Remote Sensing Sea Surface Salinity
and the
Aquarius/SAC-D Mission

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**Current Research Topics**

- **Land Surface Processes:**
  - Soil moisture
  - Snow coverage and water content
  - Vegetation type and biomass

- **Ocean Processes:**
  - Sea Surface Salinity
  - Sea Ice type and extent

- **Atmospheric Processes:**
  - Storm detection and monitoring
  - Precipitation
  - Temperature & Humidity profiles
  - Radiation from lightning
  - Hydrometeor profiles
  - Retrieval of falling snow over land

ESTAR L-band Radiometer
Sea Surface Salinity

• **Salinity needed to:**
  – Understand ocean circulation
    Salinity (with temperature) determine water density
  – Model heat exchange with the atmosphere
    Salinity gradients cause stratification at the surface
  – Monitor the water cycle
    Salinity is a tracer for water flux (evaporation & water input)
Sea Surface Salinity

• **Salinity is Important for Earth Science:**
  – Evolution of the global water cycle (is it changing?)
  – The coupling between ocean circulation and climate
• But, salinity is inadequately sampled
Remote Sensing of Salinity

\[ T_B = e \, T \]
\[ e = \text{Emissivity} \]
\[ T = \text{Physical Temperature} \]
\[ e = 1 - R^2 \]
\[ = 1 - \left[ \frac{(1-\text{ve})/(1+\text{ve})}{(1+\text{ve})} \right]^2 \]
\[ \text{(normal incidence)} \]
\[ e = \text{Relative Dielectric Constant} \]
\[ = e_d - j \, \sigma / \varepsilon_0 \]
\[ = \varepsilon(f, s, \tau) \]
Measurement of Salinity from Space

• **Sensor to Surface**
  – **Atmosphere**
    • Attenuation and emission
    • Flags (rain, RFI)
  – **Ionosphere**
    • Faraday rotation
    • Attenuation and emission
  – **Galactic Background Radiation**
    • Line emission (hydrogen)
    • Continuum emission
    • Cosmic background
  – **Sun**
    • Direct ray
    • Reflected ray

• **Surface to Salinity**
  – **Sea surface temperature (SST)**
  – **Surface roughness**
    • Scatterometer
    • Surface winds
  – **Antenna pattern correction**
    • Land/ocean mask
    • Polarization and pointing
  – **Model function**
• **Instrument**
  - L-band
  - Radiometer and Radar
  - 3 Beam Pushbroom
  - Polarimetric

• **Mission**
  - Sun-synch orbit 6 am/6pm
  - Night time look
  - 675 km Alt; 7 day revisit

• **Science**
  - Global maps of Sea Surface Salinity
  - Accuracy: 0.2 psu; 100 km; monthly
  - Seasonal and annual variations

• **Partnership**
  - NASA/CONAE
  - Argentina: Spacecraft (SAC-D)
  - NASA/GSFC: L-band radiometer
  - NASA/JPL: L-band scatterometer
Observatory Configuration

4850 mm
Aquarius Antenna Assembly
Aquarius Main Antenna Reflector

Reflector after VDA coating

Reflector: RF surface

Reflector: structure side
OMT-Feed Assembly
Mission & Partnership Overview

- SAC-D Instruments (CONAE)
- Aquarius Instrument (NASA JPL & GSFC)
- Observatory
- March 2009: Delta II (NASA)
- Salinity Maps Archive at PO.DACC (JPL)
- Aquarius Ground System
- Salinity Retrieval Algorithm (GSFC)
- Ground Station & Mission Operations Center (MOC) (CONAE)
L-Band Window for passive use only
L-band (1.413 GHz)
Bandwidth = 27 MHz

Applications for Passive Remote Sensing
Soil Moisture
Sea Surface Salinity
Vegetation Biomass

Limitation: Long wavelength means large antennas in orbit

<table>
<thead>
<tr>
<th>Application</th>
<th>Spatial Resolution</th>
<th>Radiometric Resolution</th>
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<tbody>
<tr>
<td>Soil Moisture</td>
<td>1-10 km</td>
<td>1 K</td>
</tr>
<tr>
<td>Salinity: Coastal</td>
<td>1-10 km</td>
<td>0.5 K</td>
</tr>
<tr>
<td>Salinity: Open Ocean</td>
<td>200 km</td>
<td>0.05 K</td>
</tr>
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RFI at L-Band
Conclusion

• **L-Band is an Important Resource**
  – Important Parameters
    • Soil Moisture
    • Sea Surface Salinity
    • Vegetation Biomass
  – Only viable window in a crowded spectrum

• **Needs Protection**
  – Commercial pressure for more services
  – Science pressure for more sensitivity