Contributions to IGETS processing

D. Crossley IGETS Workshop, June 2018

“Some of this was presented in Trieste, but got lost among the more interesting science papers.

I hope it may be useful when IGETS discusses processing at the GFZ Workshop

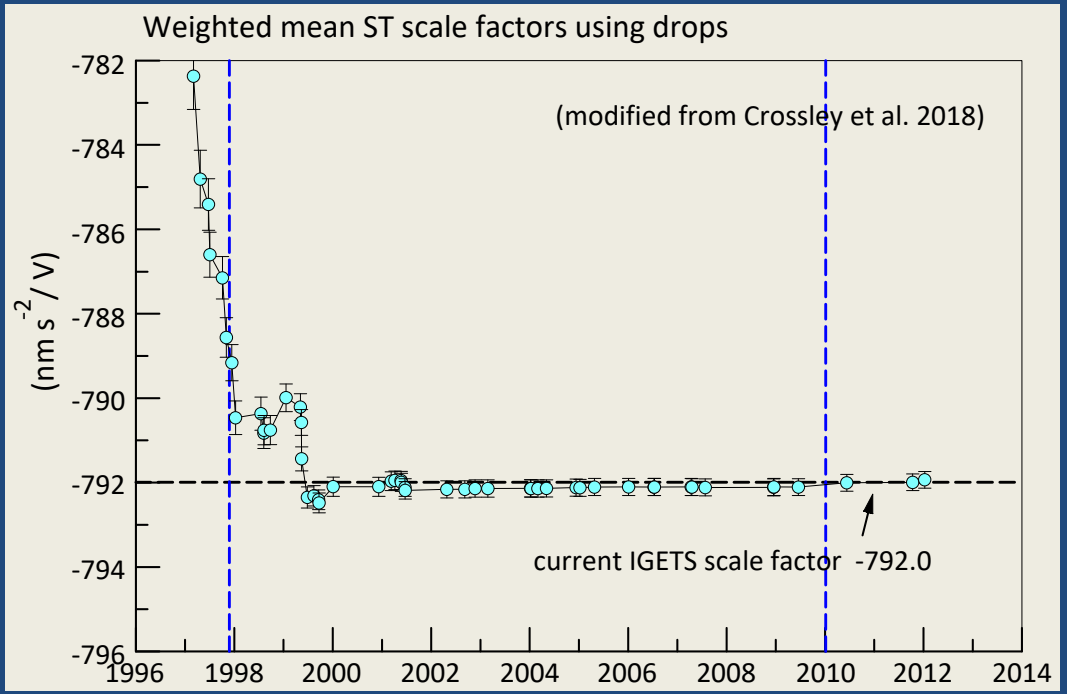
Many thanks to Jacques for showing the slides”

David

Calibration File

- a dynamic file
- should be updated whenever a new scale factor determination is made
- the weighted mean is expected to converge, e.g. ST

- already implemented by IGETS (2016)
- the preferred method of specifying SG scale factors



Correcting function (proposed Trieste G-ET 2016)

- few (I think only 2) SG operators are sending corrected 1 minute files (code ‘12’) to IGETS
- presumably such files will be the basis of the IGETS Level 3 products
- ICET has, at least until recently, been providing corrected, repair code ‘22’, files for most stations for tidal analysis; so maybe these can be used?

ICET 1 min corrected data ('cormin')

- corrections have removed spikes and disturbances, replaced with linear interpolation, (this cannot easily be undone)
- but step removal may have been too aggressive and touched the long-term evolution of the signal
- maybe can use ICET 1 min corrected data and restore offsets of specific sizes (e. g. < 1 μGal), retaining the obvious large step corrections
- this is easiest when done by ICET, but optionally can be done by the user or IGETS when the cormin files become available (a 2-step process)

ICET-style cormin file with added correcting function for every minute sample

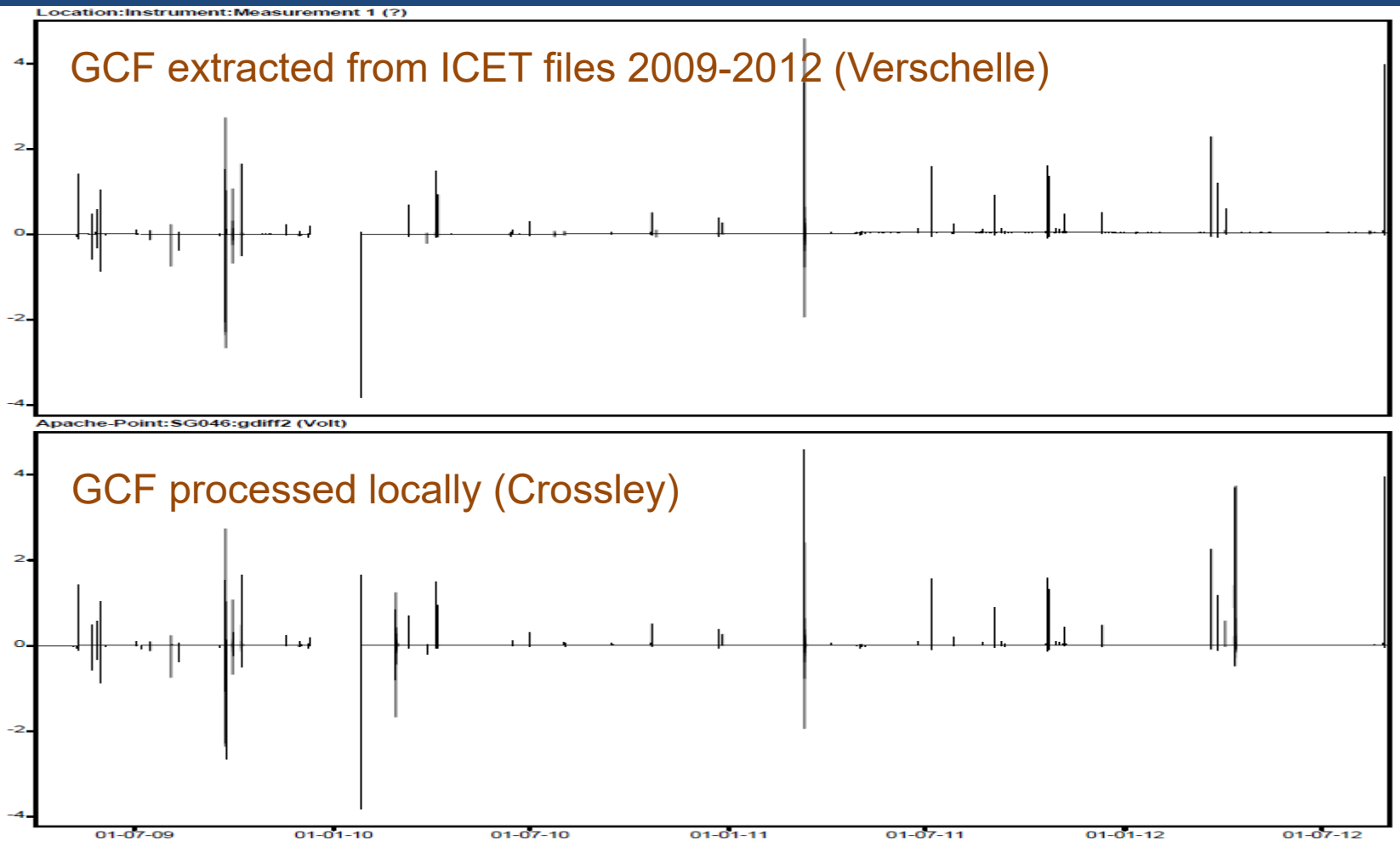
gcf = g00 – g22/gcal

advantages:

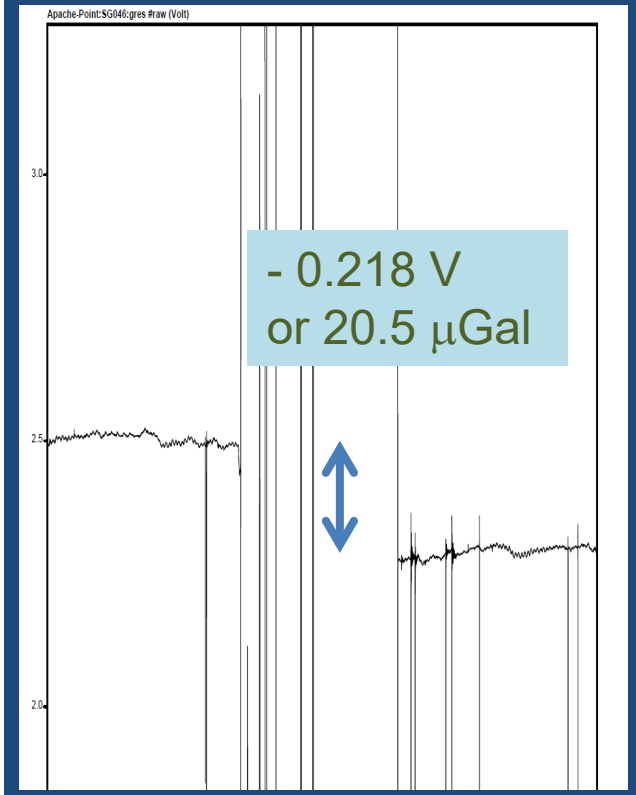
- all in volt to be used in conjunction with the new calibration file
- preterna format so as to be compatible with raw data
- (requires extra step to prepare for ETERNA34)

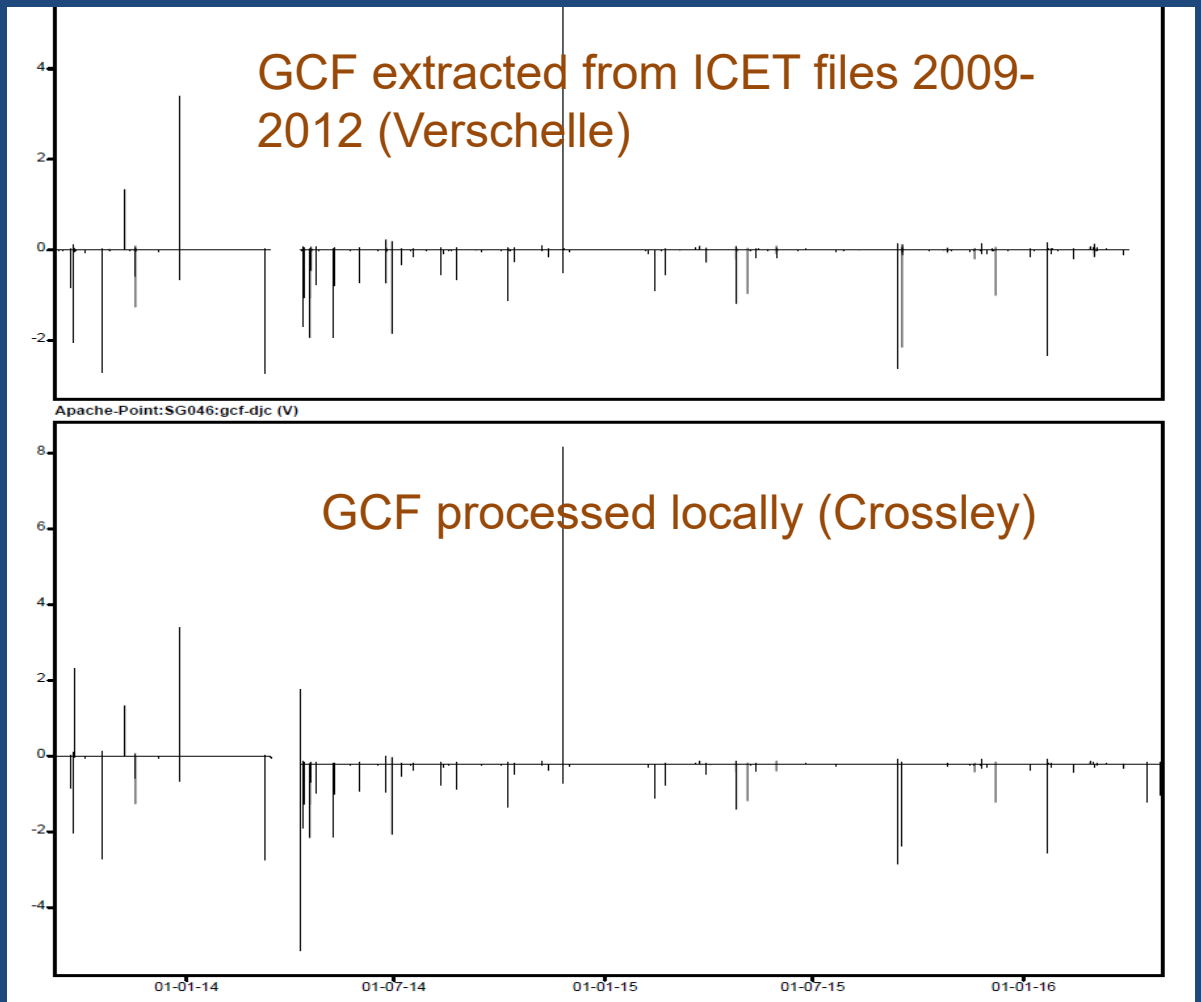
```
DATA CORRECTED AT ICET (bf.ducarme@gmail.com)
Filename              : APDATA CORRECTED AT ICET
(bf.ducarme@gmail.com)
Filename              : AP090422.ggp
Station               : Apache Point, New Mexico, USA
Instrument            : GWR OSG 046
Time Delay (sec)      :    8.2000    0.0100   nominal
N Latitude (deg)      :  32.78036    0.0010  measured
E Longitude (deg)     :-105.82042    0.0010  measured
Elevation MSL (m)     : 2788.0000    5.0000  measured
Gravity Cal (uGal/V)  :   -79.328    0.1410        AG
Pressure Cal (hPa/V)  :    1.0000    0.0001   nominal
Author                : Tom Murphy
(tmurphy@physics.ucsd.edu)
yyyymmdd hhmmss gravity(V) pressure(V) correct-func(V)
C*****************************************************
*
INSTR              1.0000    1.0000     0.000         0
77777777            0.000     0.000     0.000
20090401 000000  0.912988  721.4880  0.000001
20090401 000100  0.908741  721.4850  0.000001
20090401 000200  0.904532  721.4890 -0.000001
20090401 000300  0.900598  721.4950 -0.000001
20090401 000400  0.896731  721.5020 -0.000000
20090401 000500  0.892715  721.5030 -0.000002
```

gcf


Location:Instrument:Measurement 1 (?)
GCF extracted from ICET files 2009-2012 (Verschelle)
Apache-Point:SG046:gdiff2 (Volt)
GCF processed locally (Crossley)
4
2
0
-2
-4
01-07-09
01-01-10
01-07-10
01-01-11
01-07-11
01-01-12
01-07-12

only 1 major discrepancy in 2013-2016 data





a summary file can be created to show offsets greater than a specified amount

e.g. ap091213.off

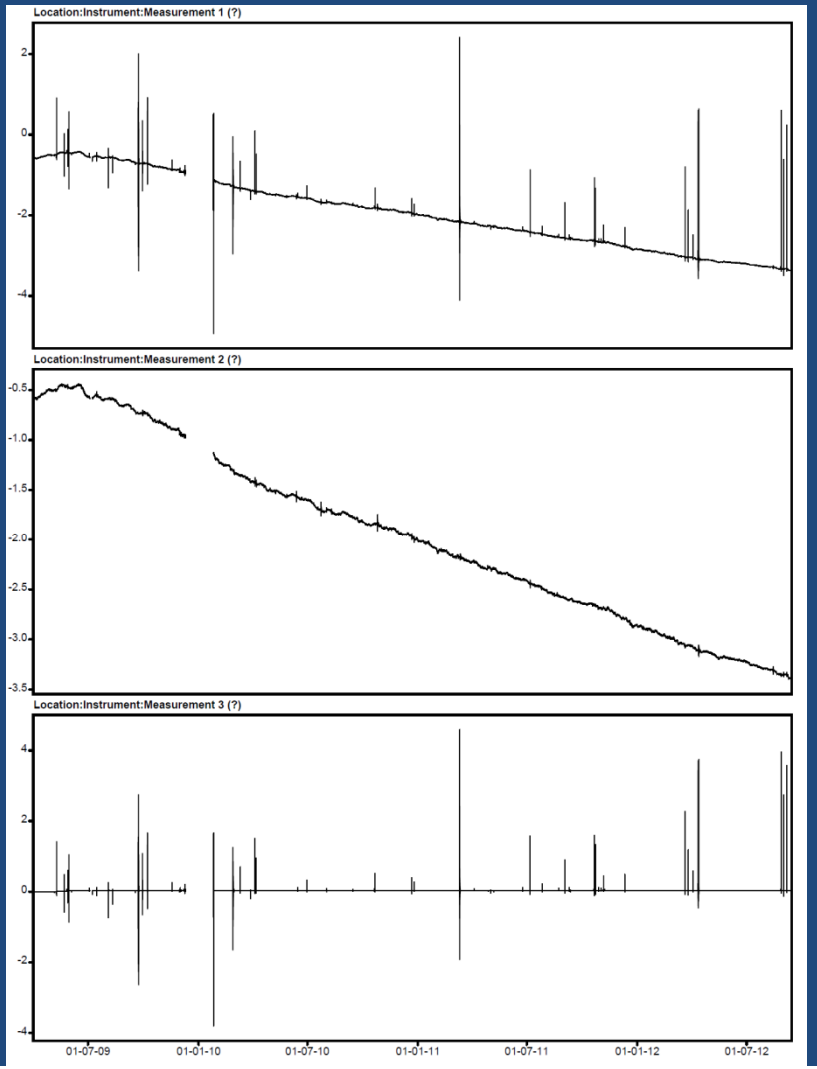
with

|offsets| > 1.0 μGal

```
Filename        : ap091213.off
Station         : Apache Point, New Mexico, USA
Instrument      : GWR OSG 046
Author          : Tom Murphy (tmurphy@physics.ucsd.edu)
Date and time of an offset >|   1.00| microgal
yyyymmdd hhmmss   voff(V)   goff(uGal) format(a8,1x,a6,f10.6,f10.4
C***************************************************************
20090409 004000  0.014697   -1.1668
20090419 040400 -0.014423    1.1450
20090602 143400  0.045121   -3.5821
20090613 150000 -0.014919    1.1844
20090625 203500  0.024216   -1.9225
20090710 161800 -0.022885    1.8169
20090724 182600  0.027053   -2.1477
20090810 154300 -0.021253    1.6873
20090821 154200  0.024957   -1.9813
20090920 060900  0.016466   -1.3072
20091007 134700 -0.023809    1.8902
20091013 014600  0.015431   -1.2250
20091125 101700 -0.018543    1.4721
20091207 202700  0.030477   -2.4195
20100228 222000  0.015253   -1.2109
```

Further Details

- shown is the gravity residual, the corrected residual and gravity correcting function (GCF) for AP 2009-2012
- it is easy to generate this function by the operator as the series moves forward
- it is better to have the 1 min files in volt, they are independent of the scale factors (that evolve)



Goal is to identify all steps taken out by ICET, and to divide into

‘small’ steps that were (correctly) removed for tidal analysis but may be detrimental to long-term signal

and ‘large’ steps that must be correctly identified for IGETS processing

automatic detection of levels in the GCF was tried using the step detection in Tsoft,

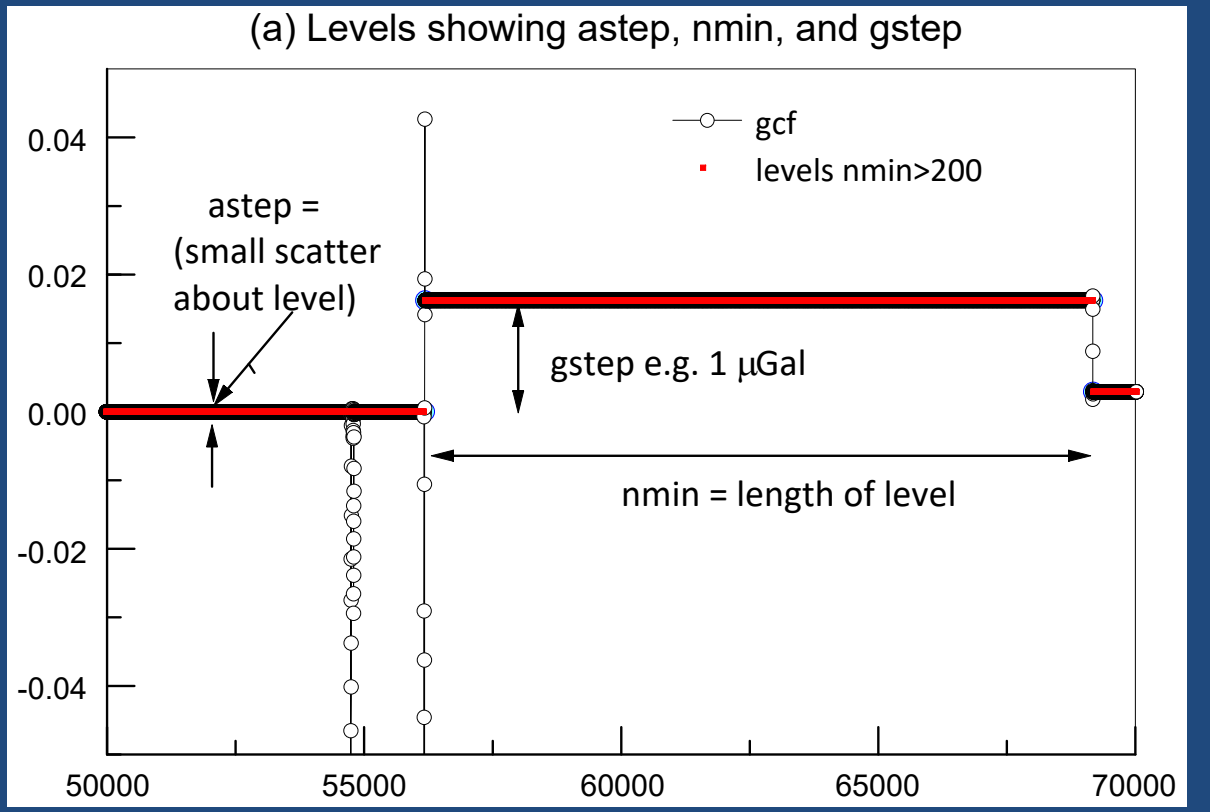
but a special program ‘steps.f’ works significantly better

the program requires 3 parameters:

(1) *astep* – the numerical variability of a level

(2) the minimum step size *gstep* to be identified

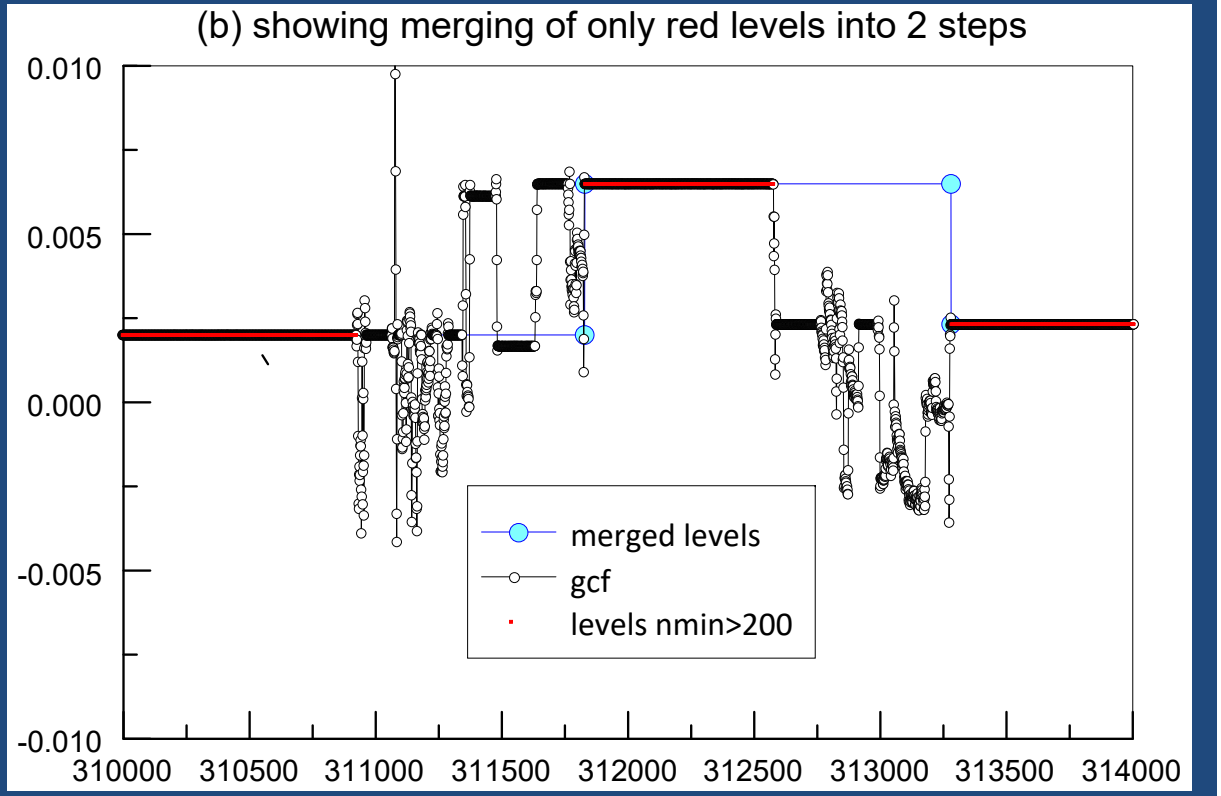
(3) the minimum time duration allowed to define a level (*nmin*)



levels can be merged if their absolute level values are within ‘astep’

this considerably simplifies the number of levels identified

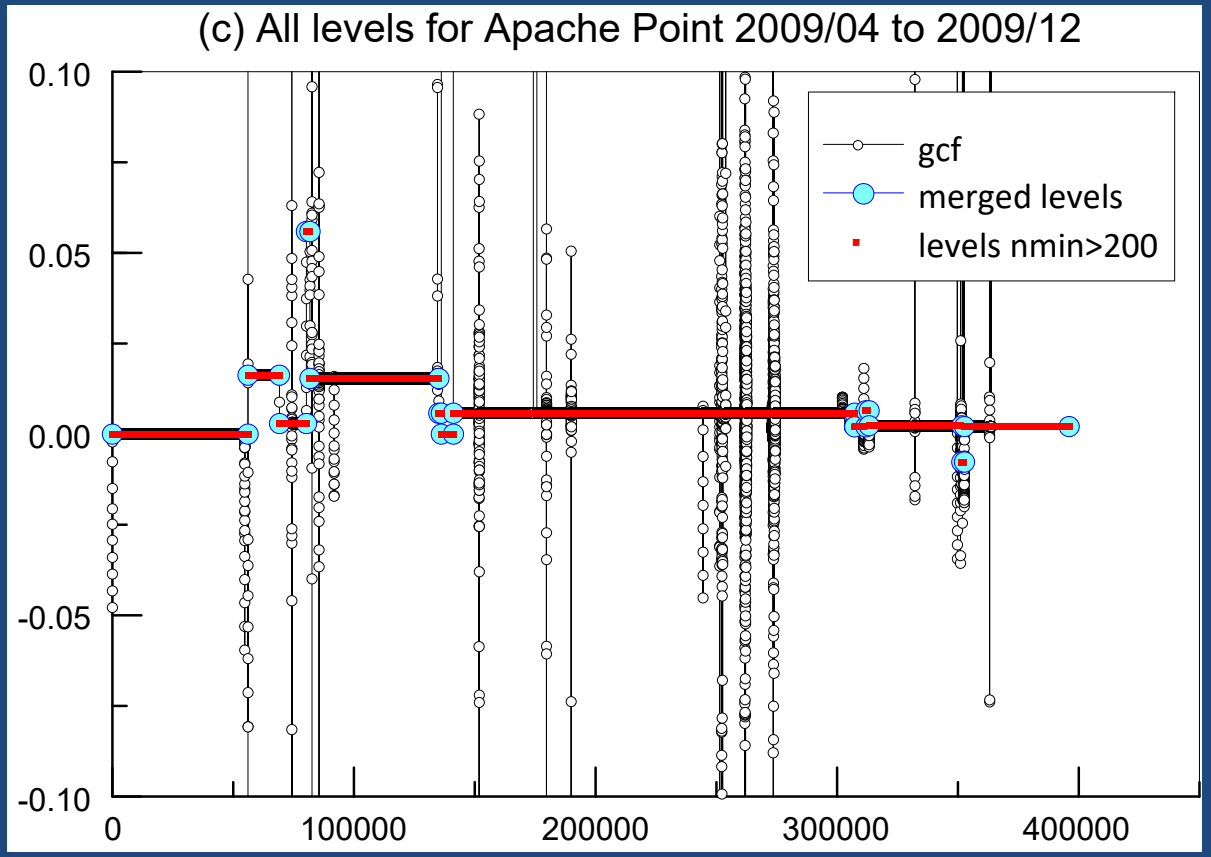
in this example only 2 steps (blue symbols) are required to represent the various red levels > nmin



once we have all merged levels, the steps can be separated into ‘small’ i.e. < gstep and ‘large’ > gstep,
where gstep = 1 μGal

further, a new gcf can be found with the small steps restored in the corrected series

giving new files ‘*24.ggp’



3 options for processing AP series 2009-2012

	1	2	3
source	user (DJC)	ICET	new ICET
example start file	ap090412.ggp	ap090422.ggp	ap090424.ggp
number of months	40	40	40
output files	ap*13.ggp	ap*23.ggp	ap*23.ggp
new corrected	ap*14.ggp	ap*24.ggp	
# all original levels	76	194	192
# simplified levels	2	29	6
steps < 1 uGal	0	21	0
steps > 1 uGal	1	7	5

series 1 user shows only 2 simplified levels, 1 step > 1 μGal

series 2 ICET shows 194 levels, 29 simplified, 21 steps < 1 μGal, 7 > 1 μGal

after reprocessing to remove small steps:

series 3 new ICET shows 6 simplified levels, 0 steps < 1 μGal, 5 > 1 μGal

Comparing 2 series for Strasbourg J9

Repeating the above on 6 years of data from Strasbourg (2000/01 to 2005/12) with same 'astep', 'nmin', results in the elimination of many of the steps

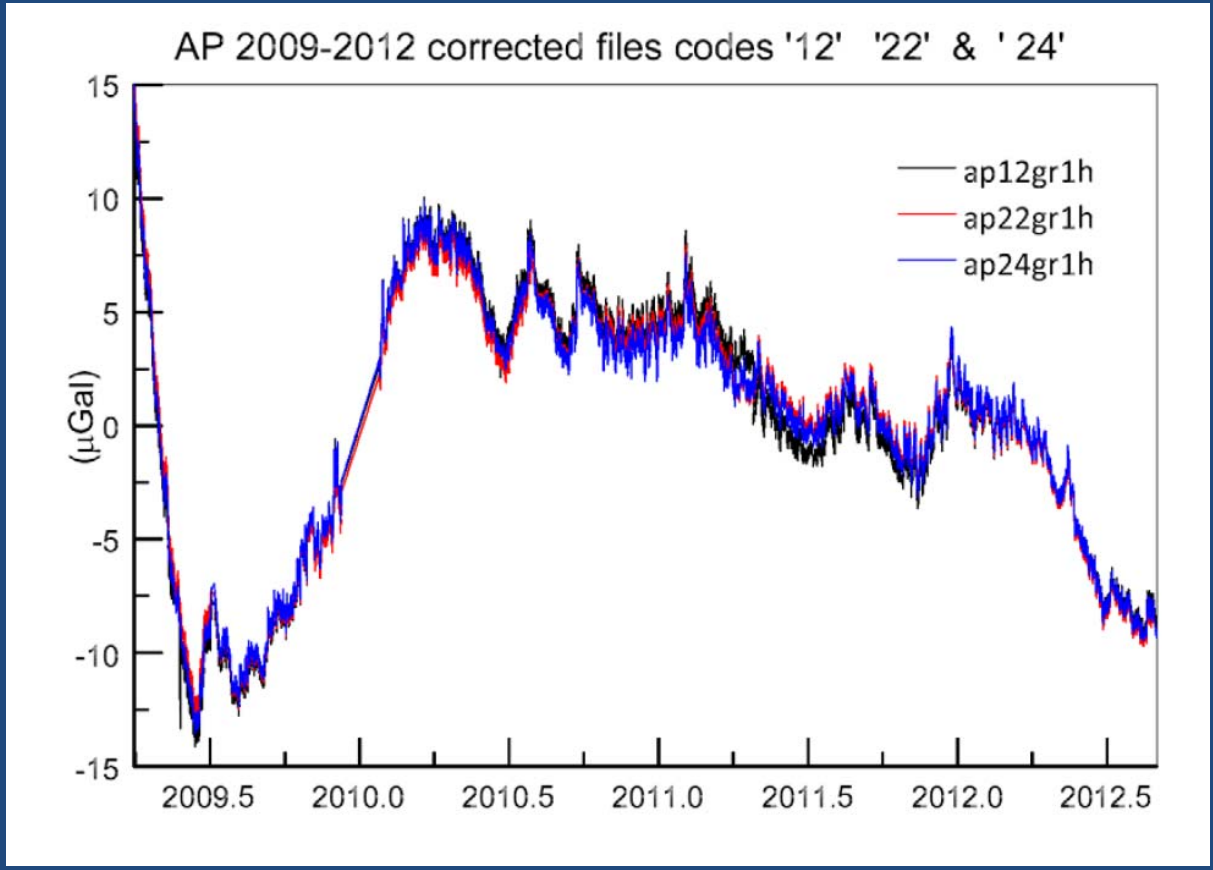
as seen in bottom row, the number of larger steps sometimes changes when smaller steps are eliminated,

especially small steps in the same direction (so can change gstep)

	3	4
source	ICET	new ICET
example start file	st000122.ggp	st000124.ggp
number of months	72	72
output files	st*23.ggp	st*23.ggp
new corrected	st*24.ggp	
original # levels	280	273
# simplified levels	28	6
steps < 1 μGal	14	0
steps > 1 μGal	13	5

Comparison of the corrected residuals from user GCF, ICET GCF, and updated ICET GCF

there is no major difference in the long period series evolution over 3.5 years



Summary

Bernard's idea can be implemented to produce a Correcting Function, code '23', in which the 3rd column, the GCF, is added in volt

the GCF can be manipulated to exclude offsets smaller than a certain size, so that only larger offsets (e.g.) are retained.

a new corrected gravity series can be produced to produce a '24' file in place of the ICET '22' file.

an offset, or 'jumplist', file can be produced for each gravity series at a station.

the fortran programs are available if required

THAT'S ALL!