TEC ESTIMATION FOR MID-HIGH LATITUDE STATION USING NEURAL NETWORK: SOLAR MINIMUM CONDITIONS

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ААНИИ

Our task is the TEC estimation by NN.

NN is the brain model as a set of neurons of the same structure.

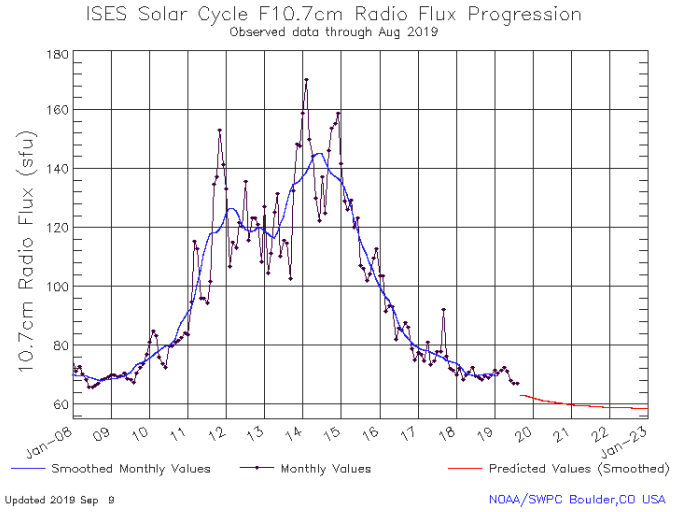
Why NN ?

- the ability to “study”
- the ability to perform generalization
- NN can find complex relationships between the input and output data
- NN helps when the theory of phenomena is absent/not well-developed

ААНИИ

mid-high latitude stations:
Svetloe (SVTL) (60.53N, 29.78E)
Yakutsk ( )

solar minimum conditions 2018:
61% of the spotless days,
no major flares,
1 intense magnetic storm



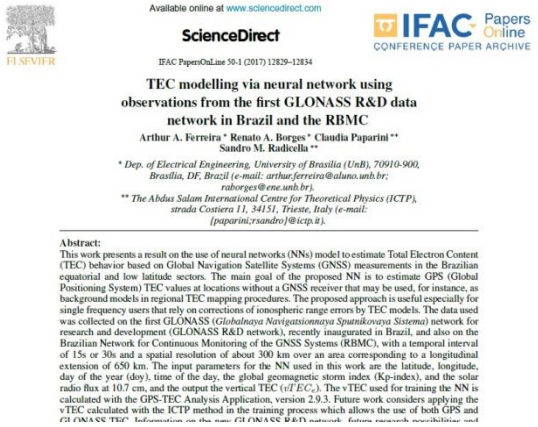
TEC values reconstructed by TayAbsTEC method [Yasyukevich et al., 2015].

www.gnss-lab.org/tay-abs-tec

GNSS lab

TayAbsTEC

Neural Network [Ferreira et al., 2017]



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TEC modelling via neural network using observations from the first GLONASS R&D data network in Brazil and the RBMC

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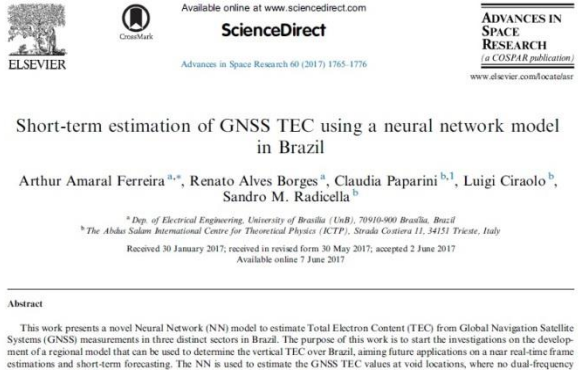
Abstract:
This work presents a result on the use of neural networks (NNs) model to estimate Total Electron Content (TEC) behavior based on Global Navigation Satellite Systems (GNSS) measurements in the Brazilian equatorial and low latitude sectors. The main goal of the proposed NN is to estimate GPS (Global Positioning System) TEC values at locations without a GNSS receiver that may be used, for instance, as background models in regional TEC mapping procedures. The proposed approach is useful especially for single frequency users that rely on corrections of ionospheric range errors by TEC models. The data used was collected on the first GLONASS (*Globalnaya Navigatsionnaya Sputnikovaya Sistema*) network for research and development (GLONASS R&D network), recently inaugurated in Brazil, and also on the Brazilian Network for Continuous Monitoring of the GNSS Systems (RBMC), with a temporal interval of 15s or 30s and a spatial resolution of about 300 km over an area corresponding to a longitudinal extension of 650 km. The input parameters for the NN used in this work are the latitude, longitude, day of the year (doy), time of the day, the global geomagnetic storm index (Kp-index), and the solar radio flux at 10.7 cm, and the output the vertical TEC ($vTEC_n$). The vTEC used for training the NN is calculated with the GPS-TEC Analysis Application, version 2.9.3. Future work considers applying the vTEC calculated with the ICTP method in the training process which allows the use of both GPS and GLONASS TEC. Information on the new GLONASS R&D network, future research possibilities and



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ADVANCES IN SPACE RESEARCH (a COSPAR publication)

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Short-term estimation of GNSS TEC using a neural network model in Brazil

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Abstract

This work presents a novel Neural Network (NN) model to estimate Total Electron Content (TEC) from Global Navigation Satellite Systems (GNSS) measurements in three distinct sectors in Brazil. The purpose of this work is to start the investigations on the development of a regional model that can be used to determine the vertical TEC over Brazil, aiming future applications on a near real-time frame estimations and short-term forecasting. The NN is used to estimate the GNSS TEC values at void locations, where no dual-frequency

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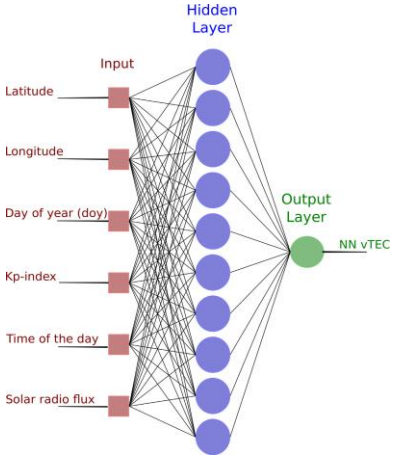
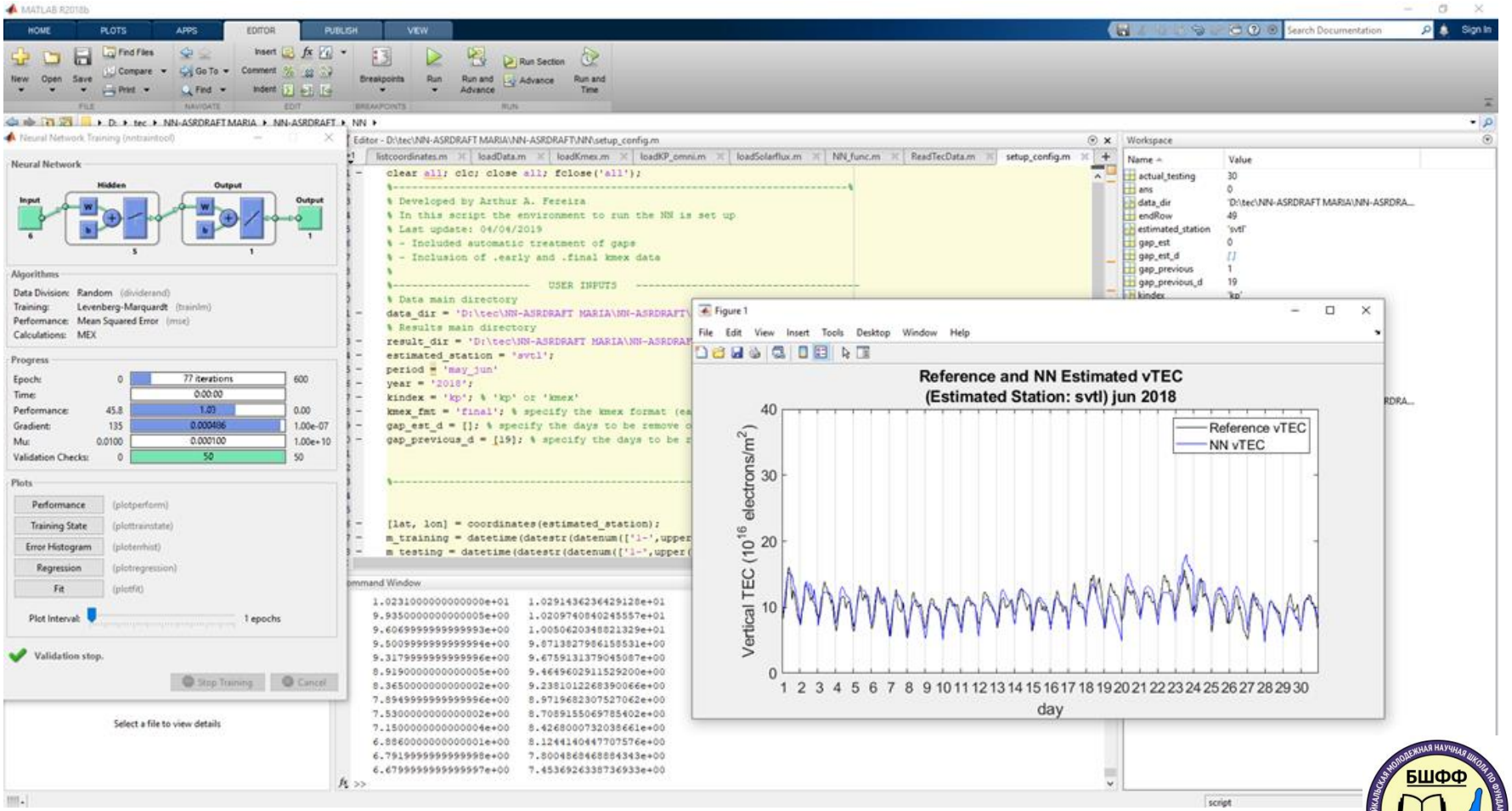
INPUT:
- F10.7 index,
- Kp index,
- TEC seasonal variation (DOY),
- monthly (training set length) and diurnal (hour of the day) variations.

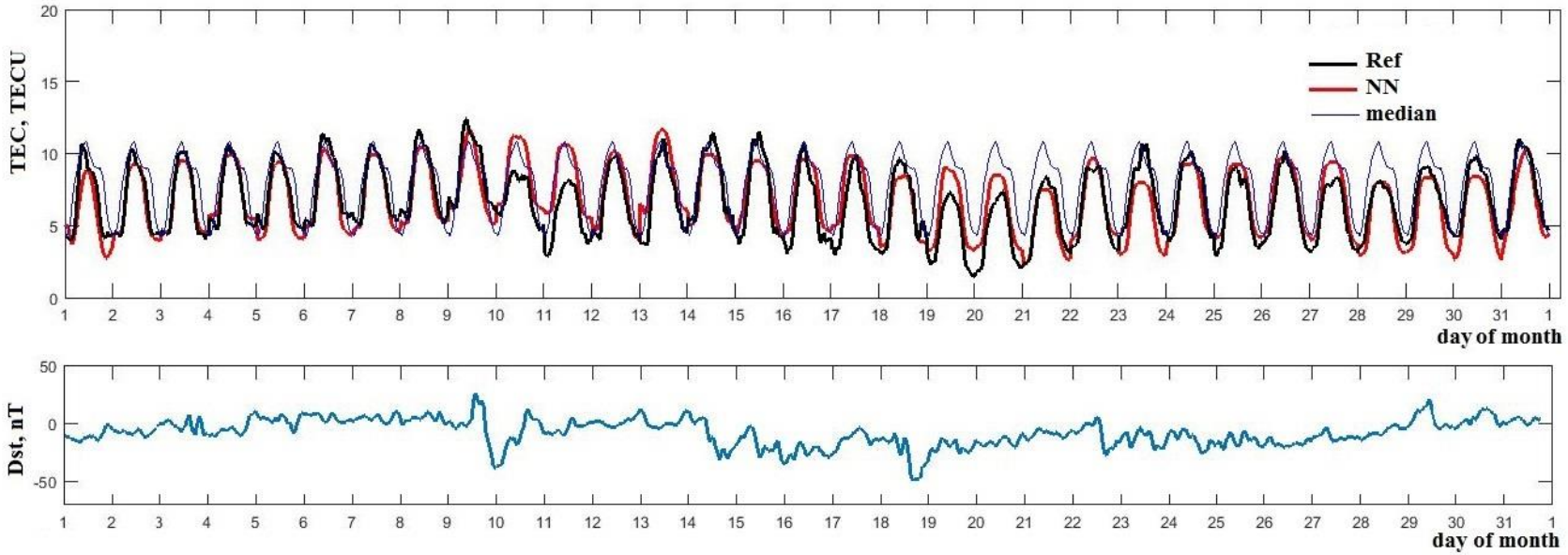


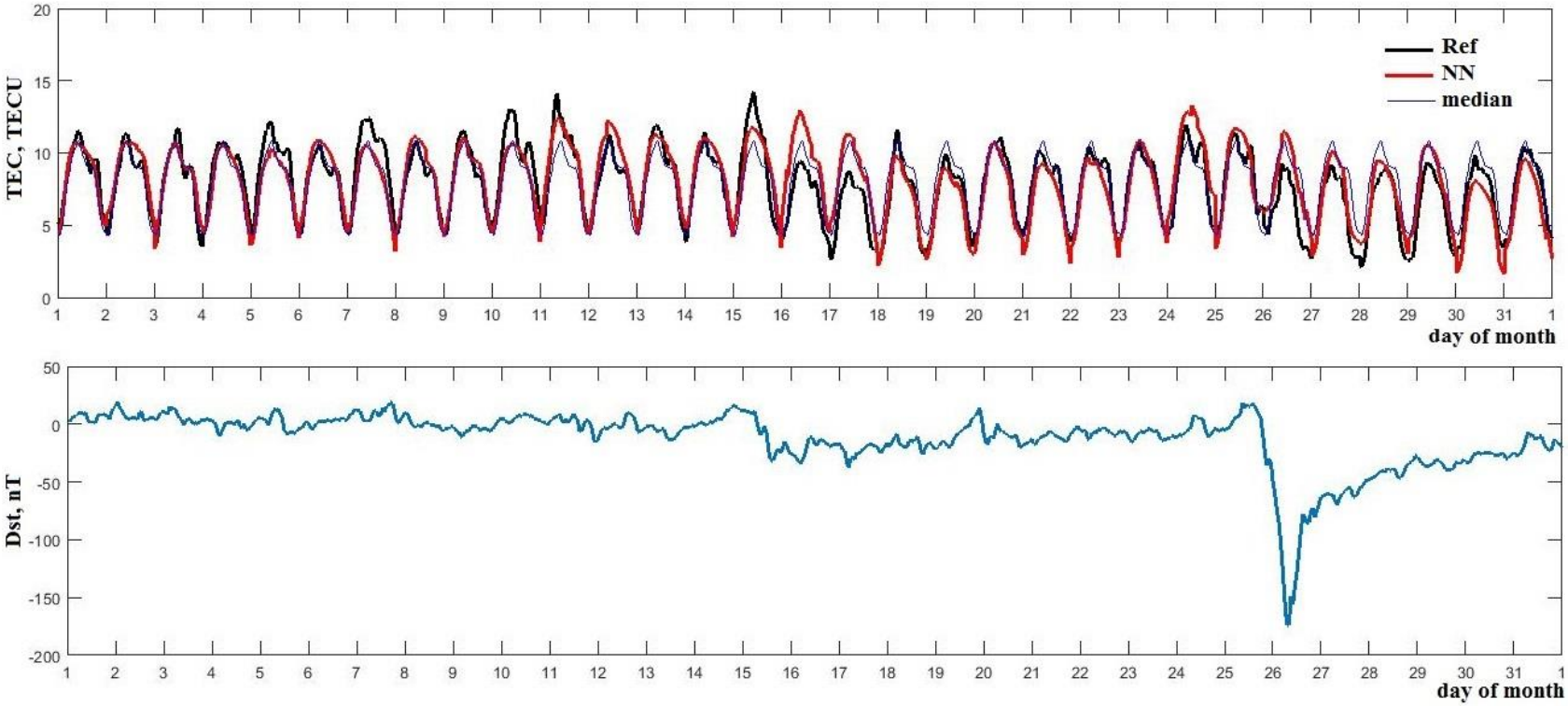
Before:	Now:
low latitudes, ascending part of the solar cycle (higher TEC values), NN training with 10 days data, high TEC data time resolution (1 sec).	high latitudes, solar minimum, NN training with 27 days data, much lower time resolution (30min).

Eventually, NN is expected to be used for nowcasting The near real-time TEC maps ~10-30 min
TASK: to check the NN performance under such conditions

Neural Network [Ferreira et al., 2017]




TEC, TECU
Ref
NN
median
day of month
Dst, nT
day of month


TEC, TECU
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NN
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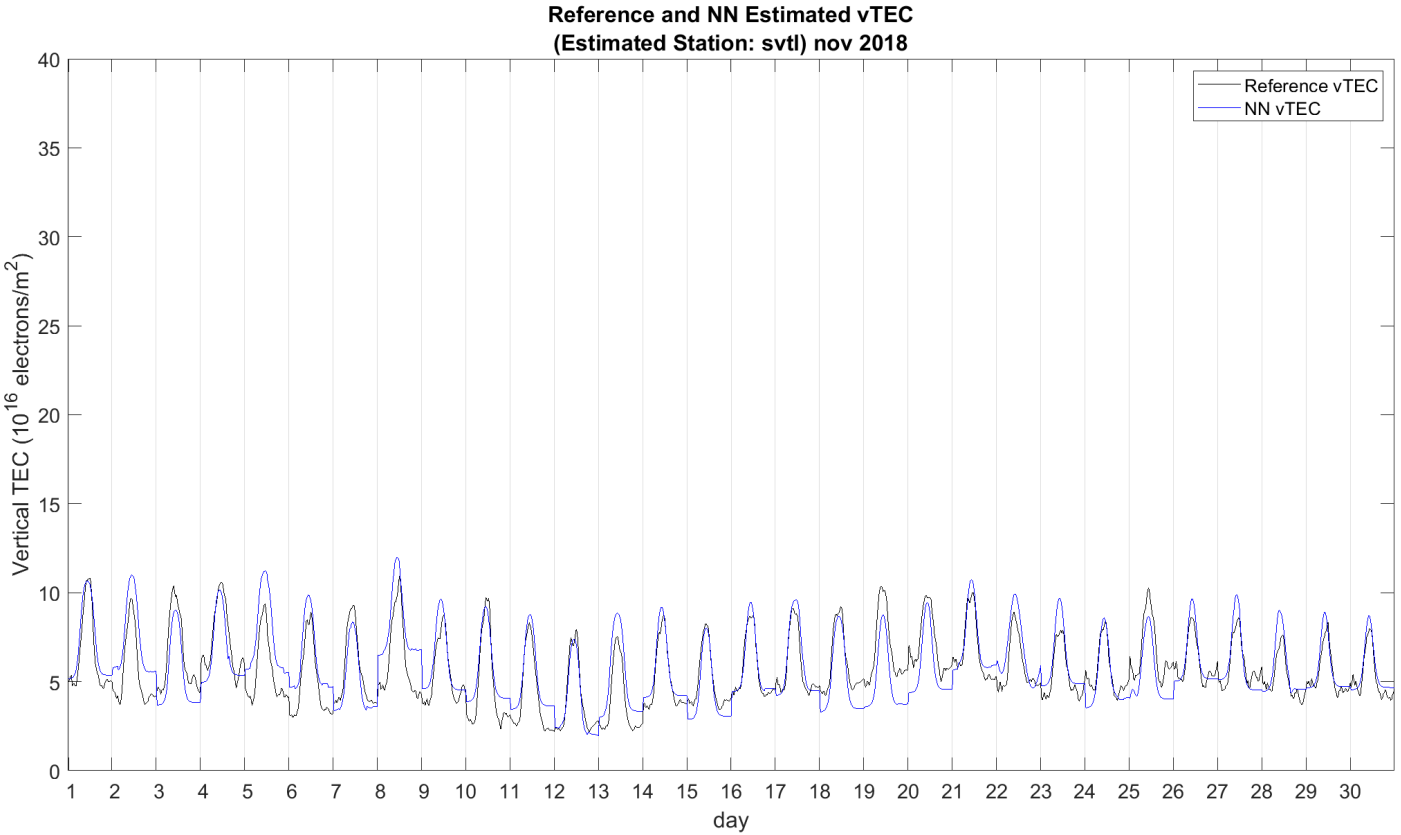
Reference and NN Estimated vTEC
(Estimated Station: svtl) nov 2018
Reference vTEC
NN vTEC
Vertical TEC (10^{16} electrons/m^2)
day
0
5
10
15
20
25
30
35
40
1
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Conclusions:

(1) The first results of the NN performance were satisfactory: correlation between modeling and experimental results was high

(2) In general, NN showed better estimation then the simplest forecast with median value.

(3) Some nighttime effects (e.g. short-time night TEC enhancements in winter) were not modeled well → the responsible physical cause was not introduced to NN

(4) during moderate GF disturbances, the diurnal TEC variation was under/overestimated → may be Kp is not sufficient in our case.

(5) NN model improvement (input and structure) are the subjects of our future work

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ААНИИ

Thank you for your attention!

Спасибо за внимание!