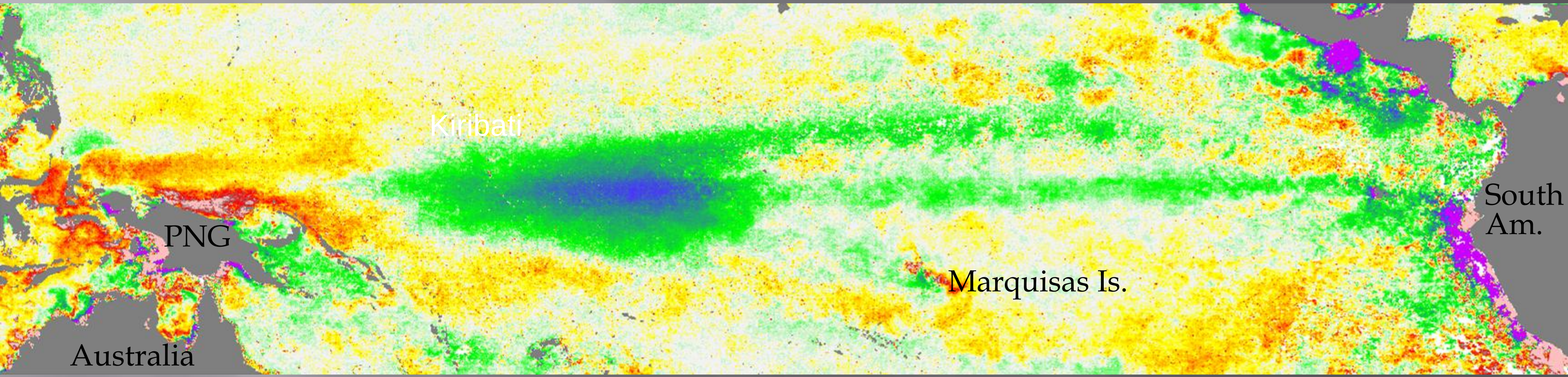
Surface chlorophyll patterns in the tropical Pacific during recent El Niño events. A multi-sensor analysis



SeaWiFS chlorophyll anomaly, December 2002

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Fabien Léger (CNES-LEGOS, Toulouse, France)
Awnesh Singh (The University of the South Pacific, Suva, Fiji)
Thierry Delcroix (IRD-LEGOS, Toulouse, France)

Radenac, Léger, Singh, and Delcroix, JGR, 2012

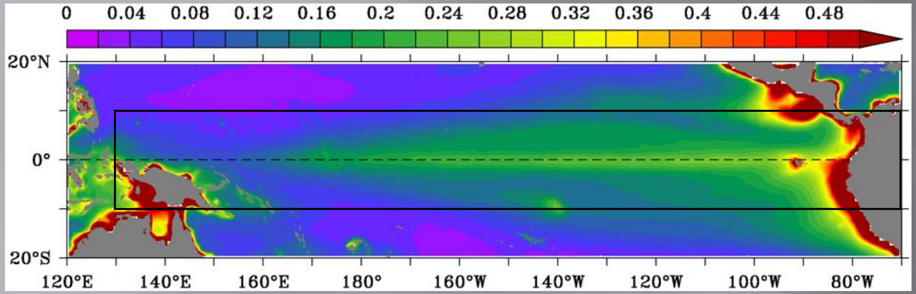
data

- SeaWiFS (& some MODIS) chlorophyll
  - September 1997-December 2010
    - monthly, 9 km × 9 km

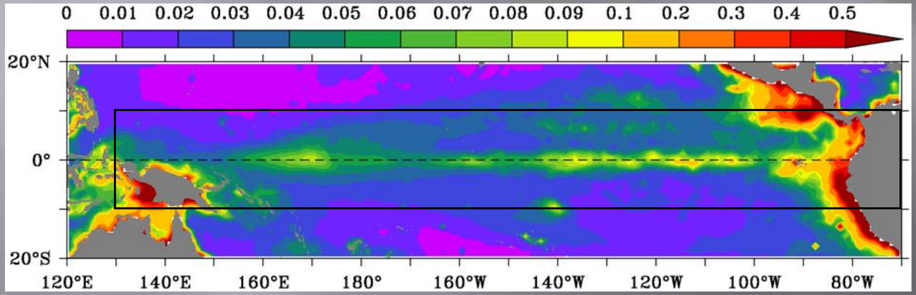
- TMI SST
  - since December 1997
  - weekly, 1/4° ×1/4°
- altimetric sea level
  - weekly, 1/3° ×1/3°
- OSCAR surface current
  - monthly, 1° ×1°
- ERS wind
  - August 1991-January 2001
  - weekly, 1° ×1°
- QuikSCAT wind
  - August 1999-November 2009
  - weekly, 1/2° ×1/2°

clustering method

mean chl (mg m^{-3})



std of interannual chl (mg m^{-3})



surface chlorophyll anomaly

SeaWiFS (+ 7 MODIS maps)

monthly, 1° × 1°

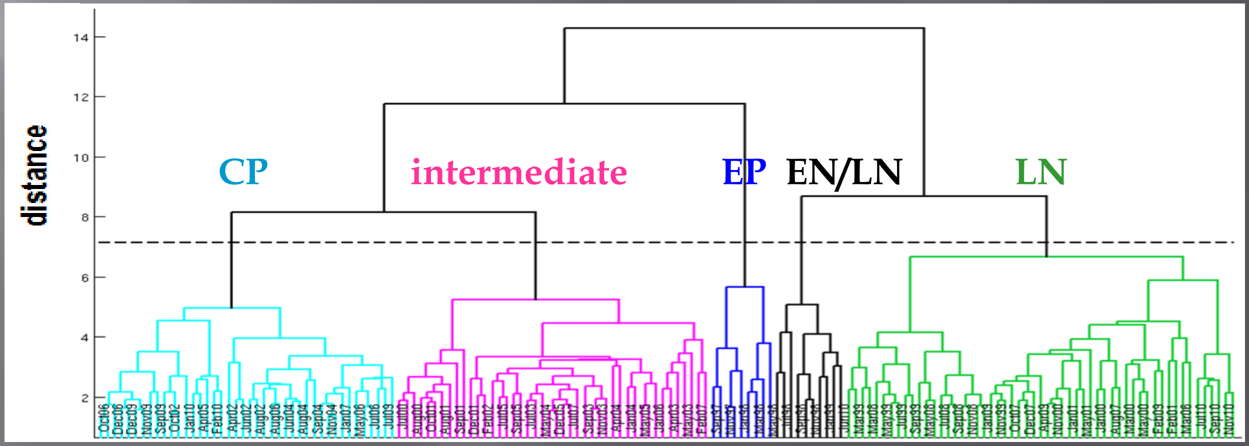
Agglomerative Hierarchical Clustering (AHC)

160 maps (September 1997 - December 2010)

130°E-70°W; 10°S-10°N

no indonesian throughflow and coastal upwellings

5 clusters

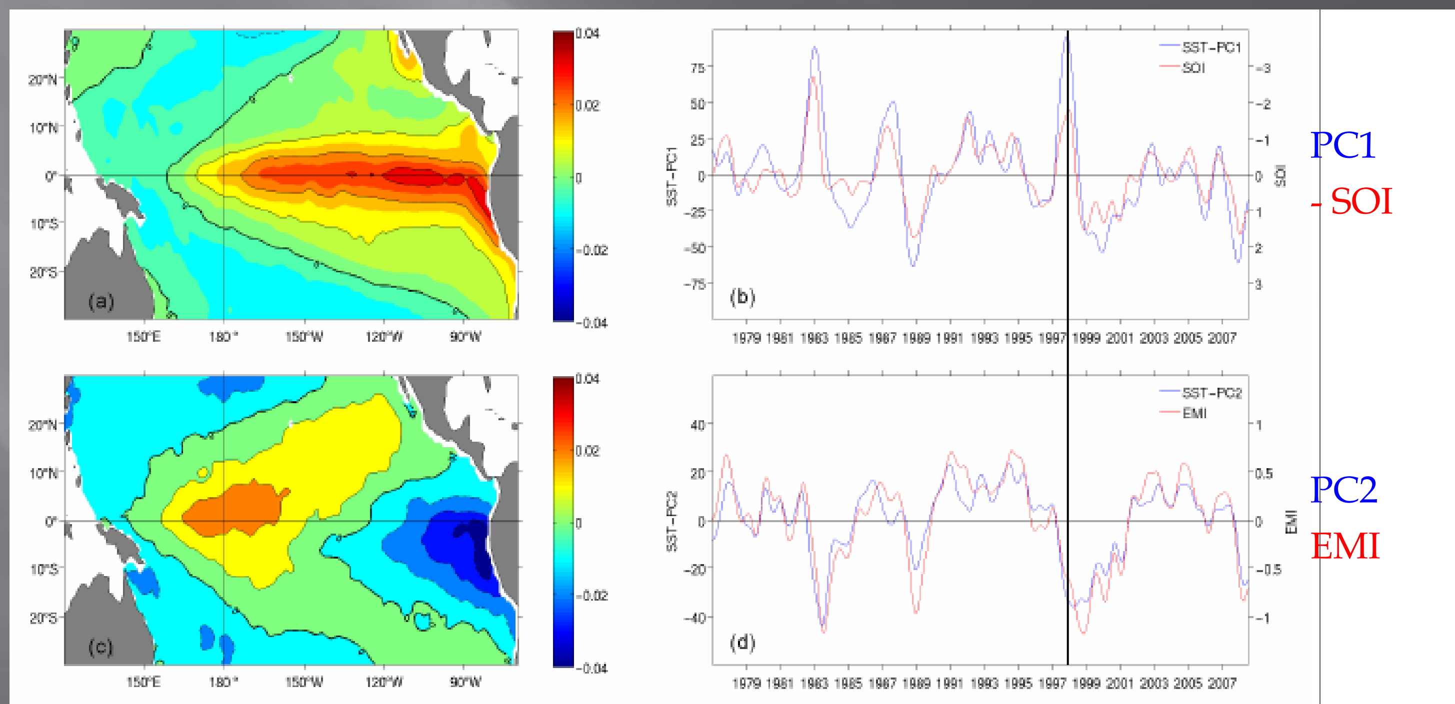


Eastern Pacific El Niño - Central Pacific El Niño SST anomaly

1975	*Wyrtki*	"no two El Niño events are quite alike"
2001	*Trenberth and Stepaniak*	El Niño comes in many different "flavors"
2005	*Larkin and Harrison*	conventional El Niño / date line El Niño
2007	*Ashok et al.*	typical El Niño / El Niño Modoki
2009	*Kug et al.*	cold tongue El Niño / warm pool El Niño
2009	*Kao and Yu*	Eastern Pacific El Niño / Central Pacific El Niño

EOF 1
Eastern Pacific
El Niño

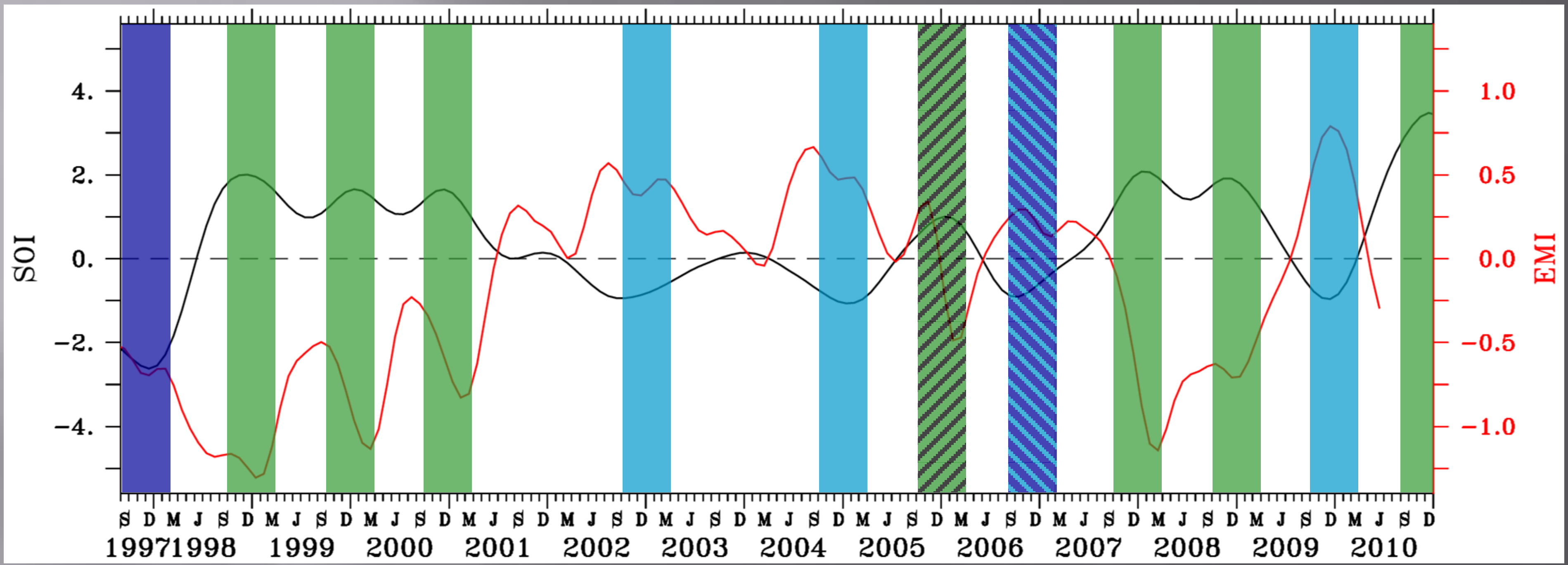
EOF 2
Central Pacific
El Niño



Singh et al., JGR, 2011

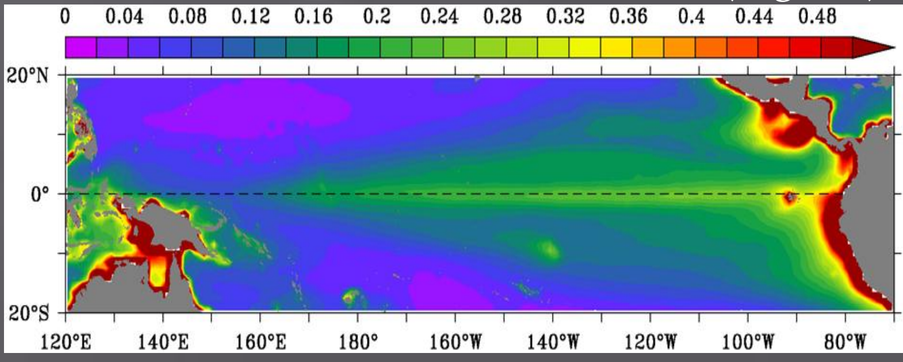
ENSO during the SeaWiFS years

Trenberth and Stepaniak, 2001; Ashok et al. (2007); Kim et al. (2009); Yeh et al. (2009); Kao and Yu (2009); Kug et al. (2009); Lee and McPhaden (2010); Ren and Jin (2011); Singh et al. (2011); McPhaden et al. (2011); Turk et al. (2011); ….; this study



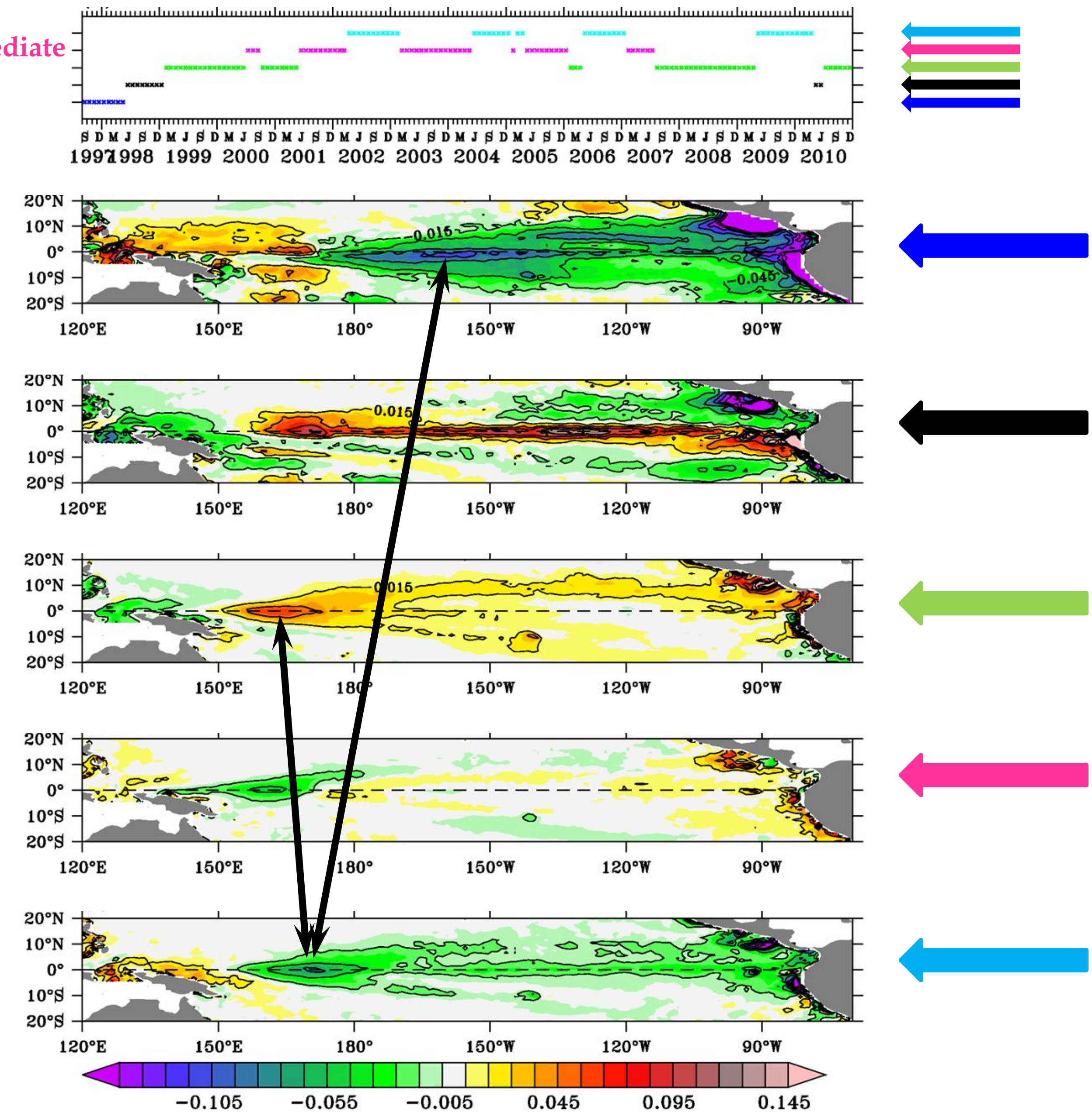
Eastern Pacific El Niño	SOI < 0 and EMI < 0
Central Pacific El Niño	SOI < 0 and EMI > 0
La Niña	SOI > 0

mean chl (mg m^{-3})



spatial structures of chlorophyll anomalies

CP
intermediate
LN
EN/LN
EP



Eastern Pacific El Niño (EP)

El Niño / La Niña (EN/LN)

Messié et al., GRL, 2006

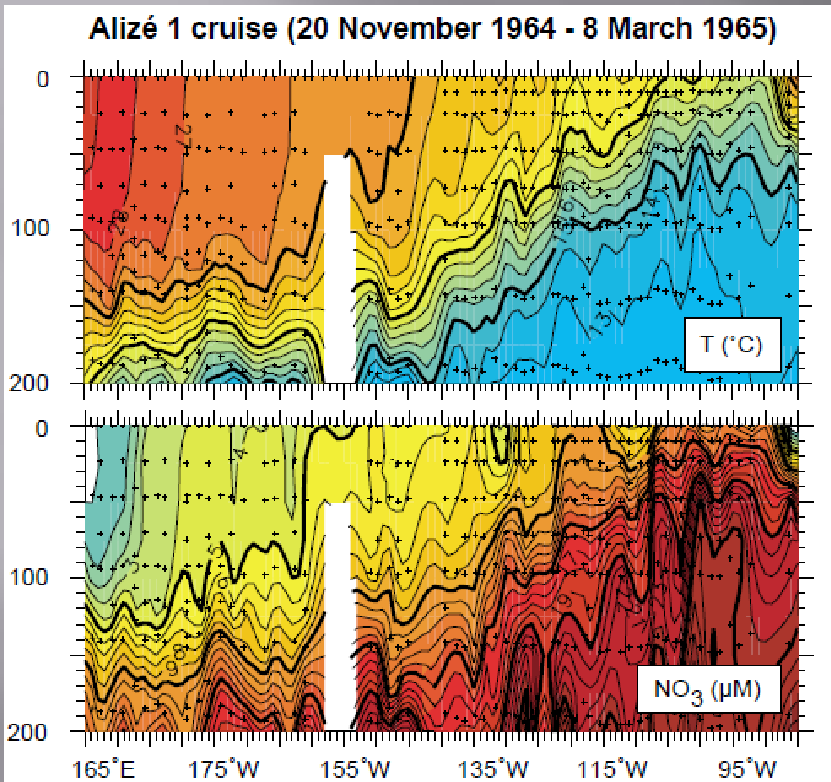
Gierach et al., GRL, 2013

La Niña (LN)

intermediate conditions

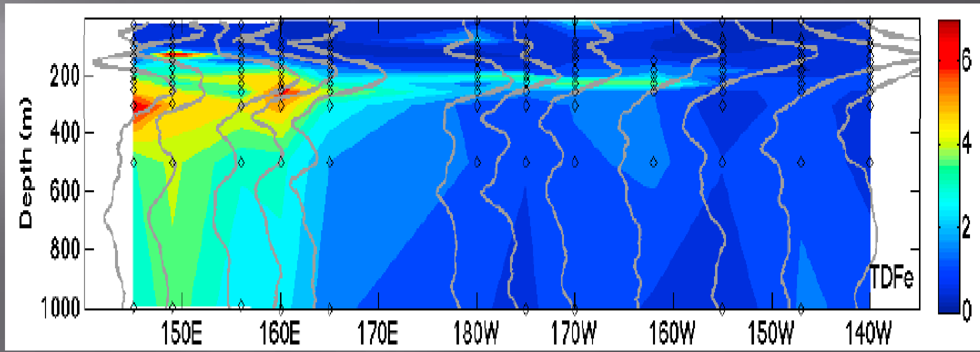
Central Pacific El Niño (CP)

processes: Eastern vs. Central Pacific El Niño

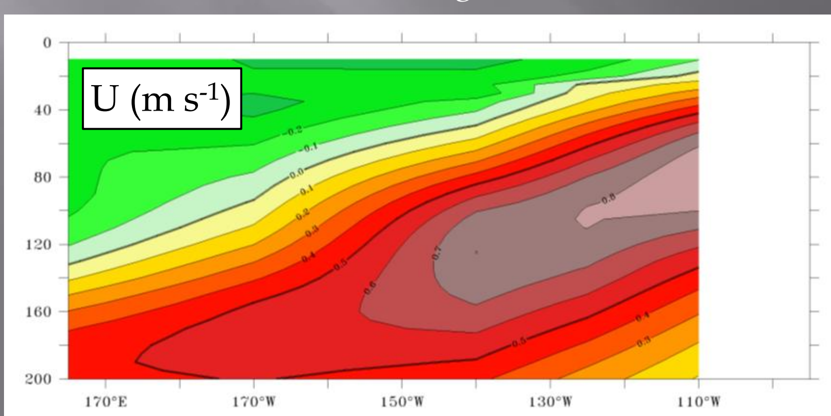


Le Borgne et al., DSRII, 2002

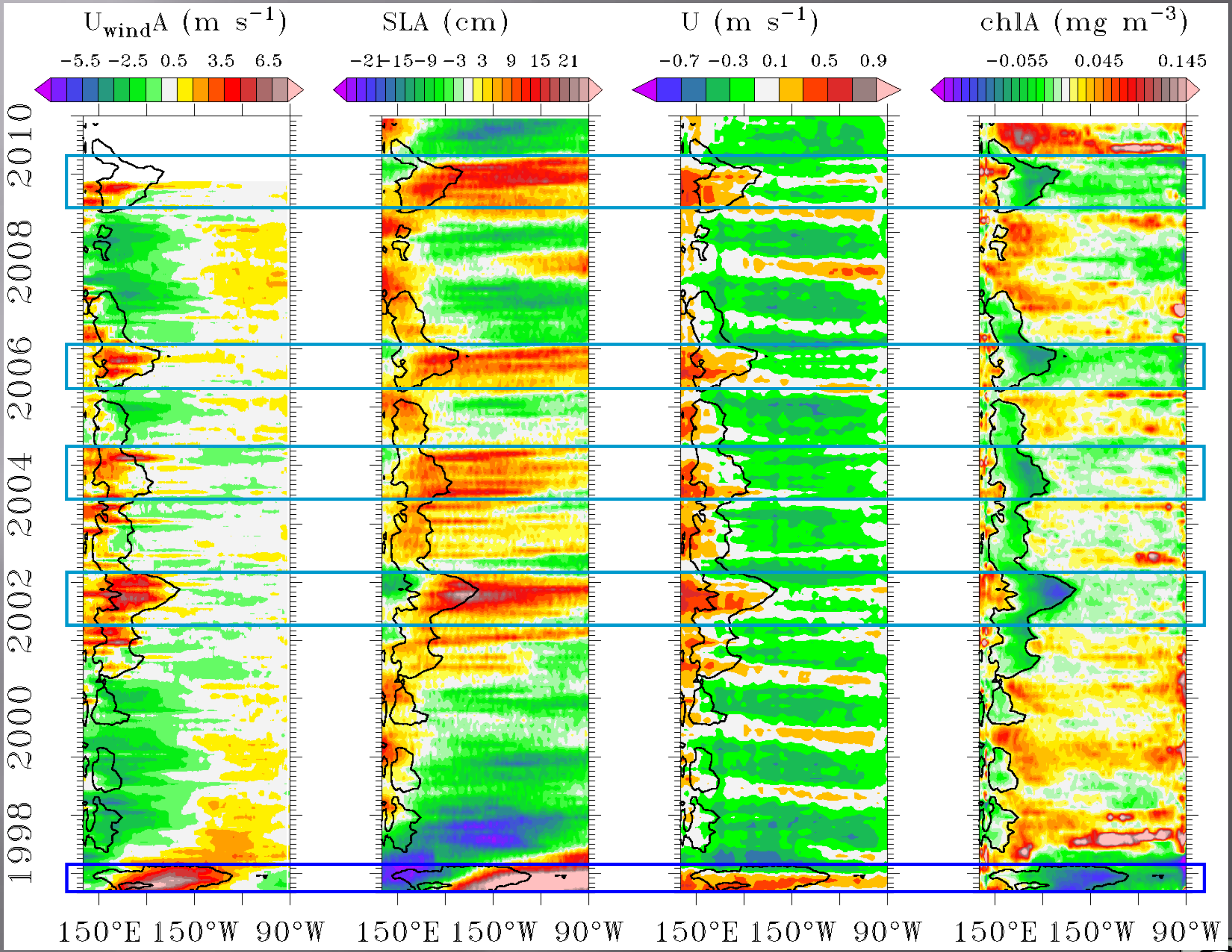
total dissolvable iron and
zonal current profiles



Slemons et al., GBC, 2010

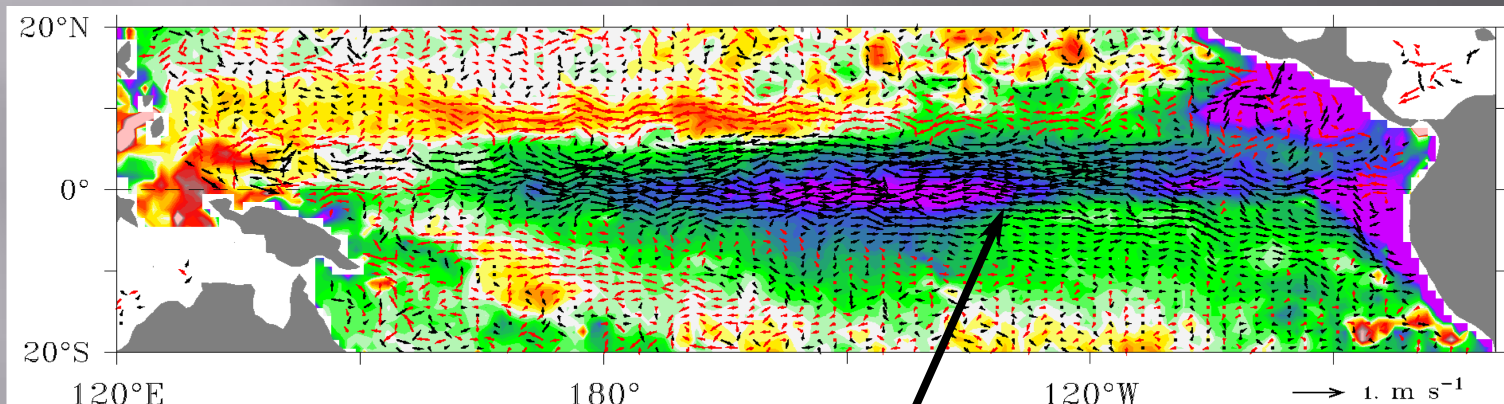


processes: Eastern vs. Central Pacific El Niño

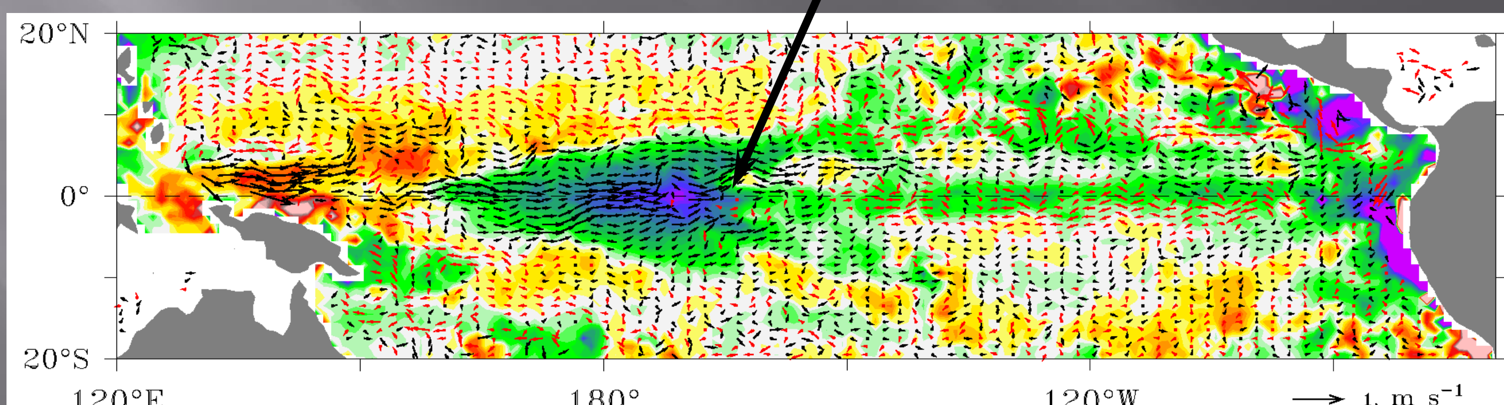


processes: Eastern vs. Central Pacific El Niño

Eastern Pacific El Niño
December 1997



Central Pacific El Niño
December 2002



surface current anomaly → eastward ← westward

conclusion

- **to contrast and explain the chlorophyll signatures during Eastern and Central Pacific El Niño**

- **clustering analysis of monthly maps of chlorophyll anomaly**
  - 1 Eastern Pacific El Niño (1997)
  - 4 Central Pacific El Niño (2002, 2004, 2006, 2009)
  - La Niña (1998-2001, 2007-2008, and 2010)

	spatial pattern of chlorophyll	physical drivers
Eastern Pacific El Niño	• decrease in the central and eastern basins	➢ zonal advection • large eastward shift of the warm pool ➢ reduced upward iron fluxes • pause of the Undercurrent (Fe source)
Central Pacific El Niño	• decrease in the western central basin	➢ zonal advection • constrained eastward shift of the warm pool ➢ reduced upward iron fluxes • deepening of the Undercurrent (Fe source)

- **need for**
  - longer observation time series
  - process studies (*Lee et al., JGR, 2014*)