

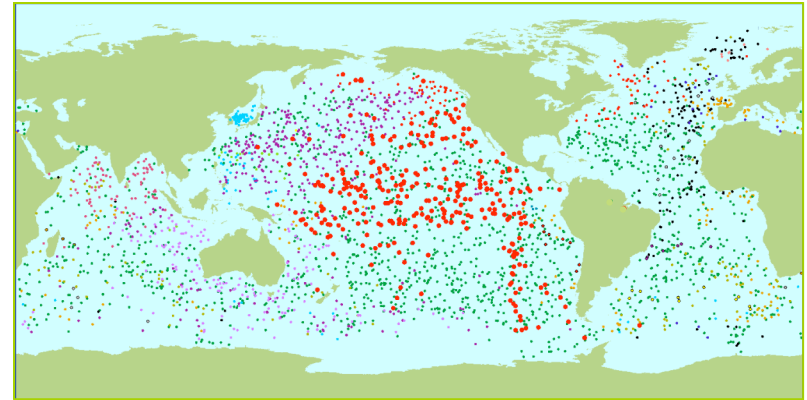


# Argo at PMEL: Intro

<http://floats.pmel.noaa.gov>



- Active float positions as of 3 July 2008
- red dots = positions of active PMEL floats
- green dots = other US floats



- International program observing the global oceans
- Fleet of 3000 robotic floats each sampling every 10 days
- Commenced in 2000 and reached 3000-float target November 2007
- 3° x 3° array -> 100,000 2-km depth profiles/year of public real-time data
- Year-round climate-quality temperature, salinity, and pressure data
- International effort: 23 countries providing floats
- US consortium provides half the global effort
- Gov't agencies (PMEL, AOML, FNMOC), Academic Institutions (SIO, UW, WHOI), and instrument manufacturers (Teledyne WRC, SeaBird Electronics)
- End-to-end (Float providers involved in instrumentation development, preparation & testing, deployment, scientific quality control, and analysis)



# Argo at PMEL: Linkages



## NOAA Research Plan and Strategic Plan

- NOAA Strategic Plan - Performance Objective:  
Describe and understand the state of the climate system through integrated observations, analysis, and data stewardship.
- NOAA Research Plan - Research Area:  
Develop an integrated global observation and data management system for routine delivery of information, including attribution of the state of the climate.

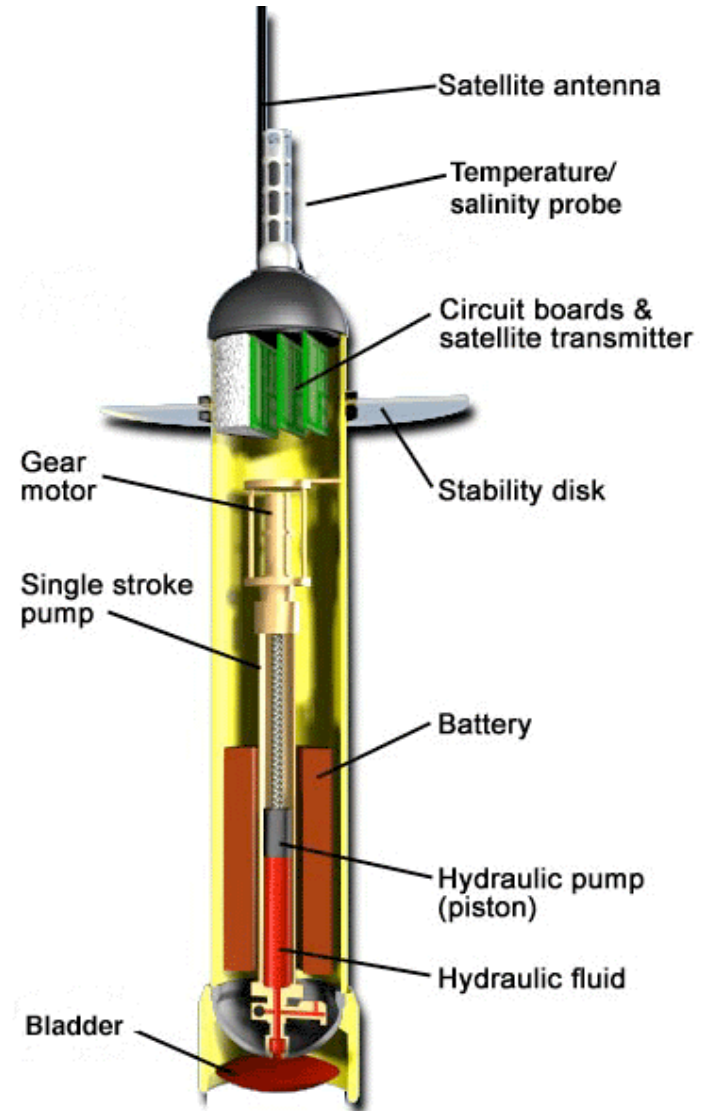
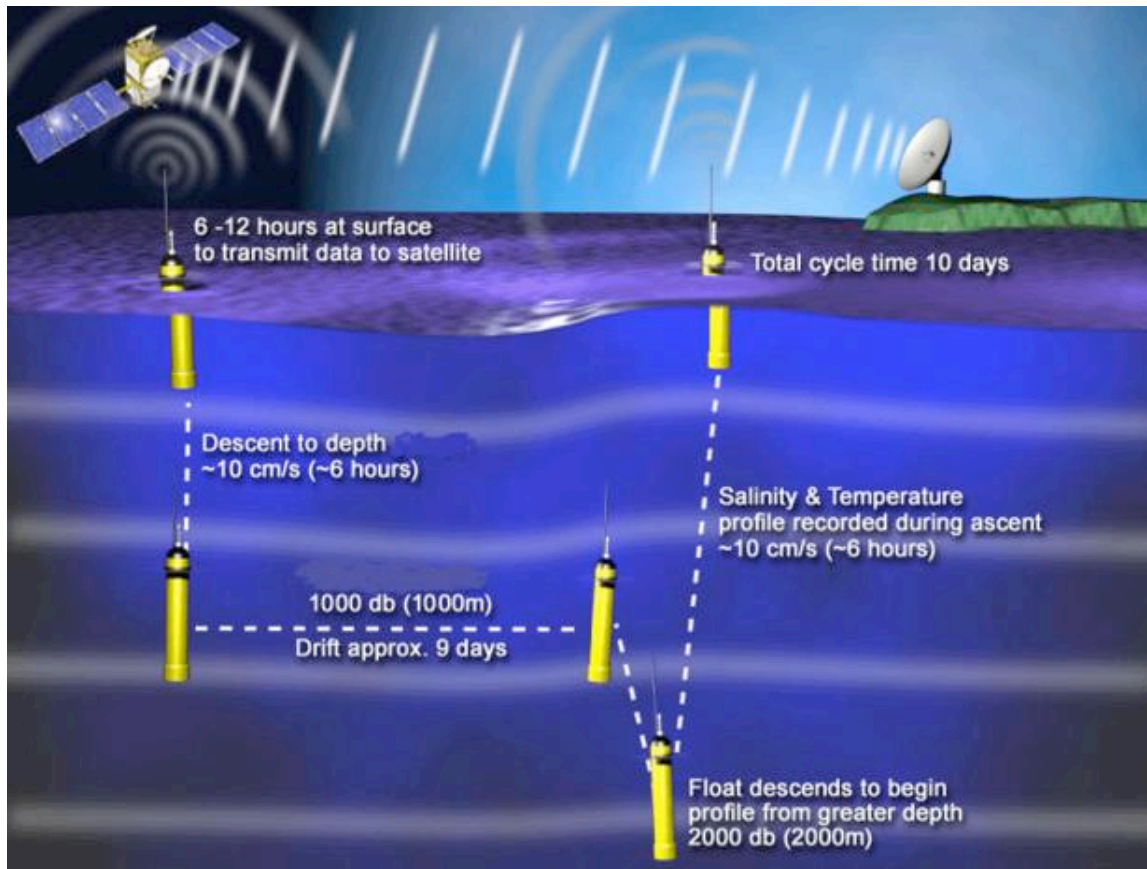
Argo epitomizes these plans  
Argo is a GEOSS success





# What is an Argo Float?

<http://www.argo.ucsd.edu/>

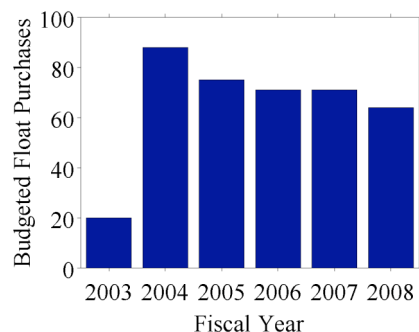




# Argo at PMEL: Float Providing

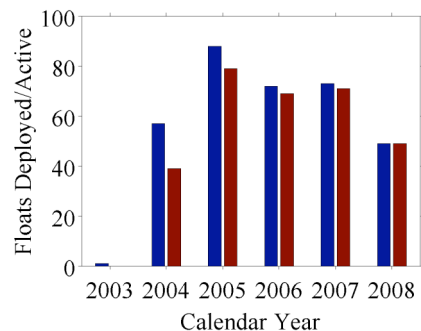


•Argo Float purchases budgeted:

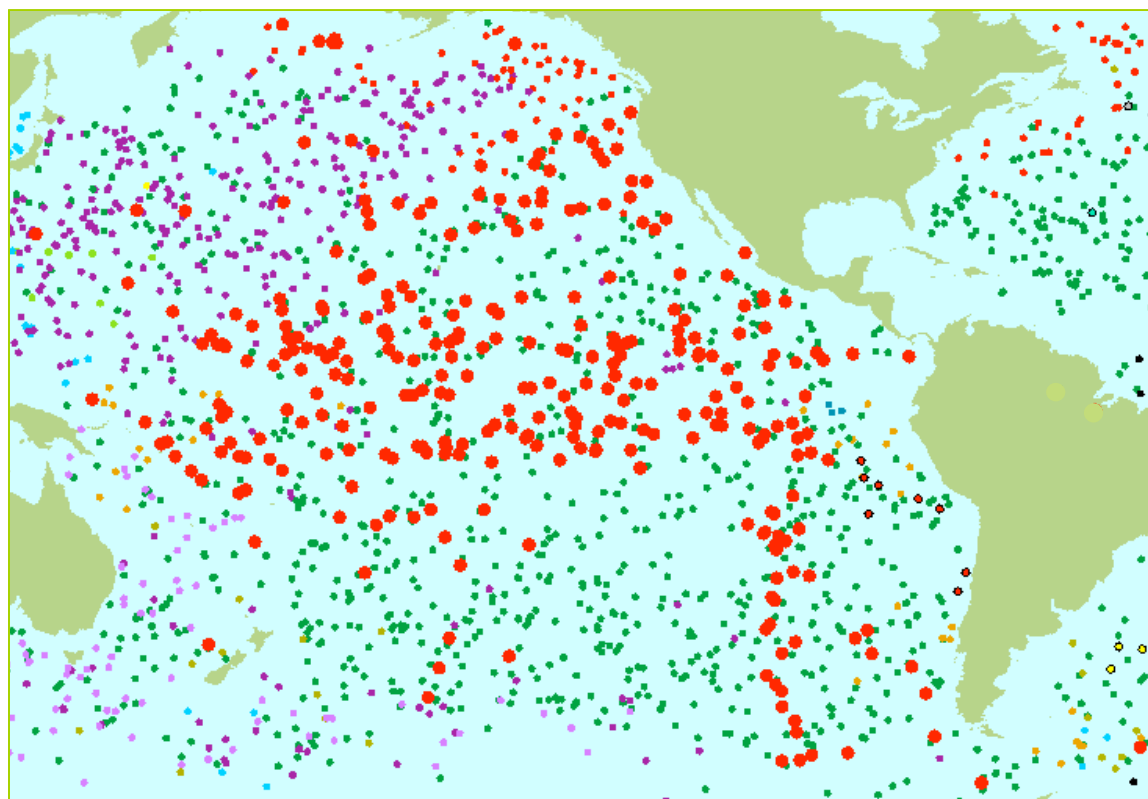


•As of 03 July 2008:

- 340 Argo floats **deployed**
- 307 Argo floats **active**



Active PMEL Float Locations 03 Jul 2008



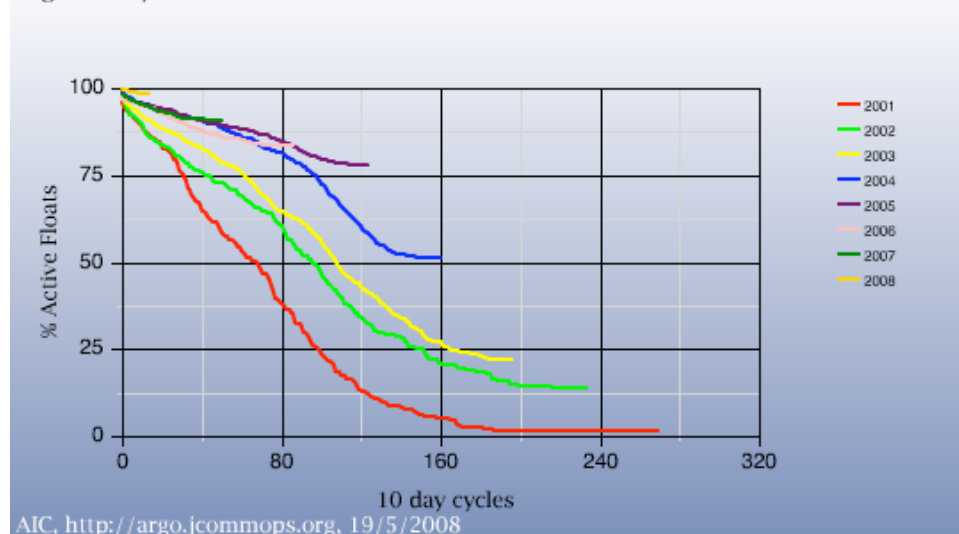
Vessels: NOAA Ship Ronald H. Brown, R/V Maurice Ewing, M/V Explorer, NOAA Ship Miller Freeman, T/S Golden Bear, NOAA Ship Hi'ialakai, NOAA Ship David Starr Jordan, NOAA Ship Ka'imimoana, R/V Kilo Moana, NOAA Ship McArthur II, R/V Melville, T/S Oshoro Maru, USCG Polar Sea, R/V Roger Revelle, SSV Robert C. Seamans, R/V Tangaroa, R/V Thomas G. Thompson, R/V Wecoma, R/V Knorr. . .



# Argo at PMEL: Float Preparation



Argo Yearly Survival Rate



Float Survival Rate, Argo, Argo PMEL



- Suite of tests developed with academic colleagues & manufacturers
- ← Proof of value in survival rate plots
- Careful preparation & deployment by user-providers maximizes data return and data quality

- Inspect exterior, seals, & components
- Check weight
- Test transmitter, oil pump, vacuum, CTD
- Check pneumatics
- Replace batteries: alkaline → lithium, increases float longevity
- Check salinity for calibration/fouling
- Dock Testing for multi-profile mission
- Monitor atmos. pressure readings
- Check vacuum, piston, mission
- Record max temperature during shipping
- Store test results in a database



# Argo at PMEL: Float Reliability



## •Feedback to manufacturers benefits all users

- Found O-ring impurities
  - > Better O-ring inspections & new vendor at WRC
- Focused attention on bladder delamination
  - > More attention to bladder stock at WRC
  - > Improved bladder welding
  - > WRC investigating new vendor
- Found numerous leaky pneumatic systems
  - > Improved testing at WRC
- Demonstrated air pump failures
  - > WRC changing software to avoid power drain
- Focused attention on TBT fouling of conductivity cells
  - > Improved TBT plug installation procedures at SBE
- Focused attention on pressure sensor problems
  - > SBE working on sensor screening procedures
- Feedback to WRC on ballasting field performance
  - >Compensator charge & piston position checks at WRC
  - >Adjustments in ballasting correction factors
- Better desiccant packs at WRC
- Focused attention on QC at WRC
  - > New checksheets
  - > Thermal cycling of components
  - > Closer attention to quality of hardware & assembly





# Argo at PMEL: Technology

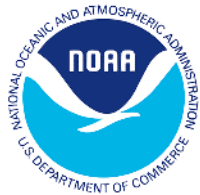


## Several PMEL-Driven Improvements Benefit Argo as a whole:

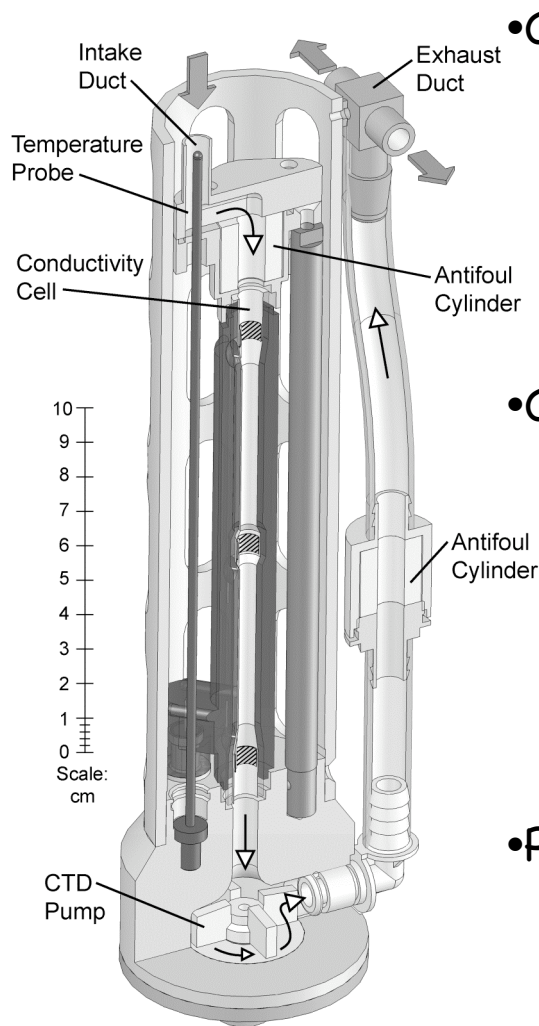
- APF-8 fast first profile
  - First profile within a day after deployment
  - Allows closer comparisons with shipboard CTD
- APEX APF-8 pressure activation
  - Float periodically checks pressure
  - Easier deployments & fail-safe backup
- APEX APF-8 improved pressure telemetry
  - Will allow reporting negative pressures
  - First floats deployed in December 2007
- APEX APF-8 air pump limitation software
  - Prevents excess power drain if pump fails
- APEX Compensator
  - Allows global 2000-dbar profiling
  - Early adopter of this device



Field testing pressure activation on Lake Washington



# Argo at PMEL: Data Quality Standards



- Conductivity sensor calibration drift correction

- Work by A. Wong (UW), G. Johnson (PMEL), & B. Owens (WHOI)
- Manuscript published in 2003 (J. Atmos. Oceanic Technol.)
- Method has been adopted & revised internationally
- Argo DMQC mainstay

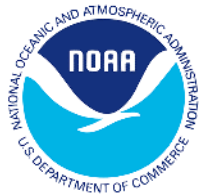
- CTD Sensor Response Corrections

- Work by G. Johnson (PMEL), J. Toole (WHOI), & N. Larson (SBE)
- SBE-41 and SBE-41CP conductivity cell thermal mass error
- Manuscript published in 2007 (J. Atmos. Oceanic Technol.)
- Correction algorithm developed & distributed
- International adoption proceeding

- PMEL Delayed Mode Quality Control

- Examine each profile for quality flag changes
- Apply pressure drift correction, sensor response corrections
- Correct conductivity sensor drift if needed





# Argo at PMEL: Outreach

Undergraduate involvement in climate observing system



SSV Robert C. Seamans  
(Sea Education Association)  
29 floats on 12 cruises!  
Ongoing collaboration



M/V Explorer  
(Semester at Sea)  
7 floats on 1 cruise  
Oceanography lectures



T/S Golden Bear  
(Cal Poly at Sea)  
22 floats on 3 cruises  
Ongoing collaboration





# Argo at PMEL: Publications



- Johnson, G. C. 2008. A cyclonic submesoscale coherent vortex in the northeast Pacific. *Journal of Physical Oceanography*, submitted.
- Willis, J. K., J. M. Lyman, J. M., G. C. Johnson, and J. Gilson. 2008. In situ data biases and recent ocean heat content variability. *Journal of Atmospheric and Oceanic Technology*, in revision.
- Lyman, J. M, and G. C. Johnson. 2008. Estimating global upper ocean heat content despite irregular sampling. *Journal of Climate*, in press.
- Johnson, G. C., and J. M. Lyman. 2008. Global Oceans: Sea Surface Salinity. In *State of the Climate in 2007*, *Bulletin of the American Meteorological Society*, 89, in press
- Johnson, G. C., J. M. Lyman, and J. K. Willis. 2008. Global Oceans: Heat Content. In *State of the Climate in 2007*, *Bulletin of the American Meteorological Society*, 89, in press.
- Stramma, L., G. C. Johnson, J. Sprintall, and V. Mohrholz. 2008. Expanding Oxygen-Minimum Zones in the Tropical Oceans. *Science*, 320, 655-658, doi: 10.1126/science.1153847.
- Johnson, G. C., and J. M. Lyman. 2007. Global Oceans: Sea Surface Salinity. In *State of the Climate in 2006*, A. Arguez, Ed., *Bulletin of the American Meteorological Society*, 88, 6, S34-S35
- Johnson, G. C., J. M. Lyman, and J. K. Willis. 2007. Global Oceans: Heat Content. In *State of the Climate in 2006*, A. Arguez, Ed., *Bulletin of the American Meteorological Society*, 88, 6, S31-S33.
- Johnson, G. C., J. M. Toole, and N. G. Larson. 2007. Sensor corrections for Sea-Bird SBE-41CP and SBE-41 CTDs. *Journal of Atmospheric and Oceanic Technology*, 24, 1117-1130.
- Aagaard, K., T. J. Weingartner, S. L. Danielson, R. A. Woodgate, G. C. Johnson, and T. E. Whitledge. 2006. Some controls on flow and salinity in Bering Strait. *Geophysical Research Letters*, 33, L19602, doi:10.1029/2006GL026612.
- Lyman, J. M., J. K. Willis, and G. C. Johnson. 2006. Recent cooling of the upper ocean. *Geophysical Research Letters*, 33, L18604, doi:10.1029/2006GL027033. & Willis, J. K., J. M. Lyman, G. C. Johnson, and J. Gilson. 2007. Correction to "Recent cooling of the upper ocean". *Geophysical Research Letters*, 34, L16601, doi:10.1029/2007GL030323.
- Johnson, G. C., J. M. Lyman, and J. K. Willis. 2006. Global Oceans: Heat Content. In *State of the Climate in 2005*, K.A. Shein, Ed., *Bulletin of the American Meteorological Society*, 87, 6, S23-S24.
- Johnson, G. C. 2006. Generation and initial evolution of a mode water theta-S anomaly. *Journal of Physical Oceanography*, 36, 739-751.
- Wirts, A. E., and G. C. Johnson. 2005. Recent interannual upper ocean variability in the deep southeast Bering Sea. *Journal of Marine Research*, 63, 38-405.
- Wong, A. P. S. 2005. Subantarctic Mode Water and Antarctic Intermediate Water in the South Indian Ocean based on profiling float data 2000-2004. *Journal of Marine Research*, 63, 789-812.
- Johnson, G. C., P. J. Stabeno, and S. D. Riser. 2004. The Bering Slope Current System revisited. *Journal of Physical Oceanography*, 34, 384-398.
- Wong, A. P. S., and G. C. Johnson. 2003. South Pacific Eastern Subtropical Mode water. *Journal of Physical Oceanography*, 33, 1493-1509.
- Wong, A. P. S., G. C. Johnson, and W. B. Owens. 2003. Delayed-mode calibration of autonomous CTD profiling float salinity data by theta-S climatology. *Journal of Atmospheric and Oceanic Technology*, 20, 308-318.





# Argo Future Possibilities



- Full-depth sampling:
  - 52% of ocean volume below 2000 m
  - For climate studies: ocean heat storage, sea level rise, and MOC
- Under ice systems:
  - Make Argo truly global
  - More observations in climate-sensitive high latitudes
- Oxygen & other biogeochemical sensors:
  - Would improve ocean carbon storage estimates
  - Additional link to ecosystems studies
- Iridium data transmission system
  - Reduces surface time
  - Allows better vertical resolution
  - Allows more sensors

All will require more resources

