

Model design and strategies Jason-2 analysis Topex, Jason-1 and -3 Conclusions

A consistent set of SSB models applied to all reference missions Topex, Jason-1, -2 and -3

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### Introduction

### UPORTO SSB model

- Nonparametric regression techniques based on penalized smoothing splines and GAMs
- 3 predictors: SWH, U10 and a mediator parameter designed by the mean wave period (Tz) derived from radar altimetry
- First tested on Jason-1 mission
- Good performances for a wide range of ocean conditions
- Pires, N.; Fernandes, M.J.; Gommenginger, C.; Scharroo, R. A Conceptually Simple Modeling Approach for Jason-1 Sea State Bias Correction Based on 3 Parameters Exclusively Derived from Altimetric Information. Remote Sens. 2016, 8, 576 [link]

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### Model parameterization

- RADS last update with DTU15 MSS on all missions
- SSB directly estimated from the residuals between SSH and DTU15 [Vandemark et al., 2002]
- 2 models tested for Tz:
  - Heuristic model G03 (SWH,  $\sigma_{Ku}^0$ ) [Gommenginger et al., 2003]
  - Neural networks Q04 (SWH,  $\sigma_{Ku}^0$ ,  $\sigma_C^0$ ) [Quilfen et al., 2004]
- Smoothing splines methods with GAMs
  - Different smoothing parameters for flexibility control
  - Bins weighting and outliers detection techniques
  - Several training datasets performed

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Jason-2 as a reference dataset

- Jason-2 Phase A was used to test different model designs and training datasets
- 5 model designs:
  - 1 2 predictors (SWH,U10),  $\lambda$ =5
  - **2** 3 predictors (SWH,U10,TzG03),  $\lambda$ =5
  - **3** predictors (SWH,U10,TzQ04),  $\lambda$ =5
  - 4 3 predictors (SWH,U10,TzQ04),  $\lambda$ =4
  - **5** 3 predictors (SWH,U10,TzQ04),  $\lambda$ =6
- 4 training datasets (10, 20, 50 and 120 cycles)

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### J2/a SSB models [trainingData: 120 cycles]



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### J2/a SSB models [trainingData: 050 cycles]



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### J2/a SSB models [trainingData: 020 cycles]



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### J2/a SSB models [trainingData: 010 cycles]



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## Resulting guidelines

- Mean wave period adds more information to the model, producing better response fittings
- Q04 has a slightly better performance than G03, especially for regions with high SWH
- Tuning parameter  $\lambda$ =4 produces excessively smoothness
- Similar results for  $\lambda = 5$  and  $\lambda = 6$
- Even with a training dataset of 20 cycles is still possible to obtain a reliable and controlled model

Selected model

 $SSB = \beta_0 + f_1 (SWH, \lambda = 5) + f_2 (U10, \lambda = 5) + f_3 (Q04, \lambda = 5)$ 



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## J2/a SLA VAR (collinear analysis) [trainingData: 120 cyc]





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## J2/a SLA VAR (collinear analysis) [trainingData: 050 cyc]





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## J2/a SLA VAR (collinear analysis) [trainingData: 020 cyc]





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## J2/a SLA VAR (collinear analysis) [trainingData: 010 cyc]



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## J2/a SLA VAR (cycle)



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## J2/a SLA VAR (cycle)



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## J2/a SLA VAR (cycle) [trainingData: 120 cyc]



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## J2/a SLA VAR (cycle) [trainingData: 050 cyc]



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# J2/a SLA VAR (cycle) [trainingData: 020 cyc]



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# J2/a SLA VAR (cycle) [trainingData: 010 cyc]



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### TX/a SSB models [trainingData: 120 cyc]



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## TX/a SLA VAR (collinear analysis) [trainingData: 120 cyc]



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## TX/a SLA VAR (cycle) [trainingData: 120 cyc]



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## TX/a SLA VAR (cycle) [trainingData: 120 cyc]



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### J1/a SSB models [trainingData: 120 cyc]





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## J1/a SLA VAR (collinear analysis) [trainingData: 120 cyc]



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## J1/a SLA VAR (cycle) [trainingData: 120 cyc]



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## J1/a SLA VAR (cycle) [trainingData: 120 cyc]



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## J1/a SLA VAR (cycle) [trainingData: 120 cyc]



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## J3 SSB models [trainingData: 020 cycles]



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## J3 SLA VAR (collinear analysis) [trainingData: 020 cycles]



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# J3 SLA VAR (cycle) [trainingData: 020 cycles]



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## J3 SLA VAR (cycle) [trainingData: 020 cycles]



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## J3 SLA VAR (cycle) [trainingData: 020 cycles]



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## Conclusions

- The mean wave period from Q04 clearly improves the model design and adds some stability when SWH is high
- The direct method is able to produce SSB estimations with good resolutions for modeling feeding, even with little information
- Regarding Topex and Jason-1, the validation results are in line with the standard SSB models currently available
- The proposed approach is capable of generating a reliable model with a limited training dataset (~20 cycles)
- For Jason-2 and -3 the proposed model achieves a reduction of SLA variance in  ${\sim}1\%$  when compared with standard SSB models