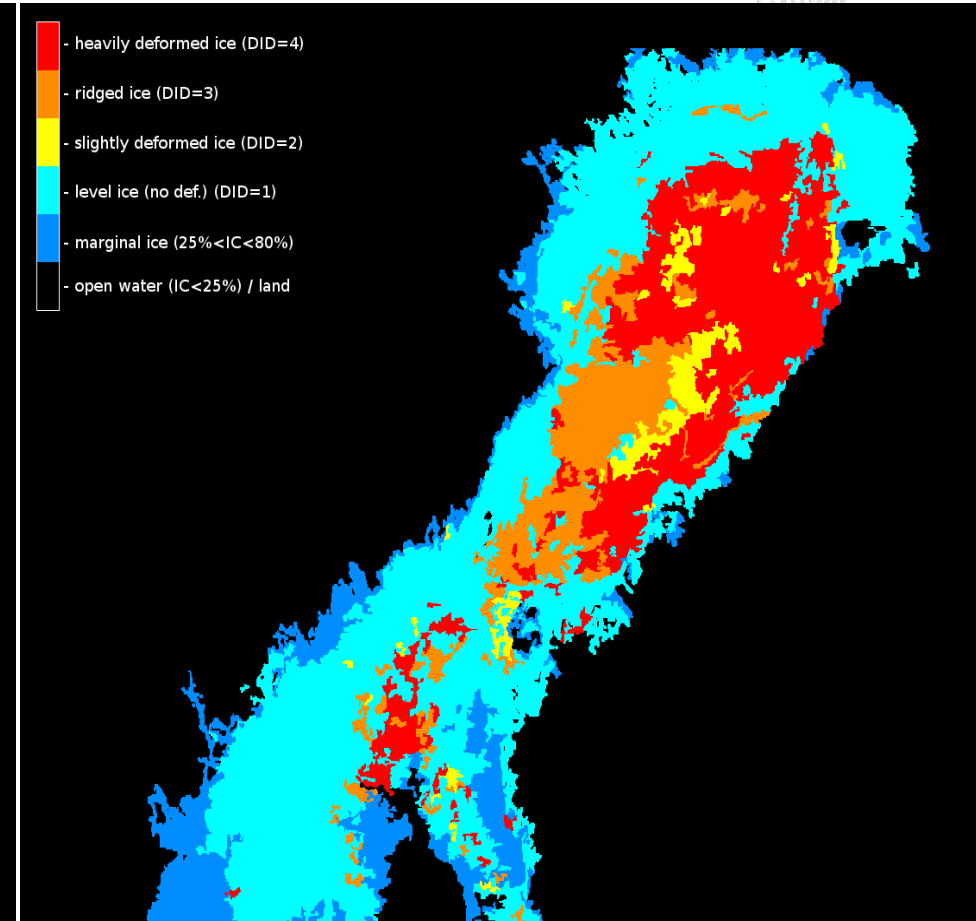- heavily deformed ice (DID=4)
- ridged ice (DID=3)
- slightly deformed ice (DID=2)
- level ice (no def.) (DID=1)
- marginal ice (25%<IC<80%)
- open water (IC<25%) / land

2nd Feb 2013

SPICES SAR classification

DID from Ice Chart

DID estimated (Random Forest Classifier)

- heavily deformed ice (DID=4)
- ridged ice (DID=3)
- slightly deformed ice (DID=2)
- level ice (no def.) (DID=1)
- marginal ice (25%<IC<80%)
- open water (IC<25%) / land

2nd Feb 2013

FINNISH METEOROLOGICAL INSTITUTE

SPICES SAR classification

What is POLARIS RIO?

- Risk Index Outcome (RIO) is a number that represents the risk posed to a ship by sea ice.

- Part of the Polar Code

- RIO is a function of ship ice class (PC1 – PC7, Finnish Swedish ice classes and no classification) – stronger the ship, lower the risk!

- RIO is meant for decision making:

  - RIO > 0 → Operations permitted → GO

  - -10 RIO < 0 → Operations permitted with restrictions

  - RIO < -10 → Operations not permitted -> NO GO

Cryosat-2 radar freeboard vs. RIO

January 2017
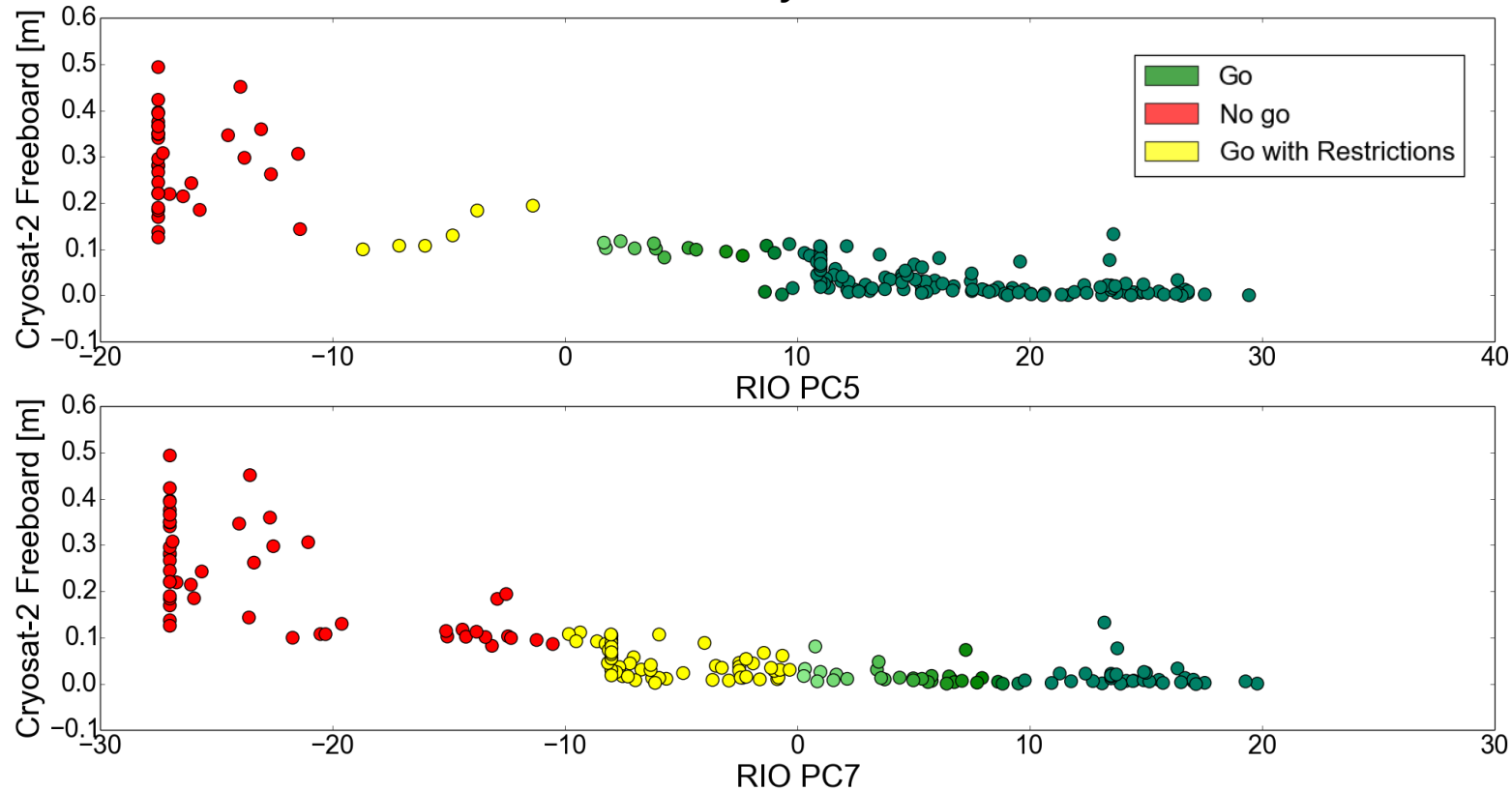
Waveform method, January 2017

"Go with restrictions" mixes with both go and nogo classes, but false "go" in "nogo" areas and vice versa is rare (~ 3%)
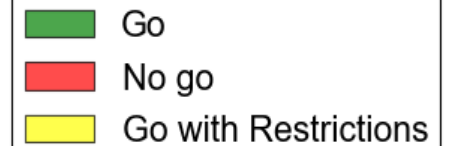
CS-2 classifier
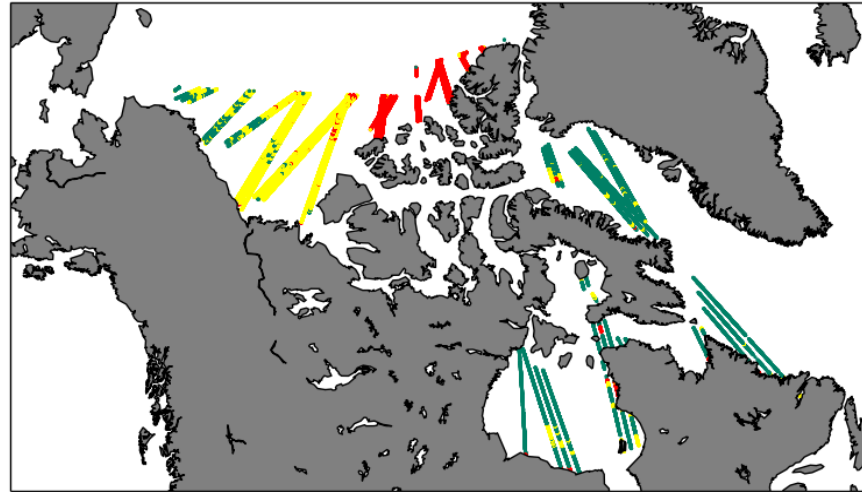
CIS ice chart

16-20 Jan 2017

- Go
- No go
- Go with Restrictions