Joint CAS/CAeM AvRDP SSC and EN-MHS/1 Meeting cum Aviation Seminar

Final report of HND/NRT

Yuki Kato Office of Aviation Weather Forecasting Japan Meteorological Agency

contents

- 1. Target Airports and Phenomena
- 2. Technical background
- 3. Establishment of MET offices to support ATM
- 4. Operations of ATMetC (JMA)
- 5. Operations of TMU (JCAB)
- 6. Operations of TMAT (JMA)
- 7. Overview of ATM CIEL
- 8. Outcomes
- 9. Benefits to local ATM
- 10. Contributions to ASBU
- 11. Gap identified
- 12. Future plan

1-1. Target Airports



Tokyo int'l airport (RJTT) Also called Haneda airport (HND).

Direction	Length (m)	Length (ft)						
16R/34L	3,000	9,843						
16L/34R	3,360	11,024						
04/22	2,500	8,202						
05/23	2,500	8,202						
Open in 1931								



Narita int'l airport (RJAA) or (NRT) Former name is New Tokyo int'l airport until March 2004.

Direction	Length (m)	Length (ft)						
16R/34L	4,000	13,123						
16L/34R	2,500	8,202						
Open in 1978								

1-2. Target weather phenomena (1)

	Cause	Cold Season (Oct - Mar)	Warm Season (Apr - Sep)	Sum	
	TS-OHD	4	23	27	
TS	Around the airport	6	28	34	
	Within the Approach Control Area	29	80	109	
СВ	Microburst Alert	2	0	2	
TS CB Wind Snow	Around the Approach Control Area	42	57	99	
CB Wind Snow	Strong Crosswind	40	29	69	
	Strong Low Level Wind	23	6	29	
	Vertical Wind Shear (Wind change on approach course)	6	Old Season Oct - Mar) Warm Season (Apr - Sep) Sum 4 23 6 28 29 80 1 22 0 42 57 40 29 40 29 40 29 5 0 2 0 40 29 40 29 5 0 23 0 40 29 23 6 40 29 40 29 5 0 20 0 159 228 3	10	
Spow	Snowfall	5	0	5	
311070	Snow Removal	2	0	2	
	Others	0	1	1	
	Sum	159	228	387	

The number of air traffic flow controls at RJTT classified by the causes (weather phenomena) (April 2013 – March 2015)



2-1. Technical background - JMA's Nowcasts products

	Precipitation Nowcasts	Thunderstorm and Hazardous Wind Potential Nowcasts	High- resolution Precipitation Nowcasts (HRPNs)	Forecast area with a spatial resolution of 250 m covering the period up to 30 minutes
Phenomenon	Precipitation intensity	Lightning and tornadoes	Precipitation intensity	ahead
Resolution	1 km	-	250 m or 1 km (up to 30 min) 1 km (35-60 min)	Forecast area with a
Forecast range (update frequency)	1 hour (every 5 minutes)	1 hour (every 10 minutes)	1 hour (every 5 minutes)	spatial resolution of 1 k
Operation	2011 - (1st gen 2004)	2010 -	2014 -	

2-2. Technical background - Precipitation Nowcasts

The following figure shows images from a heavy rain event that occurred on 29 June 2014. HRPNs successfully forecast areas of strong rain (as highlighted by the black circles) more accurately than existing Precipitation Nowcasts.



Upper left: existing Precipitation Nowcasts (initial time: 16:00 JST, 29 June 2014; forecast coverage period: 20 minutes ahead) Upper right: HRPN (initial time and forecast coverage period as per upper left) Lower left: observation values of existing Precipitation Nowcasts (16:20 JST, 29 June 2014) Lower right: analyzed values of the HRPN (time as per lower left)

2-3. Technical background - Dissemination via JMA's HP



https://www.jma.go.jp/en/highresorad/



Composite weather radar echoes and precipitation forecasts up to 60 minutes ahead are displayed in 1 km x 1 km resolution every 5 minutes, respectively. Any out-of-operation radars may cause radar echoes in affected areas to be weaker than they should be or not displayed at all.

Precipitation Nowcasts provide precipitation intensity forecasts of swiftly growing convections with a spatial resolution of 1 km up to an hour ahead to assist with disaster prevention activities.

https://www.jma.go.jp/en/radnowc/

2-4. Technical background - JMA's Very Short-range Forecasts

	Very Short- range Forecasts of Precipitation (VSRF)	Extended VSRF	Radar/Raingauge-Analyzed Precipitation Extrapolation forecast (EX6)
Forecast Element	Hourly accumulated rainfall amount	Hourly accumulated rainfall amount	T=0, 5, -1, -2, -3 $T=1, 2, 3, 4, 5, 6$ $Merge$ $Forecast time (hour)$
Spatial resolution	1 km	5 km	T=1,,15 Blend of NWP (MSM,LFM) forecast
Forecast range	Up to 6 hours	7 to 15 hours	T=1,2,3,4,5,6 Very-short-rainge forecasting of precipitation
Update interval	10 minutes	1 hour	
Operation	2006 - (1st gen 1988)	2018 -	

https://www.jma.go.jp/jma/jma-eng/jma-center/nwp/outline2019-nwp/

2-5. Technical background - Specifications of JMA's NWP models Global Meso-Scale Local Forecast Seasonal Ensemble Global Ensemble Prediction System (GEPS) Spectral Model (MSM) Model (LFM) Prediction System Model (GSM) Daily Three-month Weather warnings / forecasts, forecasts. advisories. Tropical Early warning Warm-season Tropical Very short-range forecasts of information cyclone outlooks. One-week One-month cyclone Purposes precipitation information Cold-season forecasts on extreme forecasts information and and weather outlooks Aviation forecasts and One-week forecasts El Niño outlooks Japan and its surrounding Forecast Globe Globe domain areas Atmosphere Grid size 0.1875 deg. 0.5625 deg. 1.125 deg. (TL159) and/or 5 km/ 2 km/0.375 deg. (TL479) (TL959) (TL319) number of 817 x 661 1,581 x 1,301 ~40km ~20km ~60km Ocean grids 0.3-0.5 x 1.0 deg. Atmosphere 60/0.1 hPa Vertical 100/0.01 hPa 76/21.8 km 58/20.2 km 100/0.01 hPa Ocean levels/Top 52 layers and a bottom boundary layer 5.5 days (00, 11 days (00, 18 days (00, 34 days (00, 210 days (00 UTC; Forecast 84 hours (00, 39 hours (00, range (Initial 12 UTC) 12 UTC: twice 12 UTC: twice once a month) 06, 12, 18 06, 18 UTC) 03, 06, 09, 12, 9 hours time)/number UTC) a week) a week) 264 hours (12 15, 18, 21 (hourly) of ensemble UTC) UTC) members 27 members 27 members 13 members 13 members 51 members in all Initial 4D-Var 4D-Var 3D-Var 10 Global analysis with ensemble perturbations condition Analysis Analysis Analysis

2-6. Technical background - Forecast domain of NWP models





2-7. Technical background - JMA's NWP models for aviation forecast

	Local Forecast Model (LFM)	Meso-Scale Model (MSM)	Global Spectral Model (GSM)				
Grid size and/or number of grids	2 km/ 1581 x 1301	5 km/ 817 x 661	0.1875 deg. (TL959) ~20km				
Vertical levels/Top	58/ 20.2 km	76/ 21.8 km	100/0.01 hPa				
Forecast range (Initial time)/number of ensemble members	9 hours (hourly)	39 hours (00, 03, 06, 09, 12, 15, 18, 21 UTC)	84 hours (00, 06, 18 UTC) 264 hours (12 UTC)				
Initial condition	3D-Var Analysis	4D-Var Analysis	4D-Var Analysis				
Operation	2012 -	2001 -	2014 -				



Terrain of the central region of the Main Island of Japan used for the LFM (left, 2-km horizontal resolution) and for the MSM (right, 5-km horizontal resolution)

2-8. Technical background - example of LFM and MSM forecast

Animation



2-9. Technical background - Products of forecast for aviation









TILE	Wind(kt) Vi 34~ 25~33 100 ~24 320	Vis.(m)	Ceil.(ft)	WX	TS Prob.		
	34~	~900	~100	TS	A		
	25~33	1000~3100	200~900		В		
~24		3200~	1000~-		C. D		

2-10. Technical background - Products of LFM forecast for aviation





4-1. Operations of ATMetC (JMA)

Air Traffic Meteorological category forecast (ATMet category forecast)



(Tabular Form)

(Map Type Form)

show the area and time of probability (red > yellow > blue > no color) that significant weather will affect air traffic flow.

CDM video conference



Sharing Information frequently !

4-2. Criteria of the ATMet category forecast

color area code	RJTT	RJAA	RJGG	RJBB	RJFF	ROAH	RJCC	ATC SECTOR			
		wind sp cross wind compor cross wind compor moderate or l	speed ≥ 40kt sponent to runway ≥ 30kt sponent to runway ≥ 25kt with or heavy precipitaion								
		wind direction 030∼060° or 210∼240° and gust ≧ 30kt					visibility < 800m with snow				
RED	visibility < 600m	visil	bility < 400	m			ceiling < 400ft with snow	the proportion occupied with			
	ceiling < 300ft						visibility < 1000 with blowing snow	CB (top \leq FL300) in the sector \leq 50%			
		T{	SOHD								
		snow fall rate ≧ 1 cm/1h snow fall rate ≧ 5 cm/3									
	wind speed at surface ≧ 30kt and	wind speed below 3000ft \geq 60kt when									
	wind speed below 5000ft ≧ 60kt						wind direction 120~240				
		wind speed ≧ 34kt with gust ≧ 50kt									
		cross wind compor	ent to run with	initation	đ			the proportion occupied with			
VELLOW		wind direction 030~060° or 210~240° and gust ≧ 25kt	iouty proc	,preserver a				CB (top \geq FL300) in the sector \geq 20%			
TELLOW			TS								
	OB in HANEDA sector	CB in NARITA sector					visibility < 400m				
		-					visibility < 1600m with snow				
		cei	ling < 200f	t			ceiling < 600ft with snow				
		moderate or heavy snow					C.I				
	wind speed at surface ≧ 30kt	10 () () () () () () () () () () () () ()					snow fall rate ≧ 3cm/3h when				
	and wind speed below 5000ft ≧ 50kt	wind speed below 3000ft ≥ 50kt wind direction 25					wind direction 250~110°				
		TS in TAF but CB does	sn't exist i	n the aerod	rome			all and a second second second second			
BLUE							wind speed ≧ 20kt with snow ceiling < 200ft	the proportion occupied with CB (top ≧ FL300) in the sector ≧ 10%			

Note: it may differ from present criteria due to continual improvement

4-3. Target area of the ATMet category forecast



5-1. Operations of TMU (JCAB)



5-2. Approach Control Areas



http://www.mlit.go.jp/common/001273741.pdf http://www.mlit.go.jp/koku/15_hf_000026.html



6. Operations of TMAT (JMA)



ATM Categorized Impact of weather ELement prediction Issued at 1930UTC 20 May 2015 ATMetC Tokyo Metropolitan Area TEAM, JMA 23 20 22 Sector/Time(UTC) 30 40 50 0 10 20 30 40 50 0 10 20 30 40 50 0 10 20 30 40 50 0 10 20 30 40 50 0 10 20 30 40 50 0 10 20 30 40 50 T03 CONV T03_W_NW Conv T03_W_NE Conv T03_W_SW Conv T03_W_SE Conv T07 CONV CONV T07_NW Conv T07_SW Conv T07_EAST Conv TS CONV RJAA CONV RJAA-1 Conv Wind Cross Gust VIS CIG TS SN blw3000 Wind RJAA-2 Conv BD-CROS RJTT CONV TS CONV RJTT-1 Conv Wind AC_Cross BD_Cross VIS CIG TS SN blw5000 Wind RJTT-2 Conv RJTT-3 Conv CONV T14 T09 CON -ATM CIEL T12 -T13 T13_NW Conv **ATM Categorized Impact of** T13_NE Conv T13_SW Conv T13_SE Conv weather Element prediction

7-1. Overview of ATM CIEL (ATM Categorized Impact of weather Element prediction)

• Contents

The degree to which weather conditions affect ATC capacity



ATM Categorized Impact of weather ELement prediction

	Contar/Time/(UTC)	19			20						21					
	Sector/fime(UTC)	30	40	50	0	10	20	30	40	50	0	10	20	30	40	50
	T03 🔺		СВ				со	NV								
	T03_W_NW Conv															
	T03_W_NE Conv															
	T03_W_SW Conv															
	T03_W_SE Conv															
4	T07 🔺					СВ							CO	NV		
	T07_NW Conv															
	T07_SW Conv															
	T07_EAST Conv															
	RJAA 🔺	TS TS CONV														
	RJAA-1 Conv															
	Wind															
	Cross															
	Gust															
	VIS															
	CIG															
	TS															
	SN															
	blw3000 Wind															
	RJAA-2 Conv															
	RJTT 🔺	BD- TS	CRO	DSS NV									СО	NV		
Ά	PATT-1 Conv															
	Wind												2	4		
	AC_Cross															

7-2. ATM CIEL (map format)

ATM Categorized Impact of weather ELement prediction

Issued at 0100UTC 25 Apr 2018 ATMetC Tokyo Metropolitan Area Team, JMA



7-3. Information provided by JMA

- How to decide the criteria for the product (e.g. ATM CIEL)
 - Statistic method
 - e.g. correlation of coverage area of convective clouds and the impacts on air traffic capacity



- Based on the situation that affect aircraft operations
 - e.g. whether convective clouds on the arrival route or not
- Utilizing threshold of aircraft operations
 - e.g. Cross wind limit of aircraft, Weather minimum for visibility and ceiling applied at the airport



7-4. Information provided by JMA

- To mitigate negative affect of "limit of weather forecast accuracy" on "ATFM operation"...
 - Comments for the phenomena that may cause heavy impact were required even if the occurrence possibility is not so high.

TMAT improved the product "Tokyo Metropolitan Area Weather

Bulletin for ATM" (See Regional guidance for tailored MET to support ATM (DRAFT)).



8. AvRDP Outcomes

Phase I achievements (MET Capability)

 JMA developed ATM-Tailored forecasts based on nowcast and very short range forecast for identified weather phenomena which may have an impact on aircraft operations at each target airport.

Phase II achievements (MET-ATM Integration)

• JMA researched past cases of significant weather-induced air traffic flow disturbance. Based on the result, possibility of the weather impact is categorized into four level with colour codes in the ATM-CIEL, which has been provided since 2014 as an operational product.

Verification

• JMA implements comparison of observation and restricted airspace capacity when ATFM measures executed due to meteorological phenomena.

9. Benefits to local ATM



10. Contributions to ASBU



- ASBU AMET includes the development of advanced weather information to support ATM/ATFM around terminal area and the integration of meteorological data into ATM decision-making process to support future TBO environment.
- JMA's expertise on the development of ATM impactbased forecasts will contribute to the above development to meet GANP/ASBU requirement.

11. Gap identified



• Quantitative translation methodology of MET information into ATC capacity value is yet to be developed.

12. Future plan

- Extend forecast range of <u>lightning nowcast</u>
- Develop <u>wind nowcast</u> by combining analysis wind data and NWP data
- Develop <u>visibility and ceiling nowcast</u> based on NWP data with reference to Highresolution precipitation nowcasts