

Ionosphere comparison study of VGOS and global maps of Total Electron Content.

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Introduction: Total Electron Content (TEC) of the ionosphere is an important characteristic whose accurate estimation is needed in various application which are based on measurements in radio wave band. There is a number of Global TEC models designed to describe conditions of ionosphere in different parts of the world. We have conducted a comparative study of the two selected TEC global maps with the results from the observations of the VLBI Global Observing System (VGOS). VGOS network has been established recently and it is continuously growing. The estimated differential TEC (dTEC) from VGOS data has high precision with the formal error of dTEC is of about 0.01-0.2 TECU. It can be used in evaluation of the TEC global maps, as well as an additional data source for the further improvement of the TEC map models.

Data and methodology: VGOS 24-hour sessions from 2019 conducted biweekly. The VGOS operational network consisted of 8 telescopes. 24 session were analyzed.

The ionosphere contribution to the VLBI observable is given by the dTEC for each baseline. The difference of TEC value on each baseline is provided in VGOS database.

The CODE GIM Global vertical TEC (VTEC) distribution is represented using a spherical harmonics expansion up to a degree of 15. The maps are based on the data collected from about 300 GNSS sites of the IGS. The temporal resolution of the data is one hour with 2.5° spatial resolution in latitude and 5° in longitude. The data are presented as a shell layer at a height of 450 km.

For the comparison with VGOS data the VTEC of CODE GIM data was transferred to STEC using mapping function:

$$TEC = \frac{1}{\sqrt{1 - (F \cos el)^2}} * VTEC,$$

where F is a coefficient calculated as $F = \frac{R_e}{R_e + h_{ip}}$, R_e – radius of the Earth, h_{ip} – shell layer height, and el – elevation angle of the antenna

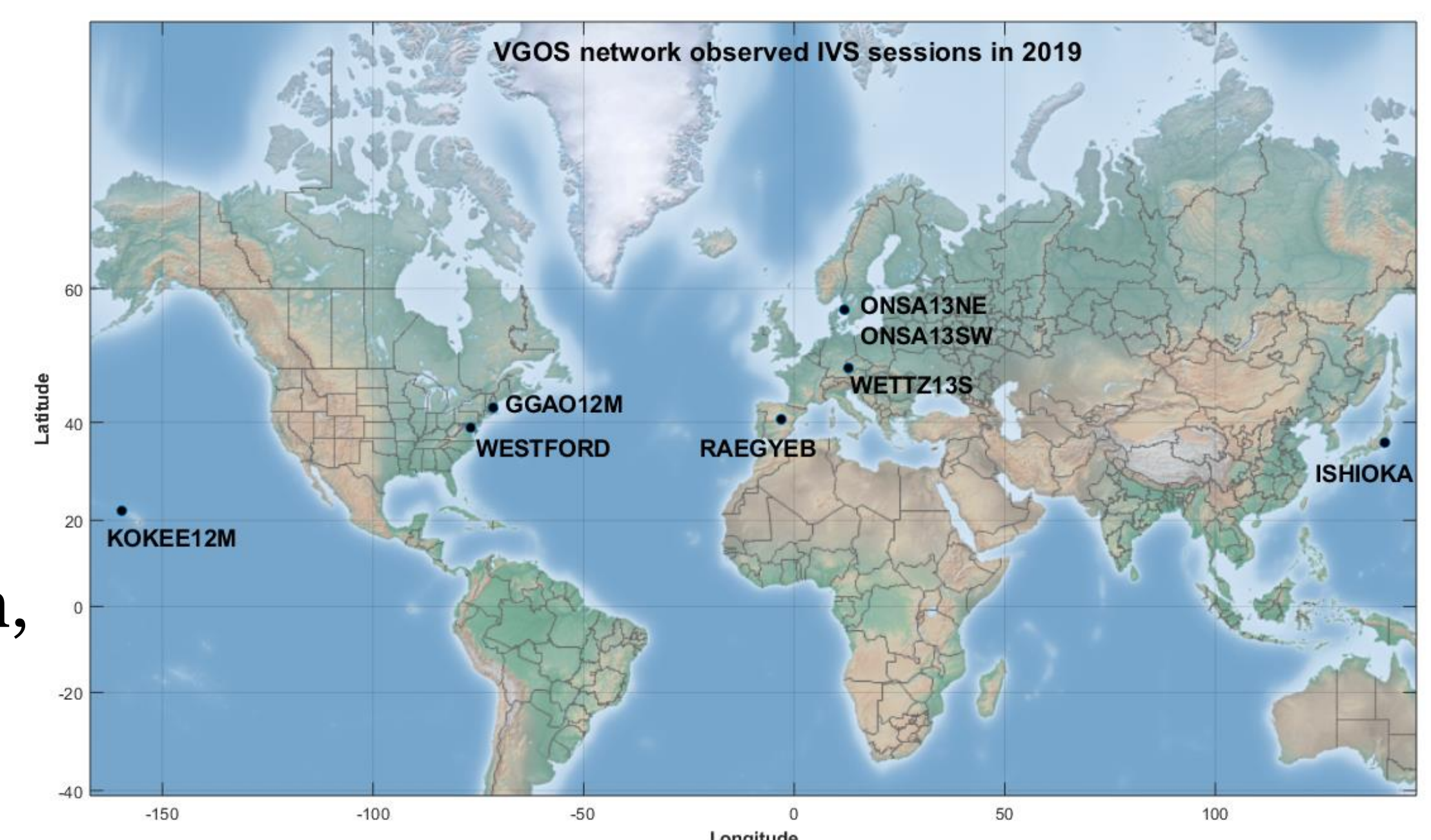


Table 1 Mean linear correlation coefficients of dTEC obtained with VGOS and CODE GIM and its standard deviation. 24 VGOS session were used in the analysis.

Baseline name	Mean corr. coef.
GGAO12M – KOKEE12M	0.95±0.02
GGAO12M- ONSA13NE	0.94±0.03
GGAO12M- RAEGYEB	0.92±0.04
GGAO12M- WETTZ13S	0.91±0.07
KOKEE12M-ONSA13NE	0.96±0.01
KOKEE12M-RAEGYEB	0.95±0.02
KOKEE12M-WESTFORD	0.96±0.02

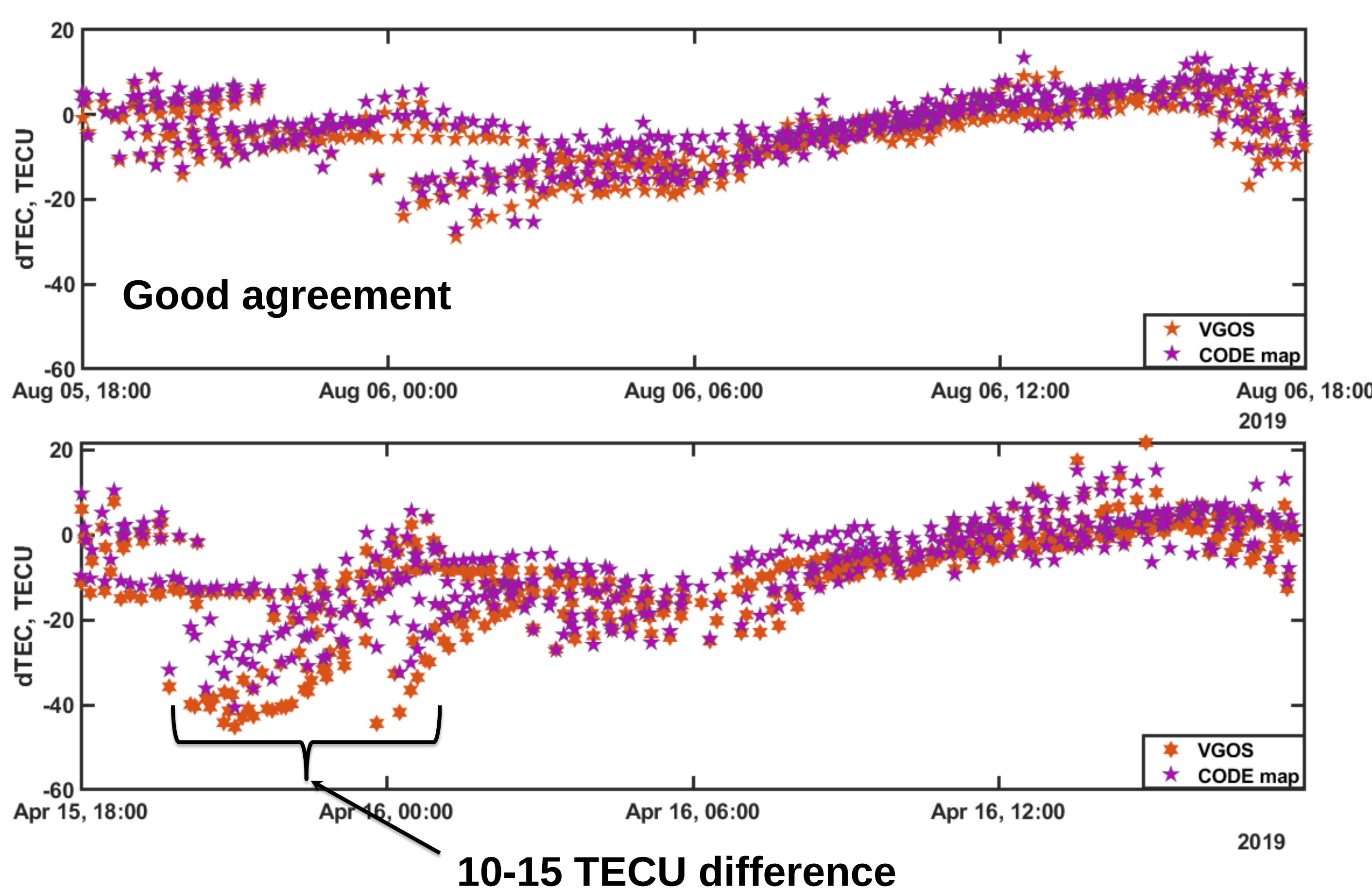


Figure 1 dTEC obtained from the VGOS observations and the CODE GIM. An agreement between dTECs is demonstrated for two different sessions.

- The comparison shows a good correlation of dTEC obtained with the two independent space geodetic techniques when baseline length is about 1000 km or longer. However, a correlation is weaker for the baselines of 500 km or shorter in length.
- dTEC comparison with CODE GIM model reveals some discrepancy of CODE GIM dTEC.
- VGOS data is affected by the radio source structure

Conclusions: The comparison bring an additional information on the VGOS data, as well the VGOS data can be considered as an extra information source for the further improvement of the global TEC models.

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