LISN network: Tools for GPS data processing and managing

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INTRODUCTION

The LISN network includes several GPS receivers installed around South-America as a distributed observatory with the purpose of study the ionospheric phenomena. All of these receivers send data every 15 minutes to a central server located at Lima – Peru.

The GPS receivers are from different brands and models so it was necessary a set of utilities capable of reading and processing the different data formats.

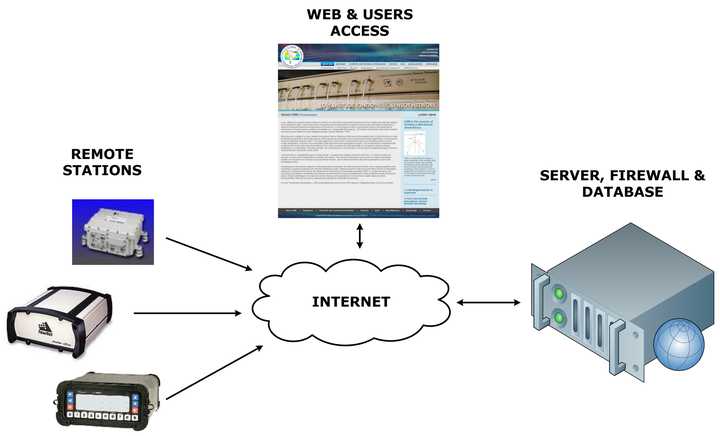


Fig. 1: GPS data flow

DEVELOPMENT

The GPS data that arrive to the server is processed to get daily files of: binary, scintillations, position, standard observables RINEX and Total Content of Electrons (TEC). To accomplish this task we have used several third-party software (written in C and Fortran languages) with the inconvenience that this software did not support all formats we required, and their use were not friendly.

For these reasons we developed a Python package "lisnUtils" (based in the C and Fortran software) that allows to process the data easily and quickly.

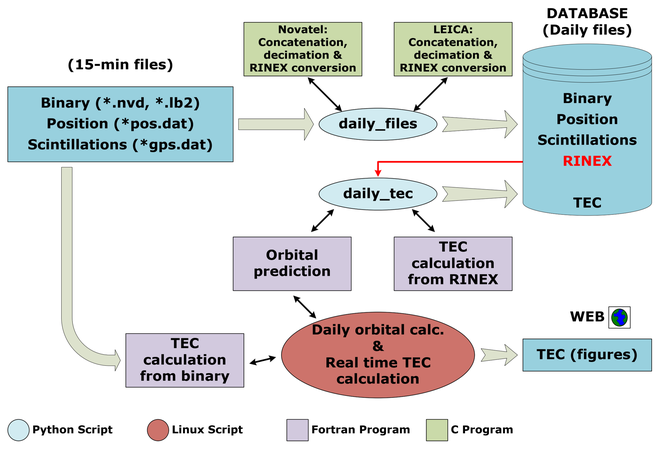


Fig. 2: Old programs used to process GPS data

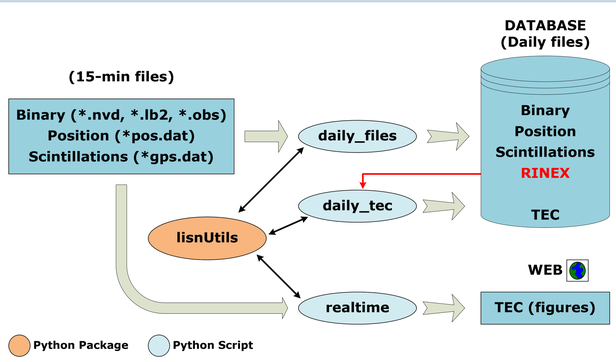


Fig. 3: New scripts used to process GPS data

Package "lisnUtils"

Main features:

- ❑ Support for Novatel binary files (*.nvd), 15-minutes server files and hourly files saved locally.
- ❑ Support for Leica binary files (*.lb2), "id_37" server files and "lb2" daily files saved locally.
- ❑ Support for observables files (*.obs) generated by GPS-Scinda.
- ❑ Support for scintillation and position files generated by GPS-Scinda.
- ❑ Conversion from all binary data supported to RINEX 2.0.
- ❑ RINEX files parser.
- ❑ TEC calculation, including receiver bias estimation with automatic download (when necessary) "satellite bias files" and "almanacs files" (YUMA format) for satellite orbital prediction.

lisnUtils	• gpsProcess.py • Rinex.py • plotter.py	Main Modules
	• __init__.py • utility.py • _myCutils.so	Other Modules
	• stations.dat • leapseco.dat	Other Files

Fig. 4: "lisnUtils" package structure

Package´s modules

- ❑ gpsProcess: decimation & concatenation of binary files and RINEX conversion.
- ❑ Rinex: RINEX file parser including TEC calculation.
- ❑ plotter: functions to plot different type of data.
- ❑ utility: classes and functions used by the main modules
- ❑ __init__: initialization module.
- ❑ _myCutils: "C" shared library (generated with SWIG) used for CRC 32 calculation.
- ❑ Stations.dat: file with stations data like name, country, position, type of receiver, etc.
- ❑ Leapseco.dat: file with information of leap seconds to update RINEX header data.

TEC calculation procedure

- ❑ Calculate the satellite's orbit (lat, lon, ele, az) using YUMA almanacs files.
- ❑ Calculate absolute TEC (from codes) and relative TEC (from carrier phases).
- ❑ Correct bad points and jumps.
- ❑ Cycle slips detection and correction.
- ❑ Read satellite bias from DCB files.
- ❑ Estimate receiver bias min(Σ[var(vTEC)]) between 3:00 and 6:00 LT.
- ❑ Correct receiver bias to avoid negative or high values of vertical TEC.
- ❑ Calculate slant TEC and vertical TEC.

RESULTS

GPS data and plots at the lisn webpage

http://200.60.148.173/lisn/stations/

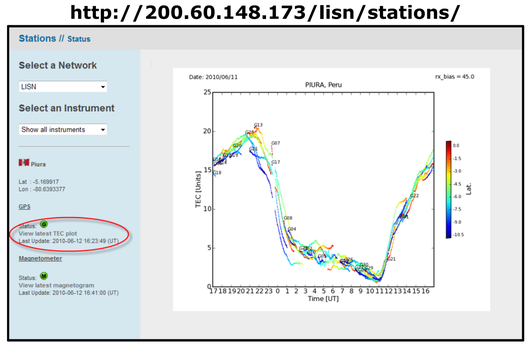


Fig. 5: Realtime plots

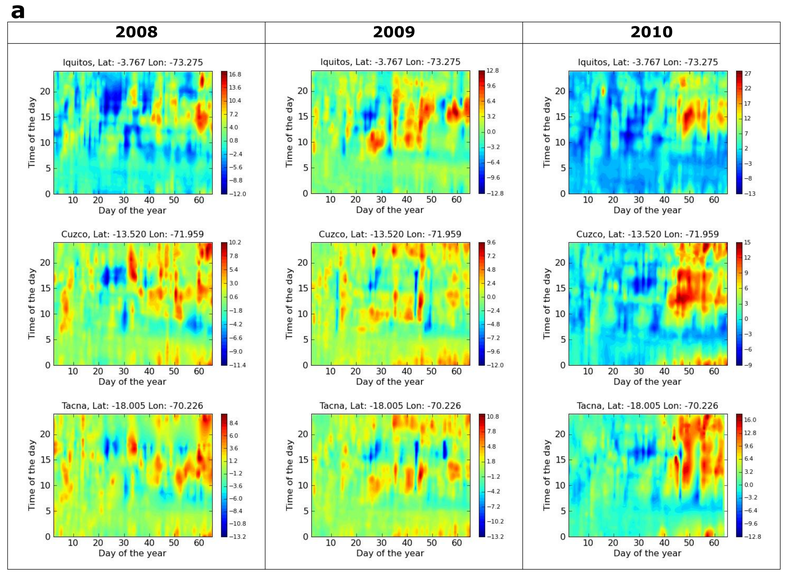
http://200.60.148.173/lisn/gps/

Fig. 6: LISN GPS database

Diferential TEC maps

TEC observations during the stratospheric warming 2008-2010 in the equatorial region.

a



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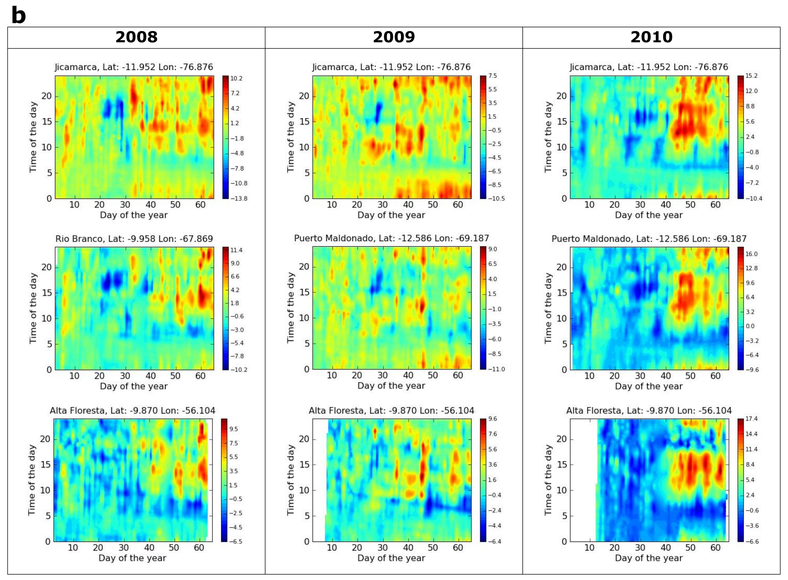

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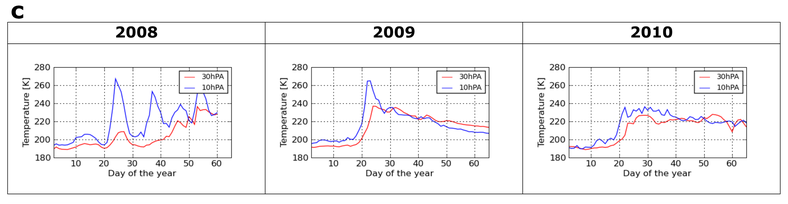

Fig. 7: Diferential TEC maps (a) for longitude around -72°. (b) for latitude around -12°. (c) Stratospheric temperature at 90°N.

Presented at the CEDAR Workshop, Boulder, Colorado – USA, June 2010