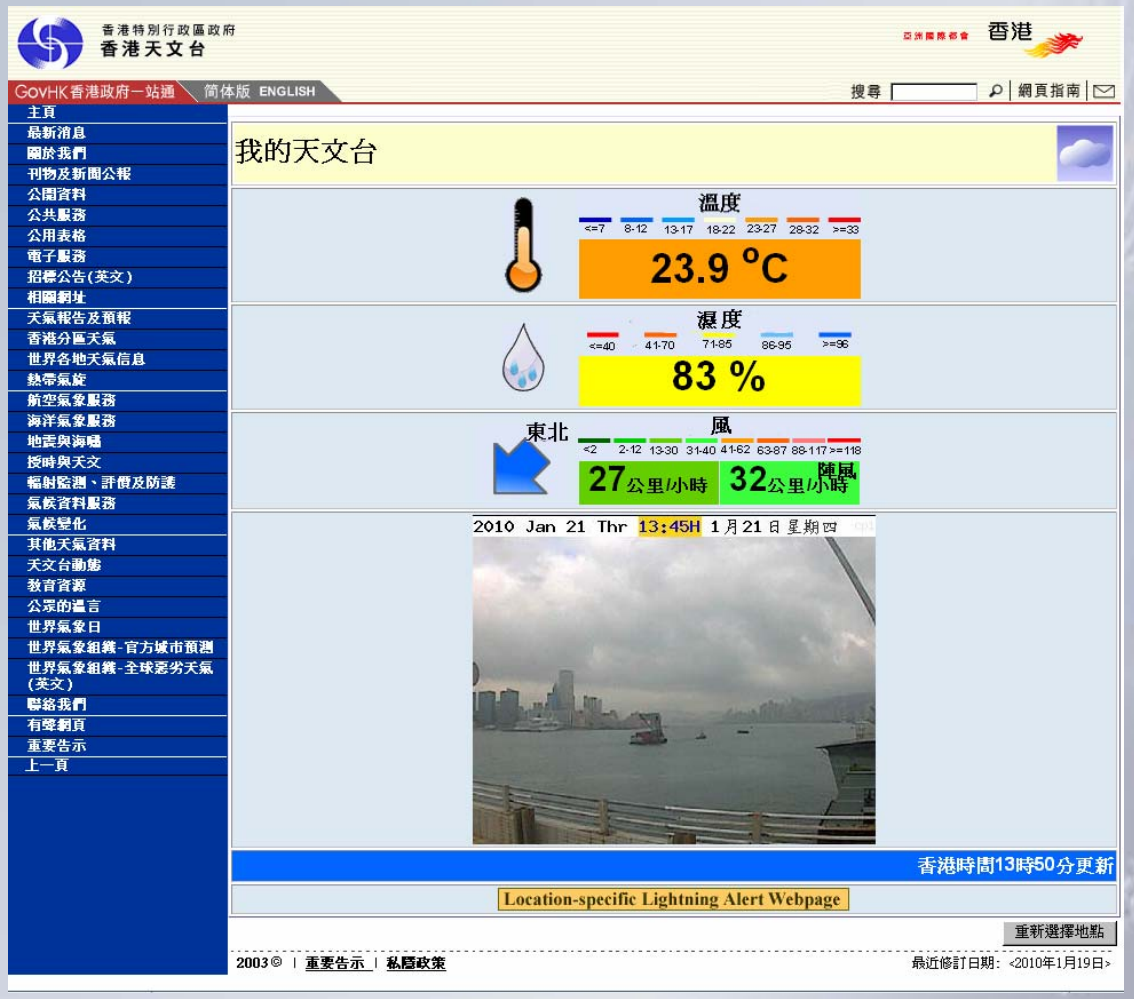
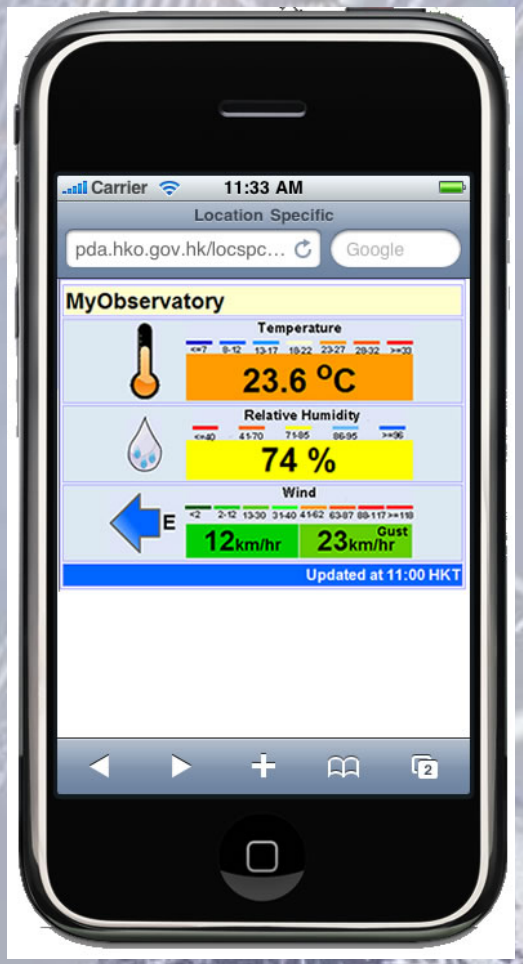
Use of GPS Signal Delay for Rainfall Nowcast in Hong Kong

S. Y. Lau
Hong Kong Observatory

HKO Location-based service coming soon!!





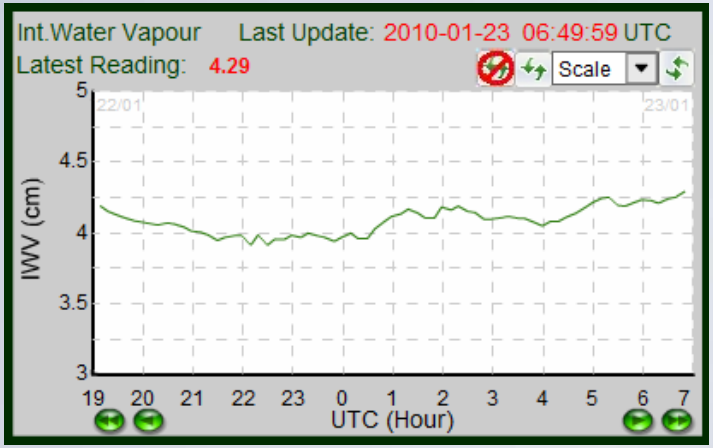
Use of GPS Signal Delay for Rainfall Nowcast in Hong Kong

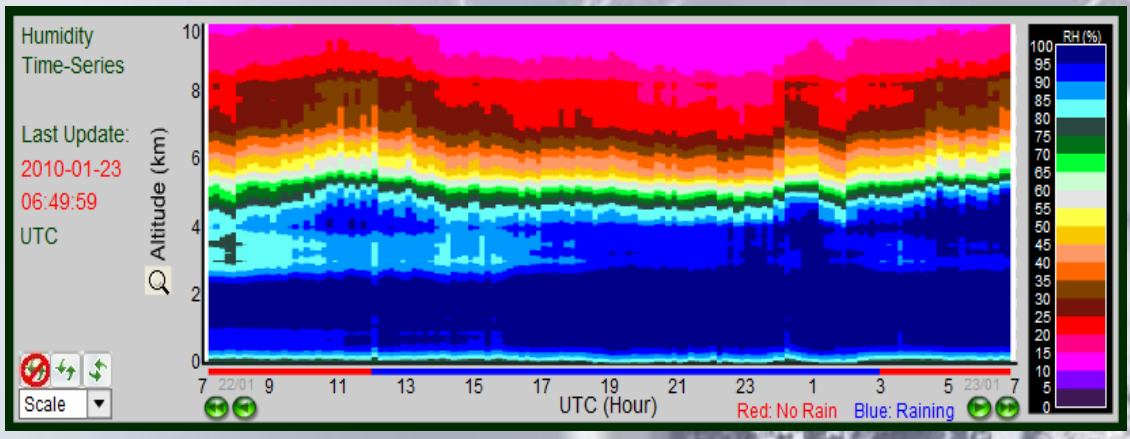
Measure upper air twice per day

Continuous measurement

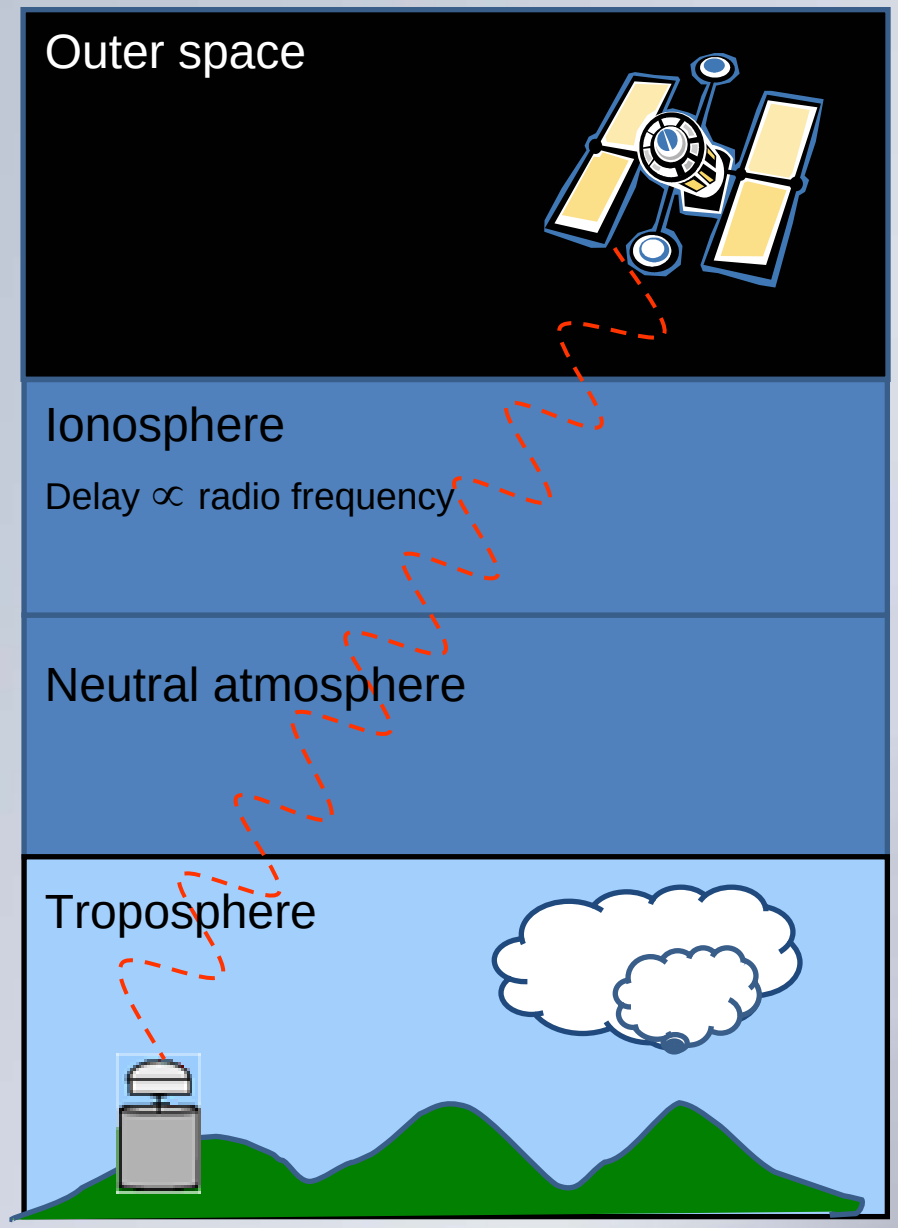
Microwave radiometer

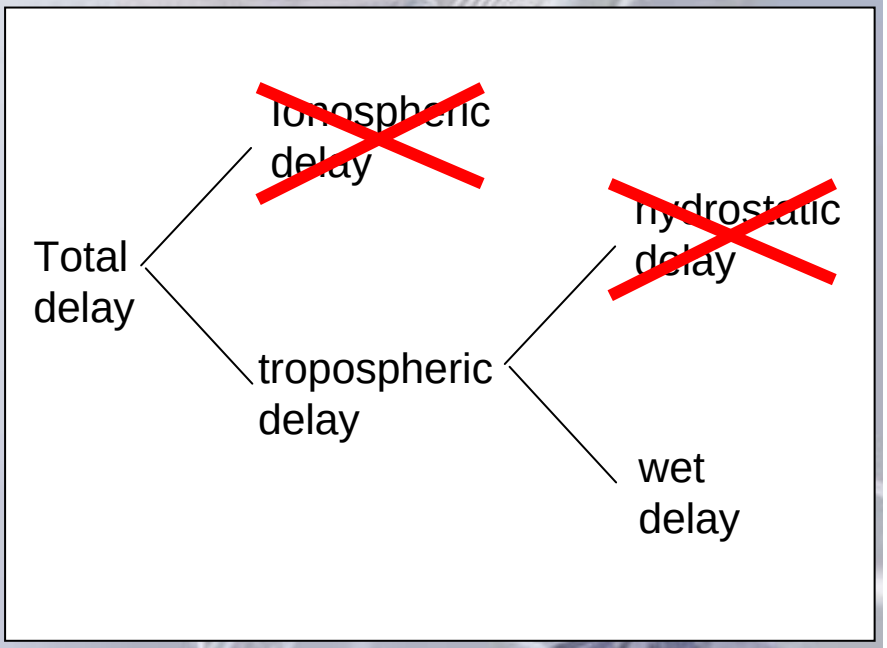
- Measures radiation intensity emitted by atmospheric water vapor, cloud liquid water and molecular oxygen to derive temperature & humidity profiles





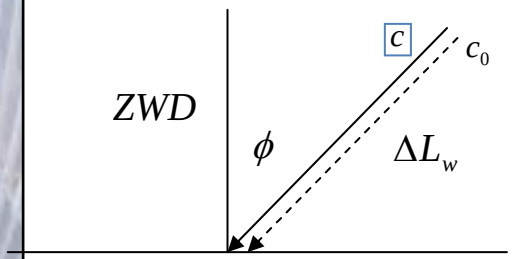
GPS signal delay

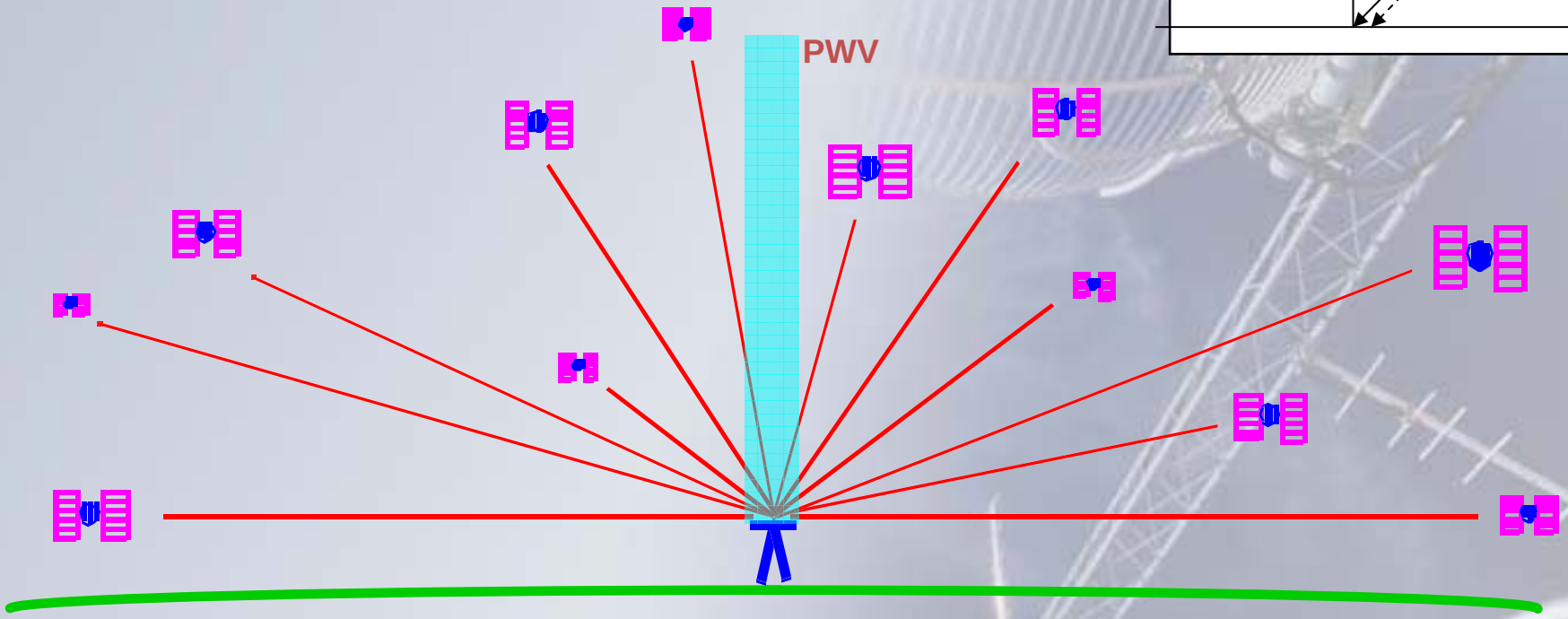




Precipitable Water Vapour Estimation

$$ZWD = \Delta L_w \csc\phi$$

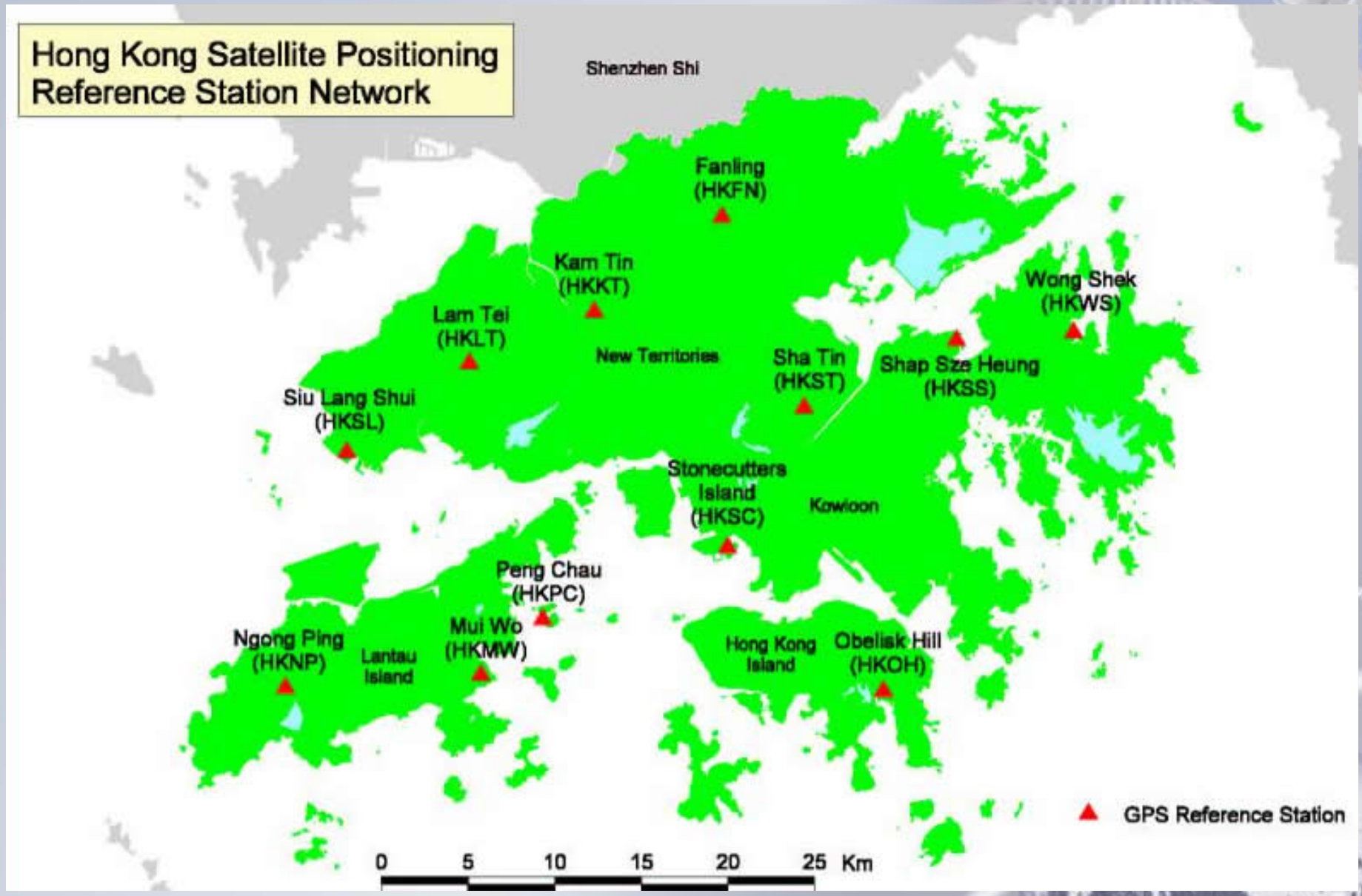




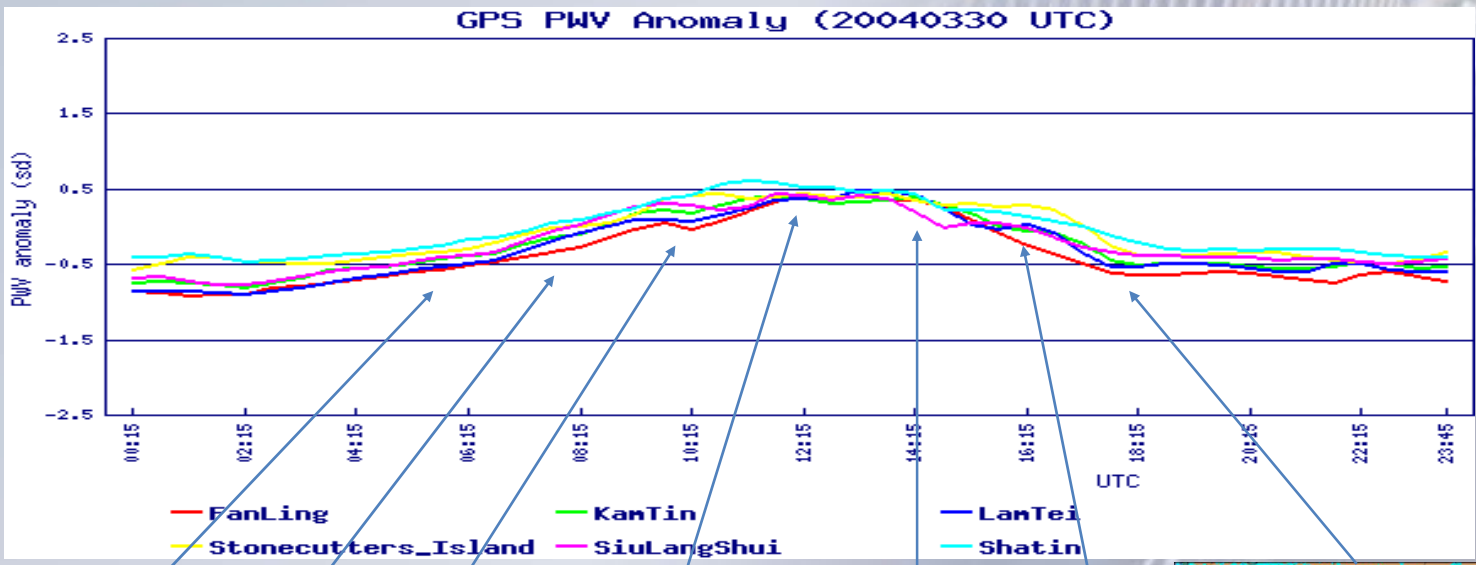
$$PWV = \int \rho_v dz = \Pi \times ZWD$$

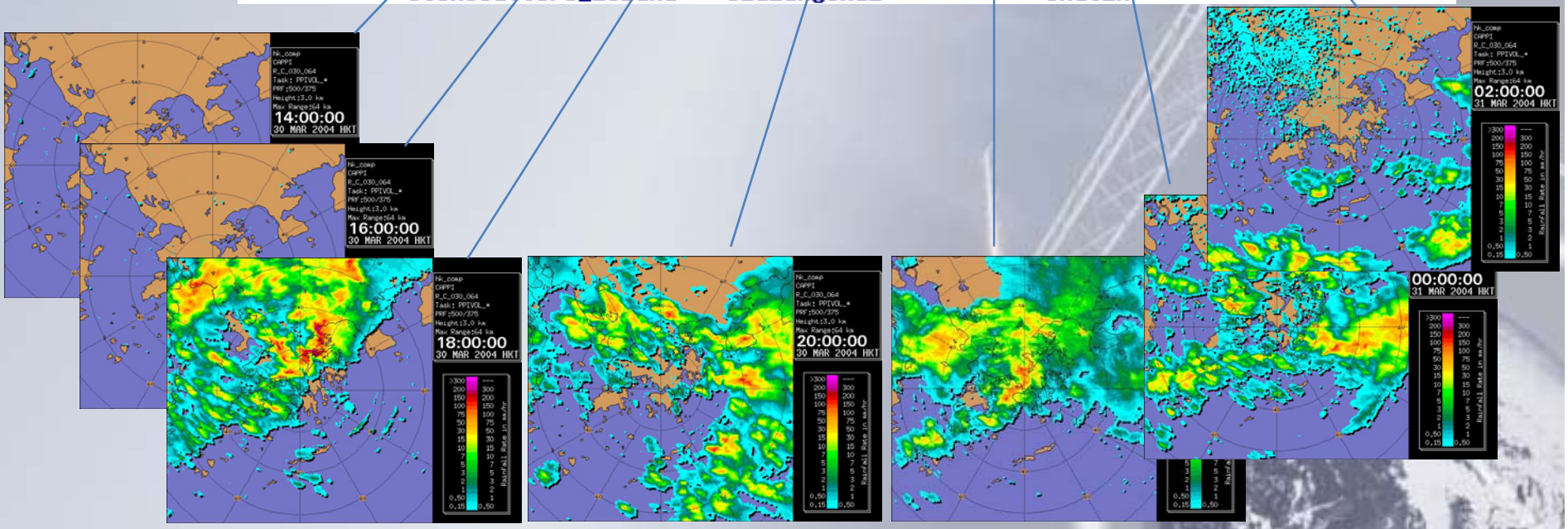
$$\Pi = \frac{10^6}{\rho R_v \left[\frac{k_3}{T_m} + k_2 - w k_1\right]}$$

(Mapping function)

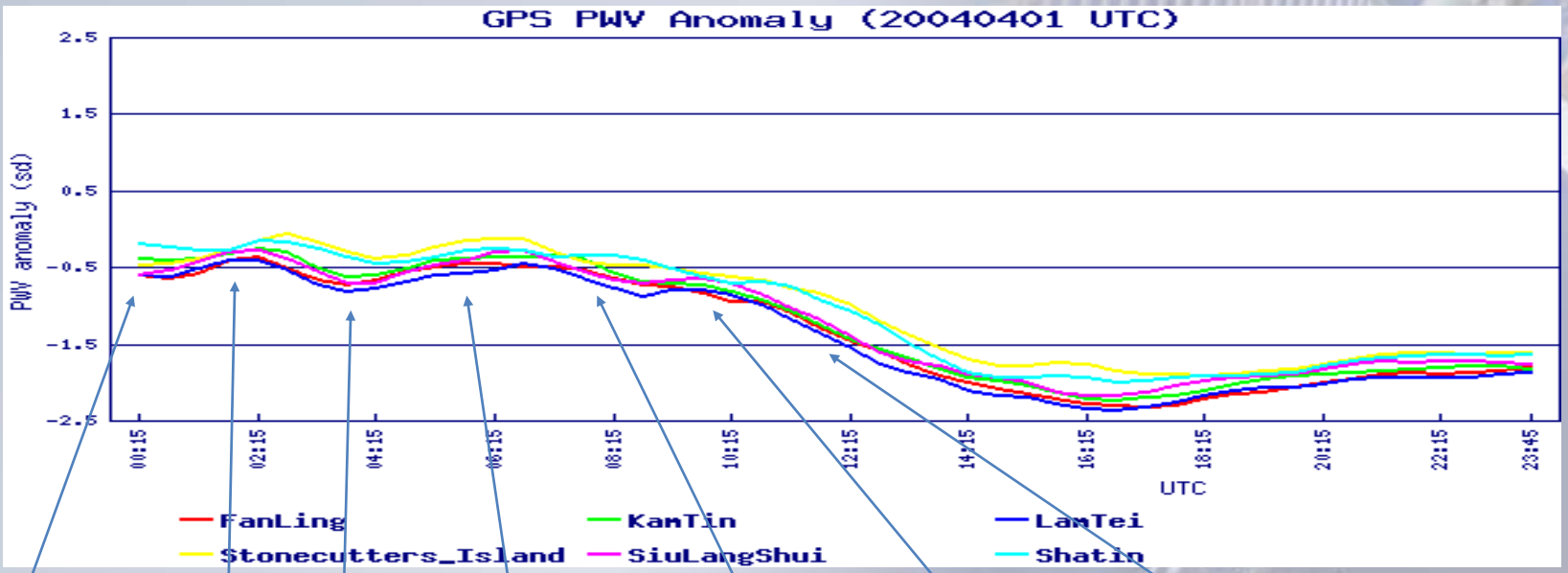

Hong Kong Satellite Positioning Reference Station Network
Shenzhen Shi
Fanling (HKFN)
Kam Tin (HKKT)
Lam Tei (HKLT)
New Territories
Wong Shek (HKWS)
Sha Tin (HKST)
Shap Sze Heung (HKSS)
Siu Lang Shui (HKSL)
Stonecutters Island (HKSC)
Kowloon
Peng Chau (HKPC)
Mui Wo (HKMW)
Ngong Ping (HKNP)
Lantau Island
Hong Kong Island
Obelisk Hill (HKOH)
GPS Reference Station
0 5 10 15 20 25 Km

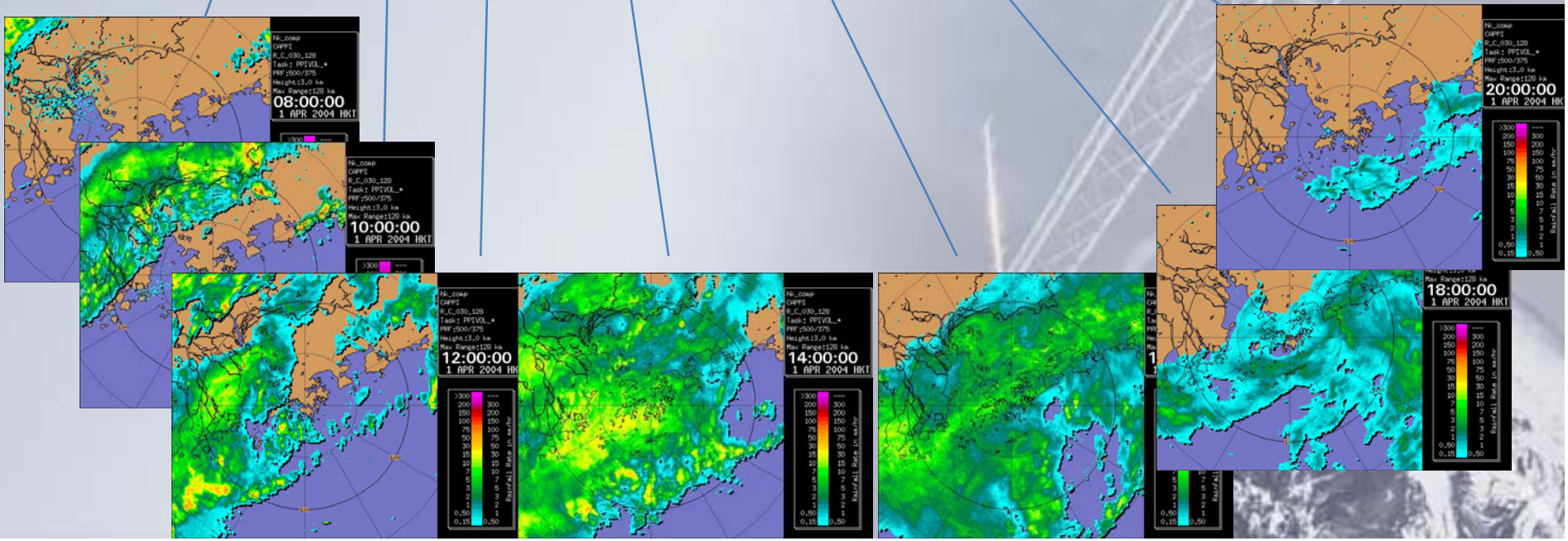
Amber Rainstorm （30-31 Mar 04）



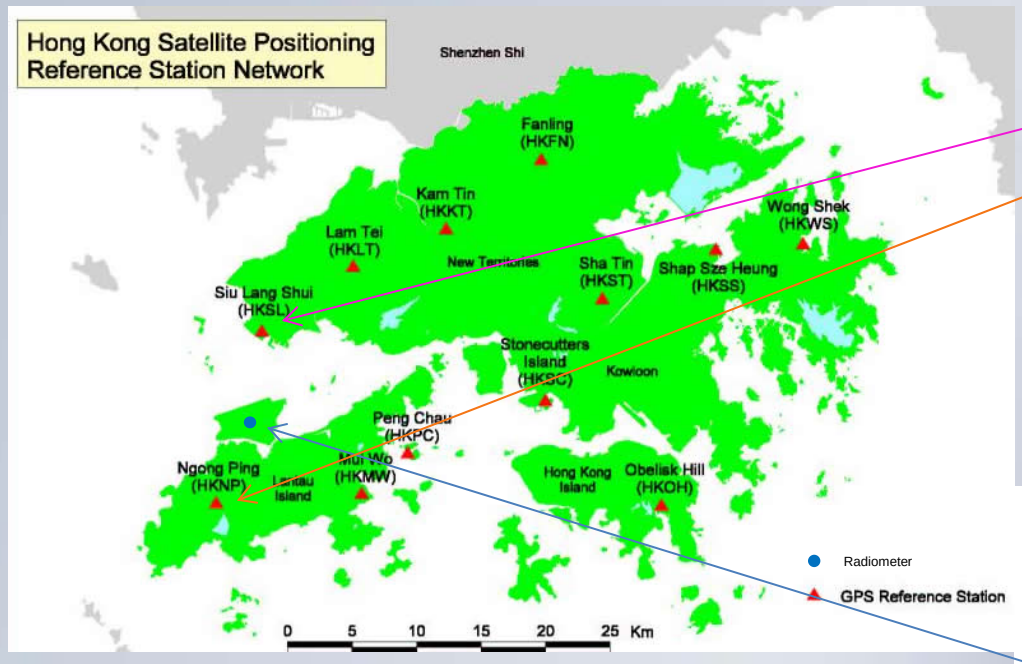


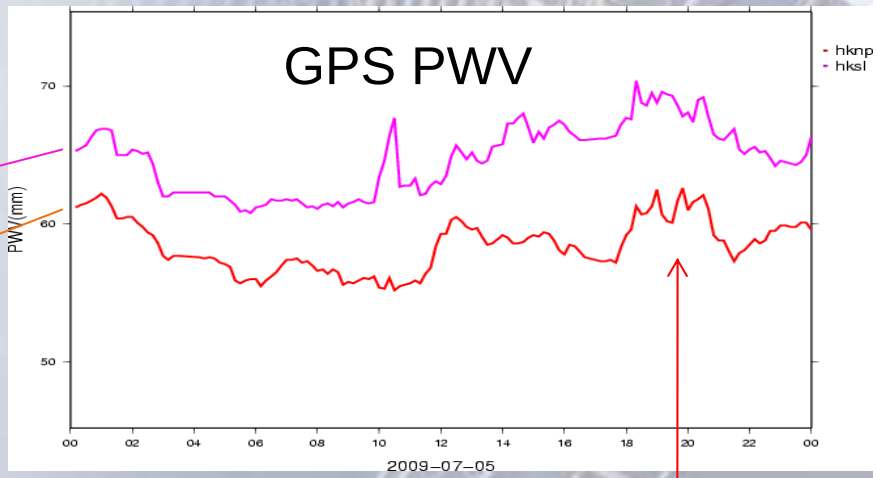
Rainstorm? (1 Apr 04)

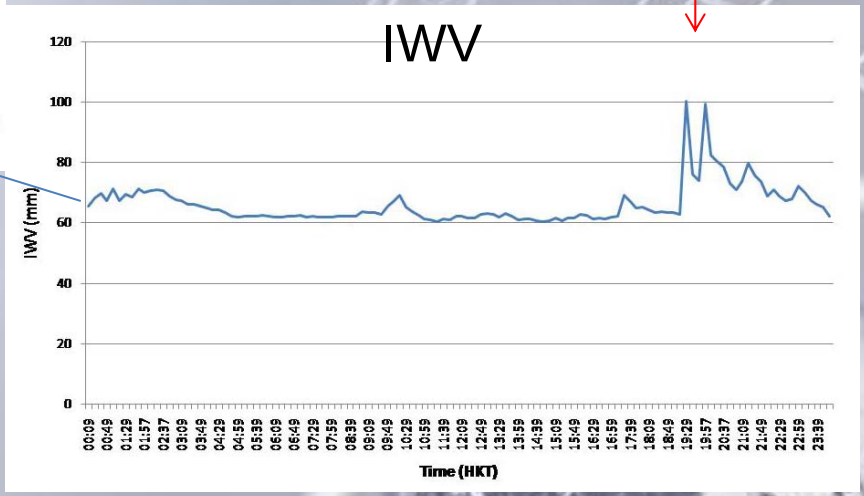


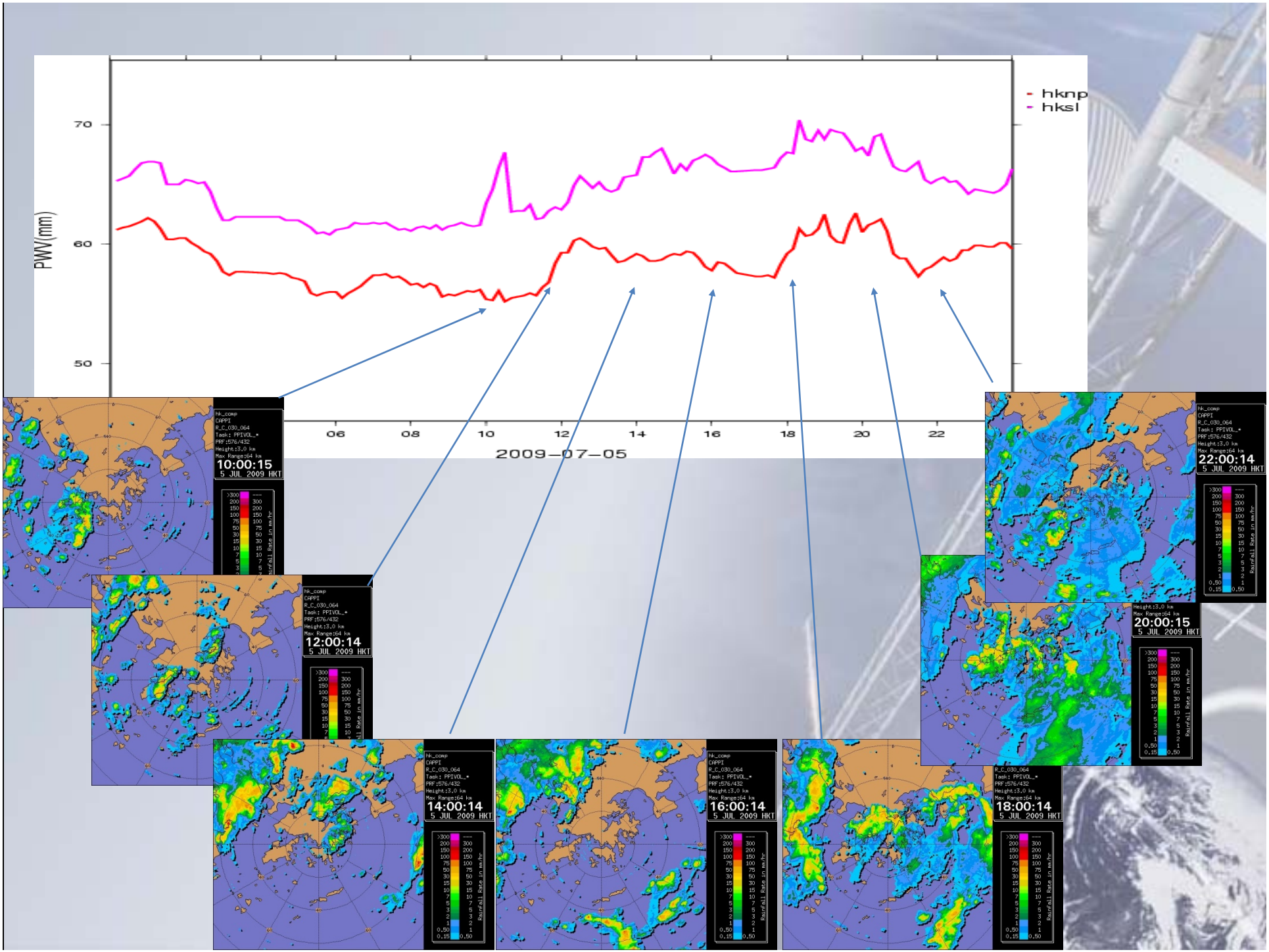


Rain Episode on 5 Jul 2009

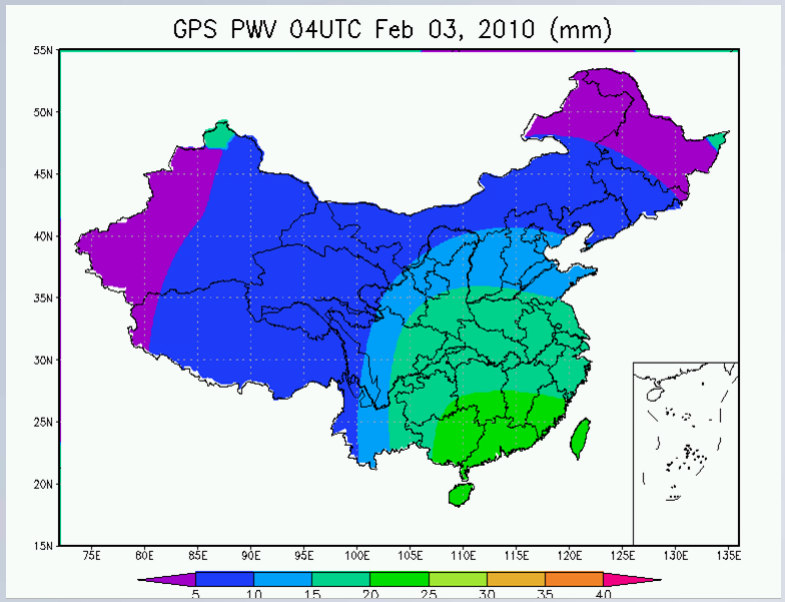


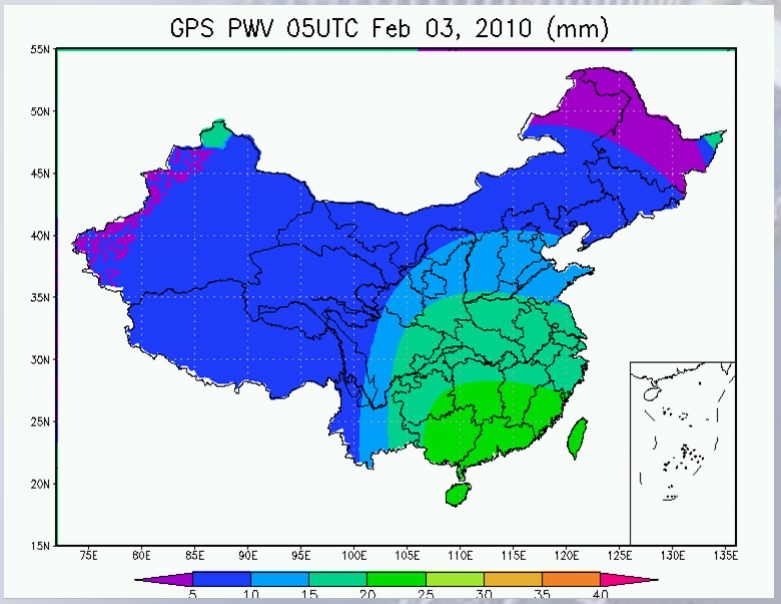


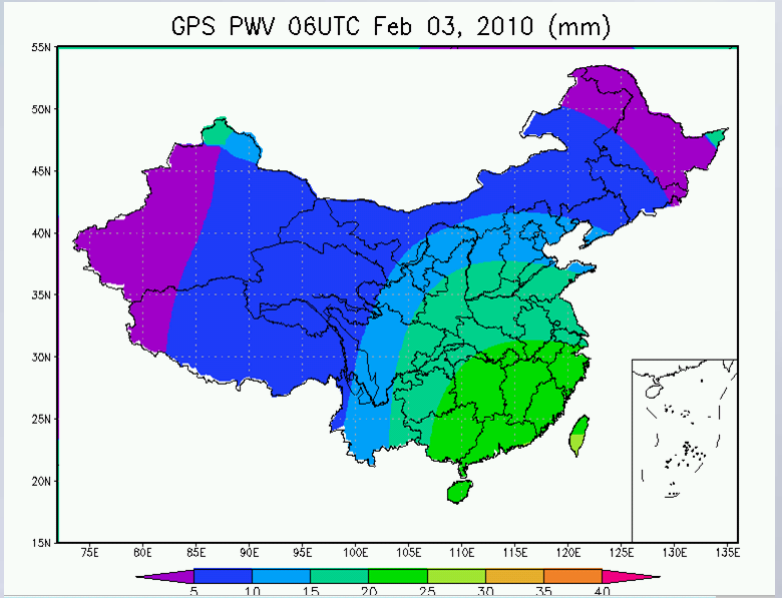


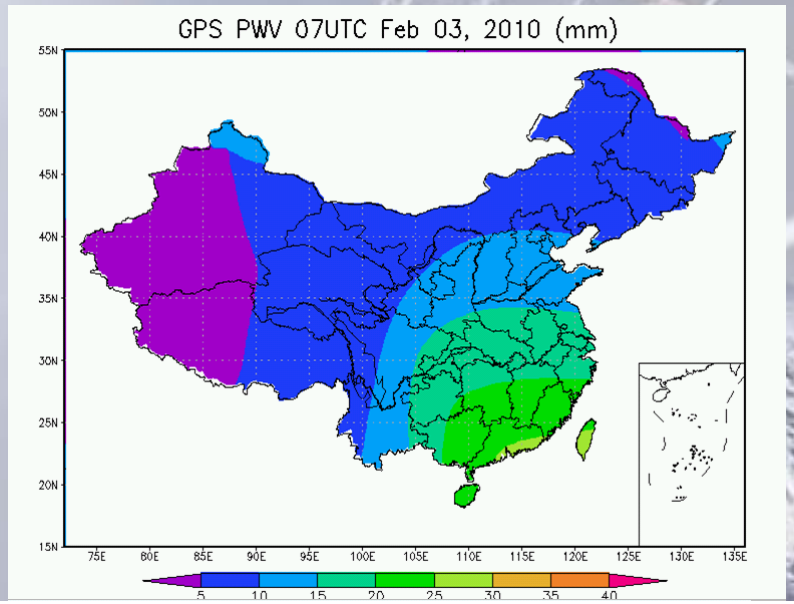

hknp
hksl
PWV(mm)
70
60
50
06
08
10
12
14
16
18
20
22
2009-07-05
10:00:15
5 JUL 2009 HKT
12:00:14
5 JUL 2009 HKT
14:00:14
5 JUL 2009 HKT
16:00:14
5 JUL 2009 HKT
18:00:14
5 JUL 2009 HKT
20:00:15
5 JUL 2009 HKT
22:00:14
5 JUL 2009 HKT

Why GPS/PWV?


GPS PWV 04UTC Feb 03, 2010 (mm)
55N
50N
45N
40N
35N
30N
25N
20N
15N
75E 80E 85E 90E 95E 100E 105E 110E 115E 120E 125E 130E 135E
5 10 15 20 25 30 35 40


GPS PWV 05UTC Feb 03, 2010 (mm)
55N
50N
45N
40N
35N
30N
25N
20N
15N
75E 80E 85E 90E 95E 100E 105E 110E 115E 120E 125E 130E 135E
5 10 15 20 25 30 35 40


GPS PWV 06UTC Feb 03, 2010 (mm)
55N
50N
45N
40N
35N
30N
25N
20N
15N
75E 80E 85E 90E 95E 100E 105E 110E 115E 120E 125E 130E 135E
5 10 15 20 25 30 35 40


GPS PWV 07UTC Feb 03, 2010 (mm)
55N
50N
45N
40N
35N
30N
25N
20N
15N
75E 80E 85E 90E 95E 100E 105E 110E 115E 120E 125E 130E 135E
5 10 15 20 25 30 35 40

Future Works

- **Implementation of GPS/PWV system in HK**
  - **System to be set up towards end-Feb to provide real-time GPS/PWV data for forecasters**
- **Integration of GPS/PWV in nowcasting of rainstorms**
  - **Identification of PWV features in rainstorms**
  - **Data assimilation to NWP**
- **Try to get PWV at various height using PPP and 3D tomography**
  - **Exploring collaboration with PolyU, University of Calgary, Environment Canada**

Monitoring crustal movement in Hong Kong using GPS: preliminary results

Dickson Lau


Thank you