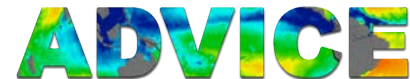


# Learn the Basics Behind NASA *Aquarius/SAC-D*

Tony Lee

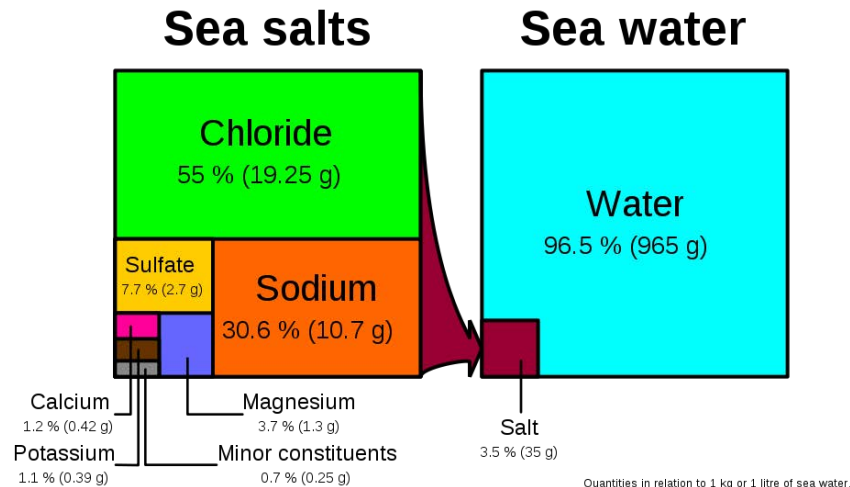
NASA Jet Propulsion Laboratory

Aquarius Project Scientist



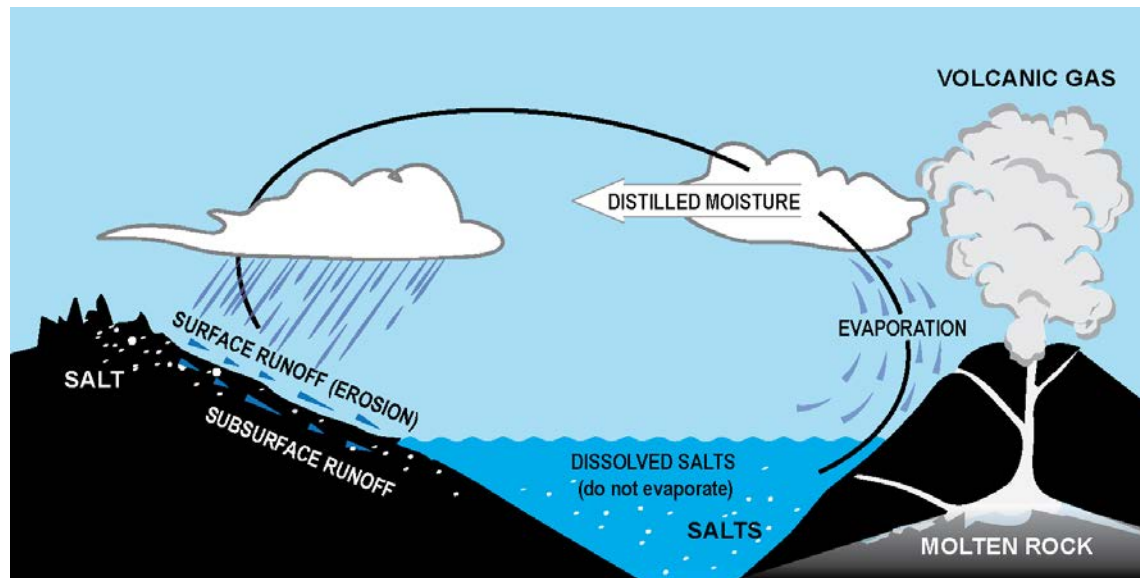
# Salinity Science

- Salinity is a measure of dissolved salts in seawater
  - Average open ocean salinity is about 35 grams of salt per 1000 grams of seawater
  - Salinity is expressed as *Practical Salinity Units (PSU)* or is a dimensionless unit ("35")



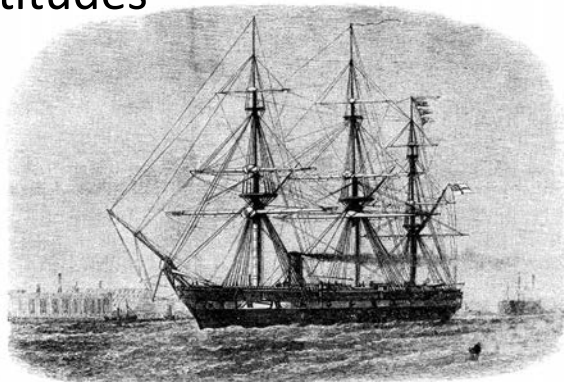
# Salinity Science

- Salts are derived from land and volcanic sources
  - Salts remain in ocean basins for thousands of years
  - Changes in salinity patterns are generally caused by the ocean's motion and/or variations in the water cycle

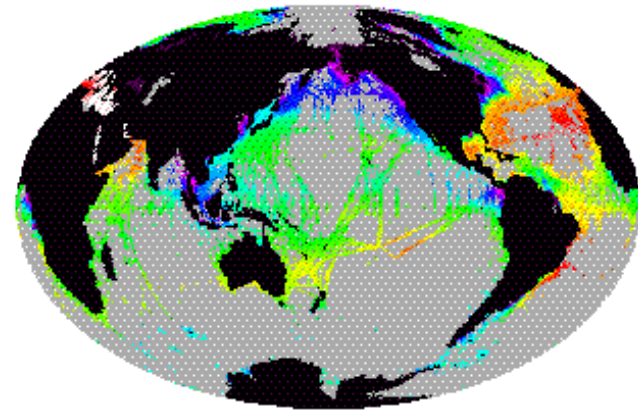


# Salinity Science

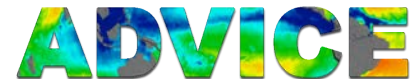
- Salinity had been measured for centuries but mostly along shipping routes
  - General patterns of salinity were known:
    - High salinity in gyres and evaporative basins (e.g., Mediterranean Sea)
    - Low salinity along tropical rain bands, near rivers, and at high latitudes



*HMS Challenger (1858)*

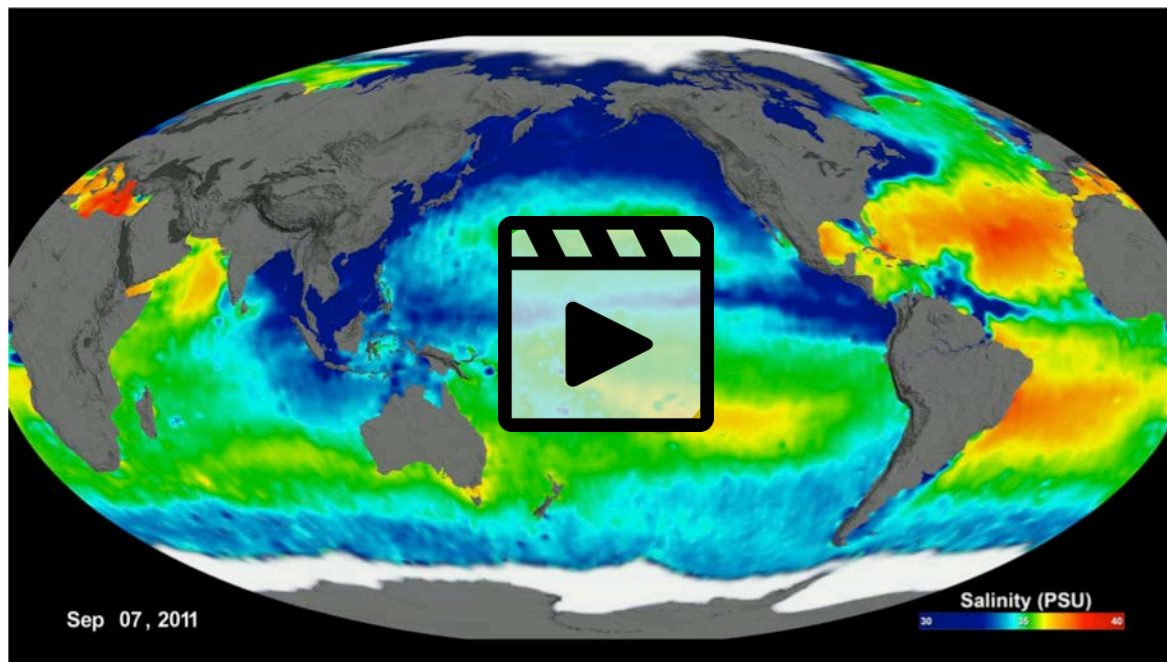


*100 years of Sea Surface Salinity (SSS) measurements*



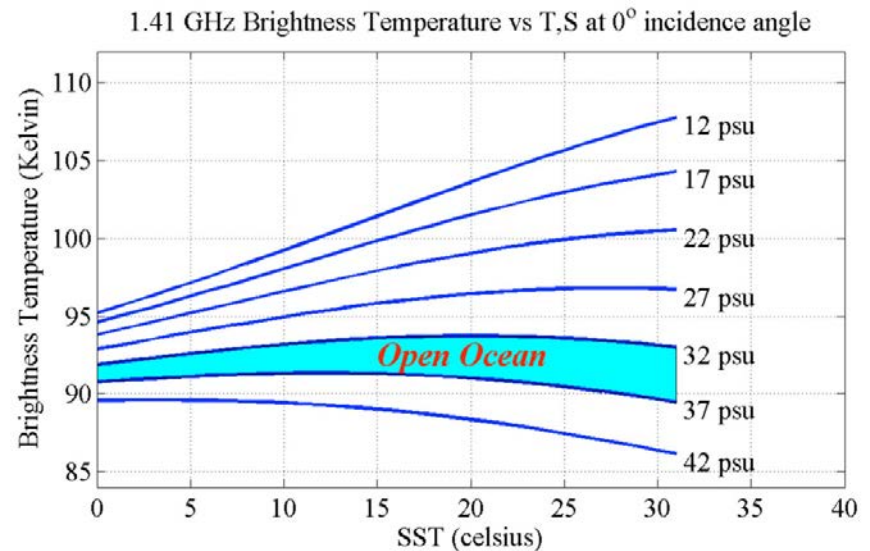
# Salinity Science

- NASA's first dedicated salinity instrument, *Aquarius*, provided weekly global maps
  - These revealed areas with high temporal variation



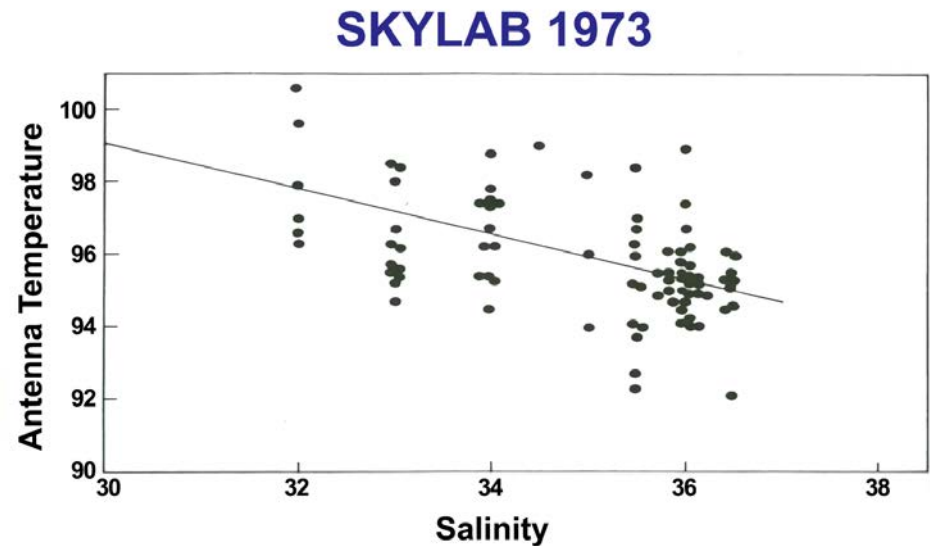
# Salinity Science

- NASA's salinity instruments measure natural microwave emission from the ocean surface in terms of *brightness temperature*
  - Like all ocean-observing satellite sensors, only the top 1 cm (or less) is measured
- Ocean brightness temperatures are related to the dielectric properties of seawater (Klein and Swift, 1977)



# Mission Design

- Salinity from space was first demonstrated in the 1970's aboard Skylab



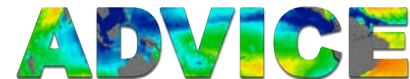
# Mission Design

- Various prototype salinity instruments were developed and tested in the 1990's and 2000's



*<< Salinity  
prototype Passive  
Active L- and S-  
band sensor (PALS)  
used for a  
controlled  
experiment at JPL*

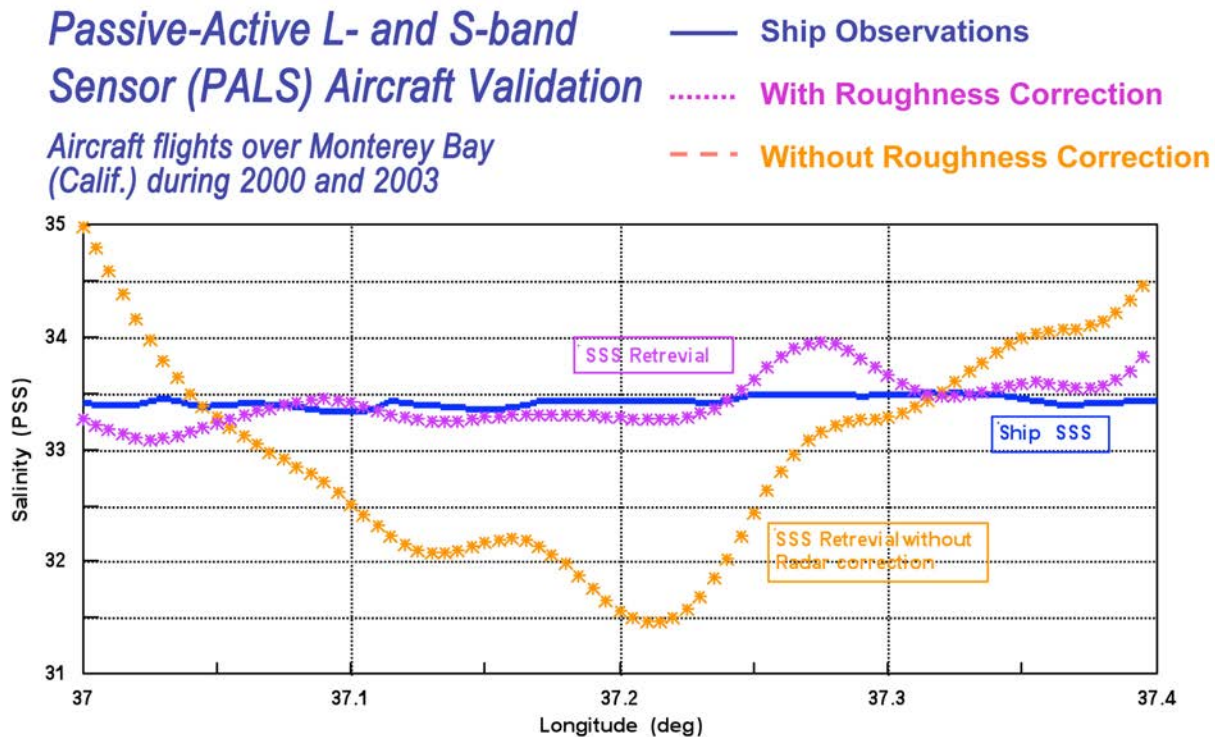
*>> PALS onboard  
C-130 for field test  
over Monterey Bay  
(Calif.)*





# Mission Design

- Coincident ship-based salinity observations showed the importance of correcting for ocean roughness



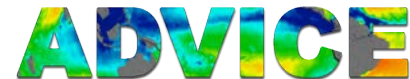
# Mission Design

- *Aquarius/SAC-D* is a U.S. – Argentina mission whose prime instrument measured salinity
  - Launched in June 2011
- Requirement for *Aquarius*:
  - *Monthly averaged sea surface salinity at 150 km spatial resolution with an accuracy of 0.2 (psu)*



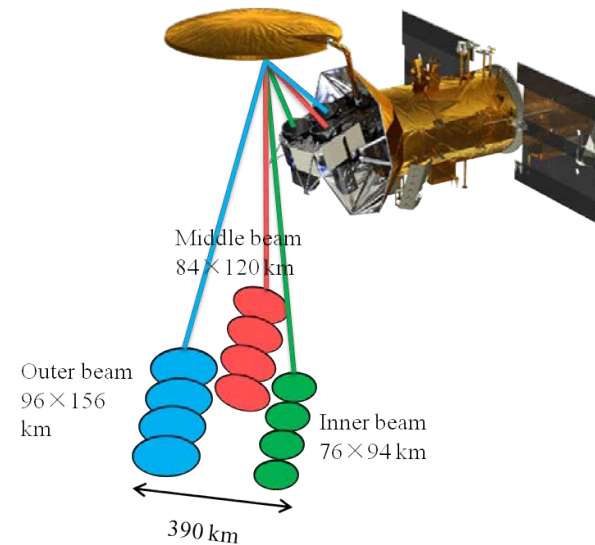
# Mission Design

- *Aquarius* has achieved its requirement through:
  - Instrument design
    - Extremely stable radiometers sensitive to changes in brightness temperature of about 0.1 K
    - Onboard scatterometer to measure ocean roughness
  - Orbit design
    - Sun avoidance
    - Global coverage
    - Repeat sampling



# Mission Design

- *Aquarius* instrument was designed as follows:
  - Three radiometers that measure brightness temperature at 1.41 GHz
    - Two polarizations (Vertical, Horizontal)
  - Beams at various incidence angles (28.7°, 37.8°, 45.6°)
  - Full swath width of 390 km



# Mission Design

- *Aquarius/SAC-D* was designed with the following orbit:
  - Ascending node of 6PM (local) straddles day/night
    - Solar panels in sun while footprint is in the dark
  - Globe is covered every 7 days



*Polar orbit  
with 657 km  
altitude*

