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                         INTERNATIONAL GNSS SERVICE

                       CODE Analysis Strategy Summary


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| Analysis Center   | Center for Orbit Determination in Europe (CODE)       |
|                   | Astronomical Institute                                |
|                   | University of Bern                                    |
|                   | Sidlerstrasse 5                                       |
|                   | CH-3012 Bern                                          |
|                   | Switzerland                                           |
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|                   | Data archive: ftp://ftp.unibe.ch/aiub/CODE/           |
|                   |               http://www.aiub.unibe.ch/download/CODE/ |
|                   | Web:          http://www.aiub.unibe.ch (CODE at AIUB) |
|                   |               http://www.bernese.unibe.ch (Bernese SW)|
|---------------------------------------------------------------------------|
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|---------------------------------------------------------------------------|
| Software Used     | Bernese GNSS Software Version 5.3, developed at AIUB  |
|---------------------------------------------------------------------------|
| GNSS system(s)    | GPS, GLONASS                                          |
|---------------------------------------------------------------------------|
| List of CODE's    | ftp://ftp.unibe.ch/aiub/AIUB_AFTP.README              |
| analysis products | http://www.aiub.unibe.ch/download/AIUB_AFTP.README    |
|                   |                                                       |
| Final Products    | Files generated from three-day long-arc solutions:    |
| generated for     | CODwwwwn.EPH.Z  GNSS ephemeris/clock data in 7 daily  |
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| GPS week 'wwww'   |                    files at 15-min intervals in SP3      |
| day of week 'n'   |                    format, including accuracy codes      |
| (n=0,1,...,6)     |                    computed from a long-arc analysis     |
| day of year 'ddd' | CODwwwwn.ERP.Z  GNSS ERP (pole, UT1-UTC) solution        |
| year 'yy'         |                    belonging to the COD-orbit files in   |
|                   |                    IGS IERS ERP format                   |
|                   | CODwwwwn.SNX.Z  GNSS daily coordinate/ERP/GC from the |
|                   |                    long-arc solution in SINEX format     |
|                   | CODwwwwn.CLK.Z  GPS satellite and receiver clock        |
|                   |                    corrections at 30-sec intervals       |
|                   |                    referring to the COD-orbits from the  |
|                   |                    long-arc analysis in clock RINEX      |
|                   |                    format                                |
|                   | CODwwwwn.CLK_05S.Z GPS satellite and receiver clock     |
|                   |                    corrections at 5-sec intervals        |
|                   |                    referring to the COD-orbits from the  |
|                   |                    long-arc analysis in clock RINEX      |
|                   |                    format                                |
|                   | CODwwwwn.TRO.Z  GNSS 2-hour troposphere delay           |
|                   |                    estimates obtained from the long-arc  |
|                   |                    solution in troposphere SINEX format  |
|                   |                                                          |
|                   | CODwwww7.ERP.Z  GNSS ERP (pole, UT1-UTC) solution,      |
|                   |                    collection of the 7 daily COD-ERP     |
|                   |                    solutions of the week in IGS IERS ERP |
|                   |                    format                                |
|                   | CODwwww7.SUM    Analysis summary for 1 week             |
|                   | CODwwww7.SNX.Z  GNSS weekly station coordinates,        |
|                   |                    SATAs, GCs, and daily sets of ERPs in |
|                   |                    SINEX format stacked from the seven   |
|                   |                    long-arc solutions of the week        |
|                   |                                                          |
|                   | Files generated from clean one-day solutions:            |
|                   | COFwwwwn.EPH.Z  GNSS ephemeris/clock data in 7 daily    |
|                   |                    files at 15-min intervals in SP3      |
|                   |                    format, including accuracy codes      |
|                   |                    computed from a clean one-day solution|
|                   | COFwwwwn.ERP.Z  GNSS ERP (pole, UT1-UTC) solution        |
|                   |                    belonging to the COF-orbit files in   |
|                   |                    IGS IERS ERP format                   |
|                   | COFwwwwn.SNX.Z  GNSS daily coordinate/ERP/GC from the |
|                   |                    clean one-day solution in SINEX format|
|                   | COFwwwwn.CLK.Z  GPS satellite and receiver clock        |
|                   |                    corrections at 30-sec intervals       |
|                   |                    referring to the COF-orbits from the  |
|                   |                    clean one-day analysis in clock RINEX |
|                   |                    format                                |
|                   | COFwwwwn.CLK_05S.Z GPS satellite and receiver clock     |
|                   |                    corrections at 5-sec intervals        |
|                   |                    referring to the COF-orbits from the  |
|                   |                    clean one-day analysis in clock RINEX |
|                   |                    format                                |
|                   | COFwwwwn.TRO.Z  GNSS 2-hour troposphere delay           |
|                   |                    estimates obtained from the clean     |
|                   |                    one-day solution in troposphere       |
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|                   |                  SINEX format                      |
|                   |                                                    |
|                   | COFwwww7.ERP.Z  GNSS ERP (pole, UT1-UTC) solution,  |
|                   |                 collection of the 7 daily COF-ERP   |
|                   |                 solutions of the week in IGS IERS ERP |
|                   |                 format                              |
|                   | COFwwww7.SUM    Analysis summary for 1 week         |
|                   | COFwwww7.SNX.Z  GNSS weekly station coordinates,    |
|                   |                 SATAs, GCs, and daily sets of ERPs in |
|                   |                 SINEX format stacked from the seven |
|                   |                 clean one-day solutions of the week |
|                   |                                                    |
|                   | Other product files:                               |
|                   | CODGddd0.yyI.Z  GNSS 2-hour global ionosphere maps in |
|                   |                 IONEX format, including satellite and |
|                   |                 receiver P1-P2 code bias values     |
|                   | CGIMddd0.yyN    GNSS daily Klobuchar-style          |
|                   |                 ionospheric (alpha and beta)        |
|                   |                 coefficients in RINEX format        |
|                   | P1P2yymm.DCB    GNSS monthly P1-P2 code bias        |
|                   |                 solutions in Bernese DCB format     |
|                   | P1C1yymm.DCB/F  GPS monthly P1-C1 code bias solutions |
|                   |                 in Bernese DCB format and in a format |
|                   |                 specific to the CC2NONCC utility    |
|                   |                                                    |
|                   | Remarks:                                           |
|                   |                                                    |
|                   |   EPH: Orbit positions correspond to the estimates  |
|                   |        for the middle day of a 3-day in case of a   |
|                   |        long-arc analysis.                           |
|                   |   CLK: Clock corrections are consistent with        |
|                   |        carrier phase as well as P1/P2 pseudorange   |
|                   |        measurements.                                |
|                   |        CODE P1-C1 pseudorange bias values of a      |
|                   |        moving 30-day solution are considered to     |
|                   |        correct C1/X2 and C1/P2 receiver data.       |
|                   |   EPH/ERP/SNX/TRO: These products are extracted from |
|                   |        one inversion of the normal equation based   |
|                   |        either on a long-arc or clean one-day        |
|                   |        solution.                                    |
|                   |                                                    |
|                   |                                                    |
| Rapid Products    | CODwwwwn.EPH_R  GNSS/GPS ephemeris/clock data in at |
| generated daily   |                 15-min intervals in SP3 format,     |
|                   |                 including accuracy codes computed   |
|                   |                 from a long-arc analysis            |
|                   | CODwwwwn.ERP_R  GNSS ERP (pole, UT1-UTC) solution in |
|                   |                 IGS IERS ERP format                 |
|                   | CODwwwwn.CLK_R  GPS satellite and receiver clock    |
|                   |                 corrections at 30-sec intervals in  |
|                   |                 clock RINEX format                  |
|                   | CODwwwwn.TRO_R  GNSS 2-hour troposphere delay       |
|                   |                 estimates in troposphere SINEX format |
|                   | CORGddd0.yyI    GNSS 2-hour global ionosphere maps in |
|                   |                 IONEX format, including satellite and |
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|                   |                   receiver P1-P2 code bias values        |
|                   | CGIMddd0.yyN_R  GNSS daily Klobuchar-style               |
|                   |                 ionospheric (alpha and beta)             |
|                   |                 coefficients in RINEX format             |
|                   | CODwwwwd.SNX_R  GNSS daily station coordinates and       |
|                   |                 set of 6-hourly ERPs in SINEX format     |
|                   |                 (for IERS inter-technique combination)   |
|                   |                                                          |
|                   | Remarks:                                                 |
|                   |                                                          |
|                   |   EPH: Orbit positions correspond to the estimates       |
|                   |        for the last day of a 3-day long-arc analysis.    |
|                   |   CLK: Clock corrections are consistent with carrier     |
|                   |        phase as well as P1/P2 pseudorange                |
|                   |        measurements.                                     |
|                   |        CODE P1-C1 pseudorange bias values of a moving    |
|                   |        30-day solution are considered to correct         |
|                   |        C1/X2 and C1/P2 receiver data.                    |
|                   |                                                          |
|                   |                                                          |
| Ultra Rapid       | COD.EPH_U       GNSS ephemeris/broadcast clock data       |
| Products updated  |                 in at 15-min intervals in SP3 format,    |
| every 6 hours     |                 including accuracy codes computed        |
|                   |                 from a long-arc analysis                 |
|                   | COD.ERP_U       GNSS ERP (pole, UT1-UTC) solution         |
|                   |                 in IGS IERS ERP format                   |
|                   | COD.SUM_U       List of considered GNSS stations          |
|                   | COD.TRO_U       GNSS 2-hour troposphere delay            |
|                   |                 estimates in troposphere SINEX format    |
|                   | COD.ION_U       GNSS 2-hour global ionosphere maps in     |
|                   |                 Bernese ION format                       |
|                   |                                                          |
|                   | Remarks:                                                 |
|                   |                                                          |
|                   |   EPH: Orbit positions correspond to the estimates       |
|                   |        for the last 24 hours of a 3-day long-arc         |
|                   |        analysis plus predictions for the following       |
|                   |        24 hours                                          |
|                   |   EPH/ERP/TRO: Files contain generally results of        |
|                   |        last update                                       |
|                   |   ION: Last rapid ionosphere product complemented by     |
|                   |        all available ionosphere predictions              |
|                   |                                                          |
|                   |                                                          |
| Predictions       | CODwwwwn.EPH_Pi GNSS/GPS ephemeris/clock data at         |
| updated every 6   |                 15-min intervals in SP3 format,          |
| hours             |                 including accuracy codes computed        |
|                   |                 from a long-arc analysis                 |
|                   | CODwwwwn.ERP_Pi GNSS ERP (pole, UT1-UTC) solution in     |
|                   |                 IGS IERS ERP format                      |
|                   | COPGddd0.yyI    GNSS 2-hour global ionosphere maps in     |
|                   |                 IONEX format, including satellite        |
|                   |                 P1-P2 code bias values                   |
|                   | CGIMddd0.yyN_Pi GNSS daily Klobuchar-style               |
|                   |                 ionospheric (alpha and beta)             |
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|                   |                coefficients in RINEX format          |
|                   | CODwwwwd.EPH_5D GNSS/GPS ephemeris/clock data at     |
|                   |                15-min intervals in SP3 format        |
|                   | CODwwwwd.ERP_5D GNSS ERP (pole, UT1-UTC) solution    |
|                   |                in IGS IERS ERP format                |
|                   |                                                      |
|                   | Remarks:                                             |
|                   |                                                      |
|                   |   "P2" indicates 2-day predictions (24-48 hours);    |
|                   |   "P" indicates 1-day predictions (0-24 hours).      |
|                   |   "5D" indicates files containing predicted          |
|                   |   information for 5 days (0-120 hours).              |
|                   |                                                      |
|                   |                                                      |
| Specialties in    | - CODE has been generating its products from a       |
| CODE's analysis   |   rigorous combination of GPS and GLONASS            |
|                   |   observations. In this way, best possible           |
|                   |   consistency of the orbit products is guaranteed.   |
|                   | - Uninterrupted POD for all transmitting GNSS        |
|                   |   satellites, specifically for:                      |
|                   |   . brand new satellites                             |
|                   |   . satellites without any broadcast orbit information|
|                   |   . satellites marked unhealthy/unusable             |
|                   |   . poorly observed (GLONASS) satellites             |
|                   |   . (GPS) satellites being repositioned              |
|                   | - Elevation mask angle of 3 degrees used.            |
|                   | - Sophisticated ambiguity resolution scheme, already |
|                   |   including GLONASS ambiguity resolution (with       |
|                   |   restrictions, specifically for baseline lengths    |
|                   |   longer than 200 km), self-calibrating for GLONASS. |
|                   | - Ambiguity verification scheme: resolved ambiguities|
|                   |   are checked in terms of compability, also in order |
|                   |   to detect unexpected quarter-cycle issues.         |
|                   | - GPS quarter-cycle phase biase issue: potentially   |
|                   |   affected GPS ambiguities are banned from ambiguity |
|                   |   resolution.                                        |
|                   | - Continuous parameterization, particularly for EOP, |
|                   |   troposphere ZPD and horizontal gradient parameters,|
|                   |   ionosphere parameters, allowing for connection of  |
|                   |   the parameters at day boundaries.                  |
|                   | - IGS fiducial sites are automatically verified for  |
|                   |   consistent datum definition. This is also true with|
|                   |   respect to all antenna-sharing fiducial sites.     |
|                   | - Inclusion of fast moving South Pole station AMU2.  |
|                   | - Inclusion of all available NGA stations.           |
|                   | - Generation of high-rate (5-sec) clock products.    |
|                   | - Generation of high-rate (1-hour) EOP results       |
|                   |   (internally).                                      |
|                   | - Setup of GNSS satellite antenna PCV parameters     |
|                   |   specific to each individual GPS and GLONASS        |
|                   |   satellite; corresponding patterns are not only     |
|                   |   available for the ionosphere-free linear           |
|                   |   combination but also for the geometry-free (L1-L2) |
|                   |   linear combination.                                |
|                   | - A multi-GNSS-capable internal PCV file format is   |
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|                    |   used; receiver antenna PCV models specific to       |
|                    |   GLONASS (or other) frequencies are applied.         |
|                    | - 3 terms of higher-order ionosphere (HOI) effects are|
|                    |   taken into account (based on CODE GIM & IGRF11SYN). |
|                    |   Scaling factor for 2nd and 3rd order HOI as well as |
|                    |   for ray bending for validation purposes and to      |
|                    |   switch the parameter on or off                      |
|                    | - Atmospheric non-tidal pressure loading correction   |
|                    |   at observation level with scaling factors to obtain |
|                    |   solutions without applying such corrections         |
|                    | - Monitoring of various differential code biases      |
|                    |   (DCBs), specifically:                               |
|                    |   . GPS/GLONASS P1-P2 satellite and receiver DCBs     |
|                    |   . GPS/GLONASS P1-C1 and P2-C2 satellite DCBs        |
|                    |   . biases crucial for GLONASS ambiguity resolution   |
|                    |   Values are extracted from different data processing |
|                    |   steps and directly from the RINEX observation files |
|                    |   (where possible)                                    |
|                    | - Extensive monitoring of IGS data flow concerning:   |
|                    |   . availability                                      |
|                    |   . latency                                           |
|                    |   . completeness                                      |
|                    |   . consistency                                       |
|                    | - SINEX loop: COD & COF SINEX results are routinely   |
|                    |   imported and re-introduced. First extracted and     |
|                    |   secondly re-produced station coordinate results are |
|                    |   cross-checked to the original analysis results (at  |
|                    |   0.01-mm level). The extracted list of fiducial      |
|                    |   stations is used for this re-production.            |
|                    | - Provision of GNSS geocenter coordinates in SINEX.   |
|                    | - Production of GNSS rapid SINEX files containing     |
|                    |   station coordinates and ERPs with a time resolution |
|                    |   of 6 hours is foreseen as a contribution for the    |
|                    |   IERS inter-technique combination.                   |
|                    | - Regular GNSS orbit validation using SLR data; CODE  |
|                    |   acts as an AAC of the ILRS.                         |
|                    | - The latest version of our steadily further          |
|                    |   developed GNSS analysis software is employed for    |
|                    |   operational analysis.                               |
|                    |                                                       |
| Computer platform  | Week 1477: UBELIX: Linux, x86_64                      |
|                    | Week 1065: UBECX: SunOS                               |
|                    |                                                       |
| Last changes:      | Week 1691: See IGSREPORT.20913                        |
|                    | Week 1643: See IGSREPORT.19947                        |
|                    | Week 1632: See IGSREPORT.19702                        |
|                    | Week 1625: See IGSREPORT.19560                        |
|                    | Week 1619: See IGSREPORT.19411                        |
|                    | Week 1618: See IGSREPORT.19385                        |
|                    | Week 1604: See IGSREPORT.19068 and IGSMAIL.6287       |
|                    | Week 1570: See IGSREPORT.18301 and IGSMAIL.6078       |
|                    | Week 1542: See IGSREPORT.17667 and IGSMAIL.5970       |
|                    | Week 1488: See IGSREPORT.16472                        |
|                    | Week 1477: See IGSREPORT.16225 and IGSMAIL.5771       |
|                    | Week 1452: See IGSREPORT.15669/IGSREPORT.14622        |
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|                   | Week 1440: See IGSREPORT.15405                         |
|                   | Week 1439: See IGSREPORT.15403                         |
|                   | Week 1409: See IGSREPORT.14695                         |
|                   | Week 1406: See IGSREPORT.14622/IGSMAIL.5507 & .5518    |
|                   | Week 1400: See IGSREPORT.14486 and IGSMAIL.5518        |
|                   | Week 1367: See IGSREPORT.13669                         |
|                   | Week 1349: See IGSREPORT.13201                         |
|                   | Week 1328: See IGSREPORT.12706                         |
|                   | Week 1326: See IGSREPORT.12657                         |
|                   | Week 1321: See IGSREPORT.12569 and IGSMAIL.5151        |
|                   | Week 1299: See IGSREPORT.12031                         |
|                   | Week 1282: See IGSREPORT.11617                         |
|                   | Week 1279: See IGSREPORT.11543                         |
|                   | Week 1255: See IGSMAIL.4913                            |
|                   | Week 1254: See IGSREPORT.10997 and IGLOSMAIL.963       |
|                   | Week 1252: See IGSMAIL.4782                            |
|                   | Week 1242: See IGSREPORT.10752                         |
|                   | Week 1222: See IGSREPORT.10361 and                     |
|                   |                IGSMAIL.4474/IGLOSMAIL.770              |
|                   | Week 1216: See IGSMAIL.4371/IGLOSMAIL.736              |
|                   | Week 1191: See IGSREPORT.9756 and IGSMAIL.4162         |
|                   | Week 1158: See IGSREPORT.9147 and IGSMAIL.3823         |
|                   | Week 1143: See IGSREPORT.8868                          |
|                   | Week 1142: See IGSREPORT.8848                          |
|                   | Week 1135: See IGSREPORT.8710                          |
|                   | Week 1130: See IGSREPORT.8616                          |
|                   | Week 1128: See IGSREPORT.8577                          |
|                   | Week 1077: See IGSREPORT.7544                          |
|                   | Week 1065: See IGSREPORT.7279                          |
|                   | Week 1057: See IGSREPORT.7107 and IGSMAIL.2827         |
|                   | Week 1021: See IGSREPORT.6351                          |
|                   | Week 0978: See IGSREPORT.5415 and IGSMAIL.2043         |
|                   | Week 0947: See IGSREPORT.4698 and IGSMAIL.1829         |
|                   | Week 0926: See IGSREPORT.4247 and IGSMAIL.1705         |
|                   | Week 0873: See IGSREPORT.3056                          |
|----------------------------------------------------------------------------|
| Preparation Date  | 18-Aug-1996                                            |
|----------------------------------------------------------------------------|
| Modification Dates| 13-Mar-1998                                            |
|                   | 12-Mar-2002/SS: Major revision and update              |
|                   | 13-Mar-2002/SS: JGM3 model up to degree 12             |
|                   | 24-Oct-2002/SS: Typo concerning satellite antenna      |
|                   |                 offset value corrected                 |
|                   | 28-May-2008/SS/RD: Major revision and update           |
|                   | 13-Oct-2010/SS/RD: Processing model update             |
|                   | 19-Dec-2012/SS: Major revision and update              |
|----------------------------------------------------------------------------|
| Effective Date for| 19-Dec-2012                                            |
| Data Analysis     |                                                        |
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|                           MEASUREMENT MODELS                               |
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| Preprocessing    | Phase preprocessing in a baseline by baseline mode     |
|                  | using triple-differences. In most cases, cycle slips   |
|                  | are fixed looking simultaneously at different linear  |
|                  | combinations of L1 and L2. If a cycle slip cannot be   |
|                  | fixed reliably, bad data points are removed or new     |
|                  | ambiguities are set up. In addition, a data screening  |
|                  | step on the basis of weighted postfit residuals is     |
|                  | performed. Outliers are removed.                       |
|--------------------------------------------------------------------------|
| Basic Observables| GPS/GLONASS carrier phase; code only used for receiver |
|                  | clock synchronization                                  |
|                  |--------------------------------------------------------|
|                  | Elevation angle cutoff :  3 degrees                    |
|                  | Sampling rate          :  3 minutes                    |
|                  | Weighting              :  6 mm for double-differenced  |
|                  |                           ionosphere-free phase        |
|                  |                           observations at zenith;      |
|                  |                           elevation-dependent weighting|
|                  |                           function 1/cos(z)**2         |
|--------------------------------------------------------------------------|
| Modeled          | Double differences, ionosphere-free linear combination |
| observables      |                                                        |
|--------------------------------------------------------------------------|
| Satellite antenna| SV-specific z-offsets & block-specific x- & y-offsets  |
| -center of mass  | from IGS using file igs08_wwww.atx based on ITRF2008   |
| offsets          |                                                        |
|--------------------------------------------------------------------------|
| Satellite antenna| block-specific nadir angle-dependent "absolute" PCVs   |
| phase center     | applied from file igs08_wwww.atx; no azimuth-dependent |
| corrections      | corrections applied                                    |
|--------------------------------------------------------------------------|
| Satellite clock  | 2nd order relativistic correction for non-zero         |
| corrections      | orbit ellipticity (-2*R*V/c) applied                   |
|                  | NOTE: Other dynamical relativistic effects under       |
|                  |       Orbit Models                                     |
|--------------------------------------------------------------------------|
| GPS attitude     | Nominal attitude implemented.                          |
| model            |                                                        |
|--------------------------------------------------------------------------|
| RHC phase        | Phase polarization effects applied (Wu et al., 1993)   |
| rotation corr.   |                                                        |
|--------------------------------------------------------------------------|
| Ground antenna   | "absolute" elevation- & azimuth-dependent (when        |
| phase center     | available) PCVs & L1/L2 offsets from ARP applied from  |
| offsets &        | file igs08_wwww.atx                                    |
| corrections      | Receiver antenna models specific to GLONASS are        |
|                  | applied (as far as available).                         |
|--------------------------------------------------------------------------|
| Antenna radome   | Calibration applied if given in file igs08_wwww.atx;   |
| calibrations     | otherwise radome effect neglected (radome => NONE)     |
|--------------------------------------------------------------------------|
| Marker -> antenna| dN, dE, dU eccentricities from site logs applied to    |
| ARP eccentricity | compute station coordinates                            |
|--------------------------------------------------------------------------|
| Troposphere      | ECMWF-based hydrostatic delay mapped with hydrostatic  |
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| a priori model   | VMF1. Coefficients from 6-hourly global grids.         |
|                  |                                                        |
|                  | Gradient model: none                                   |
|-------------------------------------------------------------------------|
| Ionosphere       | 1st order effect: eliminated by forming the            |
|                  |                   ionosphere-free linear combination   |
|                  |                   of L1 and L2.                        |
|                  |--------------------------------------------------------|
|                  | 2nd order effect: applied, IGRF11 implementation, TEC  |
|                  |                   from CODE global ionosphere model    |
|                  |--------------------------------------------------------|
|                  | 3rd order effect: applied, TEC from CODE global        |
|                  |                   ionosphere model                     |
|                  |--------------------------------------------------------|
|                  | Other effects:    ray bending applied, TEC from CODE   |
|                  |                   global ionosphere model              |
|                  |                                                        |
|                  |                   GNSS-derived global ionosphere map   |
|                  |                   information is used to support       |
|                  |                   ambiguity resolution when using the  |
|                  |                   QIF strategy.                        |
|-------------------------------------------------------------------------|
| Tidal            | Solid Earth tide     : complete model from IERS         |
| displacements    |                        Conventions 2010                |
|                  |                                                        |
|                  | Step 1: in-phase: degree 2 and 3                       |
|                  |           Nominal h02 and l02 : 0.6078, 0.0847 (anela.)|
|                  |           Nominal h22 and l22 :-0.0006, 0.0002         |
|                  |           Nominal h3  and l3  : 0.292 , 0.015          |
|                  |                                                        |
|                  |         out-of-phase: degree 2 only semi- and diurnal  |
|                  |           diurnal: nominal hI, lI :-0.0025,-0.0007     |
|                  |           semi-di: nominal hI, lI :-0.0022,-0.0007     |
|                  |                                                        |
|                  |         latitude dependence                            |
|                  |           diurnal: nominal l1 : 0.0012                 |
|                  |           semi-di: nominal l1 : 0.0024                 |
|                  |                                                        |
|                  | Step 2: in-phase: degree 2, diurnal                    |
|                  |         in-phase and out-of-phase: long-period tides   |
|                  |--------------------------------------------------------|
|                  | Permanent tide       : applied in tide model,          |
|                  |                        NOT included in site coordinates|
|                  |--------------------------------------------------------|
|                  | Solid Earth pole tide: applied (IERS 2010)             |
|                  |--------------------------------------------------------|
|                  | Oceanic pole tide    : not applied                     |
|                  |--------------------------------------------------------|
|                  | Ocean tide loading   : IERS 2010, site-dependent amps  |
|                  |                        & phases from Bos & Scherneck   |
|                  |                        website for FES2004 tide model  |
|                  |                        NEU site displacements computed |
|                  |                        using hardisp.f from D. Agnew   |
|                  |--------------------------------------------------------|
|                  | Ocean tide geocenter : coeffs. corrected for center of |
```

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|                  |                       mass motion of whole Earth       |
|                  |--------------------------------------------------------|
|                  | Atmospheric tides    : S1+S2 tidal corrections from the|
|                  |                        Vienna atmospheric pressure     |
|                  |                        model                           |
|---------------------------------------------------------------------------|
| Non-tidal        | Atmospheric pressure : Non-tidal components from the   |
| loadings         |                        Vienna atmospheric pressure     |
|                  |                        model with three scaling factors|
|                  |                        per station (one for each       |
|                  |                        component) for validation       |
|                  |                        purposes.                       |
|                  |                        The product files are generated |
|                  |                        without considering the non-    |
|                  |                        tidal pressure loading by       |
|                  |                        forcing the scaling factors to  |
|                  |                        zero.                           |
|                  |--------------------------------------------------------|
|                  | Ocean bottom pressure: not applied                     |
|                  |--------------------------------------------------------|
|                  | Surface hydrology    : not applied                     |
|                  |--------------------------------------------------------|
|                  | Other effects        : none applied                    |
|---------------------------------------------------------------------------|
| Earth orientation| Ocean tidal: diurnal/semidiurnal variations in x,y, & |
| variations       |              UT1 applied according to IERS 2010, Tables|
|                  |              8.2a, 8.2b, 8.3a, 8.3b                   |
|                  |--------------------------------------------------------|
|                  | Atmosphere tidal: S1, S2, S3 tides not applied         |
|                  |--------------------------------------------------------|
|                  | High-frequency nutation: applied according to IERS     |
|                  |                          2010, Table 5.1a              |
|                  |--------------------------------------------------------|
|                  | UT1 libration: applied according to IERS 2010, Table   |
|                  |                5.1.b                                   |
=============================================================================

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|                           REFERENCE FRAMES                                |
|---------------------------------------------------------------------------|
| Time argument    | TDT                                                    |
|                  | GPS time as given by observation epochs, which is      |
|                  | offset by only a fixed constant (approx.) from TT/TDT  |
|---------------------------------------------------------------------------|
| Inertial         | geocentric; mean equator and equinox of 2000 Jan 1     |
| frame            | at 12:00 (J2000.0)                                     |
|---------------------------------------------------------------------------|
| Terrestrial      | ITRF2008 reference frame realized through a set of     |
| frame            | station coordinates and velocities given in the IGS    |
|                  | internal realization IGb08.                            |
|                  |                                                        |
|                  |   Datum definition:                                    |
|                  |   . 3 no-net translation conditions (only if geocenter |
|                  |     is estimated)                                      |
|                  |   . 3 no-net rotation conditions                       |
```

```
|                  |   . geocenter coordinates constrained nominally to     |
|                  |     zero values                                        |
|                  |   IGb08 fiducial sites are selected as reference, if:  |
|                  |   . horizontal deviation < 10 mm                       |
|                  |   . vertical   deviation < 30 mm                       |
|-------------------------------------------------------------------------|
| Tracking         | Ultra-rapid with about 90, rapid with 120 and final   |
| network          | 270 stations per day are used.                        |
|                  | Station selection is based on long time series,       |
|                  | contribution to existing reference frames, co-location |
|                  | with other space-geodetic techniques, GLONASS-        |
|                  | capability, and all-in-view tracking support for      |
|                  | unhealthy satellites.                                 |
|-------------------------------------------------------------------------|
| Interconnection  | Precession: IAU 2000 Precession Theory                |
|                  |-------------------------------------------------------|
| (EOP parameter   | Nutation: IAU 2000R06 Nutation Theory                 |
| estimation is    |-------------------------------------------------------|
| below)           | A priori EOPs: polar motion & UT1 from IERS C04 series |
|                  |                aligned to ITRF2008                    |
===========================================================================

===========================================================================
|                              ORBIT MODELS                               |
|-------------------------------------------------------------------------|
| Geopotential     | EGM2008 model up to degree and order 12 (+C21+S21)    |
| (static)         |-------------------------------------------------------|
|                  | GM = 398600.4415 km**3/sec**2                         |
|                  |-------------------------------------------------------|
|                  | AE =   6378.1363 km                                   |
|-------------------------------------------------------------------------|
| Tidal variations | Solid Earth tides: applied according to IERS 2010     |
| in geopotential  |-------------------------------------------------------|
|                  | Ocean tides: applied, FES2004 model                   |
|                  |-------------------------------------------------------|
|                  | Solid Earth pole tide: applied according to IERS 2010 |
|                  |-------------------------------------------------------|
|                  | Oceanic pole tide: applied according to IERS 2010     |
|-------------------------------------------------------------------------|
| Third-body       | Sun, Moon, Jupiter, Venus, Mars as point masses       |
|                  |-------------------------------------------------------|
|                  | Ephemeris: JPL DE405                                  |
|                  |-------------------------------------------------------|
|                  | GMsun  = 132712500000 km**3/sec**2                    |
|                  |-------------------------------------------------------|
|                  | GMmoon =    4902.7890 km**3/sec**2                    |
|-------------------------------------------------------------------------|
| Solar radiation  | A priori: CODE RPR model coefficients for GPS         |
| pressure model   |           satellites (updated 2007)                   |
| (parameter       |-------------------------------------------------------|
|  estimation is   | Earth shadow model: cylindric shadow                  |
|  below)          |-------------------------------------------------------|
|                  | Earth albedo:       not applied                       |
|                  |-------------------------------------------------------|
|                  | Moon shadow model:  umbra and penumbra                |
```

```
|                  |-------------------------------------------------------|
|                  | Satellite attitude: nominal attitude                  |
|                  |-------------------------------------------------------|
|                  | Other forces:       none applied                      |
|--------------------------------------------------------------------------|
| Relativistic     | dynamical correction: applied according to IERS 2010, |
| effects          |                       eq. 10.12, Lense-Thirring &     |
|                  |                       geodesic precession neglected   |
|                  |-------------------------------------------------------|
|                  | Gravitational time delay: applied according to        |
|                  |                           IERS 2010, eq.  11.17       |
|--------------------------------------------------------------------------|
| Numerical        | Integration algorithms developed at AIUB by Gerhard   |
| Integration      | Beutler (see references below). Representation of the |
|                  | the orbit by a polynomial of degree 10 for 1 hour.    |
|                  |-------------------------------------------------------|
|                  | Integration step: 1 hour                              |
|                  |-------------------------------------------------------|
|                  | Starter procedure: no special starter procedure needed |
|                  |-------------------------------------------------------|
|                  | Arc length: 72 hours for long-arc solutions           |
|                  |             24 hours for clean one-day solutions      |
============================================================================

============================================================================
|           ESTIMATED PARAMETERS (& APRIORI VALUES & CONSTRAINTS)          |
|--------------------------------------------------------------------------|
| Adjustment       | Weighted least-squares algorithms                     |
| method           |                                                       |
|--------------------------------------------------------------------------|
| Data Span        | Long-arc solutions include the data from three day,   |
|                  | combined on normal equation level.                    |
|                  | Rapid/ultra-rapid: products are extracted from the    |
|                  | last day of the triple.                               |
|                  | Final satellite orbits and troposphere parameters are |
|                  | extracted from the middle day                         |
|                  |                                                       |
|                  | Clean one-day solutions consider only the data from   |
|                  | one single day.                                       |
|--------------------------------------------------------------------------|
| Station          | All station coordinates are adjusted with minimum     |
| coordinates      | constraints, see above.                               |
|--------------------------------------------------------------------------|
| Satellite clocks | Not applicable for double difference processing       |
|--------------------------------------------------------------------------|
| Receiver clocks  | Not applicable for double difference processing       |
|--------------------------------------------------------------------------|
| Orbital          | 6 Keplerian elements plus 5 solar radiation parameters |
| parameters       | at start of arc; no a priori sigmas used.             |
|                  | Estimated RPR parameters (see Beutler 1994):          |
|                  |  - Constants in D-, Y- and X-direction                |
|                  |  - Periodic terms in X-direction                      |
|                  | A priori orbits are from a previous reprocessing run  |
|                  | or from the CODE rapid orbit solution.                |
|                  | Pseudo-stochastic orbit parameters (small velocity    |
```

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|                   | changes), every 12 hours, constrained to:             |
|                   | . 1.E-6 m/sec in radial                               |
|                   | . 1.E-5 m/sec in along-track                          |
|                   | . 1.E-8 m/sec in out-of-plane                         |
|-----------------------------------------------------------------------------|
| Satellite         | Not estimated                                         |
| attitude          |                                                       |
|-----------------------------------------------------------------------------|
| Troposphere       | Zenith delay: estimated for each station in intervals |
|                   |               of 2 hours. Loose relative constraints of|
|                   |               1 m  are applied. Piece-wise, linear    |
|                   |               parameterization, allowing for connection|
|                   |               of the parameters at day boundaries.    |
|                   |---------------------------------------------------------|
|                   | Zenith delay epochs: every two hours starting at      |
|                   |                      midnight                         |
|                   |---------------------------------------------------------|
|                   | Mapping function: wet VMF1                            |
|                   |---------------------------------------------------------|
|                   | Gradients: pairs of horizontal delay gradient         |
|                   |            parameters are estimated in N-S and E-W    |
|                   |            direction for each station in intervals of |
|                   |            24 hours. No a priori constraints are      |
|                   |            applied. Piece-wise, linear                |
|                   |            parameterization, allowing for connection of|
|                   |            the parameters at day boundaries.          |
|                   |            Details about the gradient model can be    |
|                   |            found in Rothacher et al. (1997).          |
|                   |            Refined gradient model used, see Chen and  |
|                   |            Herring (1997).                            |
|-----------------------------------------------------------------------------|
| Ionospheric       | Not estimated in ionosphere-free analyses             |
| correction        |                                                       |
|                   | One scaling factor for 2nd and 3rd order terms and ray |
|                   | bending is setup to switch the components on or off   |
|                   | on normal equation level.                             |
|                   | The products are generated with considering all three |
|                   | correction components.                                |
|-----------------------------------------------------------------------------|
| Ambiguity         | Ambiguities are resolved in a baseline-by-baseline    |
|                   | mode performing the following steps:                  |
|                   | . Melbourne-Wuebbena approach (< 6000 km)             |
|                   | . Quasi-Ionosphere-Free (QIF) approach (< 2000 km)    |
|                   |   (also for GLONASS, same frequencies)                |
|                   | . Phase-based widelane/narrowlane method (< 200 km)   |
|                   |   (also for GLONASS, no restrictions)                 |
|                   | . Direct L1/L2 method, also for GLONASS (< 20 km)     |
|                   |   (also for GLONASS, no restrictions)                 |
|                   | GNSS-derived global ionosphere map information is used |
|                   | to support the code-less methods.                     |
|-----------------------------------------------------------------------------|
| Earth Orient.     | X- and Y-pole coordinates, and UT1-UTC are represented |
| Parameters (EOP)  | each with piece-wise linear polynomials which are     |
|                   | continuous in time. UT1-UTC is fixed to the a priori  |
|                   | value at the beginning of the first day. No further   |
```

	a priori sigmas are used. All reported CODE EOP solutions do include a subdaily EOP model (see above). The estimates therefore correspond to daily averages on top of the introduced a priori model. Drifts in nutation (Dpsi, Deps) are solved for in a special 3-day solution. The corresponding nutation parameters generally set up are constrained to the IAU 2000R06 model for the CODE official solution. High-rate (1-hour) X-, Y- and UT1-UTC estimates are also generated in a special 3-day solution.
Other parameters	Center of mass coordinates: Center of mass, or geocenter coordinate parameters are commonly set up as part of each solution. The related parameters are usually heavily constrained to zero values. Additional computations on the normal equation level are made regularly in order to retrieve 1-day, 3-day, as well as weekly GNSS geocenter coordinates in the current ITRF. GNSS satellite phase center offsets and patterns: Corresponding parameters are commonly set up as part of each final solution for each individual GNSS satellite. The related parameters are usually heavily constrained to the corresponding nominal values (as defined by the IGS08 PCV model). Such GNSS PCV parameters are available for the ionosphere-free as well as the geometry-free linear combination. GPS/GLONASS bias parameter: An extra set of four parameters is set up for each GLONASS observing station to characterize: - one GLONASS-GPS receiver antenna offset vector (three components) and - one GLONASS-GPS ZPD troposphere bias. These biases are estimated on a weekly basis together with the station coordinates. APL scaling factors: see above

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