Conceptual Change on Climate Change

An Educational Reconstruction of Global Warming

Dr. Kai Niebert
niebert@idn.uni-hannover.de
www.kainiebert.de

Leibniz Universität Hannover

state of research

Boyes & Stanisstreet (1992)

Boyes & Stanisstreet (1993)

Read et al. (1994)

Bostrom et al. (1994)

Dove (1996)

Boyes & Stanisstreet (1997)

Rye et al. (1997)

Bord et al. (1998)

Mason & Santi (1998)

Koulaidis & Christidou (1999)

Parchmann et al. (1999)

Andersson & Wallin (2000)

Jeffries et al. (2001)

Pruneau et al. (2001)

Khalid (2003)

Pruneau et al. (2003)

Papadimitriou (2004)

Österlind (2005)

Schuler (2005)

Ekborg & Areskoug (2006)

Sterman & Booth Sweeney (2007)

Taber & Taylor (2008)

Shepardson et al. (2009)

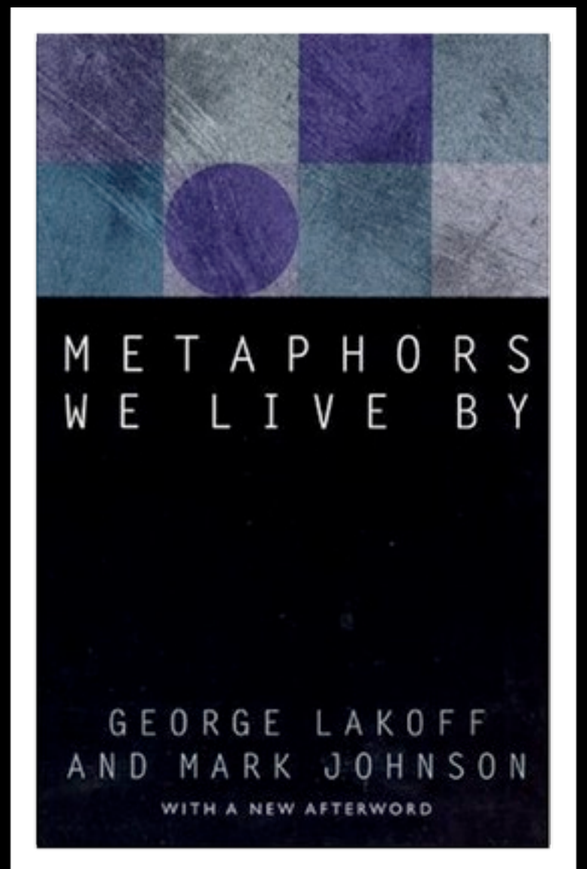
Hansen (2010)

main results:

1. Students tend to have scientifically non adequate conceptions about climate change.
2. Many students do not have scientifically adequate conceptions on the source and the role of CO_2 in the climate system.

Experientialism

cognitive linguistics (Lakoff 1990), psychology (Schmitt 2005), neurobiology (Lakoff & Gallese 2005, Rohrer 2005), philosophy (Johnson 2987), and science education (Gropengießer 2007)



1. Direct conceptions arise out of perception, body movement, and experience with our physical and social environment.

2. For concepts, which cannot be experienced directly we need to think in an imaginative way to understand them with metaphors.

3. Metaphors are not merely a linguistic phenomenon. They are a fundamental principle of thought and action.

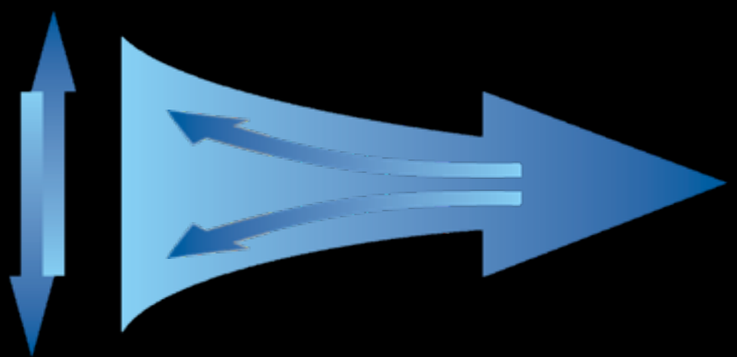
research design: educational reconstruction

Duit, Gropengießer, Kattmann (2005)

carbon cycle
IPCC (2007), Schlesinger (1997),
Houghton (2002), Smith & Smith (2006)

QCA MA

scientists‘ conceptions



development of learning environments

1. development of teaching-guidelines
2. development of learning activities
3. evaluation of learning activities

students‘ conceptions

QCA MA

reanalysis of
24 empiric studies

own interviews
(n=16, 18 y; 7f, 9m)

teaching
experiments
(n=24 18 y; 11f, 13m)

data analysis
QI: qualitative content analysis (Mayring 2003, Gropengießer 2005)
MA: metaphor analysis (Schmitt 2003, 2005)

»CO_2 is released into the atmosphere by the burning of fossil fuel. [...]

You can burn as much wood as you want. Wood does not contain CO_2, because wood is no fossil fuel.«

Dirk (18 y.)

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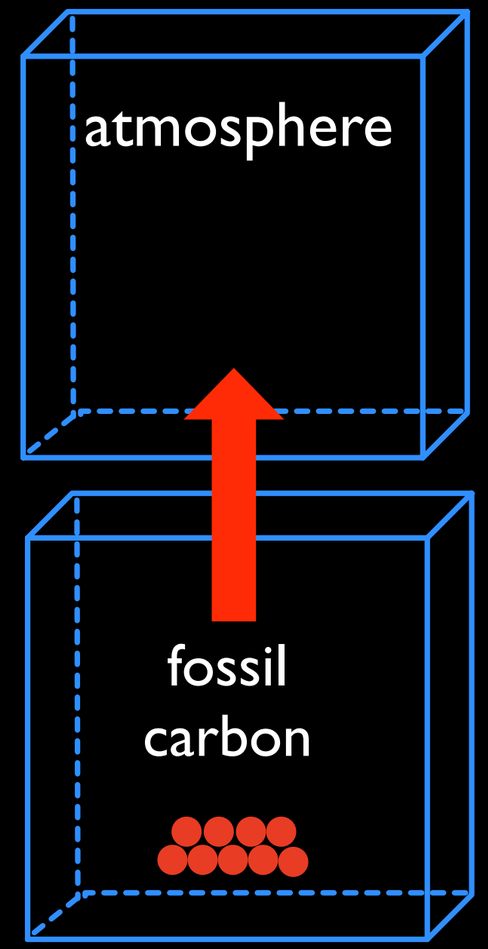
container-flow-schema

source-path-goal-schema

natural vs. man-made schema



II. natural vs. man-made CO_2

»The CO_2 emitted by the burning of fossil fuel is chemical, not biological. The chemical CO_2 does not originate by it self like the CO_2 from plants. The chemical CO_2 cannot be captured by plants« **Emma (18 y.)**

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- circle-schema
- natural vs. man-made schema

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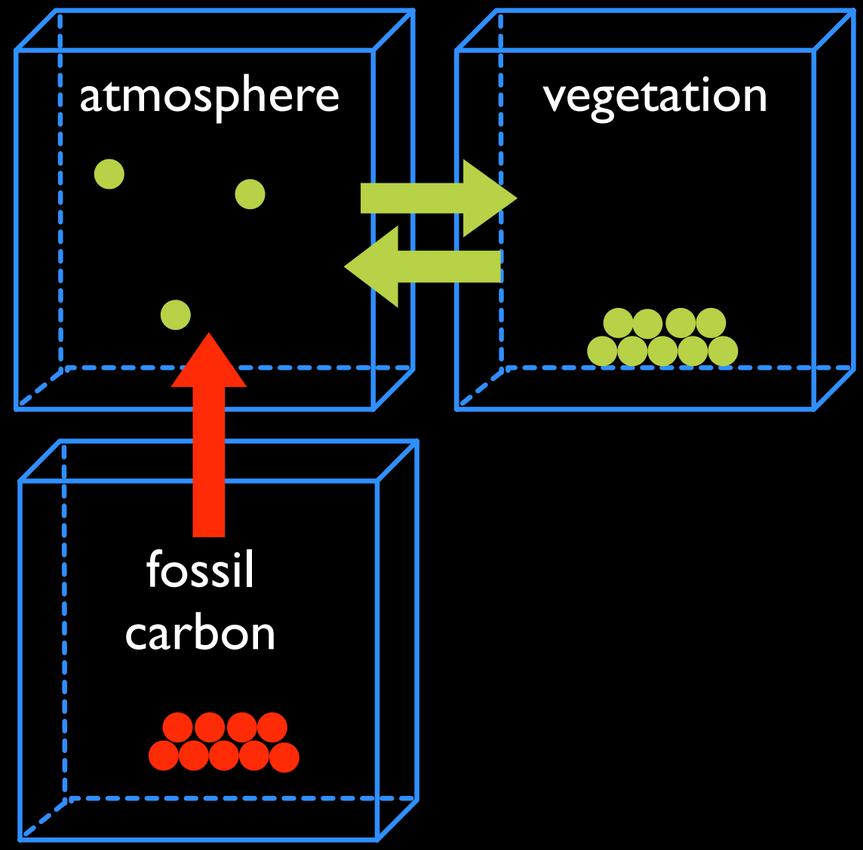

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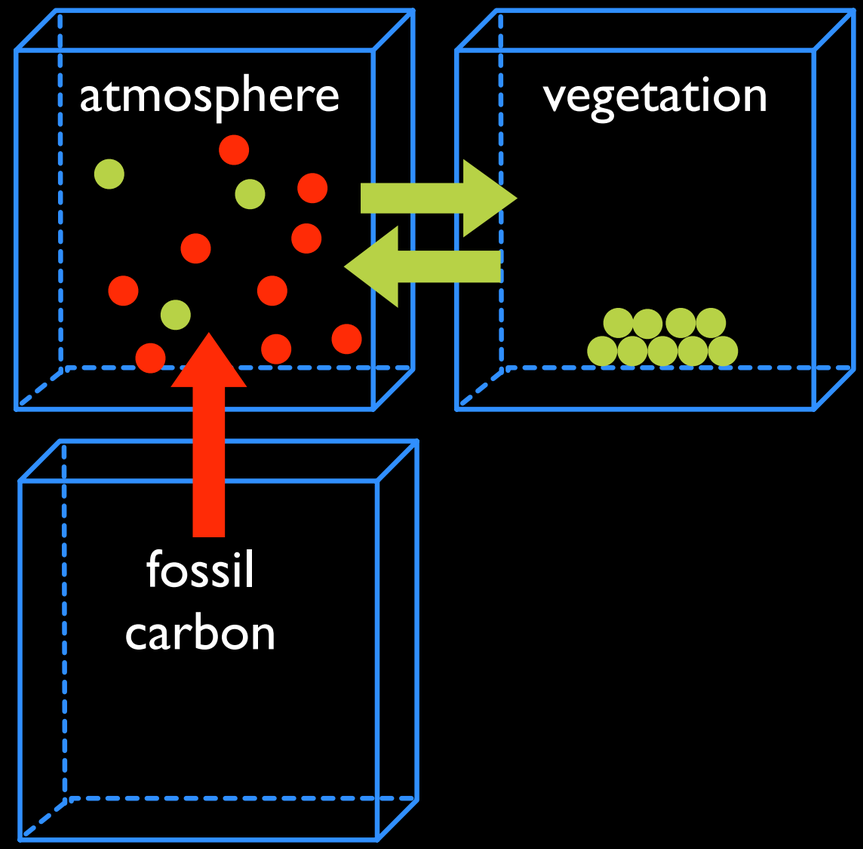
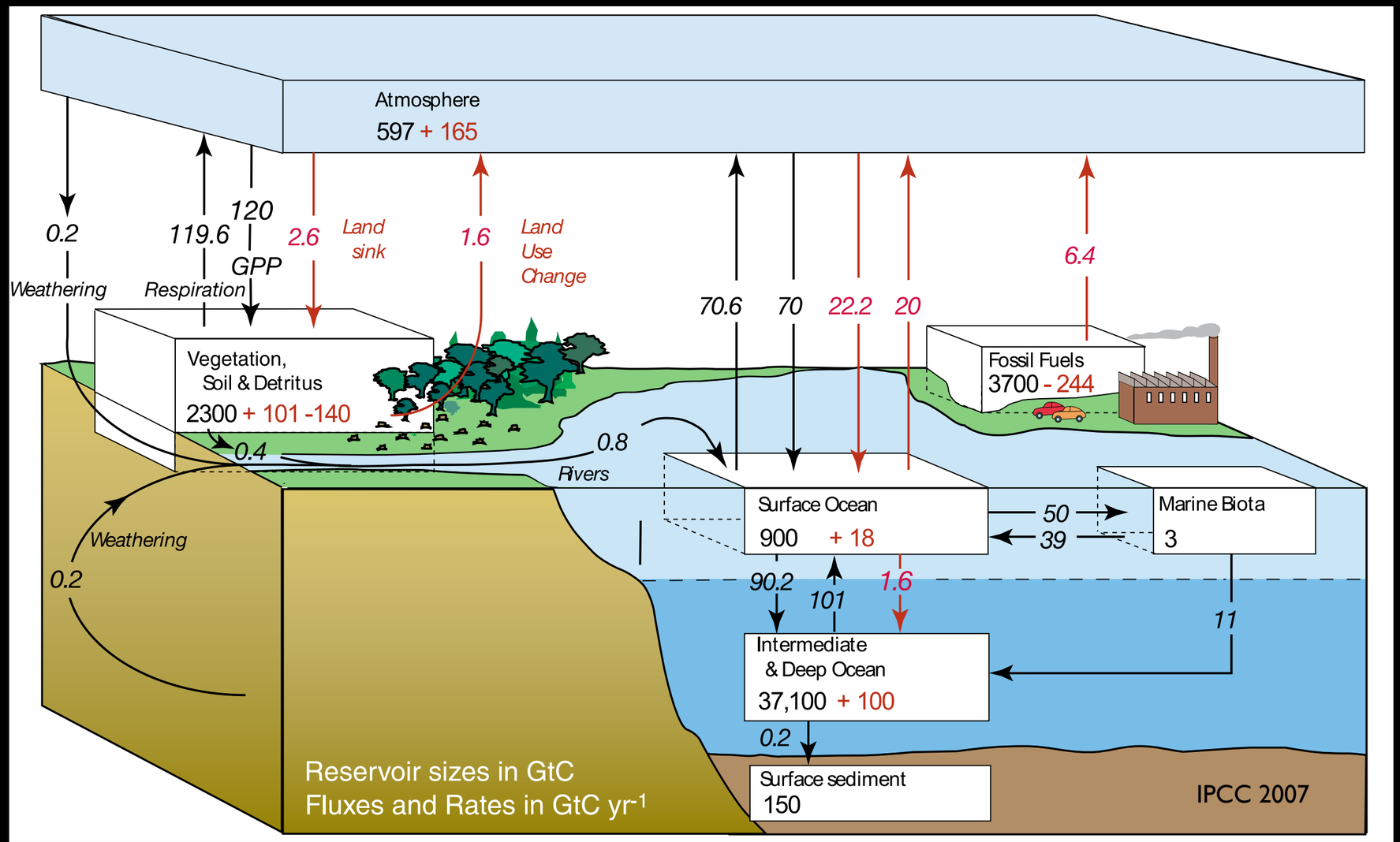
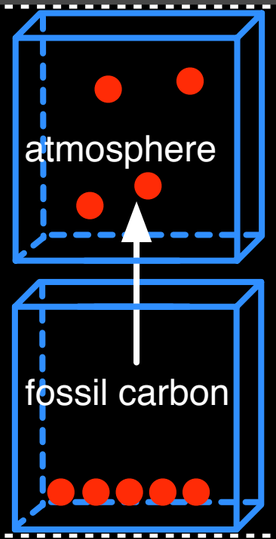
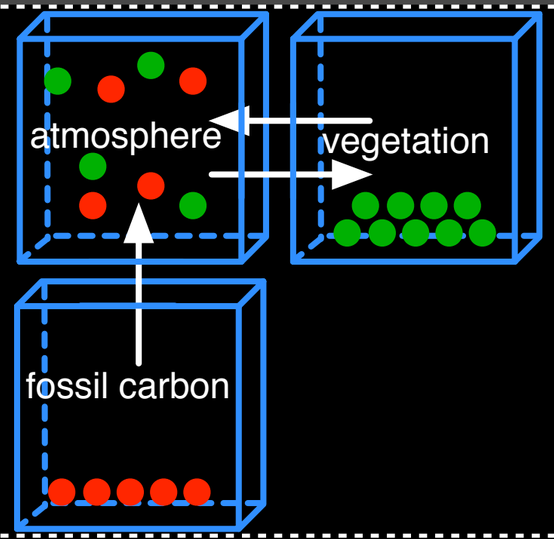
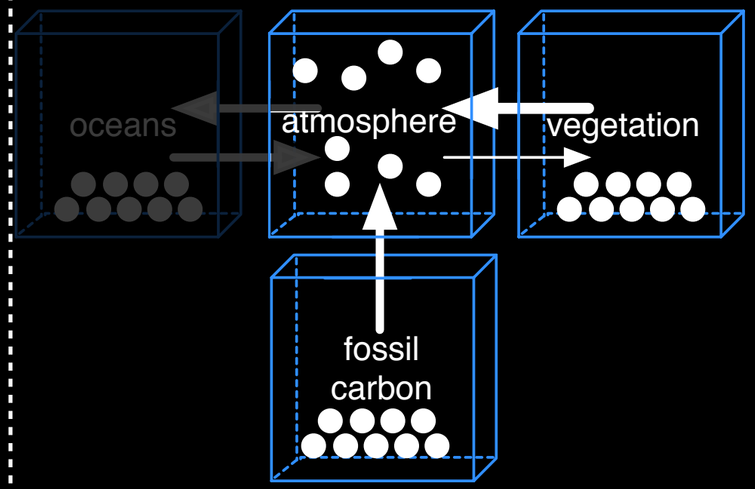


III. scientists‘ conceptions on the carbon cycle



- container-flow-schema
- circle-schema
- balance-schema

conceptions of the carbon cycle

	man-made CO_2	natural vs. man-made CO_2	anthropogenic imbalance
thinking pattern			
schemata adapted on the container-flow schema	source-path-goal schema	circle schema	
	natural vs. man-made schema	balance schema	

from man made CO_2 to anthropogenic imbalance

»We can reduce the CO_2 to zero if we use renewable energy solely.« (Laura)

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»But there has been CO_2 in the atmosphere even before man was there.« (Tina)

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»Yes. But the CO_2 from oil and coal has more effect than the natural CO_2« (Laura)

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Guideline 1:
Reflect the adaption of the natural vs. man-made on the container-flow-schema.

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Guideline 1:
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»The carbon flows between oceans and atmosphere are in an equilibrium. The imbalance comes from burning and deforestation. Deforestation detains the capturing of CO_2 by plants.« (Laura)

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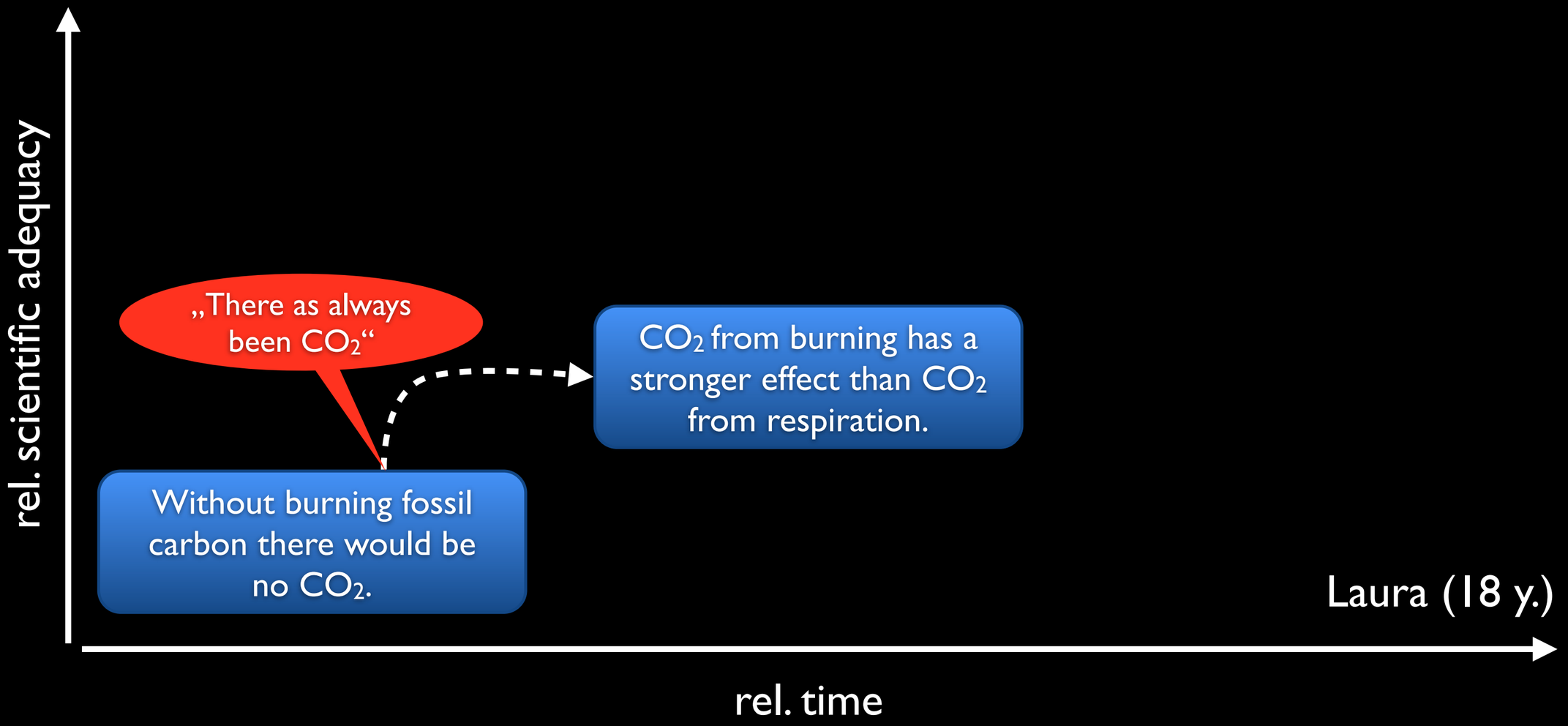

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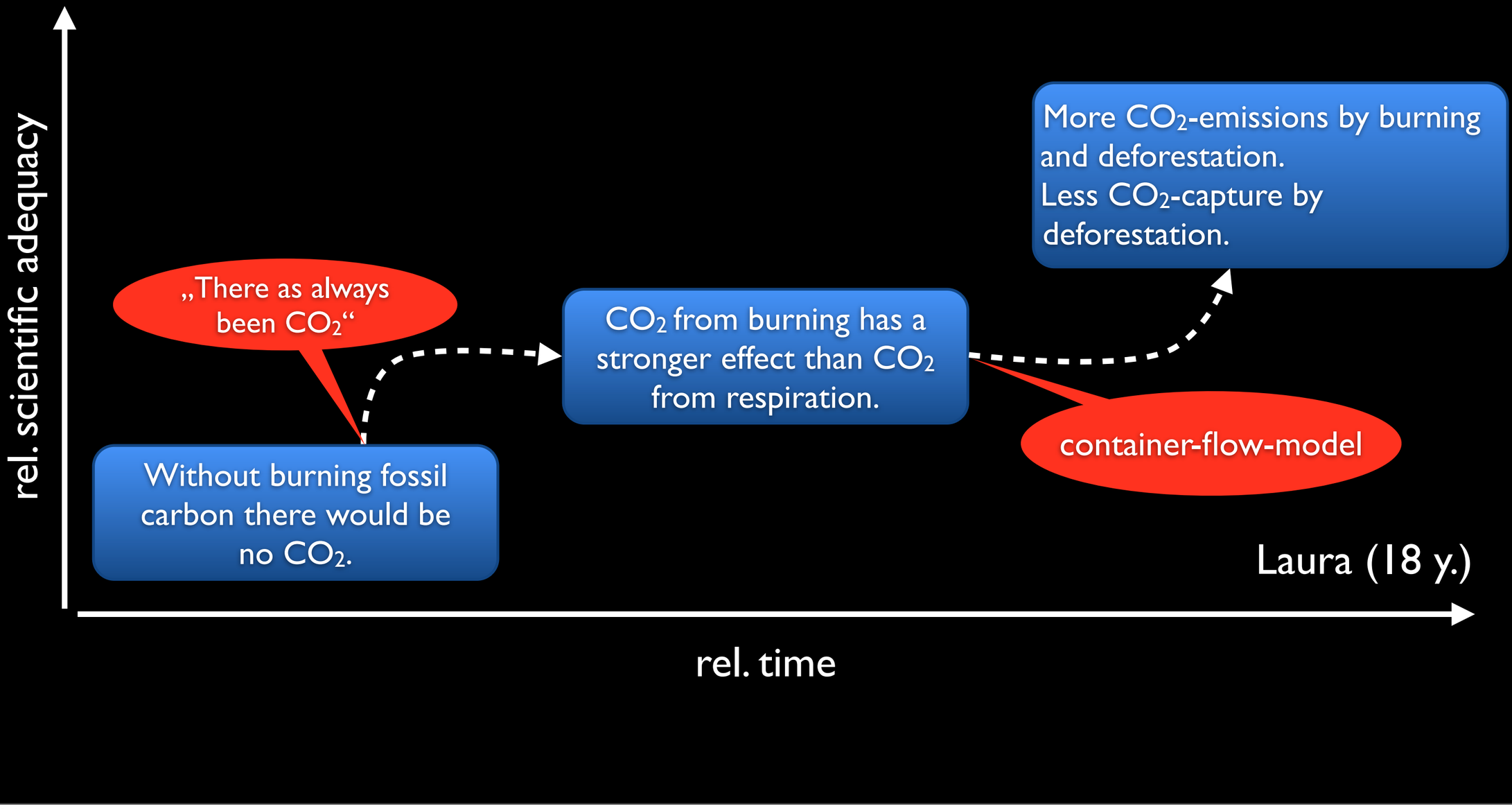

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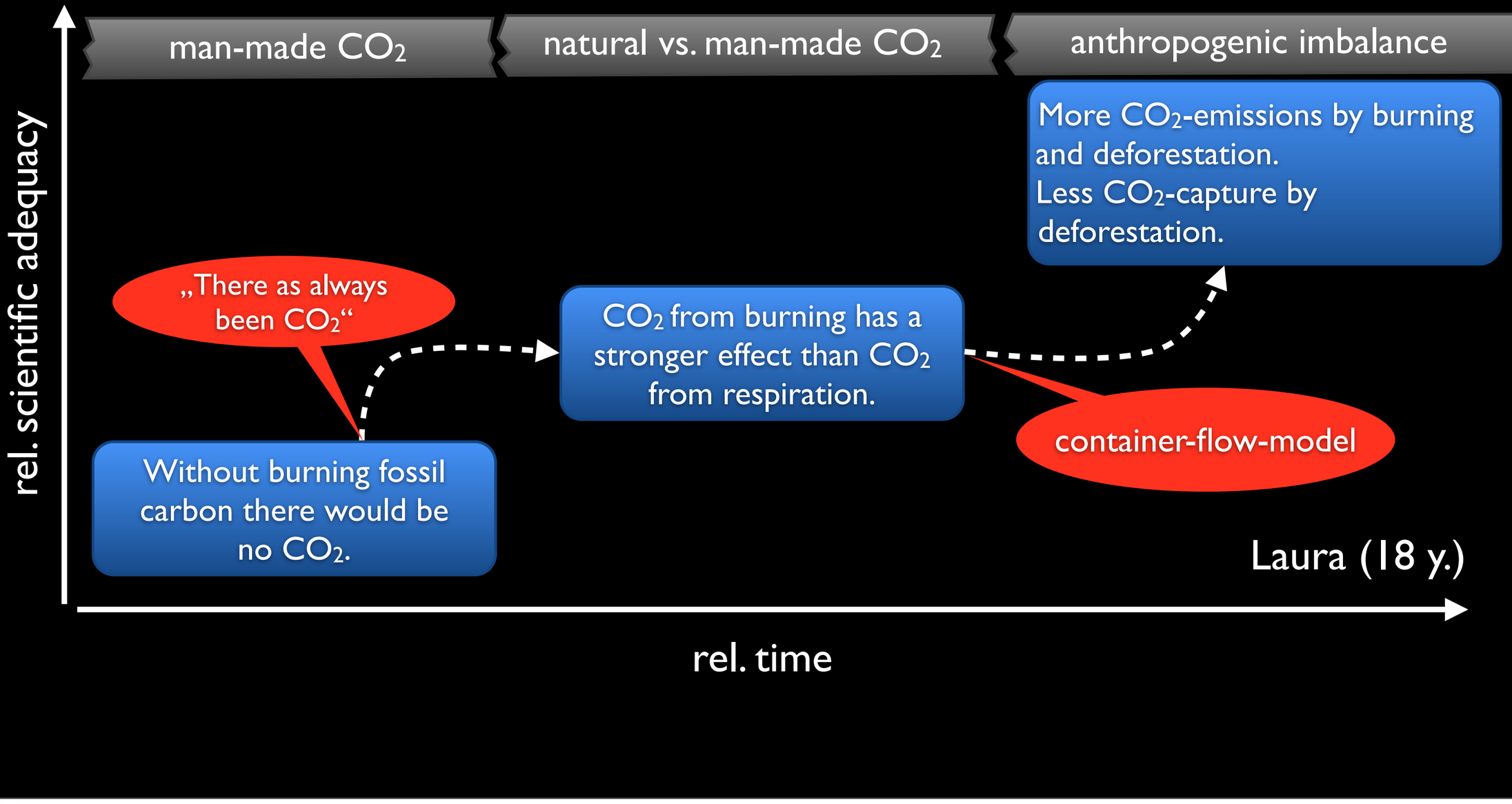

From man-made matter to man-made cause

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Guideline 2:
Recognise CO_2 as a natural element of the atmosphere.

Die Geschichte eines Kohlenstoffteilchens

Unser Held ist ein kleines Kohlenstoffteilchen, das seit Milliarden von Jahren existiert. Es sitzt seit etwa 200 Millionen Jahren an drei Sauerstoffatome und ein Calciumatom gebunden in einer Muschelschale am Meeresboden fest. Irgendwann, vermutlich durch das Absinken des Meeresspiegels während einer Eiszeit, gelangt es an die Luft und wird mit seinen Begleitern in die Welt der veränderlichen Dinge gestürzt. Im Laufe der Jahrtausende wird das Calciumteilchen von unserem Hel-

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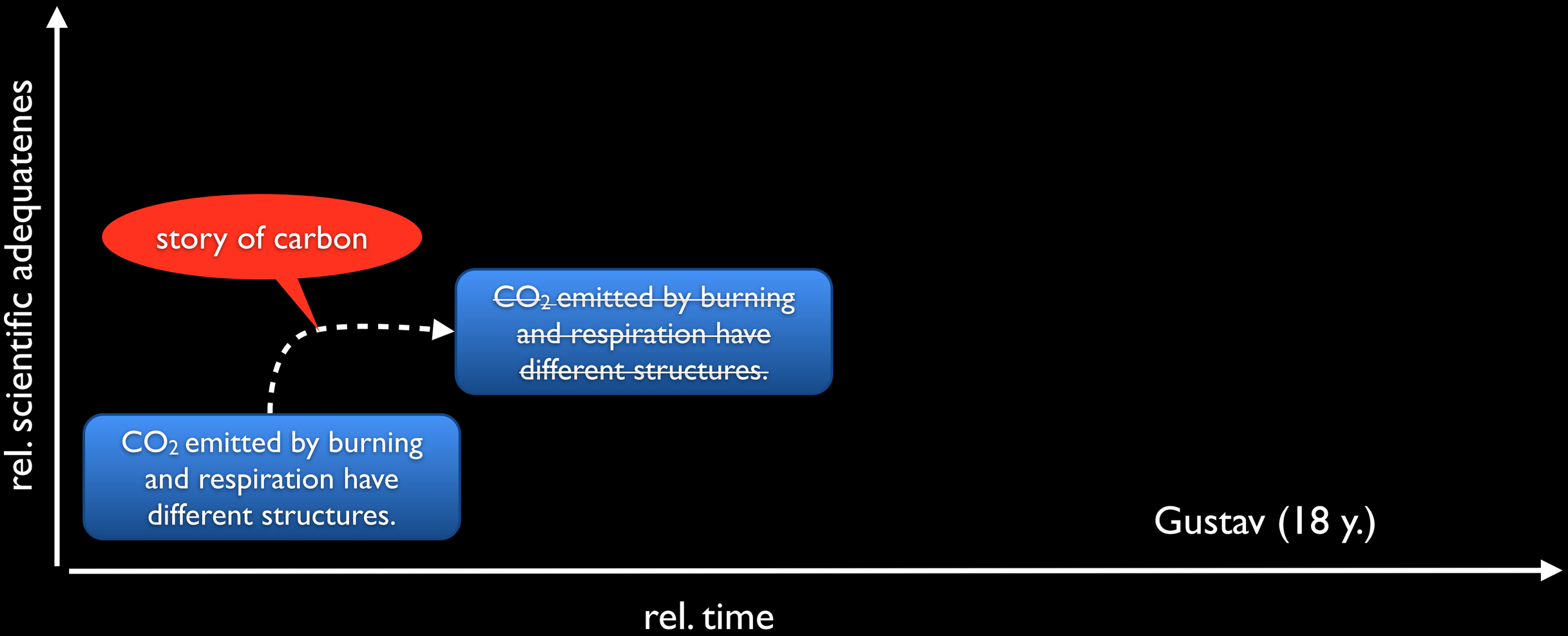
»The reason why CO_2 is emitted, the burning in man-made. Respiration is natural. Climate change comes from an imbalance, by burning and deforestation.« (Gustav, 18 J.)

thinking pathway on the carbon cycle



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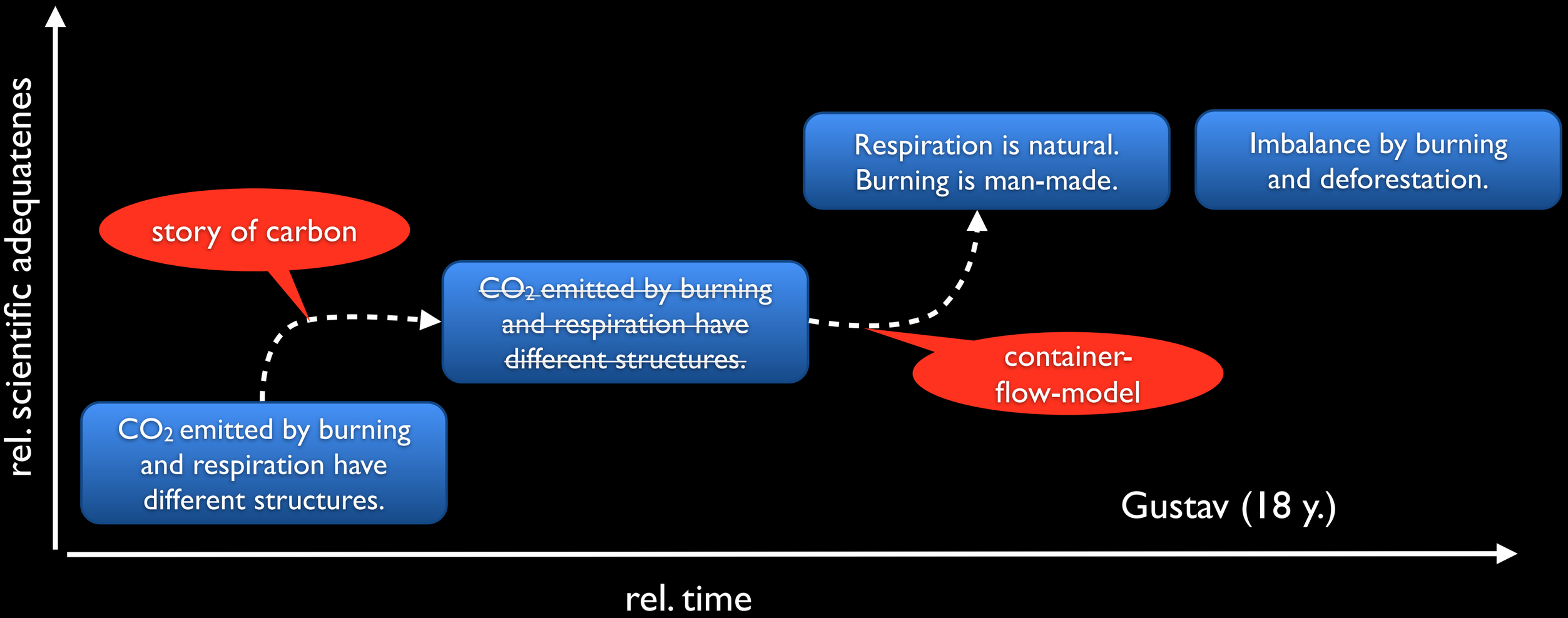

thinking pathway on the carbon cycle

natural vs. man-made CO_2

anthropogenic imbalance

rel. scientific adequatenes

Respiration is natural.
Burning is man-made.

Imbalance by burning
and deforestation.

story of carbon

~~CO_2 emitted by burning and respiration have different structures.~~

container-flow-model

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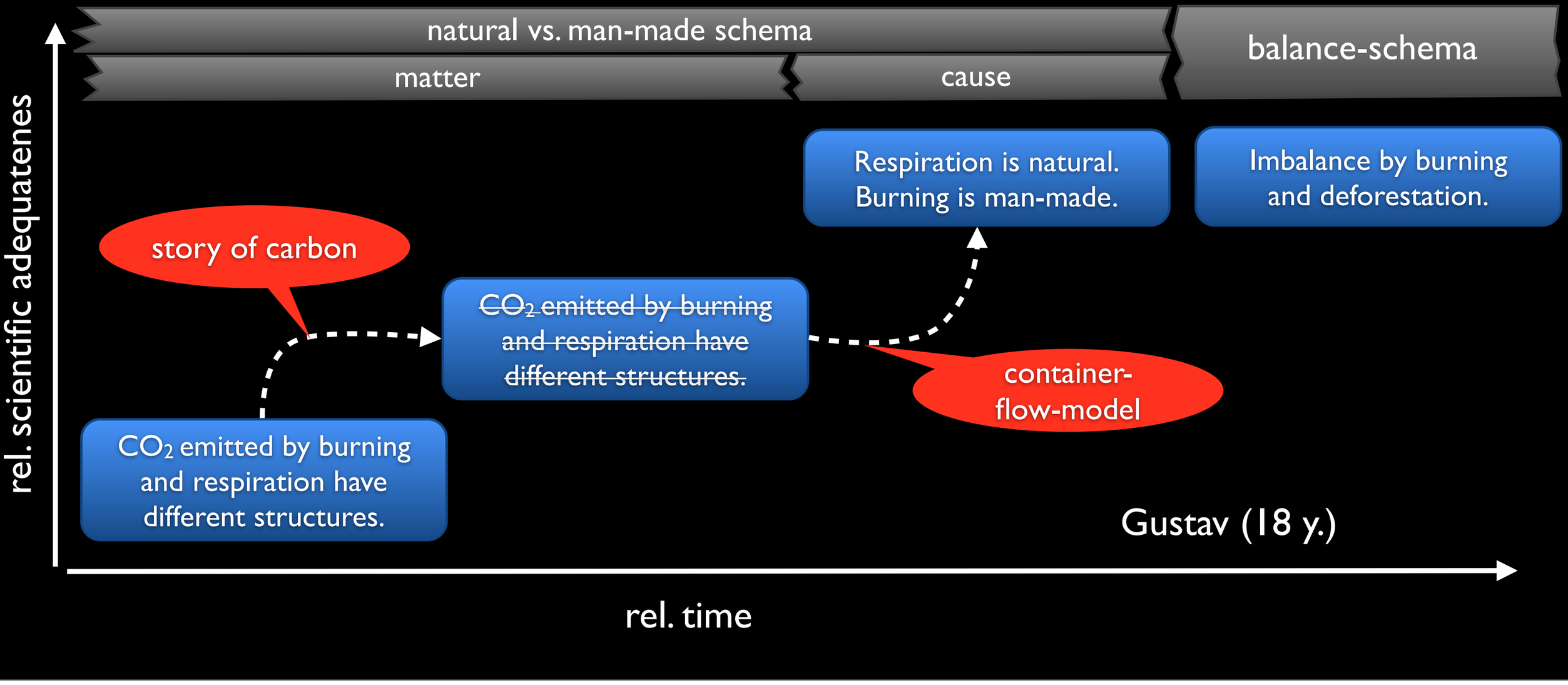
Gustav (18 y.)

rel. time

thinking pathway on the carbon cycle



language shapes thinking – and culture

language shapes thinking – and culture

coal, gas, and oil: *fossil resources, fossil fuel, fossil energy sources, energy resources…*

anthropozentric perspective

- definition of a molecule via human useage
- metaphor frames cultural model of energy consumption:

language shapes thinking – and culture

If we think of fossil carbon only as a resource for energy, our energy consuming society is hardly to imagine without using this resource.

language shapes thinking – and culture

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fossil fuel

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frames of increasing temperatures

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»It is really a problem when the atmosphere is heating up!«

Hanni, 18 years

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IPCC 2007

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summary

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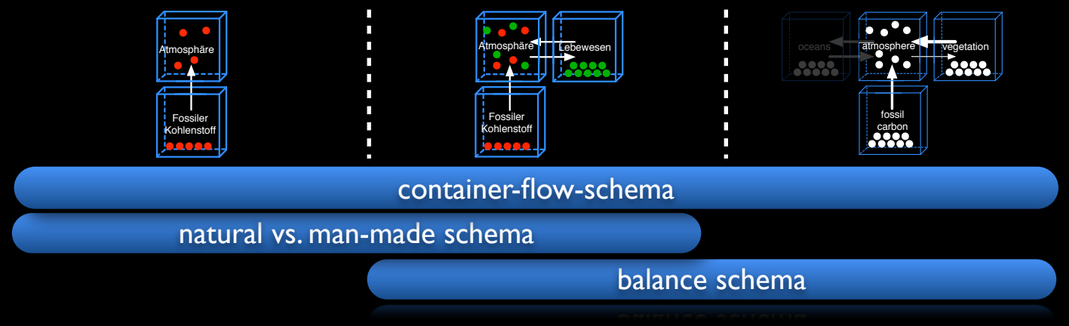
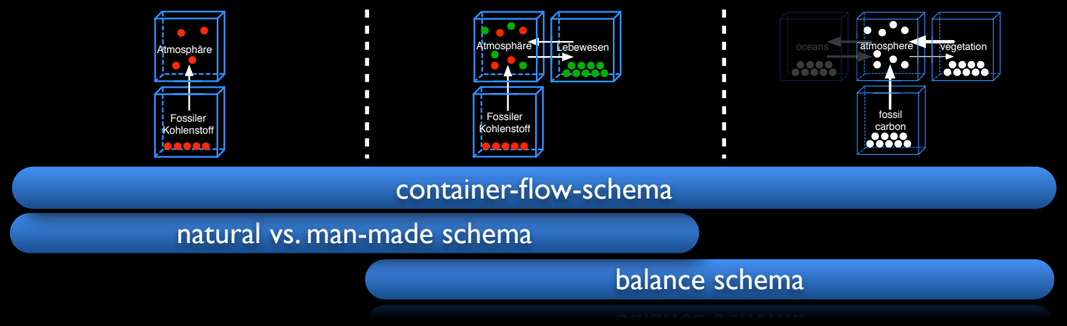


Content specific theory

To understand the carbon cycle, students and scientists use the same schemata but conceptualise them differently.

summary



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Hands on mind‘s models

Experientialism helped to give students access to their mental models by bringing them into existence.

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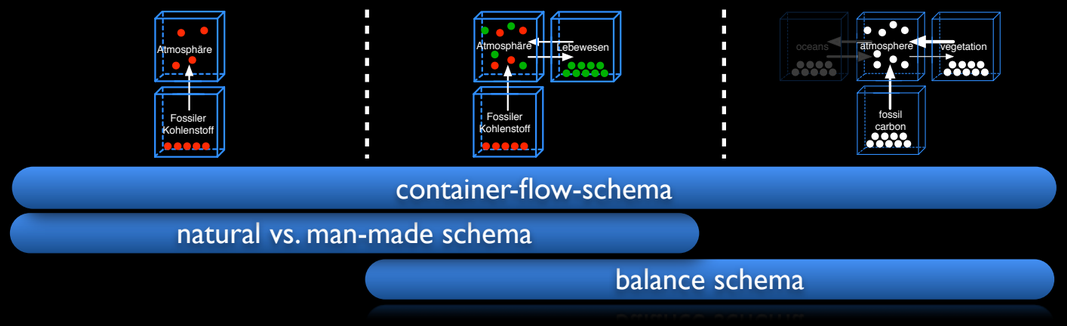

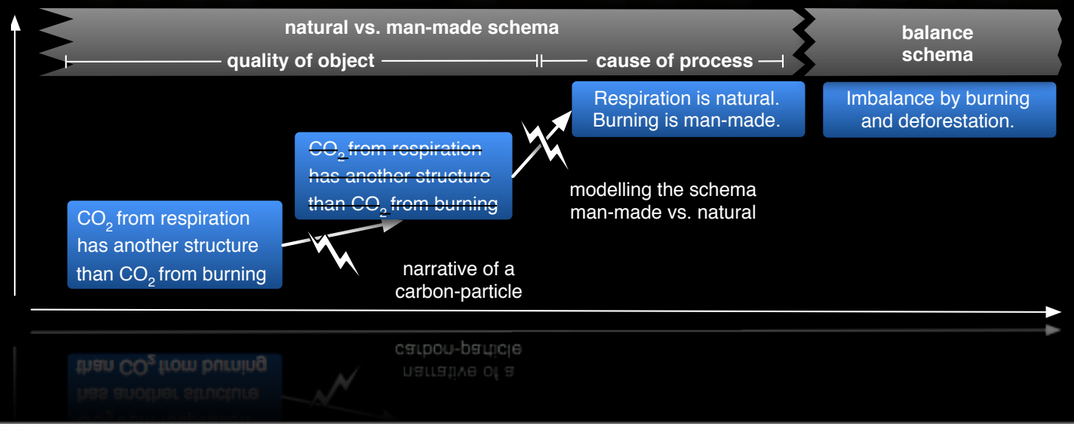

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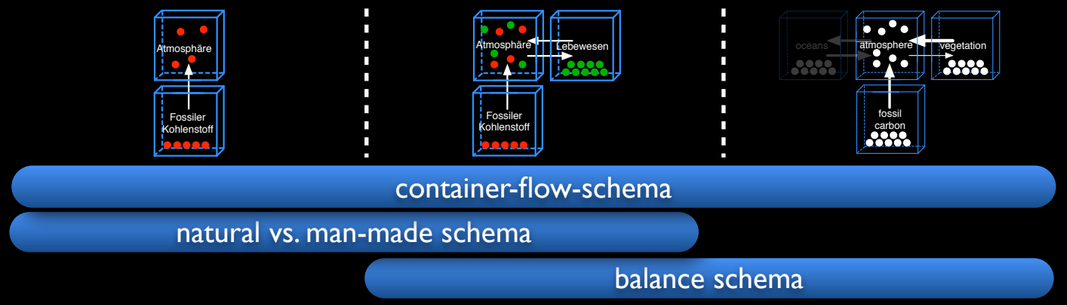
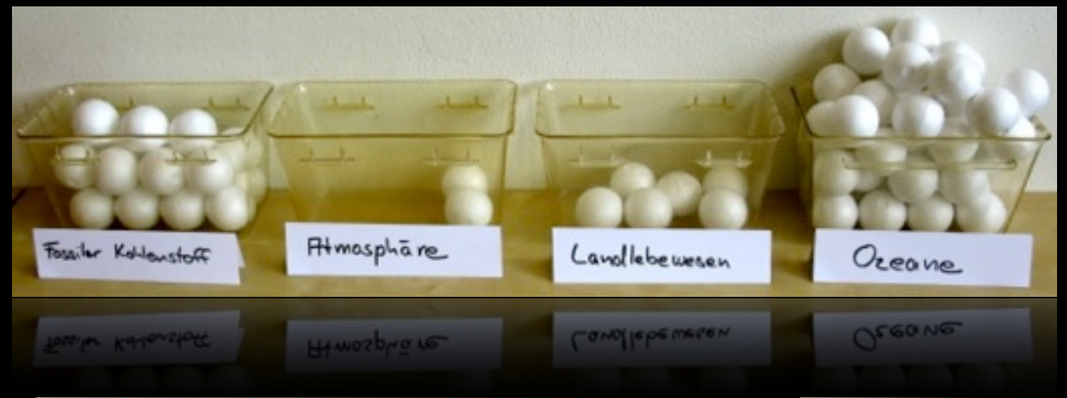
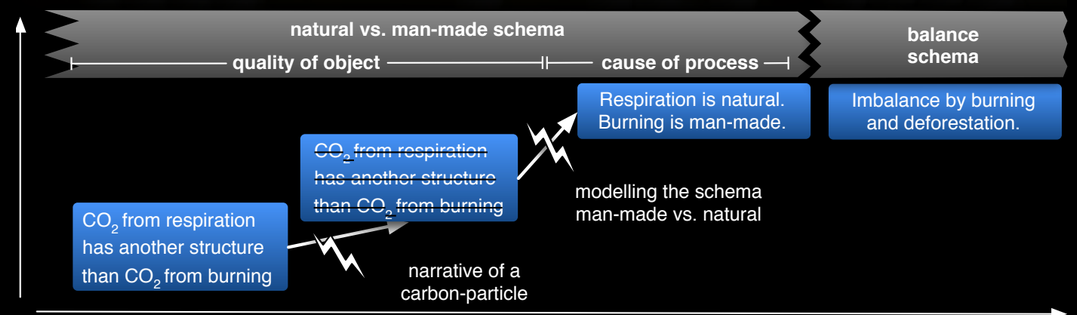
Conceptual Reconstruction

Learning on the carbon cycle bases on a reconstruction of the experience based source domains onto the abstract target domain.

Thank you for your attention!







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BIO DIDAKTIK
BIOLOGIE LEHREN LERNEN

contact & download: www.kainiebert.de

Leibniz Universität Hannover