

Elusive Earths and Other Matters:
Taking the Galactic Exoplanet
Census

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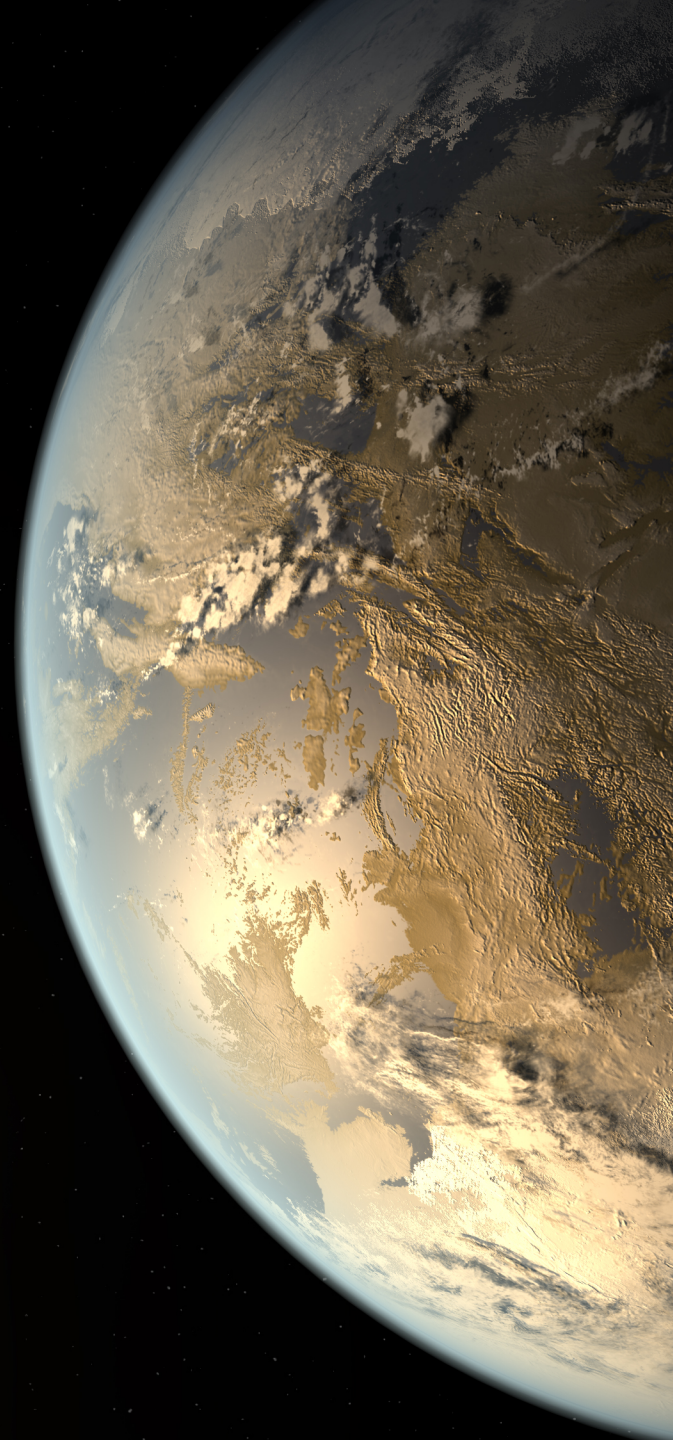
NASA Exoplanet Science Institute/Caltech

Determining η_{Earth}

Kepler was specifically designed to be a statistical mission, with the primary goal of measuring the prevalence of Earth-like planets in the Galaxy

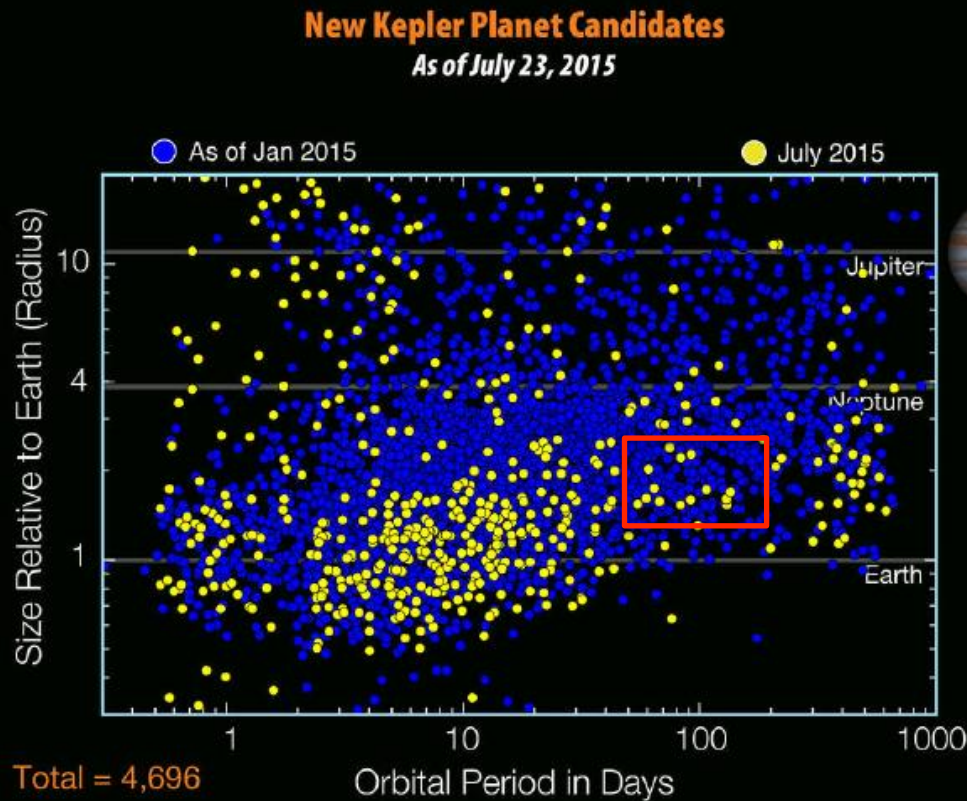
A lot of decisions were made to enable those calculations

- observing field, stellar sample, baseline
- planet sample from single pipeline run
- accompanying completeness and reliability measurements
- followup designed to interrogate a large fraction of the targets, not just the most interesting ones...



Q1-Q16 catalogue occurrence rates

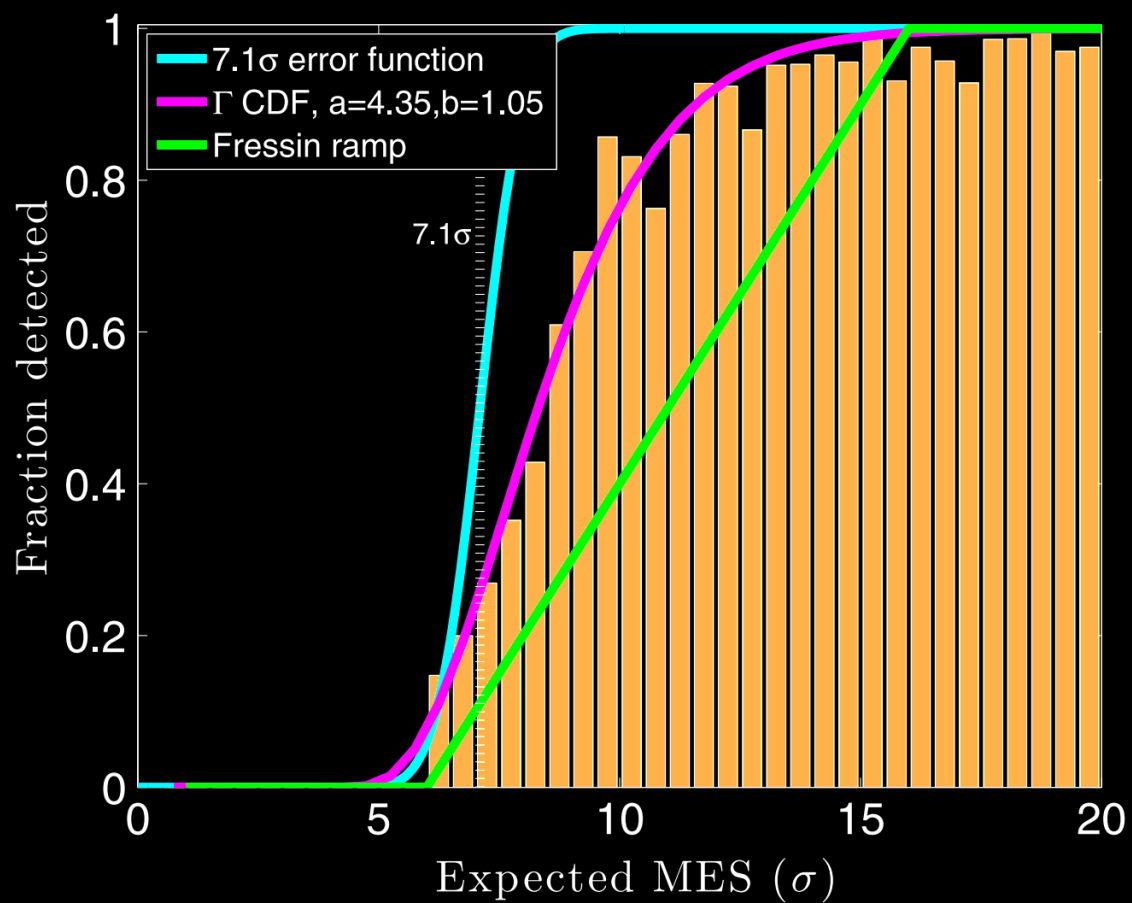
- Using the Mullally+2015 catalogue (blue points)
- GK stars (91,567 in total)
- R_p : 1-2 R_E ; Period: 50-200 days (red box)
- 138 planet candidates



Mullally+2015

Q1-Q16 catalogue occurrence rates

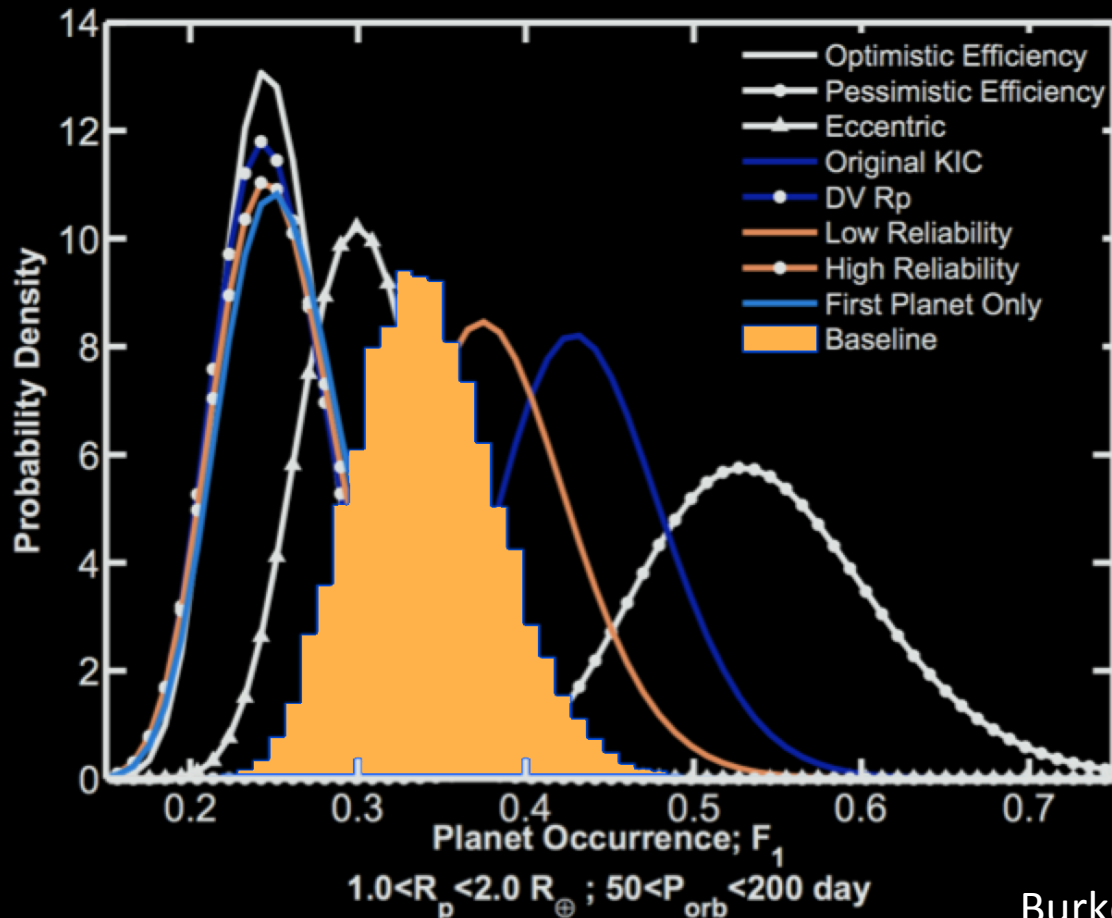
10,000 simulated planets injected
 R_p : 0.25-7 R_E ; Period: 0.5-200 days



Christiansen+2015

Q1-Q16 catalogue occurrence rates

Using the method described by Youdin 2011, Burke, Christiansen+2015 - parametric occurrence rate (best fit = broken power law in radius and power law in period)



Burke, Christiansen+2015

Questions/Considerations for K2

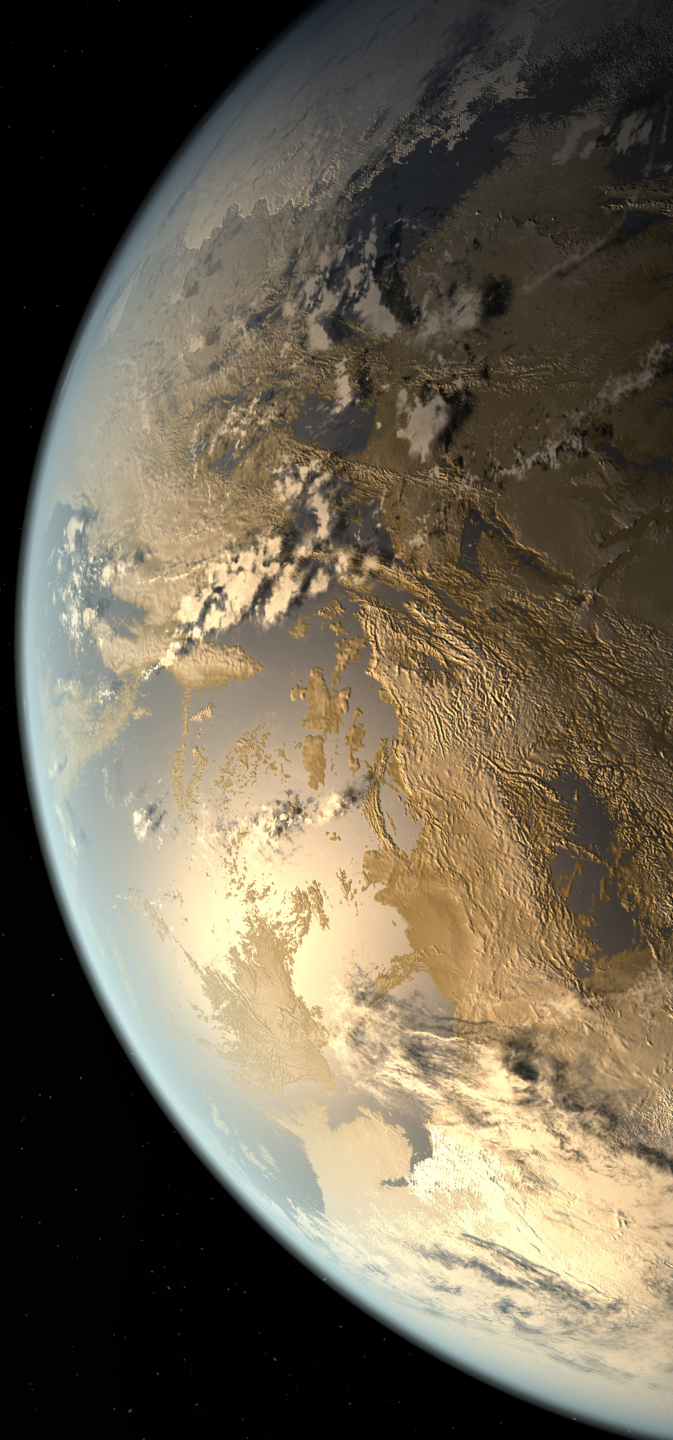
Ingredients for occurrence rate calculation:

1. Stellar sample?

Kepler: 3,700 Ms, 154,000 FGKs

K2: 26,000 Ms, 110,000 FGKs (C0-C6)

- K2 target selection inhomogenous
- How well characterised are the stellar parameters? EPIC offsets/biases?
- (It seems we are finding our 'M' candidates are more often late-K candidates)
- Can we uniformly select a stellar sample using a consistent set of criteria that we could then well characterise?



Questions/Considerations for K2

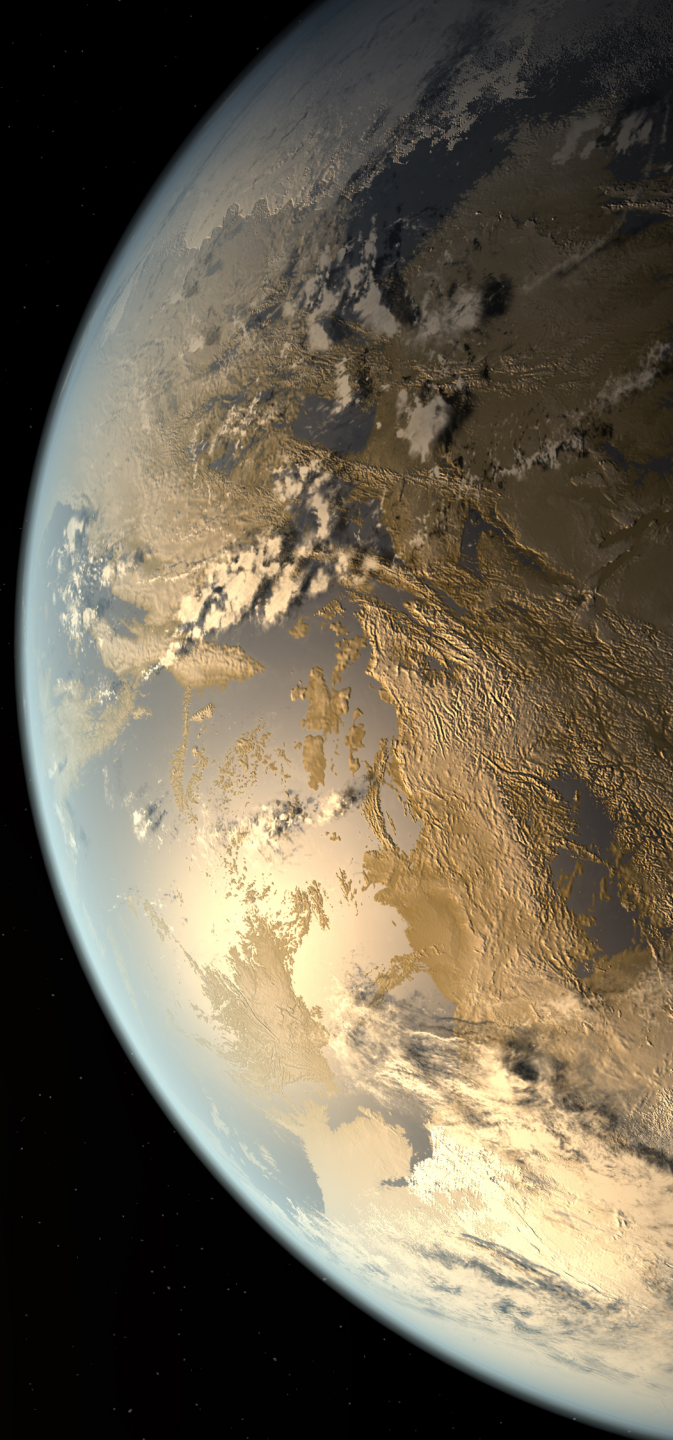
Ingredients for occurrence rate calculation:

2. Planet sample?

- Multiple candidate lists from different teams; we use TERRA
- With surprisingly little overlap (Crossfield+ catalogue ~60% of the Vanderburg+ catalogue and vice versa)

3. False negative rate?

- Injection recovery tests with TERRA
- Runs significantly faster than the Kepler pipeline, more flexibility to examine parameter space, dependence on stellar noise properties



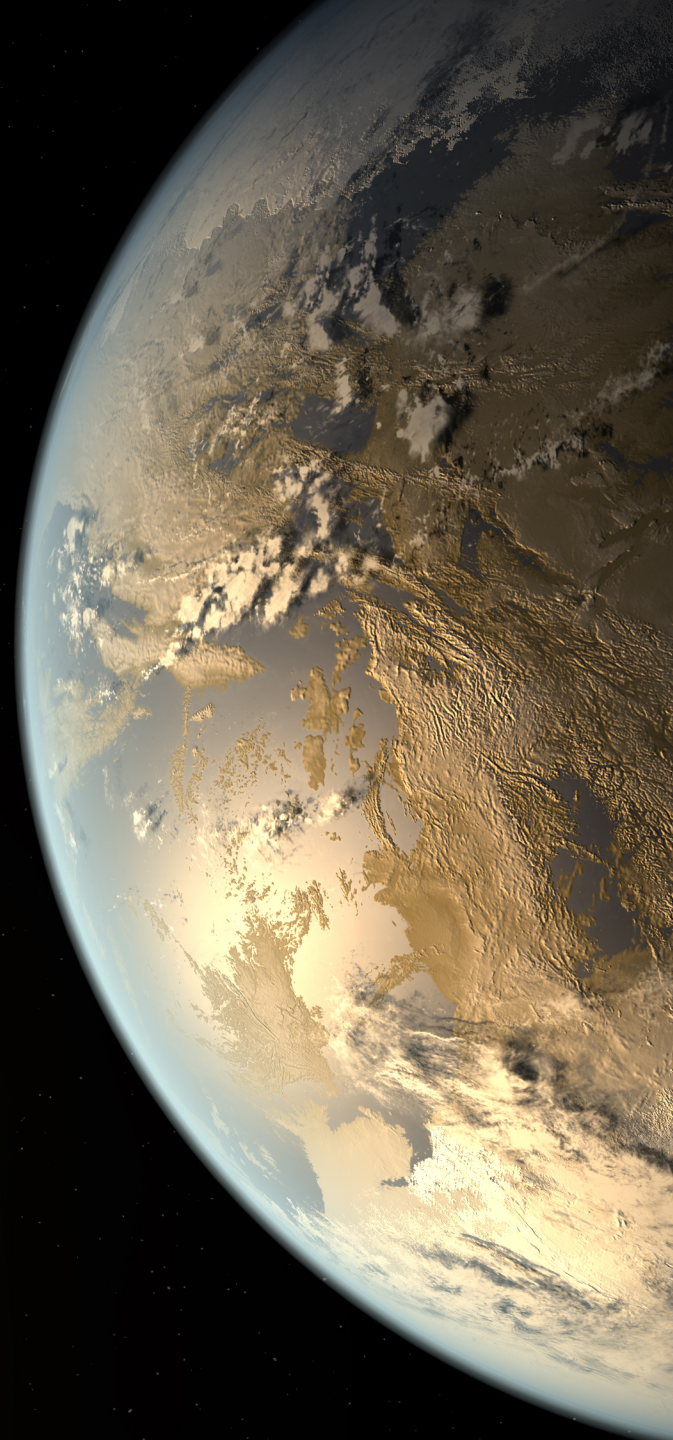
Questions/Considerations for K2

Ingredients for occurrence rate calculation:

4. False positive rate?

- Can start to bound the rate with the Crossfield+ catalogue, but we were not systematic
- How does it vary with period, stellar host type, etc?
- Select a sample on which we perform a uniform confirmation/validation effort – spectra, imaging, vespa

5. Stir, bake, serve while hot!



Summary

We have been making progress with the Kepler occurrence rates – in the process of assembling the final catalogue, making the final completeness calculations

The K2 data set is a tantalising opportunity, but full of thorny issues

The CHAI (California-Hawaii-Arizona-Indiana) K2 team is gearing up to take it on!

