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GEODYNAMICAL STUDY OF THE TERRITORY OF BALKAN PENINSULA FROM GPS SOLUTIONS

Keranka Vassileva

National Institute of Geophysics, Geodesy and Geography,
Bulgarian Academy of Sciences

Outline

- GENERAL
- SEASONAL SOLUTIONS
- ANALYSIS OF THE SEASONAL SOLUTIONS
- CONCLUSION

GENERAL

- The purpose - complete analysis and generalization of the behavior of the free available permanent GNSS stations on the territory of the Balkan Peninsula in all four seasons.
- Investigations concerning behavior of BP permanent stations in the particular seasons have been already accomplished and now they are combined and analyzed.
- The investigated period covers the time span from 2006 till 2010.
- GPS weekly data of GNSS permanent stations on the territory of the Balkans have been used in each season, in each year.
- Station velocity vectors have been estimated from combined solutions for every season with Bernese software, Version 5.0.
- The estimated seasonal horizontal velocity vectors have been compared and analyzed. They have been also compared with results from other investigations.

SEASONAL SOLUTIONS

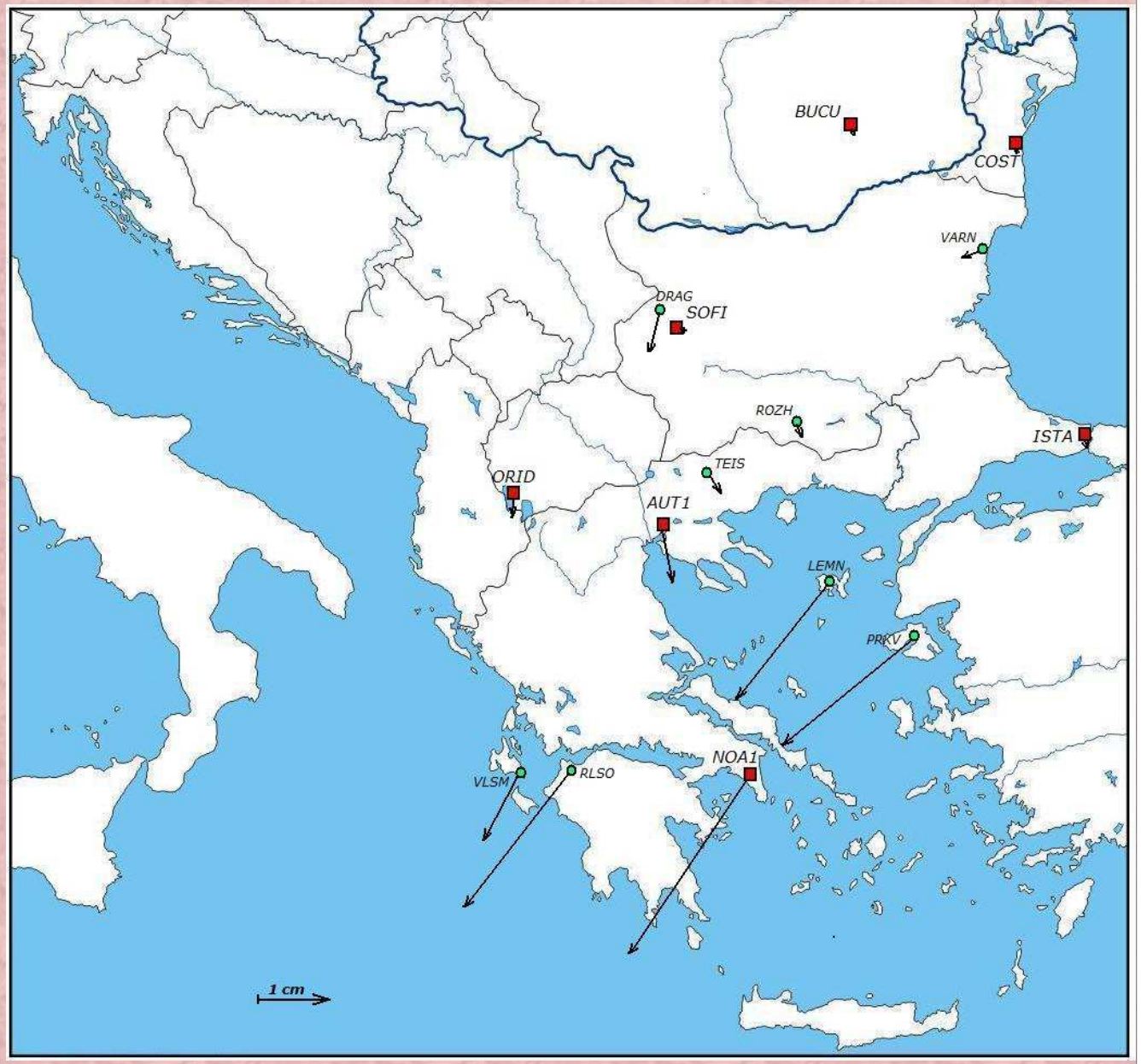
GPS one week data in each year from 2006 and 2010.

The number of Balkan Peninsula permanent stations increased during this period of five years from 6 in 2006 up to 29 in 2010.

- By the reason of comparability data from the same weeks of the involved years of the respective season have been used.
- GPS data in all years have been processed with the Bernese software, Version 5.0.
- The same general input parameters of all weekly solutions have been used and possibly almost the same IGS stations have been included for datum definition in all combined solutions.
- Station velocity vectors have been estimated from combined solutions of the particular four seasonal solutions in ITRF2005.

Winter solution

GPS weekly data in January from four years – 2006, 2007, 2008 and 2009 of 18 GNSS stations have been processed . The obtained IRF2005 estimations of the velocity vectors are consistent with the IRF2005/EPN/CEGRN long-term velocity estimations within 1-2 mm/yr in all three components V_X, V_Y, V_Z. ETRF horizontal velocity vectors have been obtained by using ETRF components of the Eurasia plate rotation pole to the obtained ITRF velocity vectors.

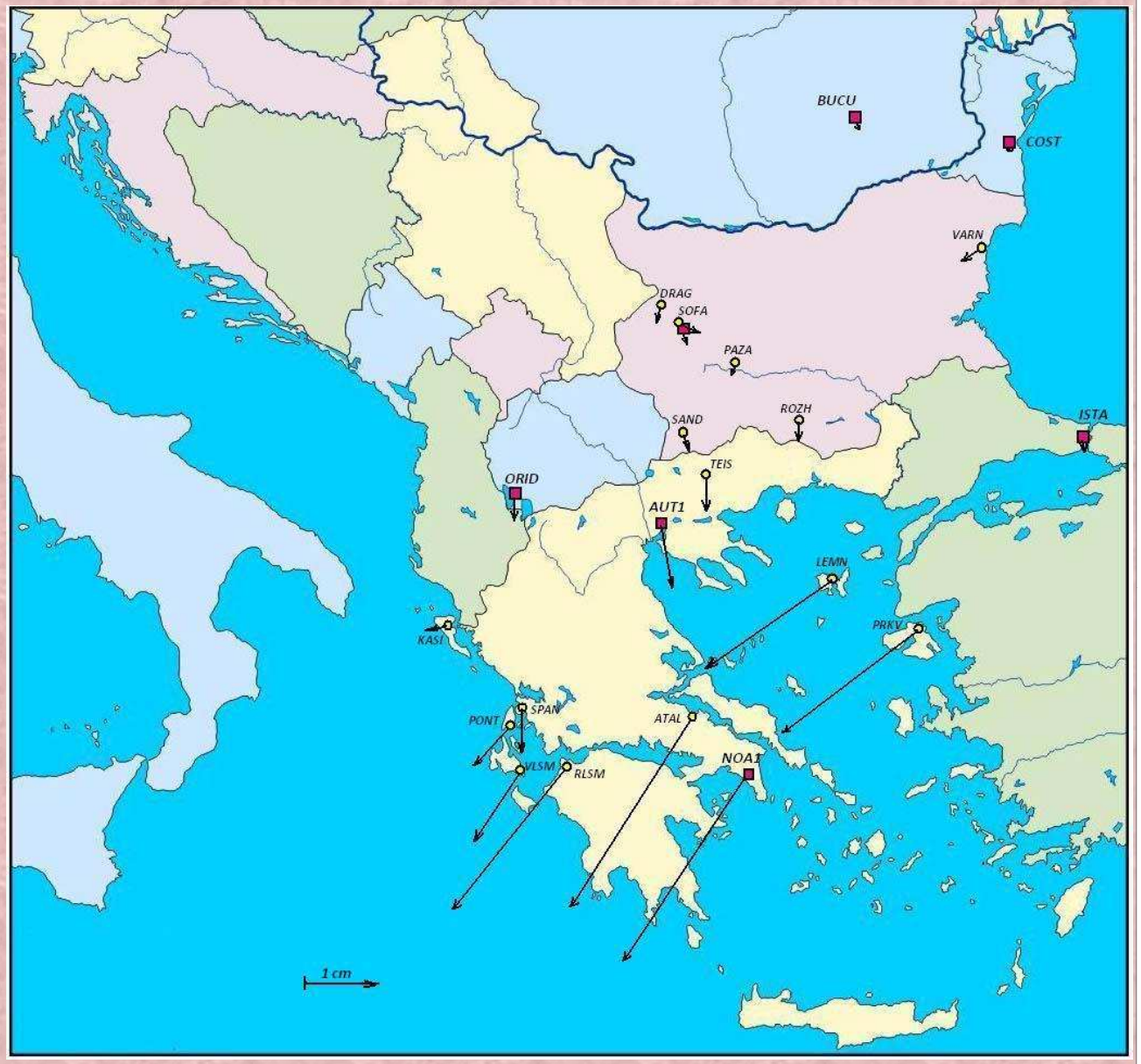


BP horizontal station velocity vectors in winter time with respect to the stable part of Eurasia

Spring solution

GPS weekly data in April from four years – 2006, 2007, 2008 and 2009 of 21 GNSS stations have been processed.

The spring velocity estimations obtained from all four years combined solution have been compared with the results from IRF2005/EPN/CEGRN long-term annual solutions. They agree within 0,1÷2,5 mm/yr with some exceptions. Higher discrepancies for some stations can be explained with shorter observation time span (only two years) and also with number of equipment alterations and subsequent offsets.



BP horizontal station velocity vectors in spring time with respect to the stable part of Eurasia

Summer solution

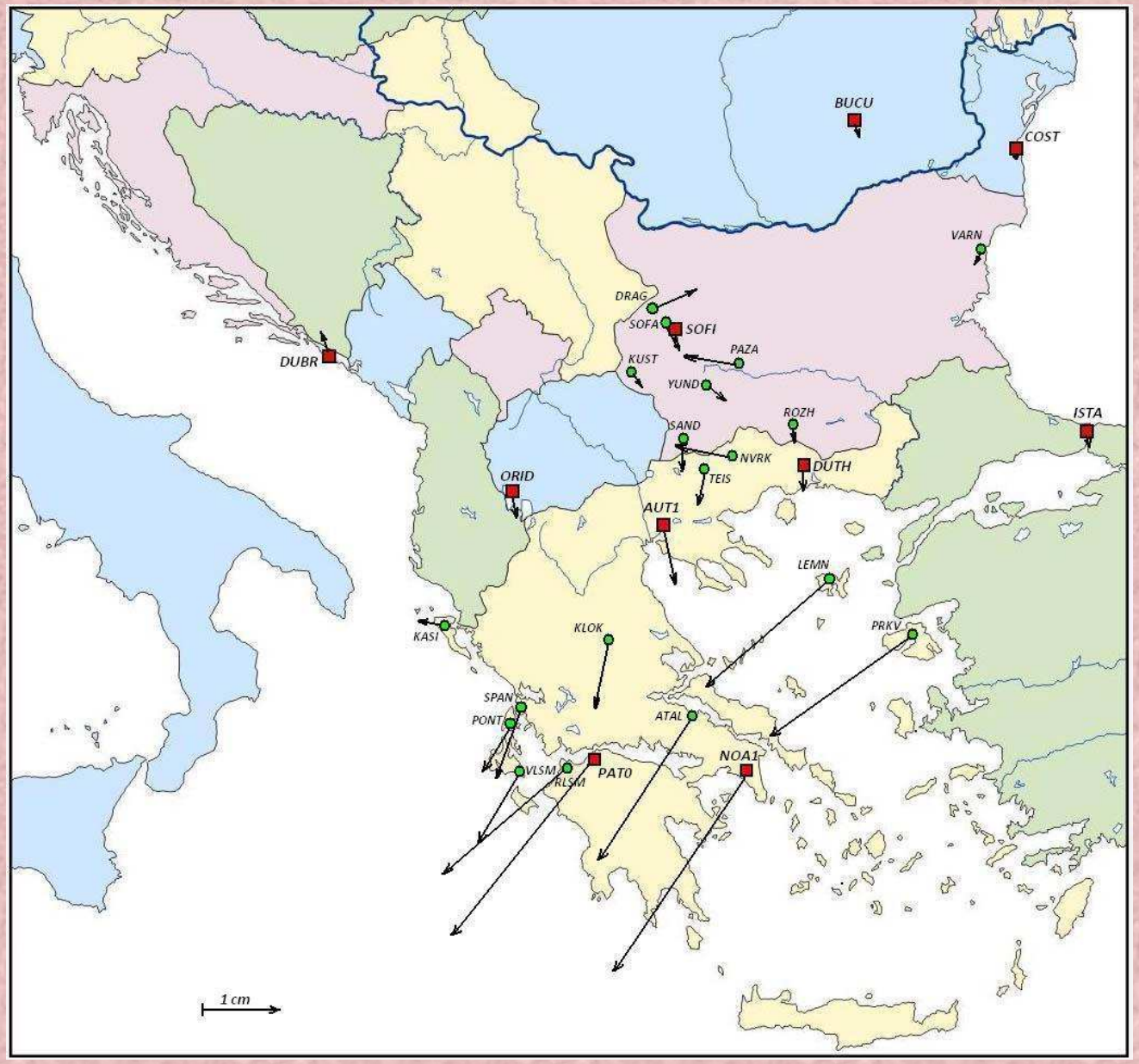
GPS one week data of 29 GNSS stations on the territory of the Balkans have been used.

They cover a time span within five years – 2006, 2007, 2008, 2009 and 2010 in July.

Individual year solutions have been combined and station velocity estimations have been obtained.

All possible three and four years combinations and total five years solution of the obtained weekly solutions in 2006, 2007, 2008, 2009 and 2010 have been processed and station velocity estimations have been obtained in the system ITF2005.

After analyzing the results from all combinations as most reliable velocity estimations have been accepted the estimations obtained from all five years observations.
The obtained velocity estimations agree very well with results from other investigations



BP horizontal station velocity vectors in summer time with respect to the stable part of Eurasia

Autumn solution

GPS one week data in five years – from 2006 up to 2010 have been used.

The total number of participated stations increased from 20 in 2006 up to 40 in 2010.

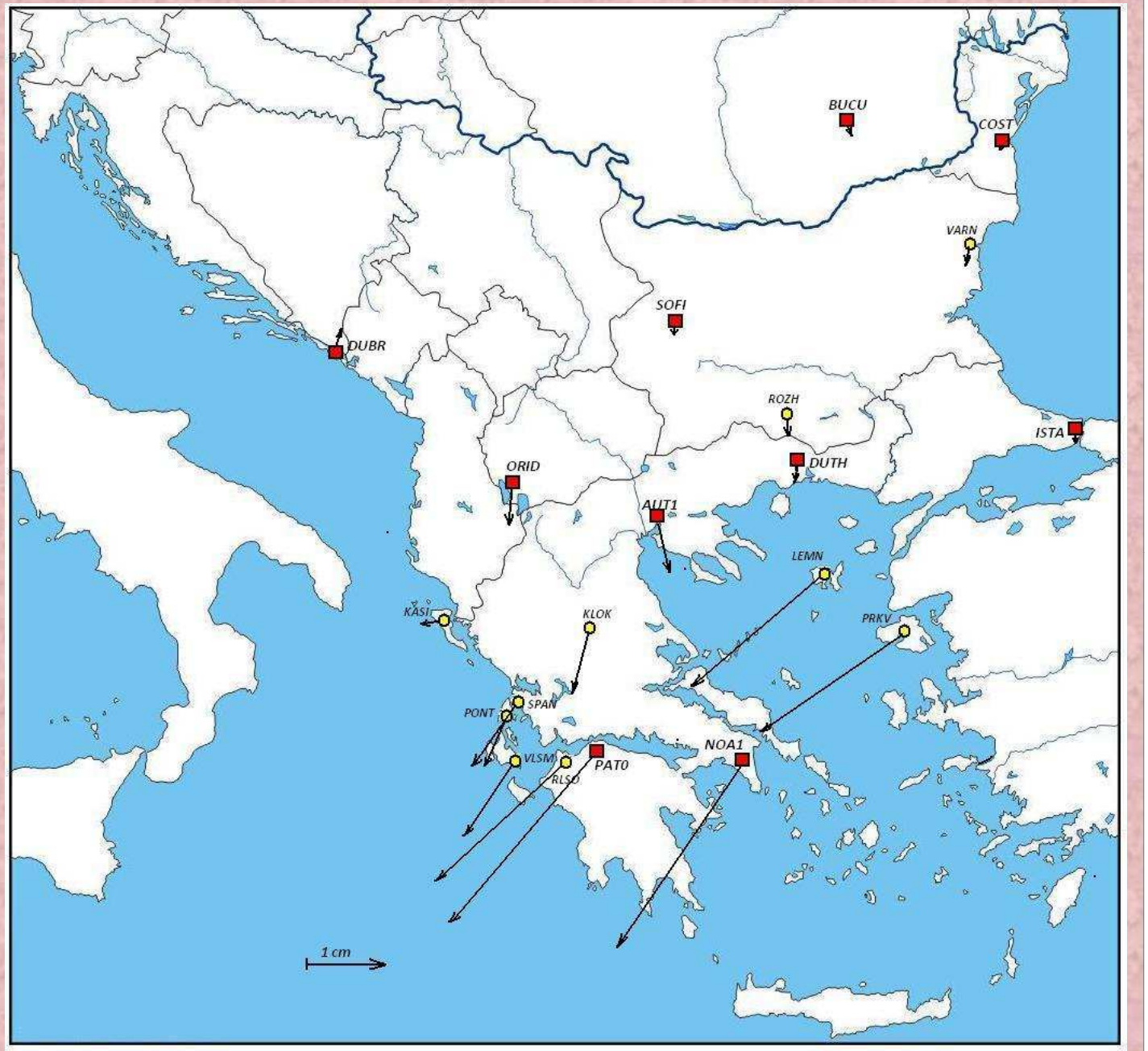
Eight Balkan Peninsula stations participated only in one year - BURG, DRAG, LOVE, MONT, NIS_, SHUM, STAR, YUND as they are very yang stations, which started operating in 2009.

Seven stations – DUTH, KUST, NVRK, PAZA, PAT0, SAND and SOFA participated only in two years.

All possible three and four years combinations and total five years solution of the obtained weekly solutions in 2006, 2007, 2008, 2009 and 2010 have been processed and station velocity estimations have been obtained in the system ITF2005.

The reduced horizontal velocities of the Balkan Peninsula stations to the stable Eurasia plate have been obtained.

Velocity vectors have been estimated only for stations for which observations have been available in three and more years. The estimations agree very well with results from other investigations .
In all four seasons the main directions of the movement of all Bulgarian stations are south-east and the main direction of the movement of the most Greek stations is south-west.
For some stations the velocity gets to 20-30 mm/yr.



BP horizontal station velocity vectors in autumn with respect to the stable part of Eurasia

ANALYSIS OF THE SEASONAL SOLUTIONS

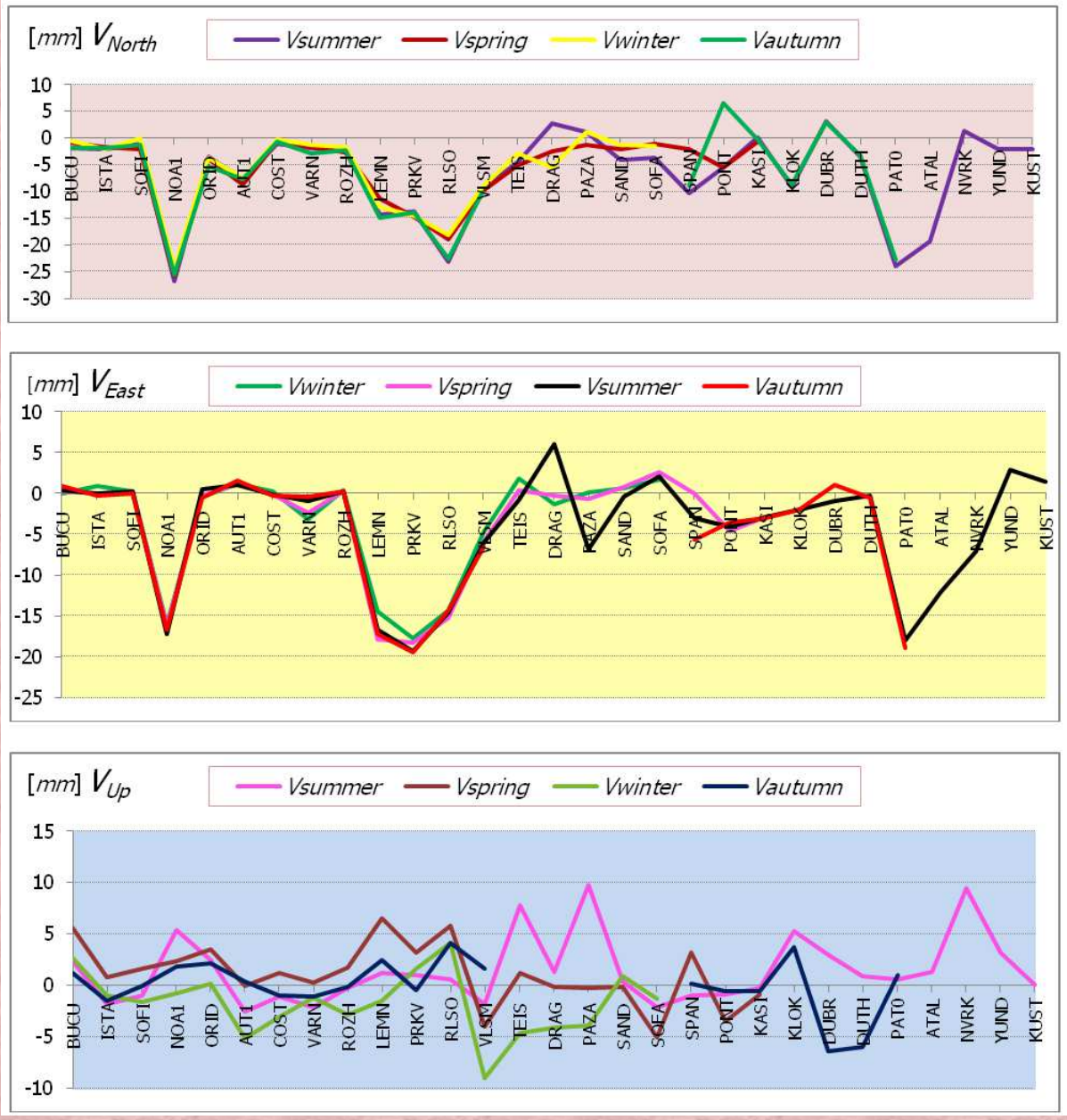
The total number of participated stations is increased from 17 in 2006 up to 40 (including IGS/EPN stations) in 2010.

29 of them are located on the territory of the Balkan Peninsula.

The velocity estimations are obtained in IRTF2005.

The BP station velocity vectors relative to the Eurasia plate have been obtained taking into account the recommendations of the EUREF Technical Working Group:

- first the IRTF2005 velocity vectors have been transformed into ITRF2000 and
- then into ETRF2000.

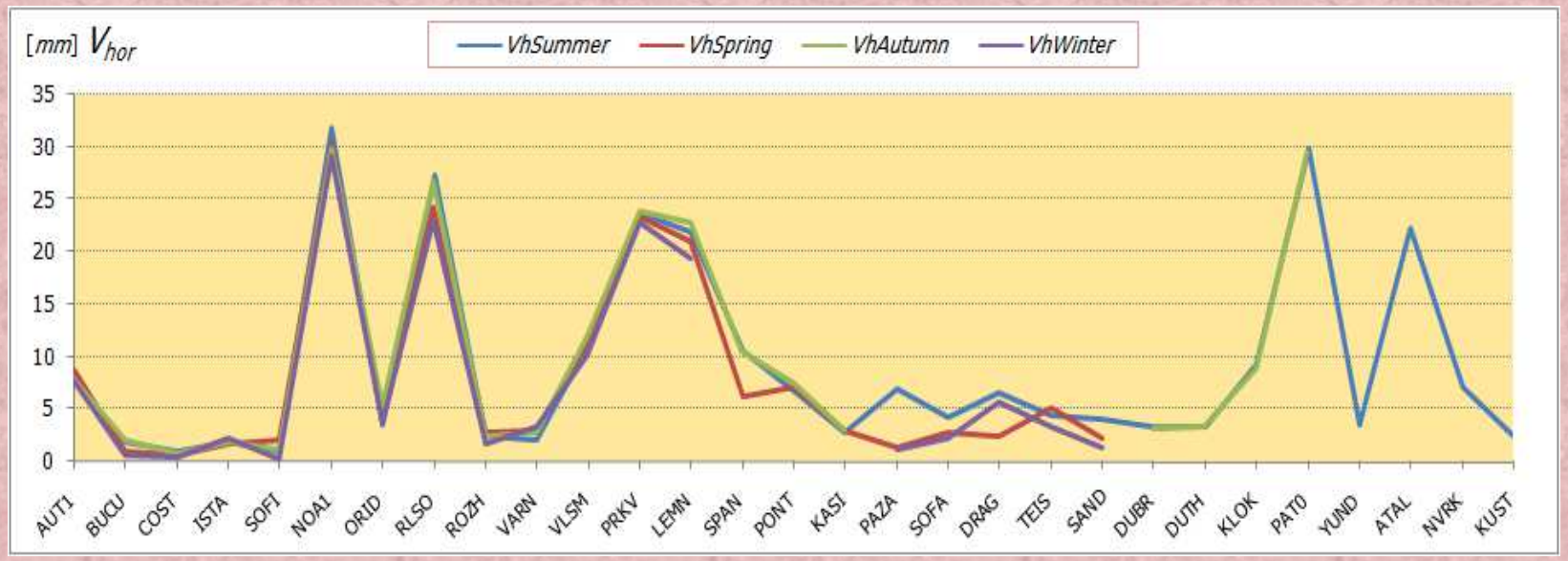


Comparison of ETRF2000 seasonal BP station velocity vectors in North, East and Up components

Comparison of the velocity estimations in North and East components shows identical results for stations which are observed in all seasons and in each year within the respective season.

- Variations of the values in both components are within 0,3÷2,5mm/yr.
- The main reason for the discrepancies could be explained with the slightly different datums used in the processing of the seasonal data and not with the seasonal variations.
- Another reason for higher discrepancies obtained could be the short time interval of station data participated in the processing (only with two year's data or only in one or two seasons).
- Data availability is four and five years for the majority of the stations.
- Discrepancies in Up component are 3÷5 times higher than the discrepancies in North and East components.

ETRF2000 horizontal velocity vectors of BP stations have been obtained for all four seasons and their trend is shown in the figure below.
The magnitude of the horizontal velocity vectors within the four seasons is kept the same for most of the stations.
Only for some stations with two years data availability or for young stations directions agree not quite well.



Horizontal velocity vectors of BP stations in winter, spring, summer and autumn time

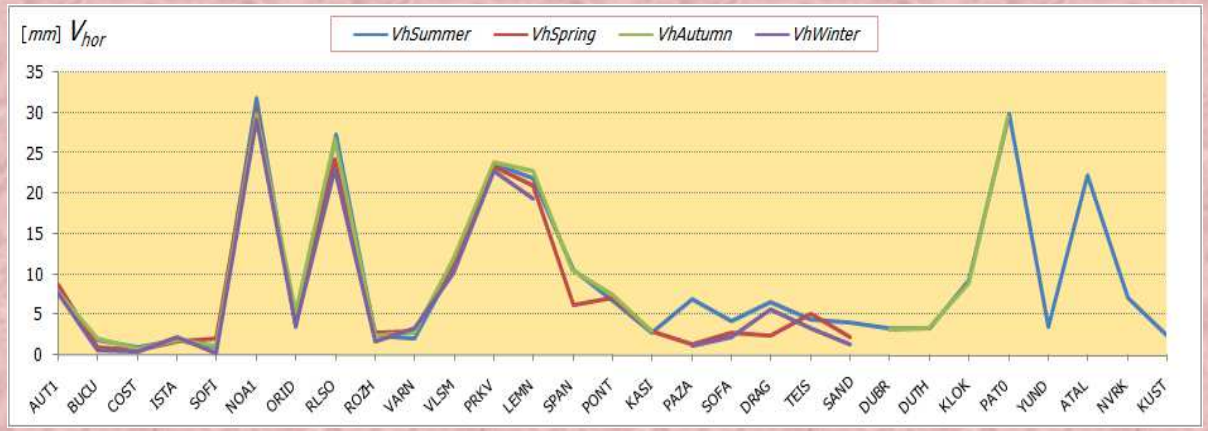
The consistency of seasonal estimates of horizontal vectors is better than 0,2-0,6mm/yr for stations with small movements.

It can be assumed that for the investigated period there is no significant impact of the seasonal variations on stations behavior and their movements are smooth and undisturbed within the four seasons.

Higher differences of about 2,5-4,0mm/yr are obtained for stations with larger movements of about 10-30mm/yr (NOA1, LEMN, RLSO).

The higher velocity differences obtained for stations DRAG, SAND, SOFA and TEIS cannot be assumed as effect of seasonal variations due to the shorter time span of observations within the seasons - only two years.

Several stations are very young (ATAL, DUTH, KLOK, NVRK, PAT0) and their velocities are estimated only from processing of summer or autumn data and therefore they are not quite reliable.



Obtained velocity estimations from this study have been compared with available results from other data processings.

Generally, components of the velocity vectors or horizontal velocity vectors themselves agree well.

Nevertheless such a direct comparison is not a quite reliable approach for validation of the estimated velocities because different datum definitions and/or different ETRF realizations in GNSS data processing are used by different GNSS analysis centers or authors.

CONCLUSION

The obtained velocity estimations agree very well with the ITRF2005 velocities within the particular seasons with some exceptions.

- Analysis of the obtained horizontal station velocity vectors relative to the Eurasia plate shows smooth, undisturbed linear trend of movement and it can be assumed that there is no significant seasonal impact on the station movements during the all seasons.
- Dominate linear motion is the behavior of the majority of the stations within all seasons.
- It is the reason to conclude that velocity estimations obtained from one week solutions in four or in five years time span are adequate with estimations obtained from long-term permanent observations.
- In case of non-permanently observed GNSS points this approach of estimation of horizontal station velocities shows reliable results which can be used for further geodynamical analysis and interpretations in other related geosciences.

THANK YOU FOR YOUR ATTENTION