Updated wind speed and sea state bias models for Ka-band altimetry

N. Tran (1), D. Vandemark (2), H. Feng (2), A. Guillot (3), N. Picot (3)

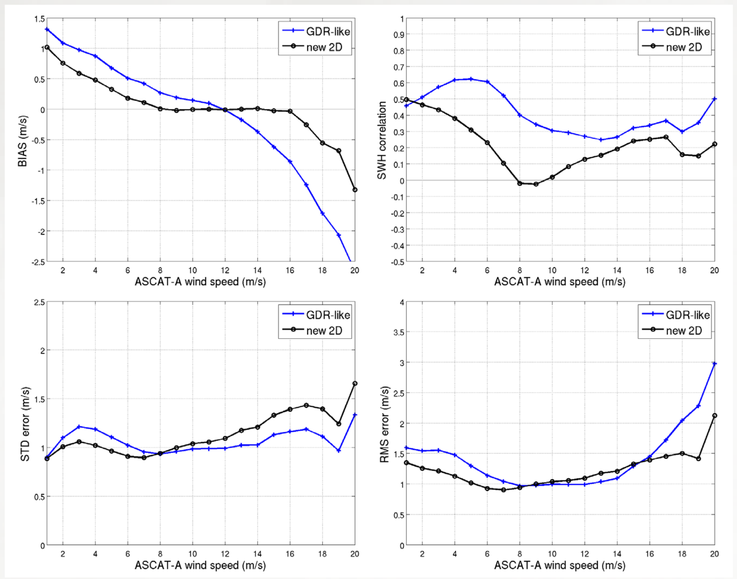
(1) Collecte Localisation Satellite (CLS), Toulouse, France
(2) University of New Hampshire (UNH), Durham, USA
(3) Centre National d'Etudes Spatiales (CNES), Toulouse, France

2D Wind Speed

METHODOLOGY

• The operational algorithm for retrieving Altika wind speed [Lillibridge et al, 2014] is based solely on the Ka-band backscatter coefficient and used the same formalism than the Envisat operational algorithm [Abdalla, 2007; 2012].

• The aim of the present work is to develop a two-parameter retrieval algorithm similarly to the one used for the Jason-1 and -2 missions [Collard, 2005] that depends on both backscatter coefficient and significant wave height.



F1: Wind speed error statistics for different algorithms as a function of ASCAT-A estimates (12 cycles, Δtime < 30 min, Δdist < 25 km).

• Its calibration is based on a 1-year collocated dataset between Altika altimeter data and ASCAT-A scatterometer measurements. We used the ASCAT-A operational NRT level 2 products with a 12.5 km sampling processed by KNMI/OSI-SAF.

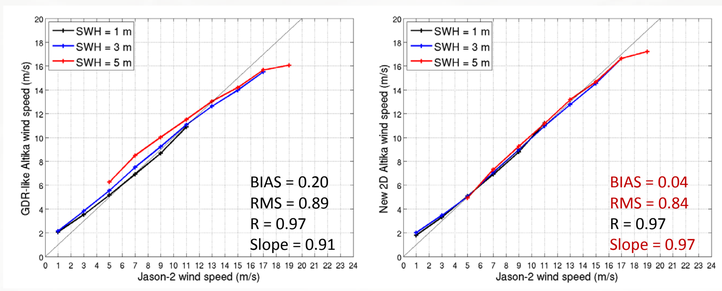
• The atmospheric attenuation correction comes from the radiometer data after correcting the saturated values observed on the 37 GHz hot calibration measurements during a few cycles [Fréry et al, 2014]. The Altika wind speeds were recomputed with the 1D algorithm and are referred as the GDR-like estimates.

• The validation of the 2D algorithm was performed by comparing with Jason-2 altimeter estimates and buoys data.

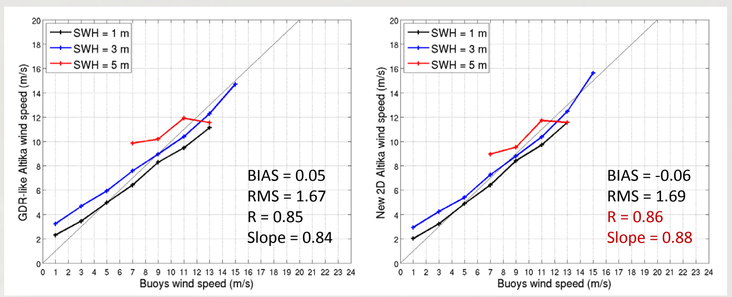
RESULTS

• As expected, the SWH dependence on retrieved winds is reduced when one compares with the one observed with the operational 1D model (F1 to F3).

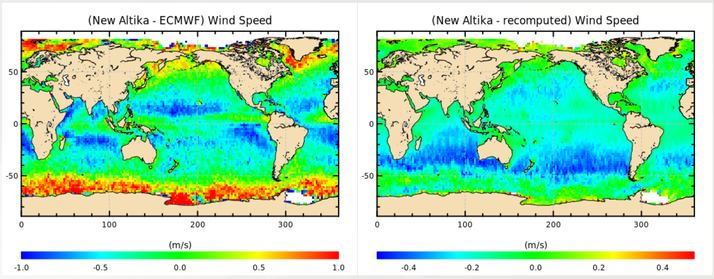
• This new model shows better agreement with Jason-2 altimeter winds and buoy data (F2 and F3).



F2: Bin-averaged wind speed values against Jason-2 data at three different SWH values (12 cycles, Δtime < 1 hour, 3720 samples).



F3: Bin-averaged wind speed values against buoys data at three different SWH values (15-month period, Δtime < 1 hour, Δdist < 50 km, 2004 samples).



F4: Maps of wind speed differences.

References

Abdalla S., 2007: "Ku-band radar altimeter surface wind speed algorithm", Proc. Of the 2007 Envisat Symposium, Montreux, Switzerland, 23-27 April 2007, Eur. Space Agency Spec. Publ., ESA SP-636.
Abdalla S., 2012: "Ku-band radar altimeter surface wind speed algorithm", Marine Geodesy, 35 (supl. 1), 276-298, doi:10.1080/01490419.2012.718676.
Collard F., 2005: "Algorithmes de vent et période moyenne des vagues Jason-1 à base de réseaux de neurones", BO-021-CLS-0407-RF, Boost Technologies.
Fréry ML., B. Picard, E. Obligis, N. Steunou, C. Goldstein, N. Picot, 2014: "Microwave radiometer aboard SARAL/ALtiKa : Correction of 37GHz channel", SARAL/AltiKa workshop, poster session, Lake Constance, Germany.
Lillibridge J., R. Scharroo, S. Abdalla, and D. Vandemark, 2014: "One- and two-dimensional wind speed models for Ka-band altimetry", J. Atmos. Oceanic Technol., 31, 630-638, doi:10.1175/JTECH-D-13-00167.1.

Updated 2D Sea State Bias

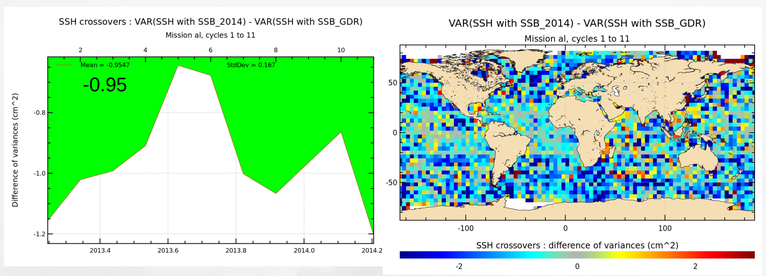
METHODOLOGY

• A preliminary 2D model based on the first four cycles of data has been computed last year and used ECMWF model for both the wind and the wet tropospheric correction. These results were presented at the last 2013 OSTST meeting and at the 2014 SARAL International Science and Applications Meeting [Poisson et al, 2013; 2014].

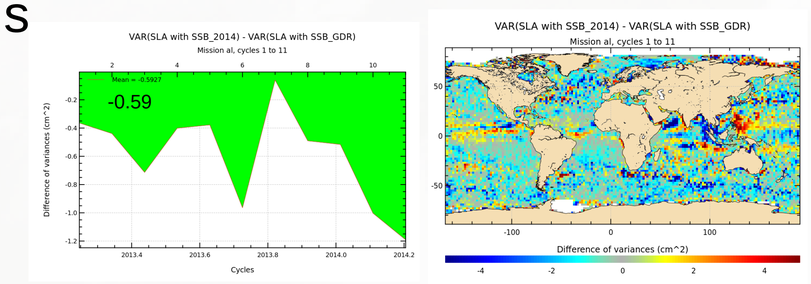
• Model estimations were used since the tunings of the wind speed and the radiometer based wet tropospheric correction were not yet optimums.

• An updated 2D SSB solution has been computed based on a year-period of AltiKa measurements with a fine-tuned altimeter 2D wind speed (above panel) and a refined radiometer wet troposphere correction that takes into account the correction of the saturated values observed on the 37 GHz hot calibration measurements during a few cycles [Picard et al, 2014; Fréry et al, 2014].

• Comparisons with the operational Altika SSB model (GDR Patch 2, [Scharroo, 2013]) and with the most up-to-date Jason-2 model [Tran et al, 2012] have been performed.



F1: Cyclic monitoring and map of differences of SSH variances at crossovers when ones uses the updated 2D model or the GDR one in the SSH computation.



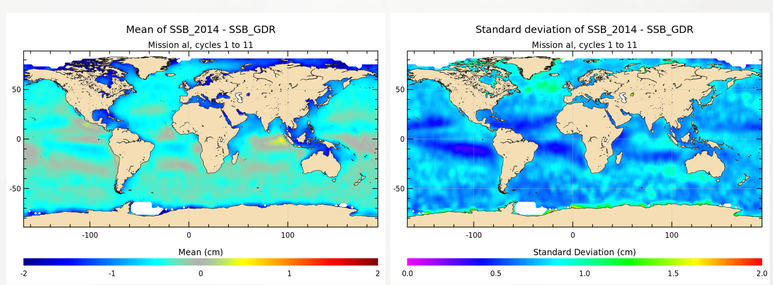
F2: Cyclic monitoring and map of differences of SLA variances.

RESULTS

• Clear improvements (i.e. reduction of variance) are obtained with the 1-year solution when one compares with the version used in GDR (F1 and F2).

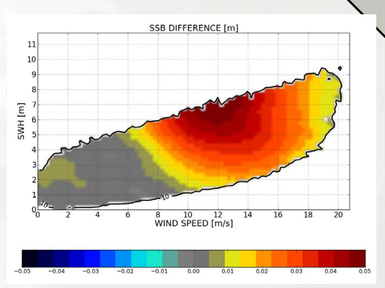
• Maps of mean and standard deviation of the differences are provided in F3.

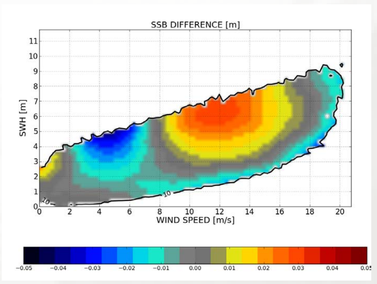
• Recommendation is to use SSB solutions based on ECMWF winds to analyze the frequency dependence (F4) to avoid introduction of wind speed differences due to differences in retrieval algorithms (F5) in the comparison.



F3: Maps of mean and standard deviation of the SSB differences (updated – GDR).

F4: (Altika – Jason-2) SSB differences in the (SWH, U) plan. U comes from ECMWF model. Results confirm what was seen earlier [Poisson et al, 2013; 2014]:
→ U<7 m/s: $|SSB_{Ka}| \sim |SSB_{Ku}|$
→ U>7 m/s: $|SSB_{Ka}| < |SSB_{Ku}|$





F5: (Altika – Jason-2) SSB differences in the (SWH, U) plan. The wind speeds U come from different retrieval algorithms. This figure compares the most up-to-date SSB models.

References

Fréry M-L., B. Picard, E. Obligis, N. Steunou, C. Goldstein, N. Picot, 2014: "Microwave radiometer aboard SARAL/ALtiKa : Correction of 37GHz channel", SARAL/AltiKa workshop, poster session, Lake Constance, Germany.
Picard B., M-L. Fréry, E. Obligis, L. Eymard, N. Steunou, N. Picot 2014: "SARAL/ALTIKA wet tropospheric correction: retrieval stategies and performances", SARAL/AltiKa workshop, instrument processing session, Lake Constance, Germany.
Poisson J-C., P . Thibaut, N. Tran, S. Peyridieu, P. Prandi, N. Steunou, J-D. Desjonquères, N. Picot 2013: "First Saral/AltiKa results: Overview of the altimeter in-flight performances and comparison with the Ku-Band", OSTST meeting, Boulder, Colorado (available at http://www.aviso.altimetry.fr/fileadmin/documents/OSTST/2013/oral/Poisson_OSTST2013_AltiKa_AltimeterPerfo.pdf)
Poisson J-C., P. Thibaut, N. Tran, N. Picot, 2014: "First estimation of the Altika sea state bias at crossovers and comparison with Jason-2", SARAL International Science and Applications Meeting, Ahmedabad, India (available at http://www.aviso.altimetry.fr/fileadmin/documents/ScienceTeams/Saral2014/22-04-2014/Session -5 / Poisson_SSB_AltiKaMeeting_IndiaApril2014.pdf).
Scharroo R., J. Lillibridge, S. Abdalla, D. Vandemark, 2013: "Early look at SARAL/AltiKa data", OSTST meeting, Boulder, Colorado (available at http://www.aviso.altimetry.fr/fileadmin/documents/OSTST/2013/oral/Scharroo_Early_look_at_SARAL.pdf)
Tran N., S. Philipps, J-C. Poisson, S. Urien, E. Bronner, N. Picot 2012: "Impact of GDR_D standards on SSB corrections", OSTST meeting, Venice-Lido, Italy (available at http://www.aviso.altimetry.fr/fileadmin/documents/OSTST/2012/oral/02_friday_28/01_instr_processing_I/01_IP1_Tran.pdf).

3D Sea State Bias

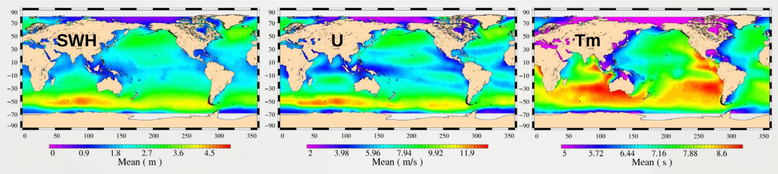
METHODOLOGY

• The purpose is to develop a 3D SSB model that better describes SSB behavior with improved description of the sea state as done for Jason-1 and Envisat [Tran et al, 2011].

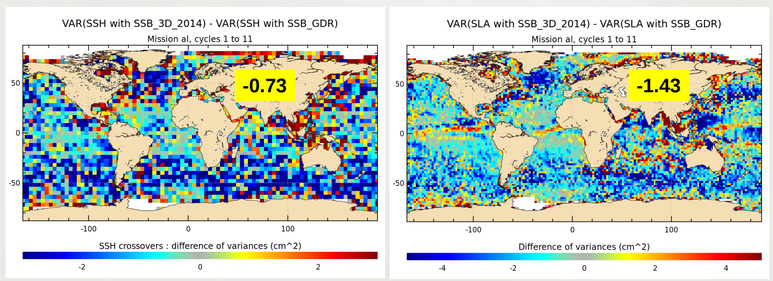
• We used mean wave period (Tm in F1) from WaveWatch3 processed by IFREMER (F. Ardhuin).

• The model is developed with the direct approach based on SLA [Vandemark et al, 2002] while 2D models are commonly derived with an approach based on SSH differences.

– Average of SLA= SSH (uncorrected for SSB) – MSS per bin of (SWH, U, Tm)
– Use of the spline-based NP regression for model derivation [Feng et al, 2010]
– Use of the CNES / CLS 2011 MSS [Schaeffer et al, 2012]



F1: Maps of SWH, U and Tm over 1-year period. Tm brings complementary information about sea state.



F2: Performances comparison (3D SSB vs GDR 2D SSB).

RESULTS

• Clear improvements (i.e. reduction of variance) are obtained with the 3D solution when one compares with the version used in GDR (F2).

References

Feng H., S. Yao, L. Li, N. Tran, D. Vandemark, and S. Labroue, 2010: "Spline-based nonparametric estimation of the altimeter sea state bias correction", *IEEE GRS letters*, doi: 10.1109/LGRS.2010.2041894, 7 (3), 577-581.
Schaeffer P., Y. Faugere, J. F. Legeais, A. Ollivier, T. Guinle, N. Picot, 2012: "The CNES CLS11 Global Mean Sea Surface Computed from 16 Years of Satellite Altimeter Data", Marine Geodesy, 2012, Special Issue, Jason-2, Vol.35.
Tran N., D. Vandemark, J-F. Legeais, H. Feng, B. Chapron, E. Bronner, N. Picot, P. Féménias, J. Benveniste, 2011: "Evaluation of 3D SSB models on Jason-1 and Envisat time-series: 2002-2009 ", OSTST meeting, San Diego, California (available at http://www.aviso.altimetry.fr/fileadmin/documents/OSTST/2011/oral/02_Thursday/Splinter%205%20IP/01%20Tran%20OSTST2011_Tran_SSB3D.pdf).
Vandemark D., N. Tran, B. D. Beckley, B. Chapron, and P. Gaspar, 2002: "Direct estimation of sea state impacts on radar altimeter sea level measurements", *Geophys. Res. Lett.*, 29 (24), 2148, doi:10.1029/2002GL015776.

Data available at http://odes.altimetry.cnes.fr