Measuring cosmological parameters

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based on: RC & Matt Dailey arXiv:1112.3108

Talk plan:

A study of cosmological parameter measurements published over the period 1990-2010.

(a) How rapidly does precision increase with time?

(b) How accurate were the measurements and their error bars (compared to the 2011 values)?

(c) Lessons for future measurements of w', f_{NL}, …

>1000 measurements of cosmological parameters have been published since 1990. To be included in this compilation we need

(a) Numerical determination + error bar in abstract

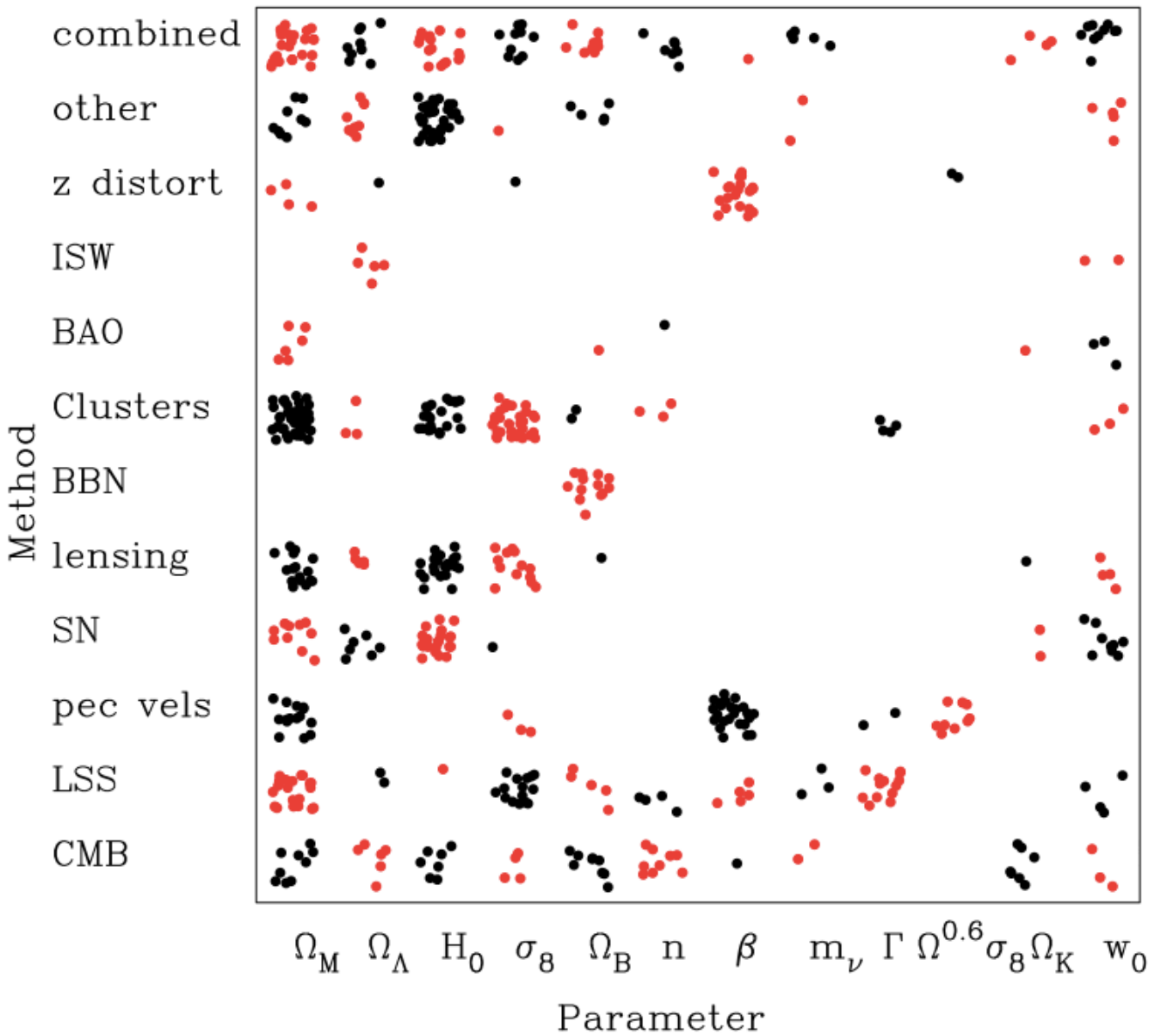
(b) Restricted to 2 journals: ApJ and MNRAS

(c) 12 Parameters: H_0, Ω_M, Ω_Λ, n, σ_8, m_ν, $\Gamma = \Omega h$, $\beta = \Omega^{0.6}/b$, $\eta_8 = \sigma_8 \Omega^{0.6}$, w_0, Ω_B, Ω_K

→ 637 measurements from ADS search

Also, we categorize into 12 techniques e.g., lensing, peculiar velocities, CMB, BAO etc.

Parameters and techniques for the measurements

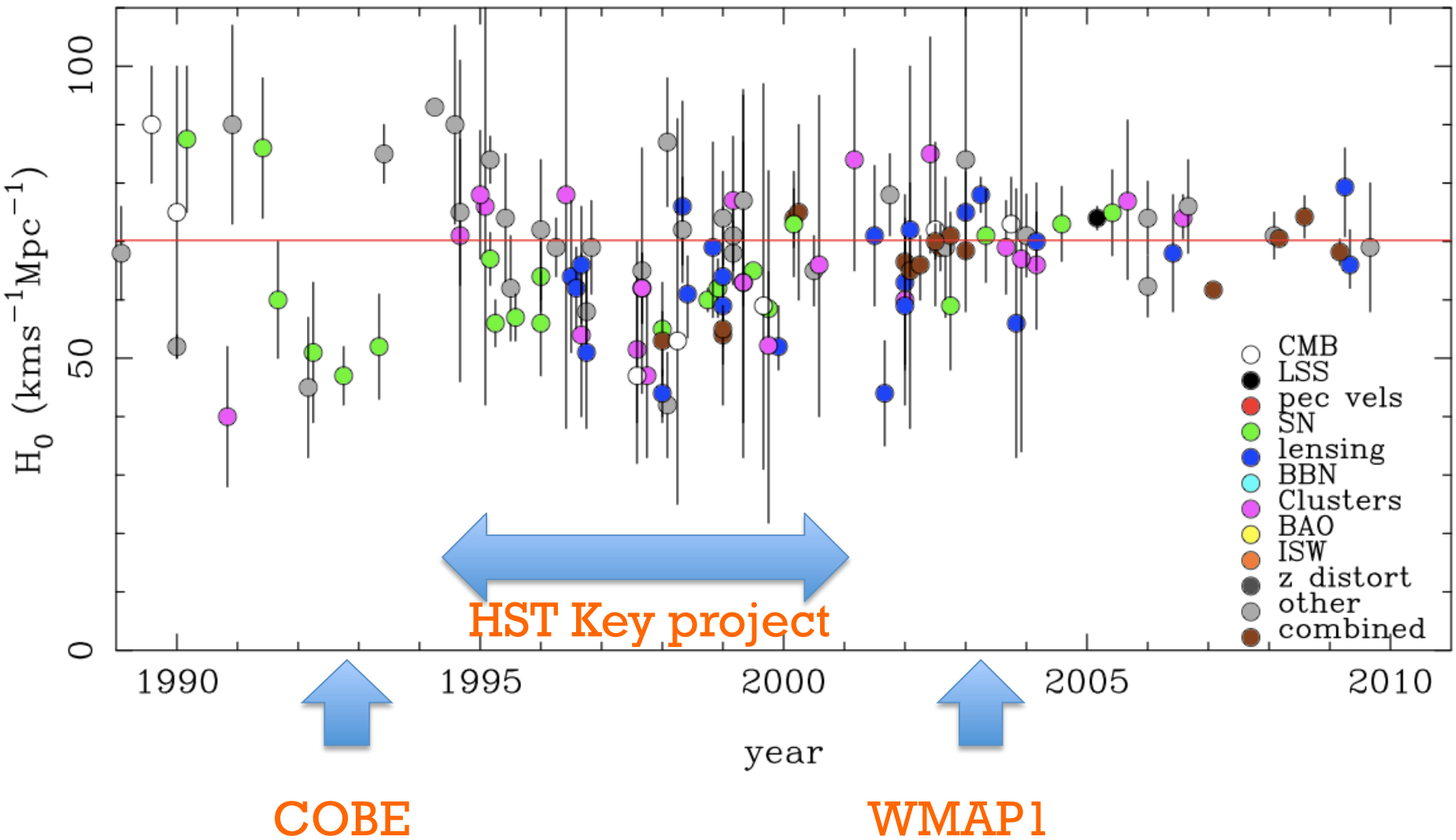


To gauge how accurate these past measurements were, we compare them later to

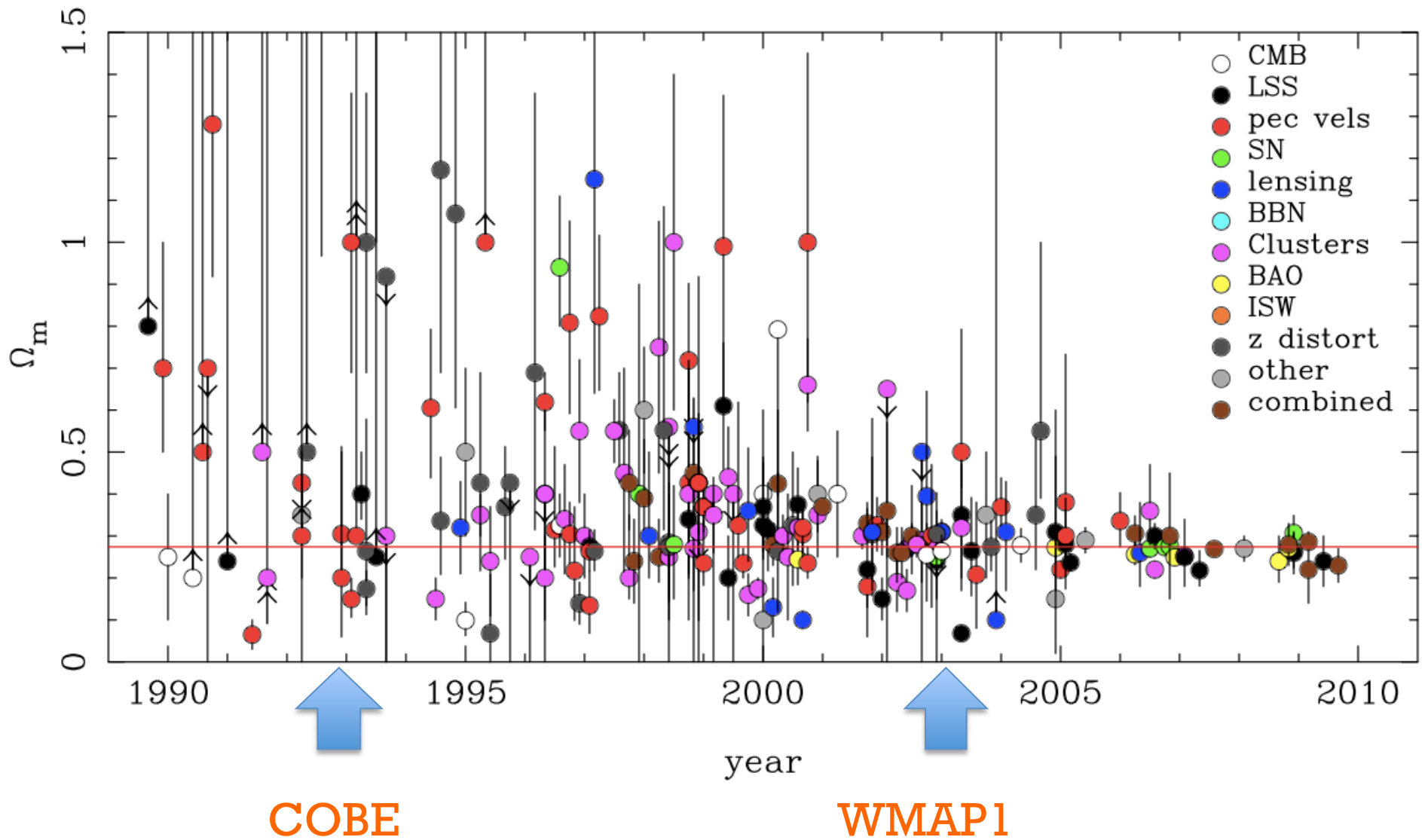
WMAP7 (Komatsu et al 2011)

First some examples of measurements vs year…

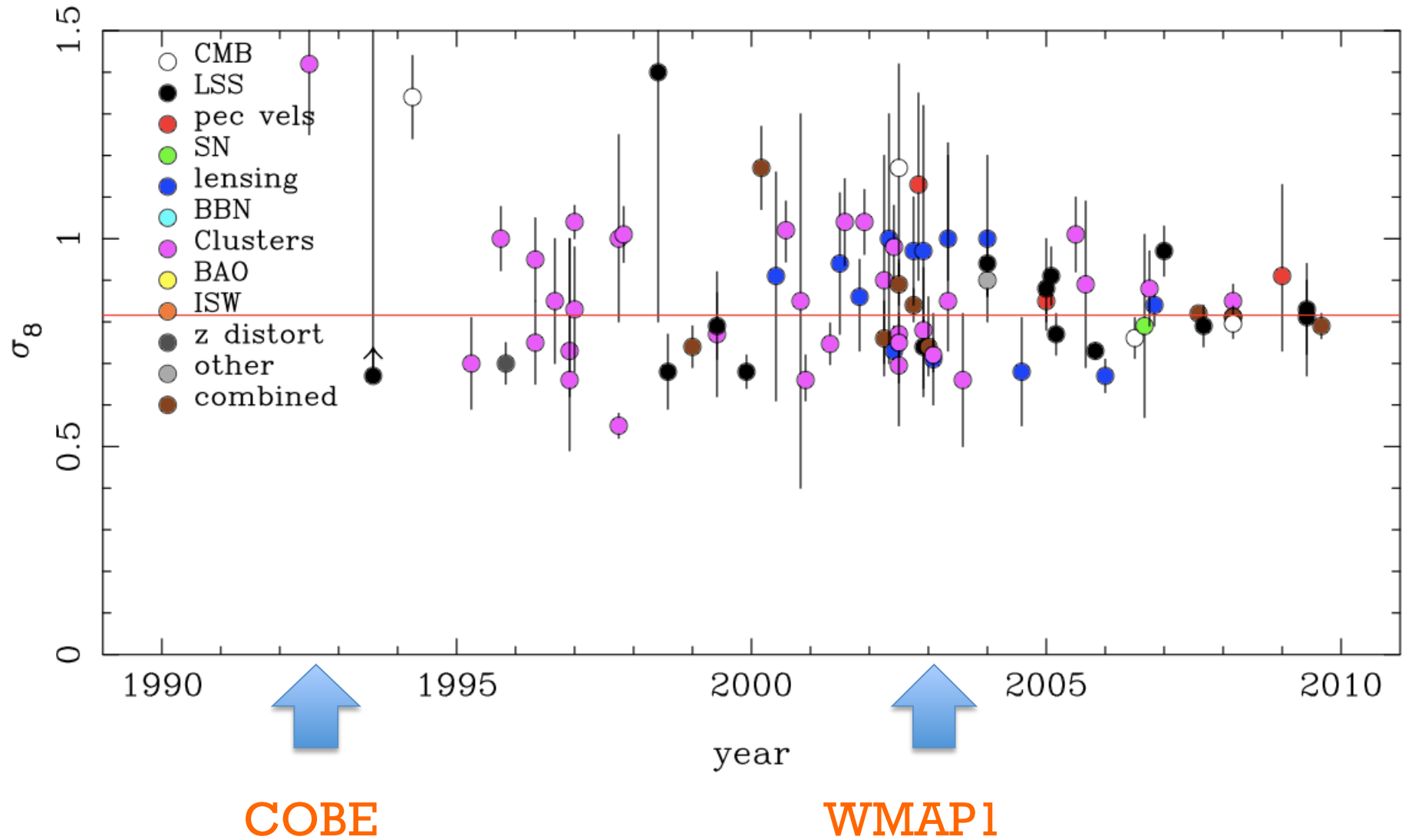
Hubble constant



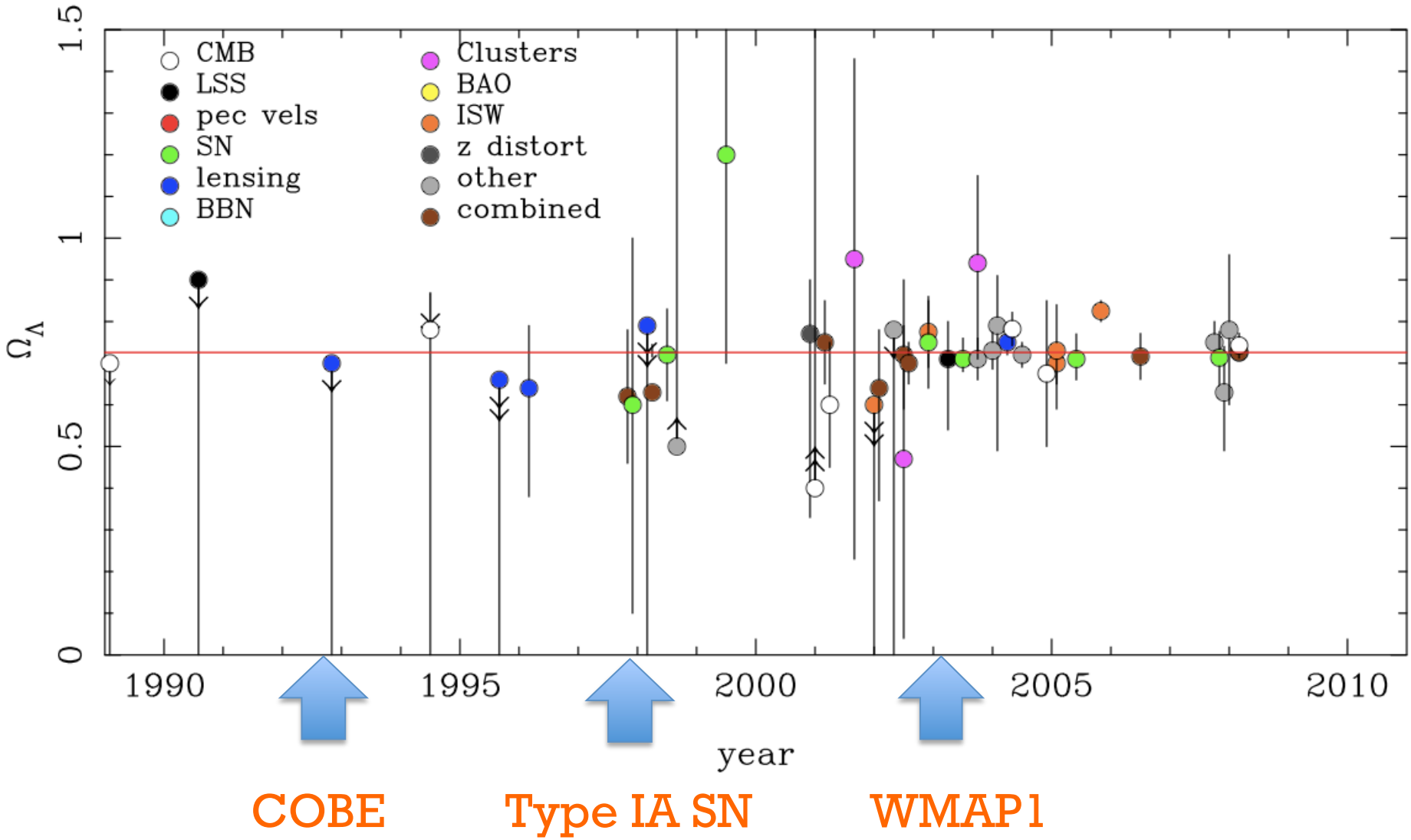
Density parameter



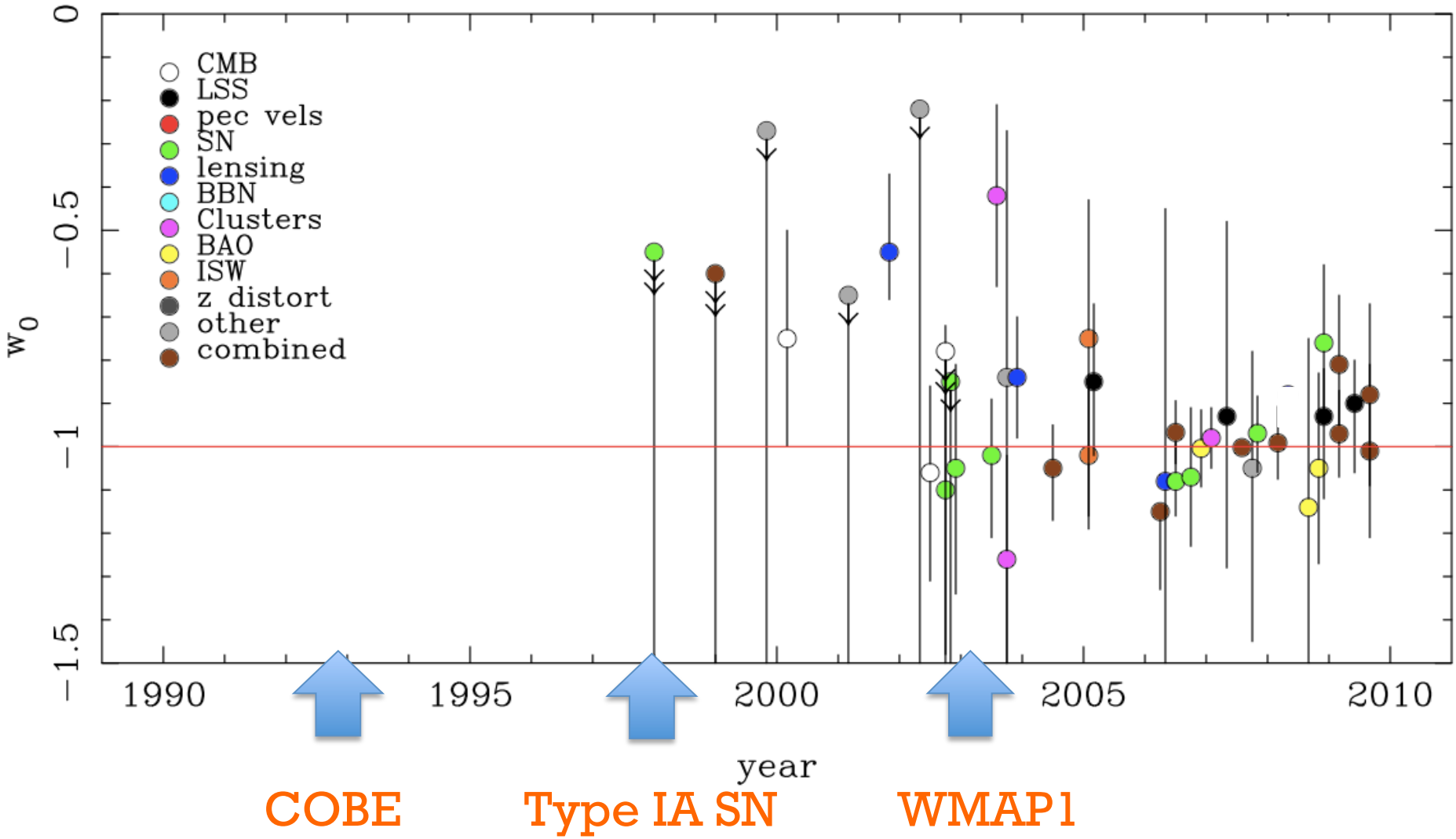
Amplitude of mass fluctuations



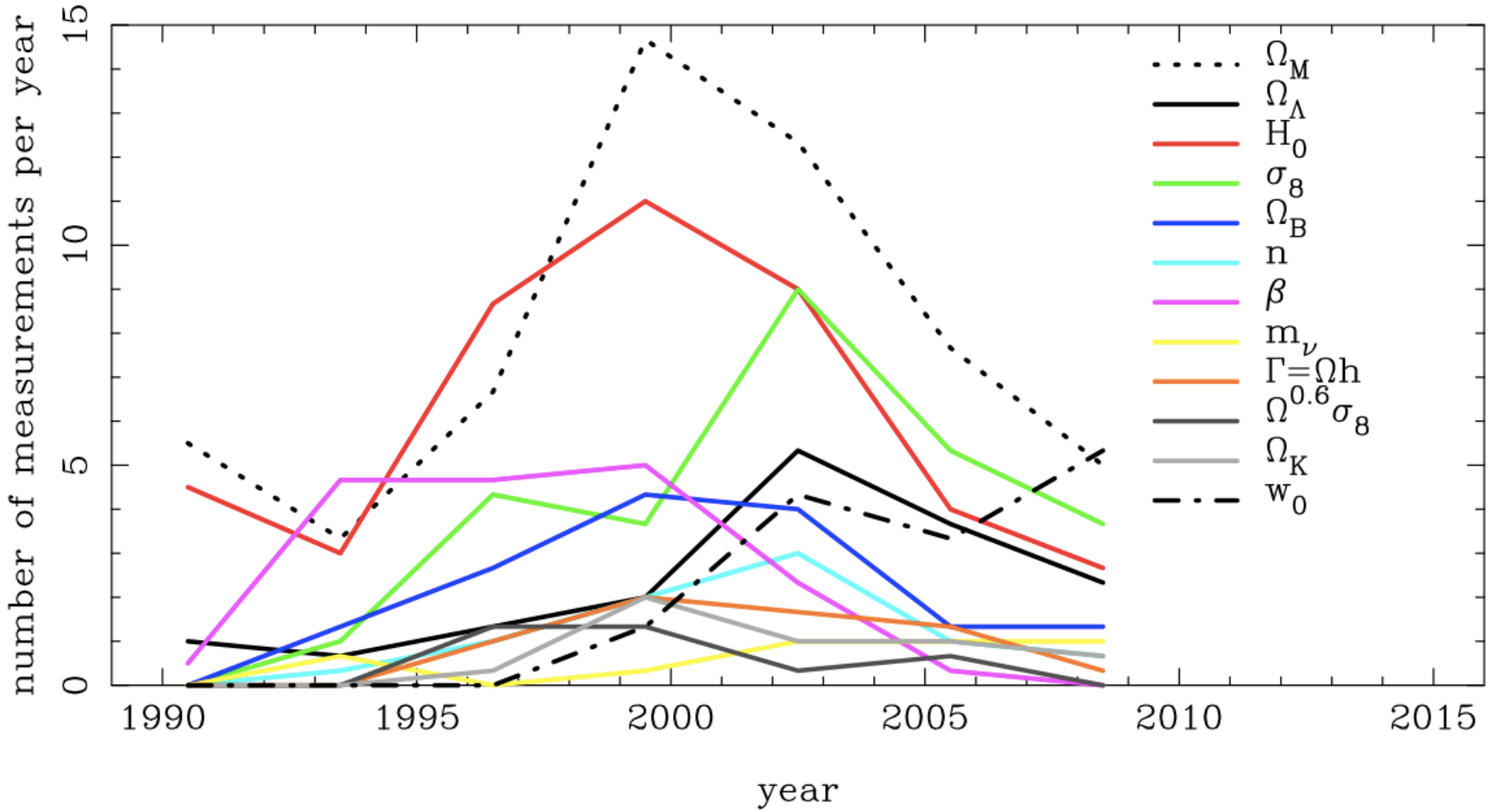
Cosmological constant



Dark energy equation of state parameter

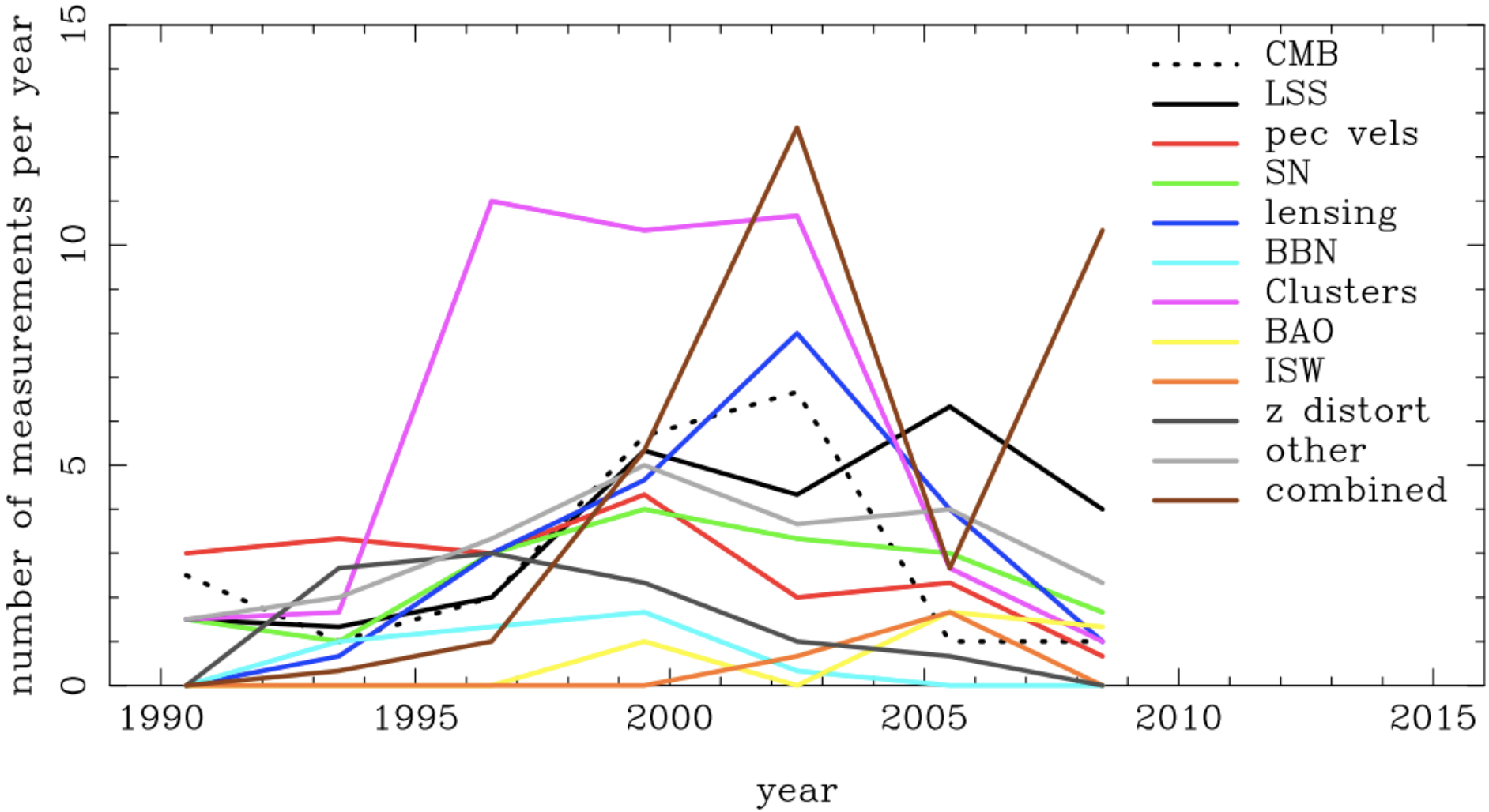


Measurements per year by parameter



Only w0 and ν mass still increasing in measurements per year

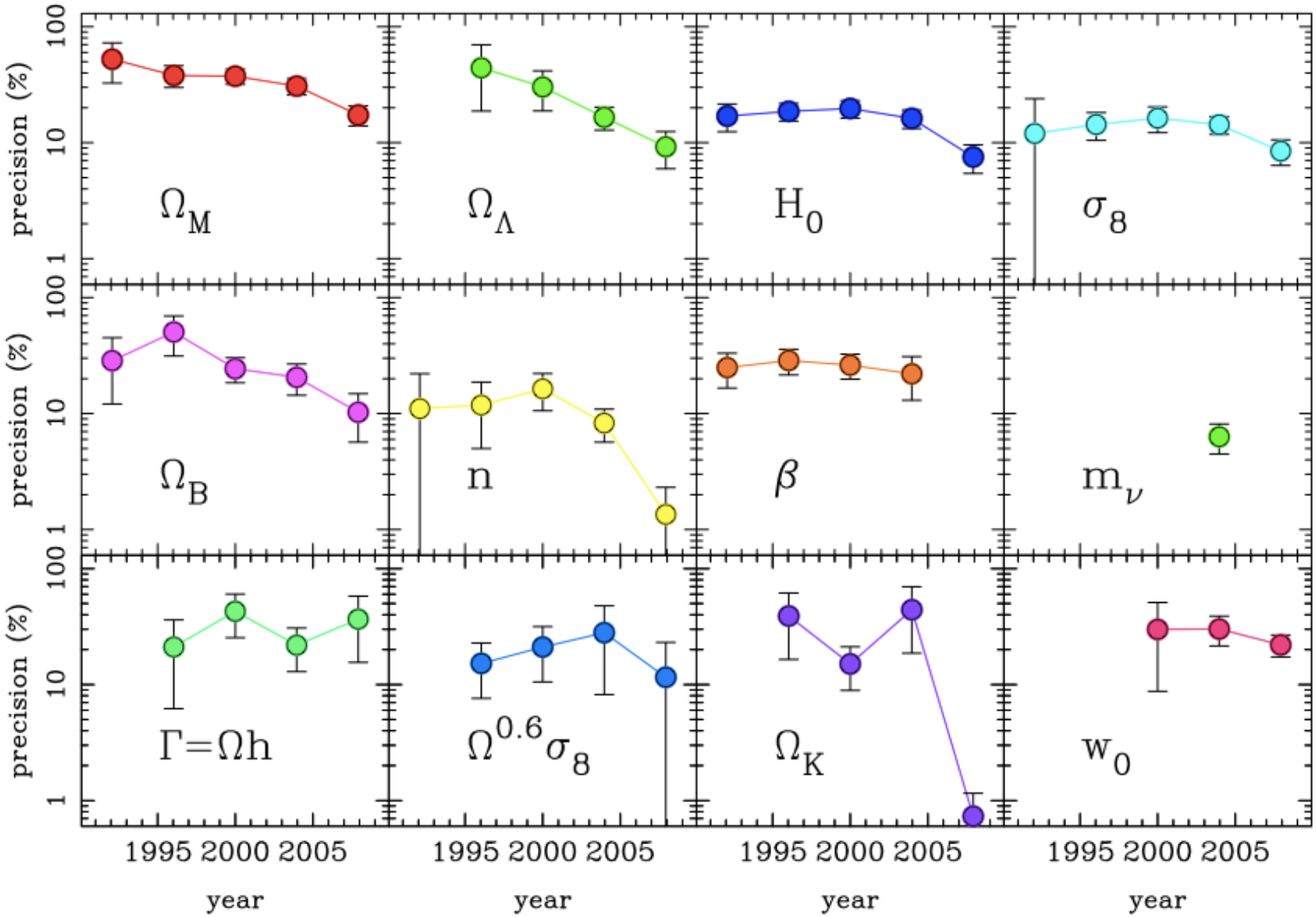
Measurements per year by technique



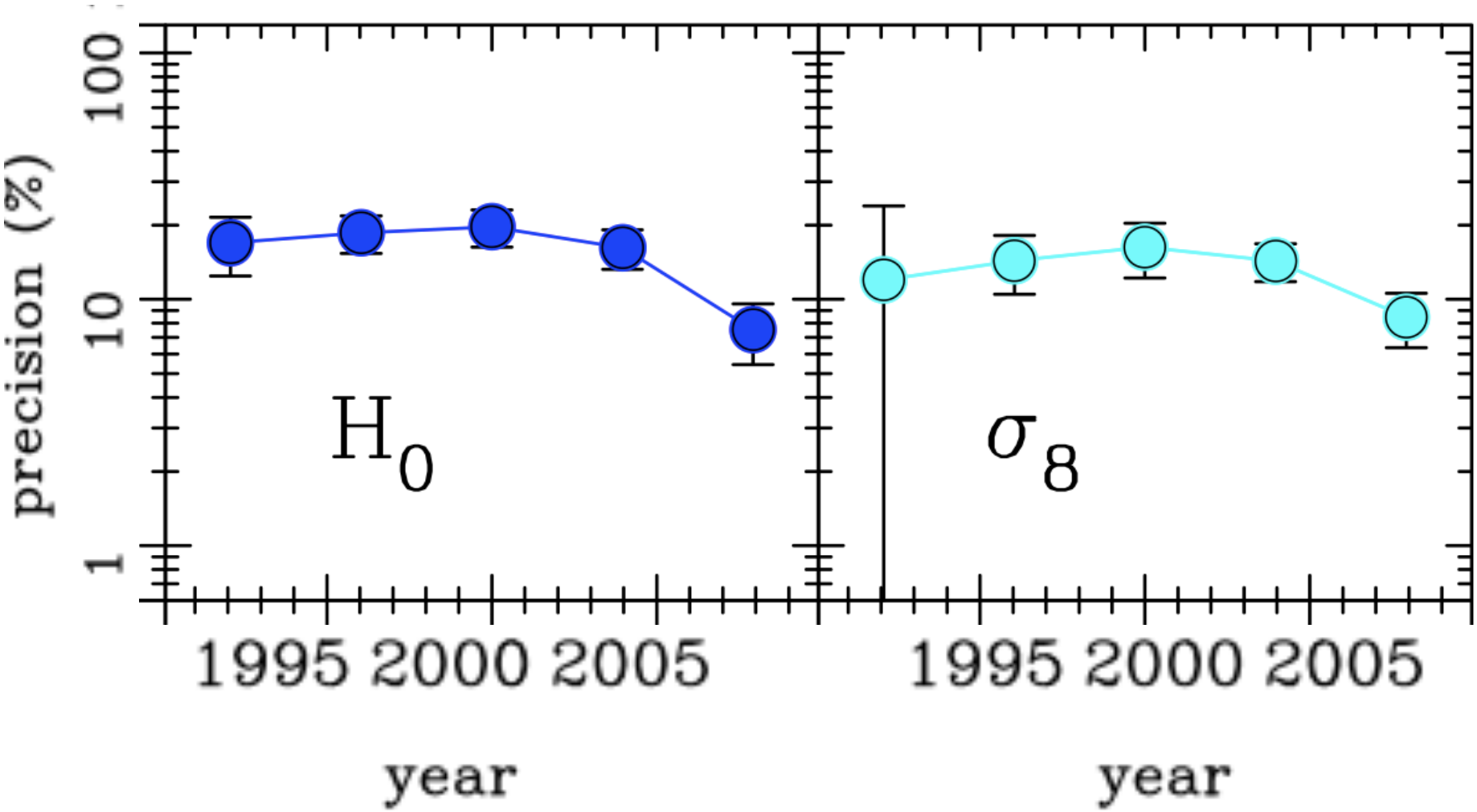
BAO still increasing

How is measurement precision (fractional error bar size) changing with time?

Precision by parameter



Slow increase in precision…



How accurate were past measurements?

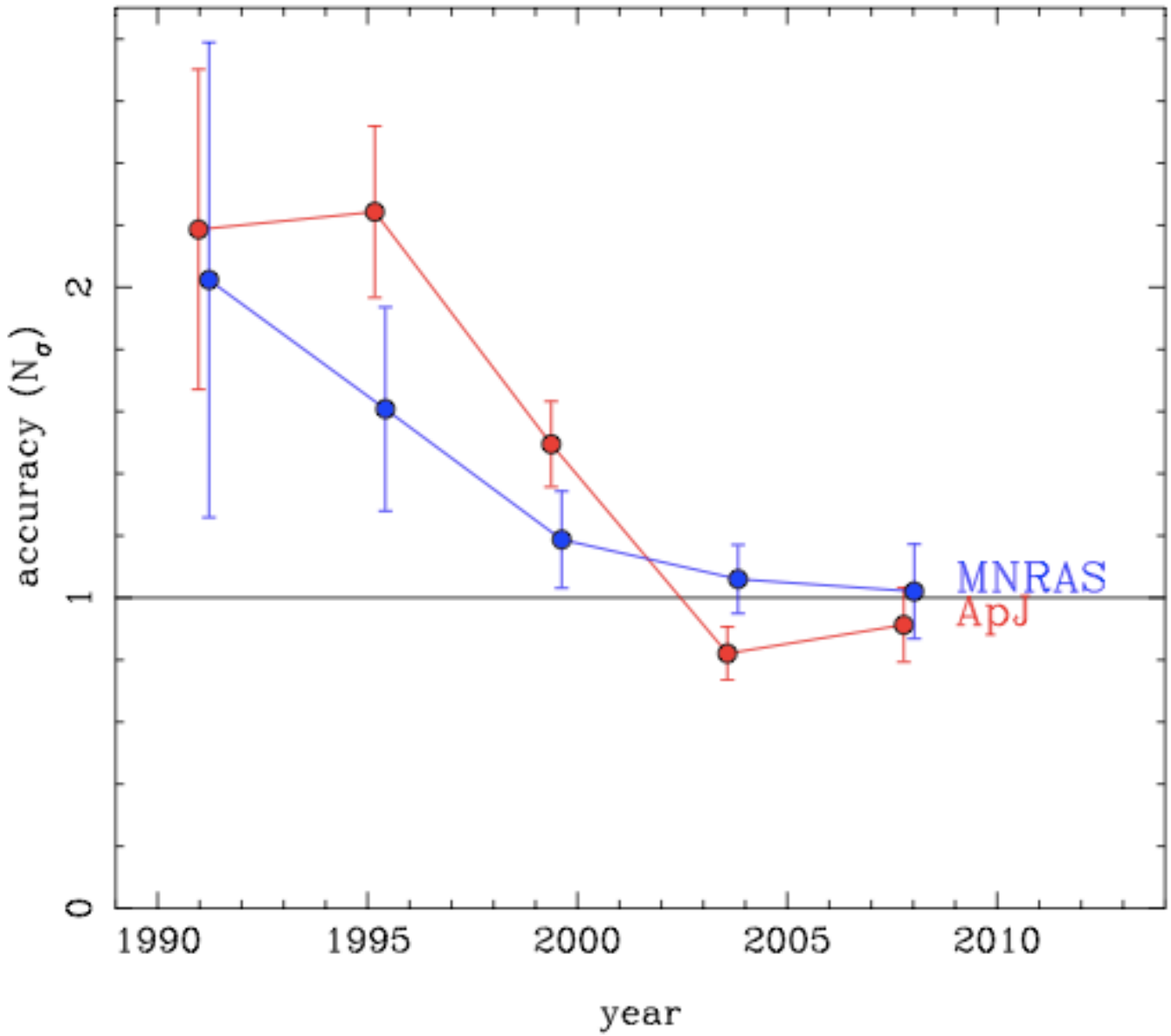
We take the mean of

(measurement-WMAP7 value)/measurement error bar

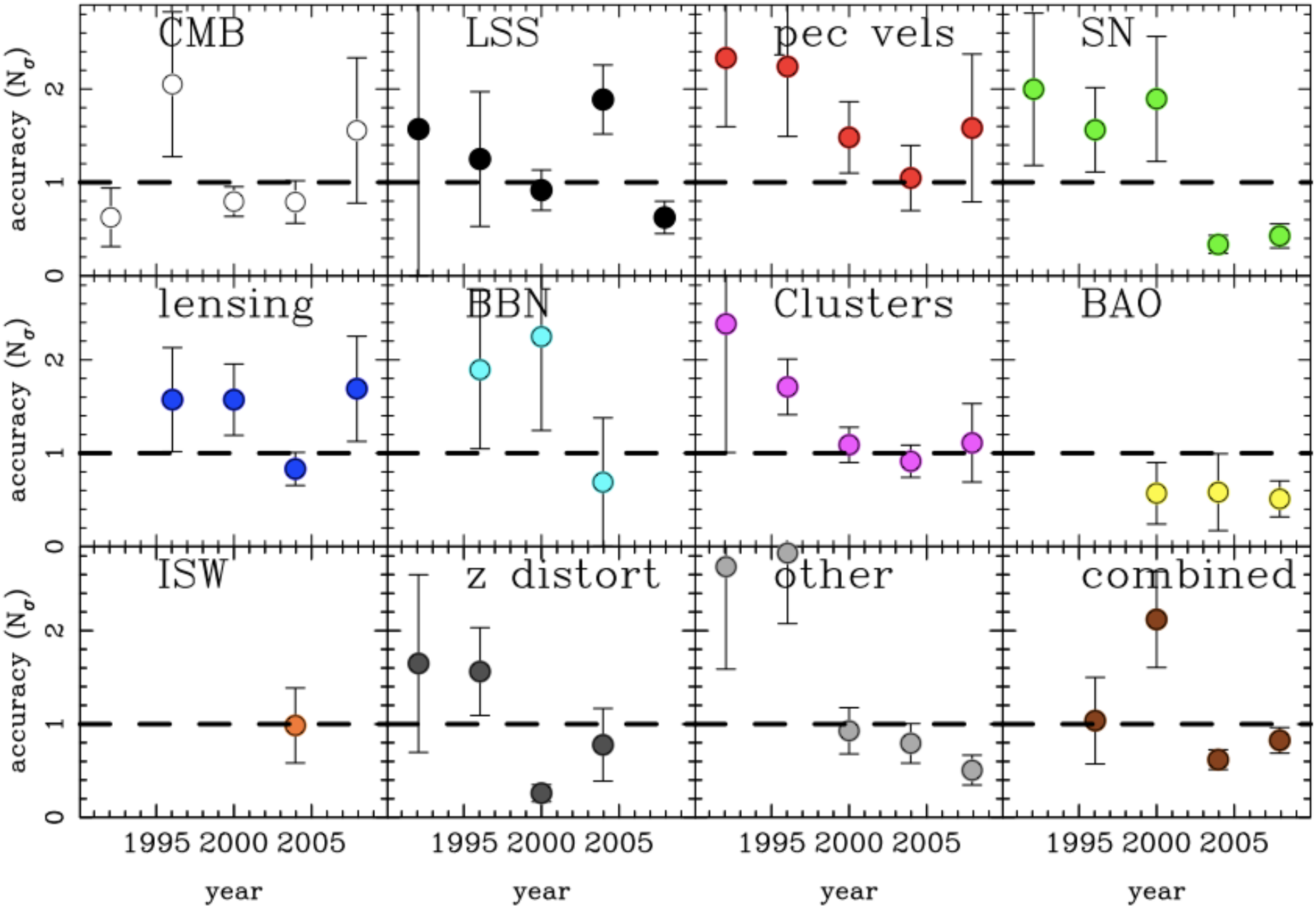
this is the mean "number of sigmas" (N_σ) that the measurements are from the "true" values.

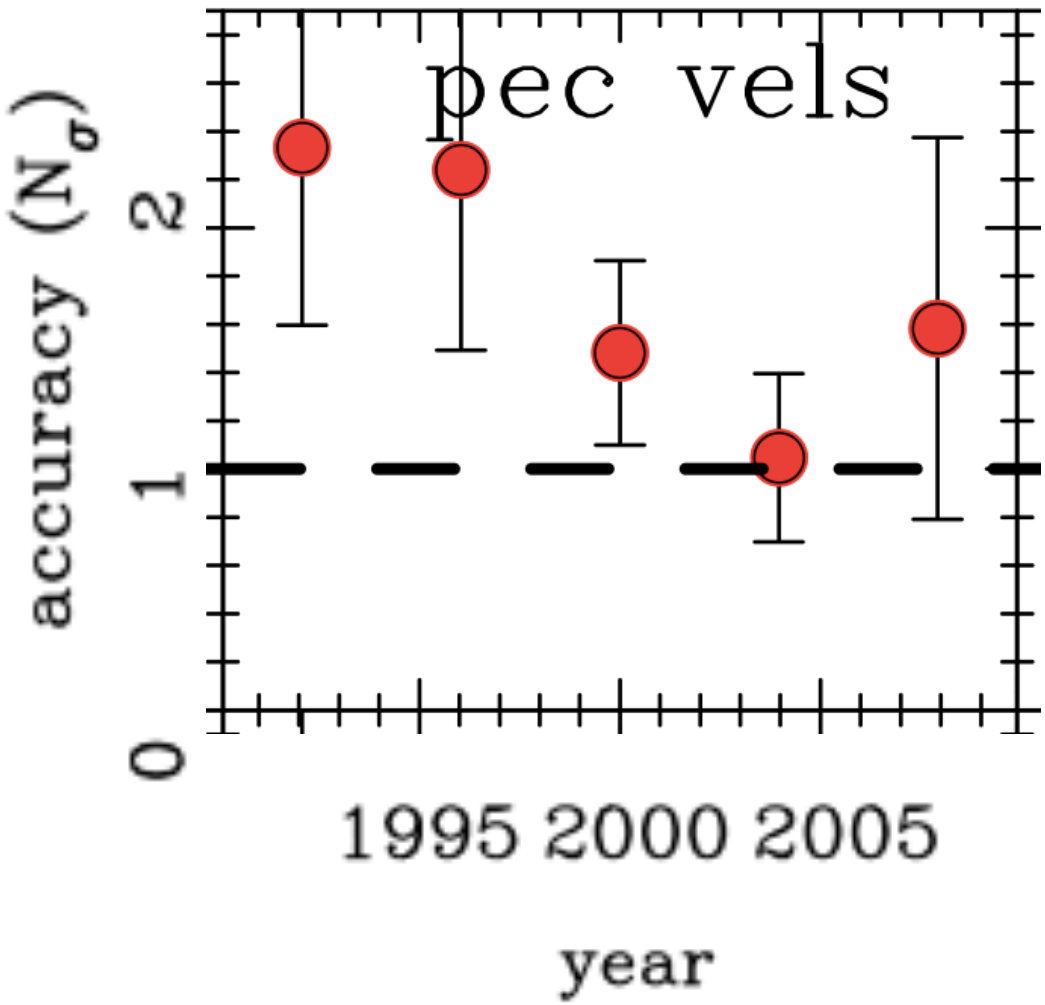
	$N < 1$	$N = 1$	$N > 1$
Could mean:	Error bars overestimated and/or Confirmation bias	Accurate measurement	Error bars underestimated

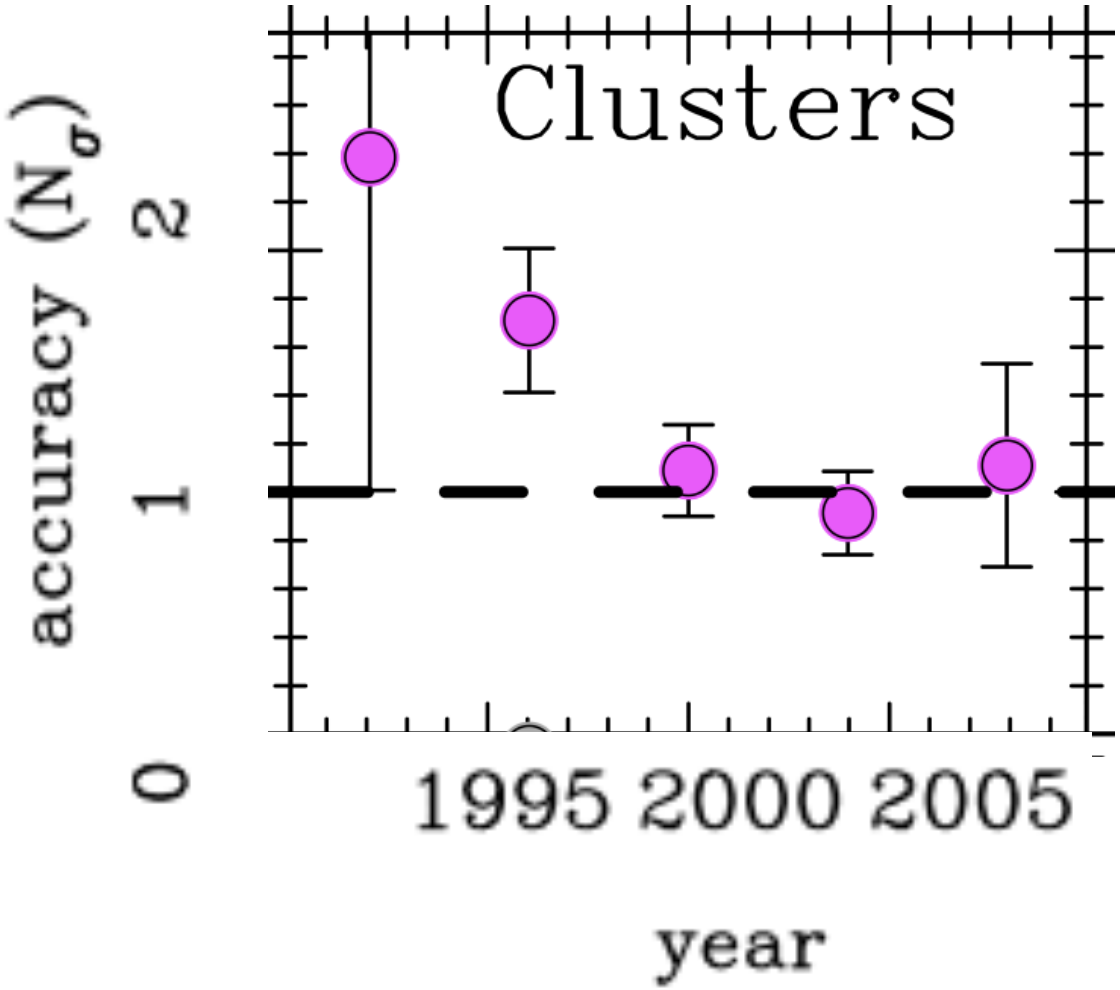
Overall accuracy vs year



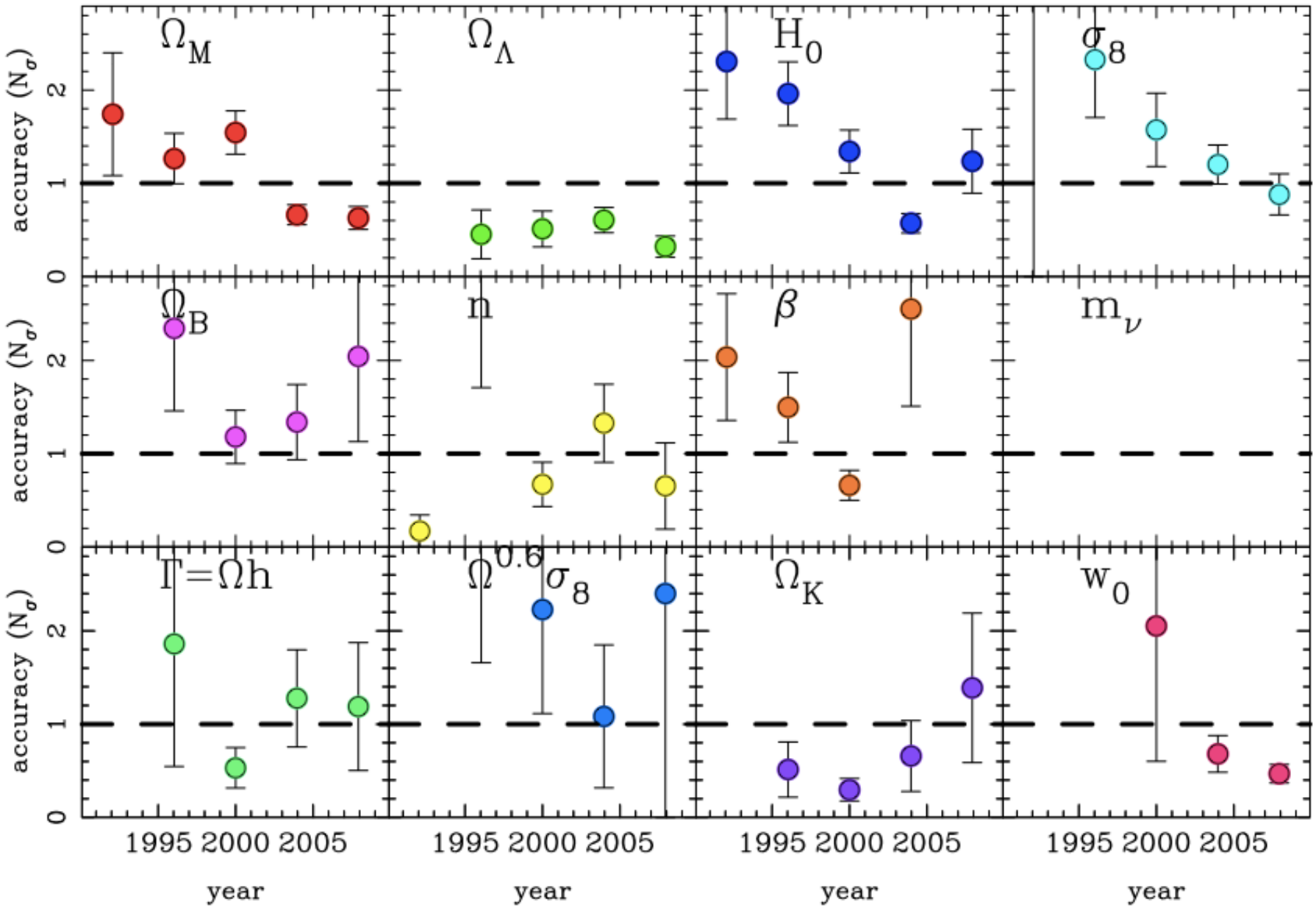
Accuracy by technique

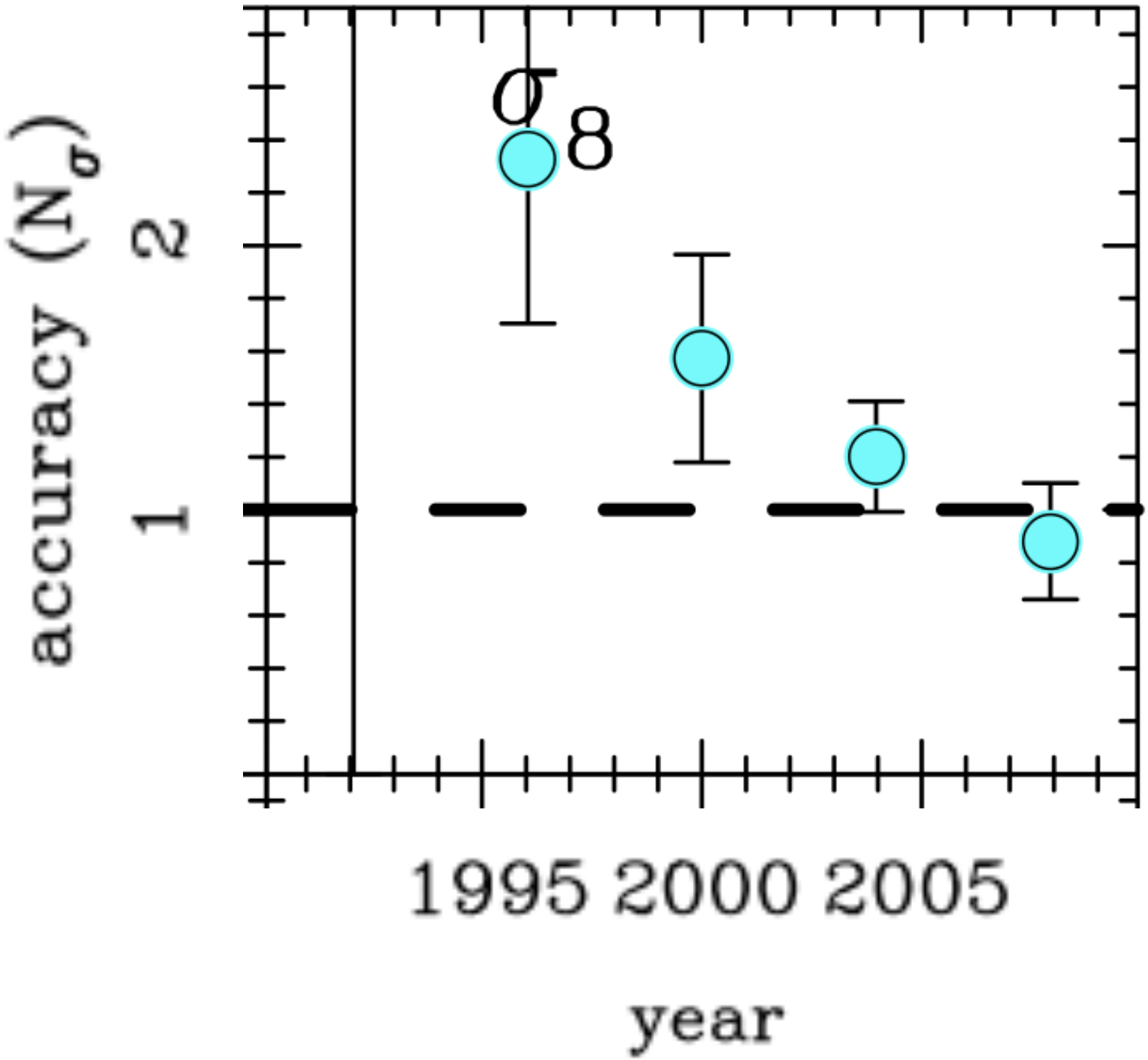


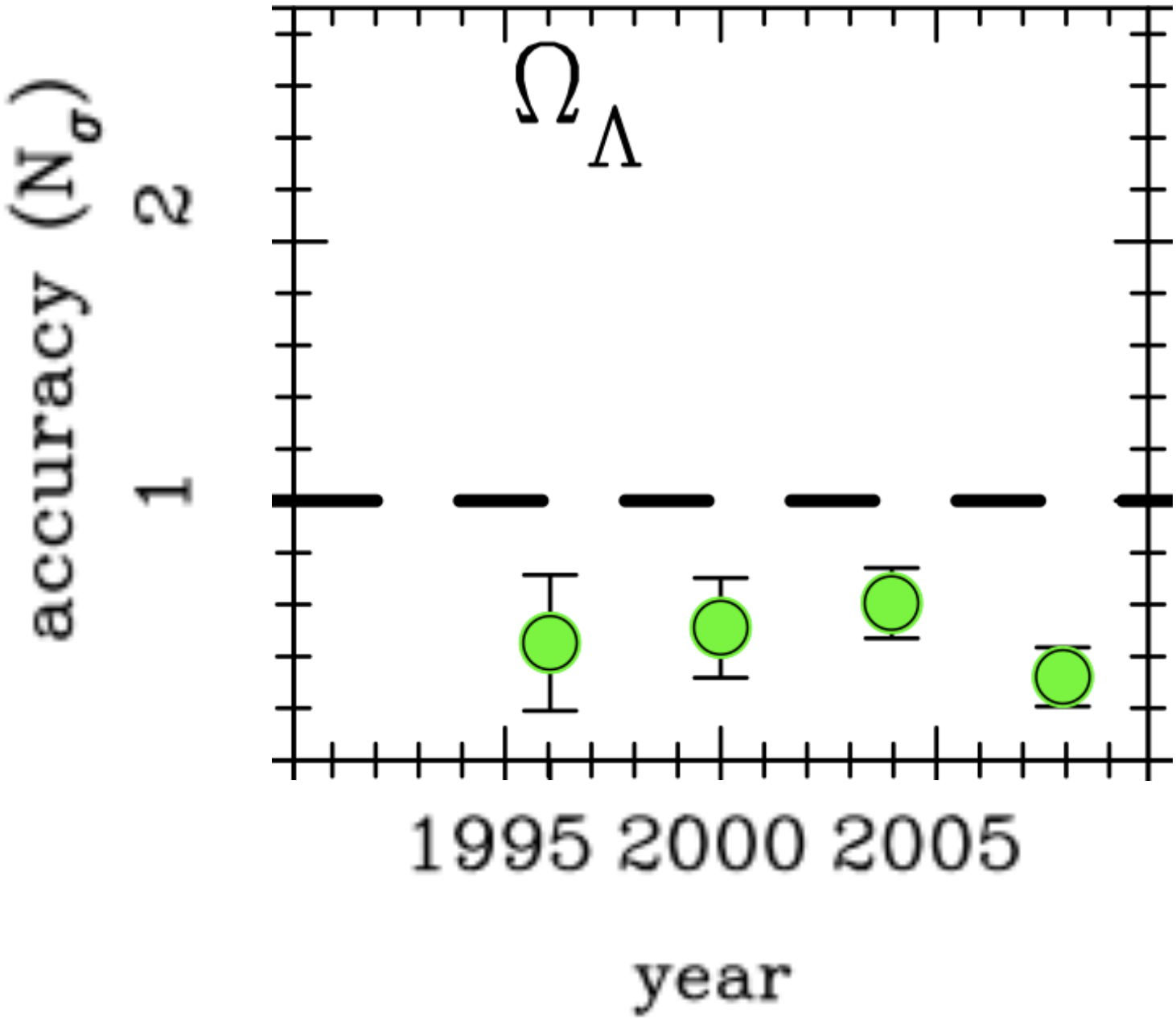

pec vels
accuracy (N_σ)
0
1
2
1995 2000 2005
year

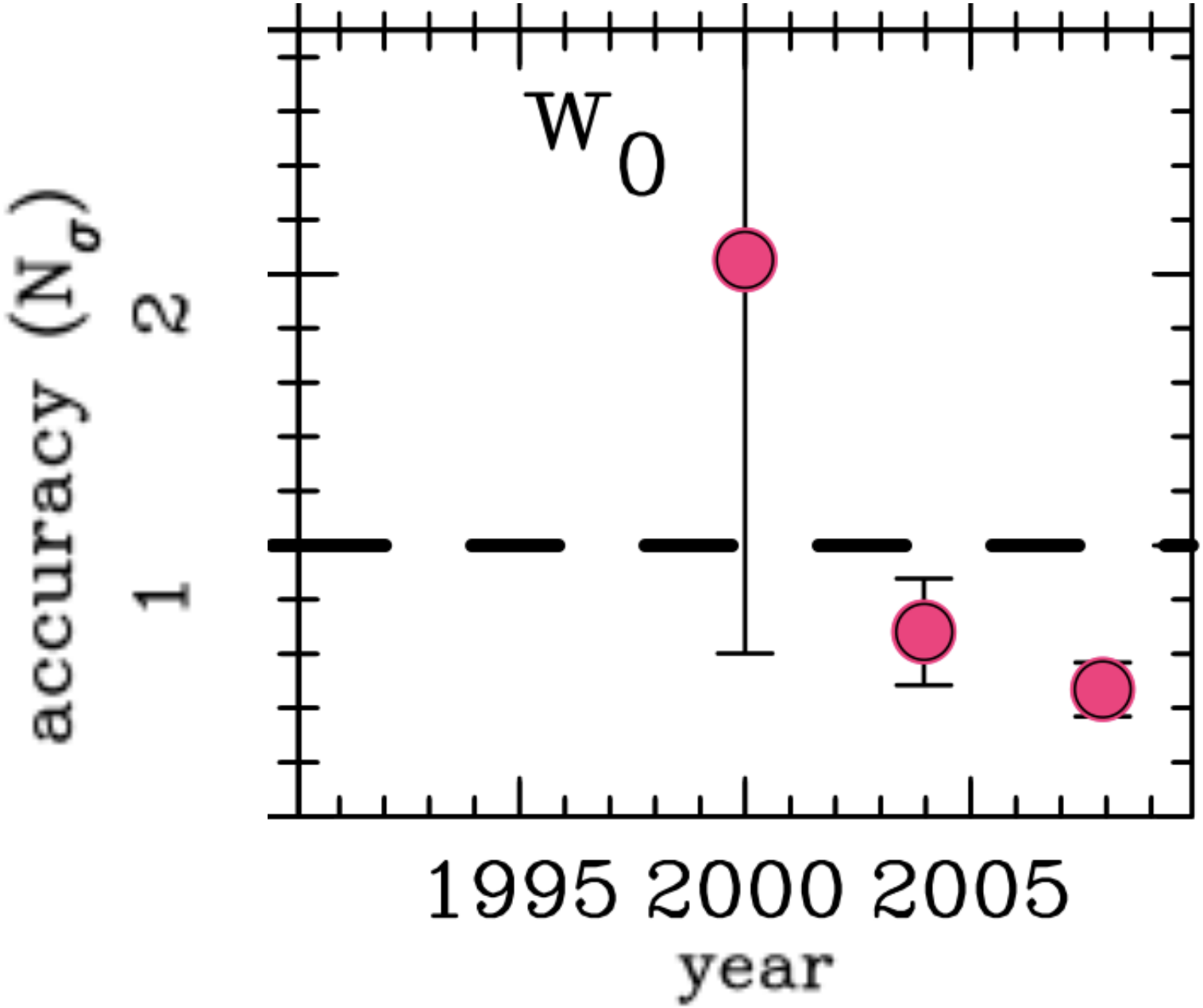

Clusters
accuracy (N_σ)
0
1
2
1995 2000 2005
year

Accuracy by parameter

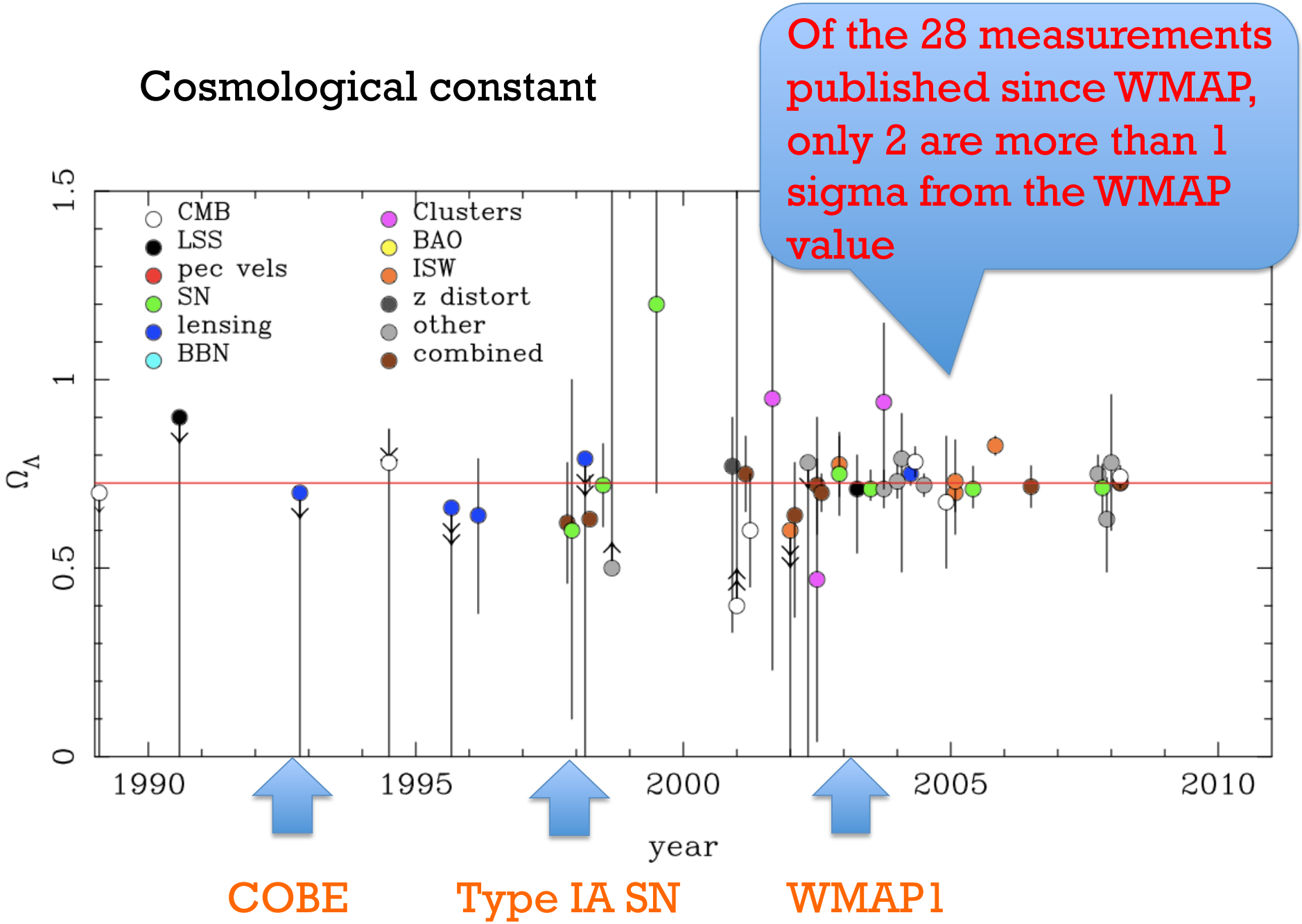



σ_8
accuracy (N_σ)
2
1
1995 2000 2005
year


Ω_Λ
accuracy (N_σ)
2
1
1995 2000 2005
year


w_0
accuracy (N_σ)
2
1
1995 2000 2005
year

Cosmological constant



Conclusions

(a) Golden age of ΛCDM parameter measurement was from ~1995-2003

(b) Published precision (fractional error bars) has decreased slowly -> progress has been in understanding systematic errors.

(c) On average, published measurements of cosmological parameters are quite accurate now, but error bars in 1990s were underestimated by a factor of 2.

(d) However, care needed to avoid confirmation bias – probably need more blind analyses as in particle physics…