A ONE-STOP SERVICE HUB INTEGRATING ESSENTIAL WEATHER AND GEOPHYSICAL INFORMATION ON A GIS PLATFORM

Hong Kong Observatory

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HONG KONG OBSERVATORY

HONG KONG OBSERVATORY

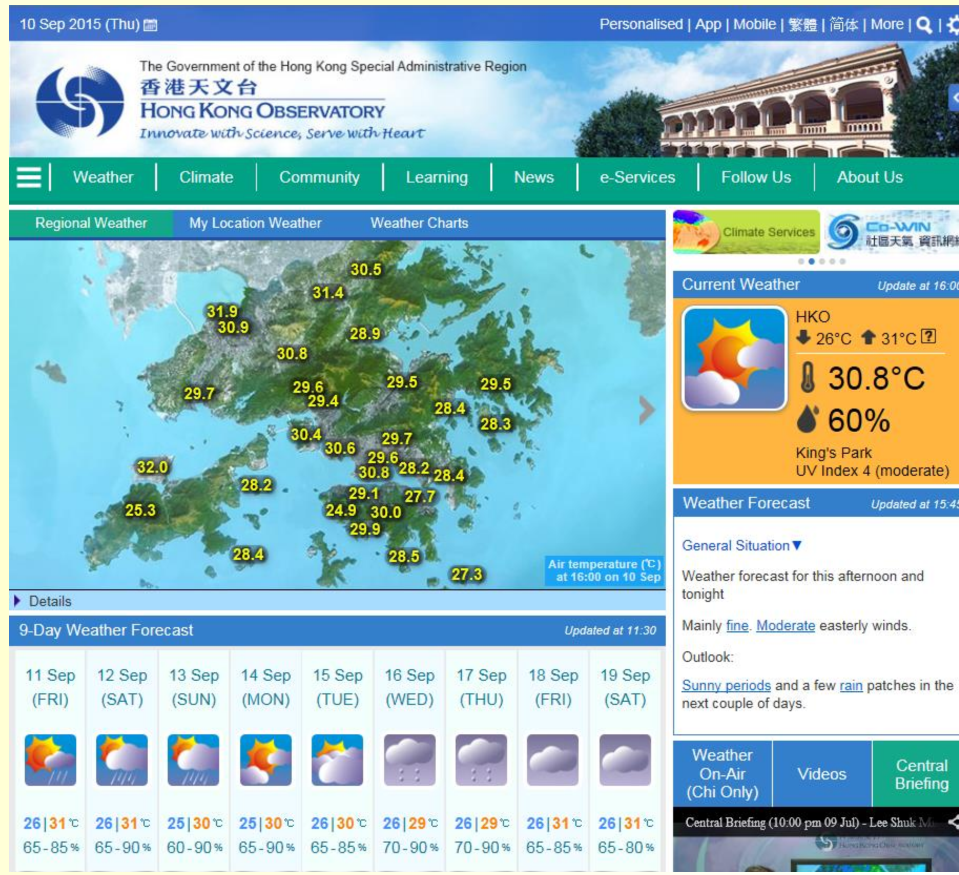
Mission

- To provide people-oriented quality services in meteorology and related fields;
- To enhance the society's capability in natural disaster prevention and response, through science, innovation and partnership.

HONG KONG OBSERVATORY

The Hong Kong Observatory is responsible for

- forecasting weather and issuing warnings on weather-related hazards.
- monitoring and assessing radiation levels in Hong Kong.
- providing other meteorological and geophysical services, to meet the needs of the public and the shipping, aviation, industrial and engineering sectors.



http://www.hko.gov.hk

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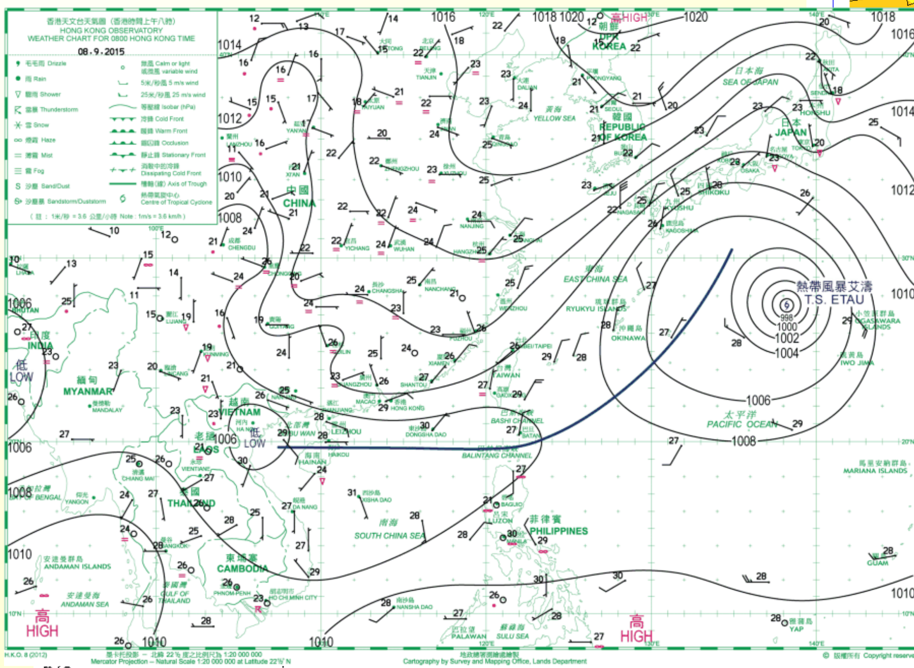
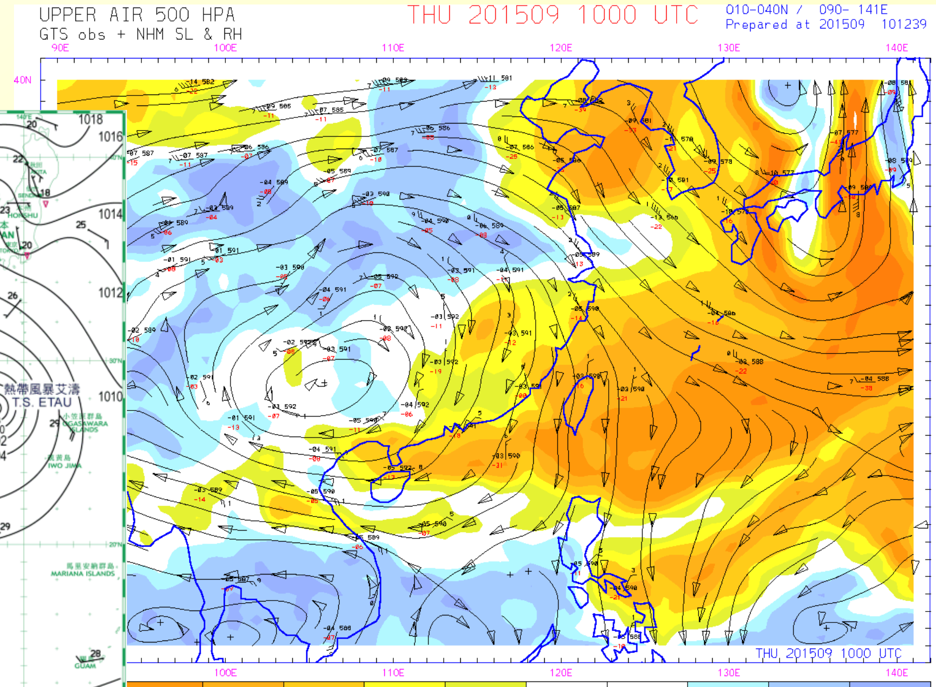
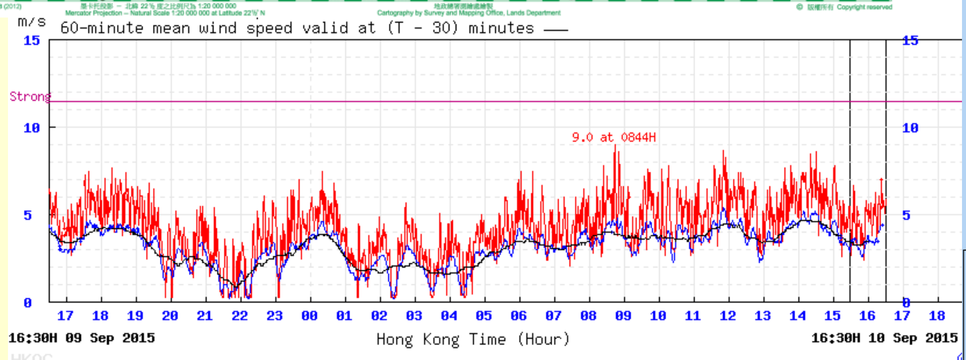
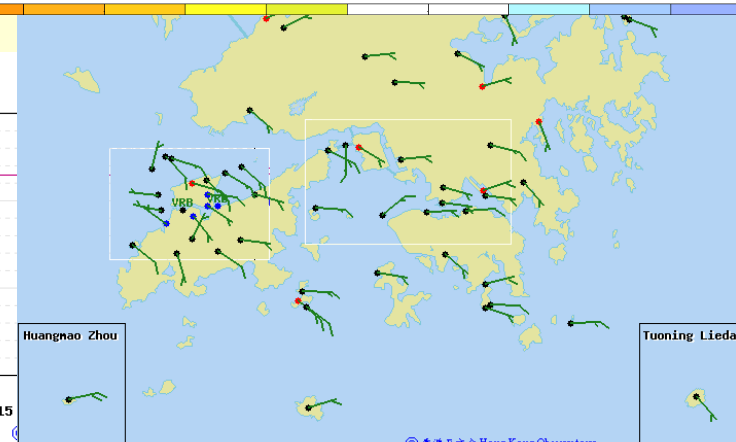
Weather analysis









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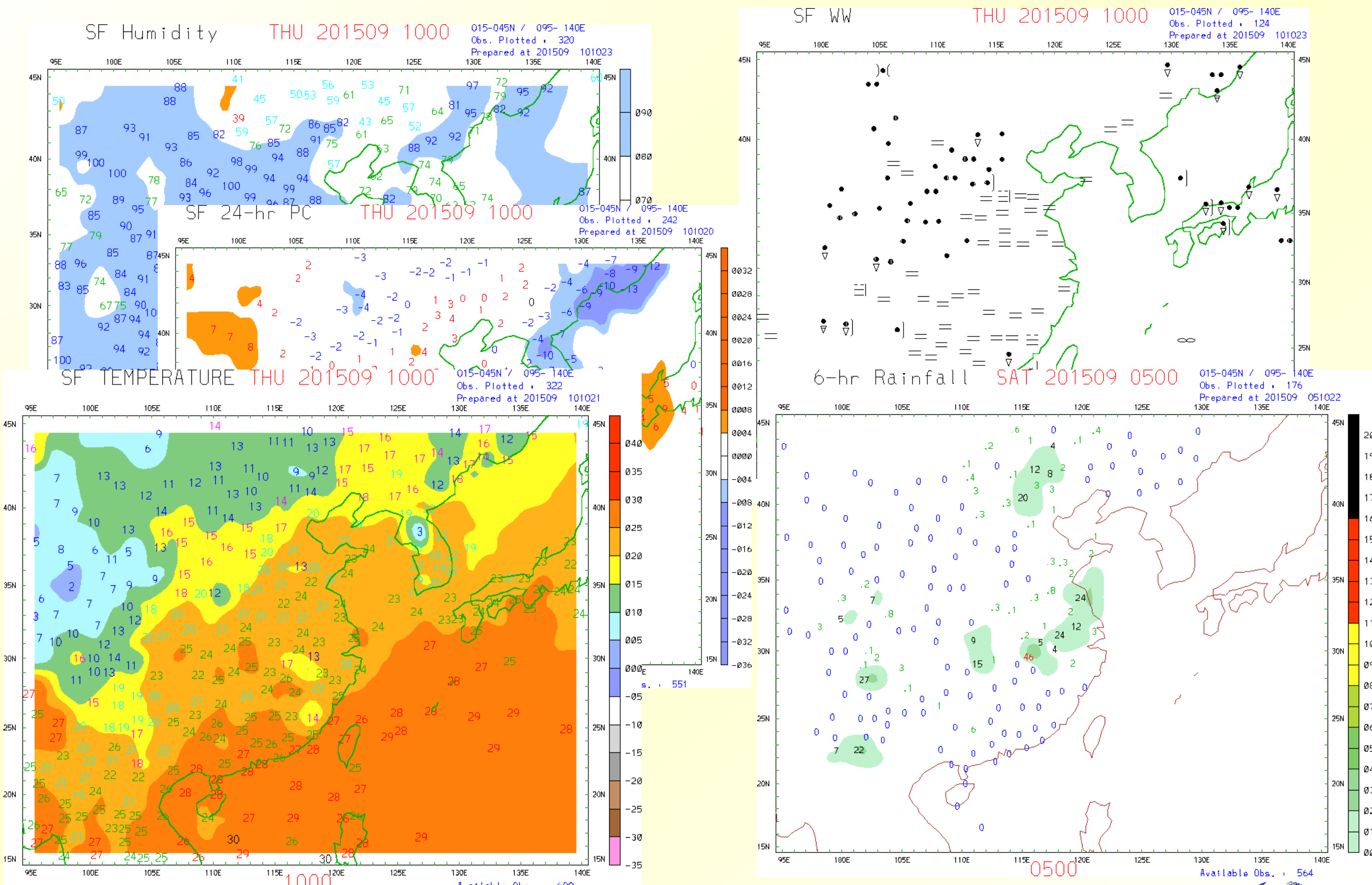
Different types of weather information



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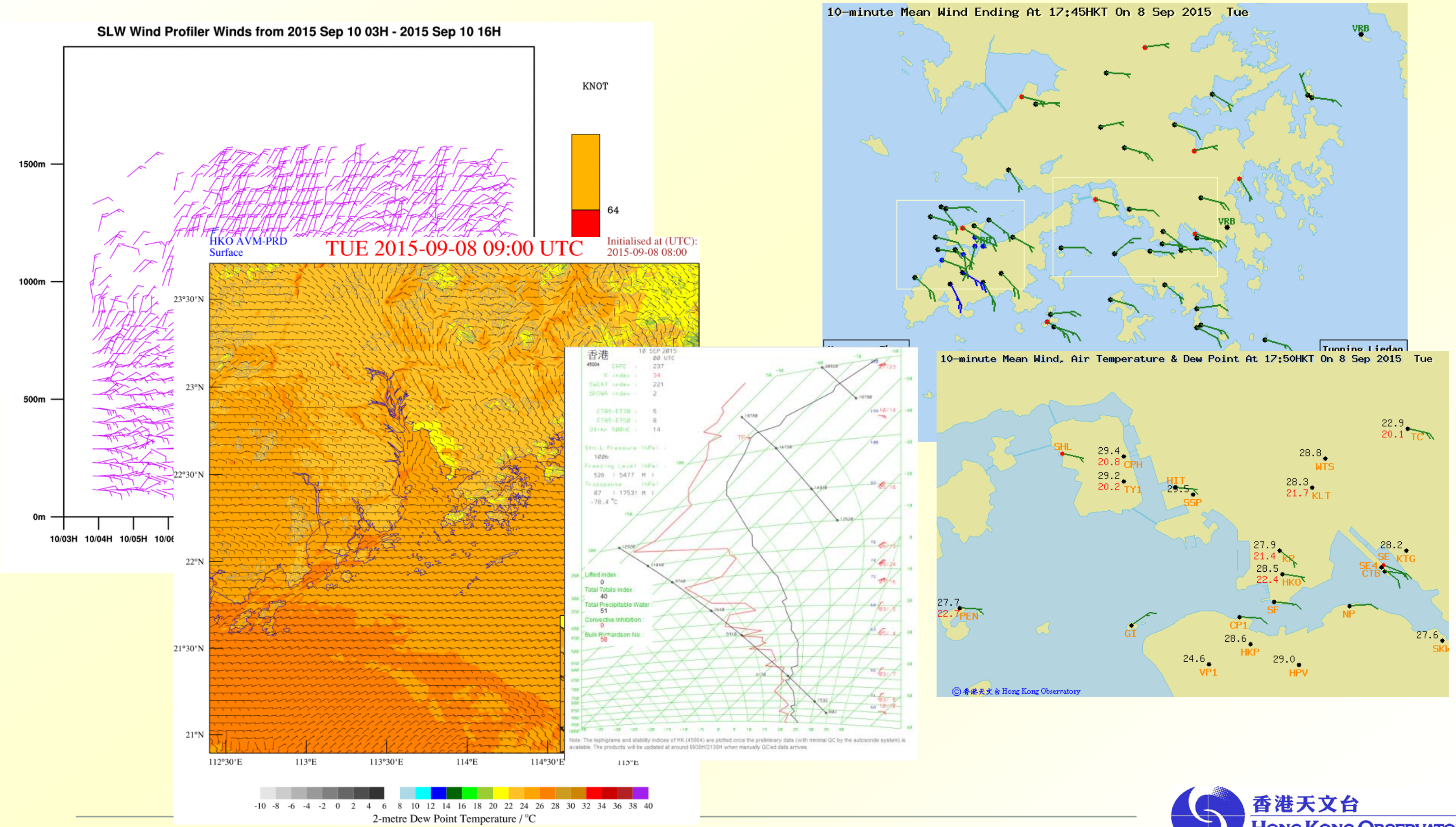
Geospatial and Temporal Weather Information



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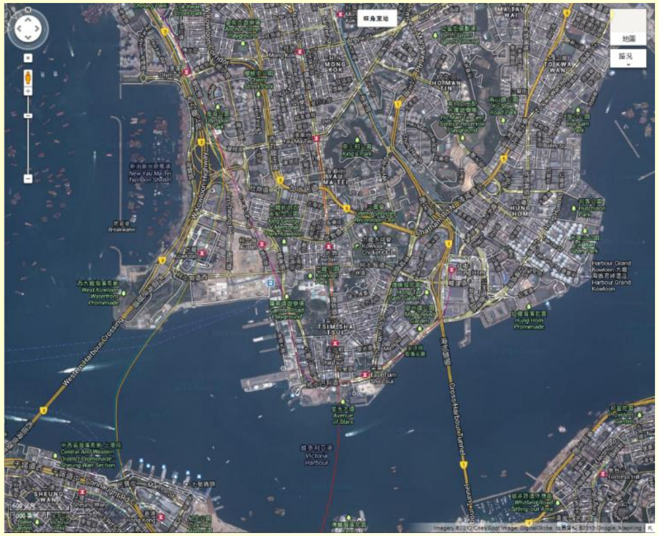
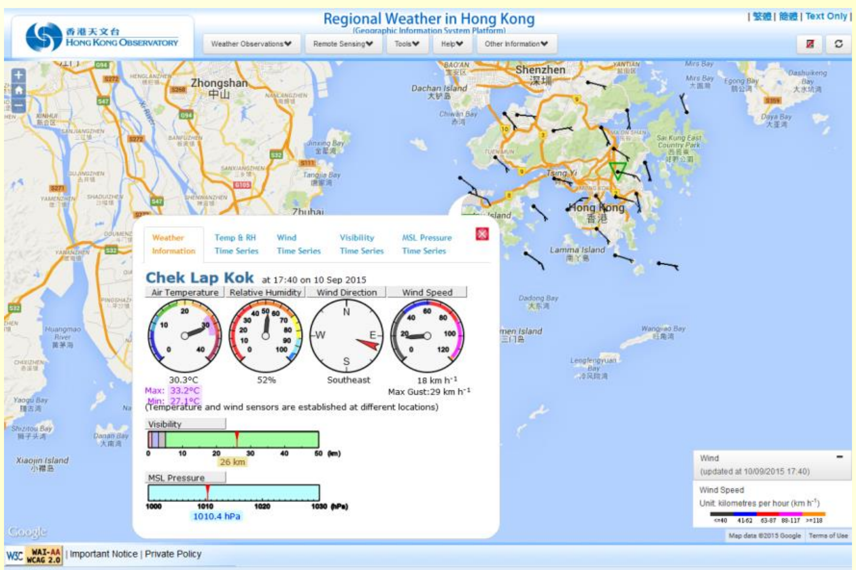
Geographic Information System (GIS)

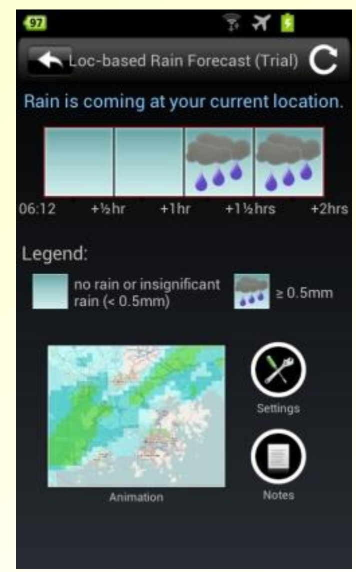
- A computer-based tool for holding, displaying, and manipulating huge amounts of spatial data.



Geographic Information System (GIS)

- From data display to analysis/decision-making
- From internal application to service delivery
- From generalized to location-specific service





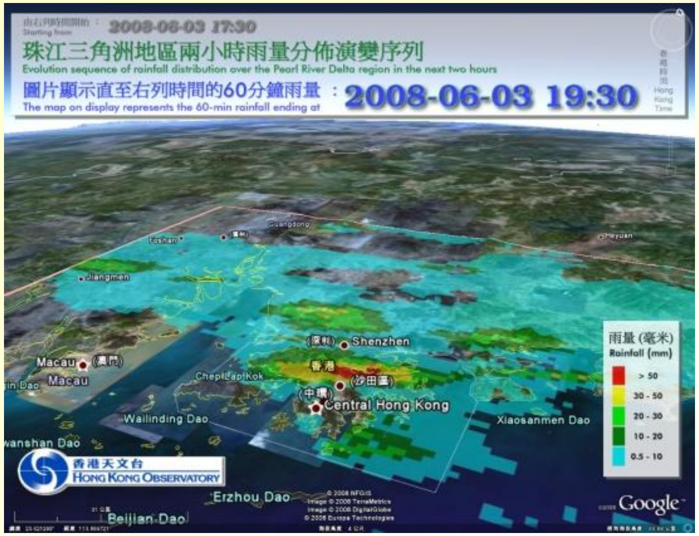
First Step

Use of GIS

The first time using GIS technology in presenting meteorological data in the webpage.

"Rainfall Nowcast for the Pearl River Delta Region"

- Use KML and geospatial information display software
- With geospatial information display software, zooming, panoramic view operations to view rainfall distribution in the region.



Proximity Analysis

- Two or more data layers can be overlaid
- GIS creates buffers around features on a particular layer
- This allows analyses such as flood zone delineation and features near a route.

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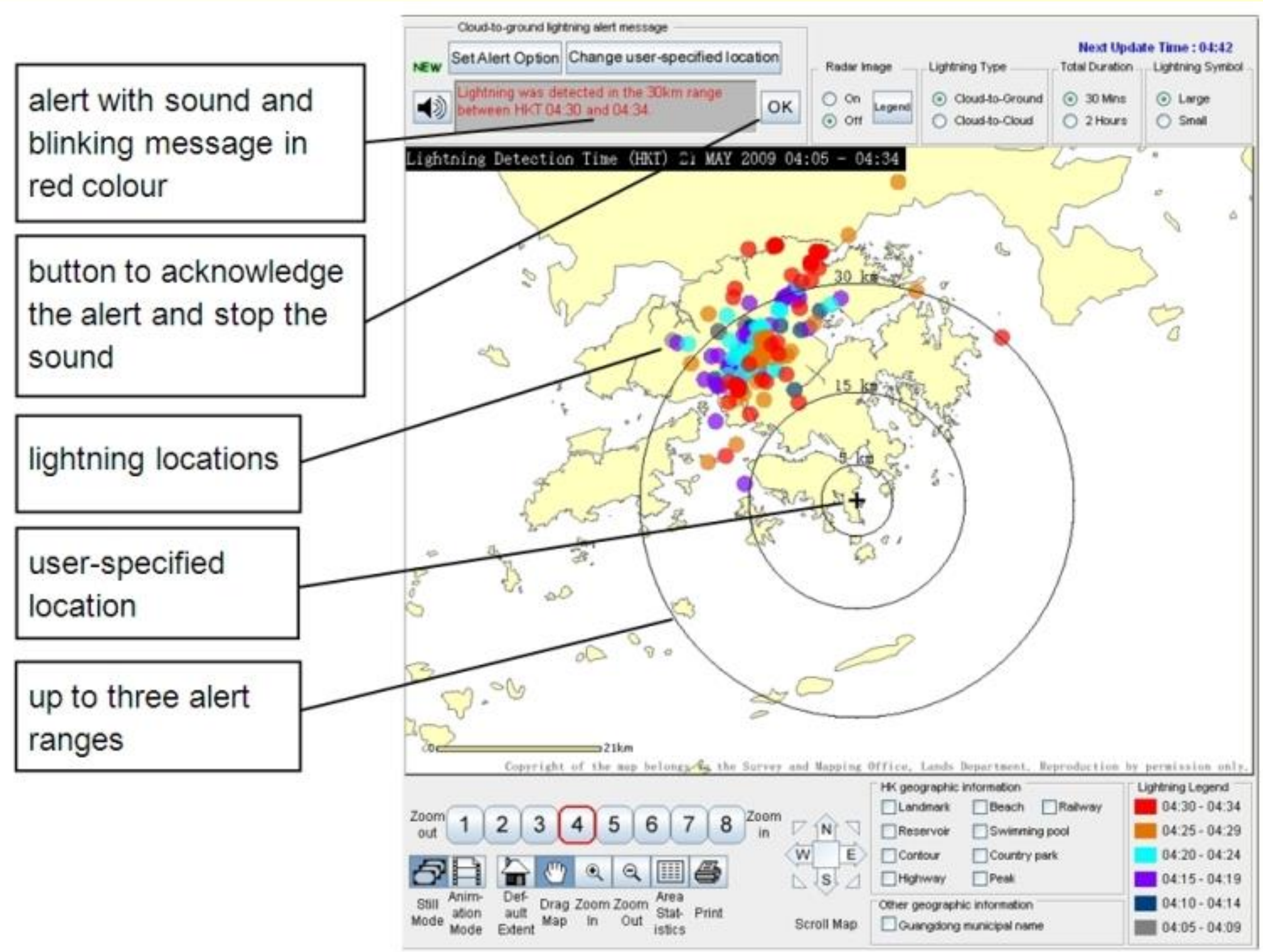
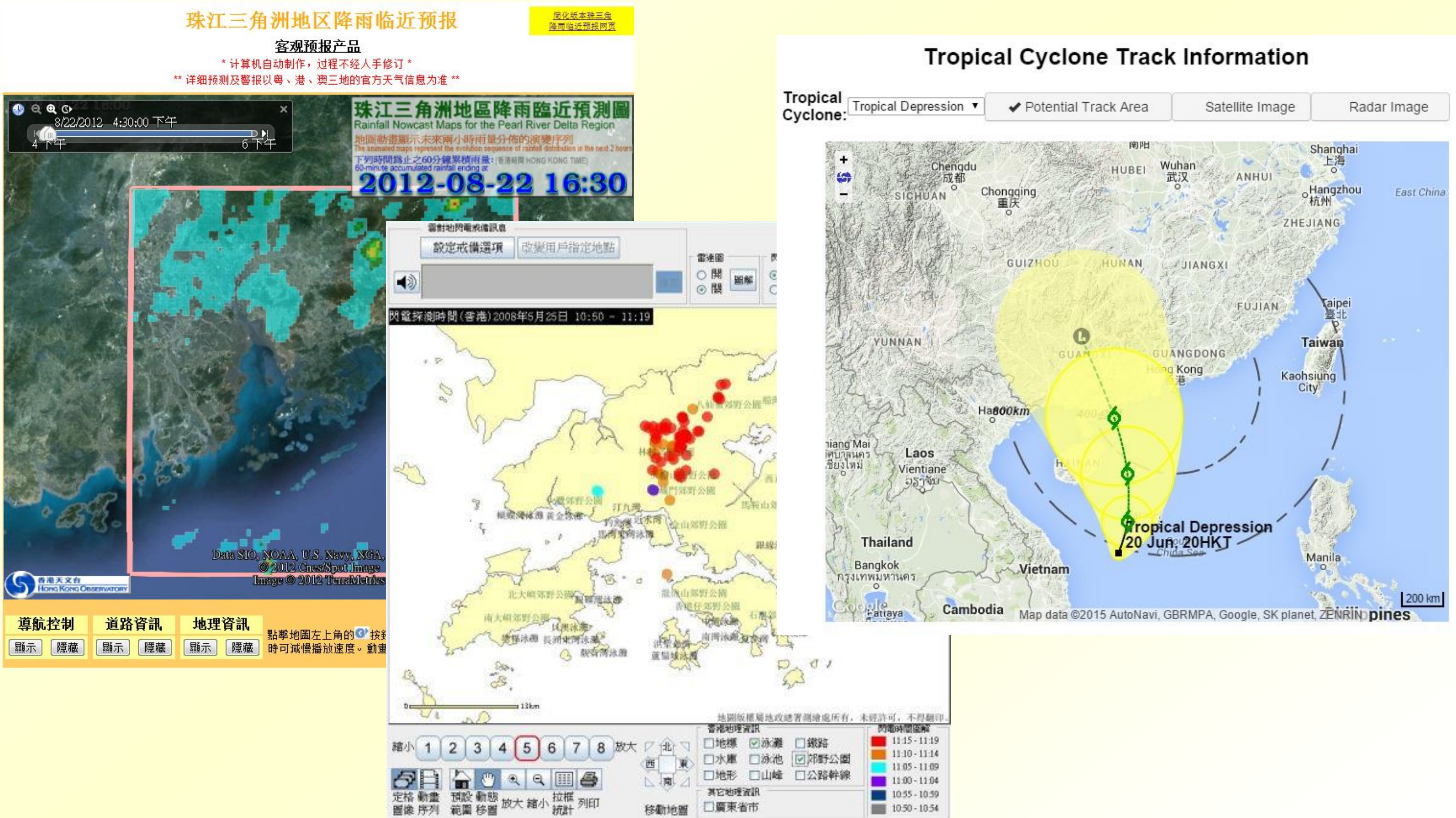
Query and Overlay Analyses



Location-specific Lightning Alert Webpage
http://www.hko.gov.hk/wxinfo/llis/alert_index.htm

GIS for Public Weather Service



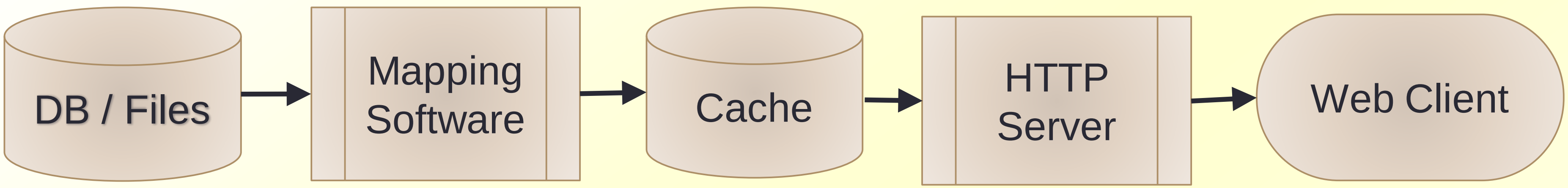
FURTHER DEVELOPMENT

Use of GIS

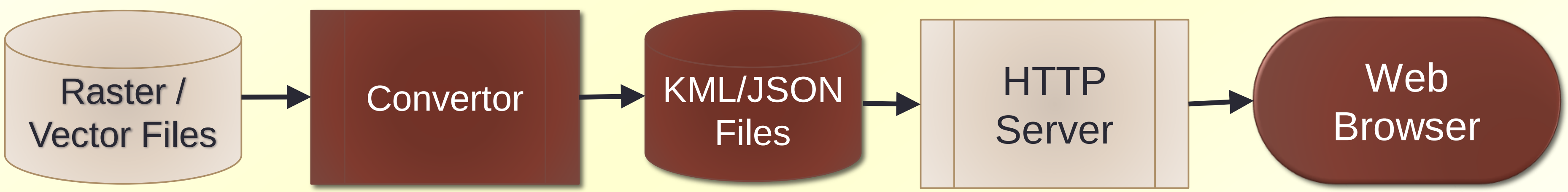
- Open source GIS technology is developing rapidly
- Development of the meteorological analysis system becomes more convenient
- Display a wide variety of real-time meteorological data, including automatic weather station data, radar images, satellite images, upper-air sounding data, lightning location information and numerical weather predication (NWP) model products on same platform.

System Design

Common GIS work flow



HKO GIS work flow



- KML supports Time, Raster and Vector
- Pre-generated at server to minimize overall processing time

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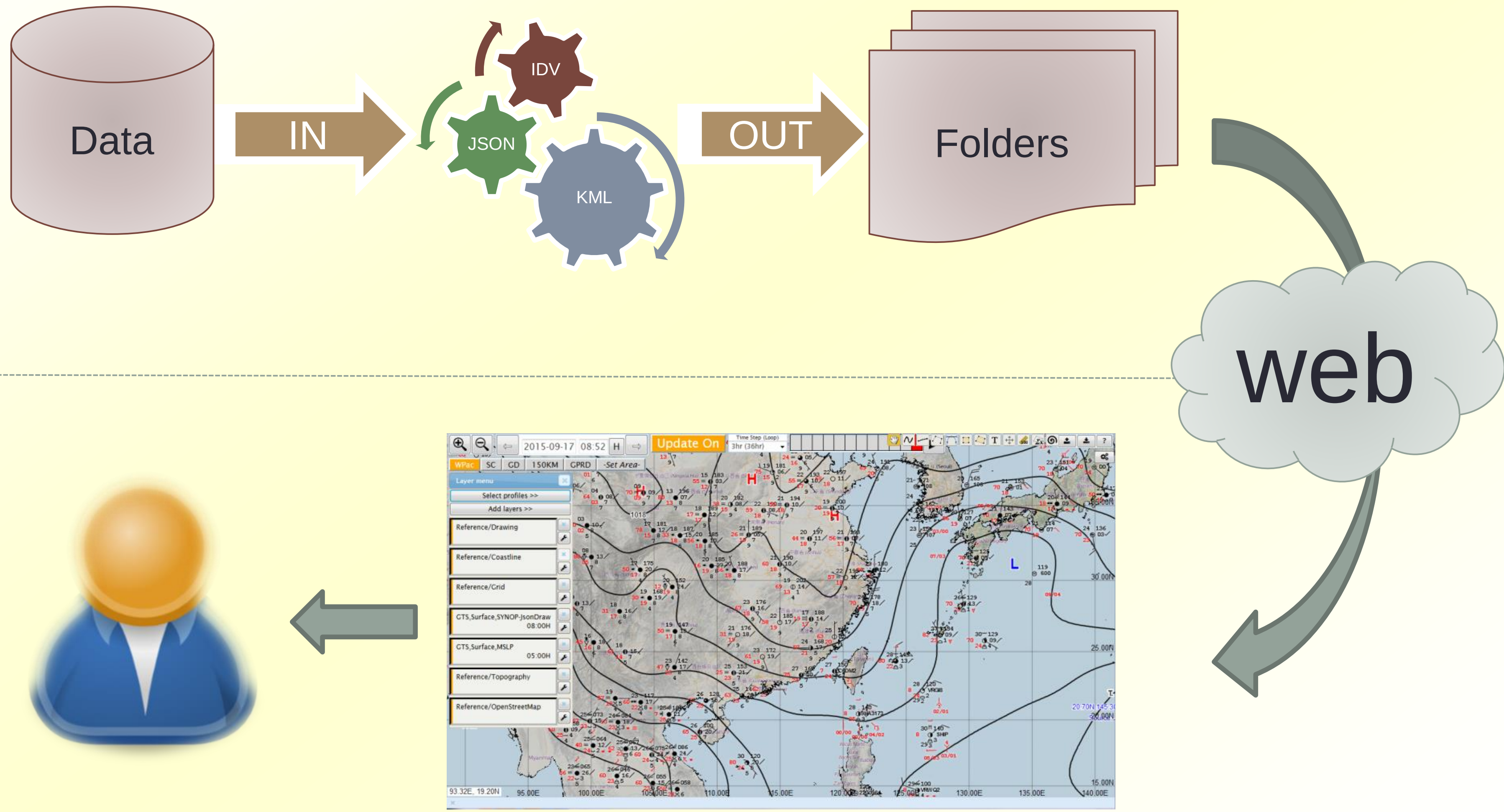
System Design

Like these …



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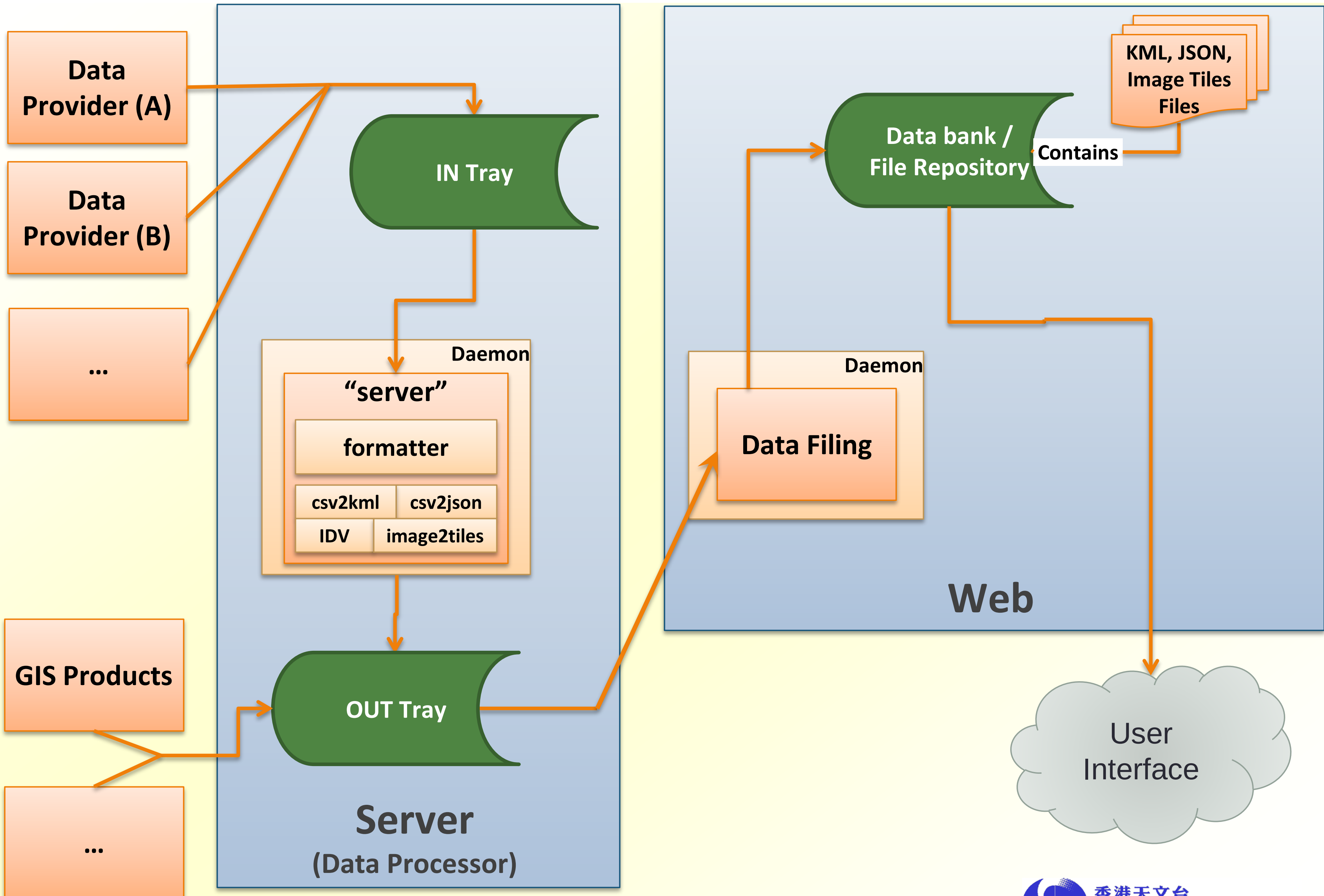
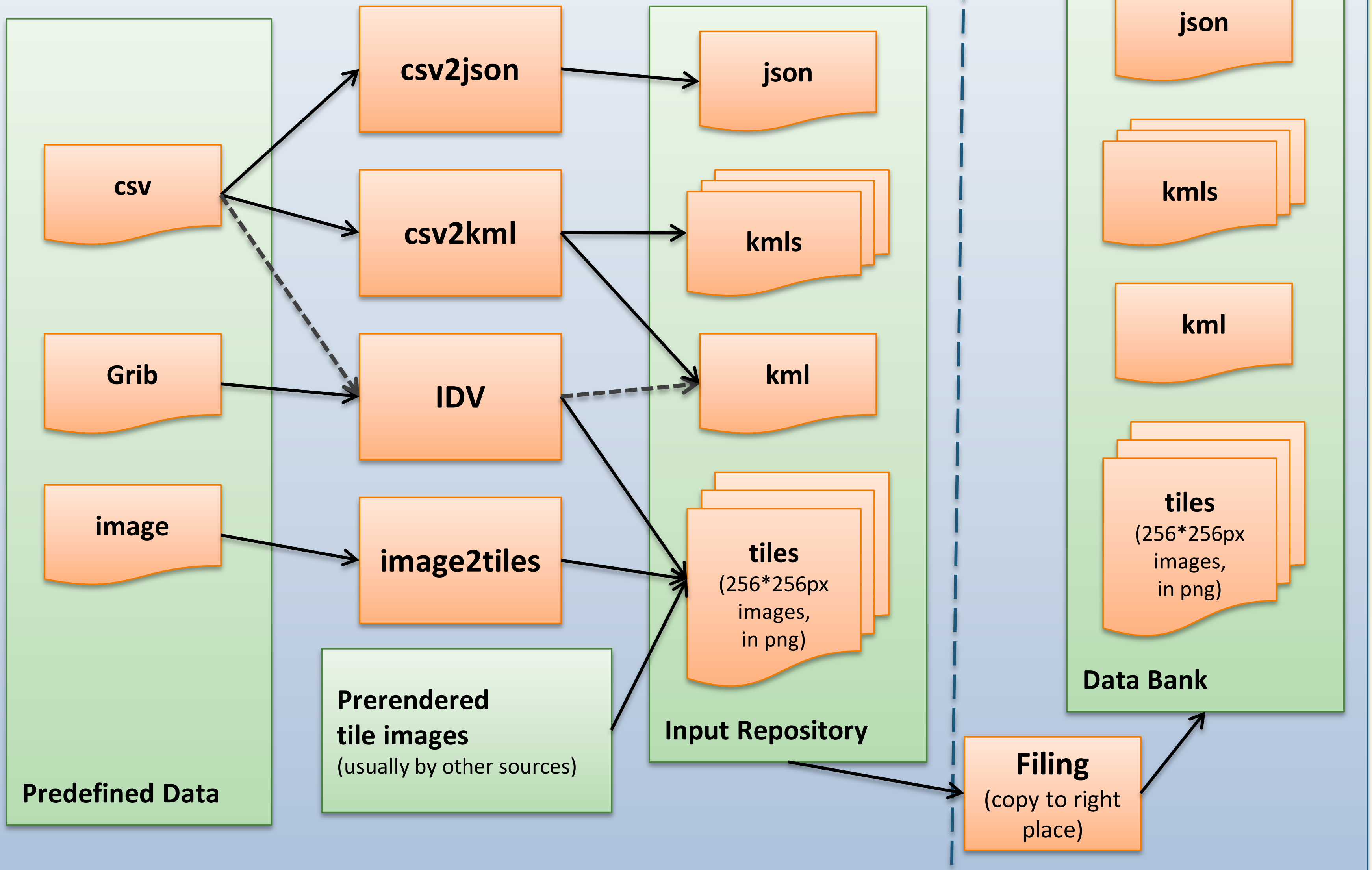


Data Provider (A)
Data Provider (B)
...
GIS Products
...
IN Tray
Daemon
“server”
formatter
csv2kml
csv2json
IDV
image2tiles
OUT Tray
Server
(Data Processor)
KML, JSON, Image Tiles Files
Data bank / File Repository
Contains
Daemon
Data Filing
Web
User Interface

Work Flow



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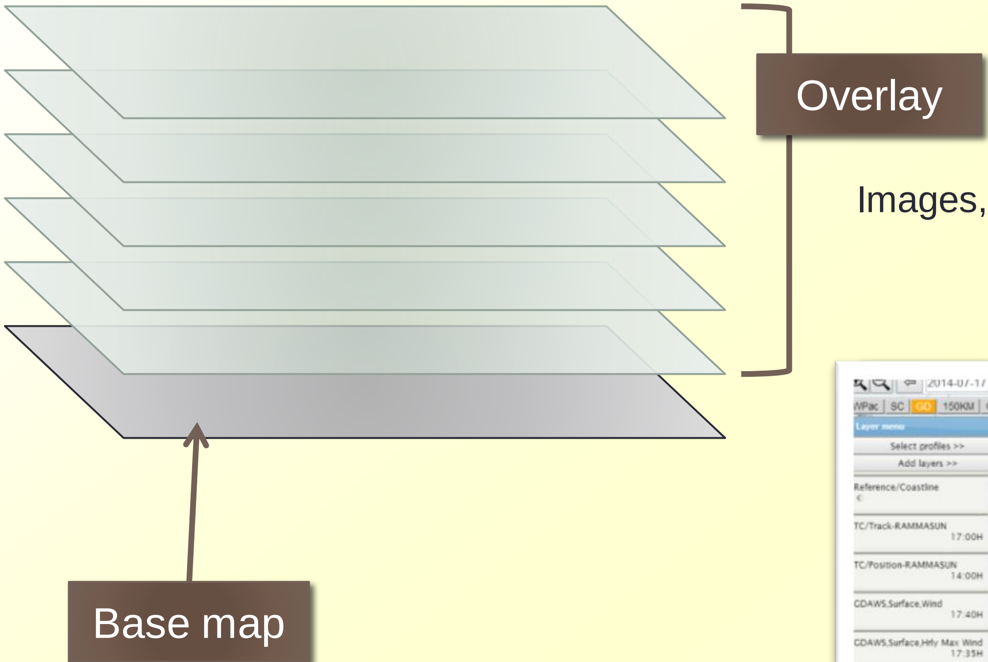
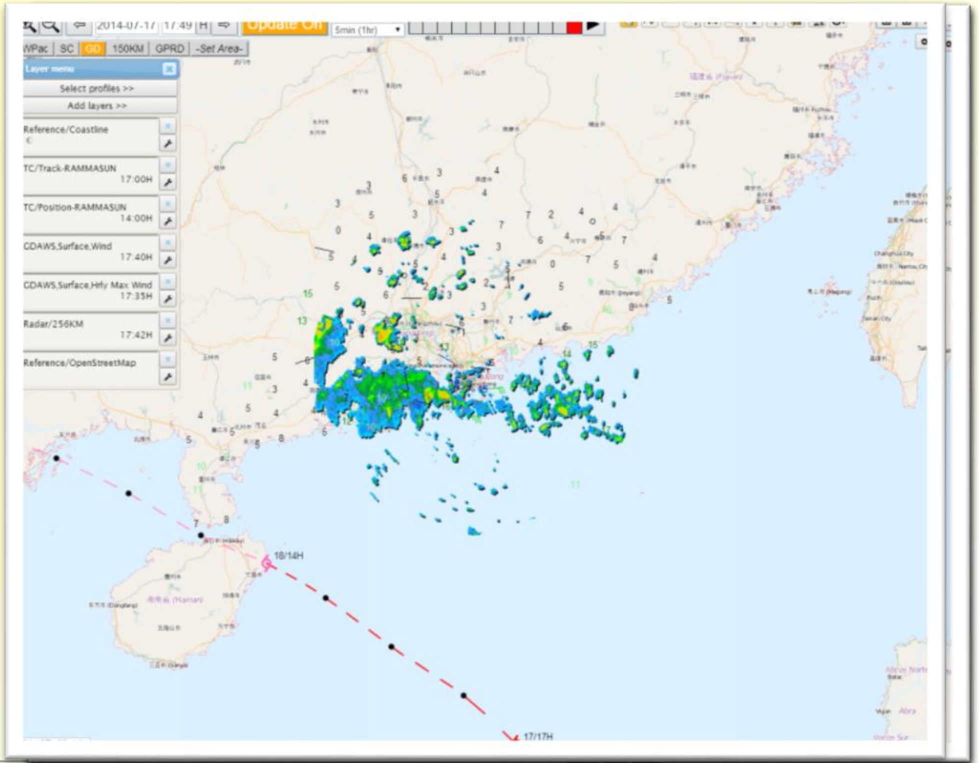
LAYERS: BASE MAP & OVERLAY



Images, icons, shapes, markers …



Components

- Client-side:
  - HTML + JavaScript + CSS + jQuery + HTML5
  - OpenLayers: Web-based GIS API
  - OpenStreetMap: Basemap Source
  - jQuery UI: Webpage component

- Server-side:
  - IDV: Transfer meteorological data (csv or grib) to images
  - Data converter : Transfer CSV/DB data to KML/JSON data

OpenLayers

Web-based GIS API

Free and Open Source JavaScript

Google Maps APIs

Web-based GIS API

Free, external and publicly available web and mobile implementations

Pay for uplifts above usage limits

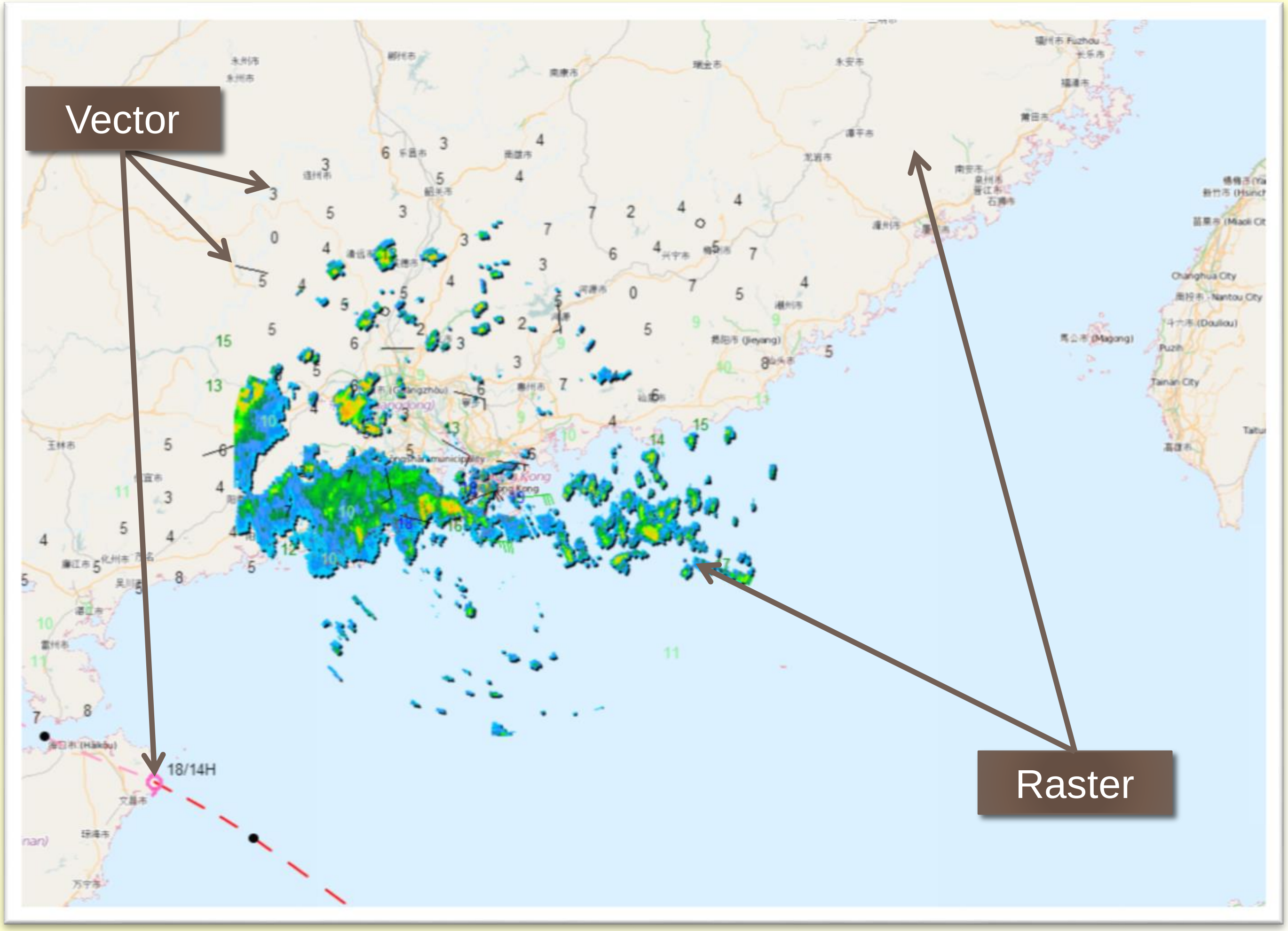
Licenses for internal implementations

OpenLayers vs Google Map JavaScript API

OpenLayers	Google Map

• JavaScript API for overlays
• No base map provided
  • Define your own layer as base map
  • Support Google Map, Bing, XYZ (e.g. OpenStreetMap), WMS (e.g. MapServer) …
• Host the JS API code in your own server
	• JavaScript API for overlays
	• Google map as Base map
	  • 4 options: Roadmap, Satellite, Hybrid, Terrain
	• Rely on JS API code in Google's server
	• License issue

Image : Vector vs Raster



Vector Image

KML

- A plain text file type, extends from XML
- It specifies a set of features for displaying in maps.
- Browser build-in XML parser

JsonDraw

- In-house developed method for layer drawing
- Data are saved in Json format (a lightweight data-interchange form)
- Browser with HTML5 support

KML

KML files in web server

× Headers Preview Response Timing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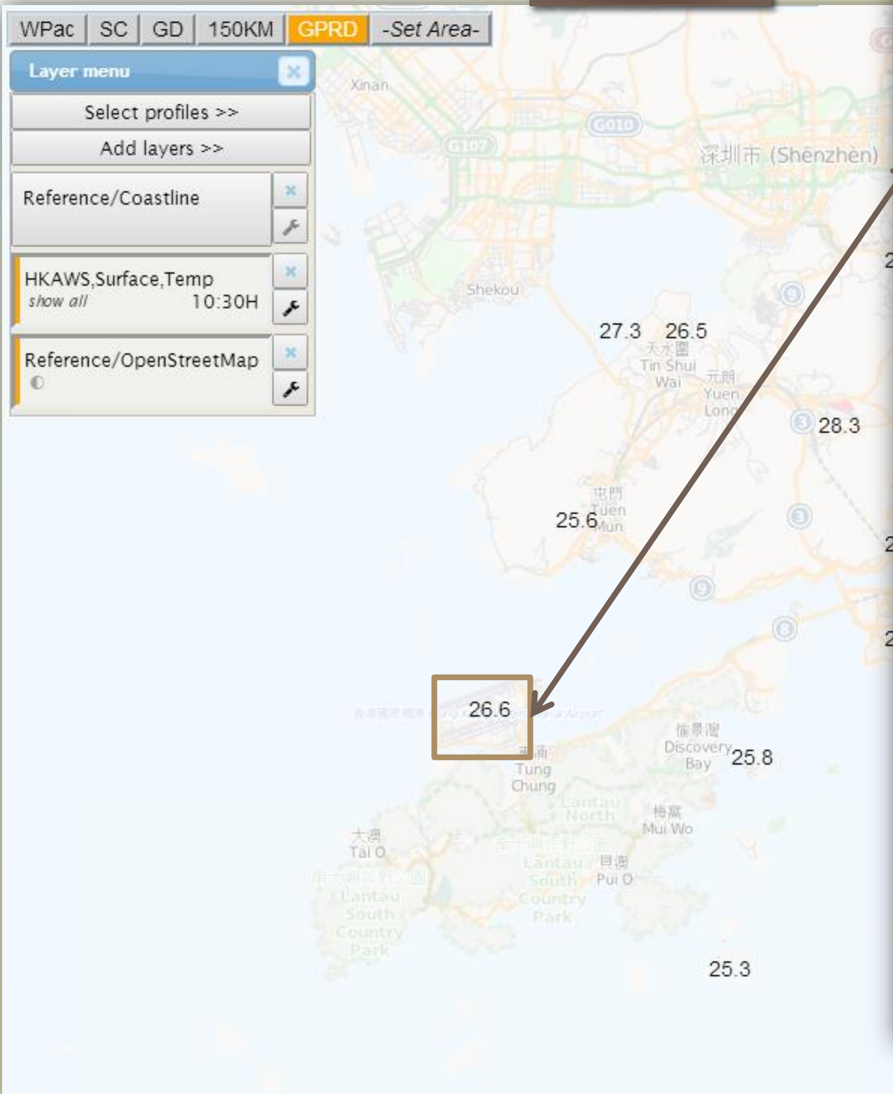
KML

Display



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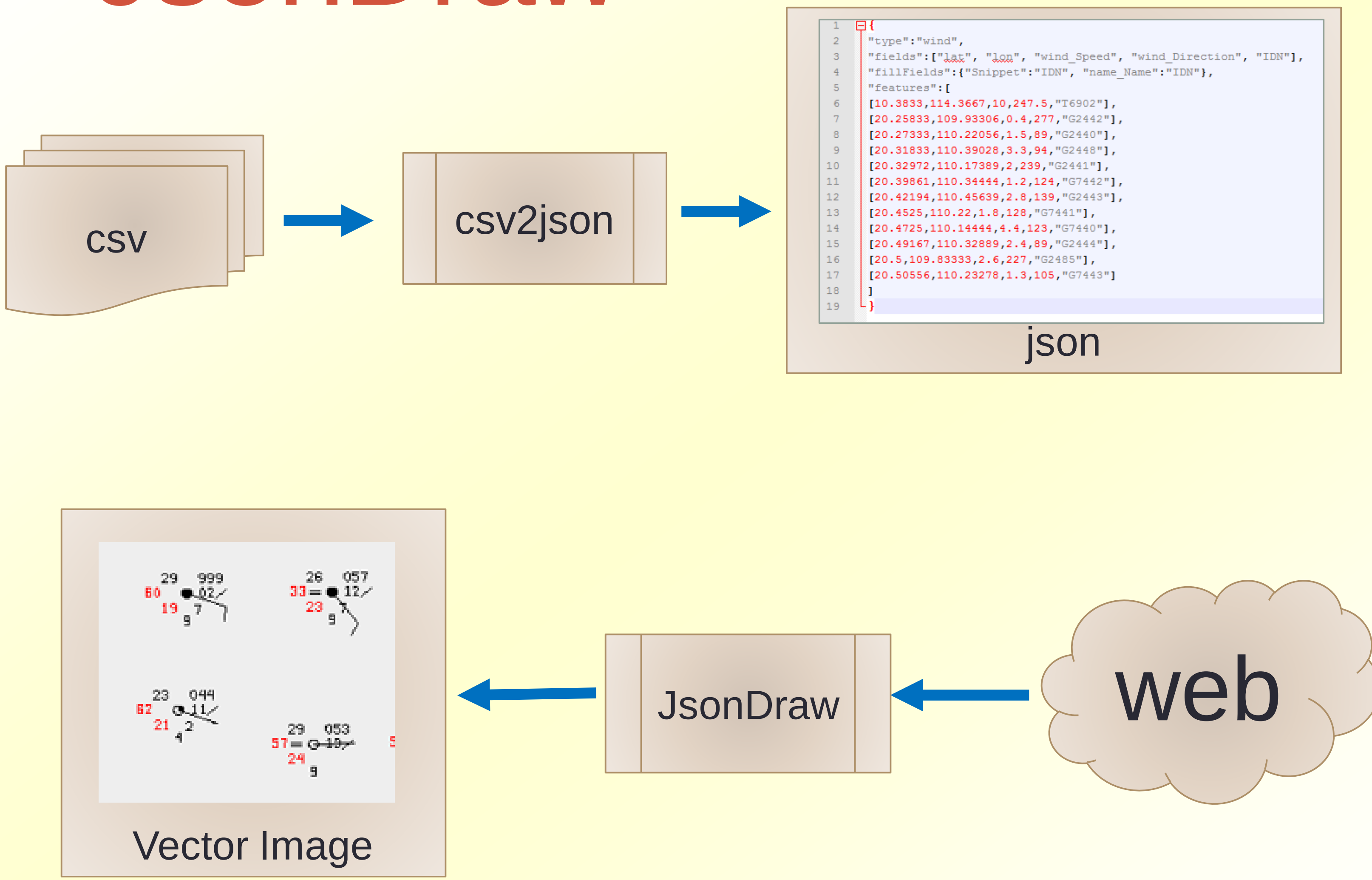
“JsonDraw”



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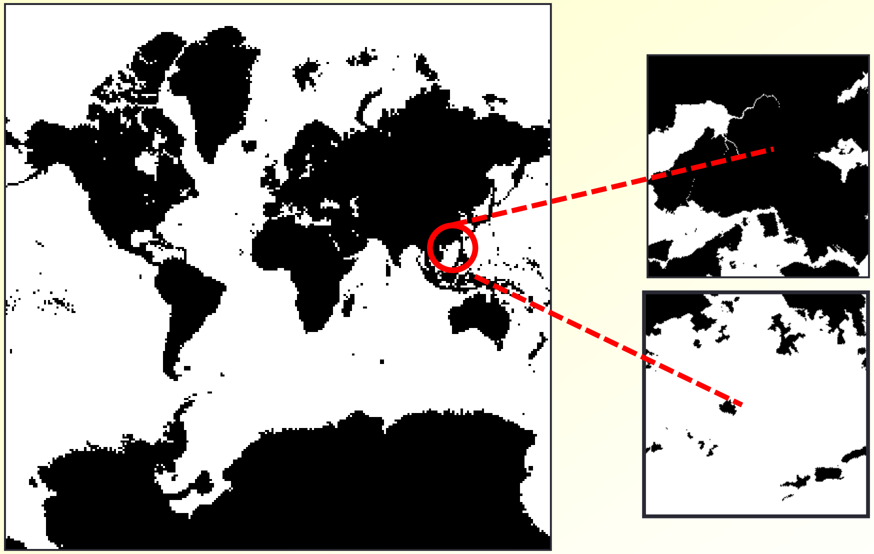
]
}
json
web
JsonDraw
Vector Image

Raster Layer Types

- Image vs. Image Tiles
  - Different zoom level require different resolution of the same image.
  - When the zoom level is too large, a single image will be too large or blur, and slow response.
  - Hence, use image tiles to target different zoom level and different space. Load the need tiles only.

Mercator Projection and Map Tiles

- After testing, 256px*256px seems optimal in our case.
- Hence, “Google Projection”
  - Codename “EPSG:900913” in OpenLayers.
  - The world is as a square.



- Map Tiles
  - It is always 256px*256px.
  - It is a square bitmap graphics displayed in a grid arrangement to show a map.

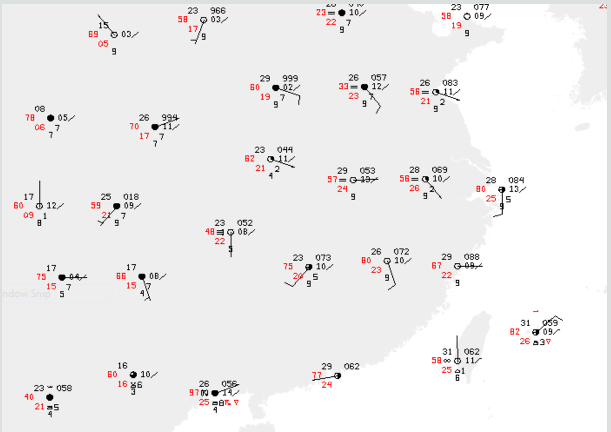
Map Ratio – zoom level

- **0, 1, 2, 3 ...**
- At zoomLevel 0, the equator of the earth is 256 pixels long. Each successive zoom level is magnified by a factor of 2.
- Zoom level 0 = The world in a map tile (256px*256px).
- Every zoom level is double (2×) of its previous size.
  - The larger zoom level, the more detail, but cover less actual area in a map tile (256px*256px)
  - Tile in zoom level 2 = ¼ of tile in zoom level 1, but still in 256px*256px
  - Area size in zoom level 1 = 2^2 × area size in zoom level

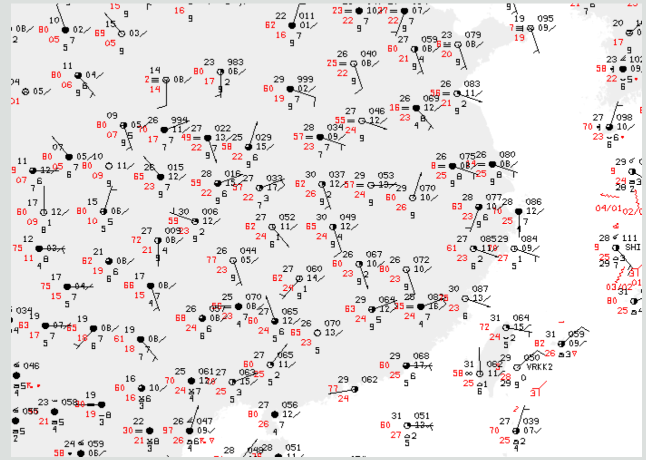
Zoom	0	1	2	3	N
Tiles in 1 side	1	2	4	8	2^N
No. of Tiles	1×1 =1	2×2 =4	4×4 =16	8×8 =64	$2^N \times 2^N$ $=2^{N\times 2}$
World coverage per tiles	1	1/4	1/16	1/64	$1/2^{N\times 2}$

Data Density Control

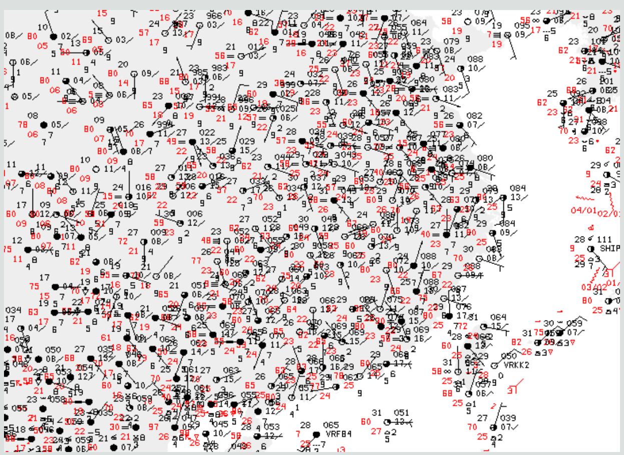
Data Density: original (x1)



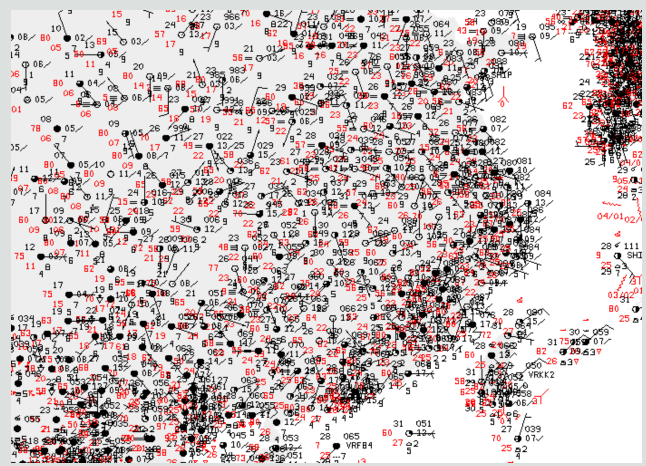
Data Density: x4



Data Density: x16



Data Density: all data



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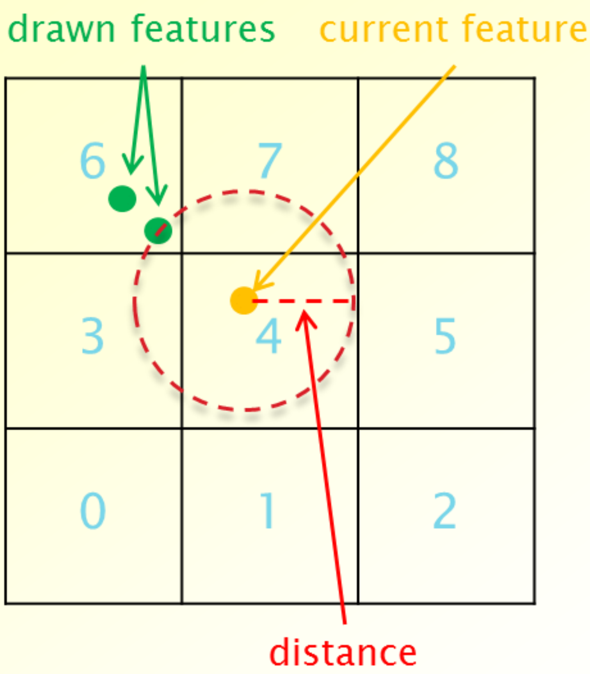
Data Density Control

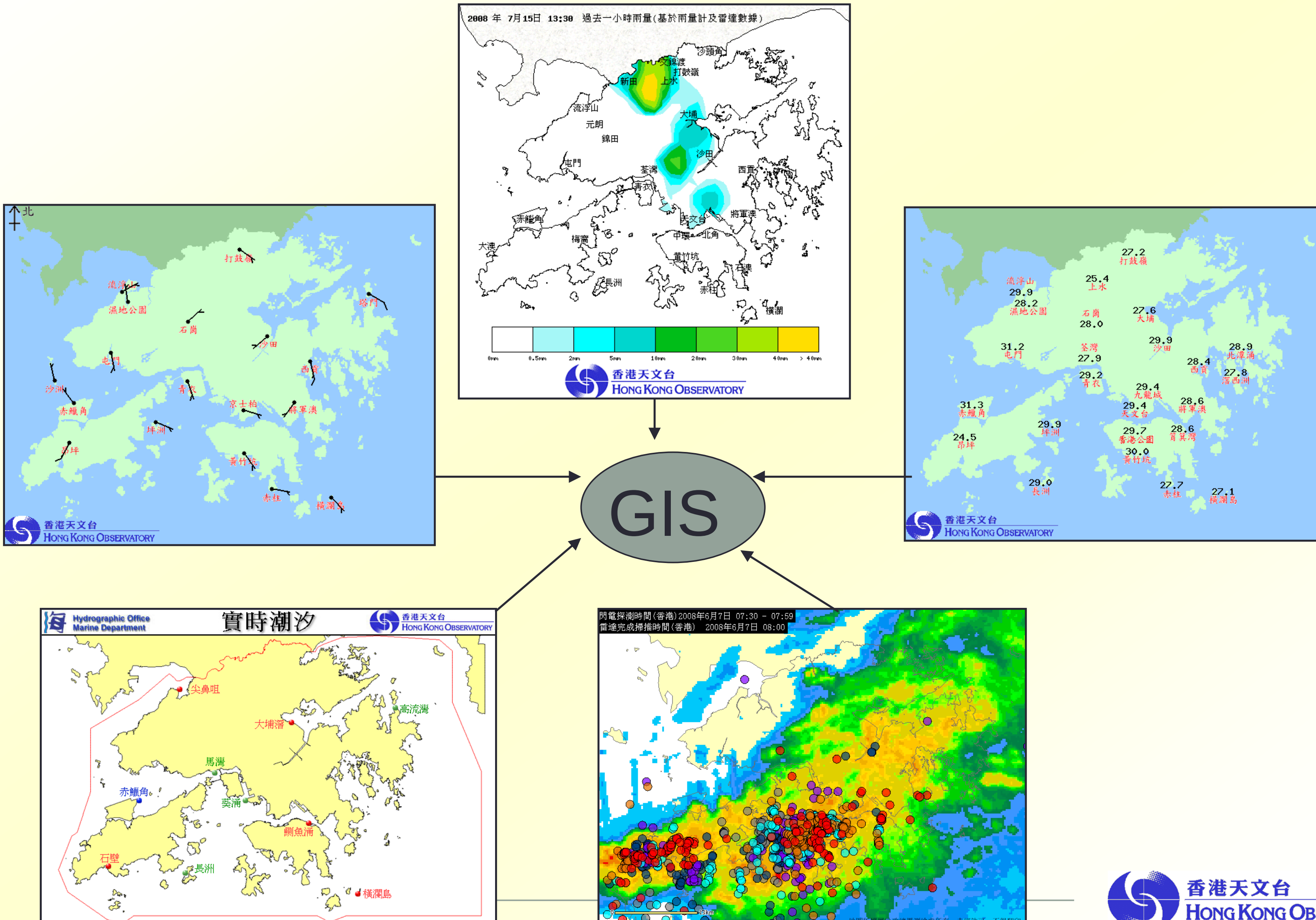
OpenLayers.Strategy.Cluster

- Strategy for vector feature clustering
- Key Property
  - distance – pixel distance between features
    - x1: distance
    - x4: distance / 2
    - x16: distance / 4
    - ALL: no distance
- De-collision
  - First-Come, First-Serve
  - Loop over the nearest 9 boxes



WHAT CAN GIS DO?

Weather Information scattered over webpages



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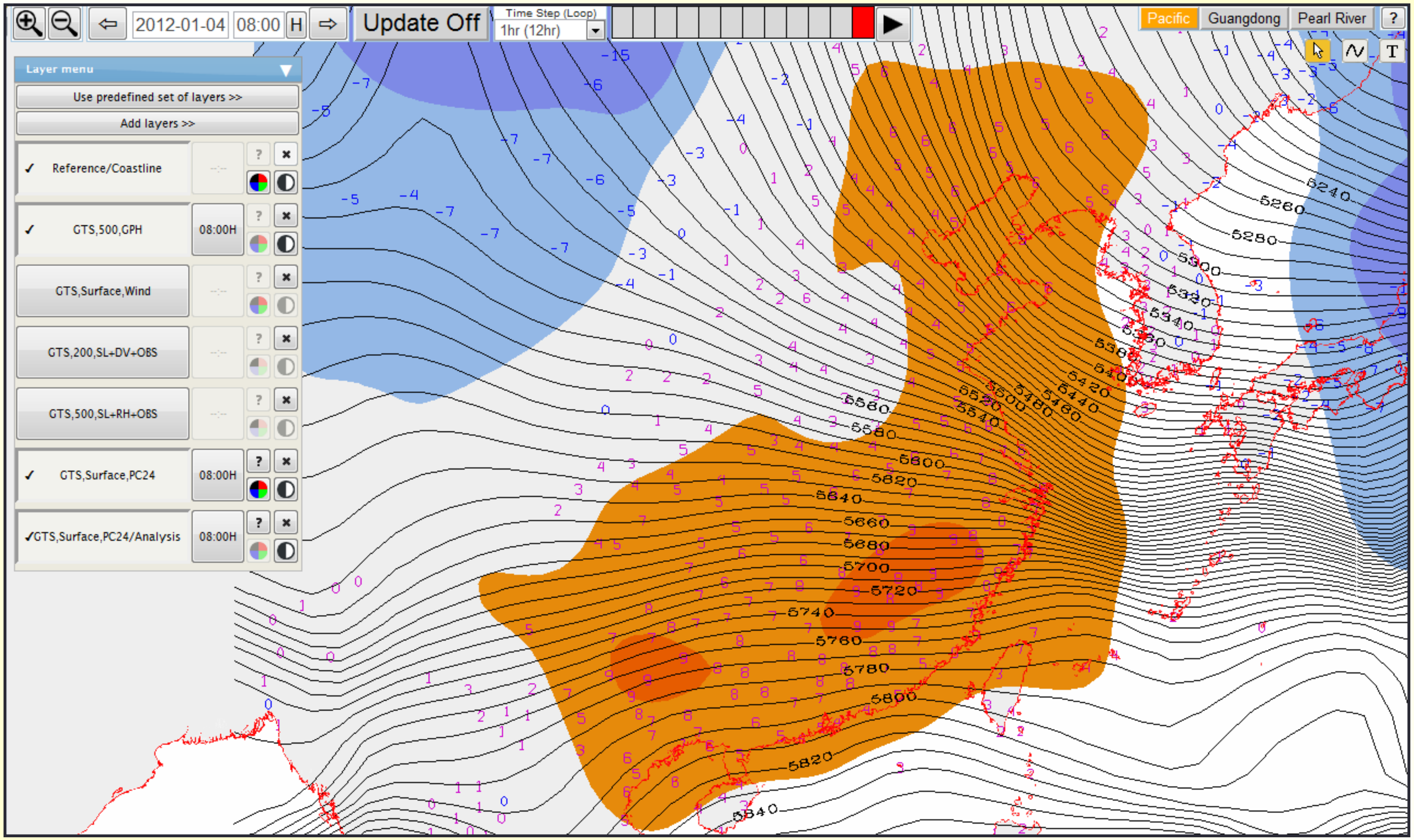
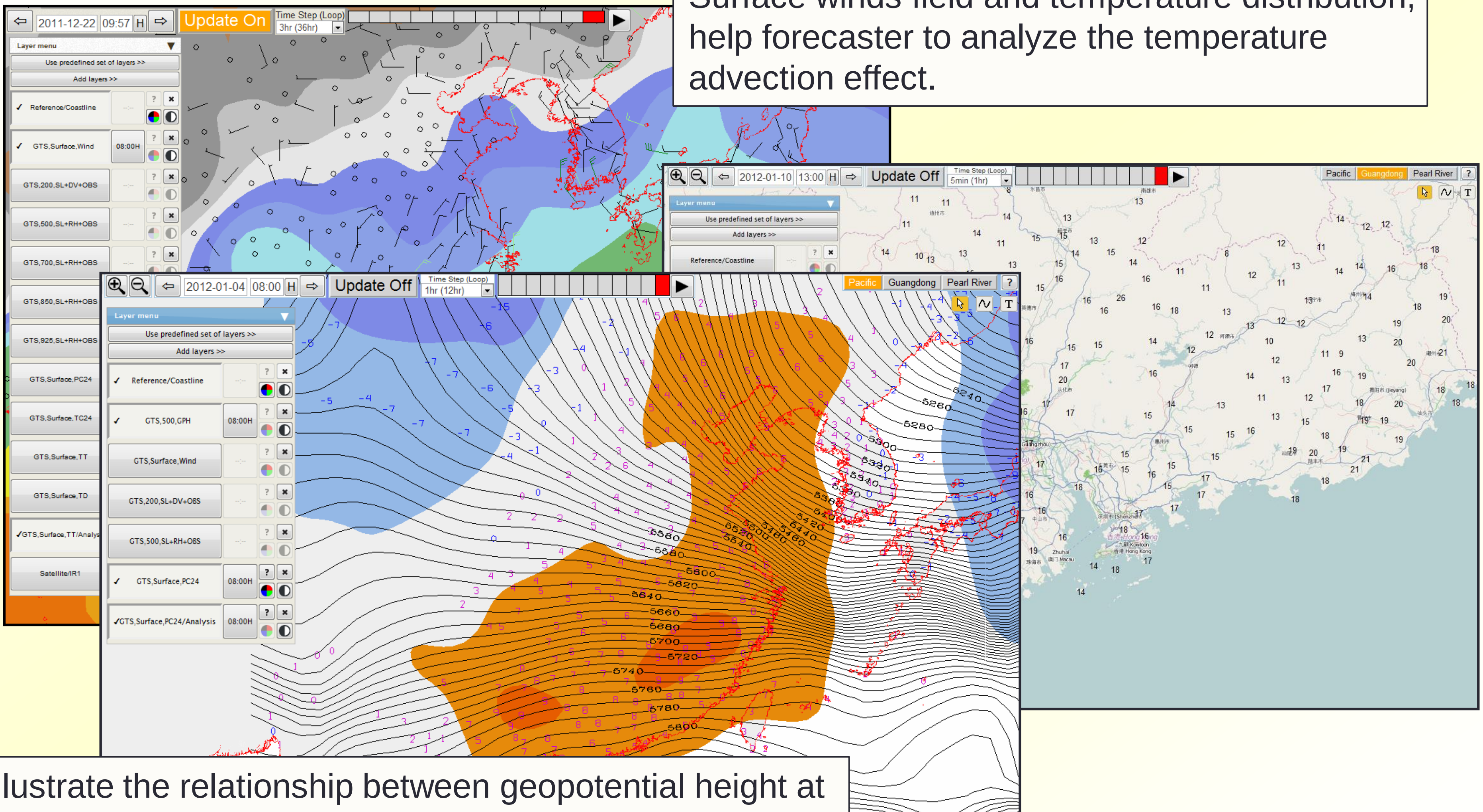
Internal Applications



Internal Applications

Surface winds field and temperature distribution, help forecaster to analyze the temperature advection effect.



Illustrate the relationship between geopotential height at upper level and changes in surface pressure, it helps forecaster to appreciate the effect on surface pressure bring along with weather system at upper level.

Internet Web Page
(Regional Weather in Hong Kong)

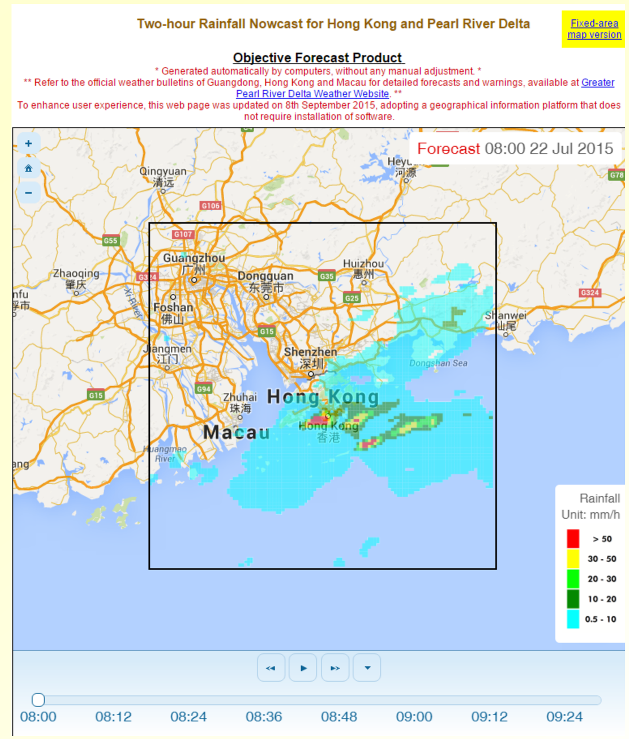
User can select weather elements on map

- different type of weather observation
- Radar Images
- Lightning Location Information

http://maps.weather.gov.hk/index_e.html

- Corresponding station observation data can also be displayed once user pointing the station location mark

Internet Web Page
(Rainfall Nowcast for the Pearl River Delta Region)



http://www.hko.gov.hk/nowcast/prd/api/index_ue.htm

香港天文台
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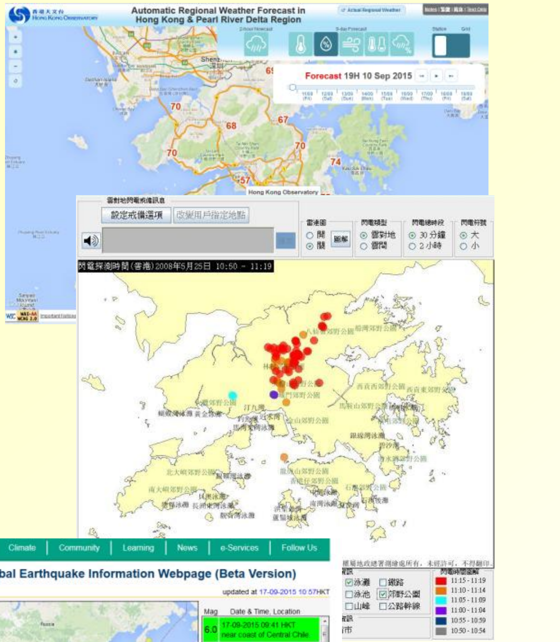
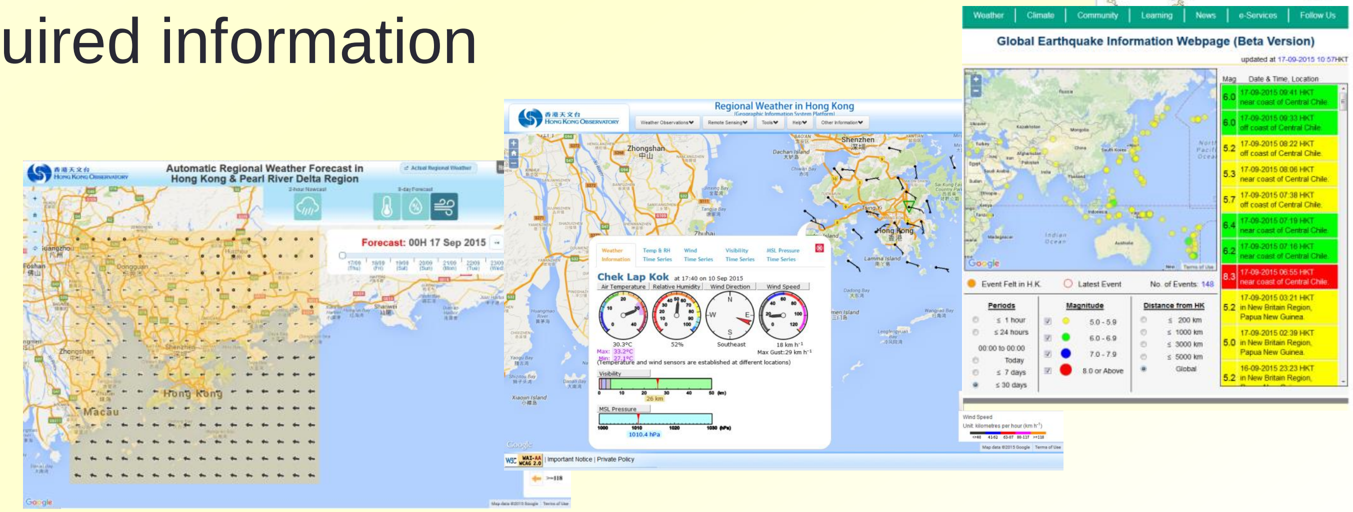
In Future

Geographic Information System (GIS)

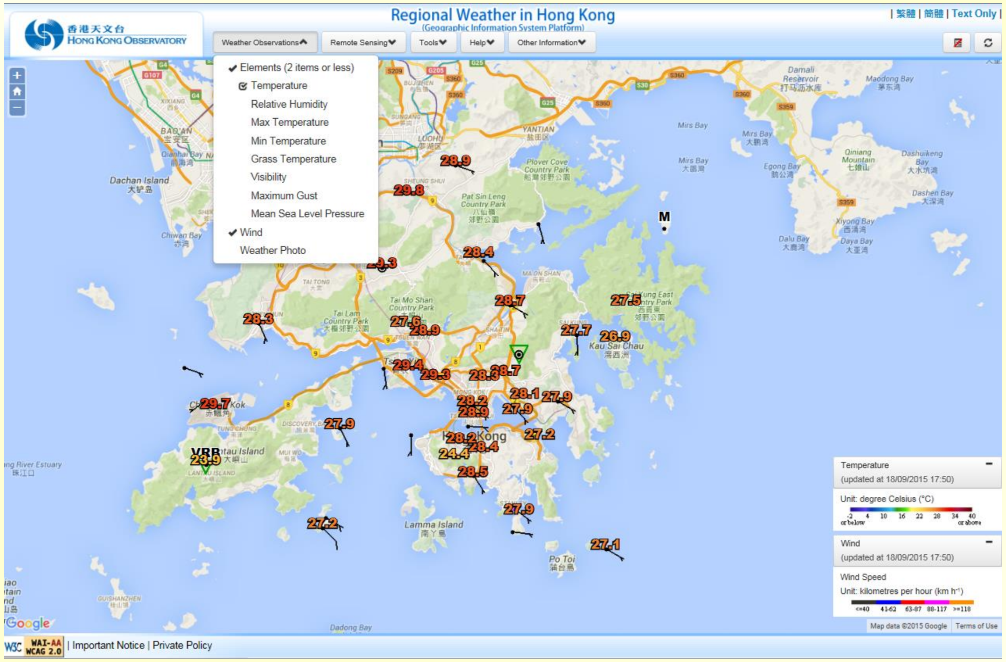
- HKO Internet Website
  - A variety of weather and geophysical information in graphical format
  - Scattering over different webpages
  - Inconvenience in getting the required information

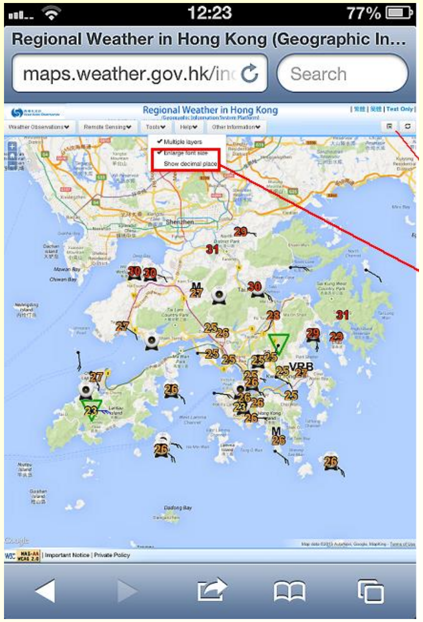




Regional Weather in Hong Kong

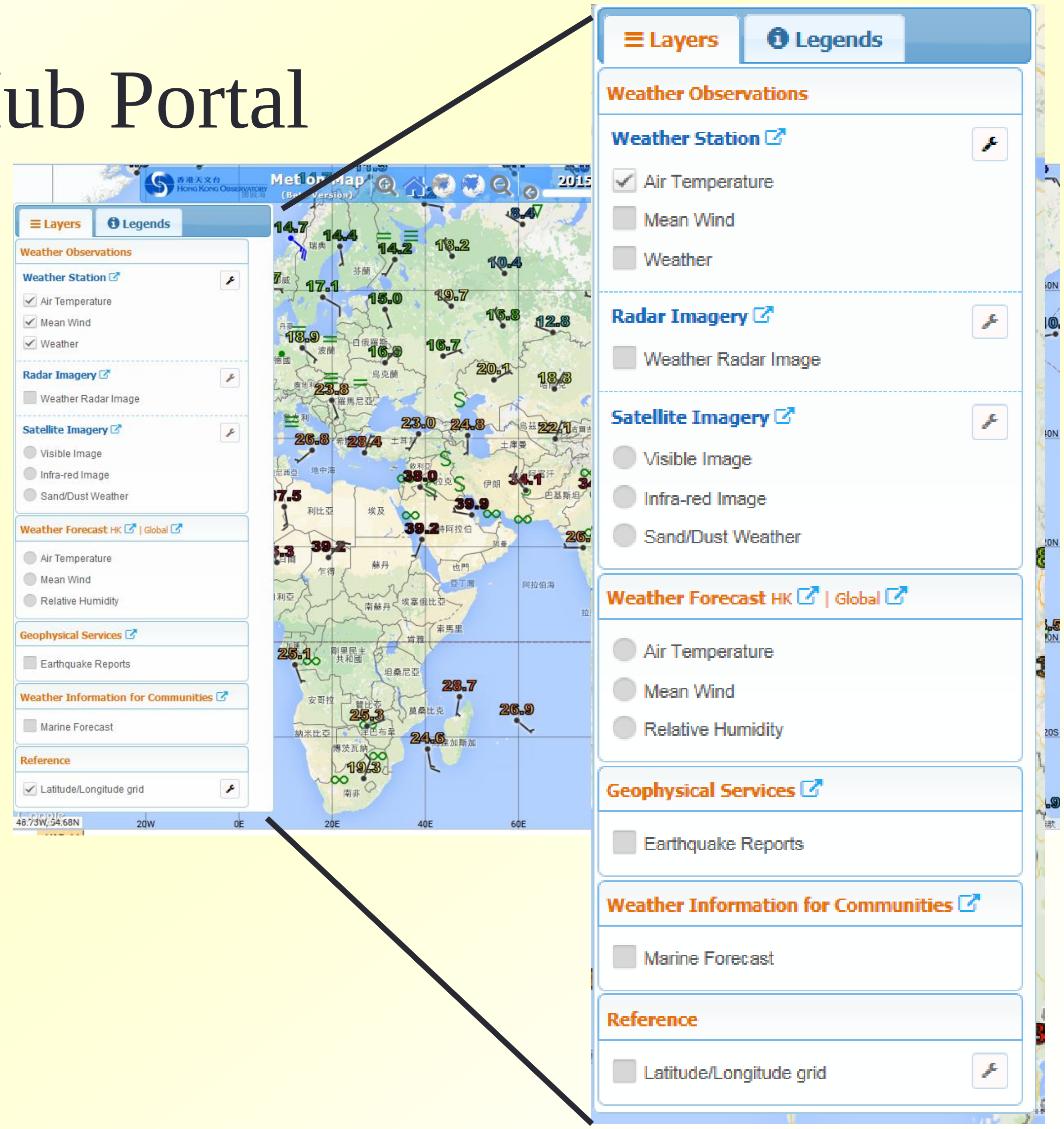
- Display different weather observations taken at various weather stations over Hong Kong
- Including radar imageries and cloud-to-ground lightning locations etc.
- Tailor make for smartphone tablet users





One-stop Service Hub Portal

- Integrating weather observations and essential weather elements around the world
- Worldwide earthquake reports
- User can select any combination of the weather elements and areas for display on map



THANKS

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