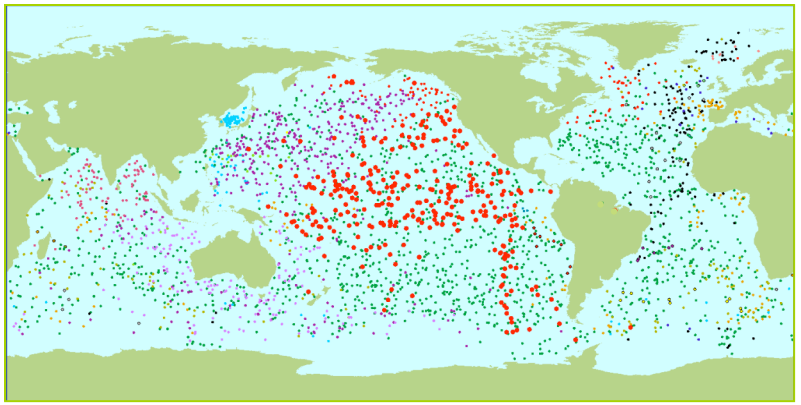
Argo at PMEL: Intro

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

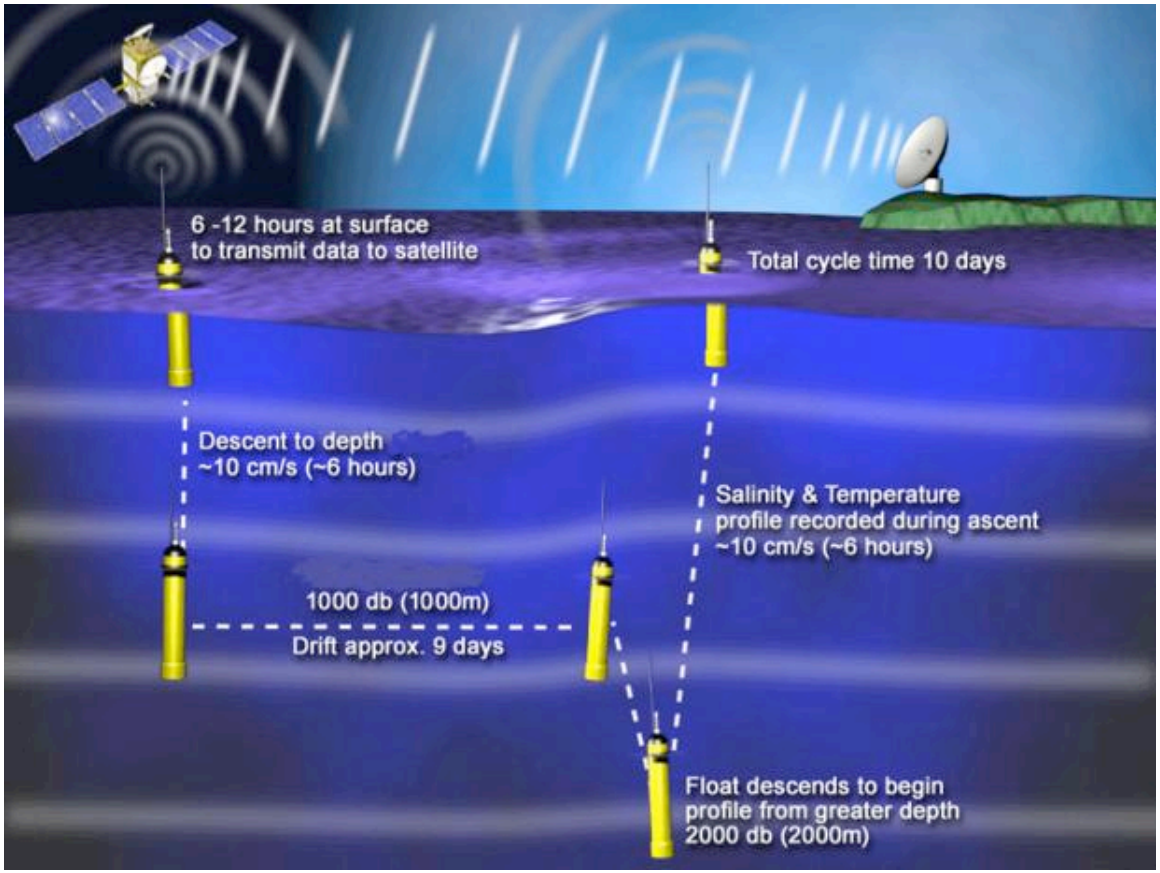
- NOAA **Strategic** Plan - Performance Objective:
  Describe and understand the state of the climate system through integrated observations, analysis, and data stewardship.

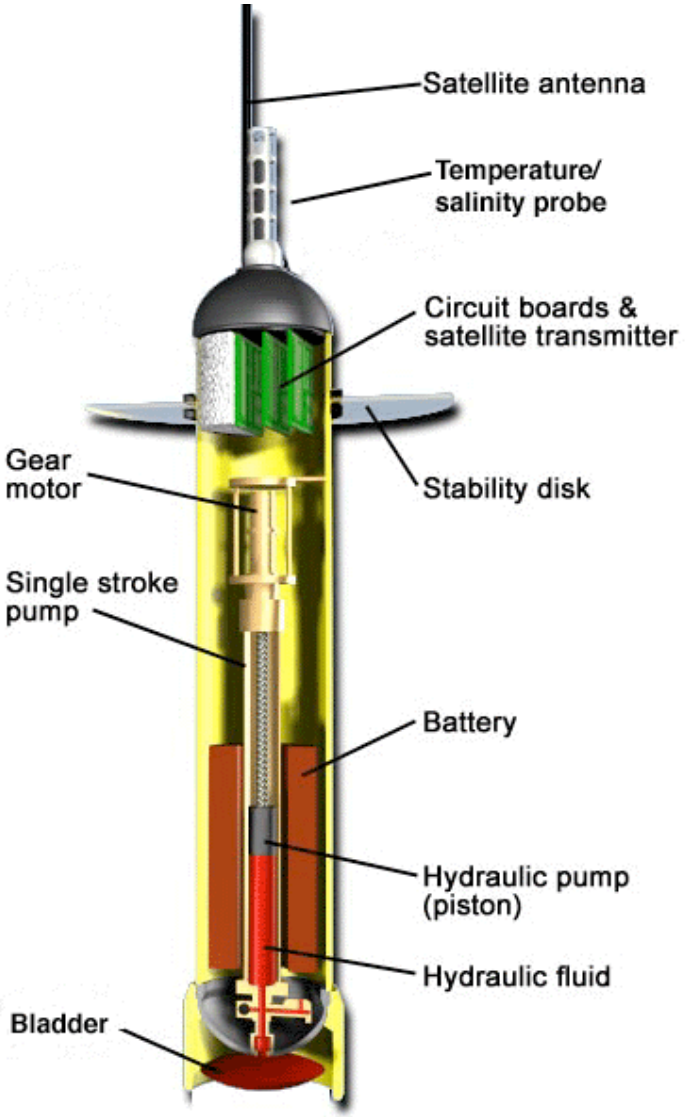
- NOAA **Research** Plan - Research Area:
  Develop an integrated global observation and data management system for routine delivery of information, including attribution of the state of the climate.

Argo epitomizes these plans
Argo is a GEOSS success

What is an Argo Float?

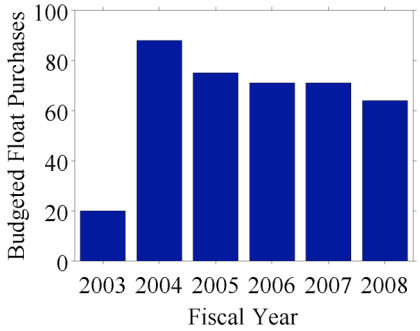
http://www.argo.ucsd.edu/



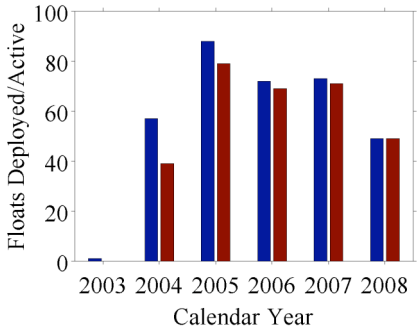


Argo at PMEL: Float Providing

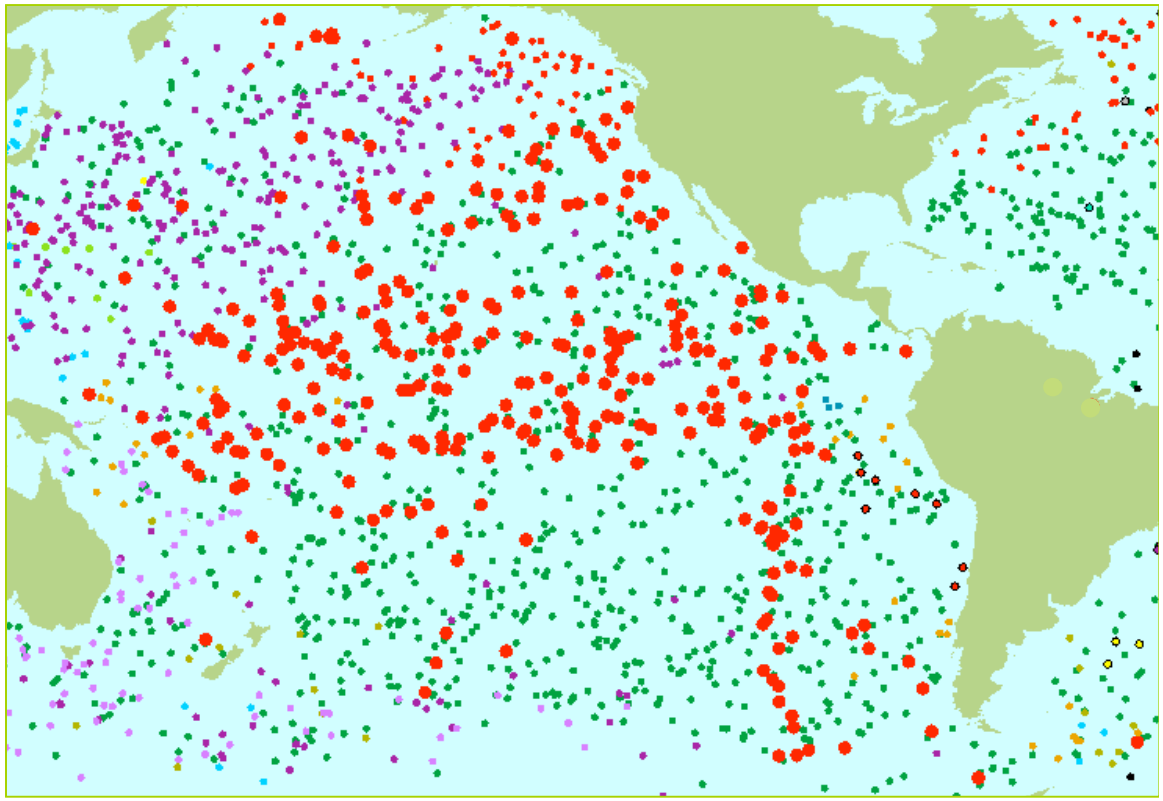
- Argo Float purchases budgeted:



- As of 03 July 2008:
  - -340 Argo floats deployed
  - -307 Argo floats active

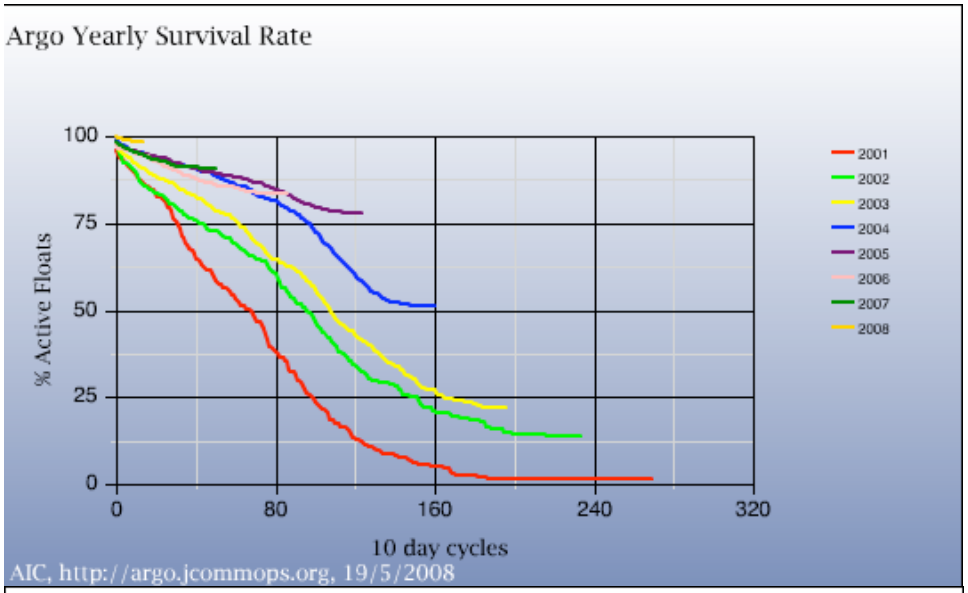


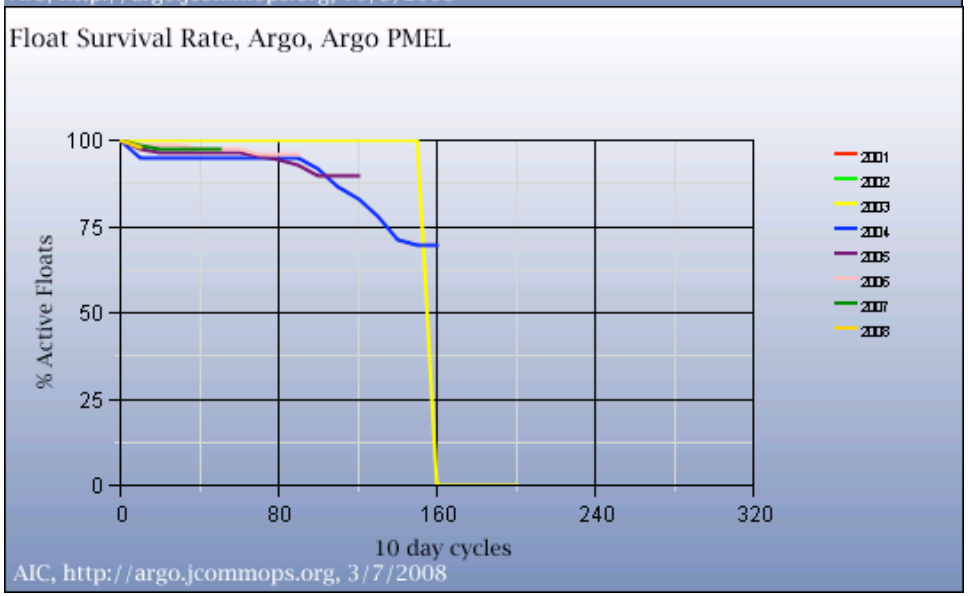
Active PMEL Float Locations 03 Jul 2008



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





- Suite of tests developed with academic colleagues & manufacturers

<-Proof of value in survival rate plots

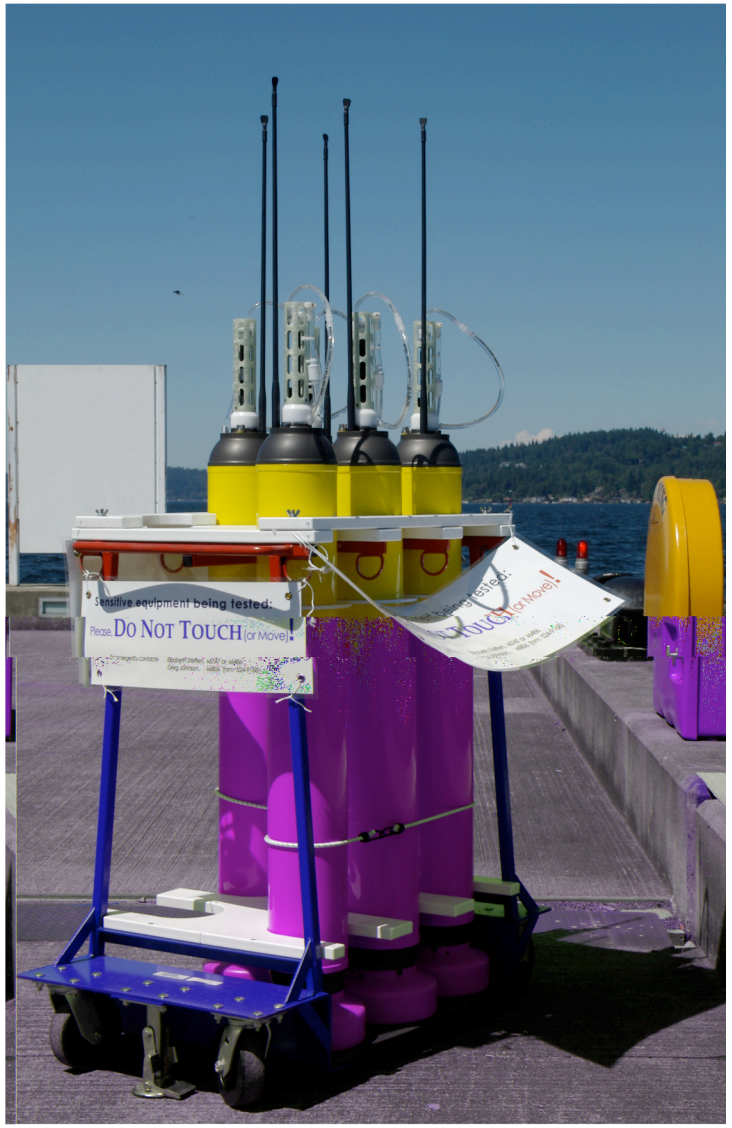
- Careful preparation & deployment by user-providers maximizes data return and data quality

-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



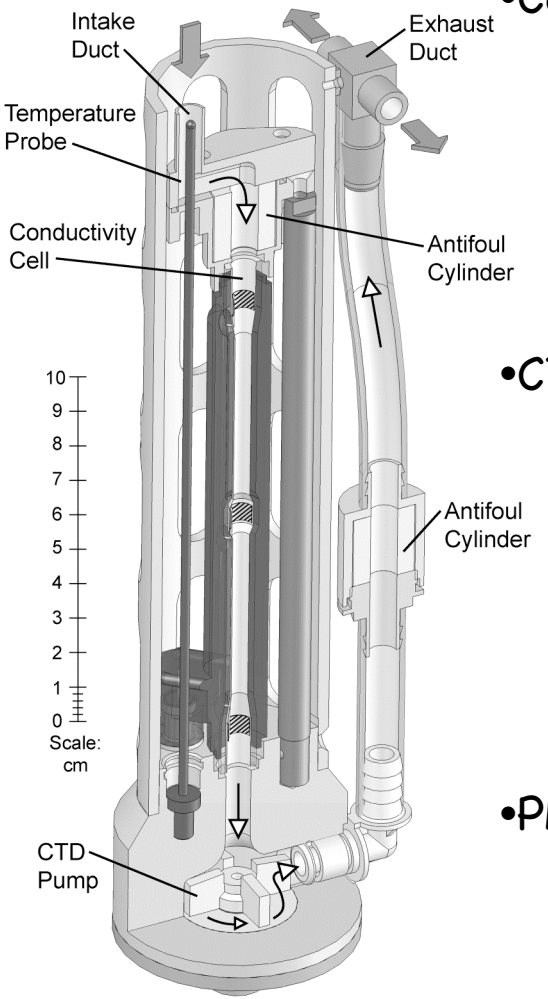
Argo at PMEL: Technology

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

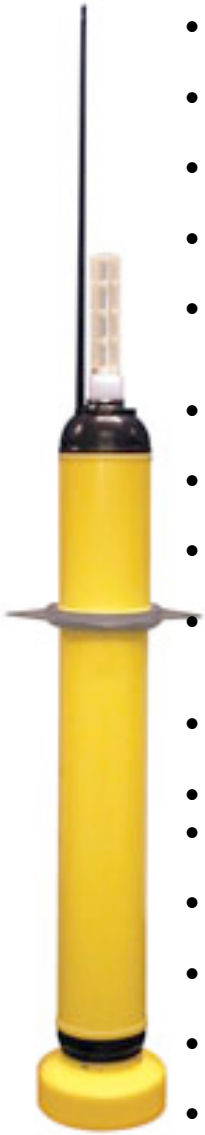
Undergraduate involvement in climate observing system

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