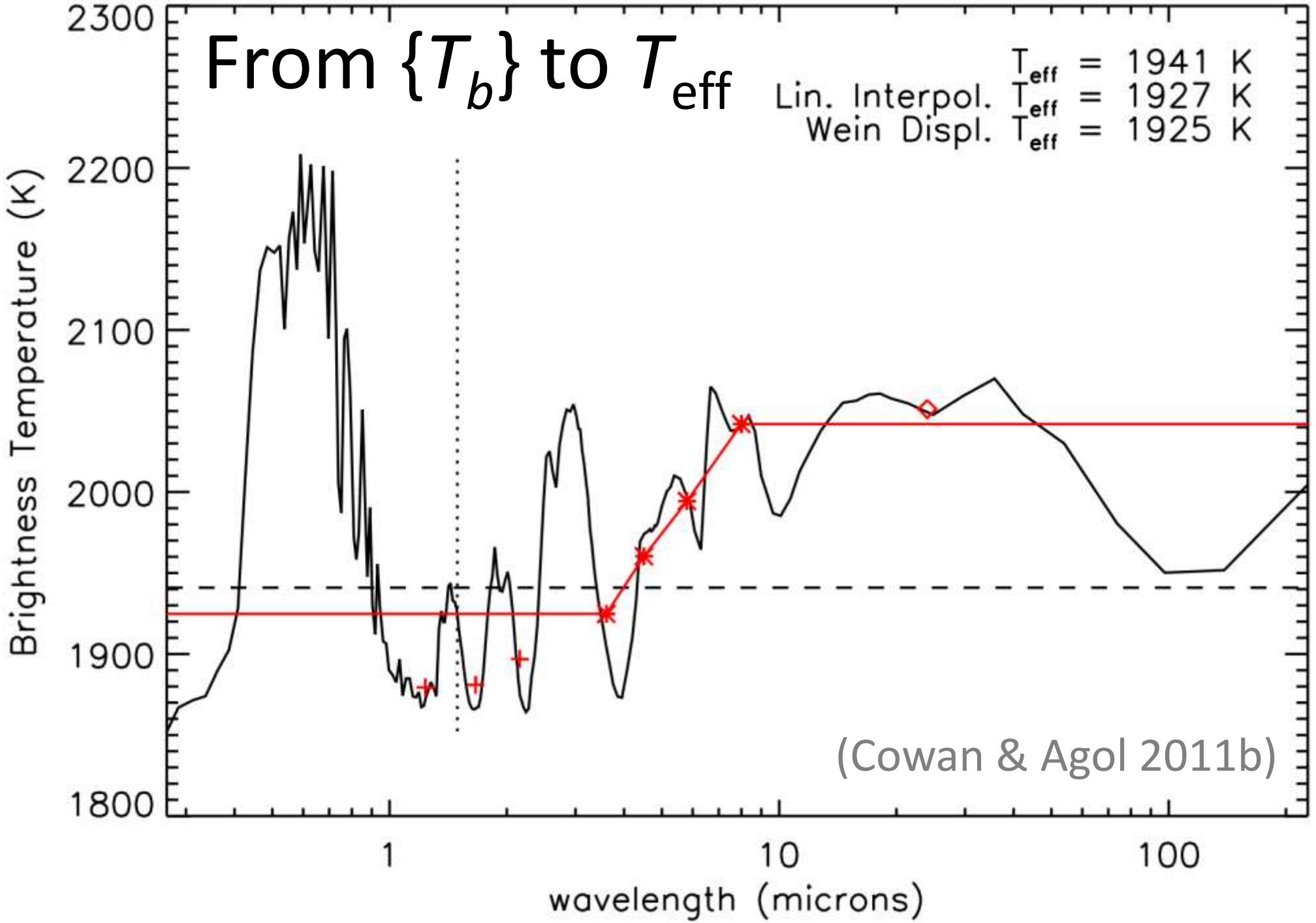
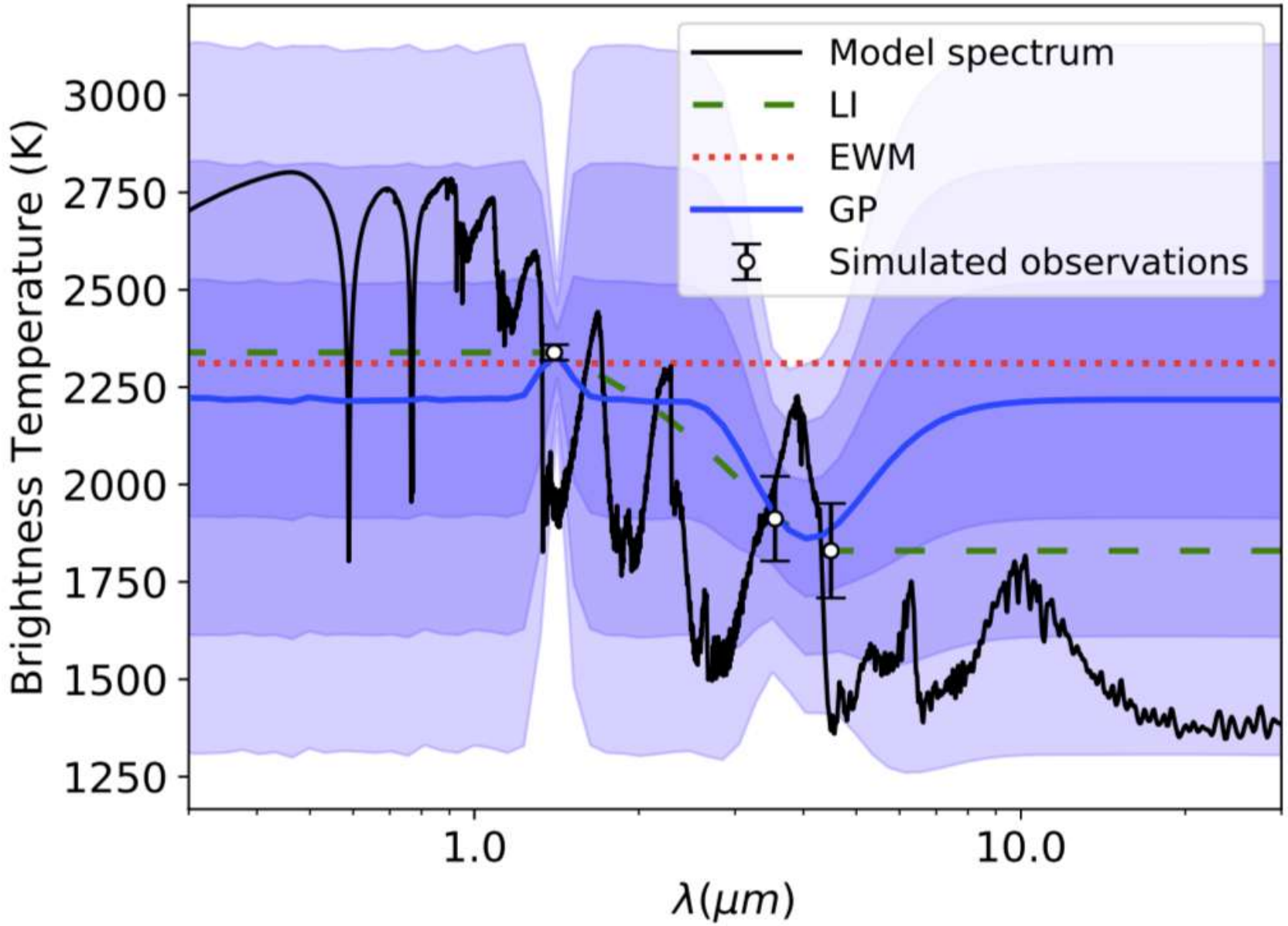

From $\{T_b\}$ to T_{eff}
T_{eff} = 1941 K
Lin. Interpol. T_{eff} = 1927 K
Wein Displ. T_{eff} = 1925 K
Brightness Temperature (K)
2300
2200
2100
2000
1900
1800
1
10
100
wavelength (microns)
(Cowan & Agol 2011b)

From $\{T_b\}$ to T_{eff} (better)



(Pass et al. 2019)

From $\{T_b\}$ to T_{eff} (pretty good)

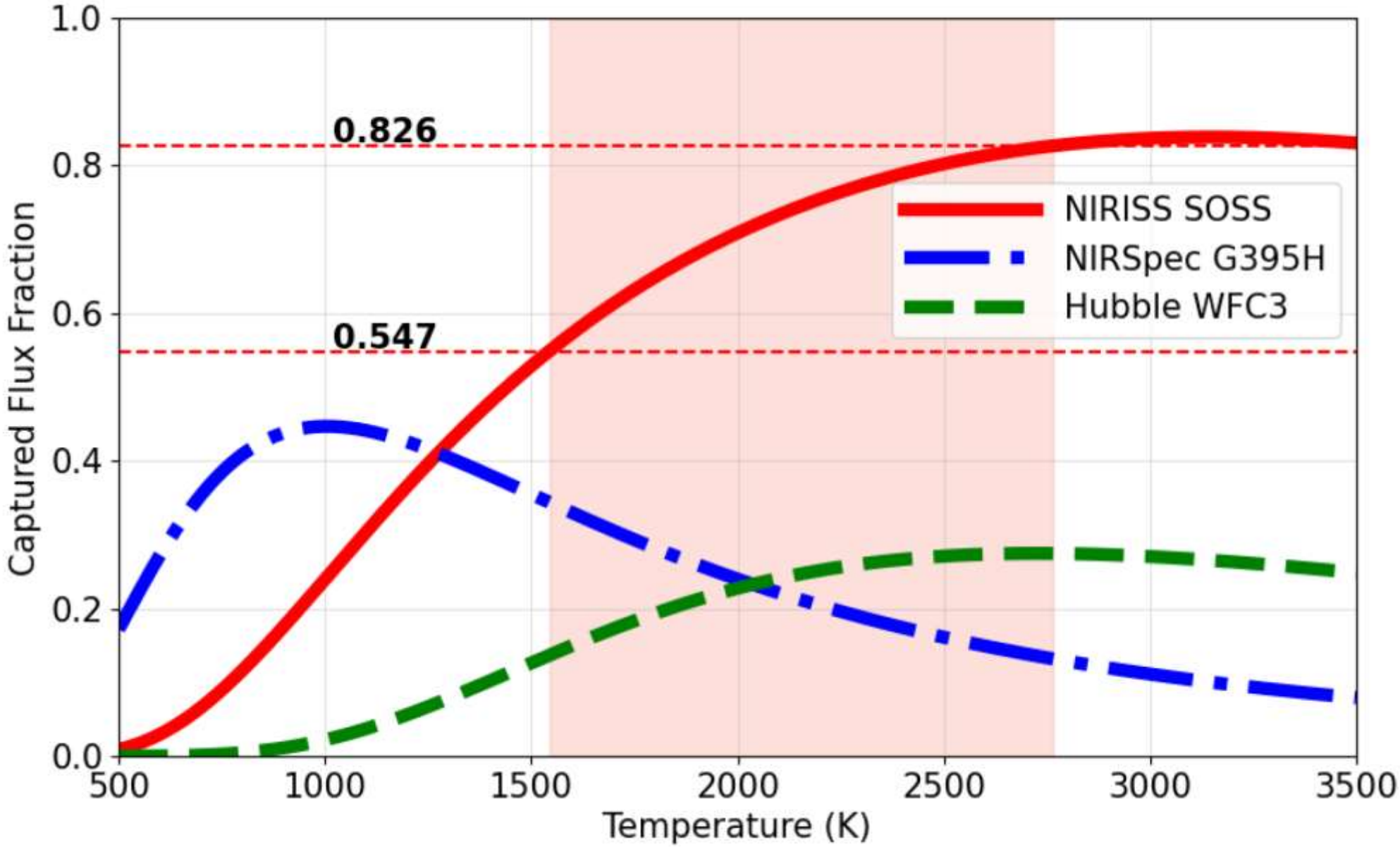
$$T_{\rm eff} = \frac{\sum_{i=1}^{N} w_i \, T_{{\rm bright},\, i}}{\sum_{i=1}^{N} w_i}$$

Total Captured Flux

$$w_i = \frac{\int_{\lambda_i}^{\lambda_{i+1}} B(\lambda_i,\, T_{{\rm bright},\, i})\, d\lambda}{\int_{0}^{\infty} B(\lambda_i,\, T_{{\rm bright},\, i})\, d\lambda}$$

(Splinter et al. 2025)

Captured Flux

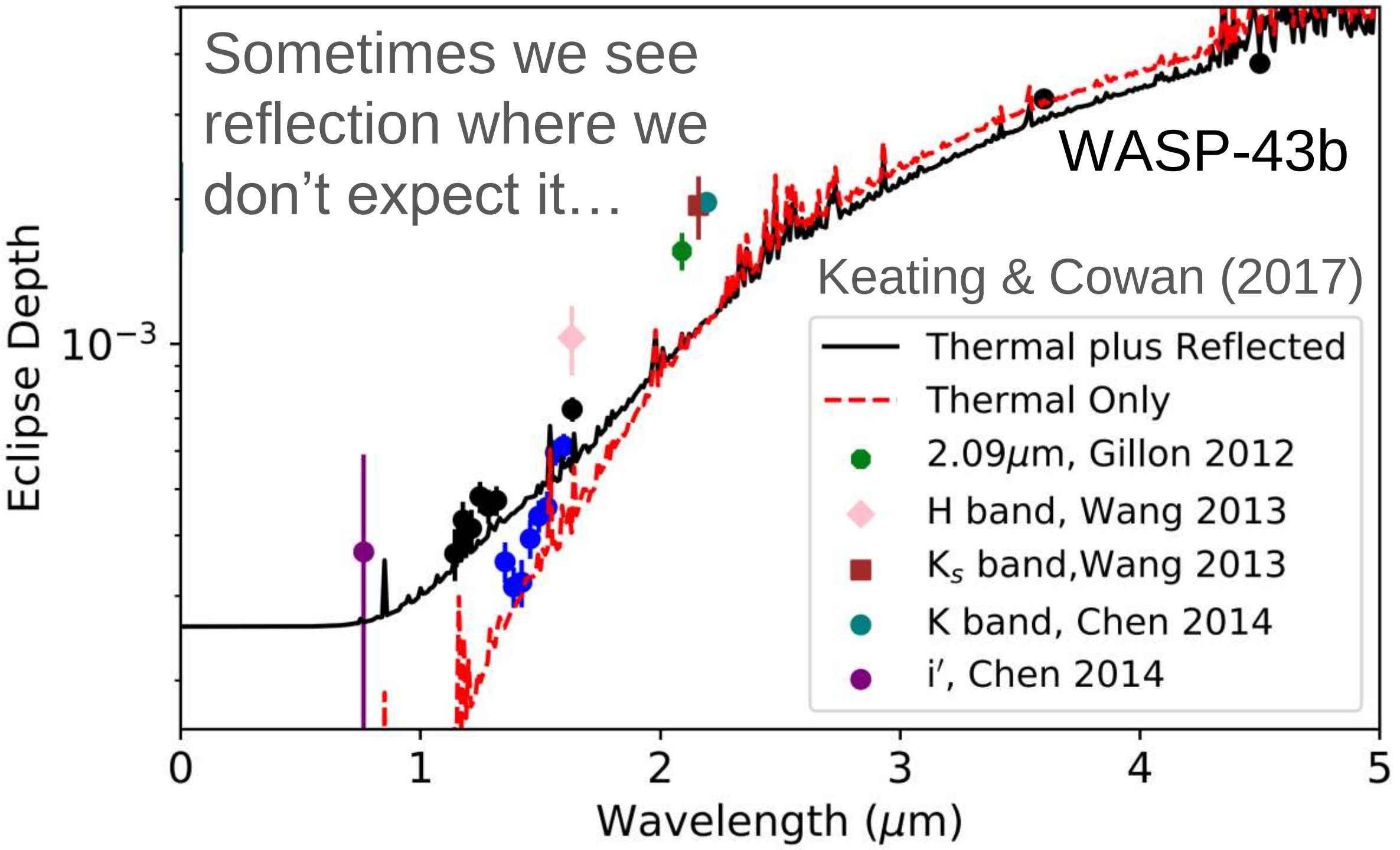


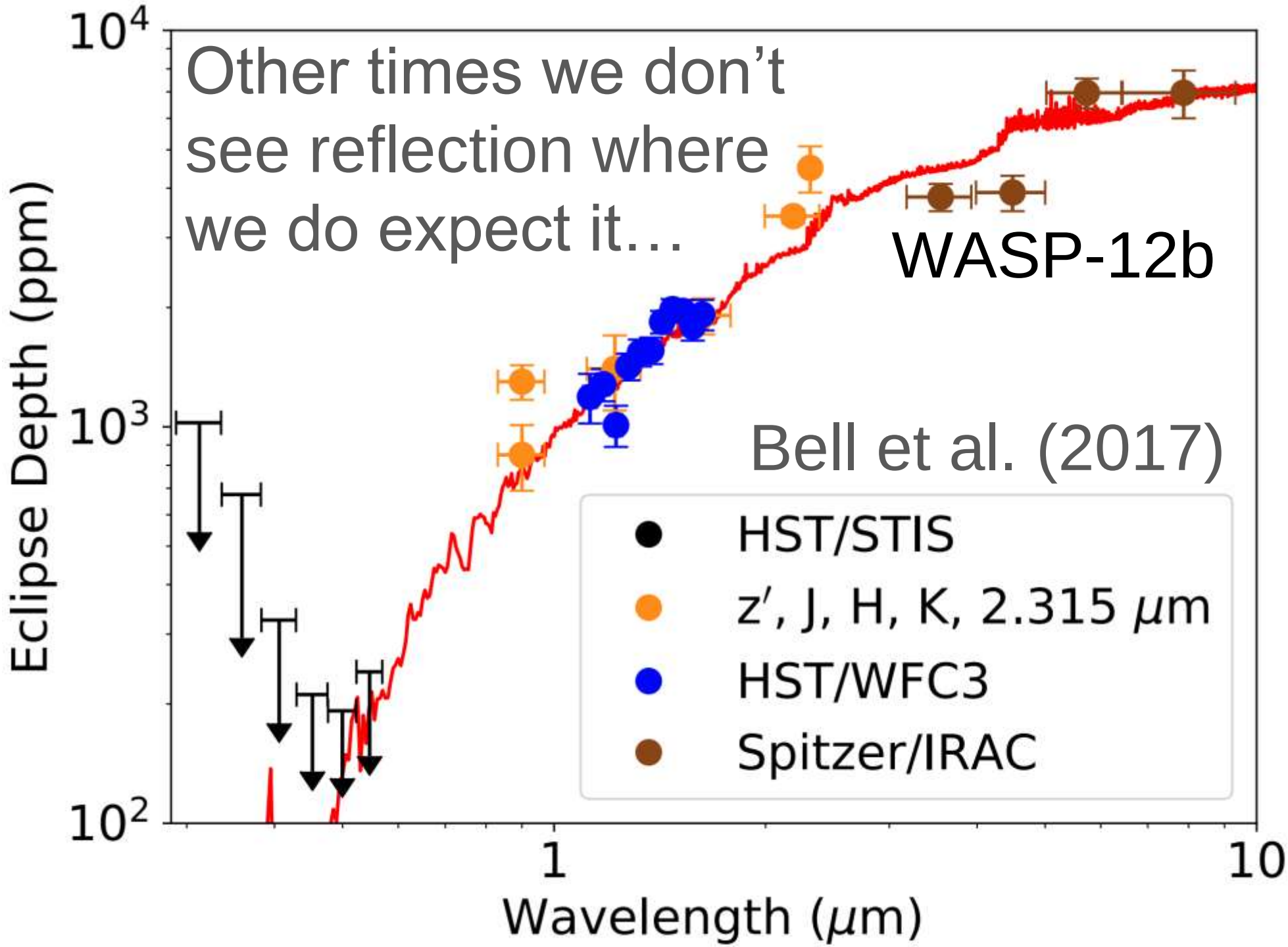
(Splinter et al. 2025)

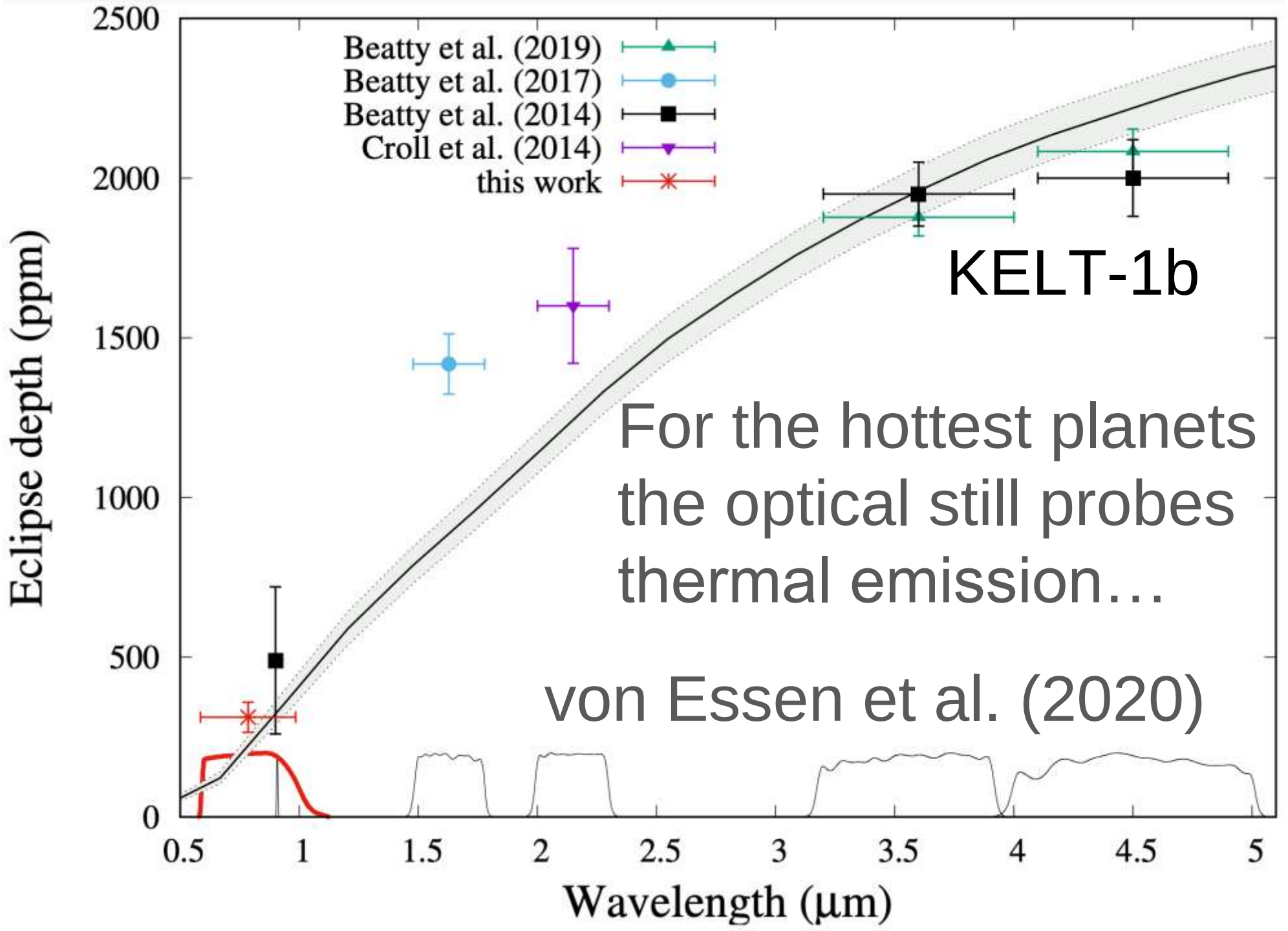
(A Complication for Hot Planets)

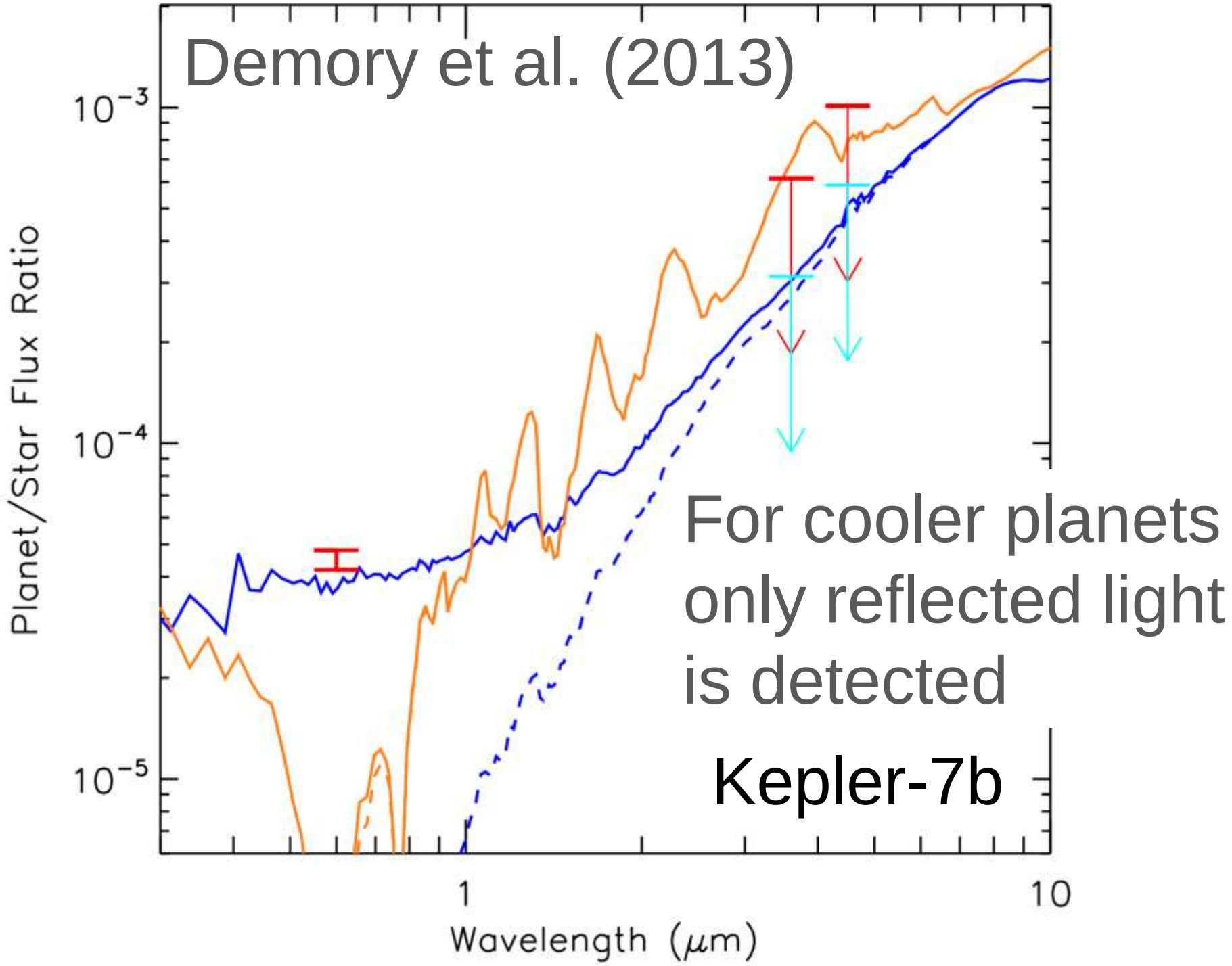
Solar System Planets are “double-humped”

Hot Jupiters are “single-humped”


Sometimes we see reflection where we don’t expect it…
WASP-43b
Keating & Cowan (2017)
Thermal plus Reflected
Thermal Only
2.09μm, Gillon 2012
H band, Wang 2013
K_s band,Wang 2013
K band, Chen 2014
i′, Chen 2014
Eclipse Depth
10^{-3}
0
1
2
3
4
5
Wavelength (μm)


Other times we don't see reflection where we do expect it…
WASP-12b
Bell et al. (2017)
HST/STIS
z′, J, H, K, 2.315 μm
HST/WFC3
Spitzer/IRAC
Eclipse Depth (ppm)
Wavelength (μm)
10^4
10^3
10^2
1
10


Beatty et al. (2019)
Beatty et al. (2017)
Beatty et al. (2014)
Croll et al. (2014)
this work
KELT-1b
For the hottest planets the optical still probes thermal emission…
von Essen et al. (2020)
Eclipse depth (ppm)
Wavelength (μm)
2500
2000
1500
1000
500
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

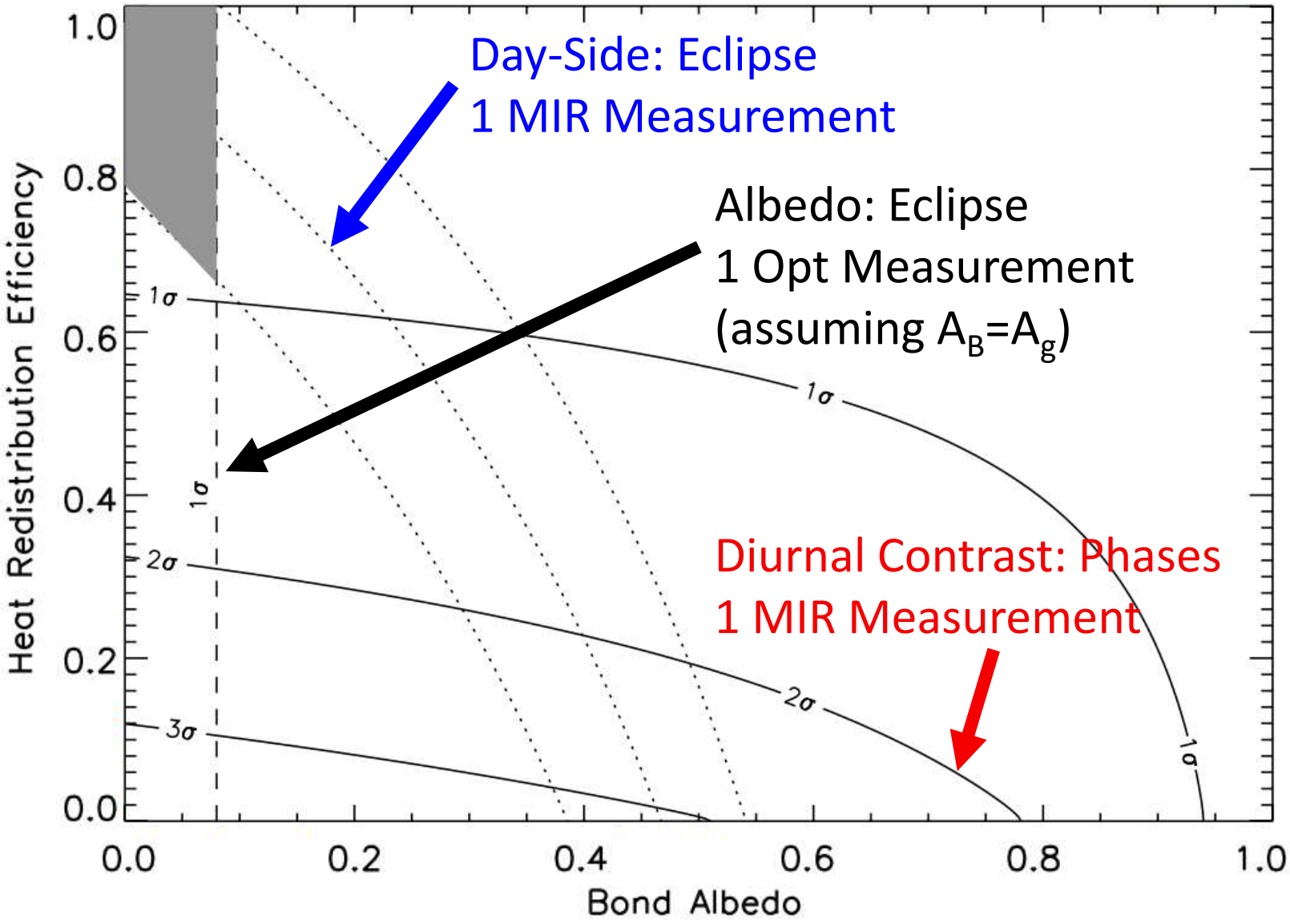

Demory et al. (2013)
10^{-3}
10^{-4}
10^{-5}
Planet/Star Flux Ratio
1
10
Wavelength (μm)
For cooler planets only reflected light is detected
Kepler-7b

Two-Slice Models

(Cowan & Agol 2011b;
Schwartz & Cowan 2015;
Schwartz et al. 2017;
Bell et al. 2021; Dang et al. 2024)

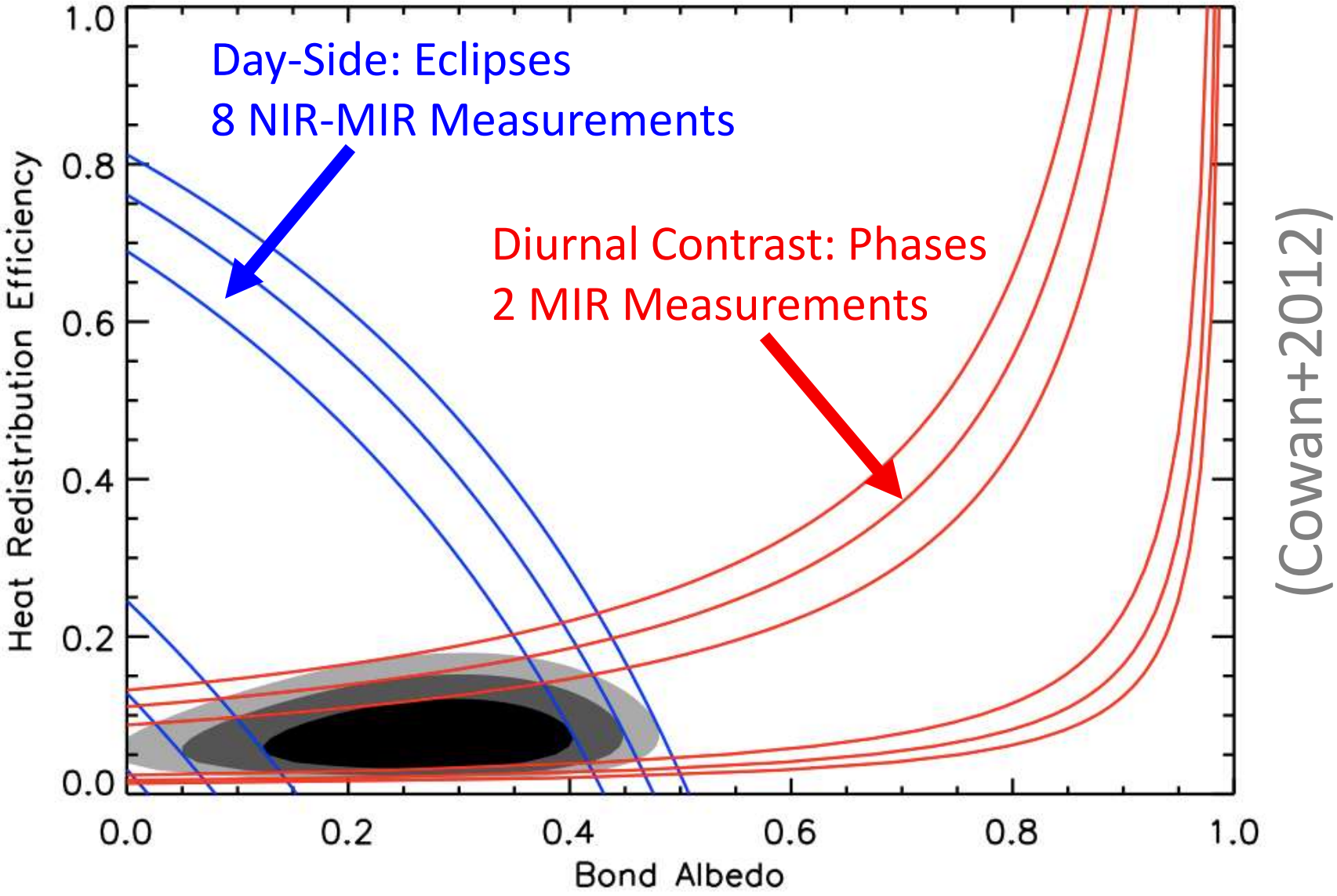
Analytic Interlude: Two-Slice Model

HD 209458b is Good at Moving Heat



(Cowan, Agol & Charbonneau 2007)

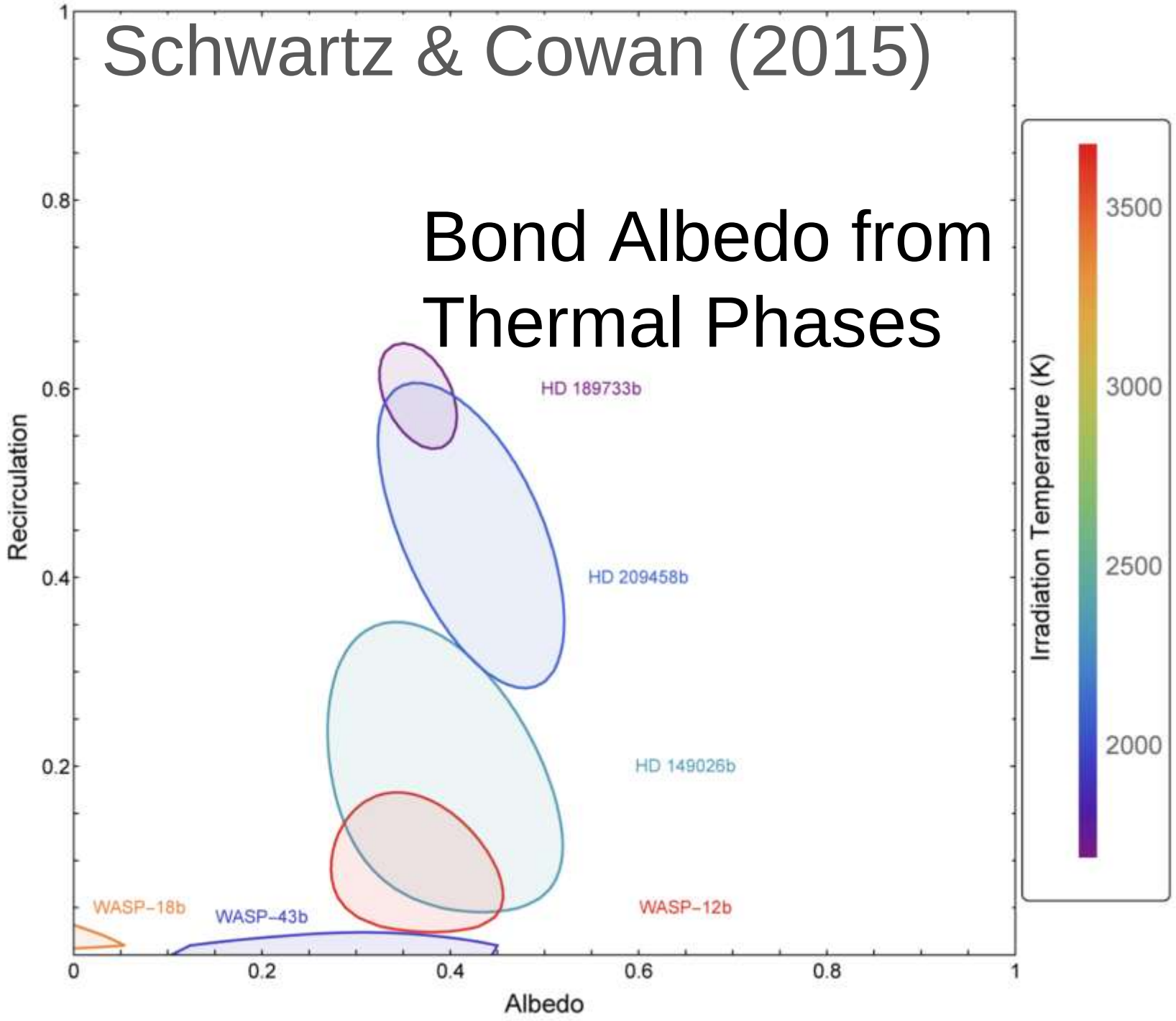
WASP-12b is Bad at Moving Heat



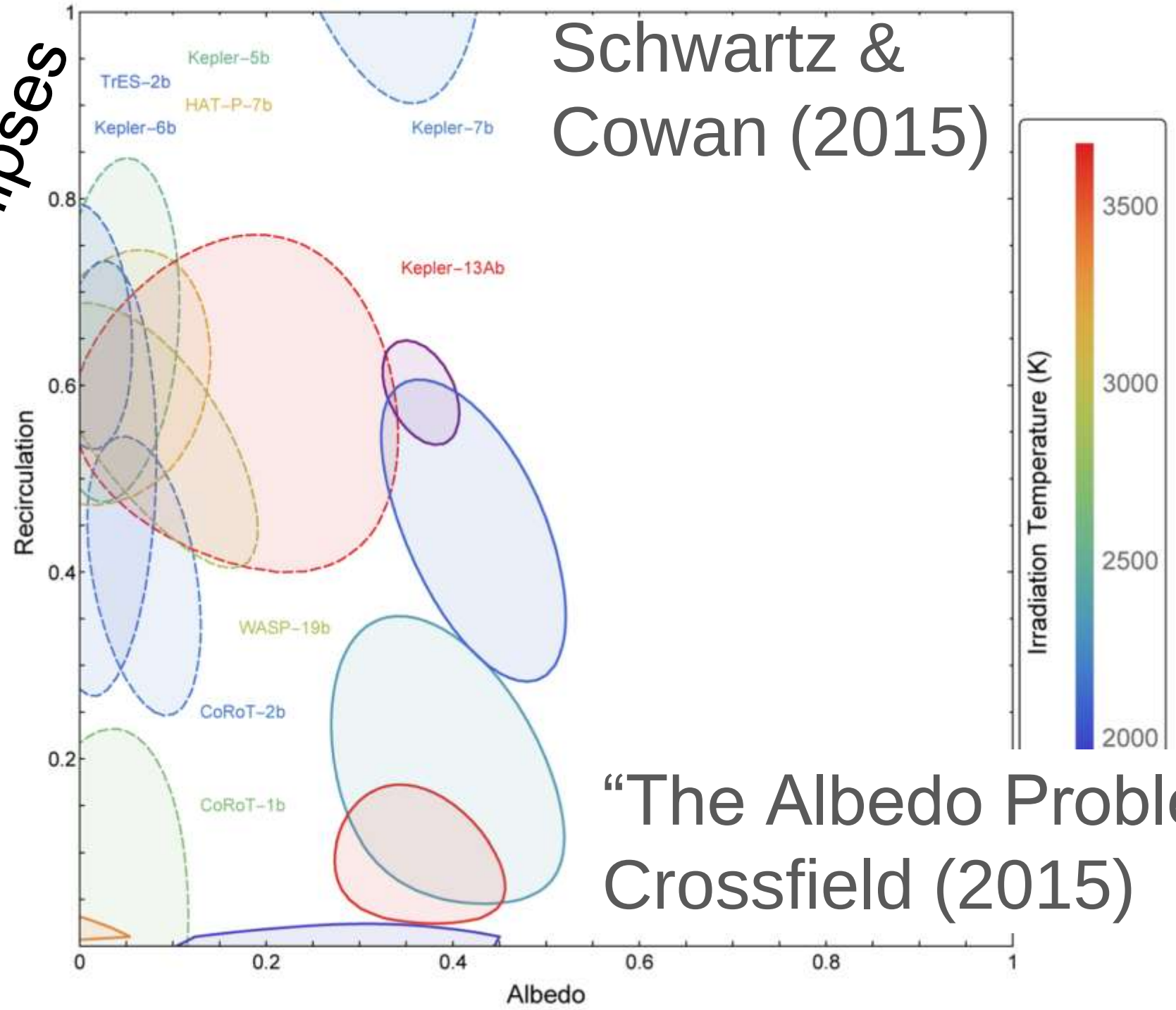
(Cowan+2012)

Schwartz & Cowan (2015)

Bond Albedo from Thermal Phases

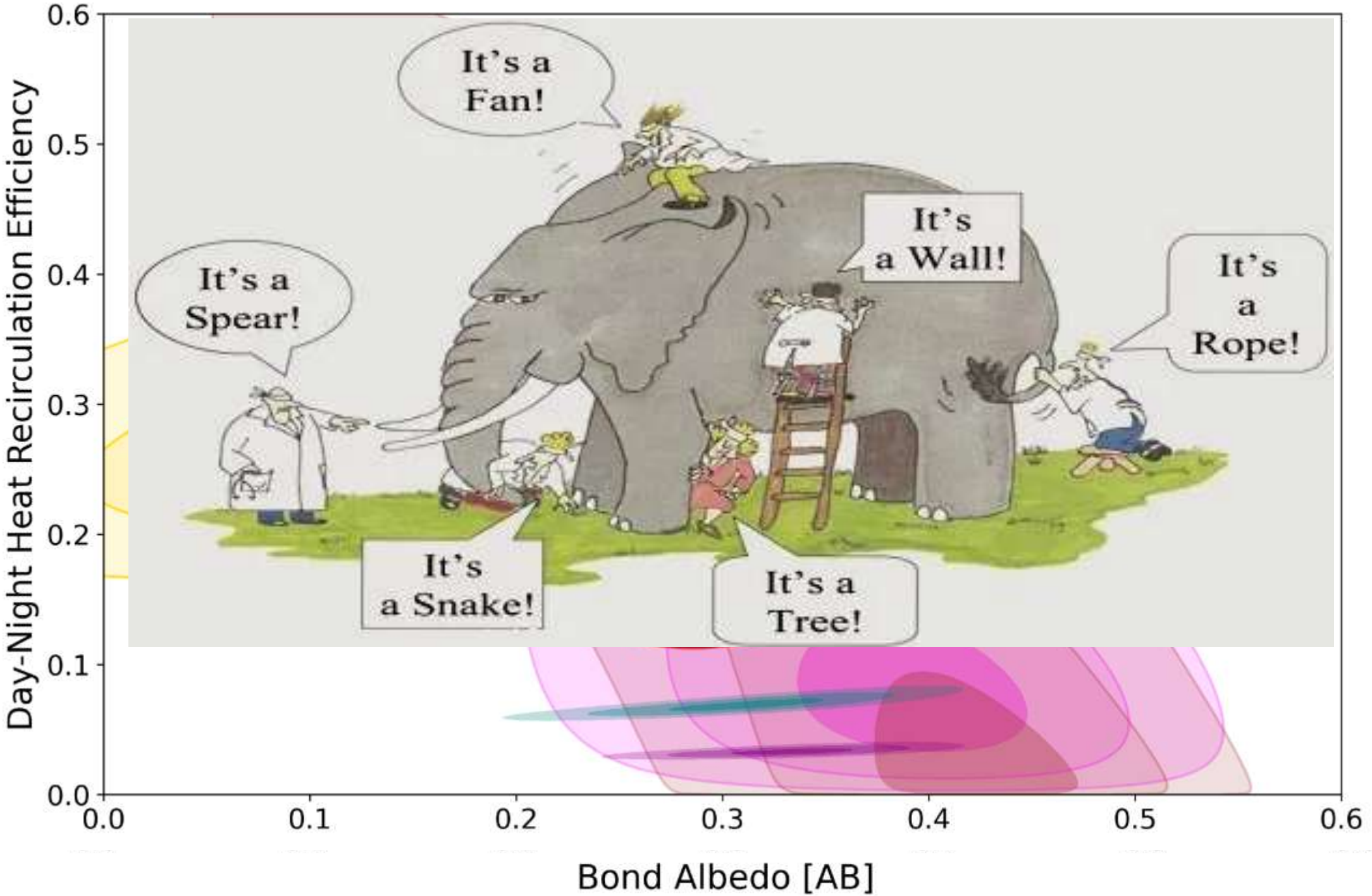


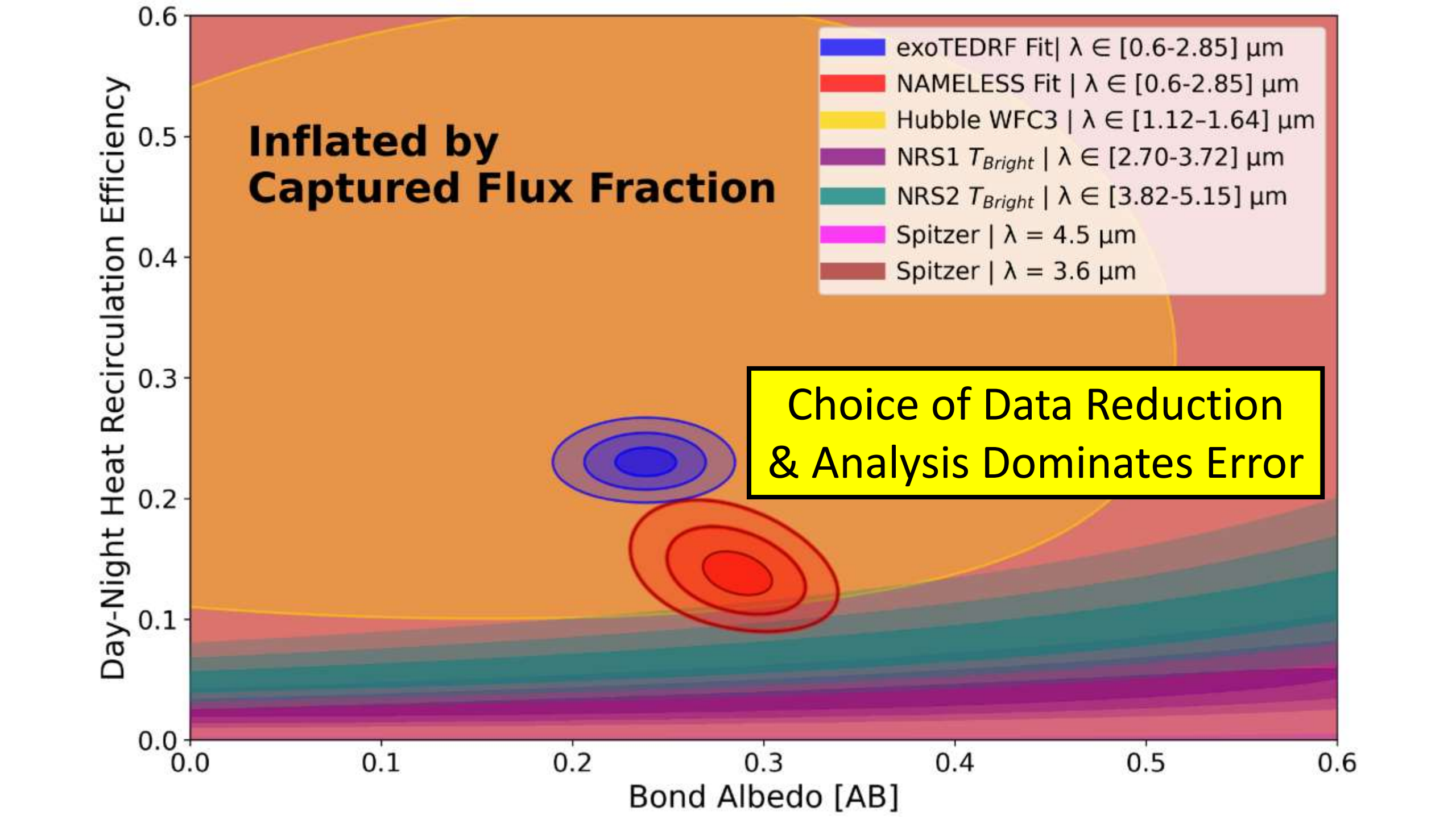
Geometric Albedo from Optical Eclipses



Schwartz & Cowan (2015)

"The Albedo Problem" Crossfield (2015)


Day-Night Heat Recirculation Efficiency
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Bond Albedo [AB]
It's a Fan!
It's a Spear!
It's a Wall!
It's a Rope!
It's a Snake!
It's a Tree!


Inflated by
Captured Flux Fraction
exoTEDRF Fit| λ ∈ [0.6-2.85] μm
NAMELESS Fit | λ ∈ [0.6-2.85] μm
Hubble WFC3 | λ ∈ [1.12–1.64] μm
NRS1 T_{Bright} | λ ∈ [2.70-3.72] μm
NRS2 T_{Bright} | λ ∈ [3.82-5.15] μm
Spitzer | λ = 4.5 μm
Spitzer | λ = 3.6 μm
Choice of Data Reduction
& Analysis Dominates Error
Day-Night Heat Recirculation Efficiency
Bond Albedo [AB]
0.0
0.1
0.2
0.3
0.4
0.5
0.6

Energy Balance Models* (Cowan & Agol 2011a; Bell & Cowan 2018)

*EBMs have been widely used to understand Earth's climate since the 1960s, see review by North (2024)