Development of a satellite mission: From concept to launch

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Development of a marine debris satellite mission: From concept to launch
Development of a marine debris satellite mission: From concept to launch

Replace “marine debris” with “ocean salinity”

Development of an ocean salinity satellite mission: From concept to launch
Aquarius Project Scientist 2003-2011
Aquarius Launch on 10 June 2011
Ocean Salinity Sensing: 1st Workshop

- First salinity sensing workshop, La Jolla, CA, USA, 7-8 February 1998

Participant List:

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Ocean Salinity Sensing: 1\textsuperscript{st} Workshop

- First salinity sensing workshop, La Jolla, CA, USA, 7-8 February 1998
- Three key ingredients
  - Increased awareness of salinity’s important role in ocean and climate.
  - Salinity (although small) can be sensed by passive microwave.
  - NASA Physical Oceanography program desires a comprehensive evaluation of the scientific importance and technical feasibility of such mission.

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Ocean Salinity Sensing

1977 - Skylab

1.4 GHz microwave radiometer

Klein and Swift, (1977)
Ocean Salinity Sensing

(From Le Vine, 1996)
Ocean Salinity Sensing: Challenge

• Technology challenge
  – Large errors ~1 psu (salinity unit): too large to justify a satellite mission
  – Need new, breakthrough, innovative ideas (R&TD)

• Community building
  – Salinity Science Working Group (Chaired by Gary Lagerloef; funded by NASA HQ)

• Working group workshops
  – #1: 7-8 February 1998 in La Jolla, CA
  – #2: 19-21 April 1999 at GFSC, Greenbelt, MD
  – #3: 22-23 January 2000 in San Antonio, TX
Passive/Active L- and S-band (PALS) Microwave Instrument at JPL

Laboratory Test

Aircraft Test
Ocean Salinity Sensing: Ground Truthing
Ocean Salinity Sensing Timeline

- **Salinity sensing theory**
- **NRL salinity mapper**
- **Passive microwave radiometer at GSFC**
- **Passive microwave radiometer & active scatterometer at JPL**
- **Workshop #1**
- **Workshop #2**
- **Workshop #3**
- **ESSP-3 RFP released**
- **Aquarius selected as NASA ESSP mission**

Aquarius Satellite Mission

- **Risk mitigation**
- **Formulation**
- **Implementation**
- **Operation**
Aquarius as a NASA ESSP-3 mission

- Aquarius is a focused, science-driven mission
  - Well-defined requirements

<table>
<thead>
<tr>
<th>Level 1 Science Mission Requirement</th>
<th>Baseline Mission</th>
<th>Minimum Mission</th>
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<tbody>
<tr>
<td>The Aquarius Mission shall collect the space-based measurements to retrieve Sea Surface Salinity (SSS) with global root-mean-square (rms) random errors and systematic biases no larger than 0.2 psu on 150 km by 150 km scales over the open ocean.</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>SSS Averaging Interval</td>
<td>1 Month</td>
<td>3 Months</td>
</tr>
<tr>
<td>Mission Duration</td>
<td>At least 3 Years</td>
<td>At least 1 Year</td>
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<tr>
<td>Deliver Level 1, Level 2 and Level 3 data validated products to a NASA Distributed Active Archive Center (DAAC).</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
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## Traceability from Science to Instruments

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Discovery and Exploration</td>
<td>Global coverage</td>
<td>Measure seawater emissivity sensitive to salinity (L-band)</td>
<td>Polar orbit</td>
</tr>
<tr>
<td>SSS mapping of unmeasured regions and features unknown to science</td>
<td>Mean and Variability Seasonal cycle</td>
<td></td>
<td>Baseline mission life: 3 years to ensure statistical confidence of seasonal cycle and track inter-year changes.</td>
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<tr>
<td>Water cycling</td>
<td>Resolution:</td>
<td>~3 meter aperture</td>
<td>Minimum mission life: 1 year</td>
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<td>Baseline: 100-km</td>
<td></td>
<td>Low Earth Orbit @ 600 km altitude</td>
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<td>Minimum: 200 km</td>
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<tr>
<td>Ocean Circulation and Climate</td>
<td>Time scale:</td>
<td>Relative stability 0.15 K for 8 days</td>
<td>≥300 km swath to obtain global coverage within 8 days (from both ascending and descending orbits)</td>
</tr>
<tr>
<td>Tropics: Air-sea interaction and climate feedback</td>
<td>Monthly (science product) 8 days (obtain multiple samples and reduce random monthly error by averaging)</td>
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<tr>
<td>Mid-Latitude: Subduction and mode water formation</td>
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<tr>
<td>High-Latitude: Deep water formation, and convection</td>
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<tr>
<td></td>
<td>Accuracy:</td>
<td>Measure ocean T₀ to &lt;0.2 K RMS error per observation</td>
<td>6 a.m. sun-synchronous orbit to avoid sun glint error.</td>
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<td></td>
<td>Baseline: 0.2 psu</td>
<td></td>
<td>Stable thermal environment.</td>
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<td></td>
<td>Minimum: 0.2 psu, tropics 0.3 psu, high latitudes</td>
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<td>Surface roughness to 0.15 K rms.</td>
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<td>Geophysical errors per observation &lt;0.5 psu.</td>
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<td>Random errors to 0.3 psu.</td>
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</tbody>
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Aquarius 3.75 years salinity data

Ocean salinity story continues...
Aquarius 3.75 years salinity data

Ocean salinity story continues...

Time to tell the story of marine debris?
Thank!
Questions?

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