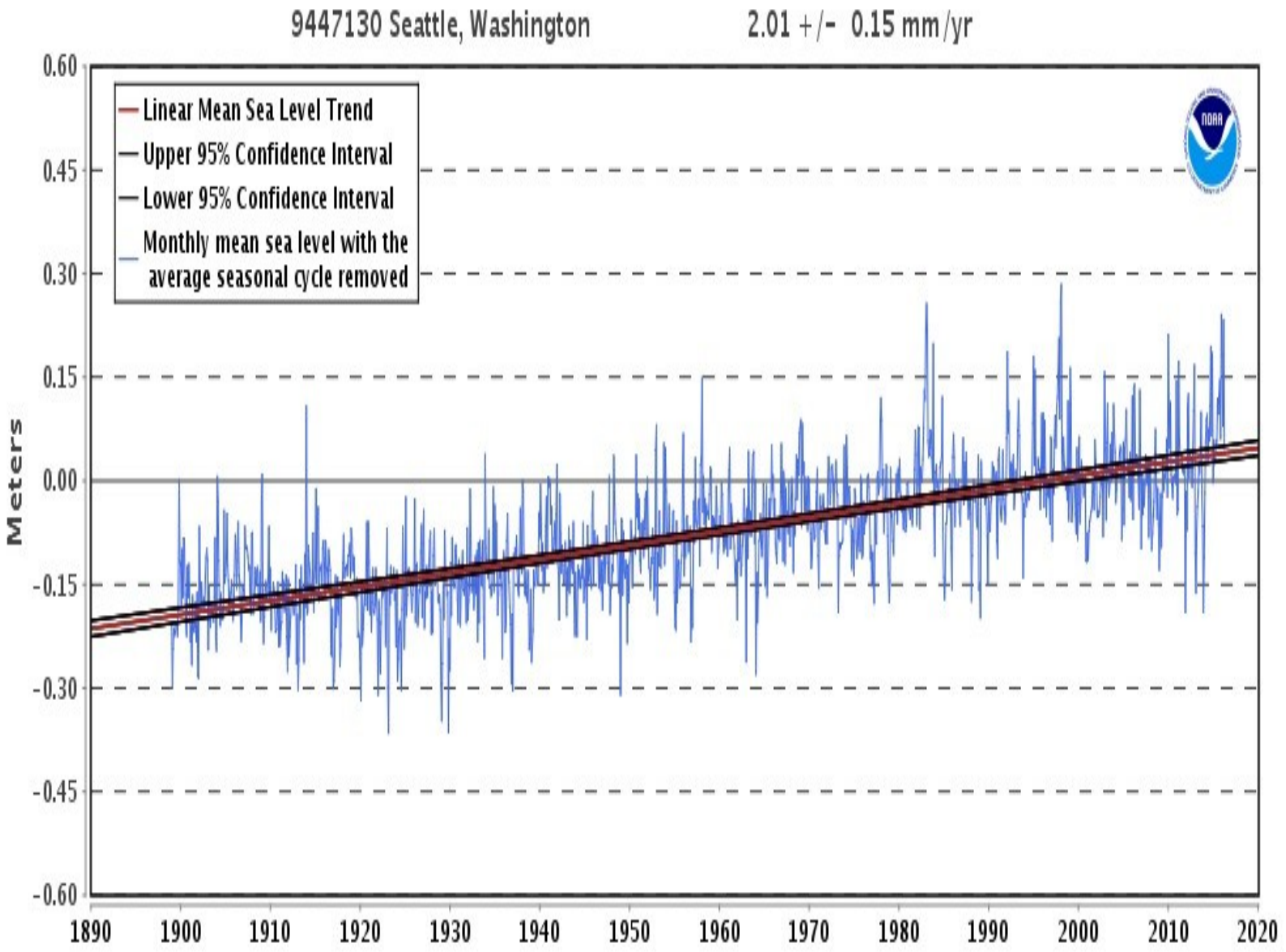
Two statistical methods

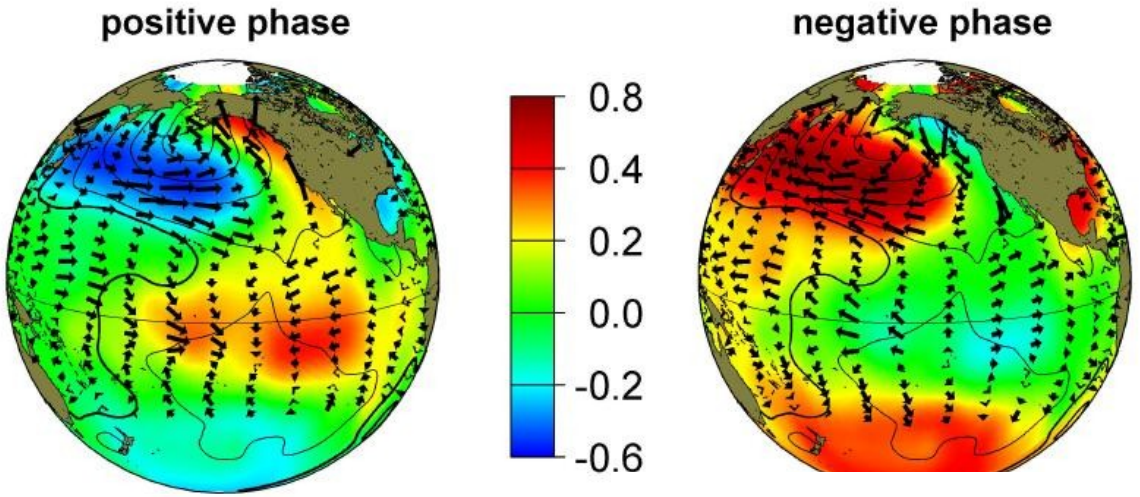
Chanlyn Jiang

- **Linear regression to predict if Seattle will be underwater.**
- **Neural network to interpolate gappy temporal-spatial field.**

Seattle historical sea level trend

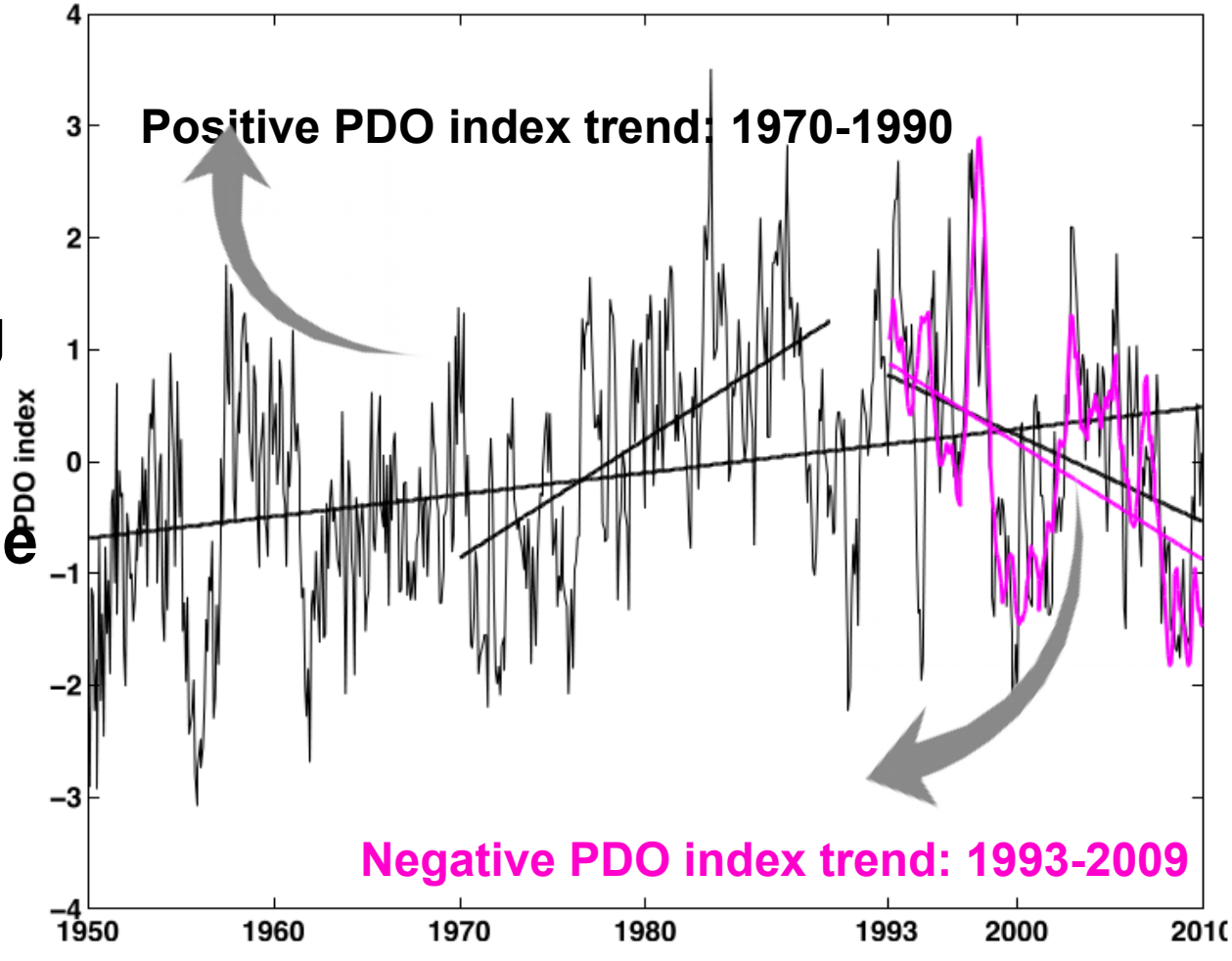


Pacific Decadal Oscillation



Mantua et al., 1997

PDO index is the standardized principle component of the leading empirical orthogonal function of monthly sea surface temperature of the North Pacific Ocean;



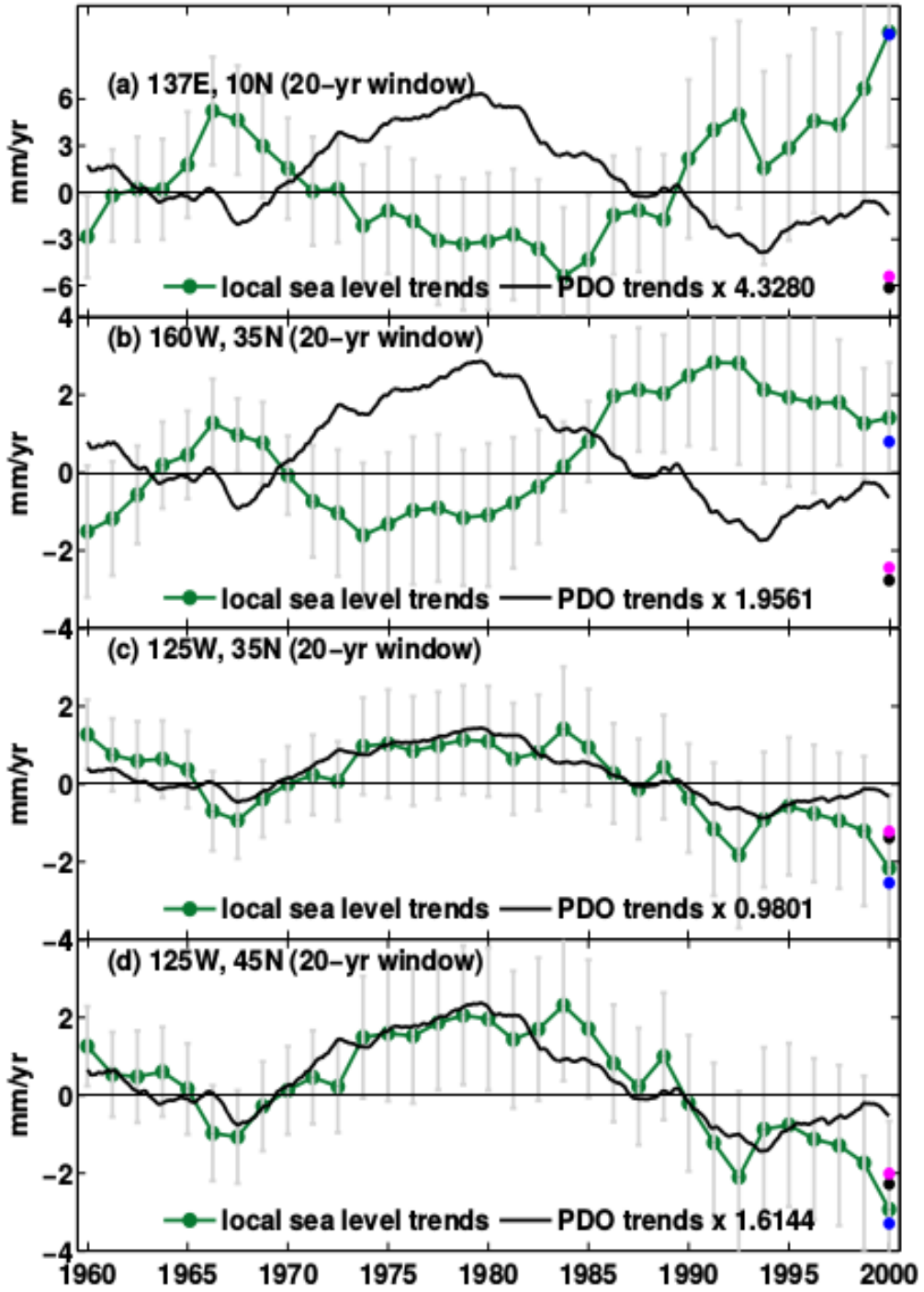
Local sea level vs. PDO index trends

Western Pacific

Central Pacific

California

Newport Oregon



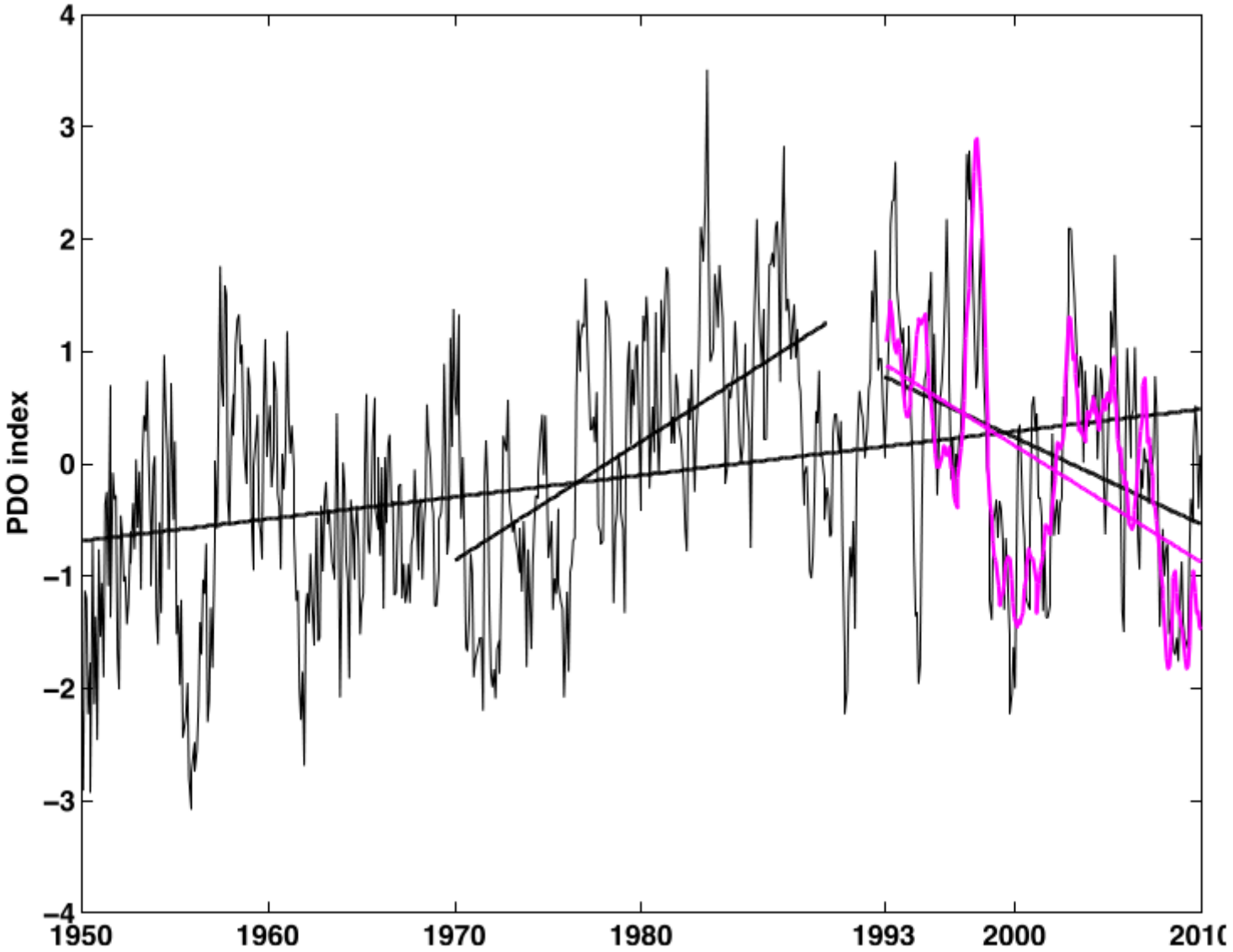
Local sea level trends along Seattle, Oregon, & California coasts are positively correlated with the PDO index trend;

Seattle local sea level trend switches to positive if PDO index trend switches to positive;

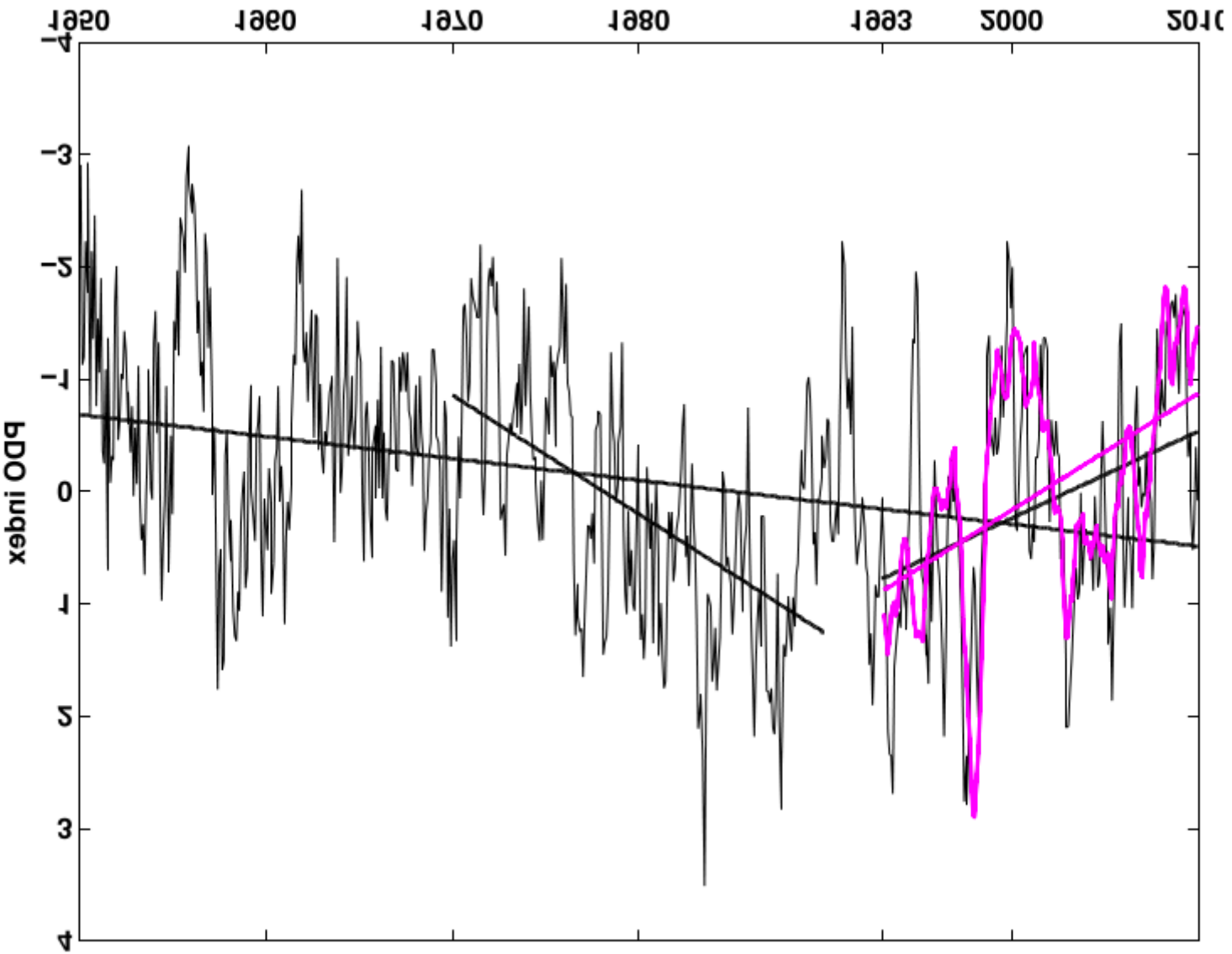
Sea level trend projection

Linear regression: sea level trend is determined by the global sea level trend due to water expansion and by the trend due to Pacific Decadal Oscillation;

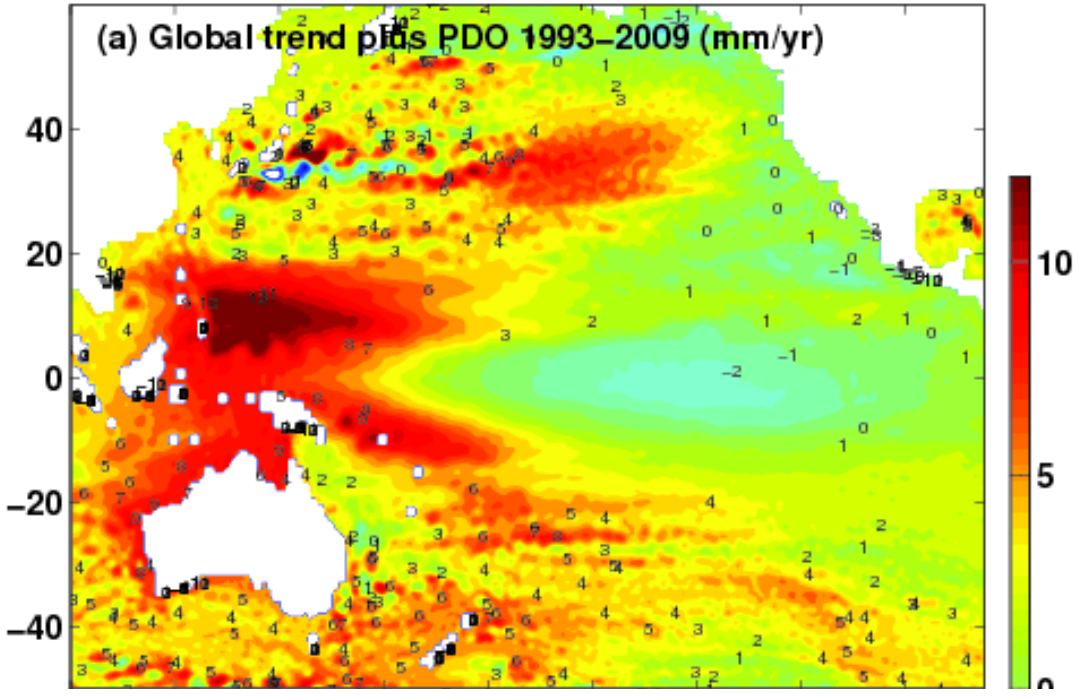
What if PDO index trend flips from negative



to positive?

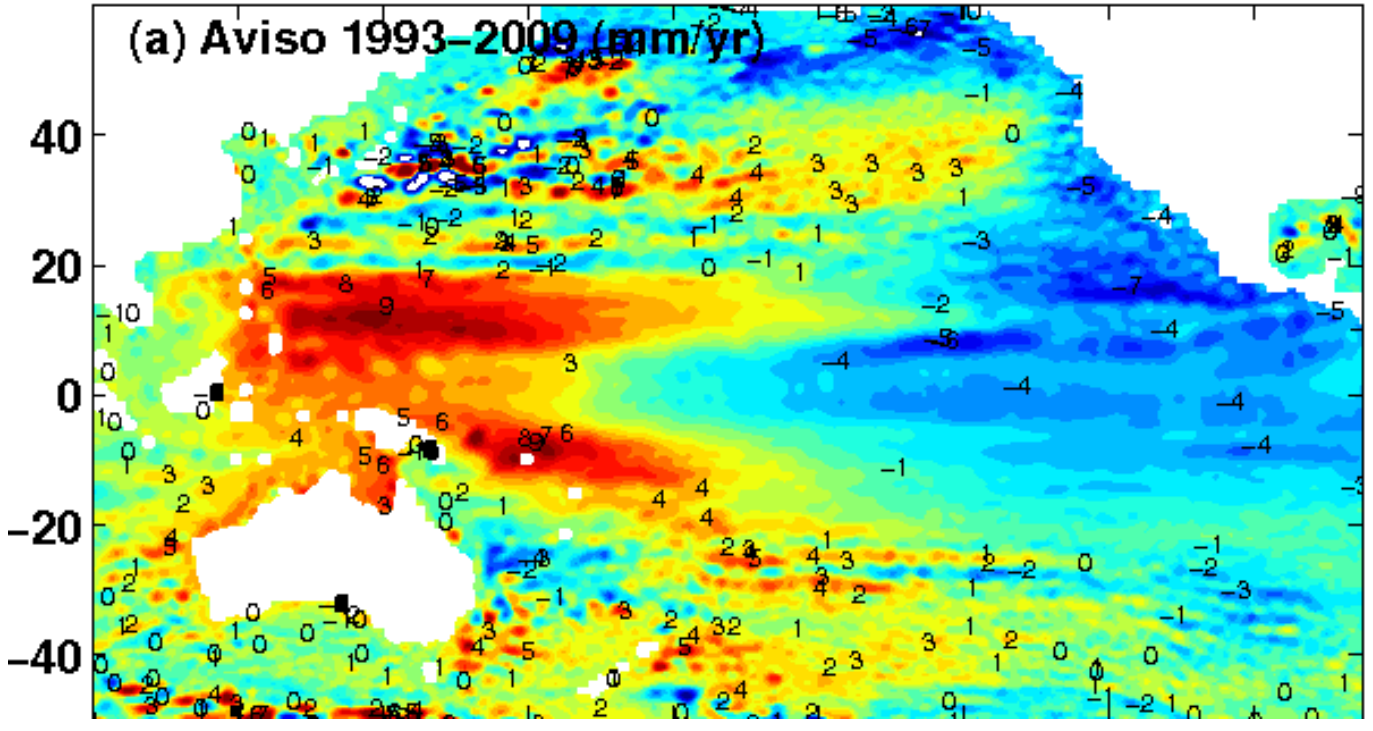


Seattle sea level trend in 20-30 yrs

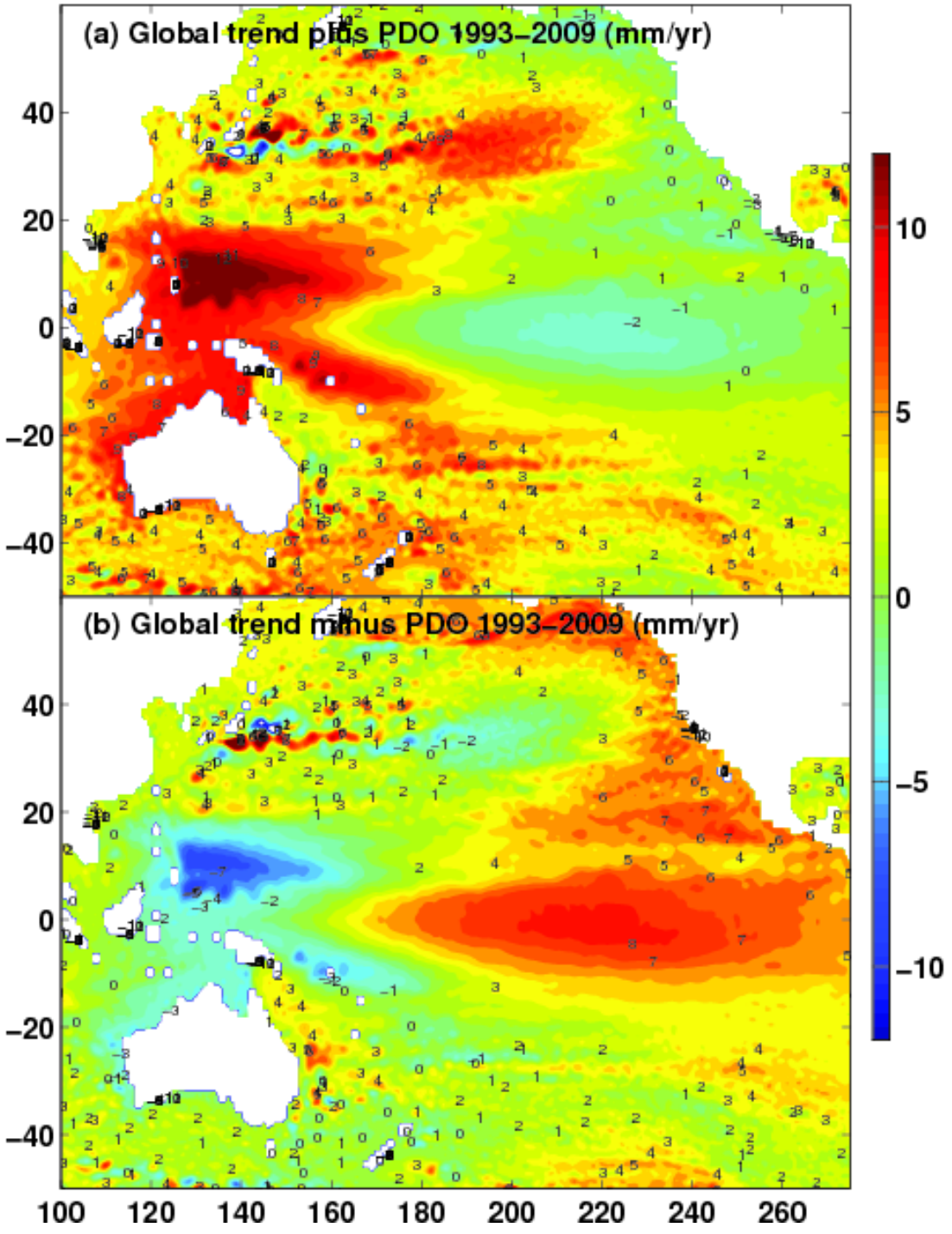


NOW:
Zero or even negative trend,

Linear model:
Explains 90% of total variance;



Seattle sea level trend in 20-30 yrs



NOW:
Zero or even negative trend;

IN 20-30 YEARS:
6-7 mm/yr,
twice or triple of the global trend;

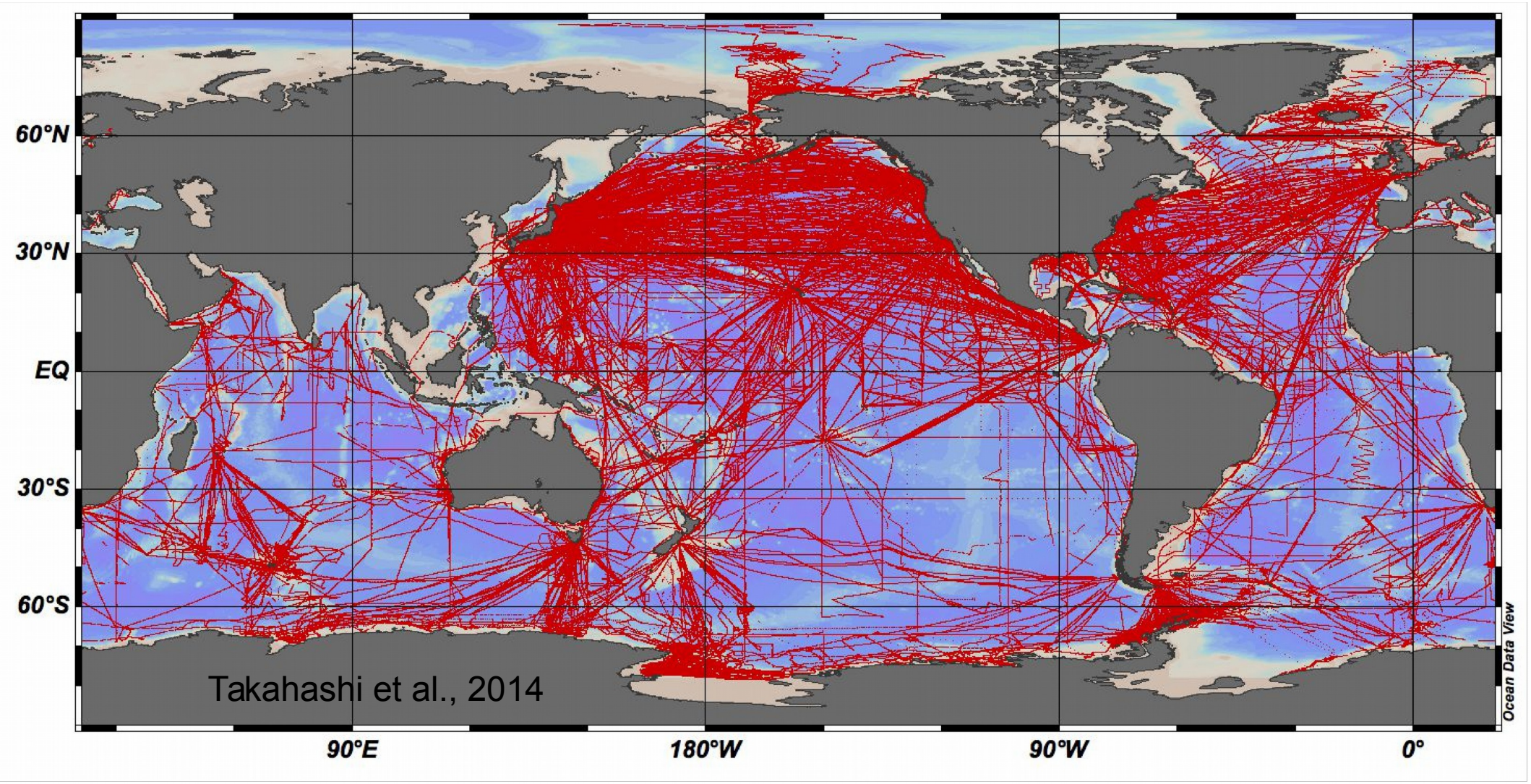
Seattle sea level projection in 2050

Areas in blue were projected to be at risk of flooding in 2050

Will Seattle be underwater in 20-30 years?

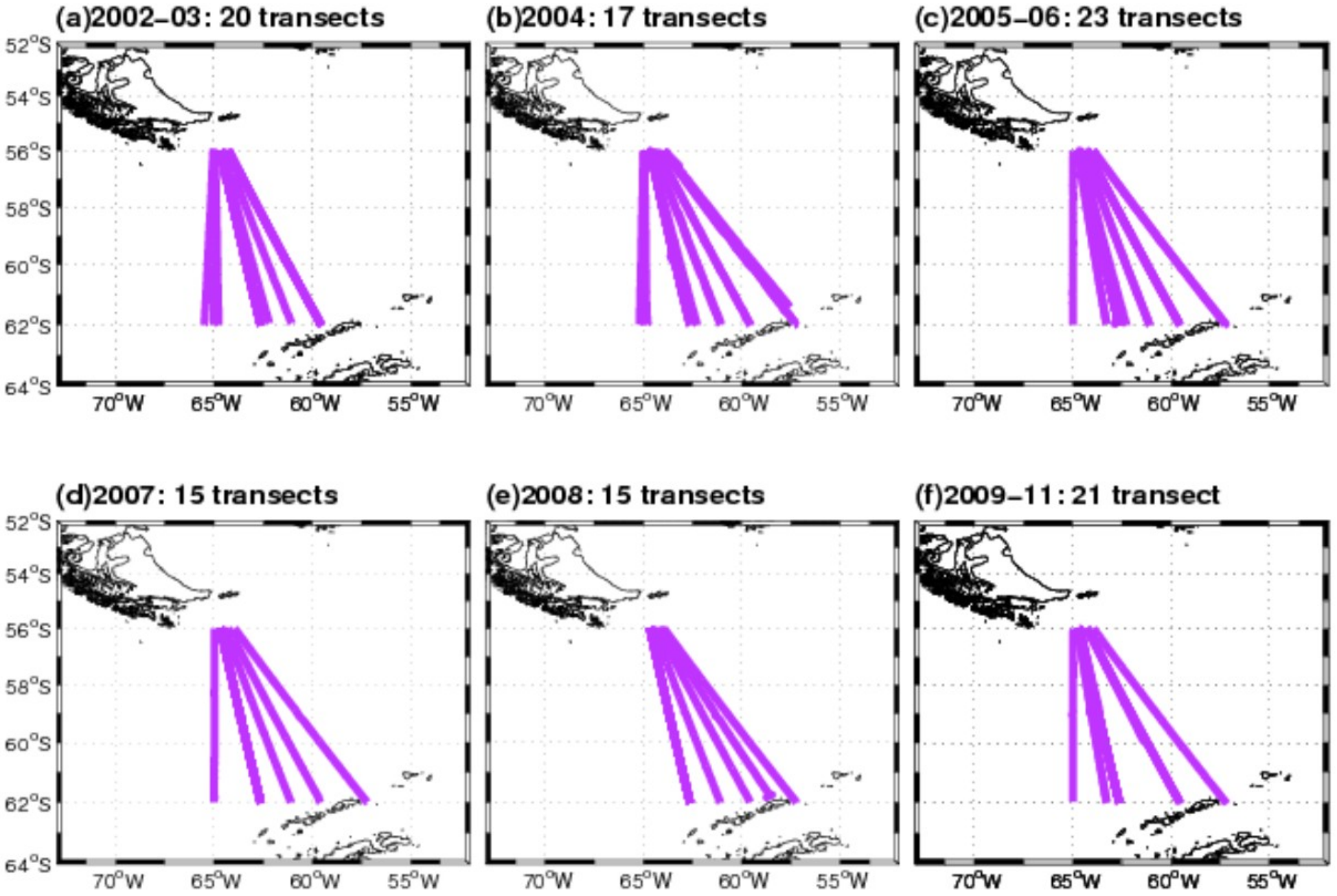
- **Linear regression: explained 90% of the total variance;**
- **More sophisticated models: Intergovernmental Panel on Climate Change (IPCC) Climate Models;**
- **Analyze multi-model ensembles;**

Gappy surface water pCO_2



Surface water partial pressure of CO_2 determines the amount of and direction of atmospheric CO_2 that can be absorbed by the ocean;

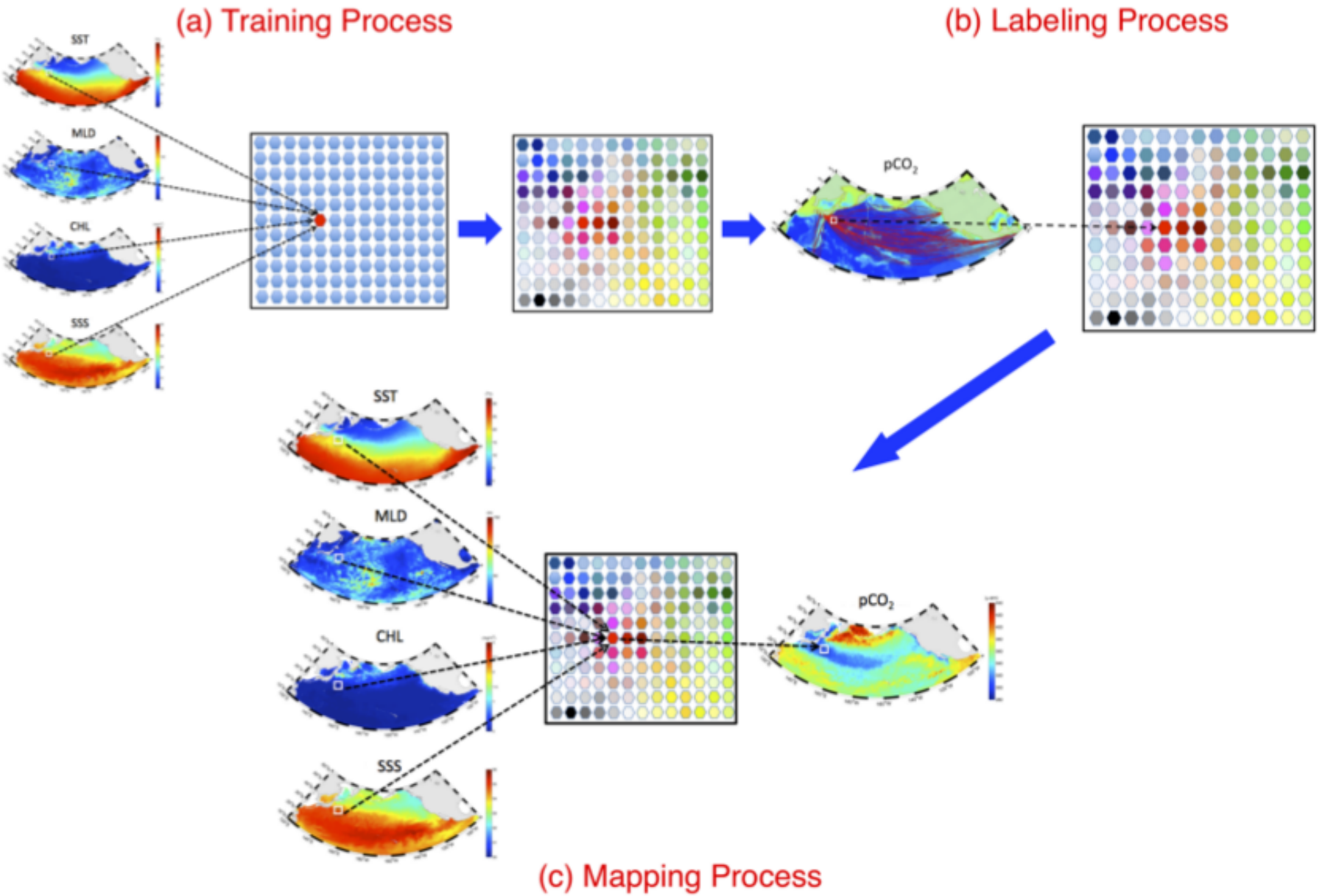
Observed pCO_2 in Drake Passage



Interpolation: SOM

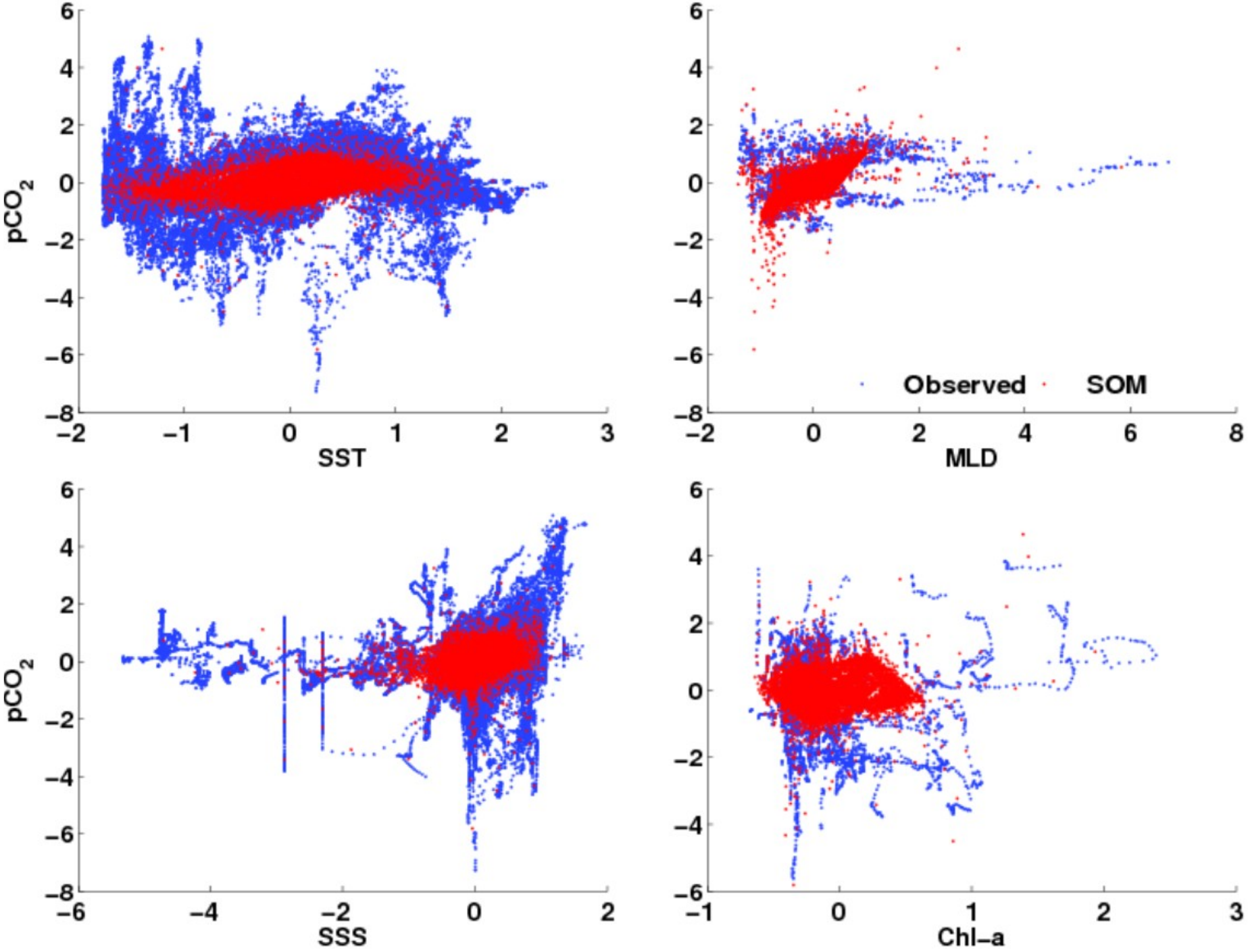
- **Simple statistical approaches fail to interpolate the field;**
- **Neural network: can resolve non-linear and discontinuous relationship among input parameters without a priori assumptions;**
- **Self-organizing feature map: a type of unsupervised neural network (Kohonen, 1988);**
- **Unlike error-correction backpropagation neural network, SOM applies competitive learning using a neighborhood function to preserve the topological properties of the input space;**

SOM processes



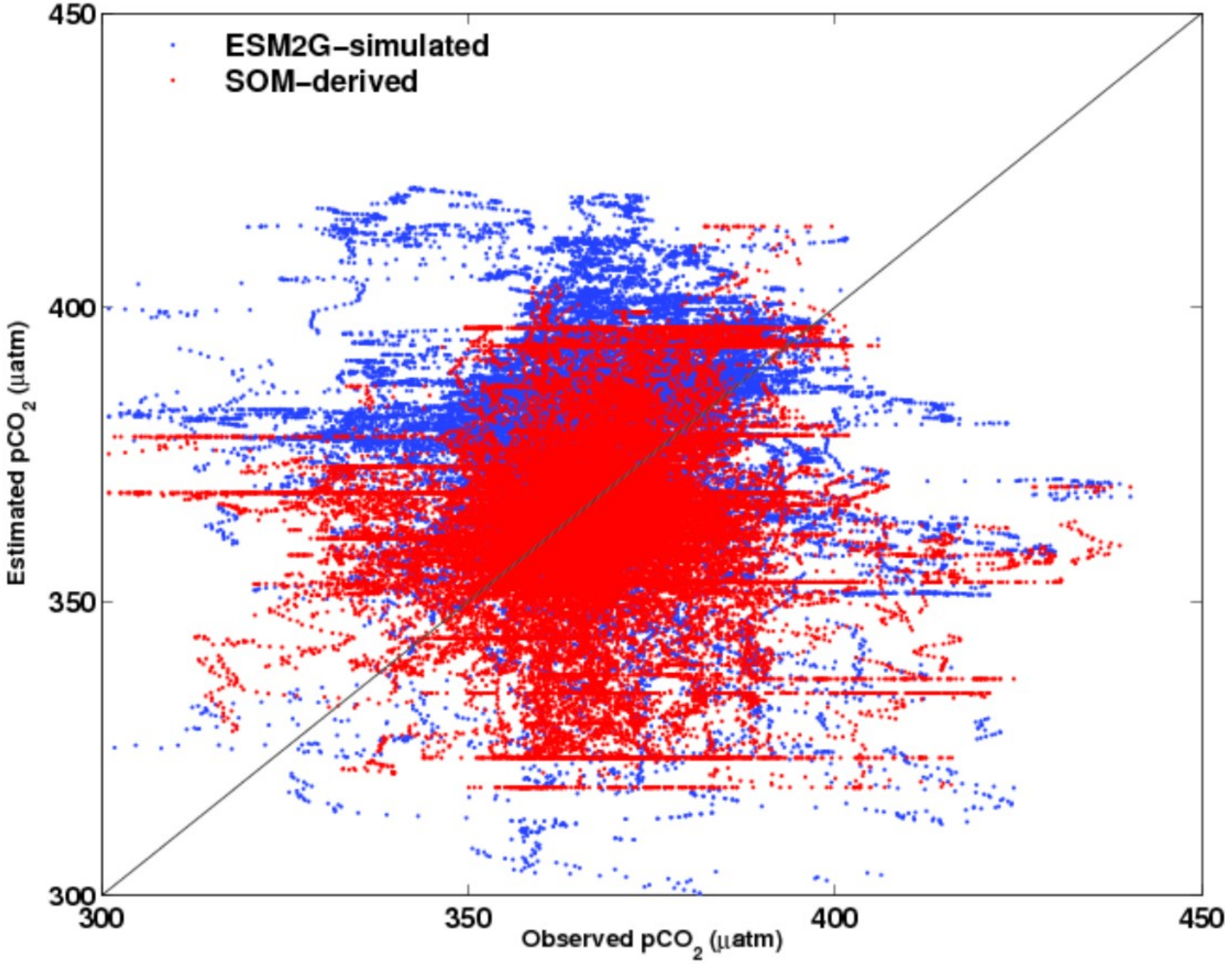
Nakaoka et al., 2013

SOM results



Jiang, Liu, and Weisberg, proposal submitted to NSF, 2015

Evaluation



Jiang, Liu, and Weisberg, proposal submitted to NSF, 2015

Summary

- **Used linear regression to predict Seattle sea level trends in the next 20-30 years, more sophisticated models can be further used to improve its accuracy;**

- **Used neural network SOM technique to extract non-linear relationship between pCO_2 and its controlling features, the estimated field can be used to constrain the climate models;**