Change of precipitable water vapor from tropospheric delay of GPS microwave when fronts pass through Hokuriku Region

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We compared precipitable water vapor (PW) estimated from GPS with PW obtained from radiosonde data at Wajima, in order to investigate suitable analysis method to estimate PW values. PW obtained without estimating horizontal gradients of tropospheric delay agrees with PW from radiosonde data better than that without estimating gradients. The difference between PW from GPS and that from radiosonde has a relation with wind velocity.

We investigated PW change from GPS at front passage in Hokuriku region.

The PW increased before a cold front passed, and it decreased after a front passed, but the shape is changed much in each front.

In the case of a stationary front passage, the PW increased slowly and didn't change drastically.

The most important meteorological product of Global Positioning System (GPS) is the estimation of precipitable water vapor (PW). There are dense GPS sites in Japan and also the PW can be estimated at short time intervals, PW estimation may improve the Japanese weather forecasting.

We compared PW estimated from GPS with PW obtained from radiosonde data at Wajima in Japan, in order to investigate the suitable analysis method to estimate PW values.

RMS of the difference of PW obtained with estimating horizontal gradients 13 times a day from PW obtained from radiosonde data is 6.4mm. On the other hand, RMS of the difference of PW obtained without estimating horizontal gradients of atmospheric path delay from PW obtained from radiosonde data is 5.7mm. We consider this decrease is caused by the fact that GPS satellites don't exist in the north sky. Because atmospheric gradients are estimated without microwave traveled from the north, estimated atmospheric delays may be different from actual atmospheric delays.

The difference between PW obtained from GPS and that from radiosonde is 9.7mm in maximum. In order to investigate the cause that the difference becomes huge, we researched the wind velocity data of radiosonde.

In the case of the difference is small, the wind velocity is slow. Radiosonde doesn't go out of the range that GPS microwaves pass through. On the other hand, in the case of the difference is huge, the wind velocity is very fast. Because radiosonde goes out of the range, the atmosphere observed with radiosonde is different from that GPS microwaves pass through. We confirmed that the horizontal gradients obtained from GPS data reflect actual azimuthally inhomogeneous of water vapor from this relation.

We compared the atmospheric delays that estimated every 60 minutes with those that estimated every 30 minutes. The result shows that the two agree well each other.

In order to investigate the relation between PW change and the front passage, we processed three sets of GPS data, in March, in August, and in December when cold fronts passed there.

The result in March shows a clear relation between PW change and front passage. The PW increased before the front passed through, and it decreased clearly after the front passed through. This change may be caused by that warm and wet air streamed into Hokuriku region from the south before the passage and that cold air blew from the north after the passage. At this time, a deepened cyclone (980hPa) passes over Sakhalin, and a big anticyclone exists over the Pacific Ocean. A cold front extends from Sakhalin to Taiwan. The difference of temperature between the north and the south of the front in March is clear.

The result in August shows a similar change to those in March, but the amount of the PW change is smaller than that in March. At this time, a cyclone and a cold front were weaker than those in March, and warm and wet air didn't stream very much. It was hot and wet all over Japan in August.

The result in December doesn't show a clear PW change. At this time, a cyclone and a cold front were weaker than those in August, and another smaller cyclone existed in warm range of the cyclone. Therefore, warm and wet air didn't stream into the surveyed area.

These results may show that the PW change has seasonal characteristics when a cold front passes.

In the case of a stationary front passage, the PW increased slowly and didn't change drastically.