Aquarius Project, Spacecraft, Instrument and Data Processing Status

Gene Carl Feldman, Joel Gales, Liang Hong, Norman Kuring, Tommy Owens, Fred Patt, Alicia Scott, John Wilding

Understanding the Interaction Between Ocean Circulation, the Water Cycle, and Climate by Measuring Ocean Salinity

Cal-Val Virtual Workshop WebMeeting

29-30 January /2013
Outline

• Instrument Status

• Spacecraft Status
  – Star Tracker issue and status

• Ground System and Data Processing Status
1- Aquarius mission-mode operation exhibits excellent performance, meeting all L3 instrument requirements.

2- Observatory anomalies have not affected Aquarius instrument performance.

3- The Aquarius instrument team is supporting routine monitoring of the instrument performance and is involved in instrument calibration.
Post-launch, L3 requirements that can be re-assessed are:

- Functional requirements:
  Telemetry and science data indicate that the Aq instrument has been functioning nominally, and instrument temperatures are within expected limits.

- Interface requirements
  The instrument interfaces have been operating nominally.

- Thermal control requirements
  Active Thermal Control (ATC) meets thermal stability and gradient requirements over 7 days.

  **ATC meets temperature drift and control authority requirements over seasons.** [New assessment, as did not have enough data to assess at time of NASA PLAR.]

- Radiometer and Scatterometer performance requirements:
  Radiometer and Scatterometer performance meets requirements based on instrument engineering data.
Spacecraft Status

Autonomous Star Tracker (ASTR) 1 and 2
OBSERVABLES FOR THE ASTR AND AOCS BEHAVIOR (CONTINUED)

Reference

- Moon intrusion/ NO mitigated / NO SHO
- Moon intrusion/ NO mitigated /SHO
OBSERVABLES FOR THE ASTR AND AOCS BEHAVIOR (CONTINUED)

Reference
- Yellow: Moon intrusion/ NO mitigated /SHO
- Green: Moon intrusion/ Mitigated /NO SHO
- Blue: NO Moon intrusion /SHO
- Red: Moon intrusion/ Mitigated /SHO
- Magenta: ASTR1 Power Cycling
- Cyan: ASTR2 Power On- Power Off

JUL

AUG

SEP

OCT

NOV

DEC

JAN-2013
OBSERVABLES FOR ASTR1 (CONTINUED)

Q Index Mean Value

- July 11
- August 11
- September 11
- October 11
- November 11
- December 11
- January 12
- February 12
- March 12
- April 12
- May 12
- June 12
- July 12
- August 12
- September 12
- October 12
- November 12

Q Index Mean Value
DISTRIBUTION OF QUALITY INDEX FOR ASTR1 AND ASTR2

NORMALIZED DISTRIBUTION OF ASTR QUALITY INDEX
LIMITATIONS AND CONSTRAINTS

- **Sub-sampled HKT data**: By default, the AOCS data is decimated to one sample every 8 seconds. It is possible to decimate some variables to one sample per second.

- **Full ASTR telemetry not available**: Only SENSOR STATUS and TELEMETRY STATUS data blocks are included in the AOCS HKT. Adding additional datawords would require an AOCS software patch.

- **ASTR CCD map download not available**: This would also require an AOCS software patch.

- **Telemetry allocation for one ASTR**: Telemetry can be obtained for only one ASTR at a time.

- **AOCS Source Code**: INVAP currently has the only copy of the source code and is the only organization that can develop flight software patches.

- **Flight Software Testing**: The SAC-D EM does not include EMs of the ASTRs to support patch validation.
Mitigation Plan Rev. A:

- Disable automatic re-promotion of ASTR AAD mode by FDIR for 20 minutes starting just before Moon intrusion (recommended by NASA SME M. Vess).
- Implemented starting 9 August 2012.

Mitigation Plan Rev B:

- Command ASTR to STB mode for 20 minutes starting just before Moon intrusion.
- Implemented starting 7 October 2012.

Mitigation Plan Rev C:

- Disable use of ASTR1 by AOCS for 49 minutes starting just before Moon intrusion.
- Implemented starting 19 November 2012.

Mitigation Plan D:

INVAP delivered an analysis of the ASTR-driven AOCS SHO transitions and a proposed solution. This proposal is currently under discussion between CONAE, INVAP and NASA and may be implemented next week.
As a result of consultations with the Project Office and the recommendations of the Standing Review Board at the SAC-D PLAR, CONAE has requested that NASA convene a group of experts from all organizations involved in the Project to achieve the following objectives:

1- A near-term operational strategy for CONAE to implement in order to mitigate the impact of the performance issues, specifically to minimize the degradation of the Aquarius and SAC-D instrument science data.

2- An understanding of the apparent change in the performance of ASTR1 since the start of the mission.

3- An understanding of the as-launched AOCS software, specifically in the implementation and quality control of the ASTR data;

4- An understanding of the performance of ASTR2 during the period when it was powered on, which was observed to be significantly worse than ASTR1.

5- A long-term resolution, e.g., AOCS parameter changes or software patches, to address the ASTR and/or AOCS issues.

The focus of the Team will be on objectives 2 through 5.
Status Summary

- The Aquarius Ground Segment -- both systems and personnel -- are working well, and there are no significant issues.

- The end-to-end process of Aquarius data collection -- planning, scheduling, downlink, acquisition -- has worked as designed since launch. Not a single minute of Aquarius data has been lost since power-on due to either spacecraft, instrument or ground system anomalies demonstrating robustness of the downlink strategy. At this time, no spacecraft-related maneuver or issue has made Aquarius exceed its data loss requirement (8% per month).

- The operations interfaces with CONAE have matured significantly since Aquarius PLAR. All planning product deliveries, verifications and CUSS/CODS products are now routine with only occasional issues - all of which have been quickly and effectively resolved.
The Aquarius and SAC-D Status and Housekeeping Telemetry web-based analysis pages are widely used by all teams and have provided comprehensive, critical and timely information to help identify many issues that have arisen since launch. As our understanding of the instrument and spacecraft has improved, the capabilities of these tools have been expanded. GS team holds quarterly telemetry workshops with the instrument team.

CONAE FOT and ACCS are joint participants in the weekly issue/anomaly review process. Other teams (e.g., Aquarius instrument, SDI) invited to participate. FOT and ACCS function as a unified team in this area.

All documents are under CM. Aquarius GS documents are signed off. Joint CONAE/Aquarius operations documents are complete.

Multiple algorithm updates (V1.2 to 2.0) have been implemented and algorithm update verification process has been refined since launch. Complete mission reprocessing takes less than 1 day and products are immediately available to the science team and PO.DAAC.
Aquarius is a focused effort to measure Sea Surface Salinity and will provide the global view of salinity variability needed for climate studies. The mission is a collaboration between NASA and the Space Agency of Argentina (Comisión Nacional de Actividades Espaciales). More >>

**Mission Status & Events**

- **Ocean Salinity Viewed from Sea and Space (SPURS Blog)**
  - 29-30 January
  - NASA WebMeeting
  - Feldman et al – Project Status
  - Aquarius Cal/Val Workshop

**Ocean Salinity Trends Show Human Fingerprint**

- 08-Nov-12

- 13-Jun-12 Aquarius Maps the Salinity Structure of a Climate-Influencing Type of Wave in the Pacific Ocean.

**News Items**

**Focus on Education**

- **Upcoming Educator Workshop**
  - How much do you know about Aquarius? Find out here!
  - Try our interactive tools!
  - Take NASA's Sea Salt Quiz!

- **Videos | Workshop**
  - Aquarius / SAC-D Poster | Poster

**About Aquarius**

First Aquarius Maps

Aquarius has produced its first maps of global ocean salinity. These preliminary data contain uncertainties and, over time, will be updated as further calibration and validation work are completed. More >>

Salinity Processes in the Upper Ocean Regional Study (SPURS)

See where Aquarius is now!

**Announcements**

- New PODAAC Aquarius Level 3 Image Browser Tool
  - February 11, 2012
  - We are pleased to announce the release of PODAAC's new, interactive Aquarius Level 3 image browser. The tool is now available online at http://podaac.gsfc.nasa.gov/aquarius/image. The browser allows effortless navigation and viewing of PO.DAAC Aquarius imagery data holdings by time periods and individual global ocean surface salinity (SSS) maps and animation sequences. Simple pickle image type (Daily, Weekly or Monthly) and use the calendar selector tool to choose a period of interest. Selectable thumbnails of all available data for the chosen period appear sequentially in the image Gallery portion of the page. Click on a particular item in the gallery listing or a specific date in the calendar tool to see the full image with associated salinity color scale. Use the interactive controls to step forward or back through the sequence or view as an animation. Double click on the image in focus to see an enlarged rendering within a pop-up window, and use mouse controls to zoom into particular areas of interest.

- All images are of global, 1 degree spatial resolution Aquarius Level 3 v.1.0r data archived and distributed by PO.DAAC. Access to the underlying source data files is possible via links provided. Please note that Aquarius v.1.0r release data are for evaluation only and are not to be used for scientific research purposes. These data are available via FTP at http://podaac.gsfc.nasa.gov/AquariusDataAccess upon prior acknowledgement of this disclaimer and registration at http://podaac.gsfc.nasa.gov/register/.

- Accompanying Image: Snapshot of a L3 browser tool page showing the various elements described above.

**Level 2 and Level 3 data for version V1.0rK of the Aquarius/SAC-D data set now available**

- February 11, 2012
- The PO.DAAC would like to announce the availability of both Level 2 and Level 3 data for version V1.0rK of the Aquarius/SAC-D data set. The differences between V1.0rK and V1.2 result from the change of correction technique for radiometer calibration drift. V1.2 also uses the global averaged differences of Aquarius brightness temperatures and the radiative transfer model of brightness temperatures computed using many ancillary data, such as the NCEP surface winds. For V1.0rK, the brightness temperature corrections are computed using the mean cloud deflections derived from the instrument data alone, and the ancillary data were only used to train the coefficients in the deflection-ratio based correction model initially.
DATA ACCESS AND TELEMETRY MONITORING TOOLS

DATA ACCESS:

JPL's PO.DAAC Aquarius page and official source of all Aquarius data products

Aquarius Data Access: GSFC's Source and non-validated data products

Ancillary Data Access: CUSS and CODS files and meteorological files used in Aquarius data processing

GSFC's Aquarius Level-1 and Level-2 visual browser/data download tool

GSFC's Aquarius Level-3 Salinity visual browser/data download tool

GSFC's Aquarius Level-3 Wind Speed Product visual browser/data download tool

Large Salinity Maps Created From Aquarius Level-2 Data

TELEMETRY MONITORS:

Aquarius Telemetry Monitor including Level-0/Level-1a data access telemetry plotting tool

SAC-D Service Platform Telemetry Monitor

SAC-D Service Platform Telemetry File Transfer Monitor

Aquarius Software Messages

Time Series Plots of 7-day and Orbit-by-Orbit Statistics for Selected Telemetry Parameters

SCIENCE DATA PLOTS:

Aquarius Radiometer Plots

Aquarius Scatterometer Plots

DATA PROCESSING STATUS AND CHANGES:

Major Events and Software Change Log

Software Change and Problem Reporting Tool (TRAC) password required

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SAC-D/Aquarius Events: Including Time Glitches and DR Coefficients

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Aquarius Downlink --> Level-3 data processing status monitor internal use only
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## SAC-D Events

<table>
<thead>
<tr>
<th>Month</th>
<th>Time Spent in Maneuvers</th>
<th>Time Spent in Anomalies</th>
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</thead>
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<tr>
<td>May 2012</td>
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<td>0.052</td>
</tr>
<tr>
<td>Jun 2012</td>
<td>00: 52:10</td>
<td>0.121</td>
</tr>
<tr>
<td>Jul 2012</td>
<td>00: 39:40</td>
<td>0.089</td>
</tr>
<tr>
<td>Aug 2012</td>
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<td>0.049</td>
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<td>0.117</td>
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### Mission to Date
- 426 days 1435
- 57:36:10
- 0.107
- 7 13: 55:23
- 1.783
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</table>

**Mission to Date:** 425 days

**14:33:17**

### Anomaly Events during Jan 2013

- **Quarter Moon Interference**
  - **Beginning:** Saturday, 5 Jan 2013 16:40:00 UTC
  - **Ending:** Saturday, 5 Jan 2013 17:29:00 UTC
  - **Duration:** 00:49:00

- **AOCS Safehold**
  - **Beginning:** Saturday, 5 Jan 2013 21:10:17 UTC
  - **Ending:** Saturday, 5 Jan 2013 22:25:37 UTC
  - **Duration:** 01:15:20

- **AOCS Safehold**
  - **Beginning:** Thursday, 10 Jan 2013 08:42:45 UTC
  - **Ending:** Thursday, 10 Jan 2013 10:24:53 UTC
  - **Duration:** 01:42:08

Files:
- Q2013010081100.L1A_SCI
- Q2013010083100.L1A_SCI
- Q20130100894900.L1A_SCI

Comment: ASTR1 Standby
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The following is a logging of events since the completion of the Aquarius instrument commissioning phase on August 25, 2011.

The official start date of the SAC-D/Aquarius Mission Operations Phase is December 1, 2011, therefore, all data calculations use a starting point of 2011-12-01/00:00:00 UTC.

Invalid Data Calculation: 657 minutes.
(Invalid' data results from the execution of planned activities, which alter or degrade data quality.)

Lost Data Calculation: 10,934 minutes.
(Lost' data is characterized as unexpectedly missed, corrupted, or otherwise irretrievable.)

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<th>DR Coefficients</th>
</tr>
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<tbody>
<tr>
<td>Q201207615100</td>
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<tr>
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<tr>
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<td>27-Dec-2012 17:22</td>
<td>Orbit Maintenance</td>
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<td>5-Jan-2013 22:25:37</td>
<td>75</td>
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INVAP delivered a report that analyzed the AOCS SHO transitions that were caused by the ASTR standby events and proposed updated to AOCS parameters to avoid the transitions.

Friday 12/21/2012:
Wayne Robinson discovered a problem with the interpolation of the HYCOM data to the rectangular global grid, that caused a 1-degree shift in latitude. This problem was reported to the AQCal group.

Saturday 1/5/2013:
A star tracker standby event, not associated with Moon interference, resulted in an AOCS transition to SHO at 21:10. CONAE commanded the AOCS back to SCI at 22:25.

Thursday 1/10/2013:
The first meeting of the ASTR/AOCS Tiger Team was held with Dave Mangus as the team leader.

A CSC was performed at the request of the Aquarius Science team, with an 8-minute dwell starting at 09:18. This CSC was timed to coincide with an ocean-to-land crossing.

A star tracker standby event, not associated with Moon interference, resulted in an AOCS transition to SHO at 09:42, immediately after the CSC. The AOCS was commanded back to SCI at 10:25 by the reinforcement command.

Peggy Li delivered updated HYCOM interpolation tables that resolved the 1-degree latitude shift in both the salinity and the land mask.

Monday 1/14/2013:
The HYCOM data for the entire mission were re-acquired and reprocessed.

Wednesday 1/16/2013:
The V1.3.8 processing of the entire mission data set was completed. This version included the latest TND exponential correction, to use in computing the radiometer offset corrections for V1.3.9.

Friday 1/18/2013:
The V1.3.9 processing of the entire mission data set was completed. This version added the radiometer offset corrections to V1.3.8.

Thursday 1/24/2013:
Fred delivered V2.0 of the Level-2 product format specification.

Friday 1/25/2013:
The V2.0 quicklook processing of the entire mission data set was completed.
DATA ACCESS AND TELEMETRY MONITORING TOOLS

DATA ACCESS:
- JPL's PO.DAAC Aquarius page and official source of all Aquarius data products
- Aquarius Data Access: GSFC's Source and non-validated data products
- Ancillary Data Access: CUSS and CODS files and meteorological files used in Aquarius data processing

GSFC's Aquarius Level-1 and Level-2 visual browser/data download tool
GSFC's Aquarius Level-3 Salinity visual browser/data download tool
GSFC's Aquarius Level-3 Wind Speed Product visual browser/data download tool
Large Salinity Maps Created From Aquarius Level-2 Data

TELEMETRY MONITORS:
- Aquarius Telemetry Monitor including Level-0/Level-1a data access telemetry plotting tool
- SAC-D Service Platform Telemetry Monitor
- SAC-D Service Platform Telemetry File Transfer Monitor
- Aquarius Software Messages
- Time Series Plots of 7-day and Orbit-by-Orbit Statistics for Selected Telemetry Parameters

SCIENCE DATA PLOTS:
- Aquarius Radiometer Plots
- Aquarius Scatterometer Plots

DATA PROCESSING STATUS AND CHANGES:
- Major Events and Software Change Log
- Software Change and Problem Reporting Tool (TRAC) password required
- SAC-D/Aquarius Event Statistics: Maneuvers and Anomalies
- SAC-D/Aquarius Events: Including Time Glitches and DR Coefficients
- Joint Configuration Items List
- Aquarius Downlink --> Level-3 data processing status monitor; internal use only
Aquarius Level-1-2 Data Browser

http://oceancolor.gsfc.nasa.gov/cgi/aquarius
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Aquarius Seasonal
Sea Surface Salinity (V1.3.9)

Summer 2011
Autumn 2011
Winter 2011/2012

Spring 2012
Summer 2012
Autumn 2012

Sea Surface Salinity (psu)
30 32 33 34 34.5 35 35.5 36 37 38 40