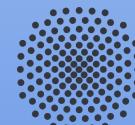


Mapping a cargo ship network to detect tsunamis

Internship supervisor: Bruce Thomas

Intern: Tasnîme-Jenna Louartani

September 2022



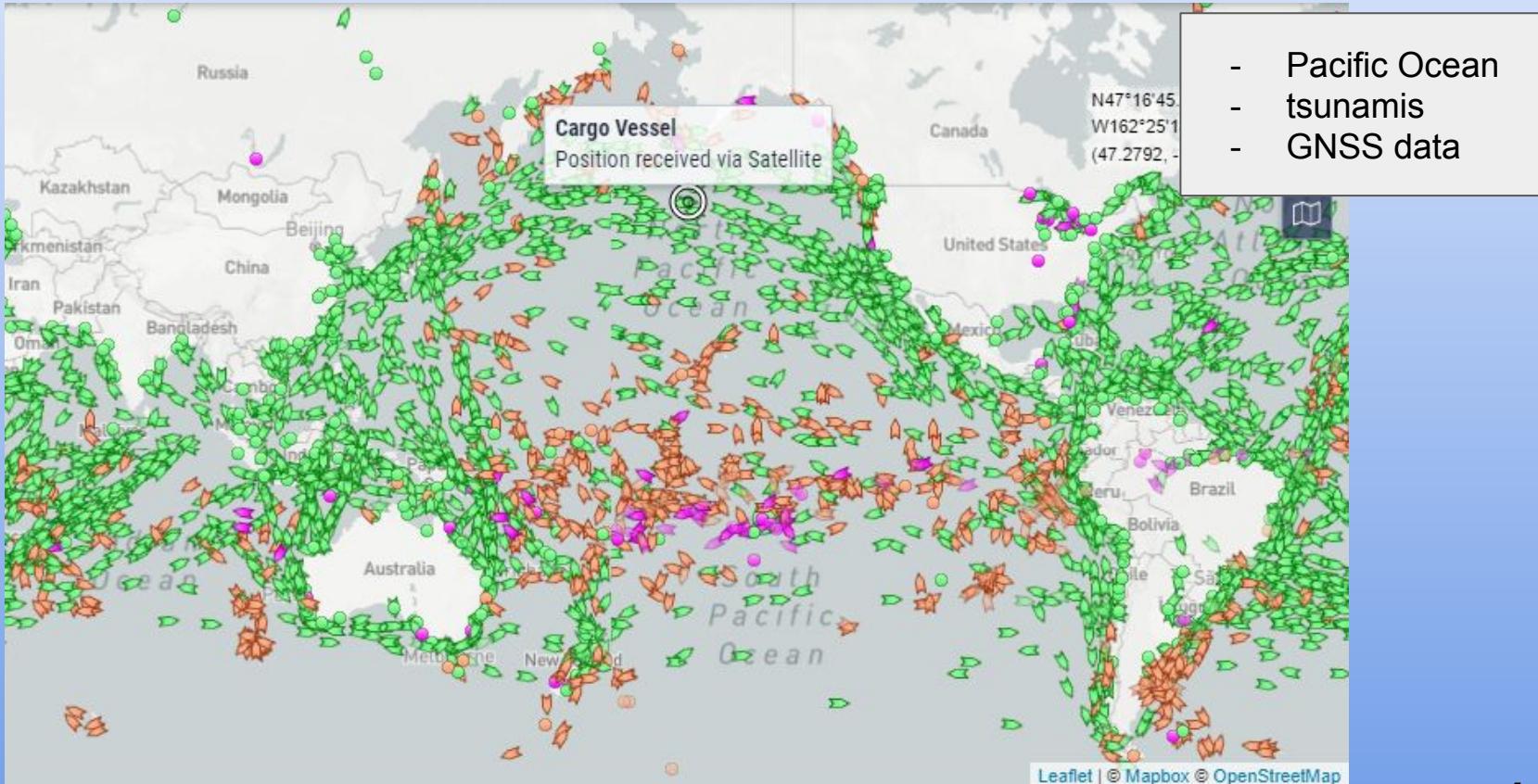
Universität Stuttgart

Summary

- 1) Project Context
- 2) Data and IT Support
- 3) Methodological aspect: Setting up the maps
- 4) Results and Analysis
- 5) Conclusion and Discussion

PROJECT CONTEXT

Project Context

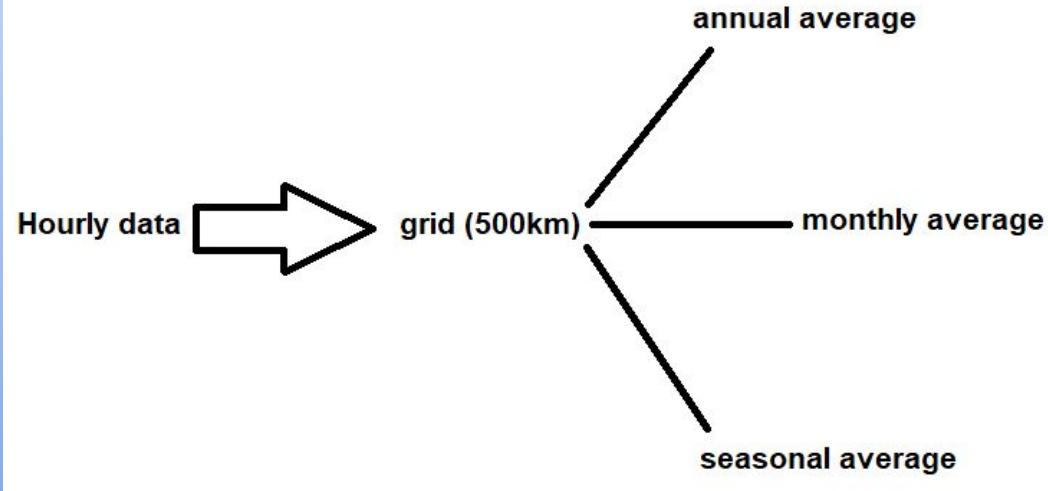


Project Context

To map a *cargo ships network* in order to determinate the relevance of monitoring certain ships to *improve tsunami warning systems*

Requirements Specification

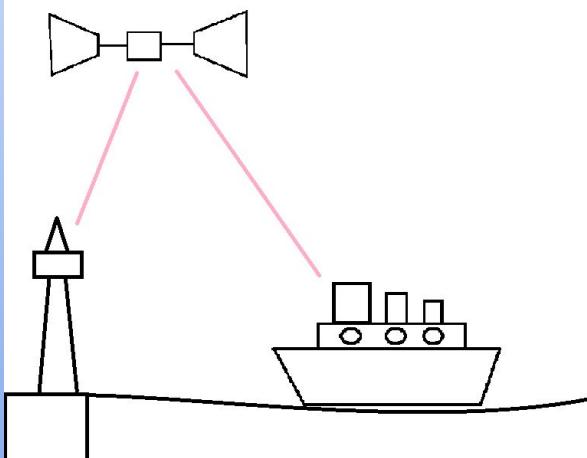
- Hourly average
- Color code
- Different criteria



Data and IT Support

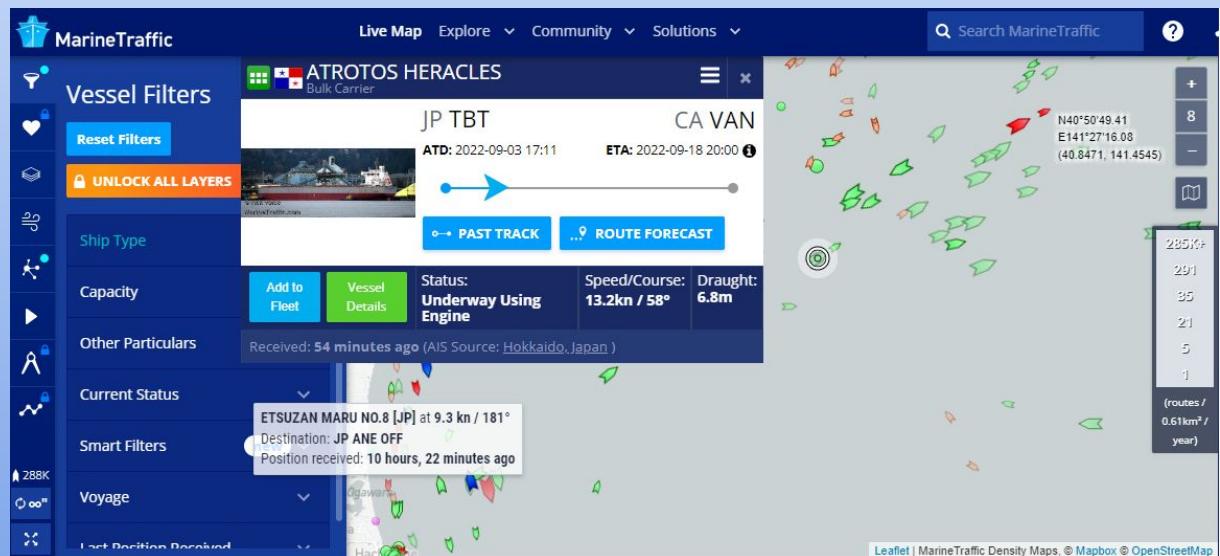
Data and IT Support

Data



Automatic Identification System (AIS) data :

- **navigation data**
- received by **terrestrial stations** and by **satellites**



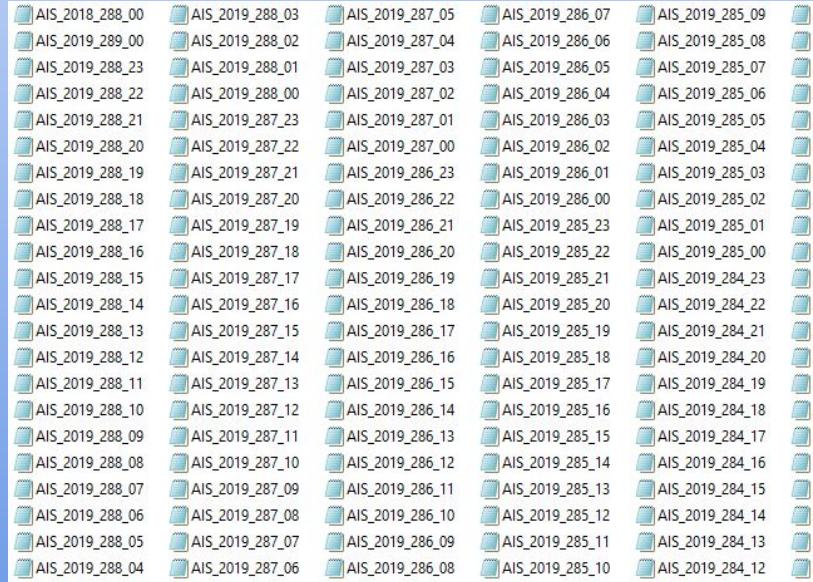
Data and IT Support

Data

AIS_2018_288_02_blo...		X
Fichier	Modifier	Affichage
269.87440	10.63035	
271.74075	11.26907	
269.92608	11.18187	
272.58283	10.98467	
272.83125	12.47944	
271.80723	9.98987	
268.75749	9.63824	
272.18134	13.33366	
272.10417	10.85080	
273.00509	9.54604	
269.62378	12.05851	
269.71215	11.48225	
270.01043	11.85873	
269.71310	13.02288	
268.72086	9.93550	
270.02450	11.74335	
268.63720	10.12613	
271.47534	10.13215	

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

- Dynamic information : **longitude and latitude**
- **8760 files for 1 year (365*24)**

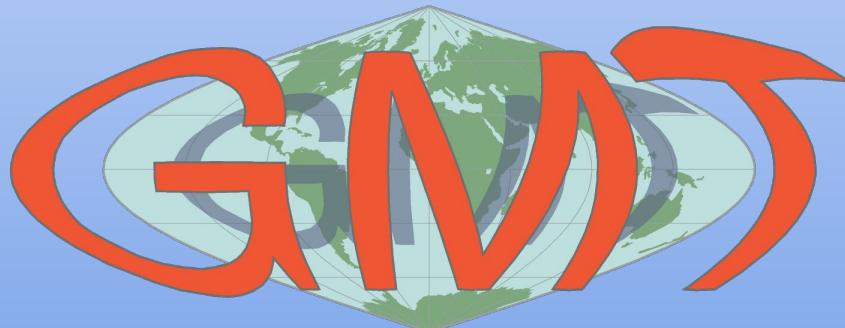


Data and IT Support

IT Support



Windows



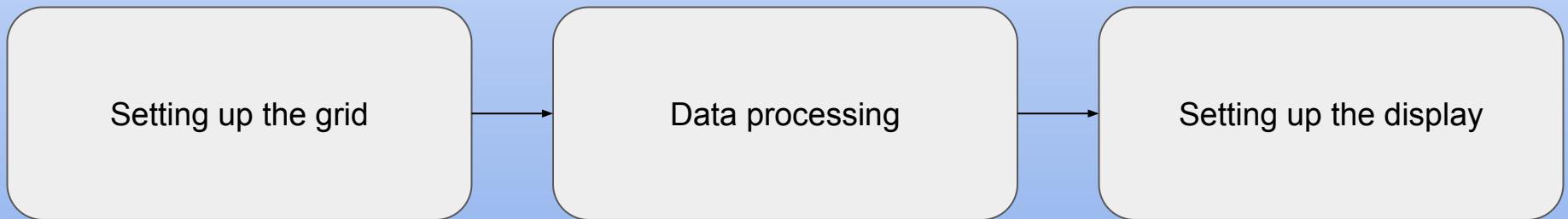
THE GENERIC MAPPING TOOLS

PyGMT

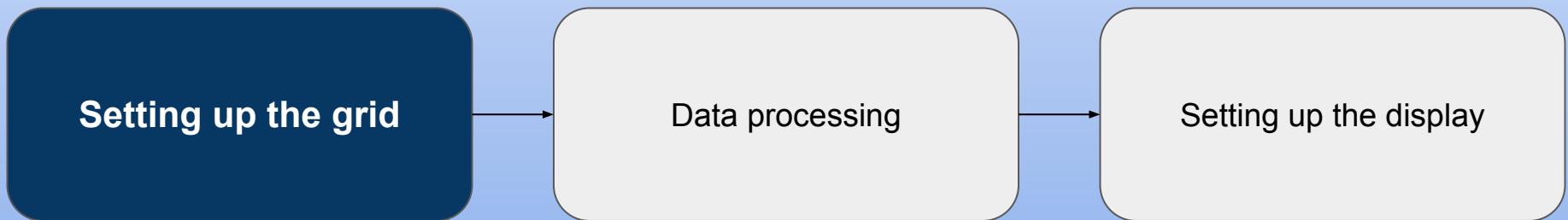


Methodological aspect : Setting up the maps

Methodological aspect

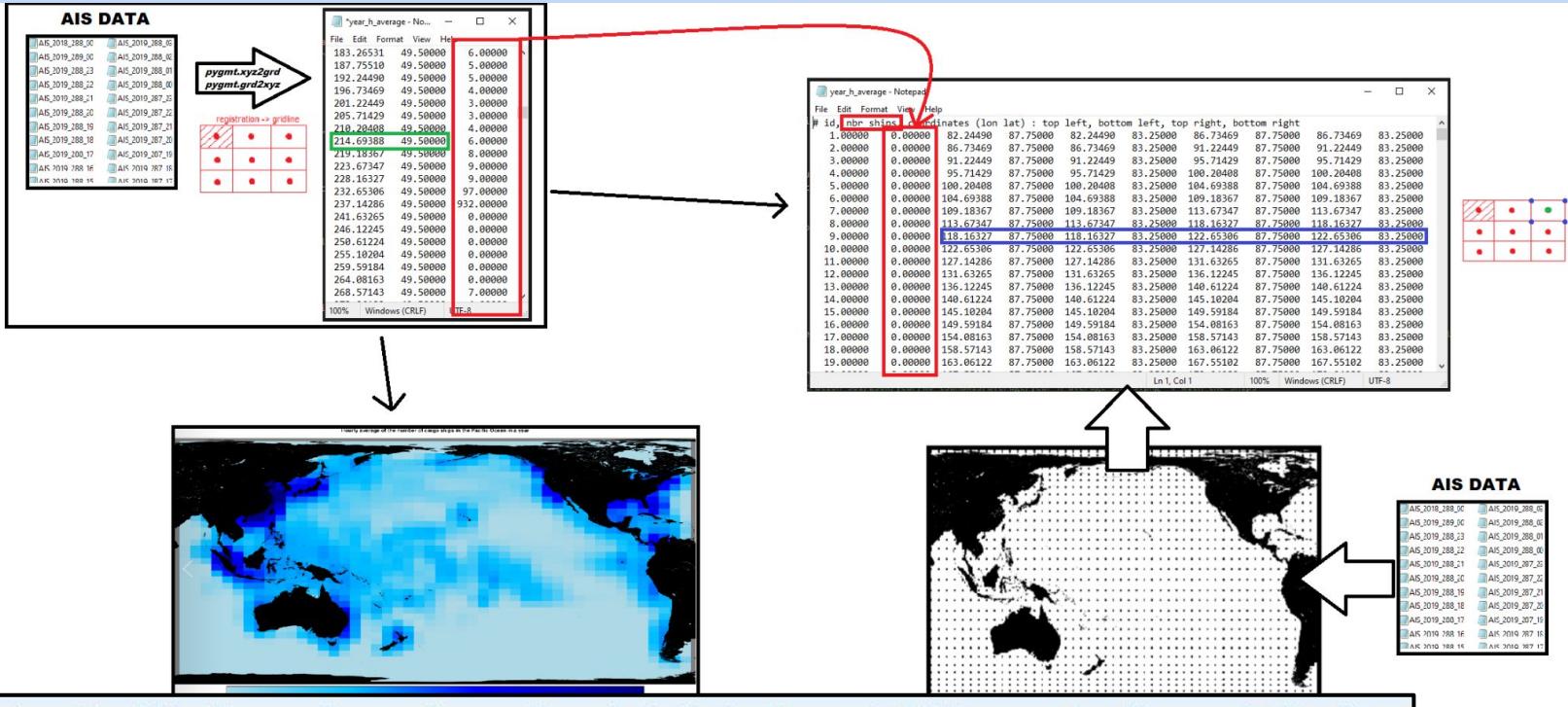


Methodological aspect



Methodological aspect : Setting up the grid

Methodological aspect : Setting up the grid



```
pygmt.xyz2grd(data=None, x=None, y=None, z=None, *, duplicate=None, outgrid=None, spacing=None, projection=None, region=None, verbose=None, convention=None, binary=None, nodata=None, find=None, coltypes=None, header=None, incols=None, registration=None, wrap=None, **kwargs) [source]
```

Methodological aspect



Methodological aspect : Data processing

Methodological aspect :

Data processing

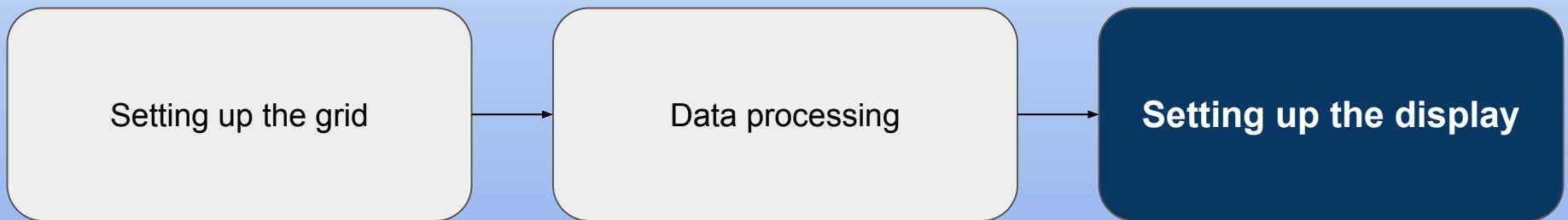
duplicate="n" → count the number of ships

```
pygmt.xyz2grd(data=None, x=None, y=None, z=None, *, duplicate=None, outgrid=None, spacing=None, projection=None, region=None, verbose=None, convention=None, binary=None, nodata=None, find=None, coltypes=None, header=None, incols=None, registration=None, wrap=None, **kwargs) [source]
```

<https://www.pygmt.org/latest/api/generated/pygmt.xyz2grd.html>

- winter : 21st dec. 2018 → 19th march 2019
- spring : 20th march 2019 → 20th june 2019
- summer : 21st june 2019 → 22nd sept. 2019
- fall : 23rd sept. 2019 → 15th oct. 2019 + 15th oct 2018 → 20th dec. 2018

Methodological aspect



Methodological aspect : Setting up the display

Methodological aspect :

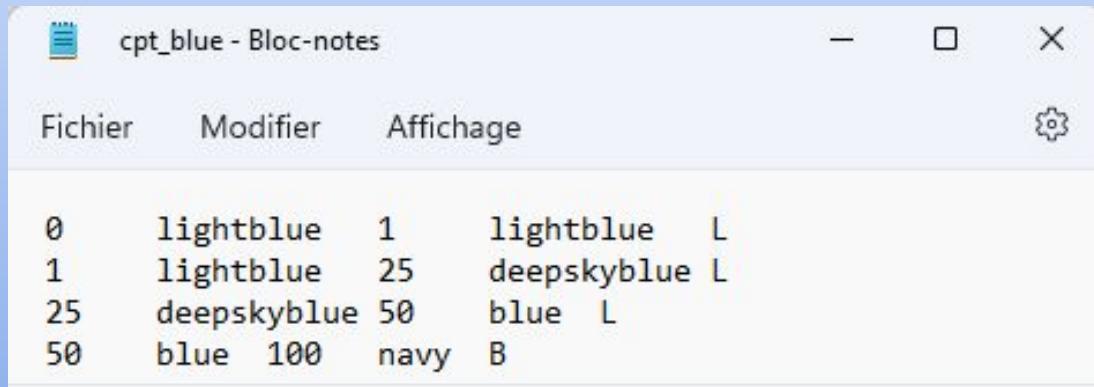
Setting up the display

- Colors
- Scale
- Projection
- Pacific Ocean

Methodological aspect :

Setting up the display

- Colors
- Scale
- Projection
- Pacific Ocean



	Fichier	Modifier	Affichage	
0	lightblue	1	lightblue	L
1	lightblue	25	deepskyblue	L
25	deepskyblue	50	blue	L
50	blue	100	navy	B

CPT File

Methodological aspect :

Setting up the display

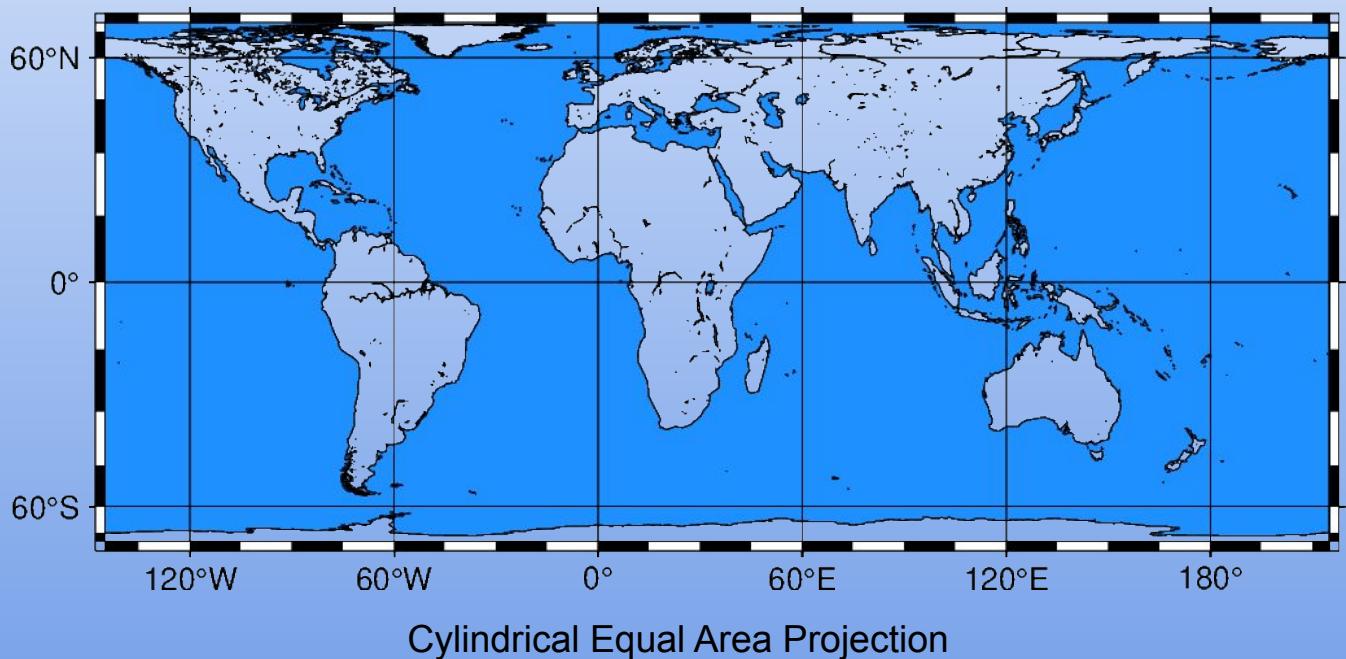
- Color code
- **Scale**
- Projection
- Pacific Ocean

cpt_blue - Bloc-notes				
	Fichier	Modifier	Affichage	
0	lightblue	1	lightblue	L
1	lightblue	25	deepskyblue	L
25	deepskyblue	50	blue	L
50	blue	100	navy	B

Methodological aspect :

Setting up the display

- Color code
- Scale
- **Projection**
- Pacific Ocean



Methodological aspect :

Setting up the display

- Color code
- Scale
- Projection
- Pacific Ocean

```
# Projection is cylindrical equal-area
region=[80, 300, -90, 90]
spacing = "500k"

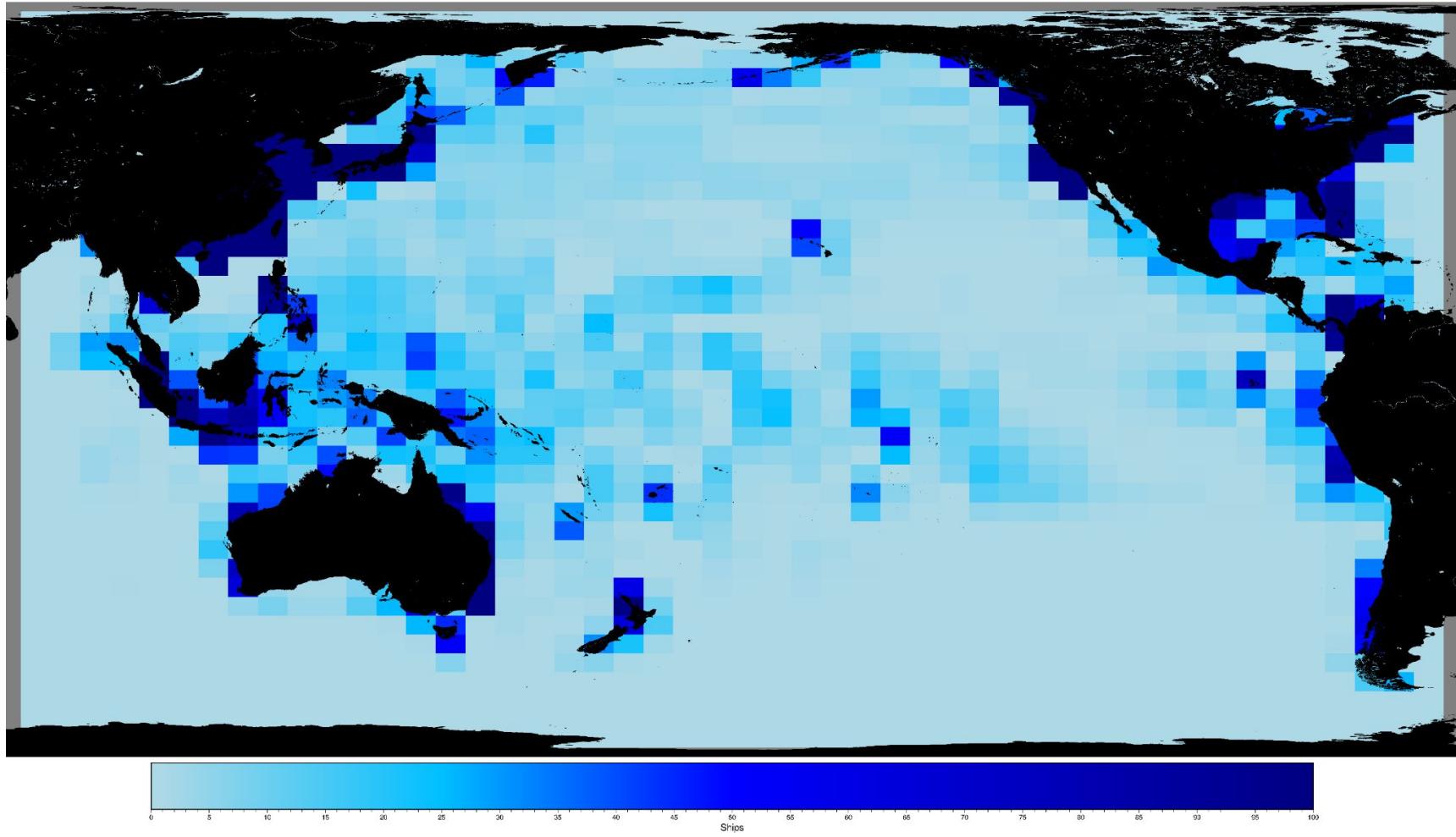
# Create a grid
grid = pygmt.xyz2grd(data=grid_color,region=region,
                      spacing=spacing)

# Plot the grid
with pygmt.config(COLOR_BACKGROUND='lightblue',
                    FONTSIZE=12):
    pygmt.makecpt(transparency=0,log=True,colors="copper")
    fig.grdimage(grid=grid,region=region,cmap="copper")
```

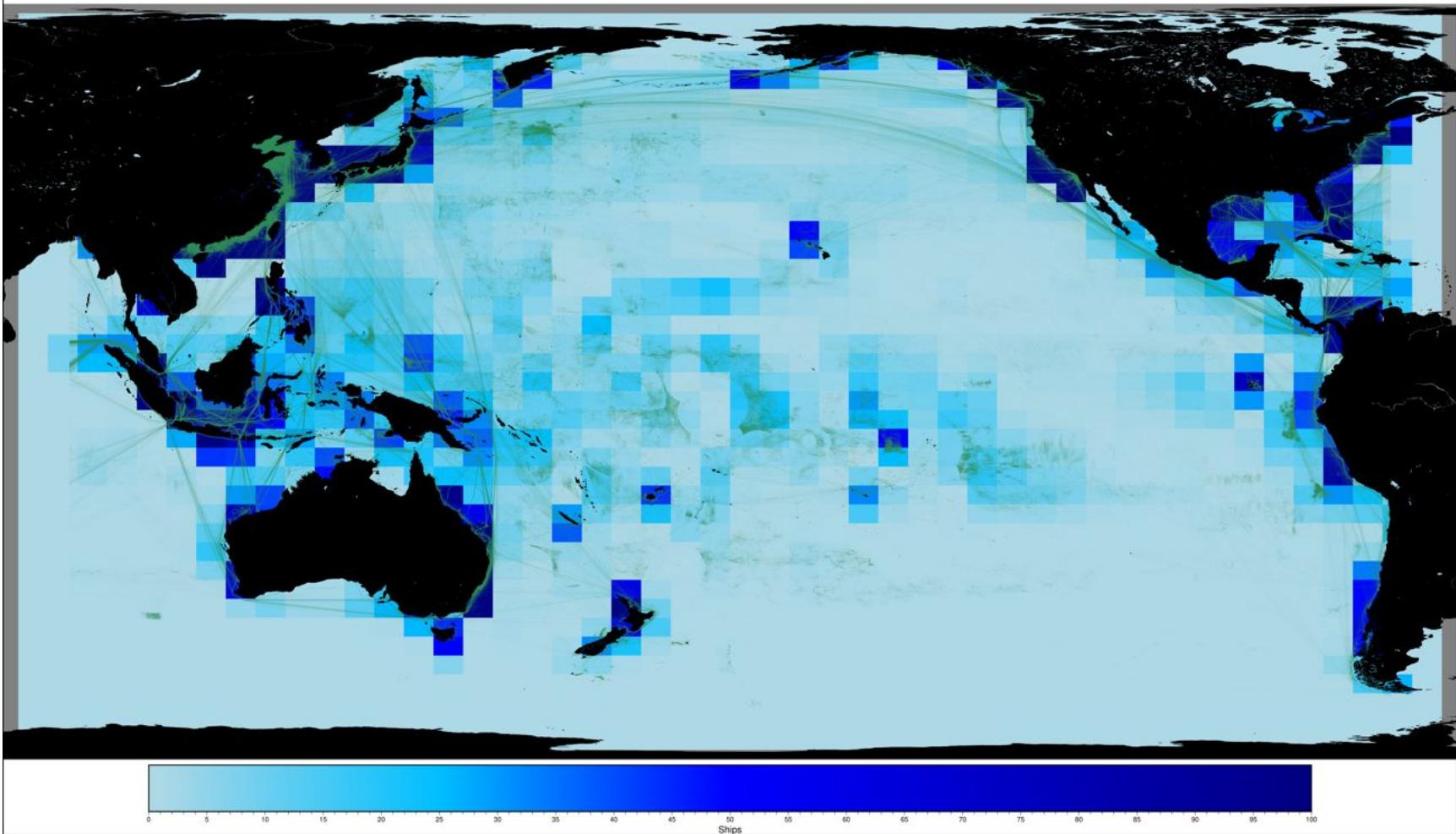
`Figure.grdimage(grid, *, img_out=None, frame=None, cmap=None, img_in=None, dpi=None, bit_color=None, shading=None, projection=None, monochrome=None, no_clip=None, nan_transparent=None, region=None, timestamp=None, verbose=None, xshift=None, yshift=None, interpolation=None, panel=None, coltypes=None, perspective=None, transparency=None, cores=None, **kwargs)`

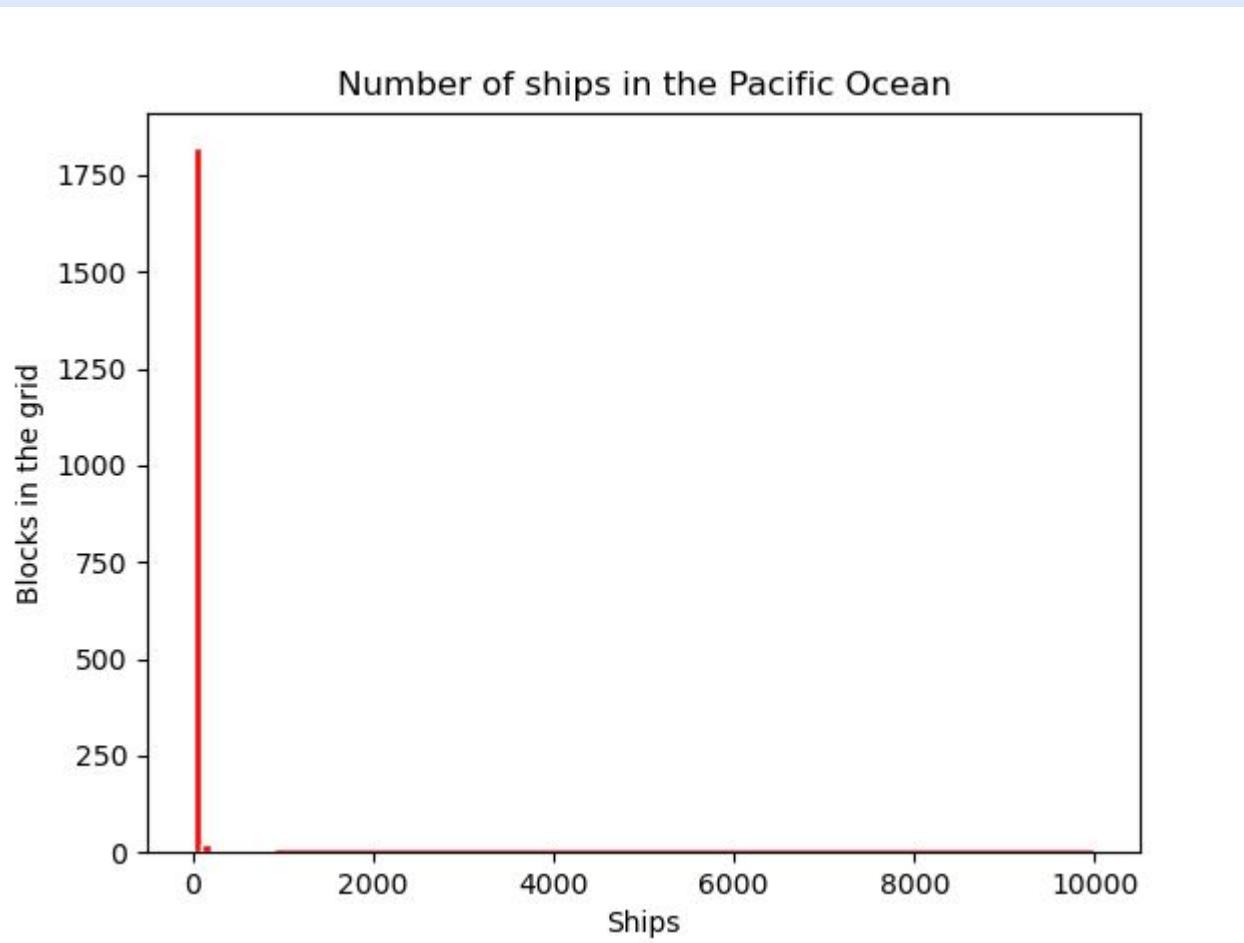
Results and Analysis

Hourly average of the number of cargo ships in a year in the Pacific Ocean

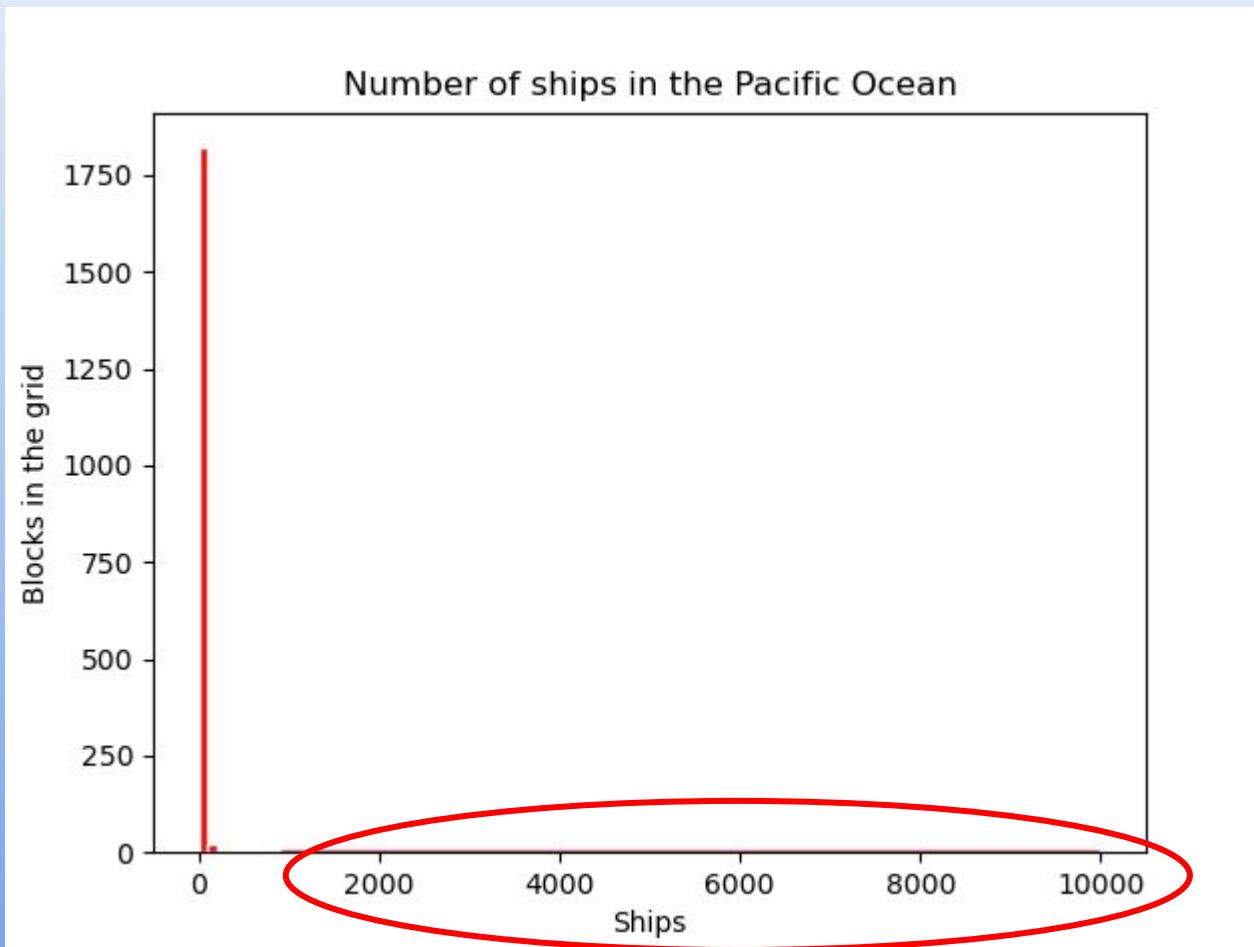


Hourly average of the number of cargo ships in a year in the Pacific Ocean





Histogram that plots the number of blocks of the grid that have 0 to 10,000 ships in it

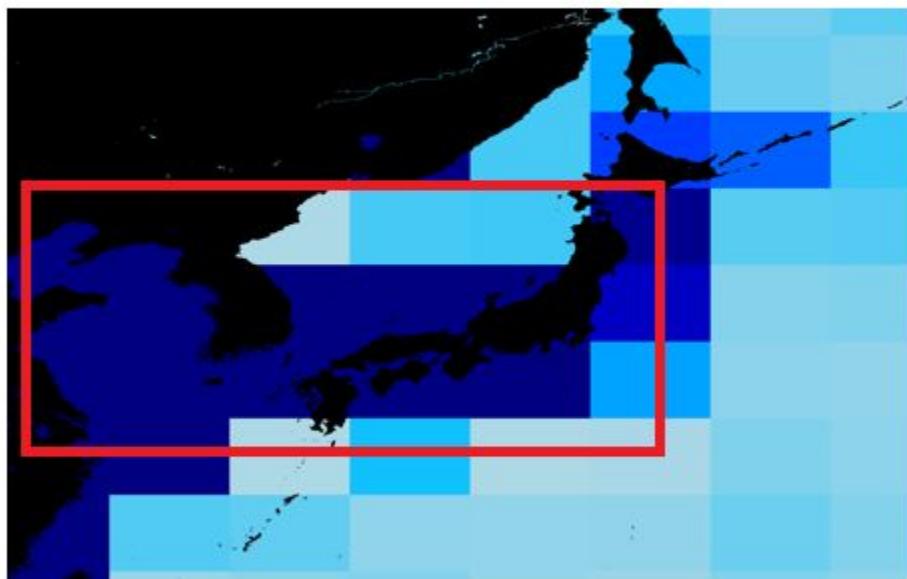


Histogram that plots the number of blocks of the grid that have 0 to 10,000 ships in it

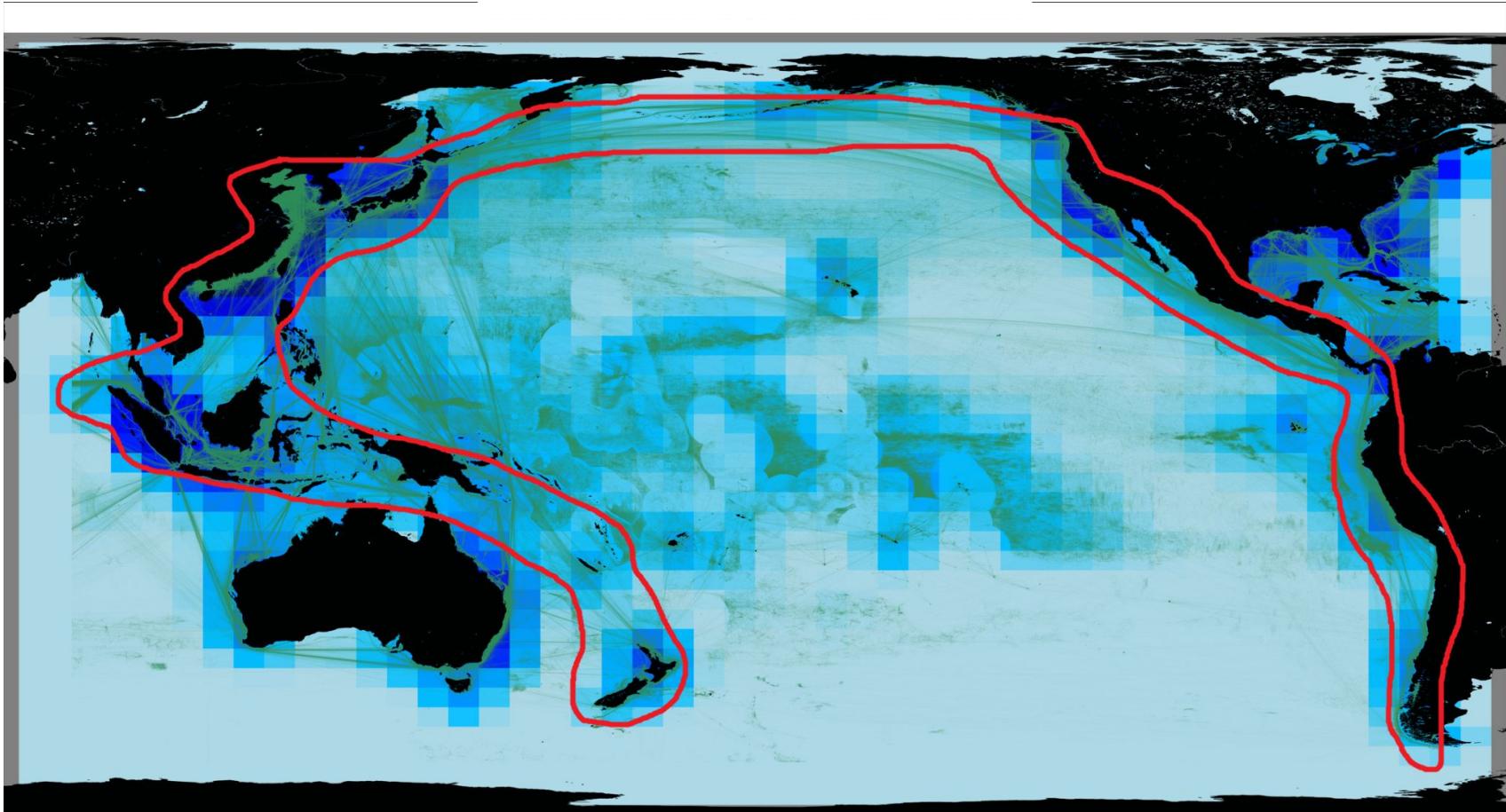
year_h_average - Blo... — X

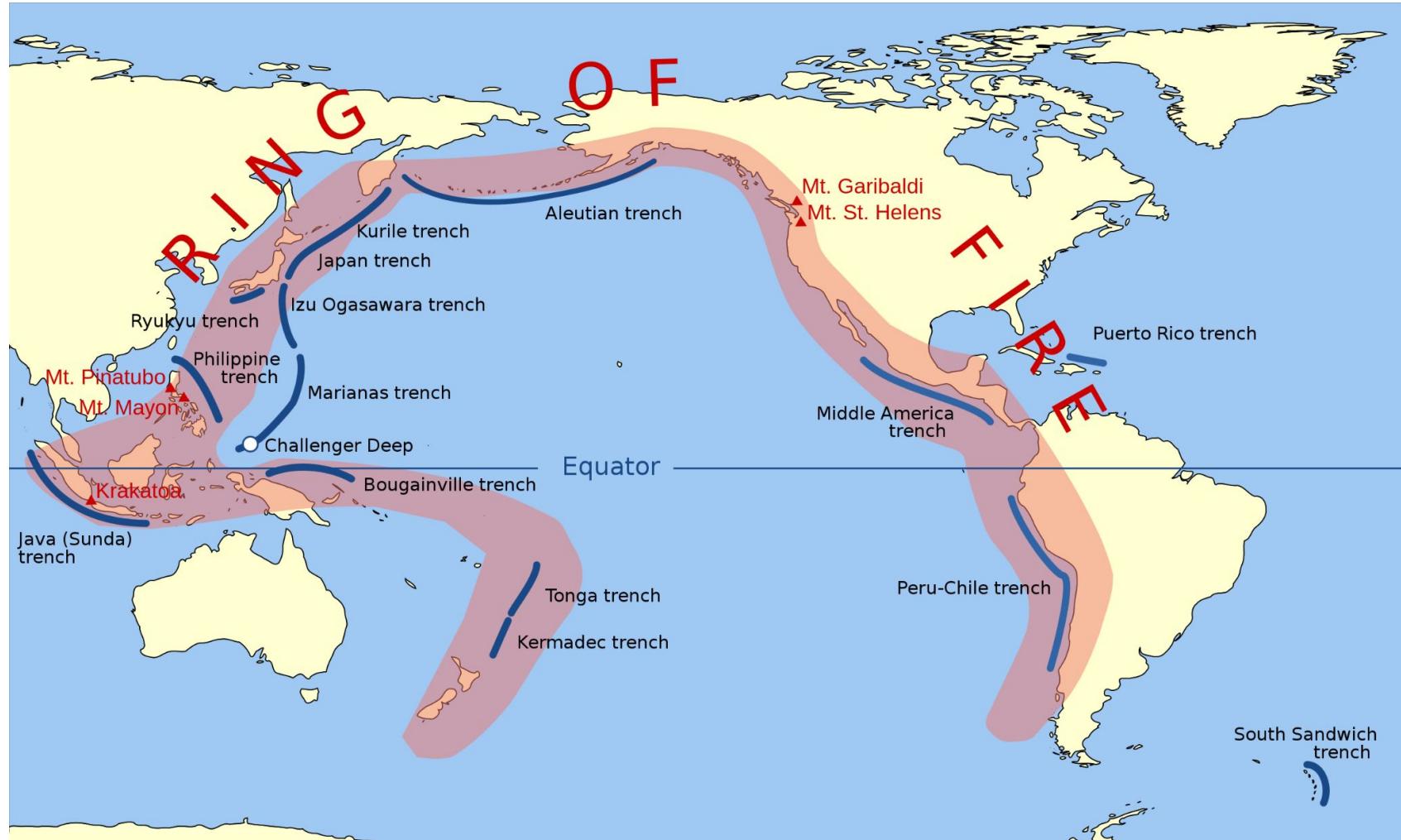
Fichier	Modifier	Affichage
291.01441	30.00000	0.00000
295.51020	36.00000	0.00000
84.48980	31.50000	0.00000
88.97959	31.50000	0.00000
93.46939	31.50000	0.00000
97.95918	31.50000	0.00000
102.44898	31.50000	0.00000
106.93878	31.50000	678.00000
111.42857	31.50000	1734.00000
115.91837	31.50000	2507.00000
120.40816	31.50000	10420.00000
124.89796	31.50000	219.00000
129.38776	31.50000	20.00000
133.87755	31.50000	61.00000
138.36735	31.50000	17.00000
142.85714	31.50000	6.00000
147.34694	31.50000	6.00000
151.83673	31.50000	5.00000
156.32653	31.50000	5.00000
160.81633	31.50000	6.00000

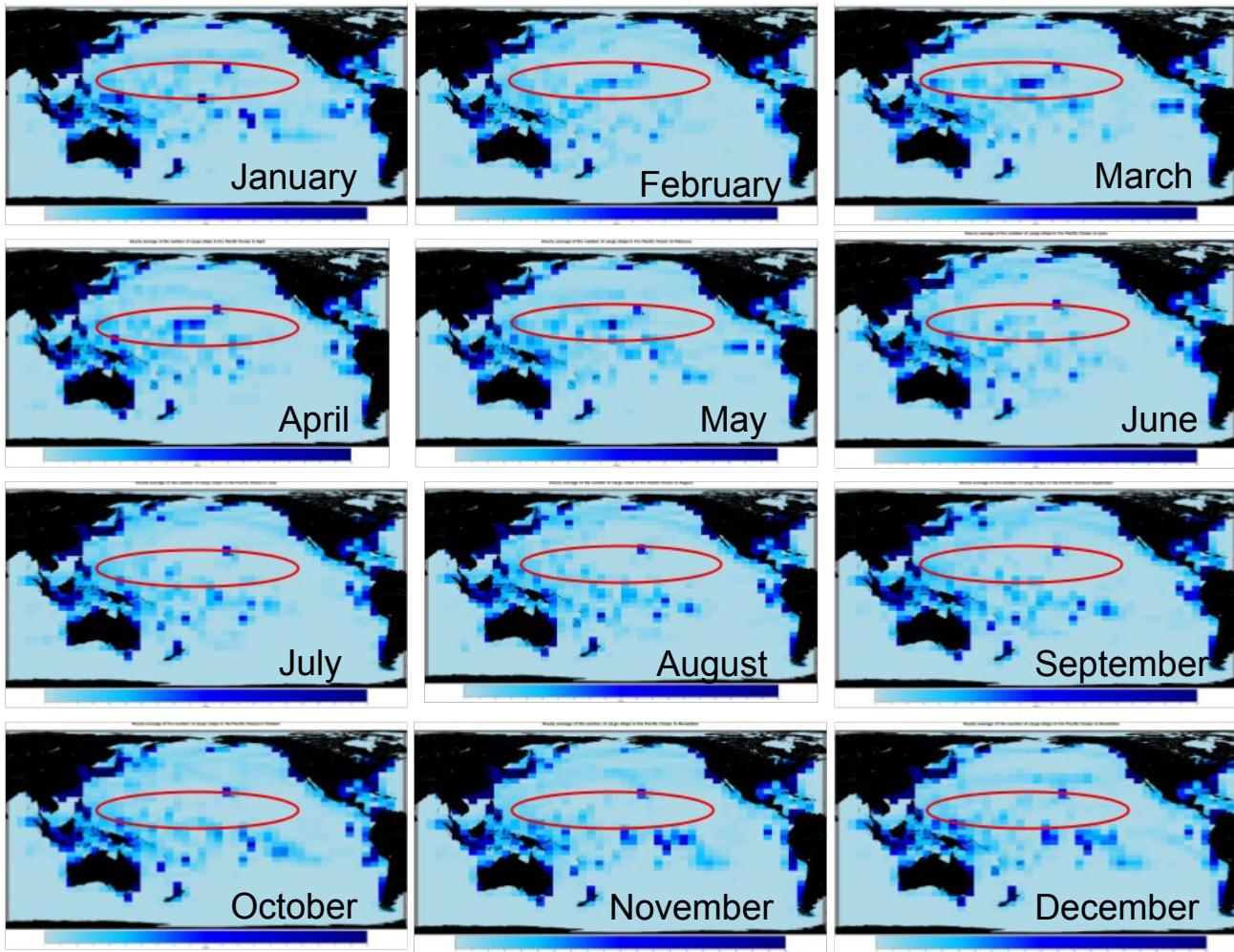
Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

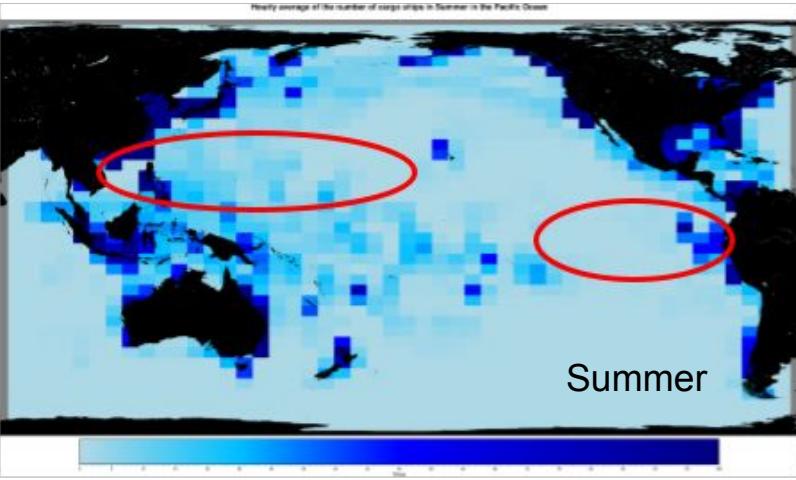
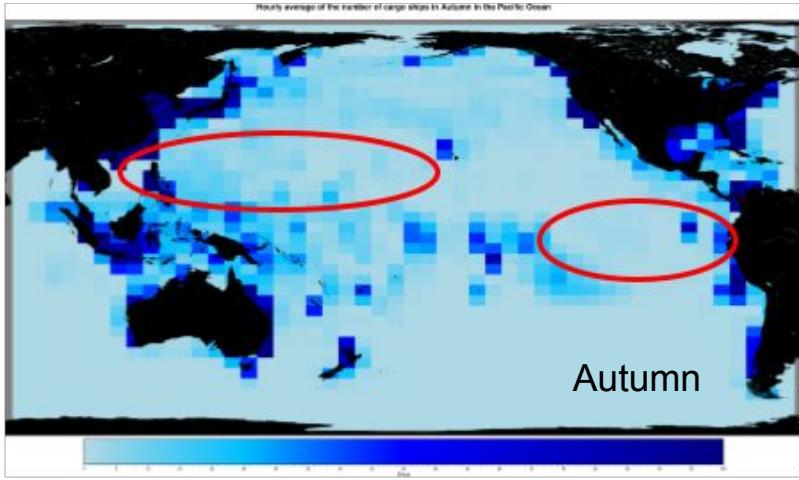
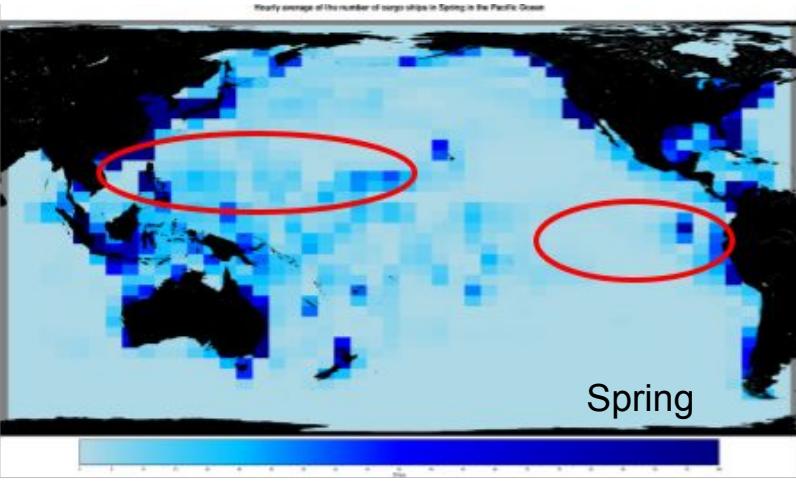
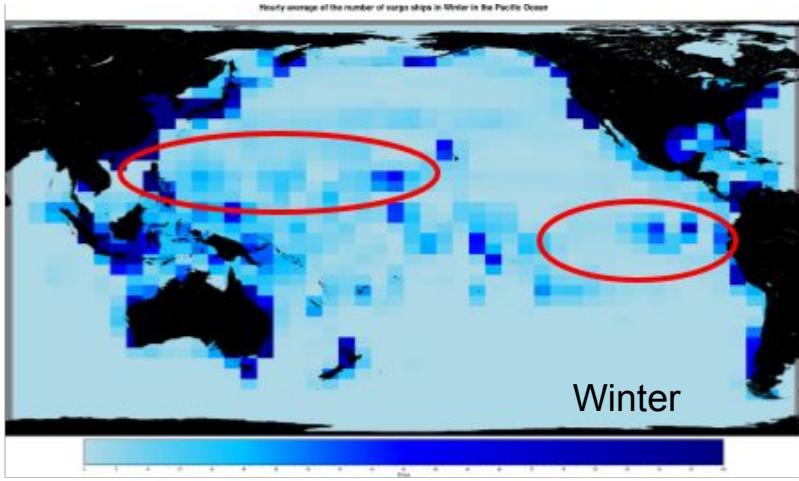


Hourly average of the number of cargo ships in a year in the Pacific Ocean

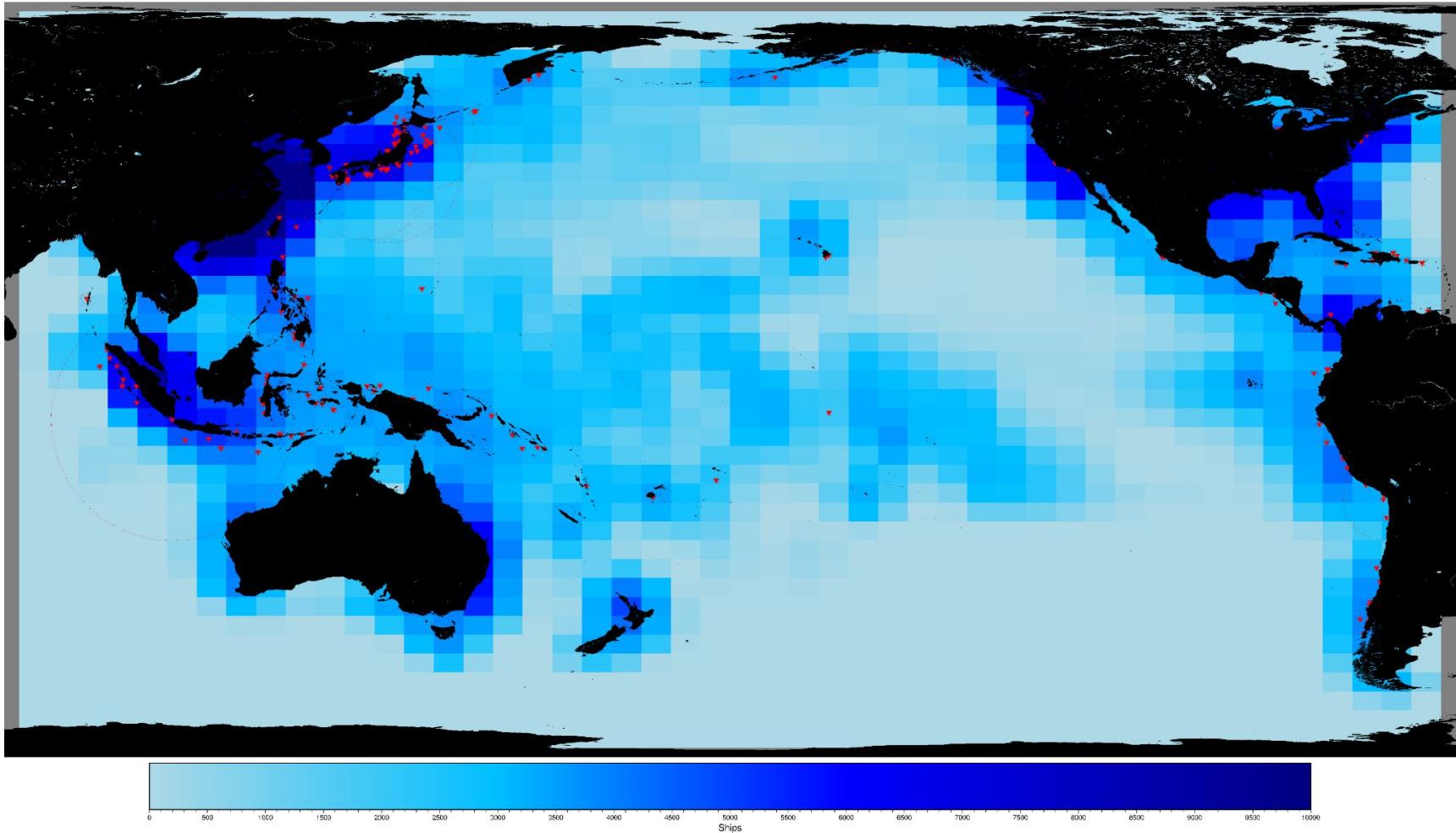


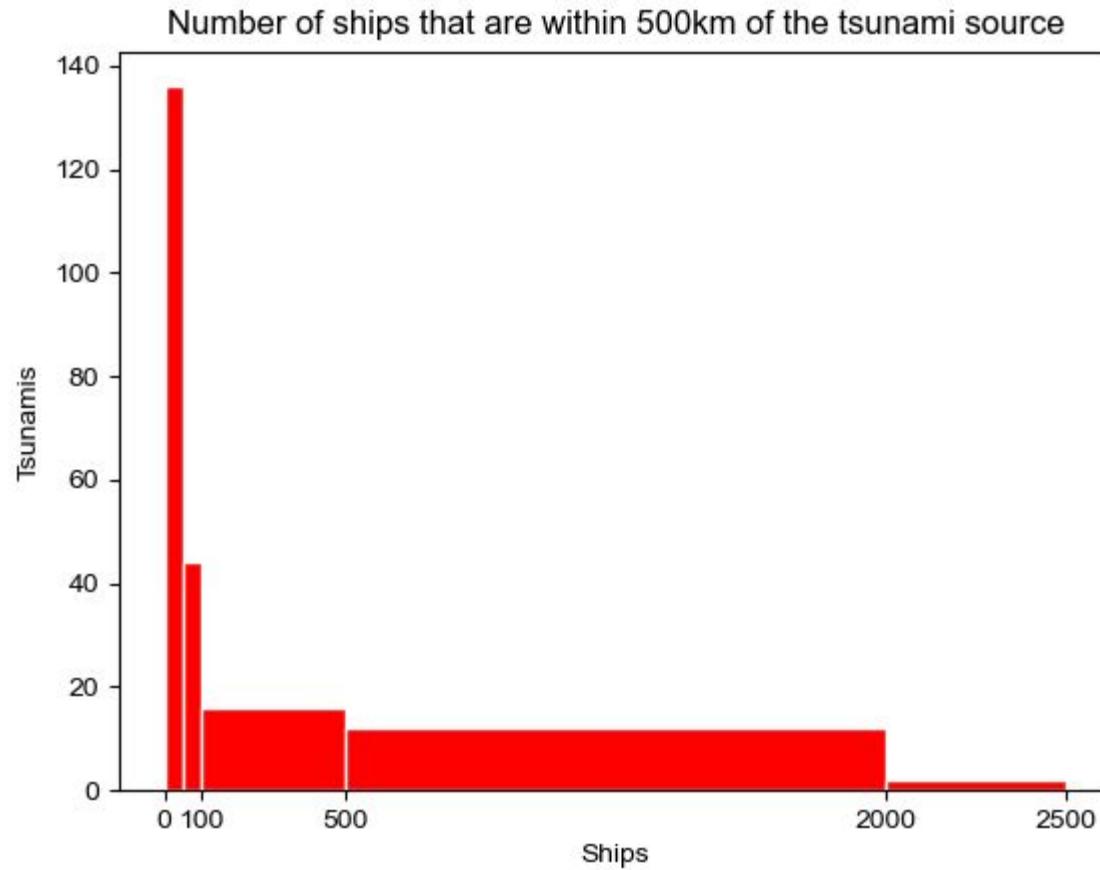






Hourly average of the number of cargo ships in a year in the Pacific Ocean



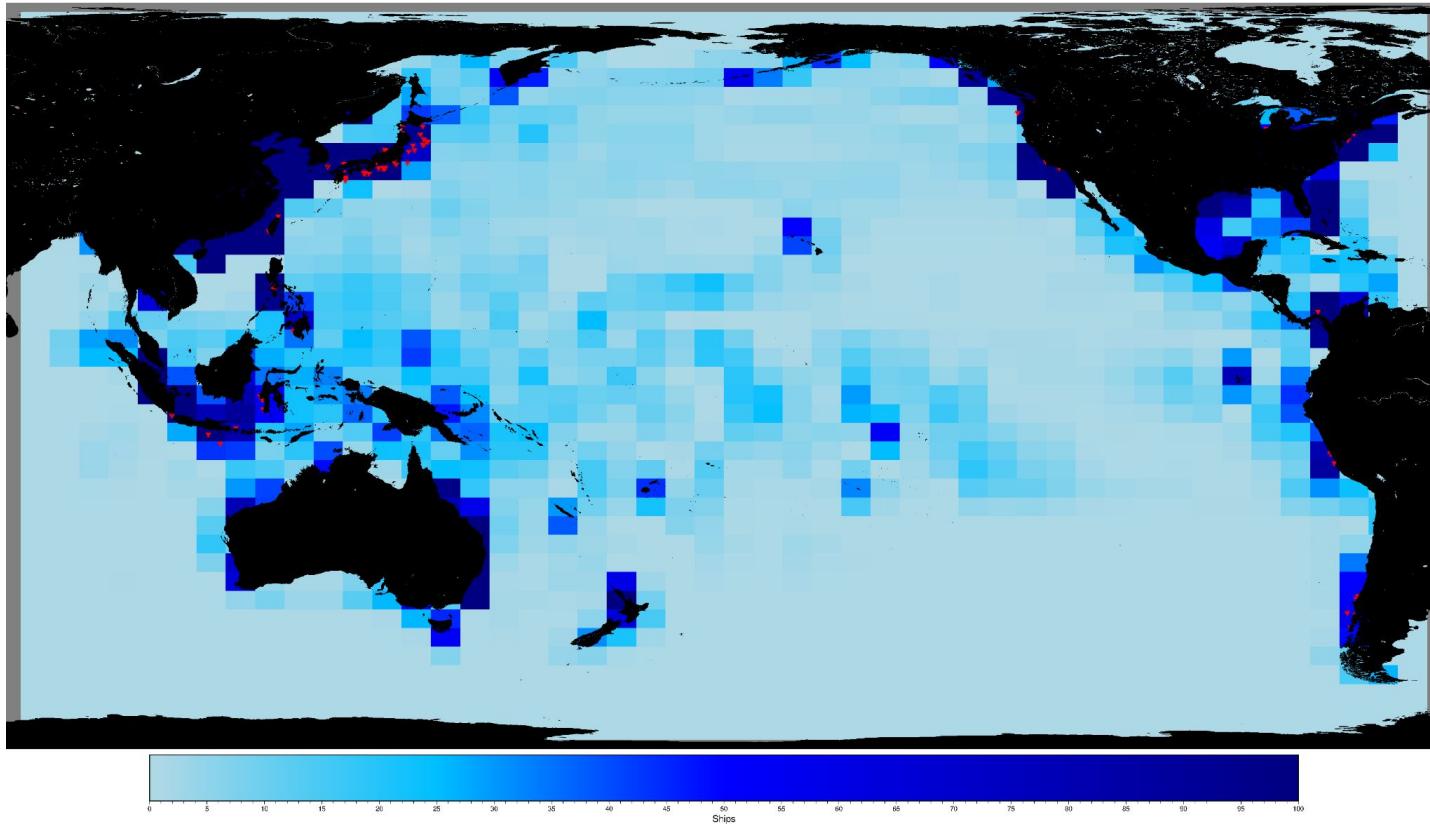


Histogram that shows the number of ships that are close to 500 km from a source of tsunami

Conclusion and Discussion

Conclusion and Discussion

Hourly average of number of cargo ships in a year in the Pacific Ocean



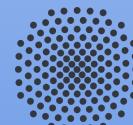
Thank you for your attention

Mapping a cargo ship network to detect tsunamis

Internship supervisor: Bruce Thomas

Intern: Tasnîme-Jenna Louartani

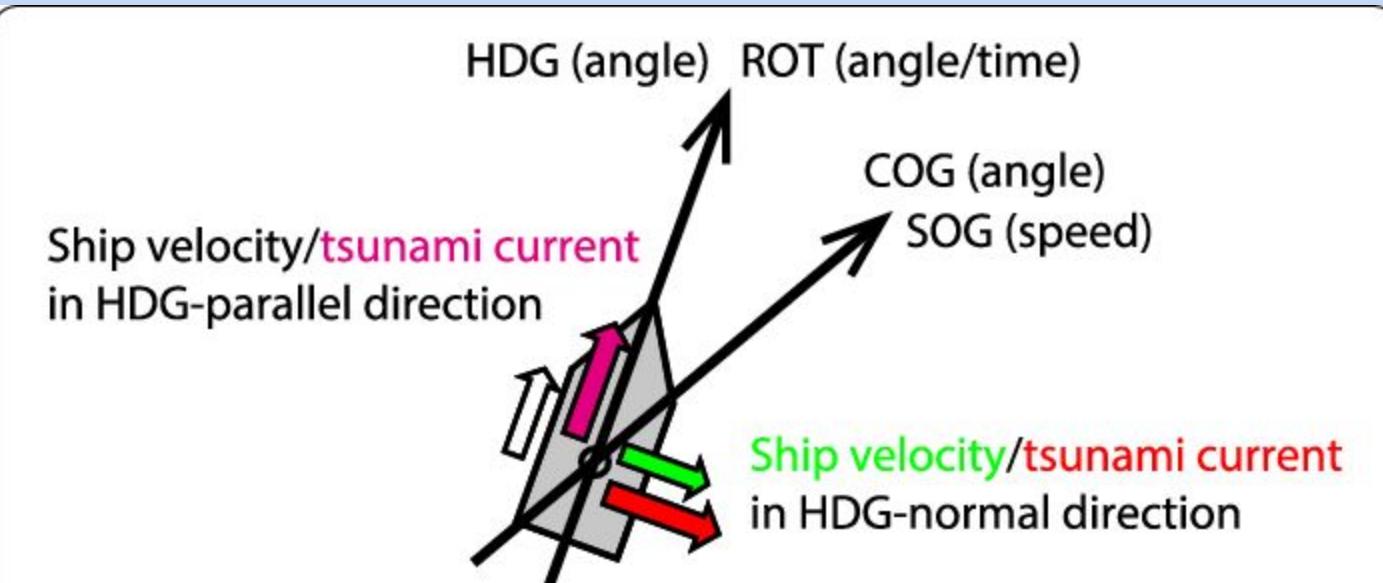
September 2022



Universität Stuttgart



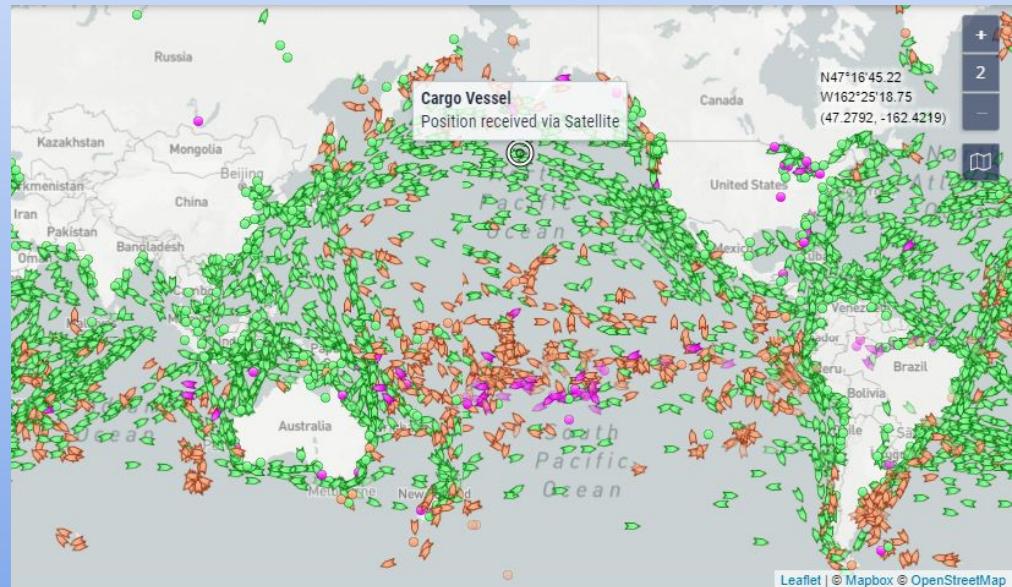
Annexe



Contexte

SITUATION

- dans l'océan Pacifique
- utilisation des technologies GNSS pour détecter en temps réel les tsunamis
- amélioration des systèmes d'alerte aux tsunamis
- utilisation des données GPS des bateaux (commerciaux)



marinetraffic.com

Contexte

SITUATION

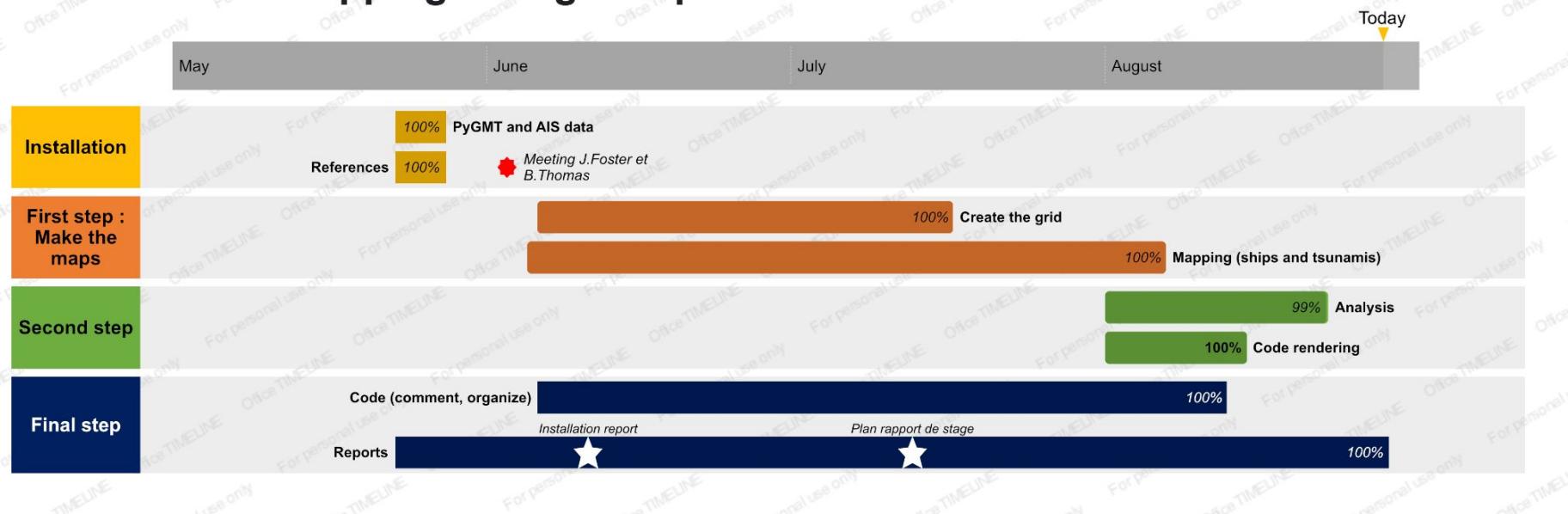
- dans l'océan Pacifique
- utilisation des technologies GNSS pour détecter en temps réel les tsunamis
- amélioration des systèmes d'alerte aux tsunamis
- utilisation des données GPS des bateaux (commerciaux)

BUT

- cartographier un réseau de bateaux commerciaux
- différents critères (taille de la grille, moyenne horaire par saisons, mois...)
- faire des statistiques

Planning

Mapping a cargo-ship network to detect tsunamis



Données et support informatique

Support informatique

Données AIS :

- données de navigation
- informations spécifiques aux bateaux (dynamique ou statiques)
- messages reçus par les stations terrestres ou les satellites

Informations dynamiques : longitude et latitude

Données de travail :

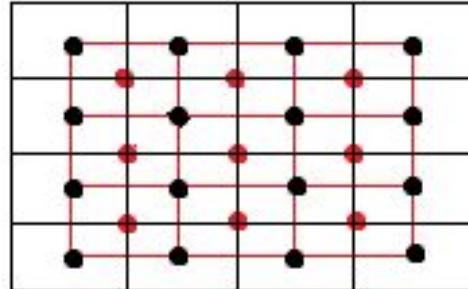
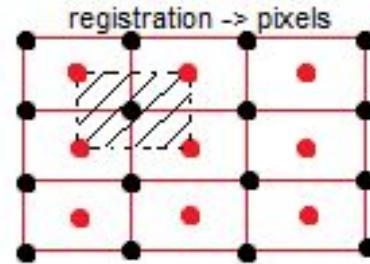
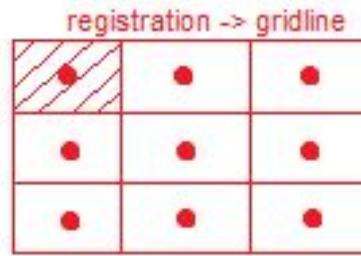
- vont du 15 octobre 2018 au 15 octobre 2019
- un fichier = coordonnées de tous les bateaux dans une heure dans l'océan pacifique
- 24 fichiers pour 1 jour donc 8760 fichiers pour 1 an (365×24)

Methodological aspect : *Setting up the grid*

```
pygmt.xyz2grd(data=None, x=None, y=None, z=None, *, duplicate=None, outgrid=None, spacing=None, projection=None, region=None, verbose=None, convention=None, binary=None, nodata=None, find=None, coltypes=None, header=None, incols=None, registration=None, wrap=None, **kwargs) [source]
```

<https://www.pygmt.org/latest/api/generated/pygmt.xyz2grd.html>

pygmt.xyz2grd
parameter “registration”
“spacing”=500km

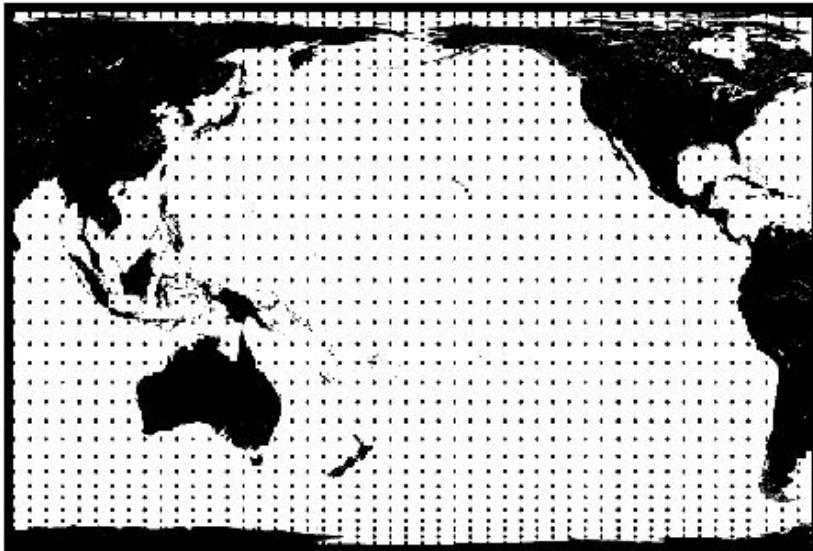
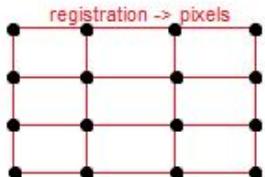


Methodological aspect : *Setting up the grid*

AIS DATA

AIS_2018_288_00	AIS_2019_288_03
AIS_2019_289_00	AIS_2019_288_02
AIS_2019_288_23	AIS_2019_288_01
AIS_2019_288_22	AIS_2019_288_00
AIS_2019_288_21	AIS_2019_287_23
AIS_2019_288_20	AIS_2019_287_22
AIS_2019_288_19	AIS_2019_287_21
AIS_2019_288_18	AIS_2019_287_20
AIS_2019_288_17	AIS_2019_287_19
AIS_2019_288_16	AIS_2019_287_18
AIS_2019_288_15	AIS_2019_287_17

*pygmt.xyz2grd
registration="p"*



Methodological aspect : *Setting up the grid*

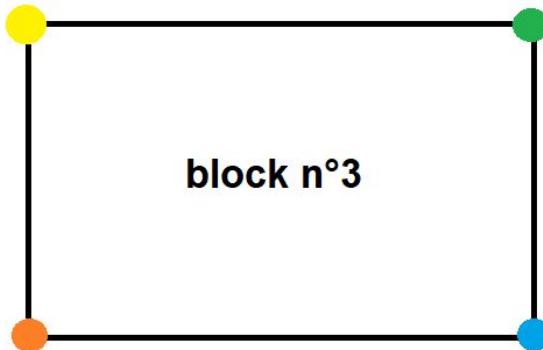
year_h_average - Notepad

File Edit Format View Help

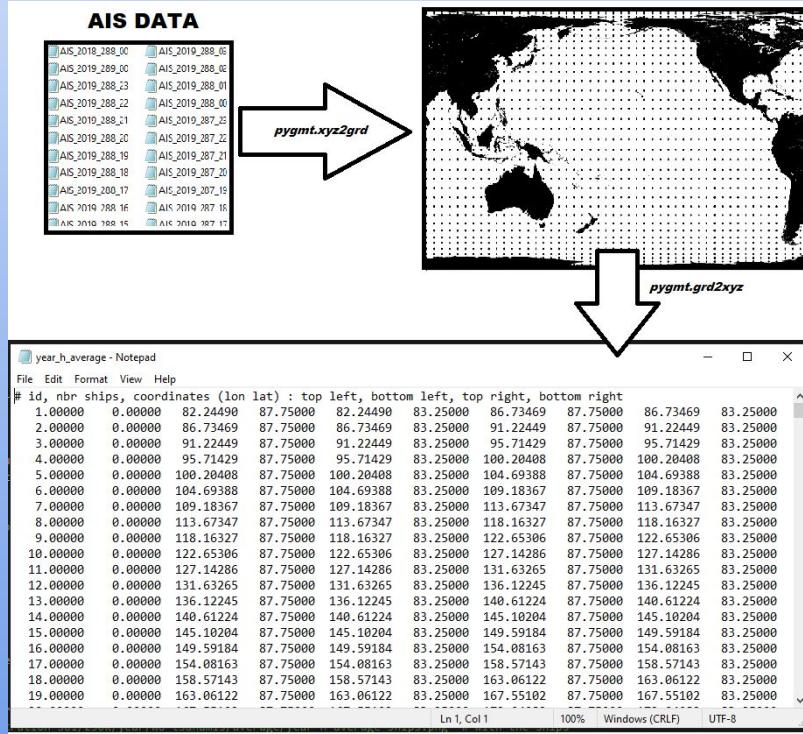
id, nbr ships, coordinates (lon lat) : top left, bottom left, top right, bottom right

1.00000	0.00000	82.24490	87.75000	82.24490	83.25000	86.73469	87.75000	86.73469	83.25000
2.00000	0.00000	91.22449	87.75000	91.22449	83.25000	95.71429	87.75000	95.71429	83.25000
3.00000	0.00000	91.22449	87.75000	91.22449	83.25000	95.71429	87.75000	95.71429	83.25000
4.00000	0.00000	100.20408	87.75000	100.20408	83.25000	104.69388	87.75000	104.69388	83.25000
5.00000	0.00000	104.69388	87.75000	104.69388	83.25000	109.18367	87.75000	109.18367	83.25000
6.00000	0.00000	109.18367	87.75000	109.18367	83.25000	113.67347	87.75000	113.67347	83.25000
7.00000	0.00000	113.67347	87.75000	113.67347	83.25000	118.16327	87.75000	118.16327	83.25000
8.00000	0.00000	118.16327	87.75000	118.16327	83.25000	122.65306	87.75000	122.65306	83.25000
9.00000	0.00000	122.65306	87.75000	122.65306	83.25000	127.14286	87.75000	127.14286	83.25000
10.00000	0.00000	127.14286	87.75000	127.14286	83.25000	131.63265	87.75000	131.63265	83.25000
11.00000	0.00000	131.63265	87.75000	131.63265	83.25000	136.12245	87.75000	136.12245	83.25000
12.00000	0.00000	136.12245	87.75000	136.12245	83.25000	140.61224	87.75000	140.61224	83.25000
13.00000	0.00000	140.61224	87.75000	140.61224	83.25000	145.10204	87.75000	145.10204	83.25000
14.00000	0.00000	145.10204	87.75000	145.10204	83.25000	149.59184	87.75000	149.59184	83.25000
15.00000	0.00000	149.59184	87.75000	149.59184	83.25000	154.08163	87.75000	154.08163	83.25000
16.00000	0.00000	154.08163	87.75000	154.08163	83.25000	158.57143	87.75000	158.57143	83.25000
17.00000	0.00000	158.57143	87.75000	158.57143	83.25000	163.06122	87.75000	163.06122	83.25000
18.00000	0.00000	163.06122	87.75000	163.06122	83.25000	167.55102	87.75000	167.55102	83.25000
19.00000	0.00000	171.22449	87.75000	171.22449	83.25000	175.71429	87.75000	175.71429	83.25000

Ln 1, Col 1 100% Windows (CRLF) UTF-8

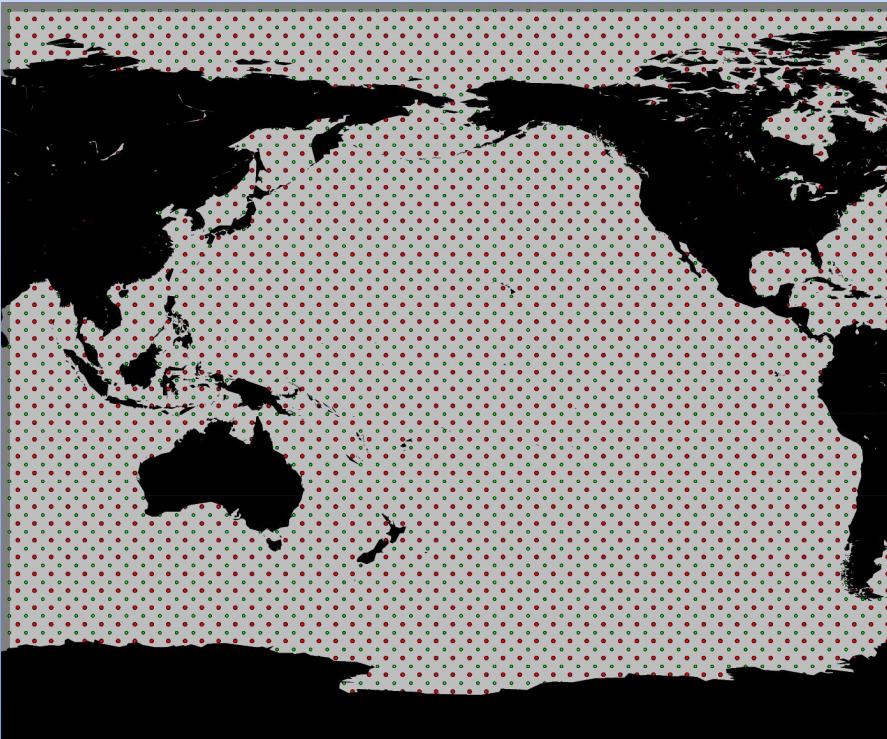


Methodological aspect : *Setting up the grid*



Methodological aspect :

Setting up the grid



Methodological aspect :

Setting up the display

```
pygmt.makecpt(transparency=0, log=True, continuous=True)
fig.grdimage(grid=grid, region=region, cmap="C:/Users/TLouartani/Documents/registration_sol/CPT/cpt_blue.cpt")

# Plot the ships
#fig.plot(x=longitude_ships, y=latitude_ships, style="krflag/0.01c", pen="0.001p,seagreen", color="seagreen"

fig.coast(land="black", transparency=0)

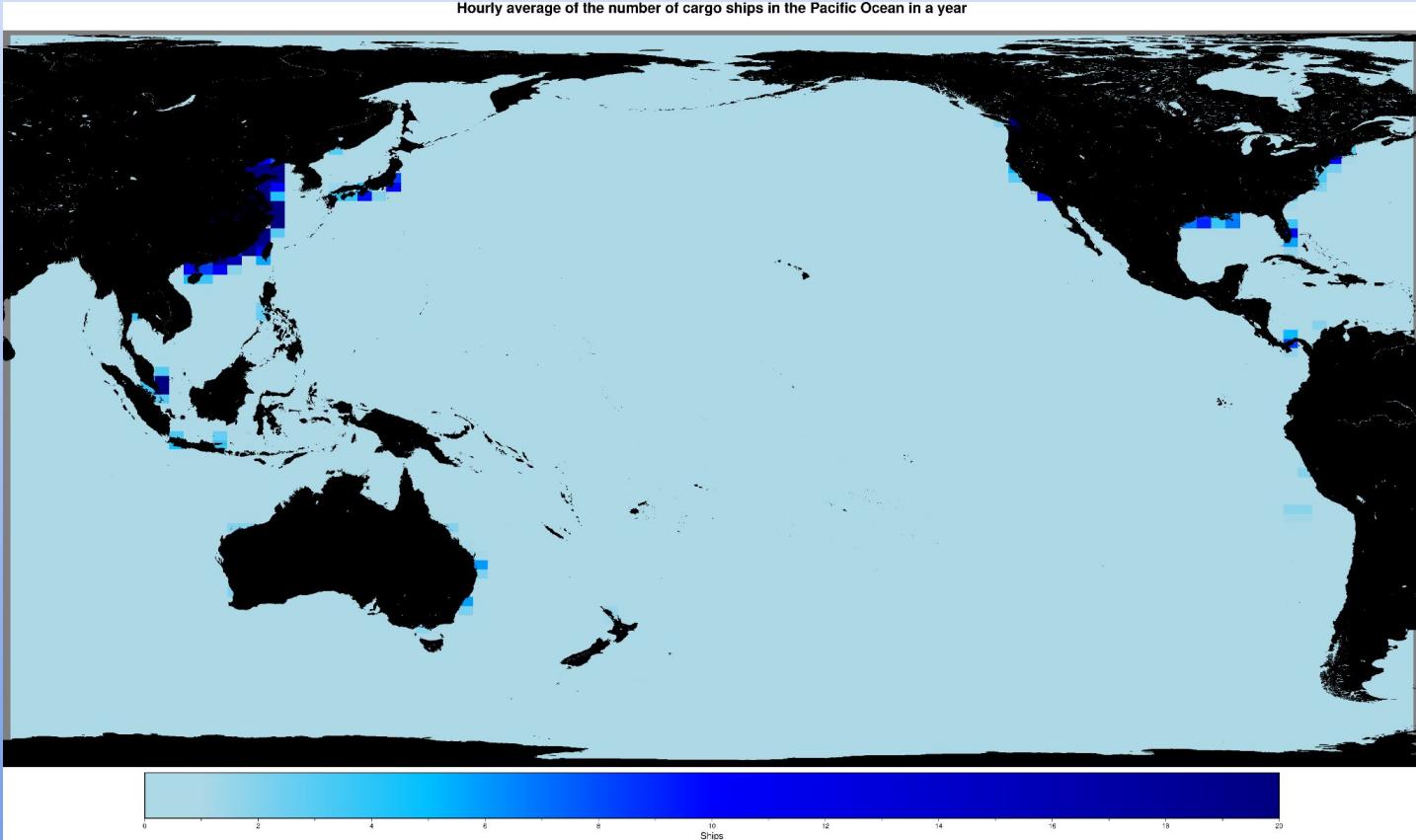
# Title of the map
fig.basemap(frame=["tHourly average of the number of cargo ships in the Pacific Ocean in a year"])

# Colorbar settings
fig.colorbar(frame=["x+lShips"], cmap="C:/Users/TLouartani/Documents/registration_sol/CPT/cpt_blue.cpt")

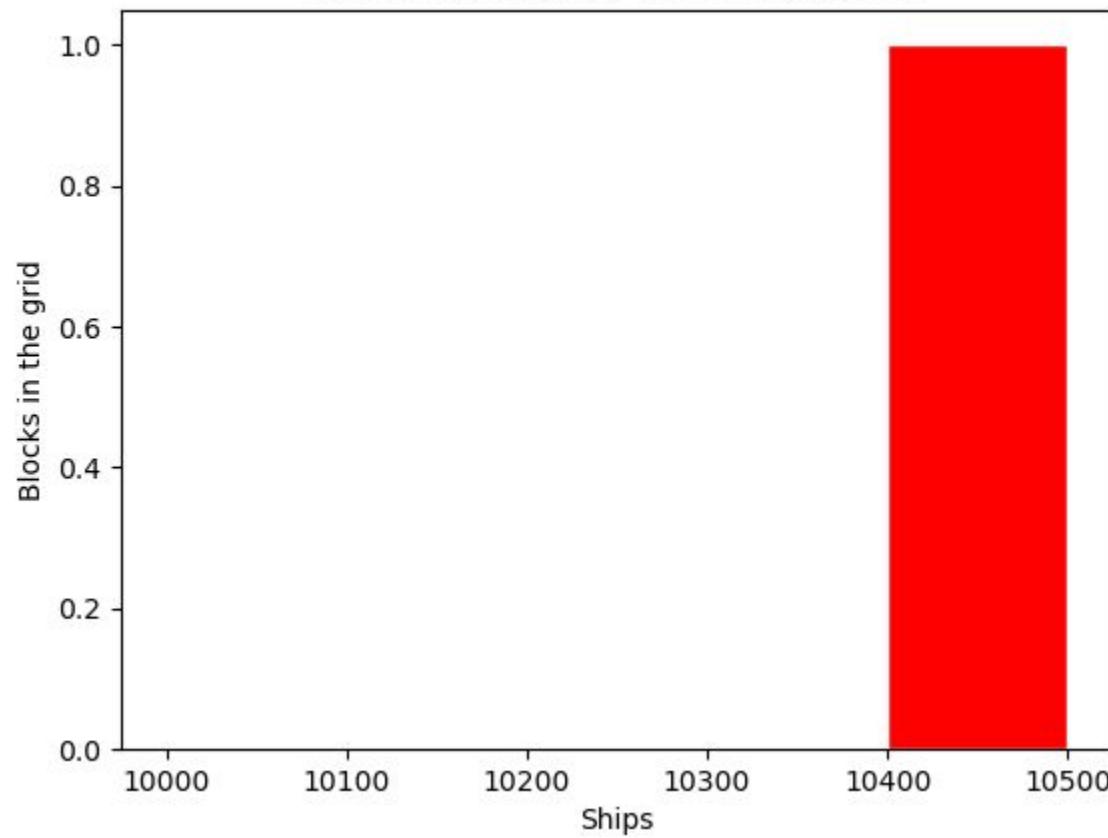
Save the map
```

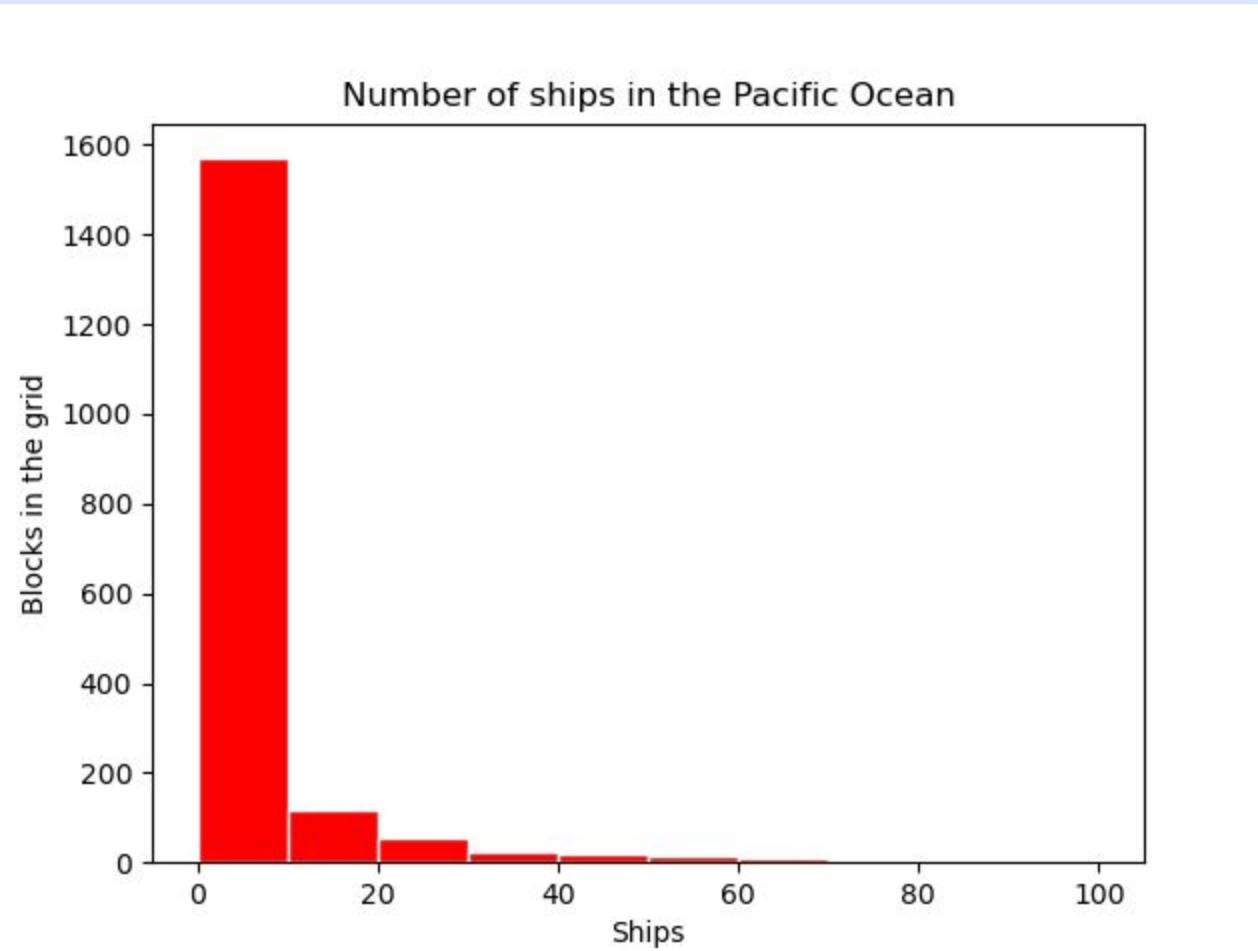
250km grid

Hourly average of the number of cargo ships in the Pacific Ocean in a year

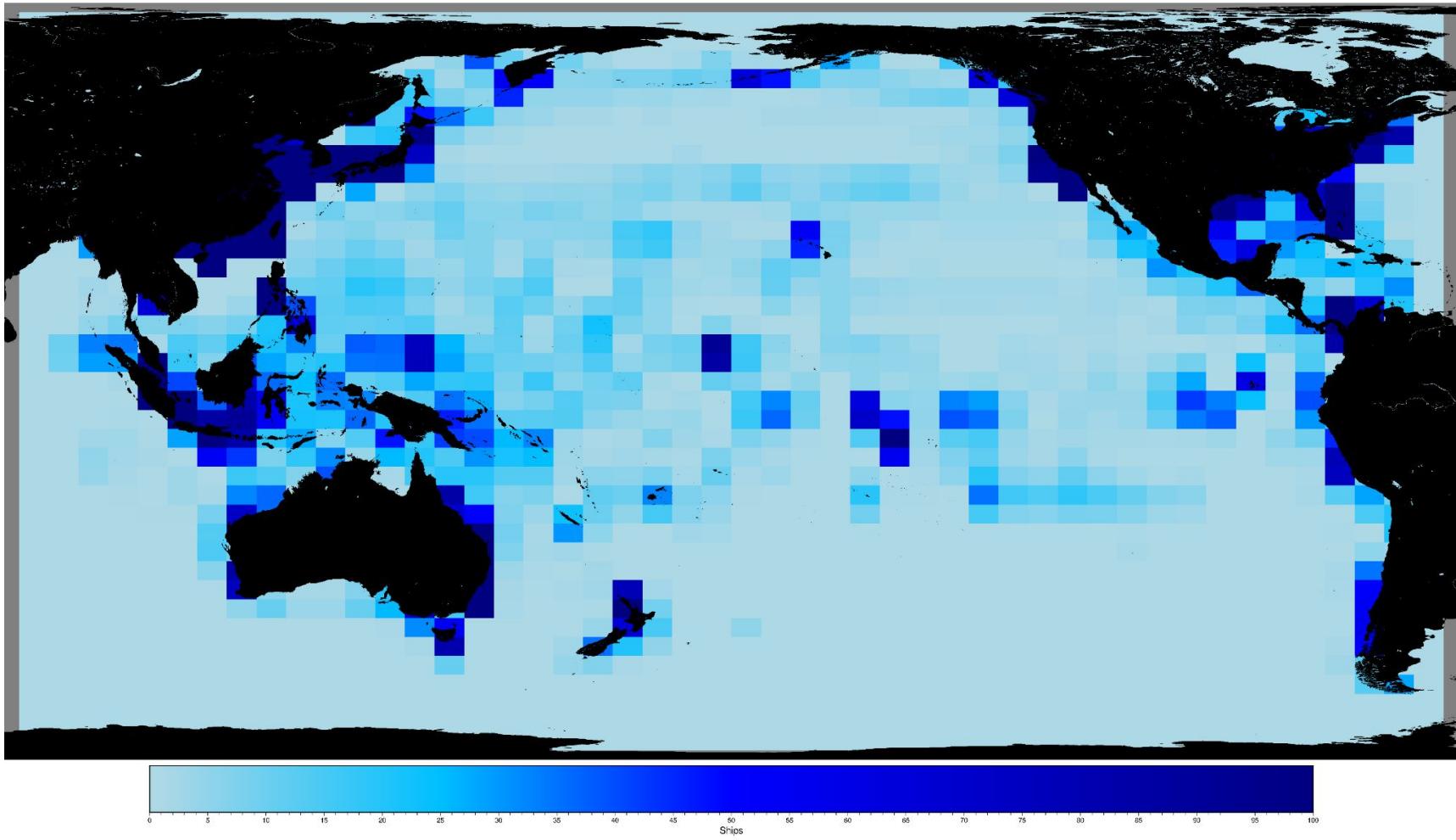


Number of ships in the Pacific Ocean

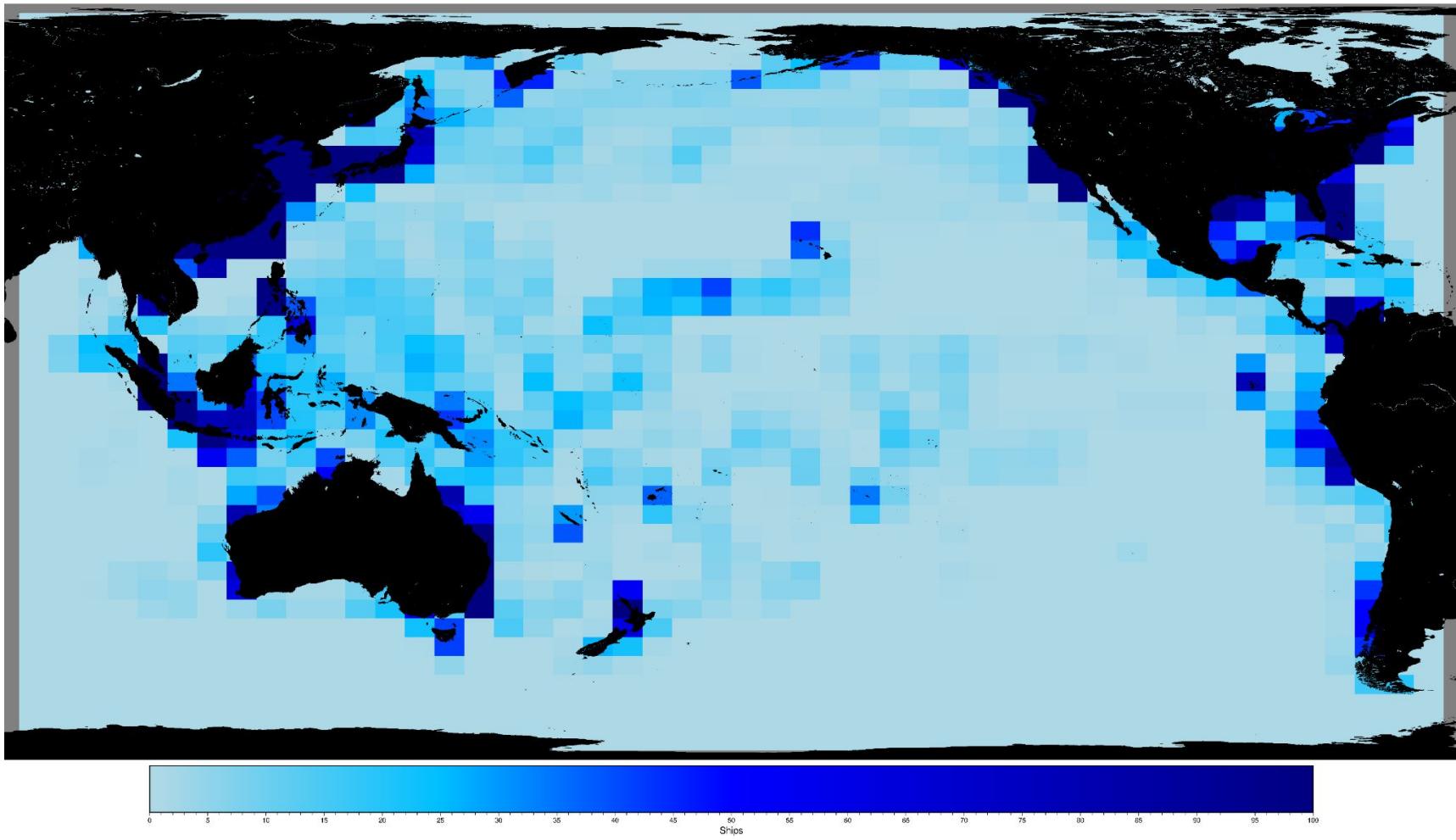




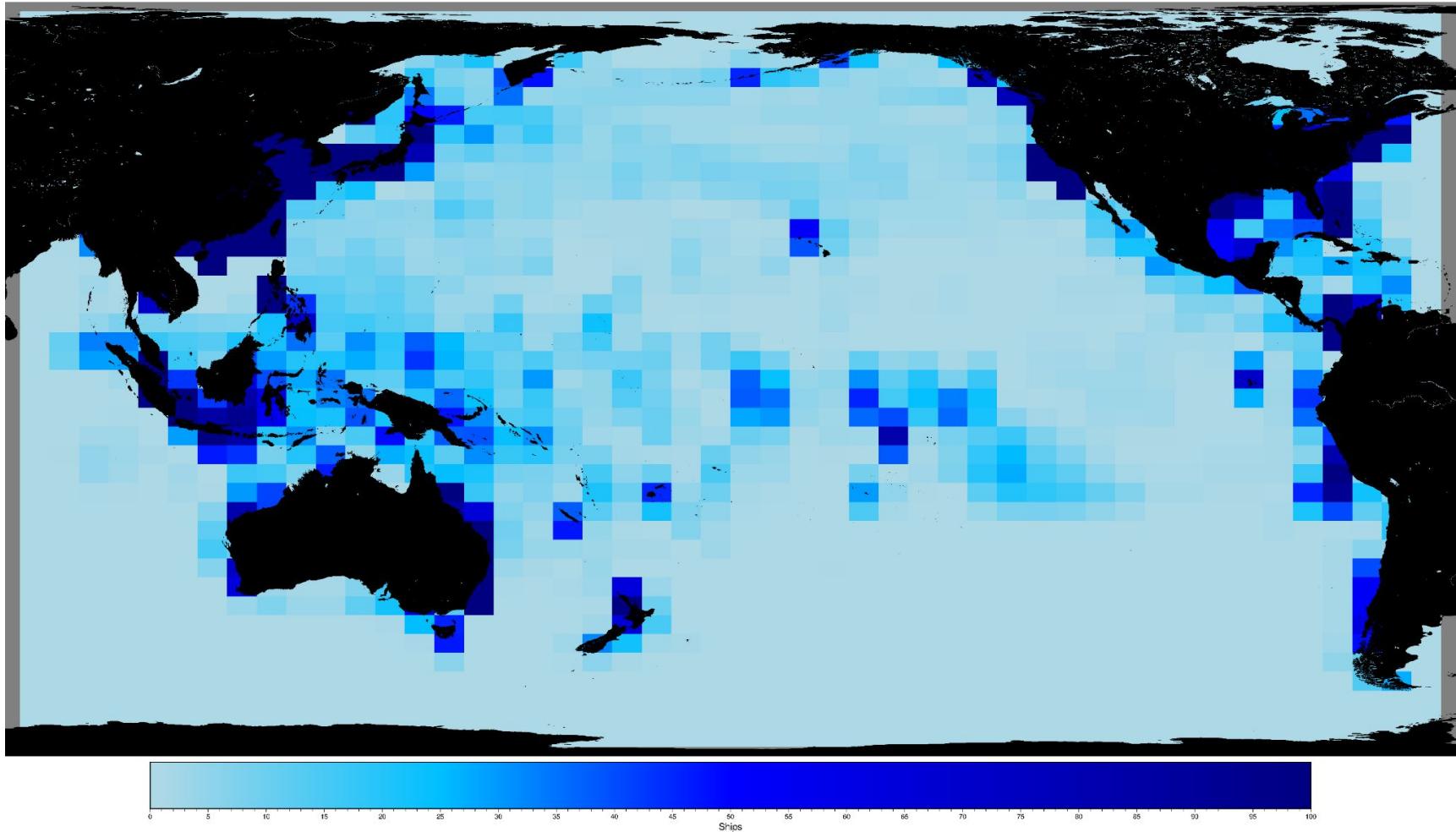
Hourly average of the number of cargo ships in the Pacific Ocean in January



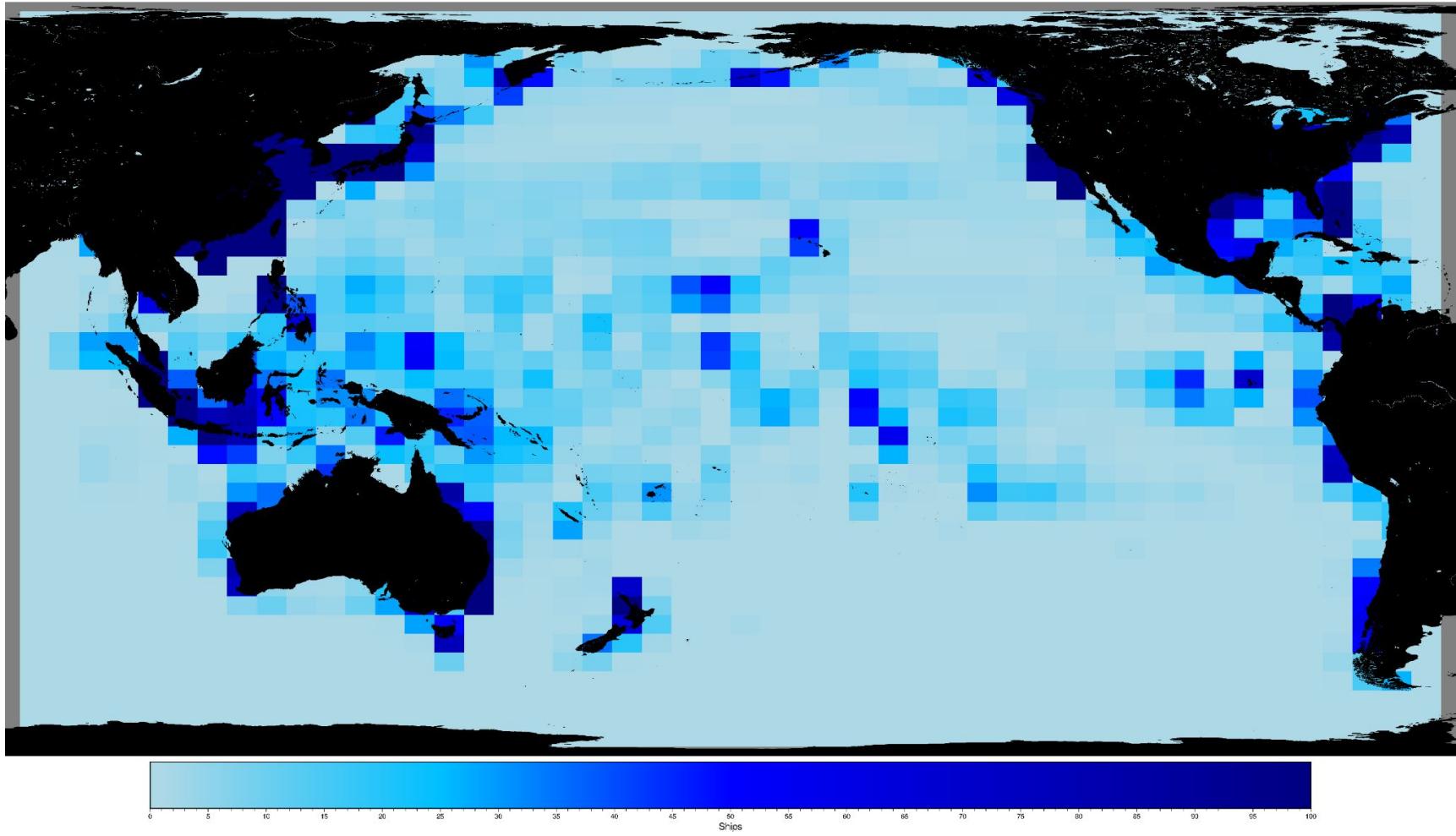
Hourly average of the number of cargo ships in the Pacific Ocean in May



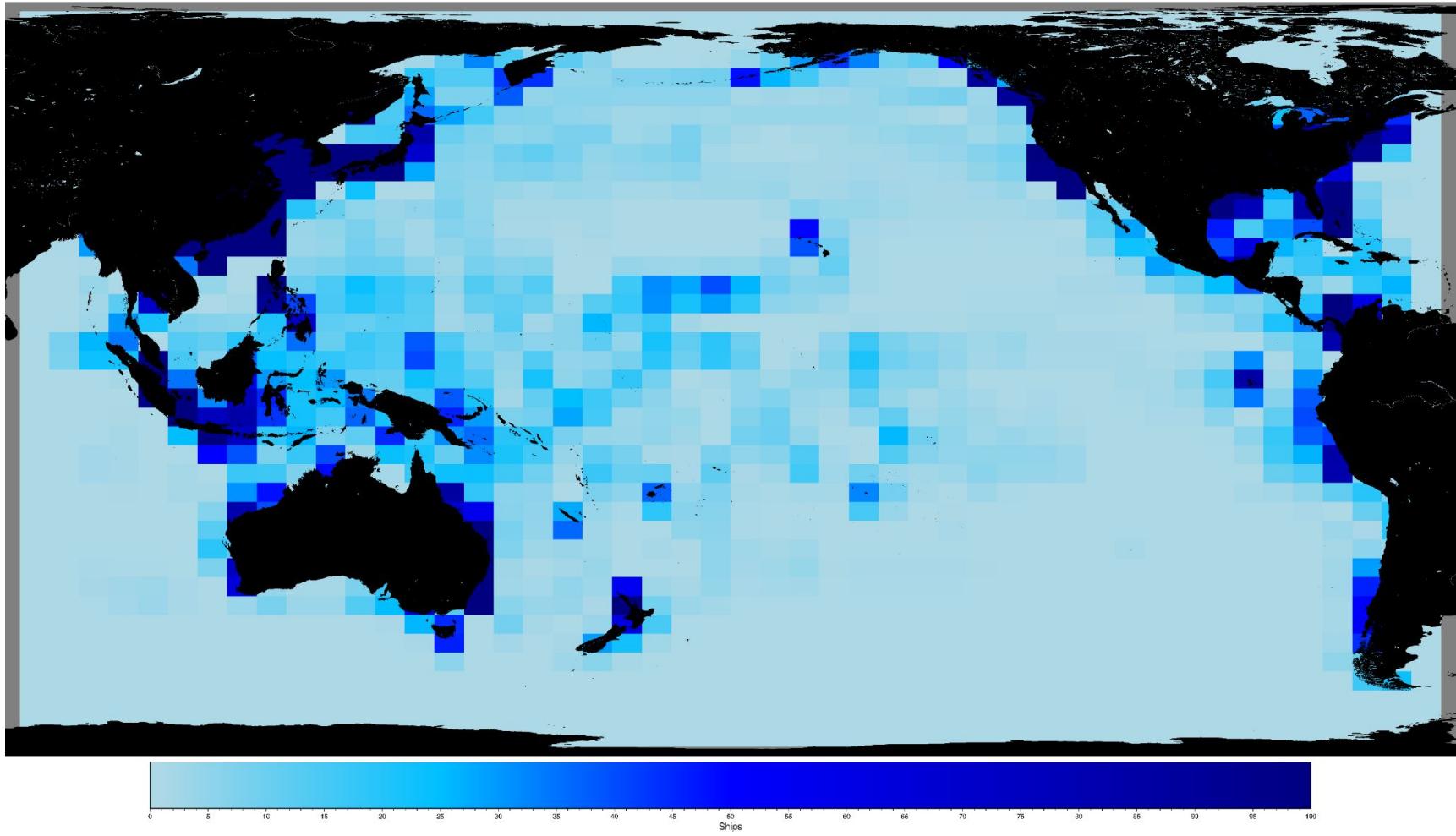
Hourly average of the number of cargo ships in Autumn in the Pacific Ocean



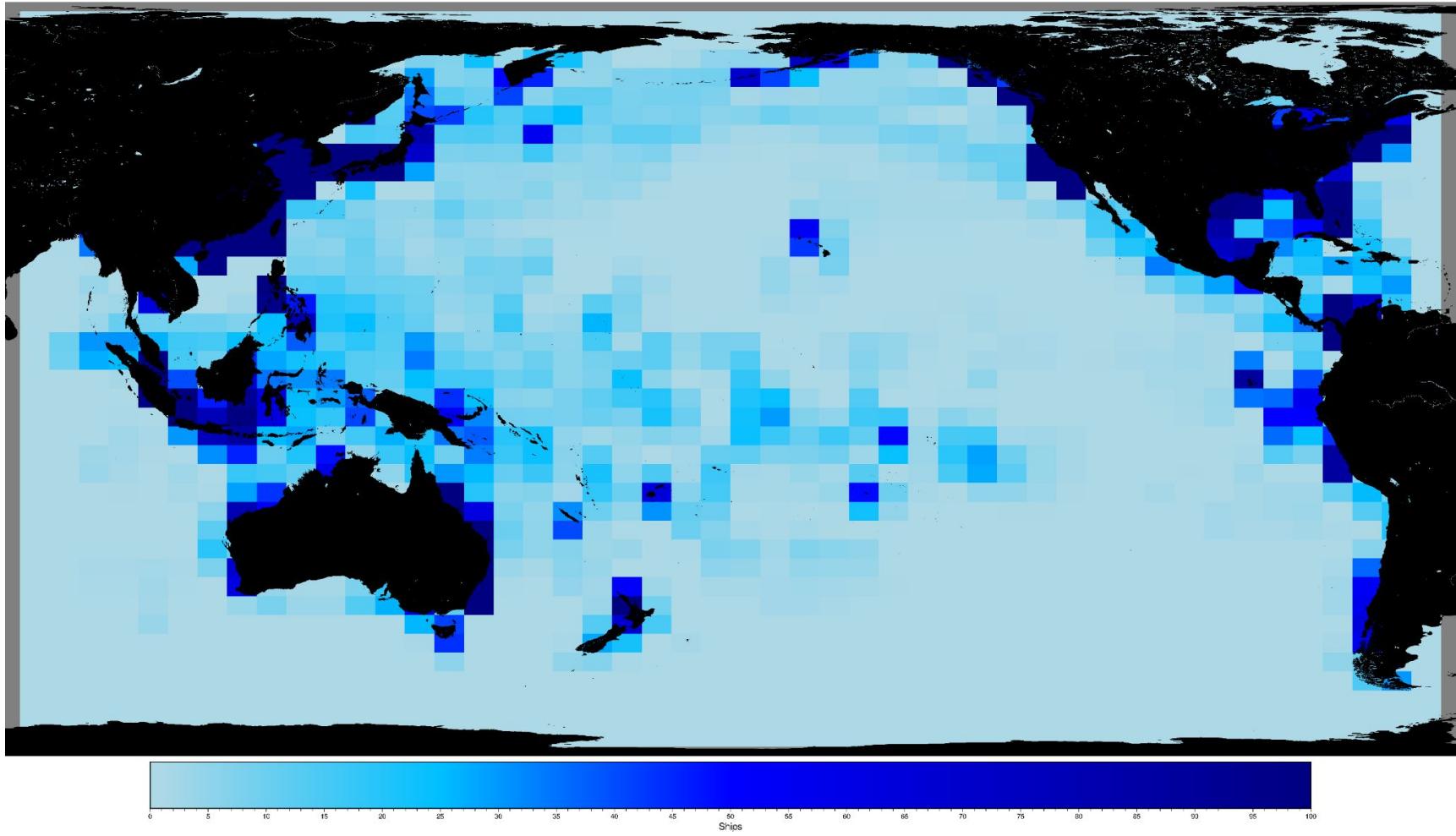
Hourly average of the number of cargo ships in Winter in the Pacific Ocean



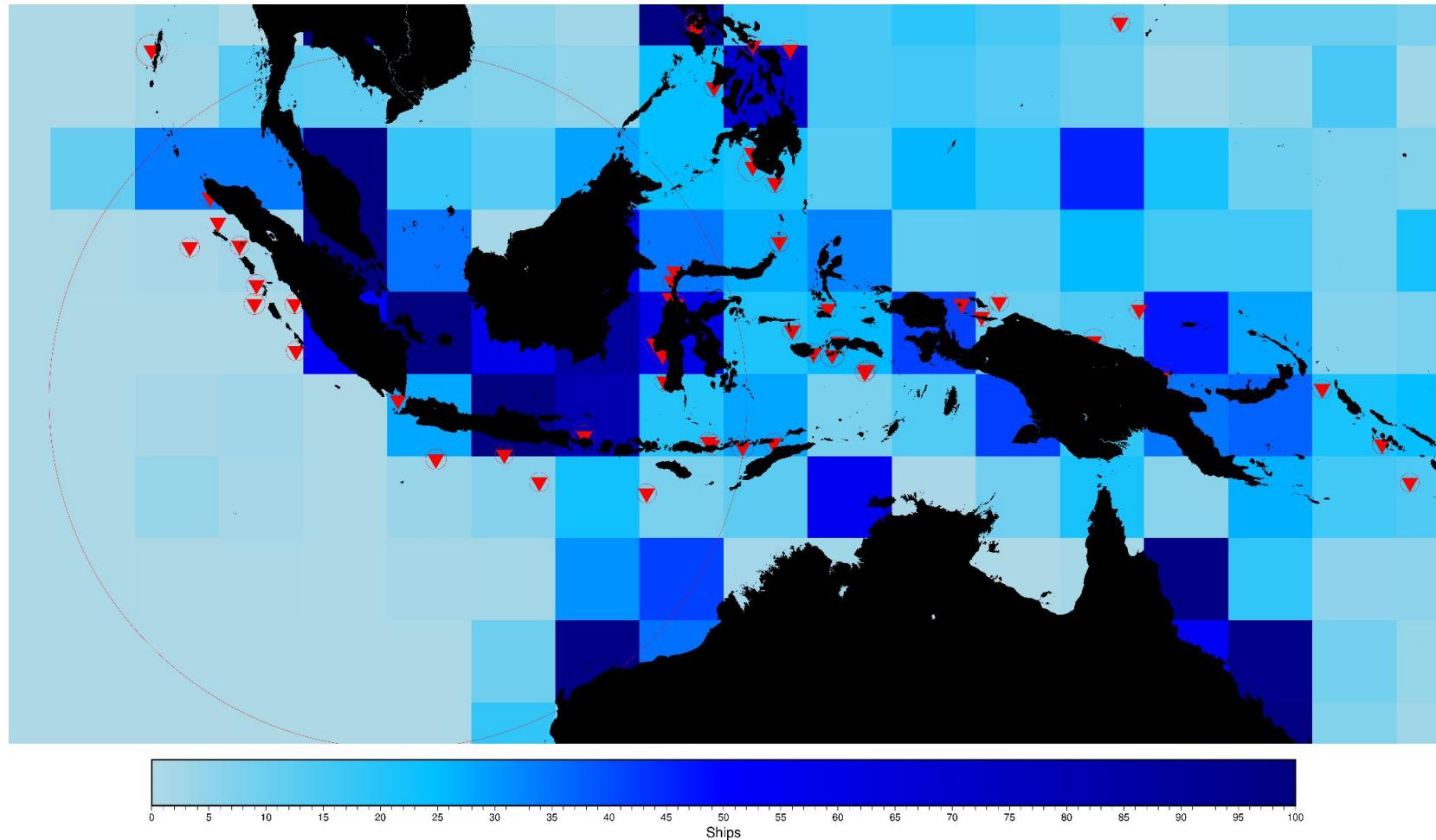
Hourly average of the number of cargo ships in Spring in the Pacific Ocean



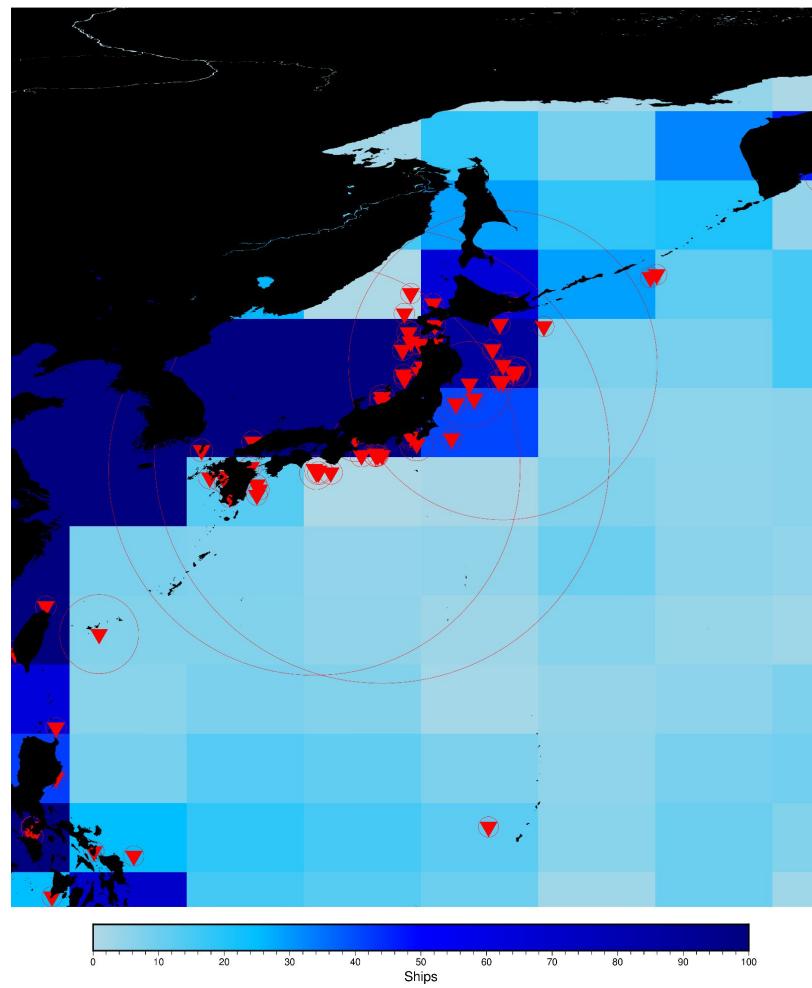
Hourly average of the number of cargo ships in Summer in the Pacific Ocean



Hourly average in a year of the number of cargo ships in Indonesia



Hourly average of the number of cargo ships in a year in Japan



Hourly average of the number of cargo ships in a year in Tonga

