Temporal Variations in Phytoplankton Community Structure and Physical Forcing at Station ALOHA

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Sampling the Time-Space Continuum

Figure from Dickey 1991, 2003
inspired by Stommel and Haury
Hawaii Ocean Time-series Program

- Sta. ALOHA: 22.75°N, 158°W
- Monthly sampling during 1988-present
# Pigment-based Chemotaxonomy

<table>
<thead>
<tr>
<th>Phytoplankton Pigment</th>
<th>Taxonomic Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total chlorophyll ( a )</td>
<td>Phytoplankton biomass</td>
</tr>
<tr>
<td>Chlorophyll ( b )</td>
<td><em>Prochlorococcus</em> spp.</td>
</tr>
<tr>
<td>Chlorophyll ( c )</td>
<td>Chromophyte microalgae</td>
</tr>
<tr>
<td>Zeaxanthin</td>
<td>Photosynthetic bacteria</td>
</tr>
<tr>
<td>Fucoxanthin</td>
<td>Diatoms</td>
</tr>
<tr>
<td>19’-Hex-fucoxanthin</td>
<td>Haptophytes</td>
</tr>
<tr>
<td>19’-But-fucoxanthin</td>
<td>Pelagophytes</td>
</tr>
</tbody>
</table>
Variability at Sta. ALOHA: Interannual Time-scale

- **Data set**: 1990 – 2002

- **Significant interannual differences** ($P \leq 0.001$) observed for all pigments in the upper 200 m

- **Salinity anomaly** observed in the upper 120 db at Station ALOHA during 1997-2003 (El Niño and PDO drought)

- **Pigment “regime shift”** observed in 1996-1997
Hawaii Salinity Time-series

Focus on highest salinity in 45+ year record

Koko Head bucket samples

Hawaii Ocean Time-series
rapid onset from strong negative anomalies

penetration to 100-120 m

decay of event
Mixed Layer T reinforces S anomaly: decreased stability

Seasonal cycle removed

Density Anomaly kg m⁻³

Cold, salty

Warm, fresh

LN EN LN EN LN EN
Stratification weakened, deeper penetration of winter mixing
Pigment Biomarkers

Prochlorococcus spp.

Cyanobacteria
Pigment Biomarkers

Pelagophytes

Haptophytes
Temporal Variations in Zooplankton
(> 0.2 mm, 0-160 m)

(Sheridan & Landry, 2004)
Regional Ocean Model System (ROMS) \( \Delta \text{SSS} [(1996-2002) \text{ minus } (1990-1995)] \)

Min = -1  
Max = 1  
(practical salinity scale)

ROMS:  
50-km resolution  
20 vertical layers  
NCEP daily forcing during 1990s
ROMS Simulation: Salinity

Station ALOHA

1991-1995

1996-2000

ROMS Simulation: SSS anomaly
( OBSERVED-red, ROMS-blue )
ROMS Simulation: Vertical velocity

Station ALOHA
Summary

• Plankton biomass and biogeochemical fluxes are not in steady-state at Station ALOHA

• High (intra-annual: *eddies and Rossby waves*) and low (decadal: *ENSO/PDO*) frequency variability in phytoplankton community structure (*possible feedback interactions*)

• The carrying capacity of the North Pacific Subtropical Ocean has increased during 1997-2002 (*nutrient entrainment?*)

• Need for high-frequency measurements coupled with high-resolution 3-D circulation/food web models
Hex-Fuco vs. SLA (1992-1999)

(Sakamoto et al., 2004)