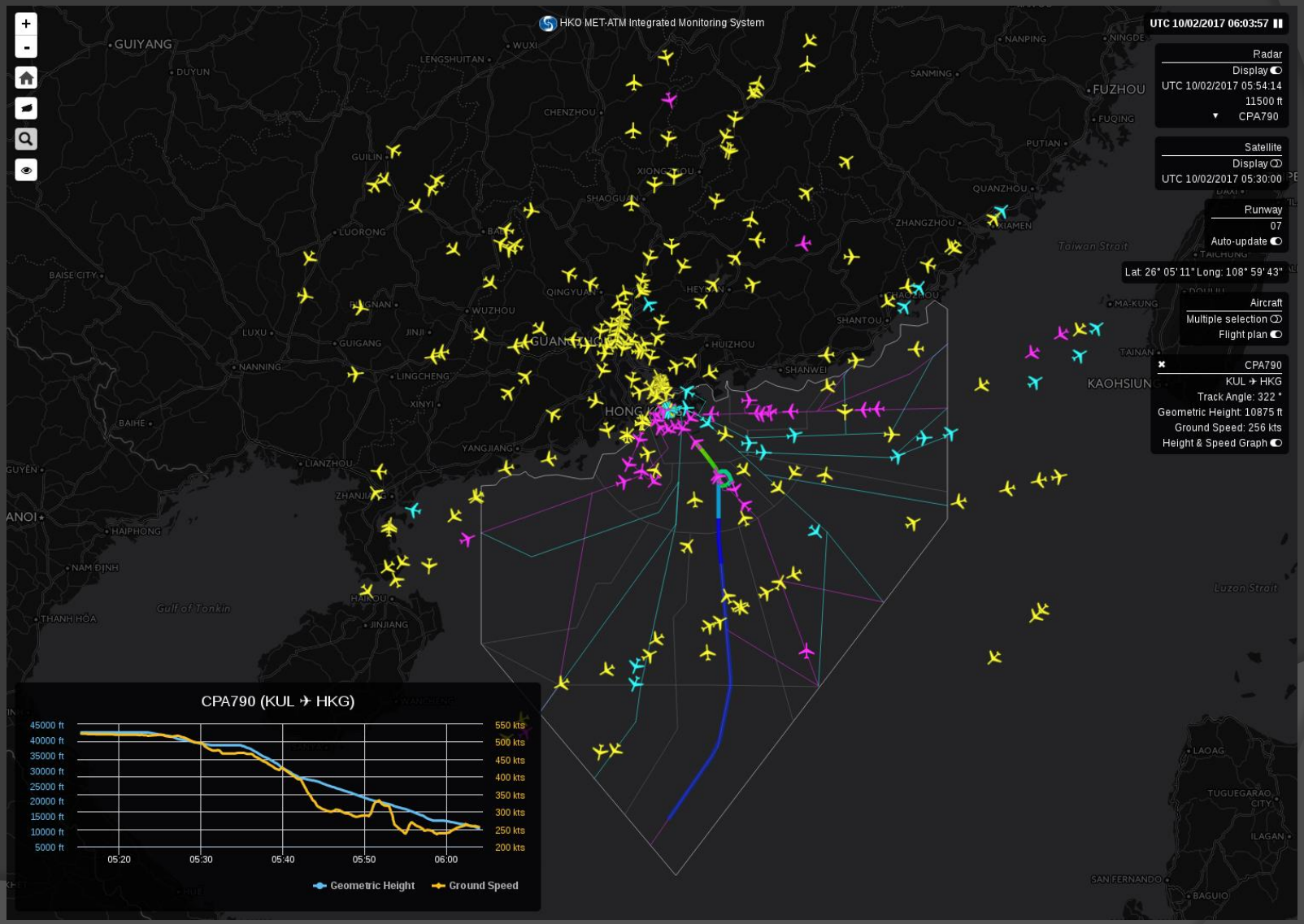
香港天文台
HONG KONG OBSERVATORY

WMO VCP MET-ATM WORKSHIOP

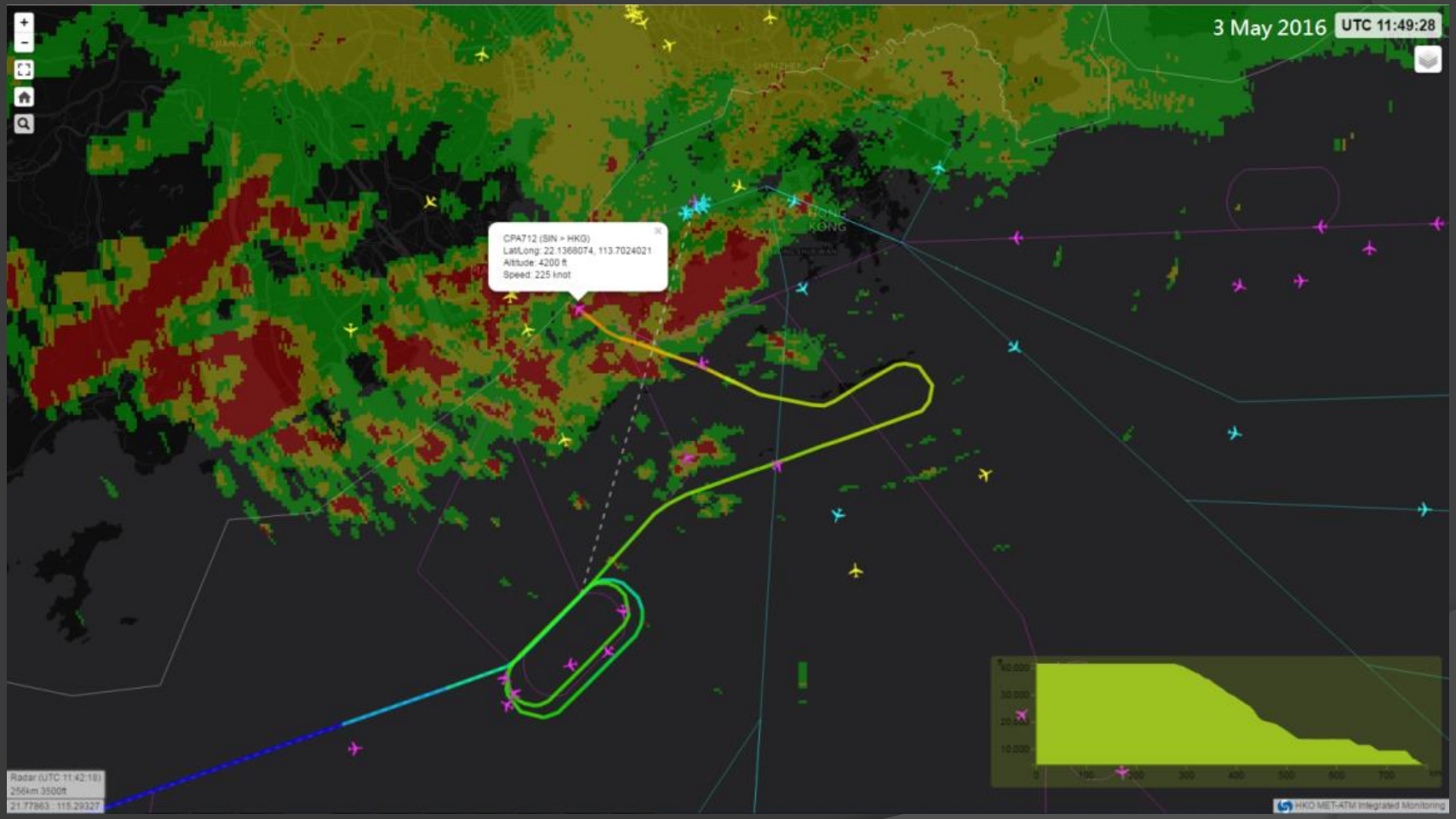
October 2018

WEATHER INFORMATION FOR AAR/ADR ASSESSMENT

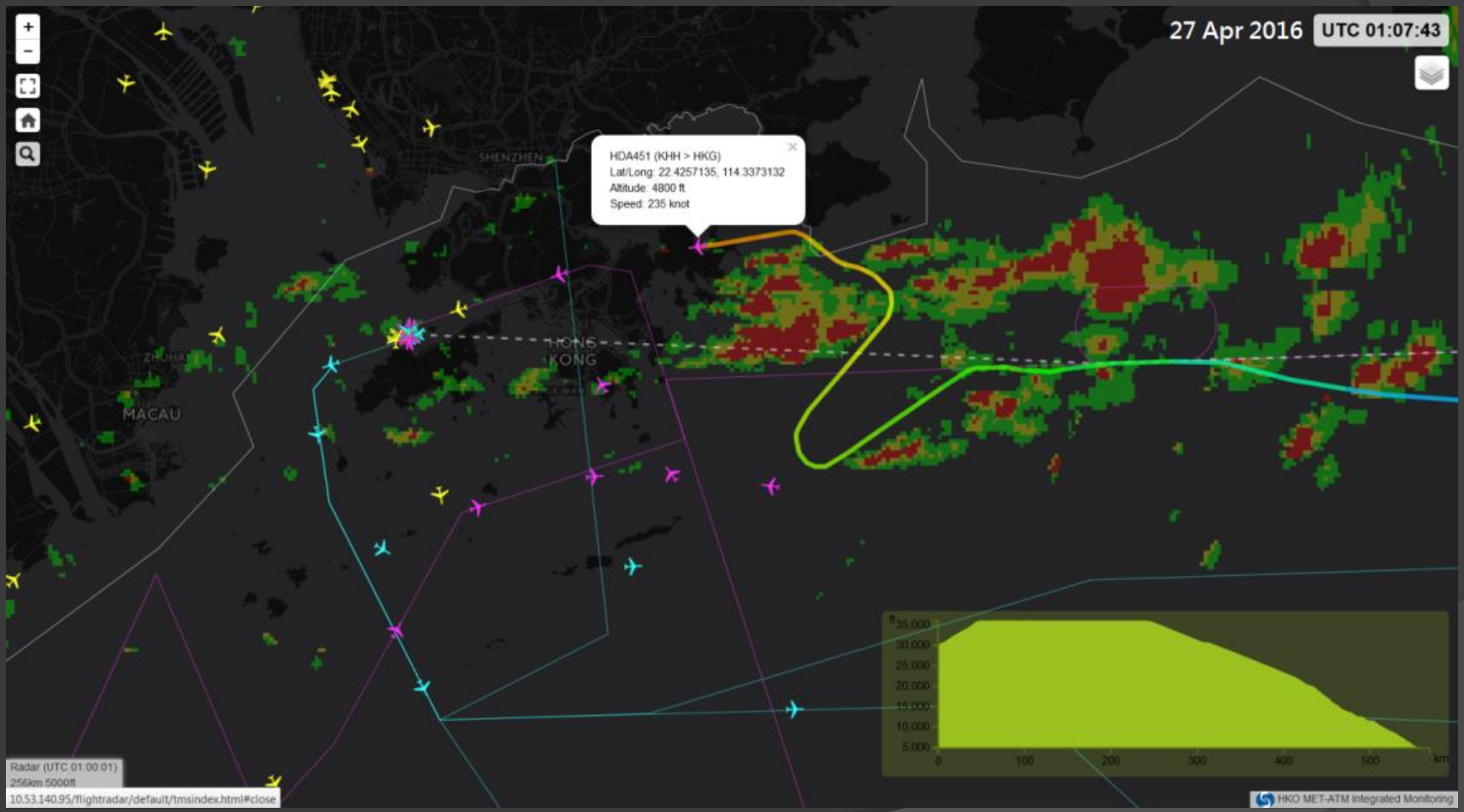
Airspace is very busy



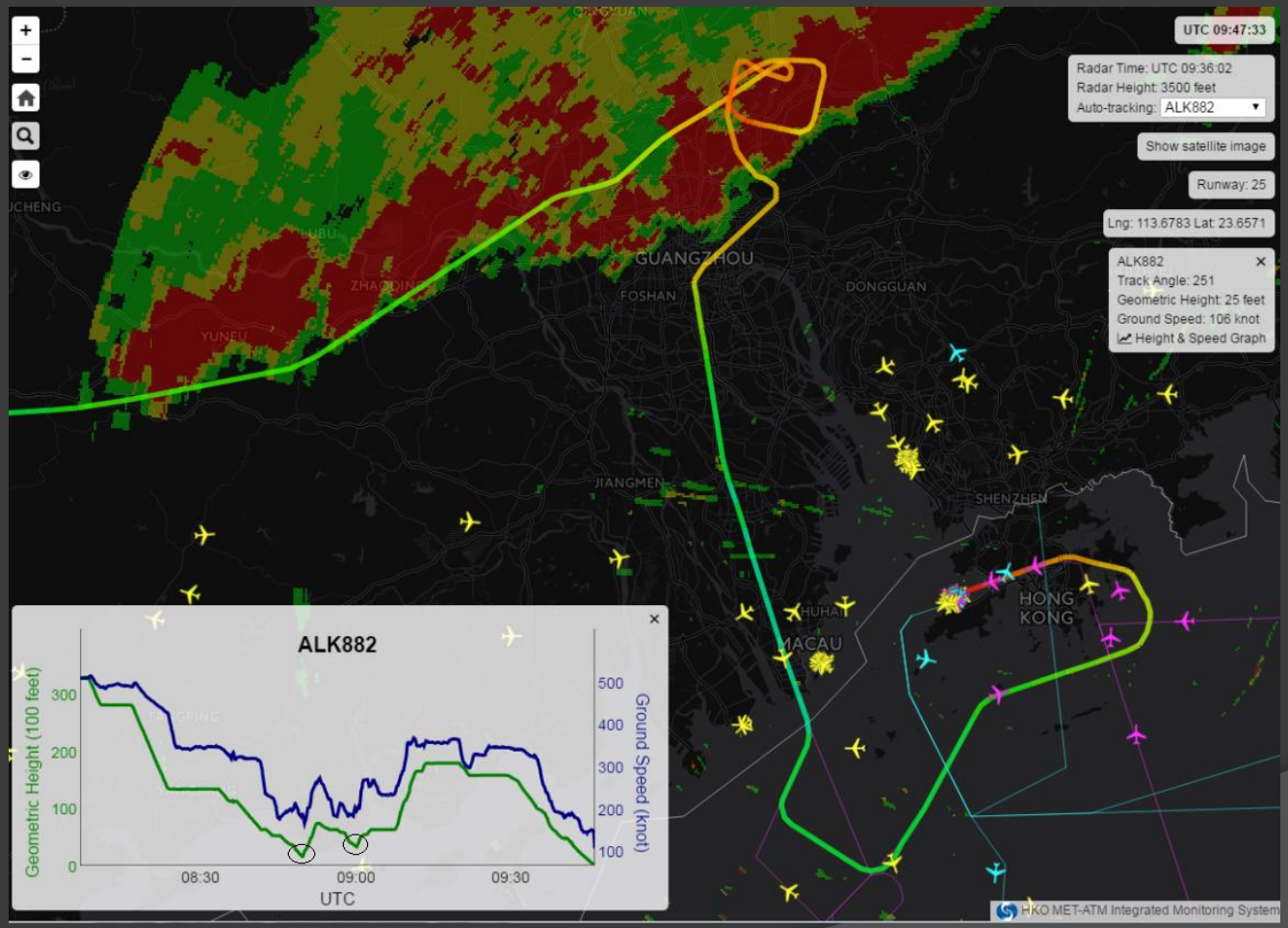
Holding due to weather



Deviation in path finding



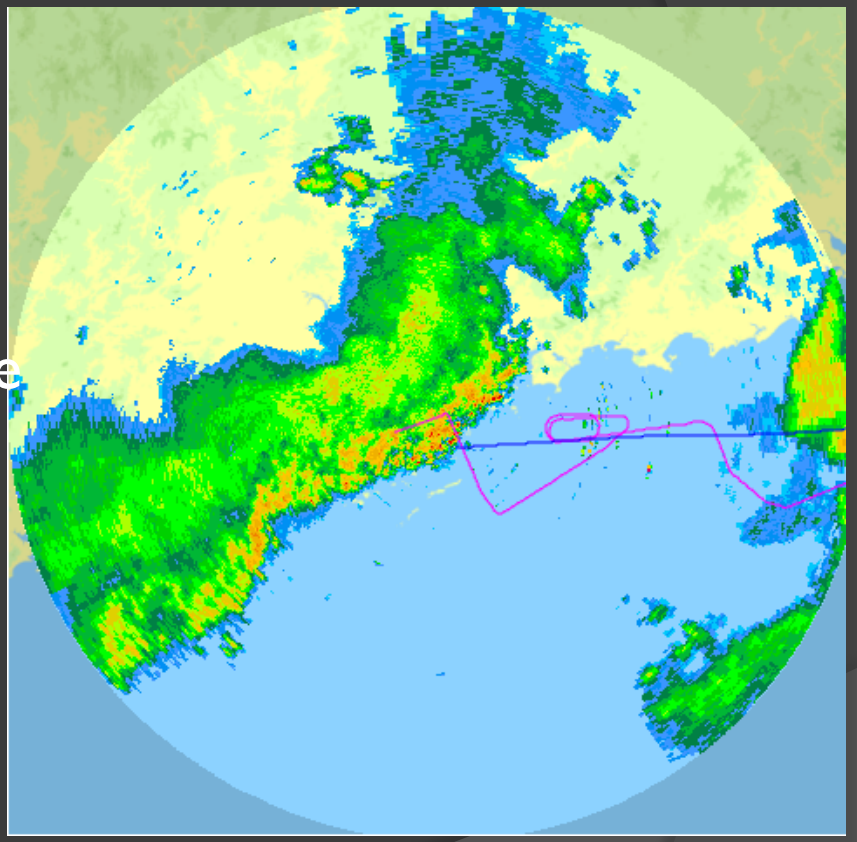
Diversion from GuangZhou



WEATHER AVOIDANCE THRESHOLDS

Aircraft and Weather Data

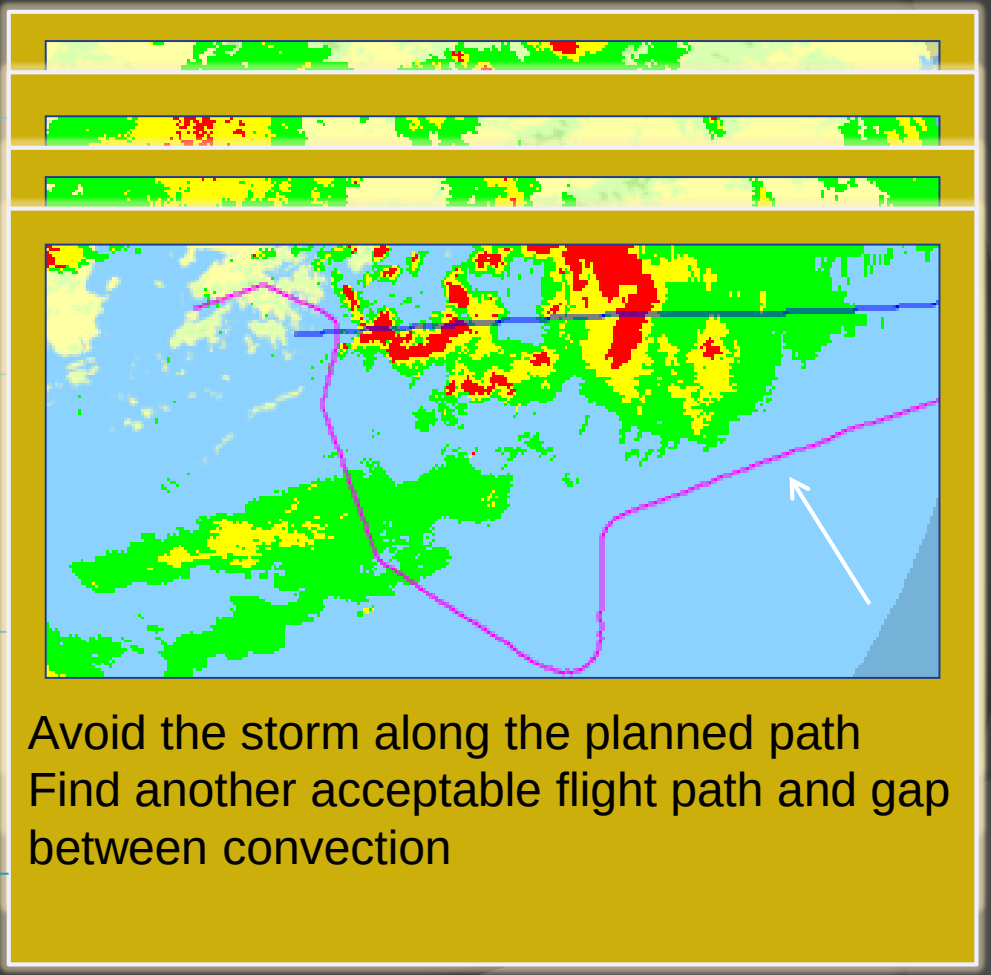
- Arrival route
  - Normal
  - Actual Flight path
- **W**ithout considering aircraft altitude
- **Range**: 256km
- **W**eather Variables
  - 90TH Percentile REF3 and VIL



Weather Avoidance Decision

Weather Avoidance Decision

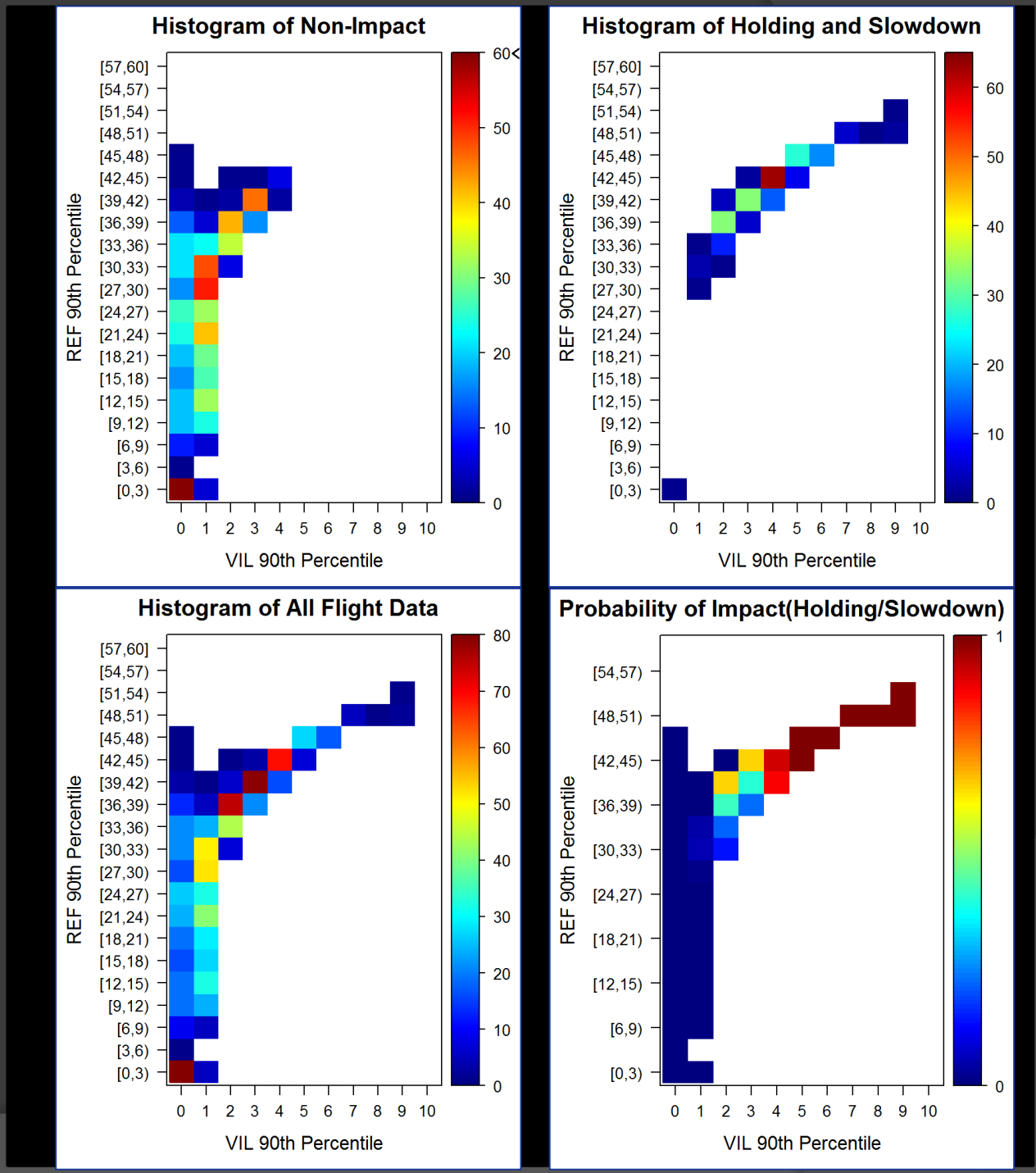
- Holding
- Slowdown
- Missed Approach
- Deviation & Path-Finding



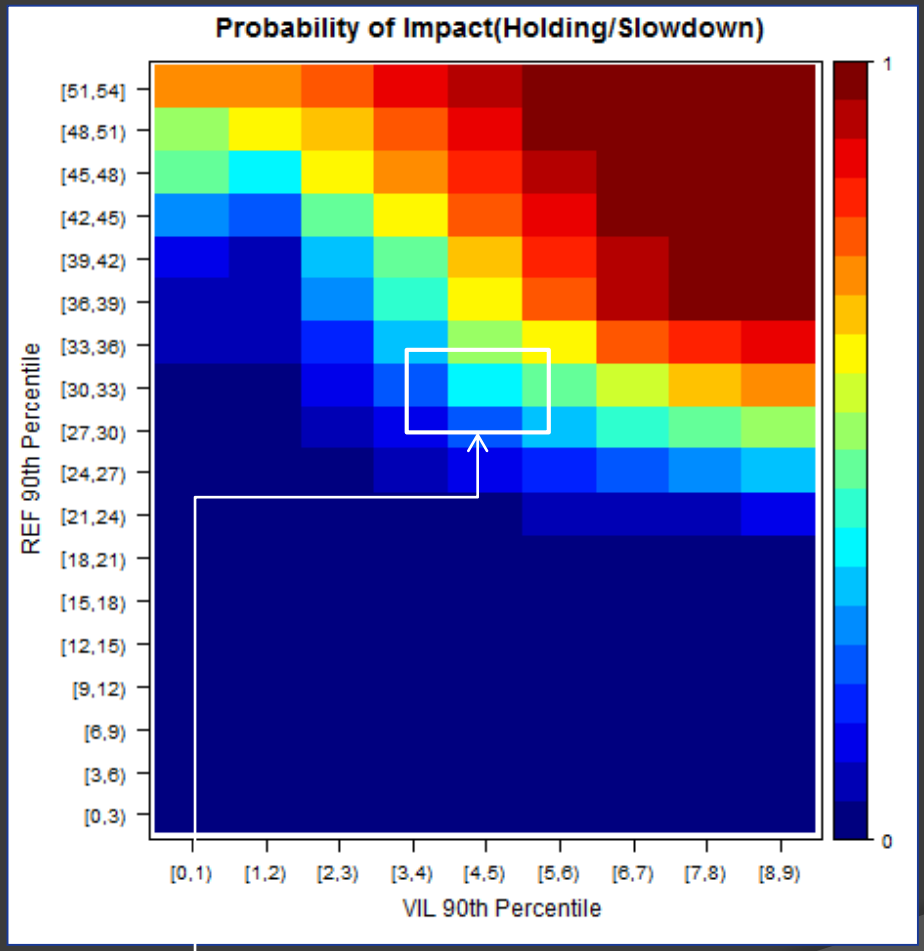
Avoid the storm along the planned path
Find another acceptable flight path and gap between convection

[REF / VIL]

Holding/ Slowdown

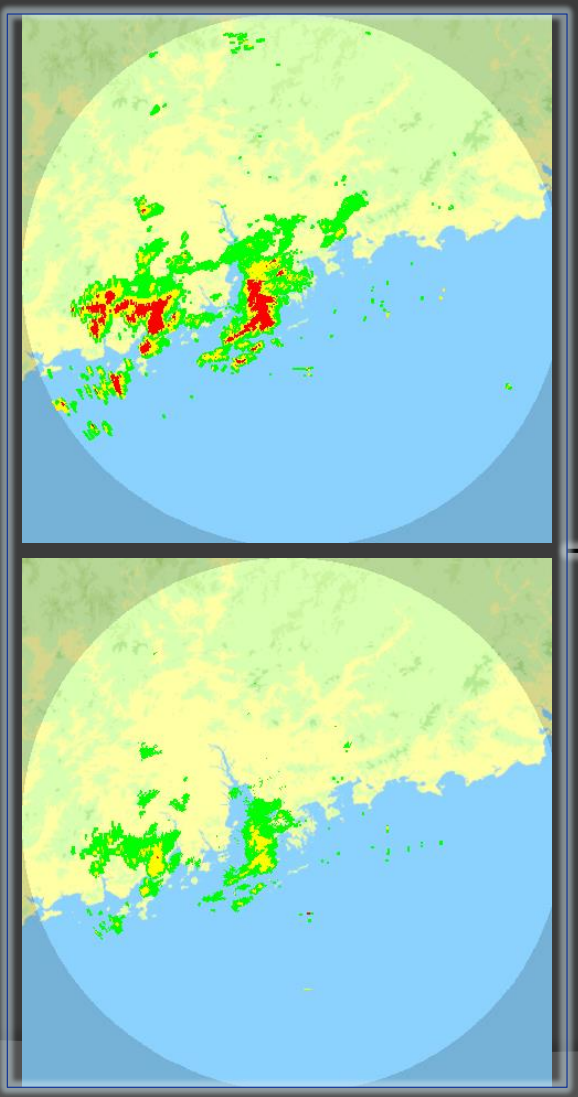


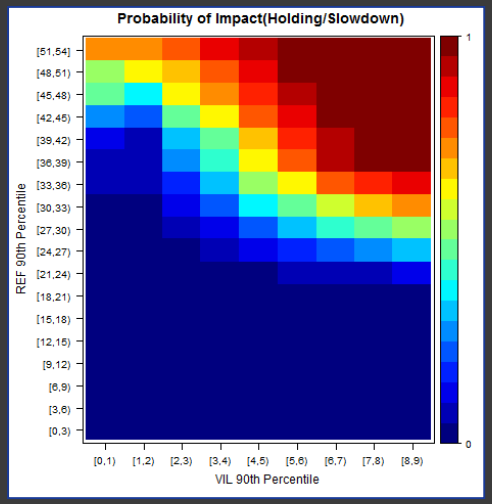
Probability table for avoidance action

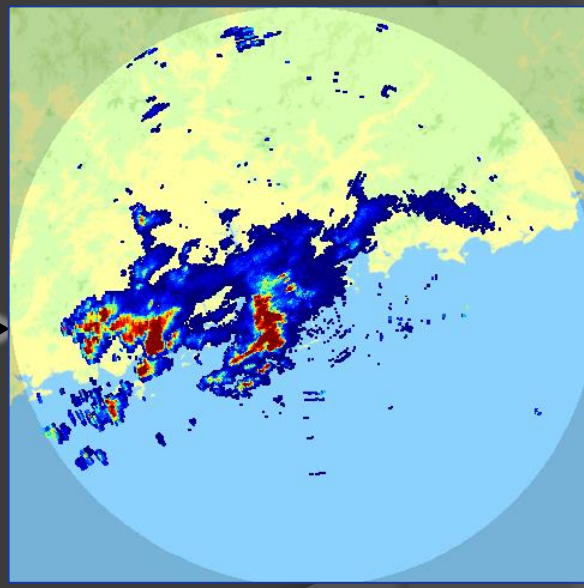


VIL>4mm, REF>33dBz

Weather Avoidance Field

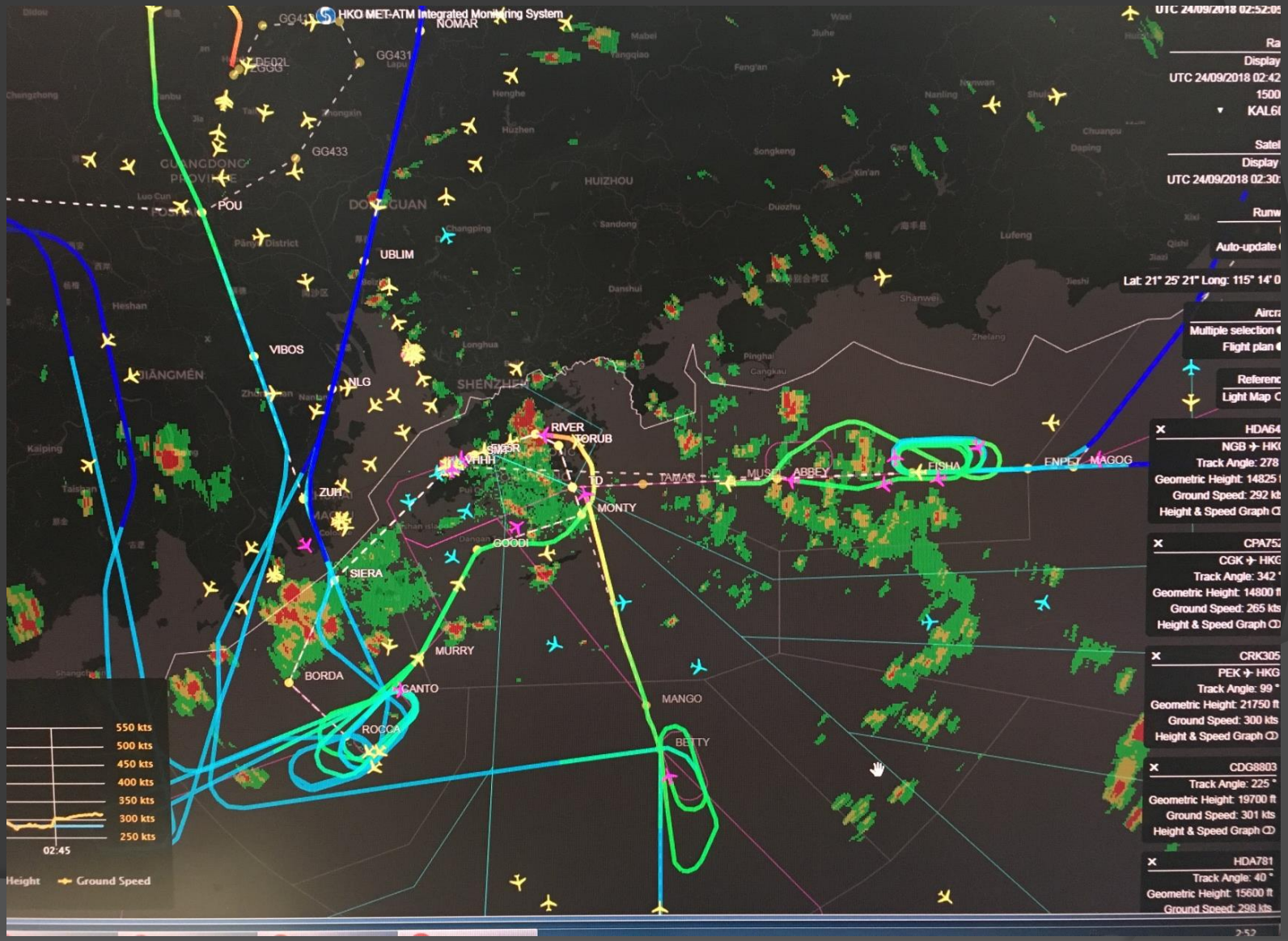


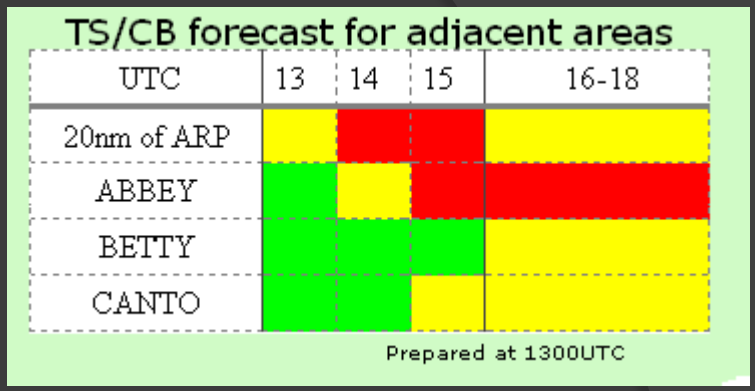




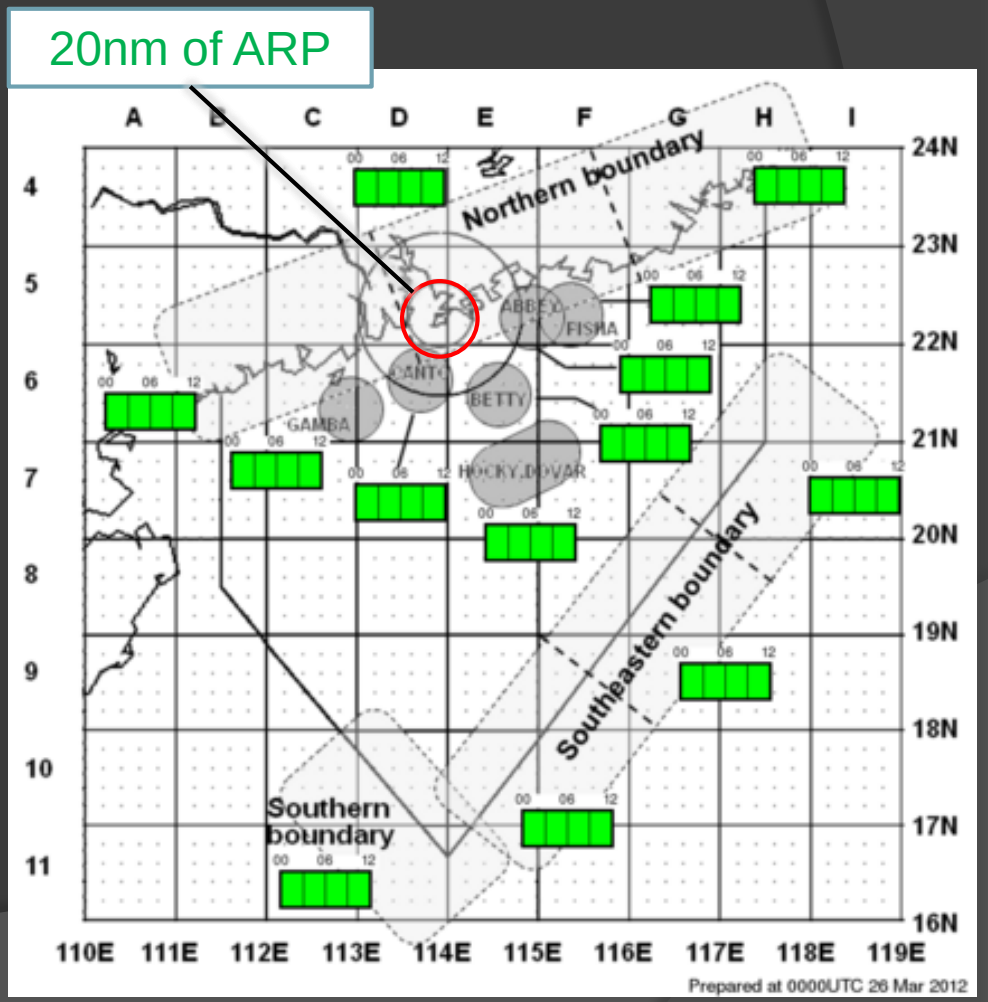
AIRPORT ACCEPTANCE RATE (AAR)

The three major“feeds”

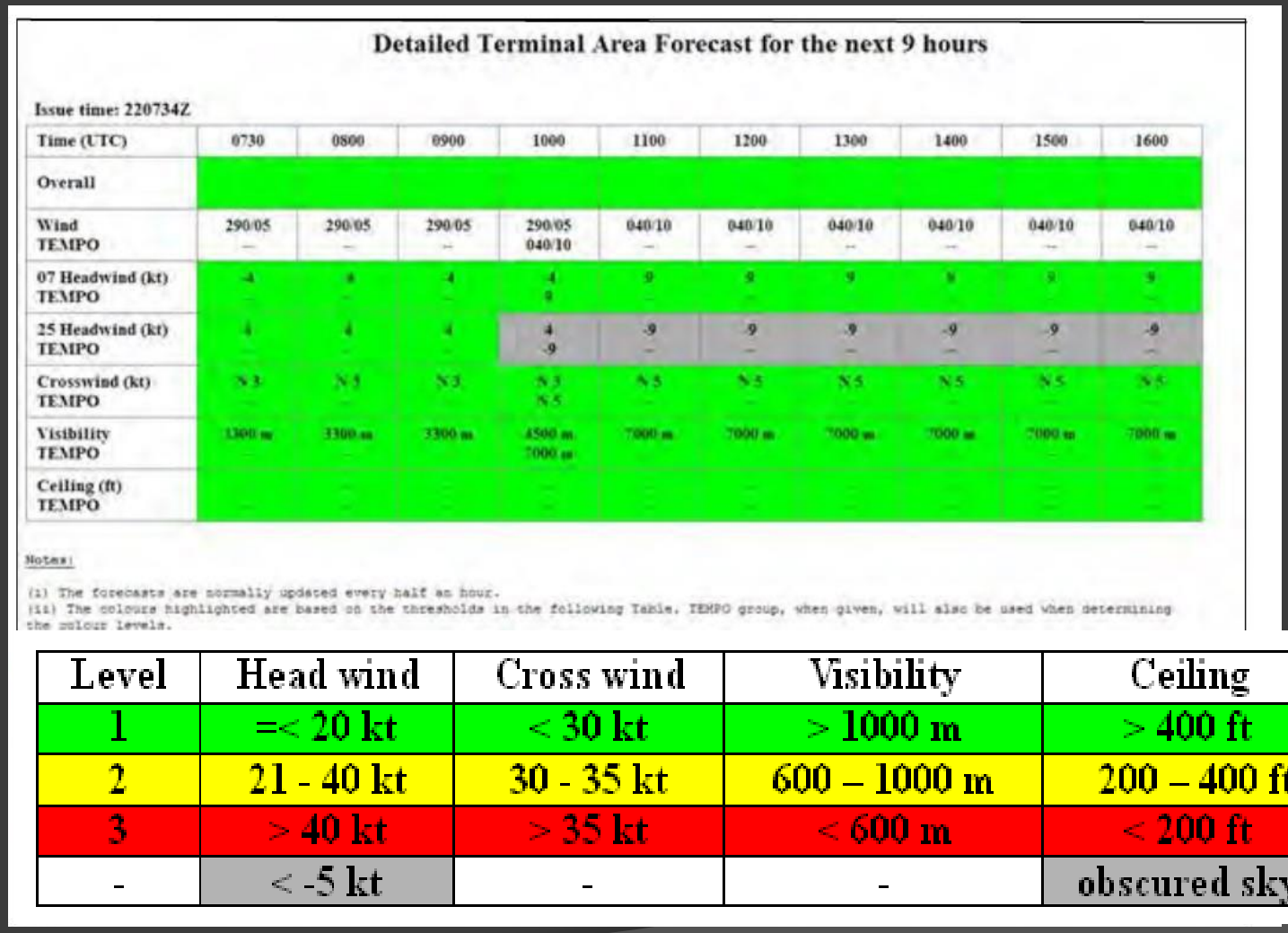




- 20 nm of Aerodrome Reference Point (ARP)
- key holding areas
  - 20 nm within Abbey Betty Canto
  - Northern and South/Southeastern boundaries



Graphical Impact Matrix



Detailed Terminal Area Forecast for the next 9 hours

Issue time: 220734Z

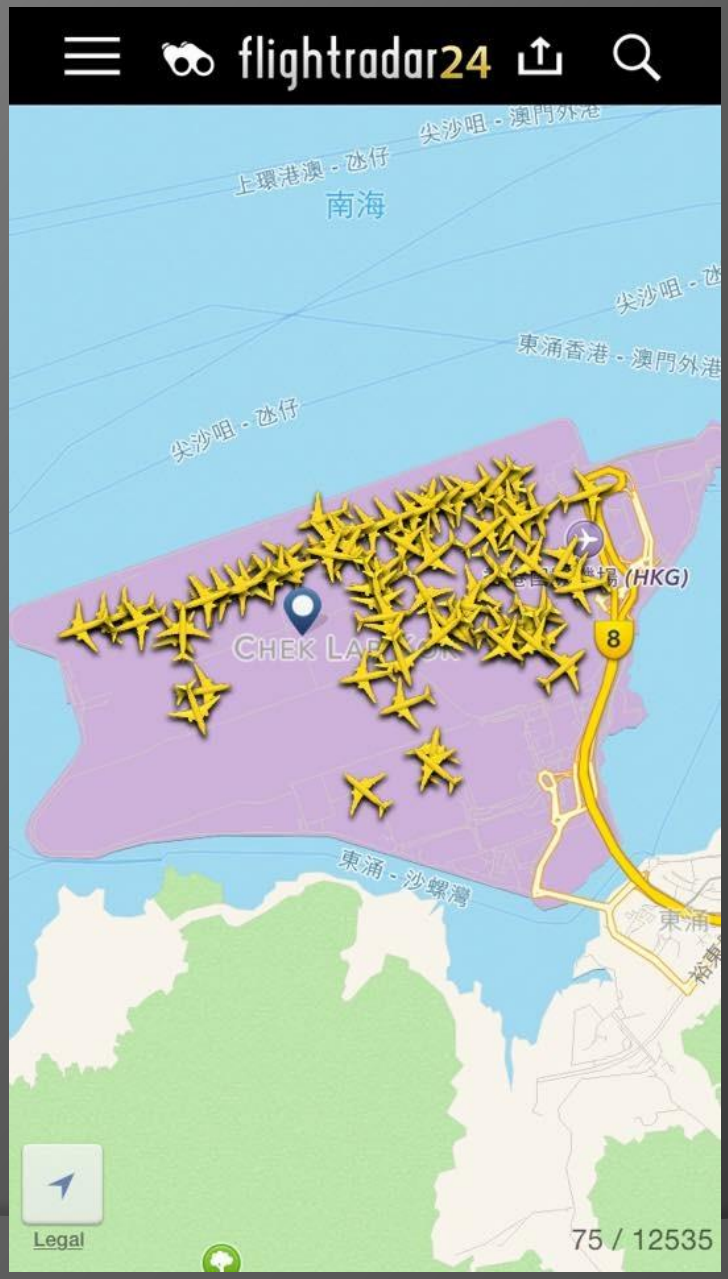
Time (UTC)	0730	0800	0900	1000	1100	1200	1300	1400	1500	1600
Overall										
Wind TEMPO	290/05	290/05	290/05	290/05 040/10	040/10	040/10	040/10	040/10	040/10	040/10
07 Headwind (kt) TEMPO	-4	-4	-4	-4 0	9	9	9	9	9	9
25 Headwind (kt) TEMPO	4	4	4	4 -9	-9	-9	-9	-9	-9	-9
Crosswind (kt) TEMPO	N 3	N 5	N 3	N 3 N 5	N 5	N 5	N 5	N 5	N 5	N 5
Visibility TEMPO	3300 m	3300 m	3300 m	4500 m 7000 m	7000 m	7000 m	7000 m	7000 m	7000 m	7000 m
Ceiling (ft) TEMPO										

Notes:

(i) The forecasts are normally updated every half an hour.
(ii) The colours highlighted are based on the thresholds in the following Table. TEMPO group, when given, will also be used when determining the colour levels.

Level	Head wind	Cross wind	Visibility	Ceiling
1	=< 20 kt	< 30 kt	> 1000 m	> 400 ft
2	21 - 40 kt	30 - 35 kt	600 – 1000 m	200 – 400 ft
3	> 40 kt	> 35 kt	< 600 m	< 200 ft
-	< -5 kt	-	-	obscured sky

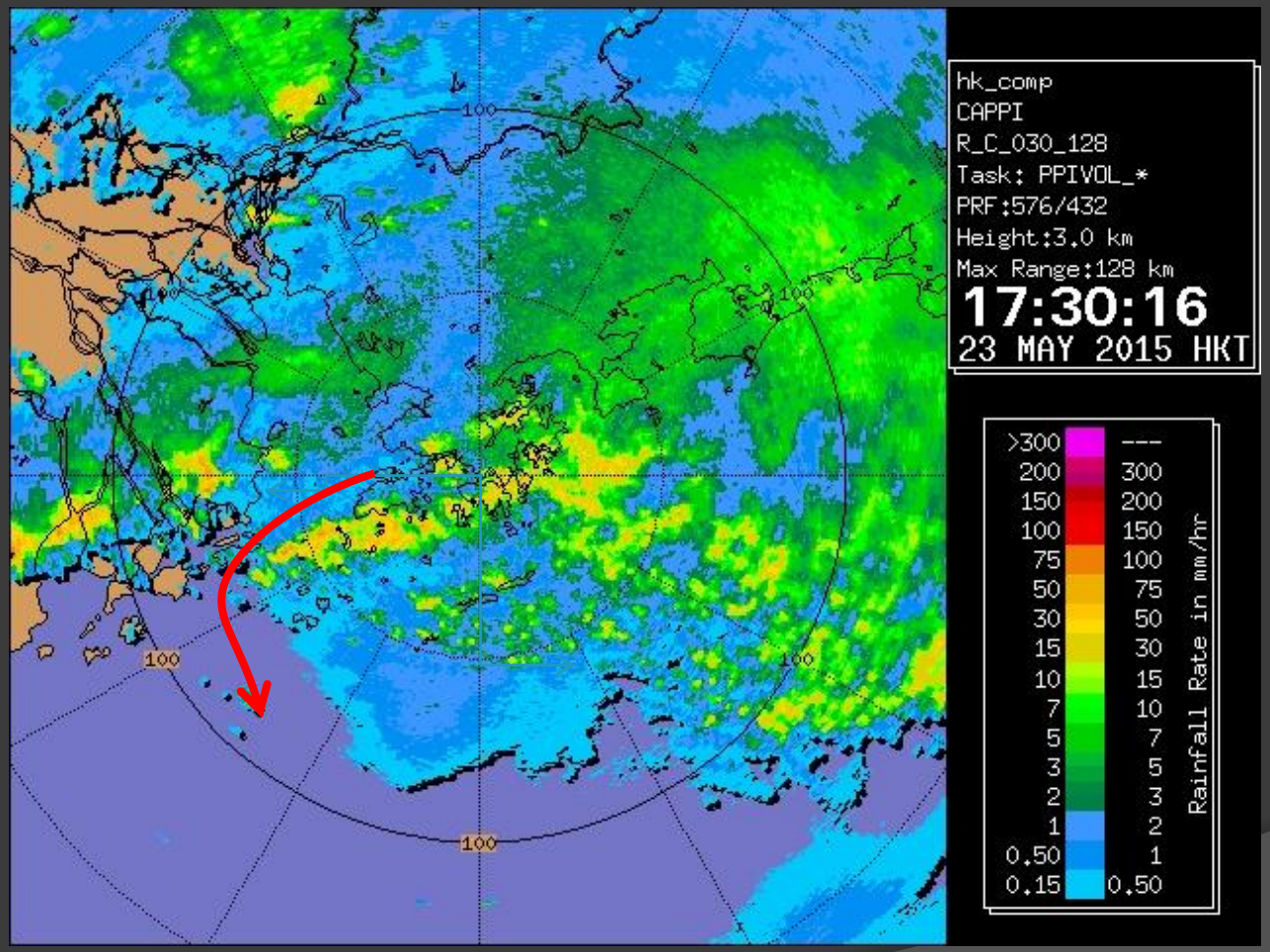
AIRPORT DEPARTURE RATE (ADR)



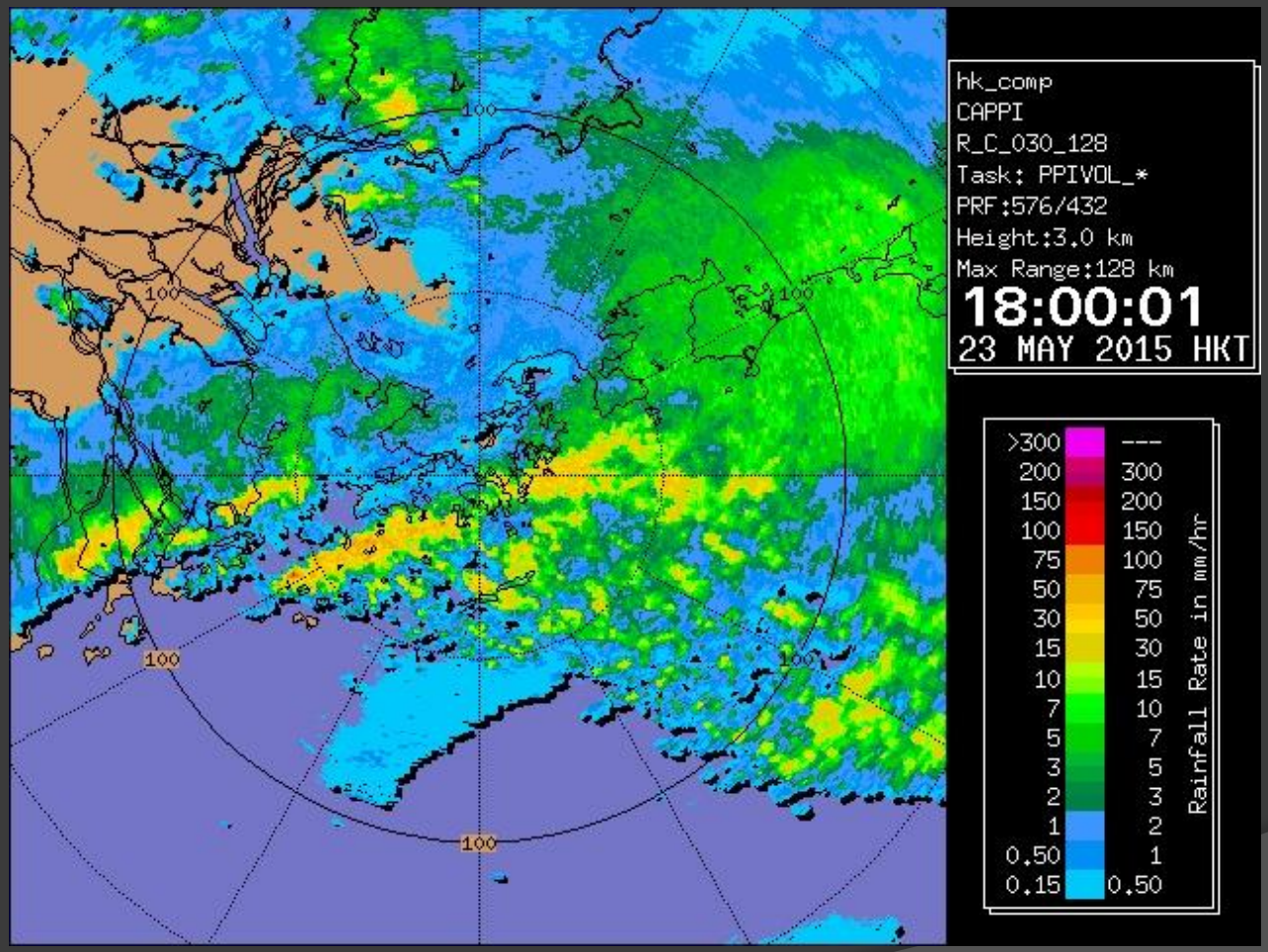
- Due to thunderstorm and weather related flow control, apron parking was full from 1800 to 0500 the next day.
- 178 passenger flights arrived and held on taxiway with a maximum waiting time of 2 hours and 32 minutes.

A Major Disruption to airport on 23 May 2015

Trouble with Outgoing flights

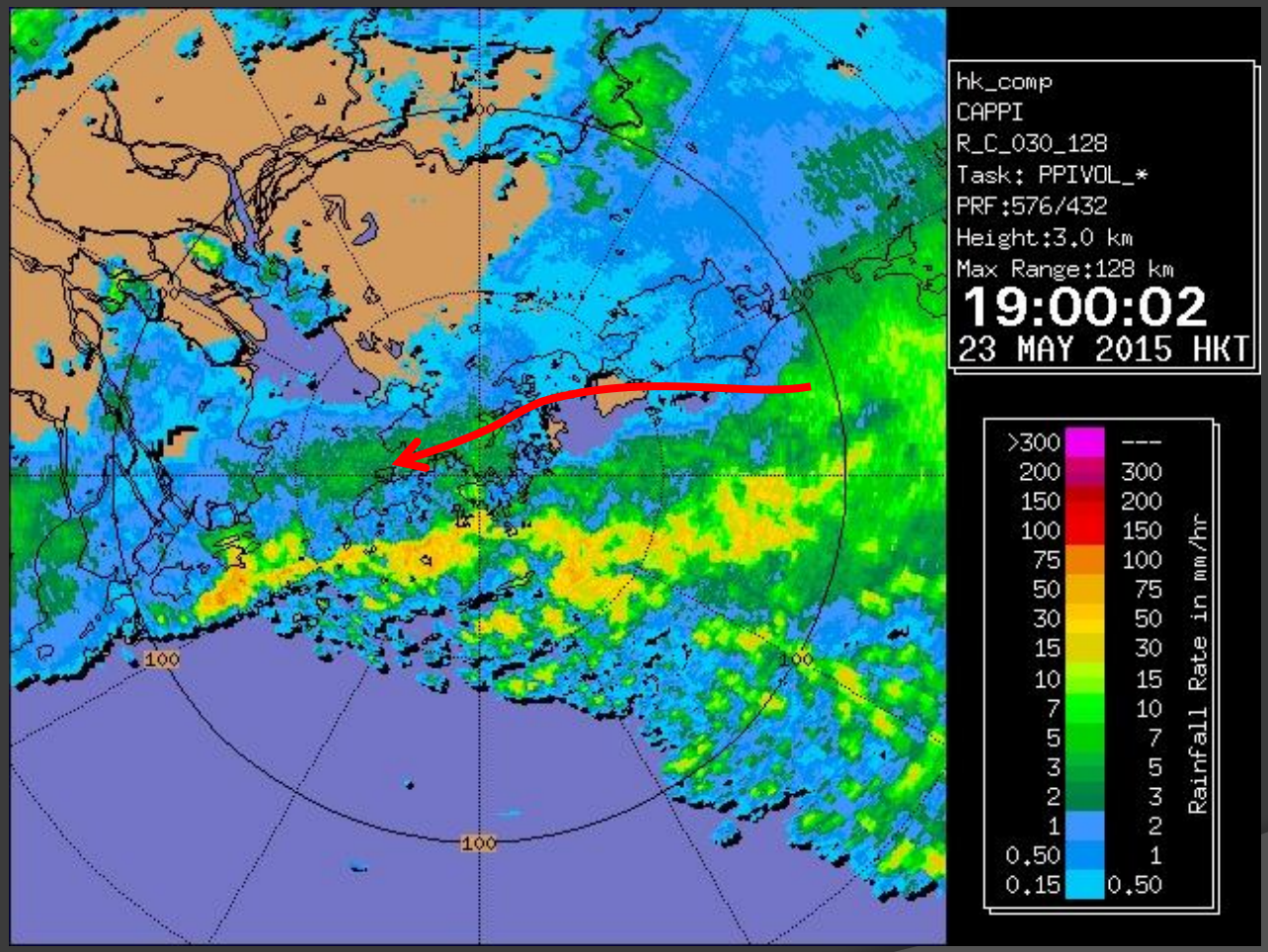


18:00H


hk_comp
CAPPI
R_C_030_128
Task: PPIVOL_*
PRF:576/432
Height:3.0 km
Max Range:128 km
18:00:01
23 MAY 2015 HKT
>300
200
150
100
75
50
30
15
10
7
5
3
2
1
0.50
0.15

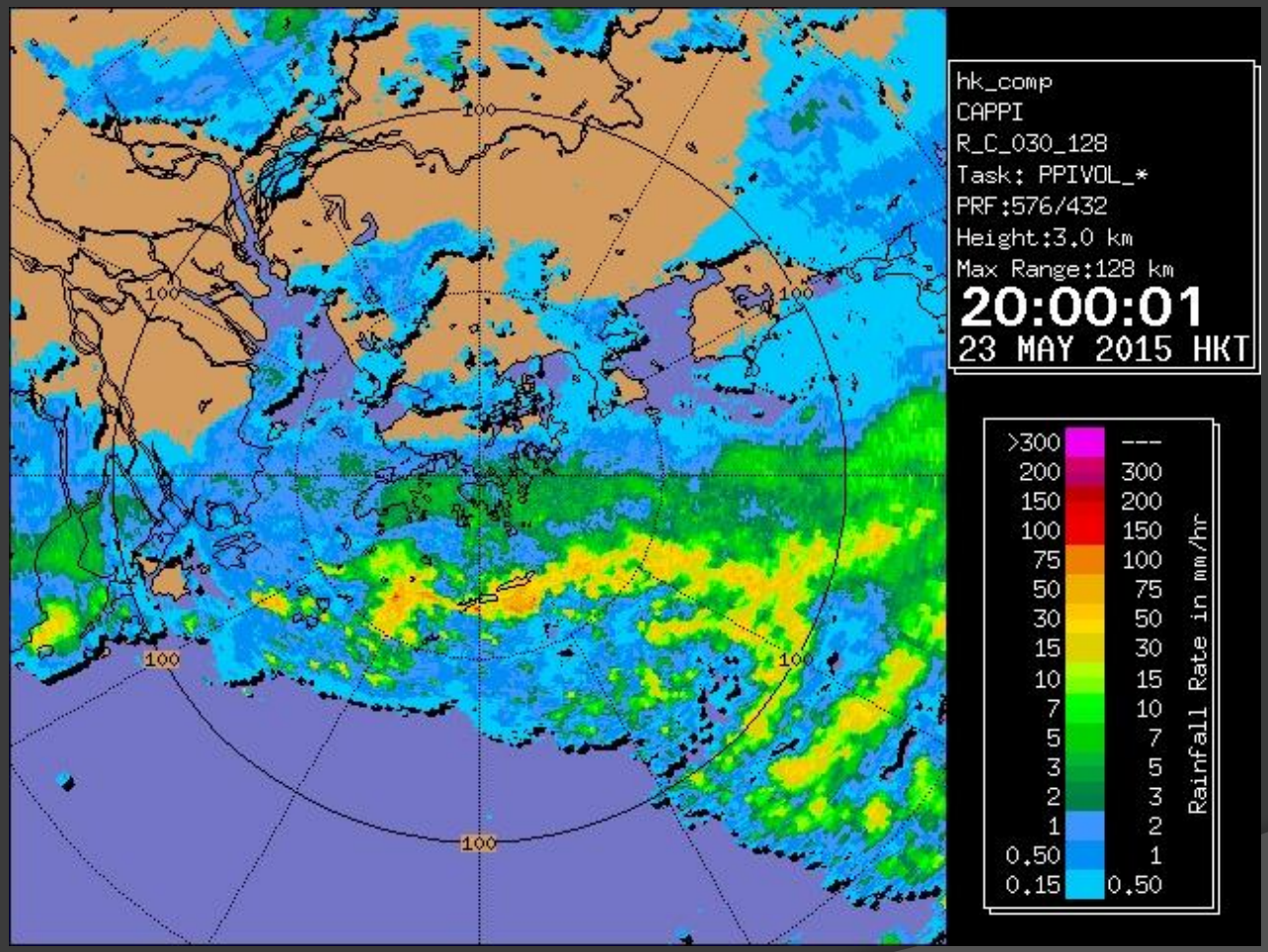
300
200
150
100
75
50
30
15
10
7
5
3
2
1
0.50
Rainfall Rate in mm/hr
100
100
100
100
100

19:00H


hk_comp
CAPPI
R_C_030_128
Task: PPIVOL_*
PRF:576/432
Height:3.0 km
Max Range:128 km
19:00:02
23 MAY 2015 HKT
>300
200
150
100
75
50
30
15
10
7
5
3
2
1
0.50
0.15

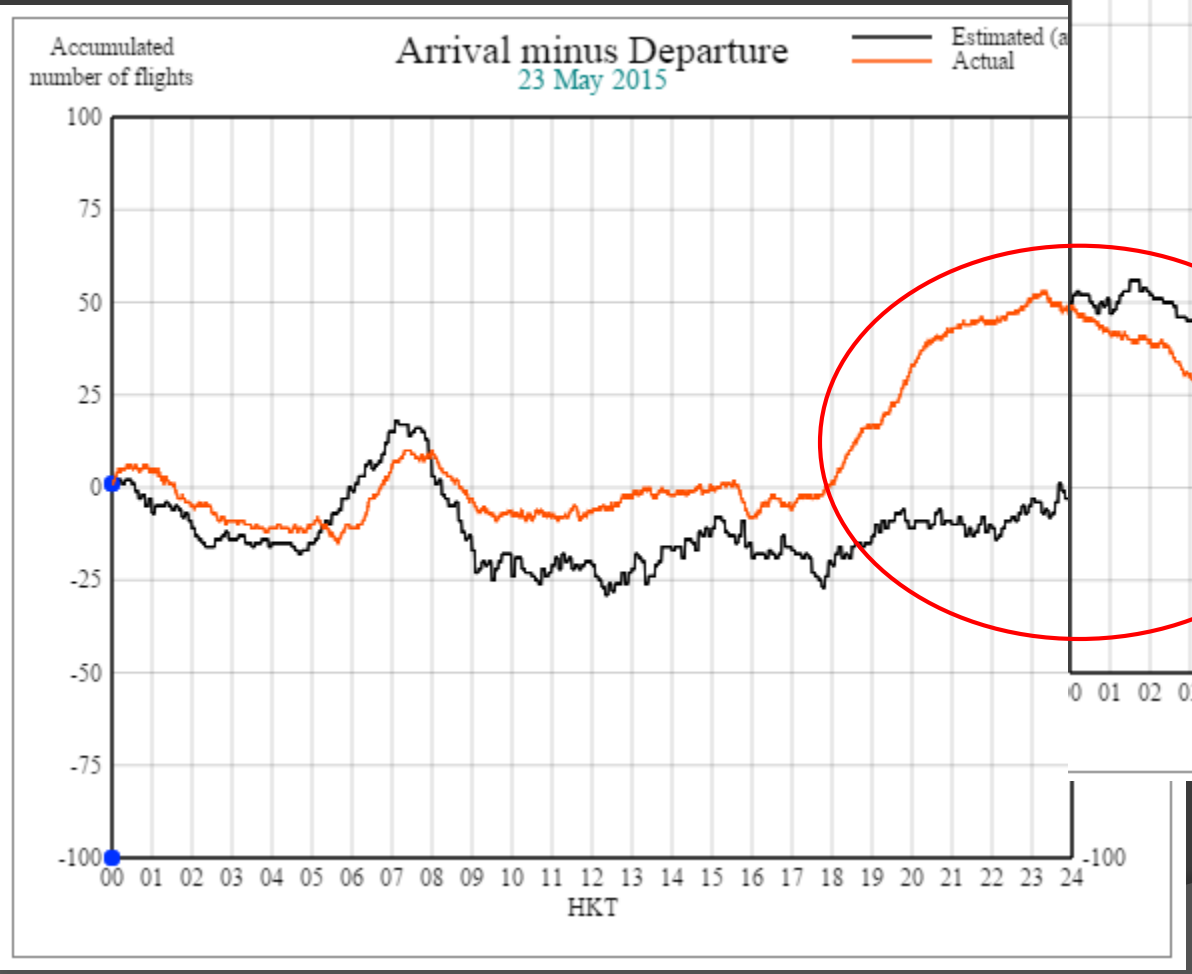
300
200
150
100
75
50
30
15
10
7
5
3
2
1
0.50
Rainfall Rate in mm/hr
100
100
100
100

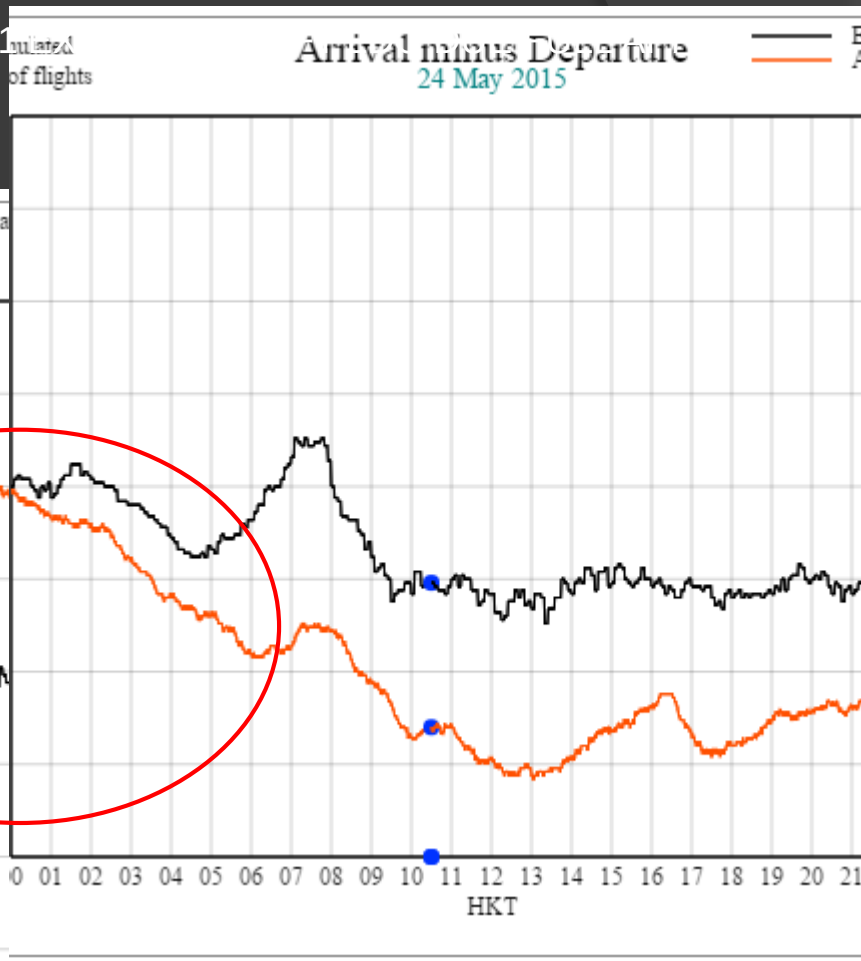
20:00H


hk_comp
CAPPI
R_C_030_128
Task: PPIVOL_*
PRF:576/432
Height:3.0 km
Max Range:128 km
20:00:01
23 MAY 2015 HKT
>300
200
150
100
75
50
30
15
10
7
5
3
2
1
0.50
0.15

300
200
150
100
75
50
30
15
10
7
5
3
2
1
0.50
Rainfall Rate in mm/hr
100
100
100
100
100

2015-05/metcond/clk_atis/150523/2219latest_atis.txt:A-SUPPL1 EXP DELAY AFTER LDG DUE FULL APRON
2015-05/metcond/clk_atis/150523/2247latest_atis.txt:A-SUPPL1 EXP DELAY AFTER LDG DUE FULL APRON_WIND VRB 6KT
2015-05/metcond/clk_atis/150524/0008latest_atis.txt:A-SUPPL1 EXP DELAY AFTER LANDING DUE FULL APRON
2015-05/metcond/clk_atis/150524/0811latest_atis.txt:A-SUPPL1



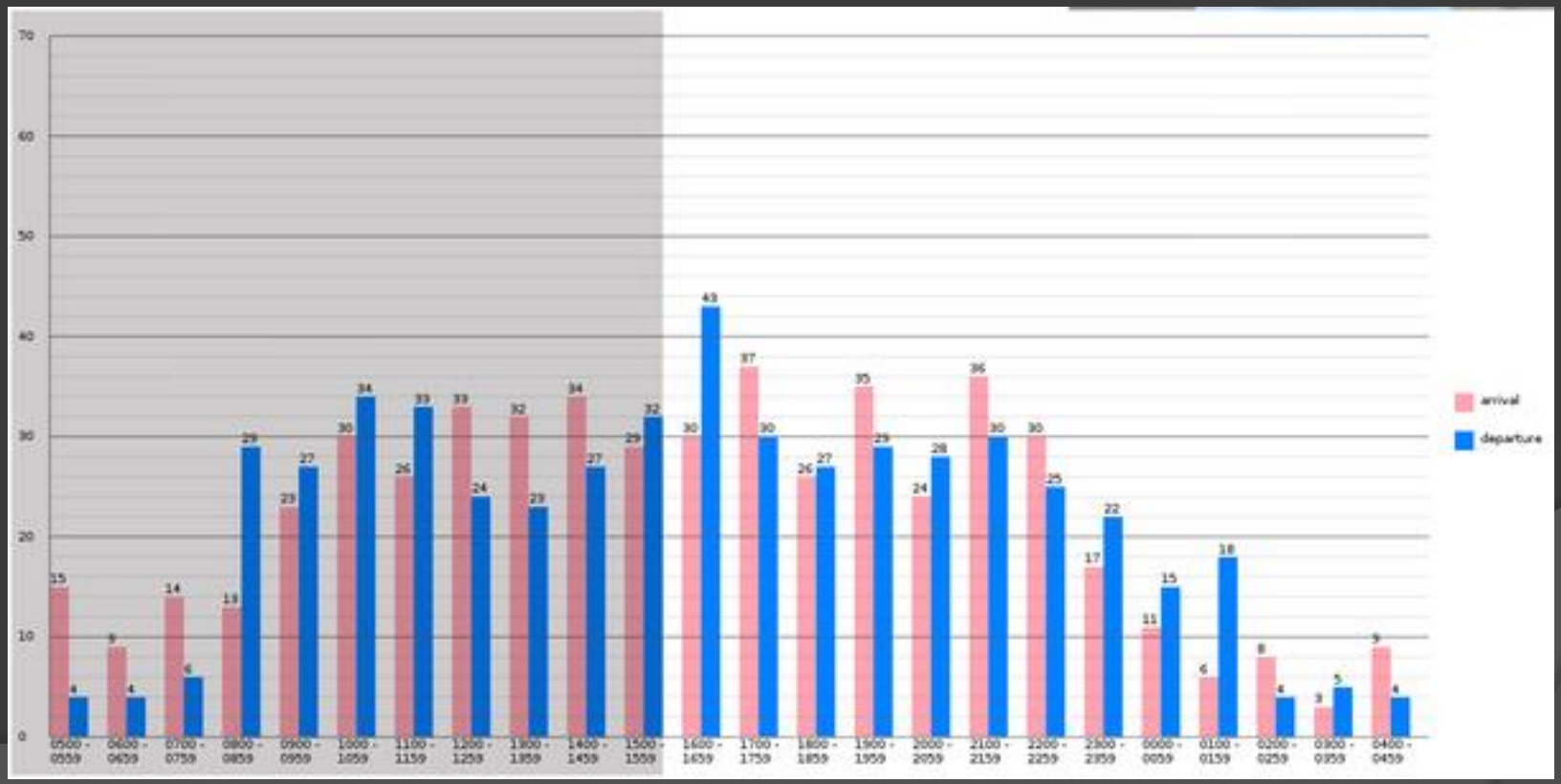


Airport Departure Rate Study

- Airport operation may have problem when Departure << Arrival
  - in general, difference of 10-20 is OK
  - on 23 May 2015, the surplus was over 40 for consecutive hours

Departure Flights

```
---295386061|A|--KAL615|--KE 615|-615|-|201101180020|201101180008|201101180002|PUS|---|---|---|W|S|0|HAS|J|----|737
---295385704|A|--AHK681|--LD 681|-681|-|201101180035|201101180018|201101180018|TPE|---|---|---|0|S|0|HAS|F|----|ABF
---295385768|A|--CEB238|--5J 238|-238|-|201101180050|201101180027|201101180024|CEB|---|---|---|W|S|0|SAT|J|----|32S
---295385690|A|--AAR989|--OZ 989|-989|-|201101180010|201101180031|201101180029|ICN|---|---|---|0|S|0|JAT|F|----|74F
---295386032|A|--HDA997|--KA 997|-997|-|201101180035|201101180026|201101180034|PEK|---|---|---|W|S|0|HAS|J|----|32S
---295385703|A|--AHK456|--LD 456|-456|-|201101180055|201101180039|201101180039|MNL|---|---|---|0|S|0|HAS|F|----|72F
```



Runway use history

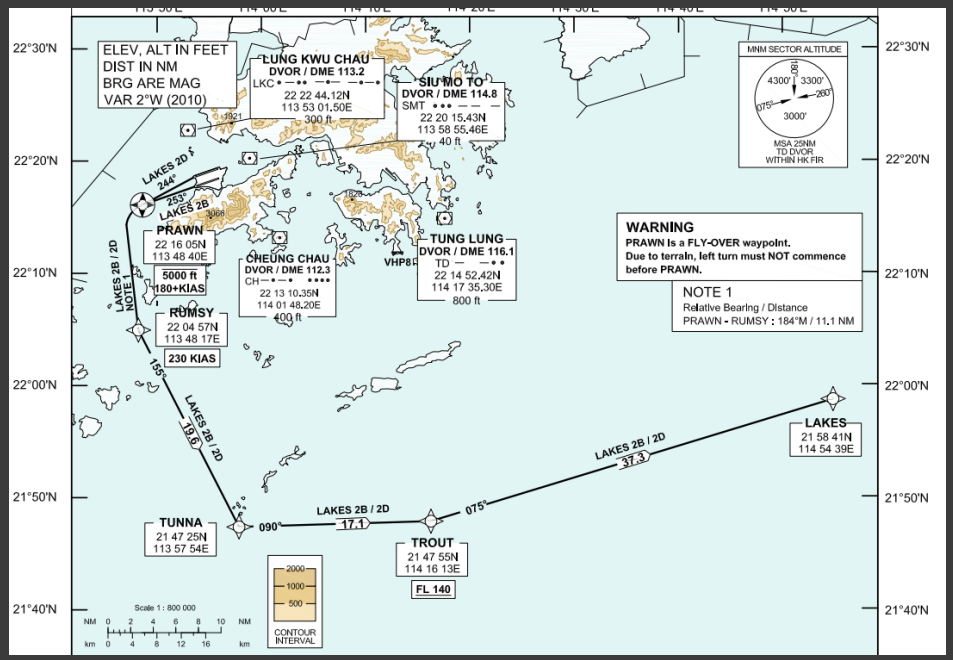
Hong Kong International Airport (HKIA)
Automatic Terminal Information Service (ATIS)

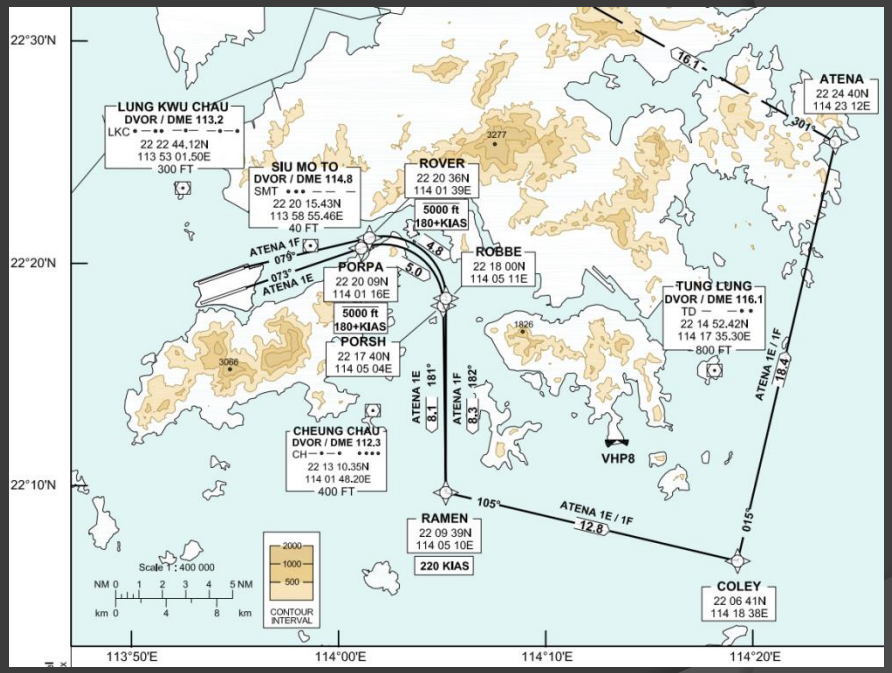
ATIS 770

A-TITLE	HONG KONG ARRIVAL INFORMATION	D-TITLE	HONG KONG DEPARTURE INFORMATION
A-IDENT	I	D-IDENT	W
A-TIME	0243	D-TIME	0244
A-INFO-D1		D-INFO-D1	
A-RUNWAY	25R	D-RUNWAY	25L
A-INFO-D2		D-WS/TURB	
A-WS/TURB		D-SUPPL1	
A-SUPPL1		D-WIND	210
A-WIND	210	D-SPEED	12
A-SPEED	12	D-VRB-BTN	
A-VRB-BTN		D-AND	
A-AND		D-MAX	
A-MAX		D-MNM	
A-MNM		D-VIS	10 KM
A-VIS	10 KM	D-RVR	
A-RVR		D-PRESENT-WX	
A-PRESENT-WX		D-CLOUD	FEW 1500FT SCT 2500FT
A-CLOUD	FEW 1500FT SCT 2500FT	D-WXCHG	
A-WXCHG		D-TEMP	32
A-TEMP	32	D-DEWPOINT	26
A-DEWPOINT	26	D-QNH	1006
A-QNH	1006	D-METINFO	
A-METINFO		D-TREND	
A-TREND	EXP SIG TAILWIND ON BASE LEG	D-SUPPL2	
A-SUPPL2		D-ACK	ACK INFO W
A-ACK	ACK INFO I	D-CDCGMC	DELIVERY

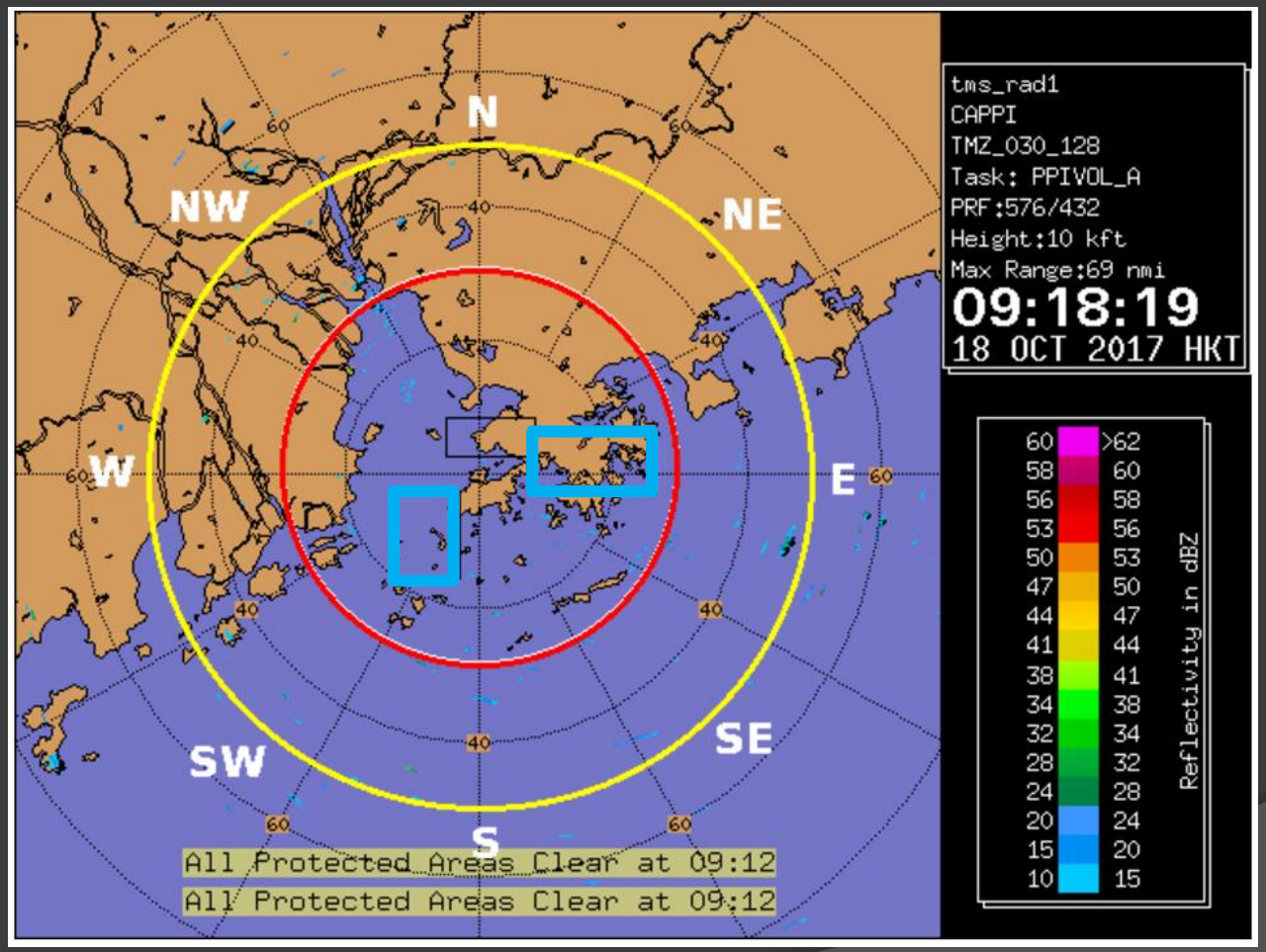
- :
- :
- :
- 2015-01/metcond/clk_atis/150101/0006latest_atis.txt:A-RUNWAY 07L
- 2015-01/metcond/clk_atis/150101/0006latest_atis.txt:D-RUNWAY 07R
- 2015-01/metcond/clk_atis/150101/0038latest_atis.txt:A-RUNWAY 07L
- 2015-01/metcond/clk_atis/150101/0038latest_atis.txt:D-RUNWAY 07R
- 2015-01/metcond/clk_atis/150101/0039latest_atis.txt:A-RUNWAY 07L
- 2015-01/metcond/clk_atis/150101/0039latest_atis.txt:D-RUNWAY 07R
- 2015-01/metcond/clk_atis/150101/0136latest_atis.txt:A-RUNWAY 07R
- 2015-01/metcond/clk_atis/150101/0136latest_atis.txt:D-RUNWAY 07R
- 2015-01/metcond/clk_atis/150101/0139latest_atis.txt:A-RUNWAY 07R
- 2015-01/metcond/clk_atis/150101/0139latest_atis.txt:D-RUNWAY 07R
- :
- :
- :

RWY 25 departure RWY 07 departure

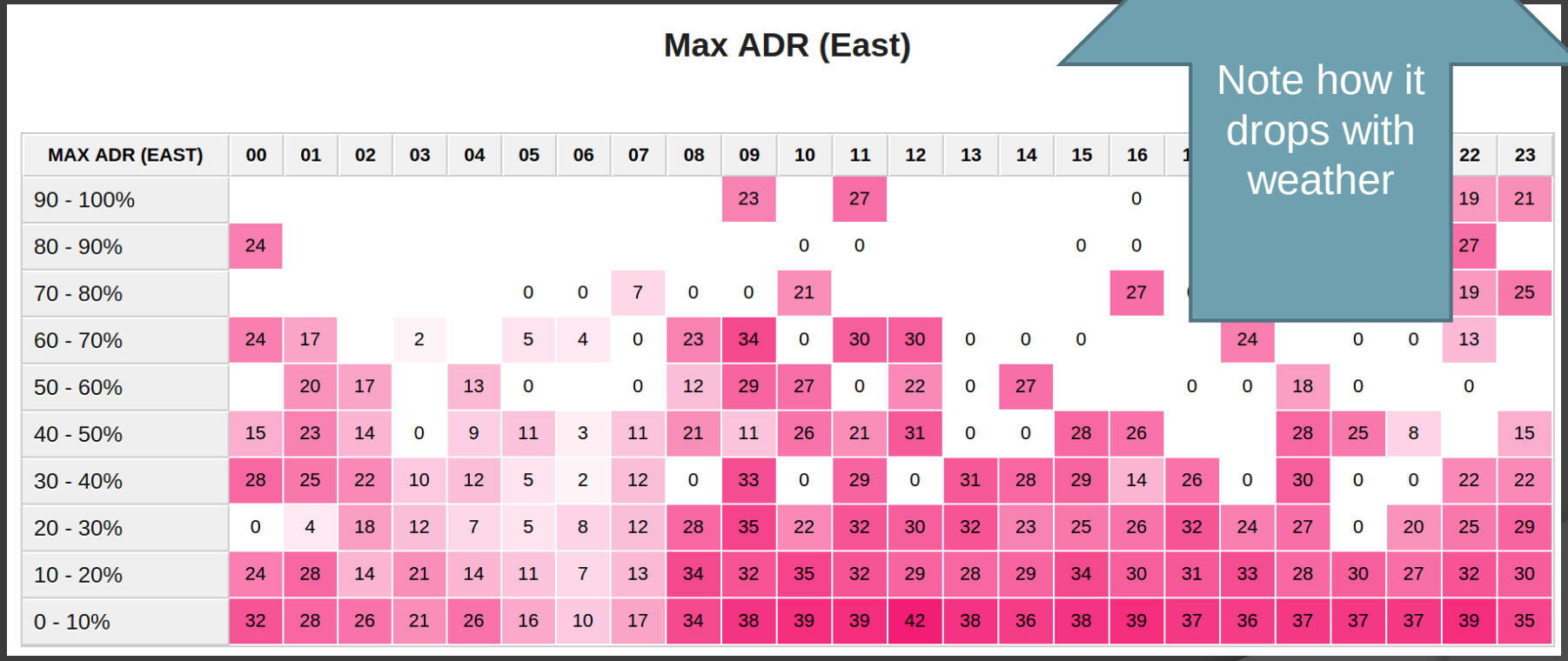




The departure corridors

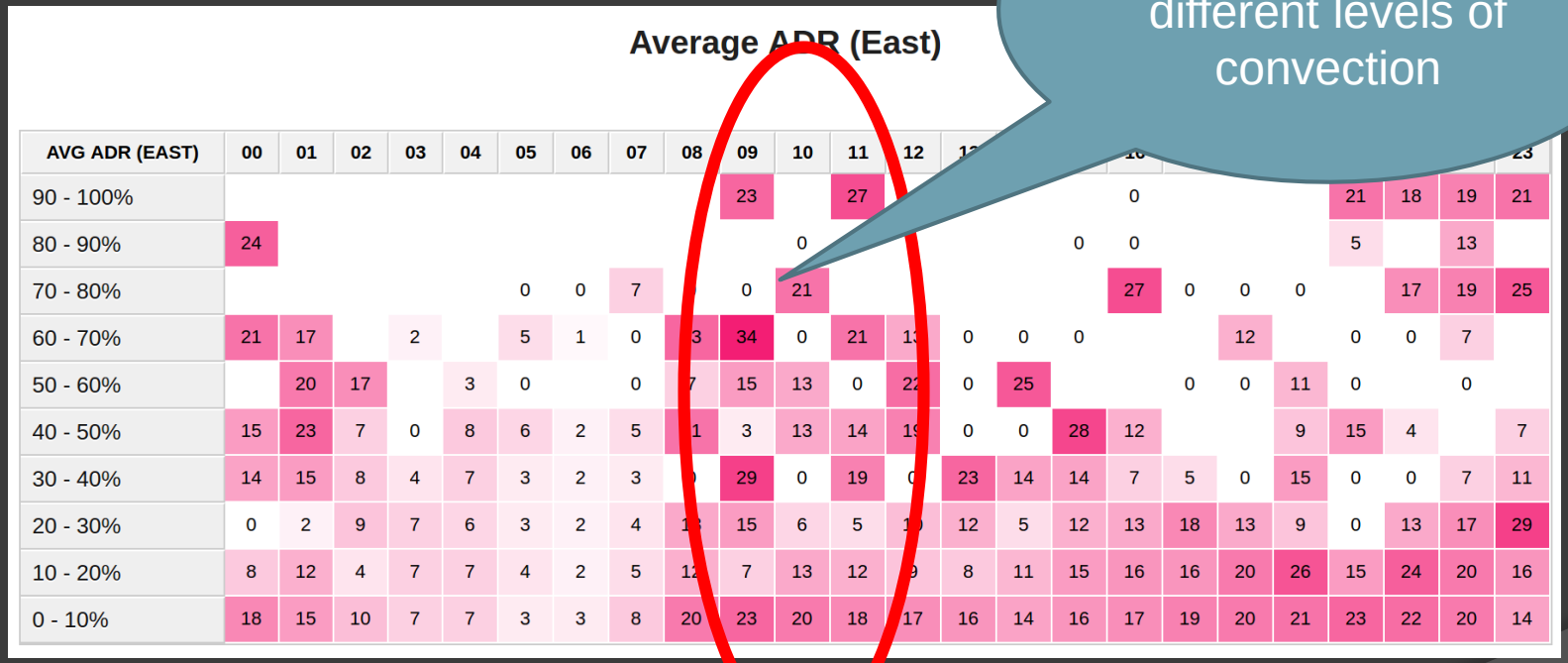


The max possible departure rate reveals some dependence to weather



MAX ADR (EAST)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	1				22	23
90 - 100%										23		27					0					19	21
80 - 90%	24										0	0				0	0					27	
70 - 80%						0	0	7	0	0	21						27					19	25
60 - 70%	24	17		2		5	4	0	23	34	0	30	30	0	0	0			24		0	13	
50 - 60%		20	17		13	0		0	12	29	27	0	22	0	27			0	0	18	0		0	
40 - 50%	15	23	14	0	9	11	3	11	21	11	26	21	31	0	0	28	26			28	25	8		15
30 - 40%	28	25	22	10	12	5	2	12	0	33	0	29	0	31	28	29	14	26	0	30	0	0	22	22
20 - 30%	0	4	18	12	7	5	8	12	28	35	22	32	30	32	23	25	26	32	24	27	0	20	25	29
10 - 20%	24	28	14	21	14	11	7	13	34	32	35	32	29	28	29	34	30	31	33	28	30	27	32	30
0 - 10%	32	28	26	21	26	16	10	17	34	38	39	39	42	38	36	38	39	37	36	37	37	37	39	35

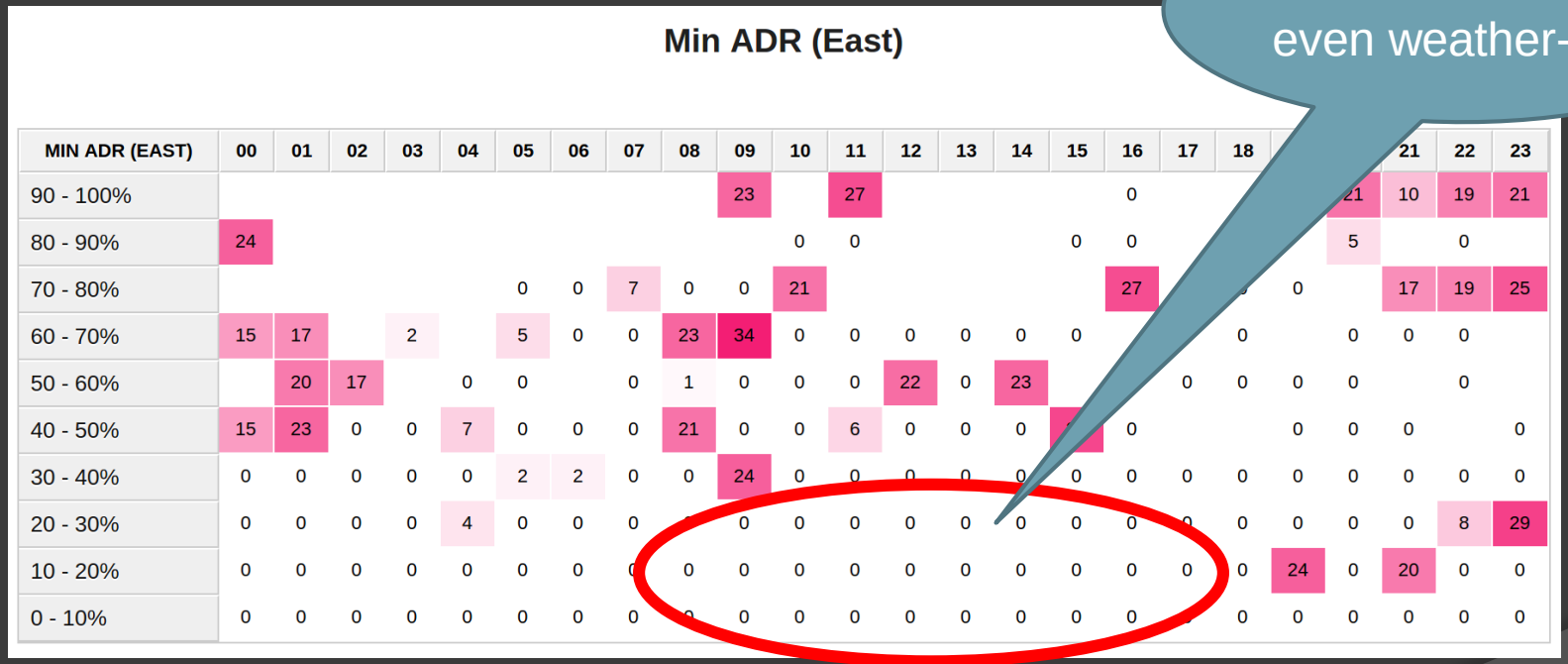
Average ADR, not much signal



AVG ADR (EAST)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
90 - 100%										23		27					0					21	18	19	21
80 - 90%	24										0					0	0					5		13	
70 - 80%						0	0	7		0	21						27	0	0	0			17	19	25
60 - 70%	21	17		2		5	1	0	3	34	0	21	13	0	0	0			12		0	0	7	
50 - 60%		20	17		3	0		0	7	15	13	0	22	0	25			0	0	11	0		0	
40 - 50%	15	23	7	0	8	6	2	5	1	3	13	14	19	0	0	28	12			9	15	4		7
30 - 40%	14	15	8	4	7	3	2	3	0	29	0	19	0	23	14	14	7	5	0	15	0	0	7	11
20 - 30%	0	2	9	7	6	3	2	4	1	15	6	5	1	12	5	12	13	18	13	9	0	13	17	29
10 - 20%	8	12	4	7	7	4	2	5	12	7	13	12	9	8	11	15	16	16	20	26	15	24	20	16
0 - 10%	18	15	10	7	7	3	3	8	20	23	20	18	17	16	14	16	17	19	20	21	23	22	20	14

Neither the Mininum ADR

(traffic is a multi-factor thing, weather being just one)

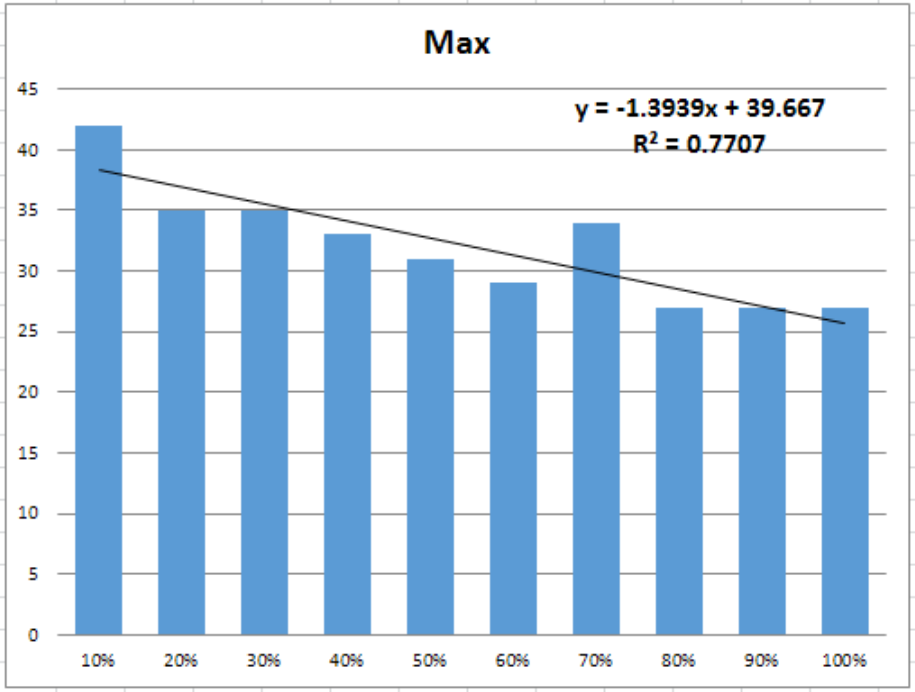


MIN ADR (EAST)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
90 - 100%										23		27					0					21	10	19	21
80 - 90%	24										0	0				0	0					5		0	
70 - 80%						0	0	7	0	0	21						27			0			17	19	25
60 - 70%	15	17		2		5	0	0	23	34	0	0	0	0	0	0			0		0	0	0	0	
50 - 60%		20	17		0	0		0	1	0	0	0	22	0	23			0	0	0	0		0	
40 - 50%	15	23	0	0	7	0	0	0	21	0	0	6	0	0	0		0			0	0	0		0
30 - 40%	0	0	0	0	0	2	2	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 30%	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	29
10 - 20%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	20	0	0
0 - 10%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Regression

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	Max ADR (East)																								
2	MAX ADR (EAST)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3	90 - 100%	0	0	0	0	0	0	0	0	0	23	0	27	0	0	0	0	0	0	0	0	21	26	19	21
4	80 - 90%	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	27	0
5	70 - 80%	0	0	0	0	0	0	0	7	0	0	21	0	0	0	0	0	27	0	0	0	0	17	19	25
6	60 - 70%	24	17	0	2	0	5	4	0	23	34	0	30	30	0	0	0	0	0	24	0	0	0	13	0
7	50 - 60%	0	20	17	0	13	0	0	0	12	29	27	0	22	0	27	0	0	0	0	18	0	0	0	0
8	40 - 50%	15	23	14	0	9	11	3	11	21	11	26	21	31	0	0	28	26	0	0	28	25	8	0	15
9	30 - 40%	28	25	22	10	12	5	2	12	0	33	0	29	0	31	28	29	14	26	0	30	0	0	22	22
10	20 - 30%	0	4	18	12	7	5	8	12	28	35	22	32	30	32	23	25	26	32	24	27	0	20	25	29
11	10 - 20%	24	28	14	21	14	11	7	13	34	32	35	32	29	28	29	34	30	31	33	28	30	27	32	30
12	0 - 10%	32	28	26	21	26	16	10	17	34	38	39	39	42	38	36	38	39	37	36	37	37	37	39	35

Severity of weather in the “departure corridor” has fair correlation to the maximum acheiveable ADR (data period: 2015)

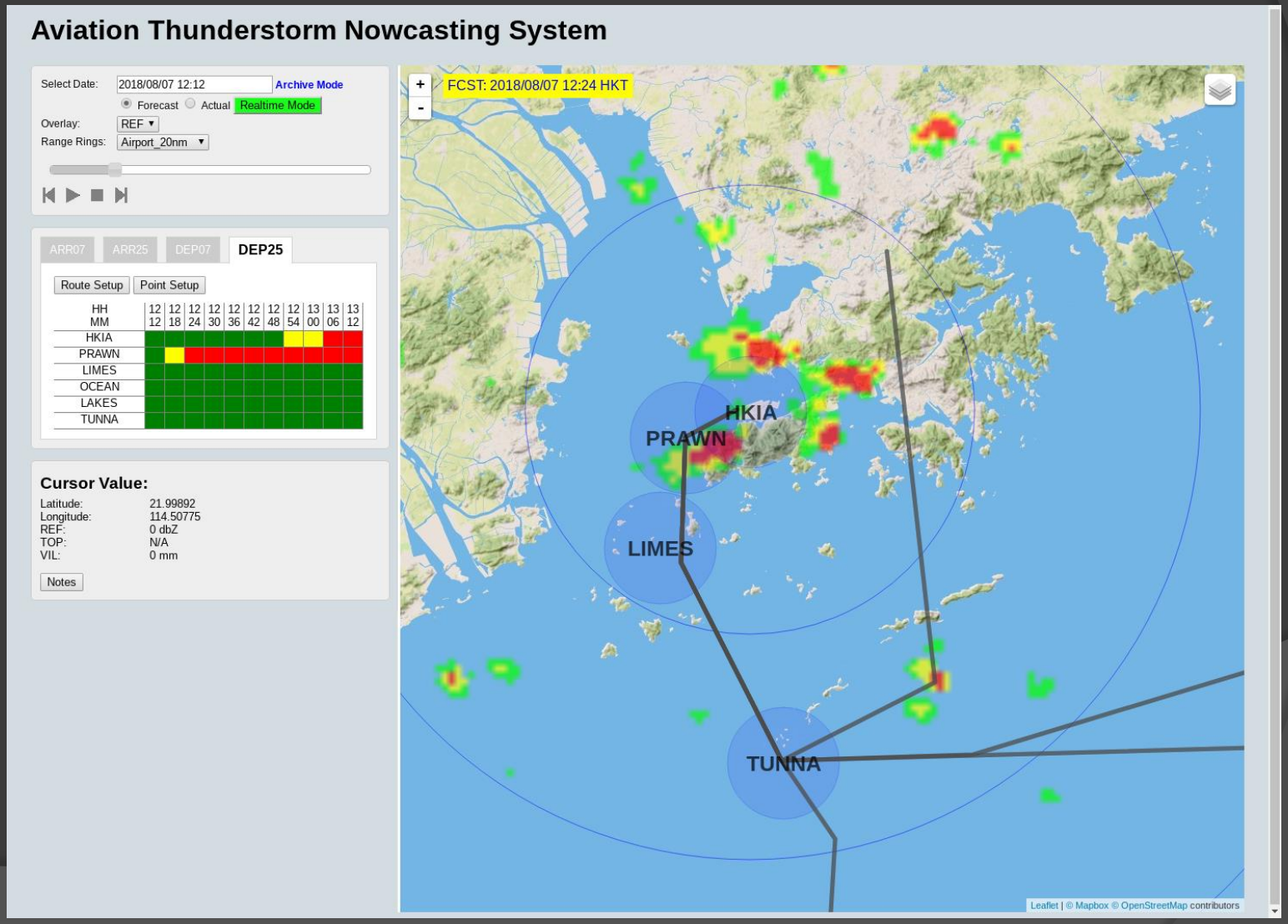


Validate/Verify the result

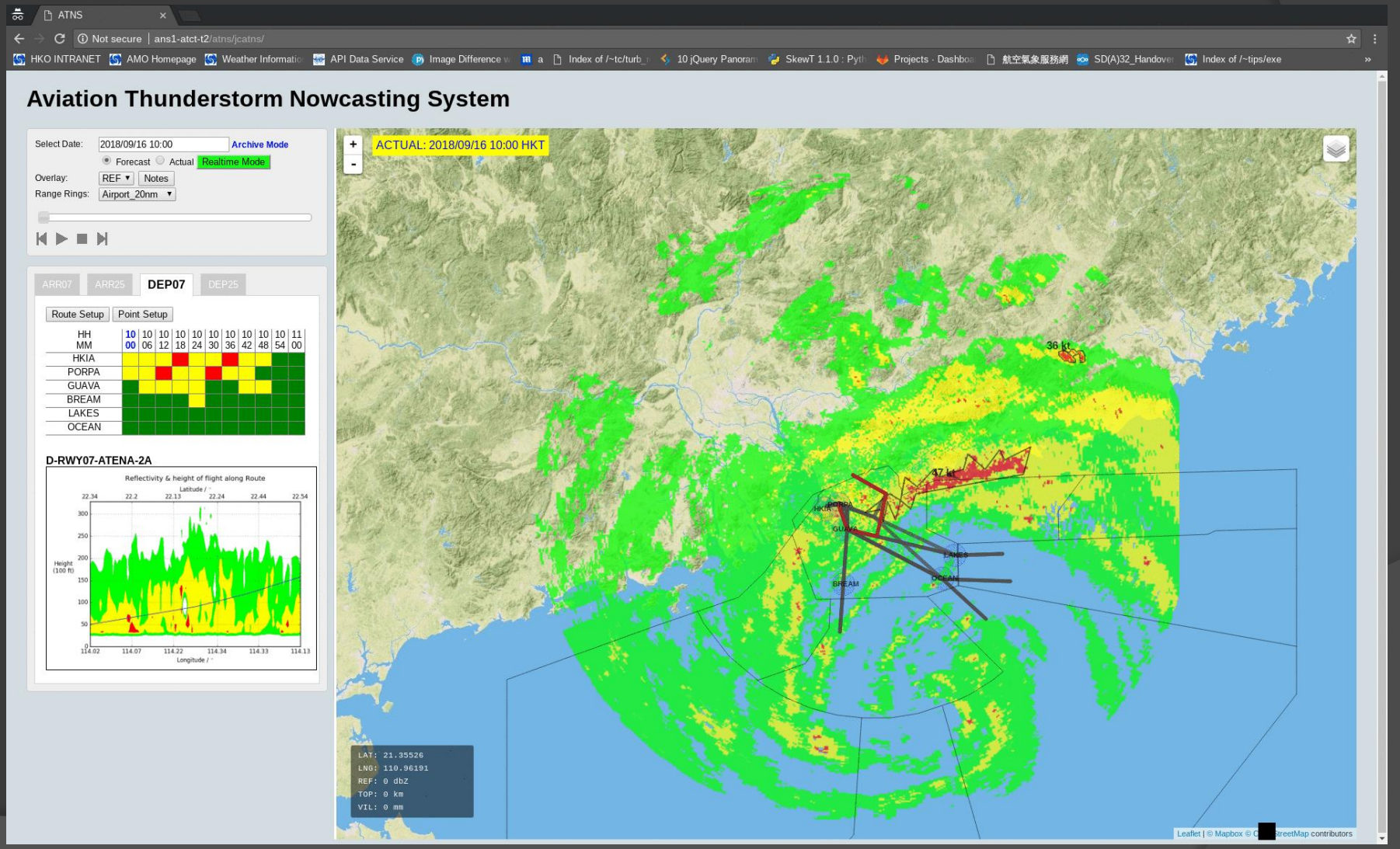
	A	B	C	D	E	F
1	#fwx,	awx,	fadr,	aadr		
2	1	0	40	31		
3	1	0	40	29		
4	15	31	38	29		
5	39	42	34	29		
6	26	23	36	30		
7	32	26	35	33		
8	36	13	35	27		
9	51	20	33	34		
10	2	2	39	14		
11	1	3	40	10		
12	5	4	39	4		
13	6	2	39	10		
14	6	2	39	28		
15	0	4	40	29		
16	11	6	38	34		
17	1	4	40	28		
18	21	6	37	27		
19	16	9	37	31		
20	12	9	38	32		
21	4	9	39	34		
22	5	1	39	28		
23	0	6	40	25		

- Data period: 2016
- 1hr forecast for “departure corridor” from ATNS
- For every weather severity level, the corresponding ADR were collected to find the maximum

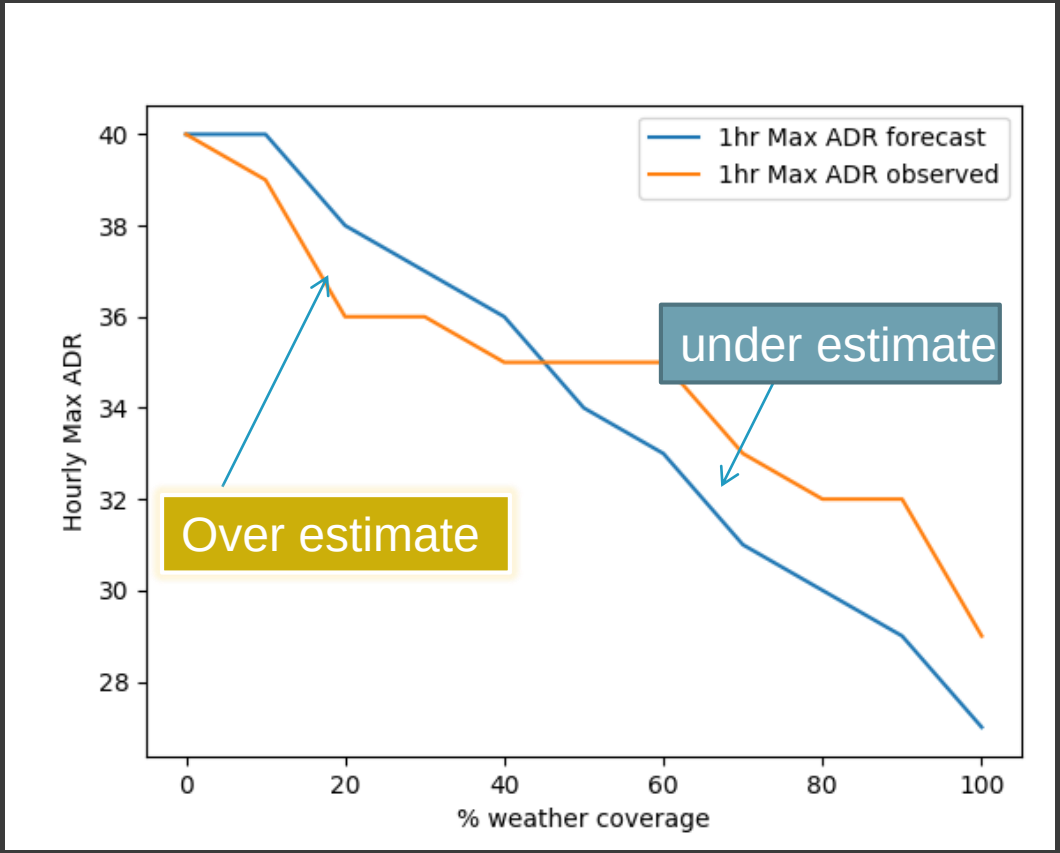
Aviation Thunderstorm Nowcasting System (ATNS)



Super Typhoon Mangkhut



Validate/Verify the result with 2016 data



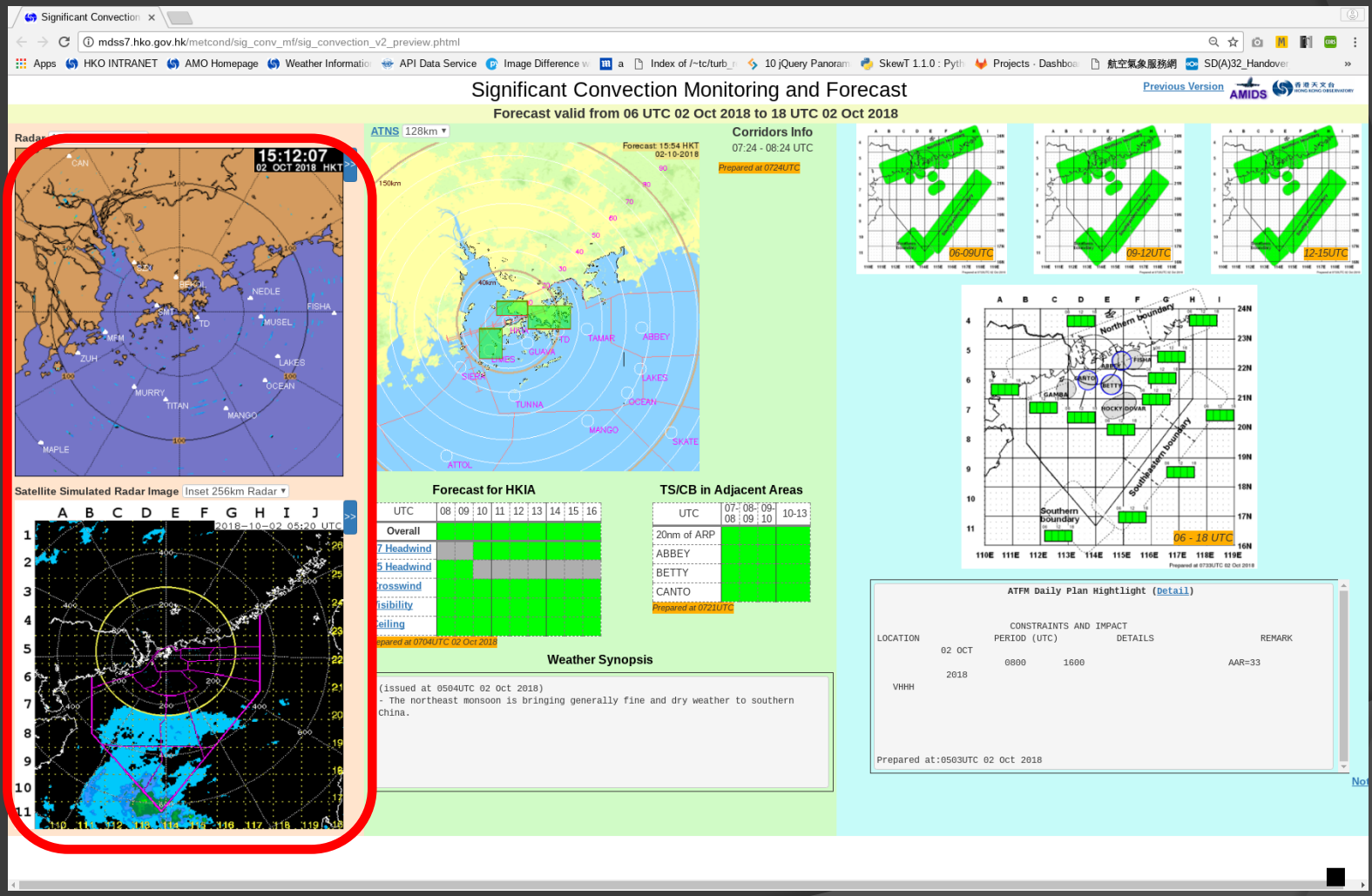
- General trend matched
- Max ADR over-estimate in less severe weather condition, and under-estimate in severe cases
  - Error in weather forecast?
  - Non-linearity of weather impact?
- Use as a reasonable **"ceiling"** for ADR estimation
- Possible application in A-CDM

Work to do on ADR

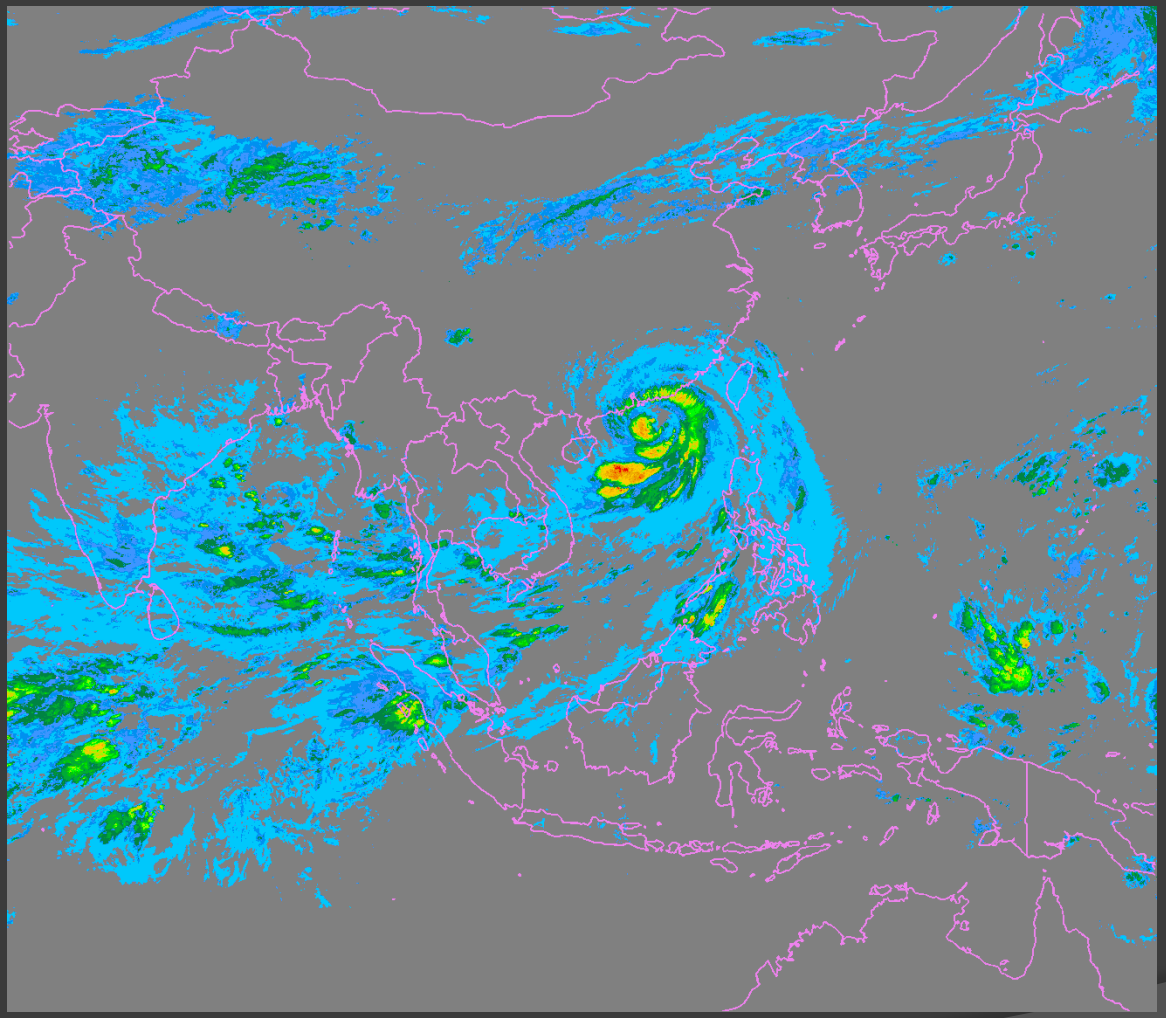
- Refine the “corridor”
- Extend forecast range to 2 hours

SIGNIFICANT CONVECTION MONITORING & FORECAST

Monitoring

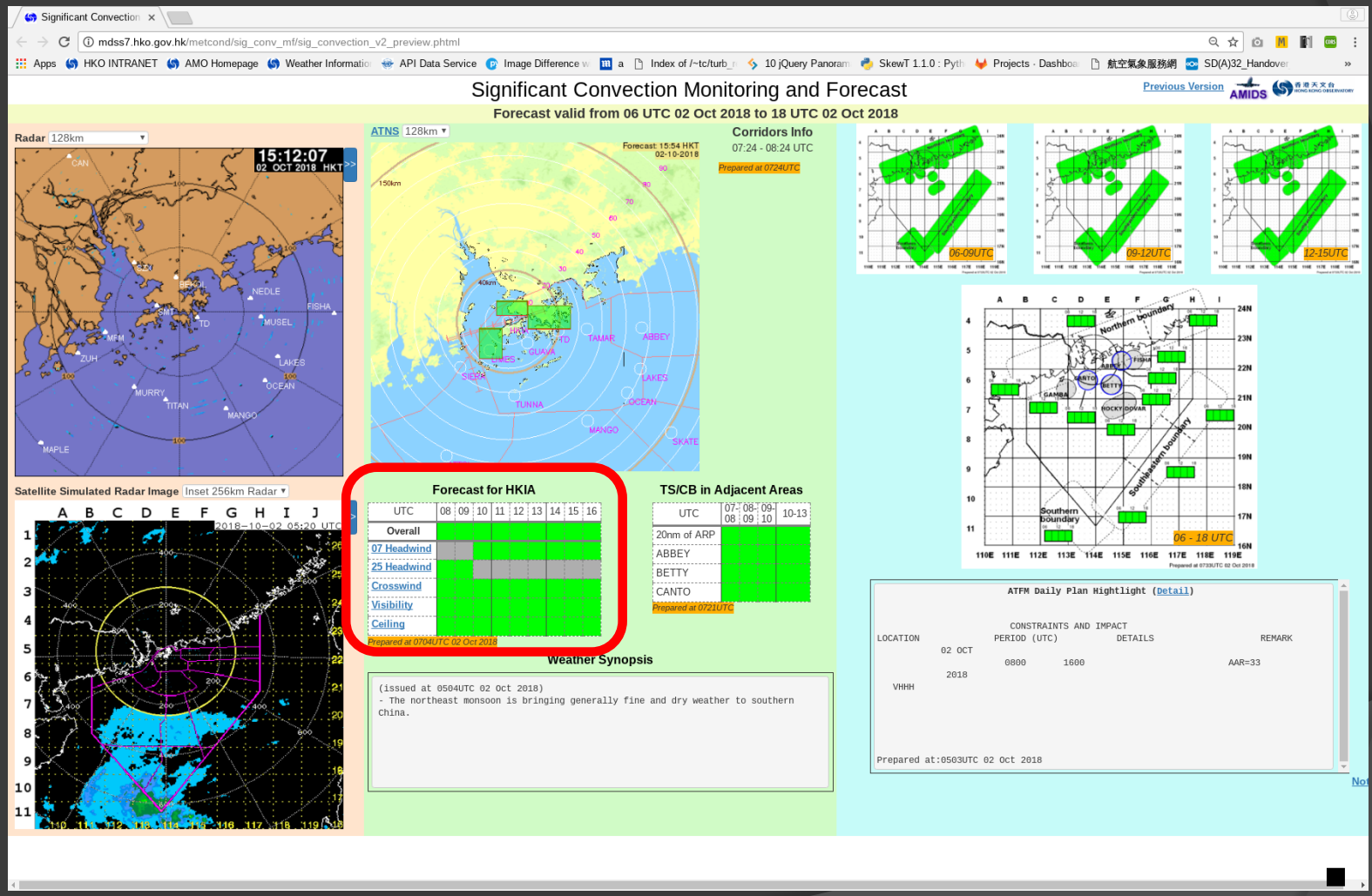

Significant Convection
mdss7.hko.gov.hk/metcond/sig_conv_mf/sig_convection_v2_preview.phtml
Significant Convection Monitoring and Forecast
Previous Version
AMIDS
Forecast valid from 06 UTC 02 Oct 2018 to 18 UTC 02 Oct 2018
15:12:07
02 OCT 2018 HKT
Satellite Simulated Radar Image
Inset 256km Radar
2018-10-02 05:20 UTC
ATNS
128km
Forecast 15:54 HKT
02-10-2018
Corridors Info
07:24 - 08:24 UTC
Prepared at 0724UTC
06-09UTC
09-12UTC
12-15UTC
Forecast for HKIA
UTC
08 09 10 11 12 13 14 15 16
Overall
7 Headwind
5 Headwind
Crosswind
Visibility
Ceiling
Prepared at 0704UTC 02 Oct 2018
TS/CB in Adjacent Areas
UTC
07-08 08-09 09-10 10-13
20nm of ARP
ABBEY
BETTY
CANTO
Prepared at 0721UTC
Northern boundary
Southeastern boundary
Southern boundary
06 - 18 UTC
Weather Synopsis
(issued at 0504UTC 02 Oct 2018)
- The northeast monsoon is bringing generally fine and dry weather to southern China.
ATFM Daily Plan Hightlight (Detail)
CONSTRAINTS AND IMPACT
LOCATION PERIOD (UTC) DETAILS REMARK
02 OCT 2018
0800 1600 AAR=33
VHHH
Prepared at:0503UTC 02 Oct 2018

Satellite-simulated-radar reflectivity

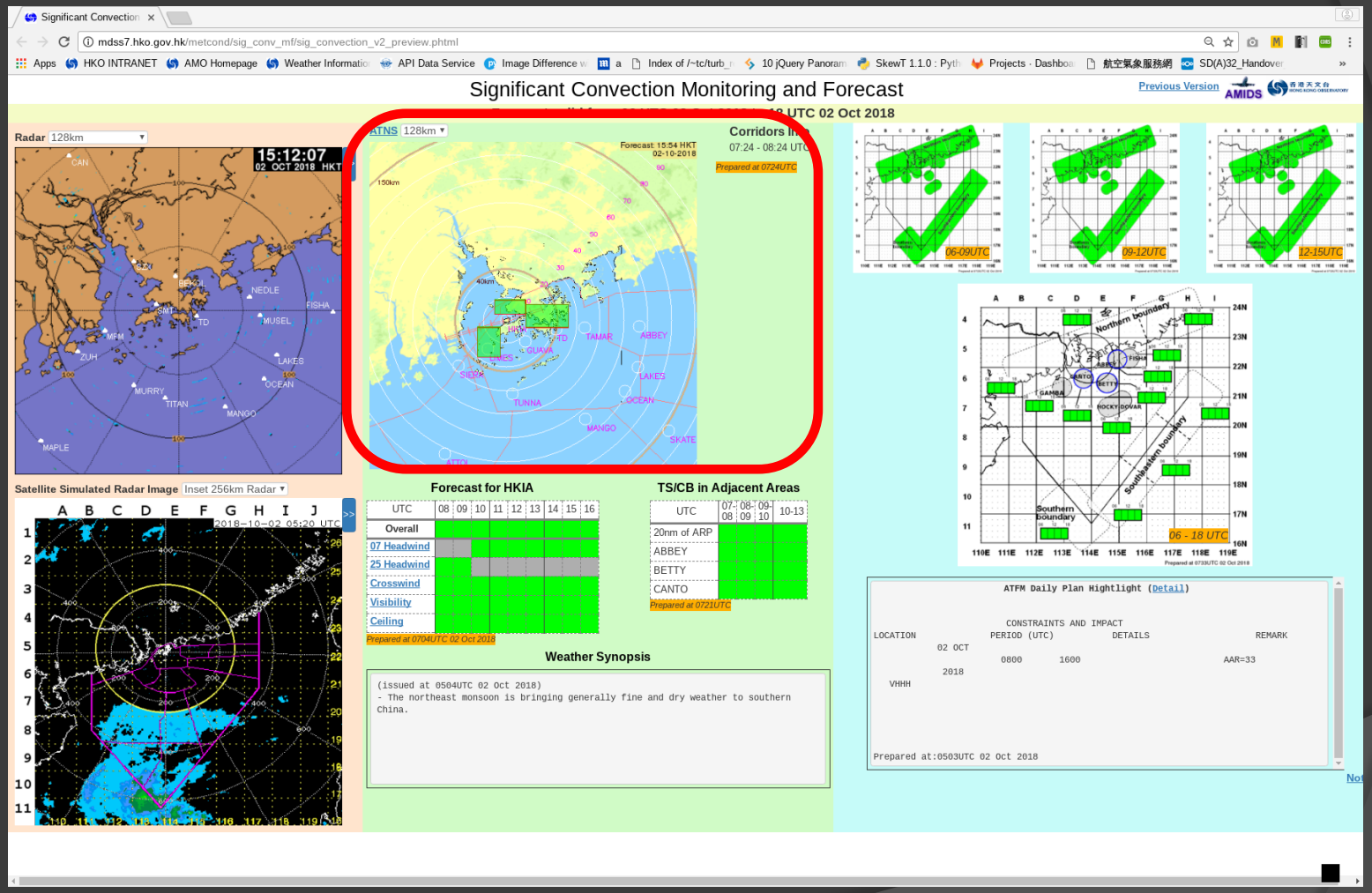


- Apply machine learning algorithm
- Handy reference to supplement limited radar coverage
- Used in regional nowcast products

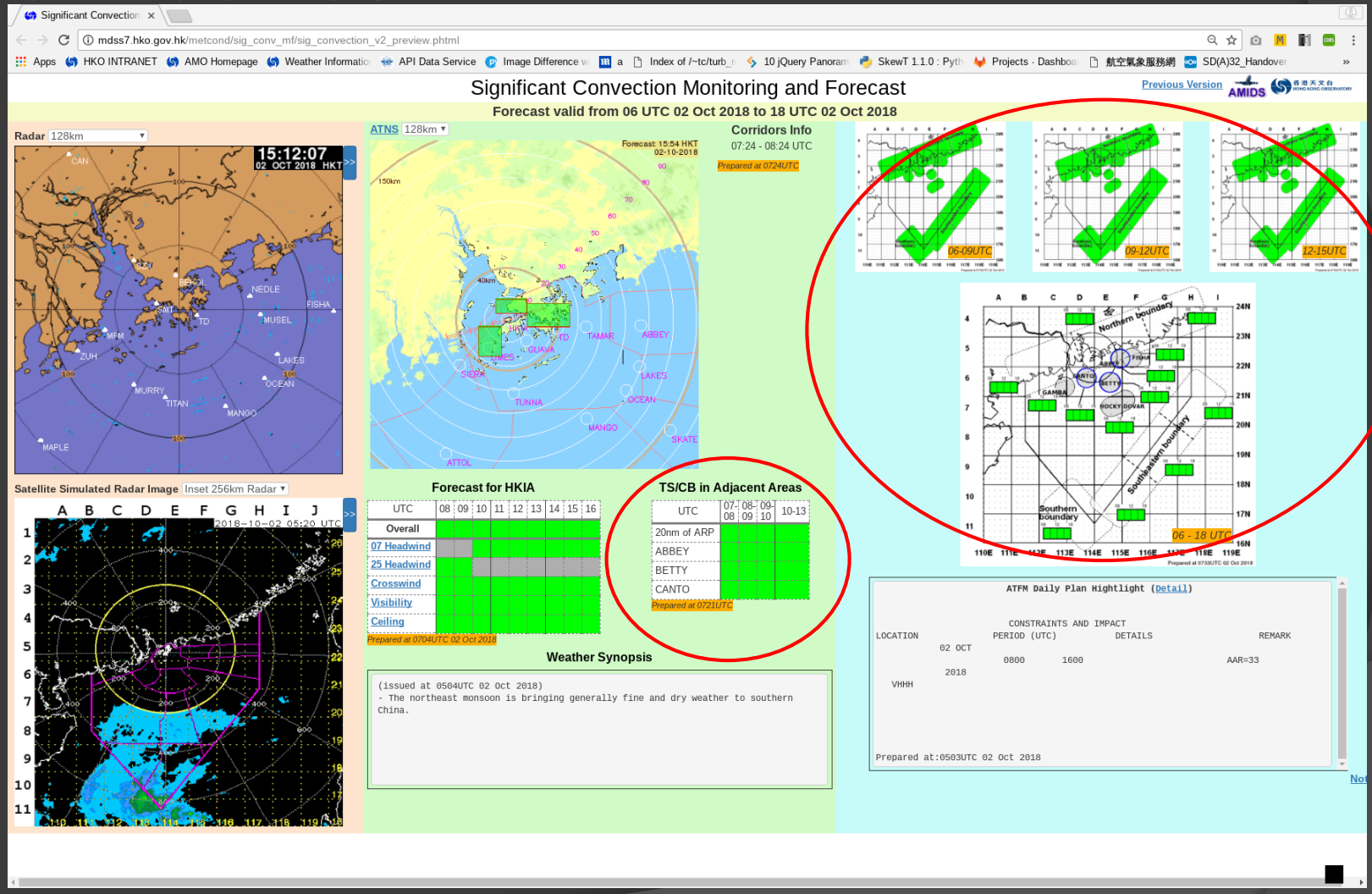
Impact Matrix, 9hr terminal forecast



Convection forecast for arrival/departure corridors



Holding areas and FIR boundaries



Significant Convection

mdss7.hko.gov.hk/metcond/sig_conv_mf/sig_convection_v2_preview.phtml

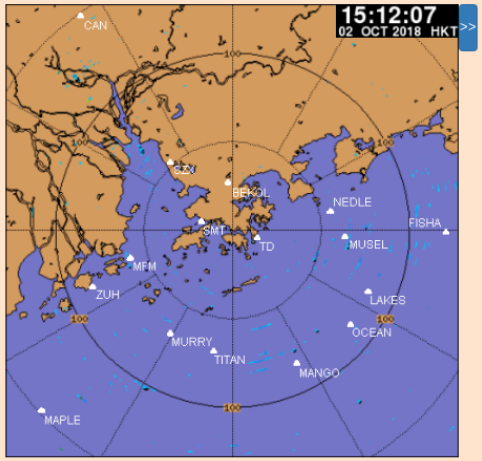
Apps | HKO INTRANET | AMO Homepage | Weather Information | API Data Service | Image Difference | a | Index of /~tc/turb_ | 10 jQuery Panoram | SkewT 1.1.0 : Pyth | Projects · Dashboa | 航空氣象服務網 | SD(A)32_Handover

Significant Convection Monitoring and Forecast

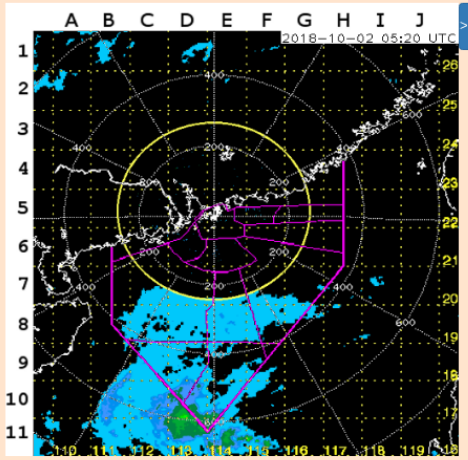
Previous Version | AMIDS | 香港天文台 HONG KONG OBSERVATORY

Forecast valid from 06 UTC 02 Oct 2018 to 18 UTC 02 Oct 2018

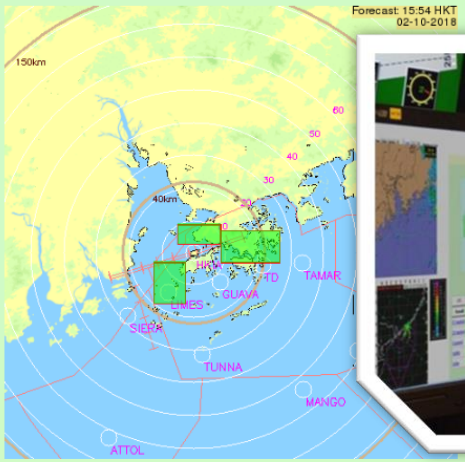
Radar 128km



Satellite Simulated Radar Image Inset 256km Radar

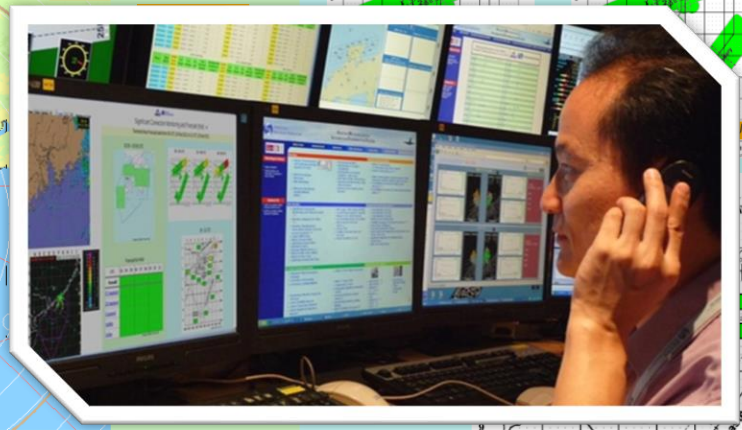


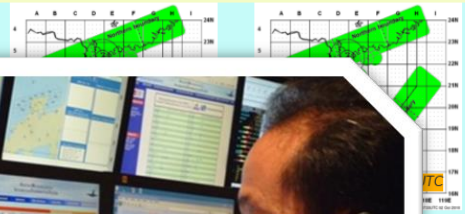
ATNS 128km

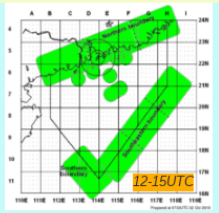


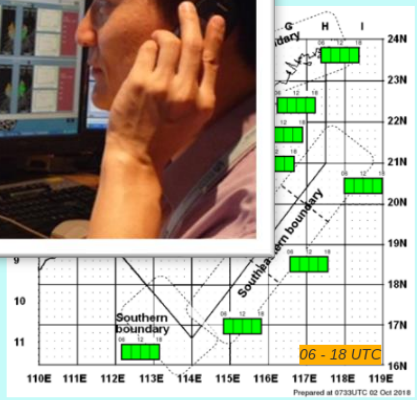
Corridors Info

07:24 - 08:24 UTC









Forecast for HKIA

UTC	08	09	10	11	12	13	14	15	16
Overall									
07 Headwind									
25 Headwind									
Crosswind									
Visibility									
Ceiling									

Prepared at 0704UTC 02 Oct 2018

TS/CB in Adjacent Areas

UTC	07-08	08-09	09-10	10-13
20nm of ARP				
ABBEY				
BETTY				
CANTO				

Prepared at 0721UTC

Weather Synopsis

(issued at 0504UTC 02 Oct 2018)
- The northeast monsoon is bringing generally fine and dry weather to southern China.

ATFM Daily Plan Hightlight (Detail)

CONSTRAINTS AND IMPACT

LOCATION	PERIOD (UTC)	DETAILS	REMARK
02 OCT 2018 VHHH	0800 1600	AAR=33	

Prepared at:0503UTC 02 Oct 2018

Not

Significant Convection

mdss7.hko.gov.hk/metcond/sig_conv_mf/sig_convection_v2_preview.phtml

Apps | HKO INTRANET | AMO Homepage | Weather Information | API Data Service | Image Difference w | a | Index of /~tc/turb_r | 10 jQuery Panoram | SkewT 1.1.0 : Pyth | Projects · Dashboa | 航空氣象服務網 | SD(A)32_Handover

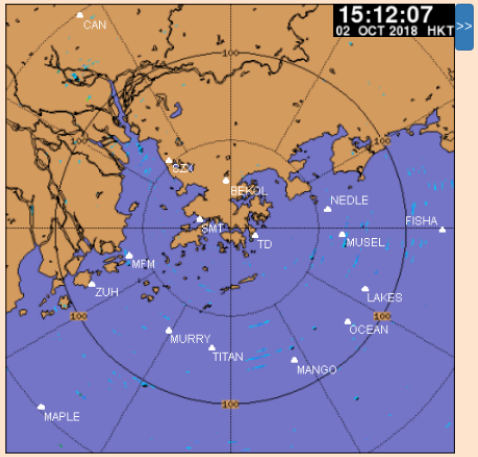
Significant Convection Monitoring and Forecast

Previous Version

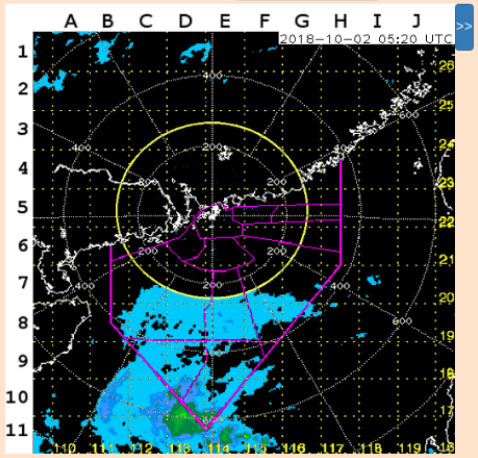
AMIDS

Forecast valid from 06 UTC 02 Oct 2018 to 18 UTC 02 Oct 2018

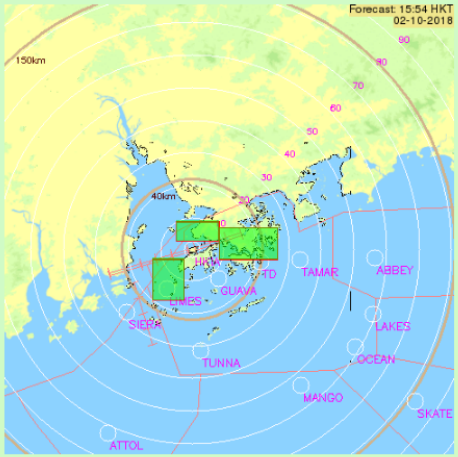
Radar 128km



Satellite Simulated Radar Image Inset 256km Radar



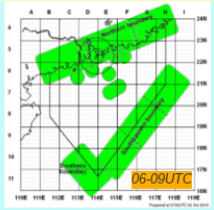
ATNS 128km

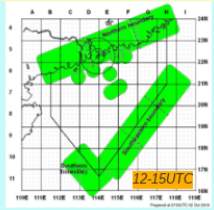


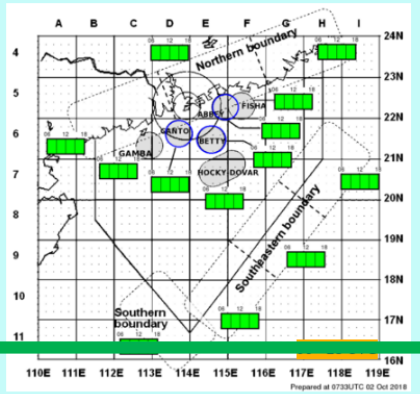
Corridors Info

07:24 - 08:24 UTC

Prepared at 0724UTC







Forecast for HKIA

UTC	08	09	10	11	12	13	14	15	16
Overall									
07 Headwind									
25 Headwind									
Crosswind									
Visibility									
Ceiling									

Prepared at 0704UTC 02 Oct 2018

TS/CB in Adjacent Areas

UTC	07-08	08-09	09-10	10-13
20nm of ARP				
ABBEY				
BETTY				
CANTO				

Prepared at 0721UTC

Weather Synopsis

(issued at 0504UTC 02 Oct 2018)
- The northeast monsoon is bringing generally fine and dry weather to southern China.

ATFM Daily Plan Hightlight (Detail)

CONSTRAINTS AND IMPACT

LOCATION	PERIOD (UTC)	DETAILS	REMARK
02 OCT 2018 VHHH	0800 1600	AAR=33	

Prepared at:0503UTC 02 Oct 2018

Nc

ATFM Daily Plan

ATFM Daily Plan (ADP)

ATFM DAILY PLAN	HONG KONG
DATE / TIME OF ISSUE	06 JUN 2018, 0352 UTC
STATUS / REFERENCE	EFFECTIVE – UTC, 06 JUN 2018 HK 01

CONSTRAINTS AND IMPACT

LOCATION	PERIOD (UTC)			DETAILS	REMARK
VHHH	06 JUN 2018	0700	1100	VHHH under the influence of Tropical Storm EWINIAR	AAR=30
		1100	1600		AAR=33

ATFM MEASURE

LOCATION	ATFM MEASURE PERIOD (UTC)			ATFM MEASURE
VHHH	06 JUN 2018	0700	1100	GDP – CTOT will be issued to traffic from Singapore & Bangkok FIR

POSSIBLE / DEVELOPING ISSUES

LOCATION	PERIOD (UTC)			REMARK

WEATHER BRIEFING

AIRSPACE STATUS BRIEFING

OTHER INFORMATION

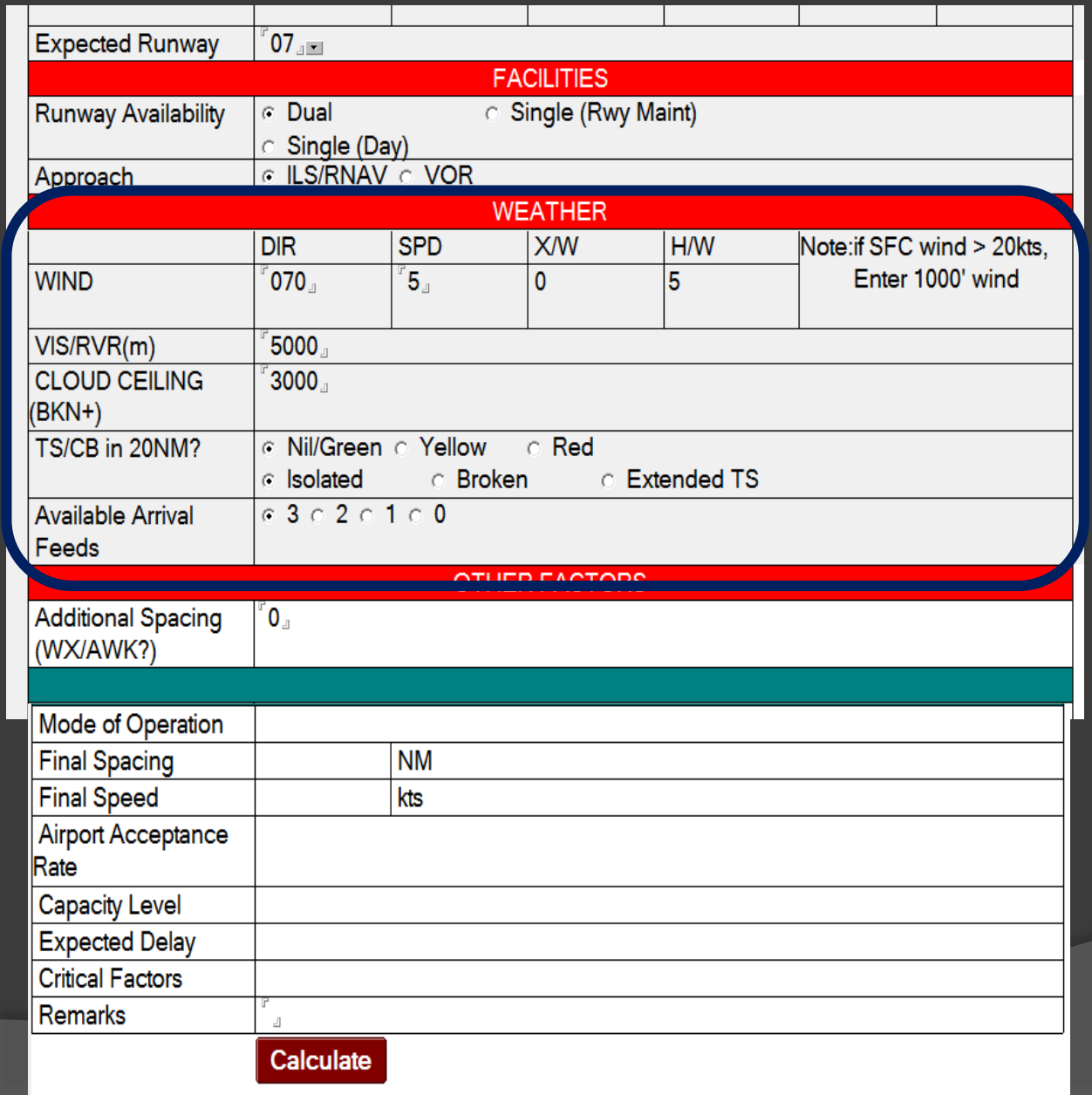
Normal AAR=34

CTOT compliance window -5/+10 minutes.

FOR CHANGES TO FLIGHTS, PLEASE CONTACT:
Primary: Hong Kong Flow Manager Phone Line: +852 2910 6859 (Operational) Email: atmdflm@cad.gov.hk
Secondary: Hong Kong ATFMU Phone Line: +852 2910 6275 Email: hkatfmu@cad.gov.hk

MORE ON AAR / ADR ESTIMATION

Acceptance Rate Estimation



Expected Runway	07					
FACILITIES						
Runway Availability	◉ Dual ○ Single (Rwy Maint) ○ Single (Day)					
Approach	◉ ILS/RNAV ○ VOR					
WEATHER						
	DIR	SPD	X/W	H/W	Note:if SFC wind > 20kts, Enter 1000' wind	
WIND	070	5	0	5		
VIS/RVR(m)	5000					
CLOUD CEILING (BKN+)	3000					
TS/CB in 20NM?	◉ Nil/Green ○ Yellow ○ Red ◉ Isolated ○ Broken ○ Extended TS					
Available Arrival Feeds	◉ 3 ○ 2 ○ 1 ○ 0					
OTHER FACTORS						
Additional Spacing (WX/AWK?)	0					

Mode of Operation		
Final Spacing		NM
Final Speed		kts
Airport Acceptance Rate		
Capacity Level		
Expected Delay		
Critical Factors		
Remarks		

Calculate

1. Landing condition (i.e. the impact matrix)
2. TS within 20NM (arrival corridor)
3. Holding capability

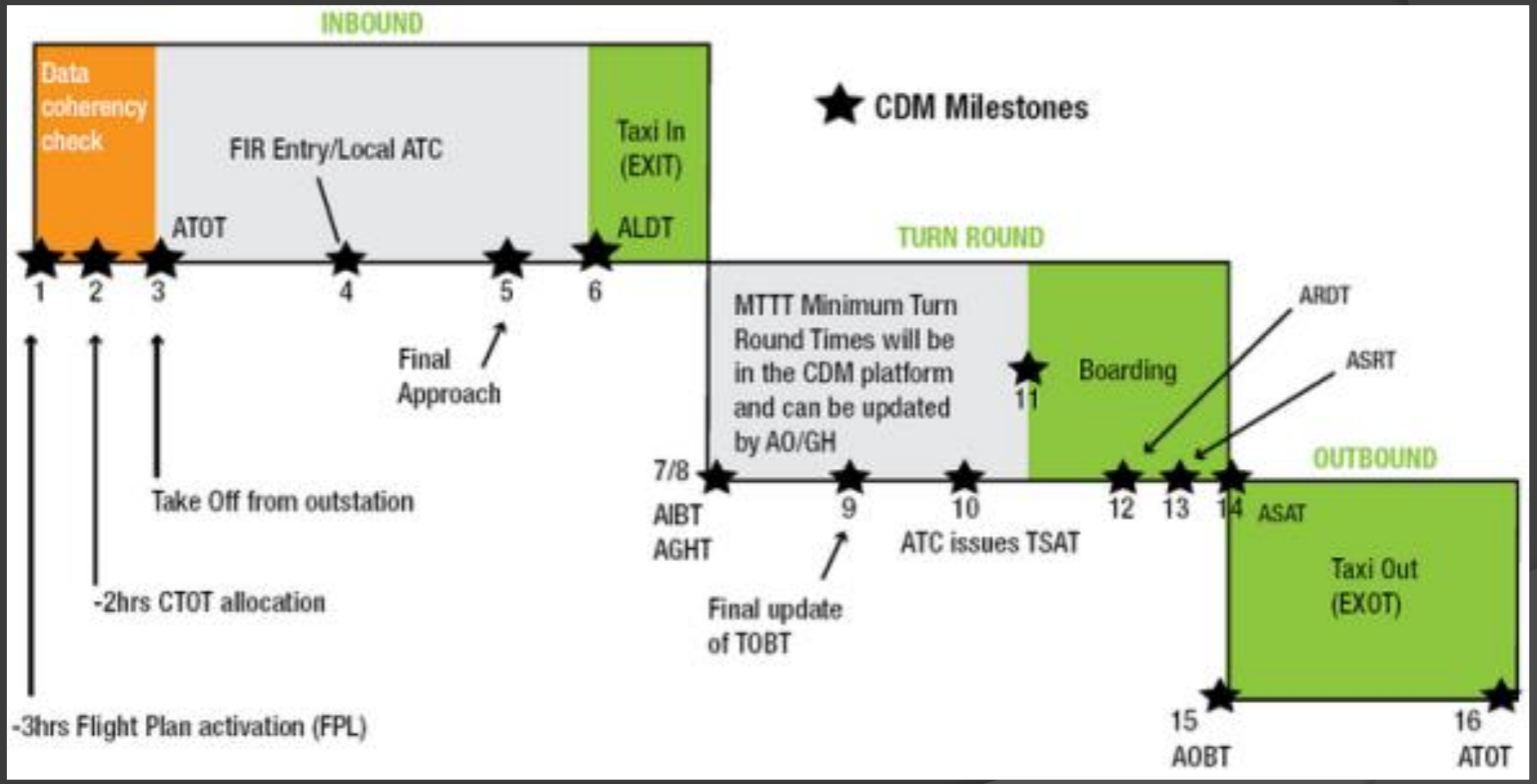
ADR Relevance

- So far, focus generally on AAR as the most constraining airport determination
- Departures typically subject to fewer constraints
  - Diversity of departure tracks often possible
  - Fewer wake vortex interactions constraining departure spacing
    - E.g. H-H requires 4NM on approach but no specific time spacing requirement on departure

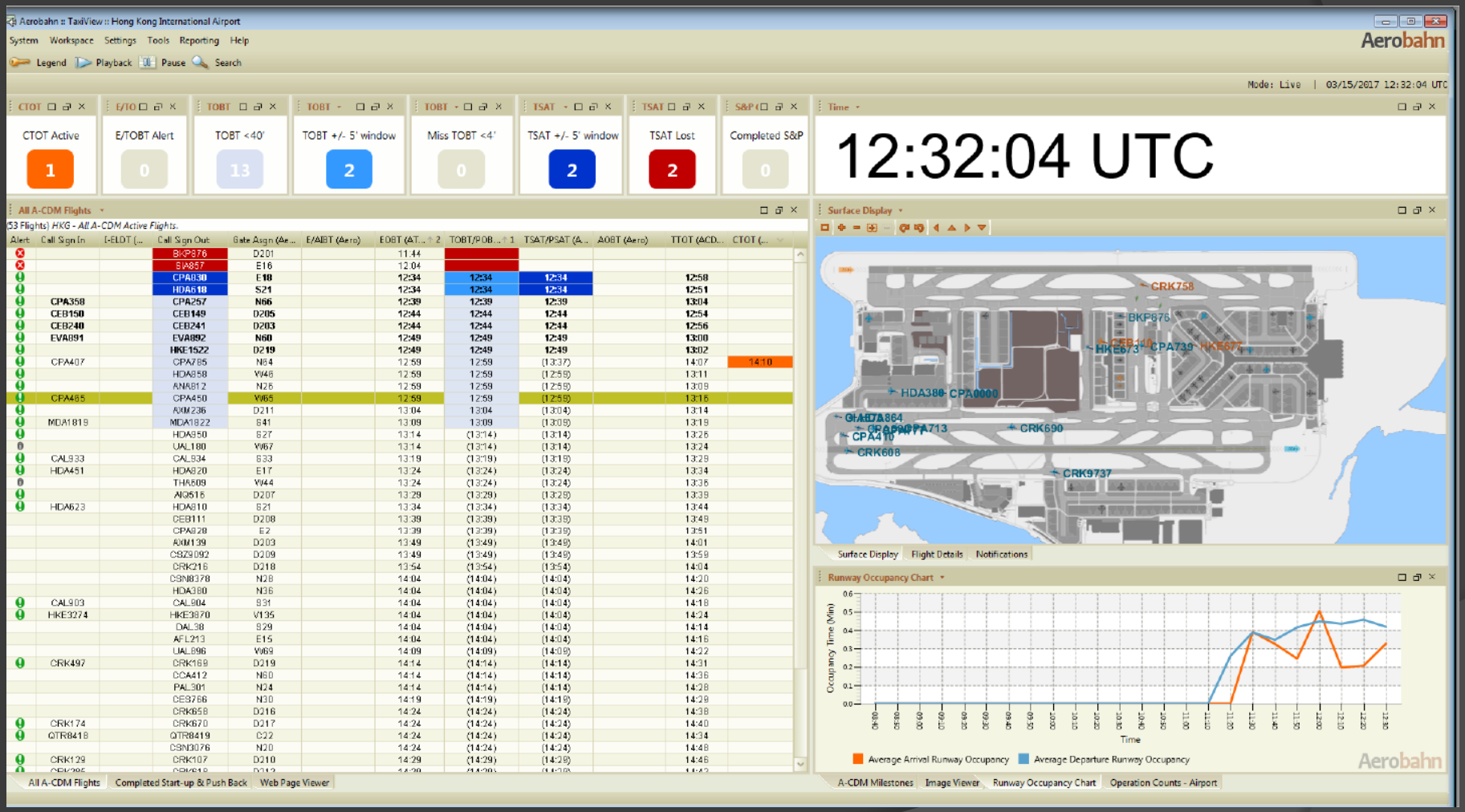
ADR Determination

- As airports approach capacity, arrival-departure mix and optimized runway balancing becomes more important
- Supplying departures to the right runway, at the right time, with minimum holding point delay is the goal
- Automated systems such as A-CDM platforms with pre-departure sequencing can assist **PROVIDED** an accurate prediction of ADR can be supplied

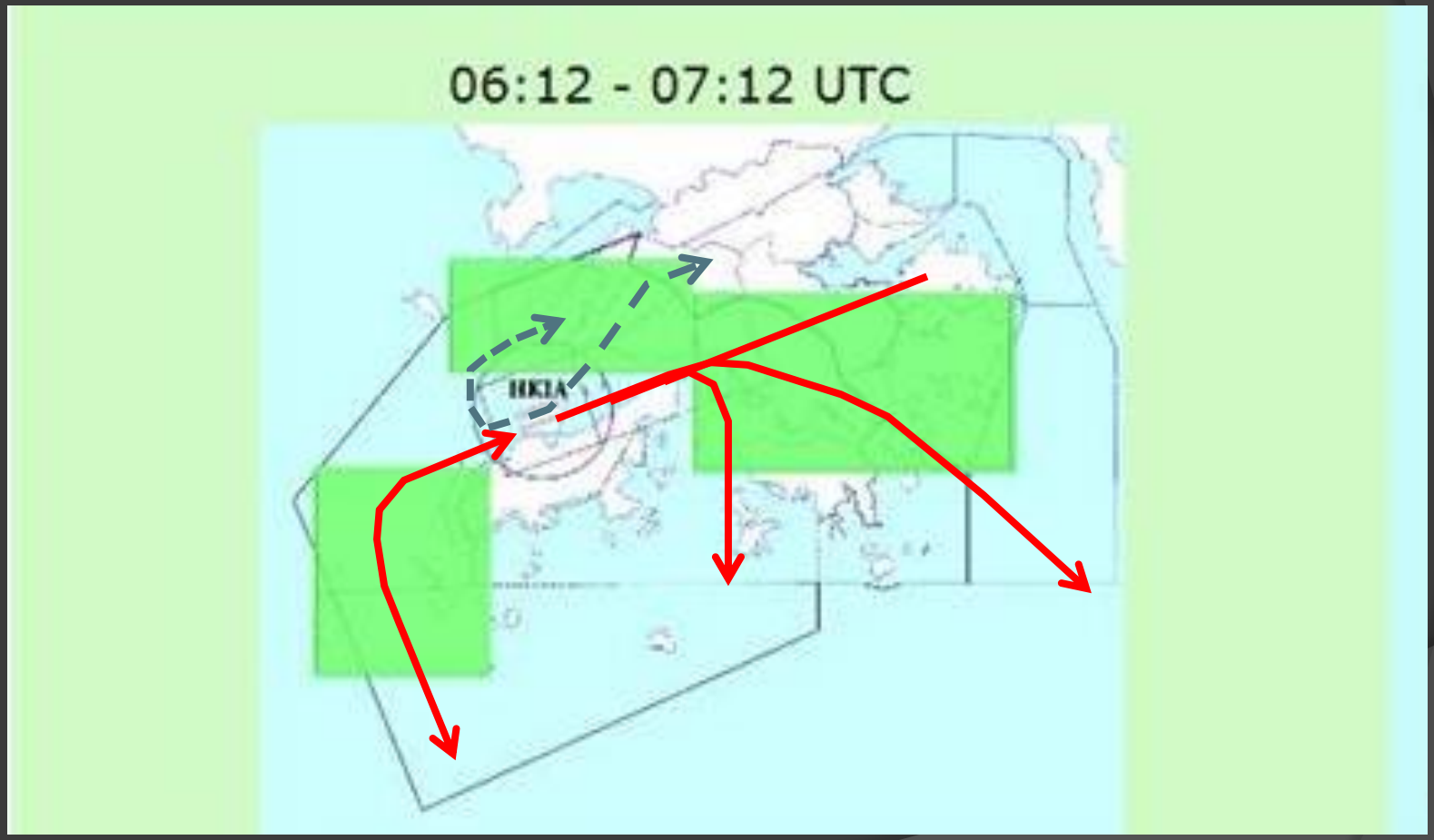
A-CDM Milestone Process



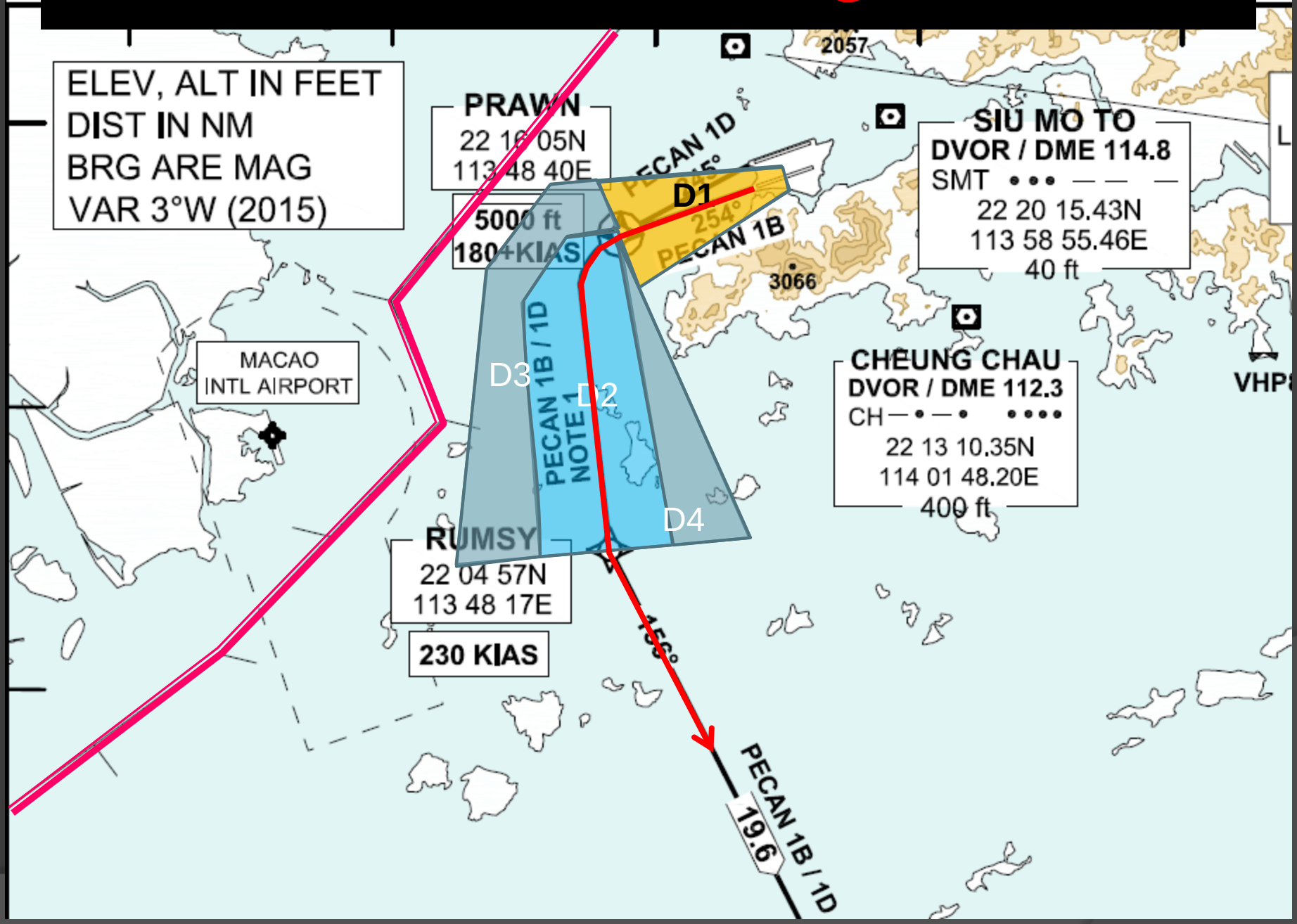
HKIA A-CDM Platform



Current APP/DEP Nowcasting Areas

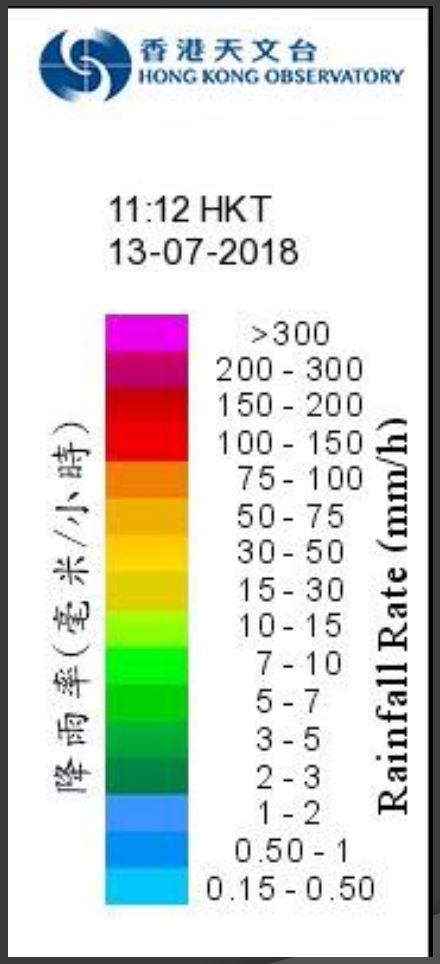


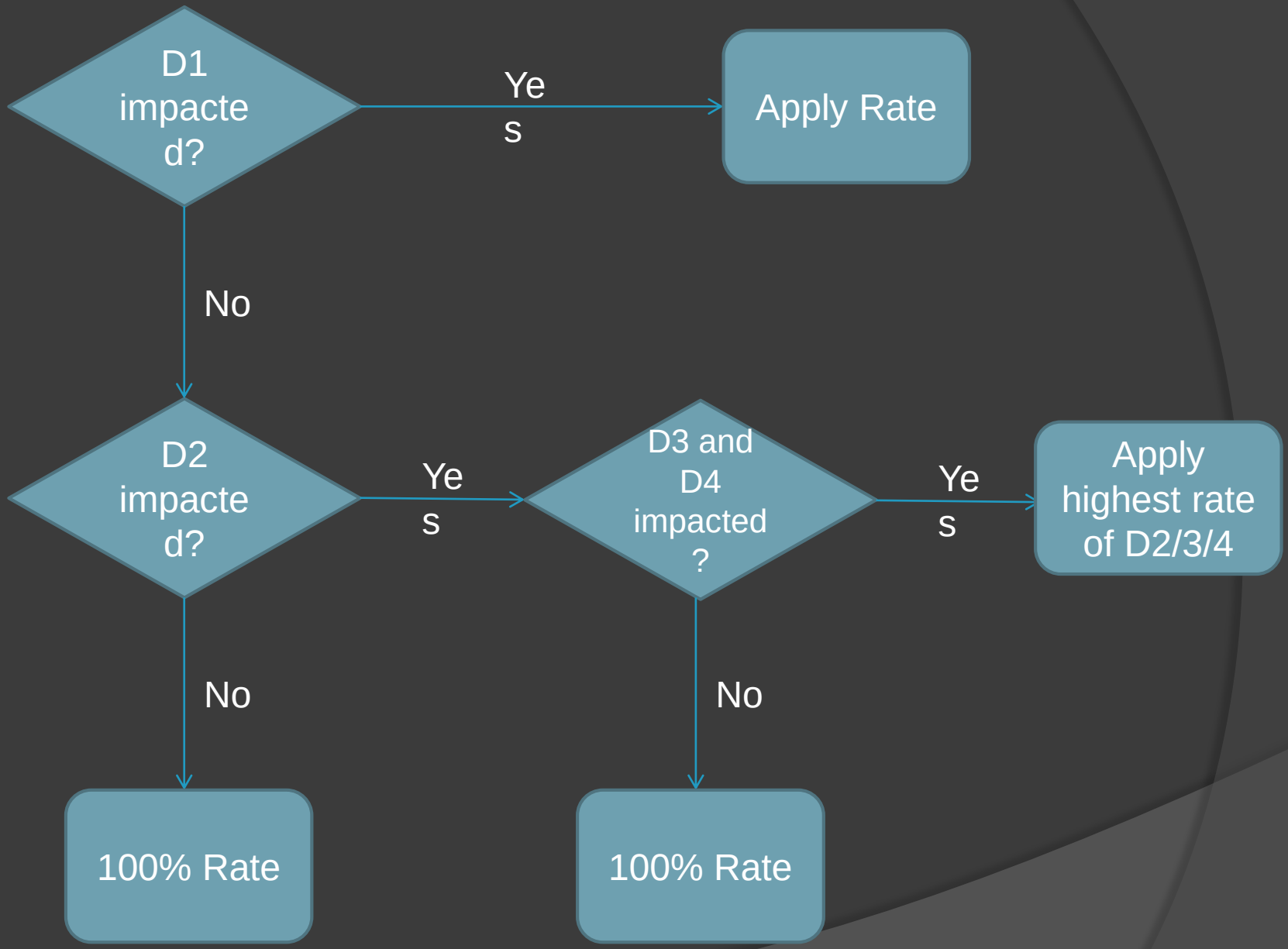
Refined DEP Funnel Nowcasting Areas



Departure Rate Impact

% of Normal Departure Rate
<10
10-25
26-50
51-75
76-90
>90




D1 impacted?
Yes
Apply Rate
No
D2 impacted?
Yes
D3 and D4 impacted?
Yes
Apply highest rate of D2/3/4
No
100% Rate
No
100% Rate

END