ARHC Presentation – Regional Proposals

IIC TECHNOLOGIES

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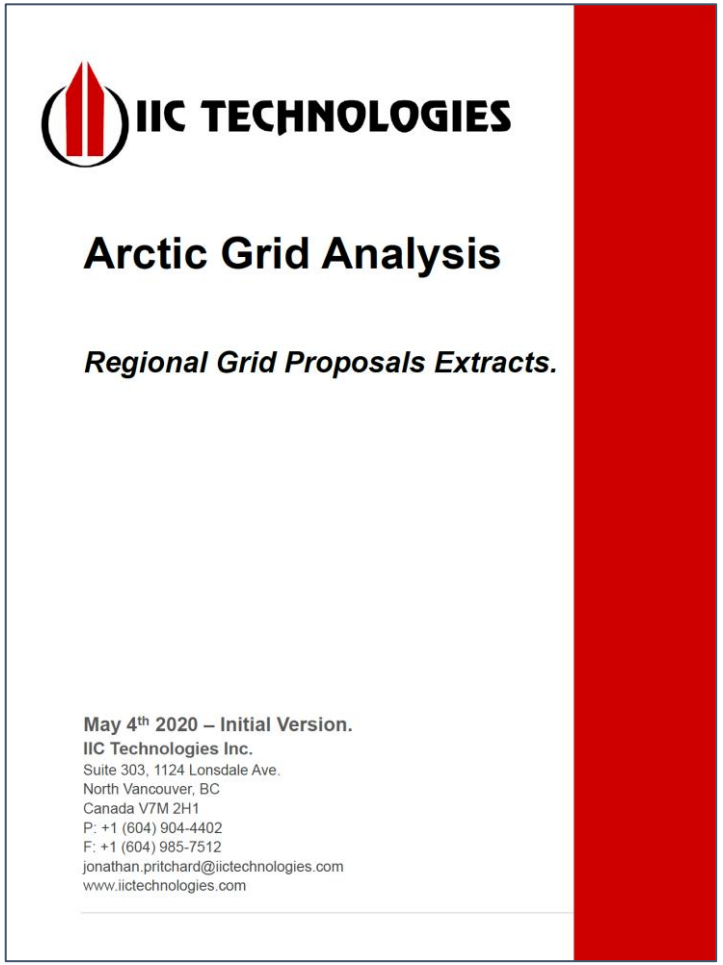
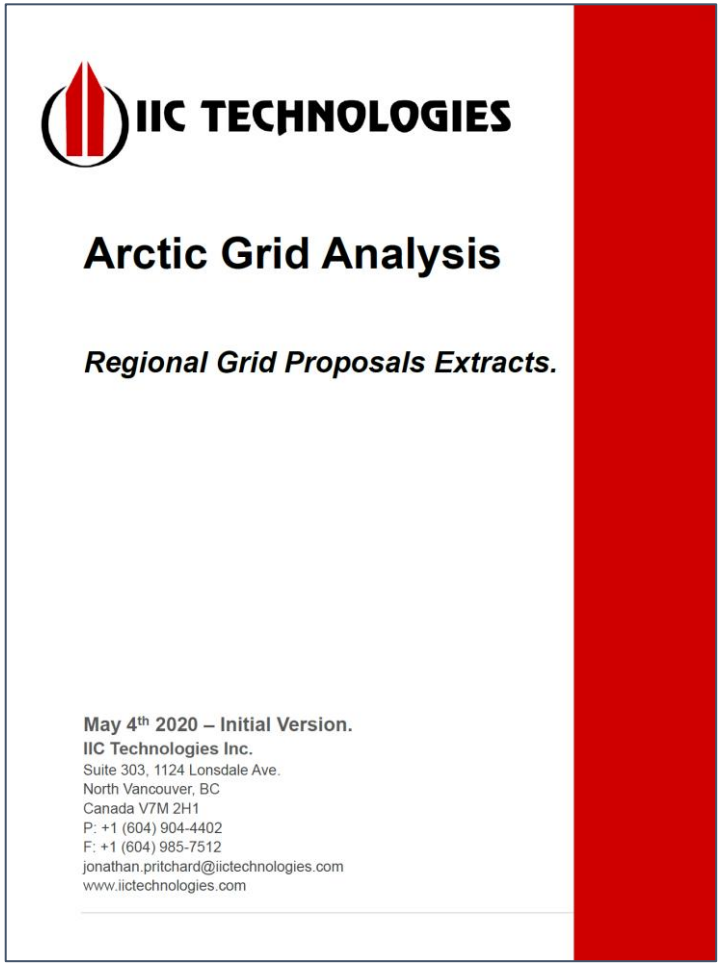
Introduction - Contents

- Background and History
  - Study content and boundaries
  - Regional Characteristics
  - Gridded Scheme studies
- Regional Proposals
  - Scope
  - Proposals
  - Definition of “Success”?



Introduction - Contents

- Original Study covered Arctic Charting in general in the context of CHS coverage in the region
  - Paper / ENC coverage
  - Evaluation of existing grid scheme proposal and scale rationalisation (e.g. overlaps, numbers of cells generated) and alternatives
  - Navigational aspects of Arctic region
  - Trends
- Other areas
  - ENC / Paper coverage within the region
  - Encoding practices
  - Comparisons with other RHC members / Associate members
  - Regional Proposals – “is it possible to propose a grid scheme for the benefit of the ARHC members”



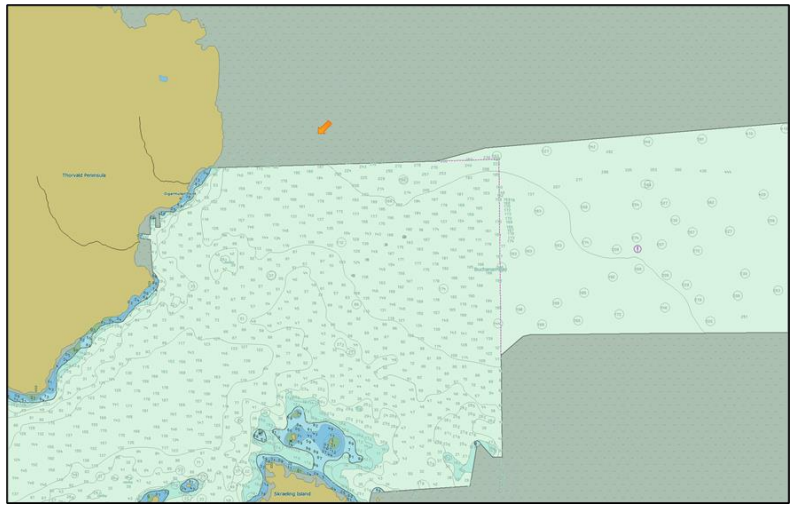
The Arctic

- The Arctic is a busy region, fast evolving with immense strategic, scientific and technical value
- It is also a region with a long history of cooperation and mutual support for initiatives
- There are some unique challenges:
  - Uncertainty, meteorological, logistical, communications, geodetic
  - Unique and fundamental challenges for navigation
  - Steadily increasing activities for regulatory, environmental / scientific
  - Tests many ENC encoding conventions and rules
- Why now?
  - S-100 – decade of implementation. Multiple product specifications
  - S-101 transition from S-57: Many HOs are rescheming data extents
  - Great interest in placing multiple products on a “common canvas”

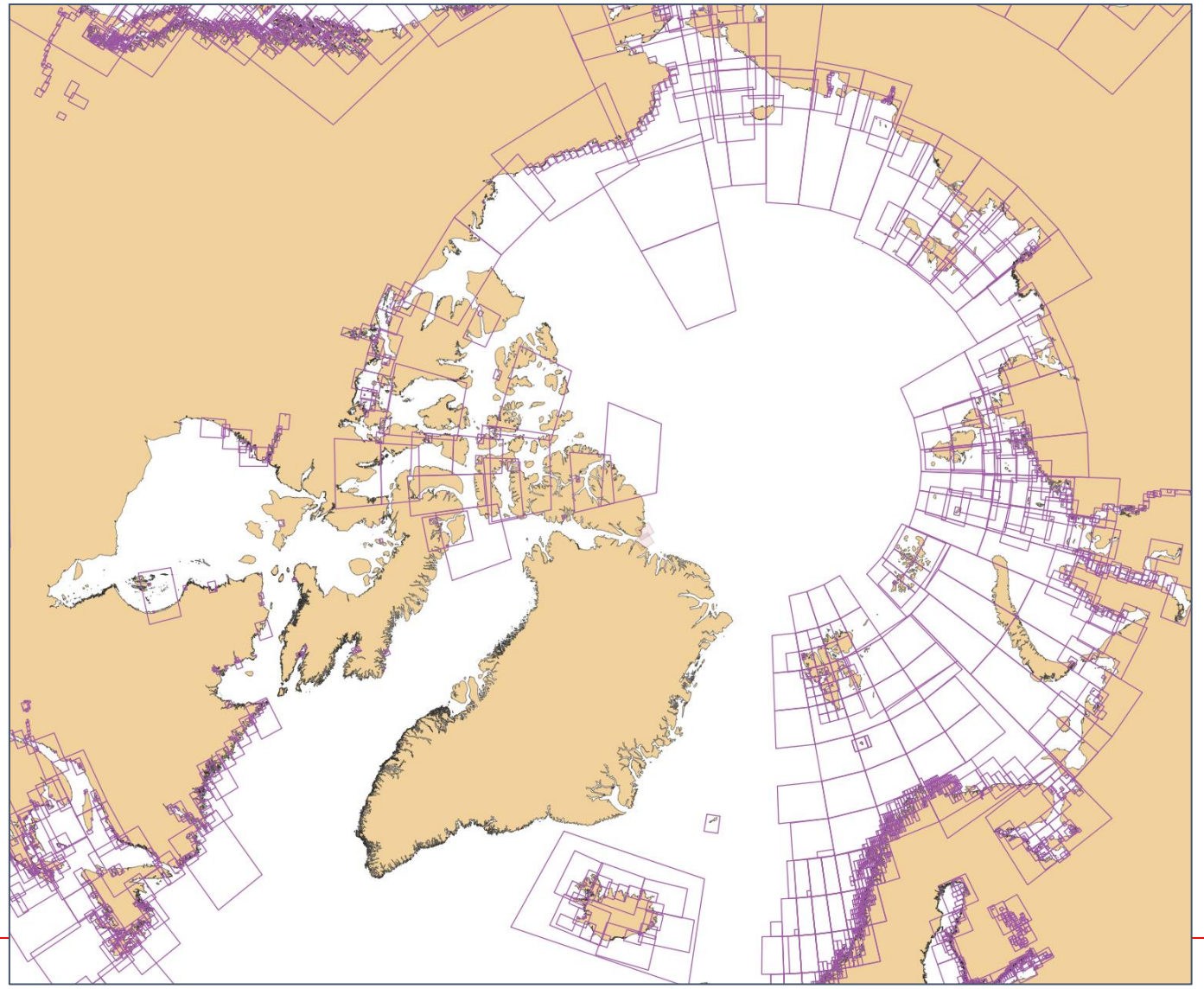
“Soundings in sloped figures are spot soundings taken through the ice by the Defence Research Board 1963-1969”

“Much of the information on this chart is of a reconnaissance nature and mariners should exercise caution when navigating in these waters”

Coverage in the Region



- Database of ENC coverage available
  - Extents, M_COVR and M_CSCL
  - Compilation Scale
  - Usage Band
  - Producer
- Data (where we have ENC)
  - Skin of the Earth
  - Bathymetry
  - Significant features
  - INFORM warning, caveats and Publications



Regional Proposal - Scope

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- Why?
  - Promote Regional Cooperation
  - Provide a common grid for multiple data products
  - Enable broader use for MSDI, scientific and environmental research
  - Promote cooperation and best practices for data in the region.

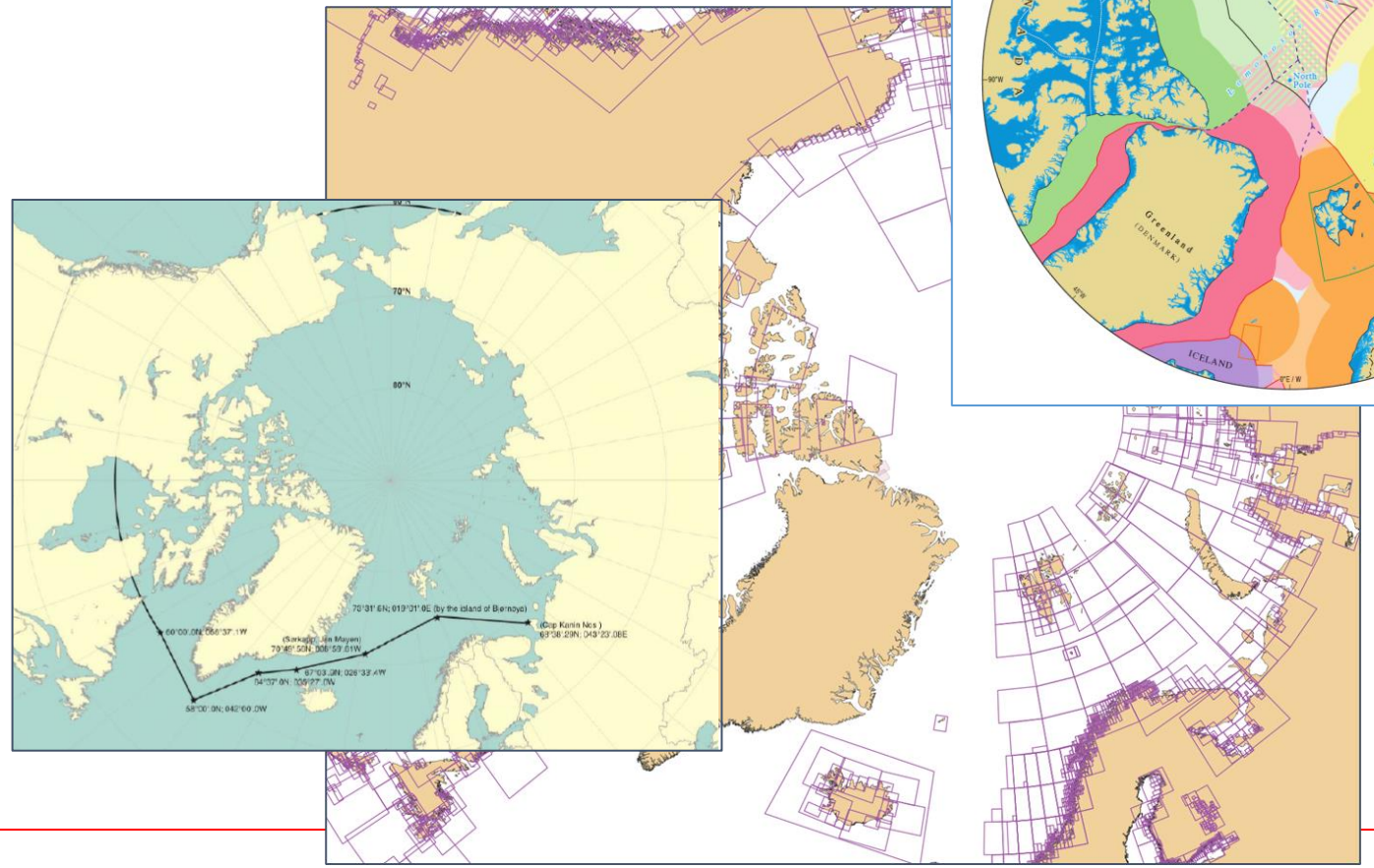
- Who?
  - ARHC members and associate members

- Scope
  - Coverage: Options, predefined, existing data coverage, limiting latitude
  - Content: Some/All data, cooperative production, navigation and other uses…

- How.....
  - A Shared grid of coverage for multiple datasets, products and services

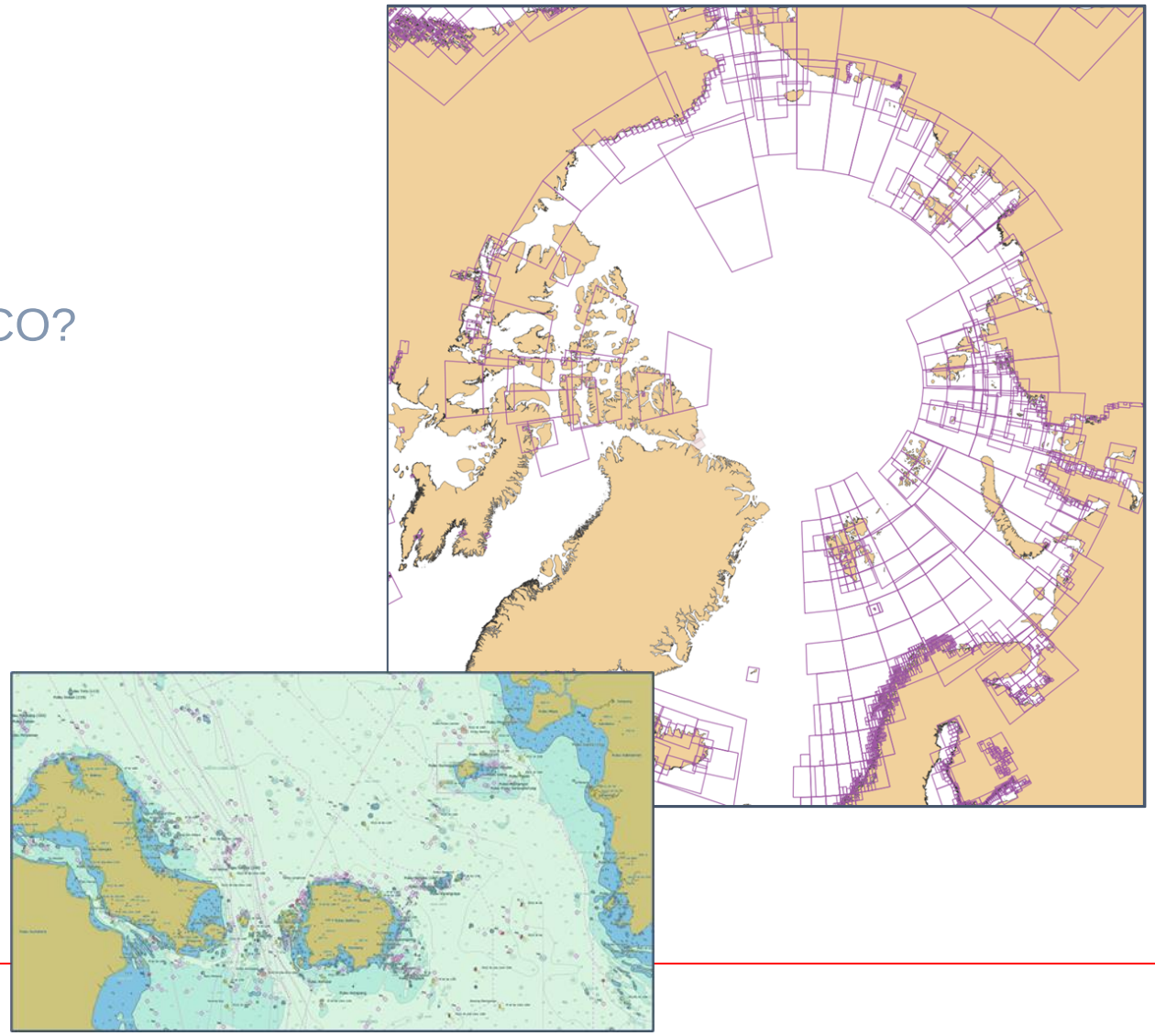
Where is the Arctic?

- What should the extent be?
- Predefined based on coverage?
- Delimited, EEZ?
- Regulatory / Other definitions
  - Polar code
  - Limiting Latitude
  - Others…
- Should be complete.
- Cover the Pole
- Useful!



Data Content?

- Data Content
- ENCs for navigation?
  - Use for primary navigation
  - In addition to national scheming – S-101 rollout
  - Regional cooperation at e.g. Small Scale, GEBCO?
- Other (S-100) data products
  - S-102 Bathymetry
  - S-411 Ice Information
  - Limits and boundaries
  - Marine protected Areas
  - Regulatory Regimes
  - bENC / SMENC



What is a Grid? What is a "Good" grid?

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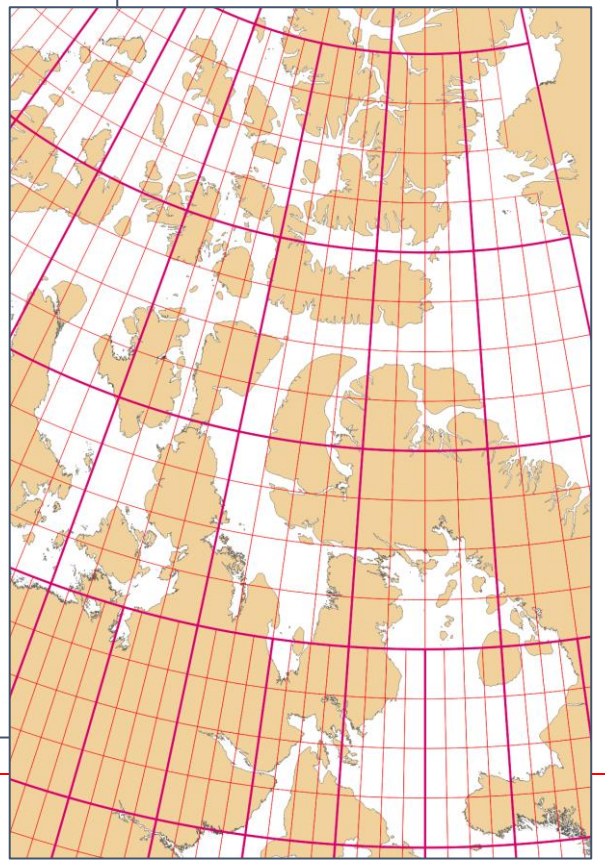
Essential Characteristics

- A set of tiles which tessellate a given area
- A number of subdivisions which divide the region into an increasing number of smaller extents
- Identifiers
- An origin

Grid Attributes

- Aligned along whole number degree boundaries
- Common boundaries between scales
- Well defined naming convention
- Regular (all cells same "shape")
- Complete (covers entire Area of Interest)
- Skew ("x" Factor between "height" and "breadth")
- Standards conformant
- Applicability outside navigation, e.g. MSDI
- Good "Cartographic suitability" – for compilation, distribution and use

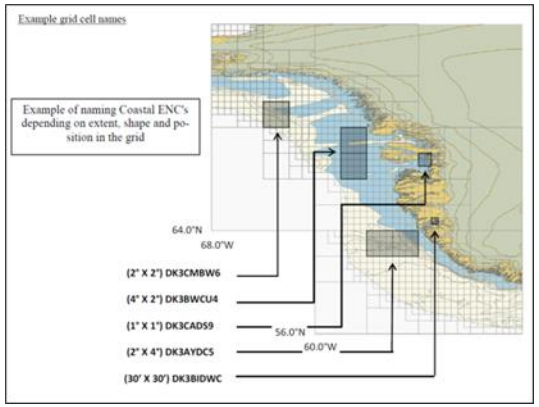


Regional Variations

- Analysis of members and associate members
- Wide variety of approaches, ages and details:
  - Norway – long established (S57 v2.0)
  - Denmark (Greenland) – documented, partially implemented
  - US – new, published, being rolled out.
  - Russian Federation – some gridding at small scales
  - Iceland – no grid
  - Italy – no grid
  - Finland – no grid

Level/usage	scales	Coverage of the arctic area south of 68N*	Coverage 68N to 80N	Coverage North of 80N
overview	< 1:150001	4° X 4°	8° X 4°	16° X 4°
transit	1:22001 to 1:150000	1° X 1°	2° X 1°	4° X 1°
Port	>1:22001	0.1° X 0.1°	0.2° X 0.1°	0.4° X 0.1°

Canada



Denmark(Greenland)

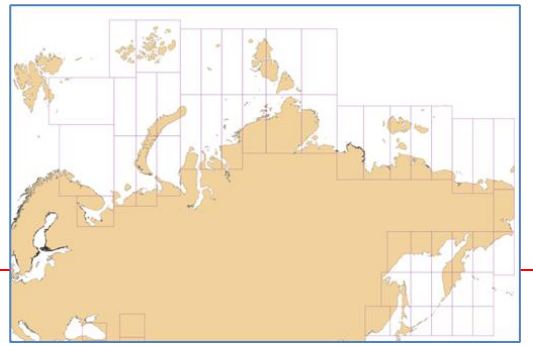
Table B.2 ENC Cell width dimension zones

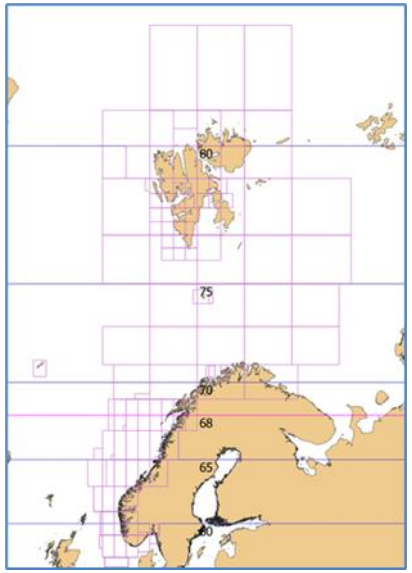
Zone	Latitude
III	64°N - 80°N
II	48°N - 64°N
	0° - 48°N

Scale band	Standard Scale (rounded)	Width	Height
Band 1	1:5,120,000	38.4	38.4
	1:2,560,000	19.2	19.2
Band 2	1:1,280,000	9.6	9.6
	1:640,000	4.8	4.8
Band 3	1:320,000	2.4	2.4
	1:160,000	1.2	1.2
Band 4	1:80,000	0.6	0.6
	1:40,000	0.3	0.3
Band 5	1:20,000	0.15	0.15
	1:10,000	0.075	0.075

US (NOAA)

RU





Norway

Proposals: Success Criteria

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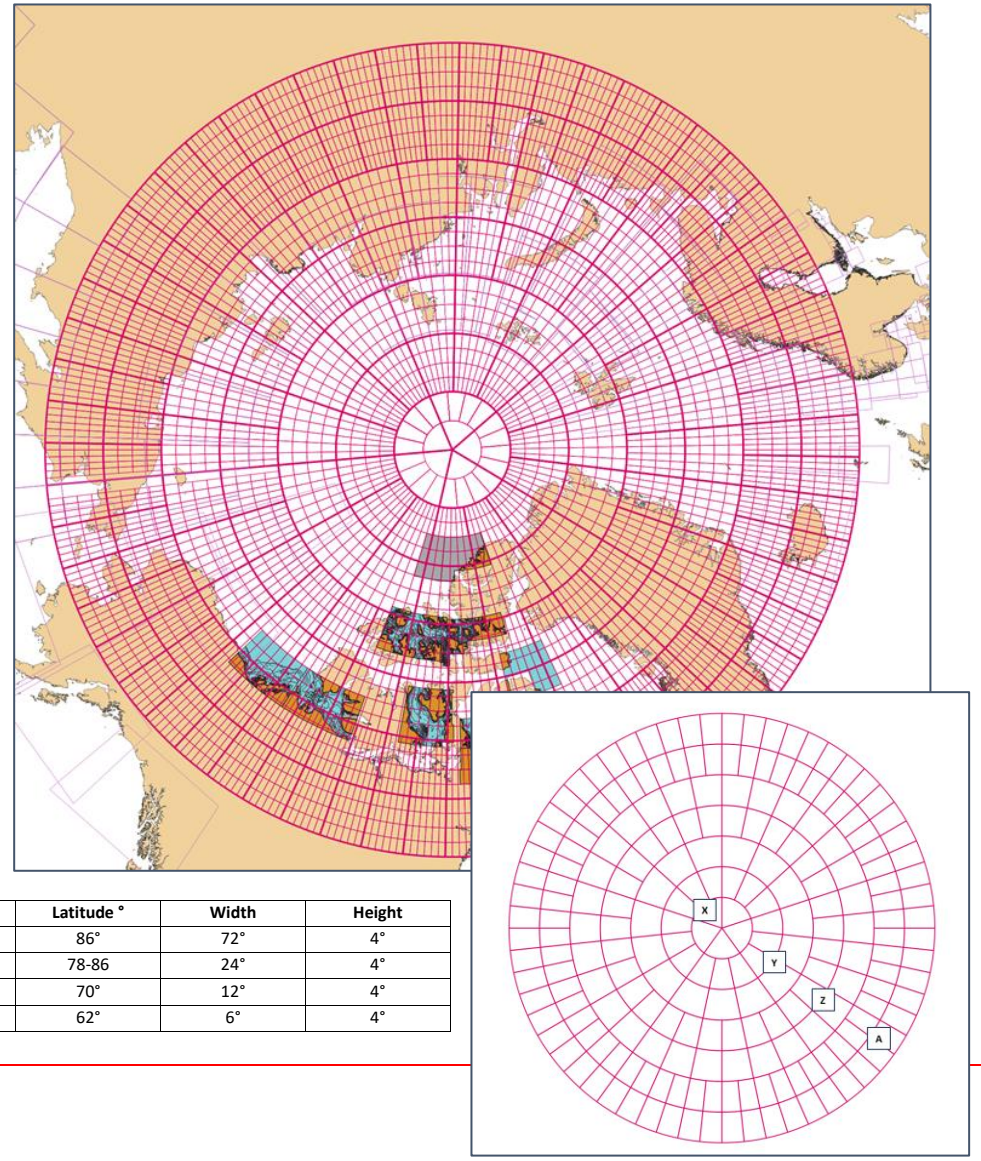
For a “Rectangular” grid

- Should be simple dimensions, whole number degrees or simple decimal or fractions. Reflects current practice of NO, DK and CA. Also RU charts in the region are whole number degrees
- Must cover entire region from -180 to +180 Longitude
- Subdivisions should ideally be simple fractions.
- The highest resolution is 0.1° (CA) or 0.125° (NO)
- Area and skew is kept under control by progressively doubling the breadth of cells at the same subdivision (CA, US, NO)
- Politically neutral. Needs have a neutral origin (the dateline is probably most appropriate)
- Subdivide around (but include) the pole – ENCs currently cannot include the pole itself.

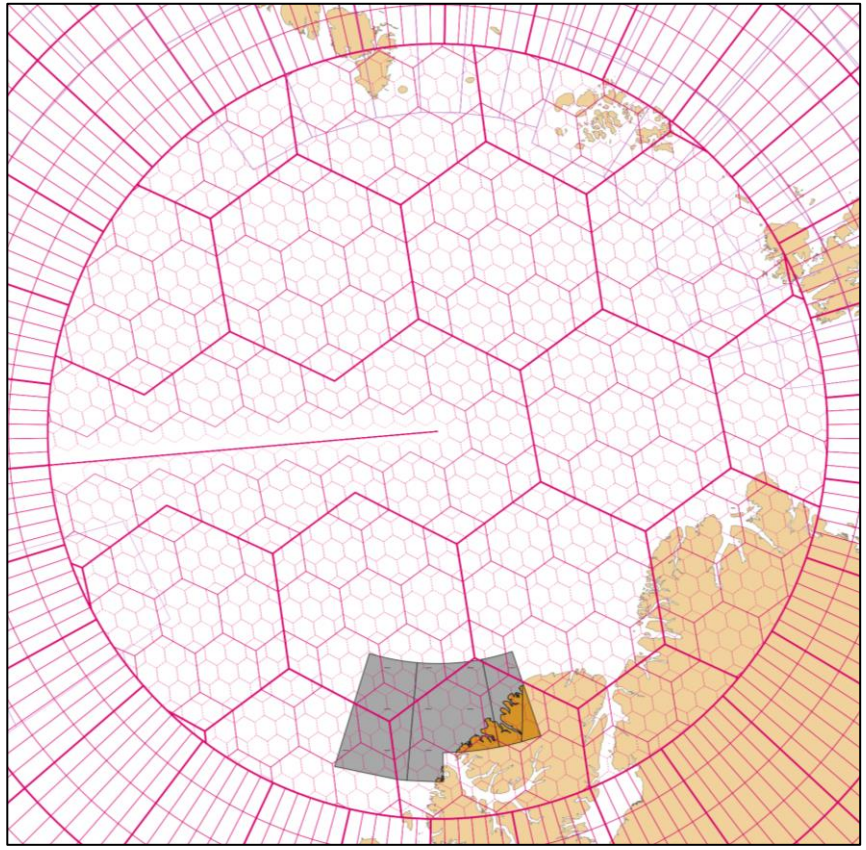


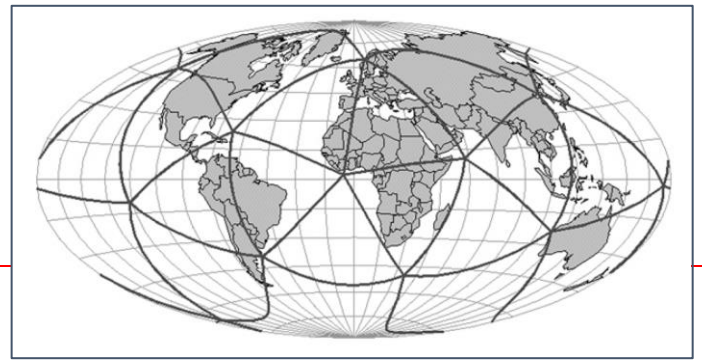
Zone	Latitude °	Width	Height
X	86°	72°	4°
Y	78-86	24°	4°
Z	70°	12°	4°
A	62°	6°	4°

The Other Option

A grid based on non-rectangular extents.

- Reduces the effect of skew at the pole
- Tiles with equal areas. Good for broader usages
- Standards conformant
- Uses public domain Algorithms and software DGGRID
- Three resolutions of hexagonal shaped cells.



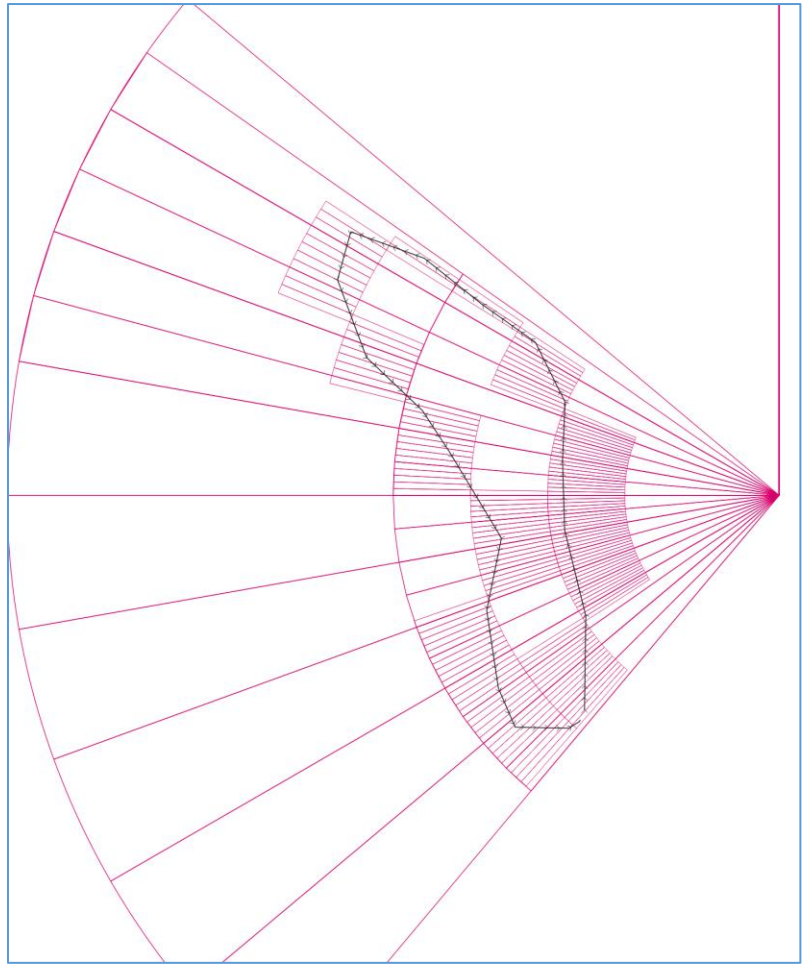


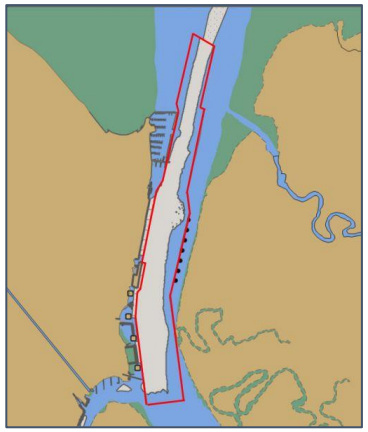
http://cs.sou.edu/~sahrk/dgg/pubs/gdggs03.pdf

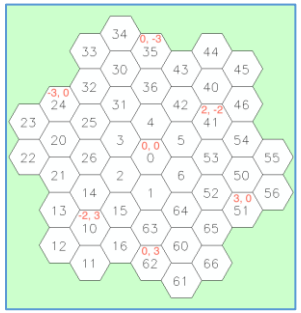
Why use Hexagons?

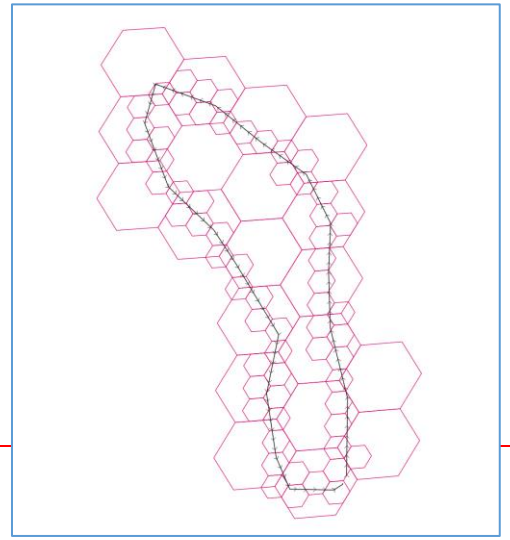
A grid based on non-rectangular extents.

- Example Route close to Pole
- Rectangular grids have high skew close to pole
- Issues with production and distribution
- Hexagon cells are regular (same shape) but more manageable for compilation and distribution
- Can be defined across the whole region without distortion









Irregular ENCs already exist…

Summary Hexagonal Cells - DGGS

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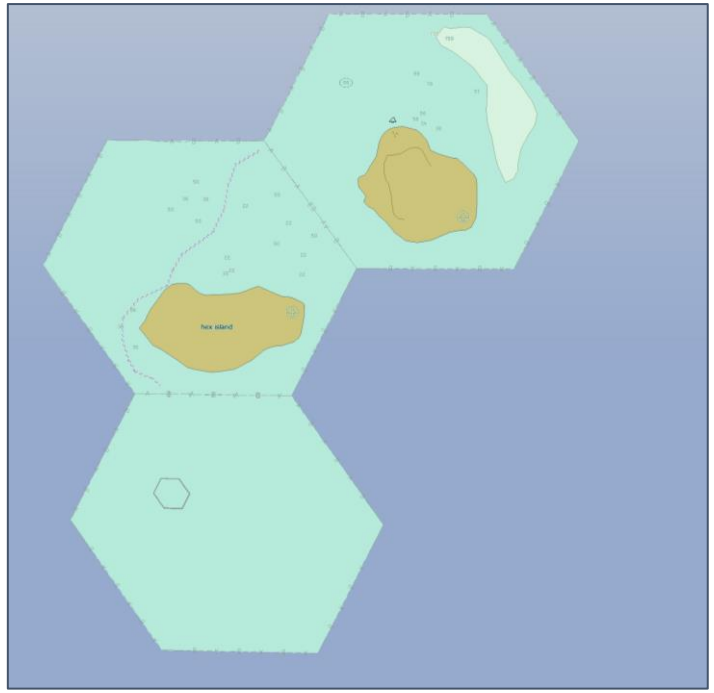
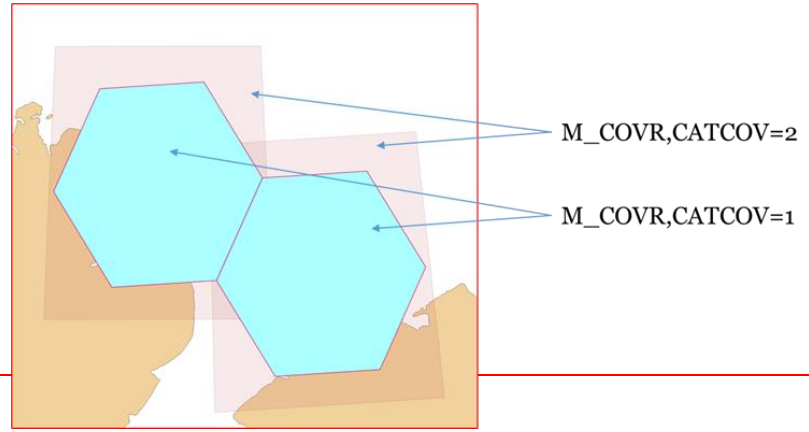
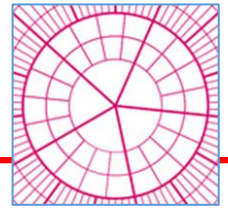
- Pros
  - Equal Area – Good for all uses
  - No skew by latitude, simple to specify, compile and use
  - Regular
  - Standards Conformant
- Cons
  - Grid isn't common at all boundaries
  - Has to be clipped to rectangular grid at limiting latitude





Middle Ground – rHealPix DGGS



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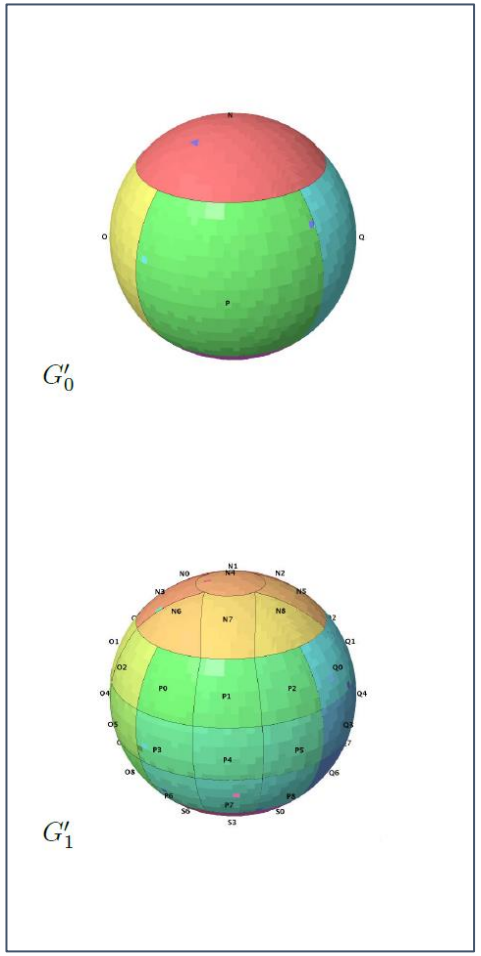
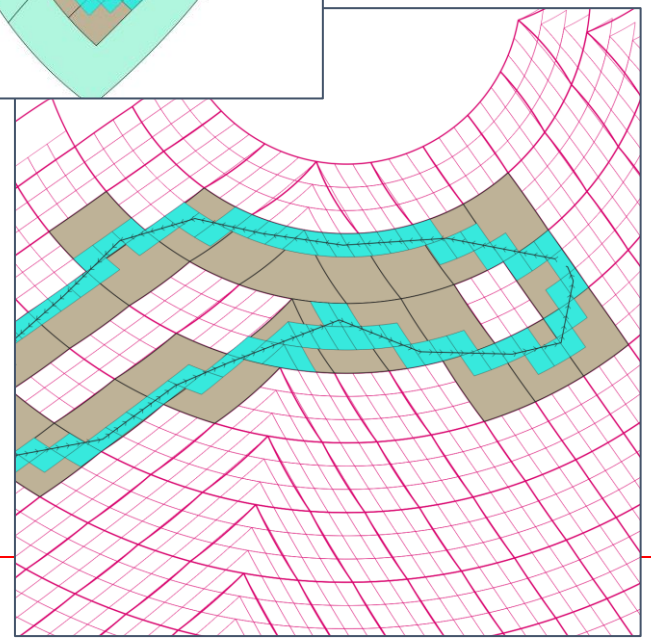
- Possible Middle Ground – rHealPix
- Derived from NASA HEALPIX grid (used for Astronomical grids) projected onto ellipsoid
- Consists of a Polar “cap” cell, quadrilateral cells and wedge shaped “dart” cells

- Pros
  - Equal Area
  - Minimal skew by latitude
  - Standards Conformant. Includes naming convention
- Cons
  - Not regular shapes.
  - Iso-latitude. No clipping





Summary

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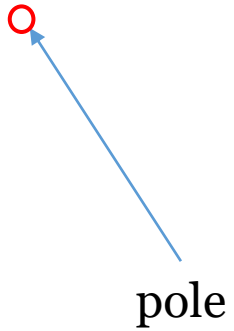
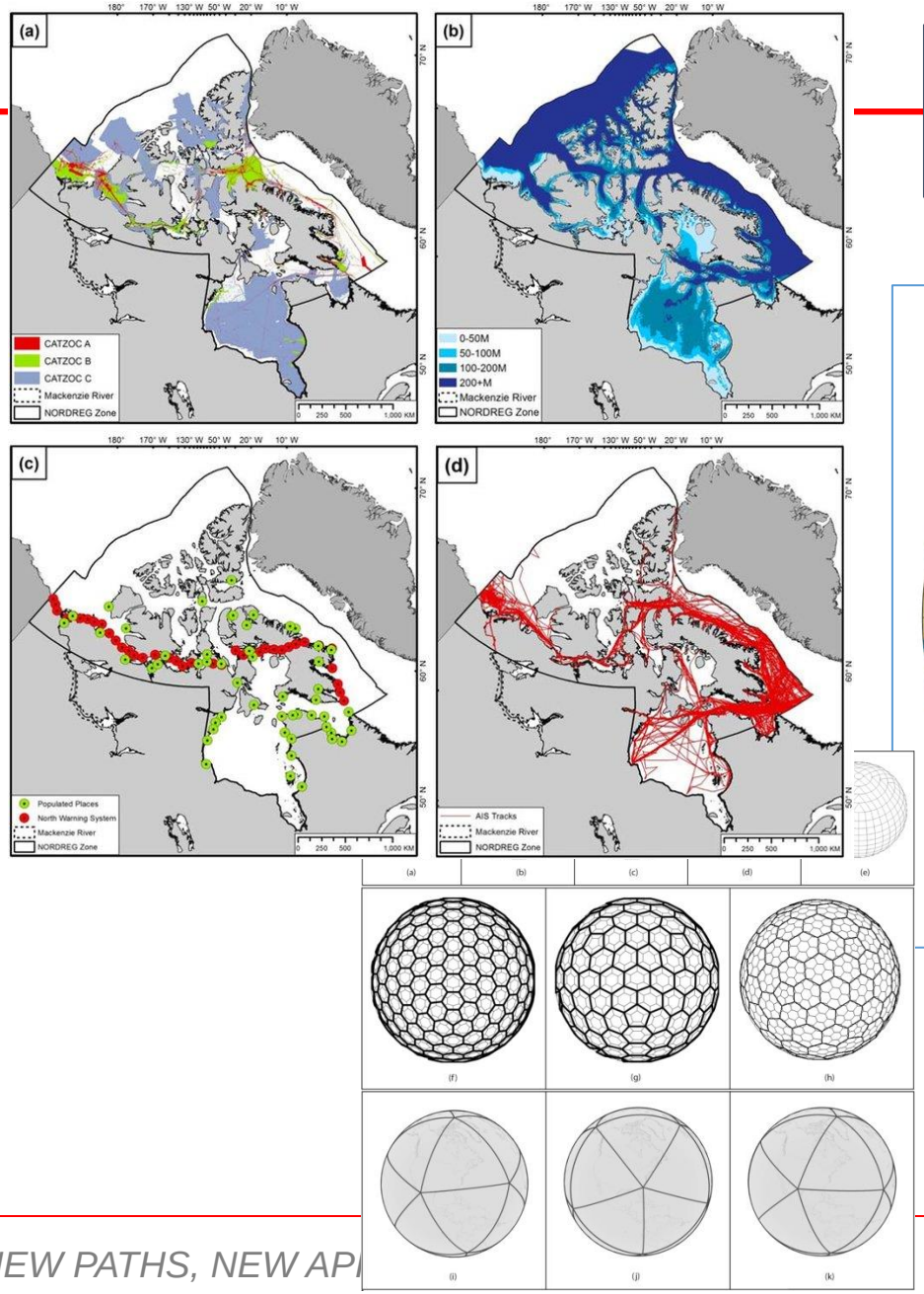
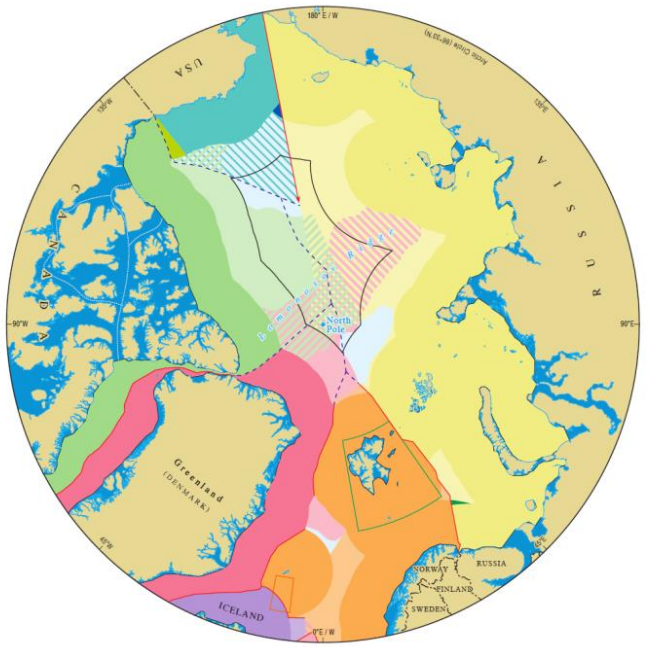
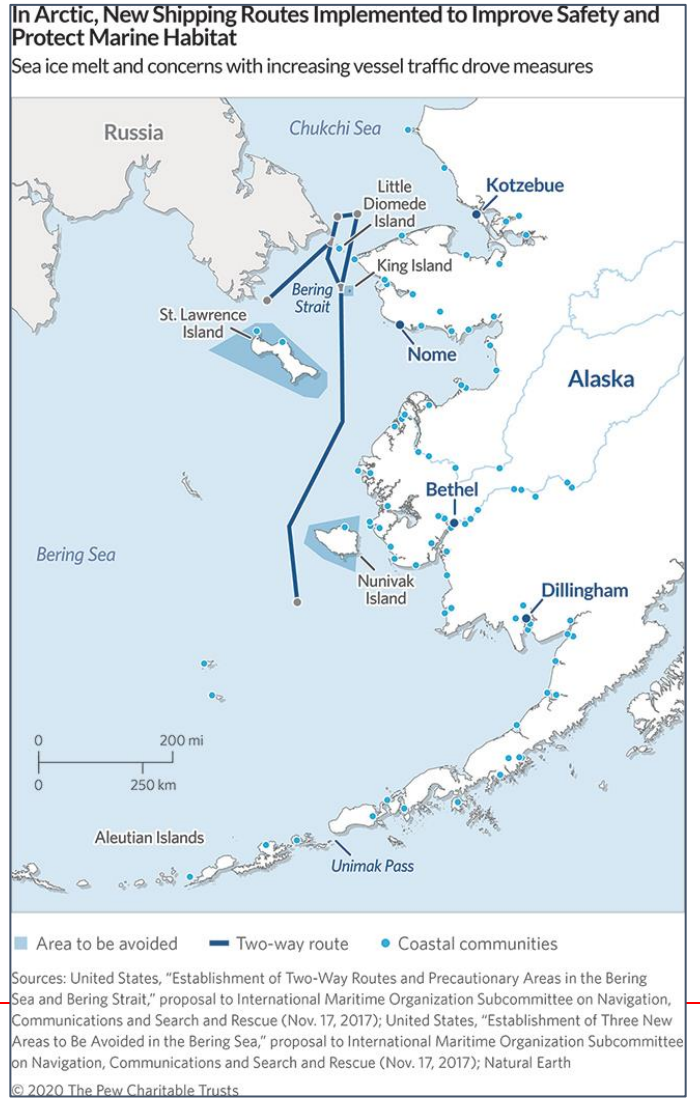
- There seems to be a good opportunity to propose regional cooperation via a grid scheme for the arctic region
- It requires negotiation over details to arrive at something optimal for all participants
- Scope should be defined first
  - Location Extents
  - Data Content
- Then grid specifications. Three options here in early stages
  - Regular rectilinear
  - DGGS Hexagon
  - DGGS rHealPix
- Next steps:
  - IIC is happy to release example implementations of grids in both geospatial and S-57 formats via Github site.
  - Include references, documentation and software links for generation
  - Possibility of producing some GEBCO grids
  - Given ENC data for region can also make sample cells
  - Workshop for interested parties culminating in a joint proposal??



Questions?


(a)
CATZOC A
CATZOC B
CATZOC C
Mackenzie River
NORDREG Zone
(b)
0-50M
50-100M
100-200M
200+M
Mackenzie River
NORDREG Zone
(c)
Populated Places
North Warning System
Mackenzie River
NORDREG Zone
(d)
AIS Tracks
Mackenzie River
NORDREG Zone


USA
Greenland
(DENMARK)
ICELAND
NORWAY
SWEDEN
FINLAND
RUSSIA
North Pole


In Arctic, New Shipping Routes Implemented to Improve Safety and Protect Marine Habitat
Sea ice melt and concerns with increasing vessel traffic drove measures
Russia
Chukchi Sea
Little Diomede Island
Kotzebue
King Island
Bering Strait
St. Lawrence Island
Nome
Alaska
Bethel
Bering Sea
Nunivak Island
Dillingham
0
200 mi
0
250 km
Aleutian Islands
Unimak Pass
Area to be avoided
Two-way route
Coastal communities
Sources: United States, "Establishment of Two-Way Routes and Precautionary Areas in the Bering Sea and Bering Strait," proposal to International Maritime Organization Subcommittee on Navigation, Communications and Search and Rescue (Nov. 17, 2017); United States, "Establishment of Three New Areas to Be Avoided in the Bering Sea," proposal to International Maritime Organization Subcommittee on Navigation, Communications and Search and Rescue (Nov. 17, 2017); Natural Earth
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