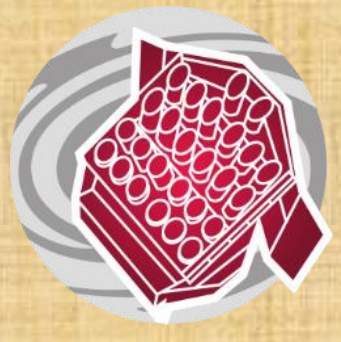


plato

LIÈGE université

Quick overview of interface WP12-GOP

Systematic limitations of estimates from high-resolution spectra

(and how to hopefully mitigate them for PLATO…)

BRIEF OVERVIEW OF INTERFACE WP12-GOP

Full details available in: IRD document on CONFLUENCE

REQUEST 1: GROUND-BASED SPECTROSCOPIC DATA

What for?

Compute the classical stellar parameters (e.g. Teff, abundances) with WP122 pipeline (SAPP aka MSteSci1/MSAP2)

What exactly?

Optical spectra for P1-P2-P5 + near-IR spectra for P4 (optical spectra may still be useful, but must be flux calibrated).
Repeated observations useful, but not requested.

TO BE DISCUSSED BY MARIA

BRIEF OVERVIEW OF INTERFACE WP12-GOP

Full details available in: IRD document on CONFLUENCE

REQUEST 2: INTERFEROMETRIC DATA

What for?

Compute nearly model-independent radius + Teff with WP122 pipeline (SAPP).
Can also constrain limb darkening in some cases.

Used as benchmarks.

What exactly?

A preparatory interferometric survey of a representative sample of F5-K7 dwarfs-subgiants + FU observations of PLATO targets of particular interest.

TO BE DISCUSSED BY DENIS

BRIEF OVERVIEW OF INTERFACE WP12-GOP

Full details available in: IRD document on CONFLUENCE

REQUEST 3: CHROMOSPHERIC ACTIVITY INDICES

What for?

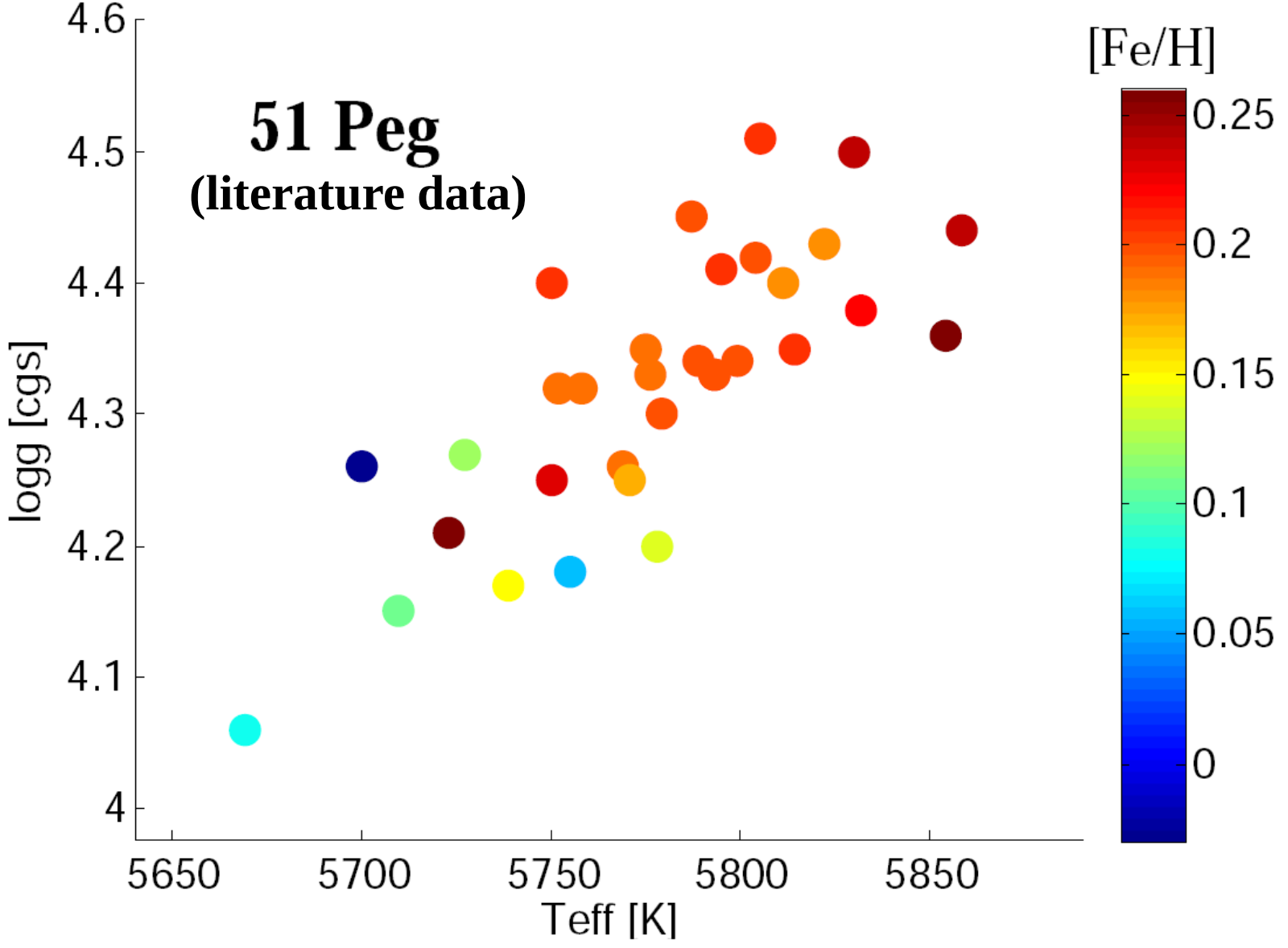
Apply activity-age relationships in WP123 pipeline (MSAP4)

What exactly?

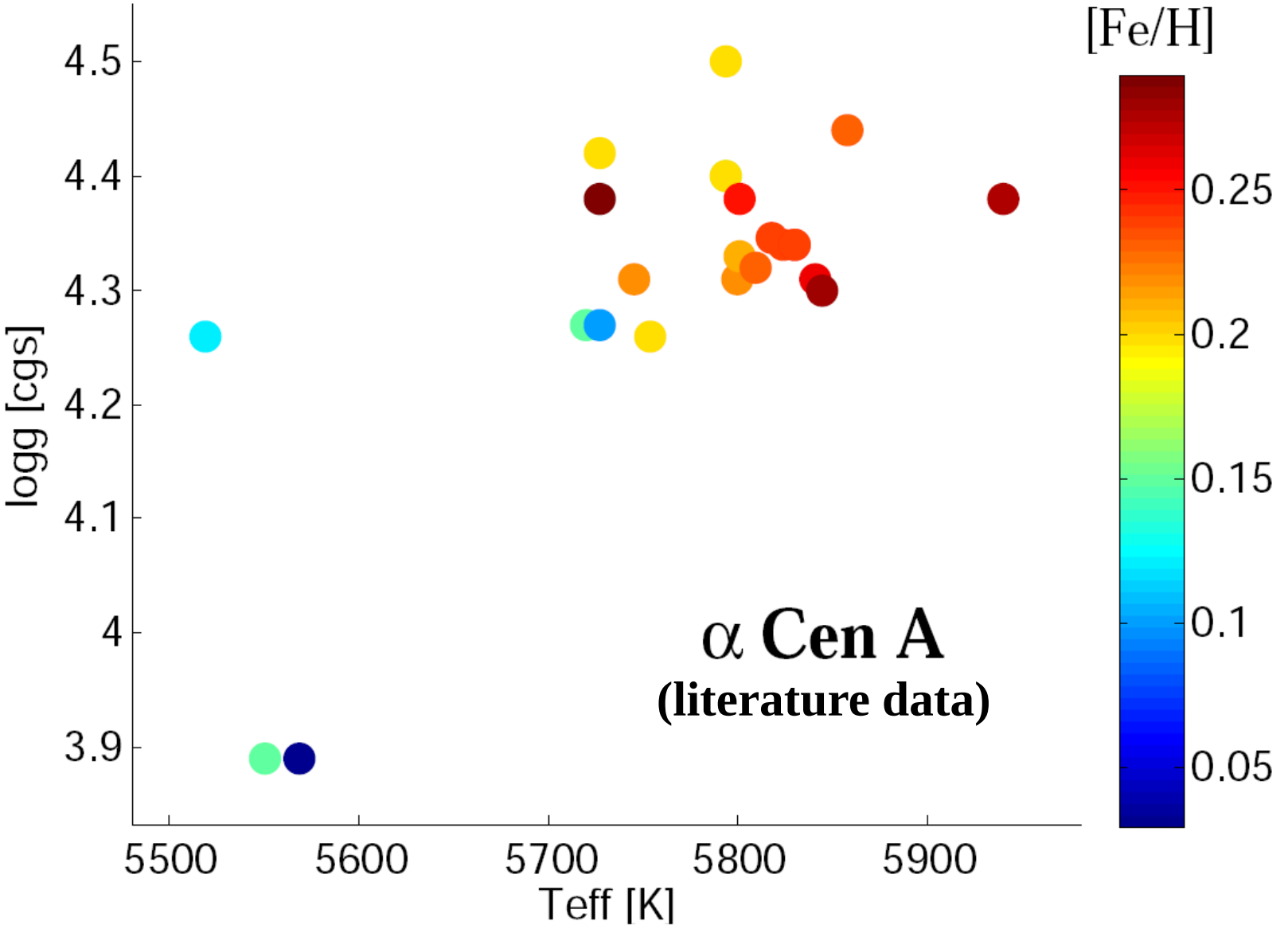
$\log R'_{HK}/S$ index from Ca II H+K + activity index from Hα.
Range of variations if repeated observations (not requested).

TO BE DISCUSSED BY NUCCIO

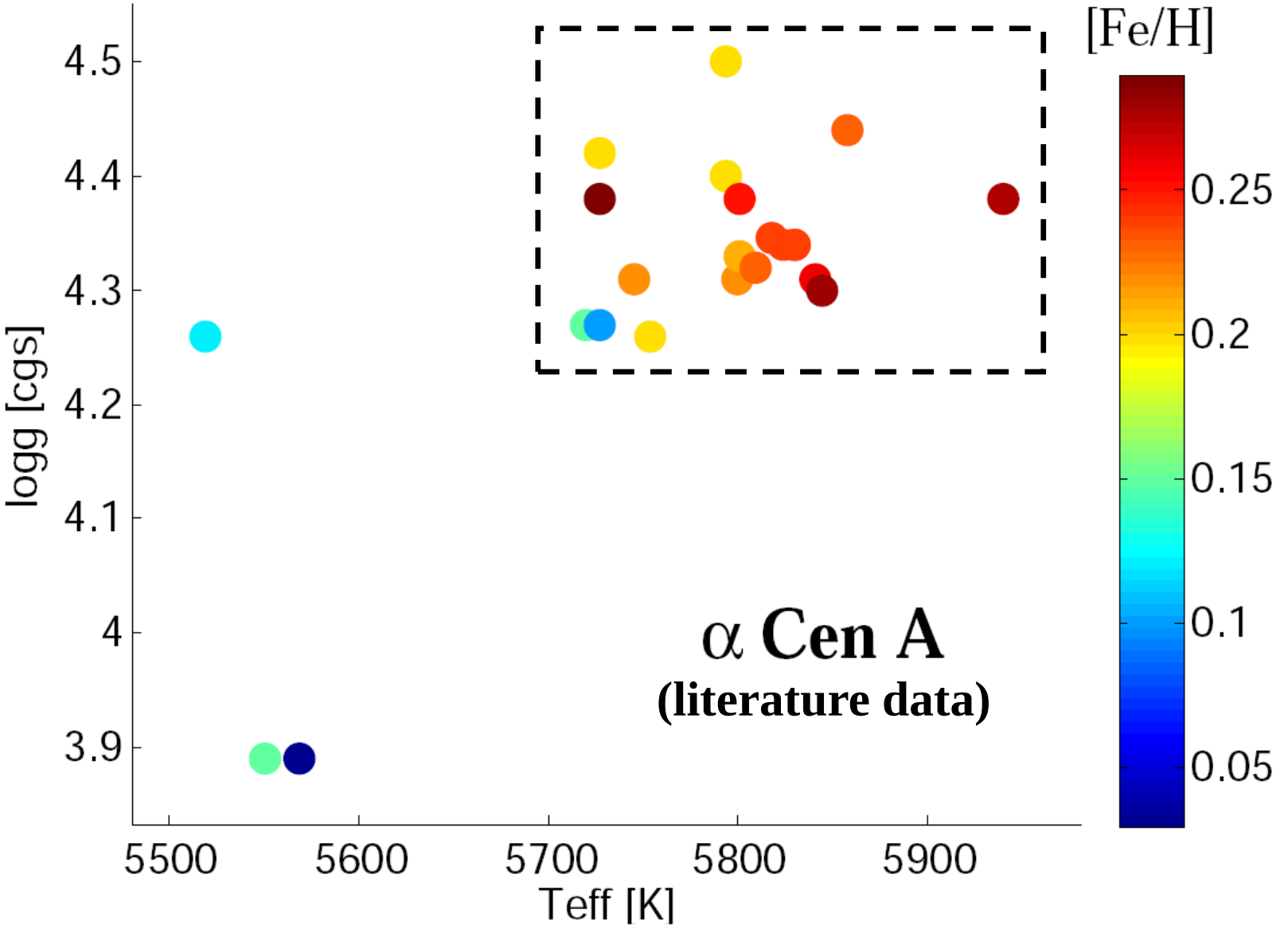
CONCERN #1: DEGENERACY OF PARAMETERS



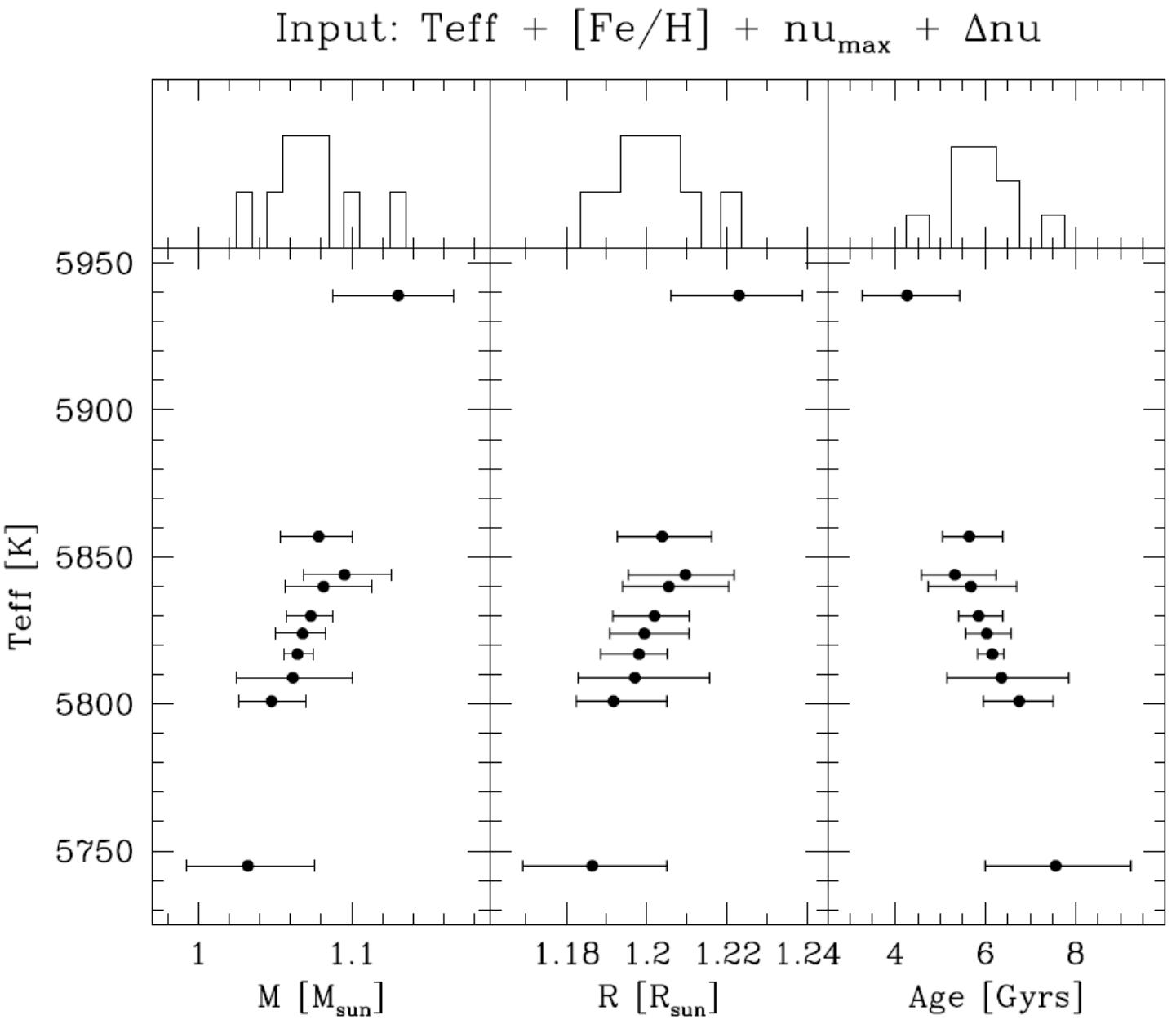
CONCERN #1: DEGENERACY OF PARAMETERS



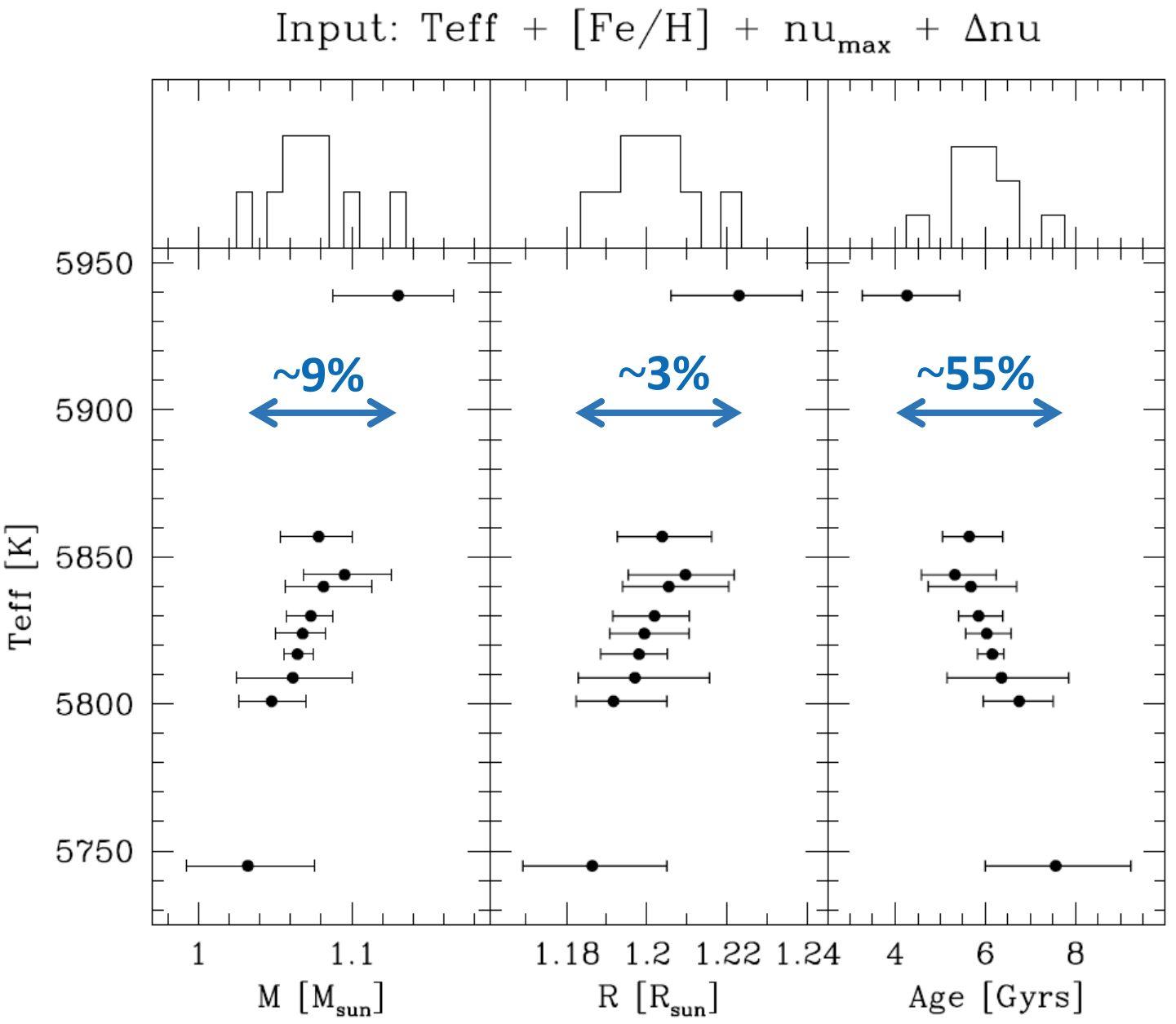
CONCERN #1: DEGENERACY OF PARAMETERS



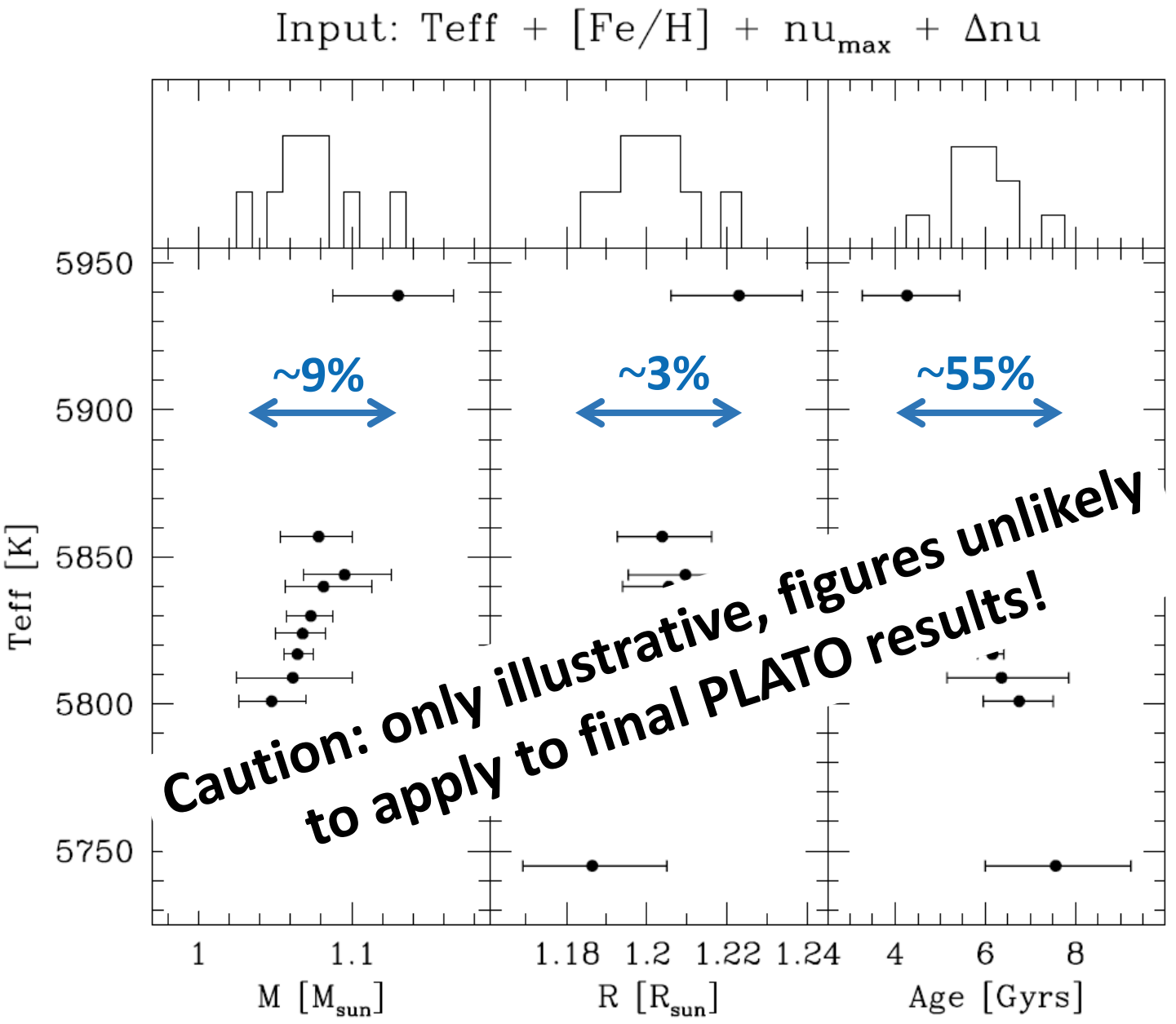
CONCERN #1: DEGENERACY OF PARAMETERS



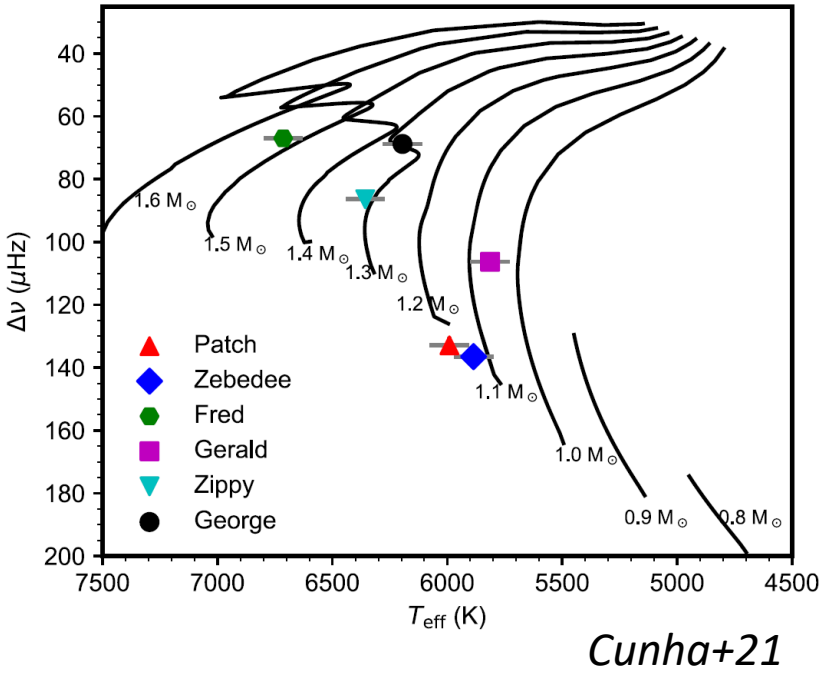
CONCERN #1: DEGENERACY OF PARAMETERS



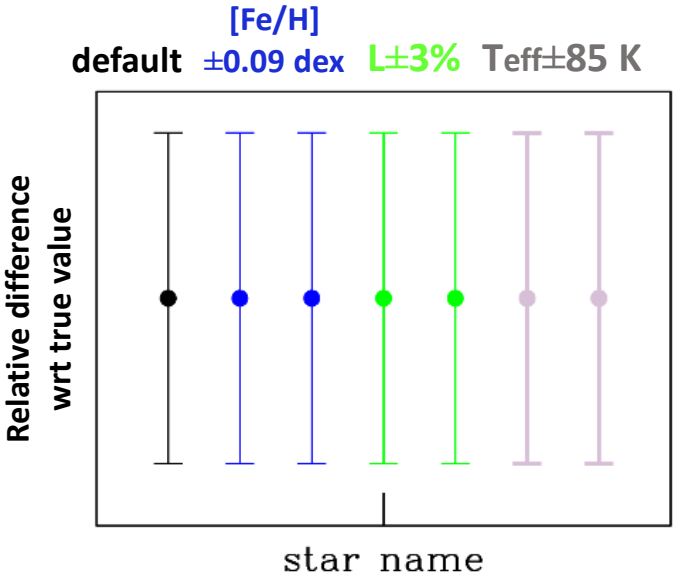
CONCERN #1: DEGENERACY OF PARAMETERS

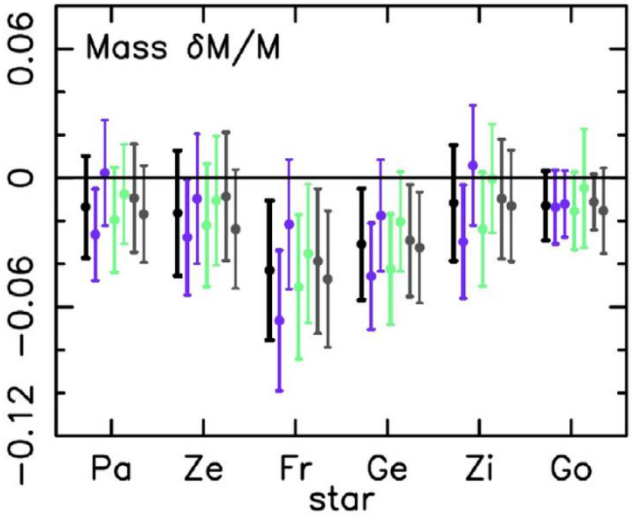


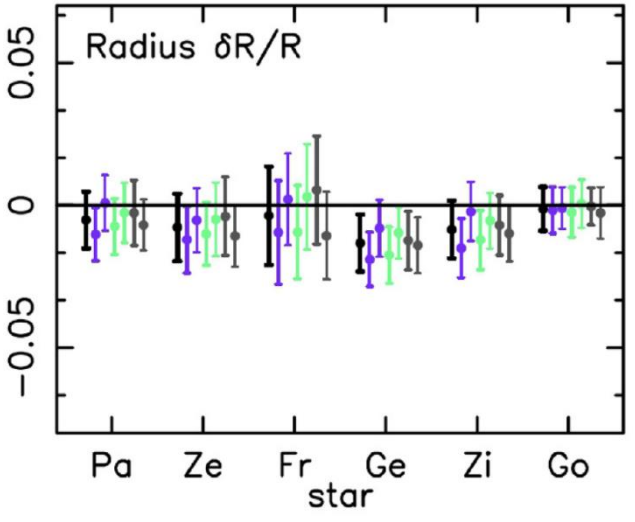
CONCERN #1: DEGENERACY OF PARAMETERS

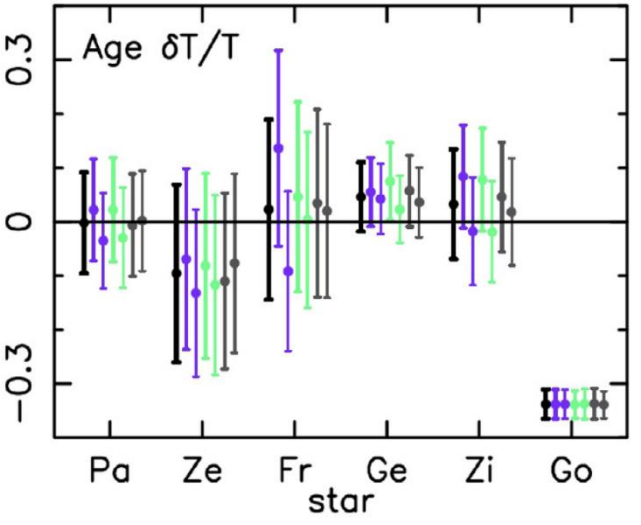


Cunha+21

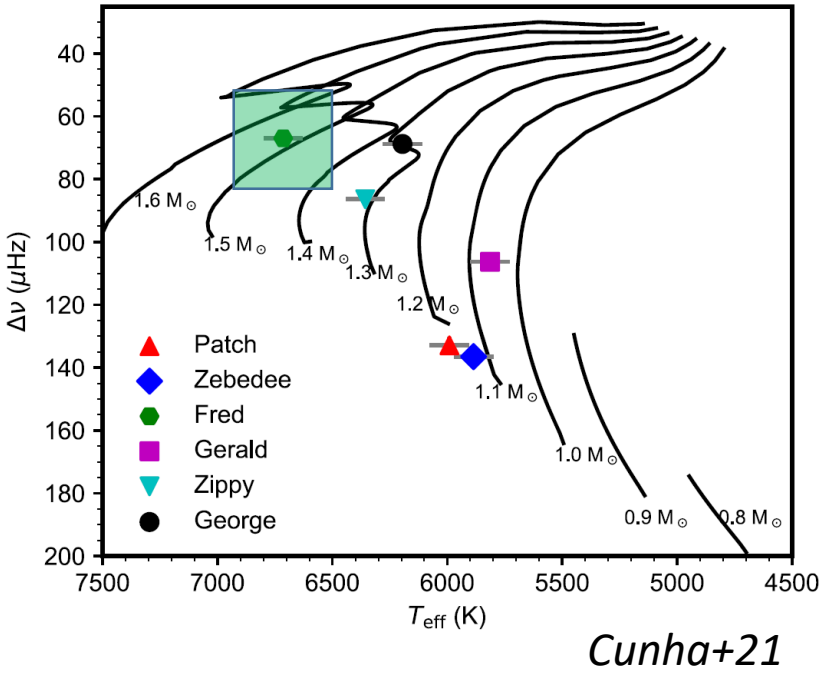




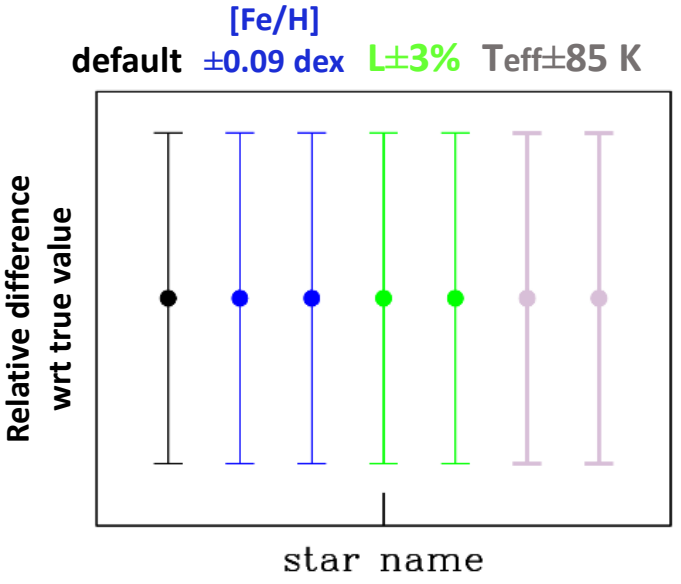


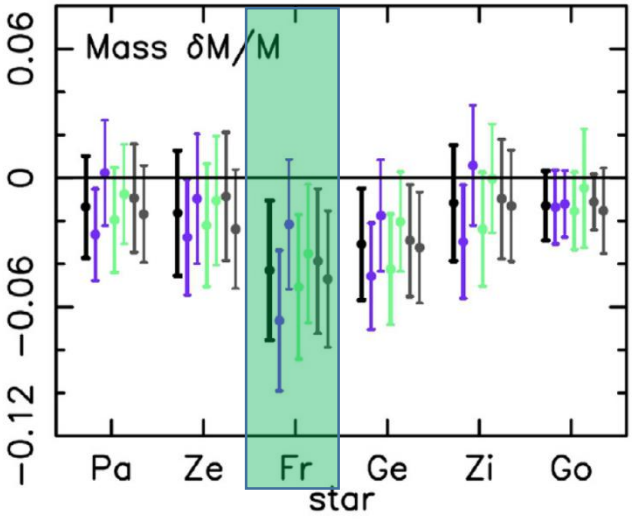


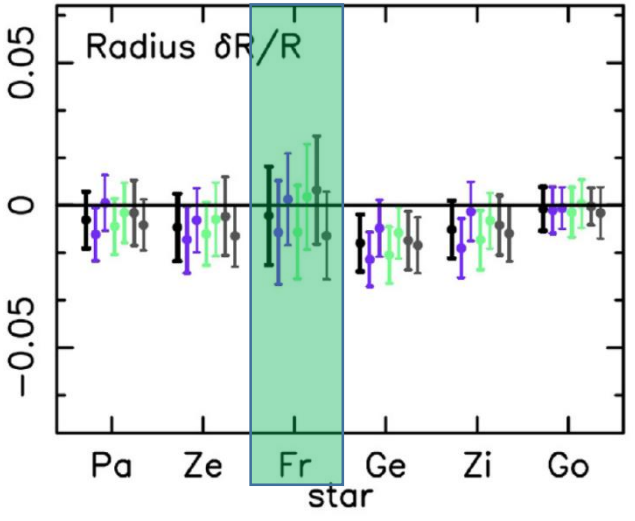
CONCERN #1: DEGENERACY OF PARAMETERS

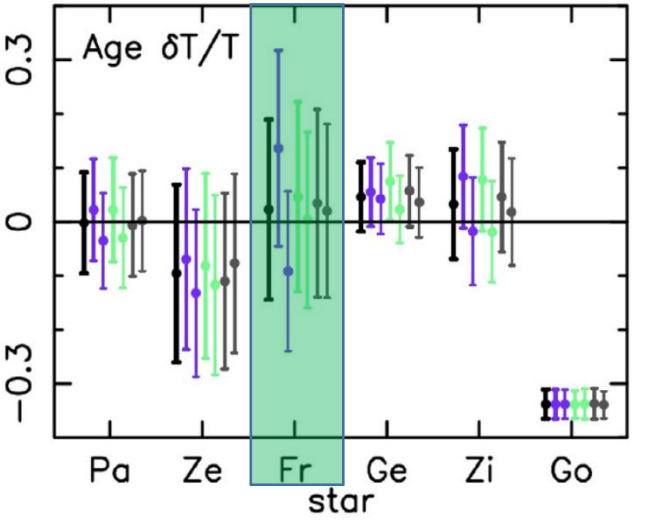


Cunha+21



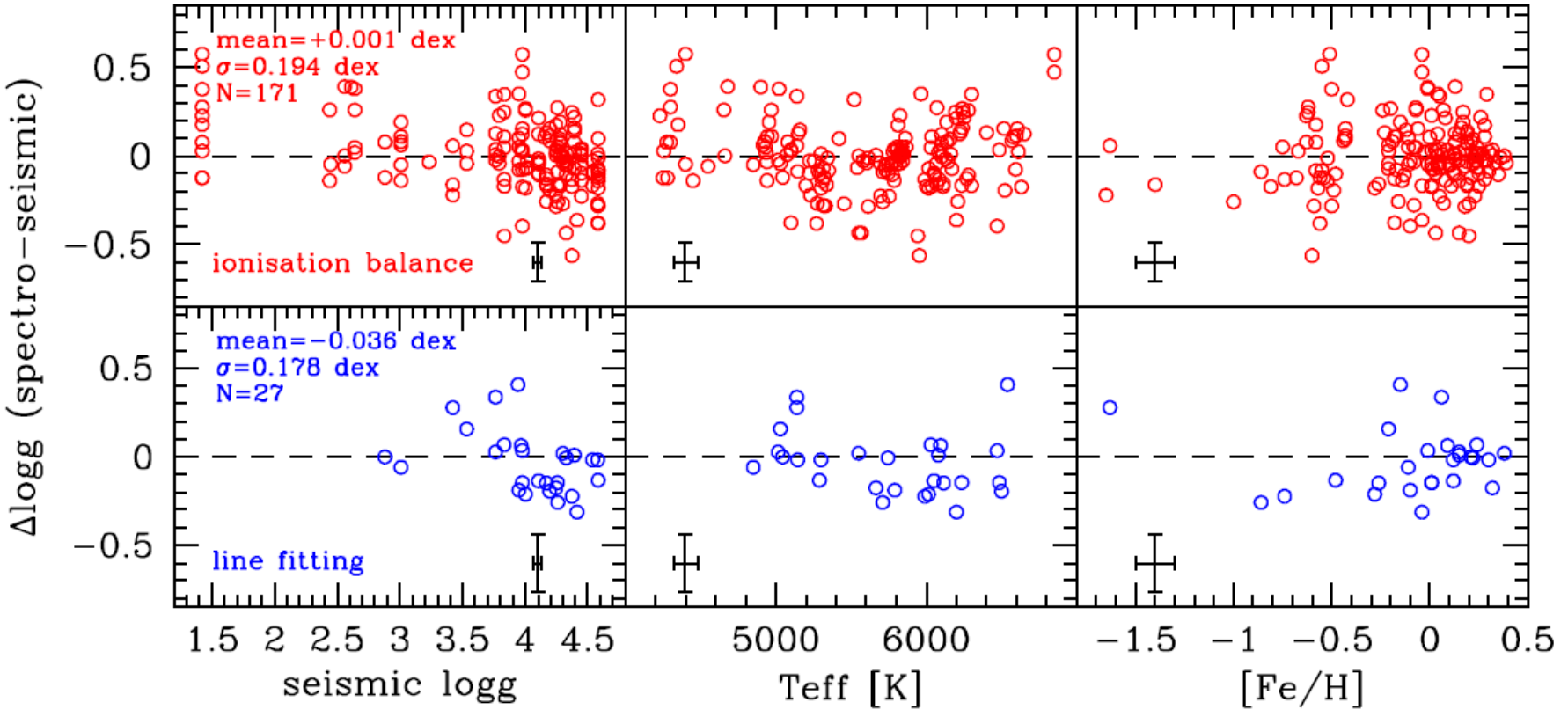






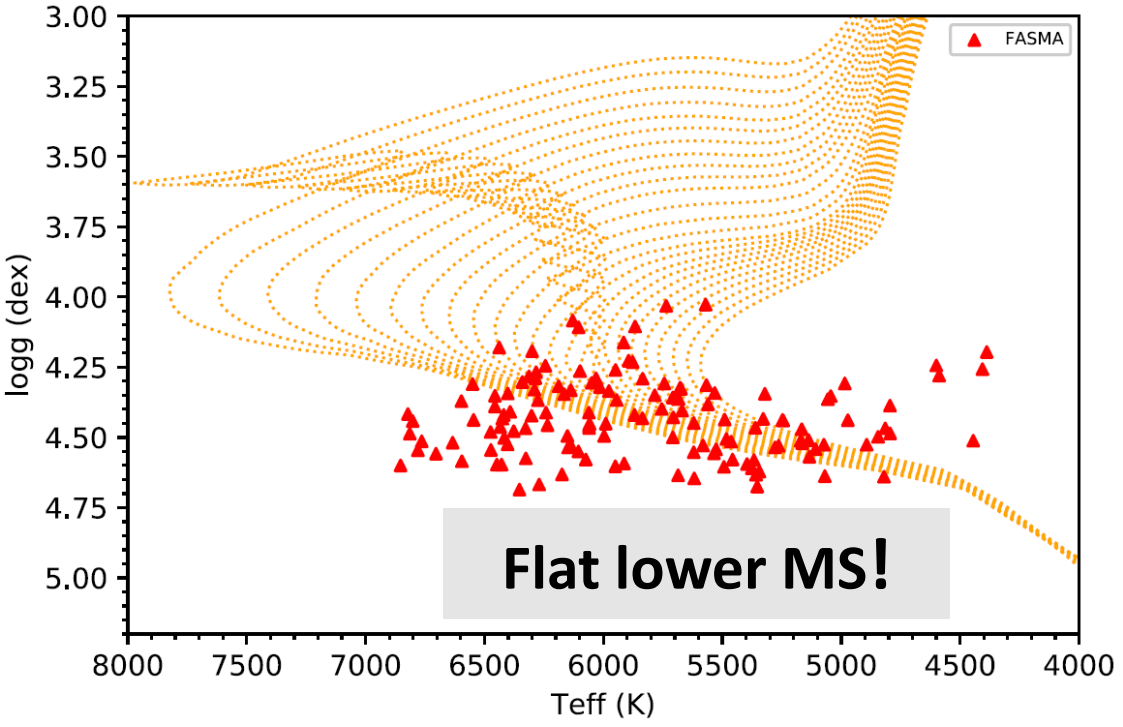
CONCERN #1: DEGENERACY OF PARAMETERS

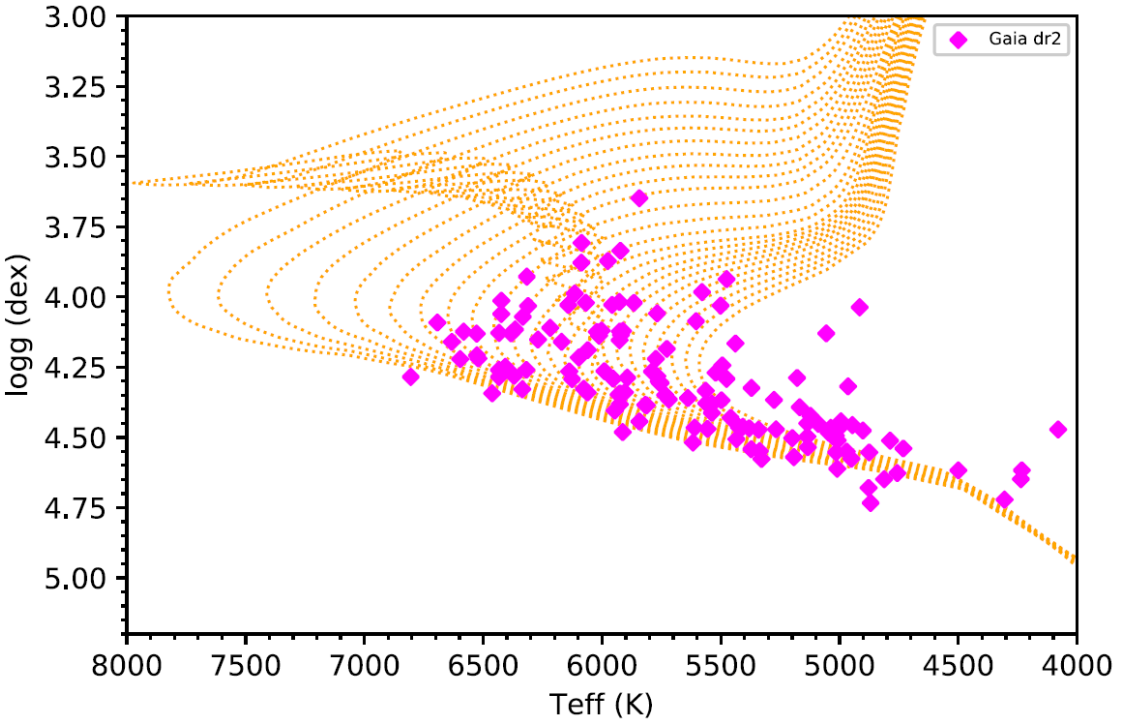
Morel & Miglio (2012)



CONCERN #1: DEGENERACY OF PARAMETERS

Brucalassi+21





CONCERN #1: DEGENERACY OF PARAMETERS

Possible solution is to take a (much) more precise/accurate surface gravity from an external source.

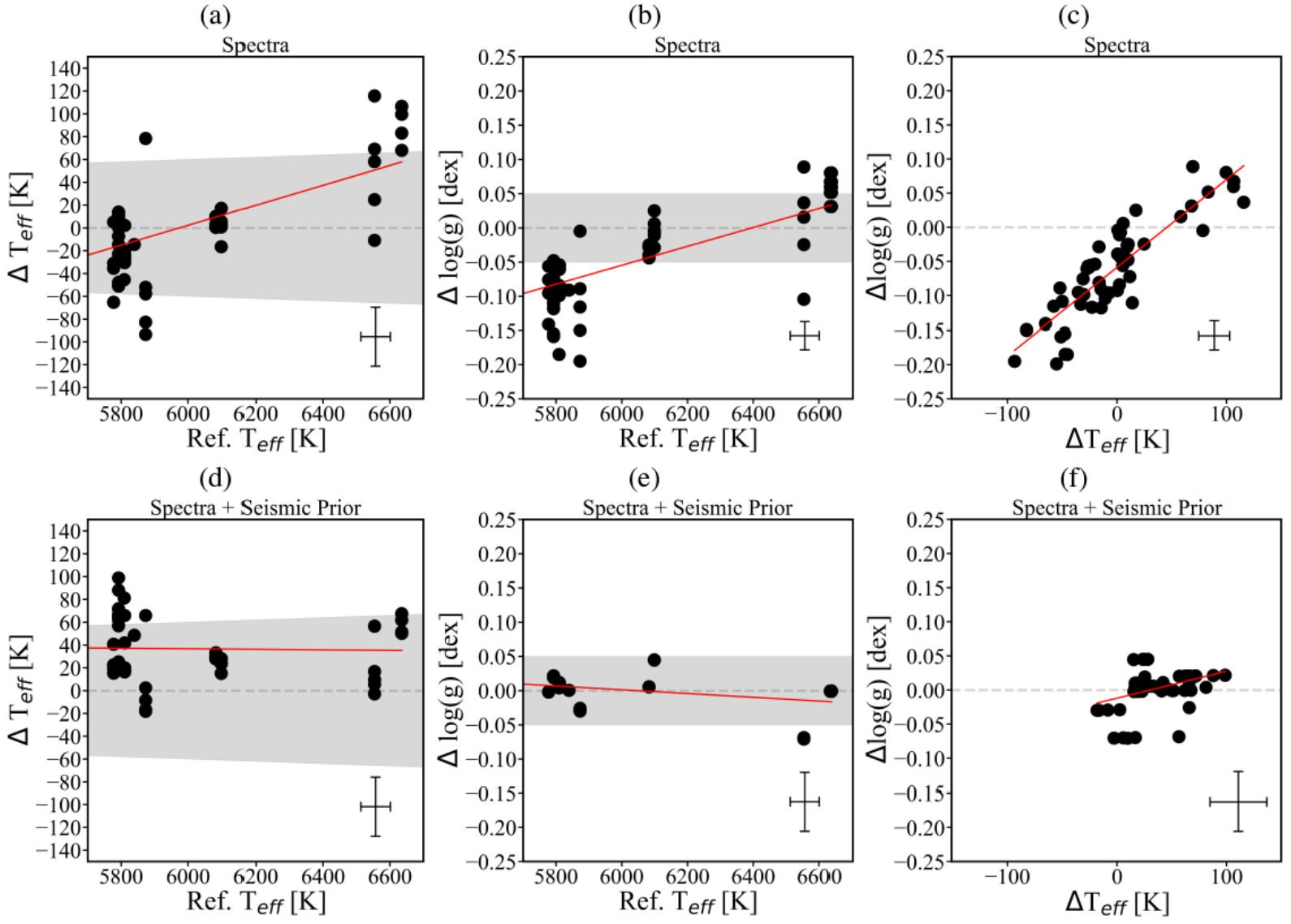
Approach adopted, for instance, to characterise through spectroscopy ARIEL planet-host targets (Magrini+22) or to build SWEET-Cat catalogue (Sousa+21):

- logg fixed to value from Gaia parallaxes + stellar models.

Approach adopted for PLATO:

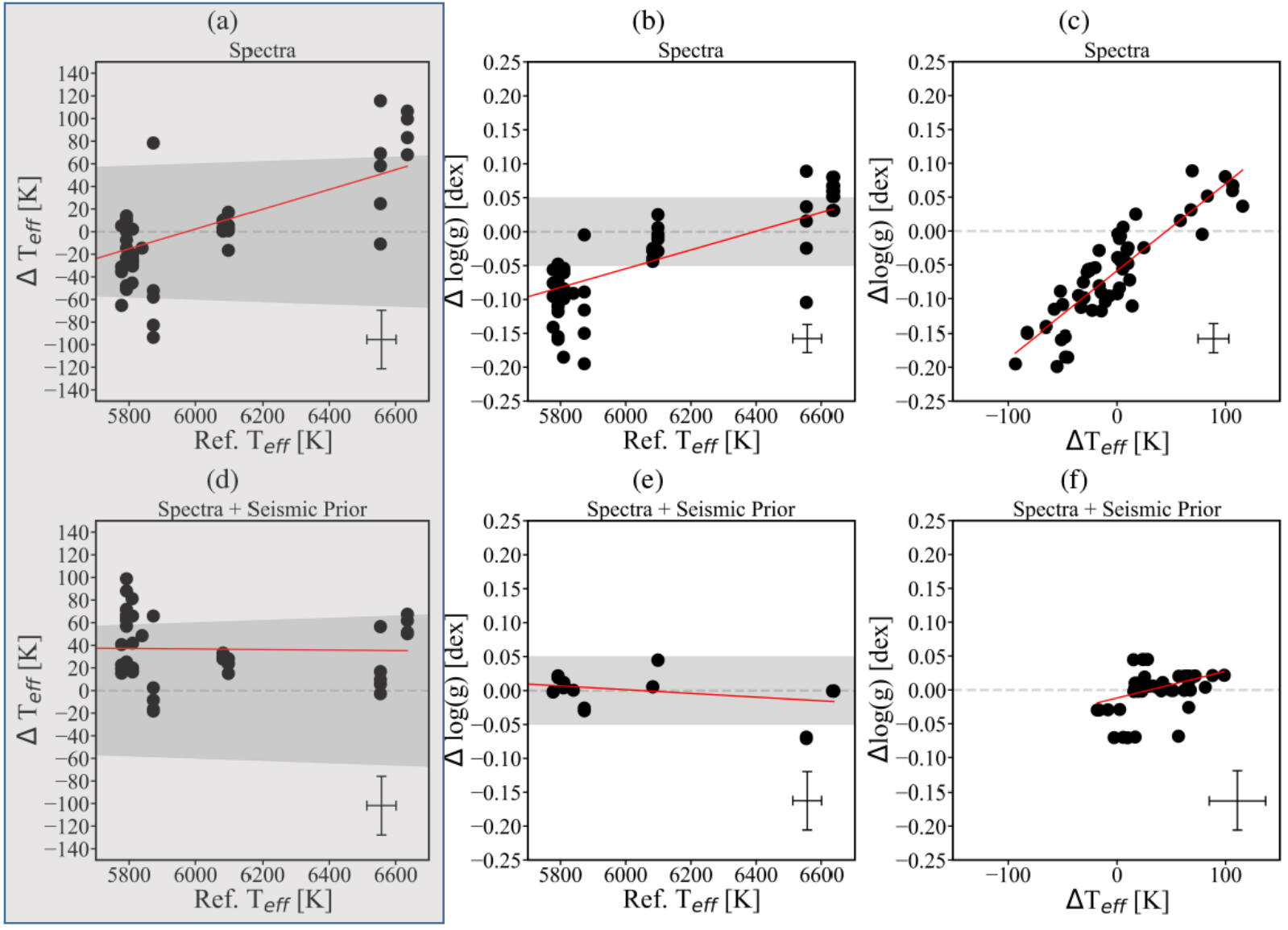
- For FGK stars: prior on logg determined from analysis of light curve Can be either from seismic or granulation properties;
- For M dwarfs: logg taken from stellar models.

CONCERN #1: DEGENERACY OF PARAMETERS



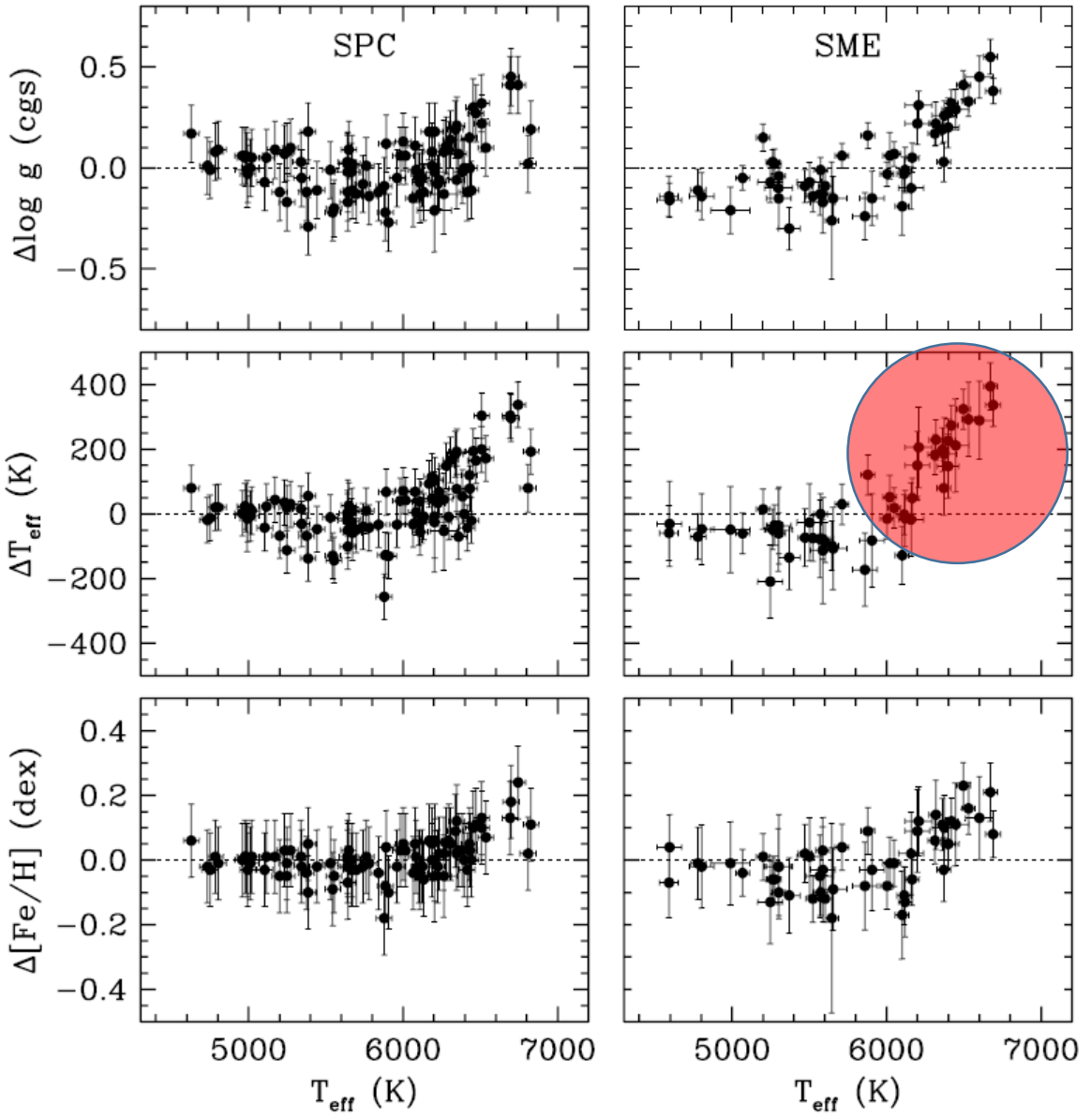
Gent+22

CONCERN #1: DEGENERACY OF PARAMETERS



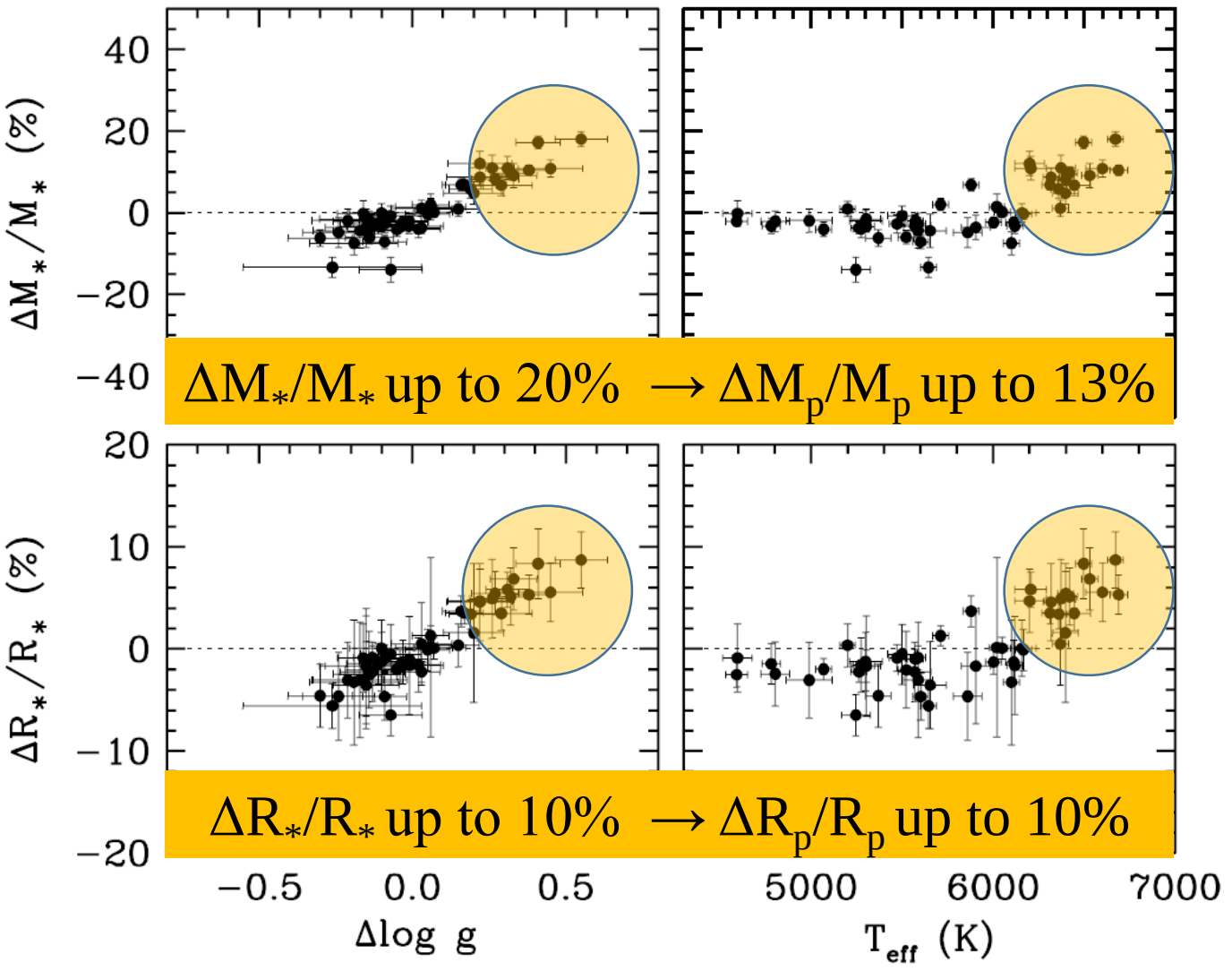
Gent+22

CONCERN #1: DEGENERACY OF PARAMETERS



Torres+12

CONCERN #1: DEGENERACY OF PARAMETERS

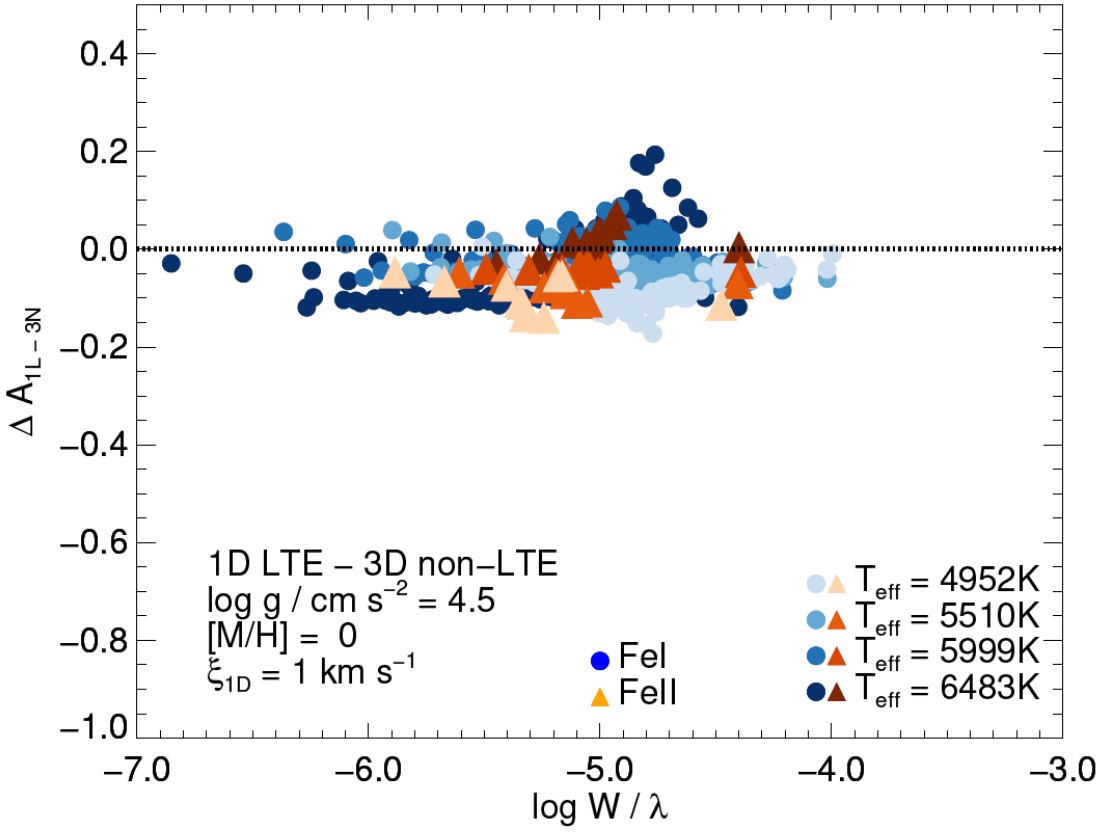


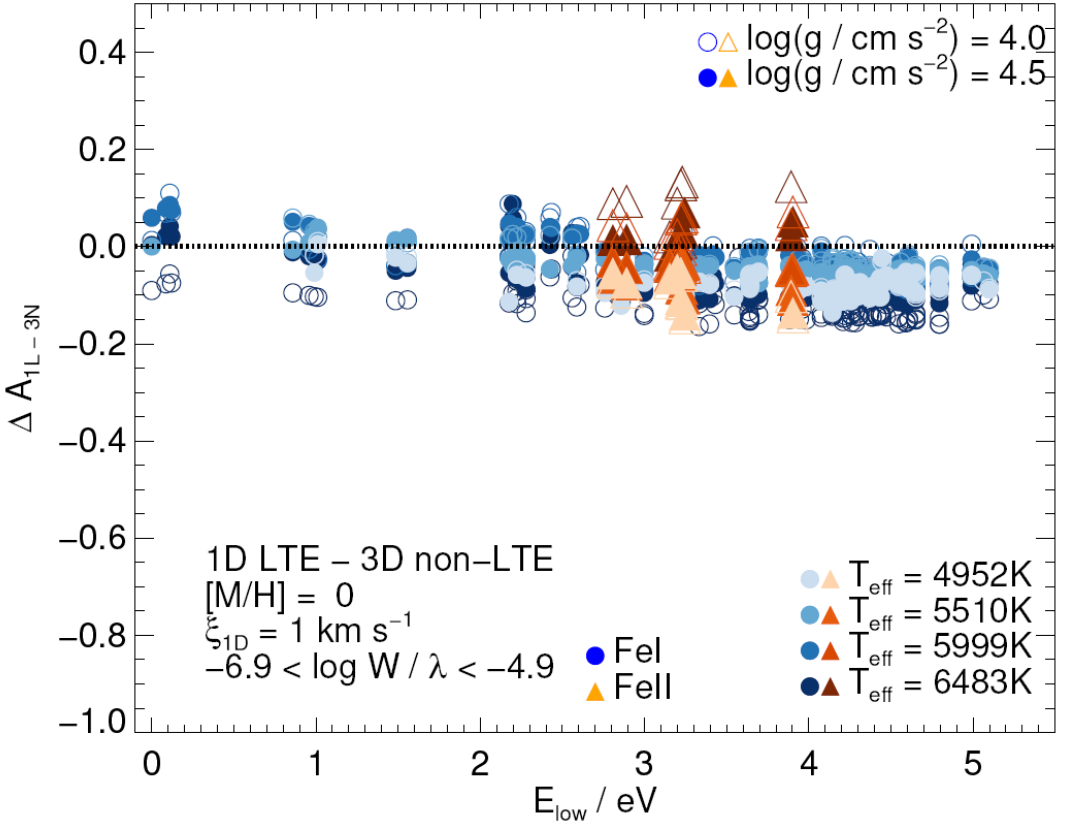
$R_p \propto R_*$

$M_p \propto M_*^{2/3}$

Torres+12

CONCERN #2: non-LTE AND 3D EFFECTS

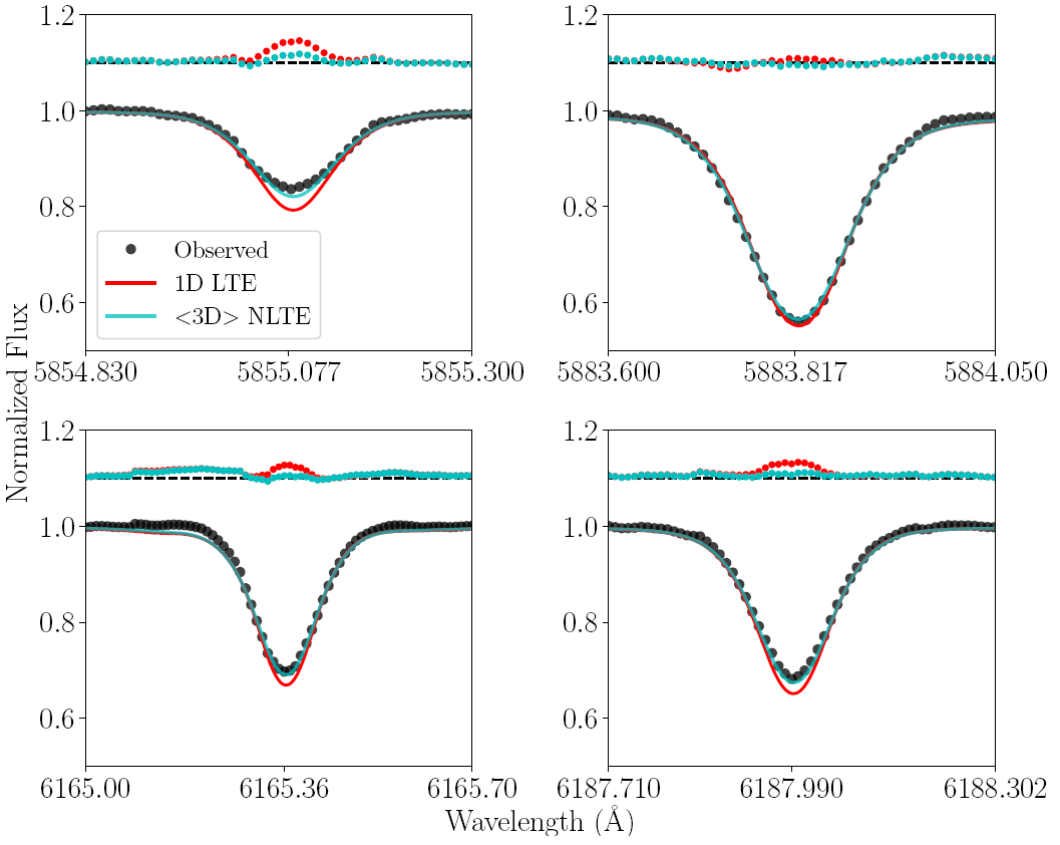


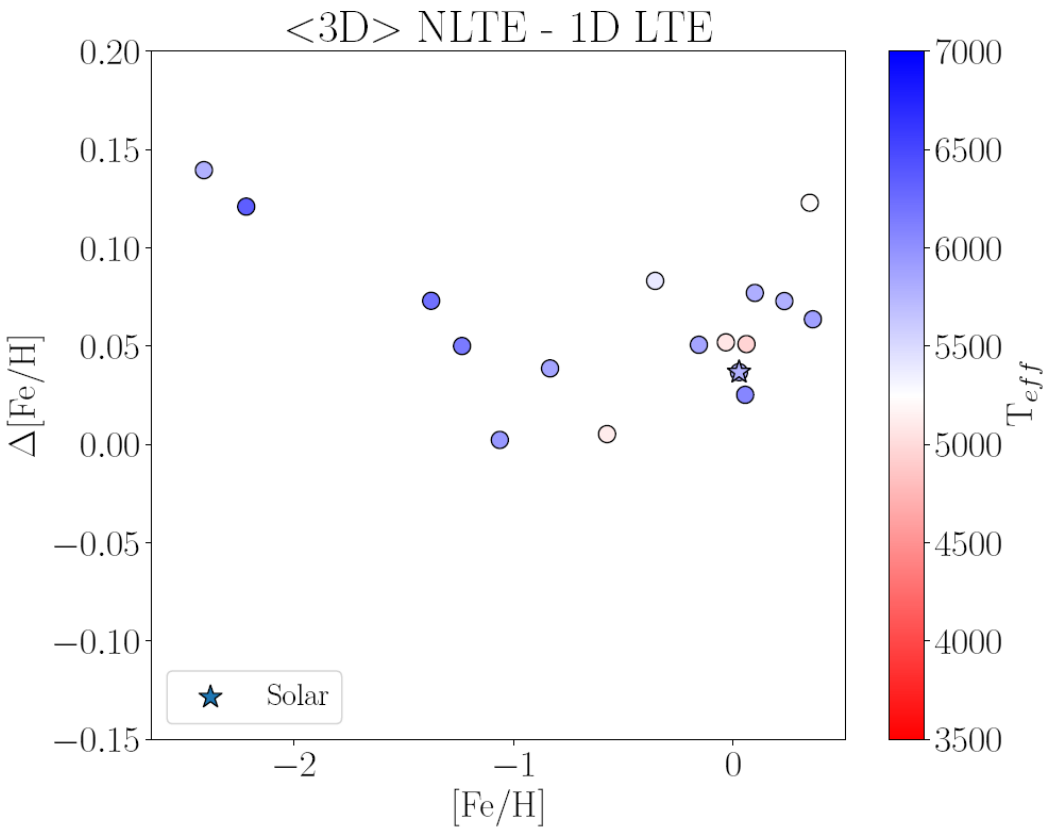


Amarsi+22

CONCERN #2: non-LTE AND 3D EFFECTS

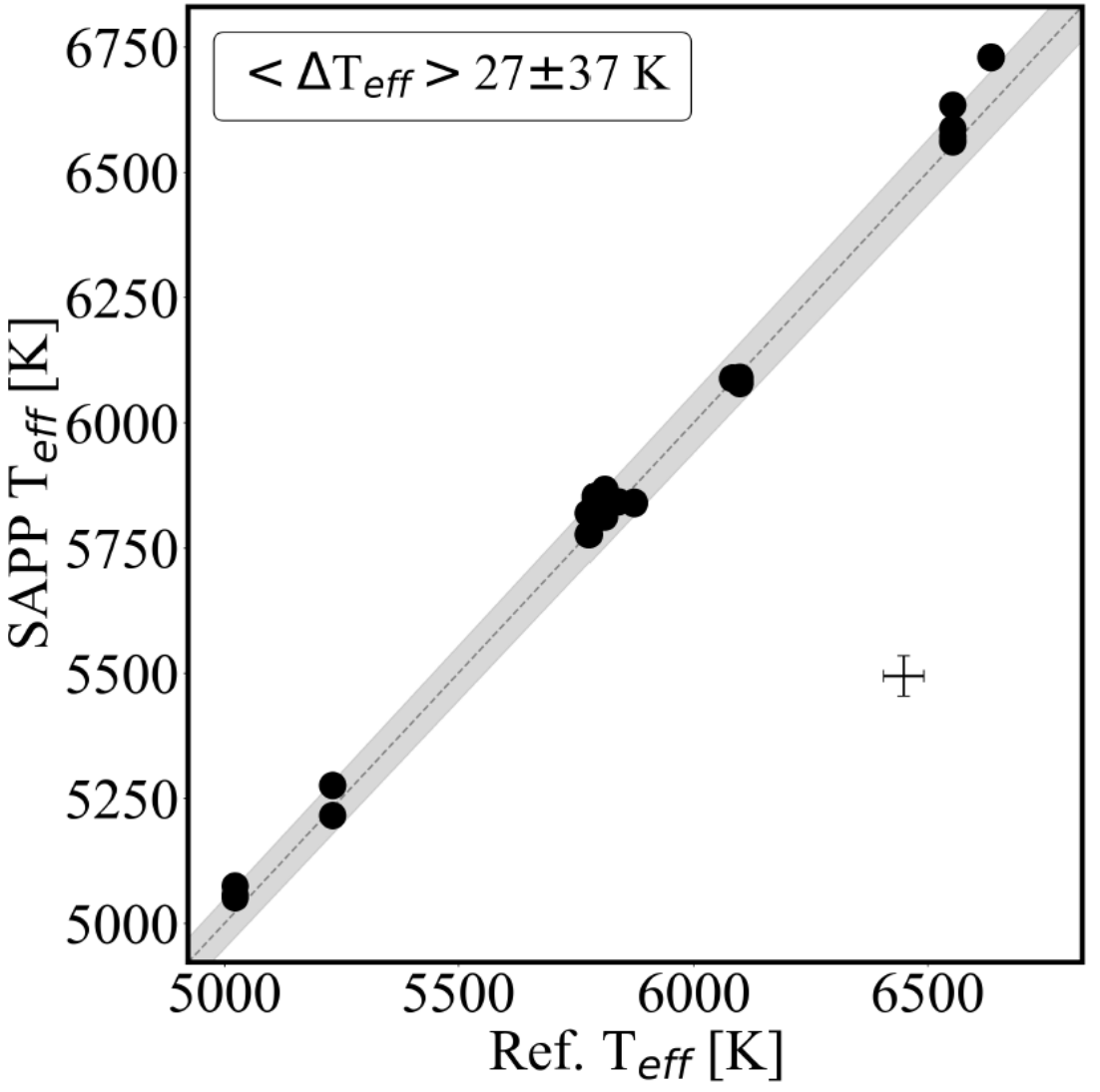
Upgrade of radiative transfer code TURBOSPECTRUM to simultaneously account for non-LTE effects for 13 elements + ability to ingest average 3D atmosphere models (<3D>)





Gerber+22

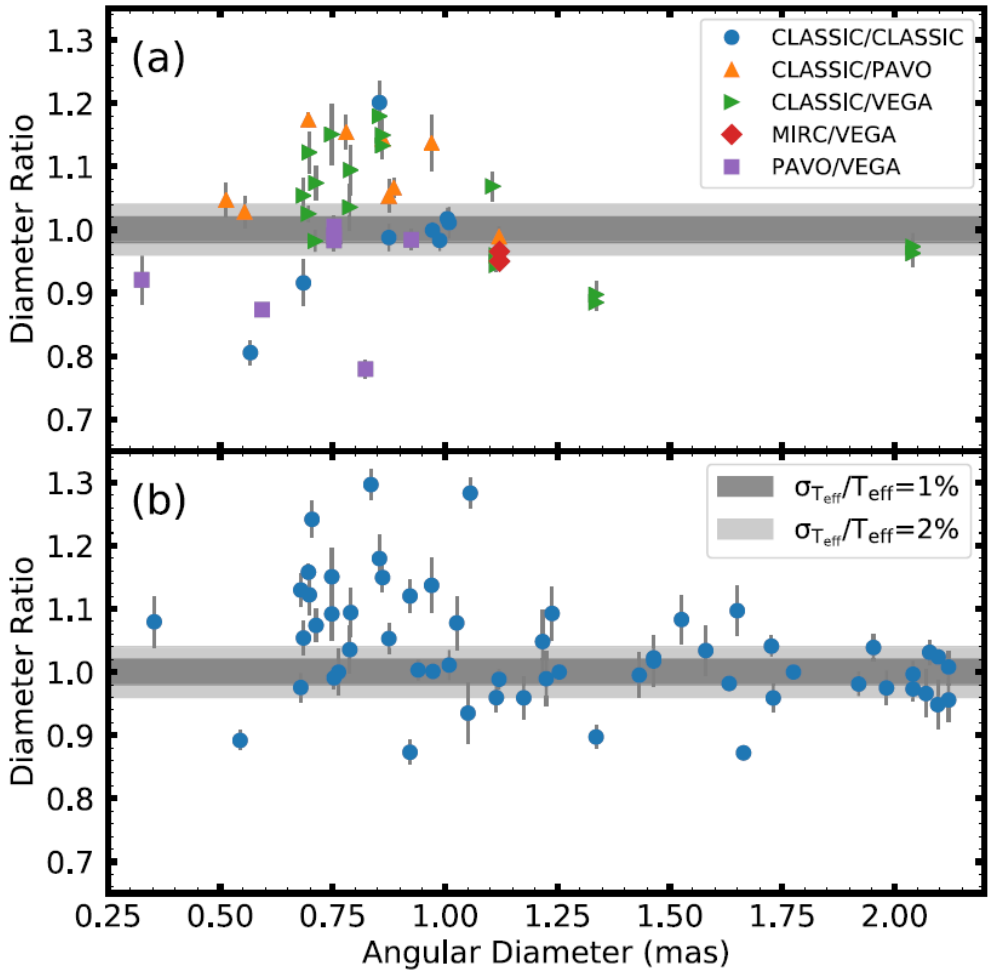
AN EXAMPLE OF ACCURACY TEST

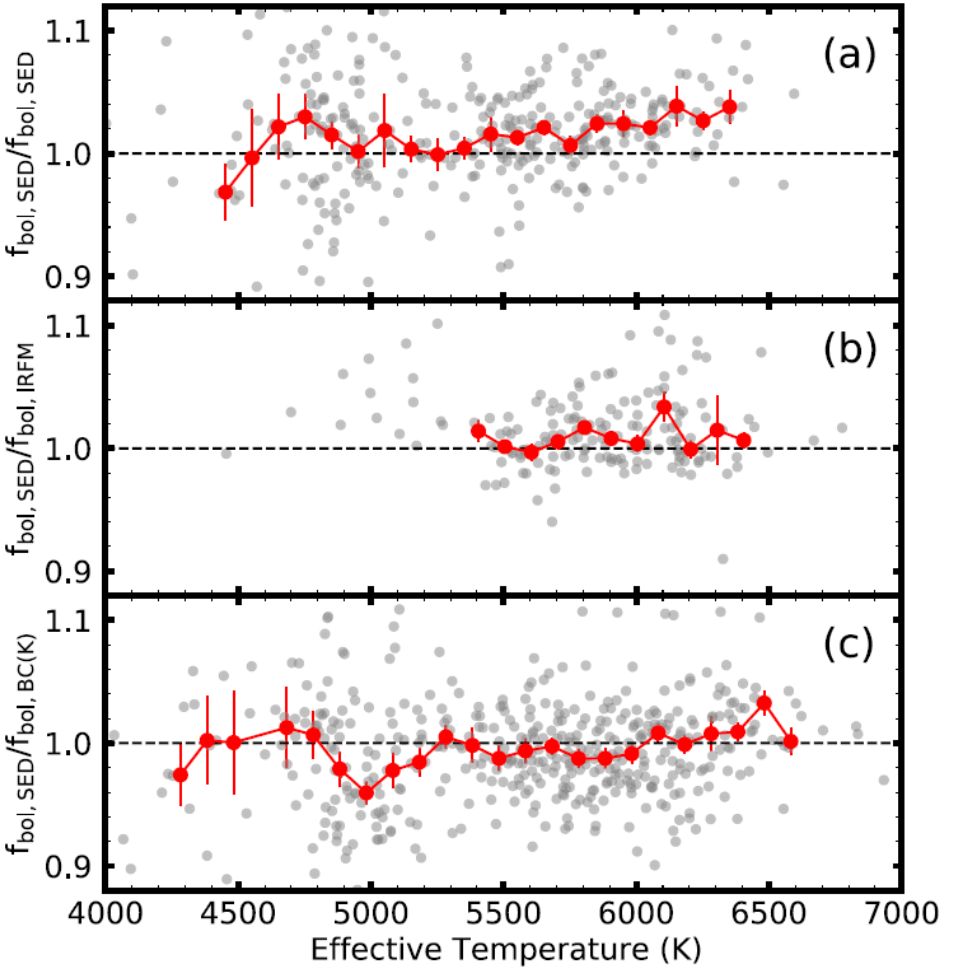


Gent+22

AN EXAMPLE OF ACCURACY TEST

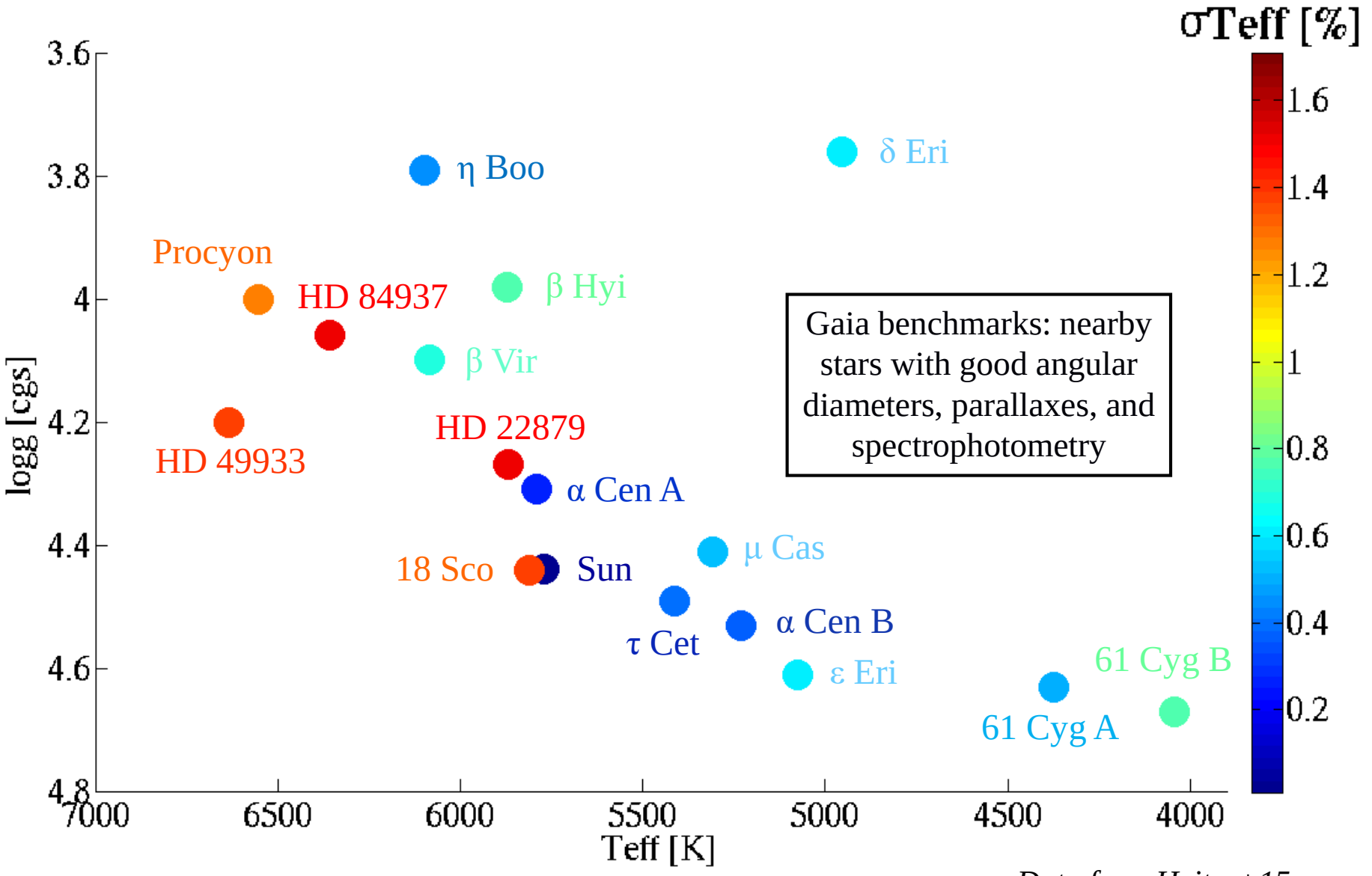
$$T_{\rm eff} = \left(\frac{4 f_{\rm bol}}{\sigma \theta^2} \right)^{1/4}$$





Tayar+22

AN EXAMPLE OF ACCURACY TEST



Data from Heiter+15

AN EXAMPLE OF ACCURACY TEST

Angular diameters: expected performance of forthcoming CHARA-SPICA interferometer (assuming limb darkening is known a priori)

Dwarfs	Challouf			Salsi-1			Salsi-2		
SpTy	O	B0	A0	F5	G7	K4	M0	M3	M4
V // V-K	-2	-1	0	1	2	3	4	5	6
0	0,10	1,00	3,35	6,28	11,82	22,25	39,94	70,70	125,14
1	0,06	0,63	2,11	3,96	7,46	14,04	25,20	44,61	78,96
2	0,04	0,40	1,33	2,50	4,71	8,86	15,90	28,14	49,82
3	0,02	0,25	0,84	1,58	2,97	5,59	10,03	17,76	31,43
4	0,02	0,16	0,53	0,99	1,87	3,53	6,33	11,20	19,83
5	0,01	0,10	0,33	0,63	1,18	2,23	3,99	7,07	12,51
6	0,01	0,06	0,21	0,40	0,75	1,40	2,52	4,46	7,90
7	0,00	0,04	0,13	0,25	0,47	0,89	1,59	2,81	4,98
8	0,00	0,03	0,08	0,16	0,30	0,56	1,00	1,78	3,14
9	0,00	0,02	0,05	0,10	0,19	0,35	0,63	1,12	1,98
10	0,00	0,01	0,03	0,06	0,12	0,22	0,40	0,71	1,25

Precision, $\sigma R < 1\%$

Current limits

Out of reach

Mourard+22

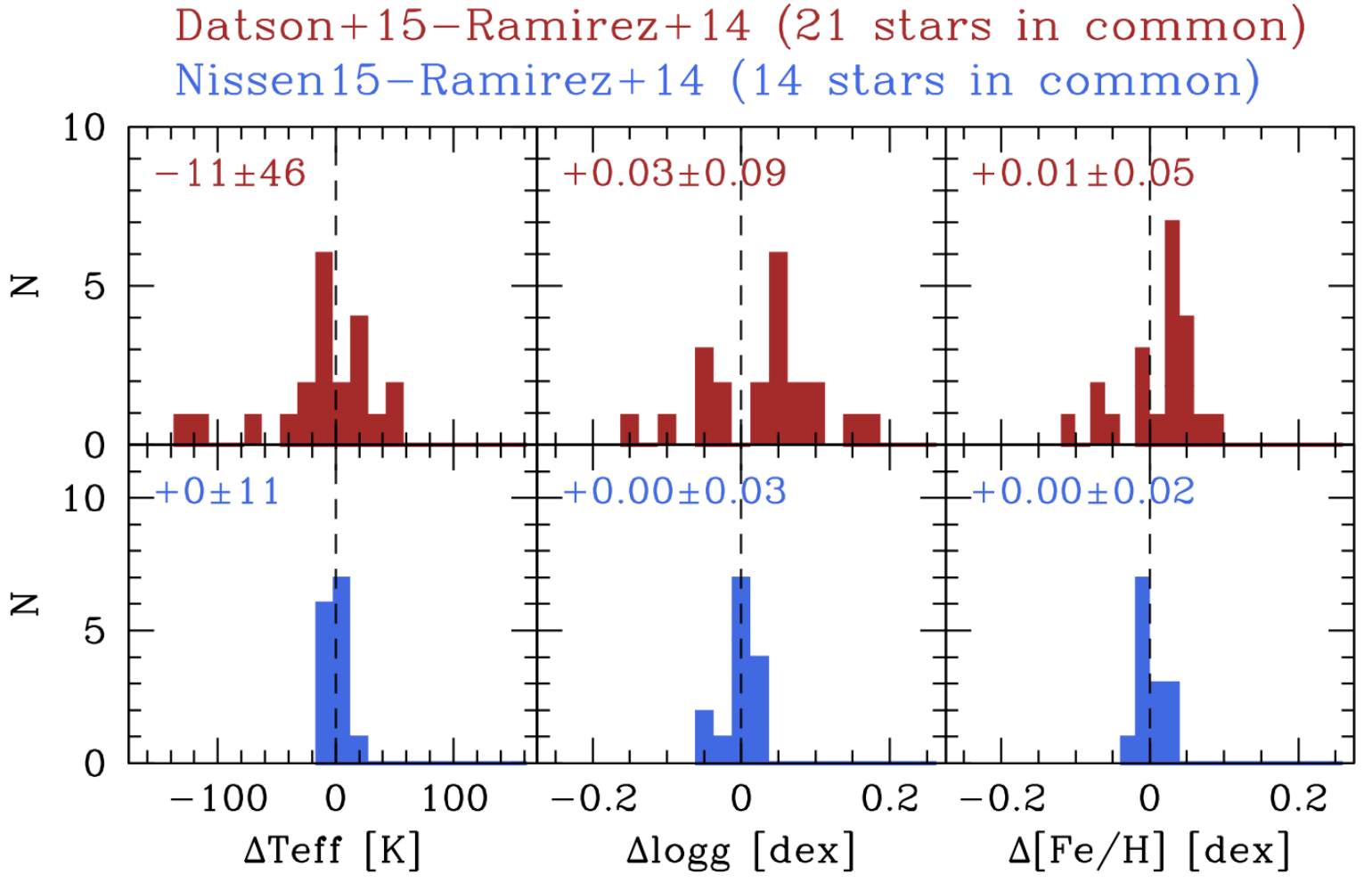
Take-away messages

- Three broad categories of data requested to GOP by WP12: see IRD document for details;
- Reliability of classical parameters (e.g. [Fe/H]) does have an effect on quality of PLATO DP5: M, R, and age;
- Prior on logg used by W12 pipeline for determination of classical parameters
  - For FGK stars: from seismic or granulation properties
  - For M dwarfs: from stellar models;
- Efforts to improve spectroscopic modelling: non-LTE and 3D effects, etc.
- Benchmarking of results essential through nearly model-independent techniques (interferometry, analysis of eclipsing binaries, …);
- Accuracy of classical parameters much more important than precision for seismic inferences (Cunha+21)
- While *accuracy* of Teff may be investigated, ONLY *precision* can be for [Fe/H] and the chemical abundances in general;
- Essential to carry out a *homogeneous* analysis for both single and candidate host stars to meaningfully study occurrence rate and properties of planetary systems as a function of [Fe/H], stellar mass, etc.

EXTRA SLIDES ABOUT DIFFERENTIAL ANALYSES

CONCERN #2: non-LTE AND 3D EFFECTS

Line-by-line differential analysis of solar analogues/twins wrt Sun is largely immune to such effects (and others like reliability of atomic data): precise and robust



CONCERN #2: non-LTE AND 3D EFFECTS

Line-by-line differential analysis of solar analogues/twins wrt Sun is largely immune to such effects (and others like reliability of atomic data): precise and robust