P-05-282

Oskarshamn site investigation

Groundwater monitoring program

Report for November 2004 – June 2005

Göran Nyberg, Eva Wass
GEOSIGMA

December 2005

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-05-282

Oskarshamn site investigation

Groundwater monitoring program

Report for November 2004 – June 2005

Göran Nyberg, Eva Wass
GEOSIGMA

December 2005

Keywords: Groundwater, Borehole, Instrumentation, Measurement methods, Monitoring, Oskarshamn.

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 November 2004 until June 2005 and consists 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 is collected by means of different transducers connected to different types of data loggers: Minitroll, 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 is 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 November 2004 – June 2005 (daily values for each section) are presented in the Appendix. 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 november 2004 till och med juni 2005 och består av grundvattennivå i borrhål. Inom ramen för platsundersökningarna moniteras aven 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, 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 november 2004 till juni 2005 (en datapunkt per sektion och 24 timmar redovisas) visas i Appendix. Ursprungsresultatet lagras i primärdatabasen SICADA. Data från denna databas kan användas för vidare analyser.

Aktiviteten har utförts i överensstämmelse med aktivitetsplanen och metodbeskrivningen.

Contents

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 400-04-095 and SKB AP PS 400-05-016. 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 Chapter 4.4.

Data presented in this report include groundwater levels collected during November 2004 – June 2005.

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 2004	AP PS 400-04-095	1.0
Platsundersökning i Oskarshamn – Grundvattenmonitering 2005	AP PS 400-05-016	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: december 2002 – november 2004	PIR-04-28	
Platsundersökning i Oskarshamn – Kvalitetskontroll av grundvattenmonitering Period: november 2004 – januari 2005	PIR-05-01	
Platsundersökning i Oskarshamn – Kvalitetskontroll av grundvattenmonitering Period: februari–maj 2005	PIR-05-12	
Platsundersökning i Oskarshamn – Kvalitetskontroll av grundvattenmonitering Period: maj–juli 2005	PIR-05-32	

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 at the end of June 2005 in the Oskarshamn site investigation:

- 14 core-drilled boreholes,
- 29 percussion-drilled boreholes,
- 21 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.

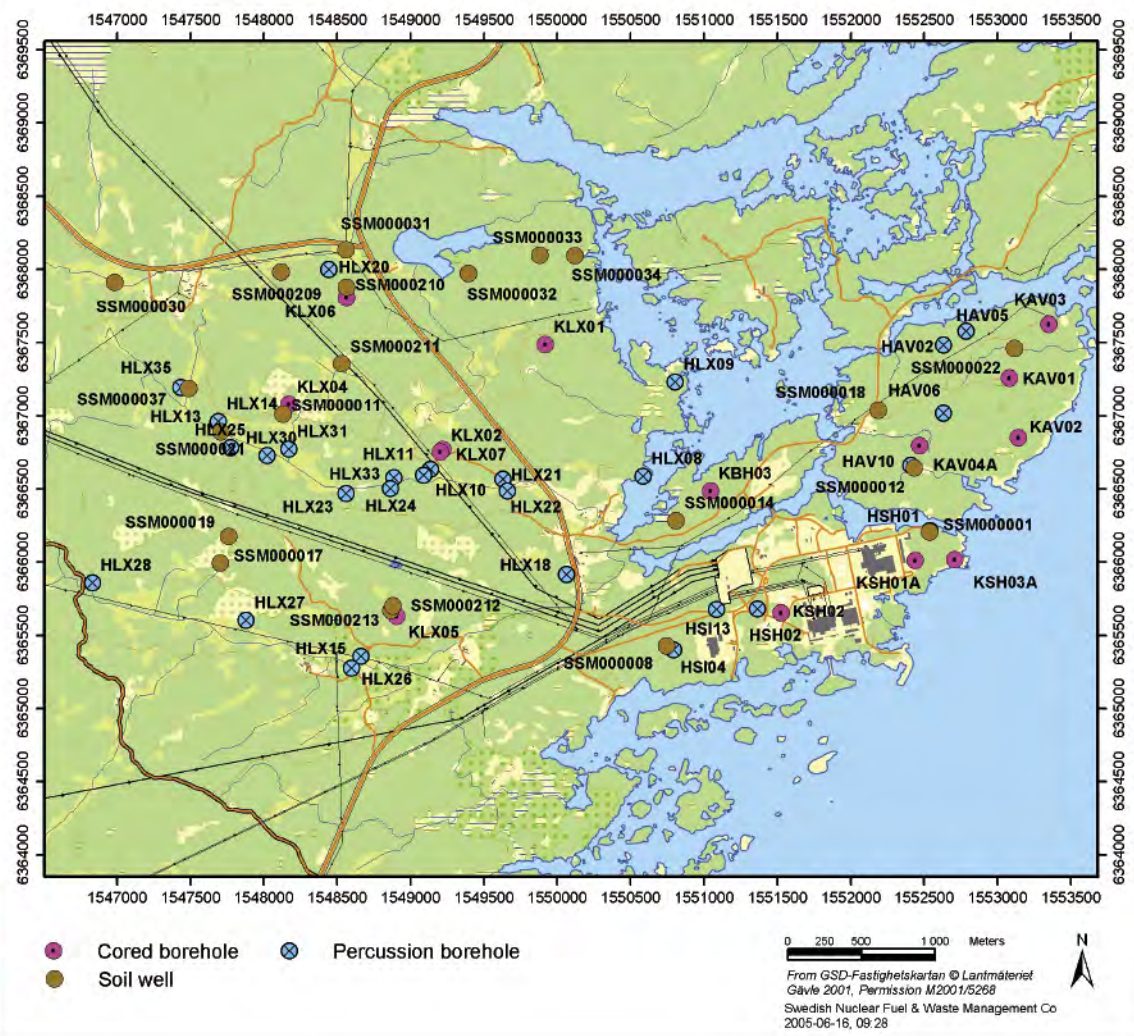


Figure 2-1. *General overview of the Oskarshamn site investigation area showing the location of monitored boreholes and soil wells.*

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	?	
HAV05	100.0	–54.5	6.86	1987-07-28	1.00	
HAV06	100.0	–59.5	12.42	1987-07-30	1.20	
HAV10	100.0	–68.5	2.23	2003-10-22	11.90	
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	Drill-water well 04-03-18 - *
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	
HLX18	181.2	–57.6	4.04	2004-07-06	15.03	
HLX20	202.2	–60.4	11.18	2004-06-21	9.03	Drill-water well 04-10-06 – 05-04-06 *
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	
HLX33	202.1	–58.8	12.20	2004-12-20	9.03	
HLX35	151.8	–59.9	14.44	2005-06-02	6.03	
HSH01	200.0	–70.0	2.86	2002-07-02	12.00	
HSH02	200.0	–80.1	6.65	2002-07-08	12.00	
HSI04	37.0	–58.5	6.63	1995-02-02	?	
HSI13	4.0	–90.0	5.54	1980-02-02	?	
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	1004.0	–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		
	1077.99	–85.3	16.77	1990-08-04	101.30	
KLX02	1700.5	–85.0	18.40	1992-11-29	202.95	
KLX04	993.49	–84.7	24.09	2004-06-28	12.24	
KLX05	1000.16	65.1	17.63	2005-01-22	15.00	
KLX06	994.94	–65.0	17.68	2004-11-25	11.88	
KLX07	844.73	–60.0	18.47	2005-05-04	11.80	
KSH01A	1003.0	–80.4	5.32	2002-12-18	12.10	
KSH02	1001.11	–85.7	5.48	2003-06-11	80.00	
KSH03A	1000.7	–59.1	4.15	2003-11-07	100.05	

Borehole	**Borehole length (m)**	**Inclination at ground (°)**	**Elevation at TOC (m.a.s.l.)**	**Drilling completed**	**Length of casing** (m)	Comment
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		
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		
SSM000037	5.95	–86.4	12.70	2004-06-22		
SSM000209	4.5	–87.8	10.85	2004-06-29		
SSM000210	4.1	–87.7	11.31	2004-06-28		
SSM000211	5.2	–83.0	15.27	2004-06-30		
SSM000212	4.1	–87.8	13.58	2004-07-05		
SSM000213	4.0	–85.0	12.38	2004-07-06		

* During this period water level data is stored in the DMS (Drilling Monitoring System) and is not presented in this report.

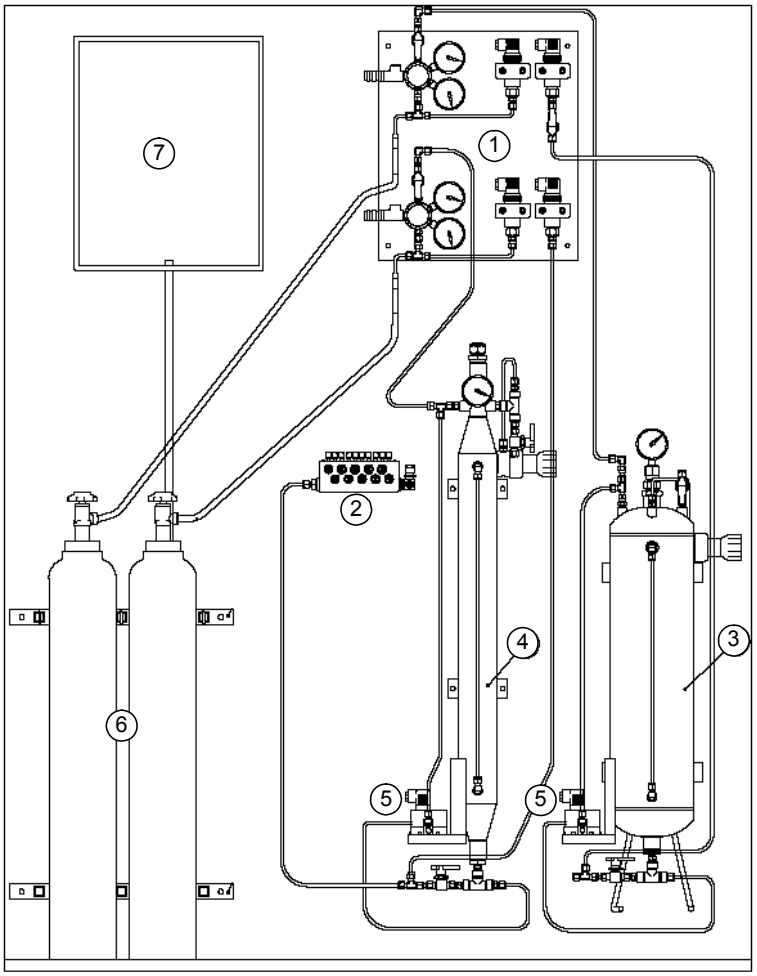
3 Equipment

3.1 Description

A drawing of the ground surface equipment used for percussion and core boreholes is shown in Figure 3-1.

A drawing of the borehole equipment for permanent instrumentation in core boreholes is presented in Figure 3-2. Instrumentation in percussion boreholes is shown in Figure 3-3.

In open boreholes, a transducer or data logger is submerged in the groundwater without any other equipment. No drawing is presented.



Regulator panel with pressure transducers for monitoring packer pressure in borehole packers and mini-packers (1)

Branching unit for mini-packer system (2)

Pressure vessels for borehole packer (3) and mini-packer system (4)

Differential pressure transducers measuring level in pressure vessels (5)

Gas bottles for borehole packer and mini-packer system (6)

Electrical distribution box (7)

Figure 3-1. *Example of ground surface equipment for percussion and core boreholes.*

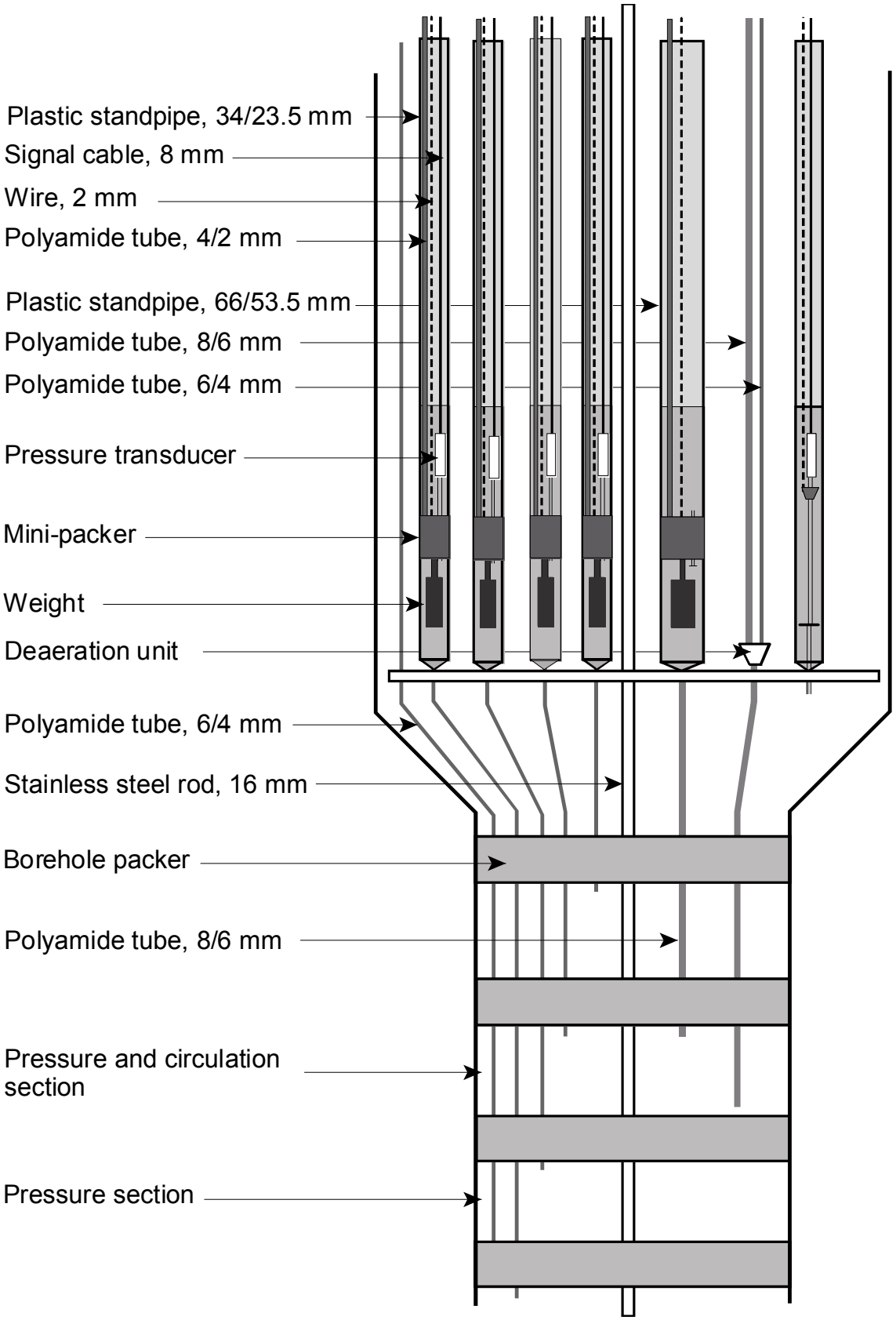


Figure 3-2. *Example of permanent instrumentation in core boreholes with a circulation section.*

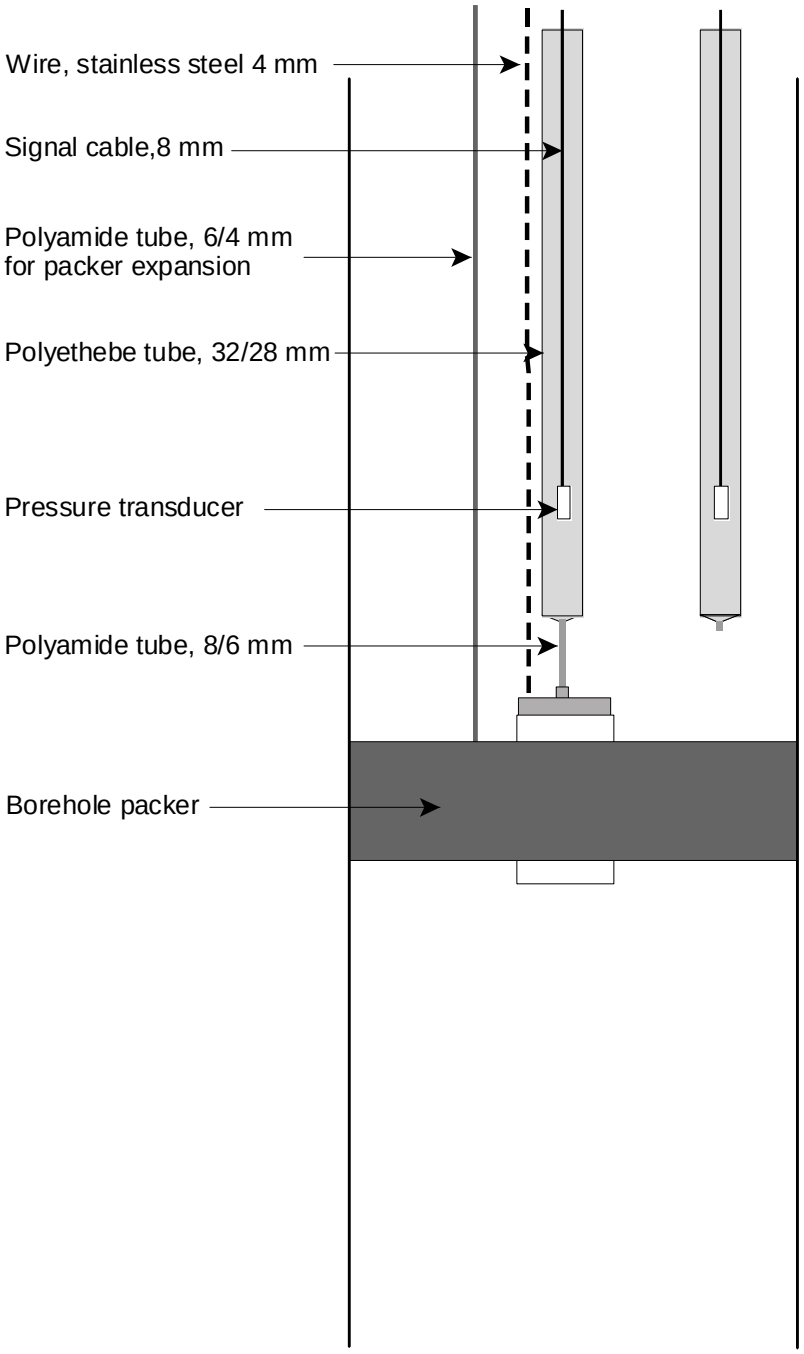


Figure 3-3. *Example of instrumentation in percussion boreholes.*

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 3-4. 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. 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.

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 cored boreholes.

Monitored data which has been quality assured is to be transferred quarterly to the site characterization database, SICADA.

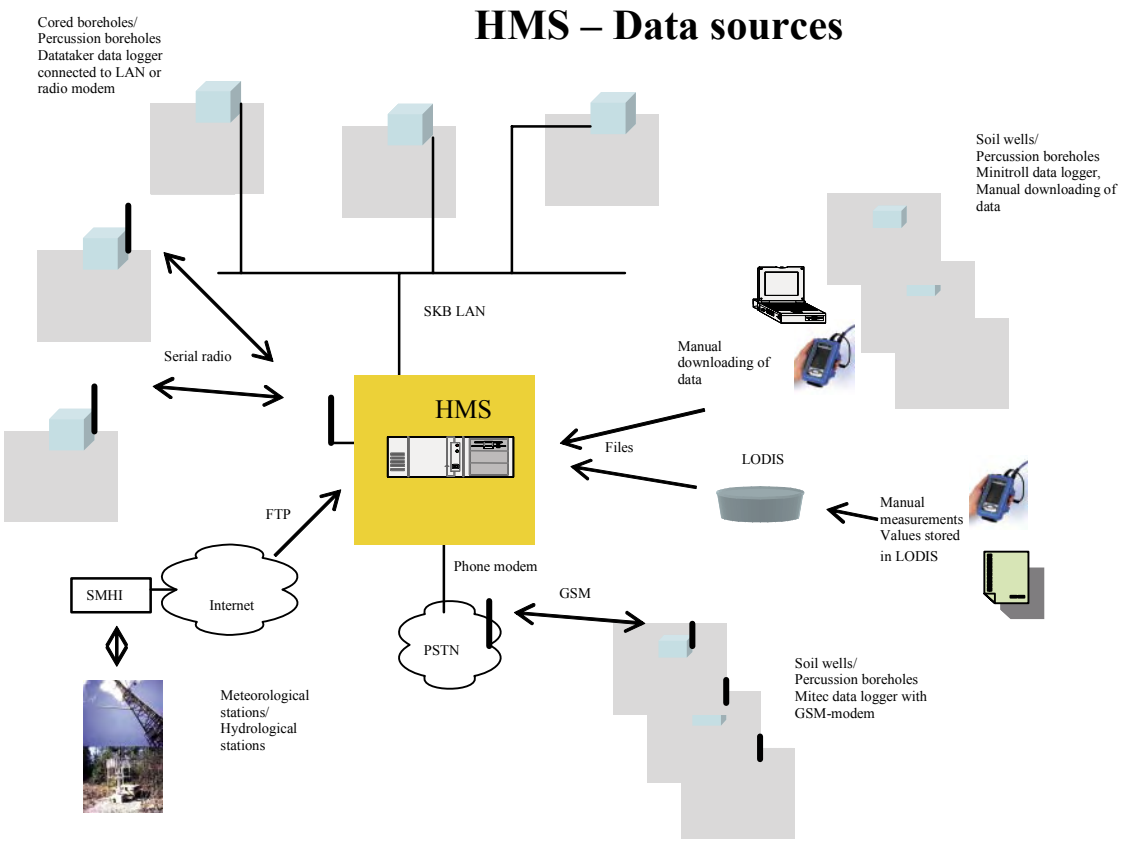


Figure 3-4. *HMS data sources.*

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.

In some boreholes, the recording interval is shortened during hydraulic test periods.

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 is 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 correspond with the manual levelling data (see Section 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 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

Annual diagrams of groundwater levels are presented in the Appendix. All levels in the diagrams are given as meters 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.

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
HAV05	1	2004-05-17	2004-11-18	16.0	100.0	
	2	2004-05-17	2004-11-18	0.0	15.0	Not monitored
HAV06	1	2004-05-04		17.0	100.0	
	2	2004-05-04		0.0	16.0	
HAV10	1	2004-02-26	2004-11-18	0.0	100.0	
HLX08	1	2004-06-21		0.0	40.0	
HLX09	1	2004-05-05		17.0	151.0	
	2	2004-05-05		0.0	16.0	
HLX10	1	n/a		3.0[1/]	85.0	Manual levelling when used as drill-water well
HLX11	1	2004-05-06		14.0	70.0	
	2	2004-05-06		0.0	13.0	
HLX13	1	2004-02-27		0.0	202.2	
HLX14	1	2004-11-15		11.0	115.9	
	2	2004-11-15		0.0	10.0	Not monitored
HLX15	1	2004-04-29	2005-02-04	0.0	151.9	
HLX18	1	2004-12-20		91.0	181.2	
	2	2004-12-20		0.0	90.0	
HLX20	1	2005-04-07	2005-08-24	0.0	202.0	
HLX21	1	2004-09-02	2004-11-03	0.0	150.3	

Borehole	Section no	Section installed from	to	Borehole Length ** from (m)	to (m)	Comment
	1	2004-11-03	2004-12-15	11.0	150.2	
	2	2004-11-03	2004-12-15	0.0	10.0	Not monitored
	1	2004-12-16		81.0	150.2	
	2	2004-12-16		0.0	80.0	
HLX22	1	2004-08-26	2004-12-17	0.0	163.2	
	1	2004-12-17		86.0	163.2	
	2	2004-12-17		0.0	85.0	
HLX23	1	2004-12-10	2005-06-28	61.0	160.2	
	2	2004-12-10	2005-06-28	0.0	60.0	
	1	2005-06-28	2005-07-05	0.0	160.2	
	1	2005-07-05		61.0	160.2	
	2	2005-07-05		0.0	60.0	
HLX24	1	2004-09-09	2004-11-04	0.0	175.2	
	1	2004-11-04	2004-12-10	11.0	175.2	
	2	2004-11-04	2004-12-10	0.0	10.0	Not monitored
	1	2004-12-10	2005-03-27	41.0	175.2	
	2	2004-12-10	2005-03-27	0.0	40.0	
	1	2005-03-27	2005-04-08	0.0	175.2	
	1	2005-04-08		41.0	175.2	
	2	2005-04-08		0.0	40.0	
HLX25	1	2004-11-03	2004-11-17	16.0	202.5	
	2	2004-11-03	2004-11-17	0.0	15.0	Not monitored
	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	2004-09-22		0.0	164.7	
HLX28	1	2004-10-02		0.0	154.2	
HLX30	1	2004-12-01	2004-12-16	11.0	164.4	
	2	2004-12-01	2004-12-16	0.0	10.0	Not monitored
	1	2004-12-16		101.0	164.4	
	2	2004-12-16		0.0	100.0	
HLX31	1	2004-12-17		101.0	133.5	
	2	2004-12-17		0.0	100.0	
HLX33	1	2004-12-22	2005-03-30	31.0	202.1	
	2	2004-12-22	2005-03-30	0.0	30.0	
	1	2005-03-30	2005-04-06	0.0	202.1	
	1	2005-04-06	2005-05-04	31.0	202.1	
	2	2005-04-06	2005-05-04	0.0	30.0	
	1	2005-05-04	2005-05-09	0.0	202.1	
	1	2005-05-09		31.0	202.1	
	2	2005-05-09		0.0	30.0	
HLX35	1	2005-06-03		65.0	151.8	
	2	2005-06-03		0.0	64.0	
HSH01	1	2004-04-01		25.0	200.0	
	2	2004-04-01		0.0	24.0	

Borehole	Section no	Section installed from	to	Borehole Length ** from (m)	to (m)	Comment
HSH02	1	2003-06-06		0.0	200.0	
HSI04	1	2004-06-23		0.0	37.0	
HSI13	1	2004-06-23		0.0	4.0	
KAV01	1	2004-04-19	2005-05-10	83.0	757.31	
	2	2004-04-19	2005-05-10	0.0	82.0	
	1	2005-05-10		0.0	757.31	
KAV02	1	2004-05-04	2005-01-14	17.0	97.1	
	2	2004-05-04	2005-01-14	0.0	16.0	
	1	2005-01-14		0.0	97.1	
KAV03	1	2004-05-11	2004-07-01	16.0	248.4	
	2	2004-05-11	2004-07-01	0.0	15.0	Not monitored
	1	2004-07-01		0.0	248.4	
KAV04A	1	2005-04-27		675.0	1000.0	
	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	
KLX01	1	2004-10-26		705.0	1077.99	
	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		1165.0	1700.5	
	2	2004-11-15		1145.0	1164.0	
	3	2004-11-15		718.0	1144.0	
	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	
KLX04	1	2004-06-28	2005-01-29	0.0	993.49	
	1	2005-01-29		898.0	1000.0	
	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	n/a	2005-01-31	n/a	n/a	Manual levelling during drilling
KLX06	1	n/a	2005-07-05	n/a	n/a	Manual levelling during drilling
	1	2005-07-05		761.0	1000.0	
	2	2005-07-05		571.0	760.0	
	3	2005-07-05		554.0	570.0	
	4	2005-07-05		411.0	553.0	
	5	2005-07-05		276.0	410.0	
	6	2005-07-05		256.0	275.0	

Borehole	Section no	Section installed from	to	Borehole Length ** from (m)	to (m)	Comment
	7	2005-07-05		146.0	255.0	
	8	2005-07-05		0.0	145.0	
KLX07	1	n/a	2005-05-26	n/a	n/a	Manual levelling during drilling
	1	2005-05-26	2005-06-04	157.0	844.73	
	2	2005-05-26	2005-06-04	103.0	156.0	
	3	2005-05-26	2005-06-04	0.0	102.0	
KSH01A	1	2004-10-07		800.0	1003.0	
	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	1000.7	
	2	2004-06-01		180.65	280.15	
	3	2004-06-01		0.0	179.65	
SSM000001	1	2002-10-08		0.0	3.1*	
	screen			2.0	3.0	From report P-03-80
SSM000008	1	2003-12-08		0.0	5.1*	
	screen			3.0	5.0	From report P-04-121
SSM000011	1	2004-01-29		0.0	3.1*	
	screen			1.0	3.0	From report P-04-121
SSM000012	1	2004-01-22		0.0	6.1*	
	screen			5.0	6.0	From report P-04-121
SSM000014	1	2003-12-09		0.0	3.1*	
	screen			2.0	3.0	From report P-04-121
SSM000017	1	2004-05-04		0.0	2.1*	See also field notes
	screen			1.0	2.0	From field notes
SSM000018	1	2003-12-11		0.0	3.1*	
	screen			2.0	3.0	From report P-04-121
SSM000019	1	2004-05-04		0.0	3.1*	See also field notes
	screen			2.0	3.0	From field notes
SSM000021	1	2004-05-04		0.0	4.1*	See also field notes
	screen			3.0	4.0	From field notes
SSM000022	1	2004-01-12		0.0	7.1*	
	screen			5.0	7.0	From report P-04-121
SSM000030		2004-09-10		0.0	5.1*	

Borehole	Section no	Section installed from	to	Borehole Length ** from (m)	to (m)	Comment
	screen			4.0	5.0	From report P-04-317
SSM000031		2004-06-10		0.0	4.1*	
	screen			3.0	4.0	From report P-04-317
SSM000032		2004-06-15		0.0	4.1*	
	screen			3.0	4.0	From report P-04-317
SSM000033		2004-06-15		0.0	2.2*	
	screen			1.0	2.0	From report P-04-317
SSM000034		2004-06-16		0.0	4.1*	
	screen			3.0	4.0	From report P-04-317
SSM000037		2004-06-22		0.0	4.1*	
	screen			3.0	4.0	From report P-04-317
SSM000209	1	2004-06-29		0.0	4.1*	
	screen			2.0	4.0	From report P-04-317
SSM000210	1	2004-06-28		0.0	4.1*	
	screen			2.0	4.0	From report P-04-317
SSM000211	1	2004-06-30		0.0	4.1*	
	screen			2.0	3.0	From report P-04-317
SSM000212	1	2004-07-05		0.0	2.1*	
	screen			1.0	2.0	From report P-04-317
SSM000213	1	2004-07-06		0.0	2.1*	
	screen			1.0	2.0	From report P-04-317

* 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.

1/ :Borehole length to lower end of borehole casing.

n/a :not applicable.

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 November 2004 until June 2005.

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.

5.2.2 Comments on some of the diagrams

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.

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.

HAV10: This is an artesian borehole with a lid mounted on the casing top to prevent water outflow. Because of the lid, manual levelling has not been possible. The pressure transducer is mounted on the lid instead of submerged in the borehole. The absolute level has been calculated instead of corrected using manual levelling data.

HLX15: This is fairly often an artesian borehole and manual levelling has not been possible. The level has been determined at one occasion in the beginning of January 2005, when water was barely dripping over the edge of the casing.

HLX24: The packer was deflated from the end of March to the beginning of April.

HSH01: From the beginning of December 2004, shorter periods with higher level in section 1 occur now and then. The reason for this is unknown. The higher level has been confirmed by manual levelling.

HSI13: Due to a clogged tube in which the pressure transducer was installed, registered data from June 2004 until January 2005 has been removed.

KAV02: It has not been possible to perform manual levelling in section 2 and the absolute level has been estimated.

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.

SSM000212: This borehole was at all, except two, manual levelling occasions reported to be dry. However, water level was registered after rain.

Appendix 1

Percussion boreholes:

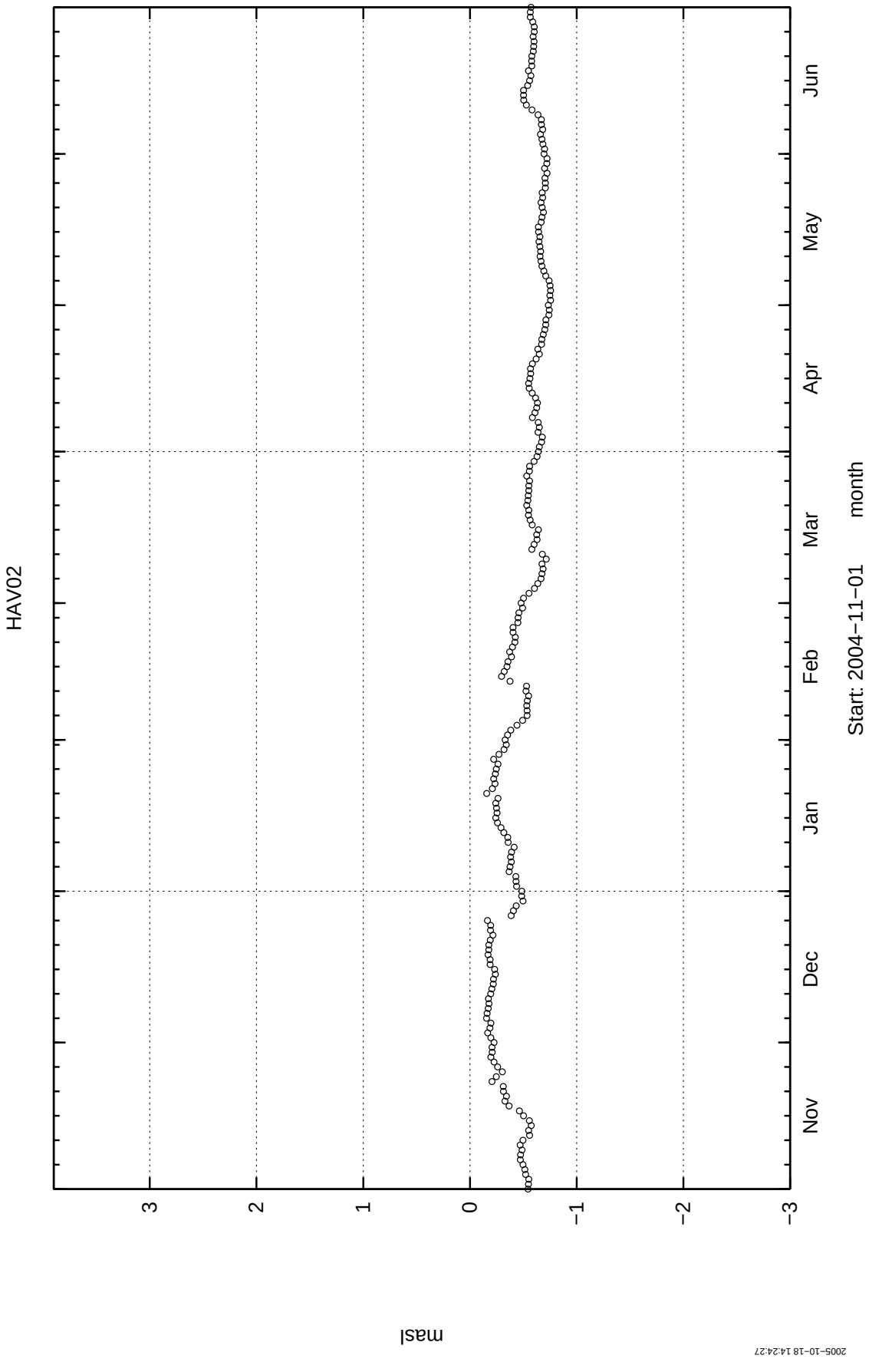
HAV02
HAV05–HAV07
HAV09
HAV10
HLX08–HLX11
HLX13
HLX14
HLX20–HLX22
HLX24
HSH01–HSH03
HSI04
HSI13

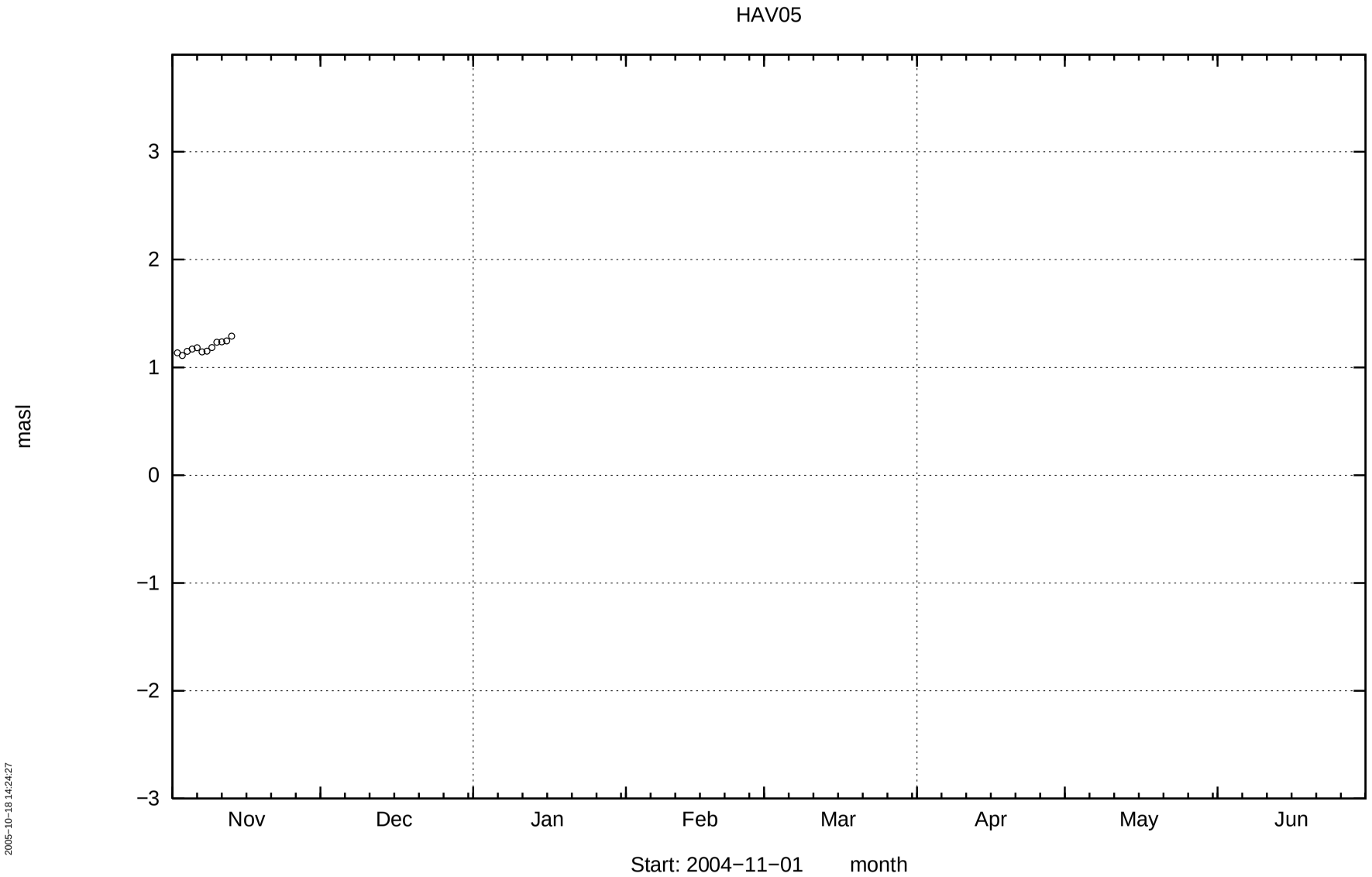
Cored boreholes:

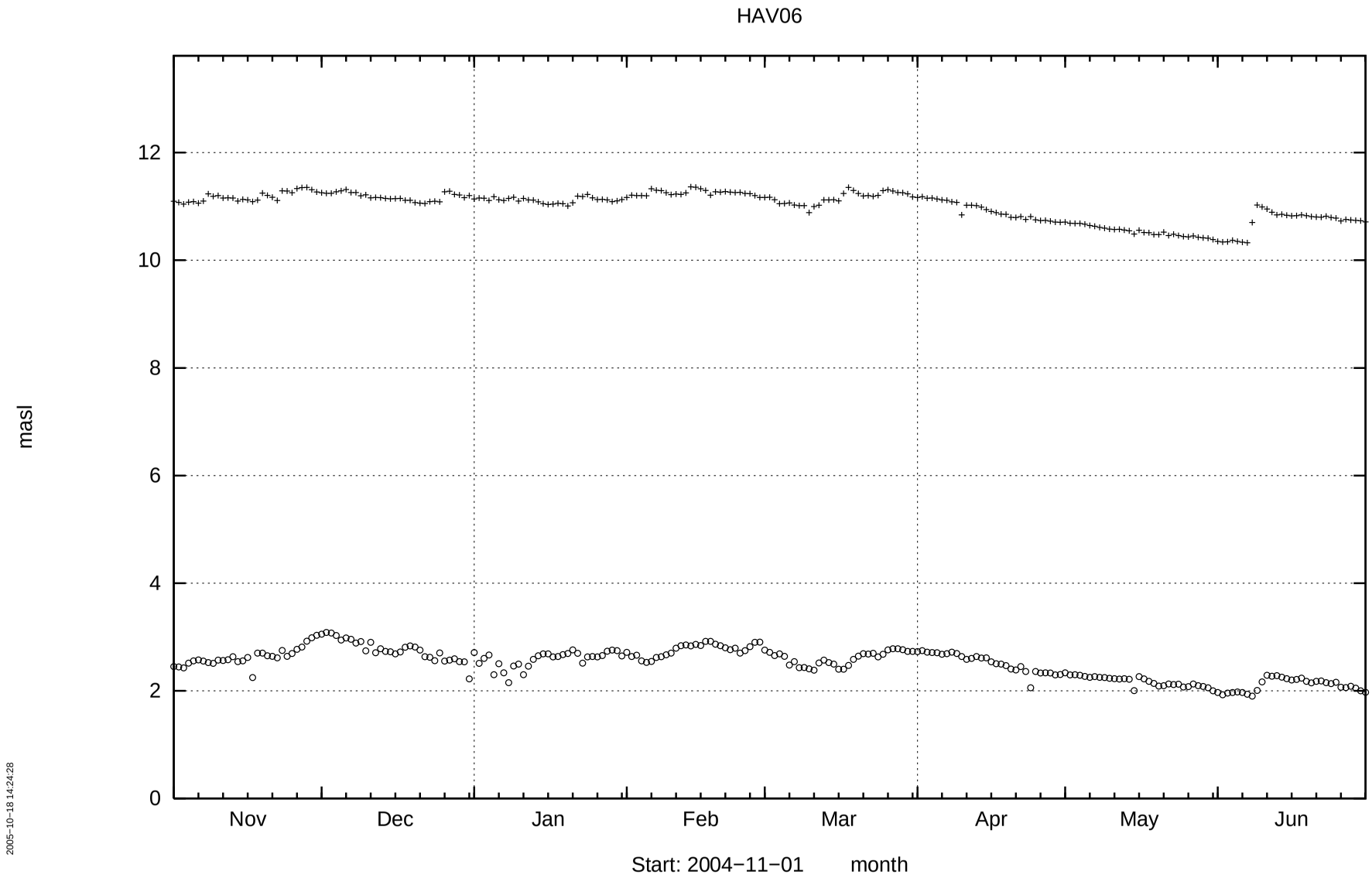
KAV01–KAV03
KAV04A
KBH03
KLX02–KLX06
KSH01A
KSH03A

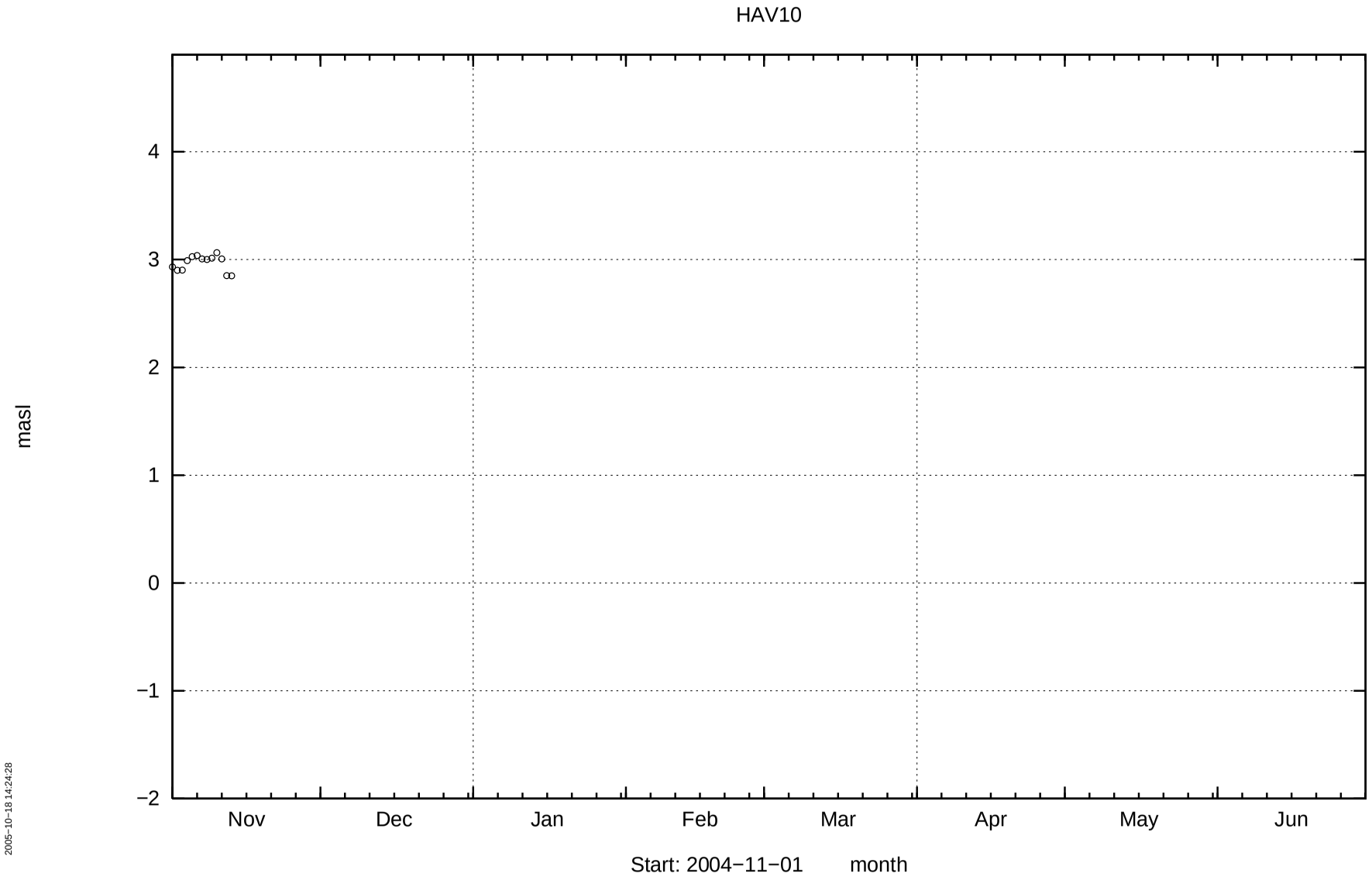
Soil wells:

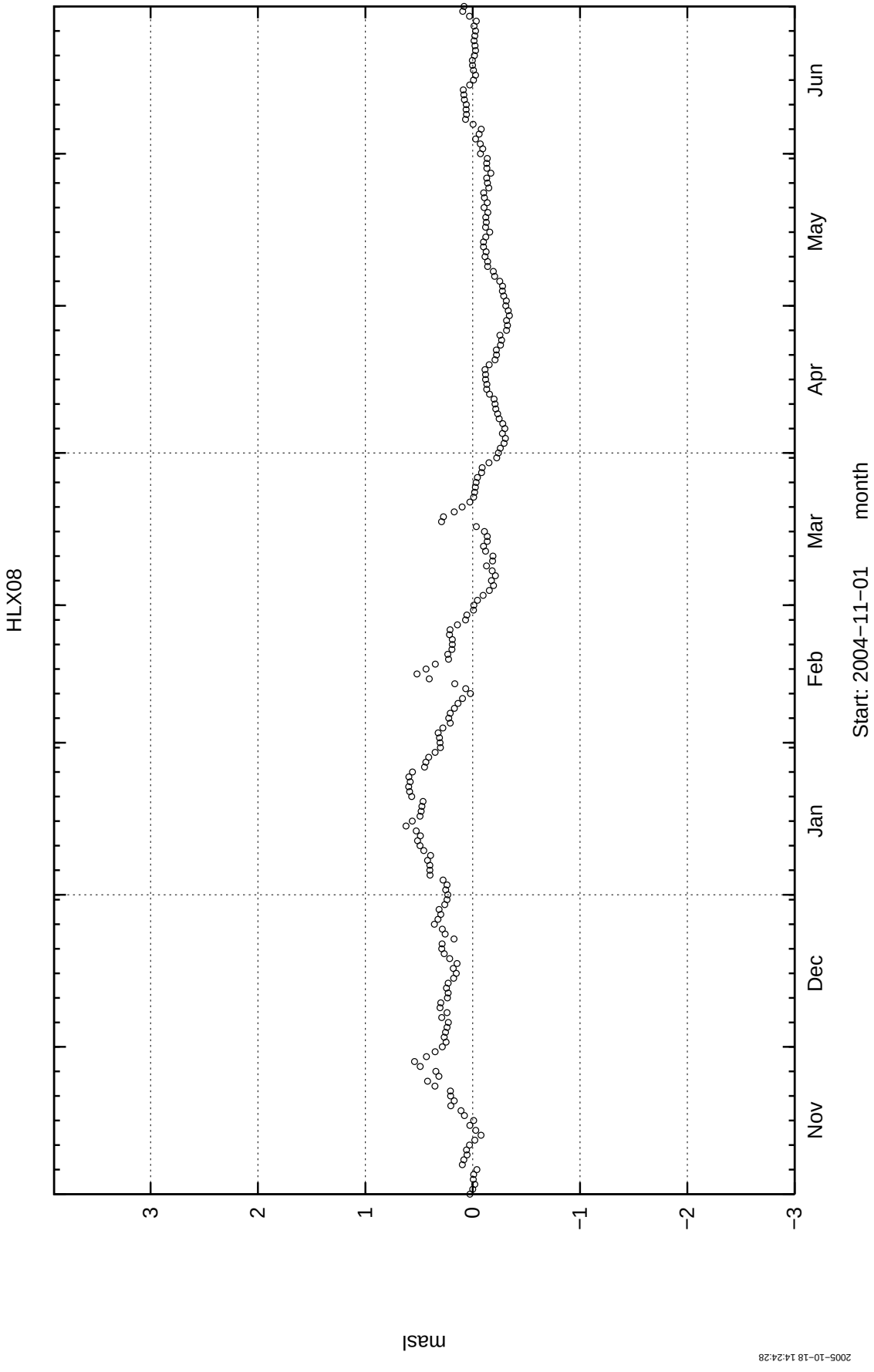
SSM000001
SSM000002
SSM000004
SSM000005
SSM000008
SSM000009
SSM000011
SSM000012
SSM000014
SSM000017–SSM000019
SSM000021
SSM000022
SSM000209–SSM000213

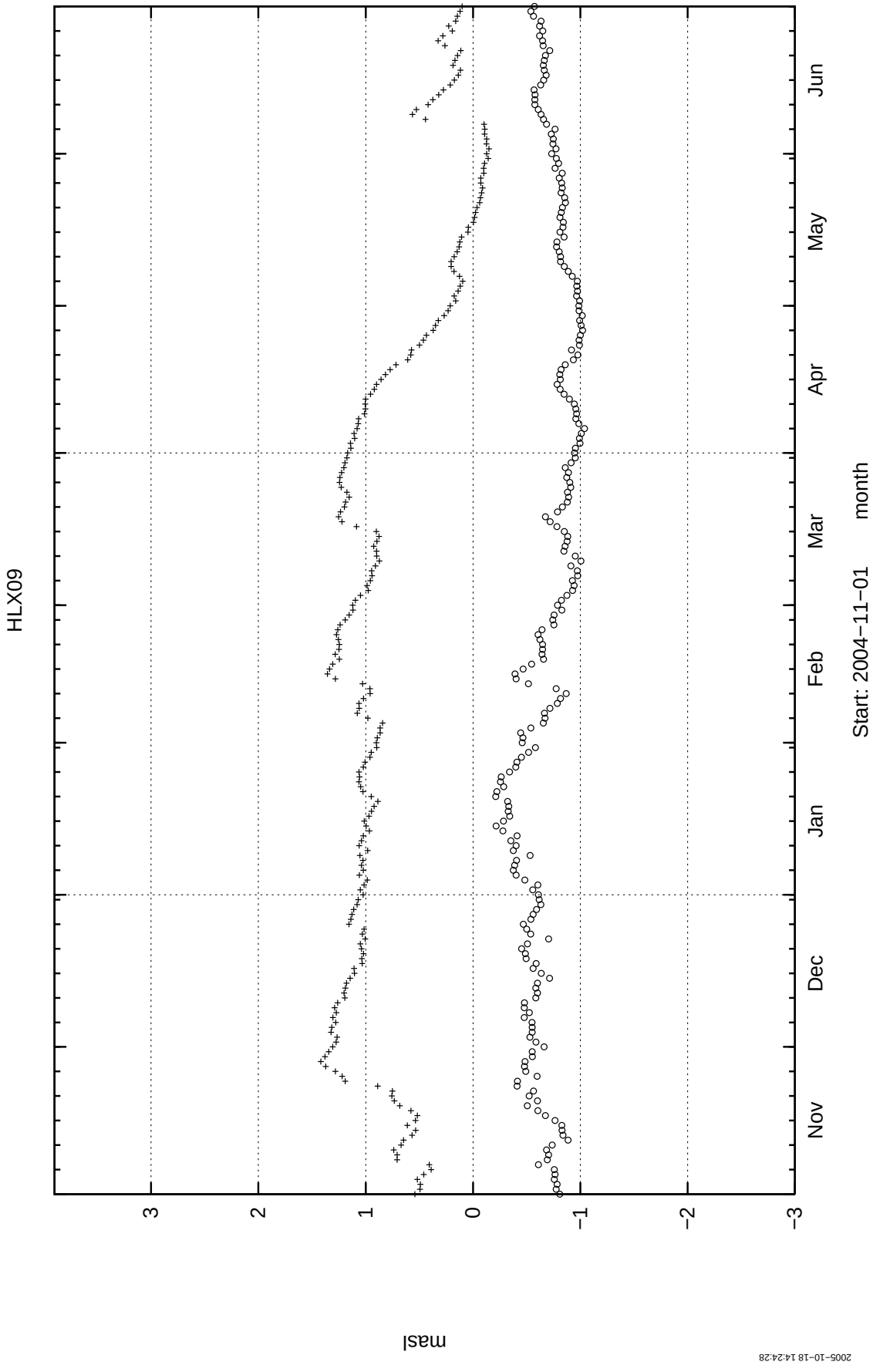

HAV02
masl
3
2
1
0
−1
−2
−3
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:27

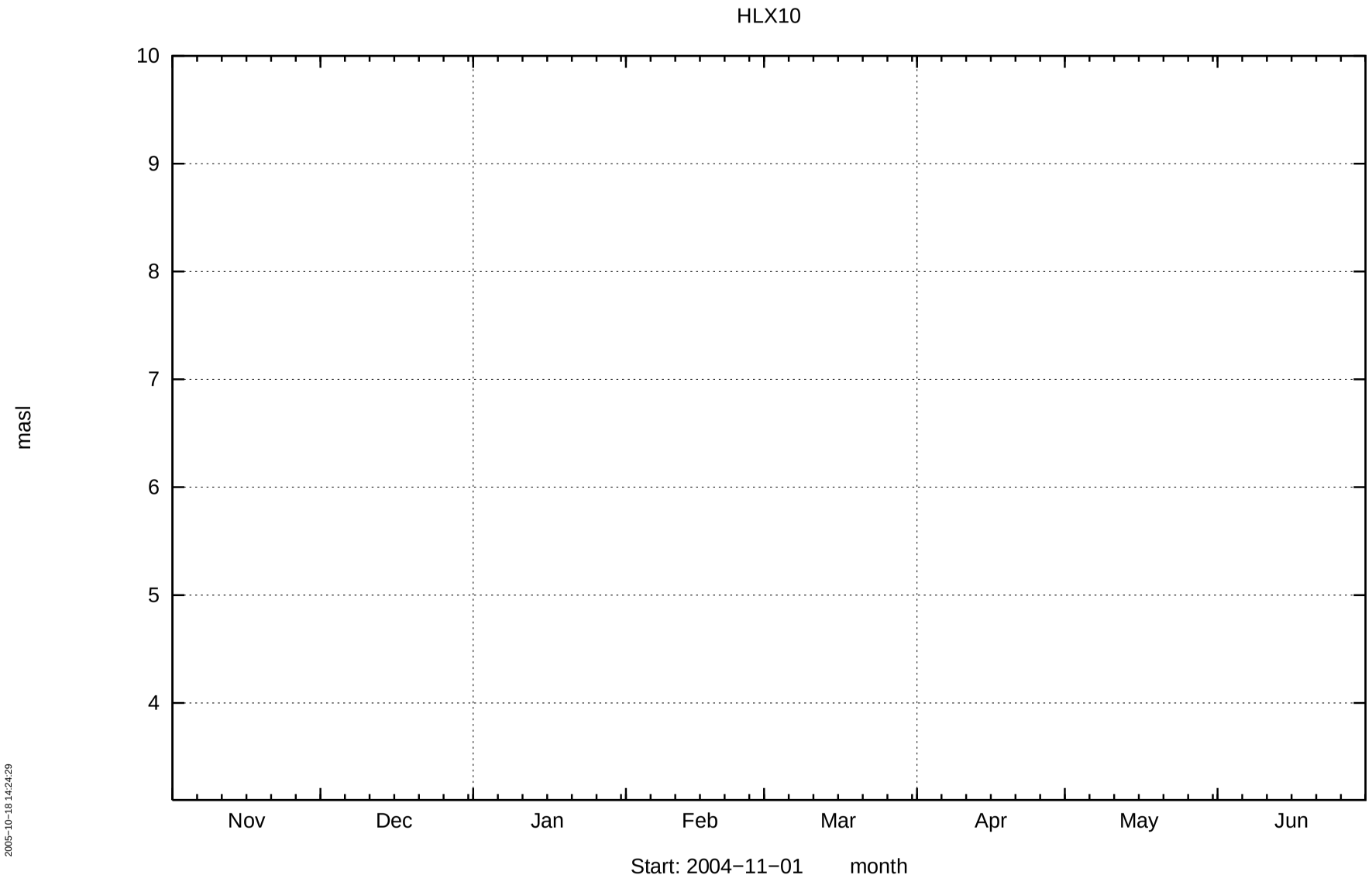

HAV05
masl
3
2
1
0
−1
−2
−3
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:27

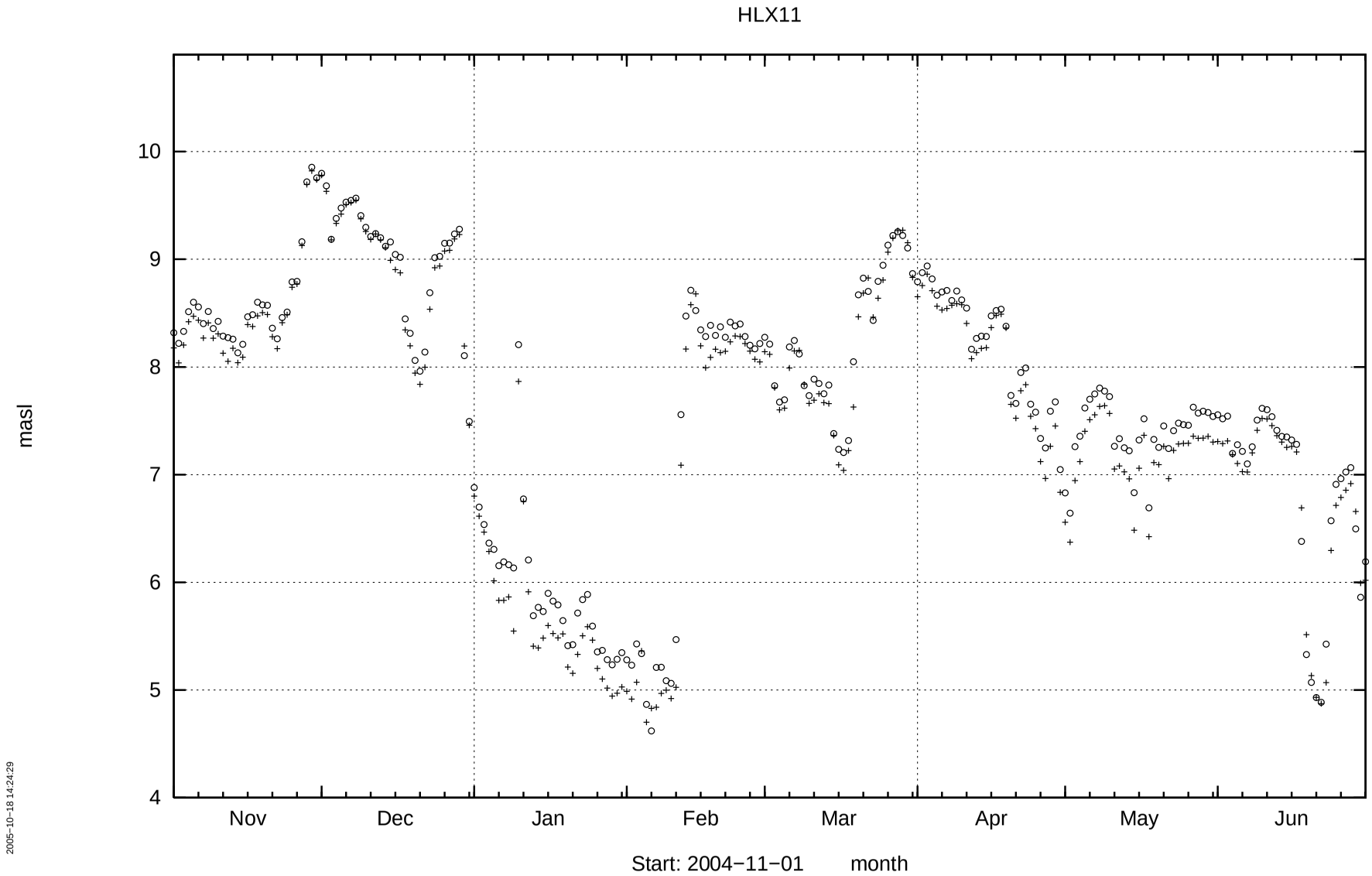

HAV06
masl
12
10
8
6
4
2
0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:28

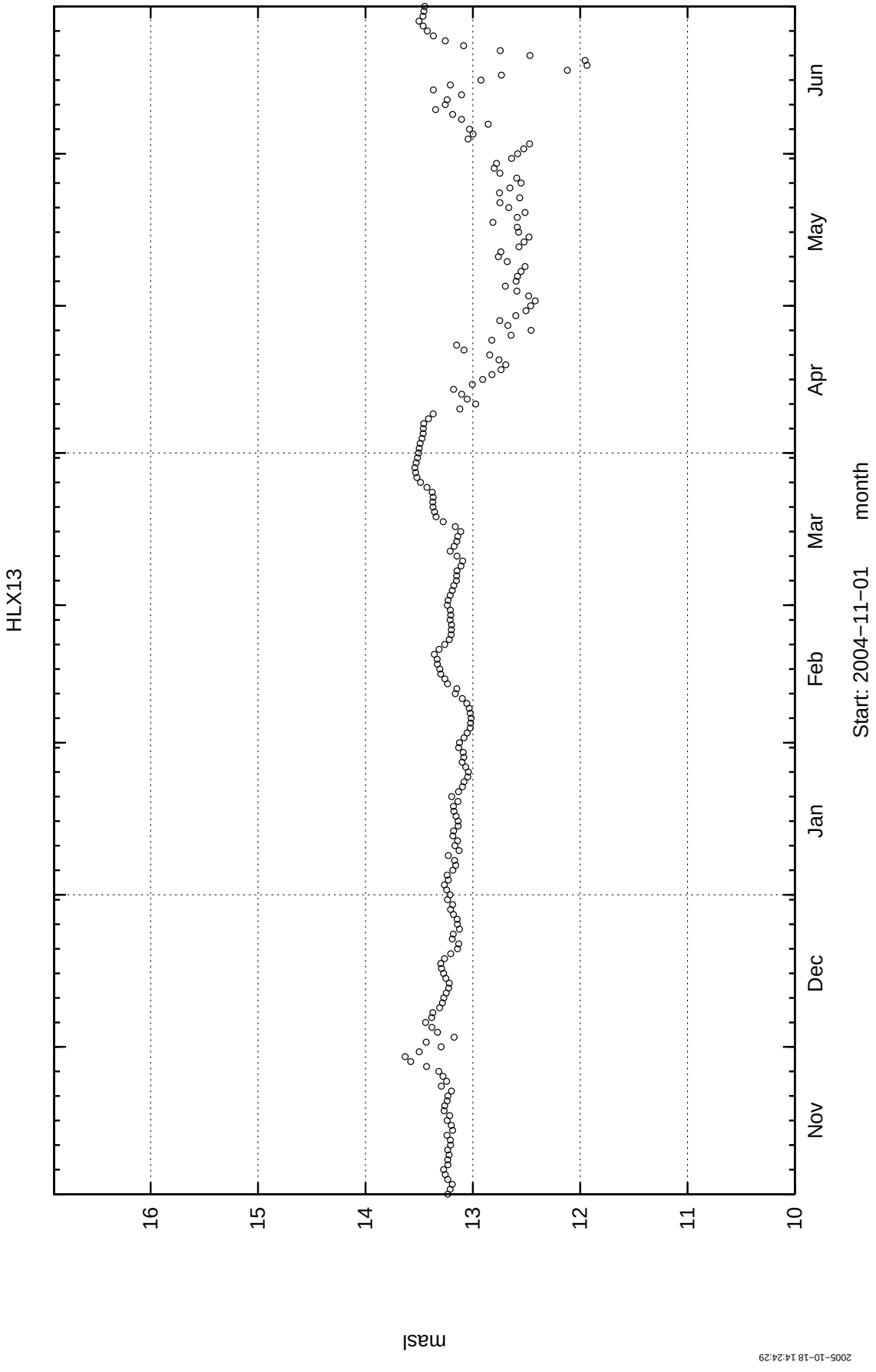

HAV10
masl
4
3
2
1
0
−1
−2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:28

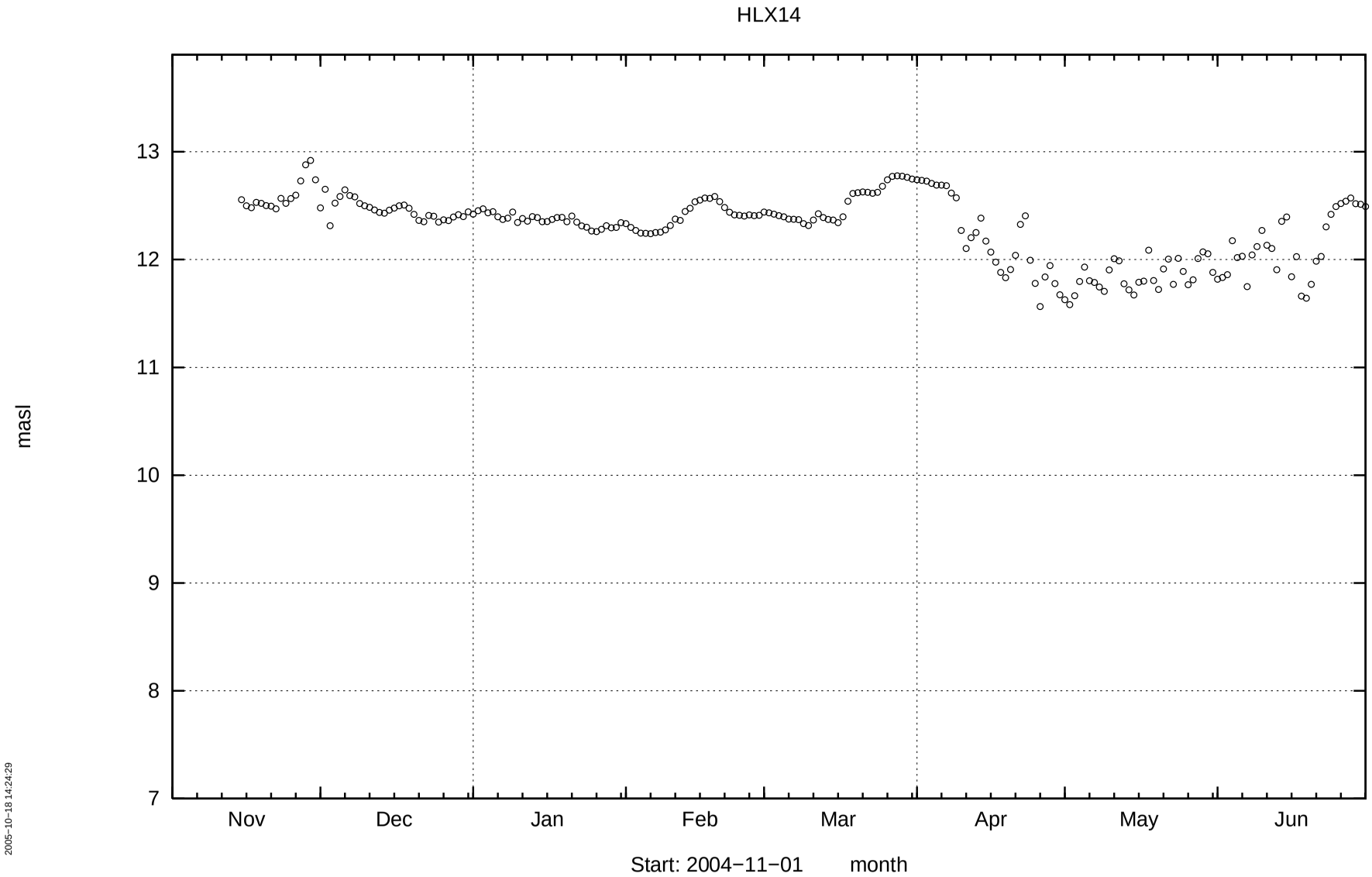

HLX08
masl
3
2
1
0
−1
−2
−3
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:28

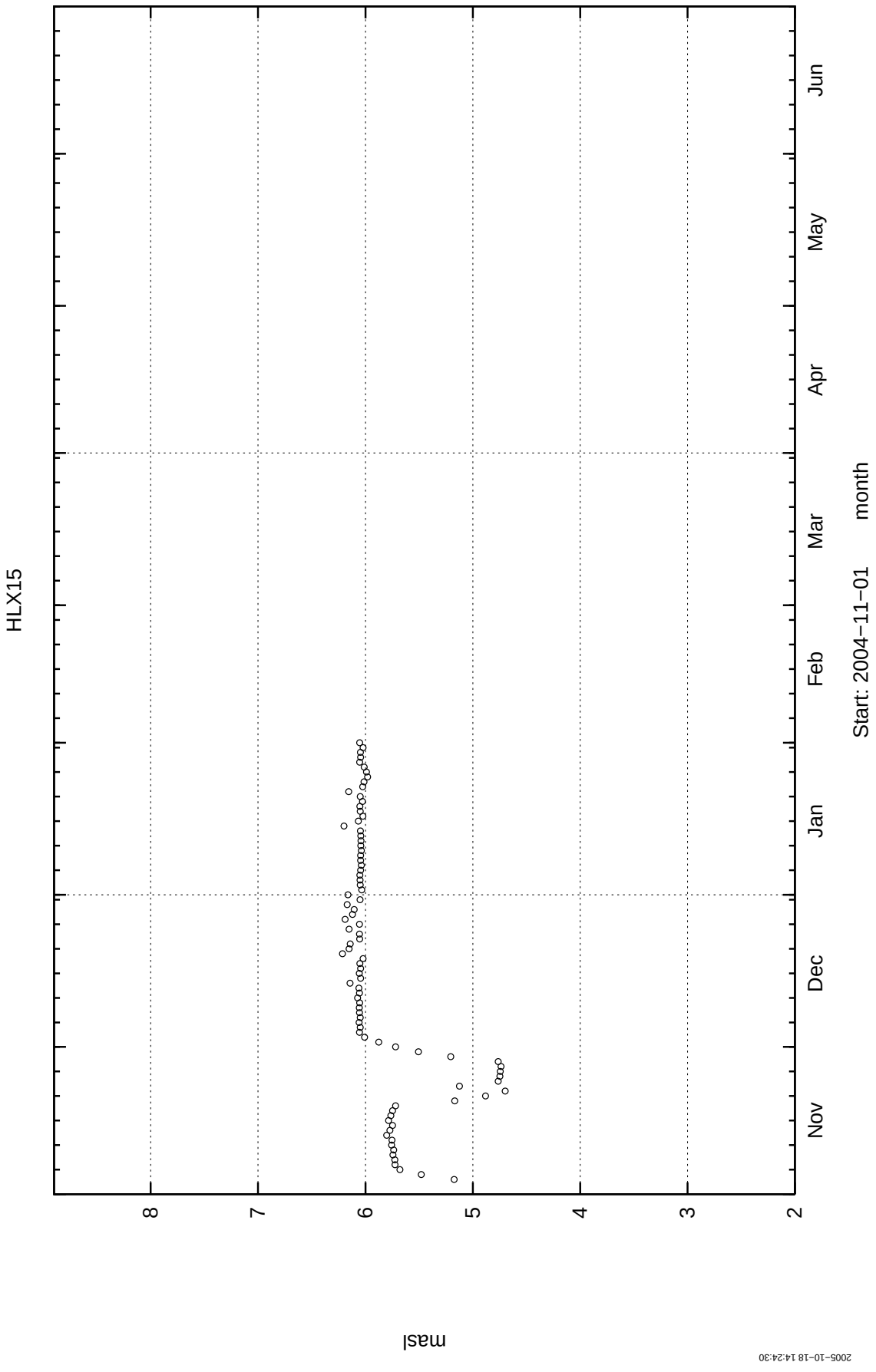

HLX09
masl
3
2
1
0
−1
−2
−3
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:28

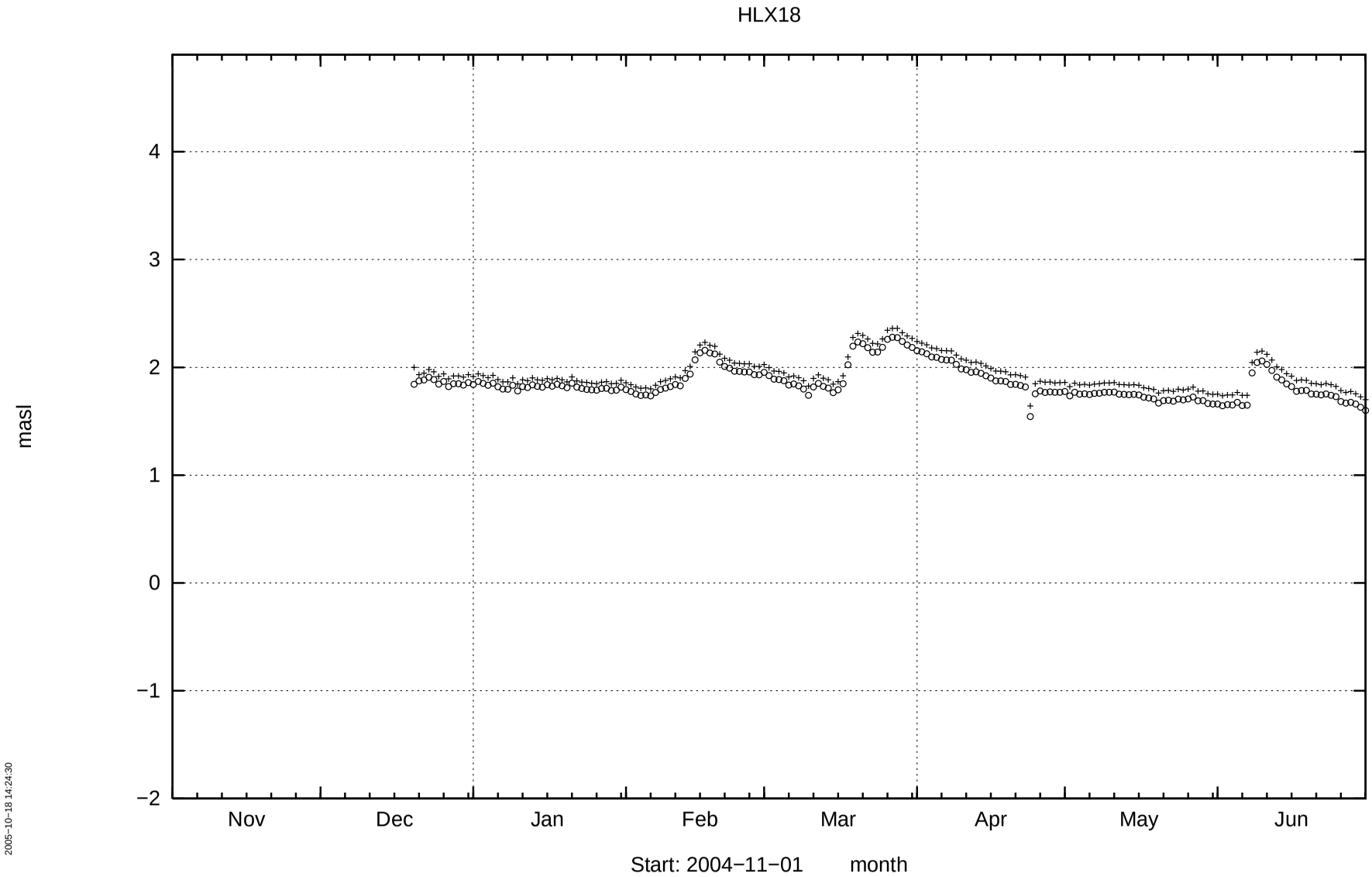

HLX10
masl
10
9
8
7
6
5
4
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:29

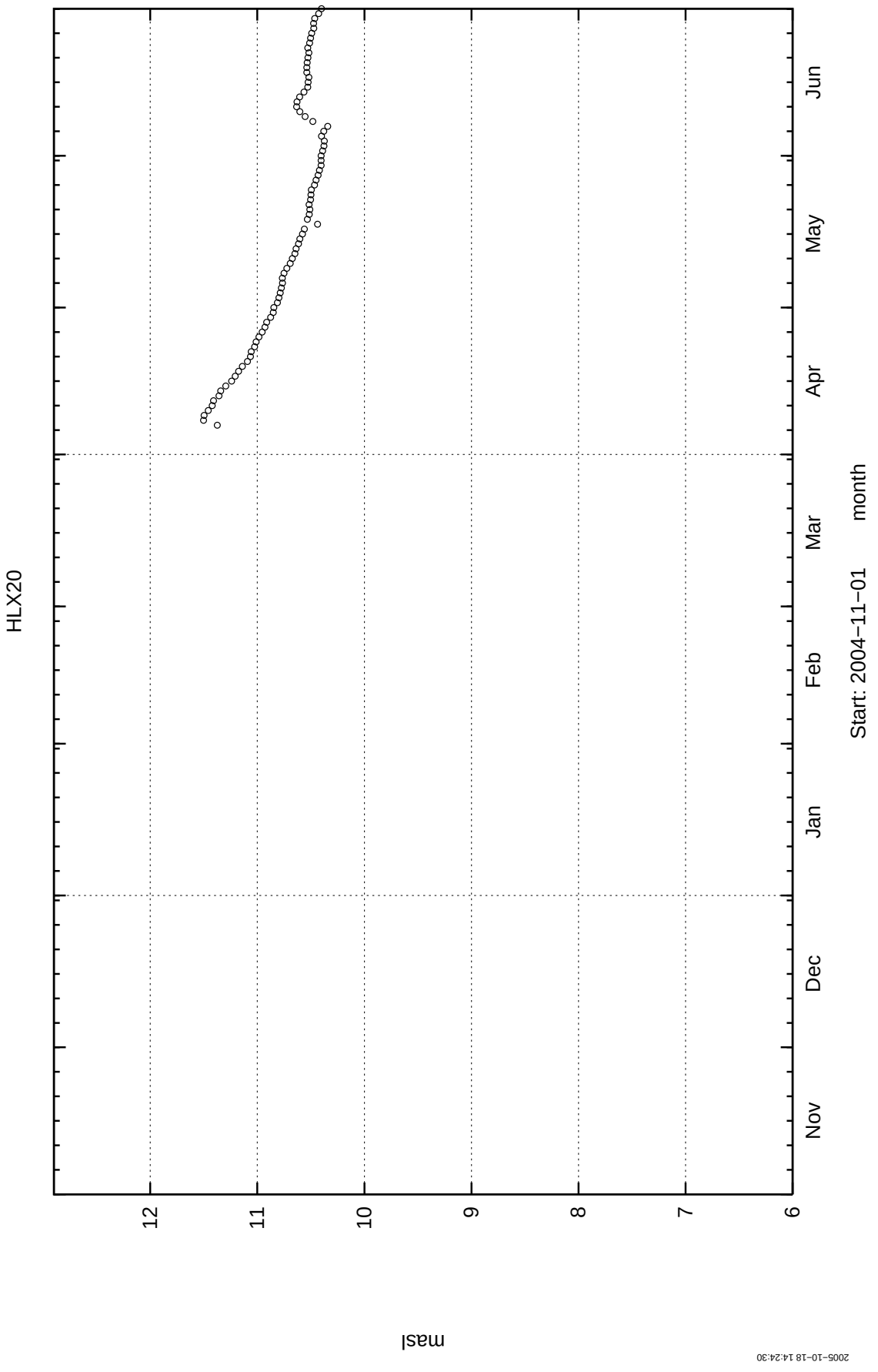

HLX11
masl
10
9
8
7
6
5
4
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:29

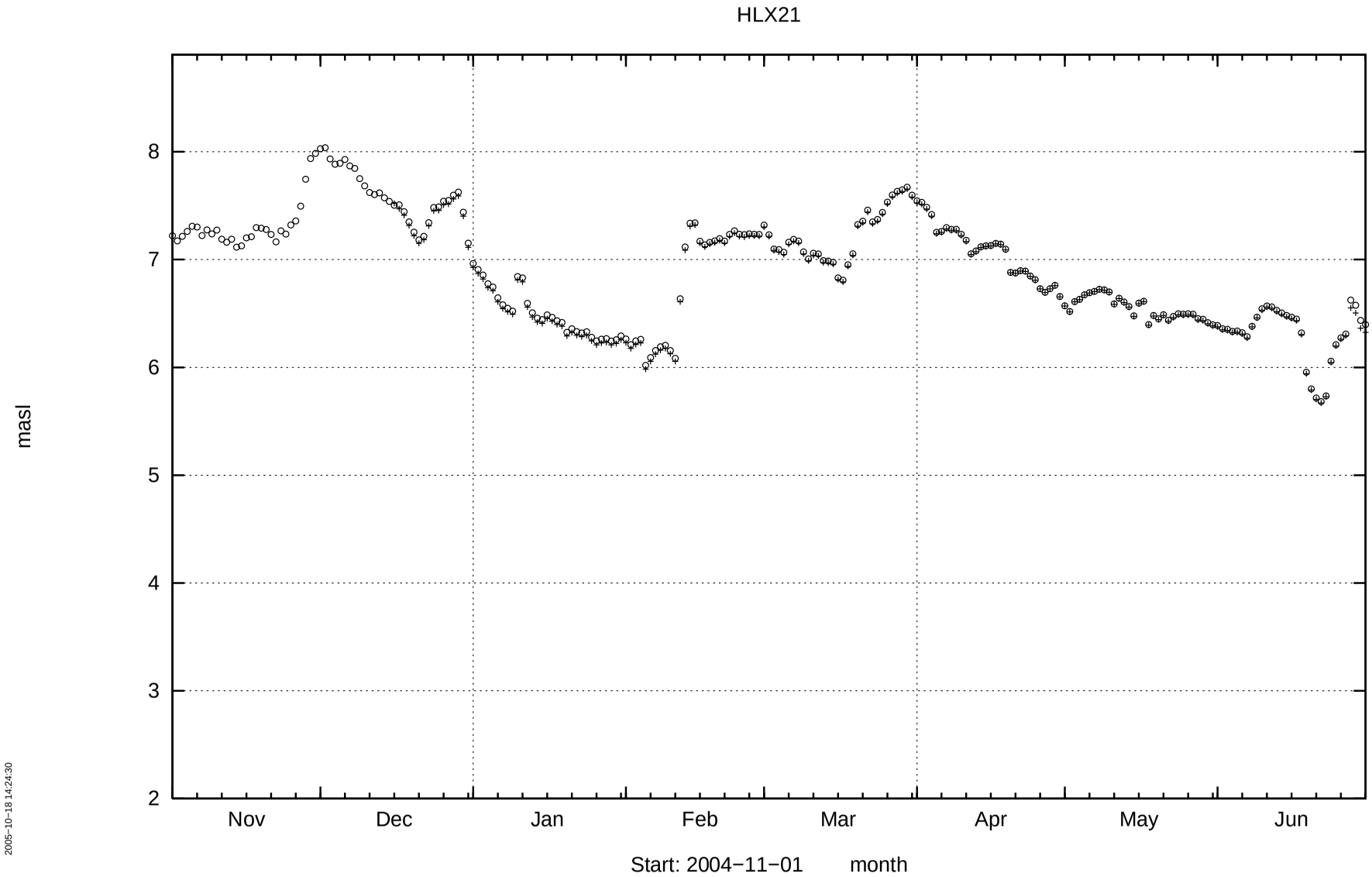

HLX13
masl
16
15
14
13
12
11
10
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:29

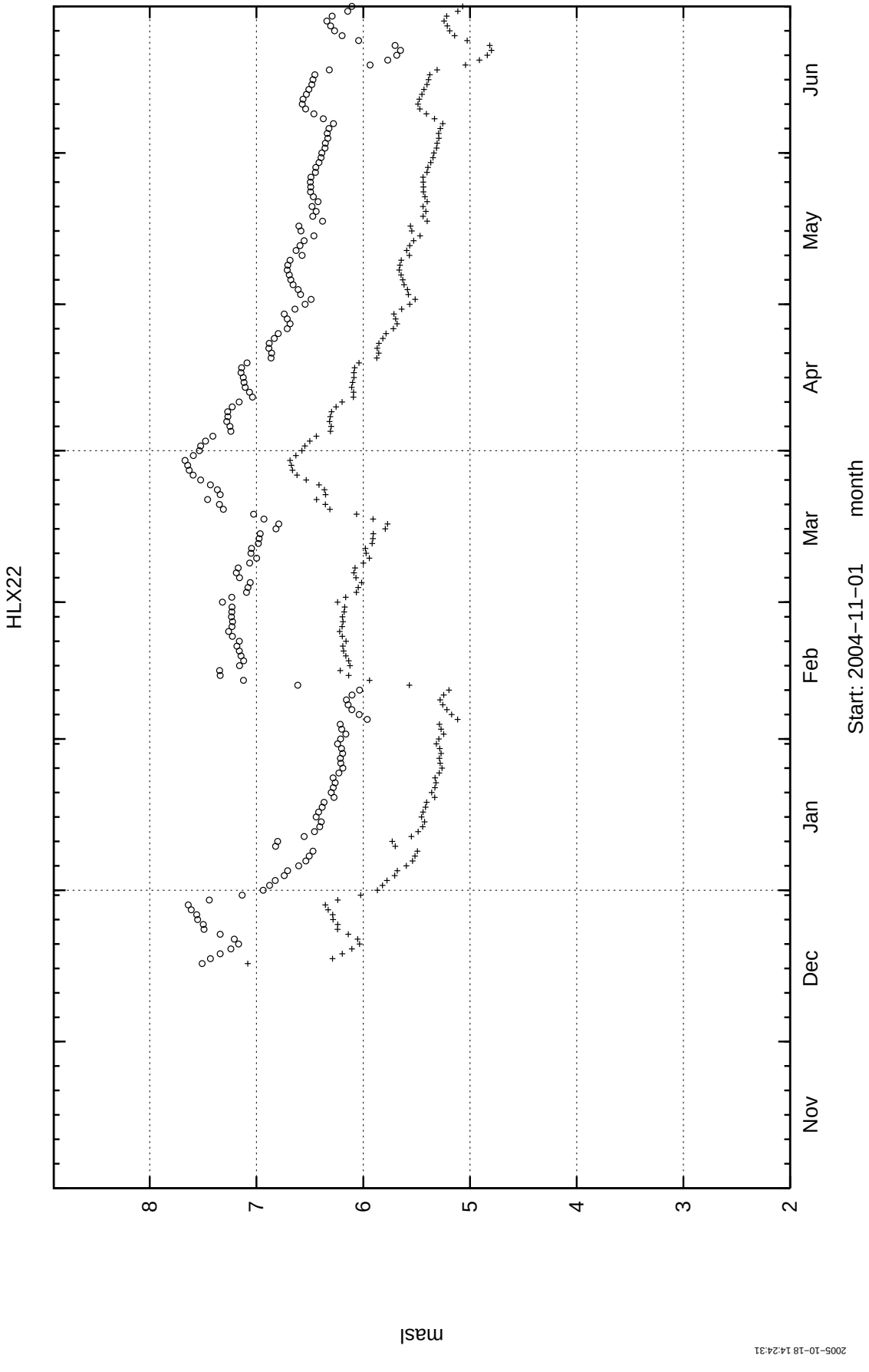

HLX14
masl
13
12
11
10
9
8
7
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:29

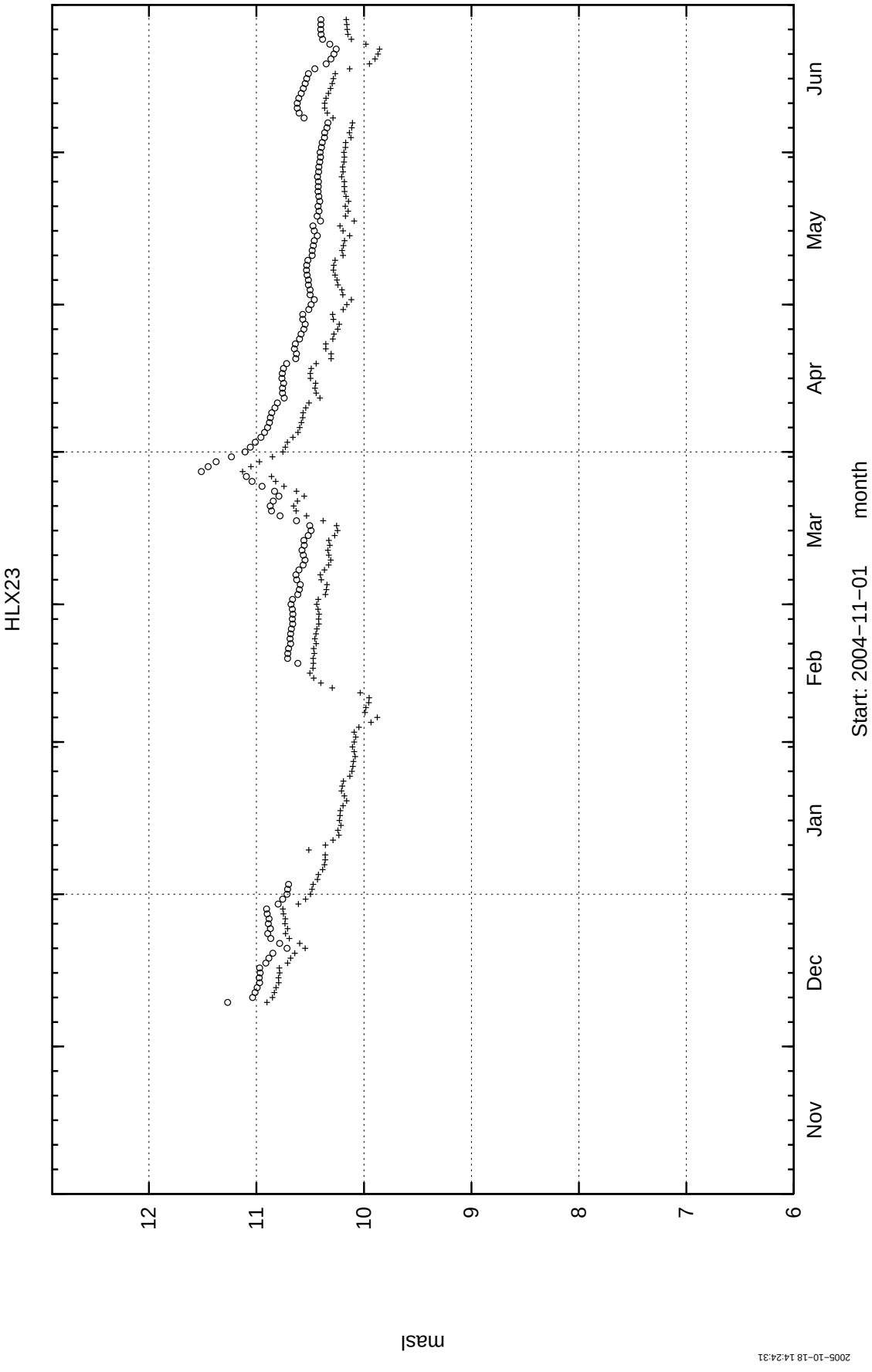

HLX15
masl
8
7
6
5
4
3
2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:30

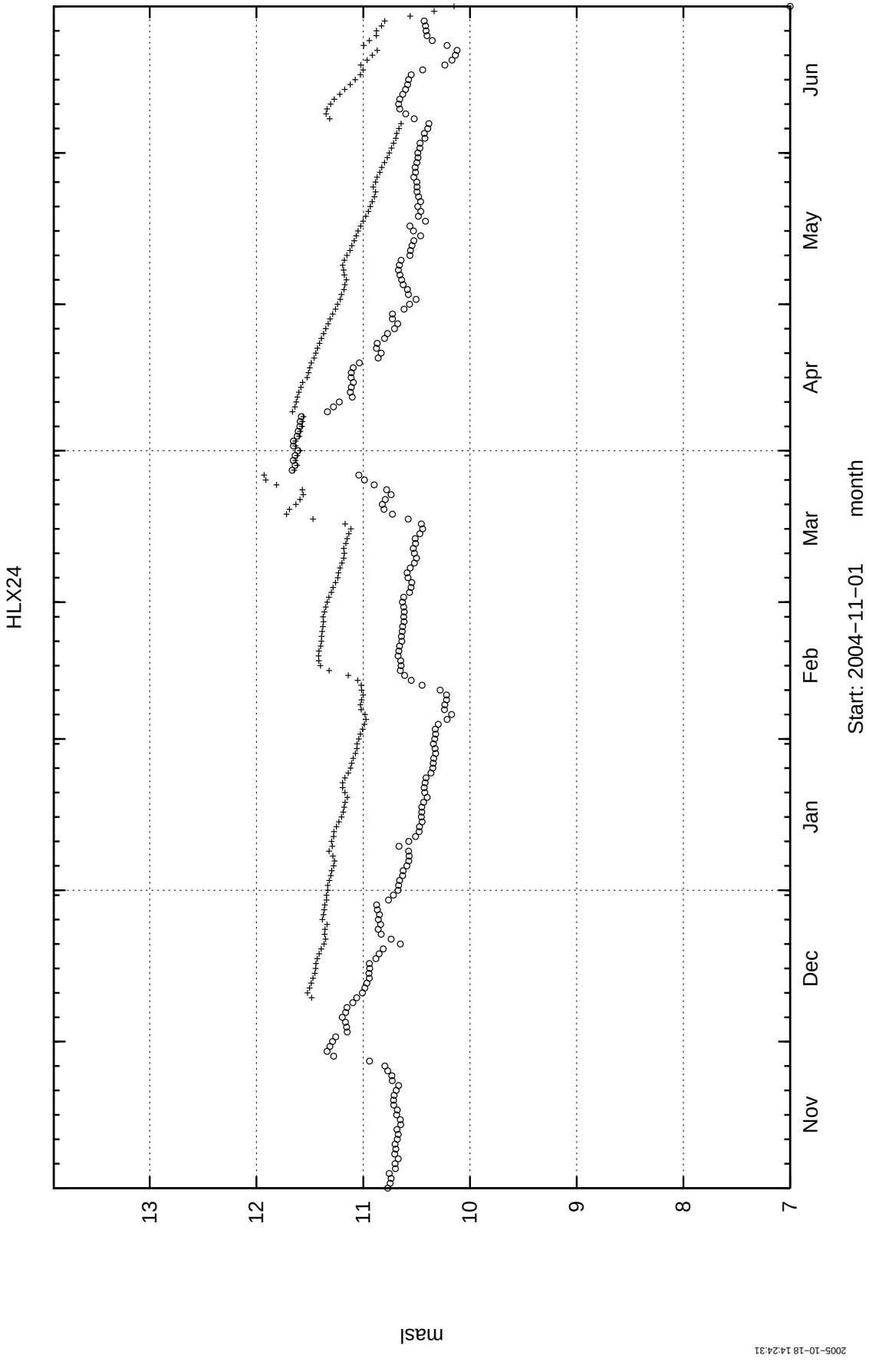

HLX18
masl
4
3
2
1
0
−1
−2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:30

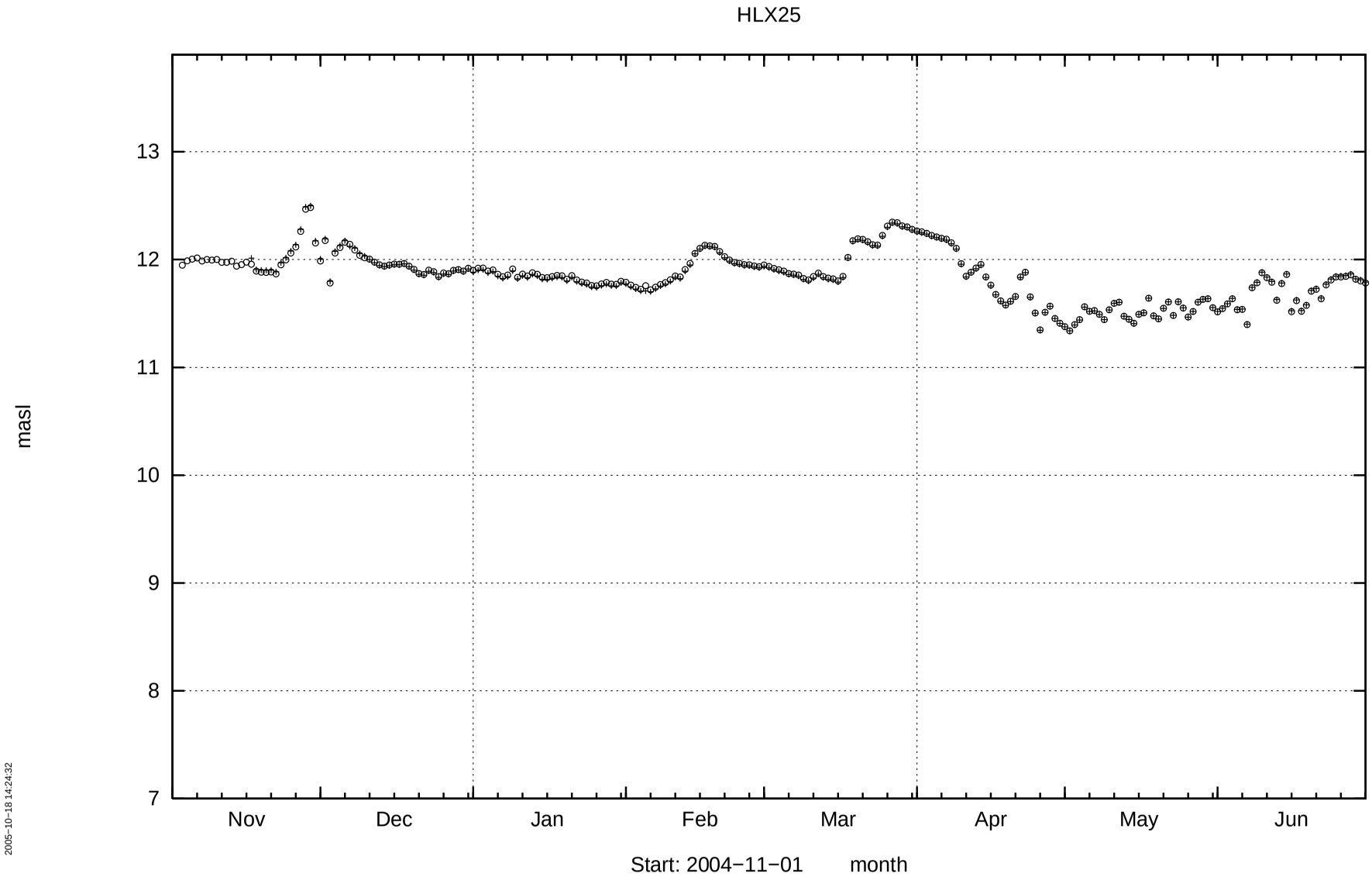

HLX20
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004-11-01
month
2005-10-18 14:24:30

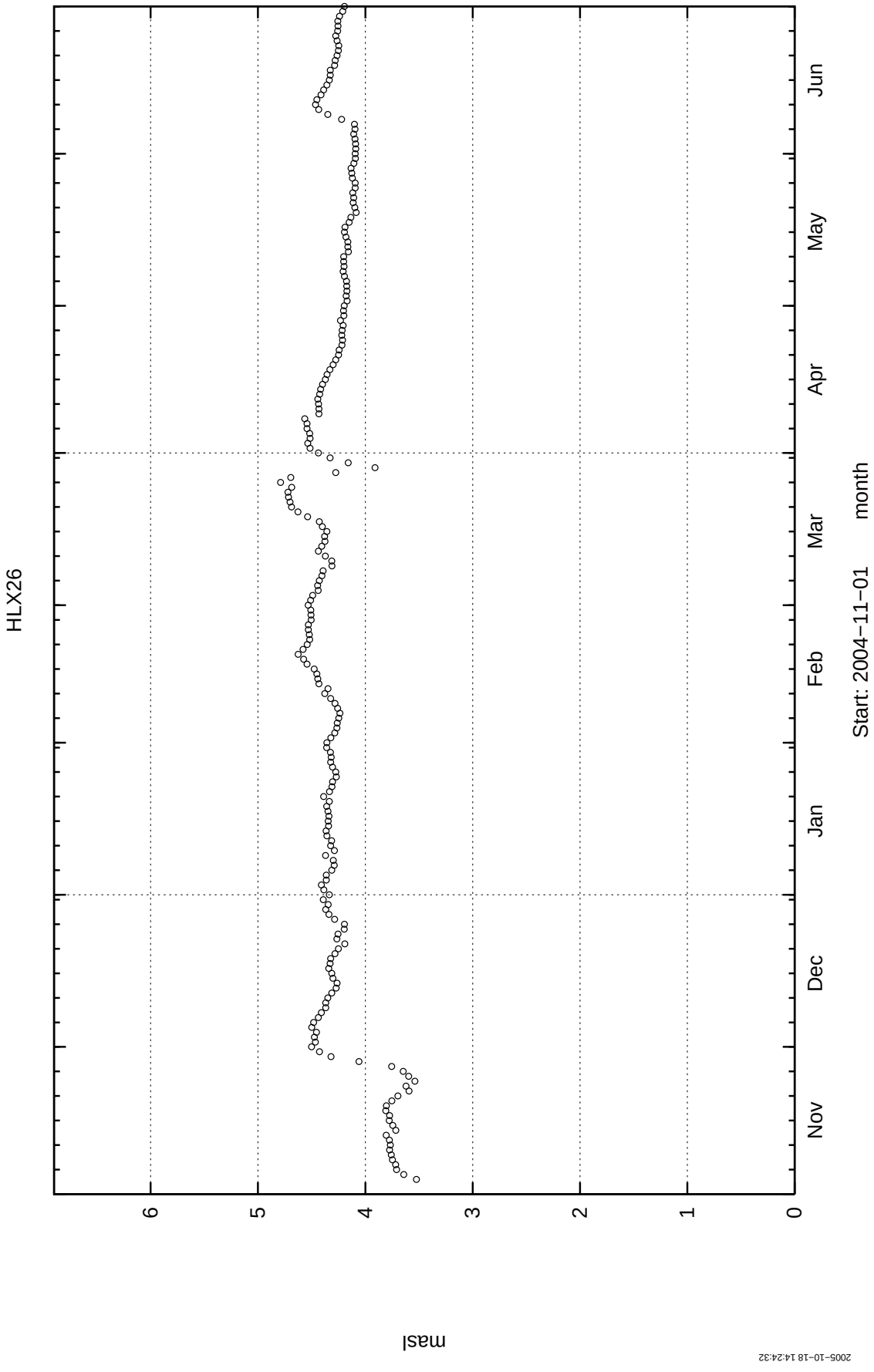

HLX21
masl
8
7
6
5
4
3
2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:30

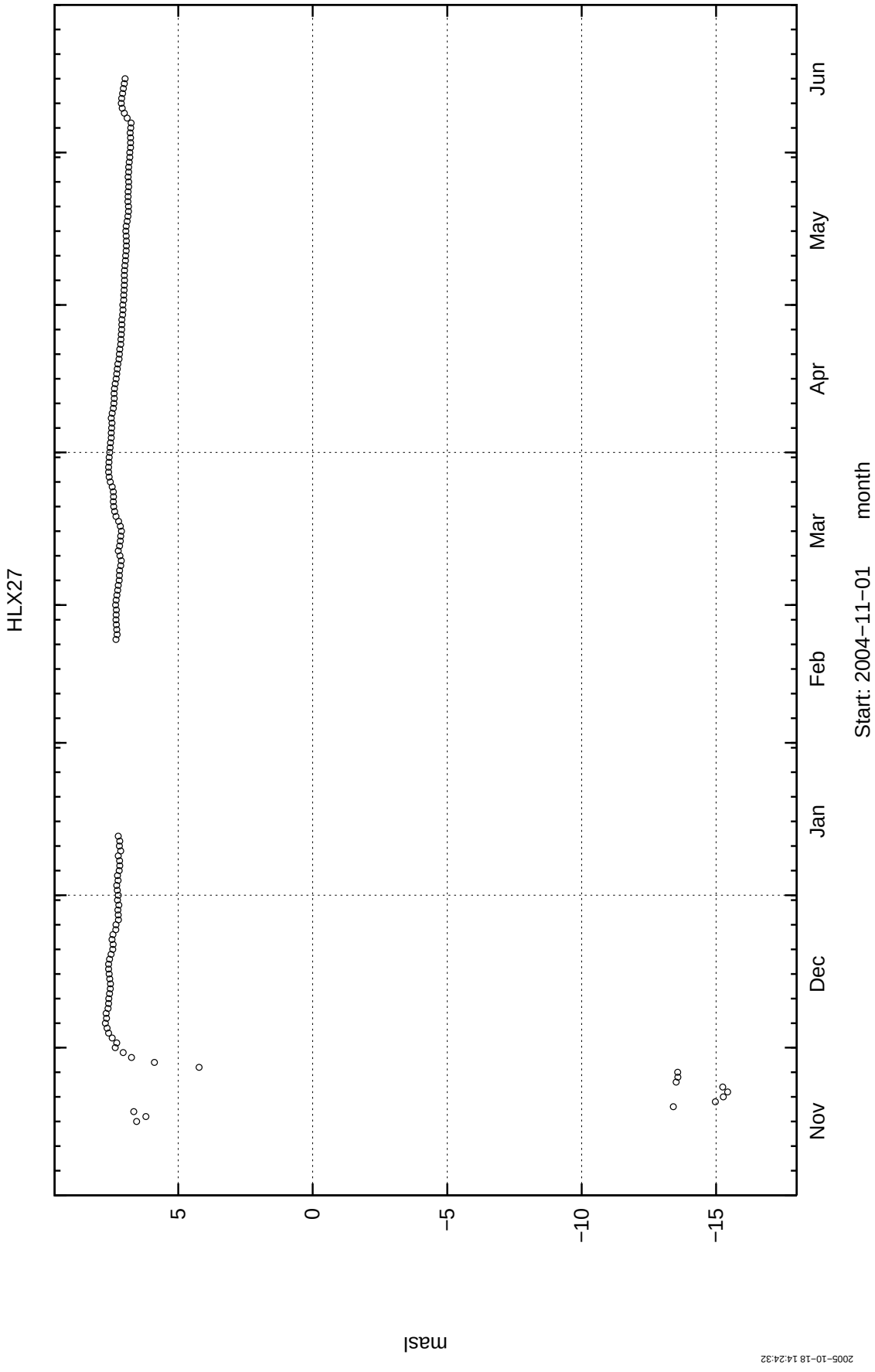

HLX22
masl
8
7
6
5
4
3
2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004-11-01
month
2005-10-18 14:24:31

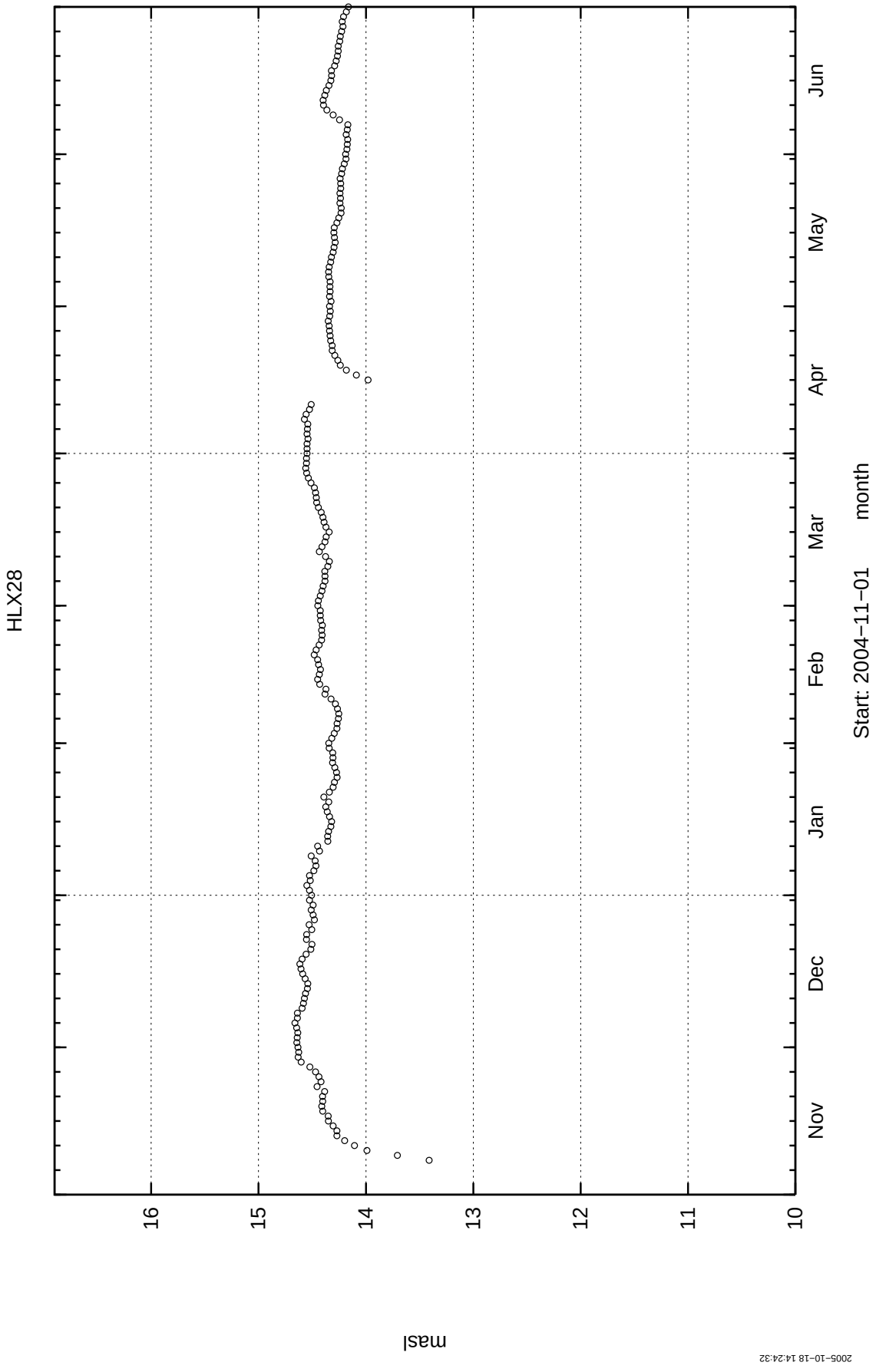

HLX23
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:31

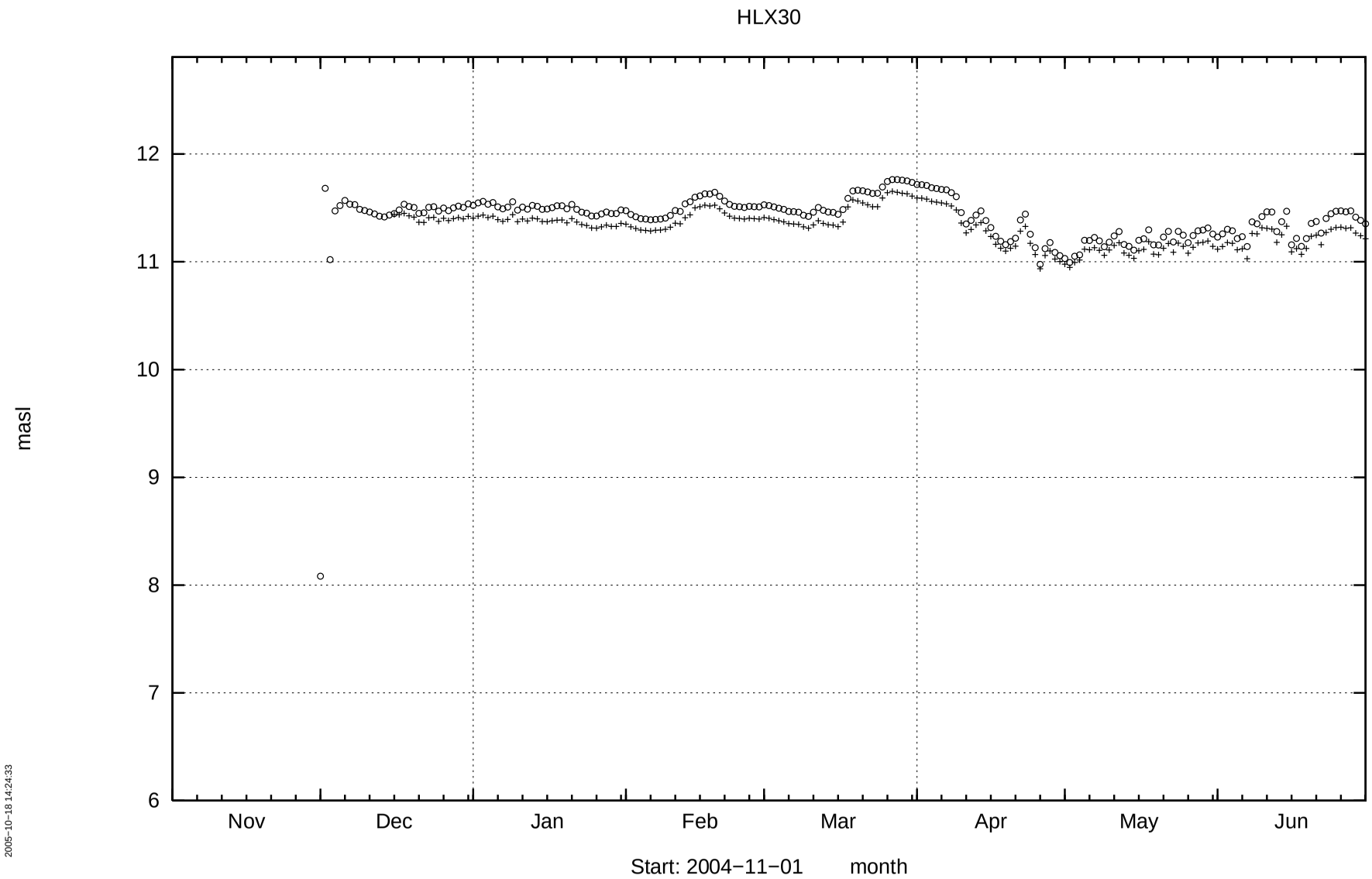

HLX24
masl
13
12
11
10
9
8
7
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:31

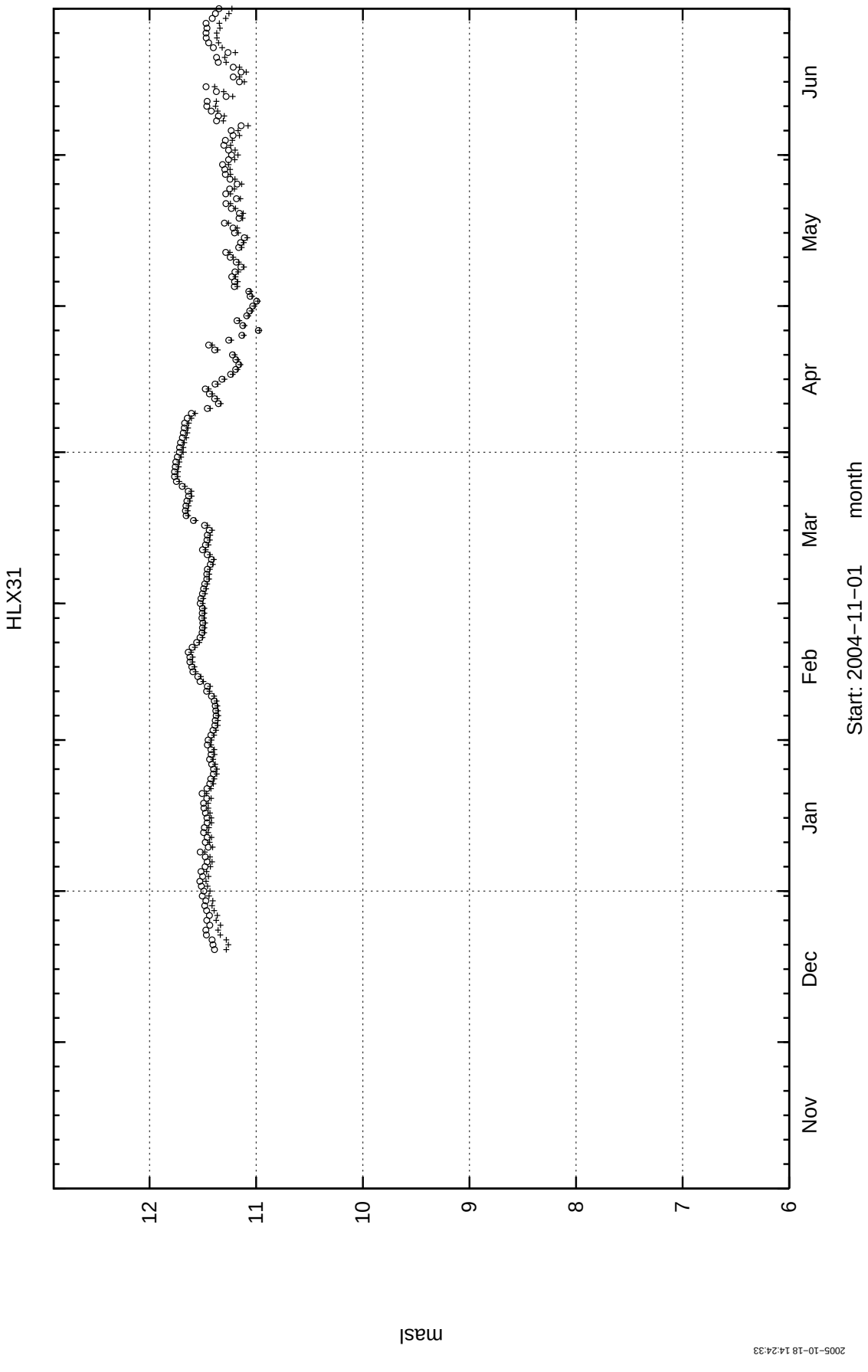

HLX25
masl
13
12
11
10
9
8
7
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:32

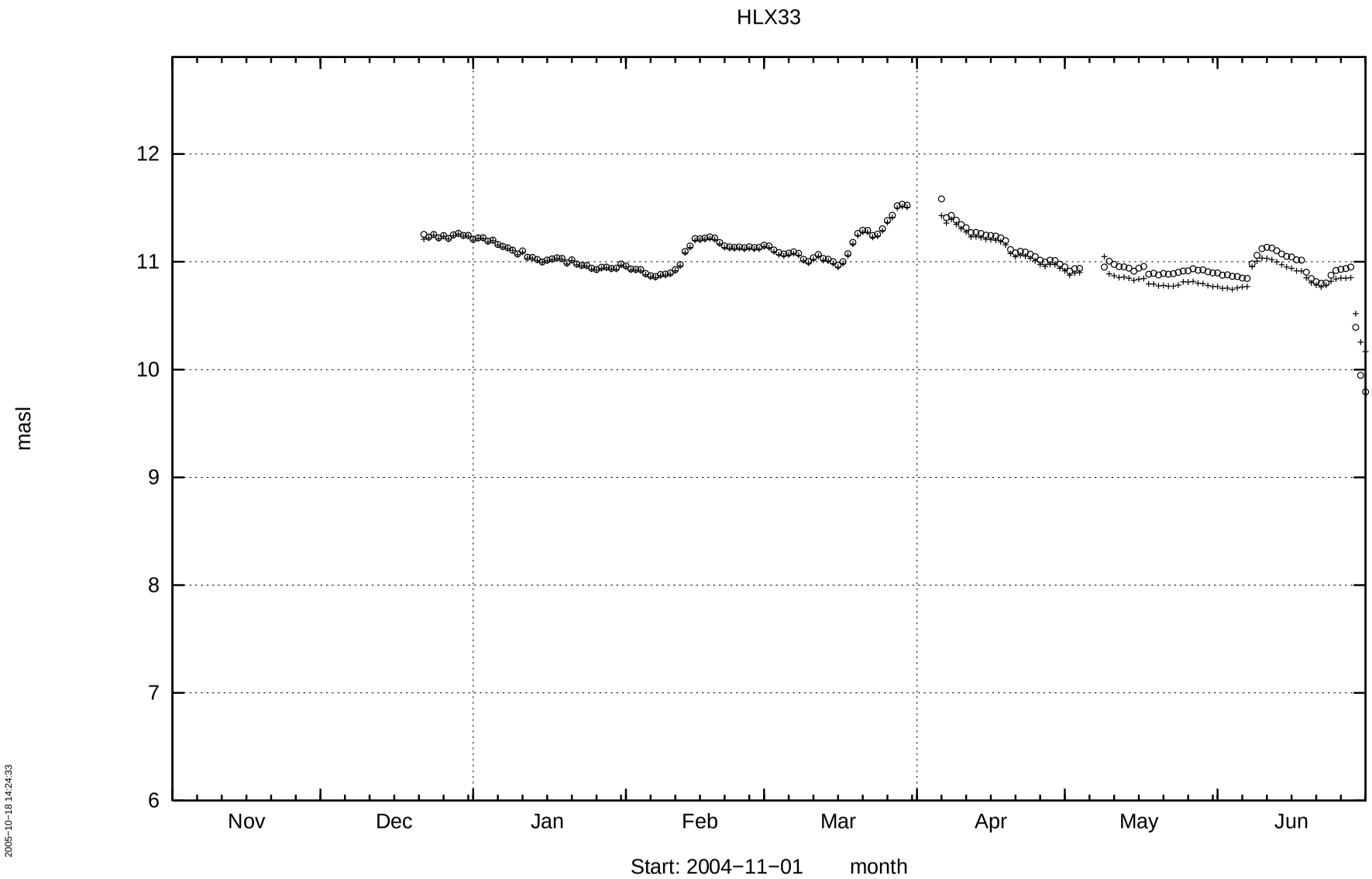

HLX26
masl
0
1
2
3
4
5
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005-10-18 14:24:32

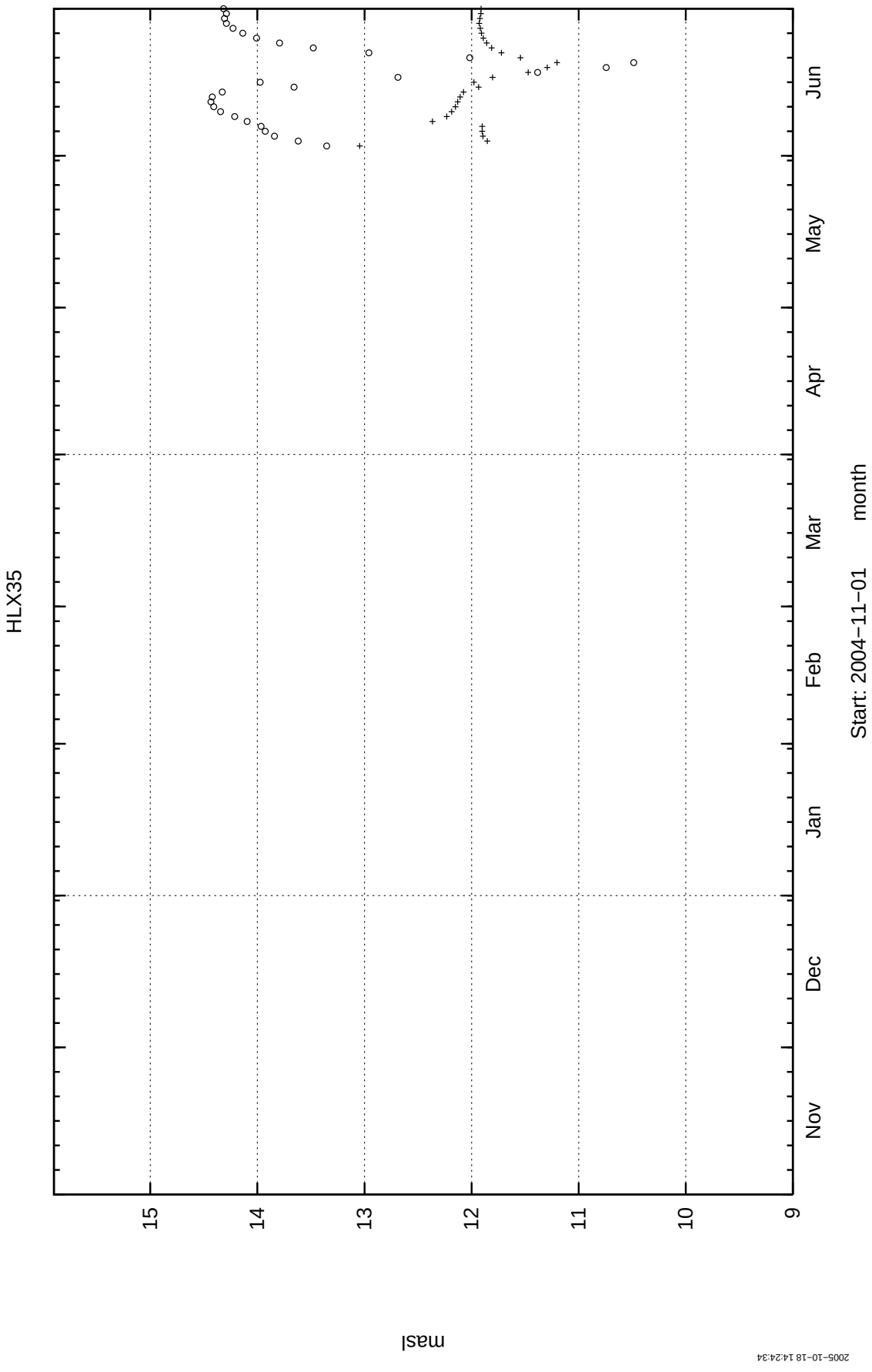

HLX27
masl
5
0
−5
−10
−15
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:32

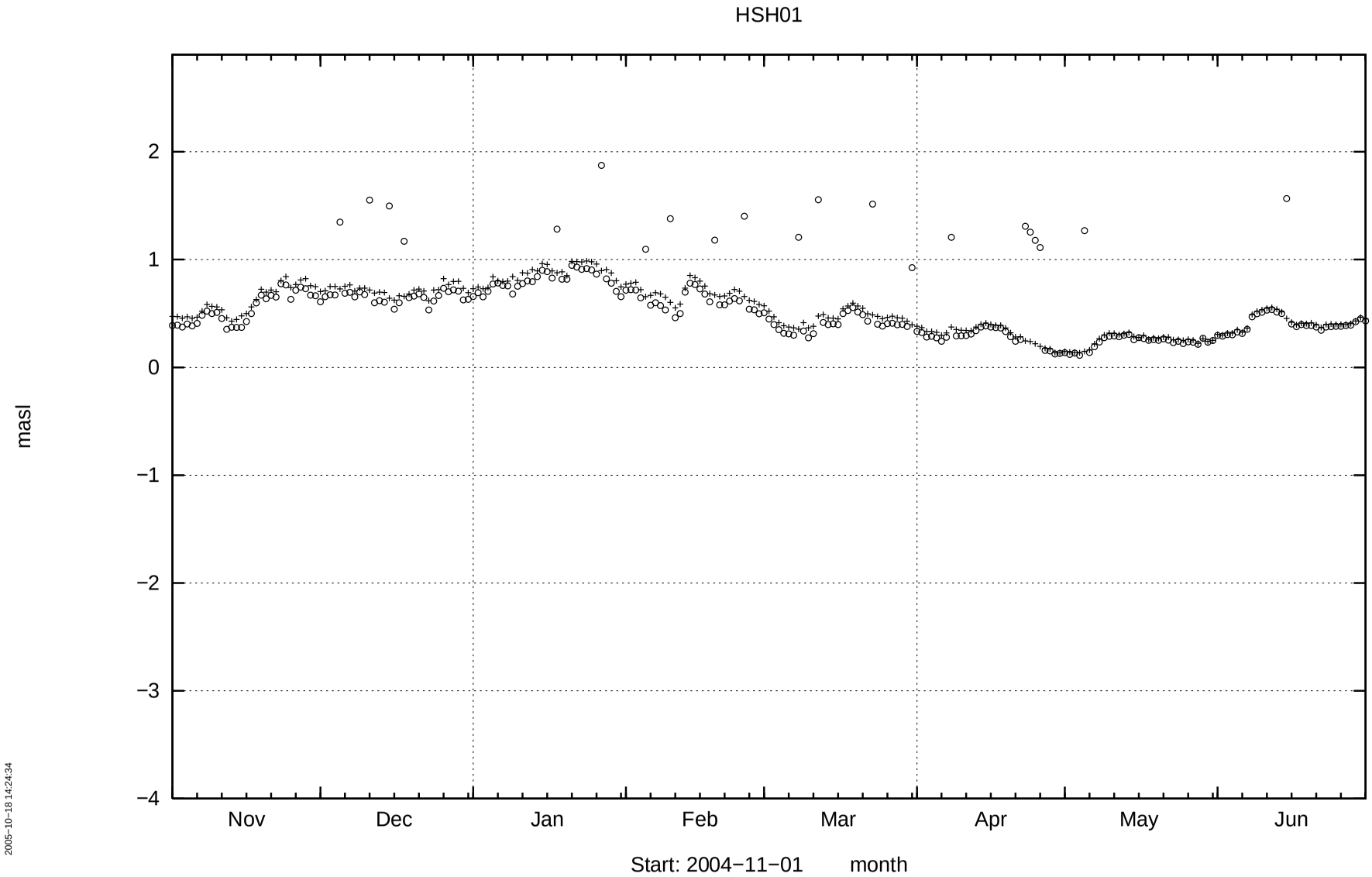

HLX28
masl
16
15
14
13
12
11
10
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:32

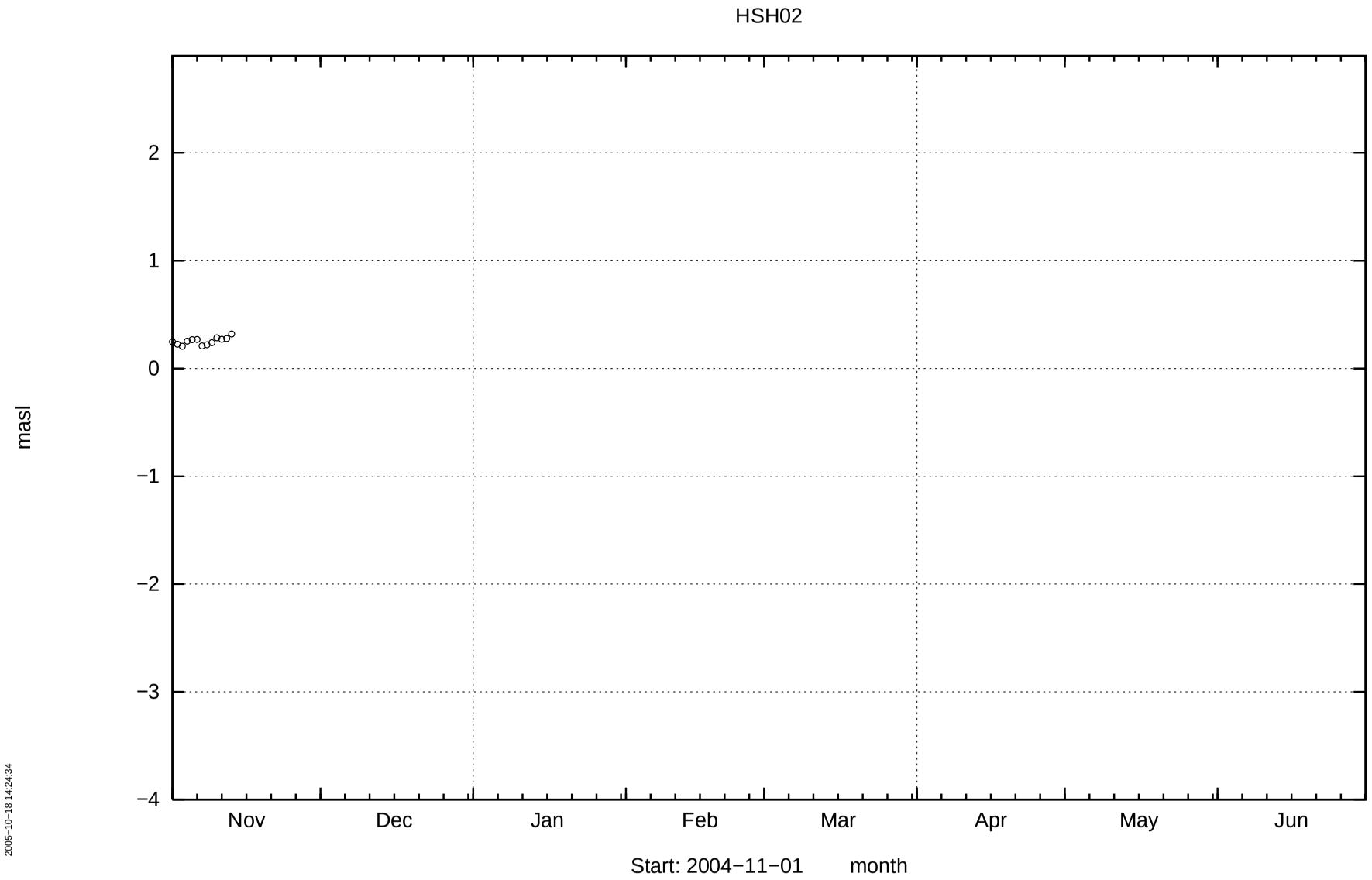

HLX30
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:33

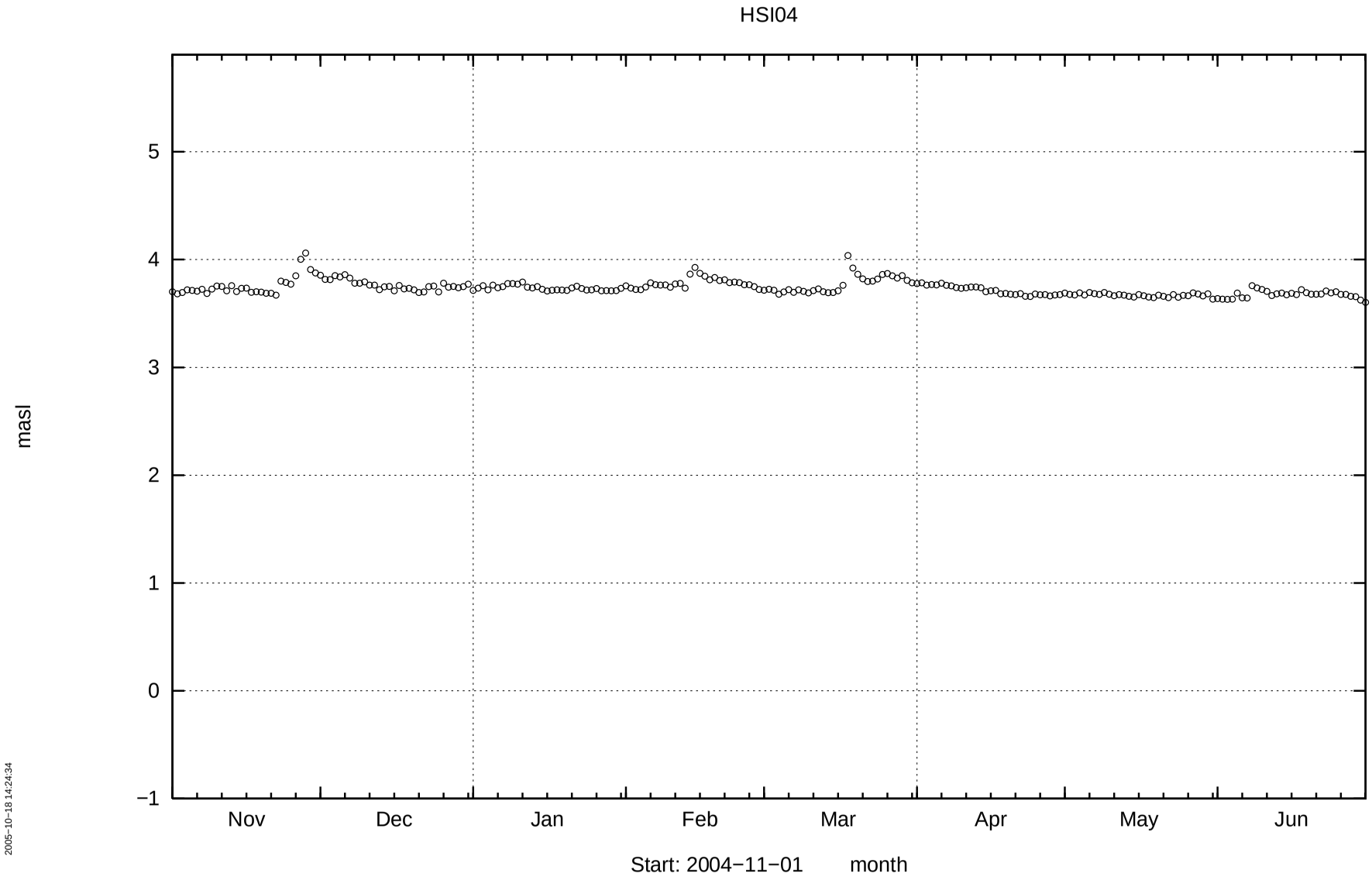

HLX31
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:33

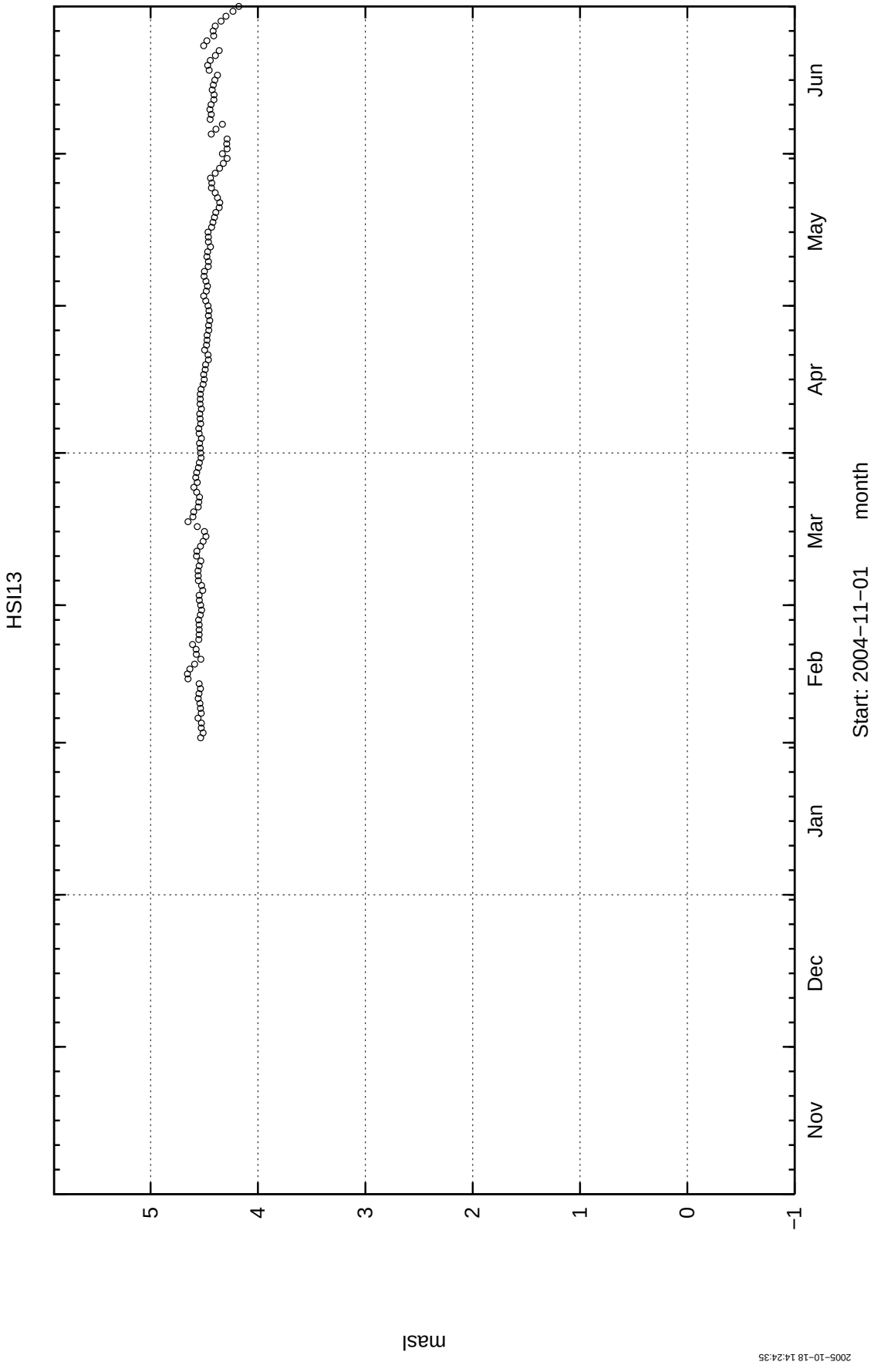

HLX33
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:33

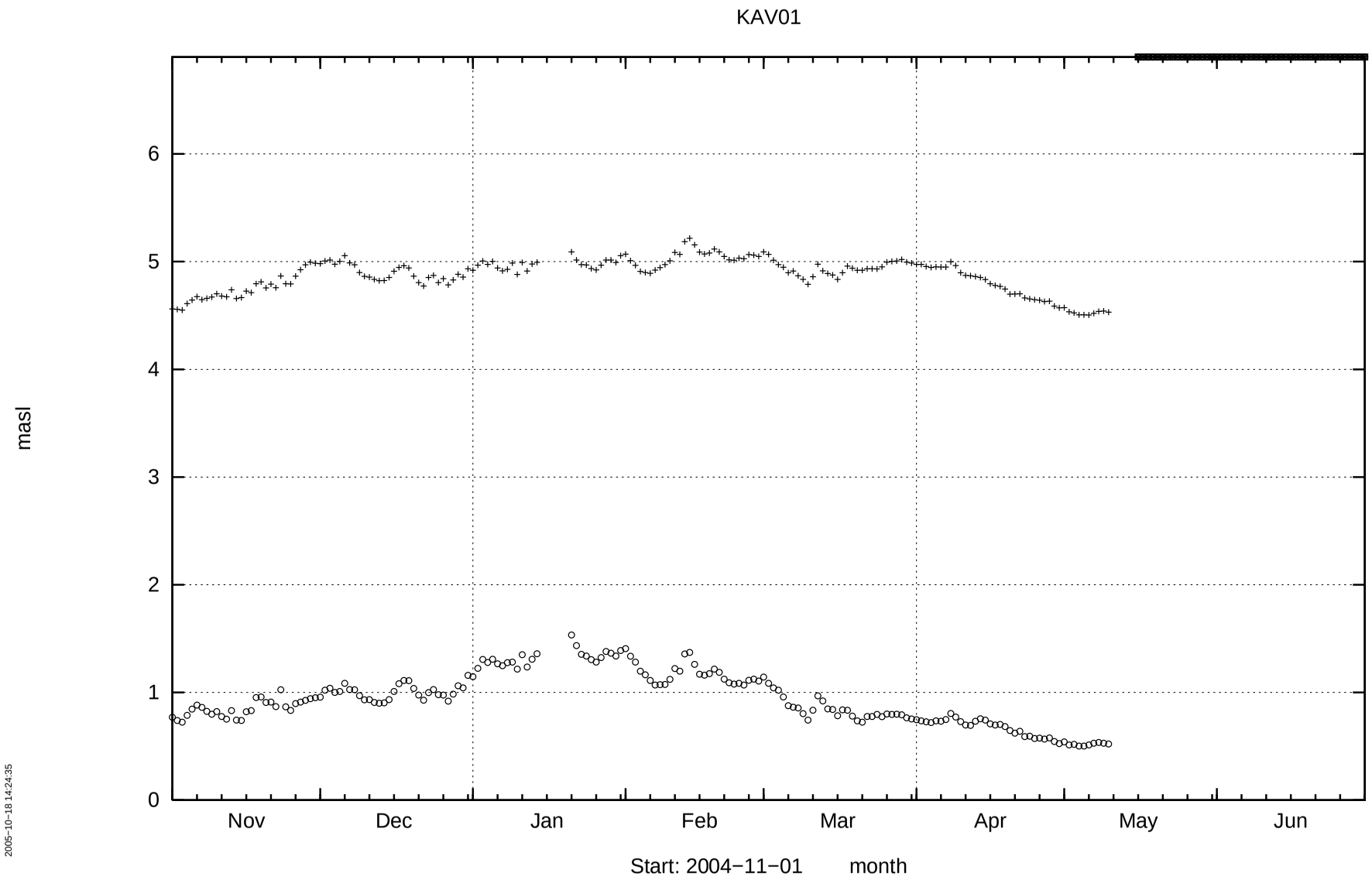

HLX35
masl
15
14
13
12
11
10
9
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004-11-01
month
2005-10-18 14:24:34

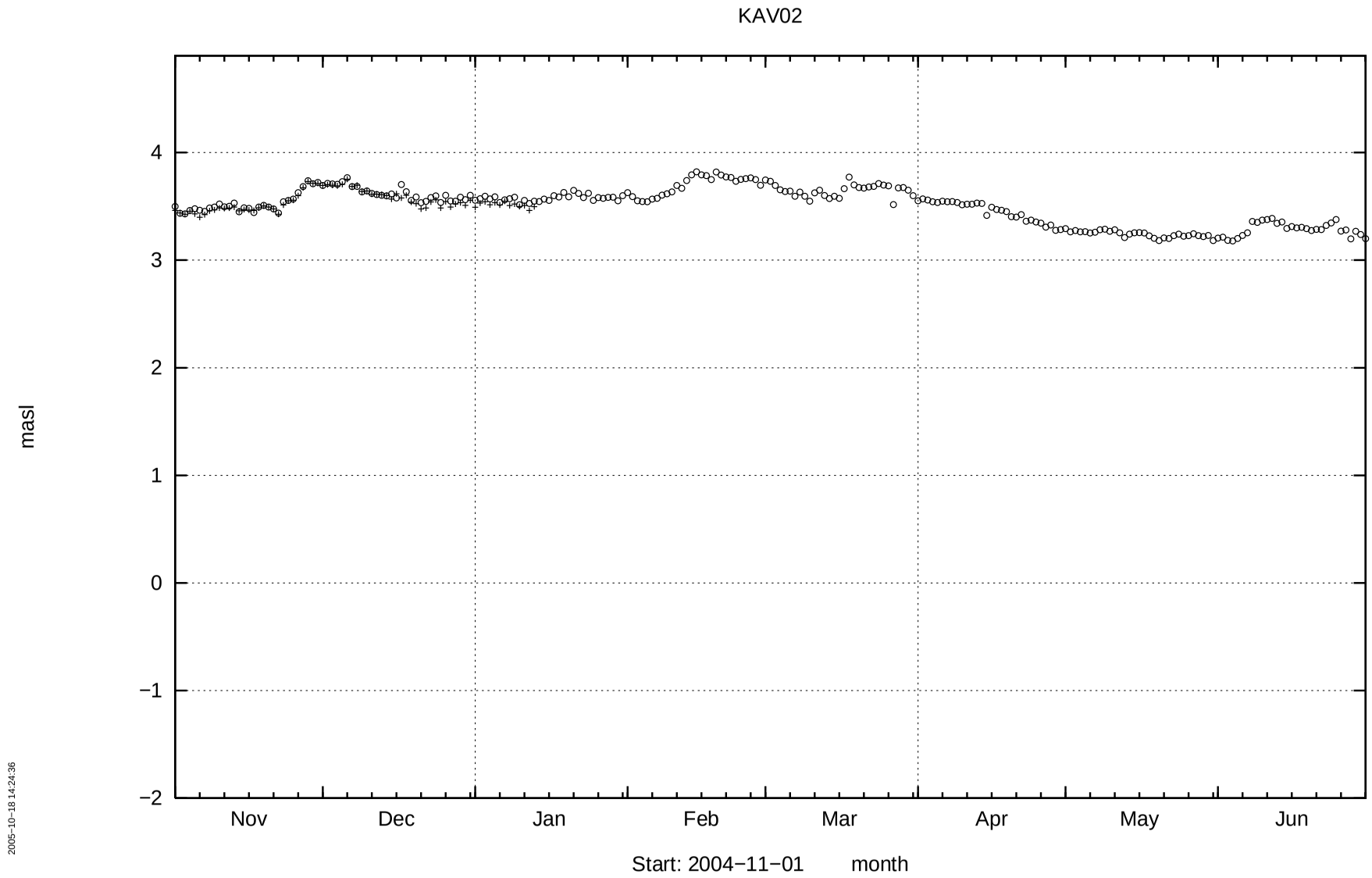

HSH01
masl
2
1
0
−1
−2
−3
−4
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:34

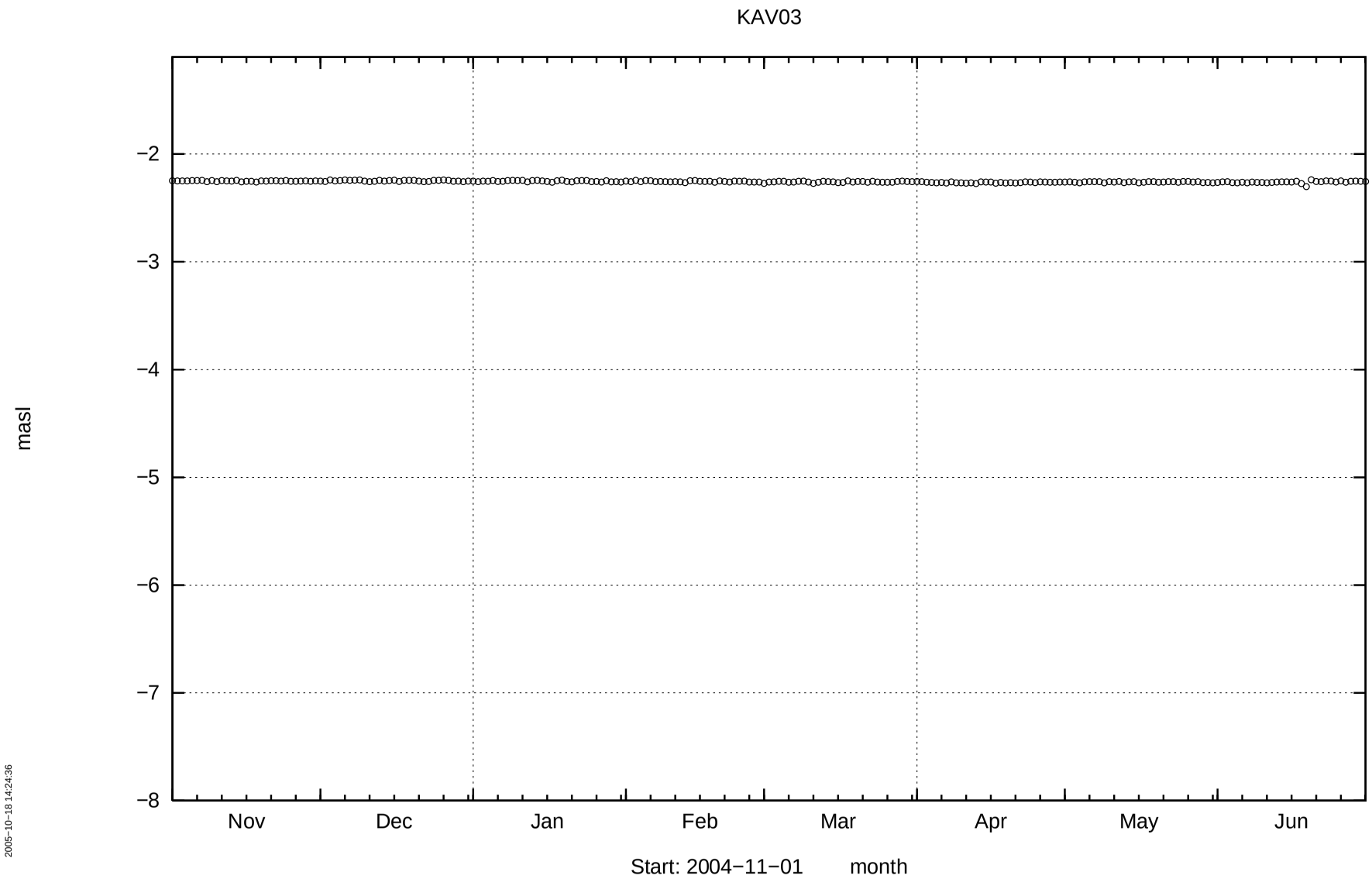

HSH02
masl
2
1
0
−1
−2
−3
−4
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:34

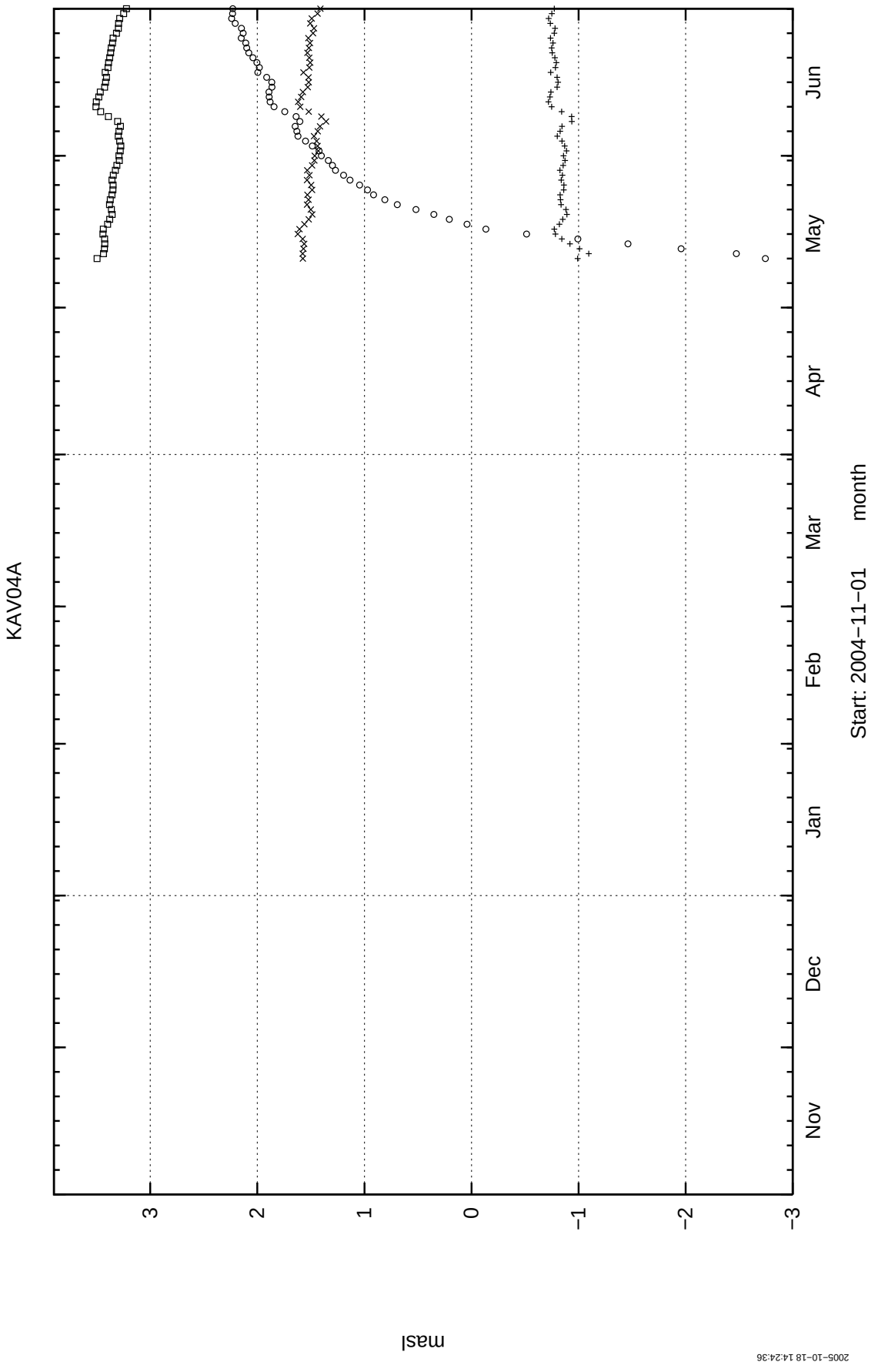

HSI04
masl
5
4
3
2
1
0
−1
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:34

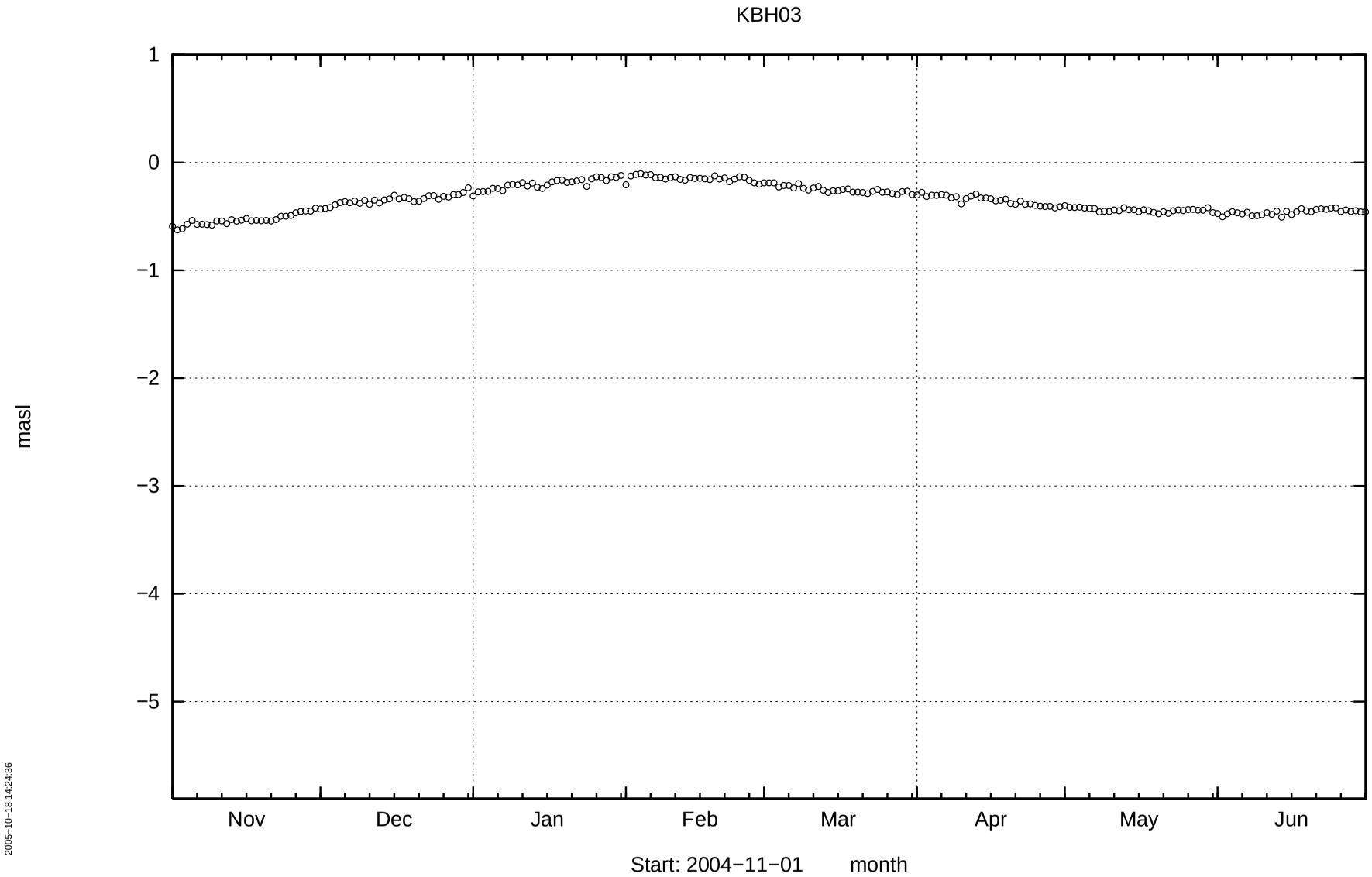

HSI13
masl
5
4
3
2
1
0
−1
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:35

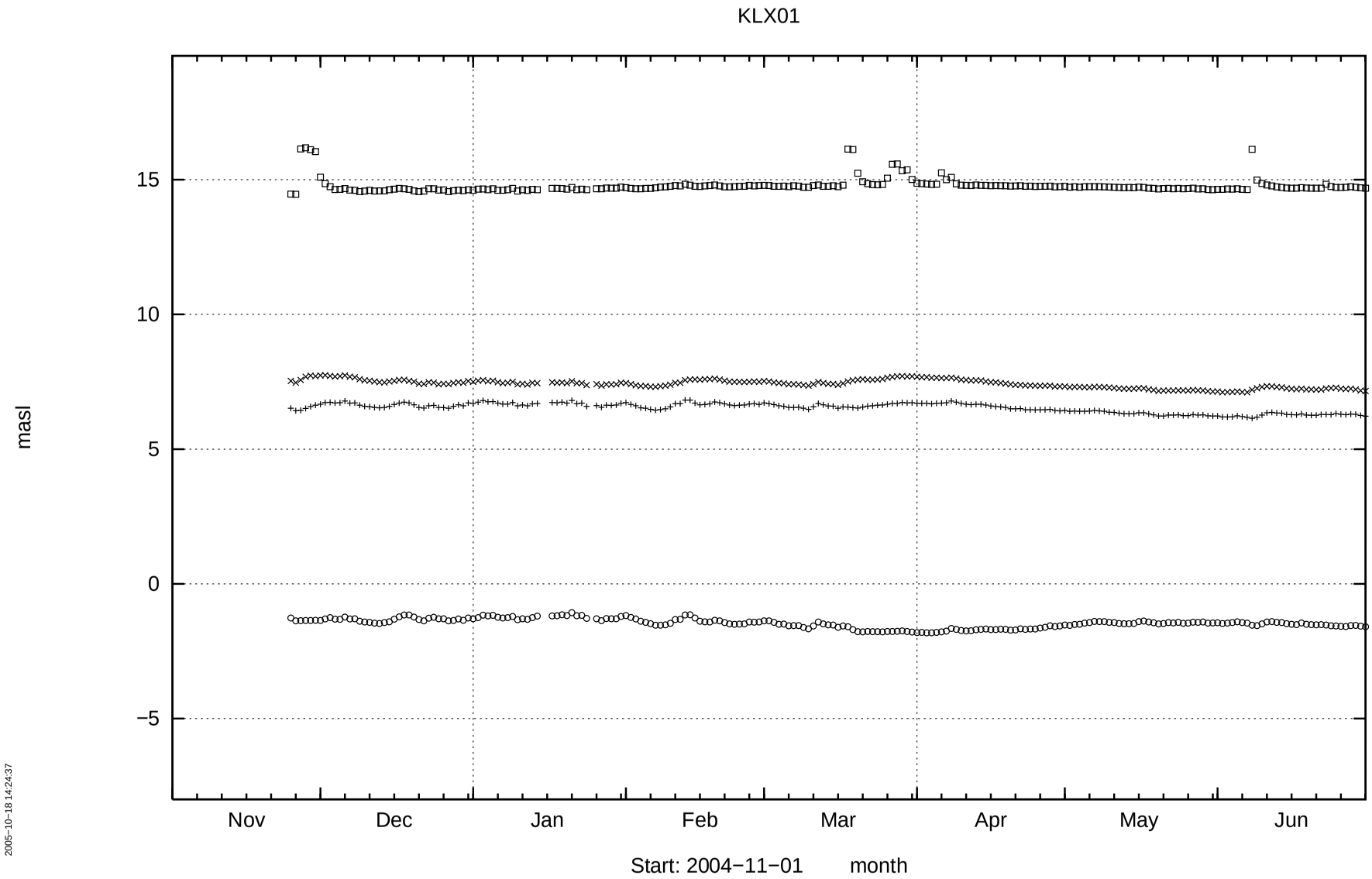

KAV01
masl
0
1
2
3
4
5
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:35

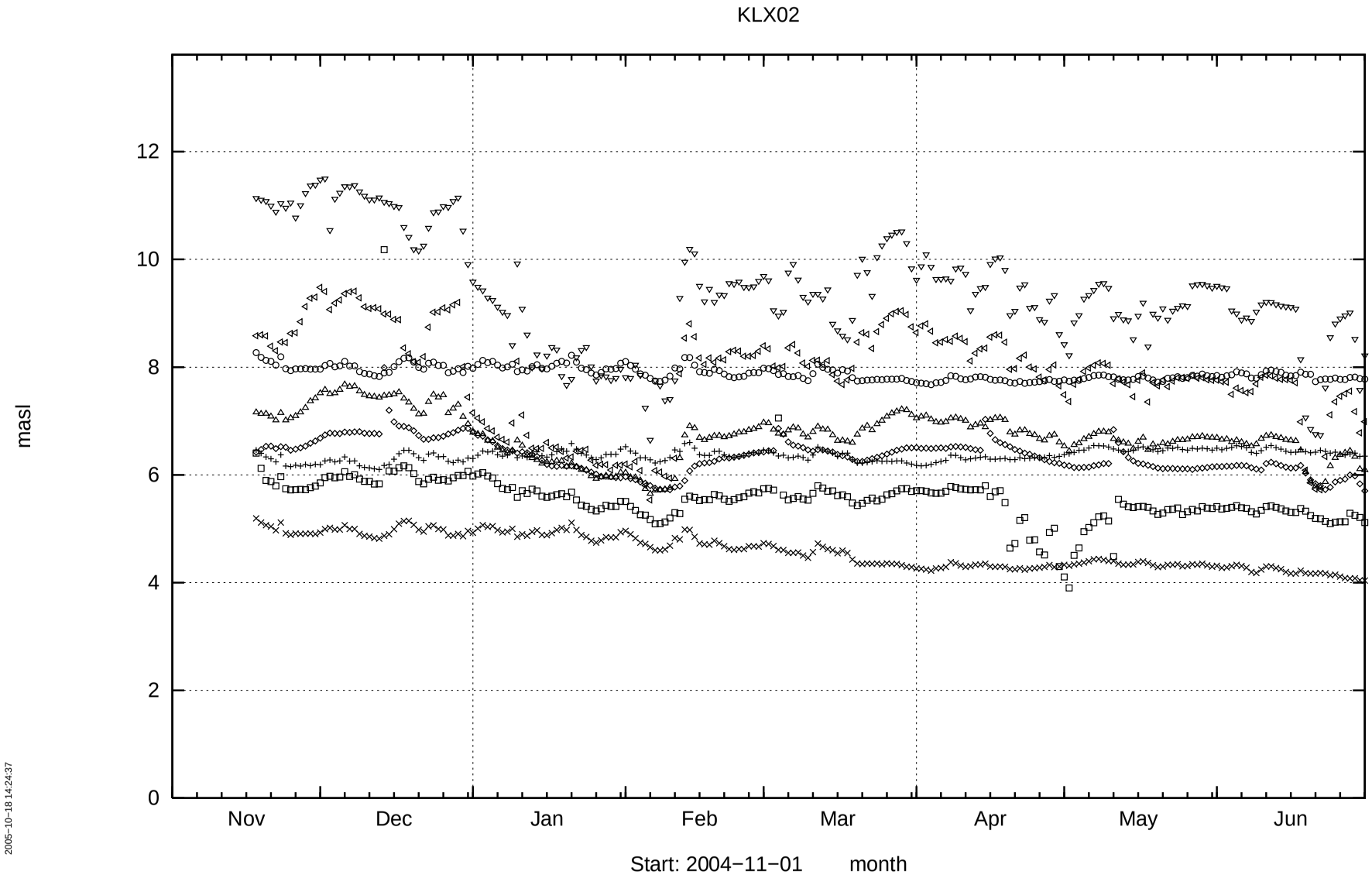

KAV02
masl
4
3
2
1
0
−1
−2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:36

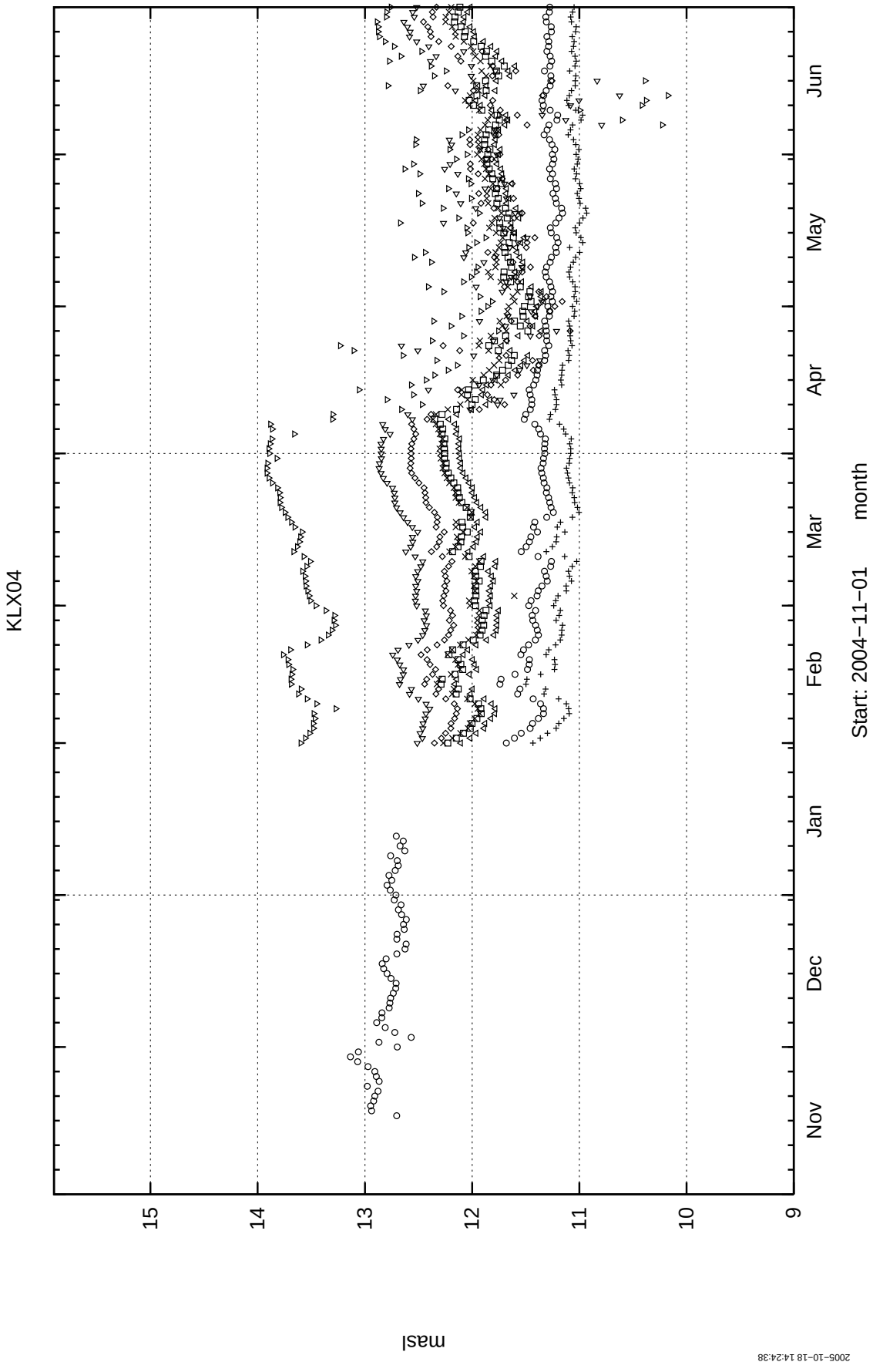

KAV03
masl
−2
−3
−4
−5
−6
−7
−8
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:36

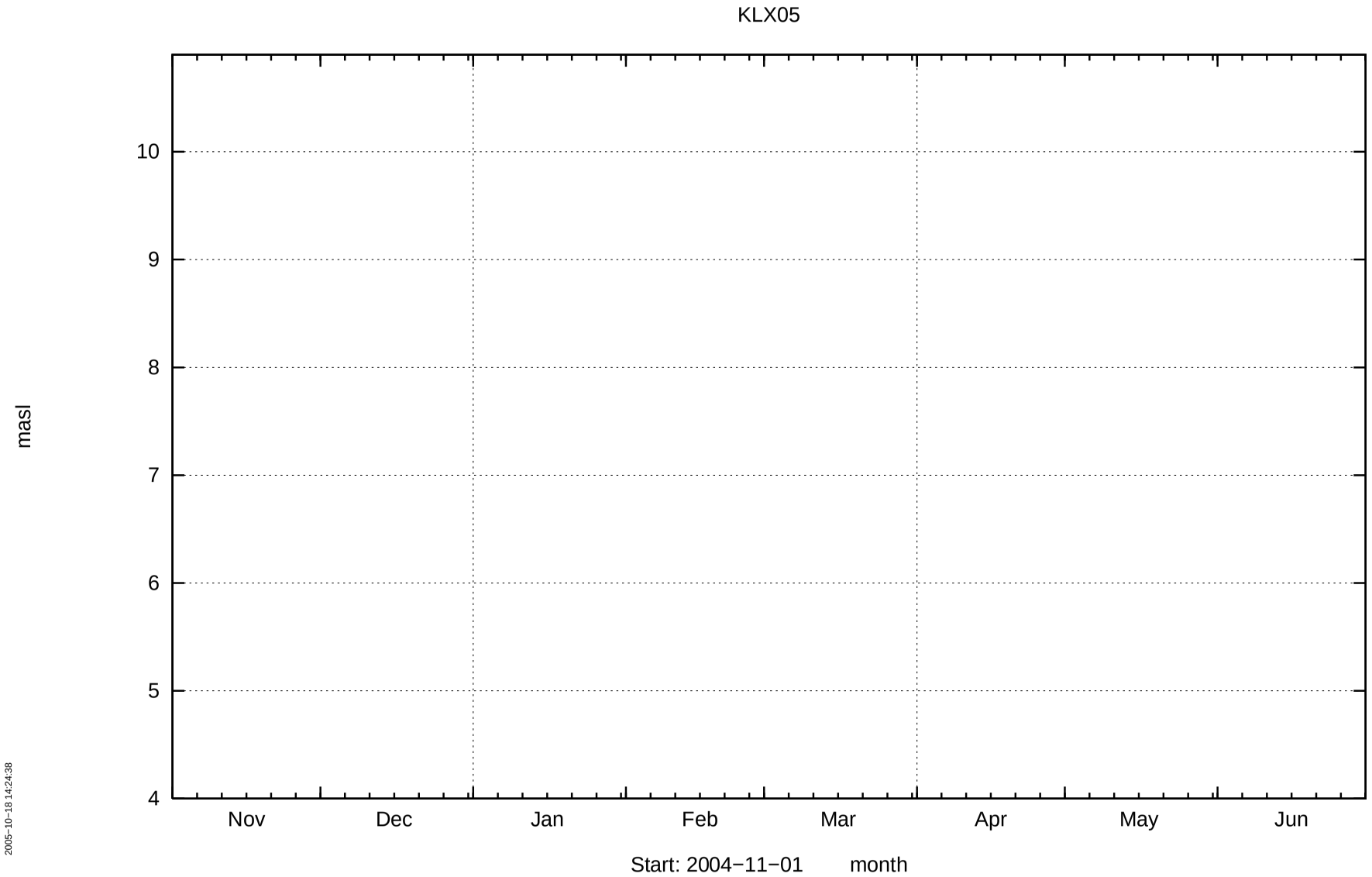

KAV04A
masl
3
2
1
0
−1
−2
−3
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:36

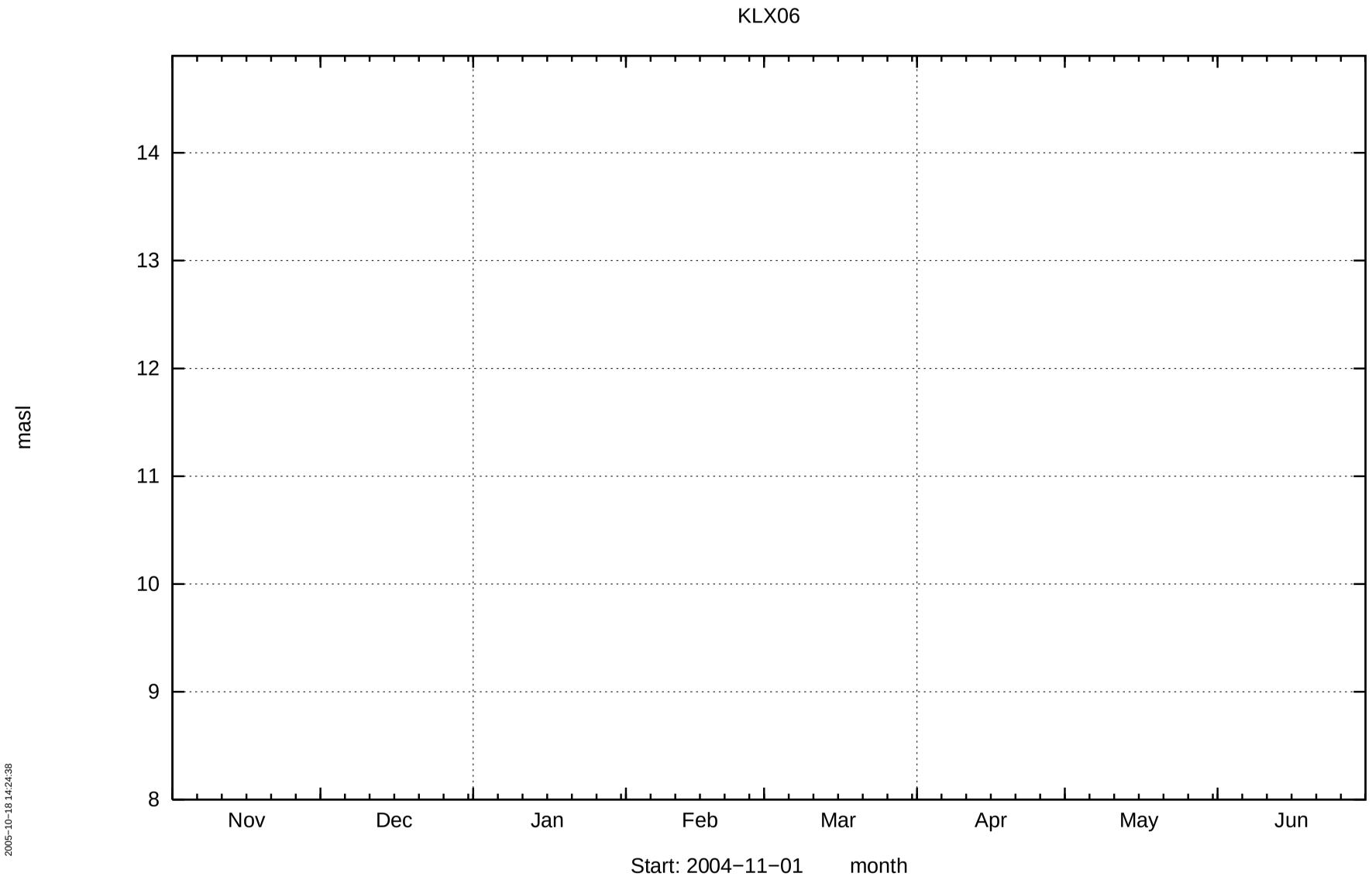

KBH03
masl
1
0
−1
−2
−3
−4
−5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:36

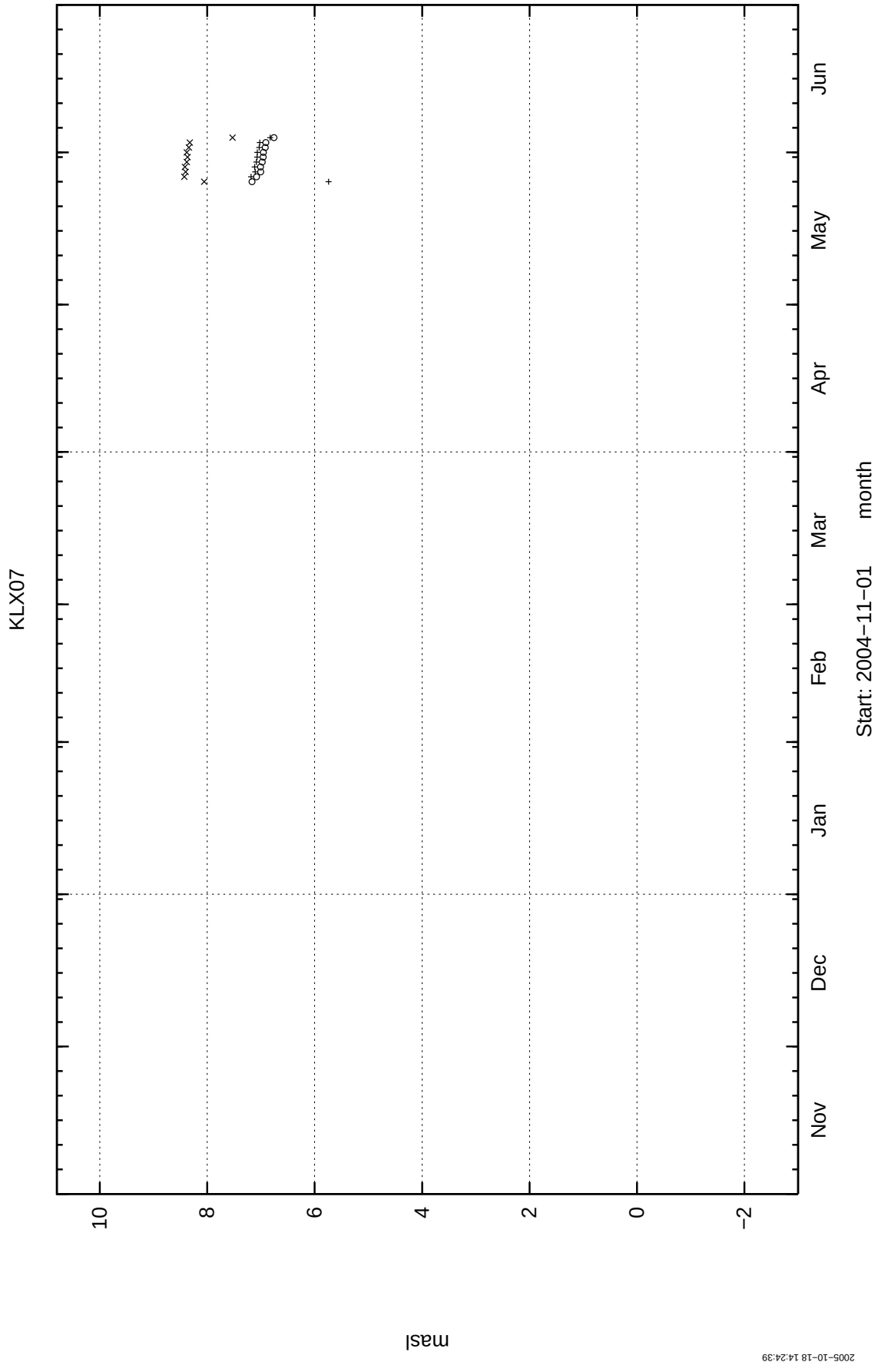

KLX01
masl
15
10
5
0
−5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:37

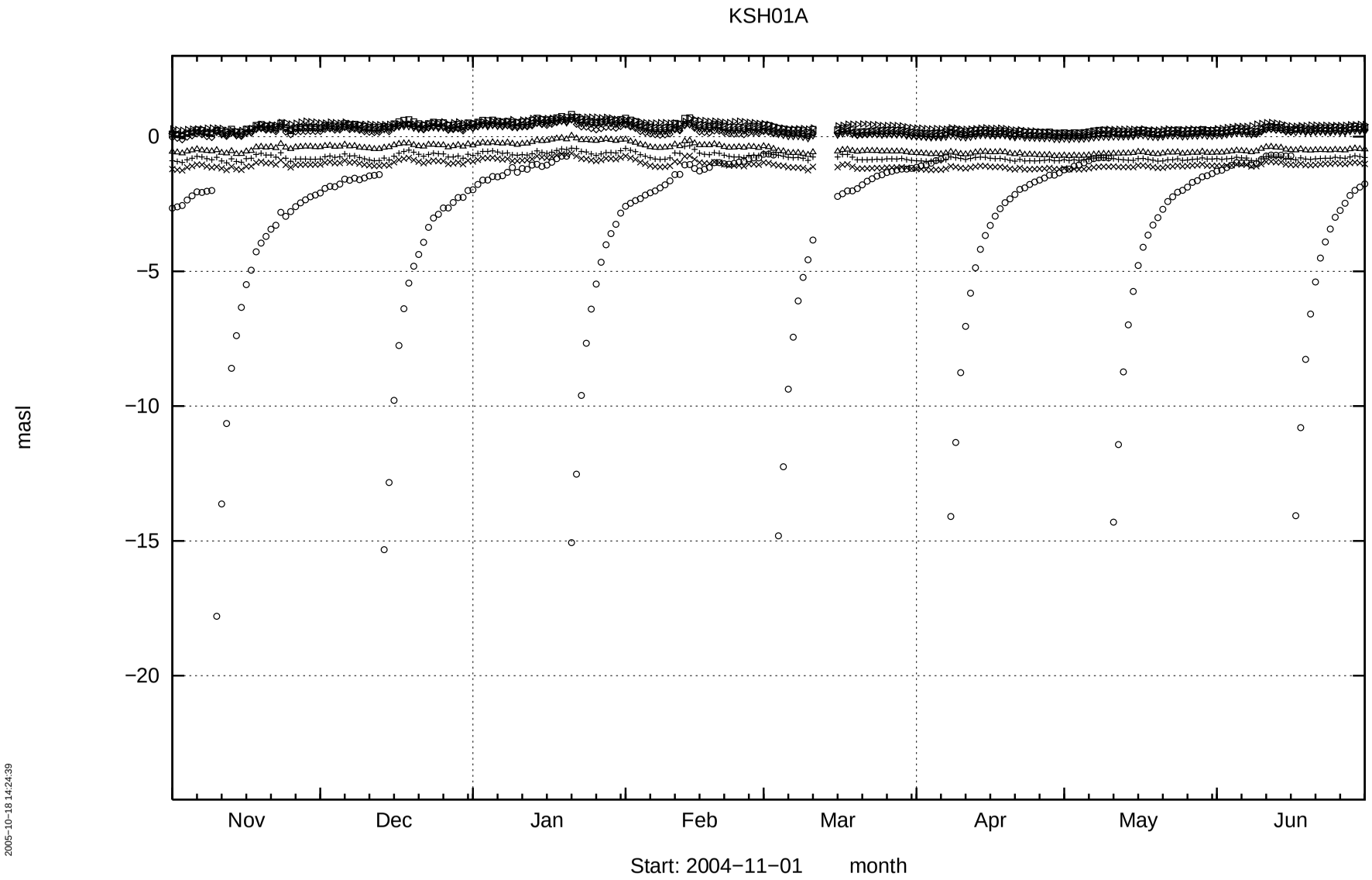

KLX02
masl
12
10
8
6
4
2
0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:37

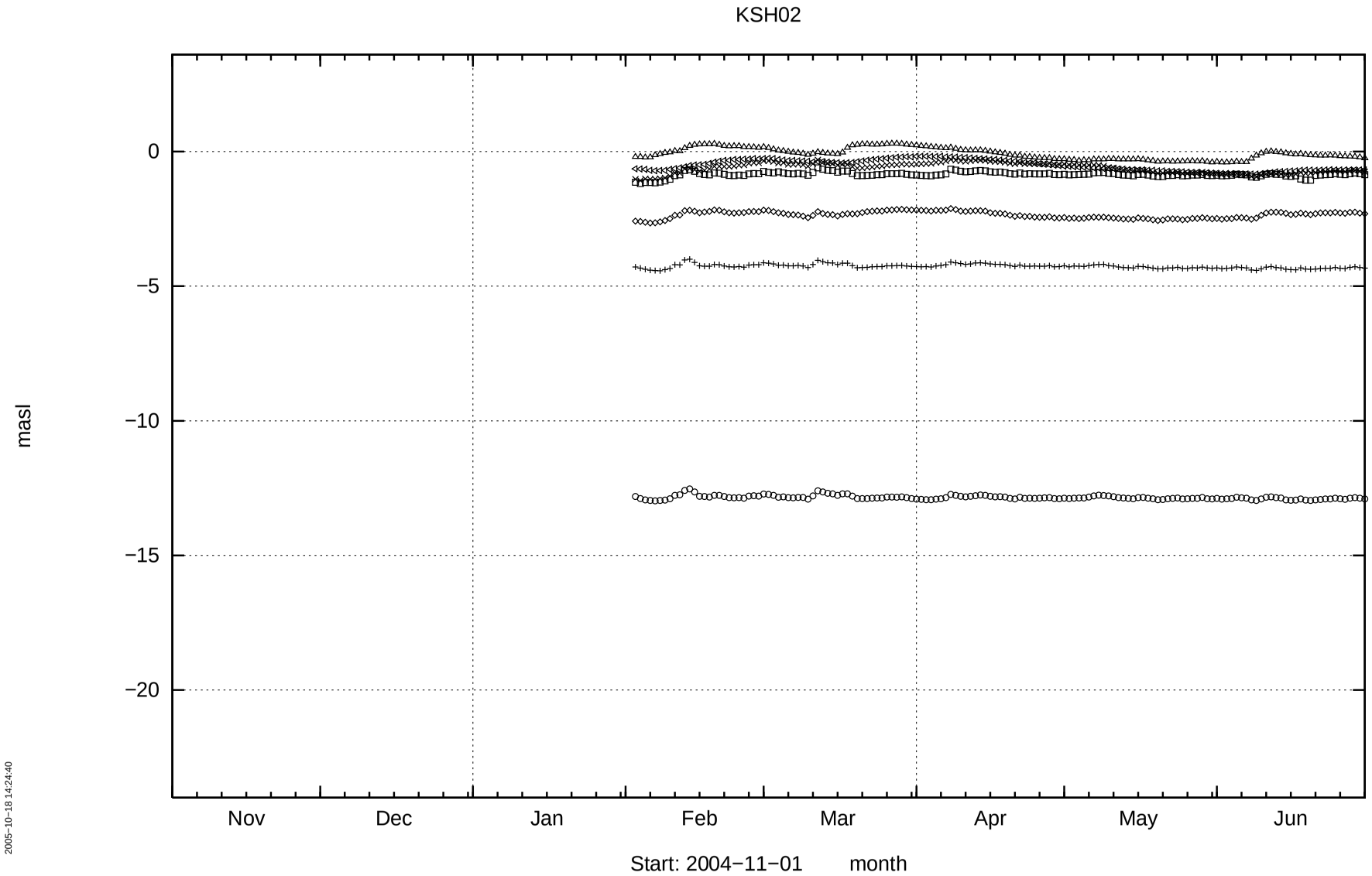

KLX04
masl
15
14
13
12
11
10
9
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004-11-01
month
2005-10-18 14:24:38

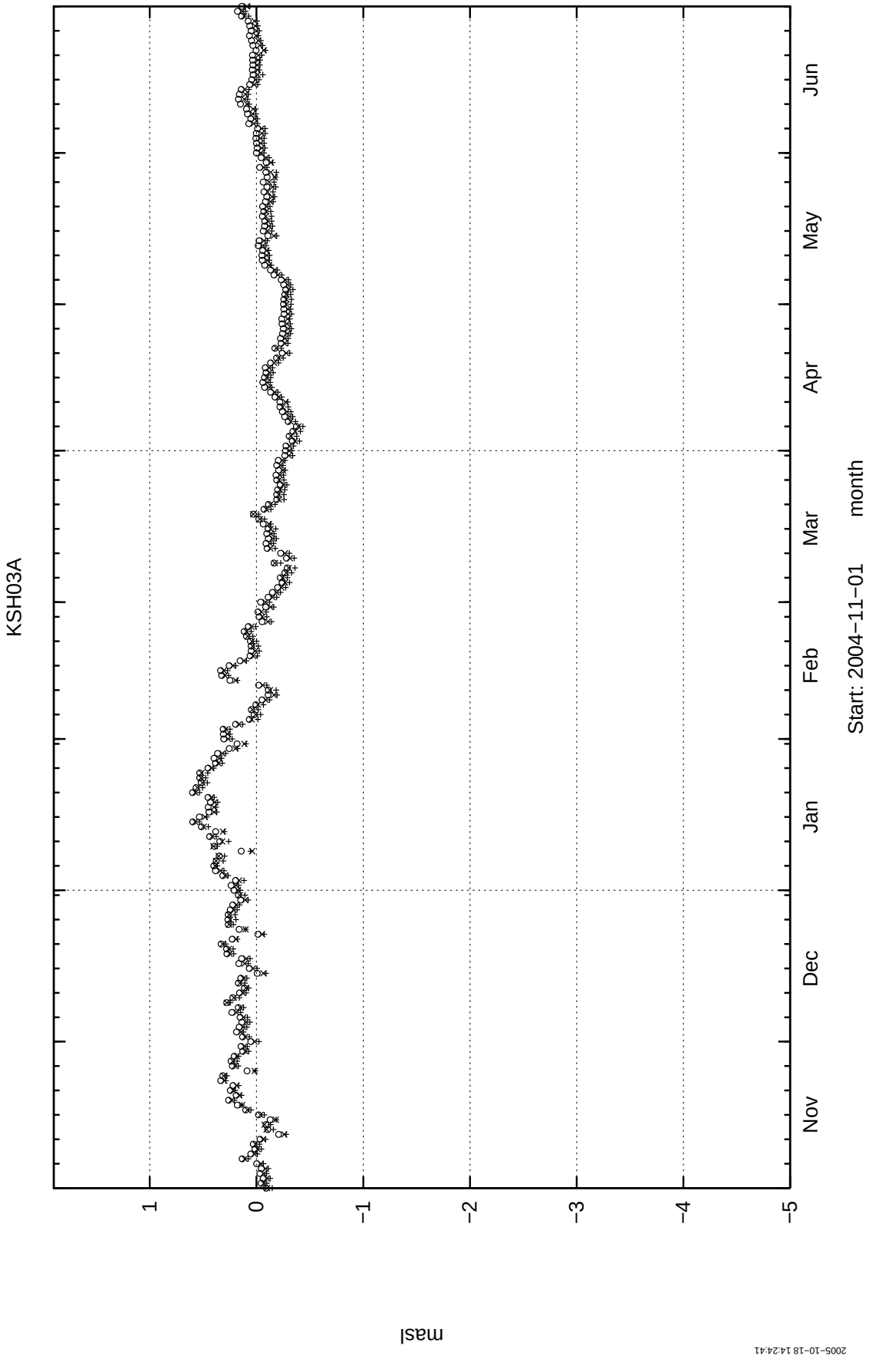

KLX05
masl
10
9
8
7
6
5
4
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:38

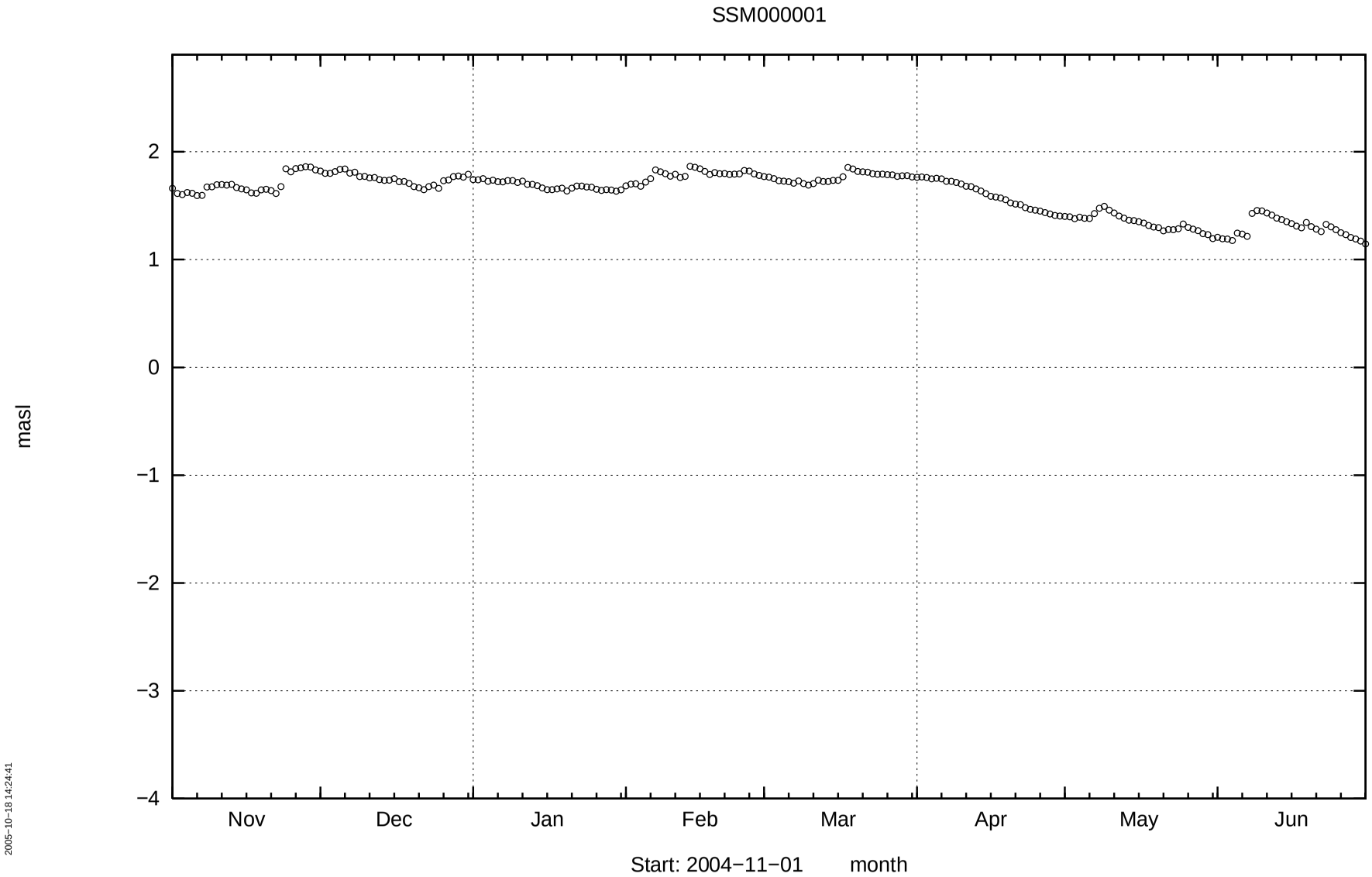

KLX06
masl
14
13
12
11
10
9
8
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:38

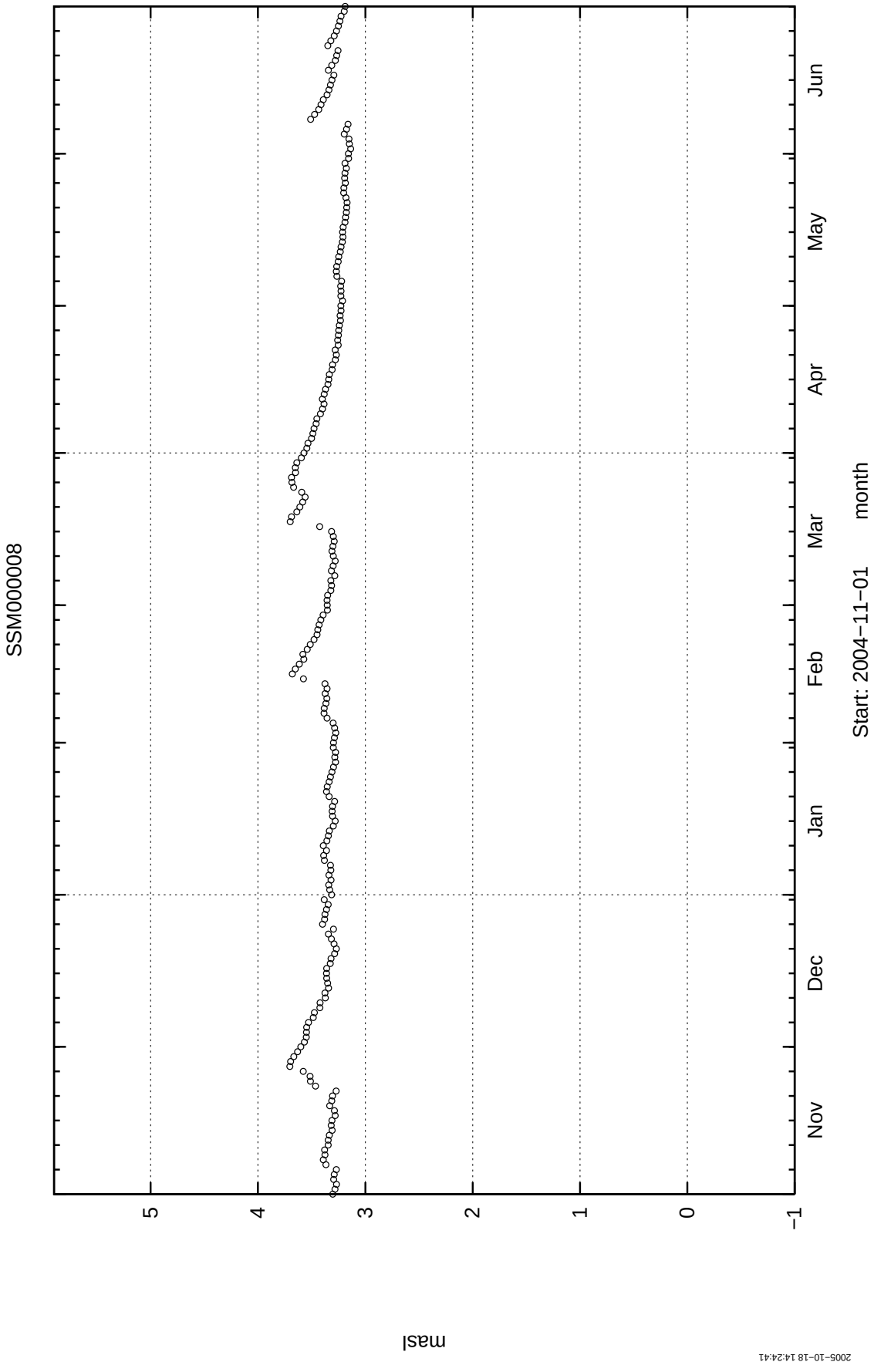

KLX07
masl
10
8
6
4
2
0
−2
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:39

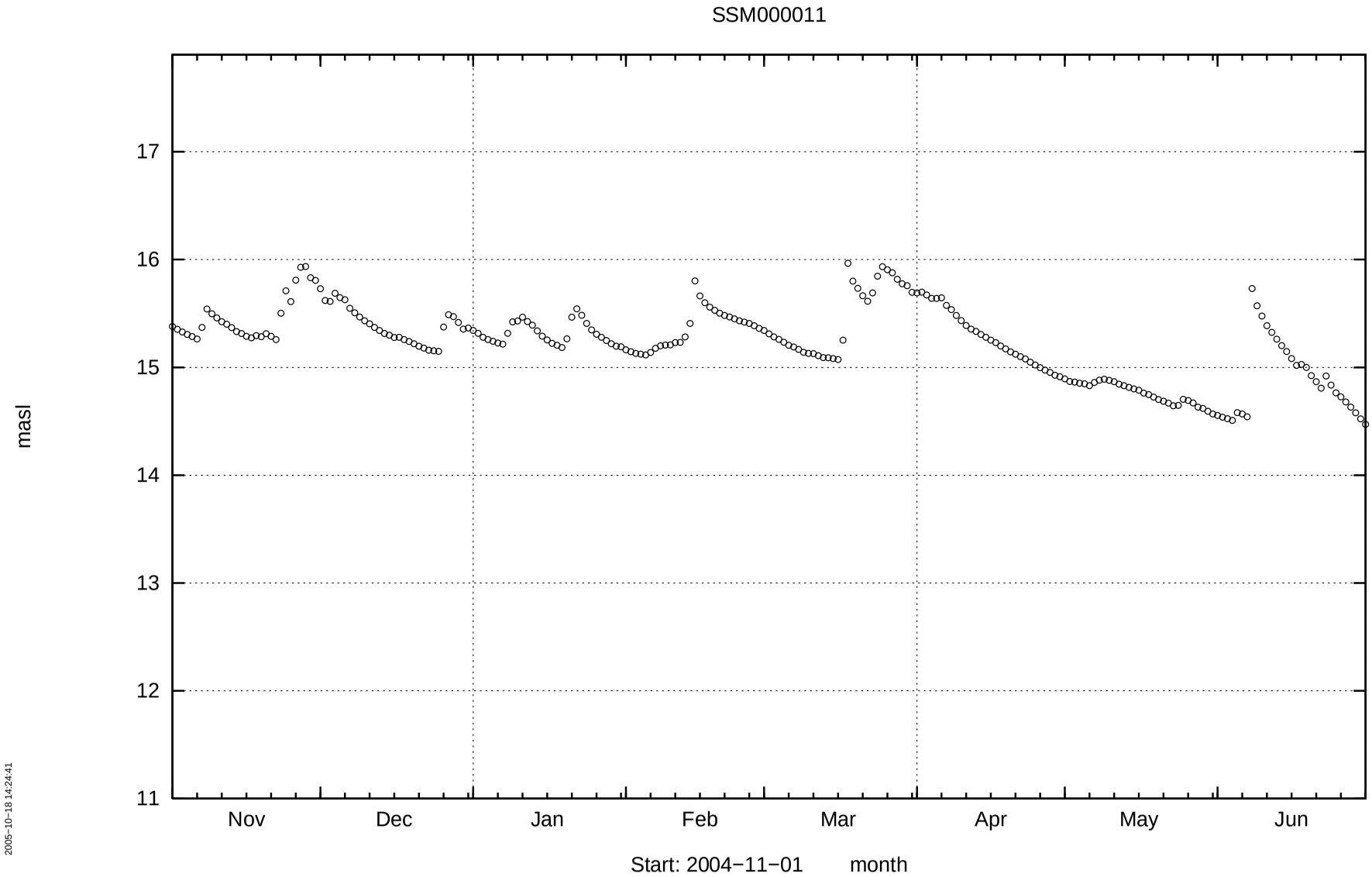

KSH01A
0
−5
−10
−15
−20
masl
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:39

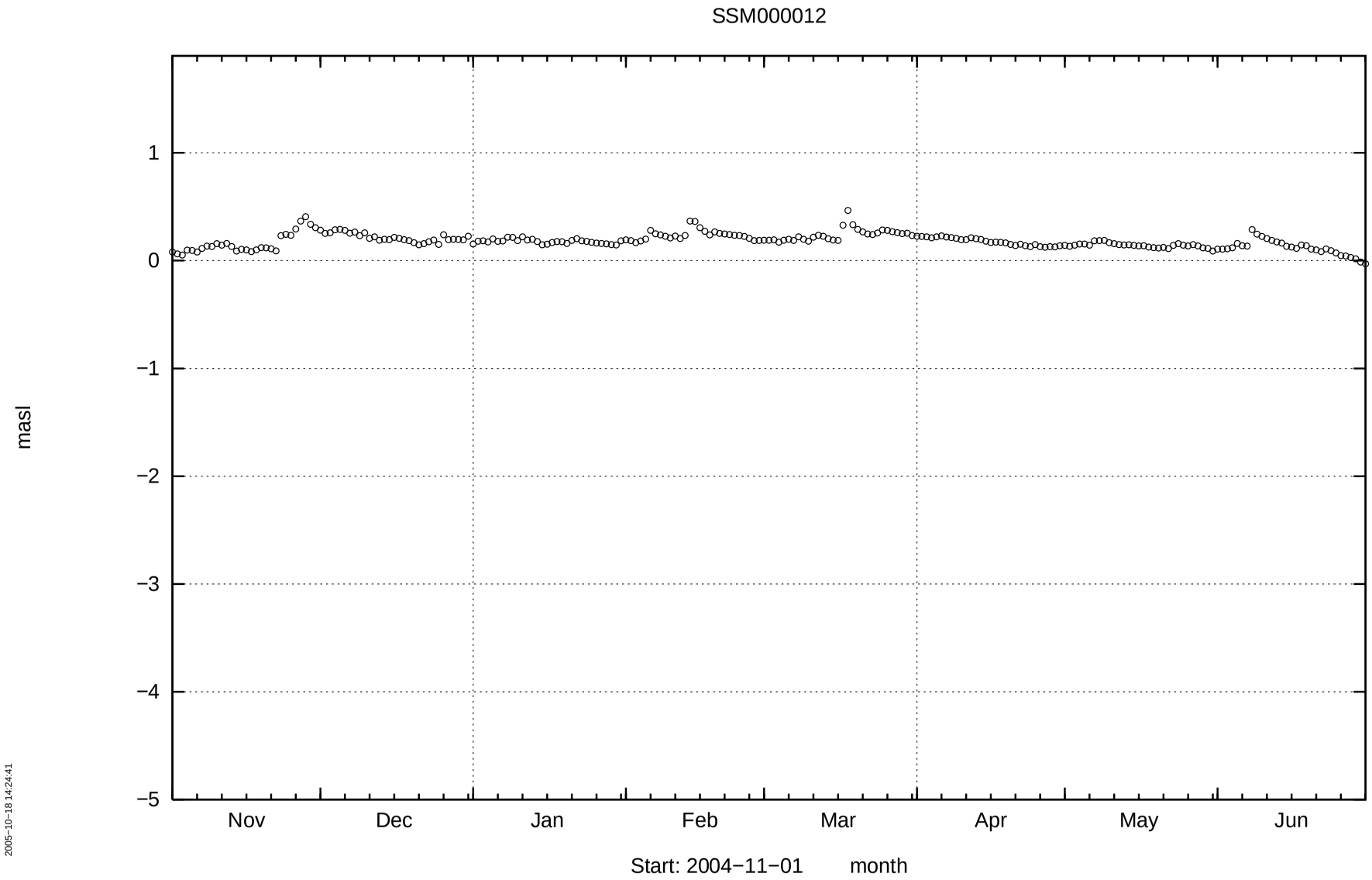

KSH02
masl
0
−5
−10
−15
−20
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:40

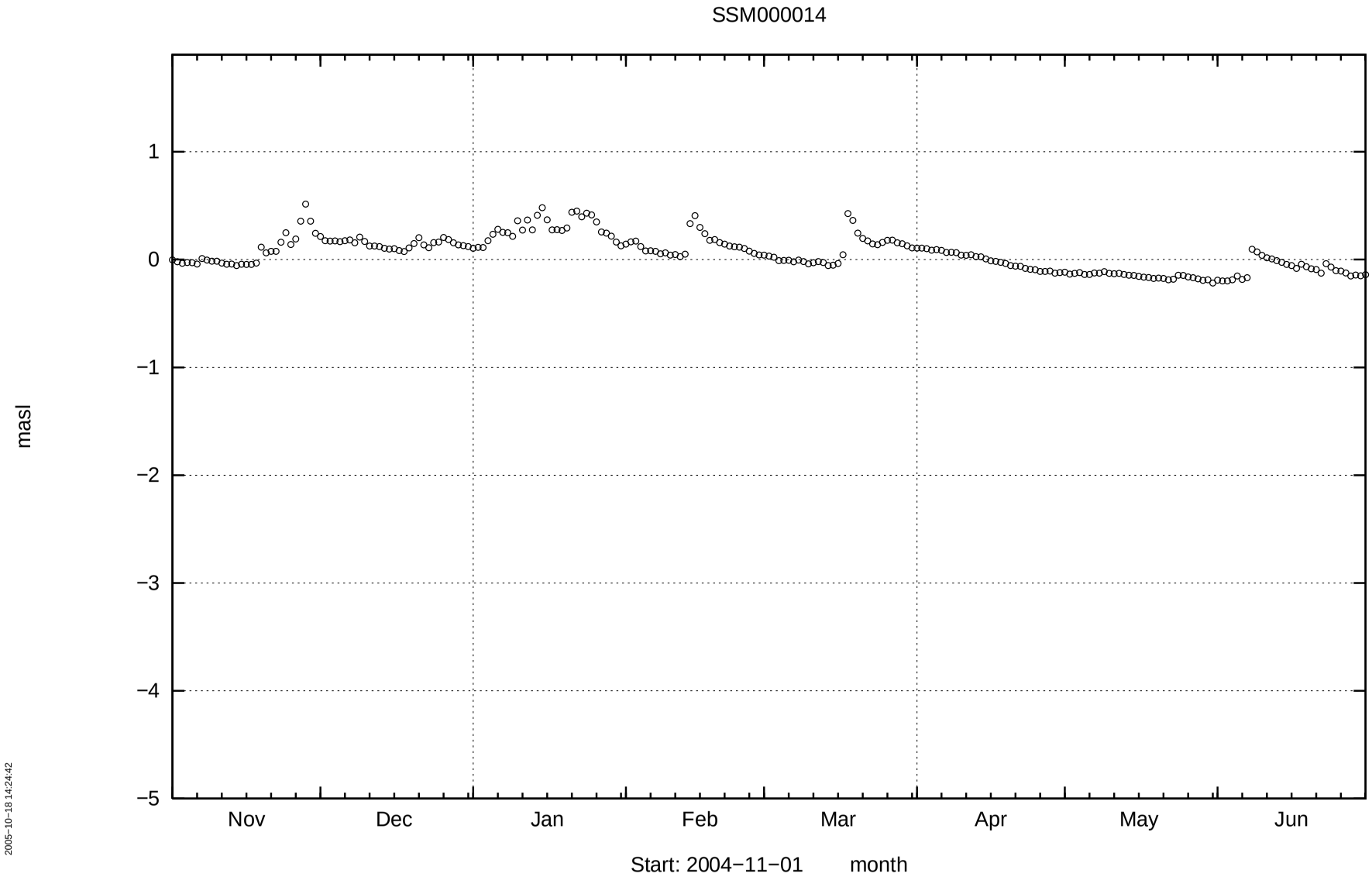

KSH03A
masl
1
0
−1
−2
−3
−4
−5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:41

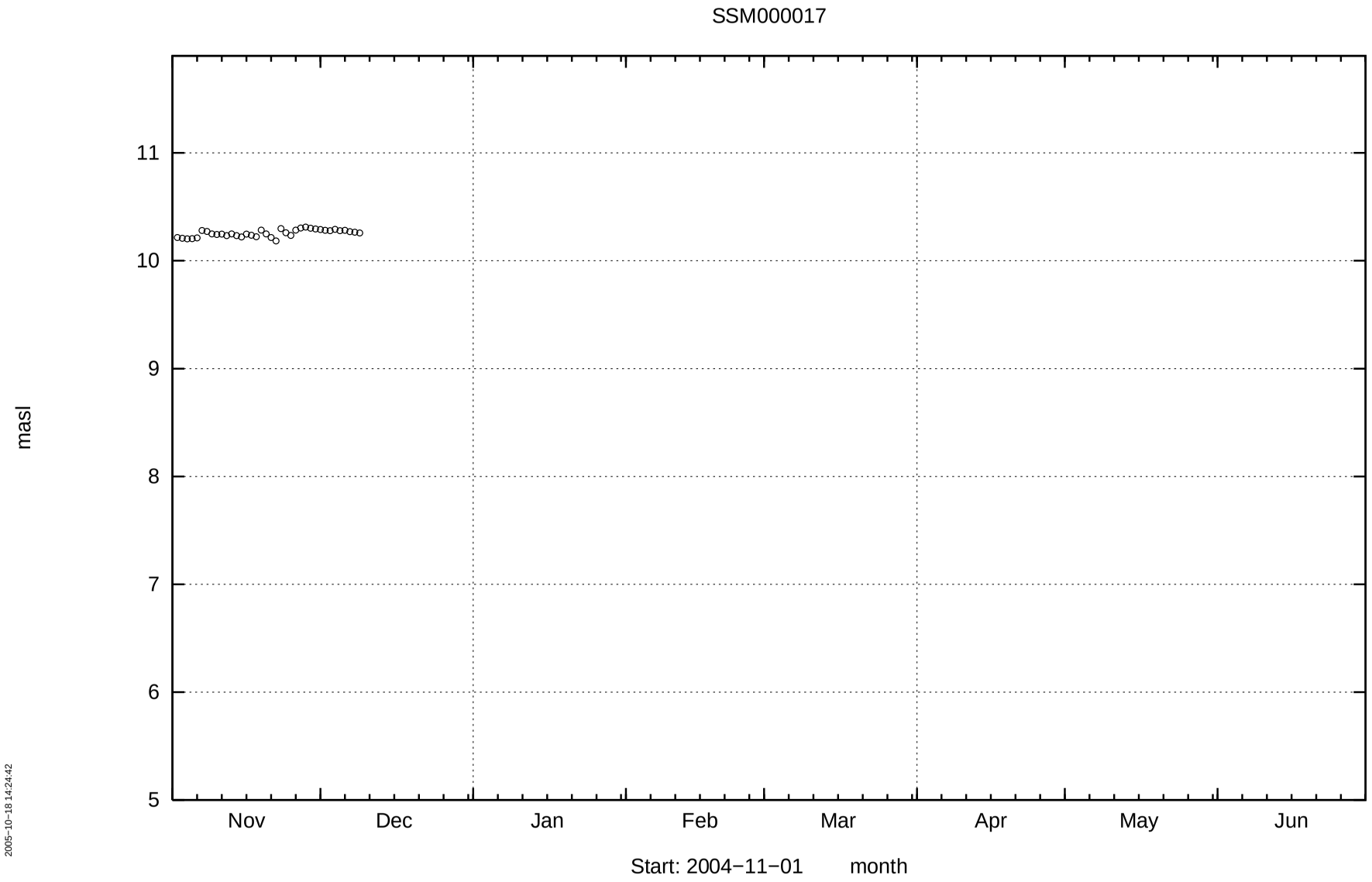

SSM000001
masl
2
1
0
−1
−2
−3
−4
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:41

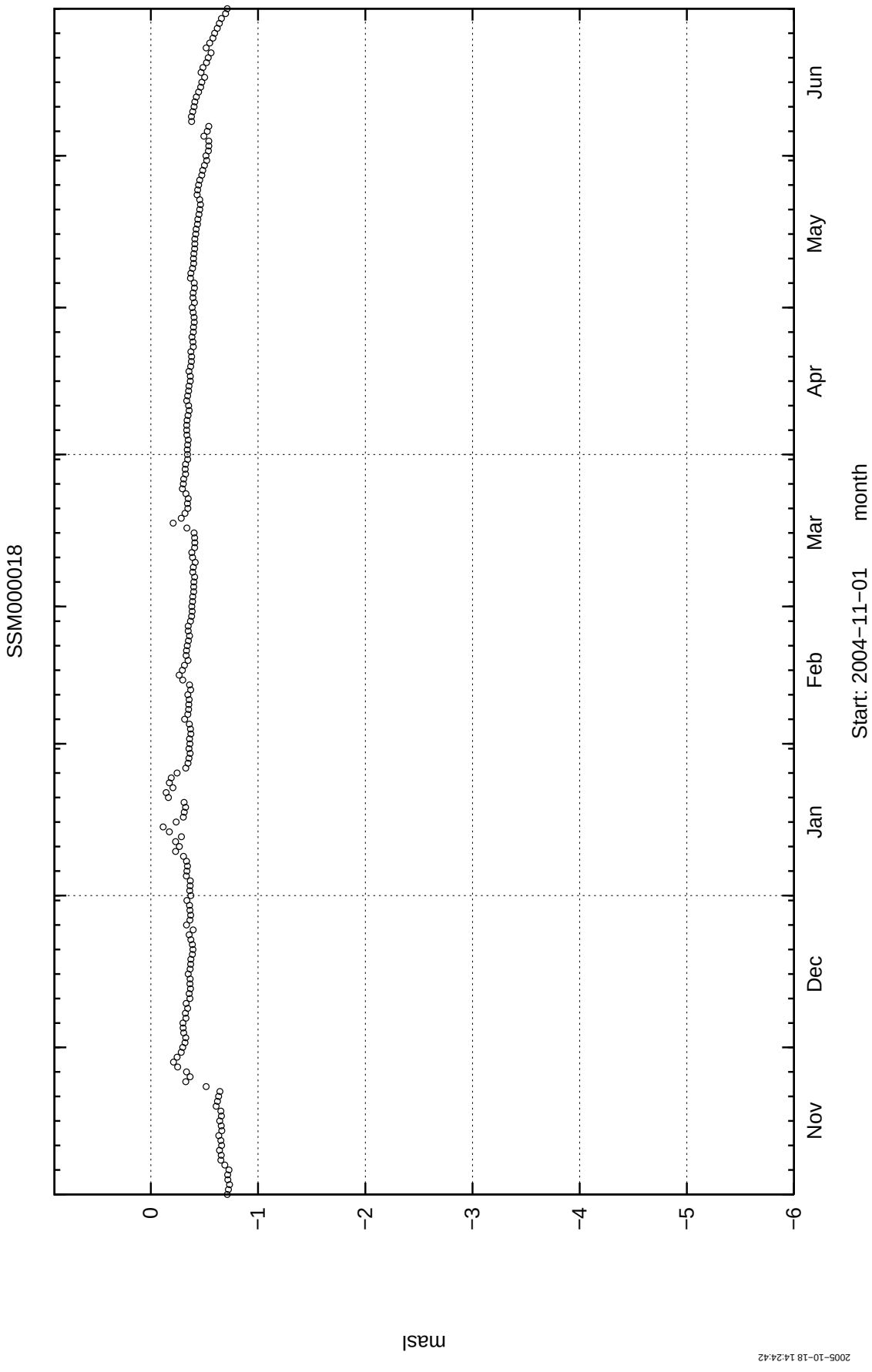

SSM000008
masl
5
4
3
2
1
0
−1
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:41

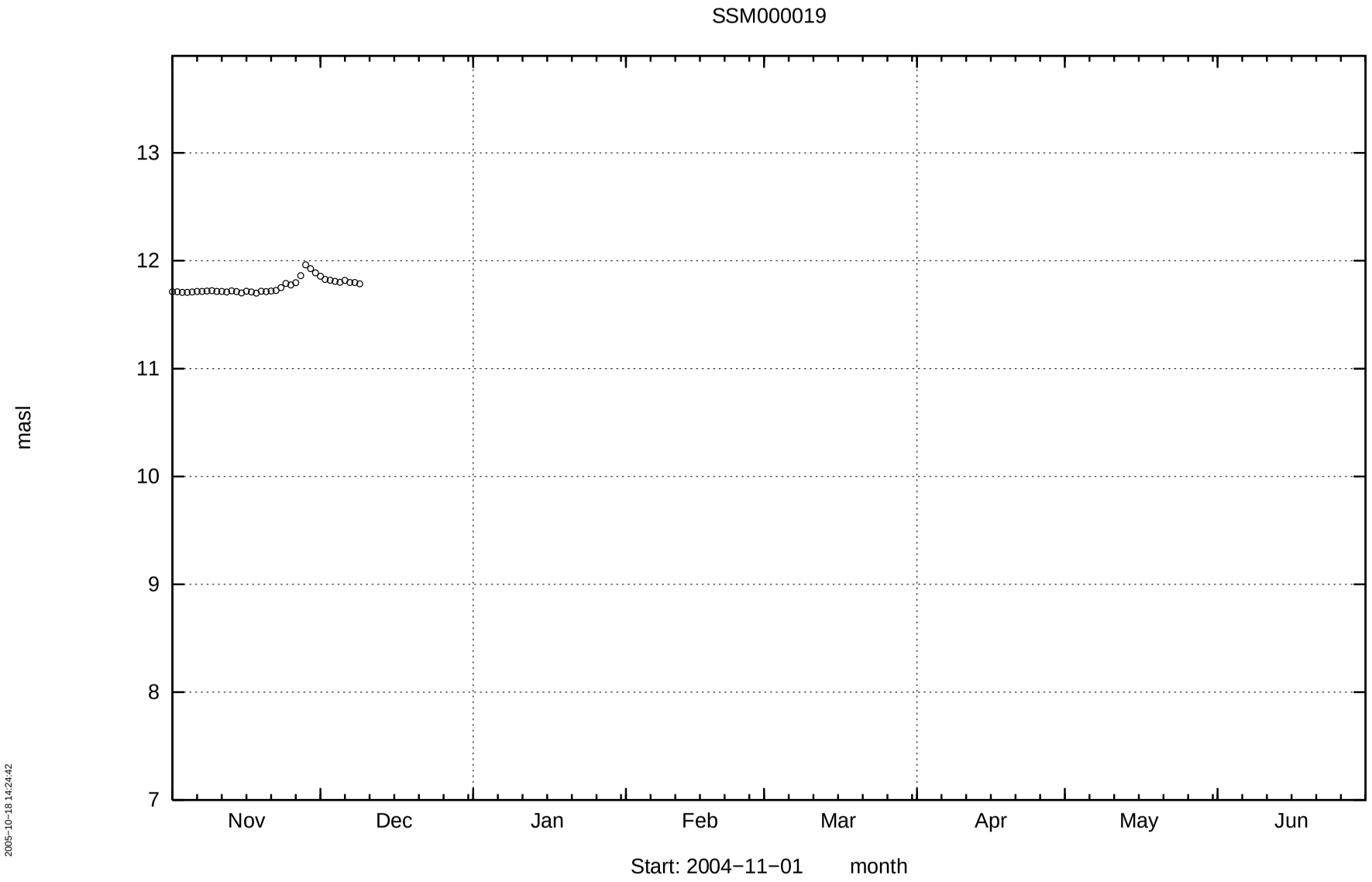

SSM000011
masl
17
16
15
14
13
12
11
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:41

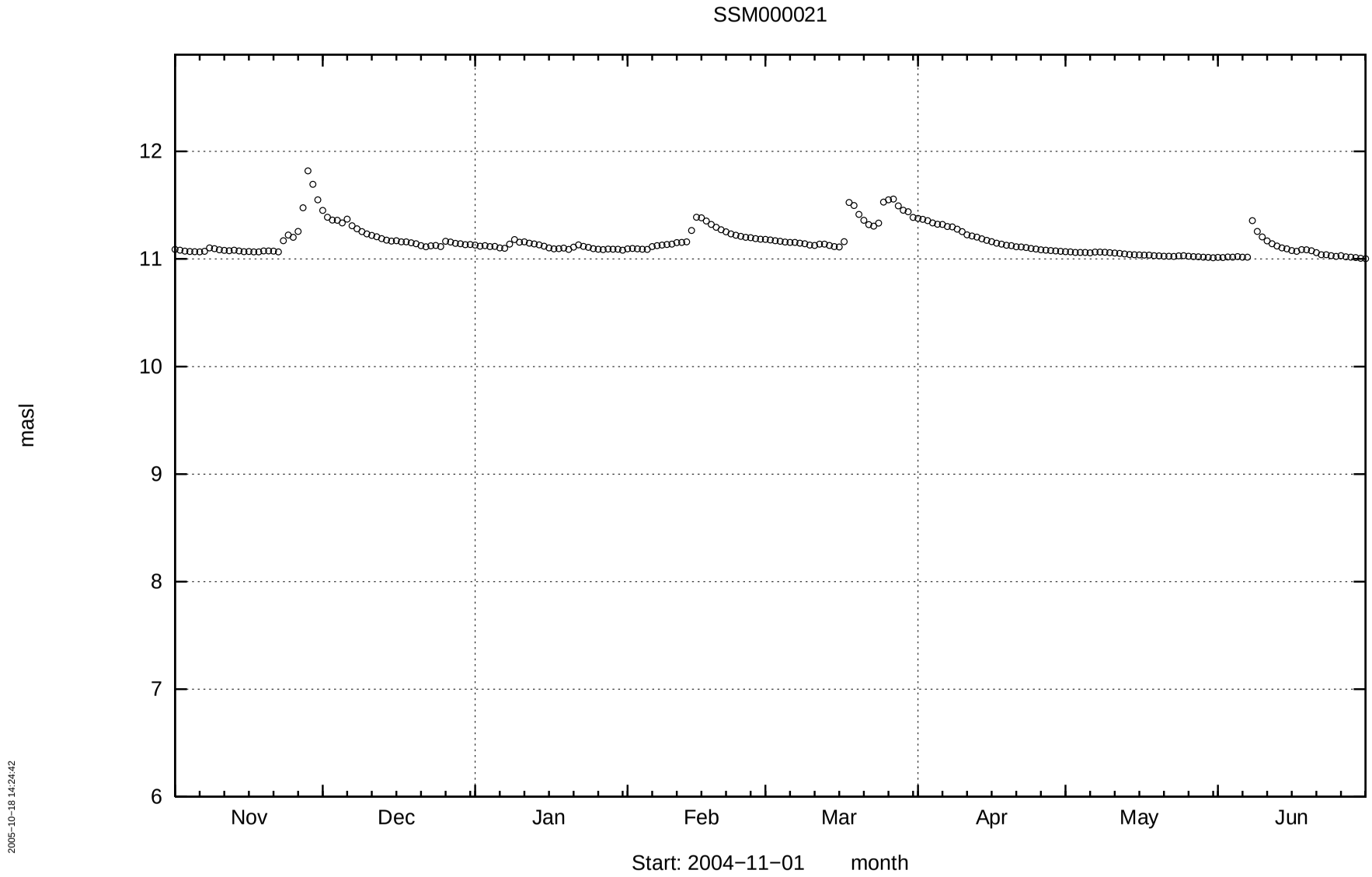

SSM000012
masl
1
0
−1
−2
−3
−4
−5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:41

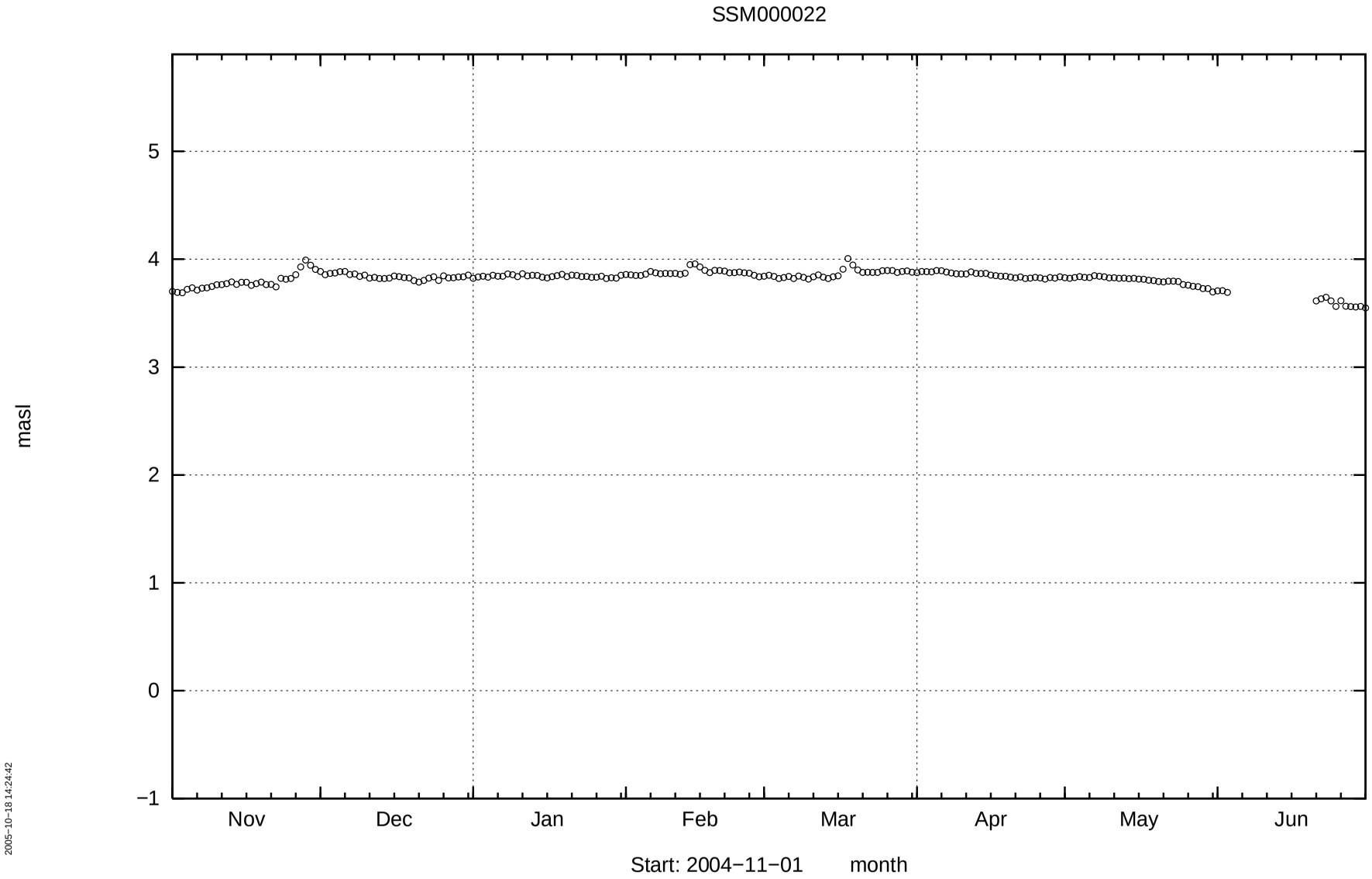

SSM000014
masl
1
0
−1
−2
−3
−4
−5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:42

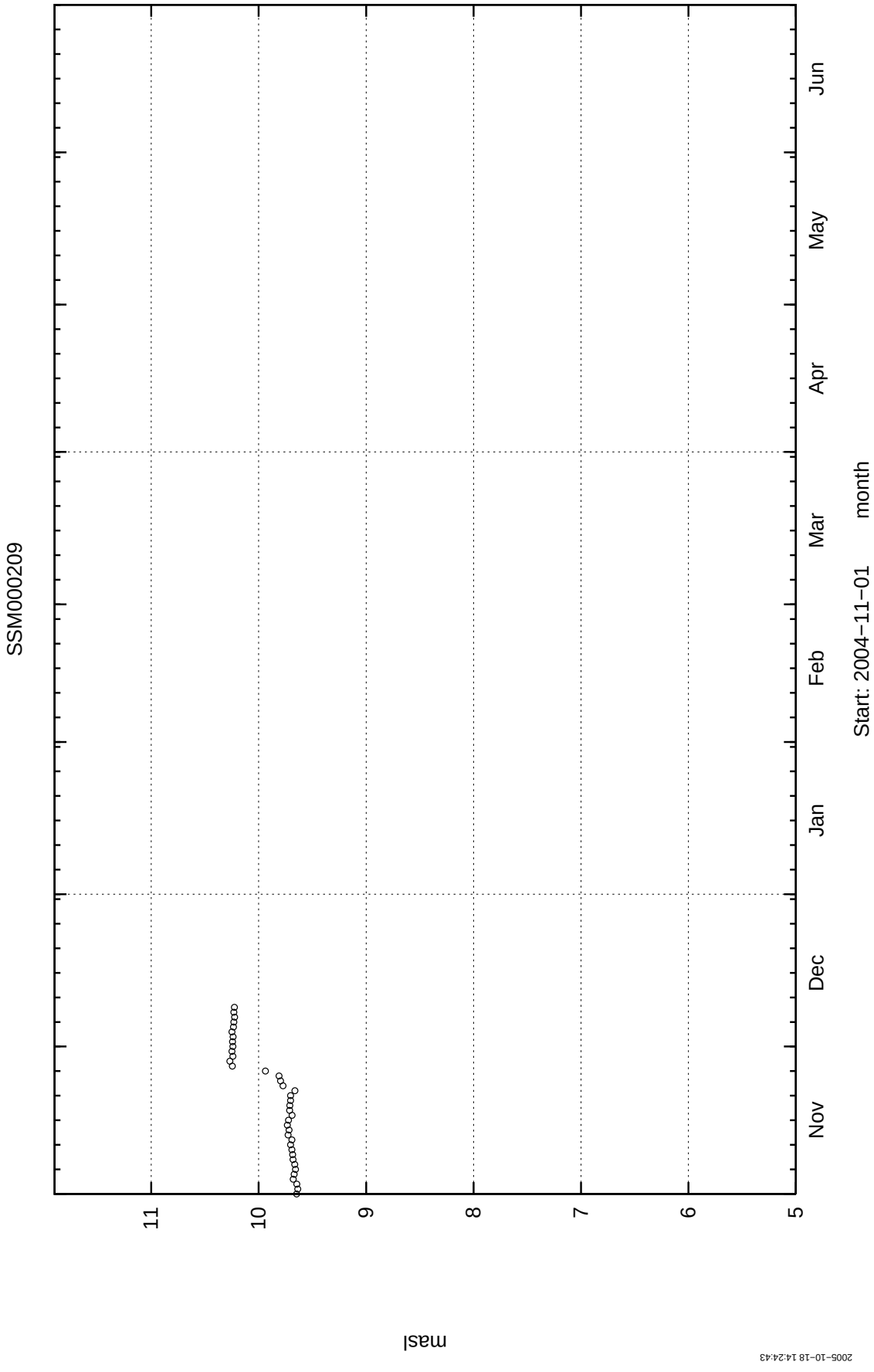

SSM000017
masl
11
10
9
8
7
6
5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:42

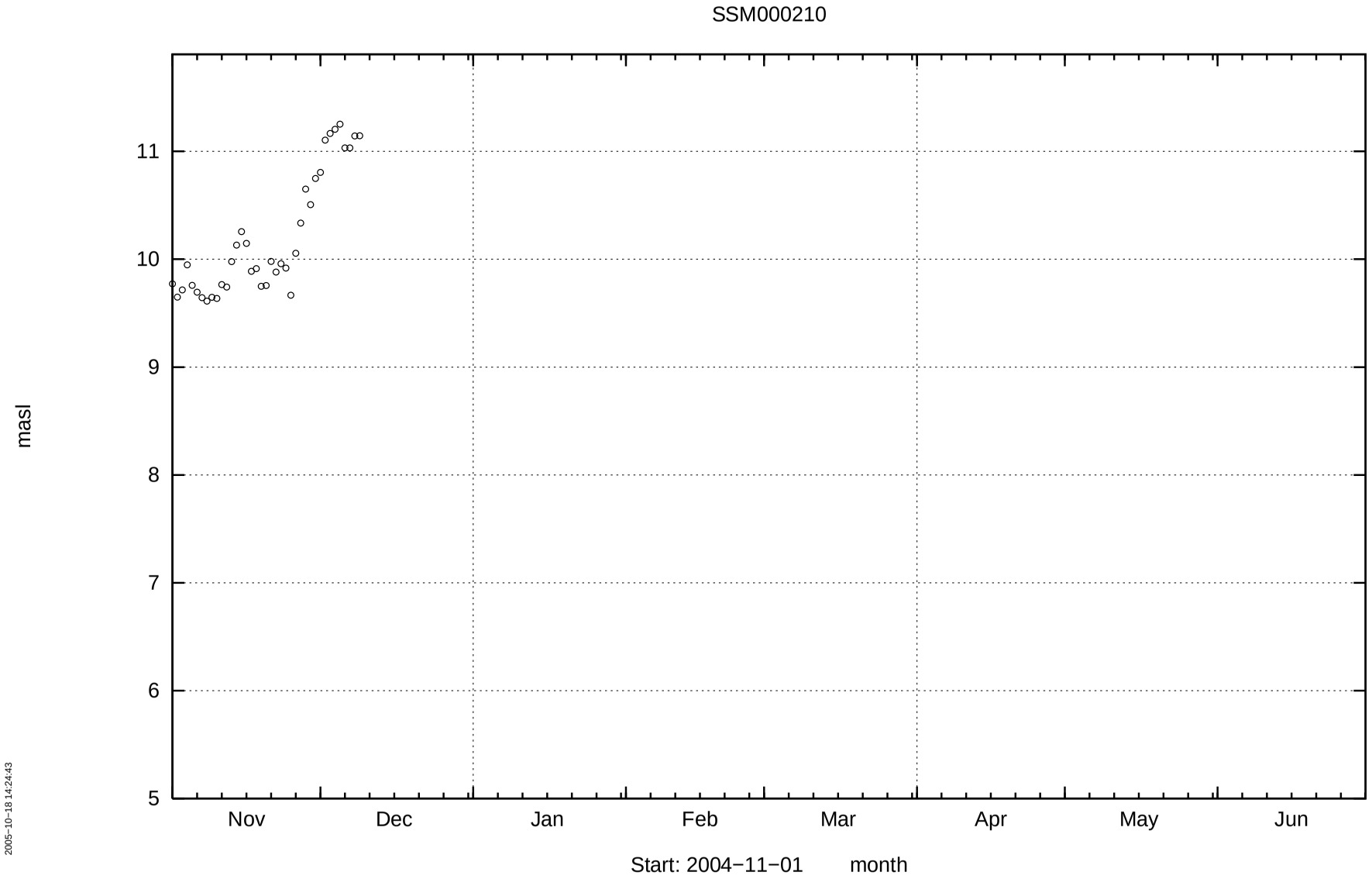

SSM000018
masl
0
−1
−2
−3
−4
−5
−6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:42

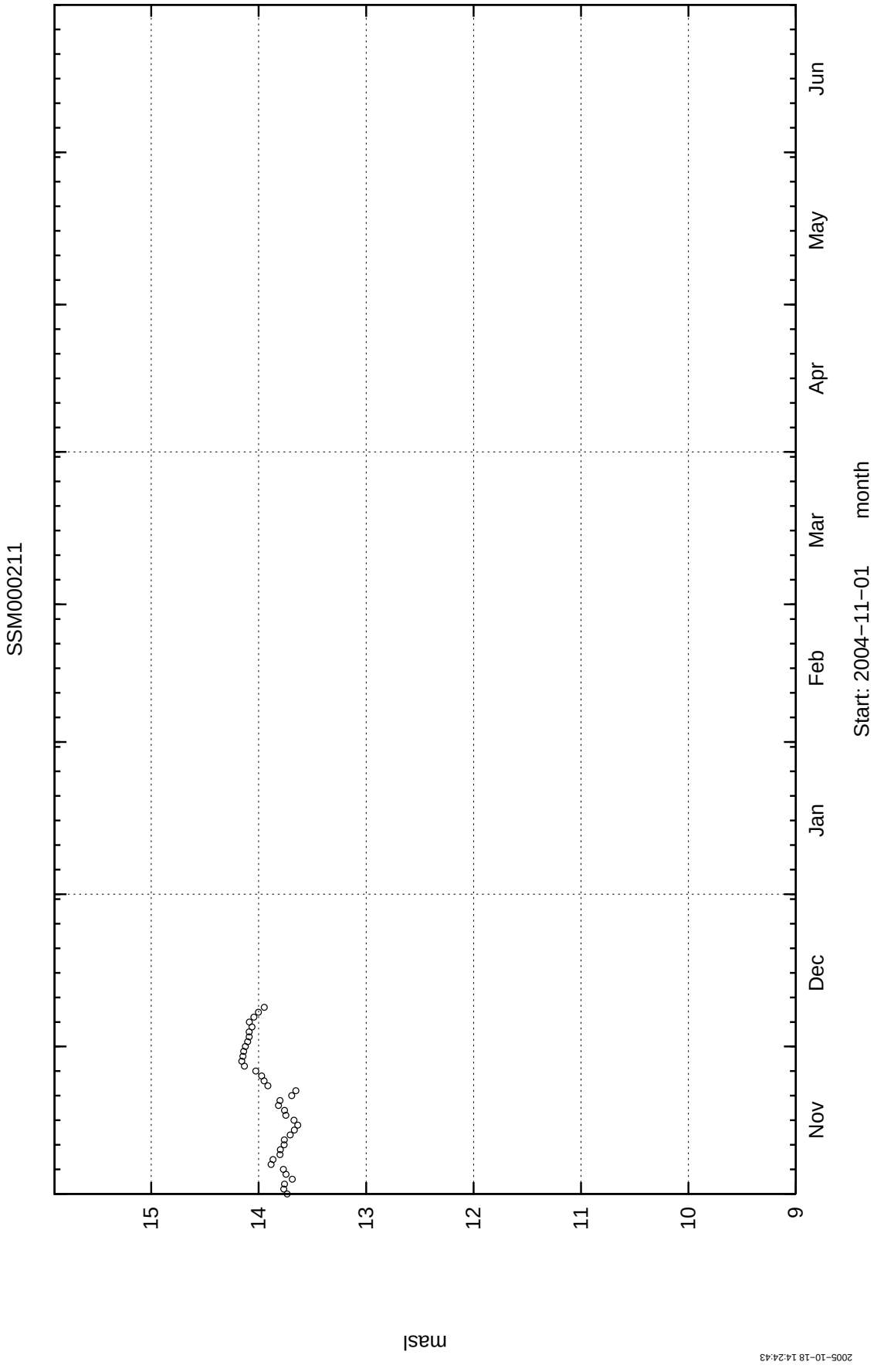

SSM000019
masl
13
12
11
10
9
8
7
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:42

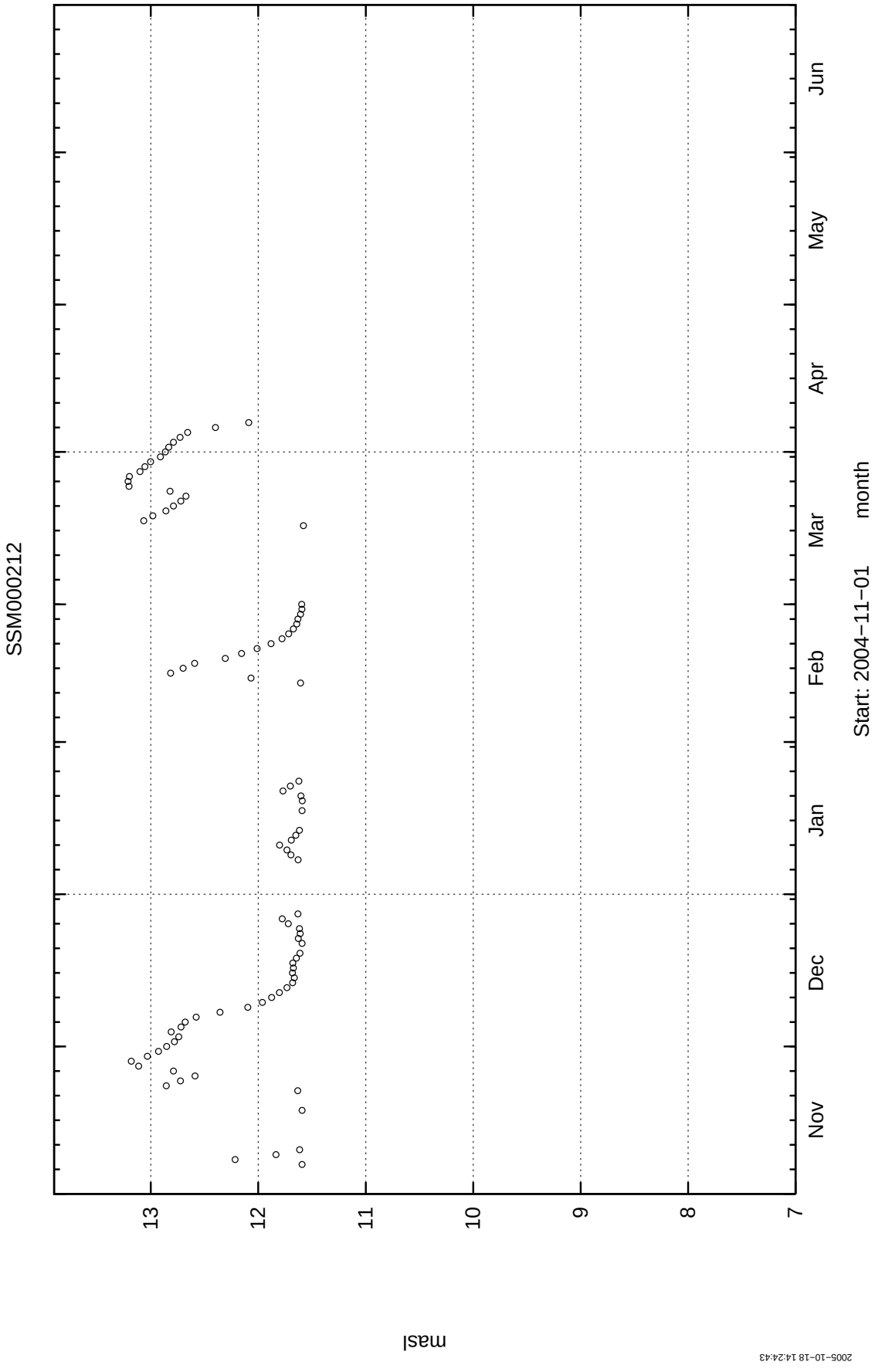

SSM000021
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:42

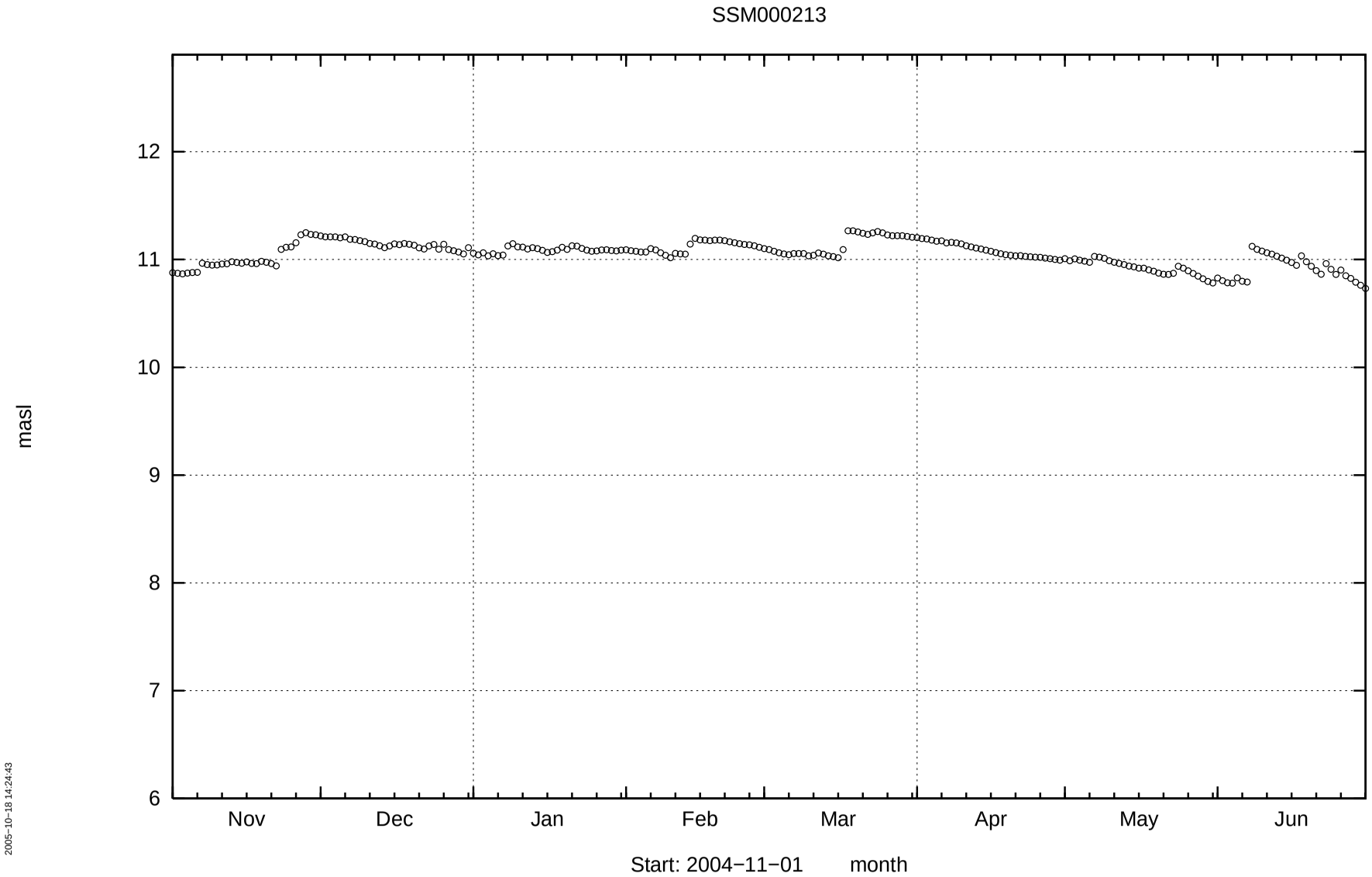

SSM000022
masl
5
4
3
2
1
0
−1
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:42

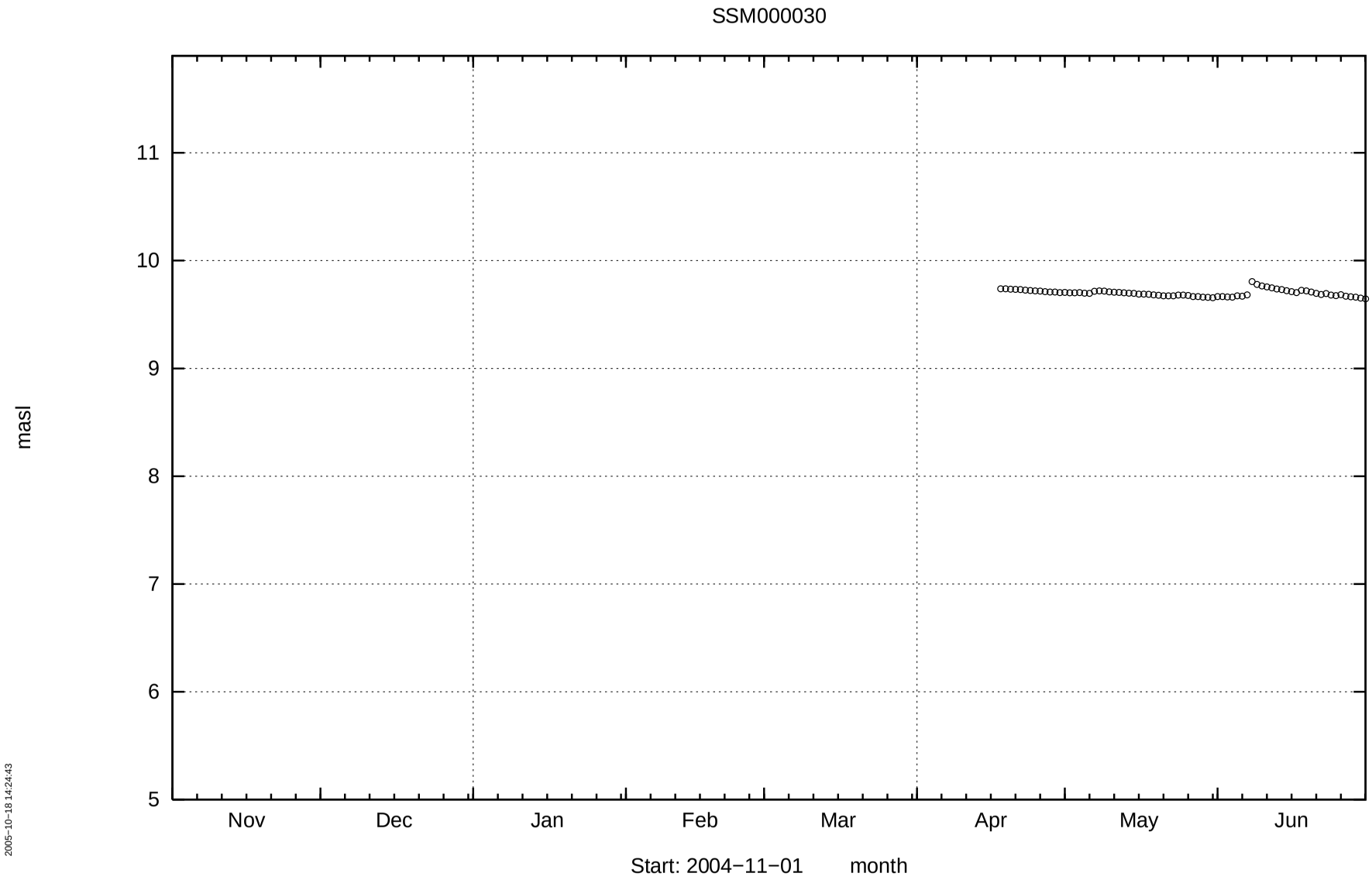

SSM000209
masl
11
10
9
8
7
6
5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:43

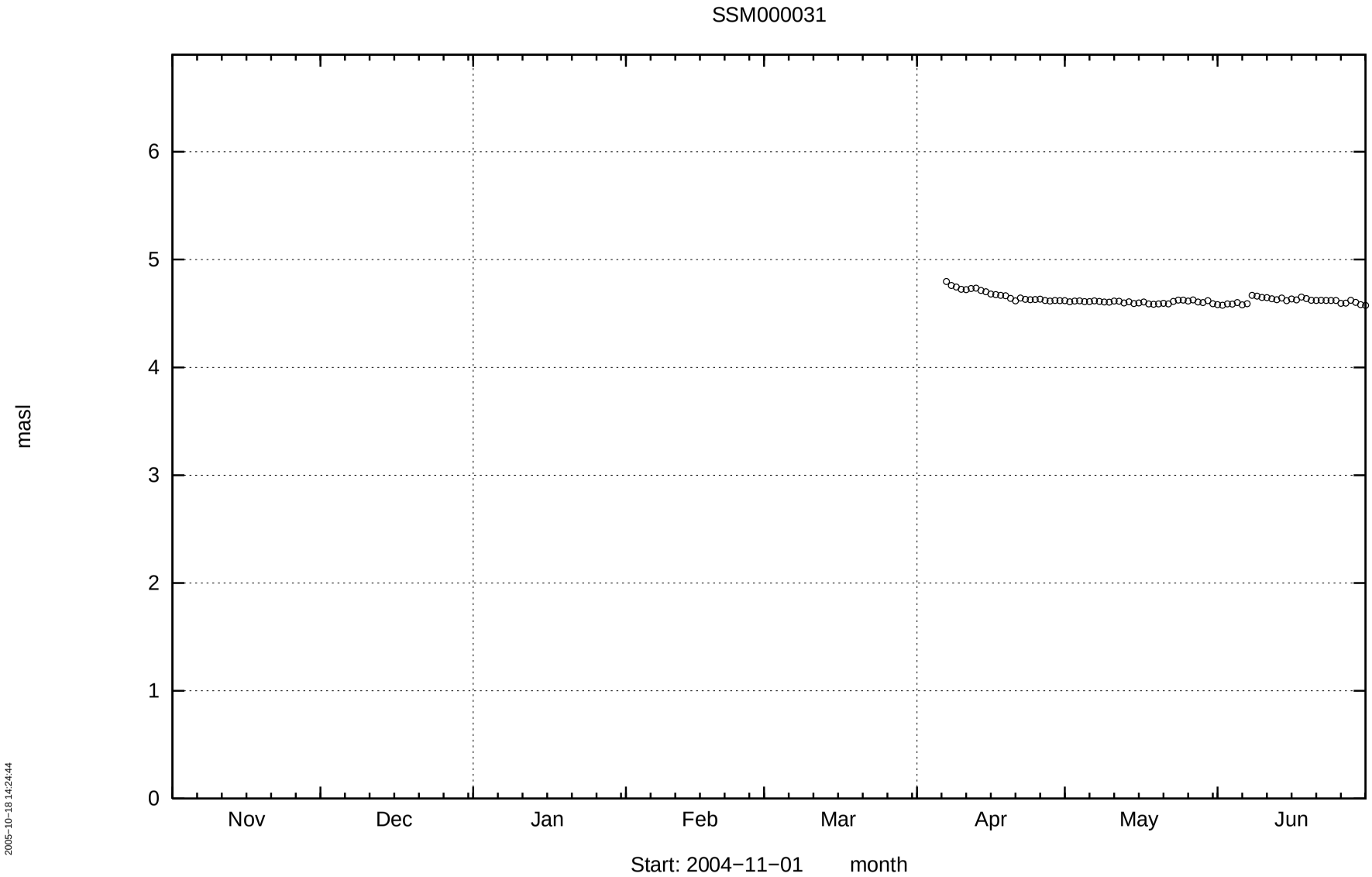

SSM000210
masl
11
10
9
8
7
6
5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:43

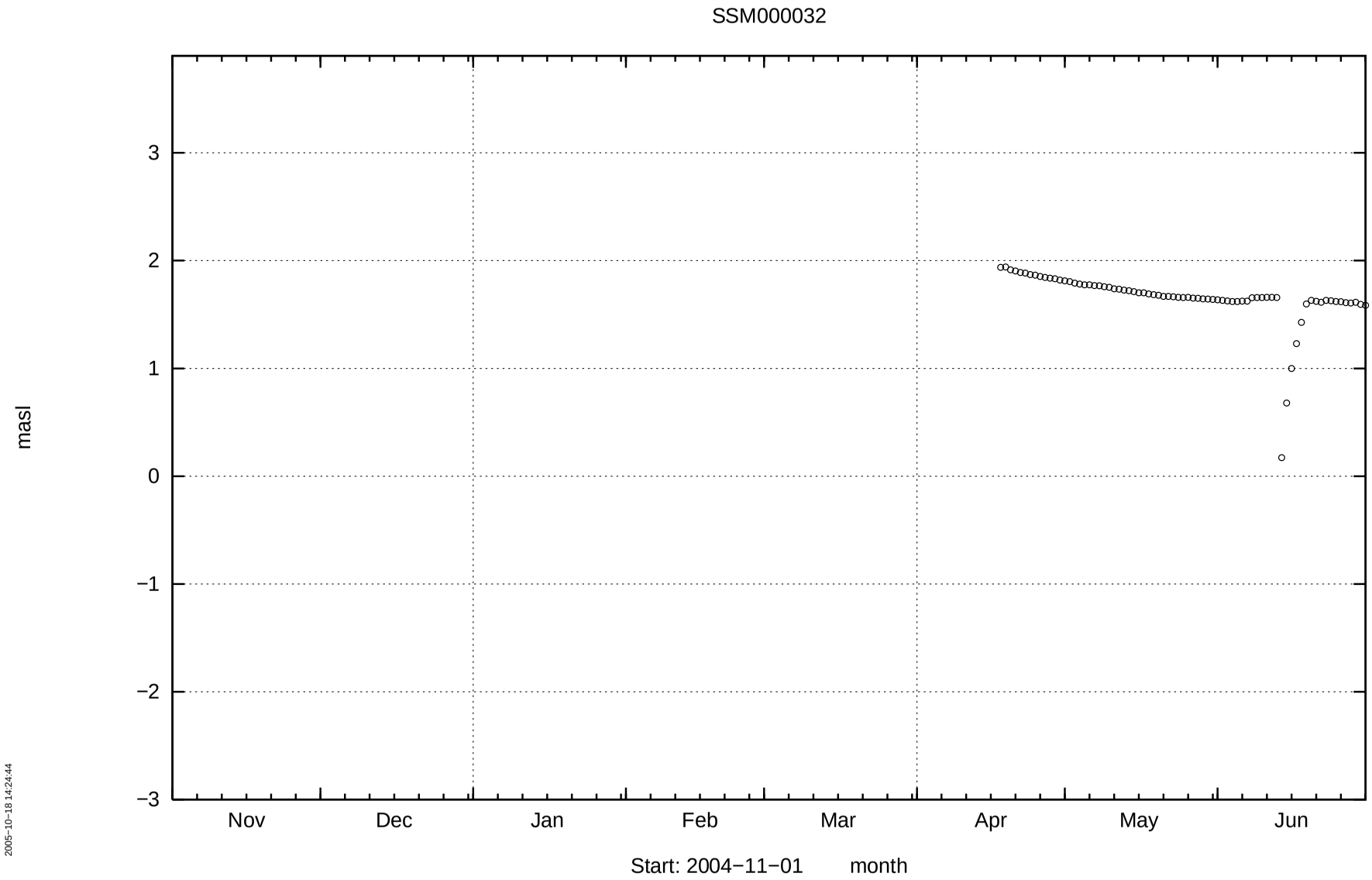

SSM000211
masl
15
14
13
12
11
10
9
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005-10-18 14:24:43

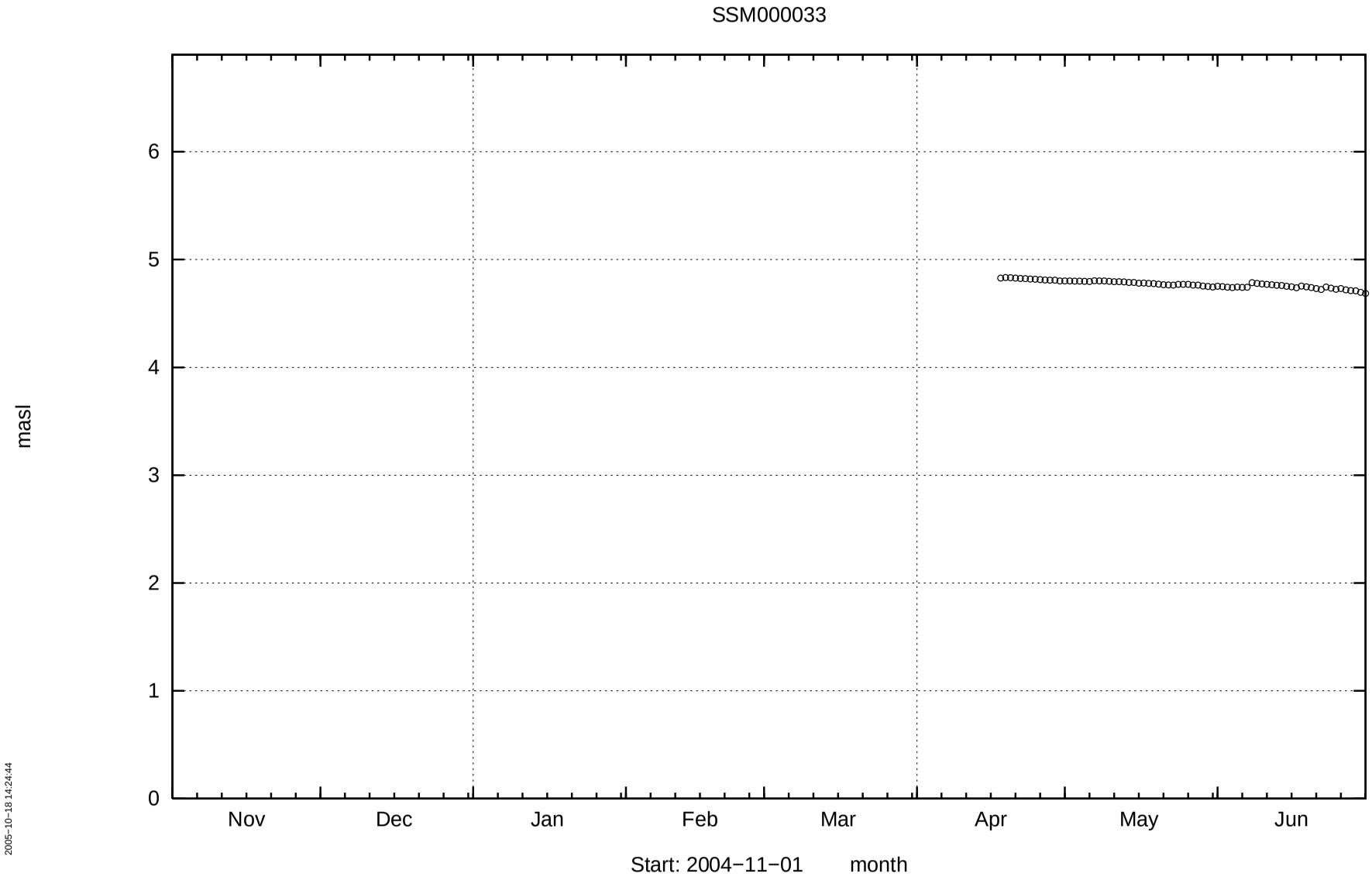

SSM000212
masl
13
12
11
10
9
8
7
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:43

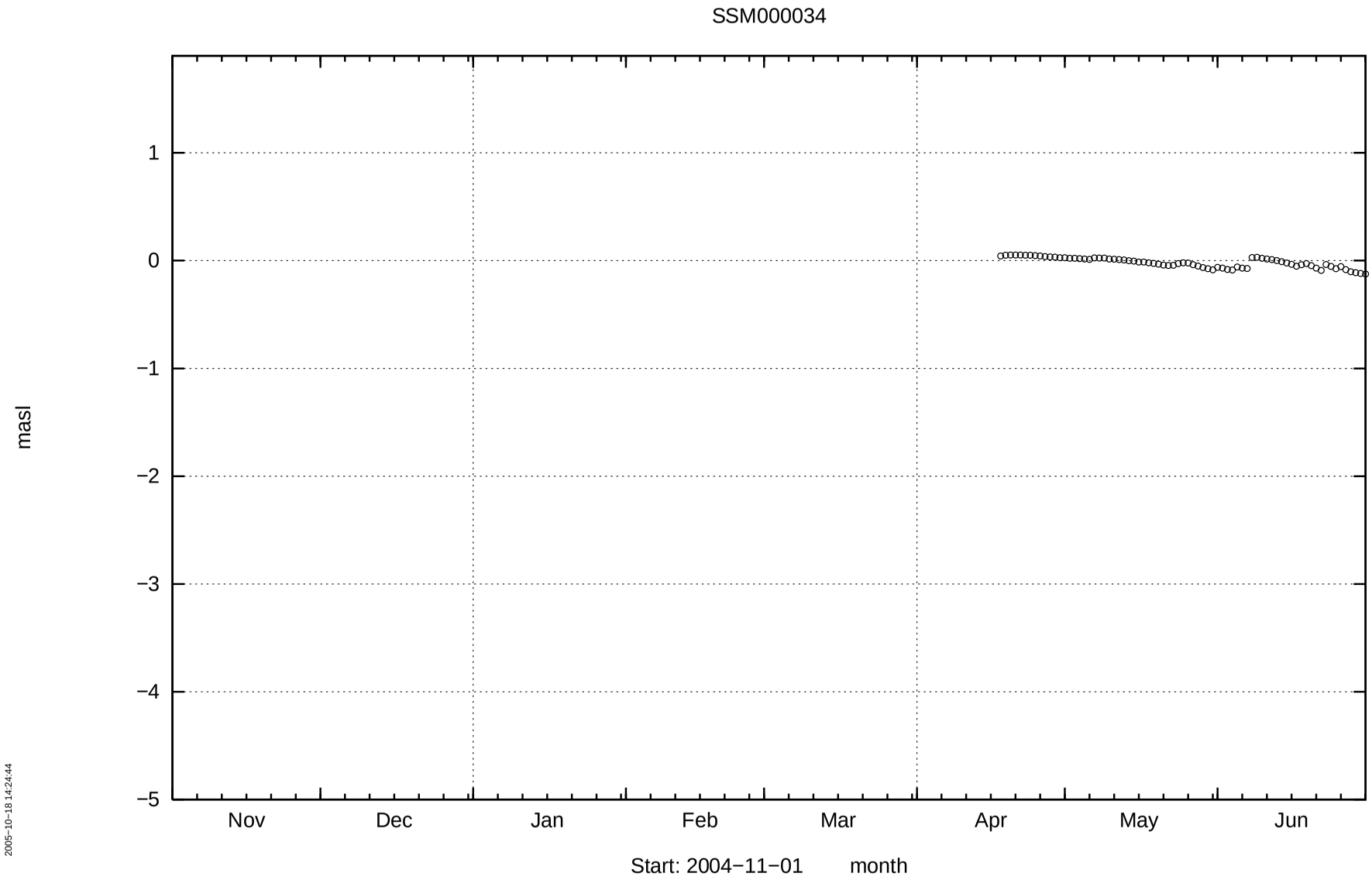

SSM000213
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:43

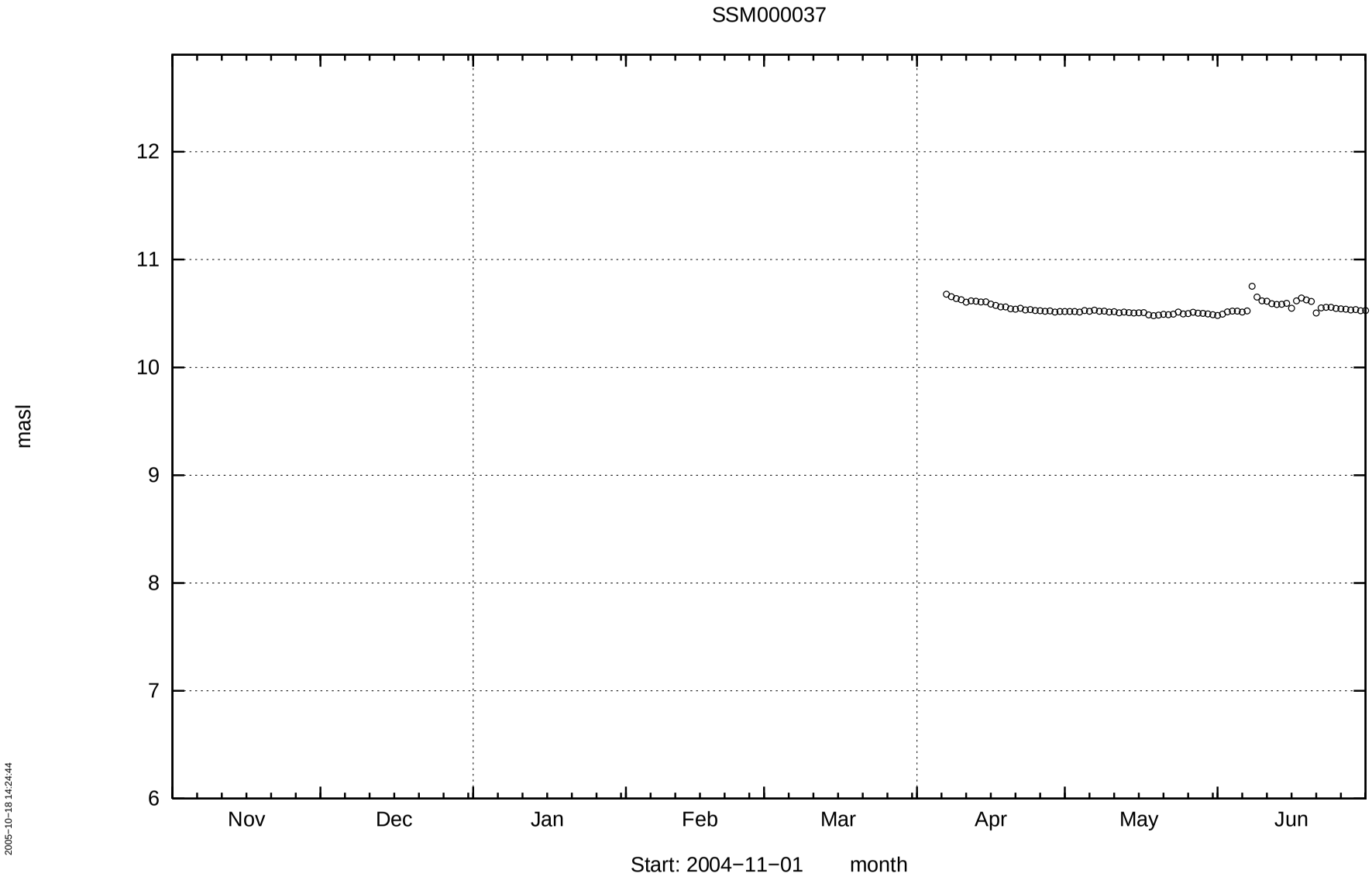

SSM000030
masl
11
10
9
8
7
6
5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:43


SSM000031
masl
6
5
4
3
2
1
0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:44


SSM000032
masl
3
2
1
0
−1
−2
−3
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:44


SSM000033
masl
6
5
4
3
2
1
0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:44


SSM000034
masl
1
0
−1
−2
−3
−4
−5
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:44


SSM000037
masl
12
11
10
9
8
7
6
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Start: 2004−11−01
month
2005−10−18 14:24:44