Review of Cryosat-2 POD and LRM CAL/VAL results

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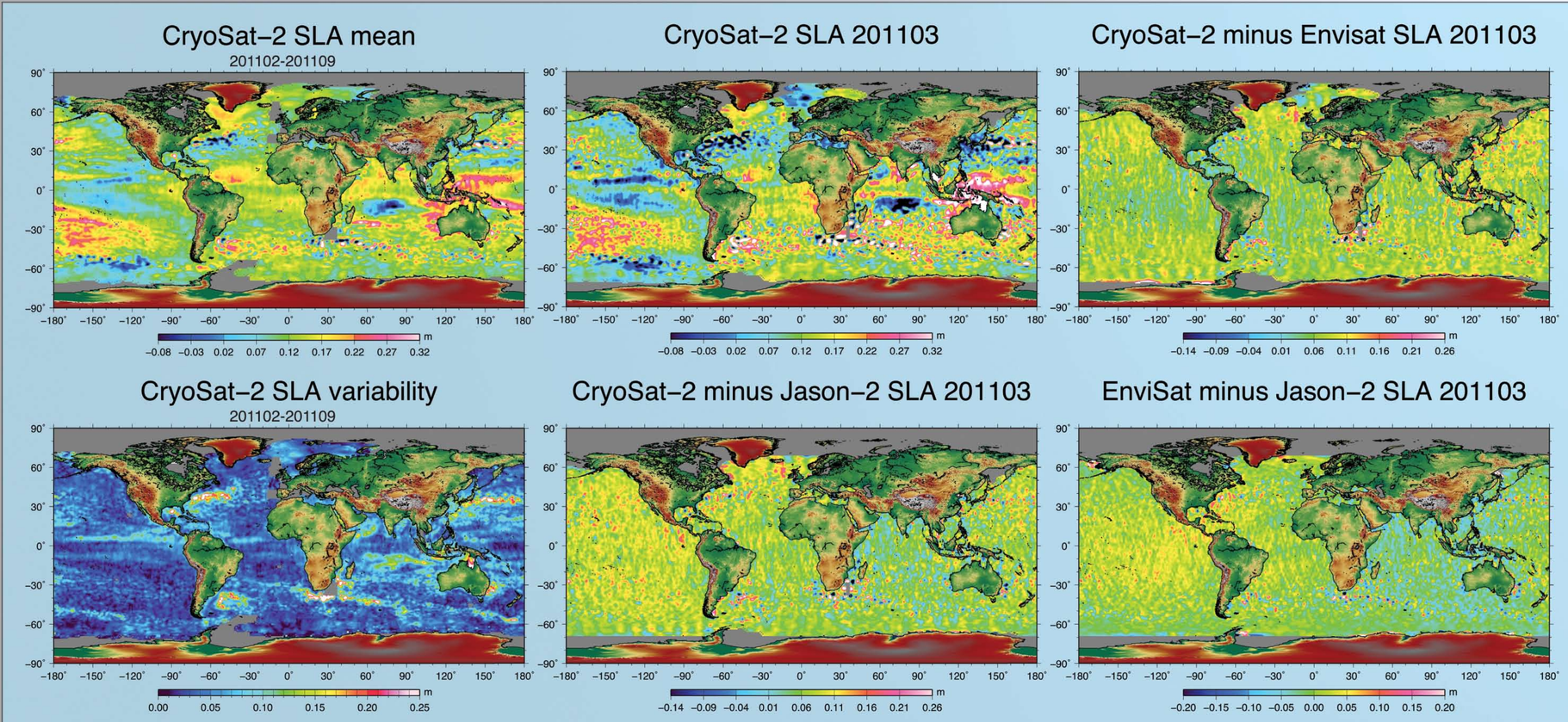
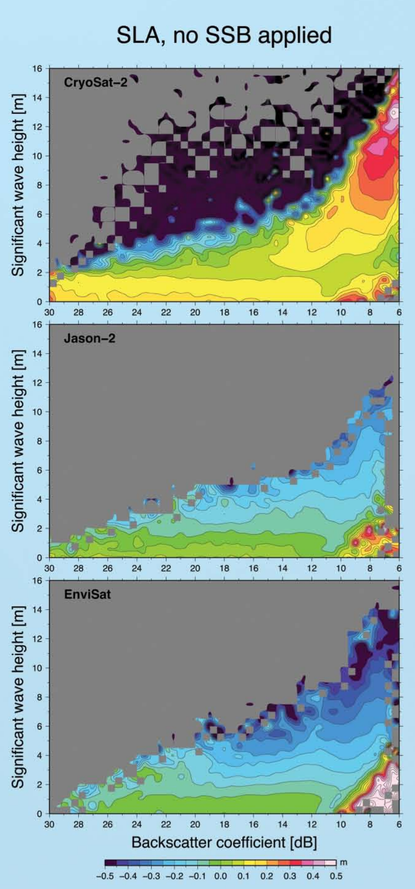
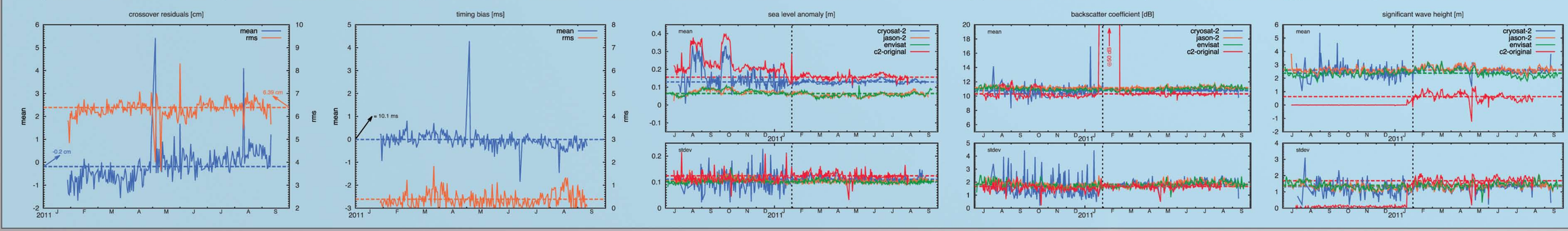
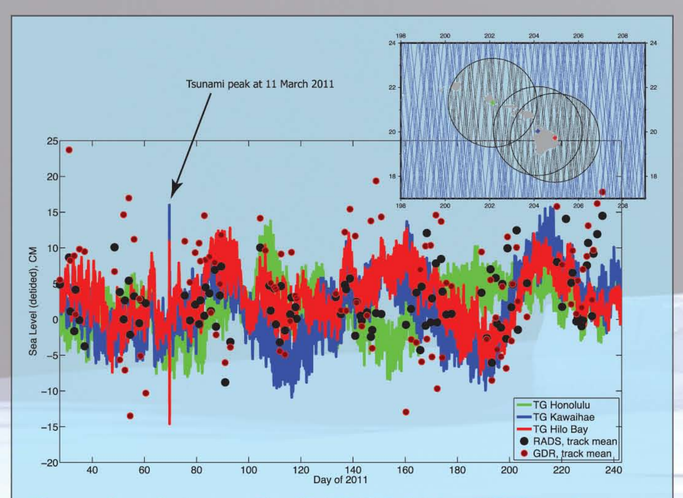
Summary CryoSat-2 was successfully launched in April 2010 to map the cryosphere with an advanced microwave altimeter system. The mission goal is to observe sea ice freeboard and ice sheet elevation changes for 3 years nominally. Precision orbit determination (POD) of CryoSat-2 relies on DORIS Doppler tracking and ground based satellite laser ranging (SLR). Here we show the results of our CryoSat-2 POD efforts. The TUDelft orbits compare very well with the MOE and POE trajectories computed by CNES and can be considered of Jason-class: RMS of both SLR residuals and radial differences near 1.5cm. Our research focusses on improving POD, for instance to deal with increasing ionosphere effect. CryoSat-2 can support the soon to be launched AltiKa mission to fill the sampling gap that Envisat would leave behind when stops working before Sentinel-3 is in place. For this purpose we validate and calibrate the LRM data, add and improve corrections (including modeling of corrections that are not directly available from the CryoSat-2 platform), and verify the orbit accuracy. Here we present an interim review of the absolute and relative calibration of LRM Level-2 data by comparison of CryoSat-2 with other satellites (global crossover and grid analyses) and with tide gauge data. Alongside we provide estimates on range and timing biases and seek explanations for them. In the original product we estimate a timing bias of around 10ms (time tag too late) and are burdened with an average crossover RMS of 13cm which is brought down to around 6.5cm in the RADS improved product in which the biases have been applied and the SWH, backscatter and SSB are much improved. Though we present an updated CryoSat-2 ocean product we strongly advise to rigoreusly change the way the sea surface echoes are being re-tracked in the original ground processing software.



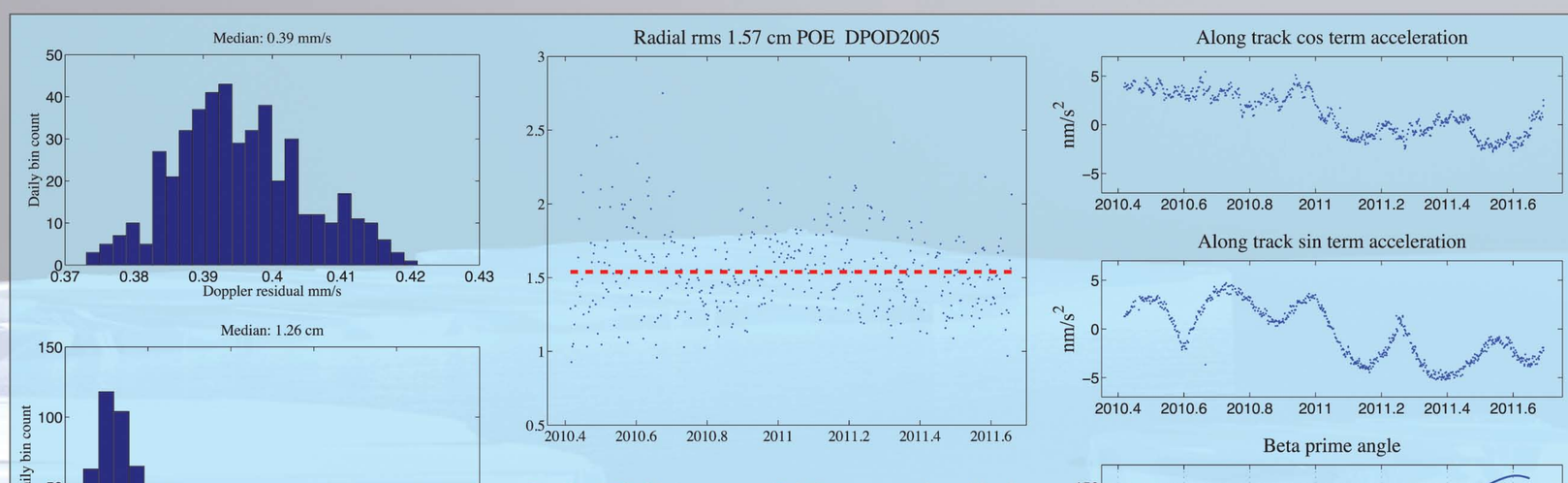


As the original product left much to be desired, among which a sigma0 which got reversed, a significant wave height that was absent, negative or too small, and a sea state bias with impossible positive values, we made an effort to improve the product to be suited for RADS. Focus is on getting the mentioned problems fixed (details upon request), but additionally we also opt for the best available media corrections. In this panel we show some qualitative and quantitative aspects of the new RADS product, and compare with the original product. The maps in the left column perfectly show the capability of the RADS CryoSat-2 ocean product; comparing with Jason-2 and EnviSat only shows the well-known systematic east-west frame issue in which CryoSat-2 performs as good as Envisat. On the right the weird SLA dependency on SWH and backscatter is displayed. We are certain the waveforms are wrongly tracked (reversed or up-side down) and suggest development of a new re-tracker.





Comparison between CryoSat-2 SLA (dots, RADS product in black, original in brown) and 6-minute compressed sea level at 3 Hawaiian tide stations (curves). No IB correction was applied to the SLA and the tide gauge data were de-tided with the COOPS tidal prediction. The dots represent the average SLA along ground track segments within circles of 2° radius (see inset). Range bias appeared to be +0cm and -63cm for RADS and original SLA, respectively. Note the superiority of the RADS product.



On the left, histograms of daily averaged residuals for 10s Doppler range change observations and satellite laser ranges (20100601 - 20110901). Medians at 0.39 mm/s and 1.26 cm. In the middle, daily radial differences RMS between TUDelft and CNES orbits: average 1.57 cm. Orbits have been computed in the DPOD 2005 system. And on the right, residual along track accelerations modeled for Cryosat-2, separated in cosine and sine components, and the beta prima angle, which refers to the position of the Sun relative to the angular momentum vector of the orbital plane. Note the pivot points at 90° in the sine component, which reveal unmodeled solar radiation pressure effects. Spectral properties for the reference SRP box model were provided by ESA.

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