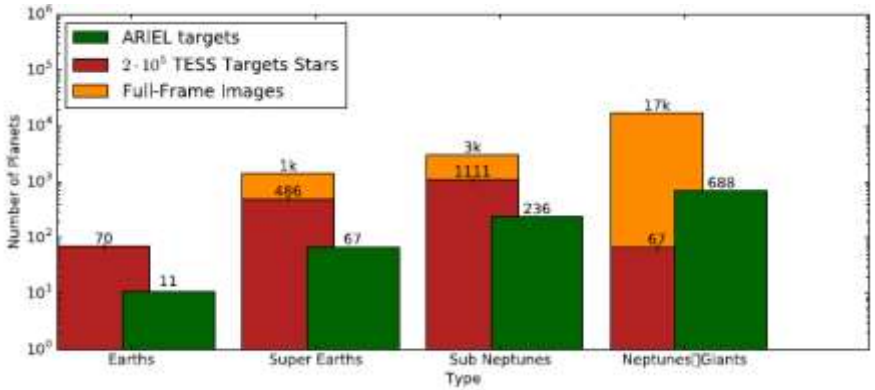

ARIEL Target Sample: Optimization & Ranking

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Target Ranking

- Useful exercise for missions with Input Catalogues
- For transit missions, Kepler did not do it, and it ultimately suffered from it
- TESS IC uses info on stellar properties, observability, companion detectability and potential for characterization (PLATO is about to do the same)
- The info is typically turned into relatively easy-to-use metrics
- One such exercise has recently been carried out to define metrics for prioritizing JWST targets
- ARIEL can certainly profit as well!

A FRAMEWORK FOR PRIORITIZING THE *TESS* PLANETARY CANDIDATES MOST AMENABLE TO ATMOSPHERIC CHARACTERIZATION

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Metric 1:

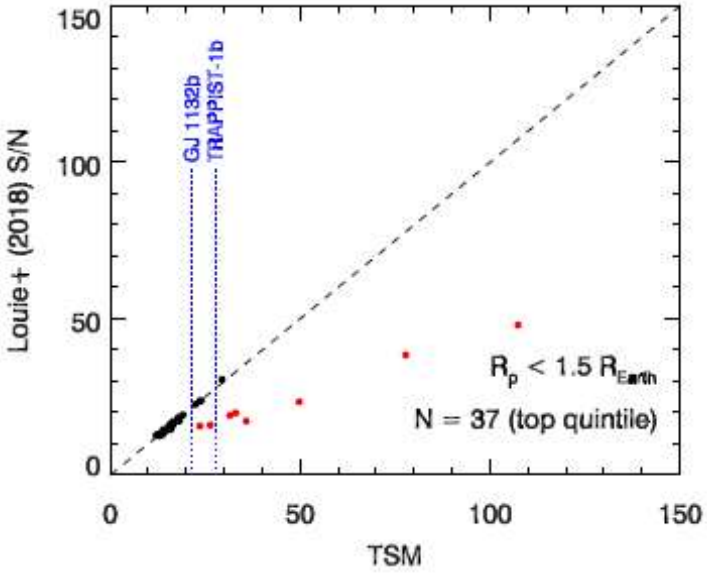
$$\mathrm{TSM} = (\text{Scale factor}) \times \frac{R_p^3\, T_{eq}}{M_p\, R_*^2} \times 10^{-m_J/5}$$

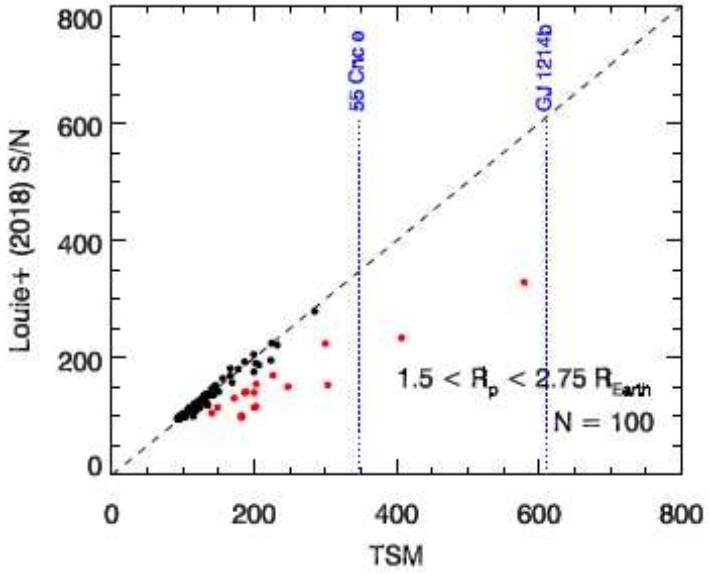
Metric 2:

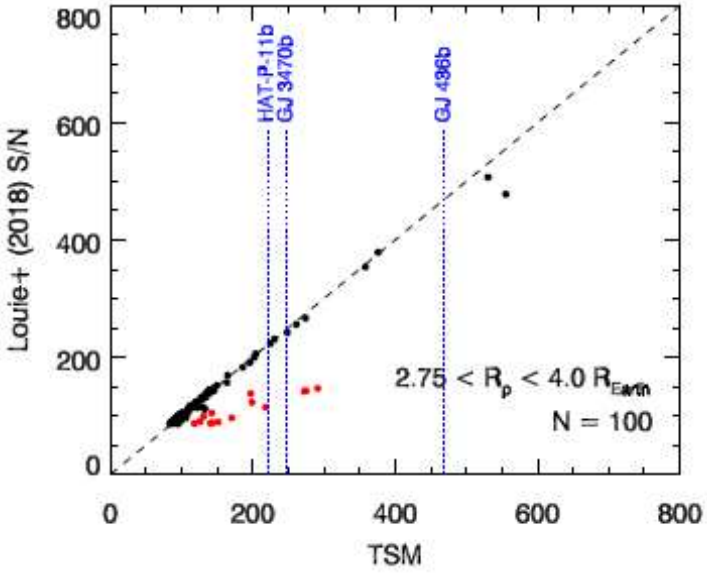
$$\mathrm{ESM} = 4.29 \times 10^6 \times \frac{B_{7.5}(T_{day})}{B_{7.5}(T_*)} \times \left(\frac{R_p}{R_*}\right)^2 \times 10^{-m_K/5}$$

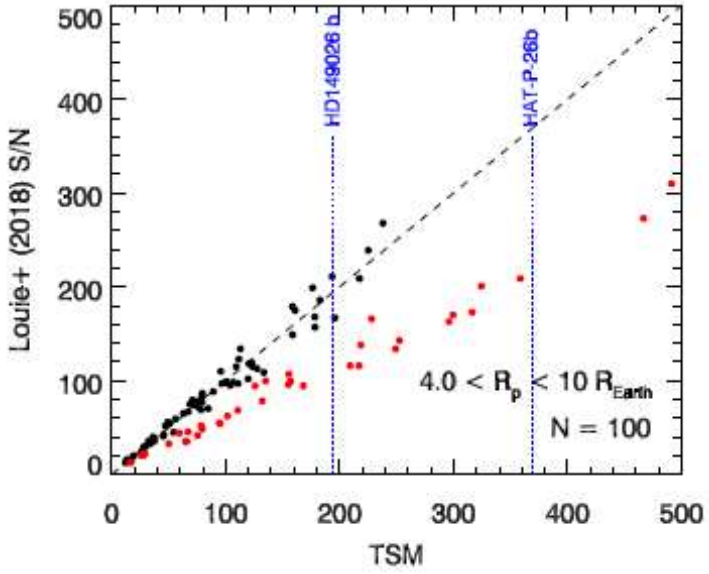
- Proportional to expected SNR in tranmission and emission spectroscopy with JWST
- Near-realistic values of the expected SNR for 10-hr observing programs with JWST/NIRISS and JWST/MIRI
- Assumptions: heavy use of TESS simulated catalogue (with caveats), analytical M-R relation, atmospheric composition, cloud-free atmospheres…

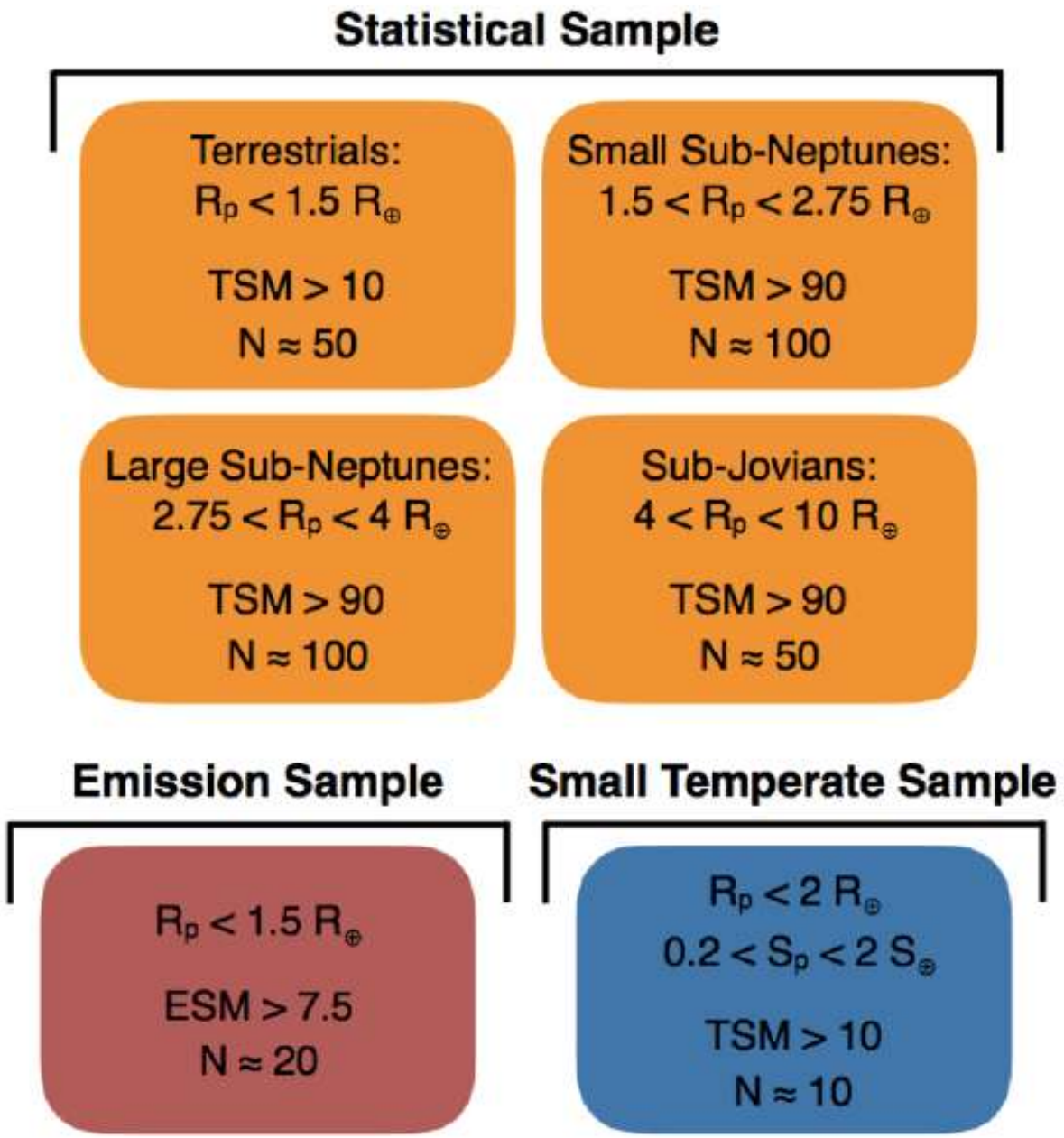
Kempton et al. 2018





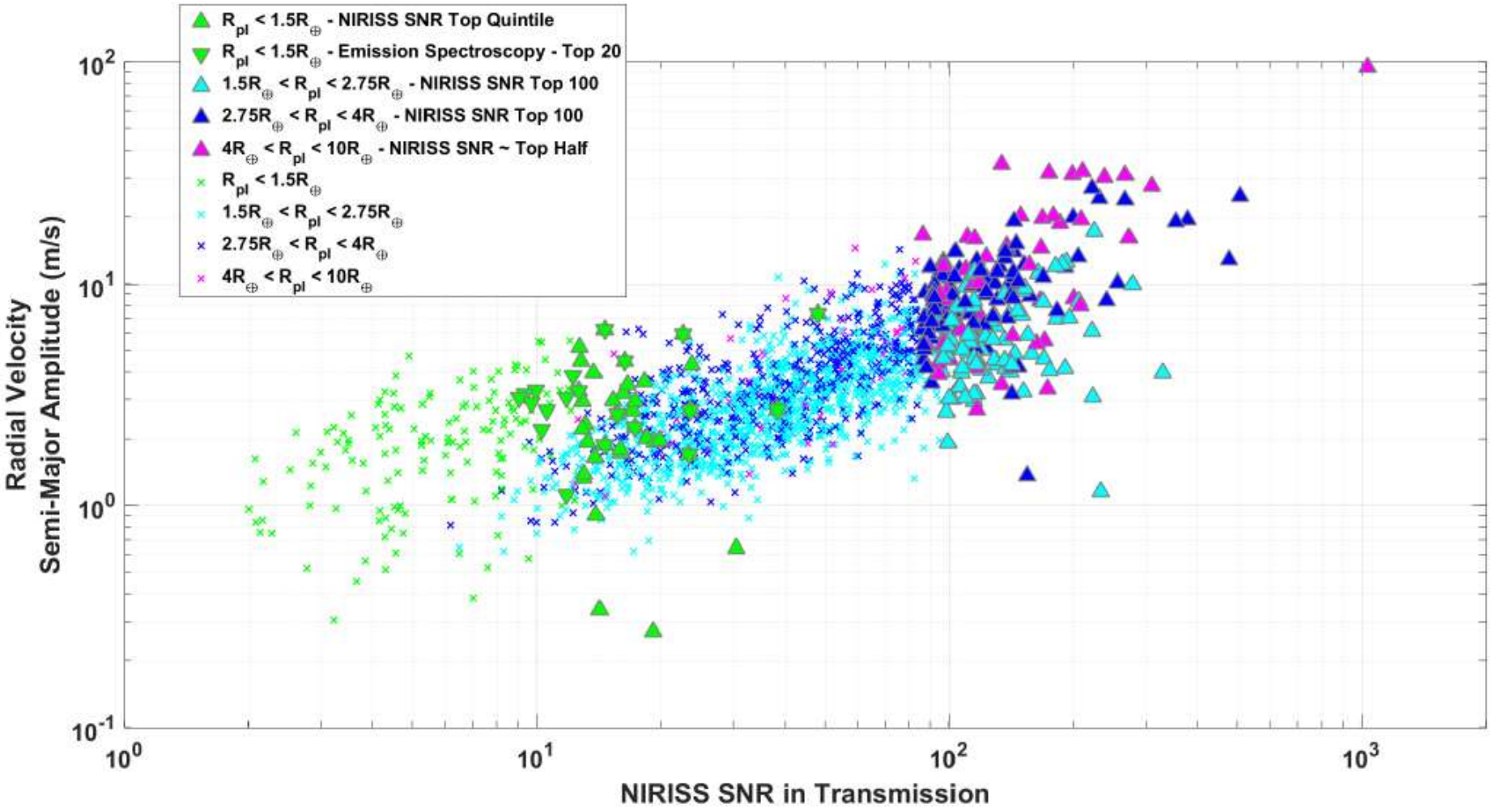






Kempton et al. 2018

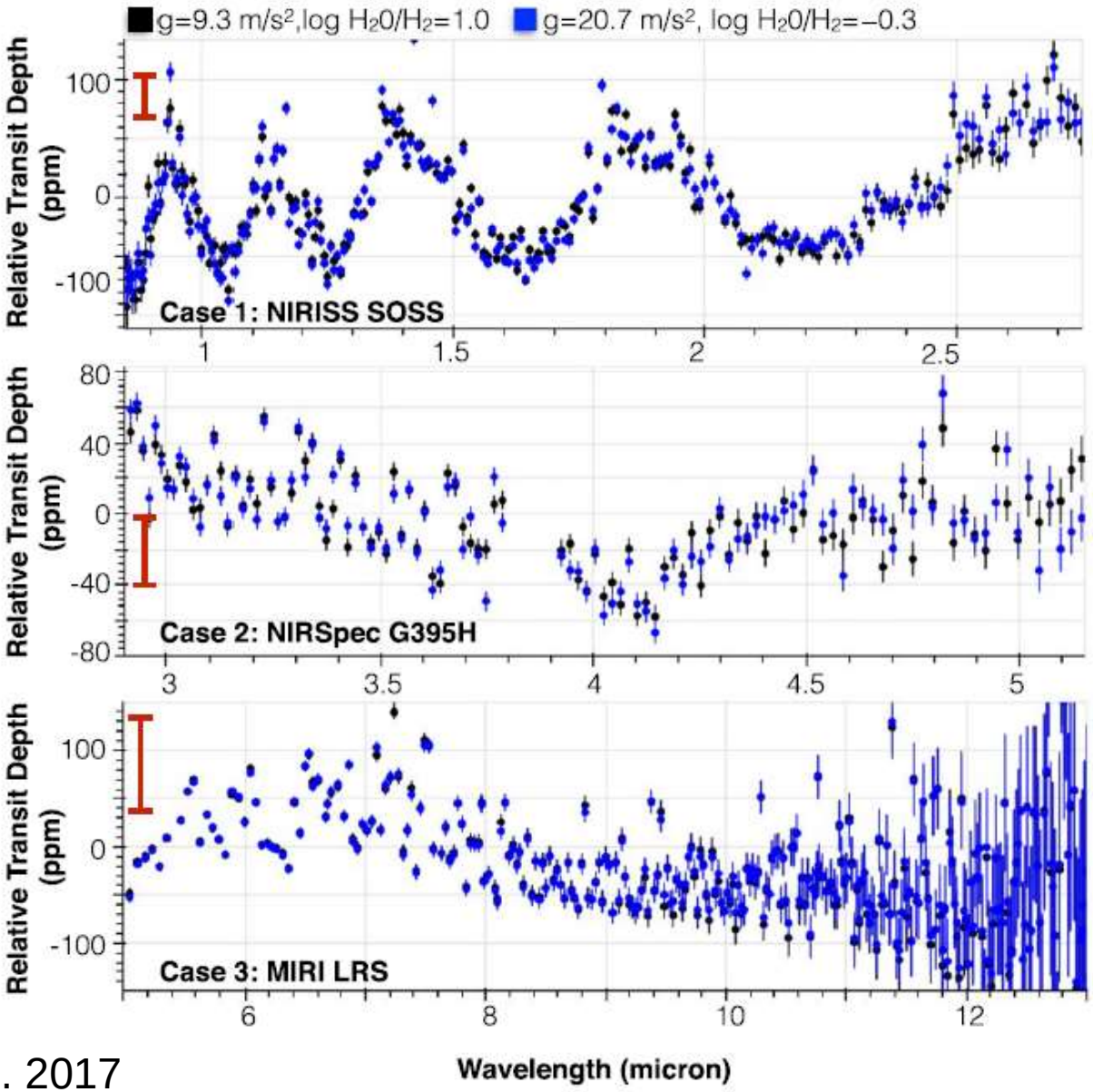
Kempton et al. 2018



Most planets expected to provide K=1-10 m/s. If you think it's easy, think twice!

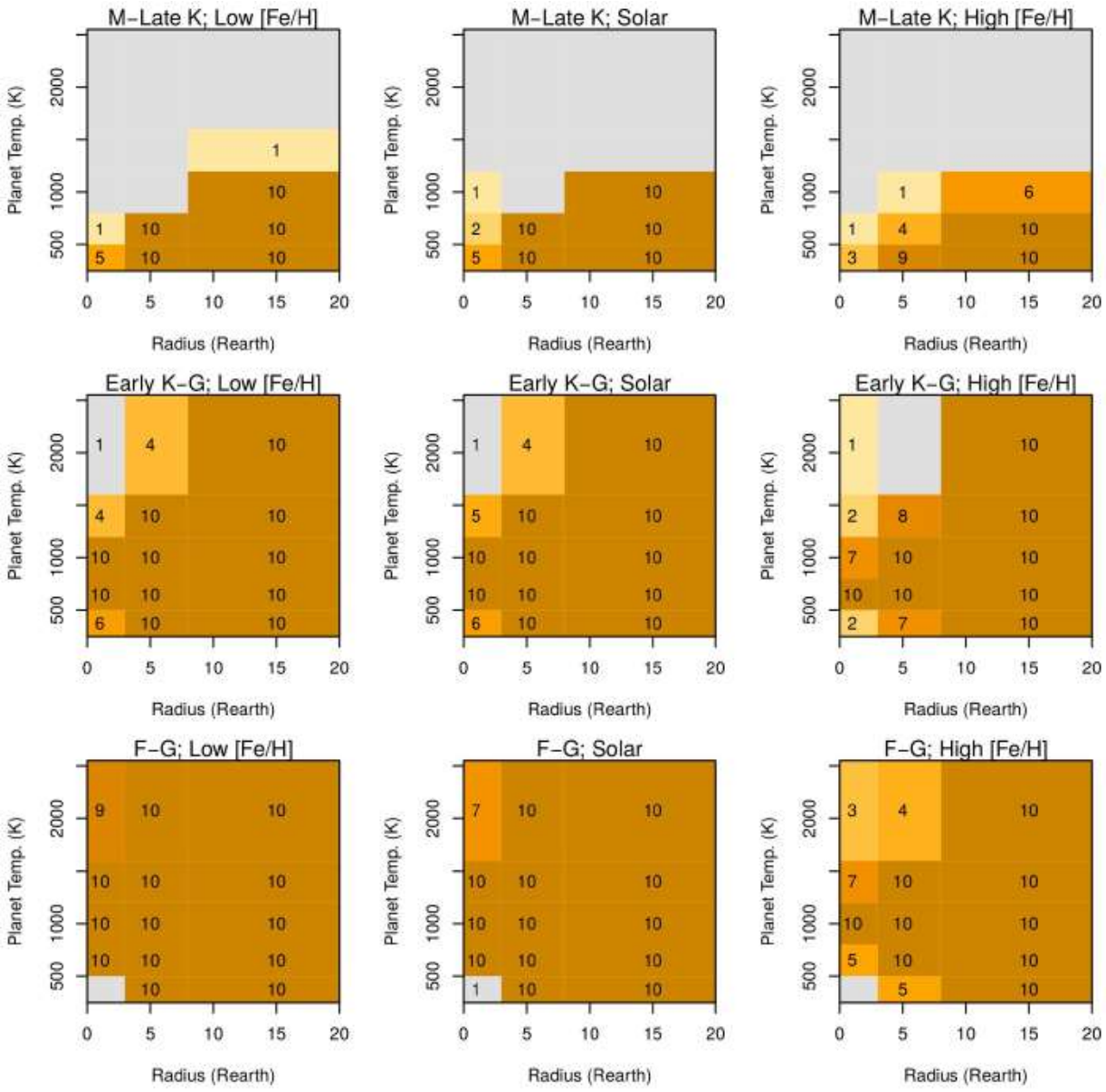
ARIEL MRS Ranking

- TSM and ESM easily adapted to ARIEL for identification of high-priority targets
- Good: Limitations in duty cycle for bright stars not as severe as JWST.
- Bad: A number of factors should be accounted for in the prioritization exercise
- Focus on one such factor: mass determination (and its uncertainties)
- Critical, as it impacts H, and any metrics



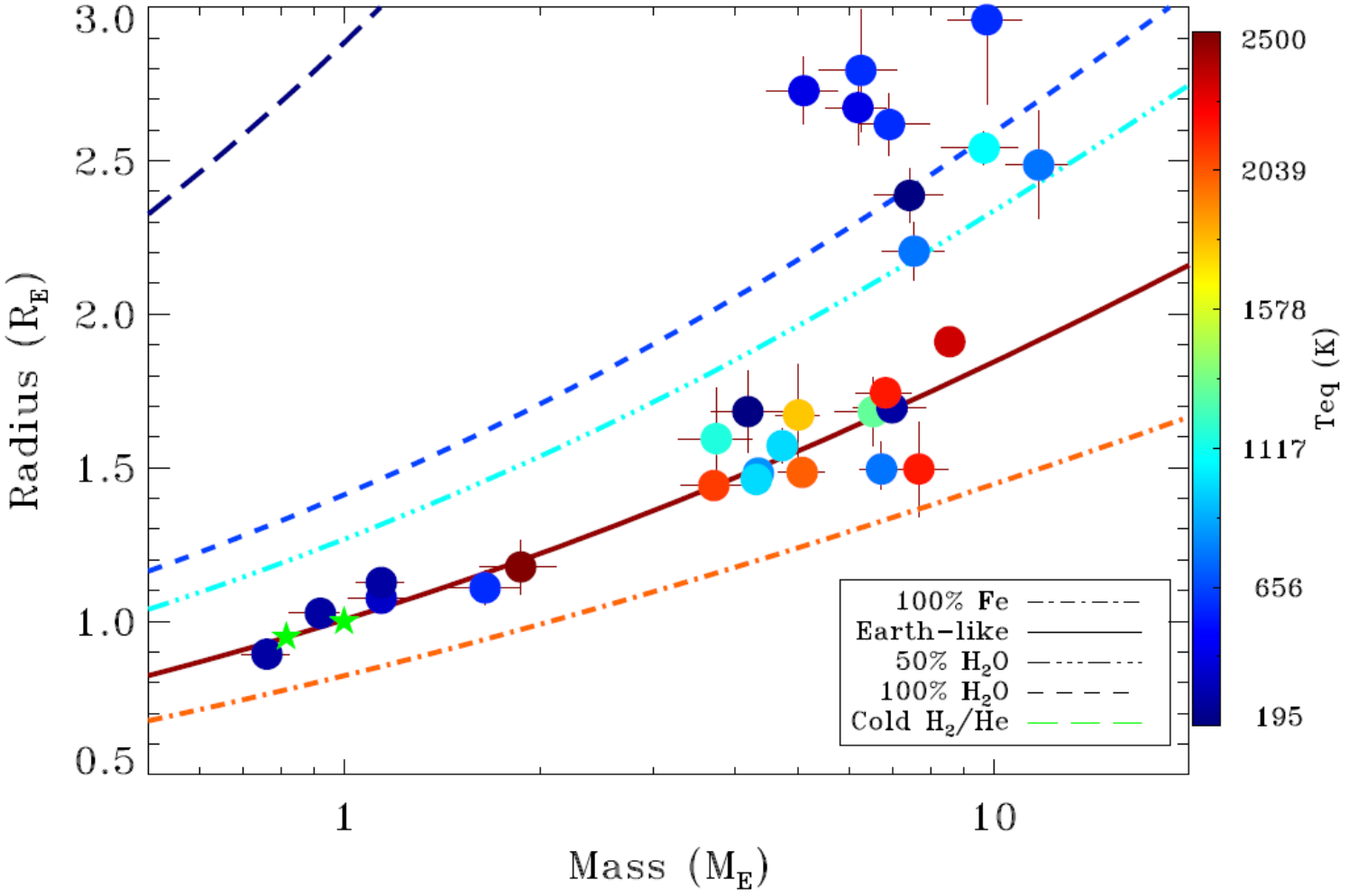
Batalha et al. 2017

Without mass knowledge, water and rocky worlds look the same to JWST



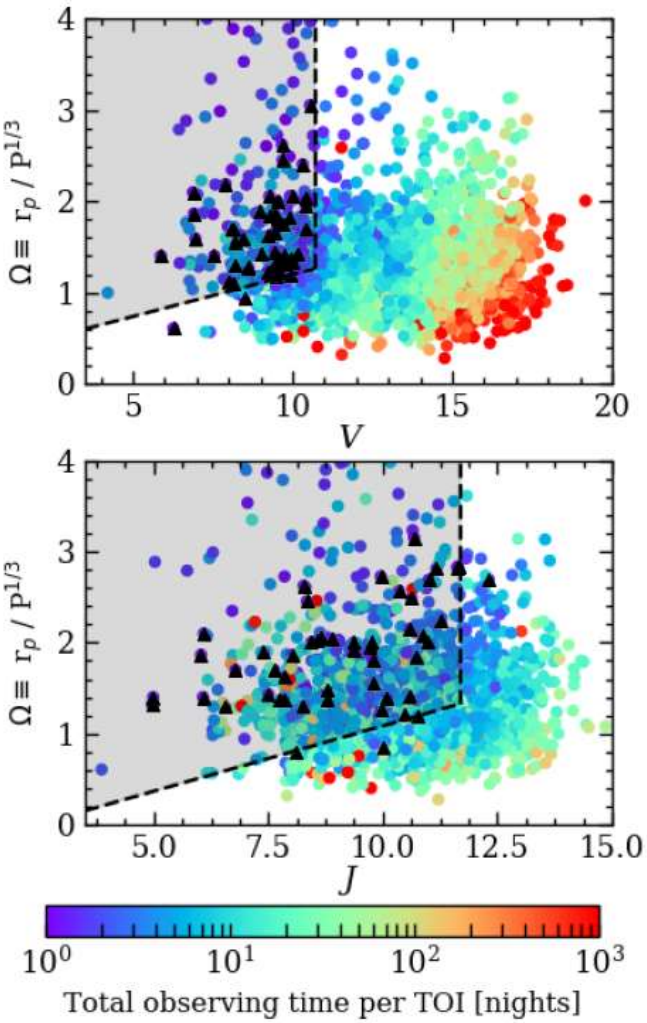
Can we get masses for (on the order of) 200 planets with radius below 3 Earth radii?

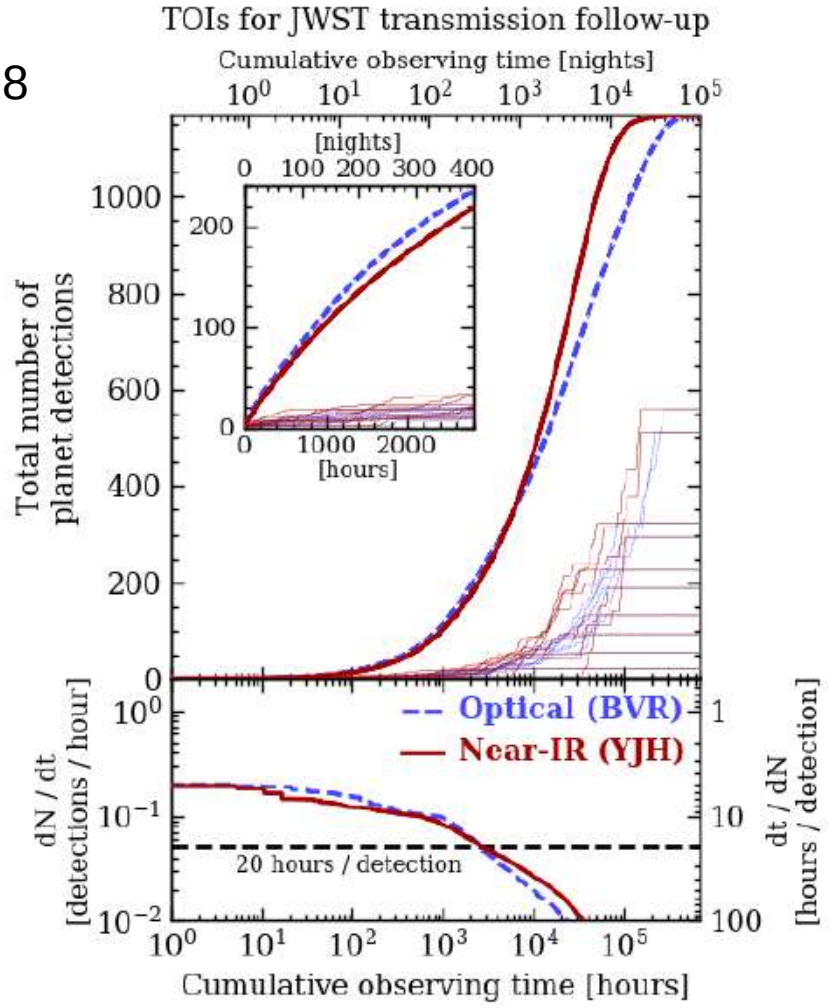
M-R Relation: $M/\sigma_M > 5$



- Around 30 planets with 5-σ mass determinations
- Some 63 with 3-σ mass determinations (but is that enough?)

Cloutier et al. 2018





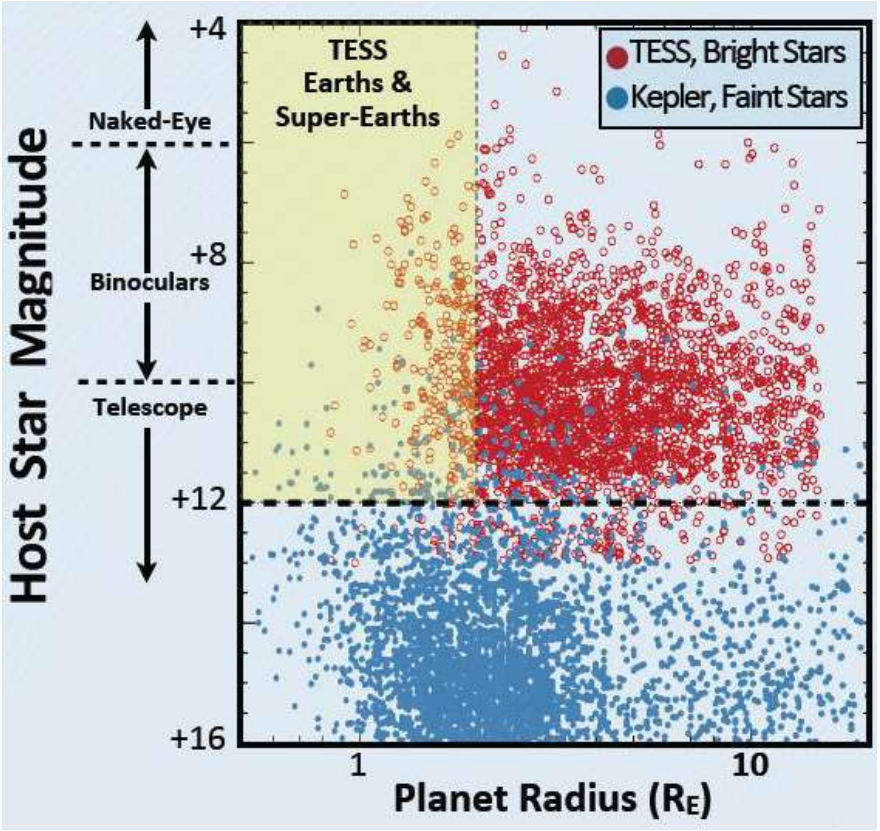
5. The TESS level one science requirement of measuring the masses of 50 planets with $r_P < 4$ $R_\oplus$ at the 20% level (i.e. 5σ mass detection) can be achieved in as little as ~ 400 hours or ~ 60 nights of observation.

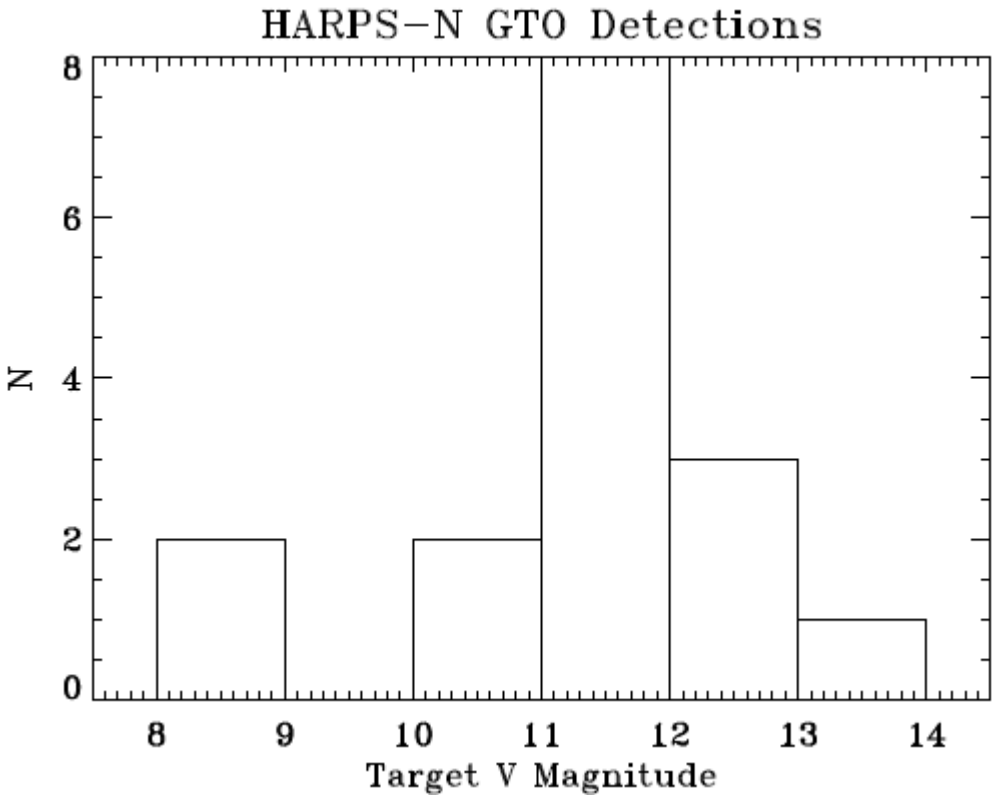
6. $\sim$ 55 TESS planets spanning the radius gap for small planets (i.e. $1.5 \lesssim r_P/R_\oplus \lesssim 2.6$) can be detected efficiently at 5σ in ~ 130 nights before the detection efficiency drops below 0.05 detections per hour (i.e. 20 hours per detection).

7. Only ~ 2 temperate super-Earths can be detected efficiently at 3σ in ~ 2.5 nights before the detection efficiency exceeds 20 hours per detection.

8. $\sim$ 220 Neptunes and giant planets amenable to transmission spectroscopy follow-up observations with JWST can be detected efficiently with a 5σ mass detection in $\sim 360 - 400$ nights before the detection efficiency exceeds 20 hours per detection.

TESS vs HARPS-N GTO





Very similar V mag distribution (with one exception) in the first list of TESS alerts

A Lesson: HARPS-N GTO

M_{pl}/σ_m > 5 within 0.1 AU

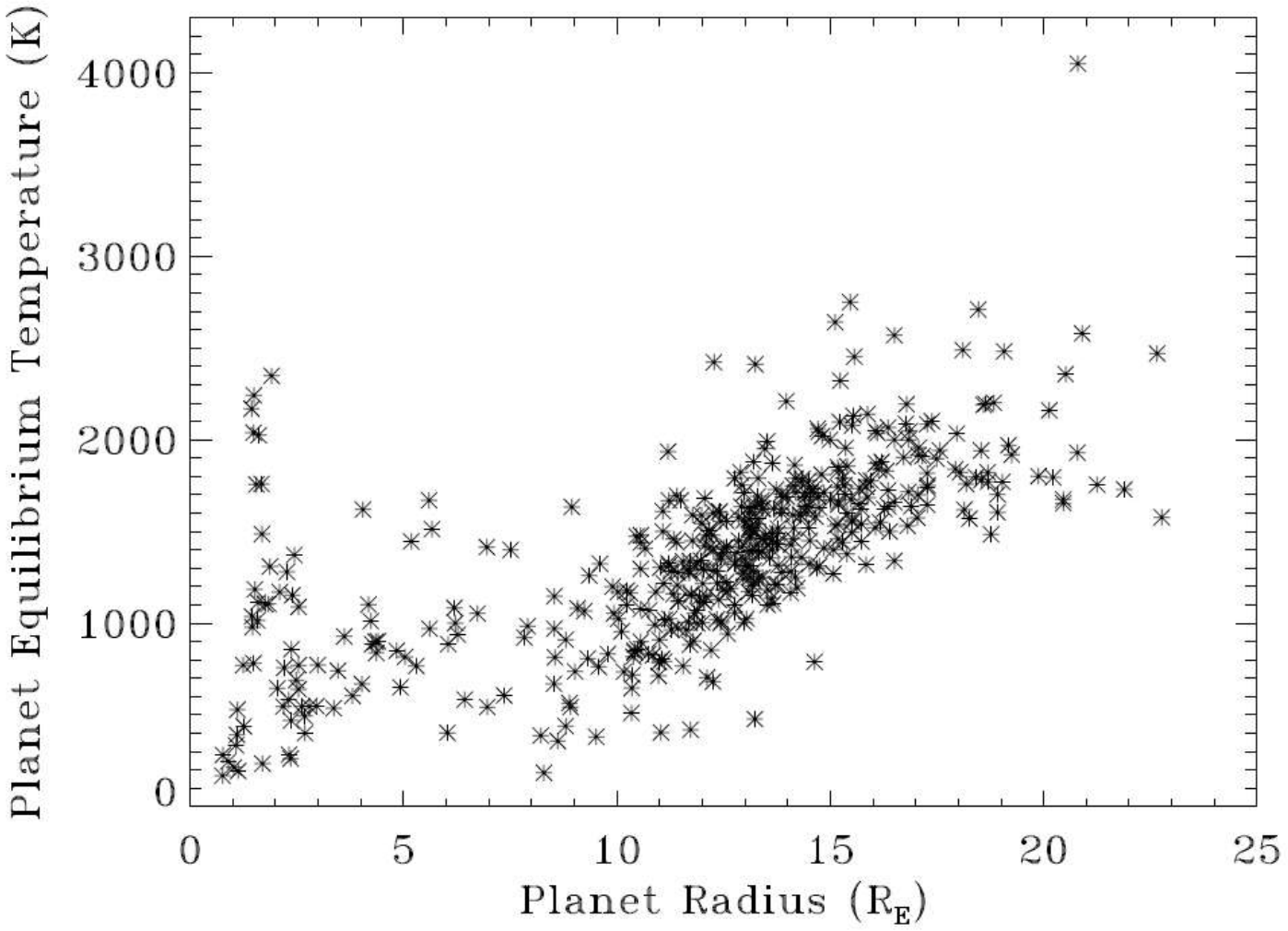
Star	5 M_{EARTH}	10 M_{EARTH}
F0 (1.60 M_{SUN})	158	40
G0 (1.05 M_{SUN})	104	26
K0 (0.79 M_{SUN})	78	20
M0 (0.51 M_{SUN})	50	13

M-R relation for:

- **rocky Super Earths**
- **sub-Neptunes**
- **> 100 obs. per target**

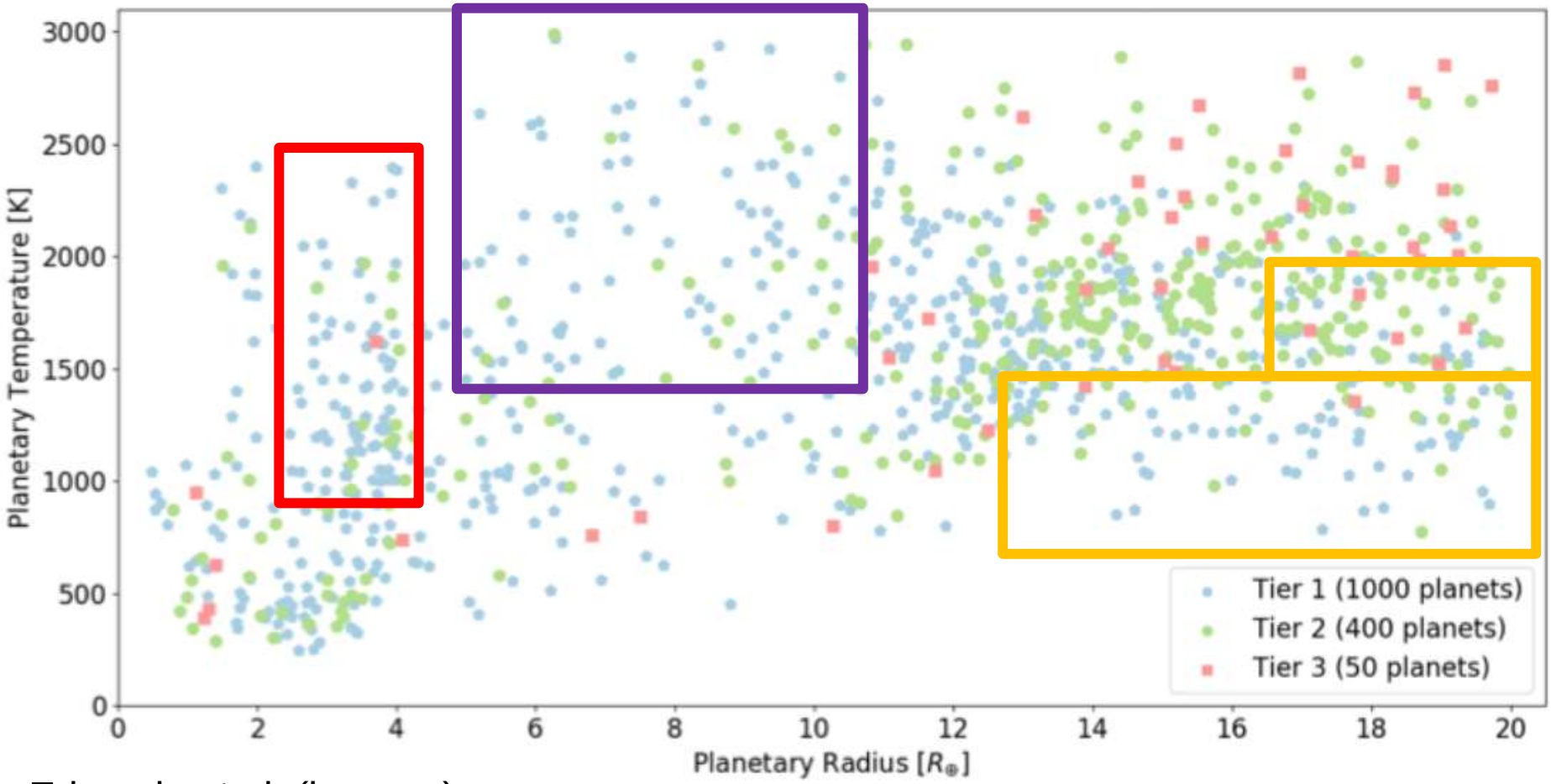
60 nights/yr for 50 planets

In the first 5 yrs of GTO, over 50 nights/yr on 16 targets only (25 planets)
20 nights (HARPS+HARPS-N) devoted to K2-3, and we are from the last word!



- 760 transiting planets (confirmed/validated) known to-date (Source: TEPCAT)
- 576 with a mass estimate (of any accuracy/precision)
- 499, 400, 216 planets with mass determined to better than 30%, 20%, and 10%

ARIEL MRS Updates



Edwards et al. (in prep.)

The objects inside the colored boundaries are not (yet) seen in reality

Summary

- Target prioritization of the ARIEL MRS is mandatory
- We can help using the present-day sample of transiting systems
- Adapt metrics used for JWST, and make them more robust
- Caution against simulations (e.g. TESS targets) that capture bulk numbers but not the structure of distributions