Natural Hazards and Disaster

Lab 1: Risk Concept

- Risk
- Probability
- Questions

Risk

Definition:
Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain”

Measuring Risk:

Insurance:
Risk (in $) = Hazard Probability * Vulnerability * Exposed Assets

Engineering:
Risk = Event rate * vulnerability * consequences

Risk = hazard probability x vulnerability x value of exposed assets

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Risk-related question:

- How likely is it that a hazard of a certain magnitude occurs?
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Knowing the probability density function of a hazard

Probability

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A simple example is the tossing of an unbiased coin. Since the coin is unbiased, the two outcomes ("heads" and "tails") are both equally probable; the probability of "heads" equals the probability of "tails"; and since no other outcomes are possible, the probability of either "heads" or "tails" is 1/2 (which could also be written as 0.5 or 50%).

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Independent events:
$P(A \text{ and } B) = \mathrm{P}(A) * \mathrm{P}(B)$

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Probability mass function:
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$$f_m(\text{dice},2) = 1/6 = 0.1667$$

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$$P[-\infty \leq X \leq \infty] = \int_{-\infty}^{\infty} f_X(u)du = 1$$

Probability

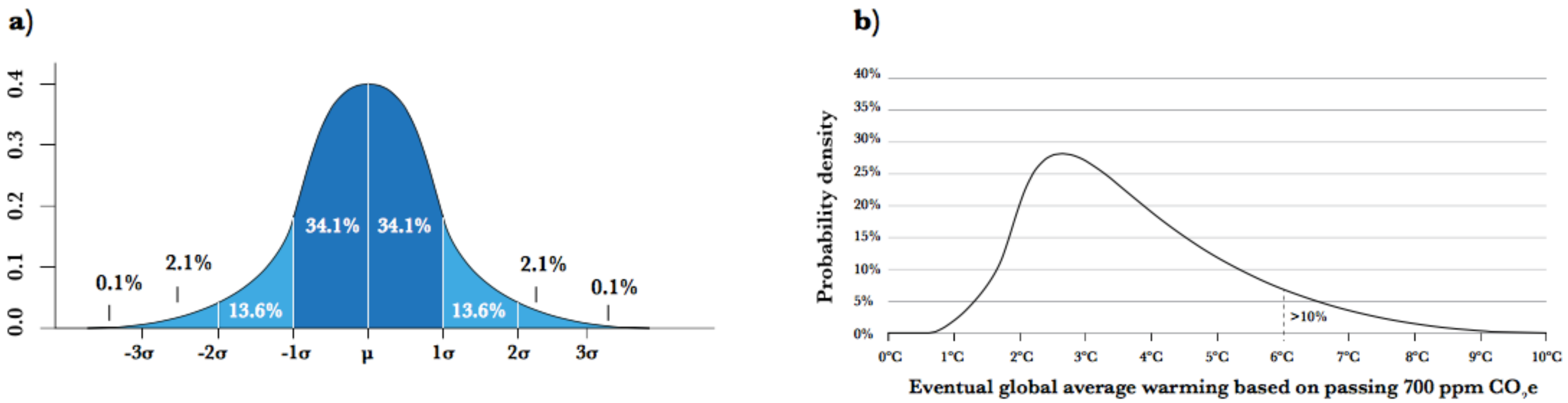

Figure 1: Normal and "fat tail" probability distributions. (a) Normal probability distribution, and (b) an estimate of the likelihood of warming due to a doubling of greenhouse gas concentrations exhibiting a "fat tail" distribution (Credit: Wagner & Weitzman 2015, *Climate Shock: The Economic Consequences of a Hotter Planet*).

Probability

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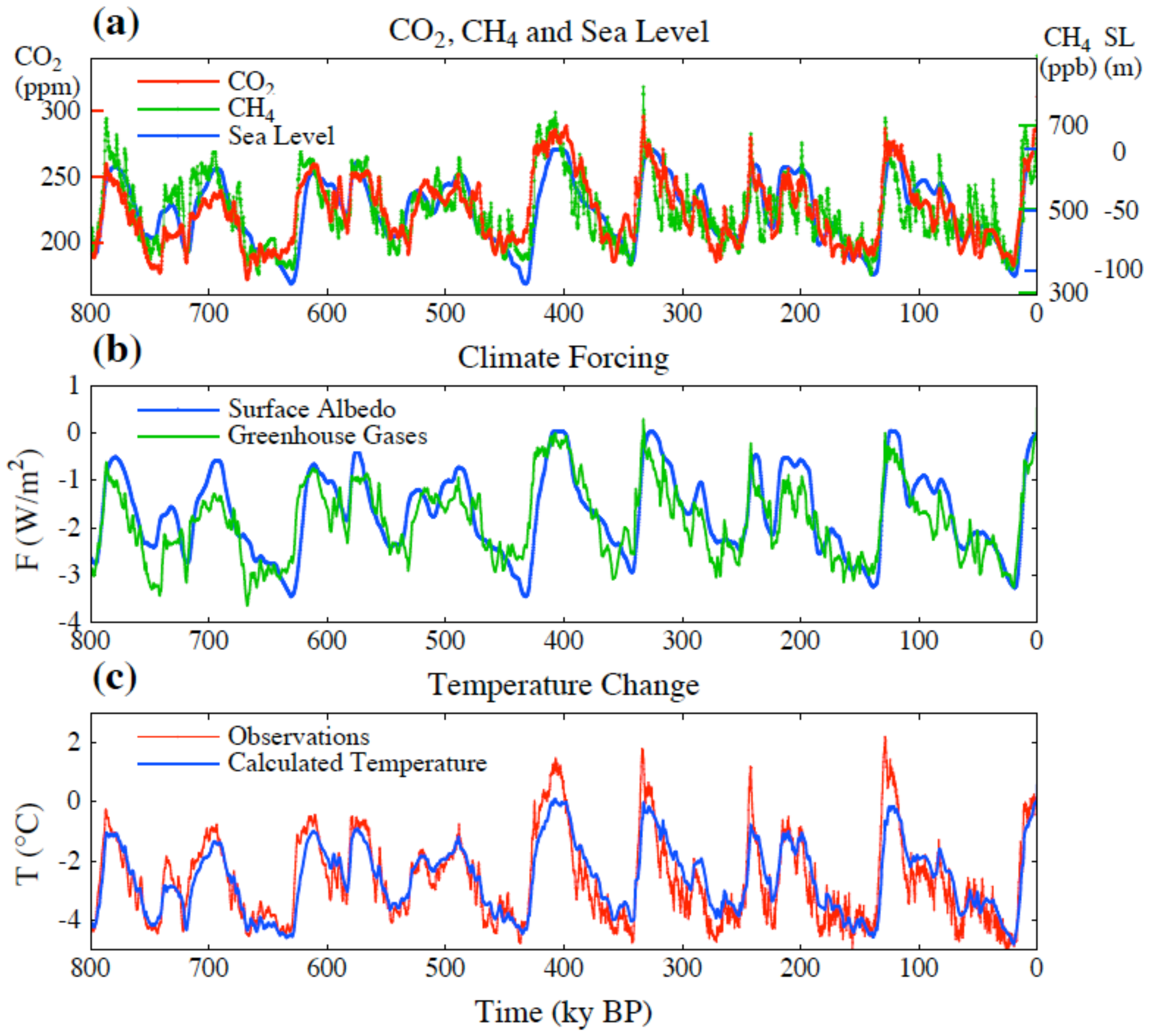

Hansen et al. (2008)

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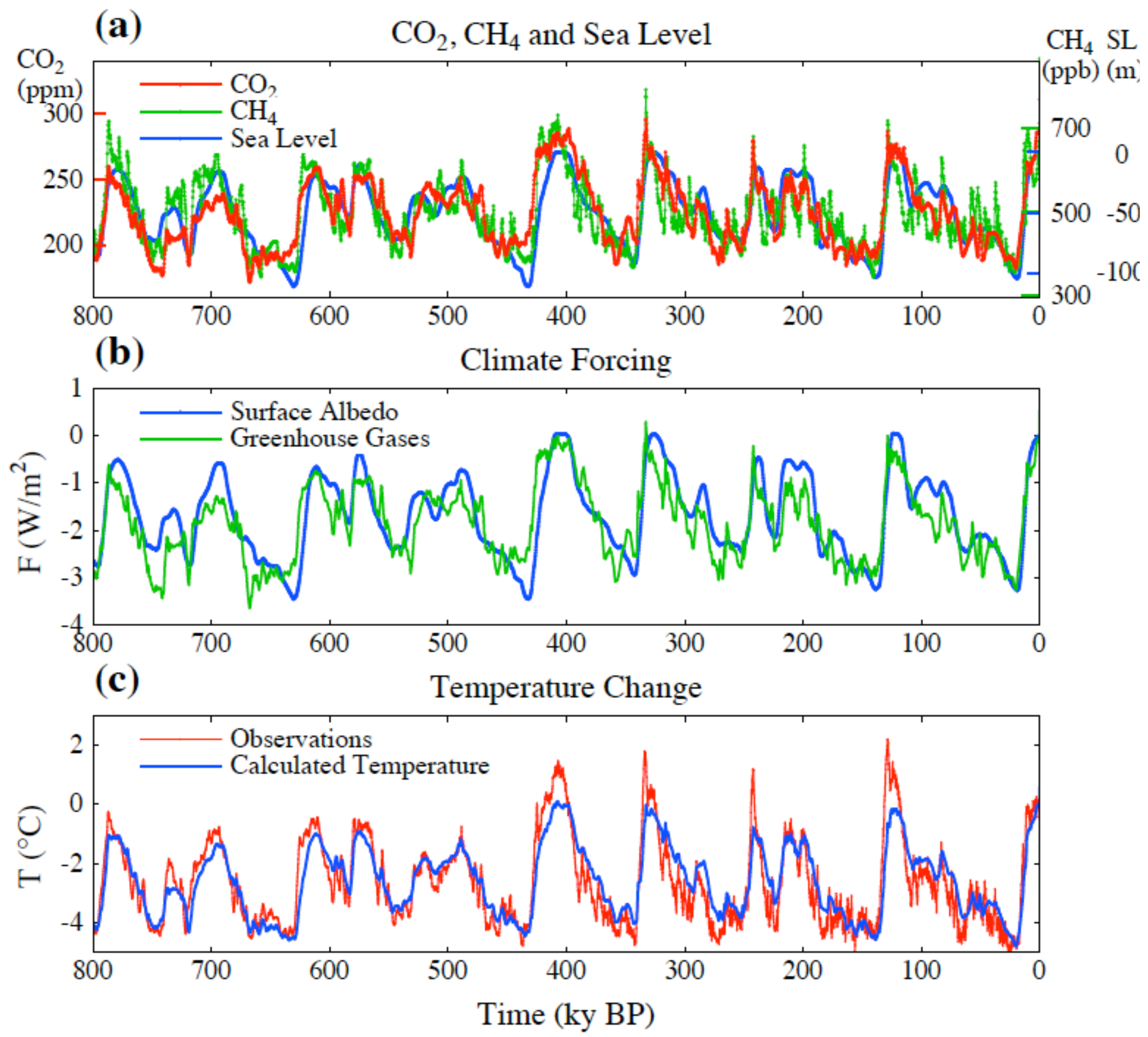

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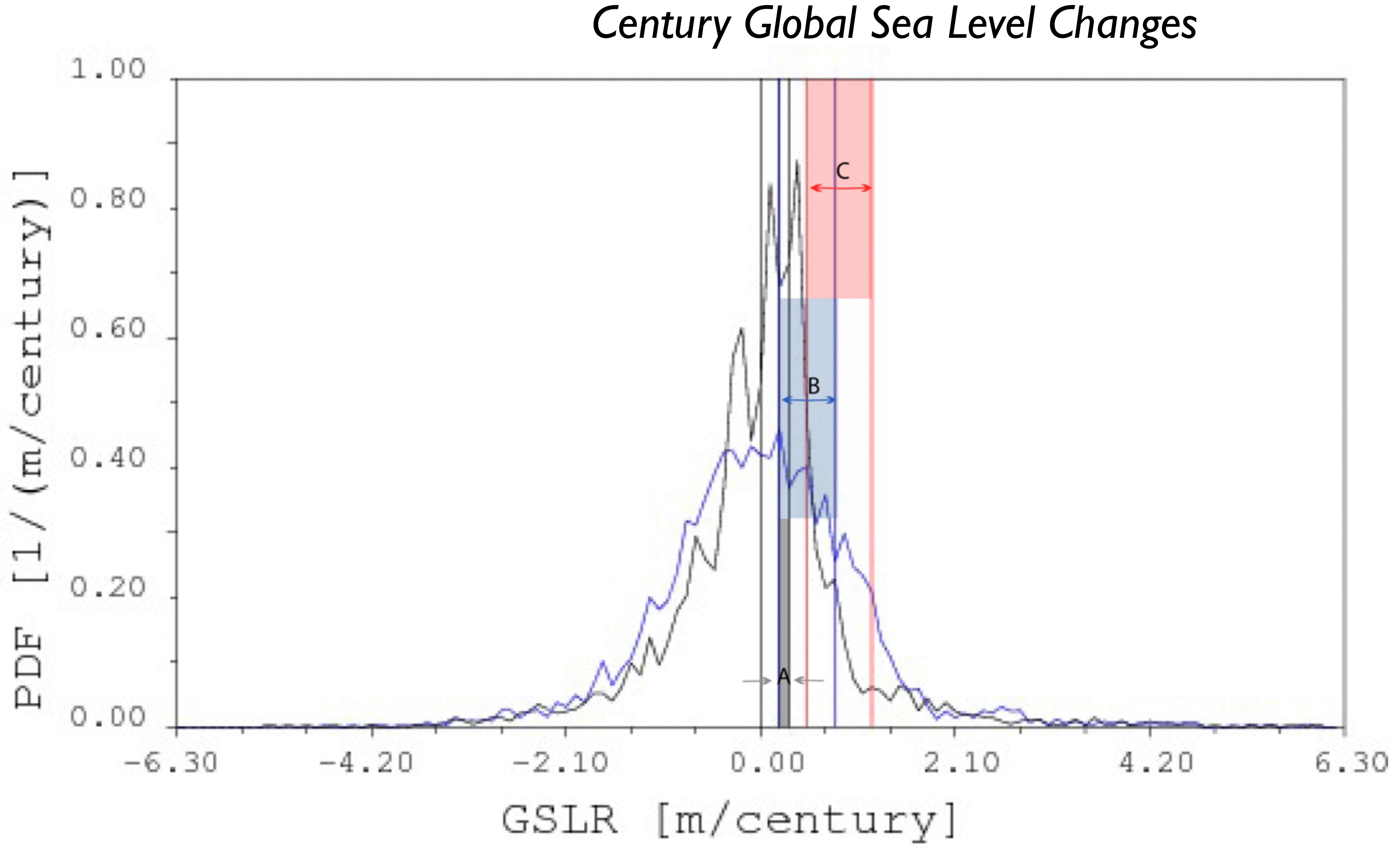

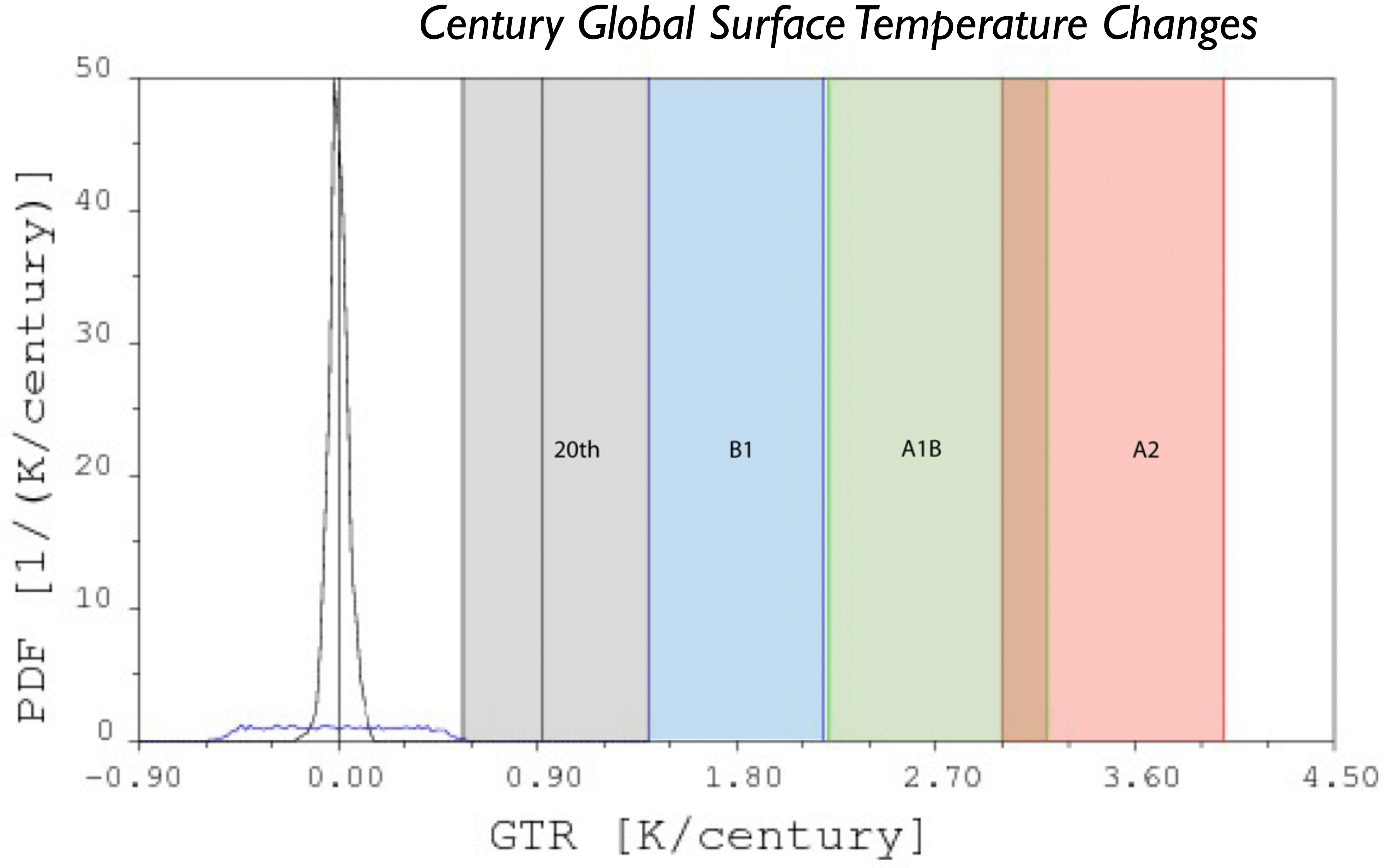

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Plag and Jules-Plag (2012)

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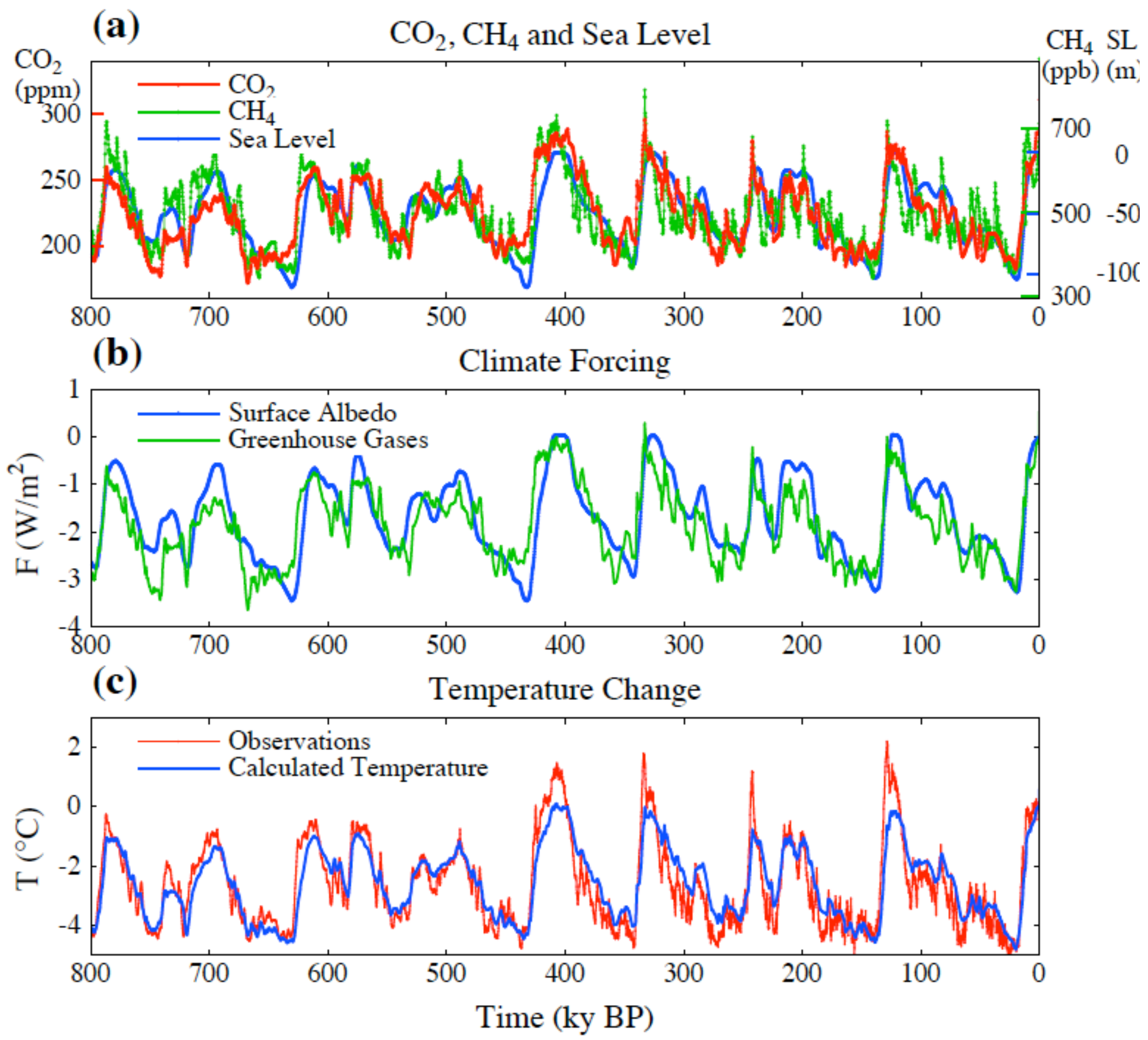

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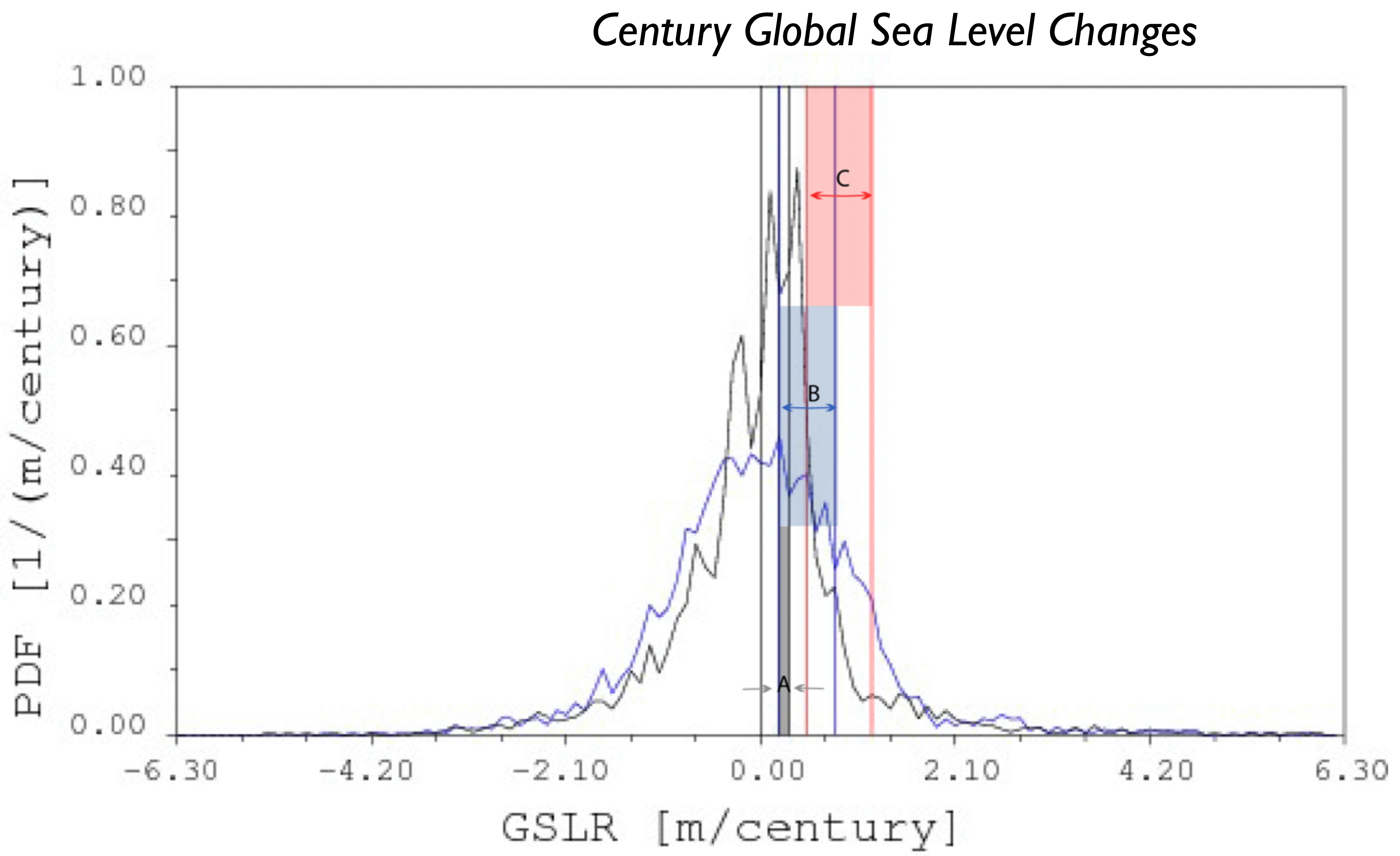

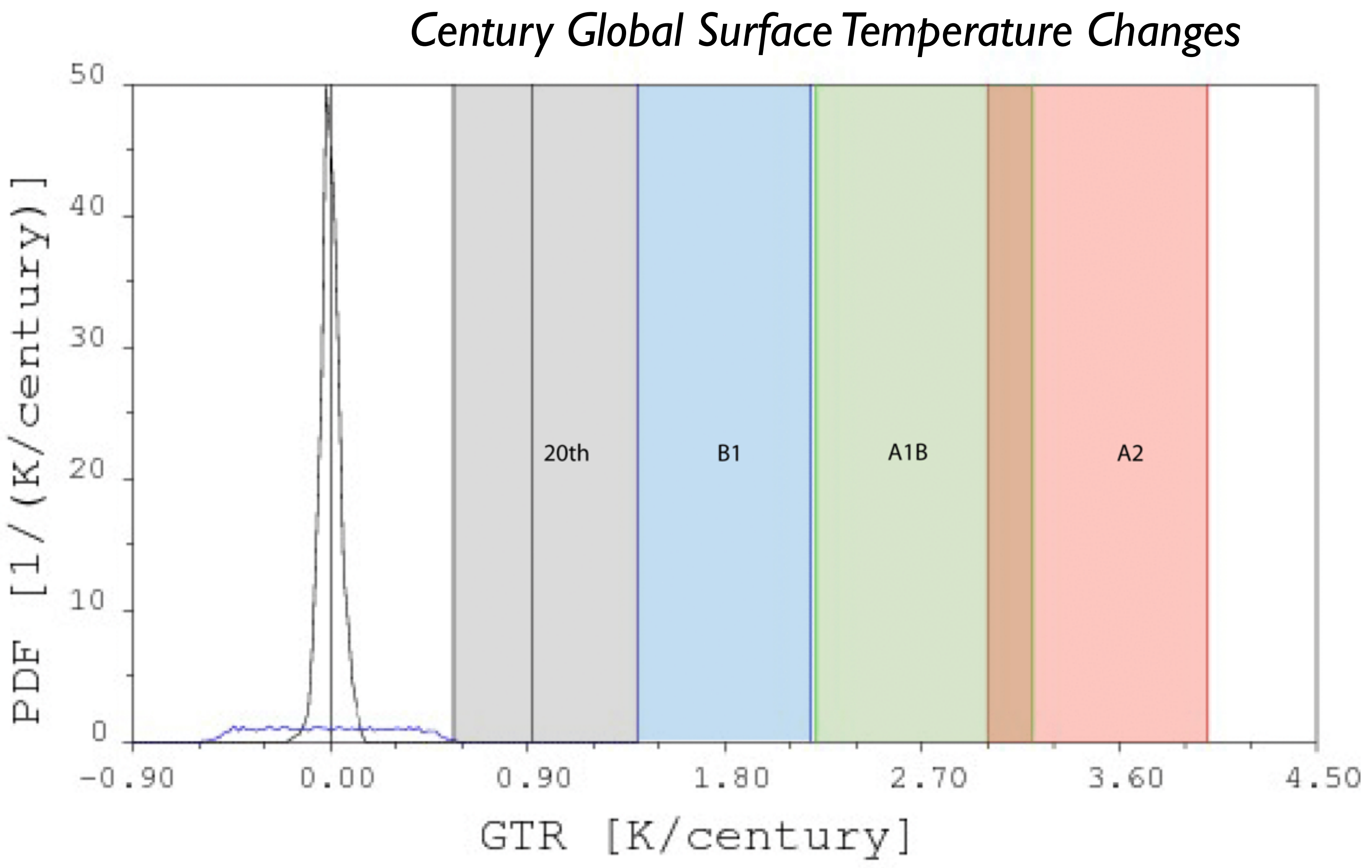

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Scientifically, we cannot exclude a large, rapid global sea level rise with large spatial variability in local sea level rise.

Plag and Jules-Plag (2012)

Risk Assessment

Risk-related question:

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How can we handle discrete events?

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Example: your e-mail
On average, you may get 14 e-mails per day with some variation.
What is the likelihood of a day where you get 0 e-mails/95 e-mails/more than 50 e-mails?

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Poisson Distribution

Conditions:

- the event is something that can be counted in whole numbers;
- occurrences are independent, so that one occurrence neither diminishes nor increases the chance of another;
- the average frequency of occurrence for the time period in question is known;
- it is possible to count how many events have occurred, but it meaningless to ask how many such events have not occurred.

Poisson Distribution

The following notation is helpful, when we talk about the Poisson distribution.

e: the base of the natural logarithm system, equal to approximately 2.71828.

μ: The mean number of successes that occur in a specified region.

x: The actual number of successes that occur in a specified region.

P(*x*; μ): The **Poisson probability** that exactly *x* successes occur in a Poisson experiment, when the mean number of successes is μ.

Poisson Formula. In a Poisson experiment, in which the average number of successes within a given region is μ, the Poisson probability is:

$$P(x=k; \mu) = (e^{-\mu})\,(\mu^k) \,/\, k!$$

where *x* is the actual number of successes that result from the experiment.

Poisson Distribution

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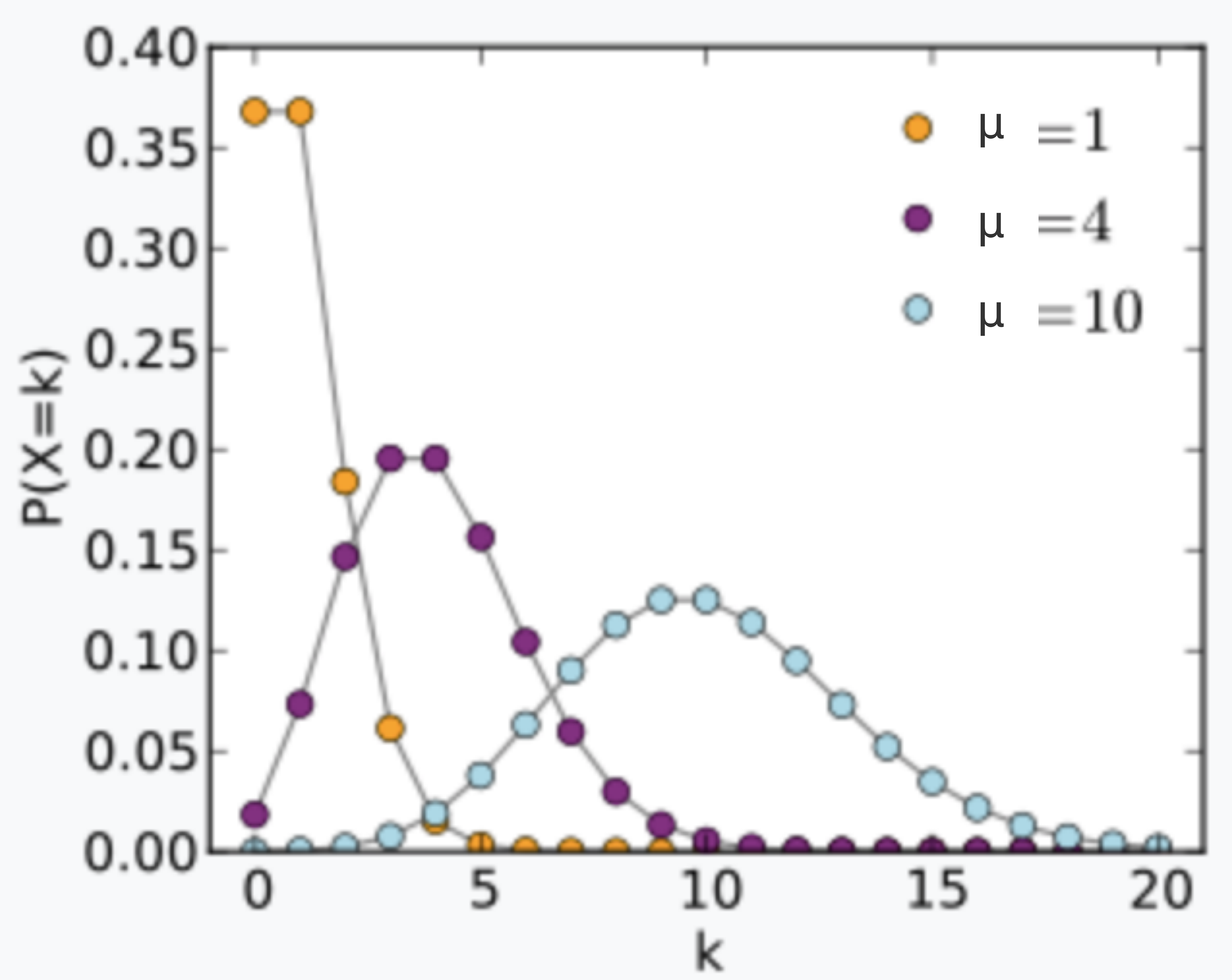

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where x is the actual number of successes that result from the experiment. $e \sim 2.71828$

$$P(x=k;\ \mu) = \frac{\mu^{k}}{e^{\mu} * k!}$$

The factorial k! is:

0! = 1

1! = 1

2! = 1*2 = 2

3! = 1*2*3=6

4! = 1*2*3*4=24

…

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Probability of exactly one 100-year flood to occur in a specific century?

μ = 1, k = 1, P=?

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Probability of exactly one 100-year flood to occur in a specific century?

μ = 1, k = 1, P=?

$$P(x=1,\ \mu=1) = \frac{1^1}{e^1 * 1!} = 0.3679$$

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Probability of no 100-year flood to occur in a specific century?

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Probability of no 100-year flood to occur in a specific century?

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$$P(x=1,\ \mu=1) = \frac{1^0}{e^1 * 0!} = 0.3679$$

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$$P(x=k;\, \mu) = \frac{\mu^k}{e^{\mu} * k!}$$

Probability of one or more 100-year flood to occur in a specific century?

$\mu = 1$, $k \geq 1$, $P=?$

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Probability of one or more 100-year flood to occur in a specific century?

$\mu = 1,\ k \geq 1,\ P=?$

$$P(x \geq 1,\ \mu=1) = 1 - P(x=0,\ \mu=1) = 1 - 0.3679 = 0.6321$$

The factorial k! is:

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Questions

Guidelines

Your answers to the questions should be concise and in a scientific writing style. Please, include your name at the top and the questions before each answer.

The answers have to cite the sources consulted in writing the answer and a list of references. Preferably, base your answer on peer-reviewed literature. At the end of the document, provide a list of the references. Insufficient citation or missing list of references will result in subtraction of up to 20 points. Citations and Reference have to follow the documentation style defined by the Council of Scientific Editors, known as the CSE style. See **SSF-Guide** or the **WISC** page for more information on the CSE style.

Make sure that your document includes your name and the title of the question set. In your answers, provide detailed citations of all sources you used to write the answer.

Please, prepare written answers to the questions based on the discussions in the lab and submit these not later than on the following Friday, 6:00 PM by e-mail to me. I recommend that you discuss the questions in small groups and then write your own individual answers. If you do discuss the question in a group, I would appreciate if you could state the names of those you discussed the questions with.

Questions

For most set, I will ask you to answer three of the four questions.

Submit your answers to hpplag@mari-odu.org

Questions

Q1.1

How do we define a hazard and a disaster in the context of the class, and what is the connection between a hazard and a disaster? Give an example of a hazard and the resulting disaster and describe the connection.

Q1.2

In your own words, describe how the term risk is defined in different disciplines/fields, and what definition we are using in the class. Please, include references (others than what is on the class slides) for the definitions you provide.

Q1.3

Discuss the probability density function (PDF) of a hazard and identify the main uncertainties in knowing the PDF for natural hazards.

Q1.4

Explain the concept of a 100-year or 500-year event and use the Poisson Distribution to compute the probability that we have one or more of a 500-year event in a given century. Note that how you answer this question will let me know whether I need to invest more time with you to explain the distribution.