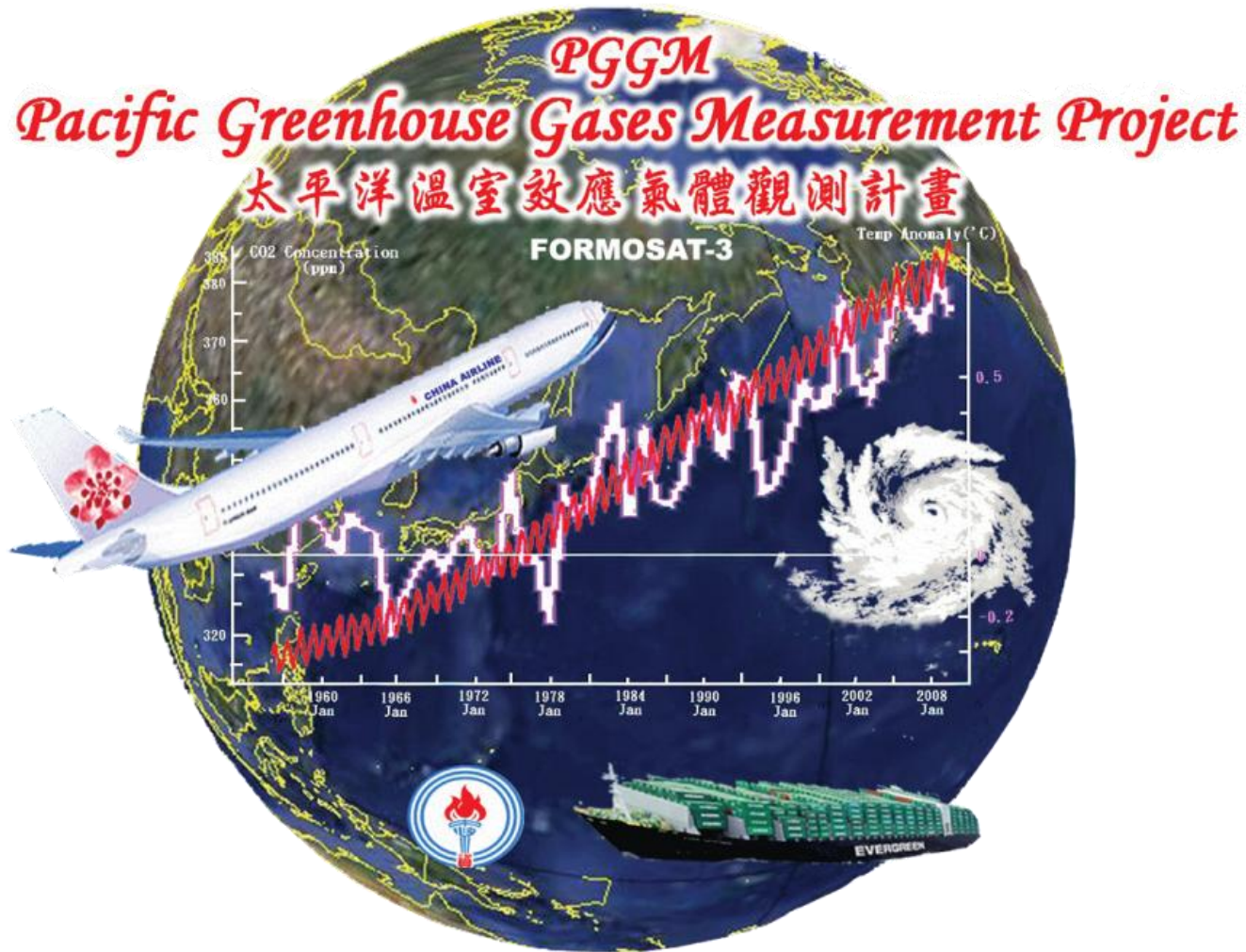


PGGM Project: 2009-2011 Measurement Results



PGGM Team

IAGOS 2011 Annual Meeting
12 Sep 2011, Manchester, UK

1. Aims

- To conduct long-term monitoring of greenhouse gases over the regions that are normally difficult to obtain.
- To complement current land-based and satellite-based greenhouse gas monitoring systems.
- To understand temporal and spatial variations of carbon dioxide over Pacific regions.
- To understand global carbon budget.
- To understand emission strength.

2. Methods

- Air-Based Measurements
 - Collaborating with the IAGOS project and China Airlines to take routine measurements over the Pacific atmosphere using in-service commercial passenger aircraft.
- Ship-Based Measurements
 - Collaborating with Evergreen Marine Corporation to take routine measurements over the oceanic atmosphere using in-service commercial container cargo ships.

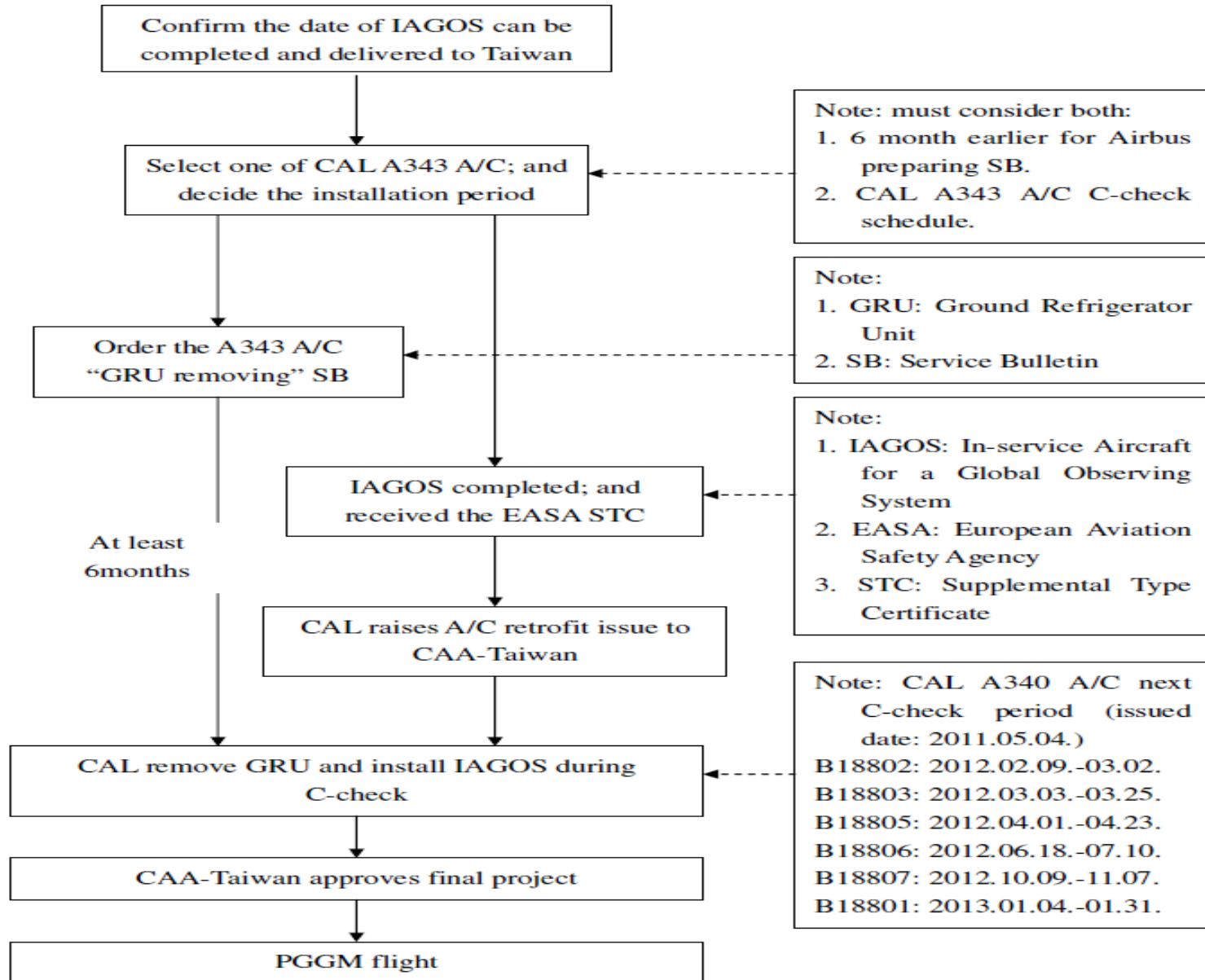
3.1. Air-Based Measurements



A Special Thanks to China Airlines



Pacific Greenhouse Gases Measurement (PGGM) Project- Process of CAL A340-300 A/C Install IAGOS Equipment



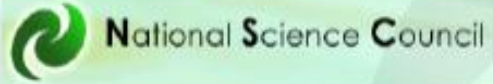
3.2. Ship-Based Measurements: Since June 2009



A Special Thanks to Evergreen



United Kingdom



太平洋溫室效應氣體船測儀器觀測計畫

Pacific Greenhouse Gases Measurement Project

PGGM Ship-Based Measurement



PGGM

2009

2010

2011

2012

Pacific Greenhouse Gases Measurement Project

PGGM Package01:EVER ULTRA



PGGM Package04:EVER DECENT



PGGM Package07:EVER DEVOTE



PGGM Package02:EVER DAINTY



PGGM Package05:EVER DIAMOND



PGGM Package08:EVER DIADEM



PGGM Package03:EVER DELUXE



PGGM Package06:EVER DEVELOP



PGGM Package09:EVER DIVINE

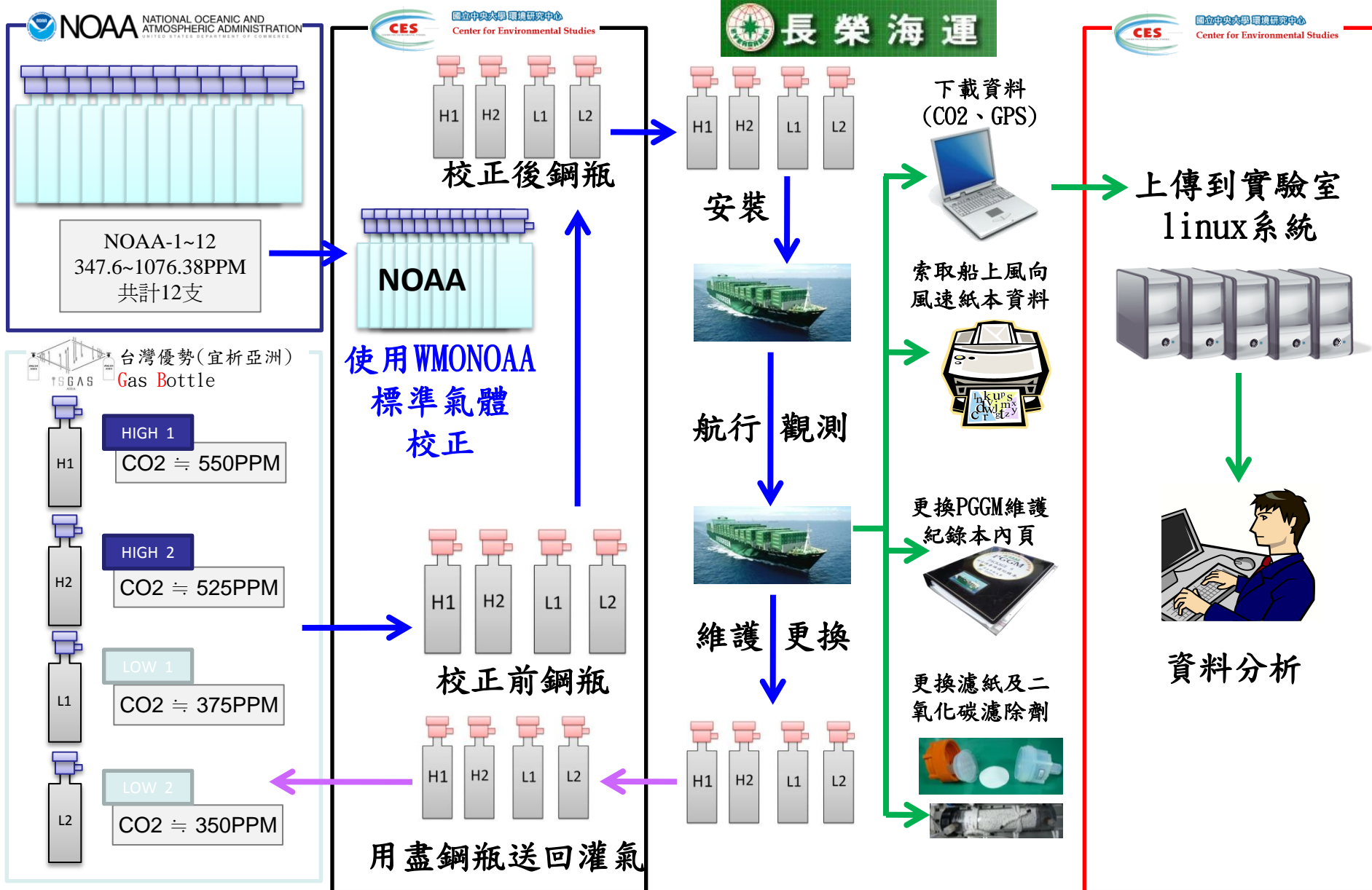


圖 12.太平洋溫室效應氣體船測計畫選定安裝之 9 艘國際貨輪

3.3. Instruments

- Picarro G2301 CO₂/CH₄/H₂O analyzers: 2
- GFC EC9820T CO₂ analyzers: 15
- Cal. Gases
 - WMO NOAA CO₂ Primary Standards: 12
 - Working Standards: 108
- Clusters of Linux/Window computers for data management, analysis, and modelling
- Models
 - High resolution Lagrangian models: Windmodel, IMS
 - High resolution Eulerian models: wrf/wrfchem, IMSL

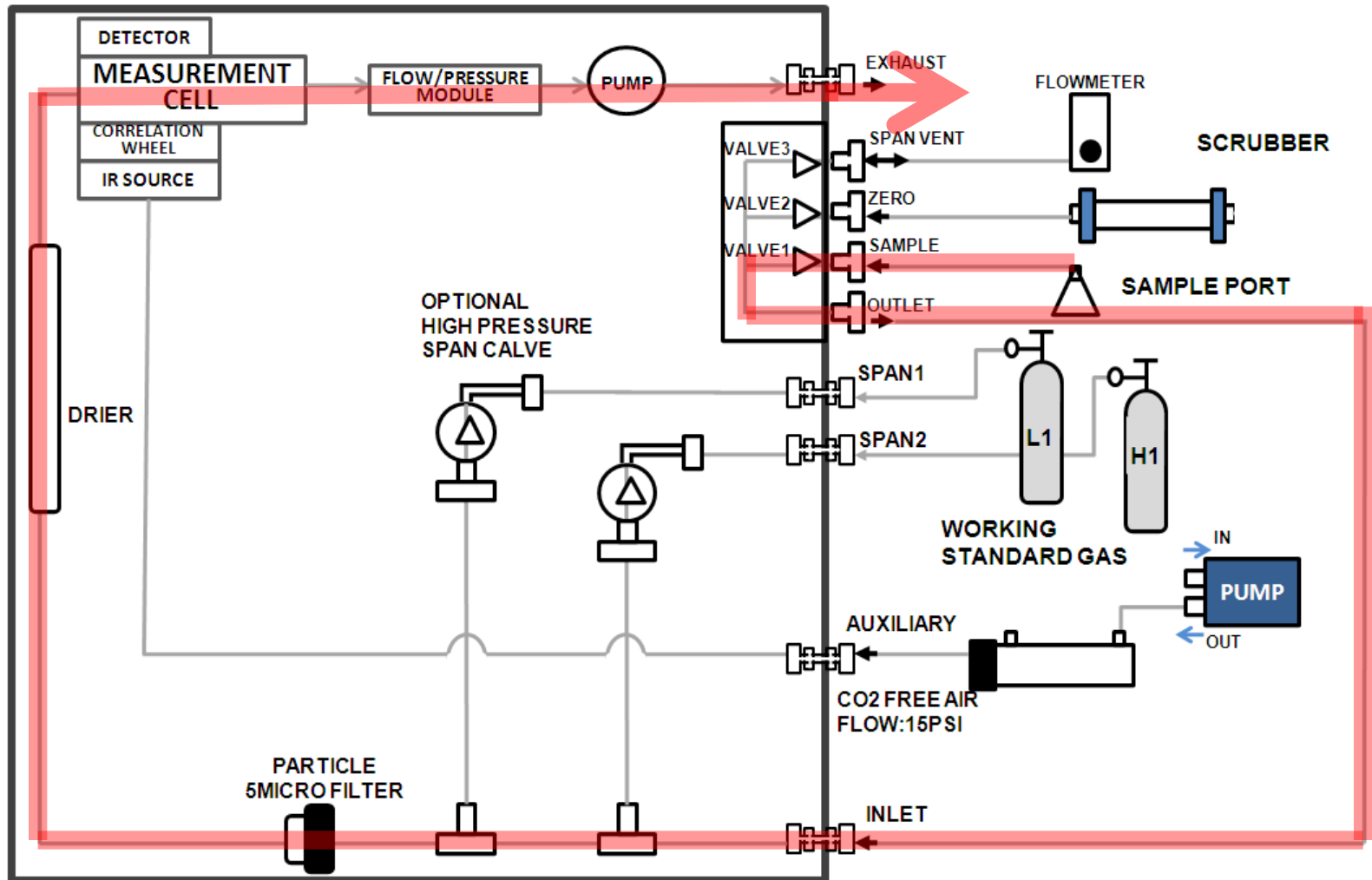
3.4. PGGM 船測觀測流程



3.5. PGGM 船上觀測流程

1. PGGM 船上觀測採樣氣體觀測示意圖

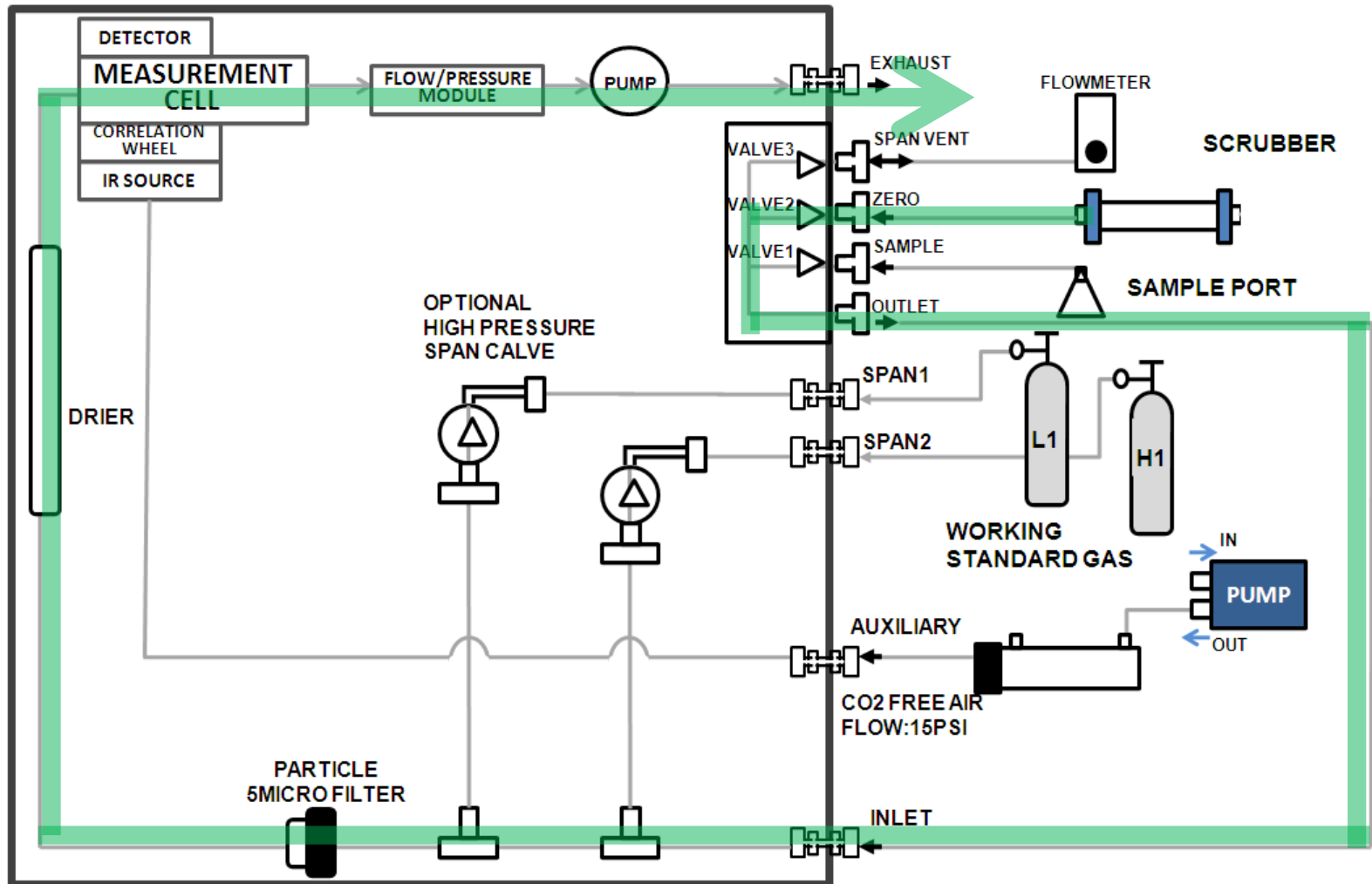
**GFC-CO₂
ANALYZER**



3.5. (CONT.) PGGM 船上觀測流程

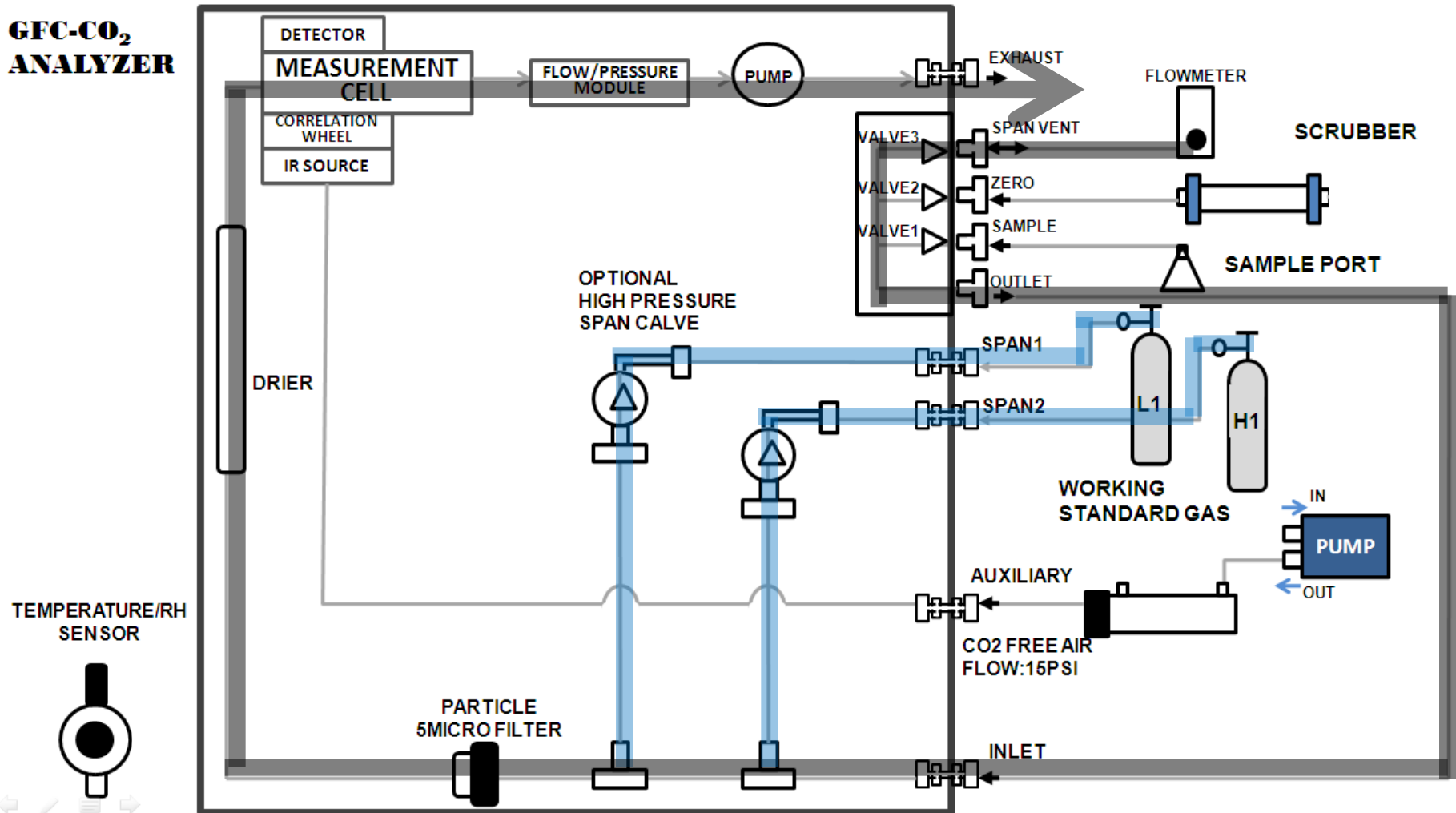
2. PGGM 船上觀測零值空氣觀測示意圖(ZERO)。

**GFC-CO₂
ANALYZER**



3.5.(CONT.) PGGM 船上觀測流程

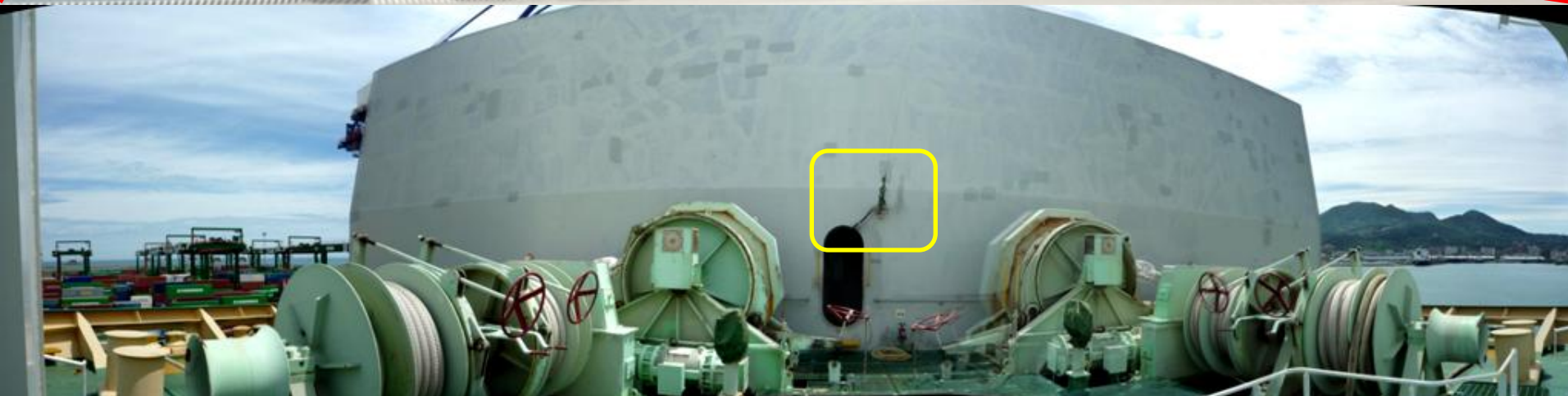
3. PGGM 船上觀測工作標準瓶氣體觀測示意圖(SPAN1、SPAN2)。



3.6. PGGM 船測觀測流程|安裝、維護儀器流程

1. 儀器安裝及維護

1. 儀器安裝於船首
2. 安裝固定工作標準瓶
3. 安裝採樣口、GPS
4. 教導船上人員儀器維護步驟



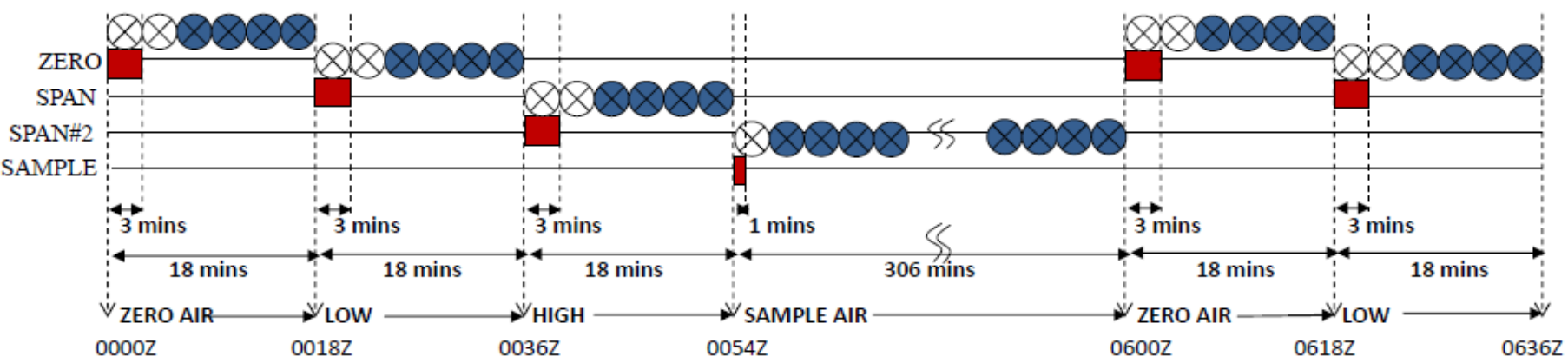
3.6. PGGM 船測觀測流程|安裝、維護儀器流程



2. 安裝位置及採樣口抽取空氣樣品示意圖



【GFC CO₂ Analyzer Sampling Method】



- 採樣氣體充氣於觀測室中。
- ⊗ 三分鐘的平均資料，但不使用。
- ⊗ 可使用的三分鐘的平均資料。

4. Results: PGGM 船測觀測流程|船測資料歸檔

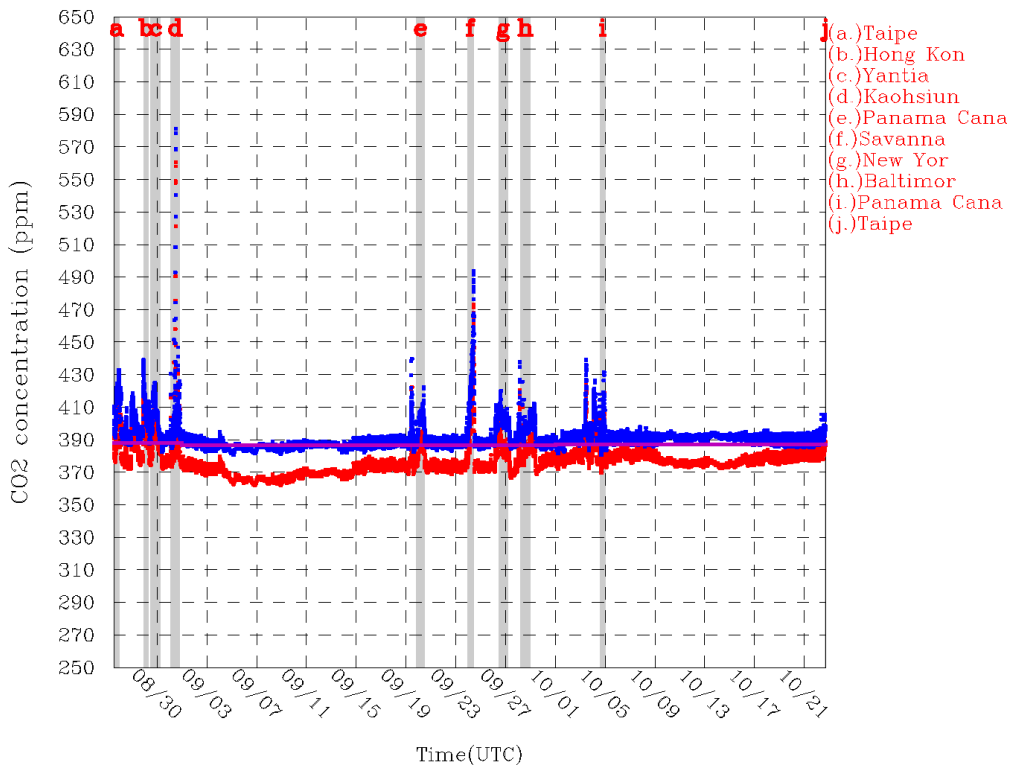
4.1. Single 觀測資料時序圖繪圖

PGGM PROGRAM 20100826 13Z-20101022 16Z EVER DELIGHT

Calibrated CO2 Sample Measurement Data

Cal. min= 380.5 Raw min= 361.8 — Cal. Data — MaunLoa Data

Cal. max= 581.2 Raw max= 560.6 — Raw Data



PGGM PROGRAM 20100826 18Z-20101022 12Z EVER DELIGHT

CO2 span Measurement Data

Span1 min=284.09 Span1 St. Gas (L1)=348.88 ppm

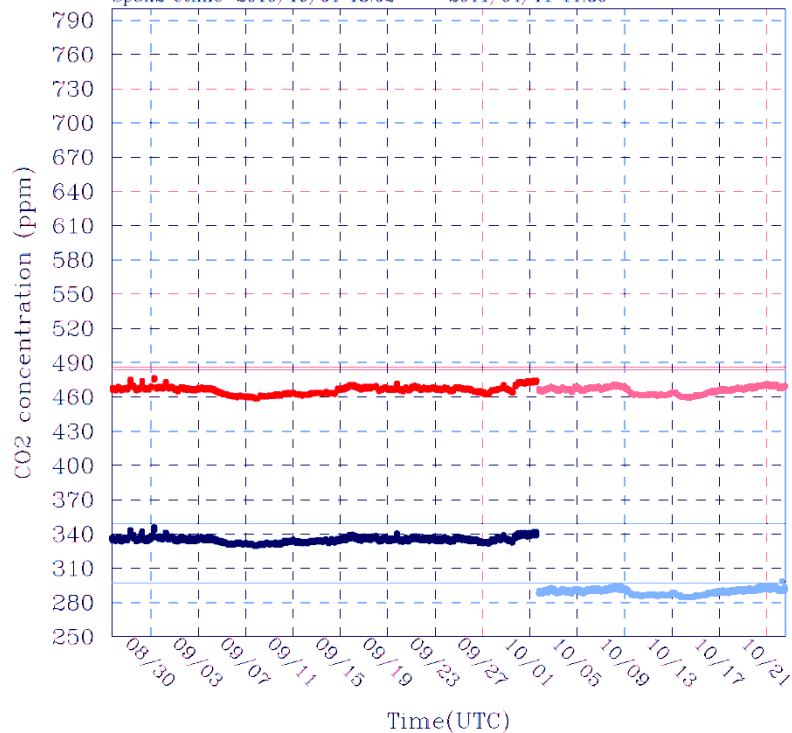
Span1 max=345.84 Span1 St. Gas (L2)=297.81 ppm

Span2 min=458.72 Span2 St. Gas (H1)=466.01 ppm

Span2 max=476.43 Span2 St. Gas (H2)=463.70 ppm

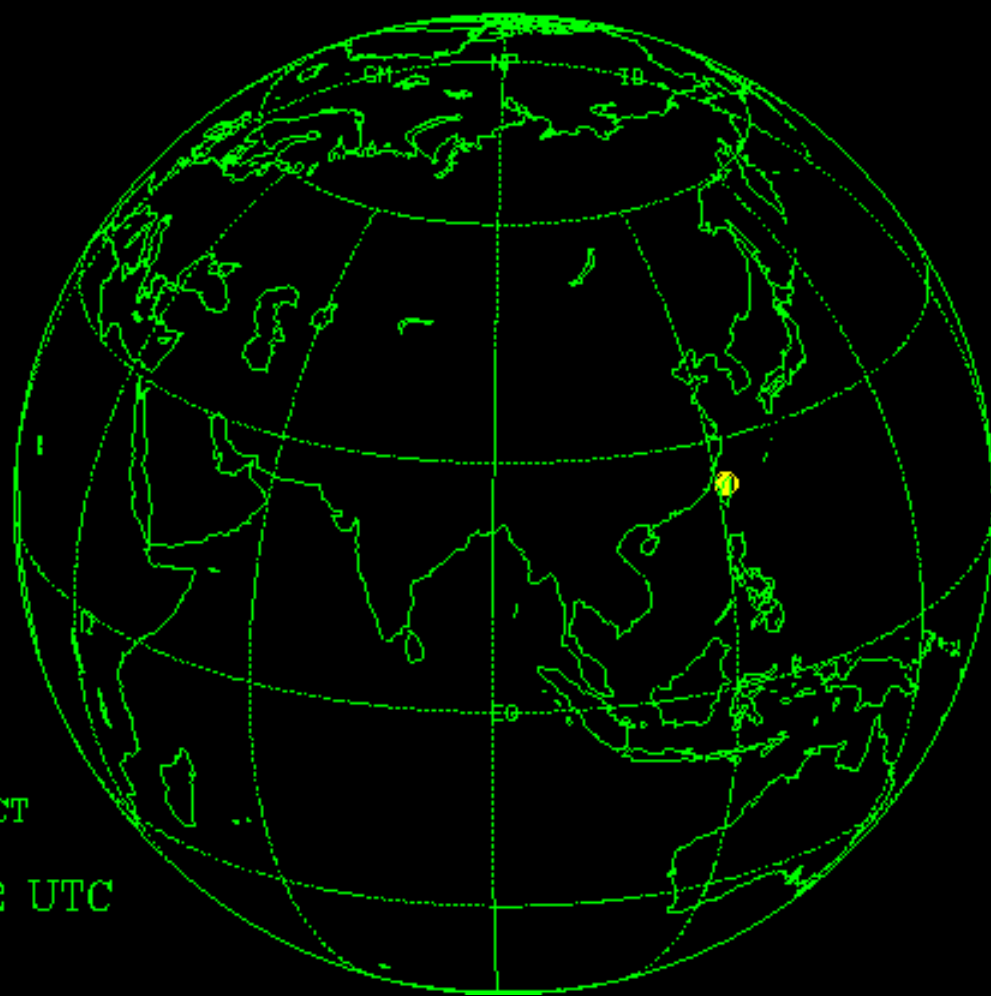
Span1 etime=2010/10/01 18.01 use lspan time(SPAN2)=

Span2 etime=2010/10/01 18.02 2011/04/11 11.80



440 ppmv

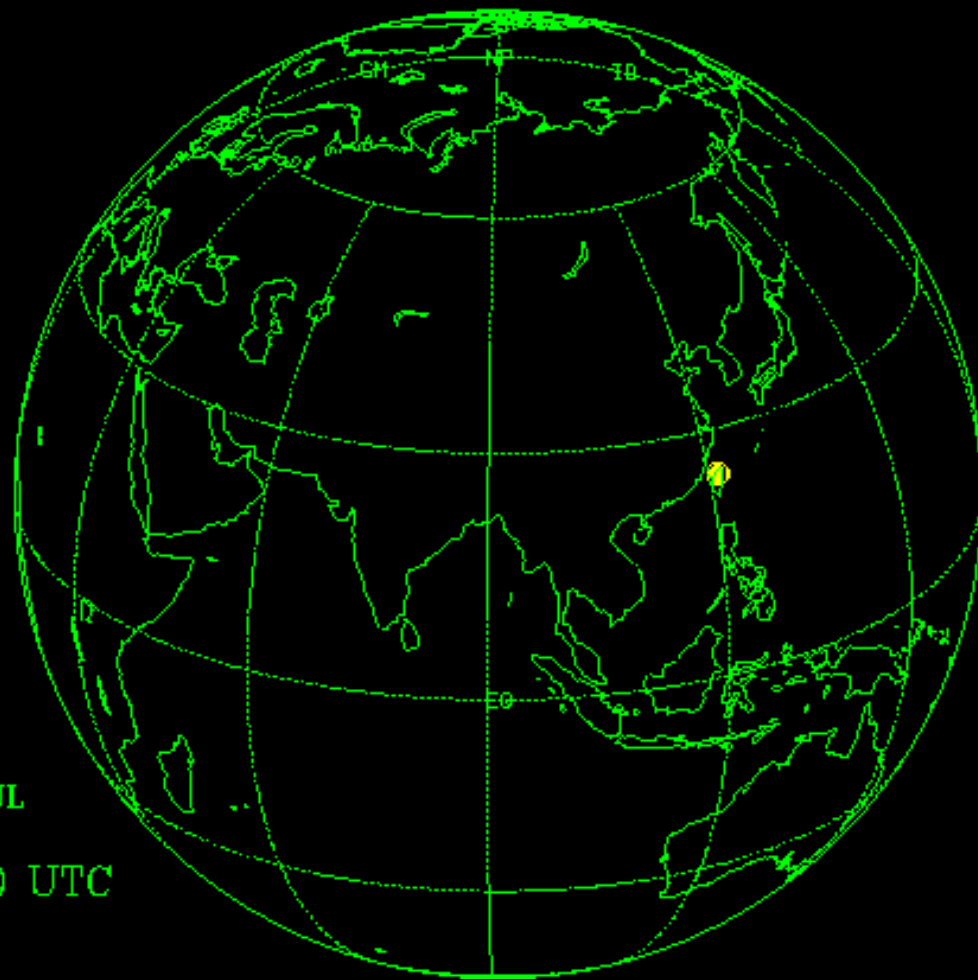
Mauna
Loa
387.50



2010
22 OCT
2042 UTC

440 ppmv

Mauna
Loa
· 390.19



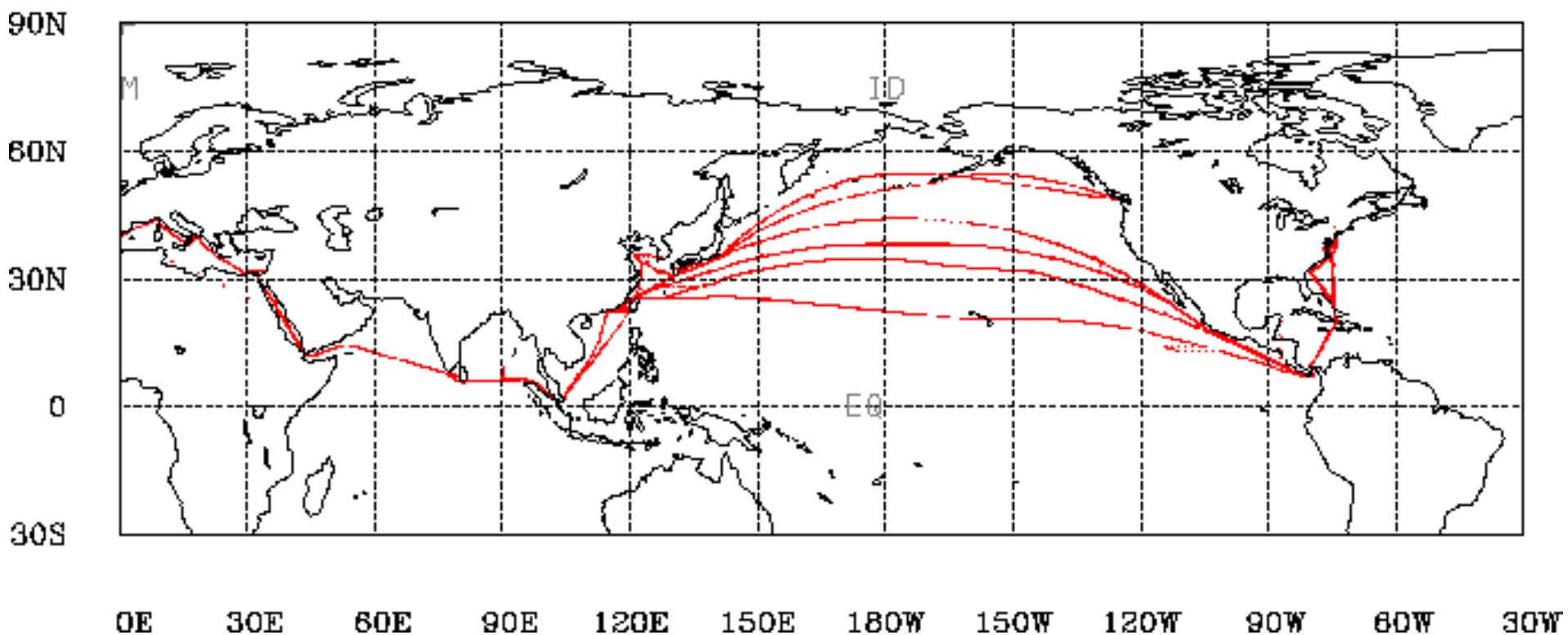
2010

14 JUL

1930 UTC

Measurements Routes Taken: Jun 2009 – Dec 2009

PGGM PROGRAM CO₂ Measurements
ALL ROUTES

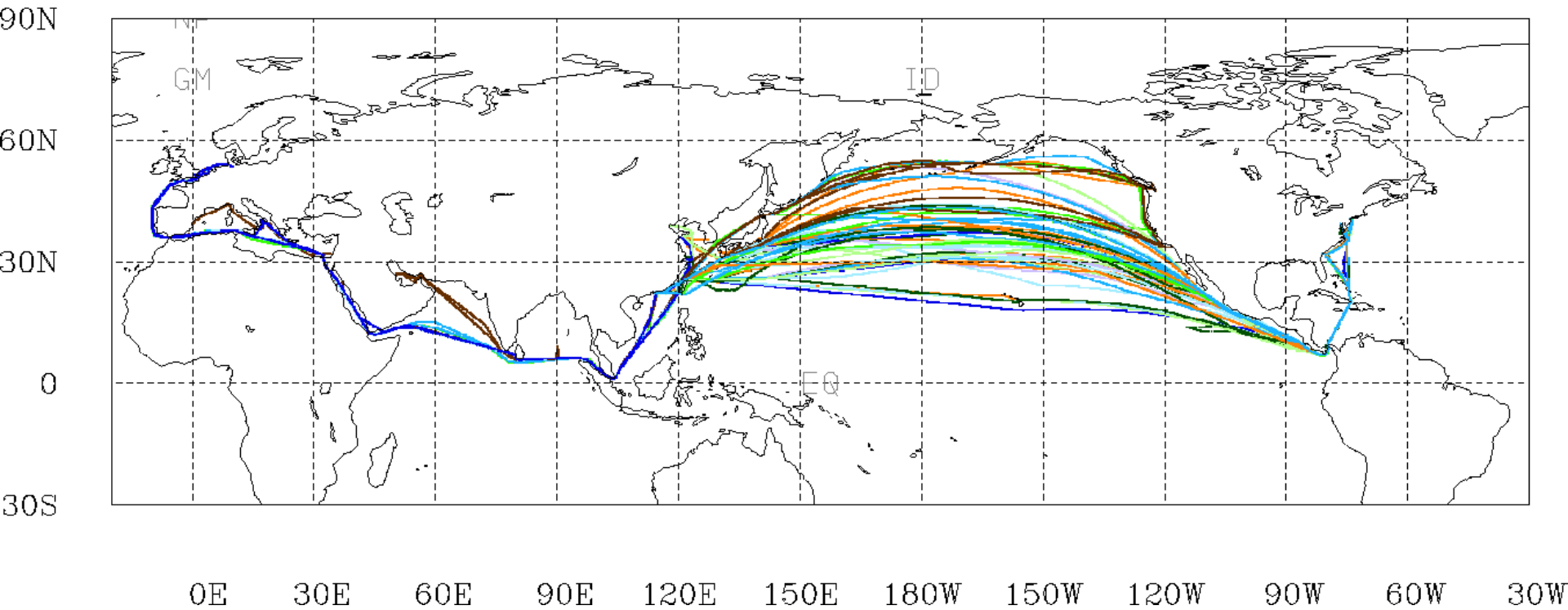


Measurements Routes Taken: Jun 2009 – Dec 2009

PGGM PROGRAM CO2 Measurements

ALL ROUTES

20101231

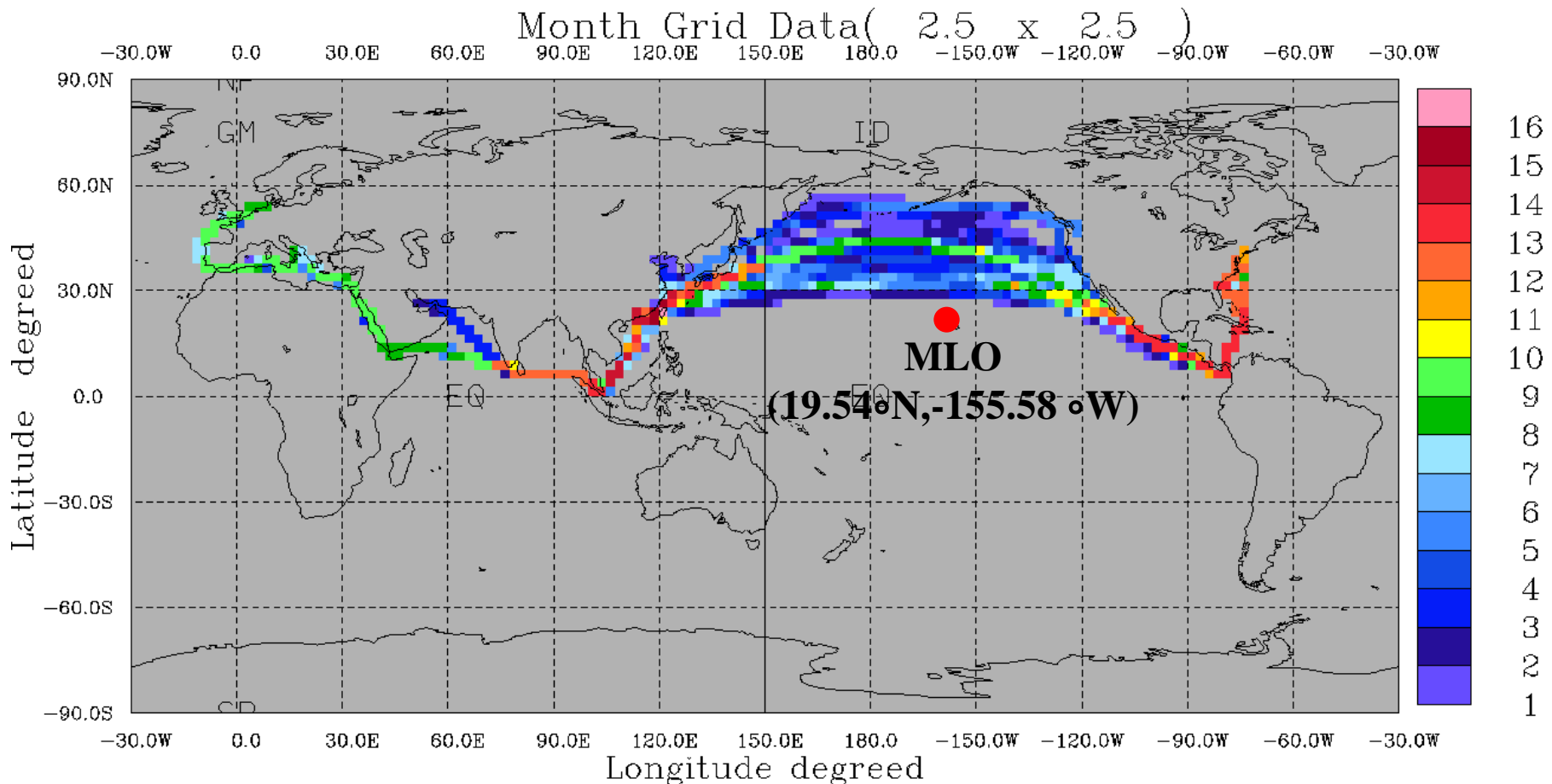


4.2. 資料分析|船測網格和測站資料比對

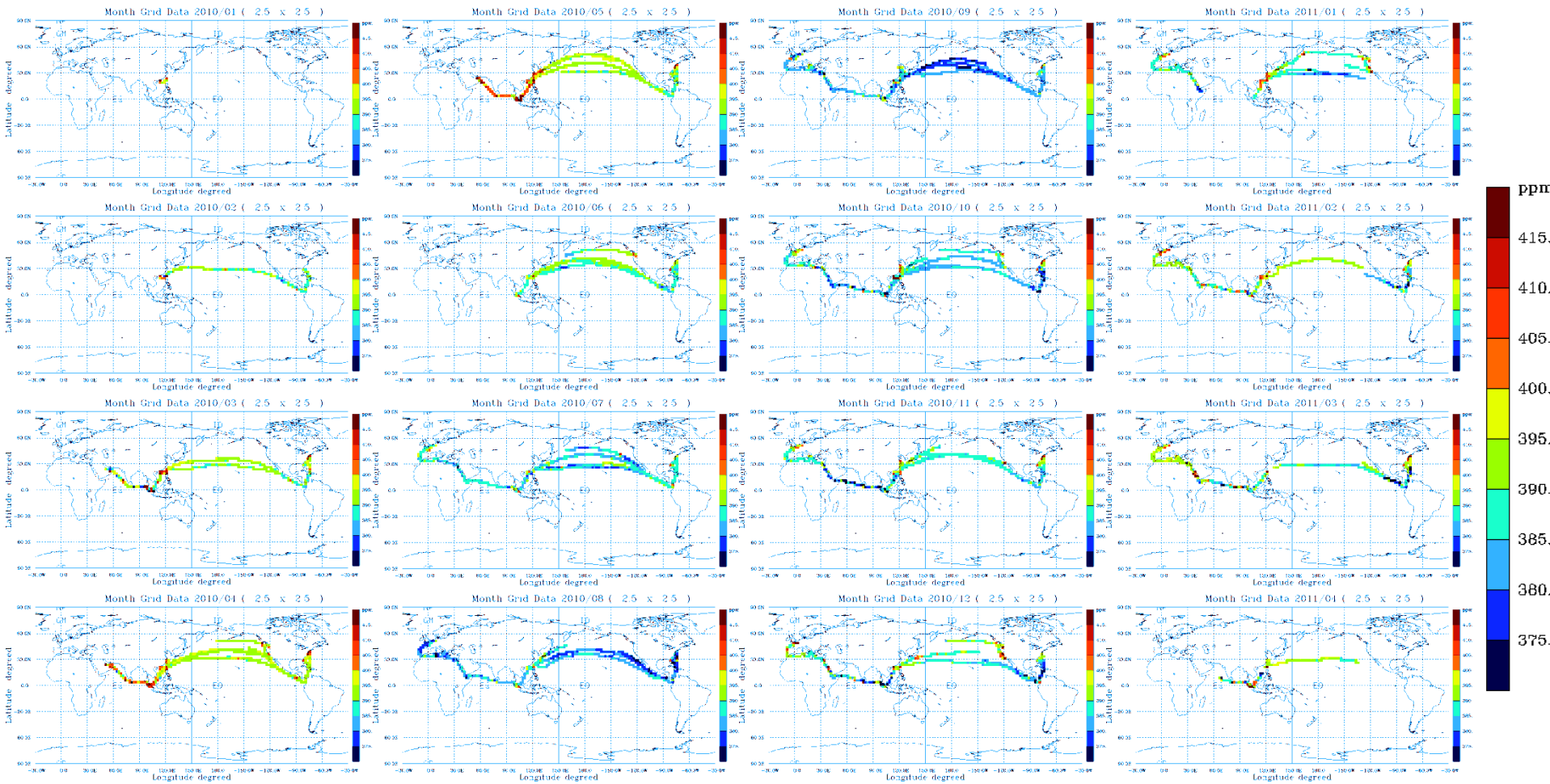
1. 船測資料分析

1. 資料網格化： $2.5^{\circ} \times 2.5^{\circ}$

2. 所有資料擁有月份頻率分佈

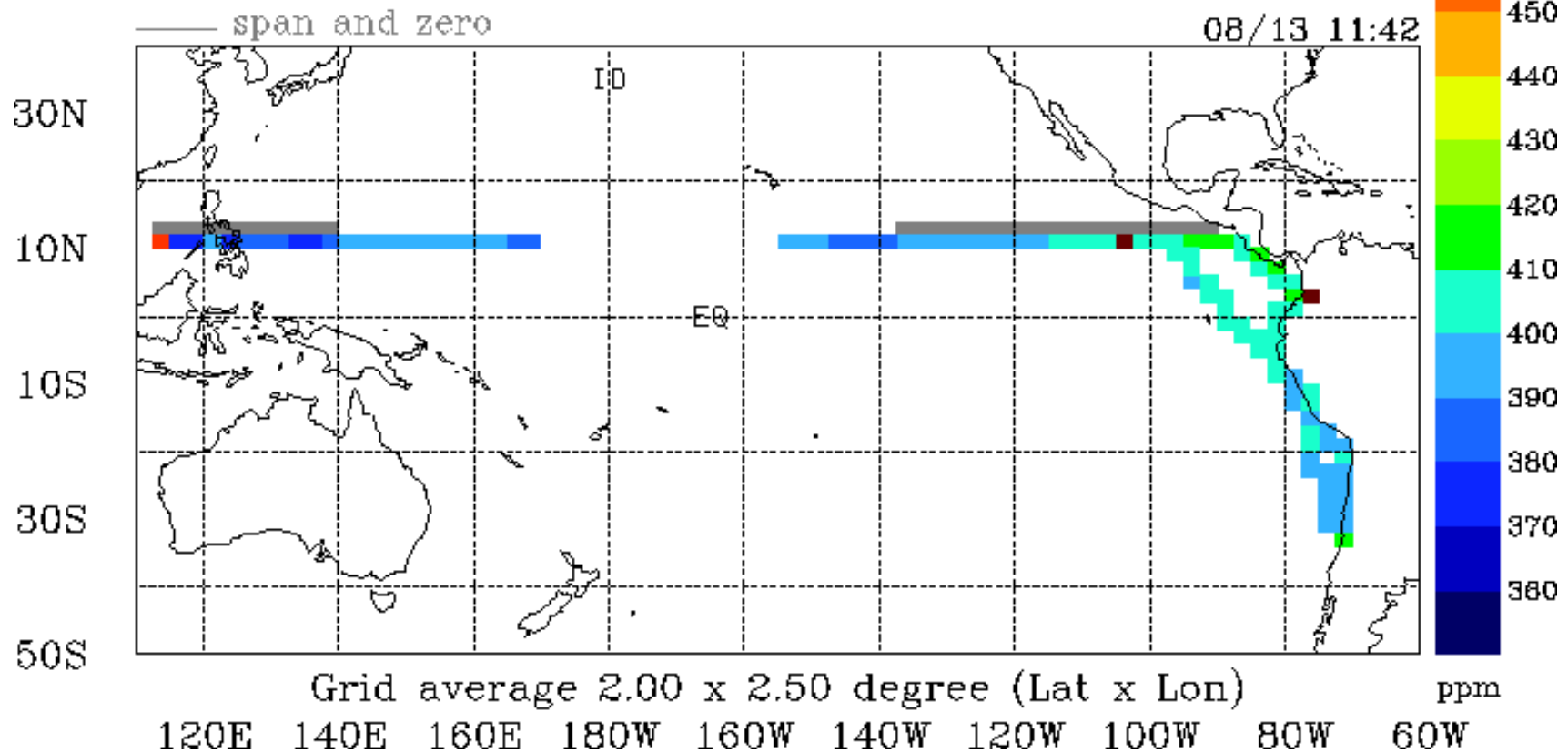


二維月平均資料分佈



4.3. New Routes to Southern Hemisphere

PGGM EVER DELIGHT Measurements
20110604~20110813 CO2 route concentration



Summary

- Air-based measurements: Scheduled to be started in 2012
- Ship-based measurements:
 - More than 80 ship measurements have been taken since June 2009 over the oceanic atmospheres of Pacific, Indian, Red Sea, Mediterranean, Northwest and Northeast Atlantic.
 - We are now in the process of writing up these results.

PGGM Publications

- Wang, K.-Y., et al. (2010), Global CO₂ and Temperature Monitoring with PGGM and FORMOSAT-3/COSMIC, Abstract presented at the 2nd International Workshop on Atmosphere Watch in Asia-Greenhouse Gases Monitoring Activities- Oct. 21-22, 2010, Jeju, Korea.
- Wang, K., S. Chang, and T. Jhang (2010), On the development of a methodology for extensive in-situ and continuous atmospheric monitoring, Abstract A21-0021 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Wang, K.-Y., S.-W. Chang, T.-C. Chang, C.-C. Wang, C.-J. Chiu, C.-J. Lin, H.-C. Chien, P.-C. Lin, and S.-C. Tai (2011), Pacific Greenhouse Gases Measurements (PGGM) project ship-based measurement 2009-2010 results, Geophysical Research Abstracts, Vol. 13, EGU2011-3940, 2011.
- Wang, K.-Y., H.-C. Chien, and J.-L. Wang (2011), Development of low-cost network of sensors for extensive in-situ and continuous atmospheric CO₂ monitoring, in Monitoring, Control and Effects of Air Pollution, pp. 60-72, InTech Open Access Publisher .

PGGM Meetings

- The 1st PGGM Workshop, 1-3 June 2008, Taipei, Taiwan 2008.
- The 2nd PGGM Workshop, 4 May 2009, Taipei, Taiwan, 2009
- The 3rd PGGM Workshop, Sep 2010, Taipei, Taiwan.
- The 4th PGGM Workshop, Oct. 2011, Taipei, Taiwan (tbc).

PGGM Collaborators

- China Airlines, Taiwan
- Evergreen Marine Corporation, Taiwan
- Taiwan CPC Corporation
- LeDer Instrument Company, Taiwan
- Instruments: ECOTECH, Australia; Picarro, USA
- Cal. Gases: WMO NOAA CMDL
- European IAGOS Project
- Centre for Atmospheric Science, Cambridge University, UK
- National Institute of Environmental Studies, Japan.
- Environmental Protection Administration, Taiwan
- National Science Council, Taiwan

謝謝大家的耐心聆聽

Thank you very much for your listening

Comments/Suggestions:

Kuo-Ying Wang

Department of Atmospheric Sciences

Center for Environmental Studies

National Central University

No. 300 Chung-Da Road

Chung-Li, Taiwan

kuoying@mail.atm.ncu.edu.tw

kuoying.wang@gmail.com