Proof of radiation-induced health effects with unconventional epidemiological methods

Report from Germany

Sebastian Pflugbeil

All methods and data belong to the group represented by
Hagen Scherb, Helmholtz-Center Muenich-Neuherberg

Background and Motivation Radiation and Sex Ratio or Sex Odds

- **Sex Ratio (SR)** is the pertinent term for the number of newborn boys divided by the number of newborn girls

$$SR = \text{boys/girls} = m/f$$

- The **male probability**

$$p_{male} = \text{boys}/(\text{girls} + \text{boys}) = m/(m+f)$$

leads to the more appropriate **Sex Odds (SO)**

$$SO = p_{male}/(1- p_{male}) = \text{boys/girls} = SR$$

- Comparing two **SO**, exposed and unexposed, leads to the obvious and natural measure **Sex Odds Ratio**

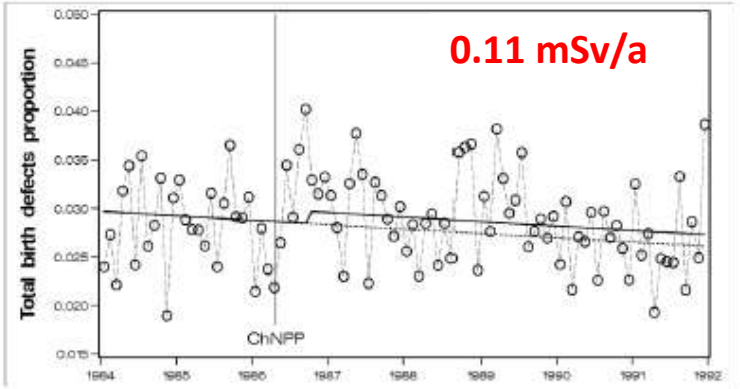
$$SOR = SO_{exposed}/So_{unexposed}$$

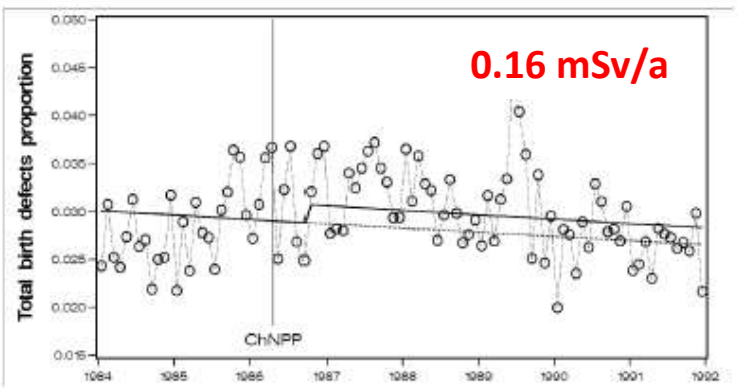
- **The inconvenient term "*Sex Ratio Ratio*" is avoided (in German: Geschlechtsverhältnisverhältnis vs. Geschlechtschancenverhältnis)**

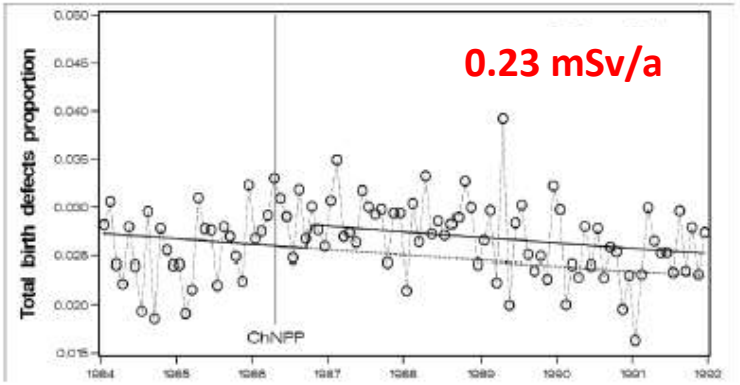
Congenital Malformations (Birth Defects)

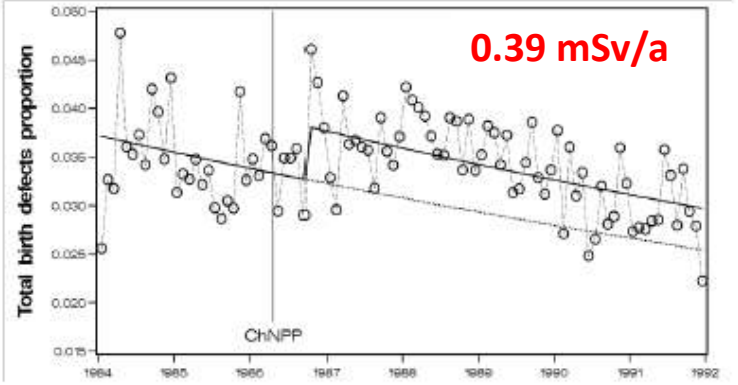
Definition of a **birth defects proportion** (rate):

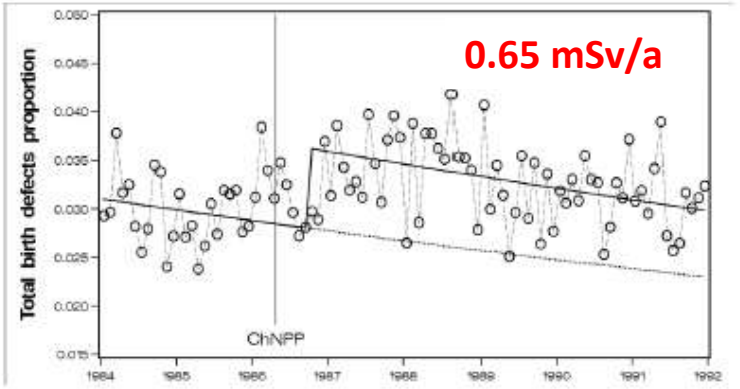
number of birth defects : number of total births











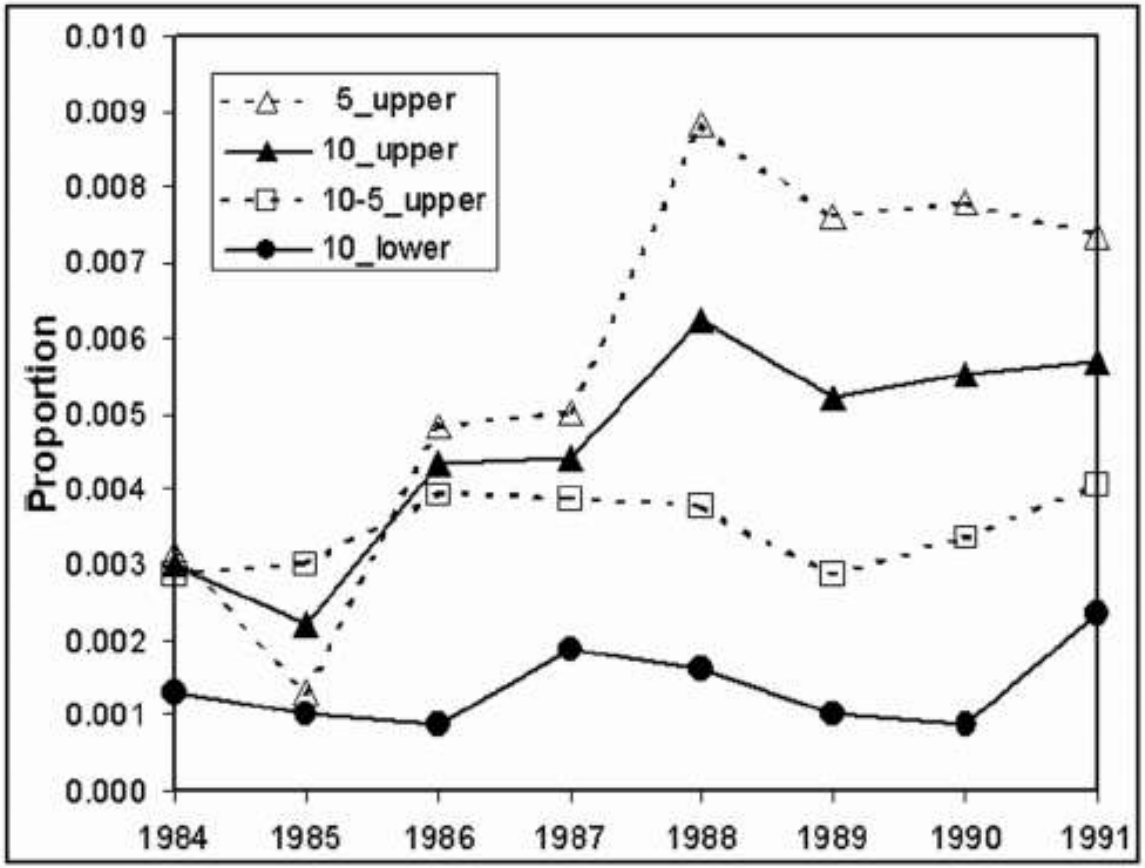
Trends of male and female congenital malformations (n=29962) in Bavaria according to quintiles of the annual exposure dose

The increase in congenital malformation rates is proportional to the mean dose in five exposure quantile classes from 96 Bavarian districts; n = 29961

Boys: 32 % per mSv/a
95% CI [13, 54]
$p < 0.0001$

Girls: 82 % per mSv/a
95% CI [53, 117]
$p < 0.0001$

!

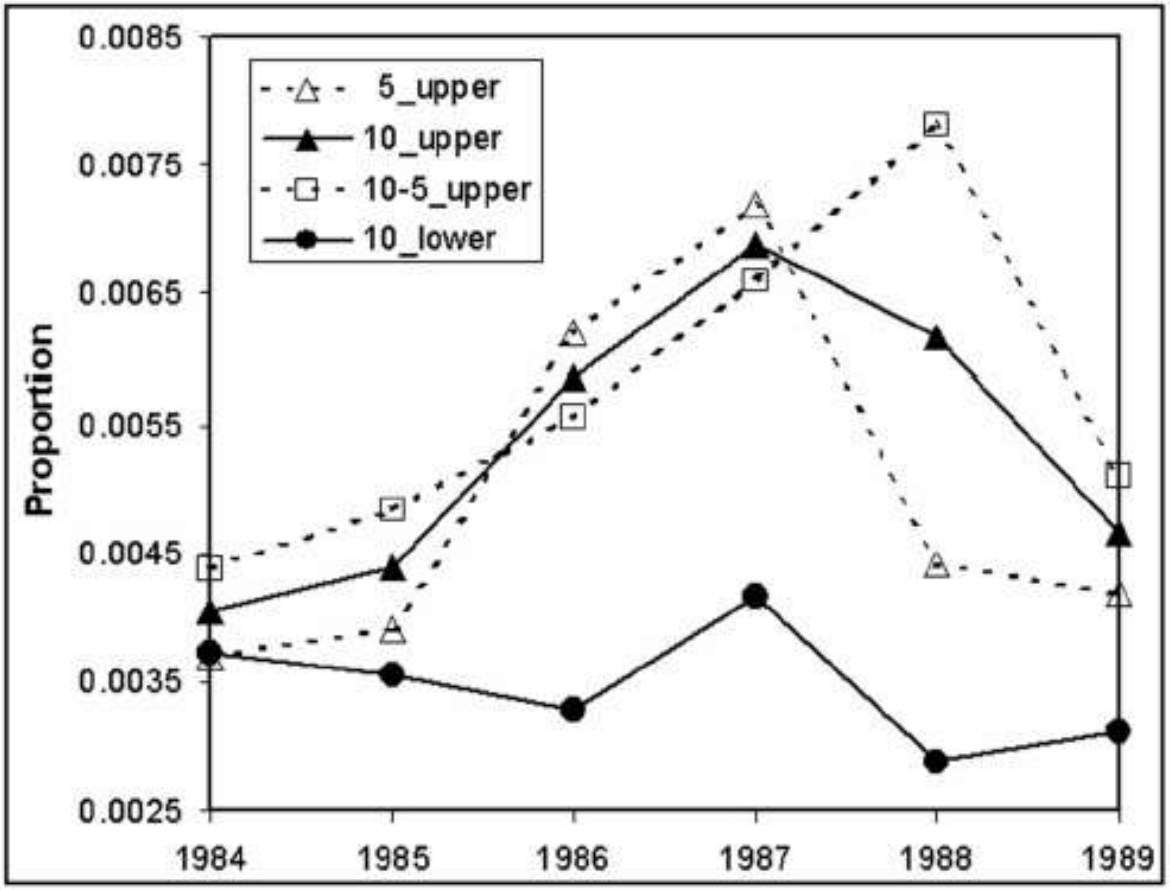


37.2 kBq/m^2

4.5 kBq/m^2

Birth proportions of congenital heart malformations
ICD9 745.4 (VSD) + 745.5 (ASD), n=2797 in Bavaria

RR = 1.013, p = 0.0020 per kBq/m^2
RR = 1.830, p = 0.0020 per mSv/a



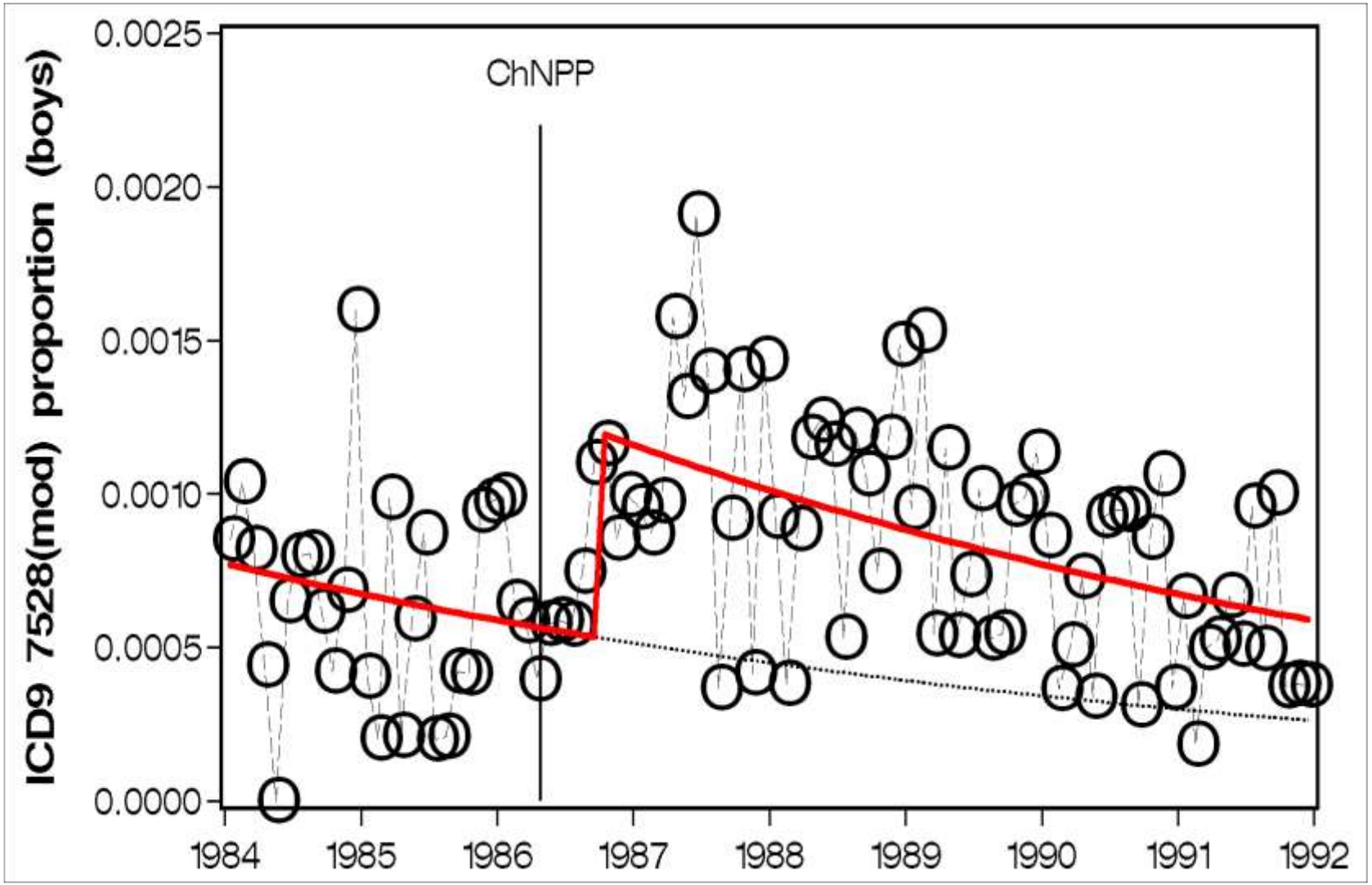
37.2 kBq/m^2

4.5 kBq/m^2

Birth proportions of deformities of the skull, face, jawbone, neck, spine, hip joints, long bones of legs, and feet (ICD9 754.0-754.4, 754.6-754.8, 756.5), n= 3686 in Bavaria

RR = 1.018 p = 0.000036, highly significant, per kBq/m^2 of cesium 137

RR = 2.295 p = 0.000036, highly significant, per mSv/a



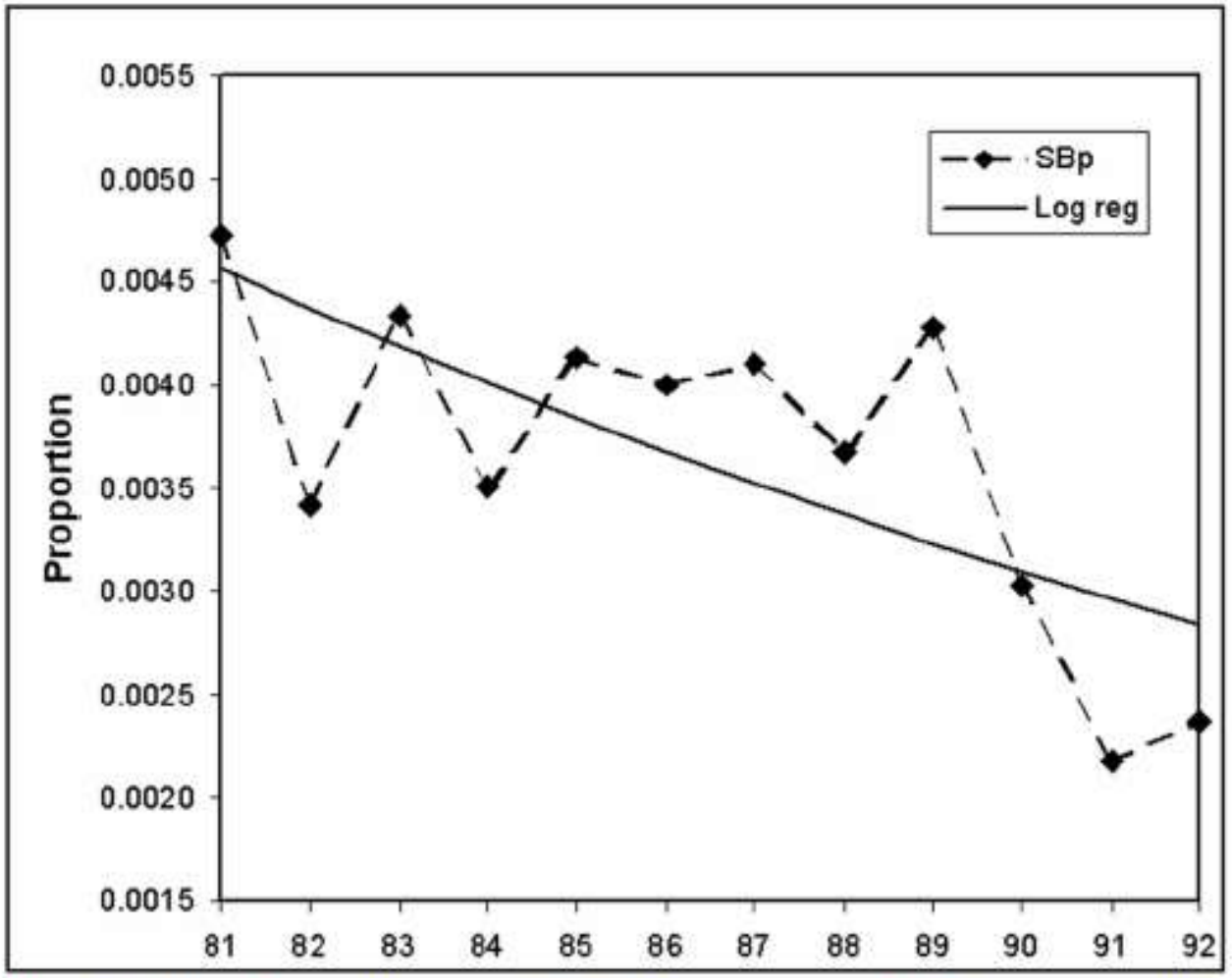
Congenital malformations in reproductive organs of boys (ICD9 752.8) in Bavaria

Odds ratio (OR) for the jump in October 1986: OR = 2.26, $p < 0.0001$

Stillbirth

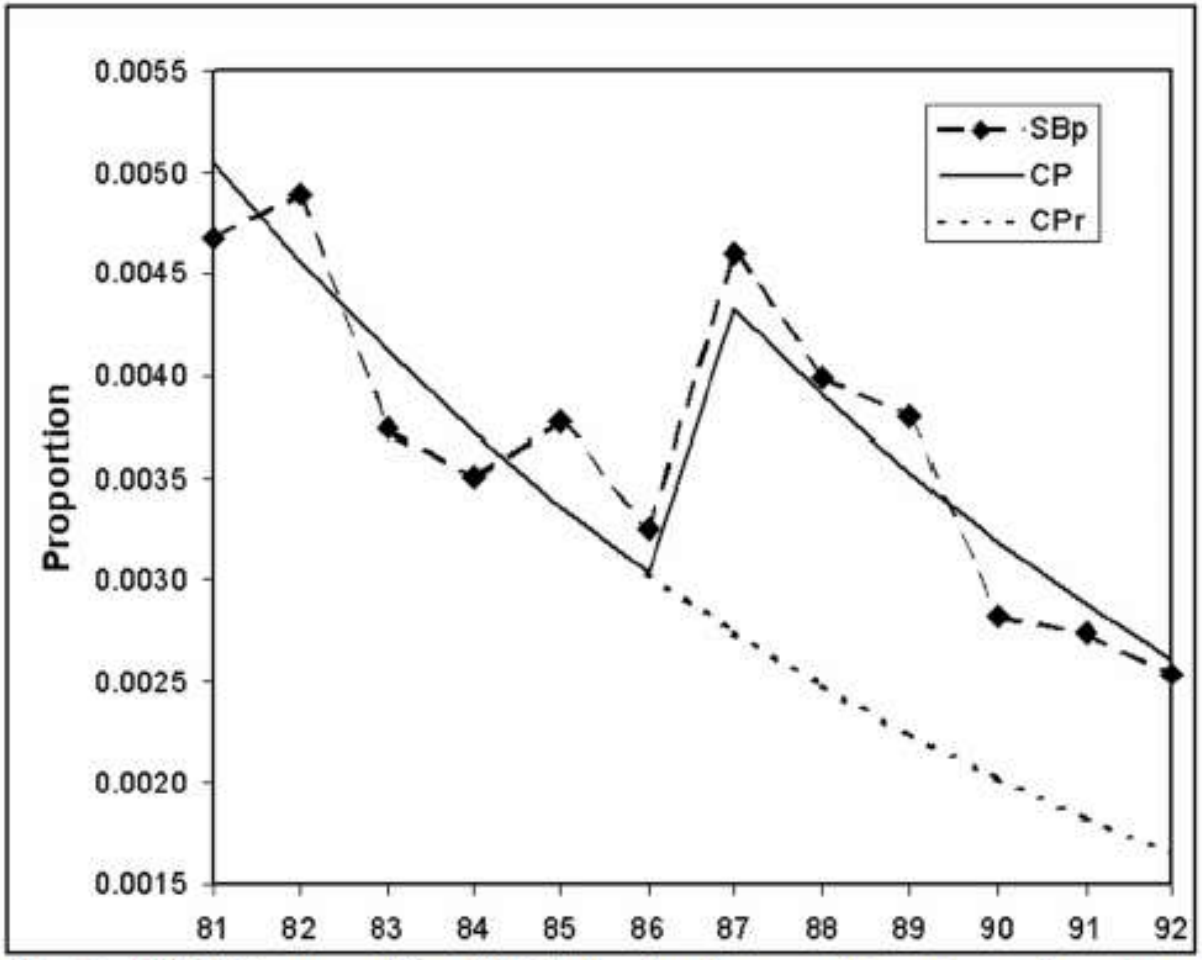
Definition of a **stillbirth proportion (rate):**

number of stillbirths : number of total births



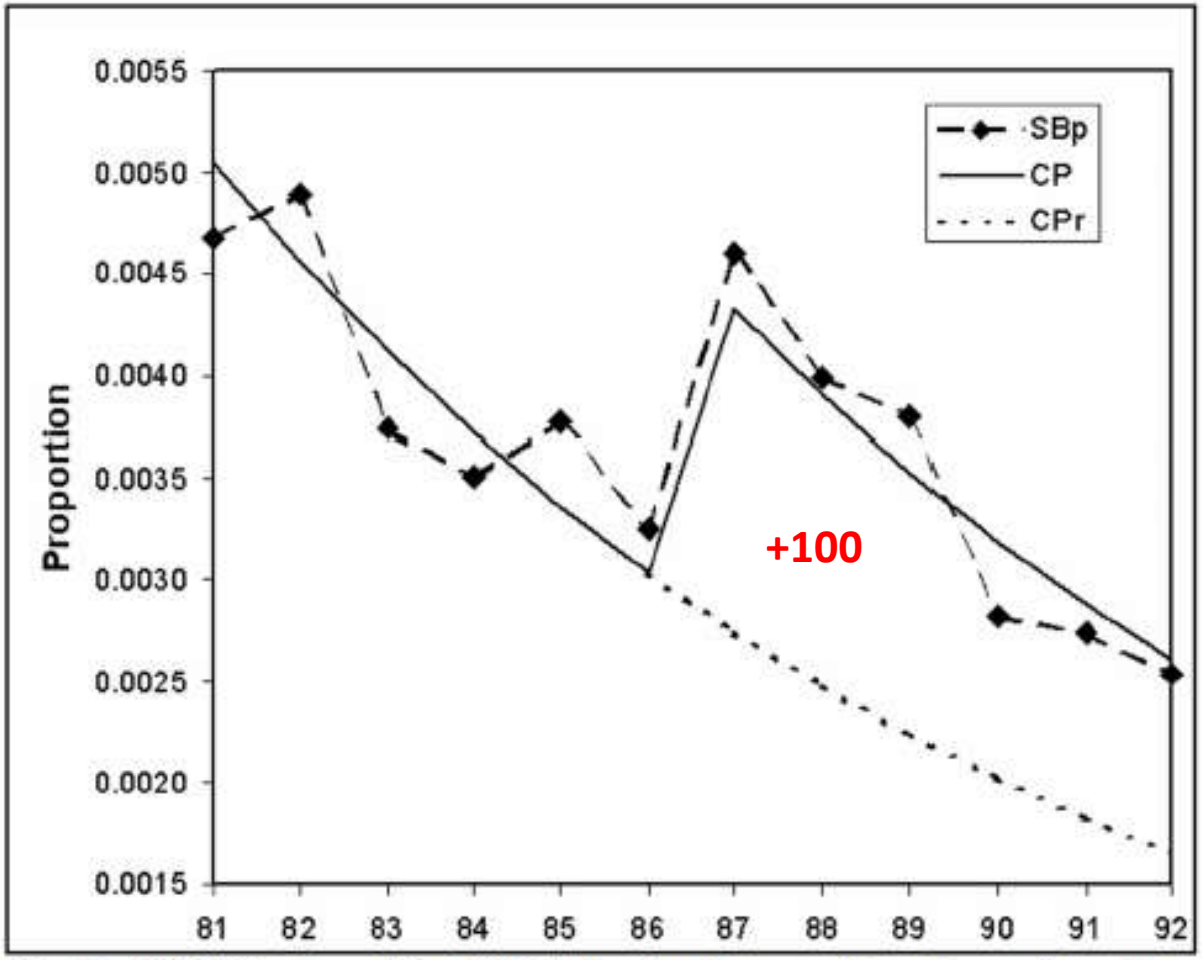
Stillbirth proportions (SBp) for the ten combined, **least** contaminated districts in Bavaria

Mean cesium 137 deposition density: **4.5** kBq/m^2
No significant change point observed



Stillbirth proportions (SBp) for the ten combined, **most** contaminated districts in Bavaria

Mean cesium 137 deposition density: **37.2 kBq/m²**
Significant change point in 1987, p = 0.0091



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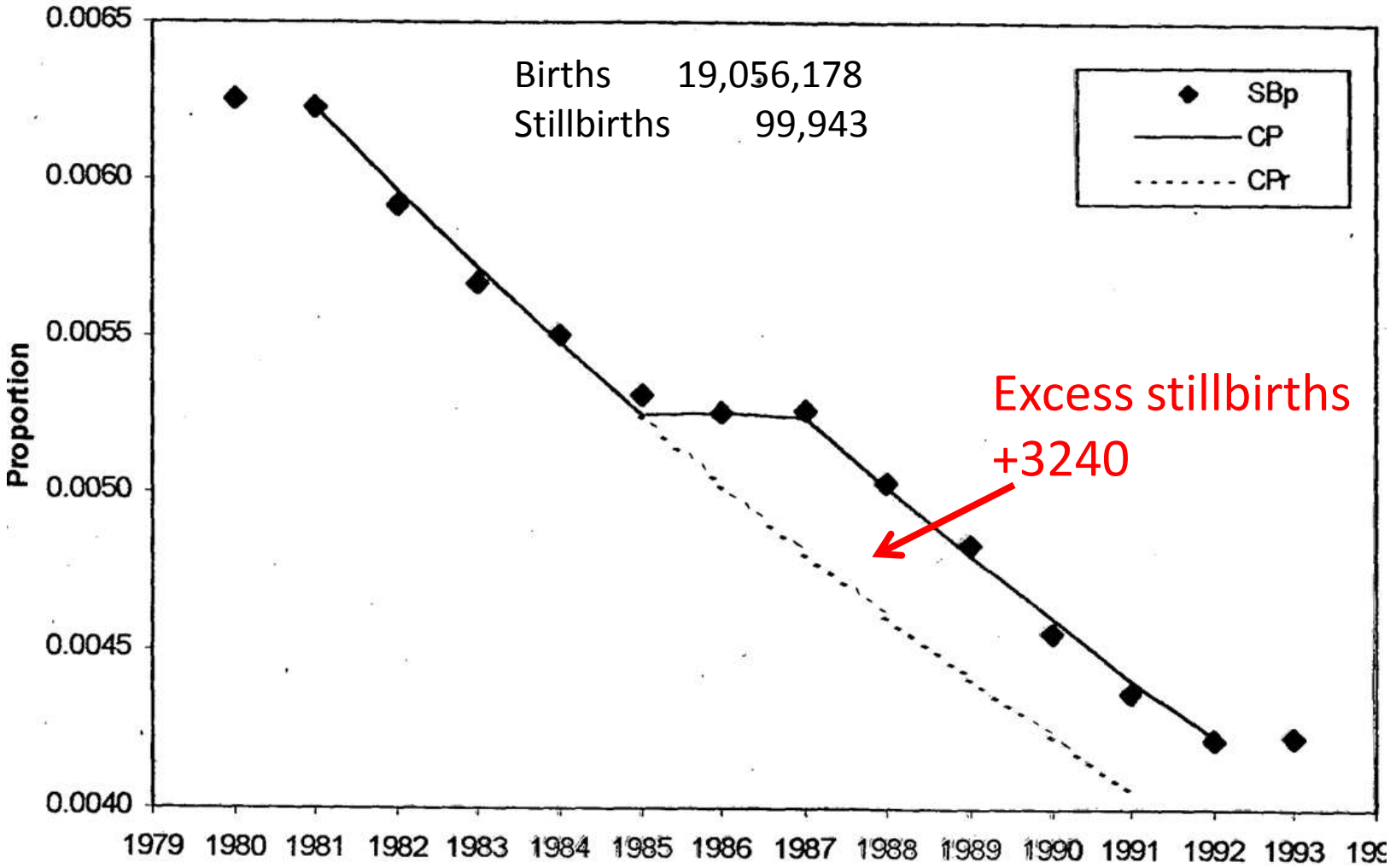
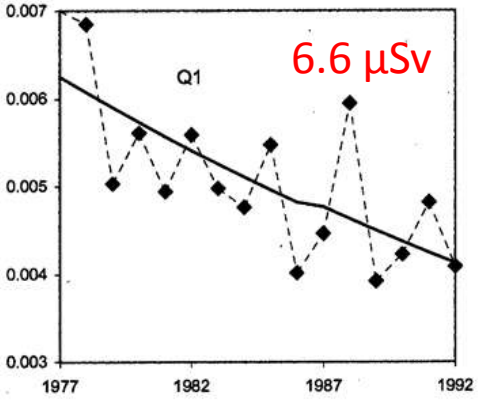
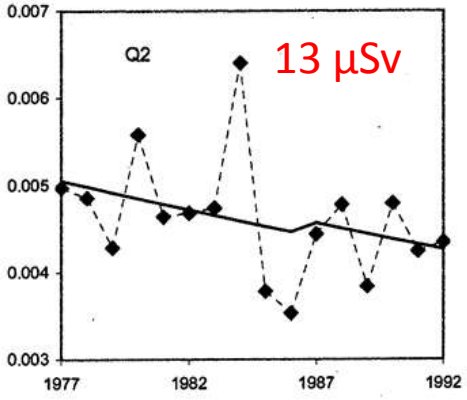


Stillbirth proportions for Denmark, Bavaria + GDR + West Berlin, Hungary, Iceland, Latvia, Norway, Poland, and Sweden combined, Change-Point (CP) and reduced Change-Point (CPr) models

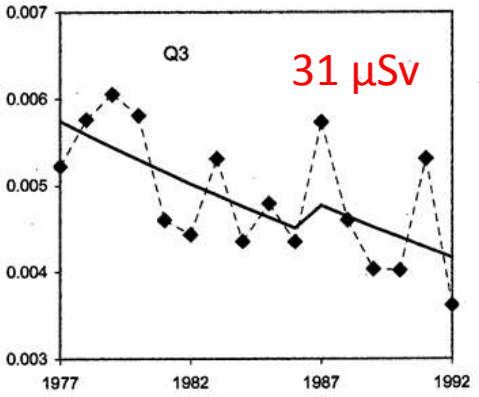
+3240, 95% CI [1973, 4560], p = 0.00000031

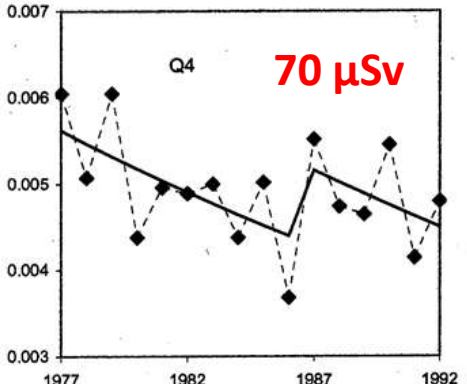


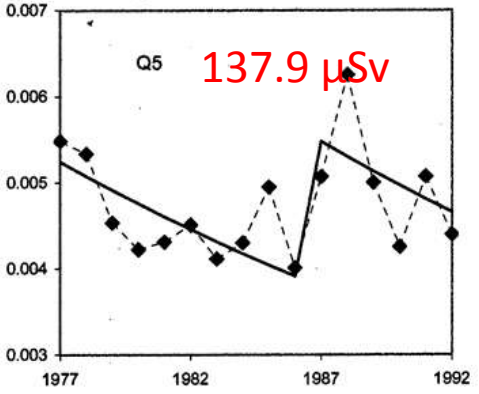


Stillbirth proportions in the Finnish exposure quintiles

Mean values in May 1986







Increases proportional to the exposure dose observed in 1987

RR per mSv/a: 1.25
95% CI [1.10, 1.42], $p = 0.0006$

409 excess stillbirths in Finland, 1987-1994

Stillbirths and Congenital Malformations

Significant Relative Risk per kBq/m^2

1.005 – 1.020

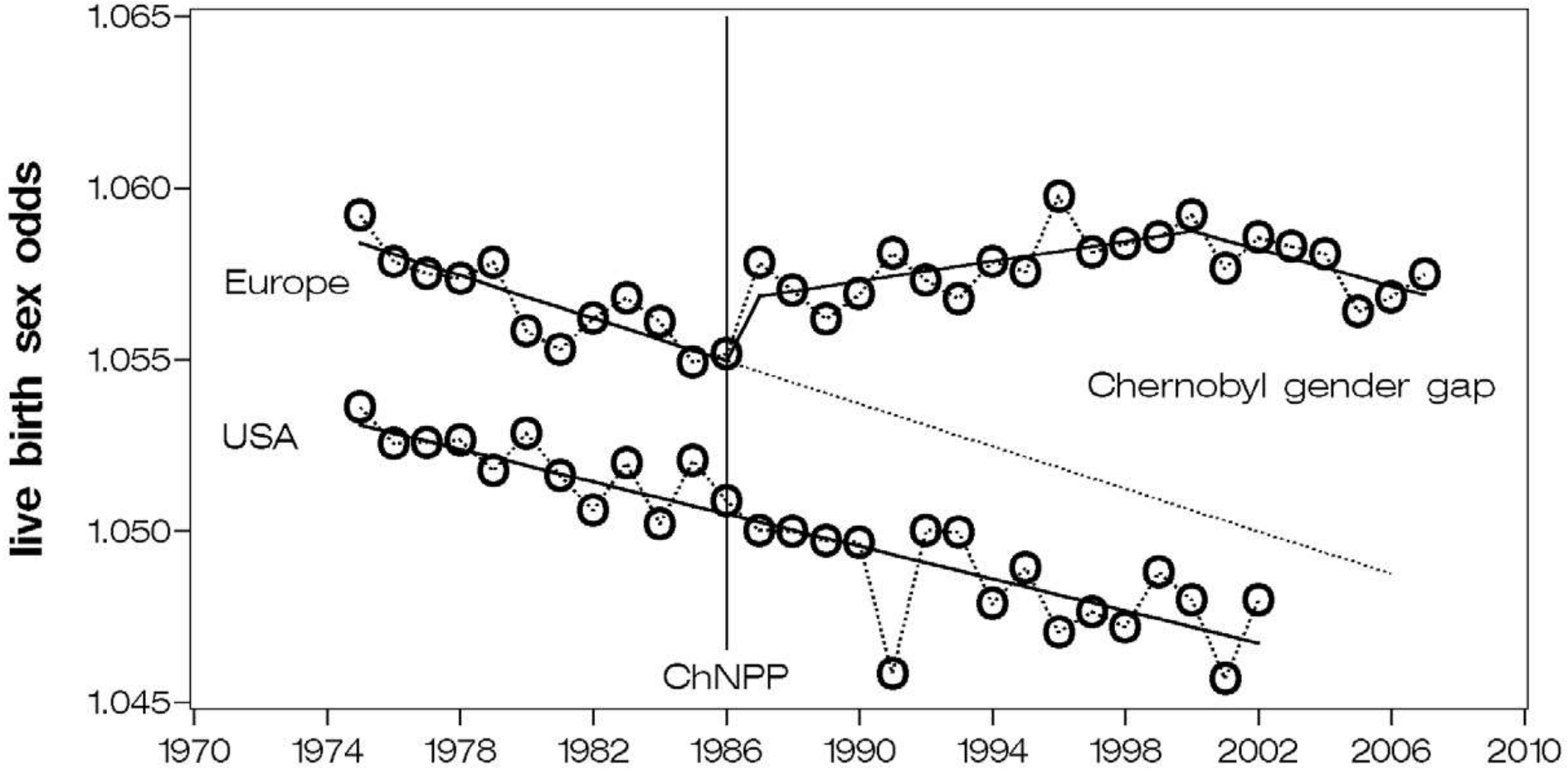
Newborn boys : Newborn girls

m : f

Sex odds (= m : f)

105 : 100

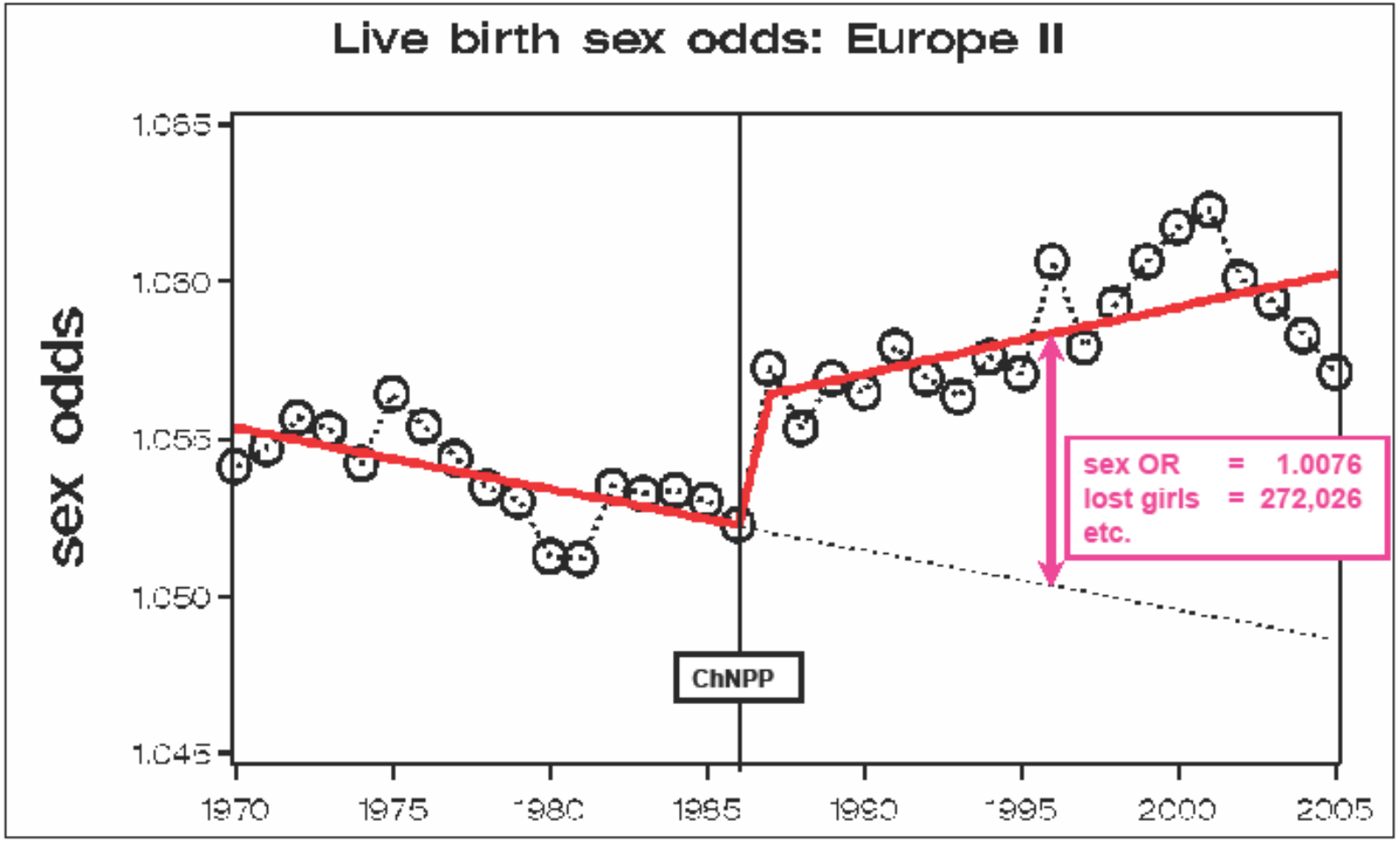
1.05



Trends of changes in the sex odds in 38 European countries – Chernobyl gap

No change in trend seen in USA

Lost children in Europe II (1987-2005) – not conservative, preliminary



HelmholtzZentrum münchen
German Research Center for Environmental Health

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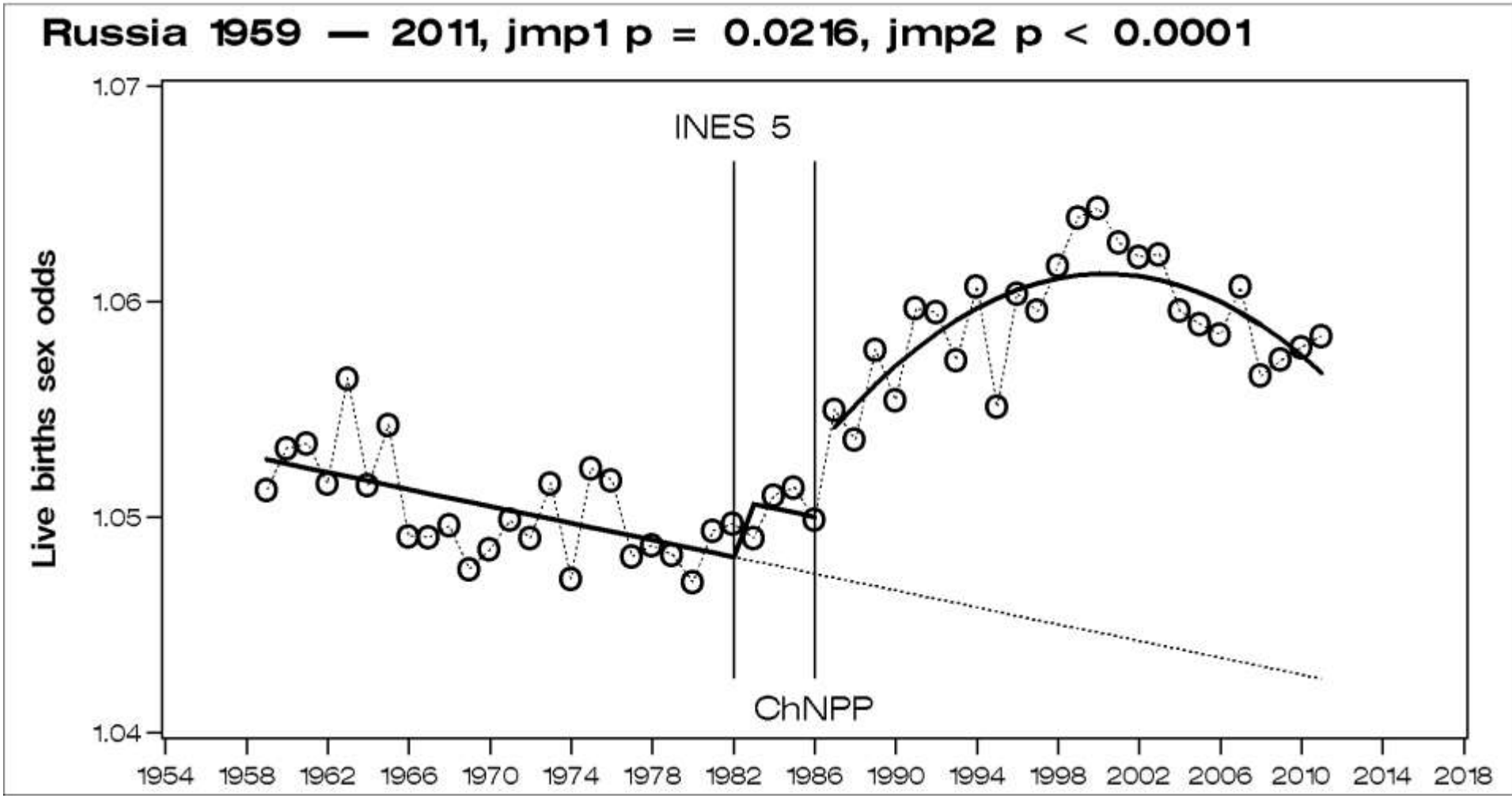
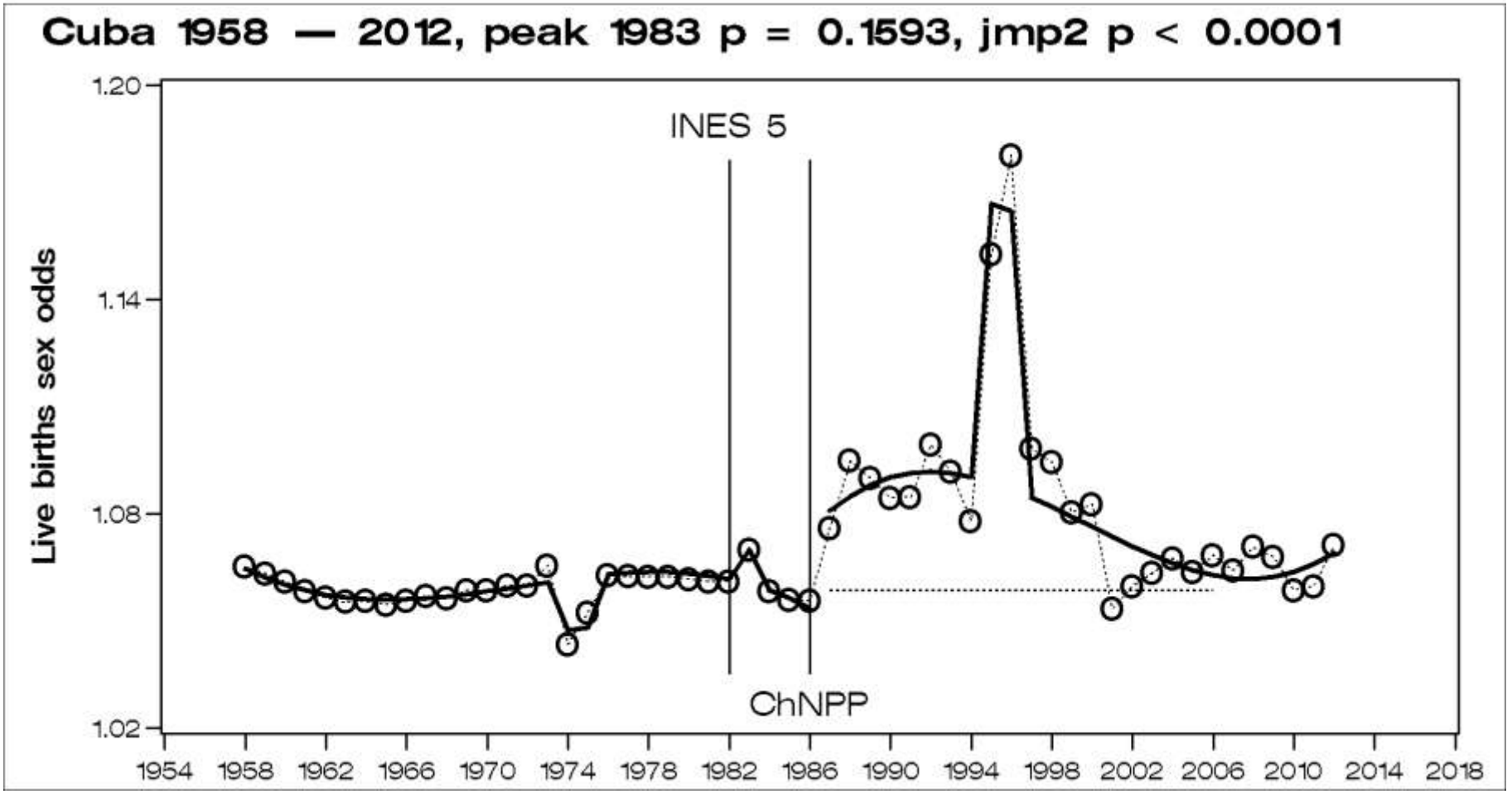
Lost children in Europe after Chernobyl



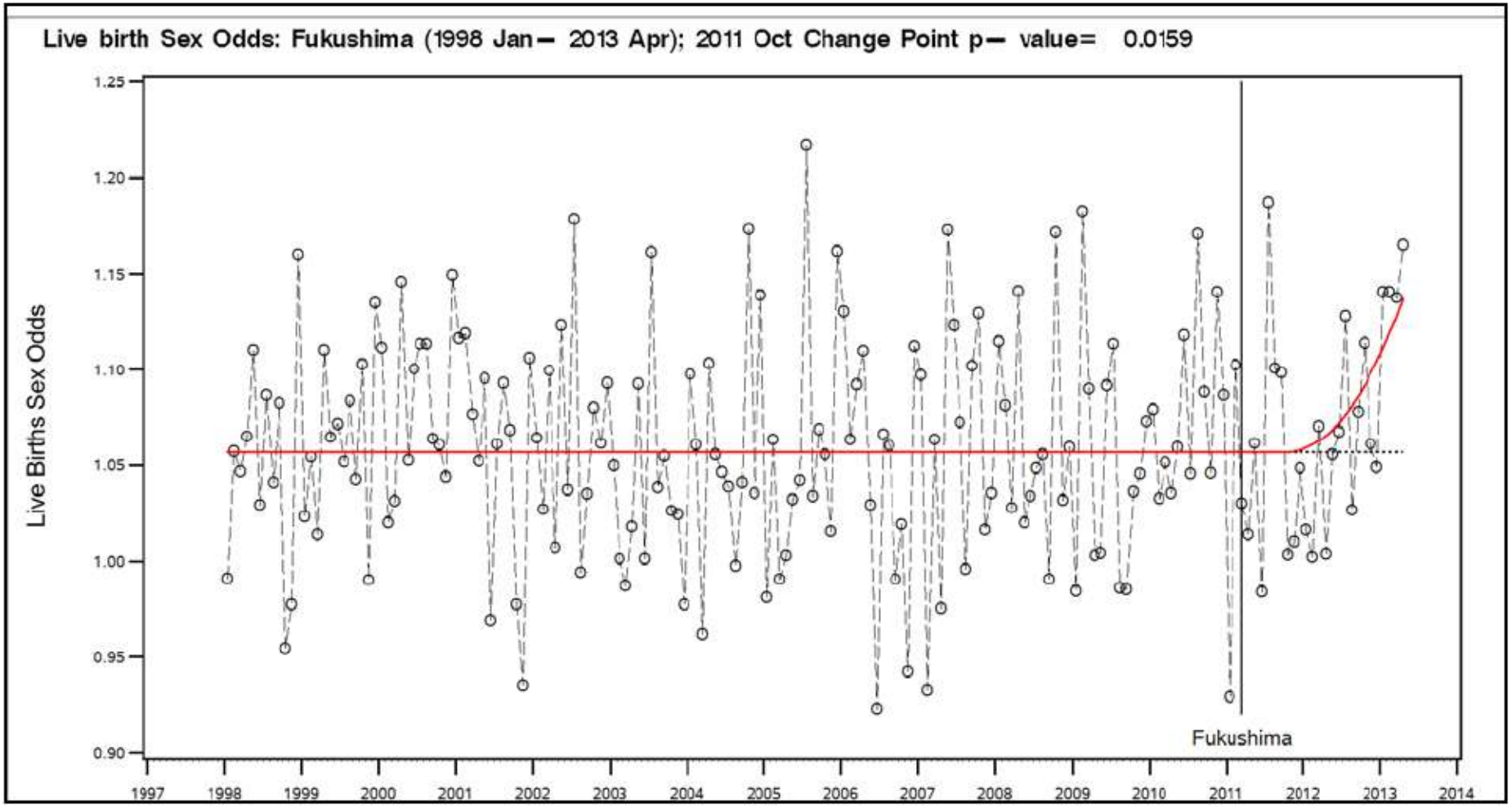
Changes in the sex odds (m/f) in Russia after Chernobyl in 1986

(INES 5 level accident in Chernobyl in 1982)



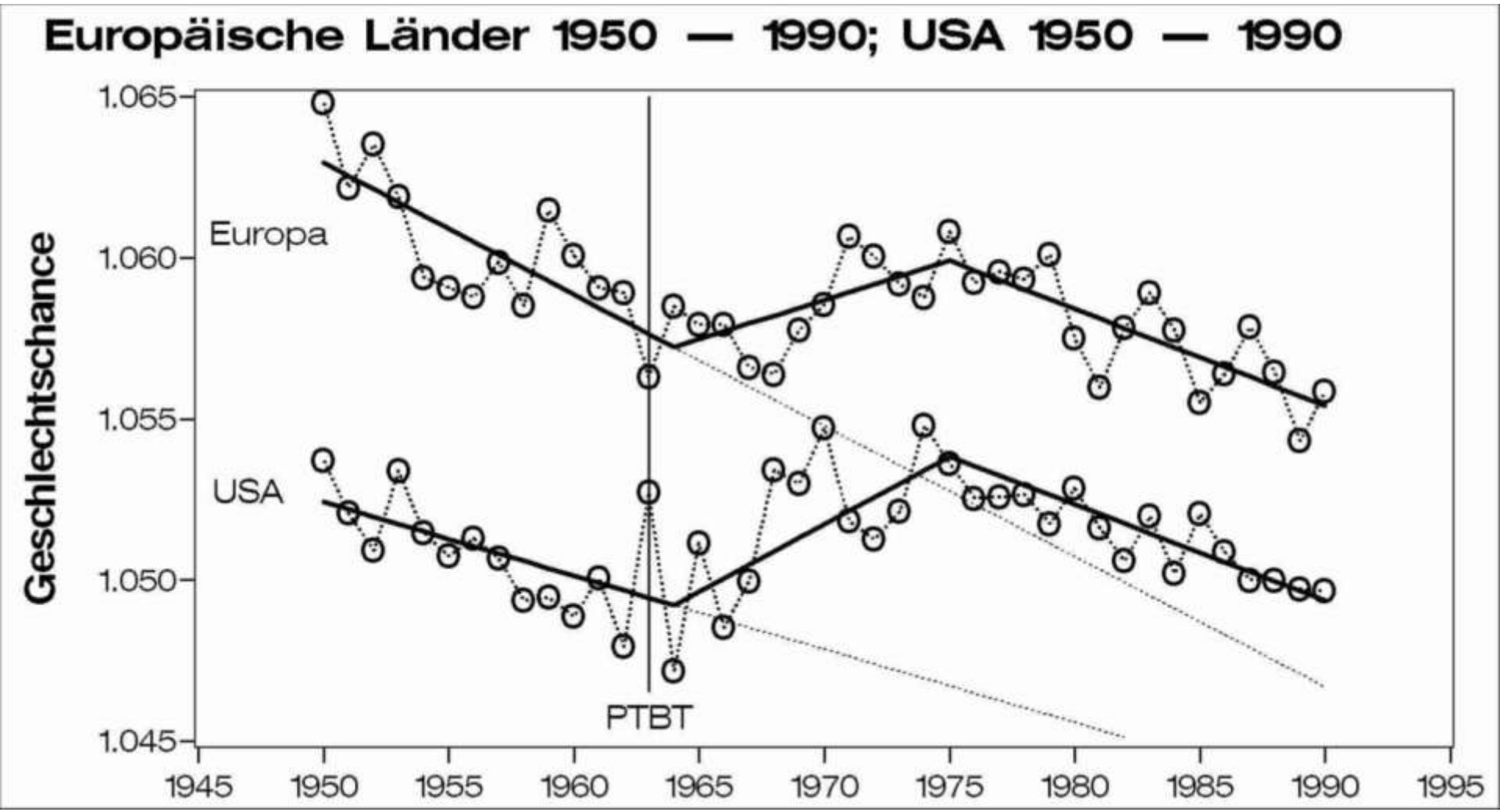
Changes in the sex odds (m/f) in Cuba after Chernobyl

Due to Russian food import ?



Changes in the sex odds (m/f) in Fukushima Prefecture after March 2011

http://www.mhlw.go.jp/tonkei/list/81-1.html



Lost children in Europe and USA after the **period of atmospheric atomic bomb tests**

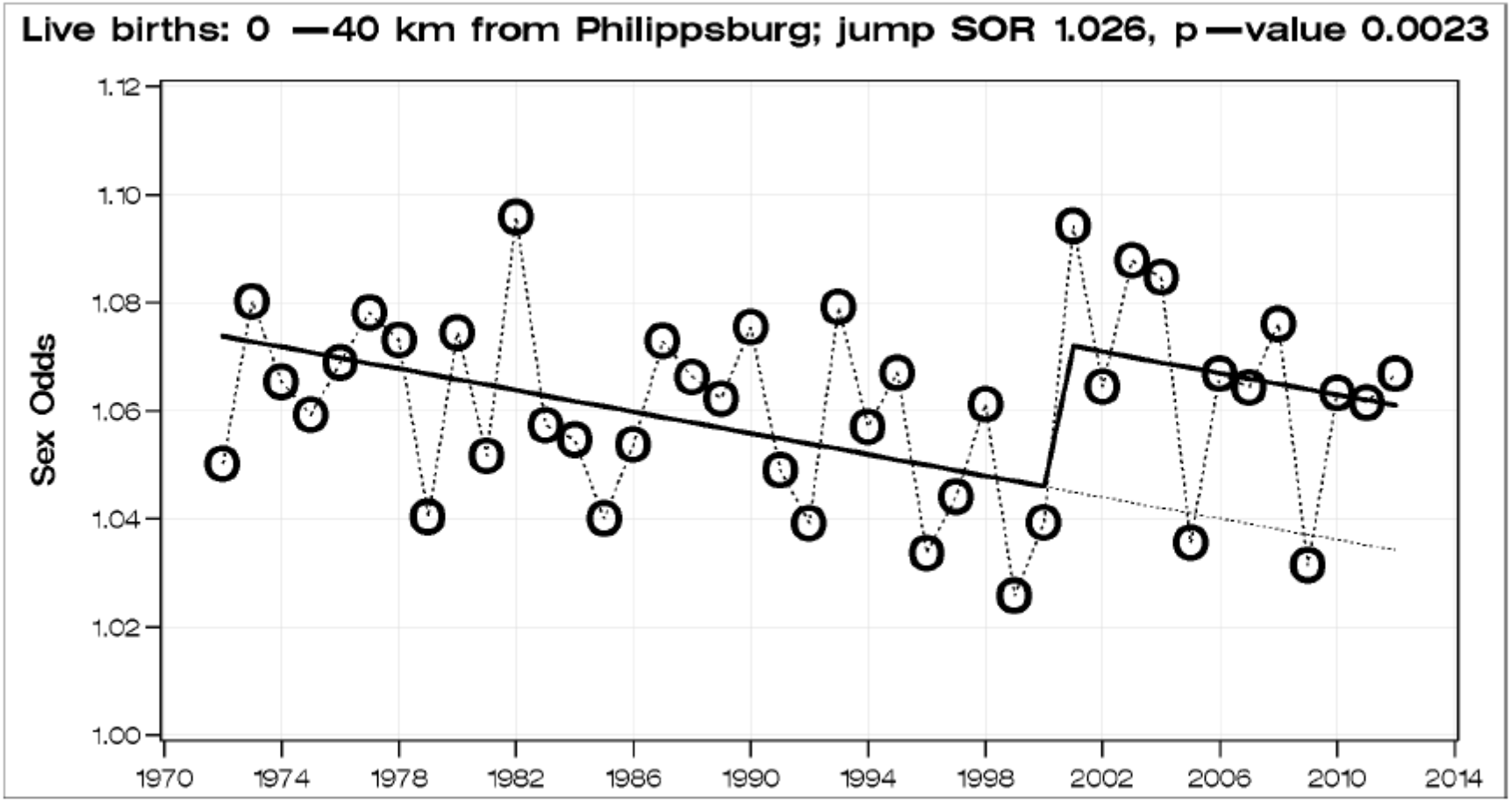
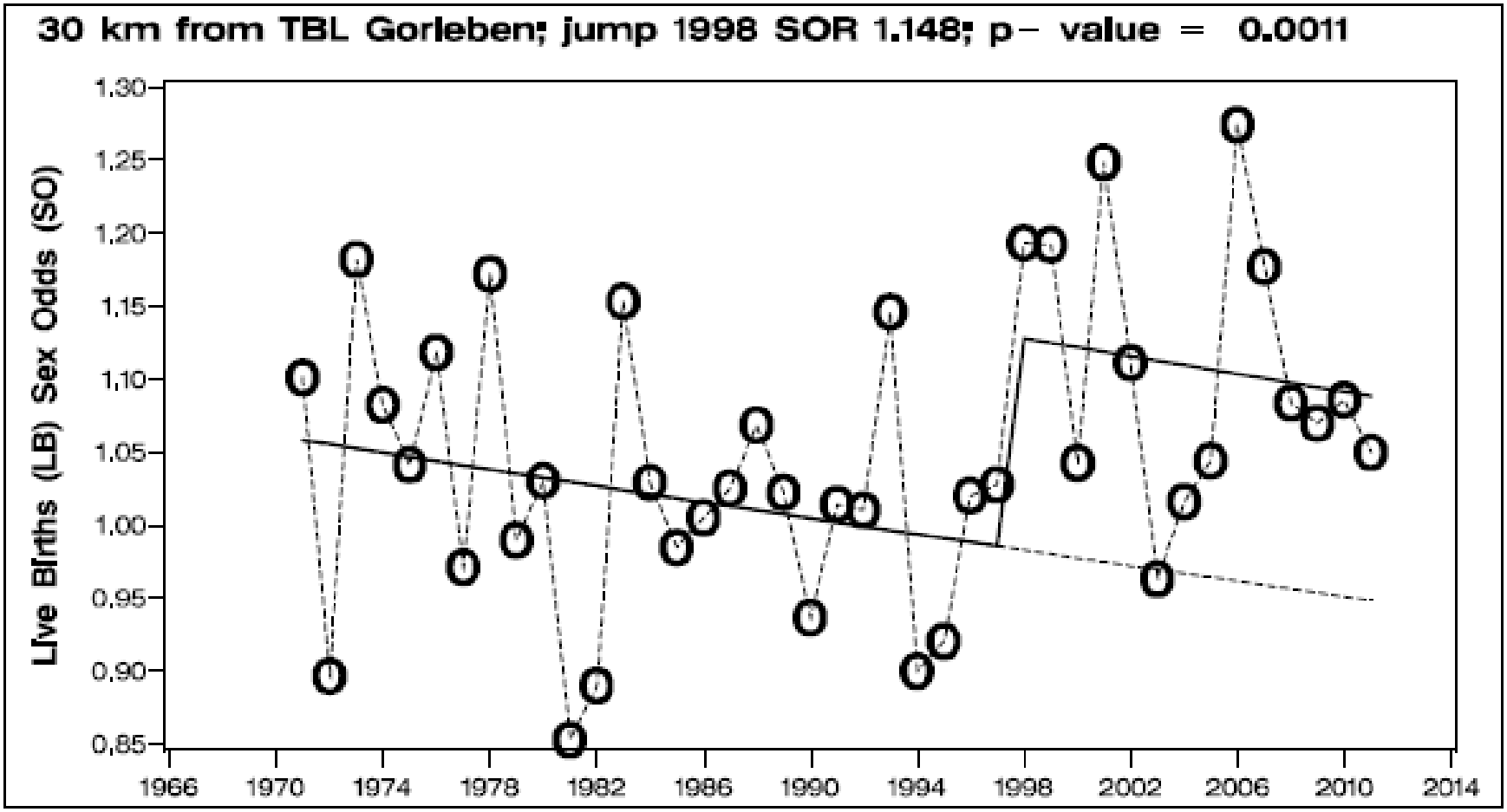


Fig. 1. Trend of the human sex odds at birth within 40 km from the HAW storage Philippsburg

Interim storage facility for highly radioactive waste near Philippsburg NPP in Germany

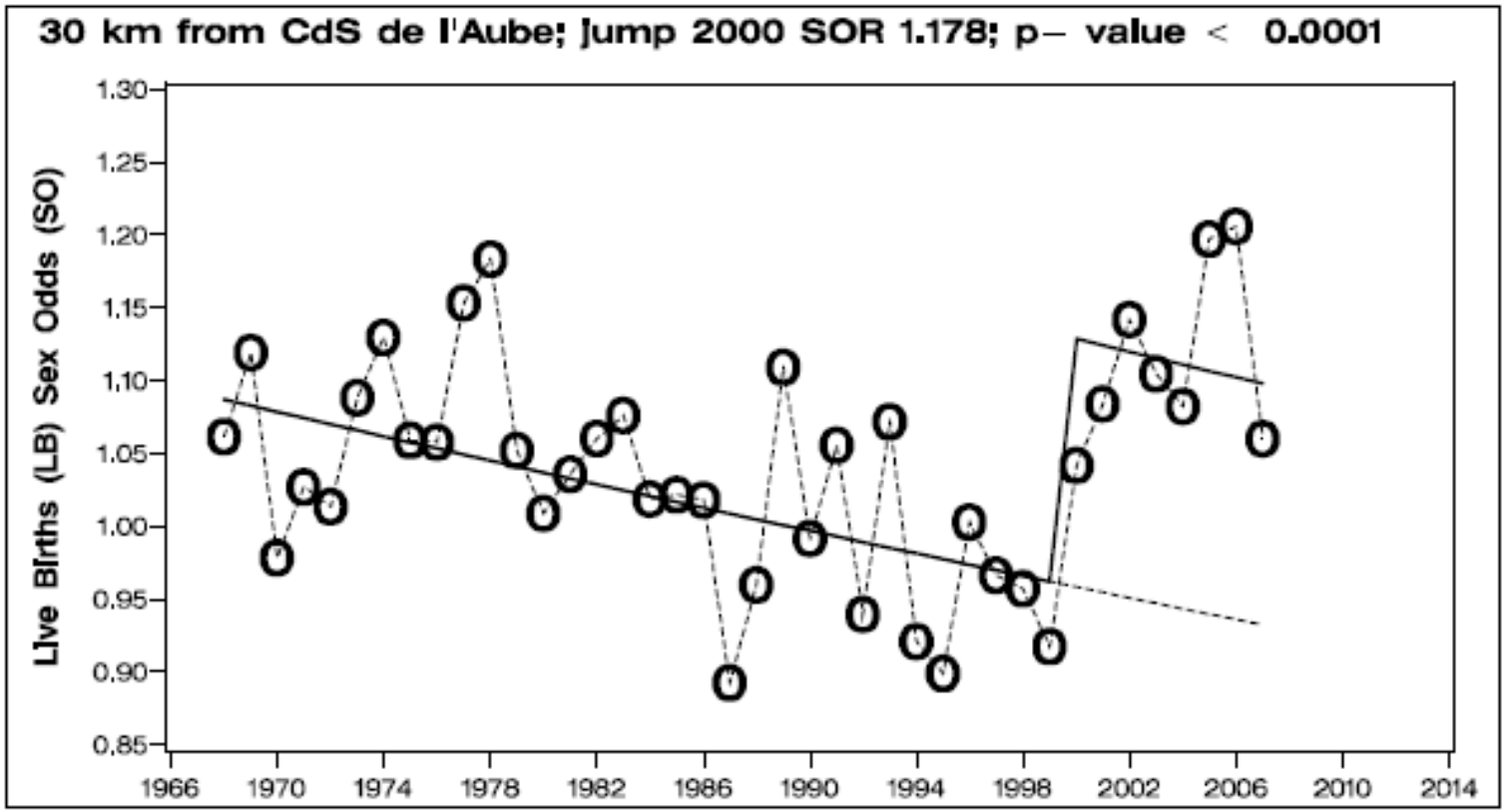
It opened in the middle of 2001.

Jump in the sex odds (m/f) in the middle of 2001 – highly significant



Jump in the sex odds (m/f) around 30 km from the interim storage facility in Gorleben (Germany)

First delivery of casks : Spring 1995



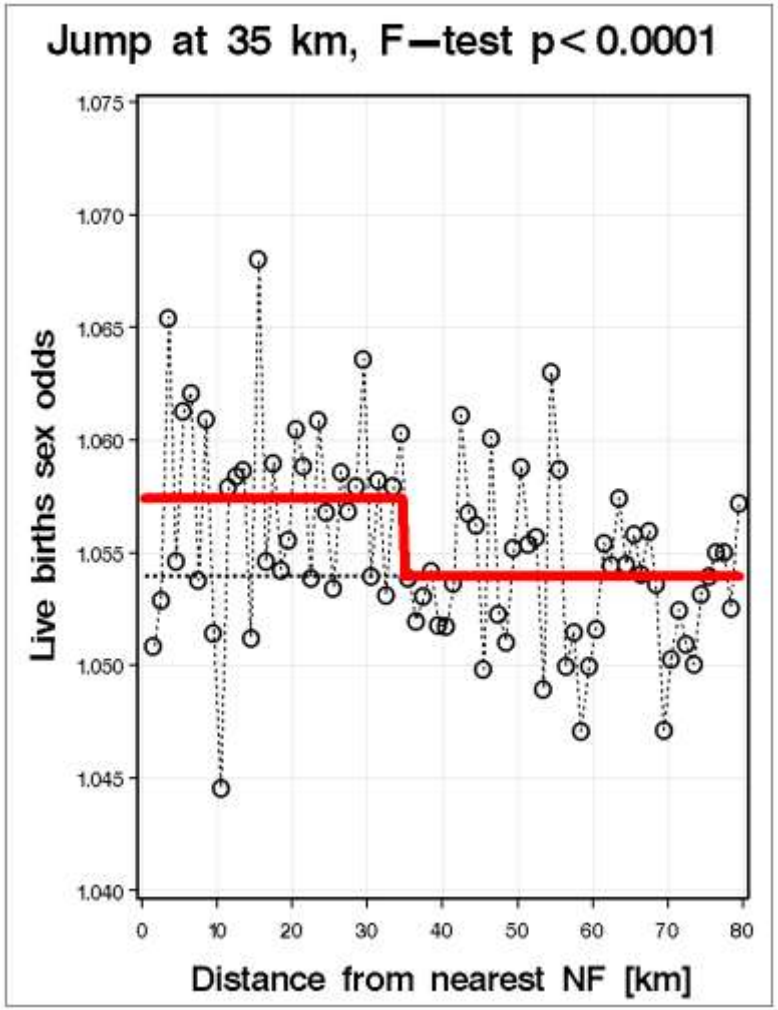
Jump in the sex odds (m/f) in 2000 around 30 km from Centre de Stockage (CdS) de l'Aube - France

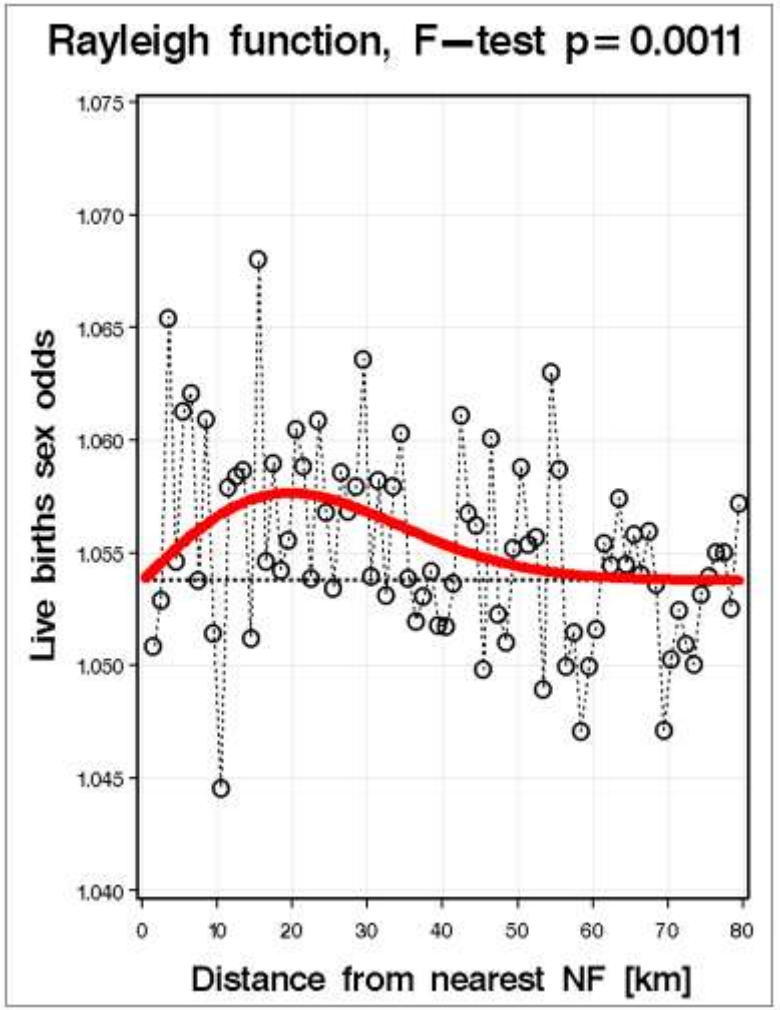
About 1,200 girls missing from areas around 30 km of Gorleben and CdS since 1998.

Results in Germany and Switzerland:

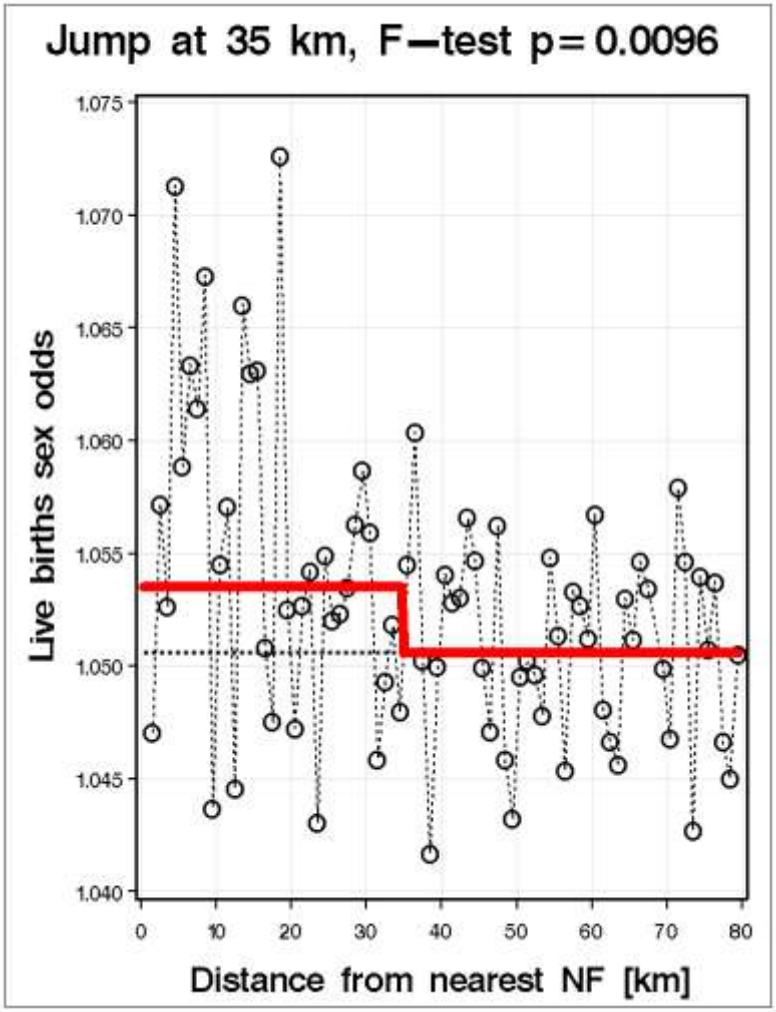
32 nuclear facilities (NF)

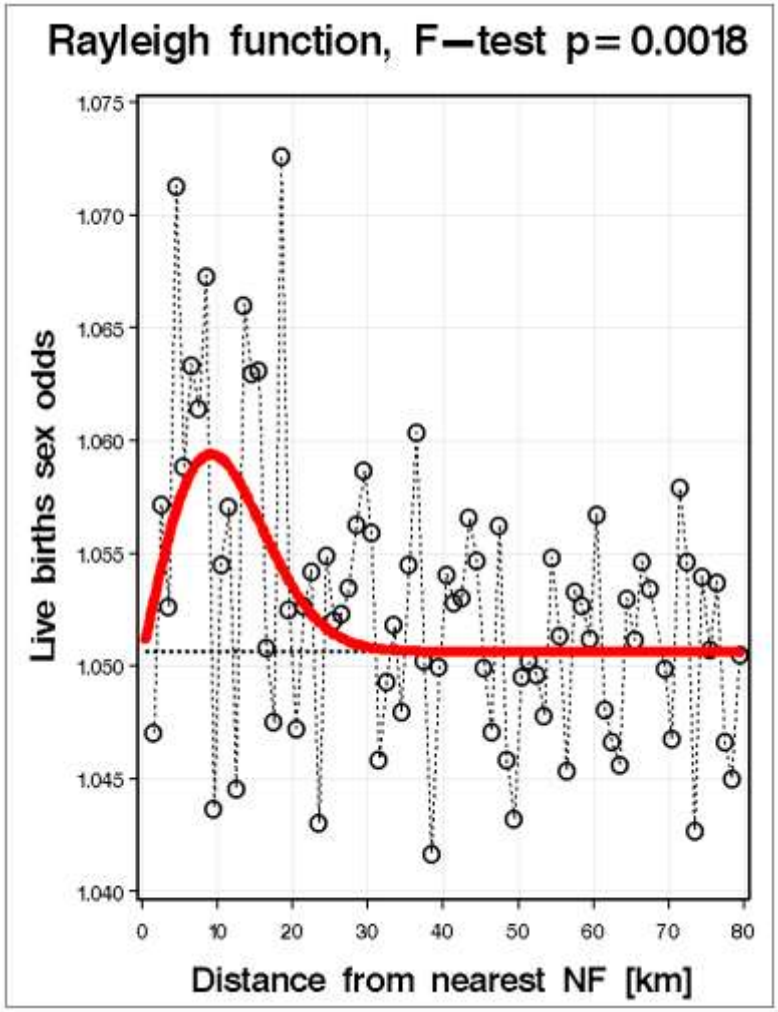
Update of published results Scherb and Voigt 2011 Kusmierz, Voigt, Scherb 2010





Results in France: 28 nuclear facilities (NF)

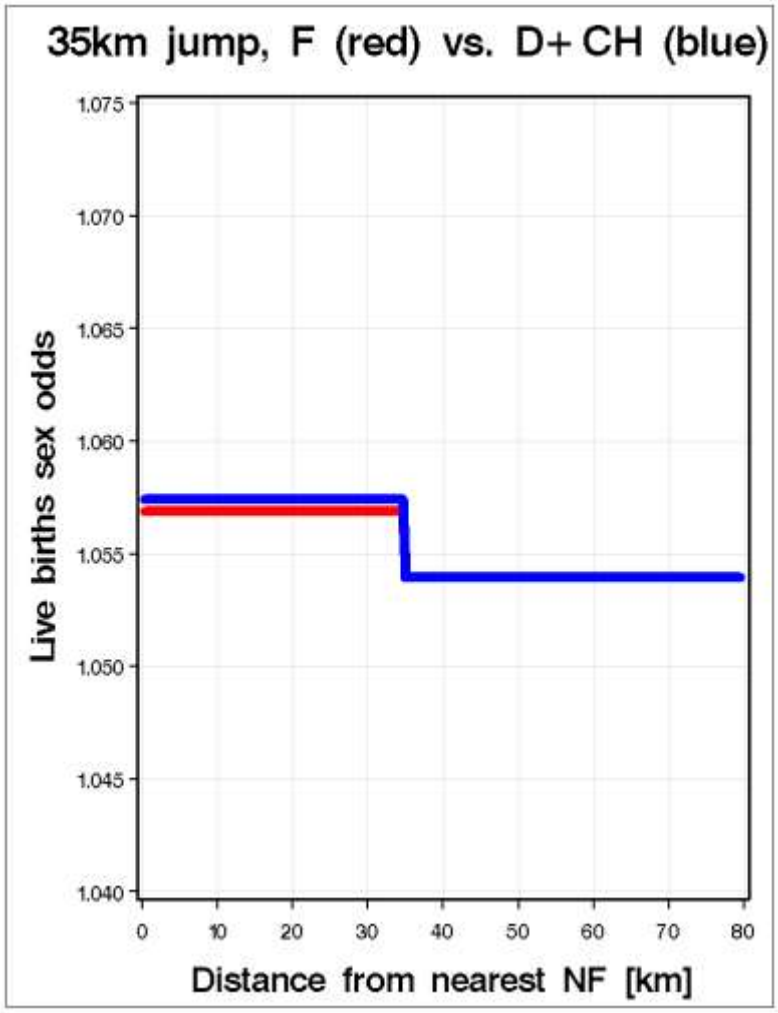


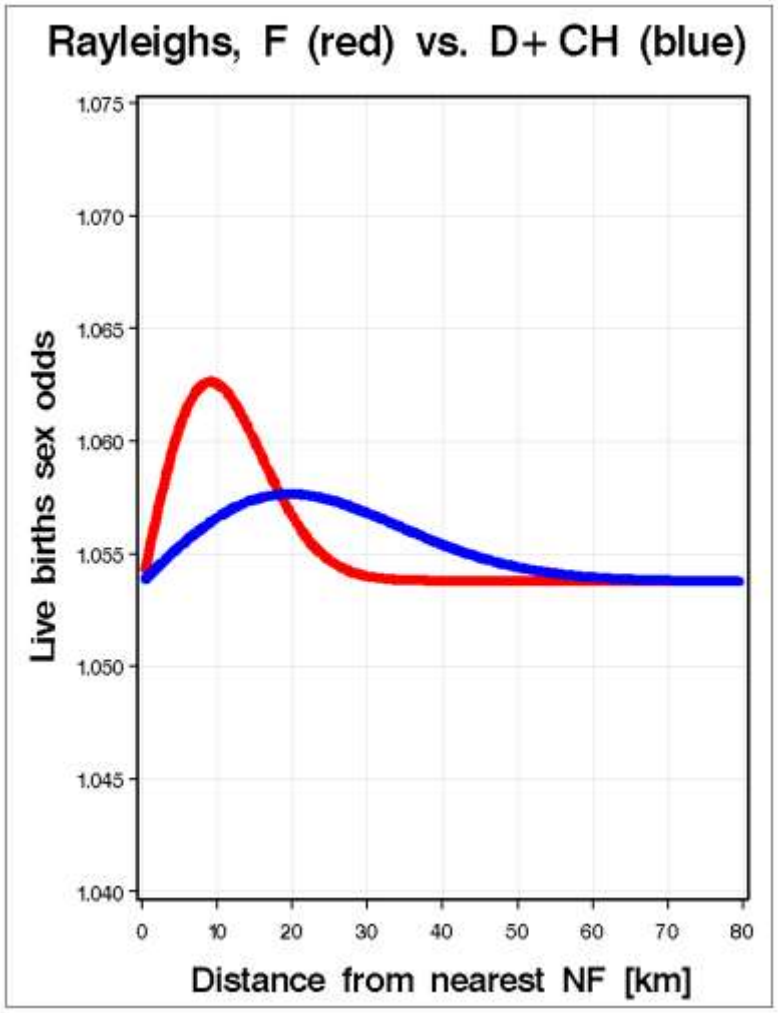


Overall results : France (red)

Germany + Switzerland (blue)

Baseline for France was adjusted !





Russia

USA

Cuba

France

Germany

Europe

Bavaria

Switzerland

Congenital anomalies

Stillbirths

Sex ratio

Atomic bomb tests

Nuclear facilities

Nuclear research centers

Nuclear waste storage facilities

Nuclear power plants

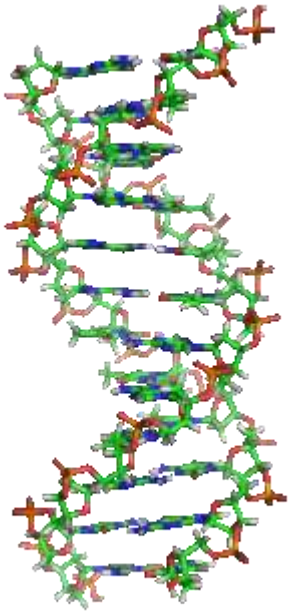
Nuclear accidents

USA

Congenital anomalies

Cuba

Stillbirths



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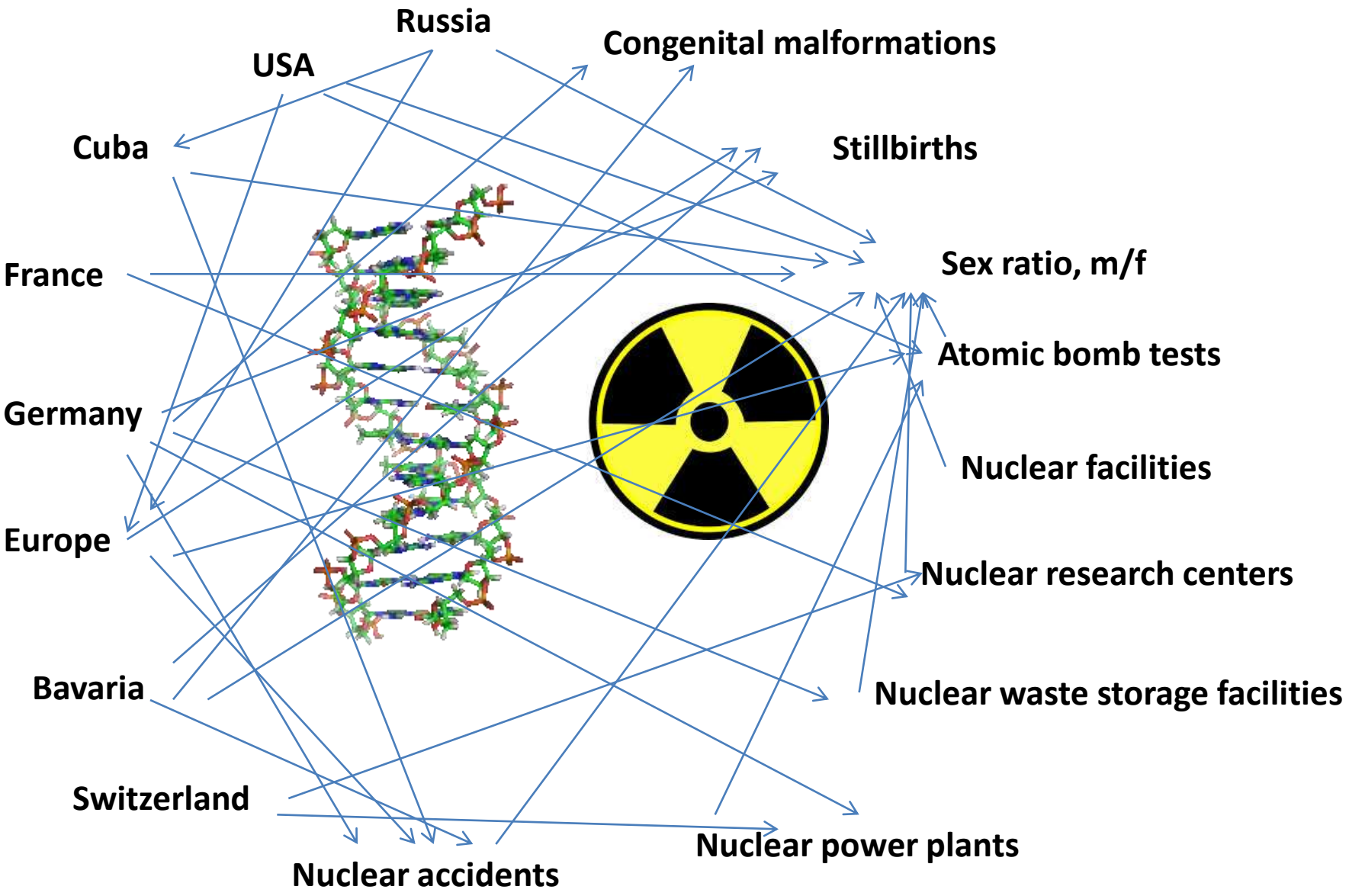
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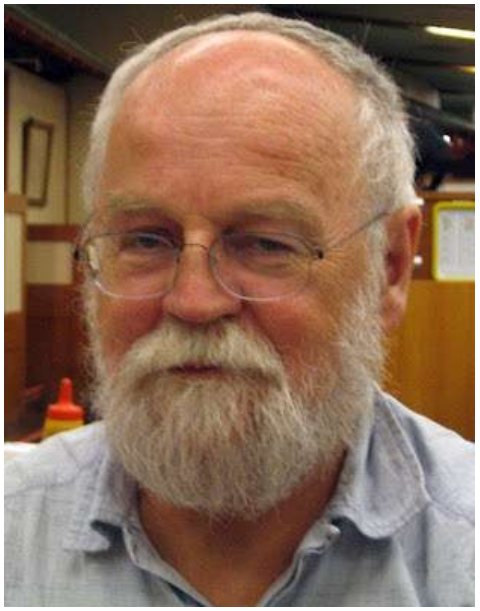

Dr. Hagen Scherb
Institute of Computational Biology
Helmholtz-Zentrum München

scherb@helmholtz-muenchen.de

Dr. Sebastian Pflugbeil
German Society for Radiation Protection
Berlin

pflugbeil.kvt@t-online.de

Thank you for your attention.

German Nuclear Map

NPP, in operation
NPP, shutdown
NPP, decommissioned
Interim storage facilities for spent fuel
Central interim storage facilities for spent fuel
Interim storage facilities for low and medium active waste
Storage facilities with problems: ASSE and Morsleben
Nuclear factories, in operation
Nuclear factories, shutdown
Nuclear factories, decommissioned
Planned storage facilities: Gorleben and Konrad
Research reactors, in operation
Research reactors, shutdown
Research reactors, decommissioned

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