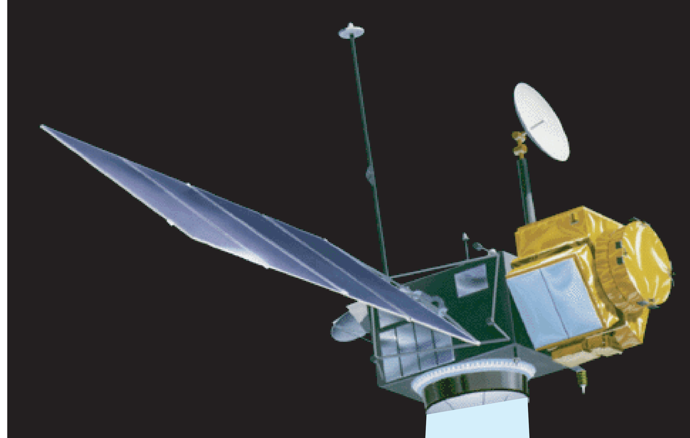
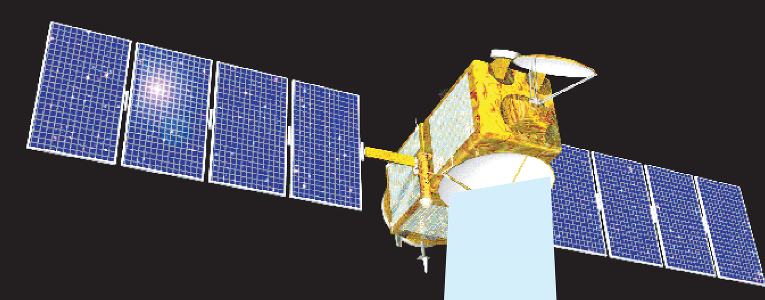
TOPEX and Jason : A second take on rain-flagging

Graham Quartly
gdq@soc.soton.ac.uk

Laboratory for Satellite Oceanography,
Southampton Oceanography Centre
Southampton, Hants, UK



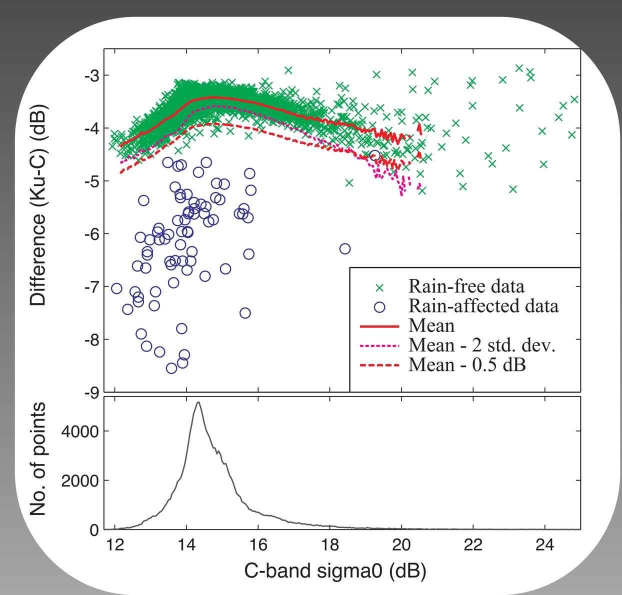


INTRODUCTION

The dual-frequency technique for altimetric rain detection was developed for TOPEX, and has been used in a number of papers to examine the global patterns of rainfall on diurnal, seasonal and interannual scales. Can Jason data be treated just the same?

1. Defining a Rain Flag

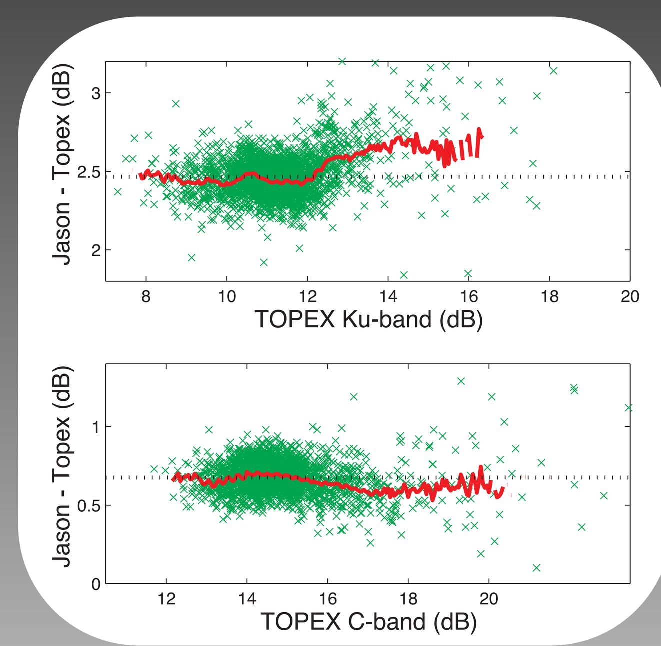
The observations of backscatter, σ^0_{Ku} and σ^0_C, usually have a tight relationship. Sub-satellite rain reduces the K_u-band signal; the basis for rain flagging is noting when the derived attenuation, $\Delta\sigma^0$, is significant (e.g. at least 0.5 dB) below the mean relationship.



2. Comparison of σ^0 Values

For rain studies, the applied atmospheric correction to σ^0 are removed. A comparison of the near-simultaneous σ^0 observations by Jason and TOPEX show some differences.

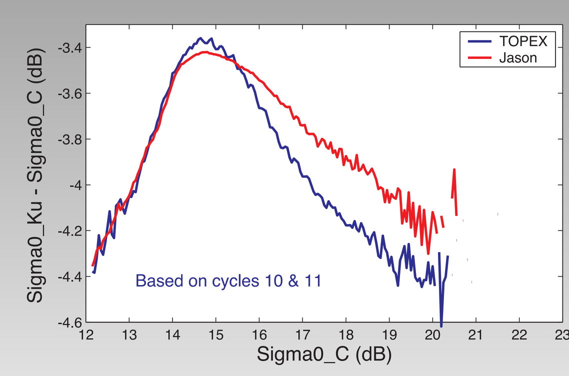
Jason's σ^0_{Ku} values are higher than those of TOPEX by an average of 2.45 dB, but with a step in the bias for σ^0_{Ku} (TOPEX) > 12.5 dB. For σ^0_C, the mean offset is 0.70 dB, with a slight variation across the range.

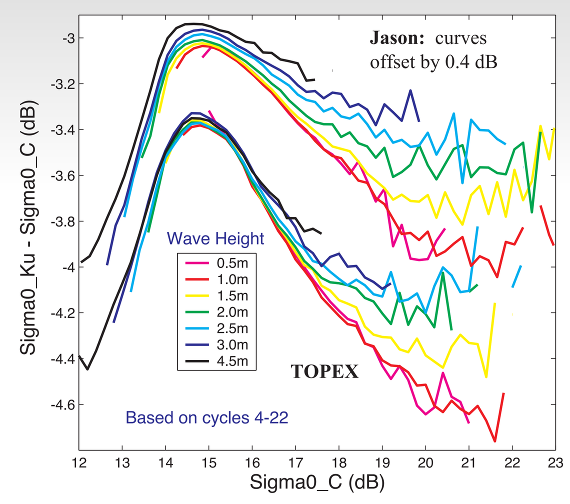


3. Comparison of σ^0-σ^0 Relationships

Not surprisingly, if the σ^0_{Ku} and σ^0_C values of Jason are adjusted so that their means coincide with those from TOPEX, the mean σ^0-σ^0 relationships agree well, apart from in the high σ^0 (low wind speed) regime.

Wave height has a pronounced effect on the relationship at high σ^0. However, the effect is the same for both altimeters; the same is not true at low σ^0, possibly due to instrument-specific processing corrections.

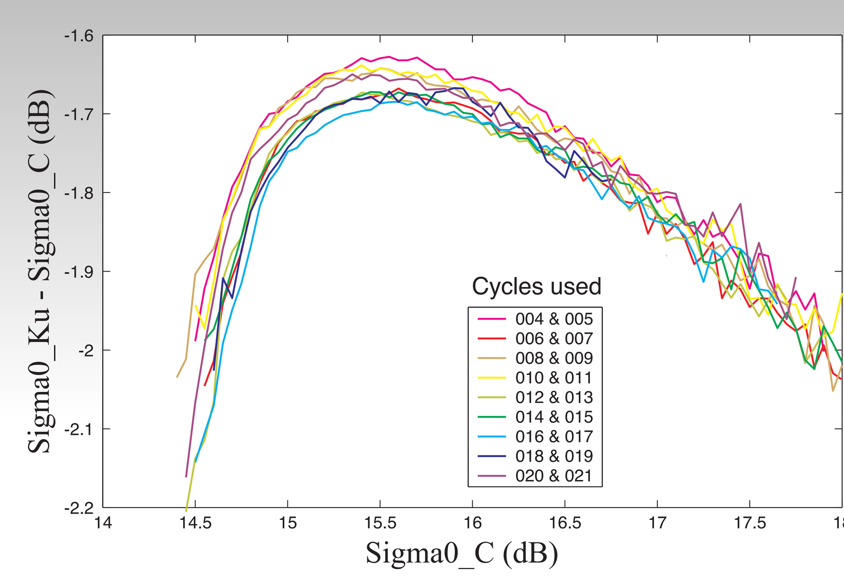




4. Constancy of relationship

To facilitate routine rain-flagging, it is beneficial if the σ^0-σ^0 relationship remains constant in time (it is assumed the surface roughness has a fixed relationship at the two scales of interest, but calibration and instrumental effects may change) .

The plot on the left shows the derived relationship does have changes of order 0.05 dB between different cycles. Although smaller than the 0.5 dB flagging threshold, such cycle-to-cycle variations should be taken into account.



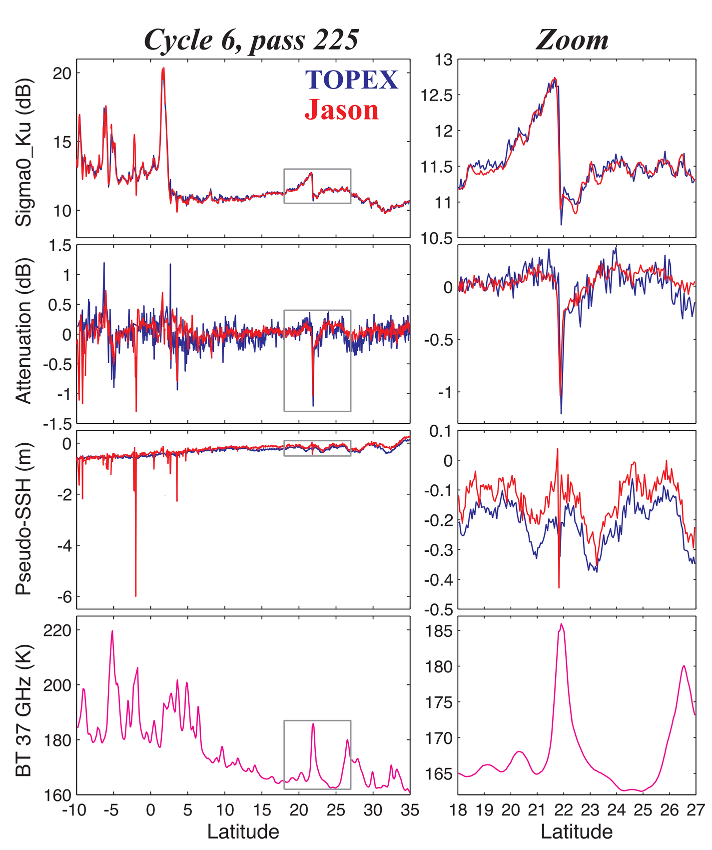
INTERIM SUMMARY

Despite different σ^0 scaling, Jason, like TOPEX, has a tight σ^0-σ^0 relationship, with a little variation with SWH and time. The two altimeters respond similarly to the large scale σ^0 variations due to wind; do they agree on the fine scale necessary for rain studies?

5. Example profile of TOPEX and Jason data

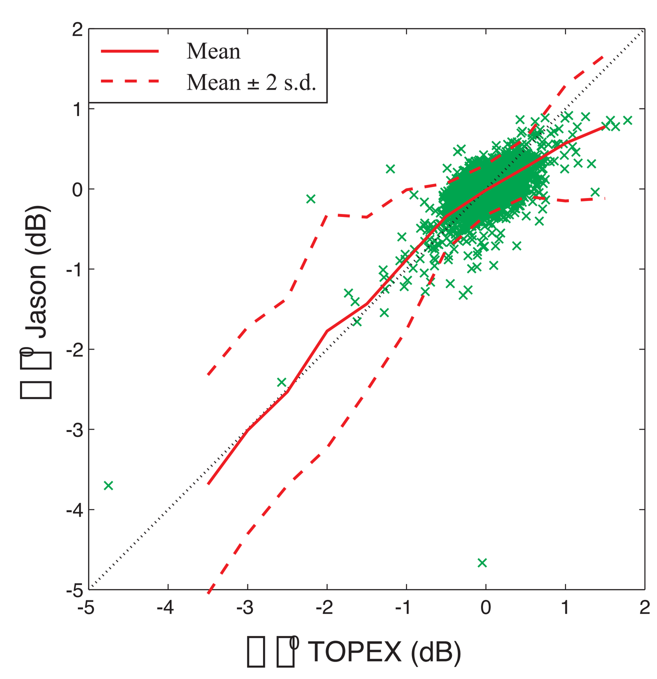
The figure to the right shows the matchup of TOPEX and Jason data. The top plots show how well the σ^0_{Ku} values agree across a wide dynamic range; the second row shows the attenuation, $\Delta\sigma^0$, derived from σ^0_C and σ^0_{Ku}. Note how well TPEX and Jason agree for the rain cell at 22°N; at high σ^0, the agreement in attenuation is less good.

The lower plots show the spikes in SSH associated with rain events, and the broad response of the TMR.



6. Comparison of $\Delta\sigma^0$ Values

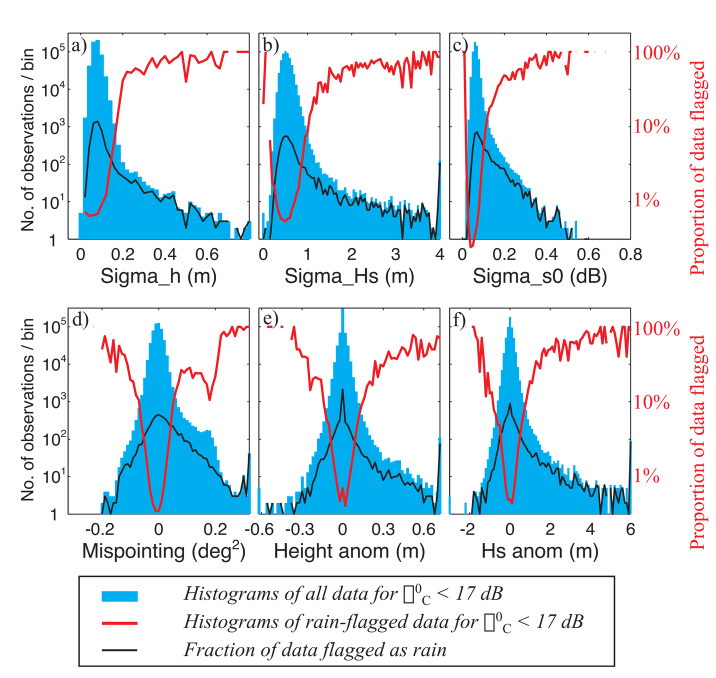
The figure on the left shows the matchup of derived attenuation from cycles 10 & 11 (only a subset of points shown). For negative values (K_u-band attenuation), there is very good quantitative agreement, with a std. dev. of ~0.6 dB. positive values (K_u-band enhancement?) show a different relationship between the two altimeters.



7. Applications I. Data editing

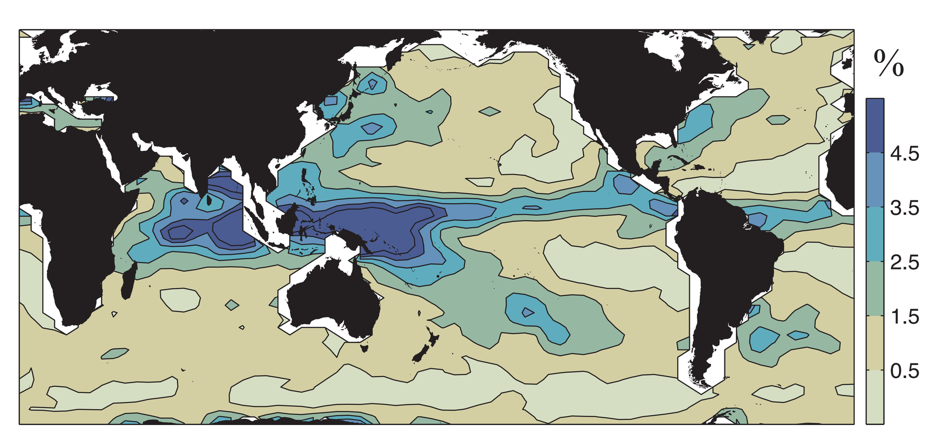
There are many causes of 'anomalous data', of which rain is an important one. It distorts waveform shape, leading to data spikes in SSH and wave height, and its short spatial scales lead to great variability within 1s averages.

For σ^0_C<17 dB, it is the primary cause of many of these anomalies; for higher σ^0 other effects (glassy seas? sea-ice?) become important.



8. Applications II. Rain climatology

The map on the left shows the fraction of data flagged as rain during Jason cycles 4-21. It not only acts as an indicator of regions of data loss, but provides an independent estimate of the frequency of occurrence of rain, which is an important factor in studies of climate change.



FINAL SUMMARY

The derived attenuations from TOPEX and Jason agree very well, so the proven validation of TOPEX rain data is applicable here. A Jason dual-frequency rain flag is a good indicator of anomalous data, and can also be used to extend the TOPEX rain climatology.