

## APPENDIX A: NOTES ON INDIVIDUAL CLUSTERS

### RSGC 1

This cluster has by far the highest reddening and the widest potential MS of all investigated objects. Compared to Froebrich (2013) there is a clear indication of the MS in our decontaminated PSF photometry at  $J - K$  colours between 3 and 4 mag. The potential MS corresponds to a  $K$ -band extinction of 2.3 mag. The scatter across the MS, which can be attributed to differential reddening is  $\Delta A_K = 0.75$  mag. This is clearly the largest differential reddening for all investigated clusters. The colour-colour plot of the high probability members indicates that a small fraction of the identified potential MS stars might be background giants, since not all of those stars are situated at the bottom of the reddening band. However, the vast majority of the MS stars are candidate late O or B-type stars based on their NIR colours and magnitudes. The slight offset from the bottom of the reddening band might be due to the photometric calibration or a lightly different reddening law in this field. The top of the MS has an apparent magnitude of about  $K = 10.5$  mag, or an absolute brightness of  $M_K = -5.9$  mag, assuming a distance of 6 kpc and considering the extinction. The total number of stars more massive than  $8 M_\odot$  is twice as large as for RSGC 2 and 3.

### RSGC 2

This is the only RSG cluster with a previously detected MS. Froebrich (2013) identified it in UKIDSS GPS data and the catalogues using aperture photometry. It hence is a good test case to investigate if our PSF photometry results in any systematic changes. In Froebrich (2013) the MS was detected at  $J - K = 1.5$  mag. With the newly obtained PSF photometry, the MS candidate stars are in exactly the same place. Furthermore, regions in the colour-magnitude diagram with enhanced membership probability but not obviously related to the cluster, as found in Froebrich (2013), have almost completely disappeared. This is most likely due to our better, cleaner photometry. All the high probability MS members are associated with the bottom of the reddening band and are thus candidate OB stars. The MS is much narrower with a maximum differential reddening of only 0.25 mag in the  $K$ -band at an extinction of about  $A_K = 1$  mag. The top end of the MS is almost identical to RSGC 1 and an apparent  $K = 10.0$  mag and  $M_K = -5.0$  mag at the same assumed distance of 6 kpc.

### RSGC 3

Of the three main RSG clusters investigated here, RSGC 3 shows the weakest sign of potential MS members. No indication of any MS stars has been found in the aperture photometry in UKIDSS GPS data by Froebrich (2013). Using PSF photometry a number of potential MS stars is revealed at  $J - K = 2$  mag. The width of the MS or the differential extinction is similar to RSGC 2, i.e. just 0.25 mag in the  $K$ -band. The colour-colour diagram shows that the majority of the high probability MS members are indeed at the bottom of the reddening band, and thus candidate OB-type stars.

However, a fraction of them is situated above the bottom of the reddening band and could thus be background giants with similar colours as the potential MS stars. The top of the MS is the faintest of the three bright RSG clusters. After the correction for distance and extinction the brightest detected MS members have an absolute brightness of  $M_K = -3.6$  mag, which is in agreement with the estimated age of about 20 Myrs (Clark et al. 2009; Alexander et al. 2009), making it the oldest, most evolved cluster investigated.

### RSGC 4 and RSGC 5

We investigated both of these objects, but we could not identify any significant overdensity within the field of  $10'$  around the cluster coordinates. No features resembling a sequence or clump of potential cluster members is present. These clusters are hence either too extended (i.e. they are larger scale associations) or there are too few MS members for them to be reliably identified as colour-magnitude overdensity with our method. This is evident when one considers that both clusters are close to one of the known, well populated RSGCs. The object RSGC 4 is  $16'$  away from RSGC 1 (Negueruela et al. 2010) and RSGC 5 is within  $14'$  of RSGC 3 (Negueruela et al. 2011). Both have a smaller number of confirmed RSGs (8 and 5 confirmed members, respectively) than the larger clusters and are embedded in more extended complexes/associations of massive stars. It might hence be difficult to confirm any potential overdensity of the MS stars in these cases.

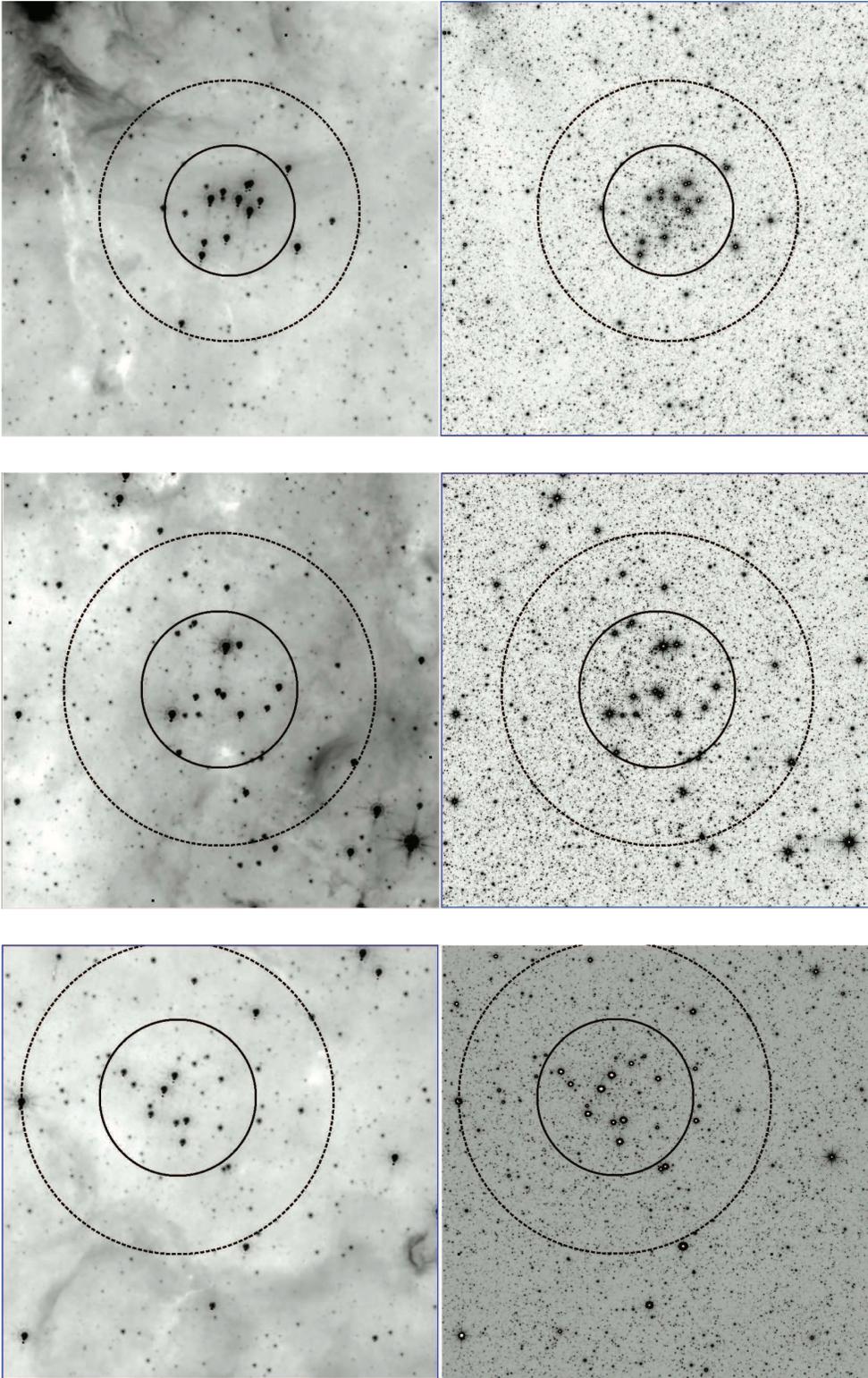
### Candidate F 3

This is the brightest (largest number of potential RSG stars) of the candidate clusters in Froebrich (2013). The aperture photometry indicated an overdensity of potential members at  $J - K = 2.2$  mag. Our reanalysis of the GPS data with PSF photometry verifies this feature. However, the colour-colour plot indicates that the vast majority of these stars have colours indicative of giants. Most of them are located near the top of the reddening band. Only a small fraction of these potential MS stars have colours in agreement with them being on the MS. Thus, while we cannot completely rule out that F 3 is not a cluster of stars, it seems very unlikely. The most probable explanation of this object is that we see red giants through a hole in the molecular cloud.

### Candidate F 4

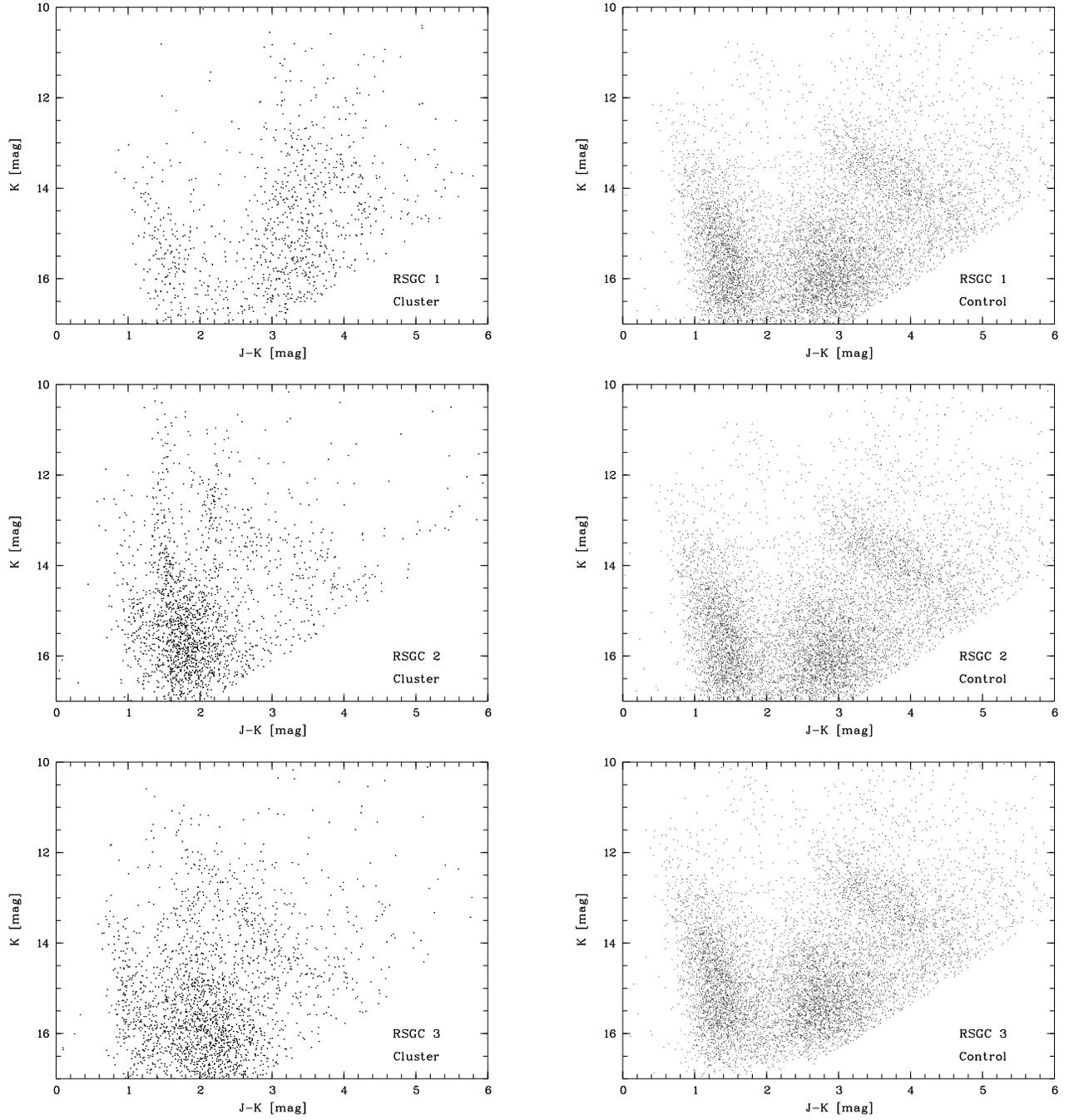
This is another of the cluster candidates from Froebrich (2013). It already showed a sequence of stars at  $J - K = 2.5$  mag in the aperture photometry data, and this is confirmed in the PSF photometry. All the stars in this clump have colours in agreement of them being giants. Hence the interpretation for this object is the same as for candidate F 3; we see giants through a hole in a molecular cloud.

**APPENDIX B: CLUSTER IMAGES**



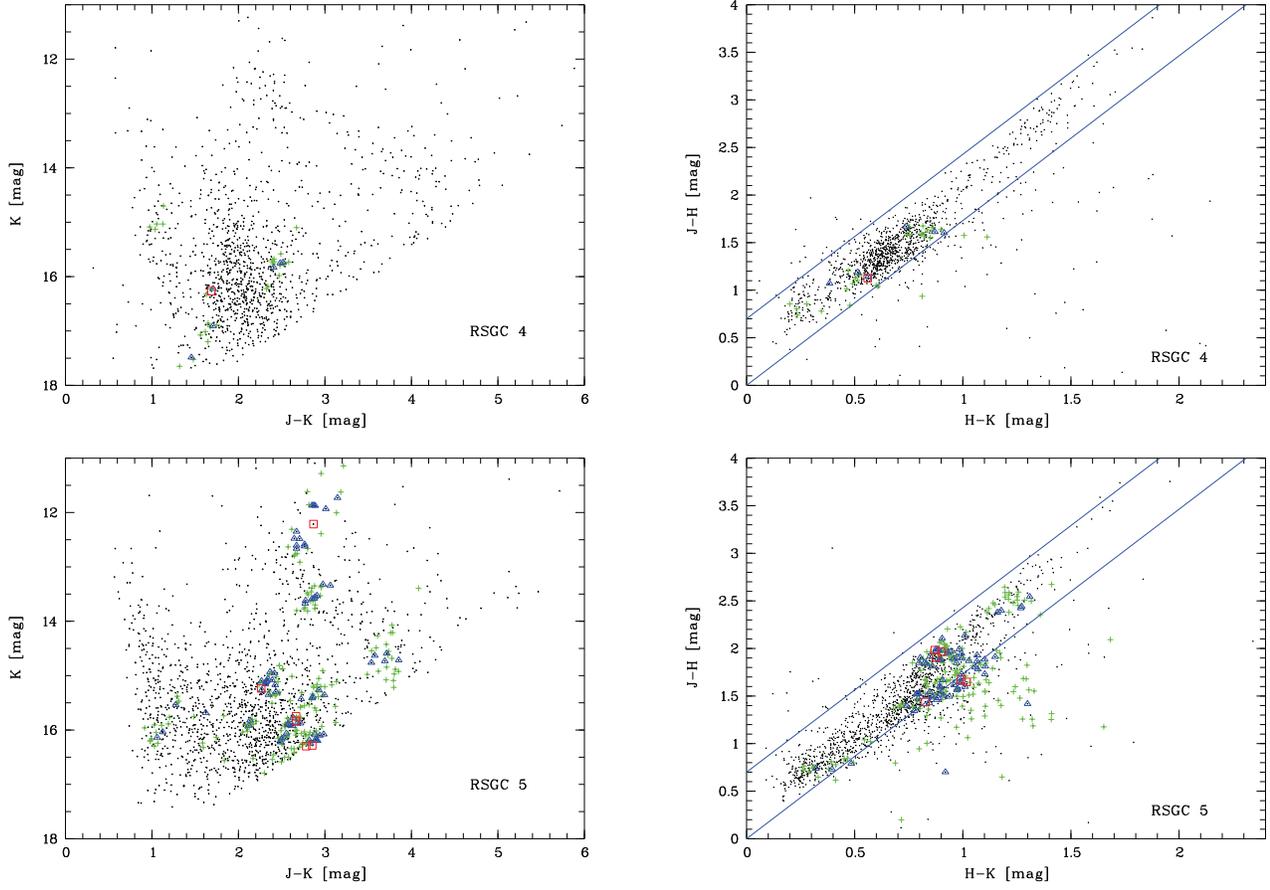
**Figure B1.** Large scale images of the regions around RSGC 1 (top), RSGC 2 (middle) and RSGC 3 (bottom). The left hand side images show the Glimpse  $8\mu\text{m}$  image and the right hand side panels the UKIDSS GPS  $K$ -band image. All images are  $10' \times 10'$  in size and North is to the top. The small solid circles indicate the cluster region with the radii listed in Table 2. As control fields we used all stars outside the dashed circle (twice the radius of the cluster region) but within the  $10' \times 10'$  sized images.

**APPENDIX C: CLUSTER AND CONTROL  
FIELDS**

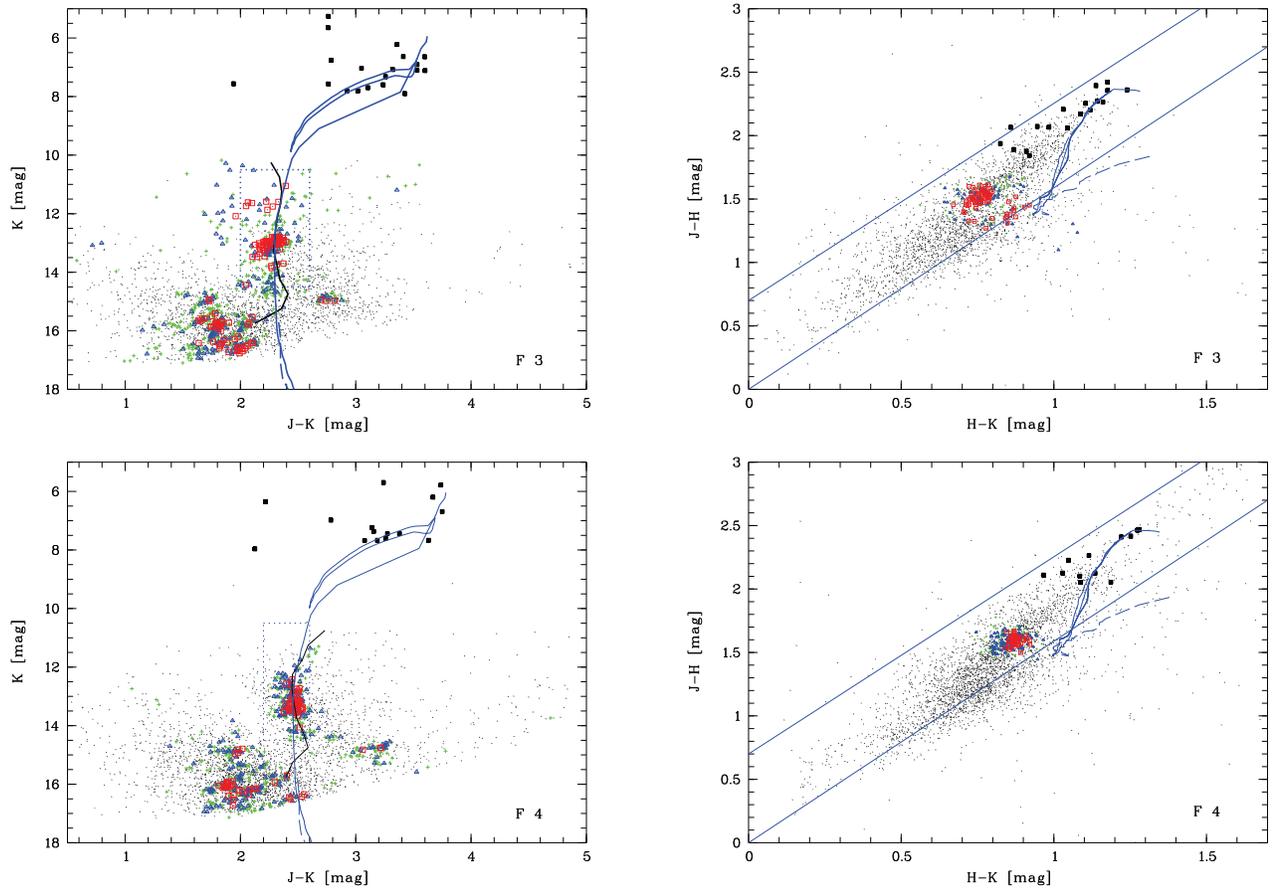


**Figure C1.** Comparison of the  $J-K$  vs.  $K$  colour-magnitude diagrams for RSGC 1 (top), RSGC 2 (middle) and RSGC 3 (bottom). The left panel shows the cluster fields and the right panel the control fields. Note that the control fields cover a larger area and thus contain a significantly higher number of stars.

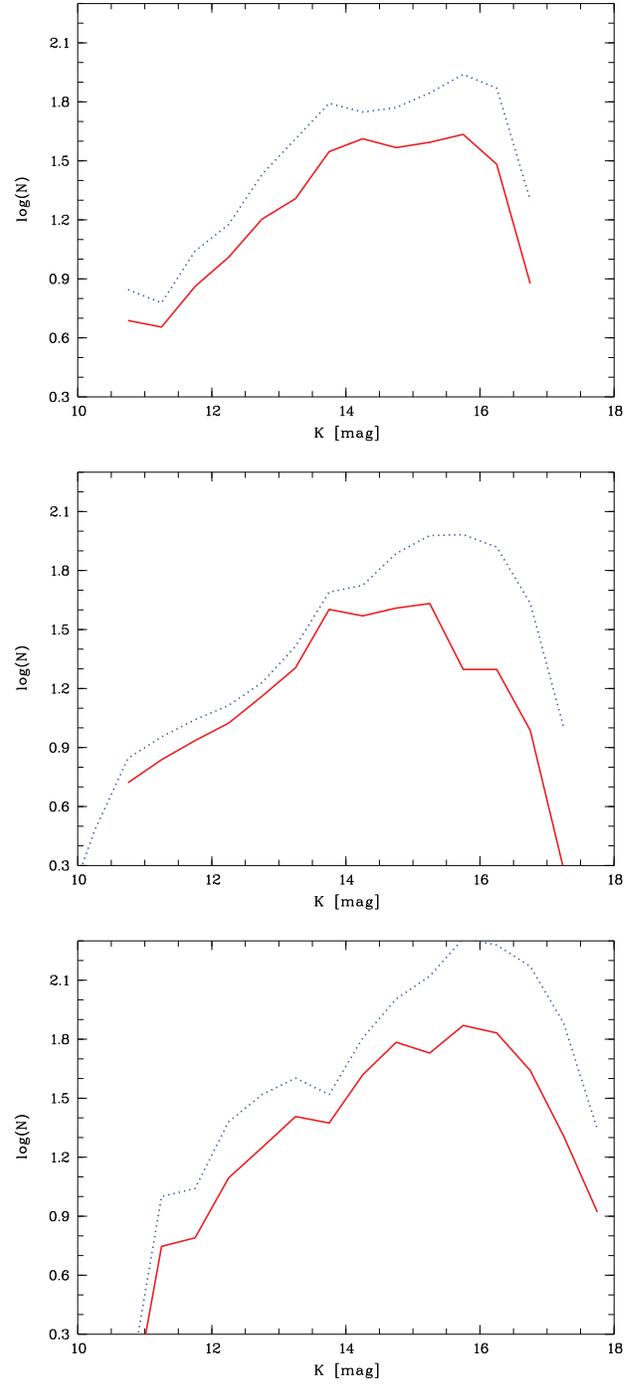




**Figure D1.** Similar to Fig. 1 but for the clusters RSGC 4 (top) and RSGC 5 (bottom). We do not detect any sequence of stars that resembles a main sequence, thus no isochrone is overplotted. The reddening band is based on the extinction law by Indebetouw et al. (2005).



**Figure D2.** As Fig. 1 but for the cluster candidates F 3 (top) and F 4 (bottom) from Froebrich (2013). One can clearly see that the colours of the high probability members are not in agreement with main sequence stars. The reddening band is based on the extinction law by Mathis (1990), since the Indebetouw et al. (2005) law seems too steep for these fields.

APPENDIX E: *K*-BAND LUMINOSITY FUNCTIONS

**Figure E1.** Histograms of the *K*-band brightness distribution of the cluster members for RSGC 1 (top), RSGC 2 (middle) and RSGC 3 (bottom). The dotted line shows the total number of stars along the main sequence, selected from *J-K* colours, and the solid line uses the cluster membership of each star as a weight.