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Using the Ice Watch system for collecting sea ice data through citizen science

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Istjenesten

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What is Ice watch (ASSIST)?

"Ice Watch coordinates the collection and archival of sea ice observations recorded by ships in the Northern Hemisphere."

Team at Met:

Nick Hughes, Trond Robertson, William Copeland, Penelope Wagner, Alistair Everett, Elena Bjørndal International collaborators: Polar Citizen Science Collective (Ted Cheeseman, Alex Cowan, Ken Southerland, Lauren Farmer). University of Alaska (Jenny Hutchings)

+ hundreds of observers!

What do we use in-situ sea ice obs for?

- Develop and improve on training sets for machine learning and other tools.
- Enhancing the validation and calibration of EO data (eg. Copernicus Sentinels, Cryosat, RADARSAT etc).
- Integrate with ice charting system
 - Ice analysts can begin to receive real-time sea ice observations (when internet is available on board).



Challenges

- Different systems for recording ice observations on different vessels, across industries and schemes e.g. VOS)
- Quality control currently not operational.

Patchy satellite coverage.

- Citizen science Expedition leaders have significant stresses already. How do we train the public in such a short time and maintain quality?
- General Public Service Providers Scientific Community Peer-reviewed literature Citizen Science Management applications Data and External Information Portal Data Accessible Data Cal/Val Quality Control and Collection Standardisation Information "Observe" **User Make Decisions** ible Scalable Information Prediction Integration Product Model Fle Format Decide How dard Orientation Sta Forecasts and models Data collection and **Content Management** Analytics standardisation System Not Published Meteorologisk institutt Wagner et al.

"Ice Watch coordinates the collection and archival of sea ice observations recorded by ships in the Northern Hemisphere."



ASSIST is compatible with ASPeCt

Collection tools and target groups

Two main tools for observation based on the skill level of the observer

ASSIST Softwear (Arctic Shipborne Sea Tce Standardization Tool)

- Scientific cruises
- Experienced users / ice observers

Ice Watch App

- Polar tourism cruises
- Fishing vessels
- Citizen scientists



Data Collection - ASSIST

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ASSIST Bata Network									About
This observation has the following Primary observer can't be b Observed at can't be blank Latitude can't be blank Longitude can't be blank I ce is invalid Meteorology is invalid I ce error: Total concentration Heteorology error: Visibility	errors: ank n can'l be Mank n is not a number lookup can'l be blank								
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General									
lce	Ice	Snow	Topogra	aphy	Melt		Other		
Mataaralamu	Primary Ice		Secondary Ice		Tertiary Ice				
meteorology	Partial Concentration (tenths)		Partial Concentration (tenths)		Partial Concentration (tenths)				
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Users collect observations using ASSIST software:

- Downloaded onto own computer and works offline.
- Can be a little fiddly to install.
- Drop downs and form filling.
- Used on operational/scientific cruises and tourist vessels through the Polar Citizen Science Collective.



Data Collection - App

■ Polar Collective	
Observed At	
2020-06-15 15:39:15	
_at/Ling ~	
57 3937834	
-5 5001575	
-3.3091373	
Ice Attributes	
Total Concentration * 9/10	~
Open Water Very narrow breaks, < 50m	~
Meteorology Attribut	tes
Visibility *	
> 10km	×
Photos Of The Ice *	
	COMPLETE

- ESA/CSEOL funded project joint between Norwegian Meteorological Institute and Polar Citizen Science Collective 2019-2020.
- Developed a user friendly app interface for collecting sea ice observations which can interface with the IceWatch website.





Methods for sea ice observation



- Observations are carried out manually by using the naked eye, past experience and a carefully laid out WMO standard criteria guide provided by ice watch (Hutchings et al, 2018)
- Observers are trained prior to taking observations. Despite this, in situ ice observations carried out by eye will always be subjective, although the same can be said for satellite imagery analysis. Hence automation activities.

ASSIST Criteria is extensive

		ASSIST	Data Fields/Codes		
		Data fields and lookup	tables for Ice Watch observations.		
PRIMARY OBSERVER (PO)	SHIP HEADING (ShH) degrees	SHIP SPEED (ShS) knots	FAUNA NAME (FN)	PHOTO NAME (Photo)	COMMENTS (COMM)
ADDITIONAL OBSERVER/S (AO)	Nearest degree	Nearest knot	Common or scientific name	Uploaded photo	Observer's comments
Full name			Any number of fauna types can be added	A CONTRACT OF A CONTRACT. CONTRACT OF A CONTRACT. CONTRACT OF A CONTRACT. CONTRACT OF A CONTRACT OF	
Add your name to the menu on first observation.	SHIP POWER (ShP)	SHIP ACTIVITY (ShA)	FAUNA COUNT (FC)	PHOTO PERSPECTIVE (PhP)	ST .
VVVV-MM-DD HH-MM-SS LITC	Not speched	10 Traveling in leads	Number of reported species	6 Port	ME
Converts computer time to UTC automatically.	1/4	20 :: Traveling in ice	NOTES (note0, note1, & note2)	E Forward	W
LATITUDE (LAT)	1/2	30 :: Back and ramming	Observer's notes, free format	Other	8
LONGITUDE (LON)	3/4	40 :: On station	Use these three fields for additional obervables you create		
DDD.DDD or DDD MM SS or DD MM.MMM Converts to decimal degrees automatically.	Full	50 :: Traveling along ice edge			
	SNOW TYPE (*SY)	MELT POND CONC (*MPC) Tenths		HIGH CLOUD TYPE (HY)	WIND SPEED (WS)
PARTIALICE CONCENTRATION (*C)	00 :: No snow observation	0::0/10	90 :: <50m	Ci :: Cirrus	Nearest knot
0::1/10	01 :: No snow, ice or brash	1::1/10	91 :: 50-200m	Cs :: Cirrostratus	
1 :: 1/10	02 :: Cold new snow, <1 day old	2 :: 2/10	92 :: 200-500m	Cc :: Cirrocumulus	WIND DIRECTION (WD) Degr
2 :: 2/10	03 :: Cold old snow	3 :: 3/10	93 :: 500-1000m		Nearest degree
3 :: 3/10	04 :: Cold wind-packed snow	4 :: 4/10	94 :: 1-2km	MED. CLOUD TYPE (MY)	
4 :: 4/10	05 :: New melting snow(wet new)	5 :: 5/10	95 :: 2-4km	As :: Altostratus	AIR TEMPERATURE (AT)
5::5/10	06 :: Old melting snow	6 :: 6/10	96 :: 4-10km	Ac :: AltoCumulus	Nearest degree, C
5:: 5/10	07 :: Glaze	7 :: 7/10	97 :: >10km	IOW CLOUD TYPE (1)	WATER TEMPERATURE (MT)
8 : 8/10	09 :: Melt puddles	9 - 9/10	TOTAL CLOUD COVER(TCC) Oktas	St -: Stratus	Nearest degree C
9 - 9/10	10 :: Saturated snow	10:: 10/10	HIGH CLOUD COVER (HV)	Sc :: Stratocumulus	Hearest degree, c
10::10/10	11 :: Sastrugi		MEDIUM CLOUD COVER (MV)	Ns :: Nimbostratus	RELATIVE HUMIDITY (RelH)
	the second se	MELT POND PATTERN (*MPP)	LOW CLOUD COVER (LV)	Cu :: Cumulus	Nearest %
OPEN WATER (OW)	SNOW DEPTH (*SN) cm	1 :: Linked	0::0	Cn :: Cumulonimbus	
0 :: No openings	Depth of surface snow	2 :: Discrete	1 :: 1/8 or less, but not 0		AIR PRESSURE (AP) mil
1 :: Small cracks			2 :: 2/8	HIGH CLOUD HEIGHT (HH) kr	n Nearest mBar
2 :: Very narrow breaks, <50m	TOPOGRAPHY TYPE (*Top)	MELT POND SURFACE TYPE (*MPT)	3 :: 3/8	3 - 8km	
3 :: Narrow breaks, 50-200m	100 :: Level ice	1 :: Frozen	4 :: 4/8		
4 :: Wide breaks, 200-500m	200 :: Rafted Pancakes	2 :: Open	5 :: 5/8	MEDIUM CLOUD HEIGHT (MH) ka	n
S :: Very wide breaks >500m	300 :: Cemented Pancakes	3 :: Bottom up	b :: b/8	2 - 4km	
7 - Polynya	400 :: Raturg 500 :: Rideer	MELT POND EREEROARD (*MRE)	7 :: 7/8 or more, but not 8/8	LOW CLOUD HEIGHT (LH)	
8 -: Water broken only by scattered floes	500 MdBea	Height of MP freeboard above MP surface	00/0	Surface - 2km	
9 :: Open sea	TOPOGRAPHY CONC (*TopC) Tenths			January Bann	
10 :: Strips and patches	0 :: 0/10	MELT POND DEPTH (*MPD) cm	WEATHER (WX)		
	1 :: 1/10	1 :: 0-10cm	00-03 Sky Change During Past Hour	40-49 Fog at the Time of Ob	70-79 Solid Precip. Not as Showers
ICE TYPE (*T)	2 :: 2/10	2 :: 10-30cm	000 :: Clouds not observable/observed	040:: Fog: distance, not at ship in past hour**Vis	may b070 :: Slight fall of snow flakes, intermittent
OTHER ICE TYPE THIN (OT)	3 :: 3/10	3 :: 30-50cm	> 001 :: Clouds dissolving/becoming less developed	041 :: Fog in patches	071 :: Slight fall of snow flakes, continuous
OTHER ICE TYPE THICK (TH)	4 :: 4/10	4 :: >50cm	002 :: State of sky as a whole unchanged	042 :: Fog thinning in last hour, sky discernable	072 :: Moderate fall of snow flakes, intermittent
B 10 :: Frazil	5::5/10	-9 :: Unknown	2 003 :: Clouds forming or developing	043 :: Fog thinning in last hour, sky not discernab	e 073 :: Moderate fall of snow flakes, continuous
- 11 :: Shuga	6::6/10	MELT DOND BOTTOM TUDE (AMOT)	P 10 13 Mint and Challens Face	044 :: Fog unchanged in last hour, sky discernable	074 :: Heavy fall of snow flakes, intermittent
12 :: Grease	77/10 88/10	1 is folid	2 010 :: Mist And Shallow Fog	045 .: Fog unchanged in last hour, sky hot discern	iccorr 075 .: Reavy fail of show flakes, continuous
15 :: Slusn 20 :: Nilas	8 .: 6/10	2 ·· Some have they holes	010 :: Mist (Visibility 1/2 nm or more)	046 .: Fog beginning/thickening in last hour, sky o	ot dis 077 .: Snow grains with/without fog
30 :: Pancakes	10::10/10	3 :: All have thaw holes	012 :: Shallow fog. more or less continuous	048 :: Fog depositing rime, sky discernable	078 :: Isolated star like crystals
40 :: Young Grey Ice, 10-15cm				049 :: Fog depositing rime, sky not discernable	079 :: Ice pellets
50 :: Young Grey Ice, 15-30cm	RIDGE HEIGHT (*RH) m	DRIED ICE? (*MDI)	14-16 Precipitation not at ship		
60 :: First Year, < 70cm	To nearest half meter	ROTTEN ICE? (*MRI)	014 :: Precipitation in sight, not reaching surface	50-59 Drizzle	80-84 Rain Showers
70 :: First Year, 70-120cm		Yes :: True	015 :: Precipitation beyond 3nm, reaching surface	050 :: Slight drizzle, intermittent	080 :: Slight rain showers
80 :: First Year, > 120cm	TOPO FEATURE OLD? (*Old)	No :: False	016 :: Precipitation within 3nm, reaching surface	051 :: Slight drizzle, continuous	081 :: Moderate or heavy rain showers
75 :: Second Year	TOPO FEATURE CONSOLIDATED? (*Cs)			052 :: Moderate drizzle, intermittent	082 :: Violent rain showers
85 :: Multiyear	TOPO FEATURE SNOW-COVERED? (*SC)		20-29 Past Hour but NOT at Ob	053 :: Moderate drizzle, continuous	083 :: Slight showers of rain and snow
90 :: Brash	Yes :: True	ALGAE CONC. (*A) %	020 :: Drizzle not freezing or snow grains	054 :: Dense drizzle, intermittent	084 :: Moderate/heavy showers of rain and snow
95 :: Fast Ice	No :: False	SEDIMENT CONC. (*SD)	021 :: Rain not freezing or snow grains	055 :: Dense drizzle, continuous	or on failed Baselalization in Channes
ICE THICKNESS (\$7)		1 0 = 20%	022 .: Show not freezing or show grains	OE7 a Erecting drize moderate of dente	85-90 Solid Precipitation in Showers
Total ice thickness in cm		2 <60%	024 :: Drizzle or rain freezing	057 .: Preezing unizzle, moderate or dense	085 -: Moderate or beausy snow thoward
Total lot theories in the	_	3 - 560%	025 :: Showers of rain	059 :: Drizzle and rain, moderate or dense	087 :: Slight showers of soft or small hail
FLOE SIZE (*F)		37007	025 :: Showers of snow, or of rain and snow	039 Of the and rail, inductate of delise	088 :: Moderate/heavy showers of soft/small hail
100 :: Pancakes		ALGAE LOCATION (*AL)	027 :: Showers of hail, or of rain and hail	60-69 Rain NOT Falling as Showers	089 :: Slight showers of hail
200 :: New sheet ice		1 :: Top	028 :: Fog in past hour, not at present	060 :: Slight rain, intermittent	090 :: Moderate or heavy showers of hail
300 :: Brash/Broken ice		2 :: Middle	029:: Thunderstorm, with or without precip	061 :: Slight rain, continuous	
400 :: Cake ice, < 20m		3 :: Bottom		062 :: Moderate rain, intermittent	
500 :: Small floes, 20-100m			36-39 Unique Snow Conditions	063 :: Moderate rain, continuous	
600 :: Medium floes, 100-500m		ALGAE DENSITY (*AD)	036 :: Drifting snow below eye level, slight/moderate	064 :: Heavy rain, intermittent	
700 :: Large floes, 500-2000m		0 :: Not Visible	037 :: Drifting snow below eye level, heavy	065 :: Heavy rain, continuous	
800 :: Vast floes, >2000m		1 :: Trace	038 :: Blowing snow, above eye level, slight/moderate	066 :: Freezing rain, slight	
900 :: Bergy floes		2 :: Light	U39 :: Blowing snow, above eye level, heavy	Ub7 :: Freezing rain, moderate or heavy	
		3 :: Medium		060 ··· Pain or drizzle and snow, slight	
		Son Colour Chart		ous nam or unizzle and show, moderate/neavy	

Example Observation

360° view 1 nautical mile from the ship over a 10 minute period only during transit.





Use of ship radar to determine 1nm.





Thicknesses determined by measuring rod or viewing window on bridge.

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Input of data into ASSIST

- Register cruise METADATA (Ship name, dates, cruise description, captain, chief scientist and primary observer).
- Manual infilling of general information (long, lat, time (UTC) observer name)
- Drop down menus for ice and meteorological observations.



Input of data into App

- Fewer infilling criteria. Basic concentration data.
- Ice service currently only produces ice concentration charts. So concentration is the most critical value.
- Stage of development / ice type charts into the future would mean adjustments to the app interface.

ODSERVED AL	
Lat/Lng *	
Latitude *	
57.3937834	
Longitude *	
-5.5091575	
Ice Attributes	
Total Concentration * 9/10	~
Open Water Very narrow breaks, < 50m	~
Meteorology Attribu	utes
Visibility *	
> 10km	
Photos Of The Ice *	
	COMPLETE

Quality control

- Quality control is carried out firstly by ASSIST and manually by the observer.
- Past observations can be edited after saving at any point during the cruise and from the exported CSV during / post cruise. Comparison to ship logs.
- Overlap between observers helps to mitigate the subjectiveness of observations.

ICE WATCH ASSIST Bata About This observation has the following errors: Ice error: Total concentration Partial concentrations must equal total concentration Primary ice observation error: Partial concentration Sum of partial concentrations must equal total concentration Secondary ice observation error: Partial concentration Sum of partial concentrations must equal total concentration · Tertiary ice observation error: Partial concentration Sum of partial concentrations must equal total concentration Total Concentration (tenths) **Open Water** 10 * No Observation • General Ice Snow Melt Other Topography Primary Ice Secondary Ice Tertiary Ice Meteorology Partial Concentration Partial Concentration Partial Concentration (tenths) (tenths) (tenths) Photos 2 * No Observation No Observation Comments Total Concentration: 10/10 Total Concentration: 10/10 Total Concentration: 10/10 Ice Type Ice Type Ice Type No Observation No Observation No Observation -Exit without Saving Thickness (cm) Thickness (cm) Thickness (cm) Floe Size Floe Size Floe Size No Observation . No Observation No Observation v



Uploading of data to data portal with **ASSIST**

- Usually carried out post cruise when internet ٠ connection is available. Live upload would be preferred but bandwidth connections are too limiting in most Arctic areas.
- Observations are exported as Zip file containing: ٠ -Cruise METADATA -CSV file (Cruise observations)
 - -JSON file (Cruise obs. and metadata)
- User creates an account at • https://icewatch.met.no/ and uploads observation CSV to ice archive for the specific cruise.

Welcome to the

Arctic Shipborne Sea Ice Standardization Tool

Start Observation

t from ship	All / None	Observation Date	Last Modified	Total Ice Concentration	Primary Observer Additional Observers	
Observations	0	2022-04-27 03:01:00 UTC	2022-04-27 03:04:40 UTC	9	William Copeland	
lected Observations		2022-04-27 04:04:00 UTC	2022-04-27 04:06:30 UTC	10	William Copeland	
port with photos	D	2022-04-27 04:52:00 UTC	2022-04-27 04:52:44 UTC	9	William Copeland	
s recommended to not port with photos until		2022-04-27 06:01:00 UTC	2022-04-27 06:01:28 UTC	7	William Copeland	
turning to port and ifficient bandwidth is		2022-04-27 06:57:00 UTC	2022-04-27 06:57:41 UTC	10	William Copeland	
I Observations	0	2022-04-27 09:13:00 UTC	2022-04-27 09:19:27 UTC	10	William Copeland	
elected Observations	0	2022-04-29 06:11:00 UTC	2022-04-29 06:12:18 UTC	10	William Copeland	
iew Cruise as	0	2022-04-29 16:10:00 UTC	2022-04-29 16:10:27 UTC	8	William Copeland	
sv		2022-04-29 17:02:00 UTC	2022-04-29 17:07:44 UTC	8	William Copeland	
SON		2022-04-29 18:01:00 UTC	2022-04-29 18:02:33 UTC	9	William Copeland	
nport		2022-04-29 19:05:00 UTC	2022-04-29 19:05:59 UTC	9	William Copeland	
rom CSV		2022-04-29 20:09:00 UTC	2022-04-29 20:10:14 UTC	9	William Copeland	
ruise	0	2022-04-29 21:10:00 UTC	2022-04-29 21:11:31 UTC	10	William Copeland	
dit		2022-04-29 21:59:00 UTC	2022-04-29 21:59:29 UTC	9	William Copeland	
		2022-04-29 23-14-00 LITC	2022 04 29 22:15:17 UTC	10	Maline Completed	



Uploading of data to data portal with Ice Watch APP

- When finished with all observations, go back to the home screen and select the double arrow marker next to Ice Watch.
- Push data to the ice watch server through API.



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Accessing and download of data

- All data can be viewed and downloaded via the ice watch webpage as csv, json, geojson or Sigrid3 format.
- Icewatch format is compatible with Sigrid-3 WMO standards



Download Options

METADATA Example

["starts_at":"2022-04-22 00:00:00 UTC","ends_at":"2022-05-09 00:00:00 UTC","ship":"RV Kronprins Haakon ","objective":"Centre for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA) cruise. Collection of ice observation, snow pit, ice core, transect and drifter deployment data. ","captain":"","chief_scientist":"Sebastian Gerland ","primary_observer":null]



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Since 1st Jan 2022

Downloads

	Event Label ?	Total Events ?
		716 % of Total: 100.00% (716)
	1. https://icewatch.met.no/cruises/121/observations.csv	28 (3.91%)
Mosaic cruises	2. https://icewatch.met.no/cruises/118/observations.csv	27 (3.77%)
	3. https://icewatch.met.no/cruises/120/observations.csv	22 (3.07%)
	4. https://icewatch.met.no/Ice_Watch_Manual_v4.1.pdf	19 (2.65%)
	5. https://icewatch.met.no/cruises/130/observations.csv	17 (2.37%)
LINFA CIUISE —	6. https://icewatch.met.no/ASSIST_v4.1_Installation_Guide.pdf	16 (2.23%)
	7. https://icewatch.met.no/ASSIST_v4.1.zip	16 (2.23%)
	8. https://icewatch.met.no./cruises/104/observations.geojson	15 (2.09%)
	9. https://icewatch.met.no/ASSIST_v4.1_Cheat_Sheets.pdf	15 (2.09%)
	10. https://icewatch.met.no/cruises/109/observations.csv	15 (2.09%)



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Meteorologisk institutt

https://github.com/metno/icewatch

Future

- Routine ice observations from multiple ships on any given day along the ice edge.
- Data mining of archive observations.
- A team of consistent ice observers on vessels to train citizen scientists.
- Integrate easy photo upload to data portal.
- Move to python
- A much greater collaboration with the maritime industry fishing industry especially.







Thanks!

Website:https://github.com/metno/icewatchE-post:icewatch@met.noTwitter:@icewatchASSIST