Name of research institute or organization:

Bundesamt für Landestopografie / Swiss Federal Office of Topography (swisstopo)

Title of project:

Automated GNSS Network Switzerland (AGNES)

Project leader and team:

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Dominique Andrey, Daniel Ineichen, Leïla Kislig, Dr. Simon Lutz, Christian Misslin, Dr. Stefan Schaer, Dr. Urs Wild

Project description:

The station is part of the Automated GNSS Network of Switzerland (AGNES) consisting of 31 sites, partly equipped with GPS and GPS-GLONASS (the Russian equivalent of GPS) combined receivers and antennas. Due to the extreme weather conditions, a special antenna is installed at Jungfraujoch. This antenna is unfortunately not capable to receive the Russian GLONASS satellite data.

AGNES is a multipurpose network which serves as reference for surveying, real-time positioning (positioning service swipos GIS/GEO) and for scientific applications (geotectonics and GNSS-meteorology). The GPS station JUJO (Jungfraujoch) is mainly contributing to scientific applications. Important results from the swisstopo processing of the GPS data of JUJO, the troposphere path delays, are provided to MeteoSwiss on an hourly basis. Furthermore, the data are sent to the European meteo community EUMETNET, where the data are available for all meteo agencies for numerical weather predictions. At the moment, UK METO, MeteoFrance, DMI, and KNMI are using the GNSS-derived troposphere models routinely in the weather forecasts. This activity is coordinated by the EGVAP project. The results are also sent to the Institute of Applied Physics (IAP) of the University of Berne where the data contribute to the STARTWAVE database.

In 2013 the new COST project named GNSS4SWEC (Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate) started. The focus of swisstopos investigations is the long-term behaviour of the troposphere parameters. Due to the fact that we reprocessed all Swiss and European GNSS data since 1996 with a homogeneous set of medelling parameters, we have a first data set which might help to detect possible changes in water vapor over time. Till now, the time series suffered from software changes and also from modelling changes which resulted in “jumps” in the troposphere time series (see Fig. 1). These jumps are “artificially” introduced and do not represent a real change in the atmosphere.

The correspondig information of the coordinate time series are given in Fig. 2 and 3. Whereas the horizontal movements are not significant, the alpine uplift of about 3 mm/yr with respect to the European plate is nicely visible (as also for other stations in the higher mountains). The results are also achieved from the reprocessing. Nevertheless, almost the same results were already achieved based on the previous operational results. This also underlines the fact that the troposphere parameters are a quite sensitive parameter in GNSS analysis.

In 2015 we plan to enhance all Swiss permanent stations to Multi-GNSS. This means that also signals of the European satellite system Galileo will be tracked as well as other new evolving satellite systems as Beidou (China) and QZSS (Japan). As a test station the ZIM3 receiver in Zimmerwald tracks already quite a lot of signals (see Fig. 4).

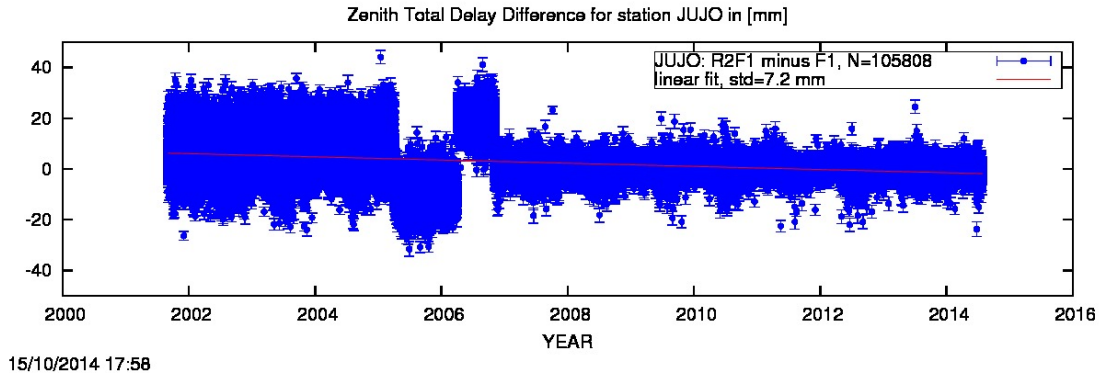

Figure 1. Troposphere estimates of JUJO: Difference of the reprocessing results and the results of the (old) operational processing. The "jumps" are purely artificial and are associated to model changes or changes of the software. Since 2007 the differences are smaller and without a significant bias due to similar software and models.

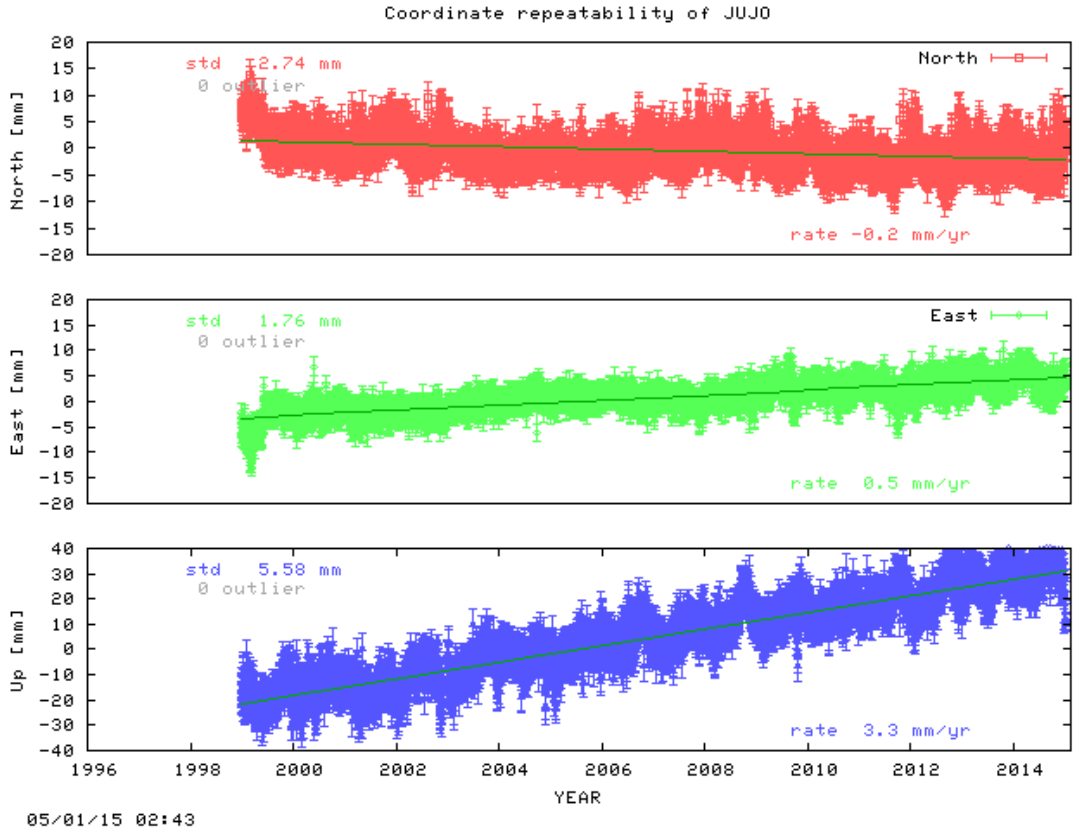

Figure 2. Coordinate time series of station JUJO (status Jan 5, 2015). The drift in the up timeseries shows the vertical uplift of the station with respect to the stable part of the Eurasian plate. Horizontally, the differences are plotted with respect to station ZIMM (Zimmerwald). The vertical movement of JUJO is 3.3 mm/yr.

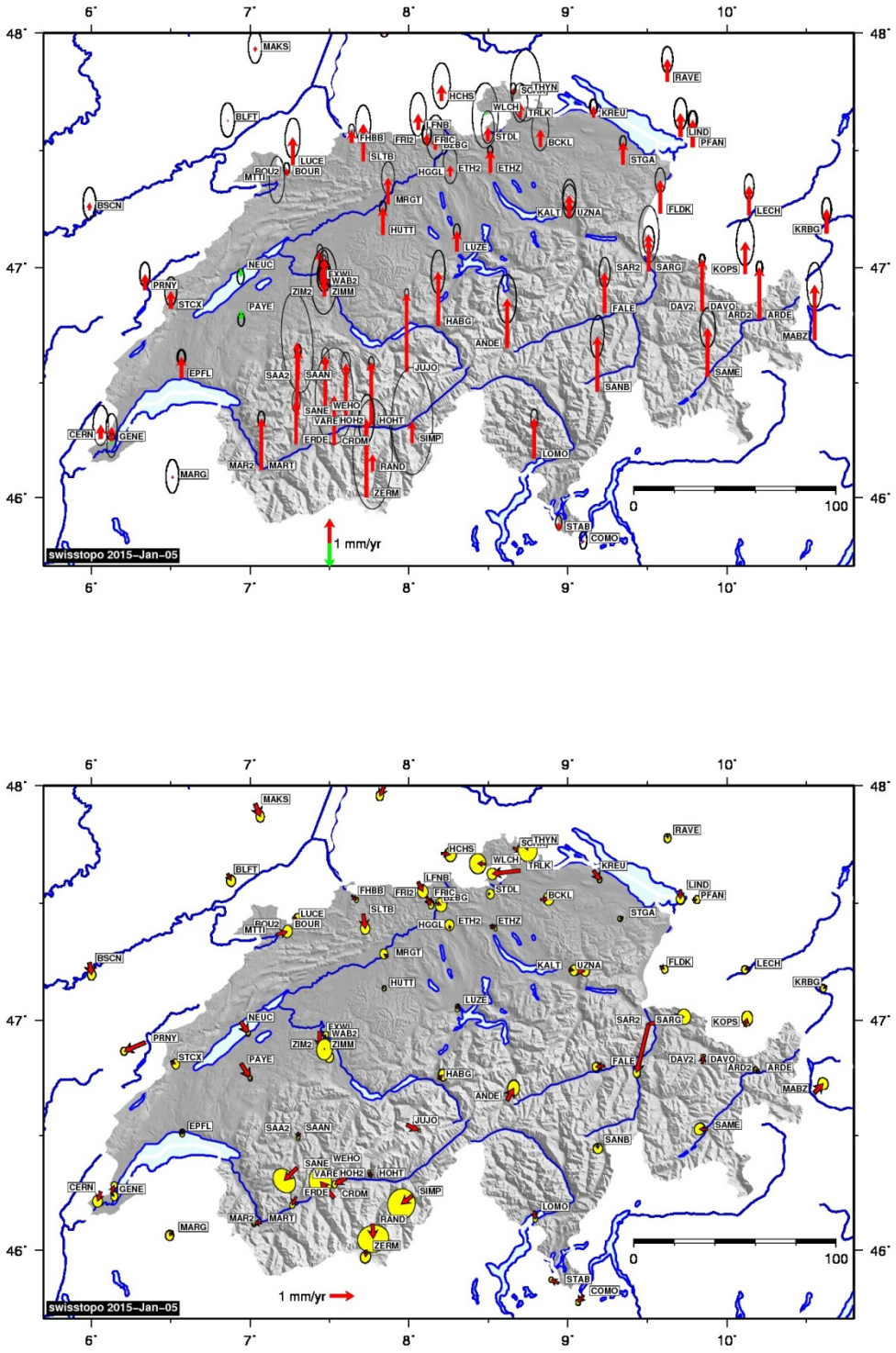

Figure 3. Upper plot: Vertical movements and the uncertainty ellipse of the Swiss permanent stations (status Jan 5, 2015). Reference is the stable part of the Eurasian plate. The movement of JUJO is 3.3 mm/yr. Lower plot: Horizontal movements with respect to station Zimmerwald (status Jan 5, 2015).

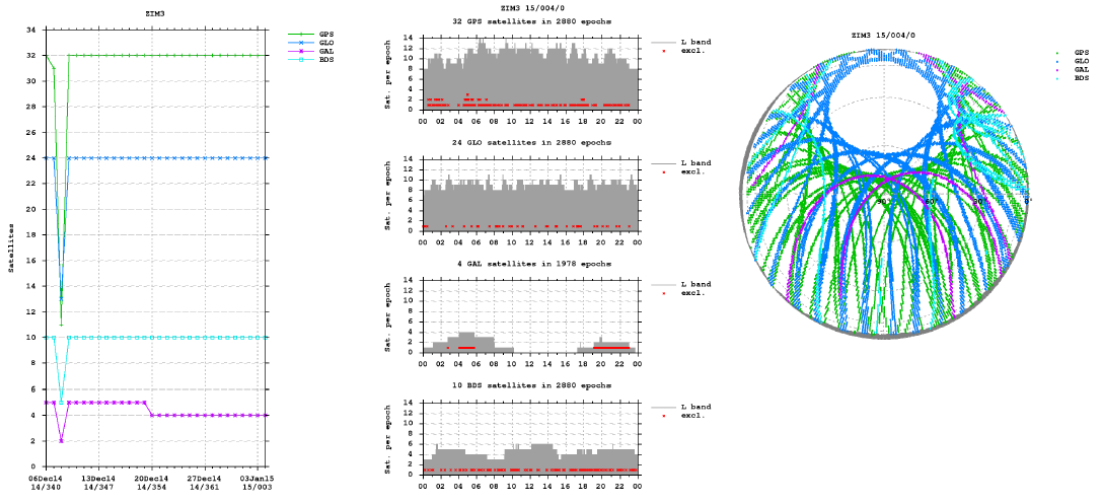

Figure 4. Satellite signals observed at test station ZIM3 in Zimmerwald. Beside 32 GPS satellites and 24 GLONASS satellites, 10 Beidou and 2-5 Galileo satellites were tracked between December 2014 and January 4, 2015.

Key words:

GPS, GLONASS, GNSS, Meteorology, Positioning, Integrated Water Vapor, Zenith Path Delay, GPS Tomography, Geotectonic

Internet data bases:

http://www.swisstopo.ch/pnac; http://egvap.dmi.dk/
http://www.iapmw.unibe.ch/research/projects/STARTWAVE/

Collaborating partners/networks:

Astronomical Institute (AIUB), University of Berne
MeteoSwiss, Zurich and Payerne
Institute of Applied Physics (IAP), University of Berne
Institute of Geodesy and Photogrammetry, ETH Zürich
E-GVAP II (EUMETNET GPS Water Vapor Programme)
GNSS4SWEC (COST EU project)

Scientific publications and public outreach 2014:

Refereed journal articles and their internet access

Lutz S., G. Beutler, S. Schaer, R. Dach, A. Jäggi, CODE's new ultra-rapid orbit and ERP products for the IGS, GPS Solutions, doi: 10.1007/s10291-014-0432-2 (paper accepted Dec. 6, 2014).

Lutz S., P. Steigenberger, M. Meindl, G. Beutler, K. Sosnica, S. Schaer, R. Dach, D. Arnold, D. Thaller, A. Jäggi, Impact of the arclength on GNSS orbits, the Geocenter, and the EOPs, GPS Solutions (paper in prep., received Dec. 15, 2014).

Conference papers

Brockmann E. et al., National Report of Switzerland, EUREF-Symposium, Vilnius, Lithuania, June 1-7, 2014.

Brockmann E., O. Bock, R. Dach, G. Dick, J. Dousa, U. Hugentobler, R. Pacione, Reprocessing Activities as possible contribution to GNSS4SWEC, GNSS4SWEC workshop, Munich, Germany, February 25-28, 2014.

Brockmann E., Intercomparison of ZTD solutions: operational – reprocessed (global, kontinental), GNSS4SWEC workshop, Varna, Bulgary, September 9-13, 2014.

Brockmann E., Status of the working progress in Switzeland, GNSS4SWEC workshop, Varna, Bulgary, September 9-13, 2014.

Brockmann E., swisstopo Report for EGVAP 2014, EGVAP expert meeeting, Exeter, United Kingdom, October 2014.

Ineichen D., E. Brockmann, S. Schaer, Reprocessing activities at swisstopo, EUREF-Symposium, Vilnius, Lithuania, June 1-7, 2014.

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