AMSR/AMSR-E Sea Surface Wind Speed Algorithm

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1. Abstract

Sea surface wind speed (SSW) is retrieved mainly from 37 GHz vertical (V) and horizontal (H) brightness temperature of AMSR/AMSR-E by a graphical method. The retrieval is restricted to no rain condition, since the brightness temperature of 37 GHz is saturated under rainy condition, SSW obtained from 37 GHz has a large anisotropic feature depending on an angle difference between antenna direction and wind direction. Its anisotropic feature is corrected by using two data from 37 and 10 GHz, since 10 GHz data are less anisotropic. Even under rainy condition, 10 and 6 GHz data are not saturated, so wind speed will be able to be retrieved by using those horizontal data. Retrieval accuracy of wind speed using 10 and 6 GHz will become worse than using 37 GHz, since a sensitivity of 10 and 6 GHz to wind speed is not so strong.

2. Wind speed from 37 GHz

The brightness temperature of vertical (V) polarization does not change under condition of sea surface wind speed less than 7 - 8 m/s. But, the one of horizontal (H) polarization increases monotonically with wind speed. At 37 GHz, the sensitivity is about 1K/(m/s). Above 7- 8 m/s of wind speed, both V and H temperature increase. Fig. 1 shows a thematic method of calculating wind speed. A line shown by “A” represents a calm sea state, and line “B” represents a roughened sea state. SSW is calculated from a horizontal length of “C” shown in Fig. 1. When atmospheric opaque due to water vapor and cloud liquid water increase, both V and H temperature increase. The atmospheric opaque is corrected by a convergence made by two lines of A and B. A position of the line A is changed in accordance with SST change, and coefficients of slope and intercept defining the line A are also changed. Those coefficients given at 5 °C interval of SST from 0 to 35 °C.

The brightness temperature of 37 GHz is saturated under rainy condition, i.e., the ocean surface can not be seen by 37 GHz data. A judge whether 37 GHz data can be used is made by using the value defined in Fig.1 in the AMSR/AMSR-E SST algorithm.

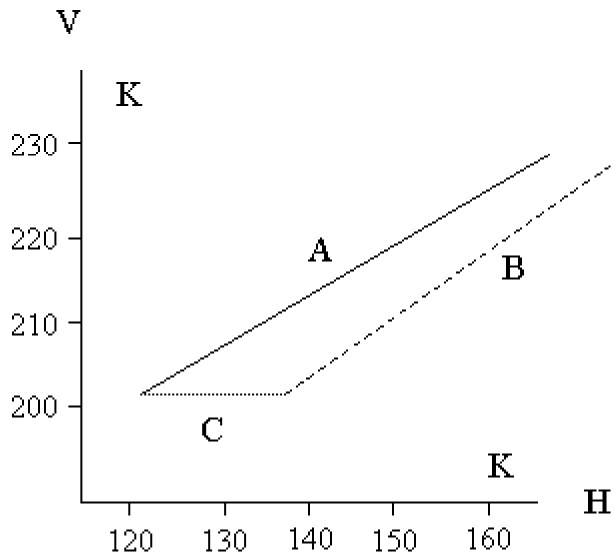

Fig. 1 Retrieval of wind speed from the vertical and horizontal polarization data

3. Correction of anisotropic wind speed

SSW obtained by the method described in § 2 has a large anisotropic feature depending on an angle between the antenna direction and wind direction. Airborne Microwave Radiometer (AMR) experiments of NASDA suggest that at about 9 m/s of wind speed, a difference of the length C defined in Fig. 1 reaches about 4K between the downwind and upwind case. In such a condition of wind speed, the brightness temperature of V polarization of the upwind direction is larger by about 2K than one of the downwind direction, and the difference of H polarization is about 1K. At lower frequencies such as 10 or 6 GHz, the anisotropic features become weaker. Even at 13 - 14 m/s of wind speed, the difference is less than 1 K at 10 GHz.

In the current algorithm, the anisotropic feature is corrected by a combination of two lengths C from 37 and 10 GHz. Fig. 2 shows a thematic method to correct the anisotropic feature. C from 37 GHz has the larger anisotropic feature than one from 10 GHz. Above 7 - 8 m/s of wind speed, two lengths C calculated from 37 and 10 GHz take different values between the downwind and upwind cases as shown in Fig. 2. The anistropic feature is corrected by taking a middle position.

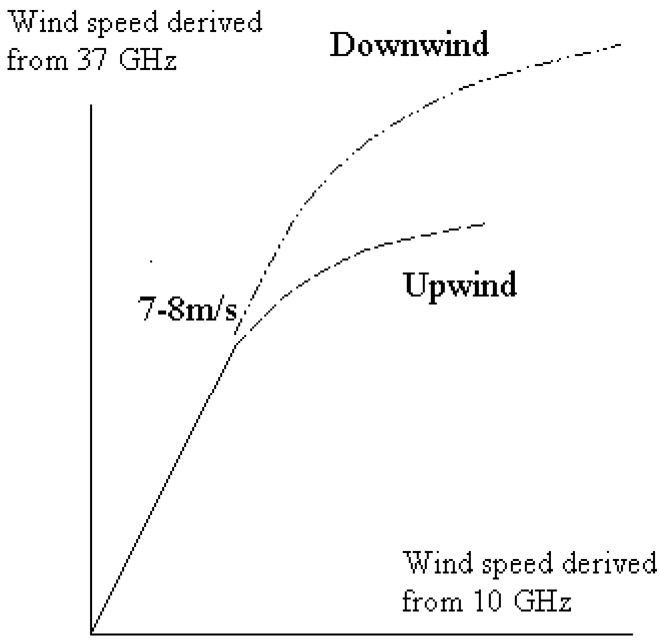

Fig. 2 Correction of anisotropic feature by using 37 and 10 GHz data

4. Wind speed from 6 and 10 GHz under rainy condition

The brightness temperature of 37 GHz is saturated under rainy condition, but ones of 10 or 6 GHz are not saturated in almost cases. The sensitivity of H polarization at 37 GHz to wind speed is about 1K/(m/s) as mentioned above, and ones of 10 and 6 GHz H are about 0.6K/(m/s). A retrieval accuracy using the former data is much better than the latter data, but 10 and 6 GHz H data can be used in retrieval of wind speed under rainy condition. The brightness temperature due to water vapor, liquid water (totally they are called as atmospheric opaque) increases as different behavior between 6 and 10 GHz. The brightness temperature change due to wind effect is almost same between 6 and 10 GHz. So, wind speed will be separated from the atmospheric opaque from two data of 6 and 10 GHz H.

5. Reference

Shibata A. (1996) :Remote sensing on ocean surface by passive microwave radiometer , Kishou Kenkyu Note, no. 187, pp. 53-63.