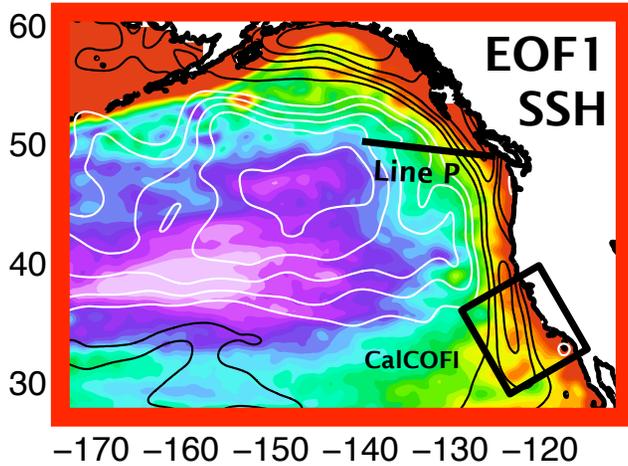


1 Northeast Pacific Physical-Biological Variability

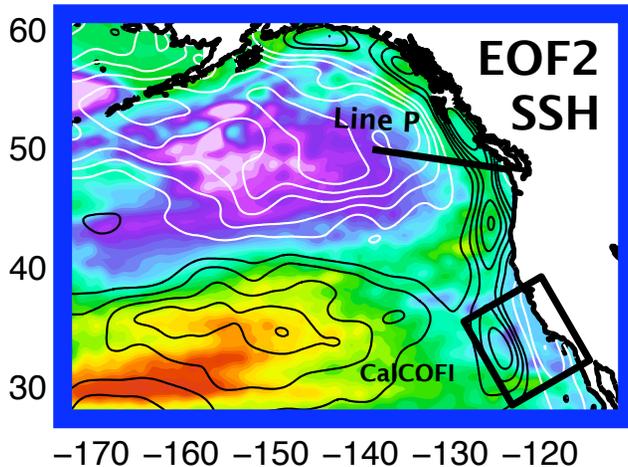
PDO mode

Pacific Decadal Oscillation (PDO)

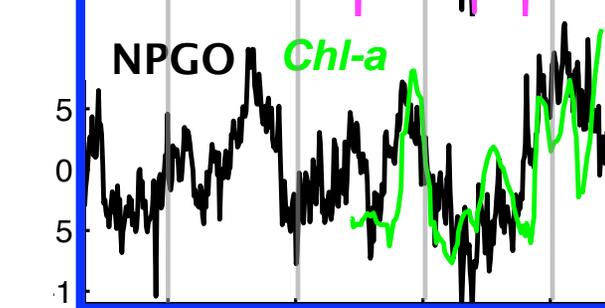
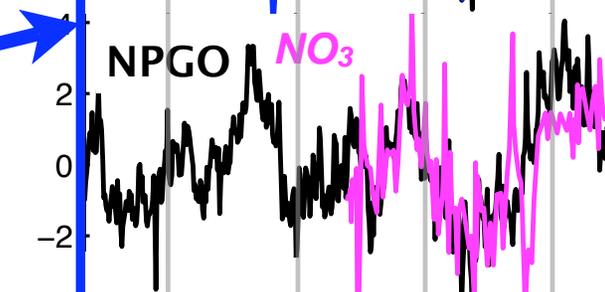
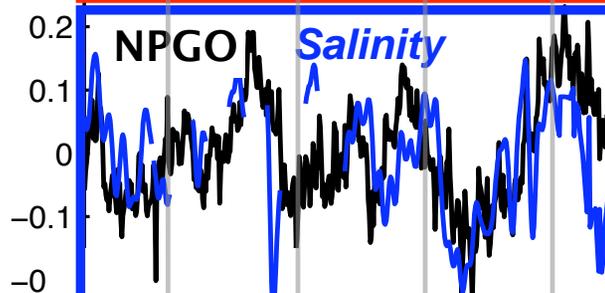
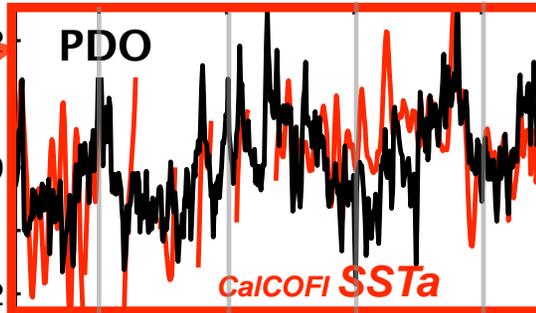


NPGO Mode

North Pacific Gyre Oscillation (NPGO)

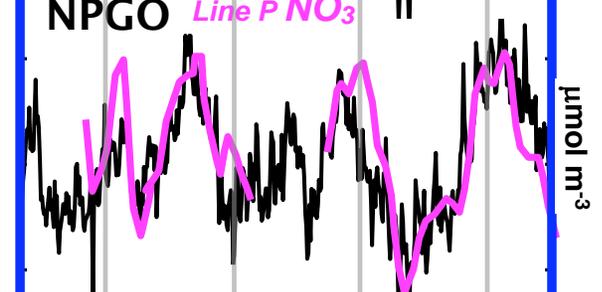
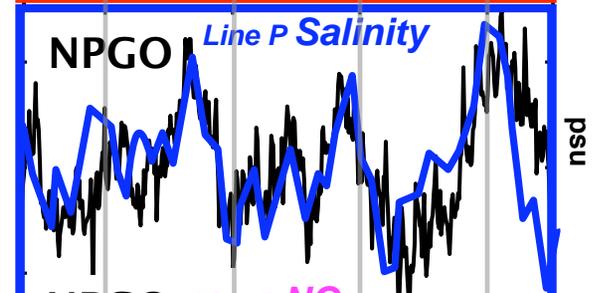
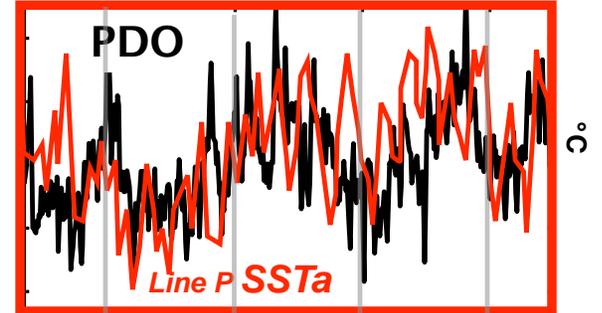


2 California Current CalCOFI Observations



1970 1980 1990 2000

3 Gulf of Alaska Line P Observations

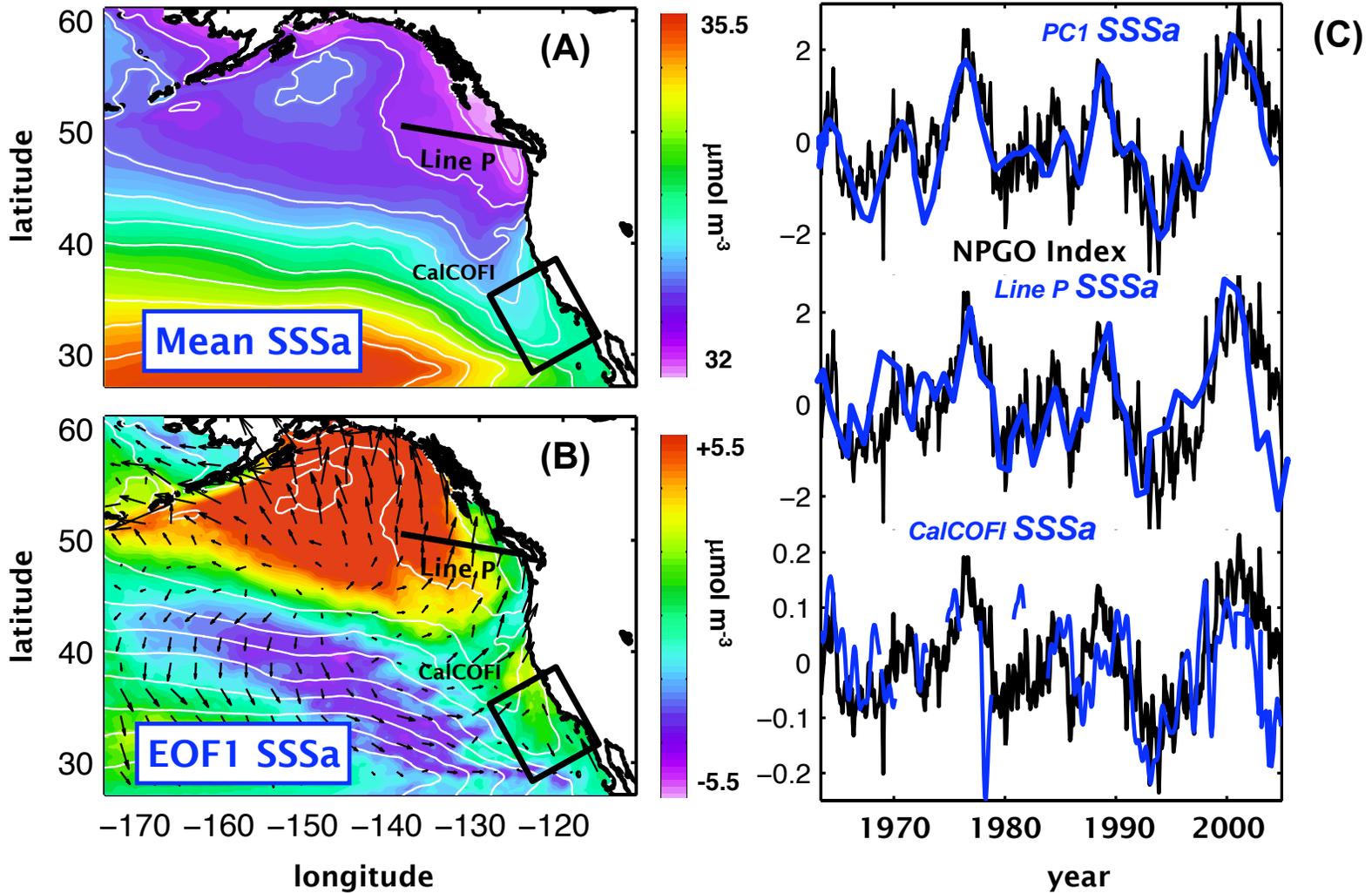


1970 1980 1990 2000
year

Di Lorenzo et al., GRL 2008.

Coherent variations of salinity in the Northeast Pacific

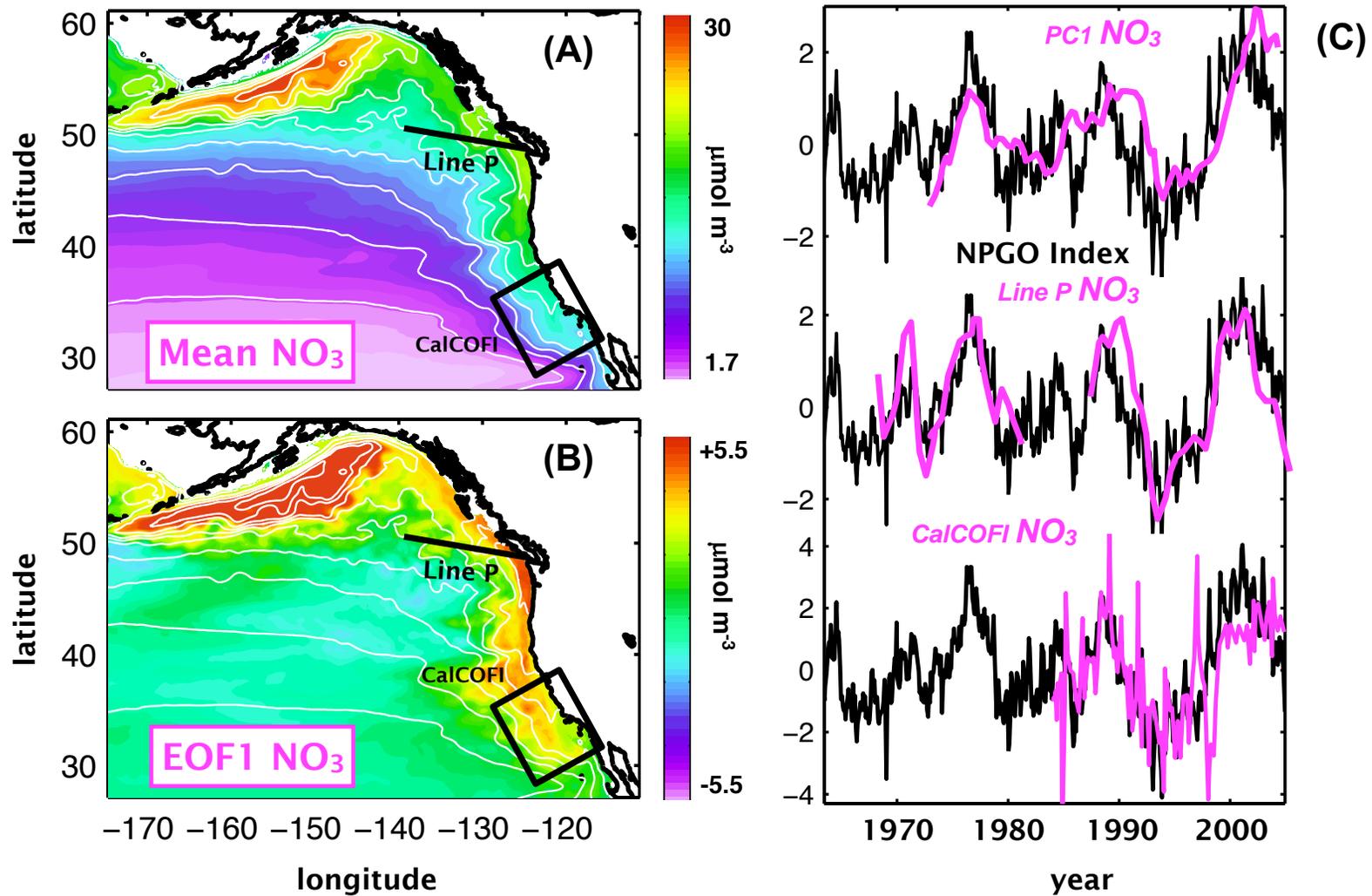
(spatial maps is from ROMS model hindcast)



Di Lorenzo et al., in prep.

Coherent variations of nutrients in the Northeast Pacific

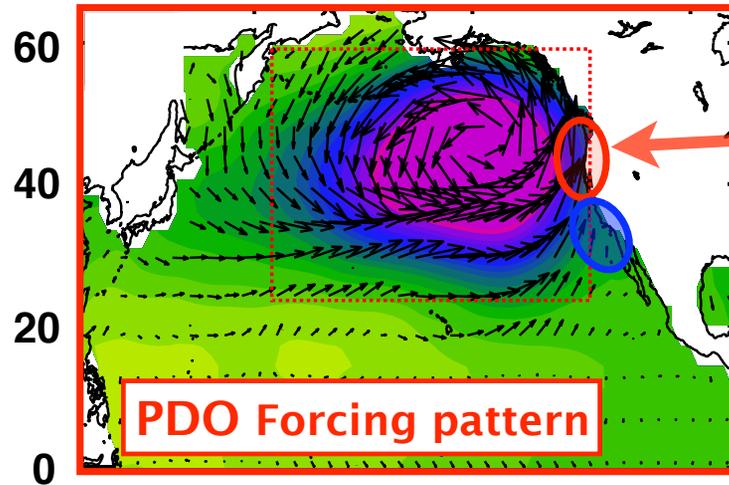
(spatial maps is from ROMS model hindcast)



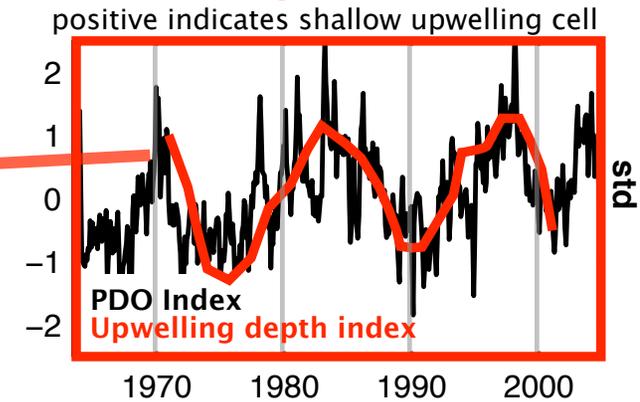
Di Lorenzo et al., in prep.

The atmospheric forcing of the PDO and NPGO drive different responses in coastal upwelling

1 Sea Level Pressure and Wind Vector Anomalies during PDO positive phase

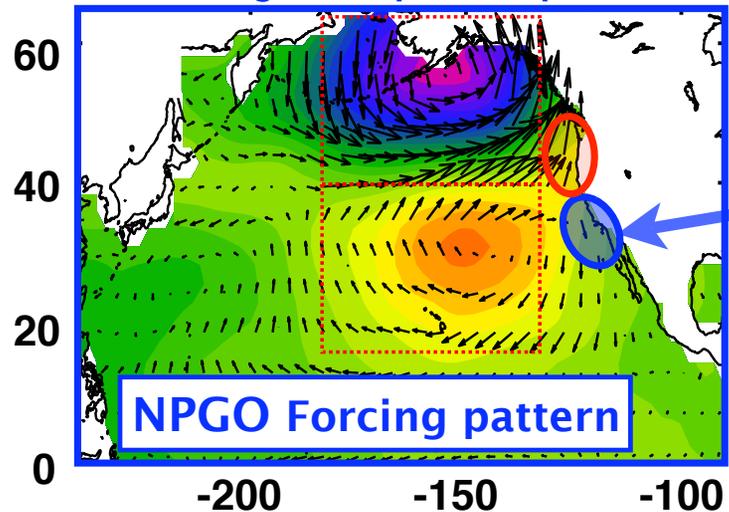


2 Upwelling depth index

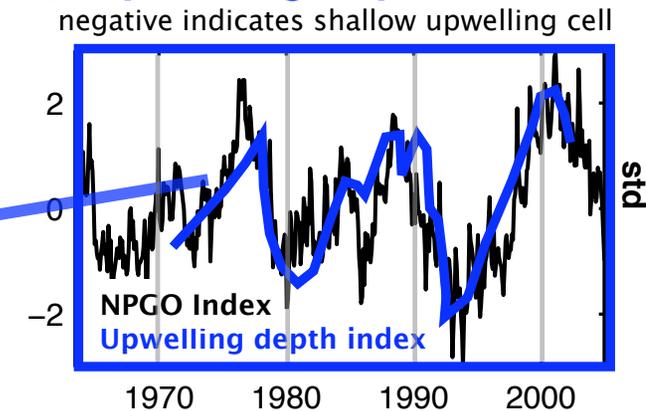


Chhak and Di Lorenzo, 2007

3 Sea Level Pressure and Wind Vector Anomaly during NPGO positive phase



4 Upwelling depth index

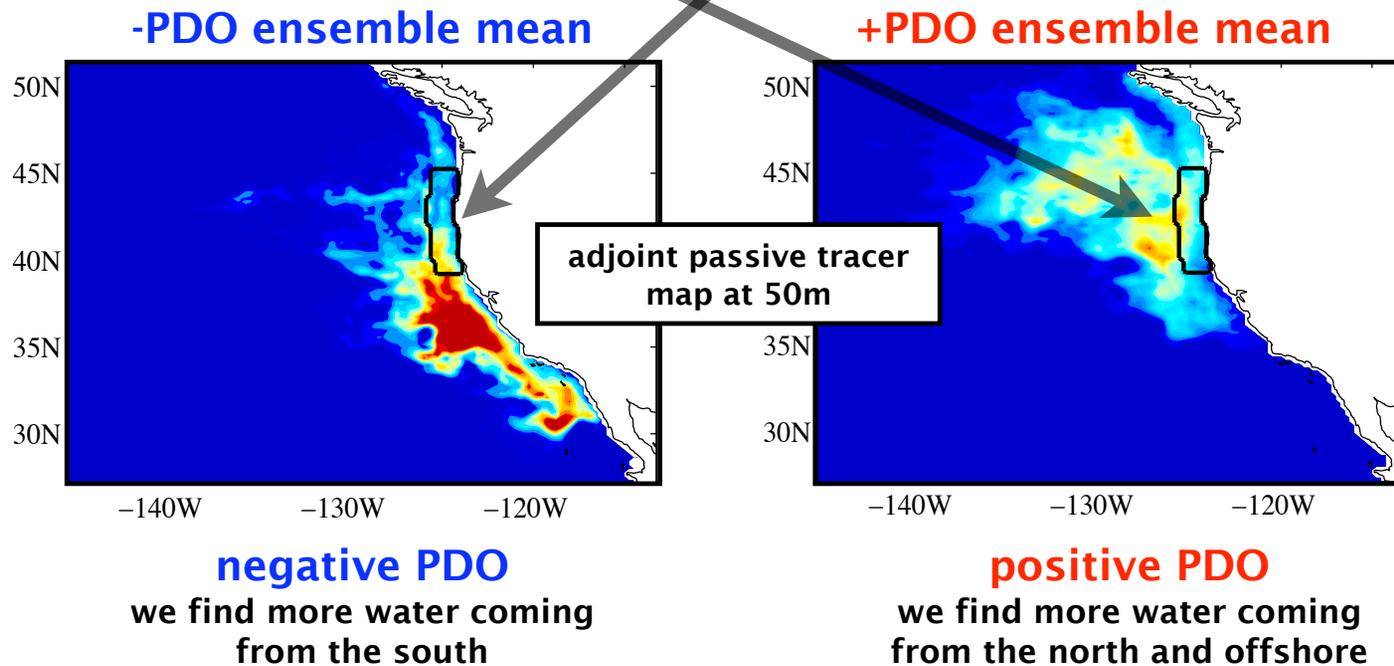


Chhak and Di Lorenzo, in prep.

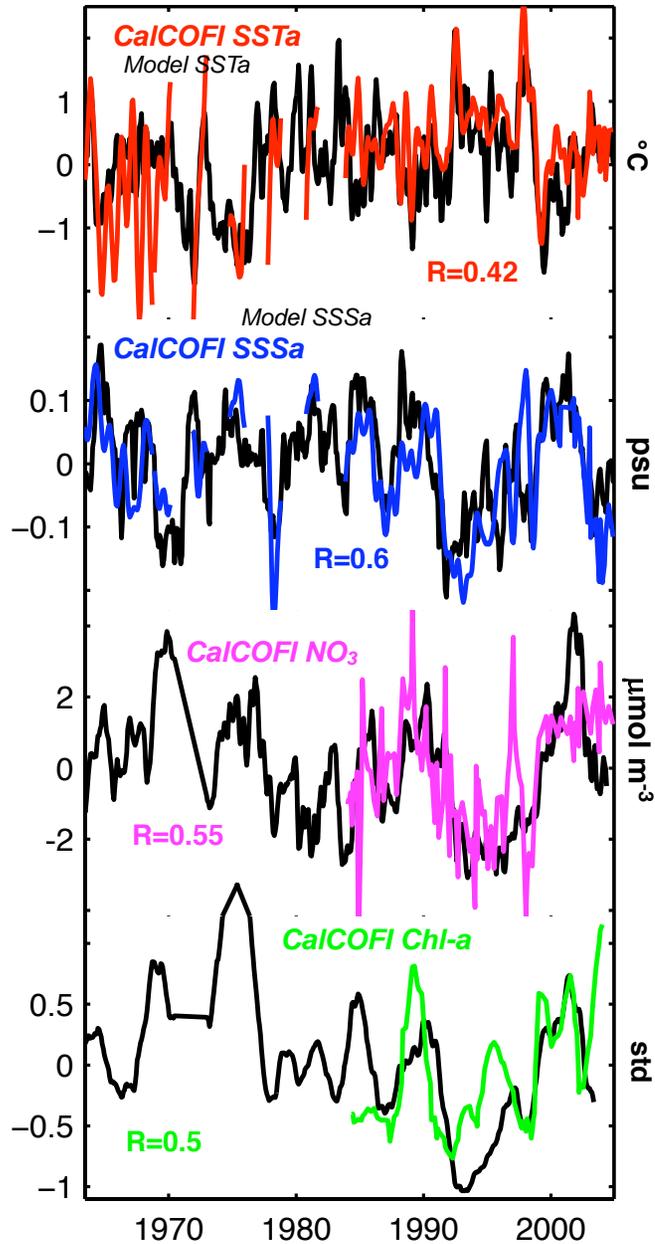
An inverse approach to track changes in upwelling during the **negative** and **positive** phase of PDO

1 QUESTION:
where do the upwelled water at the coast come from during different phases of PDO?

2 METHOD:
inject passive tracer at the upwelling location and track it backwards in time with *ROMS-Adjoint*

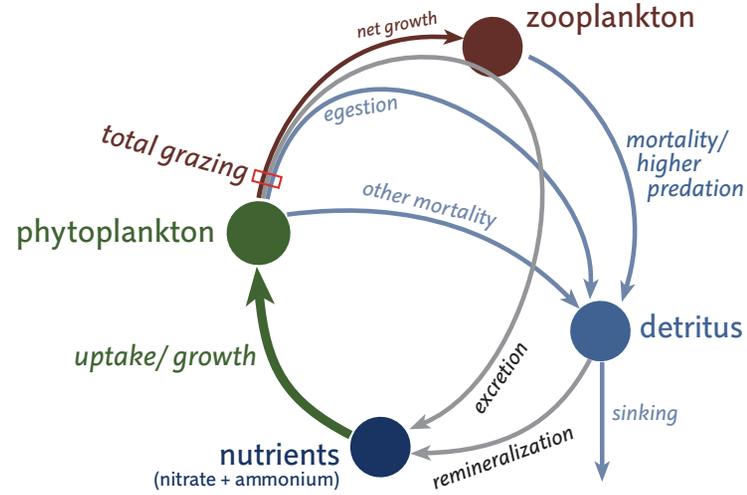


Model Hindcast of the CalCOFI Observations



1 ROMS physical-biological modeling framework

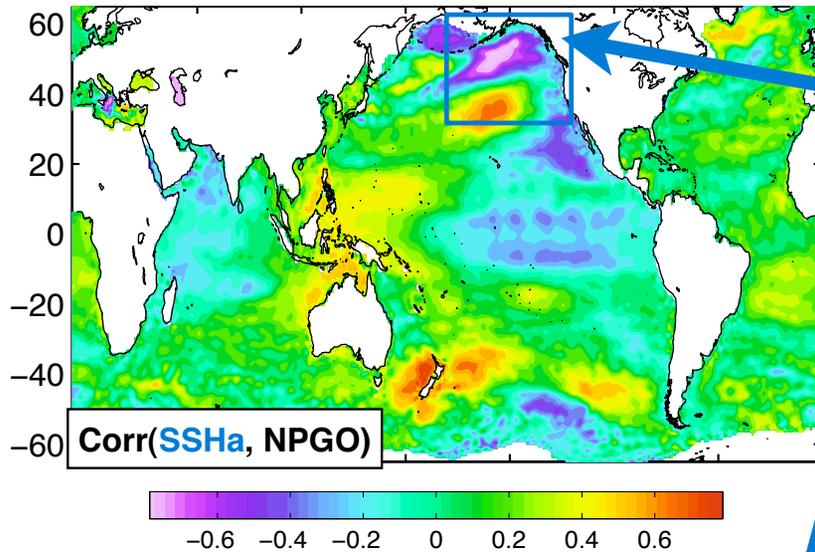
2 ROMS NPZD “simplistic” model



sketch courtesy of Neil Banas

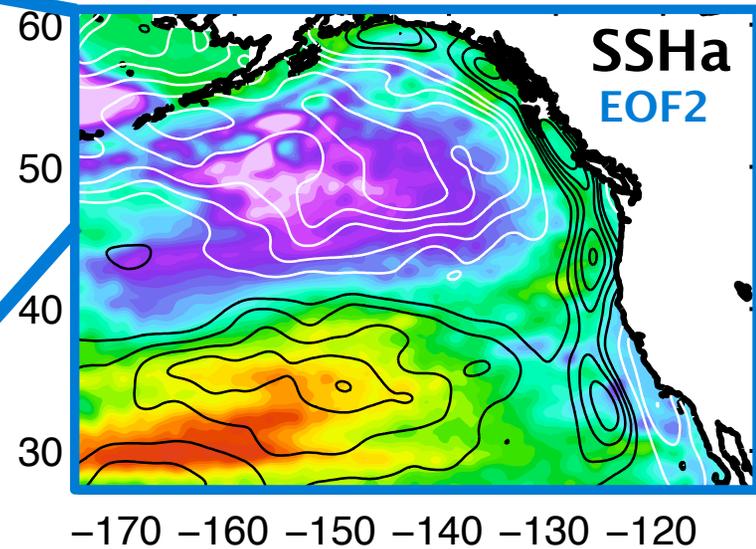
Di Lorenzo et al., 2008, GRL

North Pacific Gyre Oscillation (NPGO) pattern in Satellite SSHa

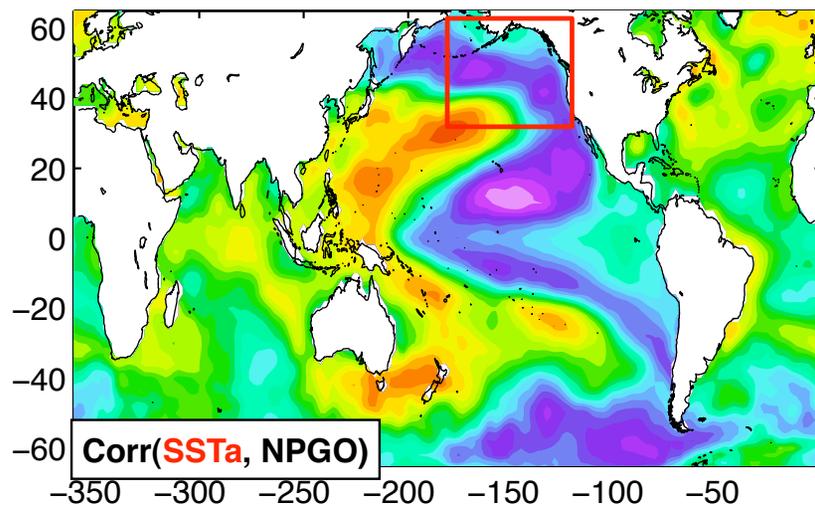


NPGO Mode

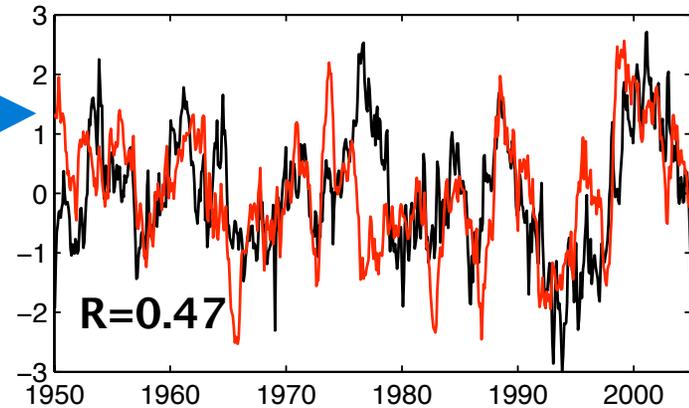
defined: as 2nd EOF of SSHa
in the Northeast Pacific



NPGO pattern in Global SSTa

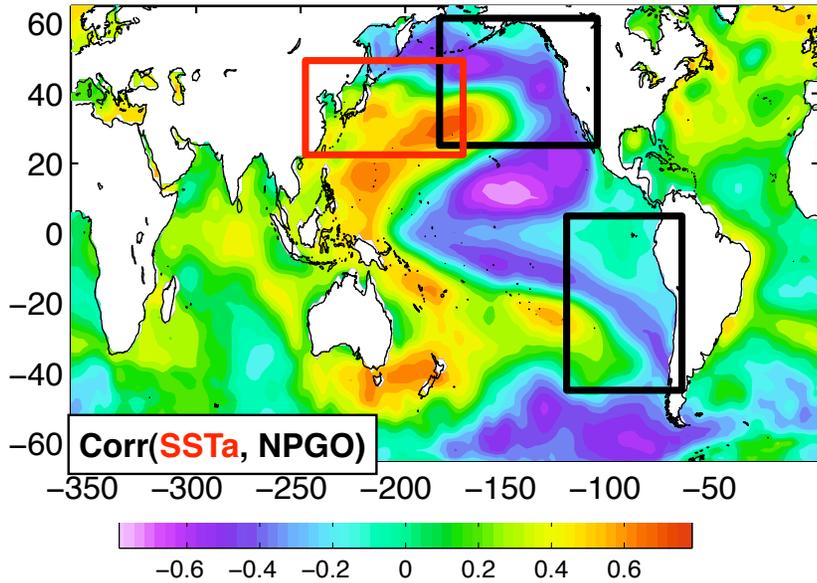


PC2 Pacific SSTa NPGO Index

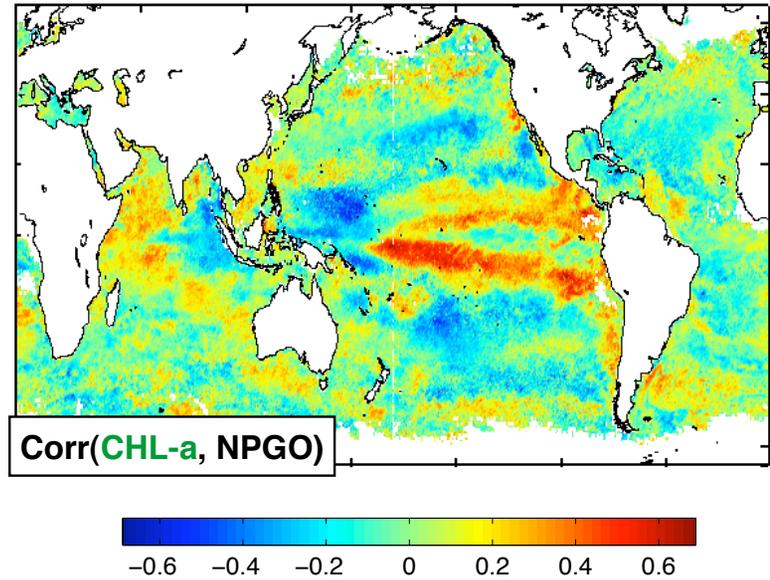


1 Large-scale climate mode in the **PHYSICS**

NPGO pattern in Global SSTa



2 ECOSYSTEM footprint of climate mode
NPGO pattern in SeaWiFS CHL-a

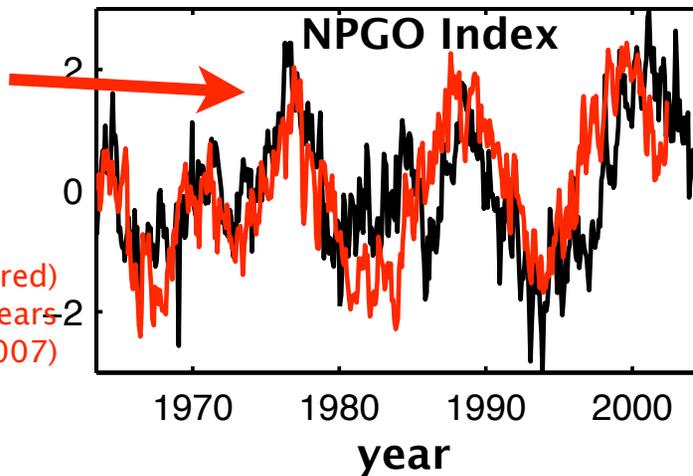


3 Phase lag response in the Western Boundary

Changes in strength of the Kuroshio lag changes in the Eastern Boundary

Plotted is KOE Zonal Mode (red) lagged by 3 years (Taguchi et al. 2007)

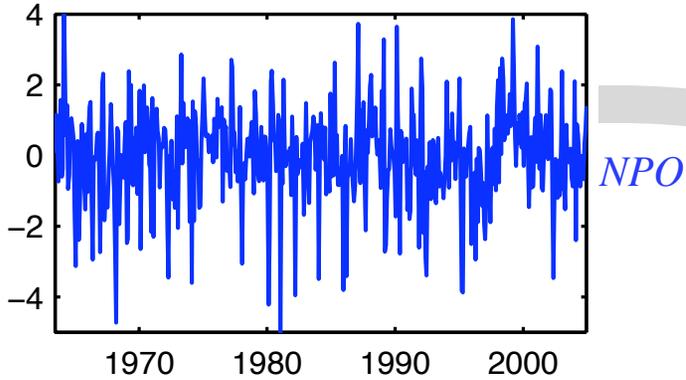
KOE Zonal Mode



Di Lorenzo et al., in prep.

1

North Pacific Oscillation Index (NPO)
Sea Level Pressure mode

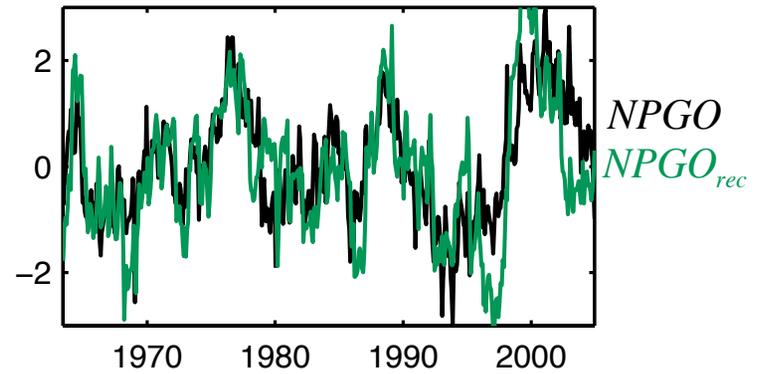


CENTRAL/WESTERN
North Pacific

Atmosphere forces
the ocean SSHa

2

North Pacific Gyre Oscillation Index (NPGO)
Central/Eastern North Pacific SSHa mode

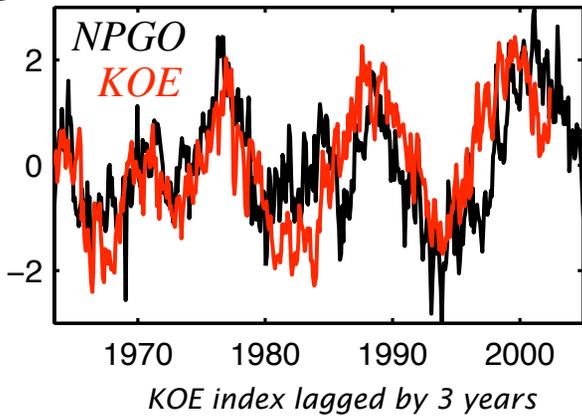


$$NPGO_{rec}(t+1) = \alpha NPGO_{rec}(t) + \gamma NPO(t) \cdot dt$$

Strength of Kuroshio Index (KOE Index) Taghucci et al. (2007)

3

Western North Pacific SSHa mode

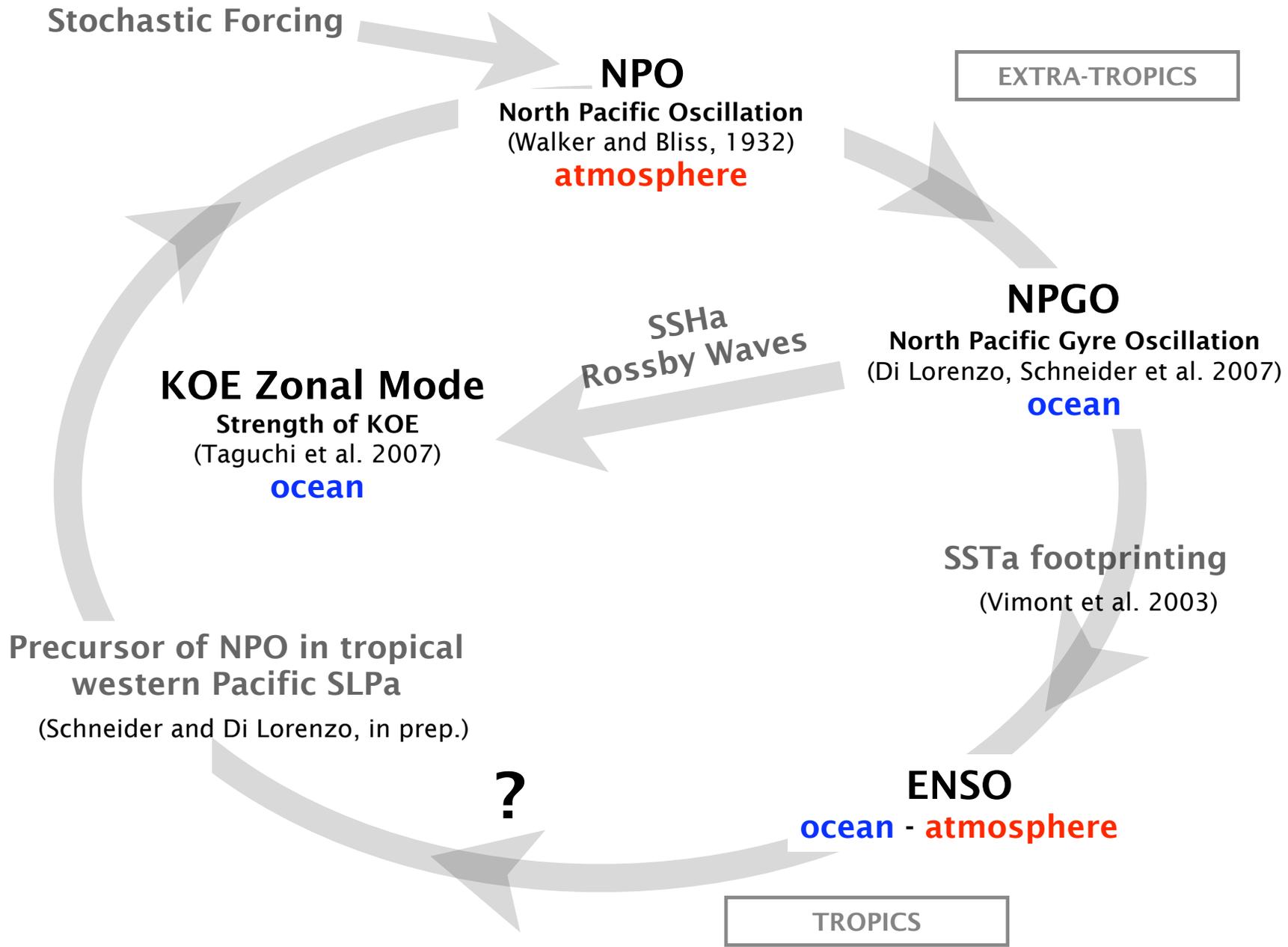


3-4 years later

ocean westward propagation
of SSHa affect western boundary

Di Lorenzo and Schneider, in prep.

WESTERN North Pacific



Stochastic Forcing

NPO

North Pacific Oscillation
(Walker and Bliss, 1932)
atmosphere

EXTRA-TROPICS

NPGO

North Pacific Gyre Oscillation
(Di Lorenzo, Schneider et al. 2007)
ocean

SSHa
Rossby Waves

KOE Zonal Mode
Strength of KOE
(Taguchi et al. 2007)
ocean

SSTa footprinting
(Vimont et al. 2003)

Precursor of NPO in tropical
western Pacific SLPa
(Schneider and Di Lorenzo, in prep.)

?

ENSO
ocean - atmosphere

TROPICS

Di Lorenzo and Schneider, in prep.