Ice Watch: Standardizing and expanding Arctic ship based sea ice observations

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1. Introduction

Visual observations of ice from airplane or ship are an integral part of sea ice monitoring for operational and research support. These observations provide information about sea ice morphology that is not obtainable or ambiguous in remotely sensed data. We present Ice Watch, a program coordinating visual observations of sea ice in the northern hemisphere conducted from ships. Following from efforts to standardize sea ice observations in the Antarctic (Worby and Alison, 1999) observation protocols and software have been developed to aid in the standardization of ship-based visual sea ice observations in the Northern hemisphere and globally.

2. Observing Arctic Sea Ice from Ships

In the past there have been a variety of methodologies used to record visual ship-based observations of the Arctic ice pack. These range from the use of the ASPeCt convention (Worby and Alison, 1999), which was designed for Antarctic sea ice, to ad-hoc systems designed for particular ships (e.g. custom designed software has been used on the United States Coast Guard Cutter *Healy*, Eicken et al., 2009). In general the systems used adhere to the World Meteorological Organisation (WMO) nomenclature (WMO, 2014) for describing sea ice characteristics.

With differences between methodologies used by different researchers, and divergence in the description of Arctic specific features, such as melt ponds, there was need to unify reporting of sea ice bridge observations from Arctic research vessels. This need was discussed during a World Climate Research Program Climate and Cryosphere (CliC) sponsored workshop in 2009 (Gerland et al. 2009), and a plan implemented to standardize Arctic bridge observations. Over the following 3 years discussions were instigated between Arctic sea ice researchers who participate in ship-based field campaigns to find consensus on the common elements of a bridge observations recording system for the Arctic. These discussions resulted in the design of a standardized recording system and software to facilitate collection and archival of standardized data. The recording system resulting from these discussions has been implemented into a standard protocol for performing sea ice bridge observations in the Arctic. The Ice Watch program was founded to facilitate uptake of the new standard methods by researchers and to assist in data archival.

Since 2012 the Ice Watch program has expanded its network of participating observers and ships. In this year data was collected during 13 separate cruises and has coverage of much of the perennial ice pack, figure 1.

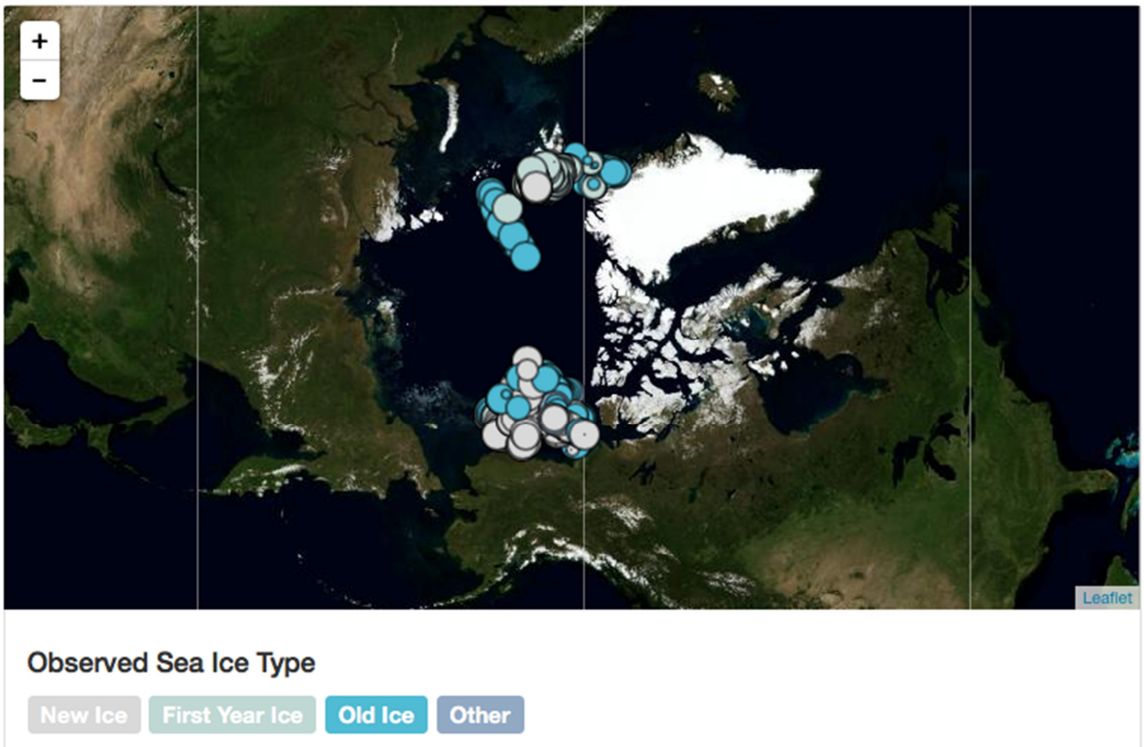

Figure 1 Location of Ice Watch data collected during 2015. This is not the full set of data collected in 2015, we are anticipating contributions in the Bering Sea and central Arctic from the Sikuliaq and Healy.

2.1 Software to record bridge observations

To facilitate accurate recording of observations following the Ice Watch Program standard protocols software was developed for recording data and archiving the data.

The Arctic ship-borne sea ice standardization tool (ASSIST) is a stand-alone web interface that guides an observer through recording visually estimated properties of the sea ice. The ice is viewed within 1 nautical mile (nm) from the ship during a 10 minute observation period that is normally performed on the ship's bridge. The philosophy of ASSIST is to guide users through the observation process, and ensure standardized data is recorded accurately. ASSIST guides the observer with basic quality control, reducing erroneous records. It has an intuitive interface (see figure 2), and runs on Windows, Mac and Linux platforms.

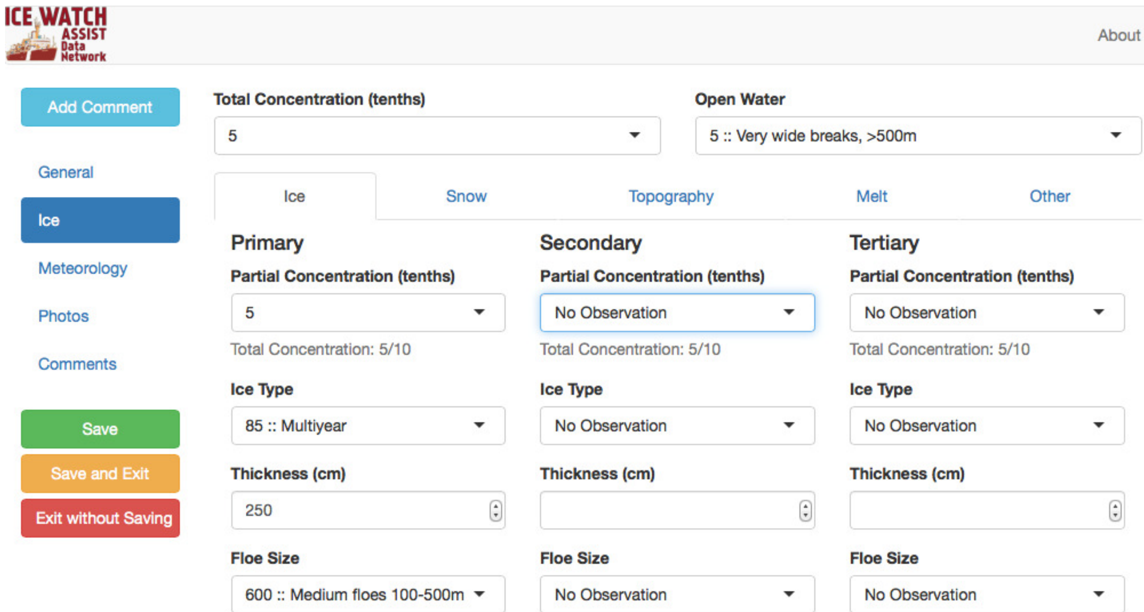

Figure 2: A screen shot showing the layout of the ASSIST data entry

Data is archived through a website hosted by the Geographic Information Network of Alaska (GINA), using the same web interface as ASSIST for error correction and checking. Both ASSIST and the Ice Watch archive allow upload of CSV data files, such that experienced observers do not need to use the web interface, and quality control can be conducted offline.

2.2 The Ice Watch Observing System

The foundation of sea ice characterization is the Egg Code (Canadian Ice Service, 2005), where ice within a region is classified in up to five categories based on the ice type. Three ice types, referred to as, in order of decreasing thickness, the primary (P), secondary (S) and tertiary (T) ice types, are recorded with detailed information. Two additional types can be noted: a thick ice type (the thickest ice that has less than 10% cover) and one additional ice type. In the Egg Code each P, S or T ice type the stage of development of the ice and form of the ice is recorded. Both ASPeCt and ASSIST preserve this convention in their recording system. However there is much additional information recorded in ASSIST that is of interest to sea ice researchers. See the Appendix for a summary of observational fields in ASSIST. Both ASPeCt and ASSIST characterize sea ice topography and snow cover, following ASPeCt convention (Worby and Dirita, 1999). ASSIST includes additional ice type and floe size options to reflect ice chart conventions (Canadian Ice Service, 2005). ASSIST also includes stage of melt information that is absent from ASPeCt, but included in observations supporting ice charting (Canadian Ice Service, 2005).

2.3 Key differences between ASPeCt and ASSIST

ASSIST is fully backward compatible to ASPeCt (Toyota 2015) , such that any ASSIST observation can be transformed into the ASPeCt format. Additional fields are included in ASSIST to characterize ice conditions more typically found in the Arctic than the Antarctic. These include fields describing the ice surface melt, sediment and algae in ice, fauna additional ice types and meteorological fields, and information about ship travel.

Table 1: Stage of Melt Classification for different ice types. Following Russian ice observer convention (pers. comm. Vasily Smolyanitsky 2003).

	Stage of Melt	Description
Young Ice	0	No melt
	1	Surface darkened, snow melt single thaw holes
	2	Greatly disrupted surface thaw holes everywhere
	3	Level ice completely melted. Only deeply seated in water remains, ridges still found
First Year Ice	0	No melt (or pack freezing, young ice forming over thaw holes)
	1	Some puddles on surface. Ice structure destruction from warming begun, brine channels enlarging.
	2	Surface darkened, snow partially melted. Big puddles, some melt ponds.
	3	Melt ponds everywhere, some thaw holes. Ice is stage of drying, ice color whitening.
	4	Greatly disrupted ice. Thaw holes everywhere. Disruption of brine channel structure complete, ice dried. Underwater ramps on ice cakes.
	5	Rotten ice. Greatly melted formless blocks. Dark grey color, greatly watered.
Multiyear Ice	0	No melt (or pack freezing, young ice forming over melt ponds/thaw holes)
	1	Snow melting on top of hummocks. Melt ponds / patches of wet snow in low places.
	2	Some ponding, <40% melt ponds. Snow melting. Places with no snow may occur.
	3	Well-defined melt ponds everywhere. Connected freshwater output through cracks. Area of melted water on surface is decreased due to output.
	4	Ice floes cracked. Area of melted water on surface is decreased from drainage, <30%. Thaw holes.
	5	Floes have become cracked and blocks, due to

intensive melt. Rotten ice.

Sea ice stage of melt can be characterized in a 5 point scale (table 1) that follows the WMO standard convention for describing melt. In North American ice charting this scale is reproducible from the standard observations (Canadian Ice Service, 2005) outlined in table 2. In ASSIST the full 5 point scale can be reproduced provided all melt fields are entered for an ice type. The pertinent information is whether thaw holes are present in melt ponds, if ice has dried or become rotten and whether ponds are freezing over. In addition to the stage of melt information, area of ice covered by melt pond and pond characteristics, such as whether melt ponds are discrete or linked (see figure 3) and the depth of melt ponds can be recorded.

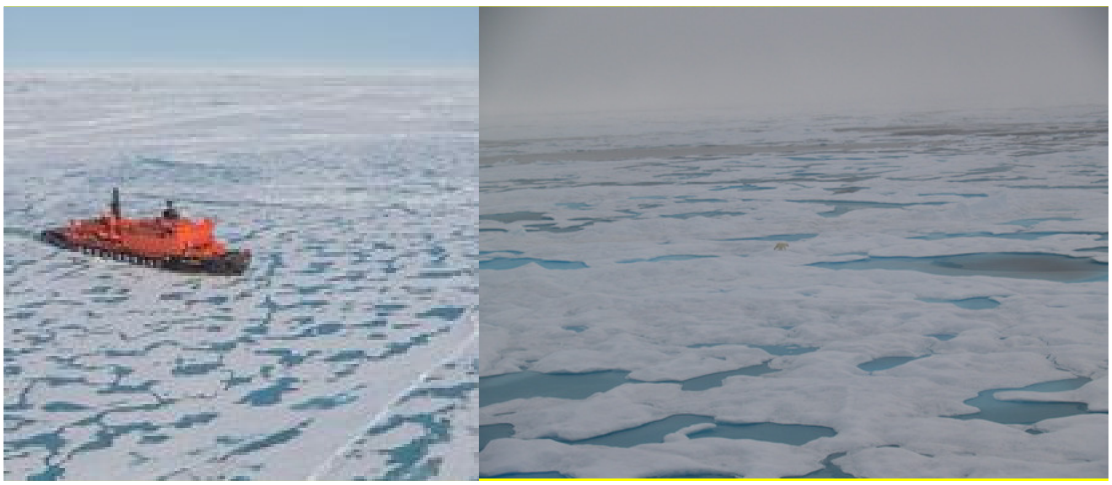

Figure 3: Photographs of linked melt ponds typical on level first year ice (left) and discrete melt ponds on older ice (right).

Table 2: MANICE characterization of stage of melt, which is somewhat less detailed that the Russian convention described in table 1

Puddles	The presence of melt ponds or puddles is noted
Thaw Holes	Thaw holes in melt pond bottoms
Dried Ice	Ice surface as dried and whitened, equivalent to stage 4, table 1
Rotten Ice	Honeycomb ice, equivalent to stage 5, table 1
Flooded Ice	Flooded ice is heavily loaded with water or water and wet snow

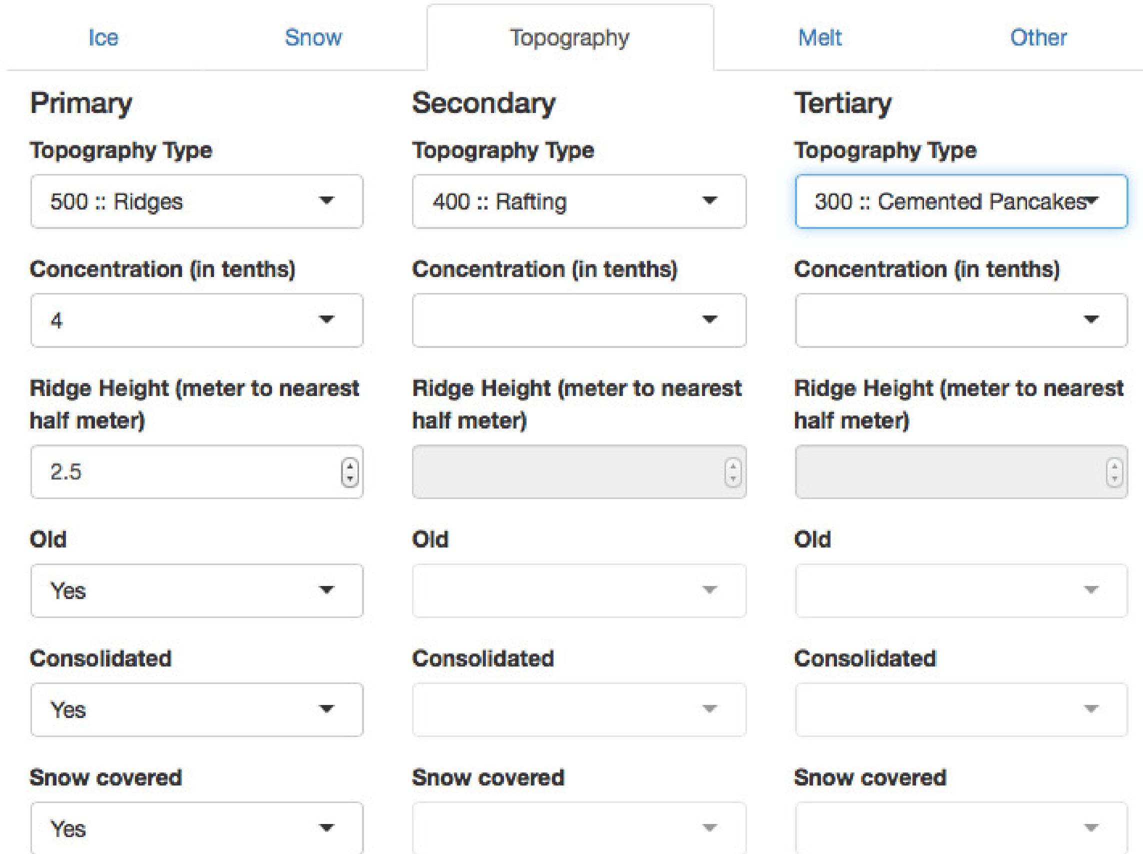

Figure 4: Ridge data entry in ASSIST.

In ASSIST the ASPeCt topography code convention (Worby and Alison, 1999) is followed. The ASSIST software eases recording of the topography codes by guiding the observer through menus characterizing the ridging (see figure 4). The observer can enter ridges as present, and record area cover and sail height of these ridges. Additional questions identify if the ridges are snow-covered, consolidated or old, negating a need to remember the codes for each of these scenarios when recording observations. While the ASSIST data is not provided as ASPeCt codes, these codes are easily recreated from the ASSIST data (see table 3).

Table 3: Conversion between ASSIST and ASPeCt Topography Codes. The ice fraction, x, and thickness, y, are recorded in the same way in both systems.

ASSIST						ASPeCt
topography	**old**	**consolidated**	**snow cover**	**fraction**	**thickness**	
500	no	no	no	x	y	5xy
500	no	no	yes	x	y	6xy
500	no	yes	yes/no	x	y	7xy
500	yes	yes	yes/no	x	y	8xy

3 Supporting Operational Needs

As ASSIST data follows the Egg Code convention and is compliant with WMO standards, it can be directly compared to and used in ice charts. The national and regional organizations that create ice charts have standardized data formats that are formalized through participation in the WMO JCOMM Expert Team on Sea Ice (ETSI). This group has developed a conventional shape file format for Ice Chart data that allows sharing of data and products between organizations. This data format is version 3 of Sea Ice GeoReferenced Information and Data, SIGRID-3 (JCOMM Expert Team on Sea Ice, 2014). Ice Watch provides SIGRID-3 format data download from the icewatch.gina.alaska.edu archive.

We are currently beta testing the SIGRID-3 format for ASSIST data, in partnership with the U.S. National Ice Center. Though we do not currently have the ability to provide SIGRID-3 data in near-real time, we are discussing how to provide software to perform the conversion from ASSIST data sent by email from ships. Near-real time data will enhance utility for ice charting and forecasting, and requires some operational support from the national ice services to manage.

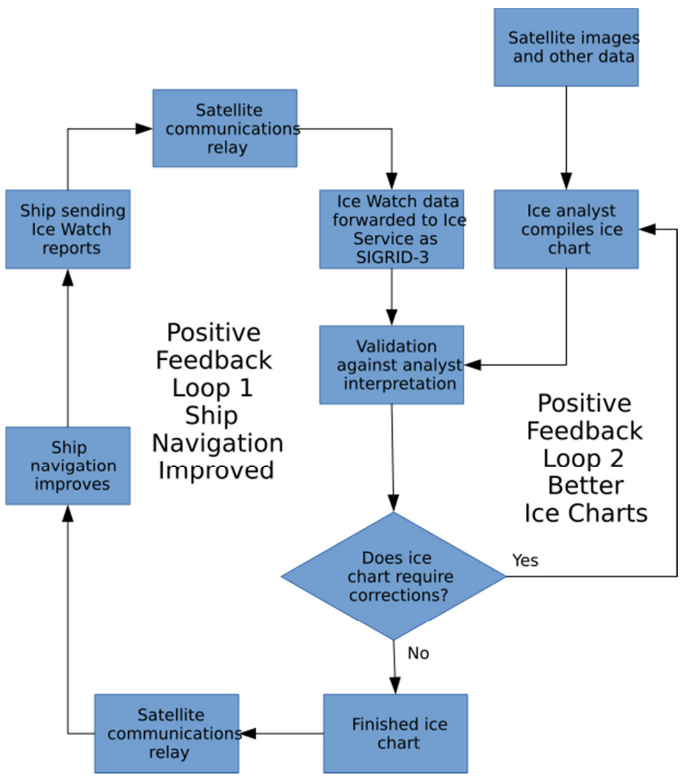

Figure 5: Schematic showing how Ice Watch data is integrated into improving accuracy of ice charts.

ASSIST data can be used to validate ice charting practices between different agencies and the ice analysts employed in producing ice charts. Ice analyst interpretation of ice conditions is subjective, and can vary according to factors including: the different types of satellite and in situ observations available; the amount of time taken to compile the ice chart particularly if working to a set deadline; and the individual level of training of the ice analyst. Near-real time availability of the data would allow this process to be undertaken during the ice chart production process, by providing the analyst with an independent and non-subjective measurement from the location that can be used to improve their interpretation of the other available data, typically synthetic aperture radar (SAR) satellite images.

Testing of Ice Watch SIGRID-3 format data ingestion into ice charts will be organized through the national ice charting agencies group, the International Ice Charting Working Group (IICWG), which arranges regular Ice Analysts Workshops to allow experimentation with new methods and cross-comparison of ice charting procedures between agencies.

4. Utility of Ice Watch Data

While the coverage of Ice Watch data is limited to one nautical mile along ship tracks, it does provide a richer data set than is possible with remote sensing alone. Sea ice characteristics that are not inferable from remote sensed data over large regions include melt pond characteristics, detailed determination of the surface roughness including area and volume estimates for ridges, and thickness of the snow and ice.

The detailed morphological description Ice Watch provides is both a tool to focus the researchers observational awareness and record detailed information that can help in future interpretation of field experiments, and inform ice charts used in navigation and hazard mitigation. The data can be used in investigating the variability of sea ice morphology and how sea ice interacts in the climate system. For example in mapping sea ice thickness (Worby et al., 2008), identifying melt pond cover (Itoh et al., 2011), tracking floe size and areas of mixed ice types (e.g. Perovich et al., 2009) .

It is the utility of the data that motivates us to grow the Ice Watch network and become closely integrated with other groups operating and supporting operations in ice covered waters.

5. Developing Partnerships

Since 2009, researchers on board vessels from Japan, China, Norway, Canada, The U.S.A, Germany, Korea, Sweden, Russia and the non-governmental organization Greenpeace have participated in Ice Watch. We are expanding participation from the Oil and Gas industry, with participation from StatOil in recent years.

In Summer 2015 Ice Watch conducted its first citizen science experiment. Tour operators on the Russian icebreaker *50 Let Pobedy* participated in Ice Watch recording bridge observations and provided a comprehensive description of evolving ice conditions between Franz Joseph Island and the North Pole over a 6 week period in July and August. This use of ASSIST demonstrated that data collection can be implemented on a cruise with little disruption to the pre-existing tour program and also provides significant additional value to the paying passengers, who were unequivocal in expressing their enjoyment in taking part in Ice Watch. The polar tourism industry is open to sharing their access with researchers and there is considerable interest within the industry in this pilot project.

Expedition cruise operators have sustained and repeated access to polar regions and are becoming increasingly aware of the value of this access for data collection. There are approximately 20 vessels in the industry, the majority ice-strengthened and one or two of icebreaking class, working for up to 5 months at a stretch in various parts of both the Arctic and Antarctic. Ice Watch is interested in engaging these cruise operators in future data collection.

Other opportunities for data collection have occurred through partnerships with researchers on field campaigns funded by oil and gas companies. We wish to expand these partnerships, providing data collection training and support to merchant navy ships. From experience worked with two industry supported cruises and Greenpeace's Arctic Sunrise we are developing strategies to engage merchant navy officers in Ice Watch. To be successful and provide observations useful for ice hazard avoidance and scientific research this program needs centrally funded organization. Services to merchant navy must include training packages and simple electronic transfer of data to the national ice charting organizations.

6. Integration into Observing Networks

Ice Watch data does not lend itself to gridding or direct comparison with model fields. It is best utilized in concert with remote sensed data. In ice charting, where synthetic aperture radar, visual, thermal and passive microwave satellite images are used to identify zones of uniform ice characteristics, a small number of visual observations within a zone are invaluable for ground truth and providing data not obtainable from the imagery such as ice thickness during summer, melt pond characteristics and snow depth. Hence the most value of the Ice Watch program in observing networks would be to (i) provide near-real time data to meteorological and ice charting groups and (ii) ensure a large network of sea ice observers are recording Ice Watch data with the ASSIST code and archiving this data for research use.

To support operational needs data transfer could be provided in coordination with the Autonomous Volunteer Observation System (AVOS) and the World Meteorological Organisation's (WMO) Global Telecommunication System (GTS).

Achieving integration in to the Global Observing System requires management support to translate ASSIST data to AVOS and GTS fields, interface with the relevant WMO World Weather Watch committees, shepherd the technological and software development required, expand the data network and interact with users. We also need to identify communities of mariners to engage through training and observation involvement to expand Ice Watch further. We are developing technology to facilitate near real time transfer of Ice Watch data such that we can integrate into global networks supporting ice charting and forecasting.

As an ice watch is an integral tool in the sea ice field workers kit, such data has been collected on cruises that pre-date the inception of the Ice Watch Program. We are interested in data rescue and working with our partners to convert older data formats into the Ice Watch standard format. While this will require some additional funding, the effort will be rewarded with increased utility of the data archive for climate investigations. The Ice Watch database is interested in building links to Polar and Global observational databases.

5. Future Sustainability of Ice Watch and its Partnerships

As shipping increases in the Arctic there is a need for increased and improved now-casting and forecasting of ice conditions ships will encounter. A key tool in providing accurate ice charts is in-situ observations. Ice Watch is interested in providing merchant and research ships the capability to deliver such observations to ice charting agencies world-wide. In the next year we will be developing a streamlined version of ASSIST for use by non-experts. In designing this tool we are interested in identifying the data needs of industry and operational centers.

Ice Watch will maintain a database of ASSIST data at both the University of Alaska Fairbanks, USA, and the Alfred Wegner Institute, Germany. The data is freely available, easily searchable and appropriate for a variety of sea ice studies. As the program has grown to include increasing number of ships and researchers over the last 6 years, with a small amount of support for data archival, data and software management it is poised to become an integrating resource for sea ice research. The creation of a program office, perhaps as part of a larger effort to integrate Arctic marine observations into the Global Observation System and support citizen observers, would facilitate expansion of observations. The link between Ice Watch as a research tool and Ice Watch's direct involvement in operational support of Arctic shipping should be exploited to grow the program to fulfill the needs of increasing human activity in ice covered waters.

For more information and to participate visit www.iarc.uaf.edu/icewatch. Ice Watch data is freely available at icewatch.gina.alaska.edu.

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Utilizing the IARC-JAXA Information System (IJIS) and Satellite Imagery". The Climate of the Cryosphere (CliC) has provided logistical support in developing the Ice Watch collaboration and hosts a technical working group facilitating conversations and integration with the SCAR/ASPeCt team. The design of the Ice Watch standardized observing method and ASSIST software has been developed from numerous conversations with many Arctic field researchers both informally and during CliC Sea Ice Working Group meetings. Many thanks to John Falkingham for discussions invaluable in developing the SIGRID-3 conversion of Ice Watch data.

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Appendix: **Ice Watch Observation Codes**

Ice Watch observations are organized in the ASSIST data input interface into a series of pages: General, Ice, Meteorology, Photos and Comments. In the description of the observation codes below we present the data in tables associated with each page and tab on the page. Data is output in comma separated value, CSV, format and the header for the data column is given in brackets next to the observable name in the following tables.

General: Observation

PRIMARY OBSERVER (PO) **ADDITIONAL OBSERVER/S (AO)**
Full name
Add your name to the menu on first observation.
OBSERVATION DATE/TIME (Date)
YYYY-MM-DD HH:MM:SS UTC
Converts computer time to UTC automatically.
LATITUDE (LAT) **LONGITUDE (LON)**
DDD.DDD or DDD MM SS or DD MM.MMM
Converts to decimal degrees automatically.

General: Ship

SHIP HEADING (ShH) degrees	**SHIP SPEED (ShS)** knots
Nearest degree	Nearest knot
SHIP POWER (ShP)	**SHIP ACTIVITY (ShA)**
Not Specified	Not Specified
0	10 :: Traveling in leads
1/4	20 :: Traveling in ice
1/2	30 :: Back and ramming
3/4	40 :: On station
Full	

General: Fauna

FAUNA NAME (FN)
Common or scientific name
Any number of fauna types can be added
FAUNA COUNT (FC)
Number of reported species

General: Notes

NOTES (note0, note1, & note2)
Observer's notes, free format

Three free format fields that can be used to include additional data entries of the observers choice.

Ice

TOTAL ICE CONCENTRATION (TC) PARTIAL ICE CONCENTRATION (*C)	Tenths
0 :: 1/10	
1 :: 1/10	
2 :: 2/10	
3 :: 3/10	
4 :: 4/10	
5 :: 5/10	
6 :: 6/10	
7 :: 7/10	
8 :: 8/10	
9 :: 9/10	
10 :: 10/10	

OPEN WATER (OW)
0 :: No openings
1 :: Small cracks
2 :: Very narrow breaks, <50m
3 :: Narrow breaks, 50-200m
4 :: Wide breaks, 200-500m
5 :: Very wide breaks >500m
6 :: Leads
7 :: Polynya
8 :: Water broken only by scattered floes
9 :: Open sea
10 :: Strips and patches

In the Ice, Snow, Topography, Melt and Other tabs information is entered for each ice type. The ice types are Primary (P), Secondary (S) and Tertiary (T). CSV data headers for the P,S and T fields are prefixed by P, S or T respectively. The letter codes following this prefix are given in the tables below with a * prefix.

Ice: Ice

Partial Ice Concentration (*C) is entered following the table for TC.

ICE TYPE (*T) OTHER ICE TYPE THIN (OT) OTHER ICE TYPE THICK (TH)
10 :: Frazil
11 :: Shuga
12 :: Grease
13 :: Slush
20 :: Nilas
30 :: Pancakes
40 :: Young Grey Ice, 10-15cm
50 :: Young Grey Ice, 15-30cm
60 :: First Year, < 70cm
70 :: First Year, 70-120cm
80 :: First Year, > 120cm
75 :: Second Year
85 :: Multiyear
90 :: Brash
95 :: Fast Ice

ICE THICKNESS (*Z)	cm
Total ice thickness in cm	

FLOE SIZE (*F)
100 :: Pancakes
200 :: New sheet ice
300 :: Brash/Broken ice
400 :: Cake ice, < 20m
500 :: Small floes, 20-100m
600 :: Medium floes, 100-500m
700 :: Large floes, 500-2000m
800 :: Vast floes, >2000m
900 :: Bergy floes

Ice: Snow

SNOW TYPE (*SY)
00 :: No snow observation
01 :: No snow, ice or brash
02 :: Cold new snow, <1 day old
03 :: Cold old snow
04 :: Cold wind-packed snow
05 :: New melting snow(wet new)
06 :: Old melting snow
07 :: Glaze
08 :: Melt slush
09 :: Melt puddles
10 :: Saturated snow
11 :: Sastrugi

SNOW DEPTH (*SN)	cm
Depth of surface snow	

Ice: Topography

TOPOGRAPHY TYPE (*Top)
100 :: Level ice
200 :: Rafted Pancakes
300 :: Cemented Pancakes
400 :: Rafting
500 :: Ridges

TOPOGRAPHY CONC (*TopC)	Tenths
0 :: 0/10	
1 :: 1/10	
2 :: 2/10	
3 :: 3/10	
4 :: 4/10	
5 :: 5/10	
6 :: 6/10	
7 :: 7/10	
8 :: 8/10	
9 :: 9/10	
10 :: 10/10	

*TopC is the fractional area of ice, separately for each type, covered by ridges or rafts

RIDGE HEIGHT (*RH)	m
To nearest half meter	

TOPO FEATURE OLD?	(*Old)
TOPO FEATURE CONSOLIDATED?	**(*Cs)**
TOPO FEATURE SNOW-COVERED?	**(*SC)**
Yes :: True	
No :: False	

Ice: Melt

MELT POND CONC (*MPC)	Tenths
0 :: 0/10	
1 :: 1/10	
2 :: 2/10	
3 :: 3/10	
4 :: 4/10	
5 :: 5/10	
6 :: 6/10	
7 :: 7/10	
8 :: 8/10	
9 :: 9/10	
10 :: 10/10	

*MPC is the fractional area of ice, separately for each type, covered by meltponds

MELT POND PATTERN (*MPP)
1 :: Linked
2 :: Discrete

MELT POND SURFACE TYPE (*MPT)
1 :: Frozen
2 :: Open
3 :: Bottom up

MELT POND FREEBOARD (*MPF)	cm
Height of MP freeboard above MP surface	

MELT POND DEPTH (*MPD)	cm
1 :: 0-10cm	
2 :: 10-30cm	
3 :: 30-50cm	
4 :: >50cm	
-9 :: Unknown	

MELT POND BOTTOM TYPE (*MBT)
1 :: Solid
2 :: Some have thaw holes
3 :: All have thaw holes

DRIED ICE? (*MDI) ROTTEN ICE? (*MRI)
Yes :: True
No :: False

Ice: Other

ALGAE CONC. (*A) SEDIMENT CONC. (*SD)	%
0 :: 0%	
1 :: <30%	
2 :: <60%	
3 :: >60%	

*A and *SD is the percentage area of the ice, of any given type, with algae or sediment present.

ALGAE LOCATION (*AL)
1 :: Top
2 :: Middle
3 :: Bottom

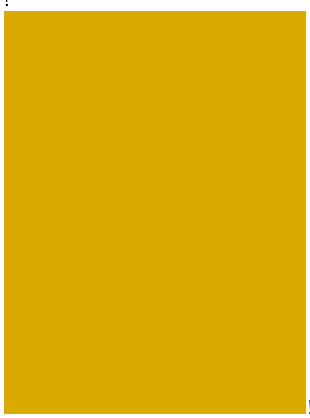
ALGAE DENSITY (*AD)
0 :: Not Visible
1 :: Trace
2 :: Light
3 :: Medium
4 :: Strong
See Colour Chart

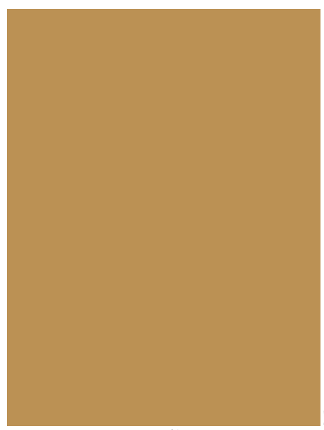
Two fields in Ice:Other not associated with P, S or T.
Other Ice Type Thick (TH)
Other Ice Type Thin (OT)
The codes for these types are given in the ice type table.

!
!!
Colour&Chart&for&Identifying&Ice&Algae&Density&
!
0&Not&Visible&
!!

&
&
1!<!!3mg!chl!a!m*2!!!!**Trace&**
!

!
2!~!4.5mg!chl!a!m*2!!!!!!!!!!!!
Pantone!100c!!!**Light**!


!
3!~!10mg!chl!a!m*2!!!!!
Pantone!110c!!!!!**Medium**!
!


!
4!~!30!mg!chl!a!m*2!!!!!!
Trumatch!49b!!!!**Strong**!
!

Meteorology

VISIBILITY (V)	m-km
90 :: <50m	
91 :: 50-200m	
92 :: 200-500m	
93 :: 500-1000m	
94 :: 1-2km	
95 :: 2-4km	
96 :: 4-10km	
97 :: >10km	

TOTAL CLOUD COVER(TCC) HIGH CLOUD COVER (HV) MEDIUM CLOUD COVER (MV) LOW CLOUD COVER (LV)	Oktas
0 :: 0	
1 :: 1/8 or less, but not 0	
2 :: 2/8	
3 :: 3/8	
4 :: 4/8	
5 :: 5/8	
6 :: 6/8	
7 :: 7/8 or more, but not 8/8	
8 :: 8/8	

WIND SPEED (WS)	Knot
Nearest knot	
WIND DIRECTION (WD)	Degree
Nearest degree	
AIR TEMPERATURE (AT)	°C
Nearest degree, C	
WATER TEMPERATURE (WT)	°C
Nearest degree, C	
RELATIVE HUMIDITY (RelH)	
Nearest %	
AIR PRESSURE (AP)	mBar
Nearest mBar	

Weather (WX)

Note, the ASSIST table is keyword and number searchable from the Weather data entry box.

00-03 Sky Change During Past Hour

000 :: Clouds not observable/observed

001 :: Clouds dissolving/becoming less developed

002 :: State of sky as a whole unchanged

003 :: Clouds forming or developing

10-13 Mist and Shallow Fog

010 :: Mist (Visibility 1/2 nm or more)

011 :: Shallow fog in patches

012 :: Shallow fog, more or less continuous

40-49 Fog at the Time of Ob

040:: Fog: distance, not at ship in past hour, Vis may be >1/2nm

041 :: Fog in patches

042 :: Fog thinning in last hour, sky discernable

043 :: Fog thinning in last hour, sky not discernable

044 :: Fog unchanged in last hour, sky discernable

045 :: Fog unchanged in last hour, sky not discernable

046 :: Fog beginning/thickening in last hour, sky discernable

047 :: Fog beginning/thickening in last hour, sky not discernable

048 :: Fog depositing rime, sky discernable

049 :: Fog depositing rime, sky not discernable

50-59 Drizzle

050 :: Slight drizzle, intermittent

051 :: Slight drizzle, continuous

052 :: Moderate drizzle, intermittent

053 :: Moderate drizzle, continuous

054 :: Dense drizzle, intermittent

055 :: Dense drizzle, continuous

056 :: Freezing drizzle, slight

057 :: Freezing drizzle, moderate or dense

058 :: Drizzle and rain, slight

059 :: Drizzle and rain, moderate or dense

60-69 Rain NOT Falling as Showers

060 :: Slight rain, intermittent

061 :: Slight rain, continuous

062 :: Moderate rain, intermittent

063 :: Moderate rain, continuous

064 :: Heavy rain, intermittent

065 :: Heavy rain, continuous

066 :: Freezing rain, slight
067 :: Freezing rain, moderate or heavy
068 :: Rain or drizzle and snow, slight
069 :: Rain or drizzle and snow, moderate/heavy

14-16 Precipitation not at ship

014 :: Precipitation in sight, not reaching surface
015 :: Precipitation beyond 3nm, reaching surface
016 :: Precipitation within 3nm, reaching surface

20-29 Past Hour but NOT at observation time

020 :: Drizzle not freezing or snow grains
021 :: Rain not freezing or snow grains
022 :: Snow not freezing or snow grains
023 :: Rain and snow or ice pellets
024 :: Drizzle or rain, freezing
025 :: Showers of rain
026 :: Showers of snow, or of rain and snow
027 :: Showers of hail, or of rain and hail
028 :: Fog in past hour, not at present
029:: Thunderstorm, with or without precip

36-39 Unique Snow Conditions

036 :: Drifting snow below eye level, slight/moderate
037 :: Drifting snow below eye level, heavy
038 :: Blowing snow, above eye level, slight/moderate
039 :: Blowing snow, above eye level, heavy

70-79 Solid Precip. Not as Showers

070 :: Slight fall of snow flakes, intermittent
071 :: Slight fall of snow flakes, continuous
072 :: Moderate fall of snow flakes, intermittent
073 :: Moderate fall of snow flakes, continuous
074 :: Heavy fall of snow flakes, intermittent
075 :: Heavy fall of snow flakes, continuous
076 :: Ice prisms, with/without fog
077 :: Snow grains, with/without fog
078 :: Isolated star like crystals
079 :: Ice pellets

80-84 Rain Showers

080 :: Slight rain showers
081 :: Moderate or heavy rain showers
082 :: Violent rain showers
083 :: Slight showers of rain and snow
084 :: Moderate/heavy showers of rain and snow

85-90 Solid Precipitation in Showers

085 :: Slight snow showers

086 :: Moderate or heavy snow showers
087 :: Slight showers of soft or small hail
088 :: Moderate/heavy showers of soft/small hail
089 :: Slight showers of hail
090 :: Moderate or heavy showers of hail

Meteorology: Cloud

HIGH CLOUD TYPE (HY)	
Ci :: Cirrus	
Cs :: Cirrostratus	
Cc :: Cirrocumulus	
MED. CLOUD TYPE (MY)	
As :: Altostratus	
Ac :: AltoCumulus	
LOW CLOUD TYPE (LY)	
St :: Stratus	
Sc :: Stratocumulus	
Ns :: Nimbostratus	
Cu :: Cumulus	
Cn :: Cumulonimbus	
HIGH CLOUD HEIGHT (HH)	km
3 - 8km	
MEDIUM CLOUD HEIGHT (MH)	km
2 - 4km	
LOW CLOUD HEIGHT (LH)	km
Surface - 2km	

Photos
Any number of photos can be attached to an observation, and it can be specified if the photo is taken facing the ship's bow, port or starboard. The CSV output (Photo) only provides the number of photos uploaded with each observation.

Comments
Comments can be attached in each tab with the 'Add Comment' button. Any number of comments can be entered. Comment strings are included in CSV output in the final column, Comments. The comment string is formatted as:
"\"Comment Text – Observer Name\""//"\"Second Comment Text – Observer Name\""