CLEAR Earth Annotation Guidelines: Sea Ice

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Jenette Preciado, Ruth Duerr, and Nicole Gordiyenko

Annotating Entities & Eventualities

Key for Annotation Examples:

- [brackets] represent annotation spans.
- [ ]$_{\text{SUBSCRIPT}}$ represents the annotation categories applied to annotation spans.
- The underscore inside an entity or property name may read as 'and' or 'or.'
- Underscores underneath multiple words represent the proper length of a span for discontinuous spans.

Annotation Categories:

Eventuality

- refers to any mention, generic or specific, of a process, event, or state related to sea ice.

Eventualities can be annotated wherever they occur, whether or not they are the syntactic head of a span, and can be any part-of-speech. Typically, they are single word spans. Their pre-modifiers can be annotated too if they are relevant to one of the annotation categories listed below.

Any eventuality that is performed, directed, or experienced by a person or living organism should be left unannotated as we are only interested in capturing those eventualities that are related to cryology. This includes but is not limited to changes in snow, ice, and water in the polar regions.

Any eventuality referring to the atmosphere that does not affect the sea ice directly should not be annotated. The eventuality "increasing" in the following sentence fragment would NOT BE annotated "the high pressure pattern is increasing precipitation" would not be annotated; but the eventuality "pushing" in the following would be - "a high pressure pattern is causing winds that are pushing the ice pack south". We are not annotating atmospheric entities and eventualities since that is a different discipline. **Please see our tricky cases section for more information.**

- [Sea ice]$_{\text{ICE\_SOURCE}}$ does not simply [grow]$_{\text{EVENTUALITY}}$ and [melt]$_{\text{EVENTUALITY}}$ in [one]$_{\text{VALUE}}$ [place]$_{\text{AREA}}$.

- As [sea levels]$_{\text{AREA}}$ [rose]$_{\text{EVENTUALITY}}$ at [the end of the ice age]$_{\text{TIME}}$, the [shelf]$_{\text{AREA}}$ was once again [covered]$_{\text{EVENTUALITY}}$ by [relatively]$_{\text{FUNCTION}}$ [warm]$_{\text{TRAIT}}$ [ocean water]$_{\text{WATER}}$,

[thawing]$_{EVENTUALITY}$ the permafrost and [releasing]$_{EVENTUALITY}$ the [trapped]$_{EVENTUALITY}$ [methane]$_{ICE}$.

- [April]$_{TIME}$ also saw [significant]$_{FUNCTION}$ [ice]$_{ICE}$ [growth]$_{EVENTUALITY}$ in the [Bellingshausen and Amundsen Seas]$_{LOCATION}$, one of the few [regions]$_{AREA}$ with [lower-than-average]$_{FUNCTION}$ [ice]$_{ICE}$ [extents]$_{TRAIT}$ [in March]$_{TIME}$.

- These [open water]$_{ICE\_CON}$ [areas]$_{AREA}$ [absorb]$_{EVENTUALITY}$ the [sun's energy]$_{EVENTUALITY}$, which will [help]$_{EVENTUALITY}$ to [further]$_{FUNCTION}$ [ice]$_{ICE}$ [melt]$_{EVENTUALITY}$ [through the summer]$_{SEASON}$.

- [The end of summer]$_{SEASON}$ is [approaching]$_{EVENTUALITY}$ in the [Arctic]$_{LOCATION}$; temperatures are dropping and [melt]$_{EVENTUALITY}$ is [ending]$_{EVENTUALITY}$ in the [high latitudes]$_{AREA}$. Yet [summer]$_{SEASON}$ is not [quite]$_{FUNCTION}$ [over]$_{EVENTUALITY}$ in the [lower latitudes]$_{AREA}$ of the [Arctic Ocean]$_{LOCATION}$, where [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ [continues]$_{EVENTUALITY}$ to [decline]$_{EVENTUALITY}$.

- The [current]$_{TIME}$ [pattern]$_{EVENTUALITY}$ of [sea ice]$_{ICE\_SOURCE}$ [retreat]$_{EVENTUALITY}$ is noticeably [different]$_{EVENTUALITY}$ than [last summer]$_{SEASON}$, with some [areas]$_{AREAS}$ [showing]$_{EVENTUALITY}$ [less]$_{FUNCTION}$ [ice]$_{ICE}$ and others [showing]$_{EVENTUALITY}$ [more]$_{FUNCTION}$.

- Satellite data reveals that the [ice]$_{ICE}$ is [low]$_{TRAIT}$ [concentration]$_{TRAIT}$ and thus [prone]$_{EVENTUALITY}$ to [melting]$_{EVENTUALITY}$.

Note: Sometimes there will be two or more eventualities in a row and sometimes there will be two or more eventualities within a single phrase.

Example of multiple eventualities in a row, but not contained to a single phrase:

- [From May through July]$_{TIME}$, [cooler]$_{FUNCTION}$ [temperatures]$_{TRAIT}$ and [winds]$_{EVENTUALITY}$ [less]$_{FUNCTION}$ [favorable]$_{EVENTUALITY}$ to [ice]$_{ICE}$ [loss]$_{EVENTUALITY}$ [slowed]$_{EVENTUALITY}$ the [decline]$_{EVENTUALITY}$ in [ice]$_{ICE}$ [extent]$_{TRAIT}$.

- [Small]$_{TRAIT}$ [areas]$_{AREA}$ of [open water]$_{ICE\_CON}$ are [common]$_{FUNCTION}$ within the [ice pack]$_{ICE\_CON}$, even at the [North Pole]$_{LOCATION}$, as the [ice pack]$_{ICE\_CON}$ [shifts]$_{EVENTUALITY}$ in response to [winds]$_{EVENTUALITY}$ and [currents]$_{EVENTUALITY}$, resulting in [cracks]$_{OPENINGS\_ICE}$ (called [leads]$_{OPENINGS\_ICE}$) in the [ice]$_{\_ICE}$.

- While the better-known [El-Nino-Southern Oscillation ([**ENSO**]) **pattern**]$_{EVENTUALITY}$[1] has been in a [neutral]$_{TRAIT}$ [state]$_{EVENTUALITY}$ for [the past few winters]$_{SEASON}$, the [NPM]$_{EVENTUALITY}$ has been in an [extreme]$_{TRAIT}$ [positive]$_{TRAIT}$ [state]$_{EVENTUALITY}$ [since the summer of 2013]$_{SEASON}$.

[1] There are two discontinuous spans here: [El-Nino-Southern-Oscillation...pattern] and [ENSO...pattern]. **ENSO**, and **NVM** are sea surface temperature patterns while their states are events, and mentions about those states being positive, neutral, or negative are traits.

- Nevertheless, [by August]$_{TIME}$ the [rate]$_{TRAIT}$ of [ice]$_{ICE}$ [loss]$_{EVENTUALITY}$ was [much faster]$_{FUNCTION}$ than [average]$_{FUNCTION}$— [even faster]$_{FUNCTION}$ than [in 2007]$_{TIME}$—as the [effects]$_{EVENTUALITY}$ of a [warm]$_{TRAIT}$ [Arctic Ocean]$_{LOCATION}$ [worked against]$_{EVENTUALITY}$ the [thin]$_{TRAIT}$ [ice]$_{ICE}$ [cover]$_{AREA}$.

Ice

- refers to any frozen form of water or methane. In the context of the WMO sea ice nomenclature this is typically limited to floating ice in an ocean.

- The [lack]$_{EVENTUALITY}$ of [winter]$_{SEASON}$ [ice]$_{ICE}$ in the [Barents Sea]$_{LOCATION}$ and the vicinity of [Svalbard]$_{LOCATION}$ has been a [common]$_{FUNCTION}$ [feature]$_{TRAIT}$ of [recent years]$_{TIME}$.

- The [Northern Sea Route]$_{LOCATION}$ appears [likely]$_{FUNCTION}$ to [open]$_{EVENTUALITY}$ [soon]$_{TIME}$, but [ice]$_{ICE}$ [still]$_{TIME}$ [clogs]$_{EVENTUALITY}$ [many]$_{FUNCTION}$ of the [channels]$_{AREA}$ in the [Northwest Passage]$_{LOCATION}$.

- Although the [Siberian area]$_{LOCATION}$ [still]$_{TIME}$ [shows]$_{EVENTUALITY}$ [ice]$_{ICE}$, satellite data reveals that the [ice]$_{ICE}$ is [low]$_{TRAIT}$ [concentration]$_{TRAIT}$ and thus [prone]$_{EVENTUALITY}$ to [melting]$_{EVENTUALITY}$.

- [Congelation]$_{EVENTUALITY}$ [ice crystals]$_{ICE}$ are [long]$_{TRAIT}$ and [vertical]$_{DIRECTION}$ because they [grow]$_{EVENTUALITY}$ [much slower]$_{FUNCTION}$ than [frazil ice]$_{ICE\_DEVEL}$.

Snow

- refers to any mention of snow as an entity including **snowpack**.

Note/Exception: Snow will sometimes appear as a weather event like *snowfall* or *snowing* and, in these cases, we should annotate them as eventualities.

- The [ice]$_{ICE}$ [sheet]$_{AREA}$ [normally]$_{FUNCTION}$ [gains]$_{EVENTUALITY}$ [snow]$_{SNOW}$ [during winter]$_{SEASON}$ and [melts]$_{EVENTUALITY}$ [some]$_{FUNCTION}$ [during the summer]$_{SEASON}$, but [in recent decades]$_{TIME}$ its [mass]$_{TRAIT}$ has been [dwindling]$_{EVENTUALITY}$.

- However, as [in recent years]$_{TIME}$, the [snow]$_{SNOW}$ [melted]$_{EVENTUALITY}$ [rapidly]$_{FUNCTION}$, and [by May]$_{TIME}$, [snow]$_{SNOW}$ [cover]$_{AREA}$ was at [near record lows]$_{FUNCTION}$.

  Note: Include function, time, and season expressions in the entire span of “snowpack” when they are its modifiers:

- As seen in Figure 5, the [April 1 snowpack]$_{SNOW}$ [over]$_{DIRECTION}$ [most]$_{FUNCTION}$ of the [western]$_{DIRECTION}$ [United States]$_{LOCATION}$ is [far below average]$_{FUNCTION}$. At many sites, [snow water equivalent]$_{TRAIT}$ is at [historic lows]$_{FUNCTION}$ for [this time of year]$_{TIME}$. [Conditions]$_{EVENTUALITY}$ are [somewhat better]$_{FUNCTION}$ [along]$_{DIRECTION}$ the [Front Range of Colorado]$_{LOCATION}$ and in [Arizona]$_{LOCATION}$, [Wyoming]$_{LOCATION}$ and [Montana]$_{LOCATION}$.

Water

- refers to any mention of water for which there is not another category (i.e tides, waves, ocean water, fresh water, salt water, etc..)

- The [Greenland Ice Sheet]$_{LOCATION}$ [contains]$_{EVENTUALITY}$ a [massive]$_{FUNCTION}$ [amount]$_{TRAIT}$ of [fresh water]$_{WATER}$, which could [raise]$_{EVENTUALITY}$ [sea levels]$_{AREA}$ enough to [flood]$_{EVENTUALITY}$ [many]$_{FUNCTION}$ [coastal]$_{AREA}$ [areas]$_{AREA}$ where people live around the [world]$_{LOCATION}$.

- While the [change]$_{EVENTUALITY}$ in [saltiness]$_{TRAIT}$ is [too]$_{FUNCTION}$ [small]$_{TRAIT}$ to significantly affect the freezing temperature, the [increase]$_{EVENTUALITY}$ in [slightly less]$_{FUNCTION}$ [dense]$_{TRAIT}$ [water]$_{WATER}$ [surrounding]$_{DIRECTION}$ [Antarctica]$_{LOCATION}$ [inhibits]$_{EVENTUALITY}$ [mixing]$_{EVENTUALITY}$, [creating]$_{EVENTUALITY}$ [conditions]$_{EVENTUALITY}$ that [favor]$_{EVENTUALITY}$ [ice]$_{ICE}$ [growth]$_{EVENTUALITY}$ (as we discussed in our [July 17]$_{TIME}$ post).

- As the [ocean water]$_{WATER}$ [begins]$_{EVENTUALITY}$ to [freeze]$_{EVENTUALITY}$, [small]$_{TRAIT}$ [needle-like]$_{TRAIT}$ [ice crystals]$_{ICE}$ called [frazil]$_{ICE\_DEVEL}$ [form]$_{EVENTUALITY}$. These [crystals]$_{ICE}$ are [typically]$_{FUNCTION}$ [3]$_{VALUE}$ to [4]$_{VALUE}$ [millimeters]$_{UNIT}$ ([0.12]$_{VALUE}$ to [0.16]$_{VALUE}$ [inches]$_{UNIT}$) in [diameter]$_{TRAIT}$. Because salt doesn't [freeze]$_{EVENTUALITY}$, the [crystals]$_{ICE}$ [expel]$_{EVENTUALITY}$ salt into the [water]$_{WATER}$, and [frazil]$_{ICE\_DEVEL}$ [crystals]$_{ICE}$ [consist]$_{EVENTUALITY}$ of [nearly]$_{FUNCTION}$ [pure]$_{TRAIT}$ [fresh water]$_{WATER}$.

Ice Form

- refers to the extent or size of any chunk of sea ice floating in water that formed by the freezing of seawater at the surface.

- [Floe]$_{ICE\_FORM}$: Any contiguous piece of [sea ice]$_{ICE\_SOURCE}$.

- The [average]$_{FUNCTION}$ [timing]$_{TRAIT}$ of [lake ice]$_{ICE\_FORM}$ out for all study [lakes]$_{AREA}$ [over these 3 years]$_{TIME}$ was [18 June]$_{TIME}$ and [lagged]$_{EVENTUALITY}$ the [0]$_{VALUE}$ [°C]$_{UNIT}$ [ATID]$_{TRAIT}$ [by 21 days]$_{TIME}$ on [average]$_{FUNCTION}$.

- [Consolidated ice]$_{ICE\_CON}$ is [floating ice]$_{ICE\_ATTACH}$ in which the [concentration]$_{TRAIT}$ is [10/10]$_{VALUE}$ and the [floes]$_{ICE\_FORM}$ are [frozen]$_{EVENTUALITY}$ together.

Ice with Source

- classifies ice according to the area in which it was formed: Sea ice is formed by the freezing of seawater at the surface, lake ice and river ice formed on rivers or lakes and glacier ice originates on land (ice of land origin).

- [Ice of land origin]$_{ICE\_SOURCE}$: [Ice]$_{ICE}$ [formed]$_{EVENTUALITY}$ on [land]$_{AREA}$ or in an [ice shelf]$_{ICE\_SOURCE}$, found [floating]$_{EVENTUALITY}$ in [water]$_{WATER}$. The concept includes [ice]$_{ICE}$ that is [stranded]$_{ATTACHMENT}$ or [grounded]$_{ATTACHMENT}$.

- A comprehensive set of observations of the [energy balance]$_{EVENTUALITY}$ of [melting]$_{EVENTUALITY}$ [Arctic]$_{LOCATION}$ [first-year]$_{ICE\_DEVEL}$ [sea ice]$_{ICE\_SOURCE}$ was conducted [during an 8-day]$_{TIME}$ ice station [in July - August 2012]$_{TIME}$.

- Viscoelastic rheological models combined with damage mechanics have already been used to model the [deformation]$_{EVENTUALITY}$ and [failure]$_{EVENTUALITY}$ of [glacier ice]$_{ICE\_SOURCE}$ e.g.,, particularly in the context of [glacier]$_{ICE\_SOURCE}$ [crevassing]$_{EVENTUALITY}$ and [ice]$_{ICE}$ [sheet]$_{AREA}$ [calving]$_{EVENTUALITY}$

Ice with Arrangement

- classifies ice according to its physical arrangement or shape.

- The [topography]$_{TRAIT}$ of [ice fields]$_{ICE\_ARRANGE}$ is determined by the [shape]$_{TRAIT}$ of the [surrounding]$_{DIRECTION}$ [landforms]$_{AREA}$.

- [Ice jams]$_{ICE\_ARRANGE}$ are [wreaking havoc]$_{EVENTUALITY}$ [across]$_{DIRECTION}$ the [Midwest]$_{LOCATION}$ as [thick]$_{TRAIT}$ [sheets]$_{AREA}$ which [froze over]$_{EVENTUALITY}$ [lakes]$_{AREA}$ and [rivers]$_{AREA}$ [start]$_{EVENTUALITY}$ to [thaw]$_{EVENTUALITY}$ following the [harsh]$_{TRAIT}$ [winter]$_{SEASON}$.

- The [biggest]$_{FUNCTION}$ [glacier]$_{ICE\_SOURCE}$ in the [Arctic]$_{LOCATION}$ is on the verge of [losing]$_{EVENTUALITY}$ a chunk of [ice]$_{ICE}$ the [size]$_{TRAIT}$ of [Manhattan]$_{LOCATION}$. A group of scientists and climate change activists who are closely monitoring the [Petermann glacier]$_{ICE\_SOURCE}$'s [ice tongue]$_{ICE\_ARRANGE}$ believe the [rapid]$_{TRAIT}$ [flow]$_{EVENTUALITY}$ of [ice]$_{ICE}$ is in part [due]$_{EVENTUALITY}$ to [warm]$_{TRAIT}$ [ocean]$_{AREA}$ [currents]$_{EVENTUALITY}$ [moving]$_{EVENTUALITY}$ [up]$_{DIRECTION}$ [along]$_{DIRECTION}$ the [coast]$_{AREA}$ of [Greenland]$_{LOCATION}$, [fuelled]$_{EVENTUALITY}$ by [global warming]$_{EVENTUALITY}$.

Ice with Attachment

- classifies ice according to the type of attachment it has (or lacks) to another physical feature such as the seafloor or shore.

- [Grounded Ice]$_{ICE\_ATTACH}$ is [floating ice]$_{ICE\_ATTACH}$ which is [aground]$_{ATTACHMENT}$ in [shoal]$_{TRAIT}$ [water]$_{WATER}$.

- When [turbulence]$_{EVENTUALITY}$ [transports]$_{EVENTUALITY}$ [frazil]$_{ICE\_DEVEL}$ to the [river bed]$_{AREA}$, the [frazil]$_{ICE\_DEVEL}$ may [stick]$_{EVENTUALITY}$ to the [bed]$_{AREA}$, [forming]$_{EVENTUALITY}$ [anchor ice]$_{ICE\_ATTACH}$.

- An [ice foot]$_{ICE\_ATTACH}$ is a [wall]$_{ICE\_SOURCE}$ or [belt]$_{ICE\_ARRANGE}$ of [ice]$_{ICE}$ [frozen]$_{EVENTUALITY}$ to the [shore]$_{AREA}$ in [Arctic regions]$_{LOCATION}$ having a [base]$_{AREA}$ [at or below]$_{FUNCTION}$ the [low-water mark]$_{AREA}$ and [formed]$_{EVENTUALITY}$ as a result of the [rise]$_{EVENTUALITY}$ and [fall]$_{EVENTUALITY}$ of the [tides]$_{WATER}$, [freezing]$_{EVENTUALITY}$ [spray]$_{WATER}$, or [stranded ice]$_{ICE\_ATTACH}$.

Ice with Development (the age of the ice)

- or Ice Stage of Development is a phrase used to classify sea ice for operational purposes using the appearance and thickness of the ice as a proxy for its age.

- An [ice rind]$_{ICE\_DEVEL}$ is a [brittle]$_{TRAIT}$ [shiny]$_{TRAIT}$ [crust]$_{AREA}$ of [ice]$_{ICE}$ [formed]$_{EVENTUALITY}$ on a [quiet]$_{TRAIT}$ [surface]$_{AREA}$.

- The understanding of [flooding]$_{EVENTUALITY}$ is even poorer and is limited to the analysis of ice cores which contain [flooded] [snow [ice]$_{ICE\_DEVEL}$]$_{MELT\_STAGE}$.

- [Frazil ice]$_{ICE\_DEVEL}$ cannot [form]$_{EVENTUALITY}$ in the [relatively]$_{FUNCTION}$ [still]$_{EVENTUALITY}$ [waters]$_{WATERS}$ [under]$_{DIRECTION}$ [sea ice]$_{ICE\_SOURCE}$, so only [congelation]$_{EVENTUALITY}$ [ice]$_{ICE}$ [developing]$_{EVENTUALITY}$ [under]$_{DIRECTION}$ the [ice]$_{ICE}$ [sheet]$_{AREA}$ can [contribute]$_{EVENTUALITY}$ to the [continued growth]$_{EVENTUALITY}$ of a [congelation]$_{EVENTUALITY}$ [ice]$_{ICE}$ [sheet]$_{AREA}$.

Ice with concentration

- refers to the concentration of ice in a region not as a measurement but as a description of the concentration.

- [Consolidated ice]$_{ICE\_CON}$ is [floating ice]$_{ICE\_ATTACH}$ in which the [concentration]$_{TRAIT}$ is [10/10]$_{VALUE}$ and the [floes]$_{ICE\_FORM}$ are [frozen]$_{EVENTUALITY}$ together.

- As [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ [shrank]$_{EVENTUALITY}$ [through the summer of 2007]$_{SEASON}$ to its [record-setting minimum]$_{FUNCTION}$ [in September]$_{TIME}$, the [large]$_{TRAIT}$ [open-water]$_{ICE\_CON}$ [areas]$_{AREAS}$ [absorbed]$_{EVENTUALITY}$ [a great deal]$_{FUNCTION}$ of the [sun's energy]$_{EVENTUALITY}$.

- The [Northwest Passage]$_{LOCATION}$ has [re-frozen]$_{EVENTUALITY}$ [after several weeks]$_{TIME}$ of [nearly]$_{FUNCTION}$ [ice-free]$_{ICE\_CON}$ [conditions]$_{EVENTUALITY}$ [in August]$_{TIME}$ and [throughout September]$_{TIME}$.

Openings in the Ice

- refers to breaks in the ice that are classified according to their size and location.

- The [ice]$_{ICE}$ could have been [formed]$_{EVENTUALITY}$ [during the initial freeze-up in fall]$_{SEASON}$, or [later on]$_{TIME}$ in a [lead]$_{OPENINGS\_ICE}$ or [polynya]$_{OPENINGS\_ICE}$.

- [Tide cracks]$_{OPENINGS\_ICE}$ are valuable resources for wildlife as they provide a [region]$_{AREA}$ where birds such as snow petrels can fish through for krill and also as a breathing hole for crabeater and Weddell seals.

- [May]$_{TIME}$ is traditionally [the time]$_{TIME}$ when [recurring polynyas]$_{OPENINGS\_ICE}$ in the [Canadian Arctic]$_{LOCATION}$ [become]$_{EVENTUALITY}$ [more]$_{FUNCTION}$ [prominent]$_{TRAIT}$ and [persistent]$_{TRAIT}$ [shore leads]$_{OPENINGS\_ICE}$ ([cracks]$_{OPENINGS\_ICE}$ in the [ice]$_{ICE}$ [near]$_{DIRECTION}$ [shore]$_{AREA}$, also called [flaw leads]$_{OPENINGS\_ICE}$) [become]$_{EVENTUALITY}$ [wider]$_{FUNCTION}$.

Ice Surface Features

- refers to ice categorized by the shape, texture and color of its surface.

- [Deformed ice]$_{ICE\_SURFACE}$ is distinguished by its [high]$_{TRAIT}$ [surface]$_{AREA}$ [roughness]$_{TRAIT}$[2].

- The [floe]$_{ICE\_FORM}$ was mainly represented by [level ice]$_{ICE\_SURFACE}$, with [ridging]$_{TRAIT}$ over [less]$_{FUNCTION}$ than [10]$_{VALUE}$ [%]$_{UNIT}$ of the [area]$_{AREA}$.

- Processing of the images used in this verification procedure yielded the image-based [fractional coverage]$_{AREA}$ of the four surface classes: [dark]$_{TRAIT}$ [ponds]$_{MELT\_STAGE}$, [bright]$_{TRAIT}$ [ponds]$_{MELT\_STAGE}$, [open water]$_{ICE\_CON}$ and [bare ice]$_{ICE\_SURFACE}$.

Stages of Melting

- refers to well-defined stages of sea ice melt.

[2] Due to time limitations on this project, we were unable to treat “surface roughness” as a multiword expression. We recommend that in future annotations it is treated as an MWE.

- The passive microwave [sea ice]$_{ICE\_FORM}$ concentration algorithm cannot distinguish the [emissivities]$_{TRAIT}$ of [flooded ice]$_{MELT\_STAGE}$ from a [partially]$_{FUNCTION}$ [open]$_{TRAIT}$ [ice pack]$_{ICE\_CON}$, so it reports a [lower]$_{FUNCTION}$ [ice]$_{ICE}$ [concentration]$_{TRAIT}$. In most other [parts]$_{AREA}$ of the [Arctic]$_{LOCATION}$, such [flooding]$_{EVENTUALITY}$ [persists]$_{EVENTUALITY}$ for [only 7 - 10 days before]$_{TIME}$ the [water]$_{WATER}$ [drains]$_{EVENTUALITY}$ through [pressure]$_{EVENTUALITY}$ [cracks]$_{OPENINGS\_ICE}$ and [open]$_{TRAIT}$ [leads]$_{OPENING\_ICE}$.

- Second, [winter]$_{SEASON}$ will minimize the difficulty of travelling [over]$_{DIRECTION}$ [pack ice]$_{ICE\_CON}$ which is becoming notoriously difficult to navigate on foot due to the [extent]$_{TRAIT}$ of [rotten ice]$_{MELT\_STAGE}$ due to [warming]$_{EVENTUALITY}$.

- In addition to [growing]$_{EVENTUALITY}$ in the [melt]$_{EVENTUALITY}$ [water puddles]$_{MELT\_STAGE}$, the green algae actively grow in the [cracks]$_{OPENINGS\_ICE}$ and [caverns]$_{OPENINGS\_ICE}$ on the [slush]$_{ICE\_DEVEL}$ [surface]$_{AREA}$ of the [dried ice]$_{MELT\_STAGE}$.

Attachment

- describes the type of attachment (if any) that an ice form has to another physical feature. Typically ice can be attached to the sea floor (ice that is aground or anchored); attached to the shore (ice that is stuck fast to the shore); ice that is footed to both the sea bottom and the shore (e.g., an icefoot); or has no attachment to any stable feature at all (e.g., the ice pack).

- [Grounded Ice]$_{ICE\_ATTACH}$ is [floating ice]$_{ICE\_ATTACH}$ which is [aground]$_{ATTACHMENT}$ in [shoal]$_{TRAIT}$ [water]$_{WATER}$.

Location

- refers to politically defined places (like cities, towns, states, provinces, countries, islands, continents, etc.) or geographic features that have proper names.

Whenever a **location is modifying a headword that is typically annotated as an area** like “Siberian coast” or “Atlantic sector” should be annotated as **one multiword expression, location**.

All mentions of the **Greenland Ice Sheet** should be treated as a proper noun, multiword expression, location.

Do not annotate locations when they occur in the names of organizations:

- Courtesy Mark Tschudi of the University of Colorado Boulder.

- The [ice]$_{ICE}$ [loss]$_{EVENTUALITY}$ is [dominated]$_{EVENTUALITY}$ by [retreat]$_{EVENTUALITY}$ on the [Atlantic side]$_{LOCATION}$ of the [Arctic]$_{LOCATION}$, including the [East Greenland, Kara and Laptev seas]$_{LOCATION}$, and [Baffin Bay]$_{LOCATION}$.

- In contrast to [December]$_{TIME}$, [January]$_{TIME}$ saw unusually low pressure [over]$_{DIRECTION}$ the [central]$_{DIRECTION}$ [Arctic]$_{LOCATION}$ and unusually high pressure [over]$_{DIRECTION}$ [western]$_{DIRECTION}$ [Europe]$_{LOCATION}$ and [Asia]$_{LOCATION}$.

- [Ice]$_{ICE}$ [extent]$_{TRAIT}$ was [above normal]$_{FUNCTION}$ in the [Bering Sea]$_{LOCATION}$, but [remained]$_{EVENTUALITY}$ [below normal]$_{FUNCTION}$ [over]$_{DIRECTION}$ much of the [Atlantic sector]$_{LOCATION}$ of the [Arctic]$_{LOCATION}$, including the [Barents Sea]$_{LOCATION}$, [part]$_{AREA}$ of the [East Greenland Sea]$_{LOCATION}$, and in the [Davis Strait]$_{LOCATION}$.

- Air temperatures [this August]$_{TIME}$ were also 1 to 3 degrees Celsius 1.8 to 5.4 degrees Fahrenheit below normal [over]$_{DIRECTION}$ the [Barents and Kara Seas]$_{LOCATION}$.

Area

- refers to place-types that are generic (surface, part, area, region, coast, sea, ocean, land masses, etc.,).

Terms like *sea level, low-water mark, high-water mark*, and *fractional coverage* should all be treated like an area.

All mentions of the **Northern Hemisphere** and **Southern Hemisphere** should be annotated as one, multiword expression area.

Latitudes and longitudes: Often, there will be mentions to specific or generic latitudes. An example of a specific latitude would be a mention like “180 degree latitude” and a generic example would be “lower latitudes.” Both instances should be annotated as areas because they encompass a wide swath of area. When a latitude and longitude are provided then that is an exact location and should be annotated as a single, location span.

- It was a [better]$_{FUNCTION}$ [year]$_{TIME}$ for the [cryosphere]$_{AREA}$.

- [Regions]$_{AREA}$ of [low]$_{TRAIT}$ [concentration]$_{TRAIT}$ [ice]$_{ICE}$ [remain]$_{EVENTUALITY}$ in the [Beaufort Sea]$_{LOCATION}$ that may yet [melt out]$_{EVENTUALITY}$ or [compress]$_{EVENTUALITY}$ by [wind]$_{EVENTUALITY}$ [action]$_{EVENTUALITY}$.

- Note the large reductions in cloud cover [north]$_{DIRECTION}$ of [Alaska]$_{LOCATION}$ compared to [2000 to 2006]$_{TIME}$, consistent with [rapid]$_{TRAIT}$ [sea ice]$_{ICE\_SOURCE}$ [melt]$_{EVENTUALITY}$ as

[more]$_{FUNCTION}$ [solar energy]$_{EVENTUALITY}$ than [usual]$_{FUNCTION}$ [reached]$_{EVENTUALITY}$ the [ice]$_{ICE}$ [surface]$_{AREA}$.

- Taken together, the [rapid]$_{TRAIT}$ [sea ice]$_{ICE\_SOURCE}$ [losses]$_{EVENTUALITY}$ that we've seen [in June and July]$_{TIME}$ can partly be explained from the effects of this "triple whammy": it was [warm]$_{TRAIT}$; atmospheric circulation pushed [ice]$_{ICE}$ [away]$_{DIRECTION}$ from the [coast]$_{AREA}$; and skies have been fairly clear.

Direction

- Describes where an entity is in relation to another entity or eventuality.

Directions can be expressed in multiple ways:

- Ordinal/cardinal directions such as 'north,' 'south,' 'west,' 'east,' 'northeast,' 'southwest,' etc.
- Directional prepositions such as 'away,' 'along,' 'across,' 'close,' 'interior,' 'exterior,' 'towards,' 'beneath,' 'between,' 'over,' 'near,' 'poleward,' etc.
- Any term that is directional should be annotated as a direction rather than a trait (do not get confused between the two; if it's referring to a position and sounds like a direction, then it is a direction!)
- Annotate all mentions as directions for all eventualities except for those having to do with the atmosphere, people, or living things (i.e polar bears).

Ordinal or cardinal directions - capture these any time they occur as head words or as modifiers to other terms that we annotate. Often these will occur as modifiers for locations, such as "southern Kara Sea" or "east Greenland." We should always annotate these instances as direction, as long as they are not the proper name (i.e. North America should be annotated as one location).

- [Sea ice]$_{ICE\_SOURCE}$ has [largely]$_{FUNCTION}$ [disappeared]$_{EVENTUALITY}$ in the [southern]$_{DIRECTION}$ [Kara Sea]$_{LOCATION}$, which [normally]$_{EVENTUALITY}$ [still]$_{TIME}$ has [considerable]$_{FUNCTION}$ [ice]$_{ICE}$ [cover]$_{AREA}$ at [this time of year]$_{TIME}$.

- [Sea ice]$_{ICE\_SOURCE}$ [motion]$_{EVENTUALITY}$, derived from AMSR-E data and averaged for [June]$_{TIME}$, [July]$_{TIME}$, and [the first week of August 2009]$_{TIME}$ (the [most recent]$_{TIME}$ data available), shows a [recent]$_{TIME}$ [change]$_{EVENTUALITY}$, with [ice]$_{ICE}$ [motion]$_{EVENTUALITY}$ [towards]$_{DIRECTION}$ the [eastern]$_{DIRECTION}$ [Siberian coast]$_{LOCATION}$ and [little]$_{FUNCTION}$ [export]$_{EVENTUALITY}$ of [ice]$_{ICE}$ [out]$_{DIRECTION}$ of the [Arctic Ocean]$_{LOCATION}$ via [Fram Strait]$_{LOCATION}$.

Directional prepositions - these directions are vectors that should be annotated any time they are referring to an entity that is also annotated, or connecting two entities, both of which are annotated as well.

- There are several [open water]$_{ICE\_CON}$ [areas]$_{AREA}$, or [polynyas]$_{OPENINGS\_ICE}$, [along]$_{DIRECTION}$ the [Arctic coast]$_{LOCATION}$, as is [typical]$_{FUNCTION}$ for [this time of year]$_{TIME}$. [Small]$_{TRAIT}$ [patches]$_{AREA}$ of [open water]$_{ICE\_CON}$ are [present]$_{EVENTUALITY}$ [along]$_{DIRECTION}$ the [Laptev Sea coast]$_{LOCATION}$ [north]$_{DIRECTION}$ of [Russia]$_{LOCATION}$, and at the [northern]$_{DIRECTION}$ [end]$_{AREA}$ of [Baffin Bay]$_{LOCATION}$.

- This resulted in a [dipole-like]$_{DIRECTION}$ [wind]$_{EVENTUALITY}$ [pattern]$_{EVENTUALITY}$ that [favored]$_{EVENTUALITY}$ [ice]$_{ICE}$ [transport]$_{EVENTUALITY}$ [across]$_{DIRECTION}$ the [ocean]$_{AREA}$.

Season

- refers to any expression of periods of the year that are defined by particular weather patterns and daylight hours. These often appear in the text as one of the four seasons (summer, autumn, winter, spring) but they also may appear as classifications (melt season, summer melt season, spring melt season, freeze-up period, ice growth season, winter's growth, melt period, etc.,).

Season annotations are not limited to headwords instead we want to capture the entire season expression (i.e. [during winter's melt] or [throughout the summer]).

Include years in the full span of a season expression (i.e. [during winter's melt of 2009], [by the spring], or [throughout the summer of 2013]).

"Period" as in "the same period in 2008" can be a time or season expression depending on the context. Read the text carefully looking for clues as to whether they are referring back to an initial time or season marker. If you find that period is referring back to a time expression like [January 2006-2015] then annotate [period] as a time. If you find that period is referring back to a season expression like [initial freeze-ups from 1999 to 2008] then annotate [period] as a season.

- [The melt season]$_{SEASON}$ became a race: [waning]$_{EVENTUALITY}$ [sunlight]$_{EVENTUALITY}$ versus [rapid]$_{TRAIT}$ [ice]$_{ICE}$ [loss]$_{EVENTUALITY}$.

- The [difference]$_{EVENTUALITY}$ [in November]$_{TIME}$ [ice]$_{ICE}$ [growth]$_{EVENTUALITY}$ [between 2012 and 2014]$_{TIME}$ [reflects]$_{EVENTUALITY}$ the [larger]$_{FUNCTION}$ [area]$_{AREA}$ of [open water]$_{ICE\_CON}$ at [the end of summer 2012]$_{SEASON}$. With [more]$_{FUNCTION}$ [open water]$_{ICE\_CON}$, there was a [larger]$_{FUNCTION}$ [area]$_{AREA}$ for [new ice]$_{ICE\_DEVEL}$ to [grow]$_{EVENTUALITY}$.

- This suggests that that [sea ice]$_{ICE\_FORM}$ there did not [thicken]$_{EVENTUALITY}$ as much as [in past winters]$_{SEASON}$, and may [retreat]$_{EVENTUALITY}$ [rapidly]$_{TRAIT}$ as [the summer melt season]$_{SEASON}$ [progresses]$_{EVENTUALITY}$.

Time

- refers to any expression of a point or period in time when an action, process, or state occurred or is occurring

Note:

Time annotations are not limited to headwords**.** Please capture the entire time expression in regards to noun phrases and adverbial phrases.

- In a nutshell, it appears that [very]$_{FUNCTION}$ [large]$_{TRAIT}$ [departures]$_{EVENTUALITY}$ from the overall [downward]$_{FUNCTION}$ [trend]$_{EVENTUALITY}$ in [September extent][3]$_{TRAIT}$ are [unlikely]$_{FUNCTION}$ to [persist]$_{EVENTUALITY}$ into [the following September]$_{TIME}$.

- [In January]$_{TIME}$, the Arctic Oscillation shifted from strongly negative to neutral [in the middle of the month]$_{TIME}$, and then back to a negative phase at [the end of the month]$_{TIME}$.

- [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ for [February 2010]$_{TIME}$ was [14.58 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([5.63 million]$_{VALUE}$ [square miles]$_{UNIT}$).

- [In mid-July 2007]$_{TIME}$, a [large]$_{TRAIT}$ [area]$_{AREA}$ of the [southern]$_{DIRECTION}$ [Beaufort Sea]$_{LOCATION}$ [north]$_{DIRECTION}$ of [Alaska]$_{LOCATION}$ [still]$_{TIME}$ had [ice]$_{ICE}$; [this year]$_{TIME}$, it is already [ice-free]$_{ICE\_CON}$.

- This [rate]$_{TRAIT}$ was unprecedented [in the satellite record]$_{TIME}$, and [changed]$_{EVENTUALITY}$ the [2007 summer]$_{SEASON}$ [decline]$_{EVENTUALITY}$ [pattern]$_{EVENTUALITY}$ from one [similar]$_{FUNCTION}$ to [recent record years]$_{TIME}$ to unprecedented [new low extents]$_{TRAIT}$.

- Clear skies and warm temperatures in turn led to [record-breaking]$_{FUNCTION}$ [rates]$_{TRAIT}$ of [sea ice]$_{ICE\_SOURCE}$ [loss]$_{EVENTUALITY}$. In Figure 5, we show a plot of the [rate]$_{TRAIT}$ of [loss]$_{EVENTUALITY}$ of the [ice]$_{ICE}$ for [this year]$_{TIME}$, [previous record]$_{TIME}$ and [near-record years]$_{TIME}$, and the [mean]$_{FUNCTION}$ [rate]$_{TRAIT}$ for [1979 to 2000]$_{TIME}$. The inset plot is from Figure 2, above. [During a two-week period in late June and early July 2007]$_{TIME}$, [sea

[3]Time and season expressions that modify “extent” are not annotated as time or season expressions instead they become part of the trait annotation for extent. These expressions tell you what data to find to calculate the actual value of the extent.
We recommend including area and location modifiers as a part of the entire, MWE trait span in future annotation projects.

ice]$_{ICE\_SOURCE}$ [declined]$_{EVENTUALITY}$ at a [pace]$_{TRAIT}$ of [up to]$_{FUNCTION}$ [210,000]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([81,081$_{VALUE}$ square miles]$_{UNIT}$) [per day]$_{UNIT}$, or the [equivalent]$_{FUNCTION}$ of an [area]$_{AREA}$ the [size]$_{TRAIT}$ of [Kansas]$_{LOCATION}$ [each day]$_{TIME}$.

Trait

- refers to any characteristic of an entity or eventuality. Types of traits include but are not limited to: color, texture, opacity, extent, temperature of sea ice[4] or sea surface, albedo, energy adsorption, width, energy, thickness, age, rate, or concentration.

- We estimate the [age]$_{TRAIT}$ of the [ice]$_{ICE}$ to be [five years old]$_{TRAIT}$, which makes it [fairly]$_{FUNCTION}$ [old]$_{TRAIT}$ for the [area]$_{AREA}$.

- [Nilas]$_{ICE\_DEVEL}$ has a [matt]$_{TRAIT}$ [surface]$_{AREA}$ and is [up to]$_{FUNCTION}$ [10]$_{VALUE}$ [centimeters]$_{UNIT}$ in [thickness]$_{TRAIT}$.

- [Glacial ice]$_{ICE\_SOURCE}$ is a different [color]$_{TRAIT}$ from [regular]$_{TRAIT}$ [ice]$_{ICE}$. It is so [blue]$_{TRAIT}$ because the [dense]$_{TRAIT}$ [ice]$_{ICE}$ of the [glacier]$_{ICE\_SOURCE}$ [absorbs]$_{EVENTUALITY}$ every other [color]$_{TRAIT}$ of the spectrum except [blue]$_{TRAIT}$.

- The black cross indicates the [geographic]$_{TRAIT}$ [North Pole]$_{LOCATION}$.

- This [thin]$_{TRAIT}$, [young ice]$_{ICE\_DEVEL}$ is [vulnerable]$_{TRAIT}$ to [melting]$_{EVENTUALITY}$ [completely]$_{FUNCTION}$ in [summer.]$_{SEASON}$

- [Deformed ice]$_{ICE\_SURFACE}$ is distinguished by its [high]$_{TRAIT}$ [surface]$_{AREA}$ [roughness]$_{TRAIT}$.

- At [the end of the month]$_{TIME}$, [Antarctica]$_{LOCATION}$ [extent]$_{TRAIT}$ was [at or near a record high]$_{FUNCTION}$ for [this time of year]$_{TIME}$.

- [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ for [May 2013]$_{TIME}$ was [13.10 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([5.06 million]$_{VALUE}$ [square miles]$_{UNIT}$).

MWE Traits: Some traits are actually MWE's. Watch out for them. Typical examples would be modifiers in front of abbreviations like ATID, any trait that has an acronym (like Snow Water Equivalent's acronym is SWE).

- The average timing of [lake ice]$_{ICE\_SOURCE}$ out for all study [lakes]$_{AREA}$ [over these 3 years]$_{TIME}$ was [18 June]$_{TIME}$ and lagged the [0°C ATID]$_{TRAIT}$ by [21 days]$_{TIME}$ on [average]$_{FUNCTION}$.

[4] We do not annotate air temperature as a trait.

- Figure 5. This map shows the rank of [snow water equivalent]$_{TRAIT}$ measured at SNOTEL sites [across]$_{DIRECTION}$ the [western]$_{DIRECTION}$ [U.S.]$_{LOCATION}$ A rank of 1 (black dots) corresponds to the [lowest]$_{FUNCTION}$ [SWE]$_{TRAIT}$ in the SNOTEL record; a rank of 31 (magenta dots) is the [highest]$_{FUNCTION}$.

New Rule for Extent & Snowpack: If a mention of extent (or snowpack) includes a time, season, or function expression as a modifier (or modifiers) then those mentions should be included in the entire *trait* span. If extent (or snowpack) is modified by a location or ice mention then those should be annotate as "location" and "ice" and not included in the *trait* span. If extent (or snowpack) is modified by both time, seasons, and/or functions as well as a location and/or ice mention, then please annotate the extent (or snowpack) as a discontinuous span excluding the location or ice mentions.

- Contrasting [weather conditions]$_{EVENTUALITY}$ were a significant factor in [**this year's higher**] [sea ice]$_{ICE\_SOURCE}$ [**extent**]$_{TRAIT}$ and [lower]$_{FUNCTION}$ [Greenland Ice Sheet]$_{LOCATION}$ [melt]$_{EVENTUALITY}$ [intensity]$_{TRAIT}$, compared to [last year]$_{TIME}$.

- The magenta line shows the [1981 to 2010 median extent][5]$_{TRAIT}$ for [that month]$_{TIME-}$.

- [2013]$_{TIME}$ [Sea ice]$_{ICE\_SOURCE}$ [continued]$_{EVENTUALITY}$ its [late-season summer]$_{SUMMER}$ [decline]$_{EVENTUALITY}$ [through August]$_{TIME}$ at a [near-average]$_{FUNCTION}$ [pace]$_{TRAIT}$. [Ice]$_{ICE}$ [extent]$_{TRAIT}$ is [still]$_{TIME}$ [well above]$_{FUNCTION}$ [last year's level]$_{TRAIT}$, but [below]$_{FUNCTION}$ the [1981 to 2010 average]$_{TRAIT}$.

- Temperatures at the 925 hPa level in the [high]$_{TRAIT}$ [Arctic]$_{LOCATION}$ ([north]$_{DIRECTION}$ of [Greenland]$_{LOCATION}$ to the [North Pole]$_{LOCATION}$) were 0.5 to 3 degrees Celsius (1 to 5 degrees Fahrenheit) [below]$_{FUNCTION}$ the [1981 to 2010 average]$_{TRAIT}$.

- [Icebergs]$_{ICE\_FORM}$ are sometimes described as [tabular]$_{TRAIT}$, [dome-shaped]$_{TRAIT}$, [sloping]$_{TRAIT}$, [pinnacled]$_{TRAIT}$.

- Heading into [2009]$_{TIME}$, the [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [cover]$_{AREA}$ is again [young]$_{TRAIT}$ and [thin]$_{TRAIT}$.

Function

- refers to all of the comparative and statistical terms that characterize the value of an entity or eventuality.

Some examples from cryology texts are: *about 40% faster, approximate, approximately, average, below, bigger, colder, common, completely, contrast, larger, largest, largest total amount, longer, lowers, maximum, mean, mean record low, minimum, median, minimum, more,*

[5] The phrase "1981 to 2010 average" in the context of this sentence actually means that if you took the ice extent data from 1981 to 2010 and averaged it, you would get a number that is an ice extent value.

more likely, most, much larger, much more, near average, nearly lower, ranged from, record low, record high, relative, remained below, roughly, shorter, significant amount, similar, sixth lowest, slightly above average, slower, smaller, thicker, typical, usually, warmer, warmest, well above.

- However, as in [recent years]$_{TIME}$, the [snow]$_{SNOW}$ [melted]$_{EVENTUALITY}$ [rapidly]$_{TRAIT}$, and [by May]$_{TIME}$, [snow]$_{SNOW}$ [cover]$_{AREA}$ was at [near record lows]$_{FUNCTION}$.

- This [thin]$_{TRAIT}$ [ice]$_{ICE}$ was [more likely]$_{FUNCTION}$ to [melt]$_{EVENTUALITY}$ [completely]$_{FUNCTION}$ than [surrounding]$_{DIRECTION}$ [thicker]$_{FUNCTION}$ [ice]$_{ICE}$.

- [Thicker]$_{FUNCTION}$, [multiyear ice]$_{ICE\_DEVEL}$ is [more]$_{FUNCTION}$ [resistant][6]$_{TRAIT}$ to [melt]$_{EVENTUALITY}$.

- This corroborates thickness information inferred from a calculation of [ice]$_{ICE}$ [age]$_{TRAIT}$ that showed [first-year ice]$_{ICE\_DEVEL}$, which is [thinner]$_{FUNCTION}$ and [more]$_{FUNCTION}$ [vulnerable][7]$_{TRAIT}$ to [melt]$_{EVENTUALITY}$.

- However, what we are seeing also seems to reflect the "memory" of the [ice]$_{ICE}$ to [changes]$_{EVENTUALITY}$ that have been [occurring]$_{EVENTUALITY}$ [over the past couple of decades]$_{TIME}$. In particular, there is mounting evidence of a [shift]$_{EVENTUALITY}$ from [fairly]$_{FUNCTION}$ [thick]$_{TRAIT}$ [ice]$_{ICE}$ to [thinner]$_{FUNCTION}$ [ice]$_{ICE}$, with this [thinner]$_{FUNCTION}$ [ice]$_{ICE}$ [more]$_{FUNCTION}$ [apt]$_{EVENTUALITY}$ to [completely]$_{FUNCTION}$ [melt out]$_{EVENTUALITY}$ [in summer]$_{SEASON}$.
-
- [Older]$_{FUNCTION}$ [thicker]$_{FUNCTION}$ [ice]$_{ICE}$ [remained] in a [region]$_{AREA}$ [roughly]$_{FUNCTION}$ [between]$_{DIRECTION}$ the [North Pole]$_{LOCATION}$ and the [Canadian Archipelago]$_{LOCATION}$ and the [Greenland coast]$_{LOCATION}$.

Value

- refers to the numeric value of a quality of a trait.

- [Snow]$_{SNOW}$ [albedo]$_{TRAIT}$ is [highly]$_{FUNCTION}$ [variable]$_{EVENTUALITY}$, ranging from [as high as]$_{FUNCTION}$ [0.9]$_{VALUE}$ for [freshly]$_{TIME}$ [fallen]$_{EVENTUALITY}$ [snow]$_{SNOW}$, to [about]$_{FUNCTION}$ [0.4]$_{VALUE}$ for [melting]$_{EVENTUALITY}$ [snow]$_{SNOW}$, and [as low as]$_{FUNCTION}$ [0.2]$_{VALUE}$ for [dirty]$_{TRAIT}$ [snow]$_{SNOW}$.

- [Through 2013 the September]$_{TIME}$ [linear rate]$_{FUNCTION}$ of [decline]$_{EVENTUALITY}$ is [13.7]$_{VALUE}$[% per decade]$_{UNIT}$ relative to the [1981 to 2010 average]$_{TRAIT}$.

- This was [1.13 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([398,000]$_{VALUE}$ [square miles]$_{UNIT}$) [below]$_{FUNCTION}$ the [1981 to 2010 average]$_{TRAIT}$ for [August]$_{TIME}$, but [well above]$_{FUNCTION}$

[6] Resistant here is a value of the trait "resistance."
[7] Vulnerable here is a value of the trait "vulnerability." First-year ice is more susceptible or vulnerable to melt because of its thinness whereas old or older ice is more resistant to melt because of its thickness.

the [level]$_{FUNCTION}$ recorded [last year]$_{TIME}$, which was the [lowest September extent]$_{TRAIT}$ [in the satellite record]$_{TIME}$.

- [Sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ has [fallen]$_{EVENTUALITY}$ [below]$_{FUNCTION}$ the [2005]$_{TIME}$ [record low absolute minimum]$_{FUNCTION}$ and is [still]$_{TIME}$ [melting]$_{EVENTUALITY}$. [Sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ is [currently]$_{TIME}$ tracking at [5.26 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([2.02 million]$_{VALUE}$ [square miles]$_{UNIT}$), [just below]$_{FUNCTION}$ the [2005]$_{TIME}$ [record absolute minimum]$_{FUNCTION}$ of [5.32 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([2.05 million]$_{VALUE}$ [square miles]$_{UNIT}$).

- The [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ had [reached]$_{EVENTUALITY}$ a [new]$_{TIME}$ [record low]$_{FUNCTION}$: [5.32 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([2.05 million]$_{VALUE}$ [square miles]$_{UNIT}$) versus the [long-term average]$_{FUNCTION}$ of [7.7 million]$_{VALUE}$ [square kilometers]$_{UNIT}$ ([2.96 million]$_{VALUE}$ [square miles]$_{UNIT}$).

Unit

- refers to the unit used to measure a feature of an entity.

- [Grey ice]$_{ICE\_DEVEL}$ is [young ice]$_{ICE\_FORM}$ that is [10]$_{VALUE}$ - [15]$_{VALUE}$ [centimeters]$_{UNIT}$ [thick]$_{TRAIT}$.

- If it is [thicker]$_{FUNCTION}$ than [about]$_{FUNCTION}$ [2]$_{VALUE}$ [meters]$_{UNIT}$ above sea-level it is called an [ice shelf]$_{ICE\_SOURCE}$

- [Monthly August] [ice]$_{ICE}$ [extent]$_{TRAIT}$ for [1979 to 2013]$_{TIME}$ shows a [decline]$_{EVENTUALITY}$ of [10.6]$_{VALUE}$ [% per decade]$_{UNIT}$.

- [Monthly September] [ice]$_{ICE}$ [extent]$_{TRAIT}$ for [1979 to 2013]$_{TIME}$ shows a [decline]$_{EVENTUALITY}$ of [13.7]$_{VALUE}$ [% per decade]$_{UNIT}$.

  Note: Keep an eye out for units that are discontinuous like [square kilometers...per day] and [square miles...per day] in the examples below:

- ….was [dominated]$_{EVENTUALITY}$ by [retreat]$_{EVENTUALITY}$ in the [Kara and East Greenland seas]$_{LOCATION}$, where the [ice]$_{ICE}$ [loss]$_{EVENTUALITY}$ [rate]$_{TRAIT}$ [from July 1 to 12]$_{TIME}$ was [-16,409]$_{VALUE}$ and [-17,678]$_{VALUE}$ [**square kilometers**] ([-6,336]$_{VALUE}$ and [-6,826]$_{VALUE}$ [**square miles**]) [**per day**]$_{UNIT}$, respectively.

- The [Laptev Sea]$_{LOCATION}$ [ice]$_{ICE}$ [retreated]$_{EVENTUALITY}$ at [about half]$_{FUNCTION}$ that [rate]$_{TRAIT}$, at [-8,810]$_{VALUE}$ [**square kilometers**] ([-3,402]$_{VALUE}$ [**square miles**]) [**per day**]$_{UNIT}$.

Relevancy

If you are not sure whether or not a mention should be annotated, ask yourself the following questions:

- Does the mention fall into one or more of the annotation categories described above?

  If the answer is no, do not annotate the mention. If the answer is yes, then ask yourself the following question:

- Does its location within its span allow you to annotate it? If it's a headword and falls into one of our annotation categories, then it's eligible for annotation.

  There are some exceptions:

- Not all entities need to be headwords in order to be annotated. All time and season expressions should be annotated wherever they occur regardless of their syntactic location. Similarly, eventualities and multiword expressions (as listed in our diagrams and as described in the following sections: Location, Area, Trait, Function, Unit) can be annotated wherever they occur.

- Is the mention in a citation or keyword list? If so, do not annotate it.

Proper Span Selection

Span Information

A span refers to the section of the text that is annotated. Different projects will have different methods for defining the proper span for that project. For Clear Earth annotation, our analysis of the proper span starts with us identifying the **minimum spans**. A minimum span is one in which only the syntactic heads are annotated. (This generally results in single-word annotations.) The head of a phrase is the word that determines what syntactic type of phrase it is.

For example, in the sentence:

- "Our neighbor [John] bought a new, green [car]."

We have “our neighbor John” in which the syntactic head of the noun phrase (NP) is the proper noun “John” and we have the NP “a new, green car” in which the head is the noun “car.”

We can also think of the head of a phrase as the word that provides the essential meaning of the phrase. Take the NP “a new, green car” for example. What is essential to our understanding of what exactly John bought is the head “car.” Although the dependents or pre-modifiers “new” and “green” give us additional information, they are less essential to our interpretation of the sentence.

This is important to know because **finding the syntactic head of a phrase will help you determine what (if any) parts of the phrase should be annotated:**

Example of a markable, syntactic head of an NP:

- The [iceberg]$_{ICE\_FORM}$ was first observed in the [Arctic Ocean]$_{LOCATION}$ [on September 2010]$_{TIME}$.

  We tag “iceberg” as the ICE_FORM because it is the head of the NP, but we do not tag the determiner “the” because it is not part of the minimum span.

We would not annotate “iceberg” if it was modifying a headword for which there is no annotation category:

- The iceberg measurement showed that it was of an average age for the region.

  We do not annotate “iceberg” here because it is not the headword of the NP, instead it is modifying the headword “measurement” which is a term we do not annotate in this schema.

There are many exceptions to the rule of grabbing the syntactic head only. As this project evolved, we came to find that many of the phrases scientists use to describe the cryosphere are descriptive and contain important concepts in regards to the characteristics of entities and complex processes, states, or events. Here are the primary exceptions:

There are certain multiword expressions (MWE) that we treat as though they are minimum spans and annotate the complete phrase. These MWEs can be annotated wherever they occur in a sentence whether or not they are syntactic heads.

Examples:

- [First-year ice]$_{ICE\_DEVEL}$ is [sea ice]$_{ICE\_SOURCE}$ of not [more]$_{FUNCTION}$ than [one winter’s growth]$_{SEASON}$, [developing]$_{EVENTUALITY}$ from [young ice]$_{ICE\_DEVEL}$; [thickness]$_{TRAIT}$ [30]$_{VALUE}$ [cm]$_{UNIT}$ - [2]$_{VALUE}$ [m]$_{UNIT}$. May be subdivided into [thin first-year ice]$_{ICE\_DEVEL}$ / [white ice]$_{ICE\_DEVEL}$, [medium first-year ice]$_{ICE\_DEVEL}$ and [thick first-year ice]$_{ICE\_DEVEL}$.

  In the example above, we have the following multiword expressions: [first year ice], [sea ice], [one winter’s growth], [young ice], [thick first-year ice], [white ice], [medium first-year

ice] and [thick first-year ice]. Please see our section on the function annotation category for a more detailed explanation on its rules regarding span.

There is an exception to annotating modifiers in a noun phrase. If the syntactic head is markable and its modifiers fit into one of the annotation categories listed below then it is fine to annotate the modifiers as well.

Example:

- These [open water]$_{ICE\_CON}$ [areas]$_{AREA}$ [absorb]$_{EVENTUALITY}$ the [sun's energy]$_{EVENTUALITY}$, which will [help]$_{EVENTUALITY}$ to [further]$_{FUNCTION}$ [ice]$_{ICE}$ [melt]$_{EVENTUALITY}$ [through the summer]$_{SEASON}$.

  The headword "areas" in the noun phrase "these open water areas" is a generic place-type and is eligible to be annotated as area. The headwords modifier "open water" is one of the multiword expressions listed in the diagrams here. Its status as an MWE makes it eligible to annotate as does its status as a modifier to a markable headword.

All time and season phrases should be annotated, regardless of their syntactic role. Make sure to capture the entire expression including determiners and pronouns.

Examples:

- [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ [continued]$_{EVENTUALITY}$ a [rapid]$_{TRAIT}$ [retreat]$_{EVENTUALITY}$ [through the first two weeks of July]$_{TIME.}$

  In the example above, the time expression " through the first two weeks of July" is annotated as a single span.

- [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ is [younger]$_{FUNCTION}$ and [thinner]$_{FUNCTION}$ as [the melt season]$_{SEASON}$ [begins]$_{EVENTUALITY}$.

Tricky Cases

How to annotate an entity that is a part of a discontinuous span:

Discontinuous spans add an extra step to entity annotation. A discontinuous span is a span that is interrupted in some way (see example immediately below). In sea ice annotation, we frequently find that the entity we'd like to tag is discontinuous because of a conjunction or a hyphen or some intervening adjectives. An annotator can capture the complete span by linking (or adding) the disparate parts of the span together.

Example:

- May be subdivided into [residual]$_{ICE\_DEVEL}$, [second-year [ice]]$_{ICE\_DEVEL}$ and [multi-year ice]$_{ICE\_DEVEL}$.

  The term [residual]$_{ICE\_DEVEL}$ is missing the word [ice] which is present in the other two terms.

Possessive adjectives:

Occasionally, a possessive adjective will modify a relevant headword/entity. If the possessive adjective corresponds to one of the annotation categories below then it is fine to annotate it, but the " **'s** " should not be included in the span unless it is part of an MWE, time expression, or season expression.

Singular versus plural nouns:

The pluralization of an entity should be annotated the same way as it would if it were singular.

Examples:

- The scientists observed the [glacier].
- The scientists observed the [glaciers].

Atmosphere-related entities and eventualities:

We do not annotate entities and eventualities related to the atmosphere because it is beyond the scope of our schema, which was designed to capture sea ice entities and eventualities. It can be challenging to discern which entities and eventualities to annotate and which to ignore, especially considering the reciprocal, causal relationship between the atmosphere and sea ice.

We have endeavored to not annotate the eventualities, traits, values, and units used to describe atmospheric phenomena. We chose to continue annotating direction, location, area, multiword expressions, time expressions, season expressions within those descriptions.

Examples:

- Persistence of this type of pressure pattern [throughout summer 2007]$_{SEASON}$ was a major factor toward [causing]$_{EVENTUALITY}$ the [record low]$_{FUNCTION}$ [September extent]$_{TRAIT}$ [that year]$_{TIME}$.

  The atmospheric eventuality “pressure pattern” is not annotated above because it is referring to atmospheric pressure patterns. Notice that we do still annotate time expressions and the causal event because those are linked directly to the extent, which we do want to make sure to capture.

- Atmospheric data averaged for [August 1–18, 2007]$_{TIME}$, show high atmospheric pressure [still]$_{TIME}$ prevailing [over]$_{DIRECTION}$ the [Arctic Ocean]$_{LOCATION}$ [north]$_{DIRECTION}$ of [Alaska]$_{LOCATION}$, with low atmospheric pressure in the [Laptev Sea]$_{LOCATION}$, broadly similar to the pattern seen for [June through July]$_{TIME}$. The high-pressure cell points to an ongoing tendency for relatively clear skies [north]$_{DIRECTION}$ of [Alaska]$_{LOCATION}$ (as seen in Figure 3 above). Temperatures at 925 millibars (about 2,500 feet) have continued to be above normal across most of the [Arctic Ocean]$_{LOCATION}$, especially [north]$_{DIRECTION}$ of [eastern]$_{DIRECTION}$ [Siberia]$_{LOCATION}$, where [winds]$_{EVENTUALITY}$ are bringing in warm air from the [south]$_{DIRECTION}$. This [wind]$_{EVENTUALITY}$ [pattern]$_{EVENTUALITY}$ has also [continued]$_{EVENTUALITY}$ to [push]$_{EVENTUALITY}$ [ice]$_{ICE}$ [away]$_{DIRECTION}$ from the [Siberian coast]$_{LOCATION}$ and into the [central]$_{DIRECTION}$ [Arctic Ocean]$_{LOCATION}$.

  “Wind patterns” and its subsequent entities and eventualities are annotated (as shown above) despite its relationship to atmospheric patterns because it is an essential link to understanding ice extent and ice movement, which are the focus of this annotation project.

  Air, atmospheric pressure including its functions or traits, clear (or cloudy) skies, temperature and its measurements are not annotated.

Air temperature versus sea surface temperature:

We chose not to annotate mentions of air temperature and non-specific mentions of temperature while annotating because of its relationship with atmospheric phenomena. We did, however, annotate mentions of sea surface temperature.

Temperature in the excerpt below was considered non-specific and therefore was not annotated:

- Figure 4 shows the [warming]$_{EVENTUALITY}$ [pattern]$_{EVENTUALITY}$ discussed above, using color to show the difference in [June through July]$_{TIME}$ temperatures compared to the average [over the period 1979 to 2007]$_{TIME}$. (We show the temperatures at 925 millibars pressure,

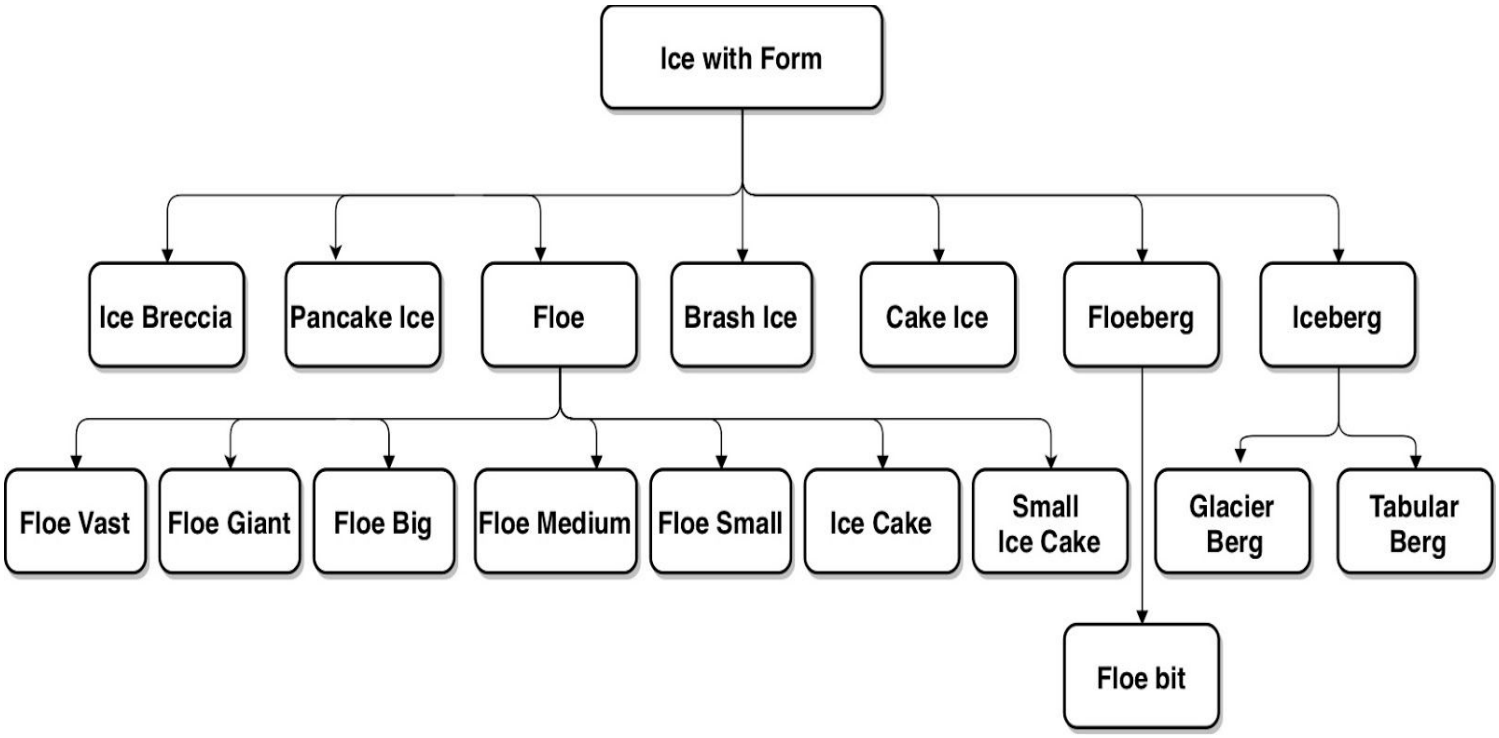
or about 750 meters [2,500 feet] in altitude, because they give a smoother temperature field than the surface map). Strong positive temperature anomalies occurred [over]$_{DIRECTION}$ much of the [Arctic Ocean]$_{LOCATION}$, accelerating [ice]$_{ICE}$ [melt]$_{EVENTUALITY}$, with the largest temperature anomalies (3 to 5 degrees Celsius or 5 to 9 degrees Fahrenheit) [over]$_{DIRECTION}$ the [Siberian side]$_{LOCATION}$ where the [largest]$_{FUNCTION}$ [ice]$_{ICE}$ [losses]$_{EVENTUALITY}$ have been observed.

The mention about sea surface temperatures in the excerpt below would be annotated, while the mention about air temperature would not:

- [On October 20, 2016]$_{TIME}$, [Arctic]$_{LOCATION}$ [sea ice]$_{ICE\_SOURCE}$ [extent]$_{TRAIT}$ [began]$_{EVENTUALITY}$ to set [new]$_{TIME}$ [daily]$_{TIME}$ [record lows]$_{FUNCTION}$ for [this time of year]$_{TIME}$. [After mid-October]$_{TIME}$, [ice growth]$_{EVENTUALITY}$ [returned]$_{EVENTUALITY}$ to [near-average]$_{FUNCTION}$ [rates]$_{TRAIT}$, but [extent]$_{TRAIT}$ [remained]$_{EVENTUALITY}$ at [record low levels]$_{FUNCTION}$ [through late October]$_{TIME}$. [High]$_{TRAIT}$ [sea surface]$_{AREA}$ [temperatures]$_{TRAIT}$ in [open water]$_{ICE\_CON}$ [areas]$_{AREA}$ were important in [limiting]$_{EVENTUALITY}$ [ice growth]$_{EVENTUALITY}$. [October]$_{TIME}$ air temperatures were also unusually high, and this warmth extended from the [surface]$_{AREA}$ through a considerable depth of the atmosphere.

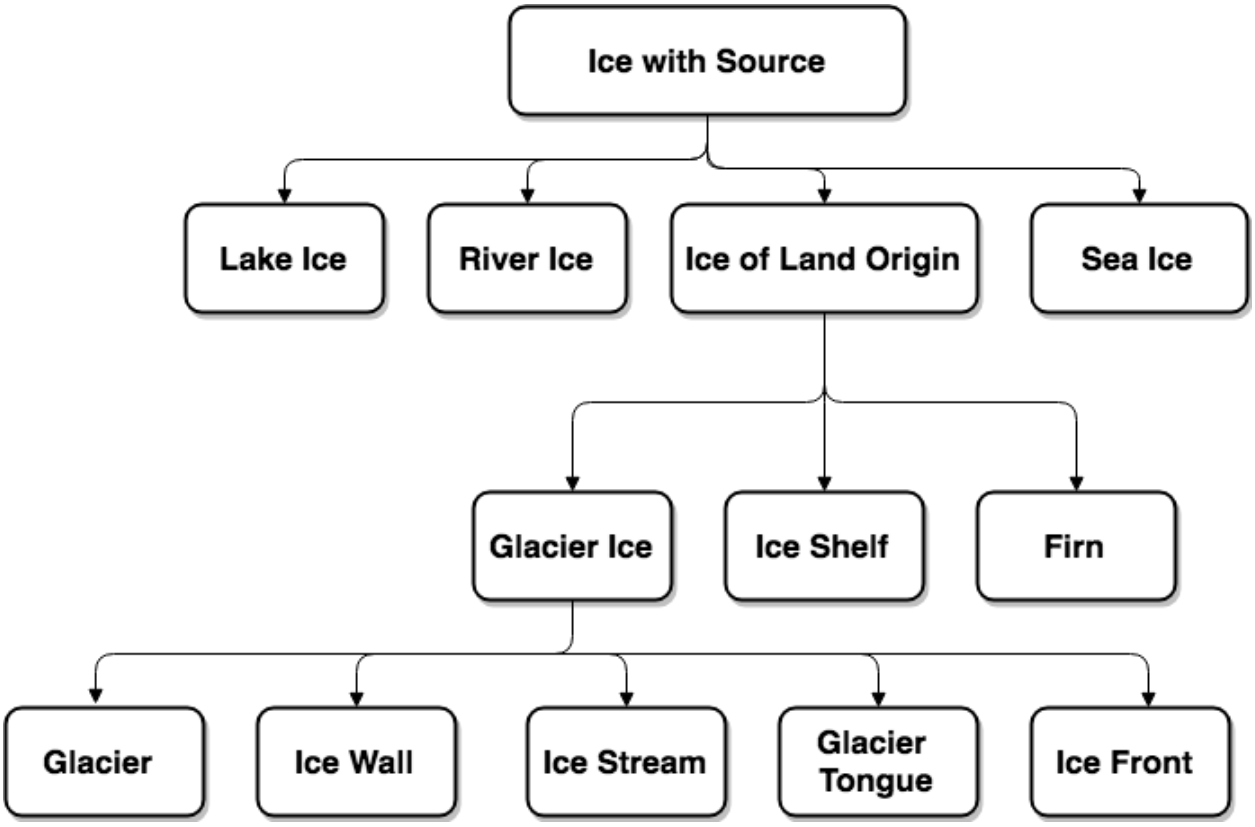
Diagrams for Entities:

Ice with Form[8]



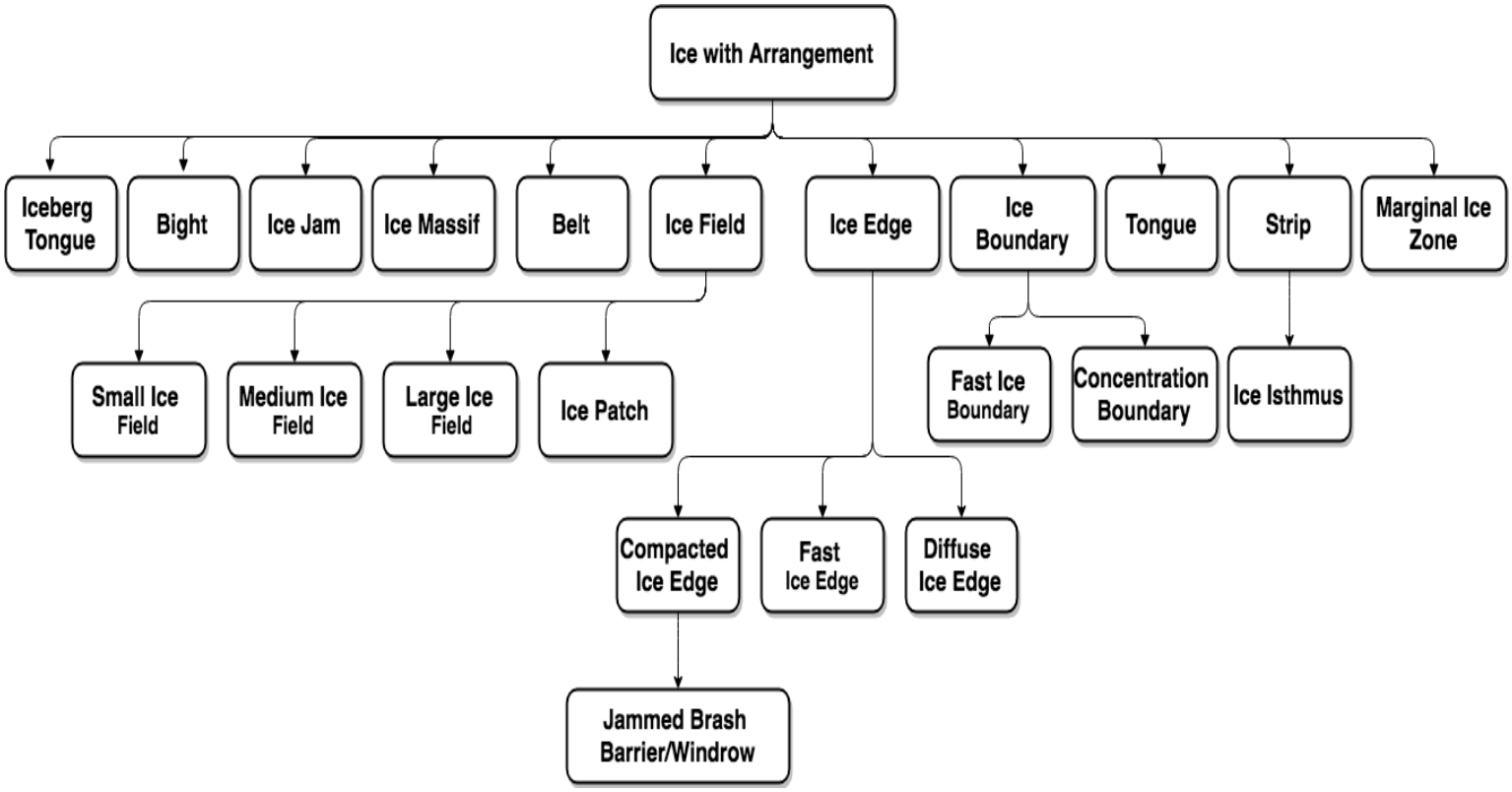
[8]**Ice with Form** terms: Ice Breccia; Pancake Ice; Floe; Brash Ice; Cake Ice; Floeberg; Iceberg; Floe Vast; Floe Giant; Floe Big; Floe Medium; Floe Small; Cake Ice; Small Ice Cake; Floe bit; Glacier Berg; Tabular Berg.

Ice with Source[9]



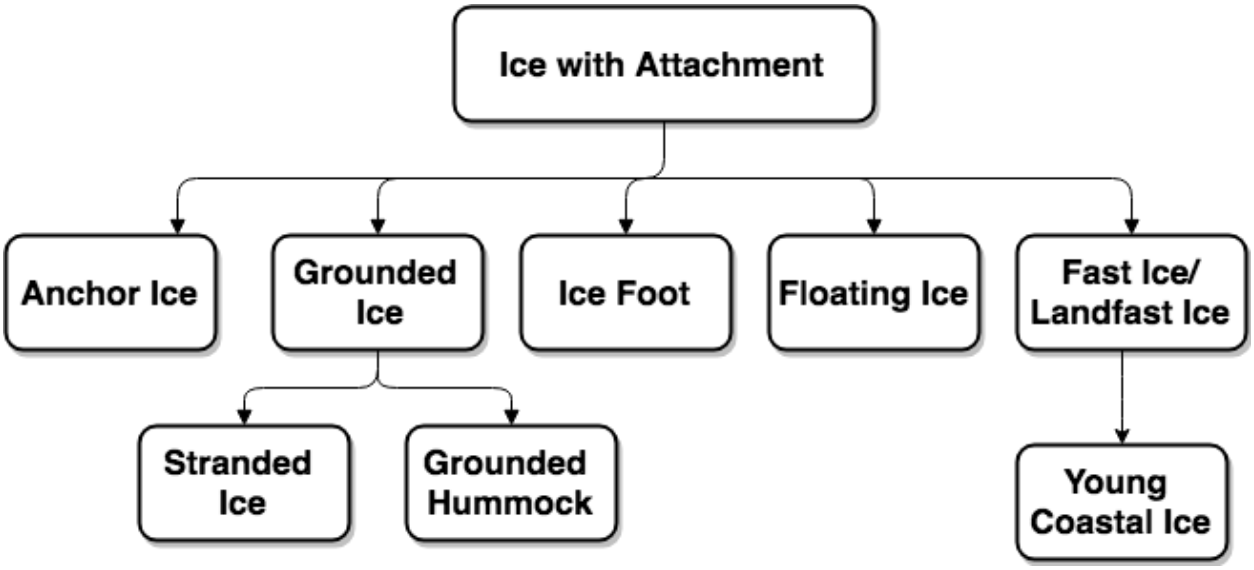
[9]**Ice with Source** terms: Lake Ice; River Ice; Ice of Land Origin; Sea Ice; Glacier Ice; Ice Shelf; Firn; Glacier; Ice Wall; Ice Stream; Glacier Tongue; Ice Front

Ice with Arrangement[10]



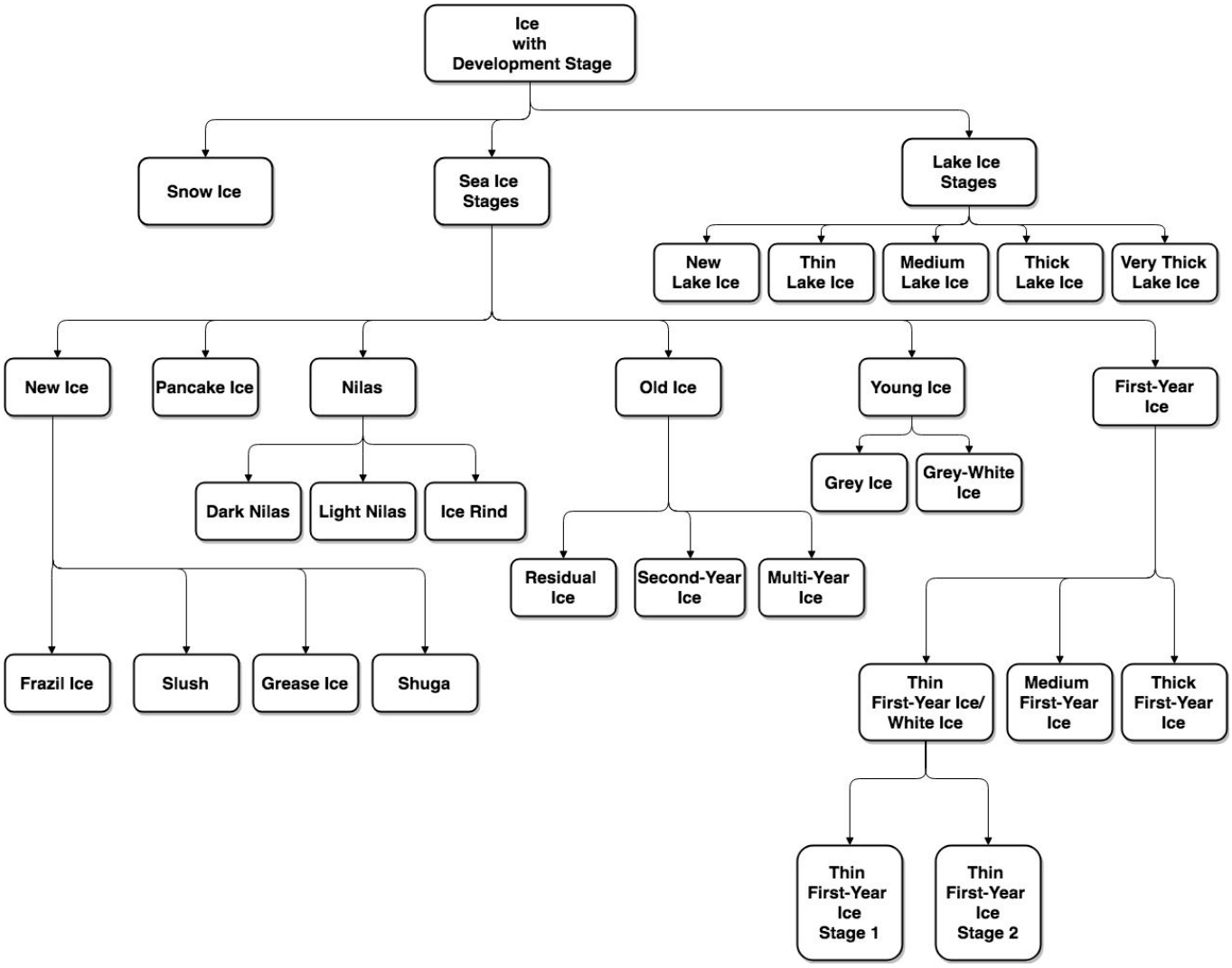
[10]**Ice with Arrangement** terms: Iceberg Tongue; Bight; Ice Jam; Ice Massif; Belt; Ice Field; Ice Edge; Ice Boundary; Tongue; Strip; Marginal Ice Zone; Small Ice Field; Medium Ice Field; Large Ice Field; Ice Patch; Fast Ice Boundary; Concentration Boundary; Ice Isthmus; Compacted Ice Edge; Fast Ice Edge; Diffuse Ice Edge; Jammed Brash Barrier/Windrow.

Ice with Attachment[11]



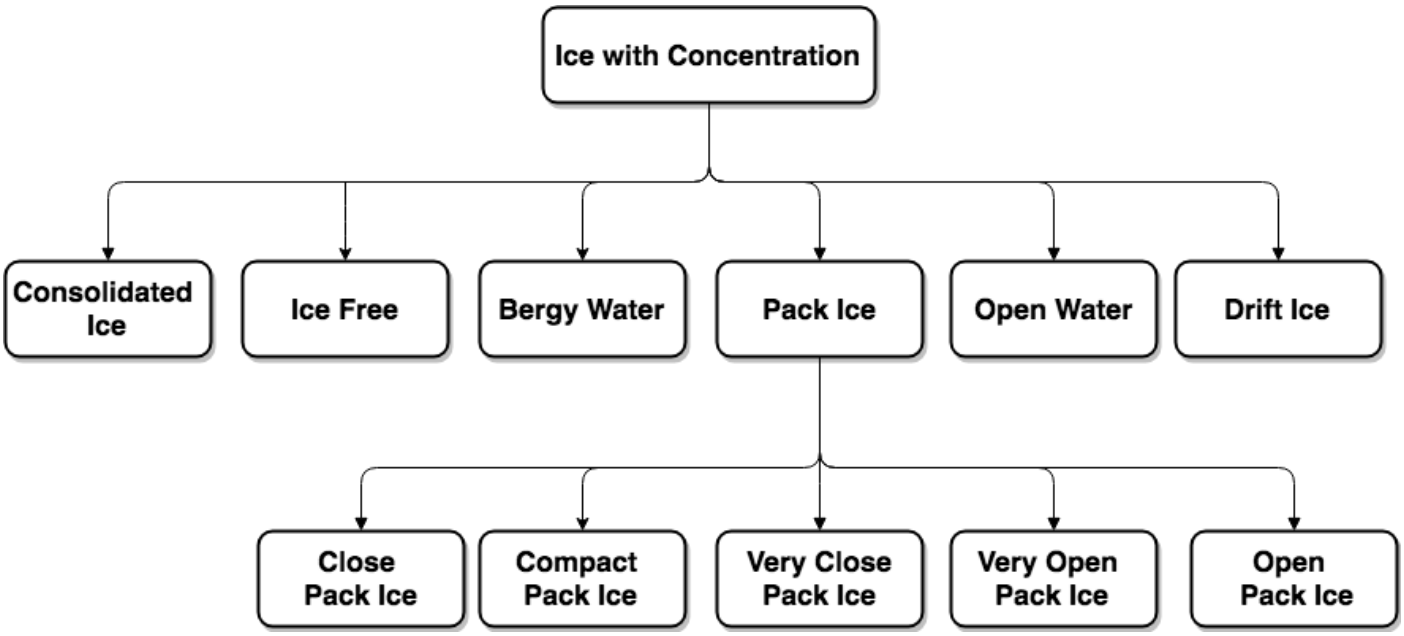
[11]**Ice with Attachment** terms: Anchor Ice; Grounded Ice; Ice Foot; Floating Ice; Fast Ice/Landfast Ice; Stranded Ice; Grounded Hummock; Young Coastal Ice.

Ice with Development (the age of the ice)[12]



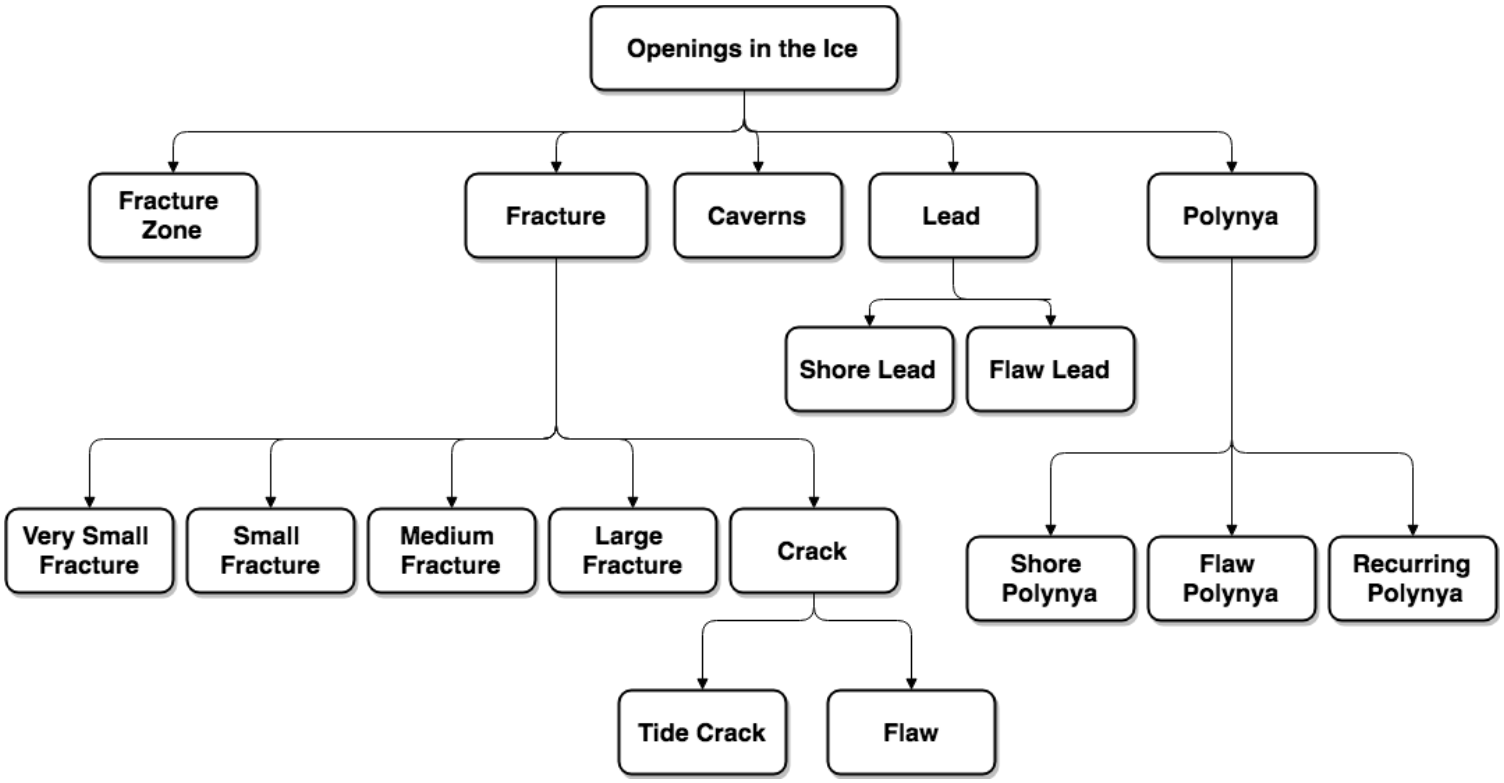
[12]**Ice with Development** terms: Snow Ice; Sea Ice Stages; Lake Ice Stages; New Lake Ice; Thin Lake Ice; Medium Lake Ice; Thick Lake Ice; Very Thick Lake Ice; New Ice; Frazil Ice; Slush; Grease Ice; Shuga; Pancake Ice; Nilas; Dark Nilas; Light Nilas; Ice Rind; Old Ice; Residual Ice; Second-Year Ice; Multi-year Ice; Young Ice;Grey Ice; Grey-White Ice; First-Year Ice; Thin First-Year Ice/White Ice; Medium First-Year Ice; Thick First-Year Ice; Thin First-Year Ice Stage 1; Thin First-Year Ice Stage 2.

Ice with Concentration[13]



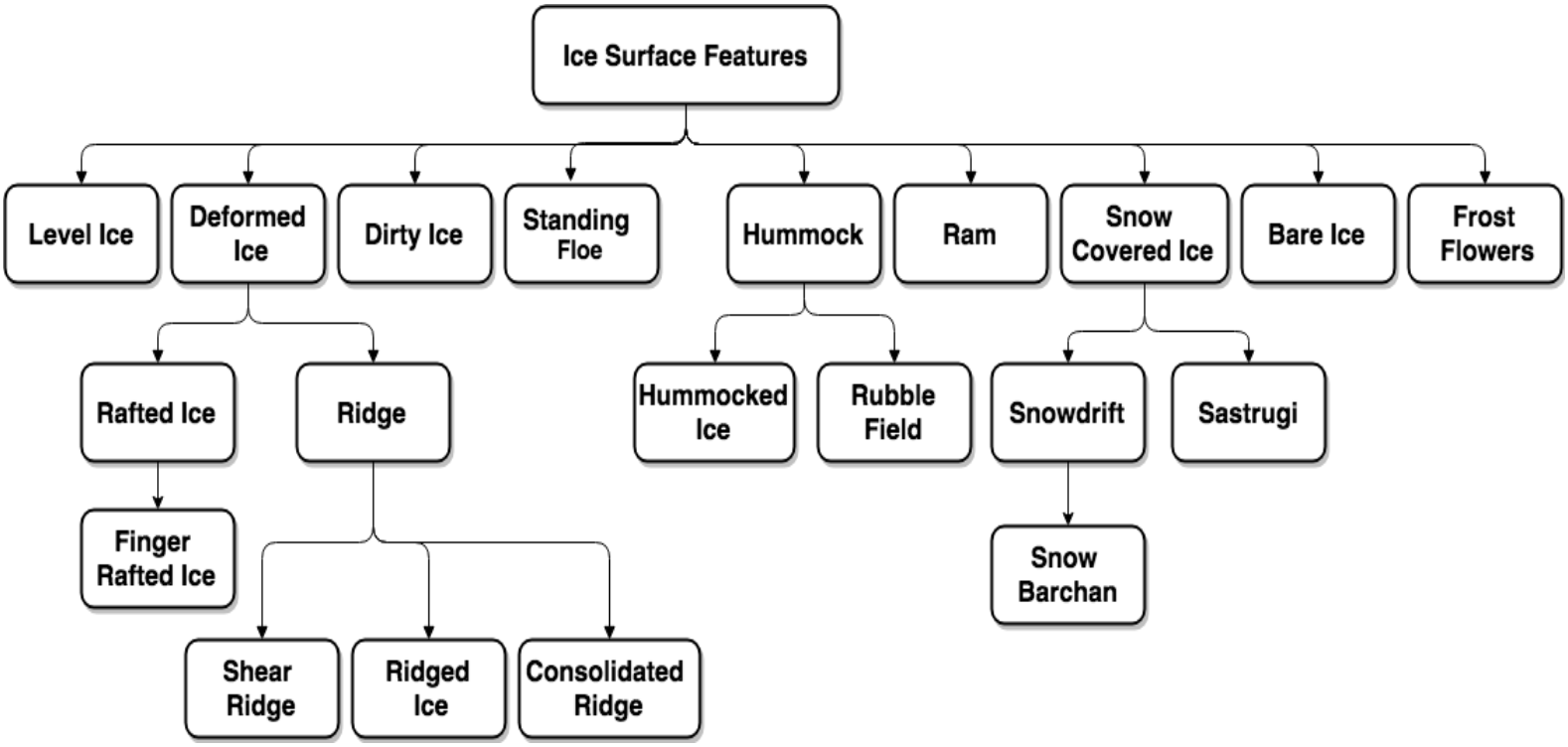
[13]**Ice with Concentration** terms: Consolidated Ice; Bergy Water; Ice Free; Pack Ice; Drift Ice; Open Water; Close Pack Ice; Compact Pack Ice; Very Open Pack Ice; Open Pack Ice; Very Close Pack Ice.

Openings in the Ice[14]



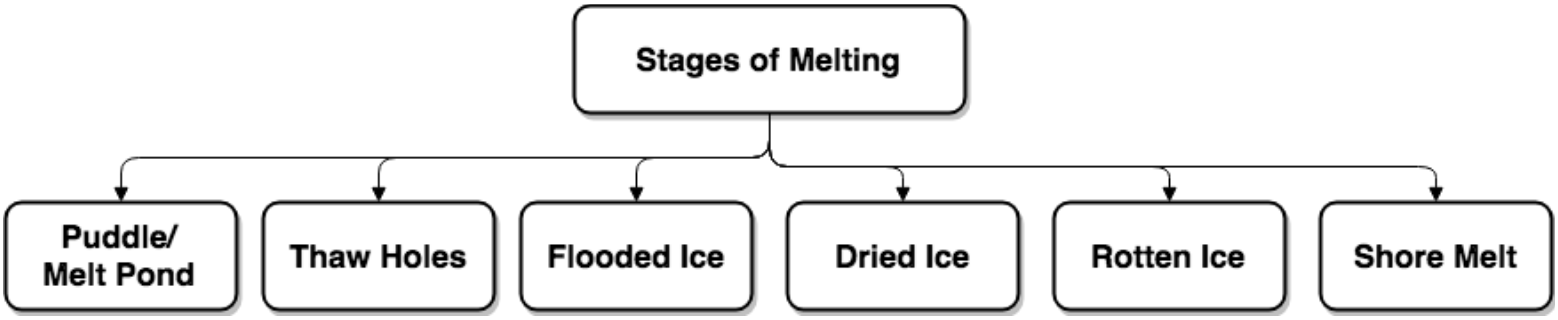
[14]**Openings in the Ice** terms: Fracture Zone; Fracture; Lead; Shore Lead; Flaw Lead; Polynya; Cavern; Very Small Fracture; Small Fracture; Medium Fracture; Large Fracture; Crack, Shore Polynya; Flaw Polynya; Recurring Polynya; Tide Crack; Flaw.

Ice Surface Features[15]



[15]**Ice Surface Features** terms: Level Ice; Deformed Ice; Dirty Ice; Standing Floe; Hummock; Ram; Snow Covered Ice; Bare Ice; Frost Flowers; Rafted Ice; Ridge; Hummocked Ice; Rubble Field; Snowdrift; Sastrugi; Snow Barchan; Finger Rafted Ice; Shear Ridge; Ridged Ice; Consolidated Ridge.

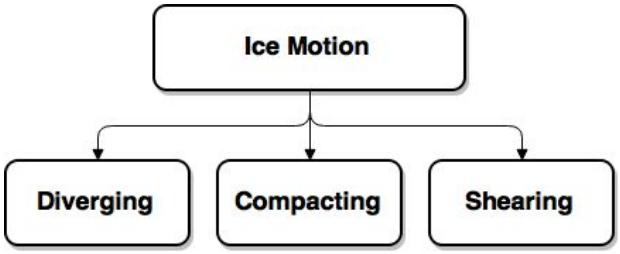
Stages of Melting[16]



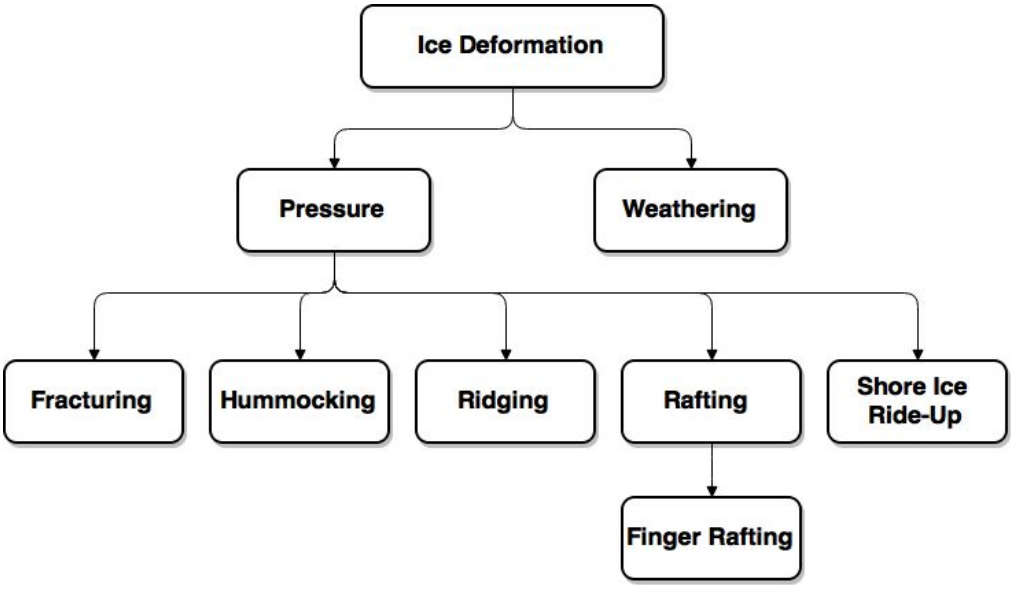
[16] **Stages of Melting** terms: Puddle/Melt Pond; Thaw Holes; Flooded Ice; Dried Ice; Rotten Ice; Shore Melt.

Diagrams for Eventualities:

Ice Motion[17]



Ice Deformation[18]



[17] **Ice Motion:** Diverging; compacting; shearing.
[18] **Ice Deformation:** Pressure; Weathering; Fracturing; Hummocking; Ridging; Rafting; Shore Ice Ride-Up; Finger Rafting.