Tested by Miriam Cortés Contreras, on July 18th 2017.

1 Summary

We compare the results in Lindgren & Heiter 2017, arXiv170508785L (hereafter LH17) with the fit results obtained with VOSA.

- Effective temperatures

  Efective temperatures computed by VOSA are in agreement with those given in LH17. On average, LH17 temperatures are systematically higher by less than 100K both for BT-Settl and CIFITS. Standard deviations are below 150 K in both cases.

  Below 3400 K, LH17 effective temperatures are larger (250 K and 450 K) than those provided by BT-Settl. This trend does not appear if CIFITS models are used. Anyway, a larger number of objects would be necessary to confirm this result.

- Surface gravities, metallicities

  As expected from the minor contribution of these parameters to the SED shape, the values obtained from VOSA are affected by large uncertainties and, thus, are not reliable.

- Stellar radii

  There are not significant differences between the radii derived using BT-Settl or BT-Settl CIFIST models and both are in very good agreement with the values derived by LH17.

- Stellar masses

  While masses directly derived from $M = gR^2/G$ are not reliable due to the large uncertainties associated to the surface gravities estimated with VOSA, those obtained using the BT-Settl and BHAC isochrones are in reasonable agreement with the ones obtained in LH17. The agreement is slightly worse if the BHAC isochrones are used.

2 Sample and input parameters

- Lindgren & Heiter 2017
  - Parameter determination for sixteen cool dwarfs using high-resolution spectra taken with CRIRES at VLT:
    - J band (1100–1400 nm)
    - R $\approx$ 50 000
    - SNR: 55–205
  - Stellar properties:
    - Temperatures determined from FeH lines for M dwarfs cooler than 3575 K, and from photometric calibration for warmer stars. $3350 < T_{eff}\,[\mathrm{K}] < 4550$ ($\pm$100 K)
    - Metallicities determined using synthetic spectra fitting. $-0.50 < [\mathrm{M/H}] < +0.40$ ($\pm$0.05 dex)
    - Spectral types: K4/K5 – M3.5 V
    - Masses derived from the mass-magnitude empirical relation by Benedict et al. (2016). $0.178 < M\,[M_{\odot}] < 0.524$
    - Radii derived from the mass-magnitude empirical relation by Mann et al. (2015). $0.214 < R\,[R_{\odot}] < 0.698$
    - Surface gravity ($g = GM/R^2$): $4.56 < \log g\,[\mathrm{cm\,s^{-2}}] < 5.03$
- SED building using VOSA
  - Photometric SED built using photometry from GALEX, Johnson, SDSS, TYCHO, APASS, GAIA, DENIS, 2MASS, WISE, AKARI and IRAS, retrieved from VO services.
  - Model fit using BT-Settl ($\log g : 4\text{–}6$; [M/H]: $-0.5\text{–}0.5$, $T_{eff}:\ 3000 - 5500$ K)
  - Model fit using BT-Settl CIFIST ($\log g\ :\ 4 - 6$; [M/H] $= 0$, $T_{eff}:\ 3000\ -\ 5500$ K)

3 Parameters determination

For comparison and to assess whether the parameters obtained with VOSA are model-dependent, we performed this analysis using two models: BT-Settl and BT-Settl CIFIST. One of the sixteen stars has not enough photometric data. Thus, this analysis was carried out for the fifteen remaining stars.

3.1 Effective Temperatures

- BT-Settl (Fig. 1)

  Mean(T_{eff}(LH17) $-$ T_{eff}(VOSA)) = 92.9 K; std = 132.4 K

- BT-Settl CIFIST (Fig. 2)

  Mean(T_{eff}(LH17) $-$ T_{eff}(VOSA)) = 86.3 K; std = 117.2 K

Both models give consistent values for the effective temperature.

3.2 Metallicity

- BT-Settl (Fig. 3)

  Mean(Metallicity(LH17) - Metallicity(VOSA)) = 0.18; std= 0.38

BT-Settl does not provide good results for the metallicities.

3.3 Surface gravity

- BT-Settl (Fig. 4)

  Mean($\log g$(LH17) $-$ $\log g$(VOSA)) = 0.05; std= 0.61

- BT-Settl CIFIST (Fig. 5)

  Mean($\log g$(LH17) $-$ $\log g$(VOSA)) = -0.48; std = 0.35

Surface gravities provided by VOSA are not consistent with the values given in the paper. Using BT-Settl we obtain higher values for stars with the lowest gravities in LH17 and lower values for the stars with highest gravities (see Fig. 4). On the other hand, this does not happen using BT-Settl CIFIST but we obtain significantly higher values.

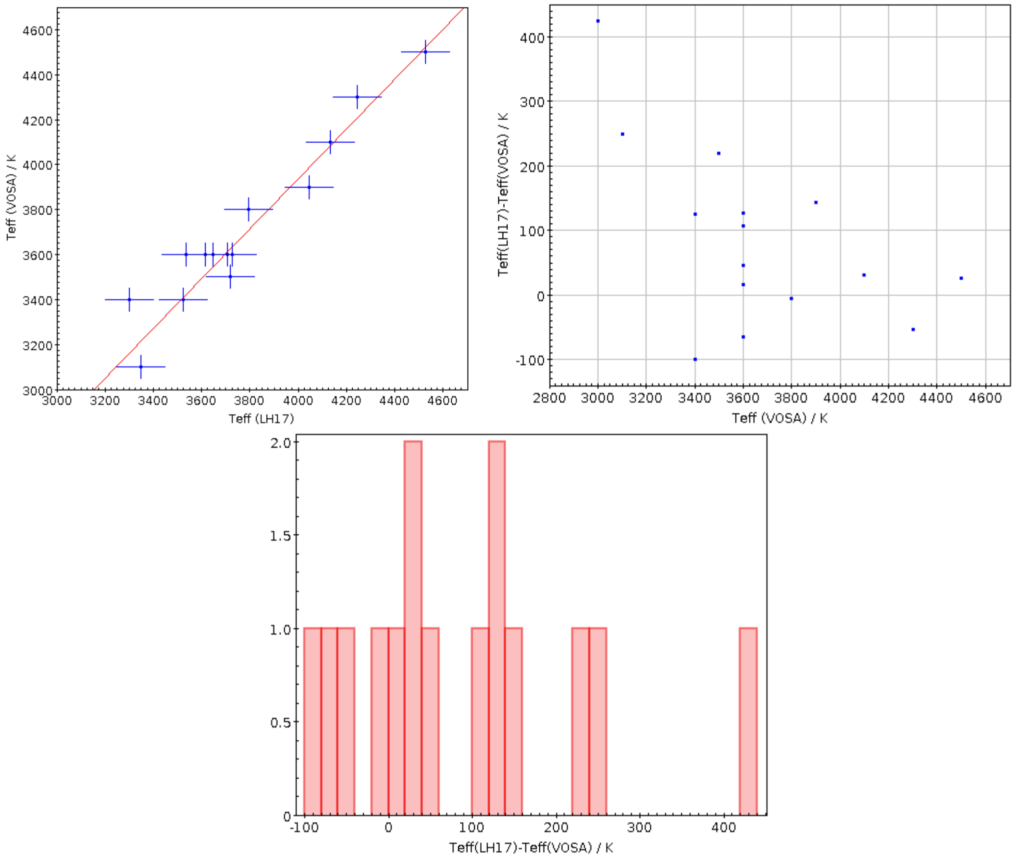

Figure 1: Effective temperatures using BT-Settl. Correlation coefficient $r = 0.95$.

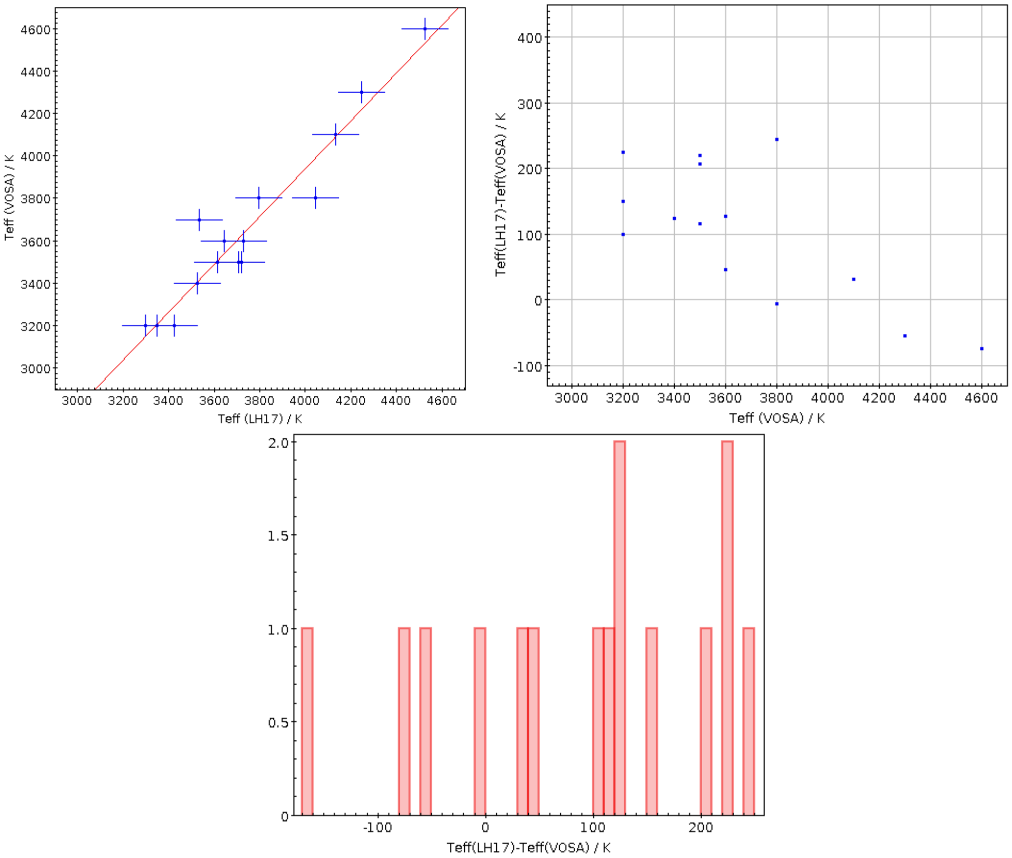

Figure 2: Effective temperatures using BT-Settl CIFIST. Correlation coefficient $r = 0.96$.

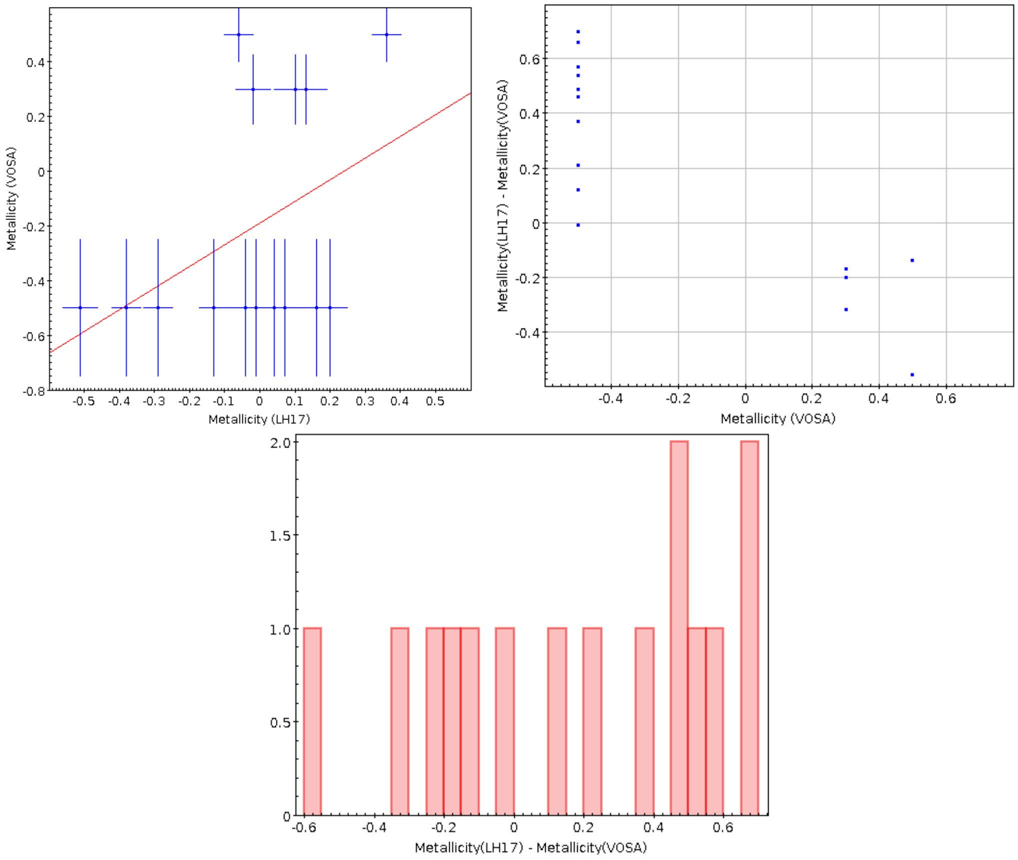

Figure 3: Metallicities using BT-Settl. Correlation coefficient $r = 0.41$.

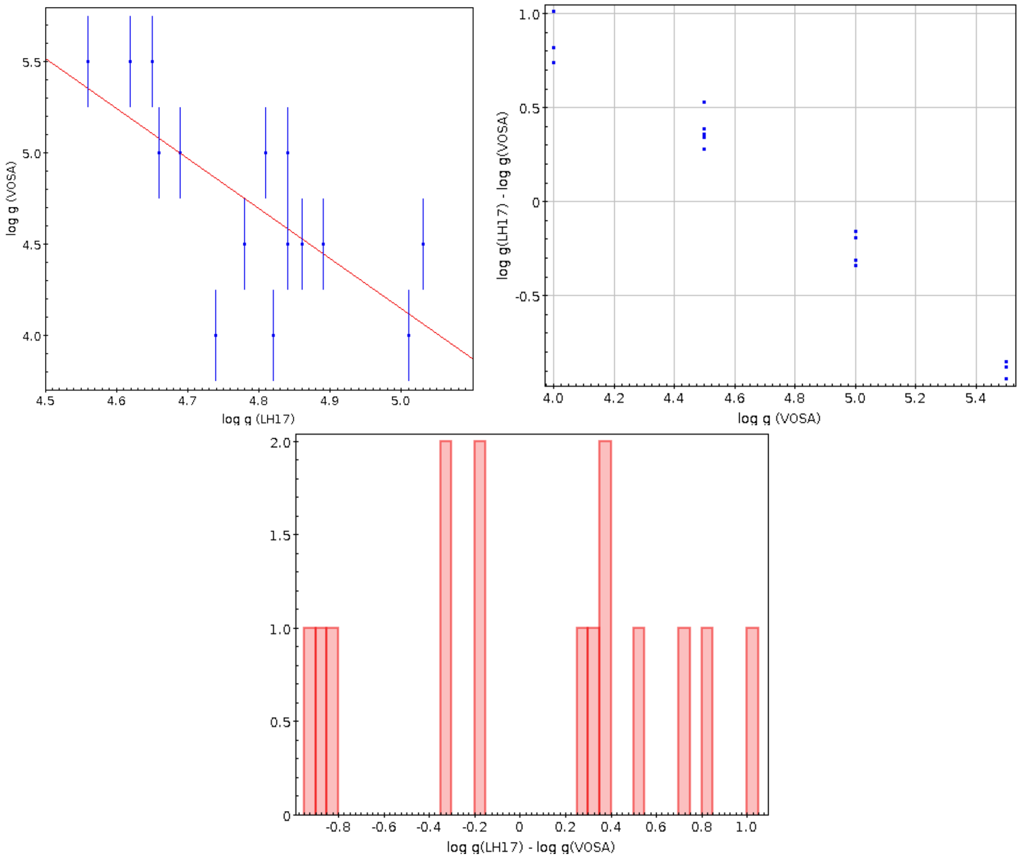

Figure 4: Surface gravities using BT-Settl. Correlation coefficient $r = -0.70$.

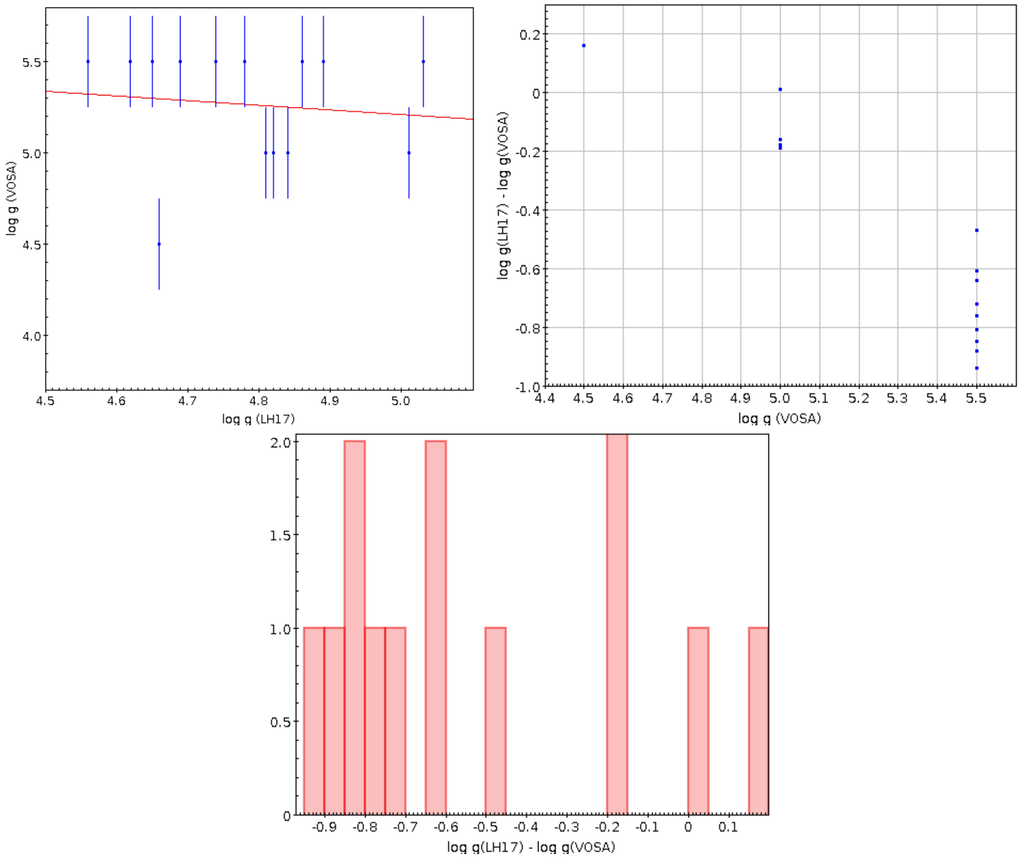

Figure 5: Surface gravities using BT-Settl CIFIST. Correlation coefficient $r = -0.11$.

3.4 Radii and masses

VOSA computes two stellar radii from two different equations:

$$M_d = (R_1/D) \tag{1}$$

$$L_{bol} = 4\pi {R_2}^2 \sigma T_{eff}^4 \tag{2}$$

where M_d is the proportionality factor used to fit the model to the observations, D is the distance and σ is the Stephan-Boltzmann constant.

From R_1 and R_2, VOSA provides also stellar masses by applying:

$$g = \frac{GM}{R^2} \tag{3}$$

Since the surface gravities provided by VOSA do not agree with those given in the paper, we do not expect consistent masses either. In any case, we performed for the masses the same analysis as for the radii and will derive proper masses from the HR diagram.

- BT-Settl (Figs. 6 and 7)

  Mean(Radius(LH17) - Radius1(VOSA)) = -0.007; std = 0.033

  Mean(Radius(LH17) - Radius2(VOSA)) = -0.003; std = 0.032

  Mean(Mass(LH17) - Mass1(VOSA)) = -0.76; std= 1.59

  Mean(Mass(LH17) - Mass2(VOSA) = -0.74; std = 1.56

- BT-Settl CIFIST (Figs. 8 and 9)

  Mean(Radius(LH17) - Radius1(VOSA)) = -0.003; std = 0.035

  Mean(Radius(LH17) - Radius2(VOSA)) = -0.002; std = 0.036

  Mean(Mass(LH17) - Mass1(VOSA)) = -1.69; std = 1.56

  Mean(Mass(LH17) - Mass2(VOSA) = -1.68; std = 1.56

There are not significant differences between the radii derived using BT-Settl or BT-Settl CIFIST models. Similar radii are obtained from Eqs. 1 and 2 and both are in very good agreement with the values derived by LH17.

On the contrary, masses are not consistent with the masses expected for cool dwarfs and, hence, do not agree with those given in the paper, as expected from the $\log g$ values obtained with VOSA.

- Masses from HRD
  - BT-Settl (Fig. 10)
    Mean($Mass$(LH17) − Mass(VOSA)) = 0.07; std = 0.06

    Two K dwarfs lie outside the area covered by the isochrone. With a few exceptions, we found good agreement between values for the thirteen remaining dwarfs.
  - BT-Settl CIFIST (Fig. 11)
    Mean($Mass$(LH17) − Mass(VOSA)) = 0.08; std = 0.08

    In this case, only one K dwarf lies outside the area covered by the isochrone. The agreement with the masses in LH17 is worse using BHAC isochrones.

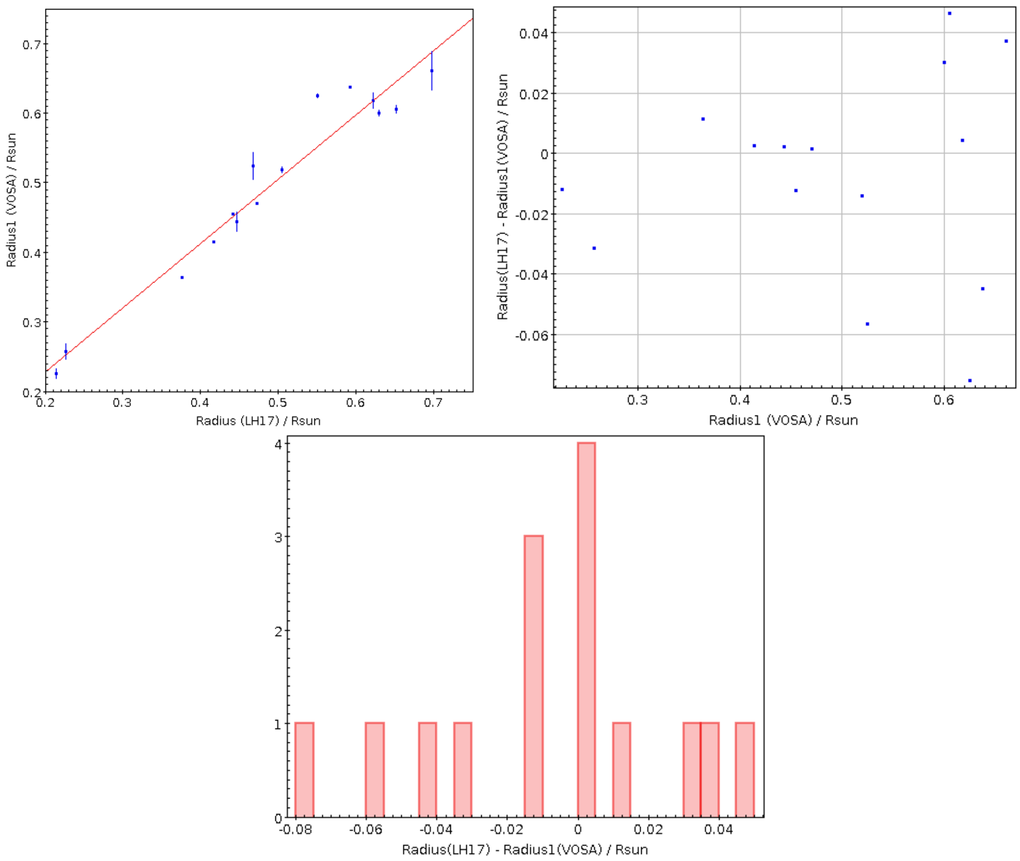

Figure 6: Radii using BT-Settl. Correlation coefficient $r = 0.97$. Similar plots are obtained for the radii derived from Eq. 2.

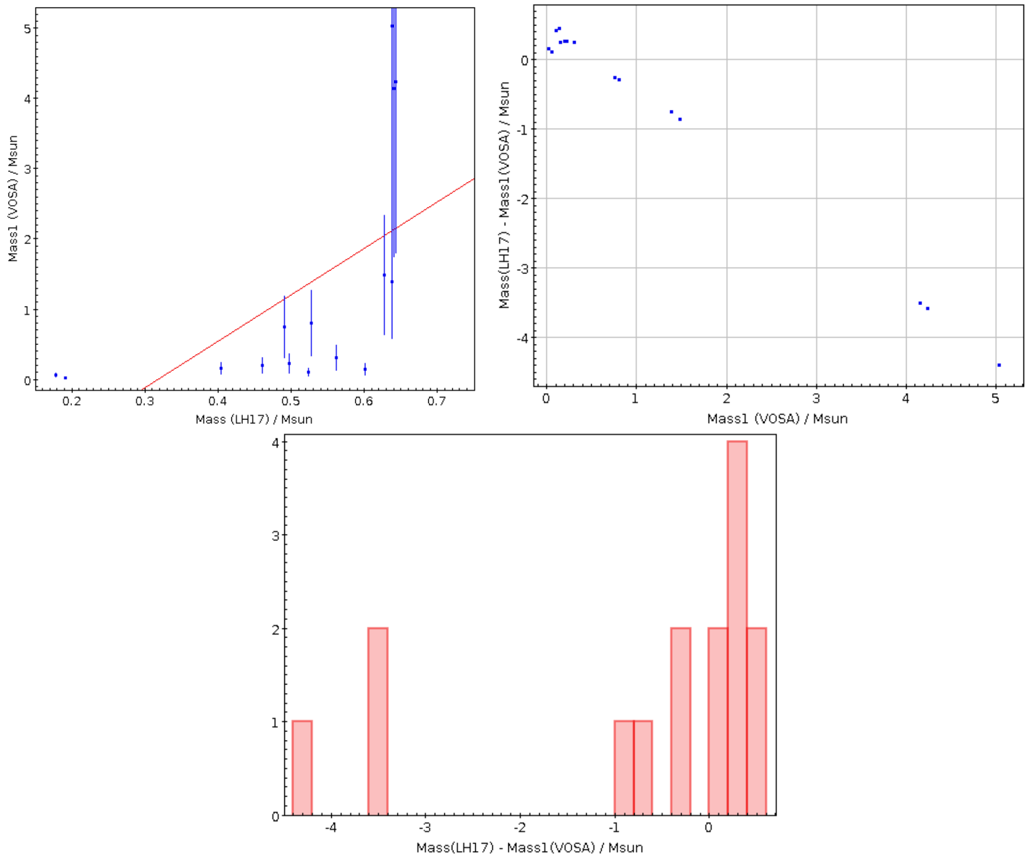

Figure 7: Masses using BT-Settl. Correlation coefficient $r = 0.58$. Similar plots are obtained for the masses derived from the radii calculated using Eq. 2.

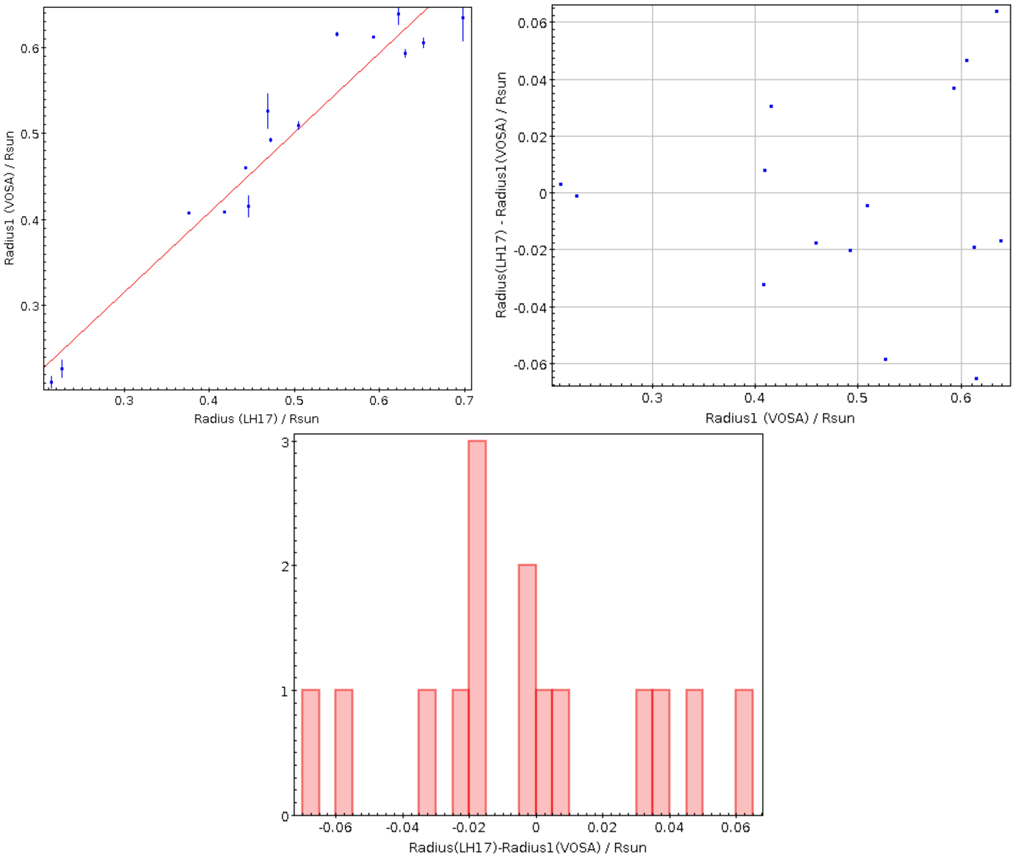

Figure 8: Radii using BT-Settl CIFIST. Correlation coefficient $r = 0.97$. Similar plots are obtained for the radii derived from Eq. 2.

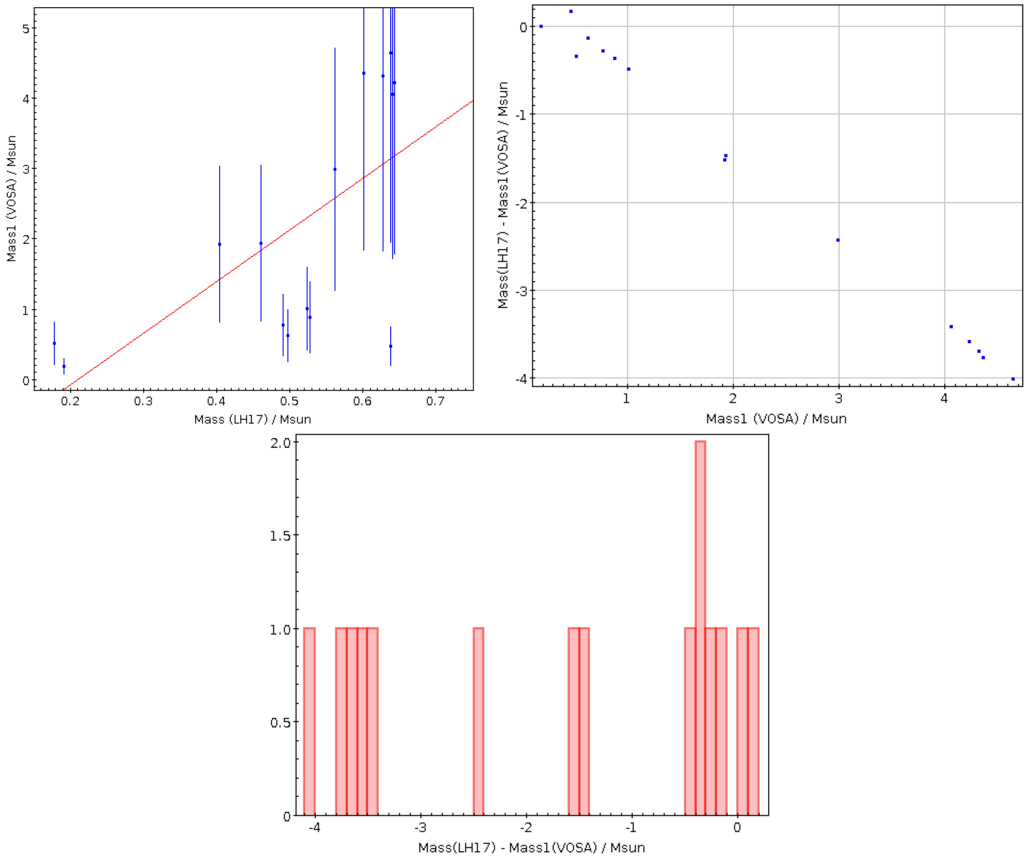

Figure 9: Masses using BT-Settl CIFIST. Correlation coefficient $r = 0.65$. Similar plots are obtained for the masses derived from the radii calculated using Eq. 2.

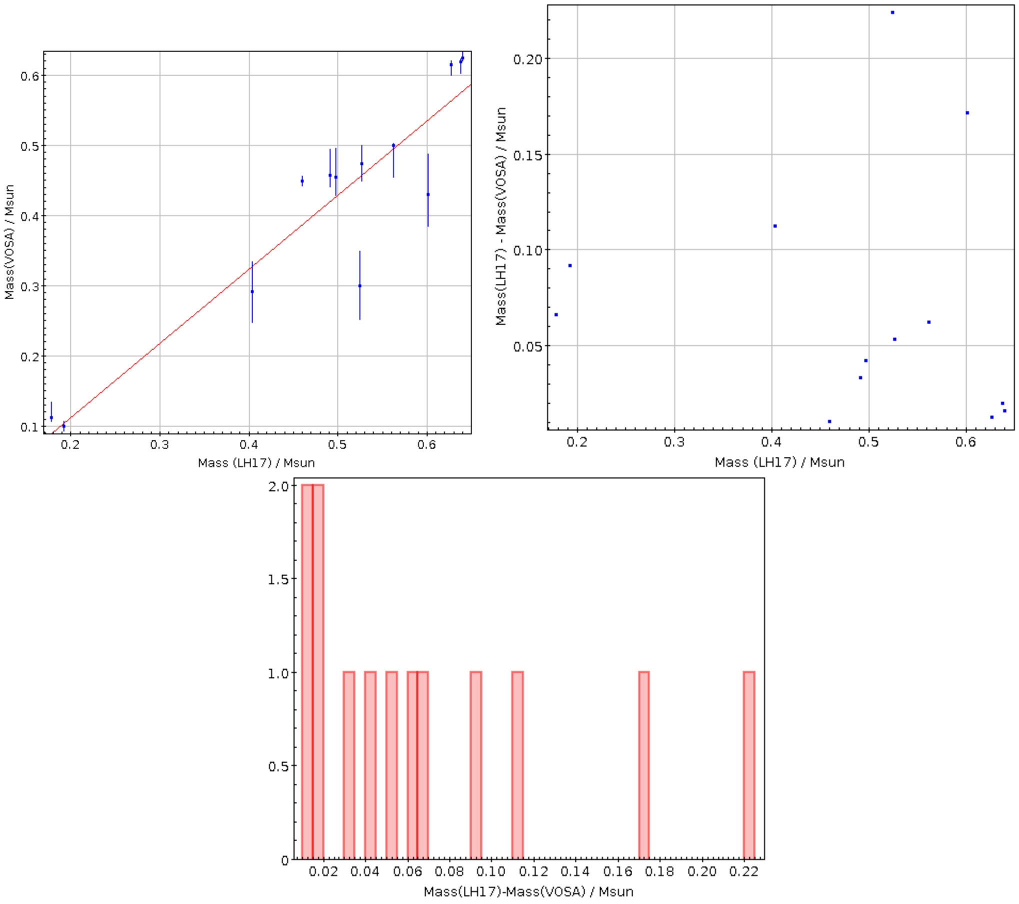

Figure 10: Masses using BT-Settl isochrones. Correlation coefficient $r = 0.93$.

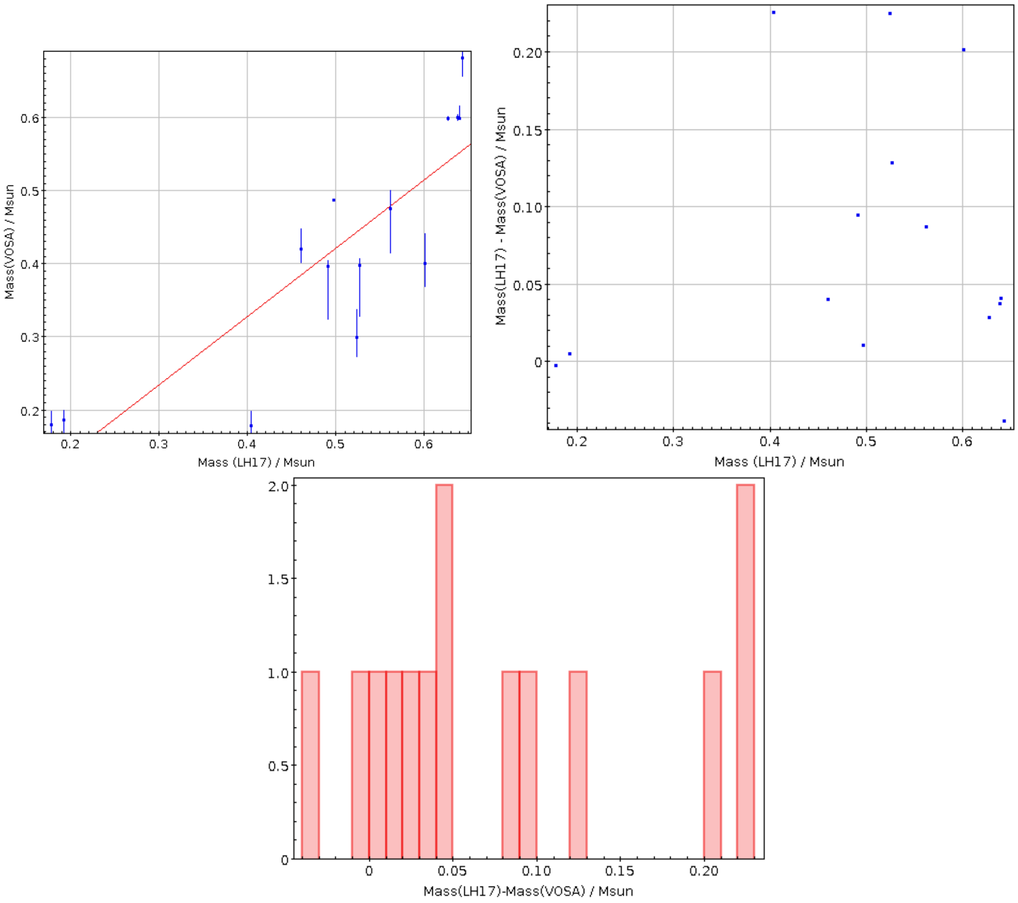

Figure 11: Masses using BHAC isochrones. Correlation coefficient $r = 0.85$.