Remote Sensing Sea Surface Salinity

and the

Aquarius/SAC-D Mission

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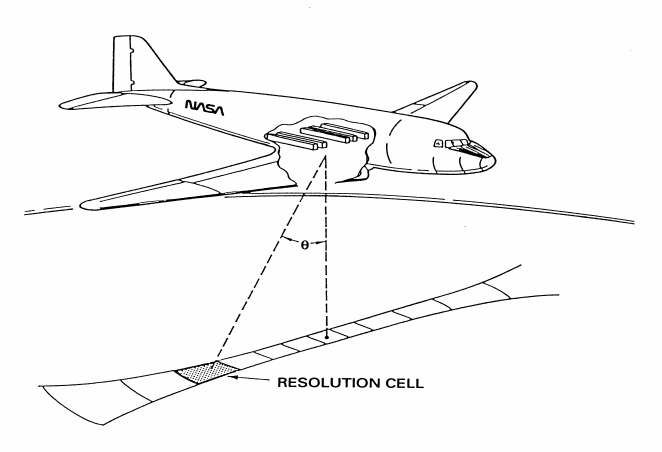
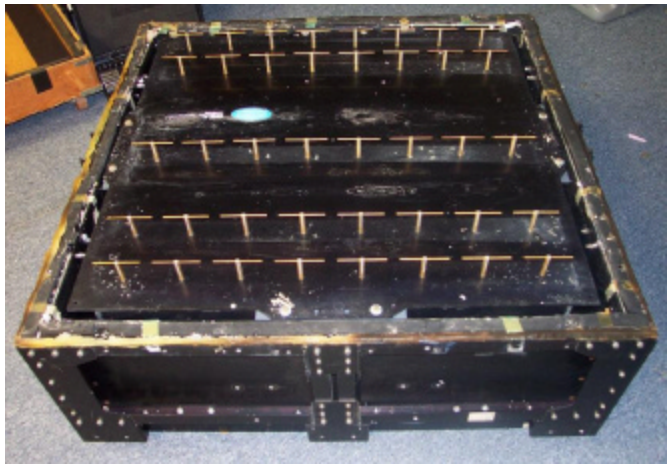
Microwave Remote Sensing Research and Development

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

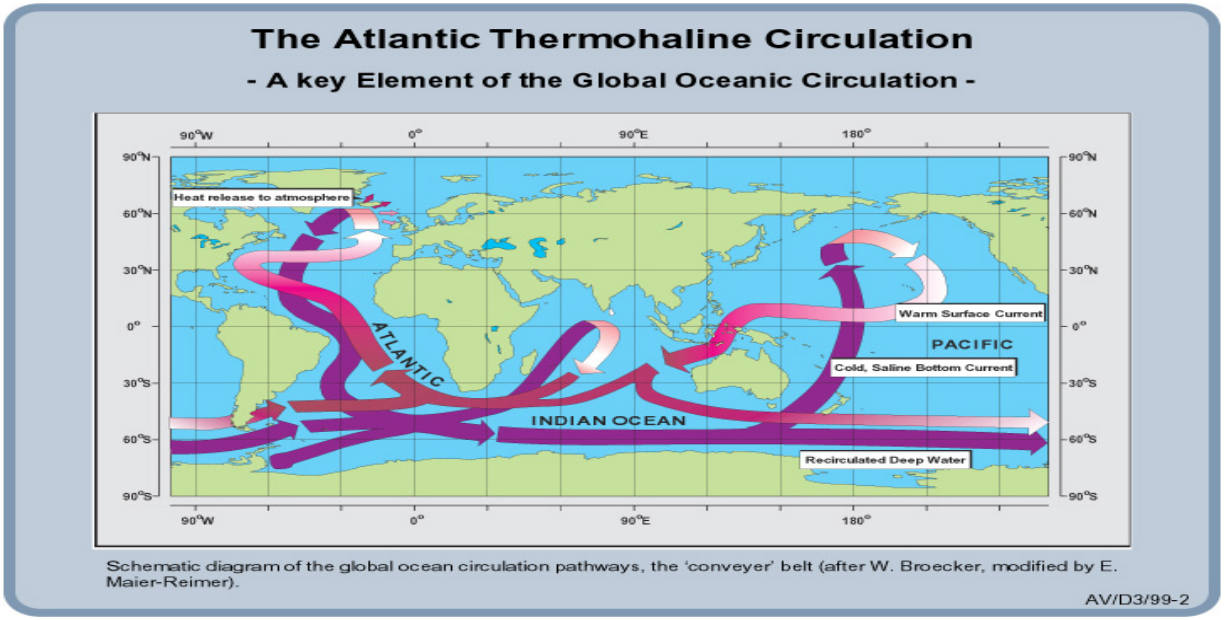




ESTAR L-band Radiometer

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**

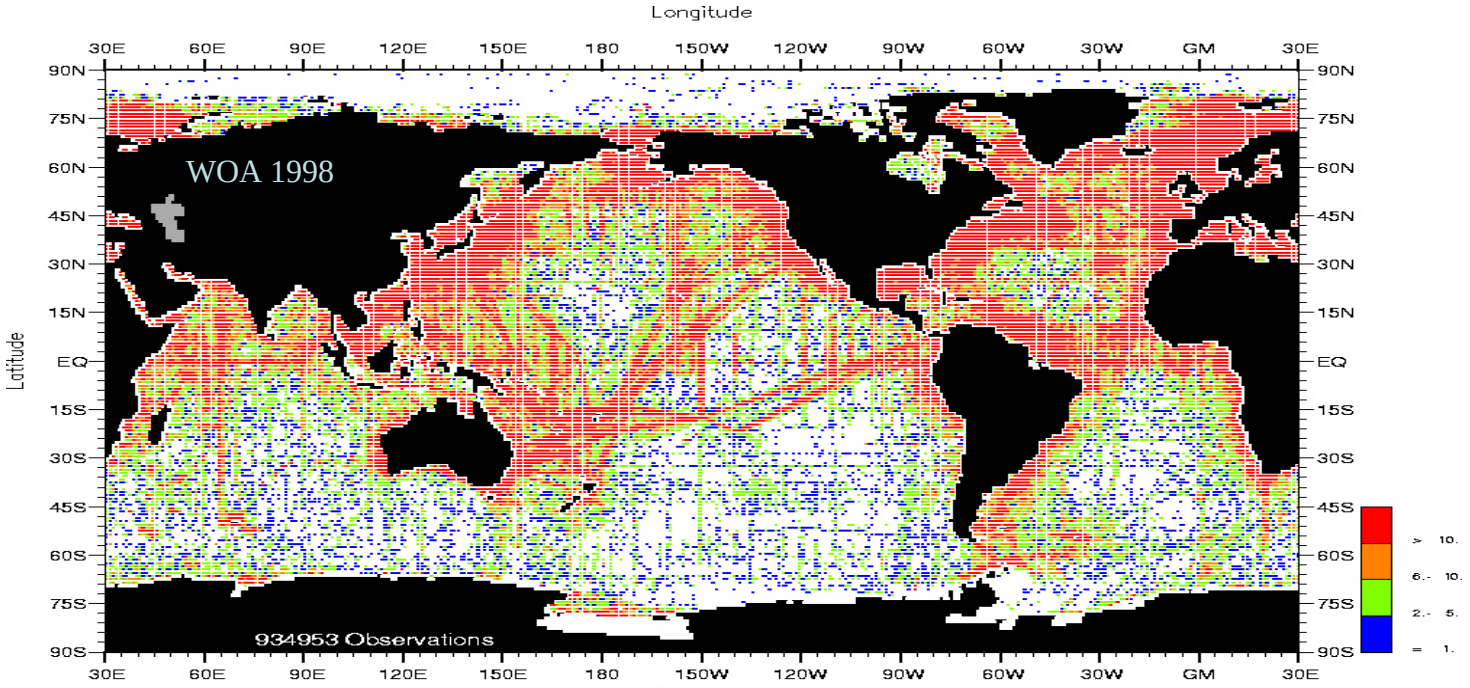


Fig. A1-1. Annual salinity observations at the surface .

Remote Sensing of Salinity

$T_B = e\,T$

e = Emissivity

T = Physical Temperature

$e = 1 - R^2$

$= 1 - [(1-ve)/(1+ve)]^2$

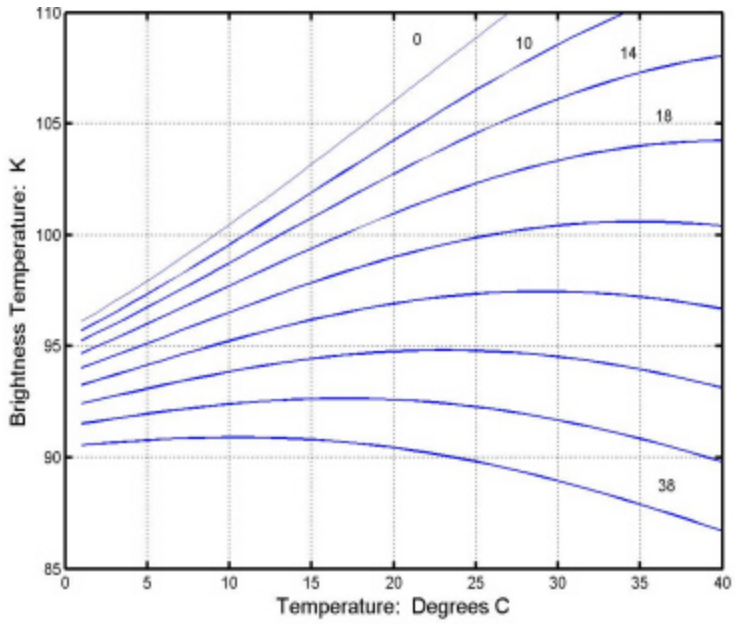
(normal incidence)

e = Relative Dielectric Constant

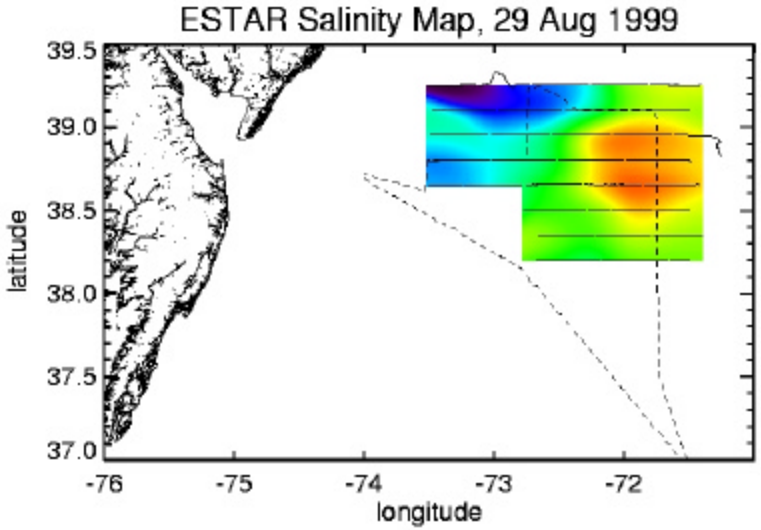
$= e_d - j\,s/?\,e_0$

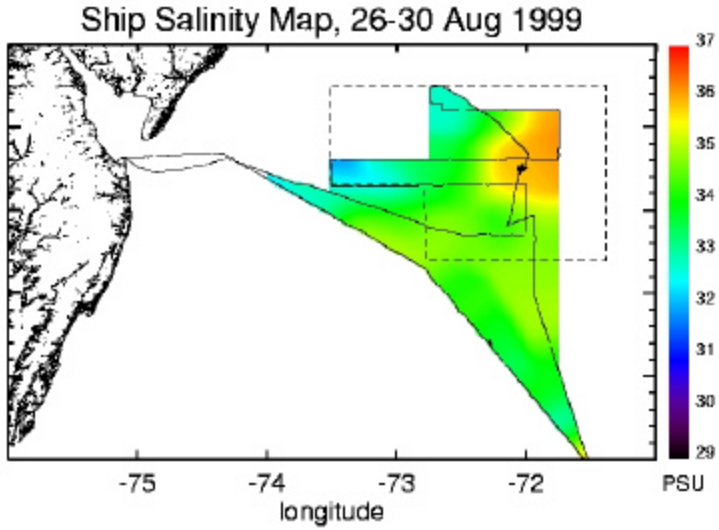
$= e(\mathbf{f}, \mathbf{s}, \tau)$

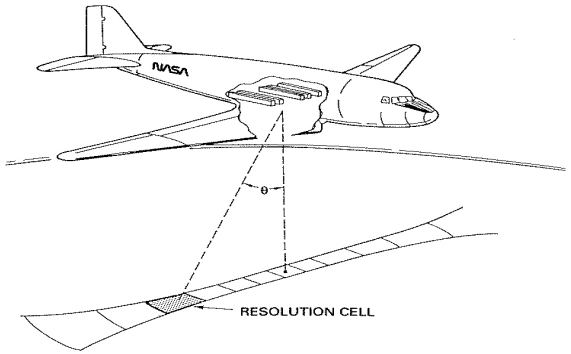
L-Band = 1.4 GHz
Normal Incidence



Gulf Stream Experiment







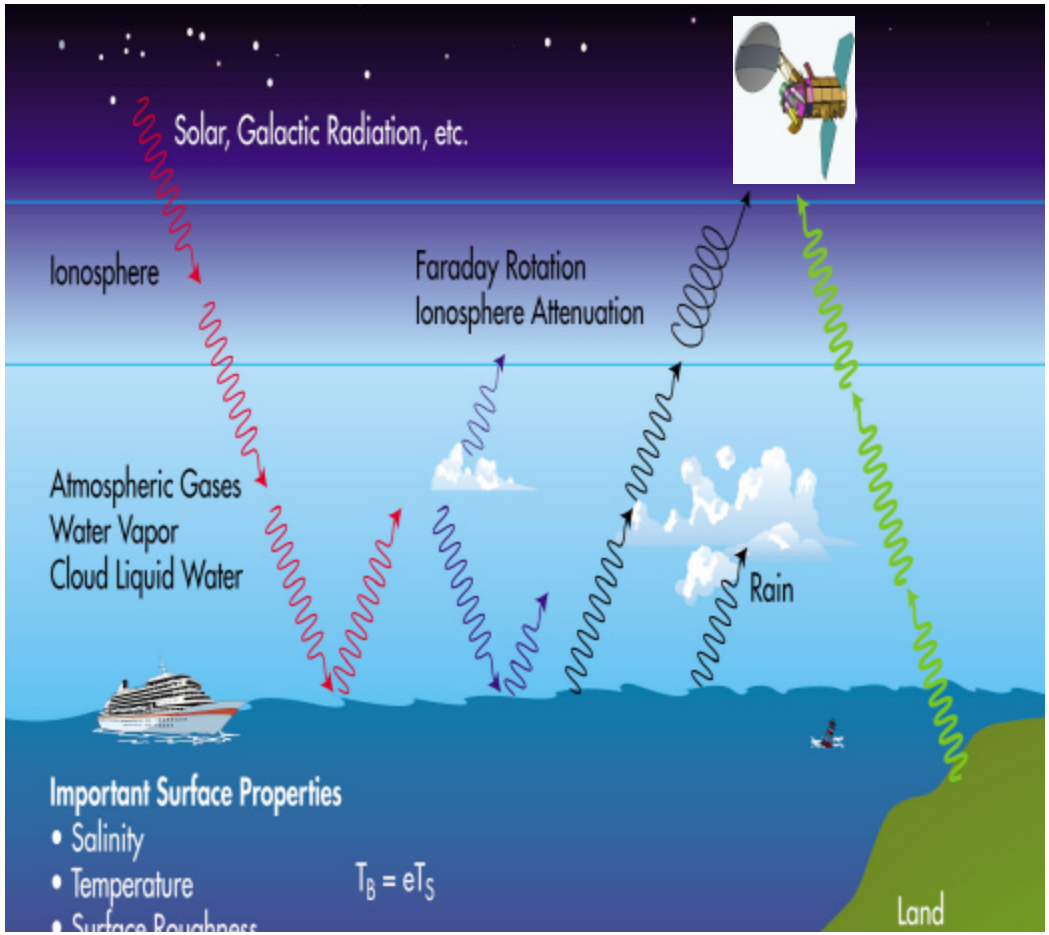
ESTAR

R/V Cape Henlopen

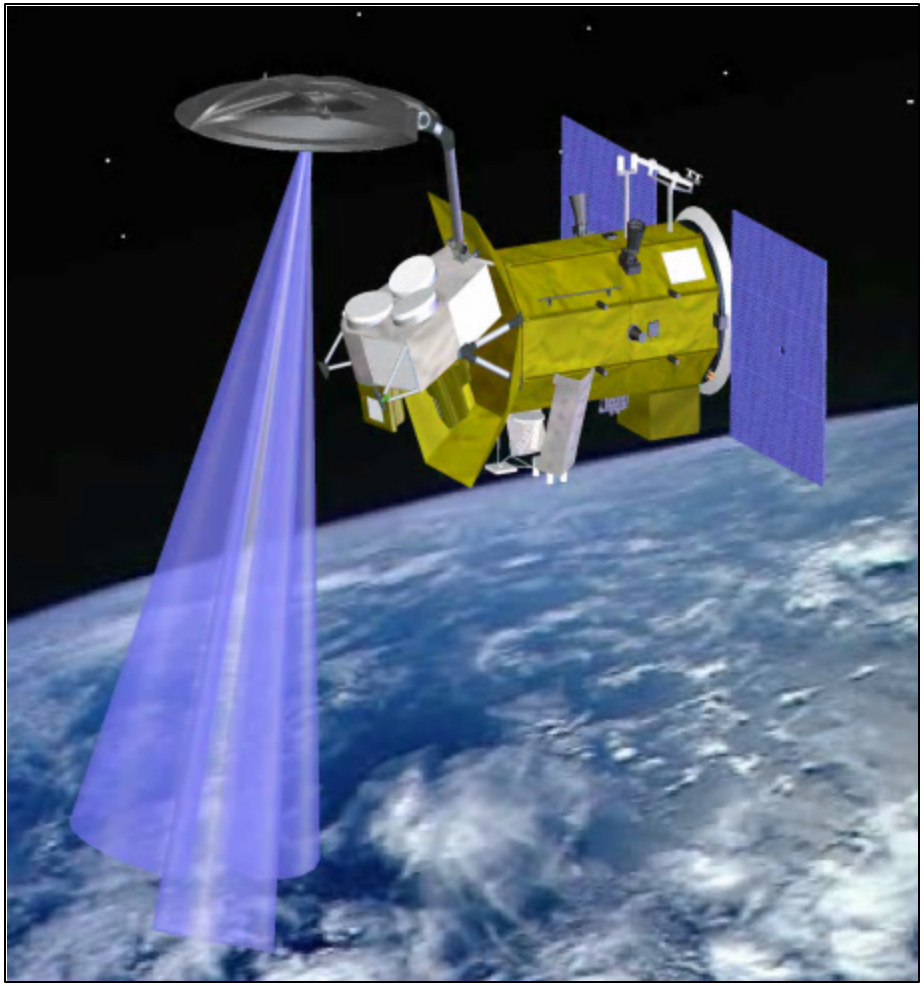
Measurement of Salinity from Space

- **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**

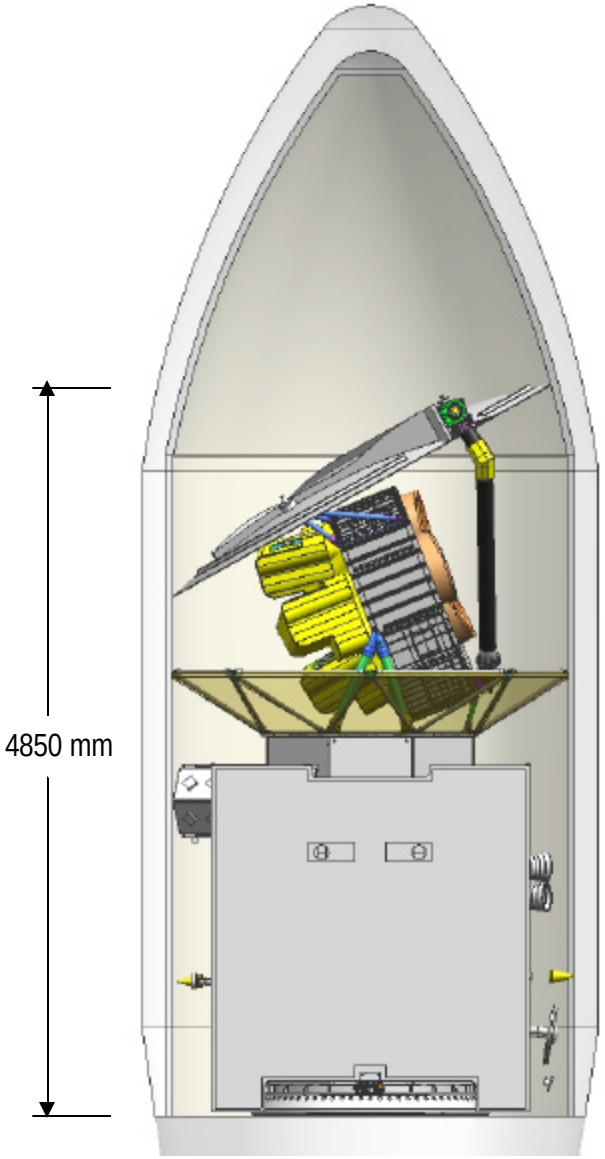


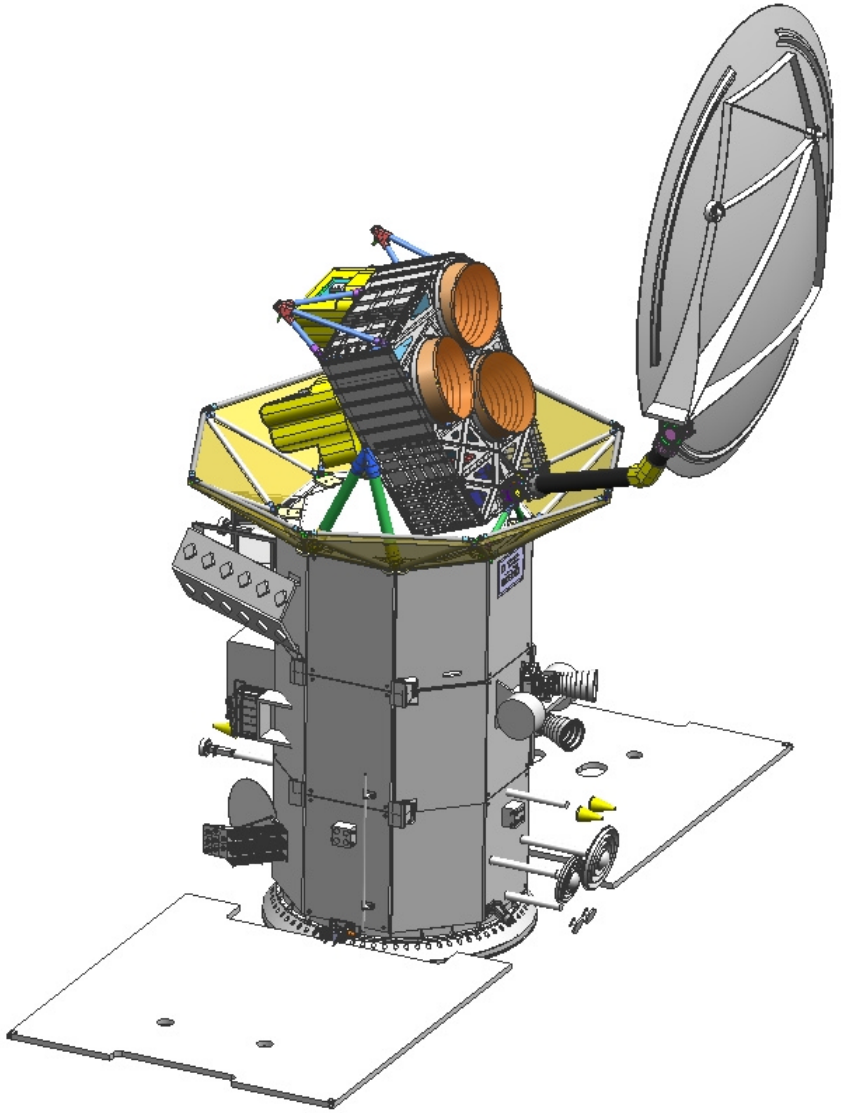
AQUARIUS



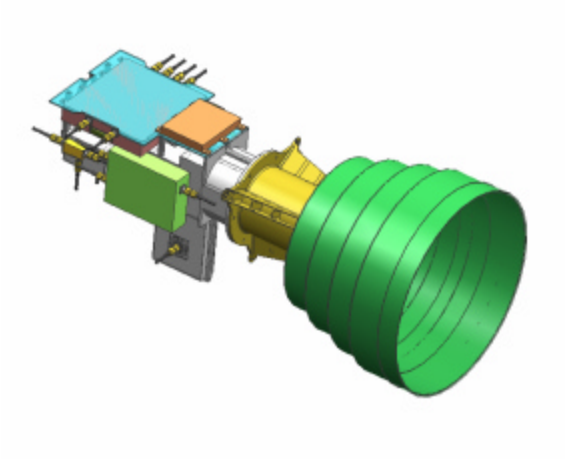
- ***Instrument***
  - ***L-band***
  - ***Radiometer and Radar***
  - ***3 Beam Pushbroom***
  - ***Polarimetric***
- ***Mission***
  - ***Sun-synch orbit 6 am/6pm***
  - ***Night time look***
  - ***675 km Alt; 7 day revisit***
- ***Science***
  - ***Global maps of Sea Surface Salinity***
  - ***Accuracy: 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***

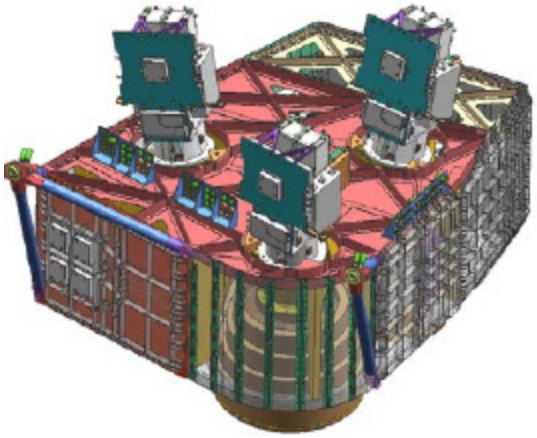
Observatory Configuration

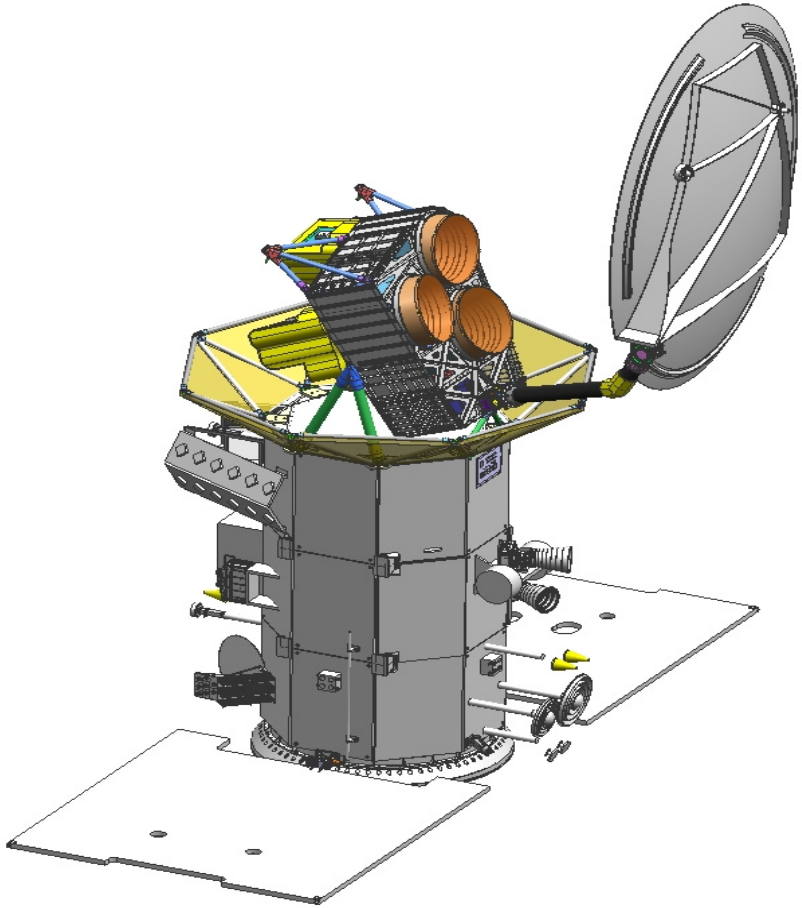




Aquarius Antenna Assembly

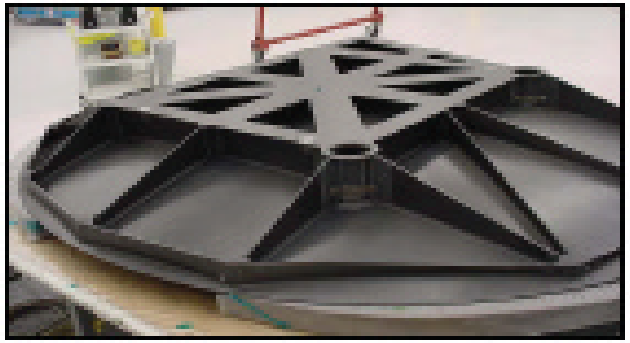






Aquarius Main Antenna Reflector

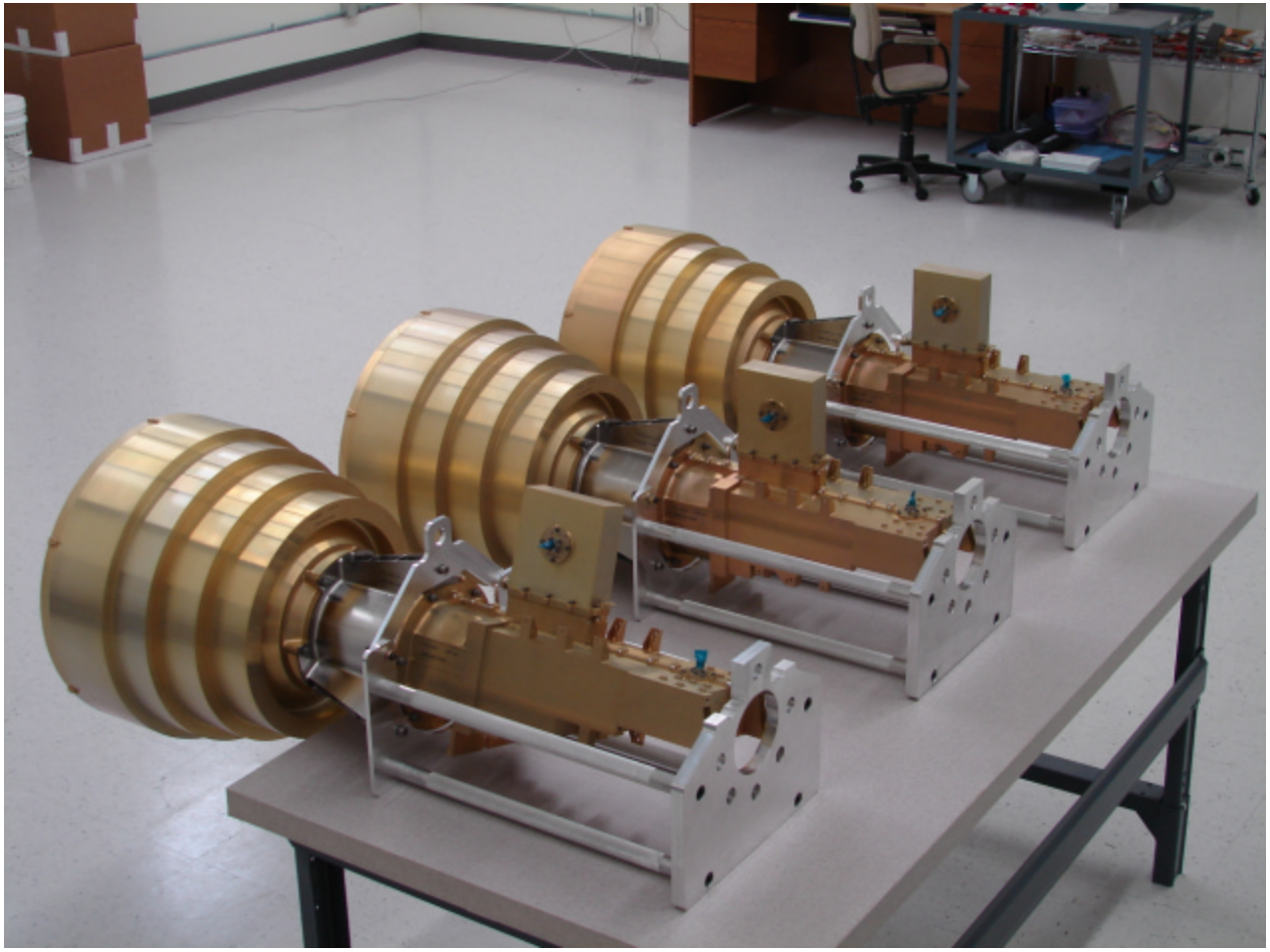
Reflector after VDA coating



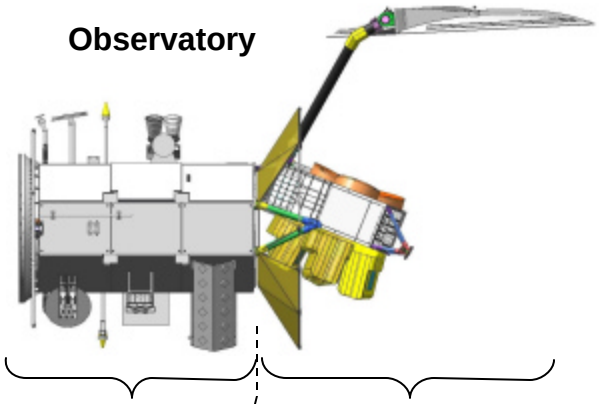
Reflector : structure side

Reflector : RF surface

OMT-Feed Assembly



Mission & Partnership Overview

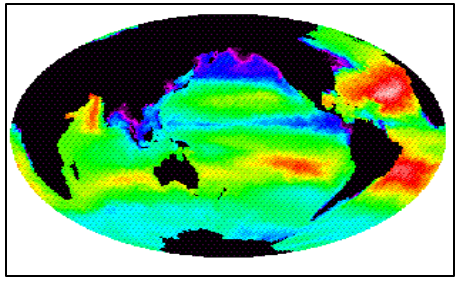


SAC-D Instruments
(CONAE)

Aquarius Instrument
(NASA JPL & GSFC)

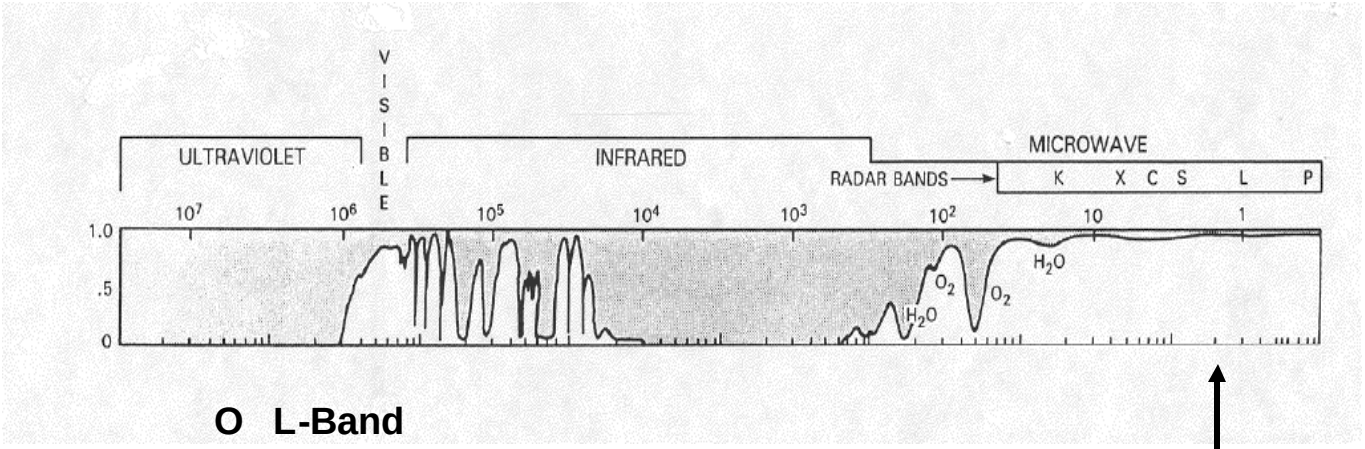
Ground Station & Mission Operations Center (MOC)
(CONAE)

Aquarius Ground System
Salinity Retrieval Algorithm
(GSFC)



Salinity Maps
Archive at PO.DACC
(JPL)

March 2009: Delta II
(NASA)



O L-Band

Window for passive use only
L-band (1.413 GHz)
Bandwidth = 27 MHz

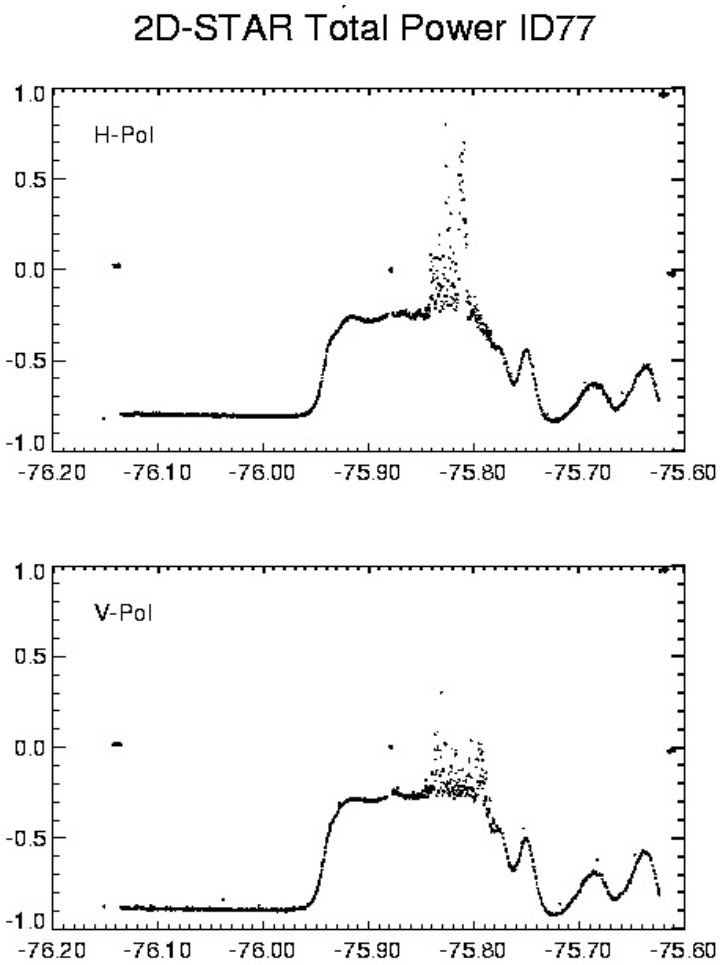
O Applications for Passive Remote Sensing

Soil Moisture
Sea Surface Salinity
Vegetation Biomass

O Limitation: Long wavelength means large antennas in orbit

Application	Spatial Resolution	Radiometric Resolution
Soil Moisture	1-10 km	1 K
Salinity: Coastal	1-10 km	0.5 K
Salinity: Open Ocean	200 km	0.05 K

RFI at L-Band


2D-STAR Total Power ID77
H-Pol
V-Pol
1.0
0.5
0.0
-0.5
-1.0
-76.20
-76.10
-76.00
-75.90
-75.80
-75.70
-75.60


Start
Finish

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