

A method to get the drift velocity of ionospheric irregularities from three spaced GPS-TEC receivers

Jinghua Li, Guanyi Ma, Qingtao Wan, Xiaolan Wang, Jie Zhang

jhli@naoc.cas.cn

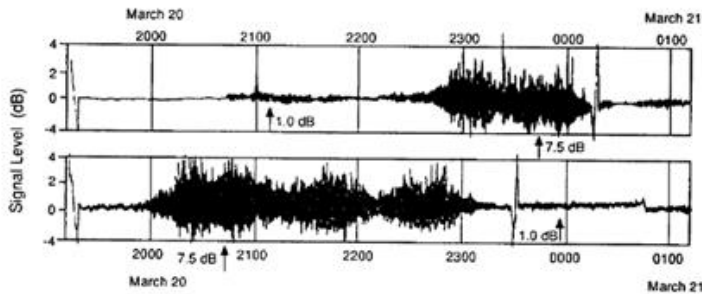
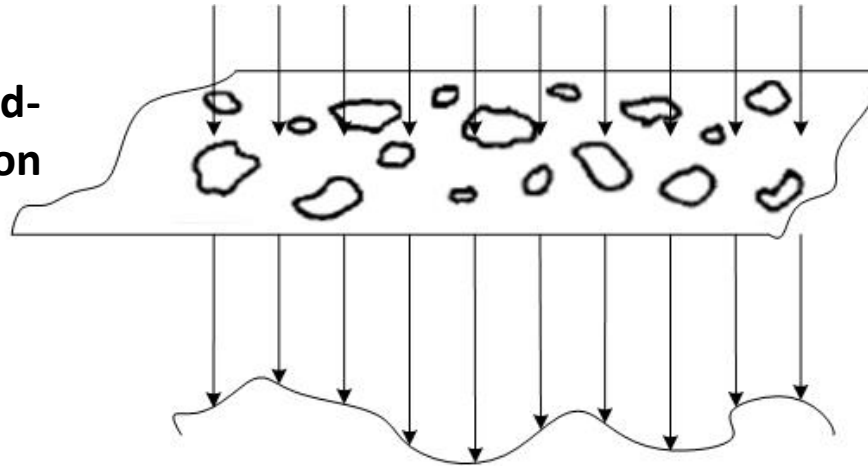
National Astronomical Observatories, CAS, Beijing, China

Outline

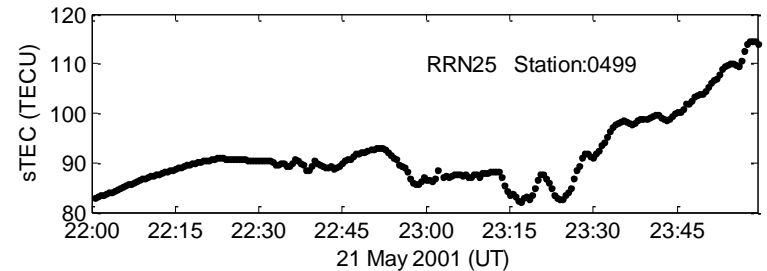
- ✓ Introduction;
- ✓ Our method based on spaced GPS-TEC;
- ✓ Results;
- ✓ Next?
- ✓ Summary.

Introduction

The effect of the irregularities on ground-based GNSS observation



Ionospheric Scintillation
March 20-21, 1979



Amplitude or phase fluctuation
Ionospheric scintillation
S4, amplitude correlation
Based on 20~50Hz sampling rate
Scintillation receiver

TEC fluctuations (GPS phase fluctuation)
ROTI
Based on 30s sampling intervals
Dual-frequency receiver

Three spaced GPS scintillation receivers have been used to get the velocity

Based on three spaced GPS scintillation receivers, the drift velocity of the ionospheric irregularities have been studied by many researchers. (Kintner PM, et al., 2004 ; Ledvina BM et al., 2004; Saito S. et al., 2008.)

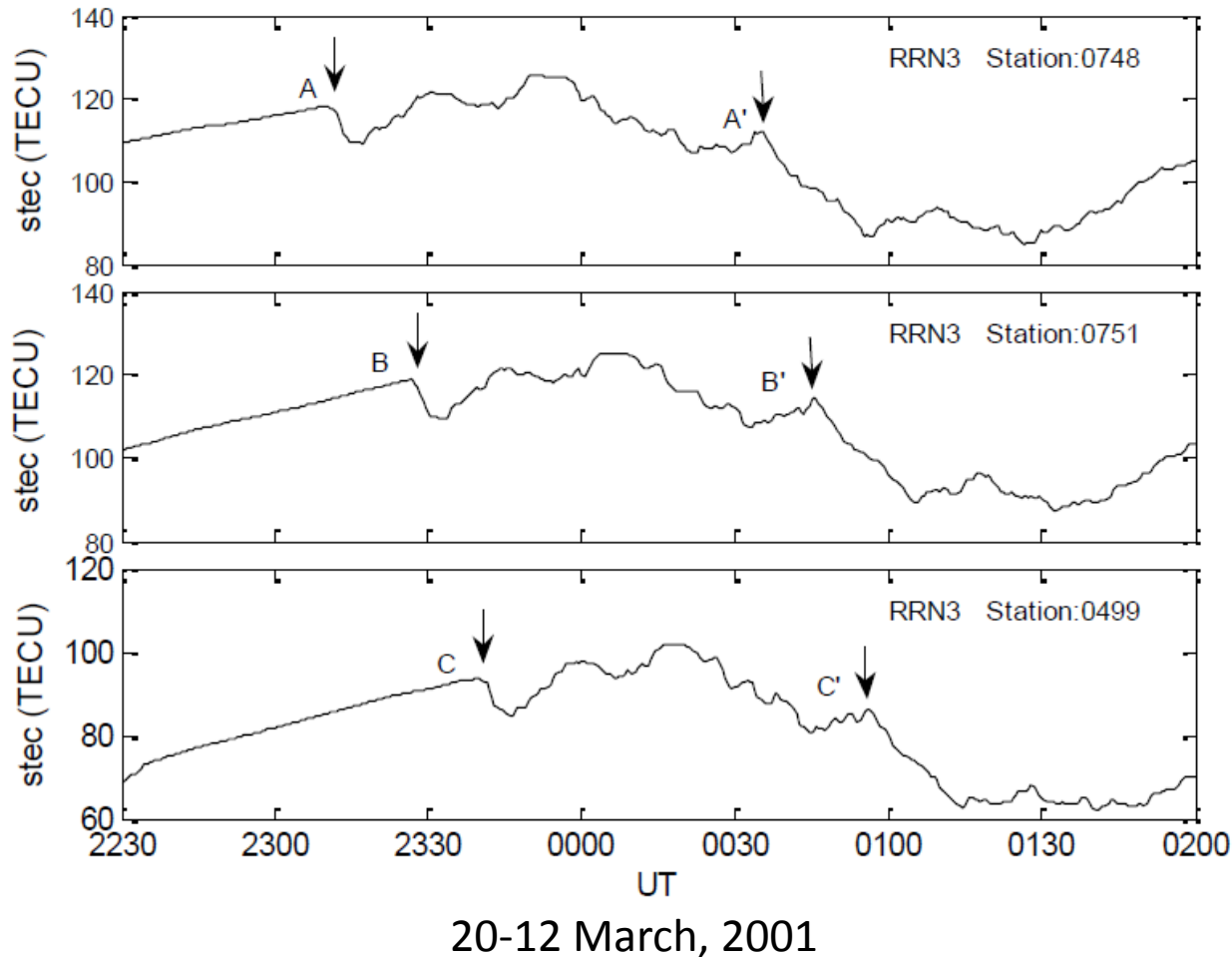
The distance between the receivers is $\sim 100\text{m}$.

The sampling rate is 20Hz/50Hz.

The cost of the scintillation receivers is expensive.

Our method

Three slant TEC from spaced dual-frequency receivers of GEONET.



The distance between the receivers is tens - hundreds of kilometers.

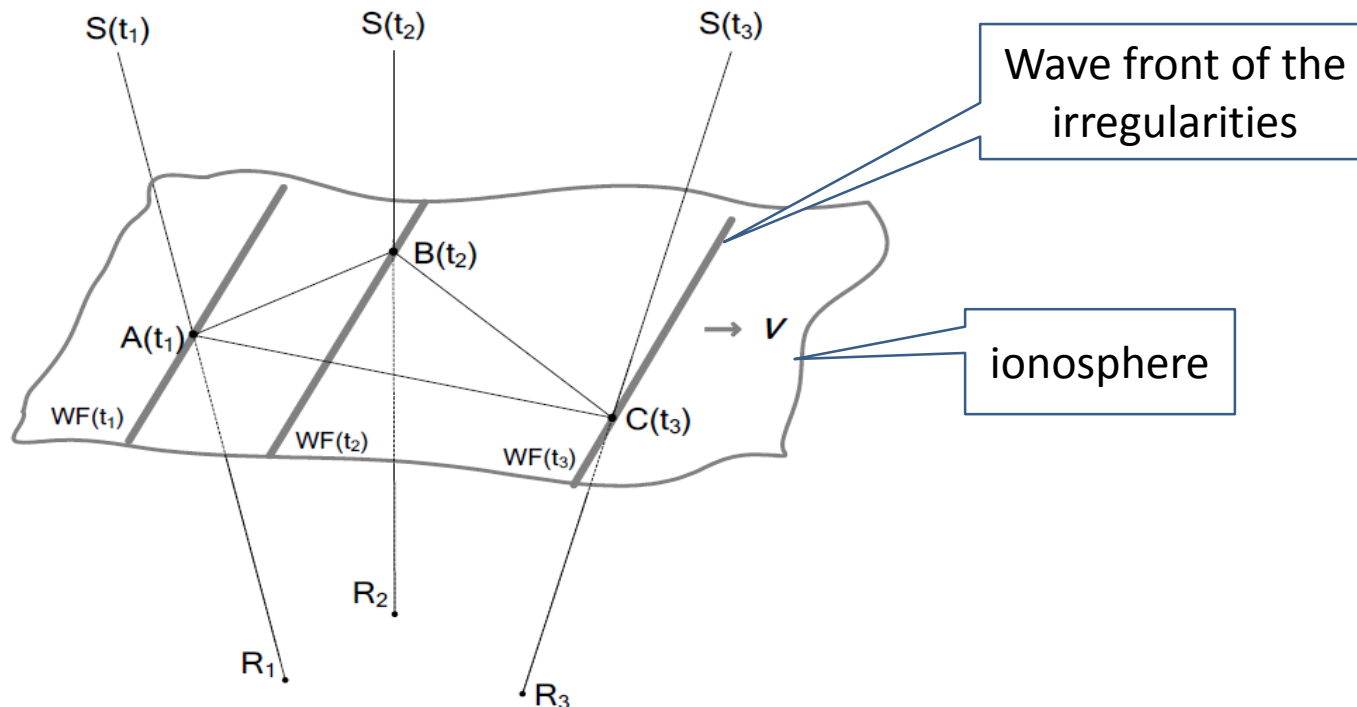
TECs from three receivers vary in a similar way.

And obvious time lag can be found between the TECs.

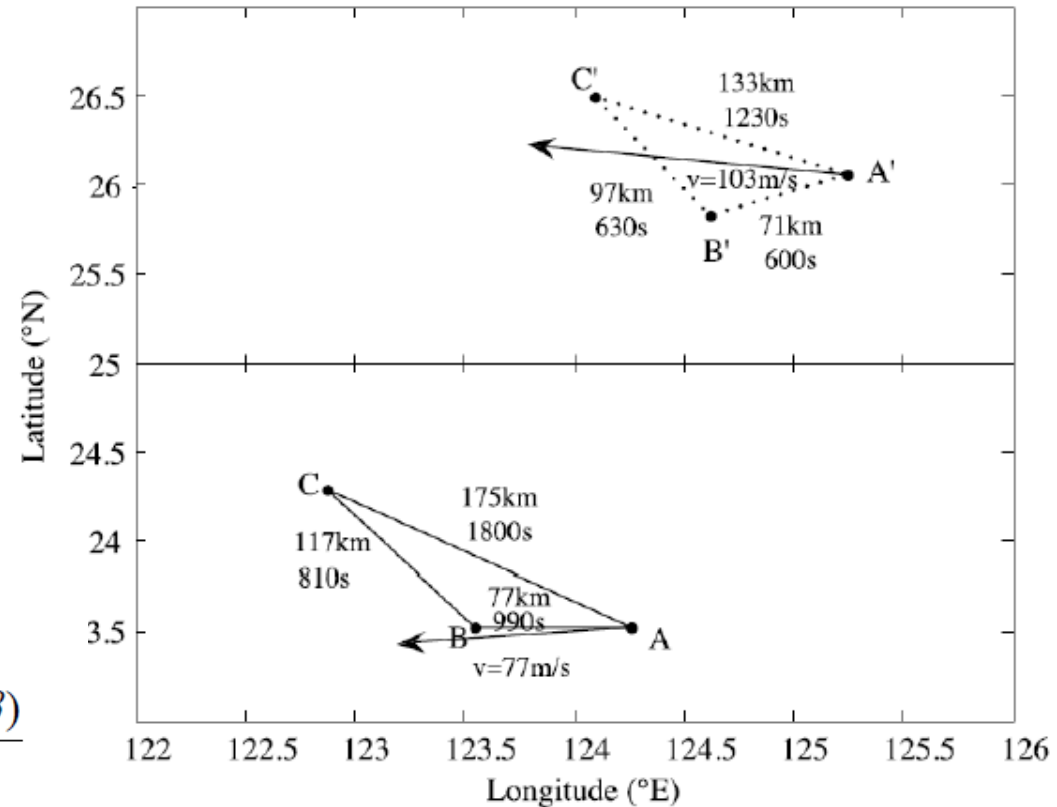
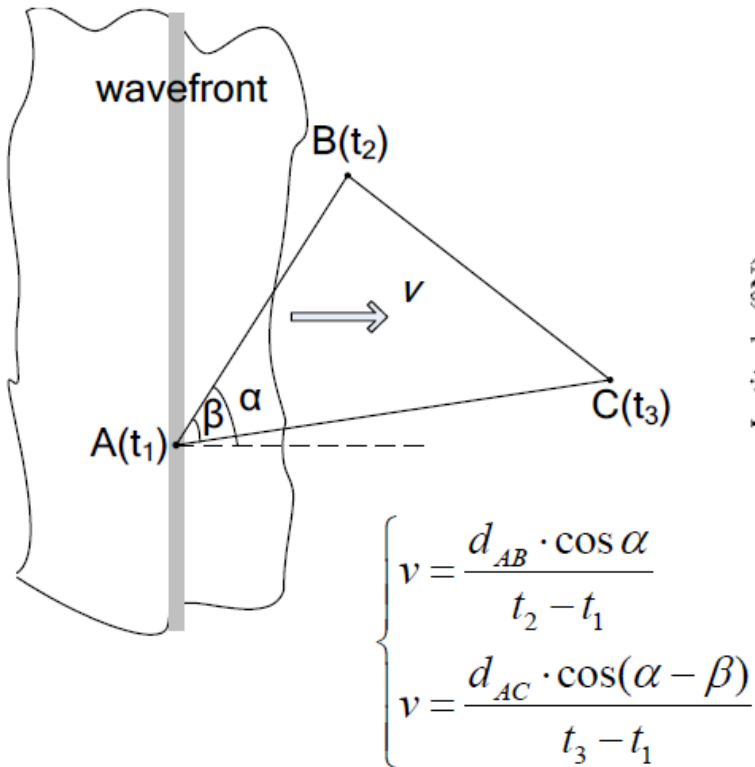
Our method

Assuming that :

- (1) The irregularities are consisted of different wave fronts.
- (2) The wave fronts are much larger than the distance of the receivers.
- (3) The points on the TEC curves with same characteristics are caused by the same wave front.

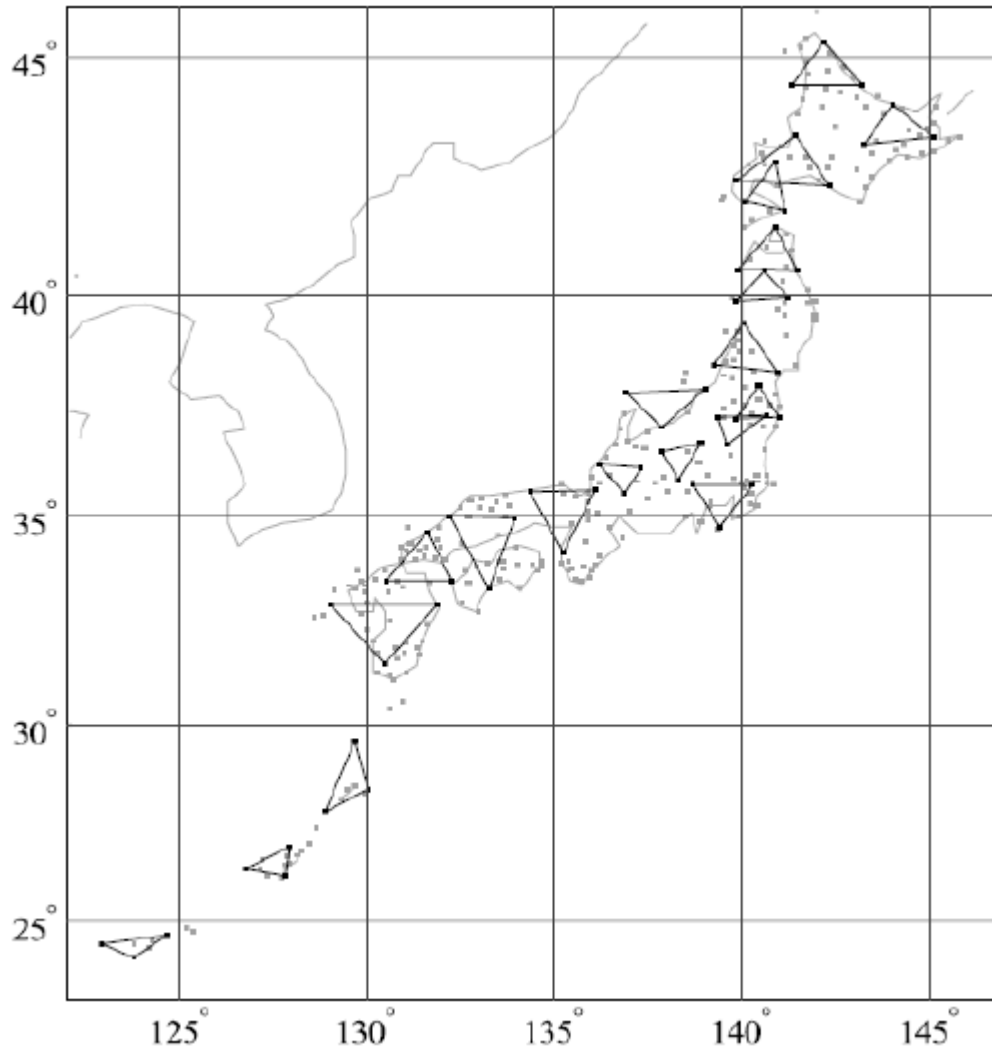


Our method



- ① The distance can be obtained from the coordinates of IPPs A, B, and C.
- ② The time lag can be obtained from the TEC curves.
- ③ And then the apparent velocity of the irregularities can be obtained.

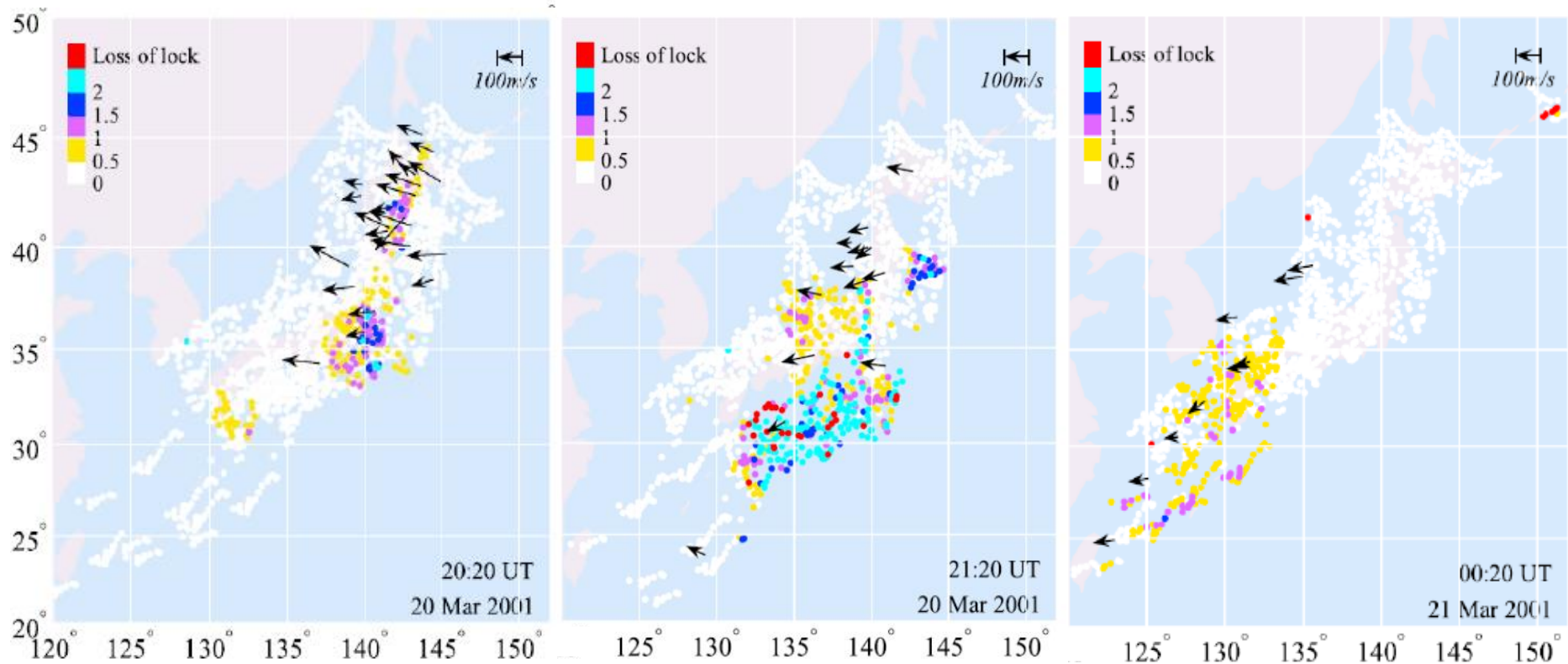
Results



Based on the method, 20 groups of spaced receivers are chosen from GEONET of Japan to get the apparent drift velocity of the irregularities.

Results

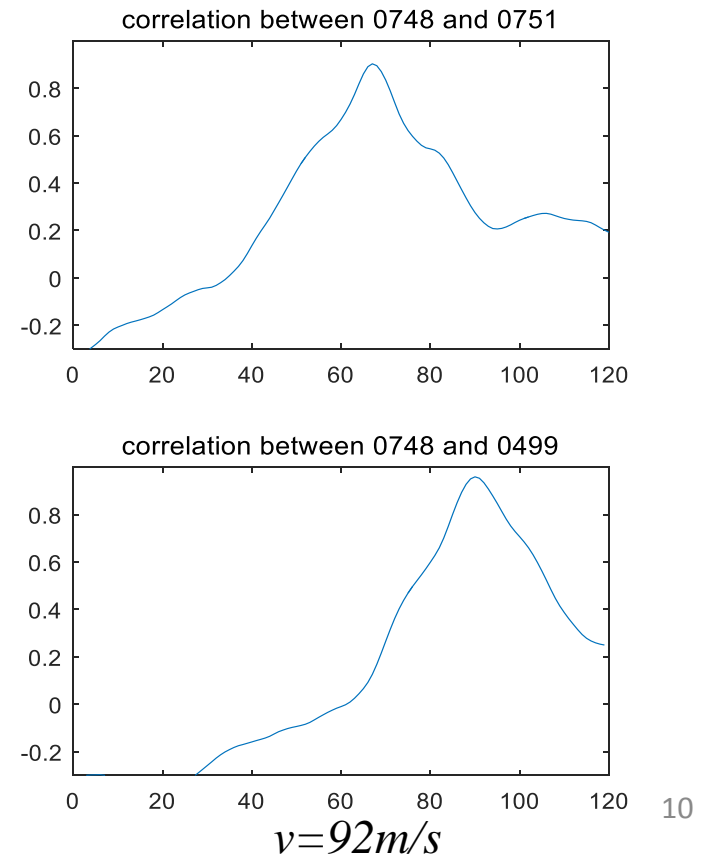
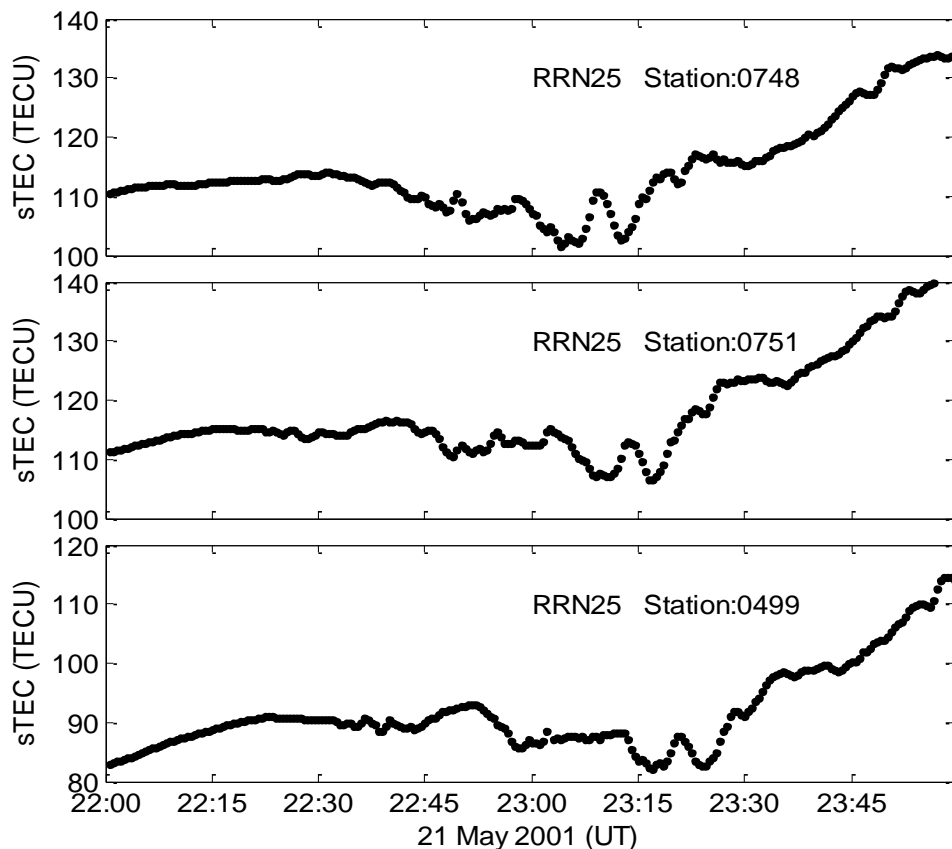
Velocity in ± 30 min.

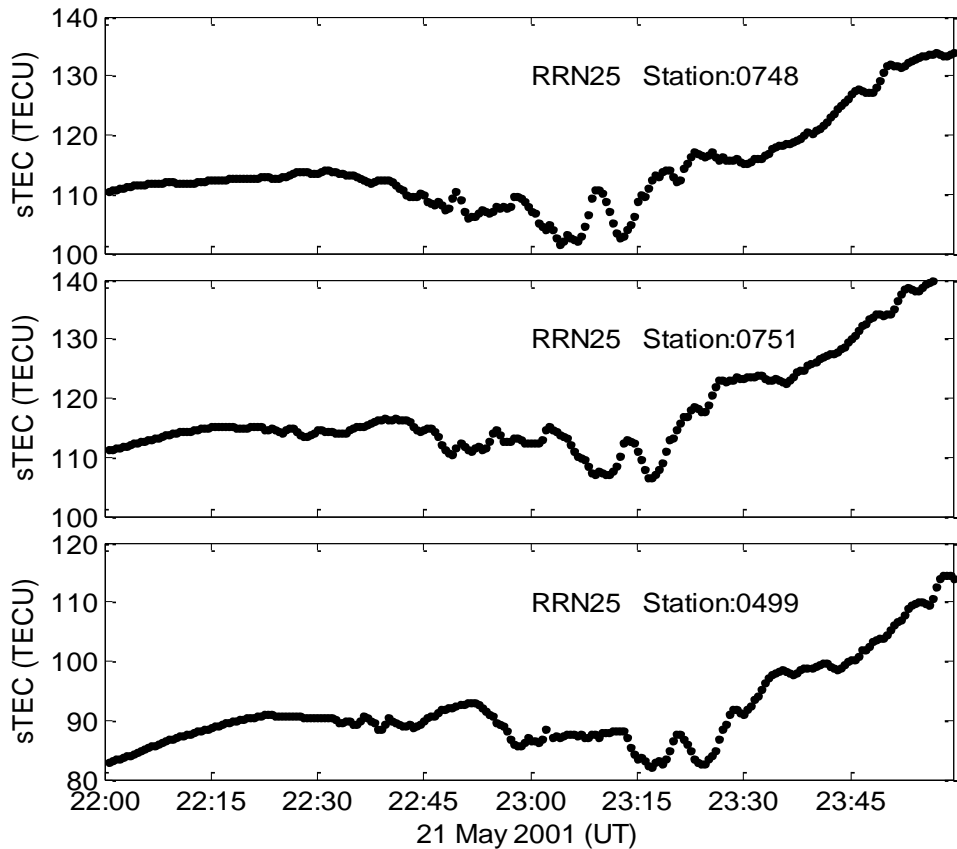


J. Li, G. Ma, T. Maruyama, Z. Li, 2012, JGR, Vol. 117, A08304, doi:10.1029/2012JA017626

Development of the method

1. In the past, we choose the characteristic points from TEC by hand, and calculate the apparent velocity.
2. Recently, an automatic program is developed to get the apparent the velocity based on the TEC correlation.





1. Get the correlation coefficient using the detrended TEC in one hour.
2. Get the time lag corresponding the maximum correlation coefficient .
3. The distance is determined by the middle IPP in one hour.
4. A 20-minutes sliding is used in the next correlation operation.

Summary: Advantages and Limitations

Advantages

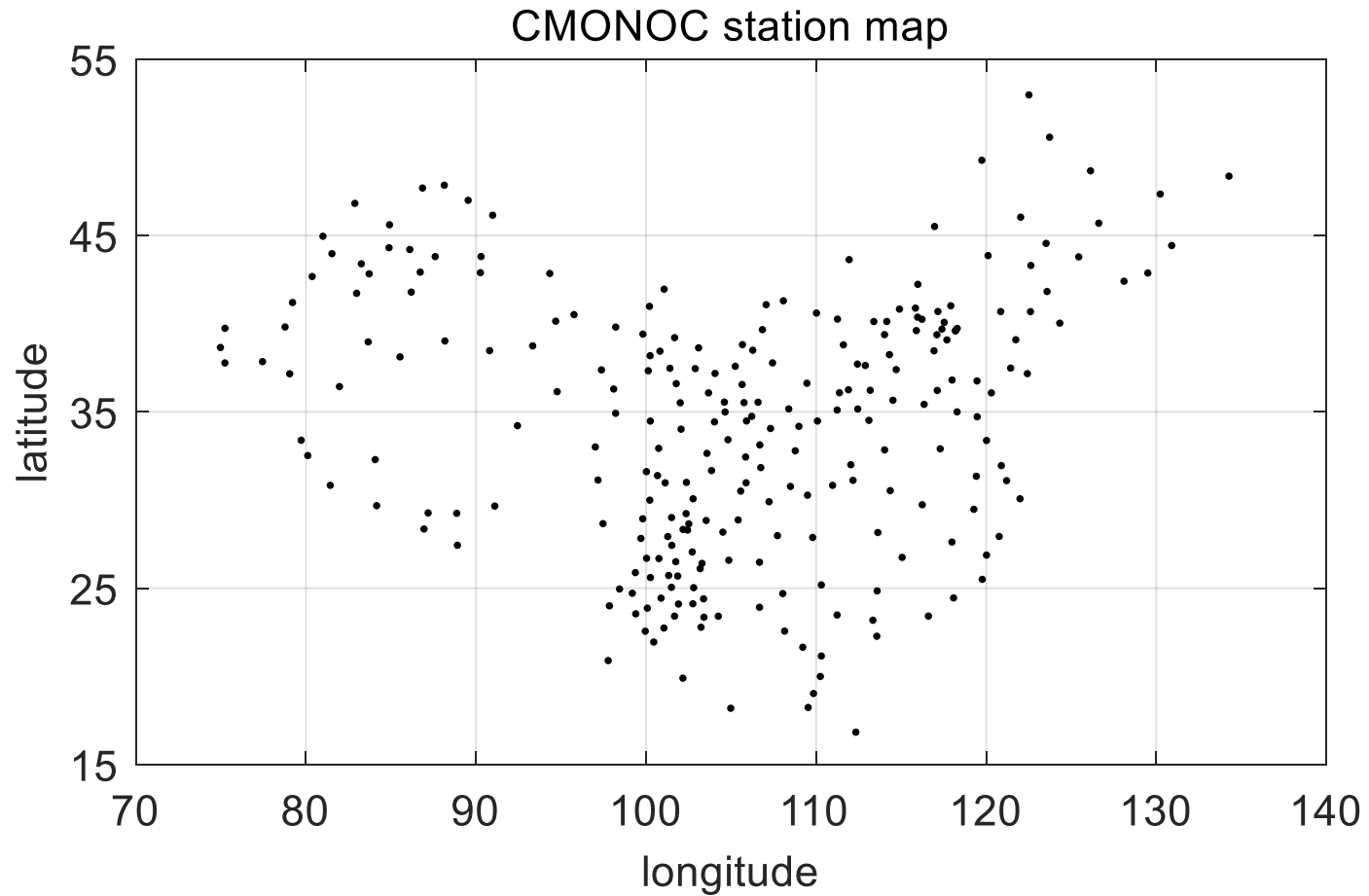
The dual-frequency receivers with 30 sec sampling interval are cheaper and easy to be established.

The spaced observations are available from IGS, GEONET, CMONOC and so on.

Limitations

1. Only valid for large temporal and spatial irregularities.
2. The cross-correlation of TEC may be not good in some irregularity events.

Next?



Thank you for your attention!