

Development, Implementation, and Validation of a Modeling and Forecast System for the San Francisco Bay: Anomalous Warming during 2014-2016

Yi Chao

John Farrara (RSS) Carrie Zhang (UCLA)

In collaboration with

Joseph Zhang (VIMS), Eli Ateljevich (DWR), Fei Chai (UMaine)
Curt Davis (OSU), Dick Dugdale and Frances Wilkerson (SFSU)

Background

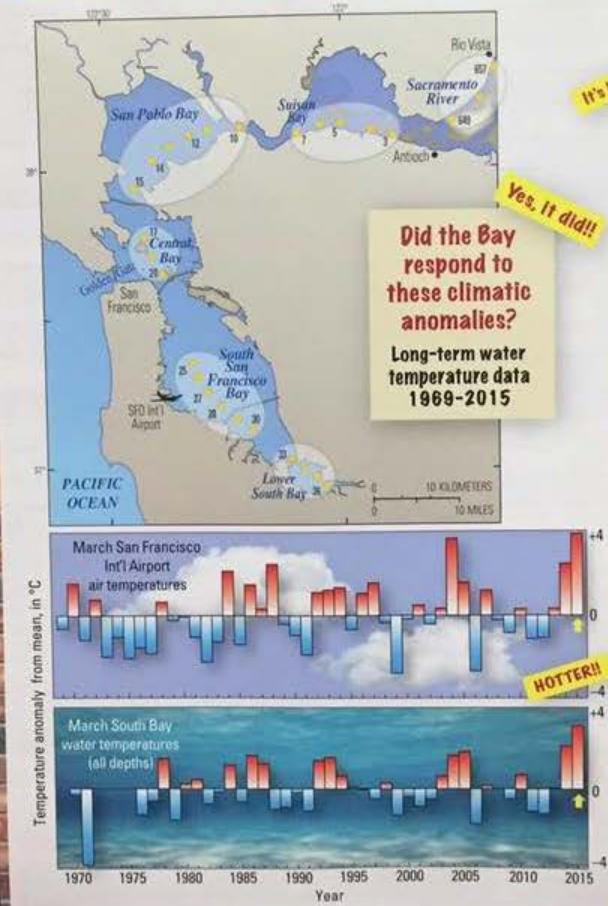
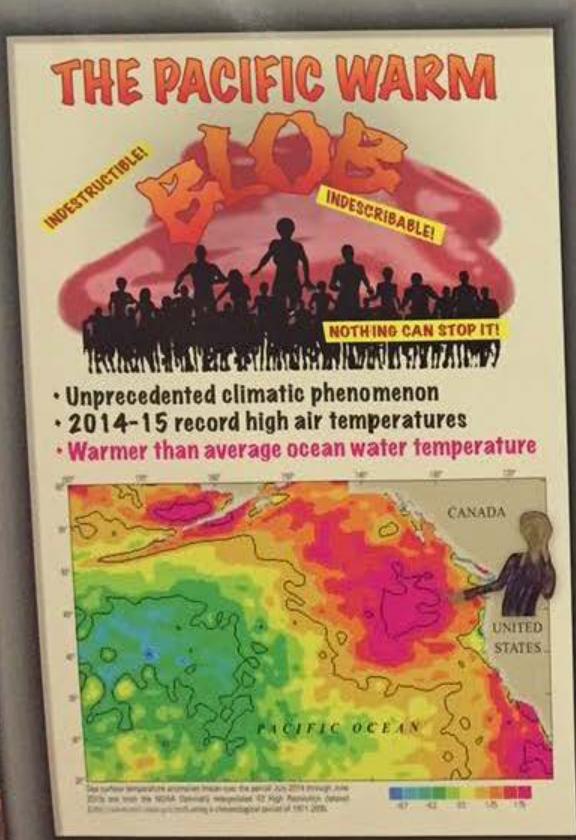
- Integrated effort complementary with the remote sensing & in situ observing components (last two talks)
- Modeling components include
 - Hydrodynamics (this talk)
 - Ecosystem (next talk by Qianqian Liu)
- Same framework used by DWR operational modeling (talk by Eli Ateljevich)

Motivation: Record high SFB temperature in 2014-15 and linked to Pacific warm “Blob”



2014-15 Record High Water Temperatures in San Francisco Bay

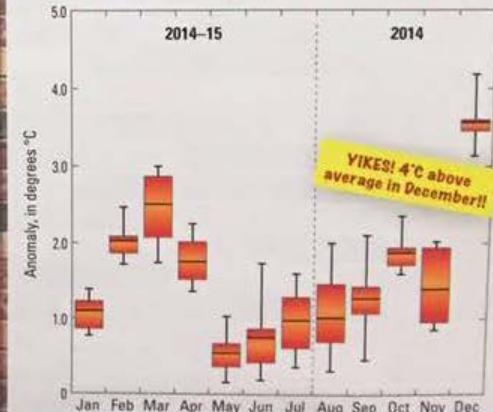
Charles Martin¹, Erica Nejad¹, Mary Tyree², Tara Schraga¹, and Jim Cloern¹



Month	Year of Record High Mean Water Temperature April 1969-July 2015					
	Lower South Bay	South Bay	Central Bay	San Pablo Bay	Suisun Bay	
Jan	1970	1970	2015	2015	1978	1997
Feb	2015	2015	2015	2015	2015	2015
Mar	2015	2015	2015	2015	2015	2015
Apr	1985	1989	1992	2014	1994	1989
May	1992	2001	2013	1992	2001	2001
Jun	2001	1985	1970	1973	2001	2001
Jul	1969	1985	2015	2015	1998	1998
Aug	1996	2014	2014	1997	2003	1998
Sep	2004	2004	1997	1997	1976	2009
Oct	2014	2014	1997	2014	2014	2012
Nov	1992	1992	1992	1992	1992	1992
Dec	2014	2014	2014	2014	2014	2014

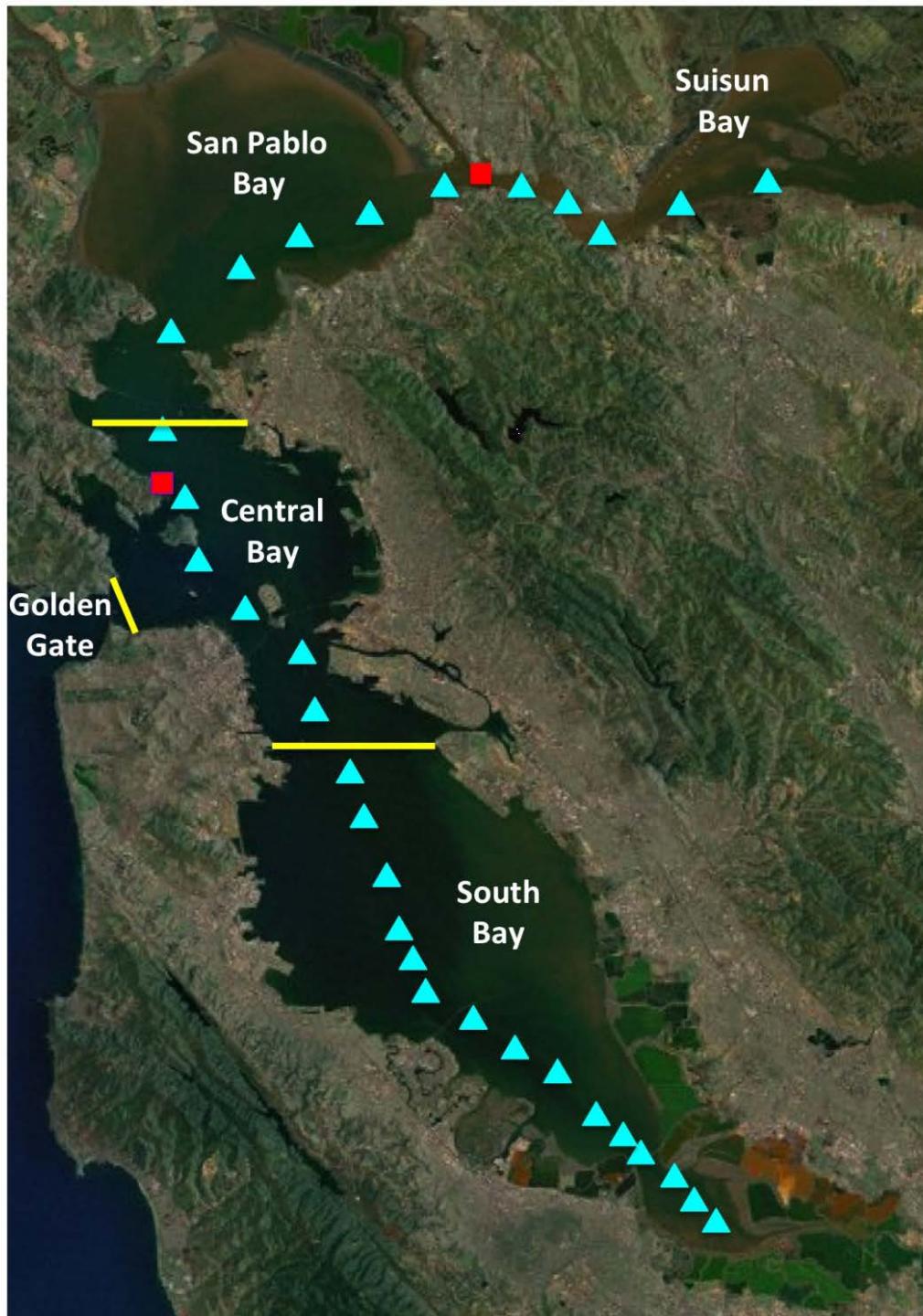
29 of 72 records occurred in 2014-15

Bay-wide deviations from long-term mean water temperature in 2014-15



Questions to be addressed by this talk:

- While the SFB warming during 2014-15 is documented and linked to the Pacific warm blob, what is the impact of 2015-16 El Niño on SFB?
- To what extent a SFB model can reproduce the SFB warming associated with both the Pacific warm blob and El Niño?
- [Assuming the model can realistically reproduce the SFB warming, then] What are the origin and governing processes of the SFB warming?

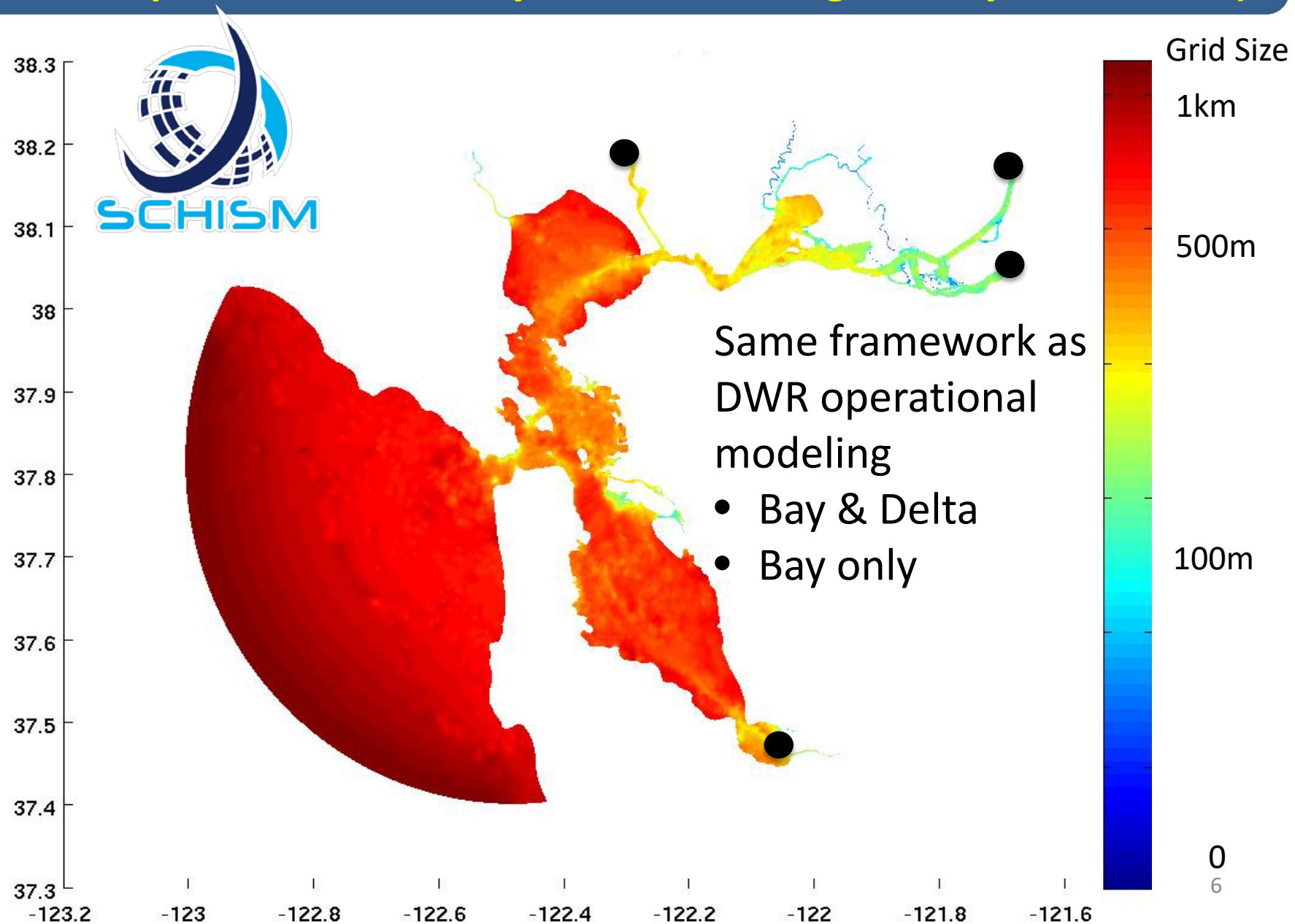


Observations

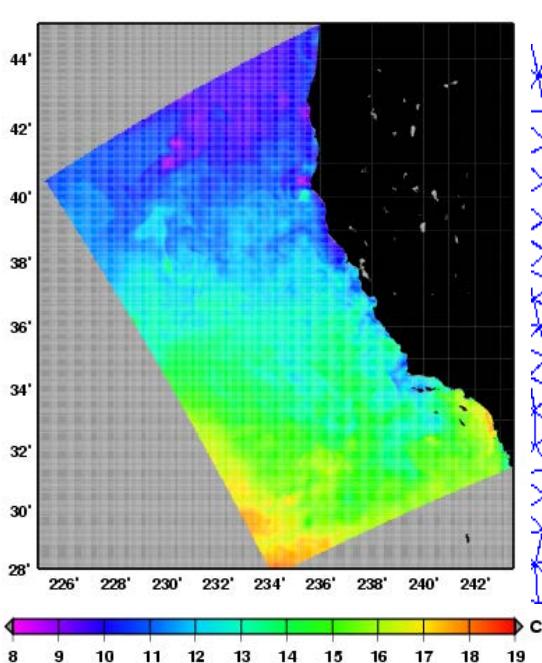
- USGS monthly ship survey
- Continuous time series at Tiburon and Carquinez stations

SCHISM

(Semi-implicit Cross-scale Hydroscience Integrated System Model)

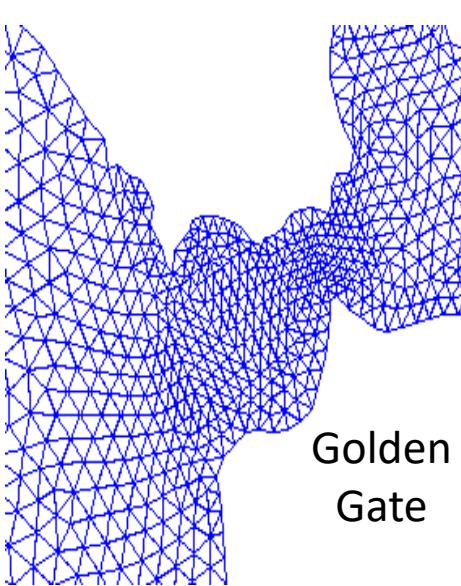


This study is unique – Linking SFB SCHISM with California coastal data-assimilative ROMS: 2004-2016 retrospective analysis/hindcast

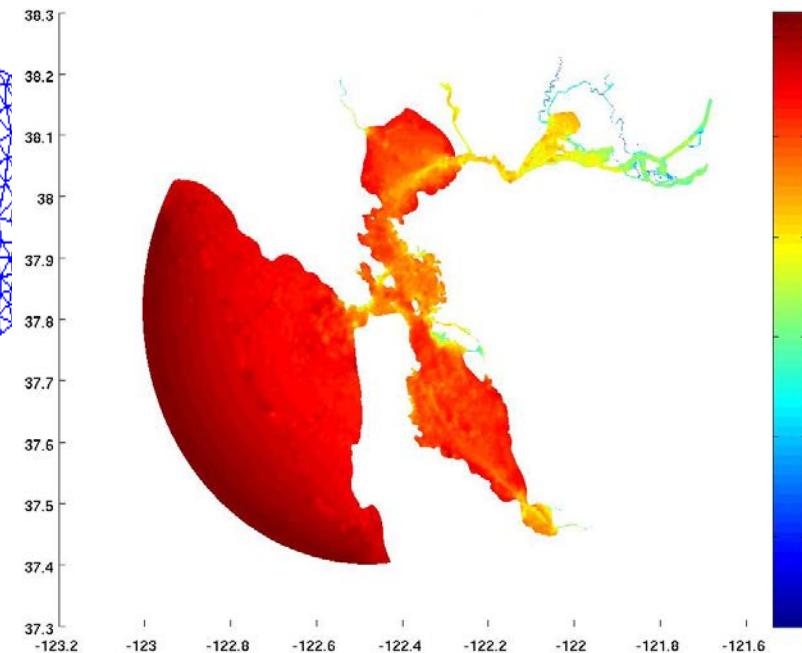


Structured grid ROMS
3-km

CeNCOOS



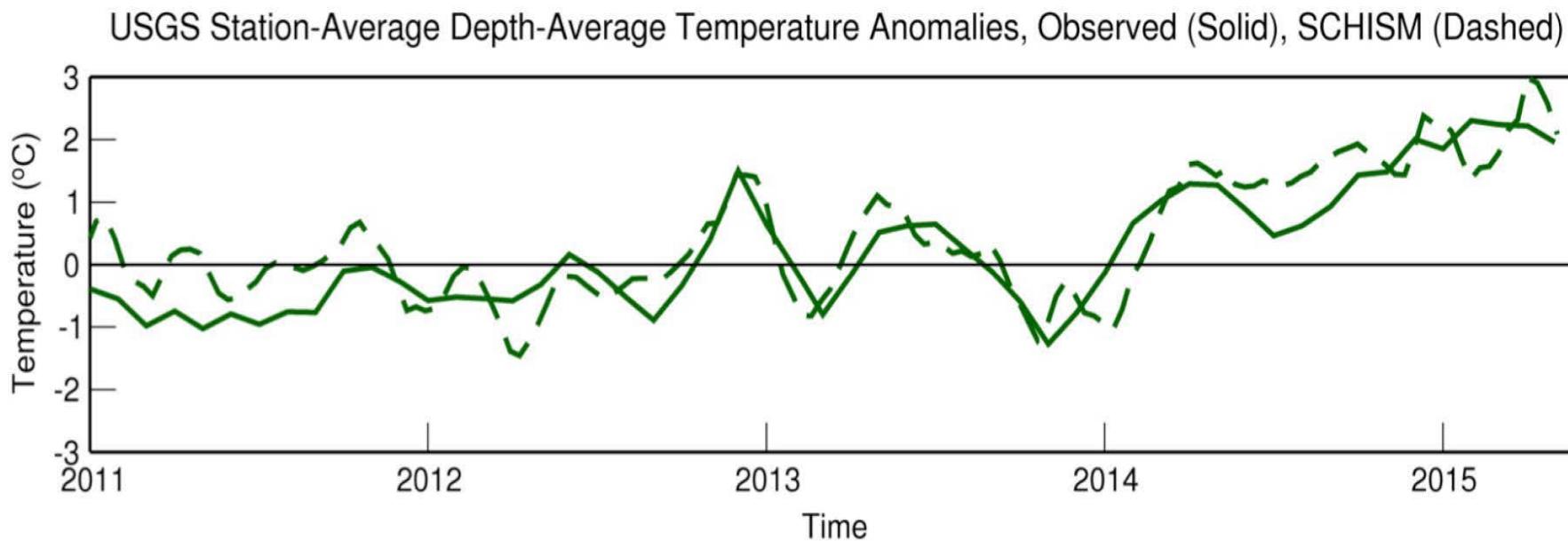
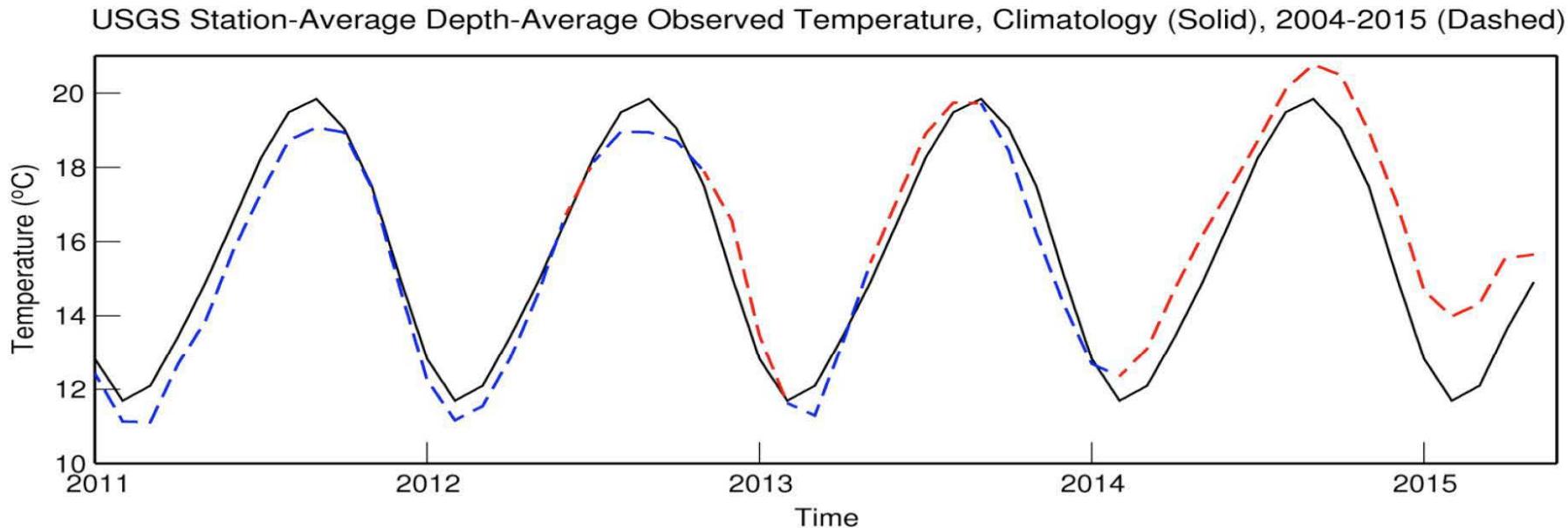
Offline
Coupling:
Tides, T/S, Current



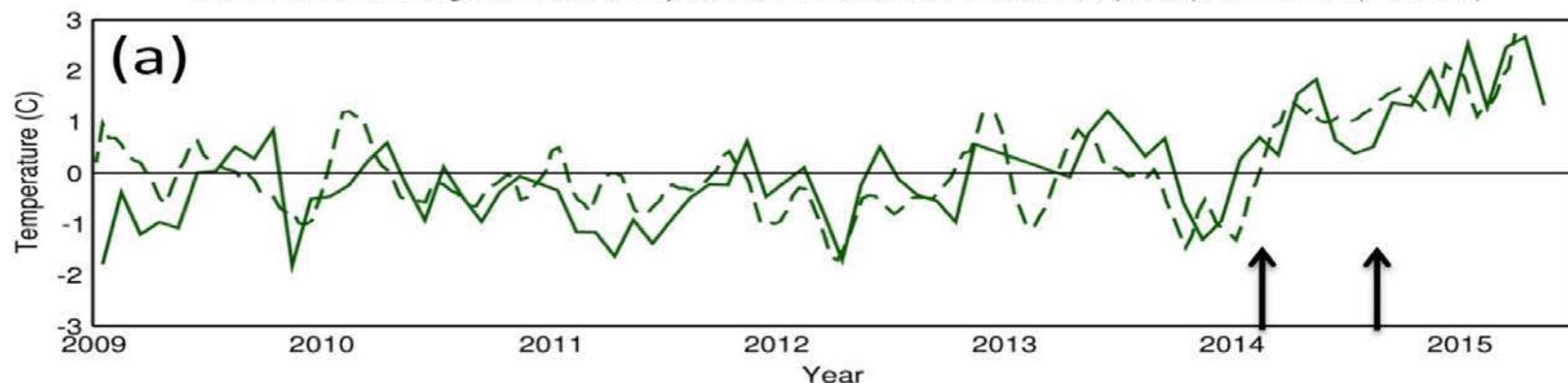
Unstructured grid SCHISM
3-km.....100-m



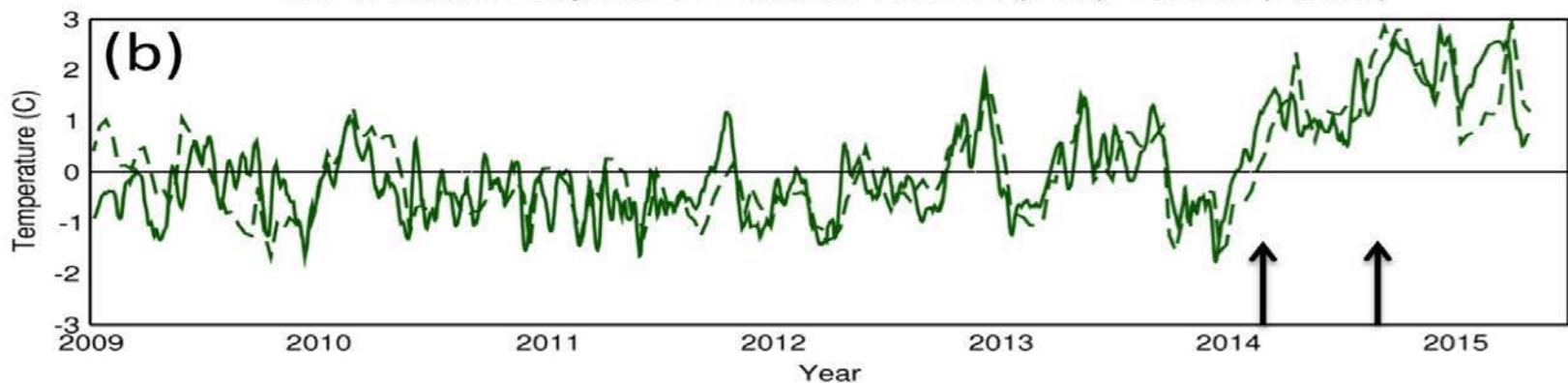
SFB warming associated with Pacific warm blob



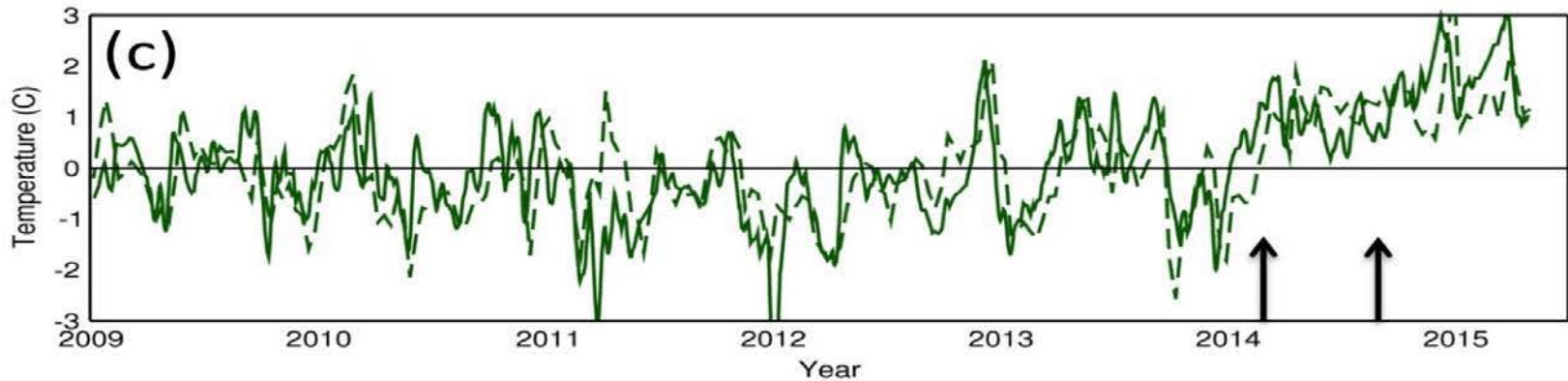
USGS Stations Avg. Surface Temperature Anomalies, Observed (Solid), SCHISM (Dashed)



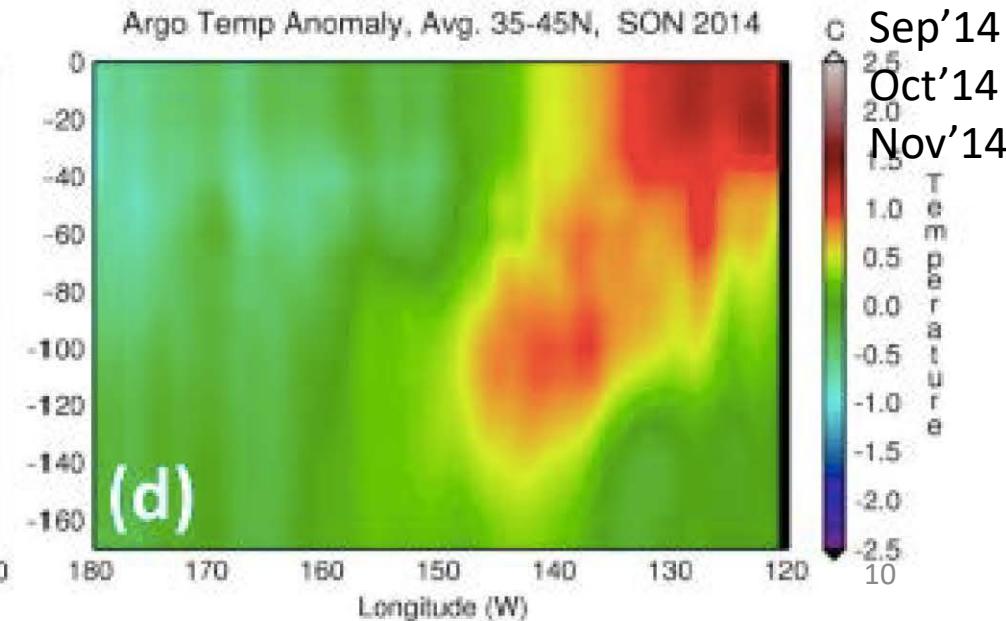
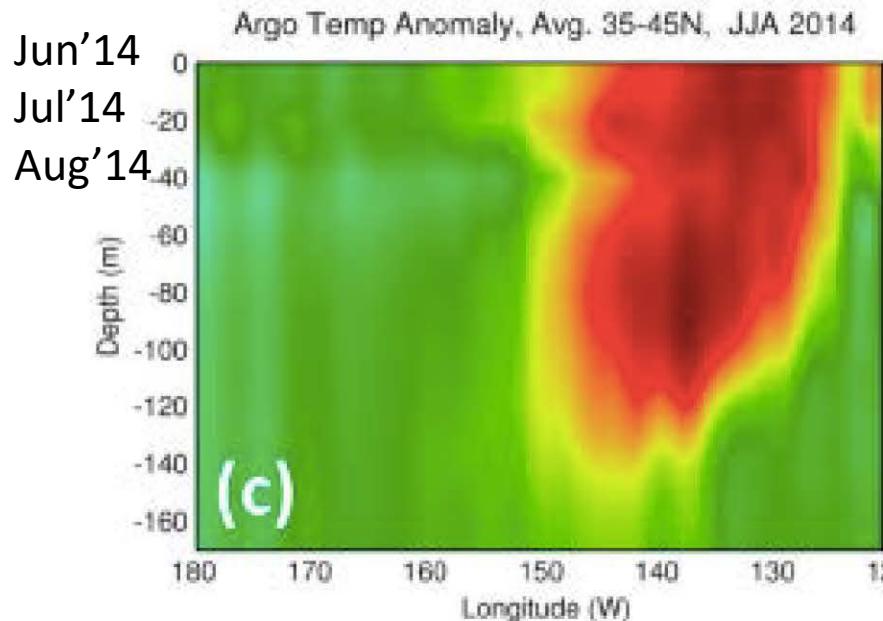
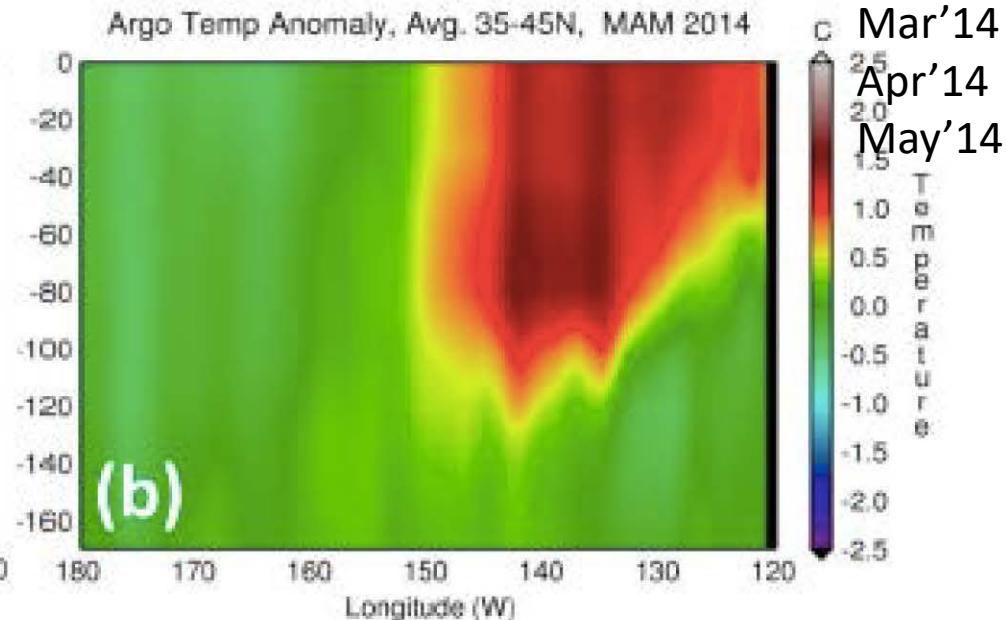
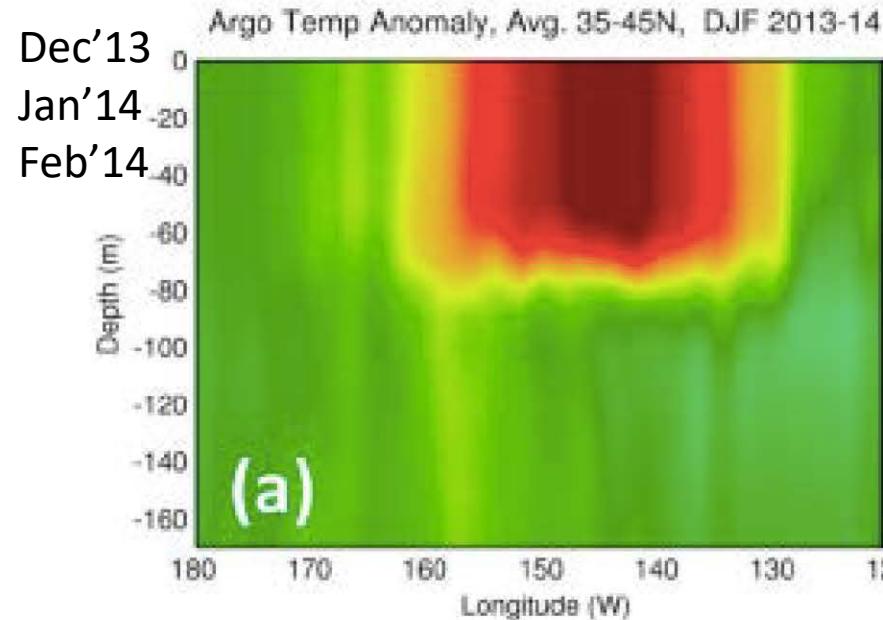
Tiburon Surface Temperature Anomalies, Observed (Solid), SCHISM (Dashed)



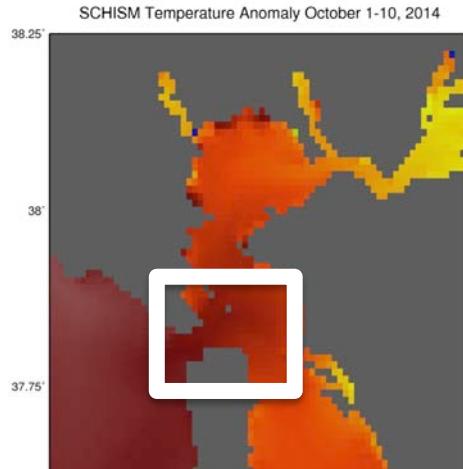
Carquinez Surface Temperature Anomalies, Observed (Solid), SCHISM (Dashed)



Pacific warm blob: Propagation and phase delay



Coastal-bay exchange: Heat budget analysis



$$\frac{d(T)}{dt} \sim \frac{d(U^*T)}{dx} + HF/H$$

Rate of Change



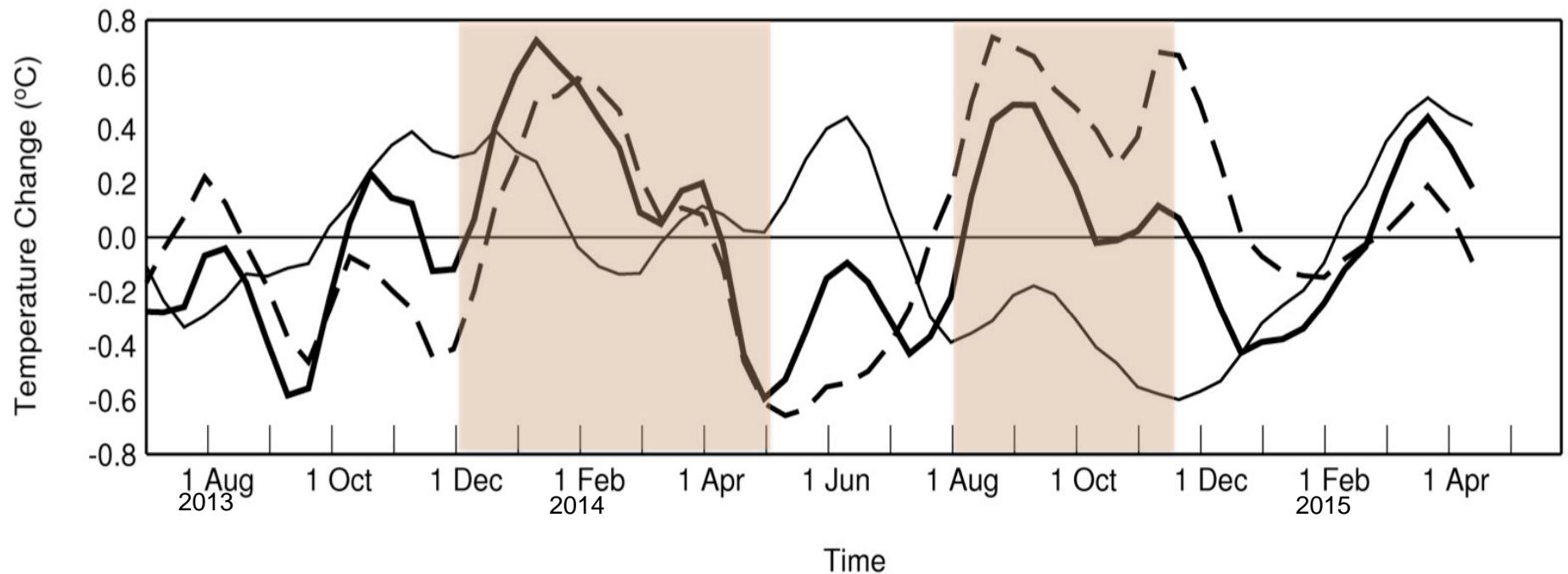
Lateral Heat
Transport



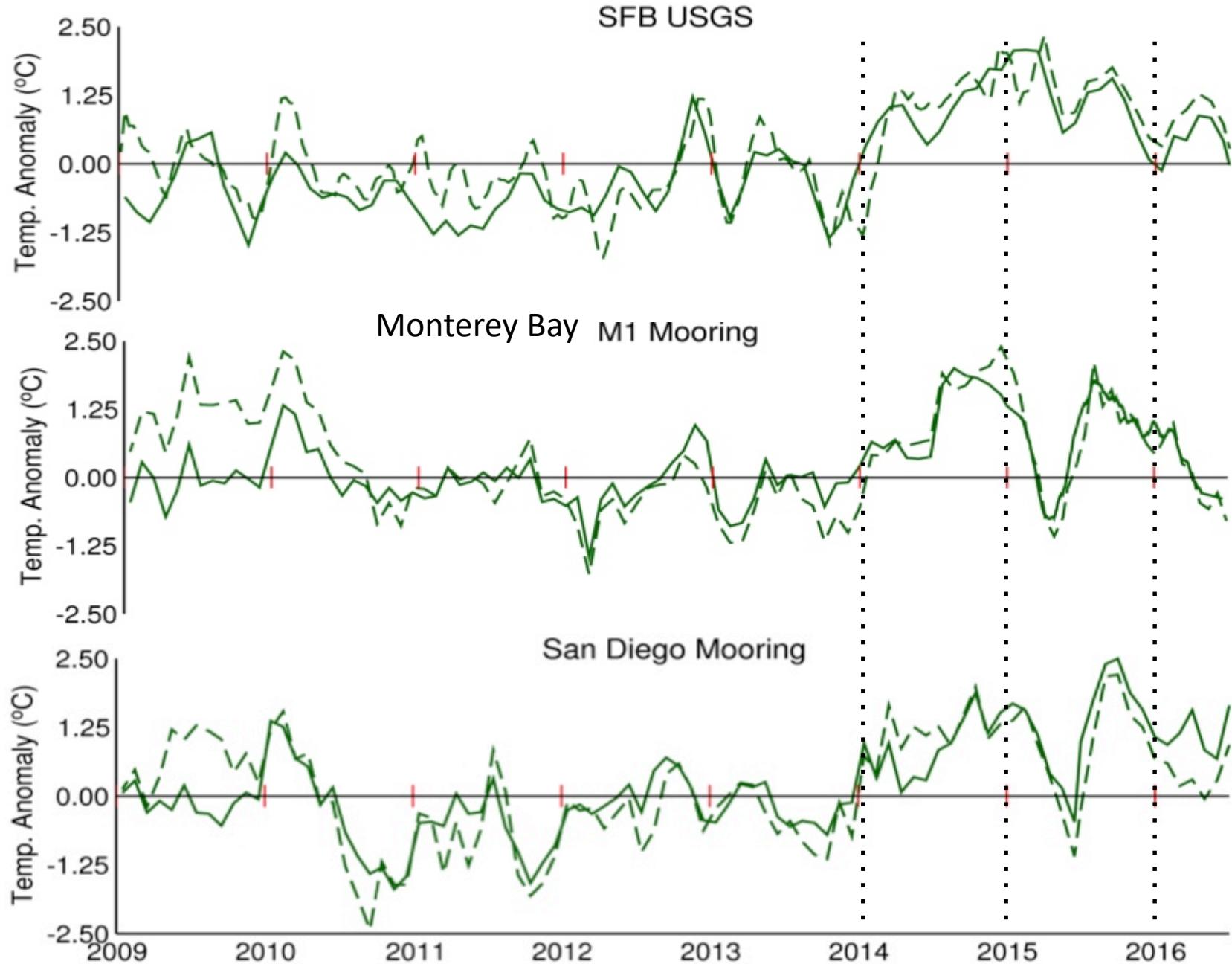
Surface
Heat Flux



SCHISM Central Bay Average Anomalies, Sfc Flux (Thin), Delta T (Thick), Lateral Boundary Flux (Dashed)



Impact of 2015-16 El Niño on SFB?



Summary: SFB warming during 2014-2016

Pacific warm

blob

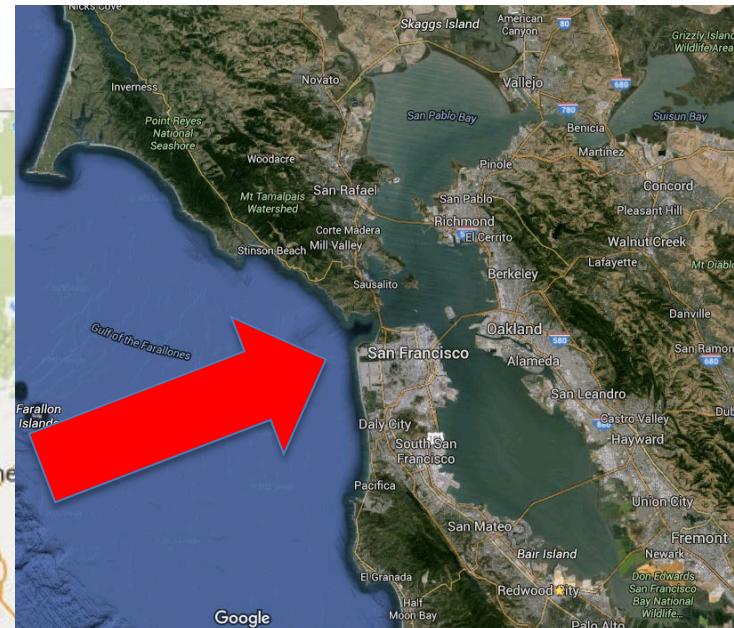
2014-15

[Propagations,
coastal-bay
exchange,
phase delay,
implied
predictability]



California Coastal
Ocean Warming

2015-16



El Niño

Question to be addressed next:

To what extent the SFB warming associated with the 2014-15 Pacific warm blob and 2015-16 El Niño can be predicted (months or seasons in advance)?

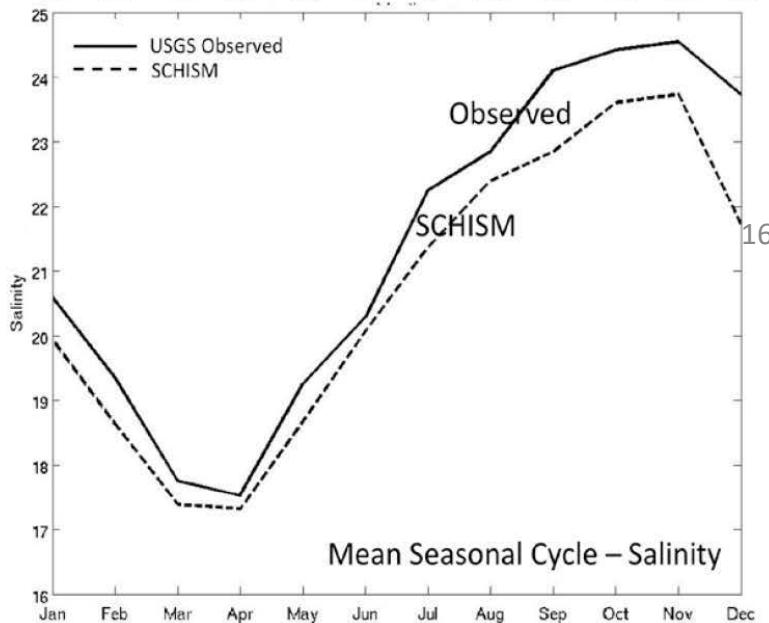
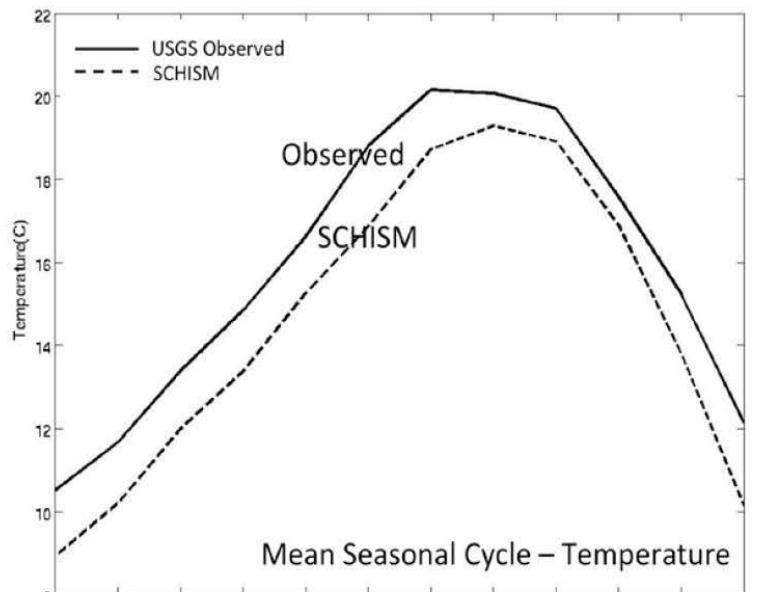
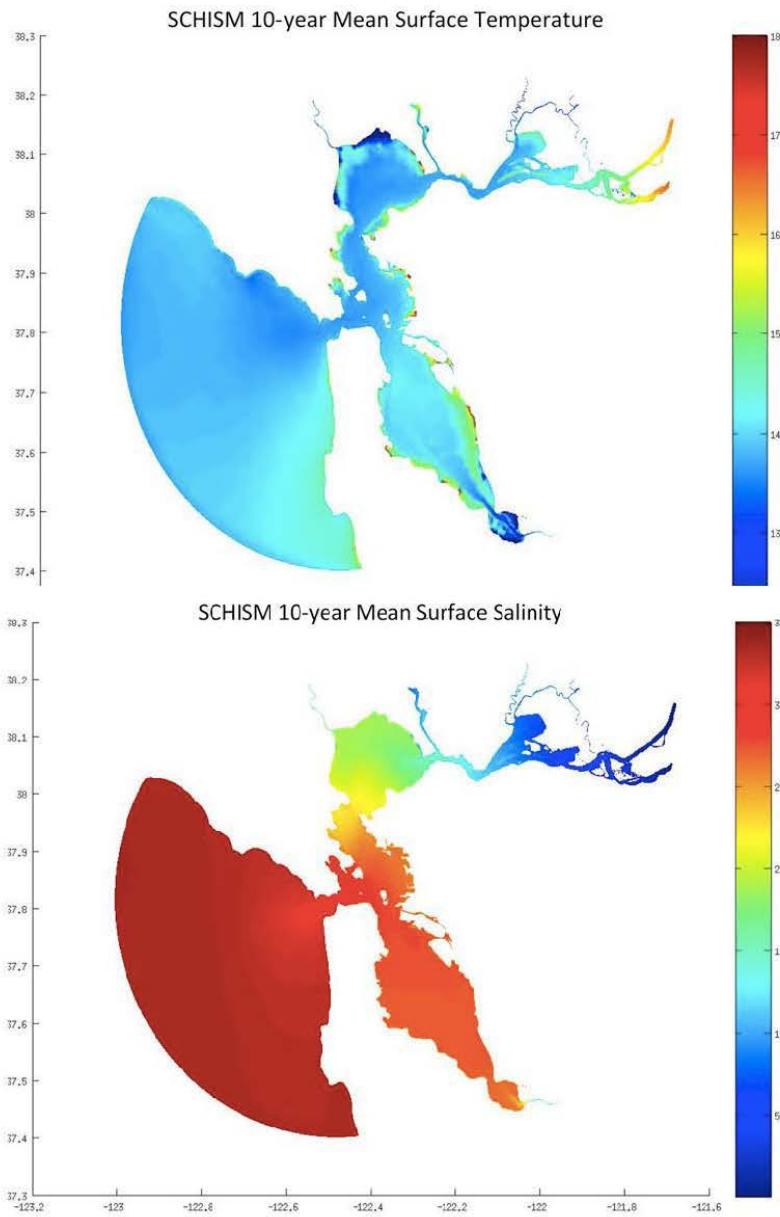
Thanks! Questions?

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ychao@remotesensingsolutions.com

Backup slides

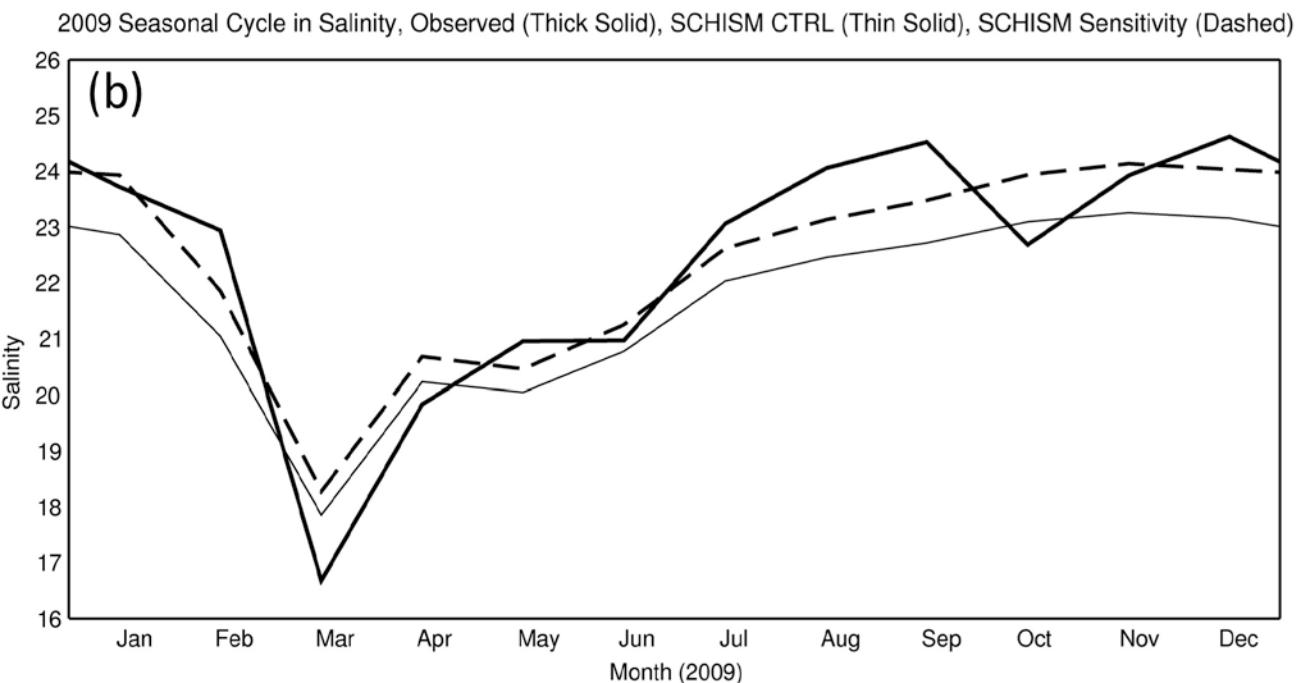
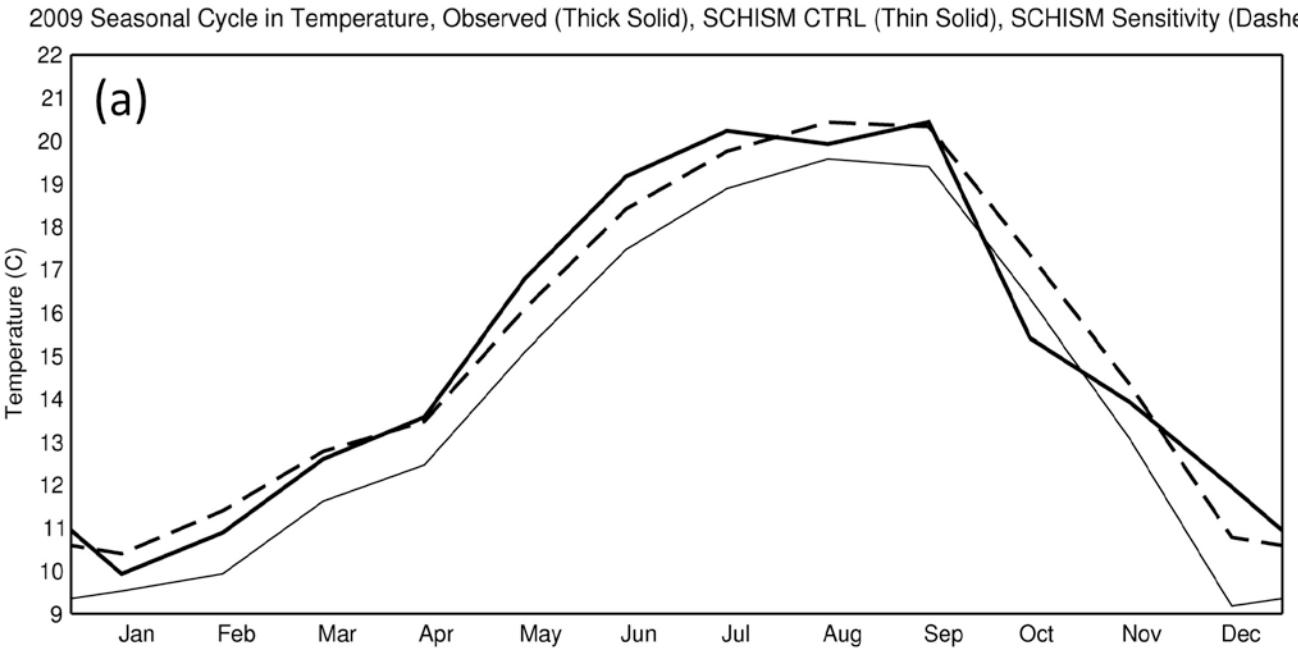
Climatology & Seasonal Cycle



Bias Corrections

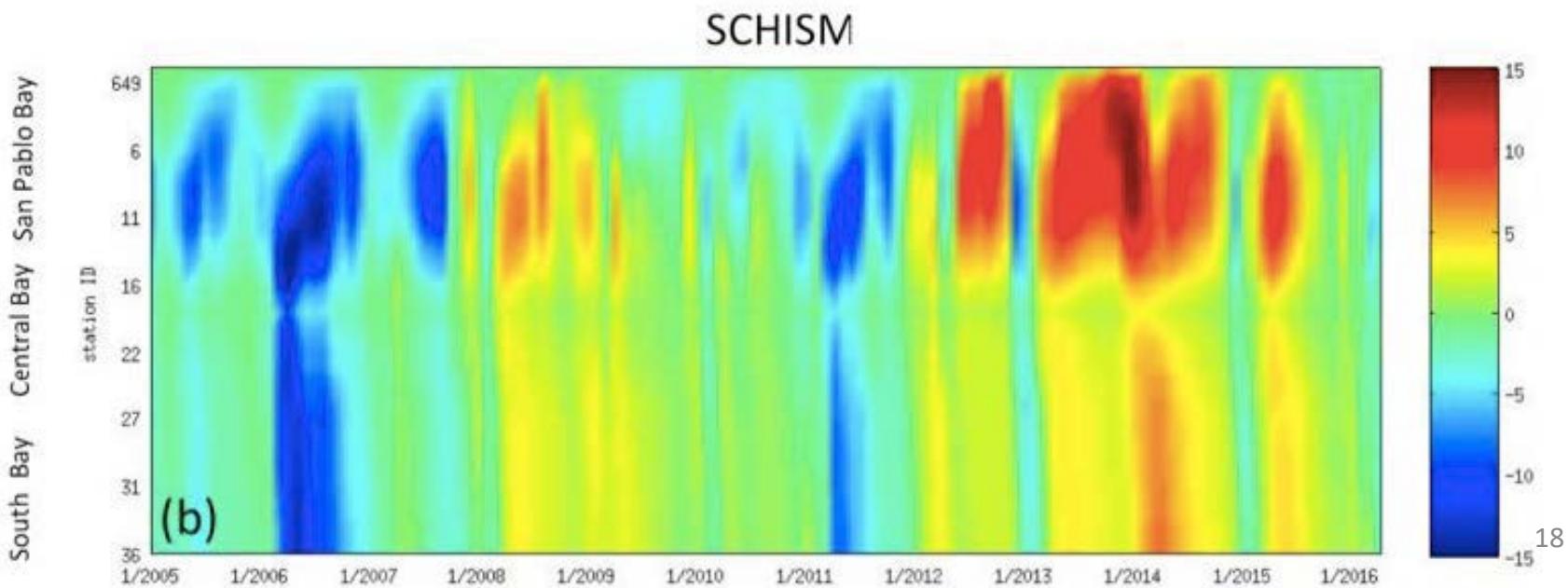
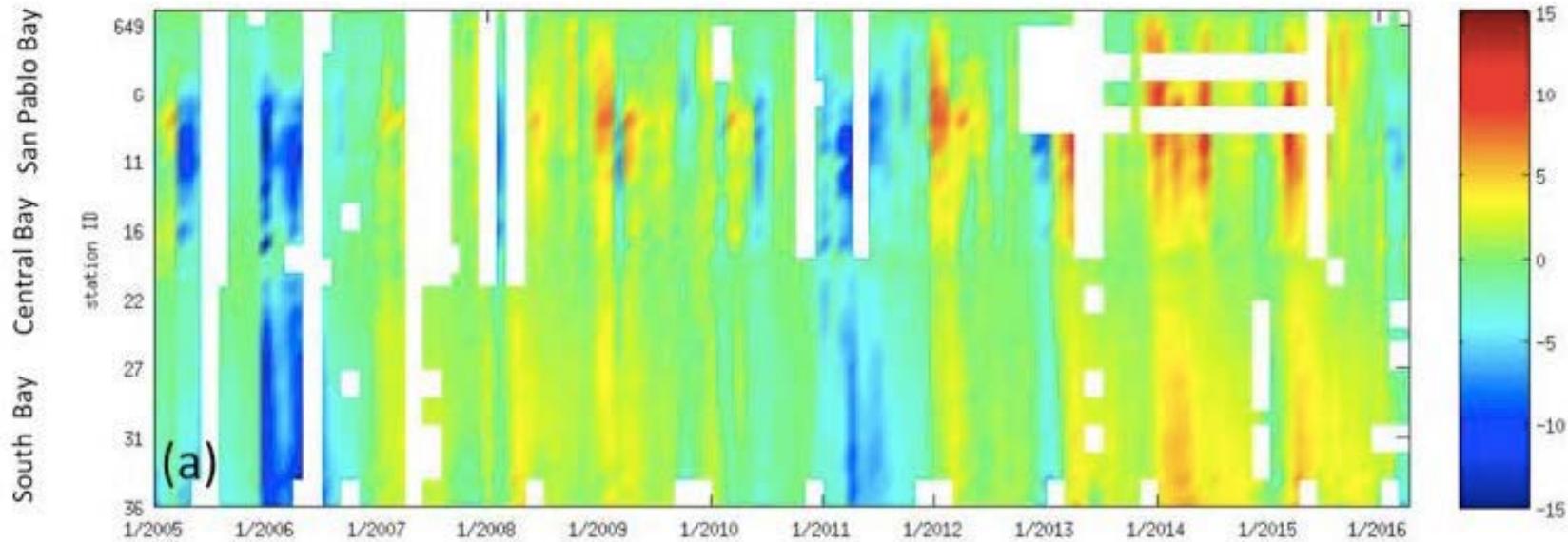
Heat flux:
+35 W/m²

Freshwater
discharge:
- 40 m³/s



Salinity Anomalies

USGS Observed



total stations mean anomaly

