IIC TECHNOLOGIES

The Arctic Grid Project

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- Our Proposition: What is the case for adopting a predefined grid scheme for all marine geospatial data in the Arctic region?
- Background
  - Strategic rationale for Grids in general
  - Interlinks, WENDWG, IHO/S-100WG, OGC, MSDIWG, UN-GGIM
- How – The Grid Methodology
  - Conceptual foundation
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- Candidates
  - Rectilinear (built from”□”)
  - Non-Rectilinear
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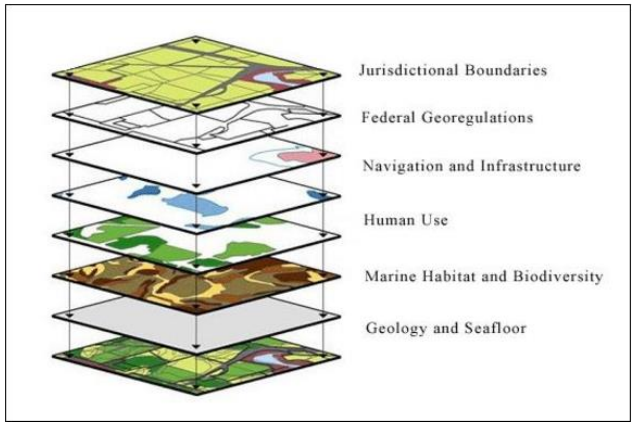
  - IHO
  - Others
- Promotion, through www.arcticgrids.com

Our Rationale

- Many S-100 implementations are adopting grids
- Essentially, a “Stack” of data argument.
  - Eases retrieval of multiple datasets
  - Multi-thematic by design
  - Promotes cross-sectoral working



- Replacement of manual chart schemes is a resource saving

- Note: Arctic has little existing coverage above 70°
  - So there is a minimum “migration” overhead

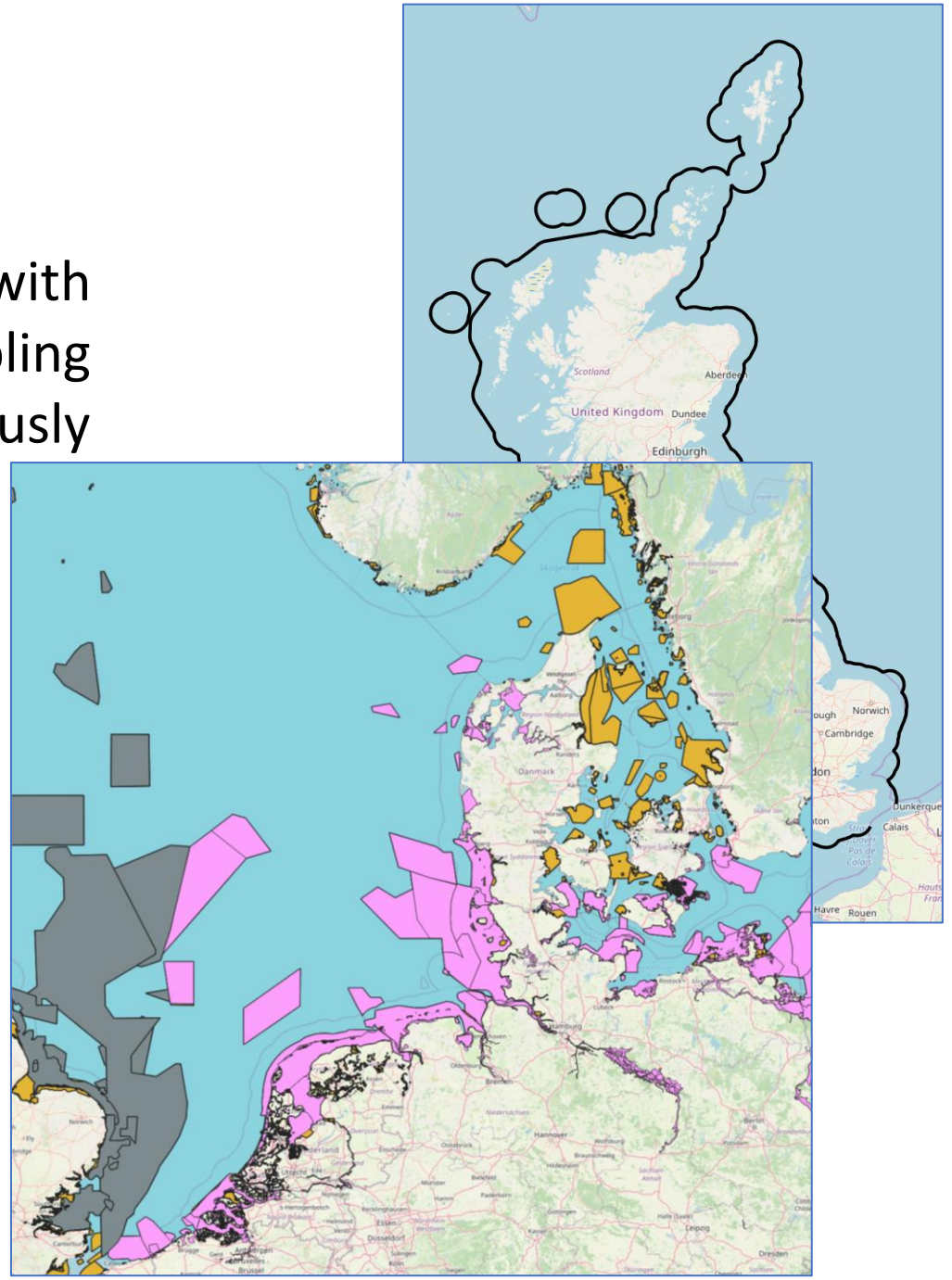
Links to broader domains

The IHO / **S-100** ecosystem is developing **links** with many international communities and enabling **interoperability** and **digitisation** of previously **disconnected** data sources:

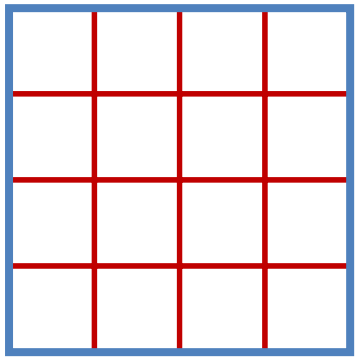
- Marine Spatial Planning
- Marine Geo-Regulation and Marine Protected Areas
- Maritime Limits and Boundaries
- UN Sustainable Development Goals
- Scientific and Environmental Data Collection

Through:

- MSDIWG
- OGC
- UN-GGIM / IGIF-Hydro

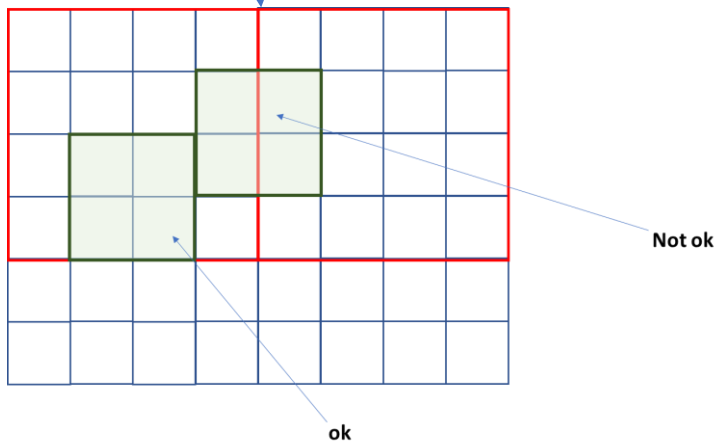


How Grids Work…



- A grid is a set of one or more spatially disjoint systems of overlapping regular structures (“cells”) which tile regions of the earth without gaps.
- A grid scheme should be capable of providing any part of the chosen region with coverage, even if the defined coverage is not used

- **A Grid consists of:**
  - **An origin**
  - **A set of subdivisions of the space.**
  - **Subdivisions “divide” the space into progressively smaller pieces, called “cells”**
  - **Normally, a naming convention is defined which uniquely identifies each cell.**
  - **Each cell does not cross the boundary of the smaller scales**



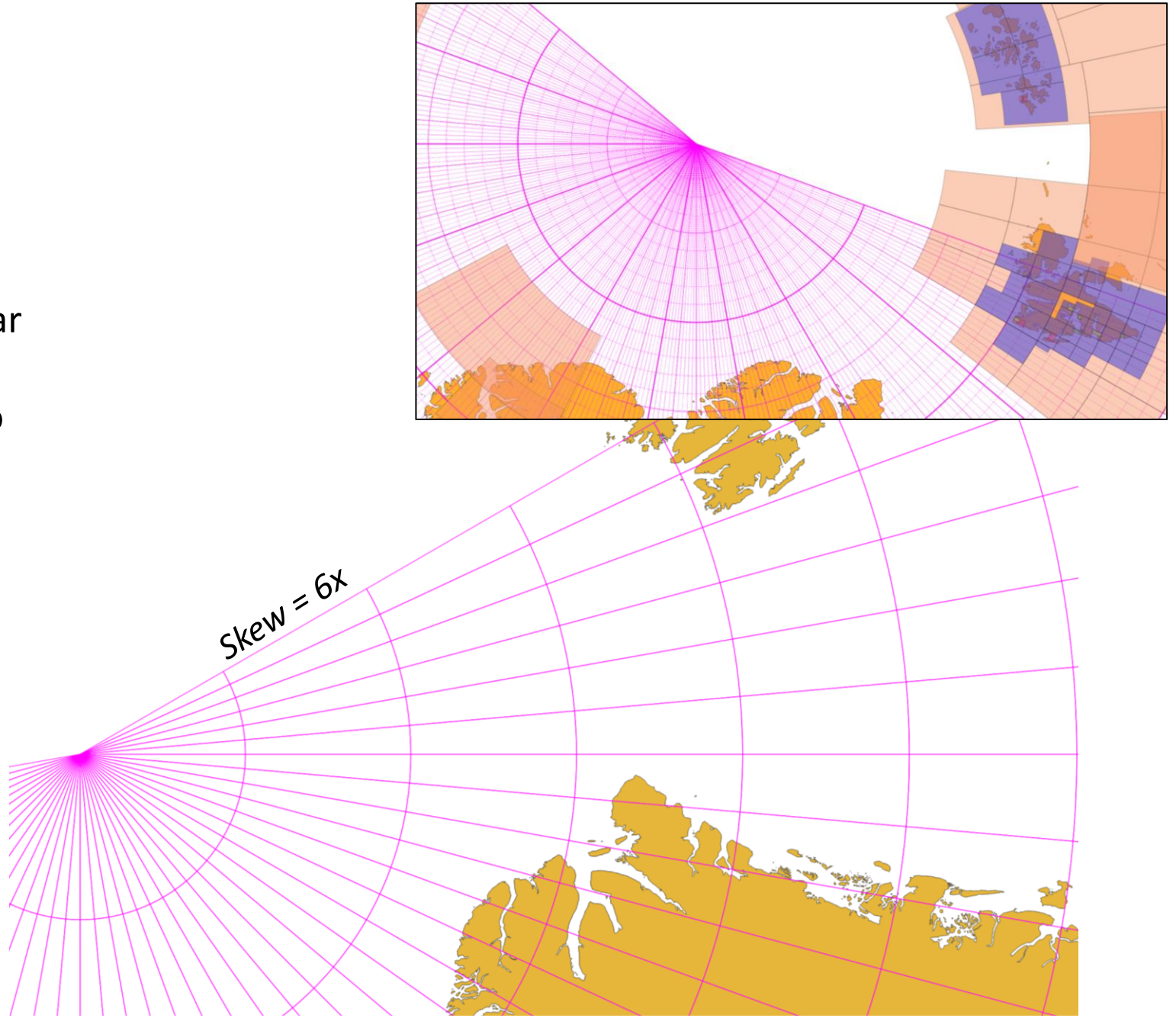
- “Realisations” of grid systems **then** map each of the subdivisions to data “products”.
  - Cells can be aggregated as long as they don’t break the common boundaries with smaller scale subdivisions

- So, the grid system itself exists independently of the implementing products.

Can’t we just come up with a simple, regular, angular, grid scheme?

The main problem with square/rectangular cells is “skew” – the tendency for regular cells (because they’re measured with °) to be elongated the closer they get to the poles.

Big impact on ENC production and numbers if dimensions and subdivisions are regular

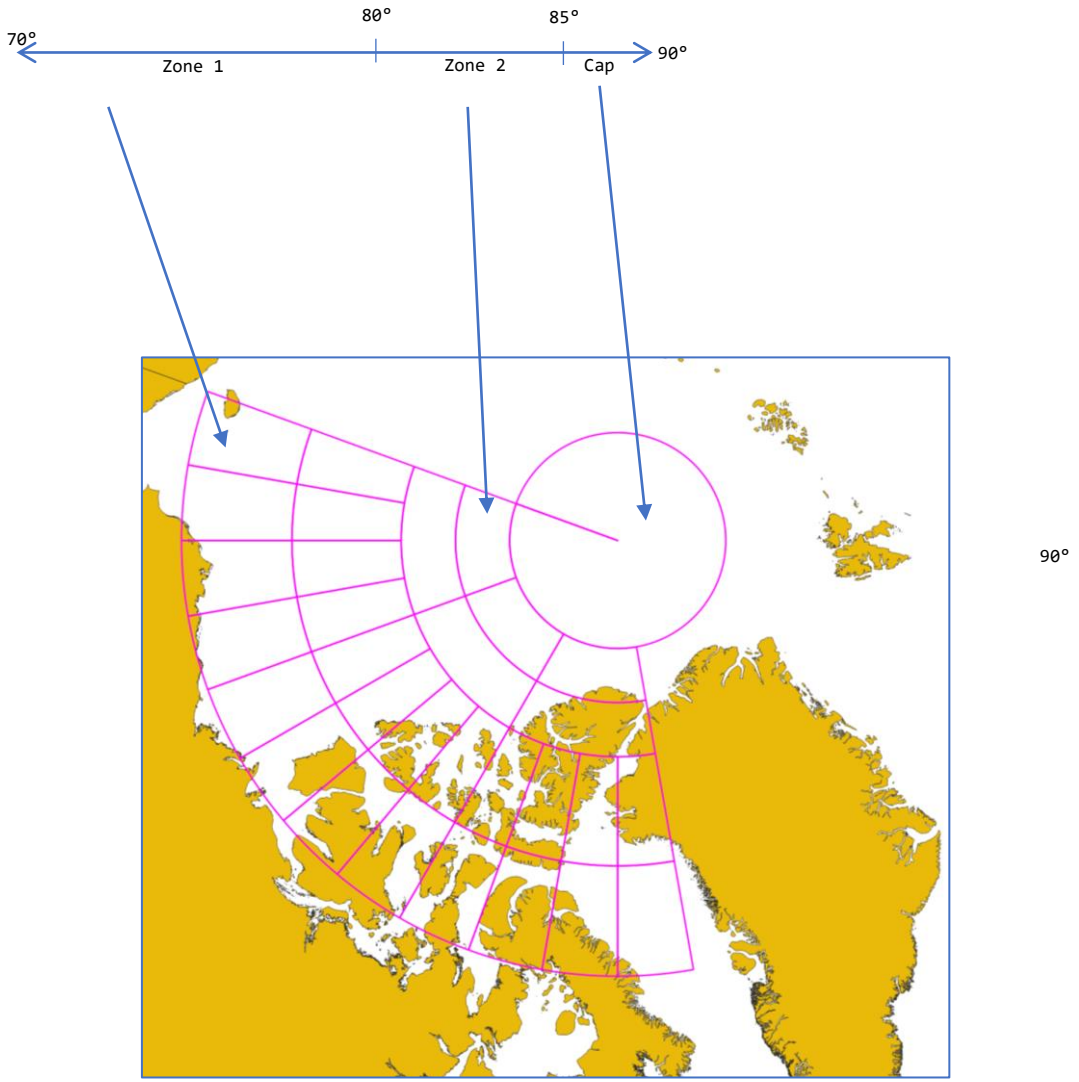


To combat the effects of skew, the candidate grids have three zones:

1. Polar cap, the zone including the pole itself
2. Z_1 “lower” Arctic
3. Z_2 “upper” Arctic

- Each zone has different (related) dimensions. Cells are broadened to account for the skew as we approach the pole

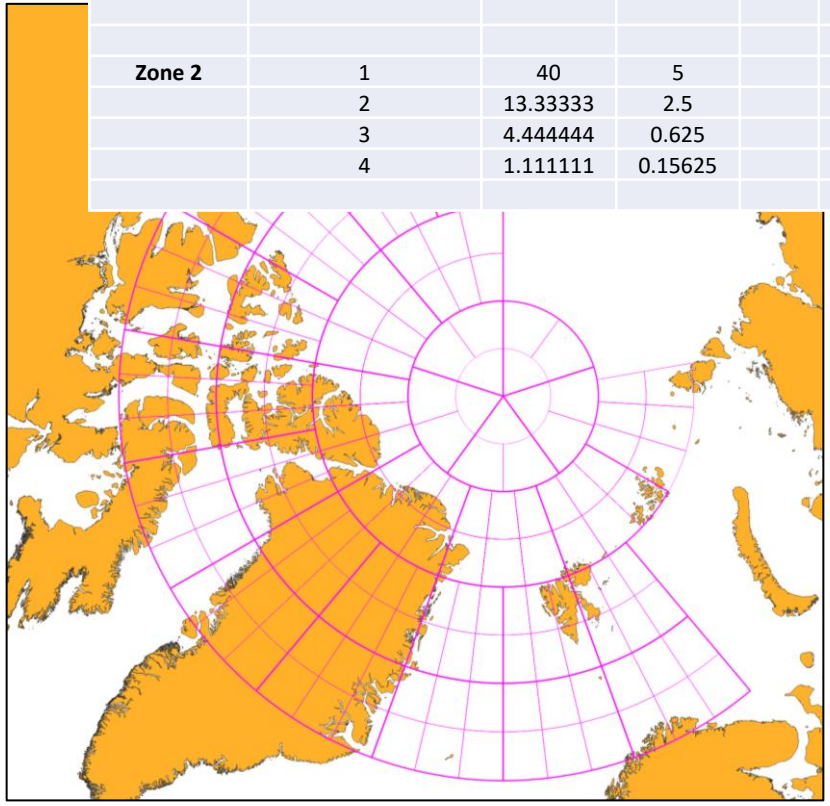
- Dimensions and latitudes are all adjustable



Grid Details – Two rectilinear candidates

G_1

Zone	Subdivision	Dimensions			
		Width	Height	Cols	Rows
Cap	1	72	5	5	1
	2	14.4	2.5	2	2
Zone 1	1	20	5	3	2
	2	6.666667	2.5	3	4
	3	2.222222	0.625	4	4
	4	0.555556	0.15625		
Zone 2	1	40	5	3	2
	2	13.33333	2.5	3	4
	3	4.444444	0.625	4	4
	4	1.111111	0.15625		



Skew = 1.2x

G_2

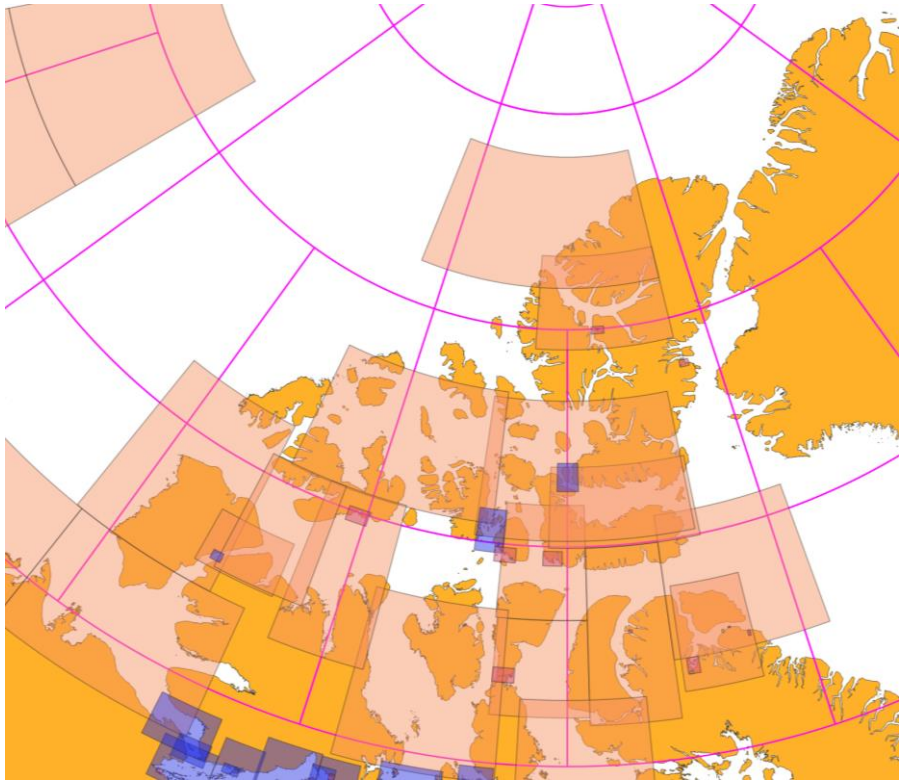
Zone	Subdivision				Multiplier	
		Width	Height		Cols	Rows
Cap	1	72	5		5	1
	2	14.4	2.5		2	2
Zone 1	1	18	5		3	2
	2	6	2.5		3	4
	3	2	0.625		4	4
	4	0.5	0.15625			
Zone 2	1	36	5		3	2
	2	12	2.5		3	4
	3	4	0.625		4	4
	4	1	0.15625			

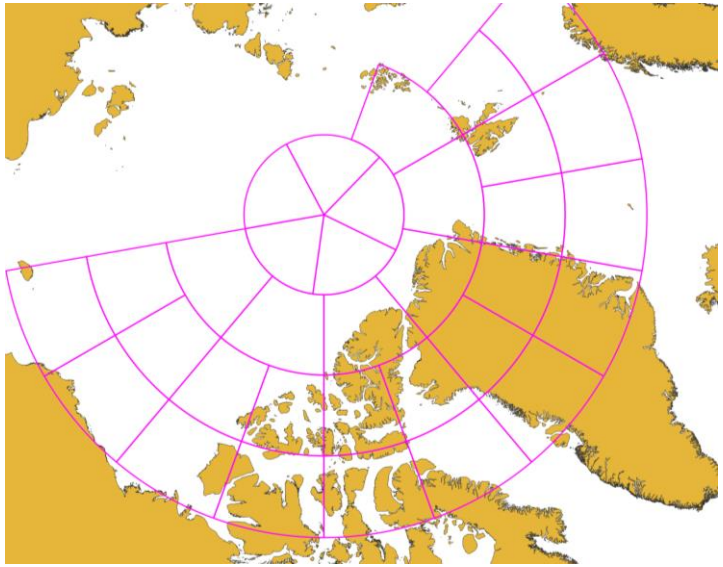
How did we come up with the two candidate grids?

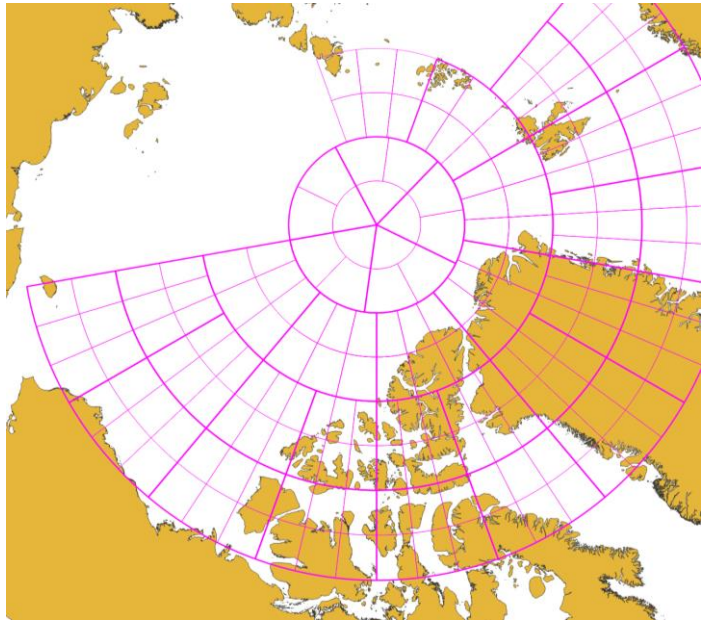
Consideration of existing chart coverage in the region

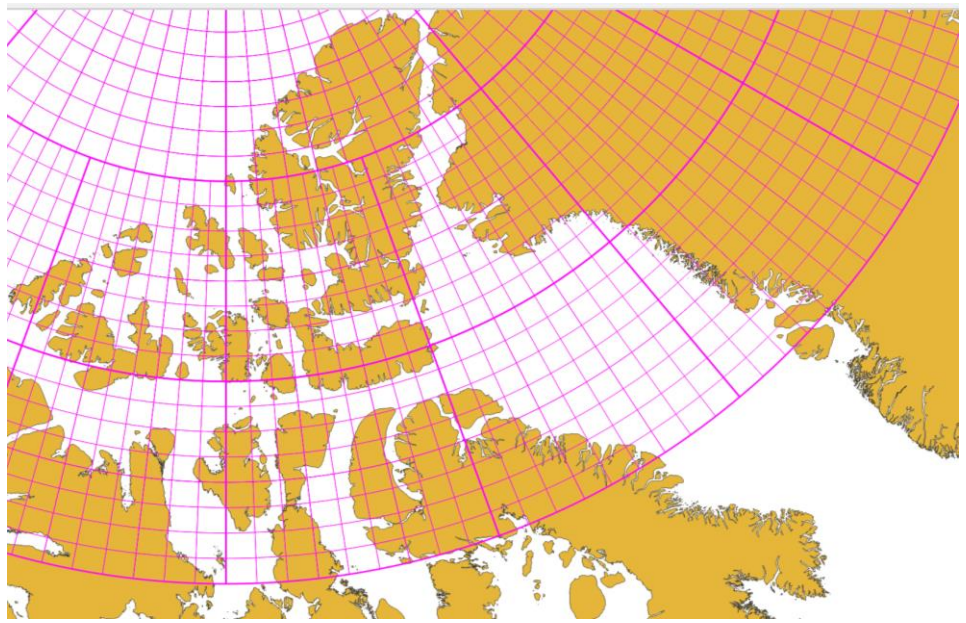
Balance between the “fit” of chart coverage and simple fractional dimensions (¼° vs 0.6666°)

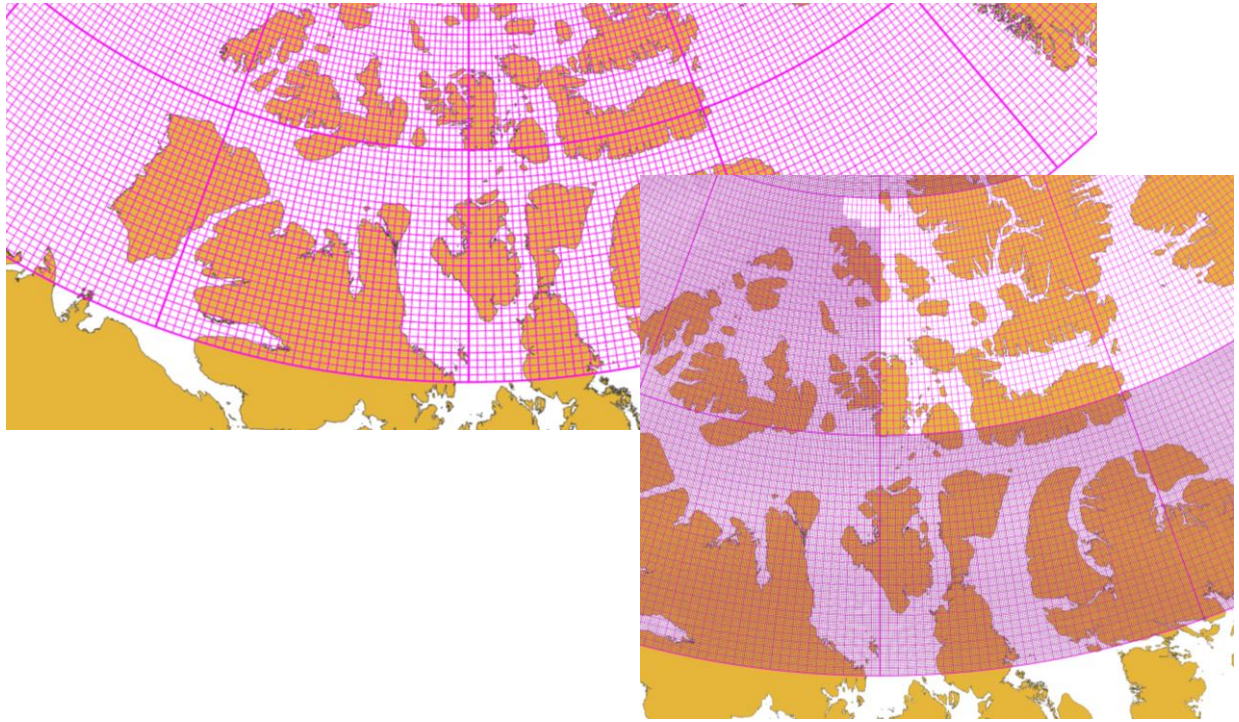
We can also overlay existing data (ENC) content on the grid and establish how many cells are generated











Zone	Subdivision	Dimensions			Cols	Rows
		Width	Height			
Cap	1	72	5		5	1
	2	14.4	2.5		2	2
Zone 1	1	20	5		3	2
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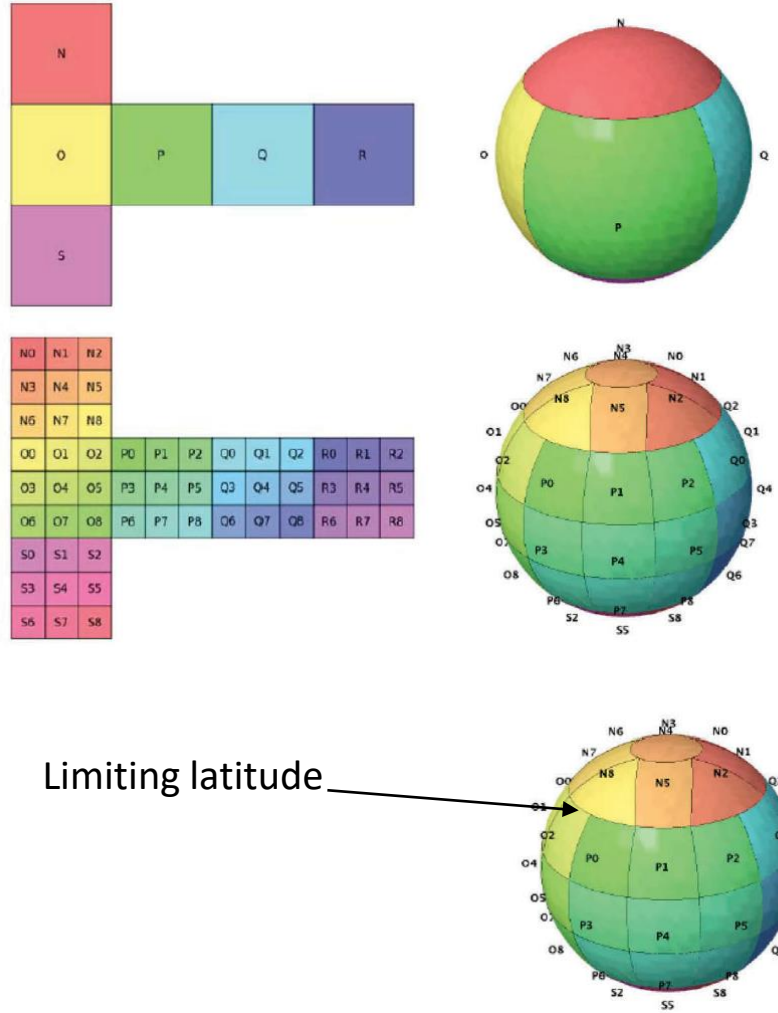
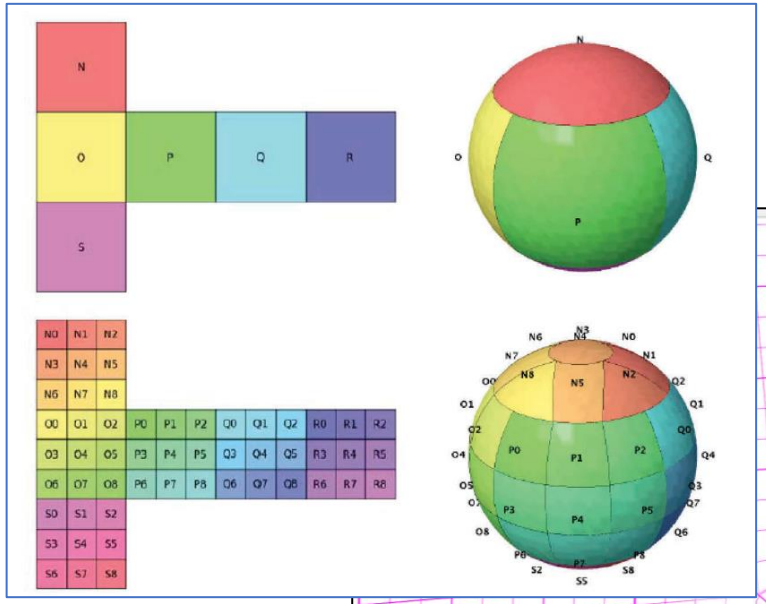
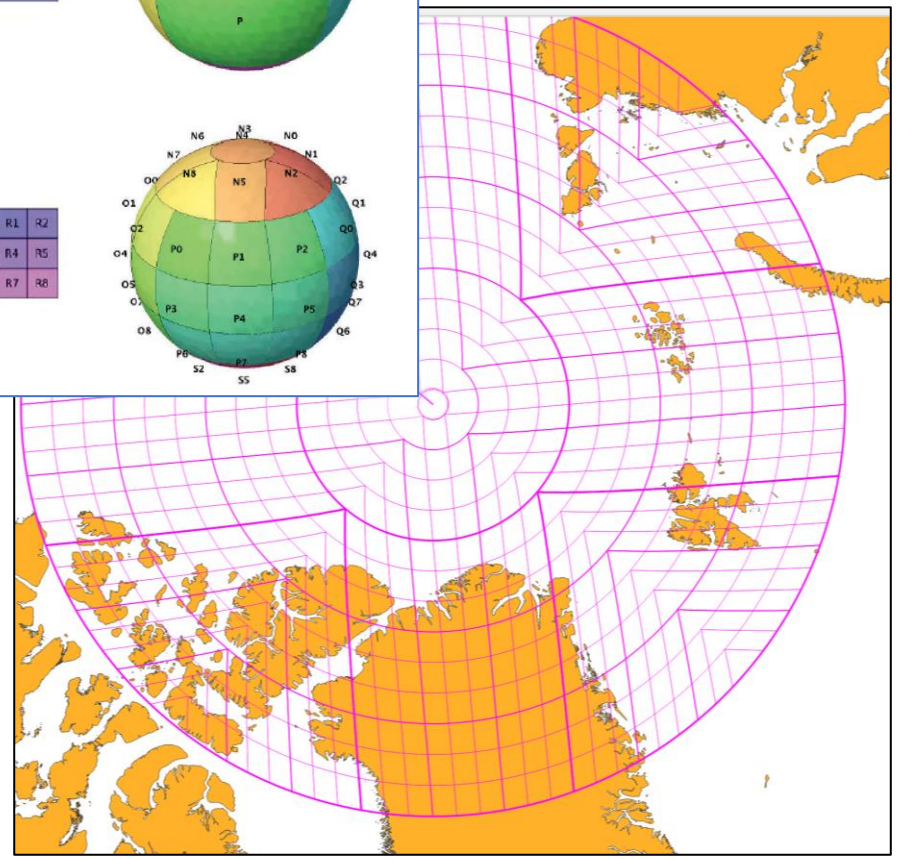
- We also have an OGC *Discrete Global Grid System* (DGGS) candidate
- “rHealPix” DGGS (developed in Australia)
- Previous DGGS research has looked at hexagonal grids
- rHealPix has an “isolatitude” property – cells have a common latitude. Makes interface with existing regions much easier
- **As a DGGS:**
  - **Cells are regular shapes**
  - **Have an existing naming scheme**
  - **Cells in each subdivision have equal area**
- Scores very highly for interoperability with Scientific, OGC and cross-sectoral data uses

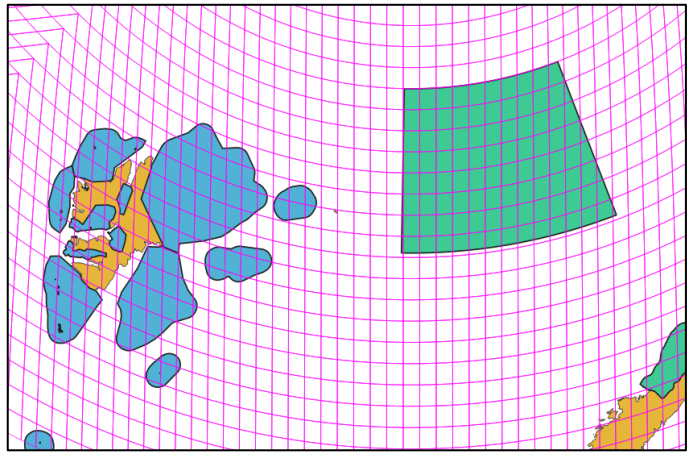


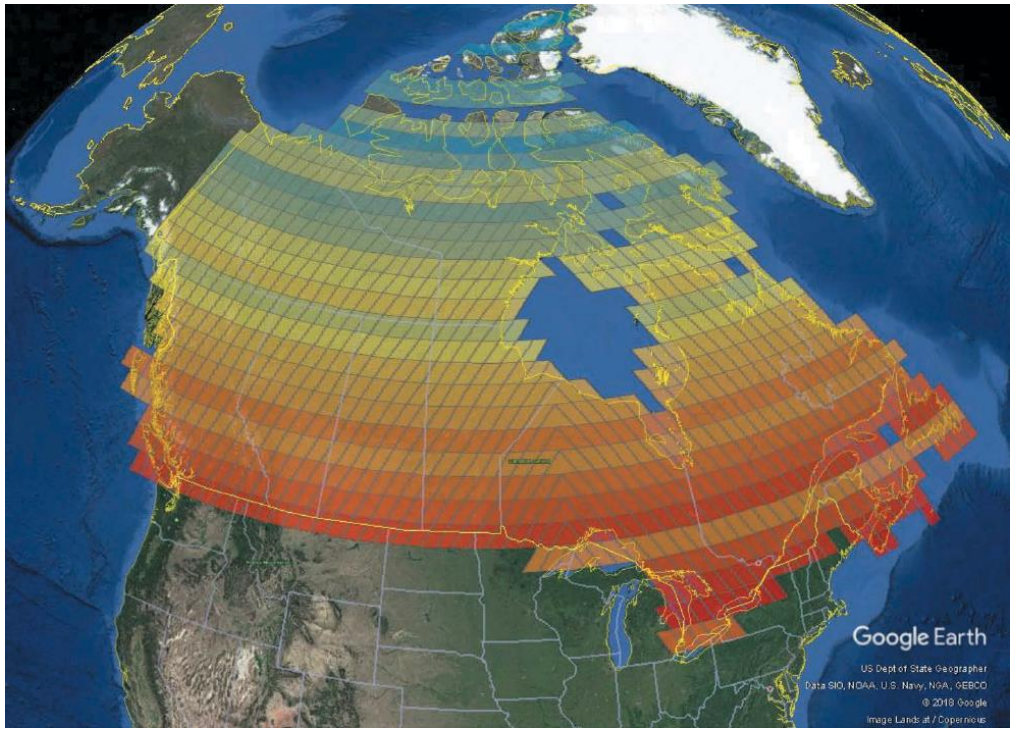
- The DGGS system selected has an unlimited number of subdivisions.
- Three shapes make up each subdivision
- Predefined naming scheme
- All cells in each subdivision are equal area
- Common borders
- Limiting latitude property

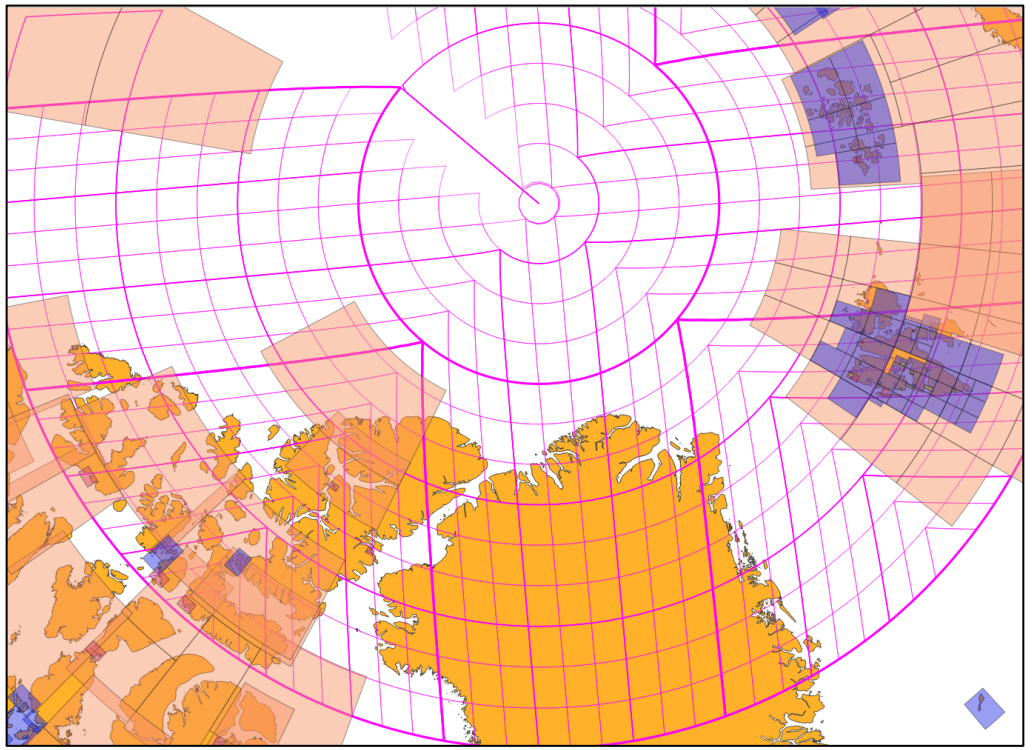




1. There is a great utility for non-navigational, scientific and environmental datasets from using a DGGS for coverage
2. The equal-area property facilitates geo-processing, statistics and routing
3. DGGS eliminates skew and coverage issues caused by measurements in degrees close to the pole



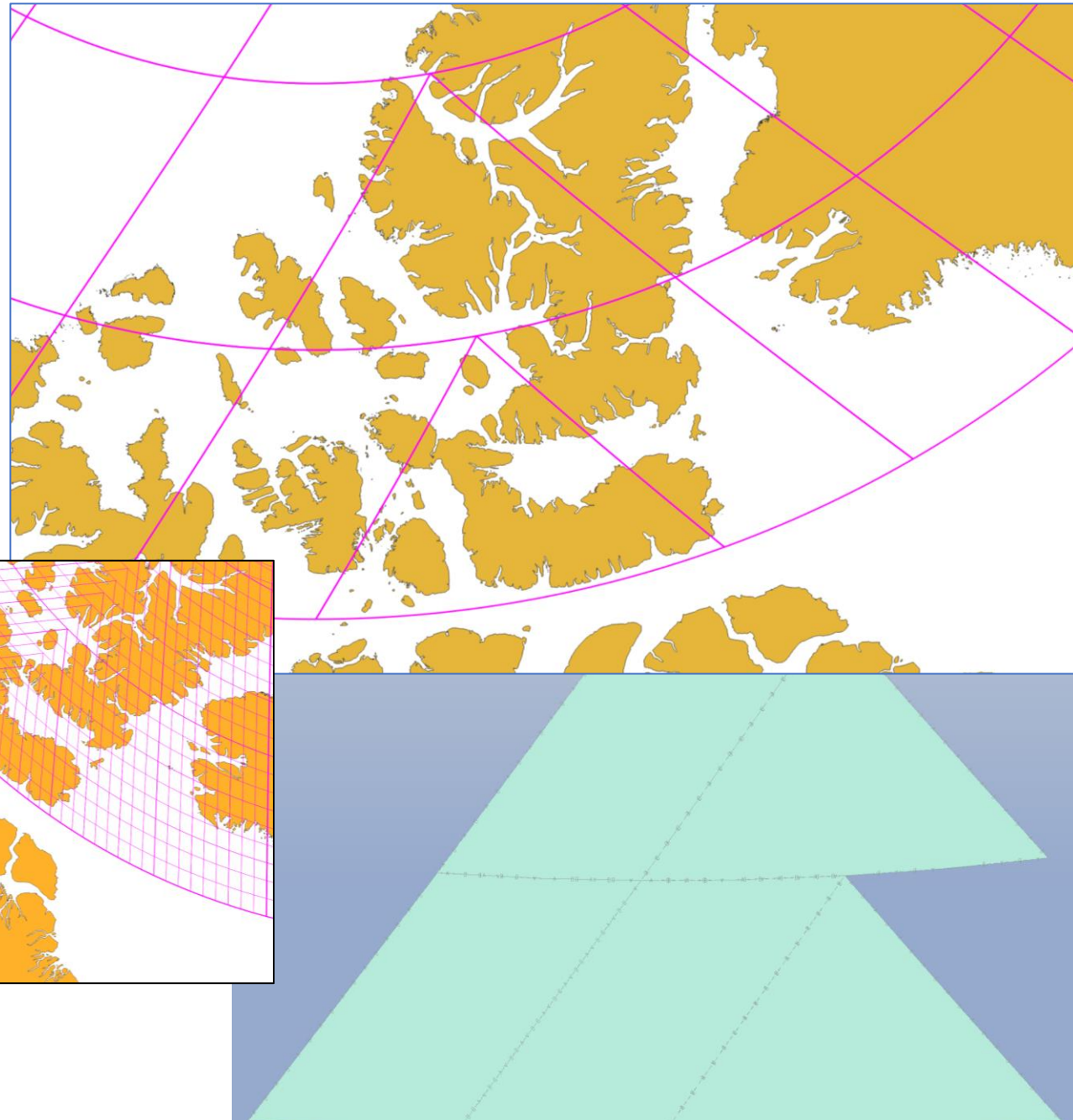




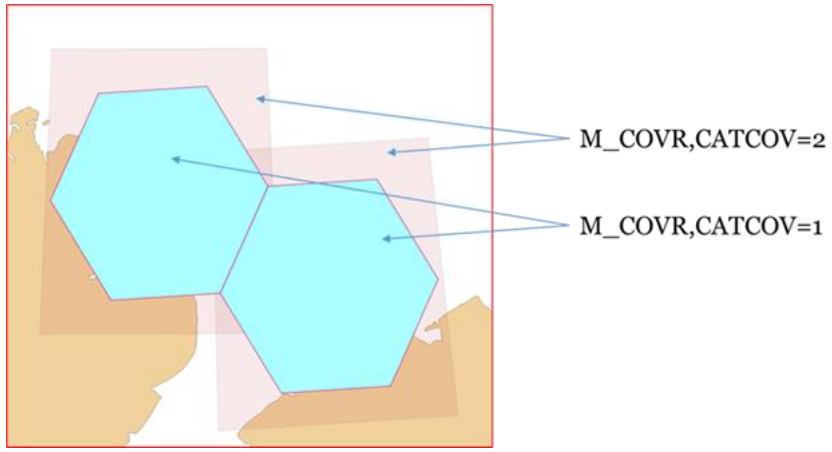
(Yes, you can make ENCs from DGGS cells!)

Advantages of DGGS approach

- No skew effects
- Resolutions are unlimited
- Predefined naming scheme
- All cells are equal area at each subdivision.



Irregular ENCs conform to S-58 if surrounded by M_COVR with CATCOV=2



Arctic Grids website

www.arcticgrids.com

- Contains much of the information presented here
- Downloads of grid data
- Example datasets, ENC (S-57 and S-101), S-122 (MPA), others.
- FTP site
- OGC Web services
- Aim is to encourage participation