

## BaselineByCode: An Educational - Purpose Software Package for GPS Baseline Determination using Code Measurements

by

D. PAPAGEORGIOU, C. PIKRIDAS, A. FOTIOU,  
and K. KATSAMBALOS,

Department of Geodesy & Surveying  
Faculty of Rural & Surveying Engineering  
Aristotle University of Thessaloniki, Greece



## Software philosophy

- BaselineByCode: a standalone windows application.
- *Main objective* → Determination of a baseline (static process) using code data with an educational user - friendly interface → *step by step* analysis and presentation of all intermediate results in an accessible file format.
- *On line help* → including theory and applications for almost every option.

FIG Working Week, Athens, 2004

Baseline By Code

AUTH.GR

## DATA IMPORT AND PROCESSING PARAMETERS

- *Rinex Data* → C/A, P code measurements.
- *Orbit files* → Rinex Nav. Files or precise orbits in SP3 format are supported.
- *Tropospheric Models* → Most of the well known models like, Saastamoinen, Hopfield, Collins, Magnavox, Goad and Goodman, and Marini are included.

FIG Working Week, Athens, 2004

Baseline By Code

AUTH.GR

- *Ionospheric Models* → Klobuchar's is supported and the Single Layer Model (by Georgiadou & Kleusberg) can be selected if the the determined SLM parameters are available.
- *Possibility to reject data* → According to signal quality, code residuals, cut-off angle, selection of satellite observing window.

FIG Working Week, Athens, 2004

Baseline By Code

AUTH.GR

## Main panel of the program

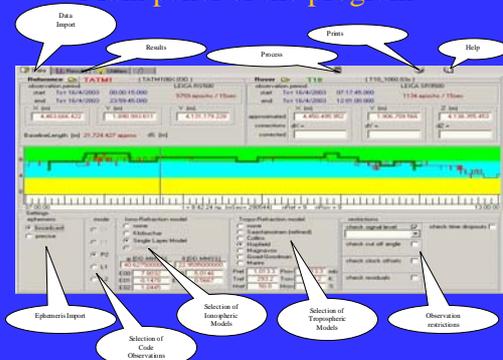


FIG Working Week, Athens, 2004

Baseline By Code

AUTH.GR

## UTILITIES AND RESULTS PRESENTATION

- Provides two types of presentation → *text files* and *graphical forms*.
- Upon user request the *text files* contain all the information about:
  - *clock offsets for each epoch*
  - *Design Matrix, Weight Matrix and Normal Equations Matrix*

FIG Working Week, Athens, 2004

Baseline By Code

AUTH.GR

- Satellite elevations, azimuths and satellite positions as a series of time tagged ECEF coordinates.
- Single and Double difference residuals.
- The DOP factors (GDOP, PDOP etc).
- The excluded observations
- The Ionospheric delay
- The Tropospheric delay

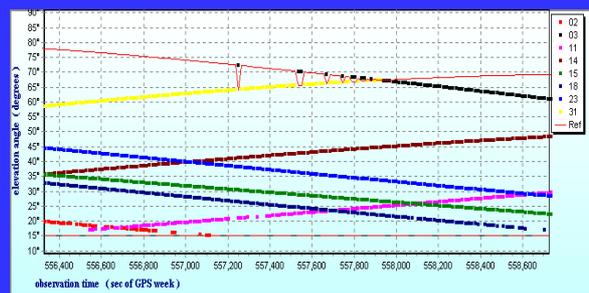
## The Orbit information text file of the program Baseline by Code

PRN	EPOCH	POSITION (E, N, U)	VELOCITY (E, N, U)	ACCELERATION (E, N, U)
14	180201	124.409114 20.4666708 270	14.7091311 1.087	14.041508 1.294
15	180201	124.702489 20.4666708 270	14.7091311 1.087	14.041508 1.294
16	180201	125.127113 20.4666708 270	14.7091311 1.087	14.041508 1.294
17	180201	125.451737 20.4666708 270	14.7091311 1.087	14.041508 1.294
18	180201	125.776361 20.4666708 270	14.7091311 1.087	14.041508 1.294
19	180201	126.100985 20.4666708 270	14.7091311 1.087	14.041508 1.294
20	180201	126.425609 20.4666708 270	14.7091311 1.087	14.041508 1.294
21	180201	126.750233 20.4666708 270	14.7091311 1.087	14.041508 1.294
22	180201	127.074857 20.4666708 270	14.7091311 1.087	14.041508 1.294
23	180201	127.400000 20.4666708 270	14.7091311 1.087	14.041508 1.294
24	180201	127.724624 20.4666708 270	14.7091311 1.087	14.041508 1.294
25	180201	128.049248 20.4666708 270	14.7091311 1.087	14.041508 1.294
26	180201	128.373872 20.4666708 270	14.7091311 1.087	14.041508 1.294
27	180201	128.698496 20.4666708 270	14.7091311 1.087	14.041508 1.294
28	180201	129.023120 20.4666708 270	14.7091311 1.087	14.041508 1.294
29	180201	129.347744 20.4666708 270	14.7091311 1.087	14.041508 1.294
30	180201	129.672368 20.4666708 270	14.7091311 1.087	14.041508 1.294
31	180201	130.000000 20.4666708 270	14.7091311 1.087	14.041508 1.294
32	180201	130.324624 20.4666708 270	14.7091311 1.087	14.041508 1.294
33	180201	130.649248 20.4666708 270	14.7091311 1.087	14.041508 1.294
34	180201	130.973872 20.4666708 270	14.7091311 1.087	14.041508 1.294
35	180201	131.298496 20.4666708 270	14.7091311 1.087	14.041508 1.294
36	180201	131.623120 20.4666708 270	14.7091311 1.087	14.041508 1.294
37	180201	131.947744 20.4666708 270	14.7091311 1.087	14.041508 1.294
38	180201	132.272368 20.4666708 270	14.7091311 1.087	14.041508 1.294
39	180201	132.596992 20.4666708 270	14.7091311 1.087	14.041508 1.294
40	180201	132.921616 20.4666708 270	14.7091311 1.087	14.041508 1.294
41	180201	133.246240 20.4666708 270	14.7091311 1.087	14.041508 1.294
42	180201	133.570864 20.4666708 270	14.7091311 1.087	14.041508 1.294
43	180201	133.895488 20.4666708 270	14.7091311 1.087	14.041508 1.294
44	180201	134.220112 20.4666708 270	14.7091311 1.087	14.041508 1.294
45	180201	134.544736 20.4666708 270	14.7091311 1.087	14.041508 1.294
46	180201	134.869360 20.4666708 270	14.7091311 1.087	14.041508 1.294
47	180201	135.193984 20.4666708 270	14.7091311 1.087	14.041508 1.294
48	180201	135.518608 20.4666708 270	14.7091311 1.087	14.041508 1.294
49	180201	135.843232 20.4666708 270	14.7091311 1.087	14.041508 1.294
50	180201	136.167856 20.4666708 270	14.7091311 1.087	14.041508 1.294
51	180201	136.492480 20.4666708 270	14.7091311 1.087	14.041508 1.294
52	180201	136.817104 20.4666708 270	14.7091311 1.087	14.041508 1.294
53	180201	137.141728 20.4666708 270	14.7091311 1.087	14.041508 1.294
54	180201	137.466352 20.4666708 270	14.7091311 1.087	14.041508 1.294
55	180201	137.790976 20.4666708 270	14.7091311 1.087	14.041508 1.294
56	180201	138.115600 20.4666708 270	14.7091311 1.087	14.041508 1.294
57	180201	138.440224 20.4666708 270	14.7091311 1.087	14.041508 1.294
58	180201	138.764848 20.4666708 270	14.7091311 1.087	14.041508 1.294
59	180201	139.089472 20.4666708 270	14.7091311 1.087	14.041508 1.294
60	180201	139.414096 20.4666708 270	14.7091311 1.087	14.041508 1.294
61	180201	139.738720 20.4666708 270	14.7091311 1.087	14.041508 1.294
62	180201	140.063344 20.4666708 270	14.7091311 1.087	14.041508 1.294
63	180201	140.387968 20.4666708 270	14.7091311 1.087	14.041508 1.294
64	180201	140.712592 20.4666708 270	14.7091311 1.087	14.041508 1.294
65	180201	141.037216 20.4666708 270	14.7091311 1.087	14.041508 1.294
66	180201	141.361840 20.4666708 270	14.7091311 1.087	14.041508 1.294
67	180201	141.686464 20.4666708 270	14.7091311 1.087	14.041508 1.294
68	180201	142.011088 20.4666708 270	14.7091311 1.087	14.041508 1.294
69	180201	142.335712 20.4666708 270	14.7091311 1.087	14.041508 1.294
70	180201	142.660336 20.4666708 270	14.7091311 1.087	14.041508 1.294
71	180201	142.984960 20.4666708 270	14.7091311 1.087	14.041508 1.294
72	180201	143.309584 20.4666708 270	14.7091311 1.087	14.041508 1.294
73	180201	143.634208 20.4666708 270	14.7091311 1.087	14.041508 1.294
74	180201	143.958832 20.4666708 270	14.7091311 1.087	14.041508 1.294
75	180201	144.283456 20.4666708 270	14.7091311 1.087	14.041508 1.294
76	180201	144.608080 20.4666708 270	14.7091311 1.087	14.041508 1.294
77	180201	144.932704 20.4666708 270	14.7091311 1.087	14.041508 1.294
78	180201	145.257328 20.4666708 270	14.7091311 1.087	14.041508 1.294
79	180201	145.581952 20.4666708 270	14.7091311 1.087	14.041508 1.294
80	180201	145.906576 20.4666708 270	14.7091311 1.087	14.041508 1.294
81	180201	146.231200 20.4666708 270	14.7091311 1.087	14.041508 1.294
82	180201	146.555824 20.4666708 270	14.7091311 1.087	14.041508 1.294
83	180201	146.880448 20.4666708 270	14.7091311 1.087	14.041508 1.294
84	180201	147.205072 20.4666708 270	14.7091311 1.087	14.041508 1.294
85	180201	147.529696 20.4666708 270	14.7091311 1.087	14.041508 1.294
86	180201	147.854320 20.4666708 270	14.7091311 1.087	14.041508 1.294
87	180201	148.178944 20.4666708 270	14.7091311 1.087	14.041508 1.294
88	180201	148.503568 20.4666708 270	14.7091311 1.087	14.041508 1.294
89	180201	148.828192 20.4666708 270	14.7091311 1.087	14.041508 1.294
90	180201	149.152816 20.4666708 270	14.7091311 1.087	14.041508 1.294
91	180201	149.477440 20.4666708 270	14.7091311 1.087	14.041508 1.294
92	180201	149.802064 20.4666708 270	14.7091311 1.087	14.041508 1.294
93	180201	150.126688 20.4666708 270	14.7091311 1.087	14.041508 1.294
94	180201	150.451312 20.4666708 270	14.7091311 1.087	14.041508 1.294
95	180201	150.775936 20.4666708 270	14.7091311 1.087	14.041508 1.294
96	180201	151.100560 20.4666708 270	14.7091311 1.087	14.041508 1.294
97	180201	151.425184 20.4666708 270	14.7091311 1.087	14.041508 1.294
98	180201	151.749808 20.4666708 270	14.7091311 1.087	14.041508 1.294
99	180201	152.074432 20.4666708 270	14.7091311 1.087	14.041508 1.294
100	180201	152.399056 20.4666708 270	14.7091311 1.087	14.041508 1.294

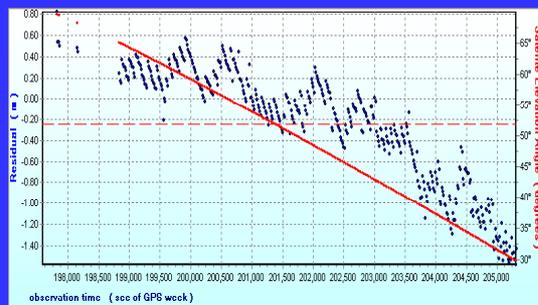
## Graphical Presentations

The program creates diagrams about:

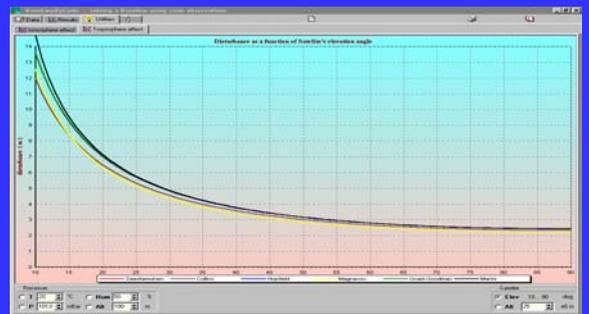
## Satellite elevations during observation time



## Satellite residuals according to elevations



## Tropospheric refraction using all the available models



## Ionospheric refraction using the available model options

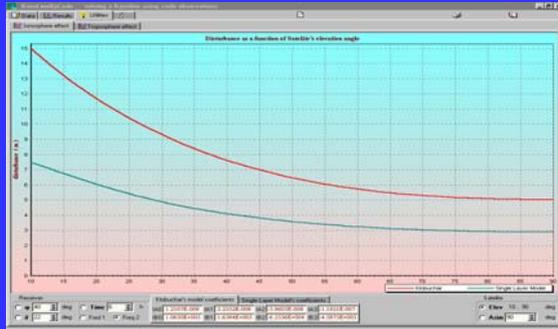


FIG Working Week, Athens, 2004

Baseline By Code

AUTHGR

## The Atmospheric delays according to satellite elevations

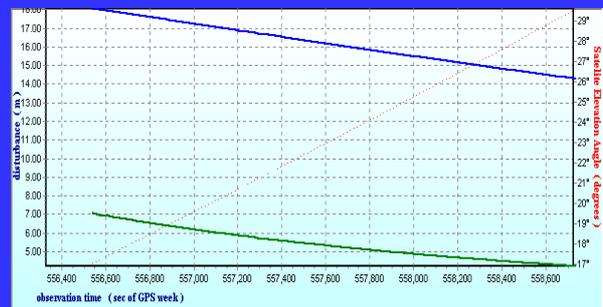


FIG Working Week, Athens, 2004

Baseline By Code

AUTHGR

## Comparison with phase solution

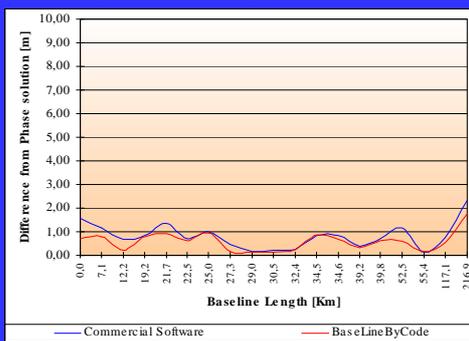


FIG Working Week, Athens, 2004

Baseline By Code

AUTHGR

## CONCLUSIONS

- Baseline By Code S/W processes code GPS measurements for baseline determination. The baseline results are reliable and useful for many low-accuracy surveying & GIS applications.
- The main advantage of this S/W is its educational character, through its options to select among various processing parameters. All intermediate results are exported for further analysis.

FIG Working Week, Athens, 2004

Baseline By Code

AUTHGR

## SOFTWARE AVAILABILITY

“BaselineByCode” has been developed as an educational package. Colleagues from academic institutions may download the self-extracted software from the following URLs.

- <http://www.softwaypro.gr/Files/Other/GPS/instBLBC.EXE>
- <http://users.auth.gr/kvek/BaselineByCode/>

FIG Working Week, Athens, 2004

Baseline By Code

AUTHGR