CGMS-XXIX PRC-WP-08
Prepared by CMA
Agenda Item: WG II

HEIGHT ASSIGNMENT METHOD IN THE NSMC WIND DERIVATION SCHEME

Summary and purpose of paper
A description of height assignment method is given.

Height Assignment Method
in the NSMC Wind Derivation Scheme

In the NSMC scheme, the height assignment of opaque clouds is based on the IR cloud brightness temperature. For semi transparent clouds, the height assignment method follows the physical principle first introduced by Szejwach (1982) by using both IR and WV channels.

Fig.1 presents a scatter diagram of IR and WV brightness temperature observations for a semitransparent cirrus cloud tracer. The tracer center at 30oN, 114oE is located close to the radiosonde station 57494 at Wuhan. The horizontal axis is the infrared (IR) temperature and the vertical axis the water vapor (WV) temperature. The dashed line in Fig. 1 presents the linear regression line derived for the observed semi-transparent cloud pixels, as explained by Szejwach (1982). By using the radiosonde report of the collocated station, the theoretical Equivalent Black-Body Temperature (EBBT) that would be observed from geostationary orbit were calculated for clouds at different levels. In the IR-WV EBBT diagram this appears as the solid curve representing opaque clouds. The curve crosses the dashed line, that represents semi-transparent cloud, at two points. Szejwach (1982) showed that the intersection point at the left (cold) side represents the environmental temperature of semi-transparent cloud tops. This point is often very close to the temperature regime where the IR and WV channels have the same brightness temperature shown as the dash-dotted line in Fig.1. Therefore in the NSMC scheme the estimated environment temperature for semitransparent high clouds is simply taken as the intersection point of the dashed regression line and the dash-dotted straight line defined by the same IR and WV brightness temperature. This approach is based on the hypothesis that the effect of water vapor above the high level clouds on the observed radiances is negligible. The impact of this assumption is demonstrated in Fig. 2. It presents observations for opaque cumulonimbus, thin cirrus and low clouds and shows that there are cases where the water vapor above the cloud has a significant impact on the radiance observed in the WV image. Neglecting the water vapor above the cloud therefore has a potentially negative influence on the height assignment.

Fig. 2 also shows that in some cases very thin cirrus clouds appear in the diagram at almost the same place as the low-level clouds and the surface. The separation of thin clouds from low clouds is therefore of essential importance. The fundamental idea to distinguish between high and low level clouds in the NSMC approach relies on the fact the observed patterns of high level clouds are very similar in the IR and WV channels. Low-level clouds, however, are not detectable in the WV channel, hence the observed patterns in the two channels will be different. Therefore, in order to separate high level clouds from the low-level clouds, the correlation between the IR and WV matching template is calculated before the height assignment. For tracers with high clouds, the correlation between the IR and WV measurements will be high, whereas for tracers with low clouds it will be low. This information is of major importance to the height assignment, because for low correlation cases the height adjustment procedure is not performed. The correct allocation of cloud types (high or low) will greatly reduce error of AMVs, as exemplified below.

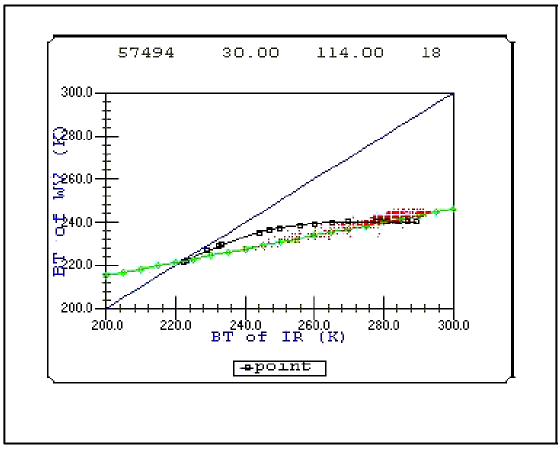

Fig.1 IR-WV Scatter Diagram

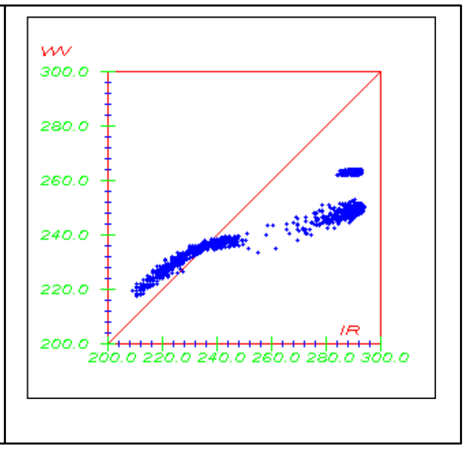

Fig.2 Typical Opaque Cumulonimbus, Thin Cirrus and Low Clouds on the IR-WV Scatter Diagram

Fig. 3 illustrates this by an example of high clouds observed from the Chinese geostationary satellite FY-2A at 5.3° N, 100.27° E on 0600Z September 11 1998. Fig. 3 shows a radiosonde profile was taken at 0000Z with inserts presenting the IR (left) and WV (right) images in the tracer region. For this tracer, the correlation coefficient between IR and WV measurements is high with 0.942. The good relation between IR and WV measurements is also discernable from IR and WV images which shows very similar patterns. The radiosonde data verifies that the height assignment is correct as the deep moist level layer shown in the radiosonde profile extends to above 200 hPa.

Fig. 4 presents, similarly to Fig.3, a radiosonde profile for an area with low clouds as observed from FY-2A at 26.2° N 127.68° E 0600Z Sept. 17 1998. For this tracer, the correlation coefficient between IR and WV measurements is -0.105. In Fig. 4 the IR image clearly depicts low clouds, whereas the corresponding WV image appears very smooth. This indicates the absence of high level clouds in this tracer region. The corresponding radiosonde sounding in Fig. 4 shows a dry mid-troposphere and a moist layer at low level around 850 hPa thus verifying the satellite analysis.

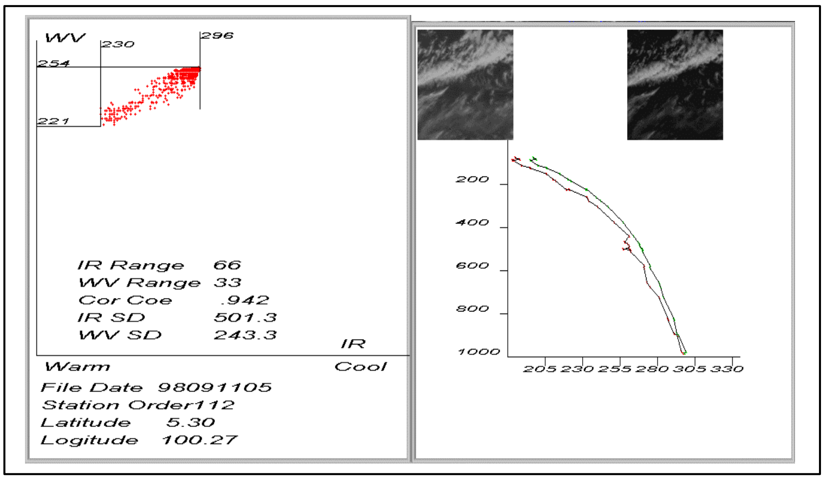

Fig.3 An Example of High Clouds Observed from the Chinese Geostationary Satellite FY-2A at 5.3° N, 100.27° E on 0600Z September 11 1998.----Scatter Diagram, Tracer Images, and Radiosonde Diagram.

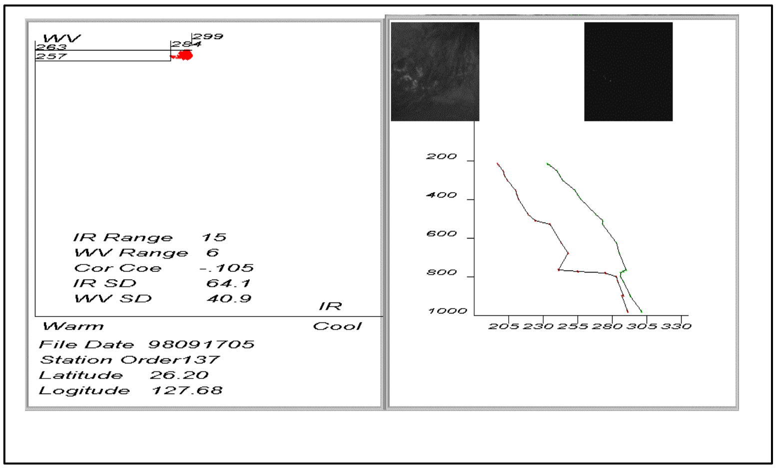

Fig. 4 An Area with Low Clouds as Observed from FY-2A at 26.2° N 127.68° E 0600Z Sept. 17 1998----Scatter Diagram, Tracer Images, and Radiosonde Diagram.

A further possibility to discriminate clouds within an IR/WV scatter plot is the use of the slope of the regression line through different parts of the observation points. The higher the slope the more likely the occurrence of high level clouds whereas low level clouds that cannot be observed by the WV channel produces a horizontal line.

The methods described above are utilized to discriminate between high and low level clouds in the following manner:

- All tracers with a WV EBBT > 252 K, WV EBBT measurement range < 5K and IR/WV EBBT slope less than 0.26 are defined as low clouds.
- For tracers with IR-WV correlation > 0.35 (except those assigned to a low level above), a height adjustment is performed. In order to avoid an over adjustment of temperature by random errors in the data, the following slope limits are applied: the slope should not exceed 0.6, 0.5, 0.4 for tracers with IR-WV correlation greater than 0.75, 0.55, 0.35 respectively. Slopes above the limits will be adjusted to the limiting values.
- All other tracers including those with IR-WV correlation less than 0.35 are not height adjusted, since those are normally low clouds.

Reference

Schejwach G., 1982: Determination of Semi-Transparent Cirrus Cloud Temperature from Infrared Radiance Application to Meteosat, J. Appl. Meteor. , 21, 384-393

Xu Jianmin, Zhang Qisong, Fang Xiang and Liu Jian, 1998: Cloud Motion Winds from FY-2 and GMS-5 Meteorological Satellites, The Forth International Wind Workshop,41-48