全域影像和觀天原理
Principles of Total Sky Imaging and Visible Sky Monitoring

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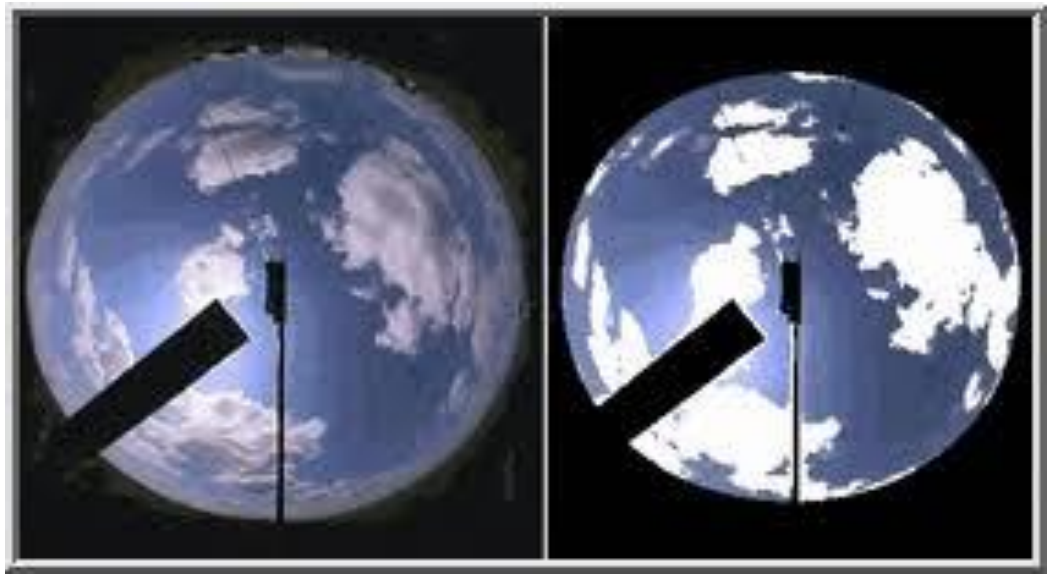
甚麼是全域影像
What is a “Total Sky Image”?



- 一張影像顯示整個半球天空
- A single image showing the whole/full hemispheric sky

- 怎樣 how?

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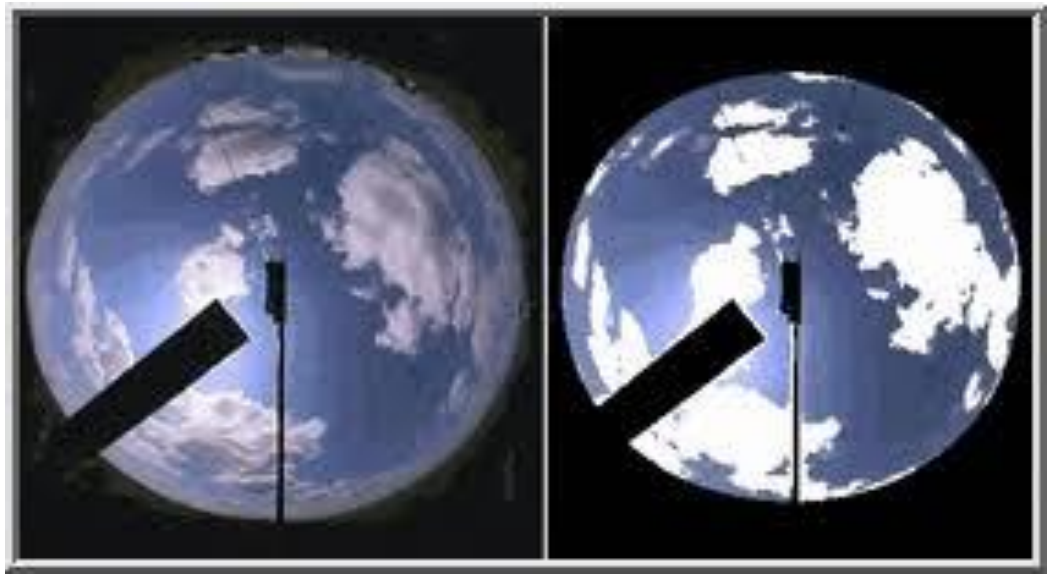
What is a “Total Sky Image”?



- 所以用普通相機拍的照片不是「全域影像」
- Therefore photos taken by ordinary camera are not “total sky images”

- 需要加裝特別鏡頭，如魚眼鏡
- Need to add a special lens, such as fish-eye lenses

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什麼是全域觀天儀？
What is a total sky imager?

- 全域觀天儀可以拍攝及記錄在某一特定時間的天空影像。 在氣象學上，除了利用人眼觀測外，全域觀天儀能夠通過圖像分析軟件有效地估算天上的雲量，儀器也能捕捉到罕見的光學現象，如日暈。
- A total sky imager is an instrument which can take picture and record the hemispheric view of the sky at a particular time instance. In meteorology, through an image analyzing software, a total sky imager is a useful tool to estimate the fraction of the sky view covered by cloud other than manual observation. The instrument can also capture the occurrence of rare atmospheric optics phenomenon, such as sun halo.

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全域觀天儀是怎樣運作的？
How does a total sky imager work?

- 傳統上，全域觀天儀包括一個向下望的CCD相機，觀看由凸面鏡或表面反射的半球形天空視圖。儀器以預設的時間表（例如每小時一次）拍攝半球的天空視圖，並存儲圖像。 通過圖像分析的軟件，可以估算雲量。
- 現今市場上的全域觀天儀都配備了直接面向天空的高分辨率魚眼攝像機。 高分辨率相機能估算雲量和雲的類型。用兩個全域觀天儀，甚至可以利用特定軟件估算雲底高度。

- Traditionally, a total sky imager consists of a CCD camera facing downwards viewing the hemispheric skyview reflected by a convex mirror or surface. The instrument takes picture of the hemispheric skyview with a preset schedule, say once every hour, and stores the images. Through a computer software analyzing the image, cloud coverage can then be estimated.
- Nowadays, total sky imager or all sky imagers available in the market are equipped with high-resolution fisheye camera facing directly to the sky. The high-resolution camera is now capable of determining the cloud coverage and cloud type. With two imagers in place, cloud base height can even be estimated using a dedicated software.

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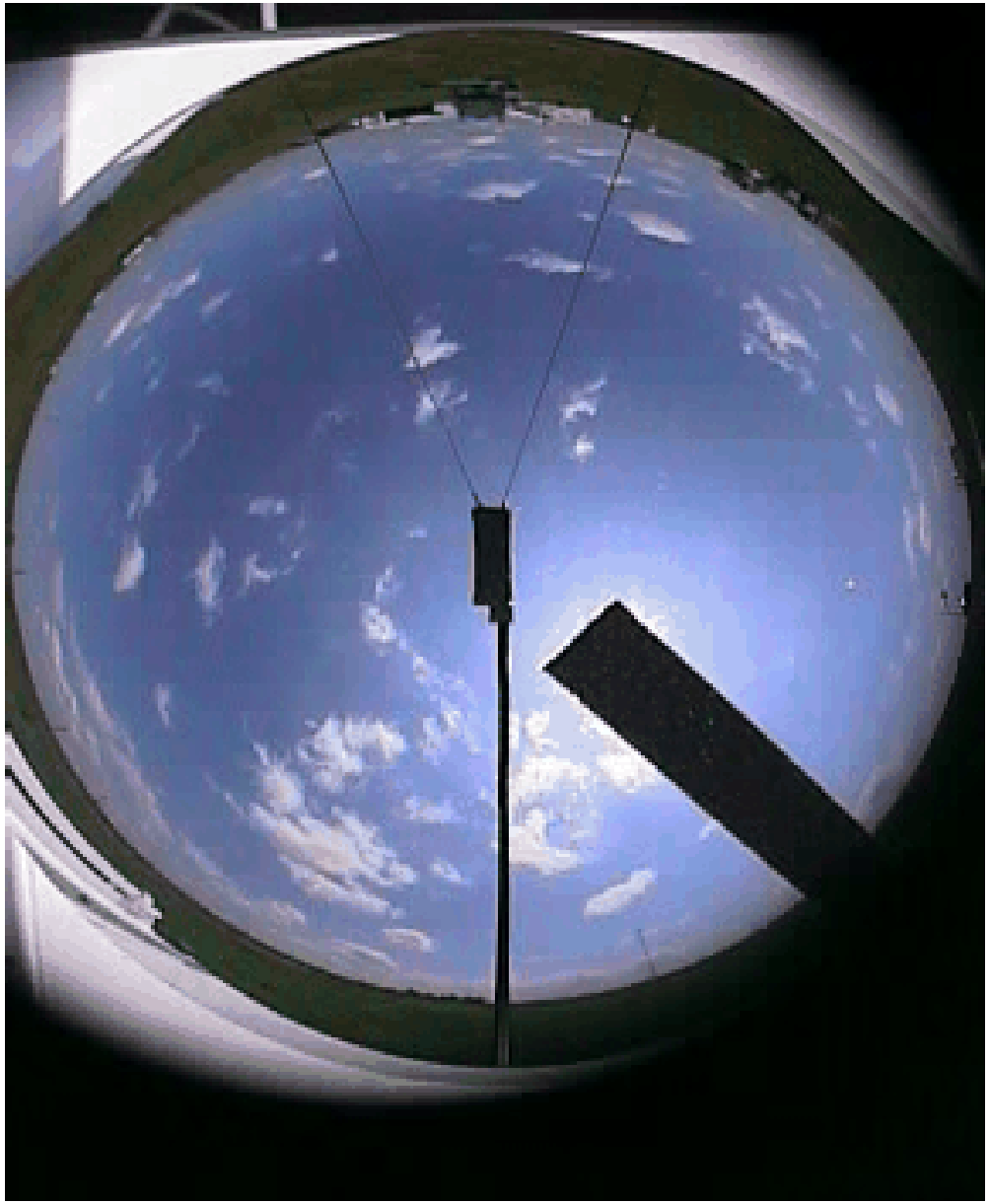

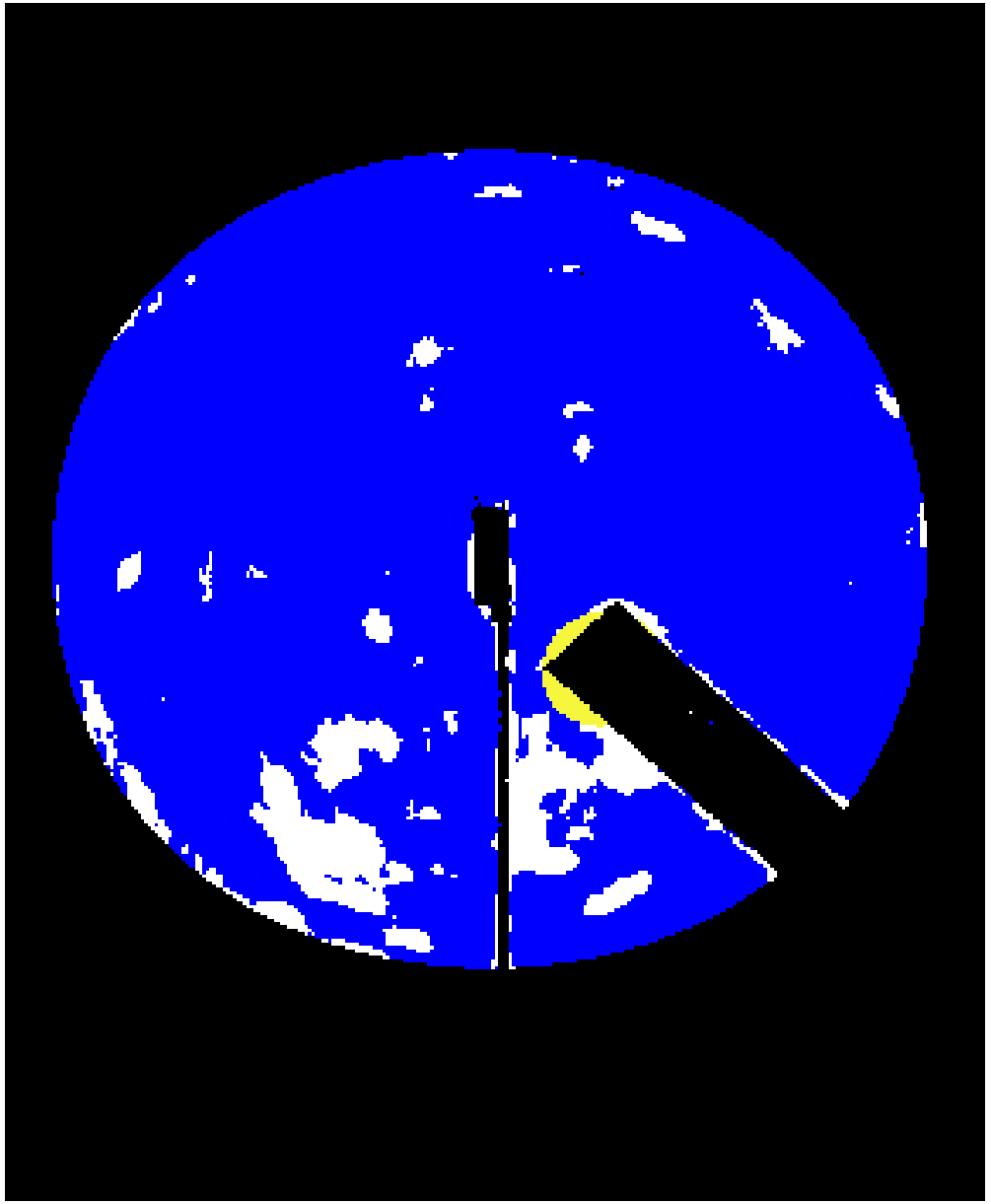

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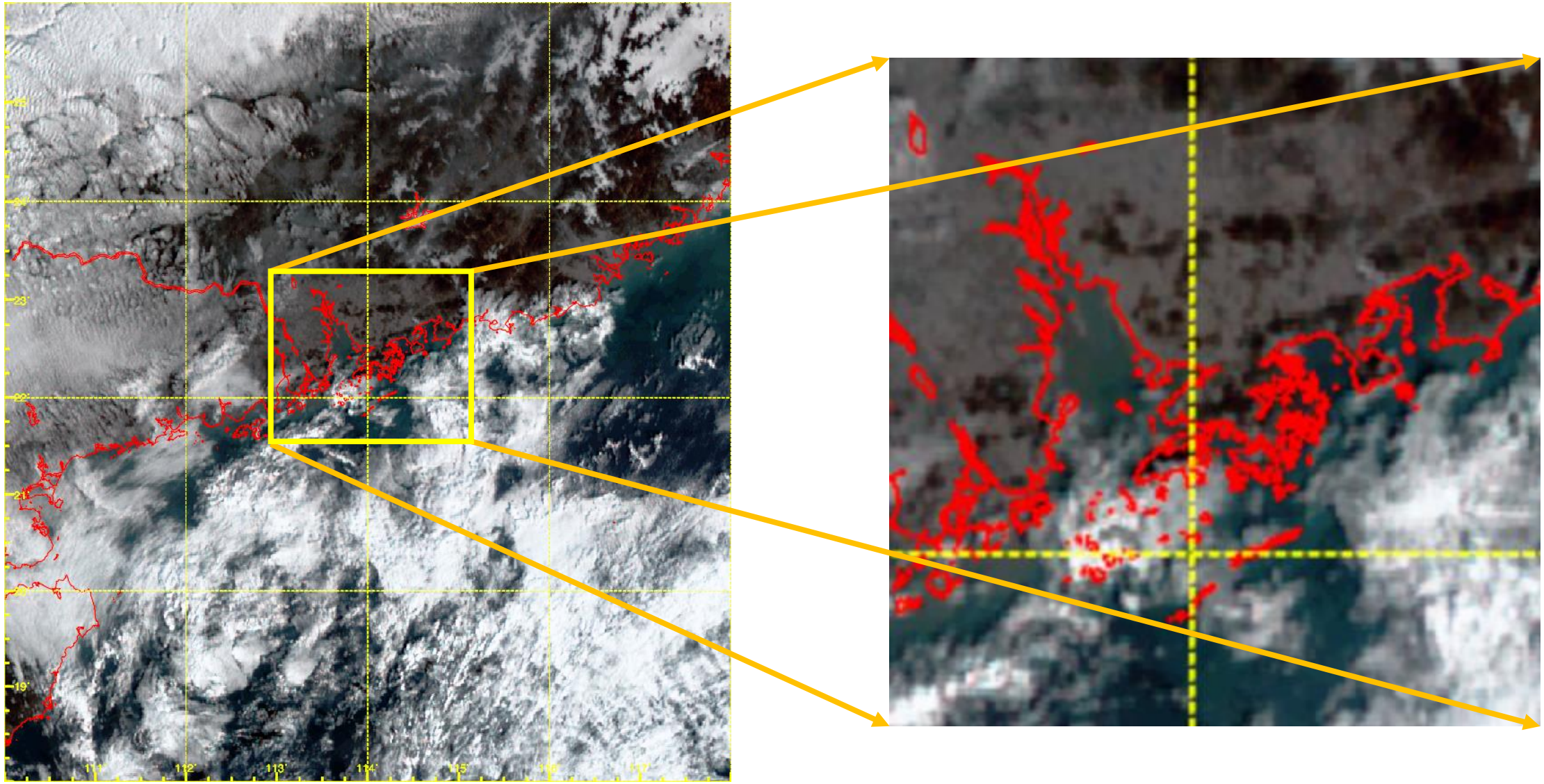
氣象衛星圖像



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天氣照片

> 天氣 > 本港天氣 > 香港分區天氣-最新天氣照片

新界

1) 流浮山
(望向西面)

2) 濕地公園
(望向東北面)

3) 上水風采中學
(望向西北面)

4) 嘉道理農場暨植物園
(遠眺新界西部)

5) 大埔滘
(望向東北面)

6) 大欖涌
(遠眺大嶼山北部)

7) 西貢水警東警署
(望向東北面)

8) 西貢水警東警署
(望向東南面)

9) 清水灣
(望向西南面)

10) 清水灣
(望向東面)

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天氣照片


imgBWB_201202_1440.jpg


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天氣照片


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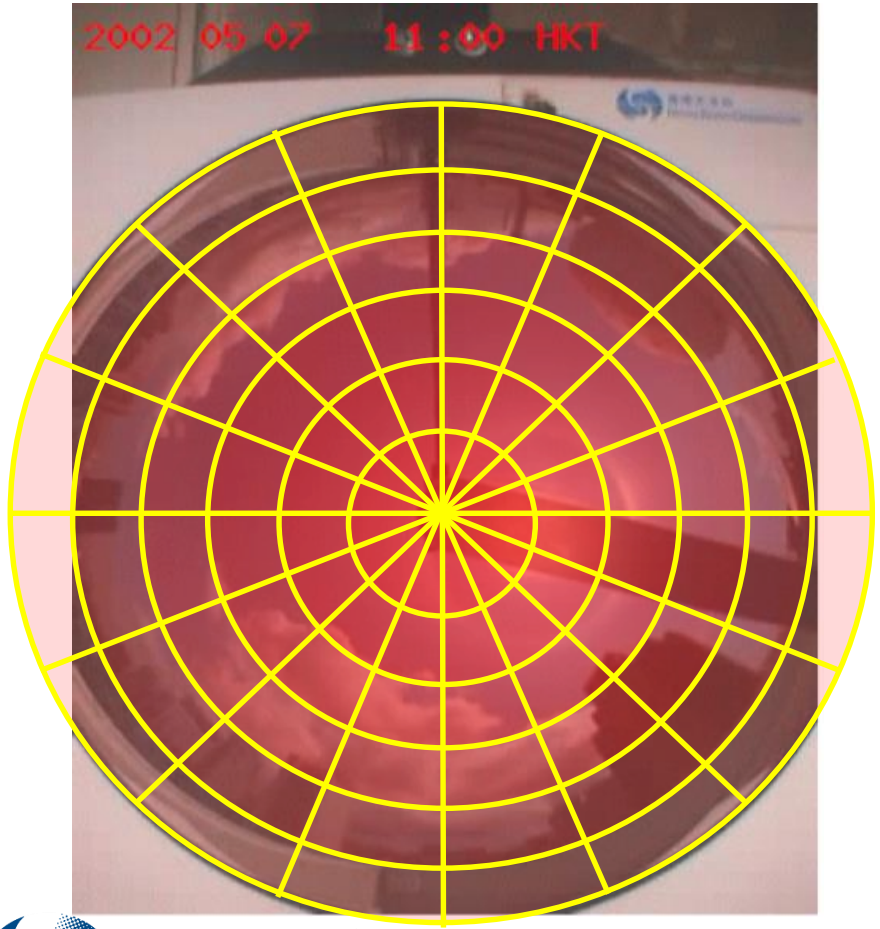
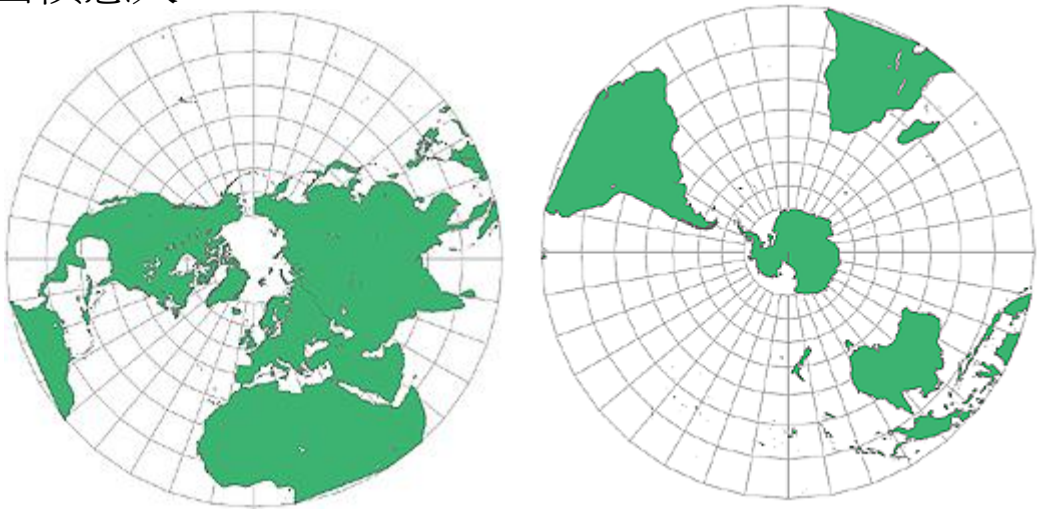
每一像素點所代表的天空面積相等？
Each pixel represents the same area of sky?



- 當然不是！
- 有點像利用「極投影法」(Polar Projection) 繪畫地圖
- 鏡頭在地球的地心
- 陸地像天空的雲
- 只有天頂的影像沒有扭曲，愈離開中心點，面積愈大

- Of course not!
- Similar to “polar projection” in mapping
- Camera set at the core of the Earth
- Land mass is projected on the map
- Only the centre with no distortion. Areas grow grater the farther away from the centre



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要留意的是 ……
Watch out ……

- 魚眼鏡也有很多種，未必是polar projection，焦距並不一樣，即影到的未必是「全天域」

- There are different kinds of Fish Eye’s lenese, which may not have polar projection, facal length bmaybe different, i.e. photo taken may not be ‘a total sky’

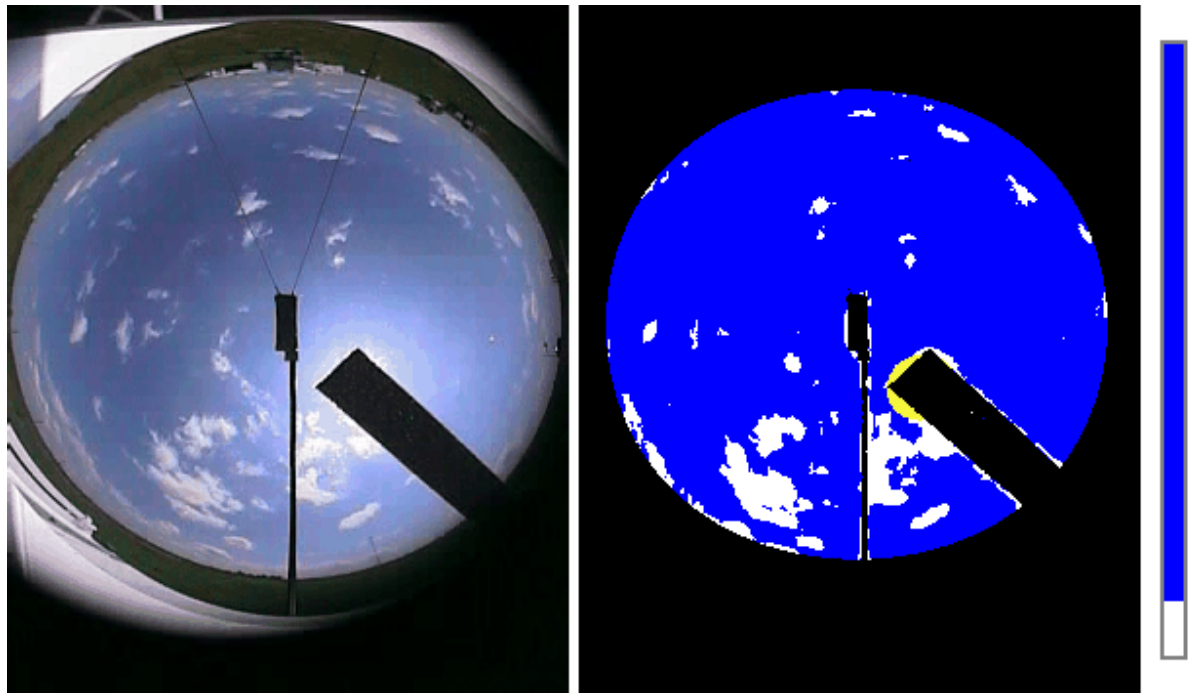
但是，可幸的是……
But, luckily……

- 只需要為用相機拍下的相片計算雲量
- 即不用理會因扭曲後的情況

- Only needs to compute the “cloud coverage” in the photo taken by the camera
- No need to take care of the distortion effect

怎樣量度雲量？
How to measure cloud coverage?

- 在氣象學上份okta是用來量度某一地點雲量的單位，把天空分成八份，零份雲(0 okta)表示天空是完全藍天，萬里無雲，八份雲(8 oktas)則表示整個天空被雲層覆蓋，是天陰。
- In meteorology, an okta is a unit of measurement used to describe the amount of cloud cover at any given location. Sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 oktas (completely clear sky) to 8 oktas (completely overcast).



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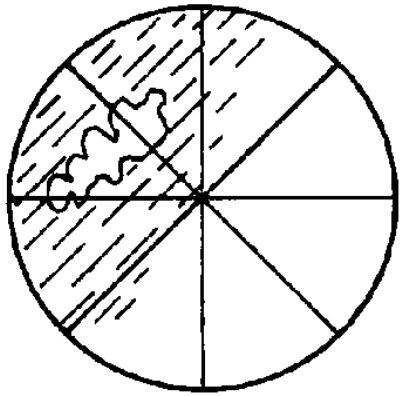
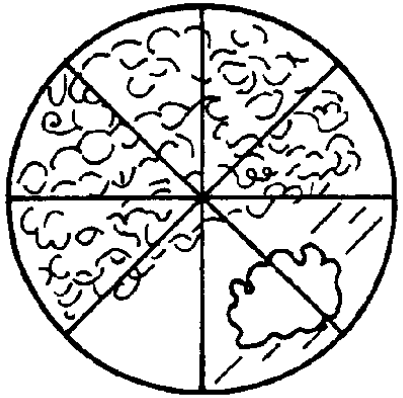
總雲量Cloud cover

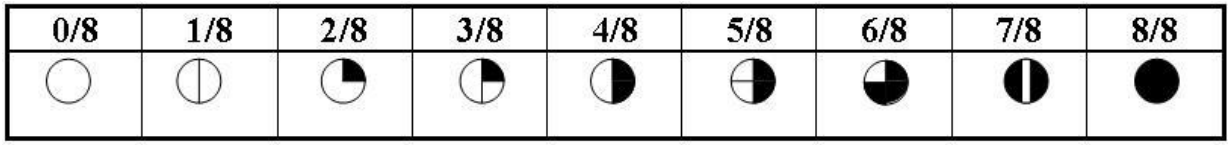
0	SKC – 無雲
1	1/8 或微量(可以判定雲狀的微量雲)
2	2/8
3	3/8
4	4/8
5	5/8
6	6/8
7	7/8
8	8/8
9	因有霧或其他視程障礙現象而使總雲量無法估計
/	未觀測(自動站未配有測雲設備)



3份



6份



總雲量釋意

0/8	1/8-2/8	3/8-4/8	5/8-7/8	8/8
Clear	Few	Scattered	Broken	Overcast
天朗氣清	稀薄雲層	零散雲層	疏鬆雲層	天色陰暗

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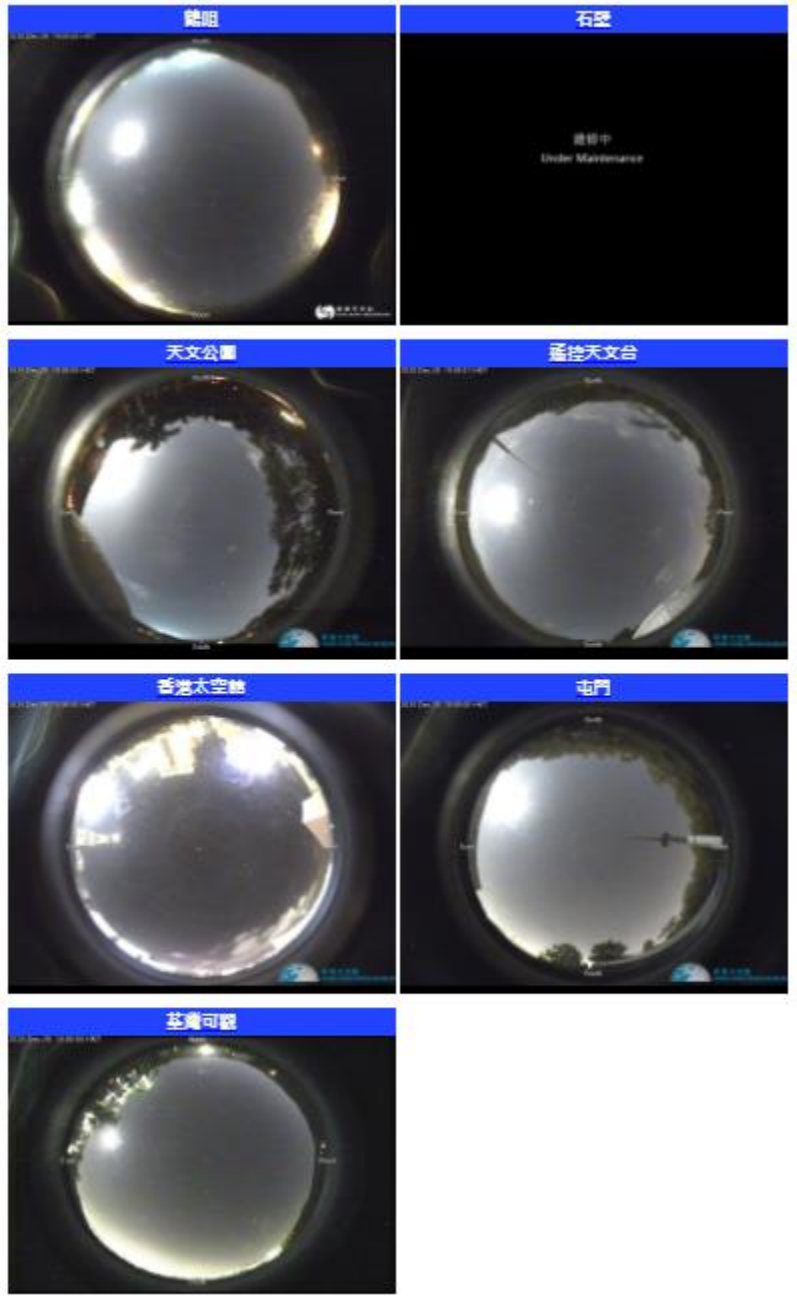
最新全天影像一覽
Overview of the latest all sky images

https://www.hko.gov.hk/tc/gts/astronomy/site_all.htm

香港天文台 Hong Kong Observatory:
鶴咀 Cape D'Aguilar
石壁 Shek Pik

香港太空館 Hong Kong Space Museum:
天文公園 Astropark
遙控天文台 iObservatory
香港太空館 Hong Kong Space Museum
屯門 Tuen Mun

荃灣可觀 Tsuen Wan Ho Koon

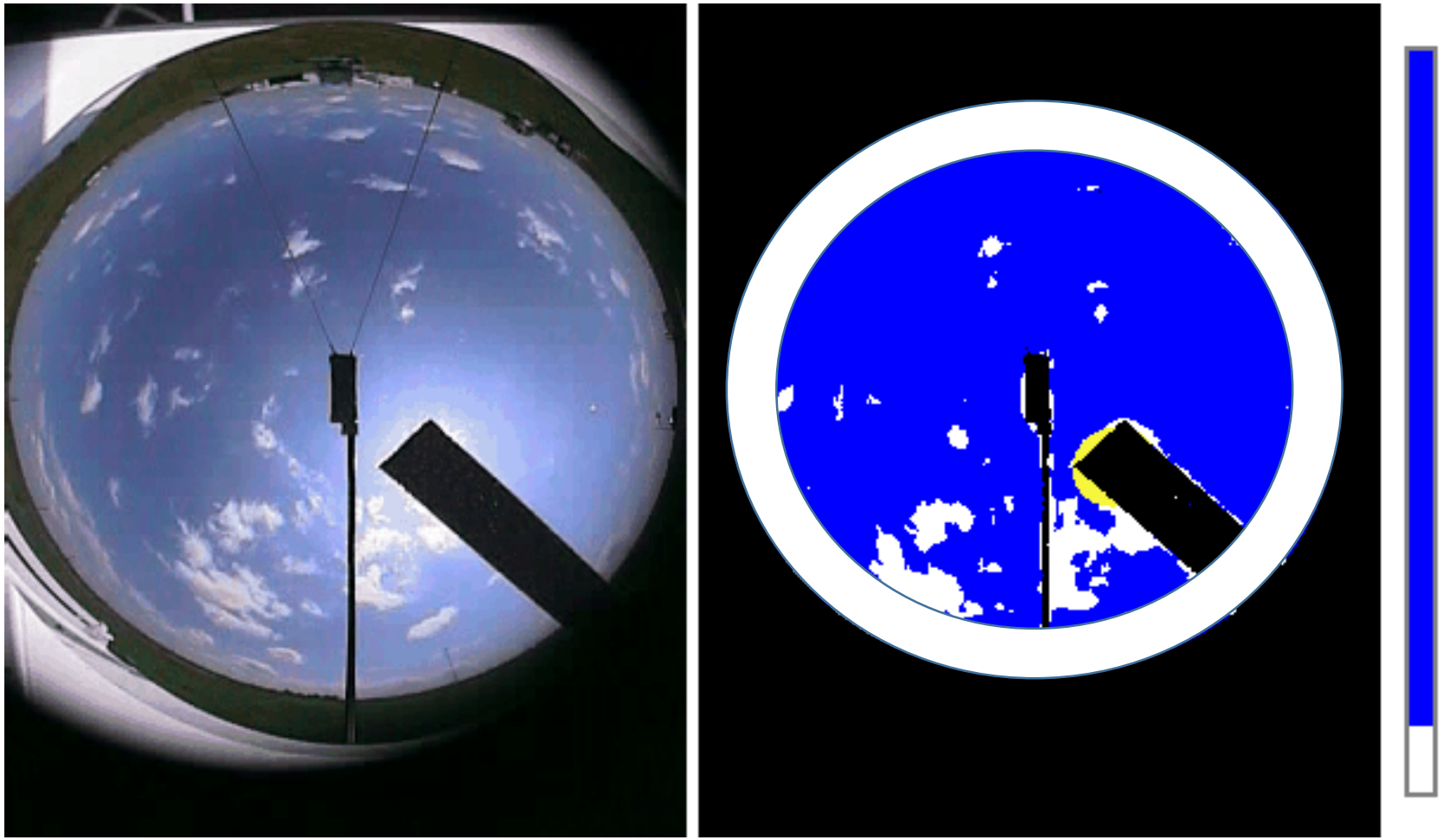


使用全域觀天儀有什麼挑戰？
What are the challenges of using a total sky imager?

- 太陽是設計全域觀天儀時必須考慮的主要問題之一。 相機直接暴露在陽光下容易損壞。 因此，在設計中可能須考慮阻擋太陽直射。 極端高溫也是一個值得思考的因素，因為特別是在炎熱的夏季，太陽會令觀天儀升溫。
- 香港是一個現代化的城市，有許多高層建築或摩天大樓阻擋了景觀，從而影響對雲量的估算。 此外，在某些氣象條件下，煙霞的存在會使天空變得模糊不清，使得雲量的估算存在相當大的誤差，更具挑戰性。

- The Sun is one of the main concerns one has to consider when designing a total sky imager. Direct exposure to sunlight can damage the camera easily. Therefore, a blocking mechanism may have to be considered in the design. Extreme heat is also a factor to think about as the imager would be heat up under the Sun especially during scotching summer.
- Hong Kong is a modernized city with lot of high-rise or skyscrapers which could block the view, hence affecting the estimation of cloud coverage. Moreover, under certain meteorological conditions, the existing of haze can obscure the sky and make the estimation of cloud cover even more challenging with considerable error.

我有辦法…
I have an idea…



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連結 Links

- Overview of the latest all sky images https://www.hko.gov.hk/gts/astronomy/site_all.htm
- Halo captured by the total sky imager http://www.weather.gov.hk/wxinfo/aws/imager/ttsd19art07_e.htm
- Wikipedia on Okta https://en.wikipedia.org/wiki/Okta
- EKO product on All Sky Imager https://eko-eu.com/products/environmental-science/all-sky-imager
- Atmospheric Radiation Measurement on TSI https://www.arm.gov/capabilities/instruments/tsi