# Influence of circadian rhythms on safety at work

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# Structure

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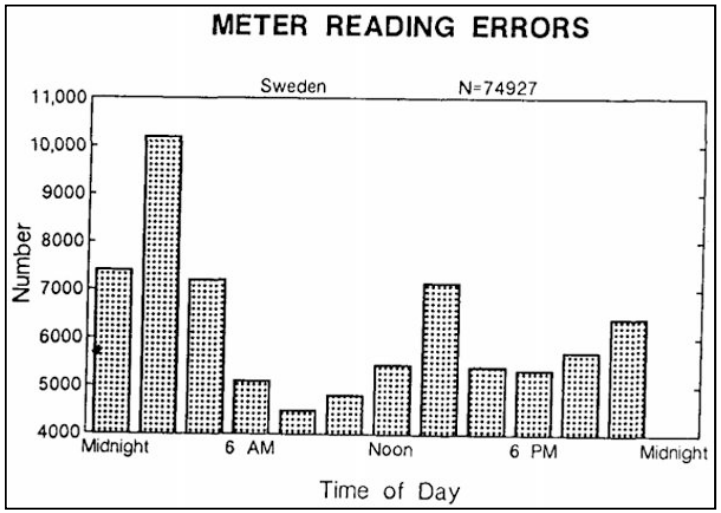
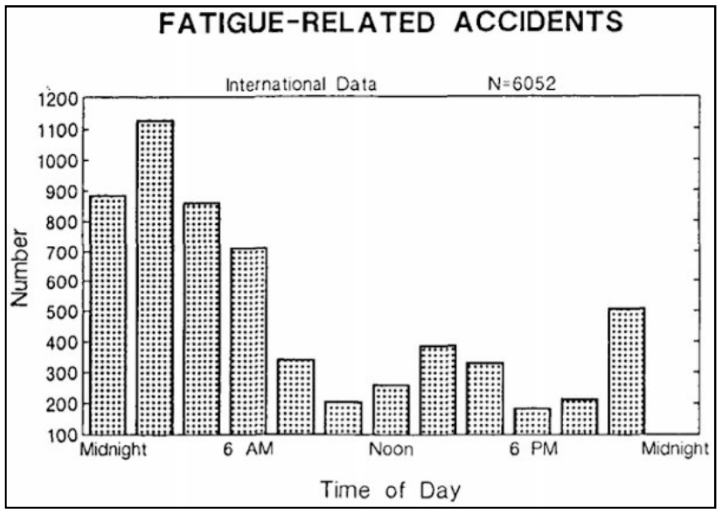
# Introduction

- **Fatigue is a contributing factor of industrial incidents**
- **Many studies analyzed the distribution of incidents throughout the 24h-day**
  - Vehicular accidents
  - Medical incidents
  - Human errors in technical operations
- **Major findings:**
  - Increased sleep tendency during 2-7 a.m.
  - To a lesser degree between 2-5 p.m.
- **Pattern of sleepiness has been replicated in clinical studies**
- **Can be explained by „two process model of sleep regulation“ (Borbély 1982)**

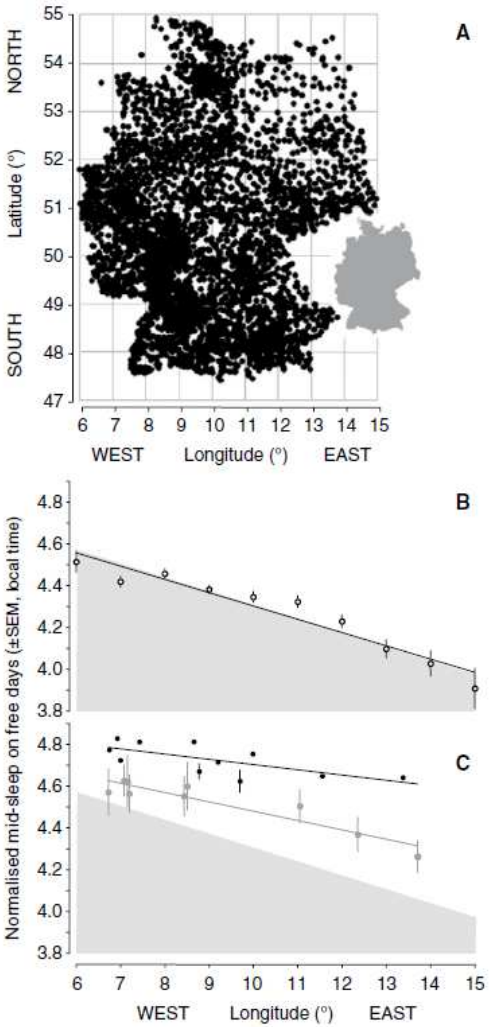



MITLER, M. M., et al. 1988. Catastrophes, Sleep, and Public Policy: Consensus Report. Sleep, 11, 100-109.

# Hypothesis

- **Light is the most important zeitgeber for the circadian system**
- **Many studies show that the human clock synchronizes to sun time**
- **Changes in the daylight pattern occur on a seasonal and geographical basis**
- **Roenneberg (2007):**
  - Adaptation of the chronotype to the time of sunrise
  - In accordance with the later time of sunrise in western regions of Germany the chronotype shifts to a later time from east to west
- **Our hypothesis:**
  - Seasonal and geographical changes in the daylight pattern influence the time of industrial incidents




ROENNEBERG, T., KUMAR, C. J. & MERROW, M. 2007. The human circadian clock entrains to sun time. Current Biology, 17, R44-R45.

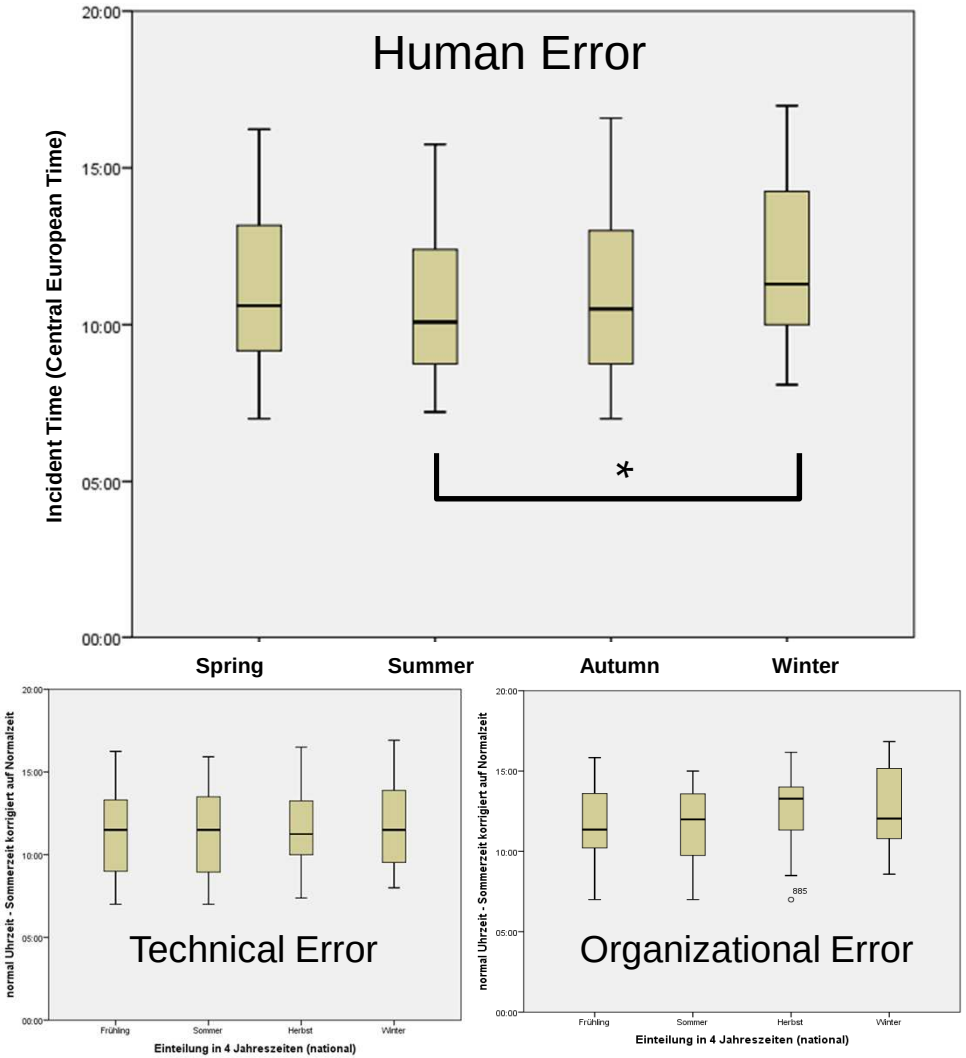
# Database

- **Combination of  two databases from German Environment Agency:**
  - ZEMA
  - ZP-Info
- **Collection of incidents focuses on release of chemical substances**
- **Serious industrial incidents must be reported to the authorities pursuant to the 12th Federal Immission Control Ordinance**
- **The Central Reporting and Evaluation Office for Major Accidents and Incidents in Process Engineering Facilities (ZEMA) records events**
- **Incident notification is sent to the BAuA for information purposes**
  - Notification form
  - Cause analysis
  - Expert reports

# Method

- **Number of incidents:**
  - 2884
- **Period of investigation:**
  - 1990-2015
- **Variables taken into account:**
  - Date
  - Time
  - Geographical position (longitude/latitude)
  - Season
  - Cause of incident
- **Modification:**
  - Correction for Central European Time
- **Filter/Restrictions:**
  - Germany
  - Human error
  - Daytime (8 a.m.- 4 p.m.)
- **Incidents left:**
  - 252

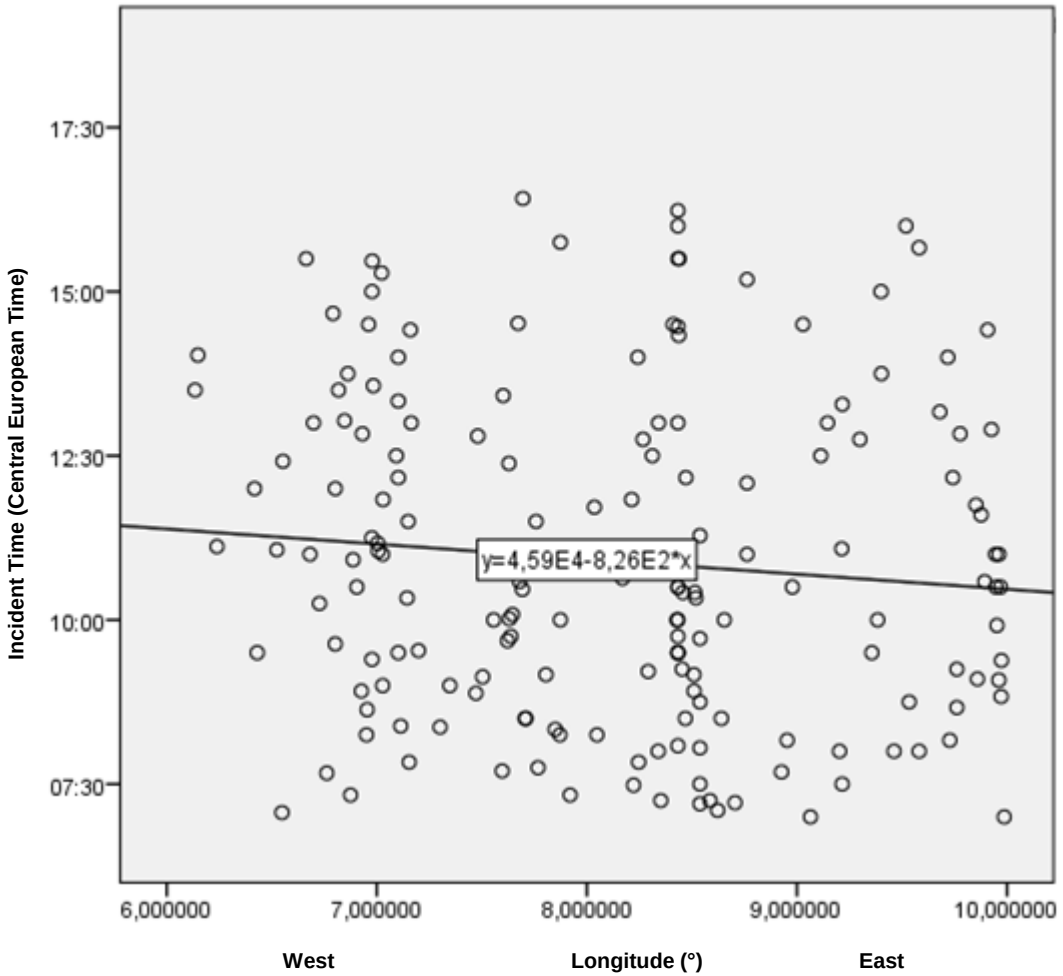
# Results – seasonal pattern




- **Data was divided according to four seasons**
- **Sunrise times differ significantly between the seasons (earlier sunrise in summer, later sunrise in winter)**
- **In compliance with our hypothesis we found:**
  - Shift in the median of incident time that corresponds to the shift in sunrise time
  - Significant difference between summer and winter
  - No difference between spring and autumn
  - No seasonal pattern in medians of technical or organizational errors

# Results – geographical pattern

- **Natural difference in sunrise time between east and west Germany:**
  - 6°-15° longitude = **36 min.**
  - Slope: -0,0667
- **In compliance with our hypothesis we found (not significant):**
  - Shift in incident time from east to west
  - 6°-10° longitude = 20 min.
  - Slope: -0,083
  - 10°-15° longitude = 10 min.
  - Slope: -0,042
  - 6-15° longitude = **30 min.**
- **Only 6 minutes deviation from hypothesis**



# Discussion

**Limitations:**

- **Unconsidered confounder:**
  - Time spend on the job / working breaks
  - Shift schedule
  - Type of task / work
  - Individual factors: sleep deprivation, chronotype, light history etc.
- **Dangerous assumptions:**
  - Constant amount of people working from 8 a.m. to 4 p.m.
- **Small database**

**Conclusion:**

- **Preliminary results**
- **Incident time shows a seasonal pattern with a shift to earlier times in summer and later times in winter**
- **Incident time shows a geographical pattern with a shift to later times from east to west**

**Outlook:**

- **Would be interesting to analyze workplace accident data**
- **Circadian influences are not considered in risk assessment so far**

Thank you for listening... ☺