Mapping a pixel using kernel regression

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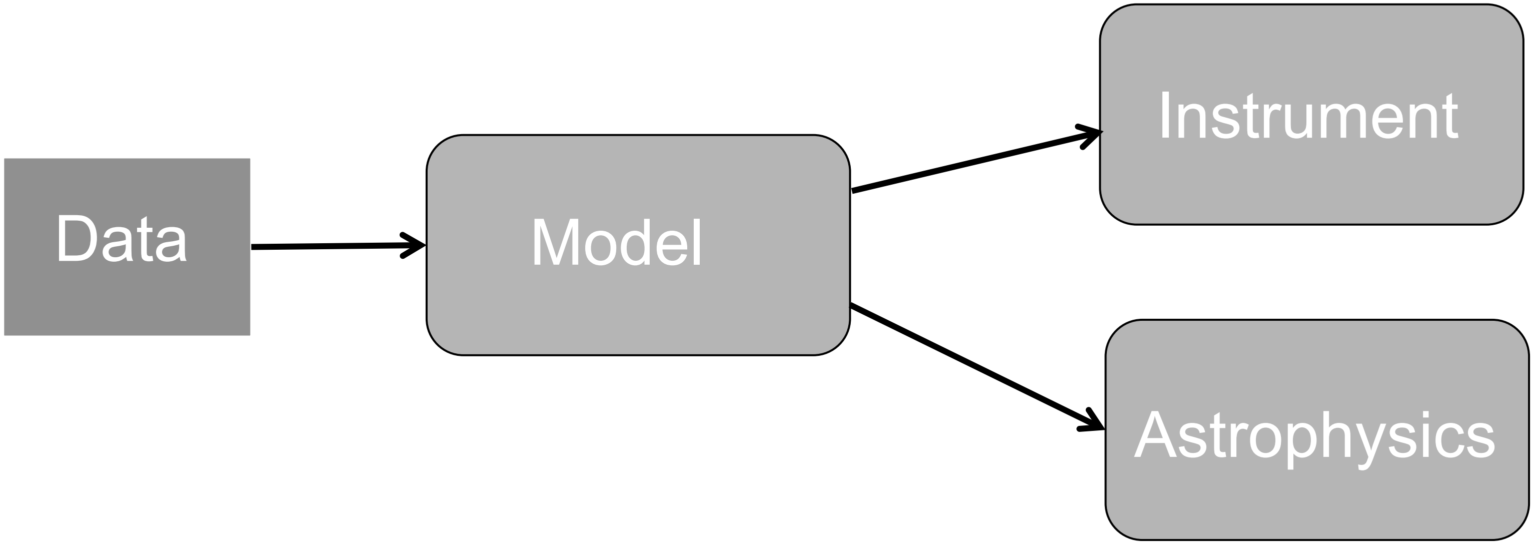
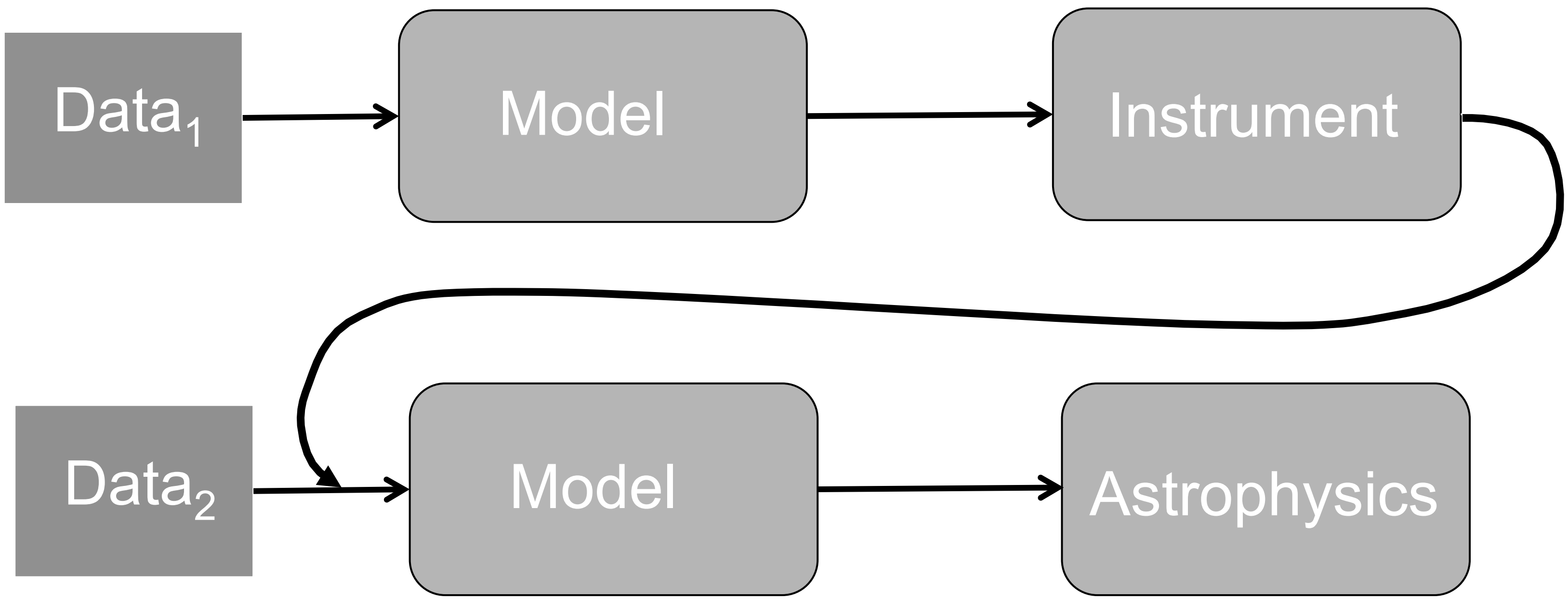
Goal

Develop a correction for correlated noise in IRAC photometry, that is independent of the data to be corrected

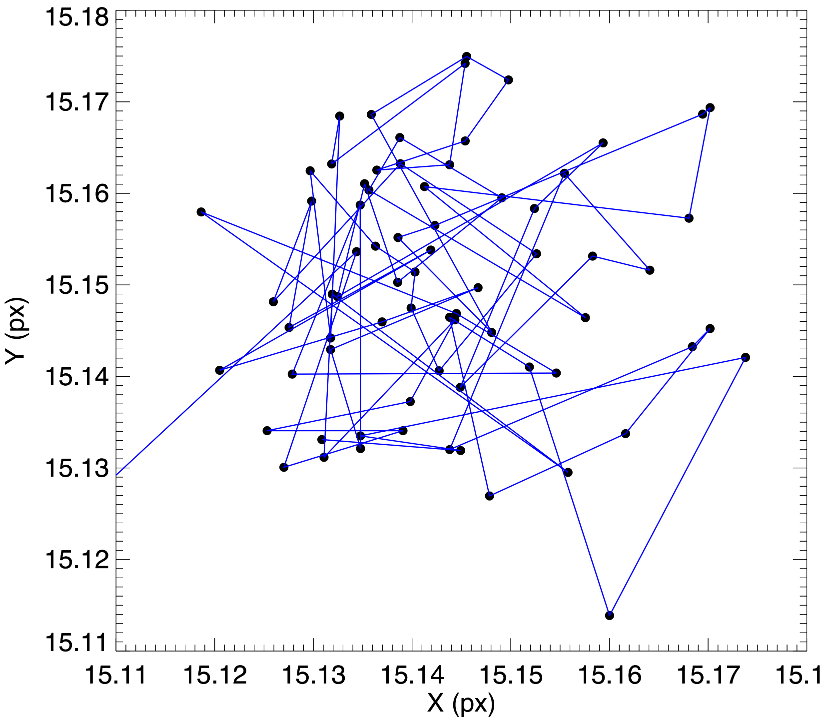


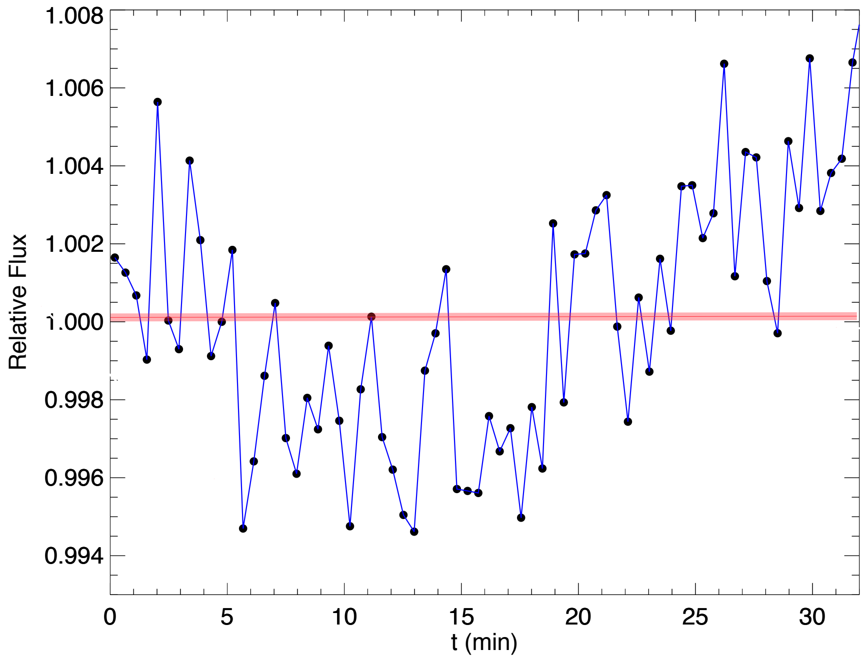
Goal

Develop a correction for correlated noise in IRAC photometry, that is <u>independent of the data to be corrected</u>

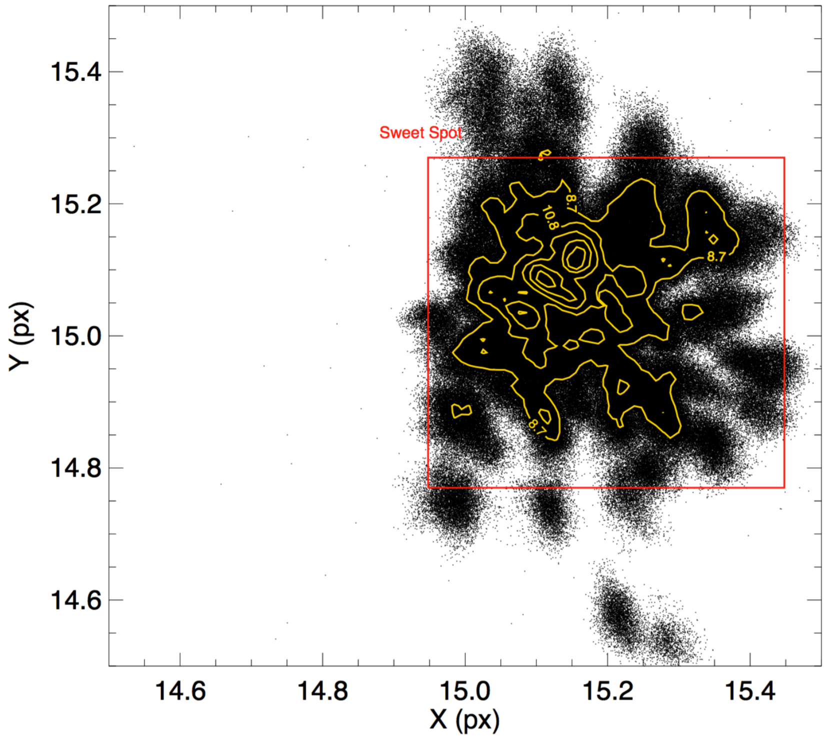


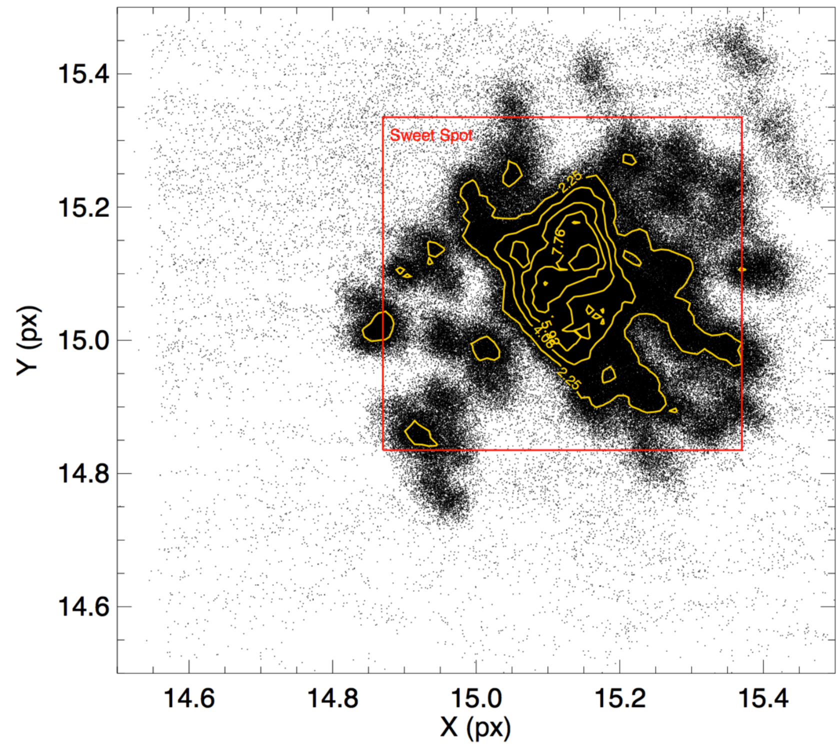
Correlated Noise in IRAC photometry





Mapping the Intrapixel Gain





Channel 1: 800,000 measurements
KF09T1

Channel 2: 500,000 measurements
BD+67 1044

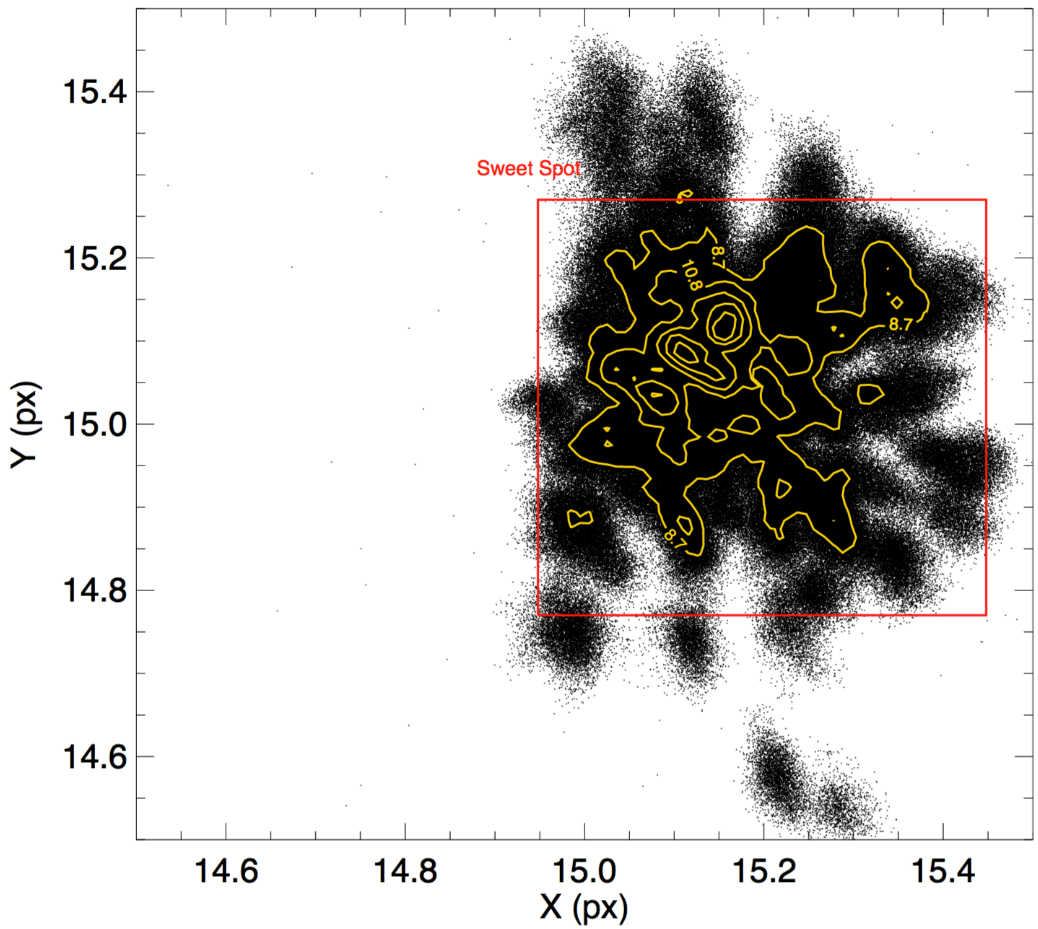
Nearest-neighbors kernel regression

$$\overline{F}(x,y) = \frac{\sum_{i<} f_i K_i}{\sum_{i<} K_i}$$

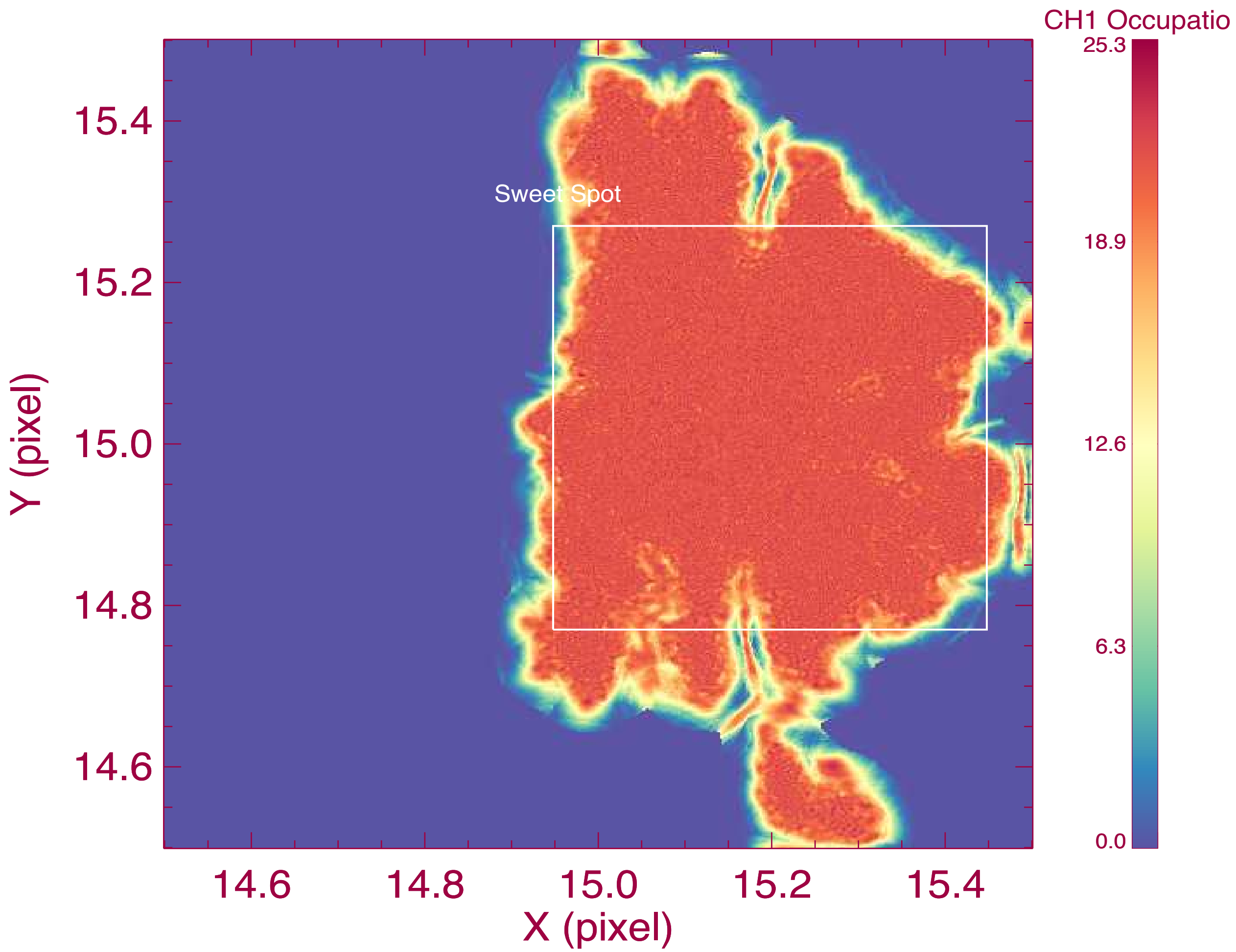
- Non-parametric regression – an inverse-distance weighted mean of the data around a point (x,y)
- Ballard et al. (2010), with science data
- Sum over ~100 nearest neighbors
- Gaussian kernel "occupation", width given by nearest neighbors' std. dev. in (x,y).
- Kernel can accept Noise Pixels, or (x,y) FWHM

$$K_i(x,y) = O_i(x,y)/\sigma^2(f_i) \qquad O_i(x,y) \equiv \exp\left\{-\left[\frac{(x-x_i)^2}{2\delta_x^2} + \frac{(y-y_i)^2}{2\delta_y^2}\right]\right\}$$

Mapping a Pixel: CH1



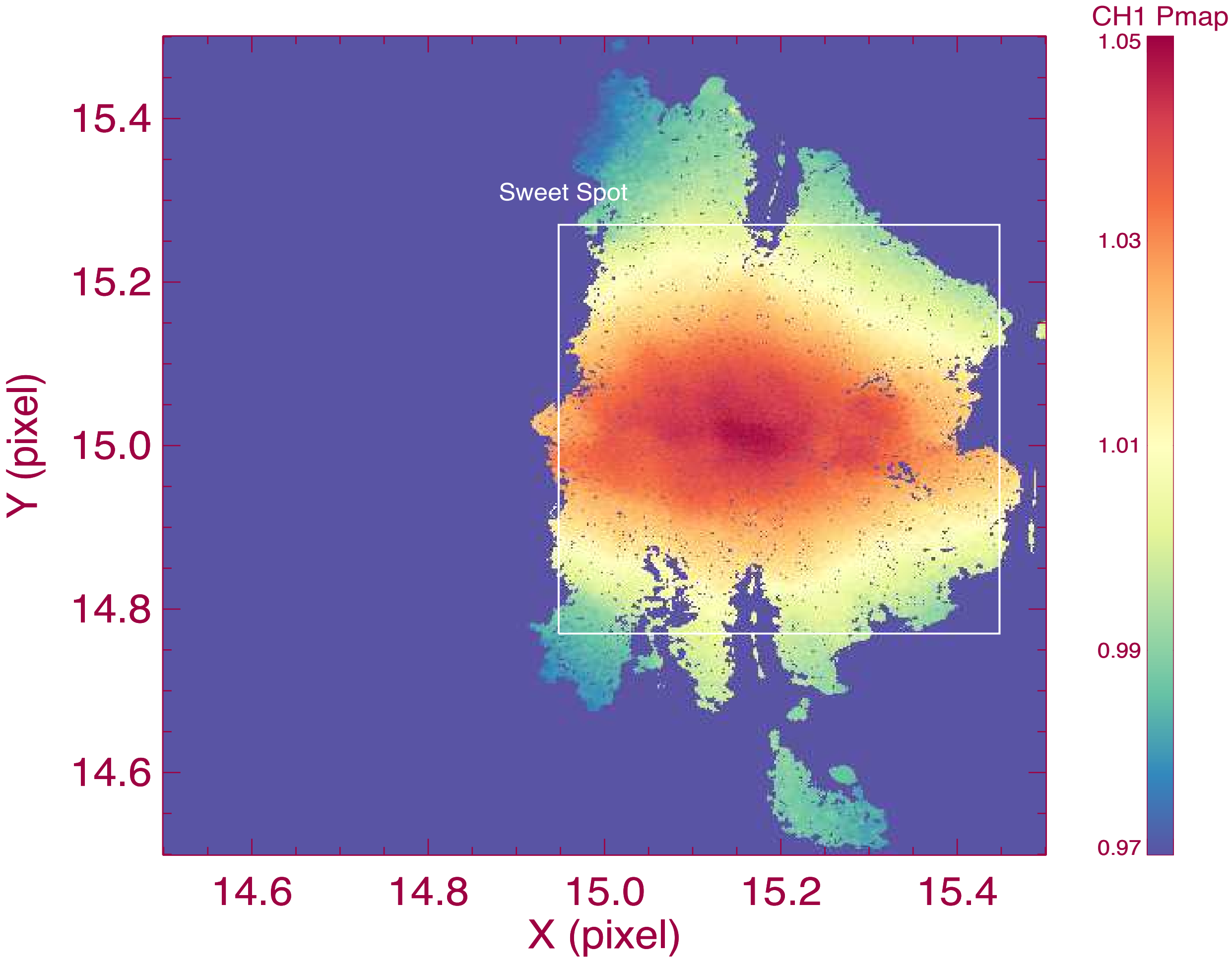
Mapping a Pixel: CH1



$$O_i(x,y) \equiv \exp\left\{-\left[\frac{(x-x_i)^2}{2\delta_x^2}+\frac{(y-y_i)^2}{2\delta_y^2}\right]\right\}$$

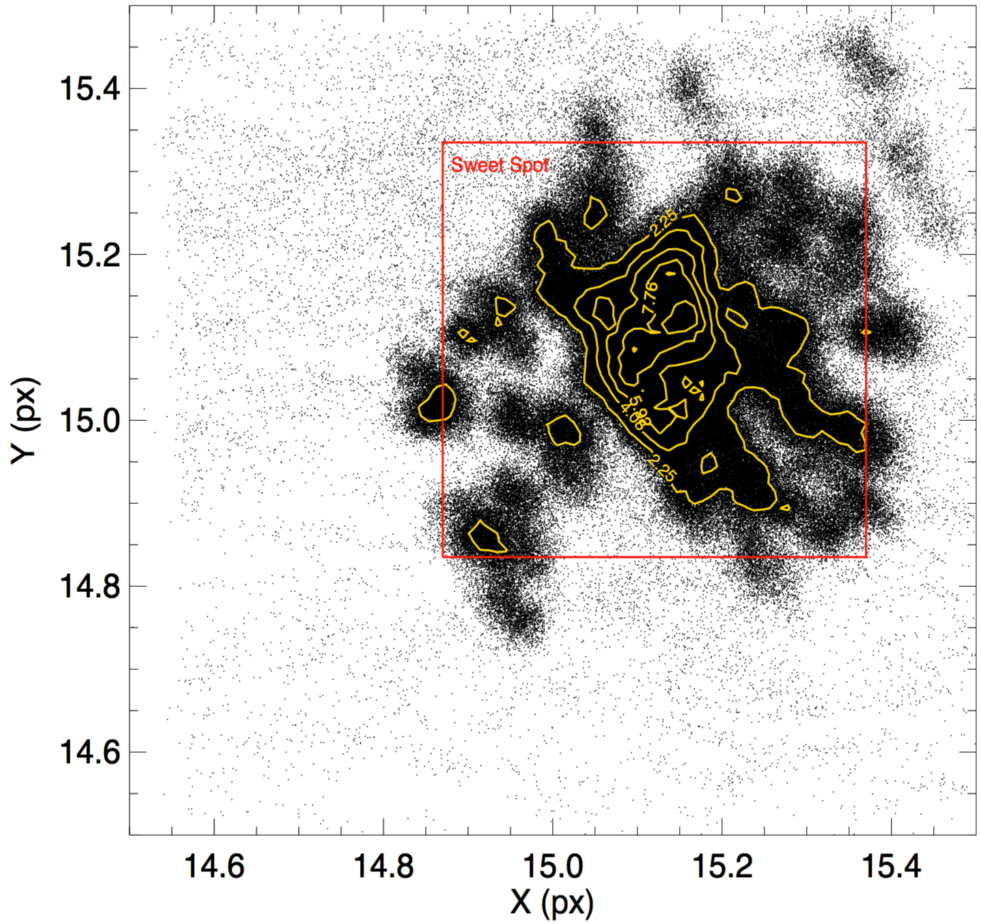
$$\mathbf{O}(x,y) = \sum_{i<} O_i(x,y)$$

Mapping a Pixel: Ch 1

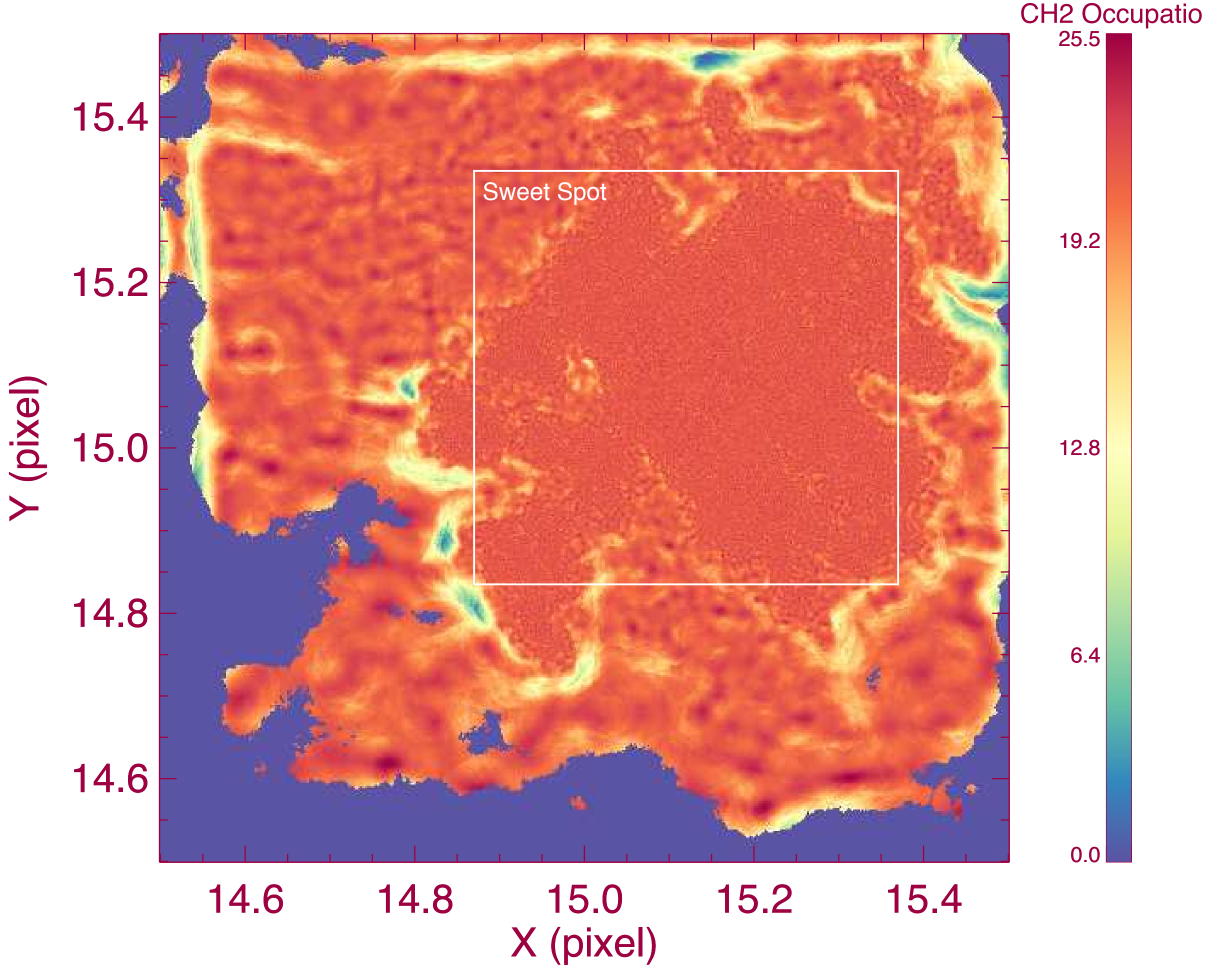


$$\overline{F}(x,y) = \frac{\sum_{i<} f_i K_i}{\sum_{i<} K_i}$$

Mapping a Pixel: Ch 2



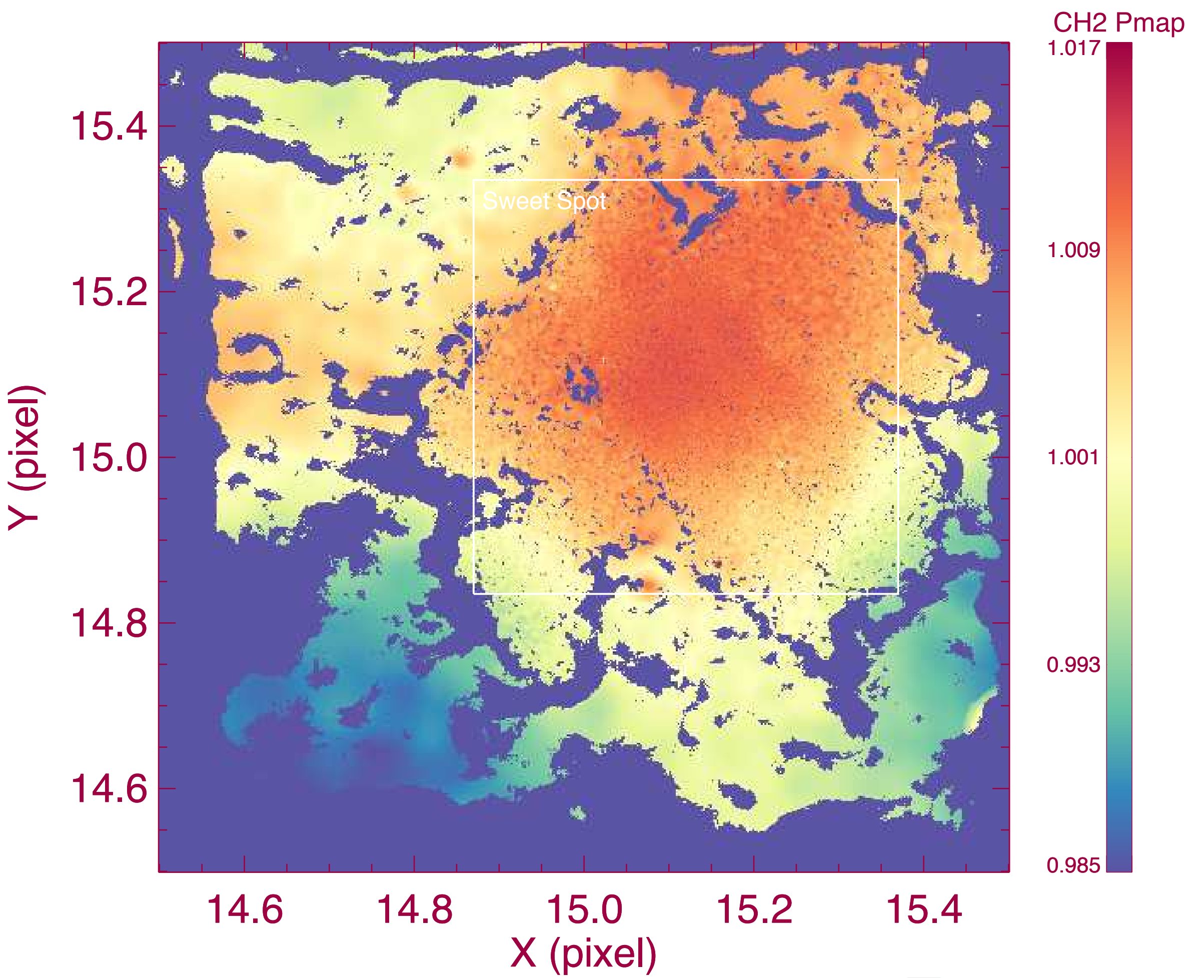
Mapping a Pixel: CH1



$$O_i(x,y) \equiv \exp\left\{-\left[\frac{(x-x_i)^2}{2\delta_x^2} + \frac{(y-y_i)^2}{2\delta_y^2}\right]\right\}$$

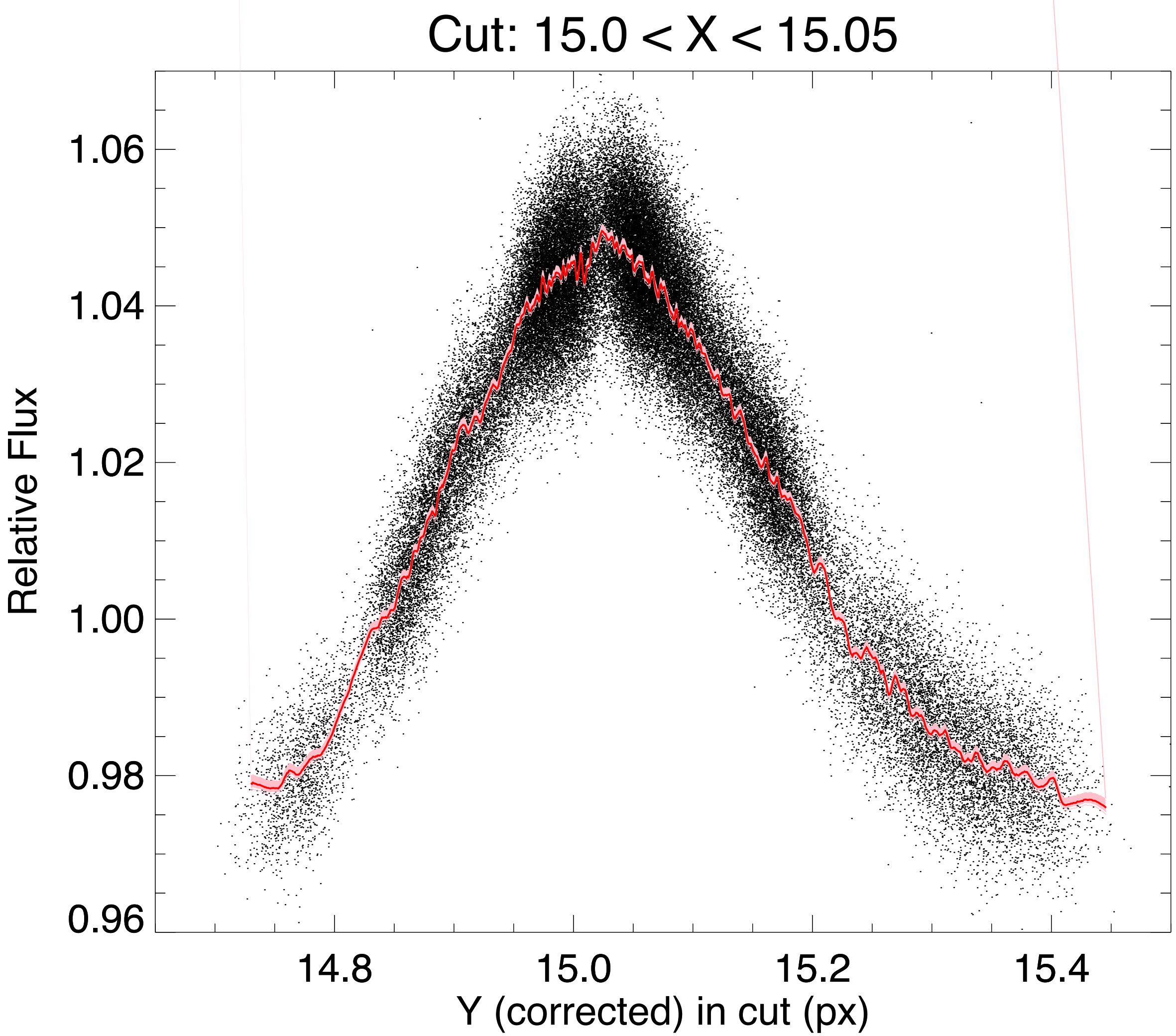
$$\mathbf{O}(x,y) = \sum_{i<} O_i(x,y)$$

Mapping a Pixel: Ch 2



$$\overline{F}(x,y) = \frac{\sum_{i<} f_i K_i}{\sum_{i<} K_i}$$

Mapping a pixel: Ch 1



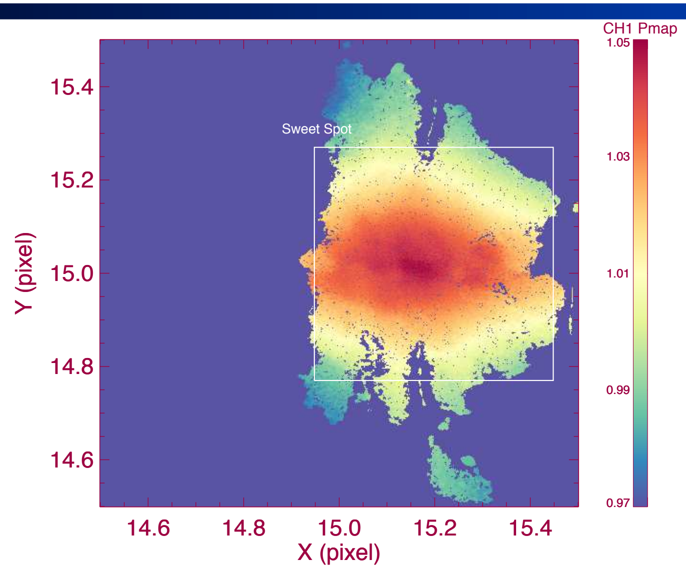
Curve shows regression result for the data shown, in a cut across the y-direction

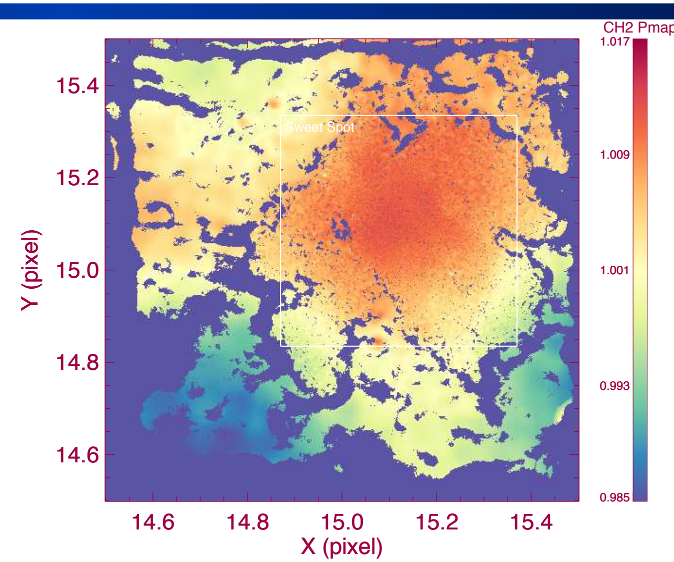
$$\overline{F}(x, y) = \frac{\sum_{i<} f_i K_i}{\sum_{i<} K_i}$$

Concerns:

- Overfitting
- Time-dependent latent flux

Correcting Data: New IDL package pmap_correct



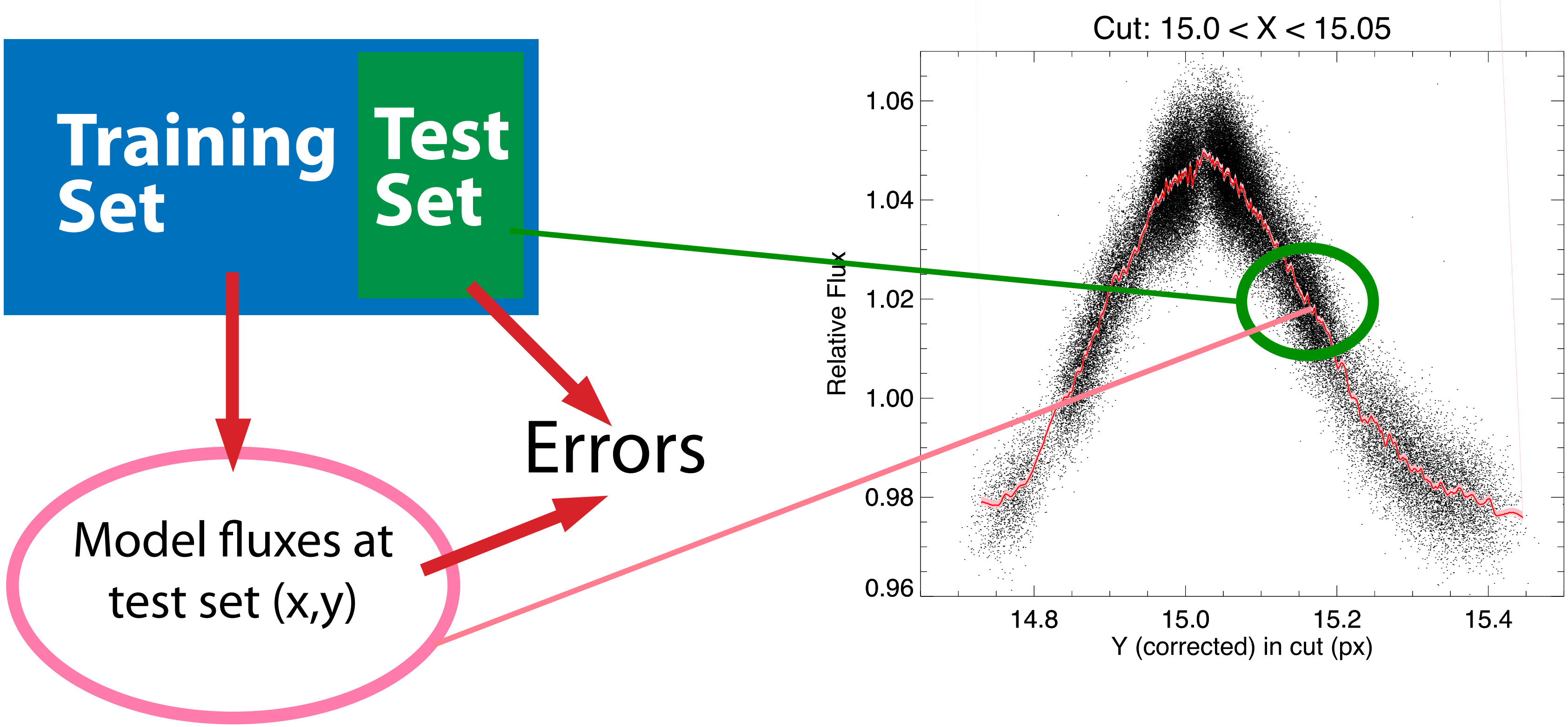


New code:

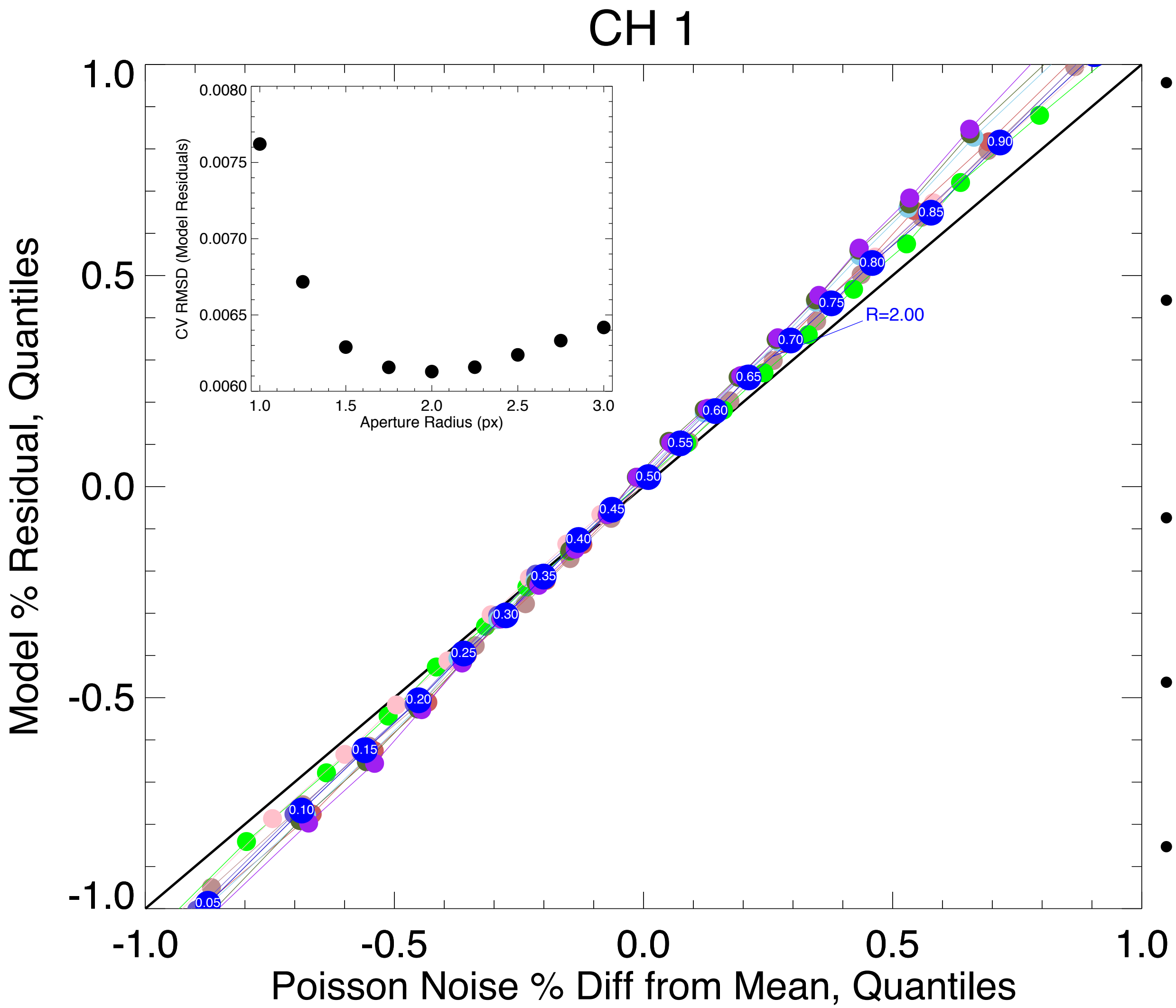
- Corrects photometry at (x,y) by dividing by the regression prediction for normalized flux at (x,y), "flattening out" the intra-pixel gain.
- Regression is computed from the NN p-map dataset at the (x,y) point. Old method interpolated gridded maps (above), suffering from poor resolution and interpolation artifacts.
- Validating with data challenge (Krick).
- Should be available Winter 2015.
- NN algorithim S L O W. Working on ways to speed up using external pre-compiled libraries.

Extra slides

Validating the model

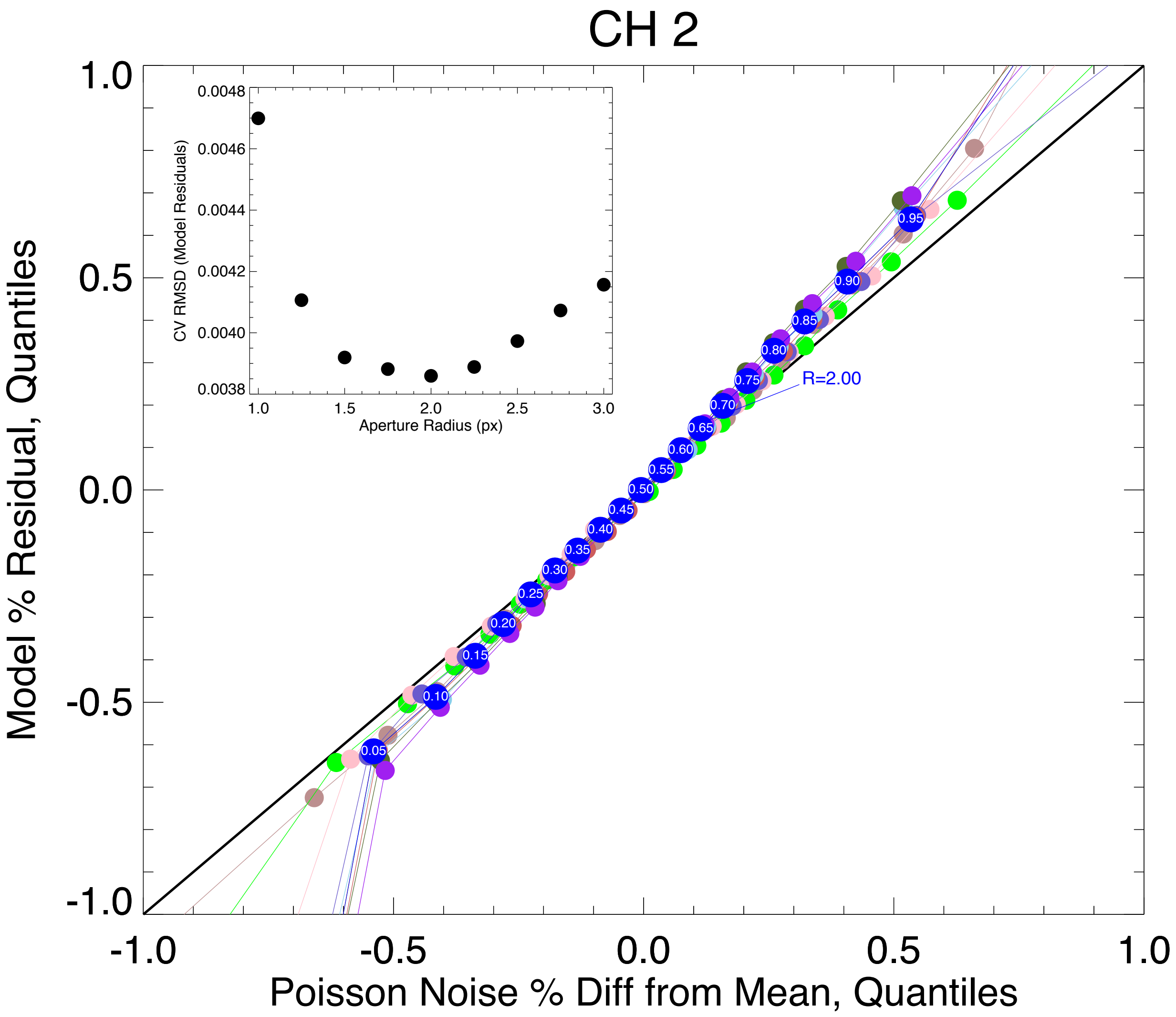


Do the residuals look like white noise?



- Q-Q plot is a high S/N technique for comparing distributions.
- Slope > 1: Model distribution is slightly broader than Poisson noise
- 50 pct-ile slightly above line, small bias.
- RMSD/Mean minimum ~0.6% at R=2.0px
- 70% of data within 0.1% of white noise

Validating the model



- Slope > 1: Model distribution is slightly broader than Poisson noise
- 50 pct-ile on line, zero bias.
- RMSD/Mean minimum ~0.38% at R=2.0px
- 70% of data within 0.1% of white noise