Warm Blob effects on NE Pacific phytoplankton

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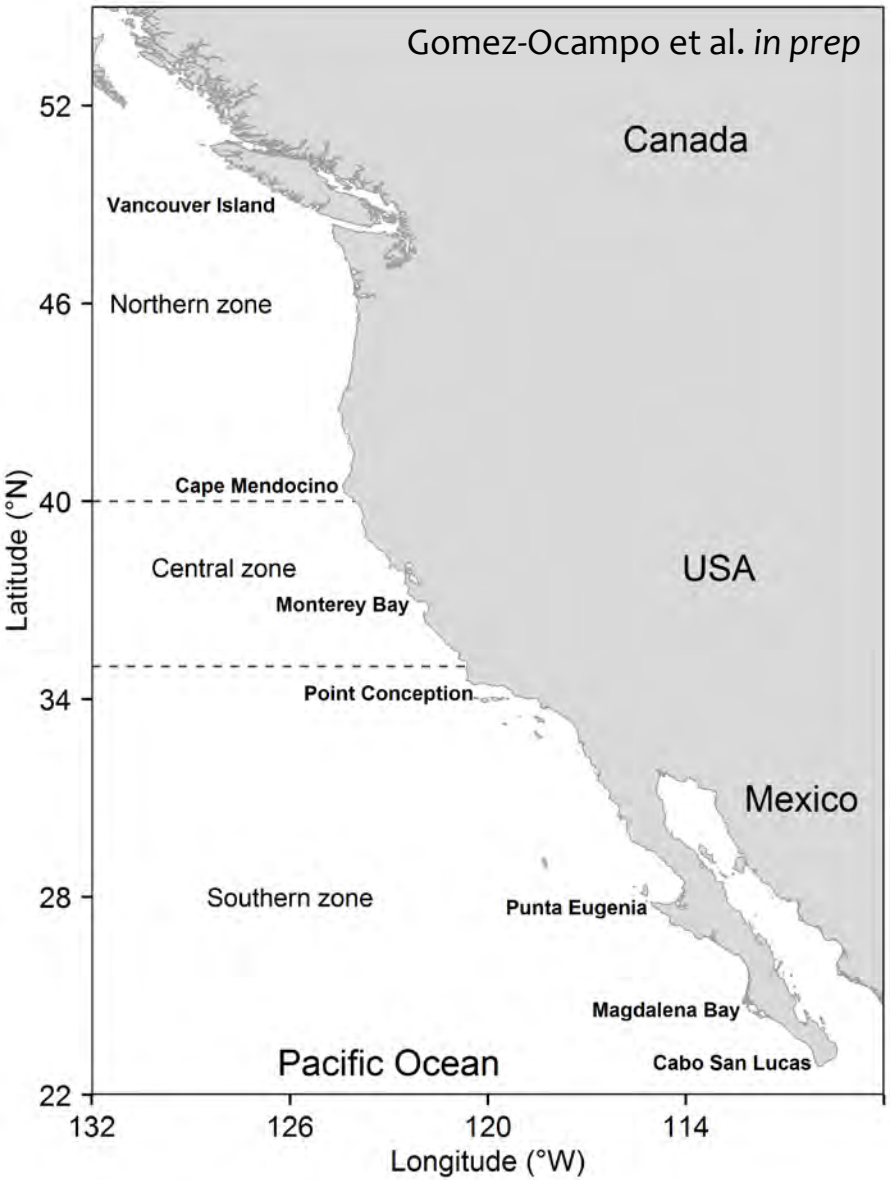
California Current System (CCS)



Located in the eastern limb of the large-scale, anticyclonic North Pacific gyre.

It extends from British Columbia to southward of Baja California (Lynn and Simpson, 1987).

It is forced by large-scale winds associated with:

the North Pacific High
the Aleutian Low
the thermal low-pressure system (from central California to northern Mexico)
Checkley and Barth, (2009)

CCS affected by large-scale events

Delay in upwelling 2005

Anomalous SubArctic Water intrusion 2002

Pacific Decadal Oscillation (PDO)

North Pacific Gyre Oscillation (NPGO)

El Niño Southern Oscillation

Positive and high SST anomalies from boreal winter 2013-2014 until now.

Lower than normal rates of the loss of heat from the ocean to the atmosphere and of relatively weak cold advection in the upper ocean *Bond* et al. (2015)

How was the effect of the warm anomalies on phytoplankton production and biomass in CCS?

Methods

Weekly → Monthly
25 km x 25 km
ADT
2003-2014

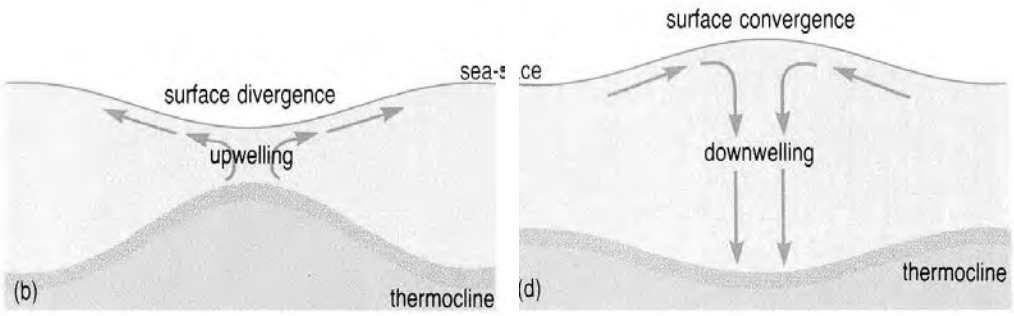
4 km AVHRR Pathfinder Project

Monthly
4 km x 4 km
PP_{mod} (VGPM)
2003-2012

ERDDAP
Easier access to scientific data

MODIS
Moderate Resolution Imaging Spectroradiometer

Monthly
4 km x 4 km
SST & CHL
2003-2014



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Data processing & Statistical Analysis

Generalized Additive models GAMs

R Studio → $PP_{\text{mod}} = s(ADT)$ → $PP_{predicted} = s(ADT)$

For the analysis we chose August 2014 because the anomalies were the highest

Results

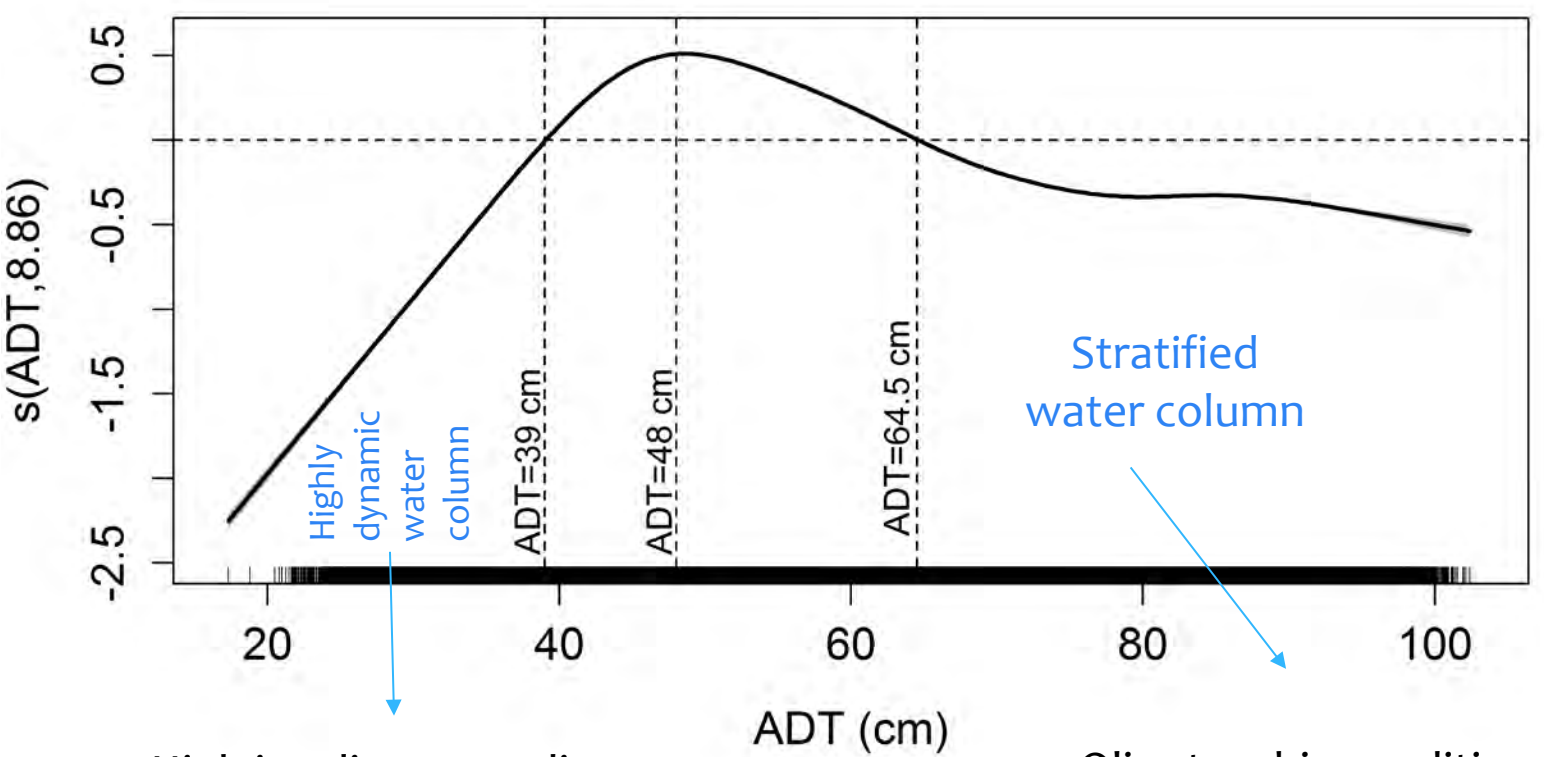
Smoothing spline

Time averaged (2003-2014) August

Anomalies August 2014

Tendencies 2003 to 2014

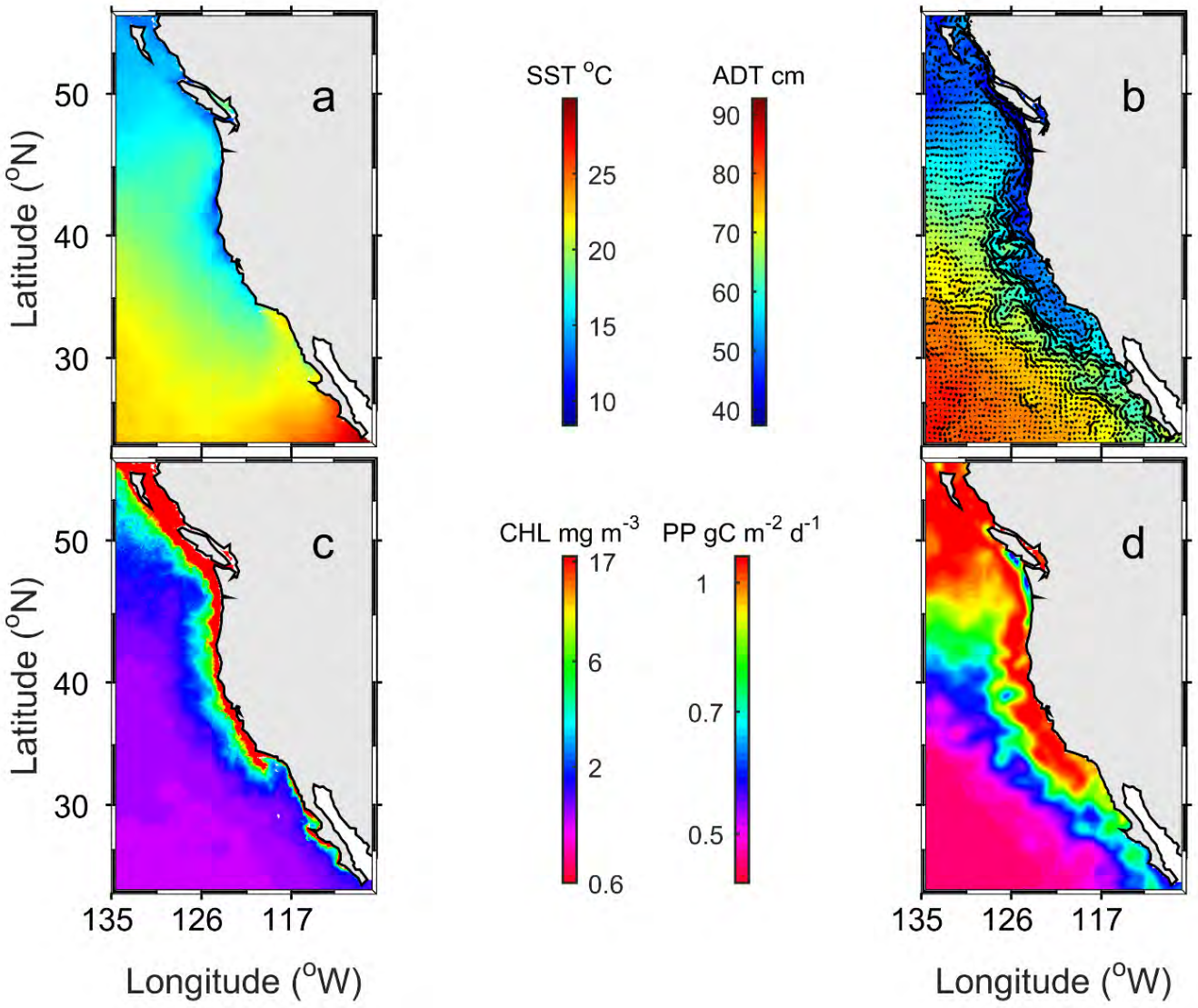
Smoothing spline



High irradiance gradient
Turbulent environment

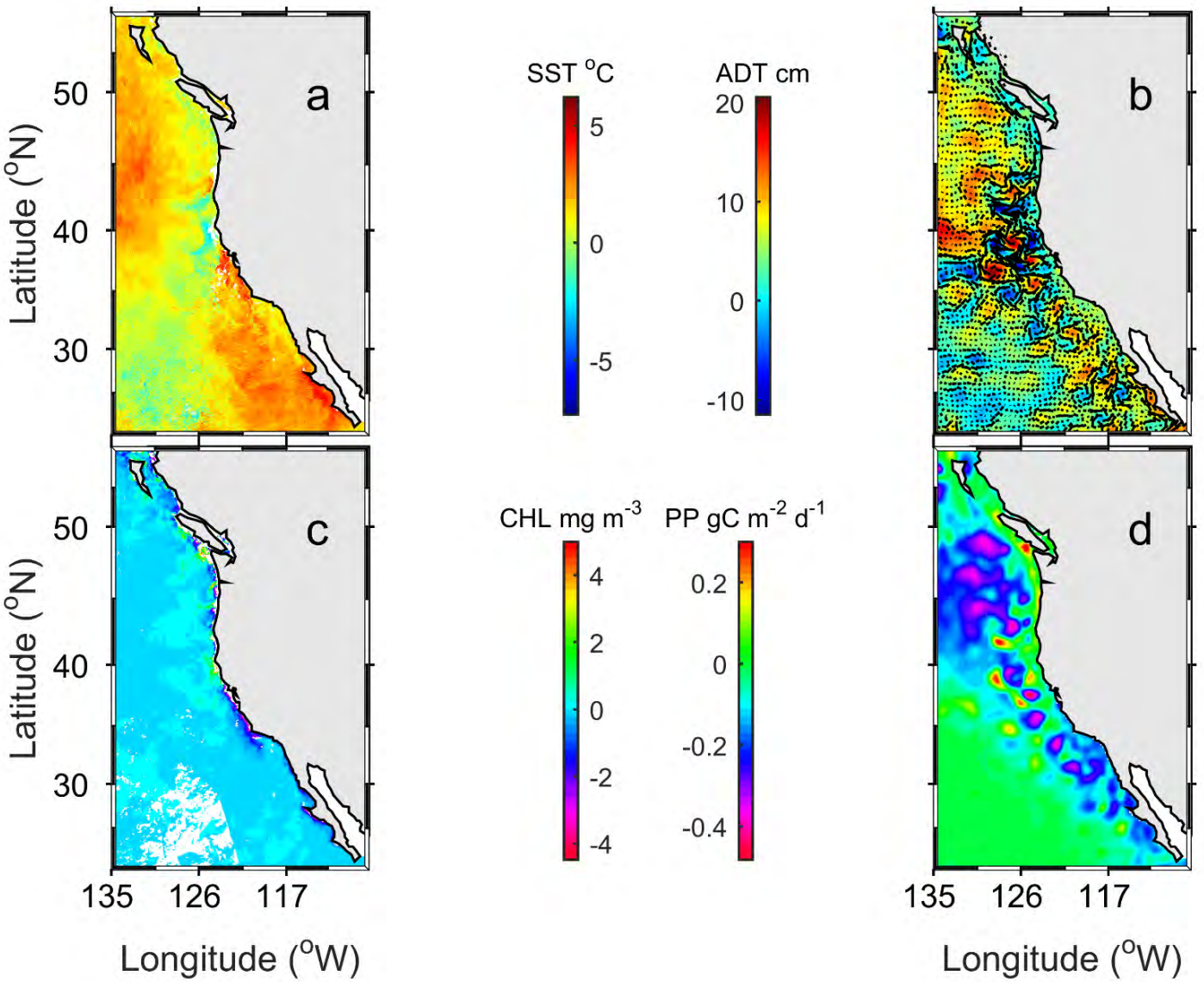
Oligotrophic conditions

Time-averaged (2003-2014) August

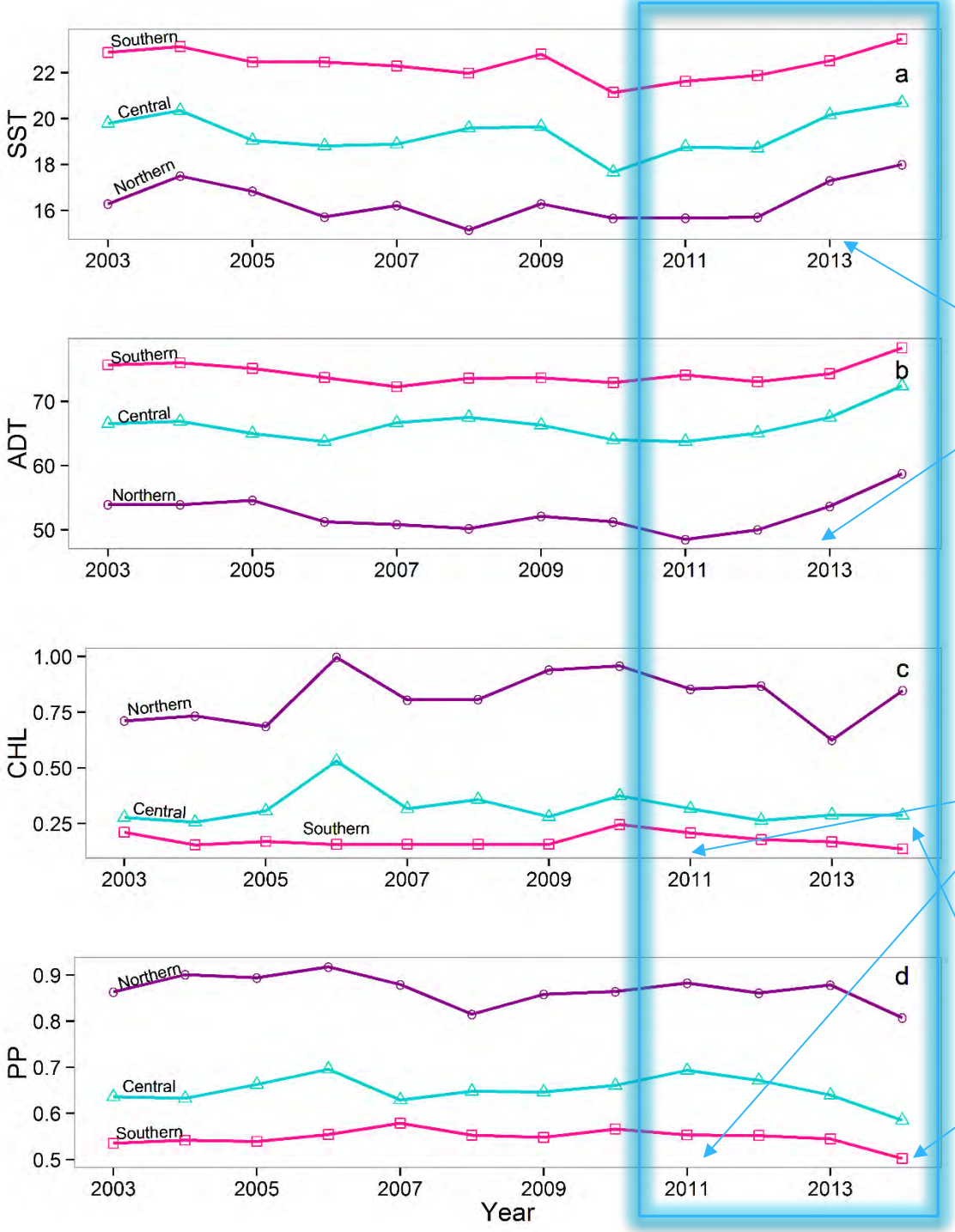


August 2014 anomalies

ADT differences of 20 cm mean ~ 50 m thermocline deepening



Tendencies



SST anomalies were reported from winter 2013-2014 to 2015 in NE Pacific [*Bond et al.*, 2015]

The CalCOFI program reported since 2011 the reduction of the standing stock.

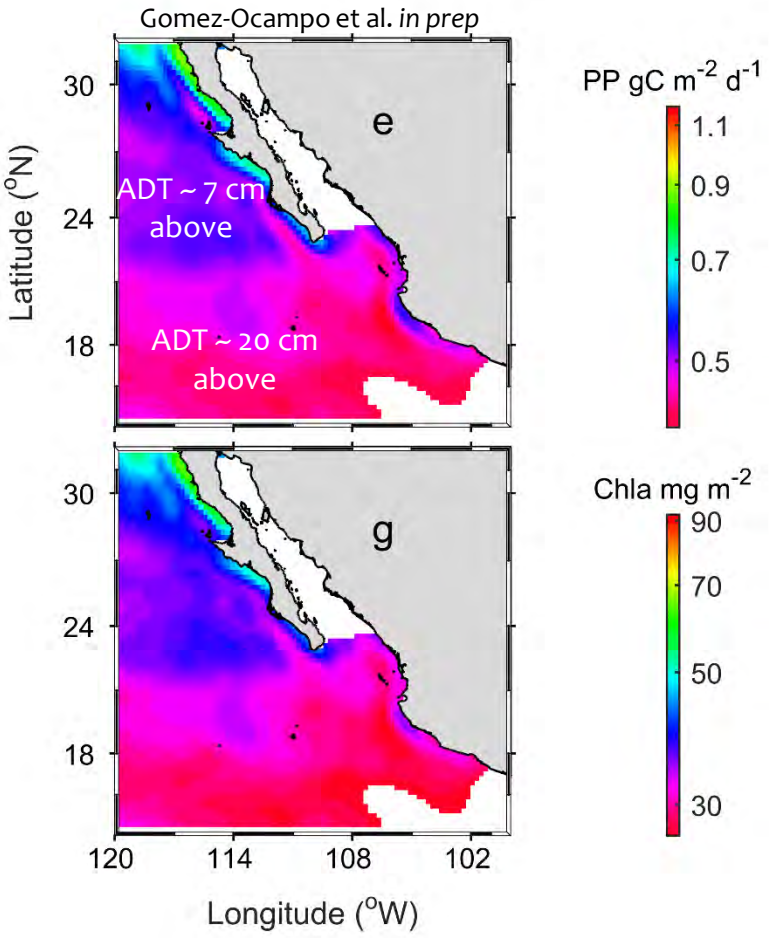
In 2014:
2% less than landed in 2013
1% less than landed in 2012
36% less than landed in 2000

Remaining questions

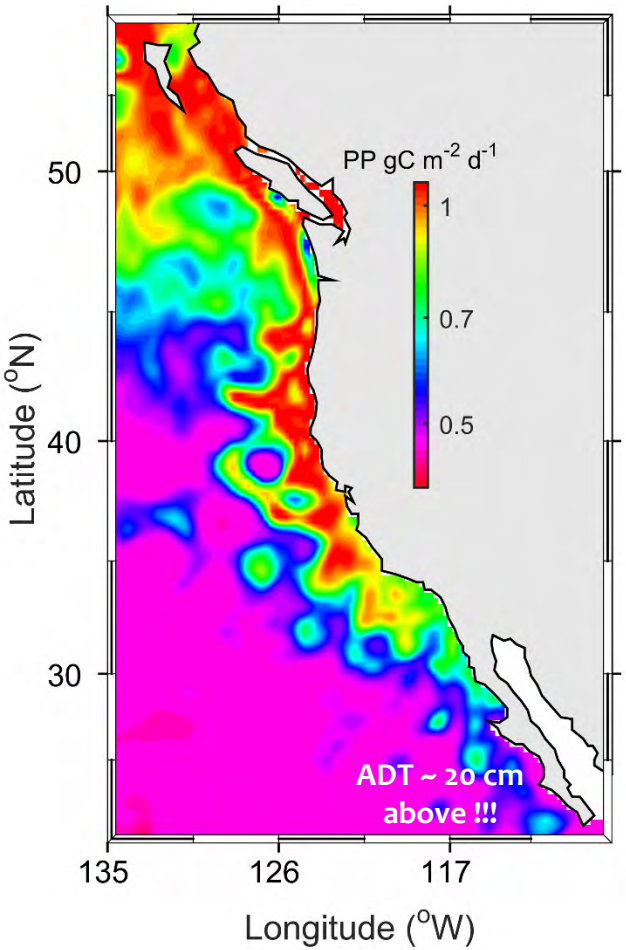
- What did happen from 2011 to 2013?
- Does the central zone recover in the next year?
- Will be the southern zone the last in recovering?
- Is the decline trend in phytoplankton because Warm Blob? O maybe El Niño influence?... or both?

How will be the PP in 2015-2016, if since 2014 there was low PP?

August 1997- El Niño



August 2014- Warm Blob



$$PP = \beta_0 + s(ADT) + (EkP) + \varepsilon$$

$$PP = \beta_0 + s(ADT) + \varepsilon$$

Conclusions

- The sea surface temperature anomalies during 2014 impacted negatively to California Current marine ecosystem.

- Although, the production and phytoplankton biomass declined in the last four years, the forcing mechanisms driving the decreasing tendency remain unclear.

- The statistical estimations about the thresholds in what the physical driver impacts positively or negatively the phytoplankton, will be a well-suited tool for ecologist to predict the changes in marine ecosystems.

Acknowledgements

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¡¡GRACIAS!!
謝意
THANK YOU!
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