Global and regional evaluation of recent Mean Sea Surfaces using the first year of Sentinel-3 data and impact for updating the DTU15MSS

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Summary

Sentinel-3a was launched in 2016 and is the first SAR only altimetric mission. It has a repeat period of 27 days giving us data along new ground tracks, which is very valuable for MSS evaluation.

The orbital setup and instrumental capabilities of Sentinel-3a provides the altimetric community with a new set of opportunities and challenges. Some of these are highlighted here, such as the amplification of tide model discrepancies due to the sun-synchronous orbit of the satellite, and small-scale variations in the sea level anomalies that are visible due to the SAR altimeter.

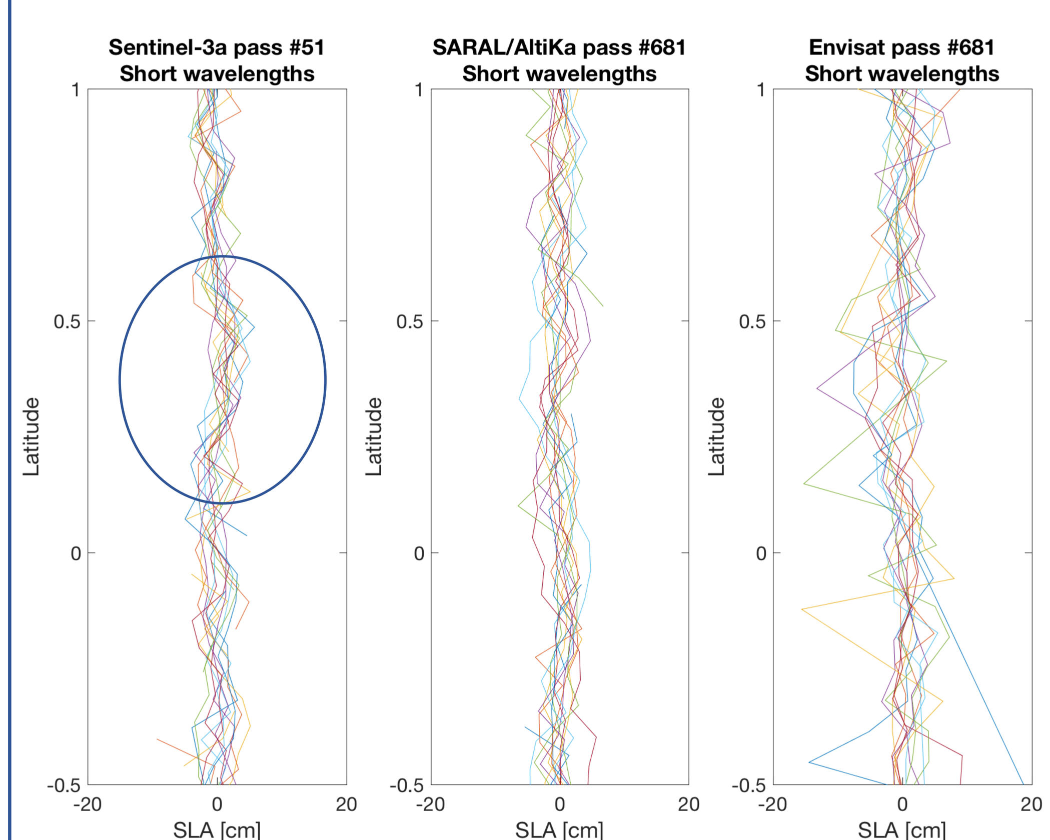
We also present an annual mean of the sea level anomaly (SLA) with respect to the DTU15MSS.

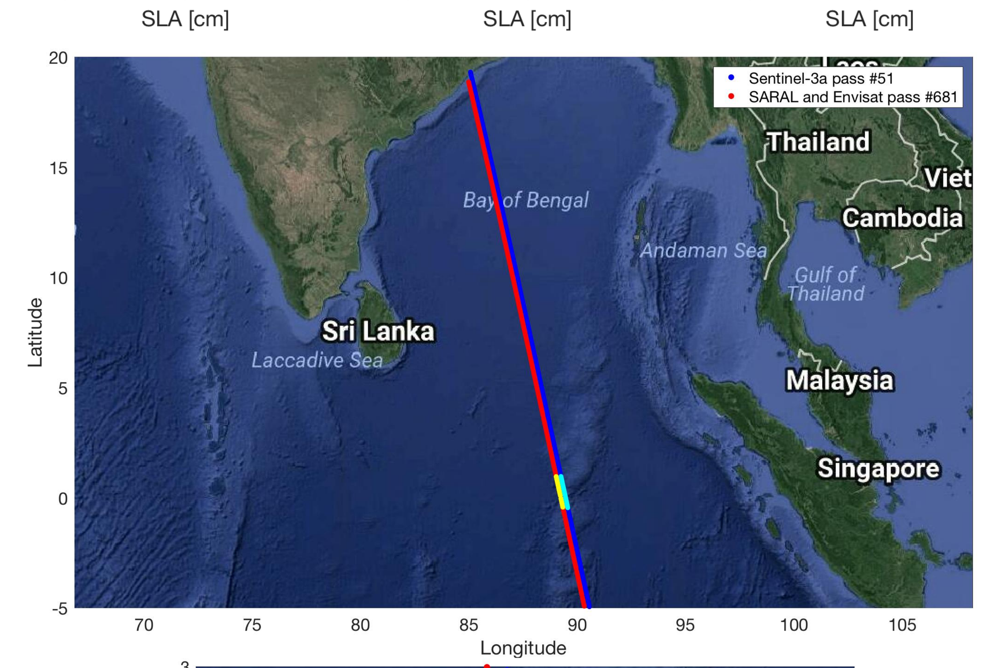
Short wavelength perturbations

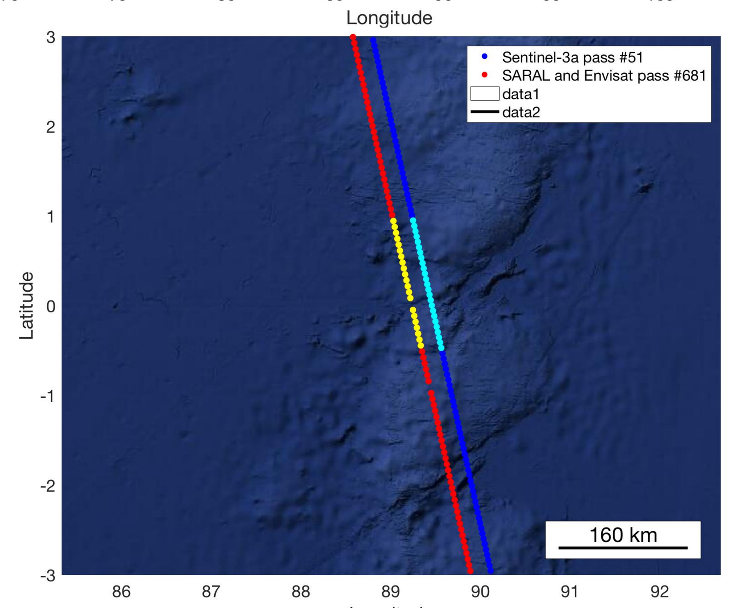
The short wavelength noise and the ability of the SAR altimeter to map short wavelength signal is investigated from Hz data from Sentinel-3A. A comparisons are shown below for pass #51 of Sentinel-3a and pass #681 for Envisat and SARAL/AltiKa where 14 cycles are shown for each mission.

The short wavelength SLA has been derived by subtracting a moving average of 14 along-track measurements filtering out signals with wavelengths longer than roughly 100 km.

Sentinel-3a shows a clear signal in the marked area, which is not visible in SARAL or Envisat data.

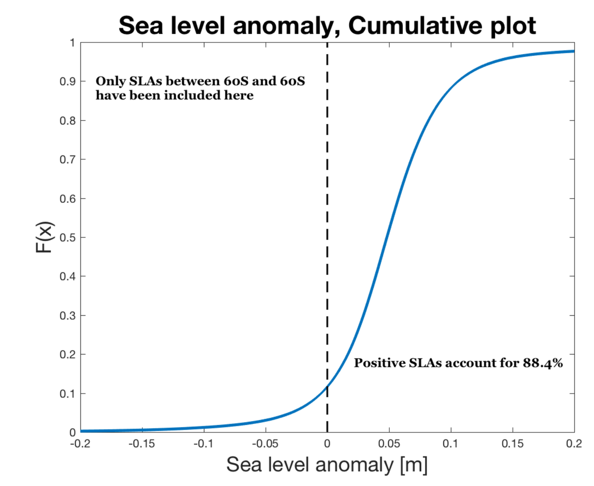


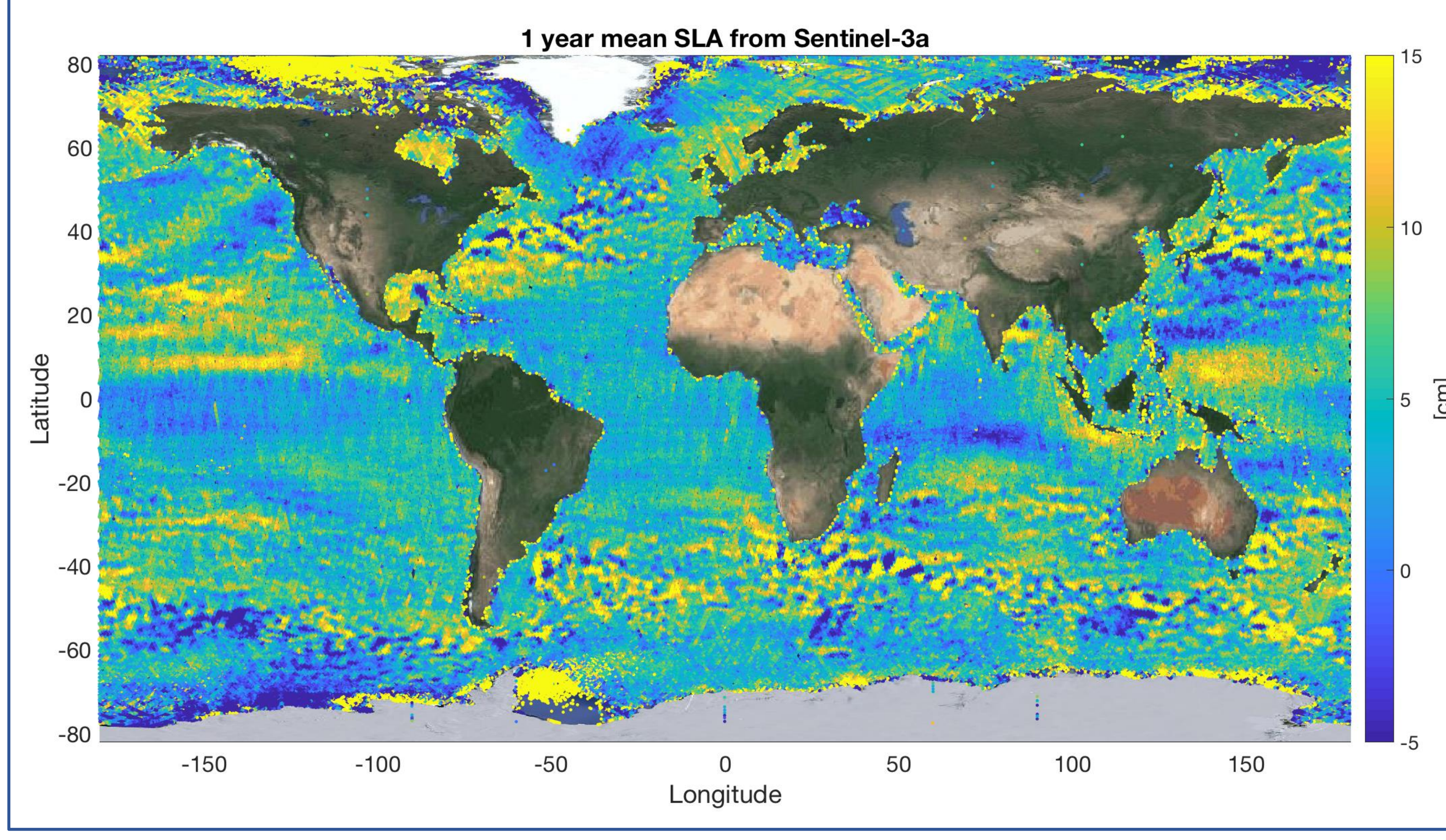


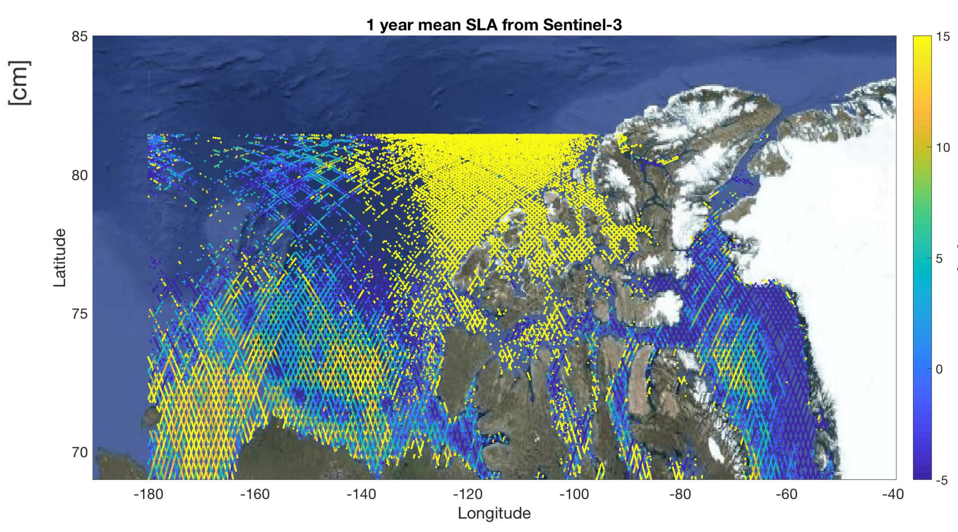


Global results

The mean SLA obtained using one year (14 repeats) of Sentinel-3a relative to the DTU15MSS using the GOT4.10 tide model is shown below. To avoid a seasonal bias cycles 8 to 21 were used to calculate the mean SLA. A mean was only displayed if all measurements were available for all 14 cycles. Notice that the color scale is not centered around zero but around 5 cm to illustrate that the mean SLA is predominantly positive. This is in agreement with sea level rise predictions of roughly 2-3 mm per year or 5 cm per 15 years.

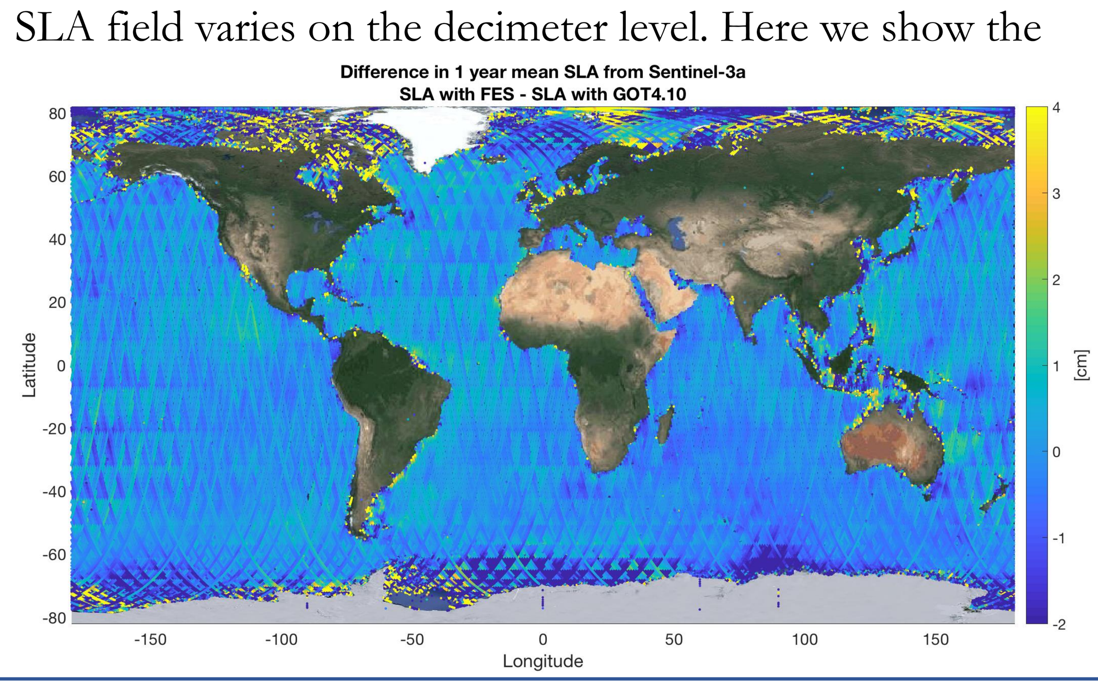


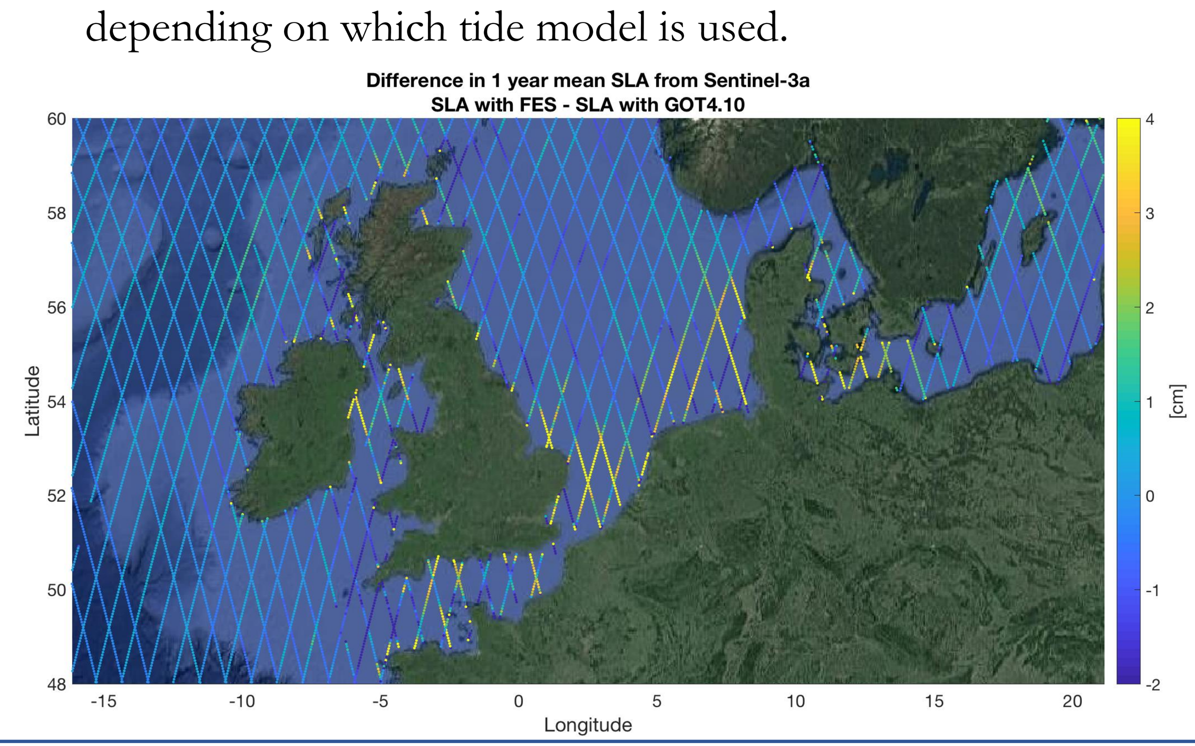




Tide model implications for MSS studies

In the evaluation of the MSS above, one must take care that the sun-synchronous orbit of Sentinel-3 will cause errors in the sun-synchronous ocean tide constituent S2 to will map into the mean depending on the local phase at the crossing time of Sentinel-3. The two mostly used models are FES2012 and GOT4.10. Depending on which model is chosen, the resulting SLA field varies on the decimeter level. Here we show the difference between the SLA fields when using FES2012 and GOT4.10 globally, but also in the area around the English Channel, which is known for strong tides. As seen, the amplitude of the S2 constituent disagree up to 5 cm in the models in this region, causes very different mean SLAs depending on which tide model is used.





Near Coastal observations

The maps below show the different one year SLAs for different sets of MSS and tide model combinations. One the scale the ocean tide model differences will only cause marginal differences. A clear signal (typically yellow) is seen for most measurements close to the coast, correspond to a mean SLA increase or the MSS being too low close to the coast.

For two passes crossing we have investigate if this is an MSS issue. For these passes we show the 14 individual SLA entering the mean along with an "arbitrarily shifted" MSS (changing the mean value to fit zero).

Further investigations are needed in order to conclude on the origin of this signal – it is caused by problems with the MSS, tide or the coast/land? A figure to the right illustrate the location of 20 year TOPEX/J1/J2 mean track observations used to compute the DTU15MSS. This mean track does not have data close to the coast.