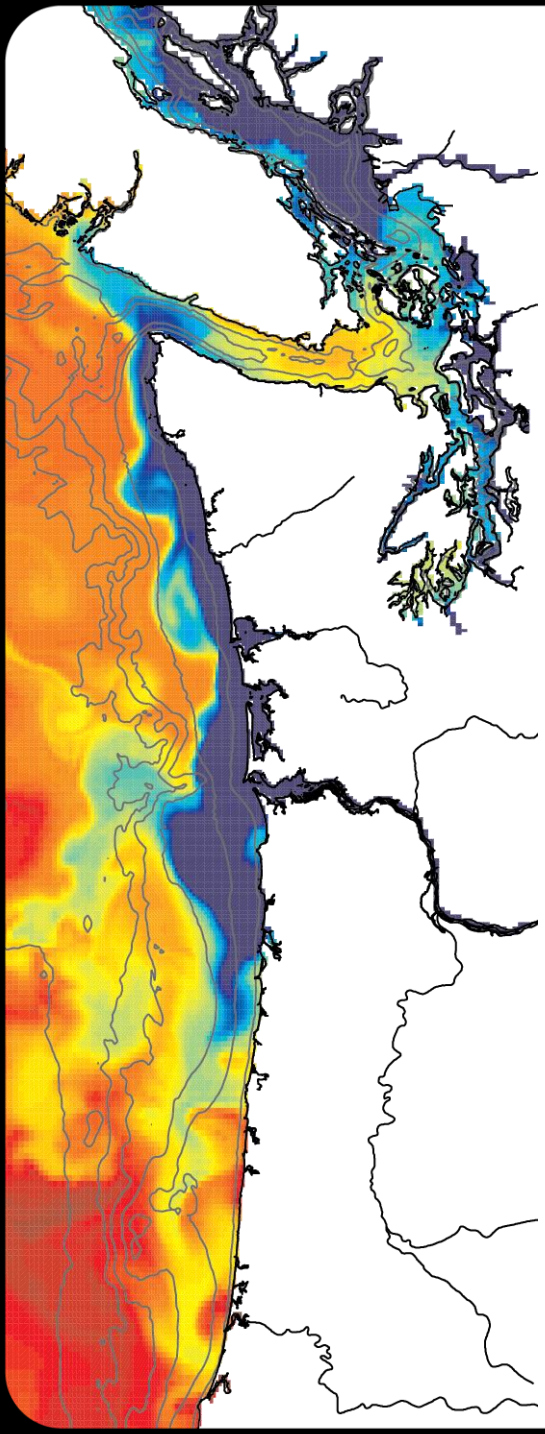


OCNMS Advisory Council Meeting, March 21, 2014

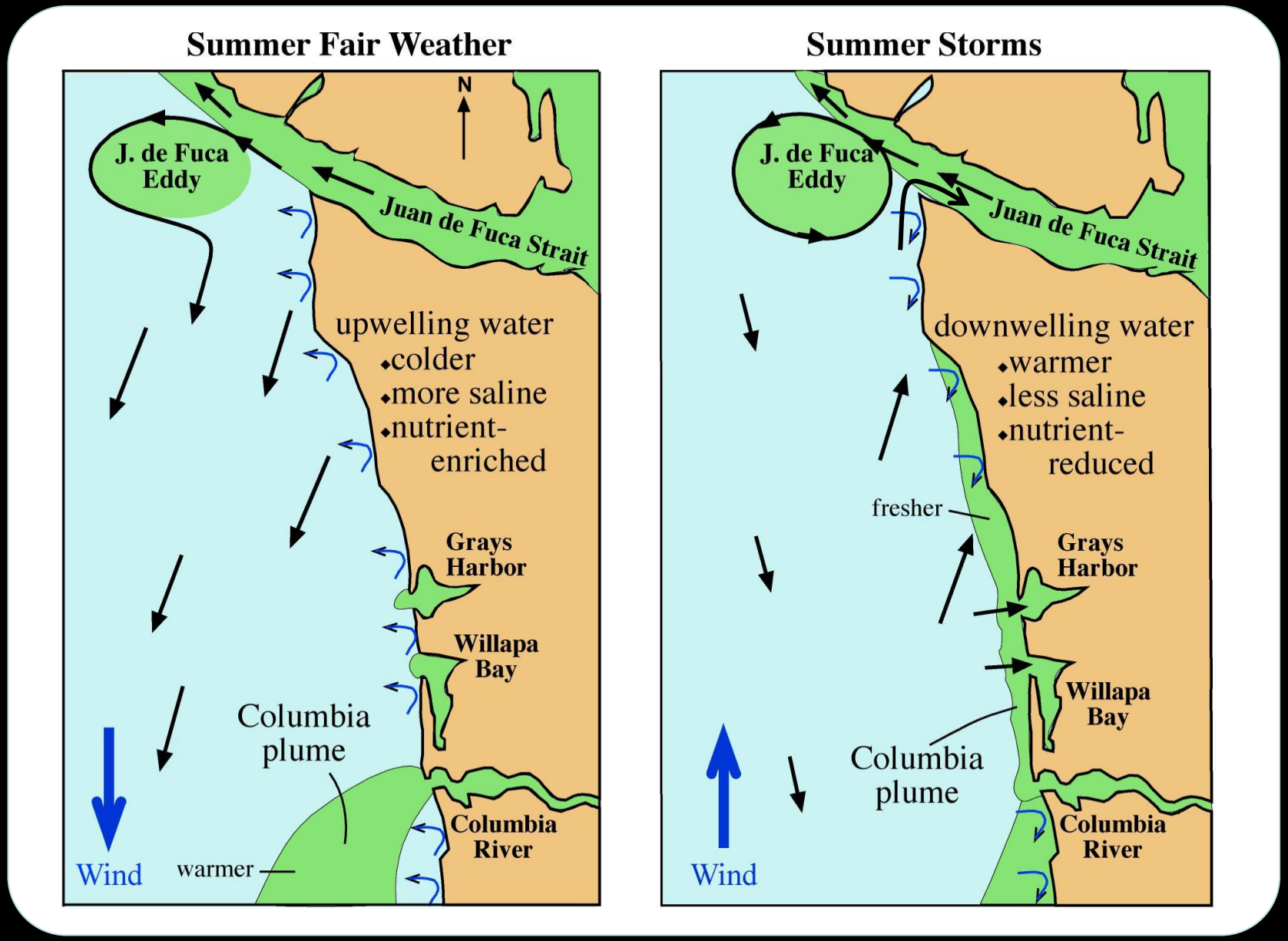
Modeling Washington Coastal Ocean Currents, Chemistry & Biology

Parker MacCready
Neil Banas
Sarah Giddings
Kristen Davis
Samantha Siedlecki
Barbara Hickey

UW Coastal Modeling Group

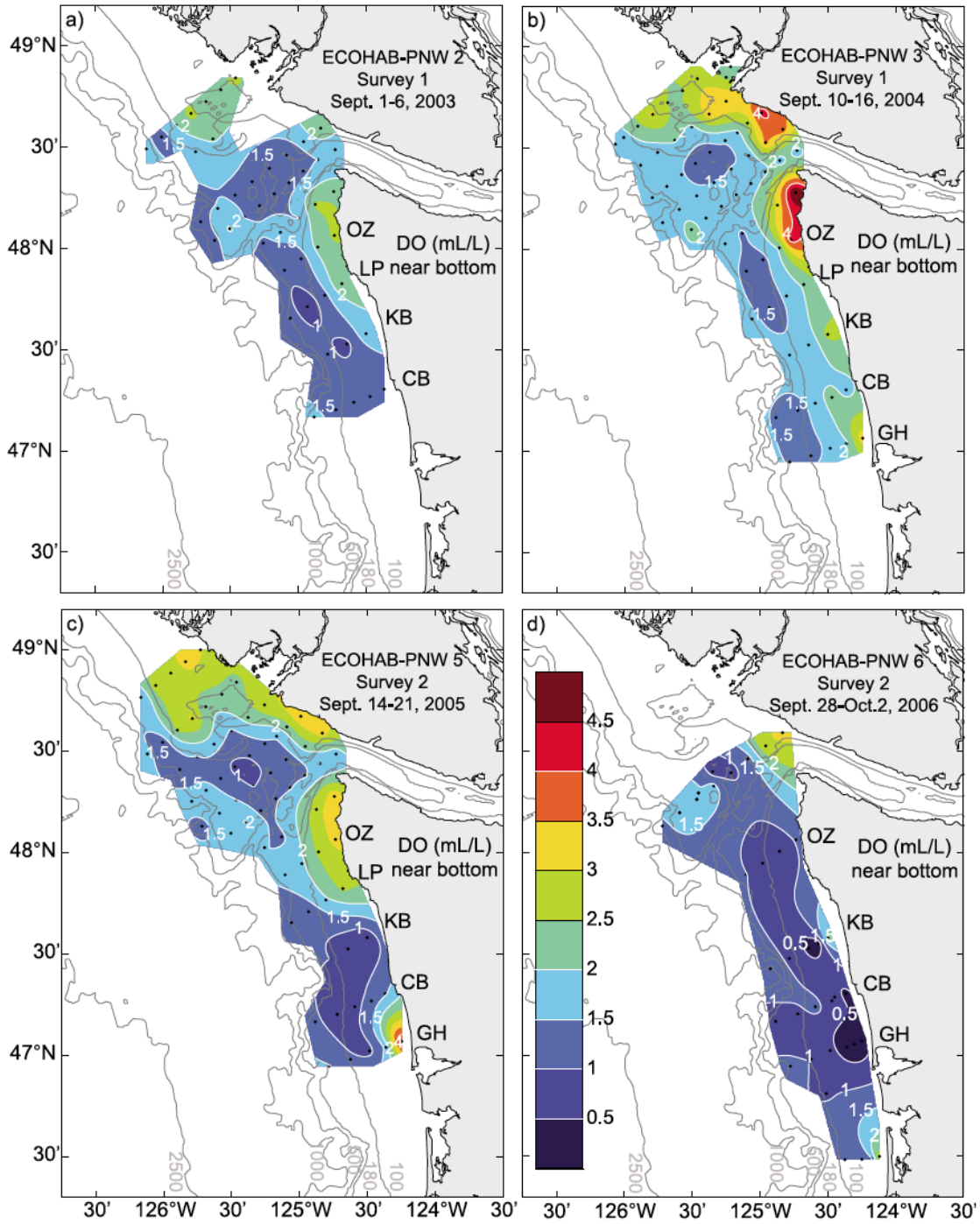
University of Washington

Oceanography of the WA Coast

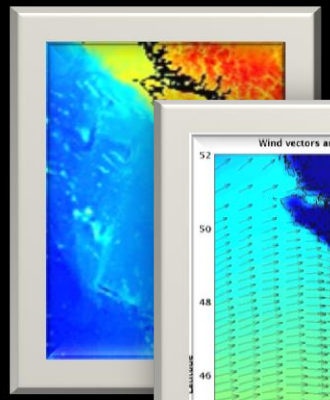


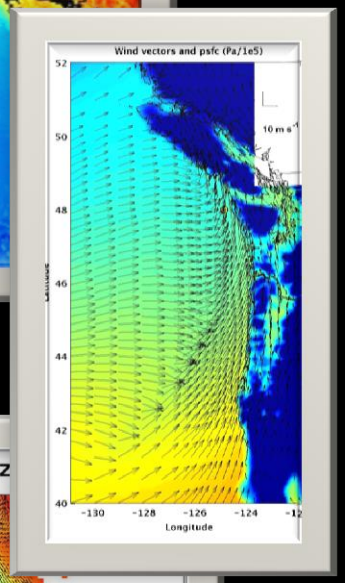
Spatial Patterns of Dissolved Oxygen (DO) on the Shelf

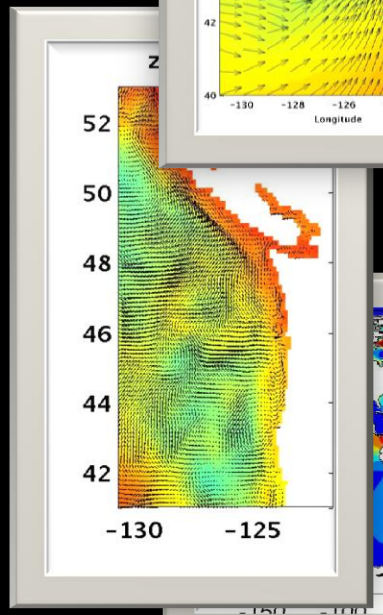
4 years

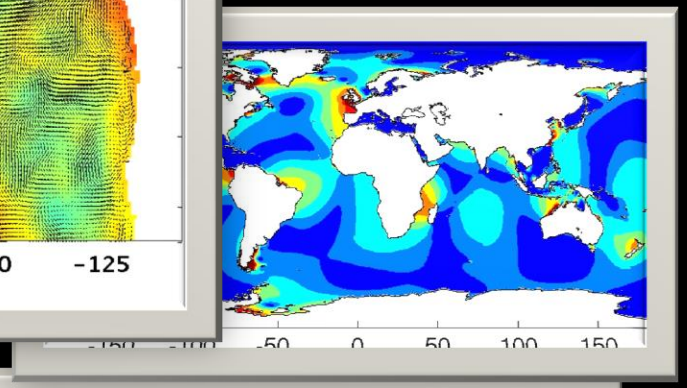


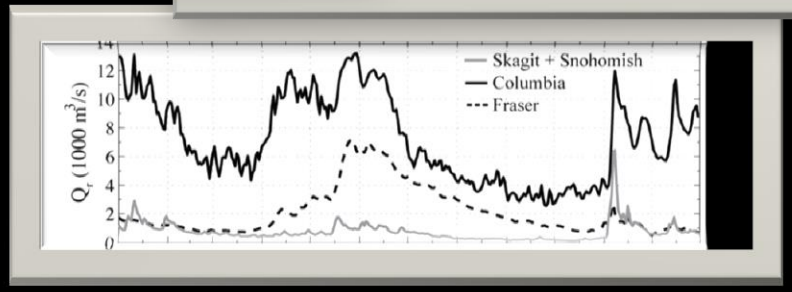
Modeling Workflow











Raw Forcing Data → Forcing Data Processed into Standard Format → Model-specific Forcing Files → MODEL → Output

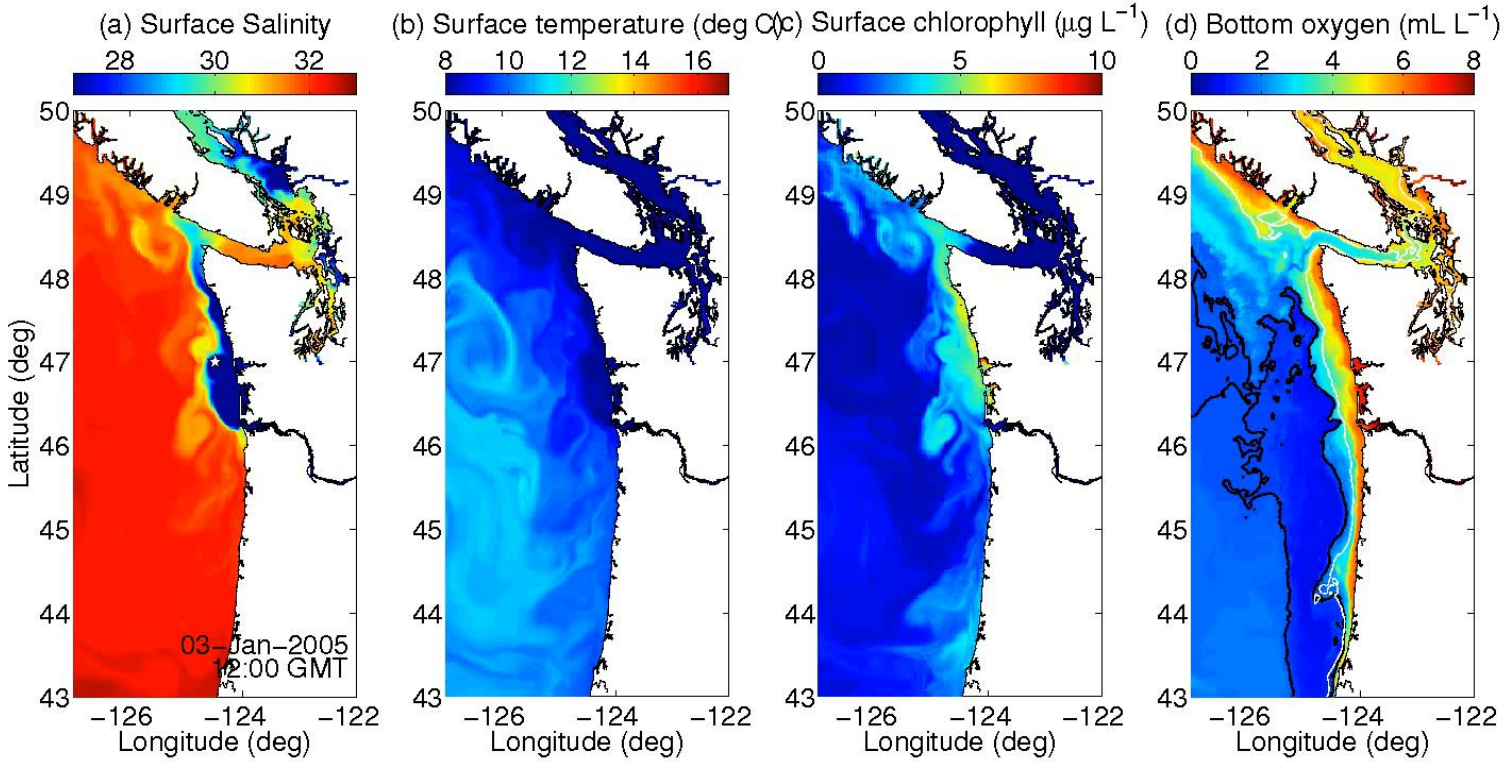
Raw Observational Data → Observations Processed into Standard Format → SKILL TEST → Skill Result

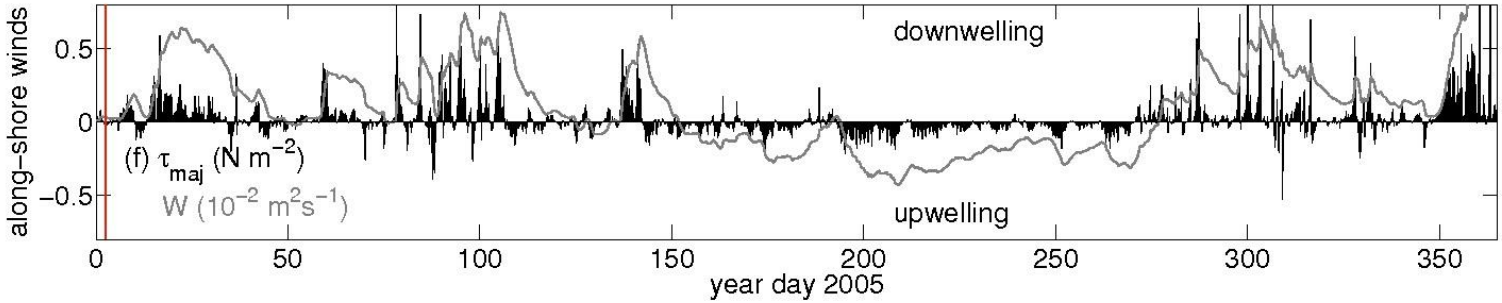
Cluster
200 cores
1 week/year

ROMS

Standard Post Processing
1 week

2 TB/year


(a) Surface Salinity
28 30 32
(b) Surface temperature (deg C)
8 10 12 14 16
(c) Surface chlorophyll (μg L^{-1})
0 5 10
(d) Bottom oxygen (mL L^{-1})
0 2 4 6 8
Latitude (deg)
50 49 48 47 46 45 44 43
03–Jan–2005
12:00 GMT
−126 −124 −122
Longitude (deg)


along–shore winds
0.5
0
−0.5
downwelling
upwelling
(f) τ_{maj} (N m^{-2})
W (10^{-2} m^{2}s^{-1})
0 50 100 150 200 250 300 350
year day 2005

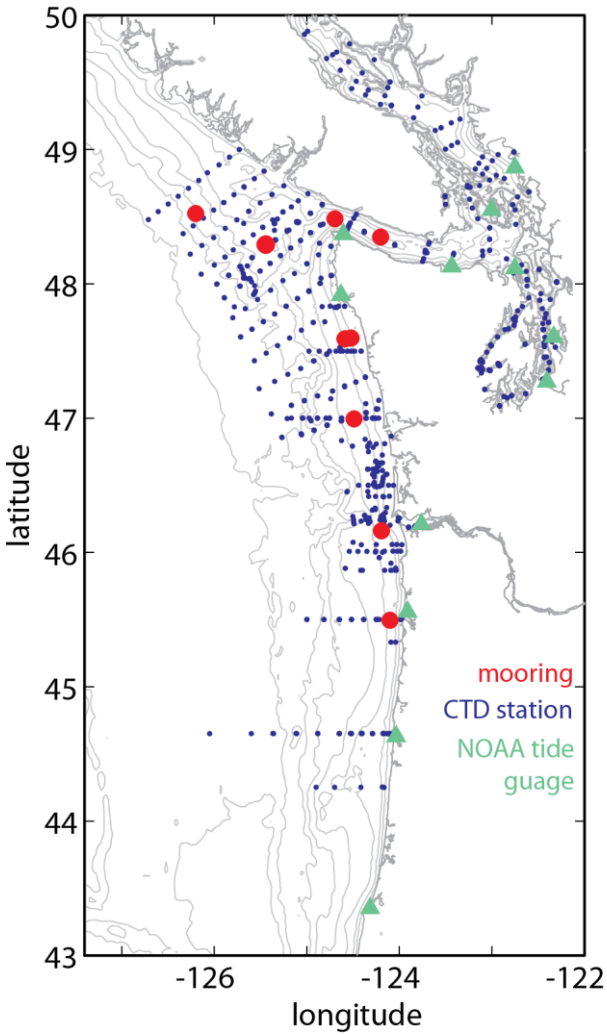
Model Validation

Comparisons were done to an extensive suite of in-situ observations

(see Sutherland et al. 2011)

- ▲ sea surface height
  12 NOAA tide gauges
- • salinity and temperature
  over 2000 CTD casts from ECOHAB, RISE, DOE, PRISM, Hood Canal, IOS, King County, and NOAA
- ● velocity and moored S,T
  7 coastal ADCP / CTD moorings from the ECOHAB and RISE projects, 2 moorings from IOS

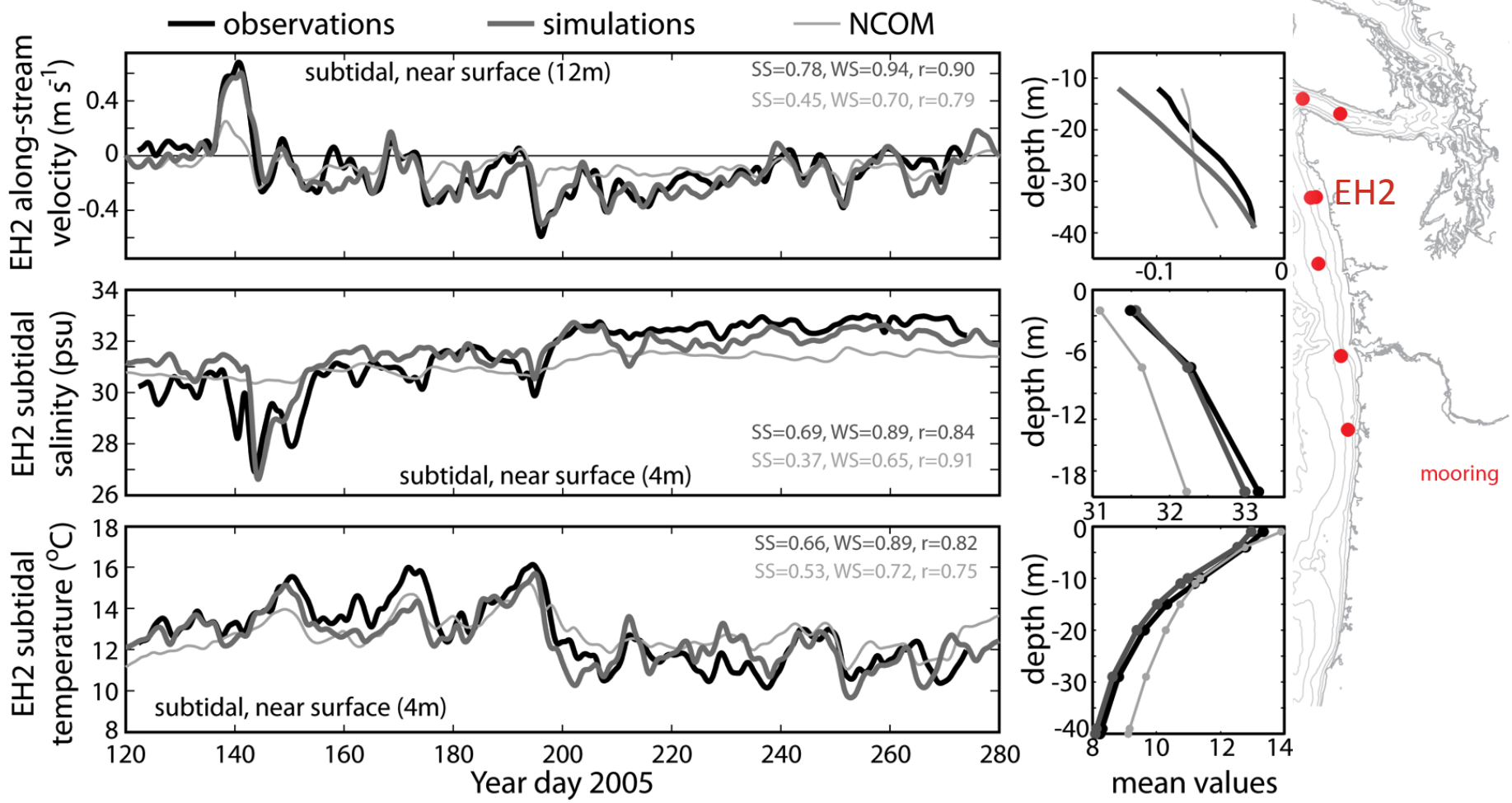
in addition: satellite and glider data



(Special thanks to R. Thomson, B. Peterson, B. Hickey, R. Kudela, N. Pelland, PRISM, ORCA, DOE, King County, Hood Canal citizen monitoring project, ORHAB, V. Trainer, and A. Odell for use of their data for model validation!!)

Model Validation - MOORINGS

Near Surface velocity, temperature, salinity at EH2



Model Statistical Validation

Willmott Score (WS) ptxhighT40_2_2005_addxxobcTout360

Mooring:	A1	J2C	EH1	EH3	EH2	EH4	RN	RC	RS	racerocks	**average**
U	0.56	0.71	0.94	0.81	0.65	0.65	0.54	0.61	0.52	NaN	**0.68**
V	0.65	0.49	0.66	0.73	0.84	0.78	0.61	0.72	0.86	NaN	**0.70**
S	0.40	NaN	0.65	0.57	0.86	0.62	0.88	0.78	0.89	0.49	**0.68**
T	0.58	NaN	0.58	0.6	0.84	0.94	0.86	0.84	0.88	0.92	**0.78**
Ulp	0.67	0.78	0.85	0.68	0.8	0.84	0.47	0.56	0.56	NaN	**0.69**
Vlp	0.62	0.59	0.67	0.73	0.92	0.85	0.65	0.73	0.91	NaN	**0.74**
Slp	0.42	NaN	0.65	0.58	0.88	0.62	0.91	0.84	0.93	0.51	**0.70**
Tlp	0.58	NaN	0.57	0.6	0.88	0.96	0.89	0.87	0.91	0.92	**0.80**
average	**0.56**	**0.64**	**0.70**	**0.66**	**0.83**	**0.78**	**0.73**	**0.74**	**0.81**	**0.71**	**0.72**

WS SSH ptxhighT40_2_2005_addxxobcTout360

Station	raw	low pass
Charleston	0.95	0.95
South Beach	0.97	0.97
Astoria	0.96	0.96
Garibaldi	0.99	0.99
La Push	0.99	0.99
NeahBay	0.99	0.99
Port Angeles	0.98	0.98
PortTownsend	0.96	0.96
FridayHarbor	0.98	0.98
Seattle	0.93	0.93
Tacoma	0.93	0.93
CherryPoint	0.98	0.98
average	**0.97**	**0.97**

WS ptxhighT40_2_2005_addxxobcTout360

variable	CTD cast aggregate
S	0.92
T	0.96

(Again, special thanks to R. Thomson, B. Peterson, B. Hickey, PRISM, ORCA, DOE, King County, Hood Canal citizen monitoring project, ORHAB, V. Trainer, and A. Odell for use of their data for model validation!!)

Biogeochemical Model

A biogeochemical model for the US Pacific Northwest coast
(NS Banas et al, JGR, 2009,
KA Davis et al, in prep,
S Siedlecki et al, in prep)

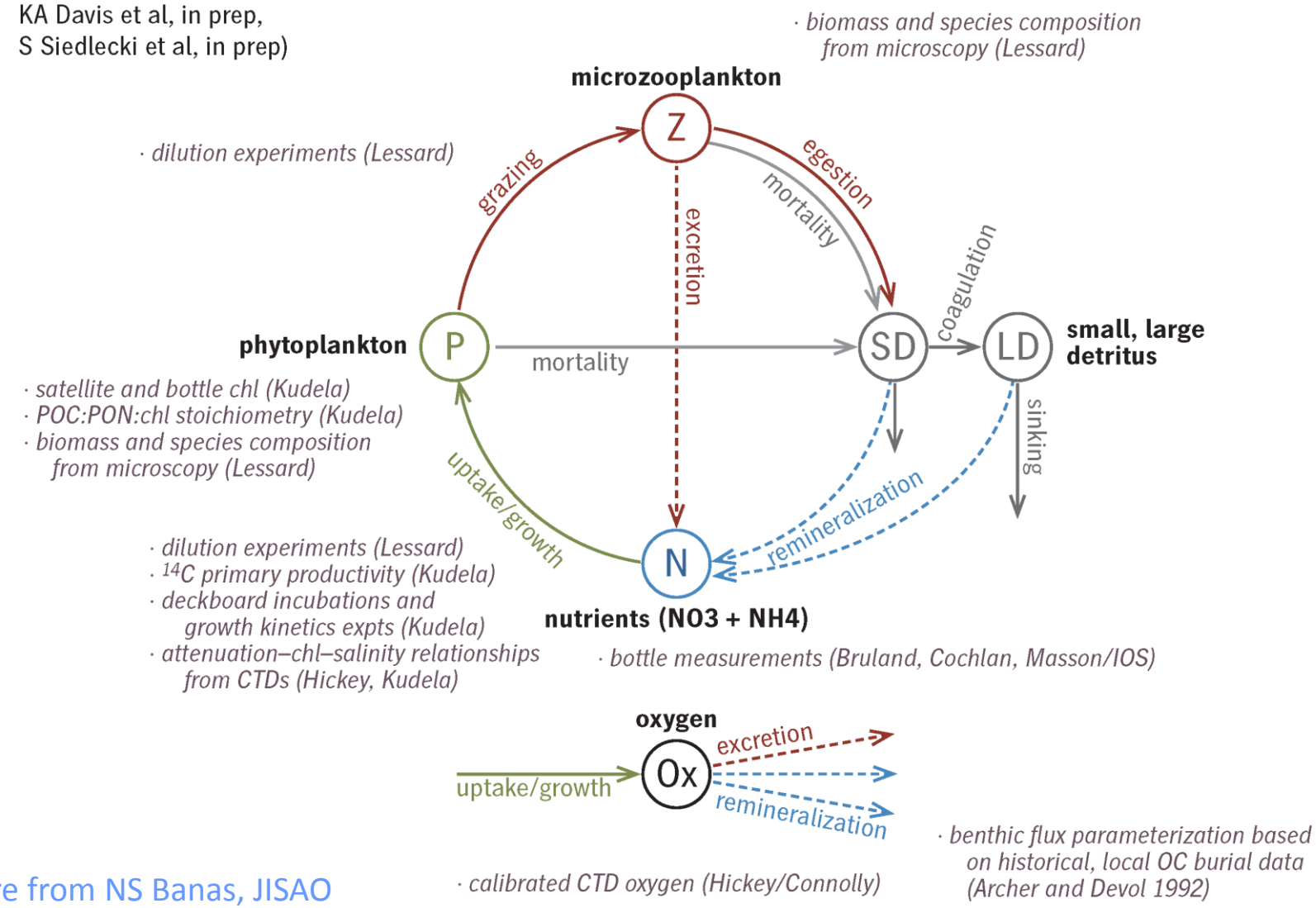
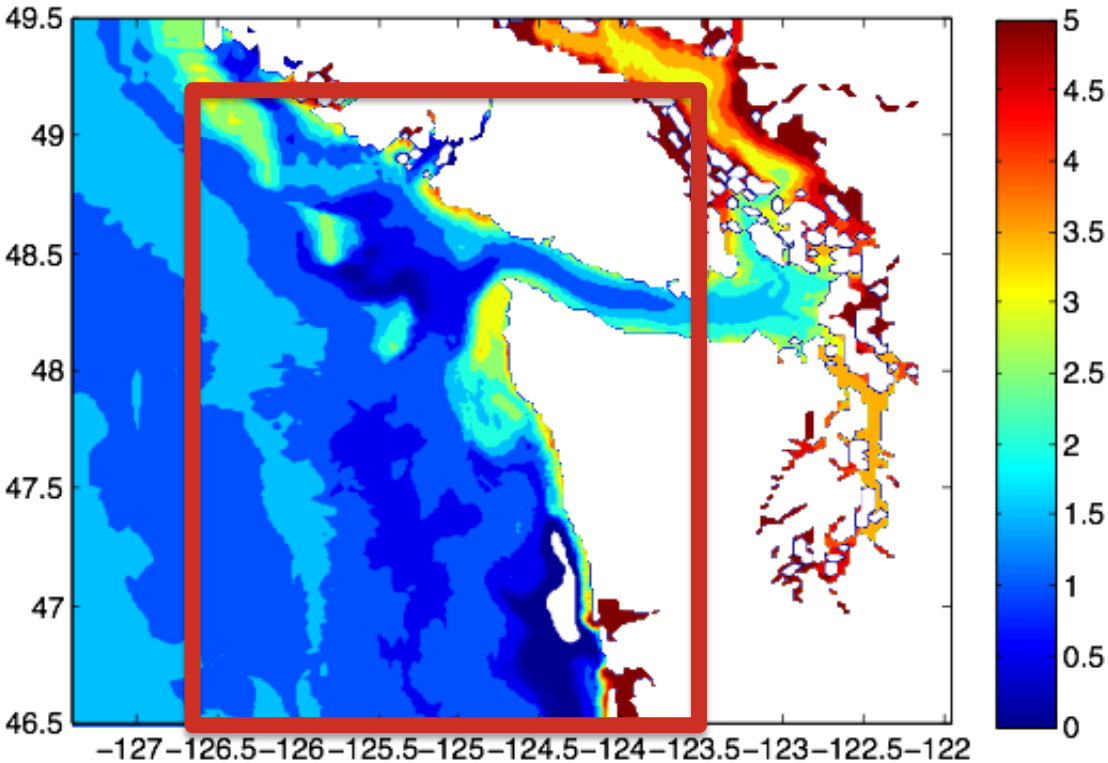


Figure from NS Banas, JISAO

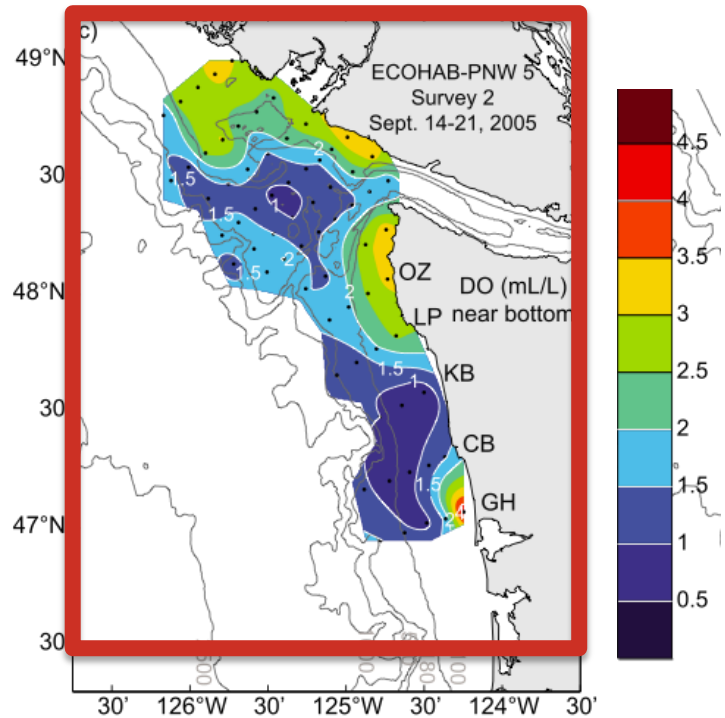
Hypoxia

Bottom Oxygen, Sept 14-21, 2005

Model



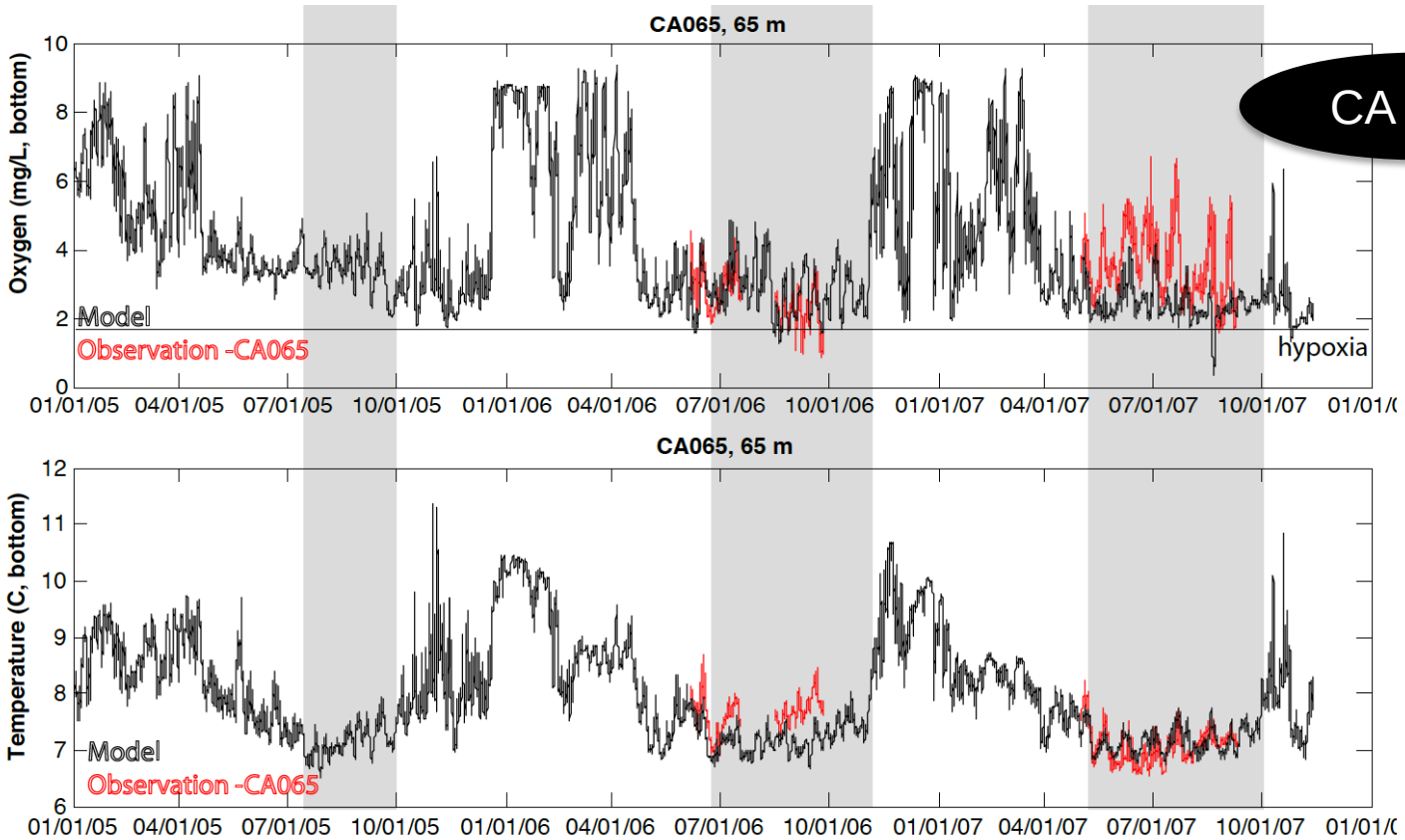
Observations



from Connolly et al, 2010

Figures from SA Siedlecki, JISAO

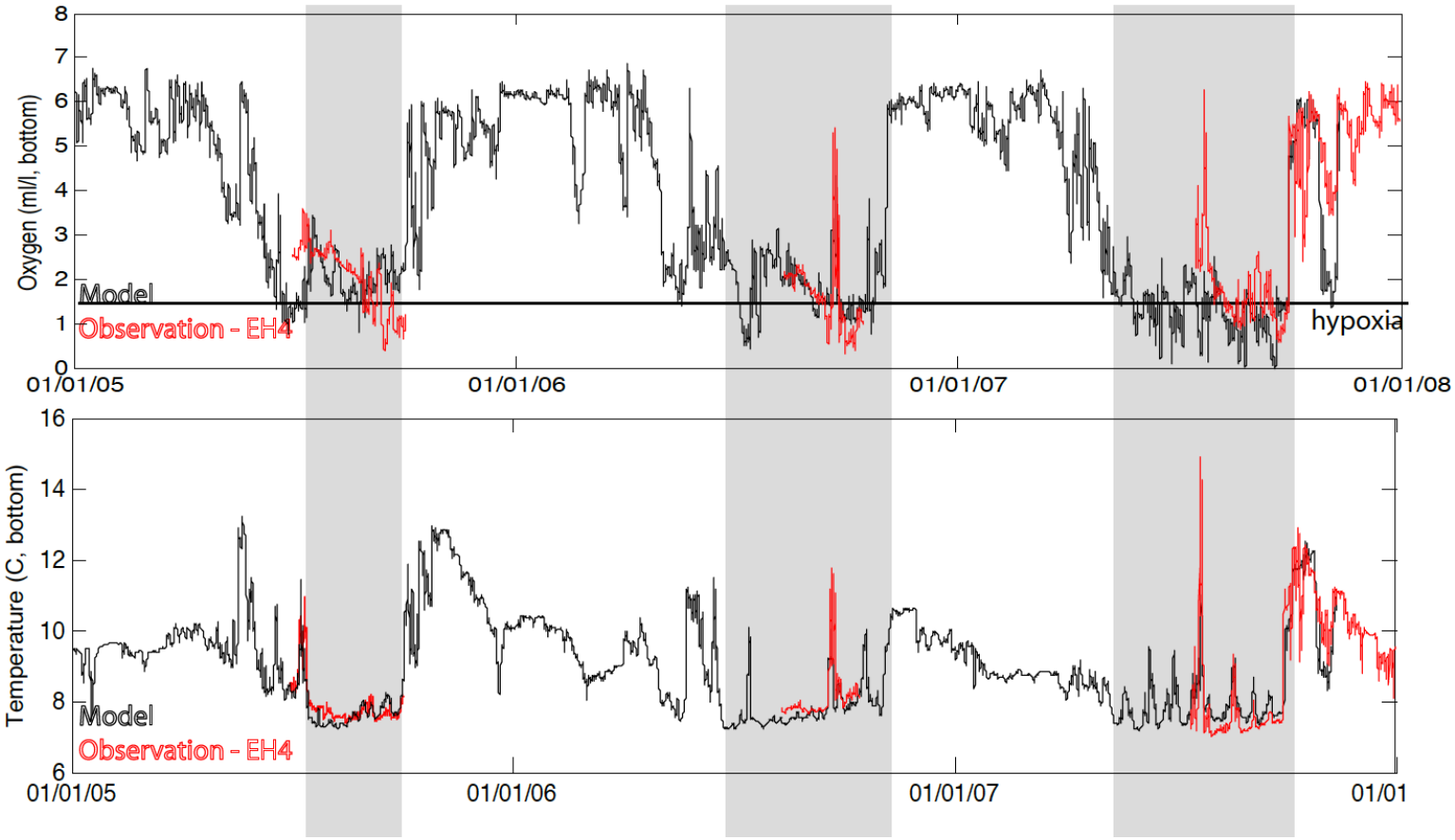
Seasonal Decline in Oxygen: OCNMS Data

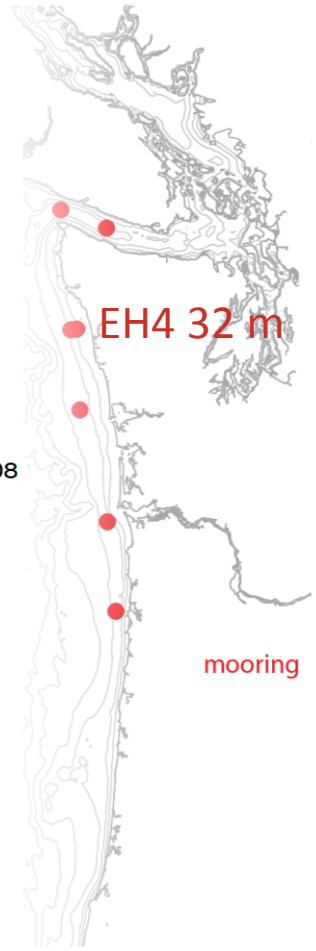


Figures from SA Siedlecki, JISAO

Observations from OCNMS Mooring

Seasonal Decline in Oxygen





Figures from SA Siedlecki, JISAO

Observations from Connolly et al, 2010

Notes on the OCNMS Data

- VERY valuable for model validation
- Time series are GREAT
- Shallow OCNMS moorings are a great complement to the NEMO mooring at 100 m on the shelf, and the coming OOI Moorings at 47 N
- Great web access to the data (nice MATLAB format)...
- BUT only through 2011

FUTURE MODELING PLANS

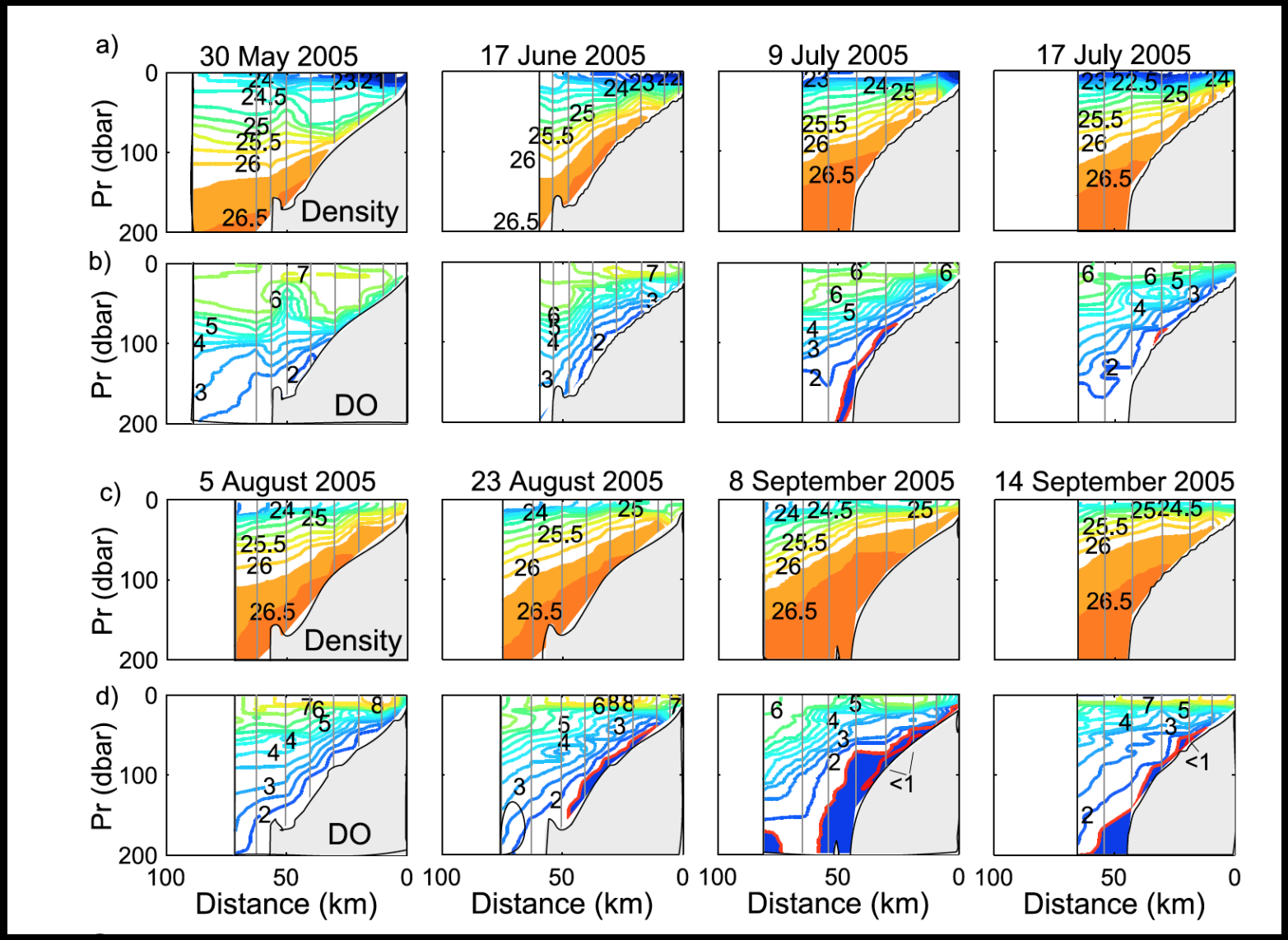
- With WOAC funding we are converting the modeling system to make daily forecasts
- Like weather forecasts: 3-5 days ahead
- Adding Carbon chemistry to address Ocean Acidification
- This Year: coastal model
- Next Year: Puget Sound

EXTRAS

Data Layers for Marine spatial Planning Project

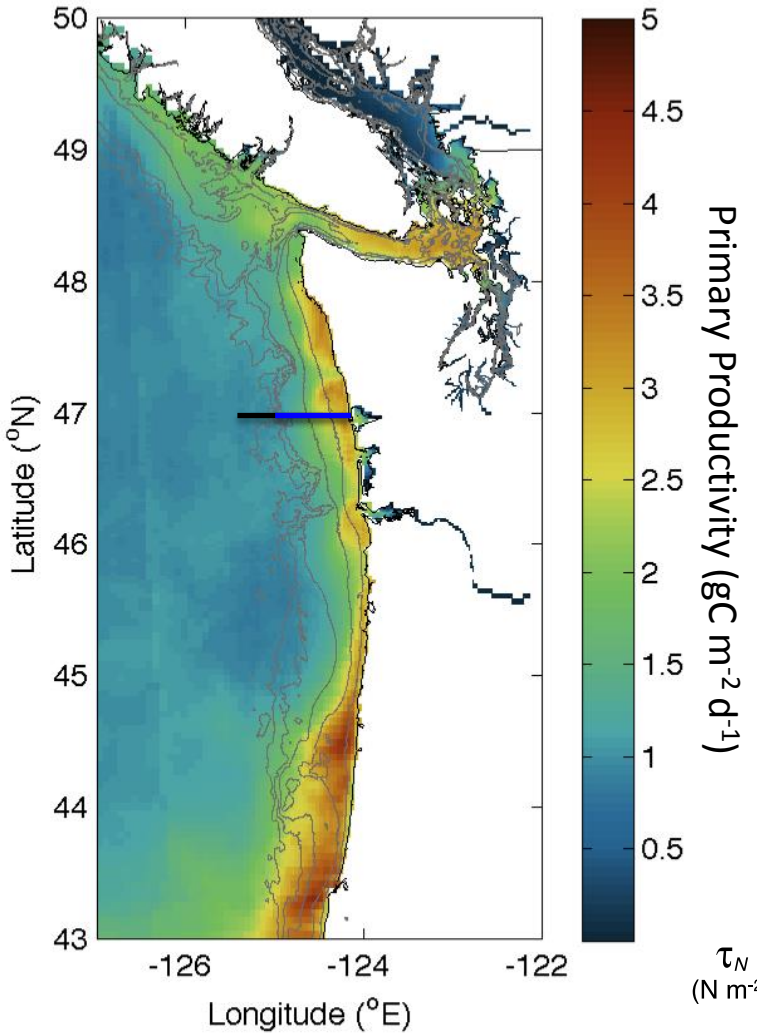
bathymetry				
current speed	Surface, bottom	winter/summer composites	mean, max	model
temperature	surface; bottom (shelf only)	seasonal composite*	Mean, max?	model
salinity	surface	seasonal composite*	Mean, max?	model
	"river influence index" (% of time < 31.5 psu salinity)	seasonal composite*	Mean, min, max	model
chlorophyll	vertically integrated	seasonal composite*	mean, min,max	model
plankton productivity	vertically integrated	seasonal composite*	mean	model
dissolved oxygen	bottom (shelf only)	seasonal composite*	mean, min	model,
	"hypoxia index" (% of time < 1.4 mg/L)	seasonal composite*	red/yellow/green classification	model,
nitrate	Surface, bottom % less than say 1mm?	Seasonal composite		model
wind ??		Seasonal composite, also max		
		*composite of 2005–07, as three-month averages		

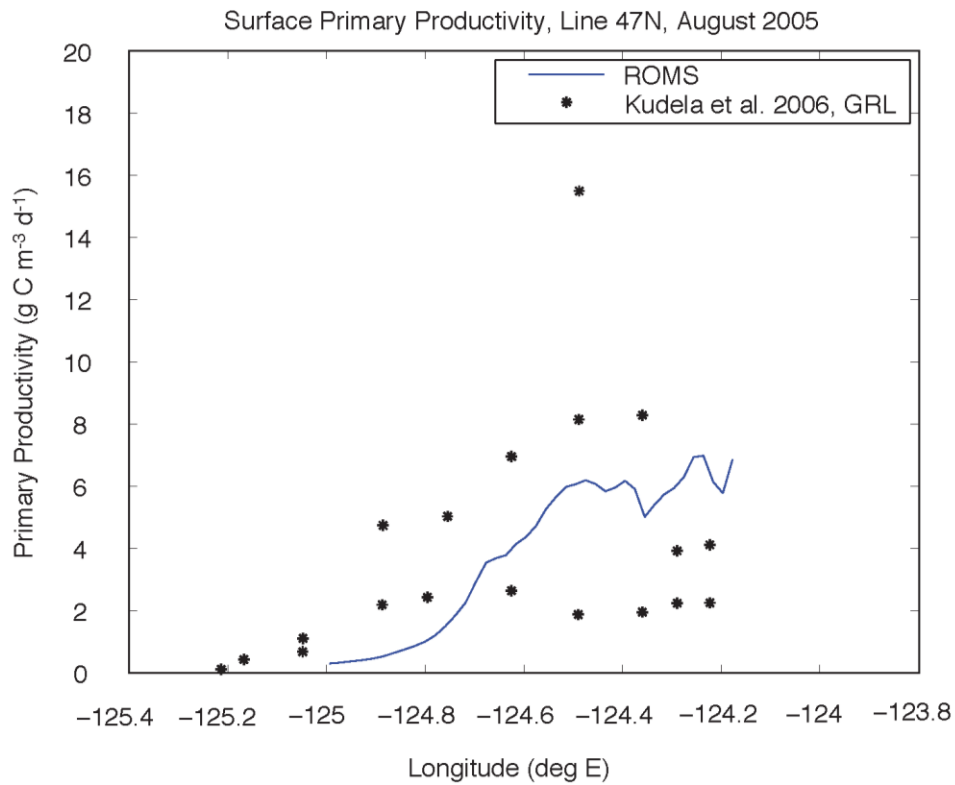
Seasonal evolution on the Shelf

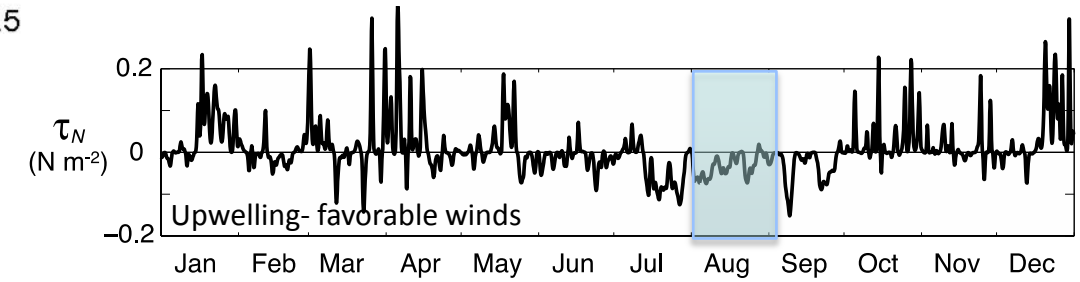


Primary Productivity

Primary Productivity



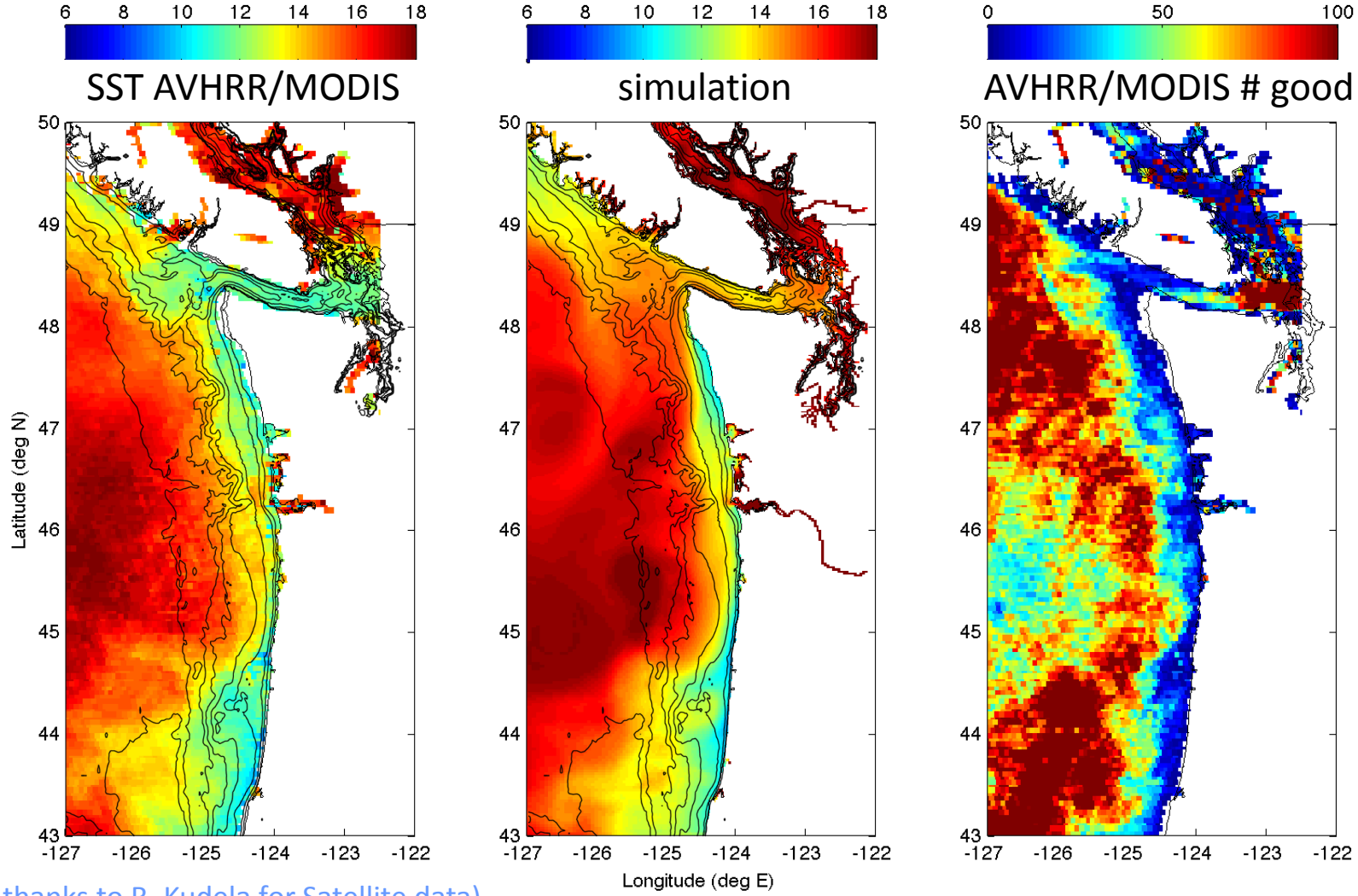




Figures from KA Davis, APL

Process Analysis - SST

August 2005

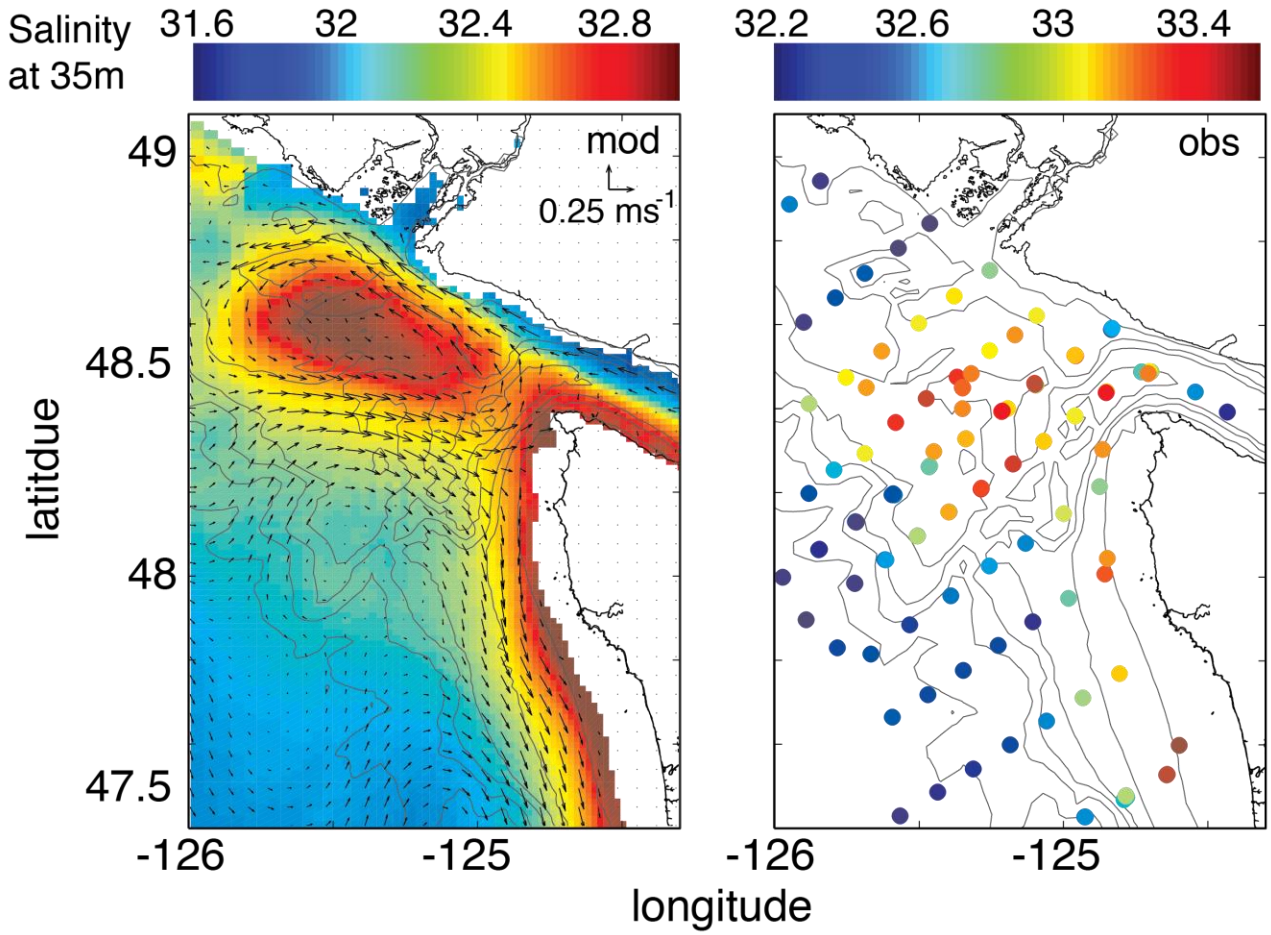


(Special thanks to R. Kudela for Satellite data)

Process Analysis – JdF Eddy

Retention area and HAB hotspot: Juan de Fuca Eddy

Mean salinity and velocity at 35m depth from Sept 2-22 2005

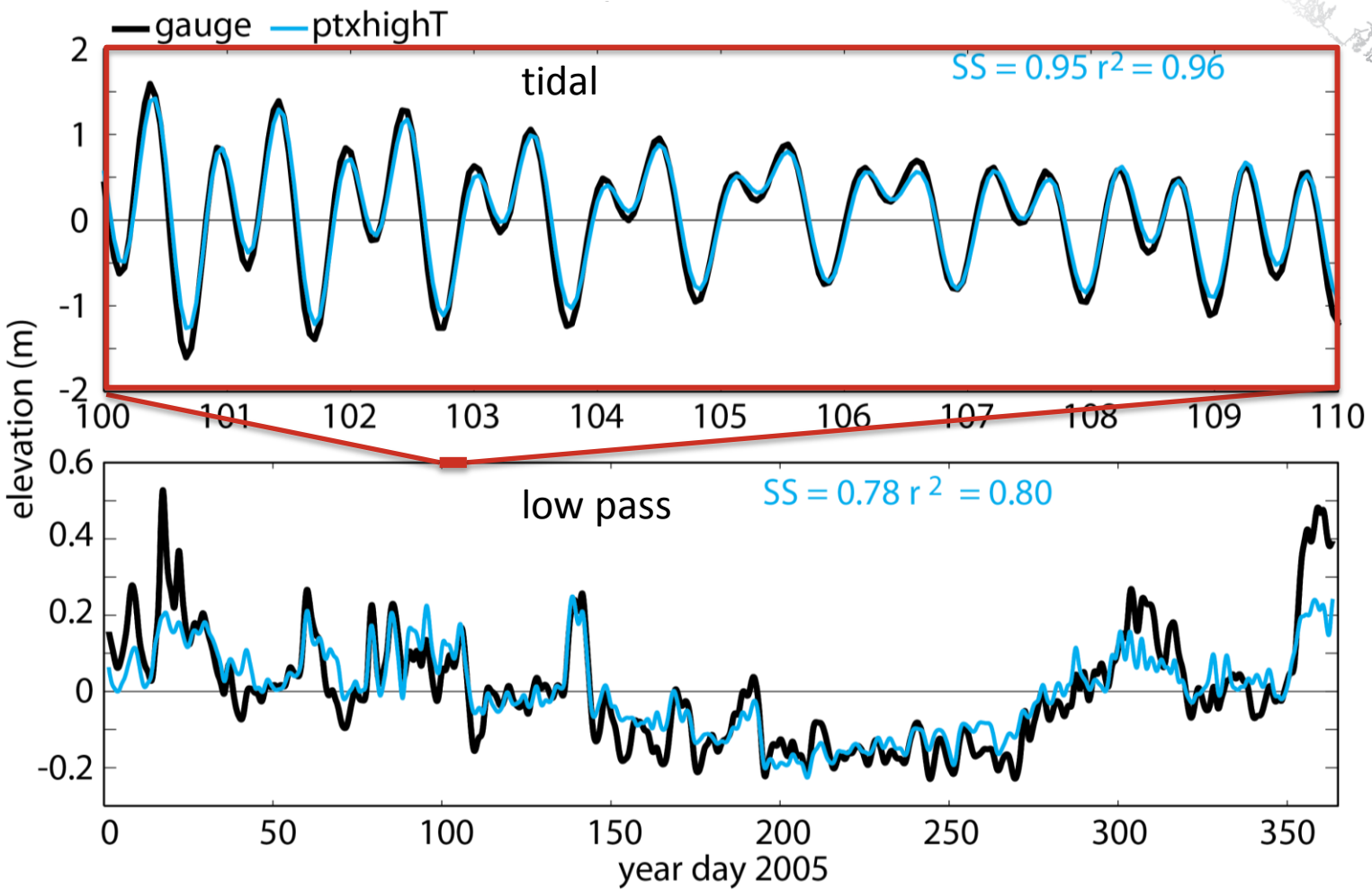


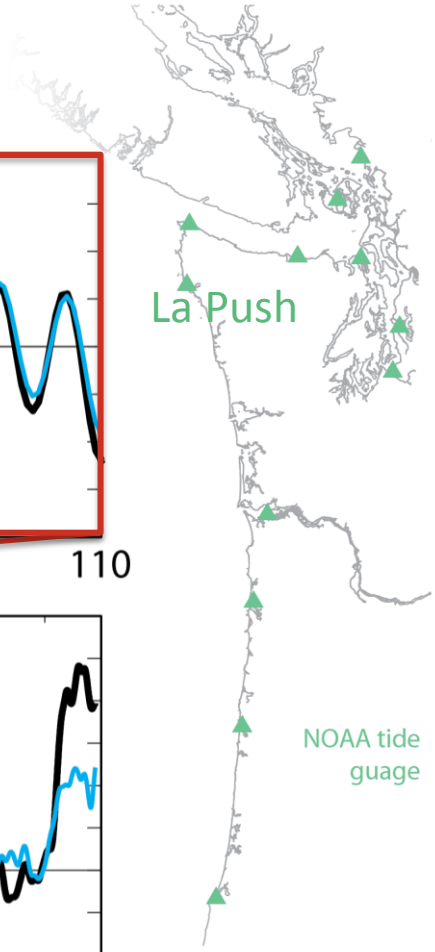
ECOHAB CTD survey Sept 2-22 2005

Bathymetry contours at 50, 100, 150, 250, 500, 1000, 2000m

Model Validation - SSH

Water level comparison at NOAA tide gauge, La Push





Model Statistical Validation

COLORSCALE WORST MEDIUM BEST

Skill Score	NCOM	ptxmed	ptxhigh	ptxhighT (turbo)						salish
					40 vert	addxxobc	addxxobc Tout360	addxxobc Tout360 sponge	40 vert addxxobc Tout360	
U	-0.10	-0.31	-0.39	-0.12	-0.19	-0.12	-0.05	-0.13	-0.11	-0.35
V	0.06	-0.27	-0.30	-0.25	-0.22	-0.22	-0.19	-0.23	-0.15	-0.27
S	-12.68	-16.45	-1.47	-2.30	-2.11	-2.36	-2.06	-2.47	-1.25	-2.16
T	-0.37	-1.00	0.15	-0.14	-0.06	-0.16	-0.19	-0.22	-0.05	0.23
Scast	0.05	0.64	0.77	0.80	0.80	0.80	0.80	0.79	0.77	0.85
Tcast	0.59	0.63	0.85	0.84	0.85	0.84	0.84	0.83	0.85	0.88
eta	0.01	0.92	0.92	0.89	0.89	0.89	0.89	0.89	0.89	0.93
Ulp	-1.13	-0.22	-0.46	-0.12	-0.11	-0.06	-0.07	-0.24	-0.08	-0.46
Vlp	-0.85	-0.03	-0.10	-0.07	-0.05	-0.07	0.01	-0.03	0.06	-0.13
Slp	-13.19	-16.55	-1.44	-2.19	-2.06	-2.25	-1.95	-2.35	-1.16	-2.13
Tlp	-2.10	-1.11	0.07	-0.23	-0.13	-0.27	-0.33	-0.39	-0.13	0.27
etalp	0.68	0.59	0.62	0.64	0.61	0.74	0.72	0.74	0.72	0.70
Umaj	0.08	0.07	0.02	0.06	0.10	0.08	0.11	0.07	0.16	0.04
Umajlp	-0.67	0.09	0.05	0.09	0.11	0.10	0.17	0.13	0.21	0.02
average	-2.12	-2.36	-0.05	-0.15	-0.11	-0.15	-0.09	-0.19	0.05	-0.11