Sediment trap time series from the North Pacific Ocean

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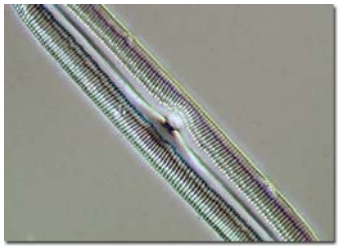
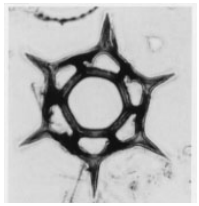
TIME SERIES FROM:

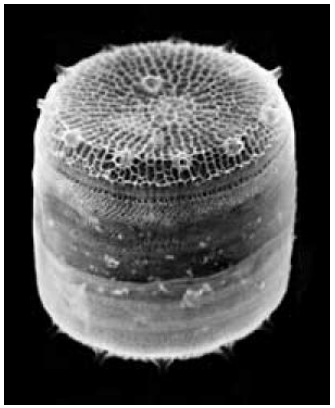
- Ocean Station PAPA
- Alaska Gyre and North Pacific Western Gyre
- Line P with emphasis at La Perouse Bank

Marine sediments are composed of…

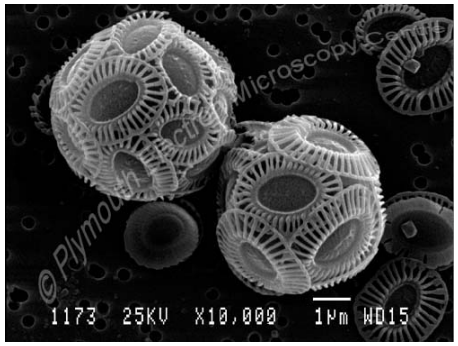
biogenic silica

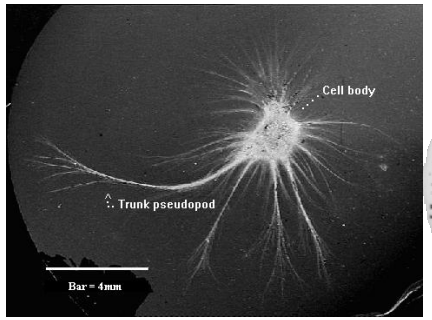


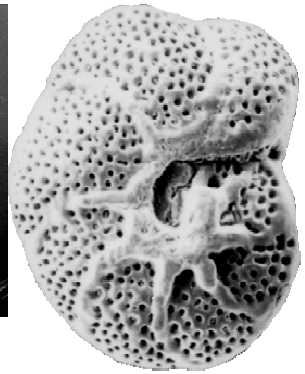




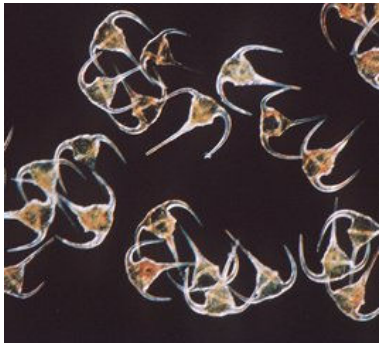
calcium carbonate



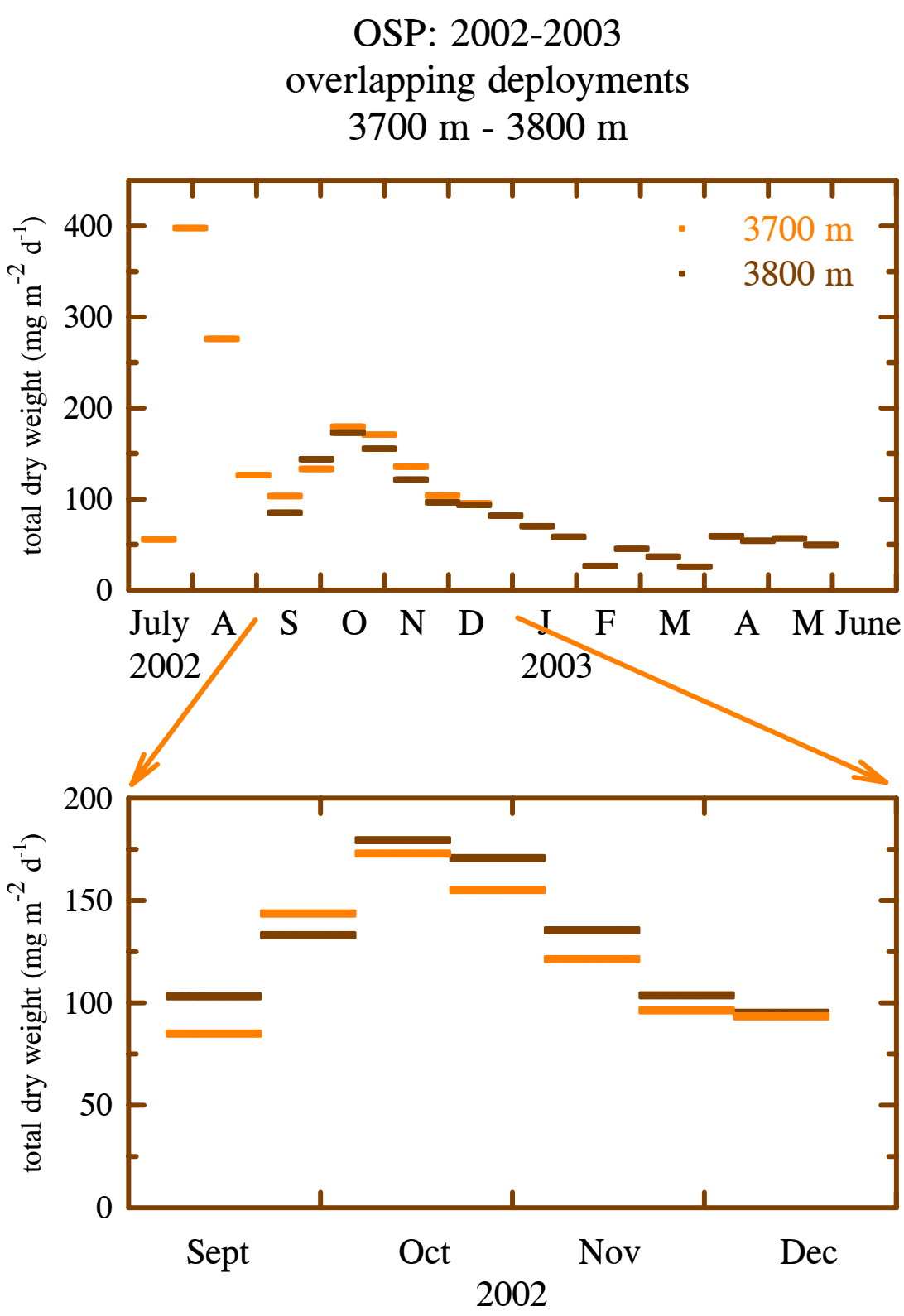




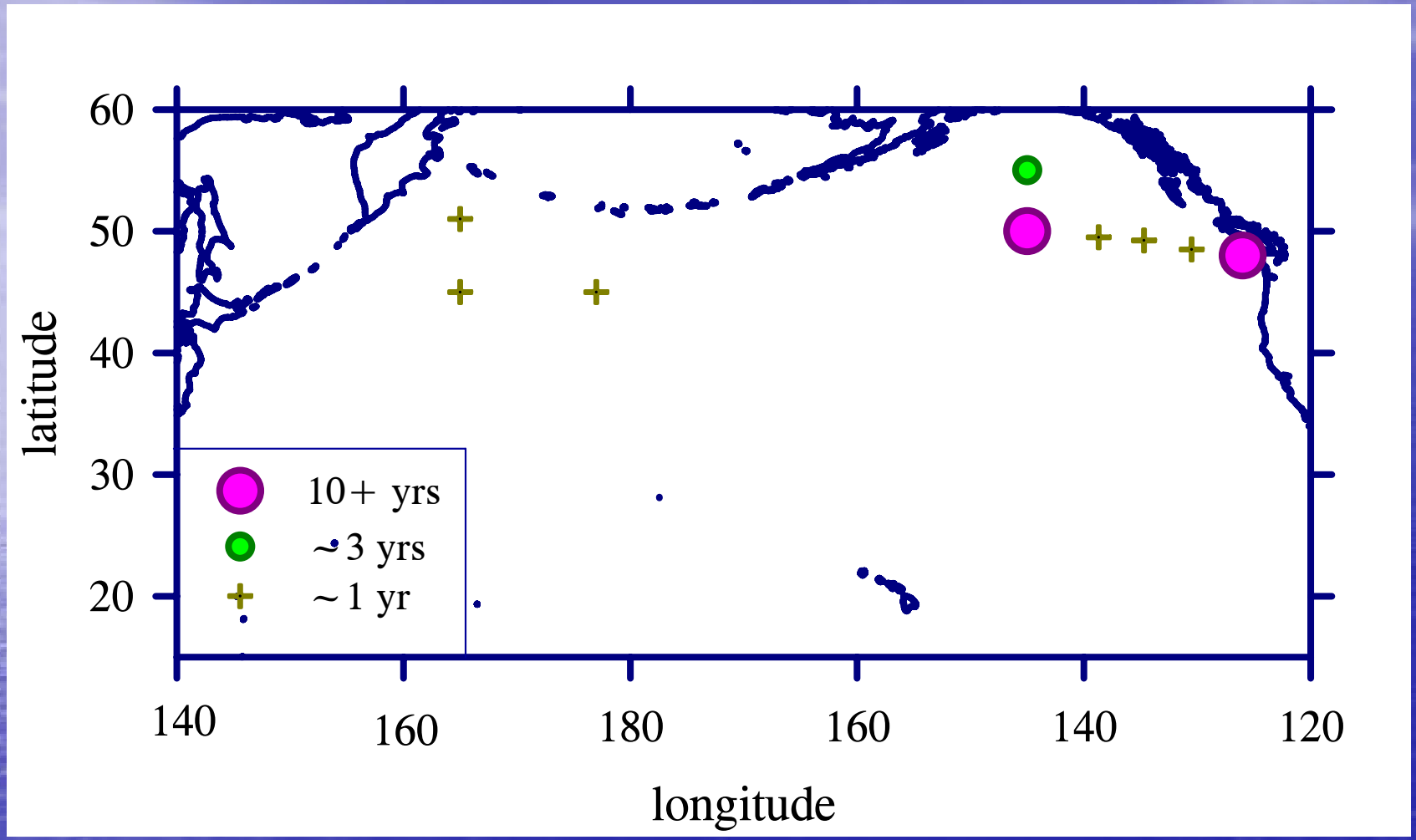
organic matter



and rocks!


OSP: 2002-2003
overlapping deployments
3700 m - 3800 m
total dry weight (mg m-2 d-1)
400
300
200
100
0
3700 m
3800 m
July
A
S
O
N
D
J
F
M
A
M
June
2002
2003
200
150
100
50
0
Sept
Oct
Nov
Dec
2002

Sediment-trap moorings deployed by IOS



OSP: 1982 to present (3 depths)

La Perouse Bank: 1986 to present

Alaska Gyre: 1990 to 1992

3 stations in the Western Pacific:
August, 1991 to June, 1992

3 stations along line P:
sporadically from 1995 to 1997

TIME SERIES FROM:

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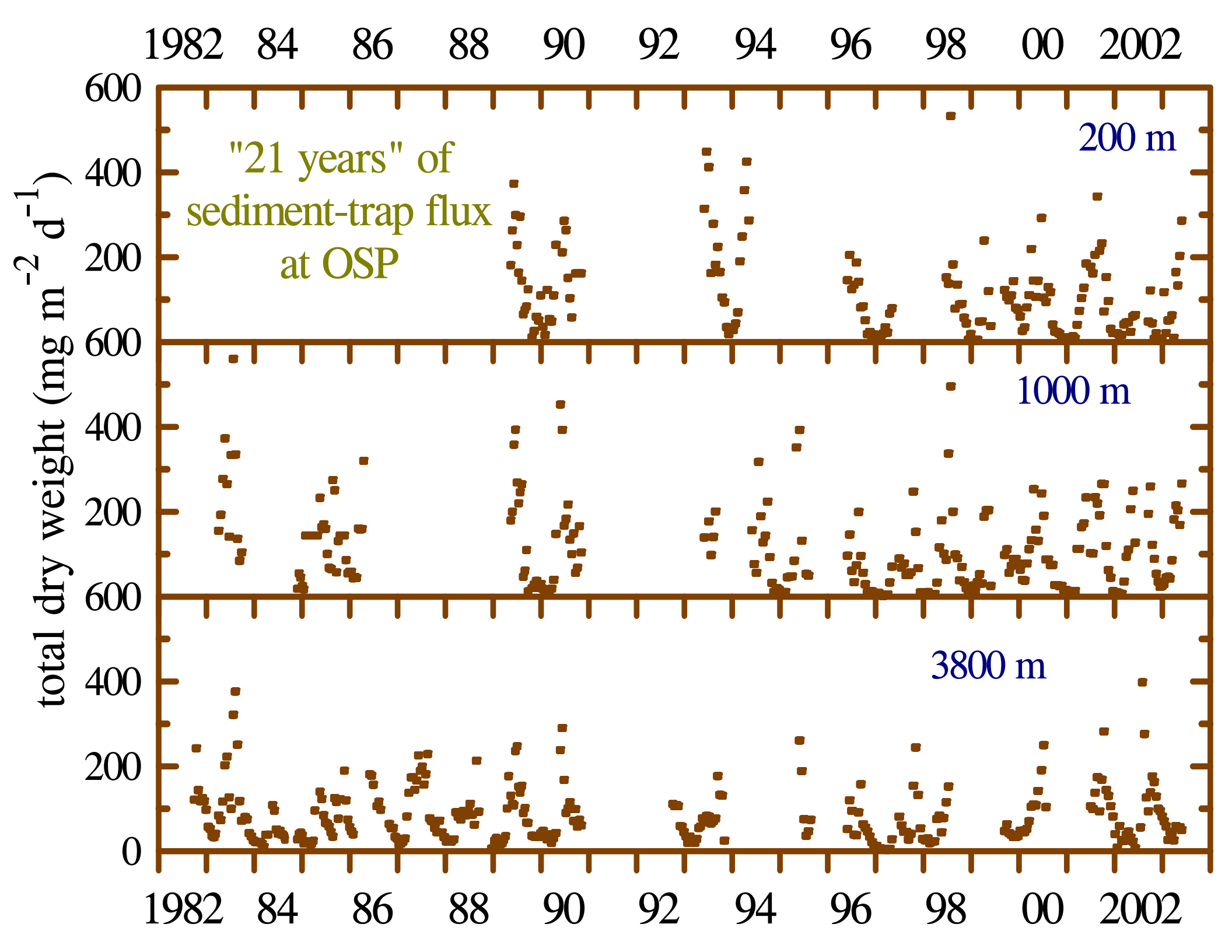
- Alaska Gyre and North Pacific Western Gyre
- Line P with emphasis at La Perouse Bank

1 year of fluxes from OSP

200 m

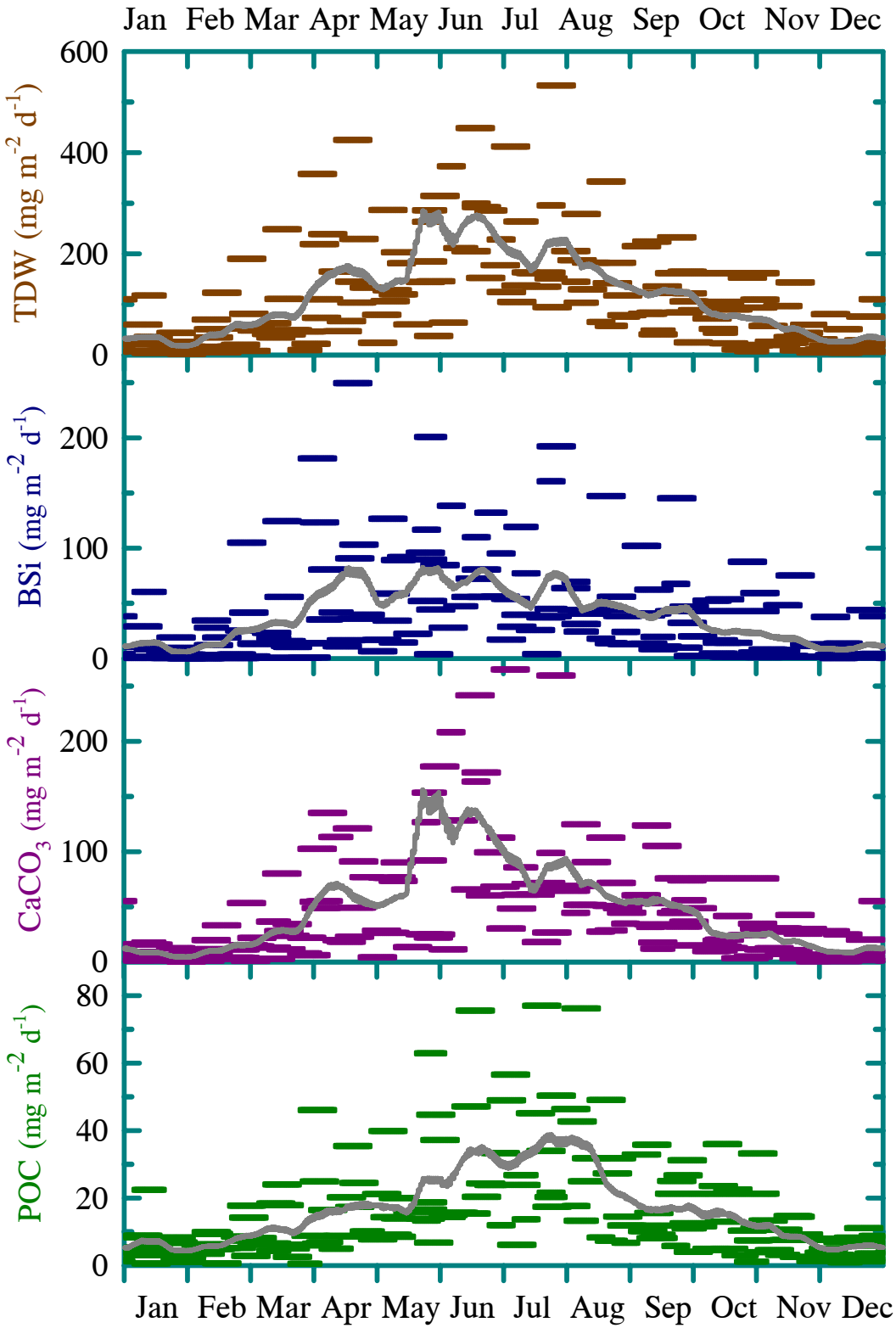
1000 m

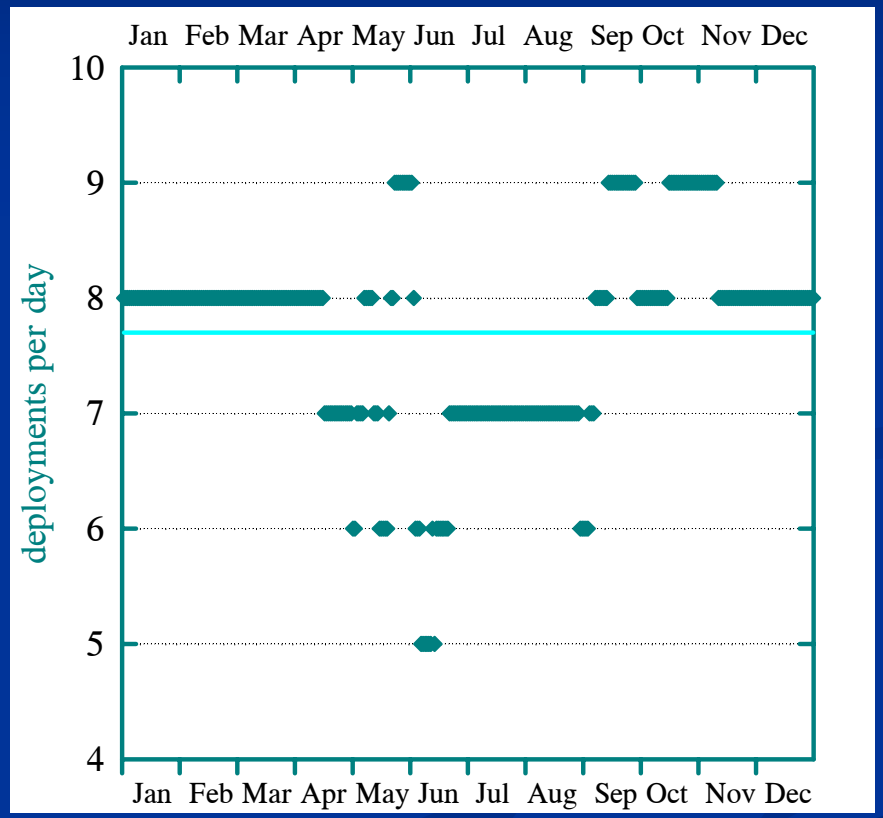
3800 m


"21 years" of
sediment-trap flux
at OSP
200 m
1000 m
3800 m
total dry weight (mg m-2 d-1)
1982
84
86
88
90
92
94
96
98
00
2002
600
400
200
0

characterising seasonality and “filling gaps”
to generate a single time-series

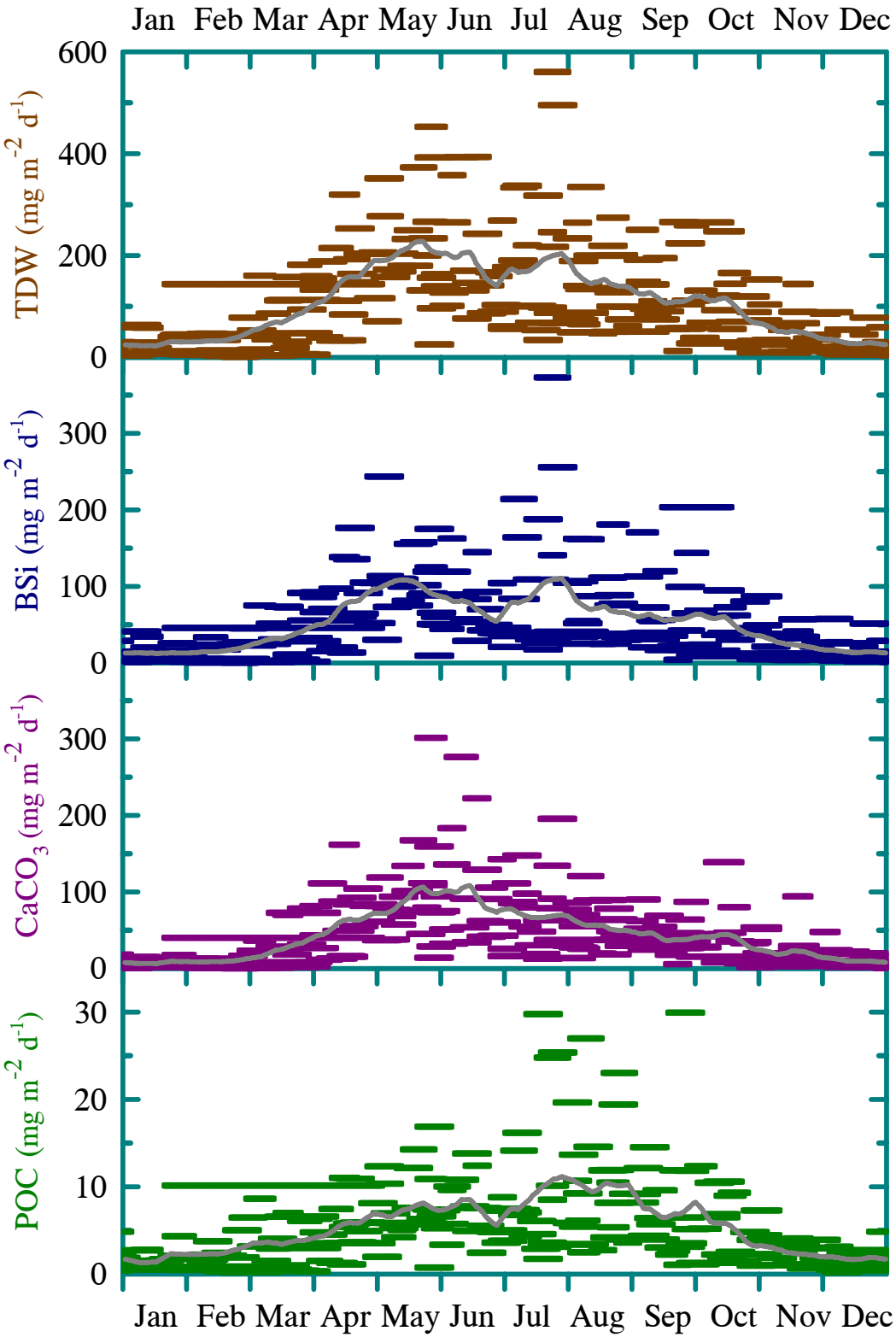
200 m fluxes at OSP sorted by Julian day

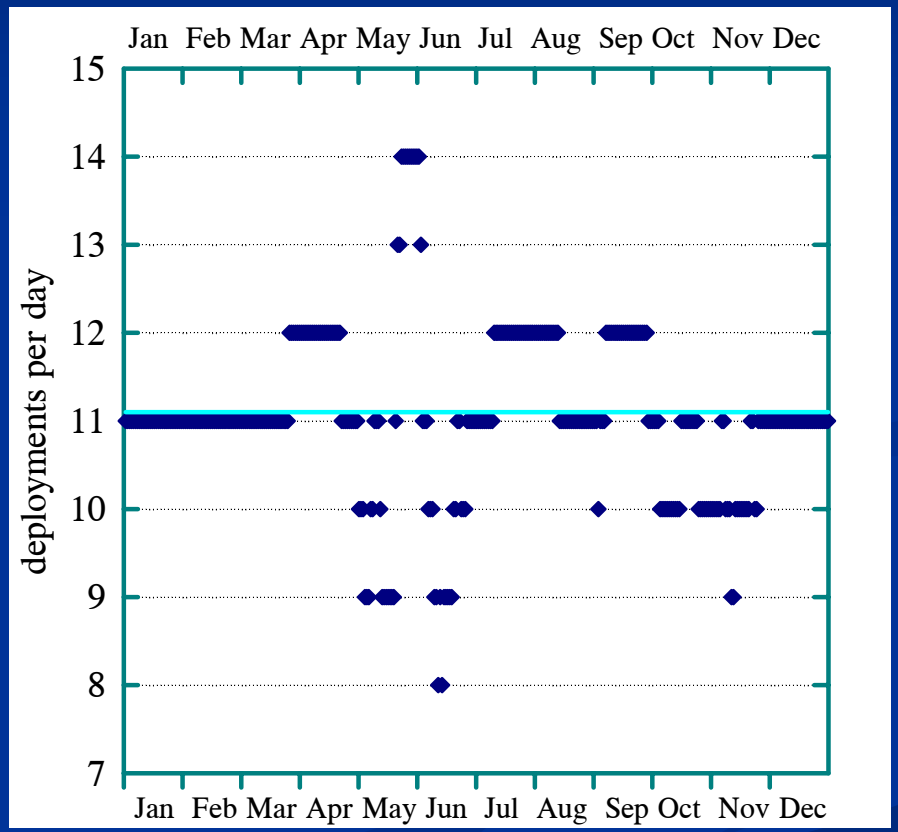




7.7 years of data

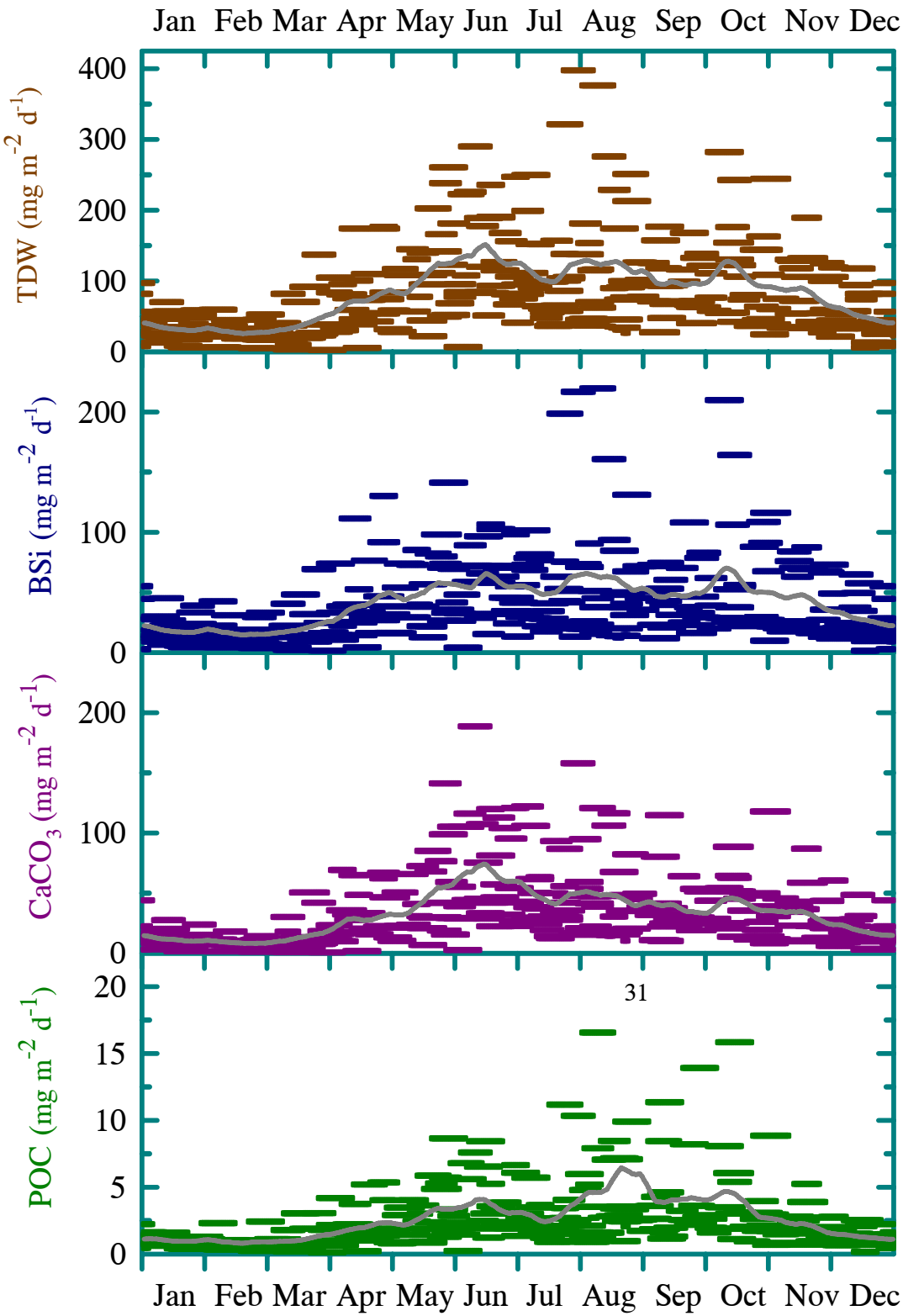
1000 m fluxes at OSP sorted by Julian day

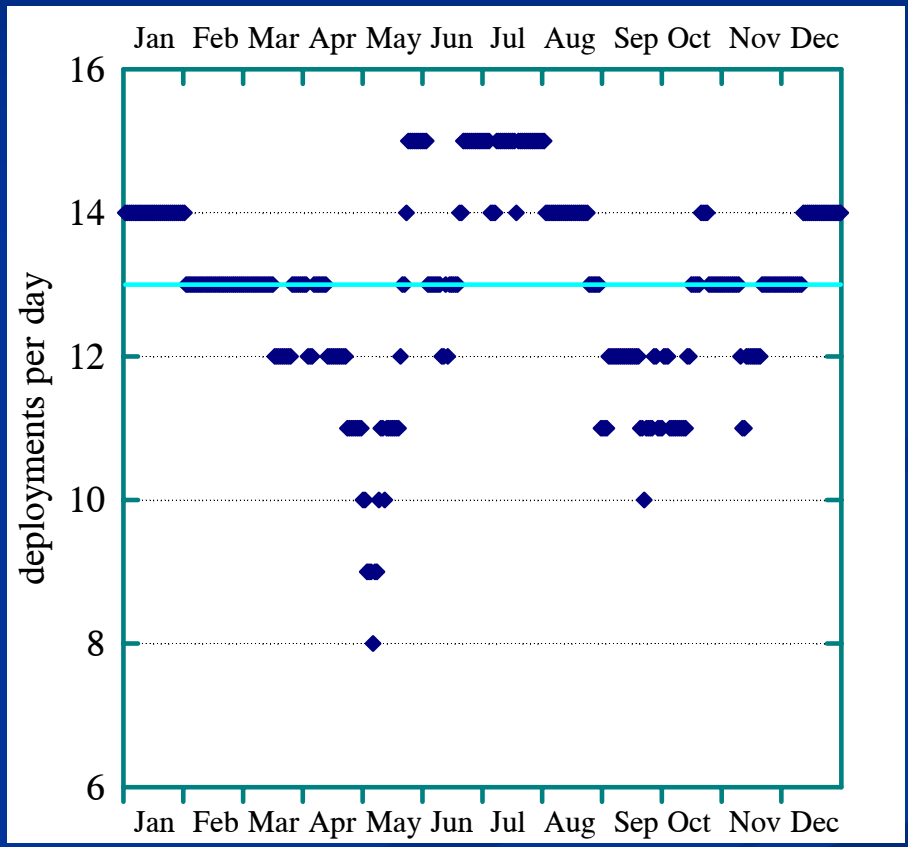




11 years of data

3800 m fluxes at OSP sorted by Julian day





13 years of data

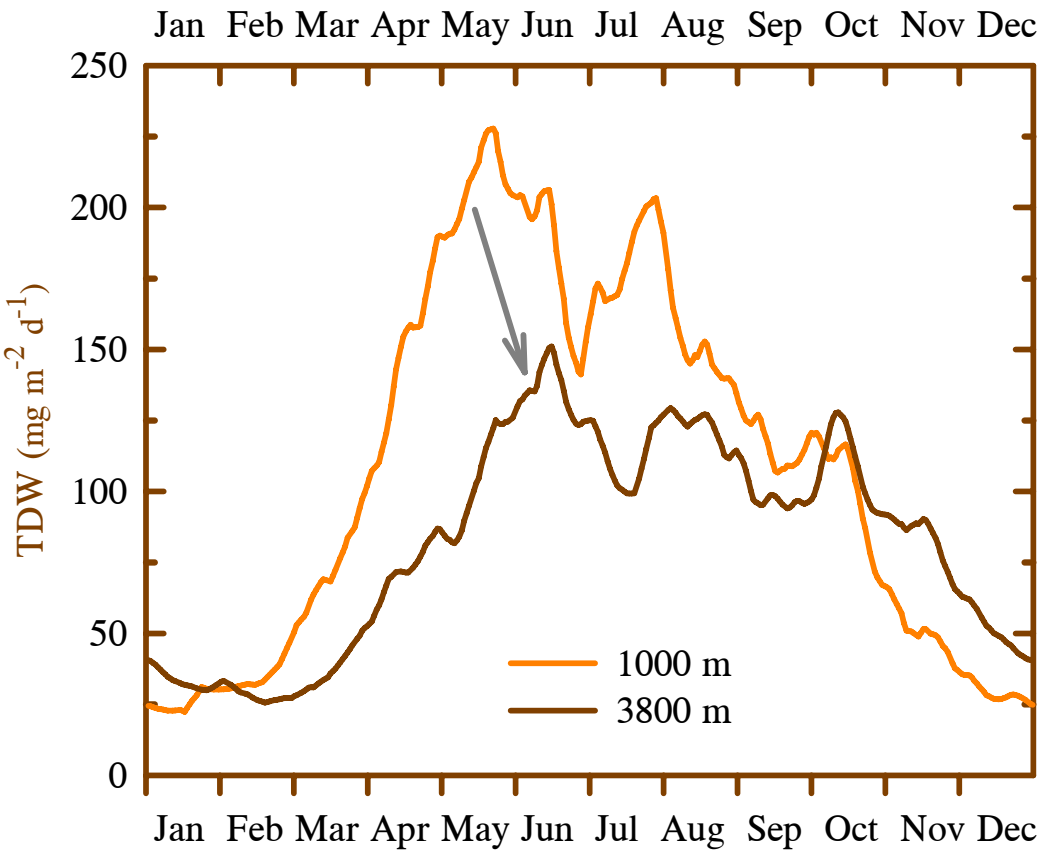
TIME-LAG IN FLUX BETWEEN SHALLOW AND DEEP TRAPS

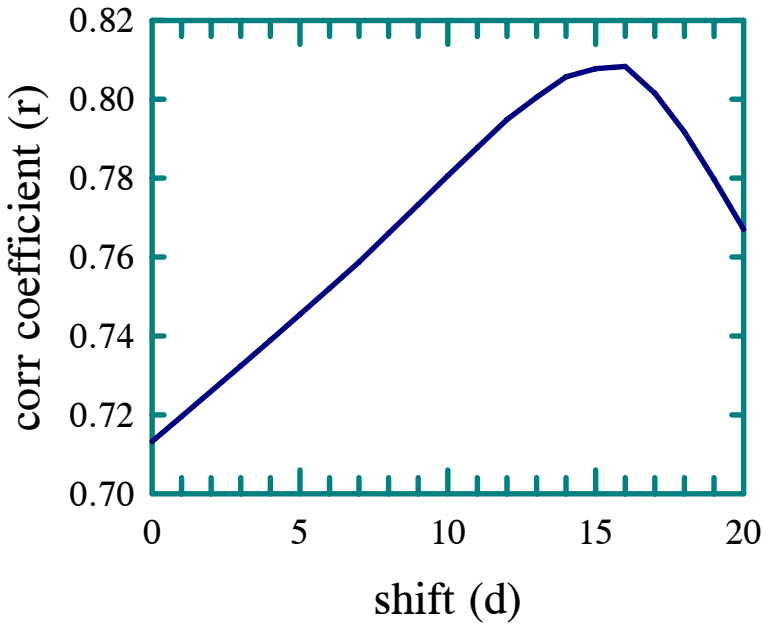
For each constituent, maximum correlation between 1000 m and 3800 m occurred at a 12-16 day shift, which is close to the average deployment period.

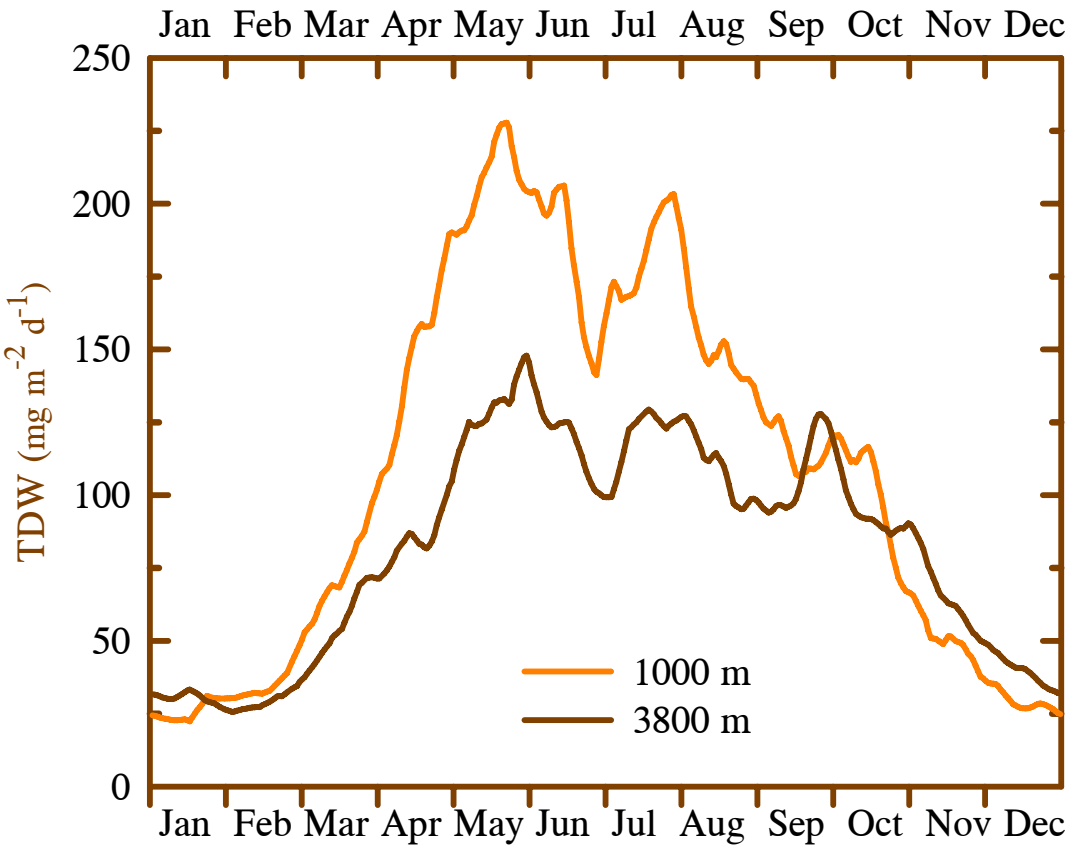
Material took ~8 to 24 days to sink 2800 m, for sinking rates of about 100 to 400 m d^{-1}.

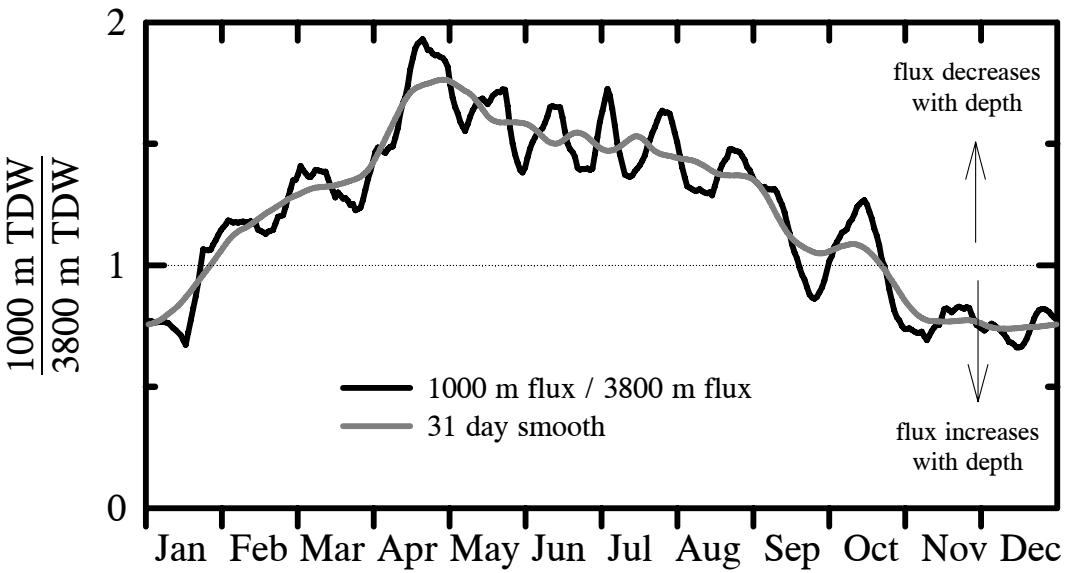
The shift for $CaCO_3$ (12 days) was less than the shift for TDW, BSi and POC (16 days). Is $CaCO_3$ sinking faster than BSi, and is POC associated with BSi moreso than with $CaCO_3$?

Correlations (lower fig) were determined by shifting the entire time series, not the seasonally averaged fluxes as implied by the upper figure.



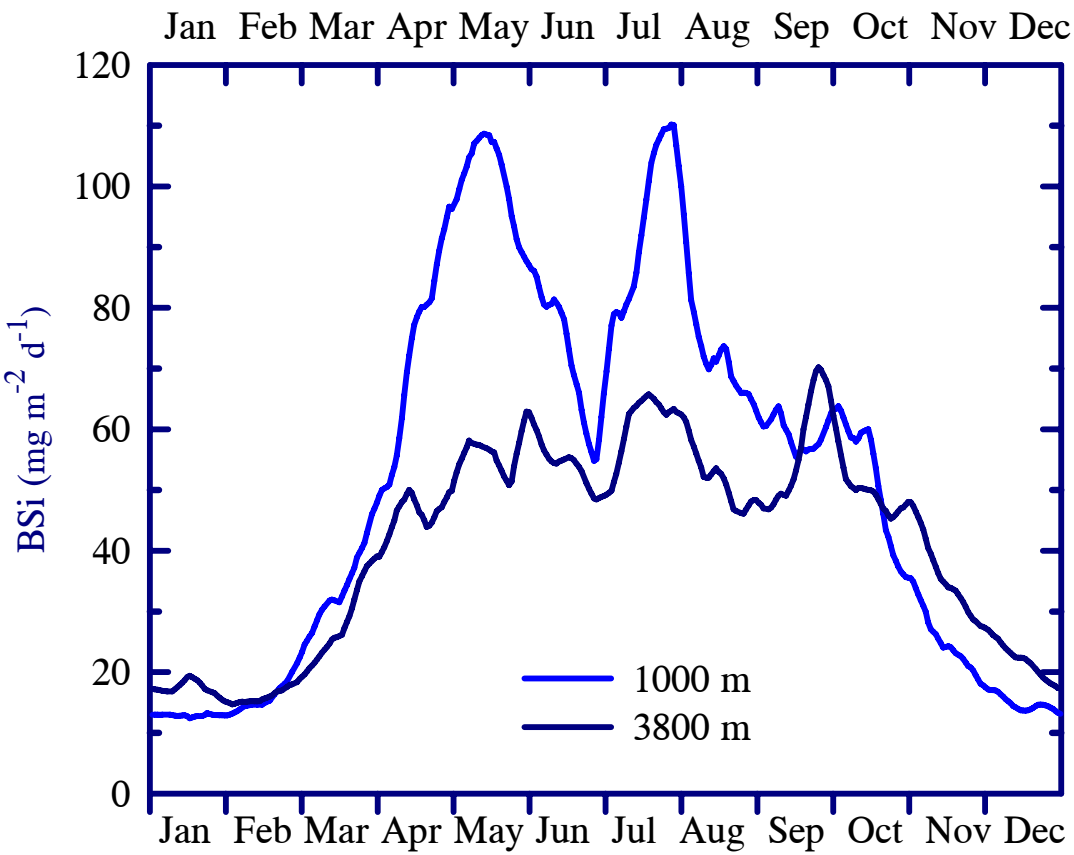


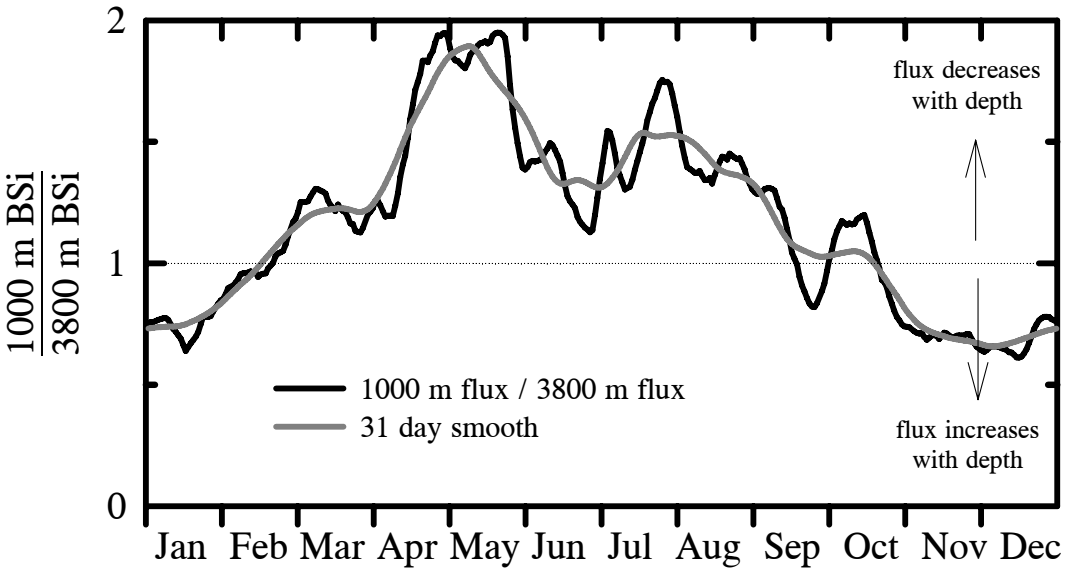




total dry weight flux at OSP with 16 day shift between 1000 m and 3800 m

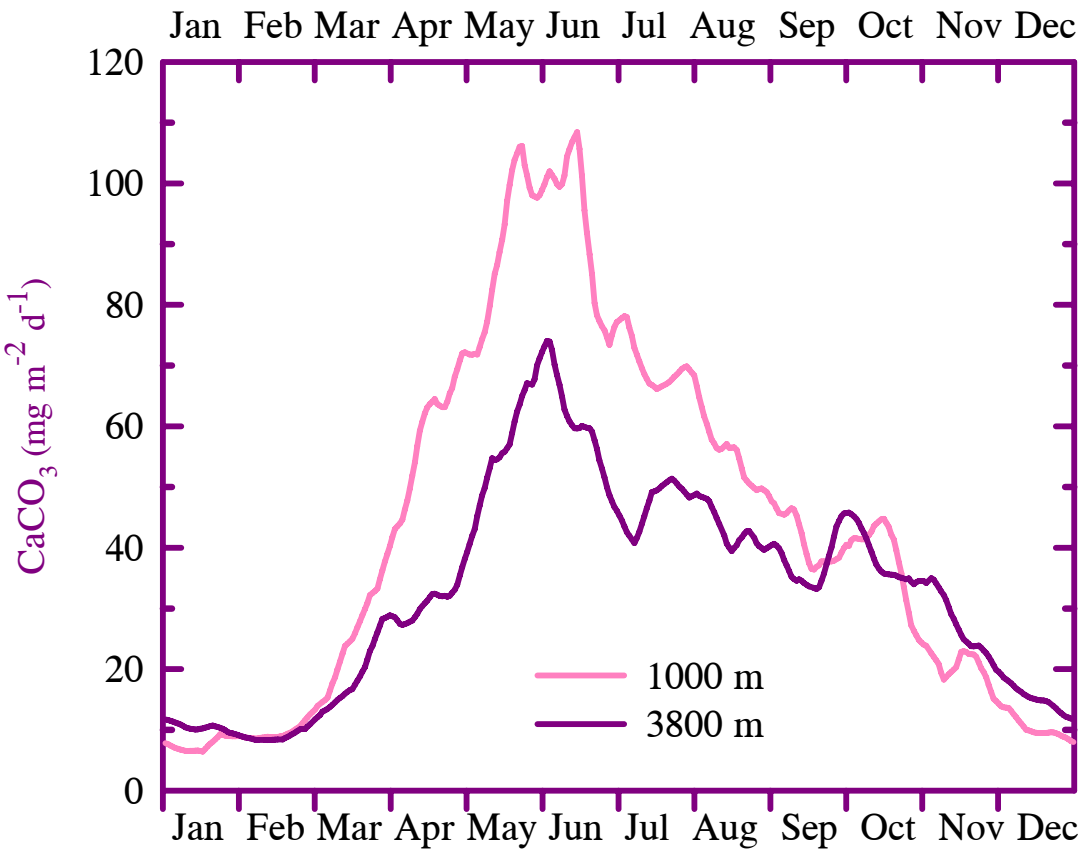
seasonally averaged change in flux with depth

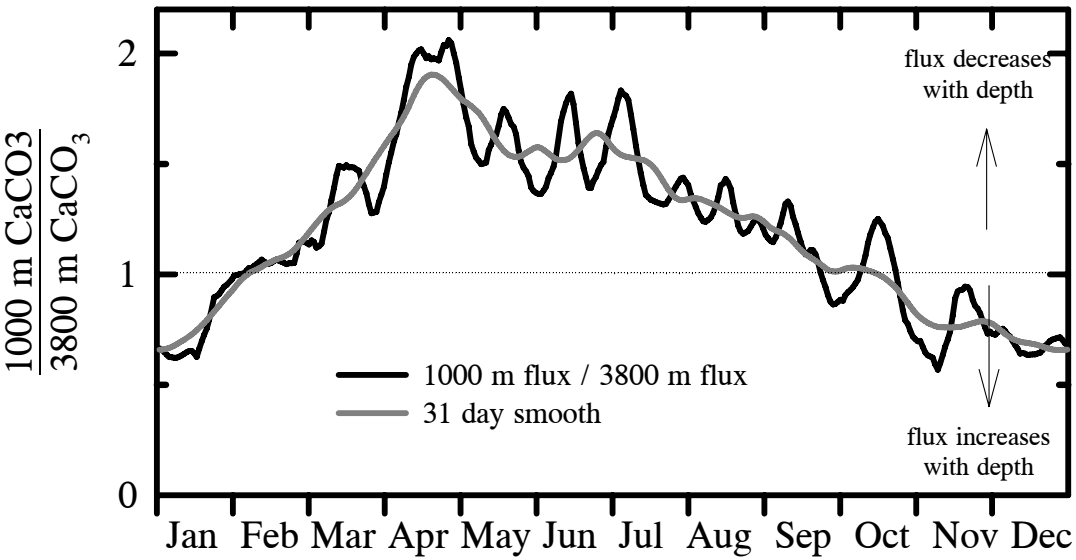




biogenic silica flux at OSP with 16 day shift between 1000 m and 3800 m

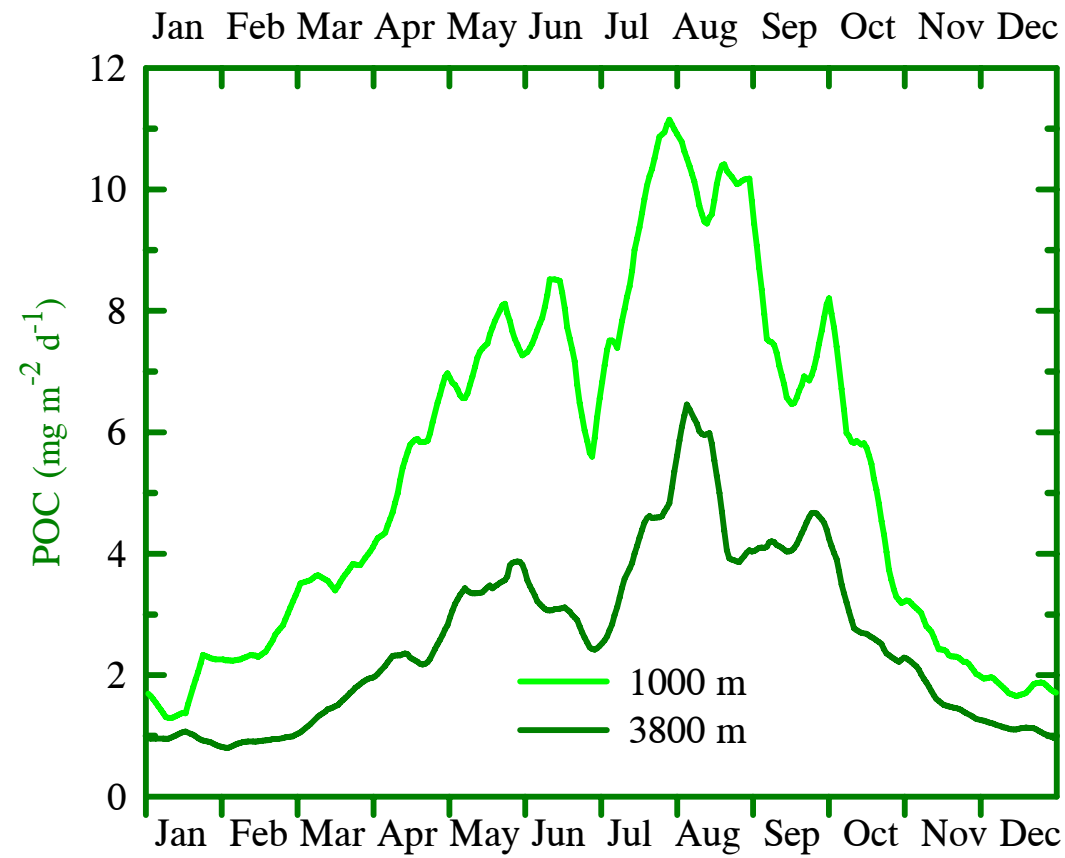
seasonally averaged change in flux with depth

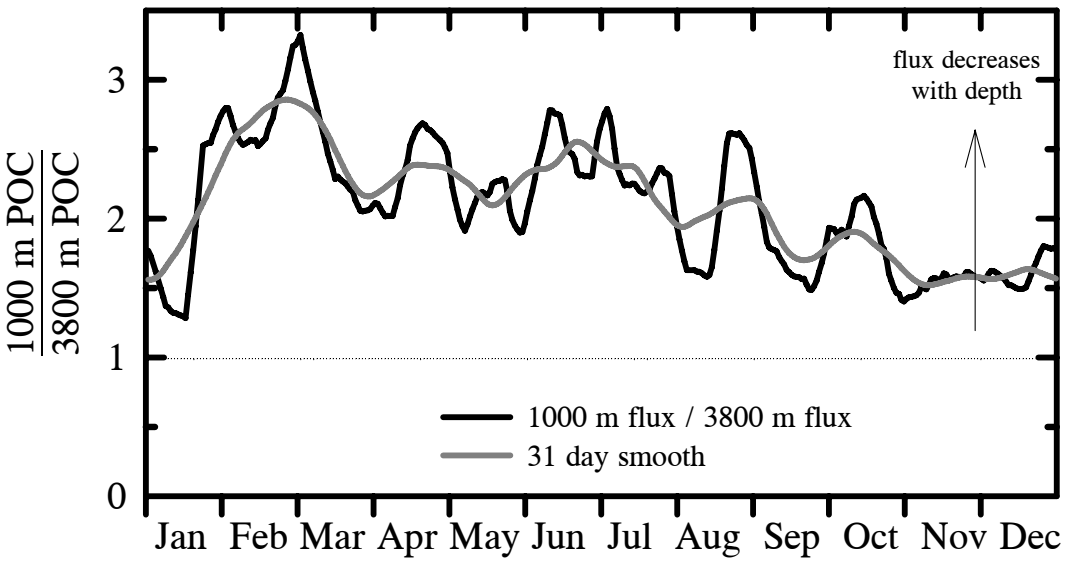




$CaCO_3$ flux at OSP with 12 day shift between 1000 m and 3800 m

seasonally averaged change in flux with depth



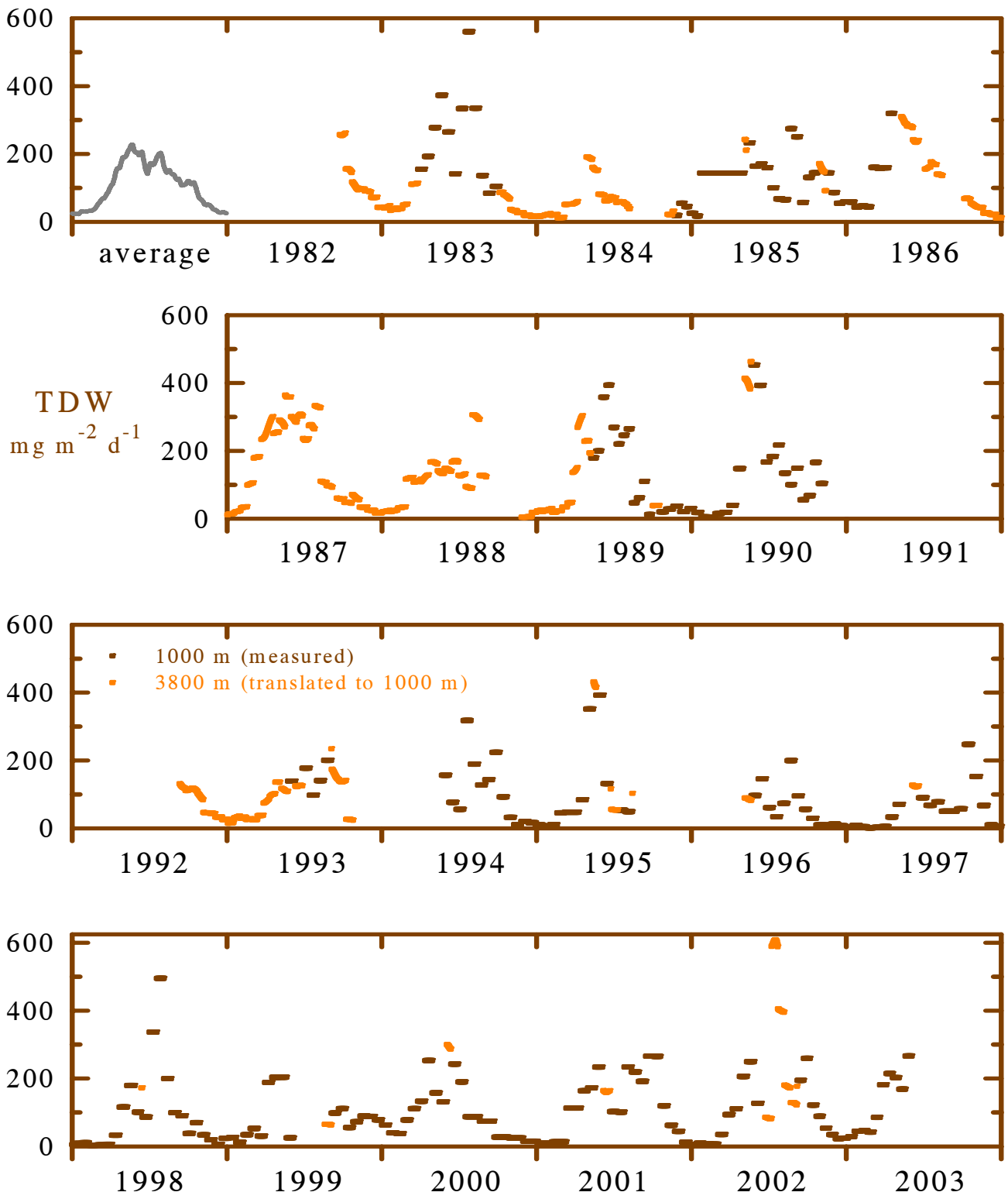


POC flux at OSP with 16 day shift between 1000 m and 3800 m

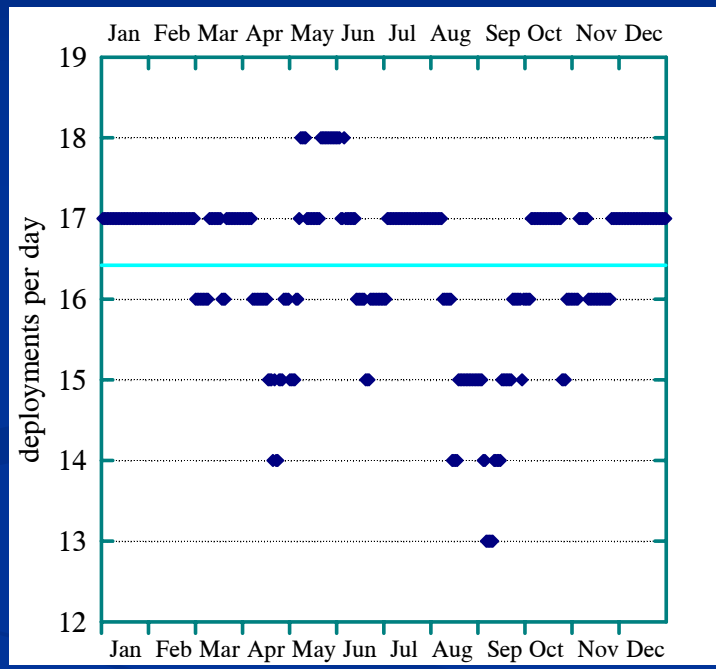
Shoaling of seasonal thermocline in Aug → high primary production (D Crawford, pers. comm.)

similar double peak but different remineralisation dynamics than presented yesterday at HOTS

seasonally averaged change in flux with depth



1000 m fluxes at OSP with merged 3800 m fluxes



16+ years

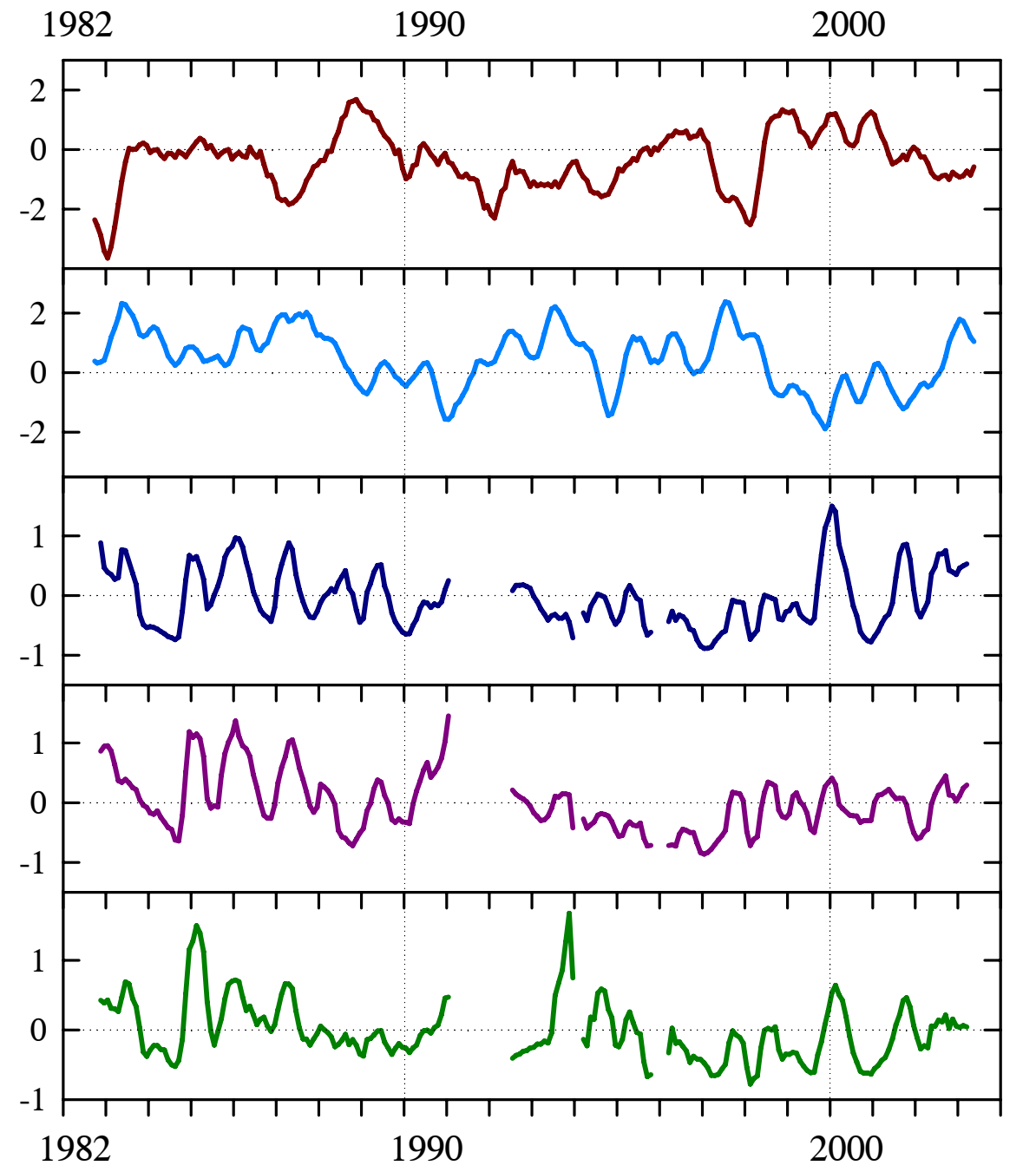
Southern Oscillation Index

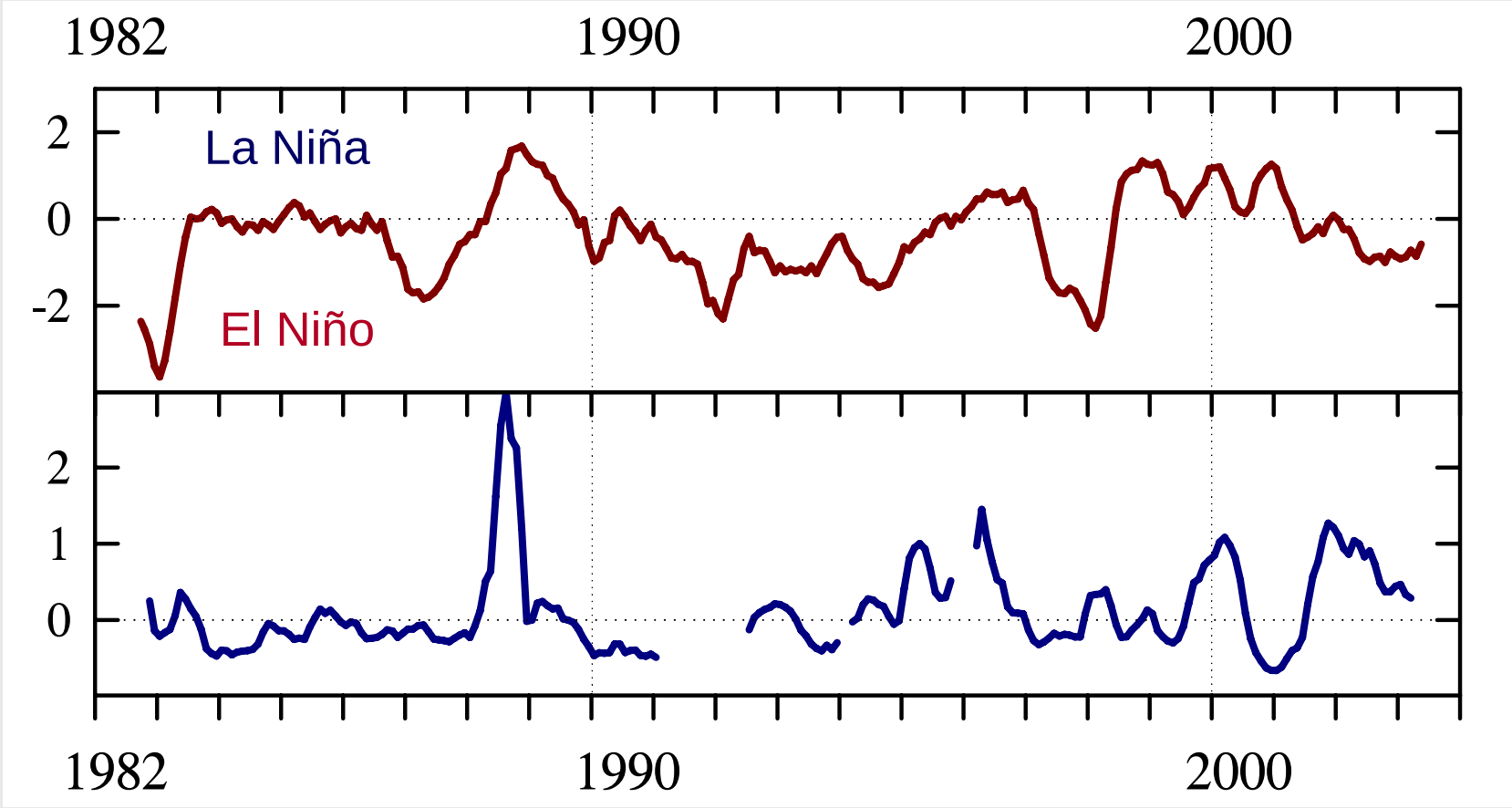
Pacific Decadal Oscillation

BSi flux anomaly

$CaCO_3$ flux anomaly

POC flux anomaly

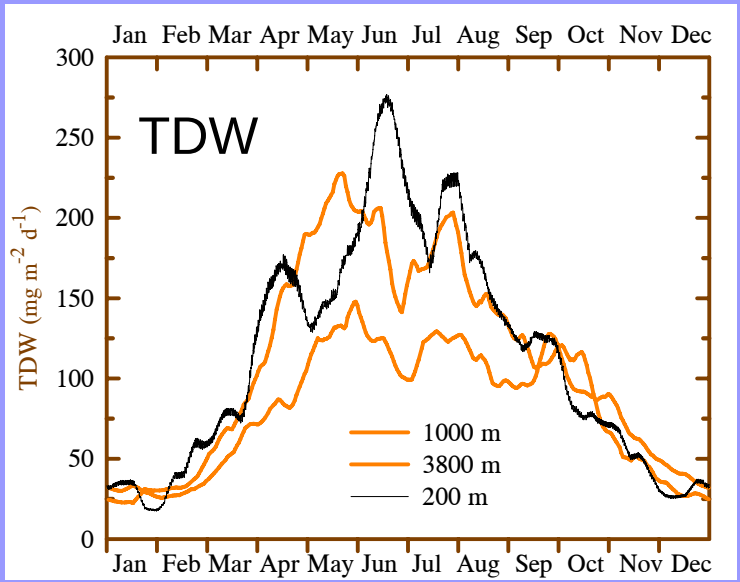


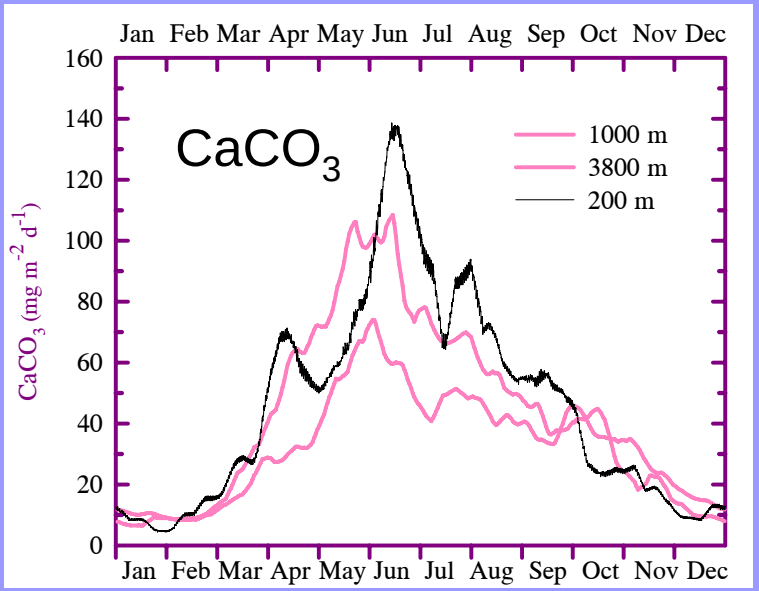


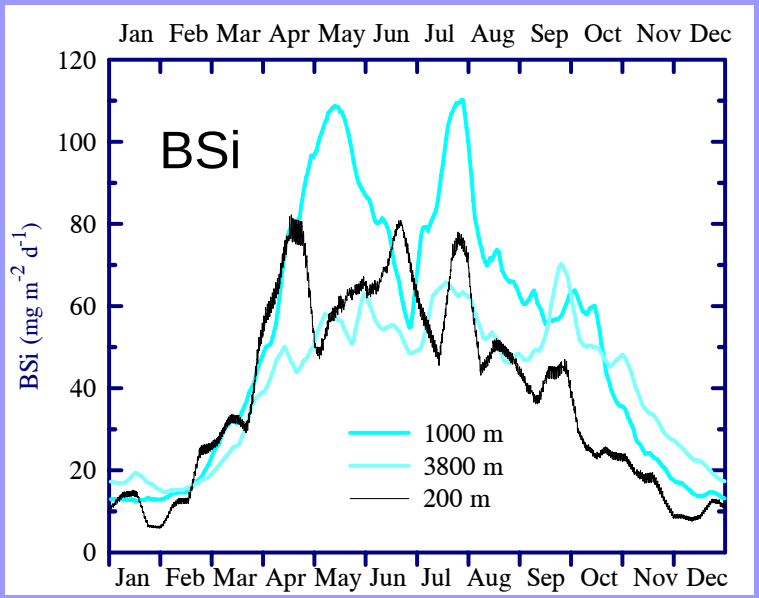
CONCERNS and ONGOING WORK

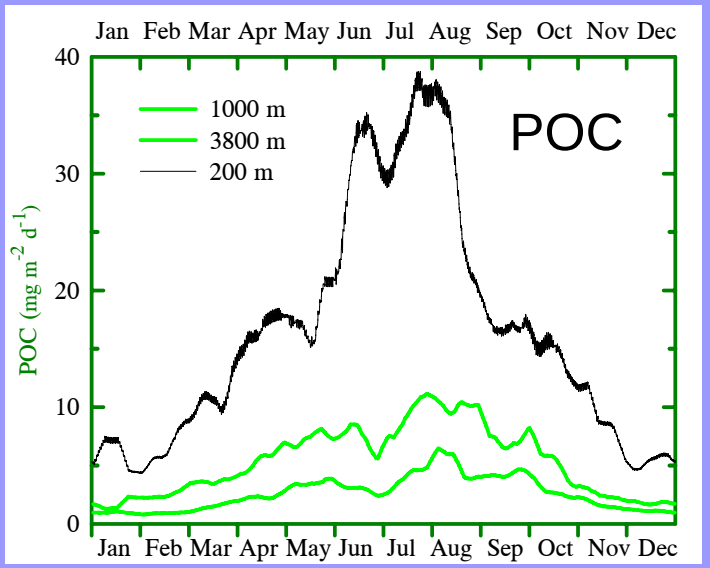
1. Large anomalies in general. Need to average fluxes over longer periods? How long?
2. Large anomalies in winter. Longer averaging?
3. 1988 is a period when 3800 m fluxes were translated to 1000 m. Need to assure 1988 anomaly exists relative to the 3800 m time-series.

200 m fluxes at OSP









OSP conclusions

- The seasonal cycle of flux at OSP occurs with spring and summer peaks in the fluxes of BSi and POC, but only a spring peak in the flux of $CaCO_3$.
- Particles sink at rates of 100-400 m d^{-1} below 1000 m, with the possibility $CaCO_3$ sinks faster than BSi and POC.
- POC follows BSi more closely than it follows $CaCO_3$.
- The time series from OSP is long enough for correlations with SOI and PDO. Preliminary analysis shows a greater predominance of diatoms during La Niña and coccolithophorids during El Niño, consistent with Wong and Crawford (2002).

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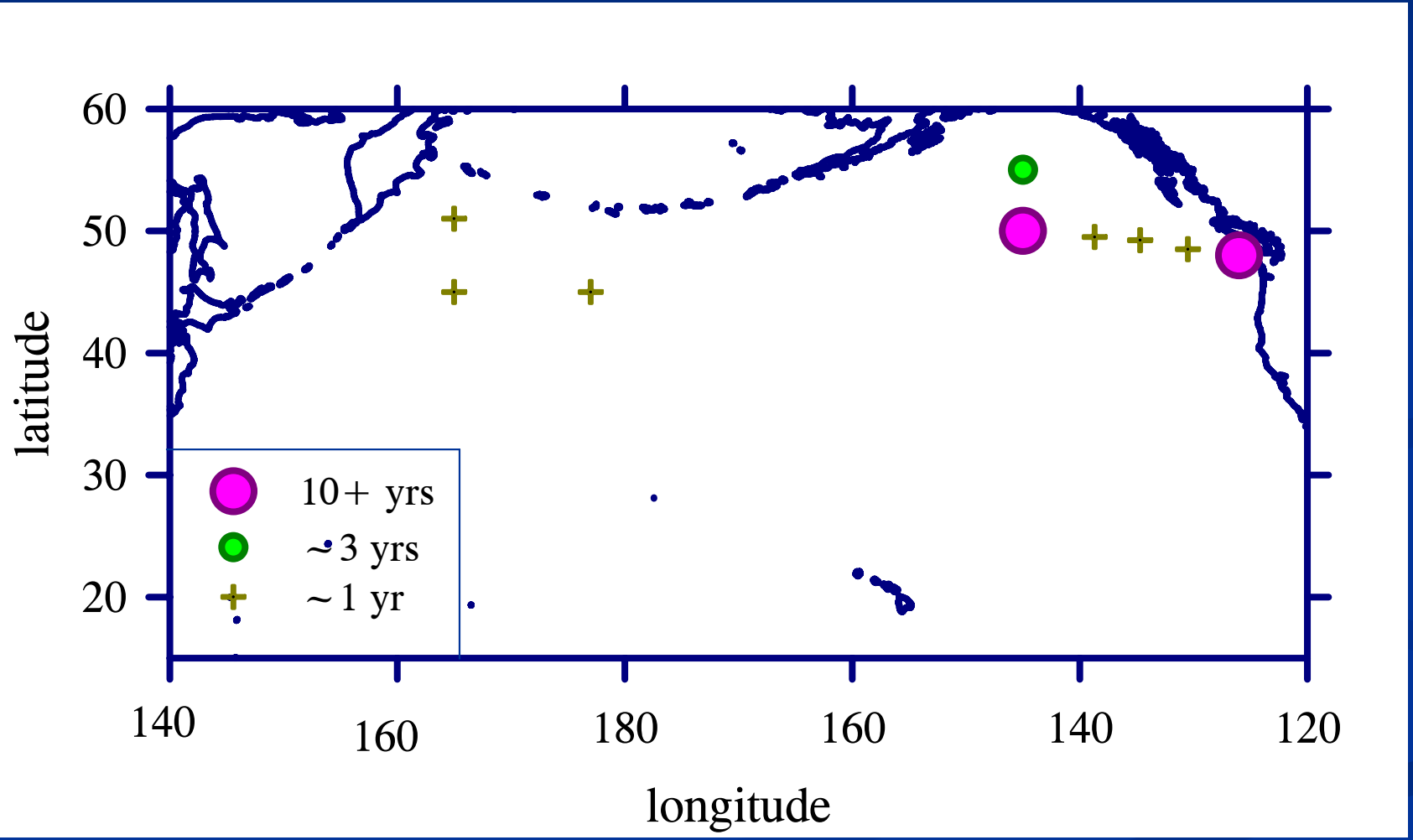
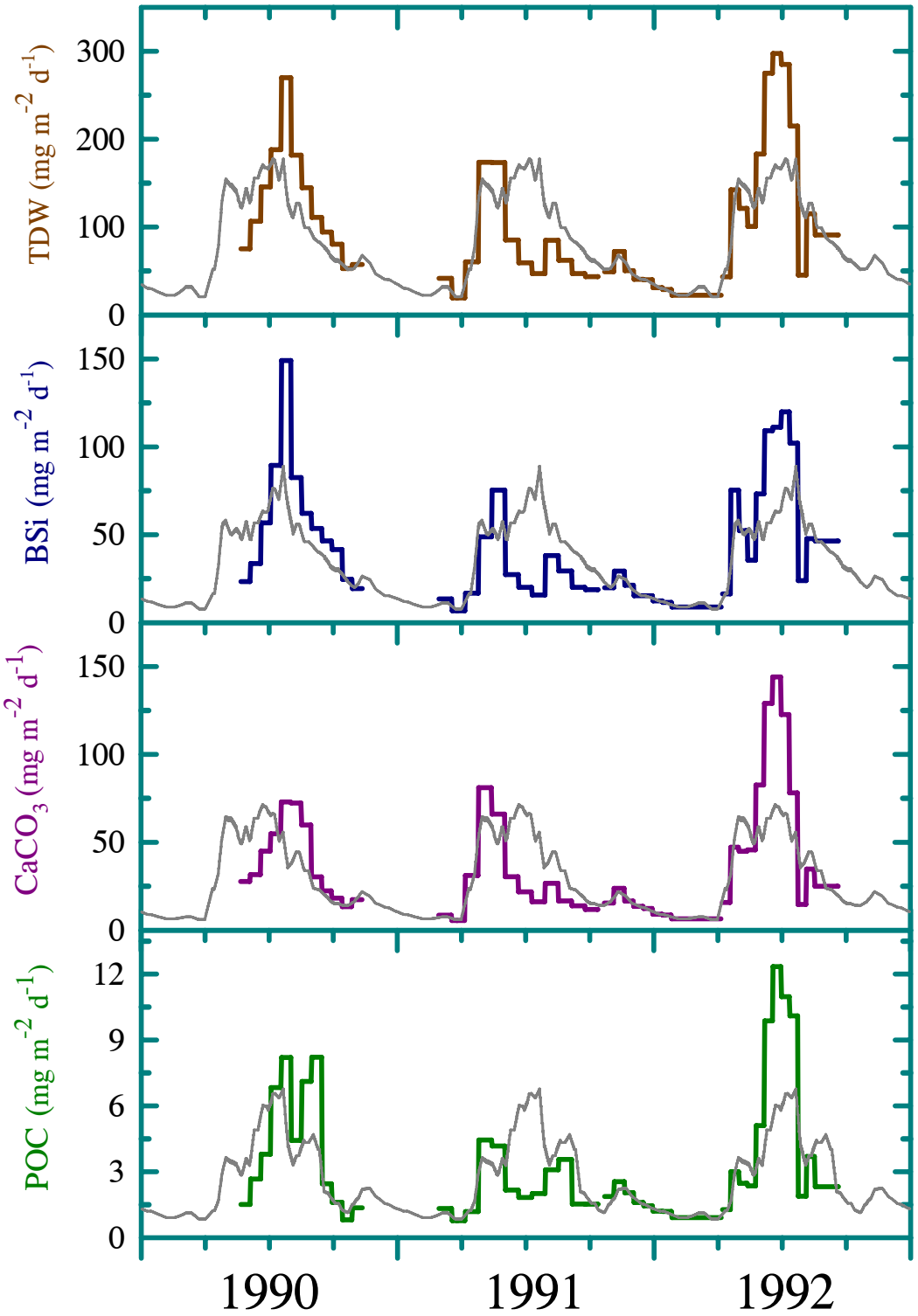
- Line P with emphasis at La Perouse Bank

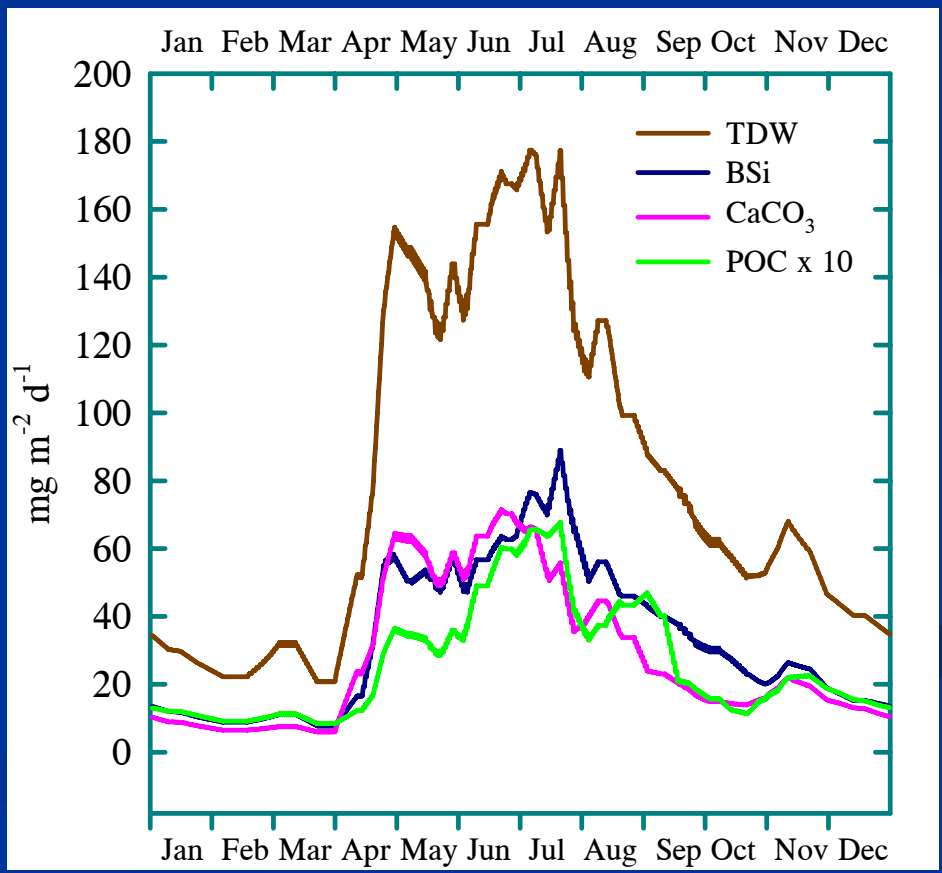
Alaska Gyre: 1990 to 1992



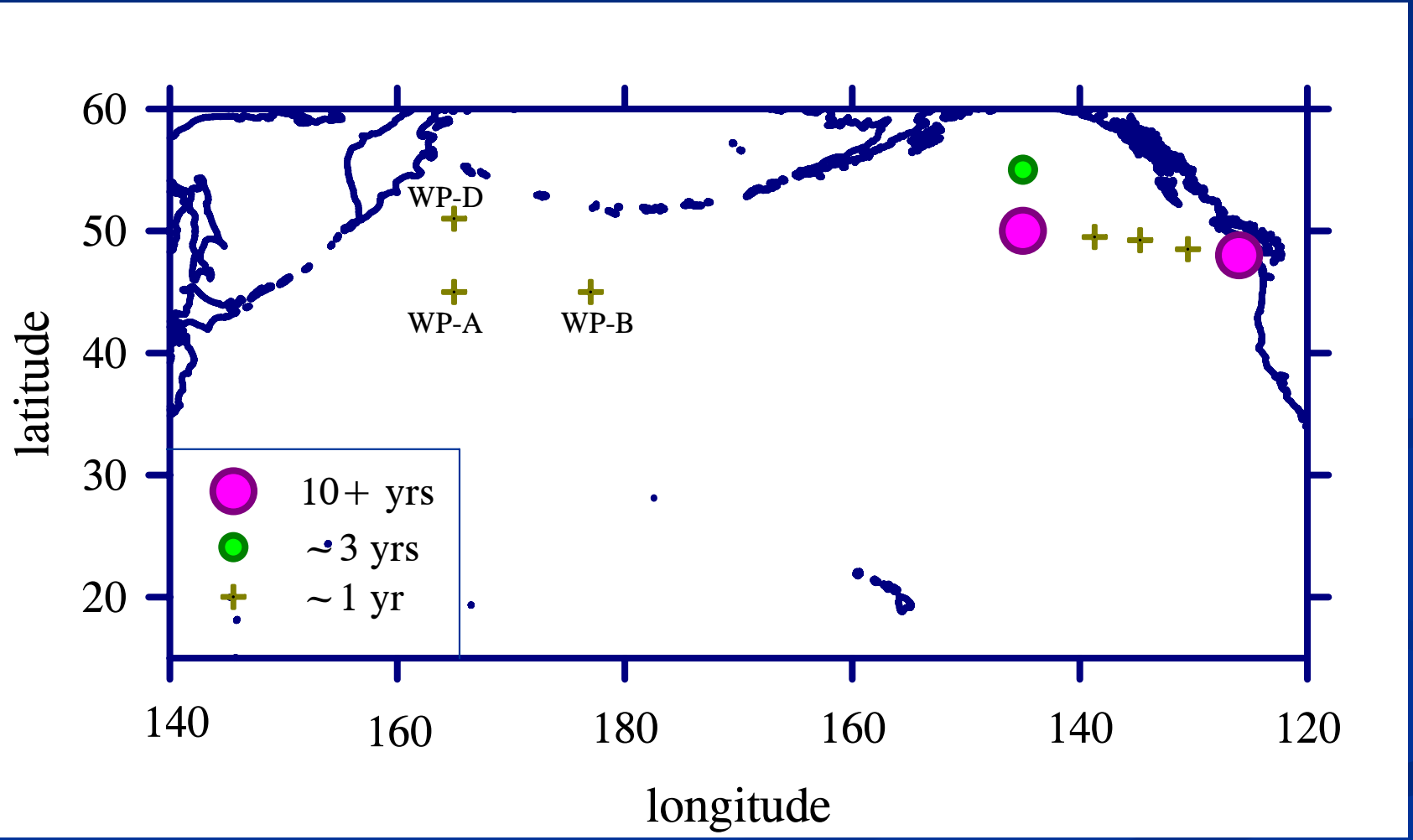
Alaska Gyre

55⁰ 00’ N
145⁰ 00’ W
trap depth = 3700 m
bottom depth = 3900 m





3 stations in the Western Pacific
August, 1991 to June, 1992



stations WP aka GEMS

North Pacific Western Gyre sediment-trap fluxes

WP D

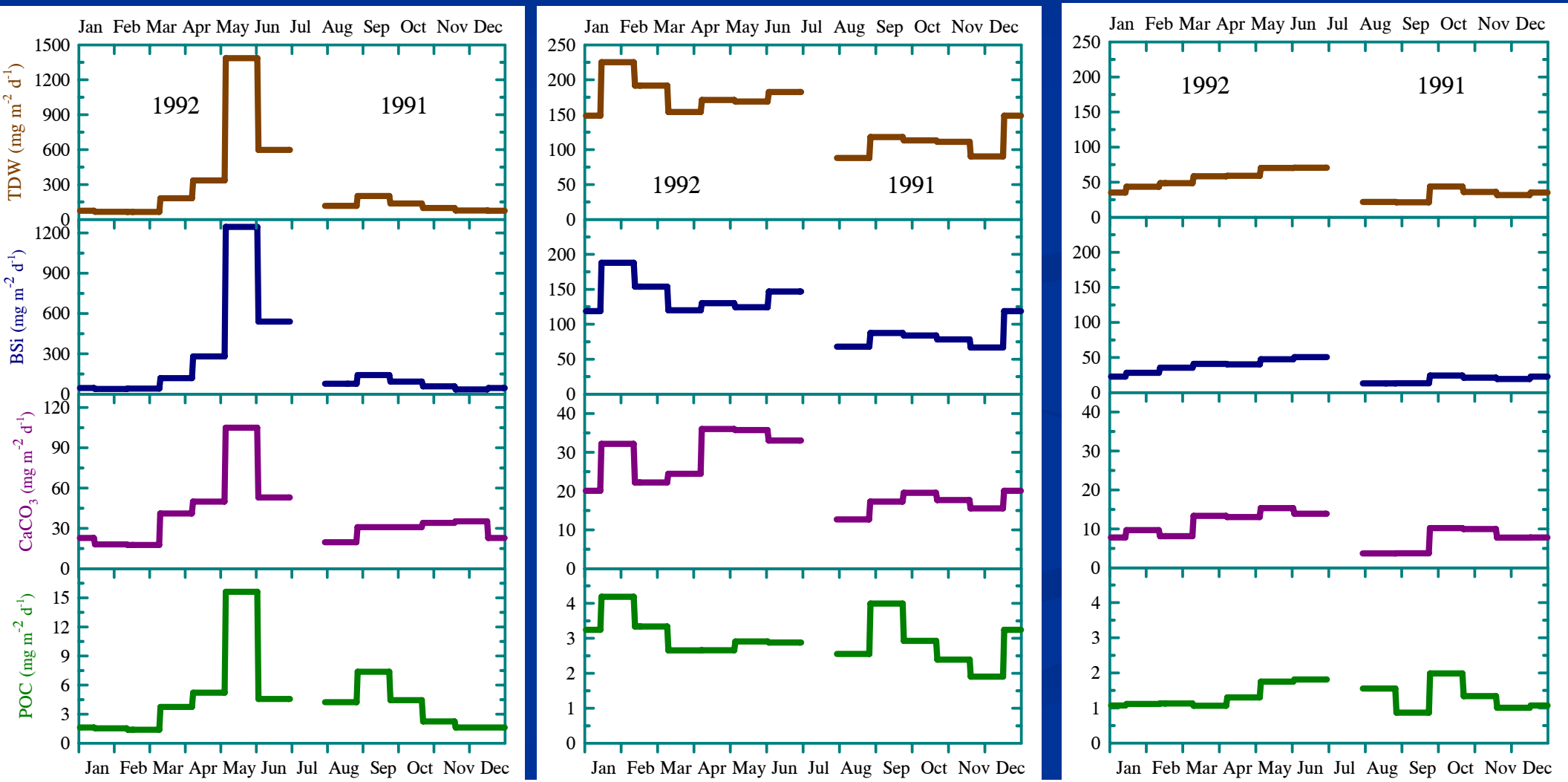
51⁰ 25’ N
165⁰ 13’ E
4300 m
bottom depth = 5200 m

WP A

44⁰ 58’ N
165⁰ 00’ E
5300 m
bottom depth = 5860 m

WP B

45⁰ 05’ N
176⁰ 53’ W
5200 m
bottom depth = 5755 m

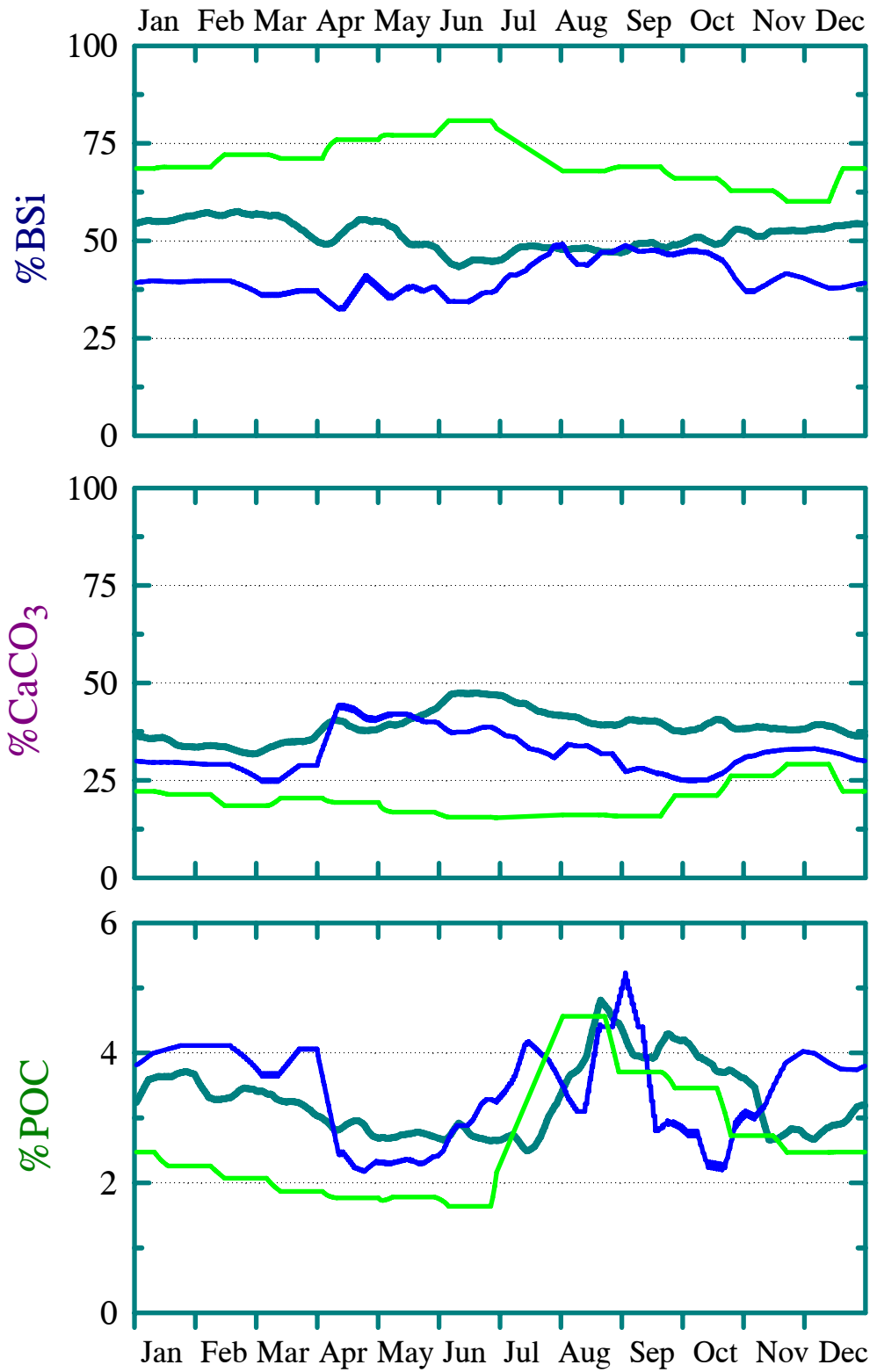


sediment composition at deep traps

W Pacific
4300 m – 5300 m

OSP
3800 m

Alaska Gyre
3700 m



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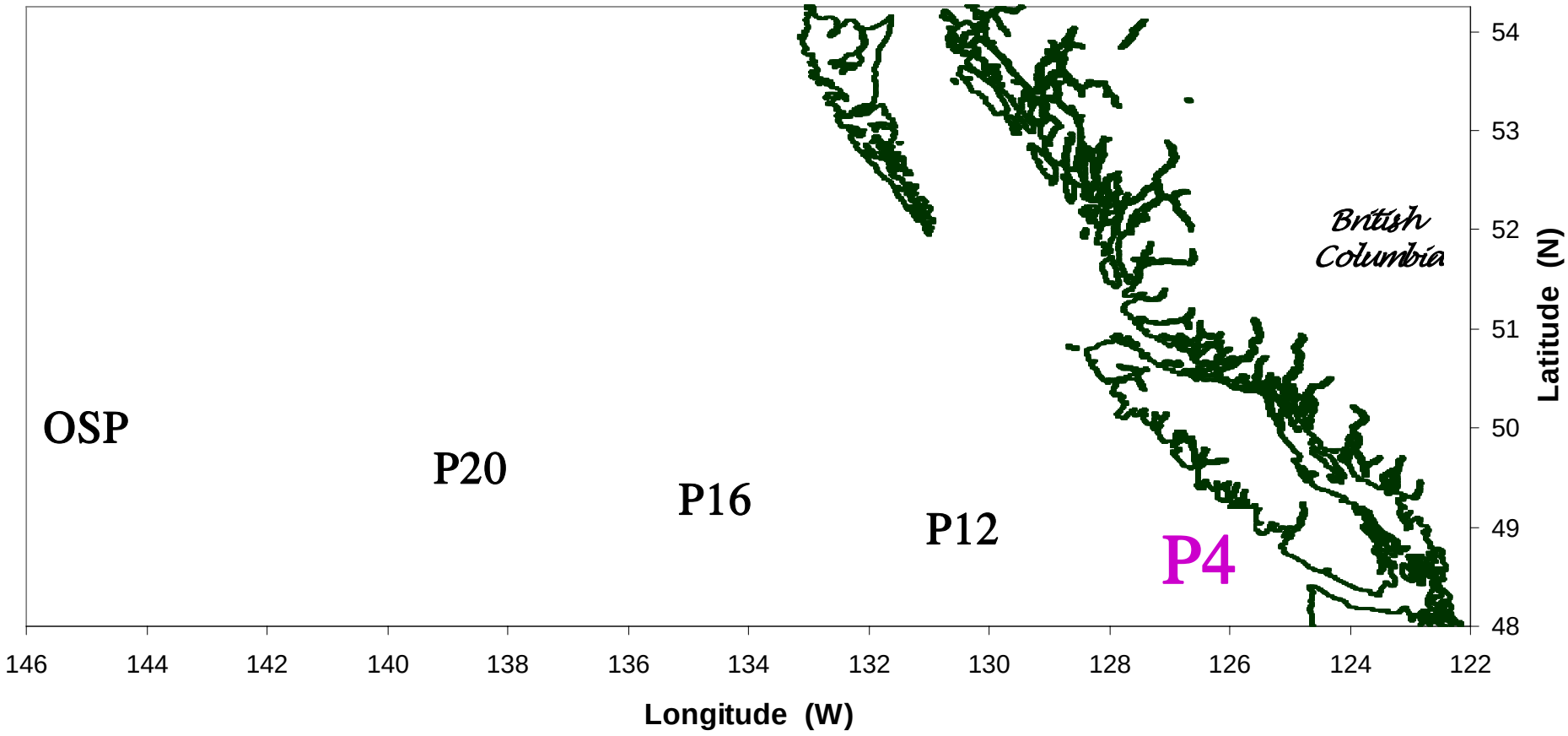
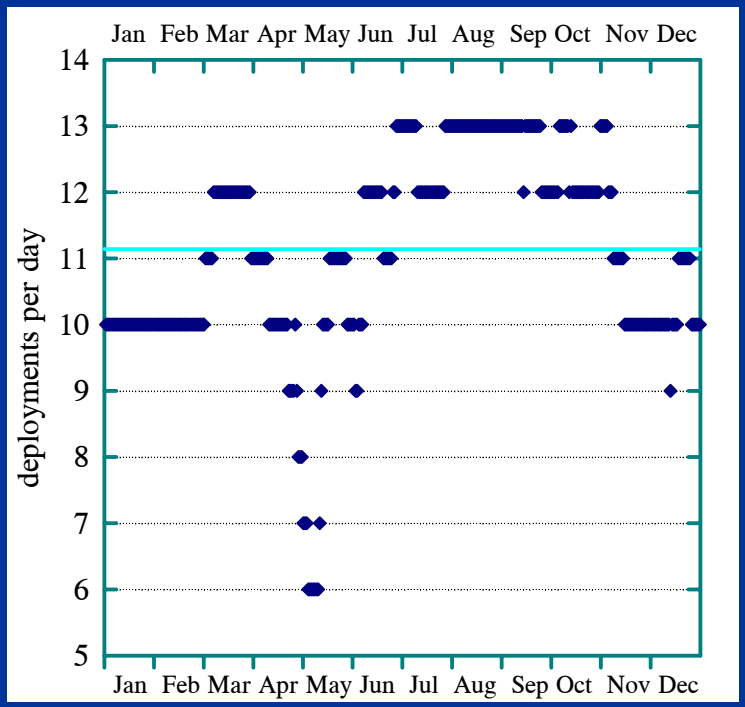
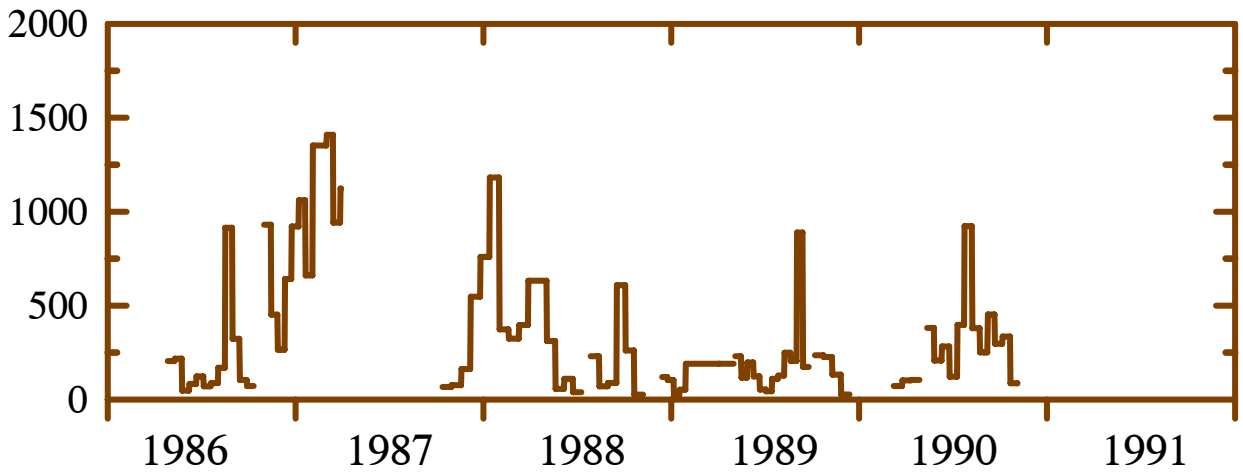

OSP
P20
P16
P12
P4
British Columbia
54
53
52
51
50
49
48
Latitude (N)
146
144
142
140
138
136
134
132
130
128
126
124
122
Longitude (W)

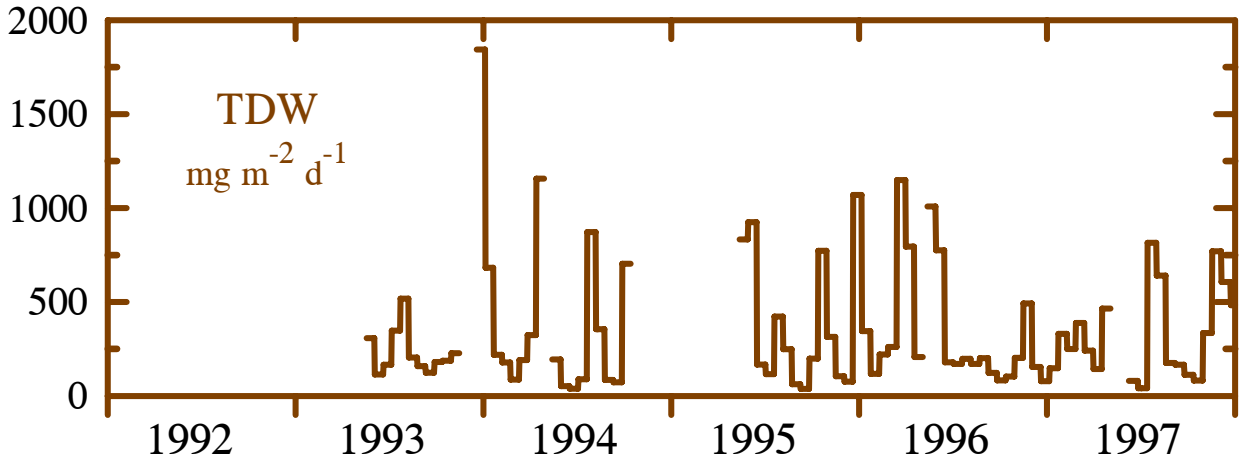
La Perouse Bank

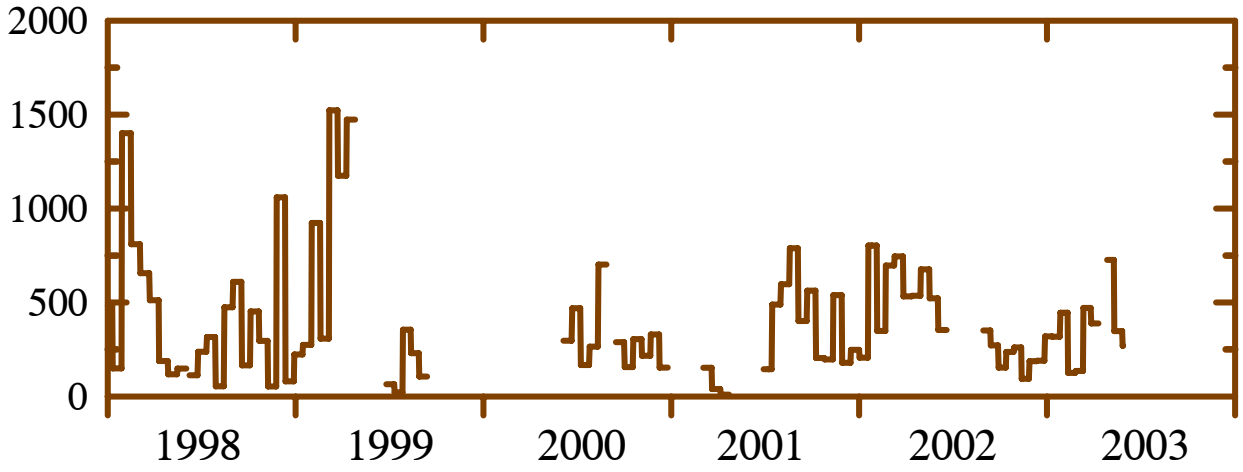
48^0 35’ N
126^0 24’ W
prior to 1991: 500 m
after 1991: 700 m
bottom depth = 1300 m



11 yrs of data





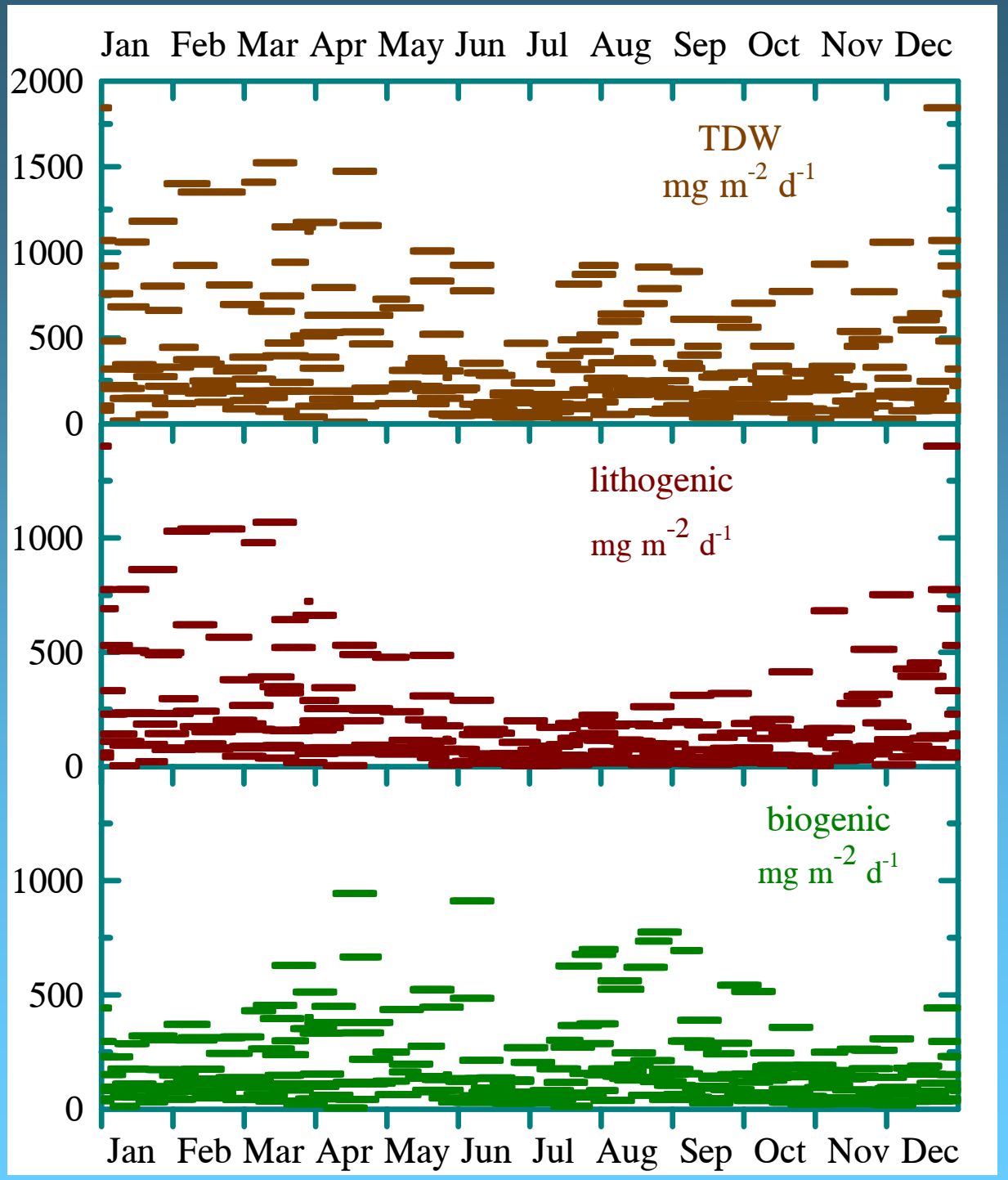


Resuspended fluxes at La Perouse Bank

no signal of primary production in the bulk flux at La Perouse Bank, and up to 75% of the sediment was lithogenic.

lithogenic sediment =
total - biogenic

biogenic sediment =
BSi + $CaCO_3$ + 1.85 (POC)



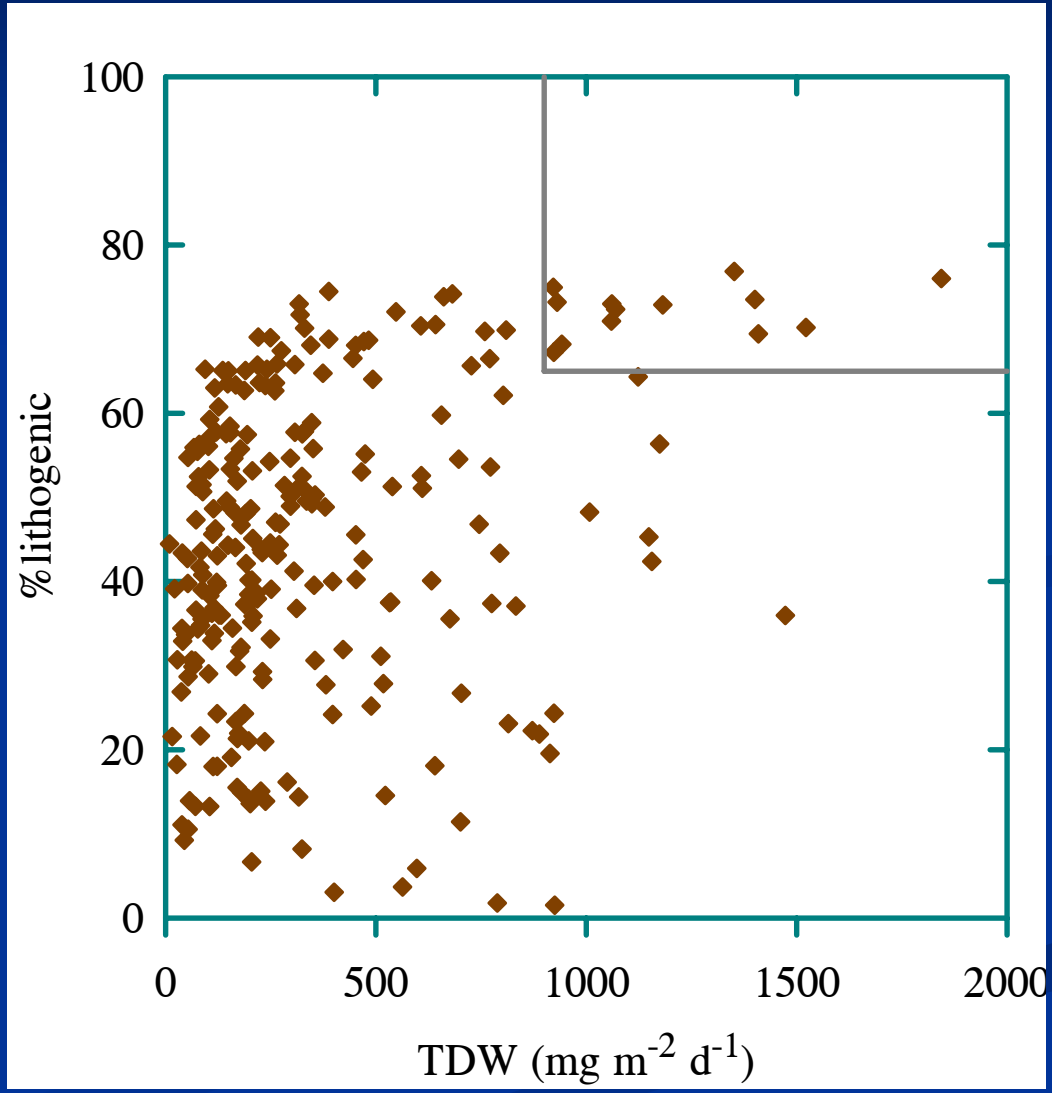
Resuspended sediment at La Perouse Bank

The composition of resuspended sediment was modelled after the samples where fluxes were more than 65% lithogenic and the total flux was > 900 mg m^{-2} d^{-1}

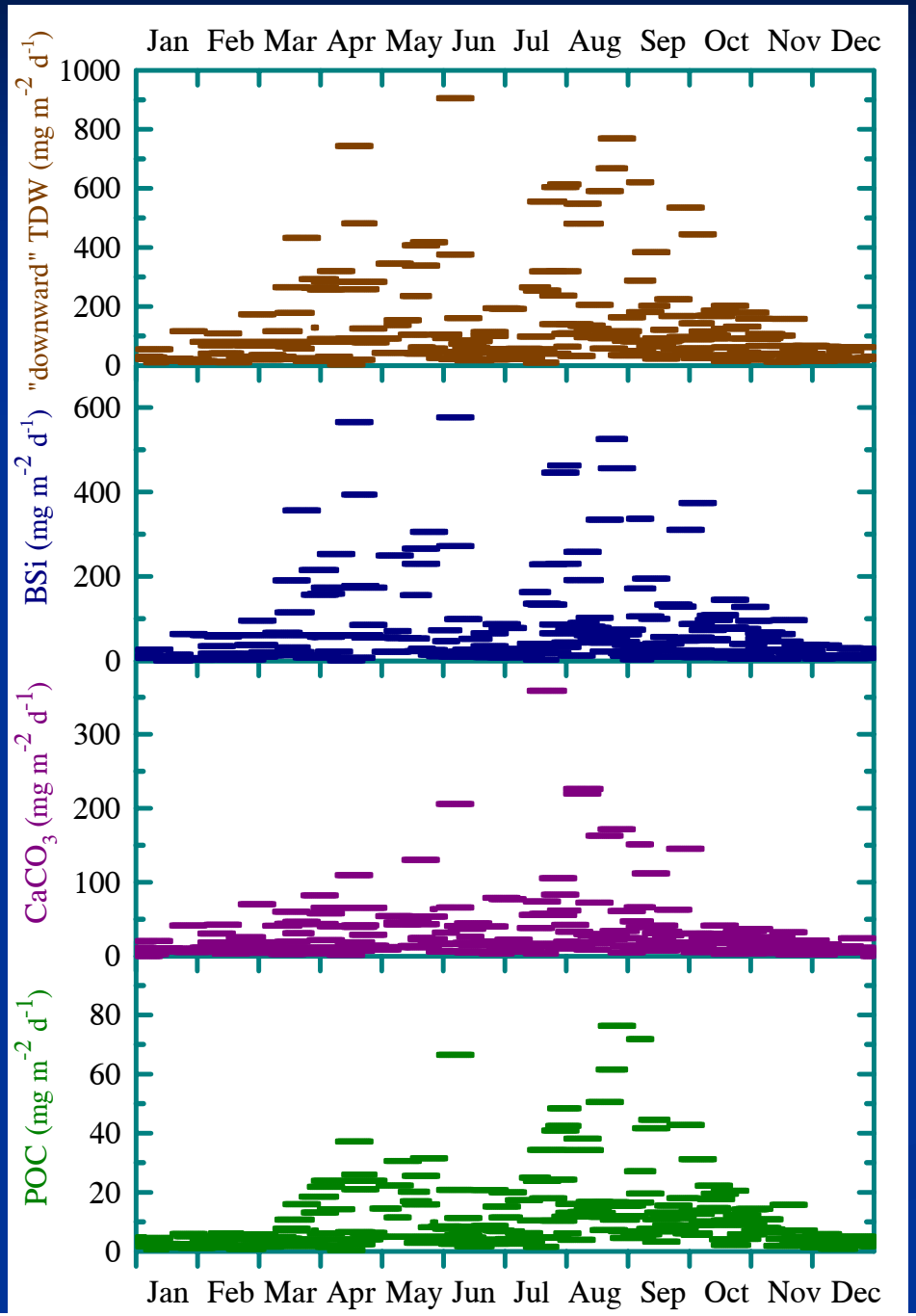
the mean composition of these samples was:

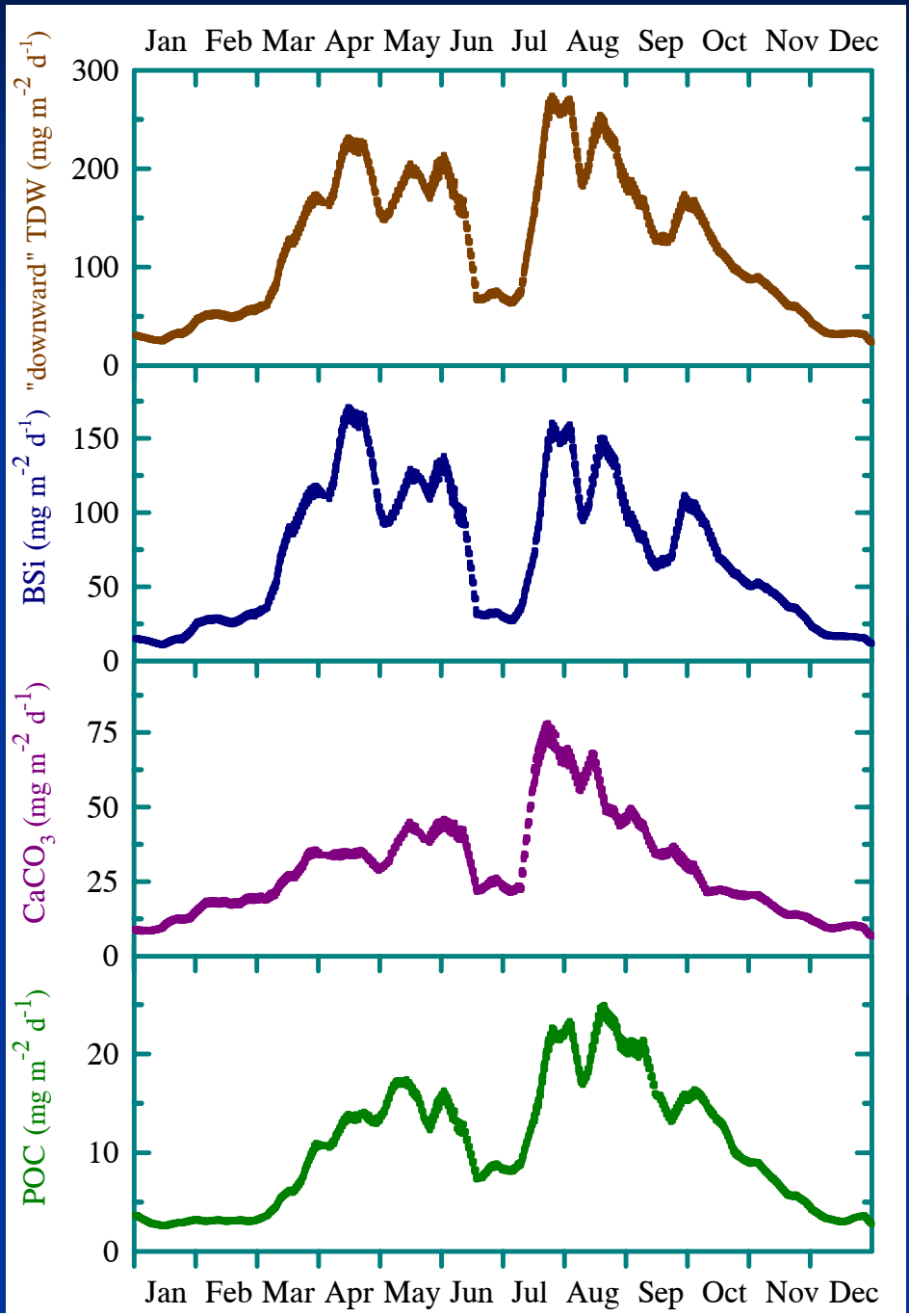
73% lithogenic
13% biogenic silica
8.3% $CaCO_3$
3.5% POC

These were all in the winter when the "downward" flux would have been minimal.

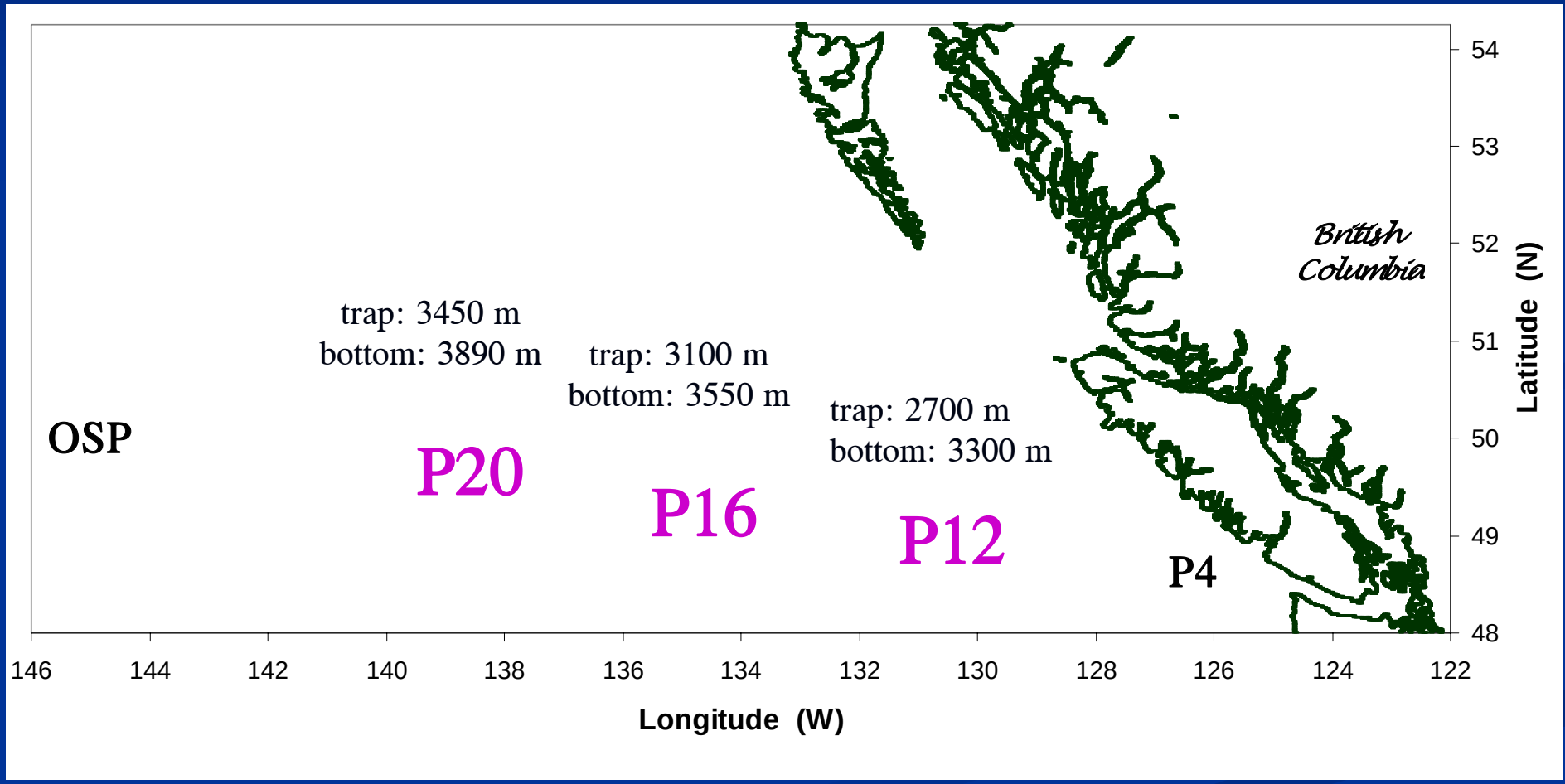


The downward flux (total – resuspended) at La Perouse Bank

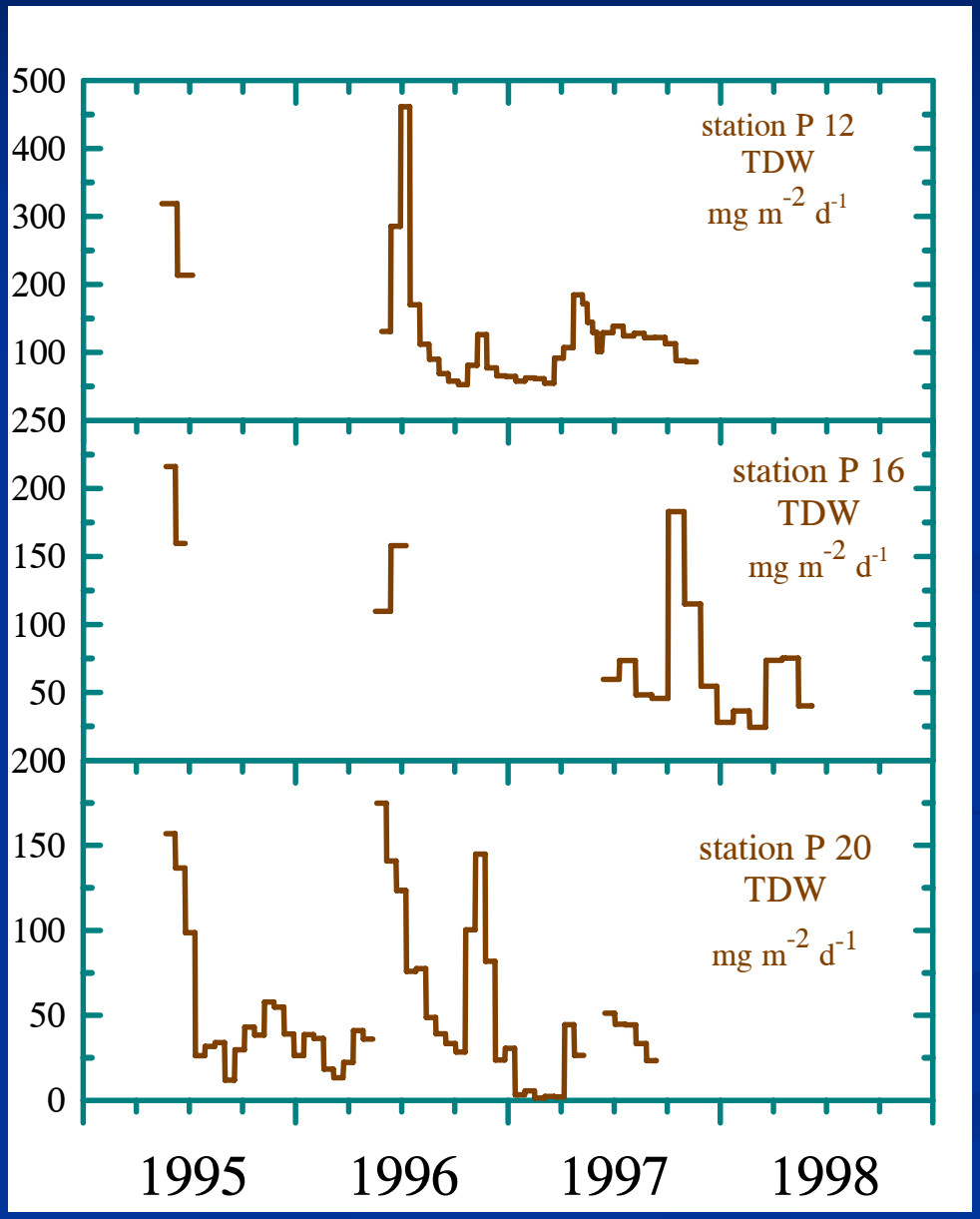




compilation from Line P

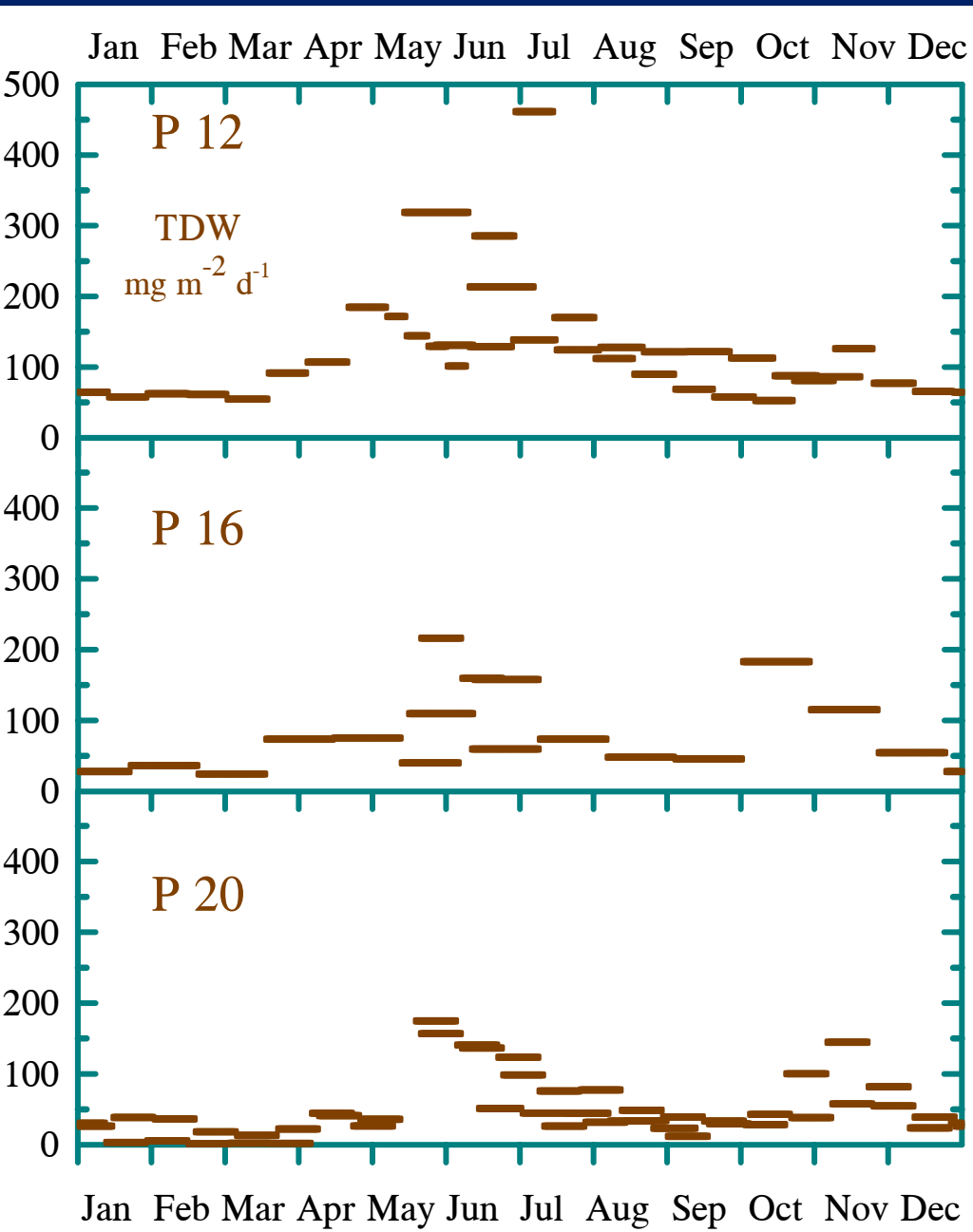


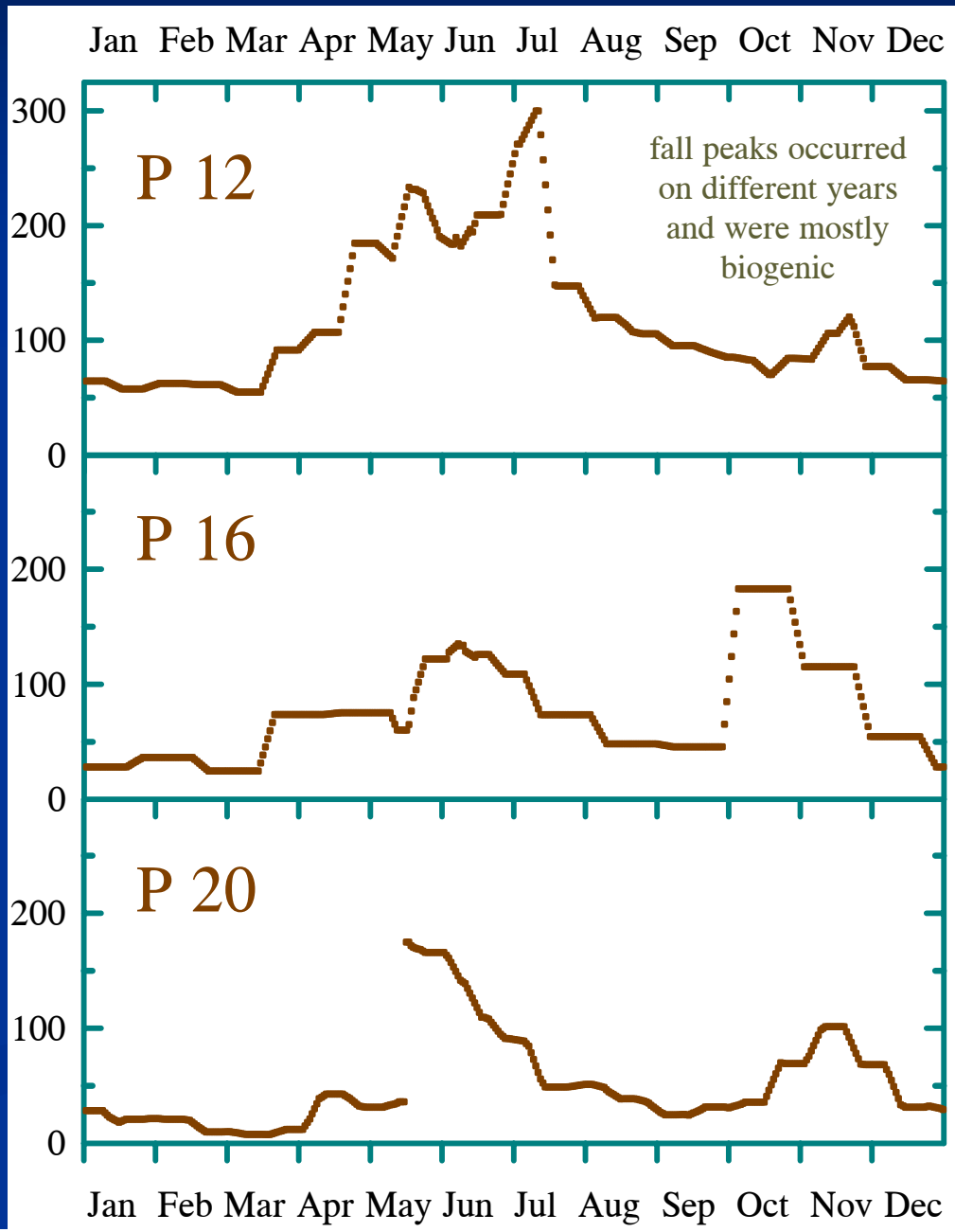
fluxes were recorded sporadically along line P between 1995 and 1998



clogs!!!

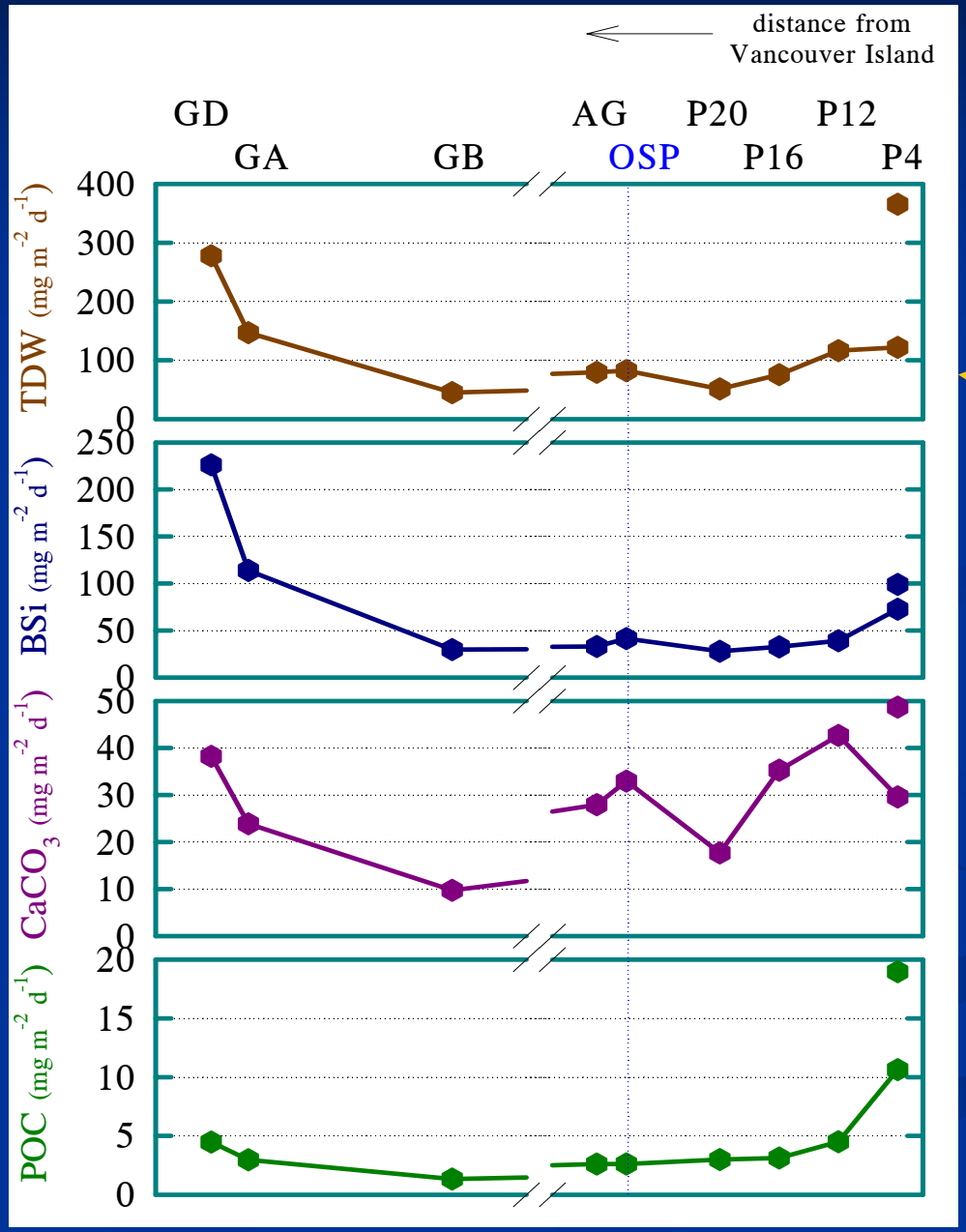
but sorted by Julian day…





Summary of fluxes in the North Pacific:

mean fluxes measured at deepest traps at each station

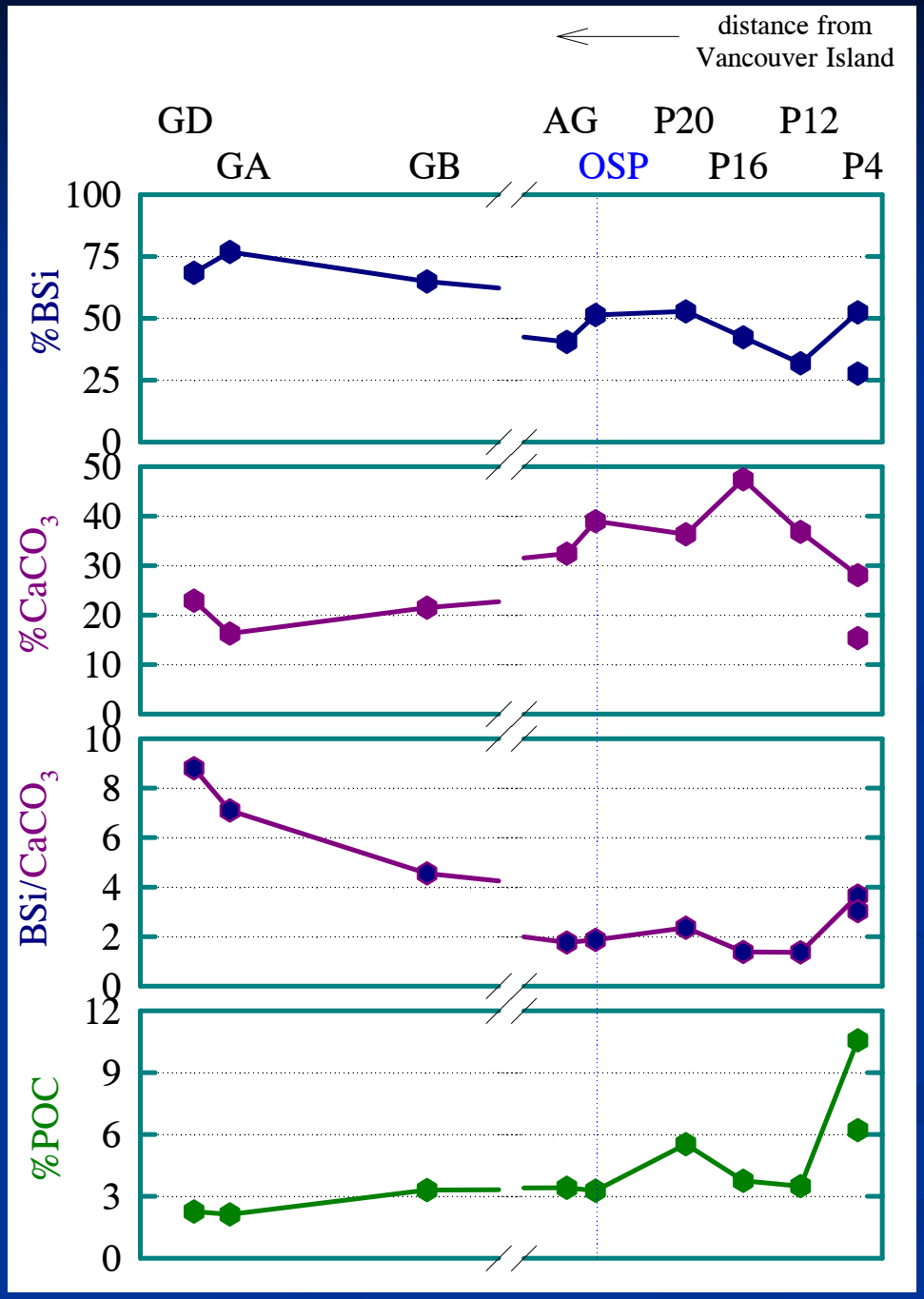


total flux at La Perouse Bank

"downward" flux

maximum coccolithophorid biomass along Line P periodically occurs at P12 (M Lipsen, pers. comm.).

highest BSi contributions occur In the Western Pacific



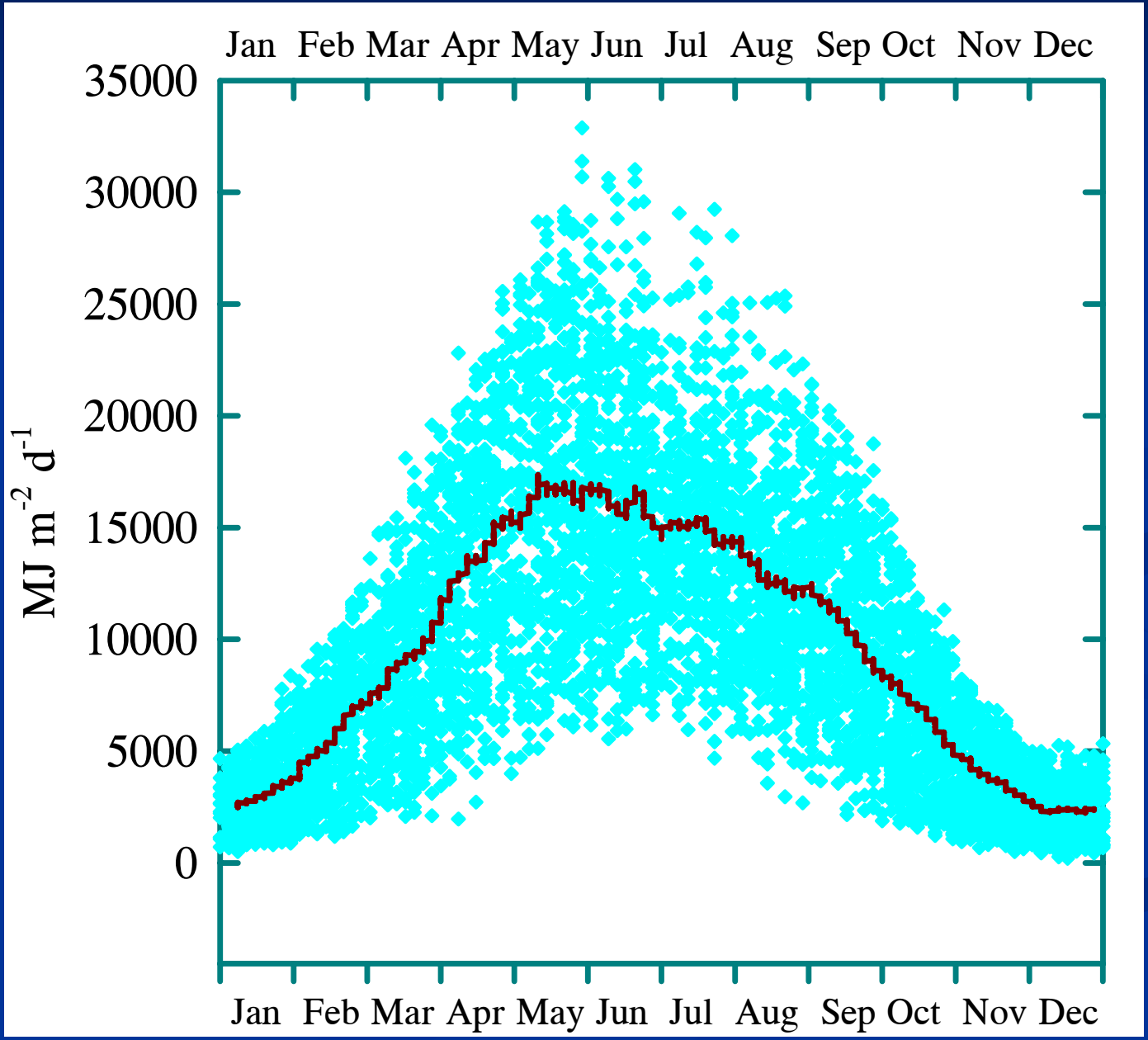
highest carbonate contribution occurs from P12 into the Alaska Gyre

Foram?
continuous plankton Recorder might help

conclusions

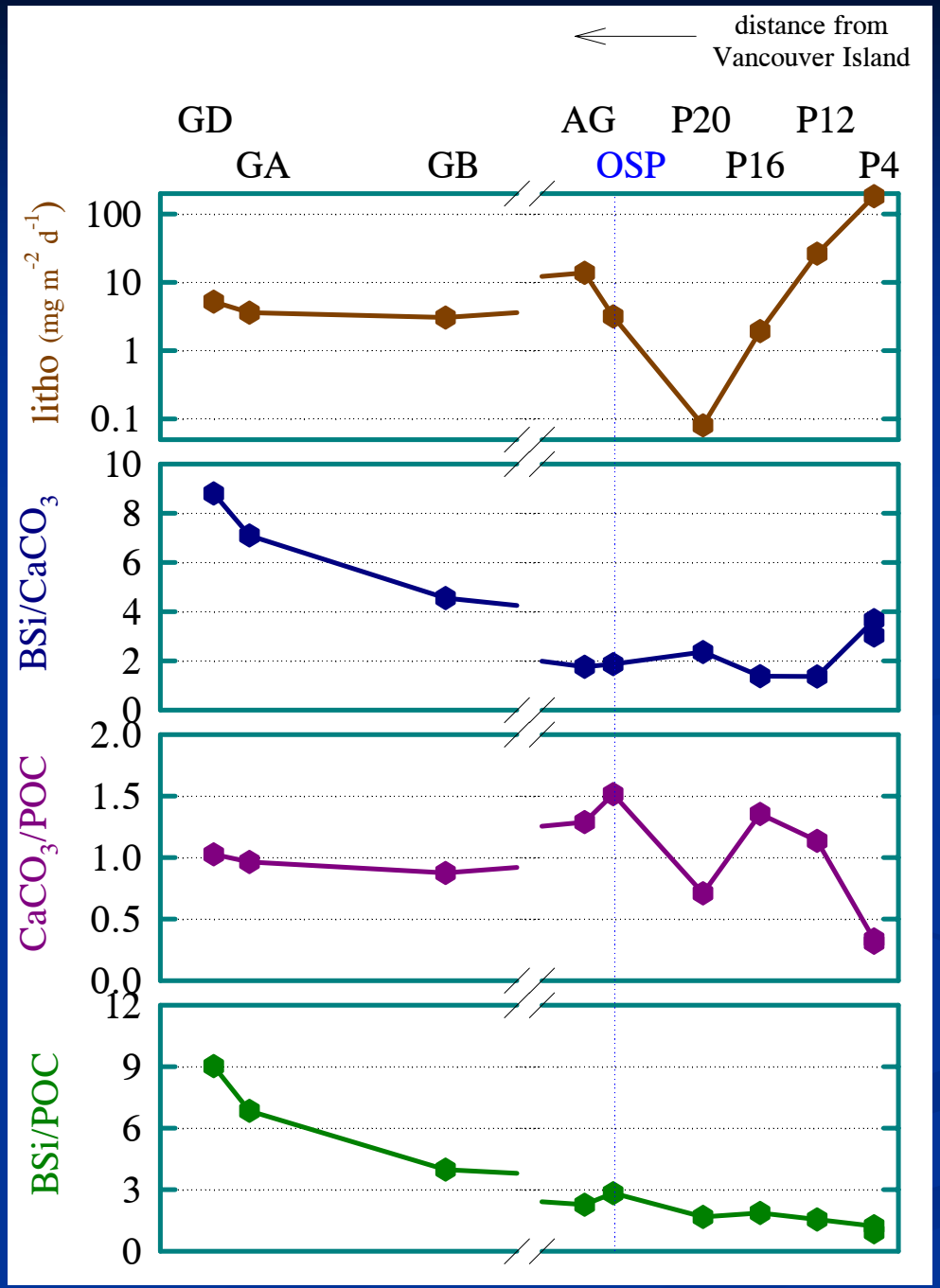
- Fluxes in the Alaska Gyre at 55°N were similar in magnitude and composition to fluxes at OSP.
- Fluxes at 3 stations west of the dateline were composed almost entirely of BSi. Total fluxes were very low near the dateline but in the NW, ~3x higher than in the eastern North Pacific.
- Fluxes along Line P decreased with distance from the coast. The "downward" flux at La Perouse Bank shows sping and summer peaks similar to those at OSP. Highest carbonate fluxes throughout the North Pacific were measured at P12 and P16.

light at OSP: 1960-1980

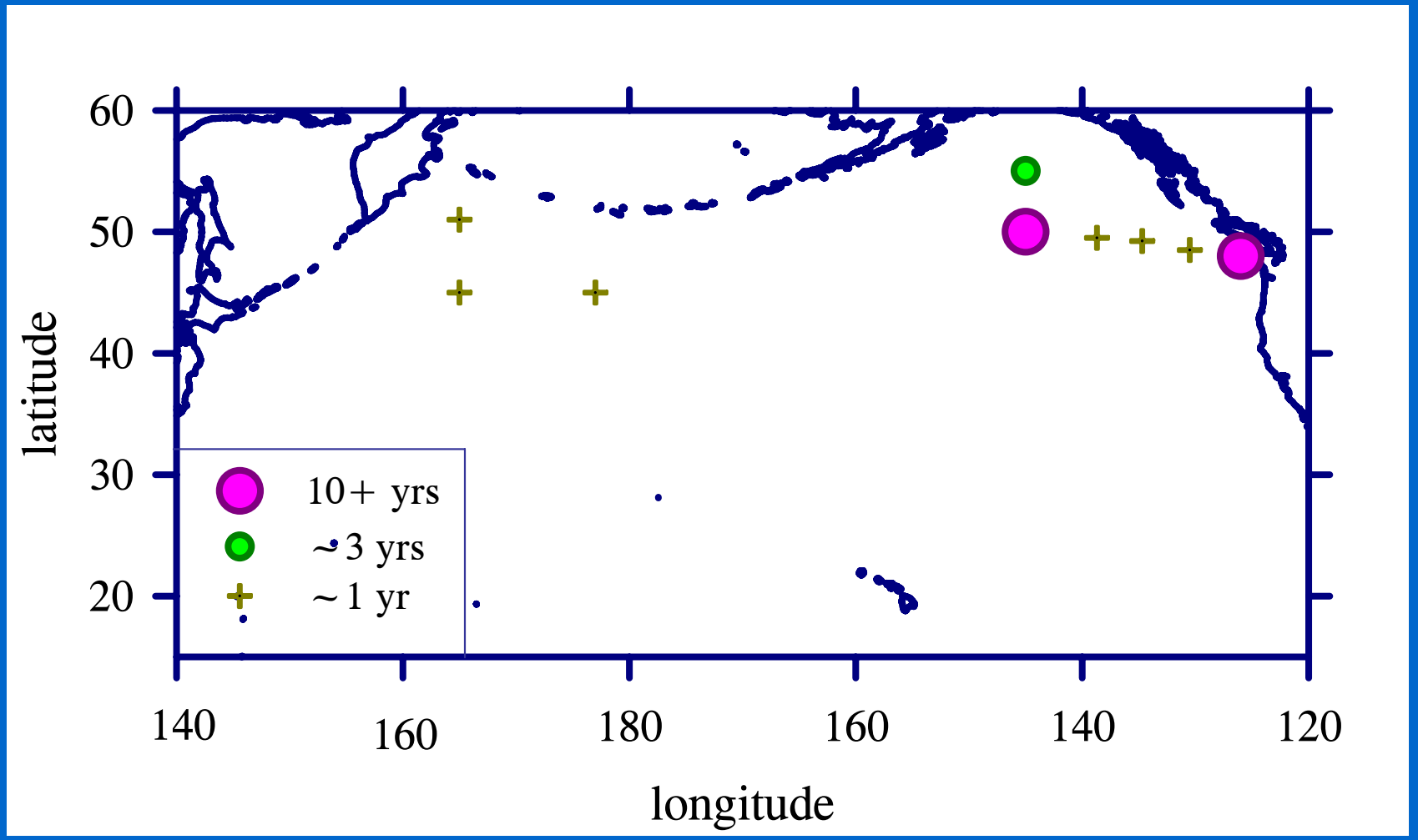


This slide will contain…

- Four figures (one for each constituent), exactly like upper right of the previous four slides, but with 200 m fluxes along with 1000 m and 3800 m. Point will be that the same signal exists at 200 m. A lot less attenuation than expected for the 200 m – 1000 m depth interval. There are some analytical issues we're dealing with, so we haven't yet pushed the 200 m time series through the calculations.


distance from
Vancouver Island
GD
GA
GB
AG
OSP
P20
P16
P12
P4
litho (mg m-2 d-1)
100
10
1
0.1
BSi/CaCO3
10
8
6
4
2
0
CaCO3/POC
2.0
1.5
1.0
0.5
0.0
BSi/POC
12
9
6
3
0

La Perouse Bank: 1986 to present



Southern Oscillation Index

Pacific Decadal Oscillation

$BSi/CaCO_3$ flux anomaly

$POC/CaCO_3$ flux anomaly

BSi/POC flux anomaly