UPDATE ON JASON-1 SEA STATE BIAS MODELING FROM COMBINATION OF WAVE MODEL AND SATELLITE DATA

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Abstract - A new generation of sea state bias (SSB) models steps forward lately. They rely on the inclusion of ocean gravity wave parameters from operational wave models as auxiliary data in the development of alternative SSB solutions. Presently, we describe two new 3-parameter models which incorporate such parameters in addition to the continued use of altimeter observed significant wave height (SWH) and wind speed (U) measurements.

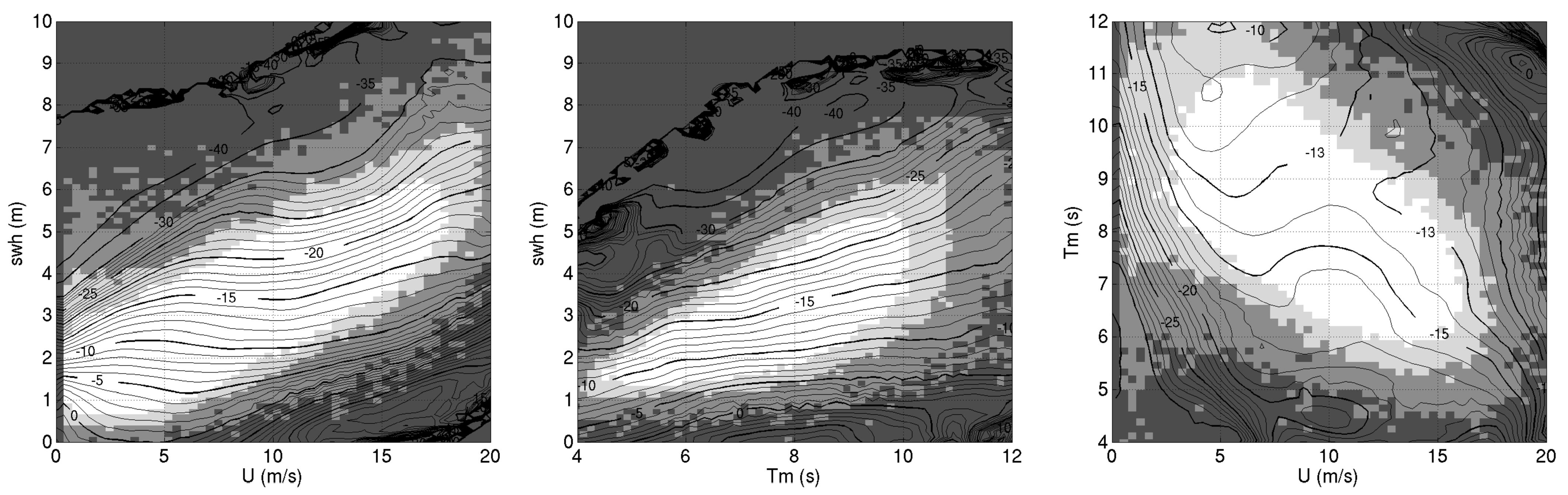

Figure 1: Sea state bias 3-parameter model (in cm) based on significant wave height, wind speed and mean wave period and shown as three 2D grids when the third parameter is fixed at a given value. Shaded areas represent bin data density: (darkest gray) where there is no data, (medium gray) from a single sample to 20 ones, (light gray) when it is between 20 and 100, and (white shade central area) when it is larger than 100 samples.

Model development

We derived different 1-year Jason-1 SSB solutions in the form of a regular grid in a 3D space by applying directly a non-parametric estimation technique based on kernel smoothing [Gaspar et al, 2002] on sea level anomalies (SLA). This approach isolates the SSB term against the chosen correlatives within the large variability of the SLA.

These new models incorporates wave field information related to its development degree not currently available in altimeter data and coming from the WaveWatch3 ocean wave model hindcast in order to provide operational alternatives to today's correction.

Because a previous analysis [Tran et al, 2006] indicated potential for parameters such as swell height (H_swell) and mean wave period (Tm) to reduce systematic regional error in the actual operational correction based on (SWH, U), we developed 2 types of models: SSB (SWH, U, H_swell) and SSB (SWH, U, Tm) as shown in Figure 1.

Variance reduction assessment

The 3D models performance skills have been evaluated on collinear DSSH as provided in Table I to expand model validation. Comparison of skills with that from the operational parameterization version, i.e. SSB (SWH, U) is shown. The single term model SSB (SWH) = -3.8% SWH serves as the low limit benchmark.

The 1-year models and 1-year datasets allow to test the stability of the models behaviors and of their performances in reducing ΔSSH variability when corrected for SSB term.

The gain in variance reduction obtained globally with the 3D models (see Table I) is always larger than the ones obtained with the 2D solution. In Figure 2, one can see that this improvement applies at all latitudes for SSB model derived with Tm.

Table I: Gain in variance reduction obtained by different 2p or 3p models when compared to the variance explained by the SSB (SWH) model. These varoiances are computed on collinear ΔSSH corrected by the different SSB models respectively.

Variance gain (cm²) of the model when compared to the variance explained by SSB (SWH) = -3.8% SWH and when applied to ΔSSH	2002 models			2004 models		
	dataset			dataset		
	2002	2003	2004	2002	2003	2004
SSB (SWH, U alt)	2.80	2.98	3.20	2.79	2.97	3.26
SSB (SWH, U_alt, H_swell)	3.76	4.02	4.25	3.39	3.87	4.37
SSB (SWH, U_alt, Tm)	4.18	4.51	4.82	3.89	4.33	4.74

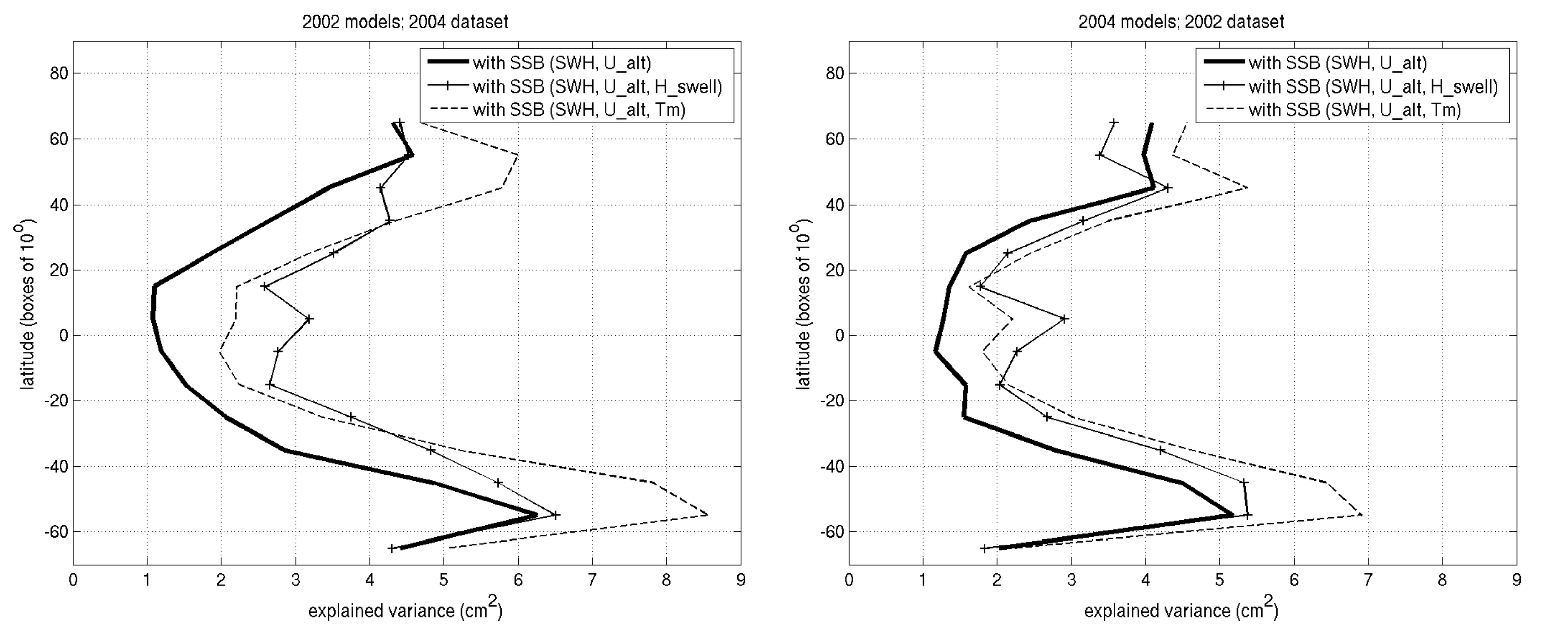

Figure 2: Zonal average of the variance explained by different models respectively minus the variance explained by the SSB (SWH) model when applied on collinear ΔSSH.

Geographical patterns

Figure 3 shows annually-averaged mean and variance differences between SSB estimates from the 2D and 3D models when derived with Tm.

Clear spatial patterns emerge and some west-to-east gradients are observed across each ocean basin. They are directly attributed to the changing wave period distributions, the 3D model proves to better capture the variability of the SSB by adjusting the magnitude of the correction between 'old' seas on the eastern edge of the basins and 'young' seas on the western edges.

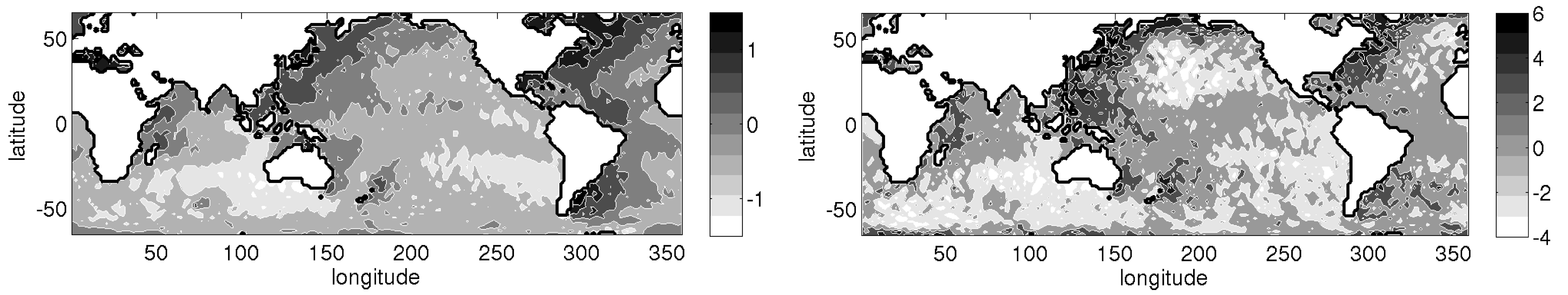

Figure 3: Maps of (a) difference of SSB (2D – 3D) mean geographical fields, in cm, computed between estimates from SSB (SWH, U) model and SSB (SWH, U, Tm) one; and of (b) difference of SSB (3D – 2D) variance fields.

Reference:

Gaspar, P., S. Labroue, F. Ogor, G. Lafitte, L. Marchal, and M. Rafanel, "Improving nonparametric estimates of the sea state bias in radar altimetry measurements of sea level", J. Atmos. Oceanic Technol., 19, 1690-1707, 2002.
Tran N., D. Vandemark, B. Chapron, S. Labroue, H. Feng, B. Beckley, and P. Vincent, "New models for satellite altimeter sea state bias correction developed using global wave model data", J. Geophys. Res., 111, C09009, doi:10.1029/2005JC003406, 2006.

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