Cohort Mortality
By Rajeev Shah
CMIB, UK

Structure

- The Continuous Mortality Investigation Bureau (CMIB)

- Two way mortality tables

- Cohort Effects

The CMIB

- Role

- Features

- Why offices contribute data

NB "Office" = "company"

Role of the CMIB

- Research – Mortality, IP and CI.
  - Methodologies
  - Graduation
  - Models
- Data collection
- Analysis & reporting
  - Industry experience
  - Contributing offices
- Standard Tables
- Projecting future experience

Features of the CMIB

- Governed by the actuarial profession
- Continuous investigations
- **Independent**
- **Confidentiality is paramount**
- Produce standard mortality/IP/CI tables
- Actuarial profession provides expertise

Why offices contribute data (1)

- Helps the market price and reserve rationally
  - Provides confidence to regulators and consumers

- Acts as a check on own assumptions
  - Comparison with industry experience and trends
  - Small areas of experience e.g. Cause of Claim

- Benchmarking of underwriting/claims control

Why offices contribute data (2)

- Benefit from new research and ideas

  - CMIB provides interface for exchange of ideas between academia and the commercial world

- Limited resources and expertise within offices

- Confidence in the CMIB and the actuarial profession

- Benevolent?

  - e.g. promote understanding and research

Standard mortality tables

Period	Assured Lives	Annuitants	Pensioners
1924-29	✓ (males)		
1947-48		✓	
1949-52	✓ (males)		
1967-70	✓ (males)	✓	✓
1975-78	✓ (females)		
1979-82	✓	✓	✓
1991-94	✓	✓	✓

Comparison of the mortality of male assured lives
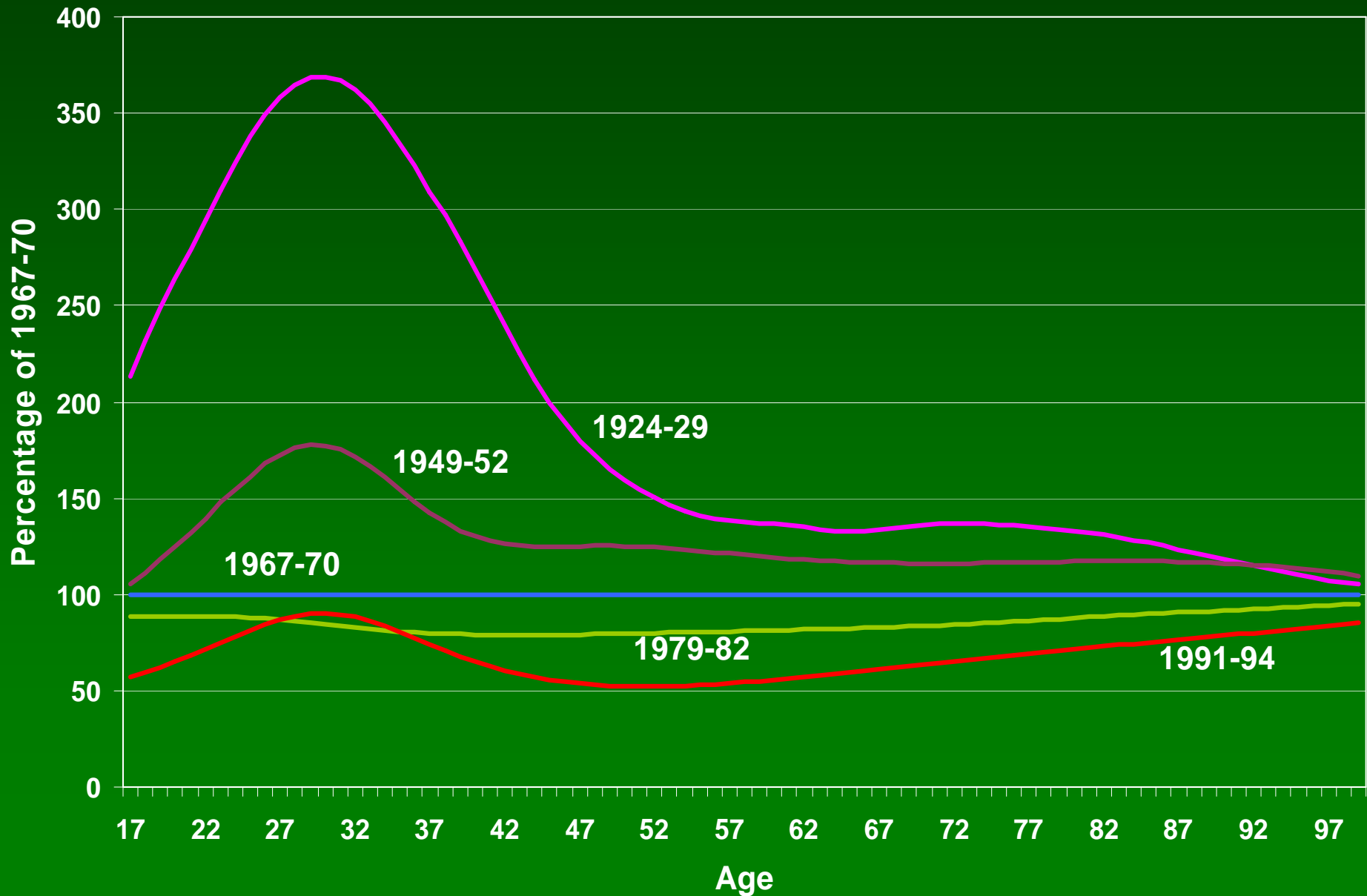
Two way mortality tables

Two way mortality tables

- Standard tables

- Show mortality rates by age and calendar year

- Allow for projected mortality improvements

Two way table for q_x – *the base table*

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
60														
61		C=1992												
62														
63														
64														
65	●													
66	●													
67	●													
68	●													
69	●													
70	●													
71	●													
72	●													
73	●													
74	●													
75	●													
76	●													
77	●													

Two way table for q_x- *year of birth 1935*

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
60														
61														
62														
63														
64														
65	●								●					
66	●									●				
67	●										●			
68	●											●		
69	●												●	
70	●													●
71	●													
72	●													
73	●													
74	●													
75	●													
76	●													
77	●													

B=1935

Two way table for q_x – *year of use 2000*

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
60									●					
61									●					
62									●					
63									●					
64									●					
65	●								●					
66	●								●	●				
67	●								●		●			
68	●								●			●		
69	●								●				●	
70	●								●					●
71	●								●					
72	●								●					
73	●								●					
74	●								●					
75	●								●					
76	●								●					
77	●								●					

U=2000

Cohort Effects

The problem

- Is the latest mortality projection (the "92" Series) still appropriate?

- If not, how should it change?

Pensioners 100A/E using the "92" Series projected mortality rates: Males
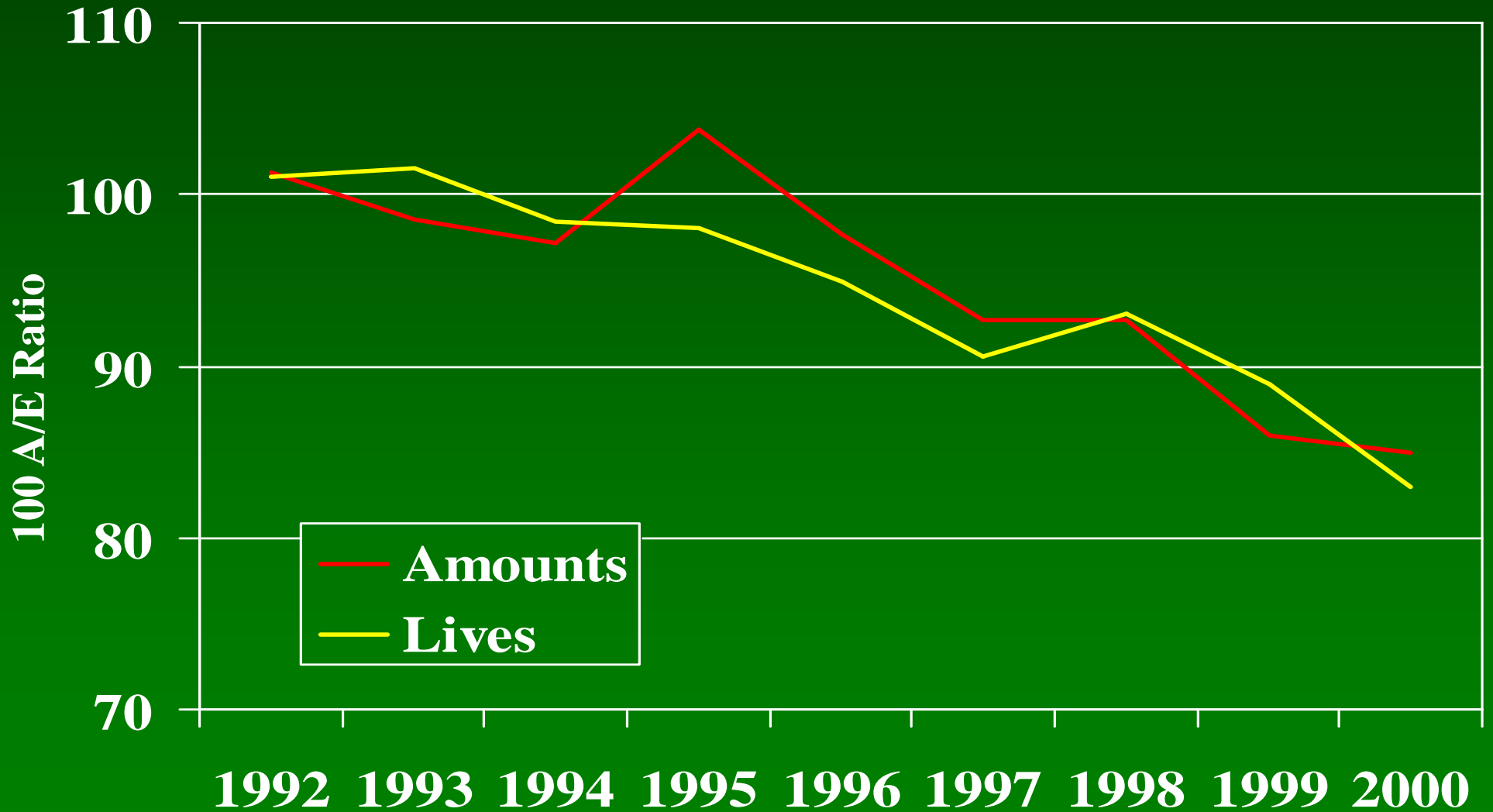
Pensioners 100A/E using the "92" Series projected mortality rates: Males, lives, by age
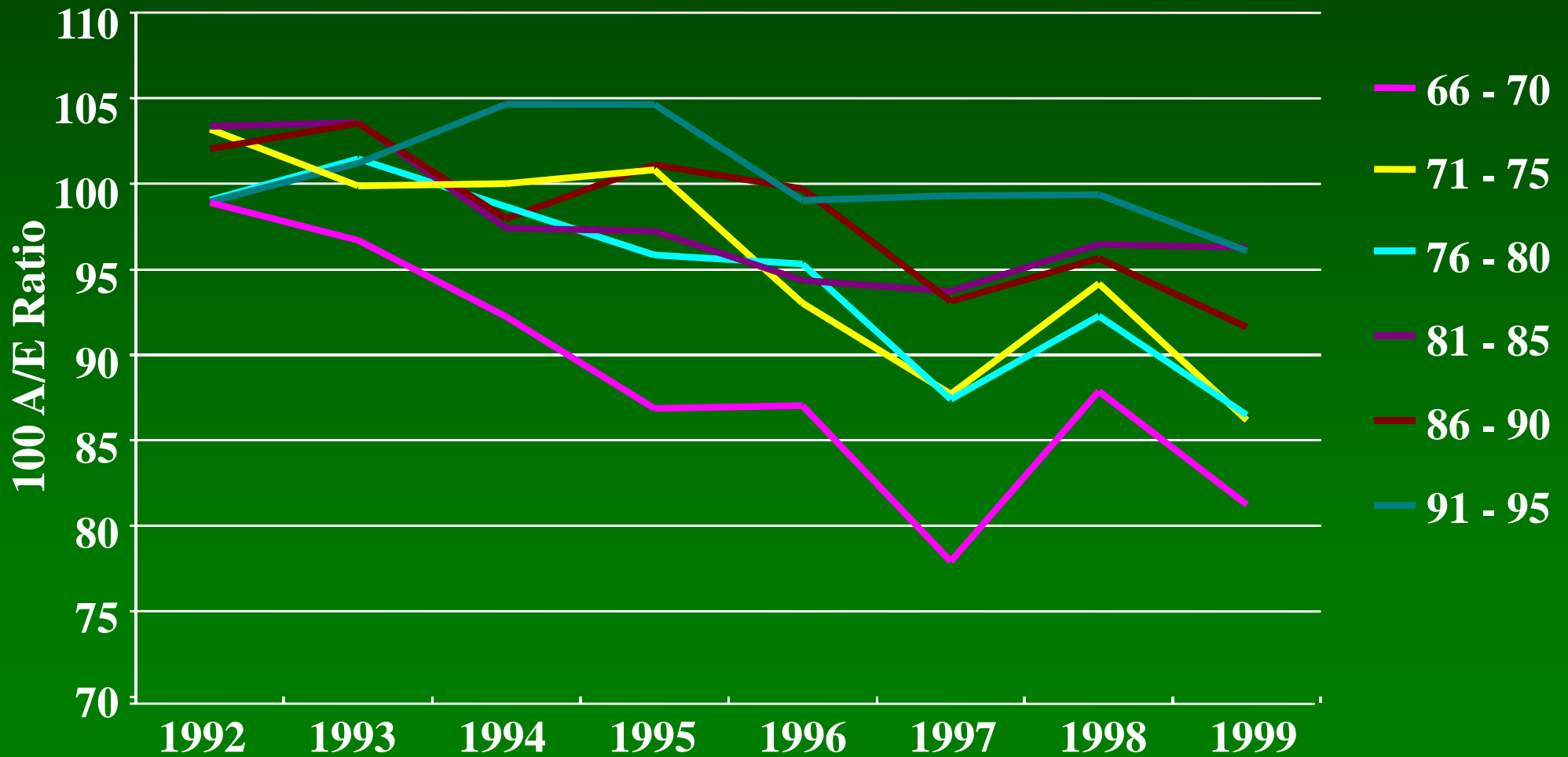
Cohort data

- Assured lives 1947 to 1999
- Age range 10 to 100+
- … 2-way table of q_x
- Pre 1974 data had to be entered manually
- Ultimate durations only
- Relatively homogeneous
- Other data sets not as complete

Smoothing

- Lots of attempts, but finally
- … two dimensional splines
- Imposes no "shape" on the data
- Smooth in two directions
- Lots of features in data
- … but difficult to see patterns in q_xs

Smoothed q_xs
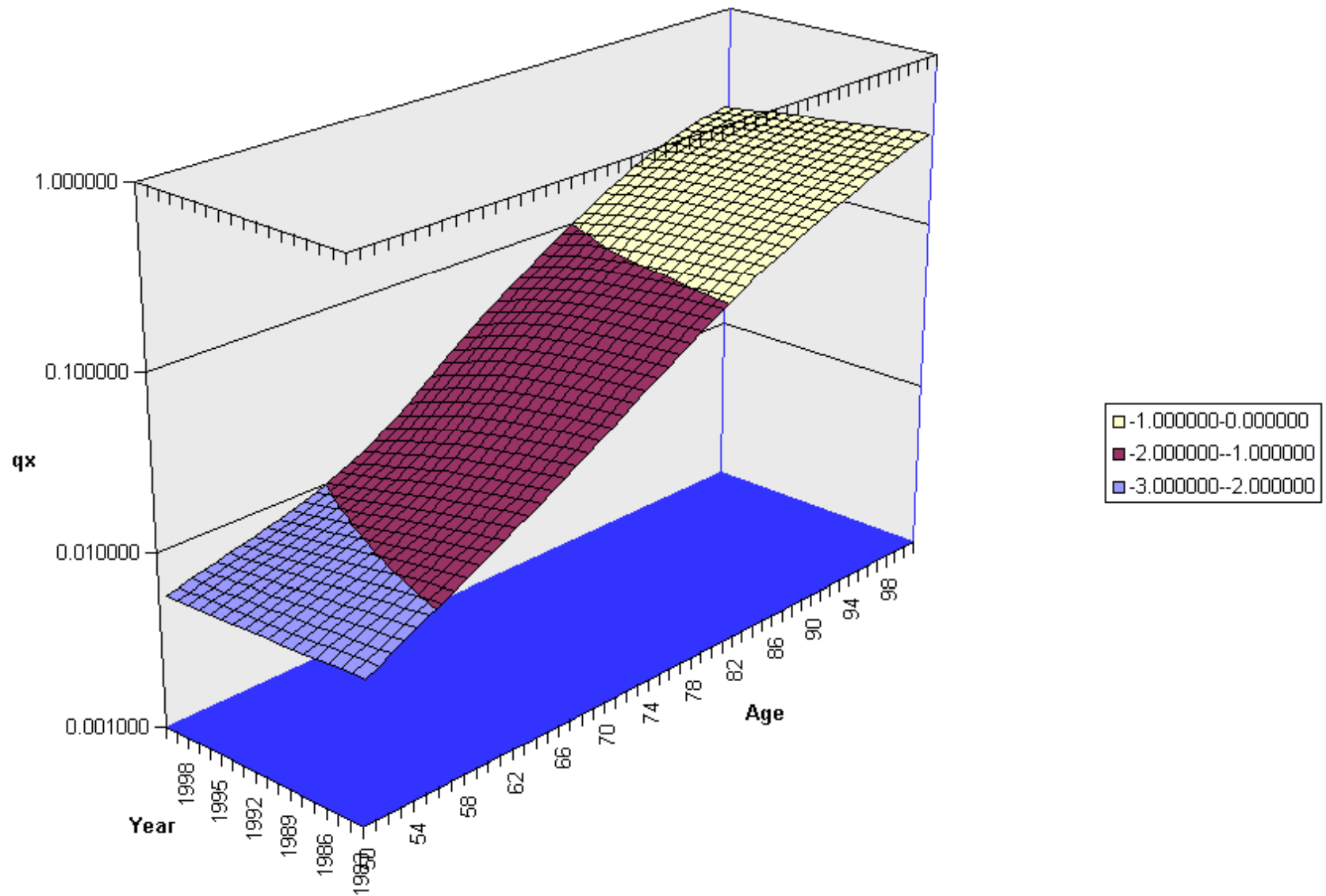
… so looked at improvement rates

$$1 - \frac{q_{x,t}}{q_{x,t-1}}$$

Improvement factors
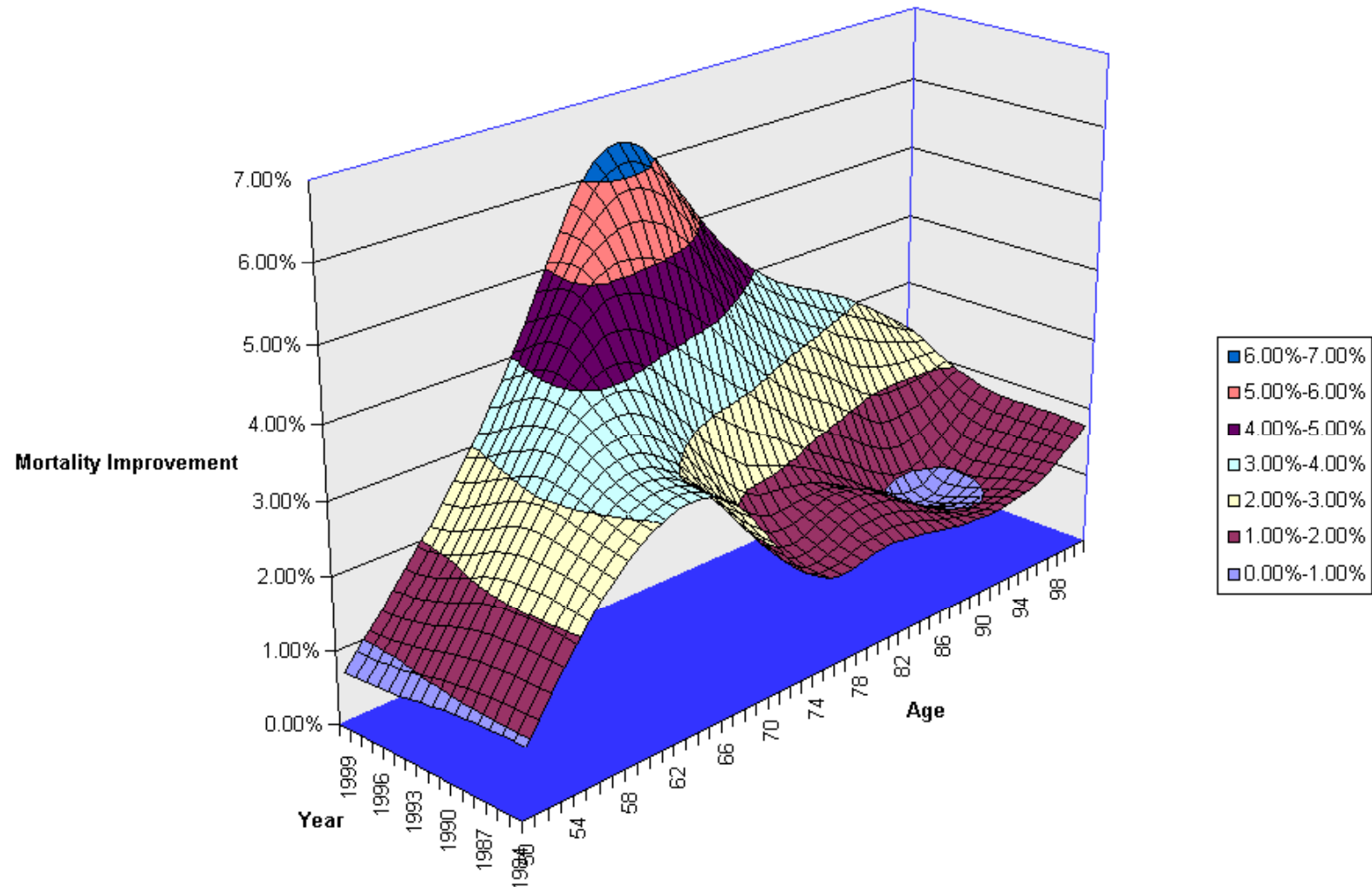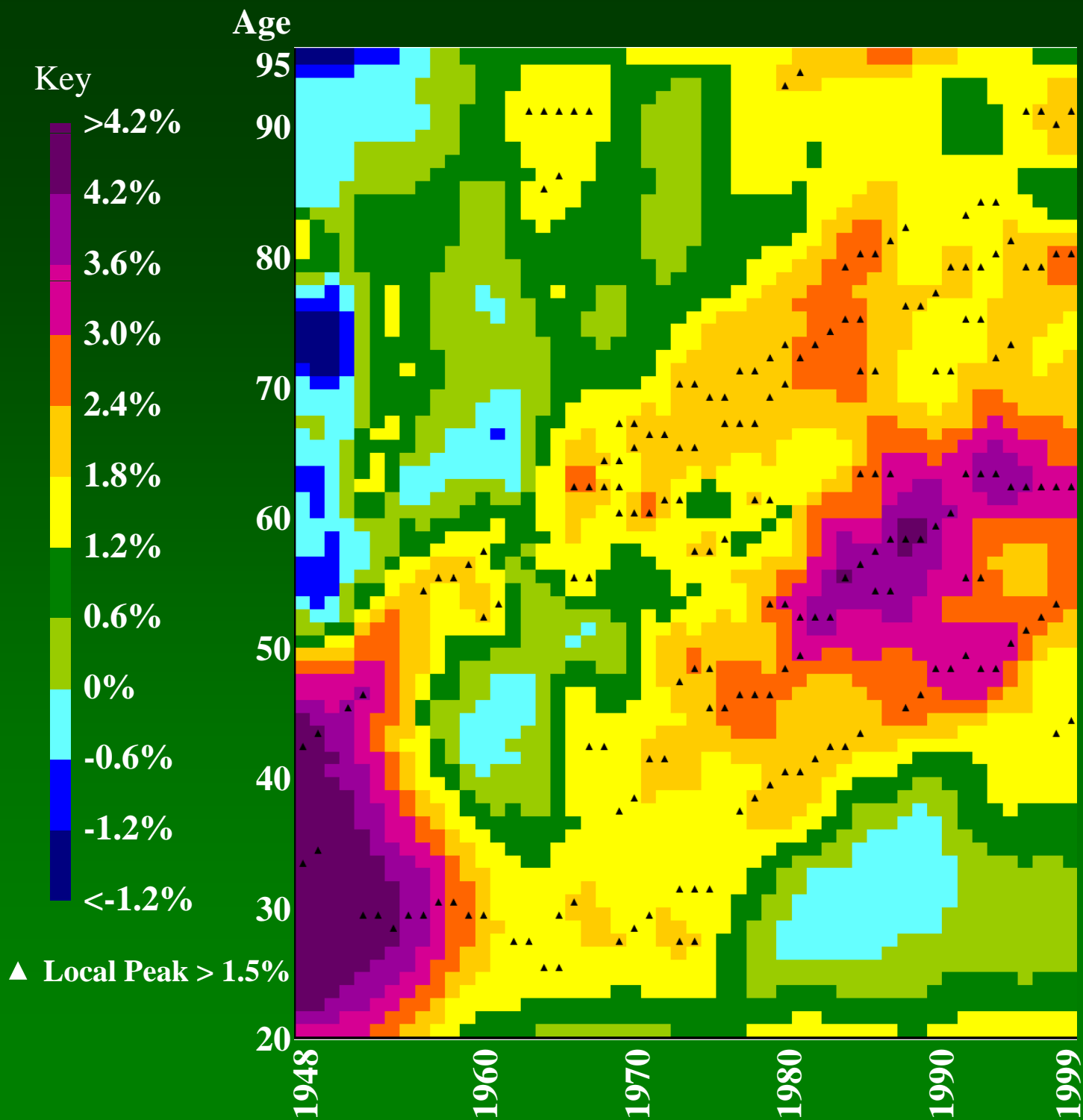
Contour map of 2D graduation

Assured lives, males, all durations
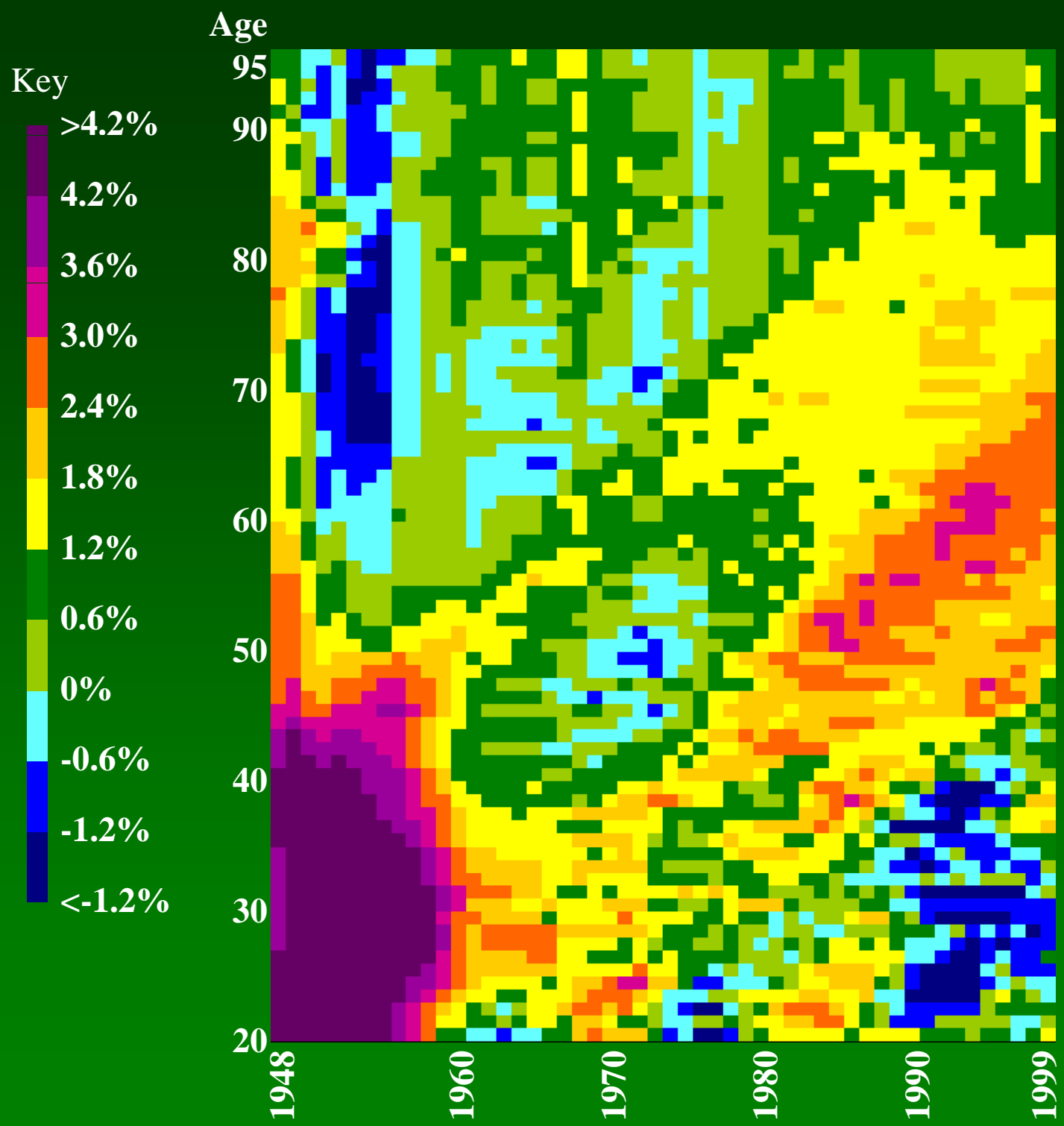
GAD Contour map

Male Population, England & Wales

Pensioner cohort data

- 1983 – 1999
- Males, Females, Lives & Amounts
- Data issues
- All Offices & Loyal Offices
- Males – improving more quickly than Assured Lives

All Office Pensioners 100A/E using the "92" Series projected with Assured lives actual mortality improvements - Males

Key

>4.2%
4.2%
3.6%
3.0%
2.4%
1.8%
1.2%
0.6%
0%
-0.6%
-1.2%
<-1.2%

▲ Local Peak > 1.5%

Age
95
90
80
70
60
50
40
30
20

1948   1960   1970   1980   1990   1999
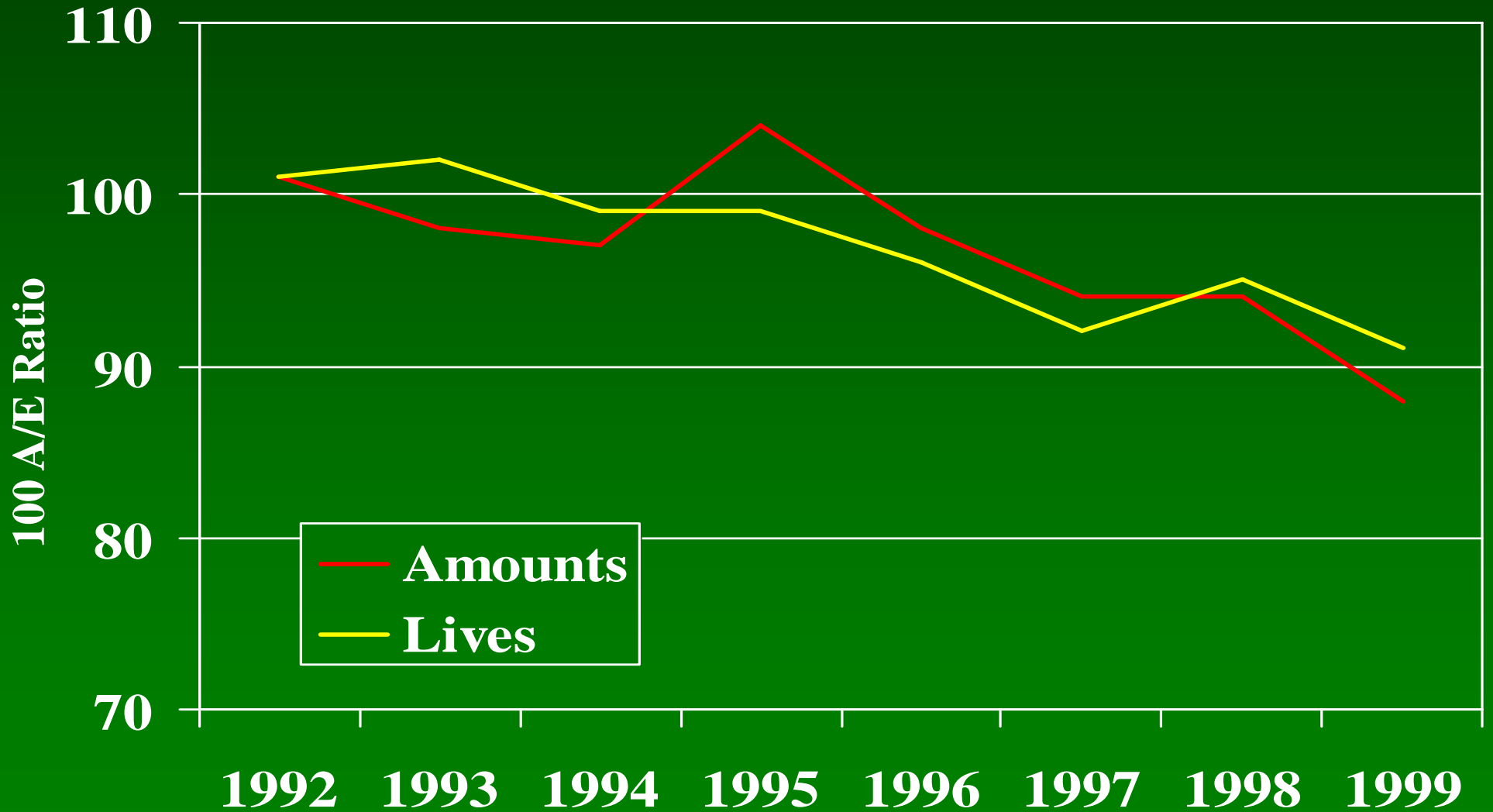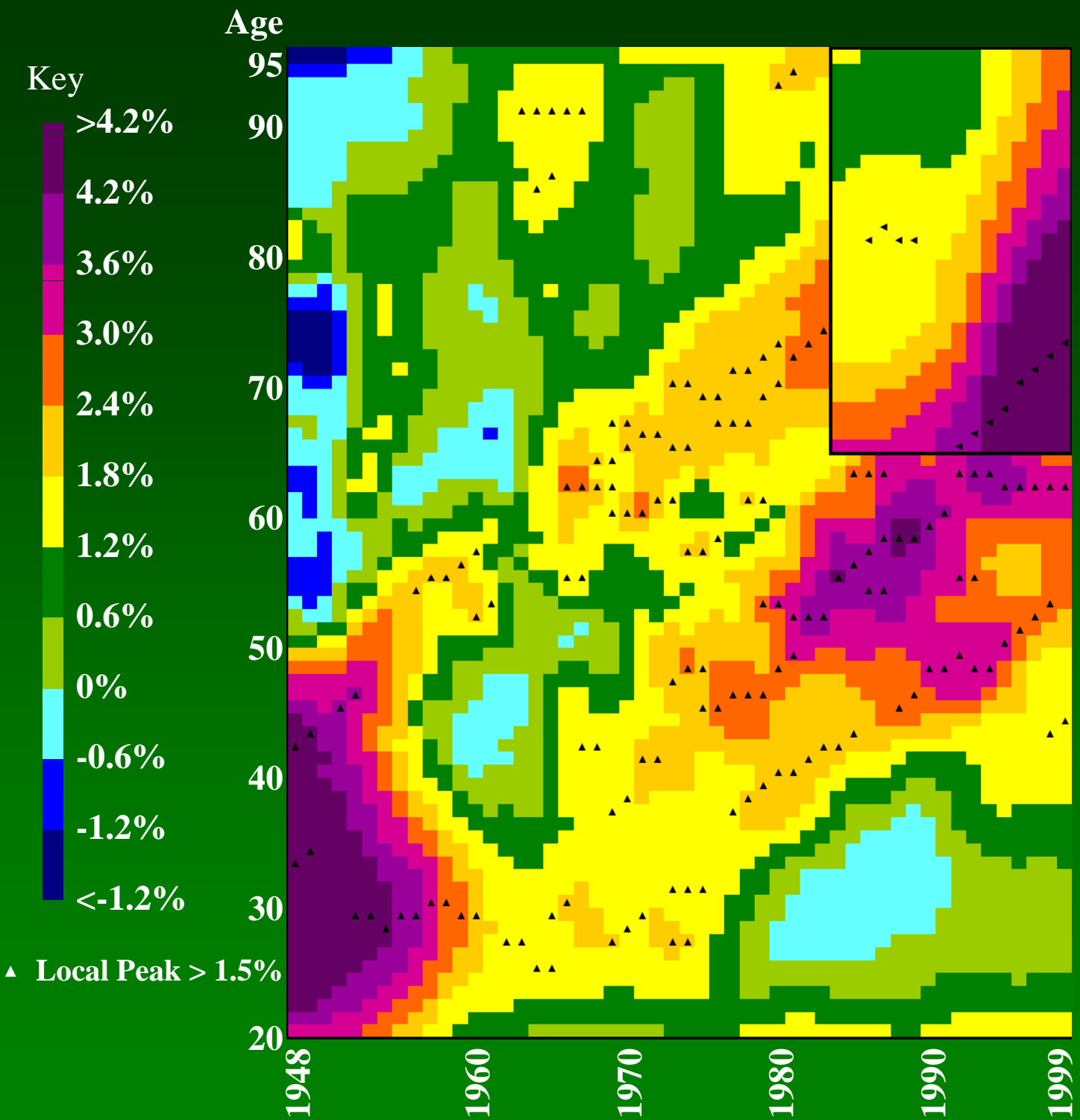
Contour map of 2D graduation

Assured lives, males + All Office pens
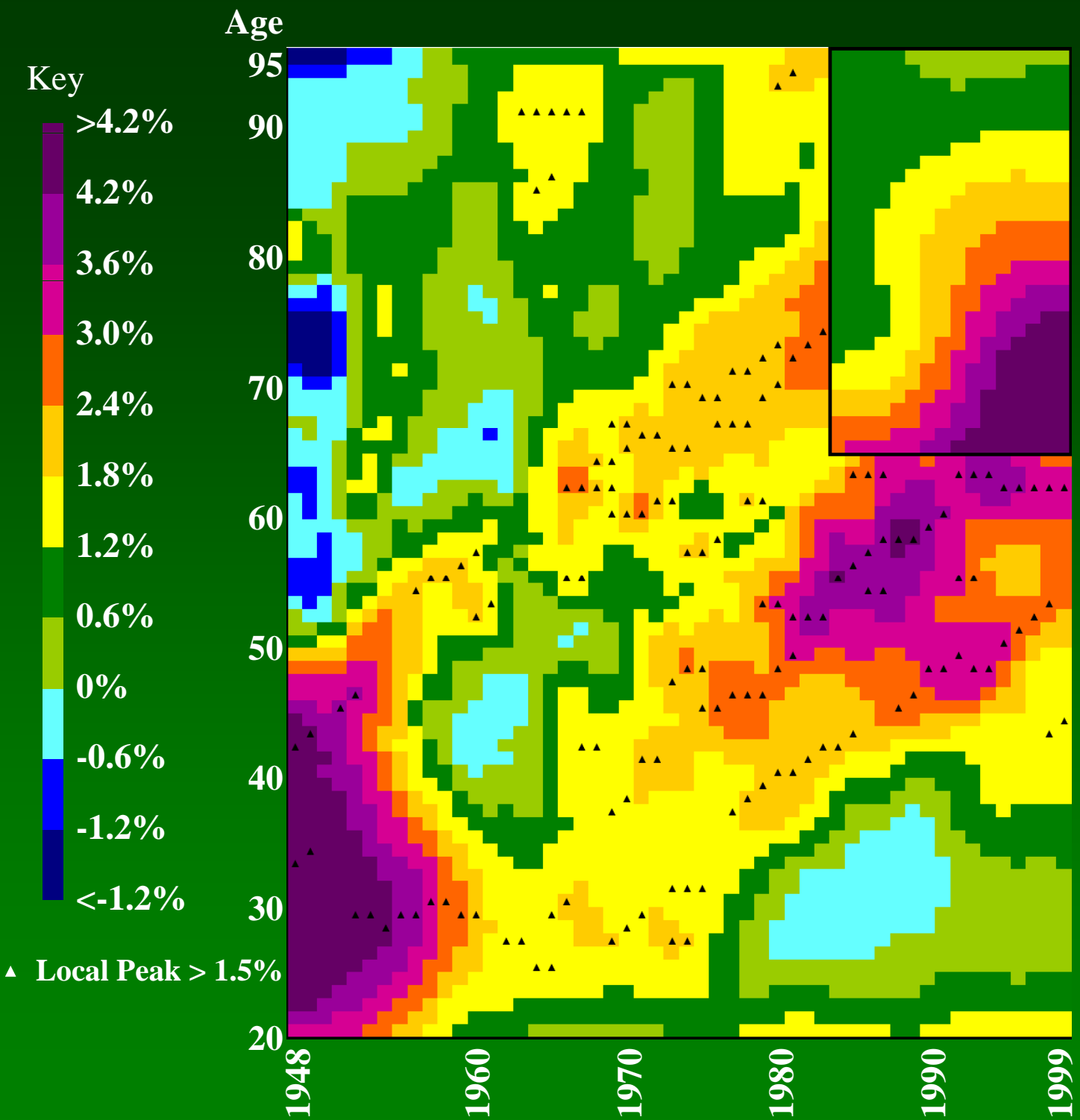
Contour map of 2D graduation

Assured lives, males + Loyal Office pens

All Office crude data to 1992, then "92" Series projection
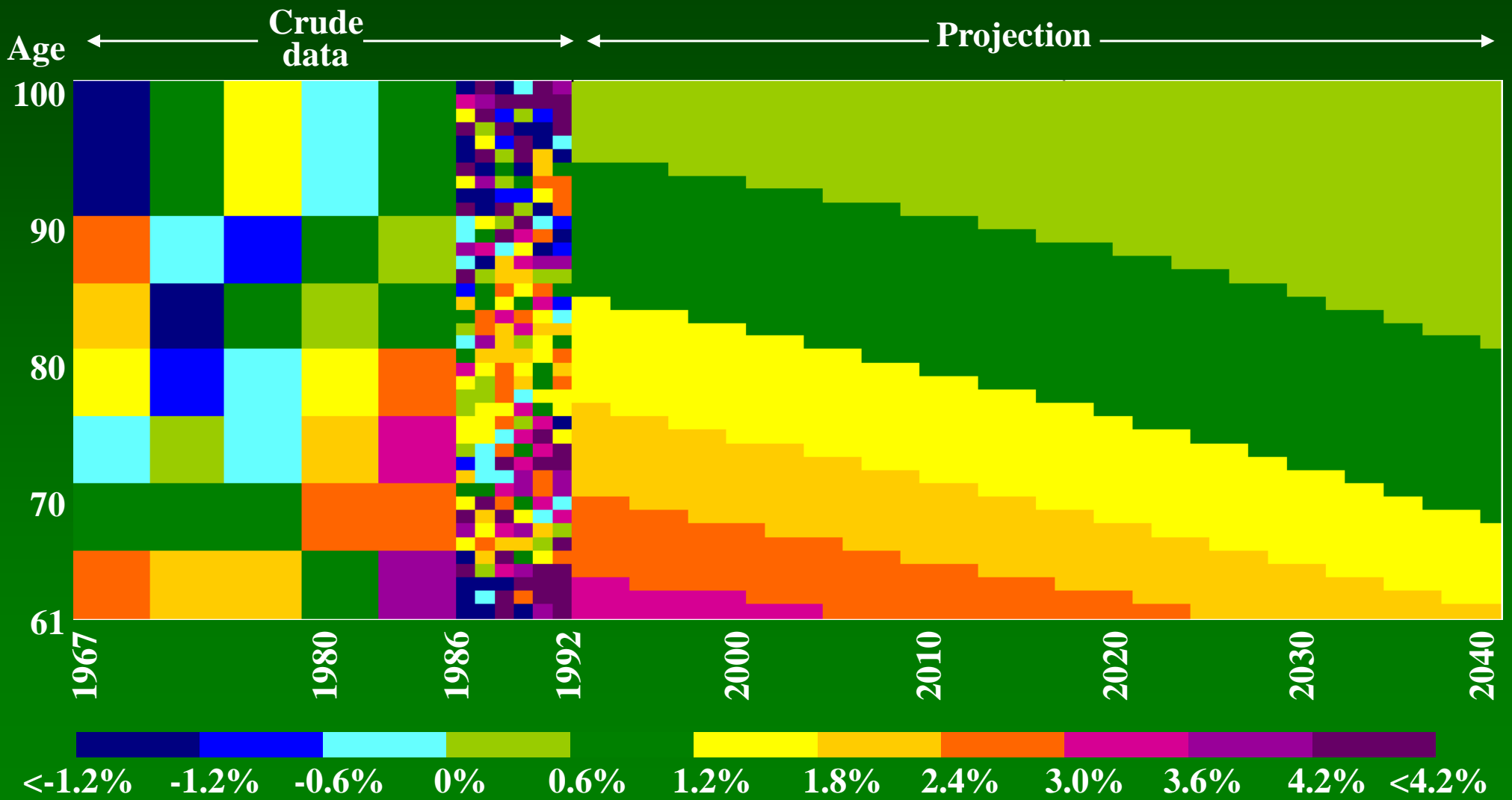
All Office to 1992, then "92" Series projection
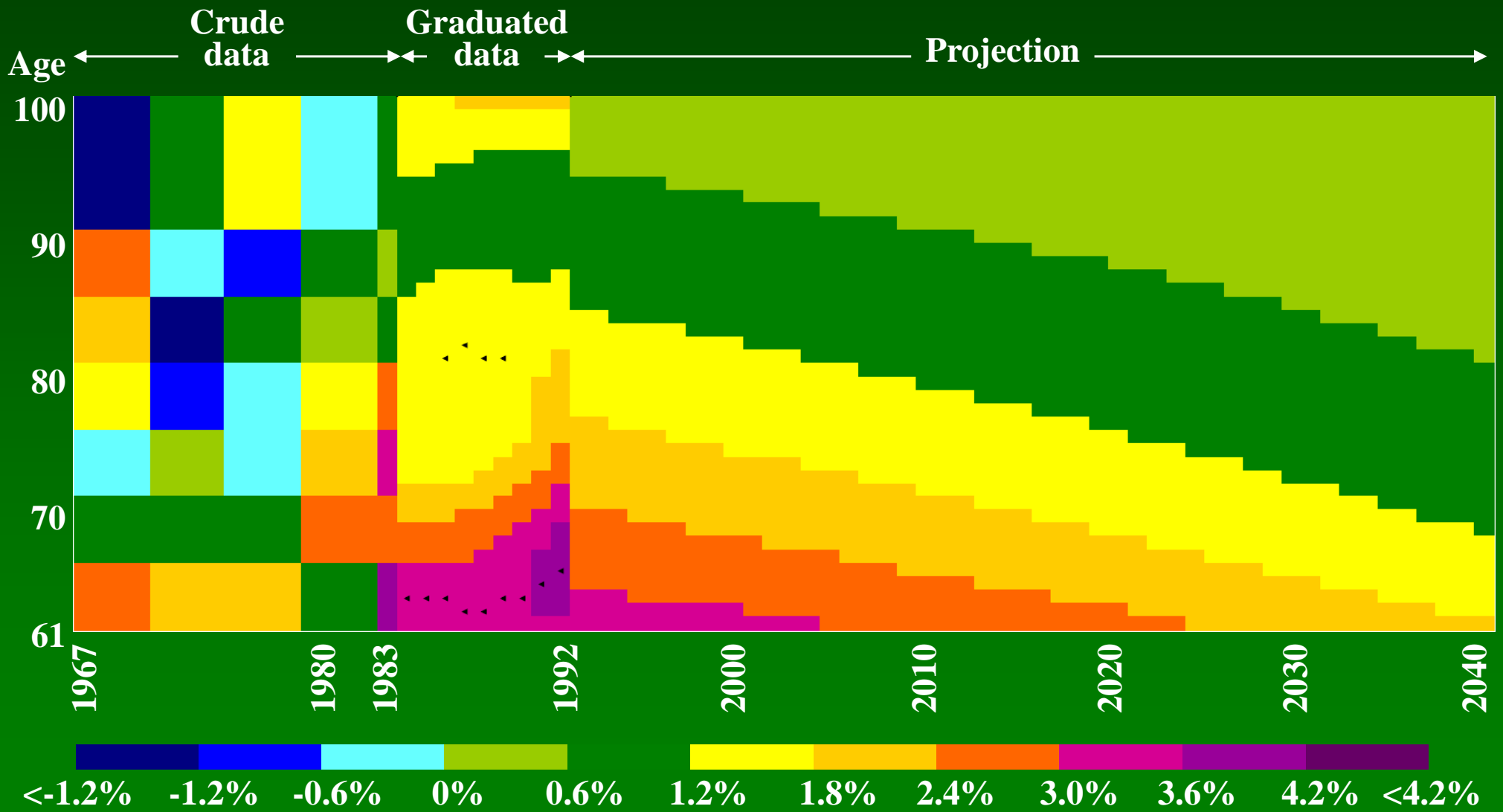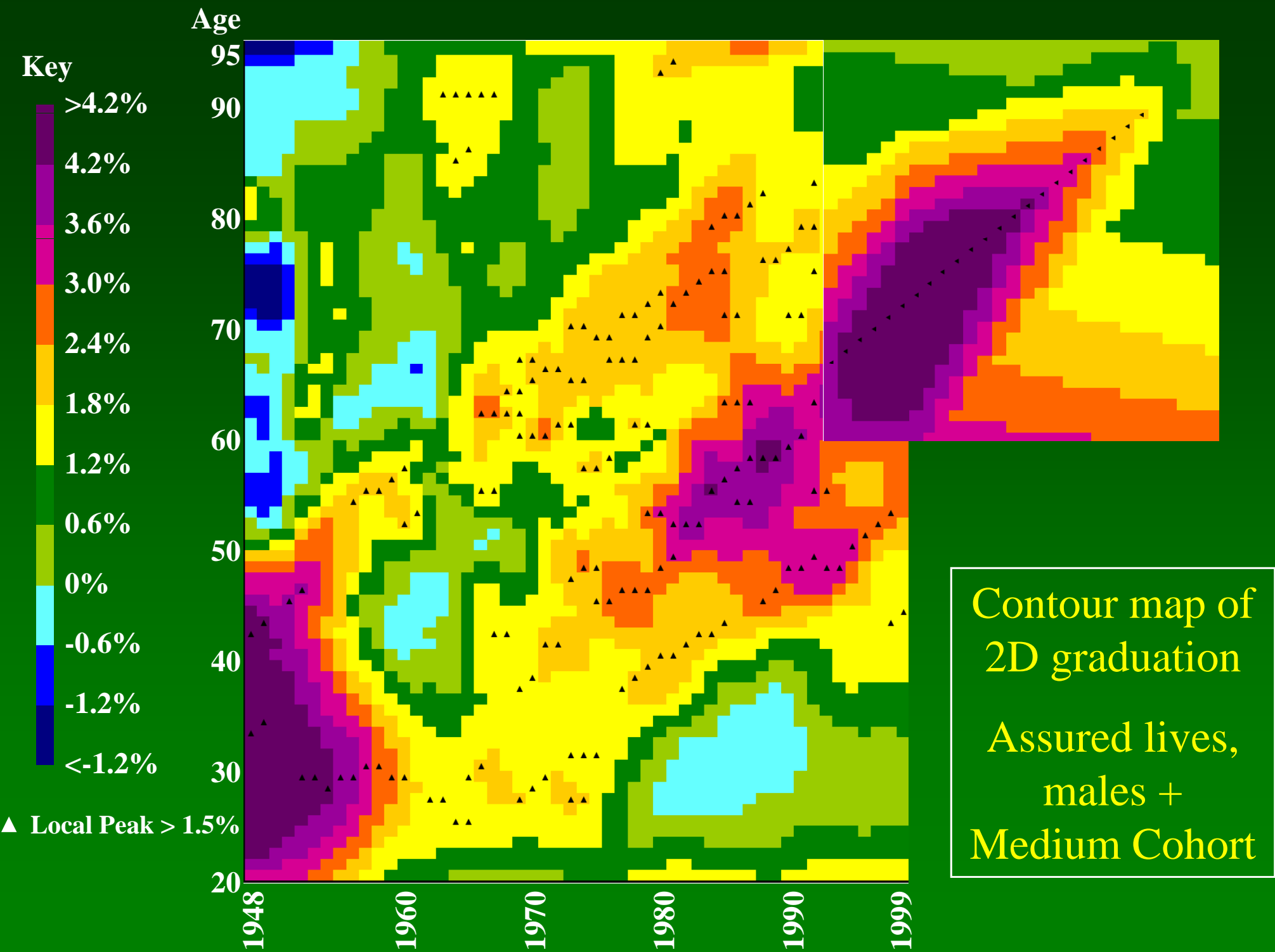
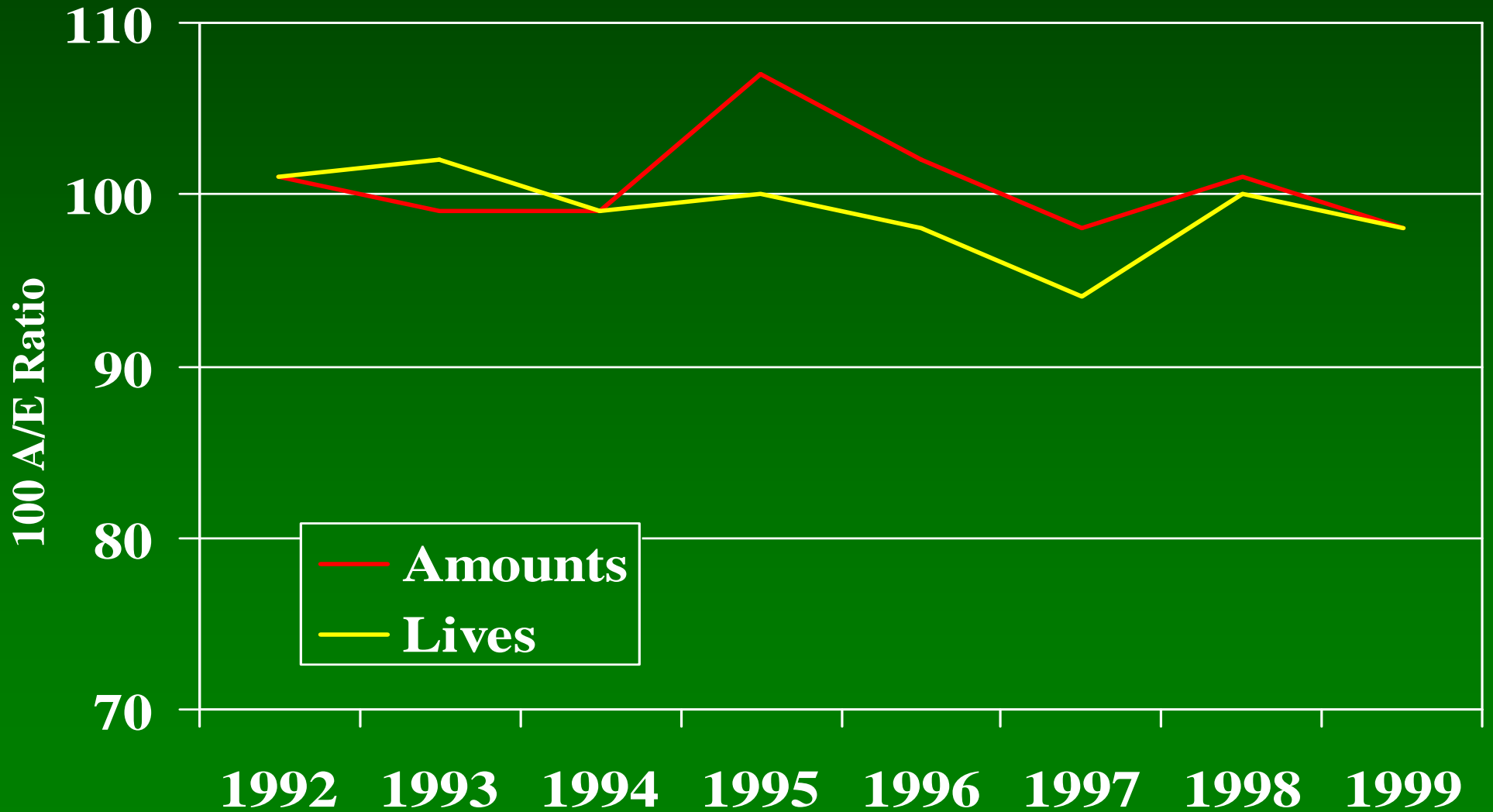# All Office to 83 - Loyal Office to 99 - then "92" Series projection

Short cohort

Medium Cohort

Long Cohort

Contour map of
2D graduation
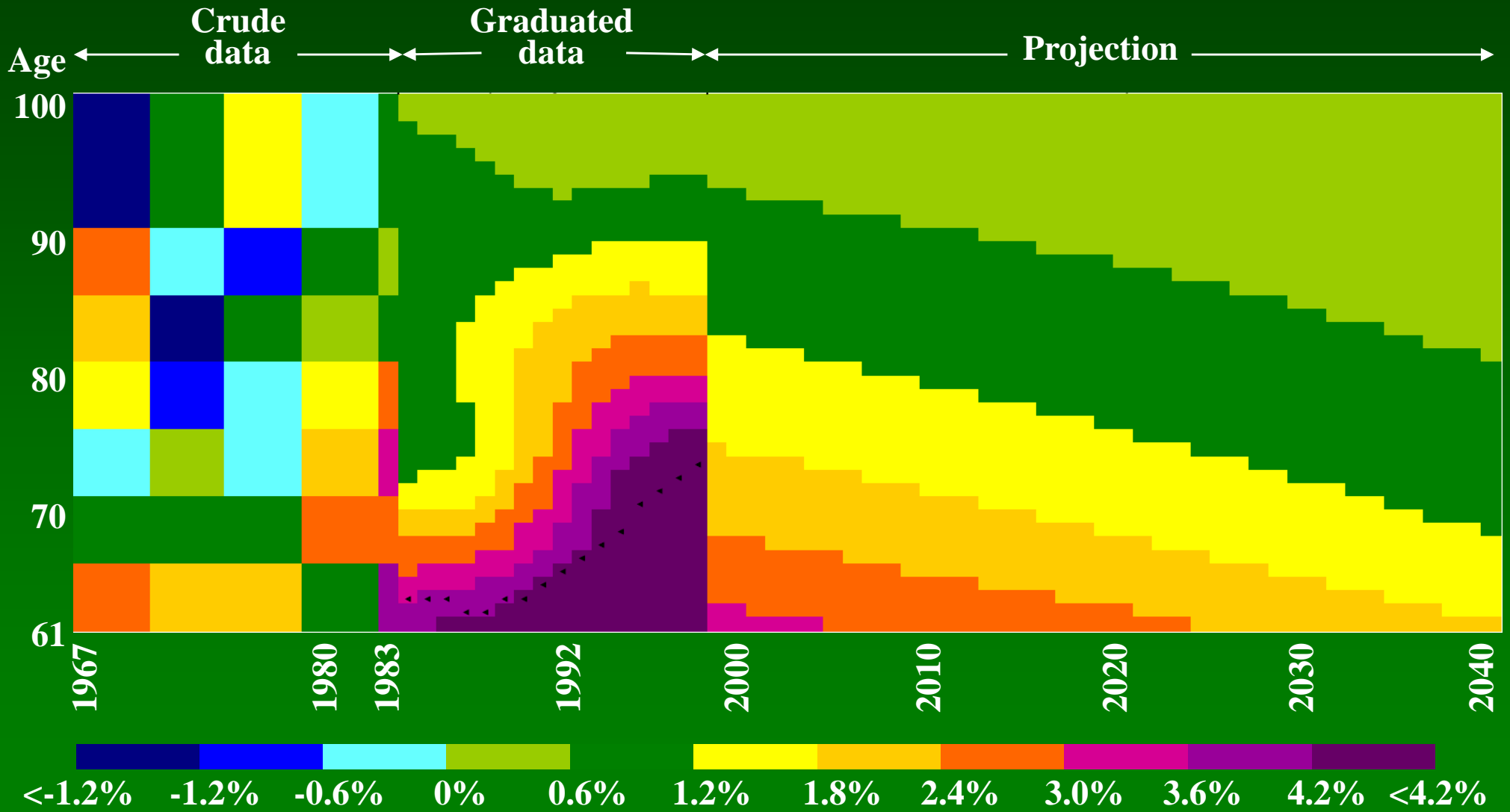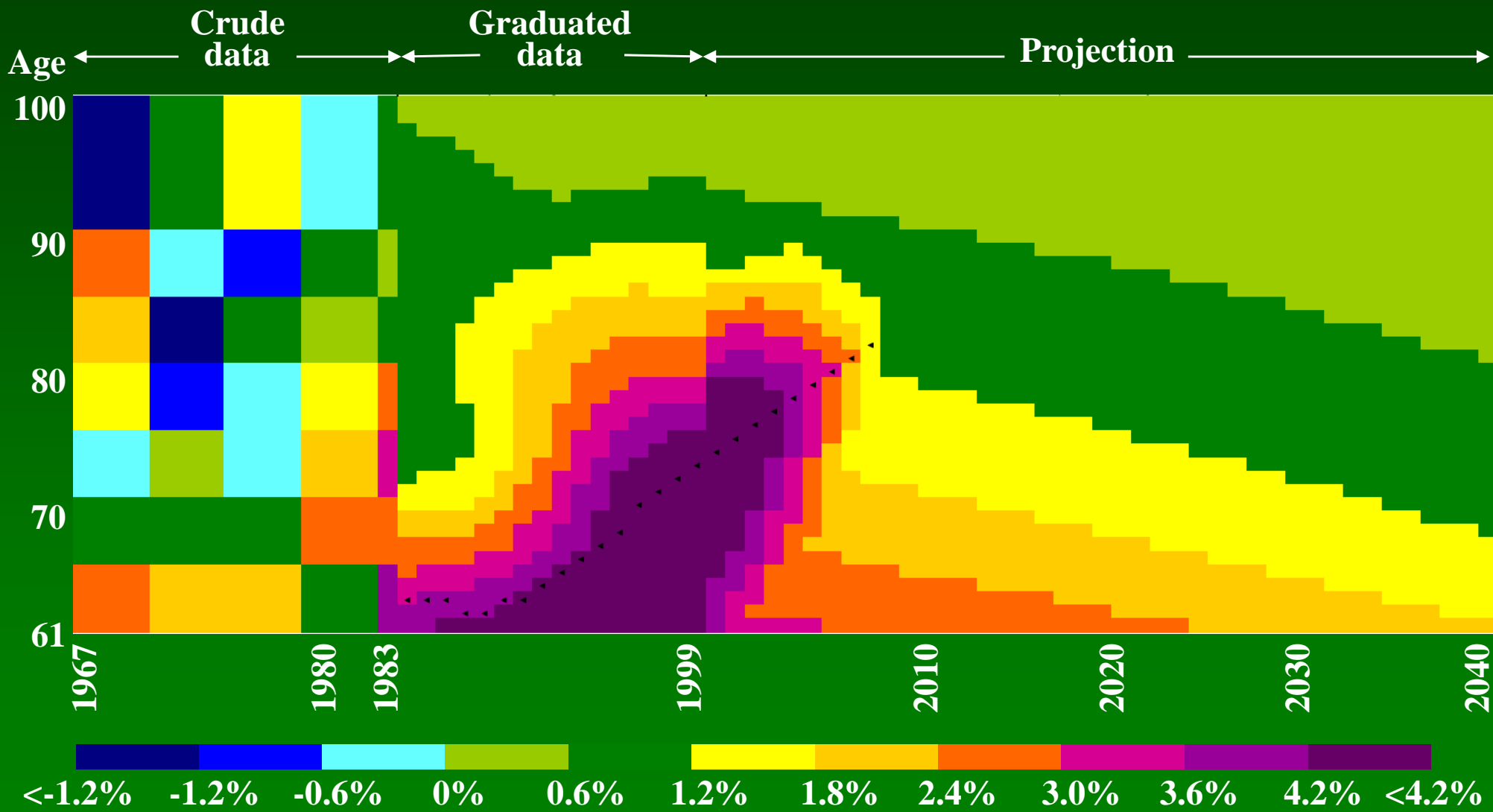
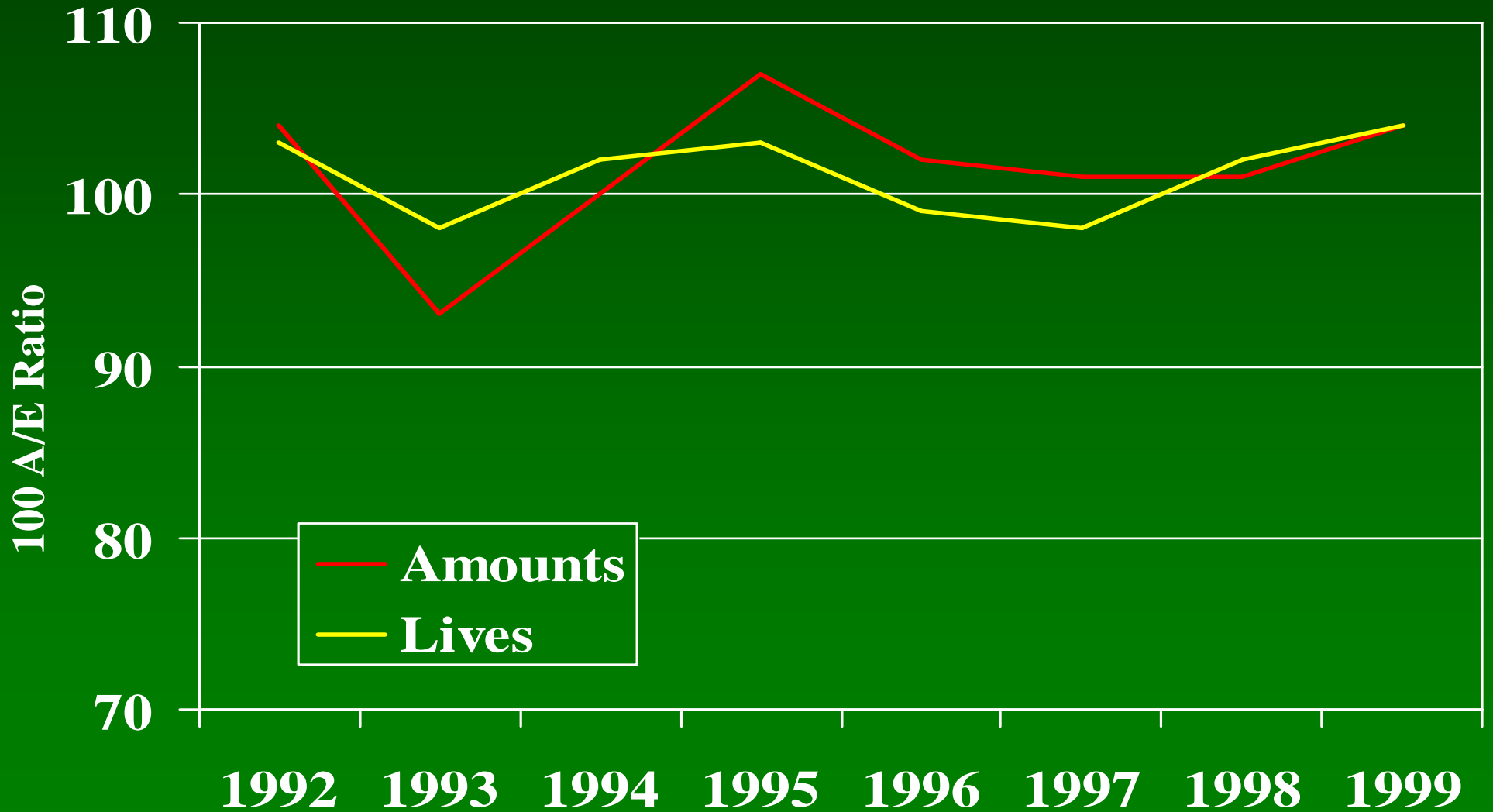Assured lives,
males +
Medium Cohort
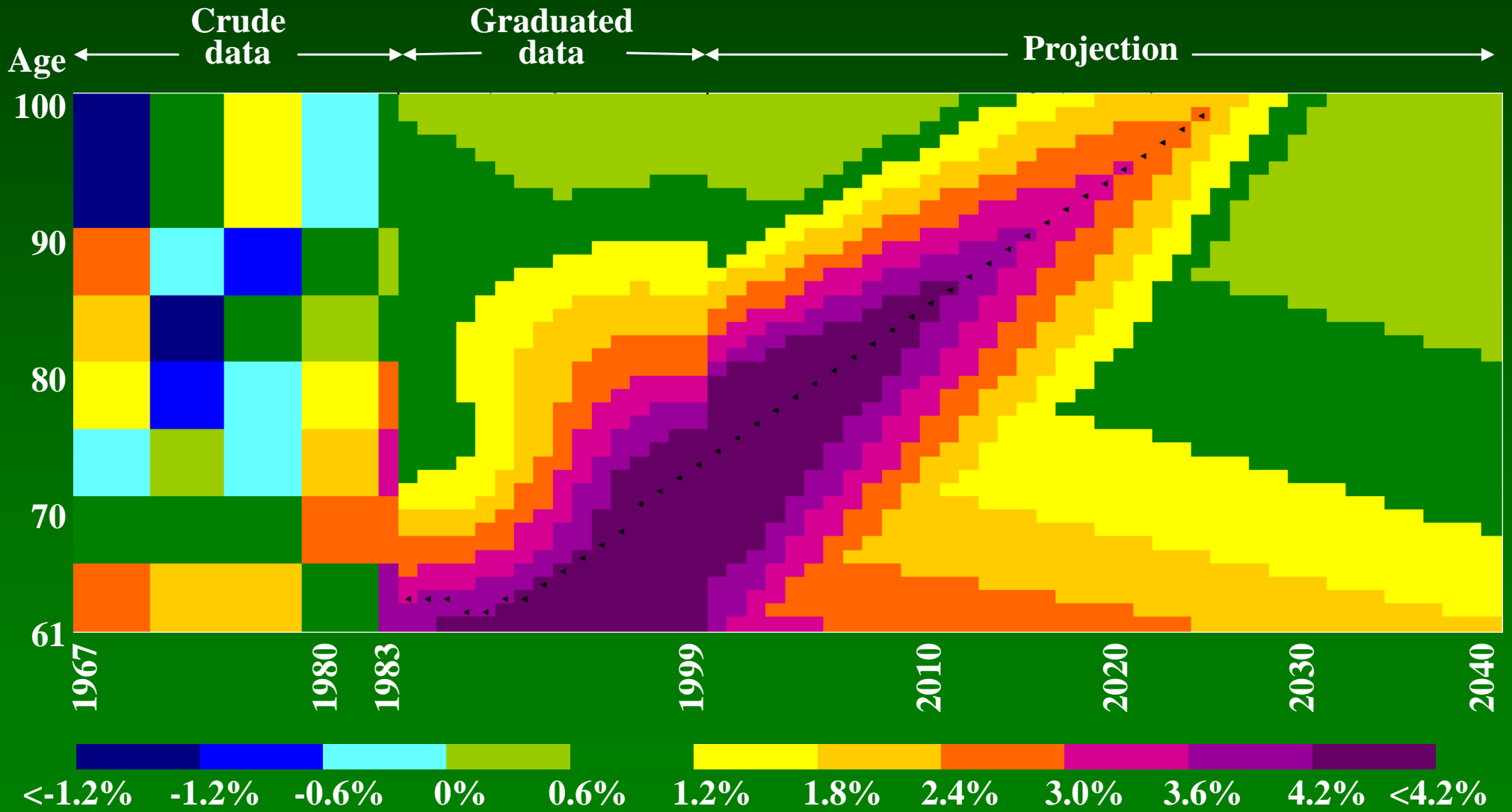
Does it fit the 1992-99 data?

All Office Pensioners 100A/E using the "92" Series projected with Medium Cohort improvement factors - Males

Loyal Office Pensioners 100A/E using the "92" Series projected with Medium Cohort improvement factors - Males

Financial effects – annuities (1)

- Comparison basis 90% of "92" Series table
- Interest 0%, U = 2000, age 65

Comparison	18.04	100%
Short Cohort	18.88	105%
Medium Cohort	19.55	108%
Long Cohort	20.97	116%

Financial effects – annuities (2)

- Comparison basis 90% of "92" Series table
- Interest 0%, U = 2010, age 65

Comparison	19.00	100%
Short Cohort	19.77	104%
Medium Cohort	20.46	108%
Long Cohort	22.12	116%

Financial effects – annuities (3)

- Comparison basis 90% of "92" Series table
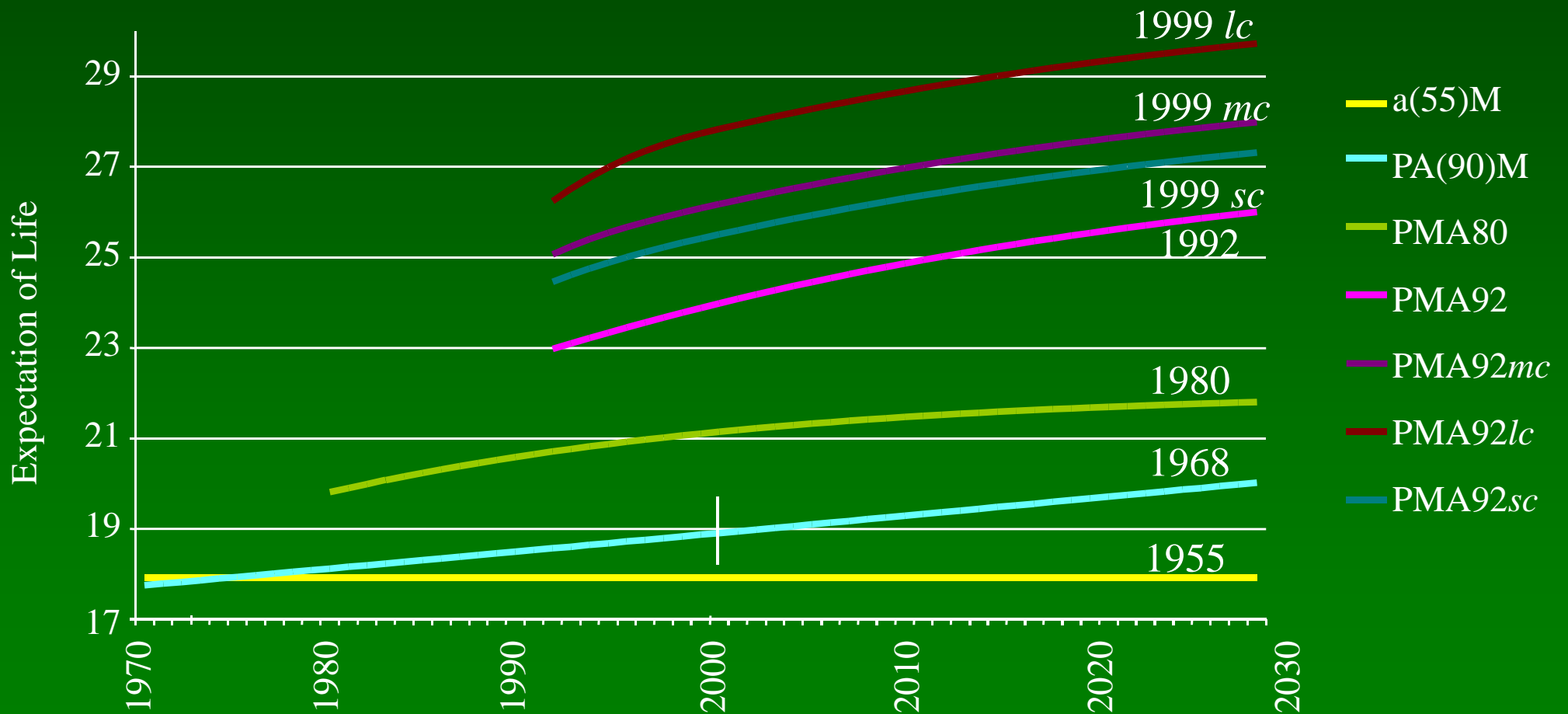- Interest 3%, U = 2000, age 65

Comparison	13.08	100%
Short Cohort	13.61	104%
Medium Cohort	13.94	107%
Long Cohort	14.58	112%

Financial effects – annuities (4)

- Comparison basis 90% of "92" Series table
- Interest 3%, U = 2010, age 65

Comparison	13.65	100%
Short Cohort	14.14	104%
Medium Cohort	14.48	106%
Long Cohort	15.24	112%

Expectation of life for males aged 60 in 2000

Things not yet done

- Amounts v Lives
- Males v Females
- Graduate crude improvement factors
- Comparison with other countries
- Medical experts
- Causes of death
- Demography
- Projection techniques (1 s.d.?)

Where to get CMIB papers?

www.actuaries.org.uk