

# **CGSIC/IISC - National Report of Germany**

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## **Fundamental Survey**

With its Satellite Positioning Service SAPOS, Germany provides a uniform system for the benefit of both private customers and state survey administrations. SAPOS is being regarded as essential contribution to the basic provisions for existence by the state and as an appropriate measure for enhancing the infrastructure provided by the state survey administrations. The extensive offer of DGPS-data, covering different levels of accuracy and different media for communication is realising the consistent step towards a modern, multi-functional provision of geodetic spatial reference. However, the development has not yet been finalised. The standardised application of the European reference system (EUREF), providing the uniform geodetic reference, remains desirable and important for the future.

## **The Satellite Positioning Service of the German State Survey**

An area-covering net of GPS-reference stations (SAPOS) is being established in Germany to provide differential GPS-data in standardised, producer-independent formats. It is putting into effect the geodetic reference system ETRS 89.

The EPS (Real-time Positioning Service) offers an accuracy of ca. 0.5 to 3 meters, correction data is broadcast in real-time. In co-operation with German Telecom, the BKG offers the ALF-service (Accurate Positioning by Low Frequency). In addition, the service RASANT (Radio Aided Satellite Navigation Technique), is available via VHP-transmitters area-covering for Germany. The correction data is broadcast using the RDS (Radio Data System) of the public VHF-radio transmitters.

The HEPS (High Precision Real-time Positioning Service) offers accuracies of 1 to 5 cm and requires a network of GPS-reference stations in distances of ca. 50 km. Correction data are broadcast via own 2m-band VHF-transmitters or can be accessed via mobile telephone. The network of reference stations is being reinforced; at present 71% of all planned reference stations are working. In different states the reference stations are linked online to erase systematic influences of e.g. ionosphere or troposphere and thus allow an accuracy of position of ca. 2 cm at maximum reliability.

For the service GPPS (Geodetic Precision Positioning Service) with an accuracy of ca. 1 cm the signals of the reference stations must be recorded. They are made available to customers for post-processing or the "near-online-method" via Internet or telephone in the RINEX format.

In 1999 the Technical Committee SAPOS was founded. Delegates of AdV are now working together with providers of GPS-hardware, software and communication technologies for improvement of common standards and further development of services.

Since 1998 an annual SAPOS symposium regularly takes place. The last symposium, which was hosted in Munich in May 2000, assembled more than 300 participants from 12 different countries, and clearly demonstrated the interest of national and international experts in DGPS services.

## **Federal Tasks in Fundamental Surveying**

The Federal Office for Cartography and Geodesy (BKG) is focussing on the connection of the geodetic horizontal, vertical and gravity reference systems to European and global reference systems. A major contribution to this task has been made by the fundamental station Wettzell, which has heavily been involved in a number of recent international surveying and evaluation campaigns applying spatial surveying methods. Since 1999 the BKG has been pro-actively working with IVS (International Very Long Baseline Interferometry - VLBI-Service) by providing a data and analysis centre. BKG also takes part in ILRS (International Laser Ranging Service). Further, the task of maintenance of the IERS (International Earth Rotation Service) central office was assigned to the BKG. This service, which will start its operational activities in 2001, encompasses

documentation, distribution and archiving of the results of IERS and the combination of the results of all spatial geodetic methods. BKG is running a regional GPS-data and analysis centre for Europe, which serves as:

- IGS data centre for Europe
- Data centre for EUREF permanent stations
- Data centre for the permanent stations of the German Reference-Net GREF
- GLONASS data centre.

The results of altogether 12 national European computer centres are collected and combined here. BKG is running a network of 20 permanent GPS stations all over Germany (GREF); it also provides the national information - and observation system GIBS on the Internet.

The EU-project UNIGRACE will determine a uniform gravity reference system for 12 countries of Central and Eastern Europe and fix the transformation parameters needed for the national gravity systems.

## References

The following list contains publications regarding application and research work on geodetic reference systems and services published since January 1999.

- Adam, J.; Augath, W.; Boucher, C.; Bruyninx, C.; Dunkley, P.; Gubler, E.; Gurtner, W.; Hornik, H.; v.d. Marel, H.; Schlüter, W.; Seeger, H.; Vermeer, M.; Zielinski, J.B.:* The European Reference System Coming of Age, In: Proceedings of the IAG General Assembly, Birmingham, July 18-30, 1999, In: IAG Symposia, Vol. 121, Geodesy Beyond 2000, Springer-Verlag, Berlin Heidelberg 2000, S. 47-54.
- Adam, J.; Augath, W.; Brouwer, F.; Engelhardt, G.; Gurtner, W.; Harsson, B.G.; Ihde, J.; Ineichen, D.; Lang, H.; Luthardt, J.; Sacher, M.; Schlüter, W.; Springer, T.; Wöppelmann, G.:* Status and Development of the European Height Systems, In: Proceedings of the IAG General Assembly, Birmingham, July 18-30, 1999, In: IAG Symposia, Vol. 121, Geodesy Begon 2000, Springer-Verlag, Berlin Heidelberg 2000, S. 55-60.
- Altiner, Y., Becker, M., Dzonov, D., Postolovski, V., Seeger, H., Todosov, A.:* The Results of the EUREF-FYROM-1996 GPS Campaign, in EUREF Publication No. 7/1, Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 6, Frankfurt/Main, 1999, pp 79-88.
- Altiner, Y., Colic, K., Marjanovic, M., Medic, Z., Medved, M., Miskovic, D., Piribicevic, B., Raisc, L., Seeger, H., Szabo, M.:* Is the Adria a Promontory or Exists as an Independent Mikroplate ?, Proceedings of the Fifth International Seminar „GPS in Central Europe,, , 5-7 May 1999, Penc/Budapest, Reports on Geodesy, Warsaw University of Technology, No. 5(46), 1999, pp 143-149.
- Altiner, Y., Ayan, T., Deniz, R., Celik, R N., Ergün, M., Kahveci, M., Lenk, O., Ocak, M., Salk, M., Seeger, H., Türkezzer, A.:* GPS Measurements in Turkey from 1990 to 1997, Proceedings of the Third Turkish-German Joint Geodetic Days, Istanbul, 1 - 4 June, 1999.
- Altiner, Y.:* Analytical Surface Deformation Theory for the Detection of the Earth's Crust Movements, Springer-Verlag, Heidelberg, 1999.
- Altiner, Y., Schlüter, W., Seeger H.:* Results of the BALKAN'98 GPS Campaigns in Albania, Bosnia and Herzegovina, and Yugoslavia, In: Gubler E., Torres A. J., Hornik H. (Editor): International Association of Geodesy / Section I - Positioning; Subcommittee for Europe (EUREF), Publication No. 8: Report on the Symposium of the IAG Subcommittee for Europe (EUREF) held in Prague, 2 - 5 June 1999 / Reports of the EUREF Technical Working Group. Bayerische Kommission für die Internationale Erdmessung, Nr. 60, München 1999.
- Ambrosius, B. A. C., Noomen, R., Angermann, D., Wilson, P., Becker, M., Reinhart, E., Walpersdorf, A., Vigny, C.:* Plate Motions in South East Asia: results of the GEODYSSSEA Project. Geophys. Res. Letters: 26, 2081-2084, 1999.
- Angermann, D.; M. Becker:* Untersuchungen zu Genauigkeit und systematischen Effekten in großräumigen GPS Netzen am Beispiel von GEODYSSSEA, ZfV, No. 3, 2000.
- Bayerisches Landesvermessungsamt (Editor):* Vorträge des 3. SAPOS-Symposiums, 23. - 24. Mai 2000, München 2000.
- Becker, M., P. Franke und G. Weber:* Die Geodätischen GPS Referenznetze GREF und EUREF-Permanent. In 3. DFG Rundgespräch zum Thema Bezugssysteme. M. Schneider (Editor), Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 5, 140-153, Frankfurt, 1999.

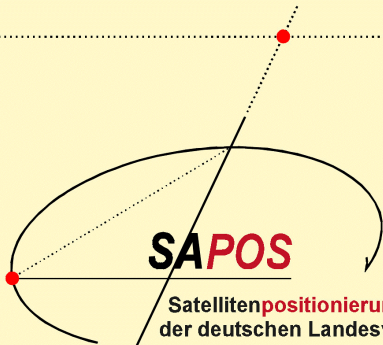
- Becker, M., Ghitau, D., Marcu, C., Radulescu, F., Reinhart, E., Rosca, V., Rus, T., Seeger, H.: German and Romanian Activities in the CERGOP, Technical Report, Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 12, 5-64, Frankfurt, 1999.
- Becker, M.; G. Berrino, A.G. Camacho, R. Falk, O. Francis, C. Gagnon, C. Gerstenecker, J. Liard, G. Läufer, B. Meurers, F.-J. Navarro, I. Nowak, F. Rehren, U. Riccardi, B. Richter, M. van Ruymbeke, K. Schmidt, M. Schnüll, D. Stizza, J.E. Friederich, P. Vauterin, H. Wilmes: Results of Relative Gravimeter Measurements at the ICAG97 Intercomparison. Accepted by Bull d'Inf. BGI, No. 85, Toulouse, Dec. 1999.
- Becker, M. E. Reinhart, Soeb Bin Nordin, D. Angermann, G. W. Michel, Ch. Reigber: Improving the Velocity Field in South and South-East Asia: The Third Round of GEODYSSSEA, Submitted to Earth, Planets and Space, Spec. Issue, Tokyo, 2000.
- Becker, M., E. Reinhart, Chakorn Boonphakdee, Sanong Mingsamon und Samad Abu: Realisation des ITRS in Thailand und Malaysia durch ein kombiniertes Netz für Geokinematik und Landesvermessung. ZfV, No. 3, 2000.
- Becker, M., Angermann, D., Nordin, S., Reigber, CH., Reinhart, E.: Das Geschwindigkeitsfeld in Südostasien aus einer kombinierten GPS Lösung der drei GEODYSSSEA Kampagnen von 1994 bis 1998, ZfV No 3, 2000.
- Becker M., S. Zerbini, T. Baker, B. Bürki, J. Galanis, J. Garate, I. Georgiev, H. Kahle, V. Kotzev, V. Lobazov, I. Marson, M. Negusini, B. Richter, G. Veis, P. Yuzefovich (2000): Assessment of Height Variations by GPS at Mediterranean and Black Sea Coast Tide Gauges from the SELF Project. Submitted to Global and Planetary Change, Elsevier.
- Crossley D., J. Hinderer, G. Casula, O. Francis, H.-T. Hsu, Y. Imanishi, G. Jentzsch, J. Kaarianen, J. Merriam, B. Meurers, J. Neumeyer, B. Richter, K. Shibuya, T. Sato, T. van Dam: Network of superconducting gravimeters benefits a number of disciplines, Trans. Am. Geophys. U., 80, 1999, 121-126.
- Denker, H., Torge, W., Wenzel, G., Ihde, J., Schirmer, U.: Investigation of Different Methods for the Combination of Gravity and GPS/Levelling Data. In: Proceedings of the IAG General Assembly, Birmingham, July 18-30, 1999, In: IAG Symposia, Vol. 121, Geodesy 2000, Springer, Berlin Heidelberg 2000, S. 137-142.
- Dick, W.R.; Mareyen, M.; Meinig, M.; Oppitz, K.; Richter, B.: SSC(BKG) 98 L 01 [Abstract]. In: C. Boucher, Z. Altamimi, P. Sillar: The International Terrestrial Reference Frame (ITRF97). (IERS Technical Note 27) Paris: Central Bureau of IERS - Observatoire de Paris, 1999, p. 20.
- Dick, W., M. Mareyen, M. Meinig, K. Oppitz, B. Richter: The consistency of the global SLR Network. Proc. 11<sup>th</sup> Int. Workshop on Laser Ranging, Deggendorf 1998, Mittlg. d. BKG, Band 10, Volume 1, 1999, 41-49.
- Dietrich, R., Dach, R., Engelhardt, G., Ihde, J., Korth, W., Kutterer, H.-J., Lindner, K., Mayer, M., Menge, F., Miller, H., Müller, C., Niemeier, W., Perlt, J., Pohl, M., Salbach, H., Schenke, H.-W., Schöne, T., Seeber, G., Veit, A., Völksen, C.: ITRF coordinates and plate velocities from repeated GPS campaigns in Antarctica - an analysis based on different individual solutions. In Vorbereitung.
- Habrigh, H.: Kombinierte Auswerteverfahren für GLONASS und GPS. in: GPS-Praxis und Trends'97, DVW Schriftenreihe 35, 1999, 24-34.
- Habrigh H.: IGEX Analysis at BKG, Proceedings of the IGEX-98 Workshop, Nashville, Tennessee, September 13-14, 1999.
- Habrigh H.: BKG's Operation of GPS/GLONASS Receivers and Its Regional IGEX Data Center, Proceedings of the IGEX-98 Workshop, Nashville, Tennessee, September 13-14, 1999.
- Habrigh H., Beutler G., Gurtner W., Rothacher M.: Double Difference Ambiguity Resolution for GLONASS/GPS Carrier Phase, Proceedings of the 12<sup>th</sup> International Technical Meeting, ION GPS-99, Nashville, Tennessee, September 14-17, 1999.
- Habrigh H.: BKG Regional IGS Data Center Report 1999, IGS 1999 Technical Reports, IGS Central Bureau, JPL, Pasadena California.
- Habrigh H.: Geodetic Applications of the Global Navigation Satellite System (GLONASS) and of GLONASS/GPS Combinations, Dissertation Universität Bern, Switzerland, 1999, published in "Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 15, ISBN 3-88648-099-2, Frankfurt / M. Germany, 2000.
- Harnisch, M., Harnisch, G.: Hydrological Influences in the Registrations of Superconducting Gravimeters and Ways to their Elimination. Marées Terrestres, Bull. Inf., Bruxelles 131 (1999), pp. 10161 – 10170.
- Harnisch, M., Harnisch, G., Nowak, I., Richter, B., Wolf, P.: The Dual Sphere Superconducting Gravimeter C029 at Frankfurt Main and Wettzell. First Results and Calibration. Proc. Second GGP Workshop, Munsbach 24-26 March 1999, im Druck
- Harnisch, M., Harnisch, G., Jurczyk, H., Wilmes, H.: 889 Days of Registrations with the Superconducting Gravimeter SG103 at Wettzell (Germany). Proc. Second GGP Workshop, Munsbach 24-26 March 1999, im Druck.

- Harnisch, M., Harnisch, G., Nowak, I., Richter, B., Wolf, P.:* The Dual Sphere Superconducting Gravimeter GWR CD029 at Frankfurt Main and Wetzell. First Results and Calibration. IAG Symposia, Vol. 121, Springer-Verlag Berlin Heidelberg 2000, 155-160.
- Hase, H.:* Globale Bezugssysteme und TIGO, DFG Rundgespräch "Bezugssysteme", Höllenstein, 30. April 1998, Mitteilung des BKG, Band 5, 1999.
- Hase, H.; Schlüter, W.; Böer, A.:* TIGO and its future application for the ITRF, Proceedings of the International Workshop on Geodetic Measurements by the collocation of Space Techniques on Earth (GEMSTONE) January 25-28, 1999, Koganei, Tokyo/Japan.
- Hase, H.; Petrov, L.:* The First Campaign of Observations with the VLBI-Module of TIGO, Proceedings of the 13<sup>th</sup> Working Meeting on European VLBI for Geodesy and Astrometry, held at Viechtach, February 12-13, 1999, edited by W. Schlüter and H. Hase, Bundesamt für Kartographie und Geodäsie, Wetzell, 1999.
- Hase, H.:* Phase Centre Determinations at GPS-Satellites with VLBI, Proceedings of the 13<sup>th</sup> Working Meeting on European VLBI for Geodesy and Astrometry, held at Viechtach, February 12-13, 1999, edited by W. Schlüter and H. Hase, Bundesamt für Kartographie und Geodäsie, Wetzell, 1999.
- Hase, H.:* Transportable Integrated Geodetic Observatory, IVS Annual Report 1999, S. 110-115, NASA/TP-1999-209243, Sept. 1999.
- Hase H.:* Theorie und Praxis globaler Bezugssysteme, Dissertation, Mittlgn. d. BKG, Band 13, Frankfurt / M. 1999.
- Hase, H.; Böer, A.; Riepl, S.; Schlüter, W.:* Transportable Integrated Geodetic Observatory (TIGO), IVS-GM-Proceedings, Kötzing, Febr. 2000.
- Ihde, J., Nothnagel, A., Reinhold, A., Soltan, G., Thorandt, V.:* Der Beitrag der VLBI zum Internationalen Erdrotationsdienst - eine wichtige Voraussetzung für die Realisierung globaler Bezugssysteme. In: Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 5, Frankfurt a. M. 1999, S. 134 - 139.
- Ihde, J., Adam, J., Gurtner, W., Harsson, B. G., Schlüter, W., Wöppelmann, G.:* The Concept of the European Vertical GPS Reference Network (EUVN). EUREF-Symposium Bad Neuenahr-Ahrweiler, 10.-12. Juni 1998. In: Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 7, Frankfurt a. M. 1999, S. 23 - 46.
- Ihde, J., Adam, J., Gurtner, W., Harsson, B. G., Schlüter, W., Wöppelmann, G.:* The EUVN Project - First Results. In: Reports of the Finnish Geodetic Institute, 99:4, Kirkkonummi, Finland 1999, S. 177 - 182.
- Ihde, J. u. a.:* Der Beitrag des European Vertical Reference Network (EUVN) zu einem einheitlichen europäischen Höhensystem. In: Schriftenreihe des DVW, Nr. 35/1999, Wittwer 1999, S. 120 - 137.
- Ihde, J., Schirmer, U.:* Das Geoid im Zeitalter der Satellitennavigation. In: Schriftenreihe des DVW, Nr. 35/1999, Wittwer 1999, S. 138 - 142.
- Ihde, J., Adam, J., Gurtner, W., Harsson, B. G., Schlüter, W., Wöppelmann, G.:* Status Report of the EUVN Project. Proceedings EUREF-Symposium Prag, 2.-4. Juni 1999, BEK Veröffentlichungen, Astr.-Geod. Arbeiten, Heft Nr. 60, 1999.
- LINDSTROT, W. (Editor):* Das Deutsche Referenznetz 1991 DREF 91. Mitteilungen des Bundesamtes für Kartographie und Geodäsie Band 9, Frankfurt 1999.
- Michel, G., D. Angermann, M. Becker, P. Wilson:* Seismische Deformation und Krustenextrusion: Interpretation der GEODYSSSEA GPS-Lösungen. ZfV, No. 3, 2000.
- Michel, G.W., M. Becker, D. Angermann, C. Reigber, E. Reinhard, and the GEODYSSSEA-Team (2000):* New evidence for crustal motion in E and SE-Asia from GPS measurements. Submitted to Earth, Planets and Space, Spec. Issue, Tokyo, 2000.
- Nothnagel, A., V. Thorandt, L. Petrov:* "The GIUB/BKG VLBI Analysis Center". In: International VLBI Service for Geodesy and Astrometry, Annual Report 1999.
- Richter, B.:* Tidal and others temporal variations of the gravity field, In: National Report of the Federal Republic of Germany on the geodetic activities in the years 1995-1999, DGK, Reihe B, 308, 1999, 106-110.
- Richter B, H. Wilmes, A. Lothhammer, R. Falk, K. Colic, B. Pribicevic:* Absolute gravity measurements in Croatia – a standardised base-net for geodynamic, height and gravity studies, Int. Symp. Geodynamics of the Alps-Adria area by means of terrestrial and satellite methods (2; 1998: Dubrovnik) Proc. 2<sup>nd</sup> int. Symp. Geodynamics of the Alps-Adria area by means of terrestrial and satellite methods, Dubrovnik, Croatia, Sept. 28.-oct.2. 1998 / edited by Colic, K. and Moritz, H., University of Zagreb, faculty of Geodesy, Zagreb, Graz 1999, pp. 263-270.
- Riepl, S.:* Lasermessungen nach Erdsatelliten auf zwei Wellenlängen unter Verwendung einer Streak-Kamera, Deutsche Geodätische Kommission bei der Bayerischen Akademie der Wissenschaften, Reihe C: Dissertation, Heft Nr. 495.
- Riepl, S.; Schlüter, W.; Schreiber, U.:* Evaluation of an SLR Adaptive Optics System, Remote Sensing, 20-24 Sept. 1999, Florence/Italy, Proceedings of SPIE.
- Sacher, M., Lang, H., Ihde, J.:* Status and Results of the Adjustment and Enlargement of the United European Levelling Network 1995 (UELN-95). EUREF-Symposium Bad Neuenahr-Ahrweiler, 10.-12. Juni 1998. In: Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 6, Frankfurt a. M. 1999, S. 131 - 141.

- Sacher, M., H., Ihde, Seeger, H.*: Preliminary transformation relations between national European height systems and the United European Levelling Network (UELN). Proceedings EUREF-Symposium Prag, 2.-4. Juni 1999, BEK Veröffentlichungen, Astr.-Geod. Arbeiten, Heft Nr. 60, 1999.
- Schlüter W.*: The International VLBI Service for Geodesy and Astrometry (IVS): Chairmans's Report, AR-IVS, 1999.
- Schlüter, W.; Dassing, R.; Kilger, R.; Schreiber, U.*: The Fundamental Station Wettzell -current status and future plans-, Proceedings of GEMSTONE, Koganei, Tokio, January 25-28, 1999.
- Schlüter, W.; Hase, H.; Röttcher, K.; Stöger, R.; Lang, H.; Zerneck, R.*: Actual Results of the Local Survey at the FS-Wettzell, Proceedings of GEMSTONE, Koganei, Tokio, January 25-28, 1999.
- Schlüter, W.; Hase, H.; Böer, A.*: TIGO - a geodetic observatory for the improvement of the global reference frame, Proceedings EUROPTO, EOS/SPI Symposium on Remote Sensing, Florence, 20-24 Sept. 1999.
- Schlüter, W.; Pähler, K.*: Permanent GPS Networks and Realtime Positioning, In: National Report of the Federal Republic of Germany on the geodetic activities in the years 1995-1999, DGK, Reihe B, 308, 1999.
- Schlüter, W.; Reinhart, E.; Pähler, K.H.*: Positioning for Global and Long Range Applications, In: National Report of the Federal Republic of Germany on the geodetic activities in the years 1995-1999, DGK, Reihe B, 308, 1999.
- Schlüter, W., Adam, J., Gurtner, W., Harsson, B. G., Ihde, J., Wöppelmann, G.*: Report of the EUVN Working Group. Vorgelegt auf dem EUREF-Symposium in Bad Neuenahr-Ahrweiler, 10.-12. Juni 1998. In: Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 7, Frankfurt a. M. 1999, S. 11 - 22.
- Schlüter W.*: The International VLBI Service for Geodesy and Astrometry (IVS): Chairmans's Report, AR-IVS, NASA/TP 1999 – 209243.
- Schreiber, U.; Kawano, N.; Yoshino, T.; Degnan, J.; Nordvedt, K.; Müller, J.; Schlüter, W.; Kunimori, H.*: Laser Ranging and VLBI for the Selene-II Mission, Proceedings of the International Workshop on Geodetic Measurements by the collocation of Space Techniques on Earth (GEMSTONE) January 25-28, 1999, Koganei, Tokyo/Japan.
- Schreiber, U.; Schneider, M.; Rowe, C.H.; Stedman, G.E., Schlüter, W.*: Stabilising the Operation of a Large Ring Laser, Symposium Gyro Technology, 14./15.09.1999, Stuttgart, Germany, Proceedings of the Symposium on Gyro Technology, Stuttgart 1999, Seite 14.0-14.10
- Schreiber, U.; Schneider, M.; Stedman, G.E.; Rowe, C.H.; Schlüter, W.*: Der C-II Ringlaser als Prototyp eines Rotationssensors für geowissenschaftliche Anwendungen, DFG-Rundgespräch Bezugssysteme, Mitteilung des BKG, Band 5, 1999.
- Schreiber, U.; Schneider, M.; Rowe, C.H.; Stedman, G.E.; Schlüter, W.; Seeger, H.*: Characteristics of a Ring Laser for Geodesy, 11th International Workshop on Laser Ranging, Mitteilung des BKG, Band 10 und Band 11.
- Schreiber, U.; Haufe, K.H.; Prochazka, I.*: Concept of a Pet4/LabView-Control System, Proceedings of the 11<sup>th</sup> Workshop on Laser Ranging, 413-420, 1999.
- Schreiber, U.; Haufe, K.H.*: Timewalk in Avalanche Photo Diodes, Proceedings of the 11<sup>th</sup> Workshop on Laser Ranging, 413-420, 1999.
- Schreiber, U.; Schlicht, A.; Haufe, K.H.*: Systematic Biases in Laser Ranging Measurements, Symposium on Satellite Remote Sensing, 20.-24. Sept. 99, Florence, Italy, Proceedings of the SPIE, Vol. 3865, Seite 64-73
- Schreiber, U.; Schneider, M.; Stedman, G.; Schlüter, W.*: Characteristics of a Ring Laser for Geodesy, Proceedings of the 13<sup>th</sup> Workshop Meeting on European VLBI, 278-284, 1999.
- Seeger, H., Altiner, Y.*: Stand und Perspektiven von EUREF. In: Gerd Riedl und Hermann Seeger (Eds.): GPS-Praxis und Trends, DVW Schriftenreihe 35/1999, Wittwer Verlag, pp 238-250.
- Simon, D., Harwardt, H.*: Validierungsverfahren für Prognoserechnungen zur Standsicherheit der Grubengebäude von Endlagern chem./tox. Abfälle durch Verwendung eines Arrays von hochauflösenden Strainmetern, Forschungszentrum Karlsruhe, Wissenschaftliche Berichte. FZKA-PTE Nr. 1, S. 265-281.
- Strakhov V.N., U.Schäfer, A.V.Strakhov*: Neue lineare Approximationen linearer Elemente des Gravitationsfeldes der Erde - Probleme und Perspektiven. in: Freedon (Editor): Progress in Geodetic Science, Shaker, Aachen, S.315-322.
- Strakhov V.N., U.Schäfer, A.V.Strakhov*: New Linear Approximation of the Gravitational Field of the Earth. (in russ.) in: Basic Problems of the Theory of Interpretation of Gravimetric and Magnetic Anomalies (russ.), Moscow, 1999, p. 126-167.
- Strakhov V.N., U.Schäfer, A.V.Strakhov*: SNAP Models of the Regional Gravitational Field in Central Europe. in: Basic Problems of the Theory of Interpretation of Gravimetric and Magnetic Anomalies (russ.), Moscow, 1999, p. 168-182.
- Strakhov V.N., U.Schäfer, A.V.Strakhov*: New linear approximations of elements of the Earth's gravitational field in global and regional variants. (in russ.) Proceedings of the Conference „Geophysics and Mathematics“, Moskau, 22-26.11.1999, p.212-222.

- Strakhov V.N., U.Schäfer, A.V.Strakhov*: New high-resolution analytical approximations of the gravitational field in Europe derived by the SNAP method. (in russ.) Proceedings of the Conference „Geophysics and Mathematics“, Moskau, 22-26.11.1999, p.222-223.
- Strakhov V.N., U.Schäfer, A.V.Strakhov*: Improved analytical approximations of the Earth's gravitational field. in: Schwarz (ed.): Geodesy Beyond 2000 - The Challenges of the First Decade. IAG Symposia, vol. 121, Springer-Verlag, Berlin Heidelberg, pp. 196-201.
- Thorandt, V.*: "BKG Data Center". In: International VLBI Service for Geodesy and Astrometry, IERS Annual Report 1999.
- Torge W., R. Falk, A. Franke, E. Reinhard, B. Richter, M. Sommer, H. Wilmes*: Das Deutsche Schweregrundnetz 1994 (DSGN94) – Band I - DKG, Reihe B, Nr. 309, München, 1999.
- Weber, G.*: Geodätisches GPS-Referenznetz GREF: Realisierung eines globalen terrestrischen Bezugssystems. Proceedings DFG-Rundgespräch „Bezugssysteme“, 22.-30. April 1998, Höllenstein, Bayerischer Wald, Mitteilung des BKG, Band 5, 1999.
- Weber, G.*: Das EUREF-Permanent GPS Array. In: Schriftenreihe des DVW, Nr. 35/1999, Wittwer 1999, S. 251- 265.

# Referenzstationen



SAPOS\_Referenzstationen  
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