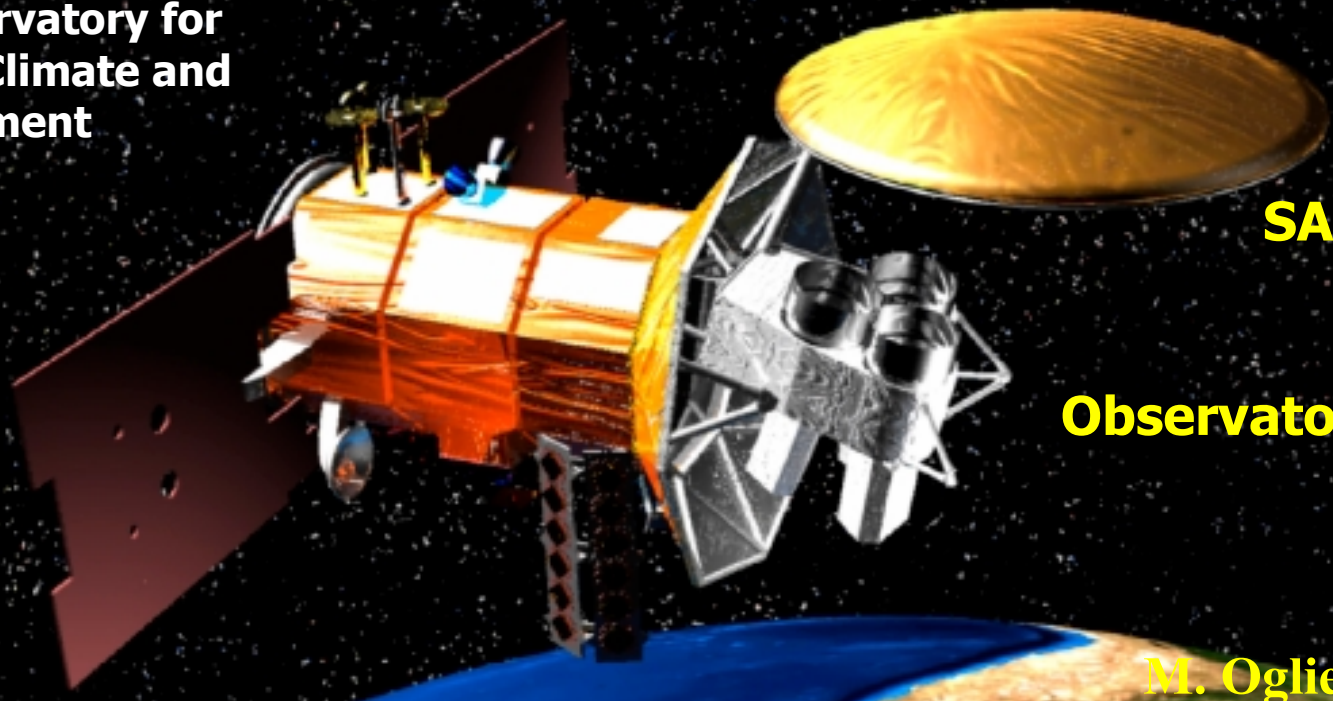
SAC-D/Aquarius

An Observatory for Ocean, Climate and Environment

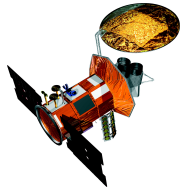


SAC-D/Aquarius

Observatory Operations Assessment

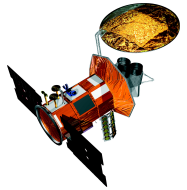
M. Oglietti and C. Filici

7th Aquarius SAC-D Science Meeting
Buenos Aires – April 11-13, 2012



1- Observatory Assessment

2- Orbit Dynamics Assessment



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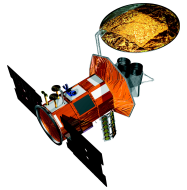
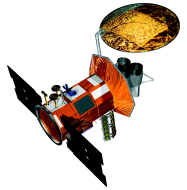


Observatory Current Status

OBSERVATORY	STATUS
SERVICE PLATFORM	Working Nominally
AQUARIUS	Working Nominally
MWR	Working Nominally
HSC	Working Nominally
DCS	Working Nominally
TDP	Working Nominally
CARMEN-1	Working Nominally
ROSA	Working Nominally
NIRST	Mirror Calibration Pending
PAD	Working Stable (w/4 Formats per week)



Observatory Commissioning Assessment

During Commissioning Phase:

1) **All the Service Platform Subsystem were commissioned Successfully.**

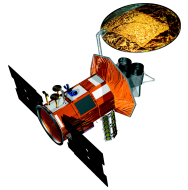
2) **Aquarius Instrument was commissioned Successfully.**

3) **All the SAC-D Instruments were turned on, tested and started operations.**

4) **The Orbit was acquired successfully (full compliant with requirements).**

5) **The process to execute the CSC (Clod Sky Calibration) was validated successfully.**

6) **The process to upload a software patch was executed successfully (AQ case)**

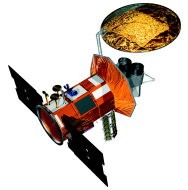


Observatory Commissioning Assessment

7) The Operations scheme demonstrated enough robustness to deal with the intense level of activity that was needed during the commissioning phase (we attend approx. 1700 passes in the first four months, around 110% of what is needed in a whole year of nominal operations).

8) The FOT have been able to deal safely with all occurred S/P flight anomalies and to adjust the S/P configuration in order to accomplish the S/P commissioning objectives.

9) GS systems and its Operations performed nominally meeting all requirements and with no open liens.



Observatory Nominal Operations Assessment

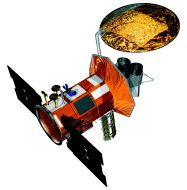
Nominal Operations:

1) We move to this phase on October 24th (2011).

2) From that day we are operating nominally using ETC and IMT for the nominal operations and NEN only for maneuvers, CSC and emergencies.

3) We are performing periodically orbit maintenance maneuver activities. Approximately one every 45 days.

4) We are performing periodically CSC maneuvers.



Observatory Nominal Operations Assessment

During Nominal Operation Nominally we are performing approximately the following Activities on a weekly basis:

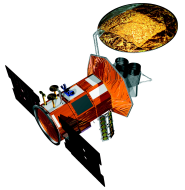
1) **29 X-Band Downloads (Science Downloads)**

2) **28 S-Band Contacts for Activities Upload and Status verification**

3) **Aquarius, MWR, CARMEN-1 and ROSA are continuously acquiring data**

4) **TDP is continuously acquiring data without its GPS data**

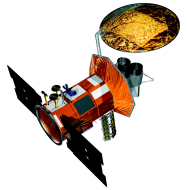
5) **NIRST 56, DCS 14 and HSC 12 Acquisitions**



1- Observatory Assessment

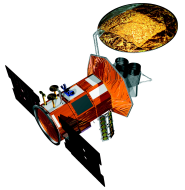
2- Orbit Dynamics Assessment

Nominal Orbit



Parameter	Value	Tolerance
Equatorial altitude	657 km	+/- 1.5 km
Groundtrack kept within	Equator Grid	+/- 20 km
Mean Semi-major axis	7028.871 km	+/- 1.5 km
Mean Eccentricity	0.0012	+/- 0.0001
Mean Inclination	98.0126 deg	+/- 0.001 deg
Mean Local Mean Time of Ascending Node	06:00:00 PM	+/- 5 min

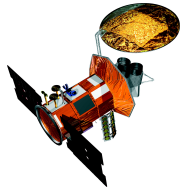
Orbit Maneuvers



- Orbit Acquisition
  - Maneuver Calibration
  - Removal of Launcher injection errors

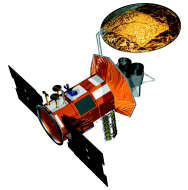
- Orbit Maintenance
  - Keep orbit within established limits

Orbit Acquisition Phases



- **Orbit Acquisition divided in three phases in relation to Instruments Commissioning:**
  - **First Phase – Initial Tests & Calibrations**
    - **Collision Avoidance Calibration**
  - **Second Phase – Prior to Instruments Commissioning**
    - **Launcher Height Injection Errors Correction**
  - **Third Phase – Post Instruments Commissioning**
    - **Launcher Inclination Injection Errors Correction**

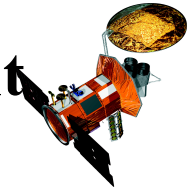
Orb. Acq. First Phase: Calibration



- **First Phase – Initial Tests & Calibrations**
  - **Short Burn to test on the Propulsion System Performace**
  - **Collision Avoidance Maneuvers Calibration**
    - » **Posigrade & Retrograde**
  - **Total of 7 Burns**

Burn Start	Duration [s]	Type	DV[m/s]
2011-07-24	3	Posigrade	0.00815
2011-07-26	5	CAM Posigrade	0.01018
2011-07-26	5	CAM Posigrade	0.01018
2011-07-28	5	CAM Posigrade	0.01018
2011-07-28	5	CAM Posigrade	0.01018
2011-07-30	5	CAM Retrograde	0.01018
2011-07-30	5	CAM Retrograde	0.01018

SAC-D/AQUARIUS Orb. Acq. 2nd Phase: Height Adjustment



- **Second Phase – Prior to Instruments Commissioning**
  - **Correction of Launcher Height Injection Errors**
  - **Reduction of the ground track drift rate**
  - **Ground Track inside nominal deadband**
  - **Approach to Frozen Orbit conditions**
  - **Short Out of Plane Burn Test for System Performance**
  - **Total of 3 Burns**

Burn Start	Duration [s]	Type	DV[m/s]
2011-08-05	42	Retrograde	0.08553
2011-08-07	116	Retrograde	0.24038
2011-08-09	8	Out of Plane	0.01659

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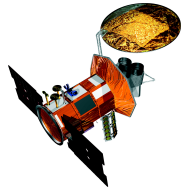
Orb. Acq. 3rd Phase: Inclination & Final Acquisition



- **Third Phase – Post Instruments Commissioning**
  - **Height fine tuning**
  - **Keep Ground Track inside longitude deadband**
  - **Correction of Launcher Inclination Injection Errors**
  - **Collision Avoidance Maneuvers Re-calibration after Aquarius Boom Deployment**
  - **Frozen Orbit Conditions**
  - **Total of 7 Burns**

Burn Start	Duration [s]	Type	DV[m/s]
2011-09-17	10	Retrograde	0.02444
2011-09-21	40	Out of Plane	0.09775
2011-09-27	46	Out of Plane	0.11241
2011-10-01	17	Out of Plane	0.04155
2011-10-07	4	CAM Posigrade	0.00978
2011-10-12	4	CAM Retrograde	0.00978
2011-10-15	17	Posigrade	0.04155

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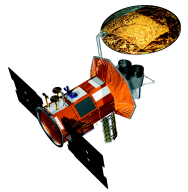
Orbit Maintenance



- **Goals**
  - **Keep orbit parameters within margins**
    - **Ground Track**
    - **Descending Node Height**
    - **Eccentricity**
    - **Argument of Perigee**
    - **Mean Local Time at Ascending Node**
  - **Perform Conjunction Avoidance Maneuvers if needed**
- **Performed so far: 5 Burns**

Burn Start	Duration [s]	Type	DV[m/s]
2011-11-11	40	Maintenance	0.09776
2011-11-16	26	Maintenance	0.06354
2011-12-14	43	Maintenance	0.10509
2012-03-02	42	Maintenance	0.10264
2012-03-25	8	Maintenance/CAM	0.01955

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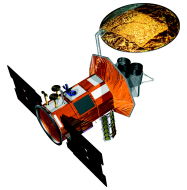
Orbit Maint. Burns Assessment



- **Maneuver Assessment**
  - **Performed after each Burn**
  - **Based on SAC-D Precise Orbit Determination**
  - **Observed performance is very close to nominal**

Burn Start	Planned [m]	Observed [m]	Performance %
2011-11-11	182	184	100.9
2011-11-16	119	120	100.9
2011-12-14	196	202	102.8
2012-03-02	192	194	101.4
2012-03-25	36	36	99.8

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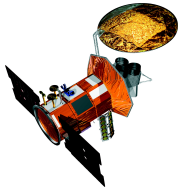
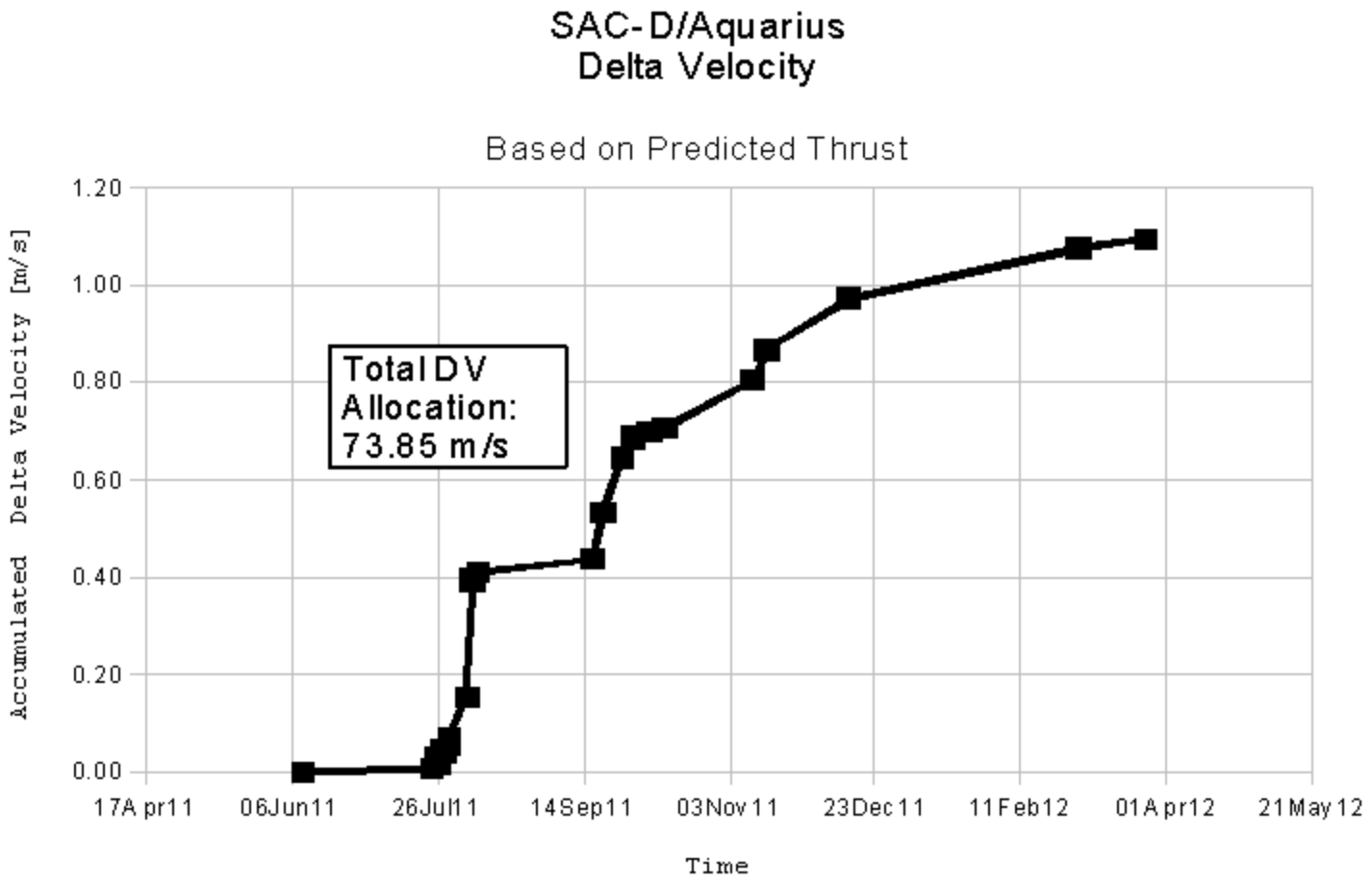
Delta V Evolution





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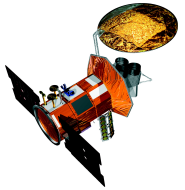
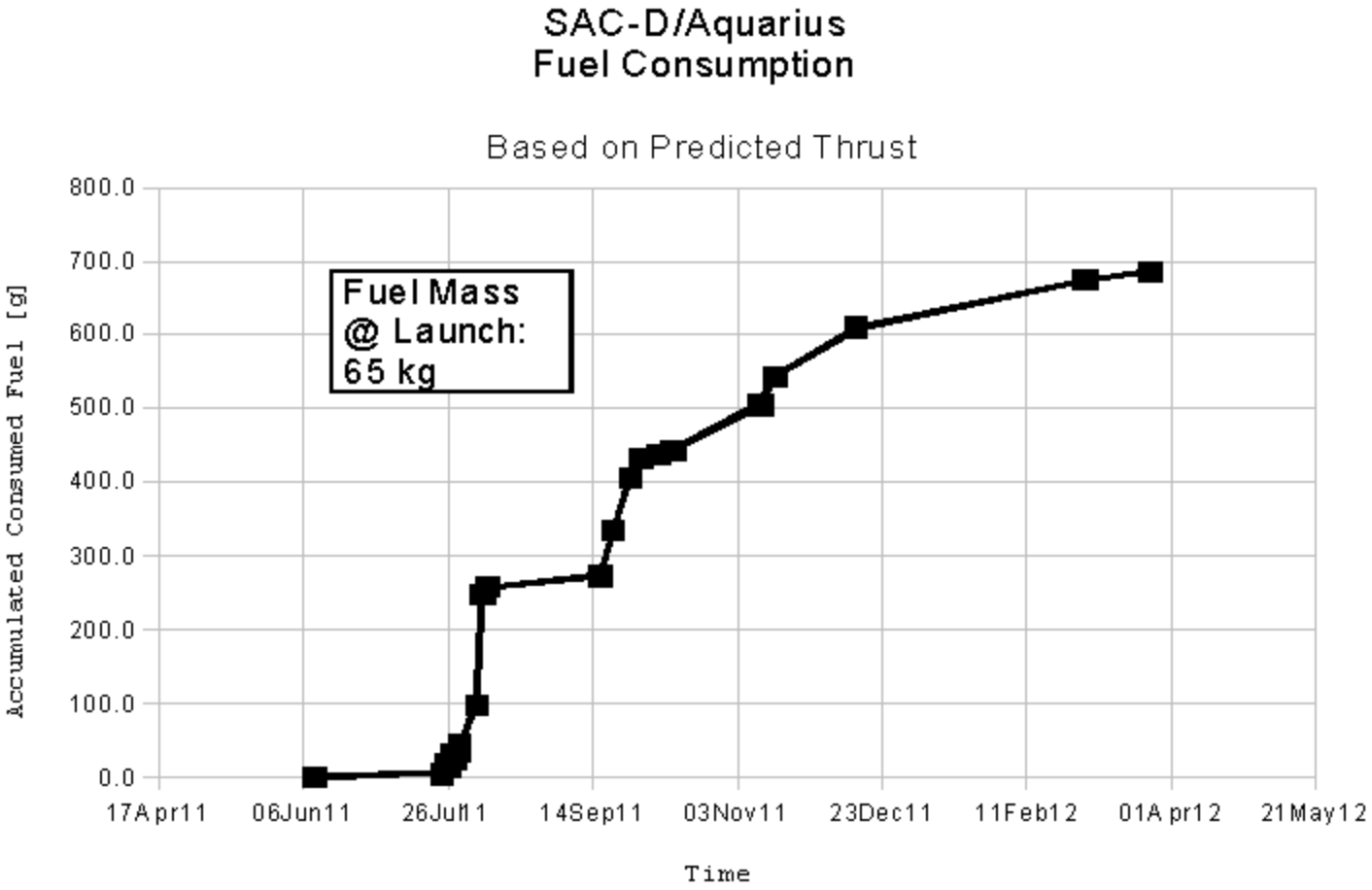
Fuel Consumption





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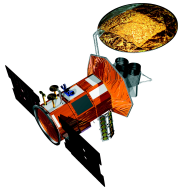
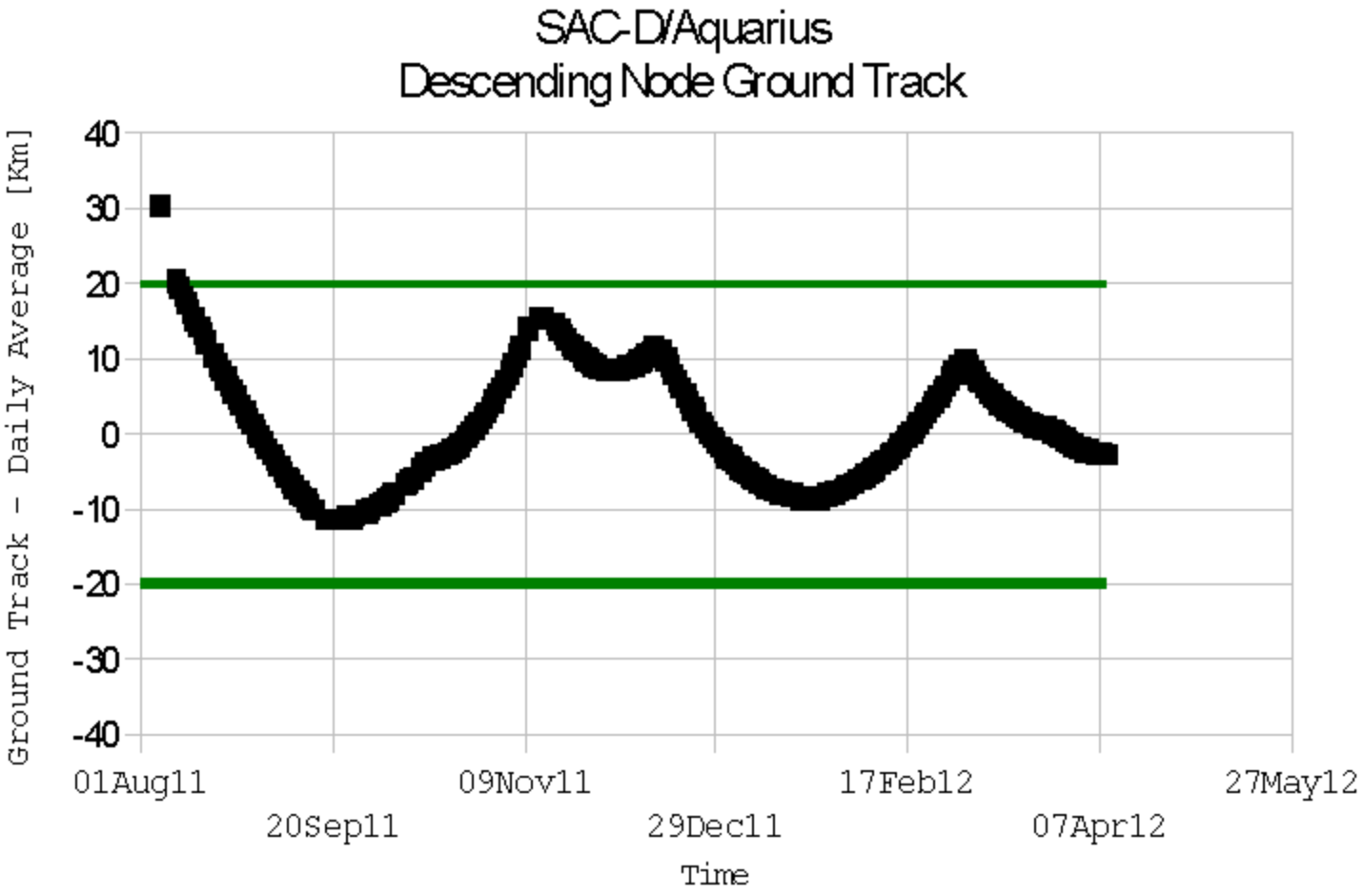
Orbit Evolution





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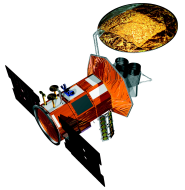
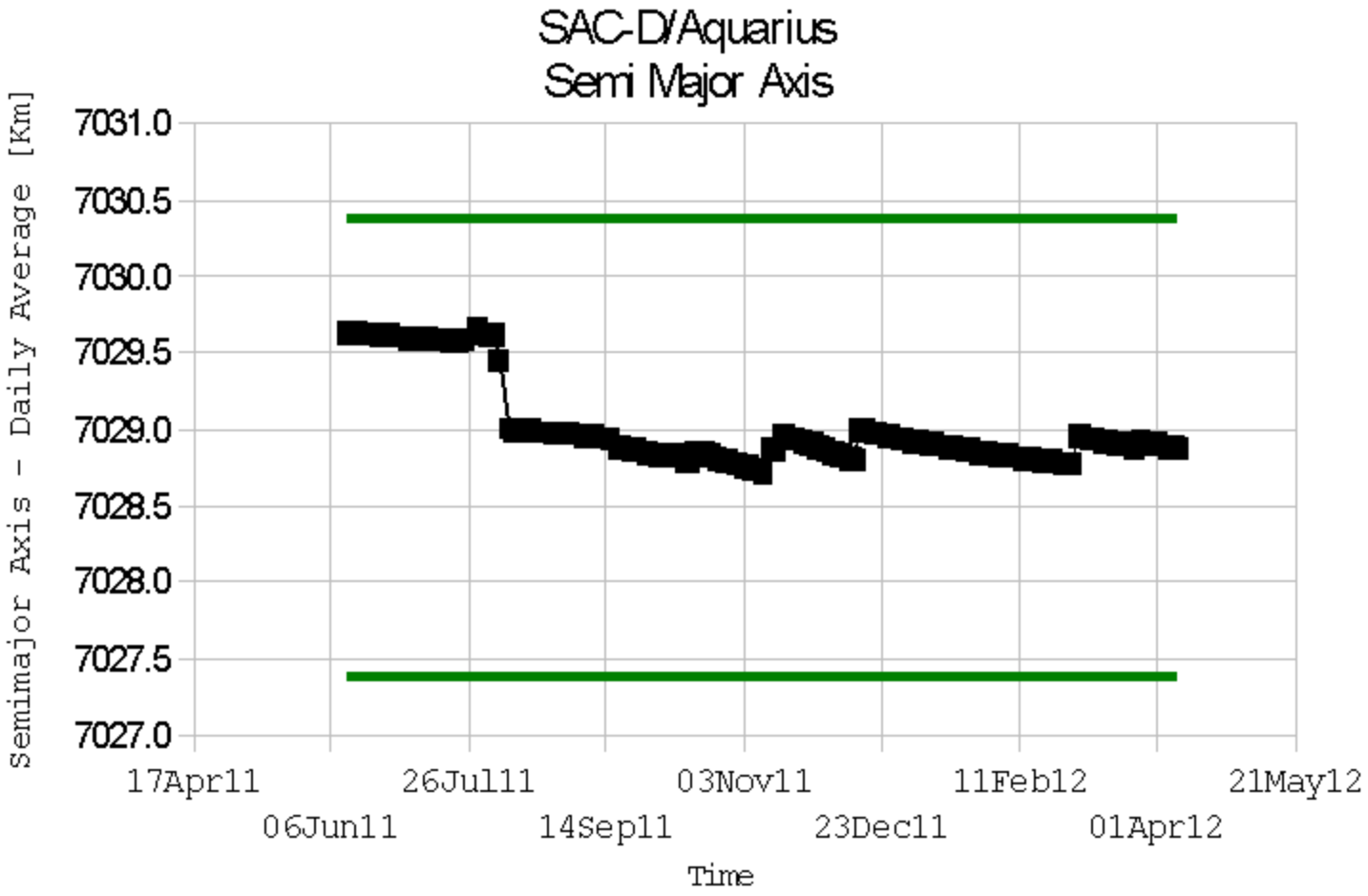
Orbit Evolution





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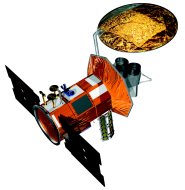

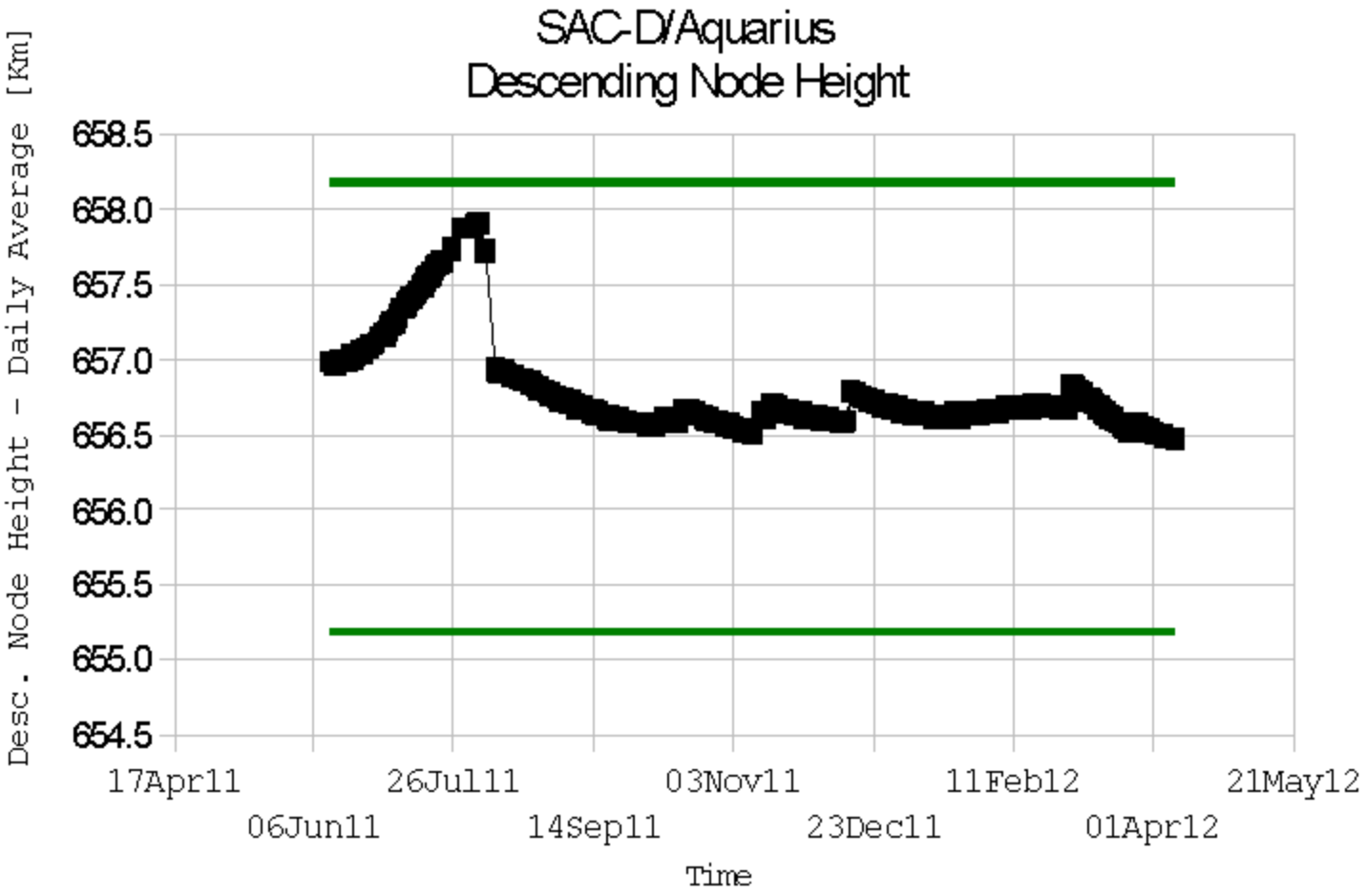

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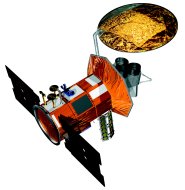

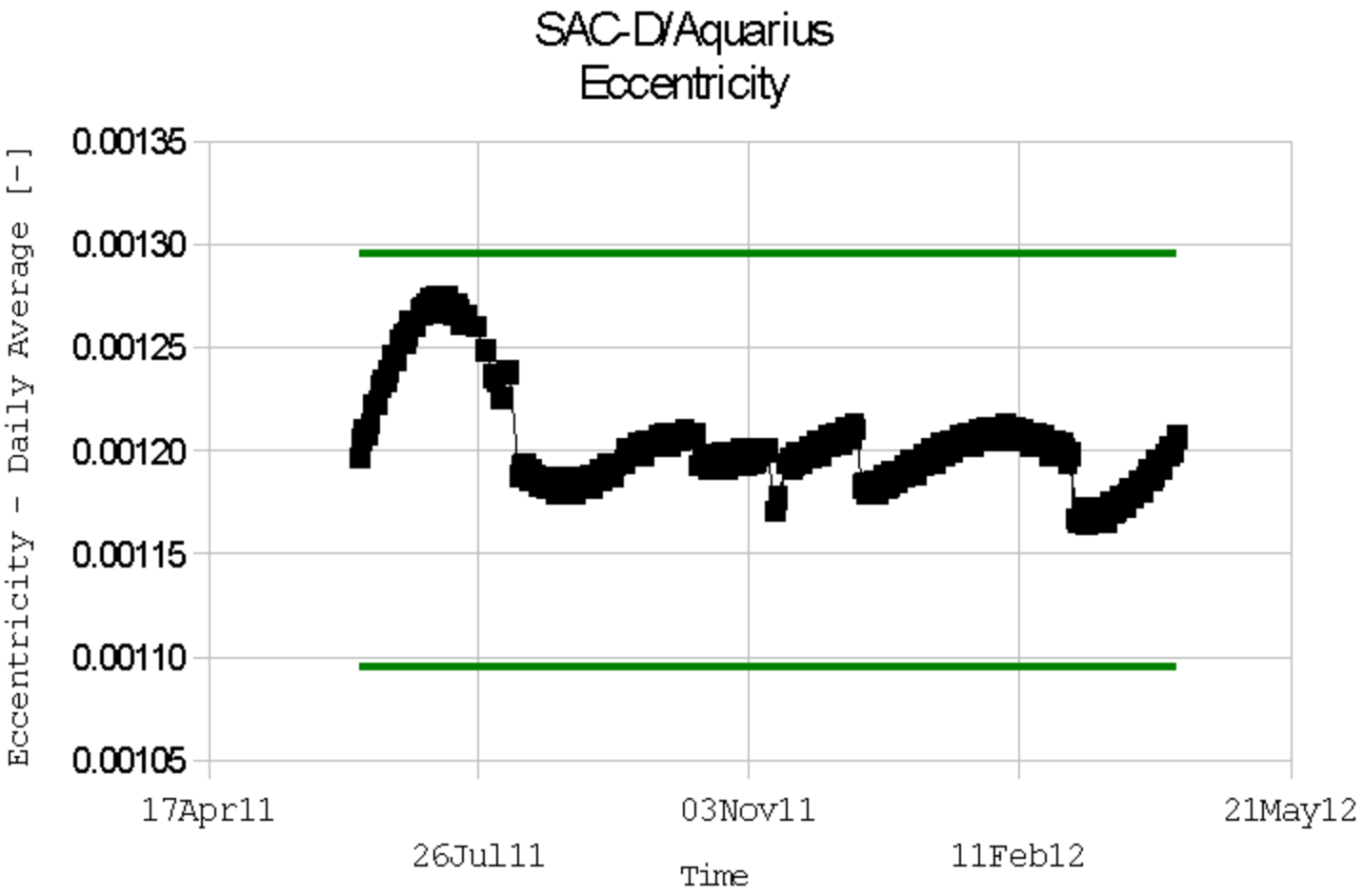

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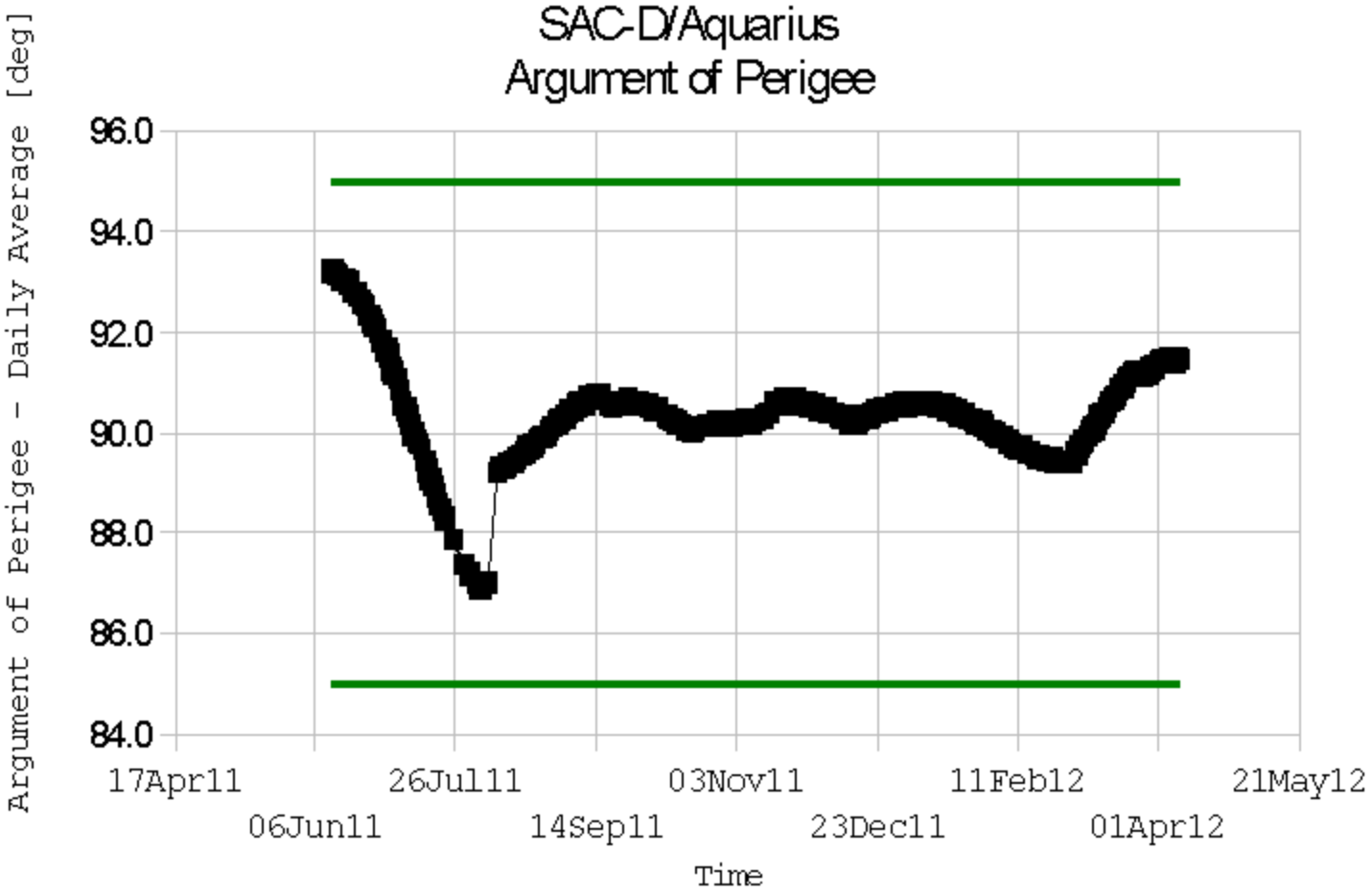
Orbit Evolution



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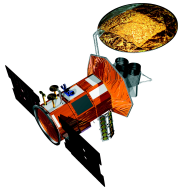

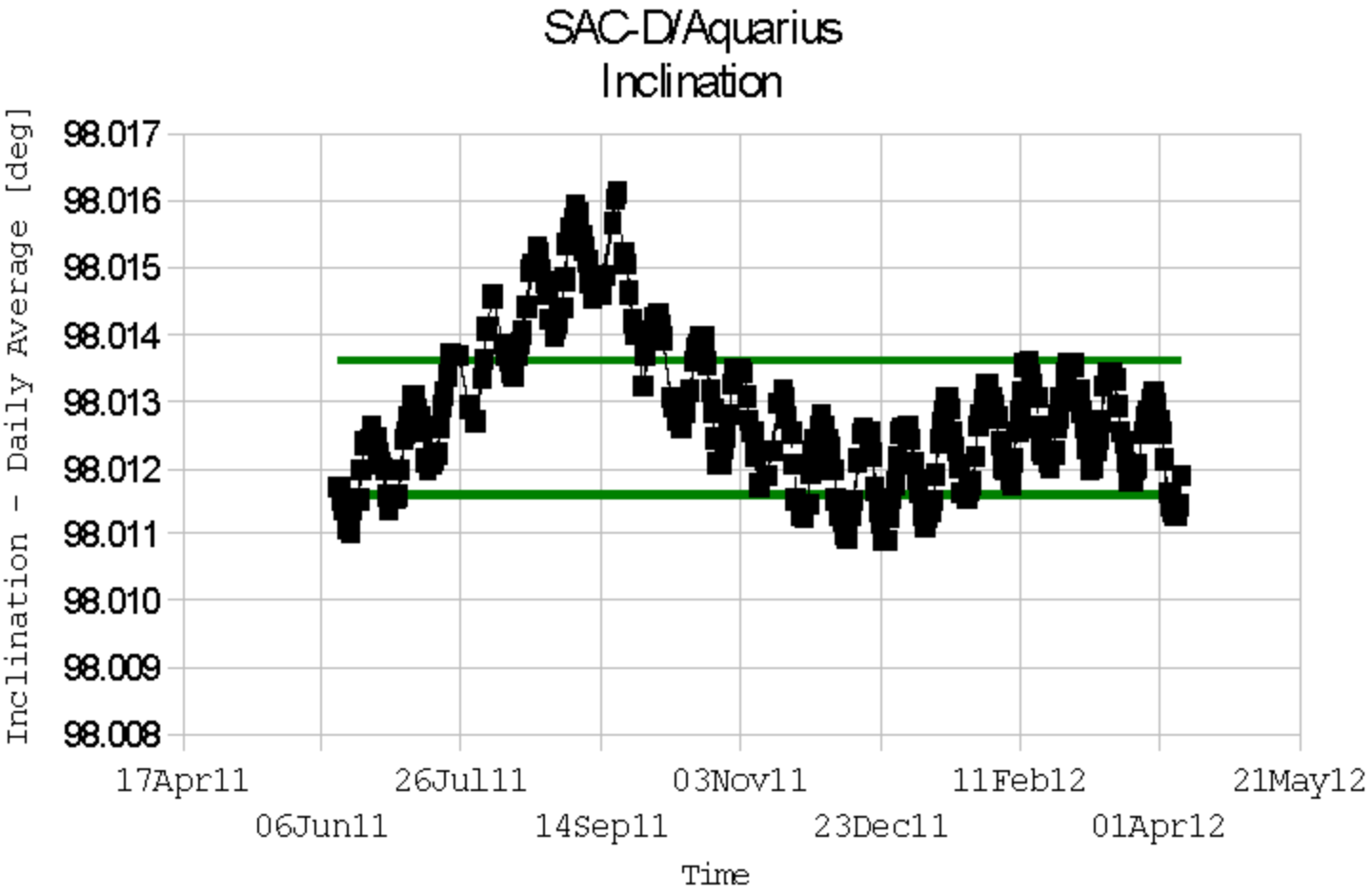

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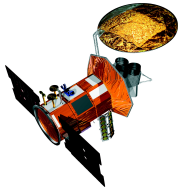
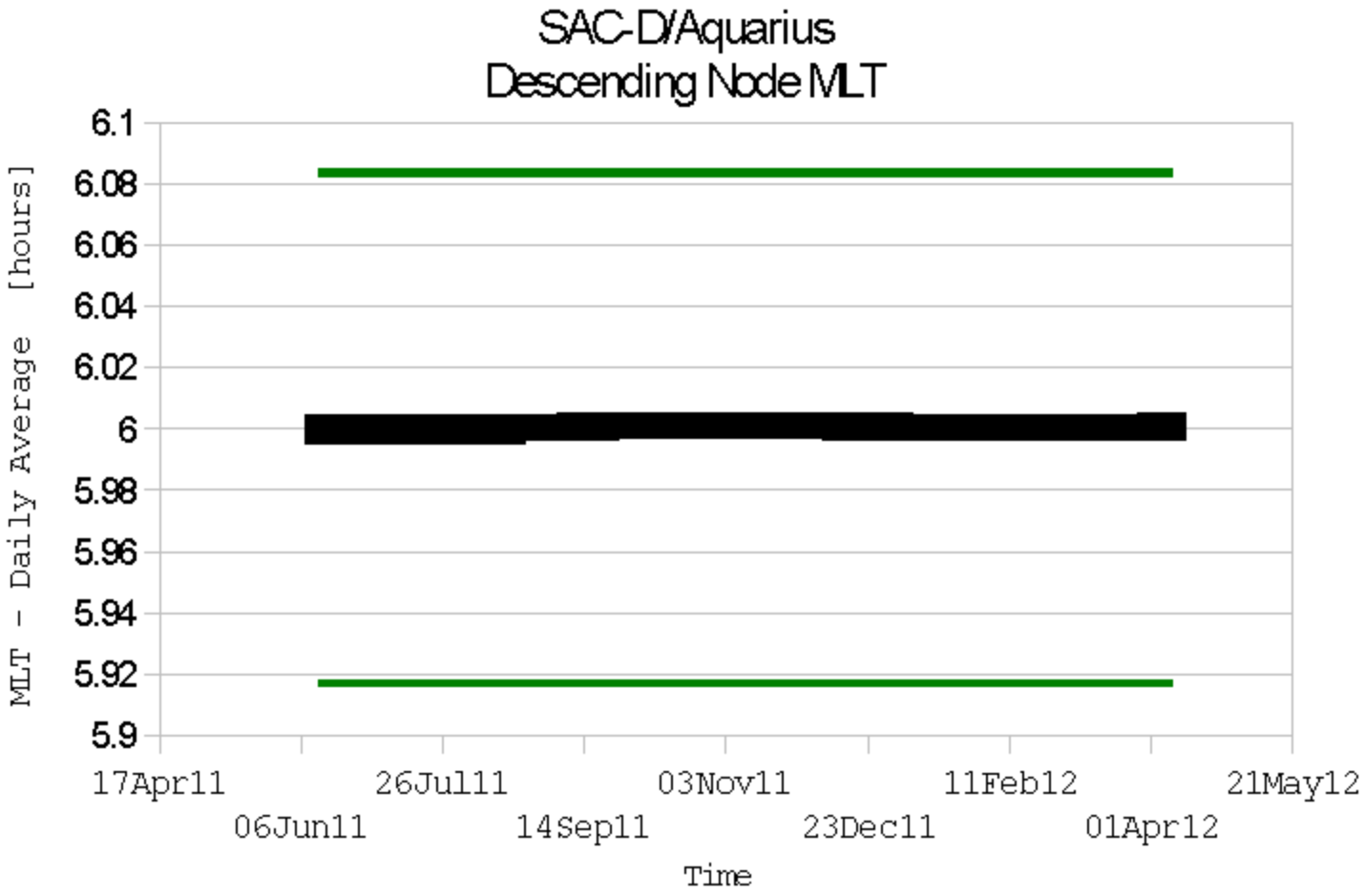
Orbit Evolution





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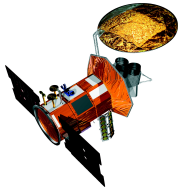
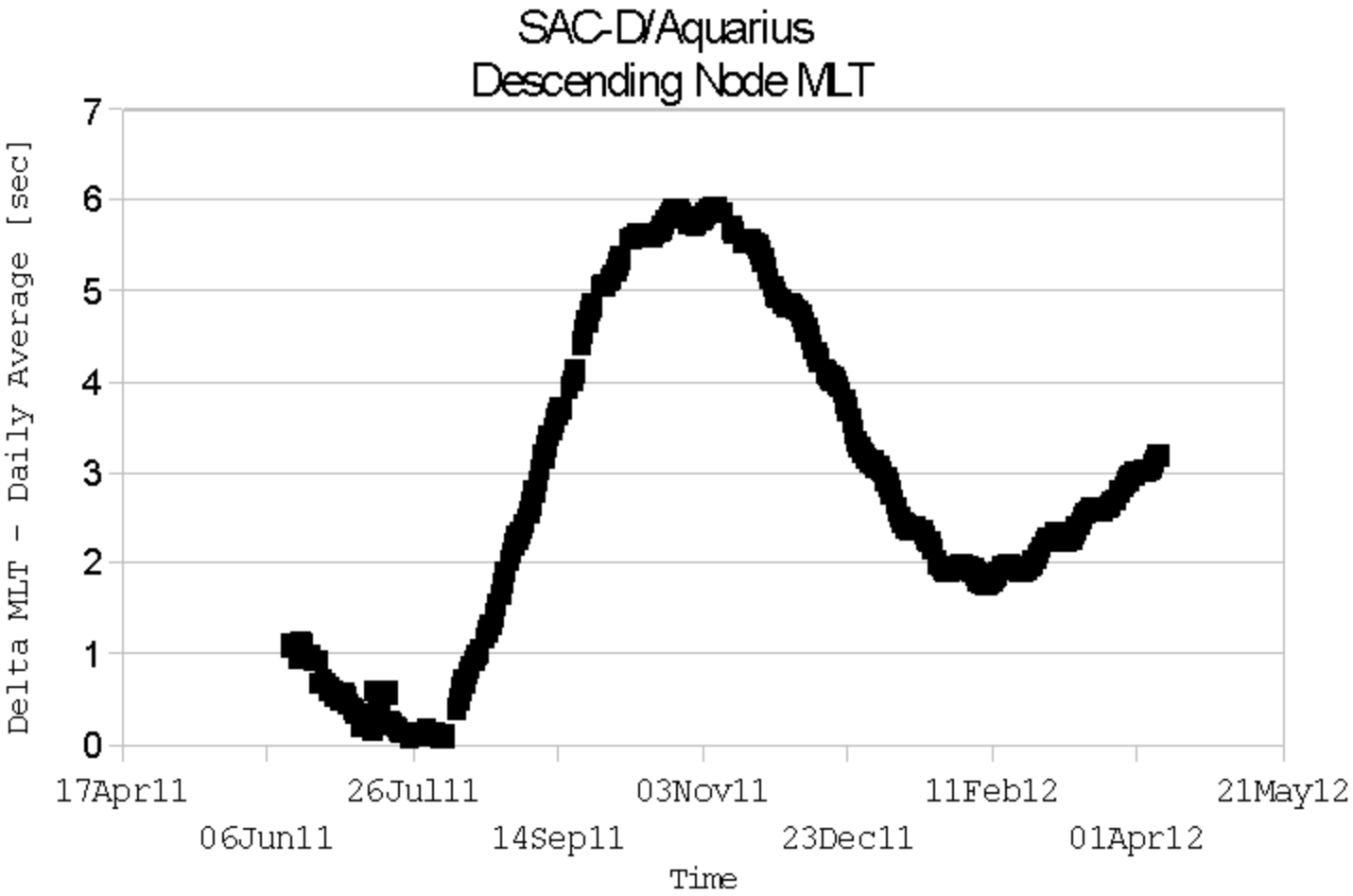
Orbit Evolution





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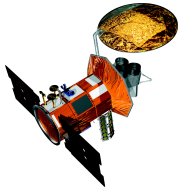
Orbit Dynamics Products



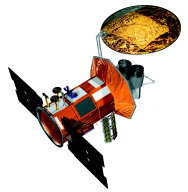
- CONAE Orbit Dynamics Services – CODS
  - responsible for the overall operations (f.i. products generation, maneuvers definitions) regarding the orbit of the CONAE satellites, including SAC-D

- CODS Daily Products include:
  - TLE, Ground Station Contacts, Orbit Events
  - Ephemeris (J2K, TOD, ECF)
    - Post Facto & Predicted, Dense
  - Interpolated Quaternions
  - Nodal Crossing Times

- CODS Maneuver Products include:
  - Maneuver definition
  - Maneuver Ephemeris
  - Maneuver Assessment

SAC-D/AQUARIUS

Orbit Dynamics Conclusions



- **Orbit Acquisition Sequence Successfully Performed**
  - **Correction of Launcher Injection Errors**
  - **Total of 17 Burns performed**
  - **Nominal ground track achieved on Aug 7th**
  - **Inclination & Fine adjustment Burns completed Oct 15th**
  - **Induced 1st Maintenance Cycle**

- **Orbit Maintenance Operations Successful**
  - **Ground Track Longitude and Descending Node Height kept within margins**
  - **Frozen Orbit maintained within margins**
  - **Descending node MLT kept well within margins, with only a few seconds dispersion**
  - **Inclination kept in very close agreement to the nominal margins**
  - **Total of 5 burns performed so far**

- **CODS services operational**

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