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Oskarshamn site investigation

Groundwater monitoring program

Report for July 2005 to December 2006

Göran Nyberg, Eva Wass
Geosigma AB

October 2007

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Abstract

This document reports data obtained within the groundwater monitoring program, which is one of the activities performed within the site investigation at Oskarshamn. The objective of the groundwater monitoring is to support the hydrogeological characterization of the area and to document the groundwater conditions before a possible excavation.

Data presented in this report are collected during the period of July 2005 until December 2006 and consist of groundwater levels in boreholes. Meteorological and hydrological variables are also monitored within the framework of the site investigations but reported separately.

The data collecting system in HMS (Hydro Monitoring System) consists of two measurement stations (computers) which communicate with and collect data from a number of dataloggers. The computers are connected to the SKB Ethernet LAN. All data are collected by means of different transducers connected to different types of data loggers: Minitroll, LevelTroll, Mitec and Datataker.

In order to calibrate registrations from the data loggers, manual levelling of all sections is made, normally once every month. The logger data are converted to water levels using calibration constants. All collected data are subjected to a quality check, during which obviously erroneous data are removed and calibration constants are corrected so that the monitored data are consistent with the manual levelling. The status of the equipment is also controlled and service might be initiated.

Diagrams of groundwater levels for the period of July 2005–December 2006 (daily values for each section) are presented in Appendix 1. The original results are stored in the primary data base SICADA. The data in this data base may then be used for further analysis.

There are no nonconformities with respect to the activity plan or the method description.

Sammanfattning

Denna rapport redovisar data erhållna inom grundvattenmoniteringsprogrammet, vilket är en av aktiviteterna inom platsundersökningen i Oskarshamn. Syftet med grundvattenmoniteringen är att stödja den hydrogeologiska karakteriseringen av platsen och att dokumentera grundvattenförhållanden före en eventuell byggnation.

Data presenterade i rapporten är insamlade under perioden juli 2005 till och med december 2006 och består av grundvattennivå i borrhål. Inom ramen för platsundersökningarna moniteras även meteorologiska och ythydrologiska variabler, men dessa presenteras i en annan rapport.

Datainsamlingssystemet i HMS (Hydro Monitoring System) består av två mätstationer (datorer) vilka kommunicerar med och samlar in data från ett antal dataloggers. Datorn är förbunden med SKB:s nätverk. Alla data samlas in med hjälp av olika givare förbundna med olika typer av dataloggrar: Minitroll, LevelTroll, Mitec och Datataker.

För att kunna kalibrera registreringarna från dataloggrarna utförs, vanligtvis en gång i månaden, manuell nivåregistrering (lodning) i alla sektioner. Loggerdata omvandlas till vattennivåer genom användande av kalibreringskonstanter. Alla insamlade data kvalitetskontrolleras. Under detta arbete tas uppenbart felaktiga data bort och kalibreringskonstanterna korrigeras så att automatiskt registrerade data överensstämmer med manuella nivåregistreringar. Vid dessa tillfällen kontrolleras utrustningens status och service kan initieras.

Diagram över grundvattennivåerna för perioden juli 2005 till december 2006 (en datapunkt per sektion och 24 timmar redovisas) visas i Appendix 1. Ursprungsresultatet lagras i primärdatabasen SICADA. Data från denna databas kan användas för vidare analyser.

Aktiviteten har utförts i överensstämmelse med aktivitetsplanen och metodbeskrivningen.

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1 Introduction

This document reports data collected within the groundwater monitoring program, which is one of the activities performed within the site investigation at Oskarshamn. The work was carried out in accordance with activity plans SKB AP PS 400-05-016 and SKB AP PS 400-05-103. In Table 1-1, controlling documents for this activity are listed. The activity plans and the method descriptions are SKB's internal controlling documents. The site investigation internal report presents the results from the quality check performed once every three months, see Section 4.4.

Data presented in this report include groundwater levels collected during July 2005 to December 2006.

The HMS (Hydro Monitoring System) is used to collect and store all data.

Table 1-1. Controlling documents.

Activity Plans	**Number**	**Version**
Platsundersökning i Oskarshamn – Grundvattenmonitering 2005	AP PS 400-05-016	1.0
Platsundersökning i Oskarshamn – Grundvattenmonitering 2006	AP PS 400-05-103	1.0
Method Descriptions	**Number**	**Version**
Metodbeskrivning för grundvattenmonitering vid SKB:s platsundersökningar	SKB MD 360.002	1.0
Site investigation Internal Reports (in Swedish)	**Number**	
Platsundersökning i Oskarshamn Kvalitetskontroll av grundvattenmonitering Period: maj–juli 2005	PIR-05-32	
Platsundersökning i Oskarshamn Kvalitetskontroll av grundvattenmonitering Period: augusti–oktober 2005	PIR-05-38	
Platsundersökning i Oskarshamn Kvalitetskontroll av grundvattenmonitering Period: november 2005–mars 2006	PIR-06-19	
Platsundersökning i Oskarshamn Kvalitetskontroll av grundvattenmonitering Period: mars–juni 2006	PIR-06-22	
Platsundersökning i Oskarshamn Kvalitetskontroll av grundvattenmonitering Period: juni–oktober 2006	PIR-06-43	
Platsundersökning i Oskarshamn Kvalitetskontroll av grundvattenmonitering Period: oktober 2006–januari 2007	PIR-07-06	

2 Objective and scope

The objective of the groundwater monitoring program during the site investigation is to determine baseline conditions of the natural variations of the groundwater levels prior to the potential excavation for a nuclear waste repository and to support the hydrogeological site characterization.

Data collected within this activity are:

- Groundwater level in boreholes.

There are also some parameters that are used for monitoring of the function of the measurement system itself. However, these are not reported herein.

The following numbers of boreholes were monitored during the reporting period within the Oskarshamn site investigation:

- 35 core-drilled boreholes.
- 44 percussion-drilled boreholes.
- 66 soil wells.

The locations of the boreholes monitored during the reporting period are shown in Figure 2-1. A list of these boreholes along with some basic information is compiled in Table 2-1 and in Table 5-1.

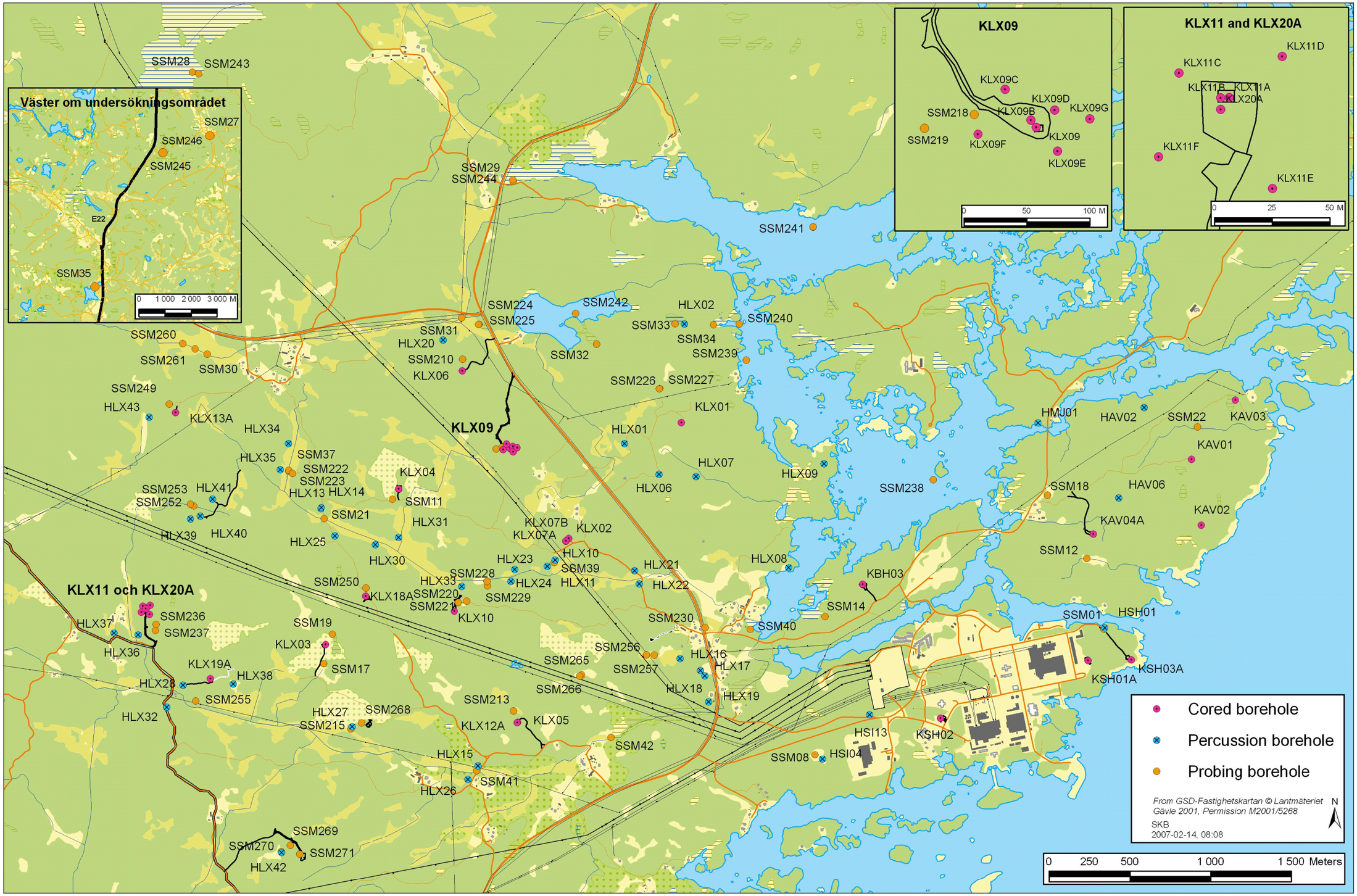


Figure 2-1. Overview of the Oskarshamn site investigation area showing the locations of monitored boreholes.

Table 2-1. Borehole length, inclination, elevation at top of casing (TOC) and date for the completion of drilling.

Borehole	Borehole length (m)	Inclination at ground (°)	Elevation at TOC (m.a.s.l.)	Drilling completed	Length of casing (m)	Comment
HAV02	163.0	–89.1	6.11	1986-08-21	?	
HAV06	100.0	–59.5	12.42	1987-07-30	1.20	
HLX01	100.63	–59.4	8.90	1987-10-21	3.00	
HLX02	132.0	–57.4	9.04	1987-10-27	0.60	
HLX06	100.0	–59.9	15.48	1987-10-30	1.00	
HLX07	100.0	–59.4	8.61	1987-11-03	1.00	
HLX08	40.0	–47.8	2.22	1991-11-14	6.00	
HLX09	151.0	–61.3	3.31	1991-11-21	3.00	
HLX10	85.0	–68.7	11.74	1992-09-30	3.00	
HLX11	70.0	–68.5	13.15	1992-10-01	6.00	
HLX13	200.2	–58.1	17.39	2004-02-26	11.85	
HLX14	115.9	–68.6	17.11	2004-03-11	11.90	
HLX15	151.9	–58.4	4.81	2004-04-29	12.04	
HLX16	202.2	–58.1	3.65	2004-06-24	12.03	
HLX17	202.2	–59.5	3.35	2004-07-01	9.03	
HLX18	181.2	–57.6	4.04	2004-07-06	15.03	
HLX19	202.2	–57.9	5.95	2004-08-12	12.03	
HLX20	202.2	–60.4	11.18	2004-06-21	9.03	
HLX21	150.3	–57.0	10.31	2004-09-02	9.03	
HLX22	163.2	–59.4	10.06	2004-08-26	9.03	
HLX23	160.2	–58.2	14.69	2004-09-16	6.03	
HLX24	175.2	–58.4	12.77	2004-09-09	9.03	
HLX25	202.5	–58.6	20.66	2004-08-19	6.03	
HLX26	151.2	–60.4	6.48	2004-09-28	9.03	
HLX27	164.7	–59.4	8.25	2004-09-22	6.03	
HLX28	154.2	–59.5	13.42	2004-10-02	6.03	
HLX30	163.4	–60.8	12.18	2004-11-30	9.03	
HLX31	133.2	–58.8	12.16	2004-12-03	9.03	
HLX32	162.6	–58.7	10.84	2005-01-11	12.30	
HLX33	202.1	–58.8	12.20	2004-12-20	9.03	
HLX34	151.8	–59.7	14.29	2005-06-14	9.03	
HLX35	151.8	–60.1	14.44	2005-06-02	6.03	
HLX36	199.8	–59.0	15.56	2005-09-22	6.03	
HLX37	199.8	–59.2	15.19	2005-09-28	12.03	
HLX38	199.5	–59.5	11.53	2006-04-10	15.02	
HLX39	199.3	–59.3	27.04	2006-06-14	6.02	
HLX40	199.5	–59.8	25.74	2006-06-09	6.02	
HLX41	199.5	–59.1	21.80	2006-06-01	6.02	
HLX42	152.6	–57.1	12.88	2006-11-16	9.10	
HLX43	170.6	–50.5	24.20	2006-10-26	6.00	
HMJ01	46.0	–60.0	1.41	1991-10-30	6.00	
HSH01	200.0	–70.0	2.86	2002-07-02	12.00	
HSI04	37.0	–58.5	6.63	1995-02-02	?	
HSI13	4.0	–90.0	5.54	1980-02-02	?	

Borehole	Borehole length (m)	Inclination at ground (°)	Elevation at TOC (m.a.s.l.)	Drilling completed	Length of casing (m)	Comment
KAV01	502.0			1977-05-16		
	746.6			1986-11-16		
	757.31	–89.2	14.10	2004-01-10	68.04	
KAV02	97.1	–89.5	7.55	1977-05-31	12.40	
KAV03	248.4	–89.4	8.74	1986-10-05	2.80	
KAV04A	1,004.0	–84.9	10.35	2004-05-03	100.00	
KBH03	100.43	–84.7	7.82	2004-02-13	24.97	
KLX01	702.11			1988-02-05		
	1,077.99	–85.3	16.77	1990-08-04	101.30	
KLX02	1,700.5	–85.0	18.40	1992-11-29	202.95	
KLX03	1,000.42	–74.9	18.49	2004-09-07	100.05	
KLX04	993.49	–84.8	24.09	2004-06-28	12.24	
KLX05	1,000.16	65.1	17.63	2005-01-22	15.00	
KLX06	994.94	–65.0	17.68	2004-11-25	11.88	
KLX07A	844.73	–60.0	18.47	2005-05-04	11.80	
KLX07B	200.13	–85.1	18.38	2005-06-03	9.64	
KLX09	880.38	–84.9	23.45	2005-10-15	11.95	
KLX09B	100.22	–89.8	23.62	2006-01-26	10.74	
KLX09C	120.05	–59.5	23.75	2006-01-15	9.00	
KLX09D	121.02	–60.2	23.10	2005-11-17	9.75	
KLX09E	120.0	–60.0	22.16	2005-12-05	9.00	
KLX09F	152.3	–59.7	19.57	2006-01-06	9.00	
KLX09G	100.1	–61.1	19.63	2006-02-03	9.30	
KLX10	1,001.2	–85.2	18.28	2005-10-15	12.10	
KLX11A	992.29	–76.8	27.14	2006-03-02	12.05	
KLX11B	100.2	–89.9	27.27	2006-04-28	2.54	
KLX11C	120.15	–60.7	27.19	2006-04-05	2.00	
KLX11D	120.35	–59.0	25.57	2006-04-13	2.00	
KLX11E	121.3	–60.9	22.65	2006-04-21	2.00	
KLX11F	120.05	–61.1	24.47	2006-03-17	2.00	
KLX12A	602.29	–75.3	17.74	2006-03-04	17.92	
KLX13A	595.85	–82.2	24.15	2006-08-16	11.75	
KLX18A	611.28	–82.1	21.01	2006-05-02	11.83	
KLX19A	800.07	–57.5	16.87	2006-09-20	522.40	
KLX20A	457.92	–50.0	27.24	2006-04-24	99.50	
KSH01A	1,003.0	–80.8	5.32	2002-12-18	12.10	
KSH02	1,001.11	–85.7	5.48	2003-06-11	80.00	
KSH03A	1,000.7	–59.4	4.17	2003-11-07	100.05	
SSM000001	3.0	–86.7	2.79	2002-10-08		
SSM000008	7.6	–88.2	4.64	2003-12-08		
SSM000011	3.8	–88.6	16.50	2004-01-29		
SSM000012	9.5	–86.0	1.77	2004-01-22		
SSM000014	6.3	–85.9	1.64	2003-12-09		
SSM000017	2.15	–81.2	10.98	2004-05-04		
SSM000018	6.4	–86.2	0.78	2003-12-11		
SSM000019	3.2	–82.8	13.21	2004-05-04		
SSM000021	4.15	–86.4	12.63	2004-05-04		
SSM000022	11.4	–87.7	5.03	2004-01-12		

Borehole	Borehole length (m)	Inclination at ground (°)	Elevation at TOC (m.a.s.l.)	Drilling completed	Length of casing (m)	Comment
SSM000027	5.2	–87.8	9.21	2004-06-28		
SSM000028	3.1	–87.8	4.09	2004-06-09		
SSM000029	7.1	–87.5	1.26	2004-06-08		
SSM000030	8.2	–85.7	11.19	2004-09-10		
SSM000031	4.1	–87.2	6.32	2004-06-10		
SSM000032	4.1	–86.4	2.81	2004-06-15		
SSM000033	2.1	–88.3	5.82	2004-06-15		
SSM000034	4.5	–89.7	0.48	2004-06-16		
SSM000035	4.1	–82.9	27.11	2004-06-09		
SSM000037	5.95	–86.4	12.70	2004-06-22		
SSM000039	5.1	–85.7	11.70	2004-06-21		
SSM000040	3.2	–88.8	1.16	2004-06-14		
SSM000041	4.6	–82.9	4.15	2004-07-07		
SSM000042	5.3	–88.3	3.35	2004-06-17		
SSM000210	4.1	–87.7	11.31	2004-06-28		
SSM000213	4.0	–85.0	11.85	2004-07-06		
SSM000215	4.7	–88.5	6.74	2004-12-03		
SSM000218	3.1	–88.5	18.93	2005-06-02		
SSM000219	5.1	–88.6	16.27	2005-06-01		
SSM000220	3.1	–85.6	13.13	2005-05-31		
SSM000221	3.1	–86.6	13.17	2005-05-30		
SSM000222	7.4	–87.6	12.79	2005-08-22		
SSM000223	12.3	–87.5	13.69	2005-08-24		
SSM000224	17.2	–88.5	6.90	2005-08-29		
SSM000225	10.1	–87.6	6.94	2005-09-14		
SSM000226	8.3	–88.6	6.97	2005-09-14		
SSM000227	2.1	–86.5	7.28	2005-09-14		
SSM000228	13.0	–87.9	13.09	2005-09-19		
SSM000229	7.3	–88.6	13.68	2005-09-20		
SSM000230	8.0	–88.4	5.10	2005-09-21		
SSM000236	5.9	–88.6	16.37	2005-11-01		
SSM000237	5.6	–86.4	15.93	2005-10-31		
SSM000238	12.2	–90.0	0.36	2006-02-21		Manual levelling in PSM000267 with the elevation 1.56 m.a.s.l.
SSM000239	5.3	–90.0	0.56	2006-02-22		Manual levelling in PSM000268 with the elevation 1.61 m.a.s.l.
SSM000240	6.4	–90.0	0.61	2006-02-23		Manual levelling in PSM000269 with the elevation 1.44 m.a.s.l.
SSM000241	33.1	–90.0	0.34	2006-02-15		Manual levelling in PSM000270 with the elevation 1.47 m.a.s.l.
SSM000242	18.1	–90.0	2.11	2006-02-07		Manual levelling in PSM000271 with the elevation 3.21 m.a.s.l.
SSM000243	15.0	–90.0	4.28	2006-02-13		
SSM000244	17.0	–90.0	1.91	2006-02-28		
SSM000245	7.9	–90.0	27.26	2006-02-02		
SSM000246	4.1	–90.0	27.58	2006-02-02		
SSM000249	6.6	–86.9	22.07	2006-01-26		
SSM000250	8.0	–87.2	16.84	2006-01-27		
SSM000252	7.7	–89.0	18.39	2006-07-13		

Borehole	Borehole length (m)	Inclination at ground (°)	Elevation at TOC (m.a.s.l.)	Drilling completed	Length of casing (m)	Comment
SSM000253	4.5	–88.8	17.96	2006-07-12		
SSM000255	10.2	–85.3	5.94	2006-05-16		
SSM000256	5.4	–88.2	3.60	2006-07-11		
SSM000257	7.0	–85.9	3.36	2006-07-10		
SSM000260	9.67	–89.8	10.80	2006-10-25		
SSM000261	10.5	–88.6	10.65	2006-10-24		
SSM000265	5.9	–87.1	6.73	2006-11-08		
SSM000266	4.5	–84.6	6.78	2006-11-08		
SSM000268	4.36	–85.7	11.21	2006-11-15		
SSM000269	3.8	–88.3	15.16	2006-11-15		
SSM000270	3.2	–88.5	14.15	2006-11-15		
SSM000271	1.5	–89.2	15.82	2006-11-14		

? This information is not fond in the Sicada database.

3 Equipment

3.1 Description

Drawings of the borehole equipment for permanent instrumentation in core boreholes and percussion boreholes are presented in Figure 3-1 and Figure 3-2, respectively. Figure 3-3 shows a more detailed close-up of the standpipe in which the pressure transducer is situated in these boreholes.

In Figure 3-4 the instrumentation in soil wells is shown. In open percussion and core boreholes, as in the soil wells, a transducer or data logger is submerged in the groundwater without any other equipment.

3.2 Data collection

The data collecting system, which is part of the Hydro Monitoring System (HMS), consists of two measurement stations (computers). A measurement station collects data from a number of data sources, see Figure 3-5. The computers are connected to the SKB Ethernet LAN.

The on-line system is designed to be able to handle short interruptions in the communication. Data can be stored for at least a couple of hours in the loggers. All data are finally stored in the main measurement station. Tape backup is made of all data.

All data are collected by means of different types of pressure transducers connected to different types of data loggers or by manual levelling. Table 3-1 shows the monitoring equipment used in different boreholes. The following data loggers are used:

Minitroll: a single channel data logger of stand-alone type where the transducer is integrated in the logger. The logger is submerged in the groundwater and has the capacity to store 80,000 data.

Leveltroll: the successor to Minitroll, which is no longer manufactured. It is a logger that in most respects is equal to Minitroll, but has the capacity to store 350,000 data.

Mitec: a data logger connected on-line by means of GSM telephony. A pressure transducer of the type Druck PTX is connected to the logger. Only the transducer is submerged in the groundwater. The logger uses two or four channels. During monitoring in boreholes, one channel is used for monitoring of the battery voltage and the other ones can be used for pressure monitoring.

Datataker: a data logger connected on-line by means of radio or network. The logger has 42 channels and is used only for monitoring in percussion and core boreholes.

Monitored data that have been quality assured are transferred quarterly to the site characterization database, SICADA.

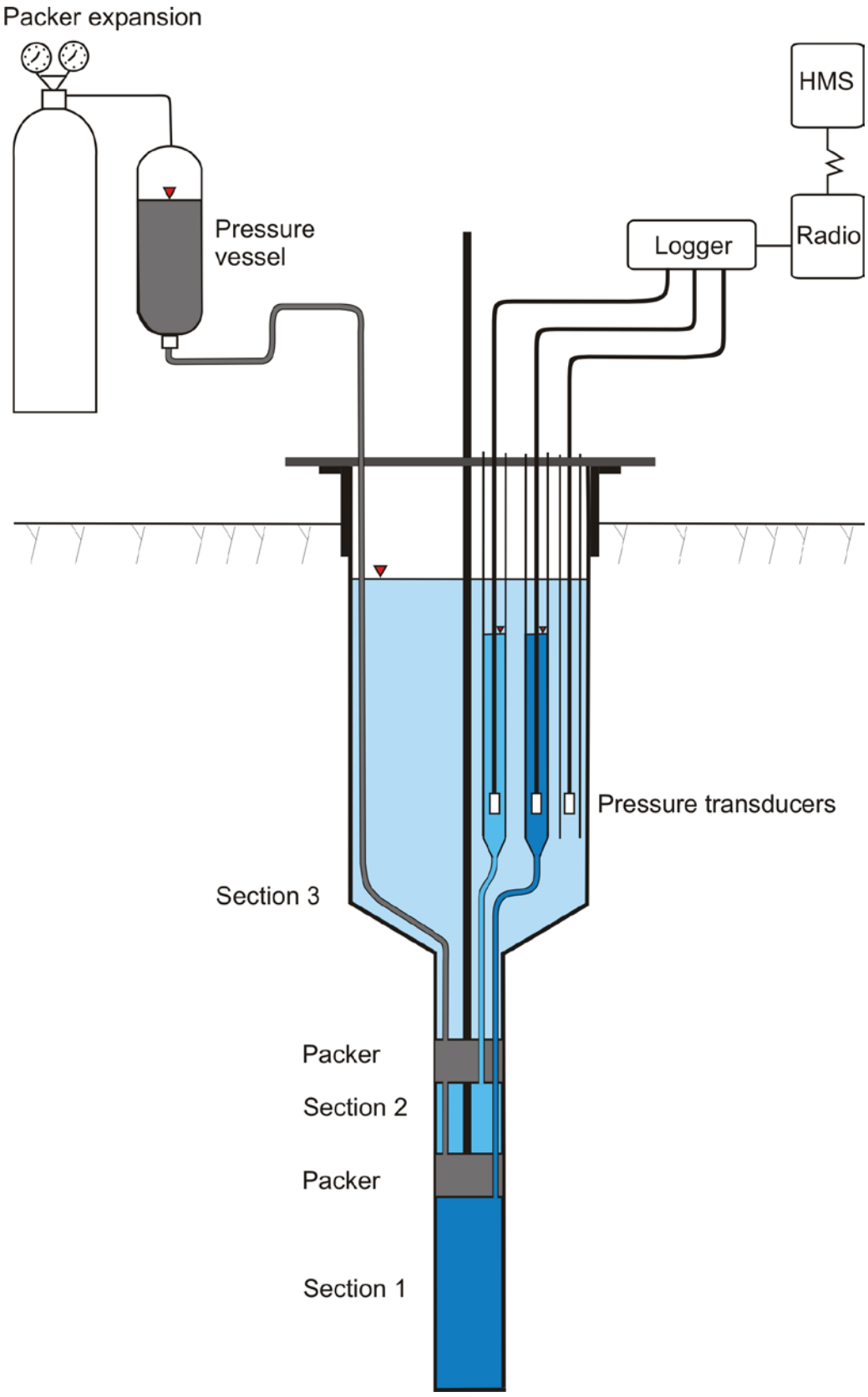


Figure 3-1. *Explanatory sketch of permanent instrumentation in core boreholes.*

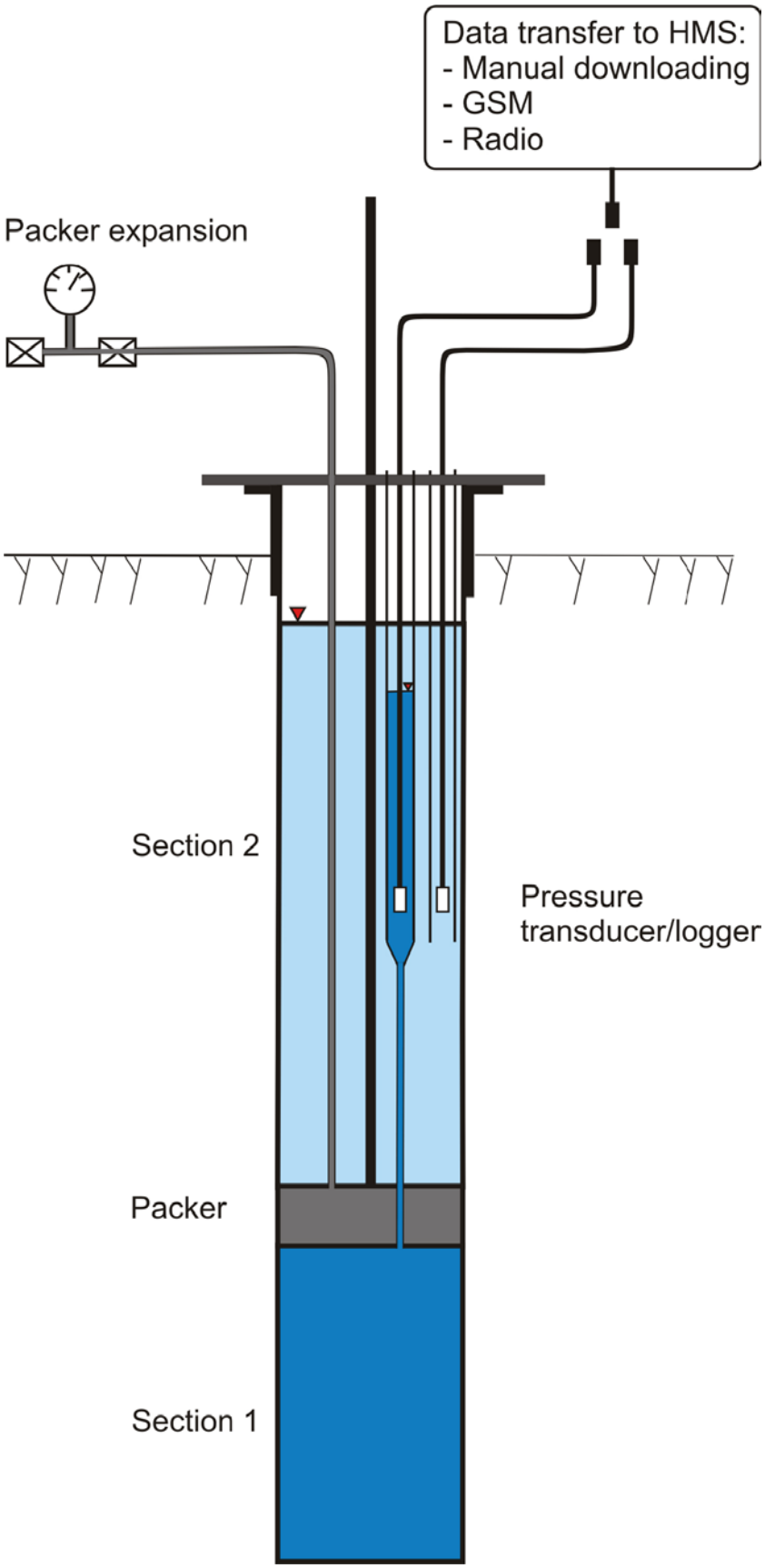


Figure 3-2. *Explanatory sketch of instrumentation in percussion boreholes.*

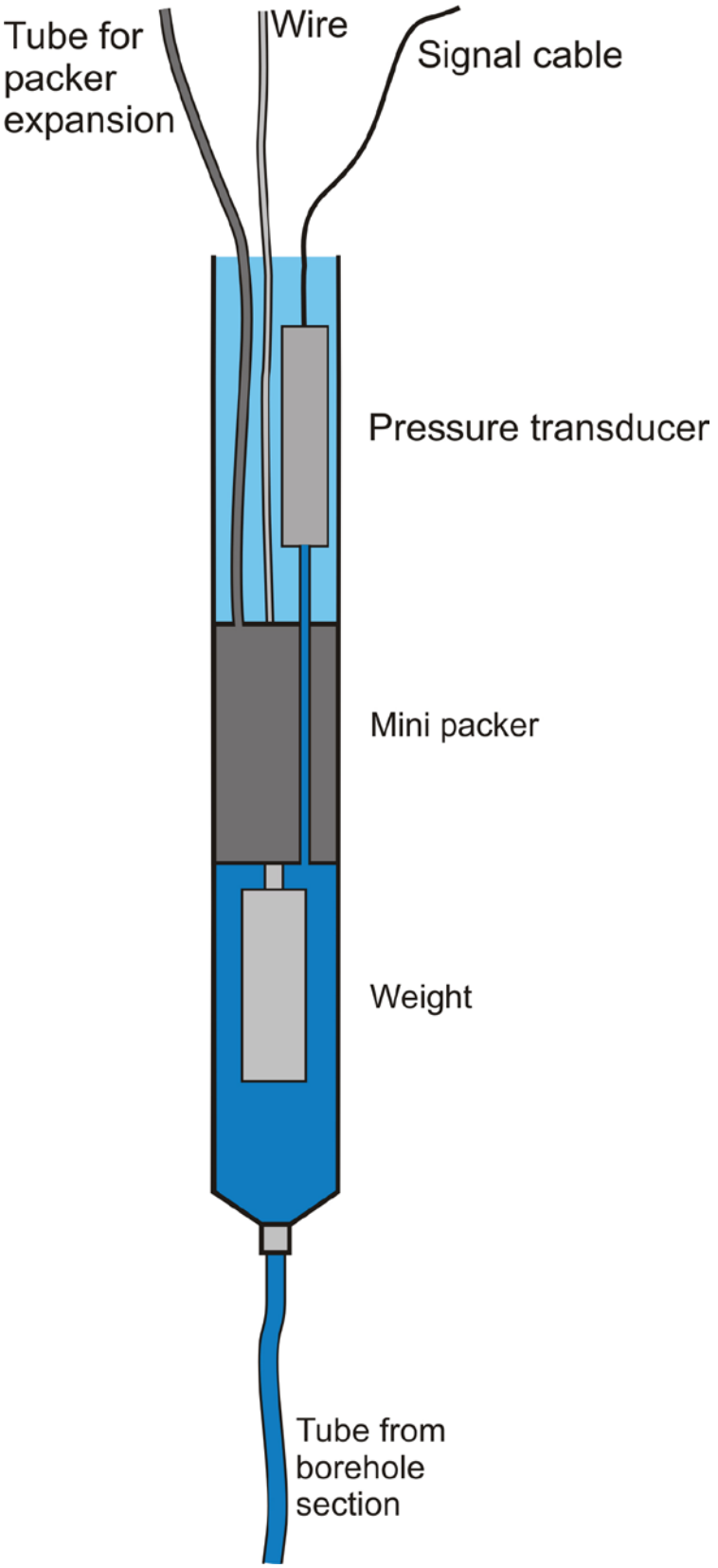


Figure 3-3. *Explanatory sketch of instrumentation in standpipes in core and percussion boreholes.*

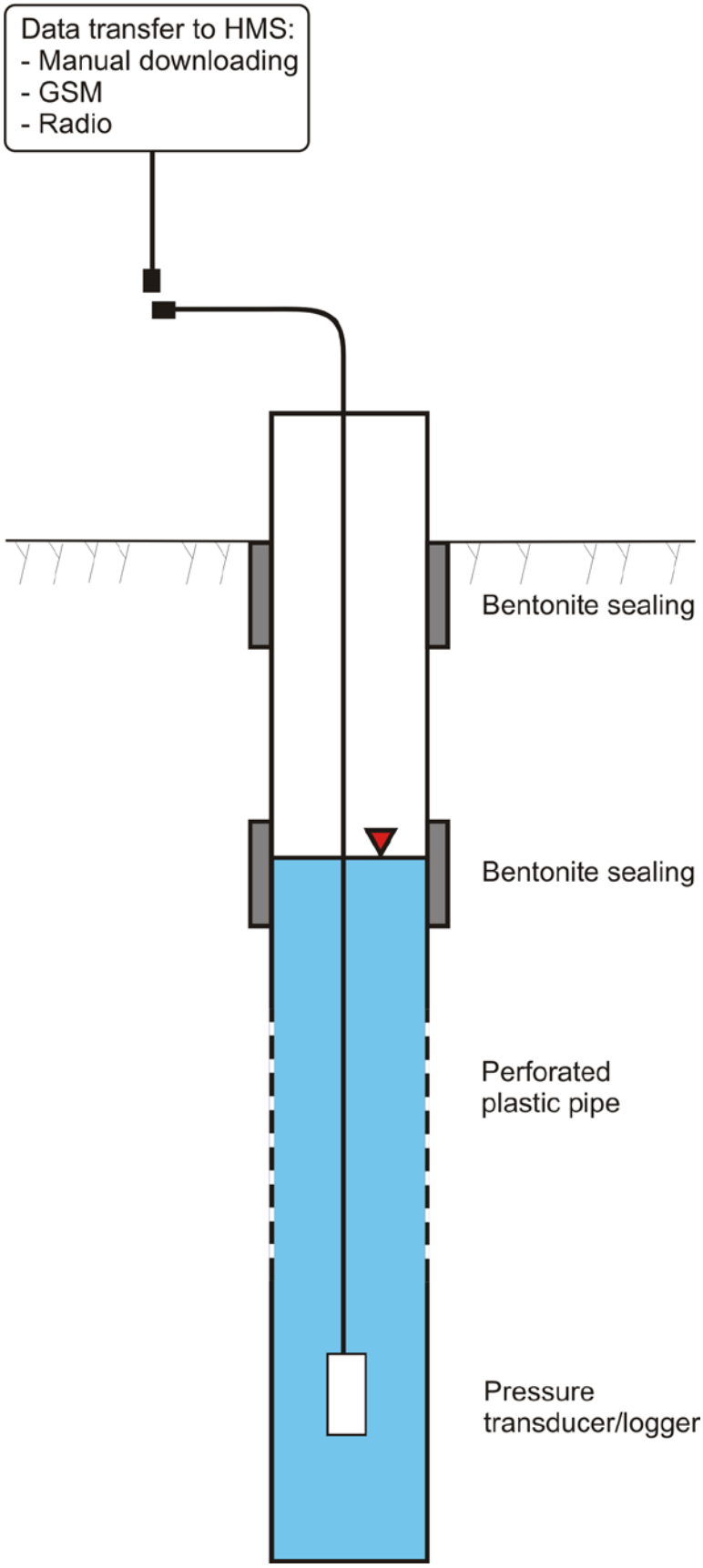


Figure 3-4. *Explanatory sketch of instrumentation in soil wells.*

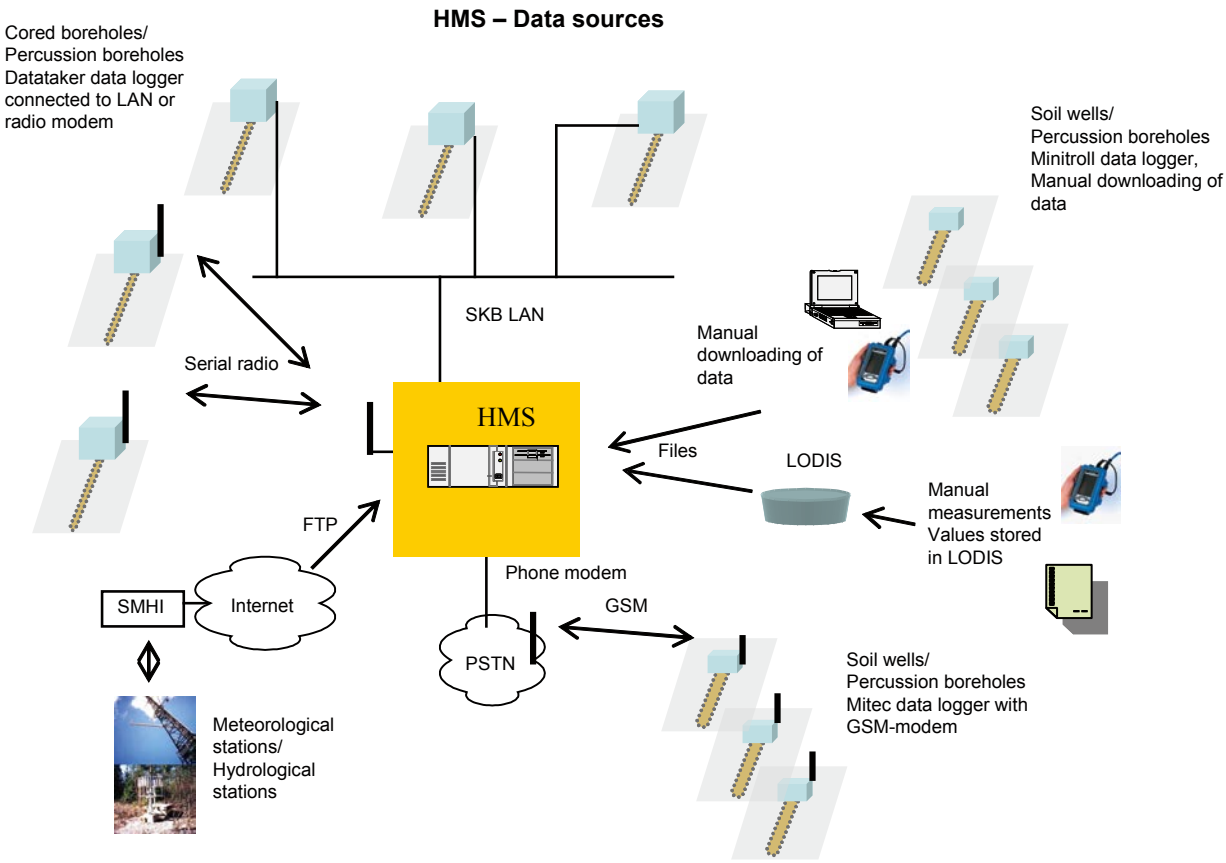


Figure 3-5. *HMS data sources.*

Table 3-1. Monitoring equipment.

Borehole	Logger	From	To
HAV02	Minitroll	2004-05	
HAV06	Mitec	2004-05	
HLX01	Minitroll	2005-09	
HLX02	Minitroll	2005-10	
HLX06	Minitroll	2005-09	
HLX07	Minitroll	2005-09	
HLX08	Mitec	2004-06	
HLX09	Mitec	2004-06	
HLX10	Manual levelling	2004-03	
HLX11	Mitec	2004-05	2005-10
	Minitroll	2005-10	
HLX13	Minitroll	2004-04	
HLX14	Minitroll	2004-11	2006-03
HLX15	Minitroll	2004-11	2005-01
	Minitroll	2005-11	2006-02
	LevelTroll	2006-08	
HLX16	LevelTroll	2006-08	
HLX17	LevelTroll	2006-08	
HLX18	Minitroll	2004-12	
HLX19	LevelTroll	2006-08	
HLX20	Minitroll	2004-09	2004-10
	Minitroll	2005-04	2005-08
	Minitroll	2006-01	2006-08
HLX21	Minitroll	2004-09	
HLX22	Minitroll	2004-09	2004-09
	Minitroll	2004-12	2006-11
	DataTaker	2006-11	
HLX23	Minitroll	2004-12	
HLX24	Minitroll	2004-09	
HLX25	Minitroll	2004-11	
HLX26	Minitroll	2004-11	
HLX27	Minitroll	2004-11	2005-06
	Minitroll	2005-09	
HLX28	Minitroll	2004-11	2005-11
	LevelTroll	2006-11	
HLX30	Minitroll	2004-11	
HLX31	Minitroll	2004-12	
HLX32	Minitroll	2005-09	
HLX33	Minitroll	2004-12	
HLX34	Minitroll	2005-09	
HLX35	Minitroll	2005-05	
HLX36	Minitroll	2005-09	
HLX37	Minitroll	2005-11	
HLX38	Minitroll	2006-09	2006-11
	LevelTroll	2006-11	
HLX39	Minitroll	2006-08	
HLX40	Minitroll	2006-05	
HLX41	Minitroll	2006-08	

Borehole	Logger	From	To
HLX42	LevelTroll	2006-11	
HLX43	LevelTroll	2006-11	
HMJ01	LevelTroll	2006-11	
HSH01	Minitroll	2004-04	
HSI04	Mitec	2004-06	
HSI13	Mitec	2005-01	
KAV01	Minitroll	2004-03	2004-04
	DataTaker	2005-09	
KAV02	Mitec	2004-05	
KAV03	Minitroll	2004-07	
KAV04A	Minitroll	2003-10	2003-10
	DataTaker	2005-05	
KBH03	Mitec	2004-09	
KLX01	DataTaker	2004-11	
KLX02	DataTaker	2004-04	
KLX03	DataTaker	2006-01	
KLX04	Minitroll	2004-11	2005-01
	DataTaker	2005-01	
KLX05	DataTaker	2005-11	
KLX06	DataTaker	2005-07	
KLX07A	Minitroll	2005-05	2005-06
	DataTaker	2006-03	
KLX07B	Minitroll	2005-08	2005-12
	DataTaker	2006-03	
KLX09	Minitroll	2005-11	2006-02
	LevelTroll	2006-02	2006-04
	DataTaker	2006-12	
KLX09B	Minitroll	2006-01	2006-04
KLX09C	Minitroll	2006-01	2006-04
KLX09D	Minitroll	2005-11	2006-04
KLX09E	Minitroll	2005-11	2006-04
KLX09F	Minitroll	2006-01	2006-04
	Minitroll	2006-05	
KLX09G	Minitroll	2006-02	2006-04
KLX10	DataTaker	2006-08	
KLX11A	Minitroll	2006-04	2006-05
	LevelTroll	2006-09	2006-10
	LevelTroll	2006-11	
KLX11B	Minitroll	2006-05	2006-05
	LevelTroll	2006-09	2006-10
	LevelTroll	2006-11	
KLX11C	Minitroll	2006-04	2006-05
	LevelTroll	2006-09	2006-10
KLX11D	Minitroll	2006-04	2006-05
	LevelTroll	2006-09	2006-10
KLX11E	Minitroll	2006-04	2006-09
	LevelTroll	2006-09	2006-10
	Minitroll	2006-10	

Borehole	Logger	From	To
KLX11F	Minitroll	2006-04	2006-05
	LevelTroll	2006-09	2006-10
KLX12A	DataTaker	2006-11	
KLX13A	Minitroll	2006-10	2006-11
KLX18A	Minitroll	2006-08	2006-09
KLX19A	Manual levelling	2006-06	
KLX20A	LevelTroll	2006-10	
KSH01A	DataTaker	2004-10	
KSH02	DataTaker	2005-01	
KSH03A	DataTaker	2004-05	
SSM000001	CR10	2002-12	2004-05
	Mitec	2004-06	
SSM000008	Mitec	2004-09	
SSM000011	Minitroll	2004-04	
SSM000012	Mitec	2004-08	
SSM000014	Mitec	2004-09	
SSM000017	Minitroll	2004-08	2004-12
	LevelTroll	2006-09	
SSM000018	Mitec	2004-08	
SSM000019	Minitroll	2004-08	2004-12
	LevelTroll	2006-09	
SSM000021	Minitroll	2004-08	
SSM000022	Mitec	2004-09	
SSM000027	Minitroll	2005-07	
SSM000028	Minitroll	2005-06	
SSM000029	Minitroll	2005-06	
SSM000030	Minitroll	2005-04	
SSM000031	Mitec	2005-04	
SSM000032	Minitroll	2005-04	
SSM000033	Minitroll	2005-04	
SSM000034	Minitroll	2005-04	
SSM000035	Minitroll	2005-06	
SSM000037	Mitec	2005-04	
SSM000039	Mitec	2005-07	
SSM000040	Minitroll	2005-07	
SSM000041	Minitroll	2005-07	
SSM000042	Minitroll	2005-06	
SSM000210	Minitroll	2004-08	2004-12
	LevelTroll	2006-09	
SSM000213	Minitroll	2004-09	
SSM000215	LevelTroll	2006-09	
SSM000218	Minitroll	2005-06	
SSM000219	Minitroll	2005-06	
SSM000220	Minitroll	2005-06	
SSM000221	Minitroll	2005-06	
SSM000222	LevelTroll	2005-11	
SSM000223	LevelTroll	2005-11	
SSM000224	LevelTroll	2005-11	

Borehole	Logger	From	To
SSM000225	LevelTroll	2005-11	
SSM000226	LevelTroll	2005-11	
SSM000227	LevelTroll	2005-11	
SSM000228	LevelTroll	2005-11	
SSM000229	LevelTroll	2005-11	
SSM000230	LevelTroll	2005-11	
SSM000236	Minitroll	2005-11	2005-12
SSM000237	Minitroll	2005-11	
SSM000238	Manual levelling	2006-10	
SSM000239	LevelTroll	2006-07	
SSM000240	LevelTroll	2006-07	
SSM000241	LevelTroll	2006-07	
SSM000242	LevelTroll	2006-07	
SSM000243	LevelTroll	2006-09	
SSM000244	LevelTroll	2006-09	
SSM000245	LevelTroll	2006-09	
SSM000246	LevelTroll	2006-09	
SSM000249	Minitroll	2006-02	
SSM000250	Minitroll	2006-02	
SSM000252	LevelTroll	2006-08	
SSM000253	LevelTroll	2006-08	
SSM000255	Minitroll	2006-06	
SSM000256	LevelTroll	2006-08	
SSM000257	LevelTroll	2006-08	
SSM000260	LevelTroll	2006-12	
SSM000261	LevelTroll	2006-12	
SSM000265	Minitroll	2006-12	
SSM000266	Minitroll	2006-12	
SSM000268	LevelTroll	2006-11	
SSM000269	LevelTroll	2006-11	
SSM000270	Manual levelling	2006-11	
SSM000271	LevelTroll	2006-11	

4 Execution

4.1 General

Data is collected to the measurement system, HMS, as described in Chapter 3.

4.2 Field work

Manual levelling is generally performed once a month. At the same time, the equipment is checked and maintenance is performed.

All data from stand-alone type loggers are manually transferred to a portable PC or PDA and then transmitted to the measurement station.

4.3 Data handling

4.3.1 Calibration method

Manual levelling of all sections is normally made once every month, in order to calibrate the registrations from the data loggers.

The logger data is transformed to water levels by means of a linear calibration equation and also by subtracting the air pressure since all transducers give the absolute pressure. Converted logger data are then compared with results from manual levelling. If the two differs, calibration constants are adjusted until an acceptable agreement is obtained.

4.3.2 Recording interval

Measurements of the groundwater level are normally made with one-minute intervals for percussion and core boreholes and with five-minute intervals for soil wells.

Measured values are not stored unless they differ from the previously stored value by more than 0.1 m for percussion and core boreholes, and 0.05 m for soil wells. In addition to this, a value is stored every two hours.

However, in most boreholes the recording intervals are shortened since they are located in areas of high interest.

4.4 Quality assurance

Preliminary inspection of all collected data is performed once every week. The purpose of this is to certify that all loggers are sending data and that all transducers are functioning.

All data collected are subject to a quality check once every quarter. During this Q/A, obviously erroneous data are removed and calibration constants are corrected so that the monitored data agree with the manual levelling data (see Chapter 4.3.1). At this occasion, the status of the equipment is also checked and service might be initiated by notifying the client via e-mail.

4.5 Nonconformities

There are no nonconformities with respect to the activity plan or the method description.

5 Results

5.1 General

The quality assured data, according to Chapter 4.4, are stored in the primary data base SICADA. The data in this data base may then be used for further analysis.

5.2 Groundwater levels

Diagrams of groundwater levels are presented in Appendix 1. All levels in the diagrams are given as metres above sea level in the national elevation system (RT90-RHB70).

In the diagrams, daily values are presented for each section. The data point shown is the first stored data point after midnight. When registrations are missing, manually levelled data, if available, are inserted.

A list of monitored borehole sections is presented in Table 5-1, where the lengths along the boreholes to top and bottom of each section are given. When packers have been installed in percussion or cored boreholes, the dates for installation/removal of the packers are given. In open boreholes (except the soil wells), the dates for installation/removal of pressure transducer/logger are given together with a comment. No information about periods between packer removal and re-installation or between measurement periods is given. For the soil wells, the dates refer to when drilling was completed.

Table 5-1. Monitored sections.

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
HAV02	1	2004-05-17		16.0	163.0	
	2	2004-05-17		0.0	15.0	Not monitored
HAV06	1	2004-05-04		17.0	100.0	
	2	2004-05-04		0.0	16.0	
HLX01	1	2005-09-23		16.0	100.0	
	2	2005-09-23		0.0	15.0	Not monitored
HLX02	1	2005-09-23		0.0	132.0	Measurement start date
HLX06	1	2005-09-23		0.0	100.0	Measurement start date
HLX07	1	2005-09-23		16.0	100.0	
	2	2005-09-23		0.0	15.0	Not monitored
HLX08	1	2004-06-21		0.0	40.0	Measurement start date
HLX09	1	2004-05-05		17.0	151.0	
	2	2004-05-05		0.0	16.0	
HLX10	1	2004-03		0.0	85.0	Measurement start date
HLX11	1	2004-05-05		14.0	70.0	
	2	2004-05-05		0.0	13.0	
HLX13	1	2004-04-27		0.0	202.2	Measurement start date
HLX14	1	2004-11-15	2006-03-29	11.0	115.9	
	2	2004-11-15	2006-03-29	0.0	10.0	Not monitored
HLX15	1	2005-11-10	2006-02-15	–1.505	151.9	Measurement start date

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
	1	2006-02-15		5.0	151.9	
	2	2006-02-15	2006-08-02	0.0	4.0	Not monitored
	2	2006-08-02		–2.025	4.0	Not monitored
HLX16	1	2006-08-28	2007-01-11	0.0	202.2	Measurement start/stop date
HLX17	1	2006-08-28	2007-01-11	0.0	202.2	Measurement start/stop date
HLX18	1	2004-12-20		91.0	181.2	
	2	2004-12-20		0.0	90.0	
HLX19	1	2006-08-28	2007-01-11	0.0	202.2	Measurement start/stop date
HLX20	1	2005-04-07	2005-08-24	–1.75	202.2	Measurement start/stop date
	1	2006-01-20	2006-08-31	0.0	202.2	Measurement start/stop date
HLX21	1	2004-12-16	2005-08-11	81.0	150.2	
	2	2004-12-16	2005-08-11	0.0	80.0	
	1	2005-08-29	2006-05-15	81.0	150.3	
	2	2005-08-29	2006-05-15	0.0	80.0	
	1	2006-07-13		81.0	150.3	
	2	2006-07-13		0.0	80.0	
HLX22	1	2004-12-17	2006-11-28	86.0	163.2	
	2	2004-12-17	2006-11-28	0.0	85.0	
	1	2006-12-15		0.0	163.2	Measurement start date
HLX23	1	2005-07-05		61.0	160.2	
	2	2005-07-05		0.0	60.0	
HLX24	1	2004-12-10		41.0	175.2	
	2	2004-12-10		0.0	40.0	
HLX25	1	2004-11-17		61.0	202.5	
	2	2004-11-17		0.0	60.0	
HLX26	1	2004-11-04		11.0	151.2	
	2	2004-11-04		0.0	10.0	Not monitored
HLX27	1	2005-09-14	2006-11-10	108.0	164.7	
	2	2005-09-14	2006-11-10	0.0	107.0	
	1	2006-11-28		133.0	164.7	
	2	2006-11-28		0.0	132.0	
HLX28	1	2004-11-08	2005-11-22	–2.025	154.2	Measurement start/stop date
	1	2006-11-28		–2.025	154.2	Measurement start date
HLX30	1	2004-12-16	2005-08-30	101.0	164.4	
	2	2004-12-16	2005-08-30	0.0	100.0	
	1	2005-09-14		101.0	164.4	
	2	2005-09-14		0.0	100.0	
HLX31	1	2004-12-17	2005-10-17	101.0	133.5	
	2	2004-12-17	2005-10-17	0.0	100.0	
	1	2005-10-17		0.0	133.5	
HLX32	1	2005-09-15	2006-11-13	16.0	162.6	
	2	2005-09-15	2006-11-13	0.0	15.0	Not monitored
	1	2006-12-07		16.0	162.6	
	2	2006-12-07		0.0	15.0	Not monitored
HLX33	1	2005-05-09	2006-06-14	31.0	202.1	
	2	2005-05-09	2006-06-14	0.0	30.0	
	1	2006-08-28	2006-11-10	31.0	202.1	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
	2	2006-08-28	2006-11-10	0.0	30.0	
	1	2006-12-07		31.0	202.1	
	2	2006-12-07		0.0	30.0	
HLX34	1	2005-09-27		–1.75	151.8	Measurement start date
HLX35	1	2005-06-03	2005-07-20	65.0	151.8	
	2	2005-06-03	2005-07-20	0.0	64.0	
	1	2005-08-30	2006-01-10	65.0	151.8	
	2	2005-08-30	2006-01-10	0.0	64.0	
	1	2006-03-15	2006-05-15	65.0	151.8	
	2	2006-03-15	2006-05-15	0.0	64.0	
	1	2006-08-03		65.0	151.8	
	2	2006-08-03		0.0	64.0	
HLX36	1	2005-09-26	2006-11-13	0.0	199.8	Measurement start date
	1	2006-11-13		50.0	199.8	
	2	2006-11-13		0.0	49.0	
HLX37	1	2005-11-15	2006-11-07	0.0	199.8	Measurement start date
	1	2006-11-07		149.0	199.8	
	2	2006-11-07		118.0	148.0	
	3	2006-11-07		0.0	117.0	
HLX38	1	2006-09-06		0.0	199.5	Measurement start date
HLX39	1	2006-08-03		0.0	199.3	Measurement start date
HLX40	1	2006-05-18	2006-07-03	40.0	199.5	
	2	2006-05-18	2006-07-03	0.0	39.0	Not monitored
	1	2006-08-03		40.0	199.5	
	2	2006-08-03		0.0	39.0	Not monitored
HLX41	1	2006-08-03		0.0	199.5	Measurement start date
HLX42	1	2006-11-22		30.0	152.6	
	2	2006-11-22		0.0	29.0	
HLX43	1	2006-11-15	2006-11-27	21.0	170.6	
	2	2006-11-15	2006-11-27	0.0	20.0	
	1	2006-12-07		21.0	170.6	
	2	2006-12-07		0.0	20.0	
HMJ01	1	2006-09-07		32.9	46.0	
	2	2006-09-07		0.0	31.9	
HSH01	1	2004-04-01		25.0	200.0	
	2	2004-04-01		0.0	24.0	
HSI04	1	2004-06-23		0.0	37.0	Measurement start date
HSI13	1	2004-06-23		0.0	4.0	Measurement start date
KAV01	1	2005-09-05		582.93	757.31	
	2	2005-09-05		434.93	581.93	
	3	2005-09-05		390.93	433.93	
	4	2005-09-05		108.93	306.93	
	5	2005-09-05		0.0	107.93	
KAV02	1	2005-01-14		0.0	97.1	
KAV03	1	2004-05-11		16.0	248.4	
	2	2004-05-11		0.0	15.0	Not monitored
KAV04A	1	2005-04-27		675.0	1,000.0	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
	2	2005-04-27		440.0	674.0	
	3	2005-04-27		214.0	439.0	
	4	2005-04-27		0.0	213.0	
KBH03	1	2004-06-23		0.0	100.43	Measurement start date
KLX01	1	2004-10-26		705.0	1,077.99	
	2	2004-10-26		191.0	704.0	
	3	2004-10-26		171.0	190.0	
	4	2004-10-26		0.0	170.0	
KLX02	1	2004-11-15		1,165.0	1,700.0	
	2	2004-11-15		1,145.0	1,164.0	
	3	2004-11-15		718.0	1,144.0	
	4	2004-11-15		495.0	717.0	
	5	2004-11-15		452.0	494.0	
	6	2004-11-15		348.0	451.0	
	7	2004-11-15		208.0	347.0	
	8	2004-11-15		0.0	207.0	
KLX03	1	2006-01-16		965.5	971.5	
	2	2006-01-16		830.5	964.5	
	3	2006-01-16		752.5	829.5	
	4	2006-01-16		729.5	751.5	
	5	2006-01-16		652.5	728.5	
	6	2006-01-16		465.5	651.5	
	7	2006-01-16		349.5	464.5	
	8	2006-01-16		199.5	348.5	
	9	2006-01-16		193.5	198.5	
	10	2006-01-16		0.0	192.5	
KLX04	1	2005-01-29		898.0	1,000.0	
	2	2005-01-29		870.0	897.0	
	3	2005-01-29		686.0	869.0	
	4	2005-01-29		531.0	685.0	
	5	2005-01-29		507.0	530.0	
	6	2005-01-29		231.0	506.0	
	7	2005-01-29		163.0	230.0	
	8	2005-01-29		0.0	162.0	
KLX05	1	2005-10-31		721.0	1,000.0	
	2	2005-10-31		634.0	720.0	
	3	2005-10-31		625.0	633.0	
	4	2005-10-31		501.0	624.0	
	5	2005-10-31		361.0	500.0	
	6	2005-10-31		256.0	360.0	
	7	2005-10-31		241.0	255.0	
	8	2005-10-31		220.0	240.0	
	9	2005-10-31		128.0	219.0	
	10	2005-10-31		0.0	127.0	
KLX06	1	2005-07-05		761.0	1,000.0	
	2	2005-07-05		571.0	760.0	
	3	2005-07-05		554.0	570.0	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
	4	2005-07-05		411.0	553.0	
	5	2005-07-05		276.0	410.0	
	6	2005-07-05		256.0	275.0	
	7	2005-07-05		146.0	255.0	
	8	2005-07-05		0.0	145.0	
KLX07A	1	2006-02-21		781.0	844.73	
	2	2006-02-21		753.0	780.0	
	3	2006-02-21		612.0	752.0	
	4	2006-02-21		457.0	611.0	
	5	2006-02-21		333.0	456.0	
	6	2006-02-21		204.0	332.0	
	7	2006-02-21		104.0	203.0	
	8	2006-02-21		0.0	103.0	
KLX07B	1	2005-08-09	2005-12-20	112.0	200.0	
	2	2005-08-09	2005-12-20	49.0	111.0	
	3	2005-08-09	2005-12-20	0.0	48.0	
	1	2006-03-01		95.0	200.0	
	2	2006-03-01		0.0	94.0	
KLX09	1	2005-11-04	2006-02-08	0.0	880.38	Measurement start/stop date
	1	2006-02-14	2006-04-24	104.0	880.38	
	2	2006-02-14	2006-04-24	67.0	103.0	
	3	2006-02-14	2006-04-24	34.0	66.0	
	4	2006-02-14	2006-04-24	0.0	33.0	
	1	2006-11-20		564.0	880.38	
	2	2006-11-20		470.0	563.0	
	3	2006-11-20		199.0	469.0	
	4	2006-11-20		104.0	198.0	
	5	2006-11-20		0.0	103.0	
KLX09B	1	2006-01-30	2006-04-12	0.0	100.22	Measurement start/stop date
KLX09C	1	2006-01-17	2006-04-12	0.0	120.05	Measurement start/stop date
KLX09D	1	2005-11-22	2006-04-12	0.0	121.02	Measurement start/stop date
KLX09E	1	2005-12-08	2006-04-12	0.0	120.0	Measurement start/stop date
KLX09F	1	2006-01-09	2006-04-12	0.0	152.3	Measurement start/stop date
	1	2006-05-18		0.0	152.3	Measurement start date
KLX09G	1	2006-02-15	2006-04-12	0.0	100.1	Measurement start/stop date
KLX10	1	2006-07-05		711.0	1,001.0	
	2	2006-07-05		689.0	710.0	
	3	2006-07-05		465.0	688.0	
	4	2006-07-05		369.0	464.0	
	5	2006-07-05		351.0	368.0	
	6	2006-07-05		291.0	350.0	
	7	2006-07-05		131.0	290.0	
	8	2006-07-05		0.0	130.0	
KLX11A	1	2006-04-07	2006-05-10	0.0	992.29	Measurement start/stop date
	1	2006-08-31	2006-10-24	104.0	611.28	
	2	2006-08-31	2006-10-24	67.0	103.0	
	3	2006-08-31	2006-10-24	34.0	66.0	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
	4	2006-08-31	2006-10-24	0.0	33.0	
	1	2006-11-15		0.0	992.29	Measurement start date
KLX11B	1	2006-05-08	2006-10-25	0.0	100.2	Measurement start/stop date
	1	2006-11-15		0.0	100.2	Measurement start date
KLX11C	1	2006-04-06	2006-10-25	0.0	120.15	Measurement start/stop date
KLX11D	1	2006-04-17	2006-10-25	0.0	120.35	Measurement start/stop date
KLX11E	1	2006-04-25		0.0	121.3	Measurement start date
KLX11F	1	2006-04-04	2006-10-25	0.0	120.05	Measurement start/stop date
KLX12A	1	2006-10-24		546.0	602.3	
	2	2006-10-24		535.0	545.0	
	3	2006-10-24		426.0	534.0	
	4	2006-10-24		386.0	425.0	
	5	2006-10-24		291.0	385.0	
	6	2006-10-24		160.0	290.0	
	7	2006-10-24		142.0	159.0	
	8	2006-10-24		104.0	141.0	
	9	2006-10-24		0.0	103.0	
KLX13A	1	2006-10-11	2006-11-08	469.0	595.85	
	2	2006-10-11	2006-11-08	340.0	468.0	
	3	2006-10-11	2006-11-08	0.0	339.0	
KLX18A	1	2006-08-30	2006-09-26	440.0	611.28	
	2	2006-08-30	2006-09-26	241.0	439.0	
	3	2006-08-30	2006-09-26	0.0	240.0	
KLX19A	1	2006-06		0	800.07	Measurement start date
KLX20A	1	2006-10-16		0.0	457.92	Measurement start date
KSH01A	1	2004-10-07		800.0	1,003.0	
	2	2004-10-07		671.0	799.0	
	3	2004-10-07		573.0	670.0	
	4	2004-10-07		532.0	572.0	
	5	2004-10-07		331.0	531.0	
	6	2004-10-07		278.0	330.0	
	7	2004-10-07		238.0	277.0	
	8	2004-10-07		181.0	237.0	
	9	2004-10-07		0.0	180.0	
KSH02	1	2004-12-16		955.0	963.0	
	2	2004-12-16		649.0	954.0	
	3	2004-12-16		440.0	648.0	
	4	2004-12-16		411.0	439.0	
	5	2004-12-16		111.0	410.0	
	6	2004-12-16		91.0	110.0	
	7	2004-12-16		0.0	90.0	
KSH03A	1	2004-06-01		281.15	1,000.7	
	2	2004-06-01		180.65	280.15	
	3	2004-06-01		0.0	179.65	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
SSM000001	1	2002-10-08		0.0	3.1*	
	screen			2.0	3.0	
SSM000008	1	2003-12-08		0.0	5.1*	
	screen			3.0	5.0	
SSM000011	1	2004-01-29		0.0	3.1*	
	screen			1.0	3.0	
SSM000012	1	2004-01-22		0.0	6.1*	
	screen			5.0	6.0	
SSM000014	1	2003-12-09		0.0	3.1*	
	screen			2.0	3.0	
SSM000017	1	2004-05-04		0.0	2.1*	
	screen			1.0	2.0	
SSM000018	1	2003-12-11		0.0	3.1*	
	screen			2.0	3.0	
SSM000019	1	2004-05-04		0.0	3.1*	
	screen			2.0	3.0	
SSM000021	1	2004-05-04		0.0	4.1*	
	screen			3.0	4.0	
SSM000022	1	2004-01-12		0.0	7.1*	
	screen			5.0	7.0	
SSM000027	1	2004-06-28		0.0	5.1*	
	screen			3.0	5.0	
SSM000028	1	2004-06-09		0.0	3.1*	
	screen			2.0	3.0	
SSM000029	1	2004-06-08		0.0	7.1*	
	screen			5.0	7.0	
SSM000030	1	2004-09-10		0.0	5.1*	
	screen			4.0	5.0	
SSM000031	1	2004-06-10		0.0	4.1*	
	screen			3.0	4.0	
SSM000032	1	2004-06-15		0.0	4.1*	
	screen			3.0	4.0	
SSM000033	1	2004-06-15		0.0	2.1*	
	screen			1.0	2.0	
SSM000034	1	2004-06-16		0.0	4.1*	
	screen			3.0	4.0	
SSM000035	1	2004-06-09		0.0	4.1*	
	screen			3.0	4.0	
SSM000037	1	2004-06-22		0.0	4.1*	
	screen			3.0	4.0	
SSM000039	1	2004-06-21		0.0	5.1*	
	screen			3.0	5.0	
SSM000040	1	2004-06-14		0.0	3.1*	
	screen			2.0	3.0	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
SSM000041	1	2004-07-07		0.0	4.1*	
	screen			2.0	4.0	
SSM000042	1	2004-06-17		0.0	5.1*	
	screen			3.0	5.0	
SSM000210	1	2004-06-28		0.0	4.1*	
	screen			2.0	4.0	
SSM000213	1	2004-07-06		0.0	2.1*	
	screen			1.0	2.0	
SSM000215	1	2004-12-03		0.0	4.1*	
	screen			2.0	4.0	
SSM000218	1	2005-06-02		0.0	3.1*	
	screen			2.0	3.0	
SSM000219	1	2005-06-01		0.0	5.1*	
	screen			4.0	5.0	
SSM000220	1	2005-05-31		0.0	3.1*	
	screen			2.0	3.0	
SSM000221	1	2005-05-30		0.0	3.1*	
	screen			2.0	3.0	
SSM000222	1	2005-08-22		0.0	5.1*	
	screen			4.0	5.0	
SSM000223	1	2005-08-24		0.0	8.1*	
	screen			6.0	8.0	
SSM000224	1	2005-08-29		0.0	17.1*	
	screen			16.0	17.0	
SSM000225	1	2005-09-14		0.0	10.1*	
	screen			9.0	10.0	
SSM000226	1	2005-09-14		0.0	5.1*	
	screen			4.0	5.0	
SSM000227	1	2005-09-14		0.0	2.1*	
	screen			1.0	2.0	
SSM000228	1	2005-09-19		0.0	7.1*	
	screen			6.0	7.0	
SSM000229	1	2005-09-20		0.0	4.1*	
	screen			3.0	4.0	
SSM000230	1	2005-09-21		0.0	5.1*	
	screen			4.0	5.0	
SSM000236	1	2005-11-01		0.0	3.1*	
	screen			2.0	3.0	
SSM000237	1	2005-10-31		0.0	3.1*	
	screen			2.0	3.0	
SSM000238	1	2006-02-21		0.0	12.1*	
	screen			11.0	12.0	
SSM000239	1	2006-02-22		0.0	5.1*	
	screen			4.0	5.0	
SSM000240	1	2006-02-23		0.0	6.1*	
	screen			5.0	6.0	
SSM000241	1	2006-02-15		0.0	33.1*	
	screen			32.0	33.0	

Borehole	Section no	Section installed from	to	Borehole length ** from (m)	to (m)	Comment
SSM000242	1	2006-02-07		0.0	18.1*	
	screen			17.0	18.0	
SSM000243	1	2006-02-13		0.0	12.1*	
	screen			11.0	12.0	
SSM000244	1	2006-02-28		0.0	12.1*	
	screen			11.0	12.0	
SSM000245	1	2006-02-02		0.0	5.1*	
	screen			4.0	5.0	
SSM000246	1	2006-02-02		0.0	4.1*	
	screen			3.0	4.0	
SSM000249	1	2006-01-26		0.0	3.1*	
	screen			2.0	3.0	
SSM000250	1	2006-01-27		0.0	4.1*	
	screen			2.0	4.0	
SSM000252	1	2006-07-13		0.0	7.7*	
	screen			5.0	7.0	
SSM000253	1	2006-07-12		0.0	4.1*	
	screen			3.0	4.0	
SSM000255	1	2006-05-16		0.0	6.1*	
	screen			4.0	6.0	
SSM000256	1	2006-07-11		0.0	5.1*	
	screen			3.0	5.0	
SSM000257	1	2006-07-10		0.0	4.1*	
	screen			3.0	4.0	
SSM000260	1	2006-10-25		0.0	9.65*	
	screen			7.45	9.45	
SSM000261	1	2006-10-24		0.0	10.5*	
	screen			9.2	10.2	
SSM000265	1	2006-11-08		0.0	5.9*	
	screen			3.58	5.58	
SSM000266	1	2006-11-08		0.0	4.5*	
	screen			3.01	4.01	
SSM000268	1	2006-11-15		0.0	4.33*	
	screen			3.03	4.03	
SSM000269	1	2006-11-15		0.0	?	
	screen			1.0	1.8	
SSM000270	1	2006-11-15		0.0	3.2*	
	screen			2.0	3.0	
SSM000271	1	2006-11-14		0.0	1.5*	
	screen			0.99	1.49	

* For the soil wells (SSM-boreholes), the bottom of the section refers to the bottom of the plastic pipe installed in the borehole. The plastic pipe is screened.

** Borehole length is set to 0.0 at centre of top of casing. If there is only one section in the borehole and the given borehole length is from 0.0 m it implies that no packers are installed and that it is an open borehole. In a few cases (artesian boreholes) an extension pipe is mounted on the casing top to enable manual levelling and in those cases the given borehole length is from a negative value instead of 0.0 m.

5.2.1 General comments

Results from the measurements in surface boreholes are presented in diagrams. Level data from all sections in each borehole are presented in diagrams for the period of July 2005 until December 2006.

The symbols used in the diagrams are:

The lowest section	=	Section 1	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○
		Section 2	+ + + + + + + + + + +
		Section 3	× × × × × × × × ×
		Section 4	□ □ □ □ □ □ □ □ □ □ □
		Section 5	◇ ◇ ◇ ◇ ◇ ◇ ◇ ◇ ◇
		Section 6	△ △ △ △ △ △ △ △ △ △ △
		Section 7	◁ ◁ ◁ ◁ ◁ ◁ ◁ ◁ ◁ ◁ ◁
		Section 8	▽ ▽ ▽ ▽ ▽ ▽ ▽ ▽ ▽ ▽ ▽
		Section 9	▷ ▷ ▷ ▷ ▷ ▷ ▷ ▷ ▷ ▷ ▷
		Section 10	✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕
		Section 11	✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕ ✕
		Section 12	○ ○

Sometimes it is difficult to differentiate registrations from individual sections in the diagrams. However, since the main purpose of this report is to present an overall view of the long-term changes, it was not found to be advantageous to show more detailed diagrams from individual sections. More detailed diagrams during test periods are presented in reports from the different tests.

Due to failures in the mechanical or electronic equipment, data is sometimes missing for longer or shorter periods. This is not commented on below. For more comments on the diagrams, see Site investigation Internal Reports.

Remarks are given when the registration for some reason has a deviating appearance.
When registrations are missing, manually levelled data, if available, are inserted.

In many boreholes, the groundwater level shows large and rapid variations. This is often due to nearby drilling. Also, many borehole sections are influenced by other activities such as pumping, water sampling, tracer tests etc.

Packers may deflate due to leakage, which can be difficult to discover. If a section in a borehole suddenly shows a pressure that is close to the pressure in a neighbouring section, the reason might be deflated packers.

5.2.2 Comments on some of the diagrams

HAV06: A packer leakage occurred in November 2005.

HLX16: The borehole is mostly artesian from the middle of November 2006.

HLX35: Due to a broken tube connector there is a short circuit between the sections from the middle of March 2006 to the middle of May 2006.

HLX37: Section 3 is artesian from the end of November 2006.

KAV03: No explanation has been found to the stepwise level increase during 2006. In October 2006 the packer was replaced. In addition, a check was made that showed that the connection through the standpipe to the borehole section seemed to be in order. After these efforts no more increases have been observed. However, the high level remains, but is, as the previous increases, confirmed by manual levellings.

KLX01: The higher level that occurs for shorter periods in section 4 is due to precipitation/ snowmelt.

KLX09: Reference level is missing for the period November 2005–February 2006. From the middle of February 2006 the transducer positions are known and absolute levels have been calculated.

KLX09G: No manual levellings have been performed and the transducer position is not known, why reference level is missing.

KLX11A: Absolute levels have been calculated from transducer positions for the measurement period September–October 2006.

KLX11D and KLX11F: Reference levels are missing for the period April–May 2006.

KSH01A: The deviating appearance for section 1 is probably caused by the very low transmissivity in this section (or poor communication between the standpipe and the section). The mini-packer is released when manual levelling is performed and a sudden jump in the level occurs. Thereafter, when the mini-packer is inflated again, the level is slowly approaching the actual level in the borehole section.

SSM000011: The borehole was reported to be dry at the levelling occasions in November 2005 and October 2006 and data have been removed. By the look of the registration, the borehole was probably also dry during a period from July to August 2006. However, during this period no manual levelling has been performed to confirm this, why data have not been removed.

SSM000039: Data have been removed from the end of August to the end of December 2005 when the borehole was reported to be dry.

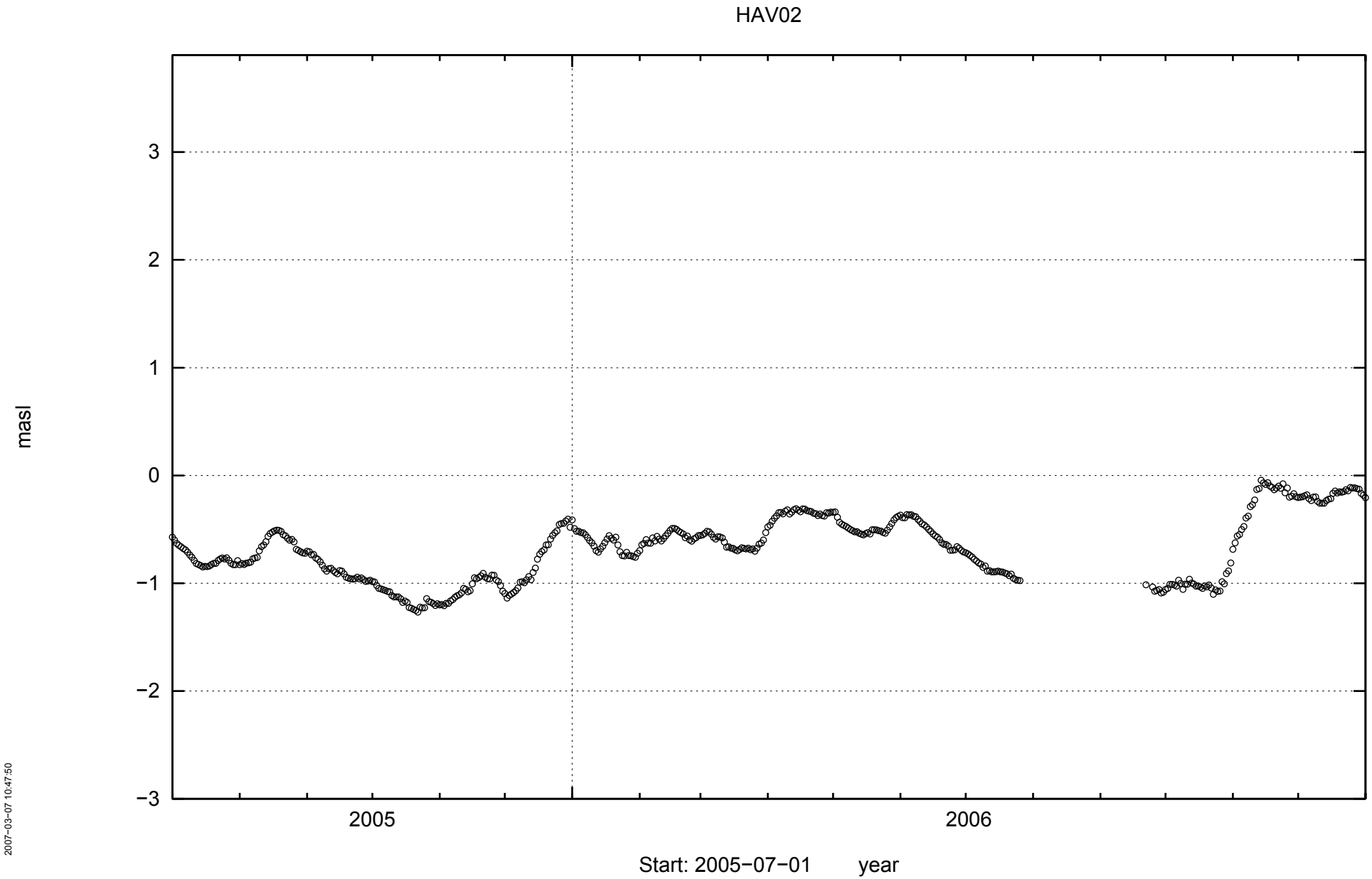
SSM000218: The borehole was reported to be dry at the levelling occasions in July, September and October 2006 and data have been removed.

SSM000227: By the look of the registration, the borehole seems to be mostly dry during a period from July to August 2006. However, during this period no manual levelling has been performed to confirm this, why data have not been removed.

Appendix 1

Groundwater level

Percussion boreholes	Core boreholes	Soil wells
HAV02	KAV01–KAV03	SSM000001
HAV06	KAV04A	SSM000008
HLX01	KBH03	SSM000011
HLX02	KLX01–KLX06	SSM000012
HLX06–HLX11	KLX07A-B	SSM000014
HLX13–HLX28	KLX09	SSM000017–SSM000019
HLX30–HLX43	KLX09B-G	SSM000021
HMJ01	KLX10	SSM000022
HSH01	KLX11A-F	SSM000027–SSM000035
HSI04	KLX12A	SSM000037
HSI13	KLX13A	SSM000039–SSM000042
	KLX18A	SSM000210
	KLX19A	SSM000213
	KLX20A	SSM000215
	KSH01A	SSM000218–SSM000230
	KSH02	SSM000236–SSM000246
	KSH03A	SSM000249
		SSM000250
		SSM000252
		SSM000253
		SSM000255–SSM000257
		SSM000260
		SSM000261
		SSM000265
		SSM000266
		SSM000268–SSM000271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0
−1
−2
−3
2005
2006
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year
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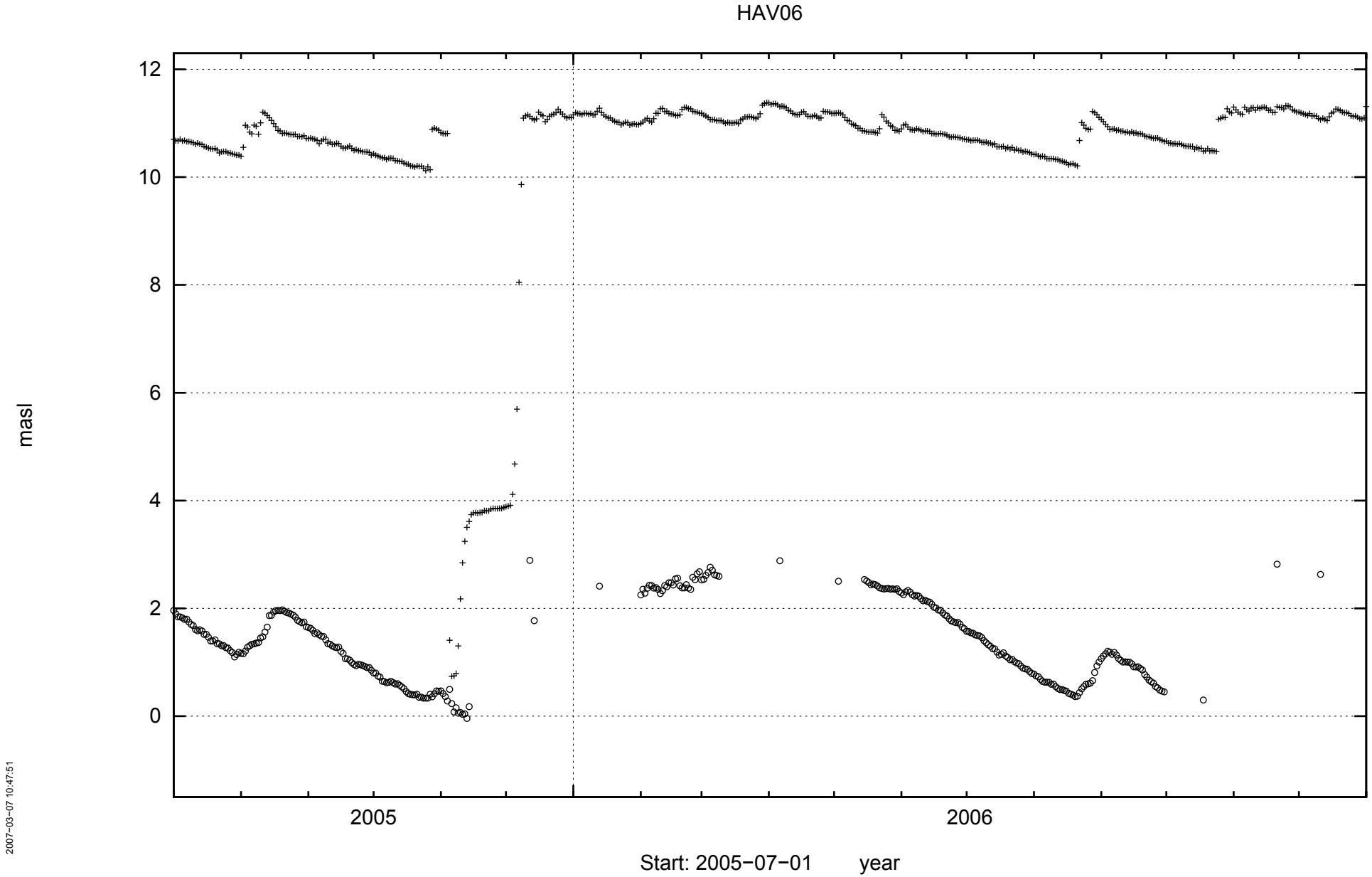
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8
6
4
2
0
masl
2005
2006
Start: 2005-07-01
year
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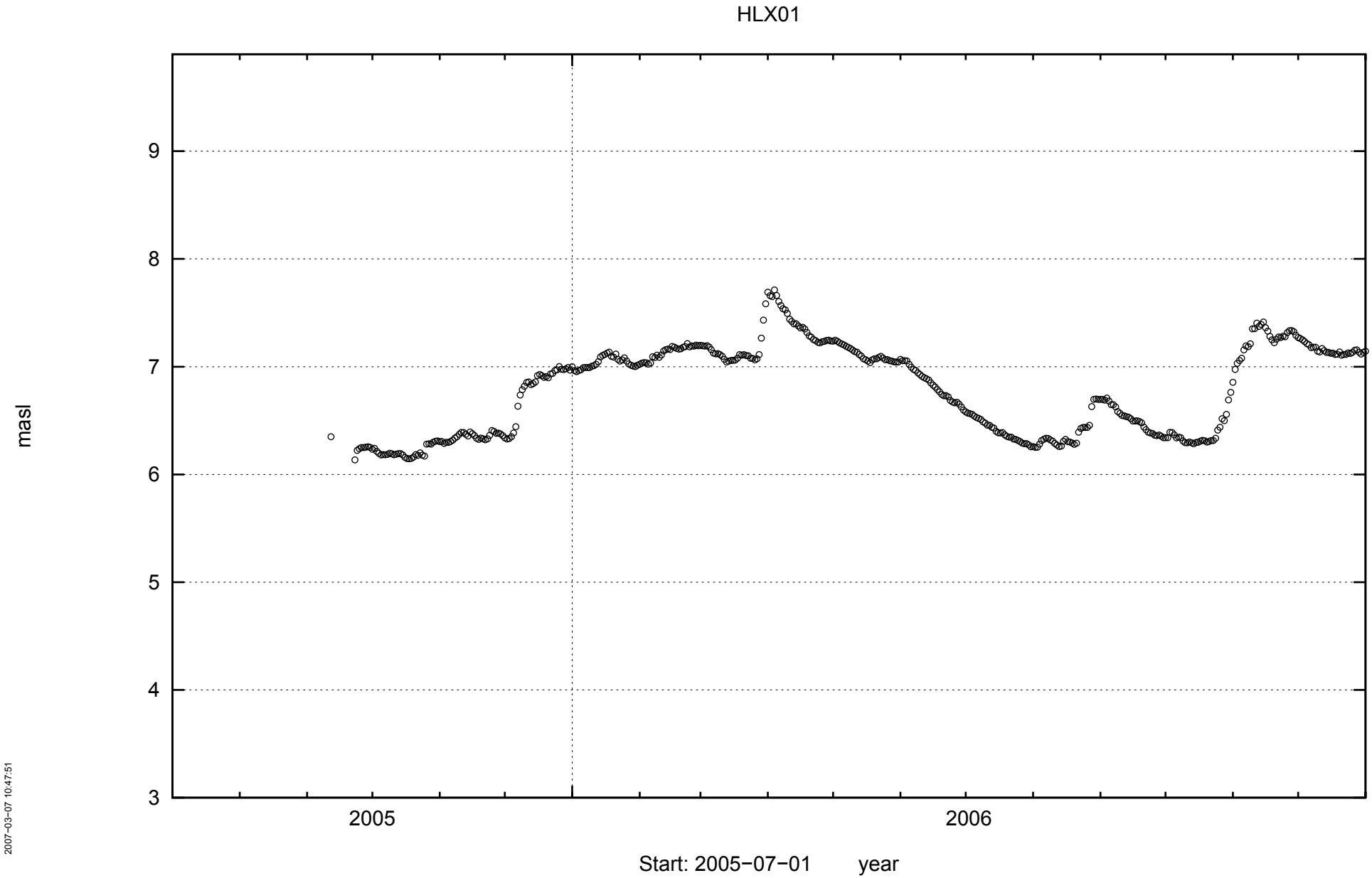
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7
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4
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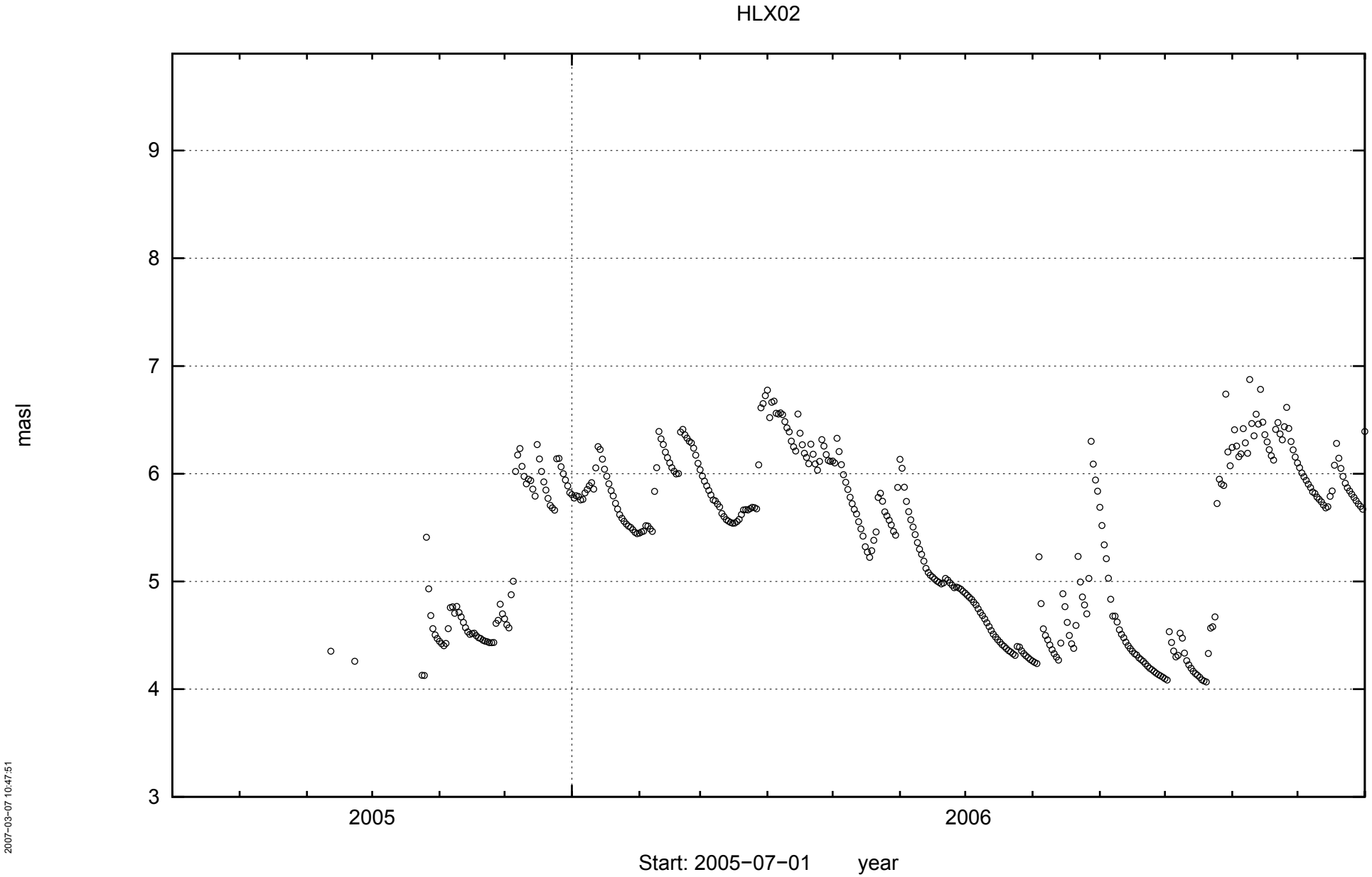

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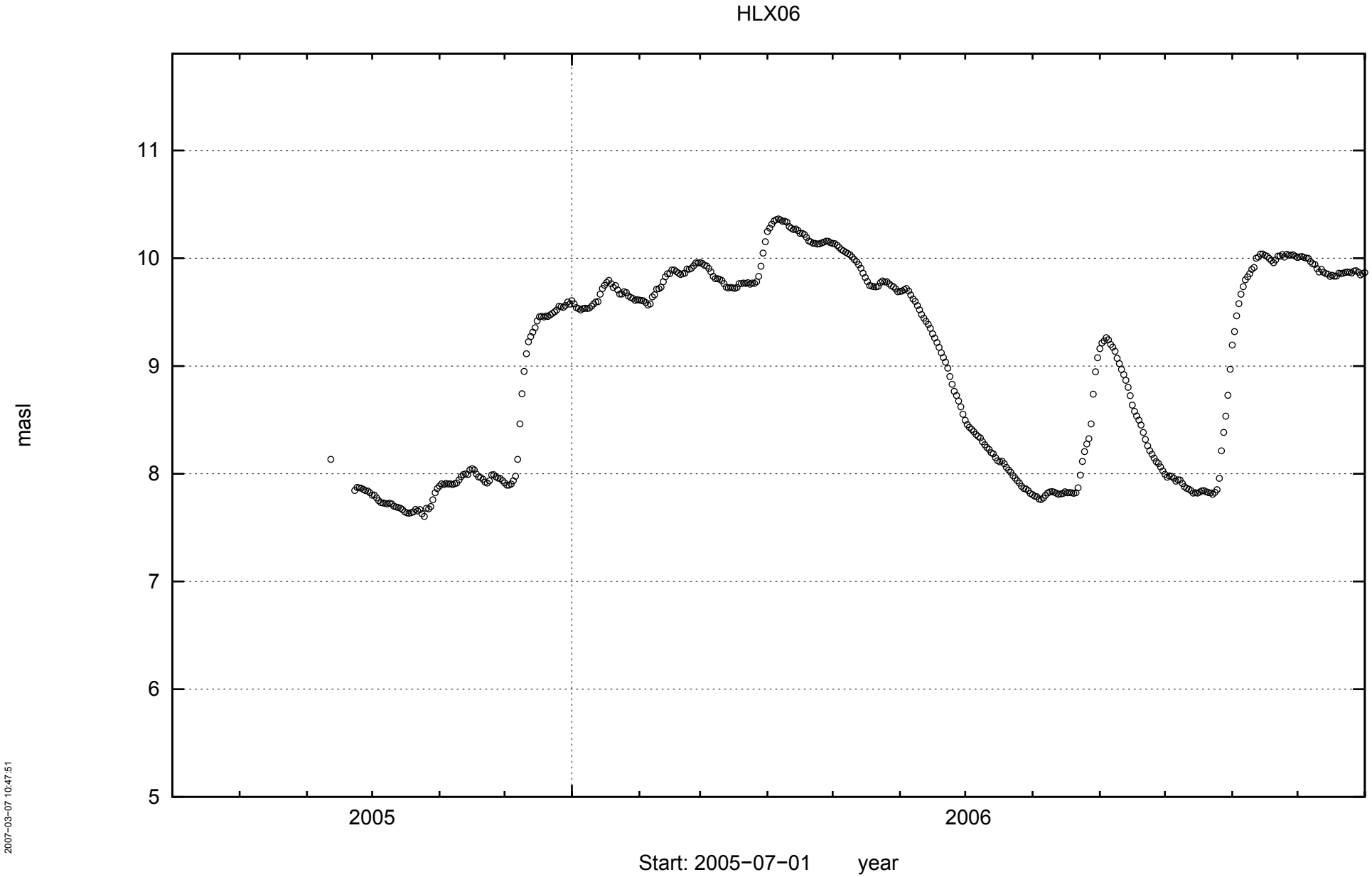
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masl
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5
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2006
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year
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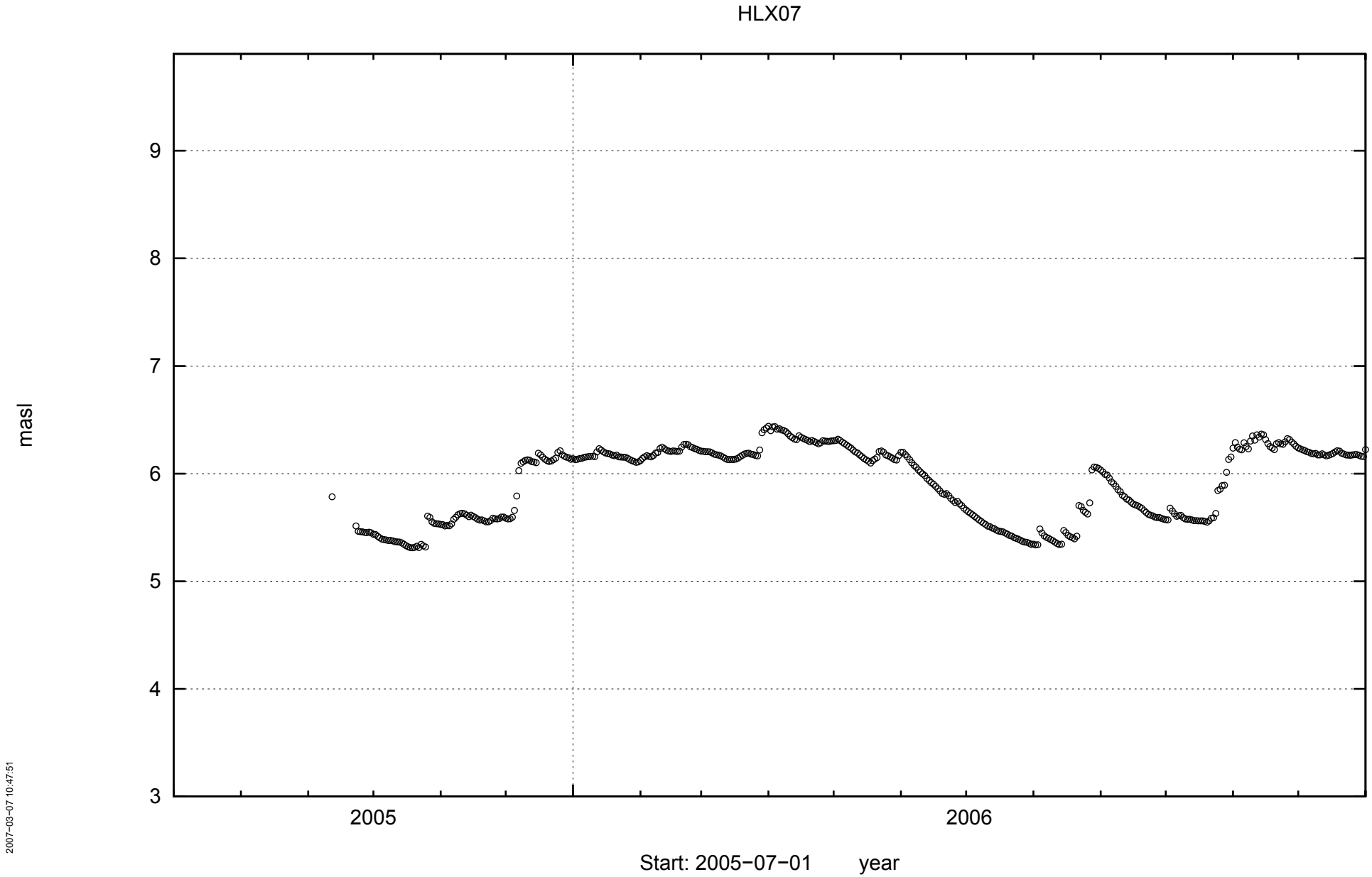
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3
masl
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year
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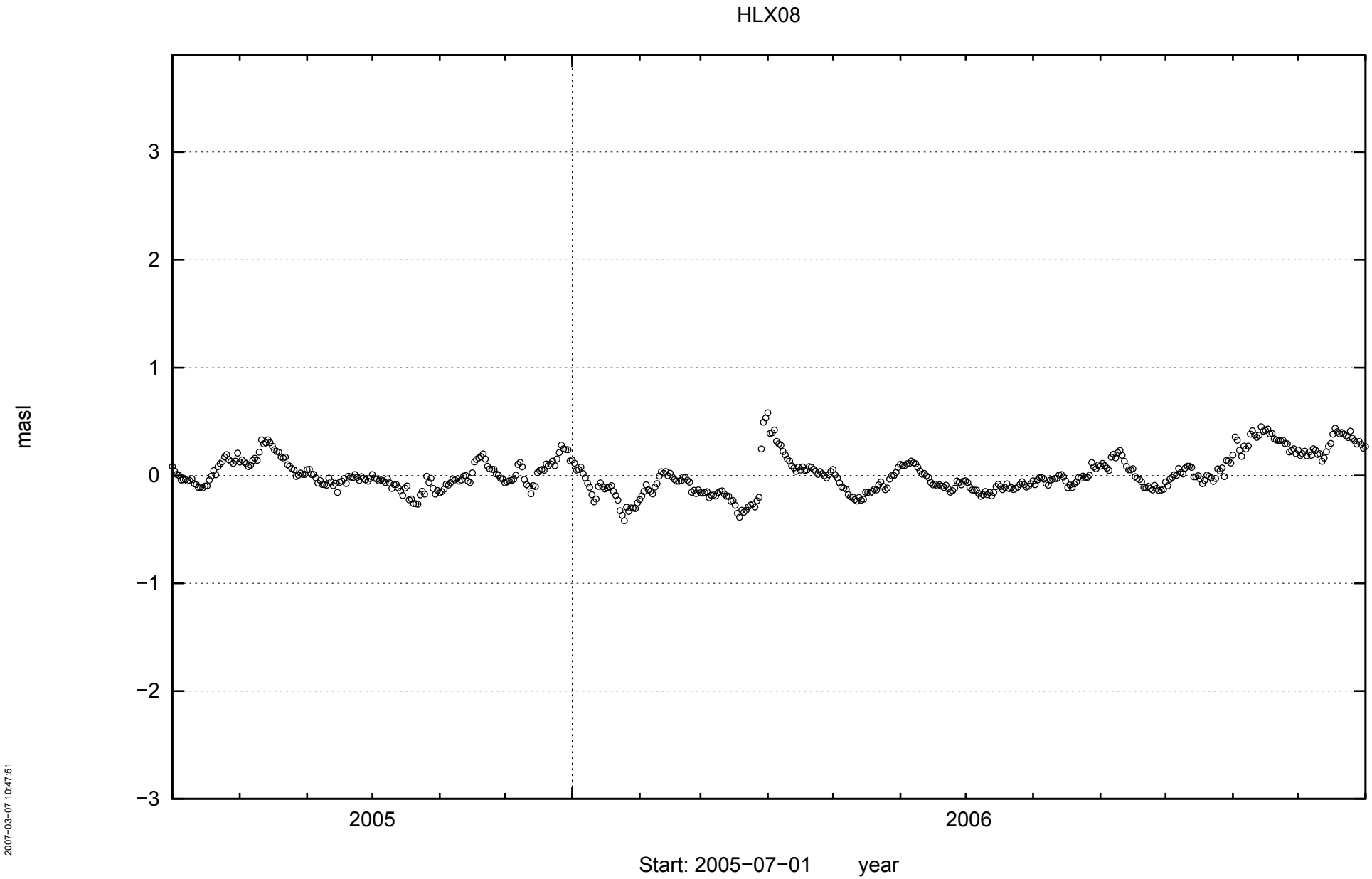
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2005
2006
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year
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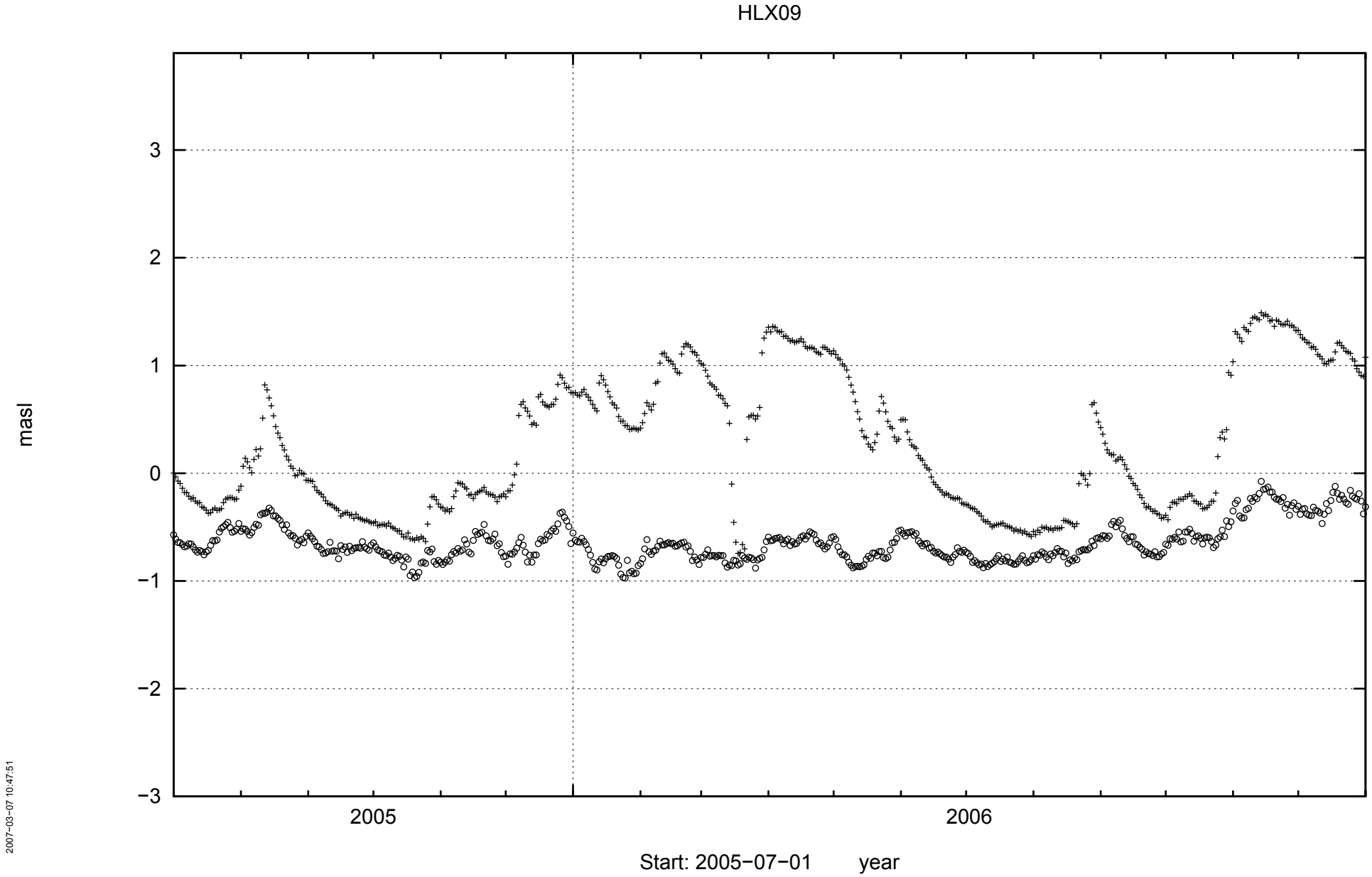
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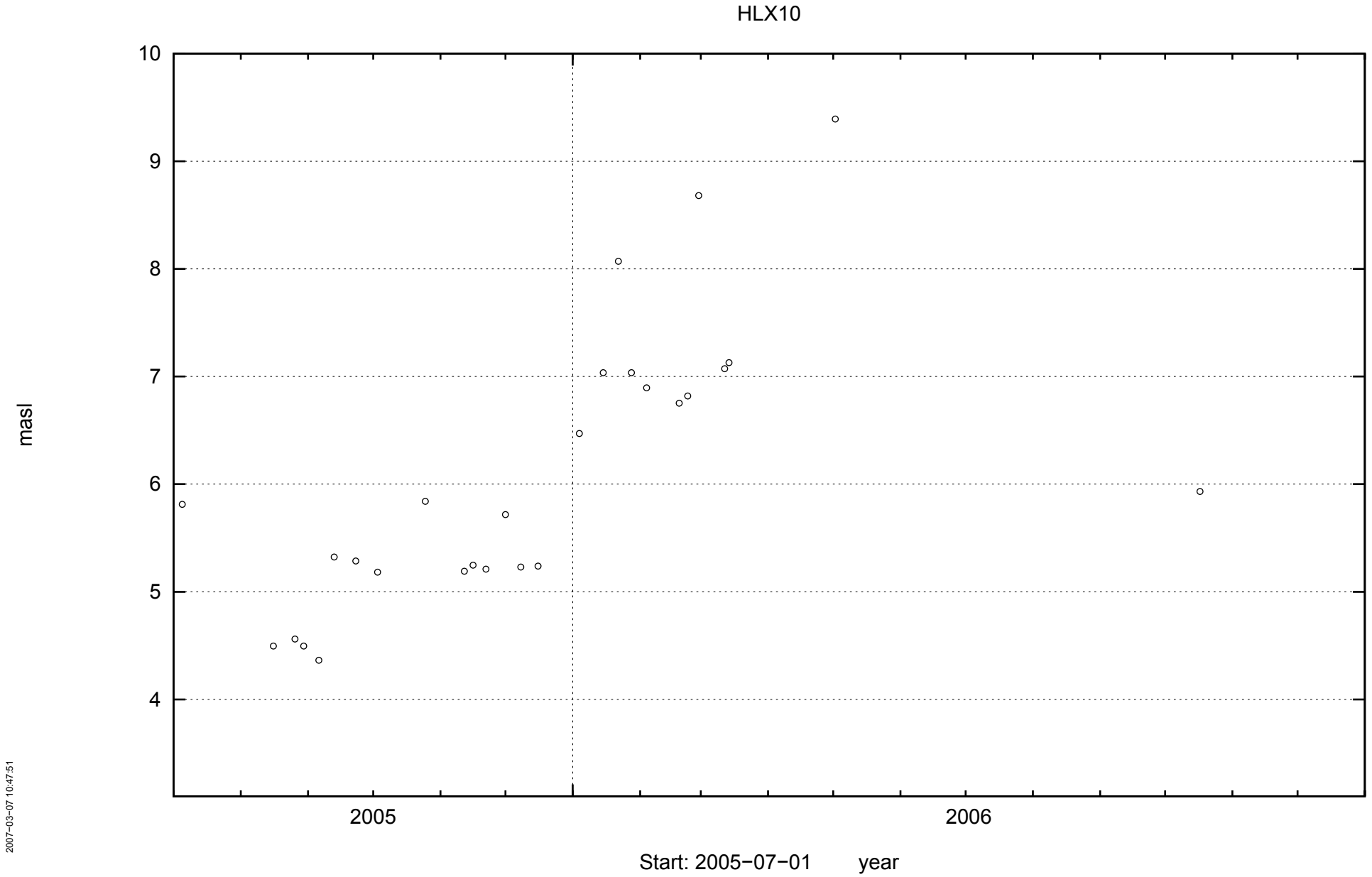
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4
masl
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2006
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year
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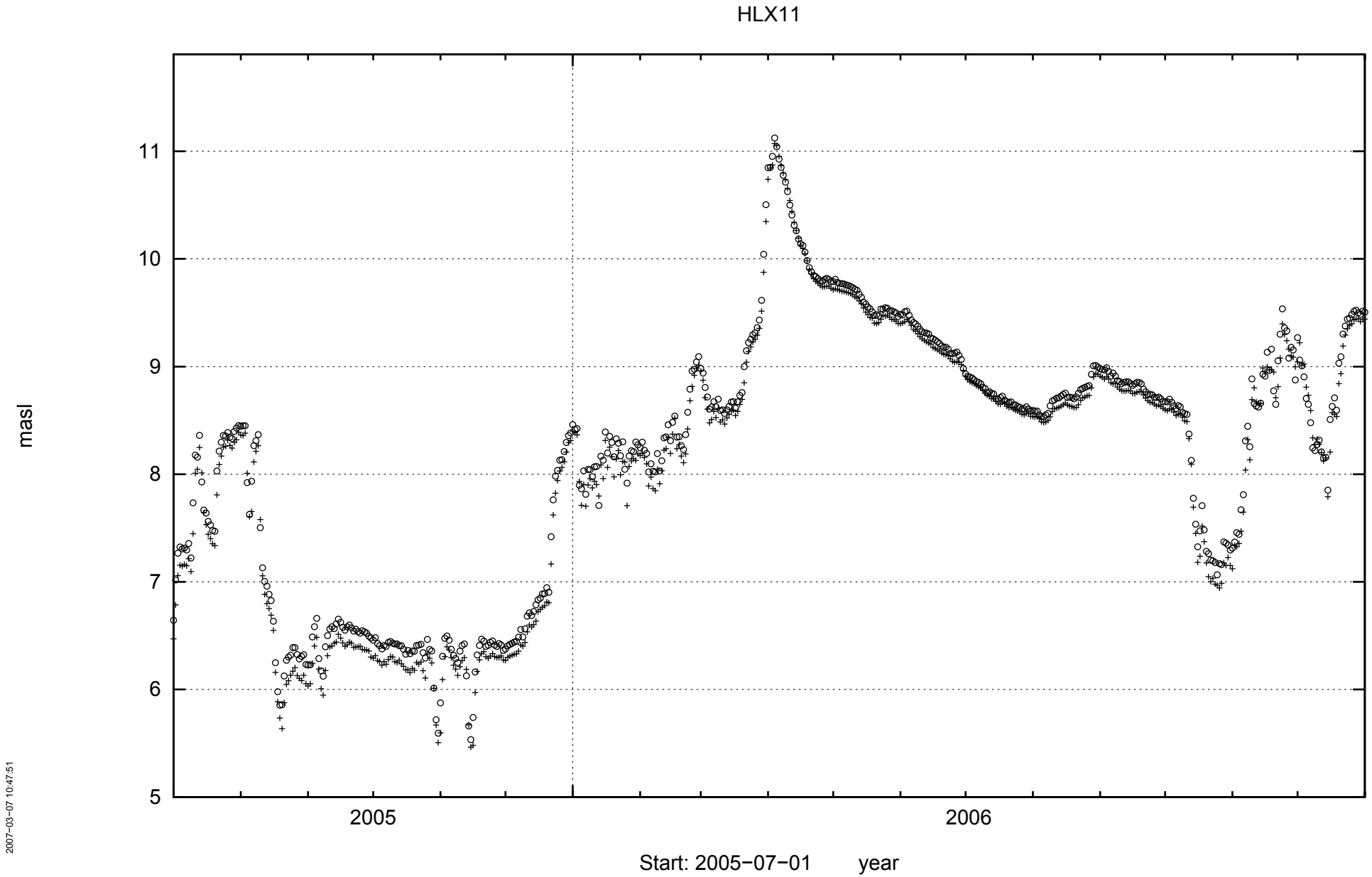

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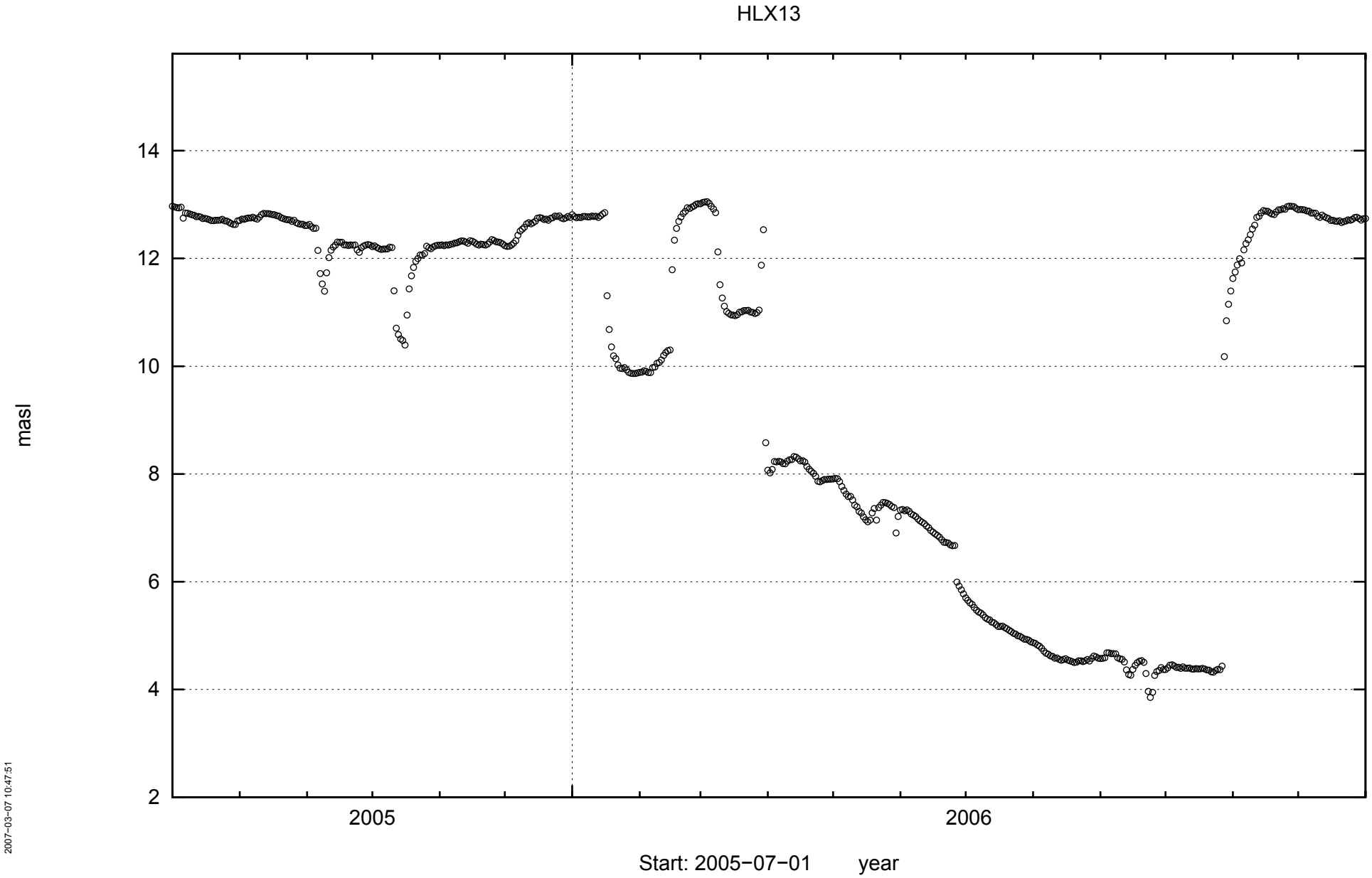
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6
4
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2005
2006
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year
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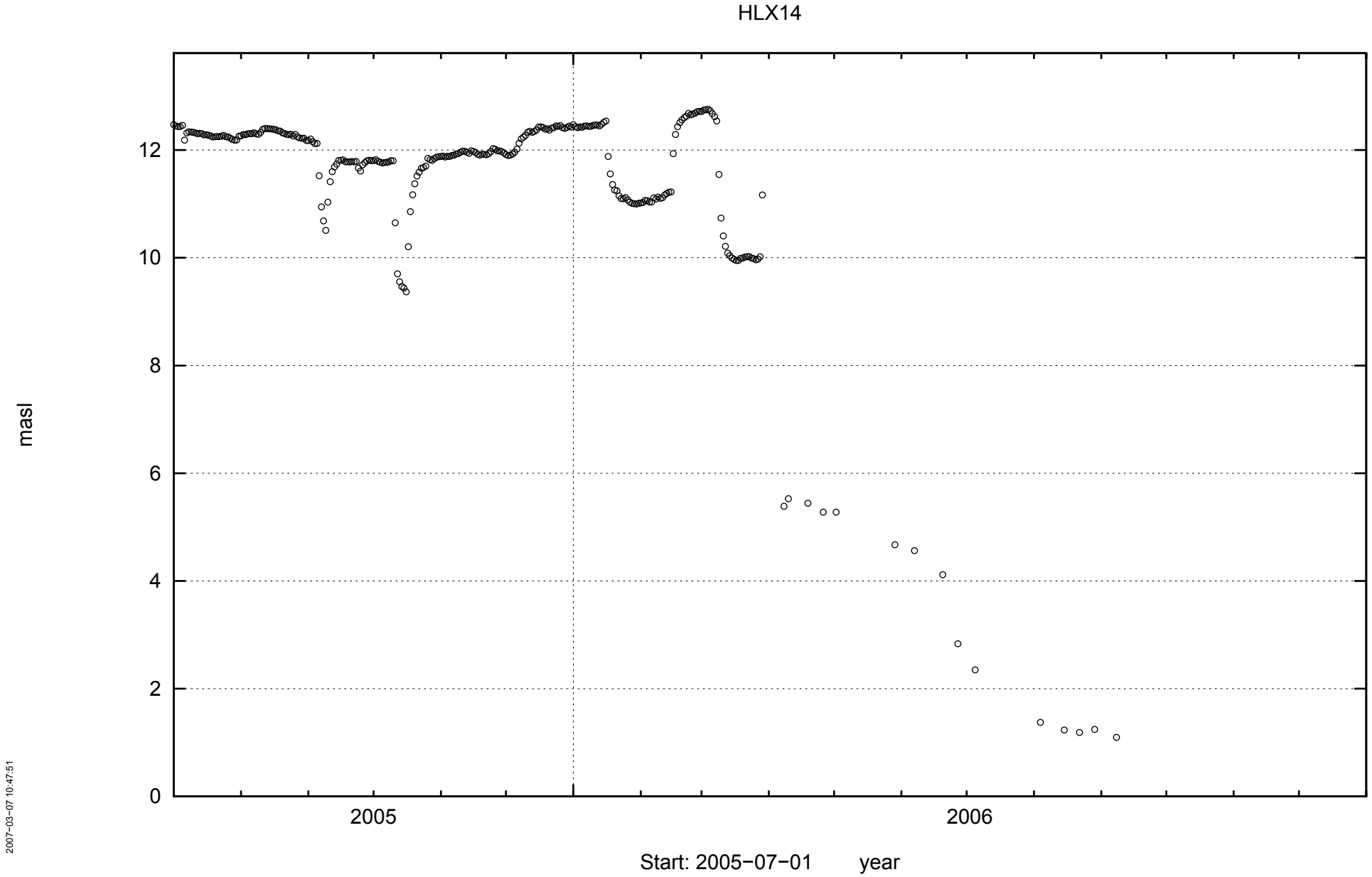
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2
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2005
2006
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year
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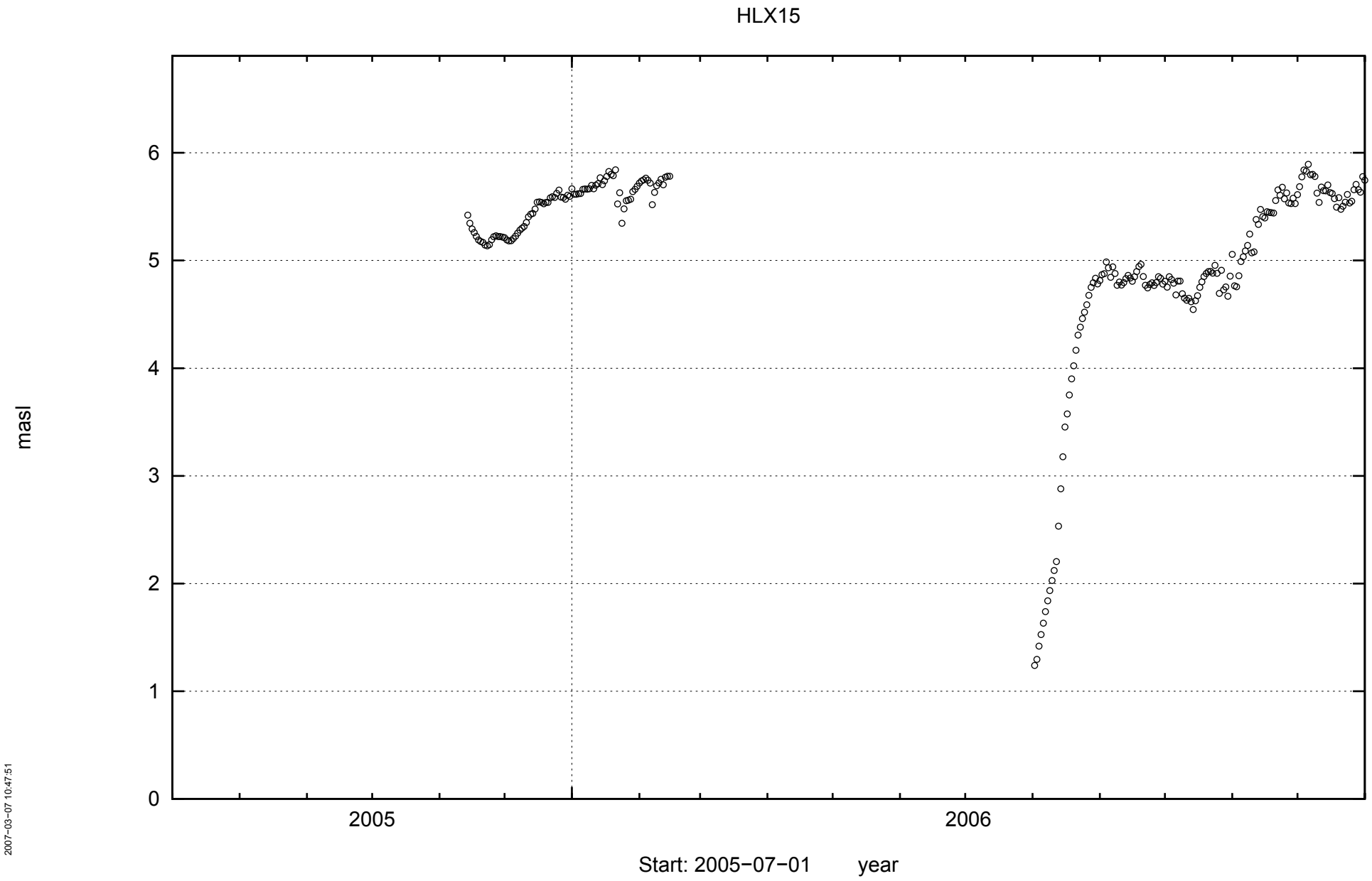
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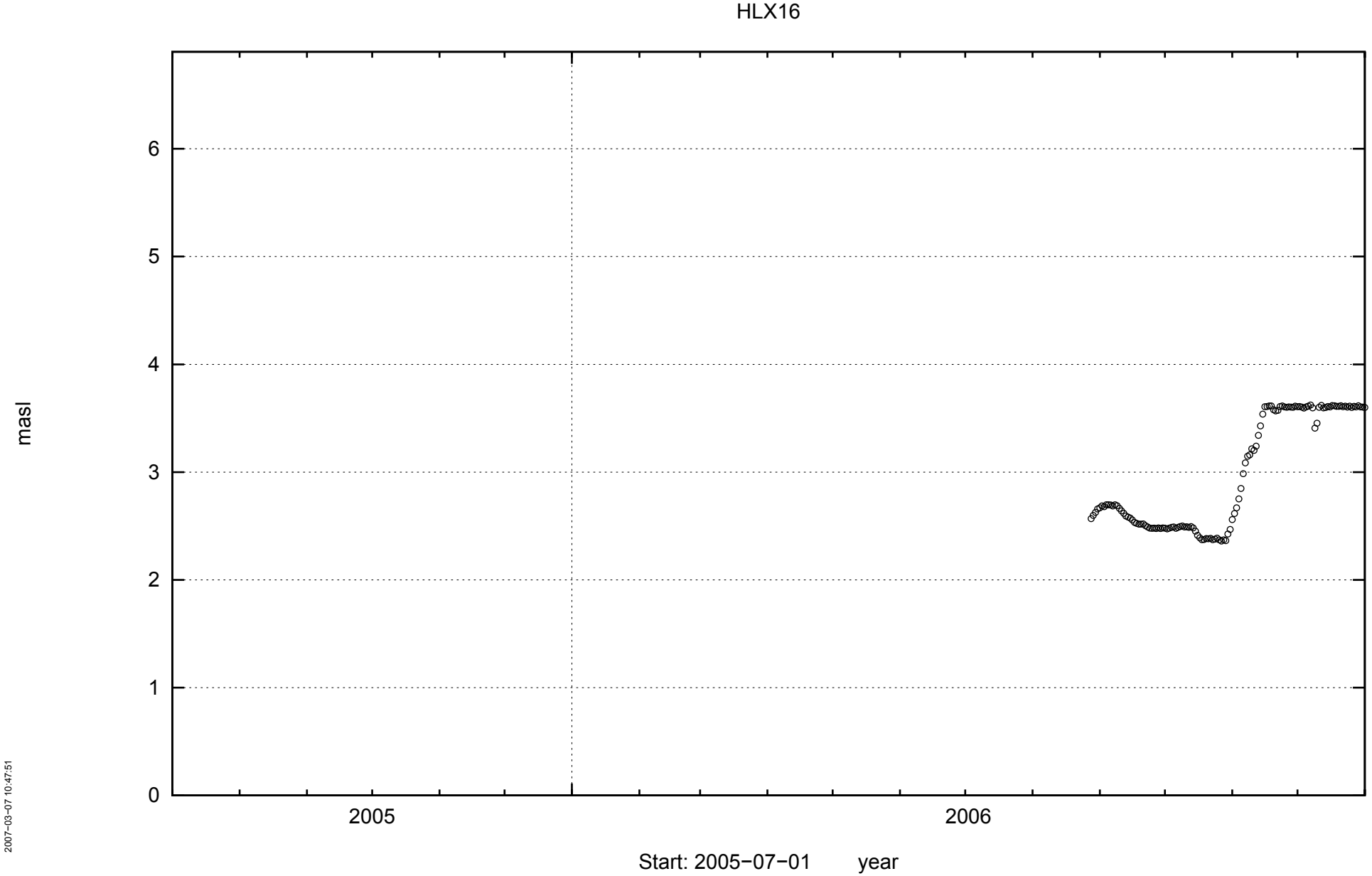
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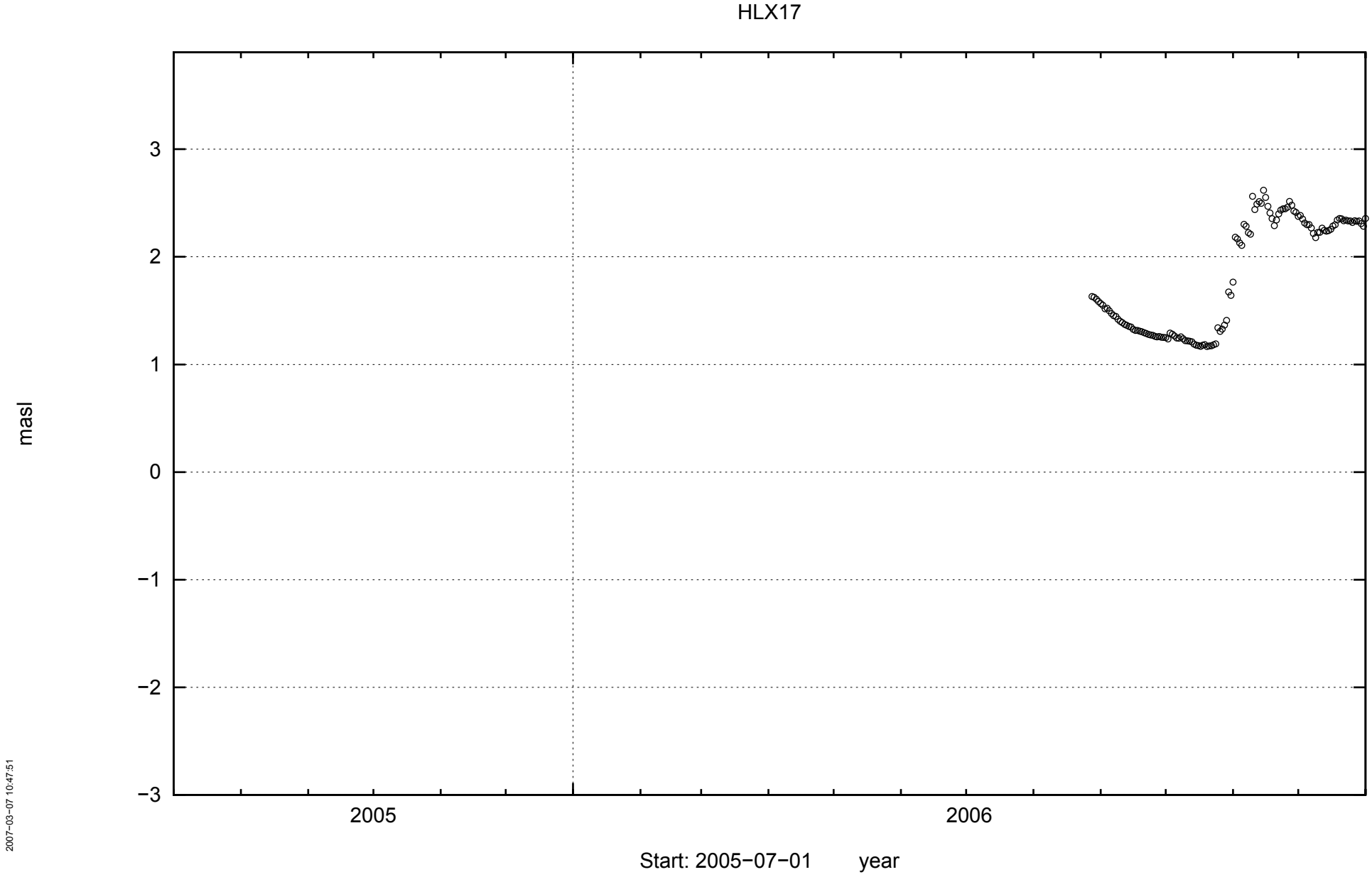
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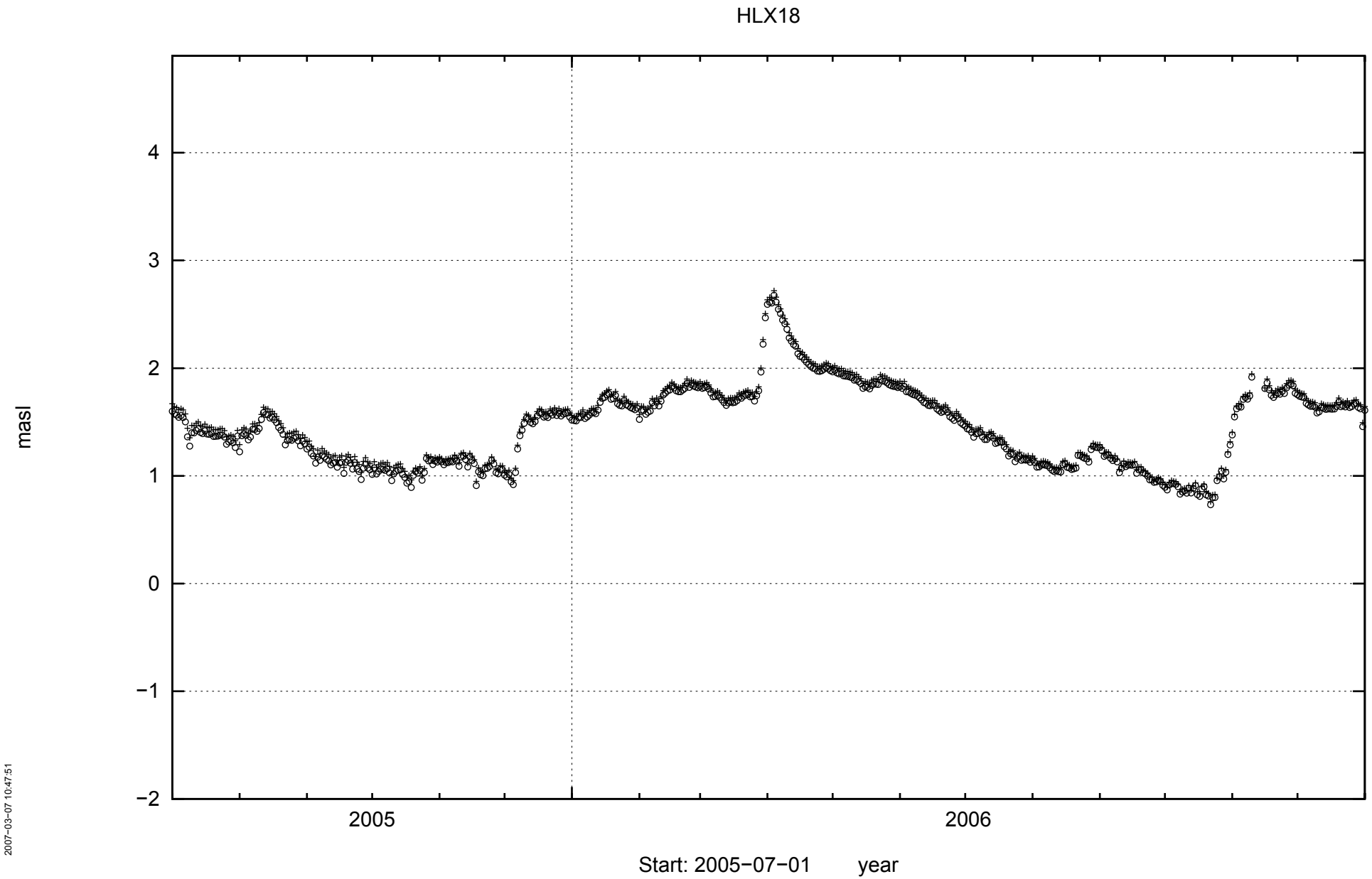
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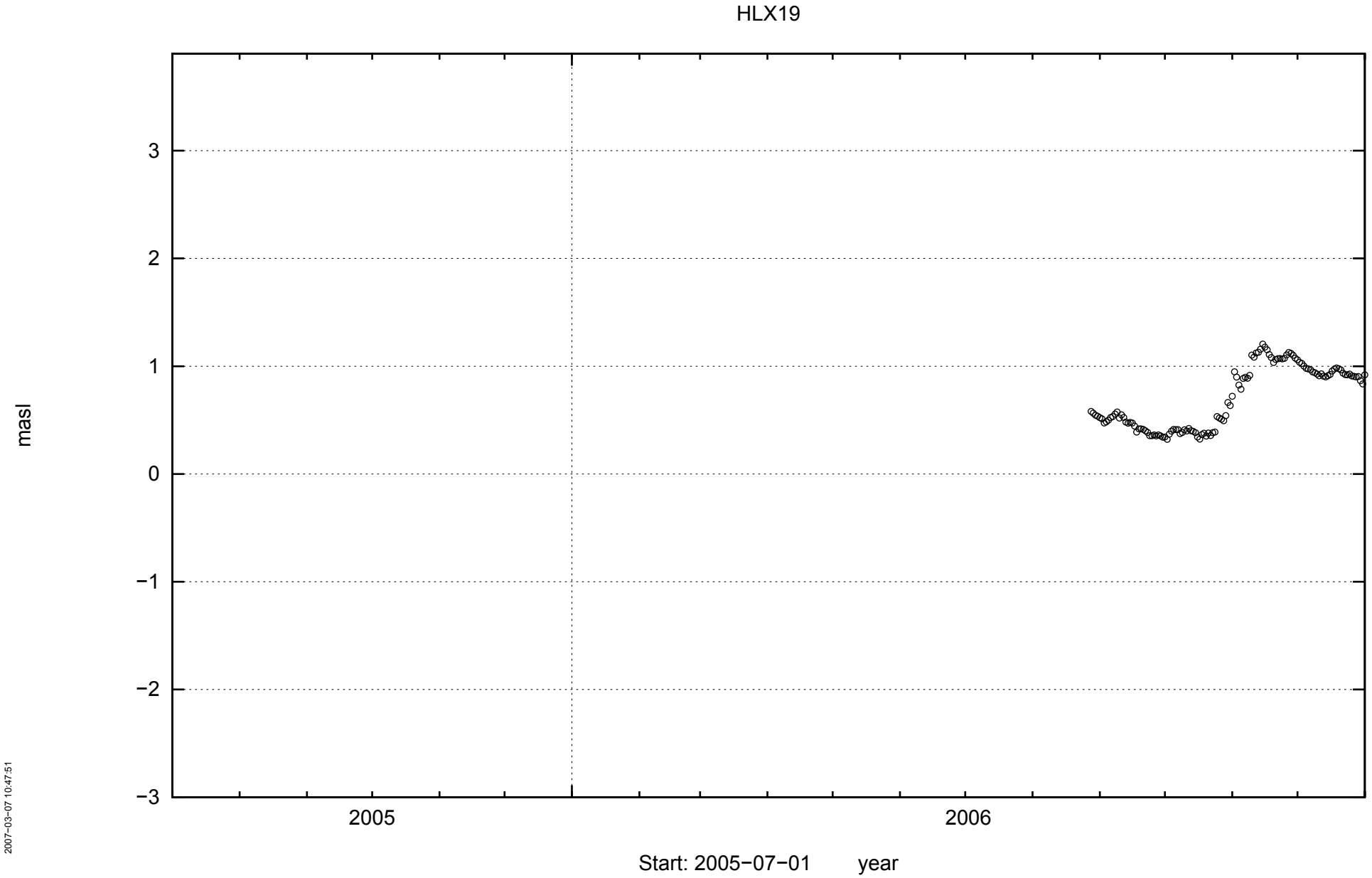
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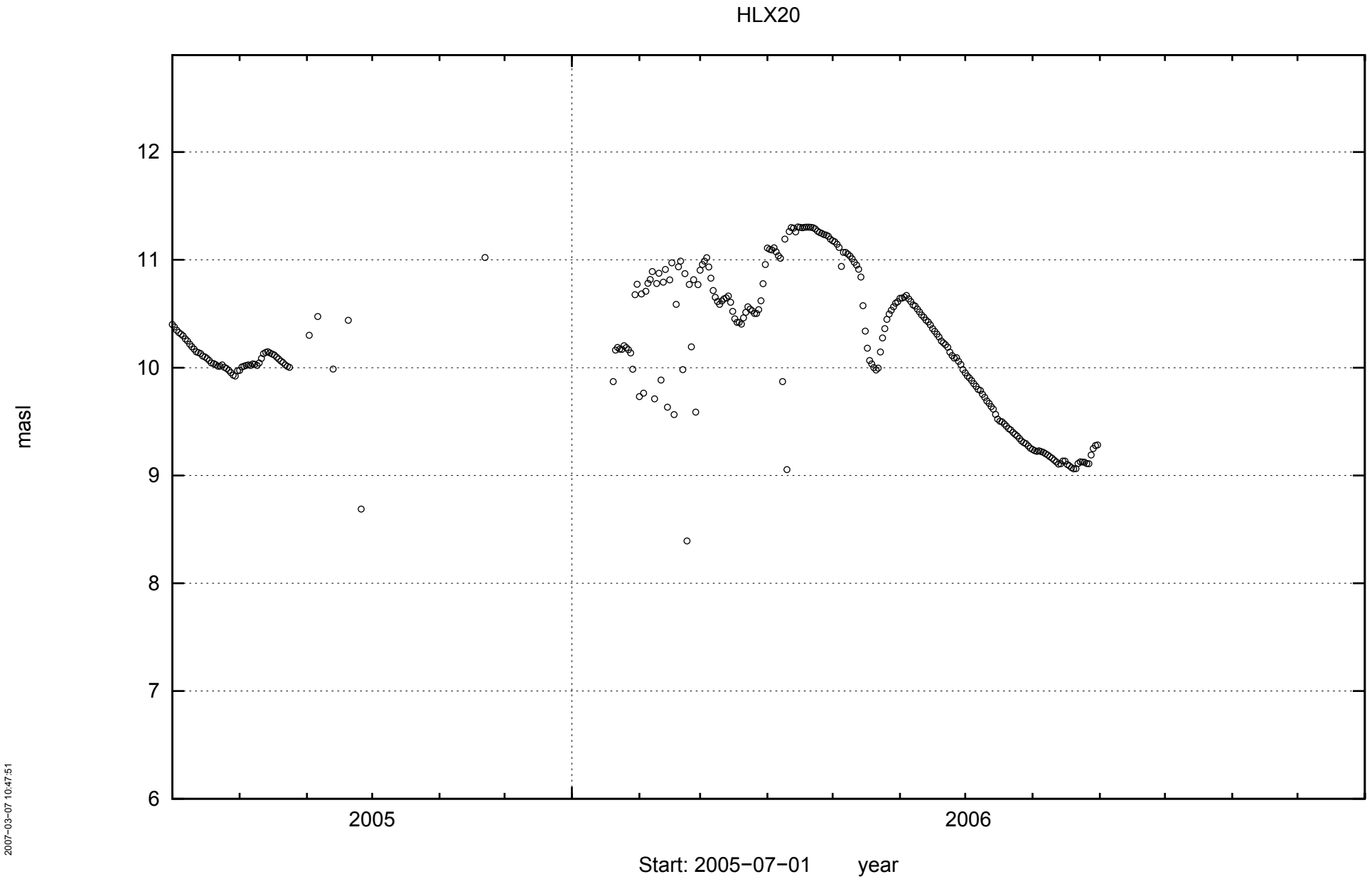
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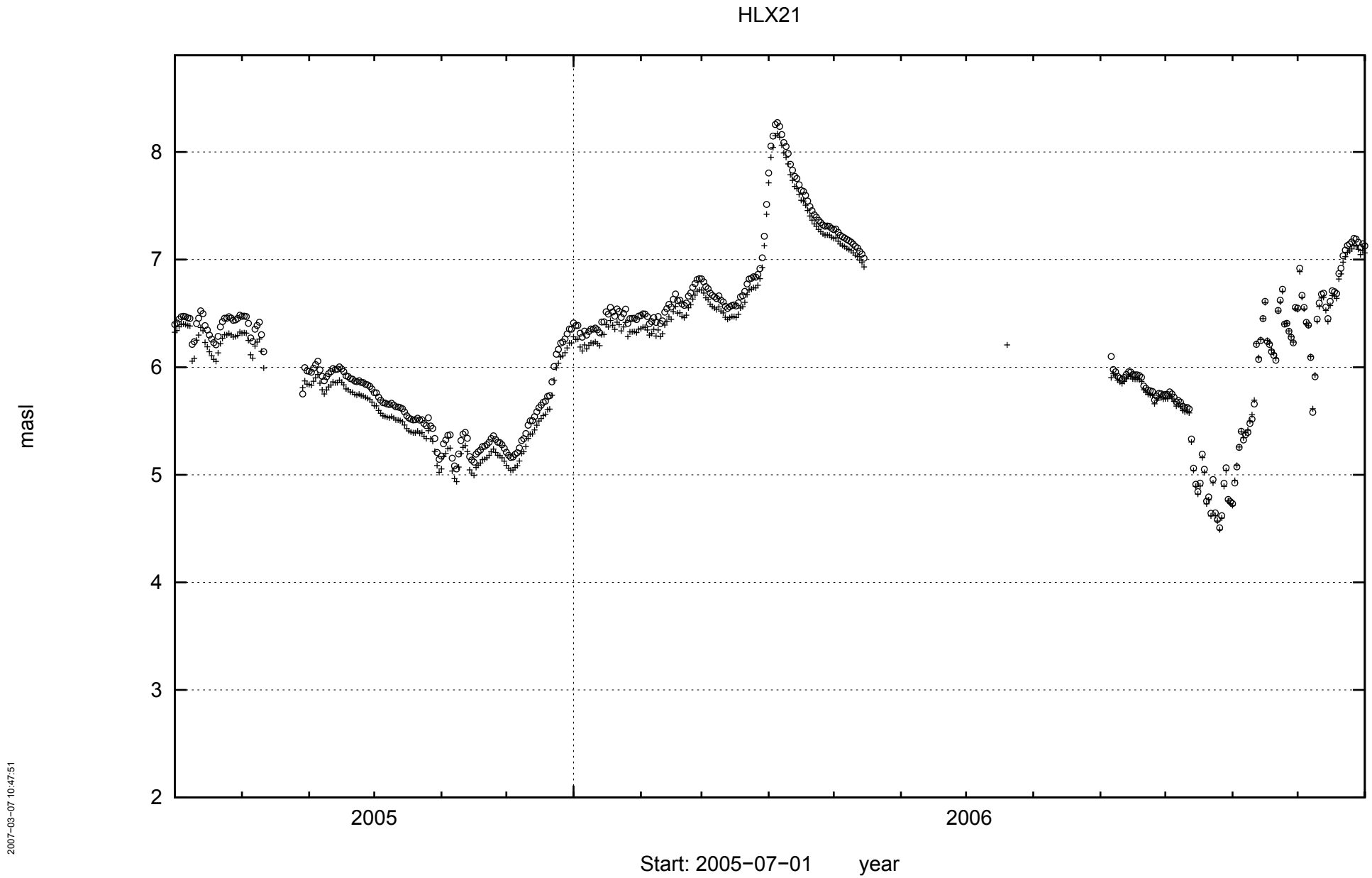
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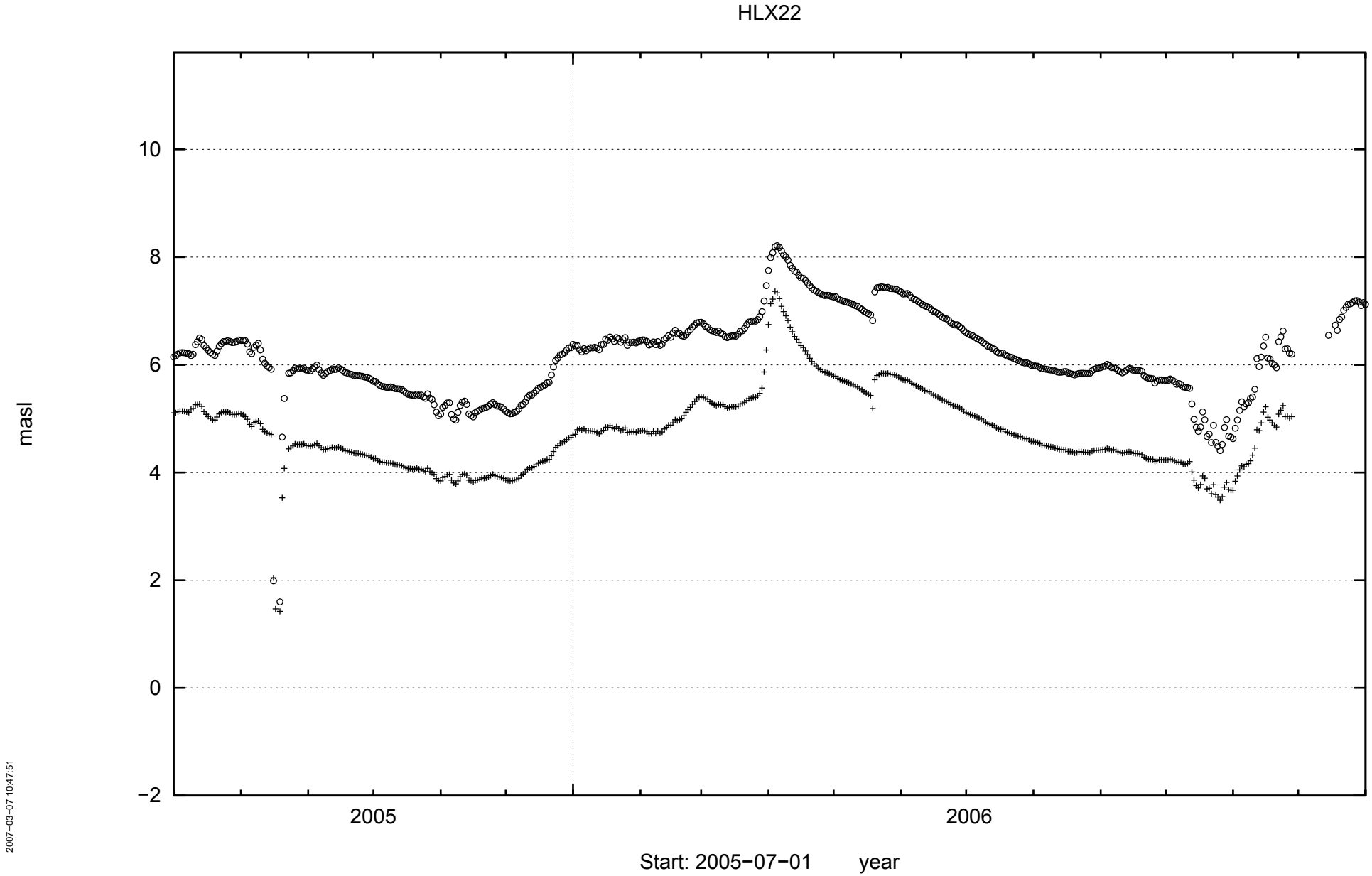
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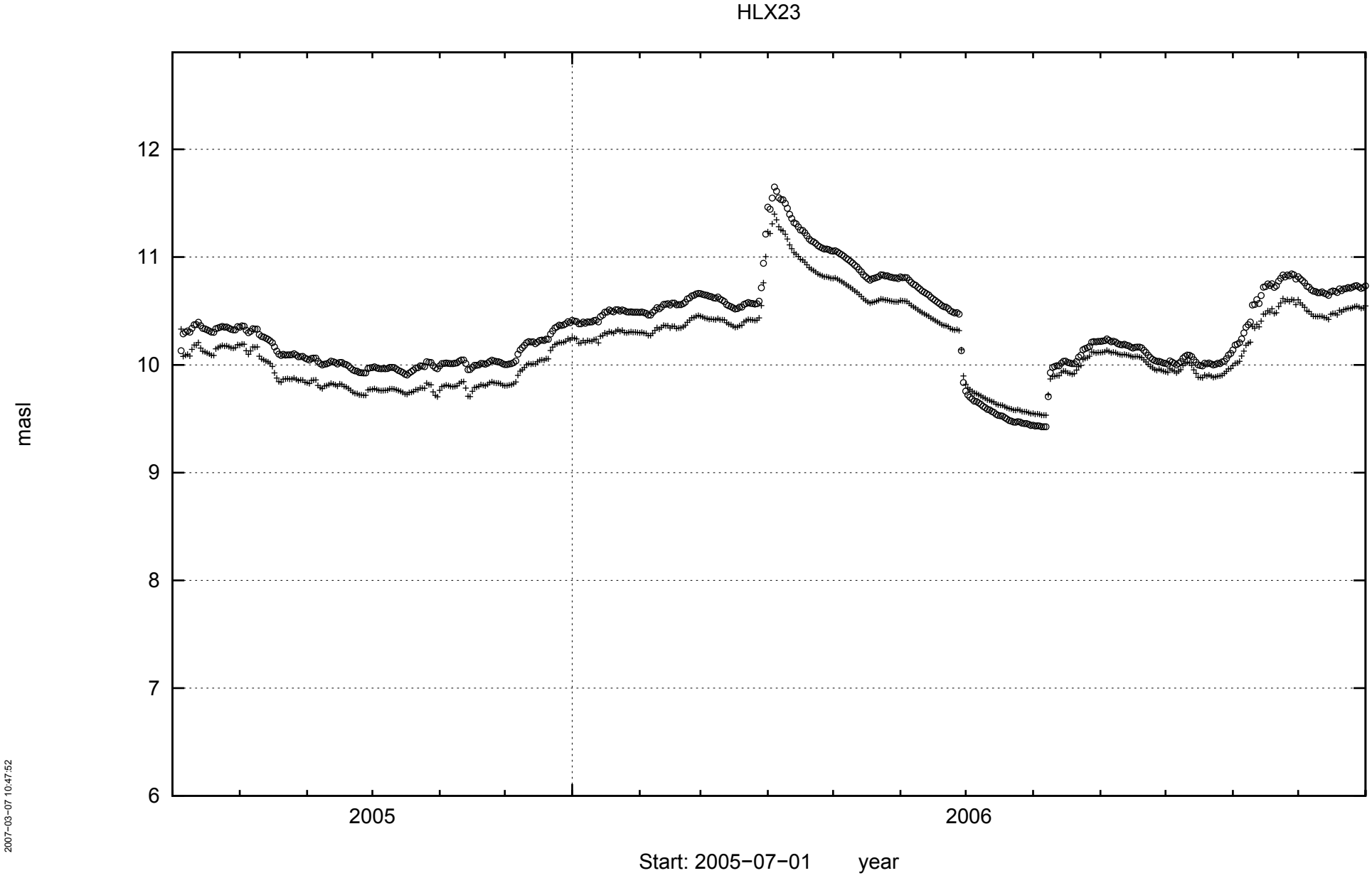
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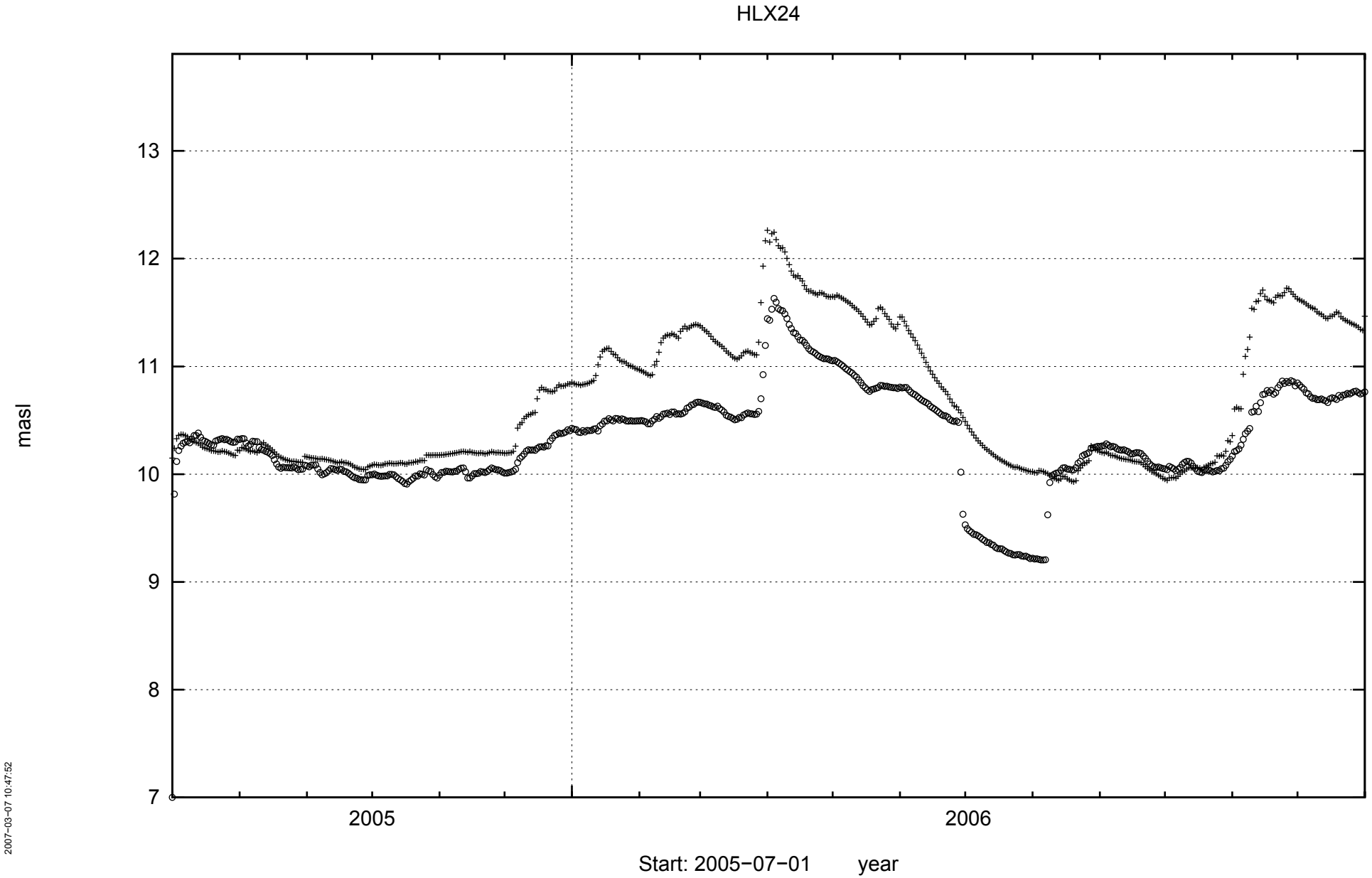
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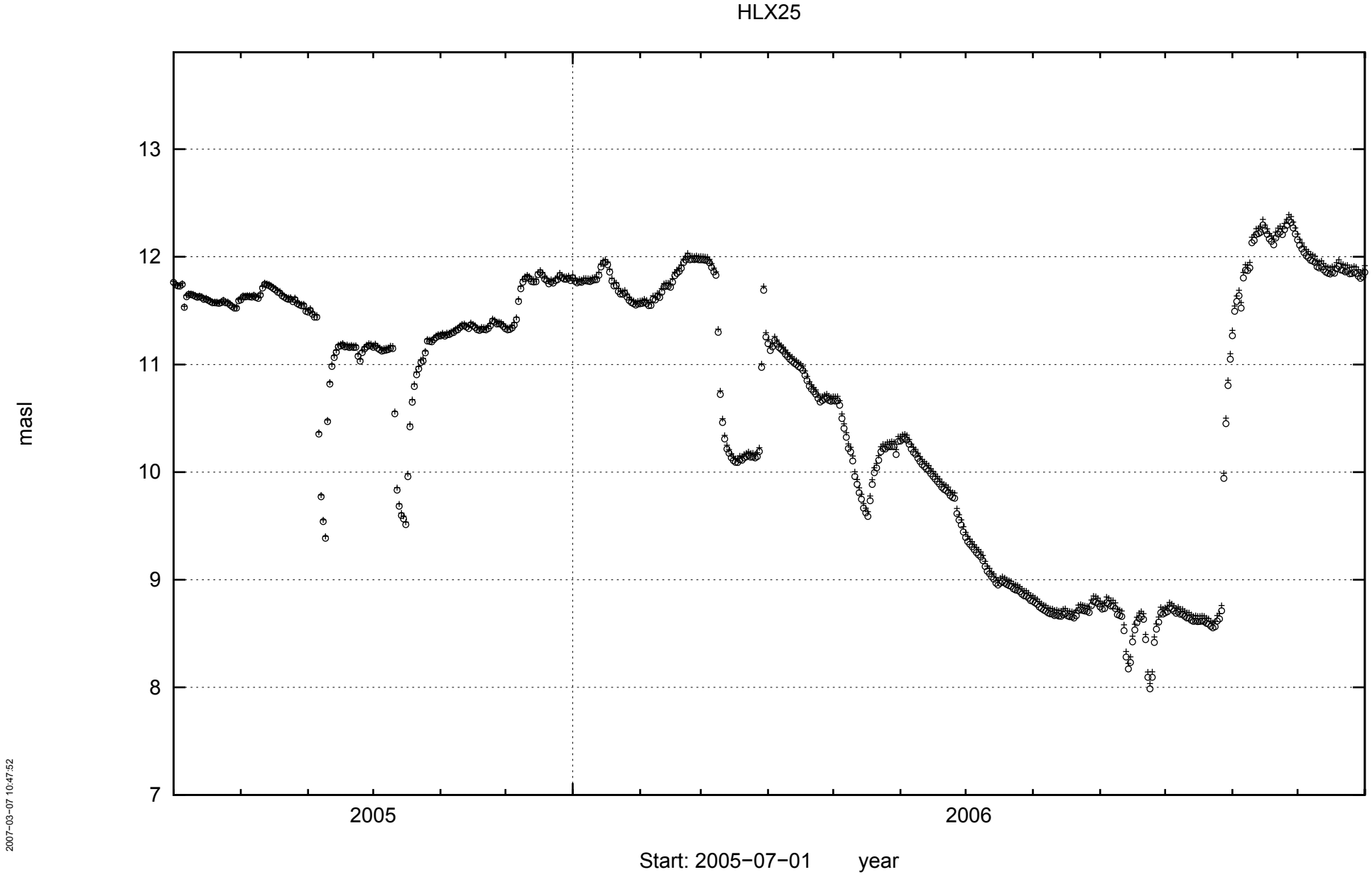
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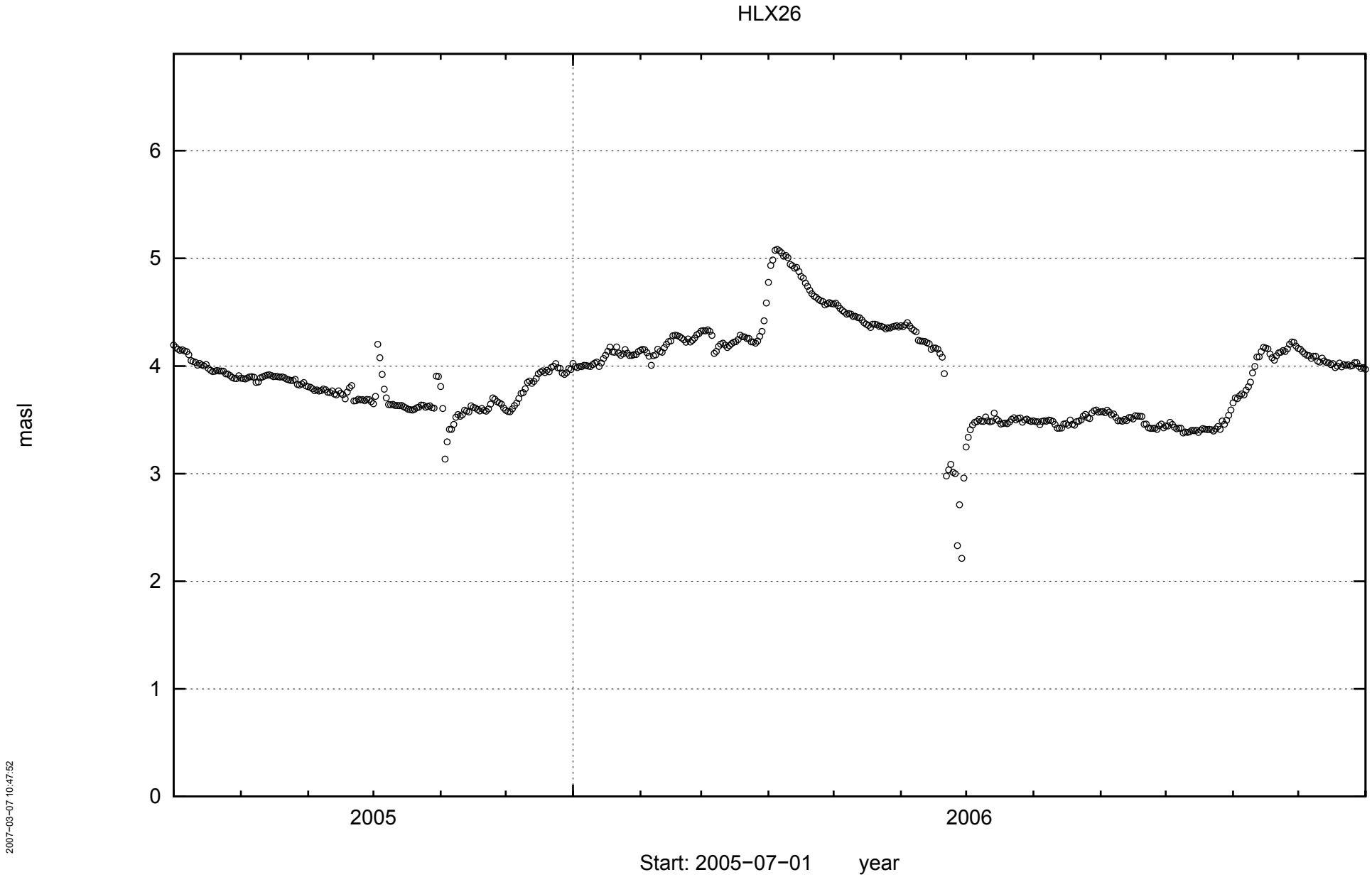
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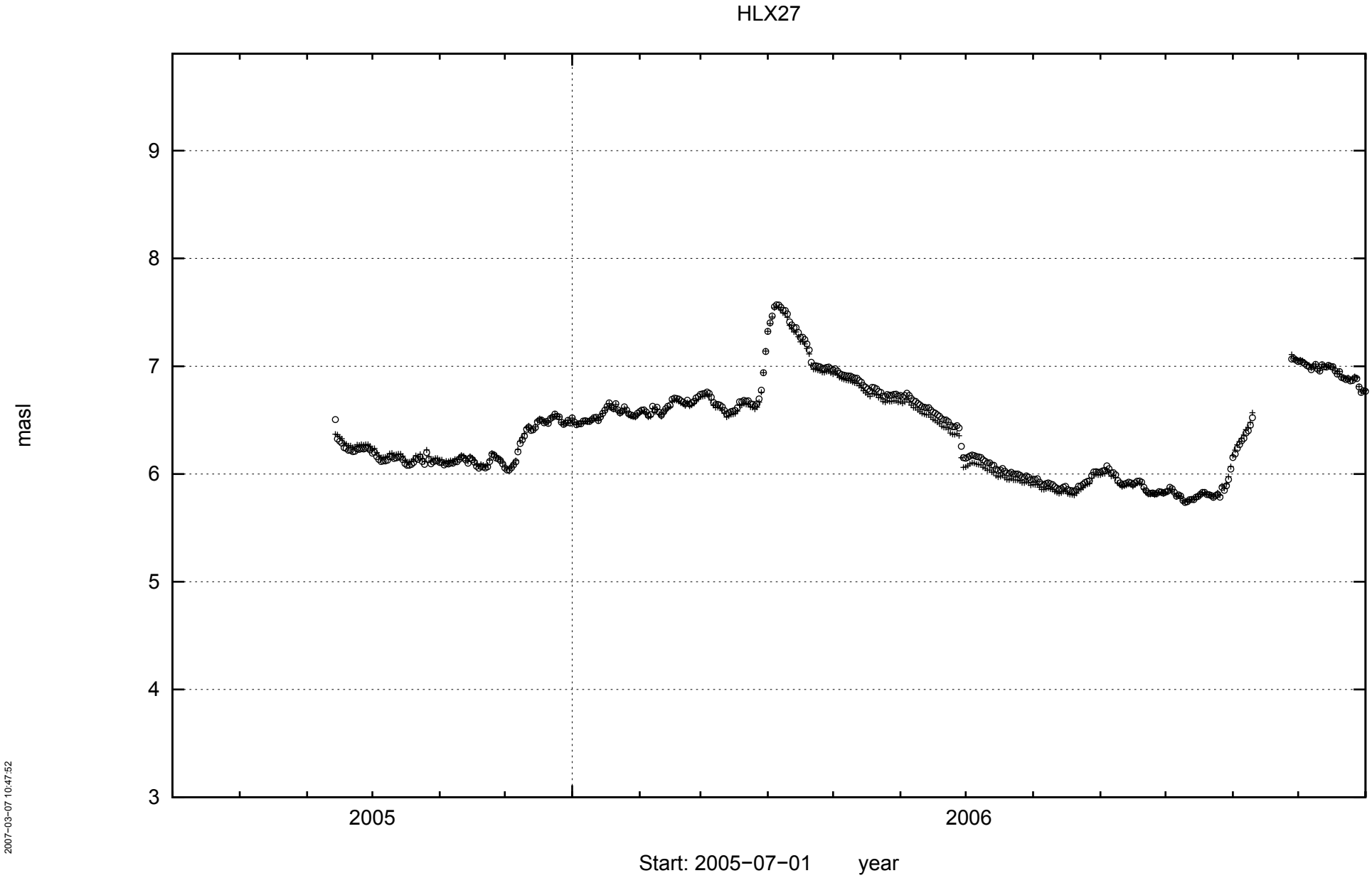
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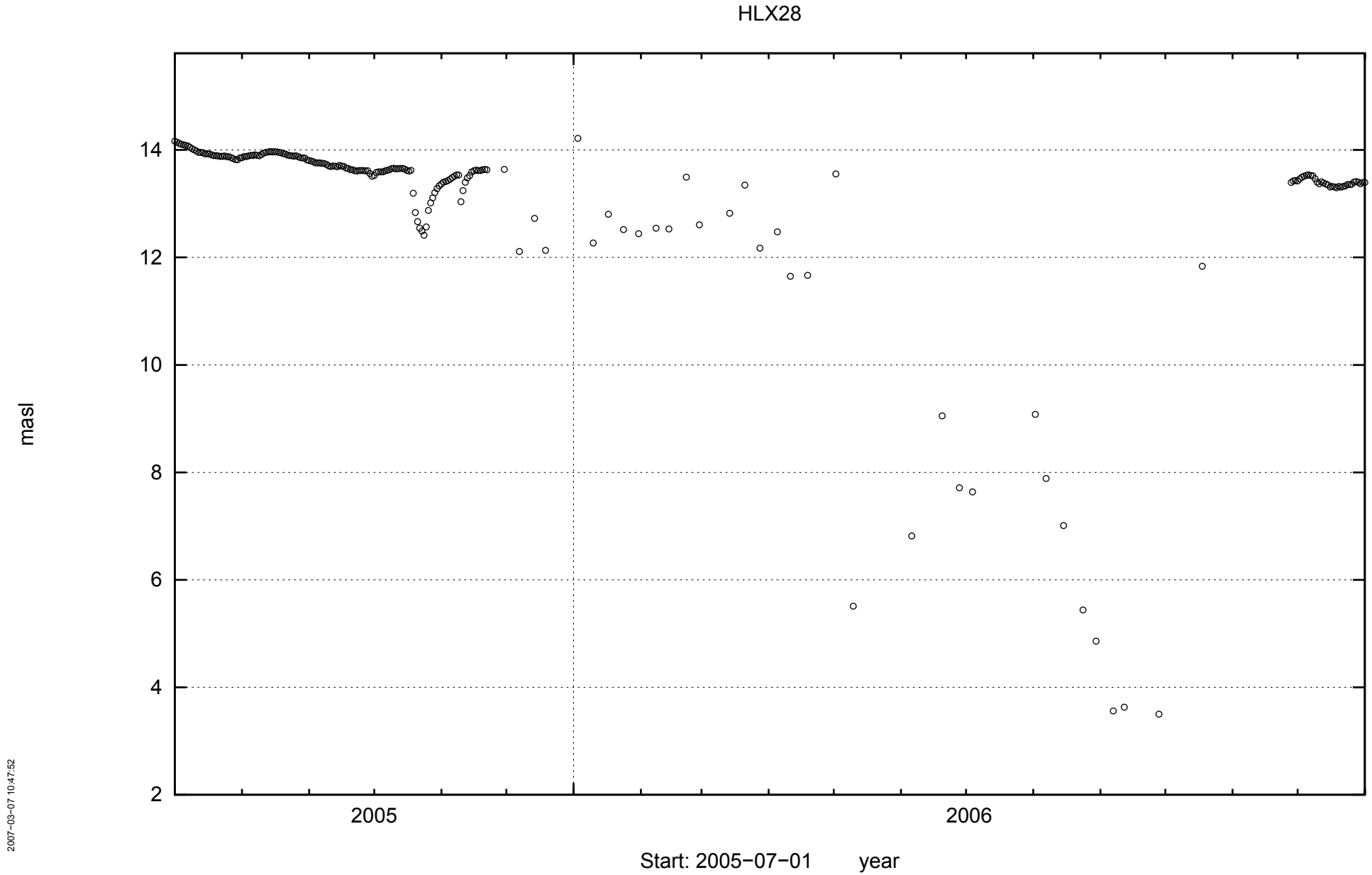
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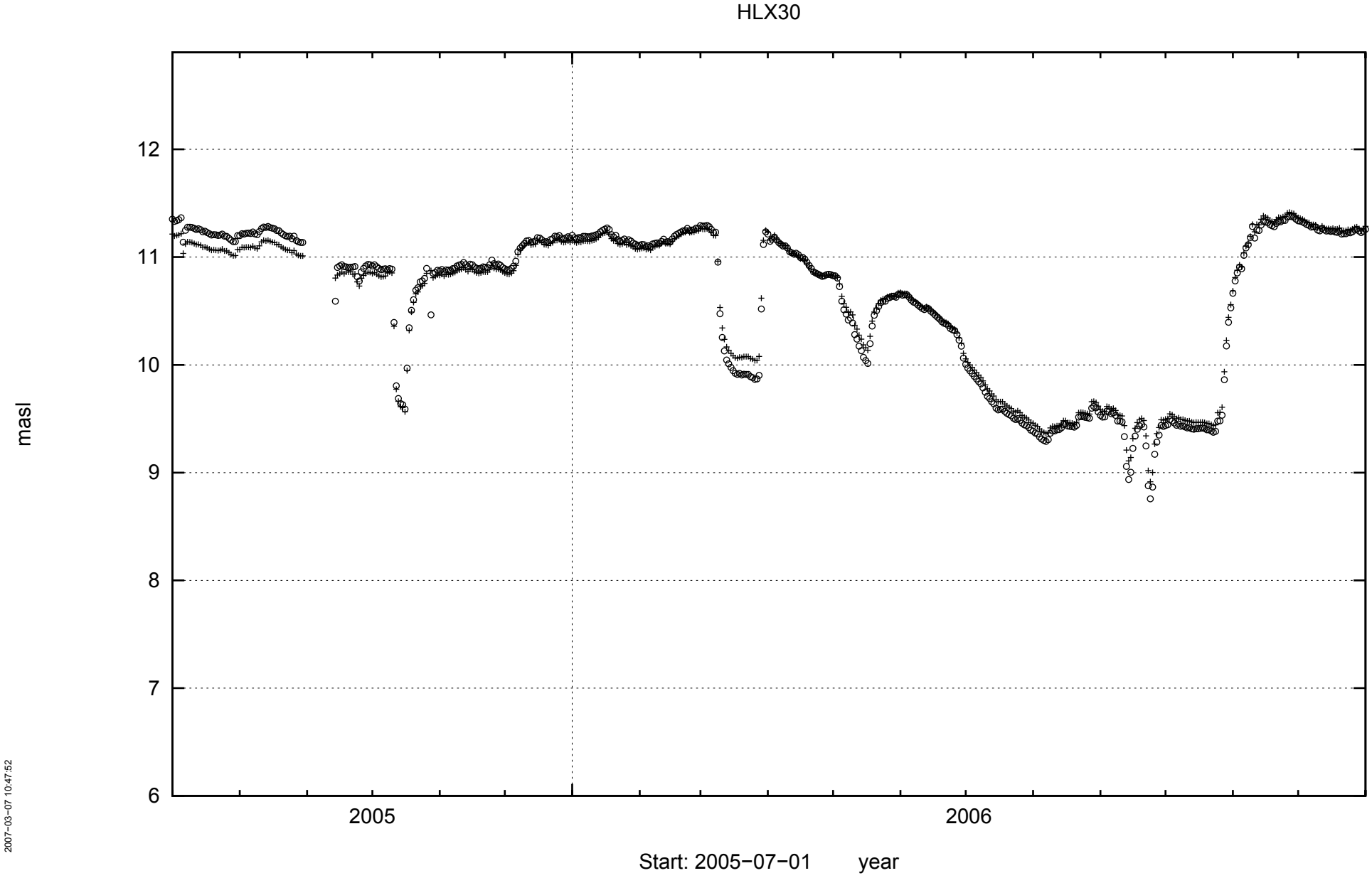
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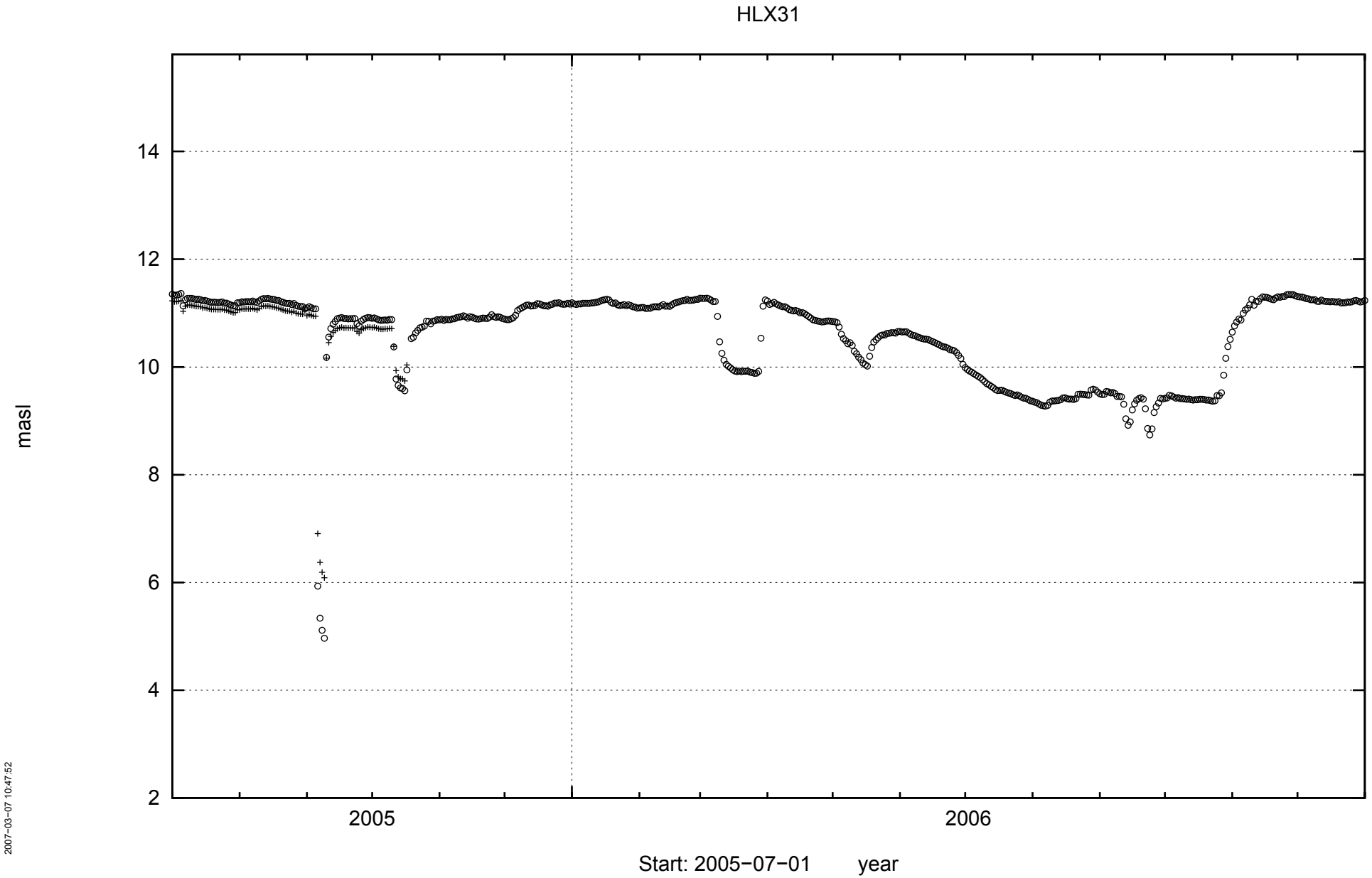
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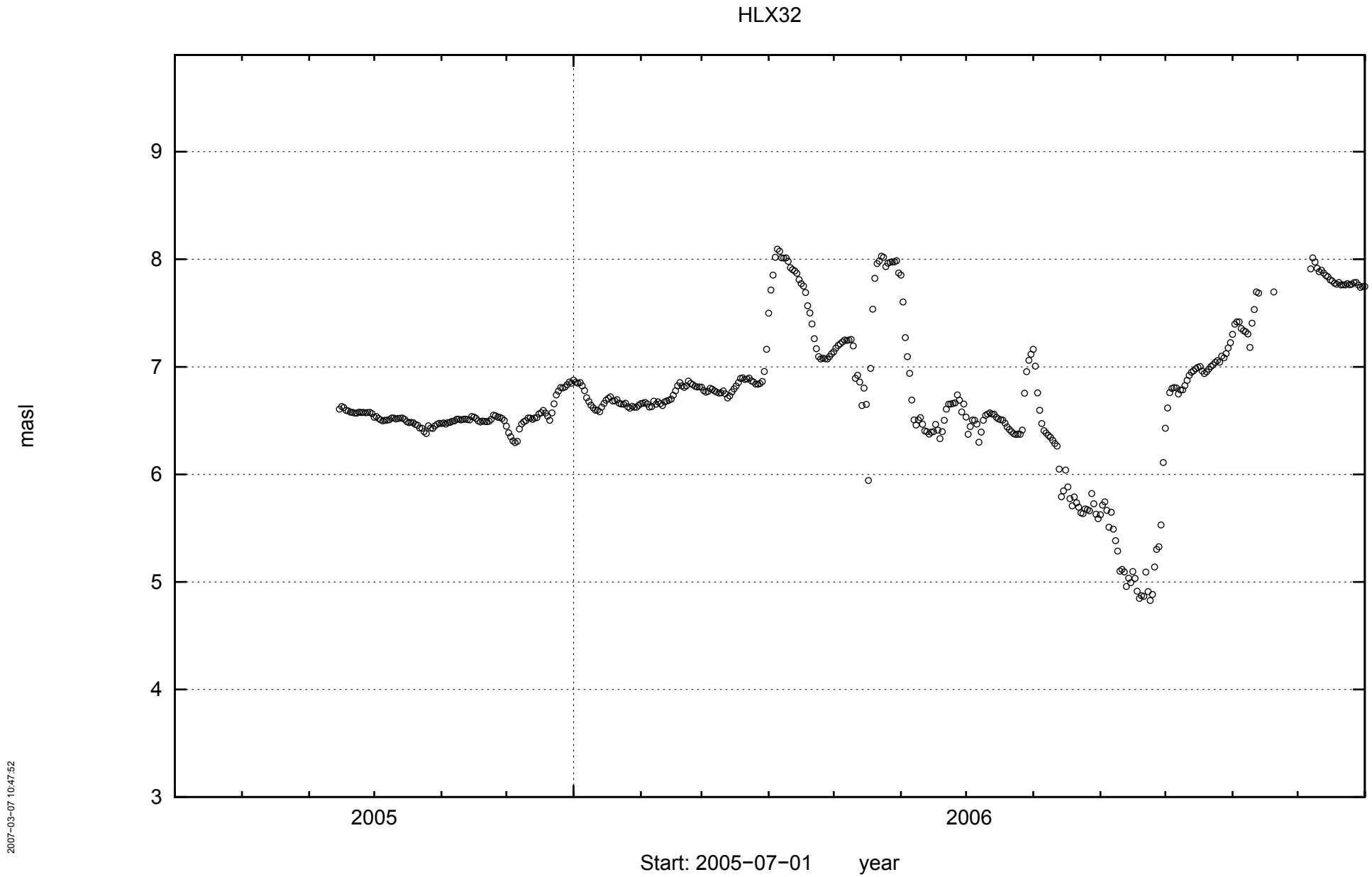
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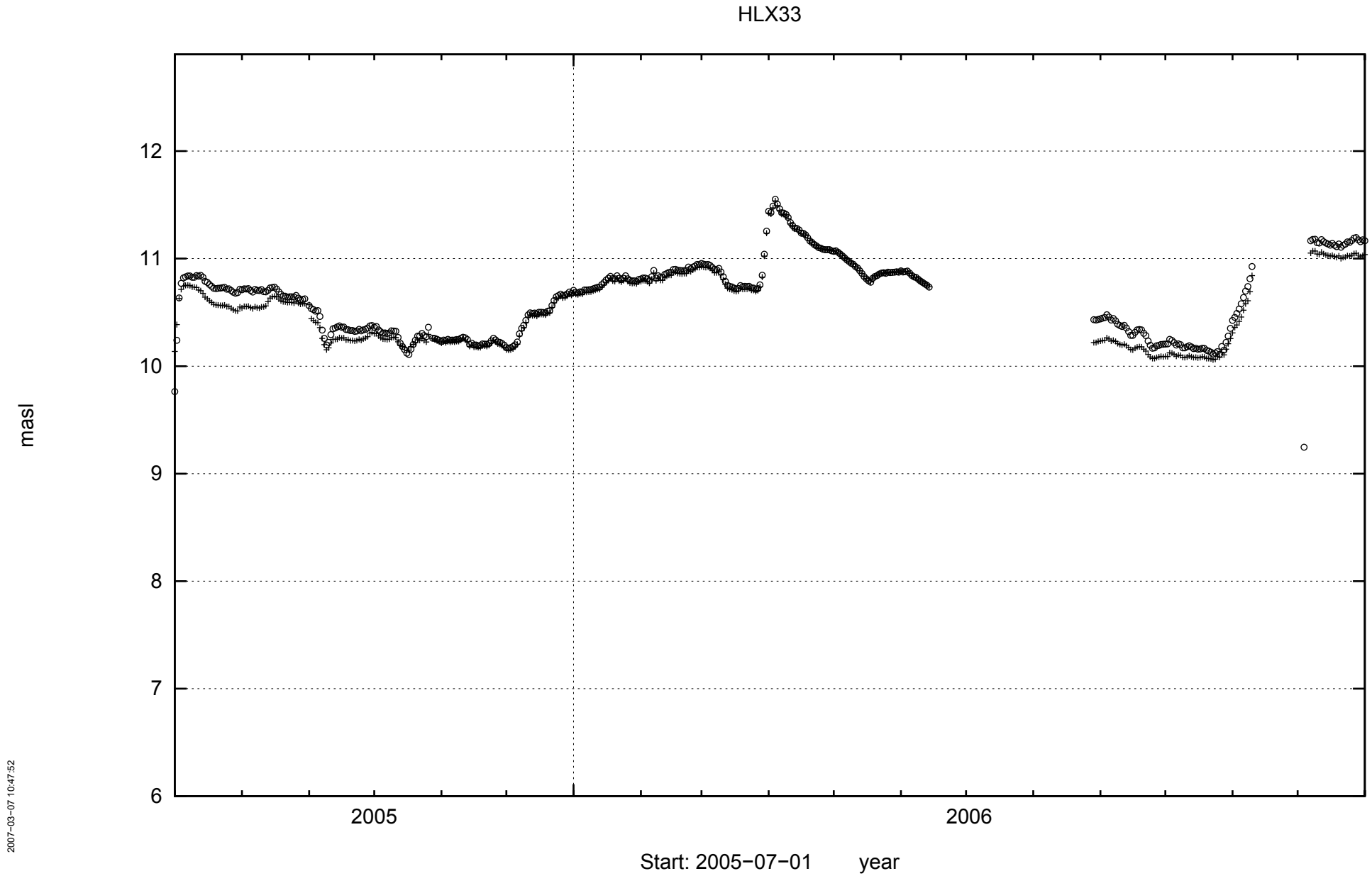
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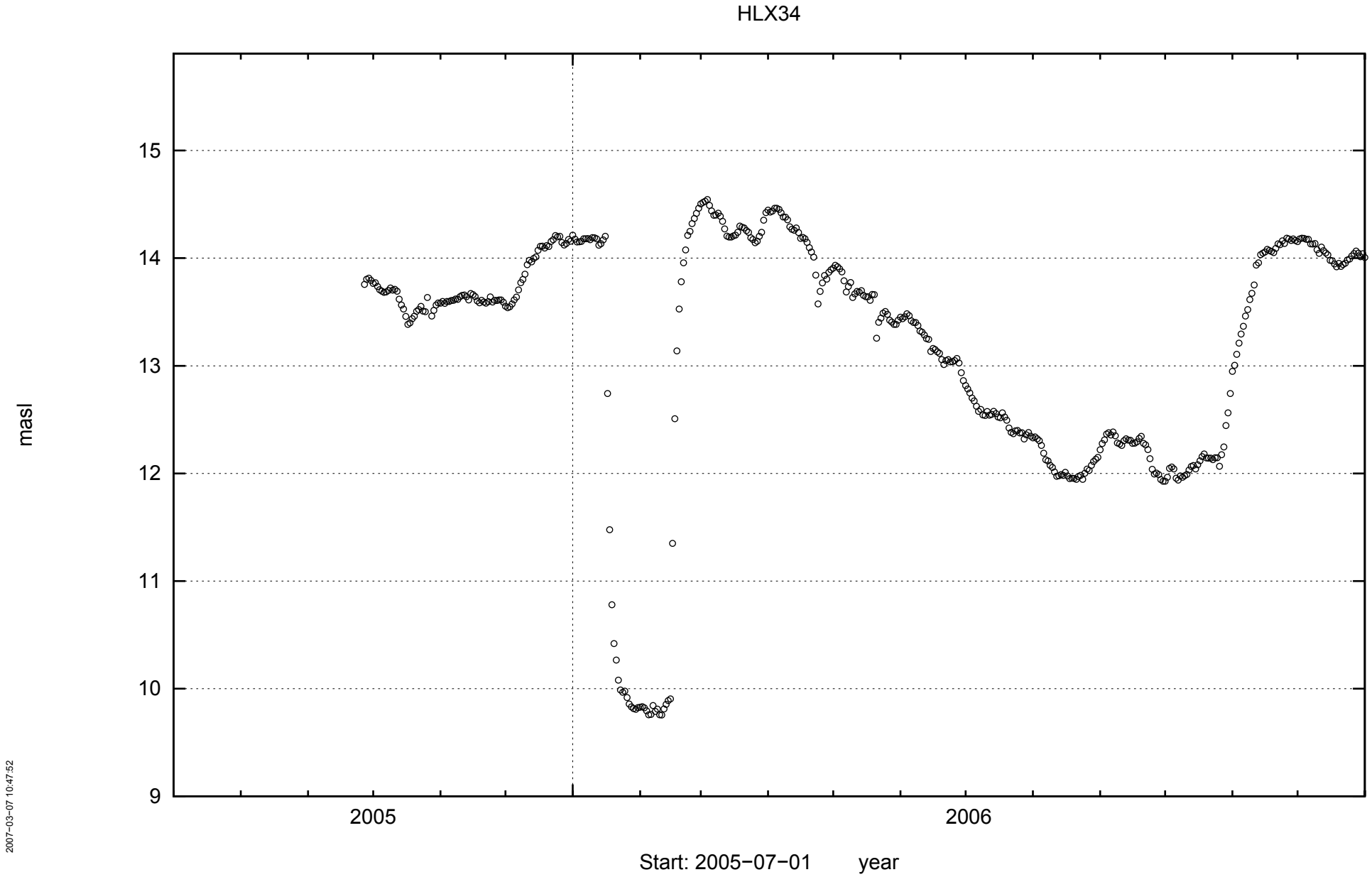
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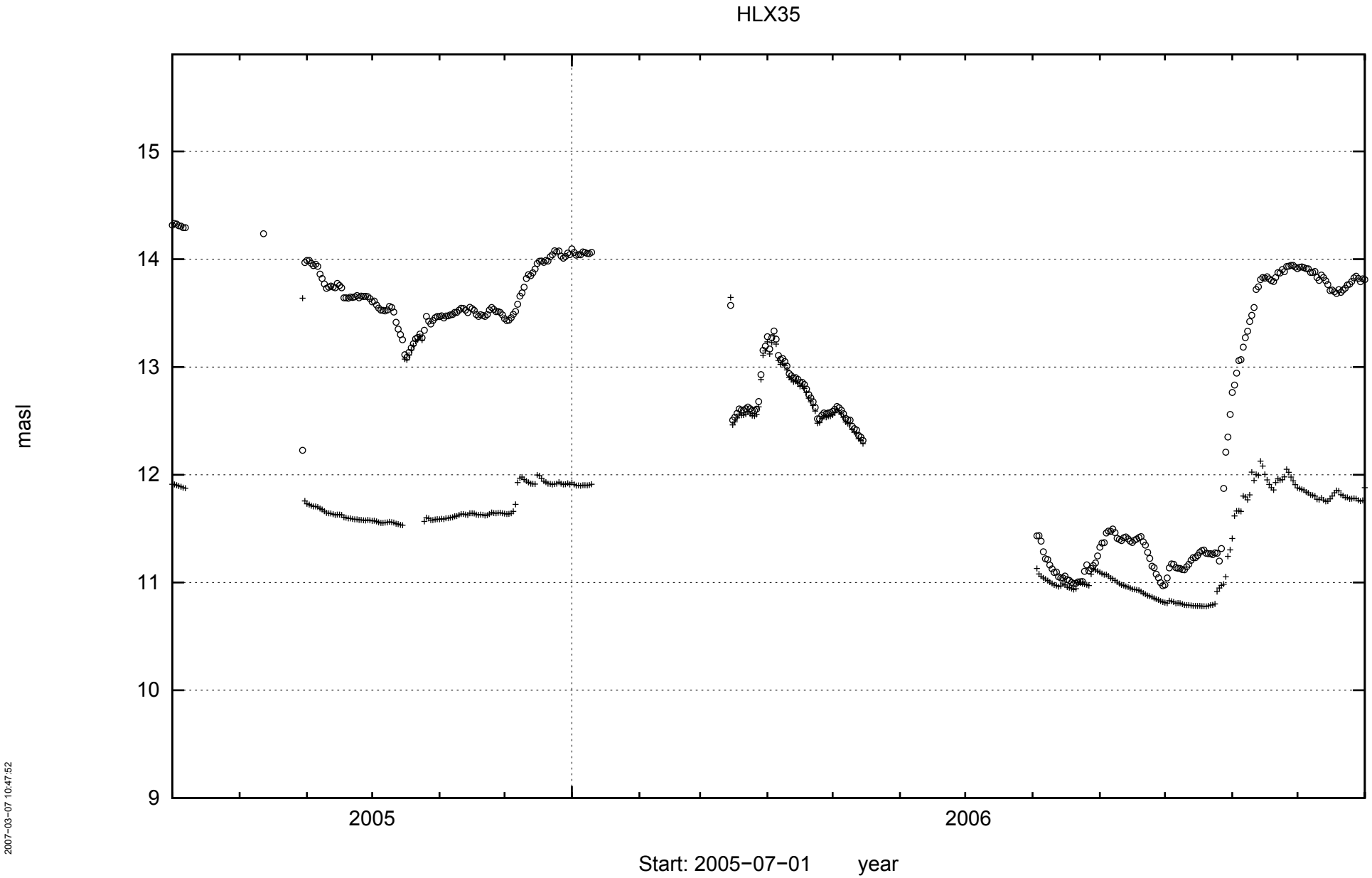
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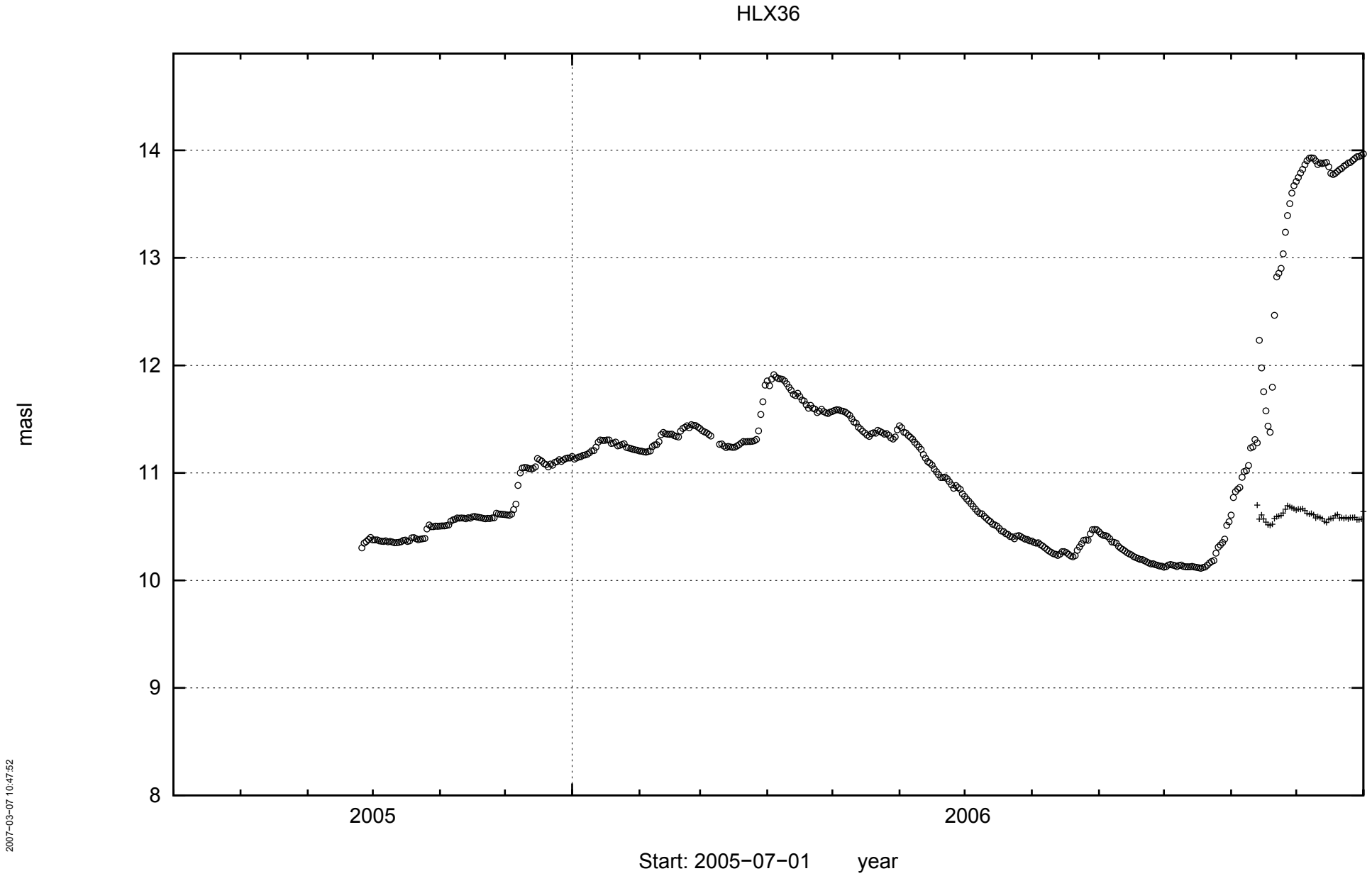
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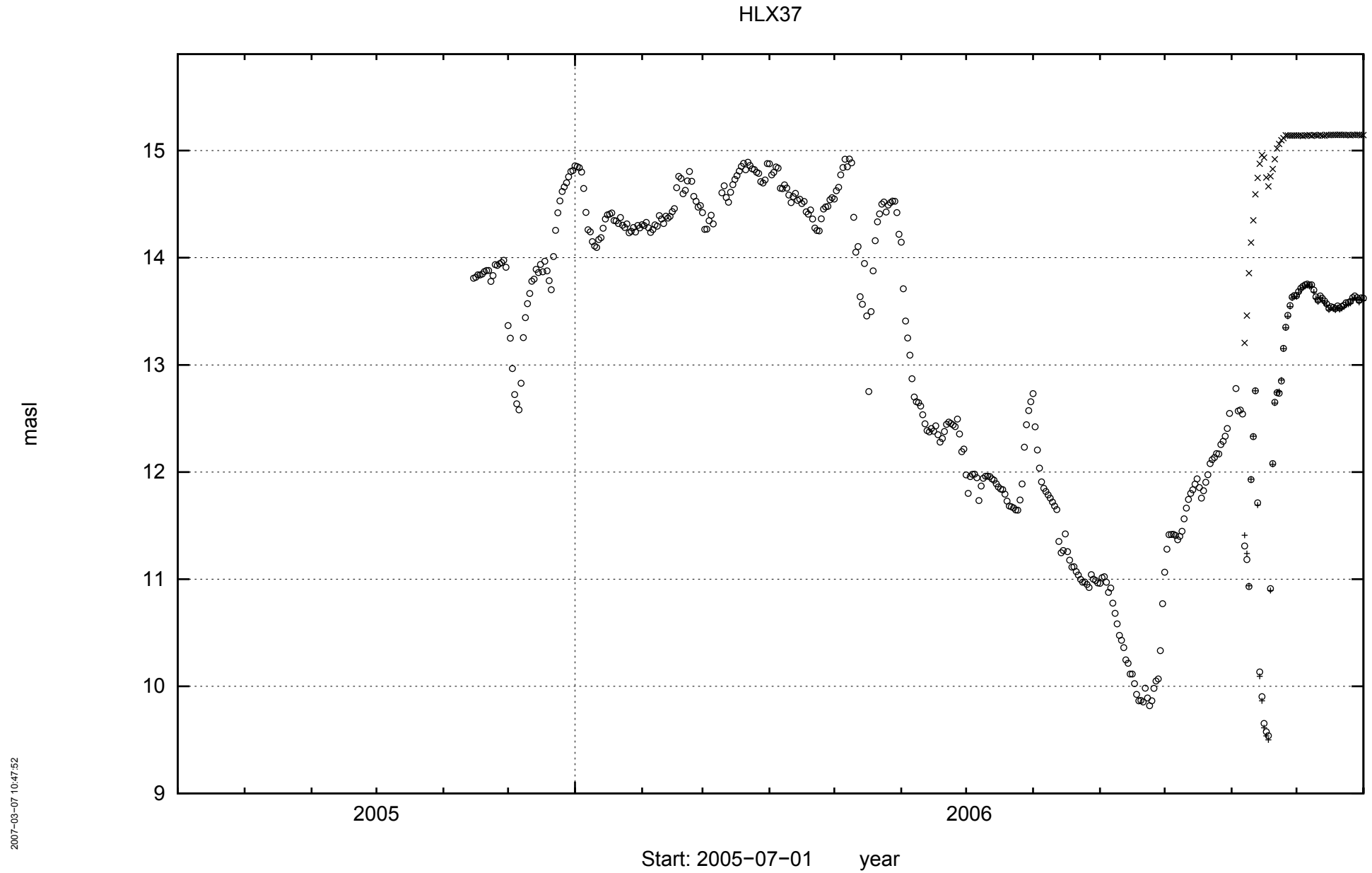
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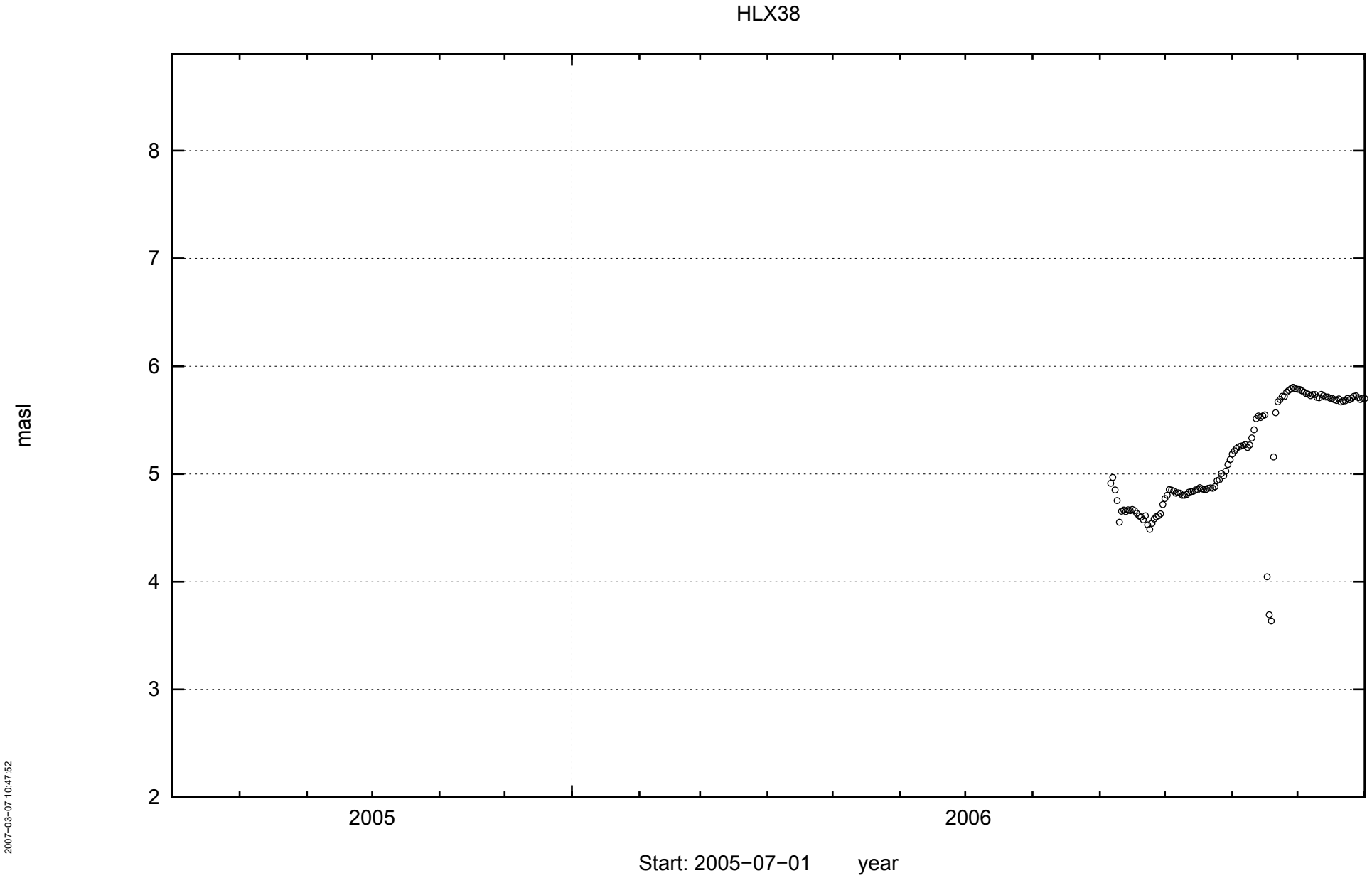
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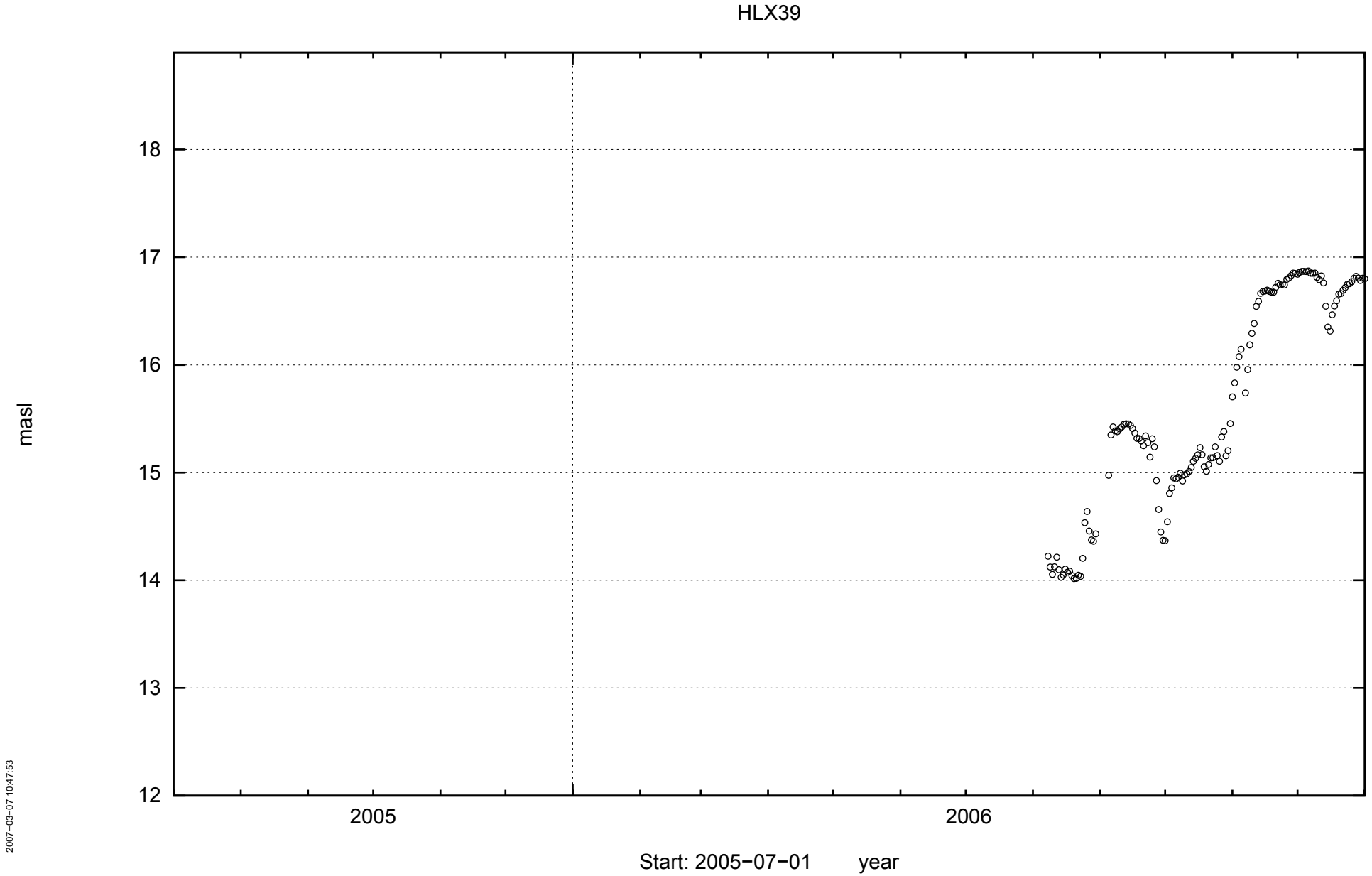
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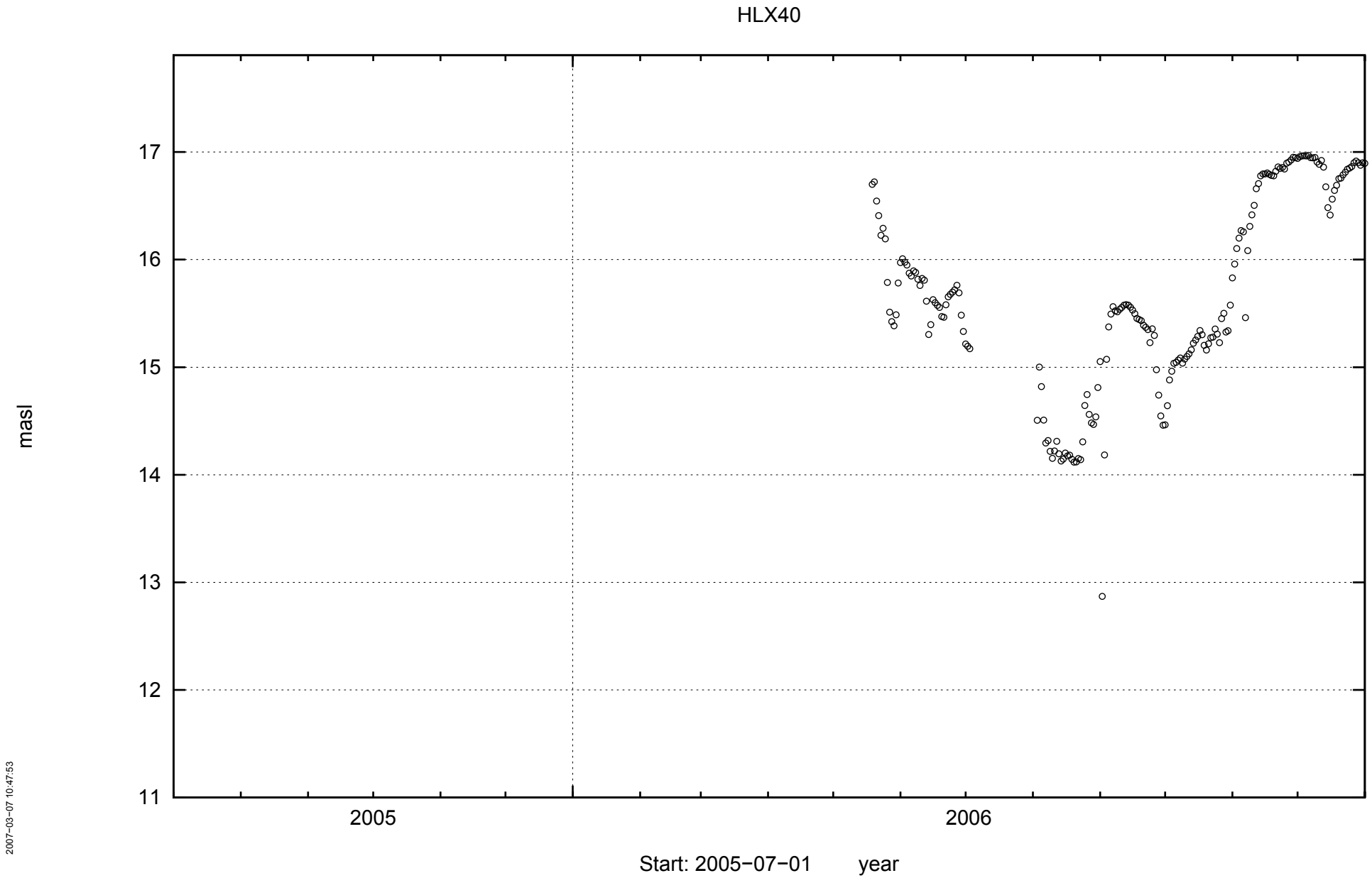
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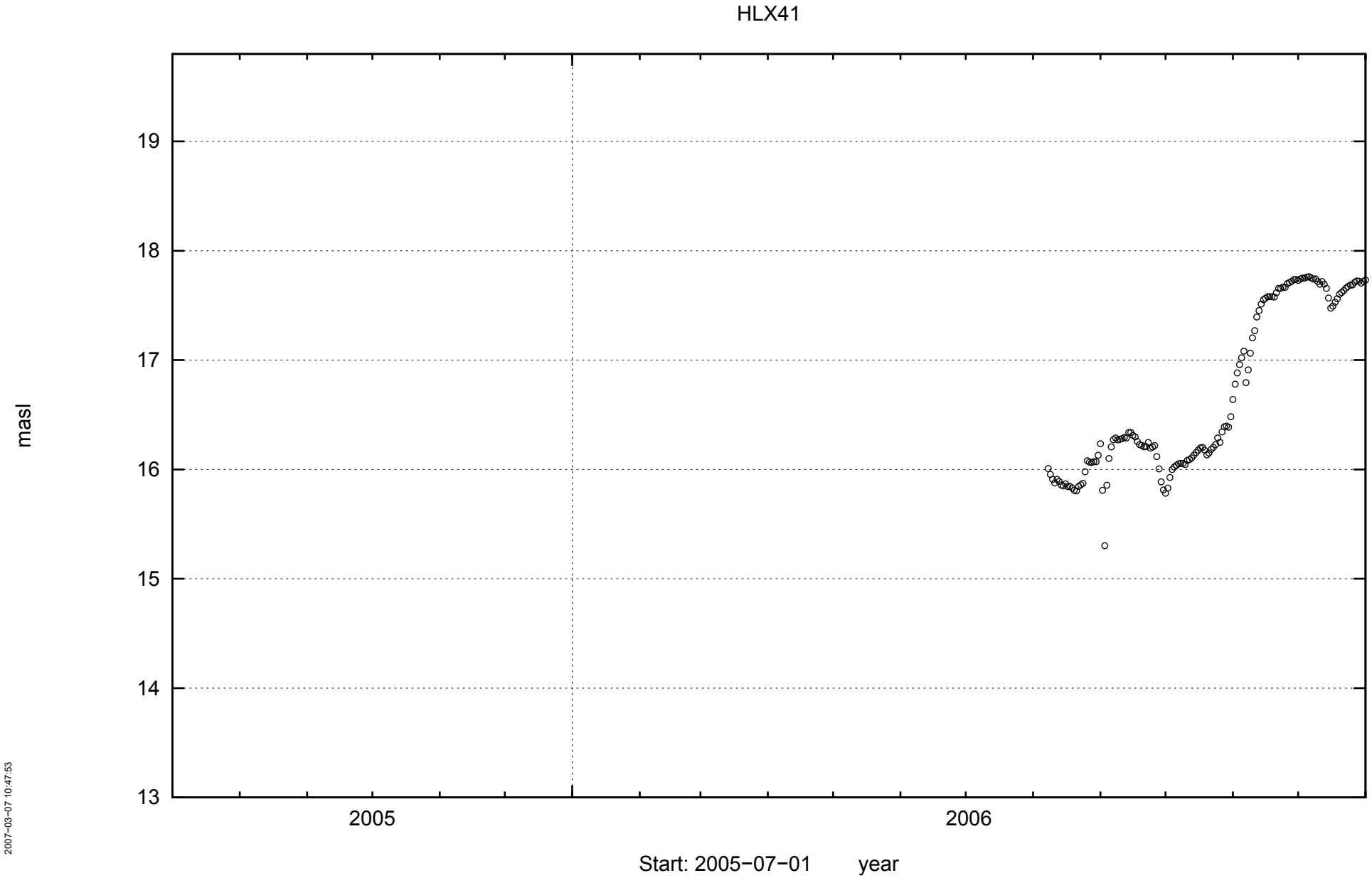
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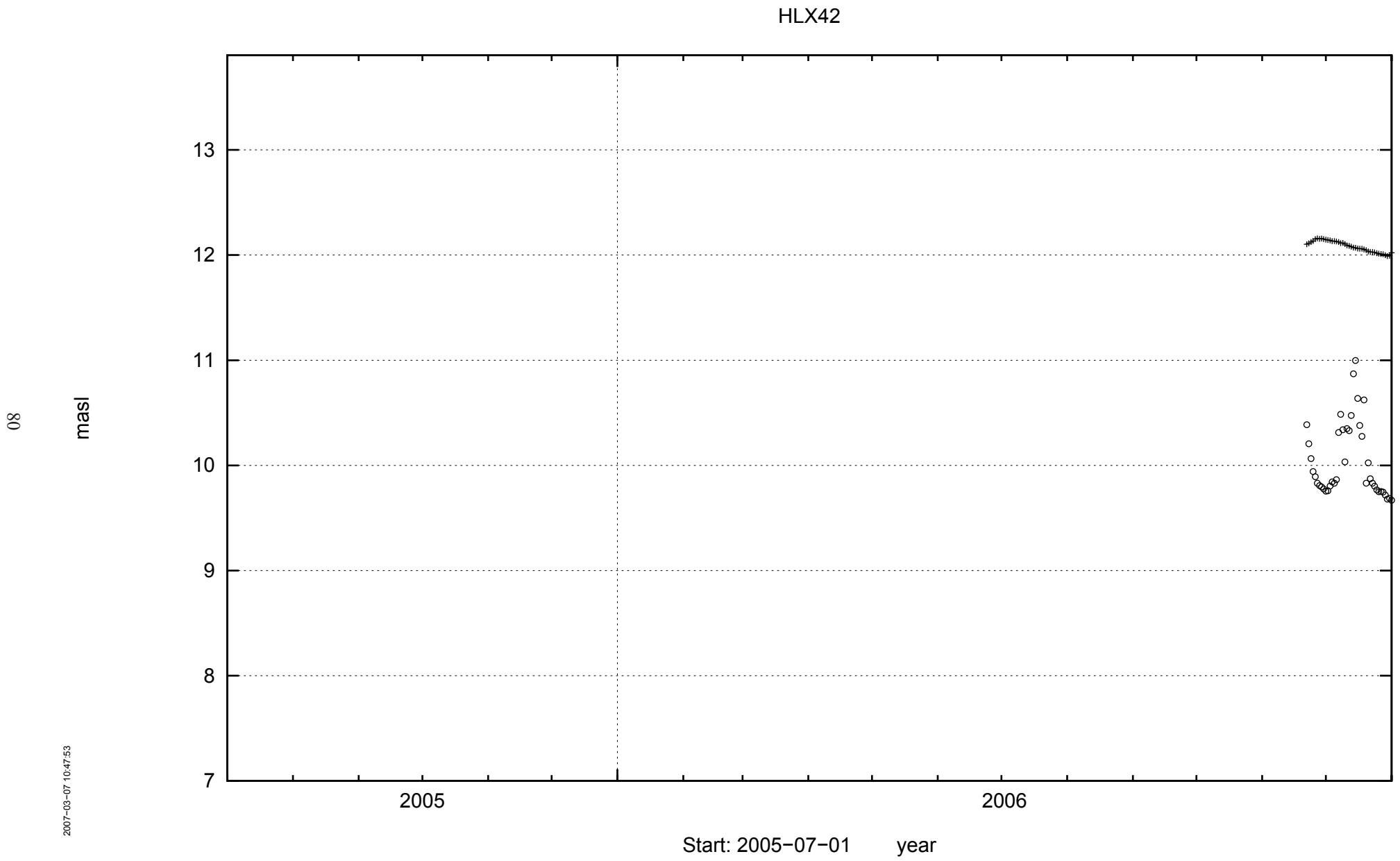
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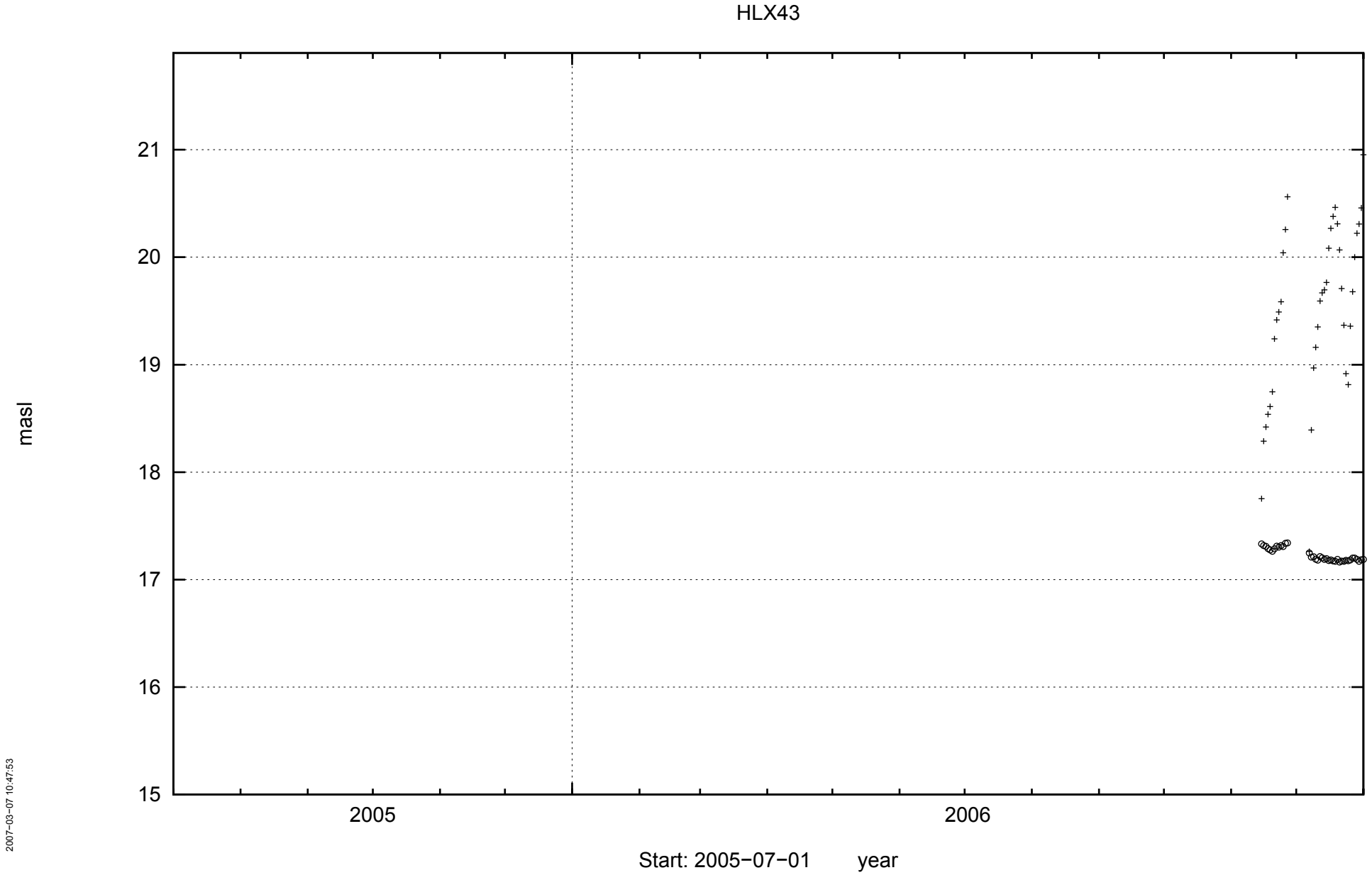
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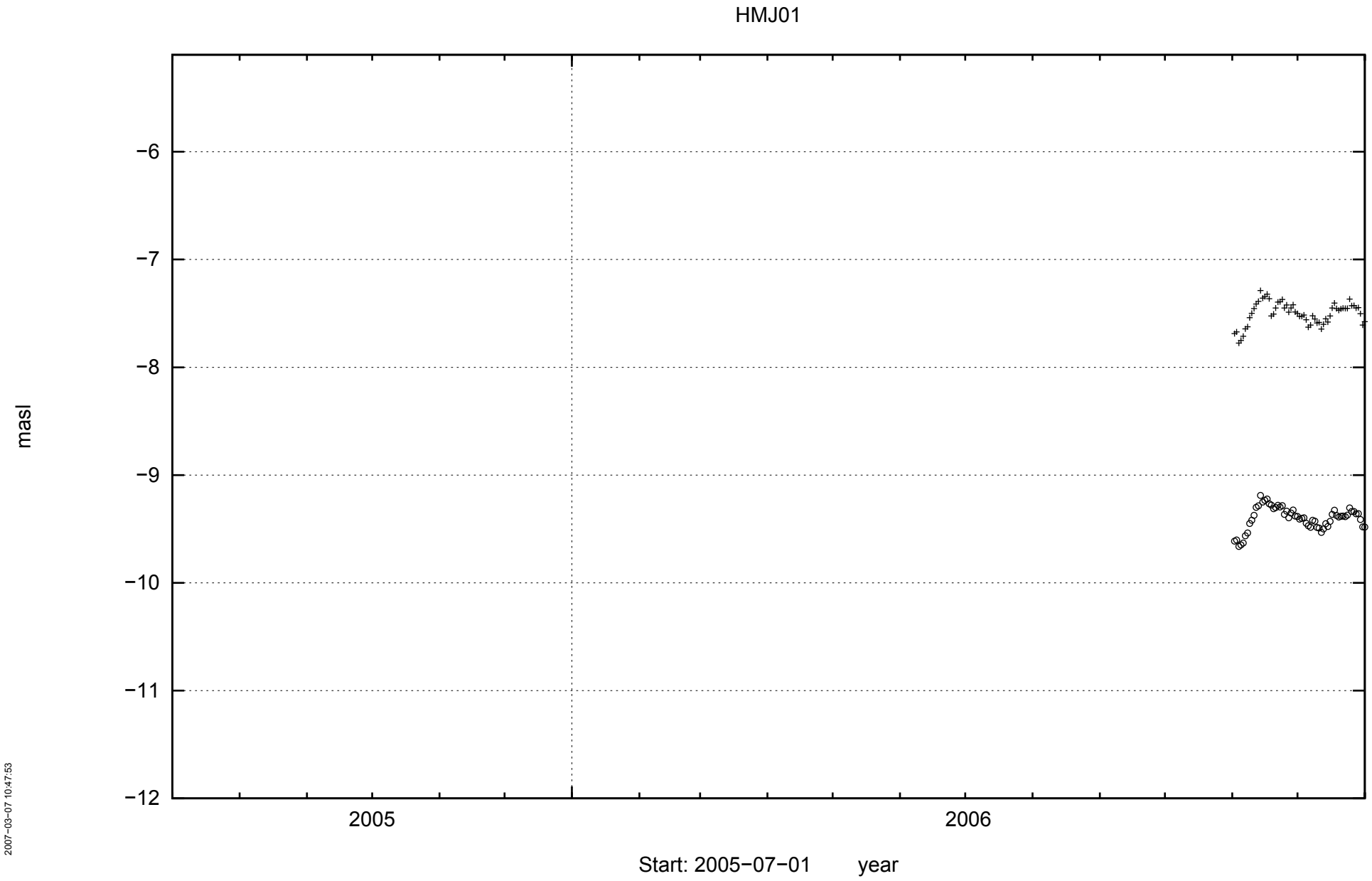
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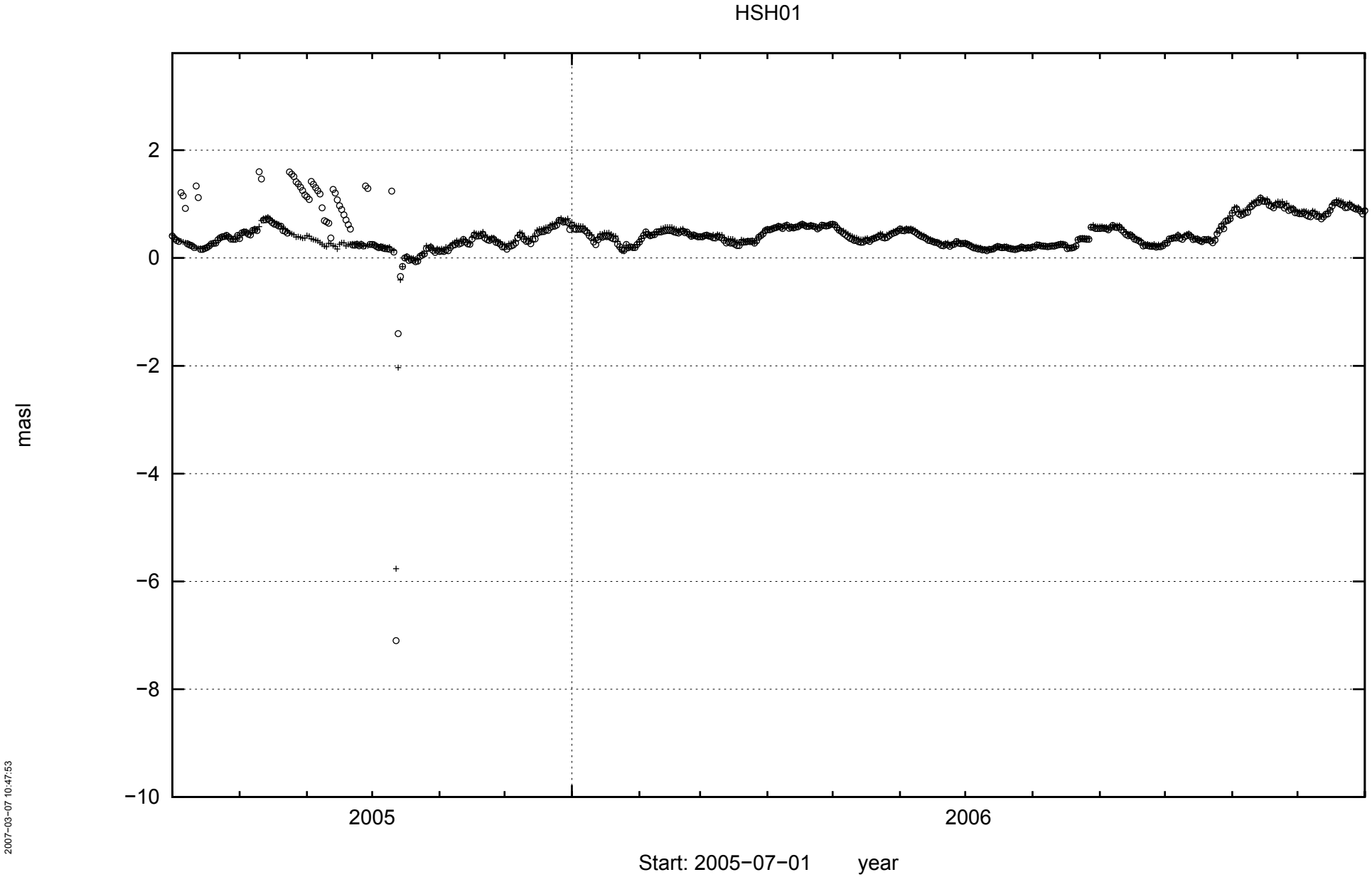
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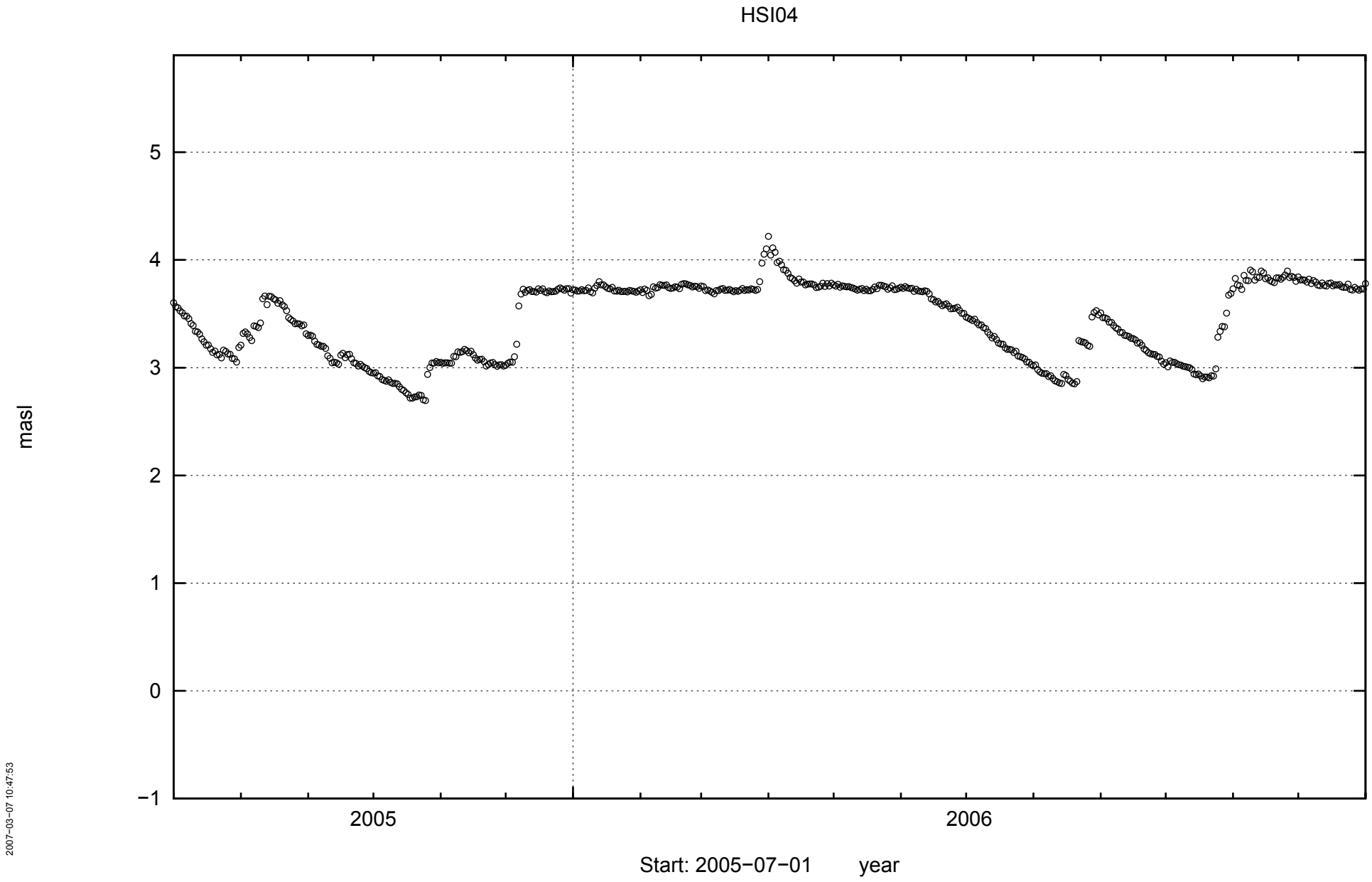
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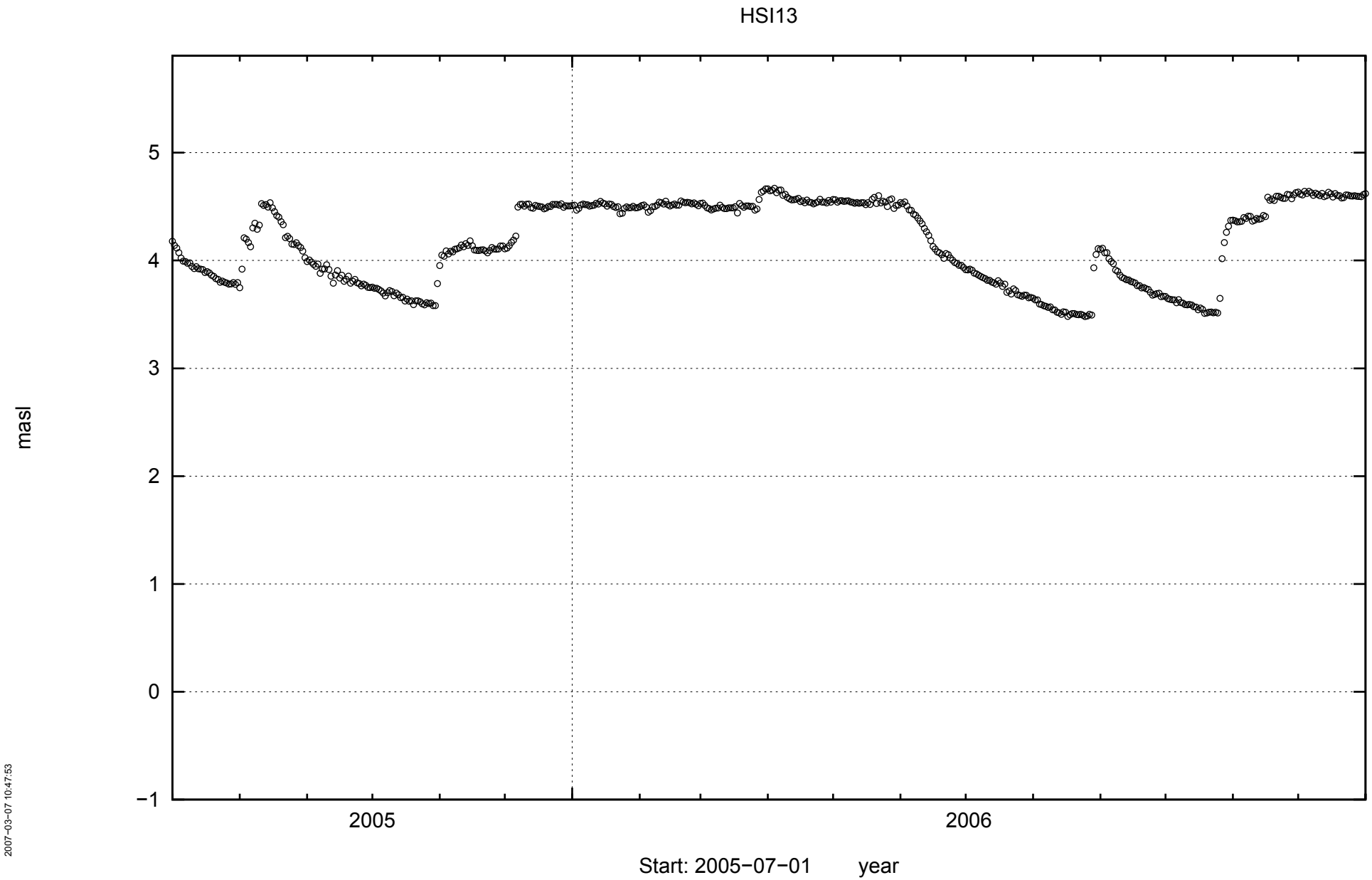
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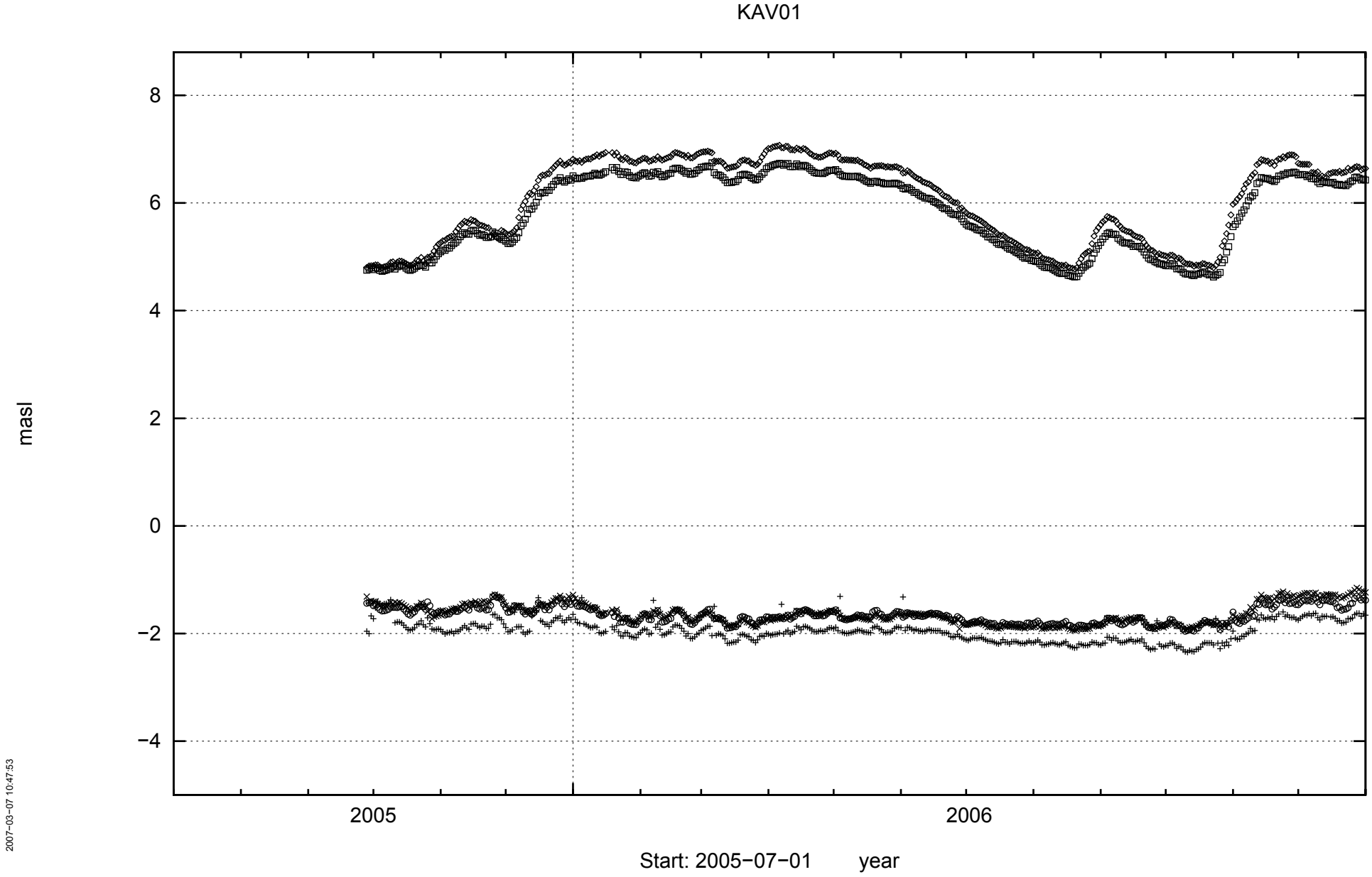
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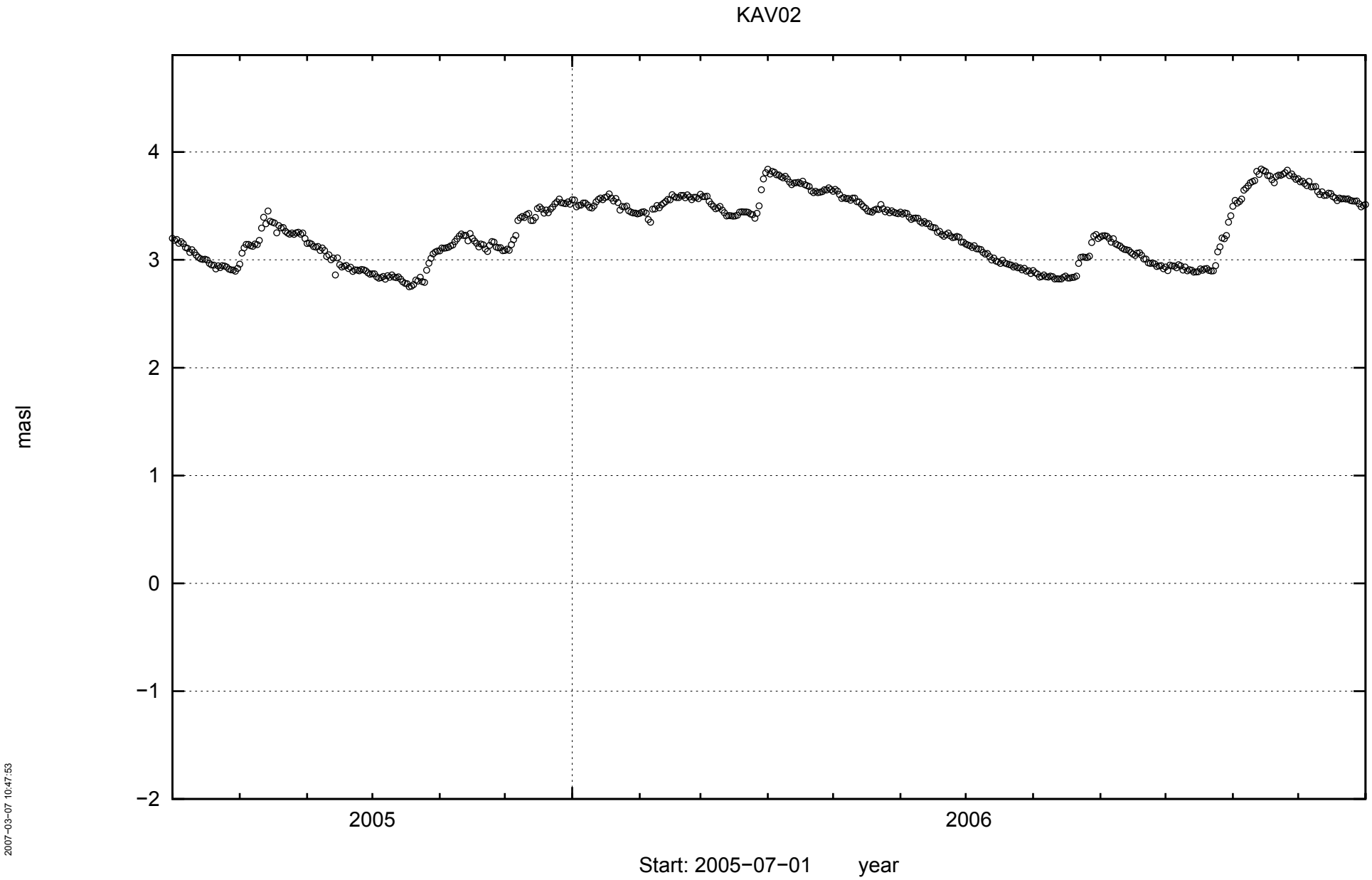
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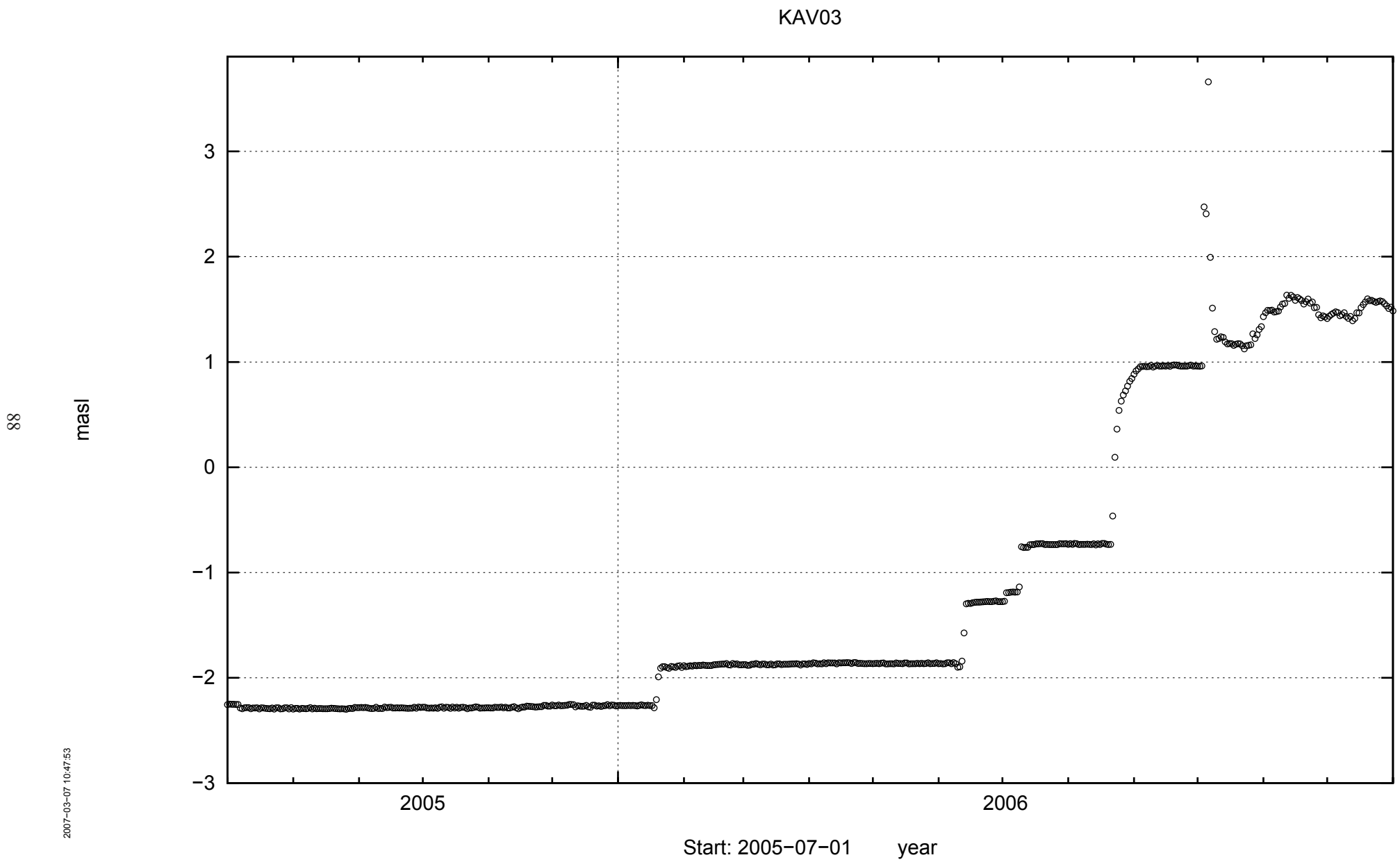
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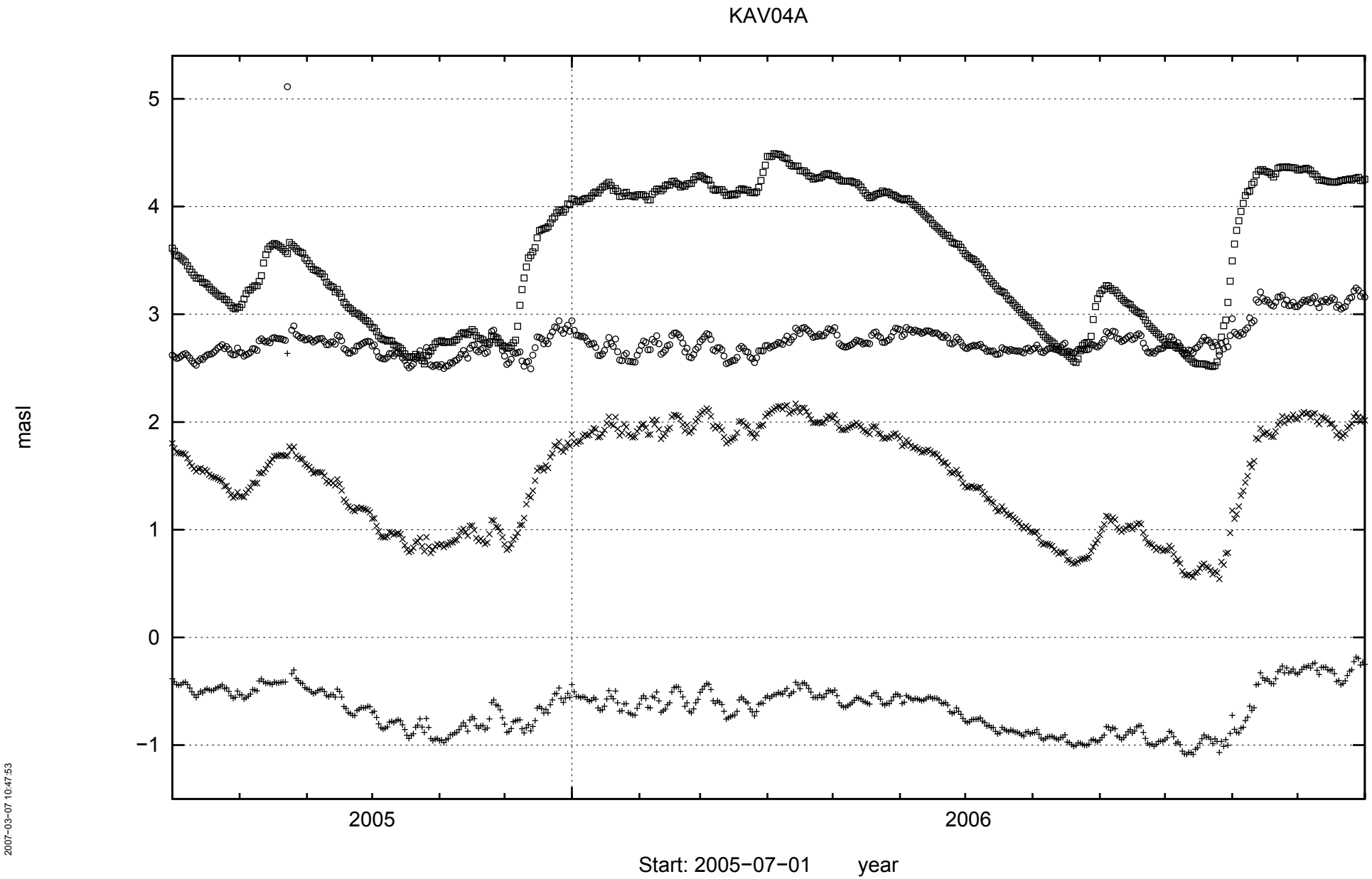
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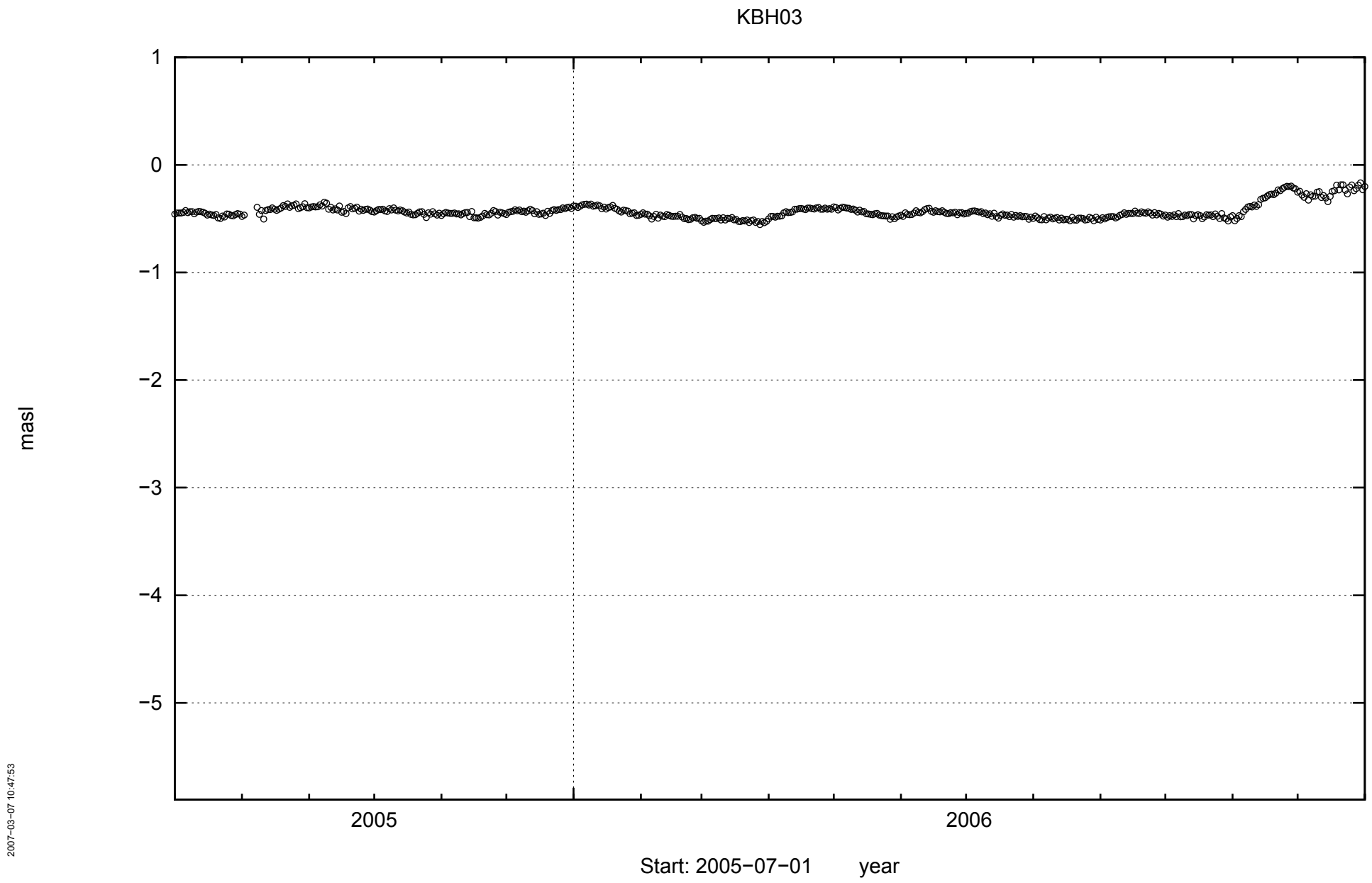
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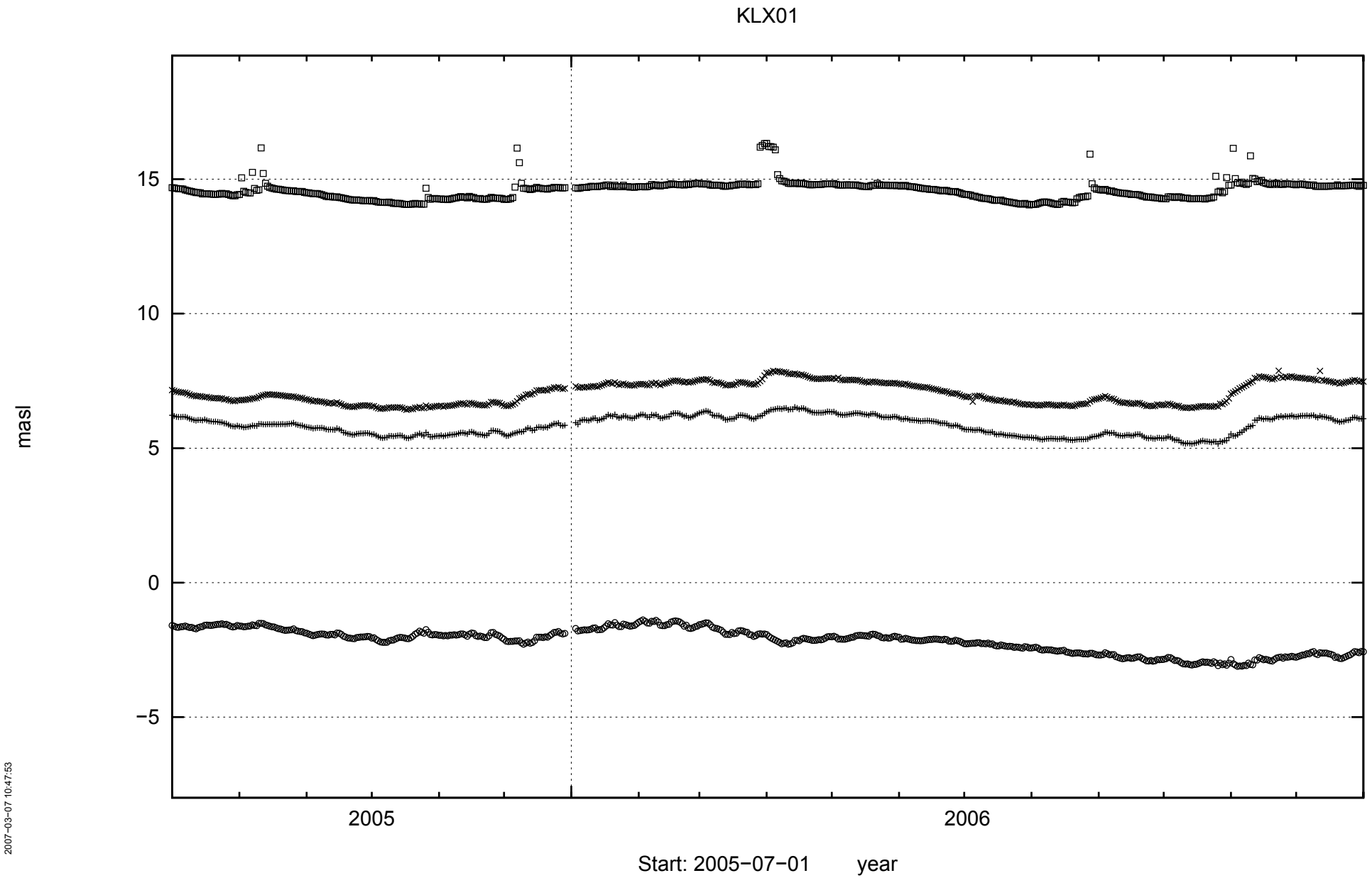
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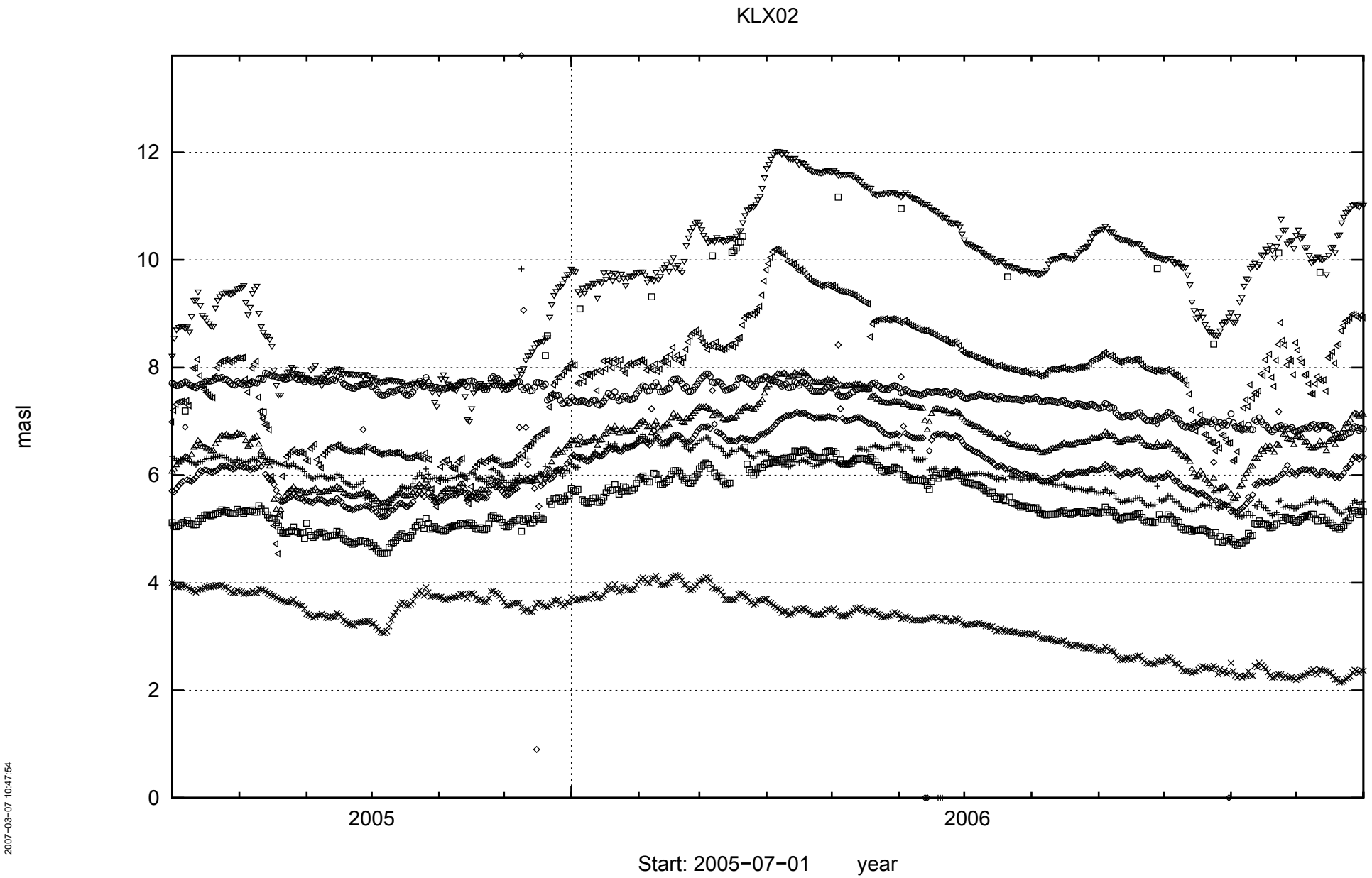
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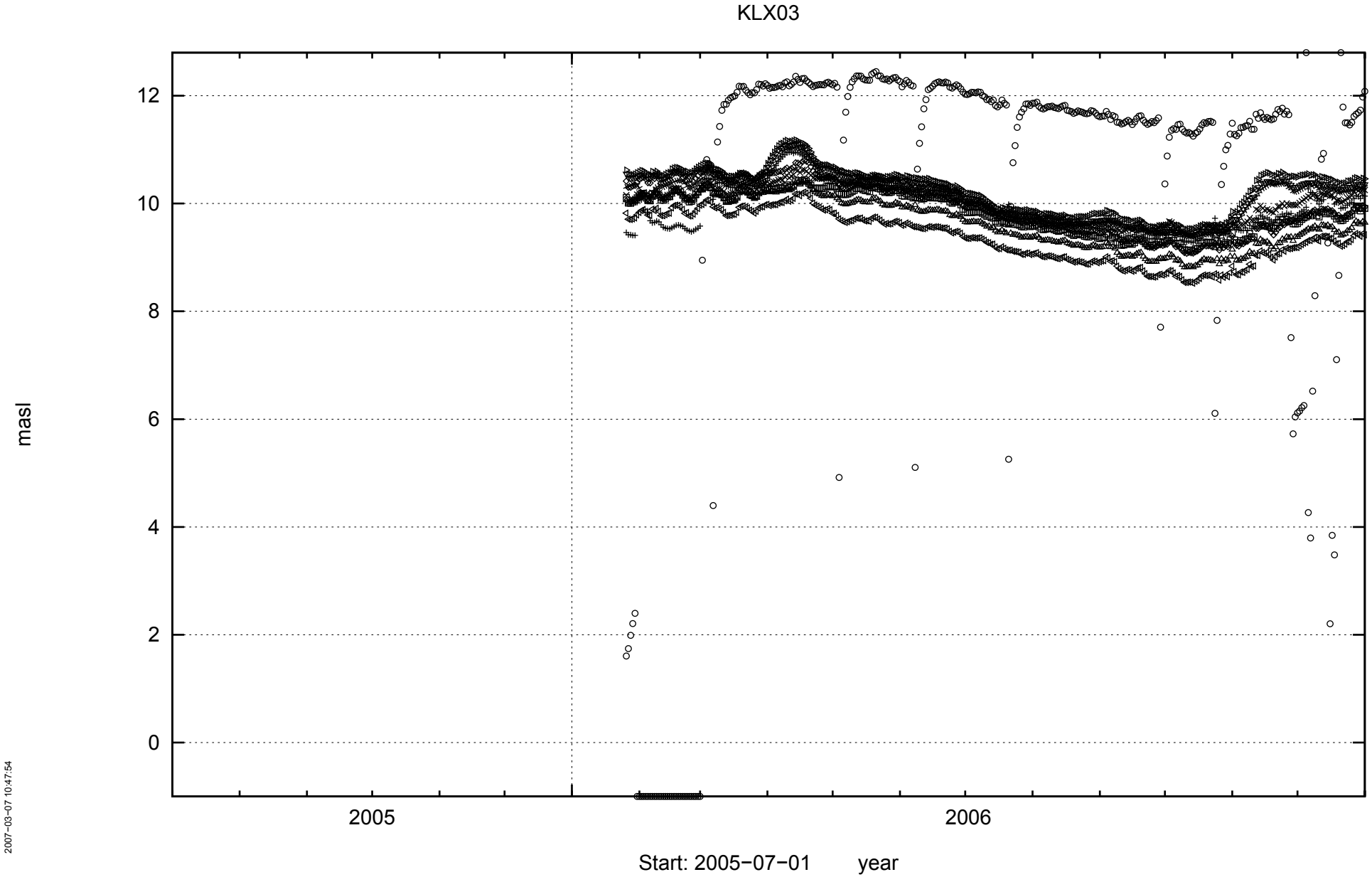
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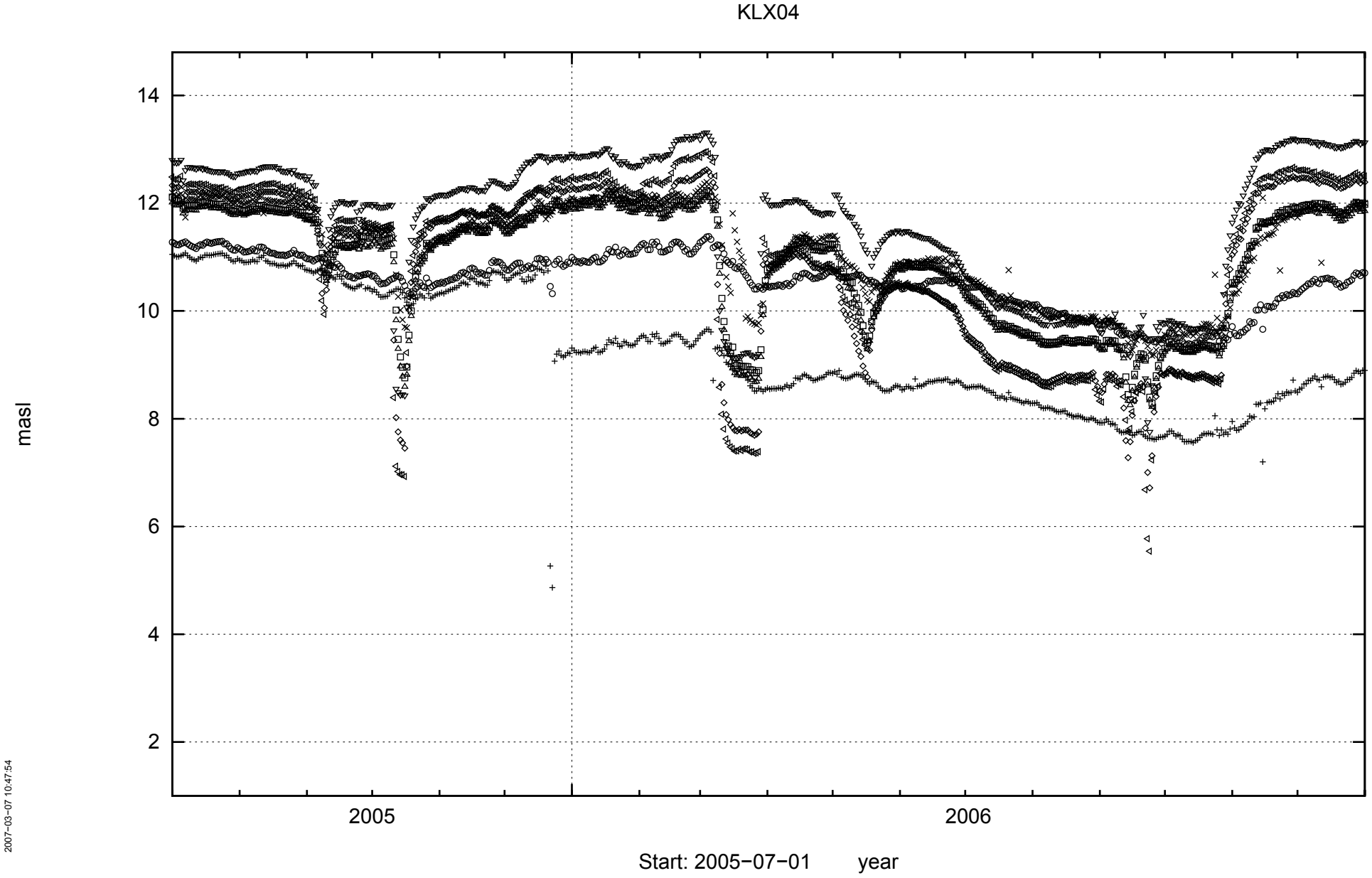
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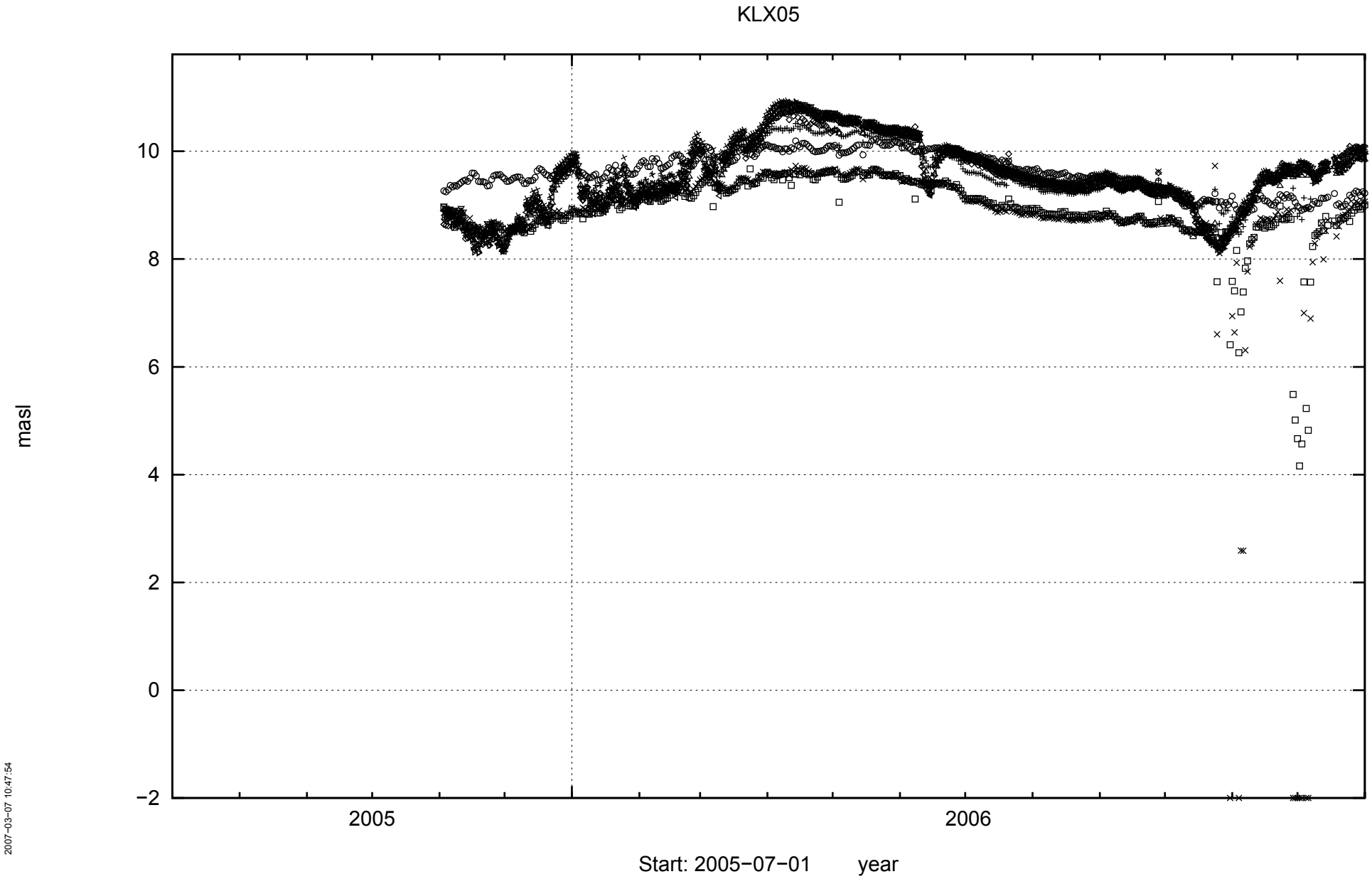
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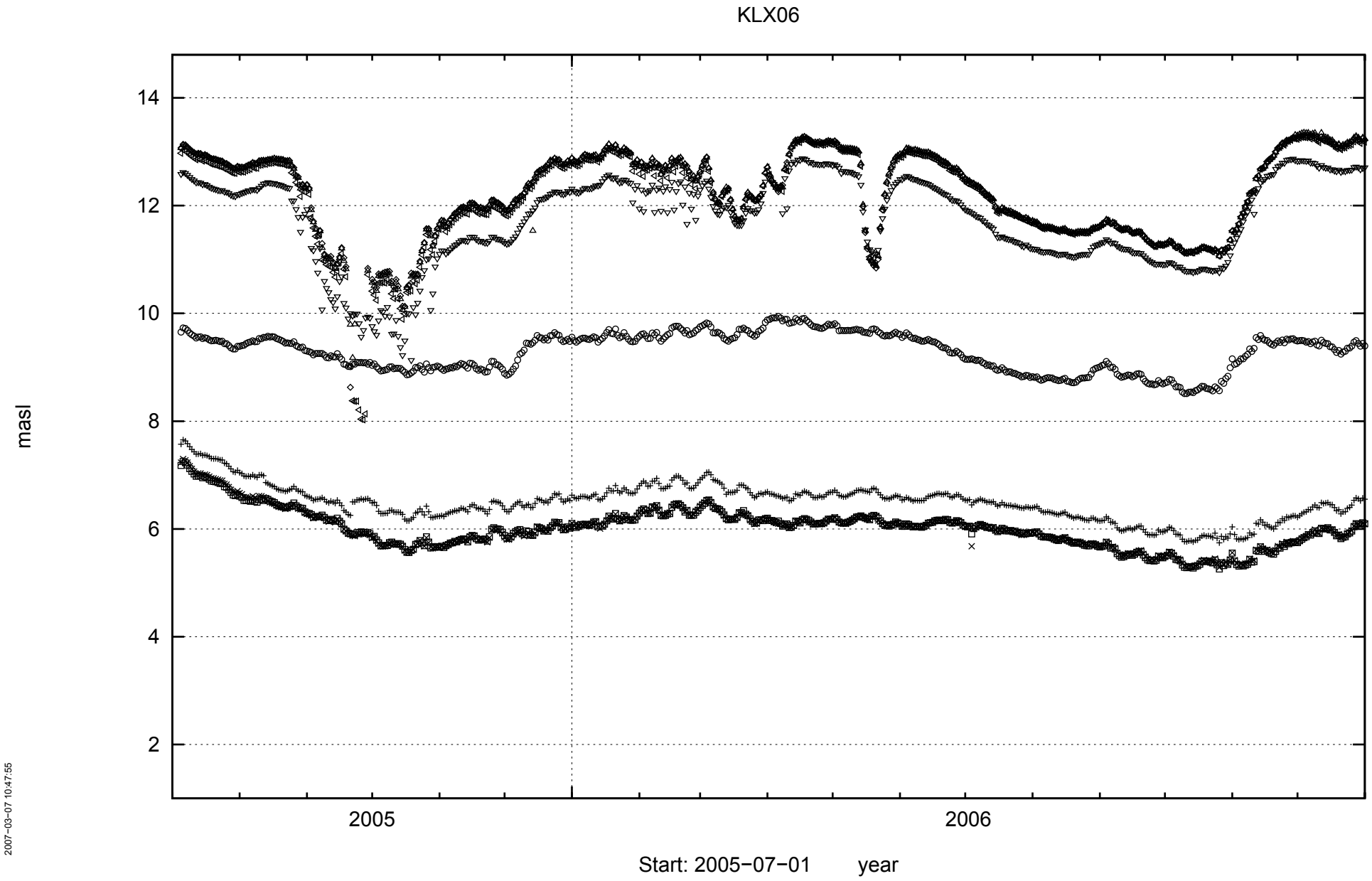
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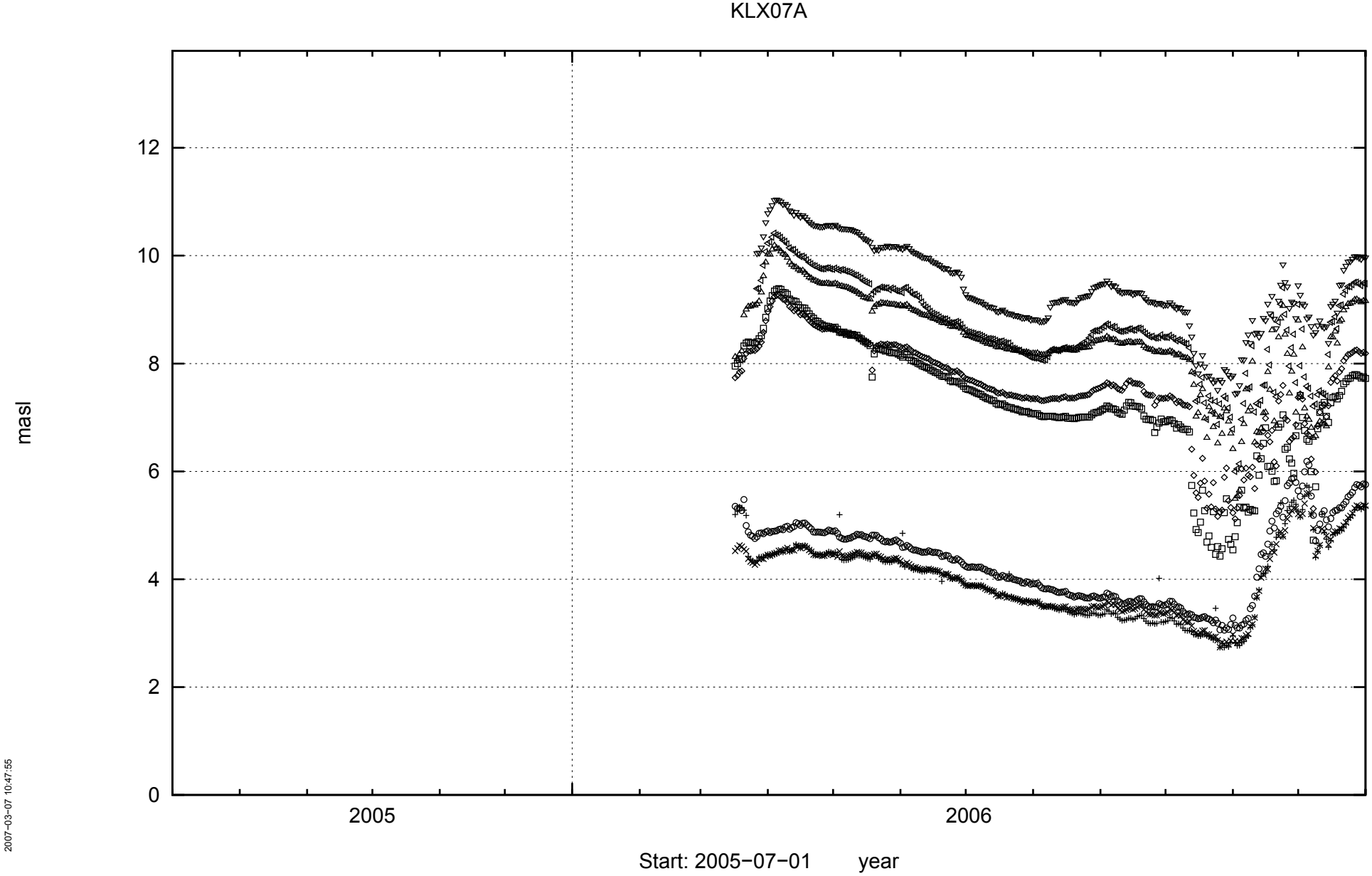
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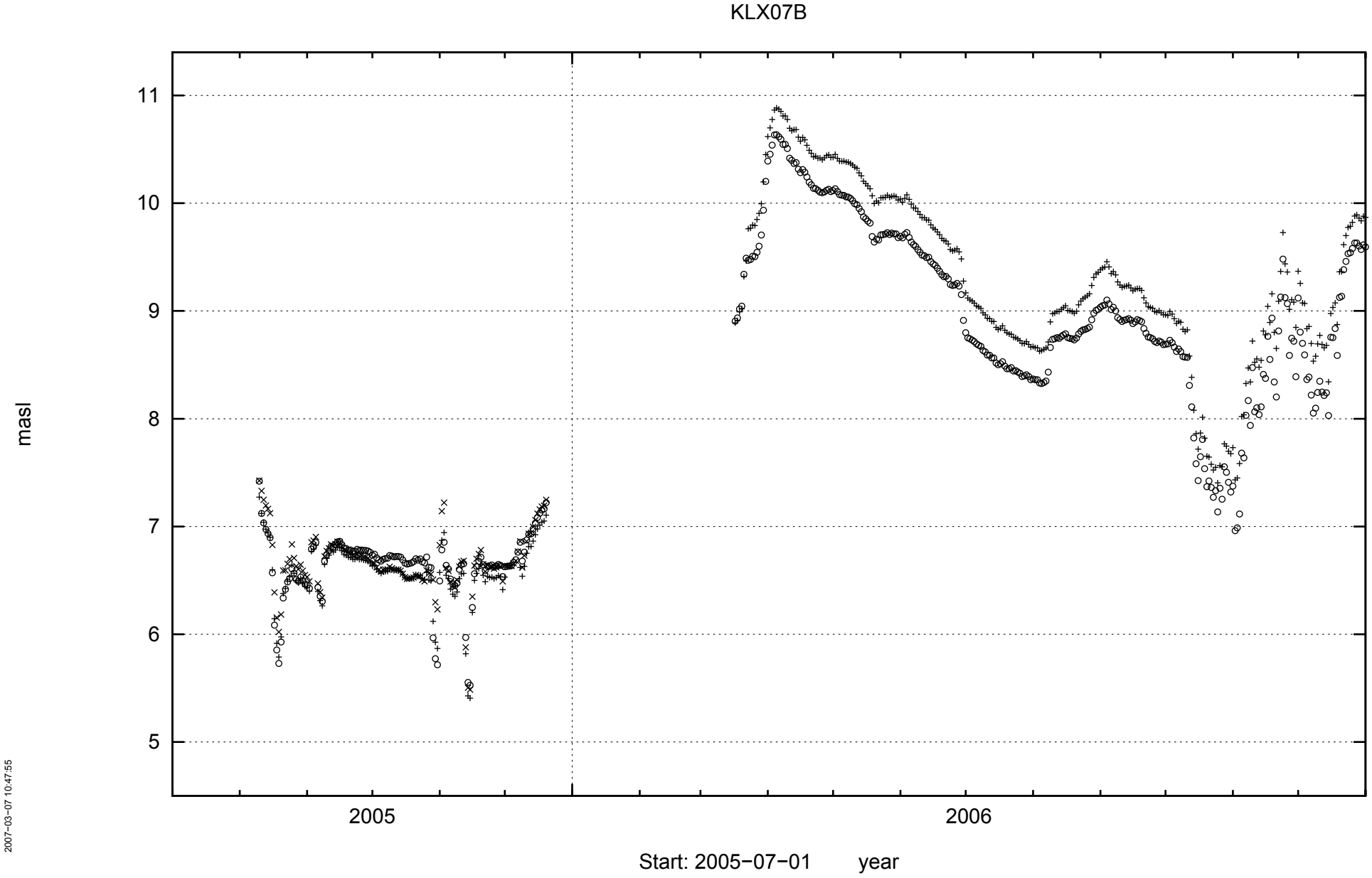
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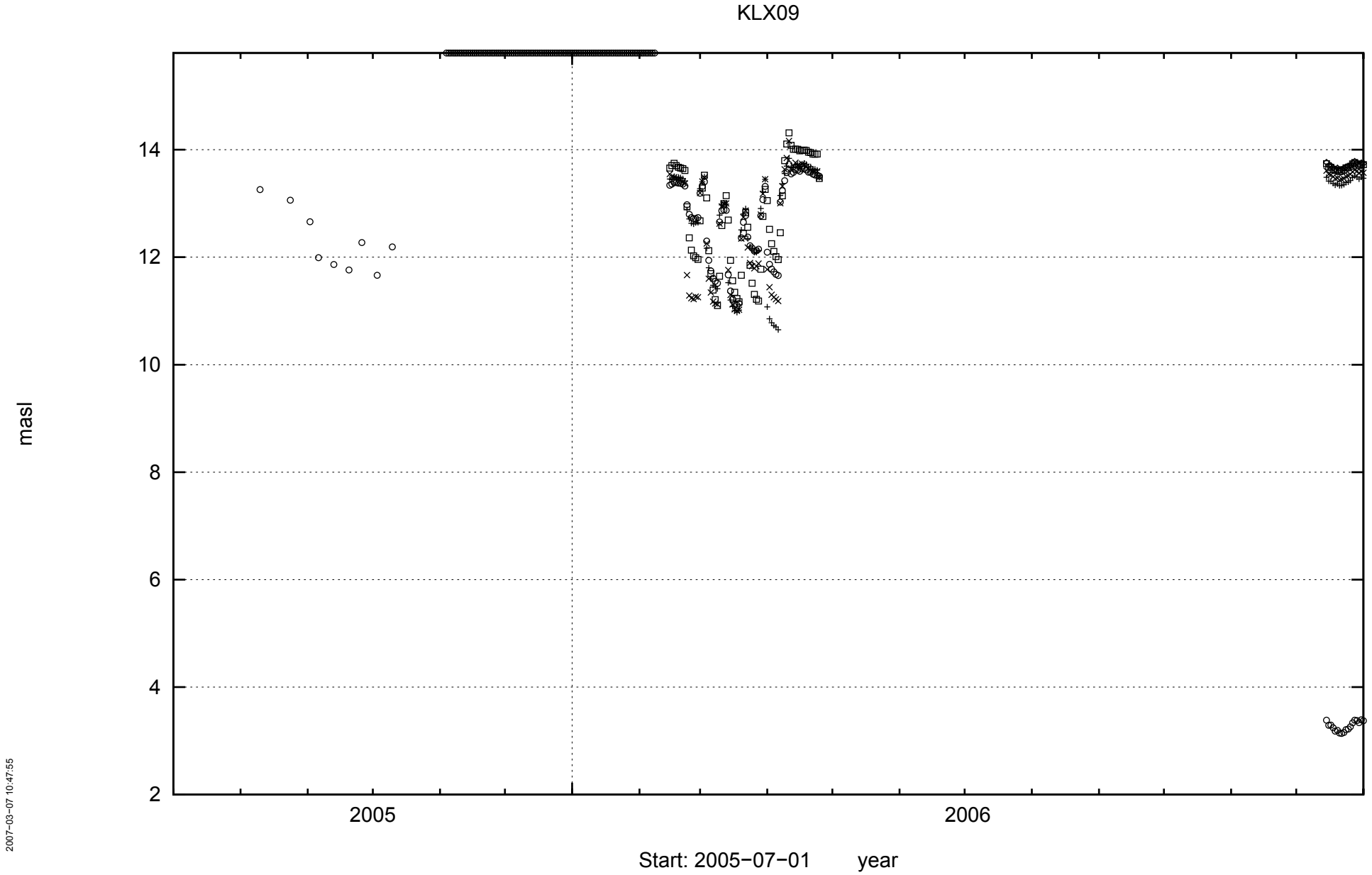
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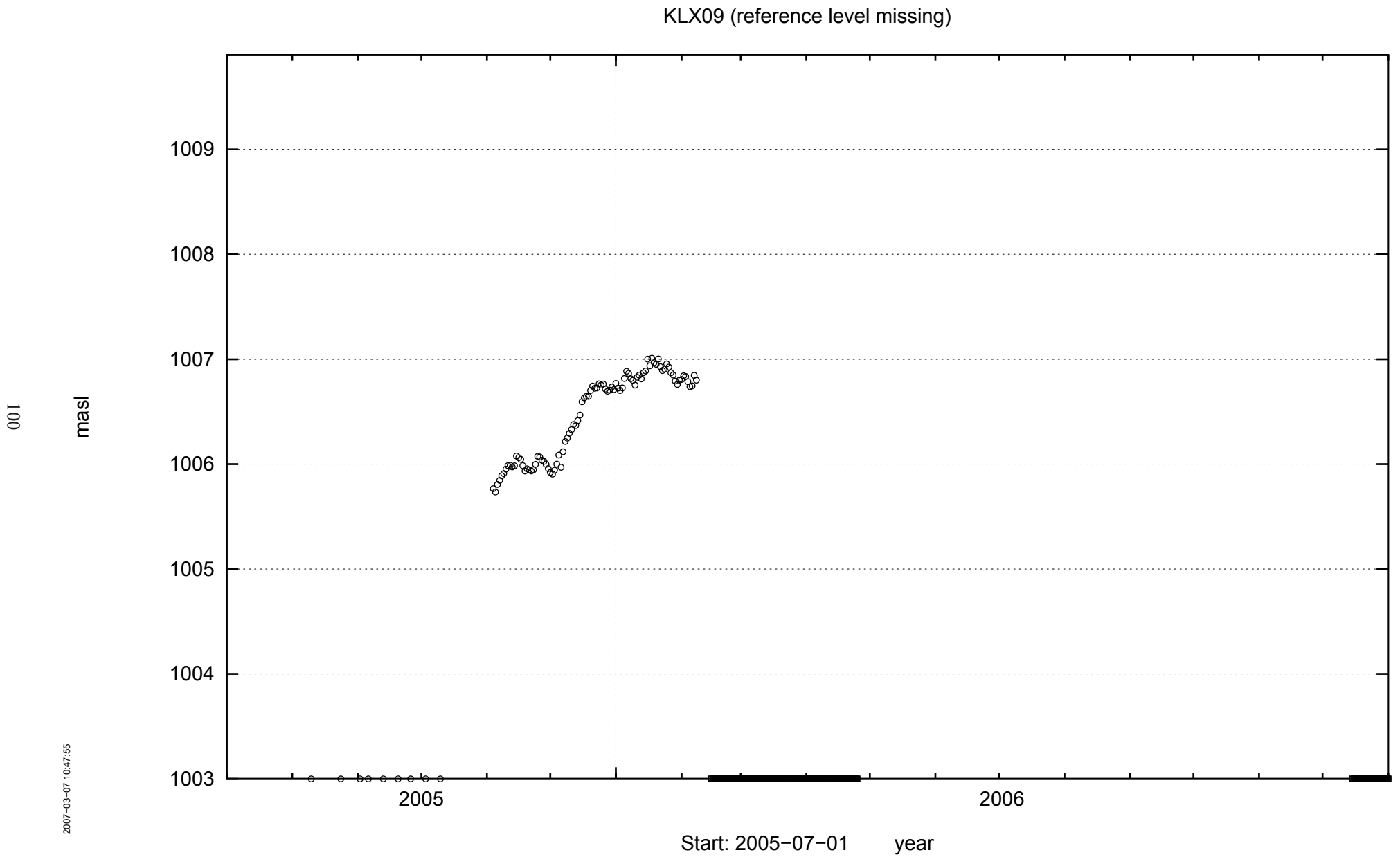
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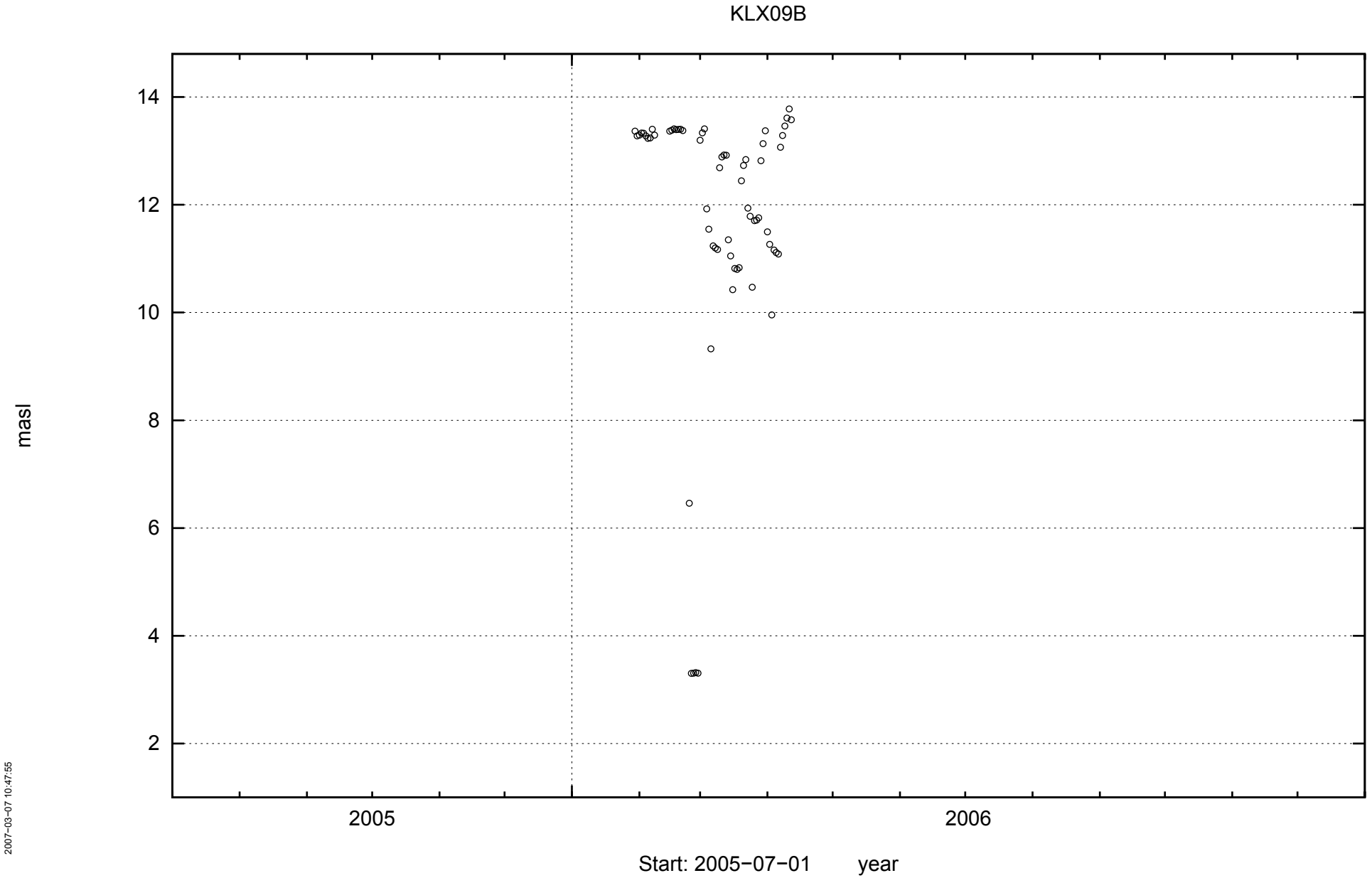
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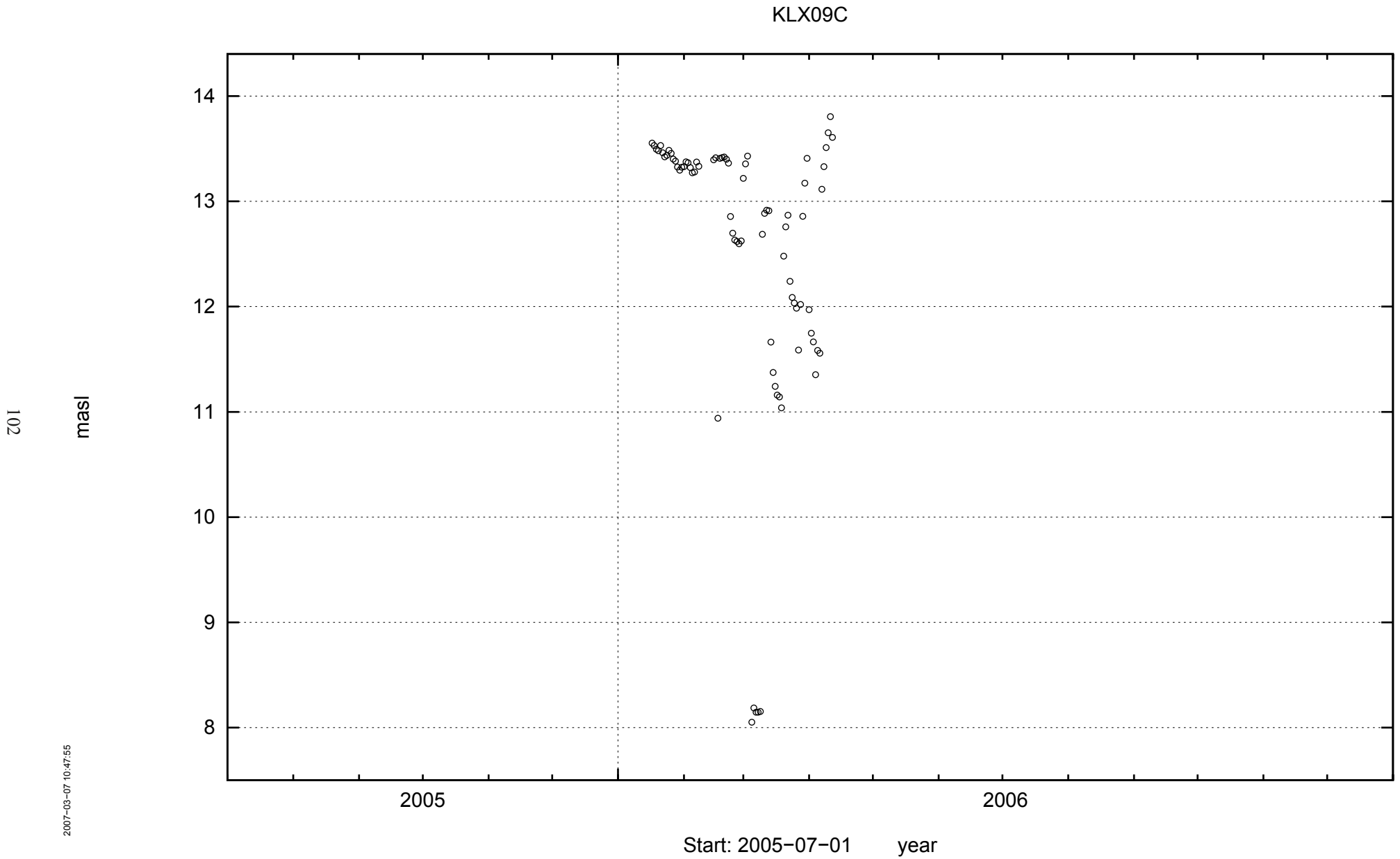
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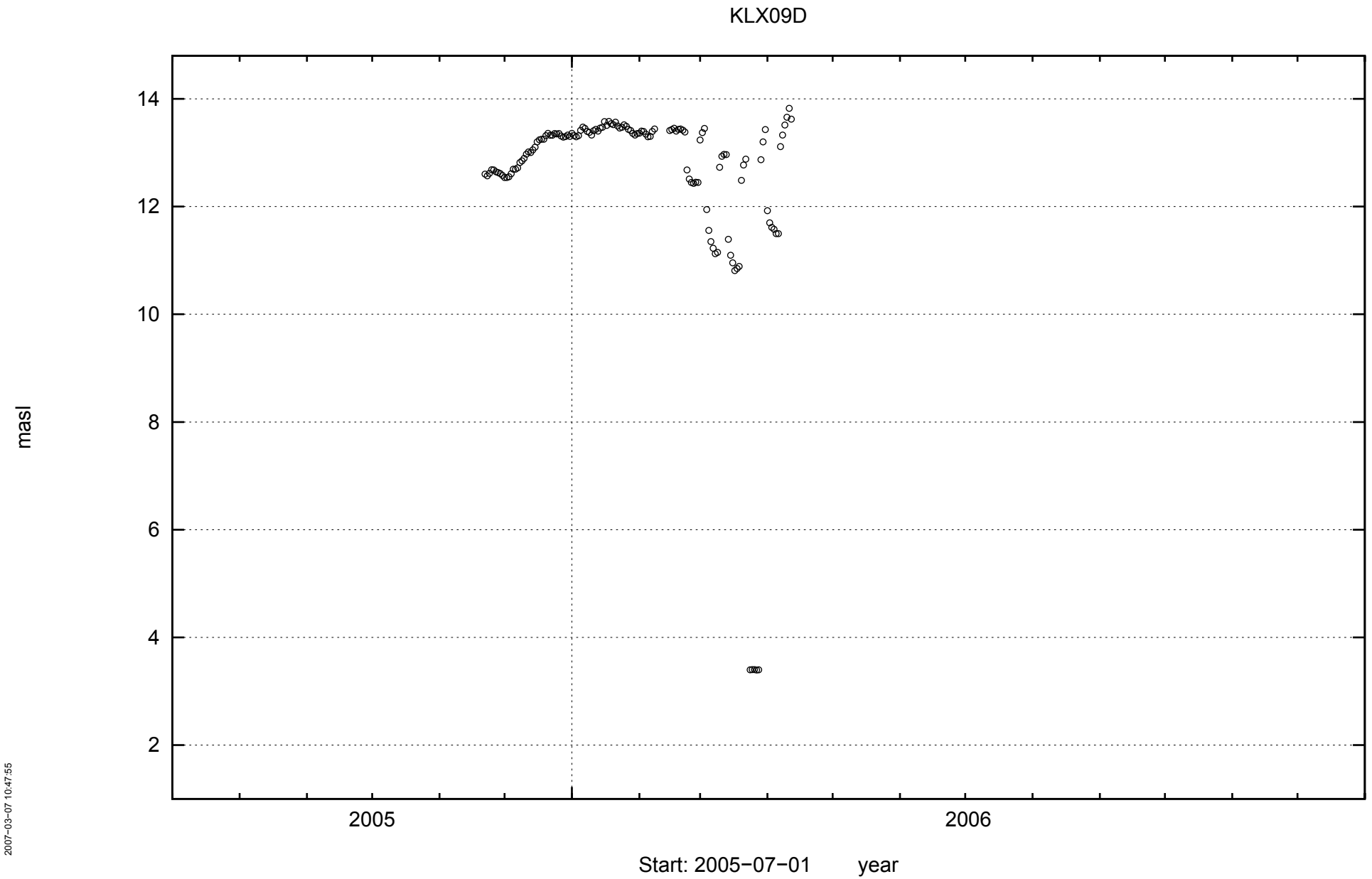
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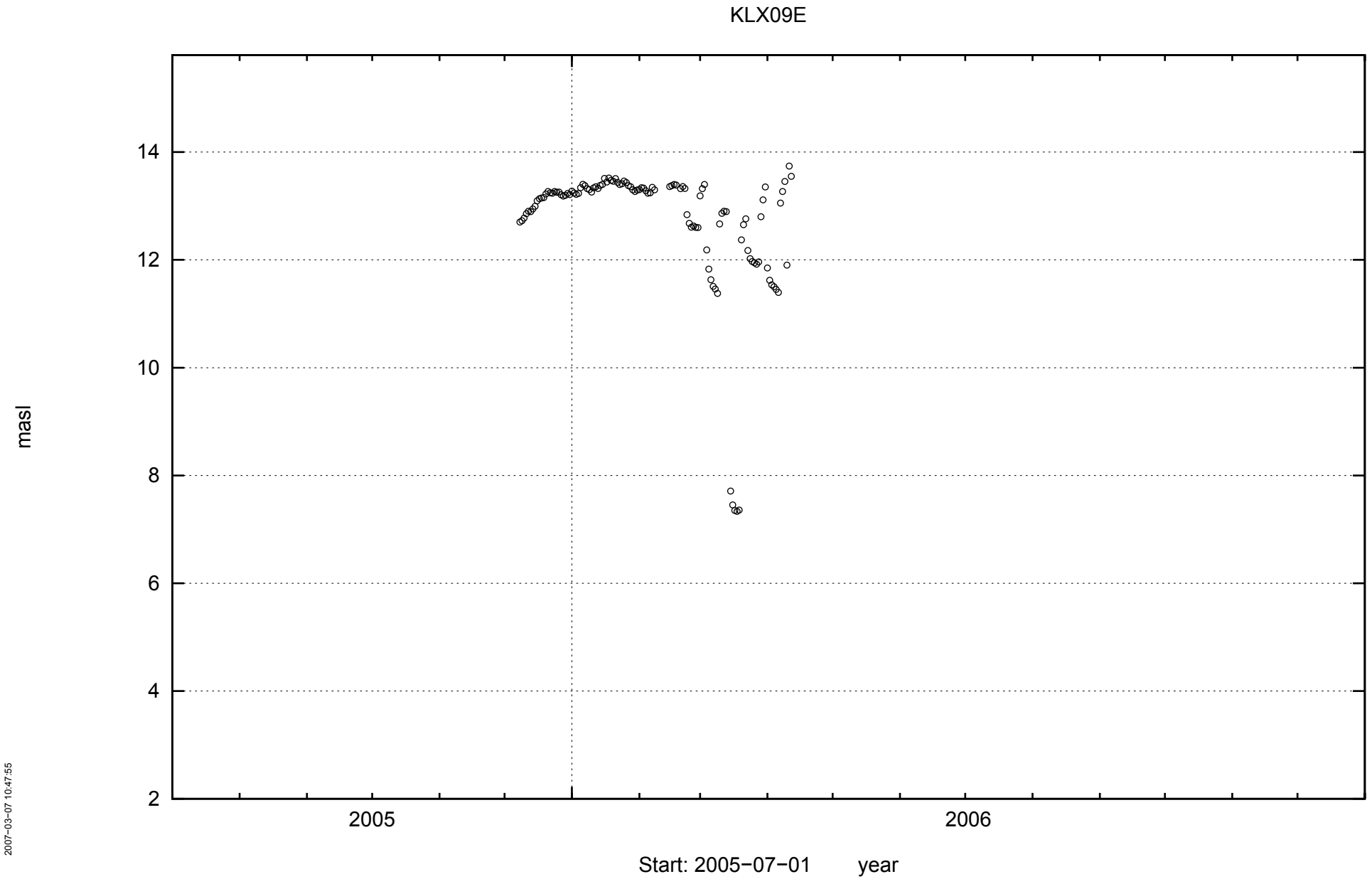
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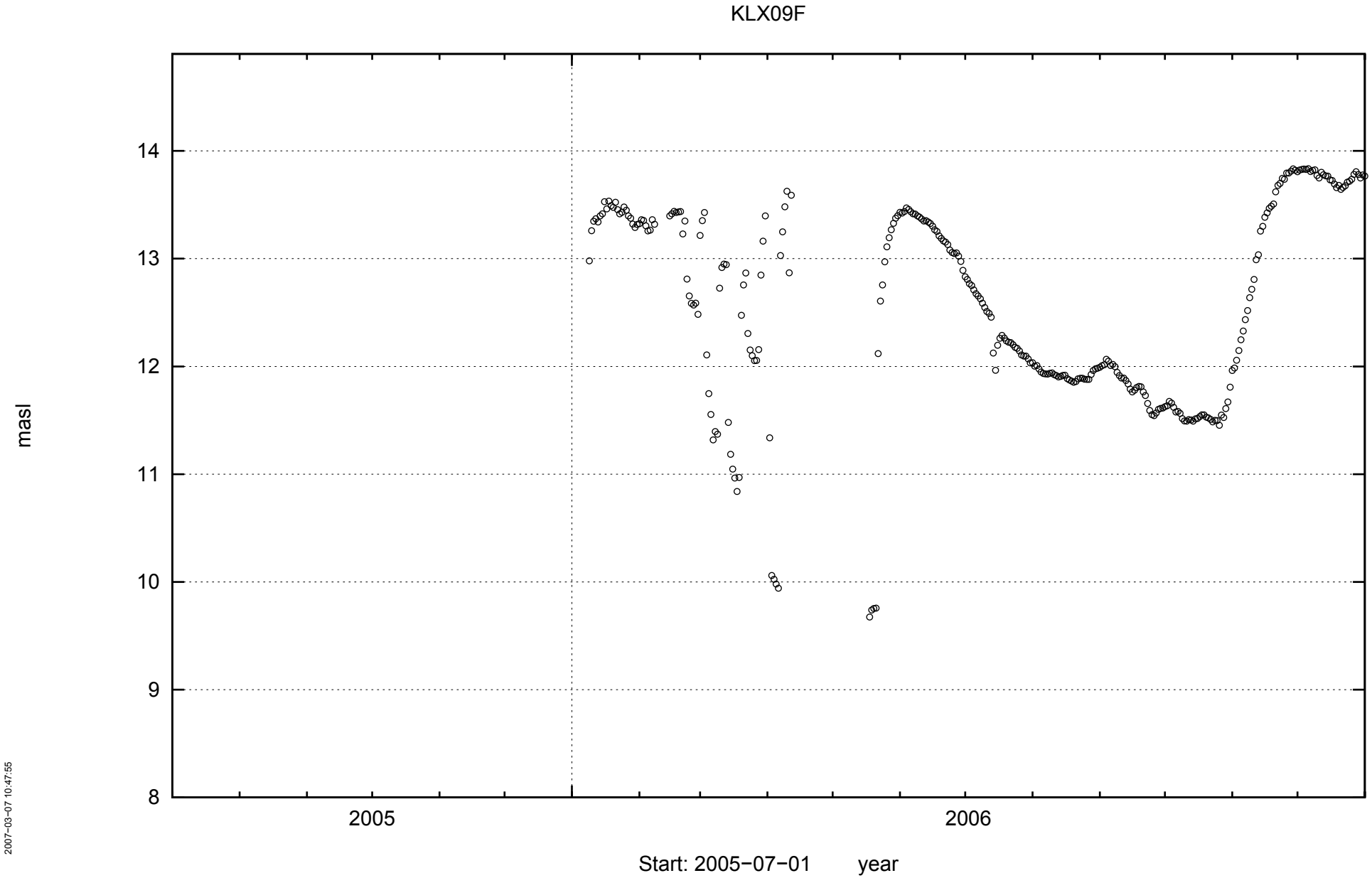
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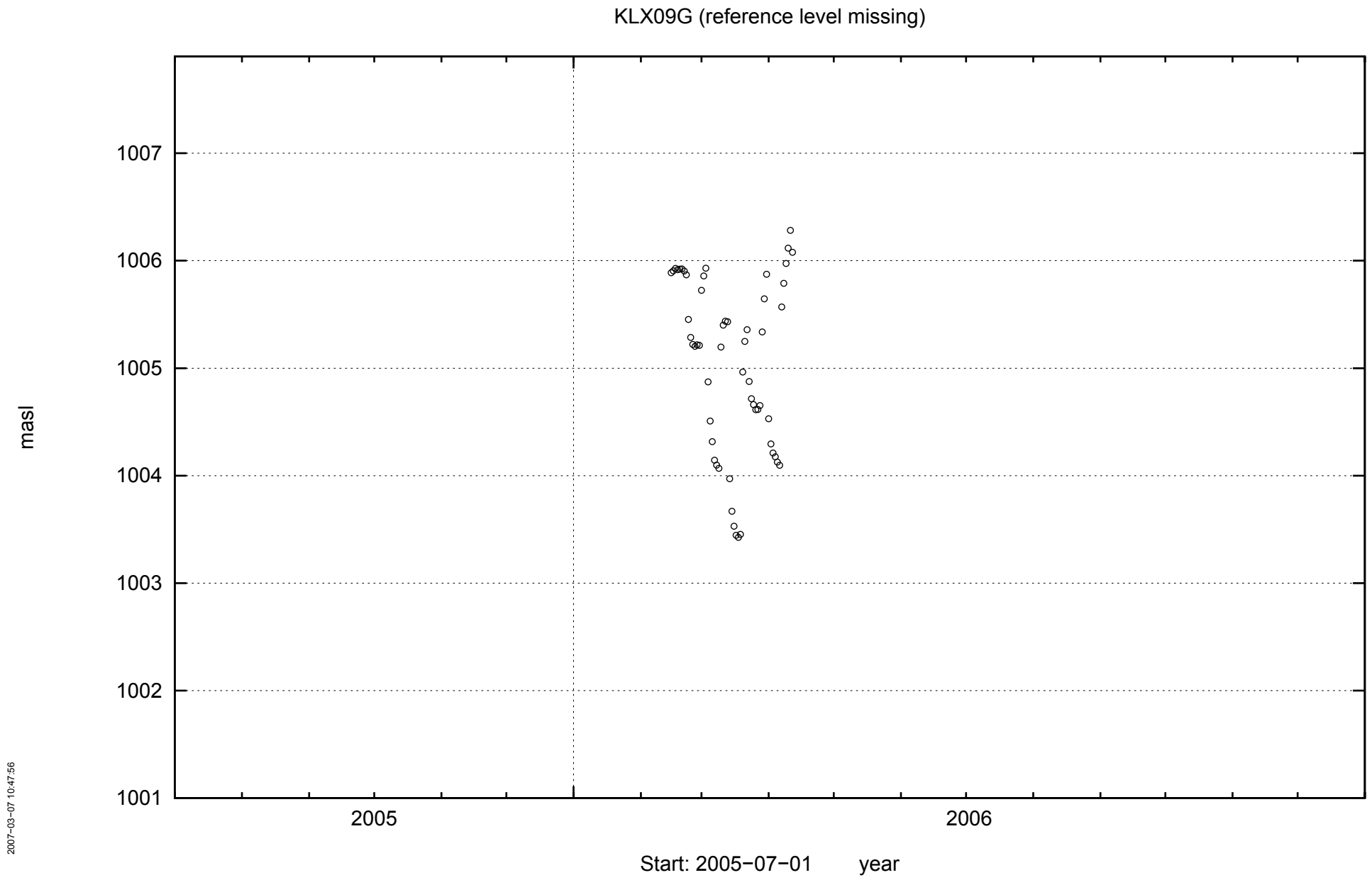
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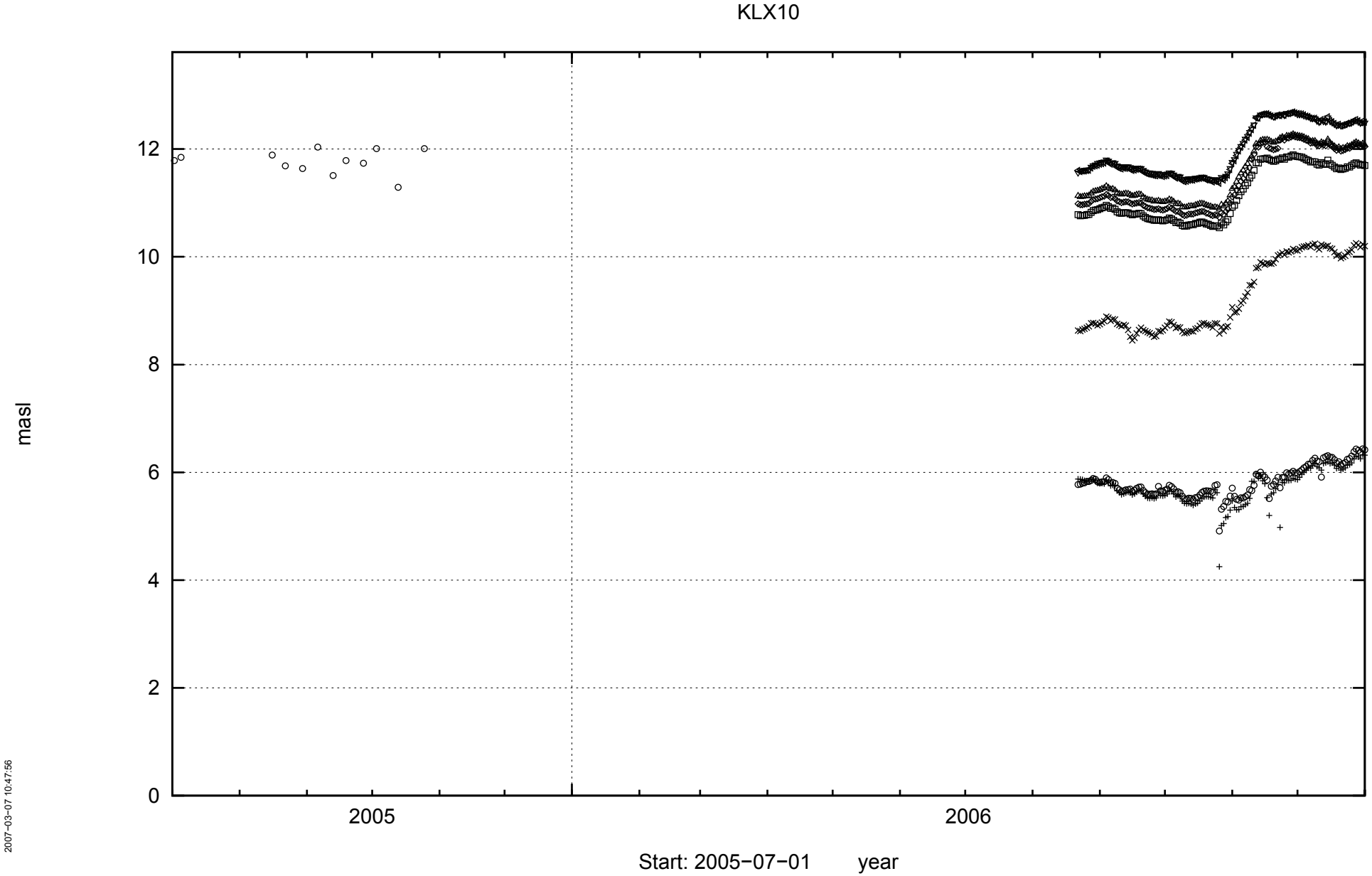
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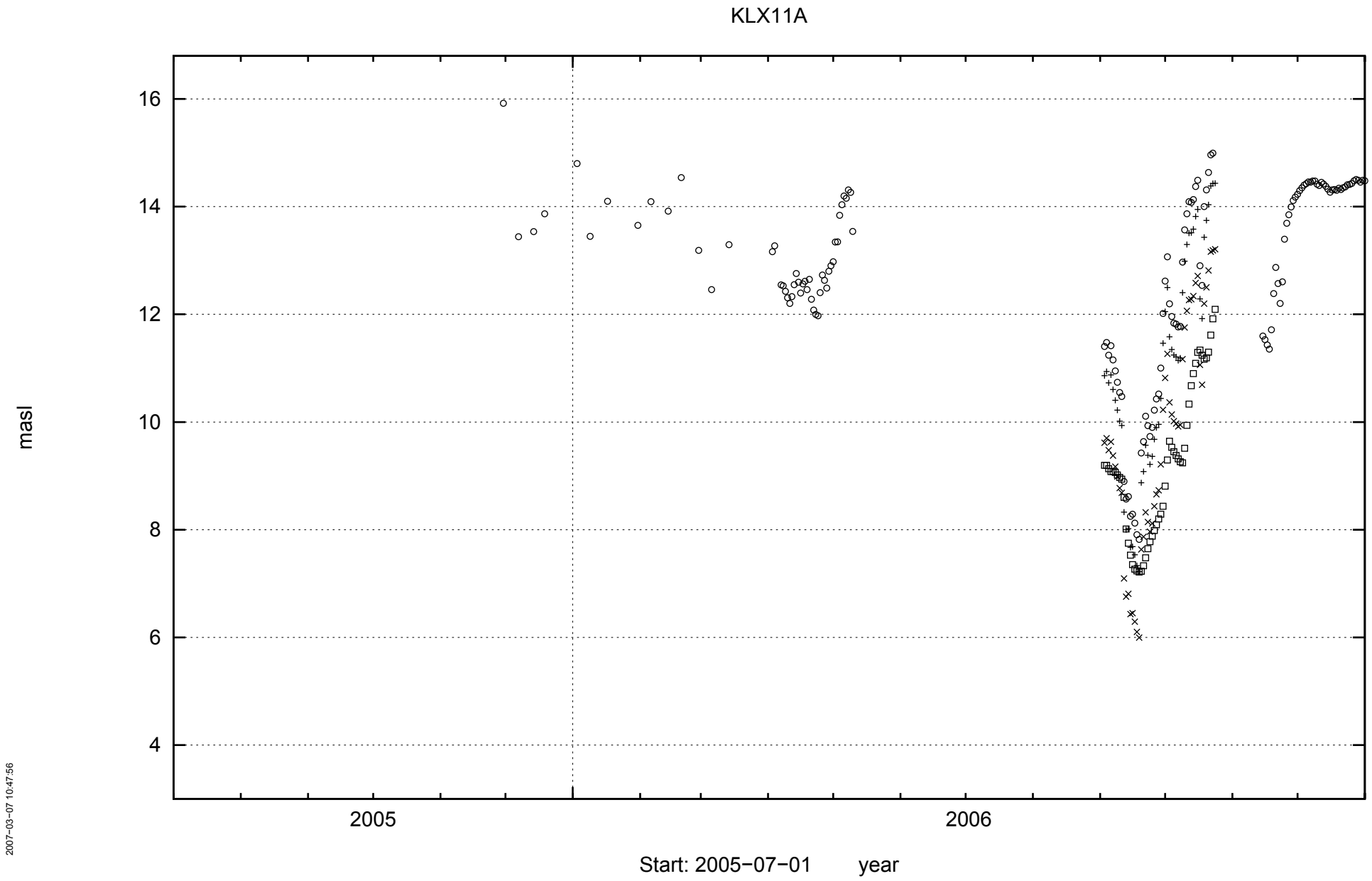
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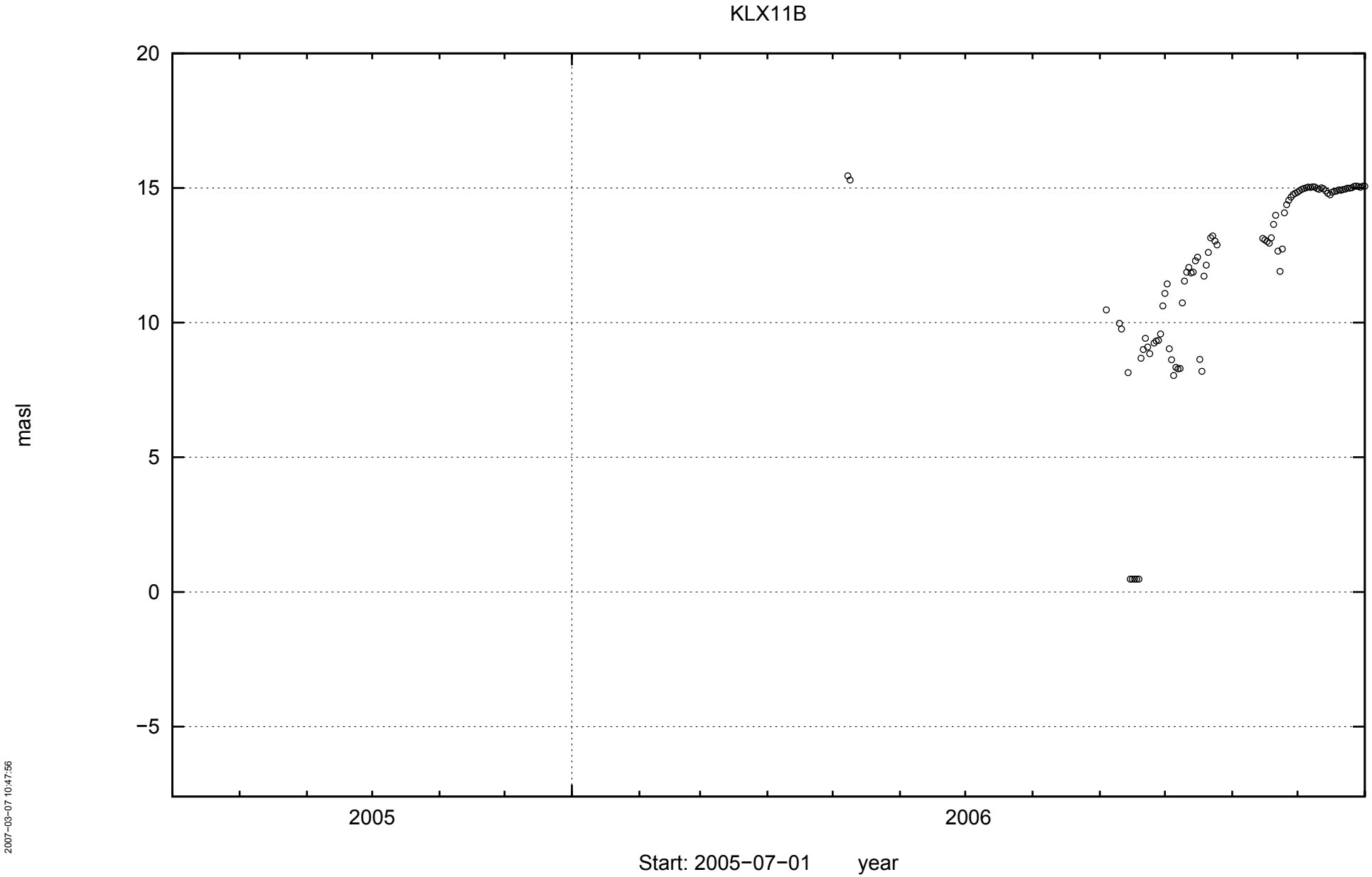
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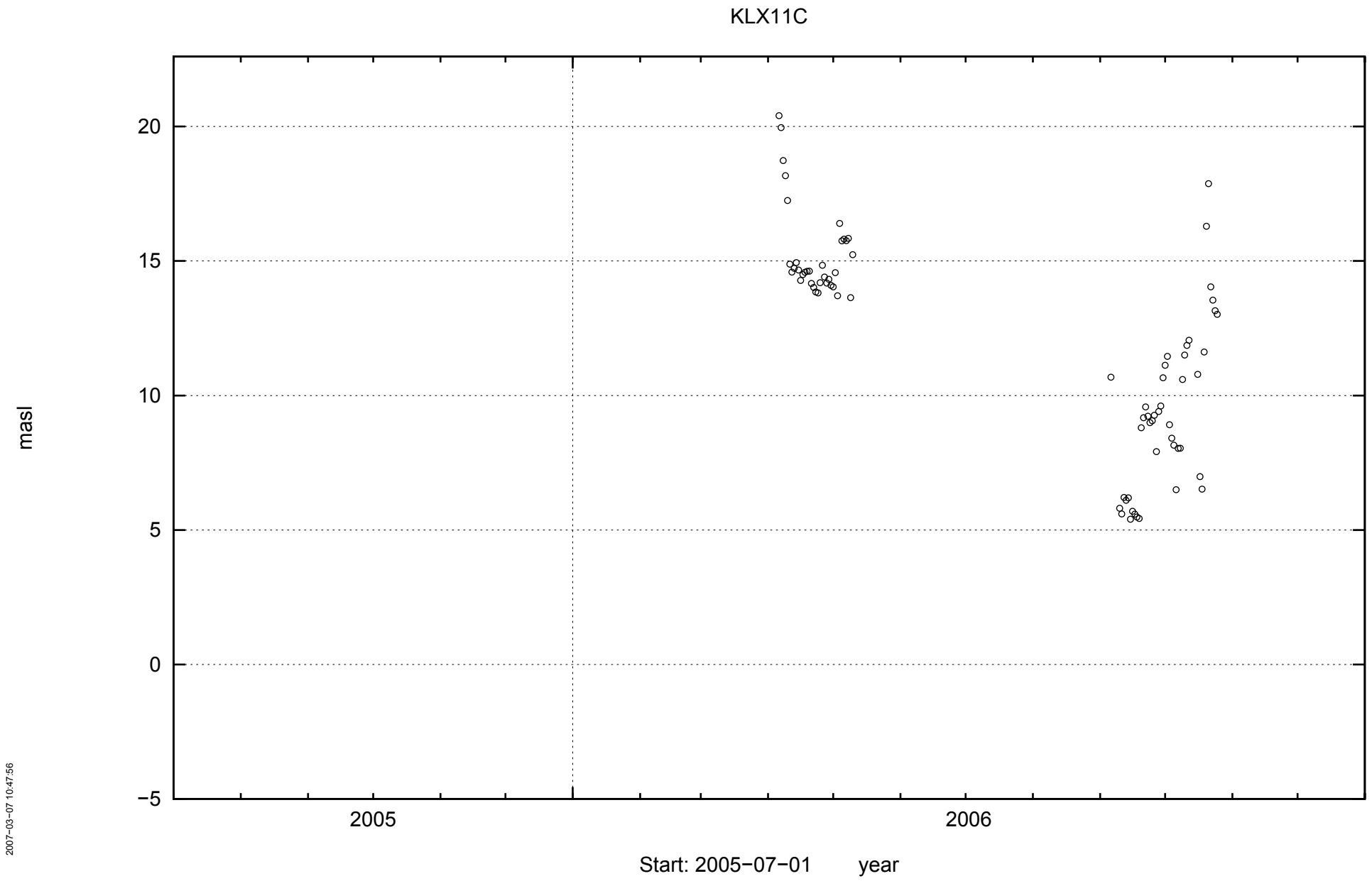
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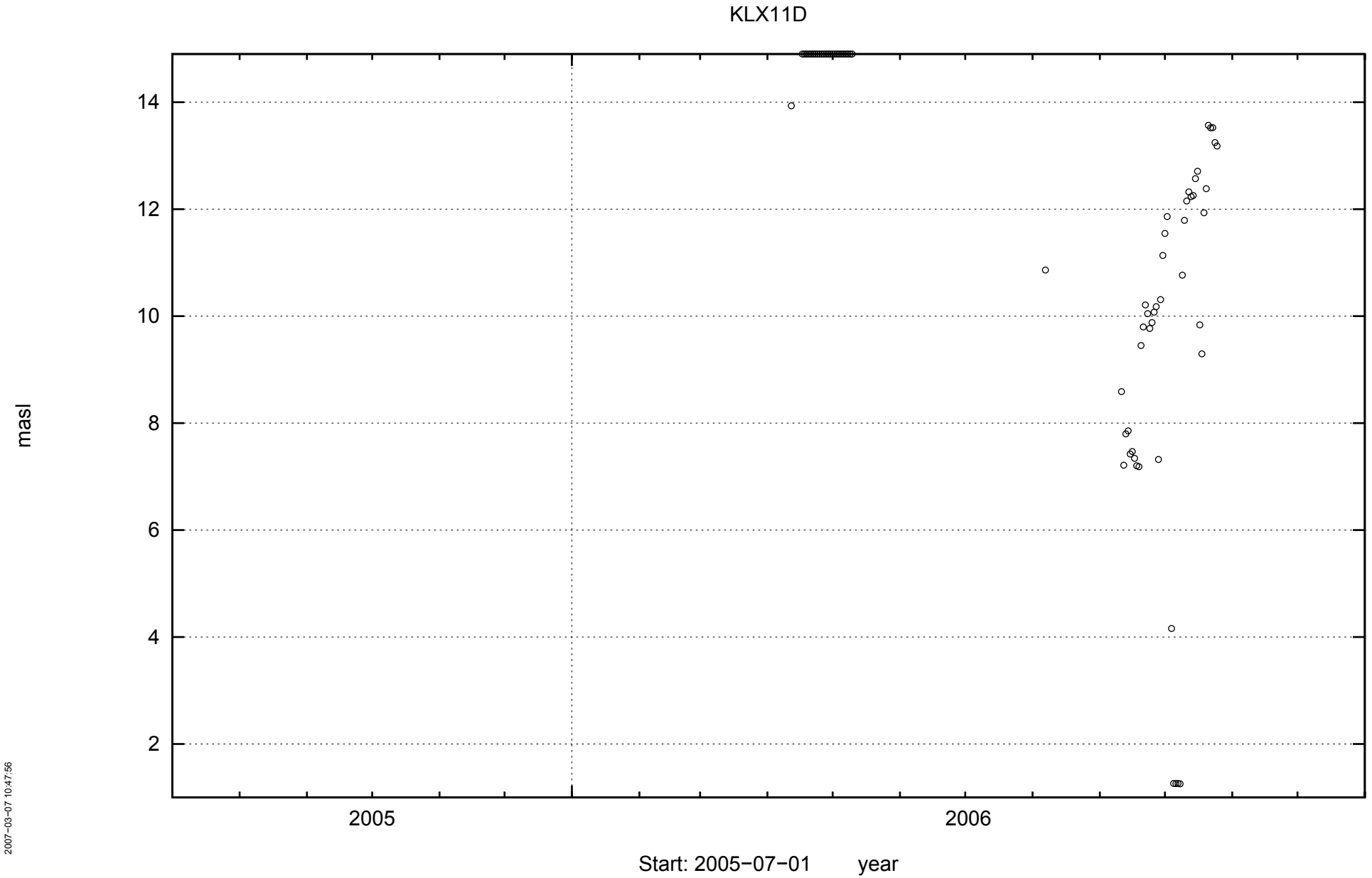

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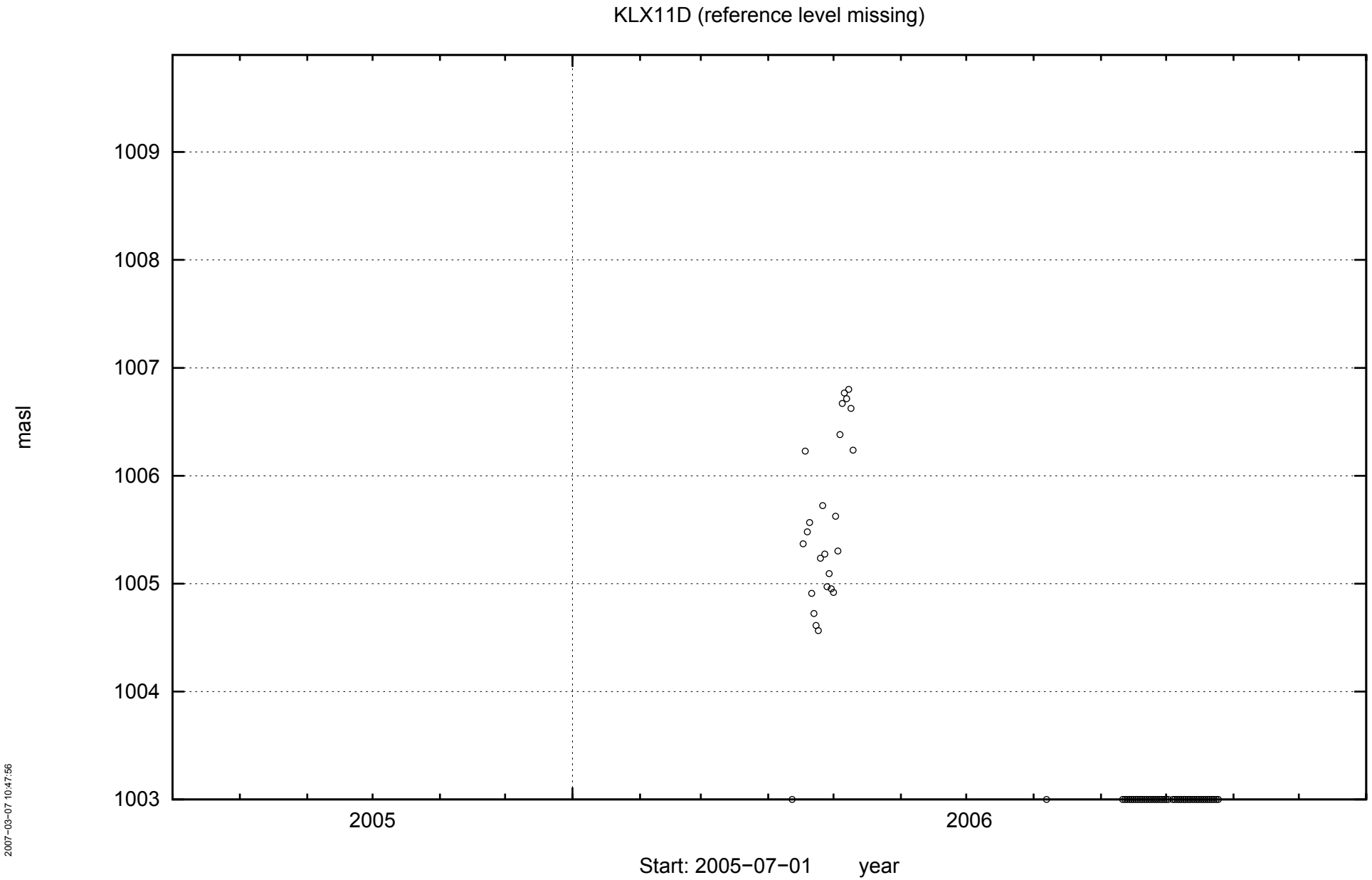
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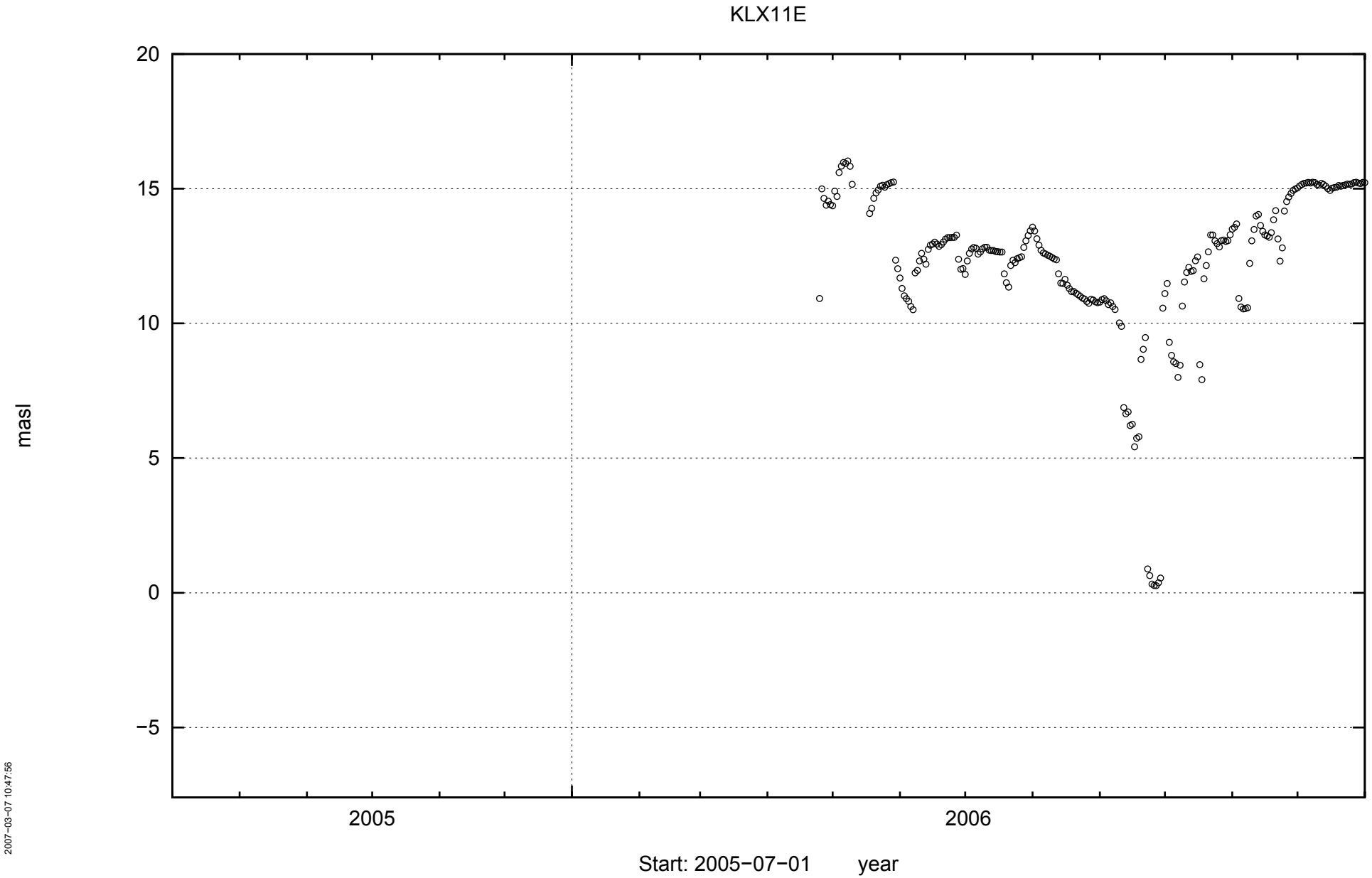
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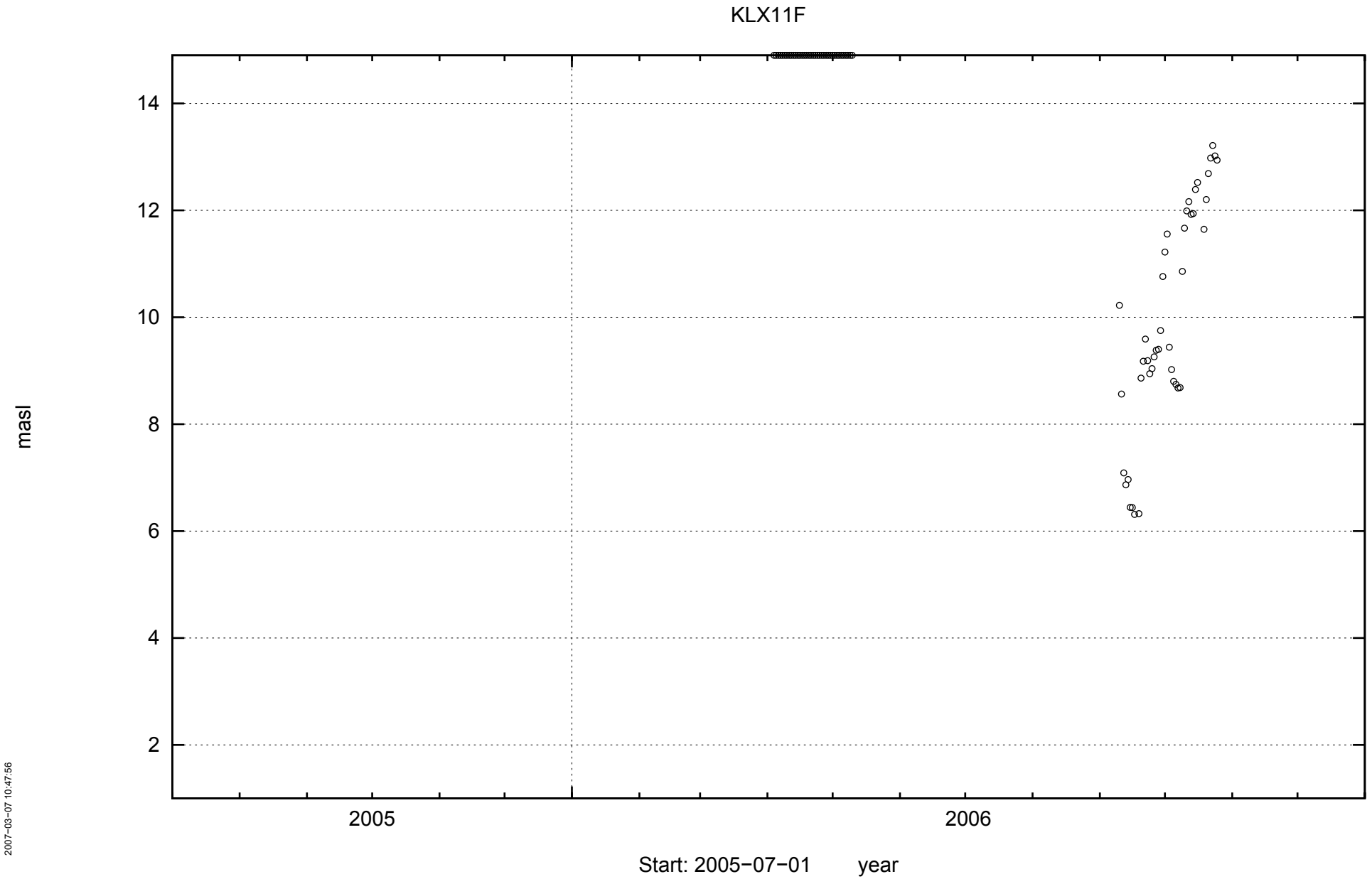
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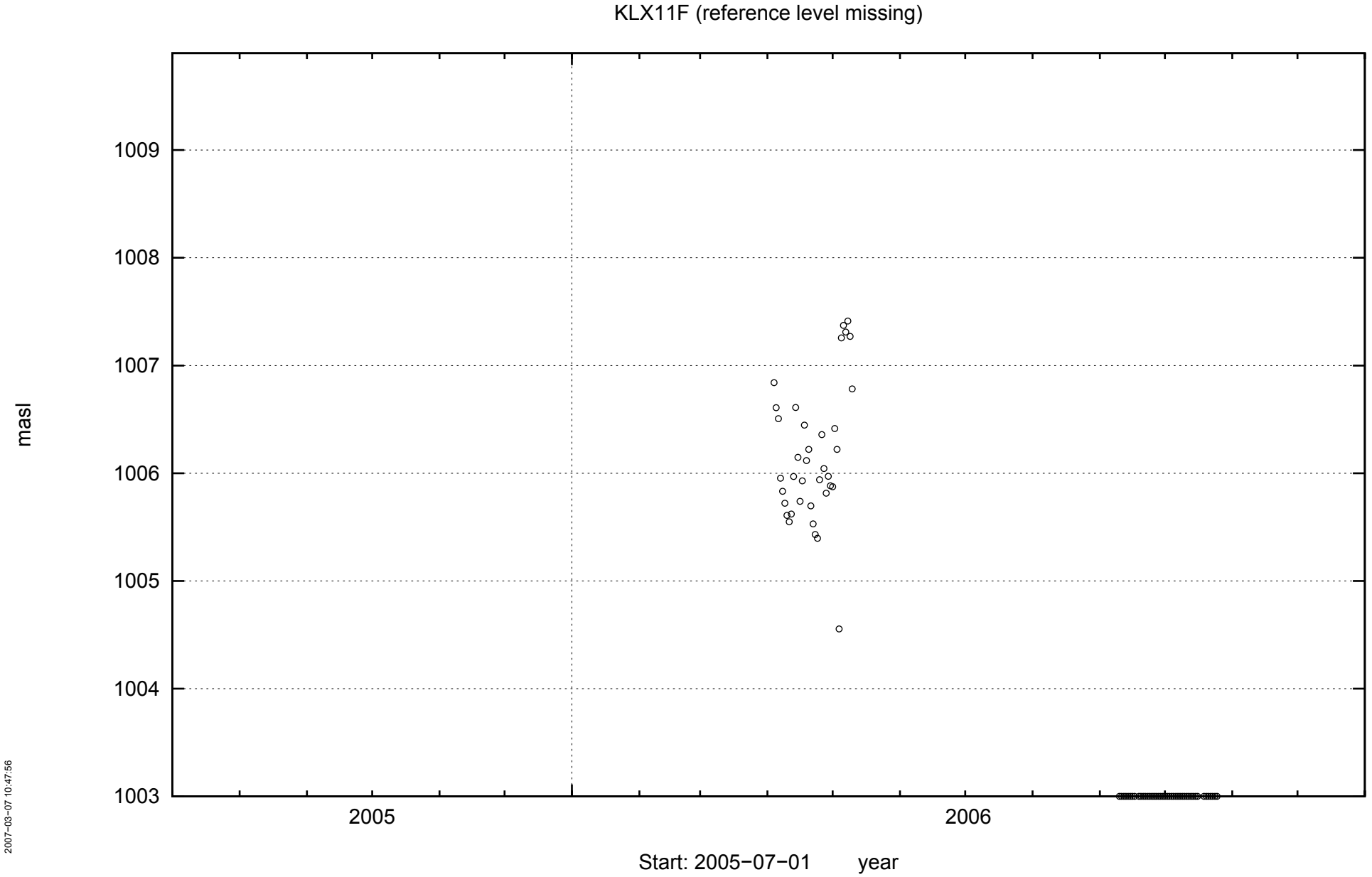
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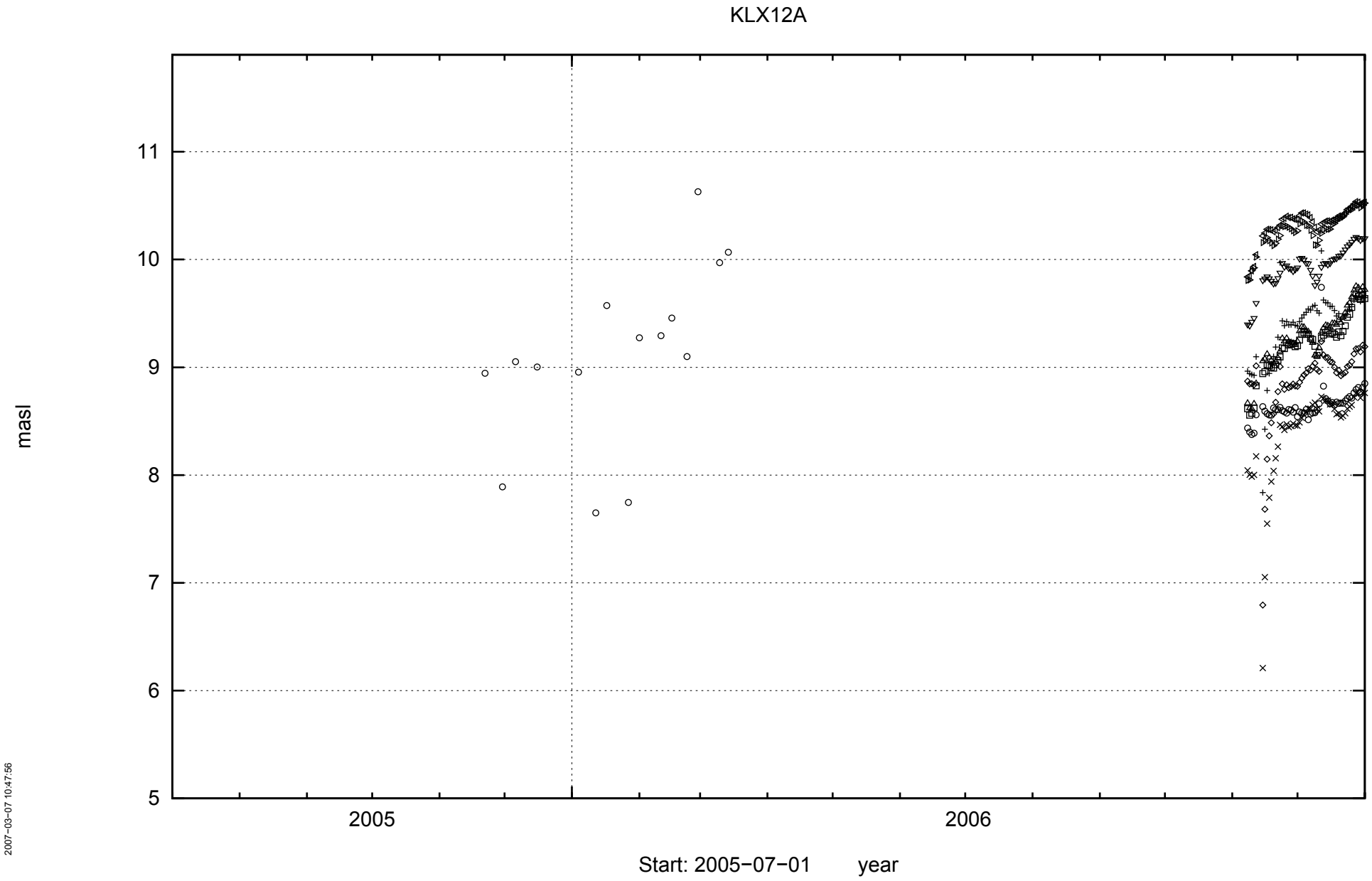
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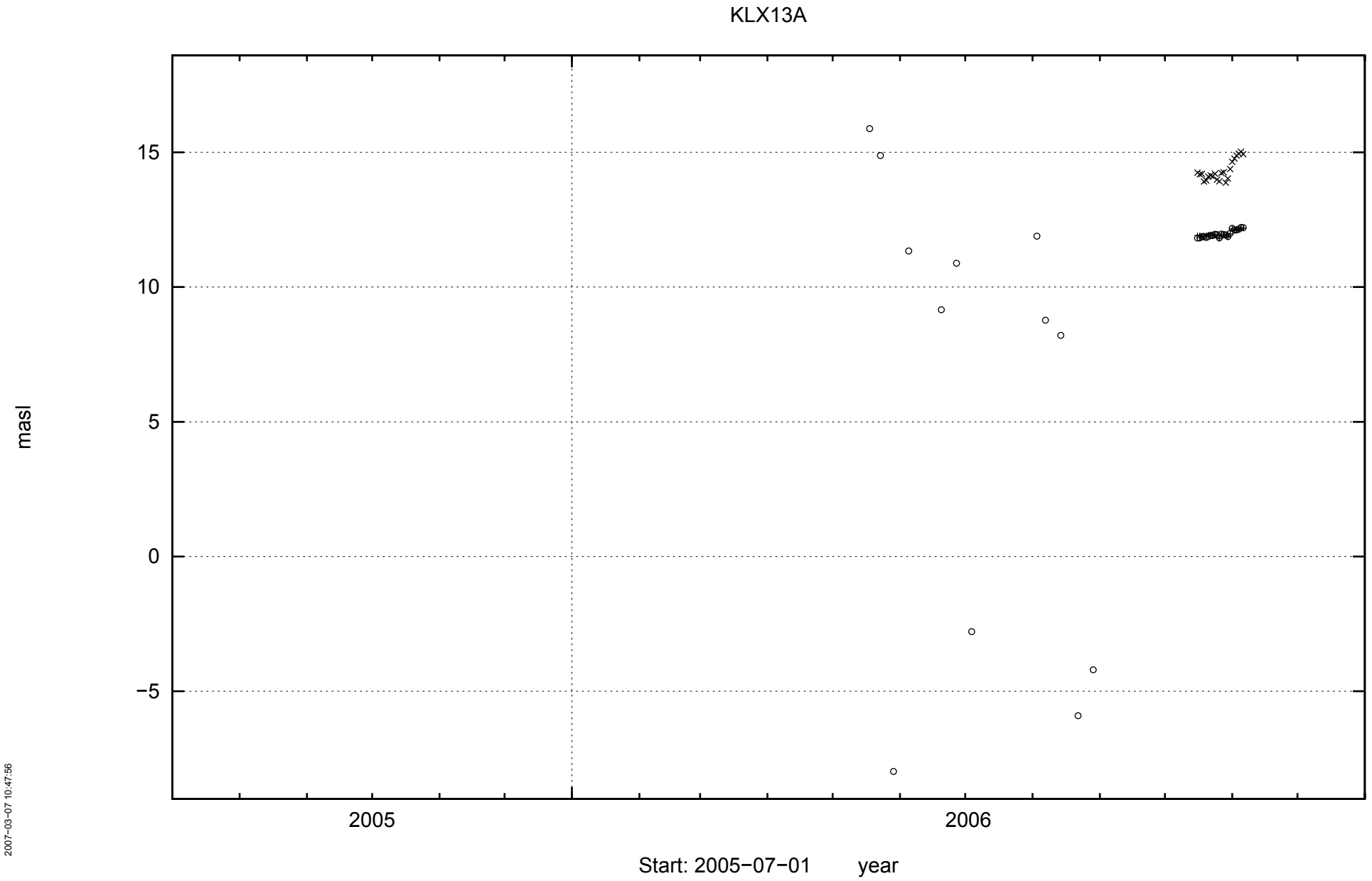
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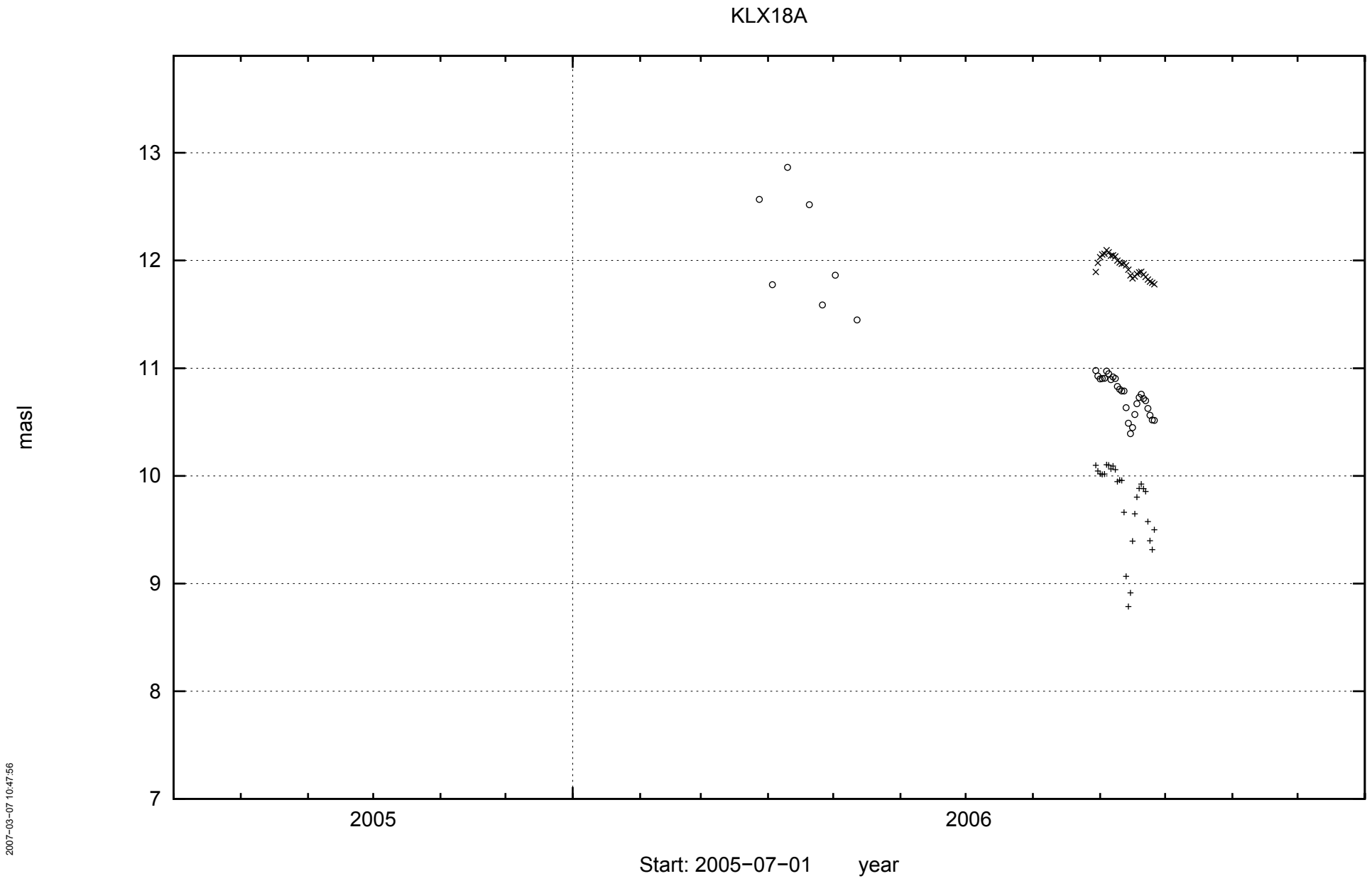
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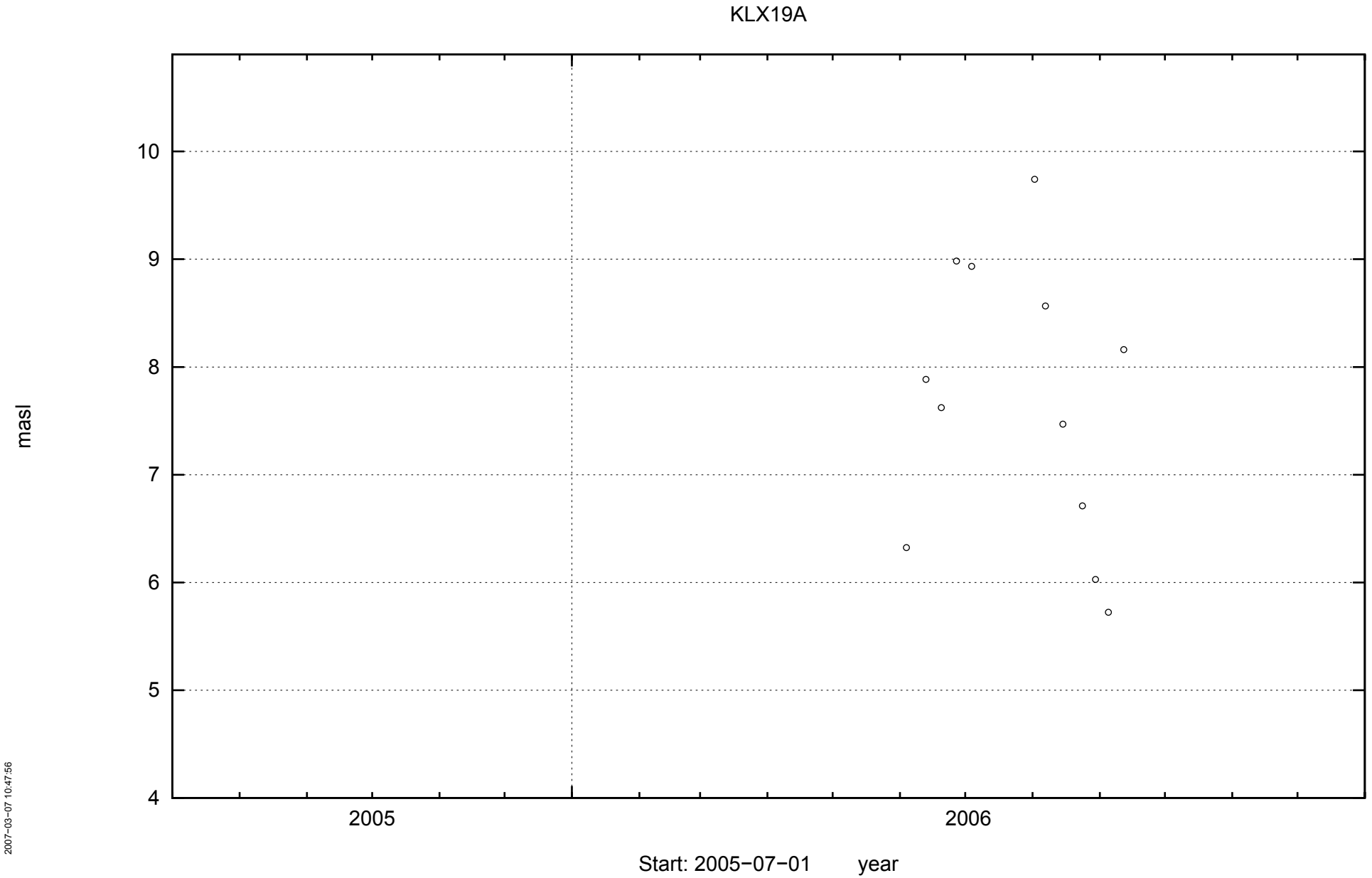
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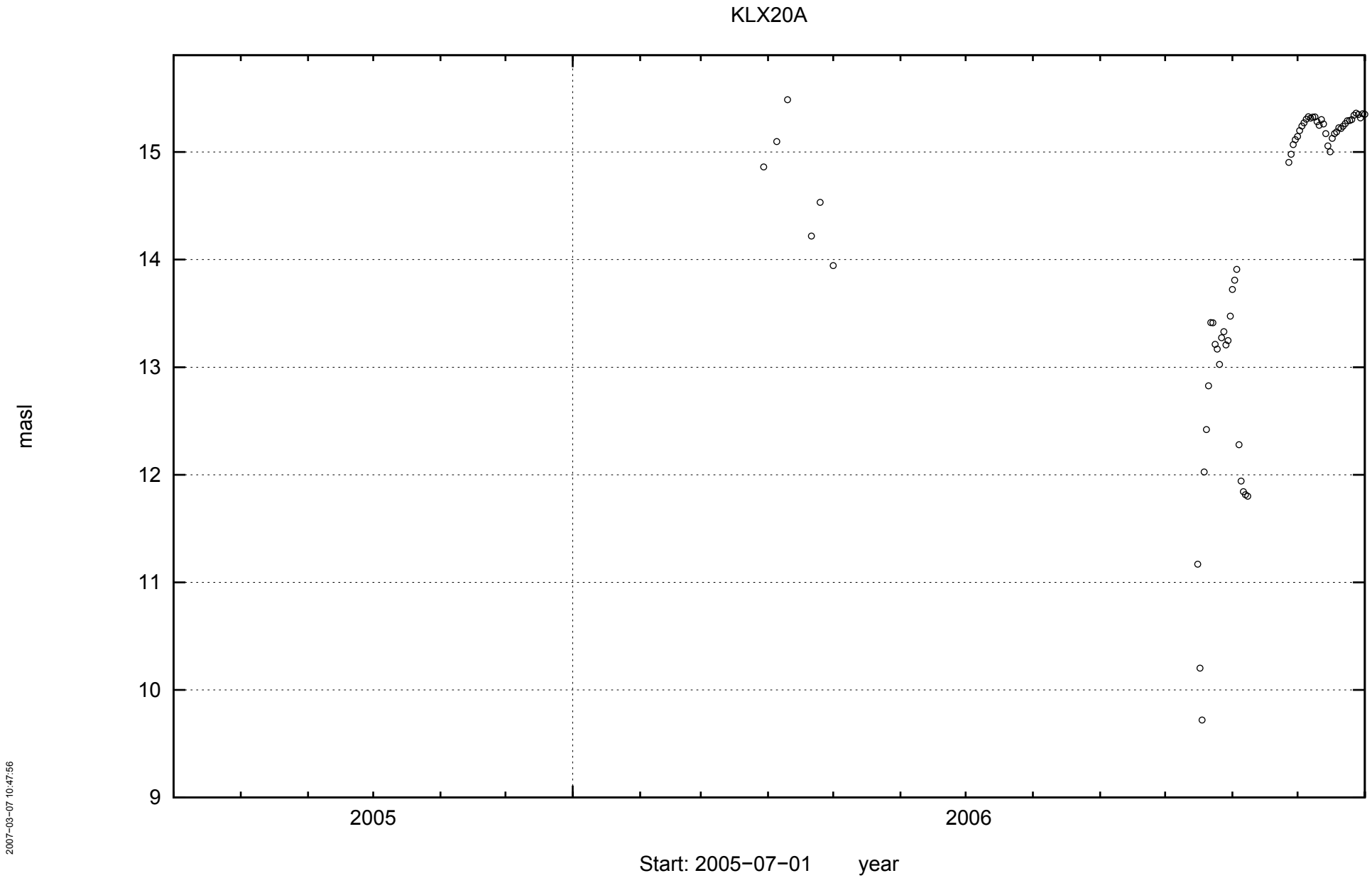
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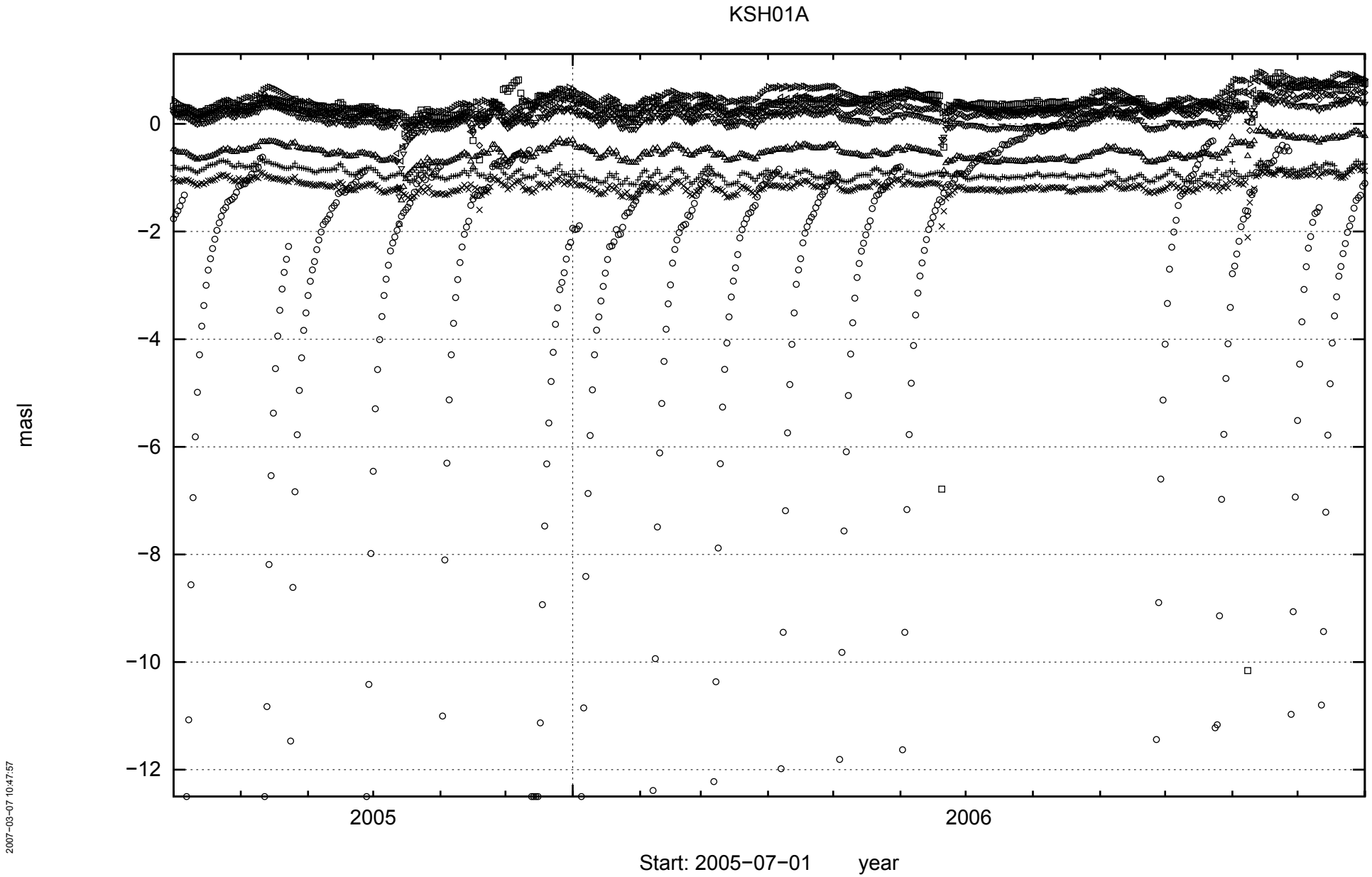
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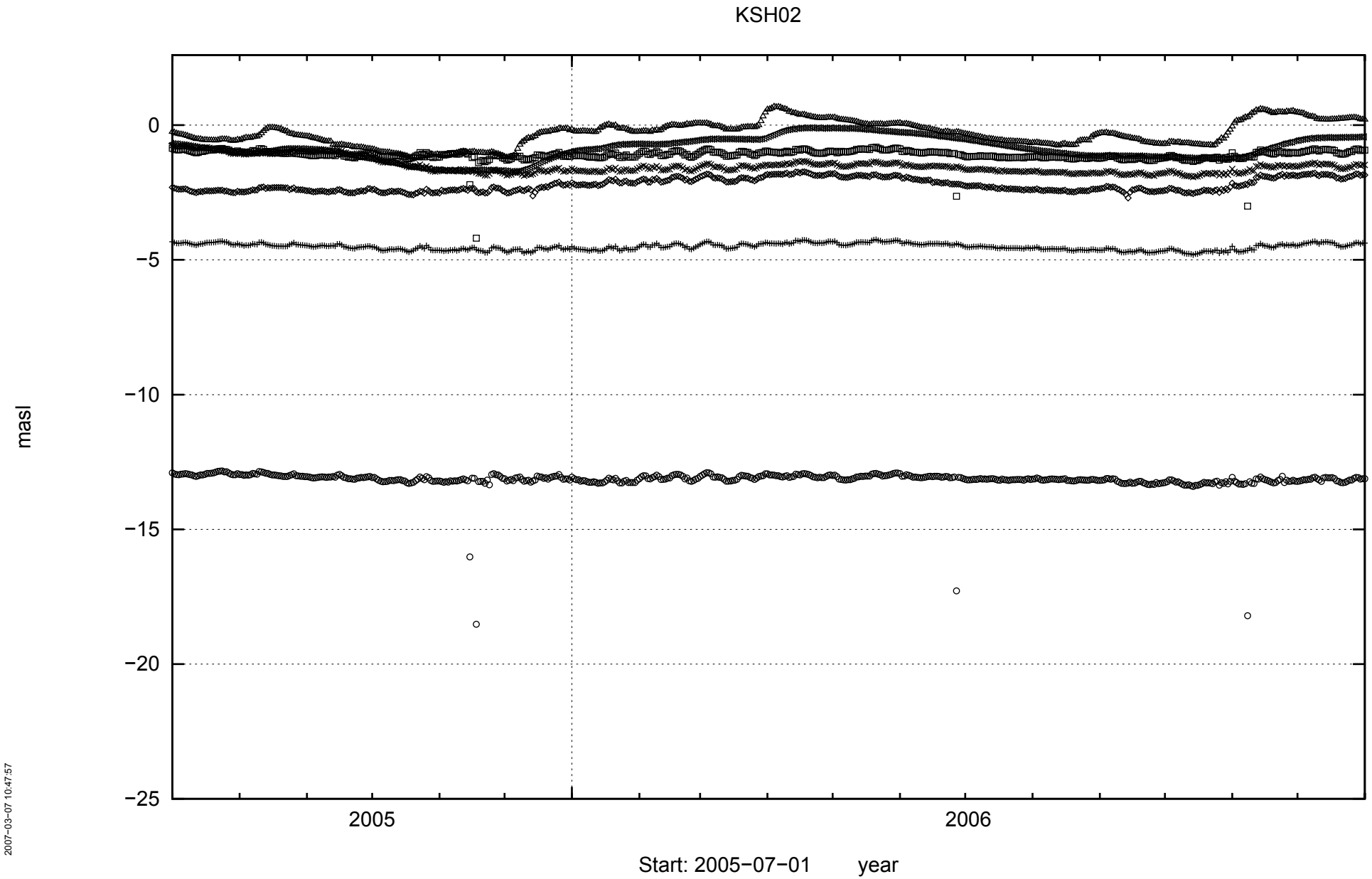
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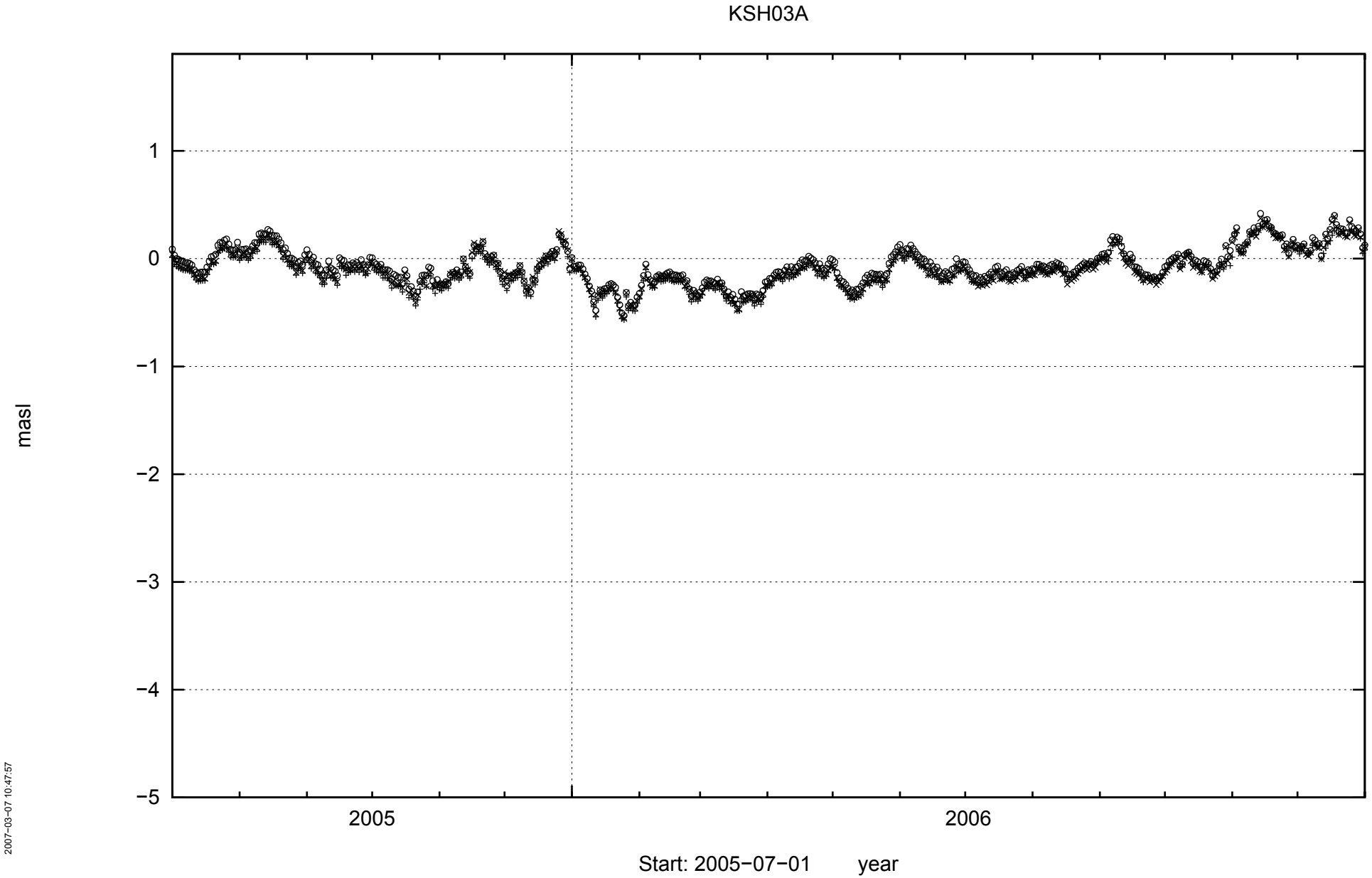
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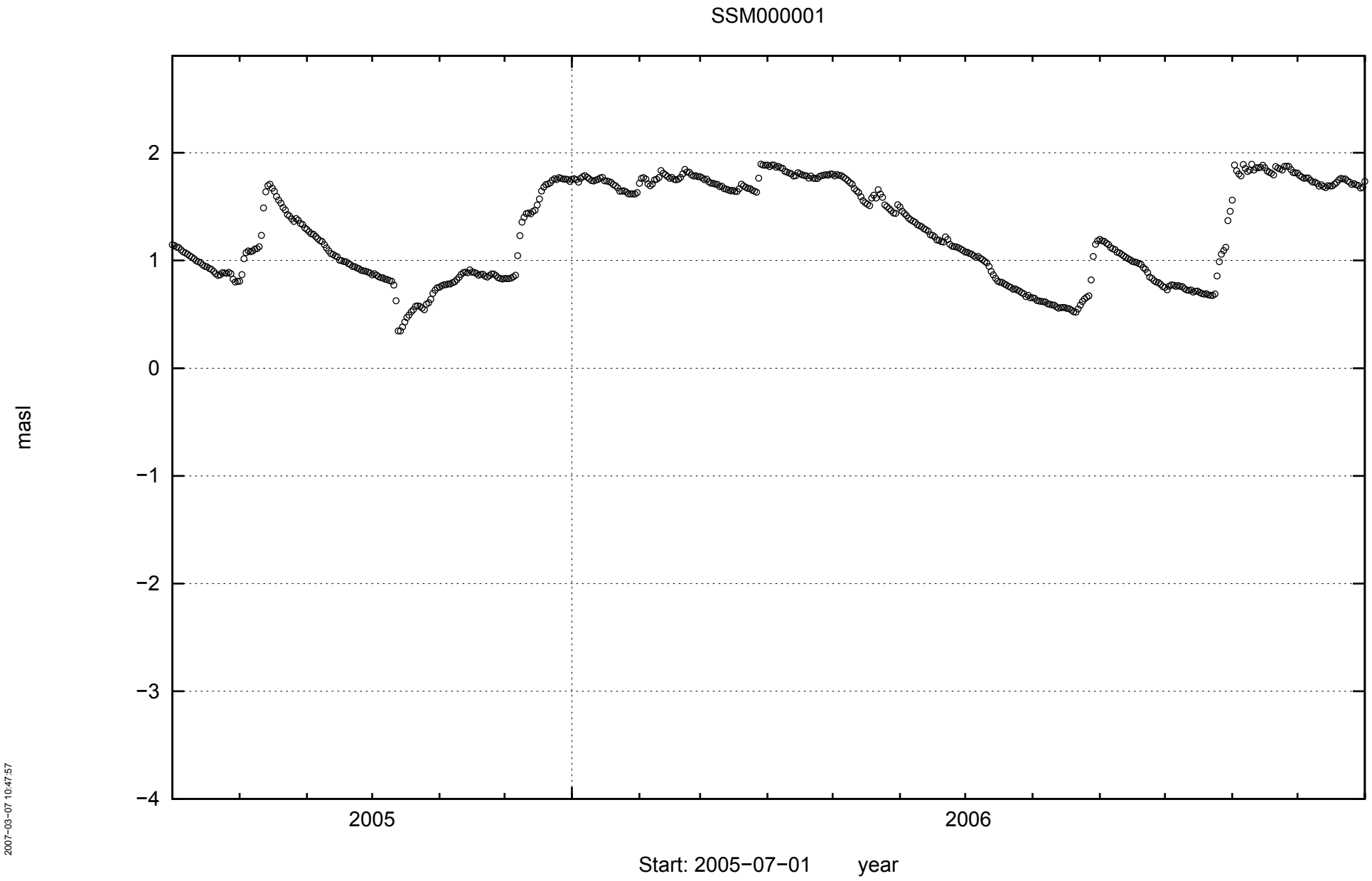
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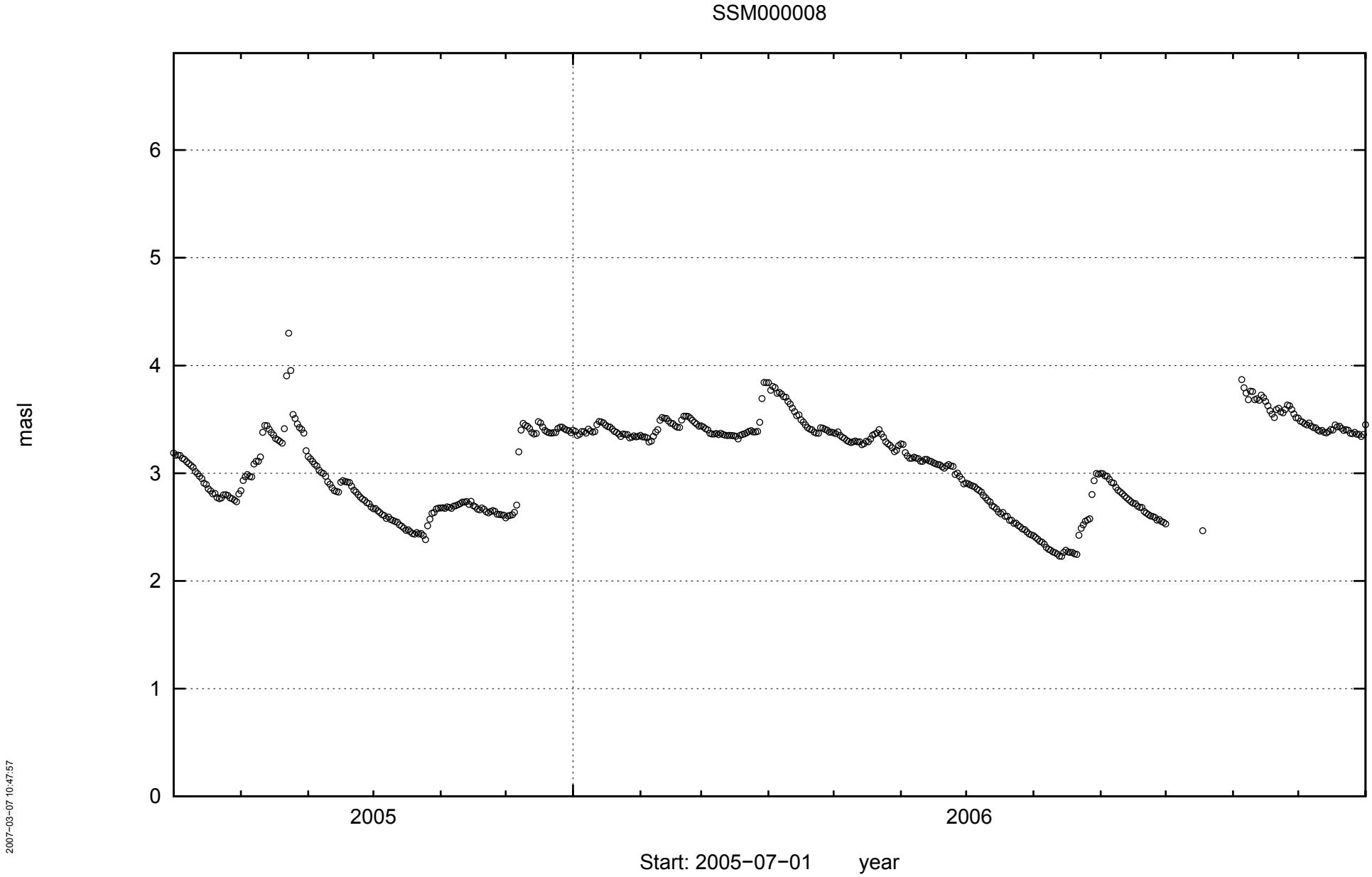
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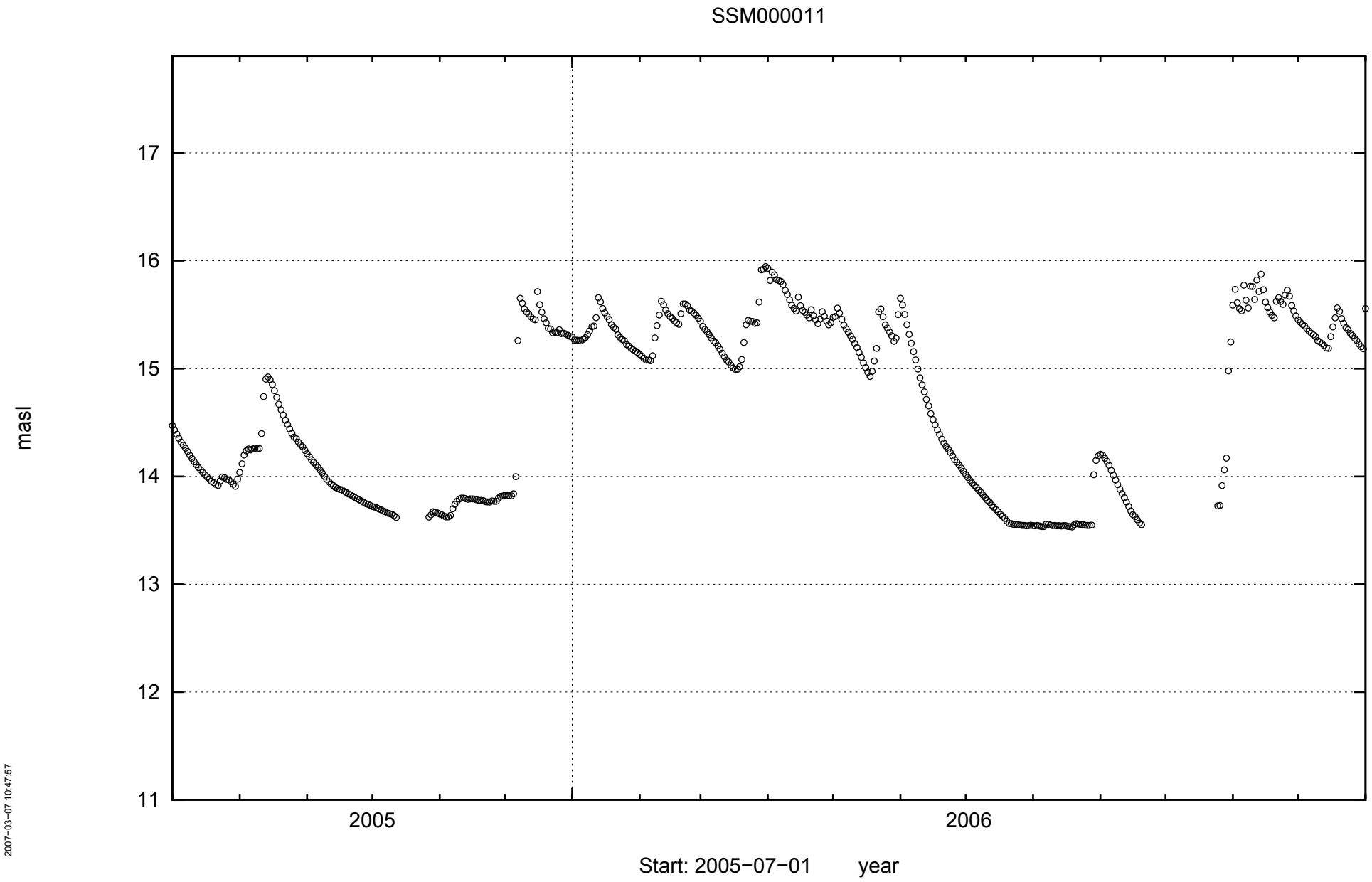
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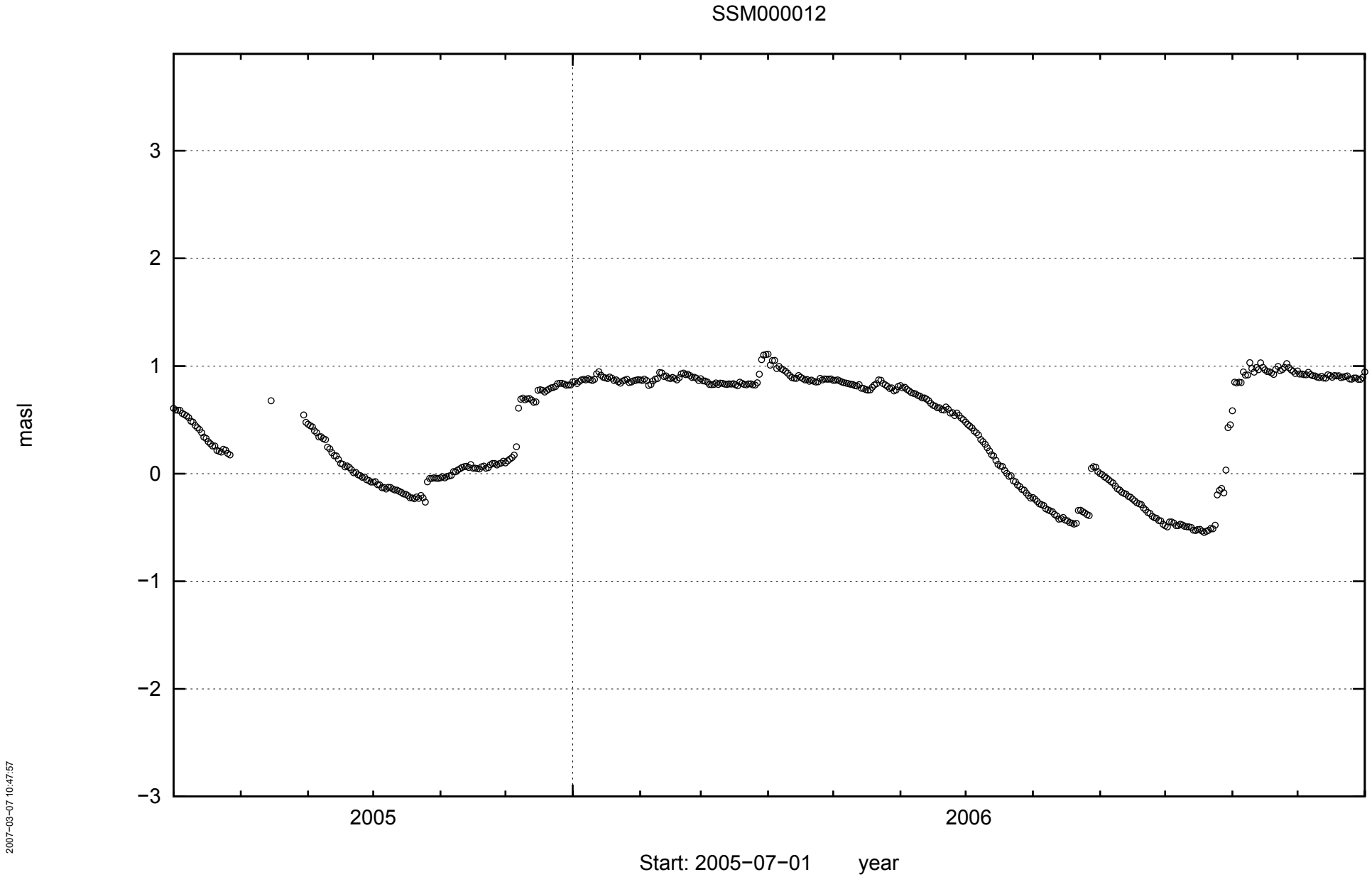
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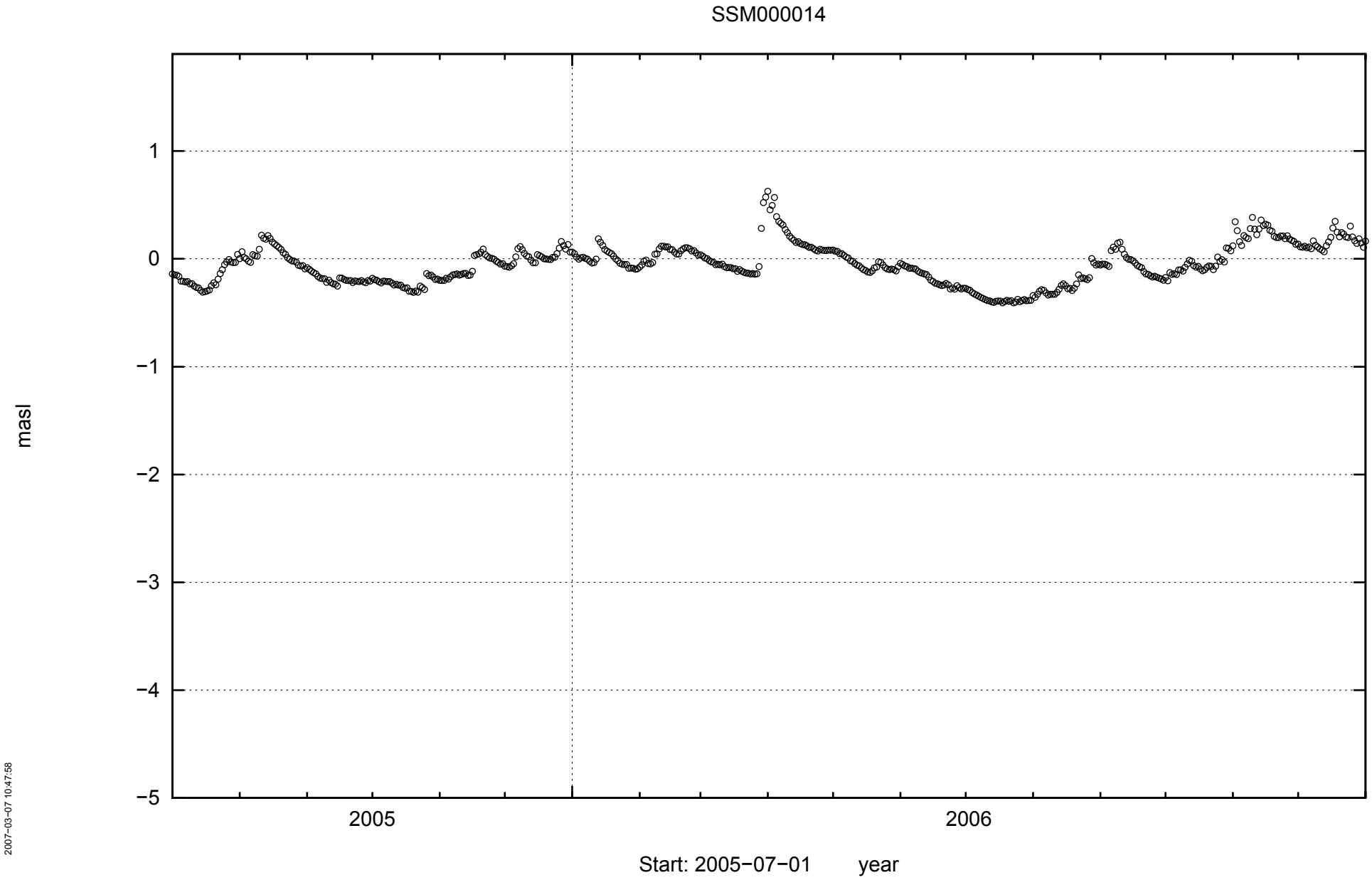
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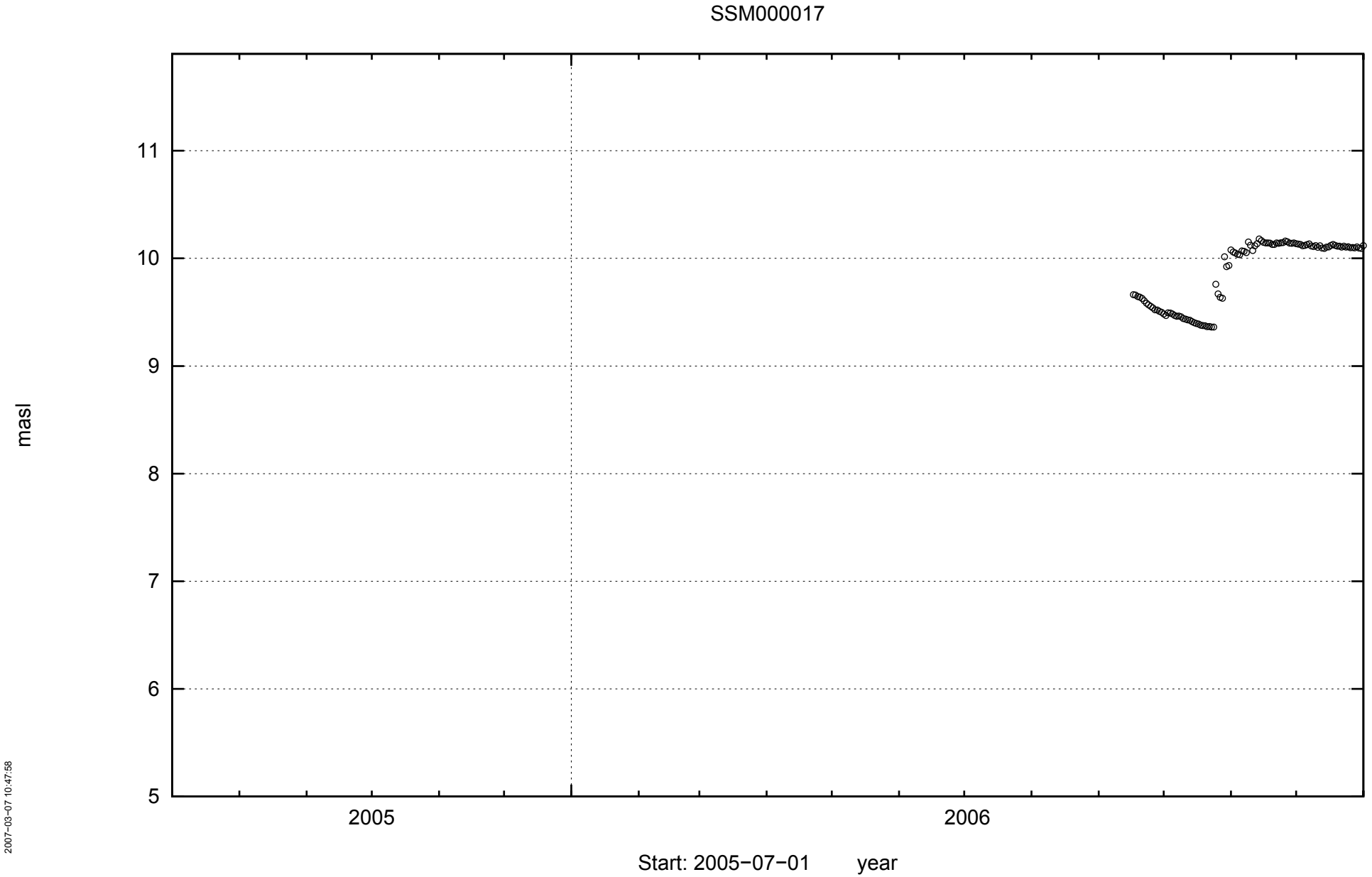
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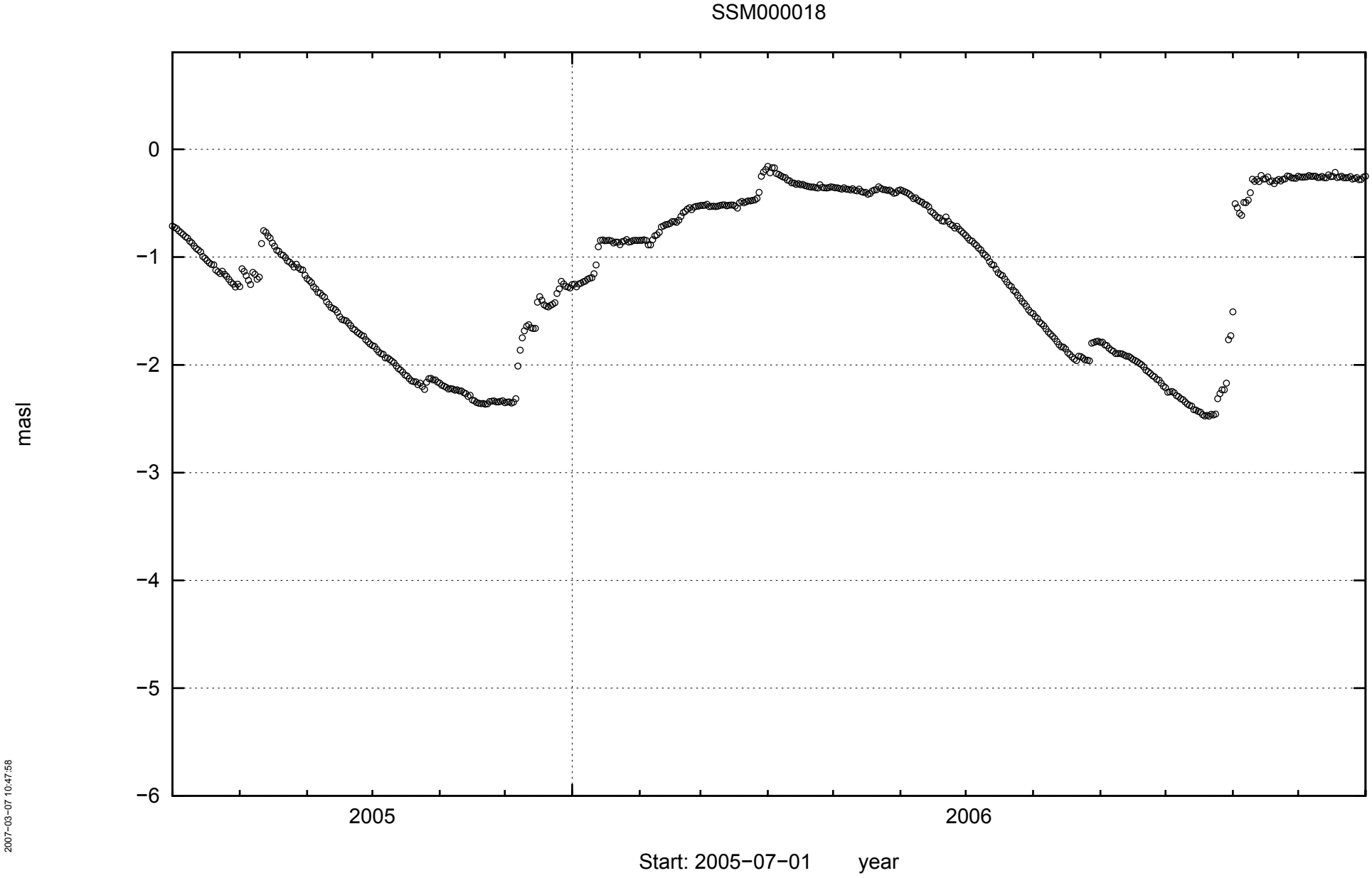
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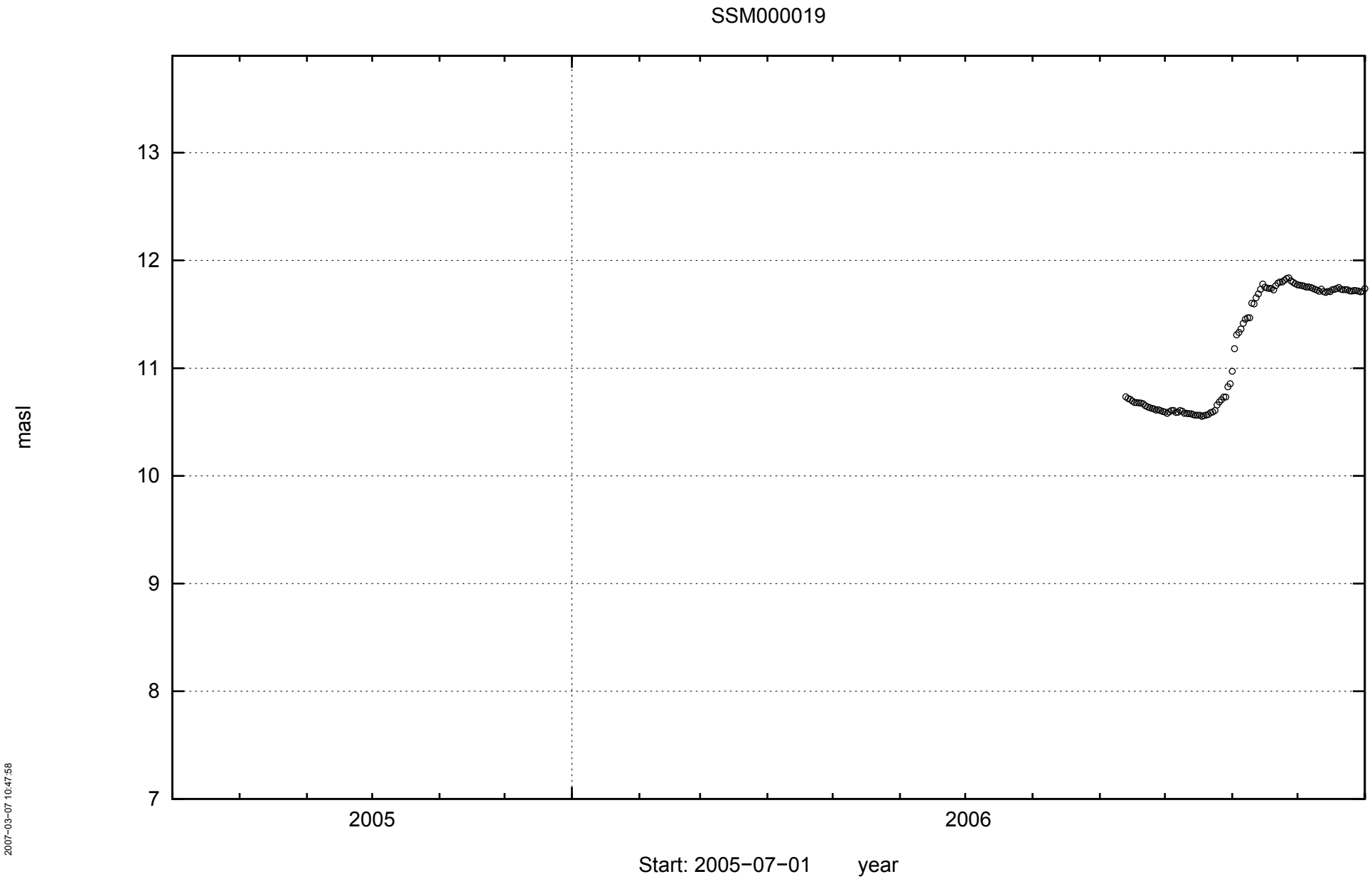
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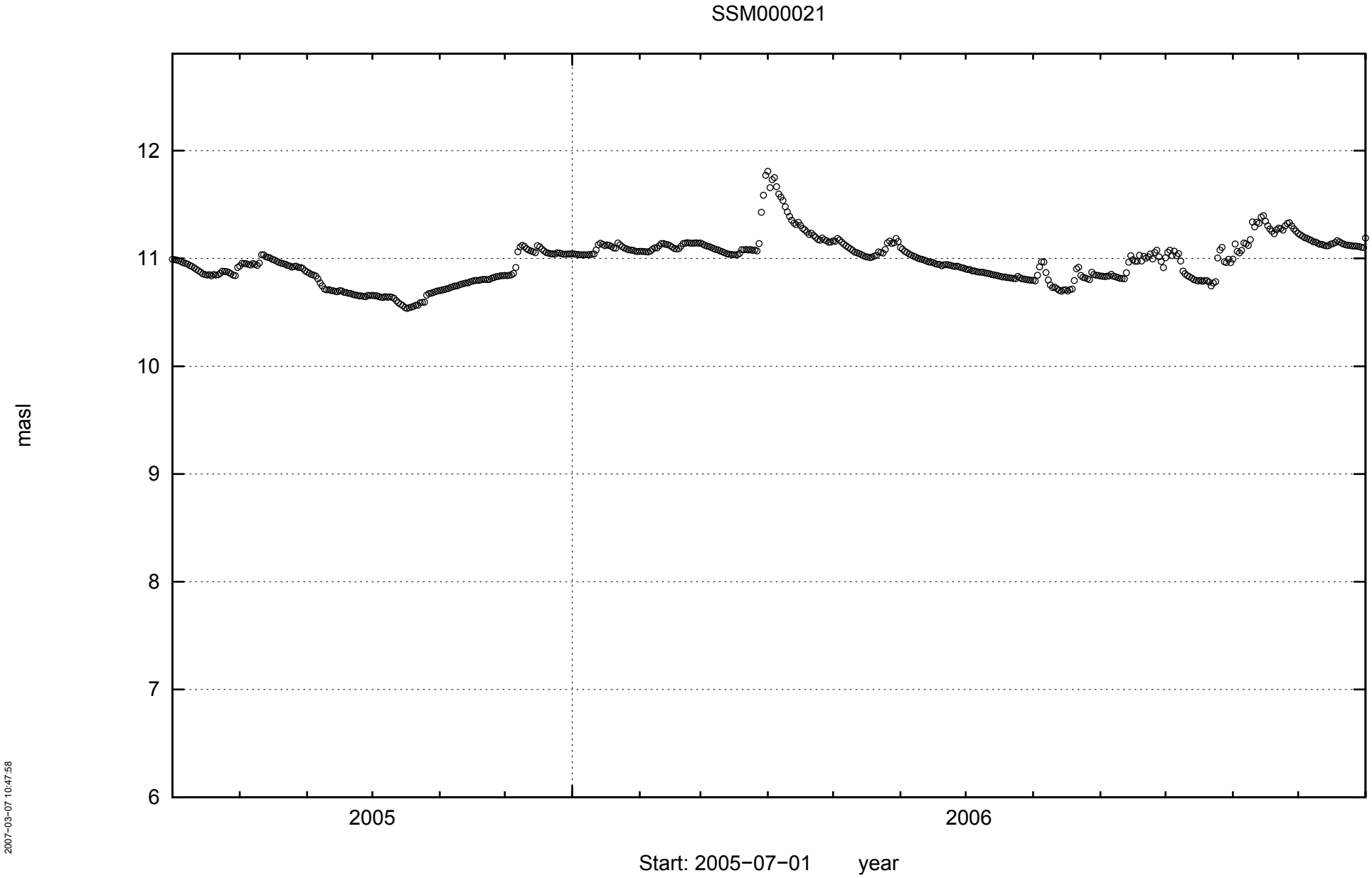
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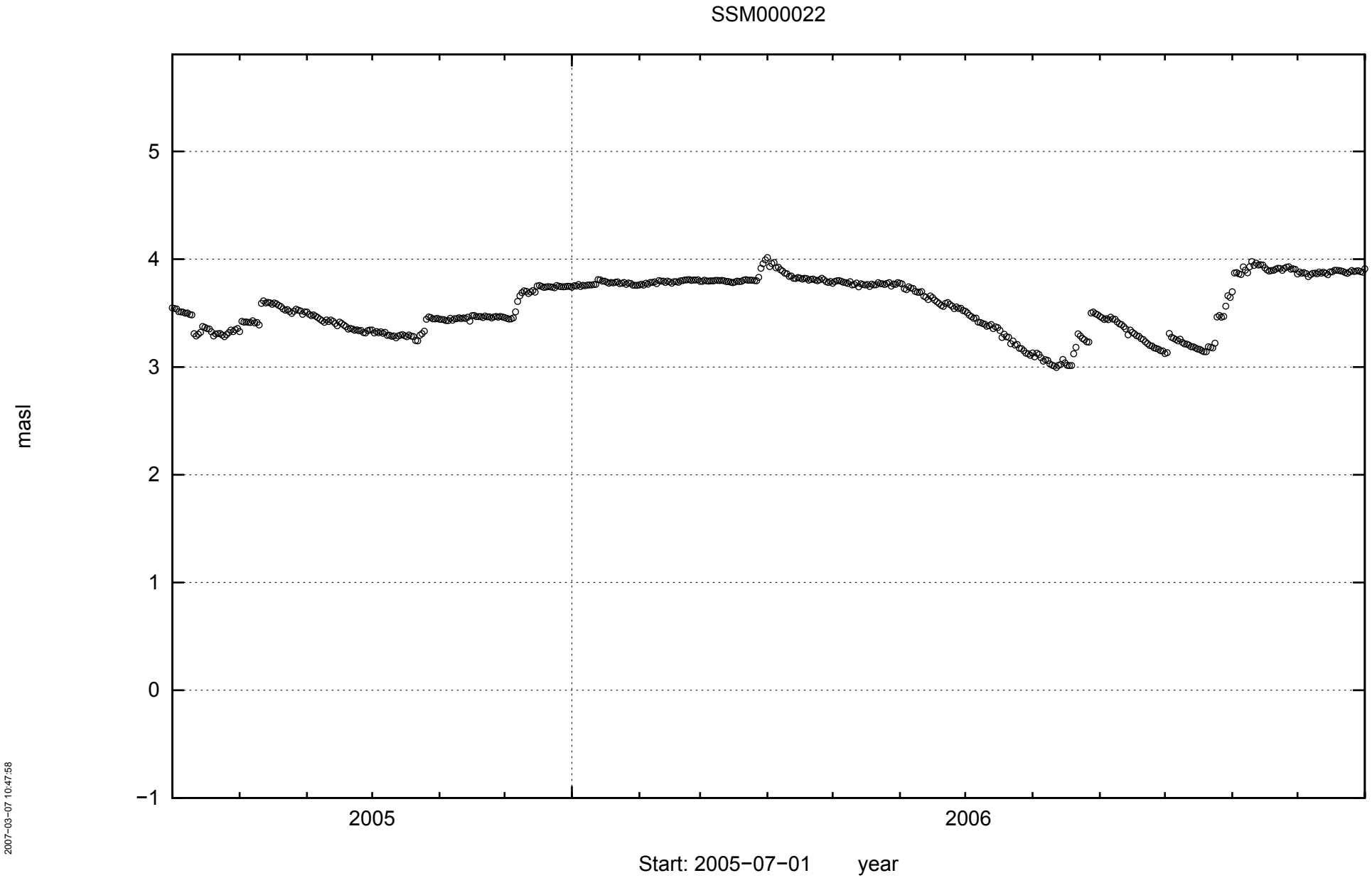
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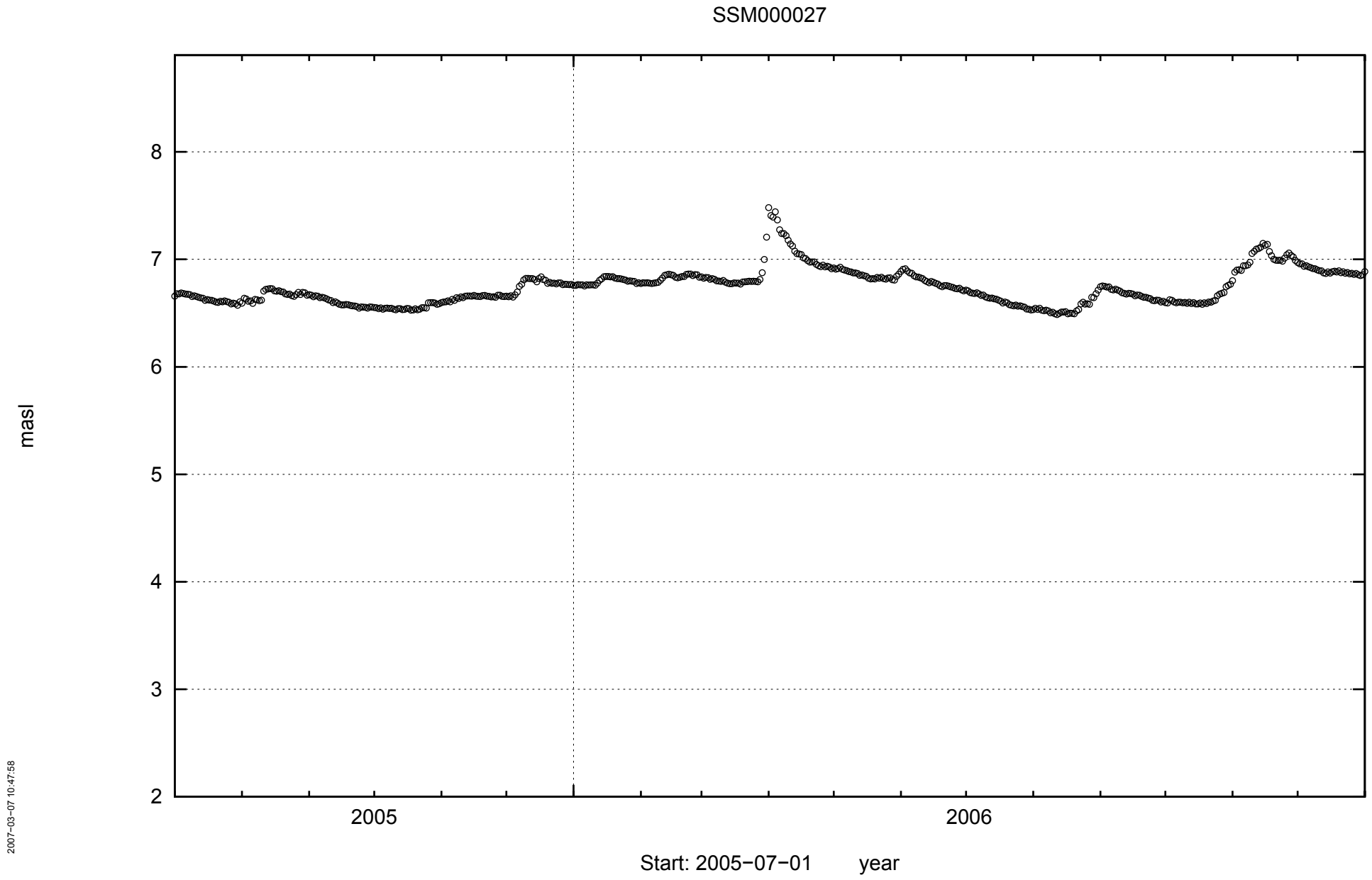
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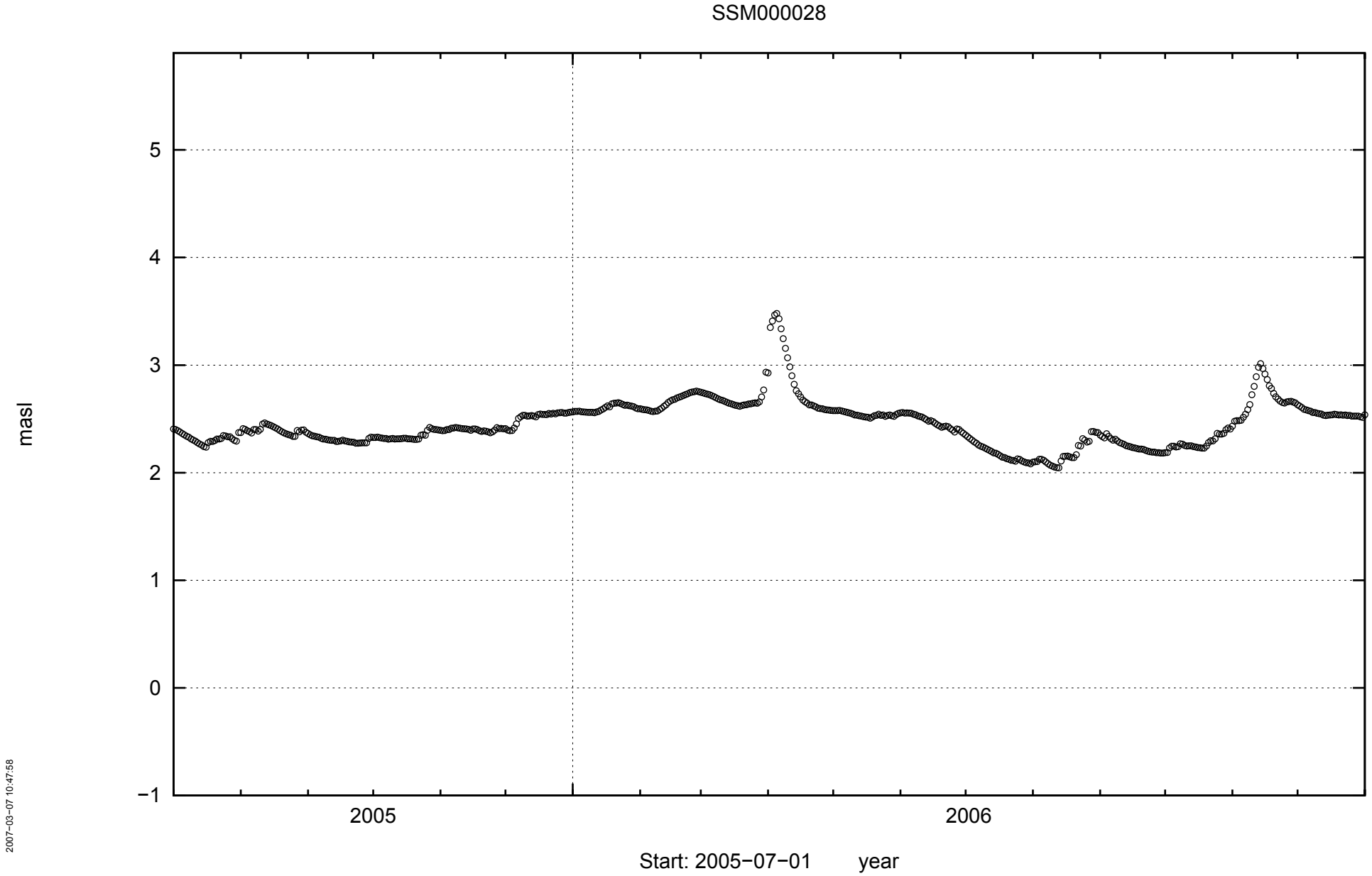
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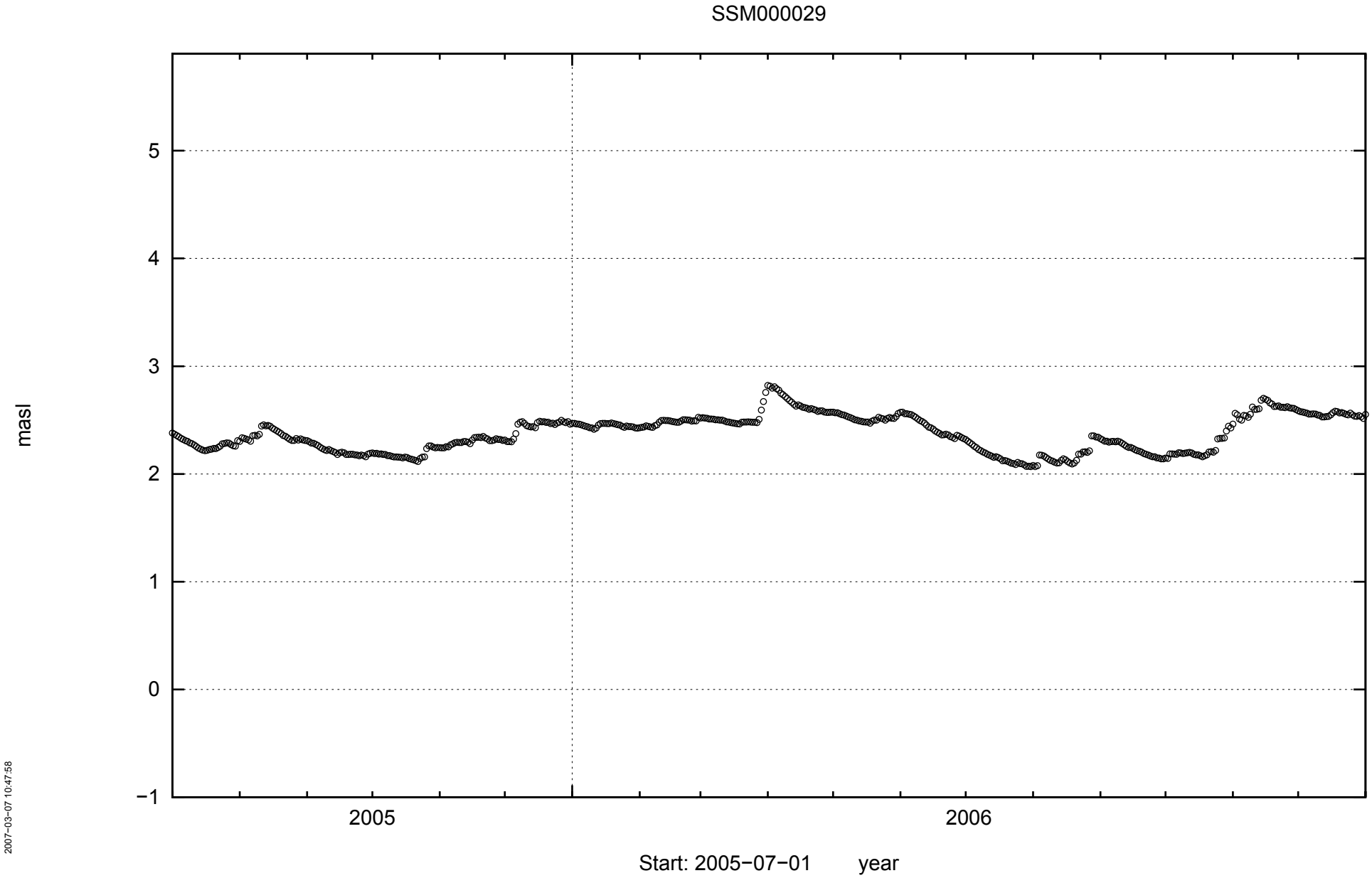
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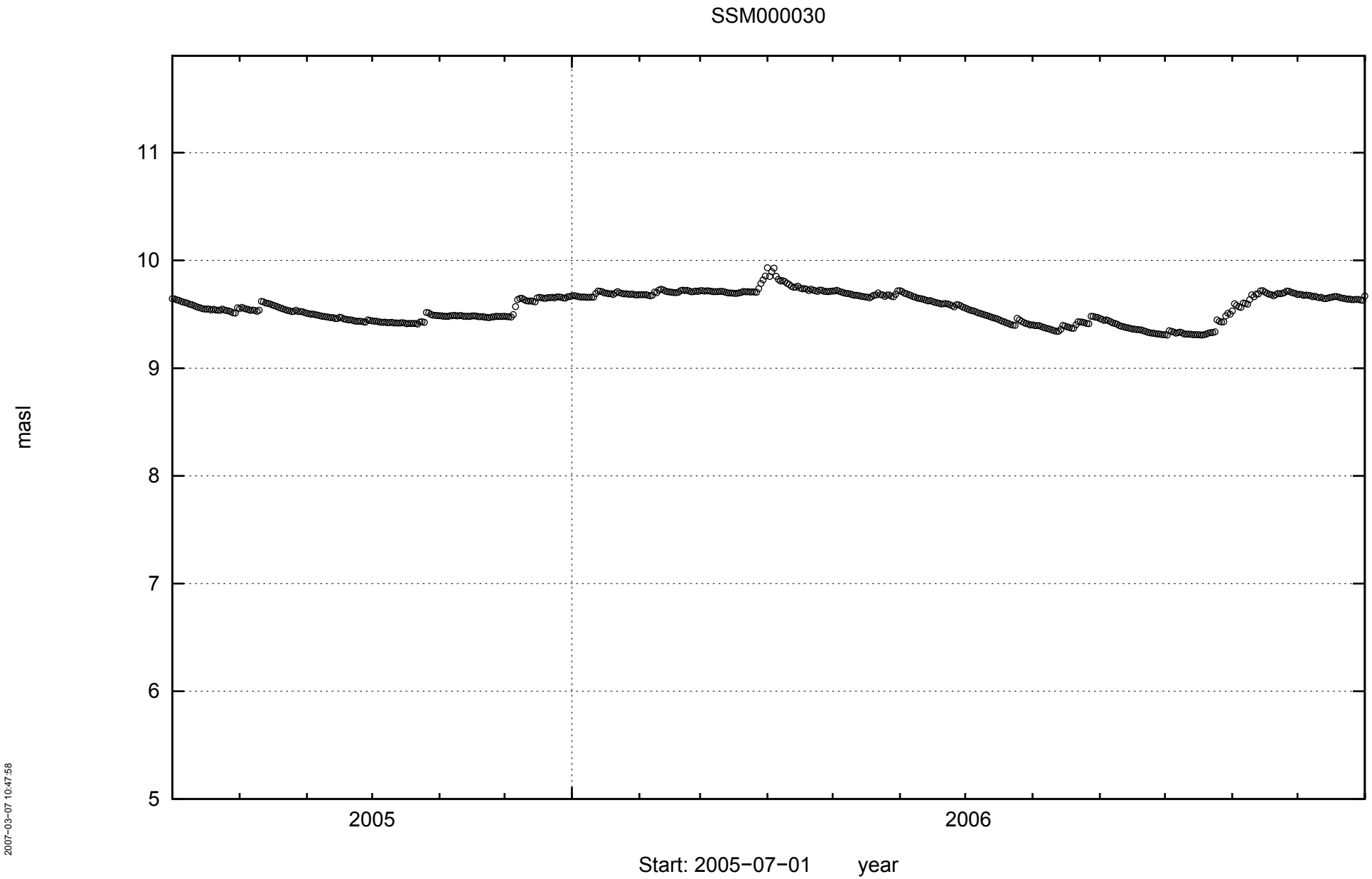
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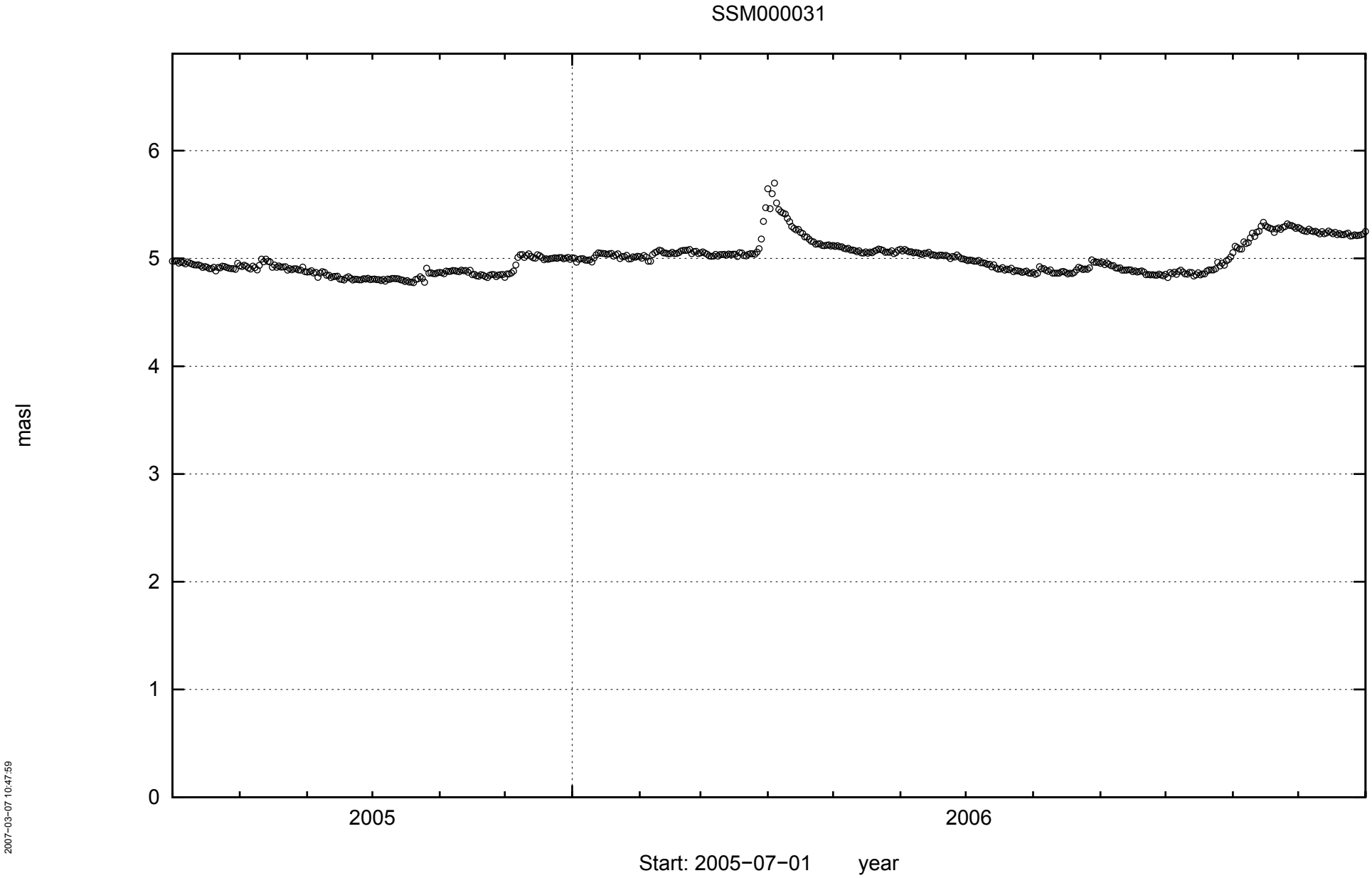
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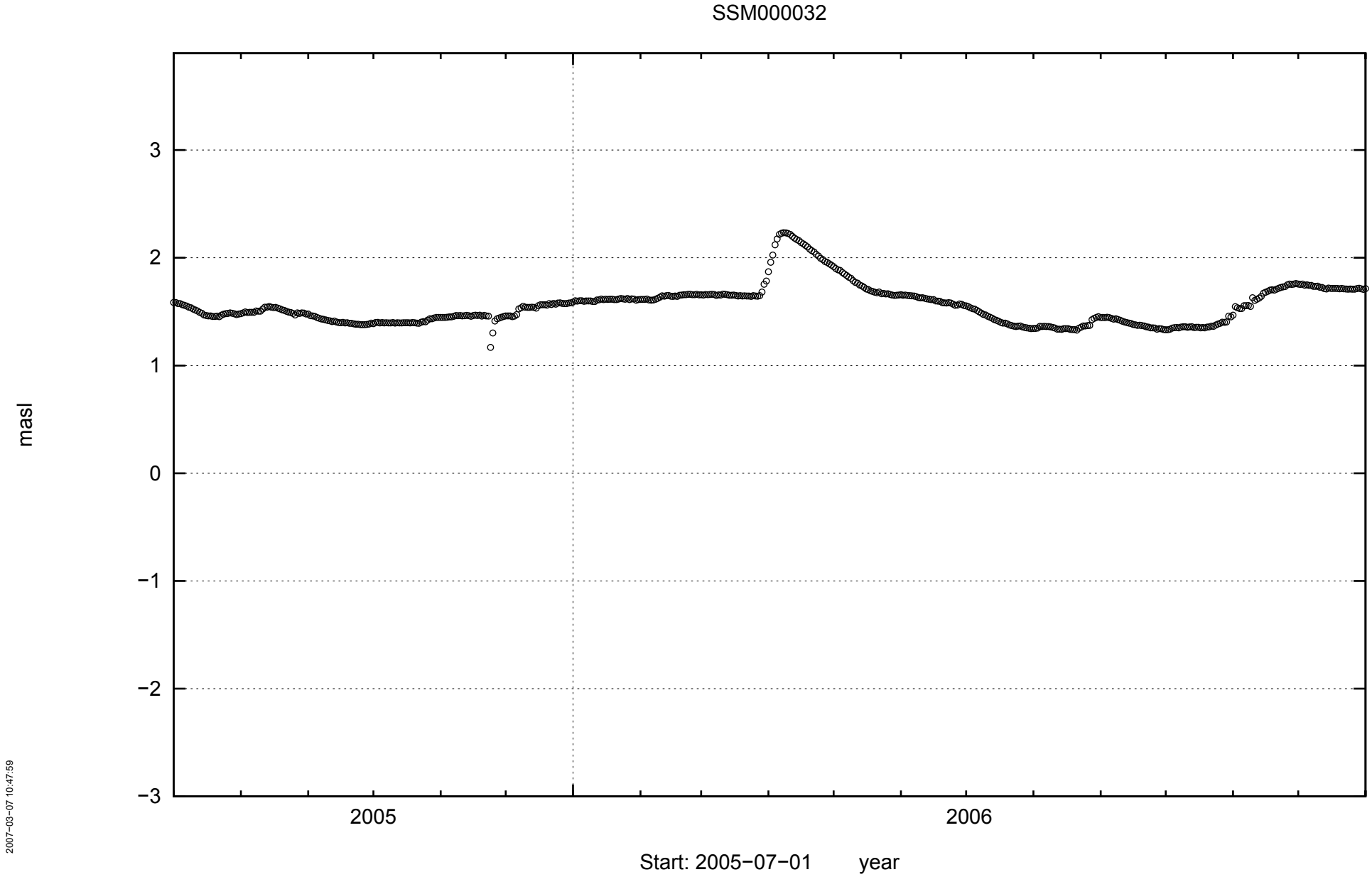
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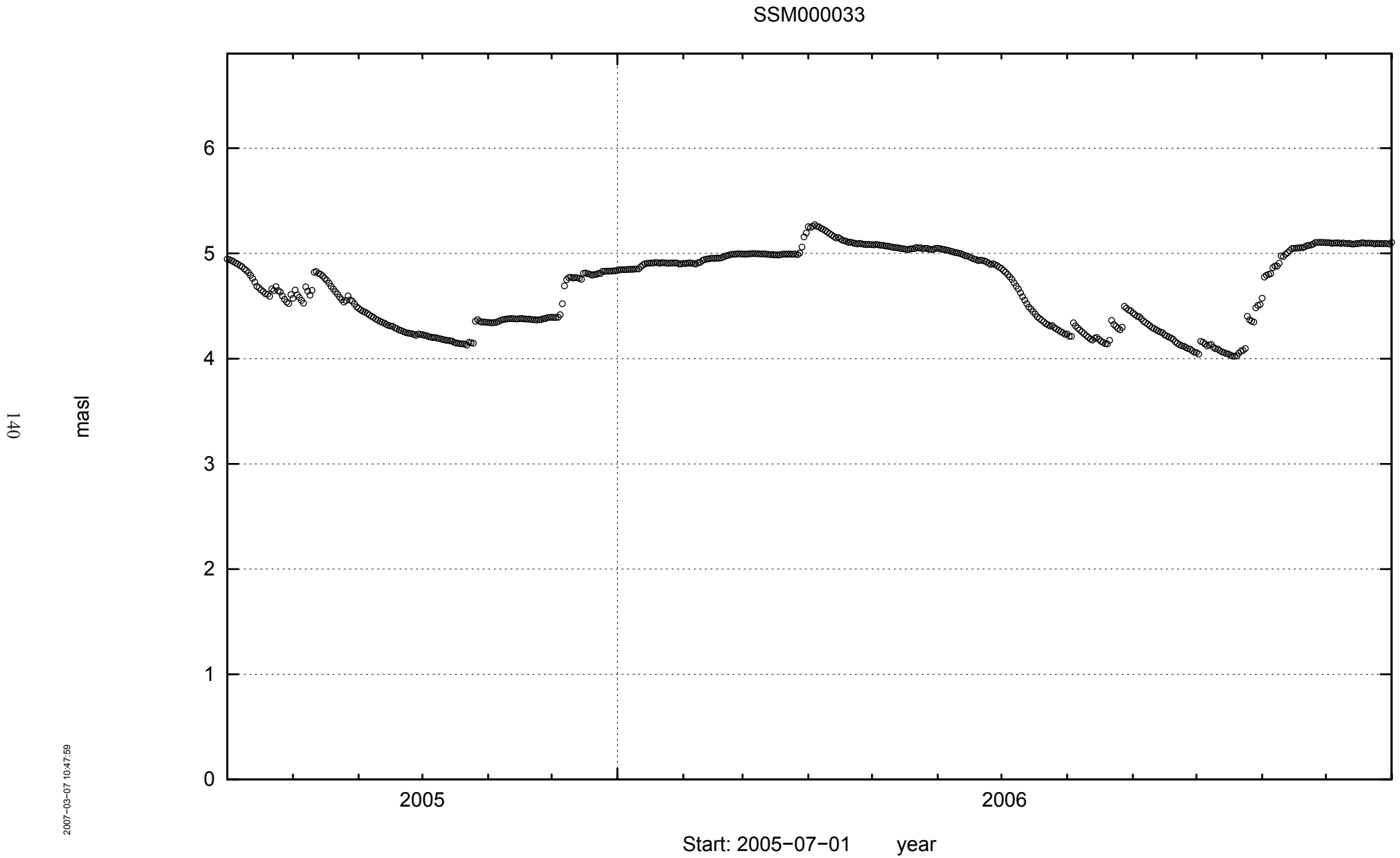
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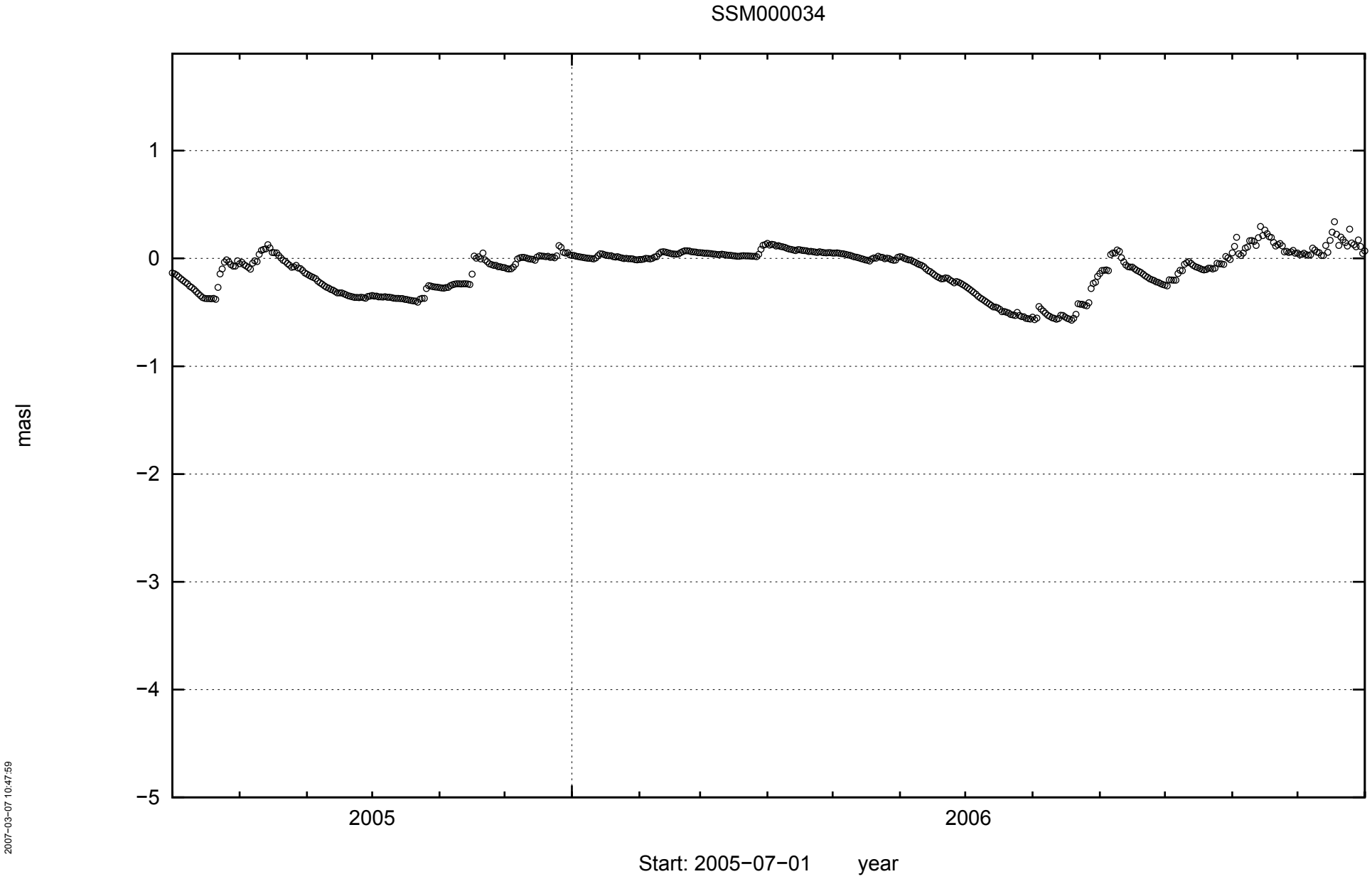
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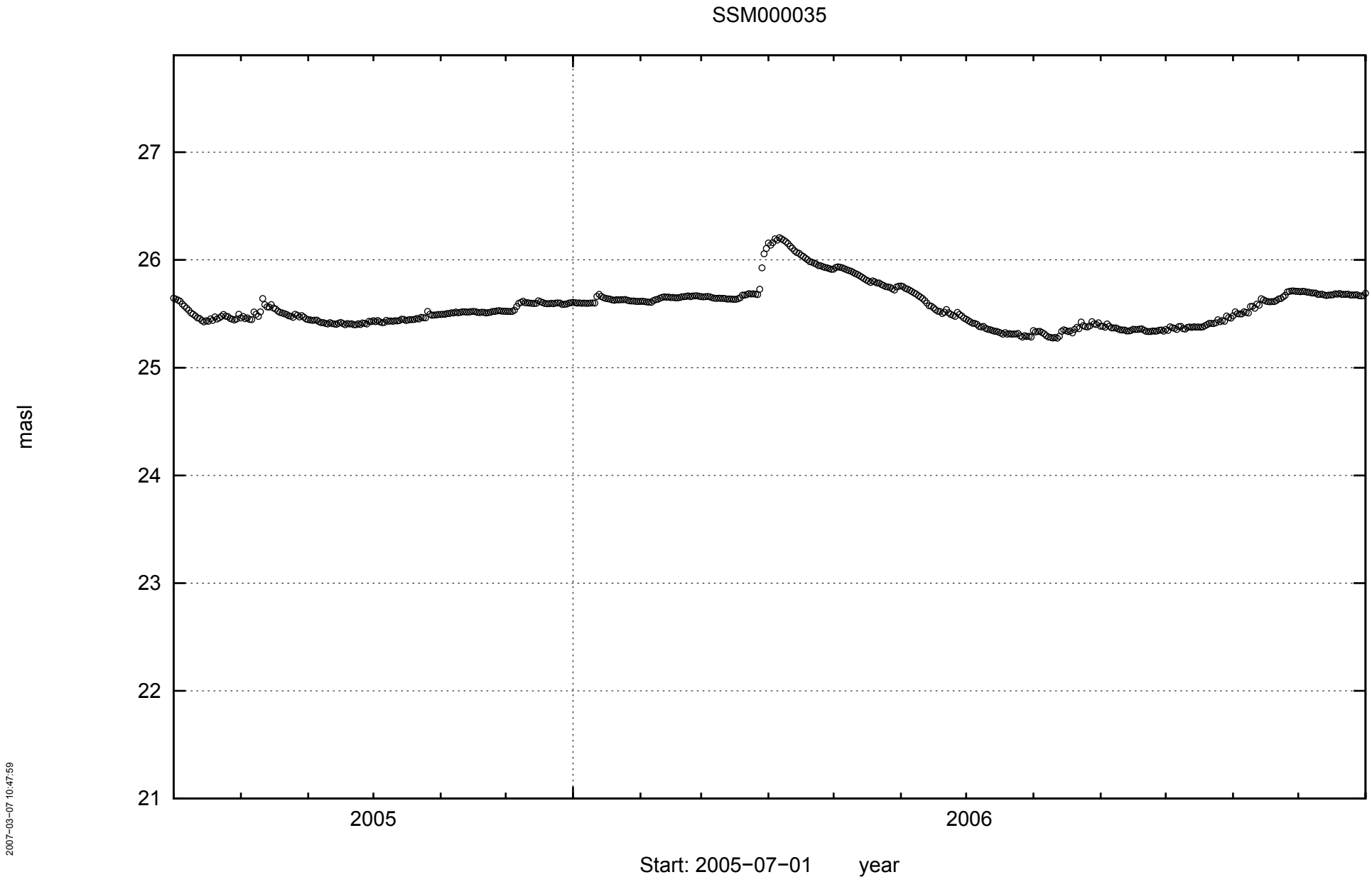
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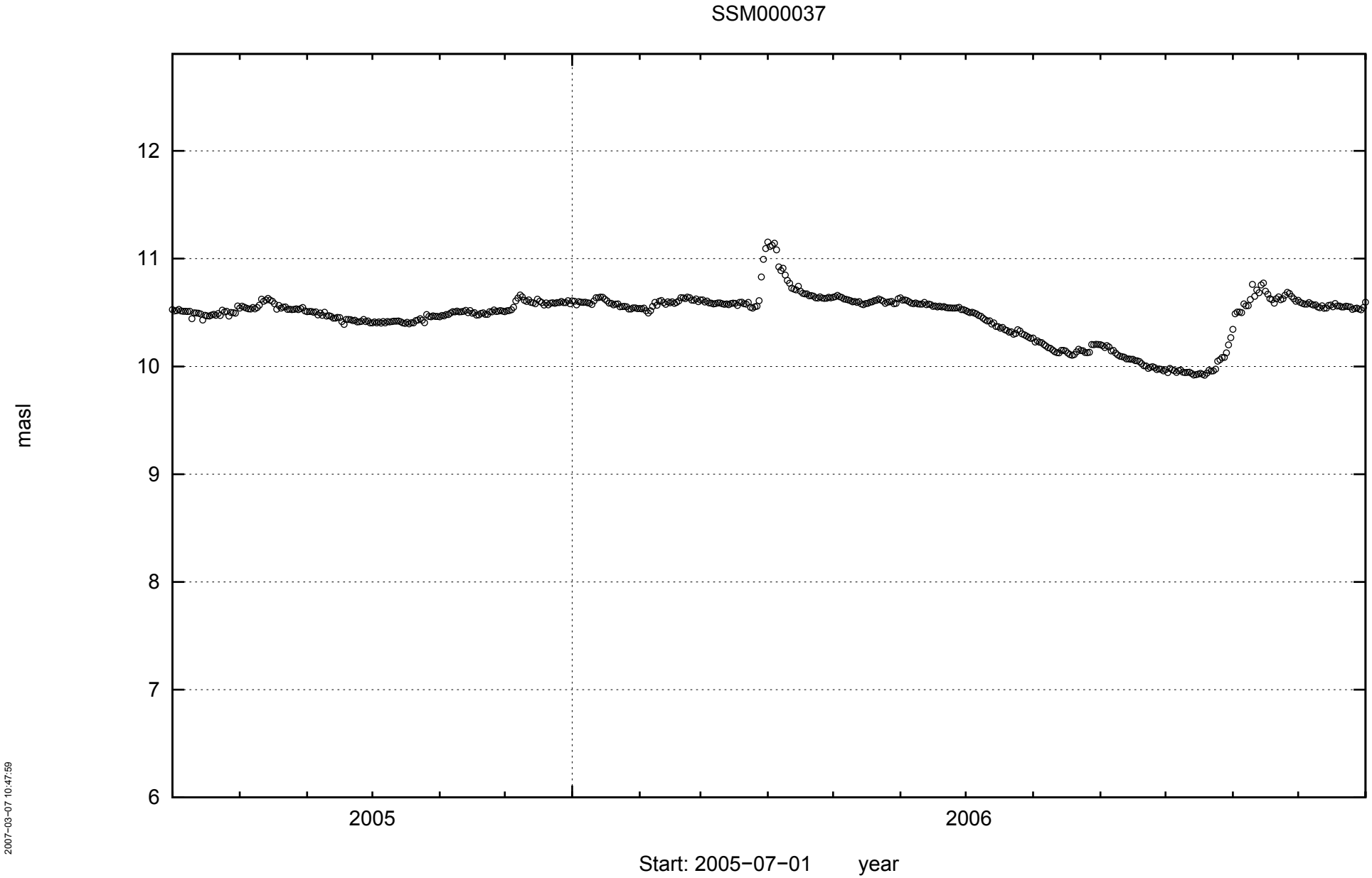
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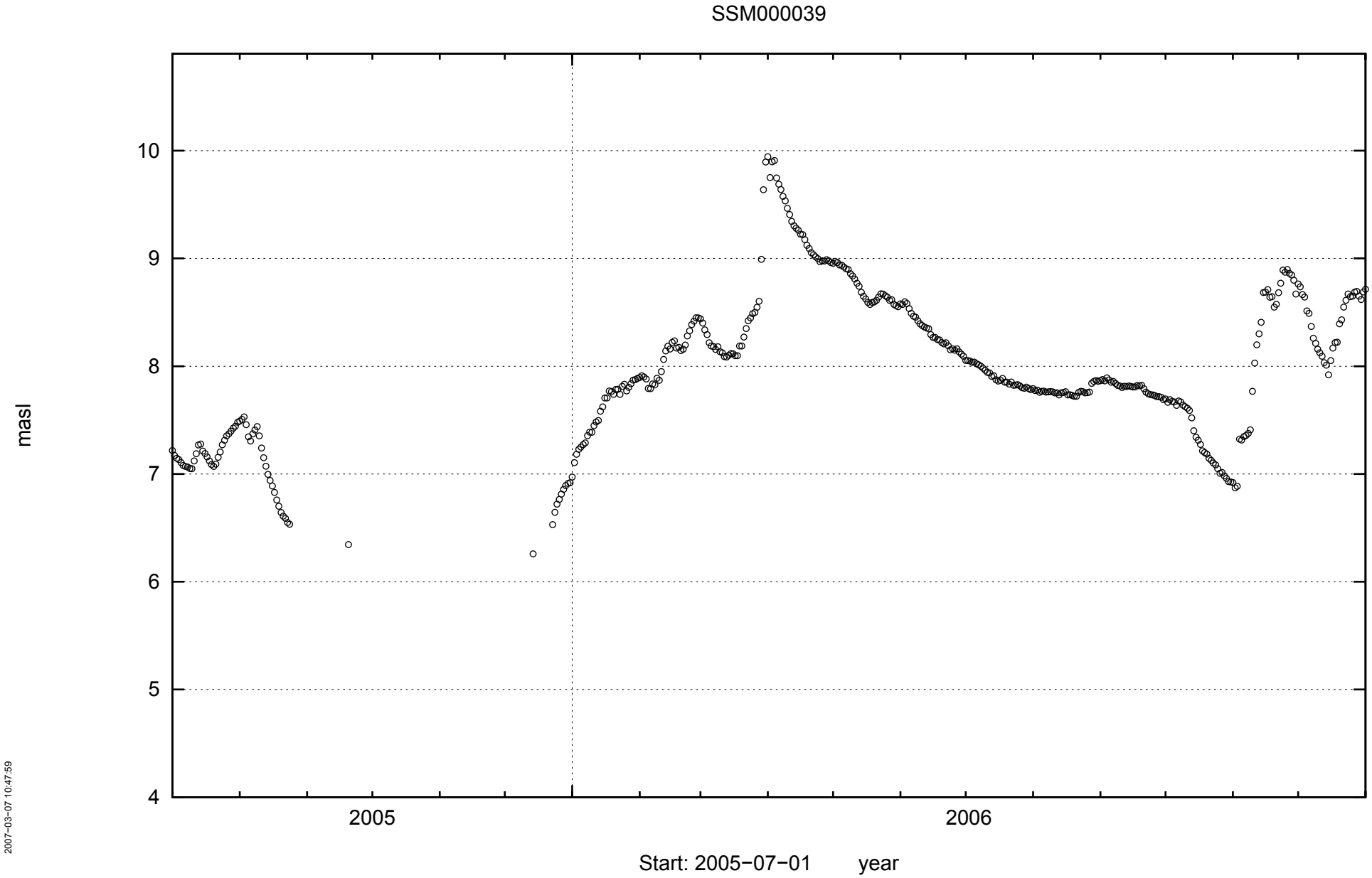
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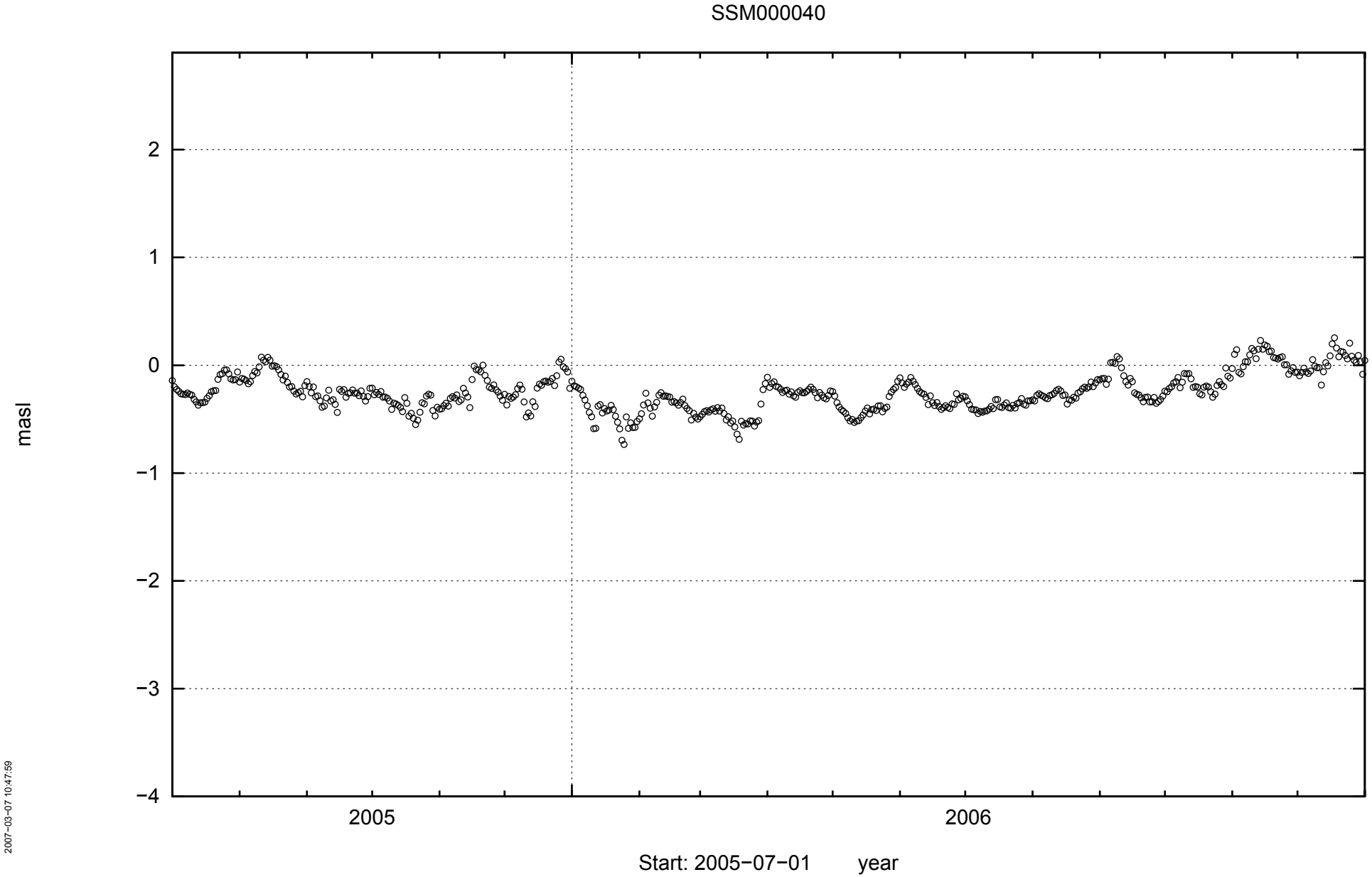
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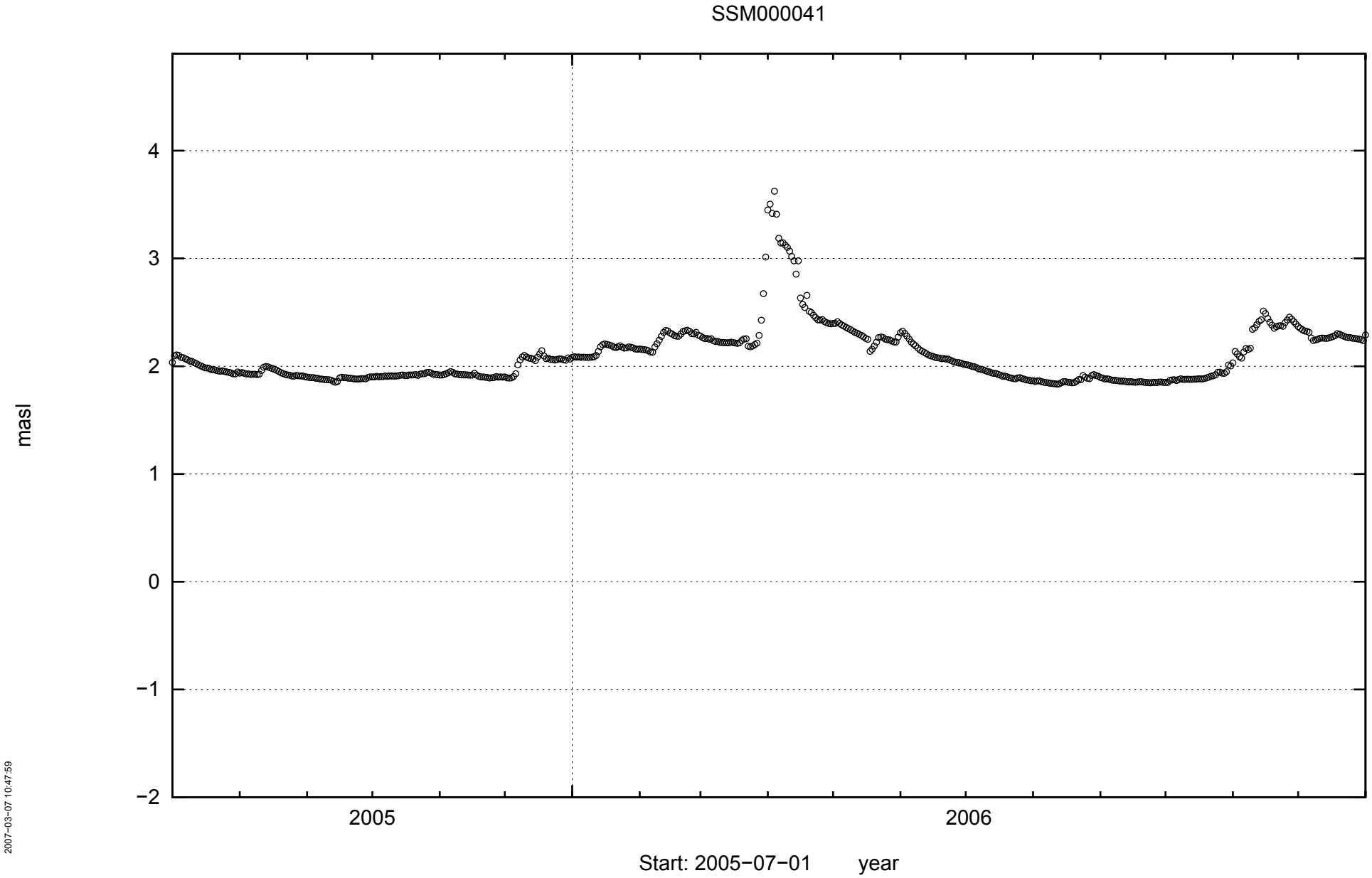
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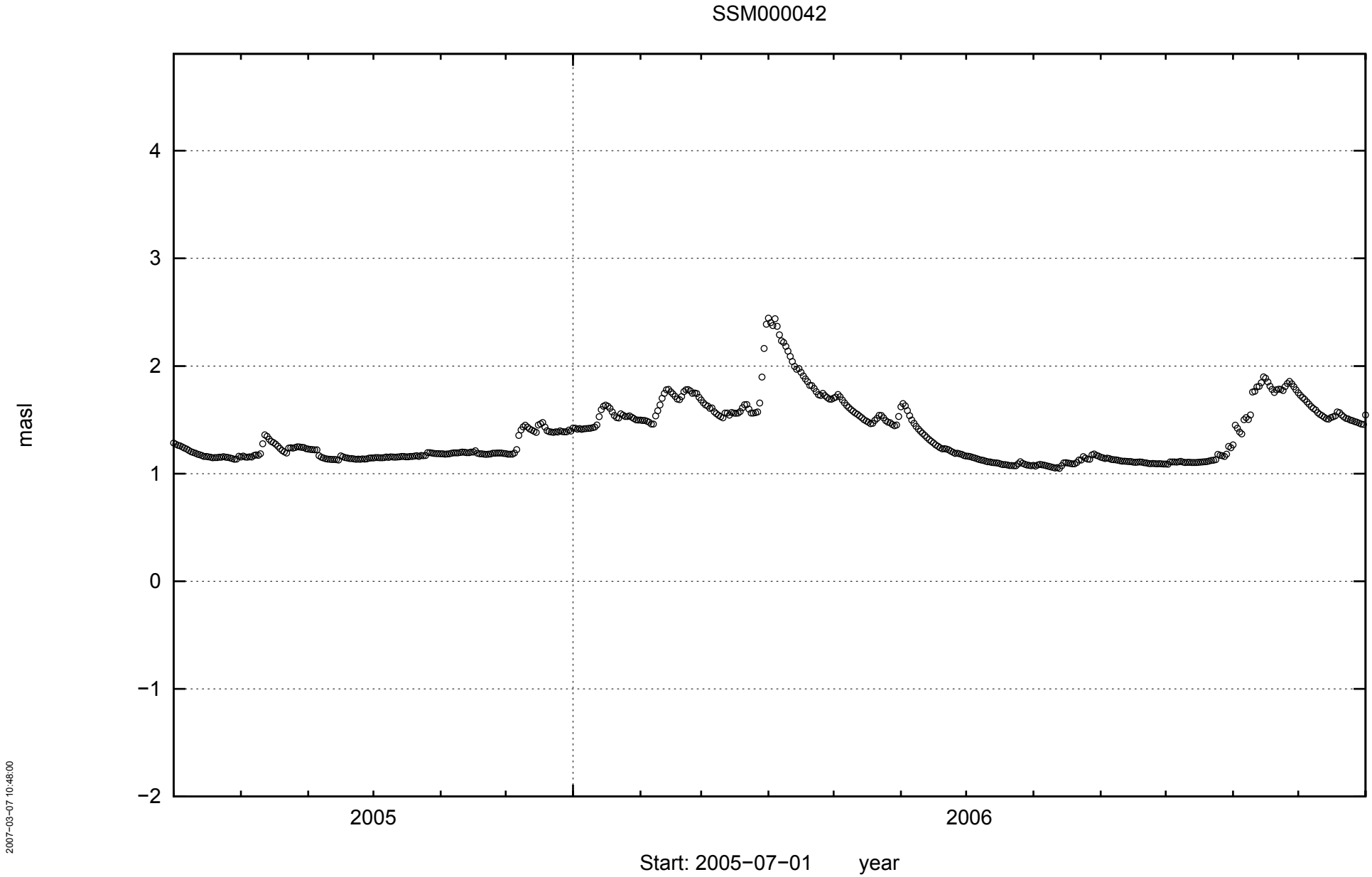
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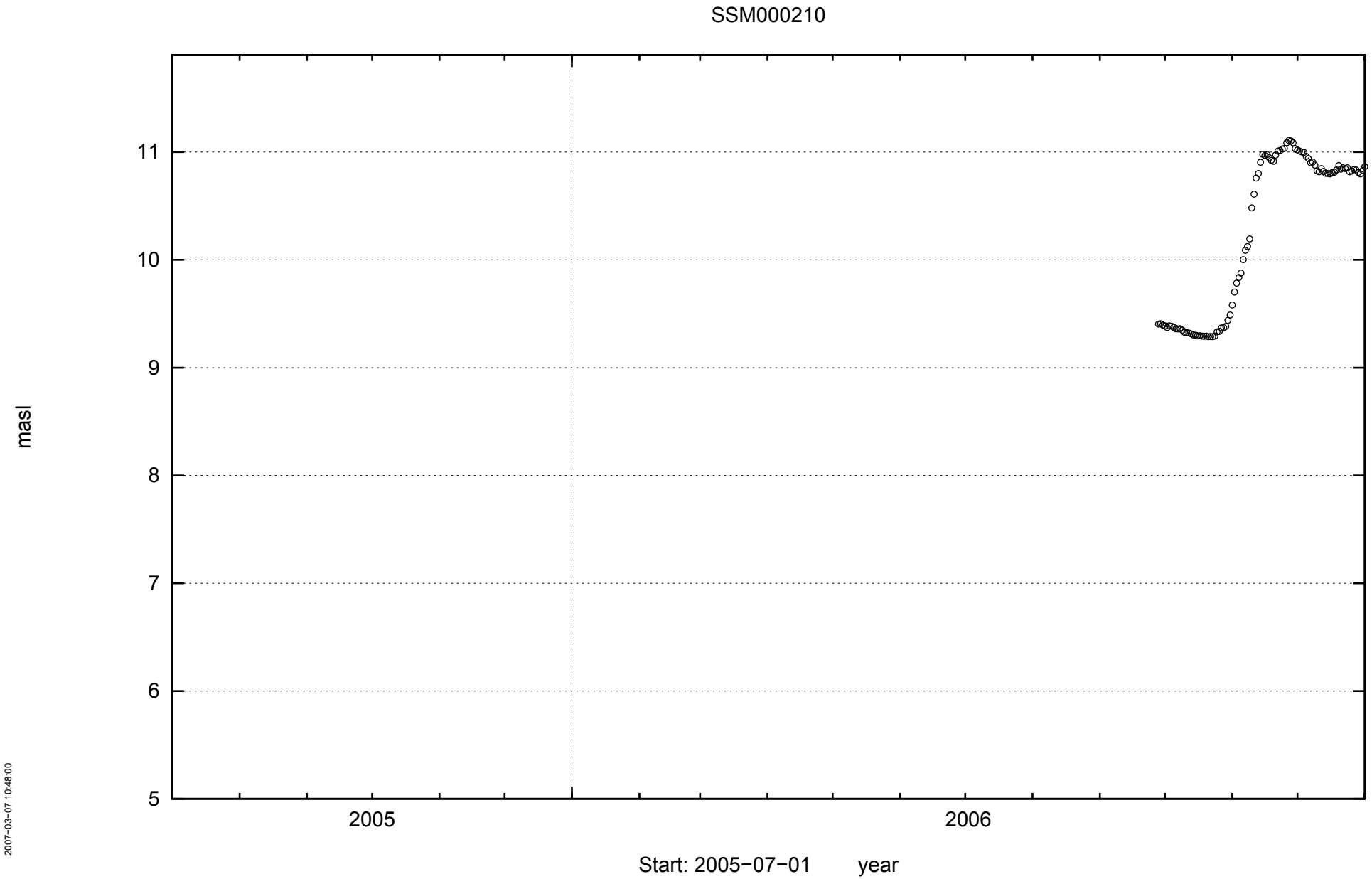
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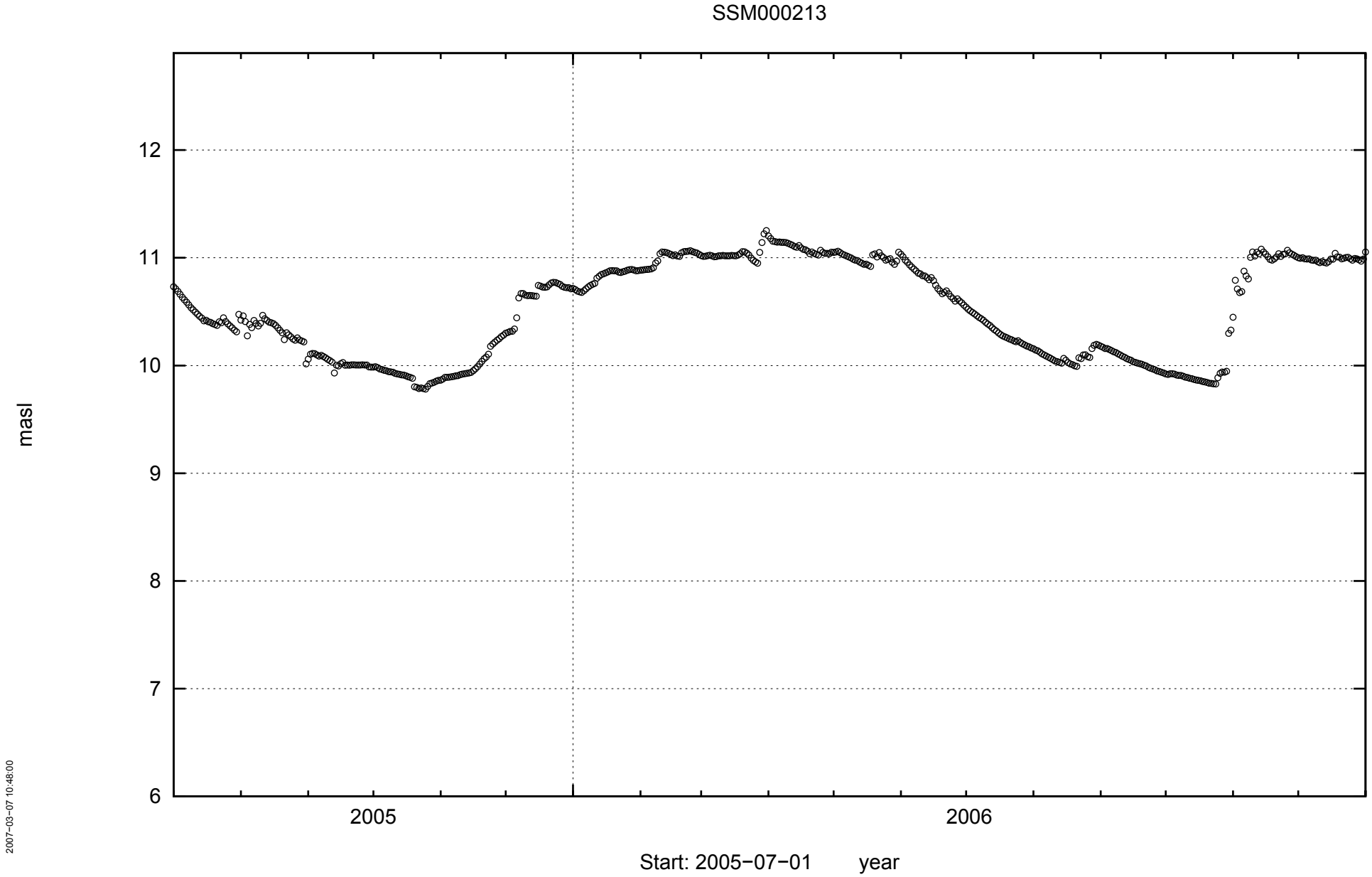
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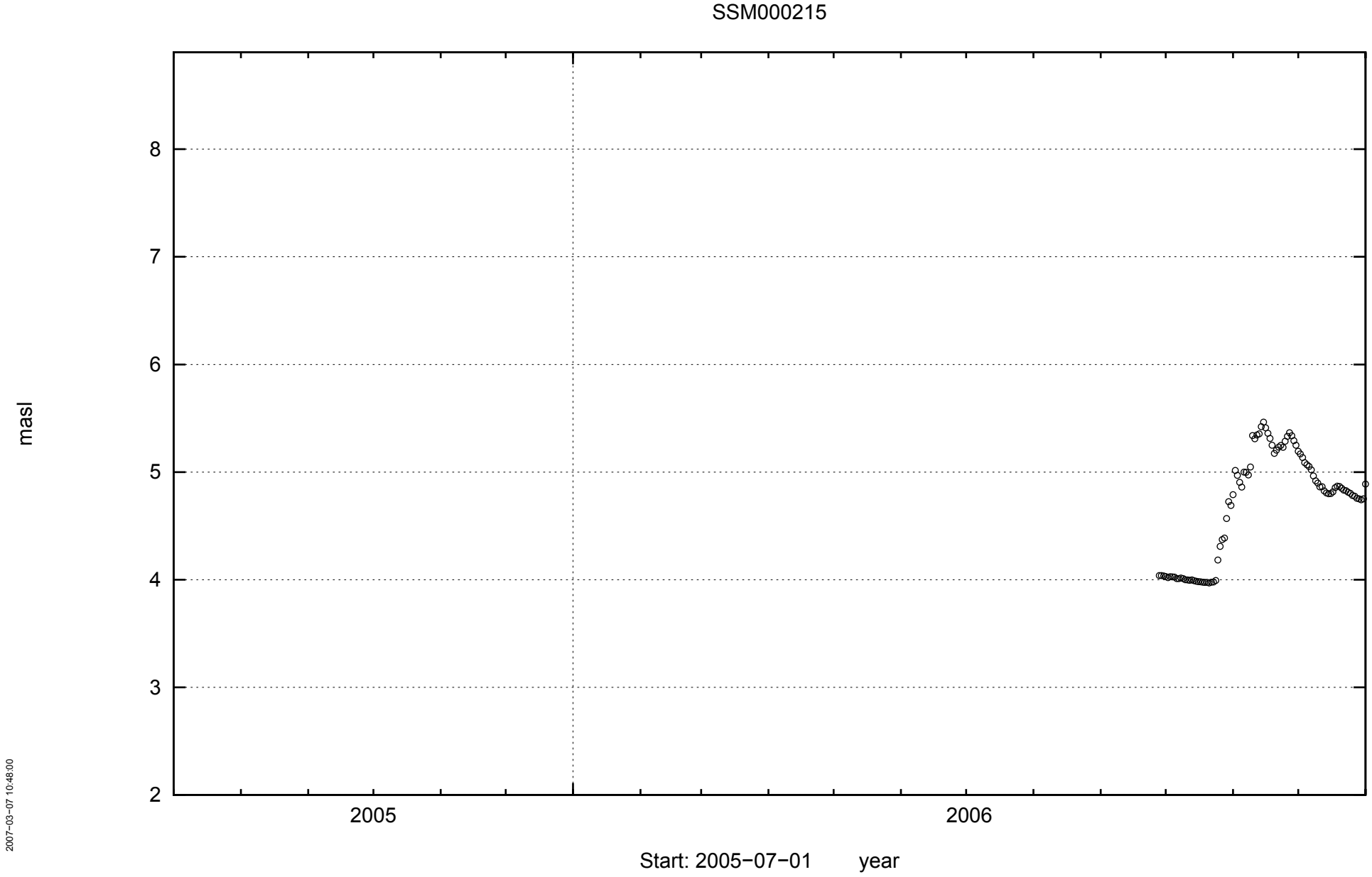
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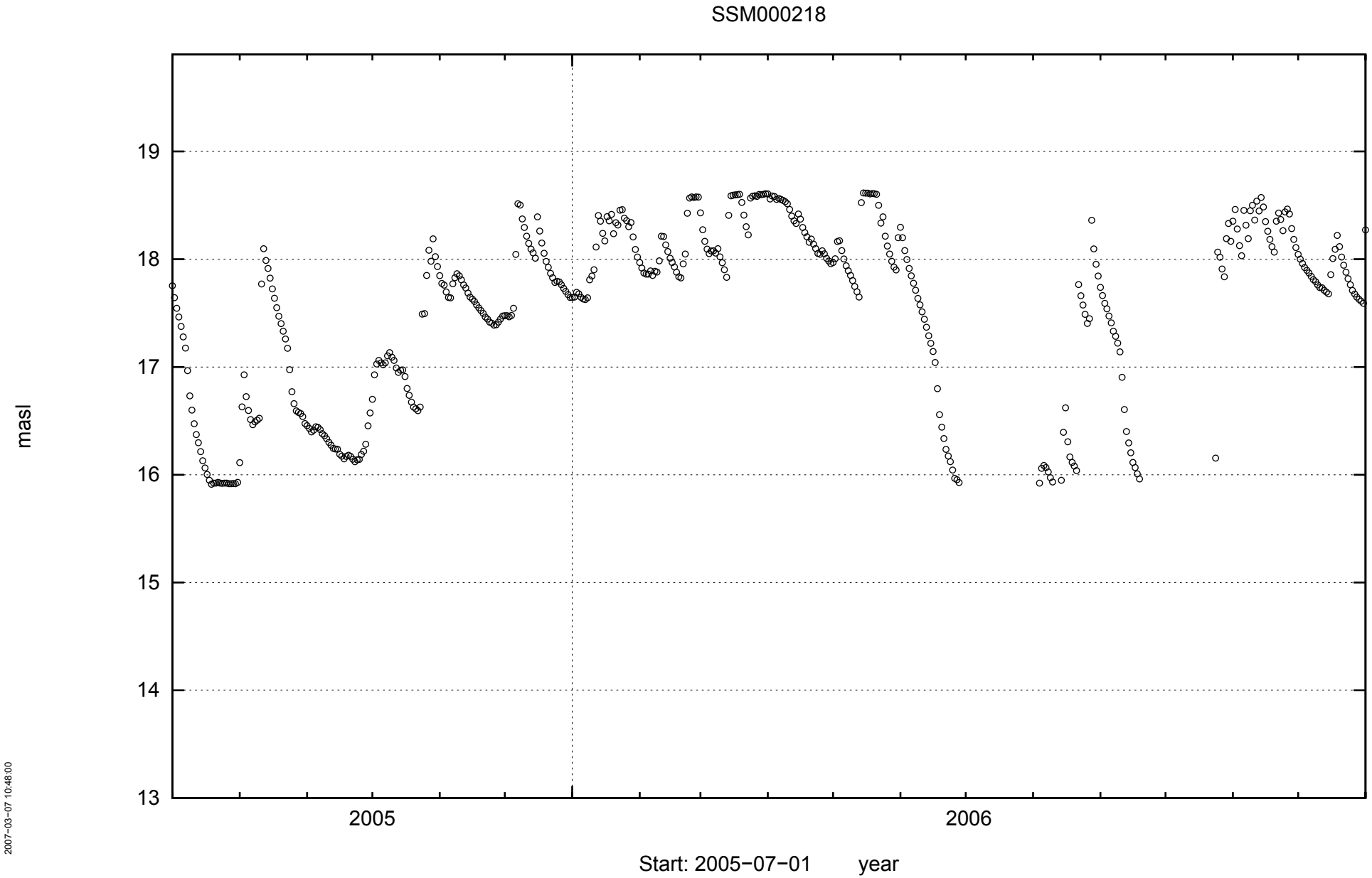
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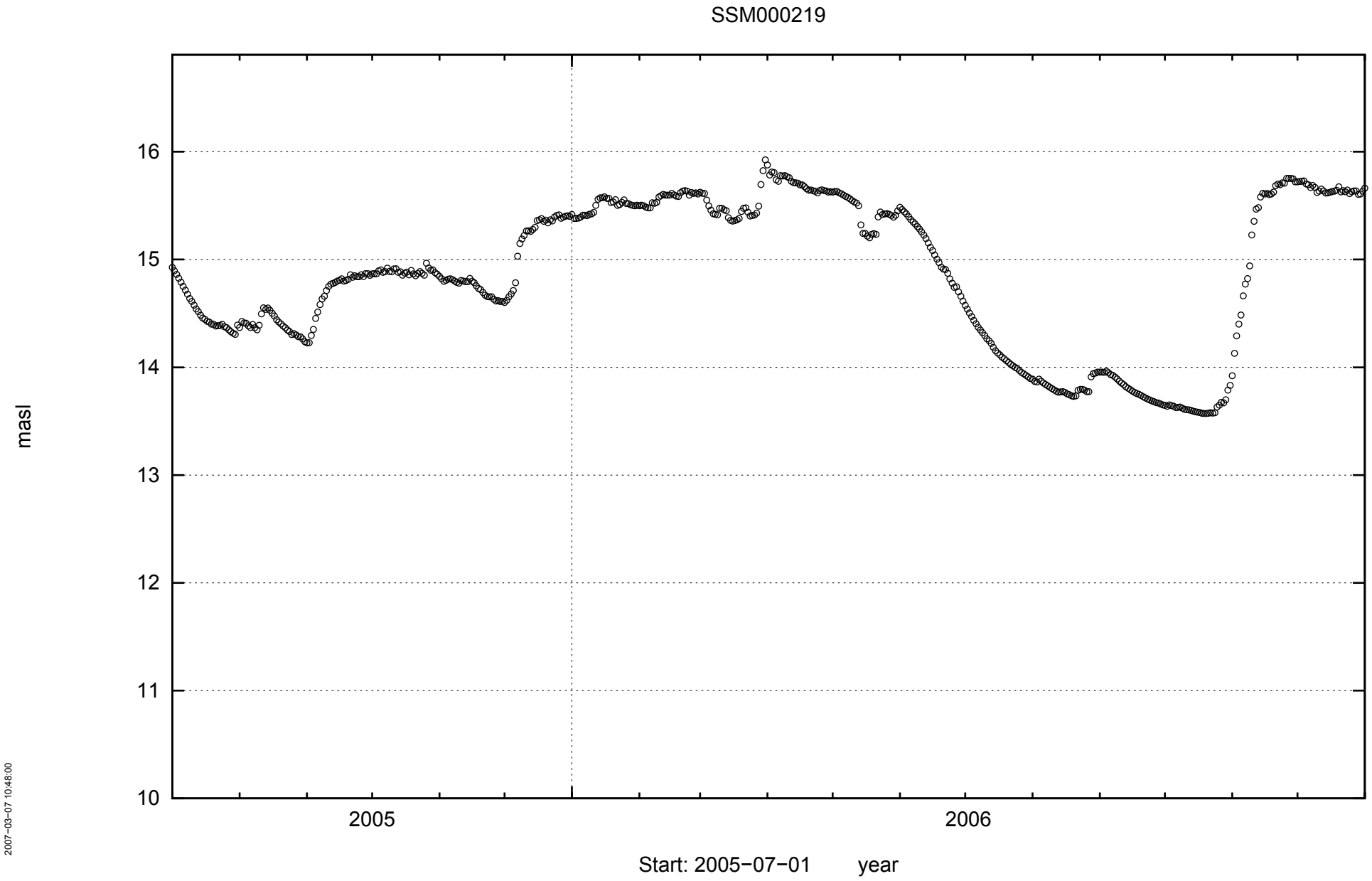
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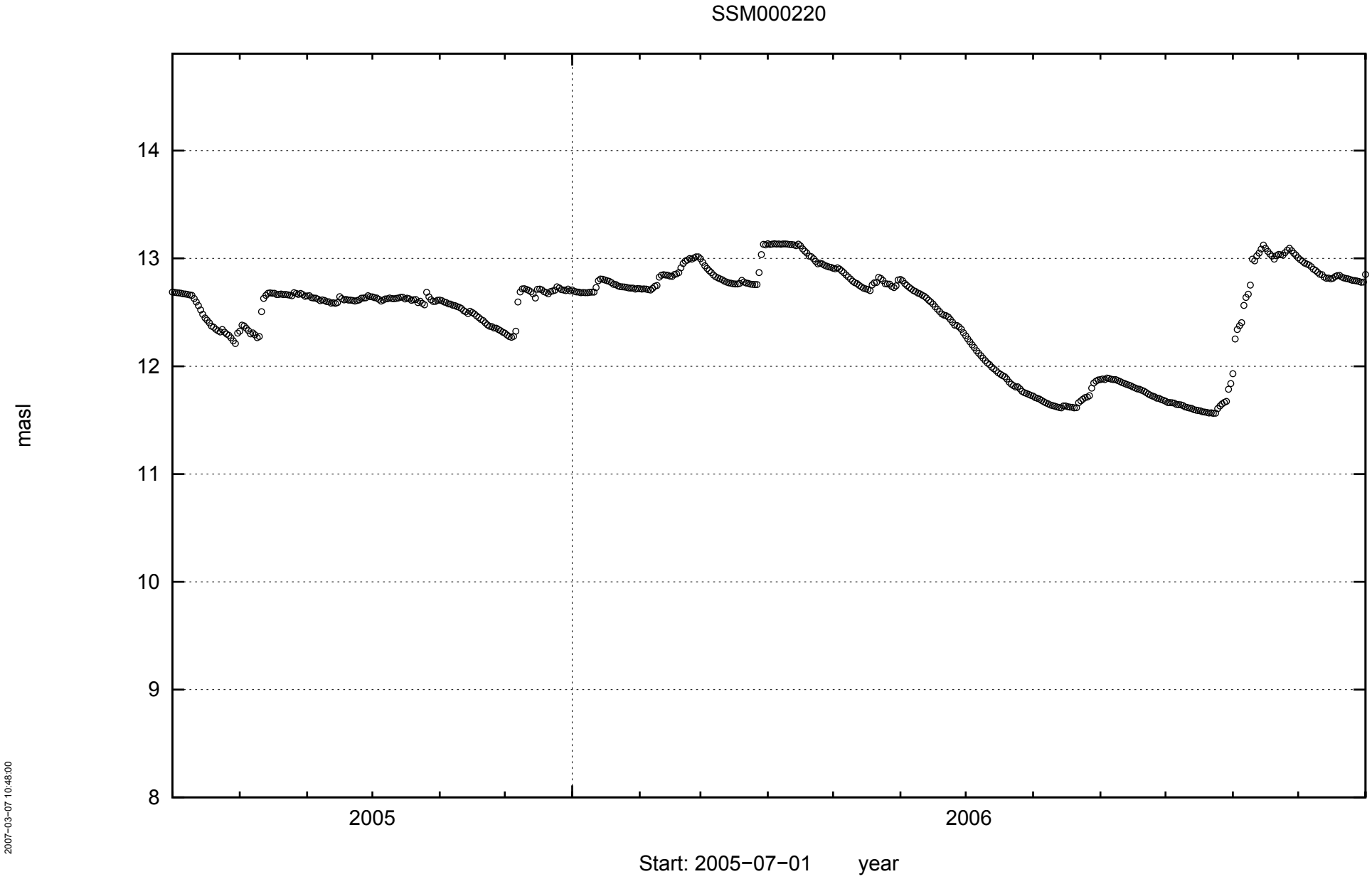
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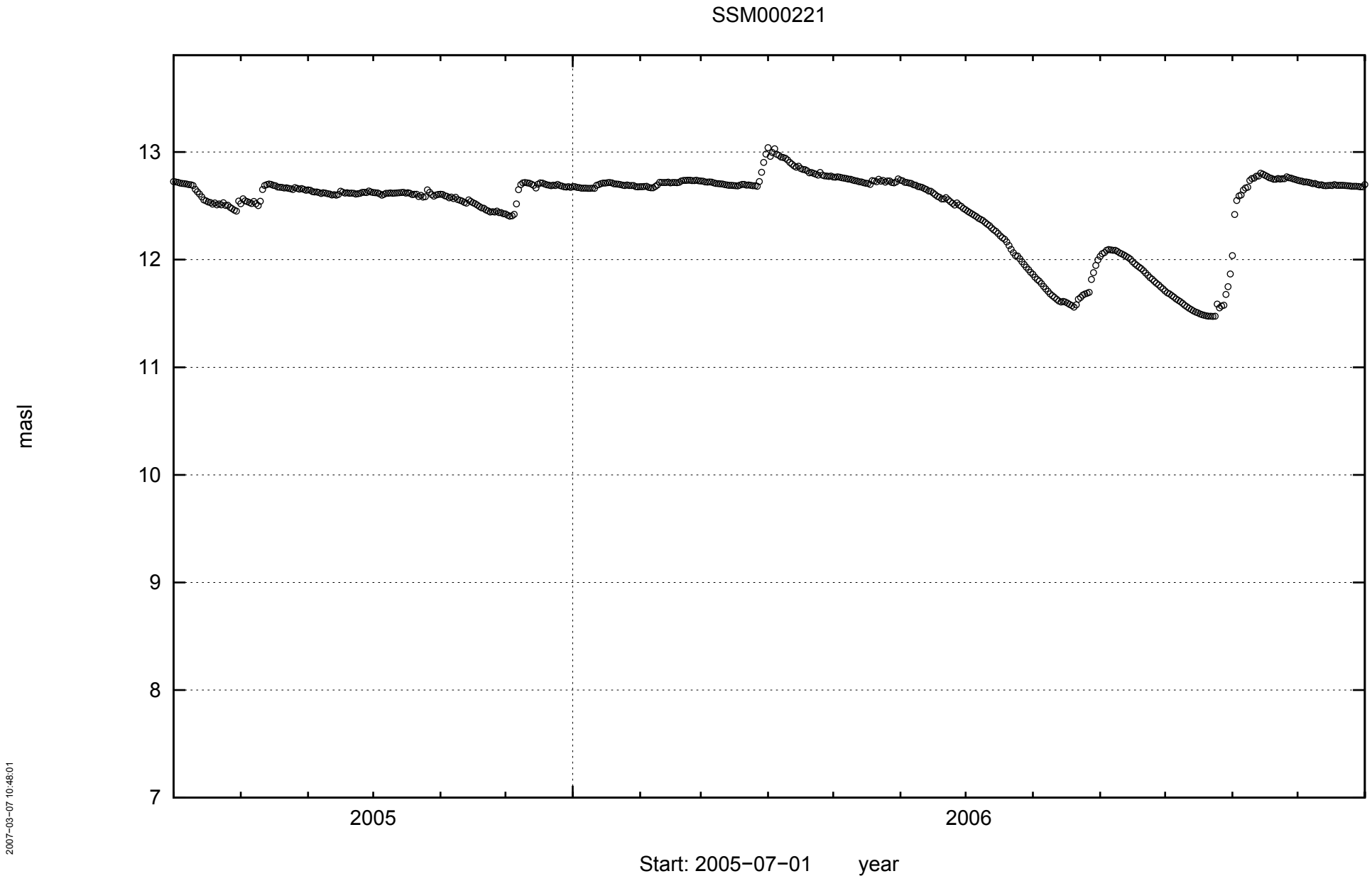
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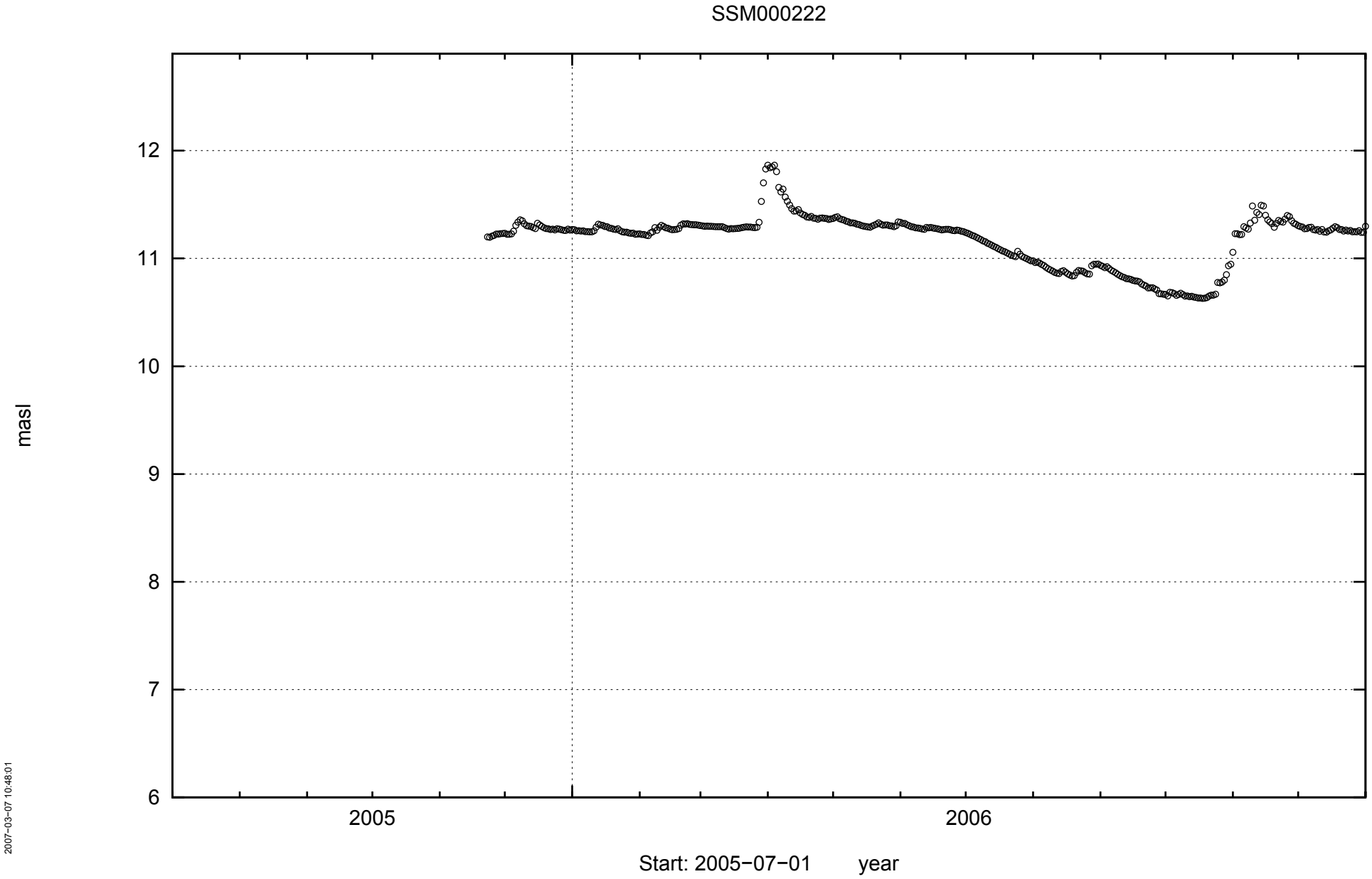
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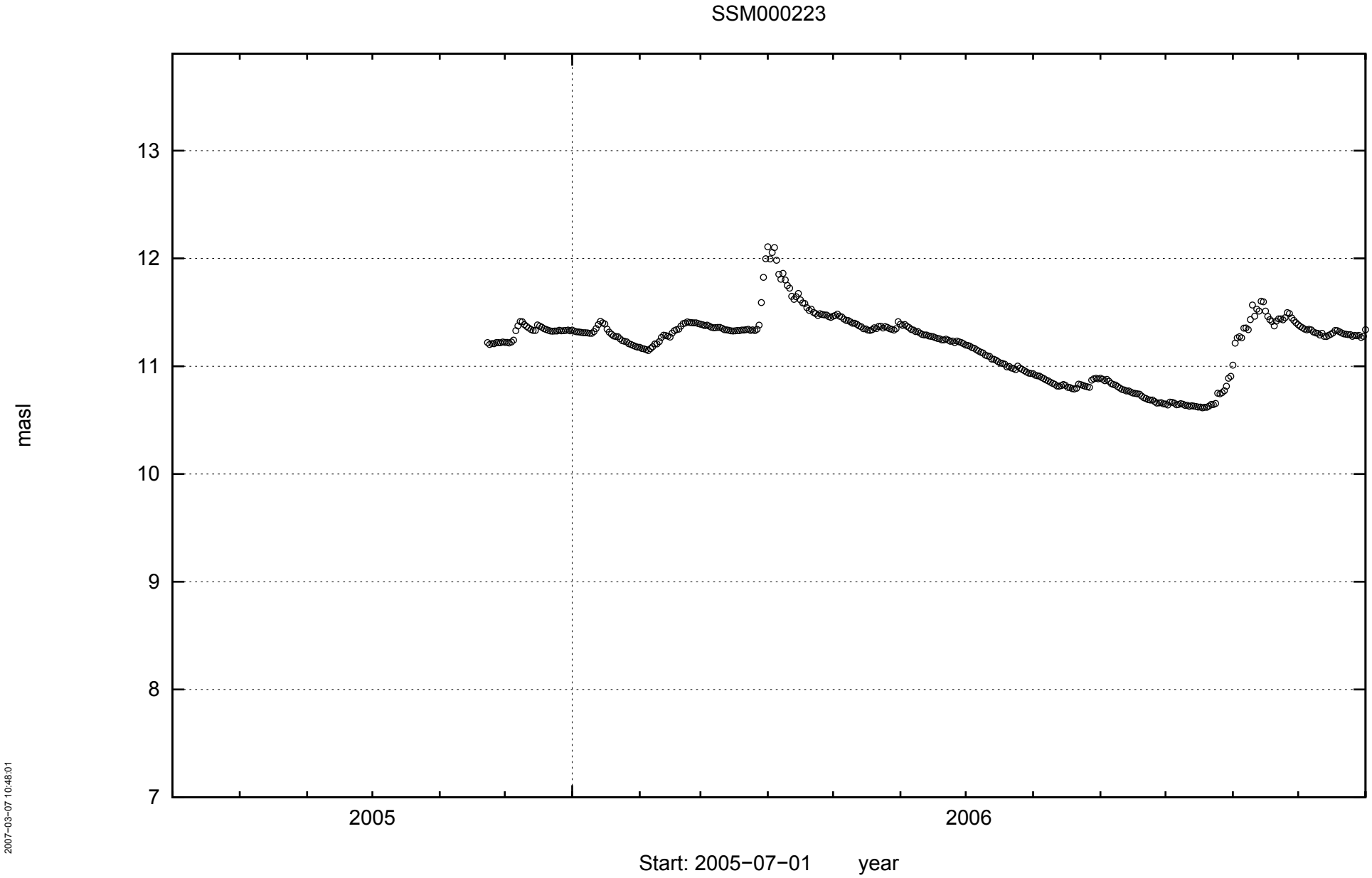
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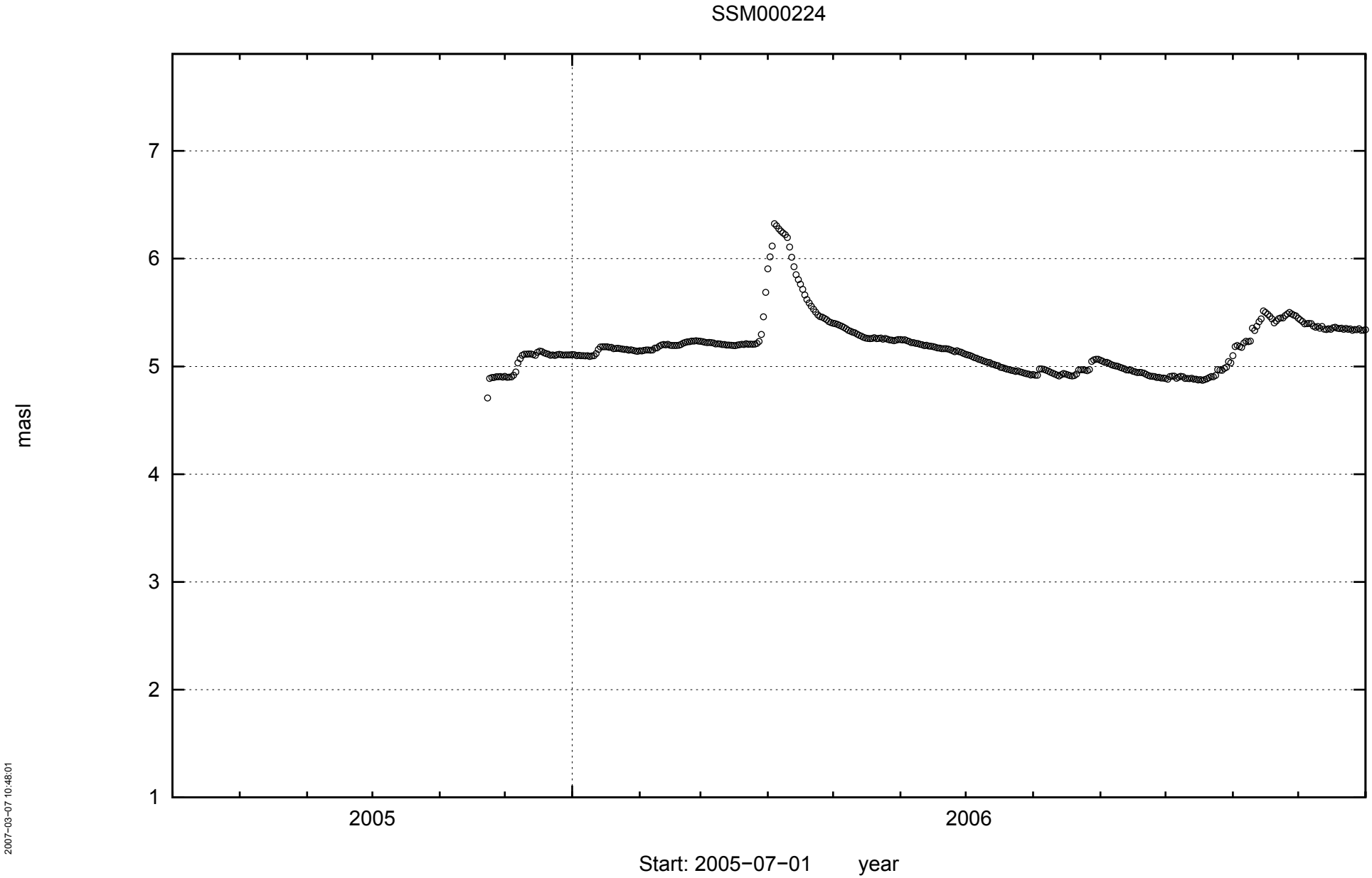
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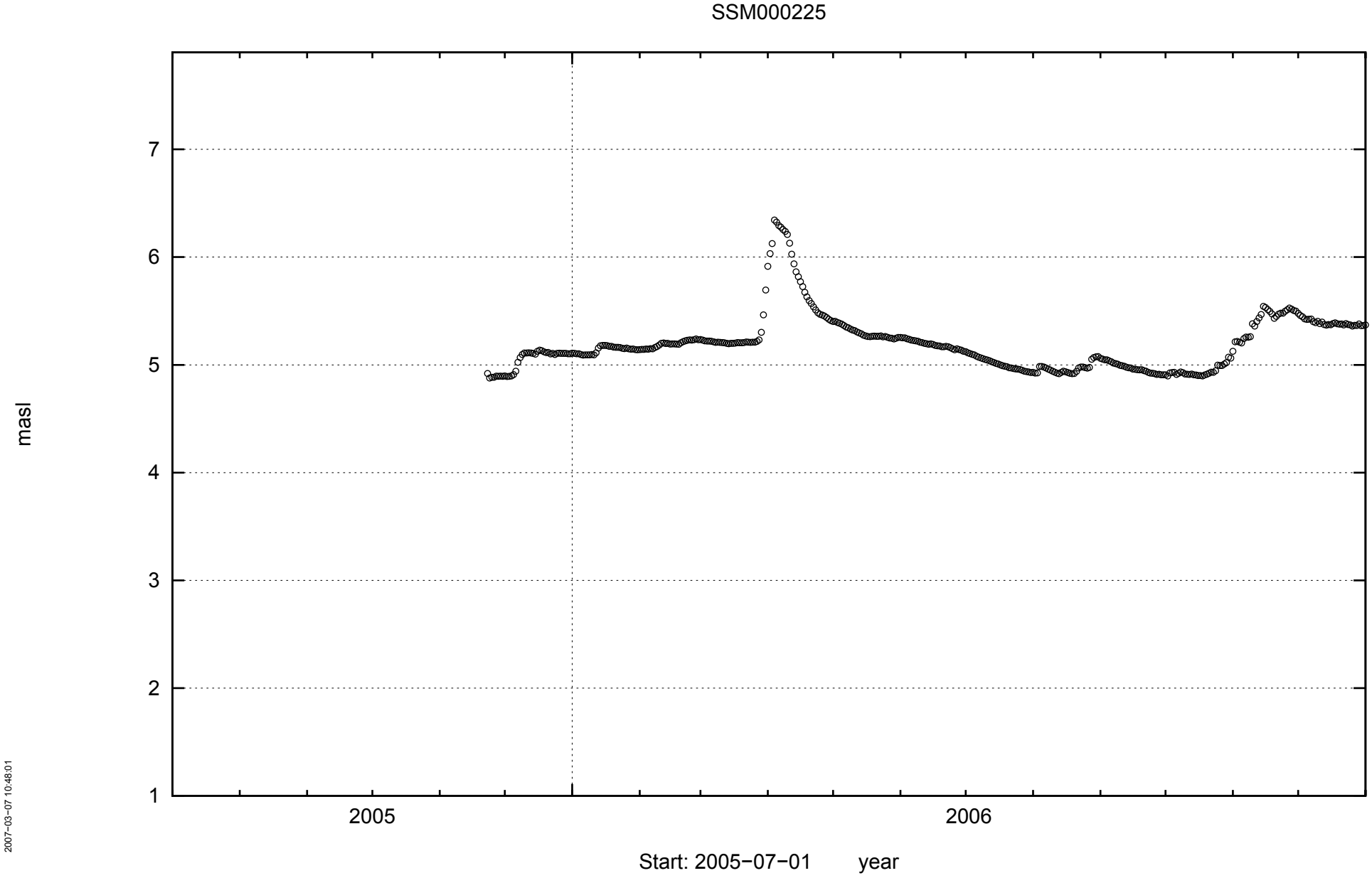
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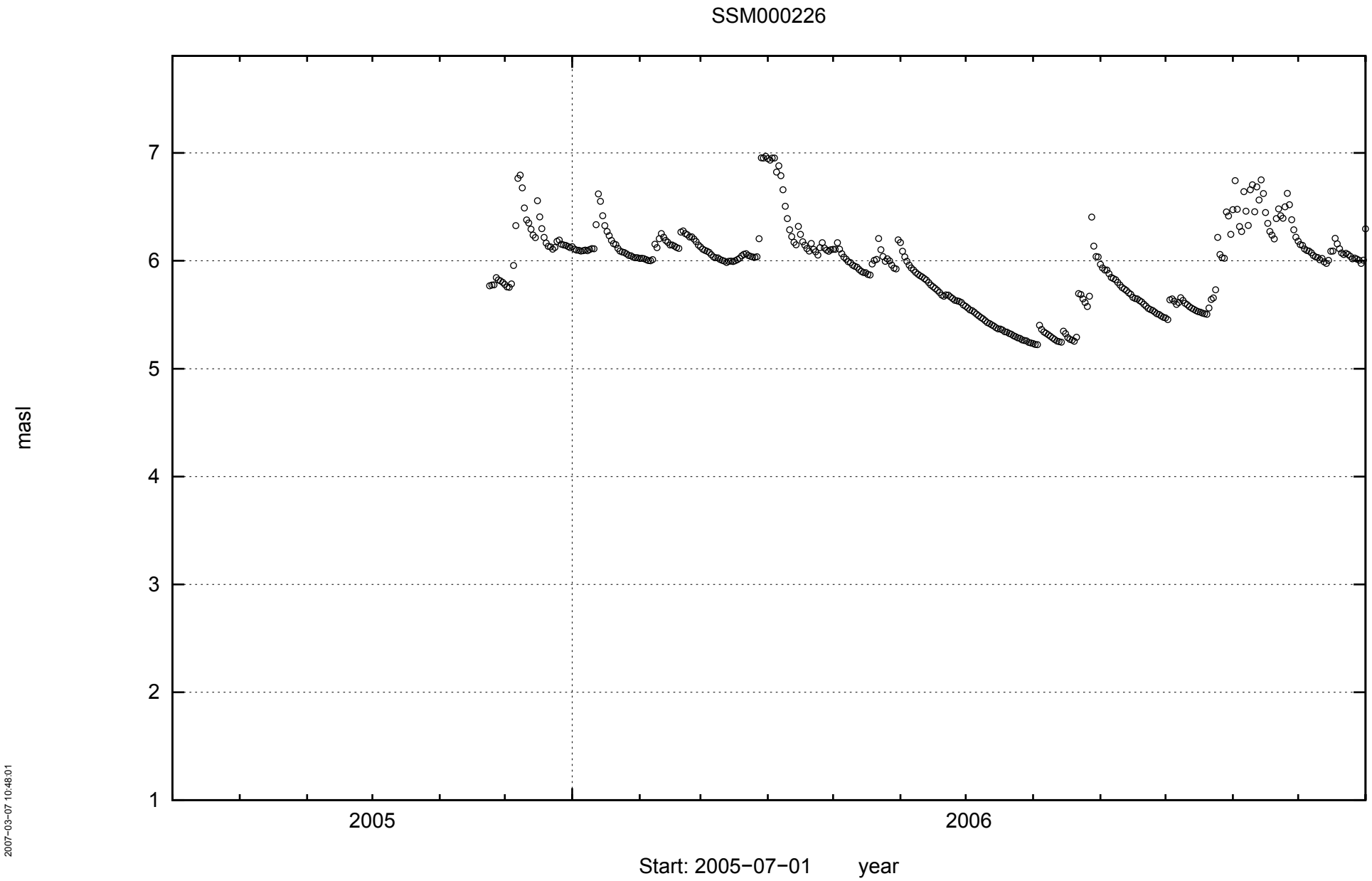
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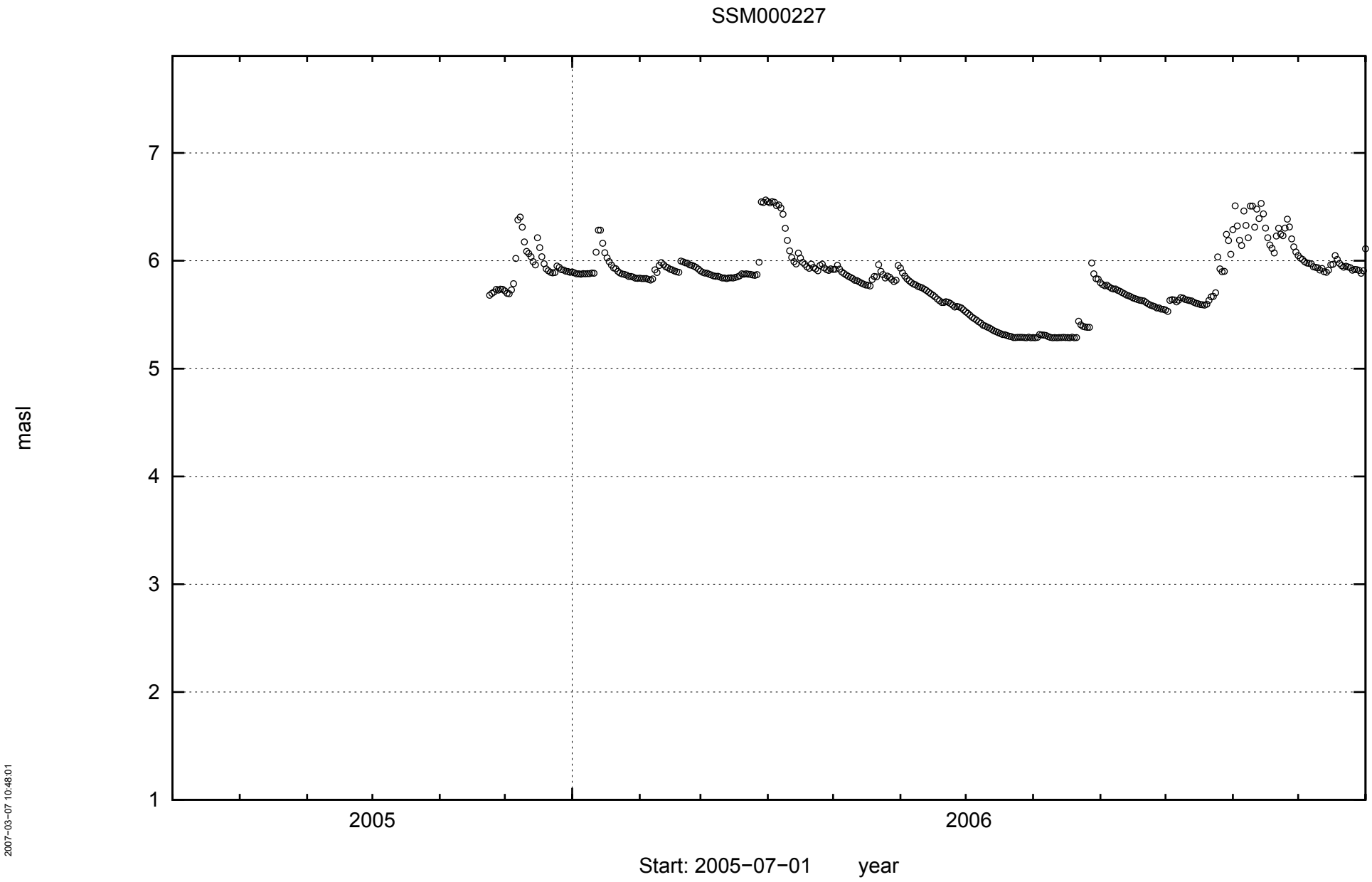
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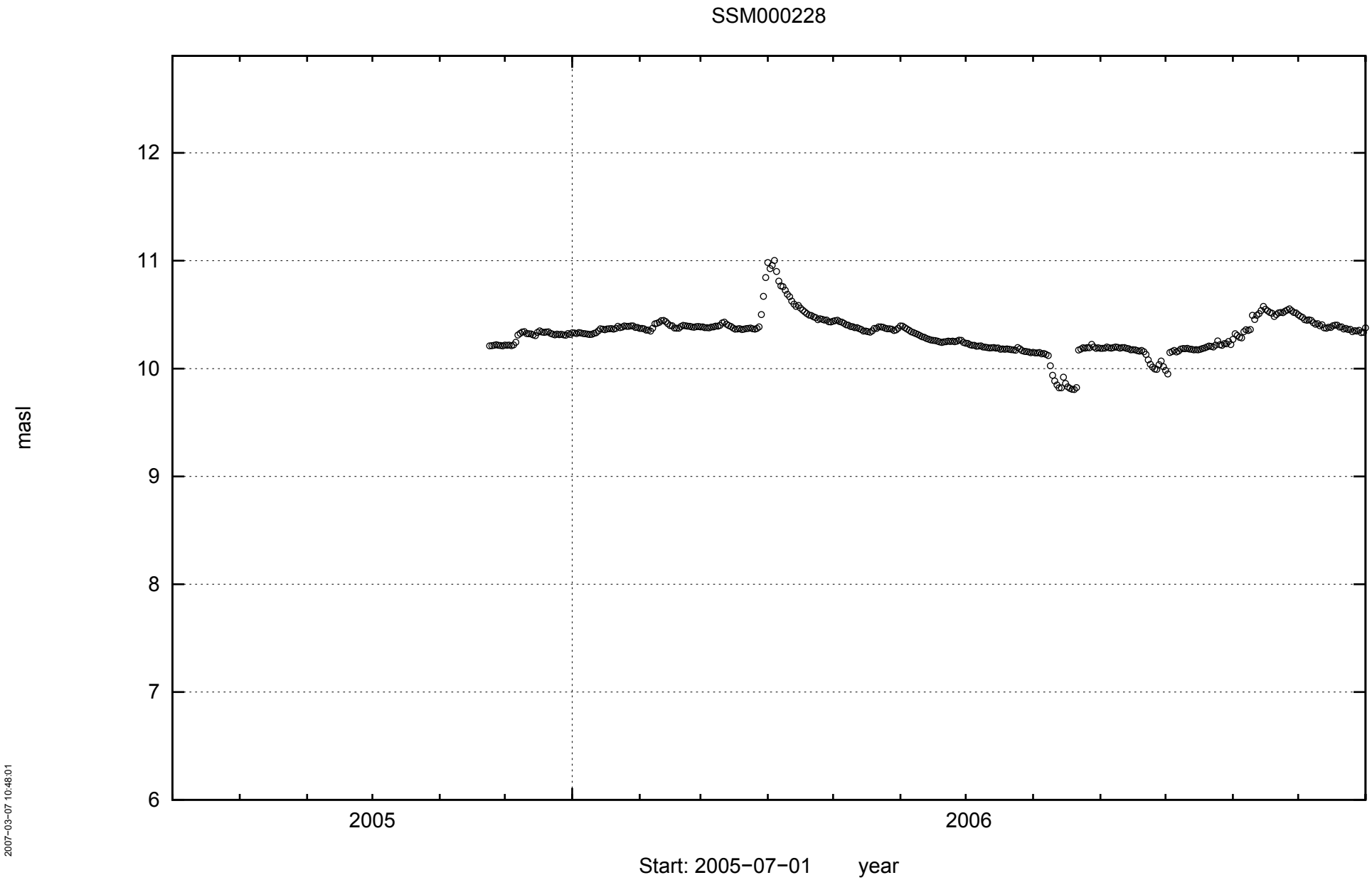
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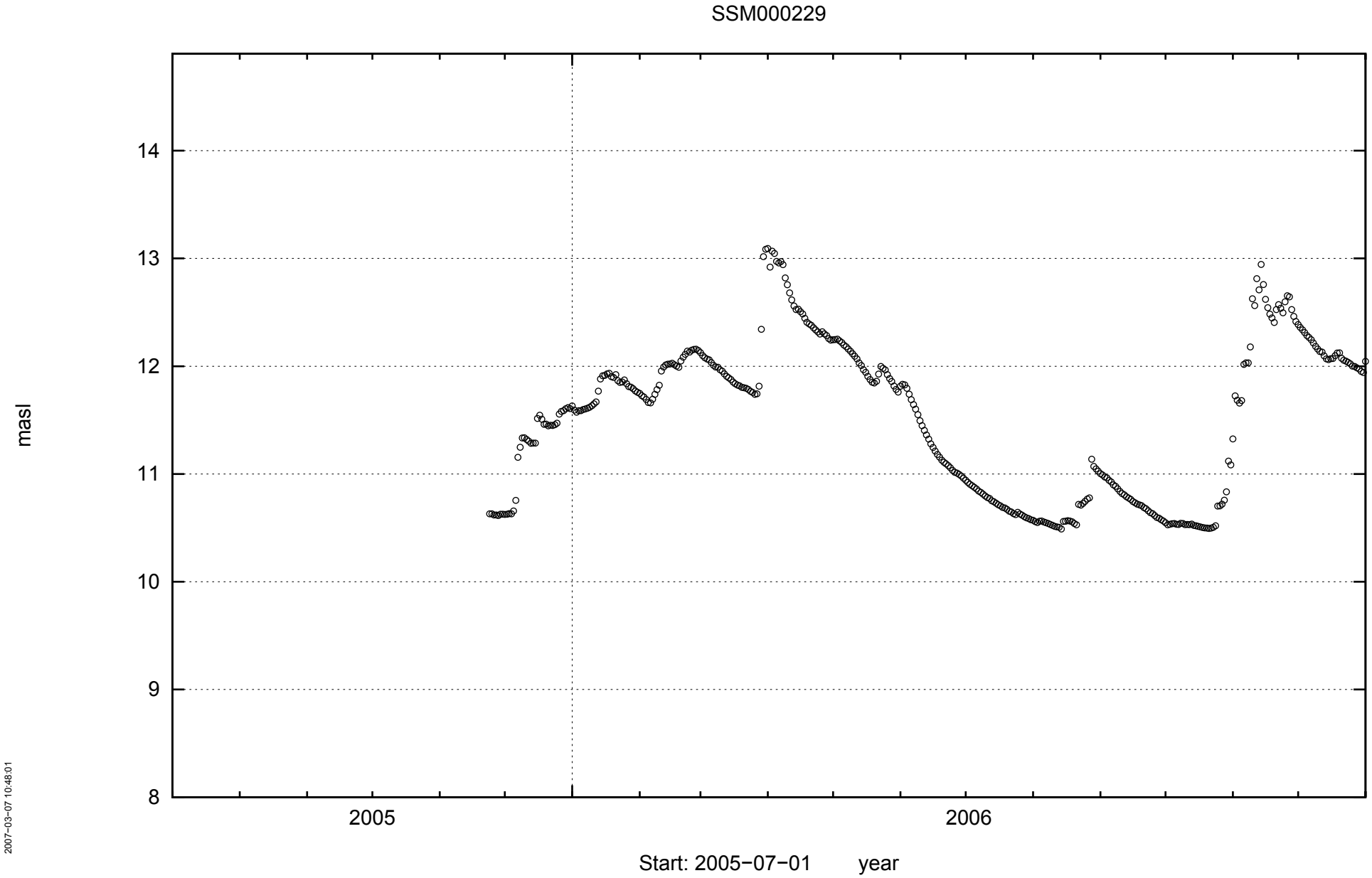
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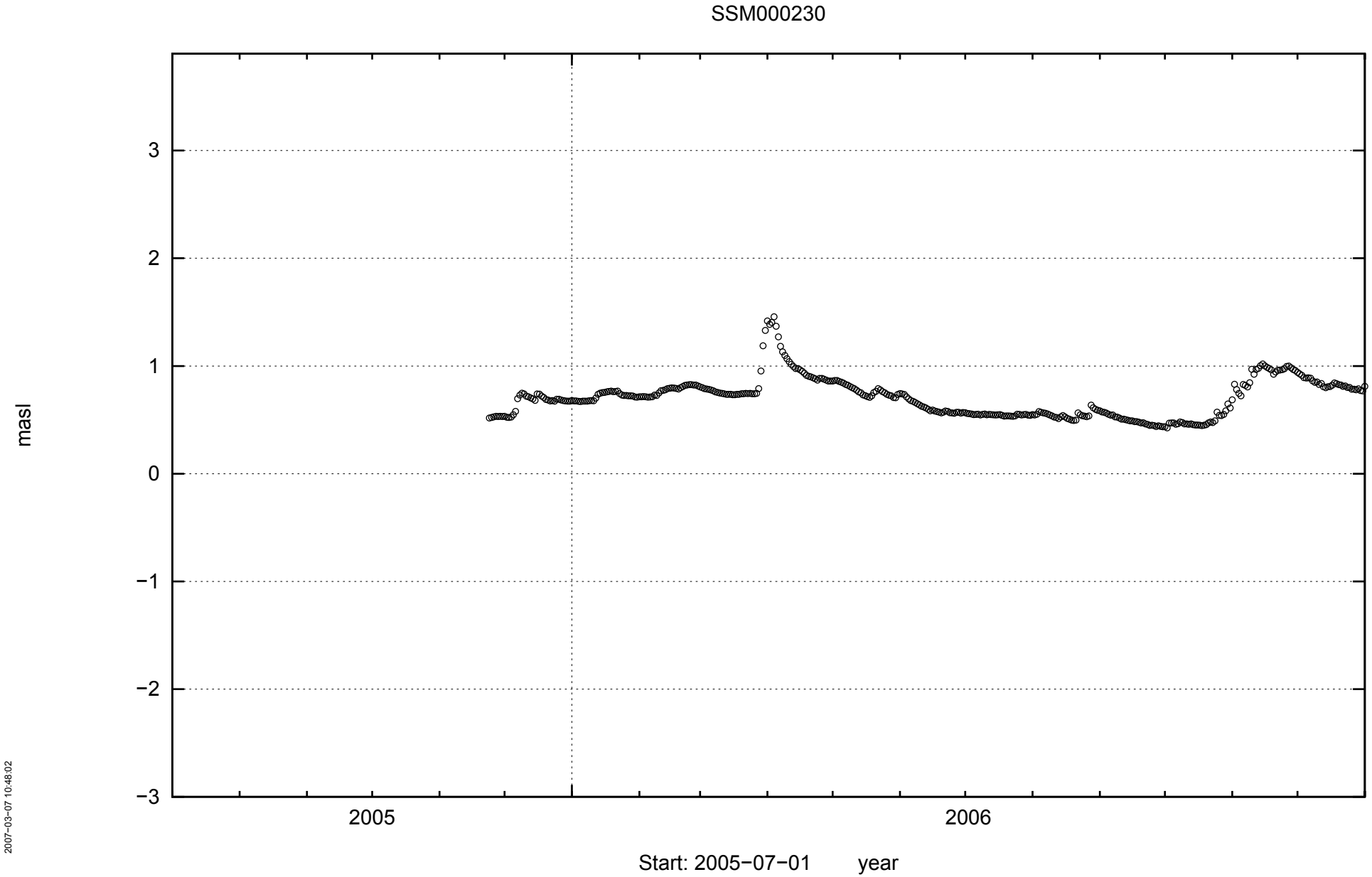
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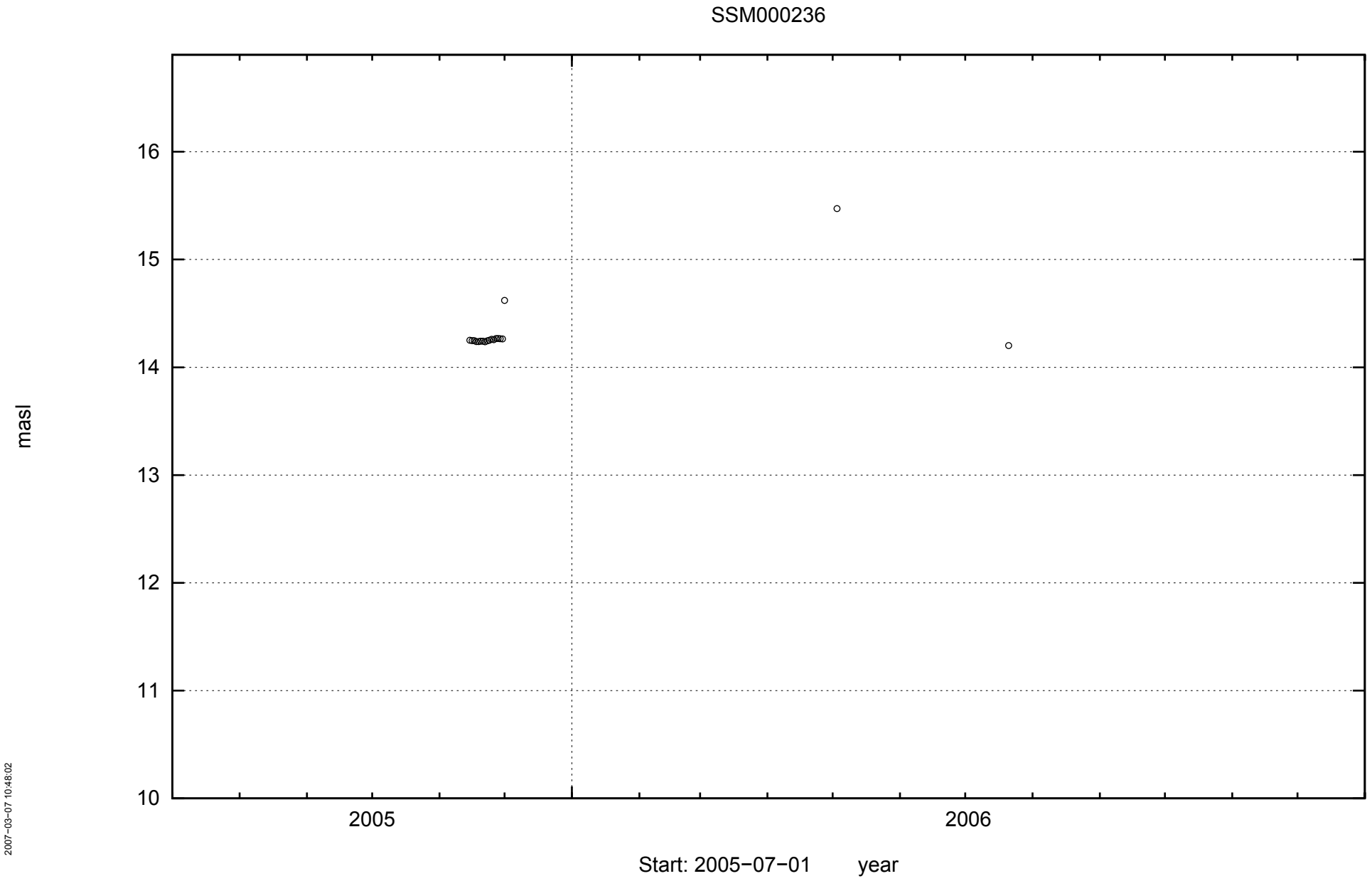
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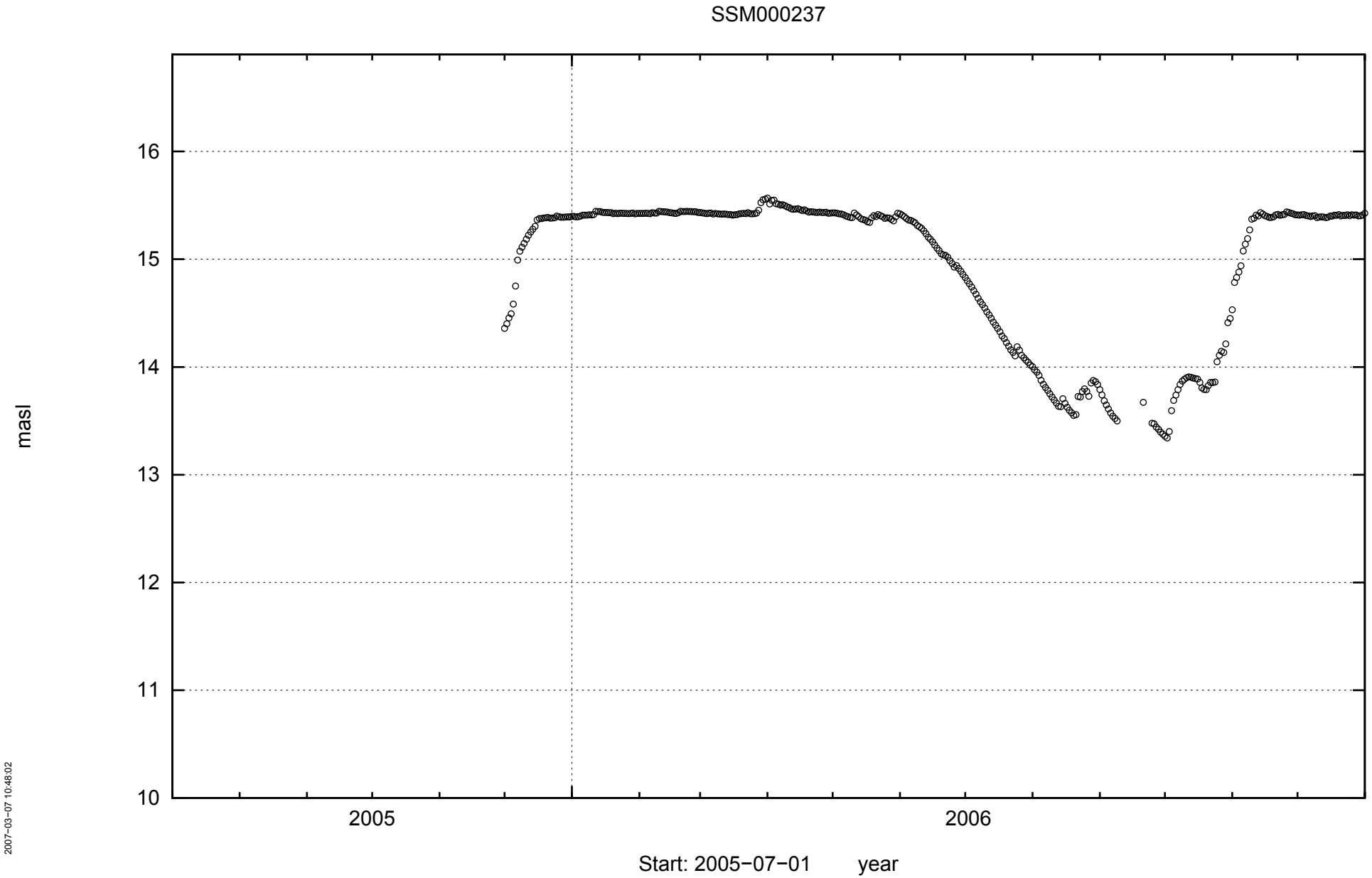
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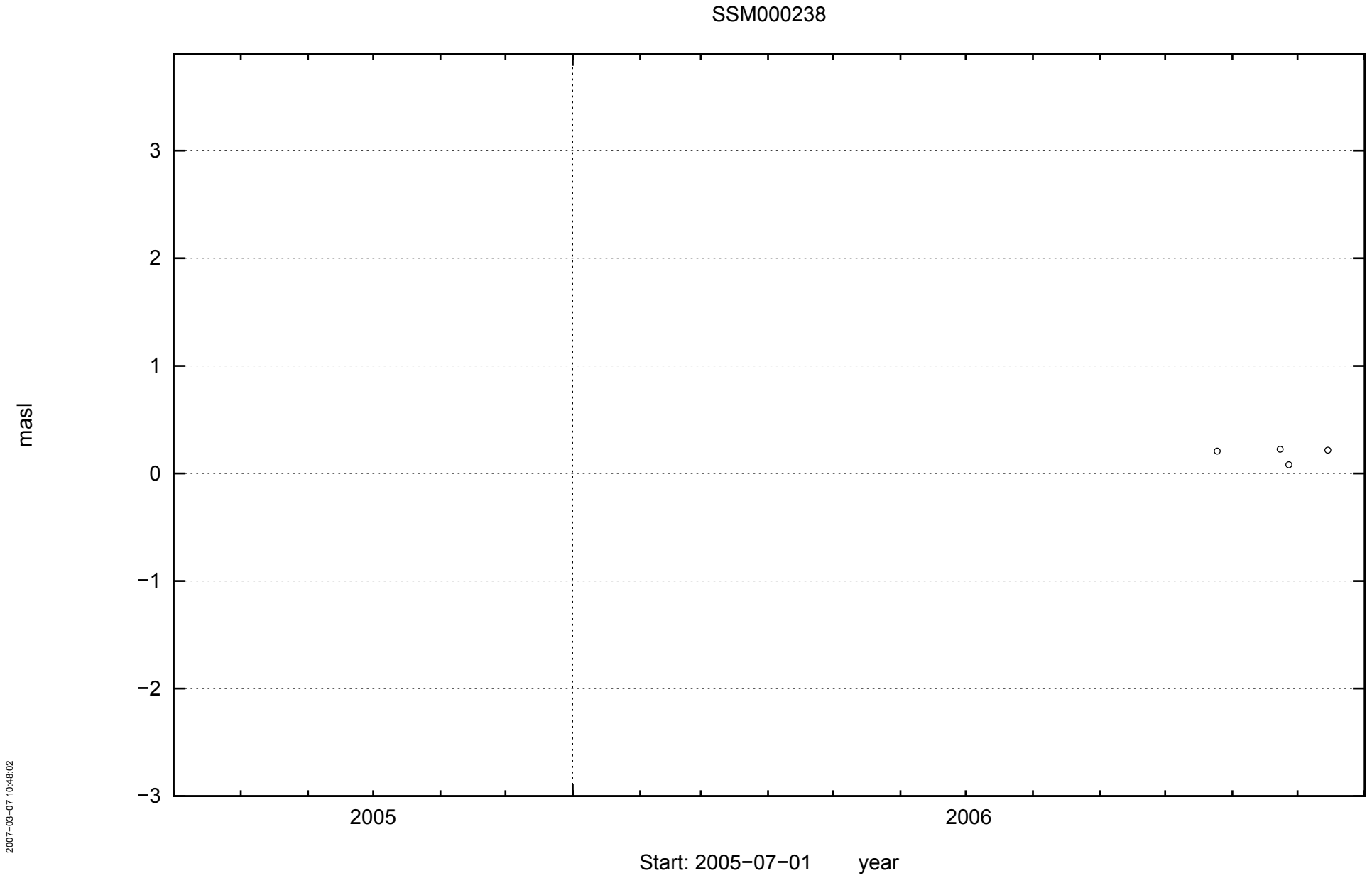
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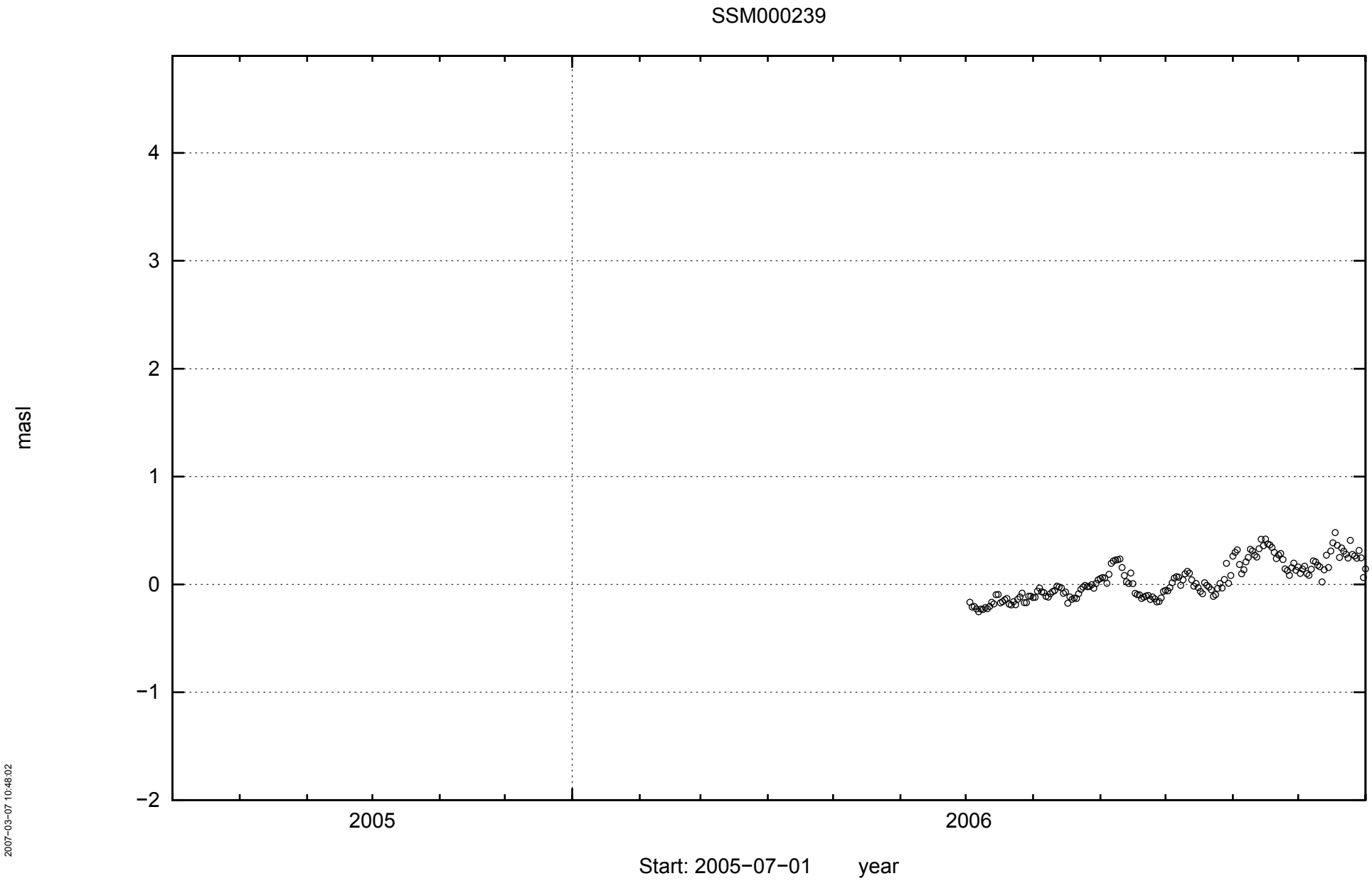
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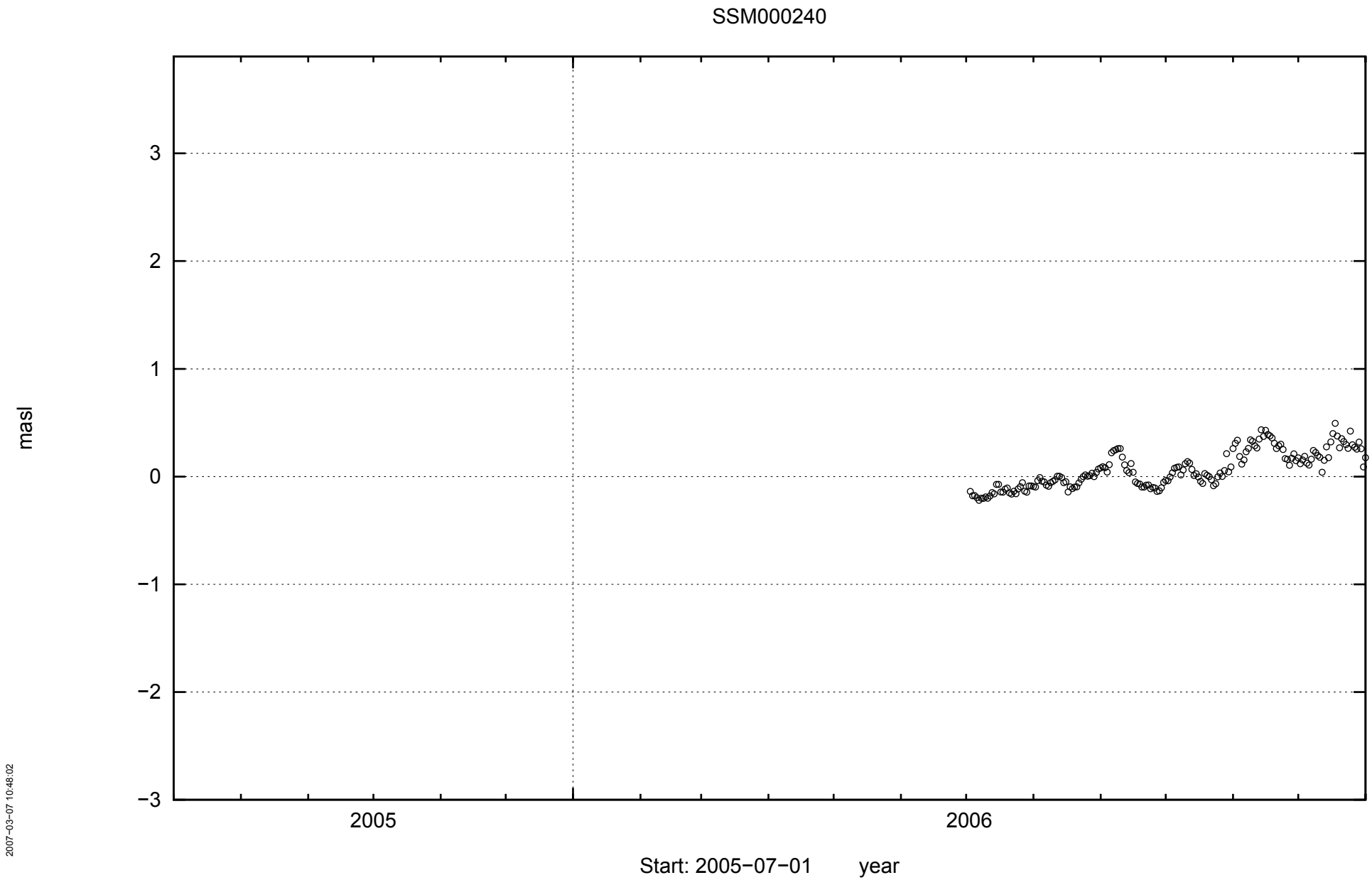
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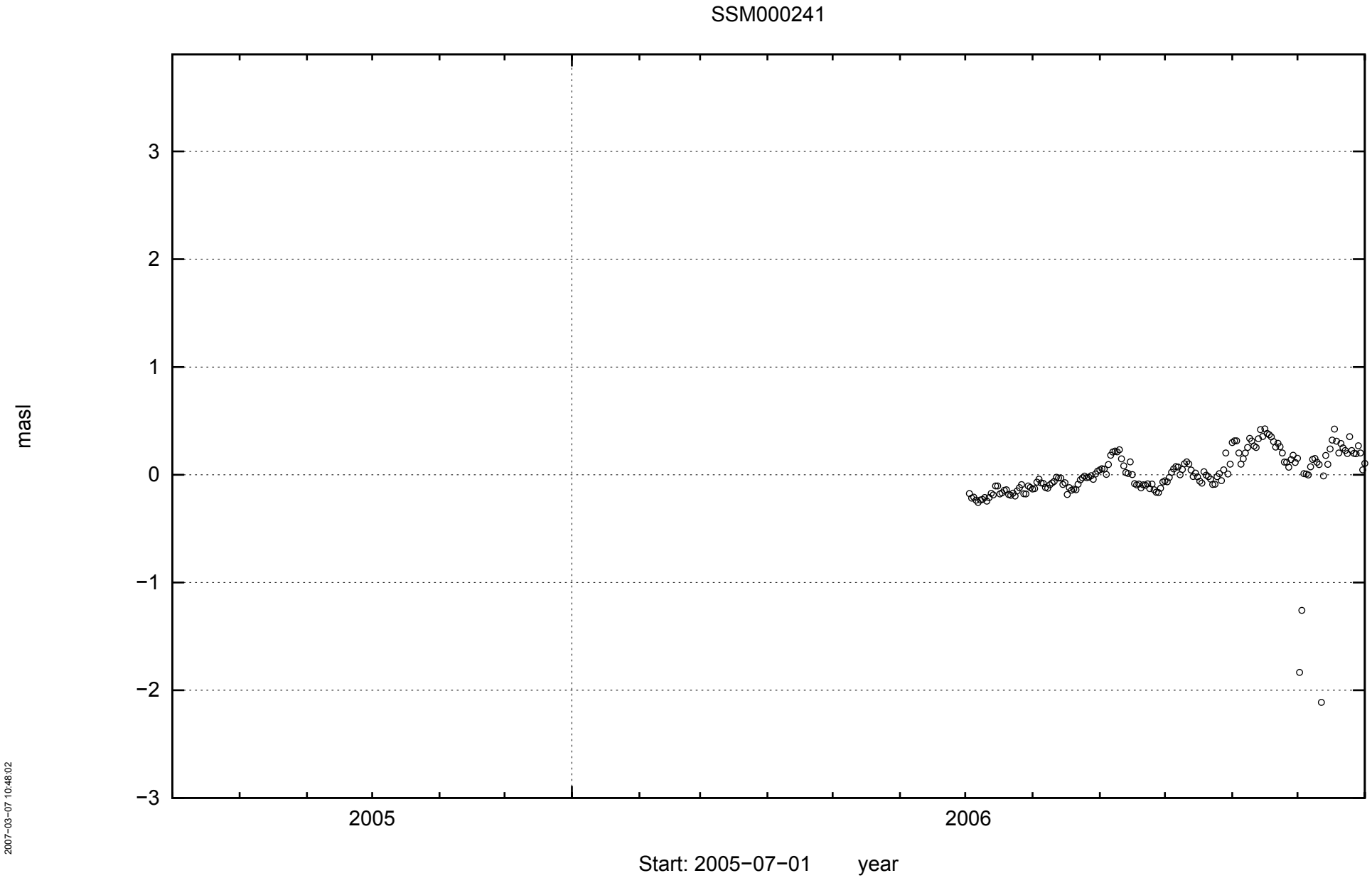
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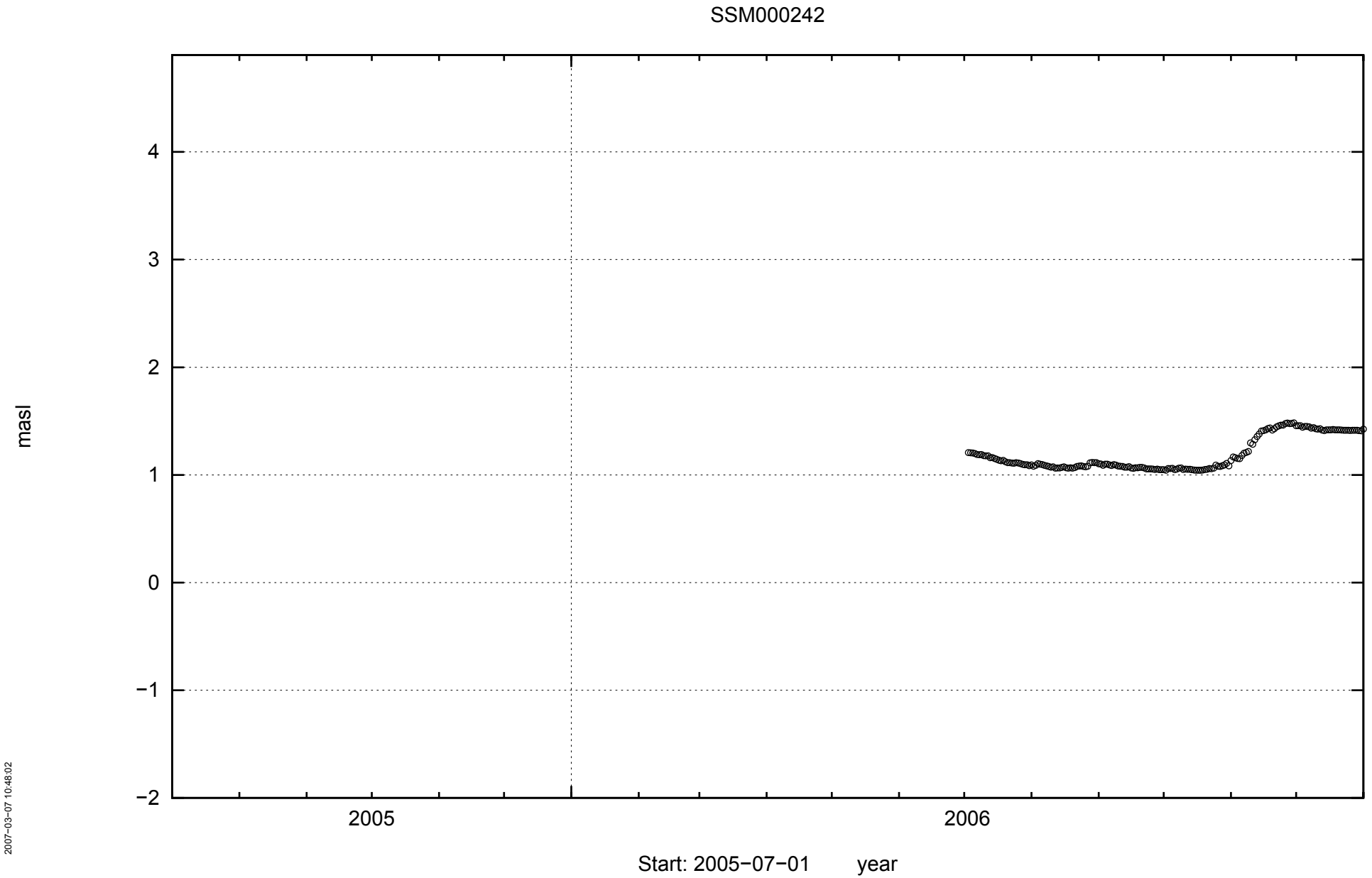
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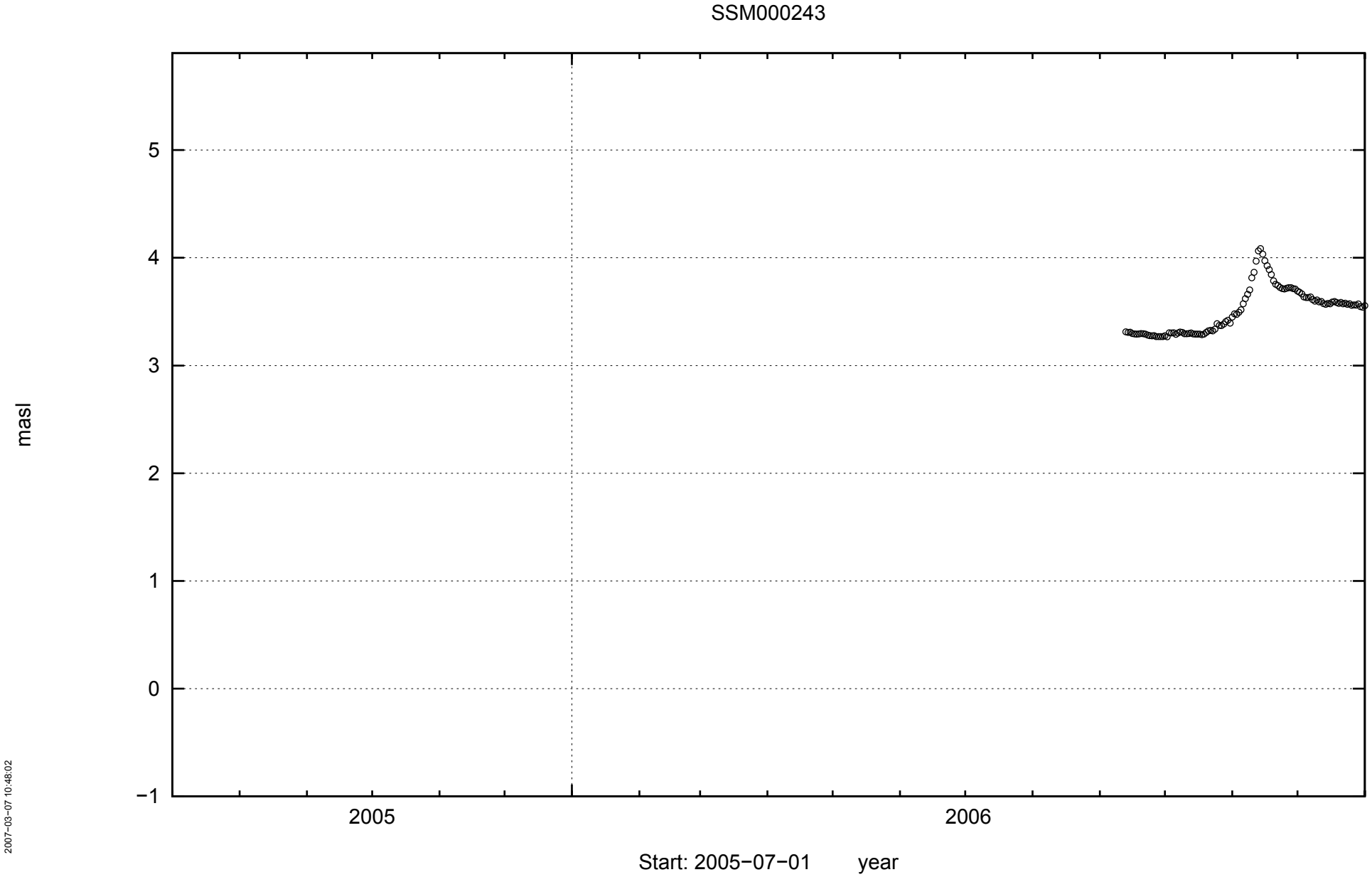
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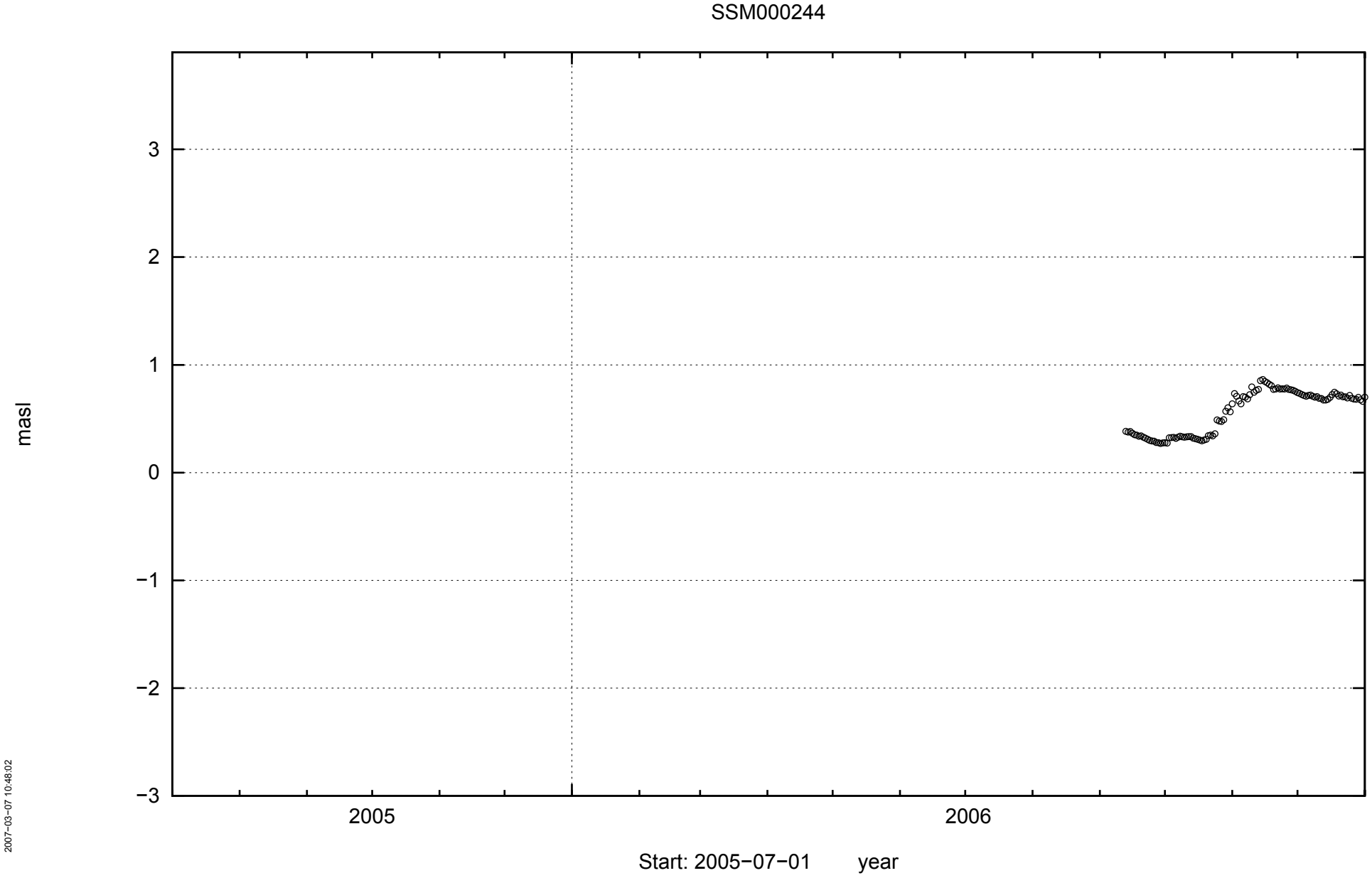
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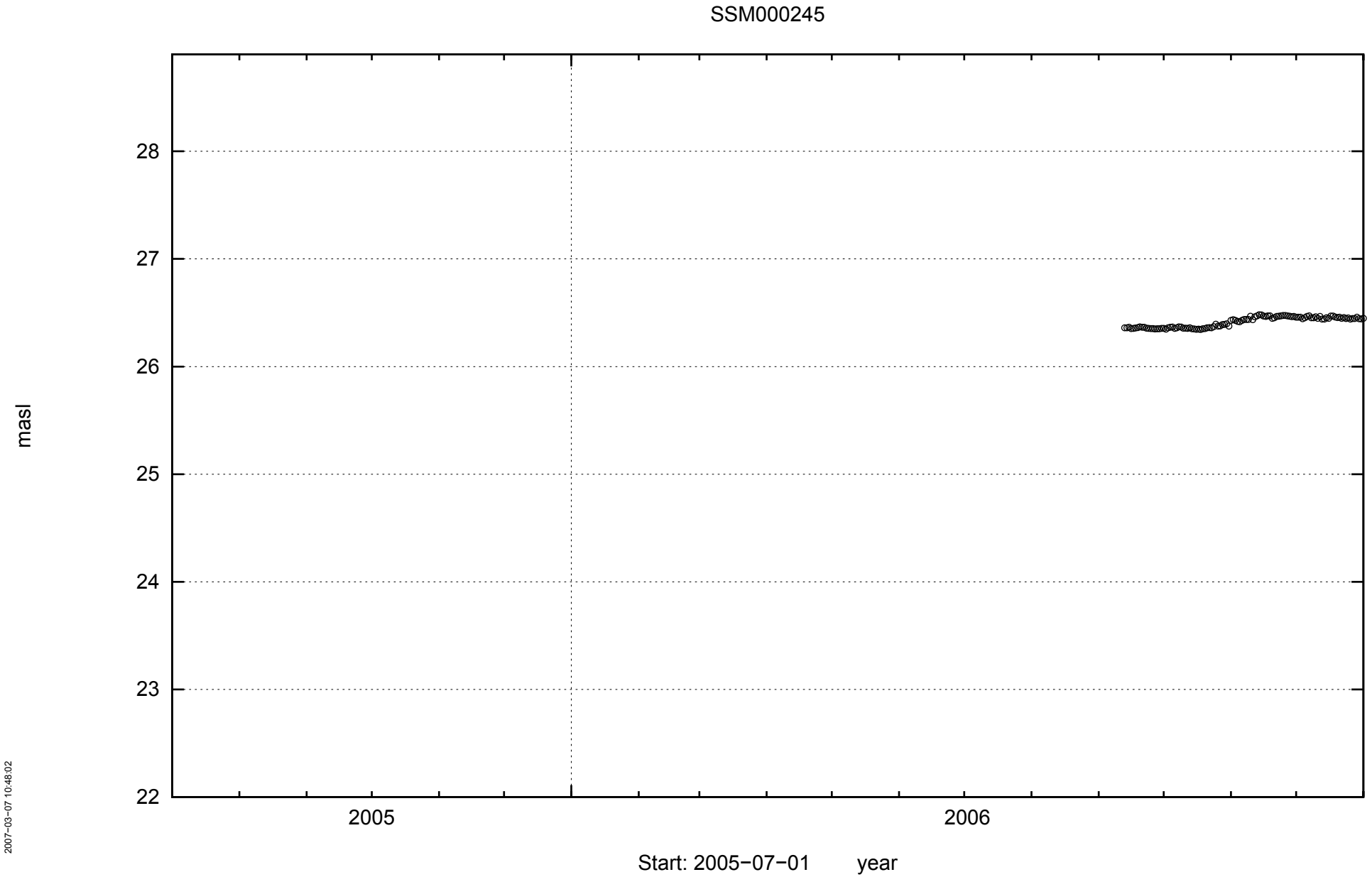
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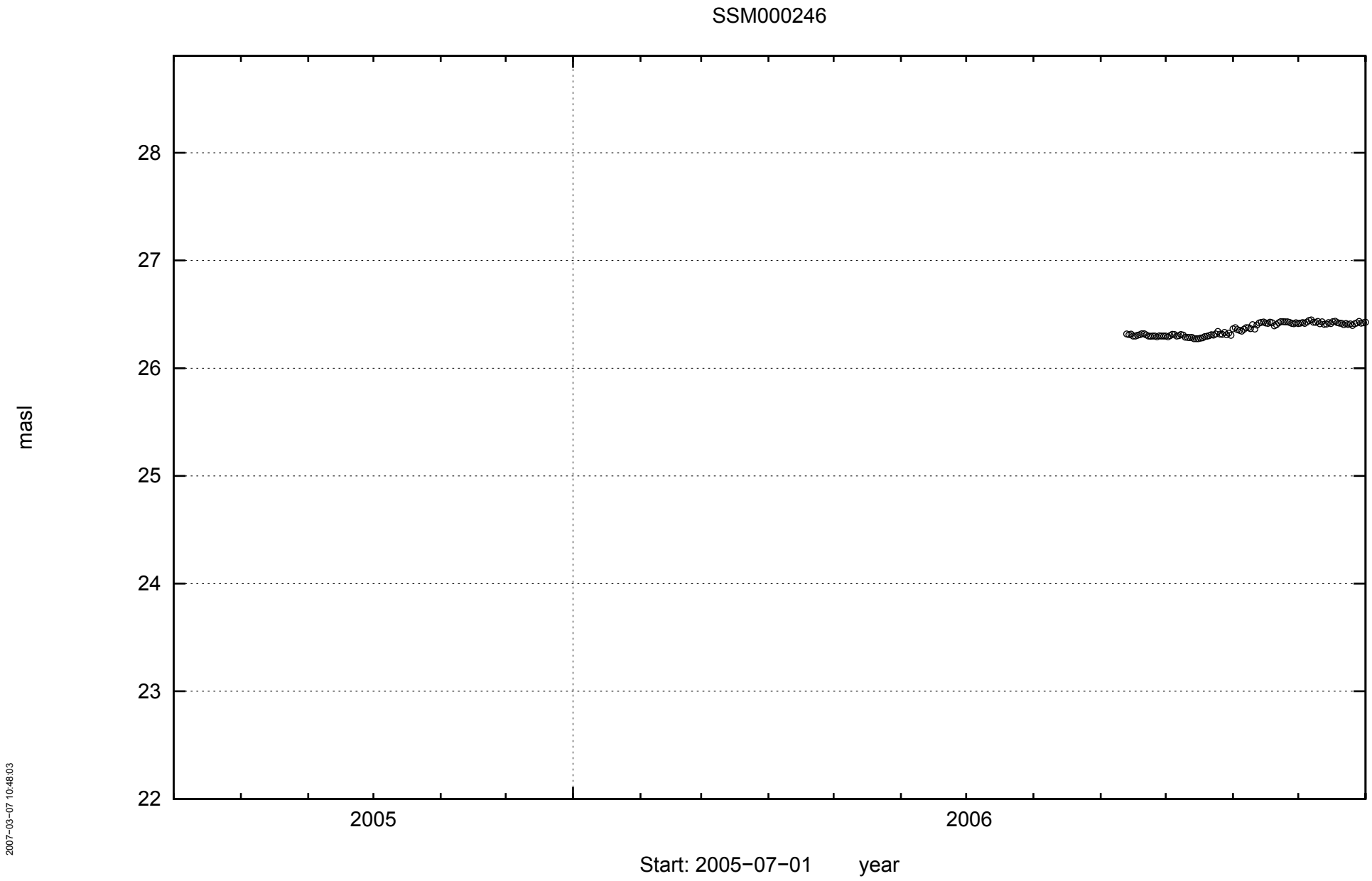
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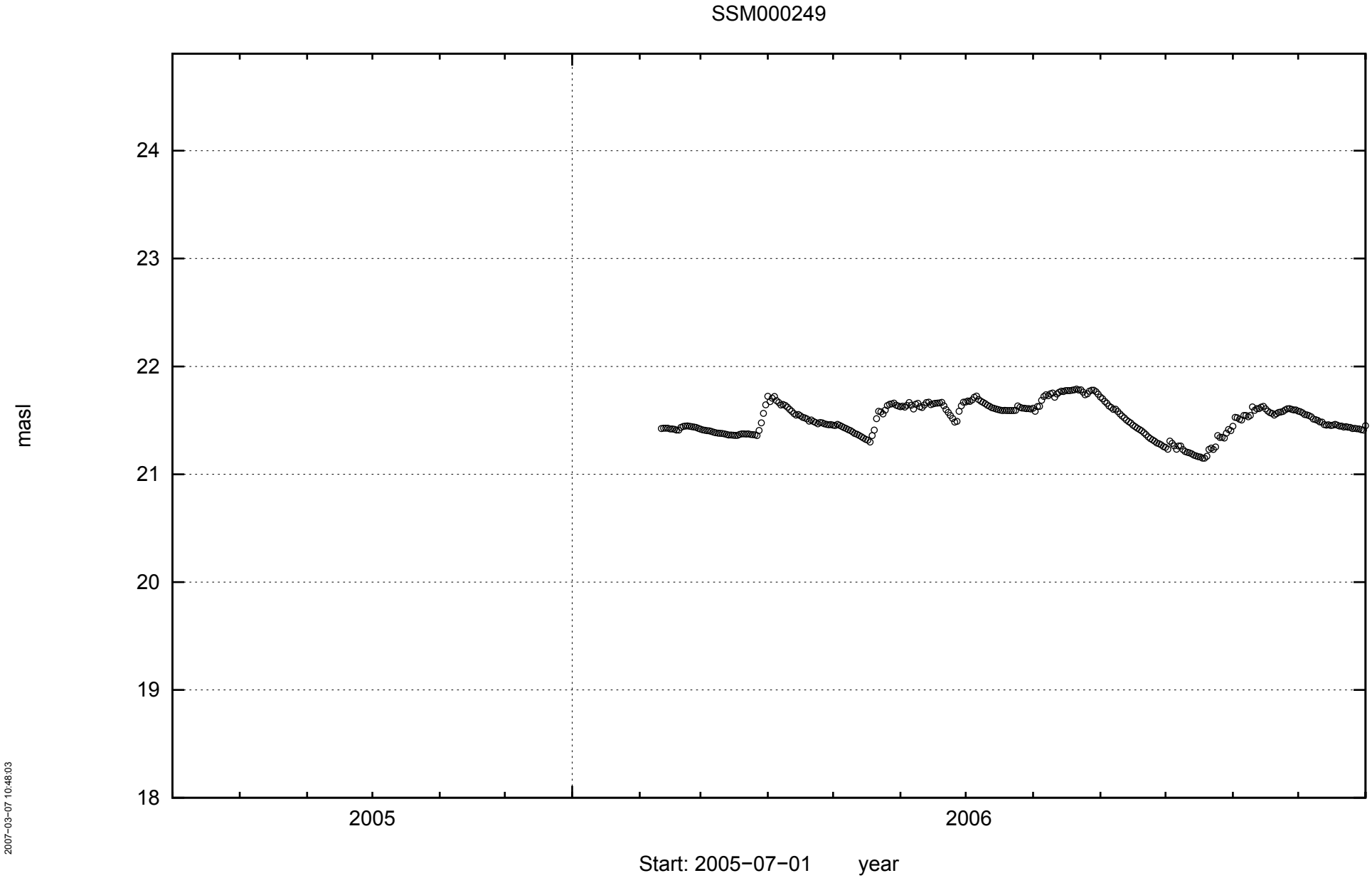
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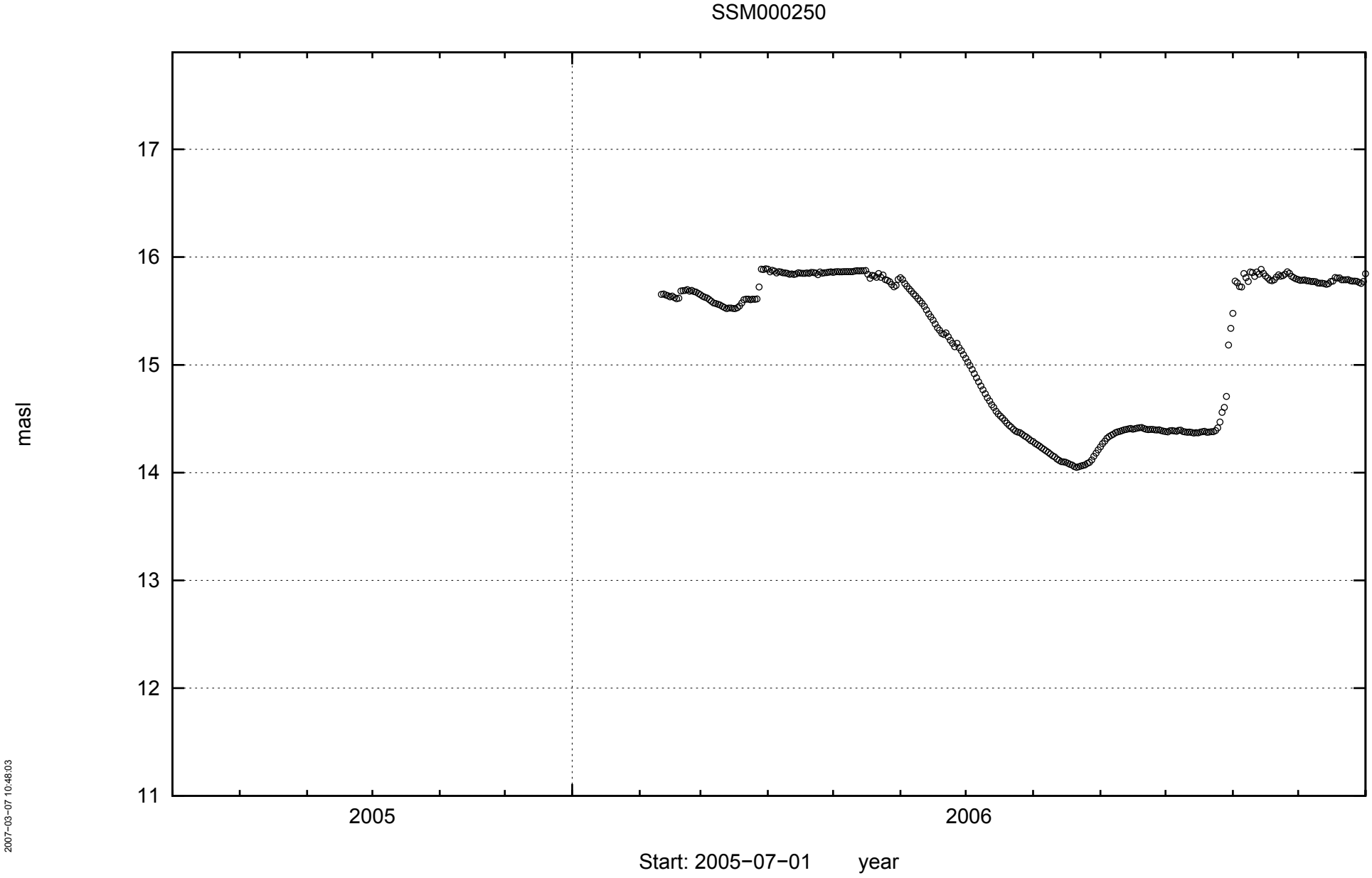
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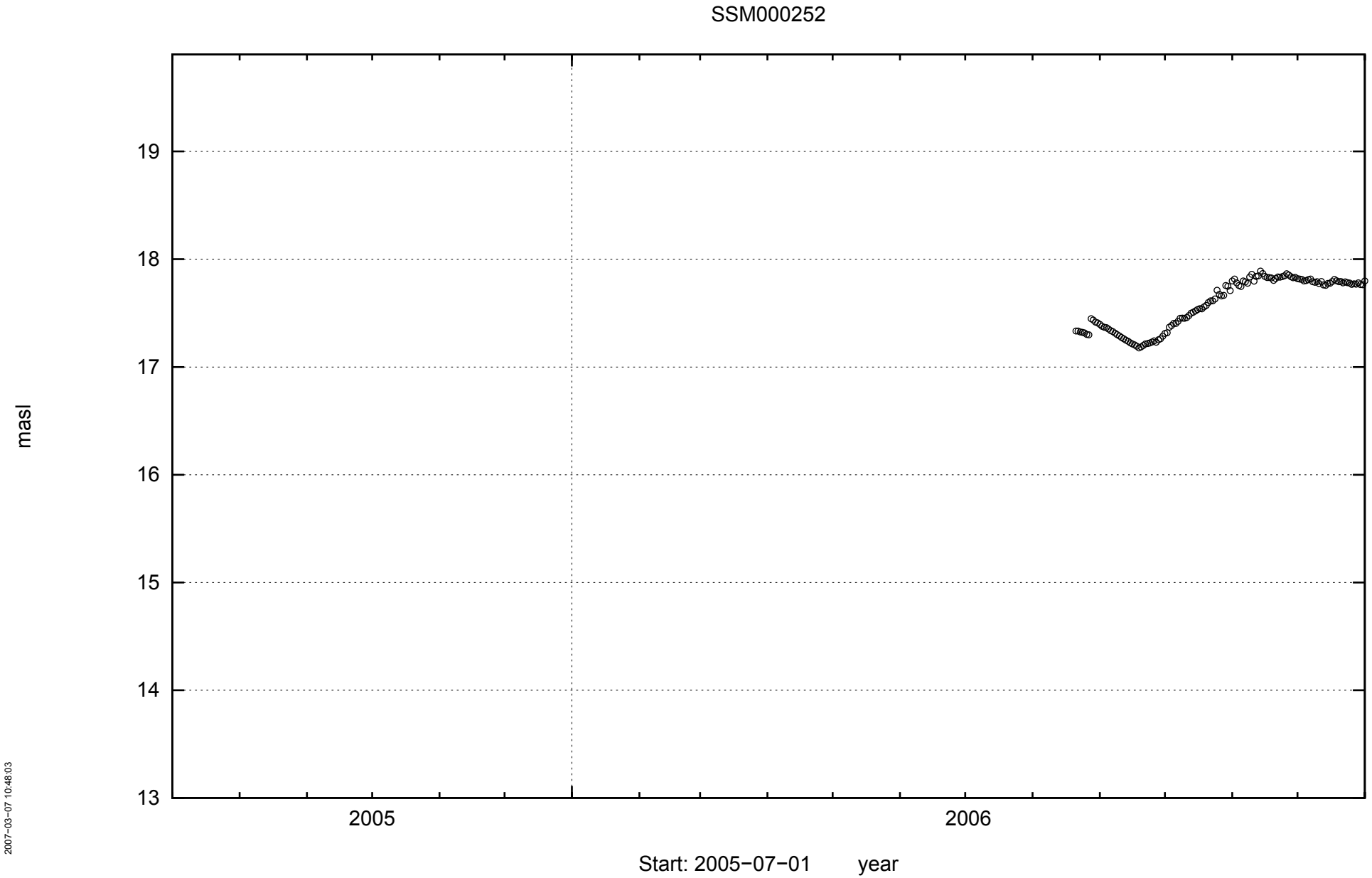
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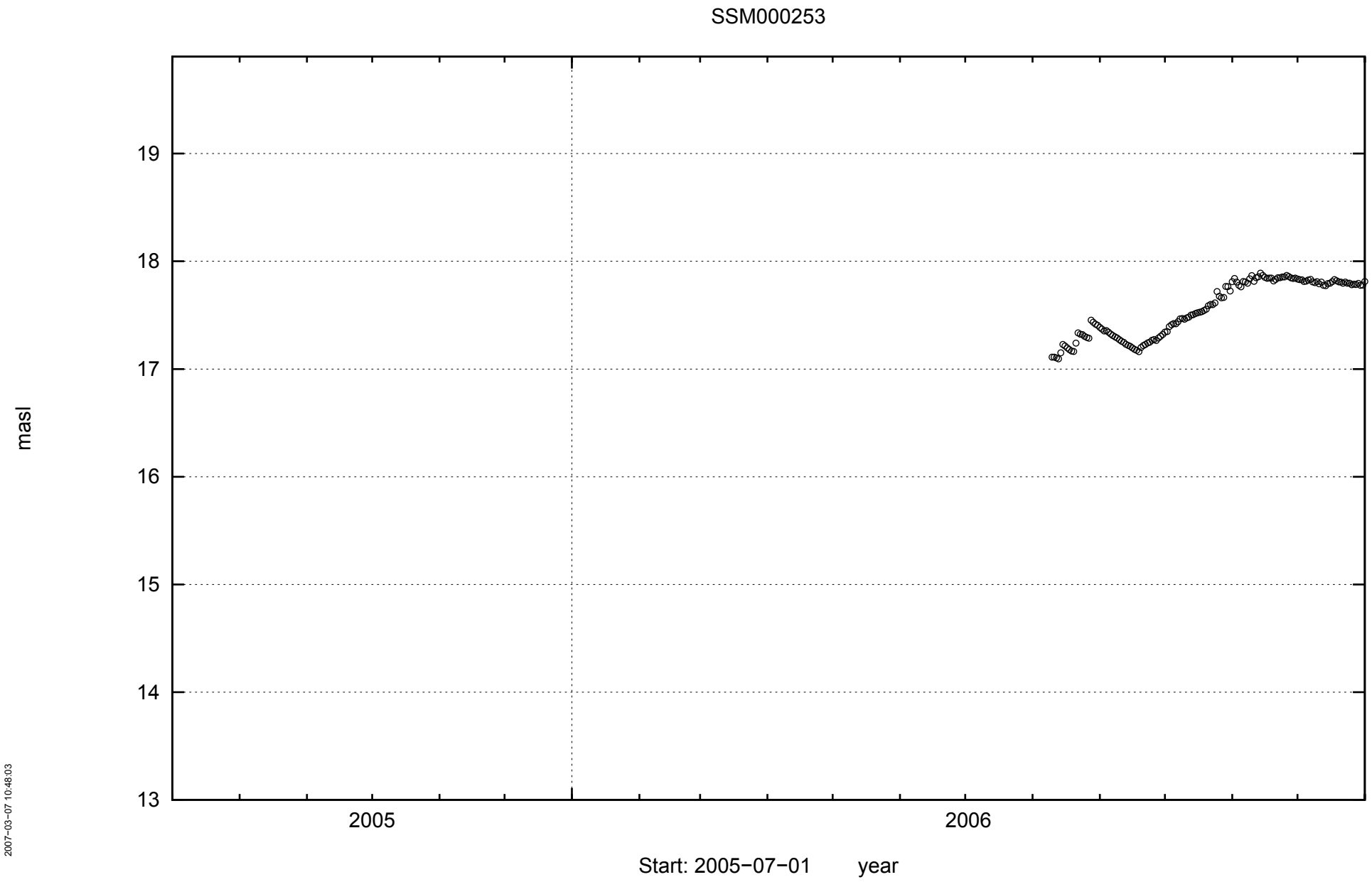
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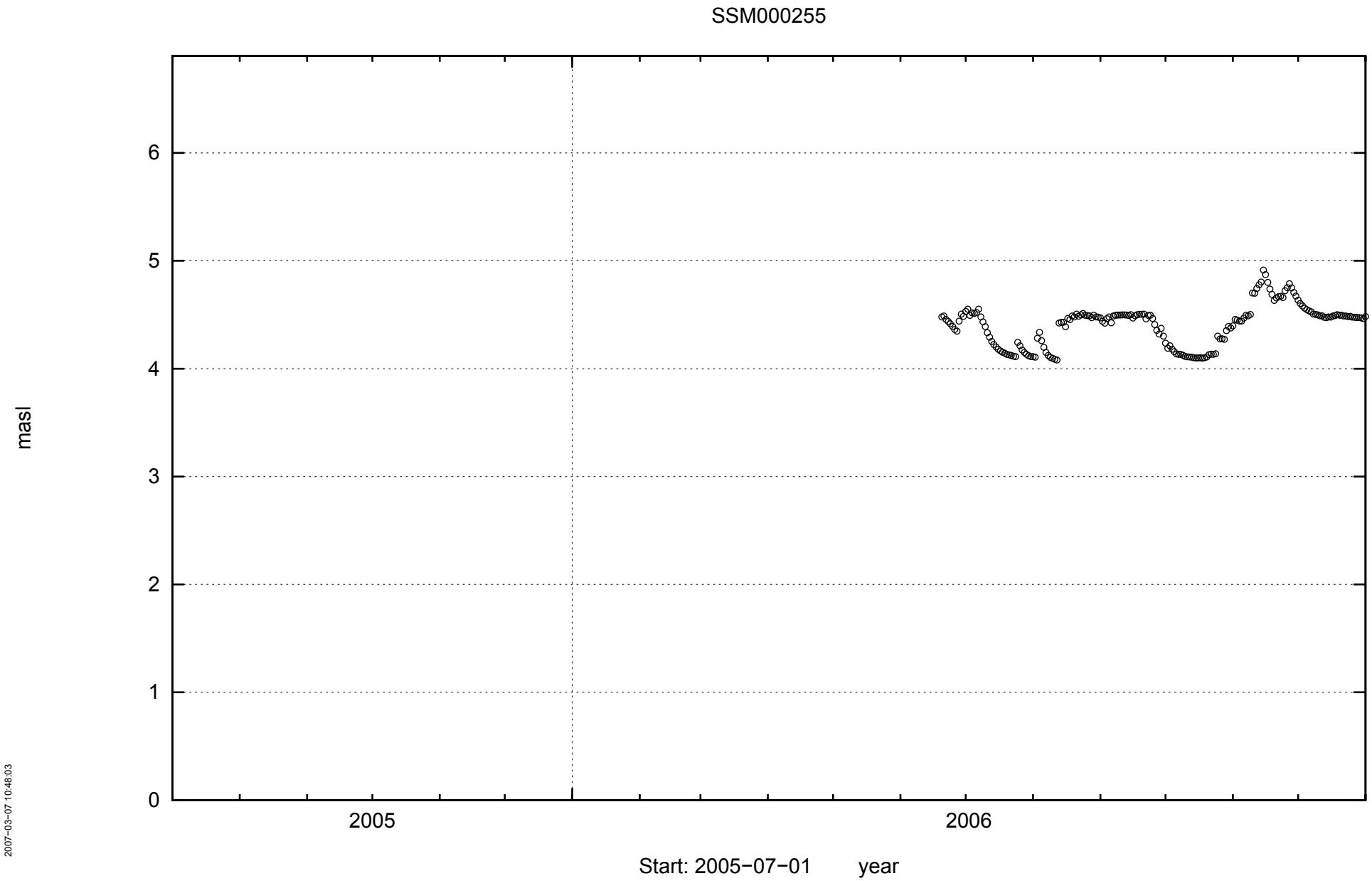
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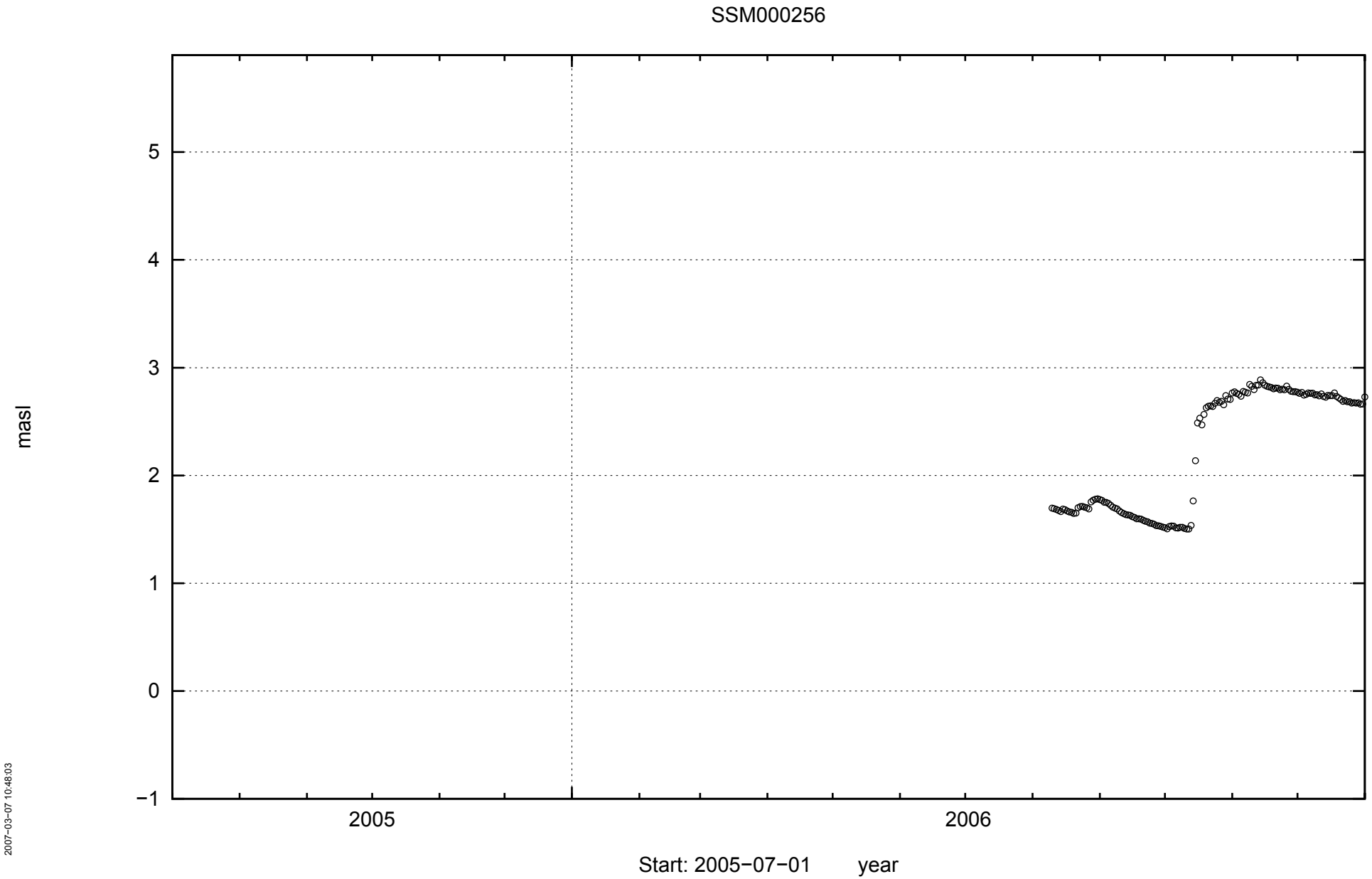
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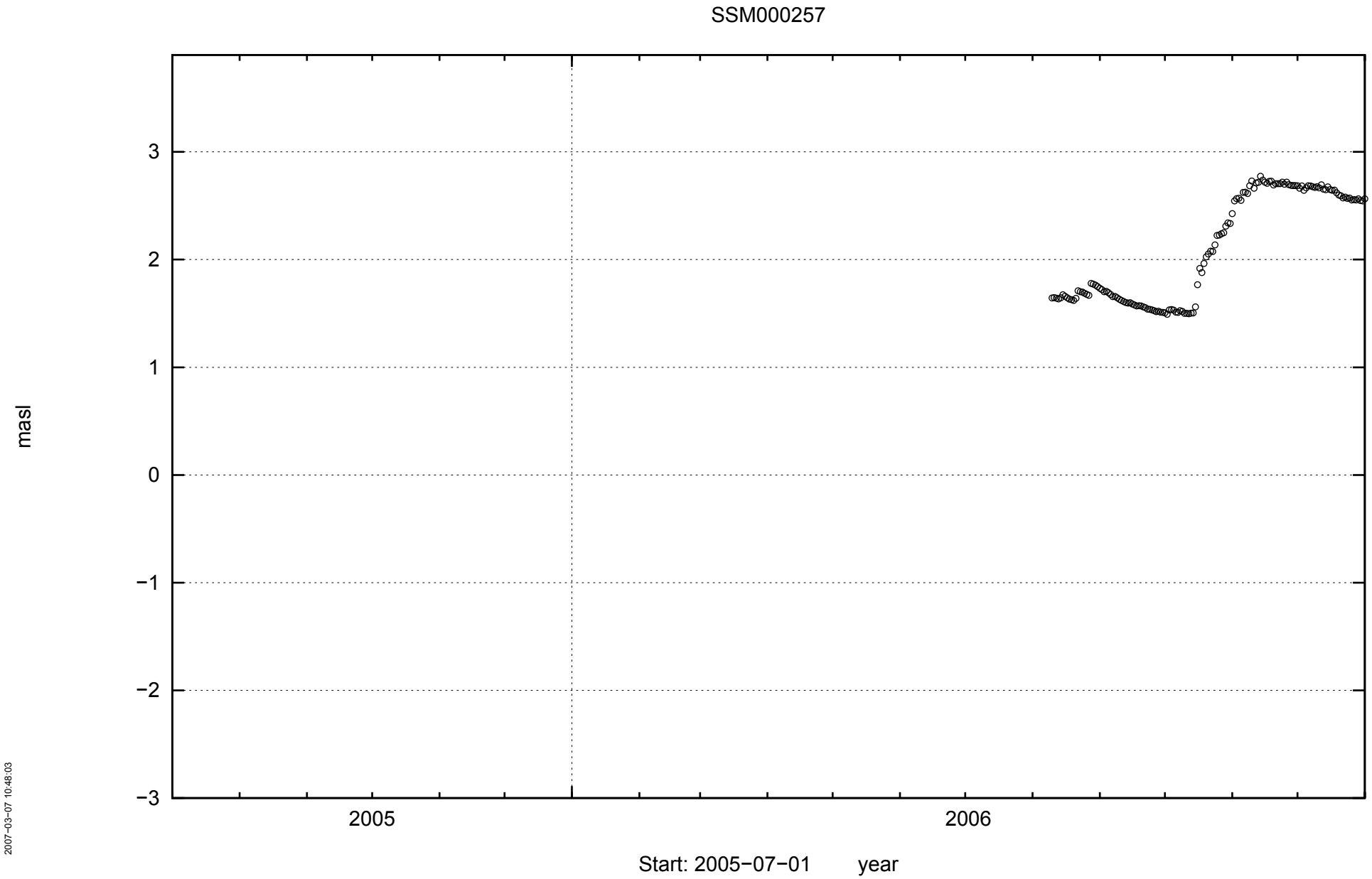
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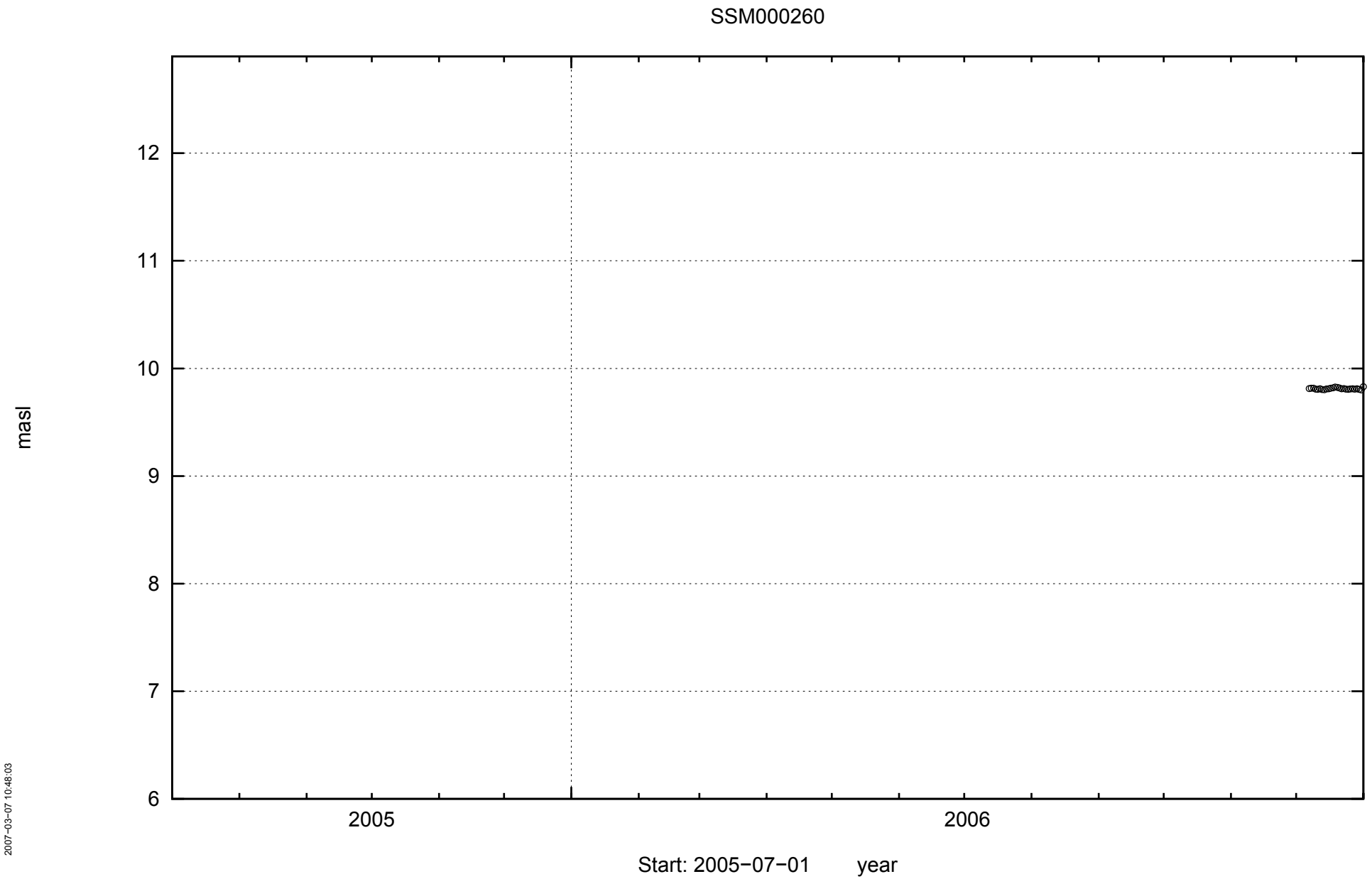
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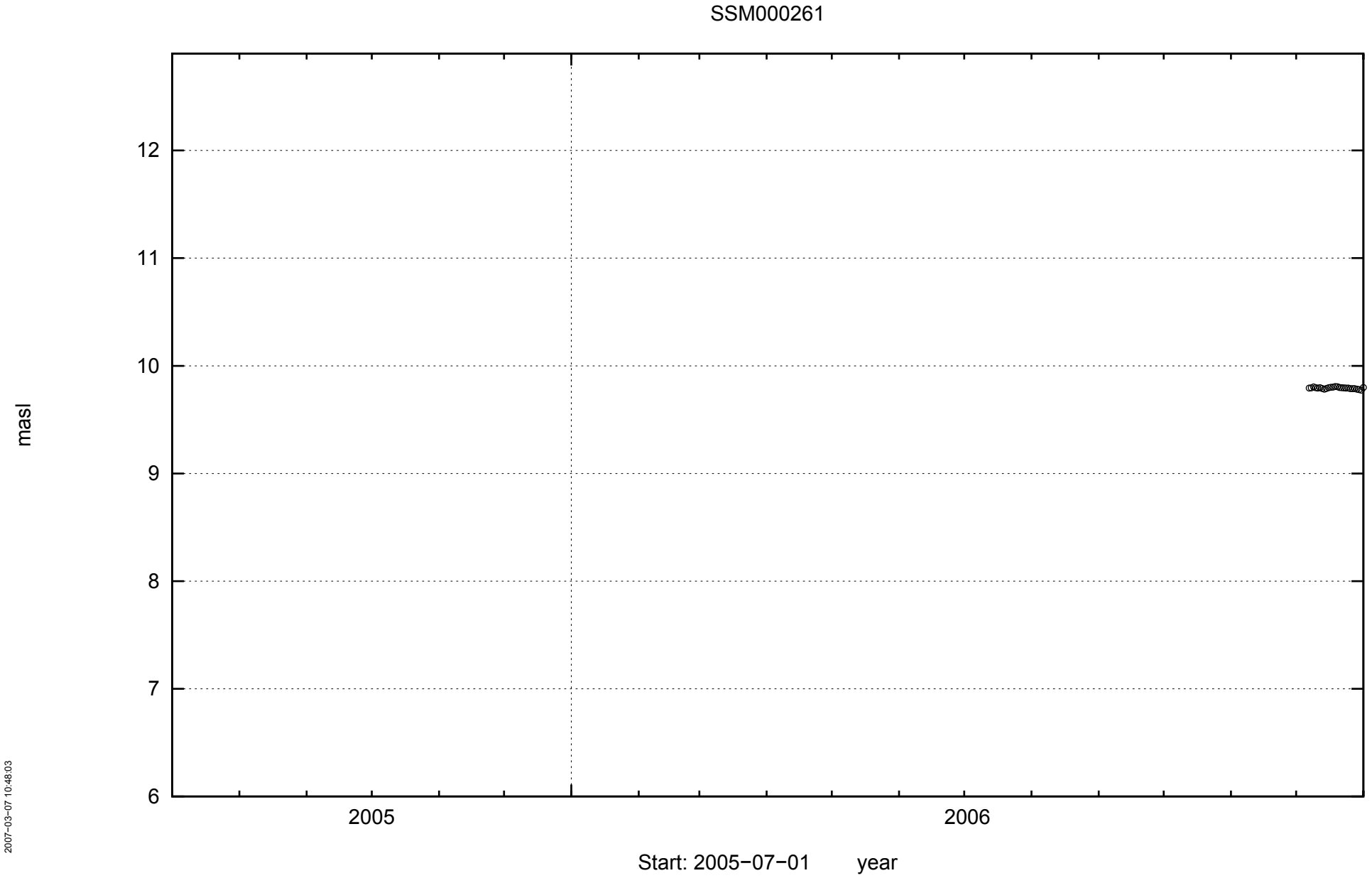
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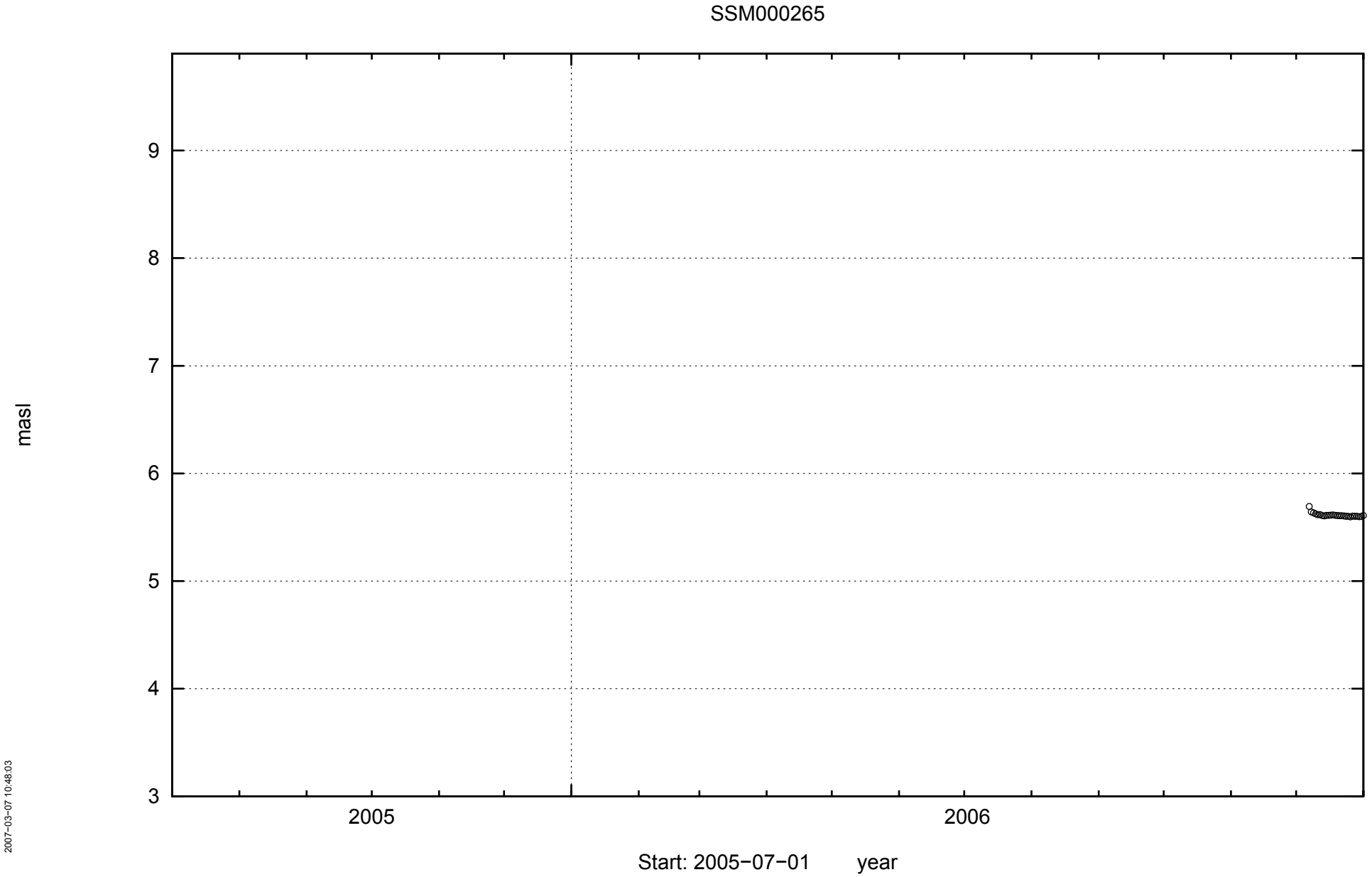
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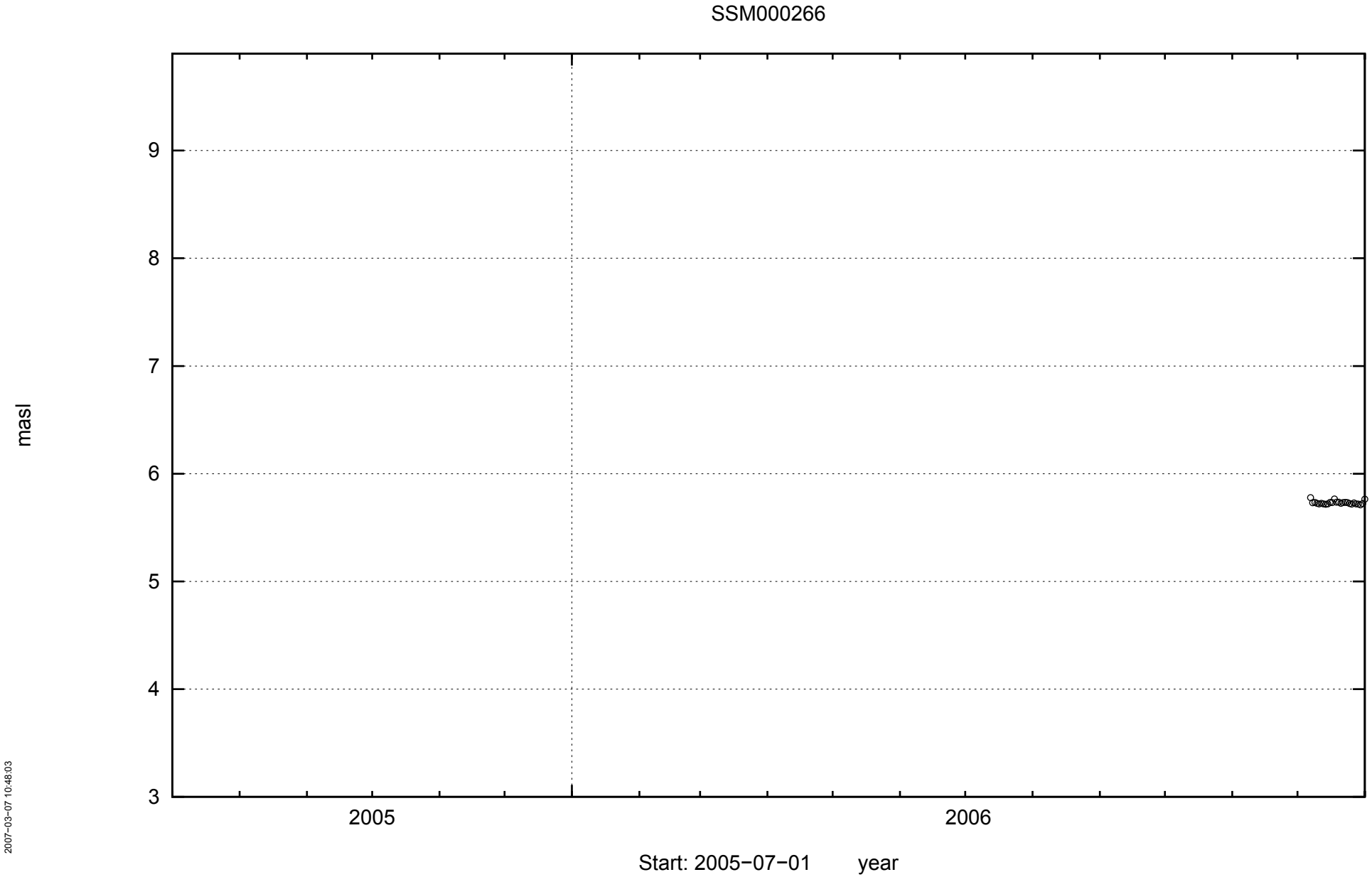
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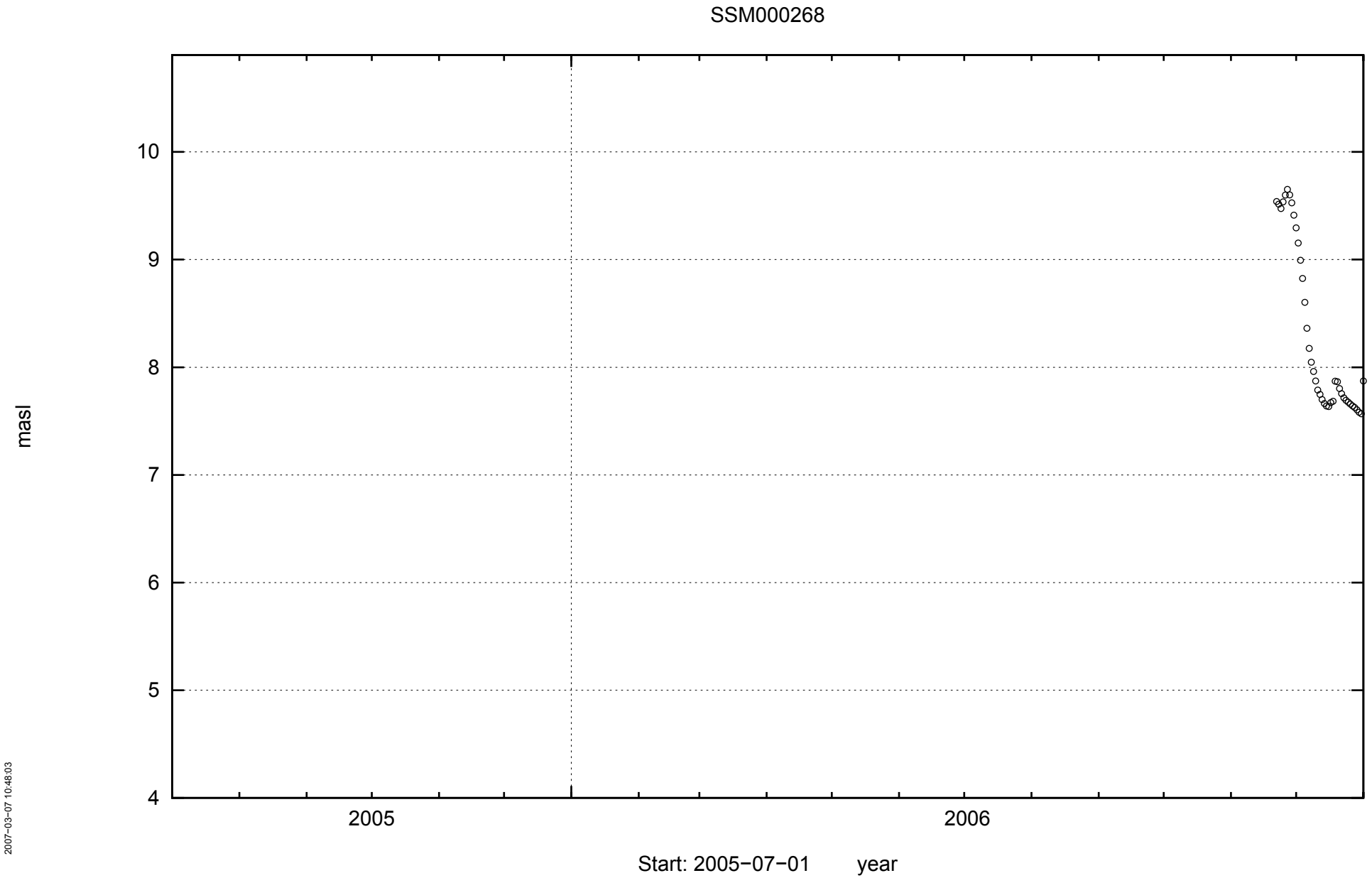
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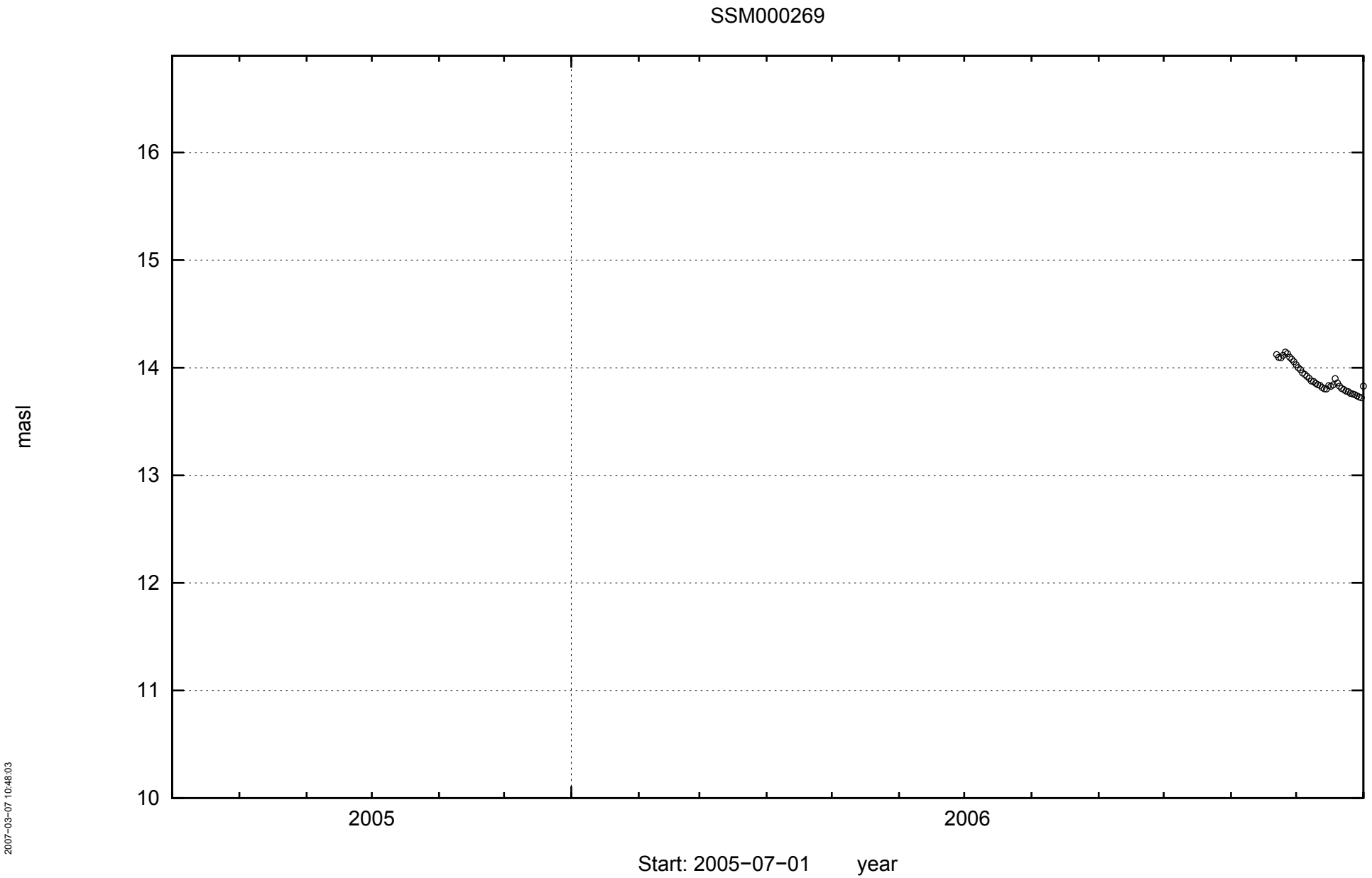
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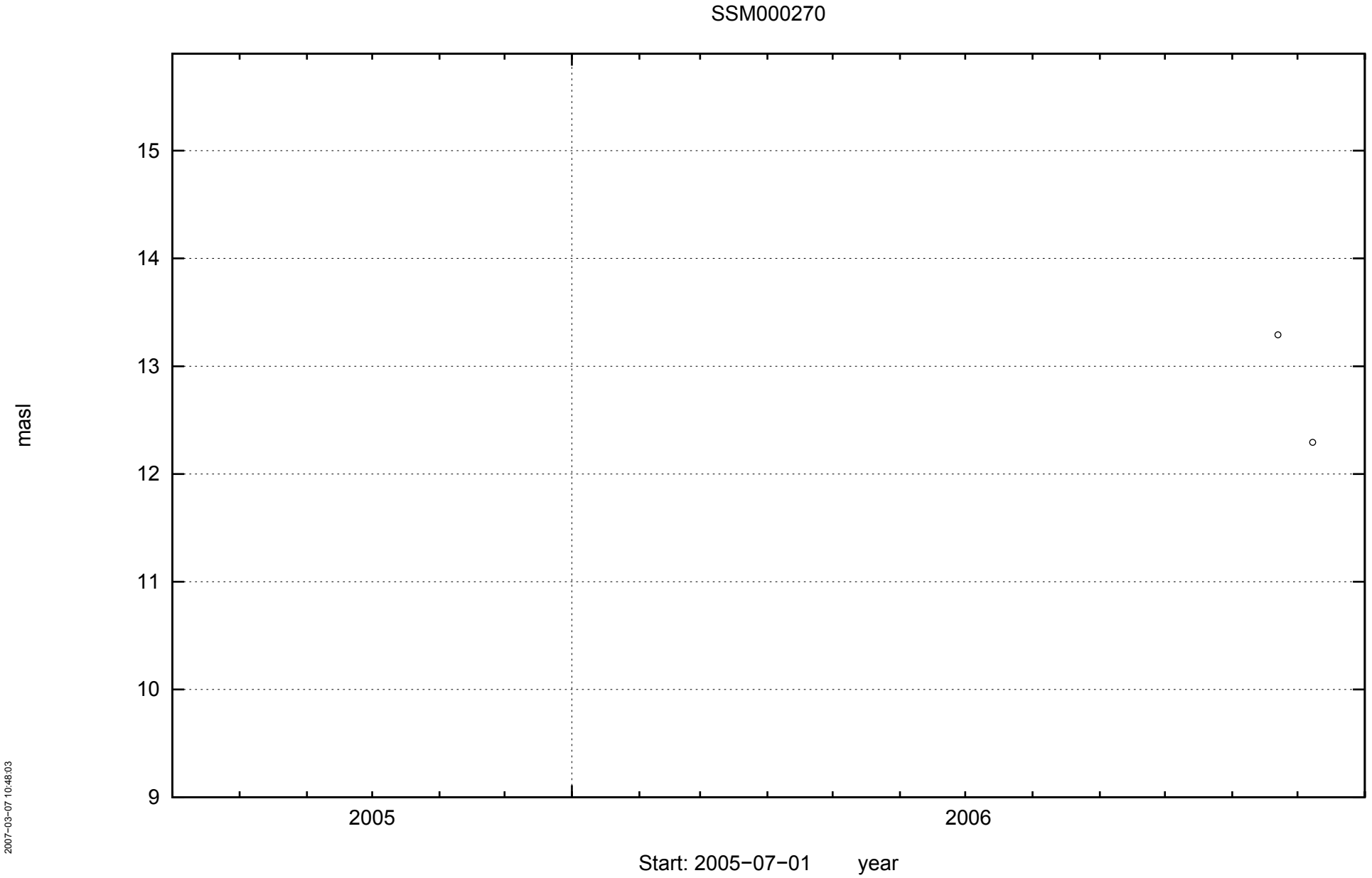
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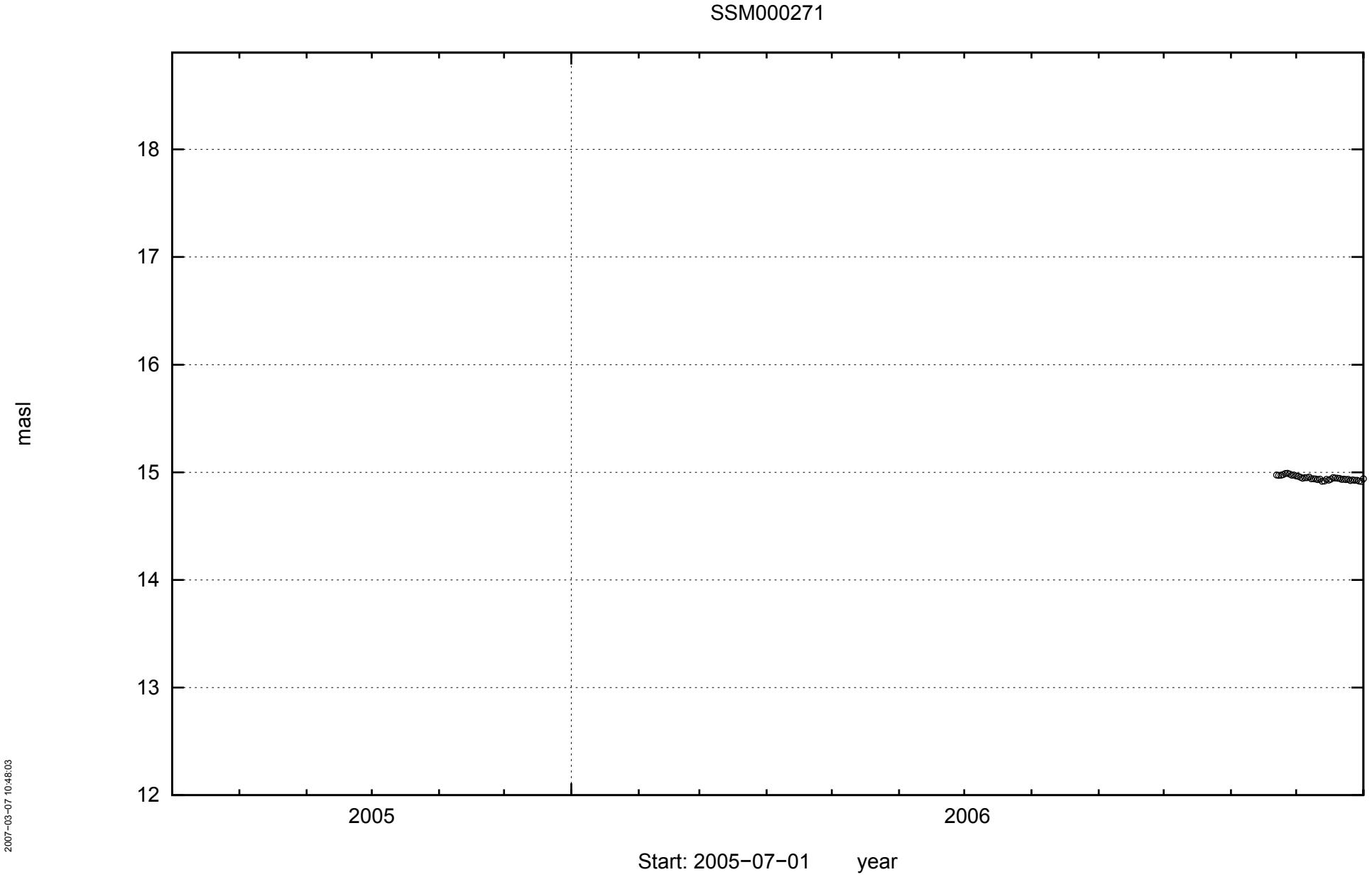
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Appendix 2

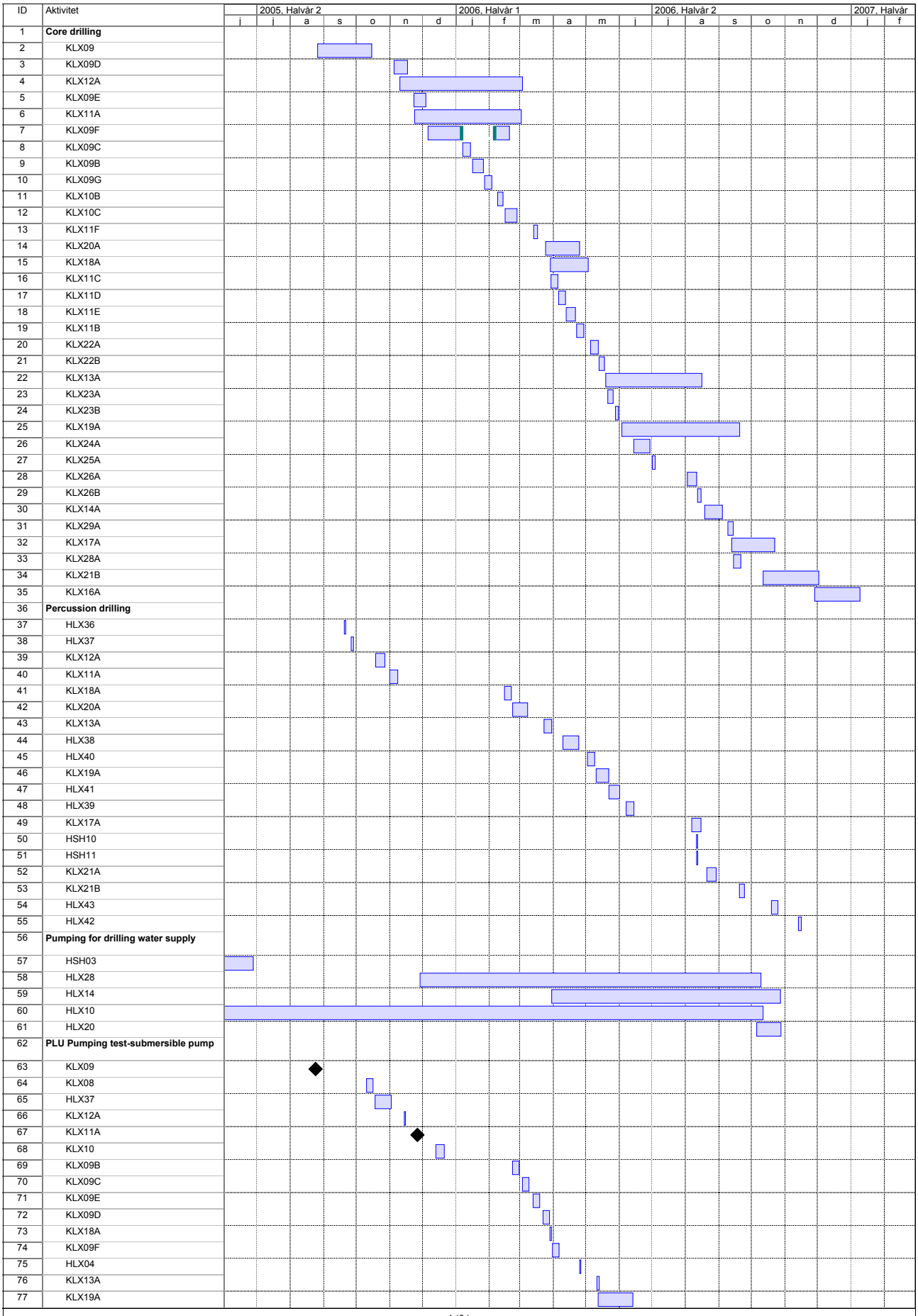
Hydraulic disturbances in boreholes – GANTT chart

The extensive geoscientific investigation programme that took place during the period for this monitoring report generated fluctuations in groundwater level to various degree.

This appendix compiles, in chronological order, the dates when major hydraulic disturbances took place in boreholes. A word of caution, the compilation endeavoured to be complete but does nevertheless not necessarily constitute all disturbances.

Hydraulic disturbances:

- **Core drilling**: While drilling of core boreholes both flushing and air-lift pumping takes place.
- **Percussion drilling**: Is done with DTH-technology which involves constantly flushing out the boreholes water with air.
- **Pumping test/pump test**: Conventional test for assessment of aquifer properties, including interference testing, flow logging (spinner and difference flow logging).
- **Pumping for drilling water supply**: While core drilling large amount of drilling fluid is required, water taken from a percussion hole serve this purpose.
- **Injection test**: Constant head injection test of relatively short duration, are done in sections along the complete borehole length for characterisation of aquifer properties.
- **Pumping for water supply**: A site investigation borehole (HLX22) was taken into production as a water supply well to the village of Lilla Laxemar.
- **Water pumping**: Performed in soil wells primarily for water sampling purposes. It is mostly performed with a suction pump.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3 KLX09D
4 KLX12A
5 KLX09E
6 KLX11A
7 KLX09F
8 KLX09C
9 KLX09B
10 KLX09G
11 KLX10B
12 KLX10C
13 KLX11F
14 KLX20A
15 KLX18A
16 KLX11C
17 KLX11D
18 KLX11E
19 KLX11B
20 KLX22A
21 KLX22B
22 KLX13A
23 KLX23A
24 KLX23B
25 KLX19A
26 KLX24A
27 KLX25A
28 KLX26A
29 KLX26B
30 KLX14A
31 KLX29A
32 KLX17A
33 KLX28A
34 KLX21B
35 KLX16A
36 Percussion drilling
37 HLX36
38 HLX37
39 KLX12A
40 KLX11A
41 KLX18A
42 KLX20A
43 KLX13A
44 HLX38
45 HLX40
46 KLX19A
47 HLX41
48 HLX39
49 KLX17A
50 HSH10
51 HSH11
52 KLX21A
53 KLX21B
54 HLX43
55 HLX42
56 Pumping for drilling water supply
57 HSH03
58 HLX28
59 HLX14
60 HLX10
61 HLX20
62 PLU Pumping test-submersible pump
63 KLX09
64 KLX08
65 HLX37
66 KLX12A
67 KLX11A
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69 KLX09B
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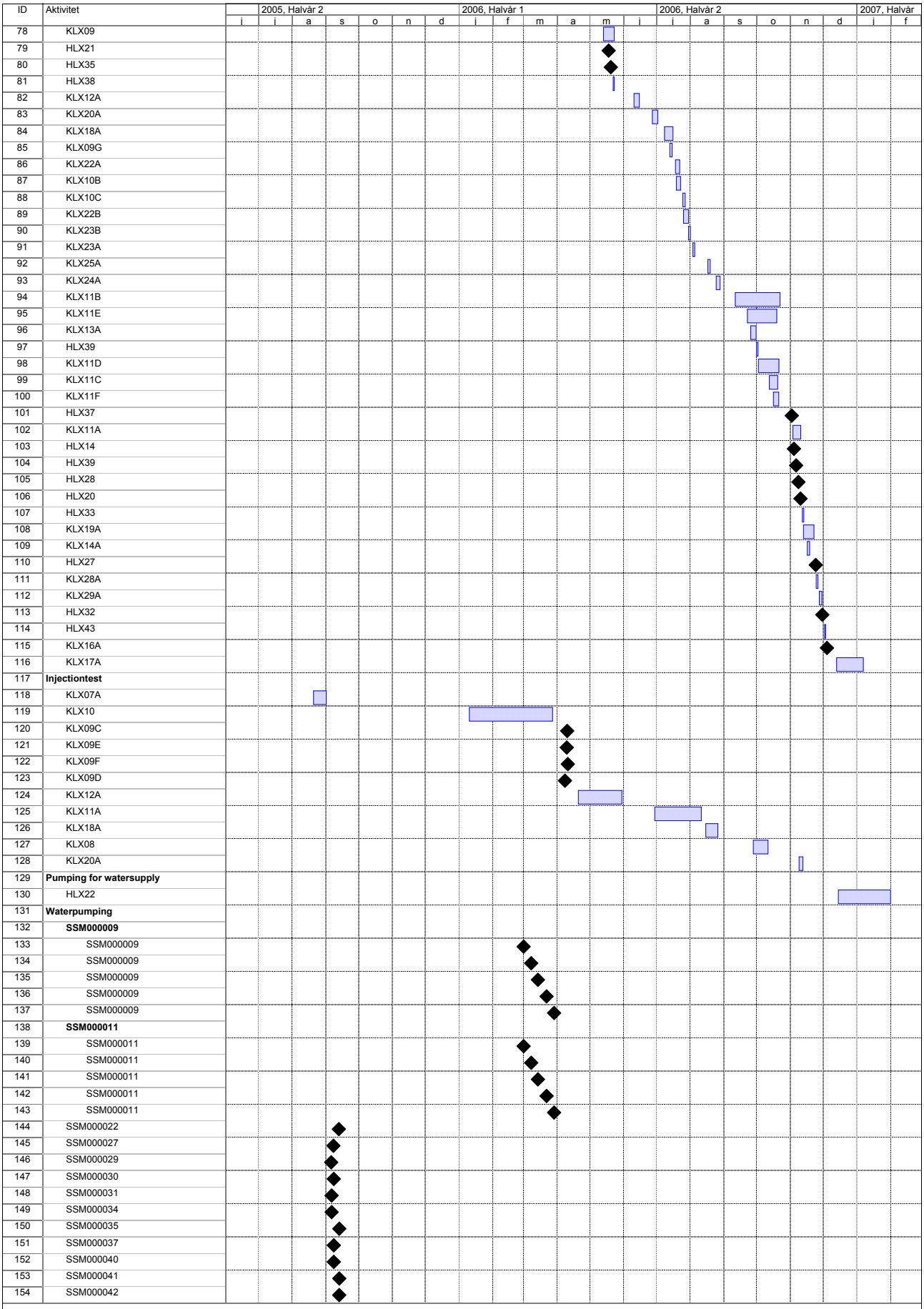
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123 KLX09D
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126 KLX18A
127 KLX08
128 KLX20A
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130 HLX22
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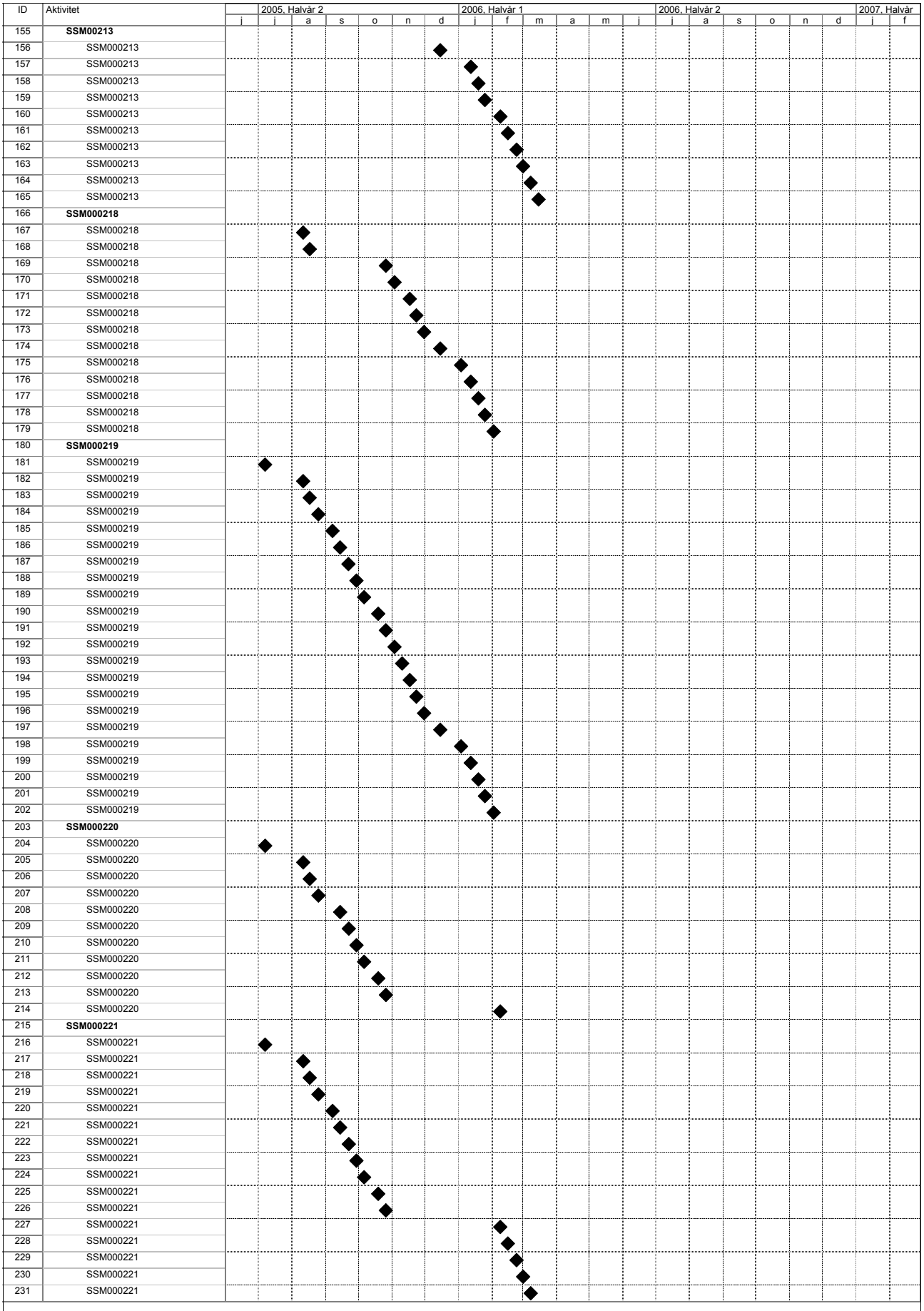
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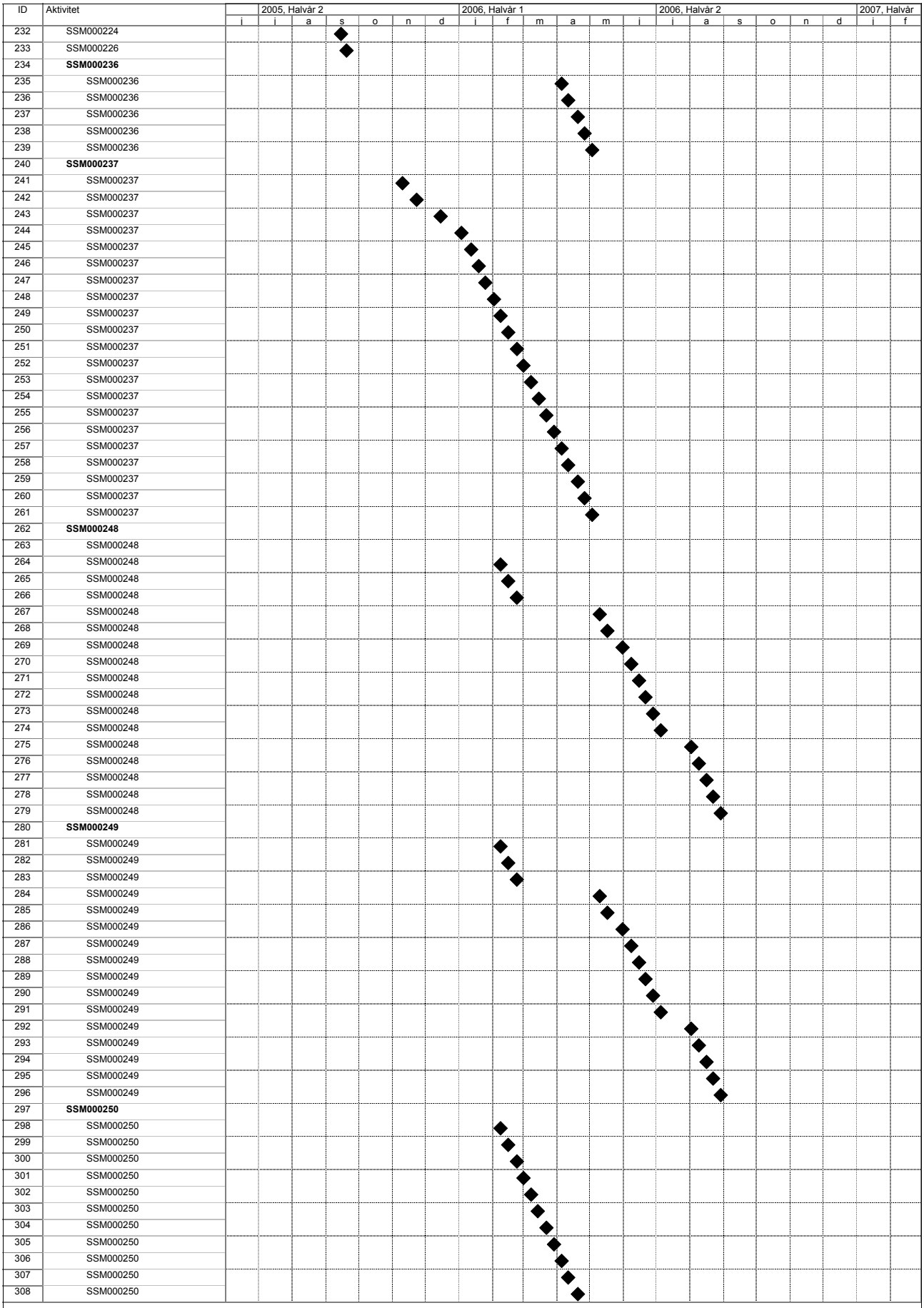
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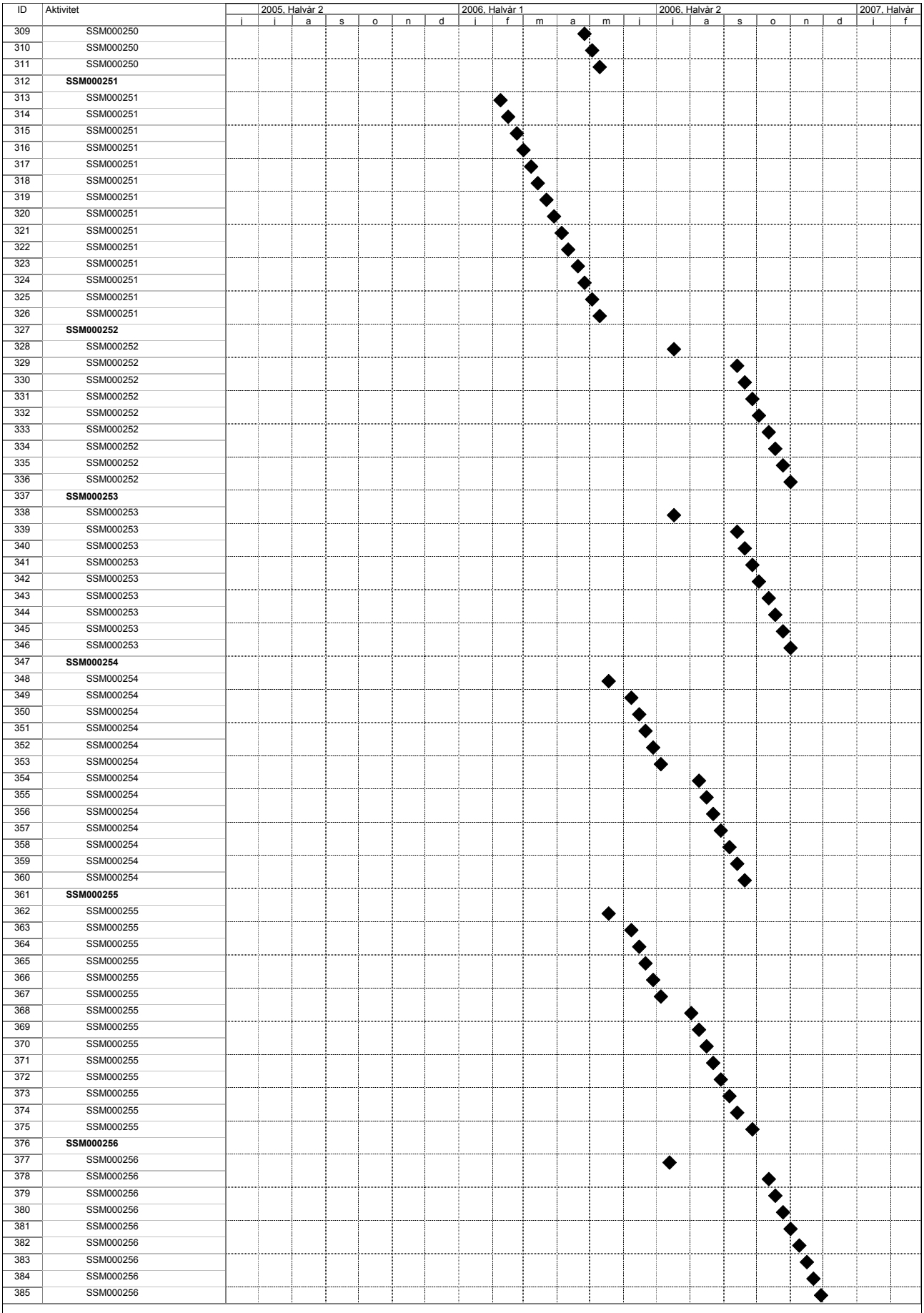
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