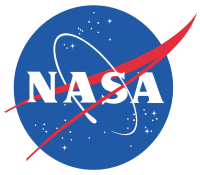

Kepler Data Release 18 Notes

Q13

KSCI-19058-001
Data Analysis Working Group (DAWG)
Susan E. Thompson (Editor)

Prepared by: Susan E. Thompson Date: Oct 23, 2012
Susan E. Thompson, Kepler Science Office, for the DAWG (page 4)

Approved by: _____ Date: Oct 23 2012
Jessie L. Christiansen, Editor-in-Chief

Approved by: _____ Date: 10/23/2012
Jon Jenkins, Co-I for Data Analysis & DAWG Lead

Approved by: _____ Date: 10/23/12
Michael R. Haas, Kepler Science Office Director

Document Control

Ownership
This document is part of the Kepler Project Documentation that is controlled by the Kepler Project Office, NASA/Ames Research Center, Moffett Field, California.

Control Level
This document will be controlled under KPO @ Ames Configuration Management system. Changes to this document **shall** be controlled.

Physical Location
The physical location of this document will be in the KPO @ Ames Data Center.

Distribution Requests
To be place on the distribution list for additional revisions of this document, please address your request to the Kepler Science Office:

Michael R. Haas
Kepler Science Office Director
MS 244-30
NASA Ames Research Center
Moffett Field, CA 94035-1000
Michael.R.Haas@nasa.gov

The Data Characteristics Handbook and accompanying Data Release Notes are the collective effort of the Data Analysis Working Group (DAWG), composed of Science Office (SO), Science Opertions Center (SOC), and Guest Observer (GO) Office members as listed below:

Jon Jenkins*, Chair
Doug Caldwell*, Co-Chair
Barclay, Thomas
Bryson, Stephen T.
Burke, Christopher J.
Christiansen, Jessie L.
Clarke, Bruce D.
Girouard, Forrest
Haas, Michael R.
Hall, Jennifer
Ibrahim, Khadeejah
Klaus, Todd
Kolodziejczak, Jeffery (MSFC)
Li, Jie
McCauliff, Sean D.
Morris, Rob
Mullally, Fergal
Quintana, Elisa V.
Rowe, Jason
Sabale, Anima
Seader, Shawn
Smith, Jeffrey Claiborne
Still, Martin
Tenenbaum, Peter G.
Thompson, Susan E.
Twicken, Joe
Uddin, Akm Kamal

The correct citation for this document is: S. E. Thompson, J. L. Christiansen, J. M. Jenkins, D. A. Caldwell, T. Barclay, S. T. Bryson, C. J. Burke, B. D. Clarke, F. Girouard, M. R. Haas, J. R. Hall, K. Ibrahim, T. C. Klaus, J. J. Kolodziejczak, J. Li, S. D. McCauliff, R. Morris, F. Mullally, E. V. Quintana, J. Rowe, S. Seader, J. C. Smith, M. D. Still, P. G. Tenenbaum, J. D. Twicken, and A. K. Uddin, 2012, Kepler Data Release 18 Notes (KSCI-19058-001).

Contents

1 Introduction

These Data Release Notes provide information specific to the release of Q13 data, processed with SOC Pipeline 8.2. These Notes contain the summary figures and tables for this quarter. The Kepler Data Characteristics Handbook (Christiansen et al., 2012) discusses most of the known phenomena found in the Kepler data in more detail.

1.1 Dates and Cadence Numbers for Q13

Contents of Data Release 18–Cadence Data

Q.m		First Cadence MJD midTime	Last Cadence MJD midTime	First Cadence UT midTime	Last Cadence UT midTime	Num CINs	Start CIN	End CIN
13	LC	56015.2379	56105.5544	29-Mar-2012 05:42:32	27-Jun-2012 13:18:20	4421	52551	56971
13.1	SCM1	56015.2280	56047.4920	29-Mar-2012 05:28:18	30-Apr-2012 11:48:26	47370	1564990	1612359
13.2	SCM2	56048.1874	56077.4272	01-May-2012 04:29:51	30-May-2012 10:15:10	42930	1613380	1656309
13.3	SCM3	56078.3270	56105.5643	31-May-2012 07:50:50	27-Jun-2012 13:32:34	39990	1657630	1697619

Contents of Data Release 18–Full Frame Images

Q	Class	Filename	UT Start	UT End
Q13	FFI	KPLR2012121122500	2012-04-30 11:55:30	2012-04-30 12:25:00
Q13	FFI	KPLR2012151105138	2012-05-30 10:22:12	2012-05-30 10:51:38
Q13	FFI	KPLR2012179140901	2012-06-27 13:39:35	2012-06-27 14:09:01

1.2 The SOC Pipeline for Q13

Data Release 18 was processed with the SOC Pipeline 8.2. For details on how Kepler processes the data through the front-end of the pipeline (modules CAL, PA, PDC), please see the Data Processing Handbook (Fanelli et al., 2011). Notable changes and improvements to this version of the pipeline include the following:

- The Presearch Data Conditioning (PDC) module, which calculates the PDCSAP_FLUX time series, has been improved for short cadence data. The PDC-MAP algorithm (Smith et al., 2012; Stumpe et al., 2012), which has been used to process the LC data, has now also been applied to each month of SC. For more information on how this affects short cadence data see §3.1.

1.3 Kepler Mission Timeline to Date

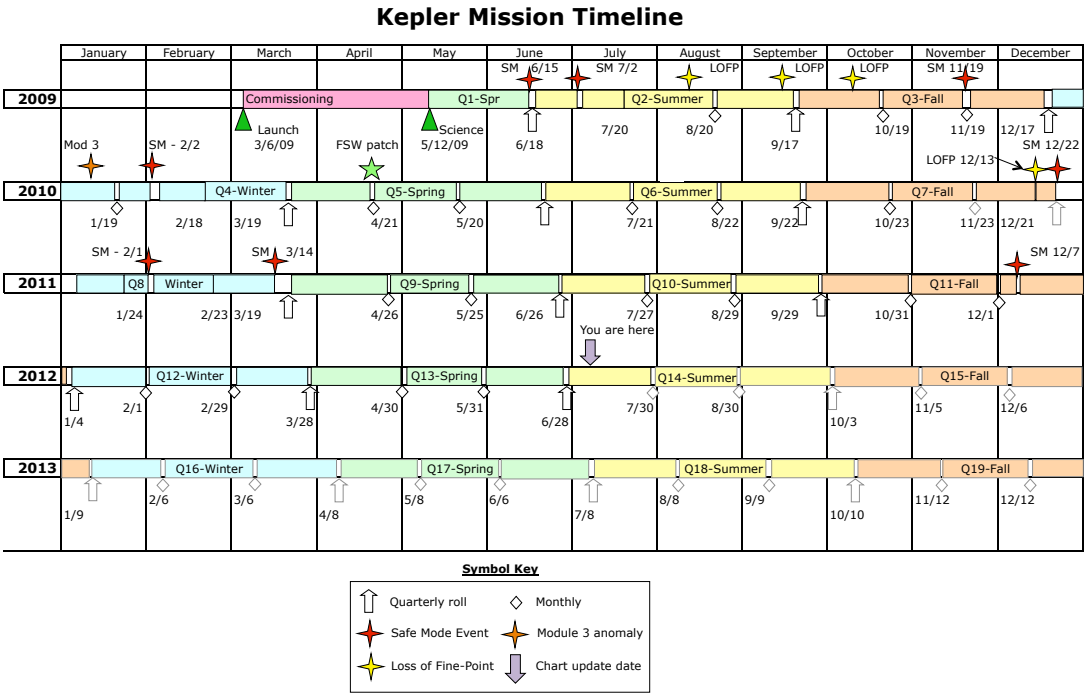

Figure 1: Kepler Mission Timeline as of the end of Q13. All future dates are tentative and subject to change.

2 Data Quality in Q13

2.1 Evaluation of CDPP

To understand the overall performance of the pipeline, we show the Temporal Median (TM) of the CDPP time series as calculated by the TPS pipeline for different versions of the SOC pipeline (Figure 2). We also provide the CDPP statistics for Q13 binned by magnitude in Table 1. In Q13 there was a slight decrease in TMCDPP that breaks the slight upward trend seen the past few quarters.

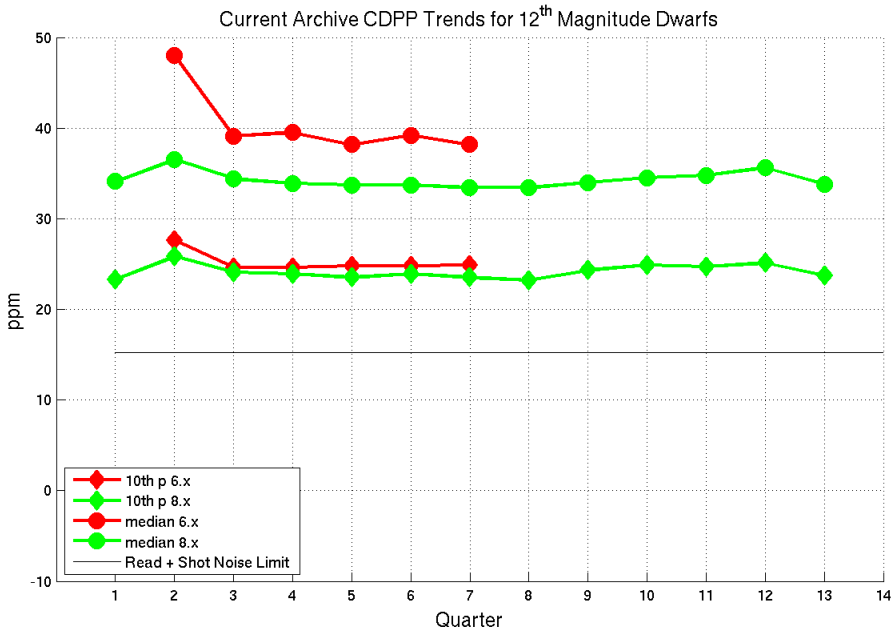

Figure 2: 6.5-h Temporal Median of the CDPP time series. The median (circles) and 10th percentile value (diamonds) for all dwarf stars between Kp=11.75–12.25 are given. The 6-h TMCDPPs have been divided by sqrt(13/12) = 1.041 to approximate 6.5-h TMCDPPs. A detailed discussion of the CDPP values is given in the Kepler Data Characteristics Handbook. The 6.x and 8.x labels given in the legend refer to the version of the SOC pipeline used.

Table 1: Aggregate statistics for the TMCDPPs by magnitude. Column Definitions: (1) Kepler Magnitude at the center of the bin. Bins are ± 0.25 mag, for a bin of width 0.5 mag centered on this value. (2) Number of dwarfs (log g > 4) in the bin. (3) 10th percentile TMCDPP for dwarfs in the bin. (4) Median TMCDPP for dwarfs in the bin. (5) Number of all stars in the bin. (6) 10th percentile TMCDPP of all observed stars in the bin. (7) Median TMCDPP for all stars in the bin. (8) Simplified noise model CDPP.

Kp mag	No. dwarfs	10th prctile	Median	No. stars	10th prctile	Median	Noise model
9.0	52	10.7	22.4	185	10.3	48.4	3.8
10.0	161	12.4	30.2	592	13.1	58.5	6.0
11.0	636	17.2	28.3	1777	19.0	65.1	9.5
12.0	2229	23.7	33.8	4262	24.8	51.7	15.2
13.0	7009	34.9	45.1	10020	35.9	51.5	24.4
14.0	14354	54.4	68.4	16559	55.0	70.2	40.1
15.0	28757	96.7	122.4	28761	96.7	122.4	68.8
16.0	15020	175.6	217.8	15020	175.6	217.8	127.8

2.2 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in Figure 3. The meaning of the flags are explained in the Data Characteristics Handbook (Christiansen et al., 2012) and Archive Manual (Thompson & Fraquelli, 2012).

There were no notable data anomalies during Q13. The lack of zero crossing events during Q13 were a result of a software change that prevents the reaction wheel velocity from crossing zero.

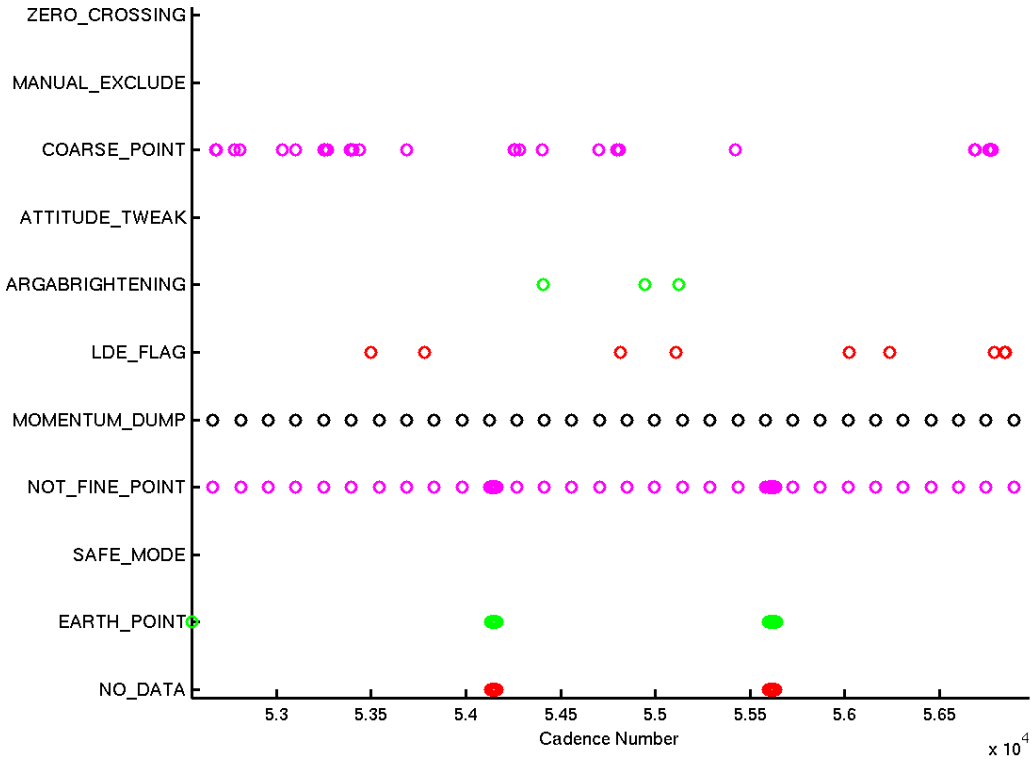

Figure 3: An overview of the location of the data anomalies flagged in Q13. "No_Data " is not an anomaly flag and simply indicates those cadences with no data collected (e.g. during Earth-point or Safe Mode events).

Clarifications on select flags in Figure 3 are listed here:

- ARGABRIGHTENING refers to cadences where the multiple-channel Argabrightening flag (flag 0x07, decimal value 64) was set. The single channel Argabrightening flag (0x0D, decimal value 4096) is not represented on this plot.
- COARSE_POINT refers to cadences where the pointing of the telescope drifted by more than 0.5 millipixels from the nominal value. NOT_FINE_POINT refers to cadences where the telescope's fine guidance sensor reported that the telescope was not in fine point mode. These flags are combined as flag 0x03 (decimal value 4) in the FITS files.
- LDE_FLAG refers to flags set by the Spacecraft when a error was detected in the Local Detector Electronics (LDE) or the on-board memory. The pipeline does not process these cadences and only raw pixels are available.

3 Notable Features of the Q13 Data

In this section we discuss features of the data that occurred during collection or processing that are either new to Q13, significantly different than previous quarters, or not discussed in the Data Characteristics Handbook (Christiansen et al., 2012). A more complete listing of events that are known to affect the data are discussed in the Data Characteristics Handbook.

3.1 New Treatment of PDC Short Cadence Data

Q13 is the first quarter for which the PDC module uses the PDC-MAP (Presearch Data Conditioning *Maximum A Posteriori*) algorithm to correct the SC data (Smith et al., 2012; Stumpe et al., 2012). PDC-MAP is designed to remove systematic trends from the data while preserving intrinsic signal. Overall the application of PDC-MAP to SC has greatly improved the SC PDC time series. However, since PDC is applied to SC on a per-month basis instead of per-quarter (as is done for LC), the user should note new features of the SC PDC time series.

Different Mean Flux Levels: PDC attempts to preserve the median flux of a data set. Most Kepler targets have long term systematic trends. As a result, the median flux in any month is likely different than the median flux for the quarter. This can cause a step function in the short cadence PDC time series across monthly boundaries; see Figure 4. The offsets can be removed by simply dividing each month of data by the median flux in that month.

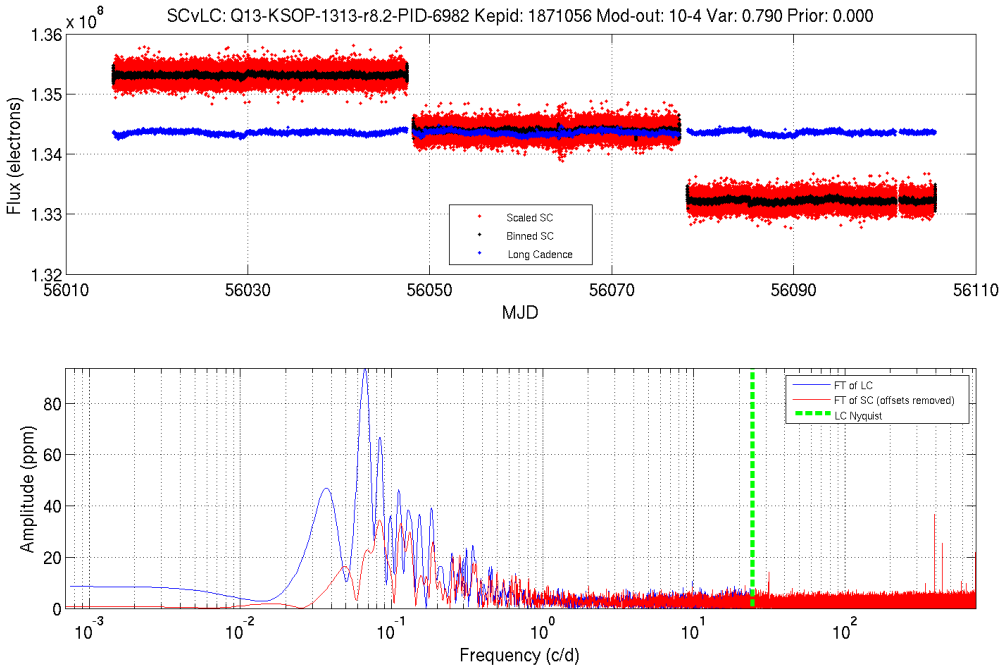

Figure 4: **Top Panel:** Long cadence (blue) and short cadence (red) PDC time series for KIC 1871056 showing different mean fluxes across different months. The short cadence is scaled to show the same average flux per cadence as the long cadence data. The black line shows the short cadence binned to the long cadence exposure time. The sudden jumps in mean flux for different months is an artifact of processing. **Bottom Panel:** Fourier transform of long cadence (blue) and short cadence (red) data. The constant offsets have been removed from the short cadence data. The vertical dashed line shows the LC Nyquist frequency.

Low Frequency Signal Attenuation: PDC has difficulty discriminating between signals and systematics on timescales comparable to the length of the data set, which results in low frequency stellar signals being fit and removed. For long cadence, periods longer than $\sim$ 20 days are heavily attenuated. For short cadence, similar attenuation occurs at approximately 7 days. We show an example in Figure 5. As SC data is primarily intended for analyzing periods less than 1 hour, this attenuation should not pose a significant problem for most users.

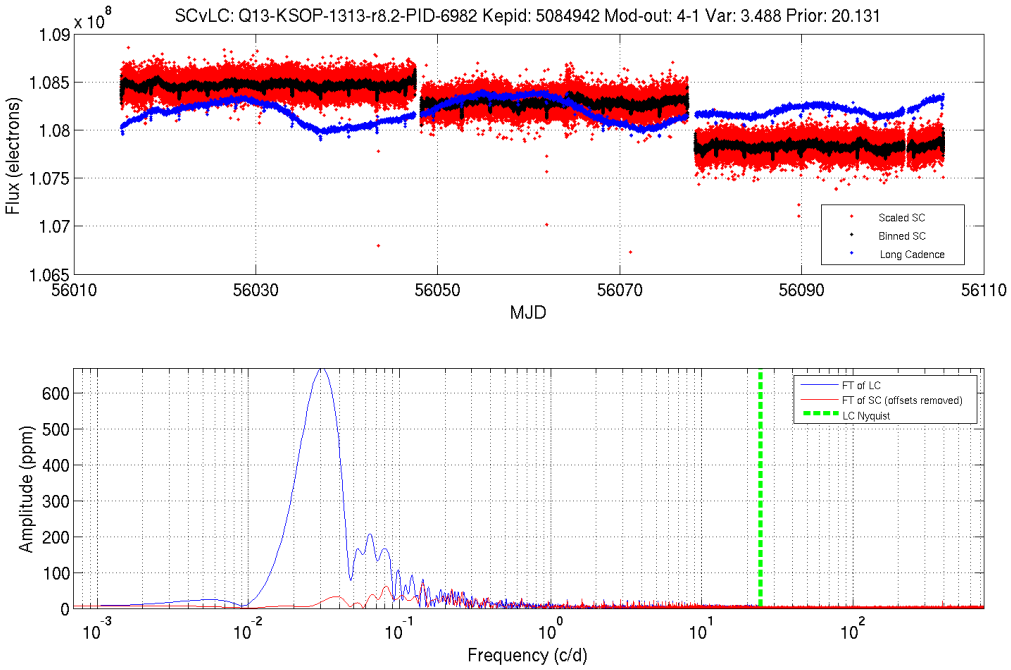

Figure 5: Long period attenuation in short cadence for KIC 5084942. Colors have the same meaning as Figure 4. A $\sim$30 day signal present in LC is removed by SC PDC.

3.2 Time and Time Stamps

Kepler has some preliminary evidence that the absolute time in the archived data files are wrong by approximately one minute. We have not identified the source of this discrepancy. If you have information, or evidence, related to this issue please email the Kepler Science Office at kepler-scienceoffice@nasa.gov.

4 Supplemental Files

All the information that was previously provided in the supplemental files can be found in the Kepler data files available at MAST. See the Archive Manual (Thompson & Fraquelli, 2012) for more details. This section will not appear in future versions of the data release notes.

References

Christiansen, J. L., Van Cleve, J. E., Jenkins, J. M., Caldwell, D. A., Barclay, T., Bryson, S., Burke, C. J., Twicken, J. D., & Uddin, A. K. (2012). Kepler Data Characteristics Handbook. *KSCI-19040-003*.

Fanelli, M. N., Jenkins, J. M., Bryson, S. T., Quintana, E. V., Twicken, J. D., Wu, H. W., Tenenbaum, P., Allen, C. L., Caldwell, D. A., Chandrasekaran, H., Christansen, B. D., & Uddin, A. K. (2011). Kepler Data Processing Handbook. *KSCI-19081-001*.

Smith, J. C., Stumpe, M. C., Van Cleve, J. E., Jenkins, J. M., Barclay, T. S., Fanelli, M. N., Girouard, F. R., Kolodziejczak, J. J., McCauliff, S. D., Morris, R. L., & Twicken, J. D. (2012). Kepler Presearch Data Conditioning II - A Bayesian Approach to Systematic Error Correction. *PASP*, *124*, 1000–1014.

Stumpe, M. C., Smith, J. C., Van Cleve, J. E., Twicken, J. D., Barclay, T. S., Fanelli, M. N., Girouard, F. R., Jenkins, J. M., Kolodziejczak, J. J., McCauliff, S. D., & Morris, R. L. (2012). Kepler Presearch Data Conditioning I - Architecture and Algorithms for Error Correction in Kepler Light Curves. *PASP*, *124*, 985–999.

Thompson, S. E., & Fraquelli, D. (2012). Kepler Archive Manual. *KDMC-10008-004*.