POL-2 Telecon
11 Mar 2015

Summary

The focal plane (FP) images have been cleaned and filtered to remove large spikes in the image while preserving large angular scale signals.

The optical model (OM) has been refit to the data with additional parameters for X and Y offsets. Large discrepancies between the OM and the data remain.

A 2D polynomial is fit across the FP for each skydip at each elevation. The results show general trends in the IP as a function of elevation. However, small-angular scale features in the arrays, and overall scaling between the skydips need to be investigated and quantified.

FP Image Processing

Large amplitude spikes appear in the FP skydip data. These are often isolated pixels and are unlikely to be any true polarisation signal. To remove them, the FP image is smoothed with a 6×6 pixel boxcar-filter and the standard deviation is measured. Any pixels in the original data that deviate from the smoothed image by larger than 3σ are flagged. Any pixel which is completely surrounded by flagged pixels are themselves flagged. This process is repeated until less than 1% of the image pixels are flagged in a single iteration. This typically results in ∼10% of the pixels being flagged across ∼5 iterations. Finally, the despiked image is smoothed with a 6×6 pixel boxcar filter. This procedure is similar to the starlink-kappa ffclean function. Figure 1 presents an example of the FP during these filtering stages.

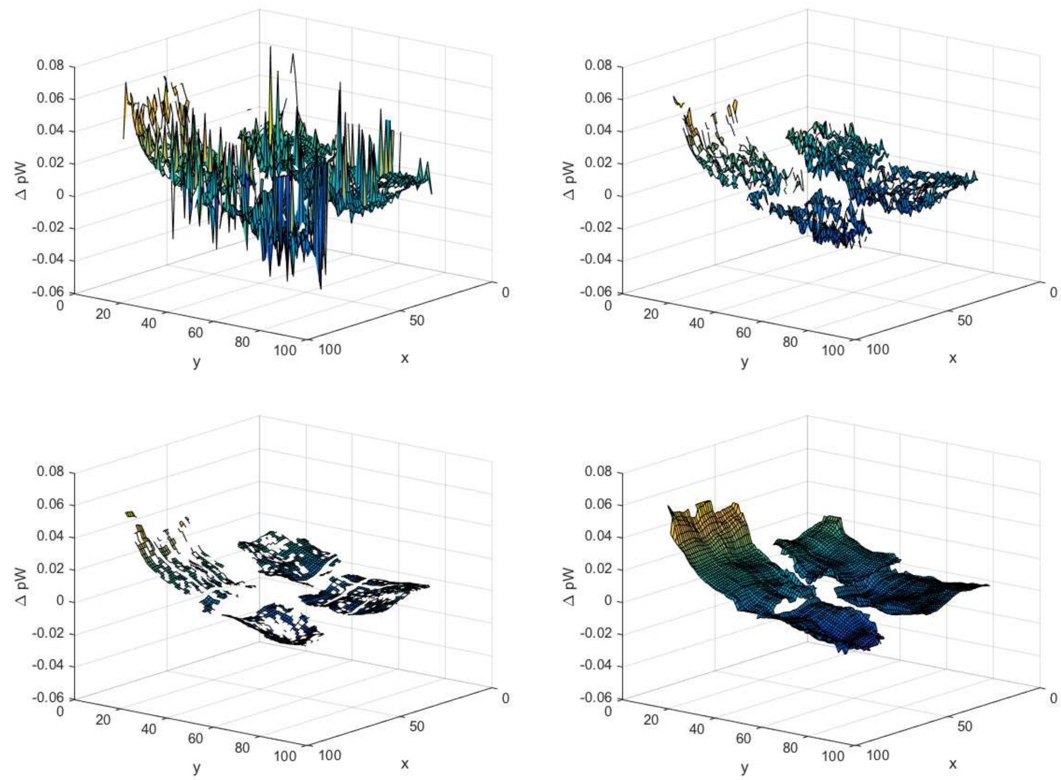

Figure 1 The FP Stokes Q image from 20120928 at an elevation of 85°. **Top Left:** The original image. **Top Right:** The despiked image. **Bottom Left:** The despiked and smoothed image. **Bottom Right:** The smoothed image with gaps filled in through interpolation.

Fitting the Optical Model

The optical model (OM) is fit to the cleaned and filtered FP images. Since the OM was determined at zenith, the FP data is restricted to those at an EL=89° (This includes only the skydips taken on 20121017, 20130303, and 20130304). The fit parameters are rotation angle θ, amplitude, an X offset, and a Y offset. The resulting fit has an order of magnitude discrepancy between the OM and the data. Figure 2 shows the θ-amplitude likelihood (marginalised over position offsets), and the X offset-Y offset likelihood (marginalised over θ and amplitude). Figure 3 shows the best fit Stokes-U surface from the OM and the Stokes-U data from the 20130303 skydip.

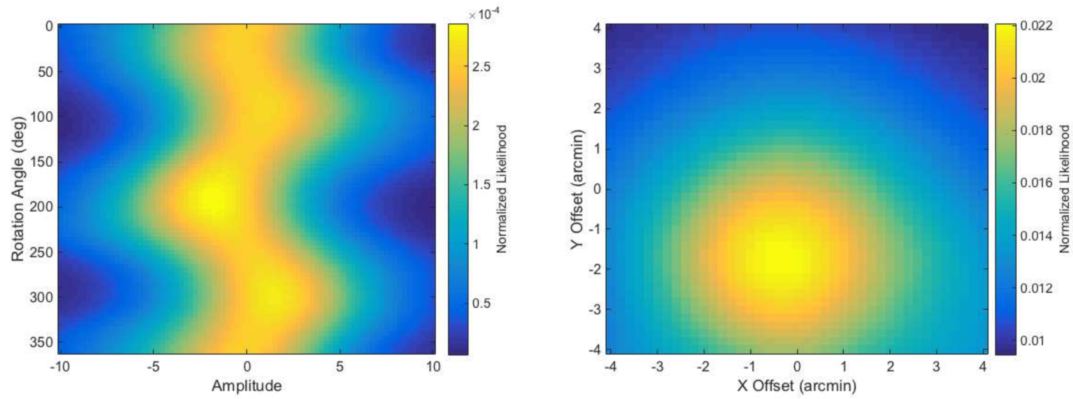

Figure 2 The likelihood surfaces from fitting the OM to the skydip data. **Left:** The θ-amplitude likelihood. The symmetric aspects of the OM results in a wavy likelihood. However, when the model amplitude is zero, all other model parameters have flat likelihood. **Right:** The X-Y offset likelihood. Due to the extremely low likelihood for the amplitude (often zero!) there is no strong constraint on the X and Y offsets and the 1-σ region spans most of the FP.

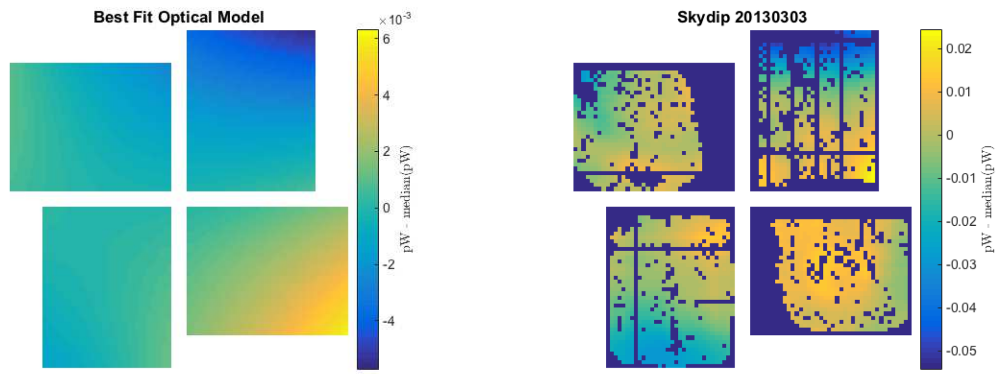

Figure 3 The best fit OM and the skydip data from 20130303. The colour scales differ between the two plots.

Fitting a polynomial across the Focal Plane

A 2D 2^{nd} order polynomial is fit across the FP for each skydip at each elevation. In general, there is a strong correlation between the images taken at the same elevation on different days. One exception is the skydip taken on 20121017. The ipt_notes.pdf document has suggested that there is an error in the wave plate phase on this day

[1] which might explain the differences seen here. Figure 4 shows an example of the smoothed skydip data alongside the fitted 2D polynomial for multiple skydips at an elevation of 85°. Shown separately are the smoothed data and 2D polynomial fit for the 20121017 skydip. Figure 5 shows the polynomial fits at lower elevations (53° and 19.5° respectively). Note that the curvature changes with elevation. For the lowest elevation, the skydip taken on 20130303 deviates from the rest due to the large positive polarisation feature in the s8b array.

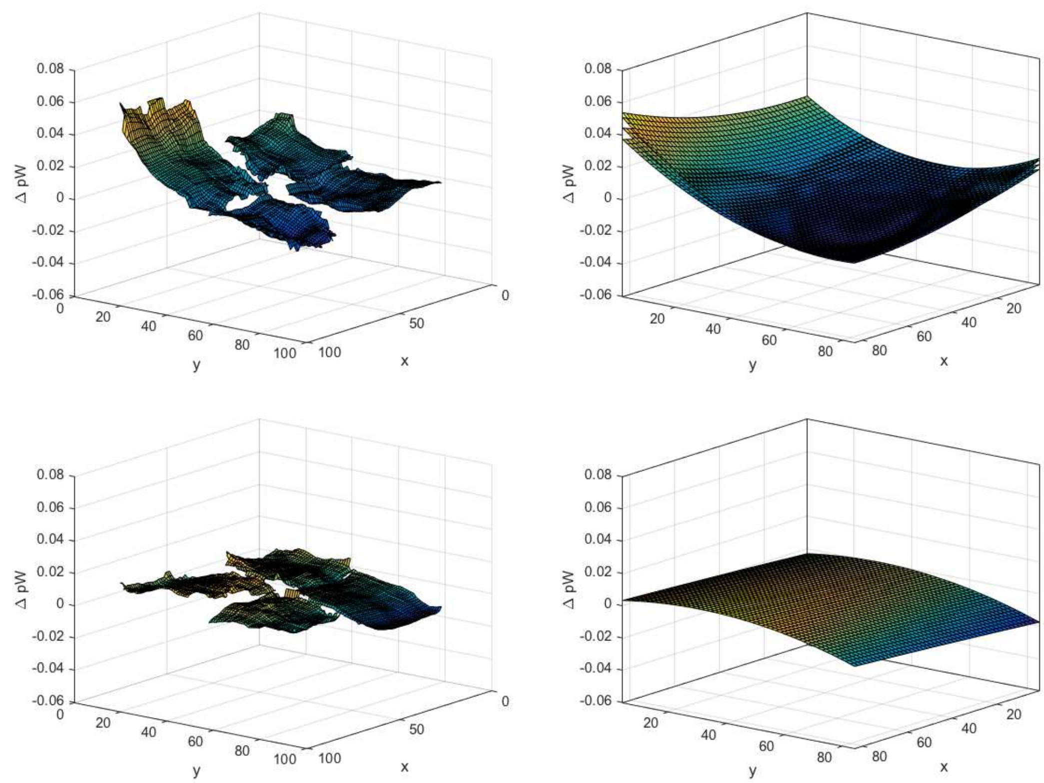

Figure 4 The smoothed FP Stokes Q images and fitted 2D polynomials at an elevation of 85°. Note: Interpolated values are not used in the fit. **Top Left:**The smoothed FP image from 20120928. **Top Right:** The best fit 2D 2^{nd} order polynomials for the 20120928, 20120929, 20130303, and 20130304 skydips. **Bottom Left:** The smoothed FP image from the 20121017 skydip. **Bottom Right:** The best fit 2D 2^{nd} order polynomial for the 20121017 skydip FP data.

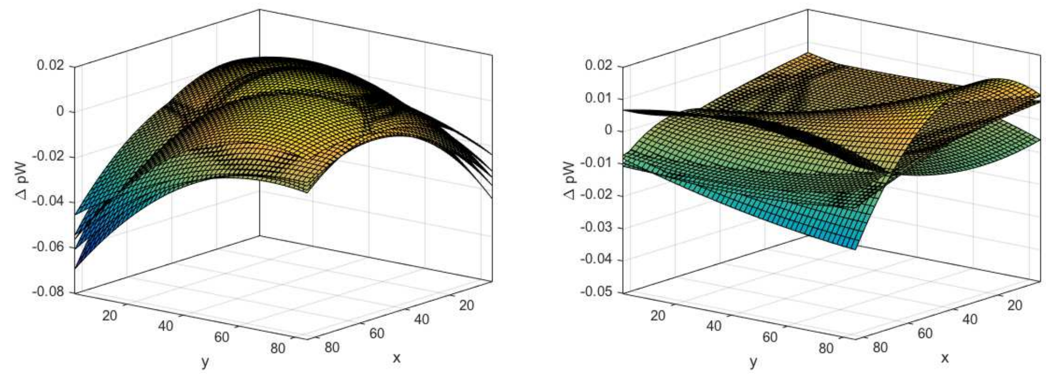

Figure 5 The best fit 2D polynomials for lower elevations. **Left:** Results from an elevation of 53°. **Right:** Results from an elevation of 19.5°. The polynomial which deviates the largest from the group corresponds to the 20130303 skydip. It is likely that this fit is strongly affected by the large positive signal observed in array s8b.

Next Steps

1. Investigate the scaling of the IP between the skydips. Any relation to other variables (eg. τ)?
2. For smaller spatial scales, fit a 2D polynomial to each array.
3. Discuss how the IP removal will be implemented. A lookup table? A polynomial for each array ?
4. Identify and de-weight high S/N, but non-IP signals (How to remove the 20130303 s8b low-elevation signal if it is not IP?).
5. Comparison with IP from planet data.

References

[1] D. Johnstone. ipt_notes. Distributed on 2013-03-12 to the POL-2 Team. Discussed on the 2013-03-25 Telecon., March 2013.