The clustering of massive galaxies at $z < 2$

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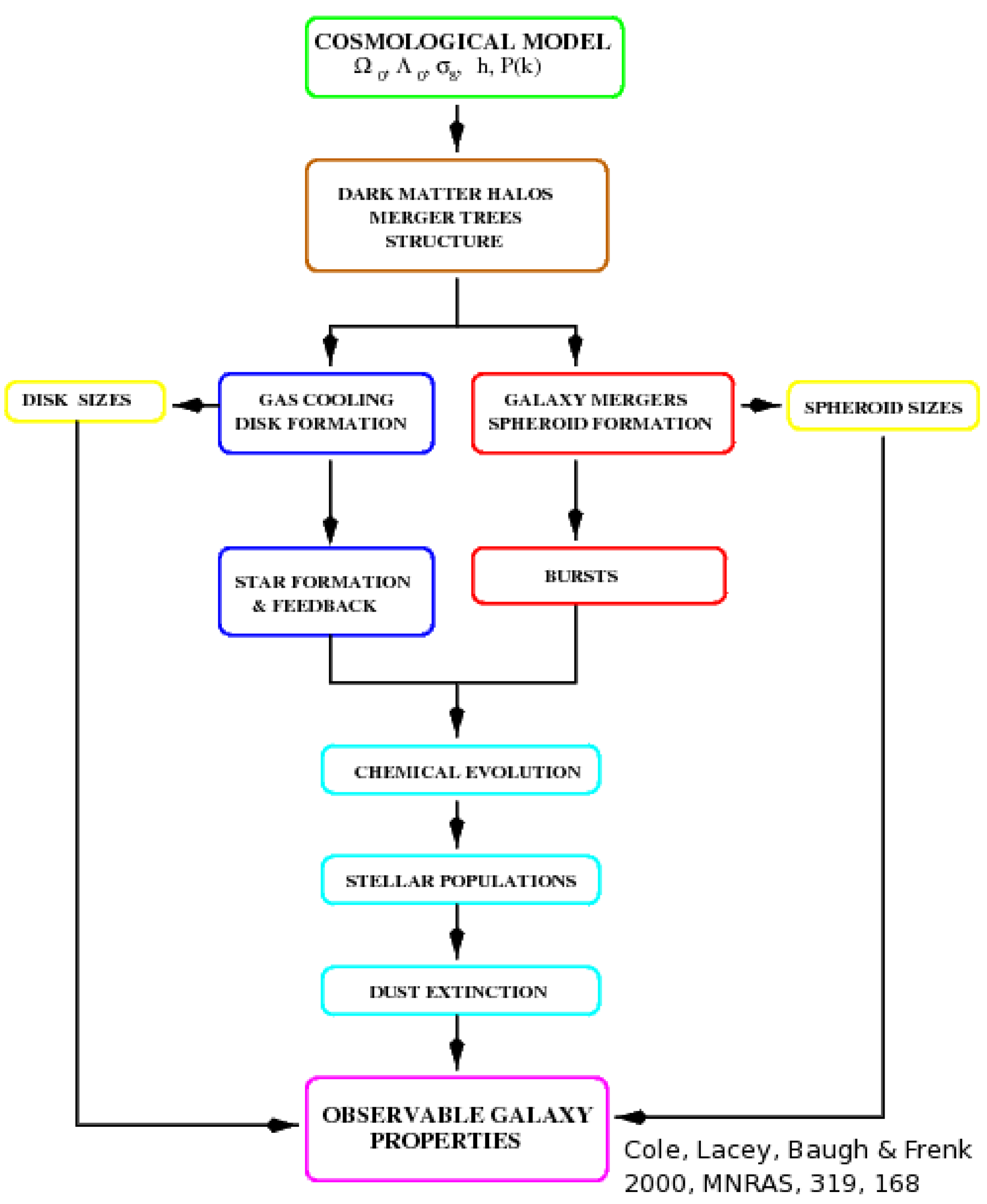
Abstract

Using the semi-analytical model of galaxy formation developed in Durham, GALFORM, we have studied the clustering of Extremely Red Objects and mass selected samples at z<2. For the first part of this work we find an angular correlation function that agrees with observations from UKIDSS, one of the largest and deepest near-infrared surveys. In the second part we find the surprising result that, although semi-analytical models predict that clustering does not change with luminosity, the variation of the predicted clustering with stellar mass is clear. Splitting the mass selected sample of galaxies at $z < 2$ into blue and red, we find that the correlation length of red galaxies stays rather flat with redshift, while that for blue galaxies tend to increase with redshift, a result in qualitative agreement with observations.

GALFORM, the model

We study the predictions of GALFORM, a Semi-Analytical Model of galaxy formation based on a ΛCDM cosmology. This is how it works:



Here we use the GALFORM development by:

	Bower et al. 2006
Ω_0	0.25
Λ_0	0.75
Ω_b	0.045
σ_8	0.90
h	0.73
DM halo merger trees	N-body
Quenching of star formation	AGN feedback
Dynamical scale for quiescent star formation	Dependent on time
Bursts triggered by	Mergers and disk instabilities
Burst IMF	Kennicut 1998

No parameters have been re-tuned here!!

References

[1] Bower et al., 2006, MNRAS, 370, 645.
[2] Cole et al., 2000, MNRAS, 319, 168.
[3] Gonzalez-Perez et al., 2009, MNRAS, 398, 497.
[4] Gonzalez-Perez et al., 2011, MNRAS, in press.

Massive, red galaxies at $z \sim 1$: EROs (Extremely Red Objects)

EROs are galaxies at $z \sim 1$, selected by their red optical-NIR colours. Their nature can pose a challenge to hierarchical models. In Gonzalez-Perez et al. (2009) we showed that **the Bower et al. model** reproduces the number counts of EROs – this is remarkable given that semi-analytical models had previously underestimated the counts by an order of magnitude. Below we show how this model also **reproduces the observed angular clustering of EROs**.

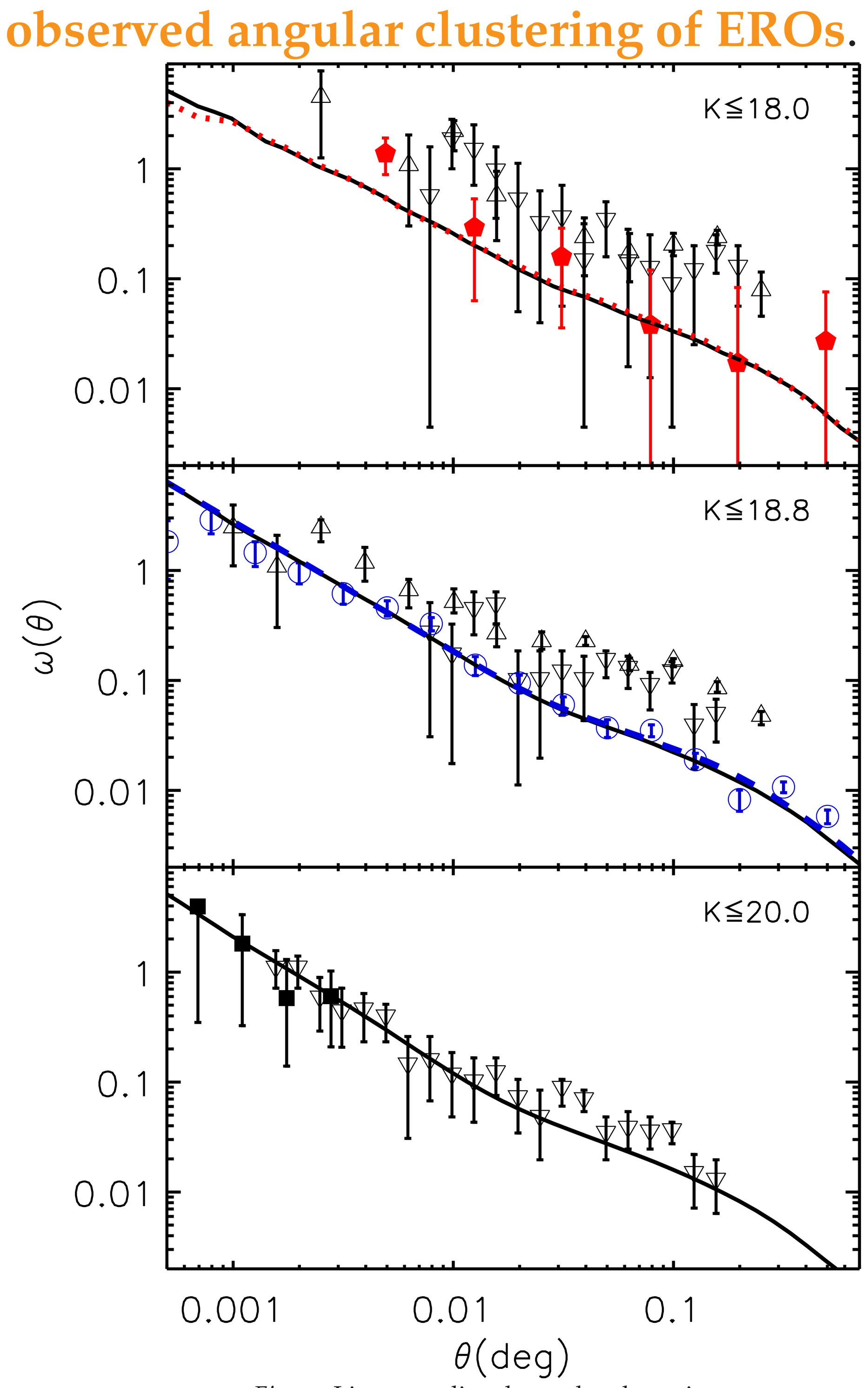
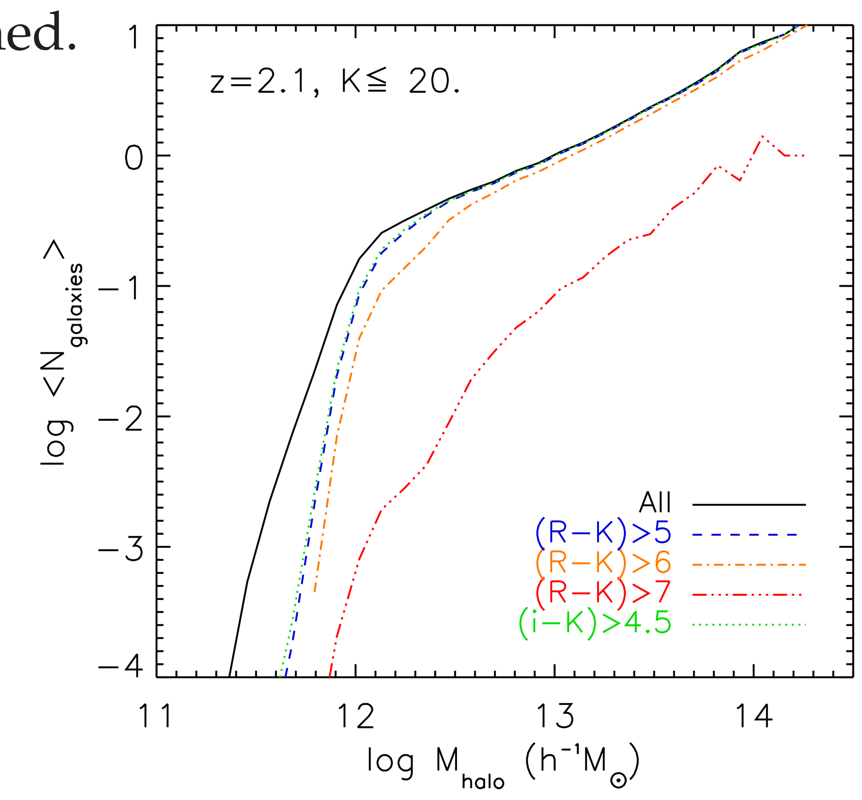


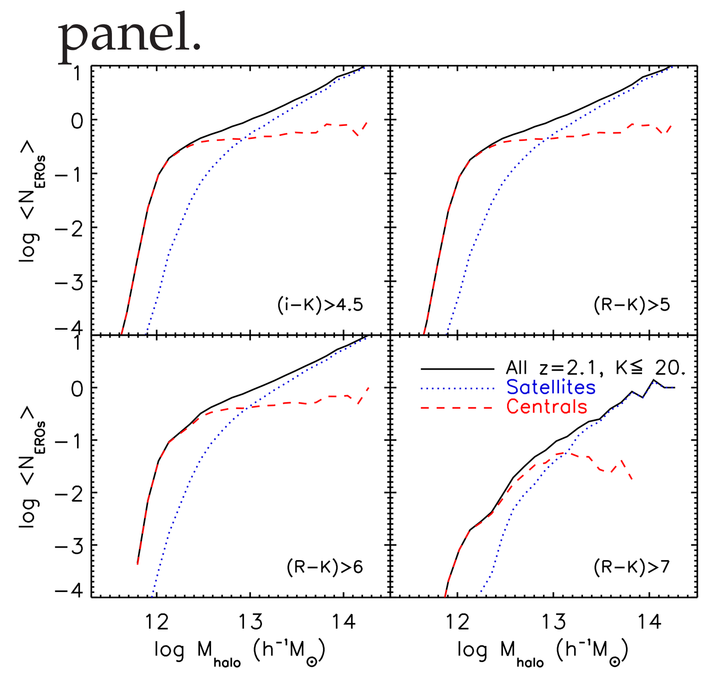
Figure: Lines: predicted angular clustering. Symbols: Observations from different surveys.

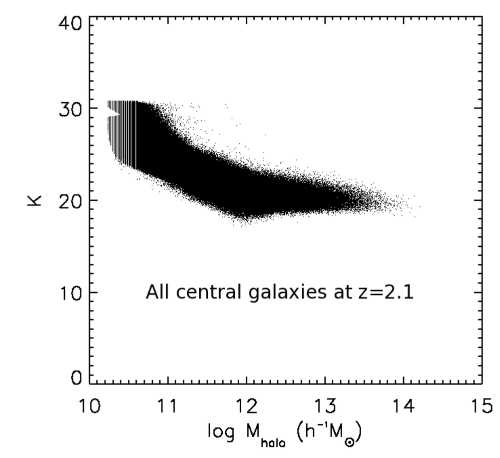
See Gonzalez-Perez et al. (2011) for further details.

Below we show that the predicted Halo Occupation Distribution (HOD) for both K-selected galaxies and EROs is different from that typically assumed.



Below, in the left panel, we can see that the above difference is a consequence of the HOD of central galaxies not reaching unity. In turn, this is a direct consequence of AGN feedback, which changes the slope and scatter of the luminosity - host halo mass relationship, with the result that in general the brightest galaxy is not in the most massive halo, as can be seen below, in the right panel.

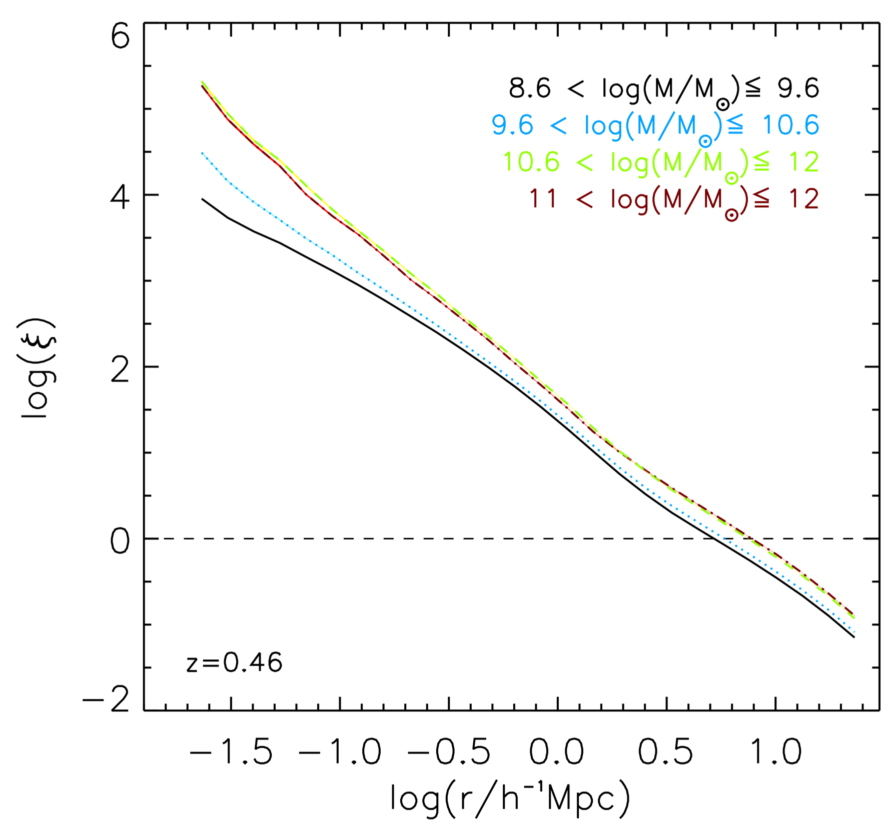




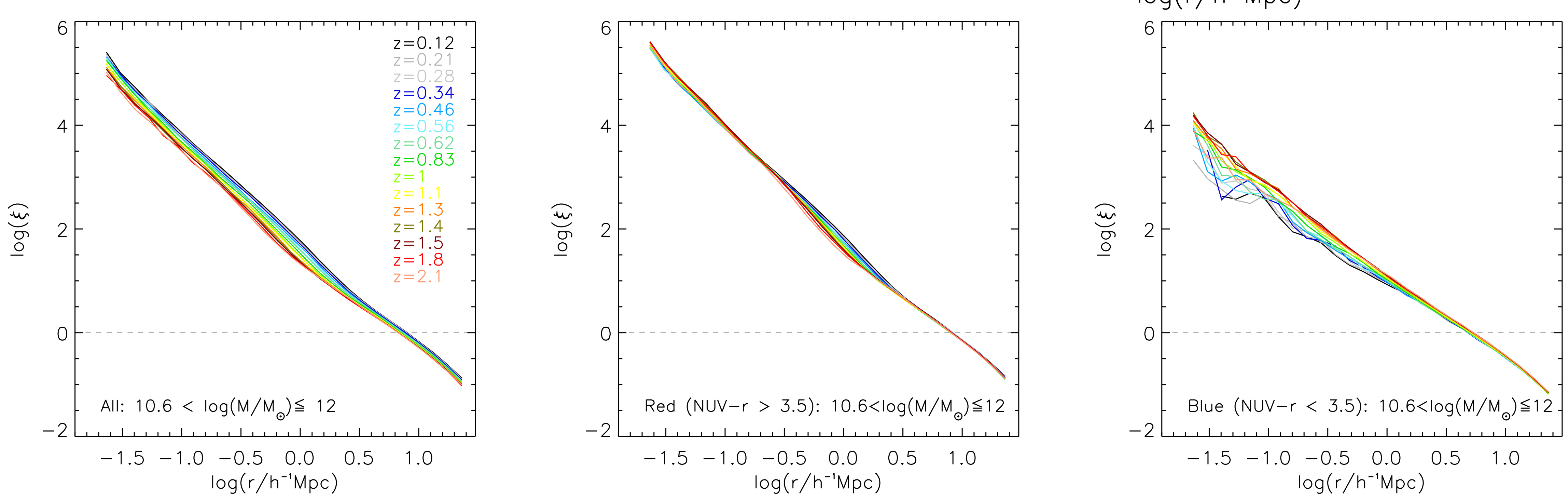
The AGN feedback modifies the HOD!

Mass selected galaxies at $z < 2$ (see also **Rich Bielby**'s poster)

On the right we present the predicted real-space two-point correlation function, ξ, at $z = 0.46$, as a function of comoving separation, for galaxies in 4 mass bins. This plot shows that **there is a weak shift in clustering strength on changing the stellar mass of the sample**. The lack of a distinct monotonic increase in clustering strength with stellar mass is again due to the impact of AGN feedback, which modifies the stellar mass - halo mass relation.



Below we present the predicted ξ at different z for all galaxies within a single mass bin (left) and for those that are red/blue (middle/right).



For all the explored mass bins the two-point correlation function of the whole population is weakly boosted with decreasing z. This is a consequence of galaxies of a certain mass being hosted, in average, by a more massive halo at a lower z. This can be seen in the figure on the right, which shows the mdian values of the host M_{halo} and the 20%, 80% percentiles. For red galaxies the trend is similar but weaker. For blue galaxies, at large scales ξ varies little with z (due to M_{halo} not varying much with z) and at small scales there is not a clear trend with z (the number of satellites do not vary monotonically with z).