OOI Global Array: PAPA

What is there? Why is it there and what it can measure? What can’t it do?

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**OOI science themes driving global component**

- **Carbon cycle and acidification**
  - Sequestration is global, depends on open-ocean phys./biol. processes

- **Ocean-Atmosphere exchange**
  - Heat, momentum, freshwater fluxes/budgets are set in the open ocean

- **Ocean Circulation**
  - Sets biogeochem. inventories & spreading, propag. of signals, stratification & mixing

- **Climate and ecosystems**
  - Variability has basin-scale mechanisms/footprints, ecosystem impacts
Anthropogenic CO₂ inventory

Observe fluxes and inventory changes, AND physical/biological processes that determine and modulate them.
Contrasting ocean productivity regimes

Nutrient-rich but (iron) limited

High productivity but still iron limited

“not limited”

chlorophyll

nitrate
Circulation variability

Energetic circulation variability
WW3 equivalent of 35-40 foot seas
Heat is entering ocean effectively

- Slope 10m = 0.015 C/y
- Slope 150m = 0.014 C/y

Oxygen is declining at depth

- Slope 26.5 = -0.74 umol kg⁻¹ y⁻¹
- Slope 28.7 = -0.66 umol kg⁻¹ y⁻¹
An Observational and Numerical Investigation of the Climatological Heat and Salt Balances at OWS Papa

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Variability in the upper ocean during MILE. Part I: The heat and momentum balances
by (in alphabetical order)
R. E. DAVIS*, R. deSZEFORE†, D. HALPERN and P. NIILER†
(Received 28 April 1980; in revised form 30 March 1981; accepted 20 April 1981)

Variability in the upper ocean during MILE. Part II: Modeling the mixed layer response
by (in alphabetical order)
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(Received 28 April 1980; in revised form 30 March 1981; accepted 20 April 1981)

Fig. 3. Mean annual cycle of monthly surface heat flux (squares) and of the heat flux inferred from monthly changes in heat content above 200-m depth (triangles), with vertical bars indicating the uncertainty in the latter. The estimated error in the former is 15 W m$^{-2}$ (appendix).

Fig. 5. Twenty-one year time series of observed (solid traces) and modeled (dotted traces) monthly mean mixed isothermal depth $h_T$, sea surface temperature SST, and sea surface salinity SSS. Also shown are modeled—observed differences, $\Delta$, in $h_T$ and SST. Modeled results are from experiment I with both heat and salt flux correction.
Upper Layer Modification at Ocean Station Papa:
Observations and Simulation

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ABSTRACT

Time-series observations of the upper mixed layer of the ocean are presented for a six-week period at Ocean Station Papa in the northeast Pacific Ocean. These observations indicate the rate and scale of the wind-induced deepening of the mixed layer during the passage of several weather disturbances. The formation of the deficit layer of warm water that occurs under conditions of low wind and intense solar heating is also evident. A numerical model, developed by Denman, accurately predicts the behavior of the upper ocean during a 12-day period for which observed values of wind speed, solar radiation, and basic radiation are used as inputs. To obtain realistic results, a value of 0.0022 (as the ratio of the potential energy increase of the water column to the downward transfer rate of turbulent energy by the wind stress) is used. This value is in agreement with that obtained from previous laboratory experiments (0.0015) indicating that the results obtained from such experiments are transferable to open ocean conditions.

Ocean Weather Station Papa

- Frequently used for validation and tuning of 1D mixed layer models
- Located in N.E. Pacific at 50N, 145W
- Ran Kraus-Turner and KPP models for one year starting in March 1961 (same as Large et al 1994)
- Used vertical resolutions of 0.5m, 2m, 5 and 10m
- Forcing fluxes calculated using bulk formulae (met data courtesy of Paul Martin)
High winds, large waves  Air-sea energy and gas exchange  PDO variability
High nutrient, lower chlorophyll, micro-nutrient limitation to productivity in contrast to Irminger Sea  Important fishery  Lower eddy variability
Collaboration with PMEL; time series since WWII (Canadian); regional partnering
Global Station Papa

(A) Apex Profiler Mooring (GP02HYPM)
(B) Flanking Subsurface Mooring A (GP03FLMA)
(C) Flanking Subsurface Mooring B (GP03FLMB)
(D) NOAA PMEL Station Papa Surface Mooring
Mobile - Open Ocean Glider (GP05MOAS-GL)
Mobile - Global Profiling Glider (GP05MOAS-PG)
Profiler mooring – 4,219 m of water

• 150 m – bioacoustic sonar (multifrequency acoustic backscatter)
• 164 m - CTD
• 310 to 2,100 m - wire following profiler
  • 2 wavelength fluorometer (chlorophyll-a conc., optical backscatter)
  • Dissolved oxygen
  • CTD
  • 3-D single point velocity
• 2,100 to 4,000 m – wire following profiler
  • 2 wavelength fluorometer
  • Dissolved oxygen
  • CTD
  • 3-D single point velocity
Flanking moorings - 4,126 and 4,145 m depth

- 30, 40, 60, 90, 130, 180, 250 350, 500, 750, 1,000, 1,500m - CTD
- 500 m – upward looking 75 kHz ADCP
- 30 m – dissolved oxygen
- 30 m – pH
- 30 m – 3 wavelength fluorometer
  - Fluorometric CDOM Concentration
  - Fluorometric Chlorophyll-a Concentration
  - Optical Backscatter
Gliders

• Patrol
  • Spatial sampling
  • Data link to flanking and profiler Moorings

• Profiling
  • Profiles to surface near profiler mooring
Gliders

• Patrol – 3 gliders
  • Spatial sampling
  • Data link to flanking and profiler Moorings
  • CTD
  • Dissolved oxygen
  • 2-wavelength fluorometer
Gliders

- Profiling – 2 gliders
  - Profiling to the surface near profiler mooring
  - CTD
  - Dissolved oxygen
  - 3-wavelength fluorometer
  - Nitrate
  - Photosynthetically available radiation
With collaborations, the PAPA array is a very capable observatory ....
Congratulations DFO Line P Program!

60-year time series in the subarctic NE Pacific

1956 – 2016 and beyond!
OOI PAPA

• Annual cruise
  • Possible ancillary sampling
  • In-situ calibration/validation

• Capacity and bandwidth
  • Available capacity on the OOI platforms (mass, power, bandwidth)
  • Proposal writing support

• Programmable sampling
  • Preserve climate record, assure power and bandwidth not compromised
  • Community directed sampling

• A site for process studies

• Data
  • OOI Data Portal and raw data download