The Crux with Reducing Emissions in the Long-term:

The underestimated “now” versus the overestimated “then”

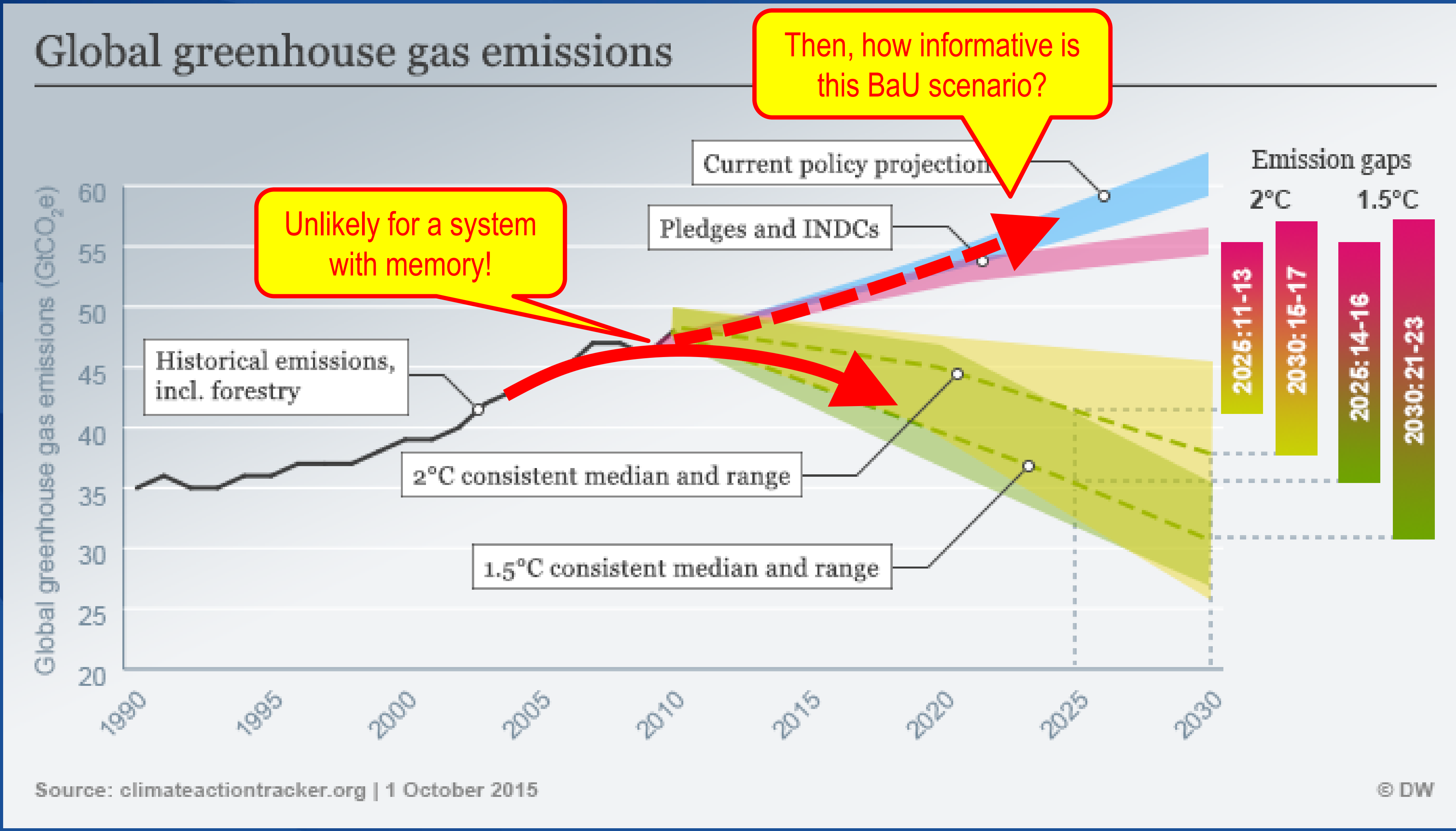
A perspective on research still to be done

M. JONAS & P. Żebrowski

International Institute for Applied Systems Analysis
Laxenburg, Austria

19th Austrian Climate Colloquium, Salzburg, Austria; 25 March 2018

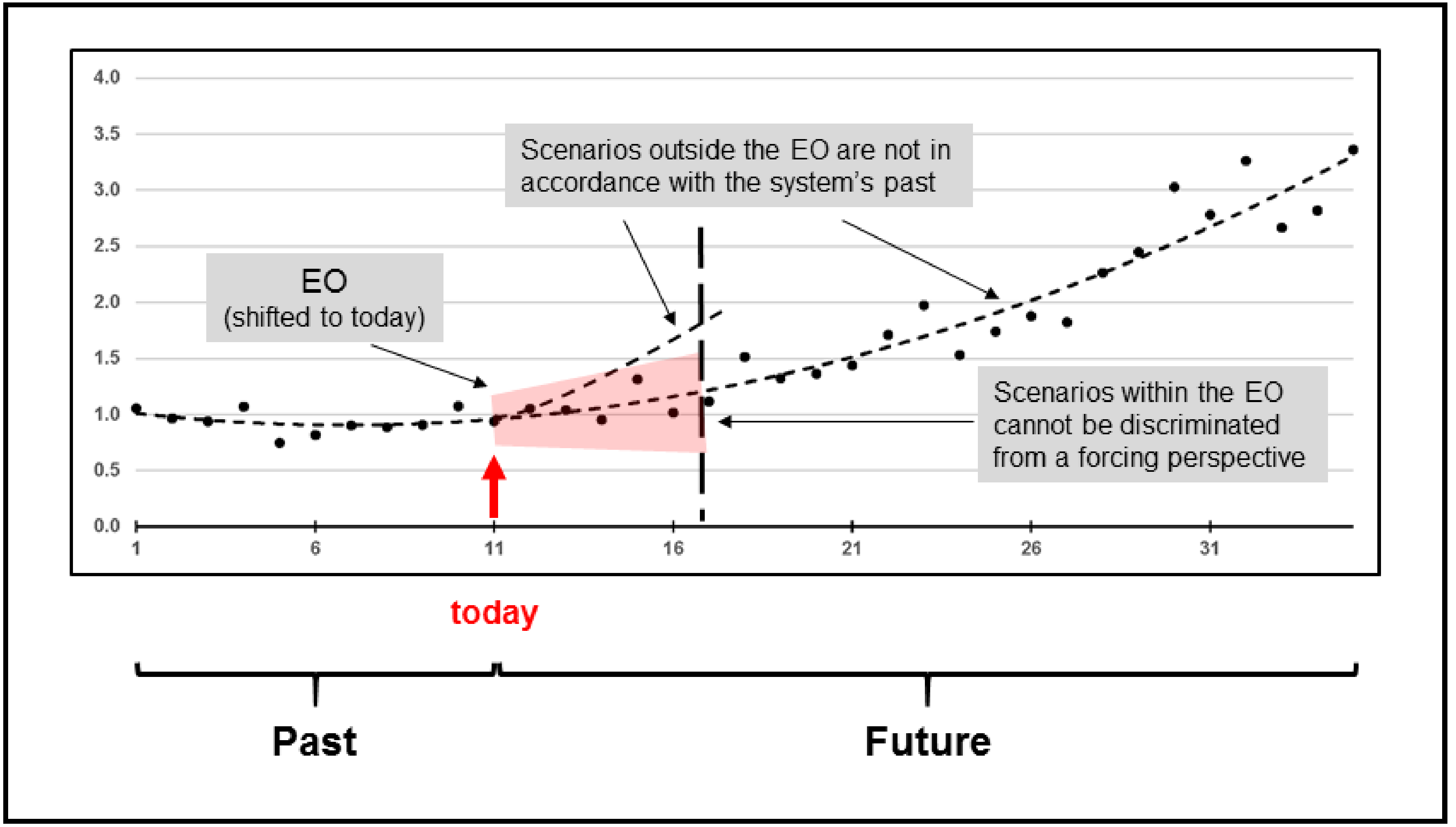
Motivation:



DW (2015); modified

What are we after?

…the Explainable Outreach (EO) → **not** prediction!!!



Jonas *et al.* (2017, 2018)

What are we after?

In the focus:

Systems with memory

Forced systems

Persistence

Explainable outreach …

Not in the focus:

Prediction (in-sample and out-of-sample)

Perfect forecasting

Bias-variance tradeoff

Signal detection …

We will proceed by explaining

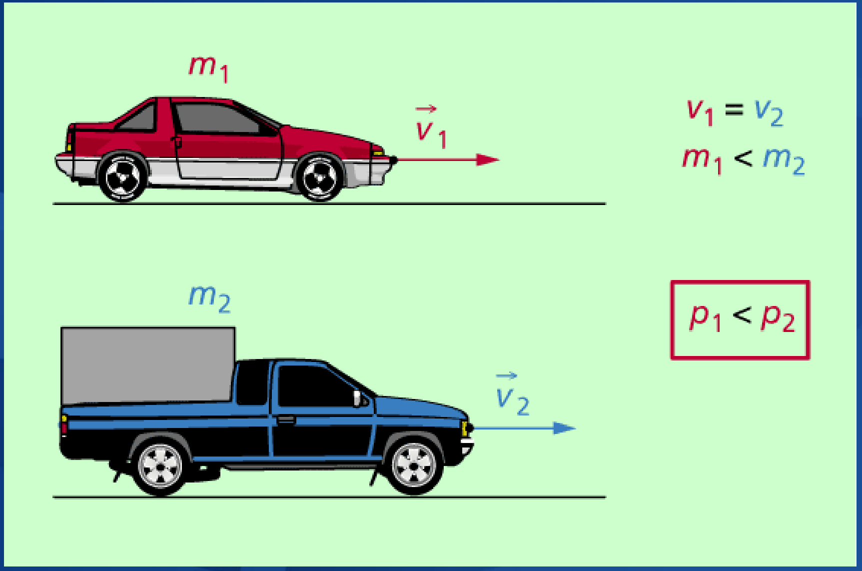
1. momentum and the change in momentum
2. how we introduce memory taking a DP approach
3. how our example works in principle
4. our methodological approach
5. our results
6. our take-home messages

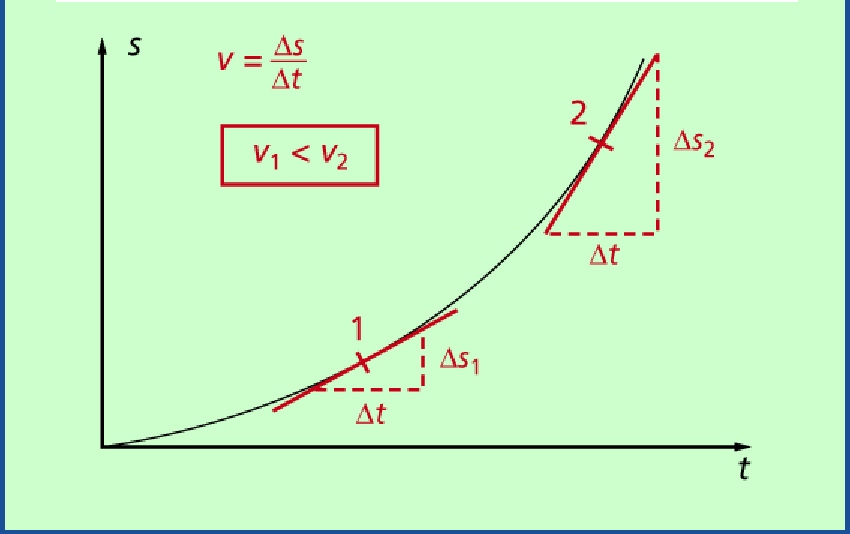
This research evolved from the project “Prognostic Uncertainty” carried out under the 2013 ESS Call of the Austrian Academy of Sciences

1. Momentum and change in momentum:

We are interested in the data series' momentum ("amount of movement"): $\vec{p} = m\,\vec{v}$

$$\vec{I} = \vec{F}\,\Delta t = m\frac{\Delta\vec{v}}{\Delta t}\Delta t = m\,\Delta\vec{v} = \Delta\vec{p}$$



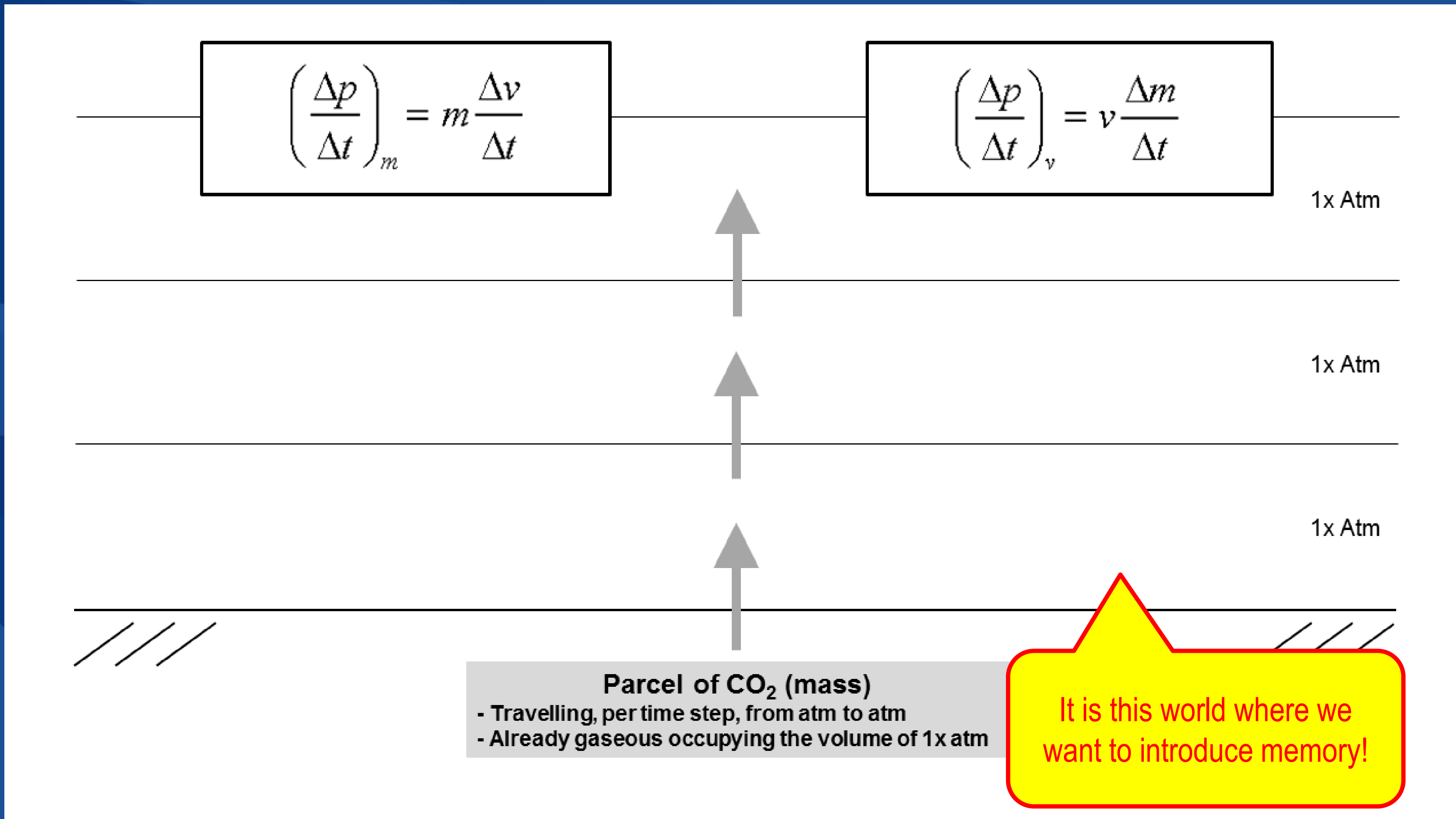


German	English
Translation	
Impuls	*Momentum*
Kraftstoß	*Impulse*
Conservative: No external impulse, no change in momentum	
Rotation	
Drehimpuls	*Angular momentum*
Drehmomentstoß	*Angular impulse*
Additive: Momentum and angular momentum add up	

1. Change in momentum:

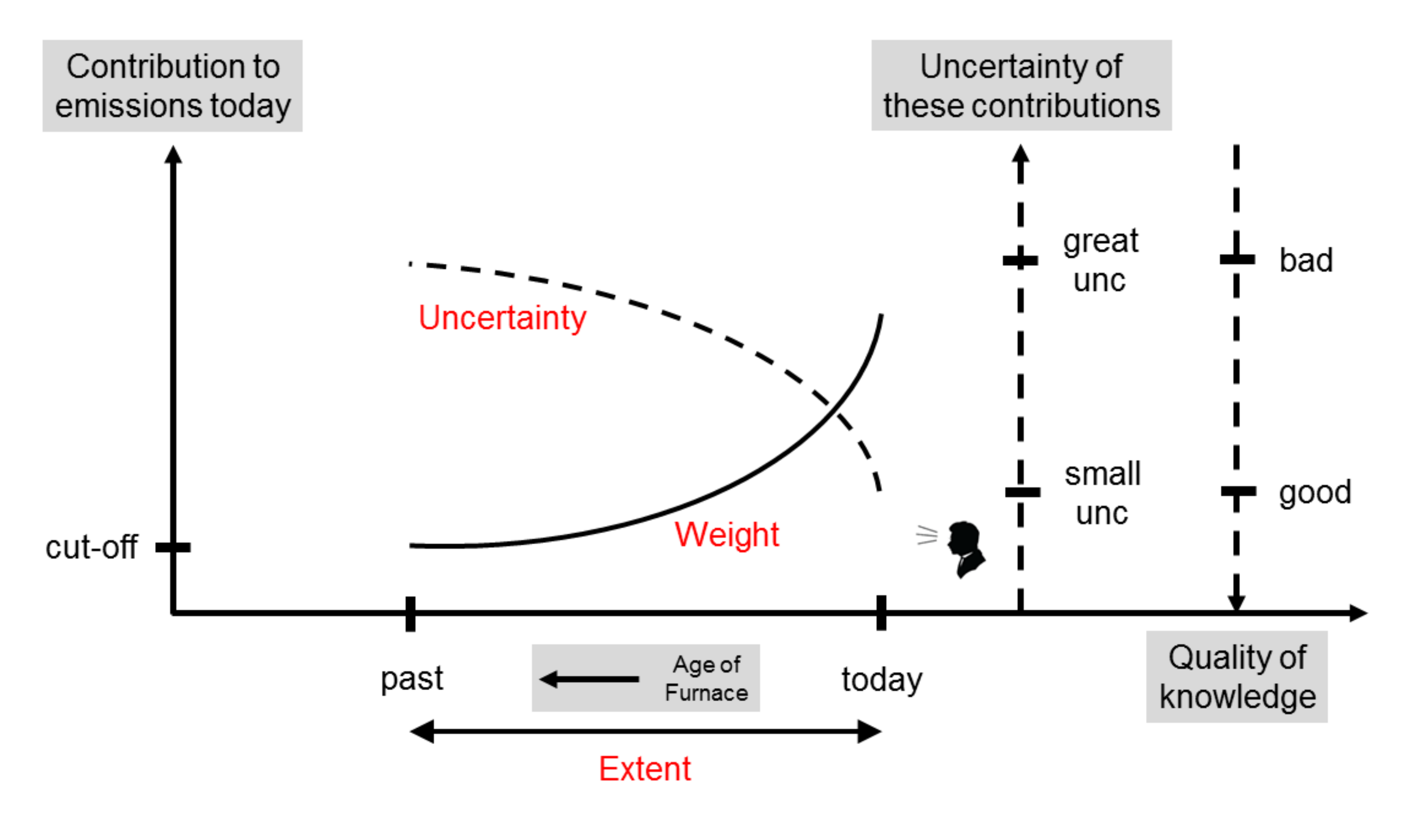
$$\left(\frac{\Delta p}{\Delta t}\right)_m = m\frac{\Delta v}{\Delta t}$$

$$\left(\frac{\Delta p}{\Delta t}\right)_v = v\frac{\Delta m}{\Delta t}$$



2. Introducing memory taking a DP approach:

$$Emissions = \underbrace{\frac{Emissions}{Furnace}}_{\text{technological state-of-the-art}} * \underbrace{\frac{Furnaces}{Capita}}_{\text{technological endowment at per-capita level}} * \underbrace{Capita}_{\text{forcing}}$$



Jonas *et al.* (2018)

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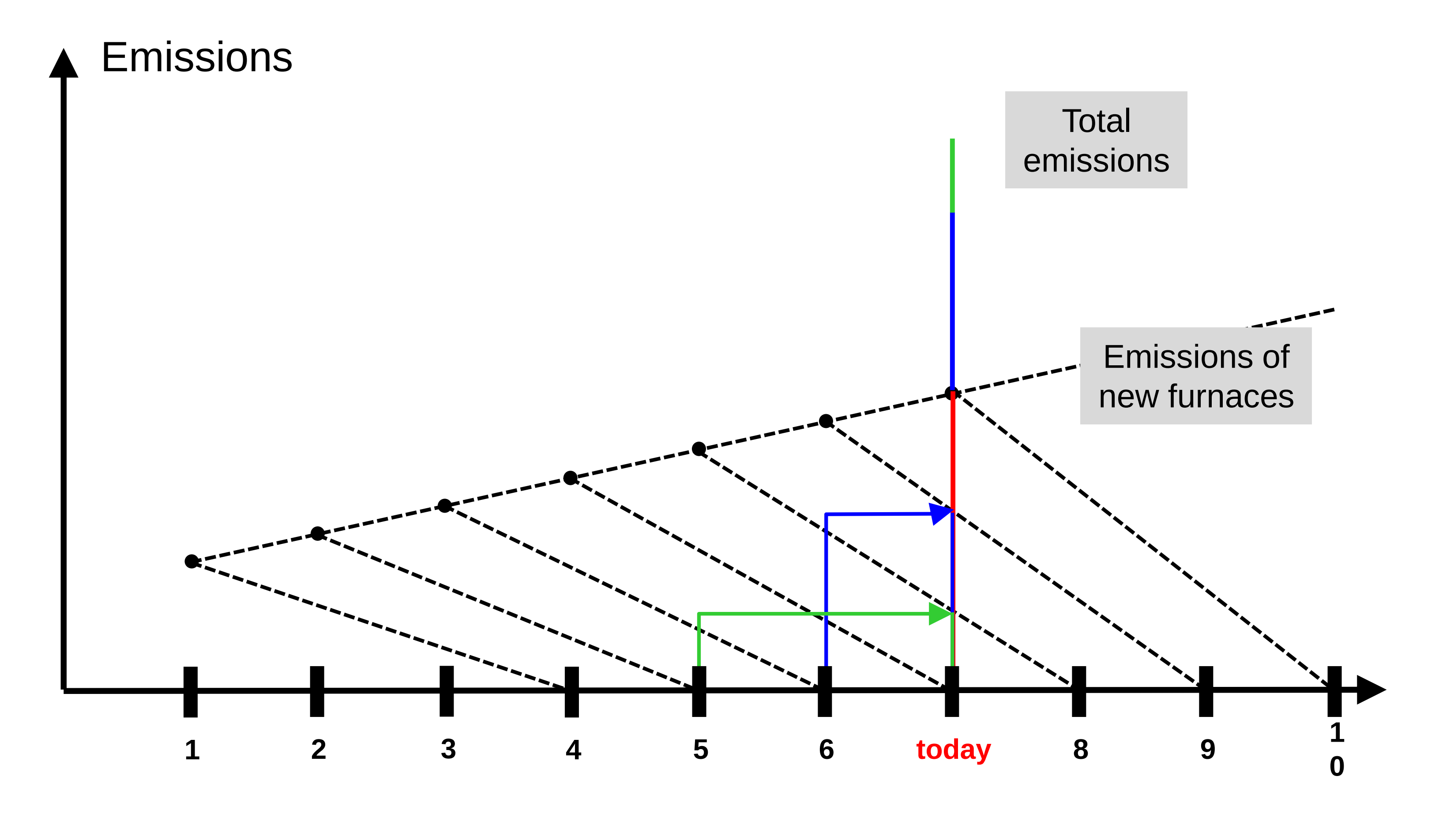

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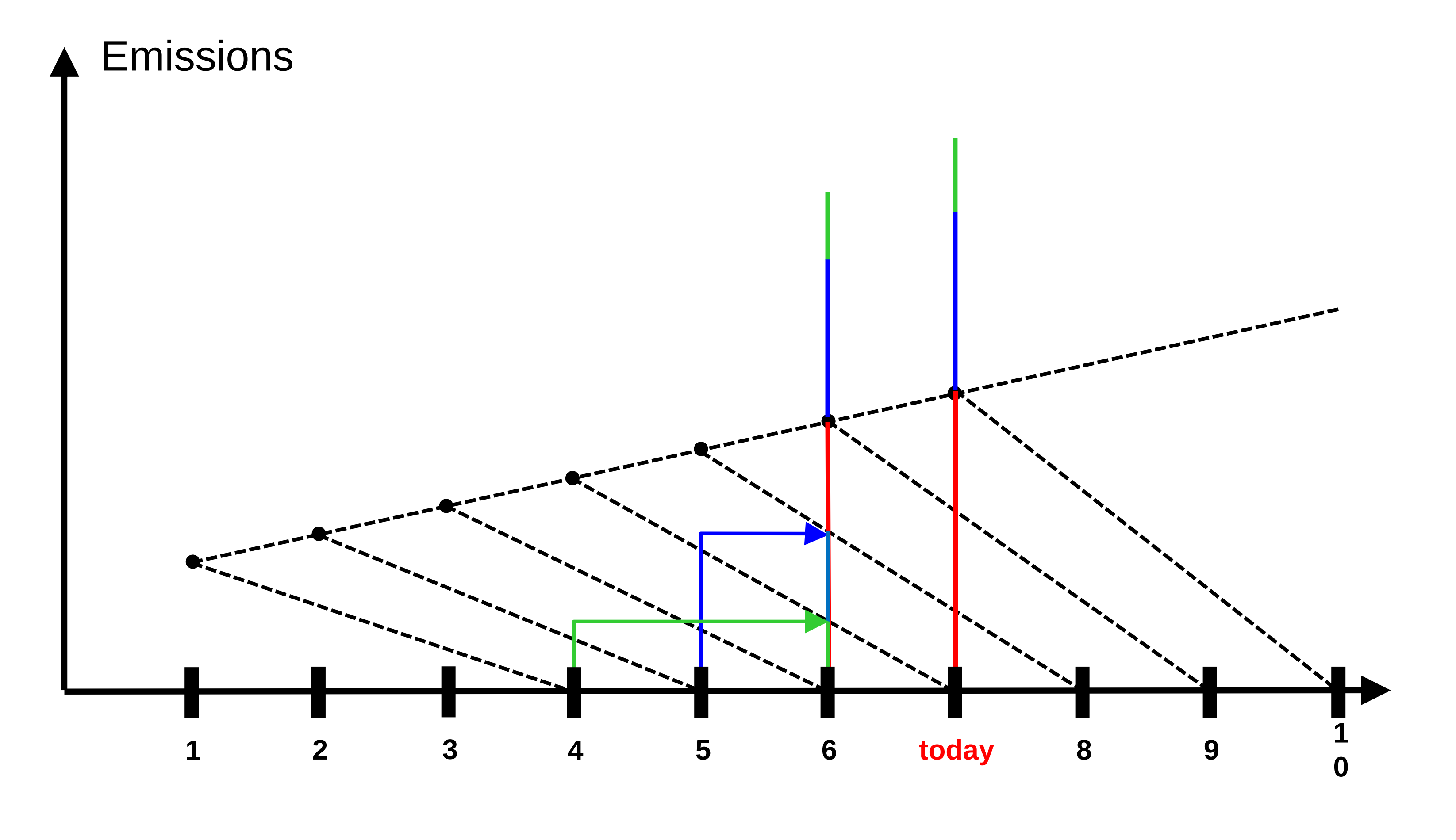

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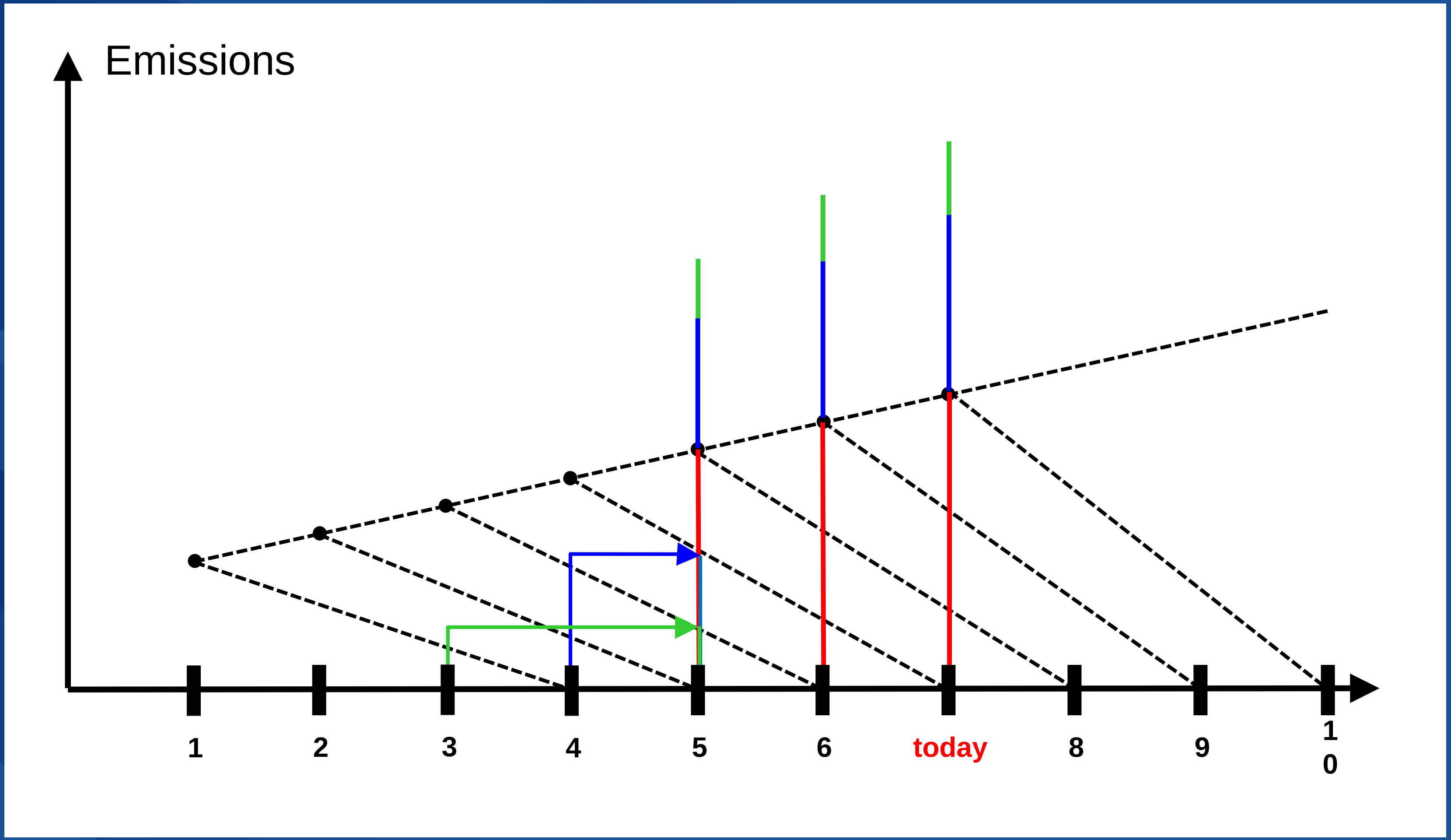

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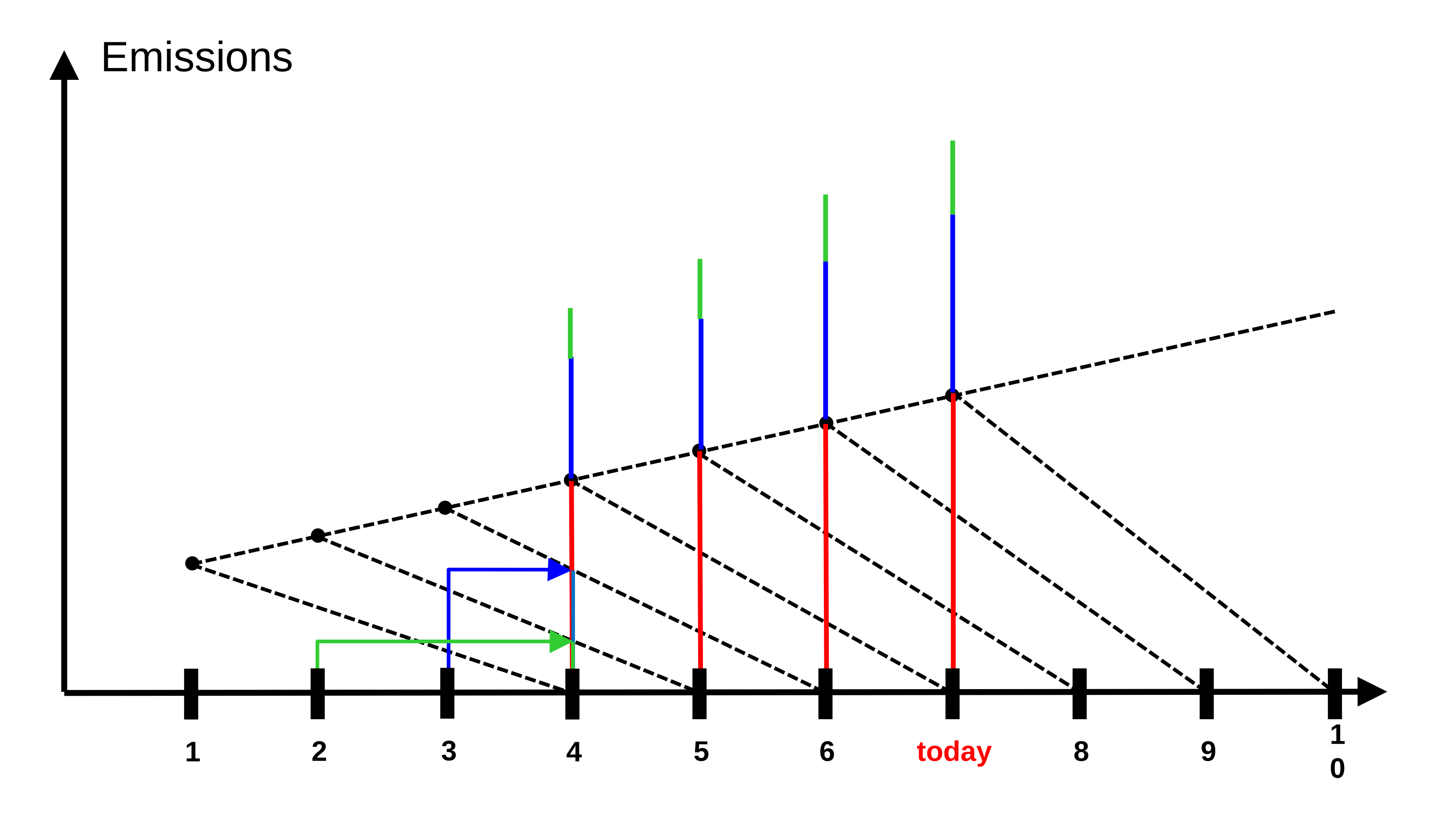

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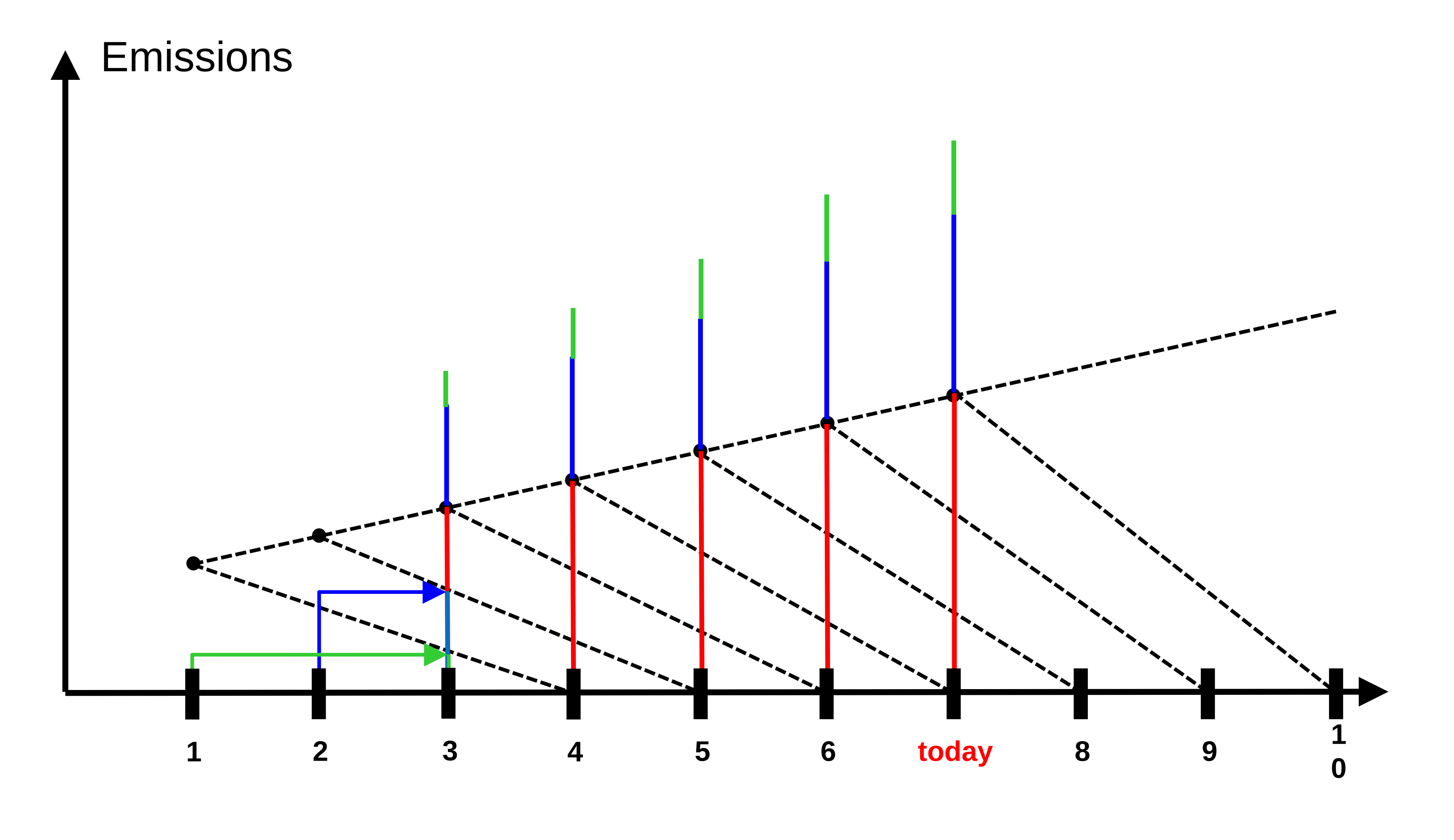

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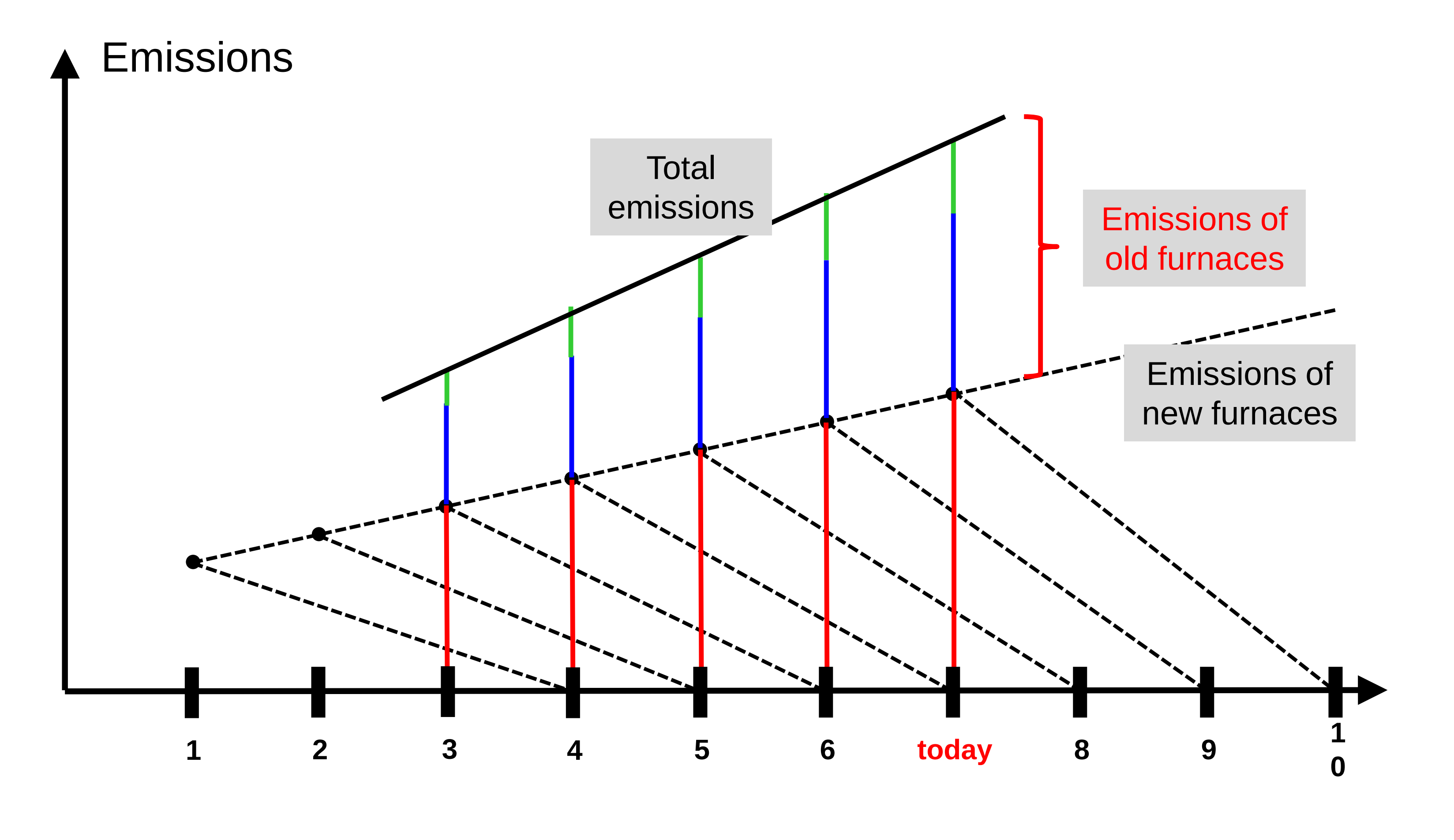


2. Introducing memory taking a DP approach:

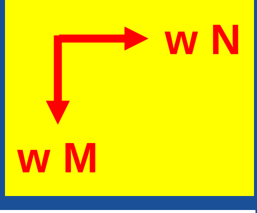
What we do not need to do:

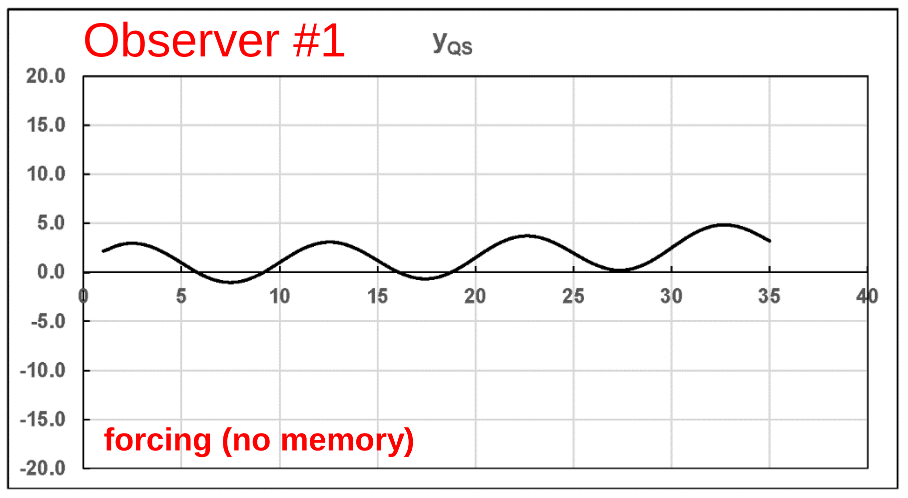
To take a detailed (prospective) modeling approach to understand how well the emissions system remembers its antecedent development!

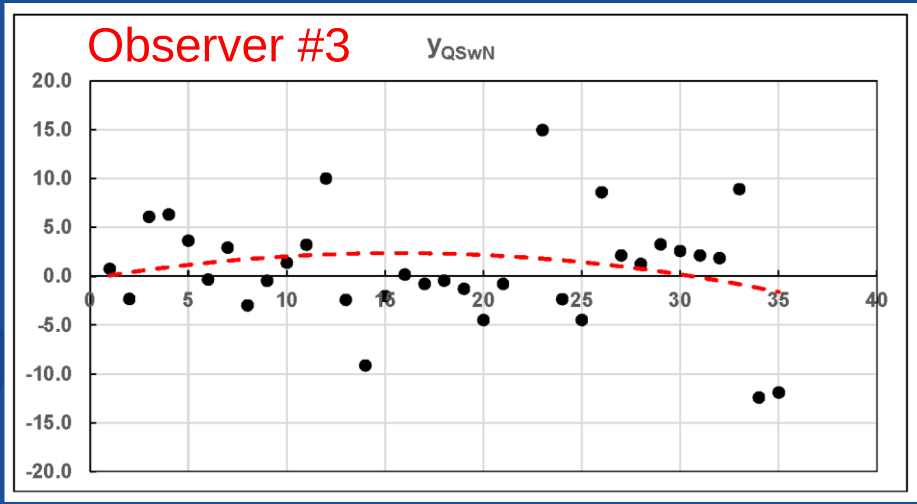
What we can possibly do instead:

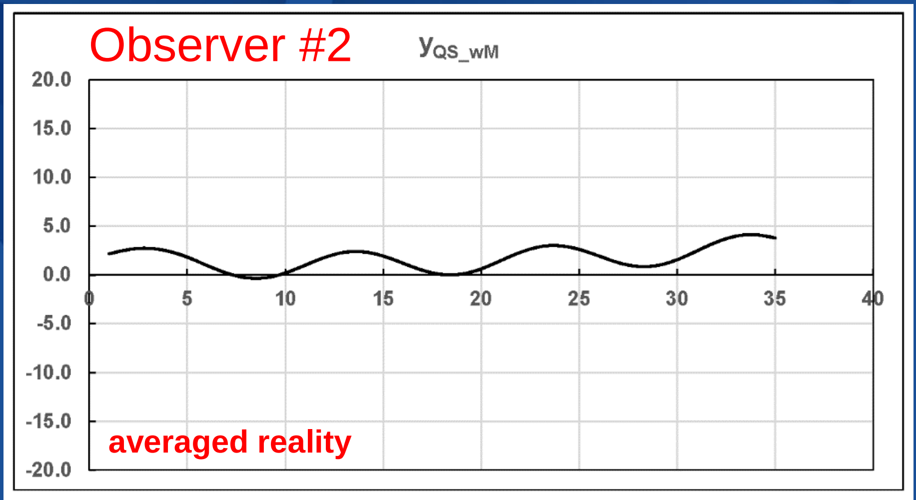
To take a curve-fitting (retrospective) data-driven approach to identify a suitable “memory model” consisting of as few parameters as possible to capture memory in the series of observations/estimates of emissions, while involving only current data at each point in time.

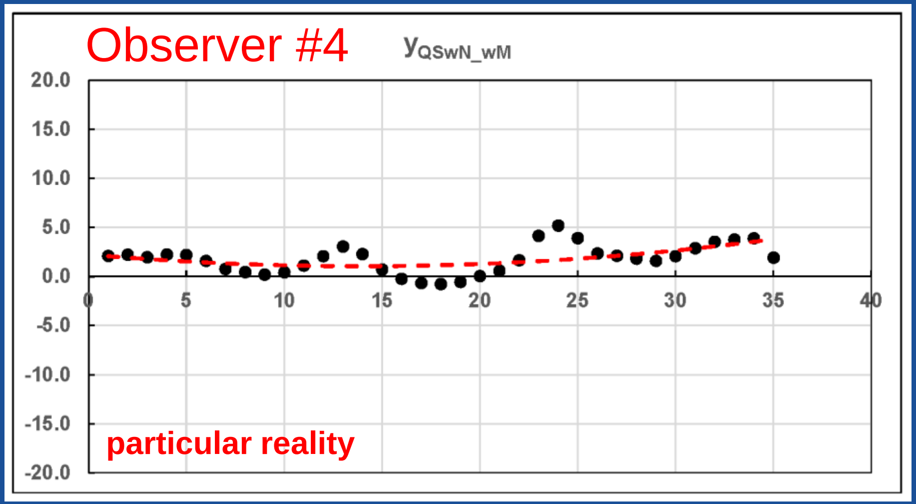
3. How our example works in principle:











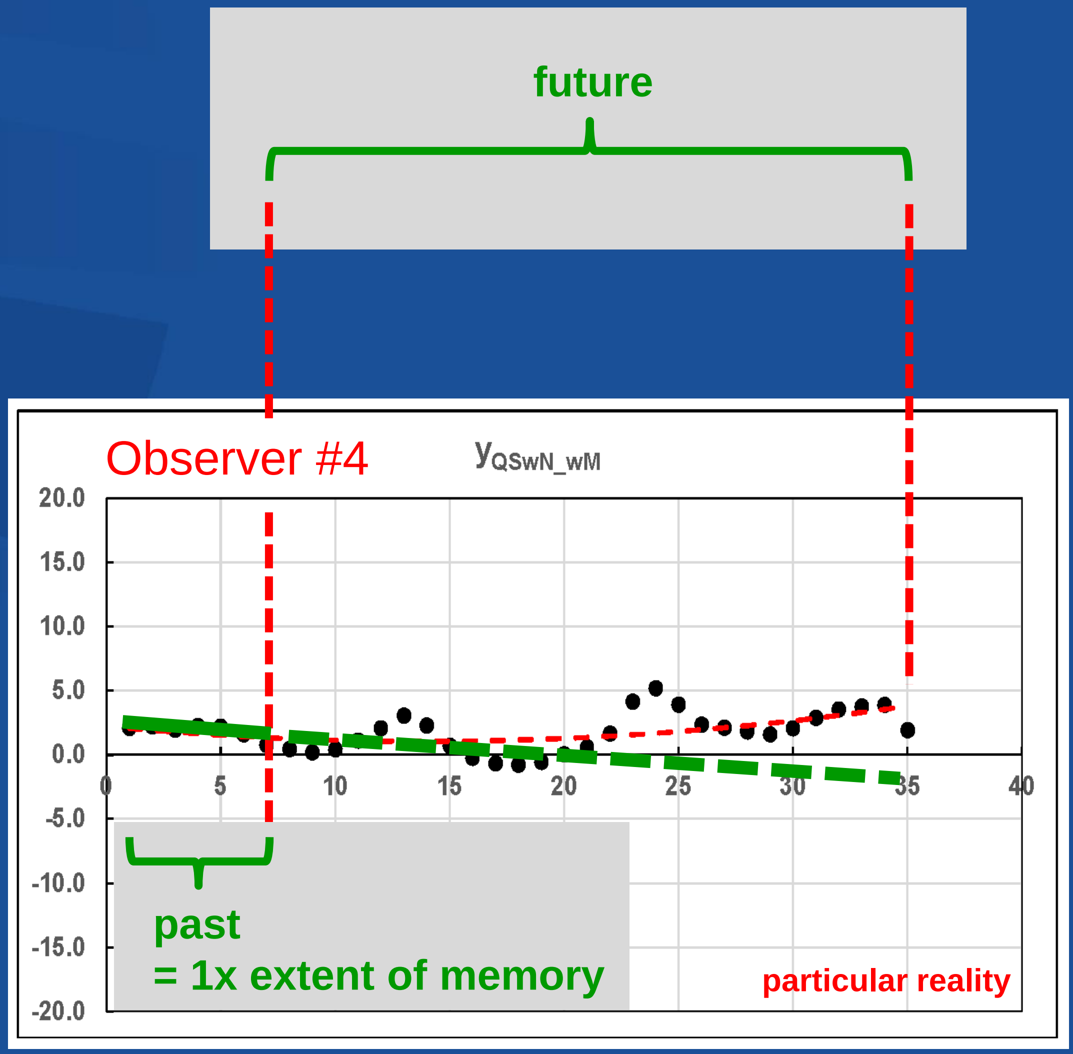
3. How our example works in principle:

We assume

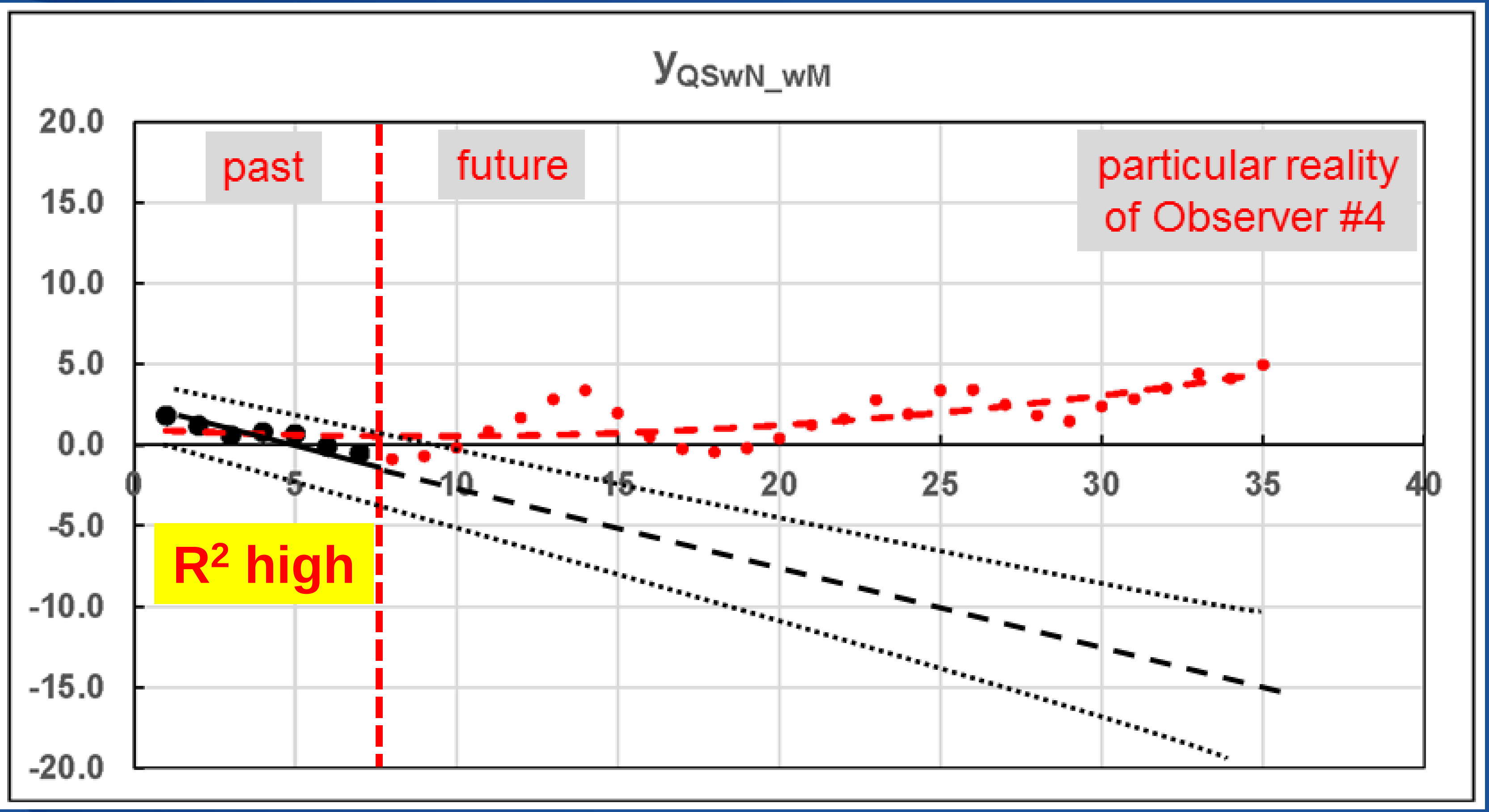
that we can observe the historical part of the "world of observer #4" only by way of linear regression, at best.

We then ask

how often does Y_{QSwN_wM} (red regression) fall within the (in- and out-of-sample) confidence band of our linear regression for a time that corresponds to 2x the extent of memory?



5. Looking ahead – our results in principle:



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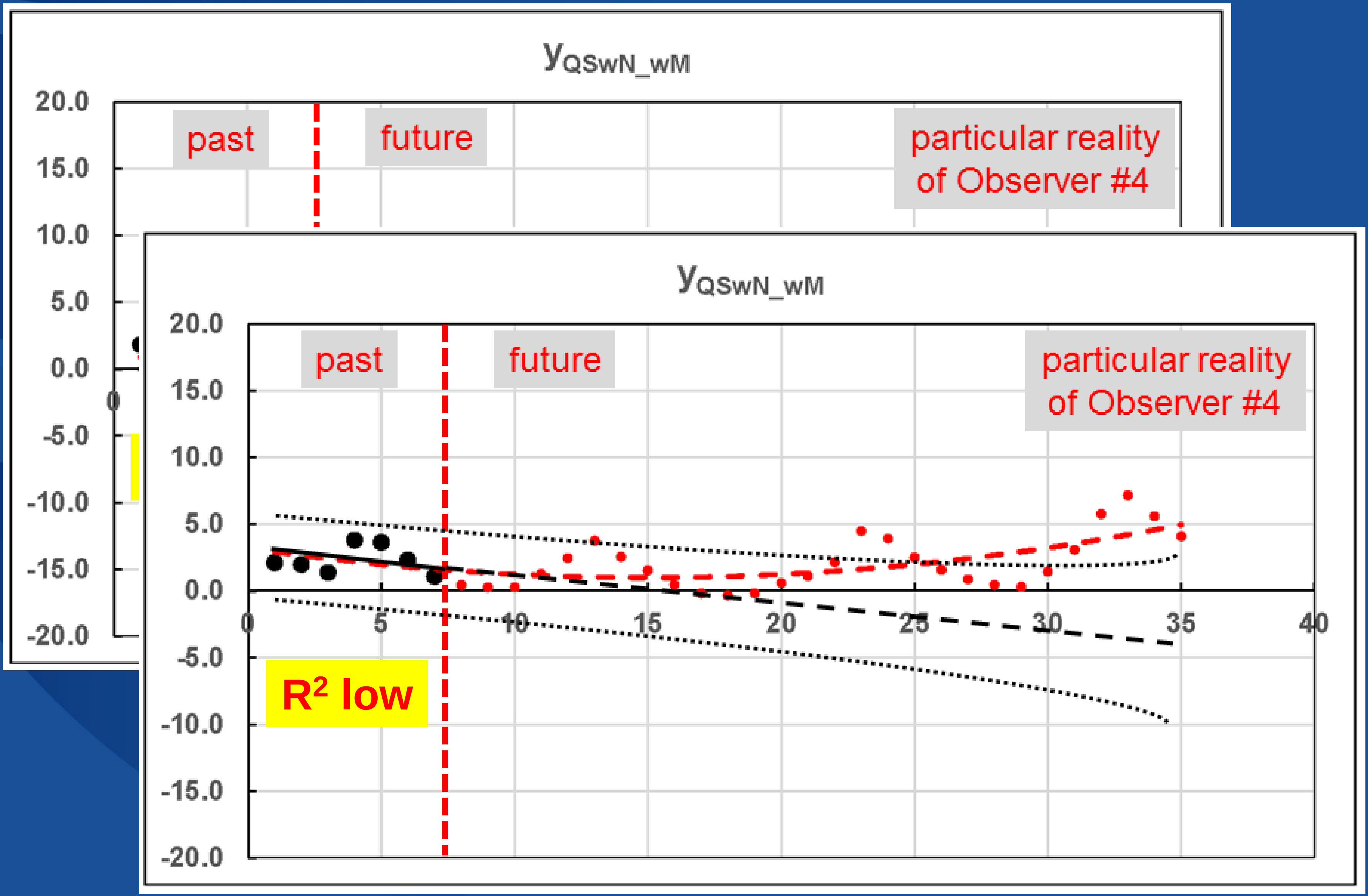

6. Our take-home messages so far:

1. We have reasons for optimism that the system's EO can be derived under both incomplete knowledge of memory and imperfect understanding of how the system is forced. We also learn that we can derive a robust EO if we resist attempting to describe the world we perceive too precisely.

2. We are confronted with the challenge of acquiring a deeper systemic understanding to substantiate how memory plays out over time (exponentially, as in our example, or otherwise). It remains to be seen whether meeting that inversion challenge is feasible. We think that it can be mastered.

Jonas *et al.* (2017, 2018)

6. Our take-home messages so far:

3. Our insights so far indicate the high chance of our conjecture proving true:

Being ignorant of memory and persistence, we underestimate, probably to a considerable extent, the momentum with which GHG emissions will continue on their historical path beyond today and thus over-estimate the reductions that we might achieve in the future.

Jonas *et al.* (2017, 2018)

References

DW (2015) Draft climate text released - but what about the emission gap? Deutsche Welle, Bonn, 05 October 2015. http://dw.com/p/1Giw2 (accessed 09 Feb. 2018).

Jonas, M. and P. Żebrowski, 2017: Learning from the Past. Supplementary Exercise on Memory, Persistence and Explainable Outreach. Working Paper, WP-17-016, International Institute for Applied Systems Analysis, Laxenburg, Austria, pp. 29. Available at: http://pure.iiasa.ac.at/14833/7/WP-17-016.pdf.

Jonas, M. and P. Żebrowski , 2018: The crux of reducing emissions in the long-term: The underestimated "now" versus the overestimated "then". *Mitig. Adapt. Strateg. Glob. Change* (under review).

Confer the latter two references for background literature as well as:

Jonas, M., P. Żebrowski and J. Jarnicka, 2018: Towards Handling Uncertainty in Prognostic Scenarios: Advanced Learning from the Past. Project Report, Austrian Academy of Sciences [Online ISBN: 978-3-7001-8290-0], doi: 10.1553/ESS-PrognosticUncertainty (forthcoming).