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（出國類別：研究）

研習空氣品質及微粒監測技術

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摘要

新加坡與臺灣同為海島型國家，空氣品質除受本地活動及氣候條件影響外，也易受外來污染影響，對於微粒監測、空氣品質資料發布及霧霾預警，均有相似作法。本次前往新加坡國立大學參觀學校微粒實驗室、新加坡環境局及空氣品質監測站，並至新加坡國家計量中心，瞭解新加坡微粒及臭氧前驅物監測、空氣品質監測站運作、監測資訊處理及發布。

我國空品監測較新加坡多樣且具規模，在儀器操作維護、品保查核、數據處理或資料發布均已建立做法且持續運行中。如有合作機會，可就儀器品保查核及監測數據處理技術與新加坡交流。而新加坡為因應鄰國農業活動引發空氣污染，訂有短期 PSI。我國常因特殊氣象條件及區域擴散不良引起短期空氣品質不良，未來可研究採用。

目錄

一、目的及背景說明 1
二、研習過程 1
（一）新加坡大學 1
（二）新加坡環境局 2
（三）新加坡國家計量中心 3
三、心得及建議事項 5

附件 1、研習期間相關照片
附件 2、新加坡空氣品質監測
附件 3、我國空氣品質監測介紹
附件 4、新加坡國家計量中心微量氣體量測

一、目的及背景說明

我國自 71 年開始進行空氣品質自動監測，在 82 年完成全國 76 座自動監測站及監測中心，建立完整空氣品質監測網。30 年來我國空氣品質監測系統隨著資訊技術演進，歷經 2 次汰換更新，逐步增加微粒及臭氧前驅物監測，即時提供國人最新監測資訊。

新加坡與臺灣均為海島型國家，空氣品質除受本地生產活動及氣候條件影響外，也易受外來污染影響。尤其新加坡因其鄰國特殊農業活動，需進行霾害預警，而我國在 103 年 11 月開始進行 $PM_{2.5}$ 預警。此外，新加坡自 101 年開始於每日空氣品質資料發布時增加細懸浮微粒（$PM_{2.5}$）資訊，我國也自 101 年開始執行 $PM_{2.5}$ 手動監測及資料發布。由於新加坡與臺灣諸多監測，均有相似作法，因此在監測及數據處理技術等，希望可借鏡新加坡作為。

本次研習前往新加坡國立大學參觀微粒實驗室、新加坡環境局及空氣品質監測站，並至新加坡國家計量中心，瞭解新加坡對於空氣品質監測及資料發布、預警及微粒監測技術與應用。

二、研習過程

（一）新加坡大學

12 月 10 日造訪新加坡國立大學，參觀環境科學與工程系于禮亞博士微粒採樣及實驗室，同時也就新加坡官方及學術界對於微粒監測及成分分析合作情況。

于博士過去曾參與本署與中央大學合作跨境監測合作「七海計畫」(7 South East Asian Studies, 7-SEAS)，負責新加坡空氣採樣。于博士在校內設置之微粒採樣設備，與本署委託國立中央大學李崇德教授所使用之設備相同，都是以自動連續方式操作，同時採集濾紙進行成分分析。

對於微粒監測技術，于博士認為美國已經發展許多微粒採樣及成分分析方法，進行微粒成分分析有助於解析空氣中污染物組成，研擬污染

管制策略。學術單位如新加坡國立大學雖有研究發展，但主要參與產業污染控制技術研發，未與環保部門有合作計畫。

（二）新加坡環境局

12 月 11 日赴新加坡環境局，由新加坡環境局人員簡報介紹新加坡空氣品質監測站設置、運作情形及監測成果。拜訪新加坡環境局為此行最主要目的，由於本署以往與新加坡環境局空氣品質監測部門並無交流經驗，因此透過電子郵件密集連繫。新加坡環境局安排專人與本署交換空氣品質監測經驗，並實地參觀監測站設置及儀器運作情形。

新加坡現有空氣品質監測站共 15 座，分別為一般性大氣空品監測站(ambient monitoring station) 11 座、交通(roadside monitoring station)測站 2 座及臭氧前驅物(VOCs monitoring station)監測站 2 座。新加坡空氣品質主要受交通車輛排放及工業區影響，目前 2 座臭氧前驅物監測站均設置於工業區附近，2 座交通測站設於新加坡交通最繁忙的道路邊，11 座空品測站則均勻分布於新加坡東、西、南、北及中部，共 5 區。

新加坡監測站設置儀器大致與我國相同，主要項目為懸浮微粒(PM_{10})、二氧化硫(SO_2)、二氧化氮(NO_2)、一氧化碳(CO)、臭氧(O_3)及細懸浮微粒($PM_{2.5}$) ，惟各監測站內儀器稍有差異，不是每個監測站都有相同設備。尚未進行 $PM_{2.5}$ 手動監測。臭氧前驅物監測站之儀器廠牌與我國相同。各監測站之測項原始數據不對外提供。

新加坡空氣品質監測方法及資料發布參考美國環保署作法，每日以空氣污染指標 (Pollution Standards Index) PSI 分東、西、南、北及中部 5 區進行空氣品質資料發布，對外網頁以 24-hr PSI 呈現。不計算全國 PSI 平均值，而以 5 區 PSI 中最大值及最小值數值範圍表示。各區監測濃度值也不採算術平均處理，遇有儀器異常或故障，則以另一測站數據取代。

新加坡空氣品質監測資料發布在 2012 年 8 月下旬以前，僅於每日下午 4 點發布 1 次 PSI。2012 年 8 月下旬以後，每日上午 8 時、中午 12 時及下午 4 時各發布 1 次 PSI。在 2013 年 6 月下旬由於發生印尼燒笆引發空氣品質不良，再提高 PSI 發布頻率，每小時更新 PSI，並增加細懸浮微粒($PM_{2.5}$)資訊。另訂有短期 PSI(3-hr PSI)，以單一指標污染物 PM_{10} 濃度換算 PSI 發布。

新加坡監測數據由監測技術人員以人工處理，每日發布 PSI 至夜間 11 點，每天晚上 11 點以後 PSI 於次日上午 7 點一併發布。監測技術人員每日輪班處理數據。對於監測數據之有效性確認，新加坡似尚未建立數據檢核程序，技術人員對於我國以資訊技術處理及發布監測結果，多所詢問。

新加坡環境局微粒監測，目前使用之自動監測儀器原理為貝他射線衰減法，PM_{10} 及 $PM_{2.5}$ 為相同廠牌，未進行 $PM_{2.5}$ 手動監測。對於環境空氣中微粒成分分析似也未規劃，學術單位如新加坡國立大學雖有研究發展也曾與環境局進行意見交換，但環保部門有合作計畫。

我國與新加坡相同，均參考美國環保署作法沿用 PSI 作為空氣品質監測結果發佈，然而由於環境變化迅速，部分監測項目例如懸浮微粒（PM_{10}），由於是以持續監測 24 小時的數值經過算數平均後再換算成 PSI，時有延遲狀況發生，常有民眾發現認為監測儀器不準確等微詞。新加坡也同樣有這些困擾，未來是否仍以 PSI 作為空氣品質監測結果，可以研究。

（三）新加坡國家計量中心

新加坡科技研究局（Agency for Science, Technology and Research；簡寫為 A*STAR，簡稱新*科研）國家計量中心（National Metrology Centre，簡寫為 NMC）類似我國工研院國家計量中心，該實驗室是新

加坡國家級氣體校驗實驗室，負責新加坡氣體校驗任務，提供產業界訂製標準氣體等服務。

12 月 12 日參加 NMC 舉行之座談會，介紹我國空氣品質監測情形，會後並參觀該中心氣體校驗實驗室。新加坡國家計量中心雖負責氣體校驗，但由於新加坡環境局對於空氣品質監測相當仰賴儀器維護廠商，測站使用之標準氣體及儀器流量查核工作均由維護廠商處理。相較於我國與工研院國家計量中心有定期流量校驗合作關係，NMC 對於新加坡環境局空氣品質監測所知有限。

座談會中當地顧問公司對於本署空氣品質預報相當有興趣，會後與環境局人員討論，發現因新加坡未進行空氣品質預報，顧問公司對於模式模擬有高度興趣。另有廠商詢問本署是否規劃對於所使用之 $PM_{2.5}$ 自動監測儀器進行認證，給予合格標章。由於本署環境檢驗所對於 $PM_{2.5}$ 自動監測儀器尚未規劃執行認證，也依此答覆。

下午參觀 NMC 氣體校驗實驗室，該實驗室臭氧一級標準光度計，提供臭氧傳輸標準比對使用，惟似乎無專責人員操作管理。本處品保室也有一套相同設備，除對本署測站儀器定期追溯，也對外提供監測儀器校驗服務。就設備使用而言，本署品保室設備有較大使用效益。

三、心得及建議事項

（一）新加坡為因應鄰國農業活動所引發之空氣污染，訂有短期 PSI(3-hr PSI) 。我國常因特殊氣象條件及區域擴散不良引起短期空氣品質不良，未來可研究採用。

（二）新加坡監測數據由監測技術人員以人工處理，每日發布 PSI 至夜間 11 點，11 點後 PSI 於次日上午 7 點一併發布。監測技術人員每日輪班處理數據。對於監測數據之有效性確認，新加坡似尚未建立數據檢核程序，技術人員對於我國以資訊技術處理及發布監測結果，多所詢問。

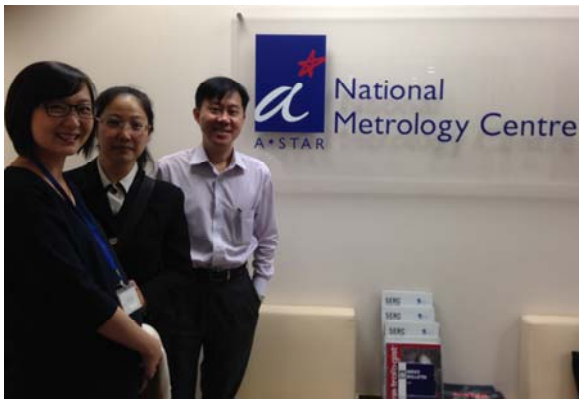
（三）新加坡環境局對於空氣品質監測儀器，似尚未建立查核機制，測站使用之標準氣體及儀器流量查核工作均由維護廠商處理。新加坡國家計量中心雖設有臭氧一級標準光度計，惟似乎無專責人員操作管理。

（四）整體而言，我國空氣品質監測較新加坡多樣且具規模，無論在監測儀器操作維護、品保查核、數據處理或資料發布等，已建立一套做法且持續運行中。未來如有合作機會，我國可就儀器品保查核及監測數據處理技術與新加坡交流。

附錄 1 研習期間相關照片


圖 1.攝於新加坡國立大學，左為于禮亞教授。右圖為微粒採樣站。


圖 2.新加坡空氣品質監測站，左為新加坡環境局污染控制部門環境監測及評估科員董惠淇，右為資深環境監測技術人員。右圖為臭氧前驅物監測站。



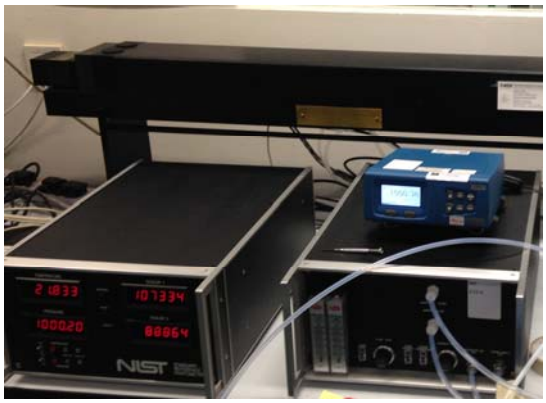


圖 3. 攝於新加坡科技研究局(A*STAR)國家計量中心(NMC)，左一為研究員劉匯，右一為量測實驗室主任蔡福安。右圖為臭氧一級標準光度計，提供臭氧傳輸標準比對使用。

附件2

Ambient Air Quality Monitoring in Singapore

Pollution Control Department

Ms Tang Hui Qi

National Environment Agency
Safeguard · Nurture · Cherish

Air Pollutants

Common Air Pollutants Monitored

Air pollutants internationally used to assess ambient air quality include:

- Sulphur Dioxide (SO_2)
- Oxides of Nitrogen (NO_x)
- Carbon Monoxide (CO)
- Ozone (O_3)
- Particulate Matter (PM10 and PM2.5)

Sulphur Dioxide (SO_2)

Sources

- Fossil fuel combustion at power plants and industrial boilers

Health Effects

- Impairment of respiratory function and aggravation of existing respiratory disease
- Narrowing of the airways that can cause difficulty breathing (Bronchoconstriction)
- Sensitive groups: asthmatics, individuals with chronic obstructive lung or cardiovascular disease, elderly and children

Nitrogen Dioxide (NO_2)

Properties

- Plays an important role in atmospheric reactions that generate photochemical oxidants such as Ozone

Sources

- High-temperature combustion processes e.g. vehicles and power plants

Nitrogen Dioxide (NO_2)

Heath Effects

- When inhaled forms acids which irritate and corrode mucous linings of lungs
- High levels: Temporary increase in airway resistance
- Increased risk of respiratory infection
- Exposure to high levels range from slight irritation, burning and pain in throat and chest, violent cough and shortness of breath to pulmonary edema and bronchitis

Carbon Monoxide (CO)

Sources

- By-product of incomplete combustion of fuels by motor vehicles and industries
- Cigarette smoke, burning of garden refuse etc

Health Effects

- Decreases oxygen carrying capacity of blood
- Haemoglobin binds to the oxygen molecules more tightly, making it more difficult for oxygen to be released to the tissues
- Chest pain during exercise
- Affects mental function, visual acuity and alertness of healthy individuals

Ozone (O_3)

Sources

- Chemical reaction between Oxides of Nitrogen (NOx) and Volatile Organic Compounds (VOCs) in the presence of sunlight

Ozone (O_3)

Health Effects

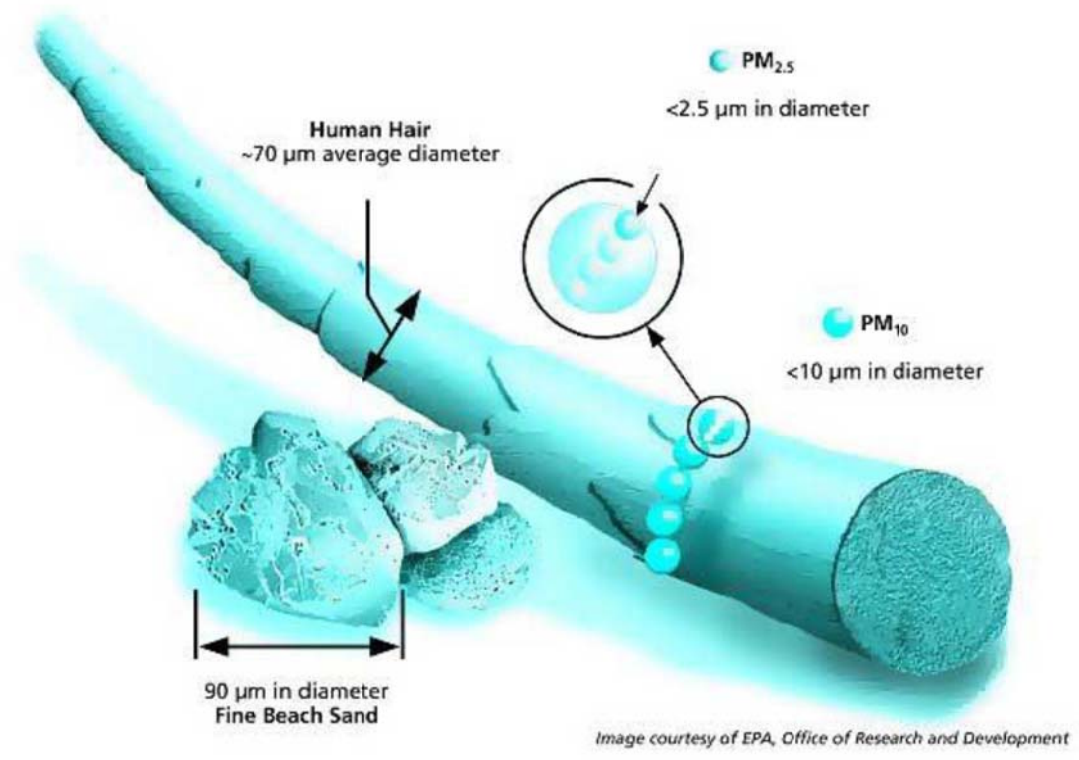
- Causes cough, chest pain, eye and throat irritation
- Irritates mucous membranes of the nose, throat and airways
- Aggravation of asthma
- Increased susceptibility to respiratory illnesses such as pneumonia and bronchitis

Particulate Matter (PM_{10} and $PM_{2.5}$)

- Complex mixture of extremely small particles and liquid droplets suspended in the air for long periods of time
- Particles with diameters less than or equal to 10 µm are termed PM10.
- Based on size, PM10 is divided into 2 distinct fractions:

1. Coarse particles between 2.5 and 10 µm in diameter
2. Fine particles less than or equal to 2.5 µm in diameter

Particulate Matter (PM_{10} and $PM_{2.5}$)

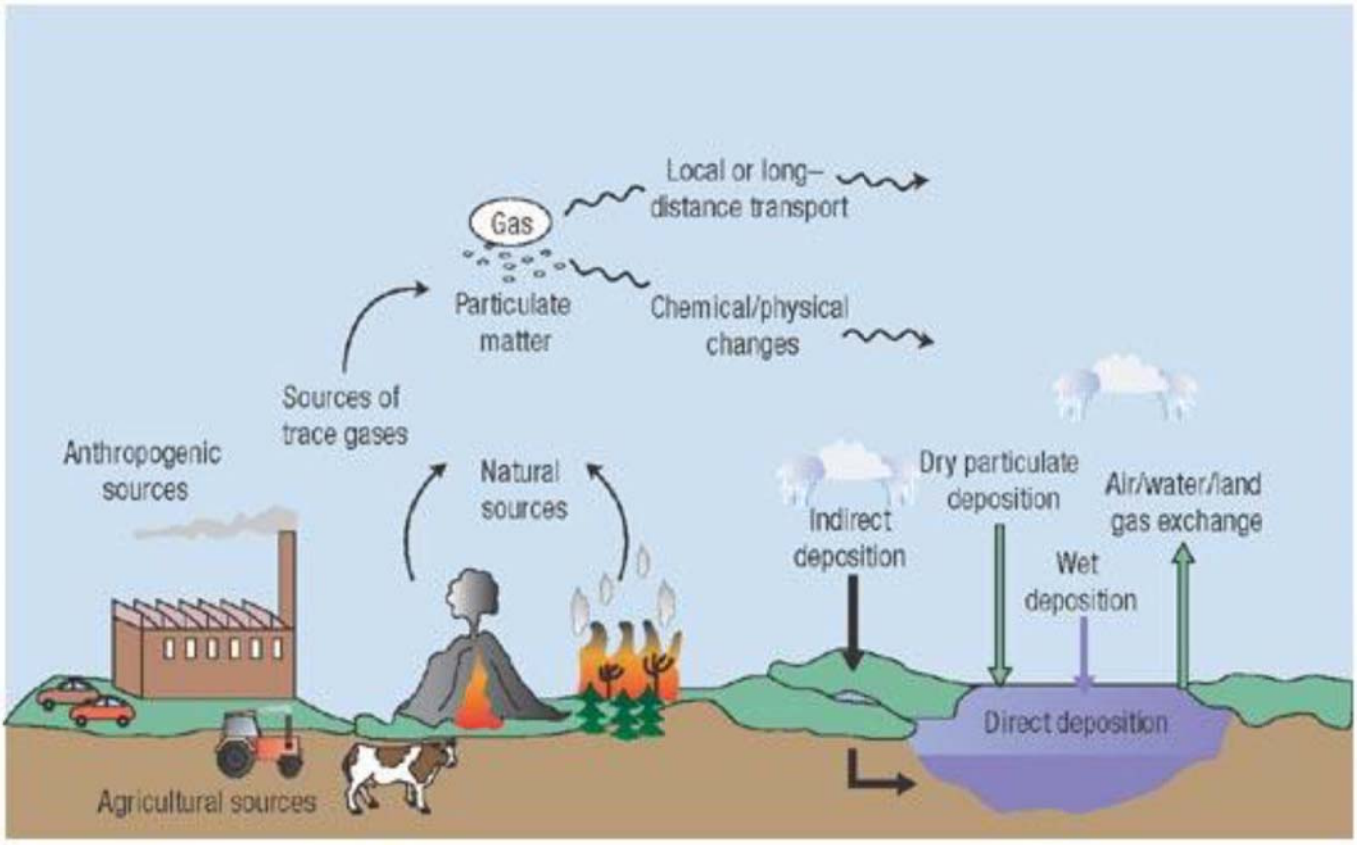


Particulate Matter (PM_{10} and $PM_{2.5}$)

Sources

- Coarse particles: earth crustal materials, windblown dust, fugitive dust from paved and unpaved roads, industries from crushing and grinding operations, wildfires
- Fine particles: industrial and residential combustion activities, vehicle exhaust

Particulate Matter (PM_{10} and $PM_{2.5}$)



Particulate Matter (PM_{10} and $PM_{2.5}$)

Health Effects

- Include premature death, increased hospital admissions and emergency room visits, increased respiratory symptoms and disease, decreased lung function, alterations in lung tissure and respiratory tract defence mechanism
- Sensitive groups: Elderly, children and individuals with cardiopulmonary diseases like asthma

Objectives

To assess nature and magnitude of any air pollution problems

To monitor trends in air quality to enable the government to make policy decisions to prevent air any pollution episodes

To assess effectiveness of pollution control measures implemented to improve air quality

Methods of Measurement

Reference Methods by US EPA

Singapore's Air Quality Monitoring Network

Telemetric Air Quality Monitoring and Management System (TAQMMS) consists of

- Remote air monitoring stations
- Central Control System (CCS)
- Linked via public telephone network and wireless modems

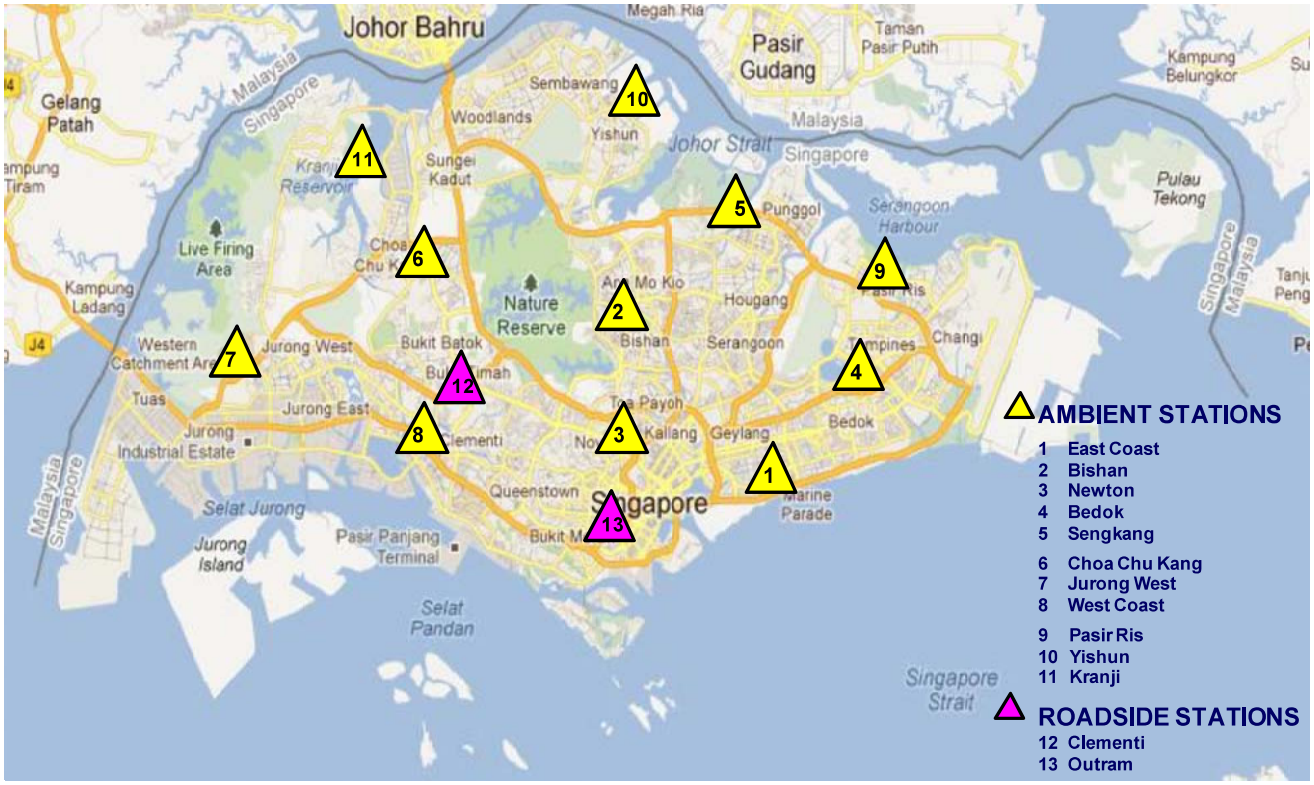
Air Monitoring Station

Air Monitoring Station

Central Control System (CCS)

- Comprises two servers (one main and one backup) and personal computers which are linked to the servers via internet
- Calls up station at regular intervals for an immediate update of air quality data collected at the stations
- Customised web-based application software
- Reports and graphs

Location of Air Monitoring Stations



Singapore Ambient Air Quality Targets

Pollutant	Singapore Targets by 2020	Long Term Targets
Sulphur Dioxide (SO_2)	24-hour mean: 50 µg/m^3 *(WHO Interim Target)* Annual mean: 15 µg/m3 (Sustainable Singapore Blueprint target)	24-hour mean: 20 µg/m^3 *(WHO Final)*
Particulate Matter ($PM_{2.5}$)	Annual mean: 12 µg/m^3 24-hour mean: 37.5 µg/m^3 *(WHO Interim Target)*	Annual mean: 10 µg/m^3 24-hour mean: 25 µg/m^3 *(WHO Final)*
Particulate Matter (PM_{10})	Annual mean: 20 µg/m^3 24-hour mean: 50 µg/m^3 *(WHO Final)*	
Ozone	8-hour mean: 100µg/m^3 *(WHO Final)*	
Nitrogen Dioxide (NO_2)	Annual mean: 40µg/m^3 1-hour mean: 200µg/m^3 *(WHO Final)*	
Carbon Monoxide (CO)	8-hour mean: 10mg/m^3 1-hour mean: 30mg/m^3 *(WHO Final)*	

Pollutant Standards Index (PSI)

- Developed by US EPA
- Since 1991
- A public information tool
- General health effects associated with different pollution levels
- Precautions to take when air pollution levels rise into the unhealthy or worse range

Pollutant Standards Index (PSI)

Computation of PSI

- Based on concentrations of 5 air pollutants (SO_2, CO, NO_2, PM_{10} and Ozone) measured over a 24-hour period
- Average concentration of each pollutant is converted into a sub-index on a scale of 0 to 500
- The highest sub-index of the 5 pollutants for each region is the PSI for that region (i.e. North, South, East, West and Central)

Pollutant Standards Index (PSI)

PSI Value	Air Quality Descriptor
0 to 50	Good
51 to 100	Moderate
101 to 200	Unhealthy
201 to 300	Very Unhealthy
Above 300	Hazardous

Reporting of Air Quality Data

- During non-haze period, PSI and $PM_{2.5}$ concentrations are released at 3 times (8am, 12 noon and 4pm) daily.
- PSI and $PM_{2.5}$ readings are reported in the media and updated on NEA website (http://www.nea.gov.sg/psi/) and myENV mobile application.
- During smoke haze episodes, hourly 3-hour PSI updates and daily 24-hour PSI are released

3-hr PSI

- Not used in any other country
- Introduced during the 1997 smoke haze episode
- In response to public request to have more current air quality information
- Only an indicative index
- 24-hr PSI is the actual index for measuring air quality and for assessing health impact

Health Advisories based on PSI

Index Value	PSI Descriptor	Health Advisories
Up to 50	Good	No special precautions are needed
51 to 100	Moderate	No special precautions are needed
101 to 200	Unhealthy	• Persons with existing heart or respiratory ailments should reduce physical exertion and outdoor activity. • The general population should reduce vigorous outdoor activity.
201 to 300	Very unhealthy	• Elderly and persons with existing heart or lung disease should stay indoors and reduce physical exertion and outdoor activity. • The general population should avoid vigorous outdoor activity.

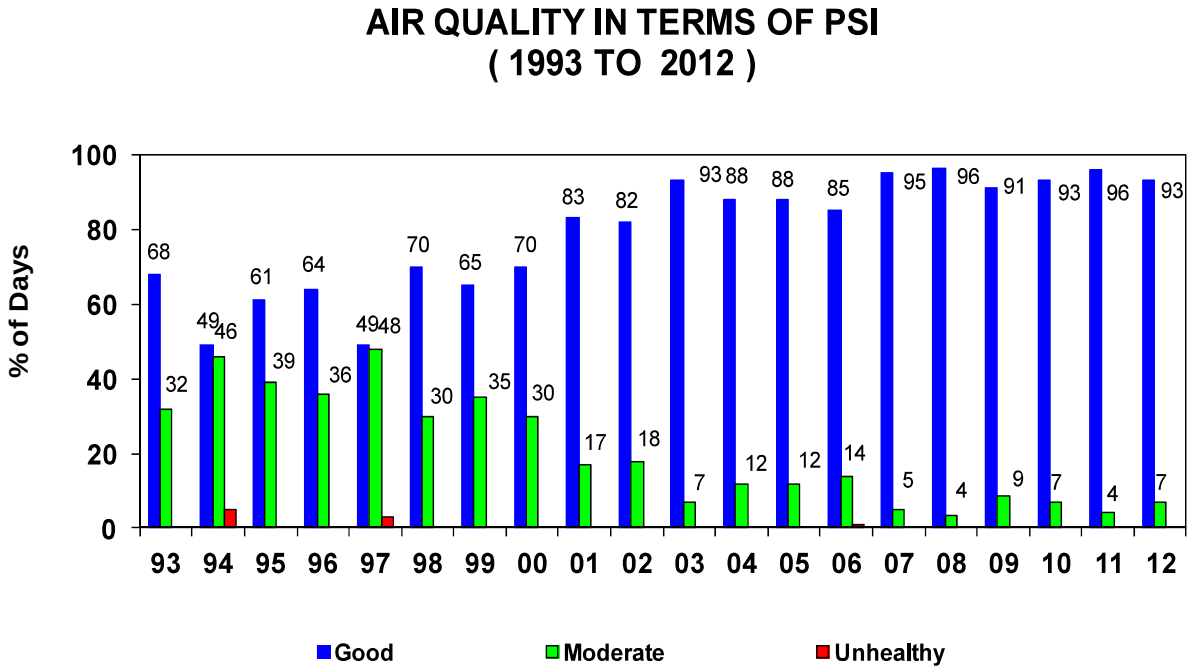
Health Advisories based on PSI

Index Value	PSI Descriptor	Health Advisories
301 to 400	Hazardous	• Children, elderly and persons with existing diseases should stay indoors and avoid outdoor activity. • The general population should avoid all unnecessary outdoor activity.
Above 400	Hazardous	• Children, elderly and persons with diseases should remain indoors, keeping the windows and doors closed and avoiding physical exertion as far as possible • Outdoor activity should be avoided • General population should keep physical exertion and outdoor activity to as low a level as possible

Health Advisories based on $PM_{2.5}$

24-hr $PM_{2.5}$ concentration ($\mu g/m^3$)	Health Advisory
0 to 15	None
>15 to 40	None for the general population. Unusually sensitive people should consider reducing prolonged or heavy exertion.
> 40 to 65	Following groups should reduce prolonged or heavy outdoor exertion: • People with heart or lung disease • Children and older adults Everyone else should limit prolonged or heavy exertion.
> 65 to 150	Following groups should avoid all physical activity outdoors: • People with heart or lung disease • Children and older adults Everyone else should avoid prolonged or heavy exertion.

Singapore Air Quality



(Air quality was affected by transboundary smoke haze from the land and forest fires in 1994, 1997 and 2006.)

Our Environment

Safeguard • Nurture • Cherish

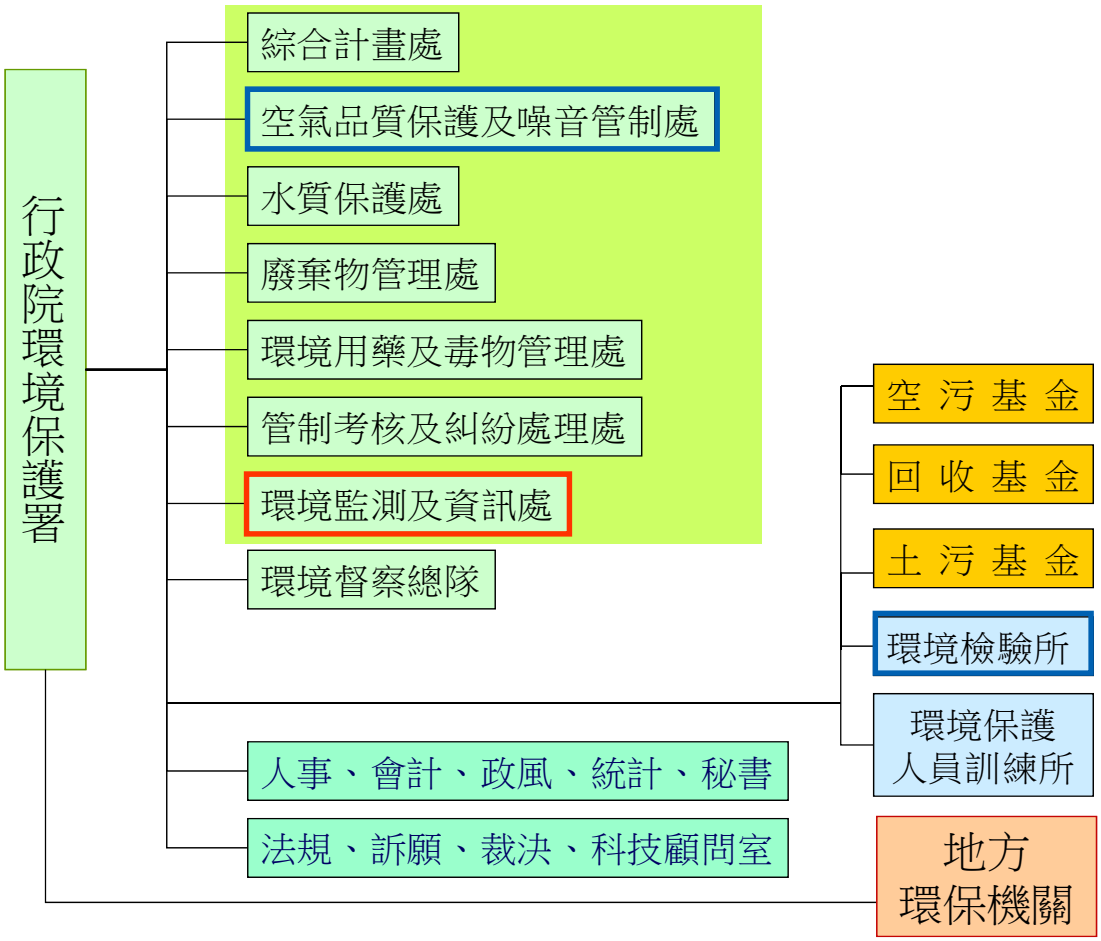
National Environment Agency
Safeguard · Nurture · Cherish

附件3

行政院環境保護署
environmental protection administration

臺灣空氣品質監測系統

陳妙玲
行政院環境保護署
環境監測及資訊處
102 年 12月 12日



空氣品質監測設施

普通測站 (76站)

- 一般站 (60)
- 交通站 (6)
- 公園站 (2) – 陽明山、恆春
- 工業站 (5) – 頭份、線西、台西、前鎮、麥寮
- 背景站 (4) – 萬里、觀音、三義、橋頭

紫外線 (14)，BTEX (10)
酸雨計 (14) 裝置於部分普通測站

特殊測站

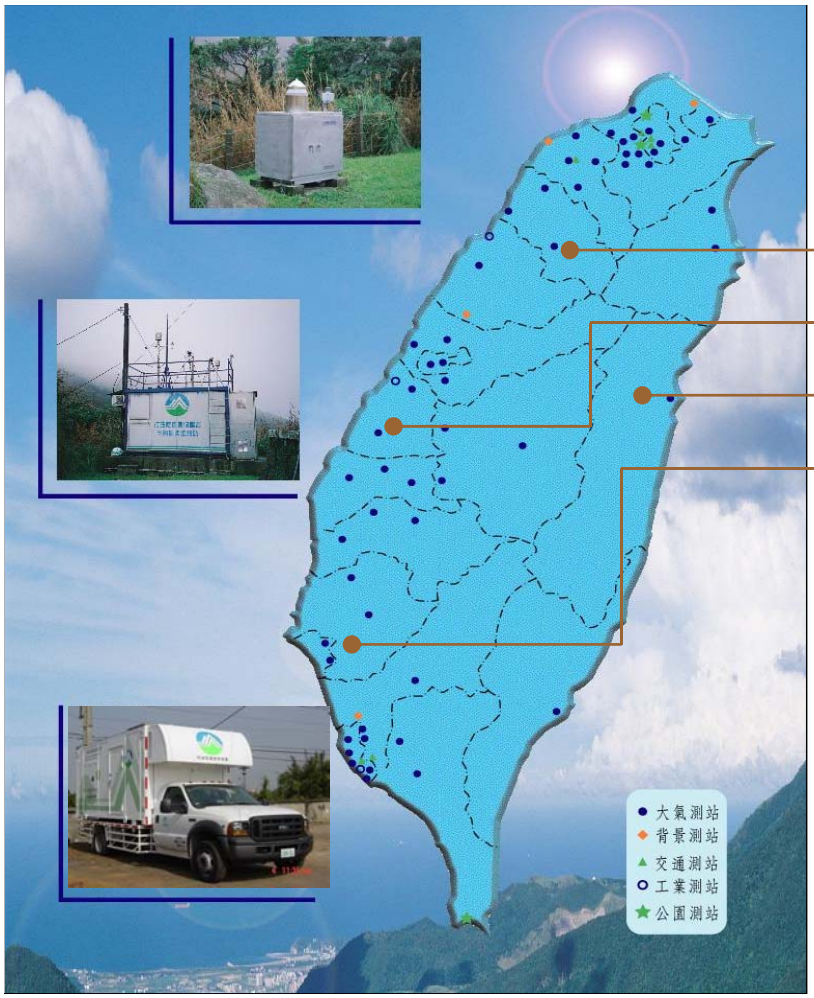
- 移動型測站 (監測車 4 部)
- 光化學測站 (9)
- 研究型測站
  - 微粒成份 (5)
    - 北部（1）
    - 中部（1）
    - 南部（3）
  - 通量測站 (2) – 宜蘭棲蘭山
  - 鹿林山背景站 –玉山國家公園
  - 東沙、東引空氣背景測站

品保室 QA Lab

輔助氣象設施

- 光達 (1) – 中壢中央大學
- 逆溫儀 (3) – 台北、台中、高雄
- 剖風儀 (1) – 高雄左營海軍基地

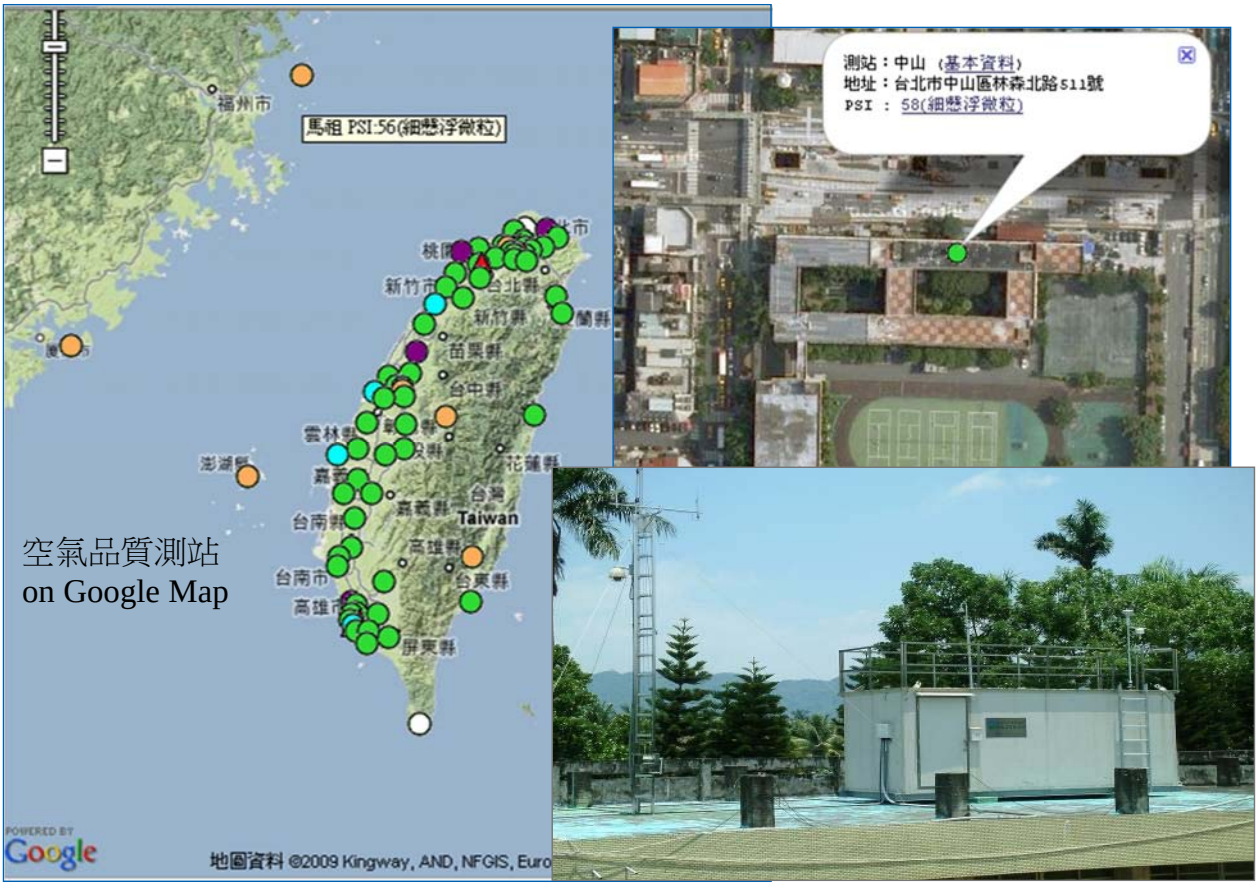
註：普通測站標示紅色及底線者，表示其兼具一般站功能
● 表示持續運作



環保署
空氣品質自動監測站

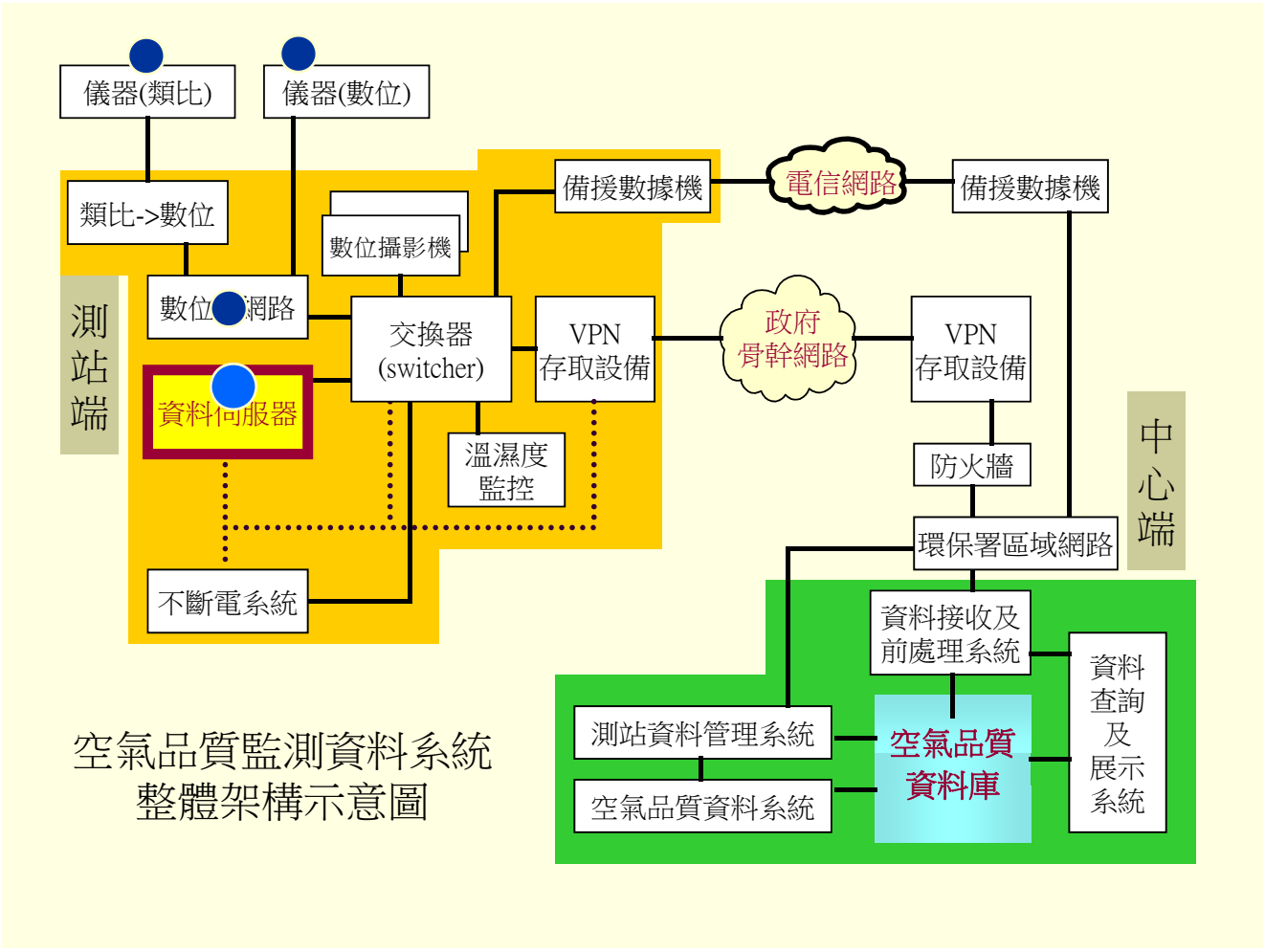
北部	26
中部	17
東部	5
南部	25
	76

澎湖、金門、馬祖 3

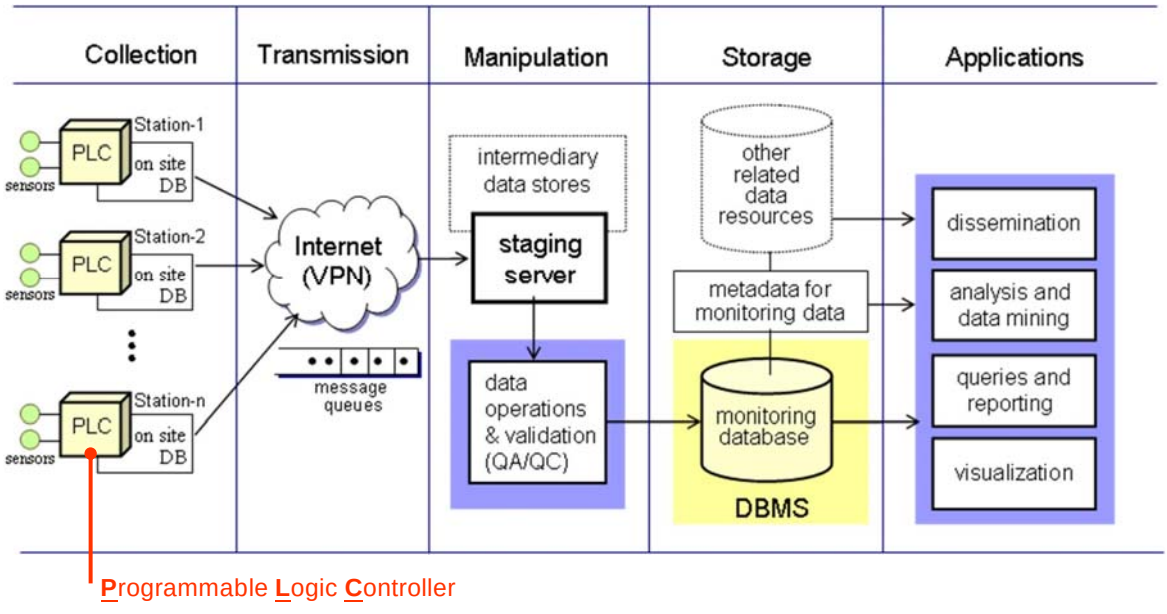


空氣品質監測項目

- 法規項目
  - PM_{10}, SO_2, NO_X, CO, O_3 → **PSI**（空氣污染指標）
    Pollutants Standard Index
  - $PM_{2.5}$
- 光化學測項
  - 56 種 VOC 物種
- 微粒成份監測
  - 硫酸鹽、硝酸鹽、元素碳、有機碳..
- 其它監測項目
  - 紫外線、酸雨、溫室氣體、能見度 …



A Multi-layered System Architecture for Environmental Monitoring Data Management – Taiwan's Experience



http://taqm.epa.gov.tw

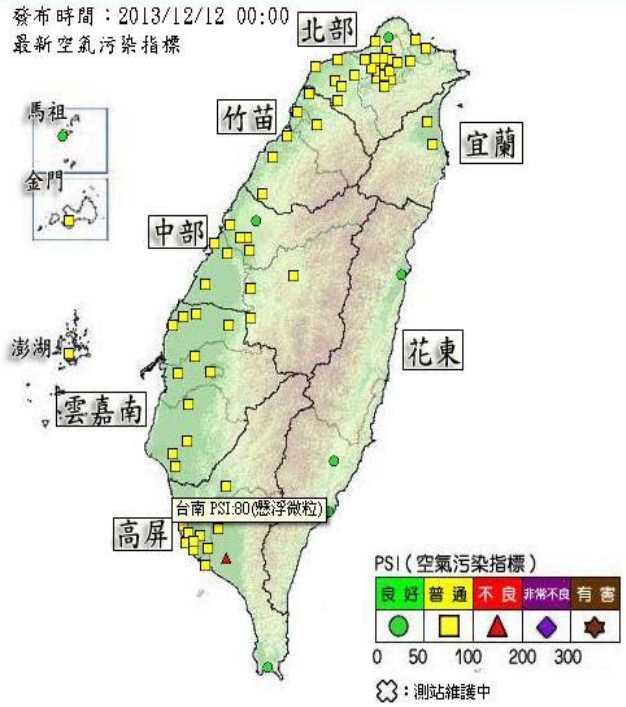
行政院環境保護署
Environmental Protection Administration
Executive Yuan R.O.C.(Taiwan)

空氣品質監測網

空氣品質監測網
空氣品質監測
普通測站
光化測站
空氣污染指標
預報作業
空氣品質標準
儀器資料庫
沙塵網站
河川揚塵監測
紫外線監測
品質保證作業
溫室氣體監測
資料查詢與服務
地方監測站資料
鹿林山背景站
東沙東引背景站
南海環境品質監測
常見問題
相關網站
網站導覽

空氣污染指標 | 細懸浮微粒(PM2.5) | 臭氧8小時 | 空氣品質預報 | 即時濃度 | 紫外線現況 | 紫外線預報

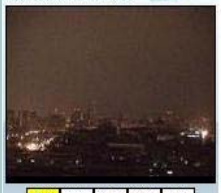
發布時間：2013/12/12 00:00
最新空氣污染指標



查詢更多小時值，請按這裏。

全文檢索
查詢
Google™
快速連結
測站地圖資訊
測站資訊
空氣污染指標
最新空氣污染指標
空氣品質預報
紫外線指數預報
紫外線現況
世界各地空氣品質現況
進階查詢

測站周圍影像



01 02 03 04 05
06 07 08 09 10
萬華(PSI=61)

明細 | 地圖

空氣品質 普通，污染指標為 57

站名	指標值	二氧化硫		一氧化碳		臭氧		懸浮微粒		二氧化氮	
		副指標	濃度值(ppb)	副指標	濃度值(ppm)	副指標	濃度值(ppb)	副指標	濃度值(ug/m^3)	副指標	濃度值(ppb)
基隆	33	4	2	8	0.73	33	40	32	32		38
汐止	41	5	3	6	0.53	30	36	41	41		37
萬里	34	2	1	4	0.32	30	36	34	34		20
新店	42	4	2	9	0.80	22	26	42	42		45
土城	49	5	3	7	0.64	32	38	49	49		36
板橋	52	6	4	17	1.53	30	36	52	53		61
新莊	54	6	4	12	1.11	33	39	54	57		59
菜寮	47	4	3	9	0.78	28	34	47	47		51
林口	46	3	2	5	0.42	38	45	46	46		35
淡水	37	6	3	3	0.30	37	44	35	35		23
士林	52	4	3	5	0.44	32	39	52	54		26
中山	54	6	3	11	0.97	24	29	54	58		44
萬華	51	4	3	12	1.07	27	33	51	52		47
古亭	54	5	3	10	0.88	30	36	54	57		48
松山	53	6	3	9	0.85	29	34	53	56		50
桃園	56	10	6	8	0.72	31	37	56	61		41
大園	52	10	6	7	0.62	31	37	52	55		44
平鎮	60	12	7	9	0.78	34	40	60	70		42
龍潭	56	6	4	11	1.01	47	56	56	63		35
區域	57	11	6	14	1.24	41	48	57	65		57

細懸浮微粒（$PM_{2.5}$）監測

1. $PM_{2.5}$之監測方法分爲「手動監測」及「自動監測」二種。依空氣品質標準規定，$PM_{2.5}$之監測數據係以「手動監測」標準方法所量測之數據爲準。
2. 「手動監測」係每3天採樣1次，經實驗室量測，約20天後公布數據。「自動監測」每小時資料自動上網，僅提供預警參考。
3. 請務必詳閱本署網頁上之各項「說明」，以正確解讀監測資料。

手動監測　　自動監測

手動監測說明

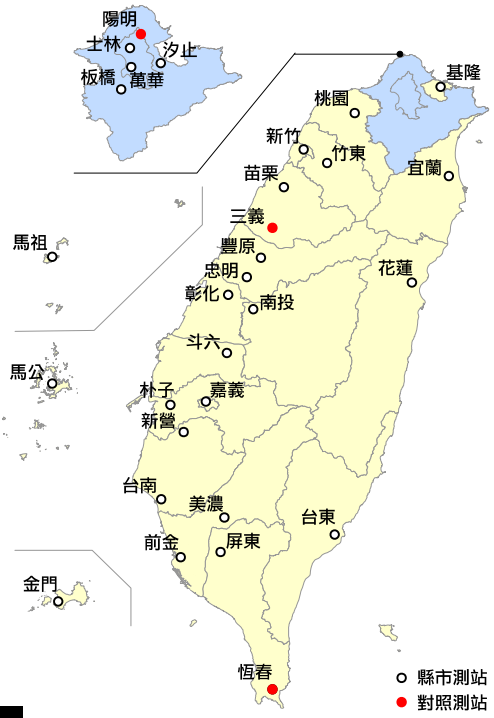
1. $PM_{2.5}$手動監測爲依據標準檢測方法，連續採樣24小時所得之測值。
2. 全國設有30站手動監測，因需人工放樣、取樣，每3天才能採樣一次，樣本需經調理、量測及品保/品管等程序，約需20天才能完成。

單位：微克/立方公尺

北部 | 竹苗 | 中部 | 雲嘉南 | 高屏 | 宜蘭 | 花東 | 離島 | 全部

站名	2013 10/25	2013 10/28	2013 10/31	2013 11/03	2013 11/06	2013 11/09	2013 11/12	2013 11/15	2013 11/18	2013 11/21	歷史資料
基隆	29	12	19	13	17	7	8	33	31	16	...
汐止	29	14	20	13	17	9	8	35	36	17	...
板橋	31	13	20	16	17	17	7	32	35	15	...
土林	29	12	18	11	12	8	5	21	36	15	...
萬華	30	13	21	11	15	7	8	32	35	16	...
桃園	30	13	20	13	20	40	8	32	36	16	...
陽明	25	10	10	7	2	3	ND	5	31	12	...

備註：1.－：無數據（包括:採樣失敗、儀器異常、分析失敗、未符品保、無法採樣、因故未放樣。）
2. ND：未檢出(表示數據低於偵側極限 2 微克/立方公尺。)
3. 空格：資料處理中



全國 $PM_{2.5}$ 手動監測站分布圖

http://taqm.epa.gov.tw/pm25

細懸浮微粒（$PM_{2.5}$）監測

1. $PM_{2.5}$之監測方法分爲「手動監測」及「自動監測」二種。依空氣品質標準規定，$PM_{2.5}$之監測數據係以「手動監測」標準方法所量測之數據爲準。
2. 「手動監測」係每3天採樣1次，經實驗室量測，約20天後公布數據。「自動監測」每小時資料自動上網，僅提供預警參考。
3. 請務必詳閱本署網頁上之各項「說明」，以正確解讀監測資料。

自動監測

自動監測說明

1. $PM_{2.5}$自動監測尚無標準方法，其小時值僅供預警參考，不宜直接與$PM_{2.5}$空氣品質標準之24小時值（35 微克/立方公尺）比較。
2. 手動監測與自動監測因方法不同，兩者測值有所差異，數據皆經嚴謹之品保品管程序後，定期於網站上公布每季比對報告並提供下載服務。
3. 2012年12月31日以前資料，請至環境品質資料倉儲系統(http://edw.epa.gov.tw/)查閱及下載。

發布時間：2013/12/12 00:00　　單位：微克/立方公尺

北部 | 竹苗 | 中部 | 雲嘉南 | 高屏 | 宜蘭 | 花東 | 離島 | 全部 | 資料下載

站名	小時值	上一小時	近24小時趨勢圖
斗六	47	51	▦
崙背	39	47	▦
新港	51	47	▦
朴子	45	47	▦
台西	38	41	▦
嘉義	65	65	▦
新營	55	63	▦
善化	64	66	▦
安南	59	62	▦
台南	67	70	▦
麥寮	38	41	▦

空格：通訊異常

http://taqm.epa.gov.tw/pm25

空氣污染指標 | 細懸浮微粒(PM2.5) | 臭氧8小時 | 空氣品質預報 | 即時濃度 | 紫外線現況 | 紫外線預報

發布時間：2013/12/11 17:00
下次發布時間：2013/12/12 10:30

圖形模式

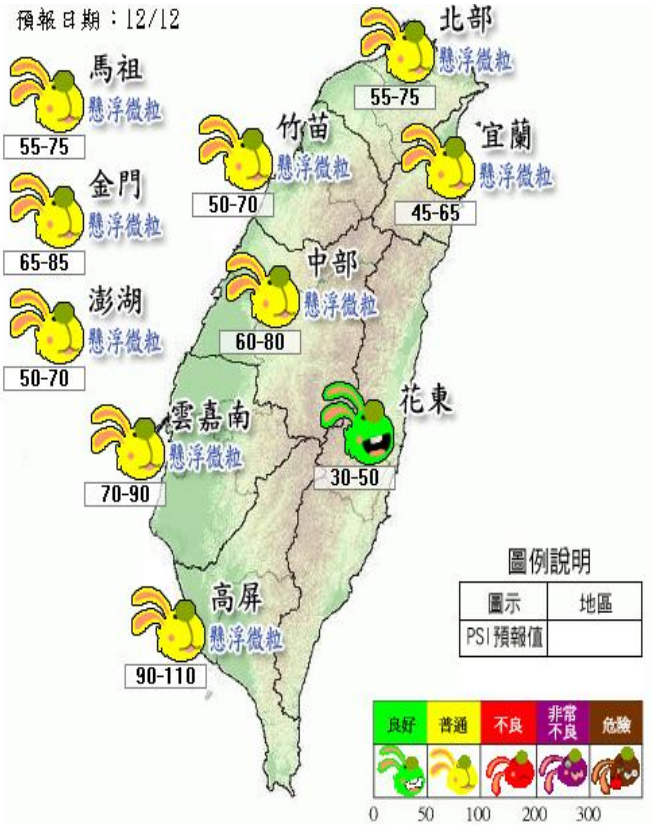
12日至14日台灣各地及離島地區空氣品質多為普通等級，主要污染物為懸浮微粒。高屏地區受擴散條件較差影響，空氣中懸浮微粒濃度較高，環保署提醒過敏族群仍應加強防範。

全國各空品區空氣品質預報

日期	空品區	北部	竹苗	中部	雲嘉南
12/12	PSI指標	55-75	50-70	60-80	70-90
	指標污染物	懸浮微粒	懸浮微粒	懸浮微粒	懸浮微粒
	$PM_{2.5}$ (μg/m³)	25 - 45	20 - 40	40 - 60	50 - 70
	$O_{3,\ 8hr}$ (ppb)	30 - 50	30 - 50	35 - 55	40 - 60
12/13	PSI指標	60-80	50-70	65-85	70-90
	指標污染物	懸浮微粒	懸浮微粒	懸浮微粒	懸浮微粒
	$PM_{2.5}$ (μg/m³)	30 - 50	25 - 45	40 - 60	55 - 75
	$O_{3,\ 8hr}$ (ppb)	35 - 55	30 - 50	40 - 60	40 - 60
12/14	PSI指標	60-80	55-75	65-85	75-95
	指標污染物	懸浮微粒	懸浮微粒	懸浮微粒	懸浮微粒
	$PM_{2.5}$ (μg/m³)	35 - 55	30 - 50	40 - 60	55 - 75
	$O_{3,\ 8hr}$ (ppb)	30 - 50	25 - 45	45 - 65	45 - 65

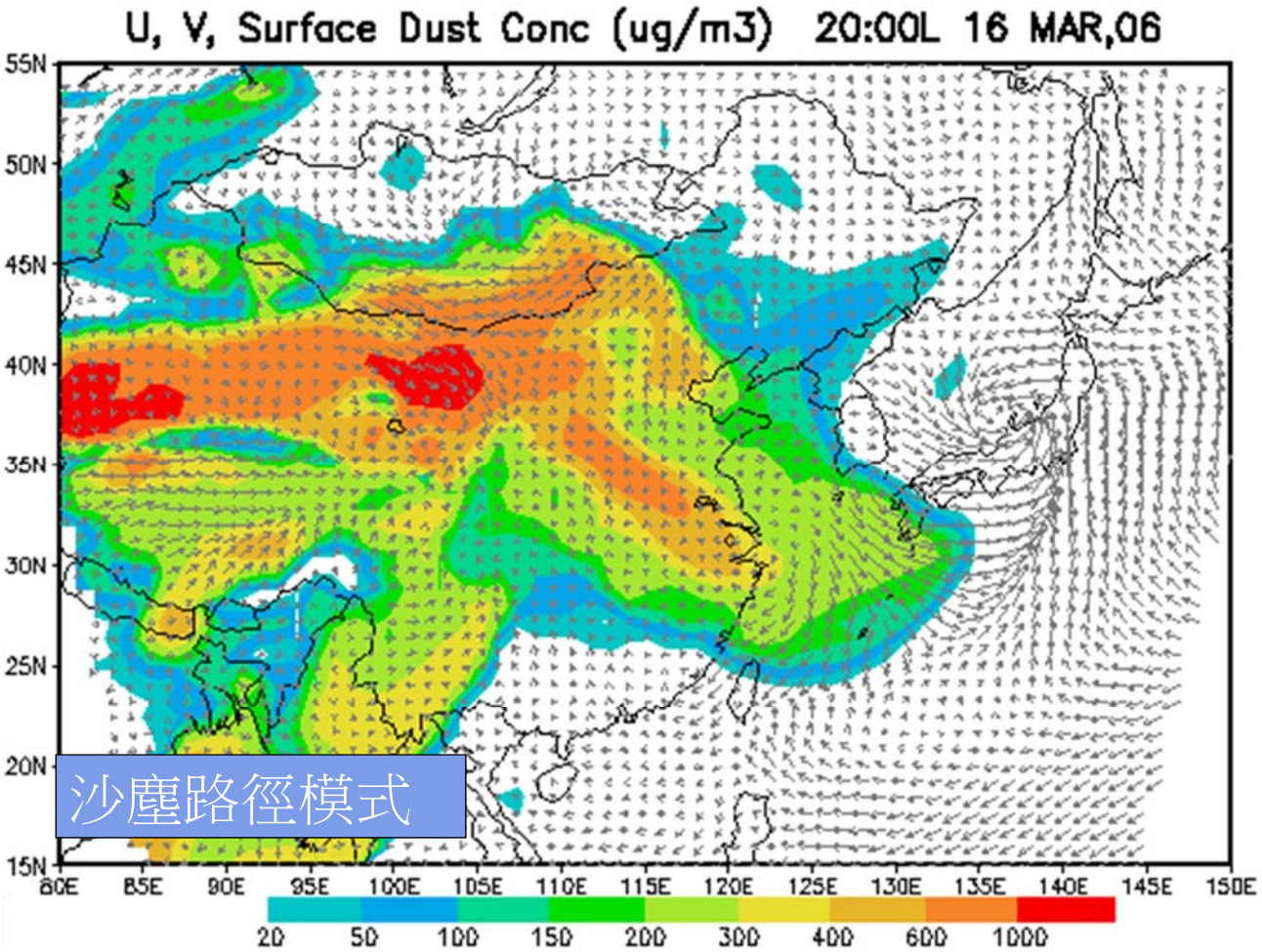
離島地區空氣品質預報

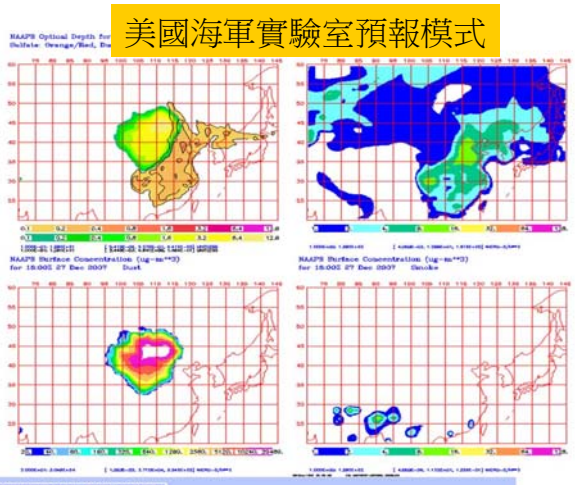
日期	測站	馬祖	金門	澎湖
12/12	PSI指標	55-75	65-85	50-70
	指標污染物	懸浮微粒	懸浮微粒	懸浮微粒
	$PM_{2.5}$ (μg/m³)	30 - 50	45 - 65	20 - 40
	$O_{3,\ 8hr}$ (ppb)	35 - 55	30 - 50	35 - 55

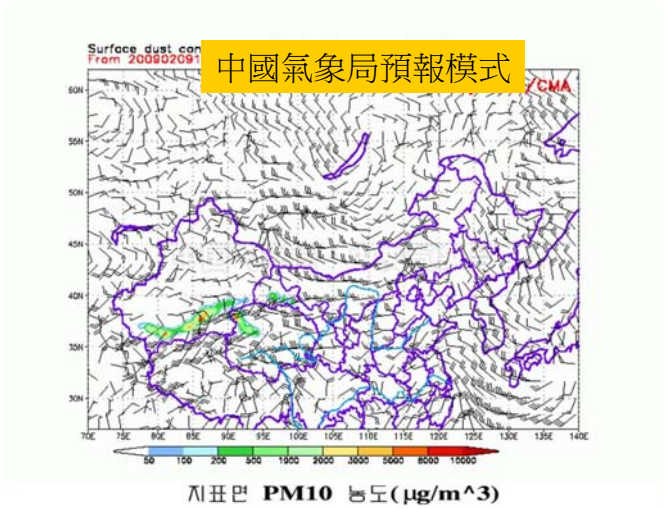


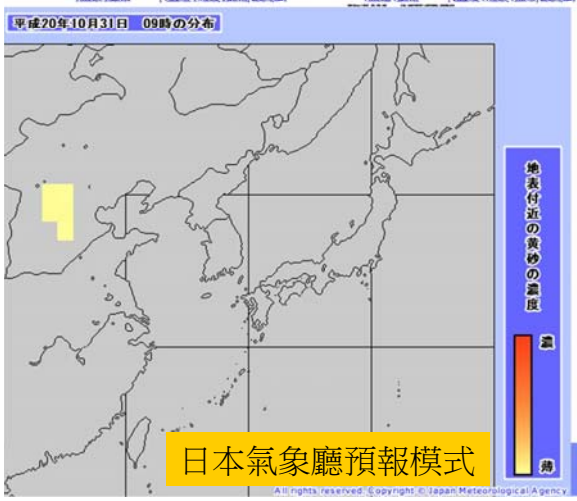
其它相關監測課題

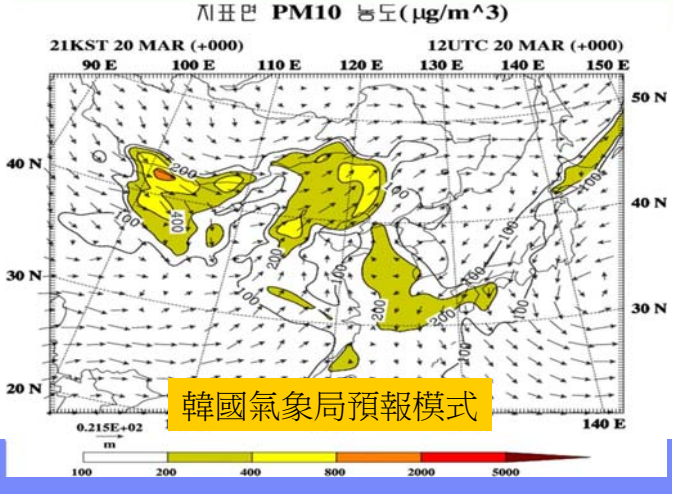
- 紫外線觀測及預報
- 沙塵觀測
- 大氣背景監測
  - 鹿林山背景測站
  - 東沙、東引
  - 南沙（太平島）


U, V, Surface Dust Conc (ug/m3) 20:00L 16 MAR,06
55N
50N
45N
40N
35N
30N
25N
20N
15N
80E
85E
90E
95E
100E
105E
110E
115E
120E
125E
130E
135E
140E
145E
150E
20
50
100
150
200
300
400
600
1000
沙塵路徑模式

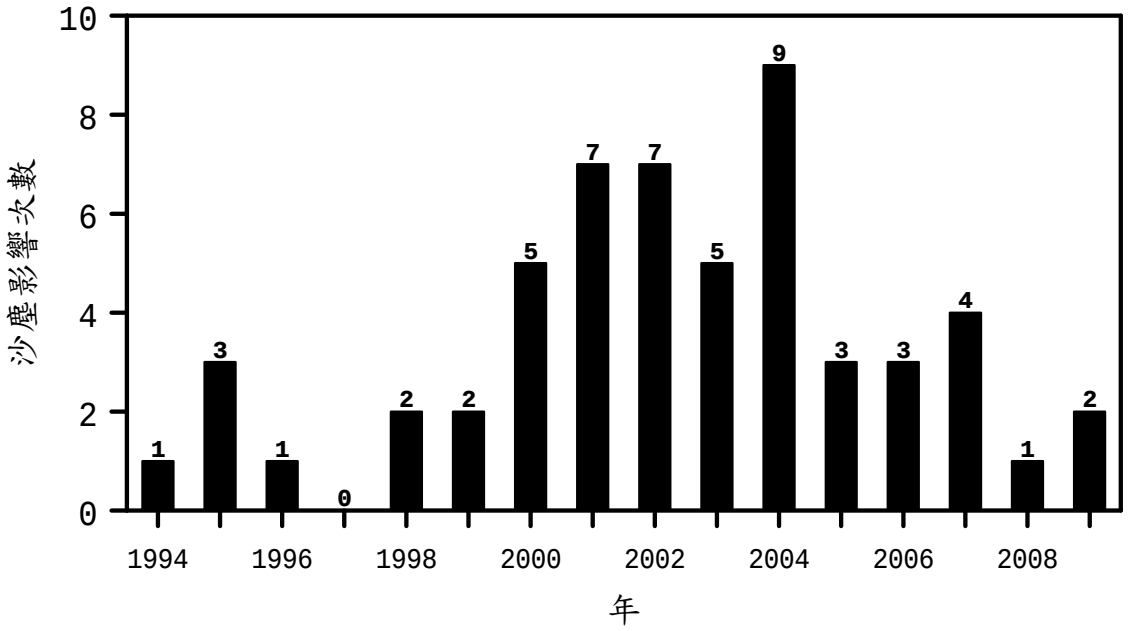

美國海軍實驗室預報模式


中國氣象局預報模式
CMA


平成20年10月31日 09時の分布
地表付近の黄砂の濃度
濃
薄
日本氣象廳預報模式


지표면 PM10 농도(μg/m^3)
21KST 20 MAR (+000)
12UTC 20 MAR (+000)
90 E
100 E
110 E
120 E
130 E
140 E
150 E
50 N
40 N
30 N
20 N
0.215E+02
m
100
200
400
800
2000
5000
韓國氣象局預報模式

歷年影響台灣之沙塵次數統計

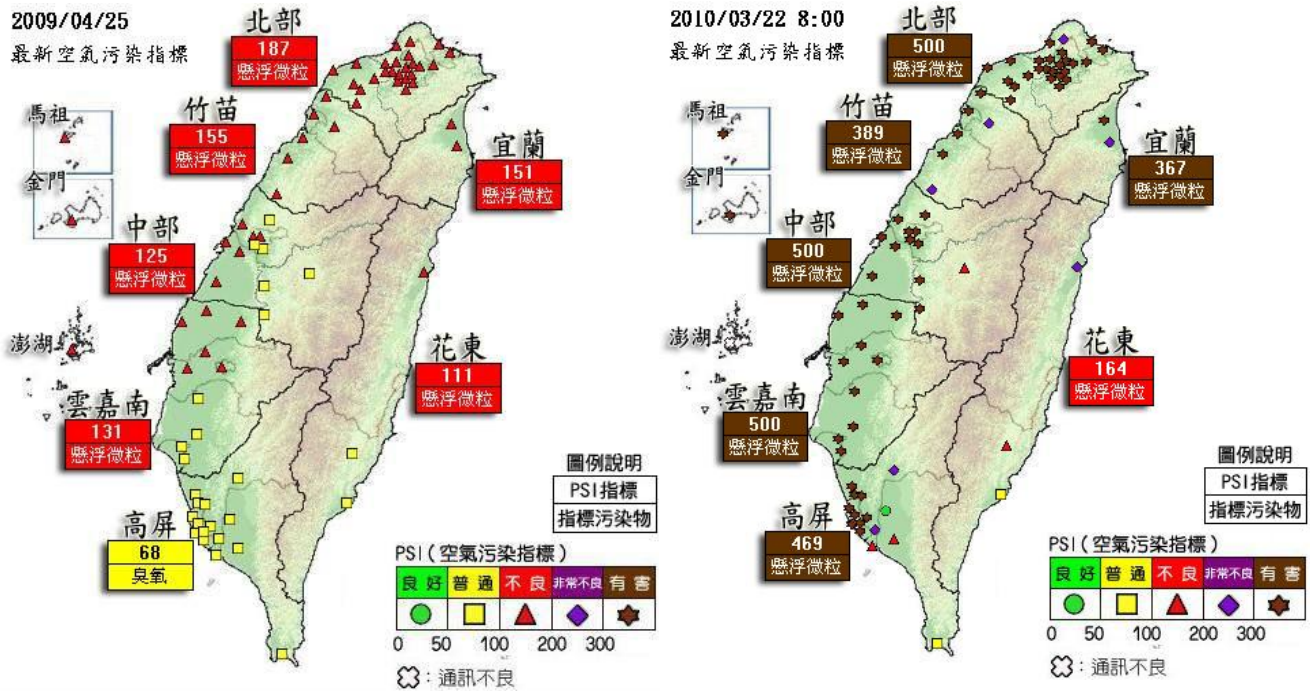


2009年 4 月 25日沙塵現象

臺灣北部地區PM_{10} 濃度逾1,000 ug/m^3

2010年 3 月 21-22日沙塵現象

逾半測站 PM_{10} 濃度逾1,000 ug/m^3，空氣品質污染指標達「有害等級」

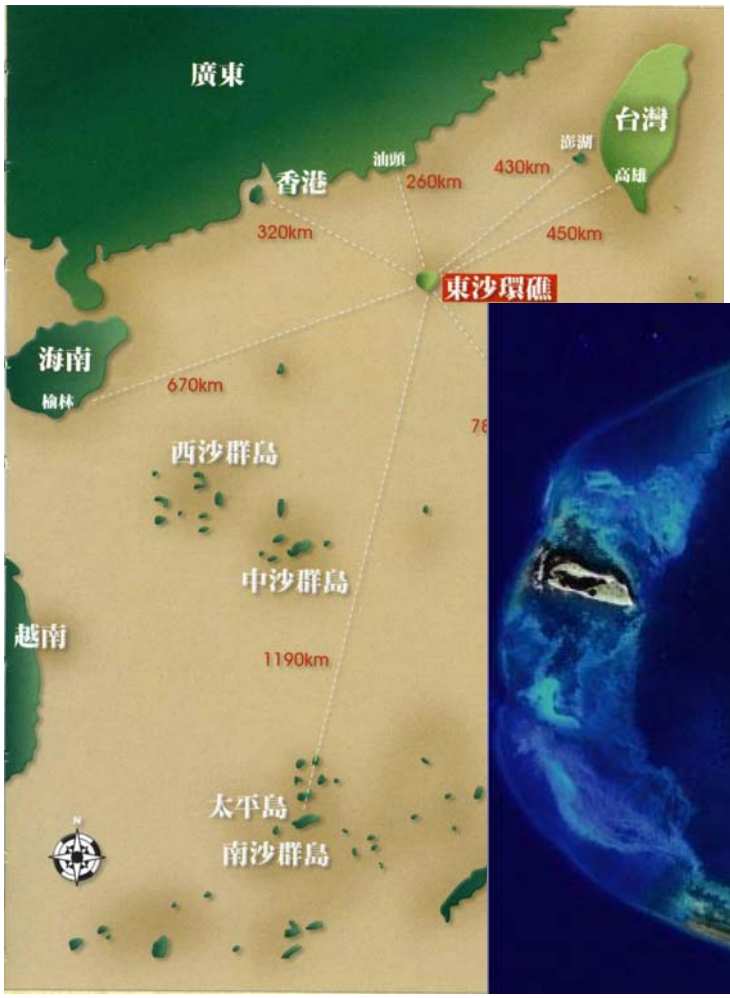


沙塵影響空氣品質

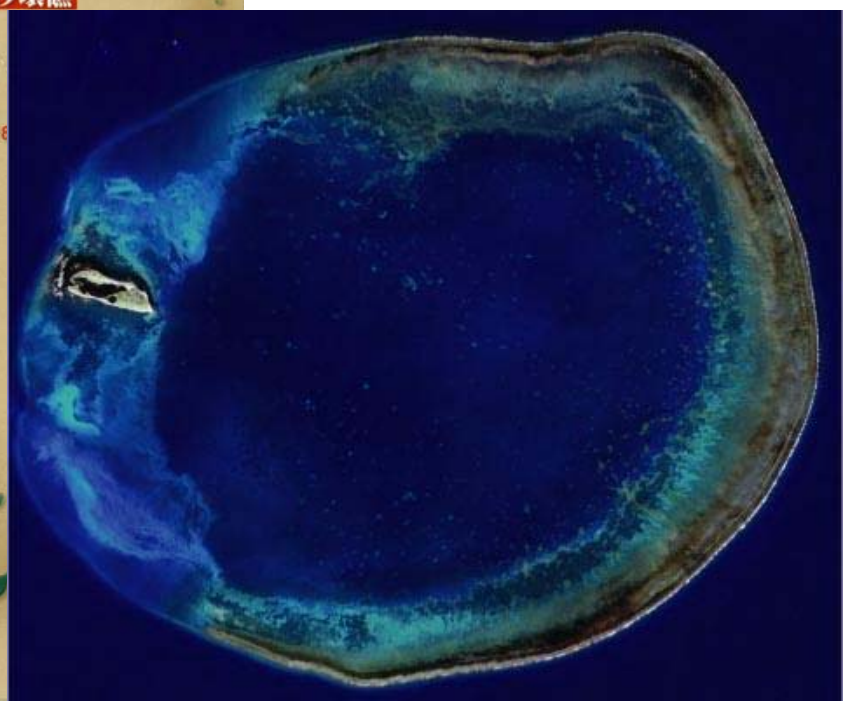
大氣背景
監測設施

大氣背景監測項目

- 氣象資料
（含能見度、全天空影像）
- 微量氣體（溫室氣體、汞…）
- 大氣氣膠
- 降水化學、 大氣輻射



東沙島
環境品質監測




Pratas Island
© 2006 Europa Technologies
Image © 2006 DigitalGlobe
©2005 Google
Pointer 20°42'56.47" N 116°42'23.29" E
Streaming 100%
Eye alt 11120 ft

2009年1月6日


東沙空氣品質背景測站
Dongsha Atmospheric Background Station
啟用典禮

2010年2月

2010年2月-- 6月

南沙 太平島
環境品質監測

幾個新的服務及應用

- WEB 2.0（網路社群）
  - *i*Google
  - Web Services
  - 微網誌（Plurk, Twitter）
  - 環境即時通&臺灣紫外線 (app)
- 地方自動監測站整合
- 高值簡訊通報（PDA 查詢界面）
- 高值觸發採樣系統

》環境即時通

「環境即時通」可提供您所在地臨近的環境即時資訊，內容包含:環保署空氣品質、紫外線及沙塵訊息，並加入中央氣象局鄉鎮天氣、豪(大)雨及地震報告，提供您豐富完整的環境資訊。

「環境即時通」亦提供您各項定位工具，包含行政區、地標、坐標點及圖面定位，您可以利用多元化的定位方式搜尋到您感興趣的區域，進而查詢當地的環境資訊。「環境即時通」可結合您的社群帳號，設定您的個人化服務，包含地理書籤及即時通訂閱項目，並透過「警示設定」功能，儲存空氣品質及紫外線的警示數值，當每小時監測值到達您設定門檻時，系統將主動推播訊息，提供您個人化環境警示提醒。

「環境即時通」可將您對周遭的環境相關議題與意見，透過「意見回饋」發送到環保署「環保e言堂」，以處理您的意見或提供您所需要之資訊。

Google play　App Store

http://www.epa.gov.tw/app/emsg.html

http://www.epa.gov.tw/app/uvtaiwan.html

》台灣紫外線

「台灣紫外線指數」提供台灣各地紫外線指數資訊。

提供包含「紫外線現況」、「本日最大值」、「紫外線預報」、「海灘水質」及「防護資訊」等內容給使用者參考。紫外線現況資料每小時更新一次，並提供監測地點相關資訊及24小時監測數值變化等資訊。海灘水質現況資料於每年7-8月進行採樣，每二週更新一次，並提供監測地點相關資訊。

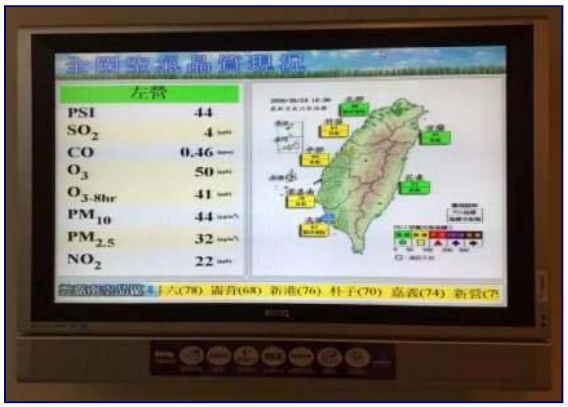
紫外線指數及海灘監測資料由行政院環境保護署提供。

Google play　App Store

UV INDEX Taiwan

其他 Web Service應用

- 豐富環保局空氣品質即時資訊
- 提供於戶外看板或電視牆



▲42吋電視螢幕

▼▶戶外看板

結語

- 環境監測是基礎性及持續性工作
- 跨境監測合作及資料分享
- 環境監測資料應用
  - 一般民眾：環境資料應能普及，簡明易懂，容易掌握生活周遭之環境狀況
  - 專業人員：提供資料加值效益
  - 深化資料整合、分析及應用

行政院環境保護署
environmental protection administration

謝謝聆聽

http://www.epa.gov.tw
email: mlchen@epa.gov.tw

附件4

Traceable Gas Measurements in Singapore

Chua Hock Ann
Mechanical Metrology
National Metrology Centre, A*STAR

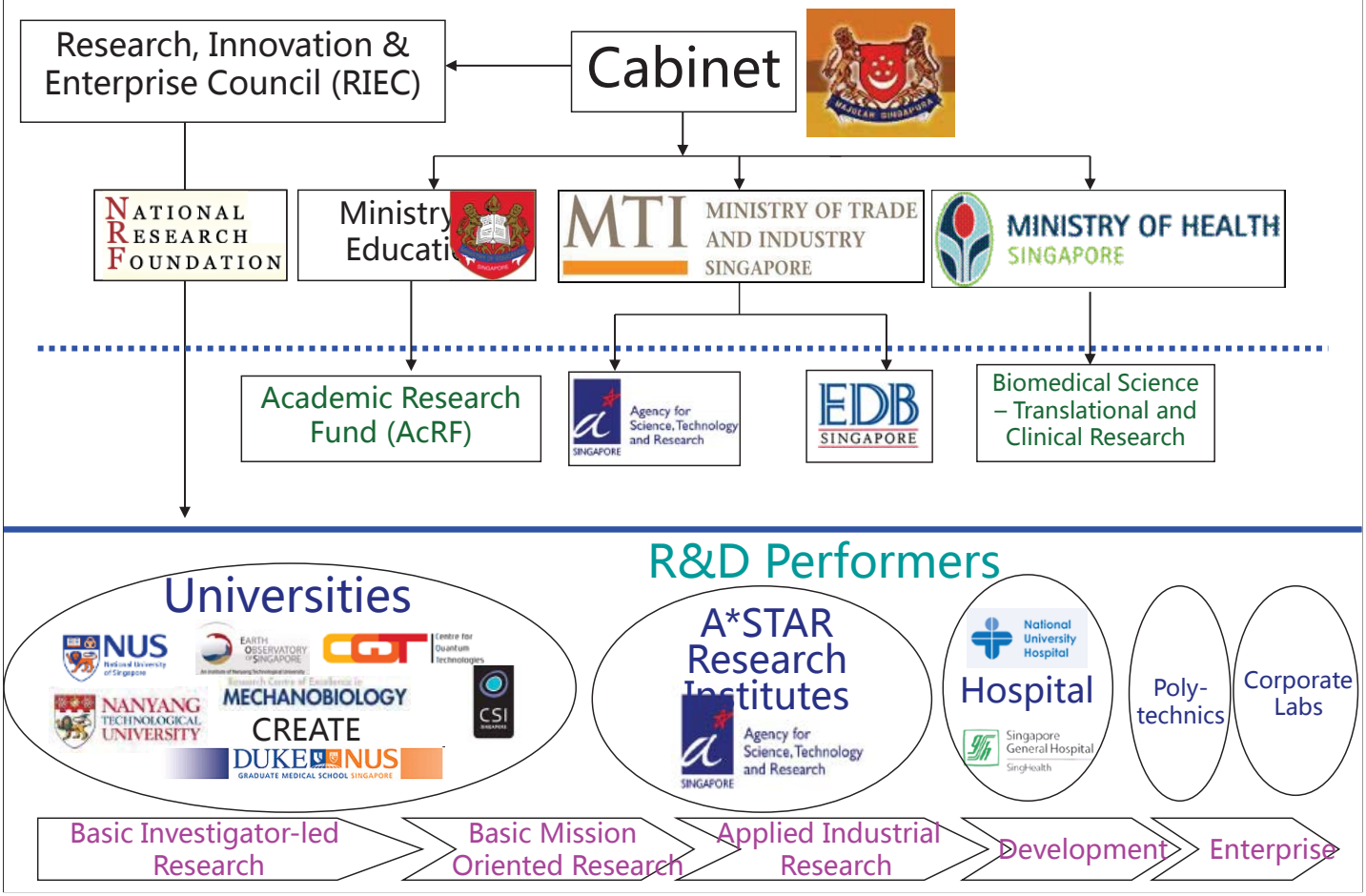
12 December 2013

NMC
A*STAR

A*STAR

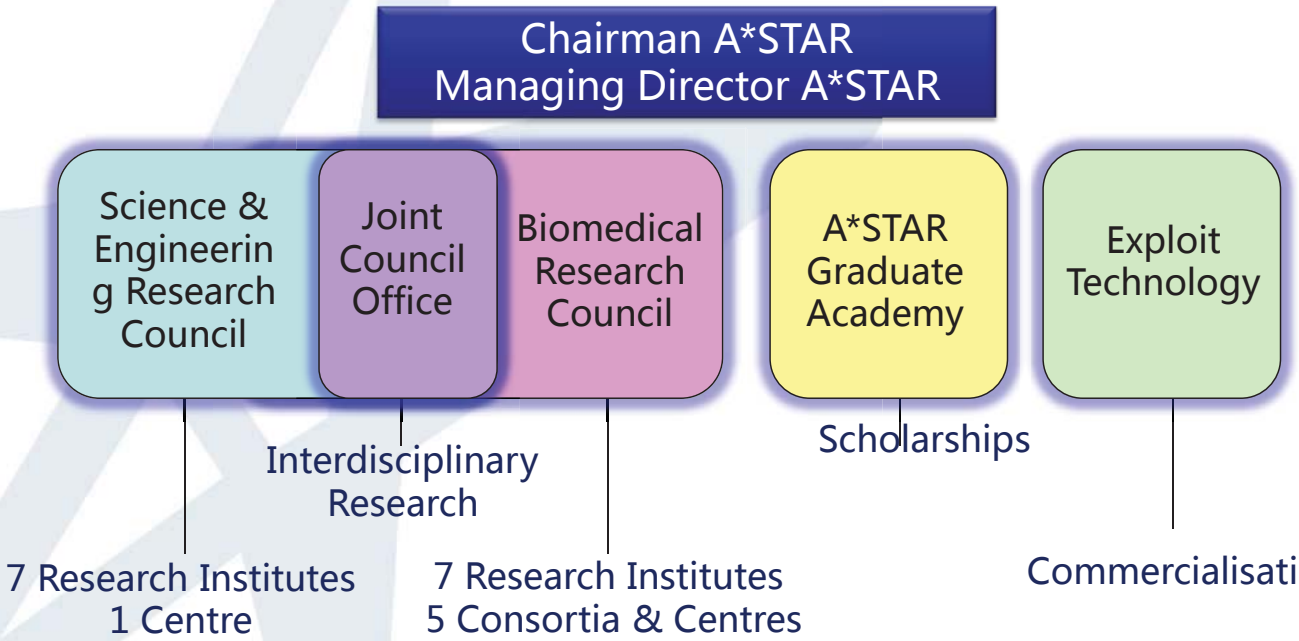
Agency for Science. Technology and Research

National R&D Framework

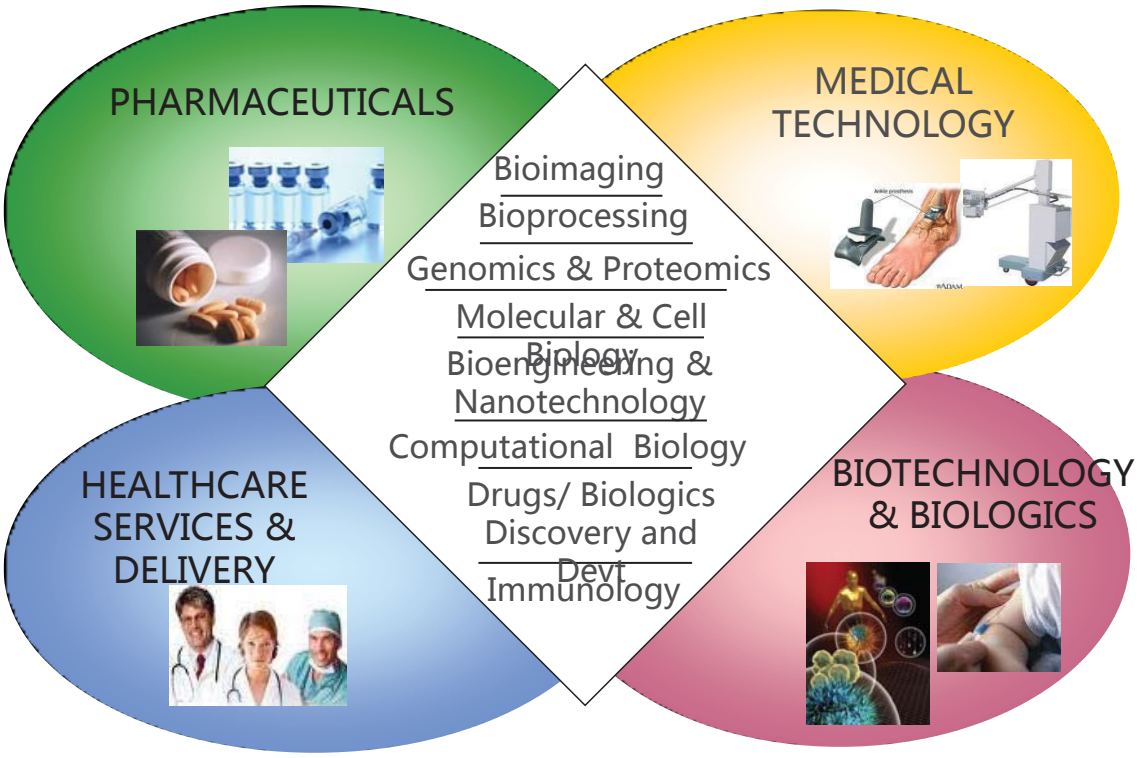


A*STAR' s Mission

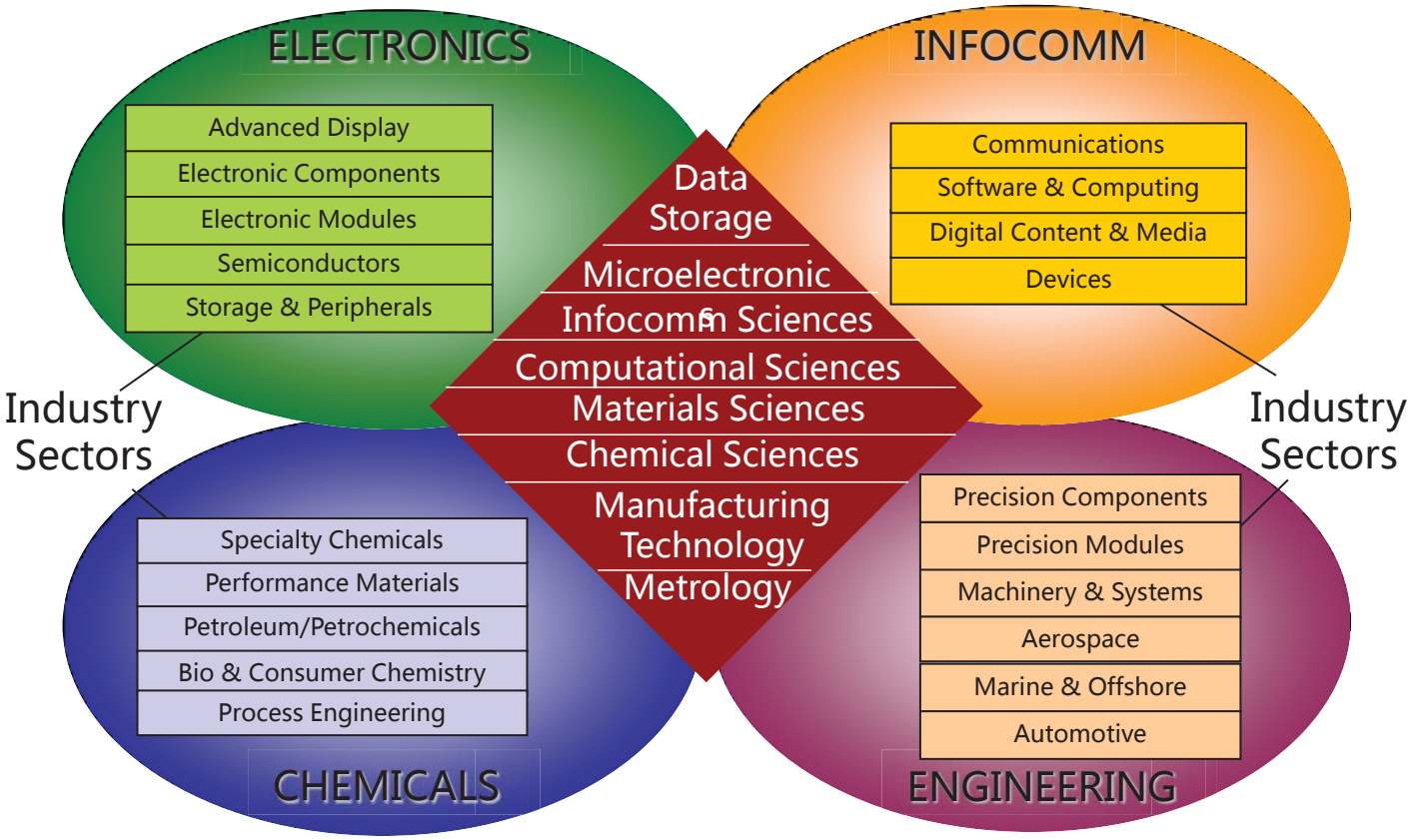
Fostering world-class scientific research and talent for a vibrant knowledge-based Singapore



Biomedical Research Council (BMRC)



Science & Engineering Research Council (SERC)



A*STAR Research Entities

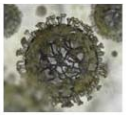
SERC Industry Clusters
- Electronics
- Chemicals
- Infocomm
- Engineering

BMRC Industry Clusters
- Pharmaceuticals
- Biotech & Biologics
- Medical Eng & Tech
- Healthcare Svc & Delivery










Institute of Molecular & Cell Biology (IMCB) 1987
Singapore Institute of Manufacturing Technology (SIMTech) 1989
Institute of High Performance Computing (IHPC) 1998
Institute of Materials Research & Engineering (IMRE) 1996
Data Storage Institute (DSI) 1992
Institute of Micro-electronics (IME) 1991
Genome Institute of Singapore (GIS) 2000
Bioinformatics Institute (BII) 2001
Institute for Infocomm Research (I^2R) 2002
Institute for Chemical & Engineering Sciences (ICES) 2002
Bioprocessing Technology Institute (BTI) 2003
Institute of Bioengineering & Nanotechnology (IBN) 2003
Singapore Bioimaging Consortium (SBIC) 2005
Singapore Stem Cell Consortium (SSCC) 2006
Singapore Consortium for Cohort Studies (SCSC) 2006
Singapore Institute for Clinical Sciences (SICS) 2006
Singapore Immunology Network (SIgN) 2006
National Metrology Centre (NMC) 2008
Experimental Therapeutics Centre (ETC) 2008
Institute of Medical Biology (IMB) 2007

1987-1989 | 1990-1999 | 2000 | 2001-2002 | 2003-2004 | 2005-2006 | 2007-2008

A*STAR has more than 2,300 RSEs (>50% are international talent from some 60 countries)

Biopolis Phase I (2003)
Biopolis Phase II (2006)
Fusionopolis Phase I (2008)

NMC

National Metrology Centre

SERC Research Institutes

Institute of Microelectronics (IME)

Institute of High Performance Computing (IHPC)

Institute for Infocomm Research (I2R) (merger of KRDL, CWC & CSP)

National Metrology Centre (NMC)

Singapore Institute of Manufacturing Technology (SIMTech)

Data Storage Institute (DSI) (from Magnetic Technology Centre)

Institute of Materials Research and Engineering (IMRE)

Institute for Chemical and Engineering Sciences (ICES)

A*STAR National Metrology Centre

National Metrology Centre

To enhance the quality of measurements in Industry through providing an international recognised national measurement infrastructure

National Standards & Conformance Framework

Enhance & Assure Quality of Products and Services
Facilitate Trade

STANDARDS AND CONFORMANCE FRAMEWORK

STANDARDS

- Voluntary Standards
- Regulatory Standards
- Legal metrology

MEASUREMENT

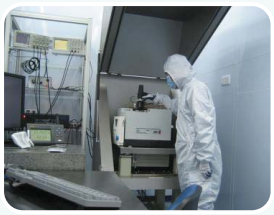
- Measurement Standards
- Calibration
- Measurement

CONFORMANCE

- Accreditation
- Quality Assurance *
- Certification *
- Testing & Inspection *

SPRING: ***National Standards Body & National Accreditation Body***
A*STAR: ***National Metrology Authority***
*** Provided by private sector***

Industry Services

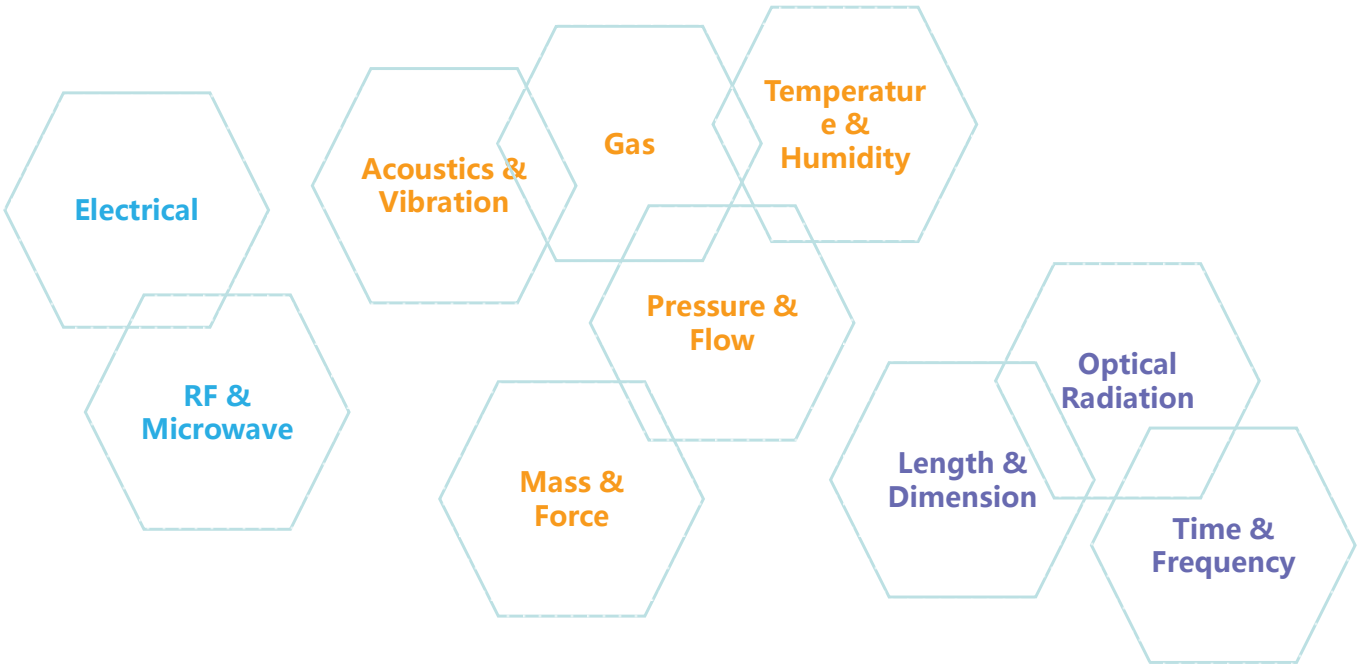
Measurement & Calibration Services

R&D for Measurement Solutions

Technical Assessments

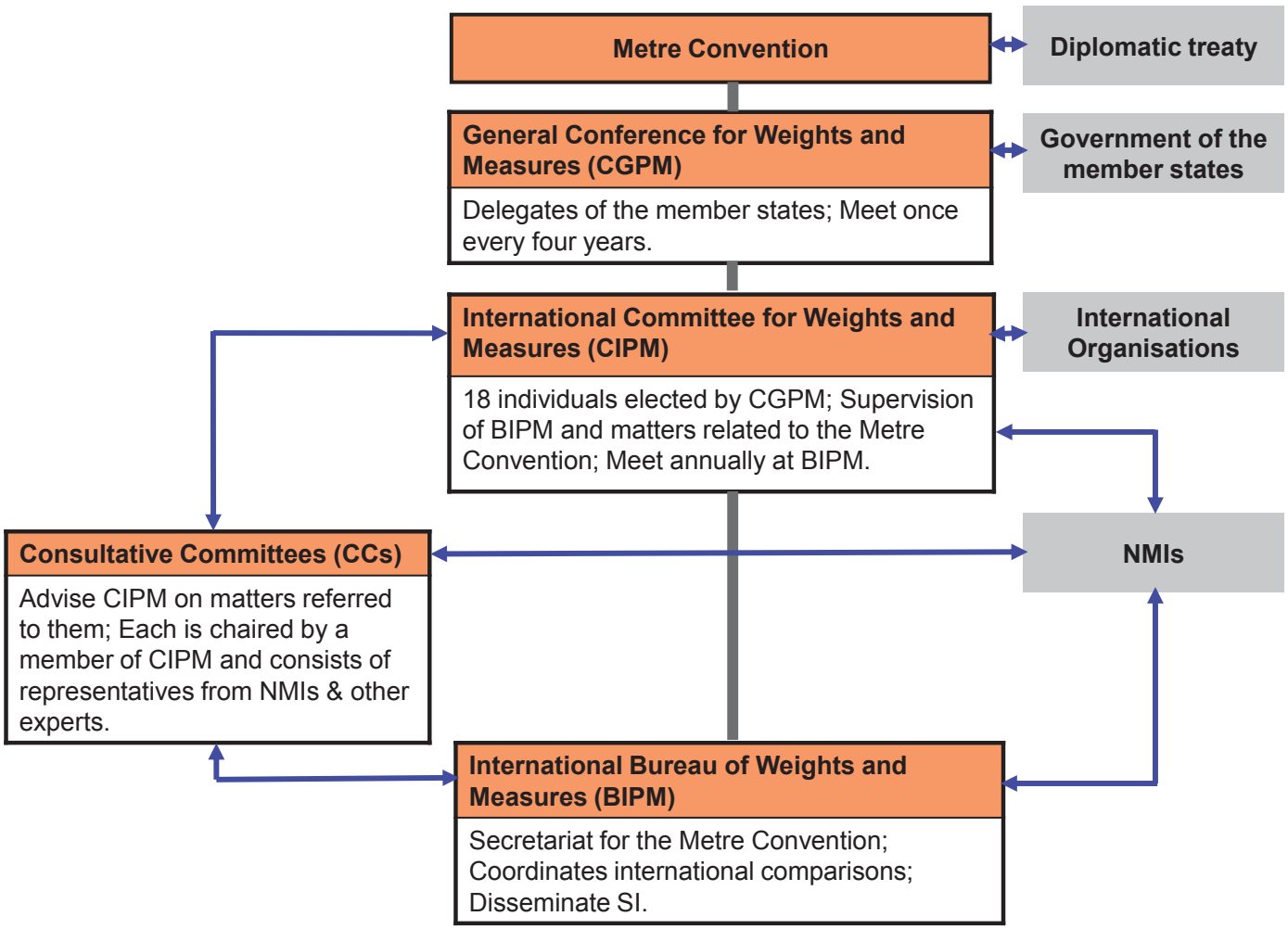
Training Courses

NMC Measurement Capabilities



SI

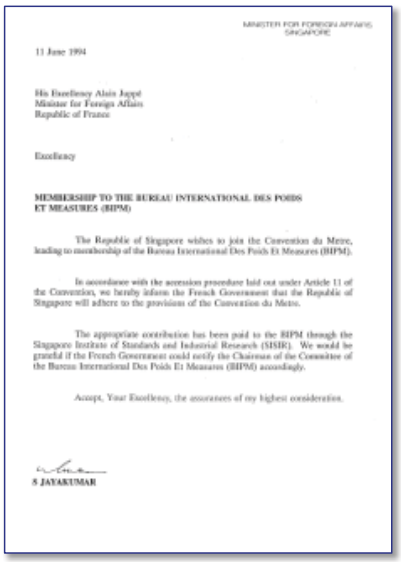
International System of Units



Metre Convention

- A diplomatic treaty
- First signed in Paris by 17 countries on 20 May 1875
- Currently 51 member states + 20 associates
- Member states to promote and propagate the SI in commerce, trade, science and engineering
- Worldwide unification of measurements

The *Salon de l'Horloge* in the French Foreign Ministry in Paris, where the Metre Convention was first signed



MINISTER FOR FOREIGN AFFAIRS
SINGAPORE

11 June 1994

His Excellency Alain Juppé
Minister for Foreign Affairs
Republic of France

Excellency

MEMBERSHIP TO THE BUREAU INTERNATIONAL DES POIDS ET MEASURES (BIPM)

The Republic of Singapore wishes to join the Convention du Metre, leading to membership of the Bureau International Des Poids Et Measures (BIPM).

In accordance with the accession procedure laid out under Article 11 of the Convention, we hereby inform the French Government that the Republic of Singapore will adhere to the provisions of the Convention du Metre.

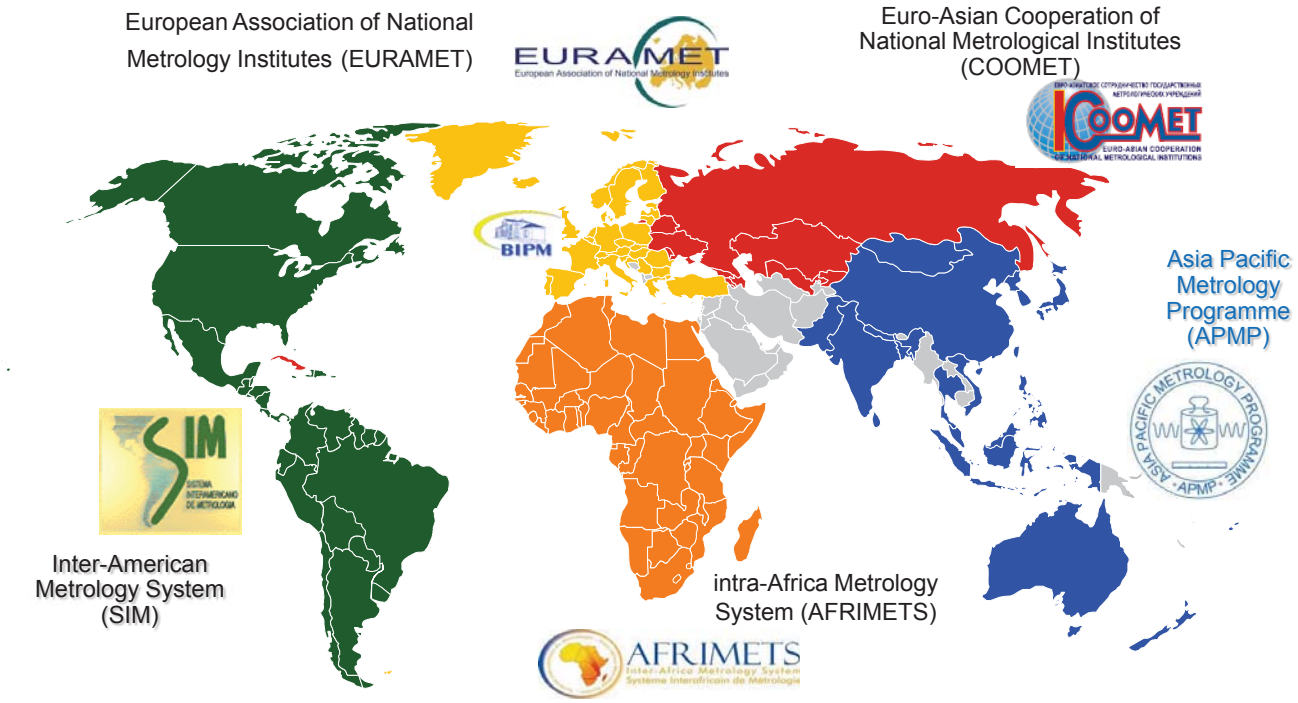
The appropriate contribution has been paid to the BIPM through the Singapore Institute of Standards and Industrial Research (SISIR). We would be grateful if the French Government could notify the Chairman of the Committee of the Bureau International Des Poids Et Measures (BIPM) accordingly.

Accept, Your Excellency, the assurances of my highest consideration.

S JAYAKUMAR

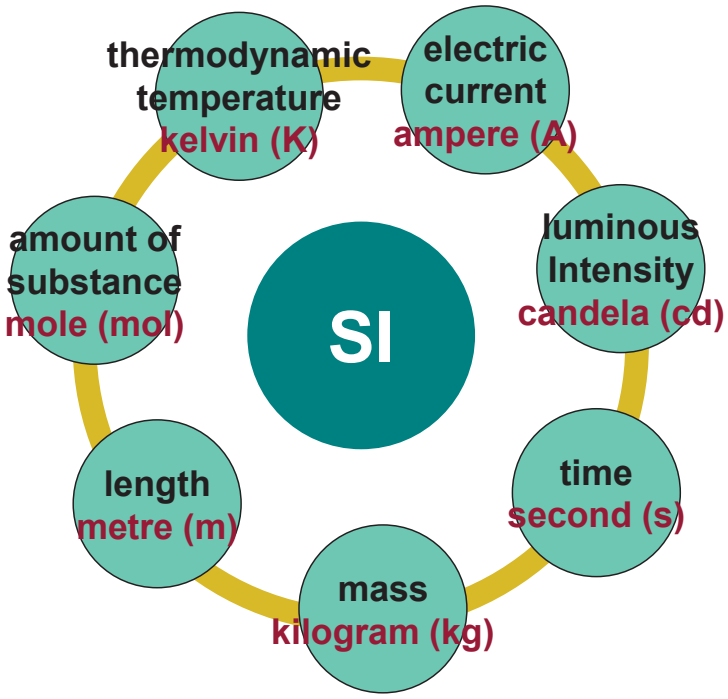
Letter signed by Prof S. Jayakumar, Minster for Foreign Affair, on 14 Oct 1994

International Metrology Organisations



- APMP has been operating since its inception as a Commonwealth Science Council initiative in 1977
- Responsible for developing international recognition of the measurement capabilities of the region's national and territorial measurement laboratories.

Le Système international d’ unités (SI)



SI Base Quantities & Units: Definitions

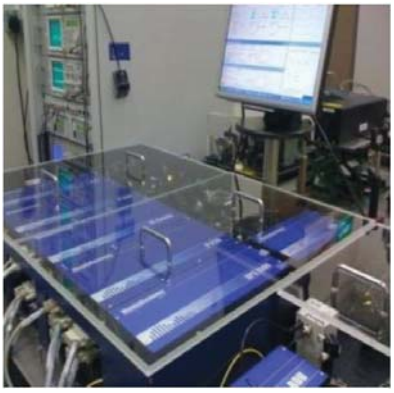
Quantity	Unit	Symbol	Realisation	Uncertainty
Length	metre	m	Wavelength of He-Ne laser stabilised against a spectral line of iodine.	2 in 10^{11}
Mass	kilogram	kg	Pt-Ir prototype kilogram No. 83.	6 µg
Time	second	s	Duration of 9 192 631 770 periods of the radiation of caesium-133 atom.	5.4 ns
Electric current	ampere	A	Based on Ohm's law via reproduction of the volt and the ohm from Josephson array voltage standard and quantised Hall resistance standard, respectively.	4 - 300 µA/A
Thermodynamic temperature	kelvin	K	The fraction 1/273.16 of the thermodynamic temperature of the triple point of water.	0.28 mK
Amount of substance	mole	mol	Number of elementary entities of a substance equal to the number of atoms in 0.012 kg of carbon 12.	5 nmol/mol (carbon monoxide)
Luminous intensity	candela	cd	Intensity of a light source (frequency 5.40 × 10^{14} Hz) that gives a radiant intensity of 1/683 watts/steradian in a given direction.	0.58%

Length - the metre, m

The metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second.

The metre is most commonly realised by means of the wavelength in vacuum of a plane electromagnetic wave of frequency f; this wavelength is obtained from the measured frequency f using the relation $\lambda = c_0/f$ and the value of the speed of light in vacuum c_0 = 299 792 458 m/s. The metre is realised at NMC by wavelength of He-Ne laser stabilised against a spectral line of iodine with an uncertainty of 2 parts in 10^{11}, and the optical frequency synthesiser with an uncertainty of 5 parts in 10^{13}.

Primary realisation of the metre using iodine-stabilised He-Ne laser with wavelength of 633 nm



Optical frequency synthesiser

Mass - the kilogram, kg

The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram.

NMC is the custodian of the primary mass standard, Singapore's prototype kilogram No. 83, directly traceable to the international prototype of the kilogram maintained by the International Bureau of Weights and Measures (BIPM) in Paris.

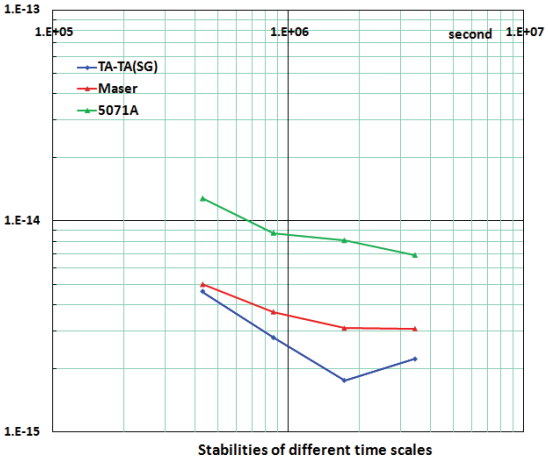
Materials	**90% Pt - 10% Ir**
Size	**Ø 39 mm; Ht 39 mm**
Mass value	**1 kg + 0.340 mg**
Mass uncertainty	**0.006 mg (*k* = 2)**
Coeff of cubical expansion	**$(25.869 + 0.00565\ t_{90}) \times 10^{-6}\ ^{o}C^{-1}$**
Density at 0 °C	**21554.72 kg m^{-3}**
Density uncertainty (rel)	**1×10^{-5} (*k* = 2)**

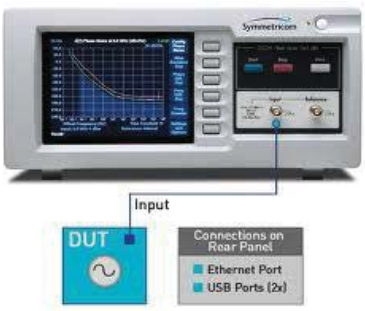
Singapore's prototype kilogram No. 83

Time - the second, s

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom.

NMC realises the second using weighted average from an ensemble of four caesium and one hydrogen atomic clocks with an uncertainty of 5.4 ns.



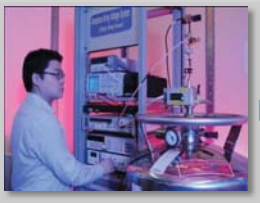


NMC's atomic clocks are part of the international time network for the computation of the international time scale – the Coordinated Universal Time (UTC).

NMC uses dual mixer time difference method to measure frequency of precision oscillators with a relative uncertainty of 5×10^{-14}, limited by the noise level and type of oscillator under test.

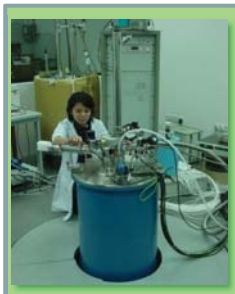
Electric Current - the ampere, A

The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 m apart in vacuum, would produce between these conductors a force equal to 2 x 10^{-7} newton per metre of length.



Josephson array voltage primary standard

Voltage reference standards



Quantized Hall resistance primary standard

Resistance reference standards

The ampere is in practice realised via Ohm's Law from the volt (unit of electromotive force), and the ohm (unit of resistance). In NMC, the volt is maintained by a group of voltage standards traceable to Josephson array voltage standard which reproduces the volt. The ohm is maintained by a set of resistance standards traceable to the quantised Hall resistance standard which reproduces the ohm.

$$\frac{\text{Voltage } (volt)}{\text{Resistance } (ohm)} = \text{Current } (ampere)$$

Calibration and Measurement Capabilities

Parameter	Range	Uncertainty
Voltage (V)	1 mV to 1 kV	0.1 to 900 μV
Resistance (R)	0.1 mΩ to 1 TΩ	0.25 to 800 μΩ/Ω
Current (I)	1 pA to 20 A	4 to 300 μA/A .

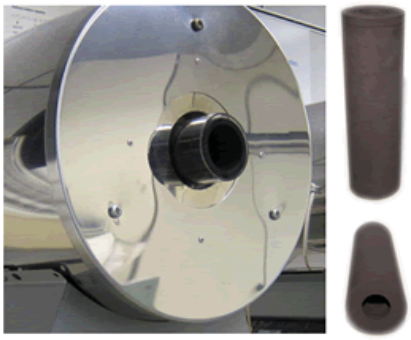
Thermodynamic Temperature - the kelvin, K

The kelvin, unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.

NMC realises temperature standards by using primary temperature fixed point standards, such as triple-point of water with an uncertainty of 0.28 mK.

Triple point of water

Fixed points for realisation of ITS-90 from -189.3442 °C to 961.78 °C



Fixed points blackbodies for realisation of ITS-90 above 961.78 °C

Amount of Substance - the mole, mol

The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12.

NMC realises the mole by gravimetric preparation of gas standards in accordance with ISO 6142 Standard; ozone (ground level) standard is realised using Standard Reference Photometer with an uncertainty of 5 nmol/mol.

Filling of gas components and matrix in a gas cylinder

Weighing of cylinder with gas standards

Gas standards

Computation of mole fraction

$$x_i = \frac{\sum_{A=1}^{P}\left[\frac{x_{i,A}\cdot m_A}{\sum_{i=1}^{n} x_{i,A}\cdot M_i}\right]}{\sum_{A=1}^{P}\left[\frac{m_A}{\sum_{i=1}^{n} x_{i,A}\cdot M_i}\right]}$$

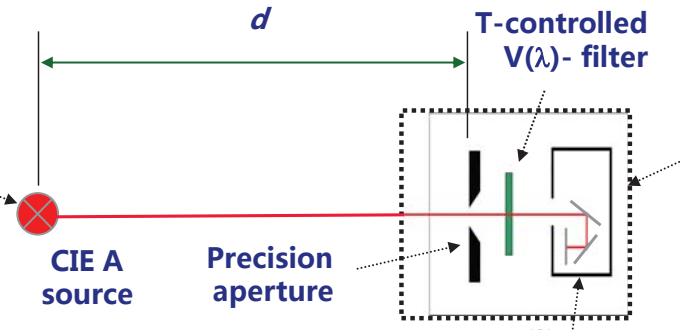
Computation of uncertainty

$$(u)^2(x_i) = \sum_{i=1}^{n}\left(\frac{\partial x_i}{\partial M_i}\right)^2 .u^2(M_i) + \sum_{A=1}^{P}\left(\frac{\partial x_i}{\partial M_A}\right)^2 .u^2(m_A) + \sum_{A=1}^{P}\sum_{i=1}^{n}\left(\frac{\partial x_i}{\partial x_{iA}}\right)^2 .u^2(x_{iA})$$

Luminous Intensity - the candela, cd

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540 x 10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.

NMC realises the luminance intensity through three temperature stabilised trap photometers with an uncertainty of 0.58%.

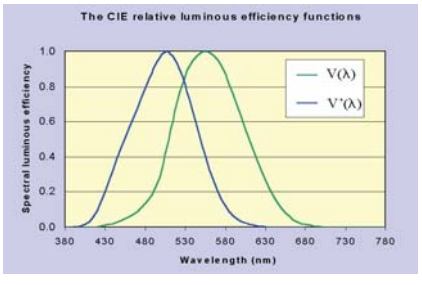


Temperature stabilised trap photometer

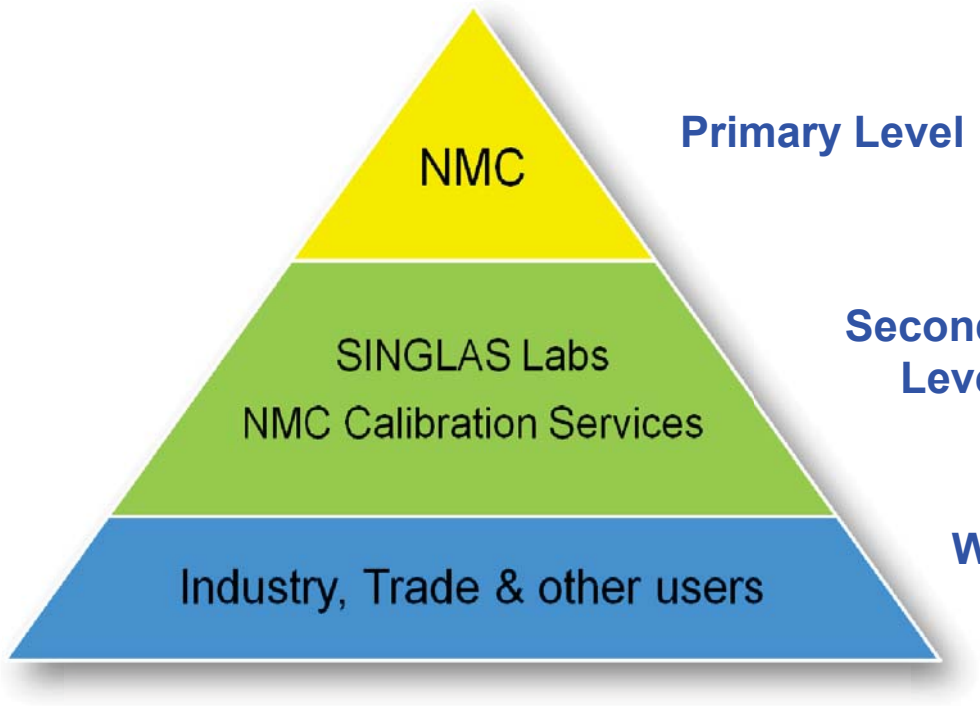
$$I_v = d^2 \bullet E_v = d^2 \bullet i / R_v$$

$$R_v = \frac{A \bullet \int E(\lambda)S(\lambda)d\lambda}{K_m \bullet \int E(\lambda)V(\lambda)d\lambda}$$

I_v :luminous intensity (cd or lm.sr^{-1})
d :distance (m)
E_v :illuminance (lm/m^2)
i :photocurrent (A)
R_v :luminous responsivity (A/cd)
A :aperture area (m^2)
$E(\lambda)$:spectral irradiance (W/m^3)
$S(\lambda)$:spectral responsivity (A/W)
K_m :maximum luminous efficacy (683 lm/W)
$V(\lambda)$:luminous efficiency function (1)



Dissemination of the SI



Mutual Recognition Arrangement on Measurement

- Initiated in 1999 for mutual recognition of national measurement standards and calibration & measurement certificates issued by national metrology institutes (79 signatories).
- To provide technical basis for wider agreements negotiated for international trade.
- NMC signed the MRA in 1999 under the Metre Convention framework.
- NMC participates in international & regional comparisons to verify capabilities.

CIPM MRA


Reconnaissance mutuelle
des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie
Paris, le 14 octobre 1999
Mutual recognition
of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes
Paris, 14 October 1999
Comité international des poids et mesures
RECONNAISSANCE MUTUELLE
MUTUAL RECOGNITION
PSB

MRA signed on 14 Oct 1999

Mutual Recognition Arrangement on Measurement

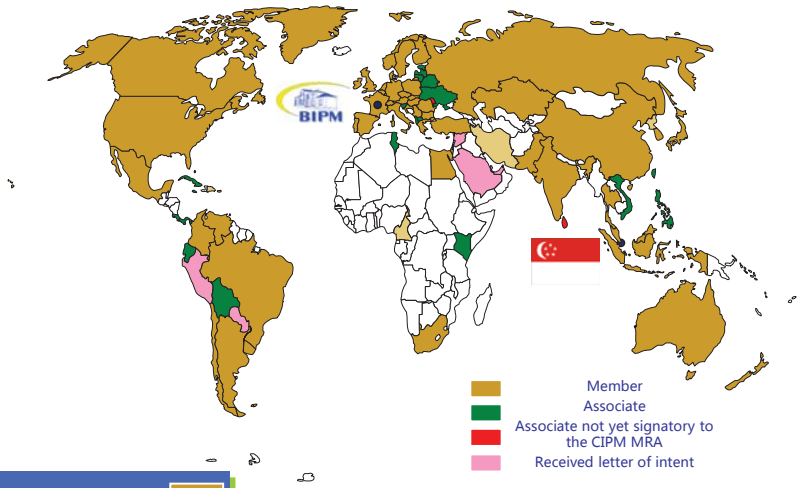
International Recognition of :

- Singapore' s national measurement infrastructure (*traceable to the SI*)
- Quality system conforms to ISO17025 Standard
- Technical capabilities in disseminating the SI
- Worldwide acceptance of NMC' s calibration & measurement reports


CIPM MRA

National Metrology Centre A*STAR

CALIBRATION REPORT



54 Members of the BI
25 Associates of the CC

Signatories to the Mutual Recognition Arrangement

BIPM Members (50)

Argentina
Australia
Austria
Belgium
Brazil
Bulgaria
Canada
Chile
China
Croatia
Czech Republic
Denmark
Egypt
Finland
France
Germany
Greece
Hungary
India
Indonesia
Ireland
Israel
Italy
Japan
Kazakhstan
Kenya
Korea, Republic of
Malaysia
Mexico
Netherlands
New Zealand
Norway
Pakistan
Poland
Portugal
Romania
Russian Federation
Saudi Arabia
Serbia
Singapore
Slovakia
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
UK
USA
Uruguay

Associates to the CGPM (34)

Albania
Bangladesh
Belarus
Bolivia
Bosnia and Herzegovina
CARICOM
Chinese Taipei
Costa Rica
Cuba
Ecuador
Estonia
Georgia
Ghana
Hong Kong (China)
Jamaica
Latvia
Lithuania
Mauritius
Macedonia, the FYR of
Malta
Moldova, Republic of
Montenegro
Panama
Paraguay
Peru
Philippines
Seychelles
Slovenia
Sri Lanka
Tunisia
Ukraine
Vietnam
Zambia
Zimbabwe

International Organisations (3)

IAEA International Atomic Energy Agency

irmm Institute for Reference Materials and Measurements

WMO World Meteorological Organization

Metre Convention member states not in MRA

Cameroon
Democratic People's Rep Korea
Dominican Repub
anBolivarian Republic of Venezuela

APMP members not in MRA: Fiji, Mongolia, Nepal, Papua New Guinea.
ASEAN members not in MRA (& APMP): Myanmar, Laos, Cambodia, Brunei

International Agreements on Measurement

CIPM-WMO Agreement (2002)

The International Committee for Weights and Measures (CIPM) and the World Meteorological Organization (WMO), recognizing the need for standardized, accurate and reliable data in the fields of meteorology, hydrology and other related geophysical sciences, have agreed to work together to ensure that data related in particular to measurements of state and composition of atmosphere and water resources, coming from the programmes organized under the auspices of the WMO, are properly based on units traceable to the SI through the procedures of the CIPM MRA and the Technical Regulations of the WMO.

BIPM-IAEA MOU (2012)

To consolidate more than 50 years of mutual cooperation between the BIPM and the International Atomic Energy Agency (IAEA), on Monday 25 June 2012 a Memorandum of Understanding (MoU) was signed by the Director of the BIPM, Michael Kühne, and the Deputy Director General, Director of Nuclear Sciences and Applications Department of the IAEA, Daud Mohamad. The ceremony took place at the IAEA headquarters in Vienna during the 13th International Symposium on Biological and Environmental Reference Materials at which the BIPM also participated.

The IAEA use the BIPM to calibrate their secondary standards, and Dr P.J. Allisy-Roberts, previously Director of the BIPM's Ionizing Radiation Department, is chairman of their standing SSDL Scientific Committee.

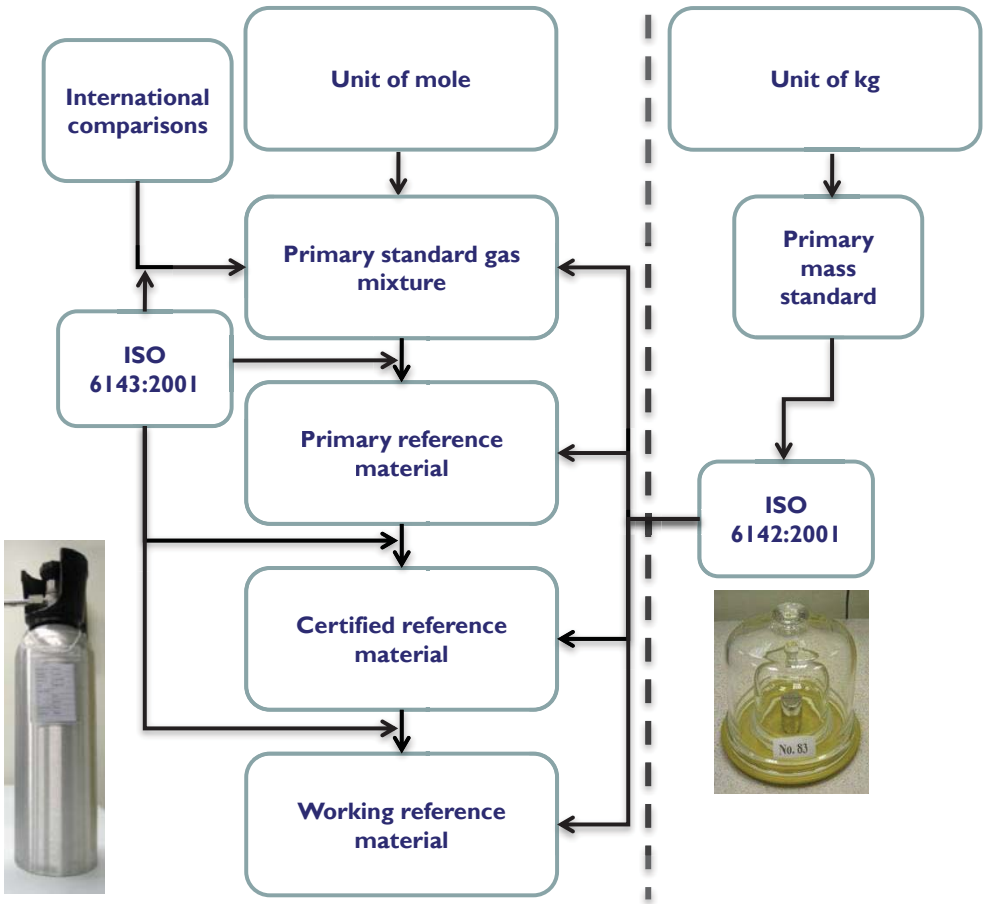
The IAEA signed the CIPM MRA in 1999 and were one of the first laboratories to publish their CMCs in the KCDB.

Traceability of Gas Measurements

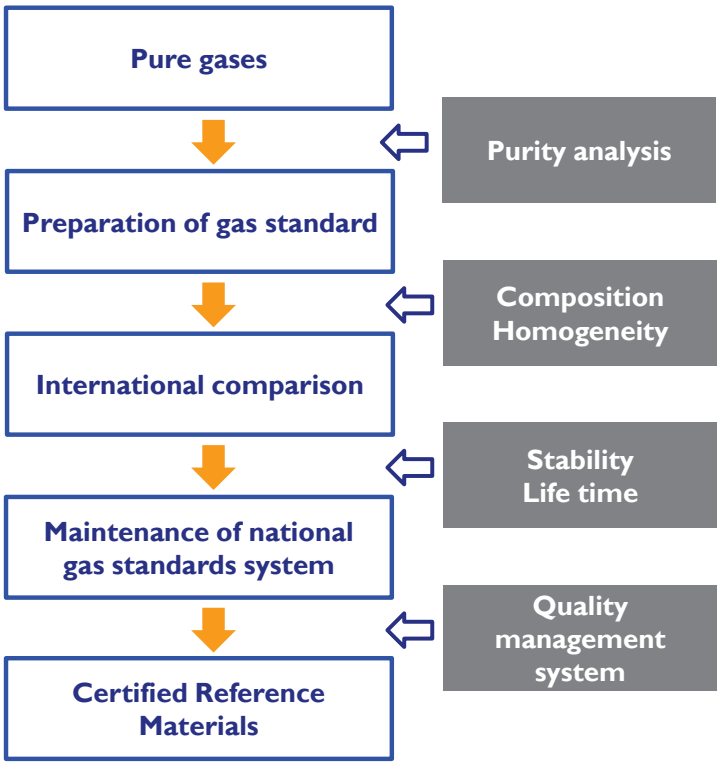
GC for automotive gases, natural gas and green house gases

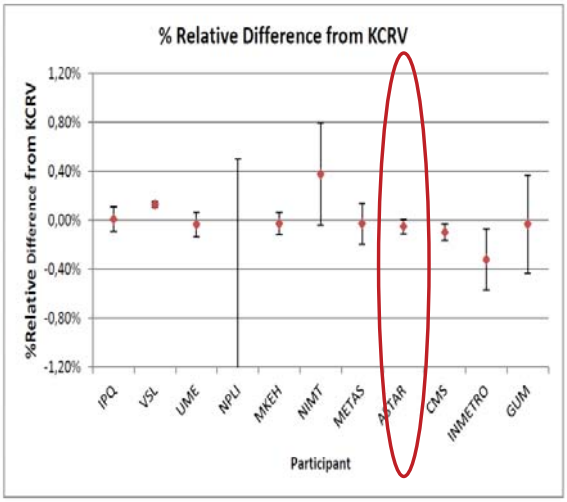
GC for purity analysis

CRDS for the measurement of H_2O & O_2



Traceable Gas Standards System





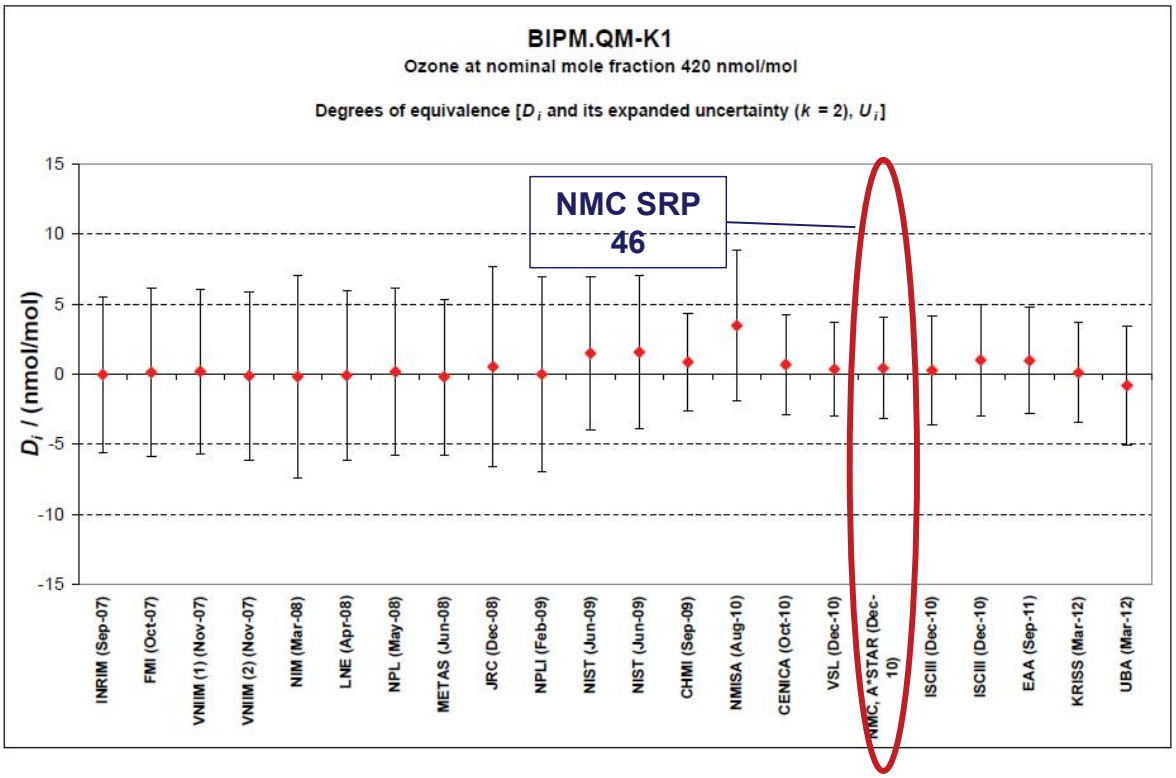
International Comparison EURO.QM-S5/1166: Carbon Dioxide Mixtures in Nitrogen

Traceability of Ozone (Ambient Level) Measurement

International ozone (ambient level) network: 26 member states & 2 international organizations

NMC ozone analyzer calibration facility

International Key Comparison on Ozone Standards (1)



The BIPM key comparison database, June 2012

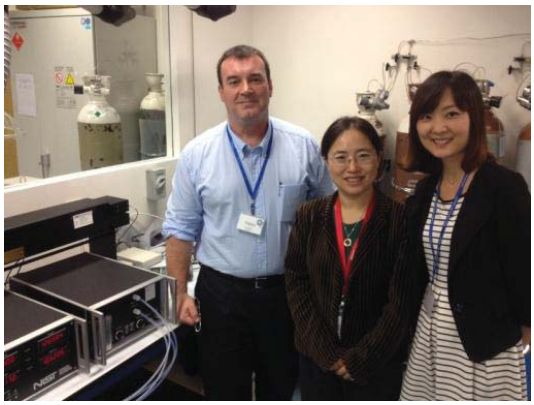
International Key Comparison on Ozone Standards (2)

BIPM.QM-K1: Ozone (Ambient Level)

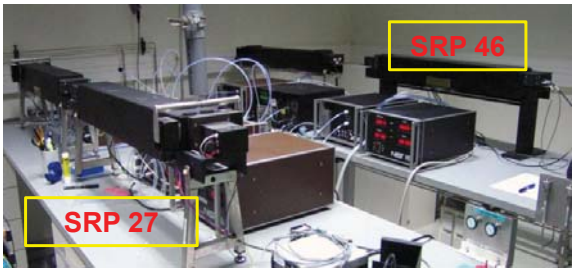
Coordinator
Dr Joele Viallon
Gas Section
Bureau International des Poids et Mesures (BIPM)

Participants
NIST (US), NMC (Singapore)

Schedule
29 April - 1 May 2013



Ozone Measurements in Singapore



Comparison of NMC Primary Ozone Standard SRP 46 with International SRP 27 at BIPM in France

NEA monitoring station

NMC ozone analyzer calibration facility

NEA ozone primary standard

International Comparison on Methane

APMP.QM-S7: 2000 µmol/mol Methane in Nitrogen

Coordinator
Dr Sangil Lee
Center for Gas Analysis
Korea Research Institute of Standards and Science (KRISS)

Participants
KRISS (Korea), NMC (Singapore), CMS (Chinese Taipei), UME (Turkey), NMISA (South Africa), NIMT (Thailand), NPLI (India)

Schedule
September 2013 - Nov 2014

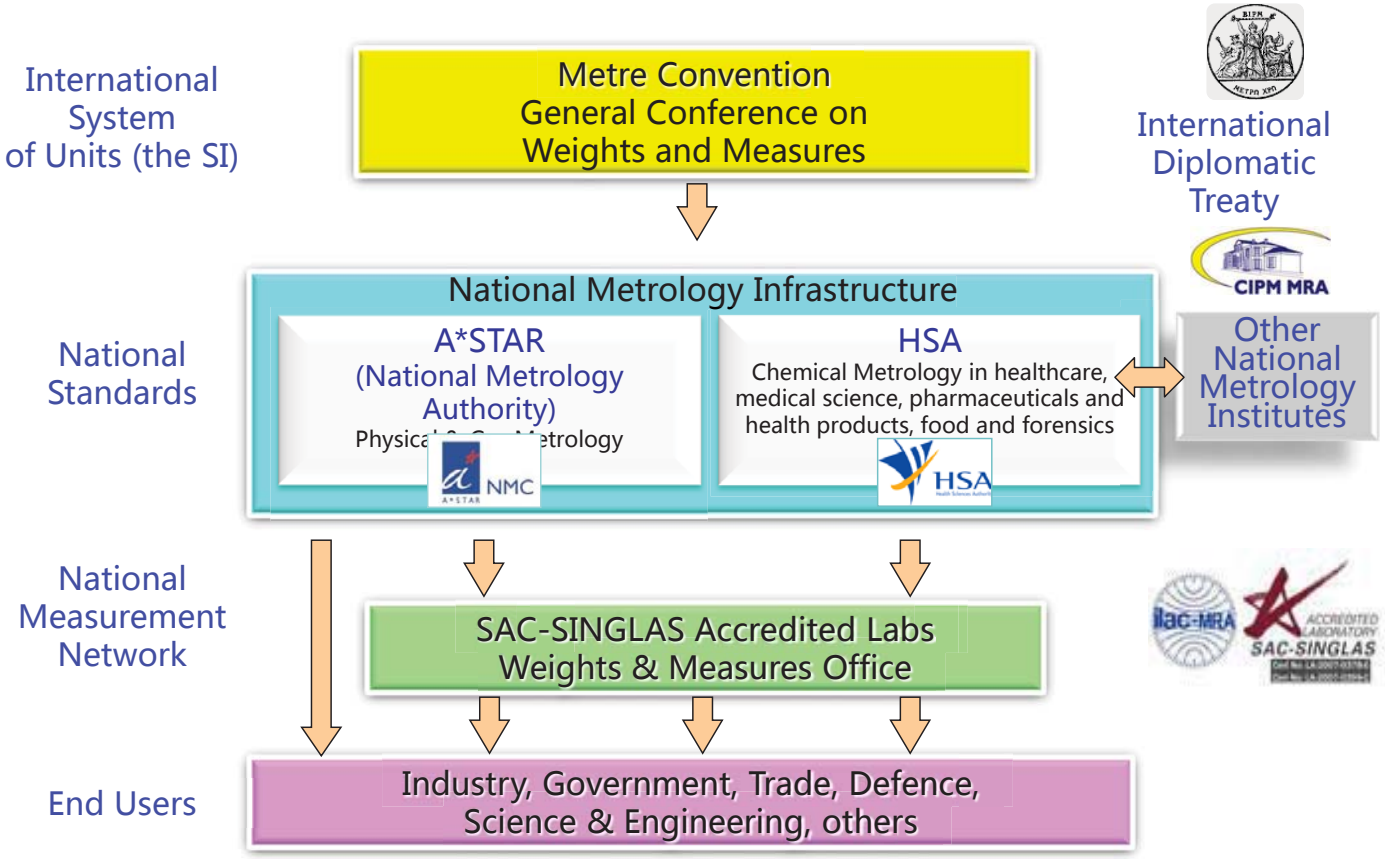
Applications of Gas Measurements

	NMC Capabilities	Future
	**Air Quality** CO CO_2 SO_2 NO NO_2 O_2 O_3	$VOCs$ H_2S
	**Greenhouse Gases** CO_2 CH_4 O_3	N_2O $CFCs$ PFC
	**Automotive Emission** CO CO_2 NO_x C_3H_8 O_2	
	**Industrial Emission** CO CO_2 NO_x SO_2 H_2 O_2 C_3H_8	$VOCs$ PM HCl Odor chemicals (NH_3, H_2S, CH_3S, CH_3S_2, CH_3SH, $(CH_3)_3N$, CH_3CHO, $C_6H_5CHCH_2$) ....

Applications of Gas Measurements

	NMC Capabilities	Future
	**Ship Emission** SO_2 CO CO_2 N_2 O_2 NO_x H_2O	HC PM
	**Natural Gas** CH_4 C_2H_6 C_3H_8 i-C_4H_{10} n-C_4H_{10} i-C_5H_{12} n-C_5H_{12} n-C_6H_{14} CO_2 N_2 He	
	**Indoor Detectors for Hazardous & Flammable Gases** O_2 CO CO_2 CH_4 C_3H_8 H_2 SO_2	H_2S

Singapore National Measurement System



Thank you!

www.a-star.edu.sg
www.nmc.a-star.edu.sg