A Non-Parametric Sea State Bias Model Based on SWH and Sigma0: Extending to Three Dimensions

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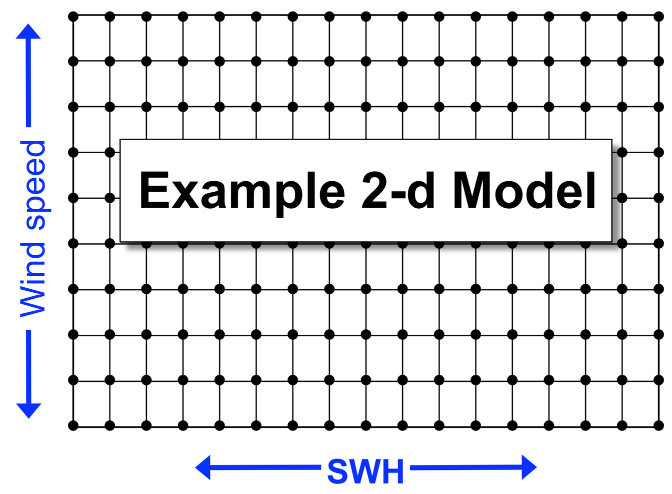
Abstract

The SSB models currently adopted for the Jason-1 and Jason-2 GDR products are based on significant wave height (SWH) and altimeter wind speed. We investigate the impact of creating SSB models based on different combinations of variables. We find that SSB models based on SWH and sigma0 have similar performance to currently adopted models based on SWH and wind-speed. We also find that models based on a third dimension, comprising the difference between 1-Hz and along-track-smoothed SWH values, reduce sea level anomaly variance by ~2 cm^2.

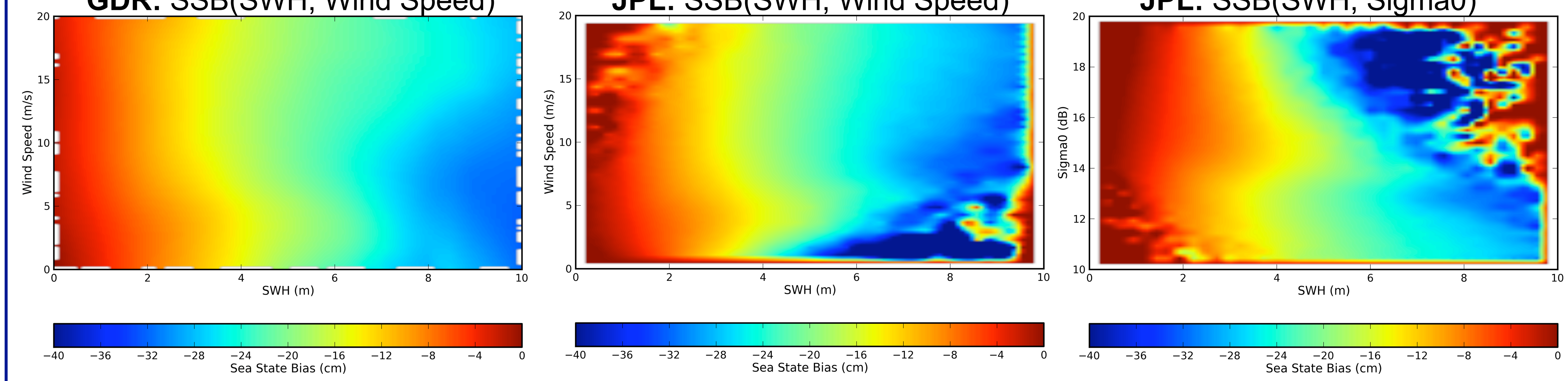
Creating SSB Models



- Construct a grid of SSB nodes
- Obtain SSB by linear interpolation
- Minimize collinear SLA differences

- Built a flexible tool for exploring N-dimensional SSB models.

Two Dimensional SSB Models For Jason-1 GDRC

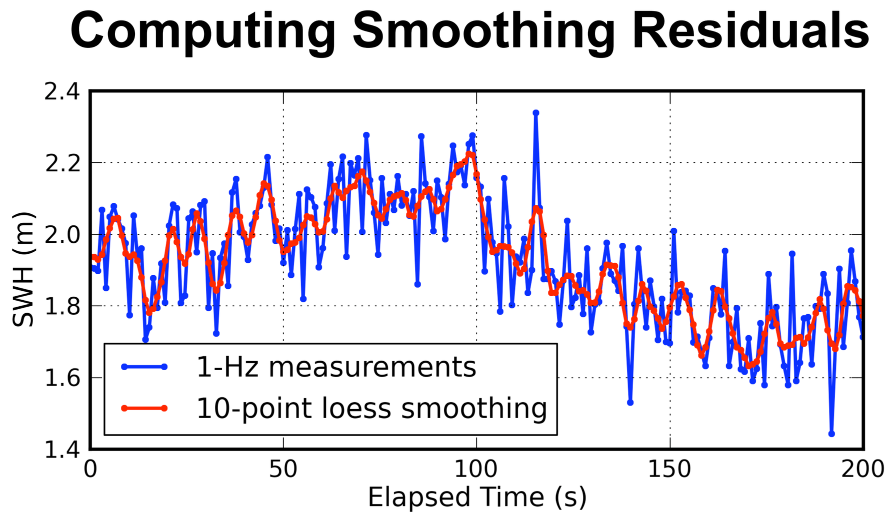


- All 2-d JPL SSB models built on 40 x 40 node grid and optimized on first 72 cycles of Jason-1 GDR-C products

- JPL SWH, Wind Speed model is similar to model on GDR
- Regions of no data result in nodes remaining at their zero a priori values

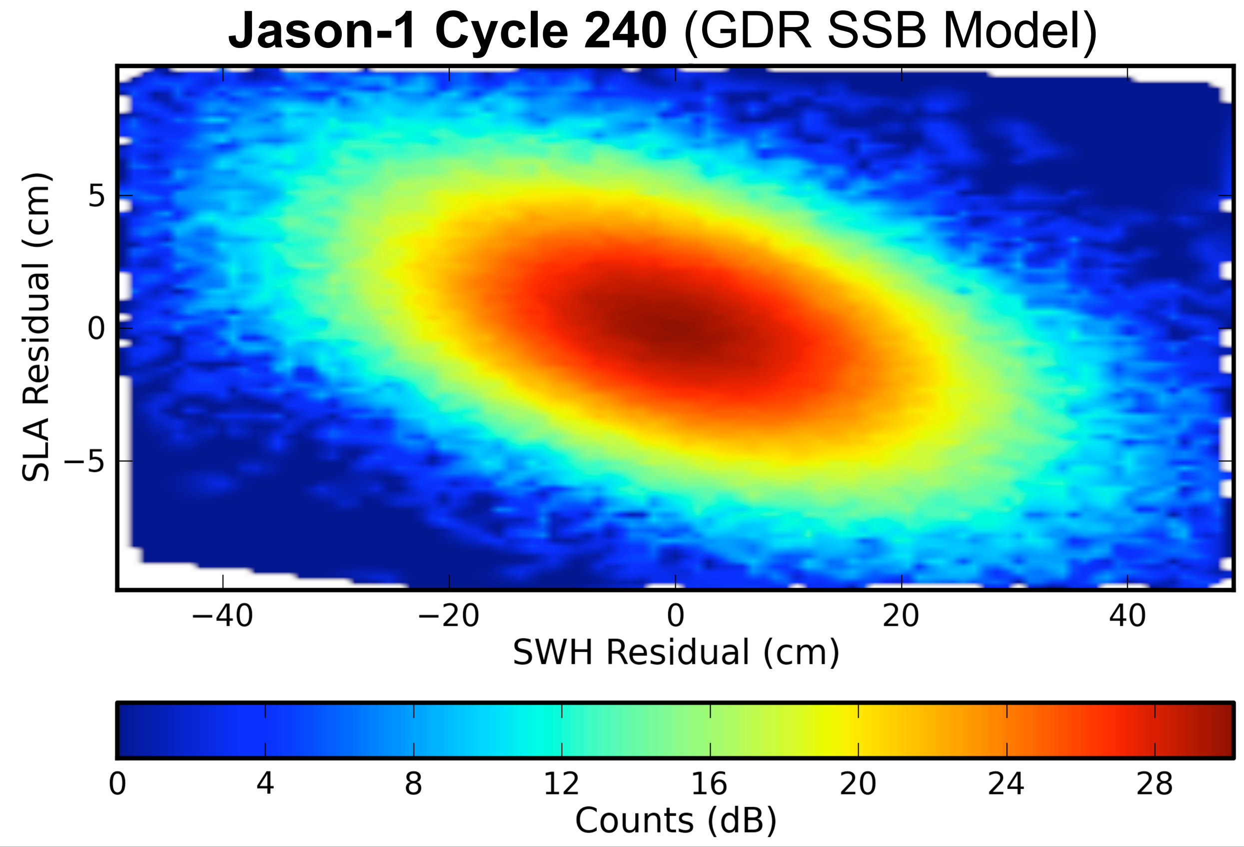
Correlated Smoothing Residuals

Computing Smoothing Residuals

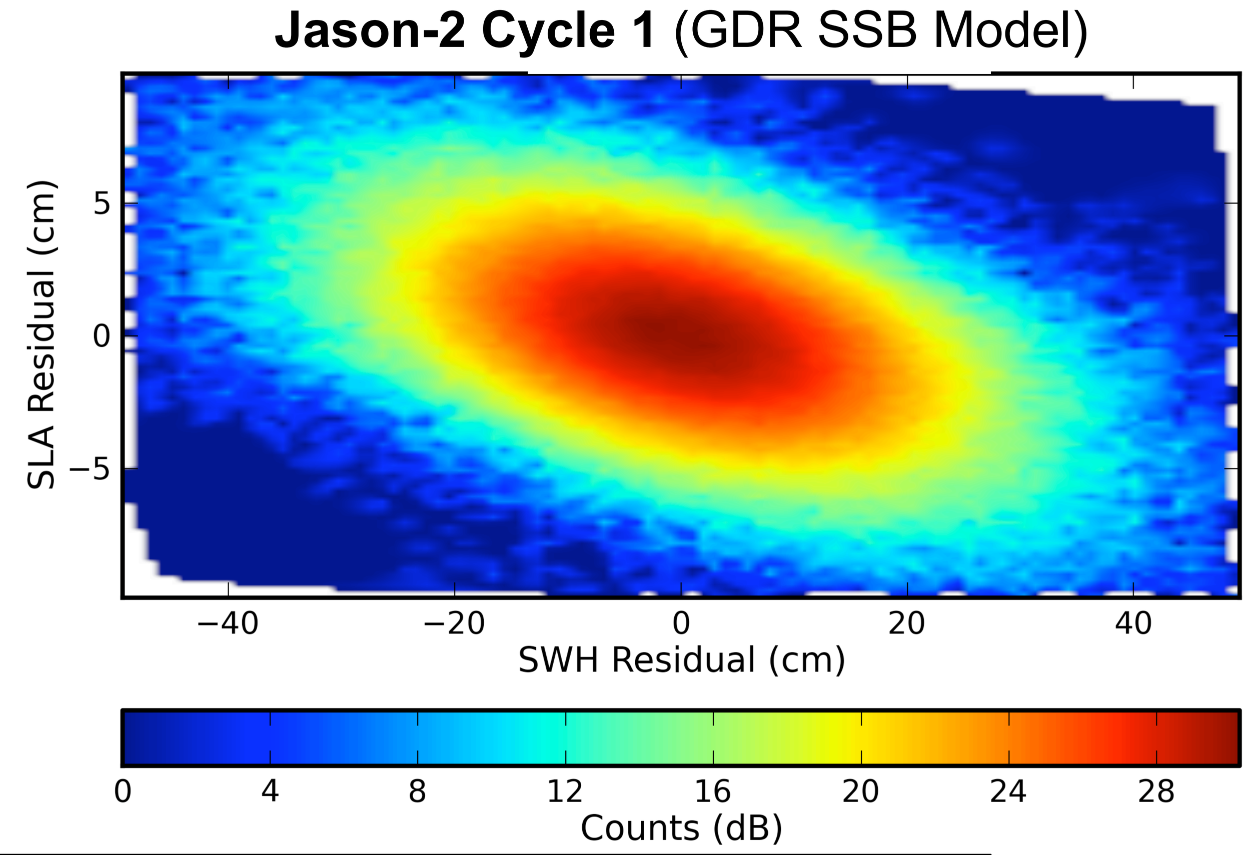


- Smooth SWH, sig0 and SLA along track
- Smoothing residual is the difference between 1-Hz measurement and the corresponding smoothed value

Jason-1 Cycle 240 (GDR SSB Model)



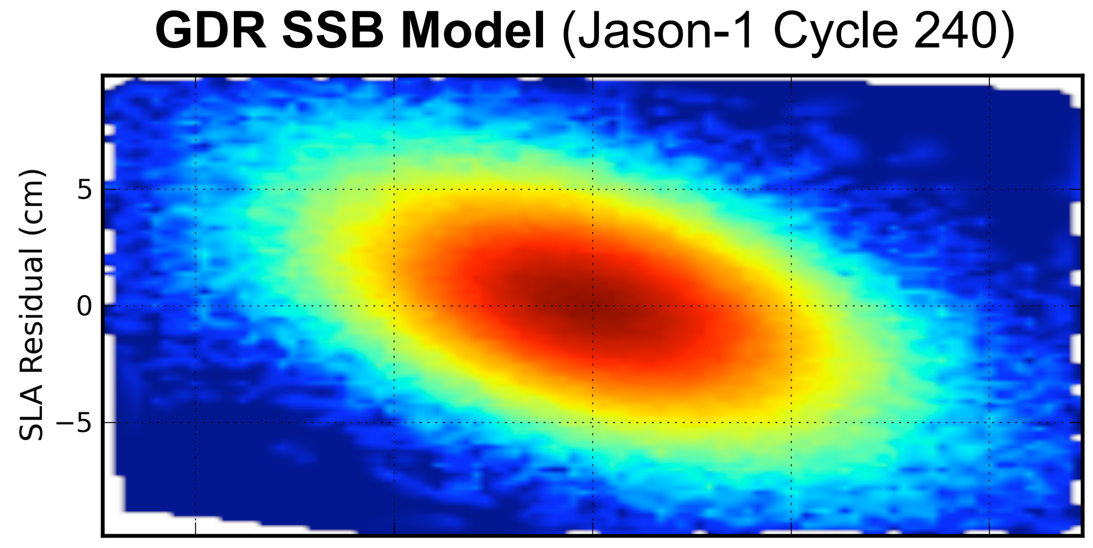
Jason-2 Cycle 1 (GDR SSB Model)



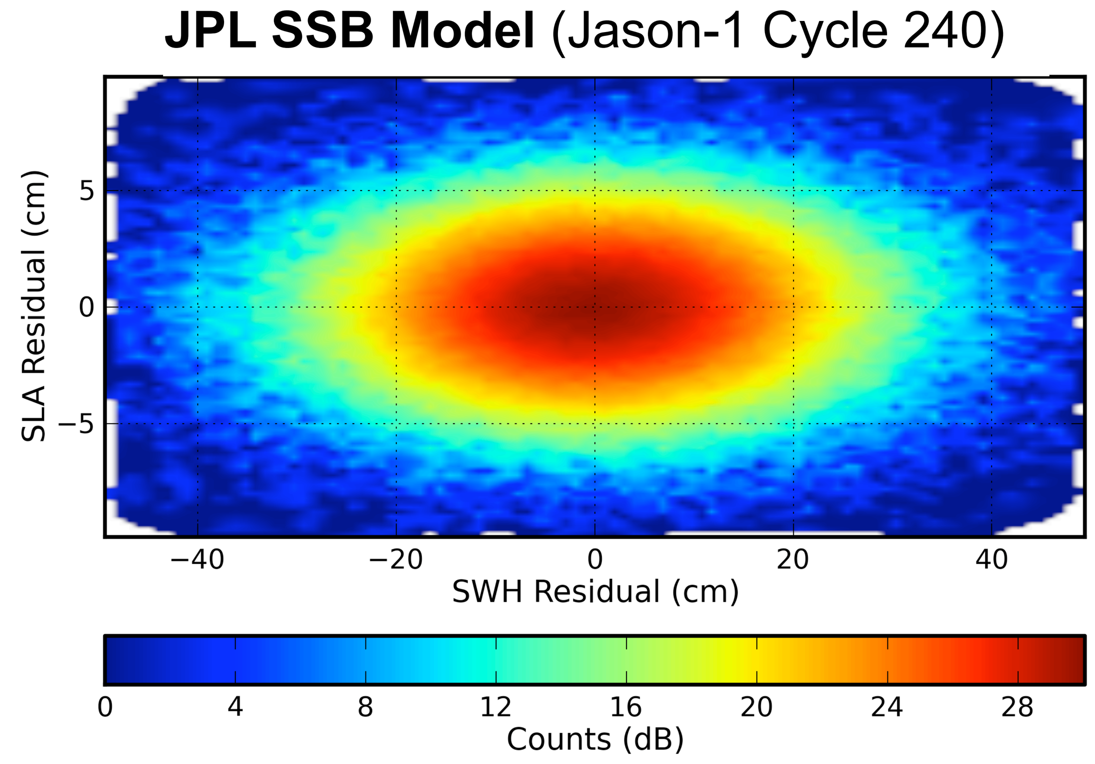
- SLA and SWH residuals are correlated at the 10% level
- Suggests that removing this correlation could reduce SLA variance

Three-Dimensional SSB Model Removes Residual Correlation

GDR SSB Model (Jason-1 Cycle 240)



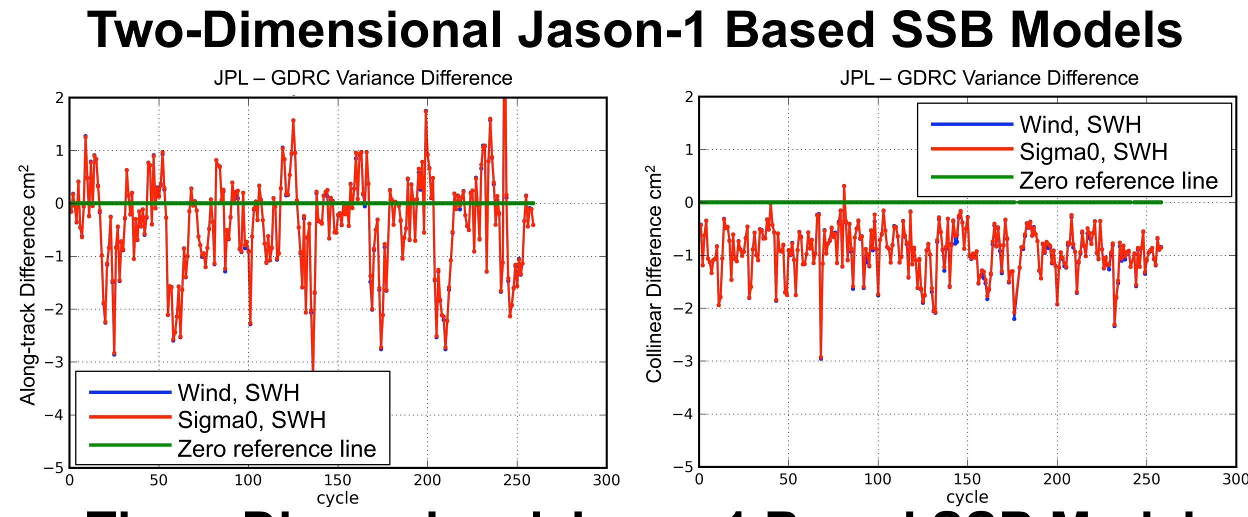
JPL SSB Model (Jason-1 Cycle 240)



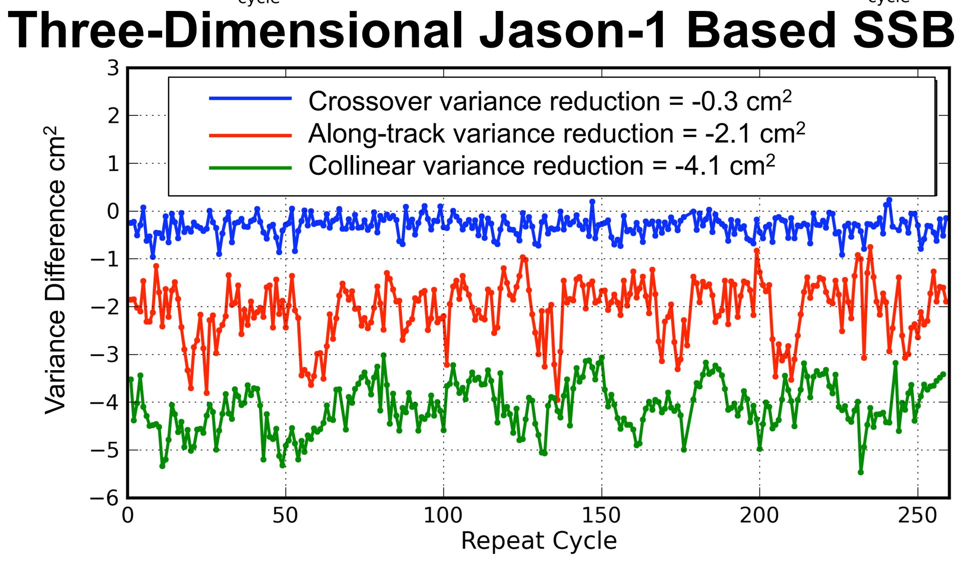
- Created a three dimensional SSB model based on smoothed sigma0, smoothed SWH and the SWH smoothing residual
- Based on data from cycles 1-72 of Jason-1
- Three dimensional SSB model removes residual correlation **including independent data from Jason-1, cycles > 72 and from Jason-2**.

SLA Variance Reduction

Two-Dimensional Jason-1 Based SSB Models



Three-Dimensional Jason-1 Based SSB Models



Mean Variance Reductions (cm^2)

	Applied To Jason-1	Applied To Jason-2
Based On Jason-1	Along-track = **-2.1** Collinear = **-4.1** Crossover = **-0.3**	Along-track = **-2.0** Collinear = **-3.5** Crossover = **+0.2**
Based On Jason-2	Along-track = **-1.9** * Collinear = **-3.6** Crossover = **-0.2** *Stats only over cycles 1-37	Along-track = **-2.2** Collinear = **-4.3** Crossover = **-0.1**

- **SSB**(swh,sigma0) and **SSB**(swh,wind) achieve virtually identical variance reduction.
- Three dimensional SSB model achieves significant variance reduction with respect to GDR-C

Summary

- Explored three different sea state bias models
  - Based on SWH and wind speed
  - Based on SWH and sigma0
  - Based on smoothed SWH, smoothed Sigma0 and SWH smoothing residual
- SWH, sigma0 models produce almost identical performance metrics to the SWH, wind-speed models
  - Sigma0 is a fundamental altimeter measurement.
  - Wind speed is derived from SWH and sigma0 using a parametric model.
  - Basing SSB on Sigma0 and SWH would eliminate one of the parametric models involved in determining global SSH.
- Three-dimensional sea state bias models based on smoothed sigma0, smoothed SWH, and the SWH smoothing residual reduce Jason-1 SLA variance by:
  - Along-track variance reduction: 2.1 cm^2
  - Collinear variance reduction: 4.1 cm^2
  - Crossover variance reduction: 0.3 cm^2
  - Variance reductions are likely the result of removing correlation between range measurement noise and SWH measurement noise.