KRC version 3.4.4 Update

Hugh H. Kieffer

Celestial Reasonings

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KRC is a thermal model for rotating (day << year) bodies: zero to modest atmosphere.

Mars < Planets, satellites, asteroids, boulders, exoplanets.

Relates IR observation to physical properties.

Continues to evolve. Today discuss new geophysics and a few interface changes

Your first source should be the KRC website: krc.mars.asu.edu

Documentation, quick or custom runs, or download the code-set.

Read the JGR paper, helplist, V34 users guide.

[could binge-watch 7 hours of video in parallel with the 2013 charts.]

KRC folks: "Ask Kenny"

Phil:	CEO
Hugh Kieffer --> ?:	Cognizant programmer
Kenny Rios:	IT support, repository and Web site

He has helpers

Robin Fergason:	Mentor and validation
Sylvain Piqueux:	Manage "Want list" priorities
Christopher Edwards:	Davinci interface (next talk)

Your first source should be the KRC website: krc.mars.asu.edu

Two E-mailing lists: for developers and users.
Register, set if you want notices

BTW: 3.4.3 and 3.4.4 KRC are identical; latter has more documentation

Version 34x New geophysics

Closer to reality: see V34 Users guide

May have a condensing gas other than CO_2.

Molecular weight, Saturation pressure relation

May invoke some Surface Photometric Models when there is no atmosphere.

Lambertian, Minnaert, Lommel-Seeliger, Keihm *Beware, some can yield A>1 at large i, but KRC limits it.*

May specify geothermal heat flow at the bottom.

May specify zone Tables of material properties versus depth.

For each zone: Conductivity, density, specific heat, thickness

Two zones may have temperature-dependent properties

Far-field seen by slopes may be temperatures from prior run. Large effect with low sun

Much closer to reality than prior "self-heating"; opens up many possibilities.

E.g., dune fields: run A=lee-face =33 deg east facing slope,

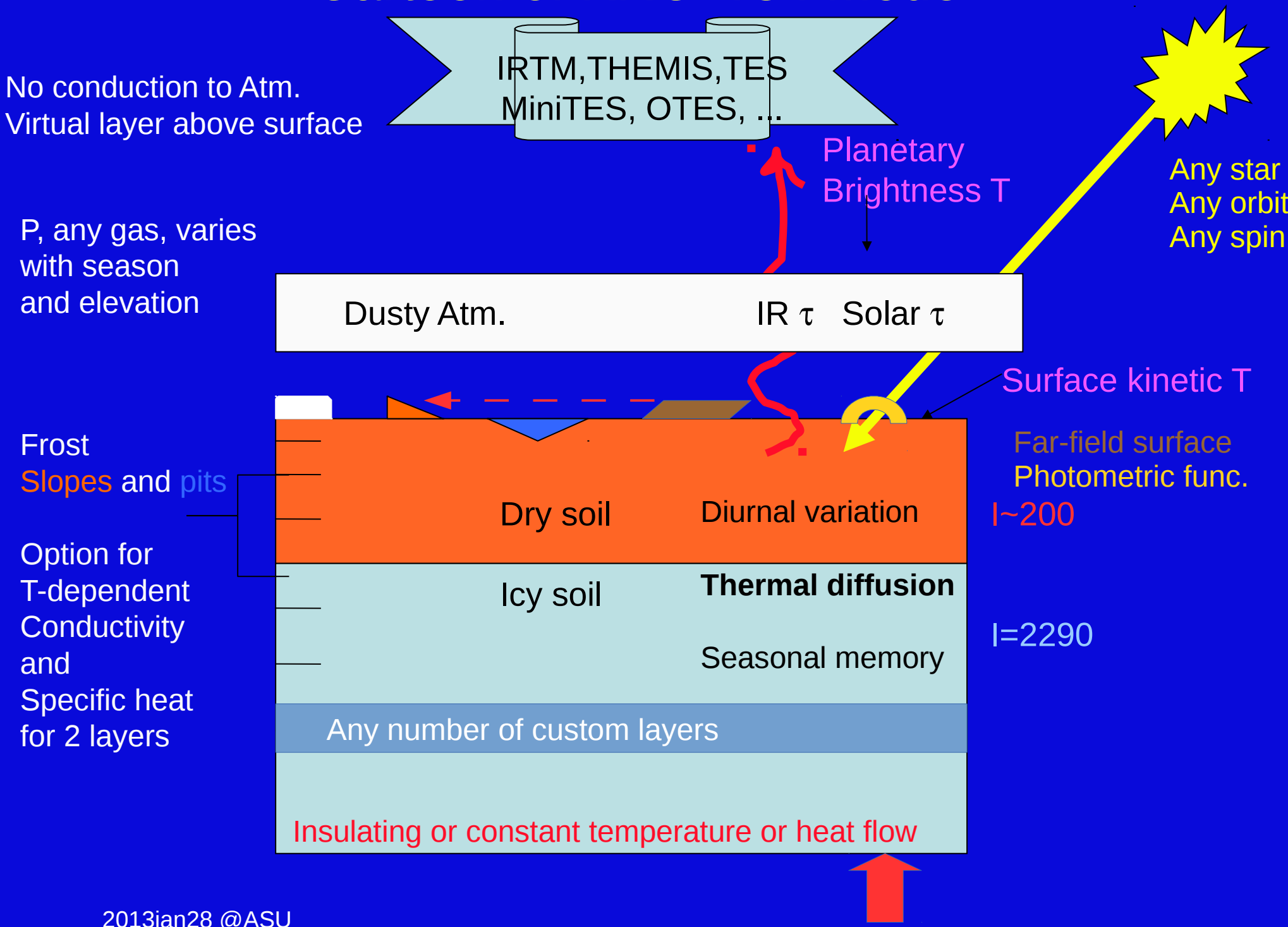
then B=windward side= west facing 15 deg slope with A as the far-field-file.

Or even with off-line step to create far-field-file as mix of lee-slopes and inter-dune flats.

Can do really thin layers! For I=50., minimum top soil layer of 32 micrometers. (But slow)

Test runs indicate differences less than about 0.1K away from frost edge; 1.5 if T-dep; 0 if no atm.

Cartoon of KRC v34 model



Other changes

Automatic file extension with keyboard: .inp and same.prt

Slope azimuth sign corrected

Default master file values: Closer to Mars atm.
Improve the numerical accuracy at a modest cost in speed
Ran out of input parameters (~110), a few have multiple meanings!

Can handle up to 3 binary temperature files at once: designation has changed
8 5 x '<file>' / Initiate Type 52 multi-case output file
Recommended file extension is .t52
8 21 x '<file>' / Direct-access output file, only the current case
value of K4OUT -1 to -3 sets how many of Tsurf, Tplanet, Tatm written
Recommended file extensions are .tm1 to .tm3 (type minus)
8 3 x '<file>' / Far-field input file. Persists until 'off'
if x=1, prints each time a season requested
Auto-detects how many of Ts, Tp, Ta present
If needs Tatm, and it is not there, will fault and go on to next case.

Using KRC

There are several apparent interfaces **(real interface is the ASCII input file):**
1) Website a: simple i) one day ii) one hour for a year
b: Single point: List of specific time, places and conditions
c: File mode: edit an input file; run on ASU cluster, import resulting file.
2) Davinci: Interface to construct an input file. Christopher or Sylvain.
3) Local: Build KRC at your site (done if at ASU); edit input file
Intimidating: but can model any spinning solid body in the universe larger than a grapefruit
(with only one star, and no eclipses [yet], and not to much hot air)

Start with a master file,
run it changing only the output file location to get familiar with the process
Then edit to your goals.
If problems, can ask Kenny or some other user,

Send an email with description of problem. Always include the input file and the print file.
Helpful to trap what appeared on to the screen.

90% of problems are simple errors (mis-understanding) in the input file.

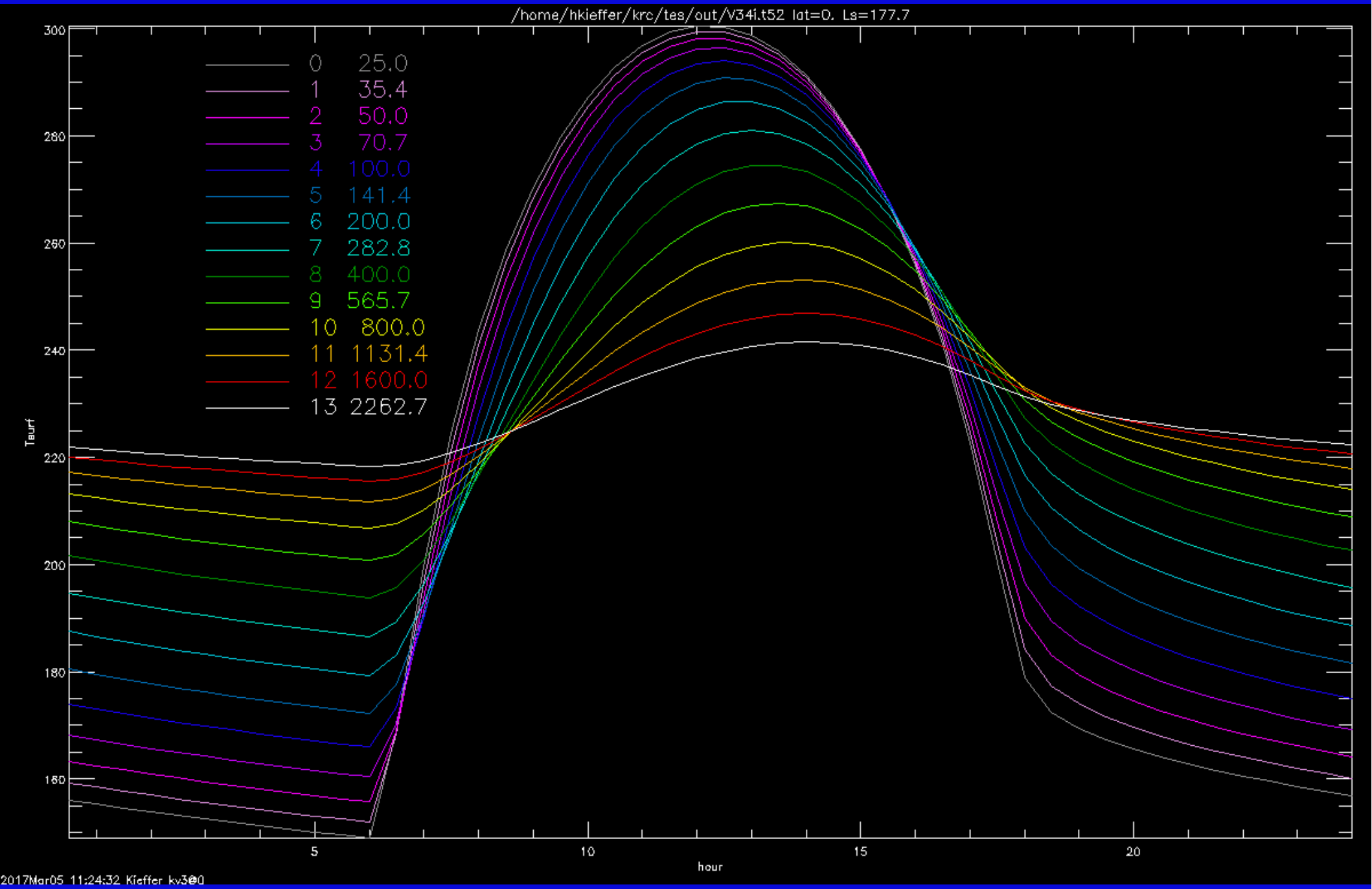
Typical input file, first part: real and integer

```
0 0 / KOLD: season to start with;  KEEP: continue saving data in same disk file
Version 33 default values.  19 latitudes with mean Mars zonal elevations
    ALBEDO      EMISS    INERTIA      COND2      DENS2     PERIOD SPEC_HEAT    DENSITY < titles
       .25       1.00      200.0       2.77      928.0     1.0275      647.      1600. < values
      CABR        AMW     SatPrA     PTOTAL      FANON       TATM     TDEEP    SpHeat2
      0.11       43.5    27.9546      546.0       .055      200.     180.0     1711.
  TAUD/PHT      DUSTA     TAURAT      TWILI  ARC2/Pho ARC3=Safe     SLOPE     SLOAZI
       0.3        .90       0.25        0.0       0.5     0.801       0.0       90.
    TFROST     CFROST     AFROST      FEMIS       AF1       AF2    FROEXT     SatPrB
     146.0    589944.        .65       0.95      0.54    0.0009       50.   3182.48
      RLAY       FLAY       CONVF      DEPTH     DRSET       DDT       GGT      DTMAX
    1.1500       .100         3.0        0.0       0.0     .0020       0.1        0.1
      DJUL     DELJUL   SOLARDEC        DAU      LsubS    SOLCON      GRAV      AtmCp
  -1222.69  17.174822       00.0      1.465         .0     1368.     3.727      735.9
    ConUp0     ConUp1     ConUp2     ConUp3     ConLo0     ConLo1     ConLo2     ConLo3 \
  0.038640  -0.002145   0.002347  -0.000750   2.766722  -1.298966   0.629224  -0.527291 | T-Dep
    SphUp0     SphUp1     SphUp2     SphUp3     SphLo0     SphLo1     SphLo2     SphLo3 | Coeffs
  646.6275   246.6678   -49.8216     7.9520  1710.648   721.8740   57.44873   24.37532 /
        N1         N2         N3         N4         N5        N24        IIB        IC2
        38       1536         15         19        120         48          0          7
     NRSET       NMHA       NRUN      JDISK     IDOWN     FlxP14 TUN/Flx15      KPREF
         3         24          0         81         0         45         65          1
     K4OUT      JBARE      Notif     IDISK2                                       end
        52          0         50          0                                       0
```

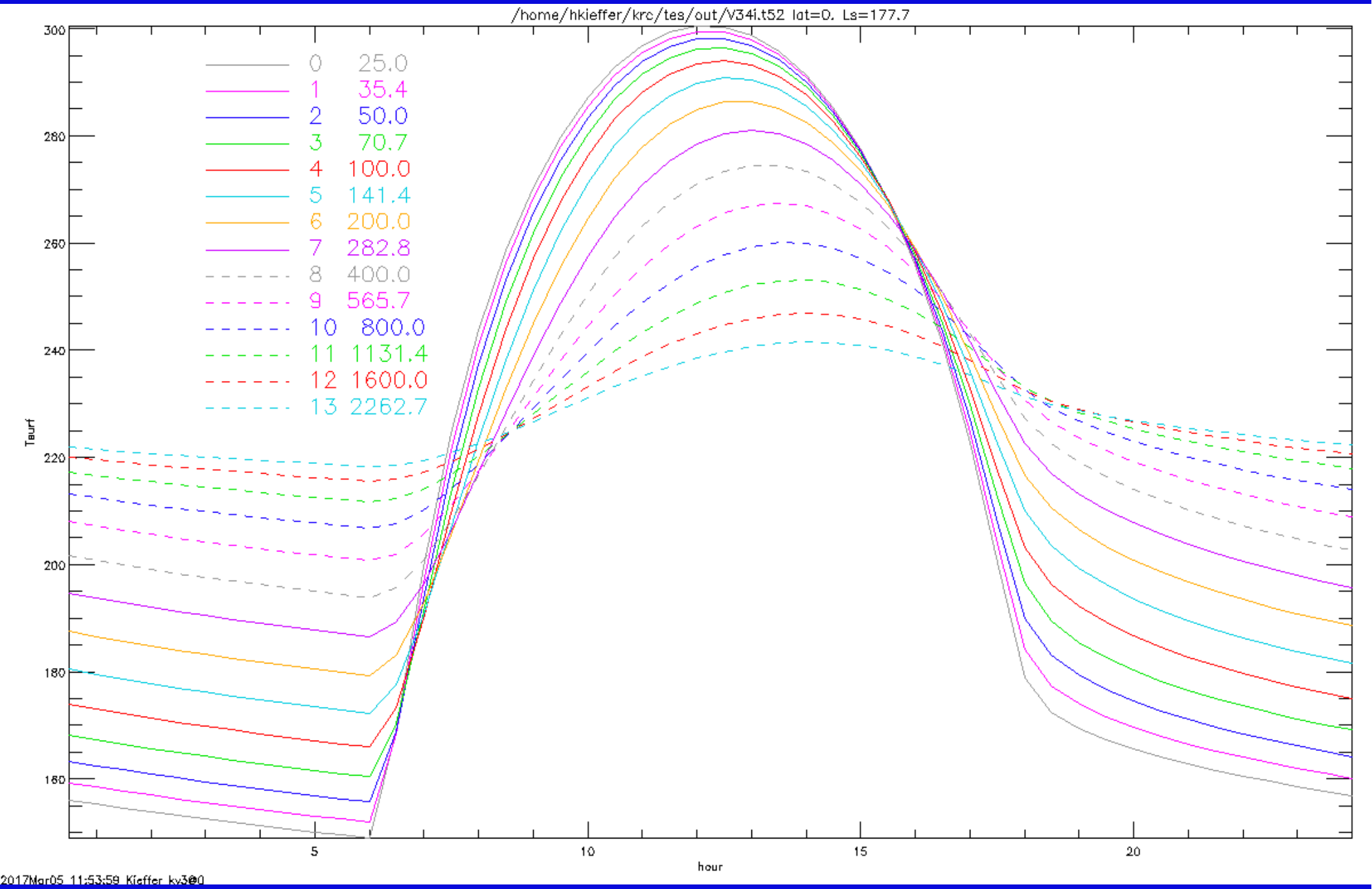
Input file, lower part: Logical, latitudes, “magic matrix”, change lines

```
    LP1     LP2     LP3     LP4     LP5     LP6 LPGLOB    LVFA    LVFT  LkofT
      F       T       F       F       F       F      F       F       F      F
  LPORB    LKEY     LSC   LZONE   LOCAL   Prt76 LPTAVE   Prt78   Prt79  L_ONE
      T       F       F       F       T       F      F       F       F      F
Latitudes: in 10F7.2  _____7 _____7 _____7 _____7 _____7 _____7 _____7
 -87.50 -80.00 -70.00 -60.00 -50.00 -40.00 -30.00 -20.00 -10.00   0.00  Line for each 10
  10.00  20.00  30.00  40.00  50.00  60.00  70.00  80.00  87.50  -0.00
 _____7 _____7 _____7 Elevations: in 10F7.2 ____7 _____7 _____7 _____7
   3.51   2.01   1.39   1.22   0.38   0.48   1.17   1.67   1.26   0.17  match the lats.
  -0.94  -1.28  -1.99  -2.51  -3.52  -4.08  -4.51  -4.38  -2.57  -0.00
 2013 Jul 24 11:28:09=RUNTIME.  IPLAN AND TC= 104.0 0.10000 Mars:Mars     \ <- what it is
   104.0000      0.1000000      0.8644665     0.3226901E-01  -1.281586   | Cut and paste
  0.9340198E-01   1.523712      0.4090926      0.000000      0.9229373   | geometry
   5.544402      0.000000       0.000000      686.9929       3397.977   | matrix from
   24.62296      0.000000      -1.240317      0.000000       0.000000   | PORB run
   0.000000      0.3244965      0.8559126     0.4026359     -0.9458869   |
  0.2936298      0.1381285      0.000000     -0.4256703      0.9048783   /
8 5 0 'trial34.t52' / Disk file name for Run 1
0/
2 8 999 'IC2' / homogenous   will be case 2
0/
2 8 777 'IC2' / Turn 2-material off. Affects only the values in krccom.
8 25 -7 '/home/hkieffer/krc/zoneX.tab' / Zone table
0/
0/  ====================== end of run
```

Nominal Mars: √2 Inertia set. Lat.=0, Ls=178



Nominal Mars: √2 Inertia set. Lat.=0, Ls=178



Type 52 output file: (learn to love it) [hours,7,latitudes,x+seasons,cases]

First x seasons contain, for each case:

Float of 4 integers that define sizes

Floating point of all input parameters: krccom

Array(nseas,5): DJU5=date, SUBS=Ls(Mars), PZREF=Surface pressure at 0 elevation,
TAUD=dust opacity, SUMF=total polar frost

For true seasons, the 7 contain:

1: TSF, surface kinetic temperature

2: TPF, planetary bolometric temperature

3: TAF. Atmosphere kinetic temperature

4: DOWNVIS: Downward solar flux at the surface

5: DOWNIR: Downward thermal flux from the atmosphere at surface

6 and 7 are packed into Hours: Nlay- means as many physical layers from top as fit.

6: NDJ4=# of convergence days, DTM4=rms temperature change on last day,
TTA4=predicted final atm. Temp., TIN(Nlay-) = minimum diurnal temperature

7: FROST4=predicted frost, AFRO4=frost albedo, HEATMM=daily average surface heat flow,
TAX(Nlay-) = maximum diurnal temperature of each layer

Type 52 use

Type 52 has large capability. Run with one case and look for :
RASE,MASE,MTOT= 37.29 37 9920736
MASE is number of cases that fit in a single run.

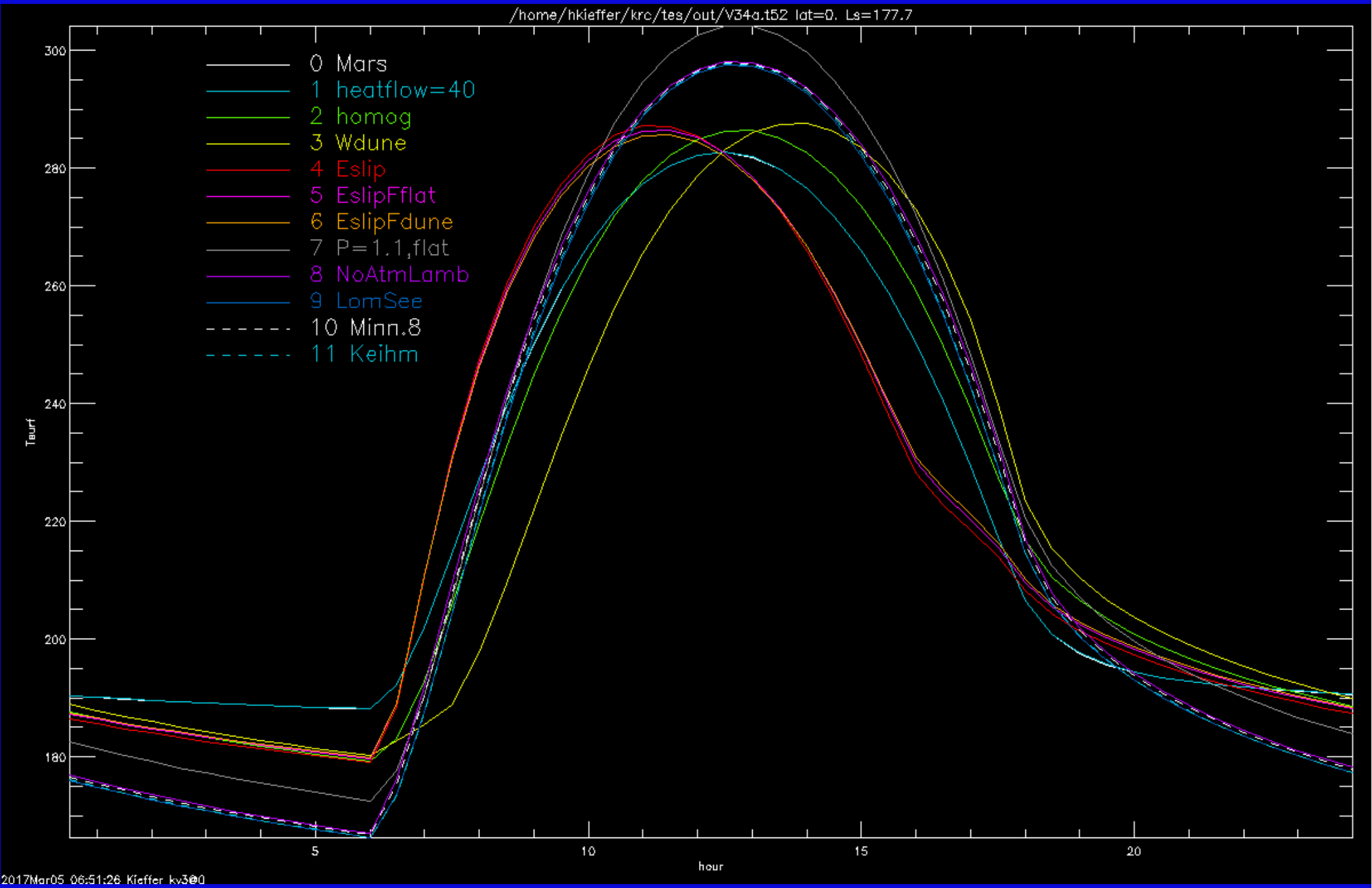
Restrictions on multiple cases in one Type 52 file:
Input items that would change any of the bin5 dimensions are not allowed to increase between cases; i.e., N24 = hours output, N4 = Number of latitudes and N5-JDISK = number of seasons output.

Dimensions are liberal, defined in krccm8.f , listed in Helplist section 7.2

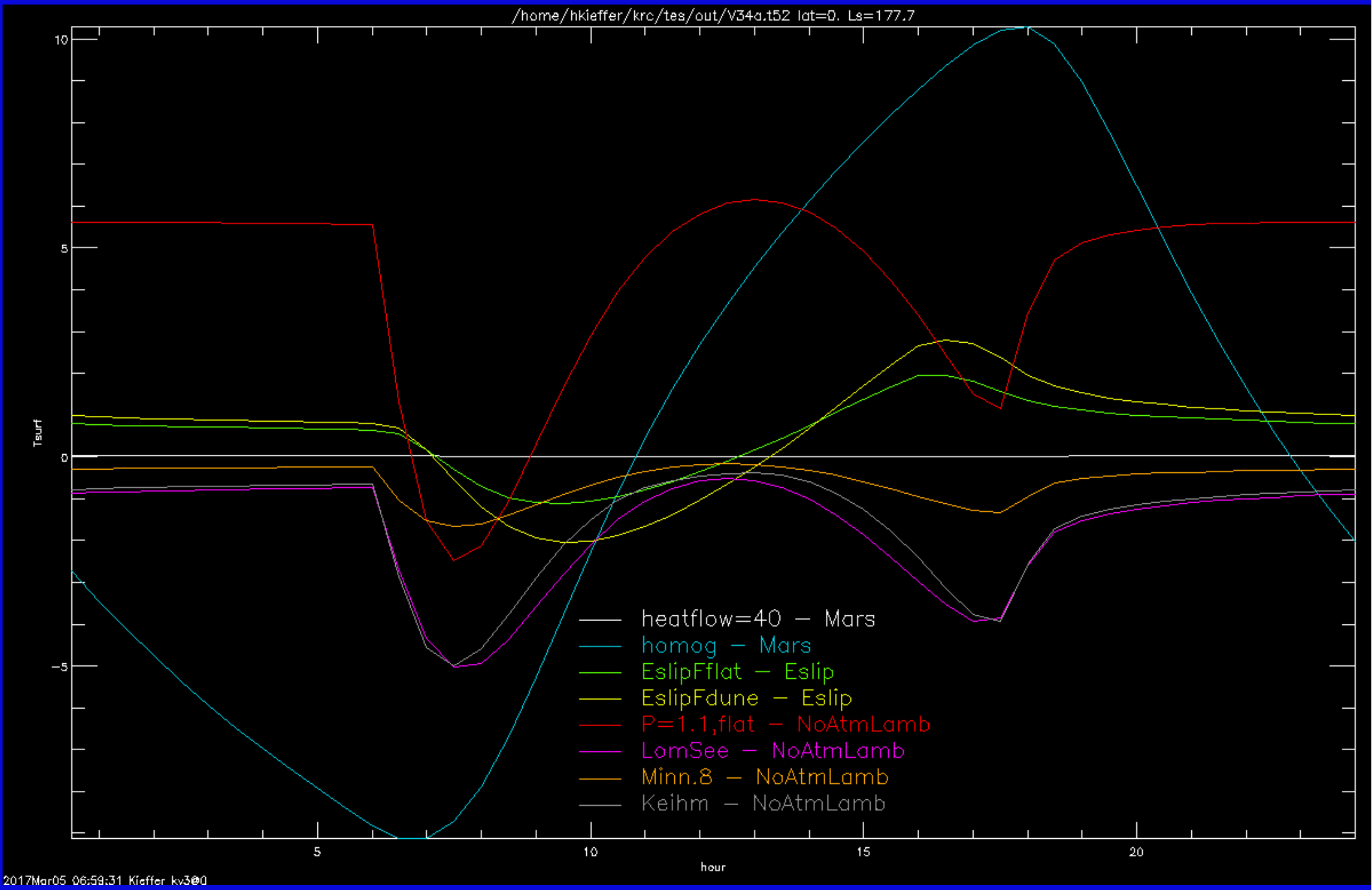
Type 52 is a “bin5” file: simple format ASCII header that lists sizes

Readers exist in IDL, C++ [?], Davinci
If you prefer another language; write a reader in it and share!

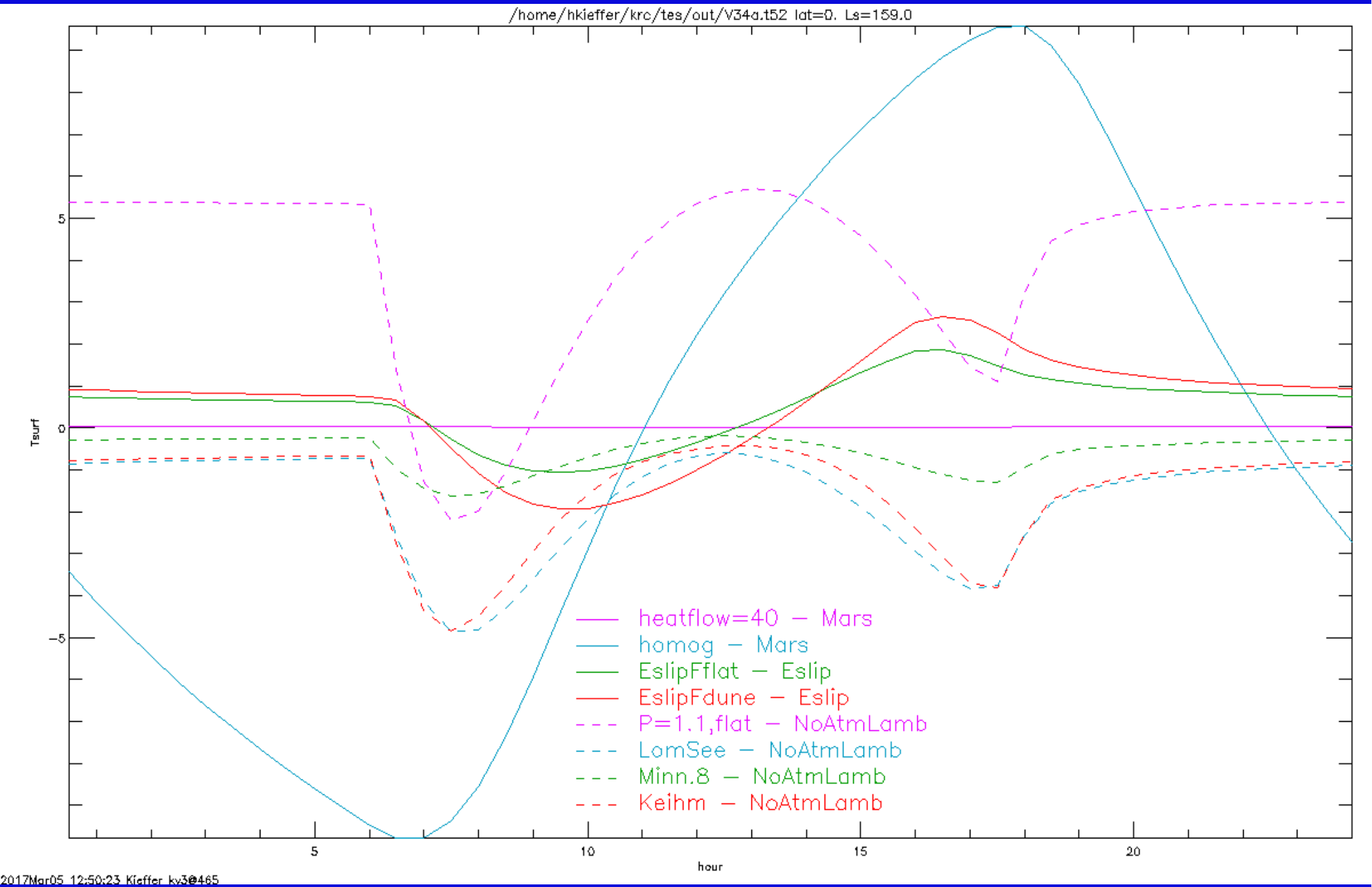
V34 features : Lat. 0, Ls 178



V34: delta Tsurf between models



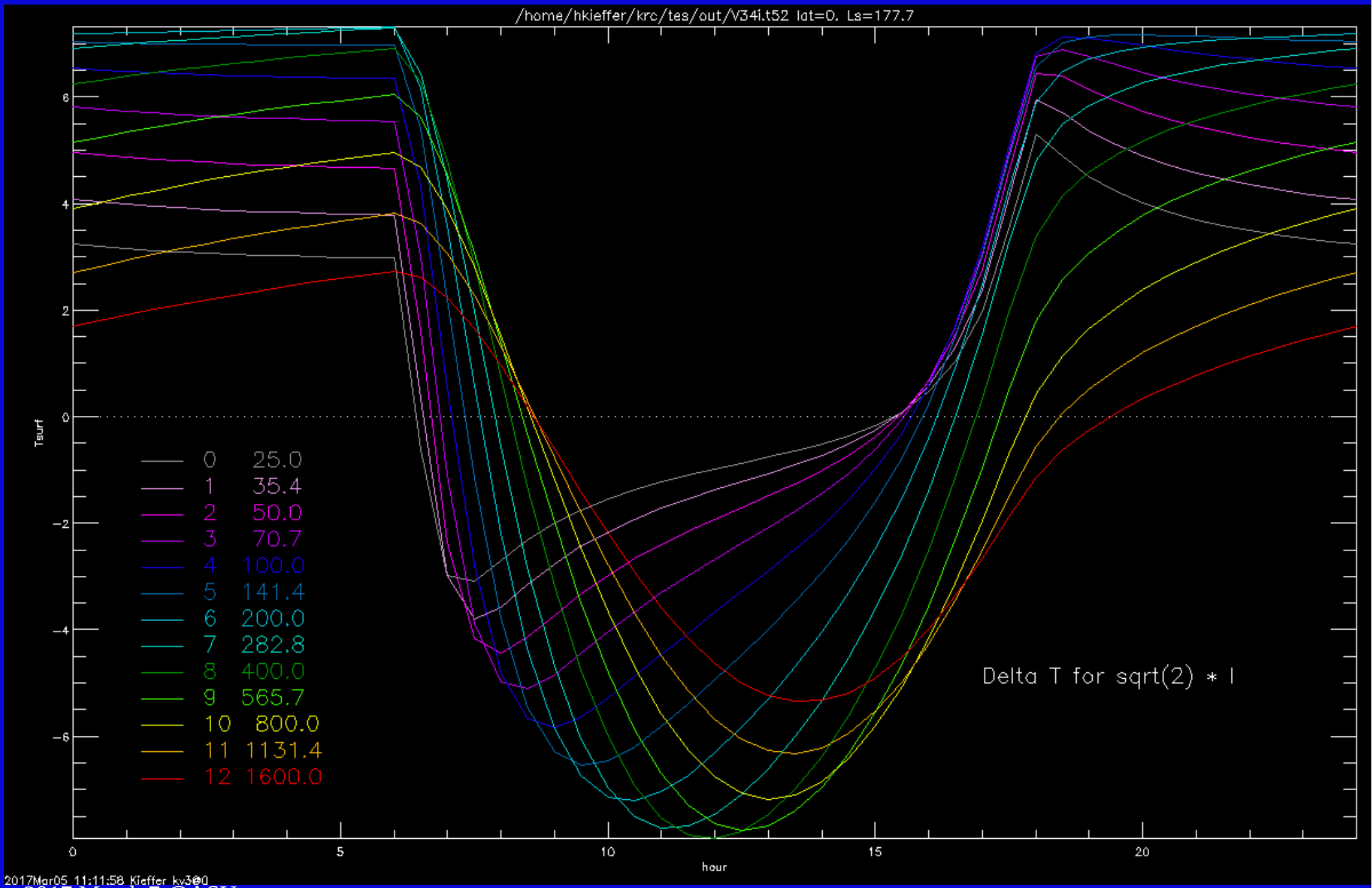
V34: delta Tsurf between models



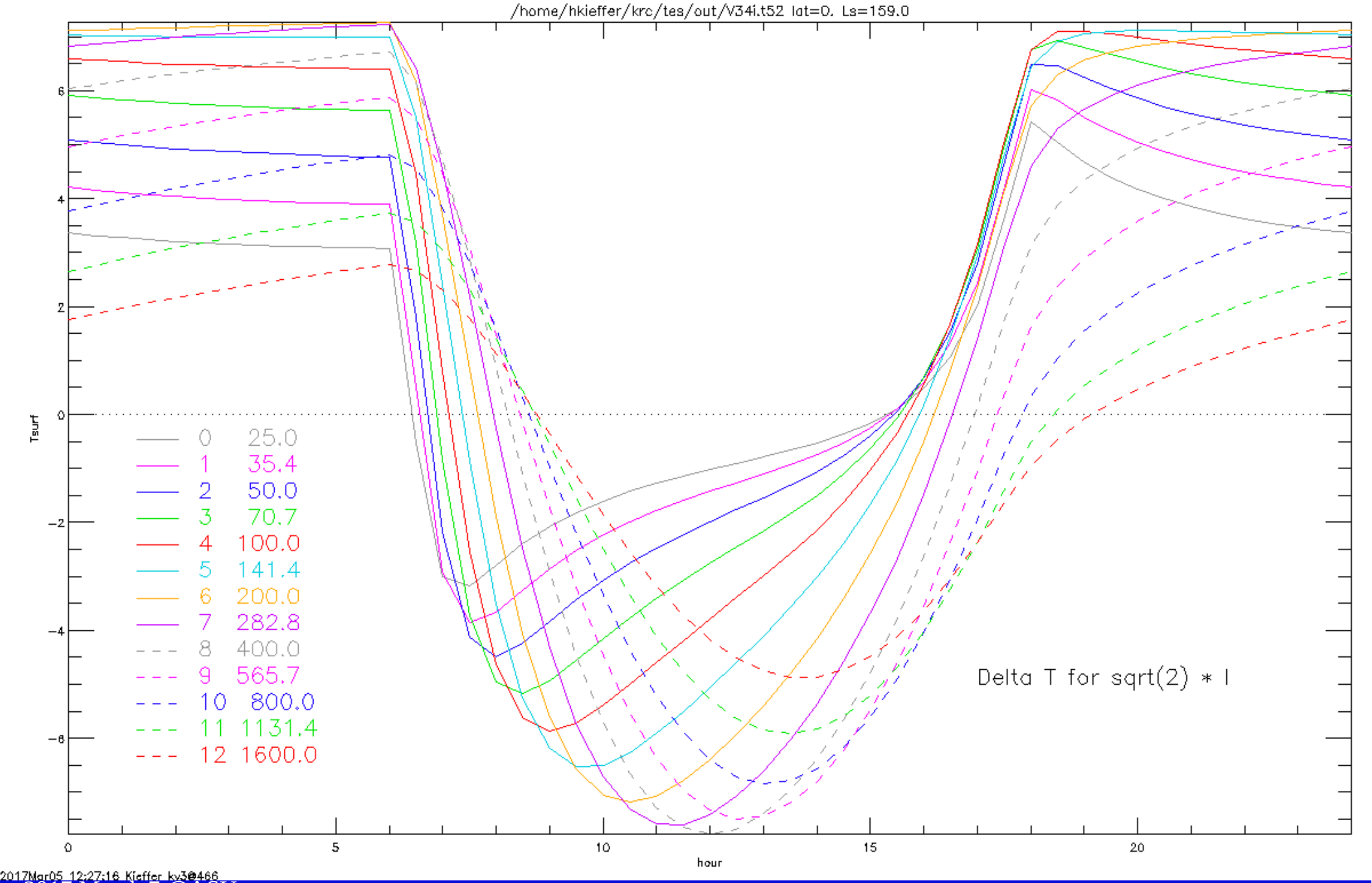
Reading packed bin5 files

```
;finame in.  String of file name
; ttt   out.    Fltarr(hour,item,latitude,season,case)   Item labels are in itemt
;                    0= surface kinetic temperature
;                    1= Top-of-atmosphere bolometric temperature
;                    2= one-layer atmosphere kinetic temperature
;                    3= Down-welling solar radiance
;                   4= Down-welling thermal radiance
; uuu   out.    Fltarr(nlat,item,case)           Item labels are in itemu
;                    0= Latitude in degrees
;                    1= elevation in Km.
; vvv   out.    Fltarr(season,item,case) I    Item labels are in itemv
;                    0= Model season julian date relative to  J2000.0 = 2000 Jan 1 noon
;                    1= L-sub-S computed in KRC
;                    2= Global mean pressure: PZREF
; itemt,u,v  out.   Strarr ID's for the items in ttt, uuu, and vvv
;
; ddd   out.    Fltarr(layer,item,latitude,season,case) Item labels are in itemd
;                    Item:  0=Tmin    1=Tmax
; ggg   out.    Fltarr(item,latitude,season,case) Item labels are in itemg
;              Items: NDJ4, DTM4, TTA4, FROST4, AFRO4, HEATMM
; itemd,g out.  Strarr ID's for the items in ddd, and ggg
;
; func. out.    Fltarr of L-sub-S corresponding to Jul.Day for the first case.
;                    If an error, returns negative integer
;                    -1: -4 are from READKRCCOM, -5 = failure here
```

dT/dI/√2 for nominal Mars. Lat.=0, Ls=178



dT/dI/√2 for nominal Mars. Lat.=0, Ls=178



If an error occurs:

Compare your input file to the master.

- Unix: use diff

Check the helplist definition for each item that was modified

If you can not get it to run properly, then ...

Send three files to the mentor: describe your goal.

- Input file
- What appeared on the screen
- Print file

Going forward

KRC is probably not faultless. Always check that the results make physical sense.

Minnaert and Lommel-Seeliger photometric functions have bug prior to v3.4.5

Documentation by coder is never a good idea! The digital truth is in the source code.

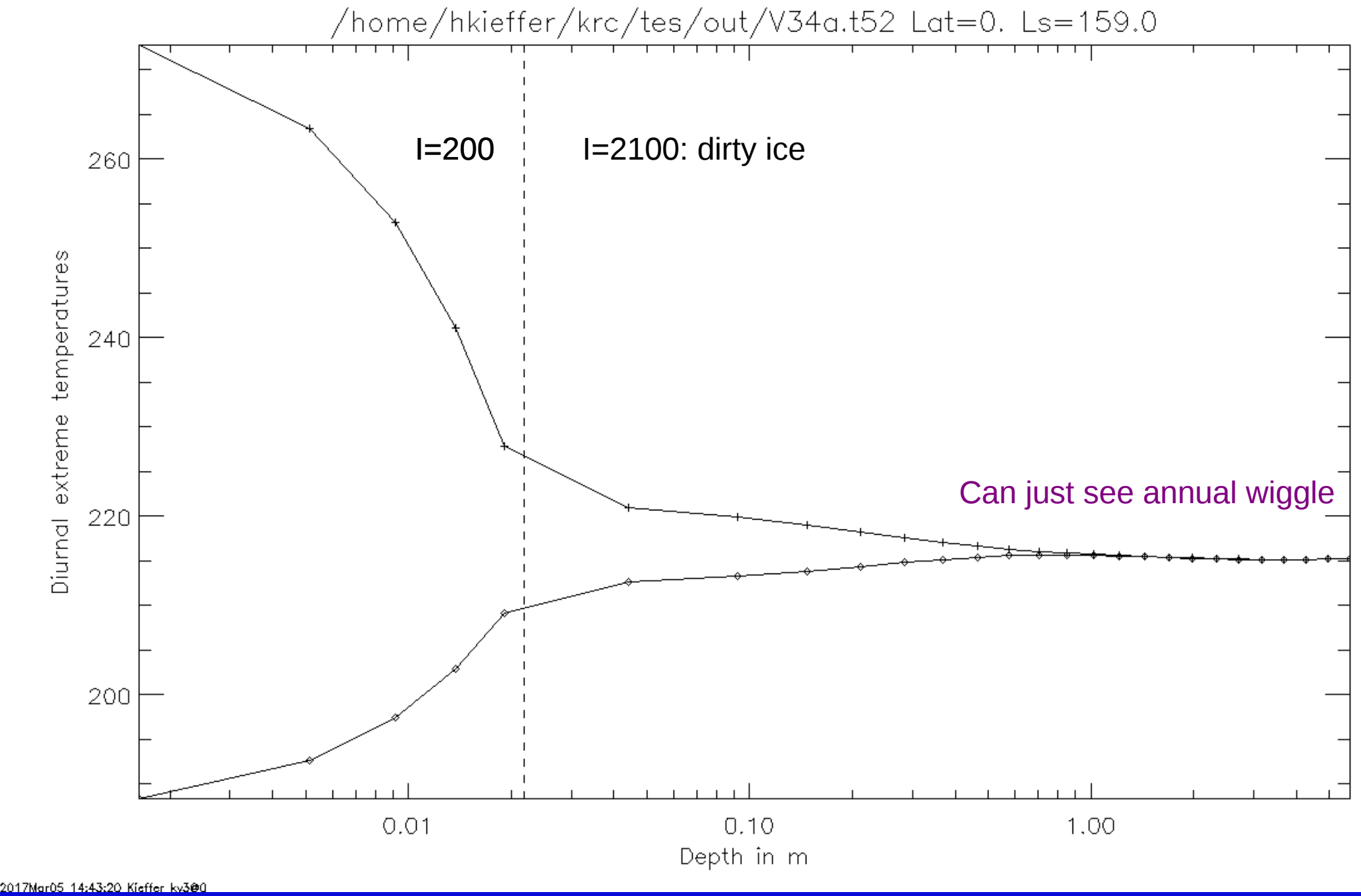
Odd shapes. If not concave, simply consider latitude and Hour of the local surface.

Rough surfaces and thermal beaming are in development as a post-process

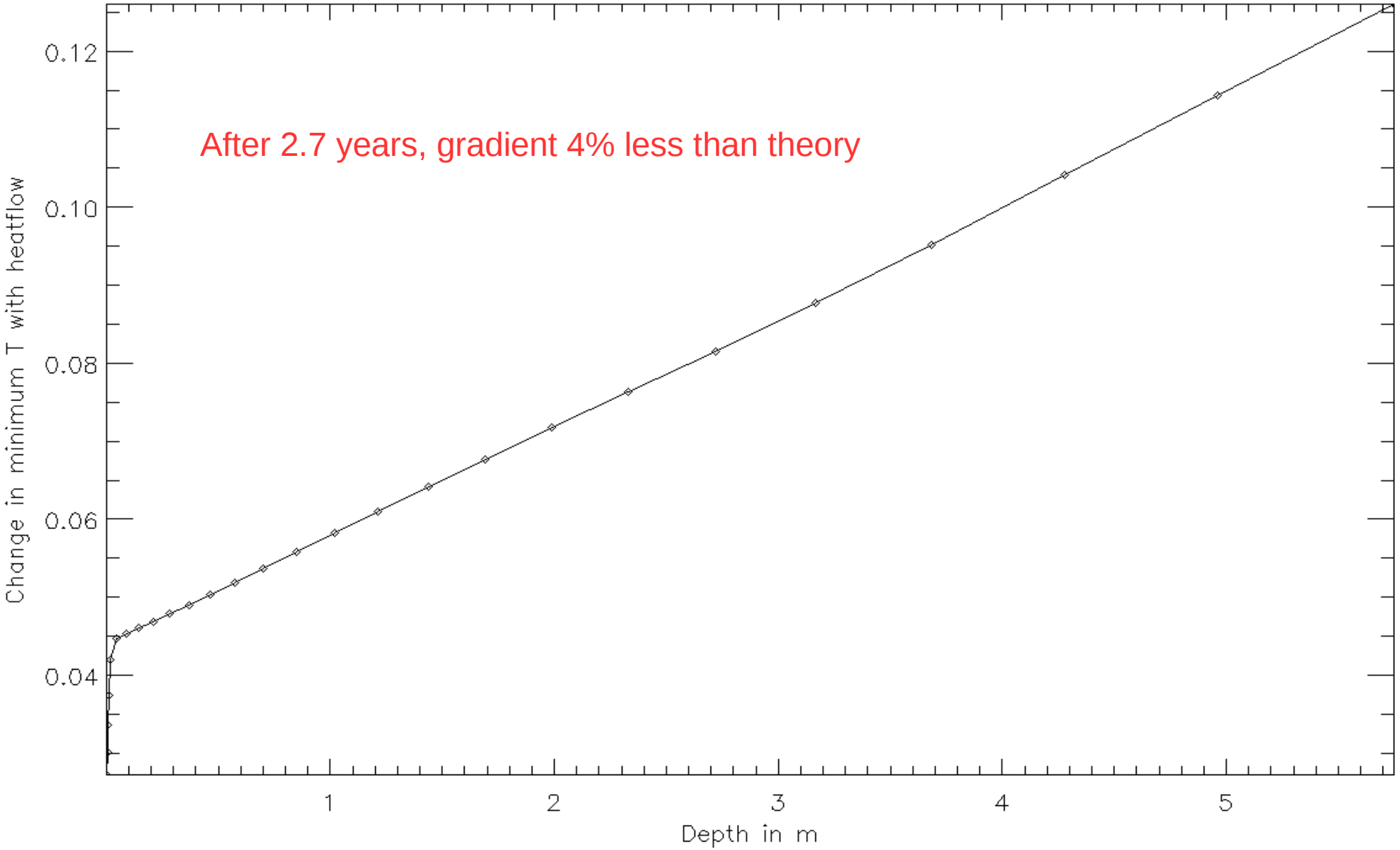
Wishlist: Eclipses and slow rotation. Big change as longitudes will be different,
Will need to add a seventh loop.

You can request new capabilities:

Diurnal Min/Max T after 2.5 years

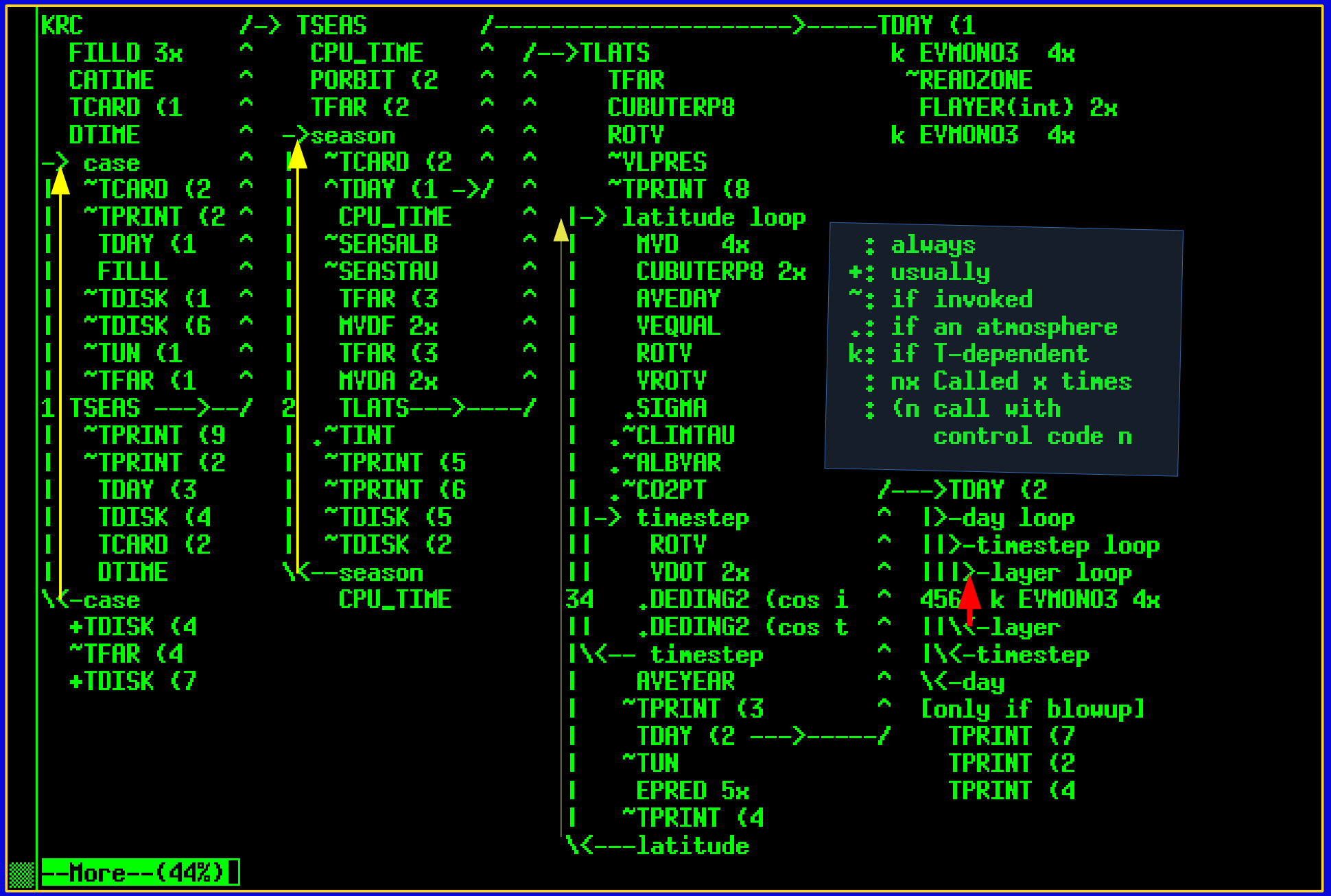


Effect of 40 mW/m2 geothermal heatflow



Crude call diagram

From: flow.txt



empty