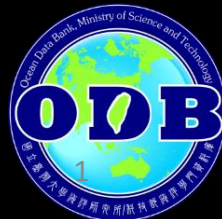
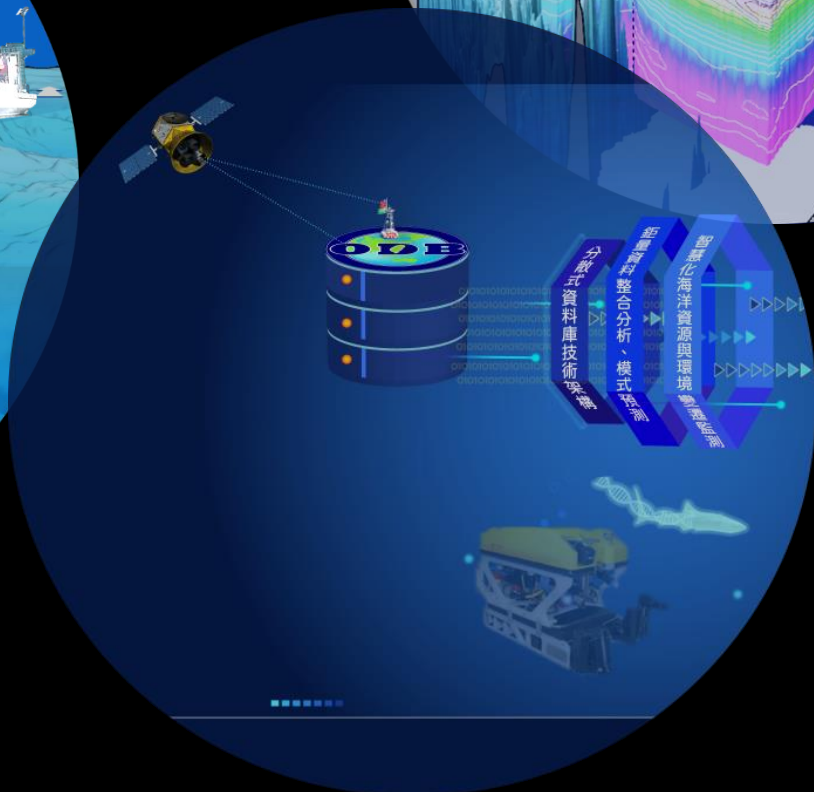
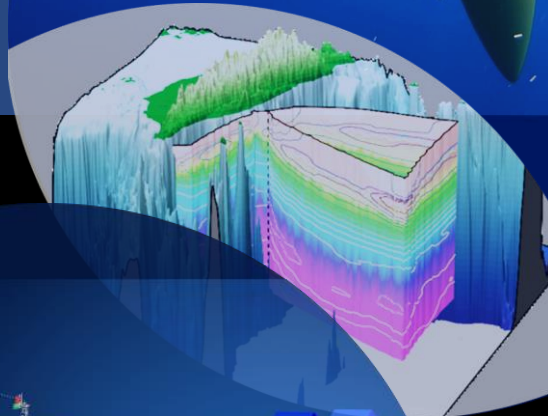


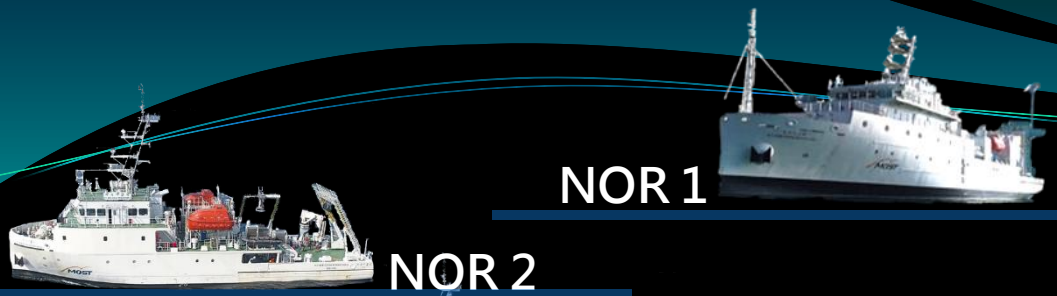
海洋資料庫的科學探索

動手"做"海洋資料

海洋學門資料庫 (ODB)

翁其羽





NOR 1

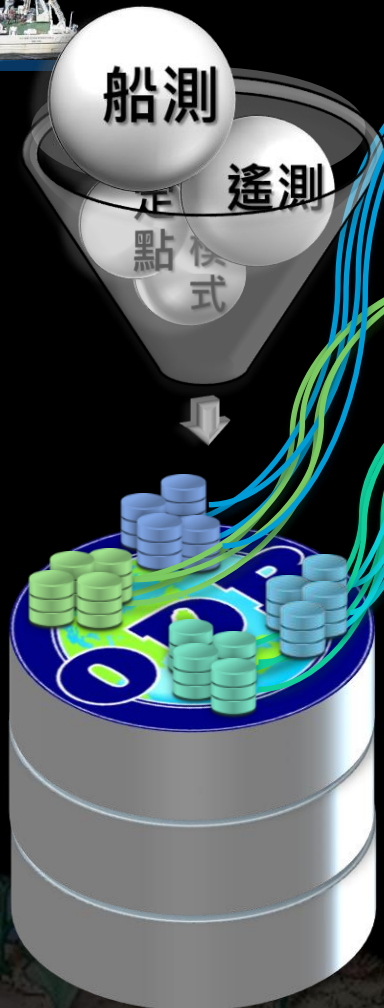
NOR 2



NOR 3

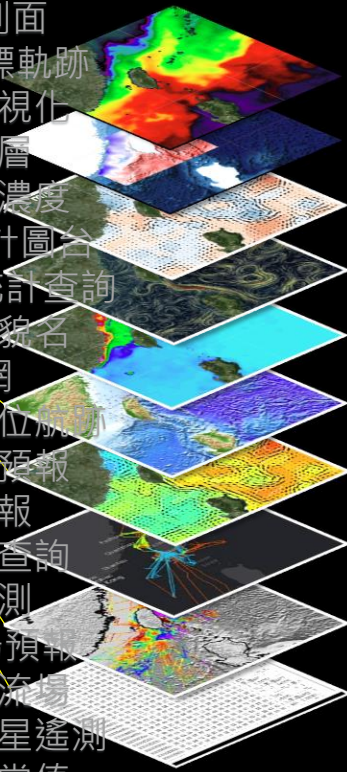


- 溫度/鹽度/深度
- 海流
- 多音束聲納
- 單音束聲納
- 重力
- 波浪雷達
- 海床底質剖面
- 二氧化碳分壓



- 物理海洋
- 地質地物
- 化學海洋
- 生物海洋

ARGO水文剖面
 SVP漂流浮標軌跡
 資料數據可視化
 海面溫度圖層
 海面葉綠素濃度
 CTD溫度統計圖表
 ADCP海流統計查詢
 海底地形地貌圖
 Glider觀測網
 海洋研究船位航跡
 潮汐與潮流預報
 海洋數值預報
 統計平均場查詢
 海洋渦旋偵測
 ECMWF風場預報
 視覺化動態流場
 海面高度衛星遙測
 海面高度異常值
 地轉流向量場
 海表溫度鋒面
 表面漂流軌跡推算
 水深斷面擷取
 浮游動物群聚分析
 海洋影像辨識資訊



新海研1號儀器資訊看板

NOR1/OR205/uart9
/data/seapath
2021/10/03 12:41:39
148559
緯度: 27 21.2134
經度: 121 48.8589
高度: 5.83 速度: 9.7 節
日期:

NOR1/OR203/co2ht4/data
2021/10/03 12:06:33
513863
513, 46.5, 24.4
512, 46.6, 24.4
521, 46.4, 24.4
520, 46.1, 24.4
526, 45.7, 24.4
526, 45.6, 24.4

NOR1/OR205/weather1
/data/bowntu
2021/10/03 12:41:39
314203
SPORWIA, 003, 09698080
31, 366, 27138, 12423, 2
0243, 60200, 00014, 390
62, 00015, 26474, 03668
, 31343*31

NOR
2021
5728
202
04:
0:0
0:0
04:
0:0
0:0
202
04:
0:0
0:0
202
04:
0:0
0:0
202
04:
0:0
0:0
202
04:
0:0
0:0

NOR1/OR205/uart10/data/gpgps
2021/10/03 12:41:39
484112
緯度: 27 21.2142
經度: 121 48.8593
高度: 5.88 速度: 9.7 節
日期:

NOR1/OR205/uart9/data/chirp
2021/10/03 12:41:39
136550
SETDBT, 252.4, f, 76.9,
M, 42.1, F*0E
SETDBT, 252.9, f, 77.1,
M, 42.1, F*0A
SETDBT, 251.7, f, 76.7,
M, 42.0, F*01
SETDBT, 263.6, f, 80.4,
M, 43.9, F*03
SETDBT, 249.7, f, 76.1,
M, 41.6, F*0B
SETDBT, 248.9, f, 75.9,
M, 41.5, F*0C

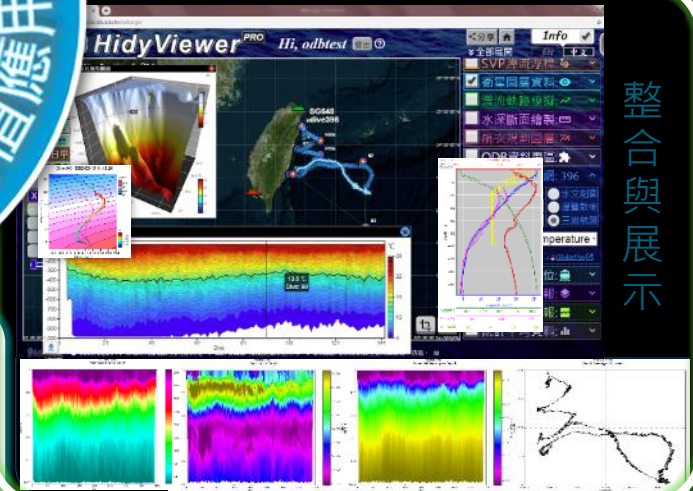
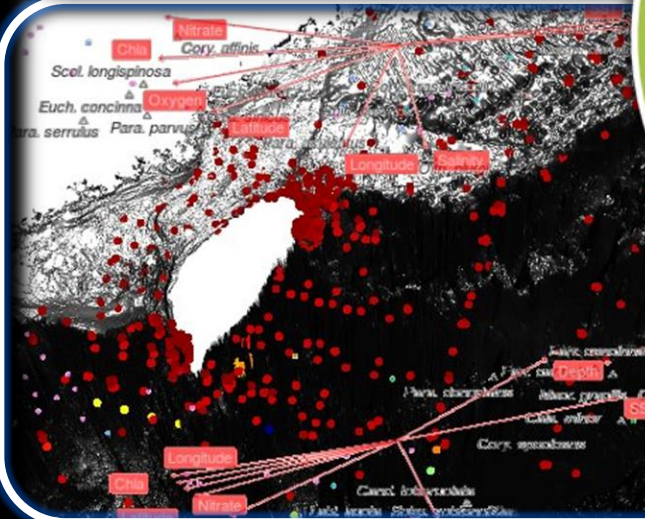
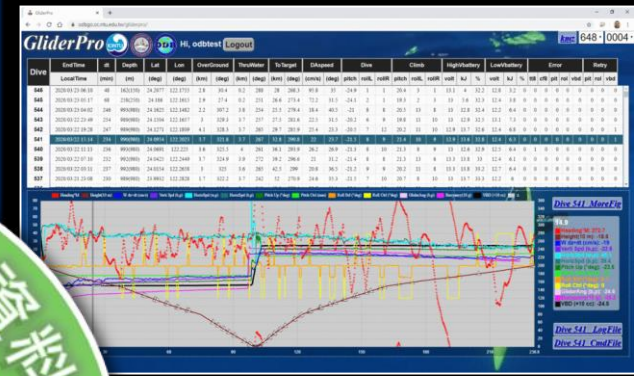
SPORWIA, 003, 09698083
29, 363, 35138, 12435, 2
0404, 60200, 00014, 390
62, 00013, 26474, 03522
, 30451*31
SPORWIA, 003, 09698083
30, 363, 38244, 12427, 2
0450, 60200, 00015, 390
62, 00014, 26474, 03602
, 30397*34
SPORWIA, 003, 09698083
31, 363, 38379, 12434, 2
0467, 60200, 00014, 390
62, 00014, 26474, 03793
, 30918*3B
SPORWIA, 003, 09698083
32, 363, 41348, 12423

NOR1/OR205/uart7/data/gyro2
2021/10/03 12:41:40
219133
019.70



ODB Glider Pro

駕駛專用平台



整合與展示



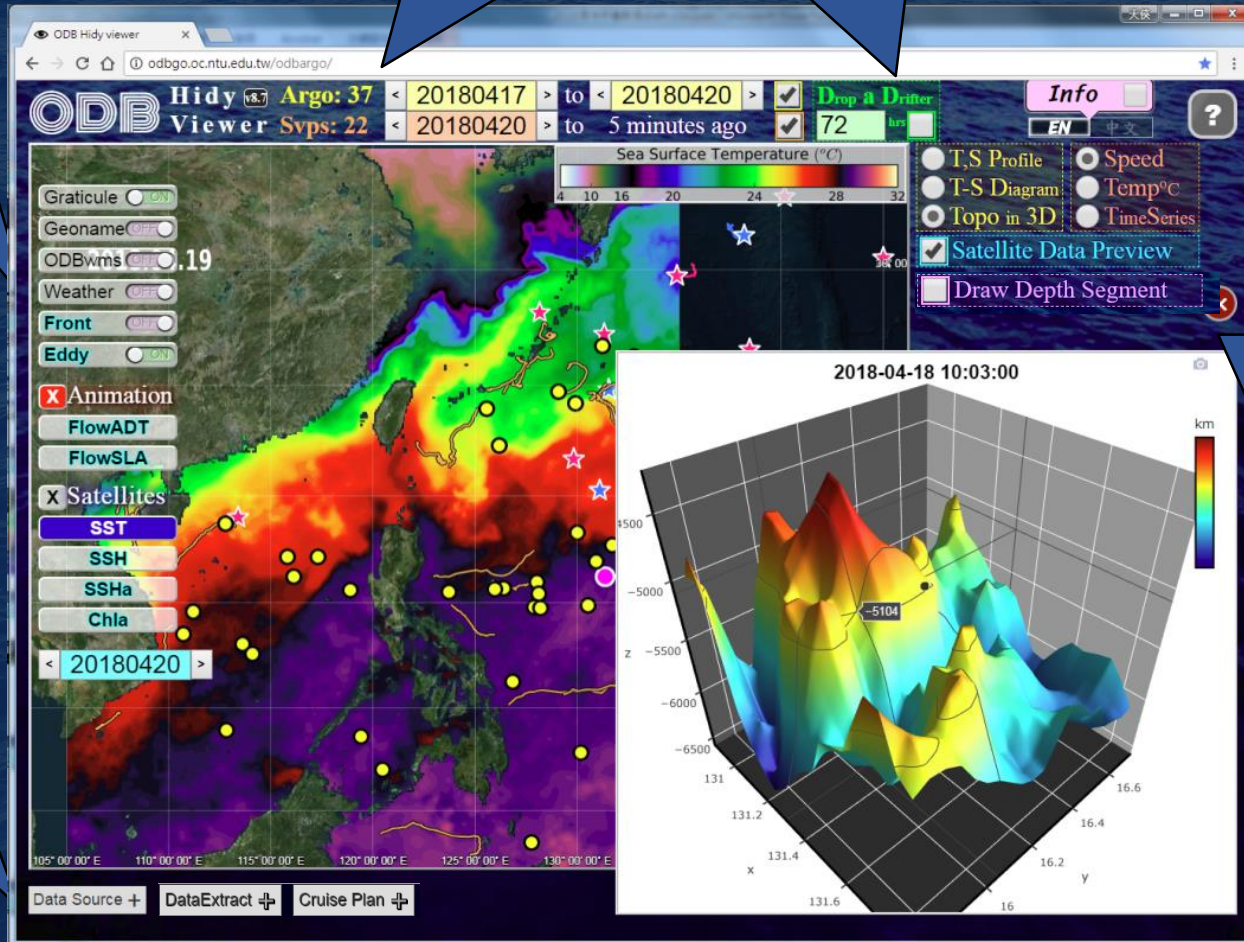
ODB Hidy viewer – 「海的」資料展示網頁

(<http://odbgo.oc.ntu.edu.tw/odbargo/>)

臺灣周遭海域Argo、SVP
數量與時間顯示／控制

表層平均場漂流軌跡模擬

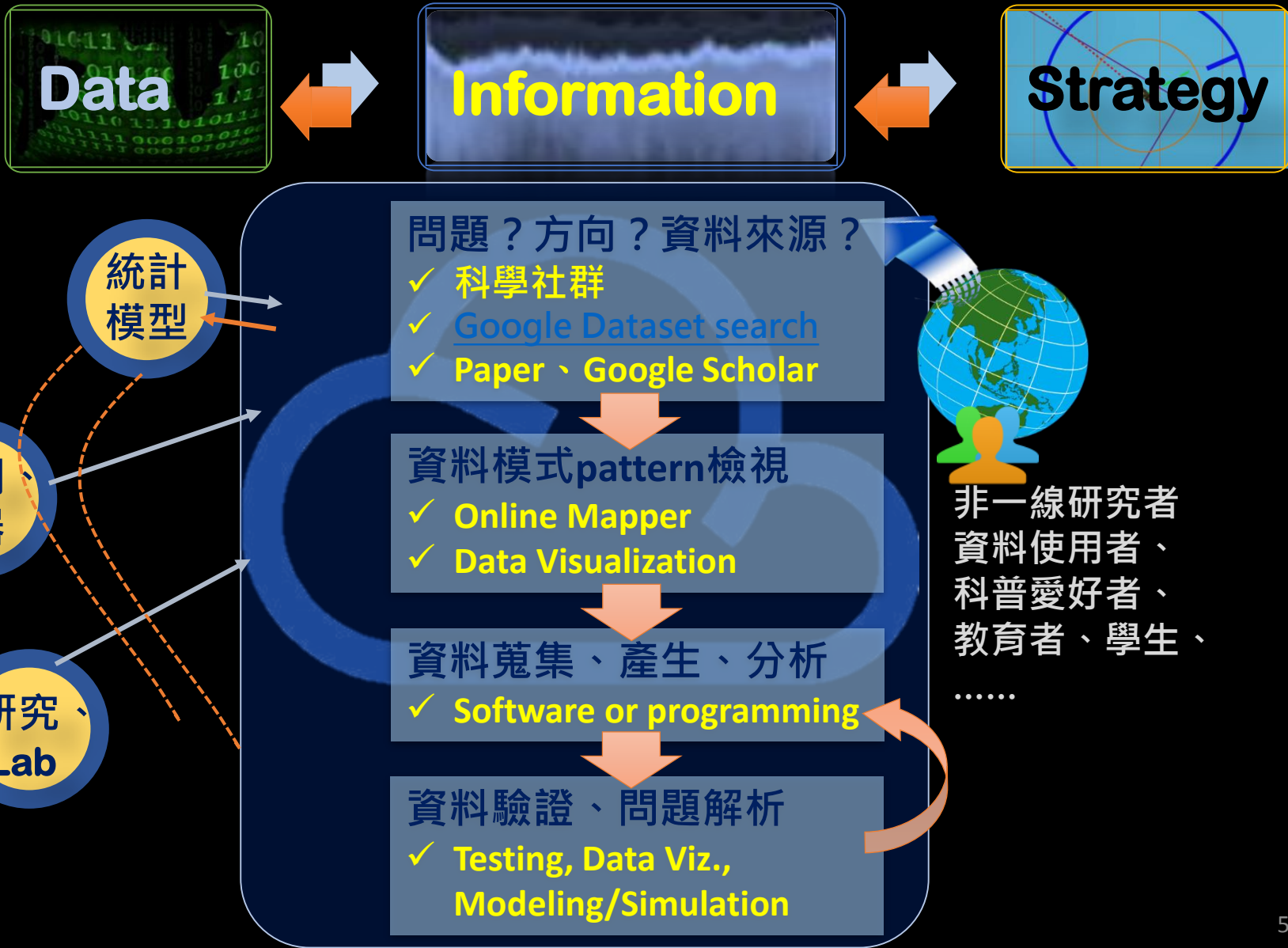
海洋地名圖層、
物理環境疊圖，
如海表溫度
SST、溫度鋒面、
渦旋、海流等



Argo水文溫
鹽深度剖面、
溫鹽密度分
布、附近3D
地形、SVP
漂流速度、
其軌跡海水
溫度、時間
序列等圖資

資料來源、資
料匯出、航次
規劃工具

Information Application Pipeline



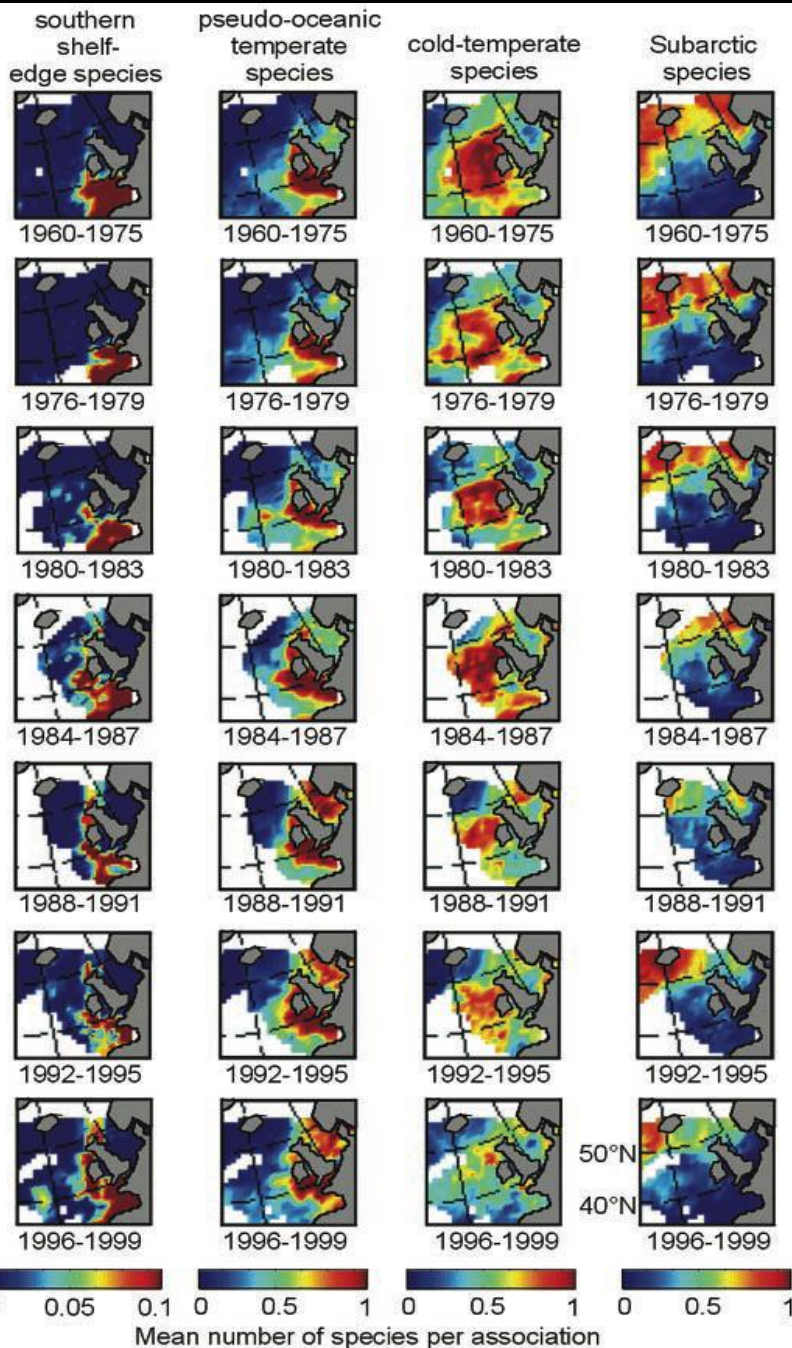
Biogeographical shifts

生物地理遷移

- ✓ warm-water species northward 10°
- ✓ cold-water species decrease

Strongly affected by SST Anomaly

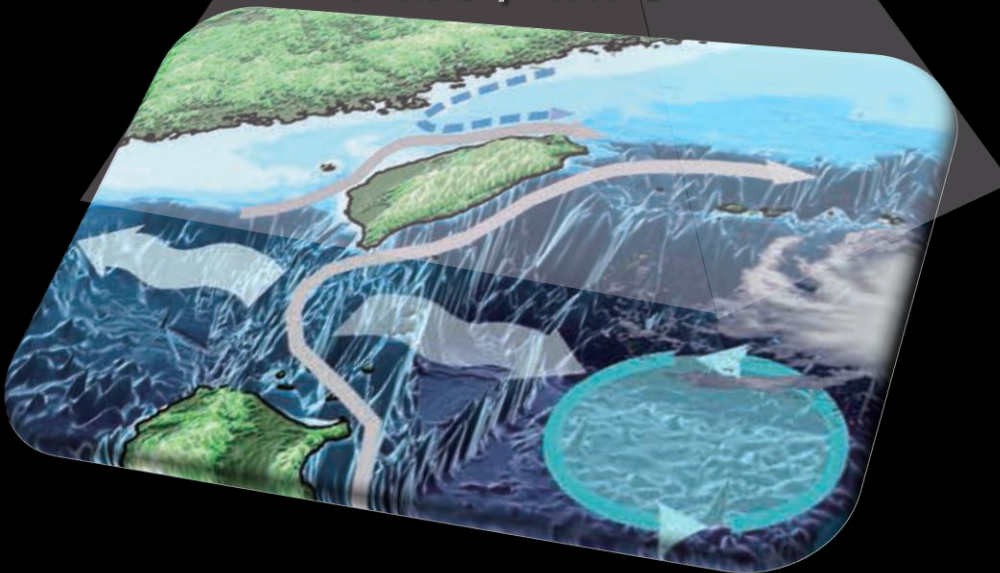
異常海表溫（海表面溫度
距平值）



在較大時空規模下
海溫 常是海洋生態機制的主要驅動因子之一



Scale
尺度；格局



較大尺度的海表溫增溫 /
異常事件

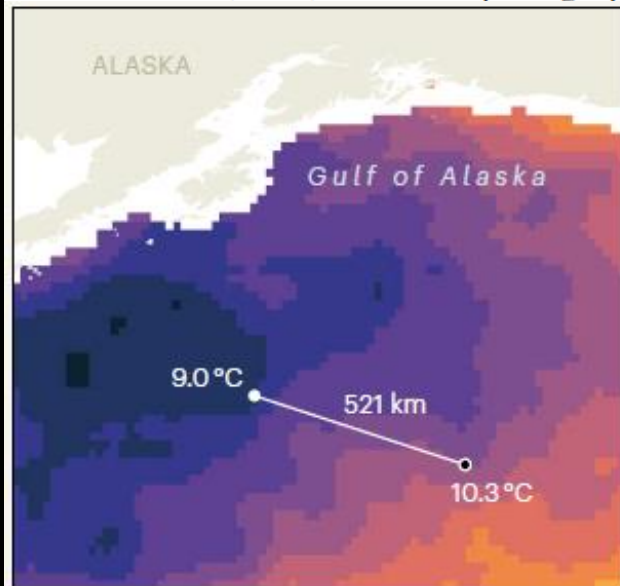
Global warming
El Niño / La Niña
Marine Heatwaves

Thermal displacement by marine heatwaves

Michael G. Jacox , Michael A. Alexander, Steven J. Bograd & James D. Scott*Nature* 584, 82–86 (2020) | [Cite this article](#)7426 Accesses | 37 Citations | 714 Altmetric | [Metrics](#)

Abstract

Marine heatwaves (MHWs)—discrete but prolonged periods of anomalously



, with profound ecolog
 t has been directed at
 1. Typically, MHWs are

Sea surface
 temperature (°C) 8 9 10 11 12 13

JACOX, Michael G., et al. **Thermal displacement by marine heatwaves**. *Nature*, 2020, 584.7819: 82-86.
www.nature.com/articles/s41586-020-2534-z

Figure redrawn by PAYNE, Mark R. Marine heatwaves put into context. *Nature*, 2020, 584.7819: 43-44.

以全球尺度、持續性 海洋熱浪(MHWs)考慮 異常海表溫可能造成 生物分布變動的 量化指標

The author's github:
 (in Matlab)

github.com/mjacox/Thermal_Displacement

My working github:
 (in R)

github.com/cywhale/marineheatwave

問題？方向？資料來源？

- ✓ 科學社群
- ✓ [Google Dataset search](#)
- ✓ Paper、Google Scholar

資料模式pattern檢視

- ✓ Online Mapper
- ✓ Data Visualization

資料蒐集、產生、分析

- ✓ Software or programming

資料驗證、問題解析

- ✓ Testing, Data Viz.,
Modeling/Simulation

Check Data Patterns

QGIS

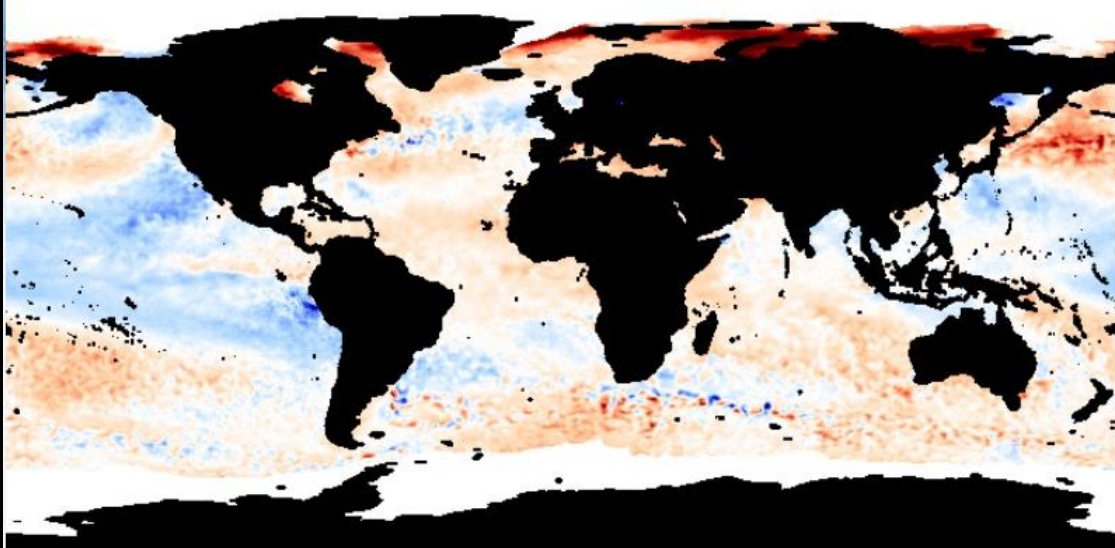
NASA Earth Observations NEO

NASA NEO NASA EARTH OBSERVATIONS

ATMOSPHERE ENERGY LAND LIFE **OCEAN** NEWS ABOUT

0 IMAGES ANALYZE

SEA SURFACE TEMPERATURE ANOMALY (1 MONTH - AQUA/AMSR-E, 2002-11)



ADD TO ANALYSIS

Currently viewing:
September 2011
Permalink

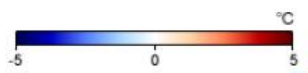
Downloads

File Type: **JPEG**

Color Grayscale

1.0 degrees	360 x 180
0.5 degrees	720 x 360
0.25 degrees	1440 x 720

View by date:
1 day 8 day **1 mo**



Download color table

Dataset you are currently viewing: September 2011 Select Year **2011**

August 2011 **September 2011** October 2011 November 2011 December 2011

Notes
AMSR-E ended data collection in October 2011 due to problems with the rotation of its antenna.

Related Websites
[Aqua](#)
[Aqua AMSR-E](#)

Further Reading
[Sea Surface Temperature Anomaly](#)

利用QGIS下載NEO資料 QGIS

WMS: NEO 頁面下拉到底

Dataset Index **WMS** Bulk Download Contact Us

Capabilities Documents

1.1.1 Capabilities

1.3.0 Capabilities

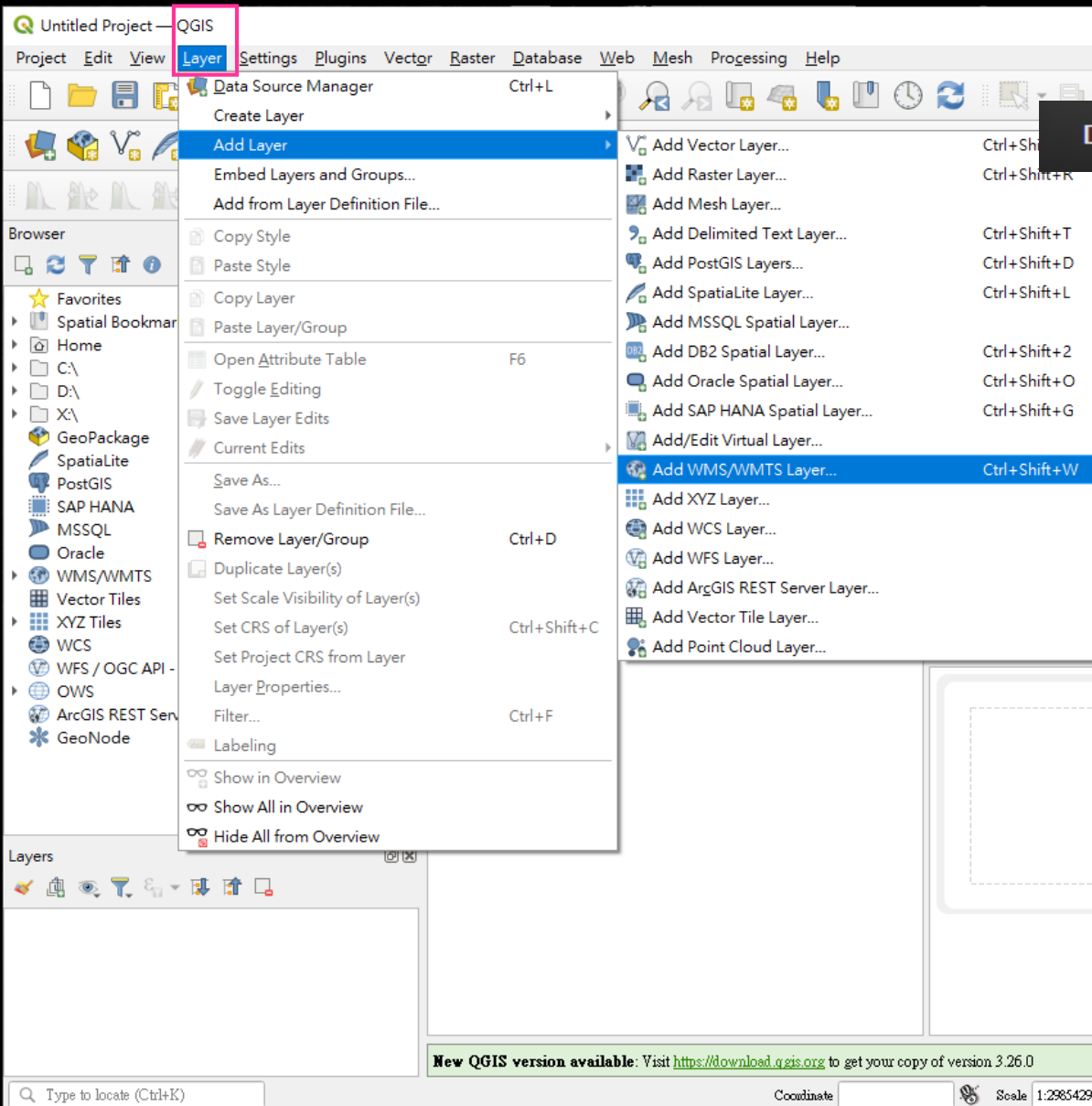
<https://neo.gsfc.nasa.gov/wms/wms>

Web地圖服務

Web Map Service, **WMS**

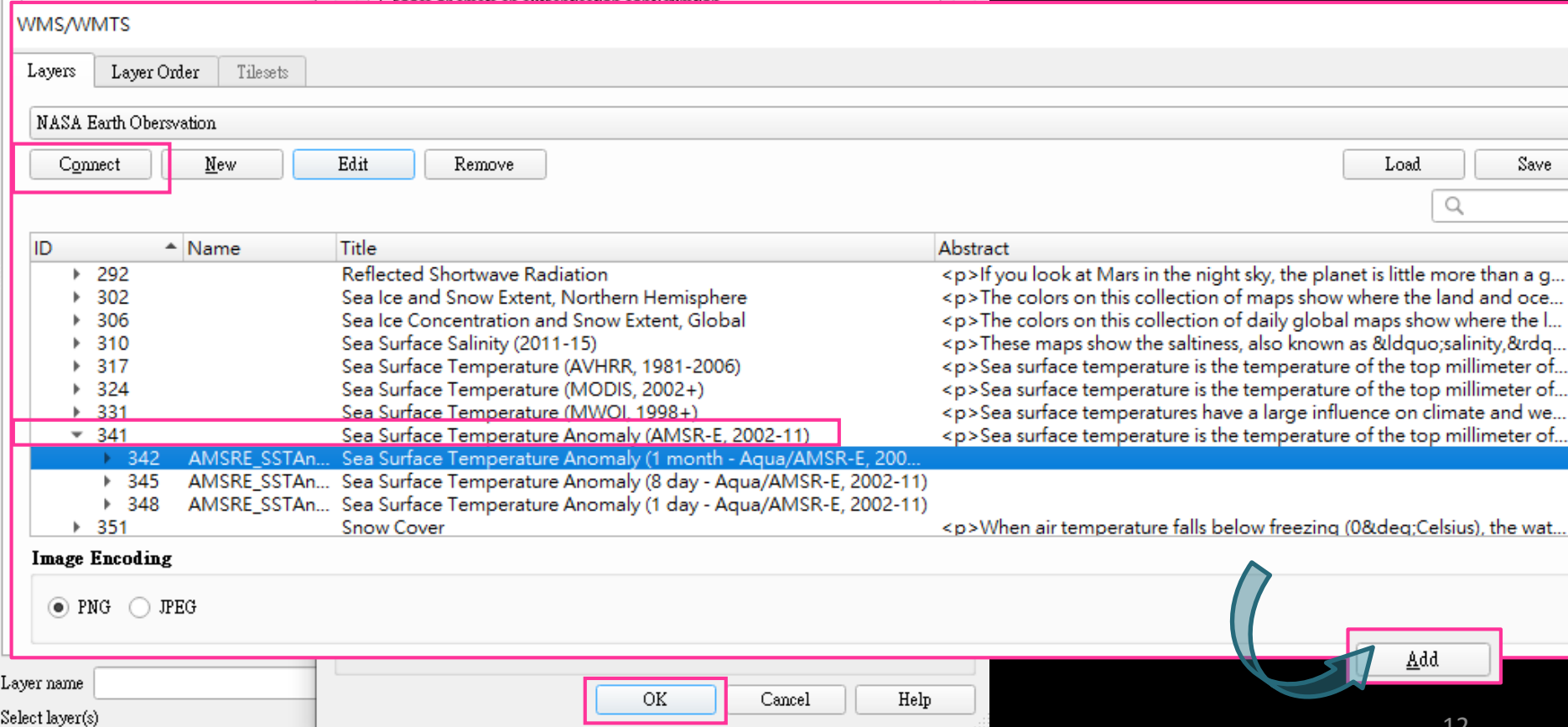
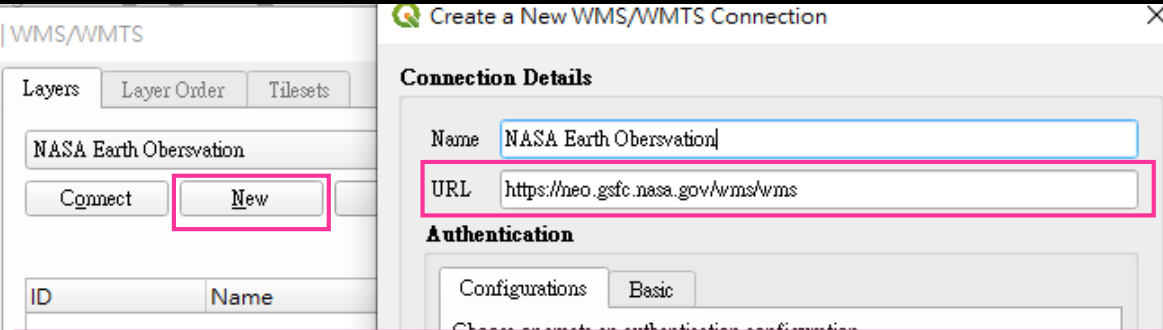
將伺服器上的地理圖層資訊，
透過網路協定傳輸的網路服務
規範

- GetCapabilities
- GetMap

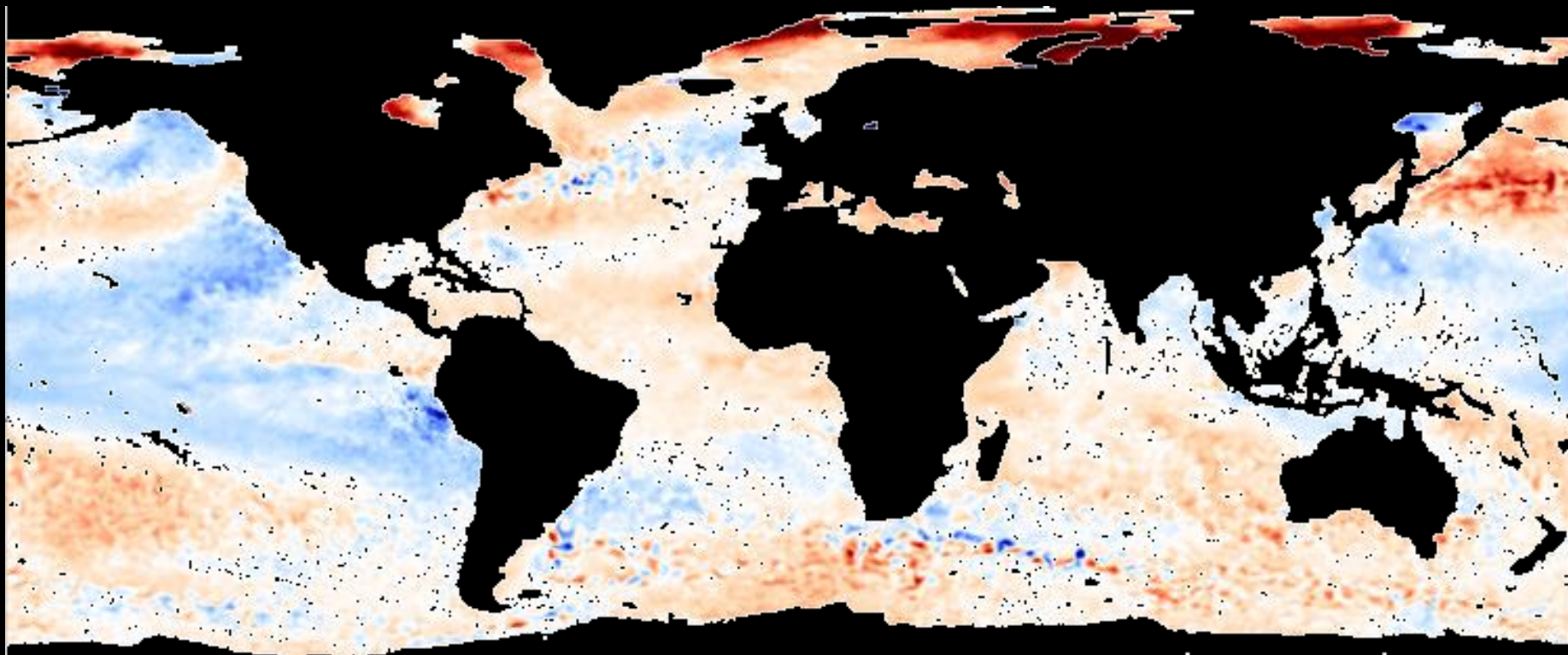


在QGIS中設定NEO WMS

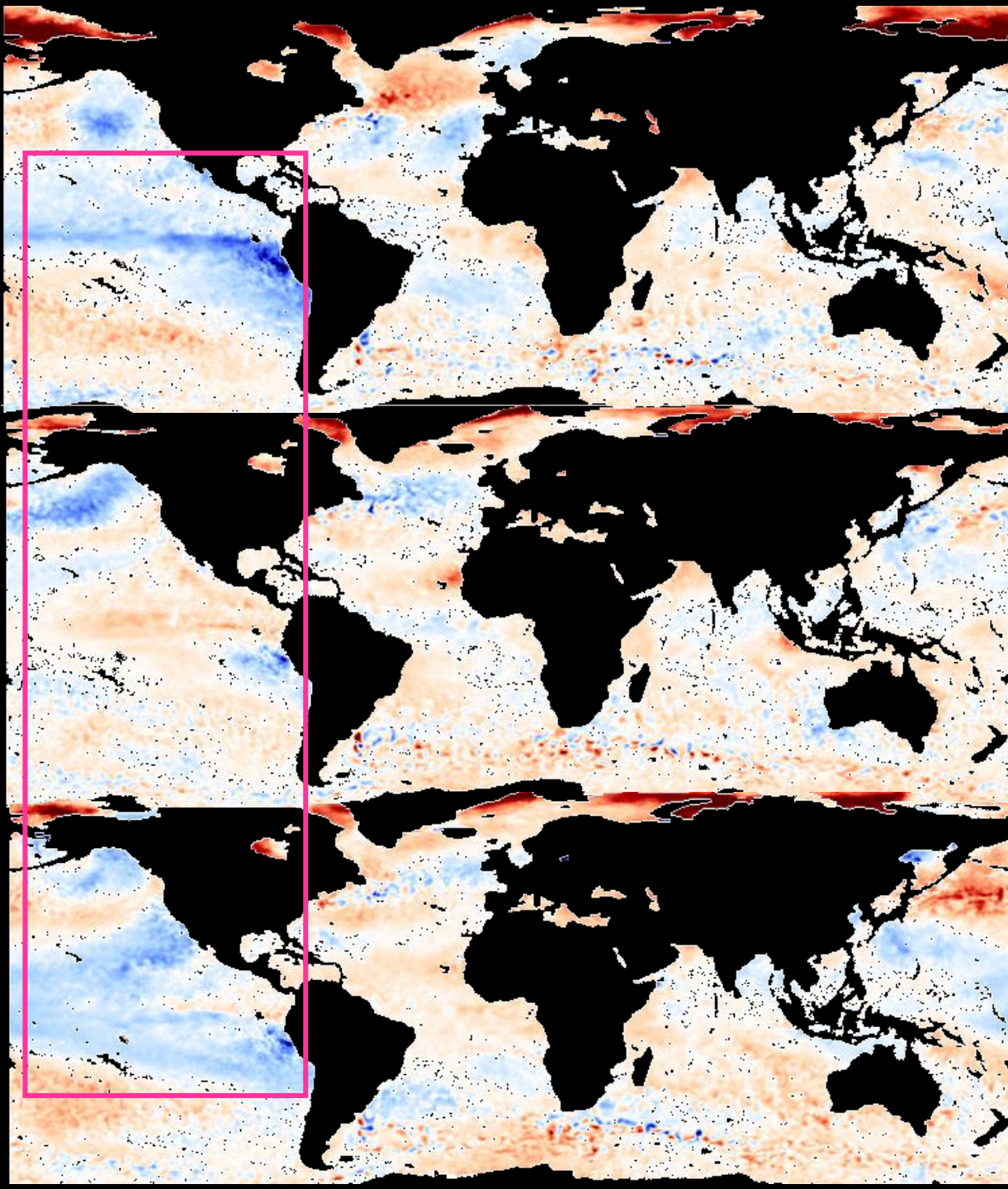
<https://neo.gsfc.nasa.gov/wms/wms>



在QGIS中檢視 SST Anomaly 資料模式



201109



2007

在QGIS中檢視 SST Anomalies 資料模式

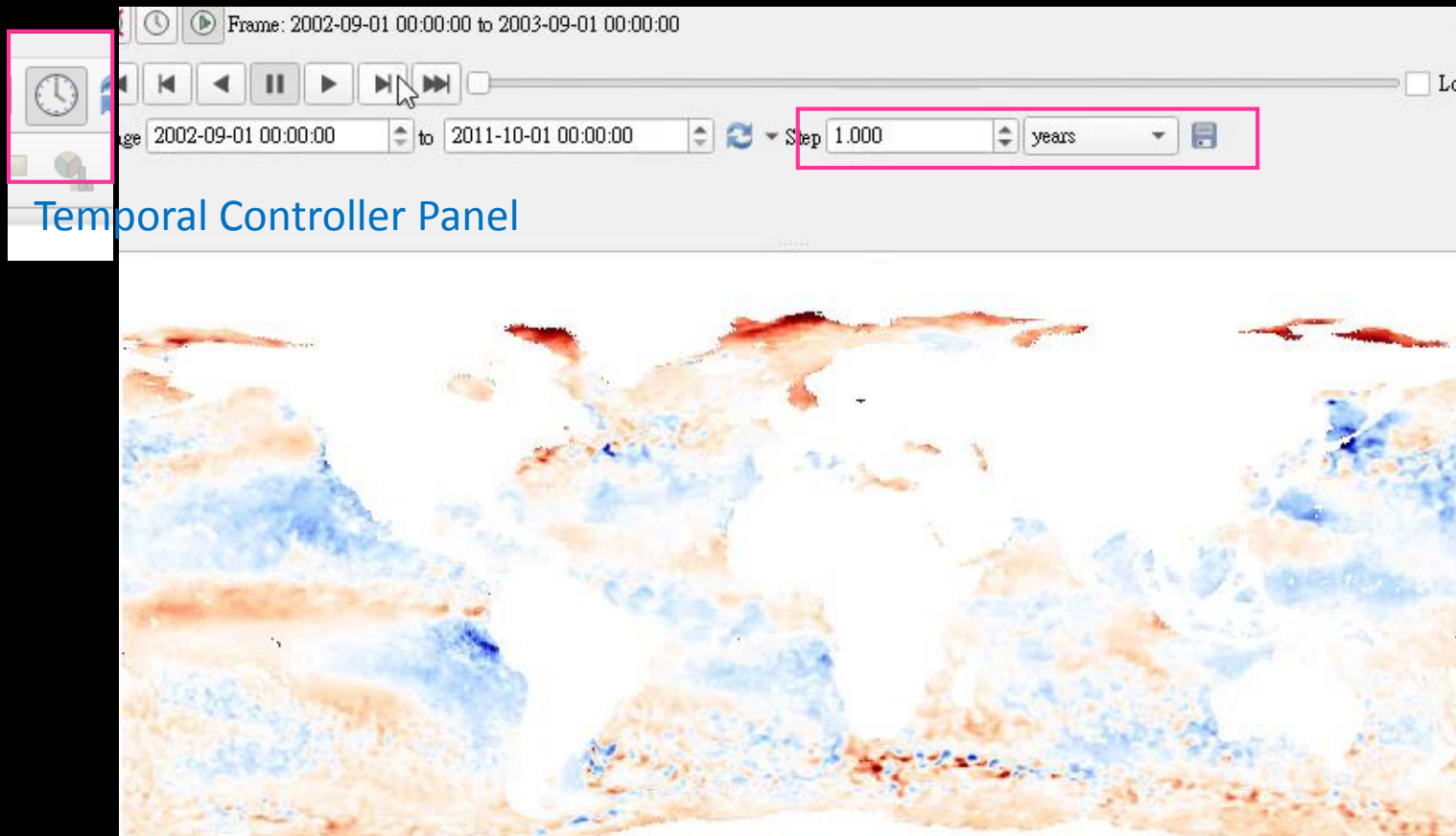
2009

- ✓ 2007(強), 2011(中)
反聖嬰
- 2009 聖嬰(弱)

see: ggweather.com/enso/oni.htm

2011

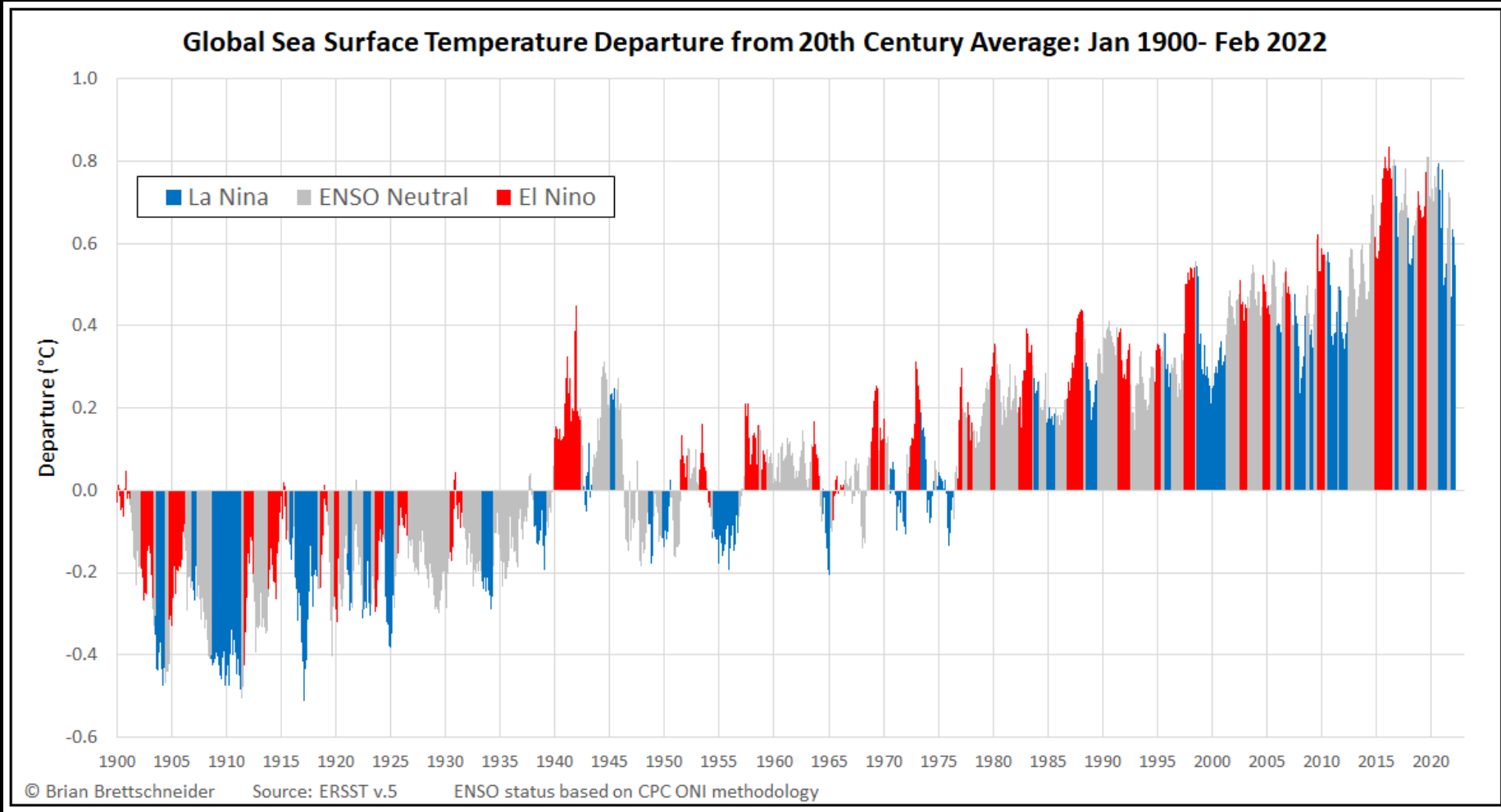
在QGIS中利用時間動態檢視資料模式



- ✓ WMS適合呈現，快速瀏覽資料模式
- ✓ NEO raster 有經過處理，非原始資料，作為資料分析，建議參考其[blog](#)說明與原始資料下載
- ✓ QGIS 亦提供許多Raster analysis tools，可參考其[線上手冊](#)

Global SST anomaly average

by Brian Brettschneider



Cited from: twitter.com/Climatologist49/status/1499491799521390592

NEO的資料有其限制，試試其他資料來源？

NASA EARTHDATA Ocean Color

L3 browser

Level-3 Browser

The screenshot displays the NASA EarthData Level-3 Browser interface. On the left, there are search filters for Product Status (Standard), Sensor (MODIS-Aqua), Start Date (2002-07-04), and End Date. Below these are navigation buttons for 'Previous' and 'Next', and a calendar view for selecting a date. The main area shows a large satellite image of the sea surface temperature (SST) for September 2021, with a color scale ranging from 0 to 10. A dropdown menu is open over the image, showing various time periods for data retrieval: Monthly Climatology (selected), 8-day, Annual, Daily, Entire Mission Composite, Monthly, Monthly Climatology, Rolling 3-day Quick-Look, Rolling 32-day, Seasonal, and Seasonal Climatology. Below the image, there is a legend for 'MODIS-Aqua Sea Surface Temperature (11 μ daytime) September 2021 (Monthly)' with 'SMI: SMI' highlighted in a pink box. The legend also includes 'Bin: BIN' and 'Images: 4km 9km'. At the bottom, there are calendar views for January 2022 and February 2022.

Product Status: Standard | Sensor: MODIS-Aqua | Start Date: 2002-07-04 | End Date: []

Period: Monthly Climatology (selected)

MODIS-Aqua Sea Surface Temperature (11 μ daytime)
September 2021 (Monthly)
SMI: SMI | Bin: BIN | Images: 4km 9km

QGIS Raster Calculator

1. Drag & Drop your NetCDF(.nc) files into QGIS, set Layer CRS

2. Raster -> Raster Calculator

Raster Bands

- AQUA_MODIS_20020901_20210930_L3m_SST_4km@1
- AQUA_MODIS_20110901_20110930_L3m_SST_4km@1
- AQUA_MODIS_20130901_20130930_L3m_SST_4km@1
- AQUA_MODIS_20150901_20150930_L3m_SST_4km@1
- AQUA_MODIS_20210901_20210930_L3m_SST_4km@1
- sst_anomaly_201109@1
- sst_anomaly_201309@1
- sst_anomaly_201509@1
- sst_anomaly_202109@1

Result Layer

Output layer: portfworkshop\est_anomaly_201109.tif

Output format: GeoTIFF

Selected Layer Extent

X min: -180.00001, X max: 180.00001

Y min: -90.00001, Y max: 90.00000

Columns: 8640, Rows: 4320

Output CRS: EPSG:4326 - WGS 84

Add result to project

Operators

+	*	sqrt	cos	sin	tan	log10	(
-	/	^	acos	asin	atan	ln)
<	>	=	!=	<=	>=	AND	OR
abs	min	max					

Raster Calculator Expression

"AQUA_MODIS_20110901_20110930_L3m_SST_4km@1" - "AQUA_MODIS_20020901_20210930_L3m_SST_4km@1"

"Layer 1 (Monthly)" - "Layer 2 (Monthly Climatology)"

Expression valid

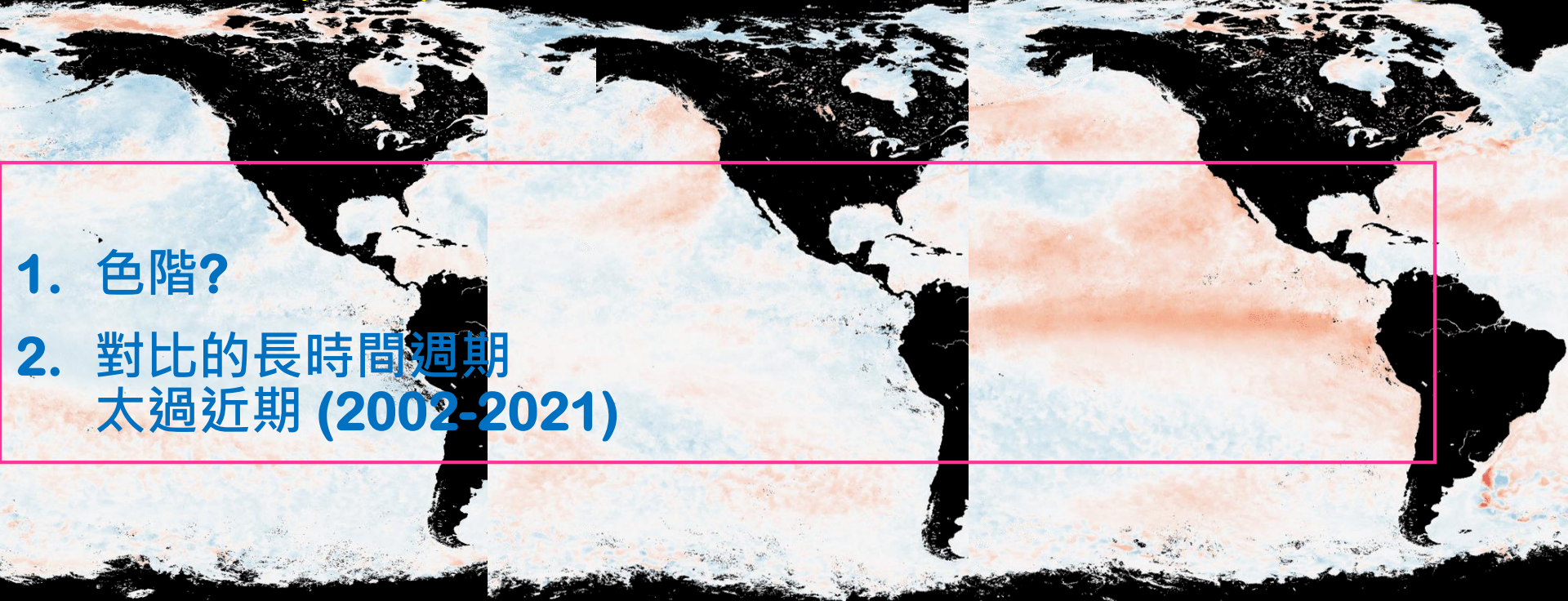
OK Cancel Help

比較 SST Anomalies 呈現的資料模式 (vs. NEO WMS pattern)

2011 La Niña (weak)

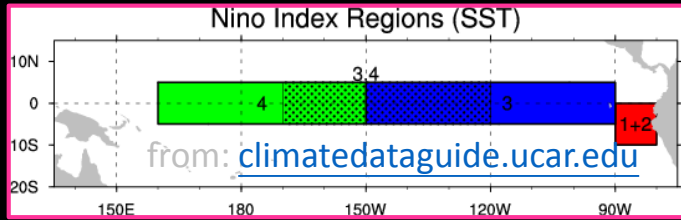
2013 Normal

2015 El Niño (Strong)



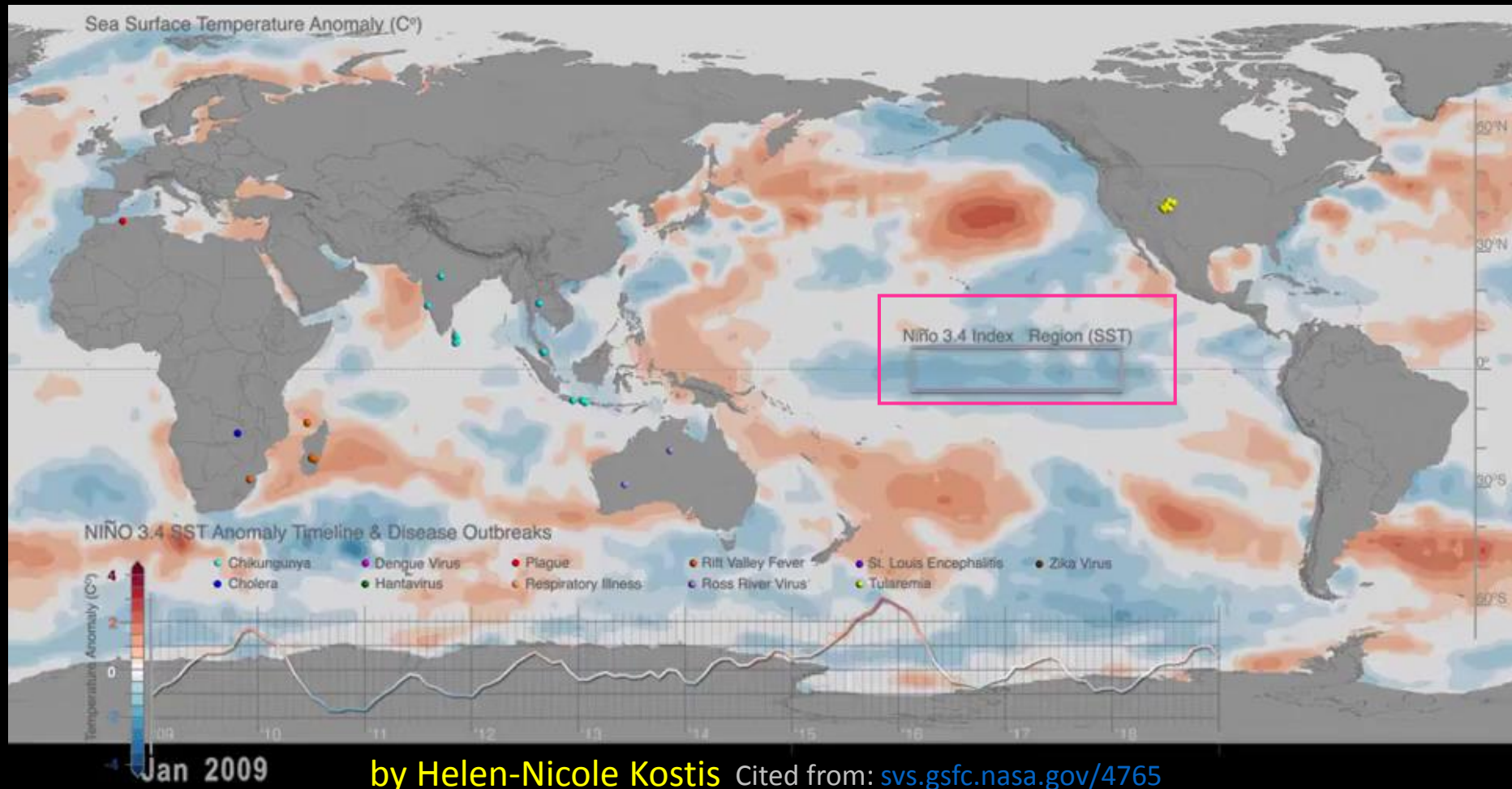
1. 色階?
2. 對比的長時間週期
太過近期 (2002-2021)

Oceanic Niño Index (ONI)



The Oceanic Niño Index (ONI)...running 3-month mean SST anomaly for the Niño 3.4 region (5°N-5°S, 120°-170°W)... 5 consecutive overlapping 3-month periods \geq / \leq $\pm 0.5^{\circ}\text{C}$

see: ggweather.com/enso/oni.htm



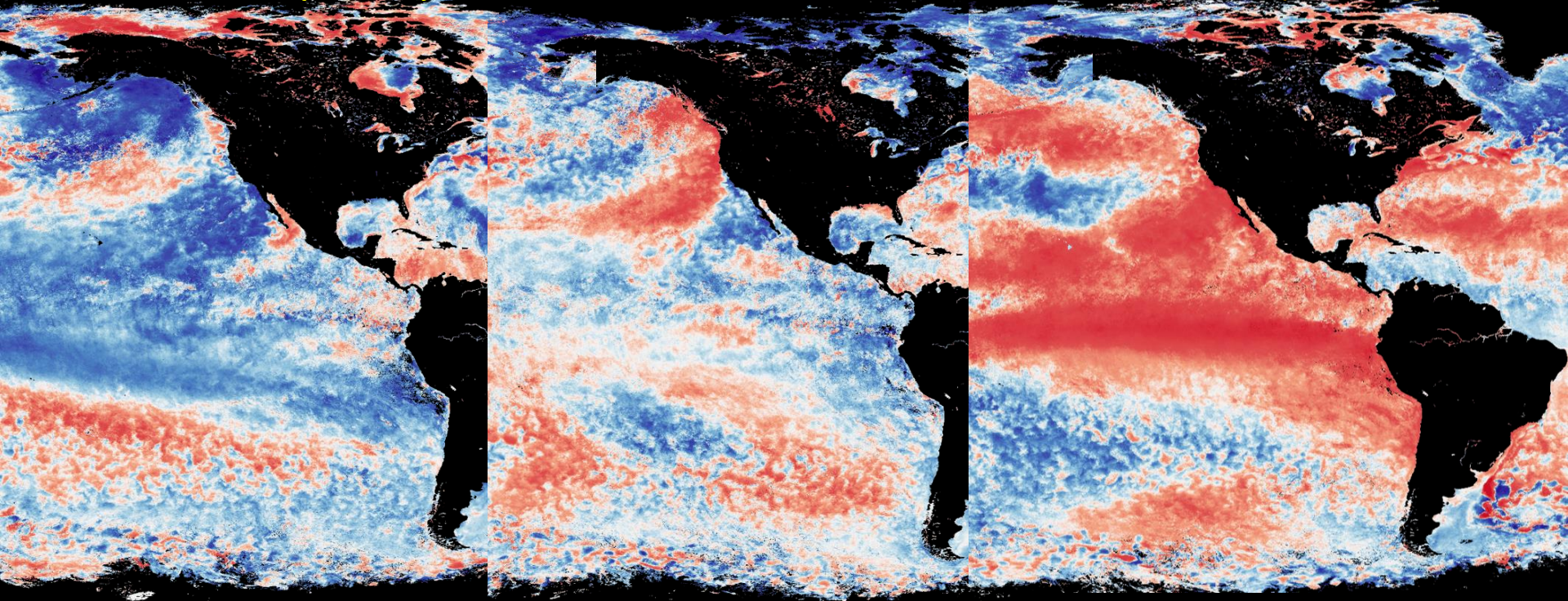
by Helen-Nicole Kostis Cited from: svs.gsfc.nasa.gov/4765

比較 SST Anomalies 呈現的資料模式 (vs. NEO WMS pattern)

2011 La Niña (weak)

2013 Normal

2015 El Niño (Strong)



這也反映了在“產生資料”過程中的問題：
1. 客製化、2. 自動化的需求

問題？方向？資料來源？

- ✓ 科學社群
- ✓ [Google Dataset search](#)
- ✓ Paper、Google Scholar

資料模式pattern檢視

- ✓ Online Mapper
- ✓ Data Visualization

資料蒐集、產生、分析

- ✓ Software or programming

資料驗證、問題解析

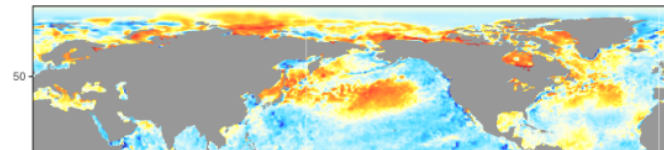
- ✓ Testing, Data Viz.,
Modeling/Simulation

My working github (in R)

github.com/cywhale/marineheatwave

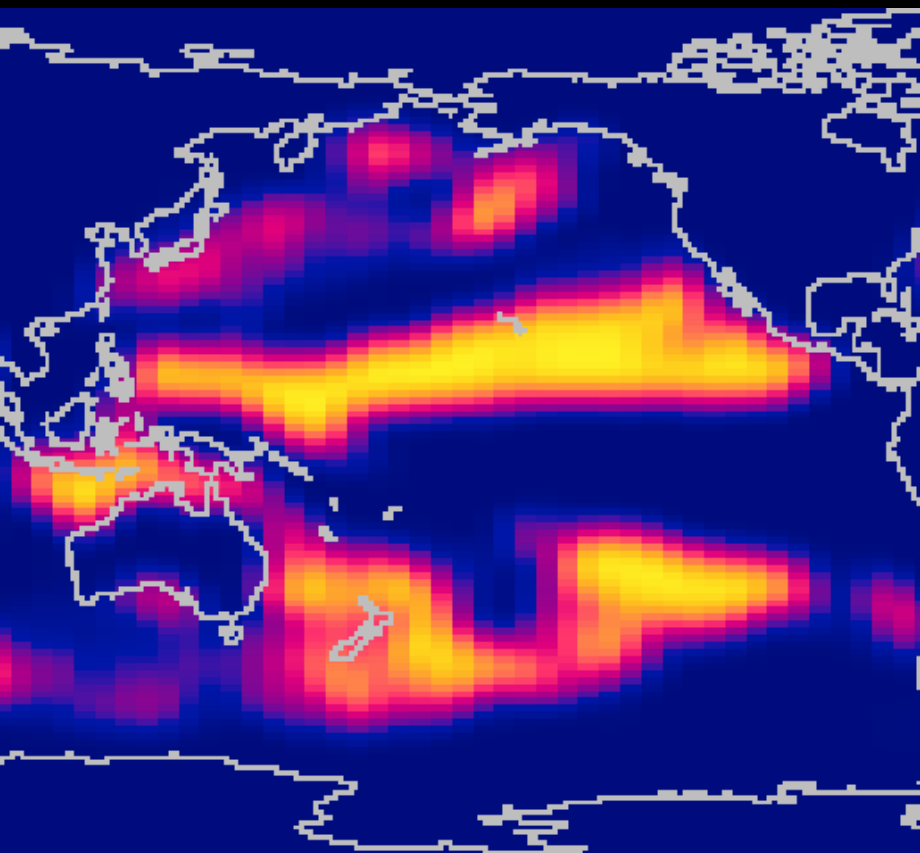
https://htmlpreview.github.io/?https://github.com/cywhale/marineheatwave/blob/main/R/01_OISST_data.html

```
ga <- ga +  
ggExtra::removeGrid(x=TRUE, y=TRUE) +  
theme(  
  panel.background = element_blank(),  
  panel.border = element_rect(colour = "black", fill=NA, size=0.75),  
  panel.grid.major.x = element_blank(),  
  panel.grid.major.y = element_blank(),  
  panel.grid.minor = element_blank(),  
  plot.margin = unit(c(0,0,0,0), "cm"),  
  panel.spacing = unit(0,"cm"),  
  strip.background = element_blank(),  
  strip.text.y = element_text(angle = 0),  
  axis.text.x = element_text(family = "sans"),  
  axis.title.x = element_text(family = "sans"),  
  axis.title.y = element_text(family = "sans"),  
  axis.text.y = element_text(family = "sans"),  
  legend.key = element_blank(),  
  legend.key.size = unit(0.6,"line"),  
  legend.box.background = element_blank(),  
  legend.title = element_text(size=10),  
  legend.text = element_text(family = "sans", size=6),  
  legend.background = element_rect(fill = "transparent", colour = "transparent"),  
  legend.direction="horizontal",  
  legend.key.height = unit(0.2, 'cm'),  
  legend.key.width = unit(1.5, 'cm'),  
  legend.position = "bottom"  
)  
ga
```

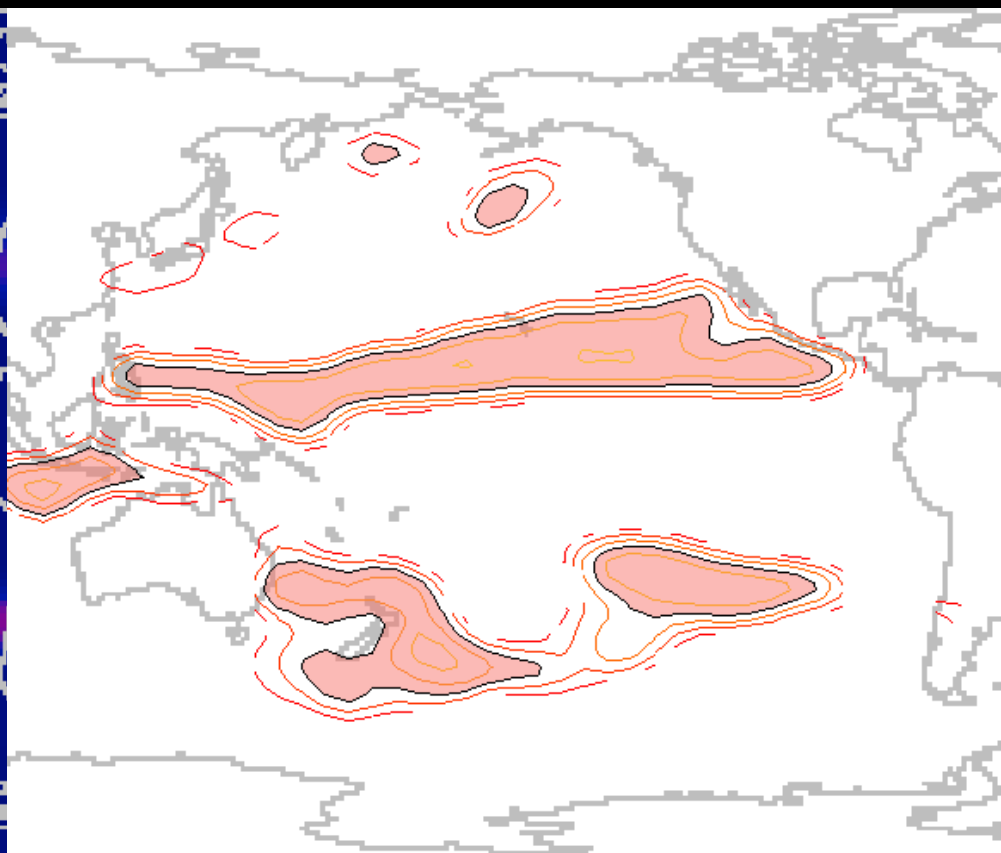


地理資訊圖層資料

Raster



Vector



Vector “data” in GIS

SST

geometry

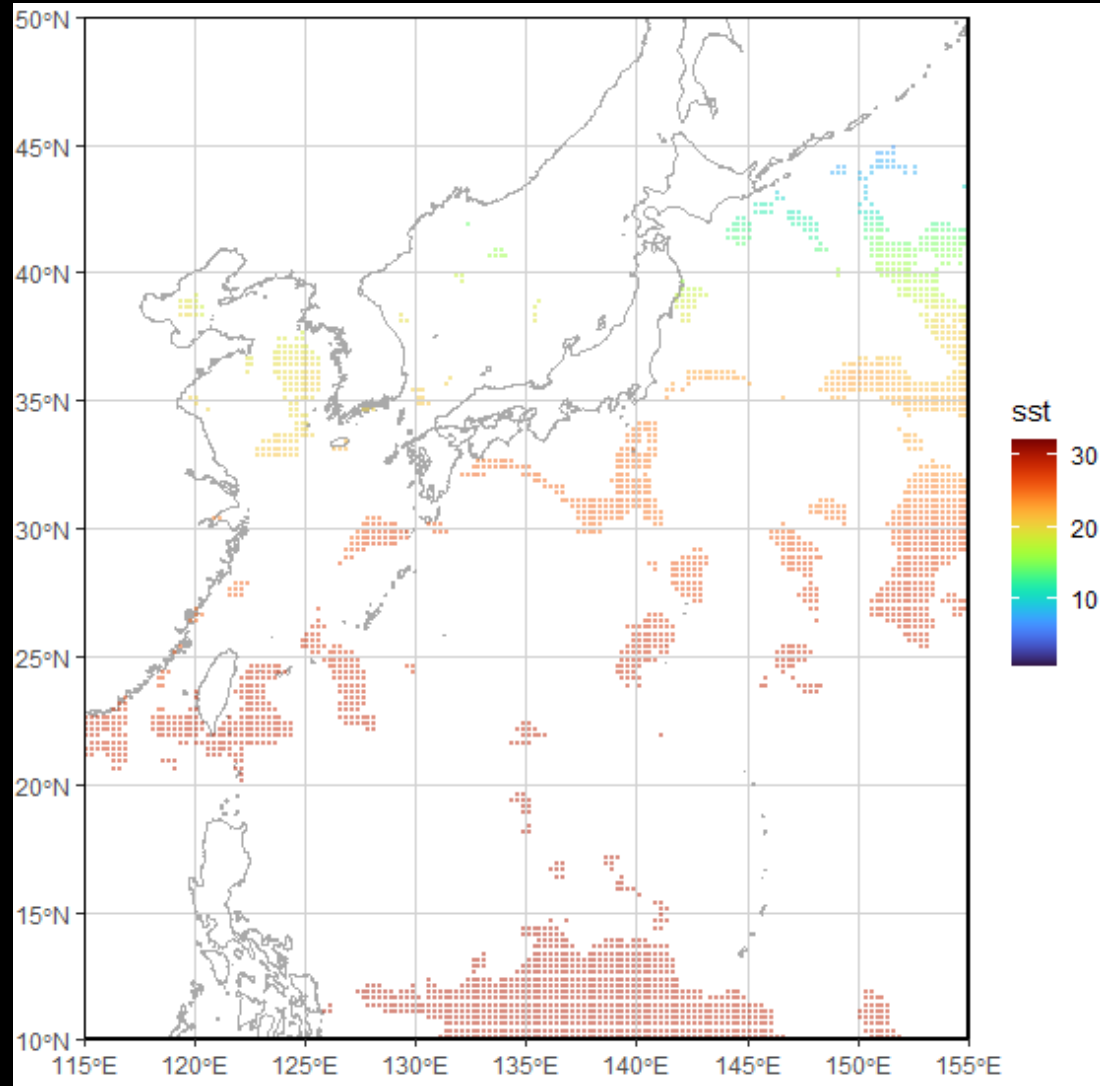
```
1: 28.5453 POINT (115.125 21.125)
2: 28.6900 POINT (115.125 21.375)
3: 29.0320 POINT (115.125 21.875)
4: 29.0117 POINT (115.125 22.125)
5: 28.8973 POINT (115.125 22.375)
```

```
---
996: 29.9647 POINT (136.625 13.625)
997: 29.9457 POINT (136.625 13.875)
998: 29.8937 POINT (136.625 14.125)
999: 29.9597 POINT (136.625 16.375)
1000: 29.9243 POINT (136.625 16.625)
```

帶有地理空間訊息的
幾何元素 “feature”

Spatial geometry +
ISO 19125-1:2004:

Simple features (sf)



NEO csv

1440 x 720

2-dimension matrix

Latitude
-89.875 ~
89.875 if
0.25 degree
gridded

99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	1.68	1.6	1.4
99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	1.68	1.64	1.48
99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	1.64	1.56	1.6
99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	1.48	1.44	1.52
99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	1.28	1.4	1.48
99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	1.28	1.32	1.44
99999	99999	0.61	99999	99999	99999	99999	99999	99999	99999	1.36	1.4	1.44
0.57	0.61	0.69	0.65	99999	99999	99999	99999	99999	99999	1.48	1.48	1.44
0.61	0.61	0.69	0.69	0.69	0.57	99999	99999	99999	99999	1.52	1.52	1.48
0.77	0.73	0.69	0.73	0.77	0.89	0.93	99999	99999	99999	1.44	1.56	1.52
0.77	0.73	0.73	0.73	0.85	0.97	1.17	1.32	1.48	1.52	1.4	1.36	1.4
0.73	0.73	0.81	0.77	99999	99999	1.13	1.25	1.44	1.48	1.44	1.36	1.4
0.61	0.65	0.69	0.73	0.81	0.93	1.05	1.25	1.44	1.48	1.44	1.36	1.4
0.61	0.57	0.61	0.65	0.81	0.97	1.13	1.21	1.25	1.28	1.36	1.4	1.44
0.65	0.53	0.53	0.65	0.85	1.09	1.25	1.28	1.25	1.17	1.28	1.32	1.28
0.69	0.49	0.49	0.61	0.81	1.05	1.21	1.25	1.21	1.21	1.21	1.17	1.32
0.42	0.34	0.42	0.53	0.73	0.97	1.13	1.21	1.25	1.25	1.28	1.17	1.28
0.18	0.14	0.34	0.45	0.65	0.85	1.13	1.25	1.25	1.25	1.28	1.17	1.17
0.3	0.22	0.34	0.53	0.65	0.85	1.09	1.25	1.25	1.28	1.28	1.25	1.25
0.3	0.26	0.38	0.57	0.77	0.89	1.09	1.32	1.4	1.52	1.44	1.36	1.28
0.42	0.38	0.45	0.65	0.85	1.05	1.25	1.44	1.56	1.64	1.64	1.48	1.44
0.65	0.57	0.65	0.81	1.01	1.28	1.44	1.6	1.76	1.92	1.96	1.8	1.56
0.77	0.81	0.89	1.05	1.28	1.52	1.64	1.72	1.88	2.04	2.08	2	1.84
0.81	0.97	1.13	1.32	1.56	1.72	1.8	1.84	1.88	2	2	2	1.96
0.85	1.01	1.25	1.48	1.72	1.88	1.96	1.96	1.92	1.92	1.96	2.04	1.96
0.93	1.09	1.32	1.6	1.84	1.88	1.92	1.88	1.84	1.84	1.96	2.04	1.96
0.85	1.13	1.32	1.56	1.72	1.8	1.76	1.68	1.76	1.88	1.96	2.11	2.11
0.85	1.01	1.17	1.4	1.52	1.52	1.48	1.48	1.6	1.8	1.96	2.11	2.19
0.93	0.93	1.01	1.13	1.25	1.28	1.25	1.32	1.44	1.68	1.88	2.08	2.11
0.85	0.89	0.85	0.89	0.93	1.01	1.09	1.21	1.36	1.52	1.76	1.92	2.11
1.05	0.85	0.81	0.73	0.77	0.81	0.93	1.17	1.32	1.44	1.56	1.8	2
1.09	0.89	0.85	0.85	0.77	0.81	0.93	1.09	1.21	1.36	1.44	1.68	2
1.05	0.97	0.93	0.93	0.85	0.93	0.93	1.09	1.21	1.36	1.44	1.68	2
1.21	1.09	1.09	1.05	0.97	0.89	0.97	1.05	1.17	1.25	1.4	1.68	1.96
1.28	1.28	1.21	1.17	1.09	1.05	1.05	1.13	1.21	1.36	1.4	1.64	1.96
1.36	1.32	1.25	1.25	1.17	1.13	1.09	1.09	1.17	1.25	1.4	1.64	1.96
1.25	1.25	1.25	1.13	1.05	1.05	1.05	1.05	1.17	1.32	1.48	1.72	1.84
1.25	1.25	1.13	1.05	1.05	1.05	1.05	1.05	1.17	1.28	1.36	1.36	1.36
1.25	1.25	1.13	1.05	1.05	1.05	1.05	1.05	1.17	1.28	1.36	1.36	1.36

Downloads

File Type: **JPEG**

Color Grayscale

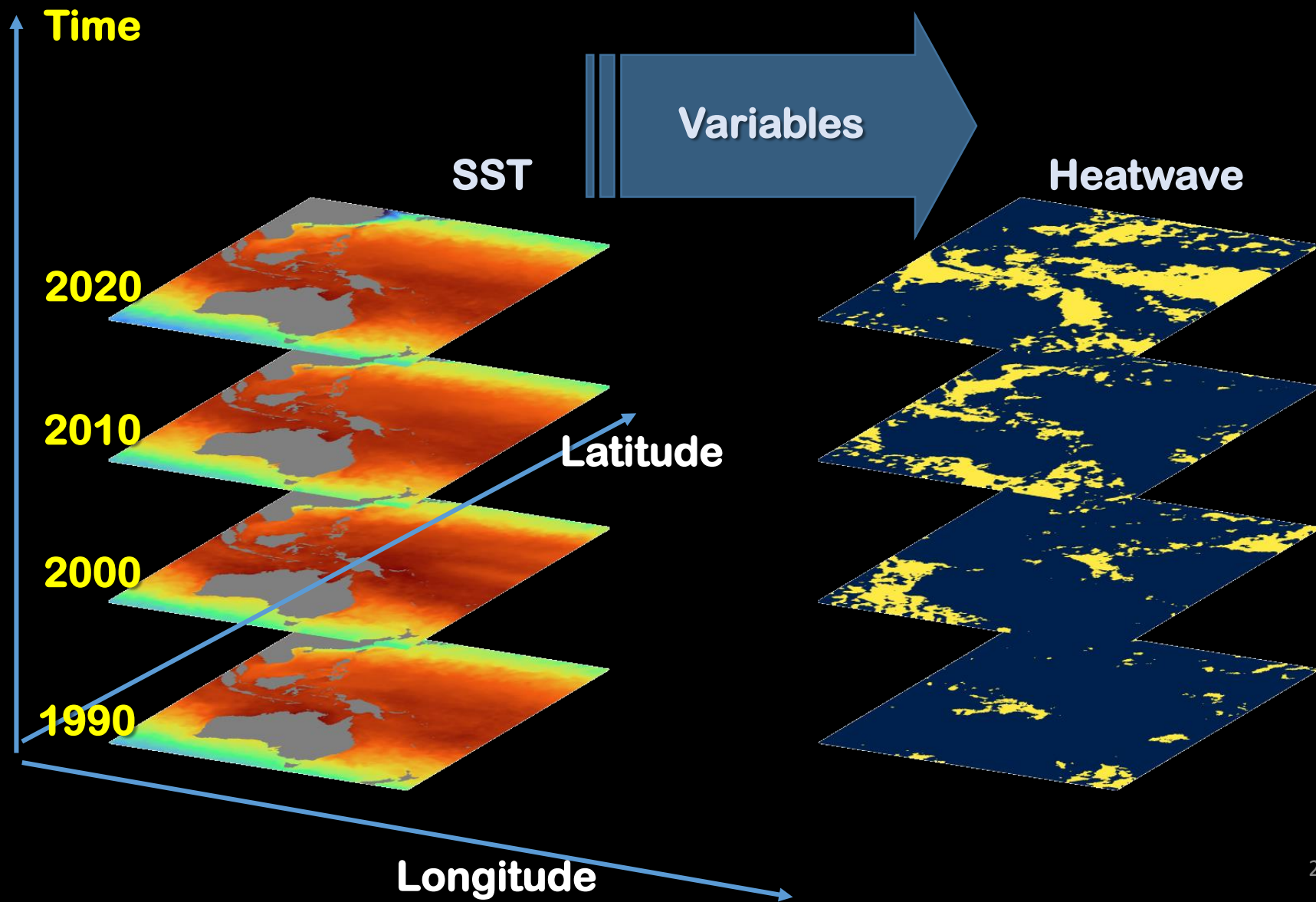
1.0 degrees 360 x 180

0.5 degrees 720 x 360

0.25 degrees 1440 x 720

Longitude
-179.875 ~ 179.875 or
0 ~ 359.875 if
0.25 degree gridded

NetCDF nc file



Optimum Interpolation SST

The NOAA 1/4° Daily Optimum Interpolation Sea Surface Temperature (OISST) is a long term Climate Data Record that incorporates observations from different platforms (satellites, ships, buoys and Argo floats) into a regular global grid. The dataset is interpolated to fill gaps on the grid and create a spatially complete map of sea surface temperature. Satellite and ship observations are referenced to buoys to compensate for platform differences and sensor biases.

Optional User Registration

<https://www.ncei.noaa.gov/data/sea-surface-temperature-optimum-interpolation/v2.1/access/avhrr/>

Product Details

About

Help

Data Access

Additional Data

Three other maps at the same 1/4° spatial resolution complement the daily OISST:

- **Anomalies** (i.e., the daily OISST minus a 30-year climatological mean) represent departures from "normal" conditions. Computation of several climate indices, such as the El Niño index, utilize SST anomalies
- The **error field** provides a measure of confidence or quality, allowing users to exclude (using a threshold) the impact of daily OISST values with greater interpolation errors.
- The seven-day median of daily **sea ice** concentrations serves as the basis for proxy SSTs in the marginal ice zone where satellite observations are lacking. The proxy SST allows interpolation of temperatures from the open ocean to the ice margin.

[NetCDF](#)

Index of /data/sea

Name	Last modified
Parent Directory	
198109/	2020-05-15 17:08
198110/	2020-05-15 17:08
198111/	2020-05-15 17:08
198112/	2020-05-15 17:08
198201/	2020-05-15 17:08
198202/	2020-05-15 17:08
198203/	2020-05-15 17:08
198204/	2020-05-15 17:08
198205/	2020-05-15 17:08
198206/	2020-05-15 17:08
198207/	2020-05-15 17:08
198208/	2020-05-15 17:08
198209/	2020-05-15 17:08
198210/	2020-05-15 17:08
198211/	2020-05-15 17:08
198212/	2020-05-15 17:08
198301/	2020-05-15 17:08
198302/	2020-05-15 17:08
198303/	2020-05-15 17:08
198304/	2020-05-15 17:08
198305/	2020-05-15 17:08
198306/	2020-05-15 17:08
198307/	2020-05-15 17:08
198308/	2020-05-15 17:08
198309/	2020-05-15 17:08
198310/	2020-05-15 17:08
198311/	2020-05-15 17:08
198312/	2020-05-15 17:08

Download OISST

```
library(curl) #呼叫函式庫
```

```
# 變數 <- 賦值 (比如給予網址字串)
```

```
oisstfile <- "https://www.ncei.noaa.gov/data/sea-  
surface-temperature-optimum-  
interpolation/v2.1/access/avhrr/201109/oisst-avhrr-  
v02r01.20110901.nc"
```

```
# curl: 網路傳輸、下載的開源工具
```

```
# (函式庫::)呼叫功能 function(傳遞參數)
```

```
curl::curl_download(oisstfile, destfile = outputfile)
```

```
for (i in years) {  
  for (j in 1:12) {  
    days <- month_dayx(i, j)  
    file_list <- lapply(1:days, function(k) {  
      #OISST_url <- paste0(..., i, j, days...)  
      curl_download(OISST_url, destfile = outputfile)  
      return(fileo)  
    })  
  })  
  #.....  
}
```

下載每日資料，傳回月檔案列表

Index of /data/sea

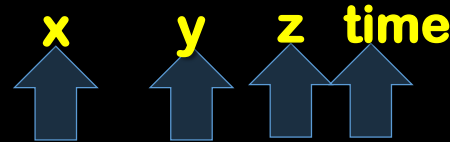
<u>Name</u>	<u>Last modified</u>
<u>Parent Directory</u>	
198109/	2020-05-15 17:08
198110/	2020-05-15 17:08
198111/	2020-05-15 17:08
198112/	2020-05-15 17:08
198201/	2020-05-15 17:08
198202/	2020-05-15 17:08
198203/	2020-05-15 17:08
198204/	2020-05-15 17:08
198205/	2020-05-15 17:08
198206/	2020-05-15 17:08
198207/	2020-05-15 17:08
198208/	2020-05-15 17:08
198209/	2020-05-15 17:08
198210/	2020-05-15 17:08
198211/	2020-05-15 17:08
198212/	2020-05-15 17:08
198301/	2020-05-15 17:08
198302/	2020-05-15 17:08
198303/	2020-05-15 17:08
198304/	2020-05-15 17:08
198305/	2020-05-15 17:08
198306/	2020-05-15 17:08
198307/	2020-05-15 17:08
198308/	2020-05-15 17:08
198309/	2020-05-15 17:08
198310/	2020-05-15 17:08
198311/	2020-05-15 17:08
198312/	2020-05-15 17:08

讀取Daily OISST NetCDF (.nc) file

```
library(stars)
```

```
sts <- read_stars(outputfile) #讀取NetCDF檔案
```

```
str(sts) # str: 查看變數結構
```



```
>List of 4
```

```
$ anom: Units: [degree_Celsius] num [1:1440, 1:720, 1, 1] 0.05 ...
```

```
$ err : Units: [degree_Celsius] num [1:1440, 1:720, 1, 1] 0.36 ...
```

```
$ ice : Units: [%] num [1:1440, 1:720, 1, 1] NA ...
```

```
$ sst : Units: [degree_Celsius] num [1:1440, 1:720, 1, 1] -1.75 ...
```

```
> sts$sst[1:10, 1:10, 1, 1]
```

```
Units: [degree_Celsius]
```

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]	[,8]	[,9]	[,10]
[1,]	-1.75	-1.75	-1.75	-1.75	-1.74	-1.74	-1.74	-1.73	-1.72	-1.72
[2,]	-1.75	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.73	-1.72	-1.71
[3,]	-1.75	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.73	-1.72	-1.71
[4,]	-1.75	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.72	-1.72	-1.71
[5,]	-1.75	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.72	-1.71	-1.70
[6,]	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.73	-1.72	-1.71	-1.70
[7,]	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.73	-1.72	-1.71	-1.70
[8,]	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.72	-1.71	-1.70	-1.69
[9,]	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.72	-1.71	-1.70	-1.69
[10,]	-1.75	-1.75	-1.75	-1.74	-1.74	-1.73	-1.72	-1.71	-1.70	-1.68

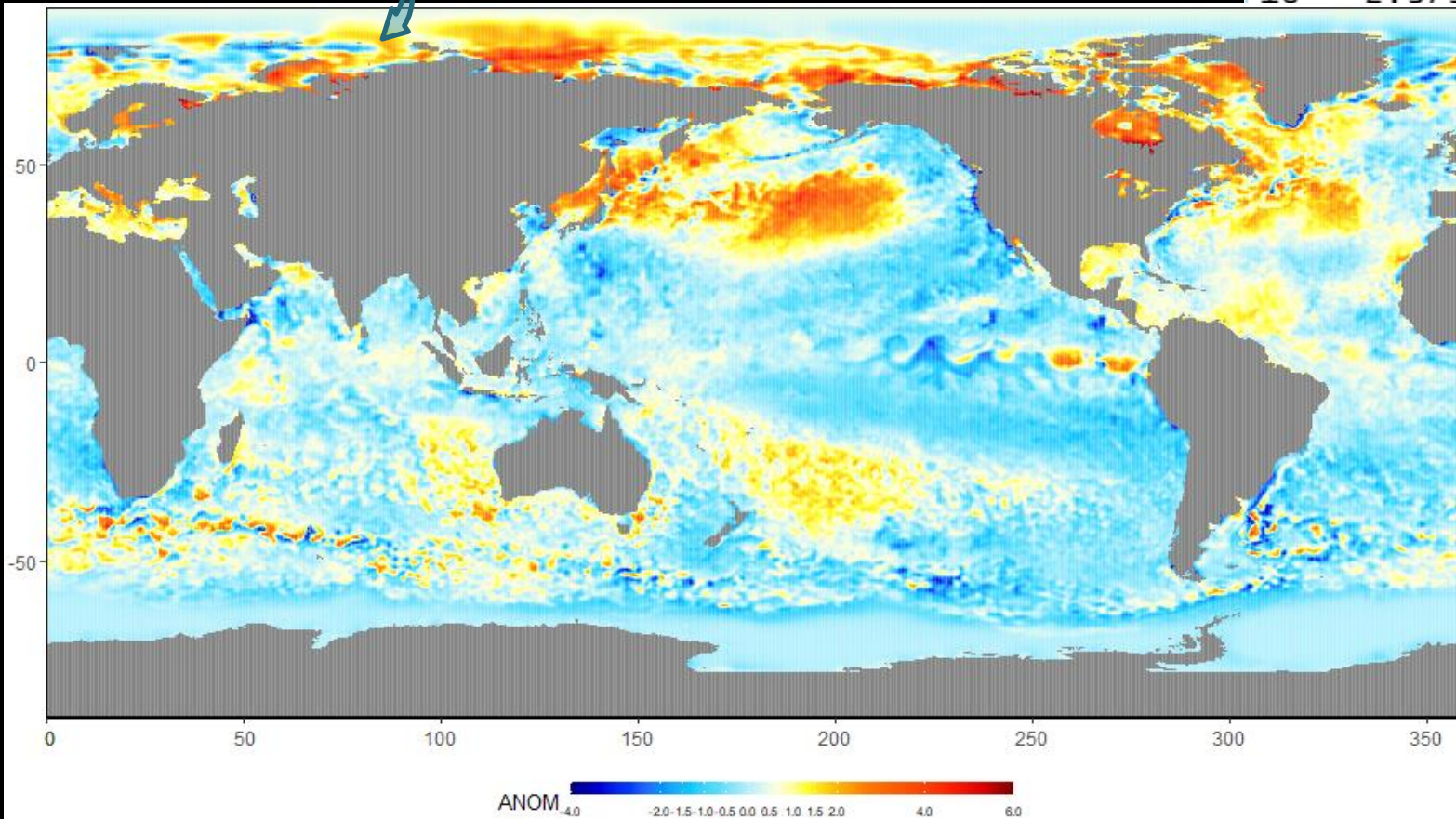
取出 SST and SST anomaly

```
var <- "sst"  
z <- sts %>% dplyr::select(var) %>% abind::adrop  
# adrop: 選擇 (select) SST 丟棄其他維度  
df <- as.data.frame(z) #轉換為欄位變數之資料
```

anom

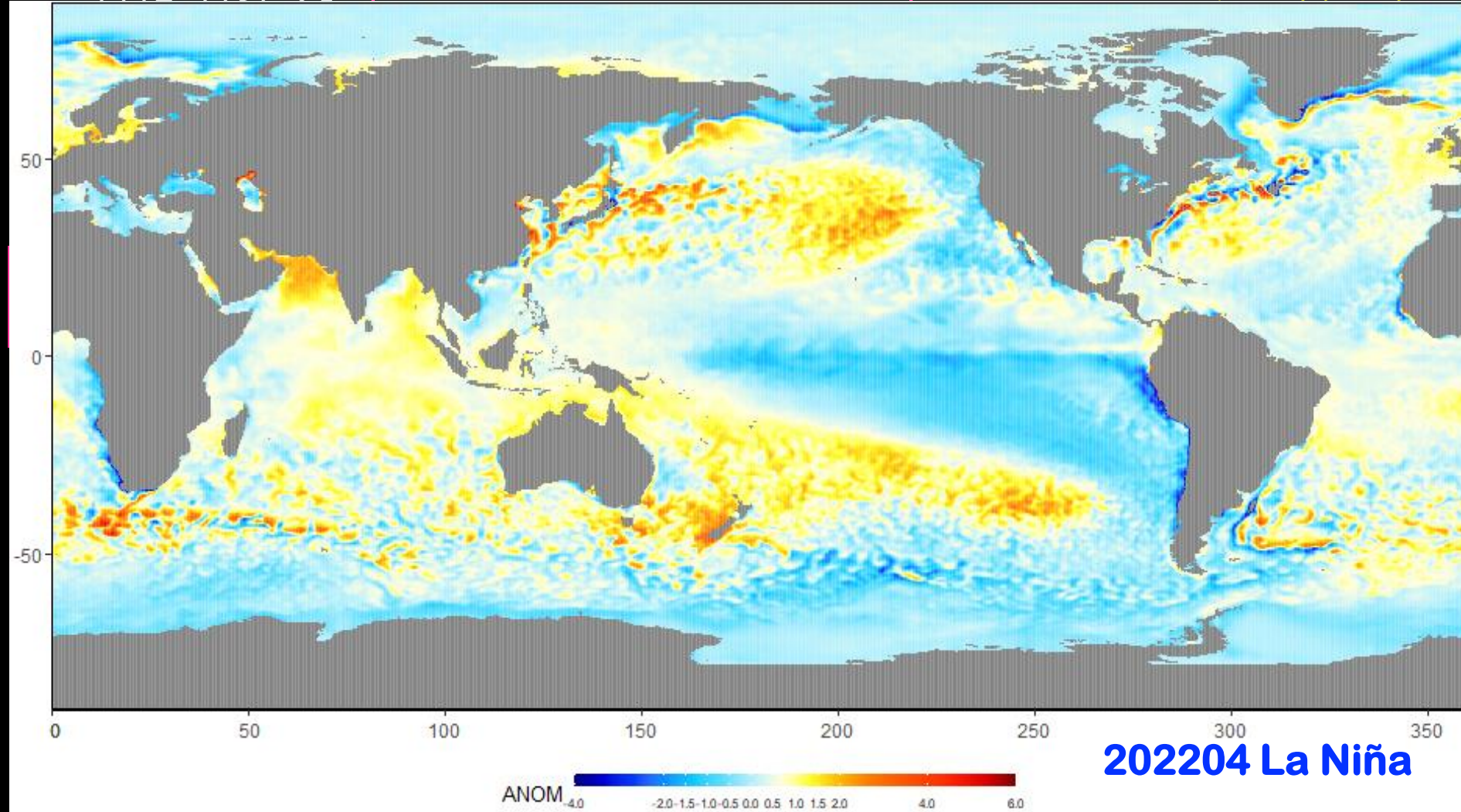
Note: it's daily data, not average

```
> df  
      x      y      sst  
1  0.125 89.875 -1.75  
2  0.375 89.875 -1.75  
3  0.625 89.875 -1.75  
4  0.875 89.875 -1.75  
5  1.125 89.875 -1.75  
6  1.375 89.875 -1.75  
7  1.625 89.875 -1.75  
8  1.875 89.875 -1.75  
9  2.125 89.875 -1.75  
10 2.375 89.875 -1.75  
89.875 -1.75  
89.875 -1.75  
89.875 -1.75  
89.875 -1.75  
89.875 -1.75  
89.875 -1.75
```



計算月平均 Monthly SST & anomaly

```
for (i in years) {  
  for (j in 1:12) {  
    days <- month_dayx(i, j)  
    file_list <-
```



Climatology of 30yrs monthly SST

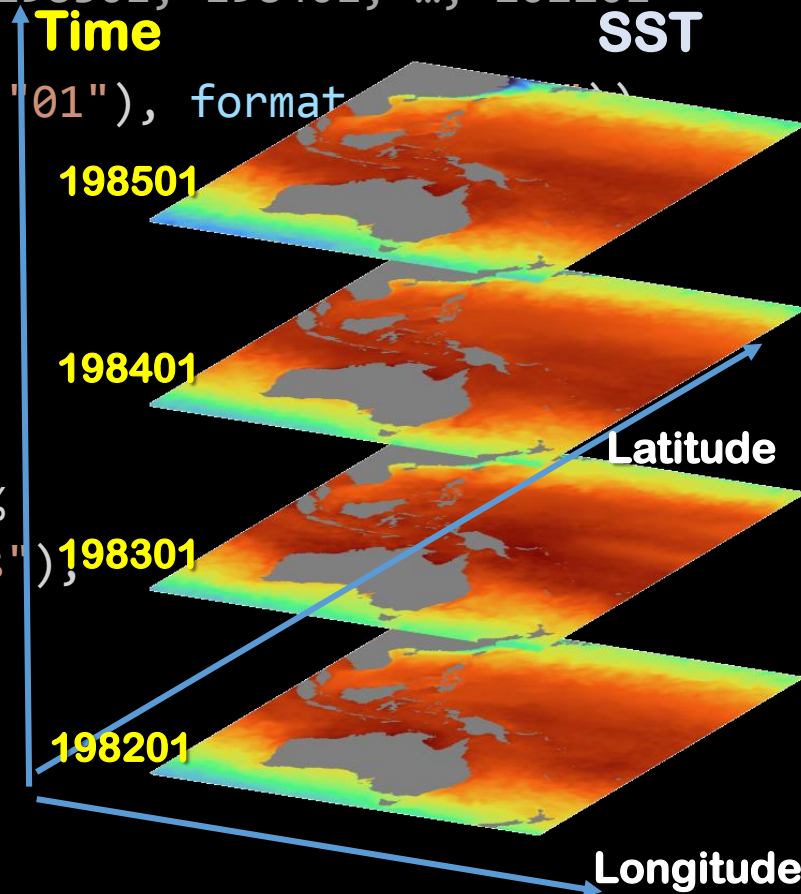
```
sstm <- lapply(1:12, function(j) {  
  for (i in 1982:2011) { #Years for climatology, 30yrs (climyrs)  
    x <- read_stars("Monthly_SST_file.nc by i, j")  
    #連接30年中的單一月分，比如依序 198201, 198301, 198401, ..., 202201  
    stmj <- c(stmj, x) #總共會有30個  
    datex <- c(datex, as.Date(paste0(i, j, "01"), format="%Y%m%d"))  
  }  
}
```

串接 SST 月平均檔案

```
sstx <- merge(stmx) %>%  
  st_set_dimensions(3, values=  
    as.POSIXct(datex), names="time") %>%  
  aggregate(by=paste0(climyrs, " years"),  
    FUN=mean, na.rm=TRUE)
```

求30年平均，並為變數取名為Jan, Feb, Mar,...

```
names(sstx)[1] <- jstr  
return (sstx)
```



SST 減去30yrs平均，並去除線性趨勢

```
anomy <- read_stars("Monthly_SST_file.nc by I, j")  
anomy[[1]] <- anomy[[1]] - sstm[[j]][[1]]
```



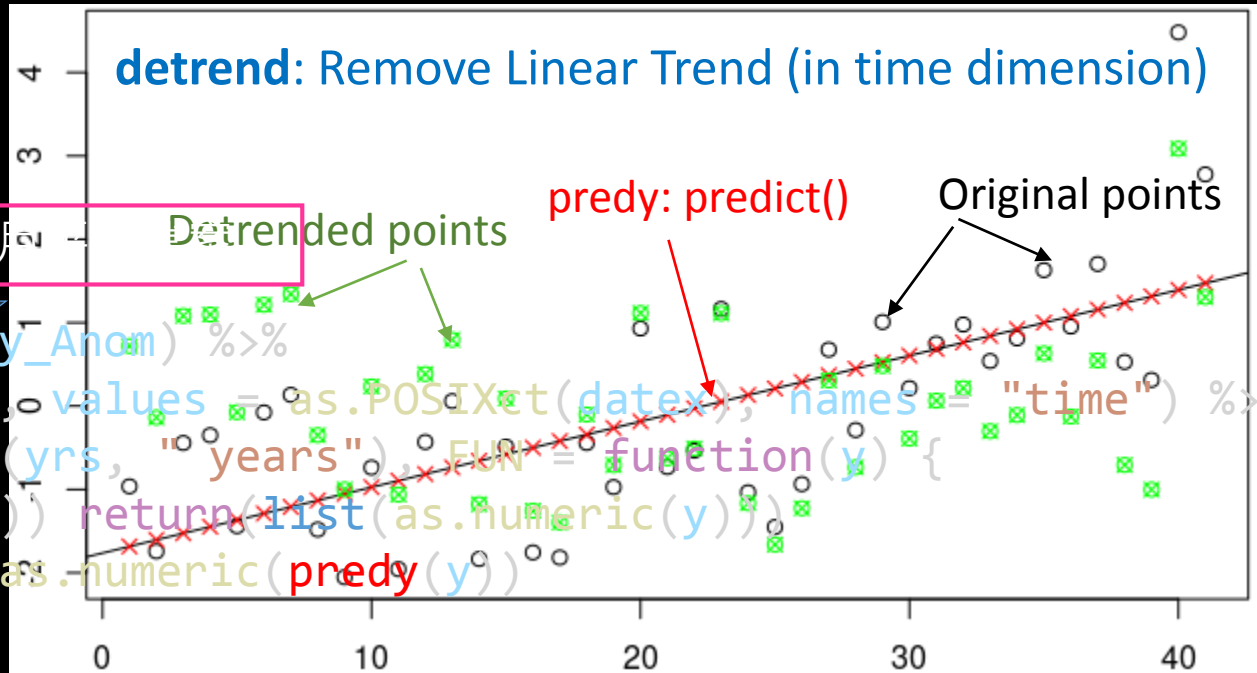
依序讀出月平均檔案，扣除當月30yrs平均

```
predy <- function(y) { return (  
  stats::predict(lm(y ~ seq_along(datex)))  
)}
```

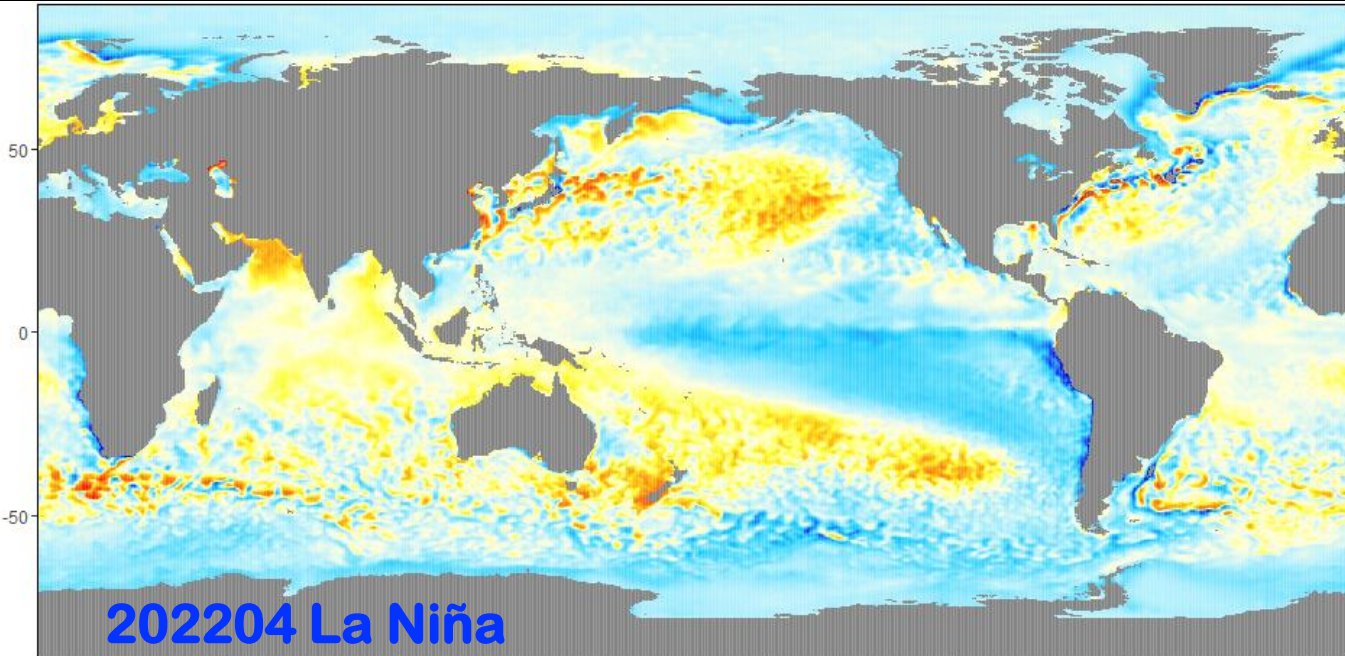
```
for (j in 1:12) {  
  for (i in years) {
```

串接 Anomalies

```
trend <- merge(Monthly_Anom, %>%  
  st_set_dimensions(3, values = as.POSIXct(datex), names = "time") %>%  
  aggregate(by=paste0(yrs, " years"), FUN=function(y) {  
    if (all(is.na(y))) return(list(as.numeric(y)))  
    y[!is.na(y)] <- as.numeric(predy(y))  
    return(y)  
  })
```

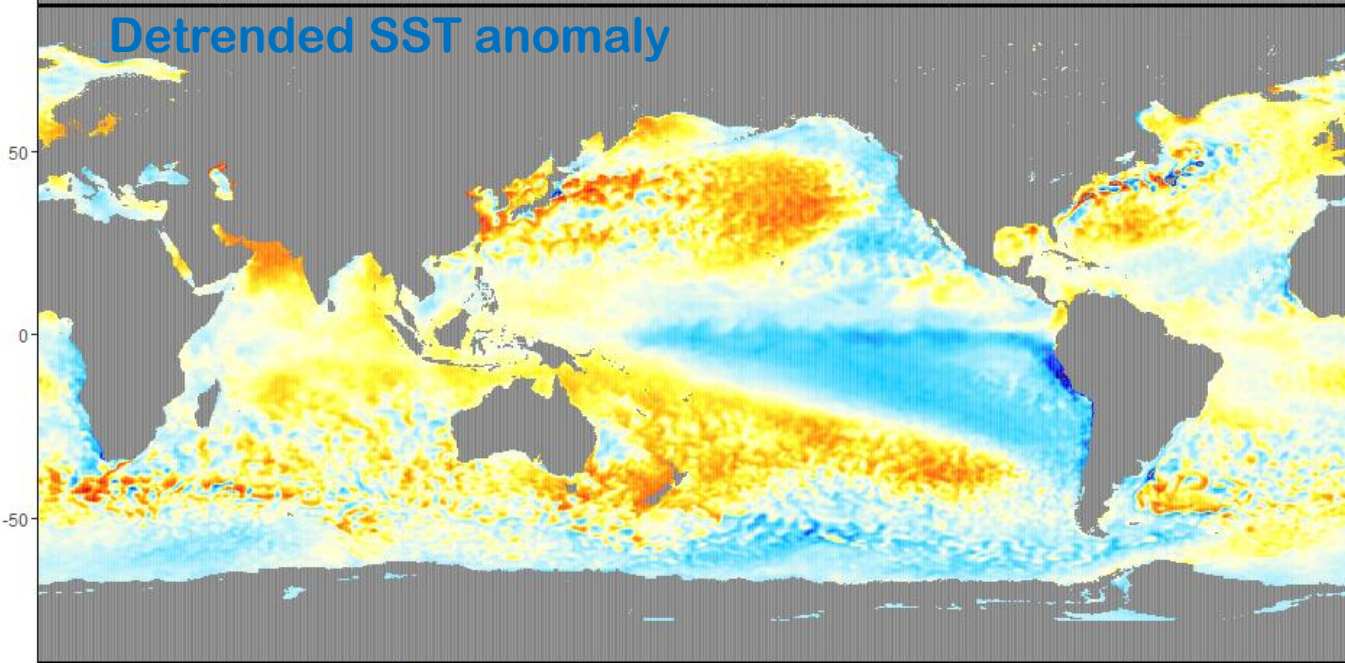


```
anomy <- read_stars("Monthly_Anomaly_file.nc by i, j")  
anomy[[1]] <- anomy[[1]] - trend[[1]]
```



202204 La Niña

Detrended SST anomaly



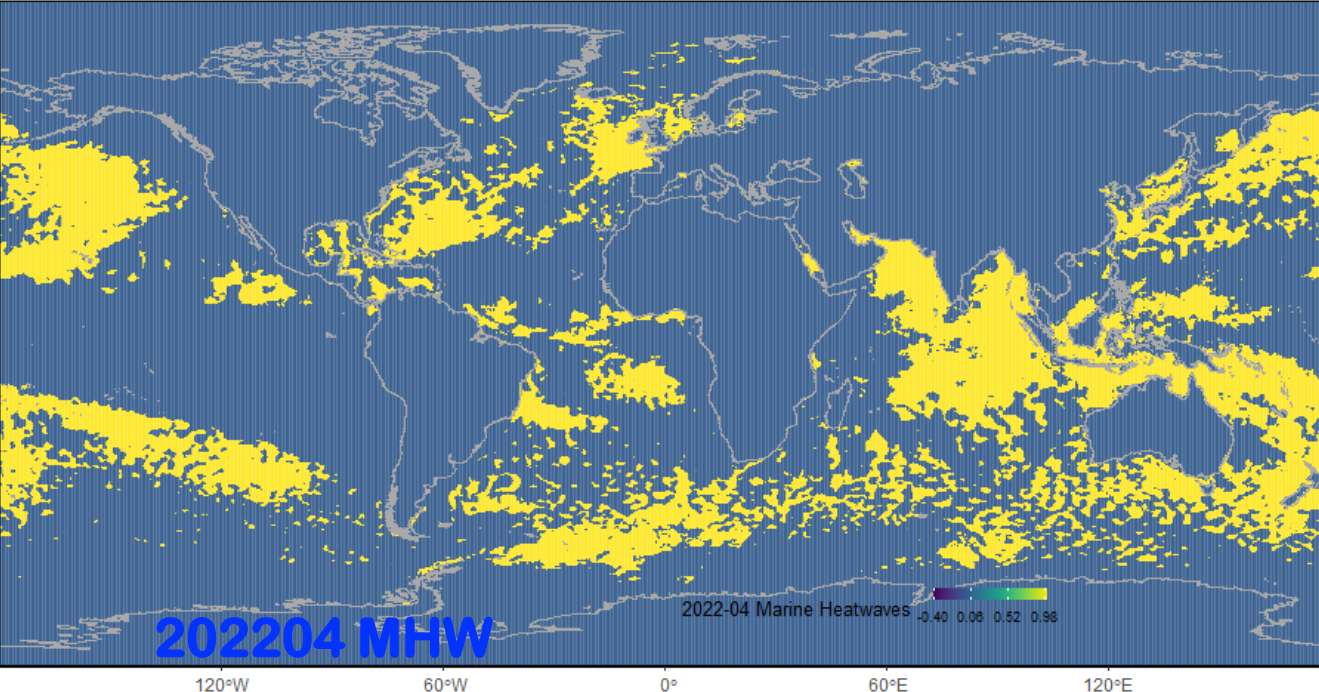
**Monthly SST
Anomaly vs
Detrended
Monthly SST
anomaly**

JACOX, Michael G., et al. **Thermal displacement by marine heatwaves**. *Nature*, 2020, 584.7819: 82-86. www.nature.com/articles/s41586-020-2534-z

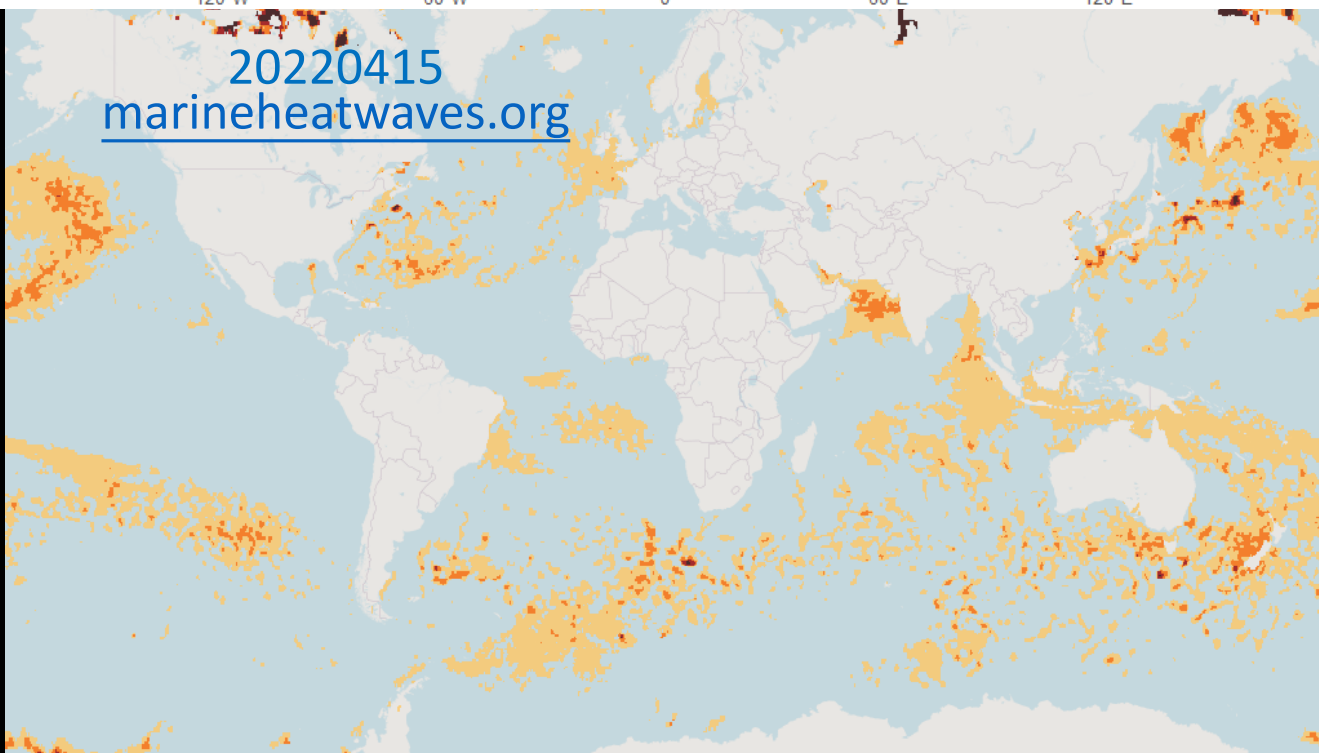
tology and classified MHWs as periods with SST anomalies above a seasonally varying 90th-percentile threshold (Extended Data Fig. 5). Our analysis differs from those used in some other studies in that we used monthly averaged SST rather than daily data, and we detrended the SST anomalies to distinguish discrete, transient MHWs from the long-term warming signal³¹. Although we believe that the choices to use

定義 Marine Heatwaves (MHW)

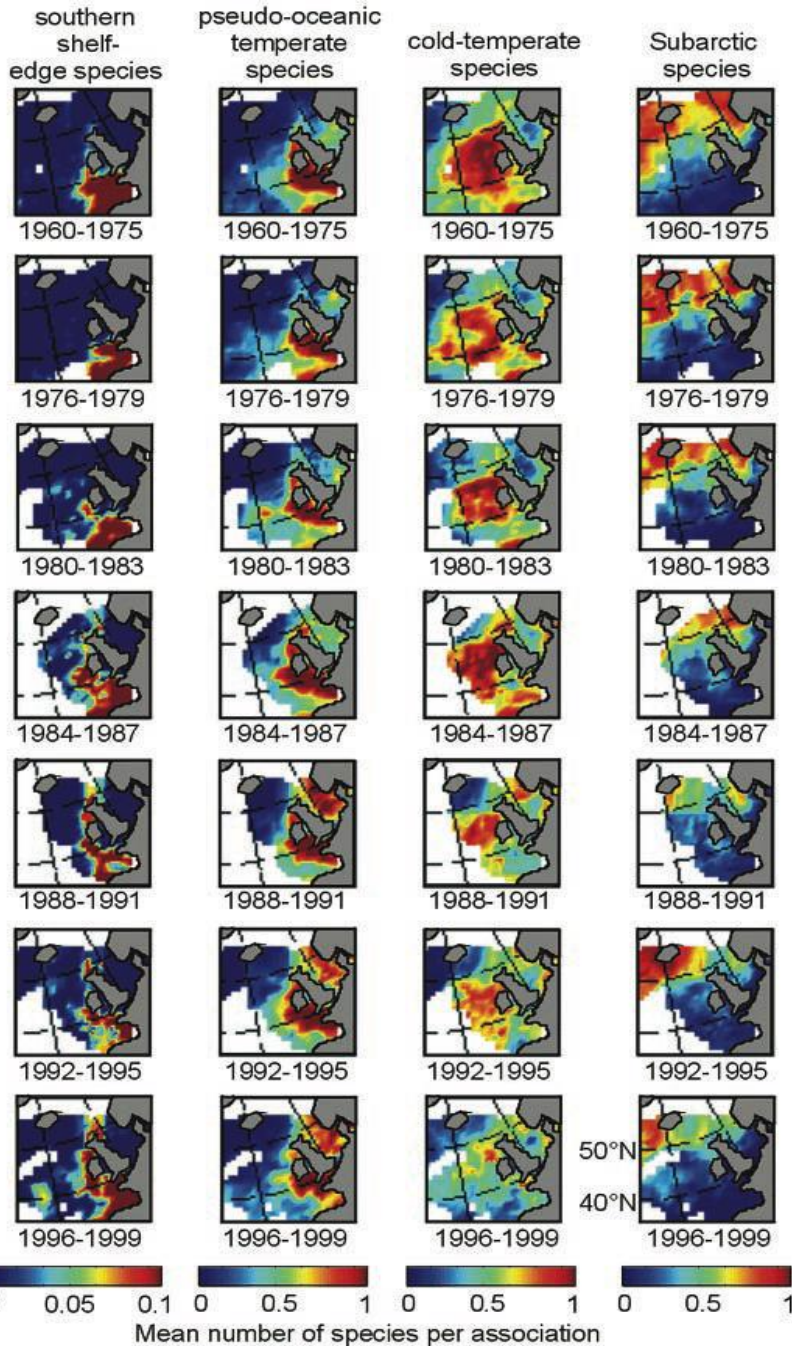
```
sty <- future_lapply(1:12, function(j) {  
  winj = c(j-1, j , j+1)  
  for (i in clim_years) {  
    x <- c(read_stars("Monthly_Anomaly_file.nc by i, winj[1]"),  
          read_stars("Monthly_Anomaly_file.nc by i, winj[2]"),  
          read_stars("Monthly_Anomaly_file.nc by i, winj[3]"))  
    datex <- c(as.Date(paste0(i, monj[1], "01"), format="%Y%m%d"),  
              as.Date(paste0(i, monj[2], "01"), format="%Y%m%d"),  
              as.Date(paste0(i, monj[3], "01"), format="%Y%m%d"))  
    styx <- c(styx, x)  
    datey <- c(datey, datex)  
  }  
  styx <- merge(styx) %>%  
    st_set_dimensions(3, values=as.POSIXct(datey), names="time") %>%  
    aggregate(by=paste0(clim yrs, " years"), FUN=quantile, probs=0.9, ...)  
  return (styx)  
})
```



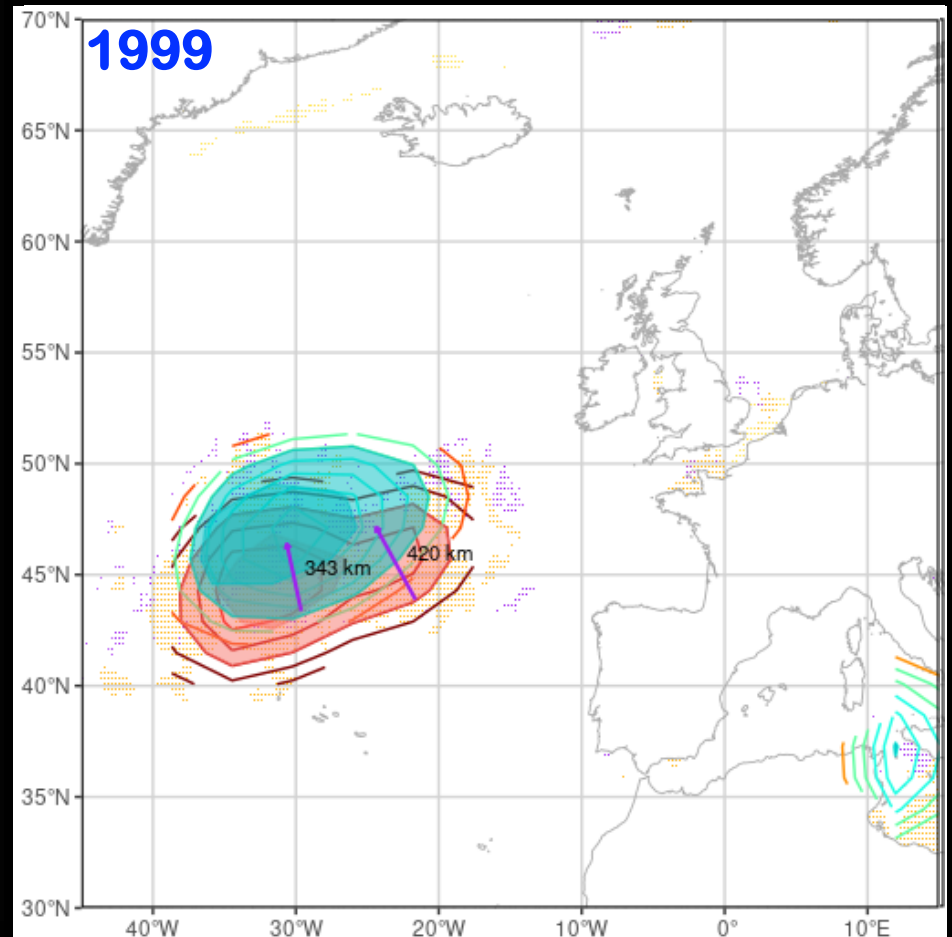
Marine heatwaves vs Daily MHW from marineheatwaves.org



MHW: SST in the top 10% of temperatures ever recorded during that time of year for at least 5 straight days.
[Hobday et al. 2016](#)



MHW-driven Thermal Displacement since 1982



Take home message

- ✓ **Definition matters** : 例中作者對MHWs採取了不同的“操作型定義” Why? 這也是操作資料前必須釐清
- ✓ **不只是產生資料** : 資料可發展成實務性解決問題的資訊應用，關鍵在於能否進一步轉化問題成為**可量化指標**
 - 但量化後的 Thermal Displacement 不等於 Biogeographical shifts 量化指標的適用性必須慎思
- ✓ **站在巨人肩上** : 一篇好的 paper 惠我輩良多！

謝謝聆聽

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