Variation in phytoplankton composition between two North Pacific frontal zones along 158/159°W during winter-spring 2008–2015

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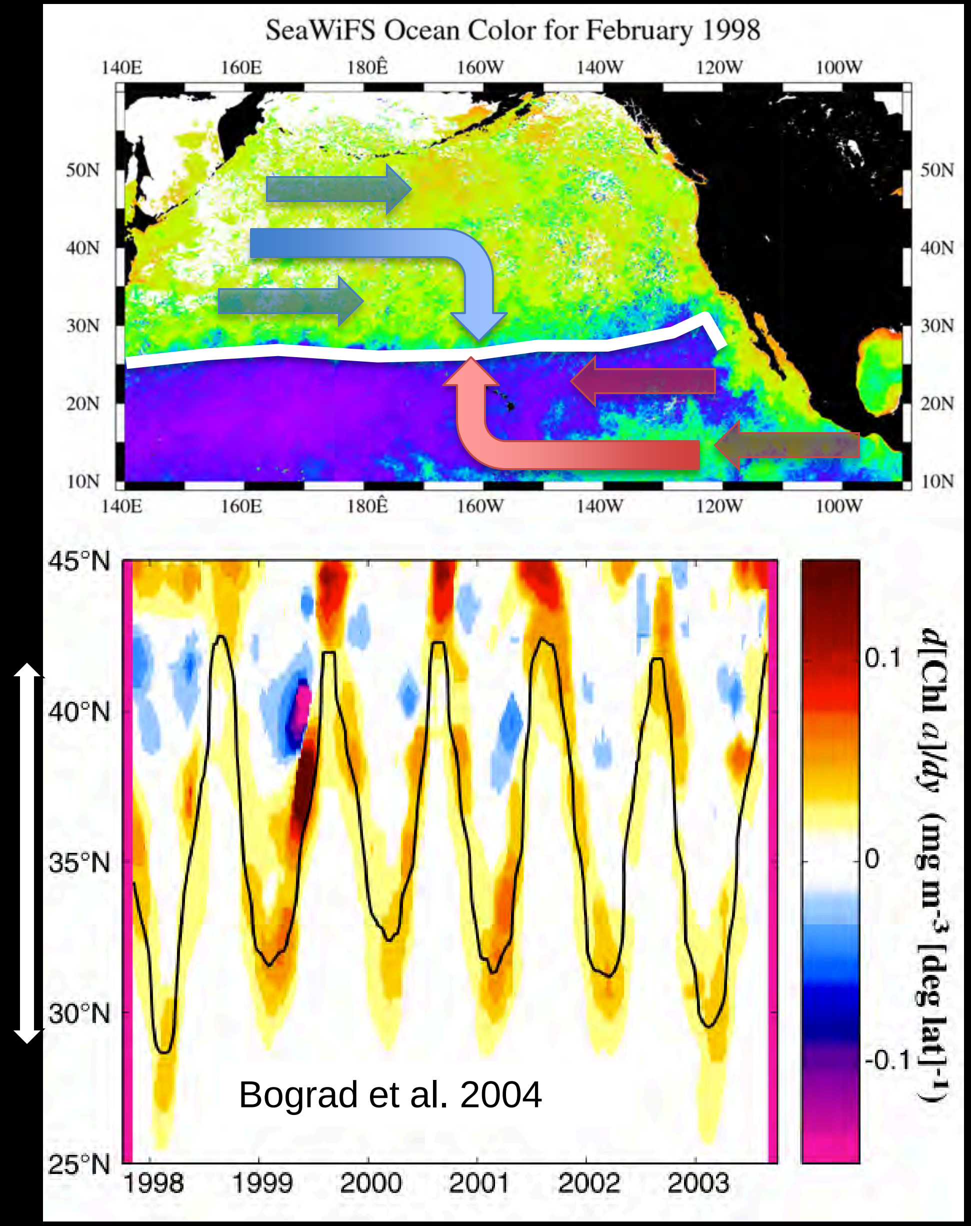
**Howell, E.A., et al. Variation in phytoplankton composition between two North Pacific frontal zones along 158°W during winter–spring 2008–2011. Prog. Oceanogr. (2015)*

The North Pacific Transition Zone (NPTZ)

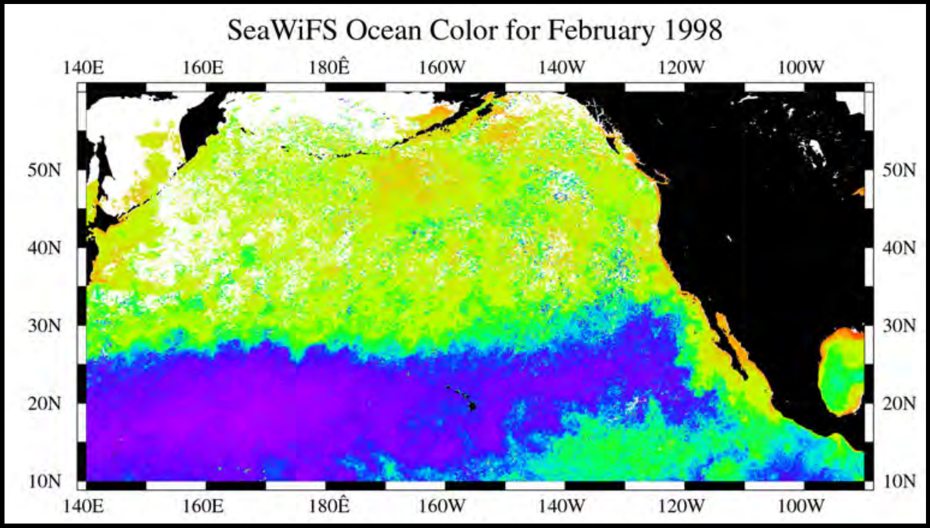
- Is the separation between the productive northern Subarctic Gyre (upwelling) and the oligotrophic southern Subtropical Gyre (downwelling)

- Area of high convergence with seasonal spatial variability
  - Convergence forced by wind fields
  - Increase in wind field during winter drives convergent frontal area south
  - Frontal zone can move up to 1,000 km from northern maximum (Aug-Sep) to southern minimum (Feb-Mar)



Importance of NPTZ Region

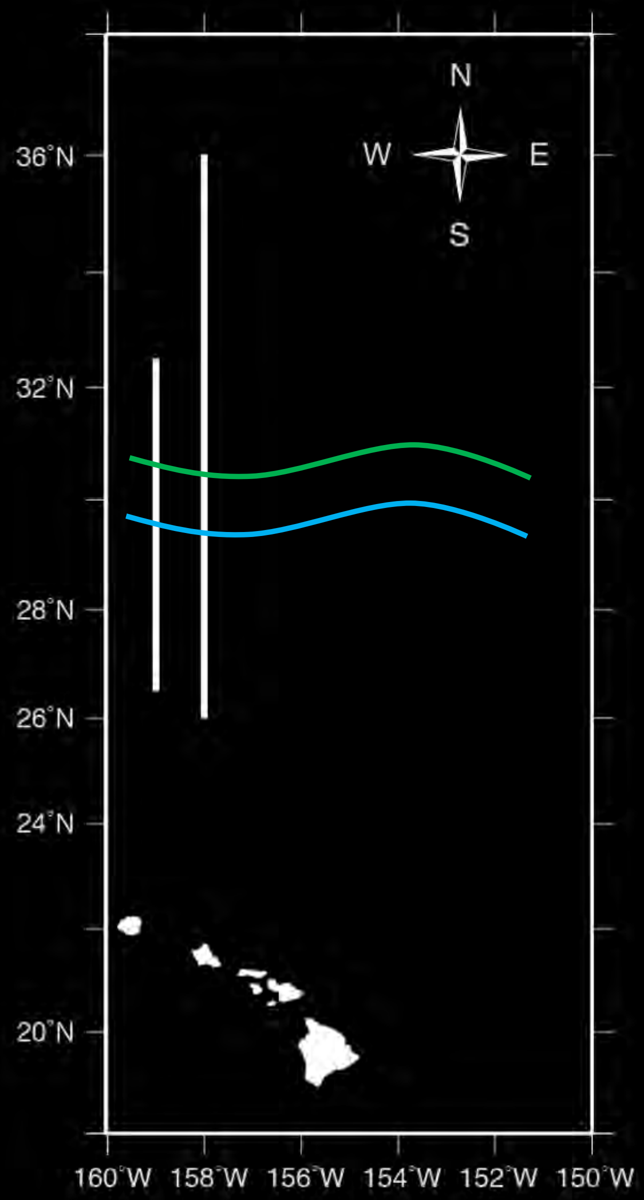
- Series of physical and biological frontal zone including SSTF, STF, and TZCF
- Migration and forage pathway for numerous species
- Physical dynamics have effect on biological composition of region
- Biological composition provides energy base for NPTZ food web
- Large seasonal and interannual changes in position of surface fronts



Questions:

- What are the differences in phytoplankton composition at STF and TZCF fronts?
- How much variability is there in phytoplankton composition over space and time?

NPTZ study area and variables

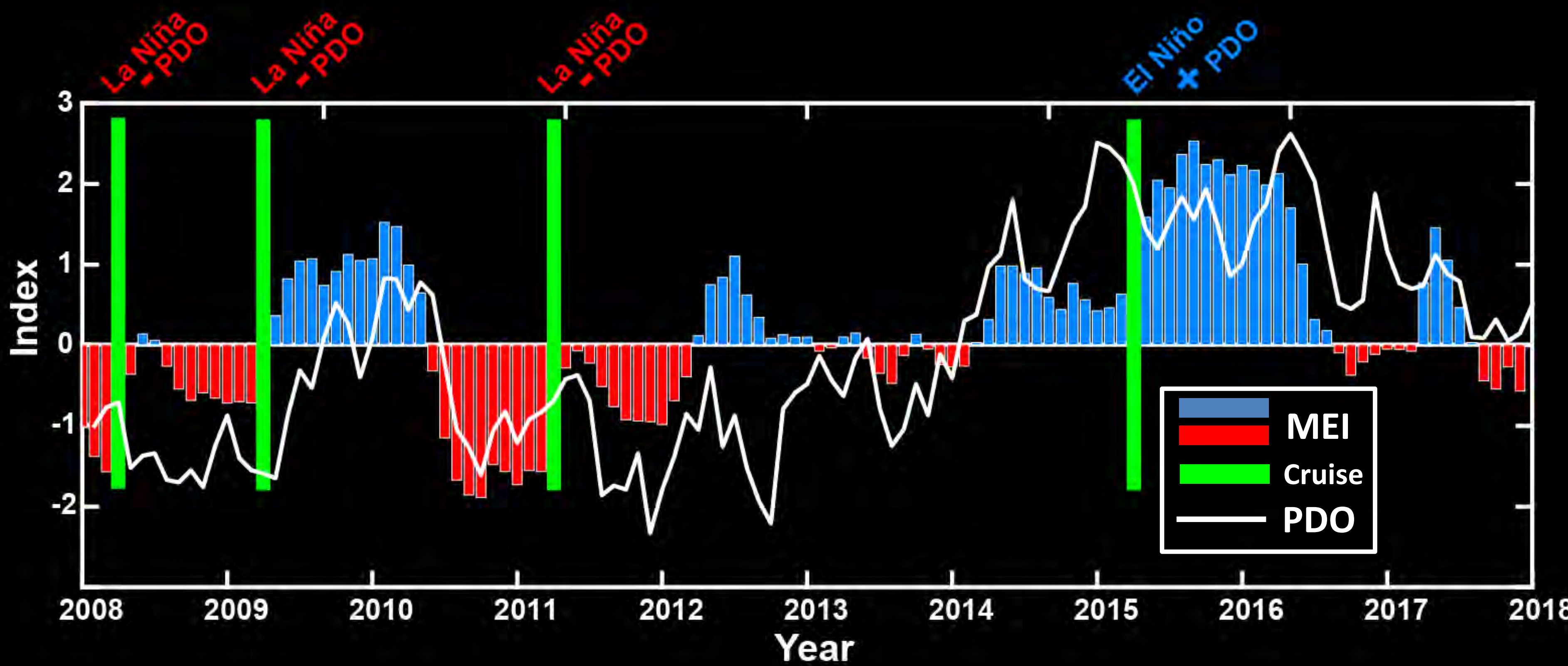


- Four cruises along 158/9°W during Mar-Apr 2008, 2009, 2011, 2015
  - 2008-2011 26°N-36°N, 158°W
  - 2015 26.5°N-32.5°N, 159°W
- Measured:
  - Physics (T,S)
  - Chemistry (N,P,Si,O)
  - Biology (Chl-*a*, HPLC pigments)

STF: Surface expression (0–20 m) of the 17–18 C isotherms

TZCF: Surface expression (0–20 m) of 0.15–0.25 mg m3 chlorophyll-a isopleths

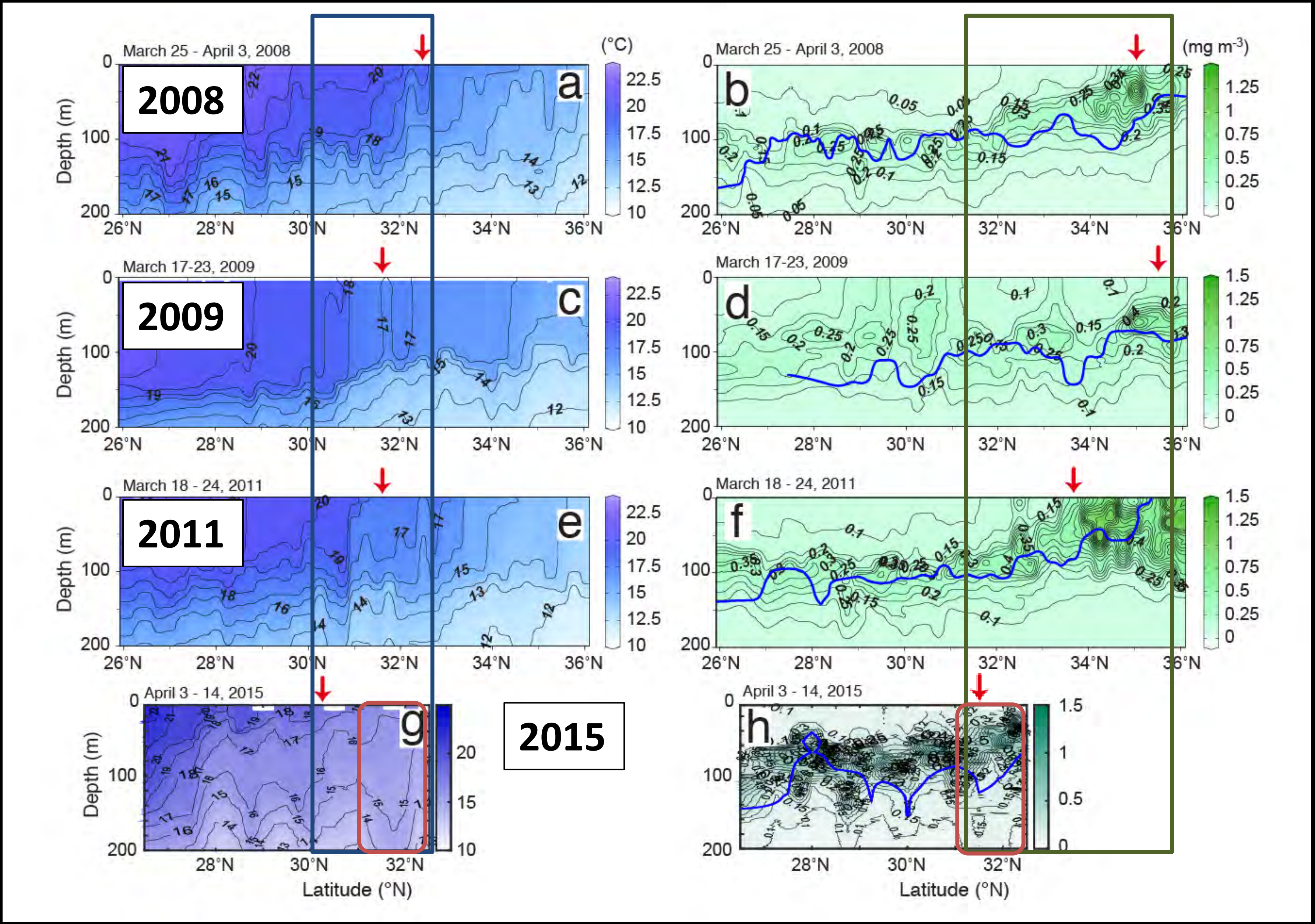
NPTZ Interannual Variability



Mean effects of variability in North Pacific:

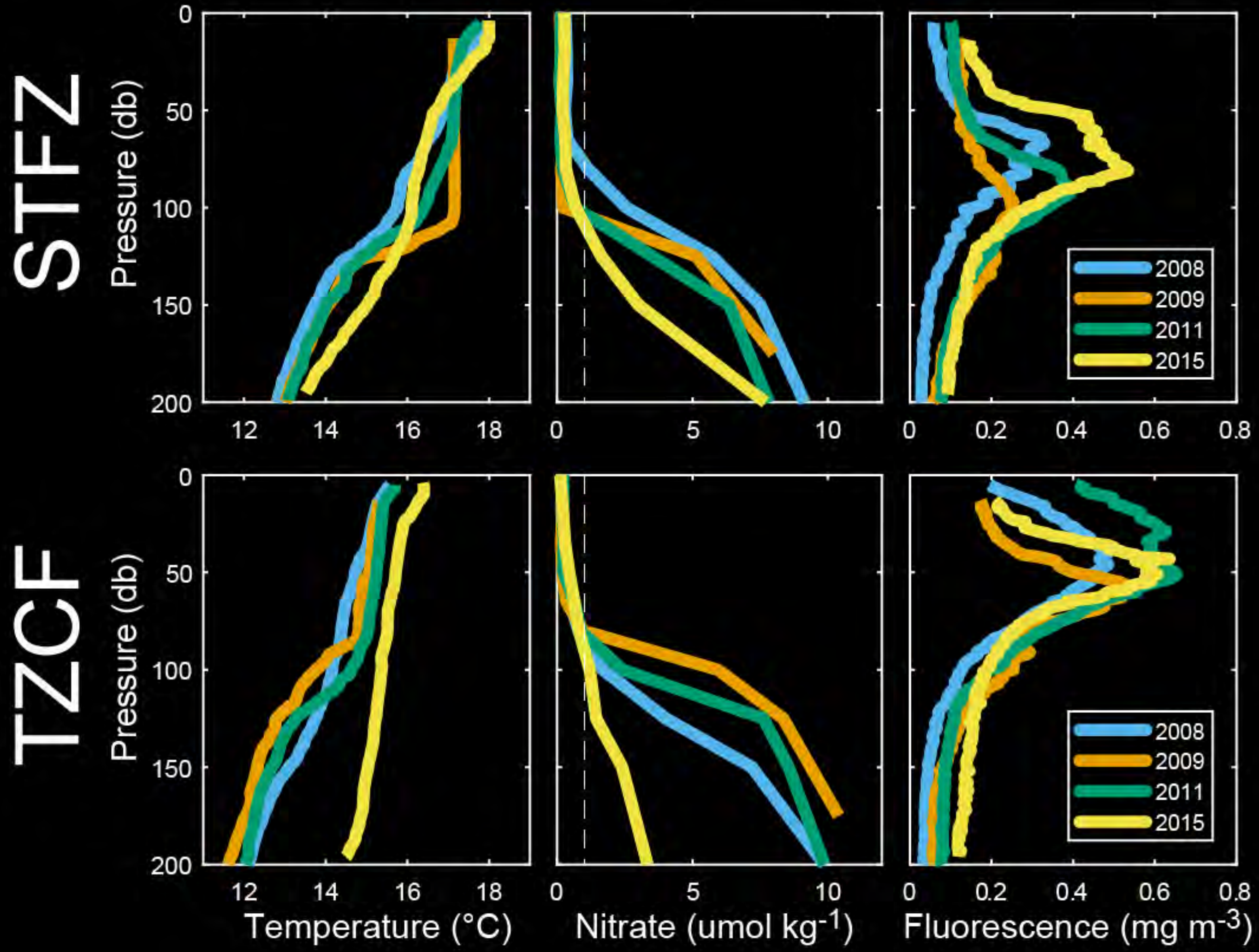
- El Niño/Positive PDO = Increased winds, southern STF and TZCF
- La Niña/Negative PDO = Decreased winds, northern STF and TZCF

In Situ Cruise Transects



Subsurface T, NO_3, Chl-*a* Variability

- Subsurface variability in all parameters across both zone and year



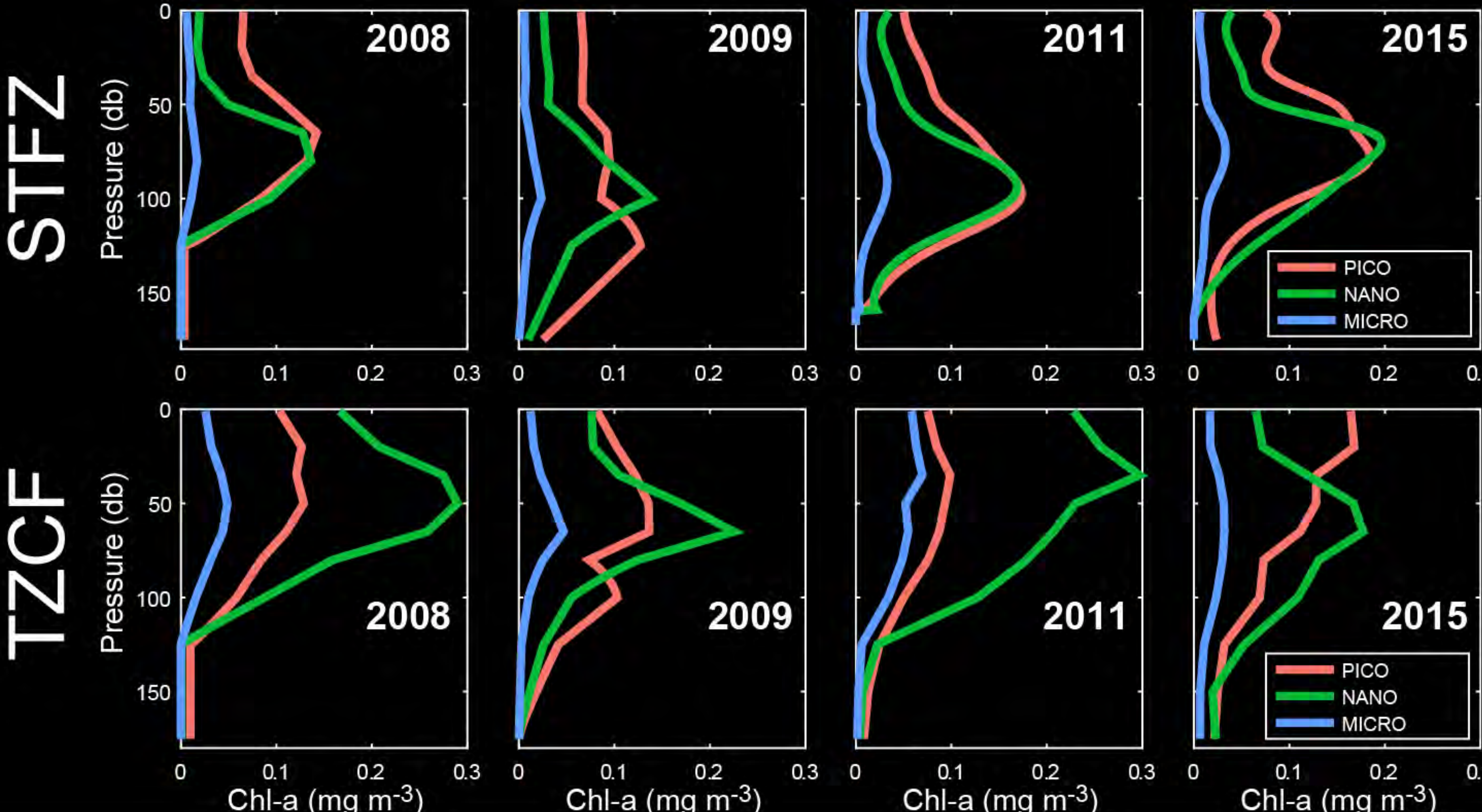
Phytoplankton Functional Type and Class

- Phytoplankton chloropigments measured using HPLC
- Phytoplankton functional type (PFT) and size classes (PSC) calculated from chloropigments following Vidussi *et al*. 2001; Hirata *et al.* 2011

PFT	Diagnostic Pigments	Estimation formula	PSC
Diatoms	Fucoxanthin (Fuco)	1.41[Fuco]	microplankton
Dinoflagellates	Peridinin (Perid)	1.41[Perid]	microplankton
Prymnesiophytes (coccolithophores)	19'-hexanoyloxyfucoxanthin (Hex-fuco)	1.27[Hex-fuco]	nanoplankton
Pelagophytes (chromophytes and nanoflagellates)	19'-butanoyloxyfucoxanthin (But-fuco)	0.35[But-fuco]	nanoplankton
Cryptophytes	Alloxanthin (Allox)	0.60[Allox]	nanoplankton
Green algae (green flagellates and prochlorophytes)	Total chlorophyll *b* (TChlb)	1.01[TChlb]	picoplankton
Prokaryotes (cyanobacteria and prochlorophytes)	Zeaxanthin (Zeax)	0.86[Zeax]	picoplankton

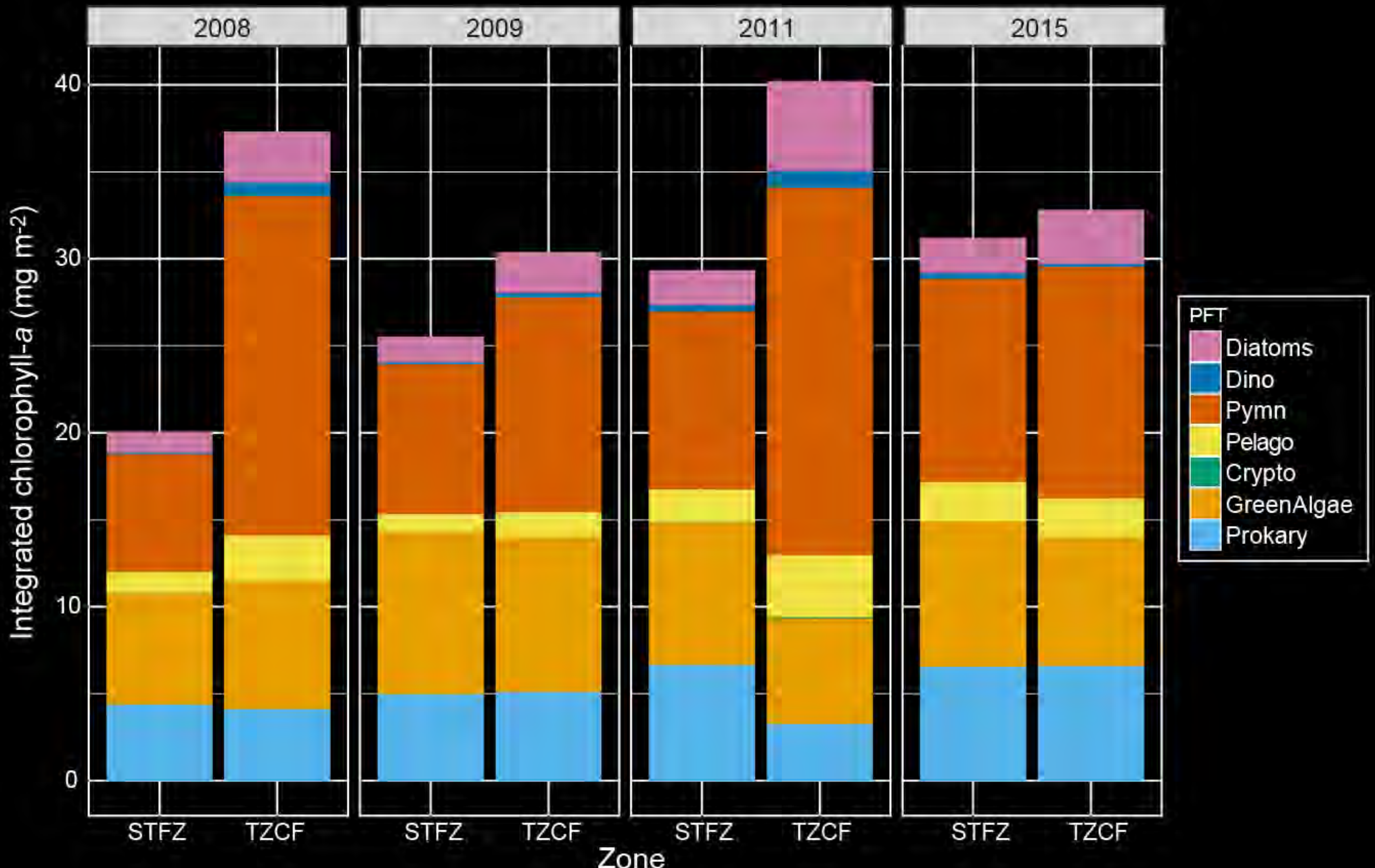
Phytoplankton Size Class (PSC) Variability

- STF equal pico and nano phytoplankton
- TZCF has shallower DCM with more nanophytoplankton in 2008 + 2011



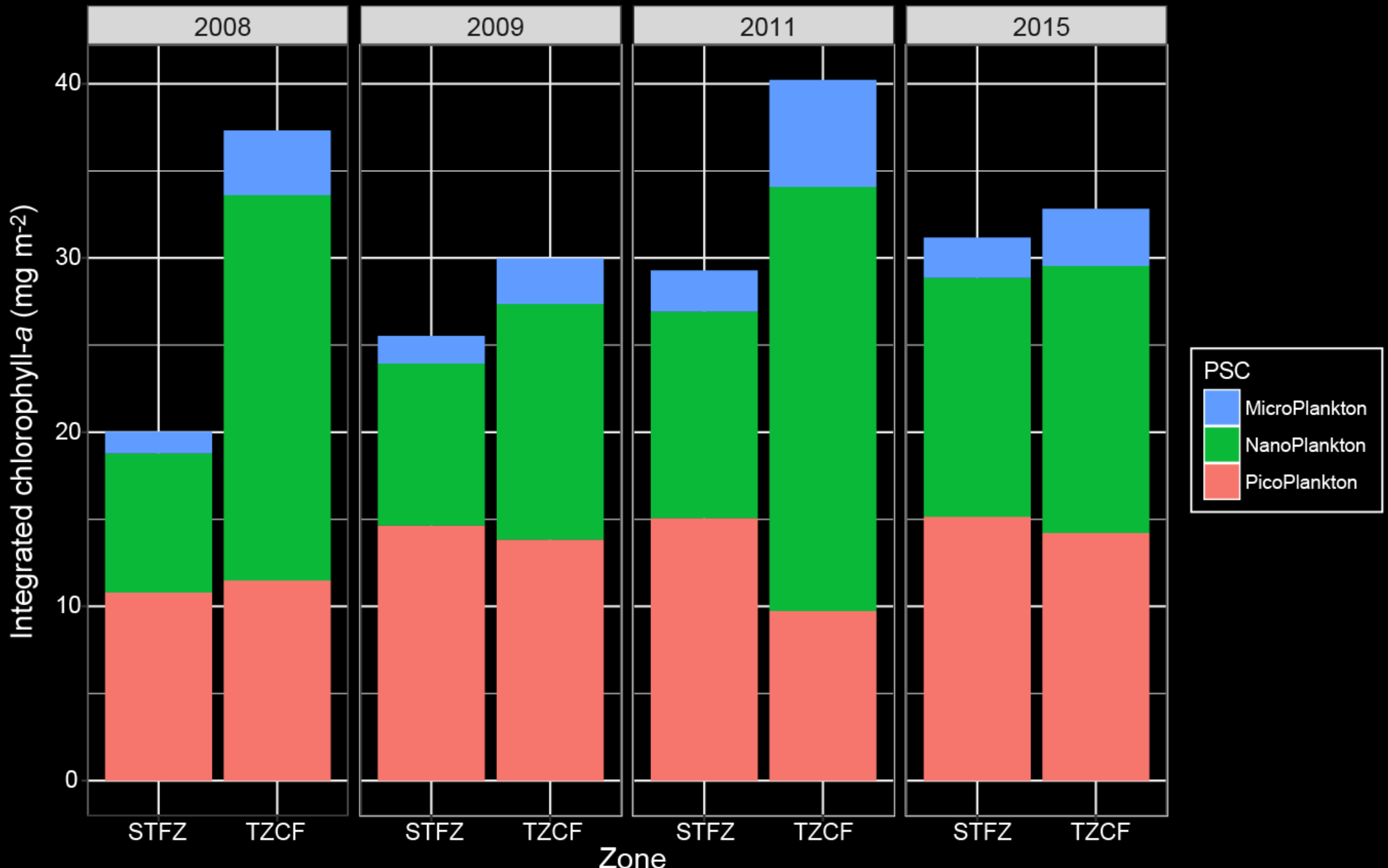
Integrated (0-160m) PFT Variability

- Subsurface variability in all parameters across both zone and year



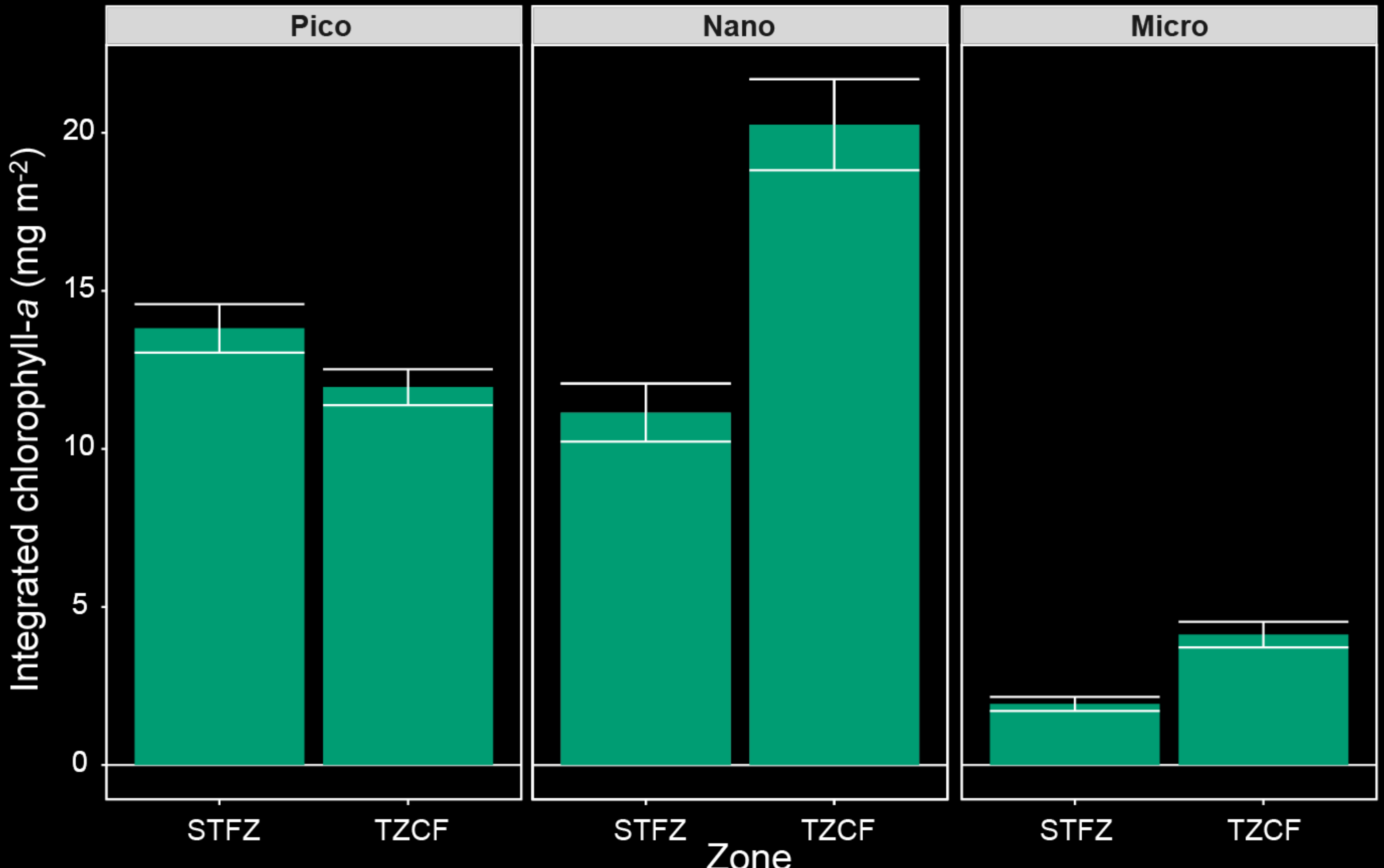
Integrated (0-160m) PSC Variability

- Subsurface variability in all parameters across both zone and yea
- More variance in TZCF between years



Integrated Total Chlorophyll-*a* Variability

- Significant differences in all three groups between frontal zones
- Greater variability between zones in nano and microphytoplankton



ANOVA Year x Zone x PSC on 0-160 Chl-*a*

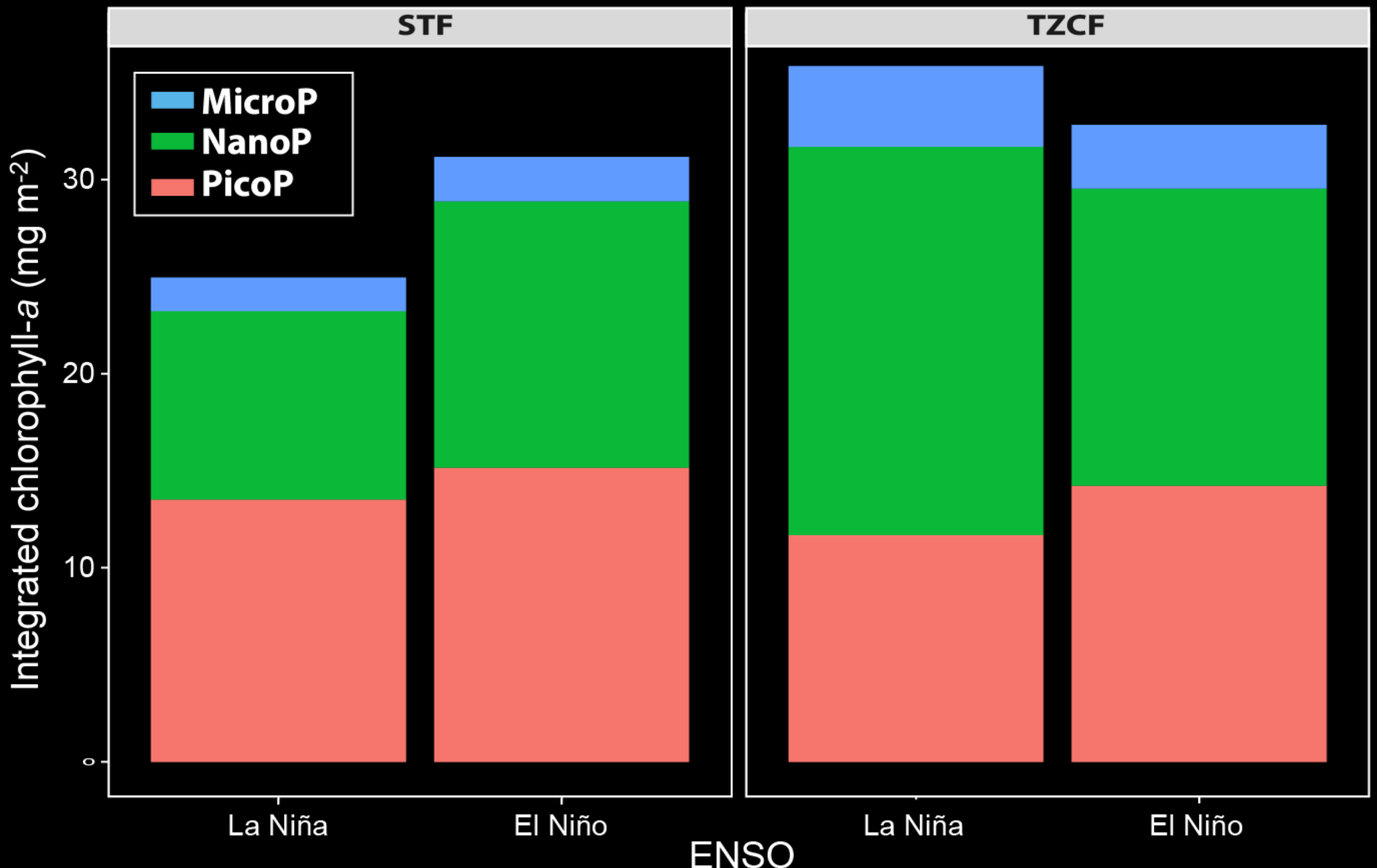
- Strongest variability across Phytoplankton size classes
- Significant variability also across Zone and Zone x PSC interaction term

Source	**df**	**SS**	**F**	***p***	**sig. factor**
Zone x PSC	**2**	**96.2**	**5.859**	**0.01**	*****
Year x PSC	2	2	0.124	0.88	N.S.
Residuals	14	114.9			
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ N.S.					

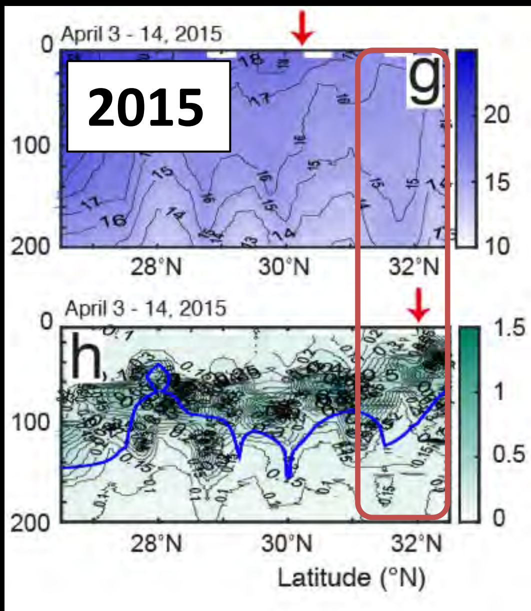
What about 2015 El Niño?

Integrated Total Chlorophyll-*a* Variability

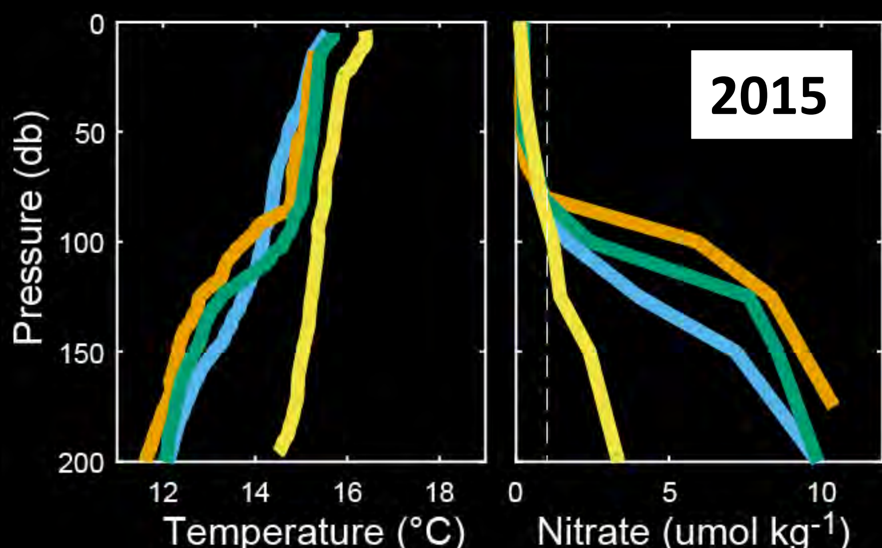
- TZCF during 2015 El Niño has lower Chl-*a* signal than expected

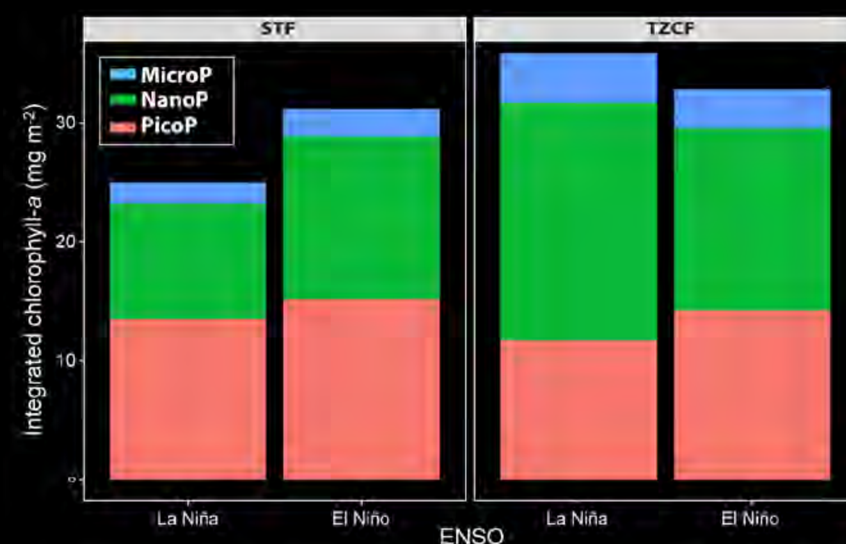


Why was 2015 lower than expected?



- STF moved ~1° south, TZCF ~2-3°
- Warm core meander/eddy at TZCF
- Observed warmer T, lower NO3
- Increased southern advection, less vertical upwelling
- More recycled pico, less new nano





Summary

- Interannual PP variability at both STF and TZCF
- This variability in size class composition will have impacts on energy transfer at frontal system
- Can generalize persistent size class differences at fronts over time
- El Niño event interesting:
  - 2015 TZCF had lower nitrate, micro and nanophytoplankton
  - Possibly due to mesoscale eddy meandering and decreased vertical mixing
- Additional El Niño year sampling and expanded northern range will provide important information