Practical application of least square theory

* Function Fitting
* Inverse problem
I want to compute SST anomalies

Which mean do I remove?
OPTION 1: Remove the constant spatial mean

Mean = 13.5 °C
Function Fitting

OPTION 2: Remove the meridional gradient (better)
Function Fitting
How to remove the gradient with least square?

Spatial Mean Gradient removed

(1) Least Square Solution
\[
\begin{align*}
J &= (y - Ex)^T (y - Ex) \\
\hat{x} &= (E^T E)^{-1} E^T y
\end{align*}
\]
What if we want to remove the gradient associated with the California Current?

(2) Weighted Least Square Solution

\[
\begin{align*}
J &= (y - Ex)^T W (y - Ex) \\
\hat{x} &= (E^T WE)^{-1} E^T Wy
\end{align*}
\]
Remove the meridional gradient (with different weighting)
Equally weighted California Current and Cina Sea

Weighted Least square looks like this
Anomalies (with different weighting)
What if we want to remove the gradient associated with the South China Sea?
What if we want to remove the gradient associated with the South China Sea?

Not so happy!
Limit the size of the model parameter, in particular the parameter controlling the zonal gradient.

\[ J = (y - Ex)^T W(y - Ex) + x^T S x \]
\[ \hat{x} = (E^T WE + S)^{-1} E^T Wy \]