5.7 Application Products for Aviation Services

5.7.1 Aerodrome forecast guidance

Two types of guidance are in operation for Terminal Area Forecast (TAF). One is derived from the output of RSM twice a day, and gives 3-hourly predictions up to 45 hours (named TAF-L guidance). Another is derived from the output of MSM 8-times a day, and gives hourly predictions up to 15 hours (named TAF-S guidance). This TAF-S guidance was implemented in Aug 2002. The predicted parameters of these guidances are listed in Table 5.7.1.

The forecast time of MSM will be extended to 33 hours in May 2007, so TAF-L guidance also will be derived from the output of MSM. In addition, the technique of TAF-L guidance will be same as TAF-S and both guidance will be integrated.

Table 5.7.1 Predicted Parameters of Aerodrome Forecast Guidance. Predicted stations are 76 airports in Japan.

Parameters	TAF-L guidance	TAF-S guidance
Visibility	Minimum visibility during 3 hours Probability of minimum visibility during 3 hours < 5km	Minimum visibility during an hour
Cloud	Cloud amount and height of 3 layers at minimum ceiling during 3 hours	Cloud amount and height of 3 layers at minimum ceiling during an hours
Weather	Categorized weather every 3 hour	Categorized weather every hour
Temperature	Maximum temperature in the daytime, minimum temperatures in the morning and temperatures every 3 hours	Temperatures every hour
Wind	Wind speed and direction at 3 hourly indicated time	Wind speed and direction of hourly maximum peak wind

(a) Visibility

The minimum visibility in TAF-S guidance (S-VIS) uses statistical interpretation from model output. The S-VIS is calculated by linear equation whose coefficients are adapted by Kalman filter (see Section 5.6.2 (a)) with the predictors and METAR reports. The S-VIS consists of three linear equations classified by weather (rain, snow, no precipitation). The following predictors from the output of MSM are used for each equation.

no precipitation : $(1\text{-}Rh)^{1/2}$ here, Rh is surface relative humidity (0 ~ 1)

rain : $RR^{1/2}$, $(1\text{-}Rh)^{1/2}$ here, RR is precipitation amount (mm).

snow : $RR^{1/2}$, $(1\text{-}Rh)^{1/2}$, VV*T here, VV is surface wind speed (m/s),T is surface temperature(C, only < 0)

After the frequency bias correction (see Section 5.6.2(b)) is applied to each prediction, a final prediction is determined to select one by the weather guidance (described later). This stratification by weather was implemented in Mar 2006, improved forecast score especially in winter.

The minimum visibility in TAF-L guidance (L-VIS) is also calculated by linear equation whose coefficients are adapted by Kalman filter, but it consists of an equation. The following four predictors from the output of RSM are used for the L-VIS.

$RR^{1/2}$, $(1\text{-}Rh)^{1/2}$, $VV^{1/2}$, ΔT here, ΔT is temperature change in 3 hours(K), other symbols express as above.

The probability of the minimum visibility < 5km uses the same method as the L-VIS except predictand.

(b) Cloud amount and height

The TAF-S cloud guidance uses statistical interpretation from model output. First, each cloud amount at 38 layers(0,100,…,1000,1500,…,5000,6000,…,10000,12000, …,30000ft) is predicted, then three cloud layers are searched upward from surface like METAR reports. Each cloud amount at 38 layers is calculated by neural net (see Section 5.6.3). The input data (predictors) are relative humidity at three model levels and difference between 850hPa and surface temperature from MSM. The utilization of neural net was introduced in Mar 2006, improved forecast score.

The TAF-L cloud guidance utilize Kalman filter instead of neural net, and its predictors are relative humidity at three model levels from RSM.

(c) Weather

The weather guidance predicts categorized weather (fine, cloudy, rain, snow and the intensity of precipitation). The TAF-S weather guidance uses diagnostic method to interpret from MSM output directly (JMA 1997). But, the hourly temperature guidance is used instead of MSM temperature to distinguish snow and rain more skillfully. The TAF-L weather guidance is extracted from the gridded weather guidance for general forecast (see Section 5.6).

(d) Wind and temperature

The wind and temperature guidance are calculated with the same methods as the guidance for general forecast (see Section 5.6).

Table 5.7.2 Specifications of SIGGPV

Base model	MSM (initial = 00,03,06,09,12,15,18,21 UTC)
Forecast time	T=0-15, 1 hourly
Grid coordinate	Polar Stereographic (60N,140E), 40km, 83 x 71
Parameters	U,V,T,Rh,Psea,Rain,Cl,Cm,Cb,Ptrp [surface] U,V,T,Rh,Turb [1,000-55,000ft / every 2,000ft]

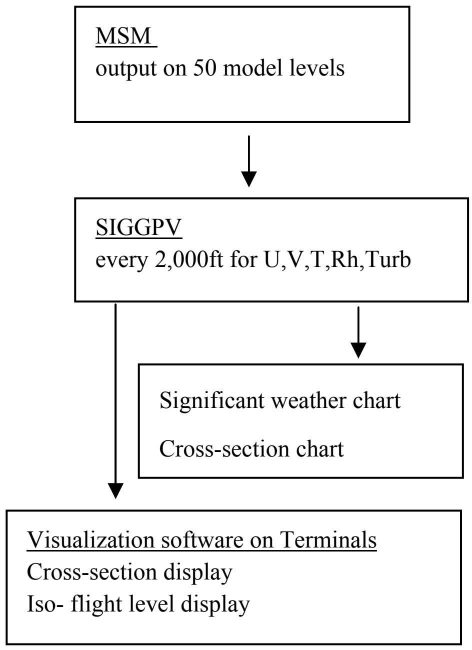

Fig. 5.7.1 Data flow of products for domestic area forecast

5.7.2 Products for domestic area forecast

(a) Grid-point values of significant weather

Aviation impact variables derived from the MSM output are calculated at original model levels and interpolated to flight levels. This purely aviation-oriented dataset is called *SIGGPV* (Grid-Point Values of Significant weather), whose specifications are listed in Table 5.7.2. The parameter *Turb*, which is an indicator of Clear Air Turbulence (CAT), is calculated as vertical wind shear between the model levels in kt/1000ft. The parameter *Cb* is an indicator of cumulonimbus amount and is calculated based on Kain-Fritsch convective scheme which is used in the MSM. As illustrated in Fig. 5.7.1, *SIGGPV*, which is distributed as binary data and can be visualized on terminals at aviation forecast offices, is also used for production of the following fax-charts.

(b)Domestic significant weather chart (Fig. 5.7.2)

This chart shows 12- hour forecast fields of the parameters listed below in four panels:

Upper-left : Jet stream axes.
Possible CAT areas.
Possible Cb areas.

Lower-left : Contours of 0℃ height.
Possible icing areas at 500, 700 and 850 hPa based on the –8 D method (Godske et al, 1957)

Upper-right : Contours of sea level pressure.
Moist areas at 700 hPa.
Front parameters DDT= $-\nabla_n|\nabla_n T|$, where T is mean temperature below 500 hPa and ∇_n denotes the horizontal gradient perpendicular to the isotherms.
“NP fronts” drawn along the maxima of DDT.

Lower-right : Cloud indices indicating the low, middle and upper cloud amount.

(c)Domestic cross-section chart (Fig. 5.7.3)

This chart shows 6- and 12-hour forecast fields along the major domestic route. The information drawn is: temperature, equivalent potential temperature, wind barbs and isotachs, moist areas, vertical wind shear and tropopause height.

5.7.3 Products for international area forecast

Global Grid Point Values are derived from GSM four times a day and distributed in thinned GRIB codes, a format compatible with the products from the World Area Forecast Centers (WAFC). In addition to the parameters included in the WAFC products, *Turb*, an indicator of CAT, derived with the same method as that in domestic SIGGPV(see Section 5.7.2), and *Cbtop*, pressure of the top of Cb areas, derived from the relative humidity at 850, 700, 500 and 300hPa and the vertical velocity at 400hPa, are included.

From March 2006, JMA produces 13 Significant weather (SIGWX) charts and 18 Wind and temperature (WINTEM) charts, they are based on the WAFS Significant weather data provided form the World Area Forecast Centers (WAFC).

Reference

Godske, C.L. et al., 1957: *Dynamic Meteorology and Weather Forecast*, Chapter 18, Amer. Met. Soc.

Japan Meteorological Agency, 1997: *Outline of operational numerical weather prediction at Japan Meteorological Agency*, 123–124.

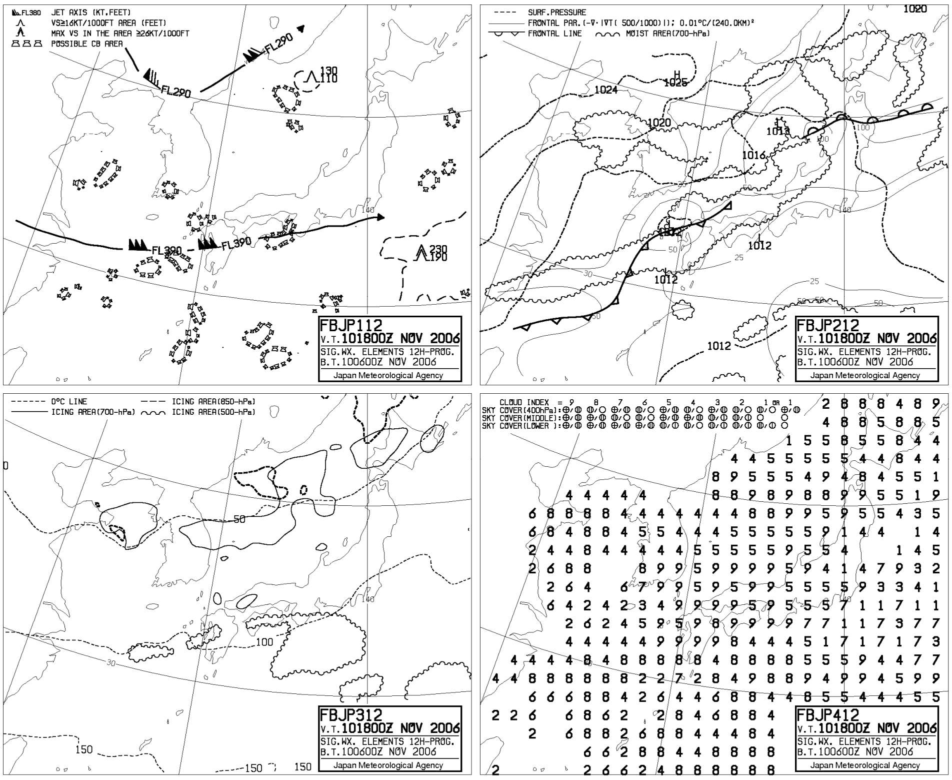

Fig. 5.7.2 An example of the domestic significant weather chart.

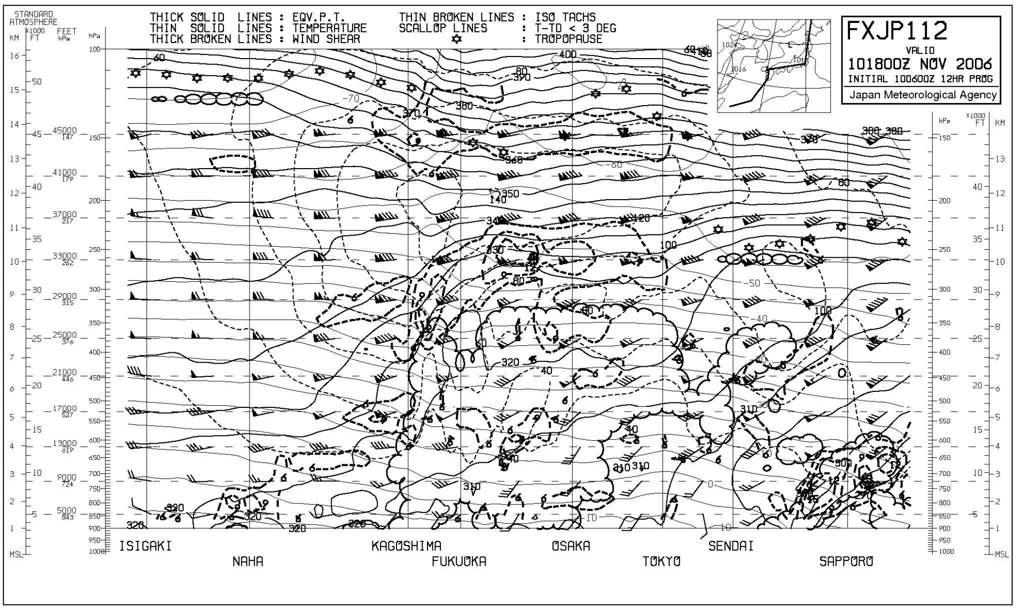

Fig. 5.7.3 An example of the domestic cross-section chart.

Only the lower part of the fax, corresponding to 12- hour forecast, is shown.