What are the data requirements for addressing science questions as the radiation budget record gets longer?

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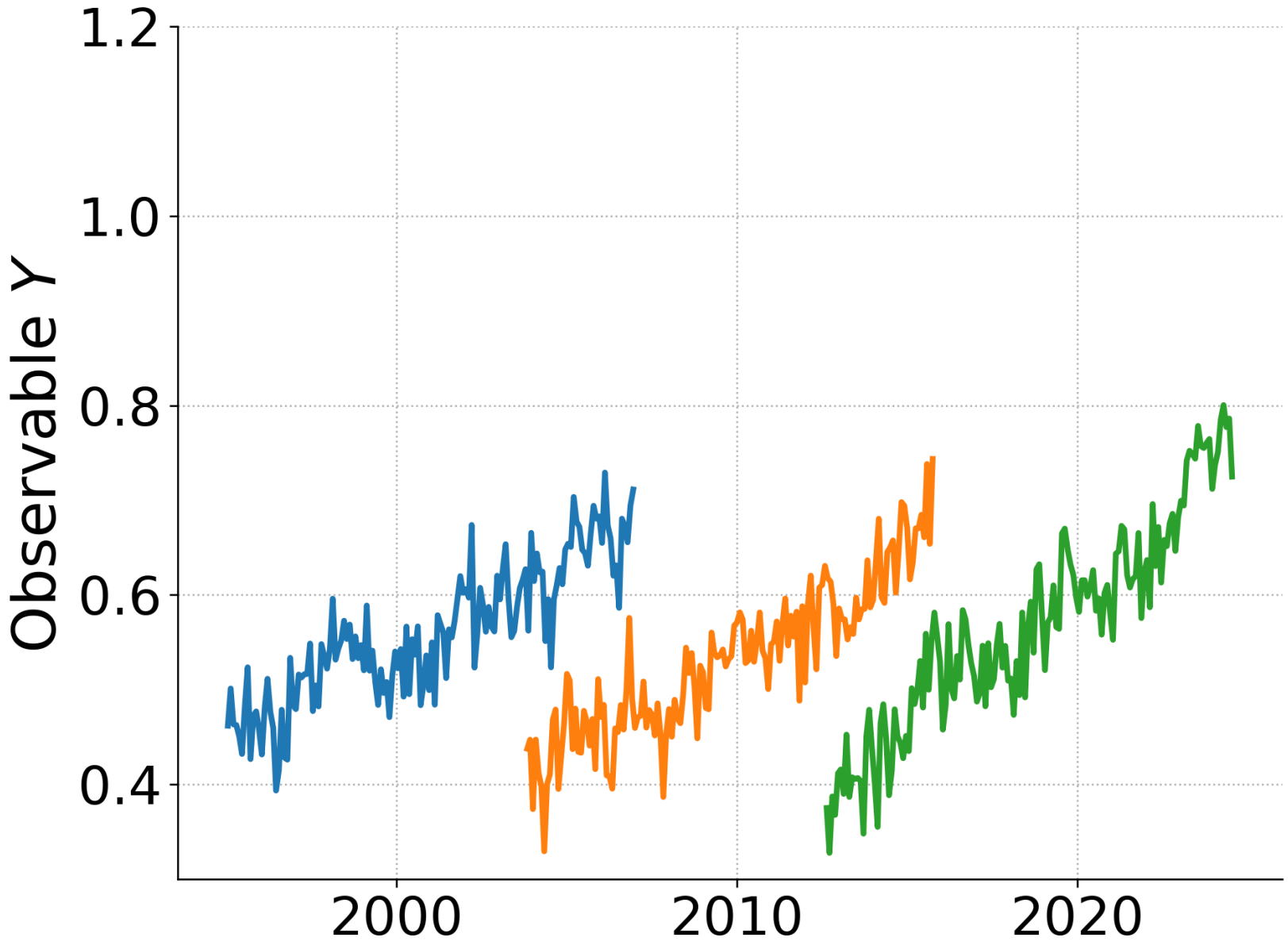
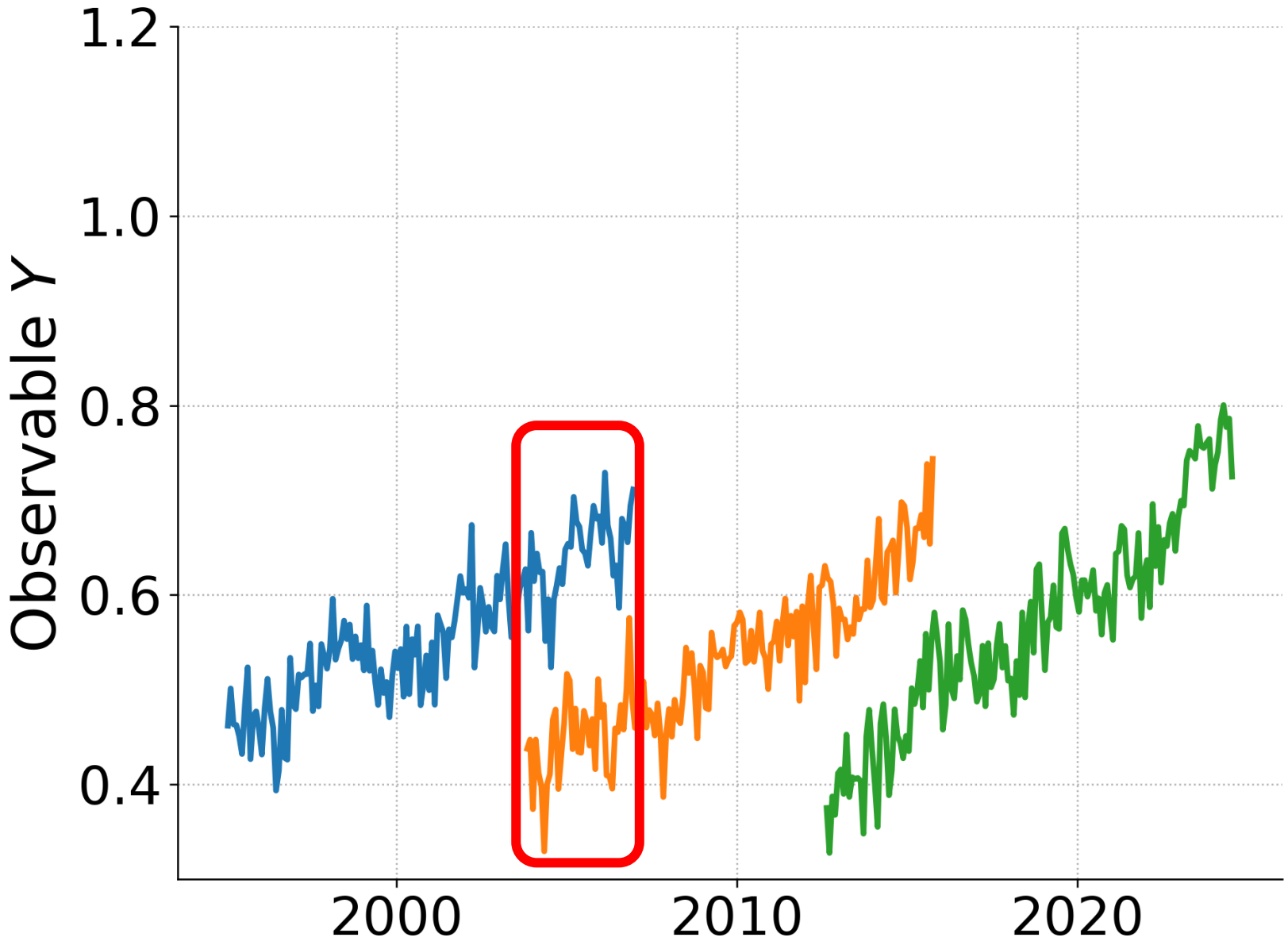
DISCLAIMER: During the preparation of this work the author(s) used Google Gemini in order to generate cartoons. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.


1.2
1.0
0.8
0.6
0.4
Observable Y
2000
2010
2020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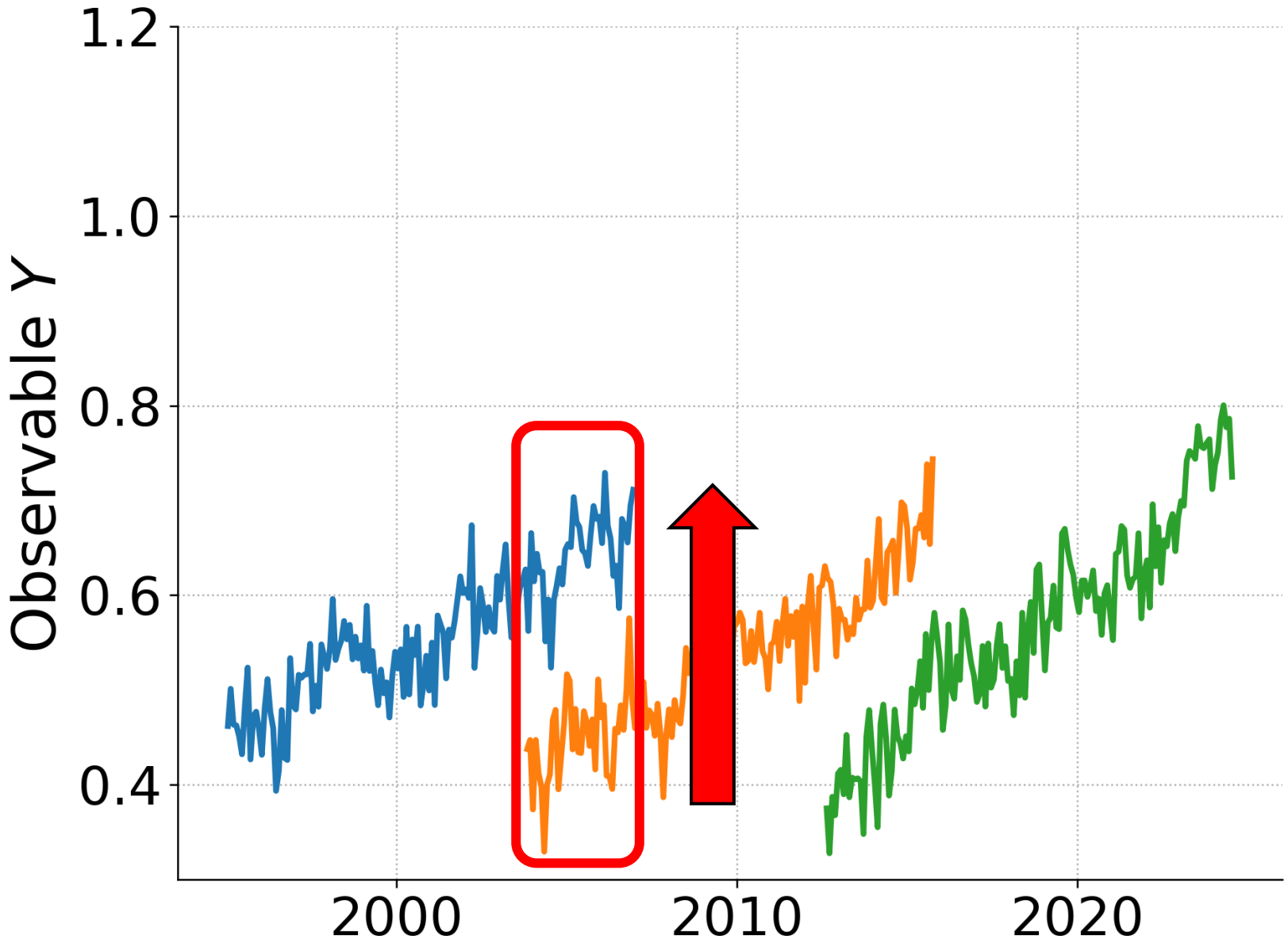
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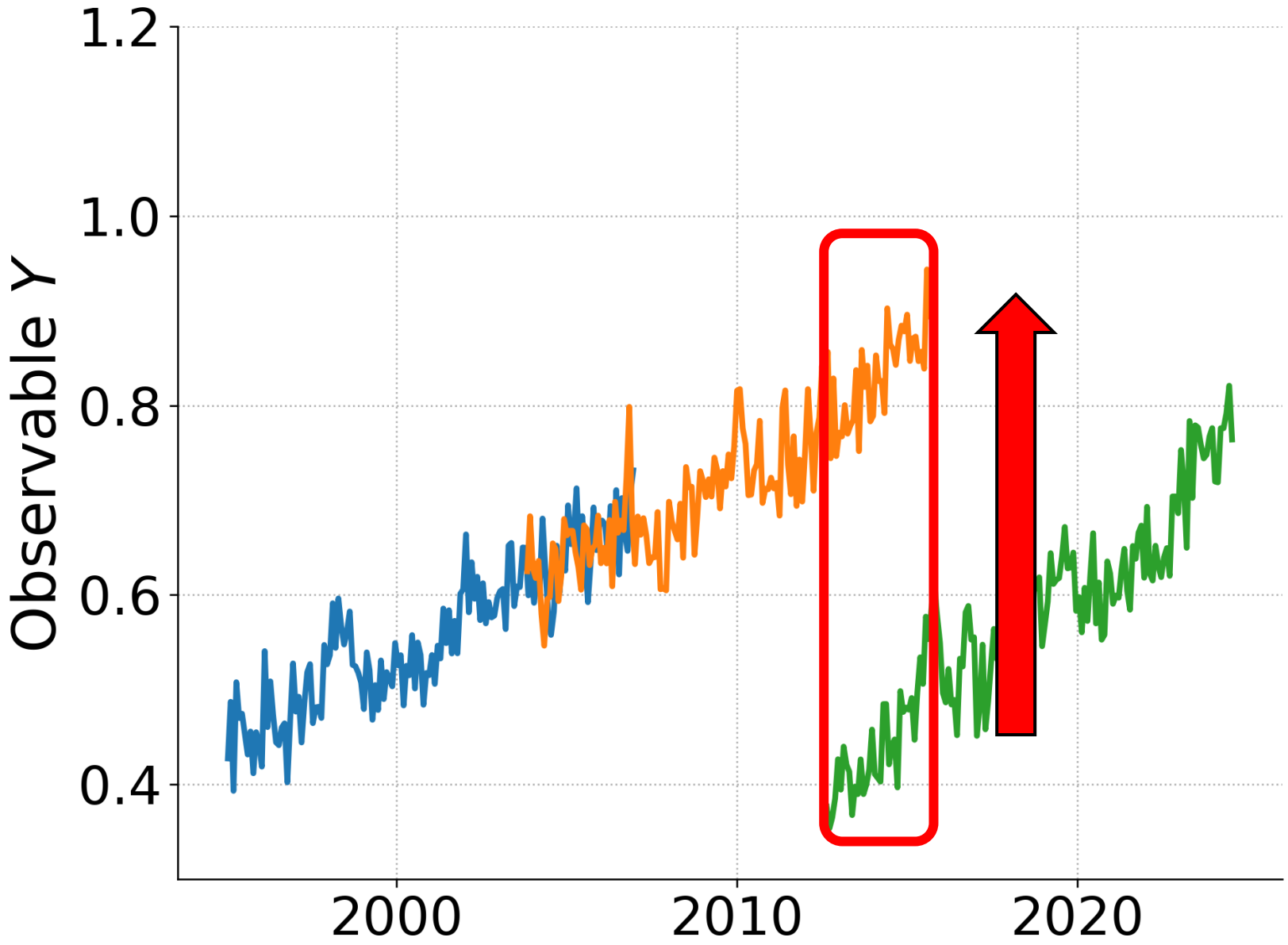
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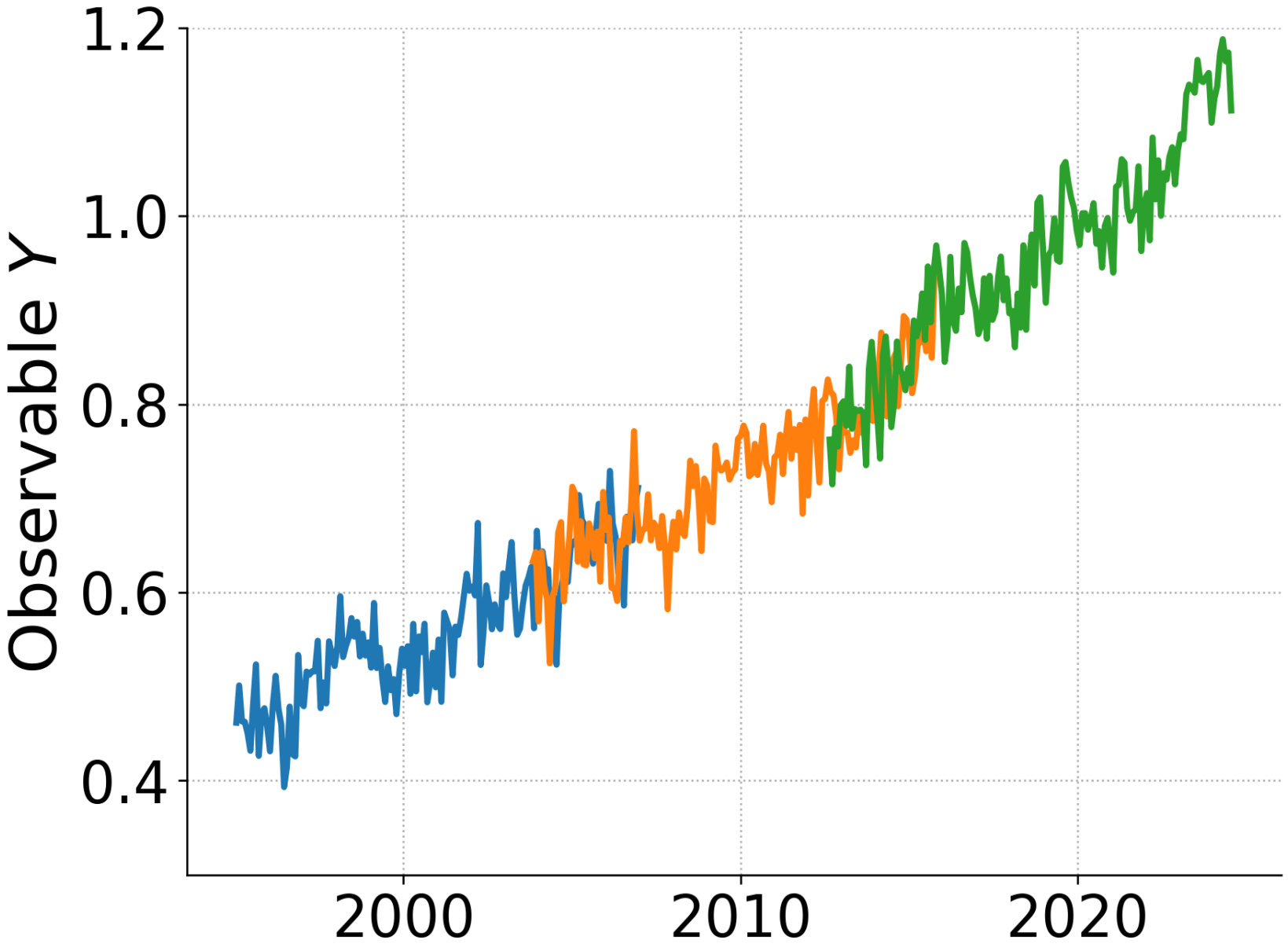
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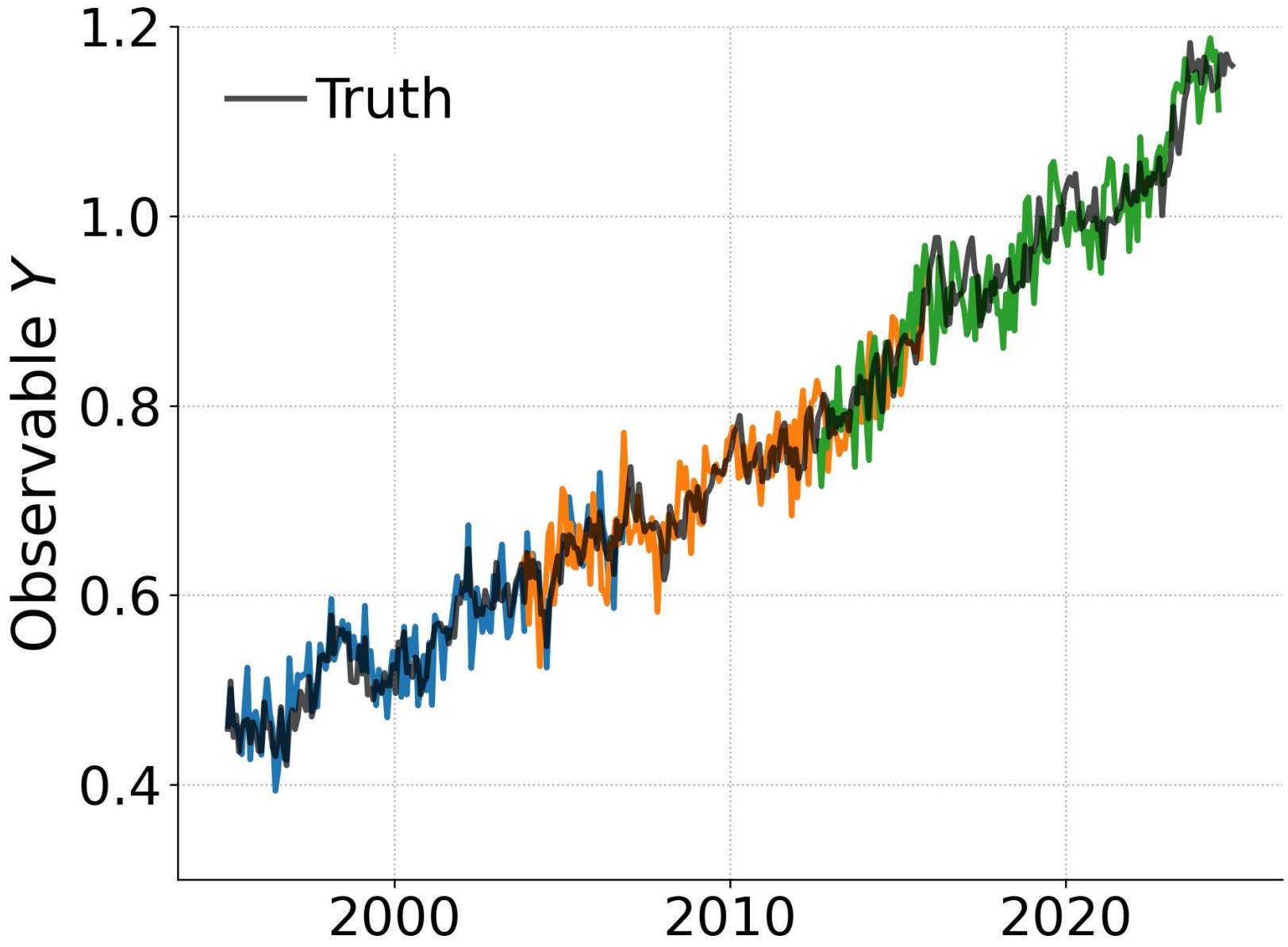
Truth
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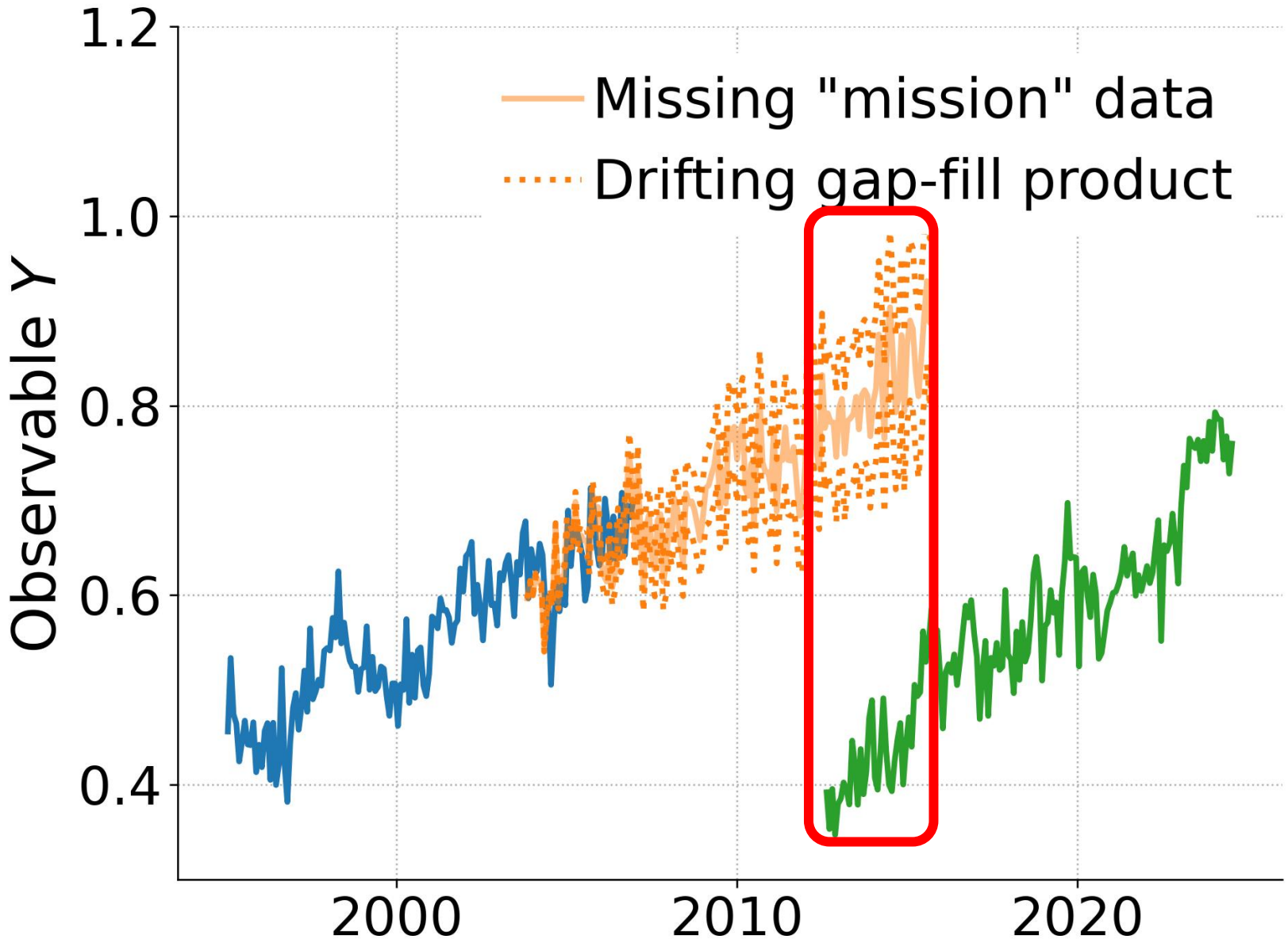
What if we fill the gap with data with more “drift”



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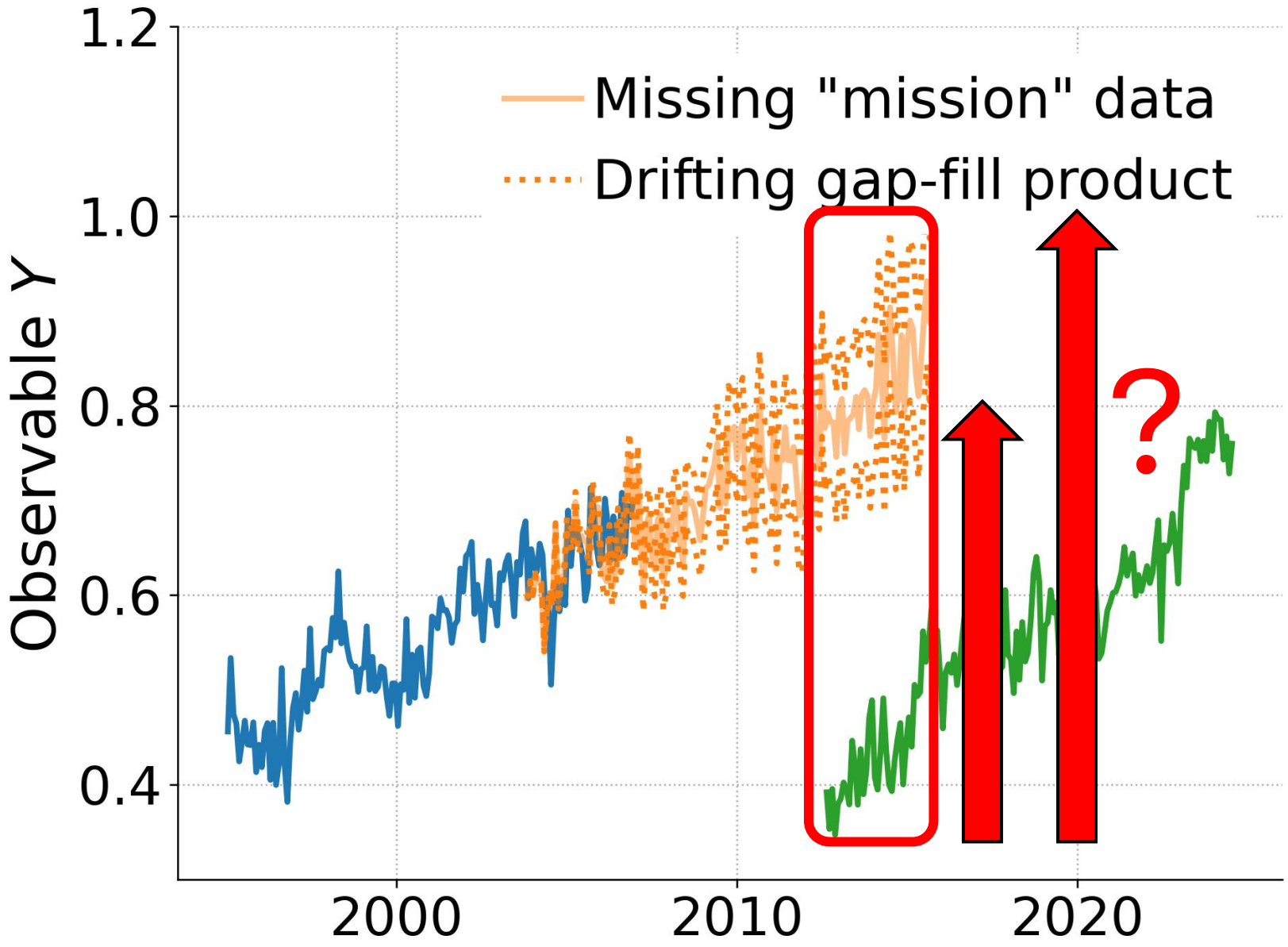
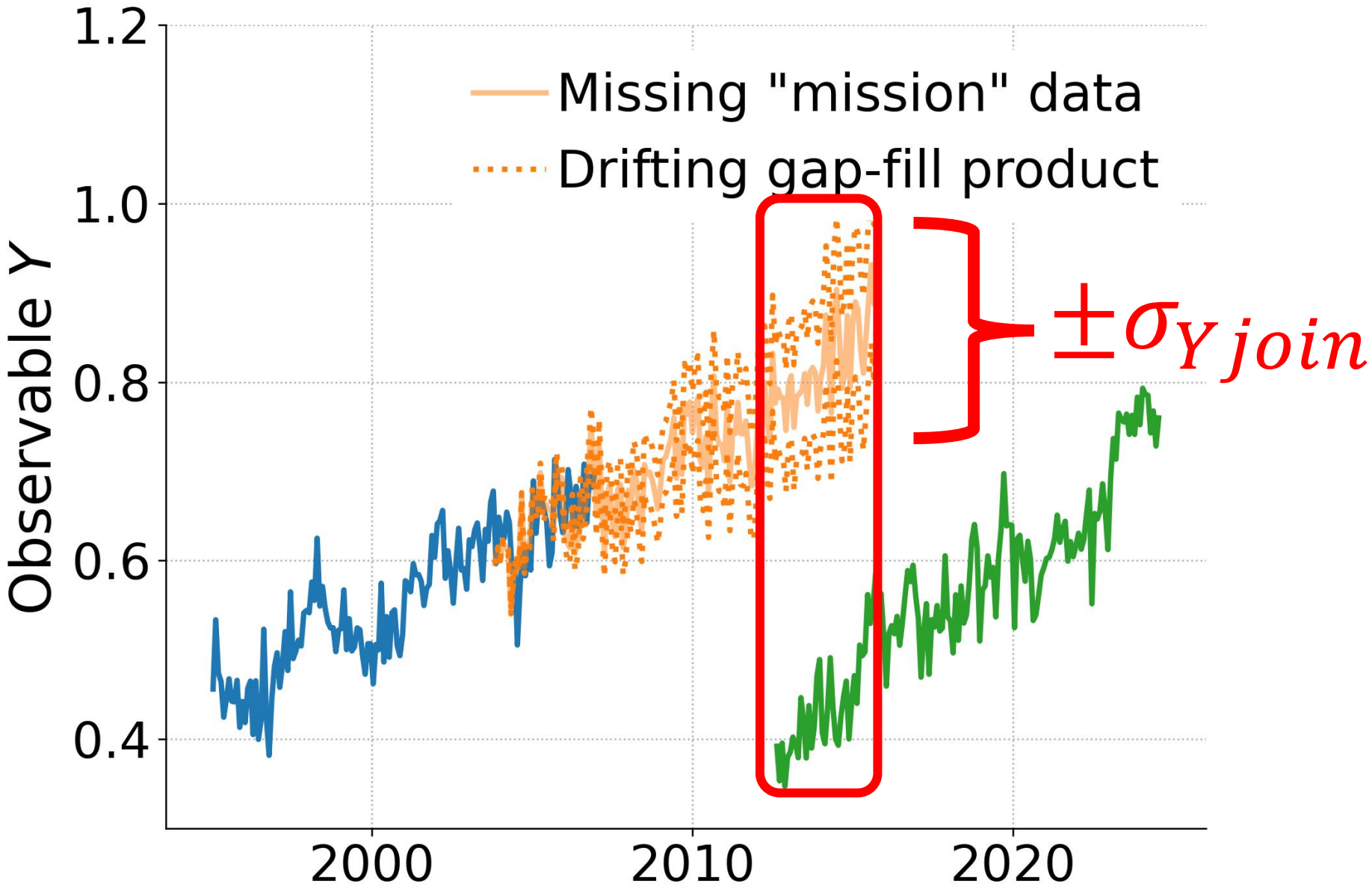


There will be some error: $\sigma_{Y\,join}$



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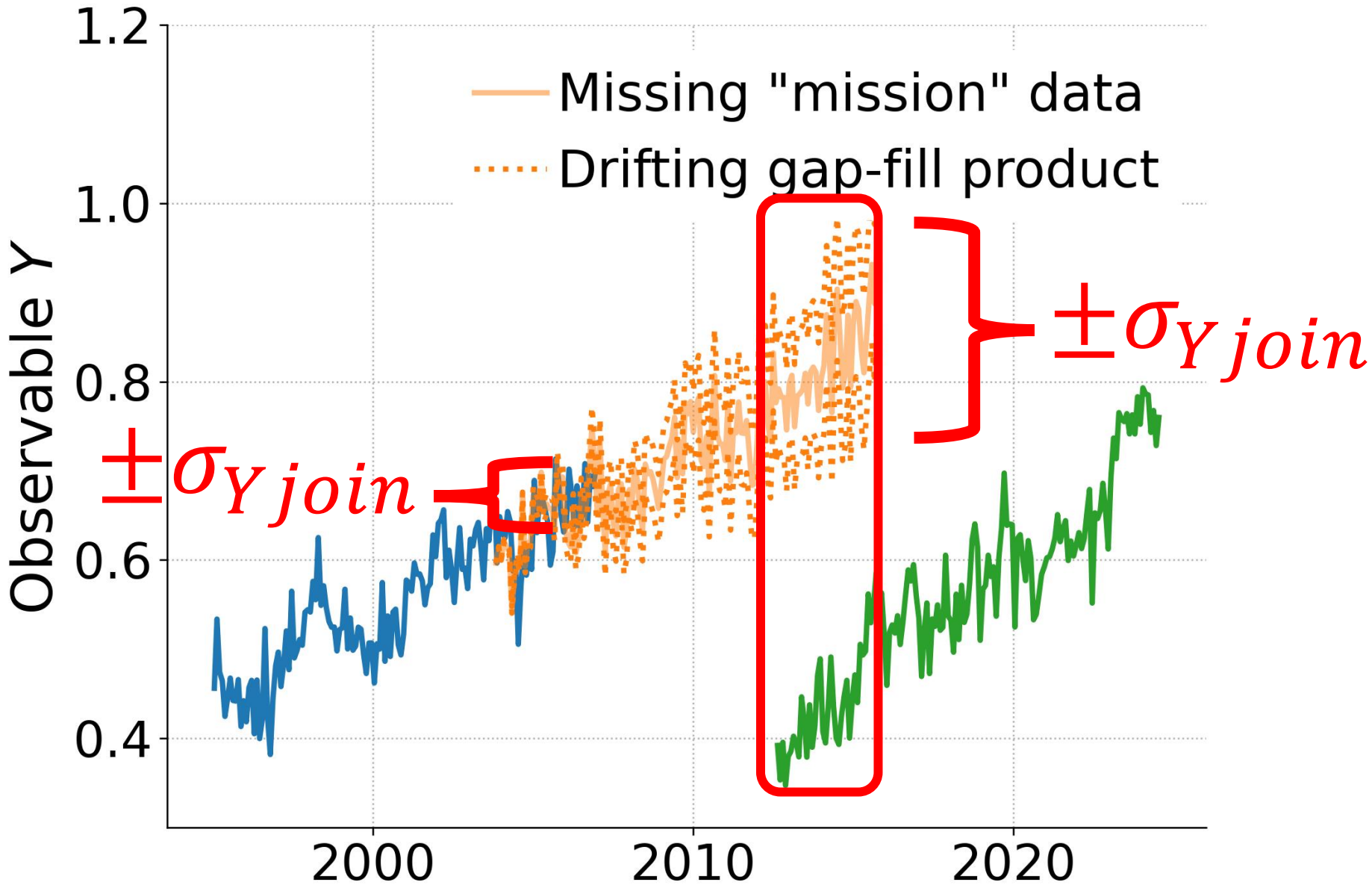


- We can (often) estimate $\sigma_{Y\,join}$

- We can predict the effect of $\sigma_{Y\,join}$ on e.g. trend uncertainty

- **We can (often) estimate σ_{Yjoin}**

- We can predict the effect of σ_{Yjoin} on e.g. trend uncertainty

We can often estimate $\sigma_{Y\,join}$

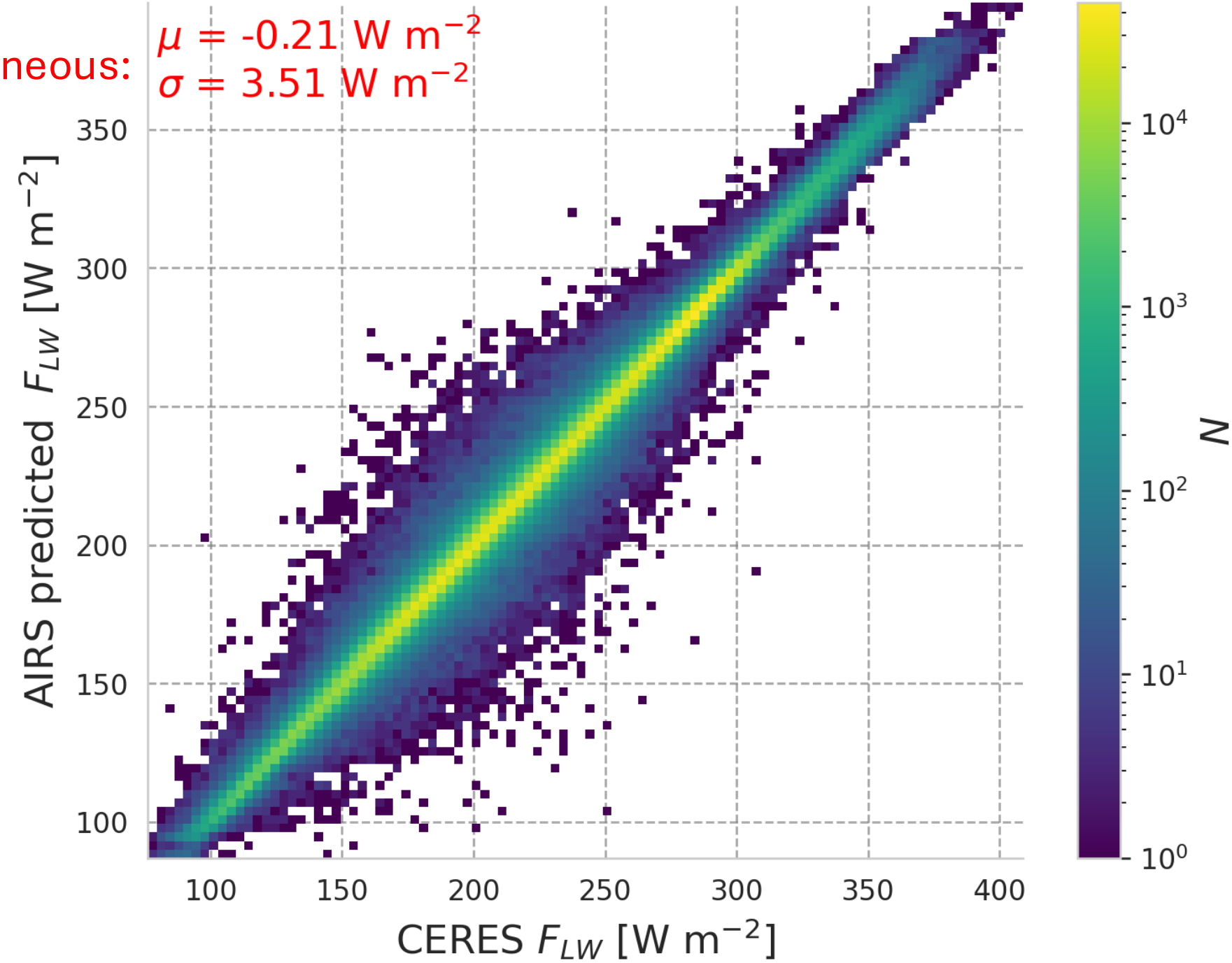
- For EEI: trends in Earth's heat content constrain EEI
  - Example concern: you need a long-enough overlap period to remove bias

- For e.g. SW/LW components, methods include:
  - We can use the common overlap period

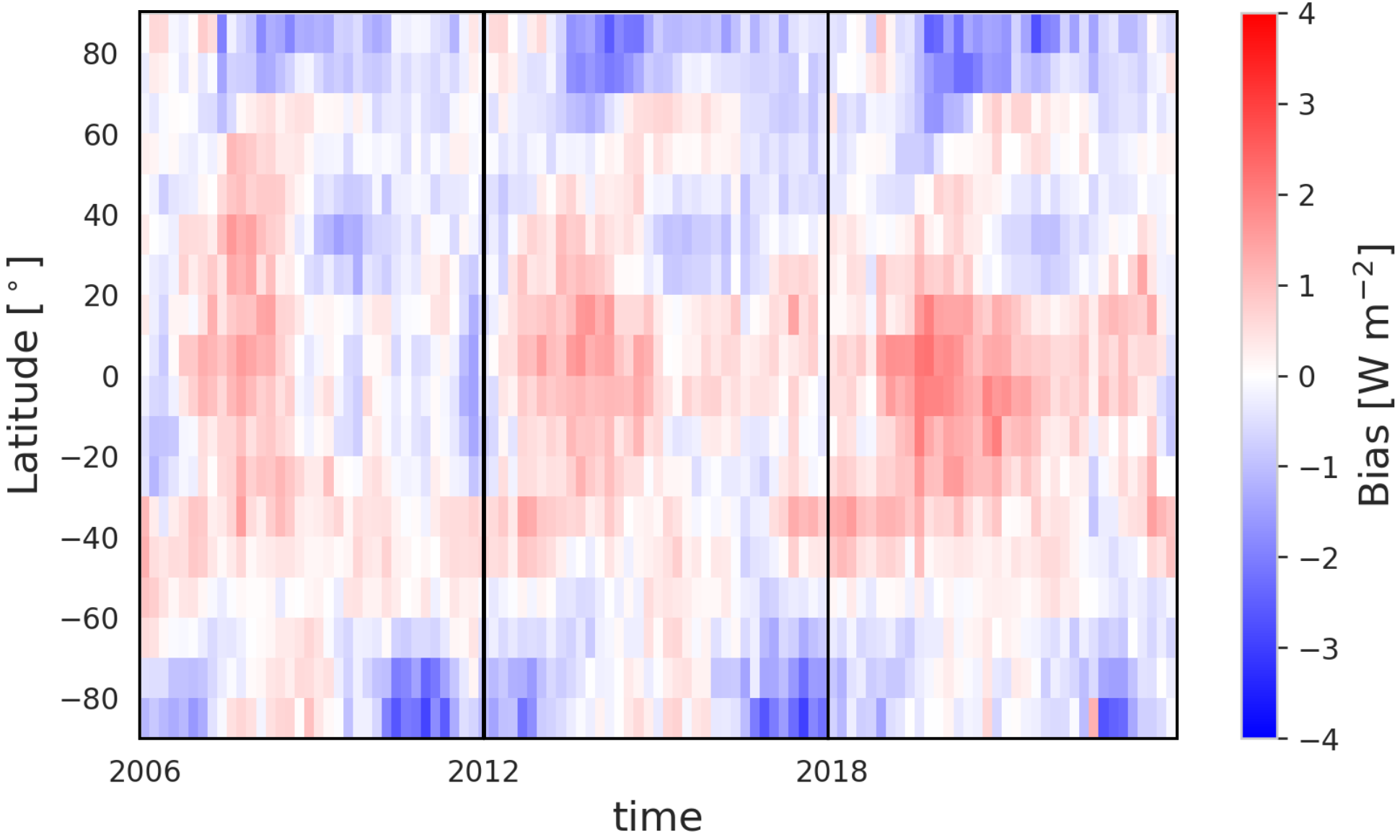
AIRS + Machine Learning as a proxy (see Chris Wilson poster)

- Train a random forest to predict CERES 1° average longwave irradiance from AIRS spectra + viewing angle

1°, instantaneous:

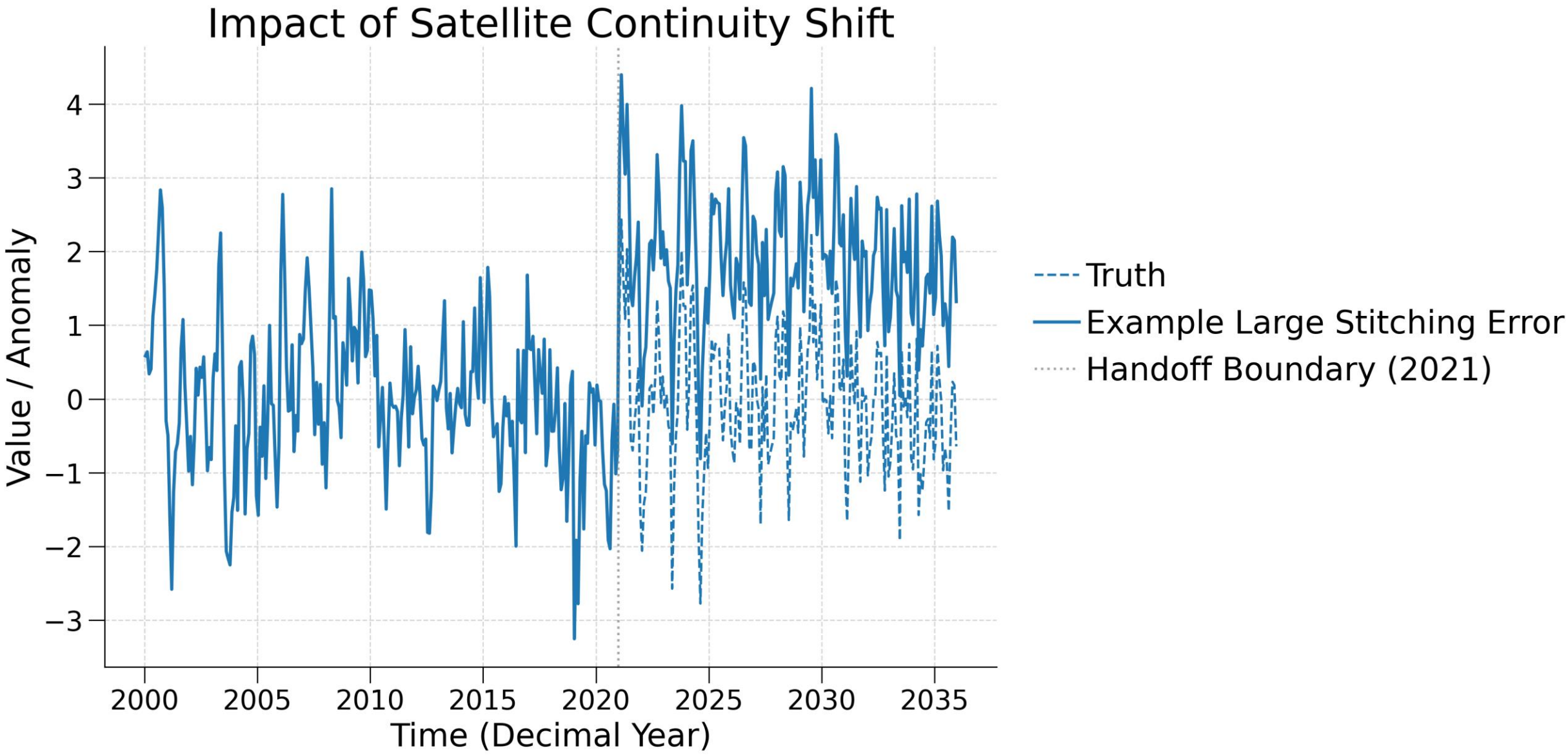


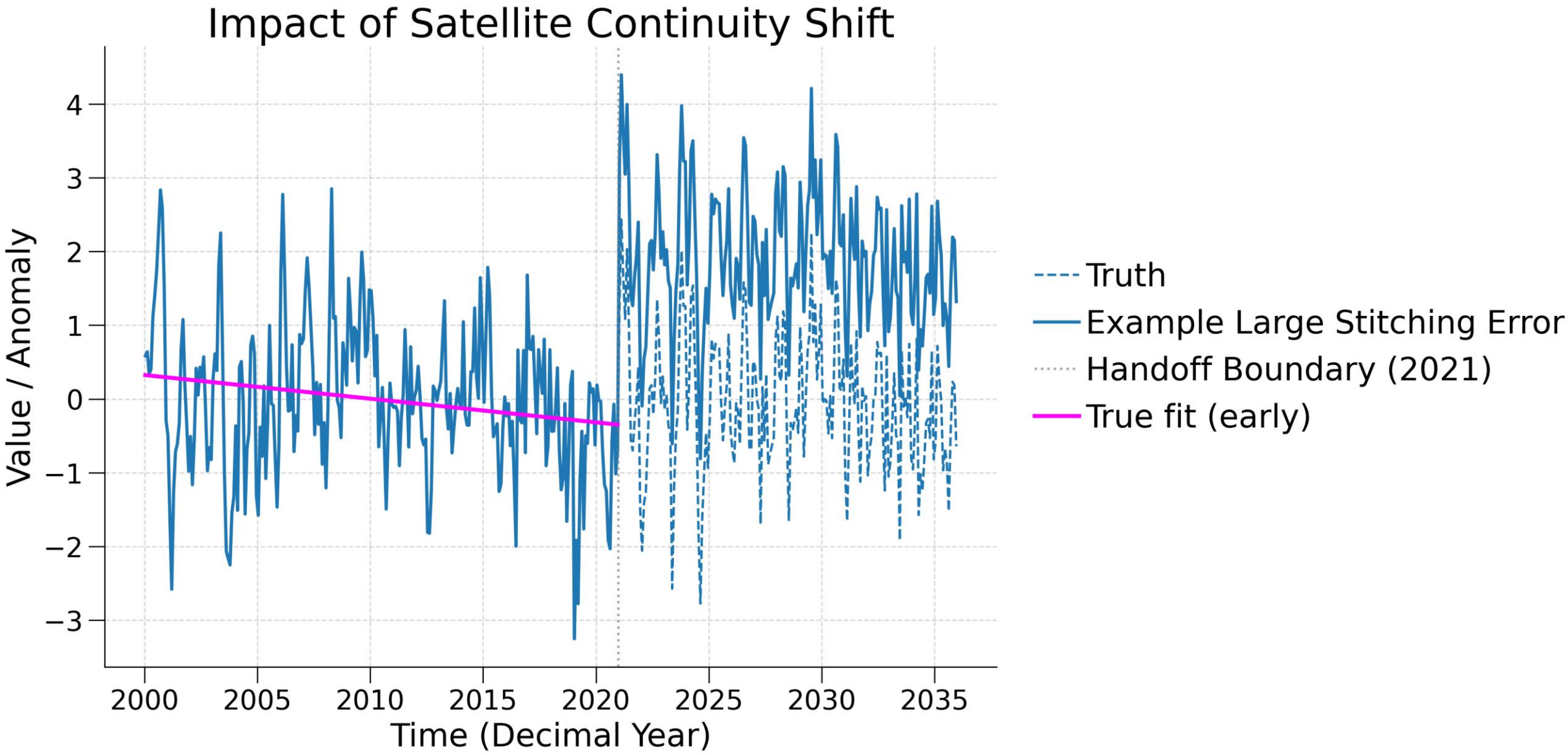
Bias by day-10° lat bin for 3 example years



I will now show a **cartoon** of how drift can affect reported trends vs truth

We will then combine everything to talk about science questions & requirements.


Impact of Satellite Continuity Shift
Value / Anomaly
4
3
2
1
0
−1
−2
−3
2000
2005
2010
2015
2020
2025
2030
2035
Time (Decimal Year)
Truth
Example Large Stitching Error
Handoff Boundary (2021)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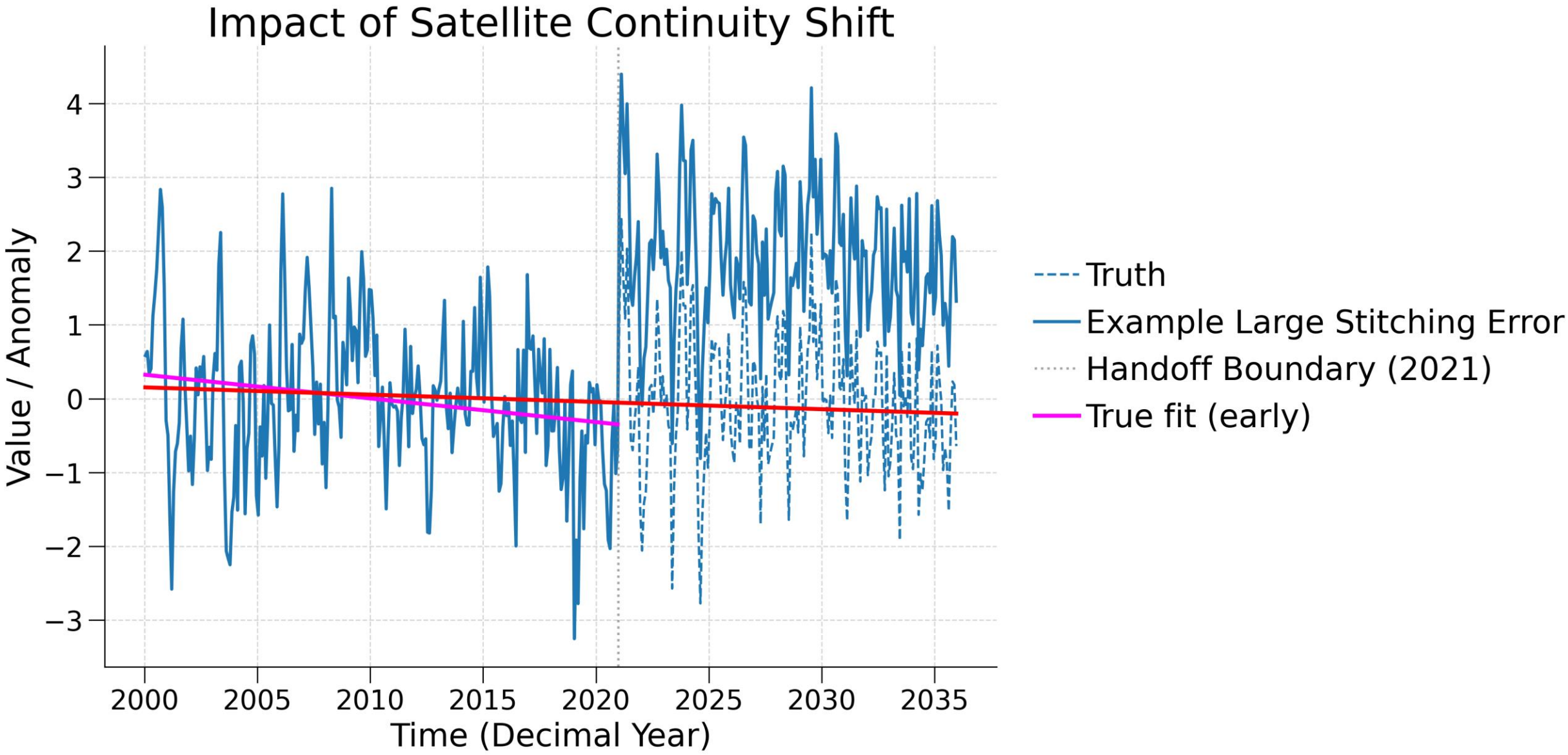
True fit (early)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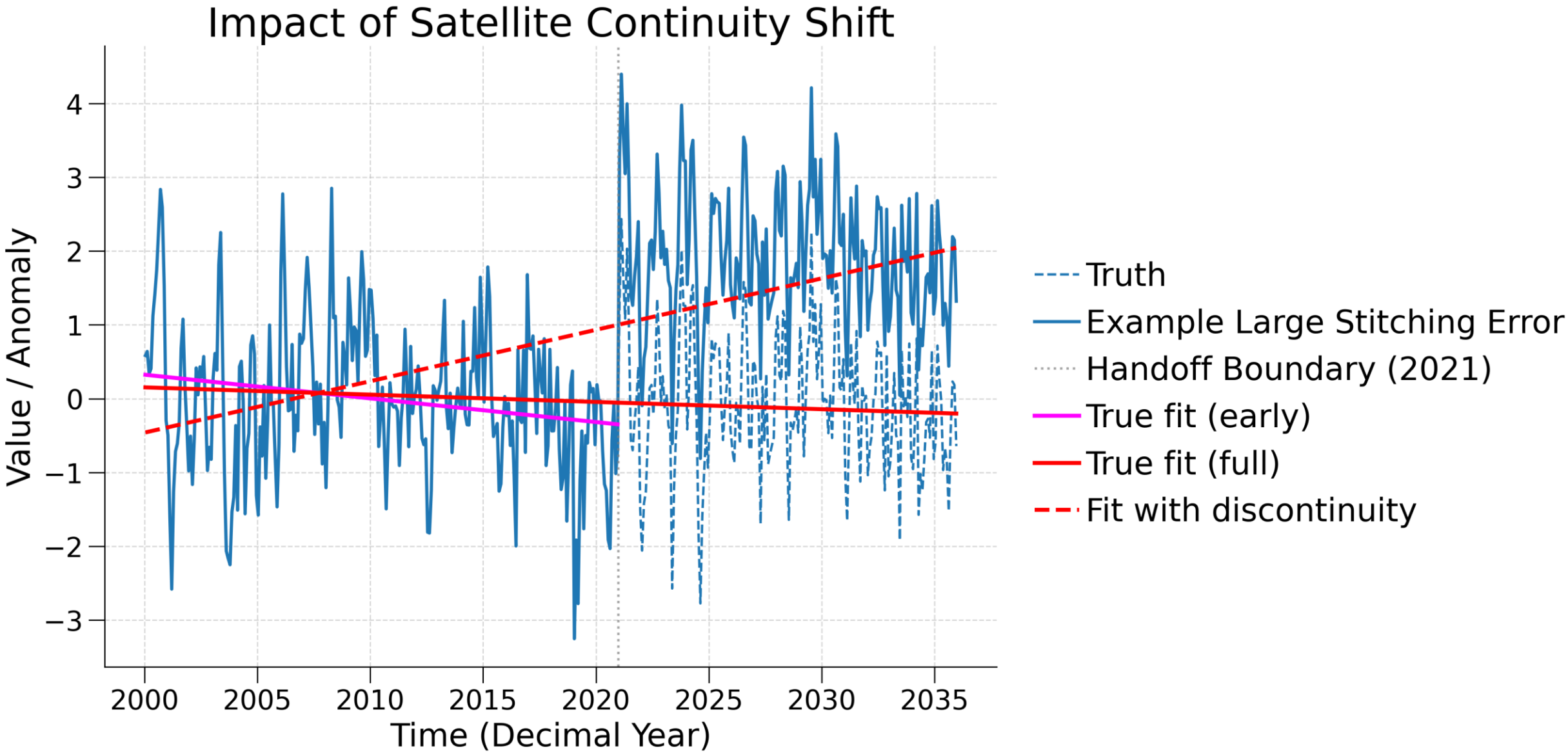
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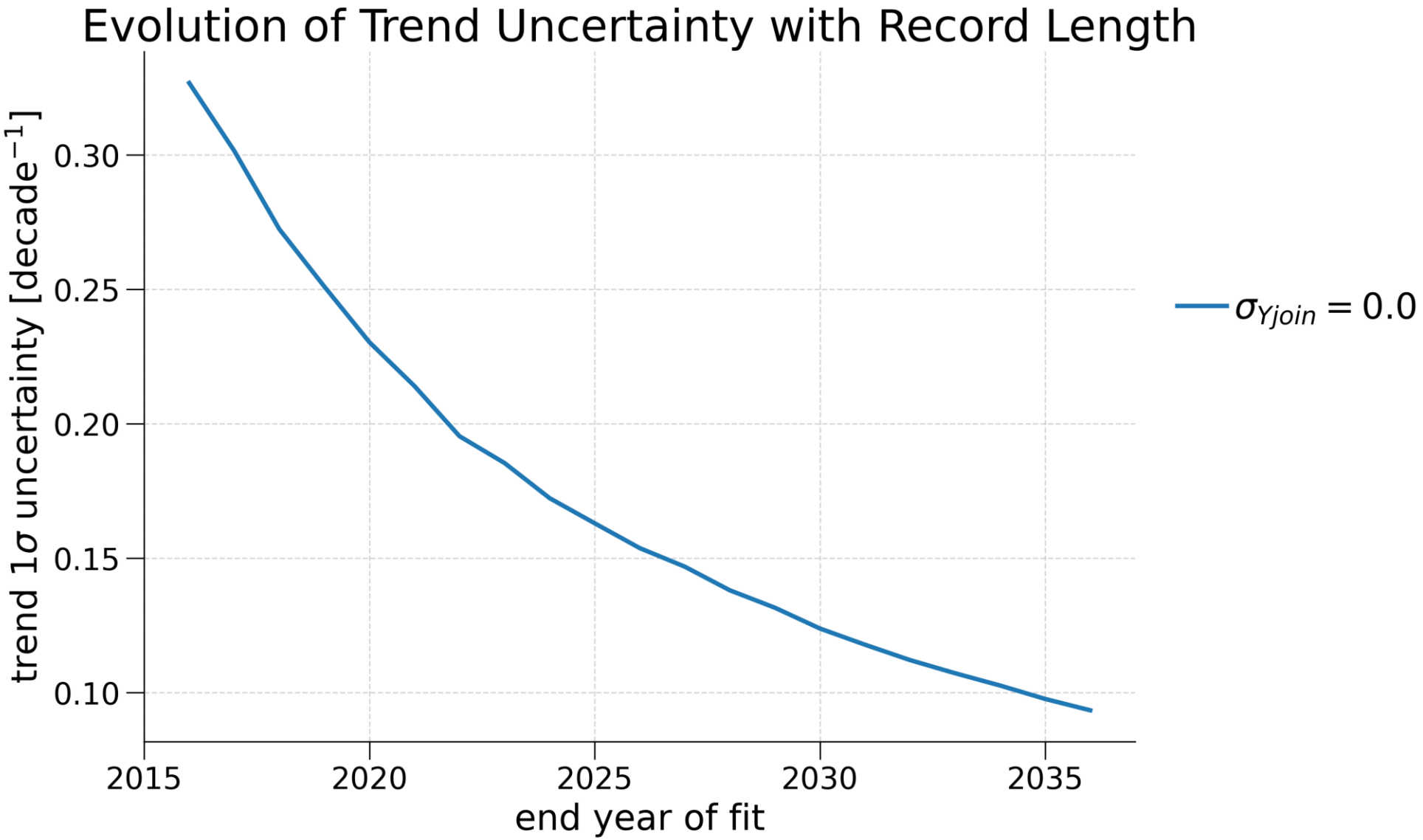
Handoff Boundary (2021)
True fit (early)
True fit (full)
Fit with discontinuity

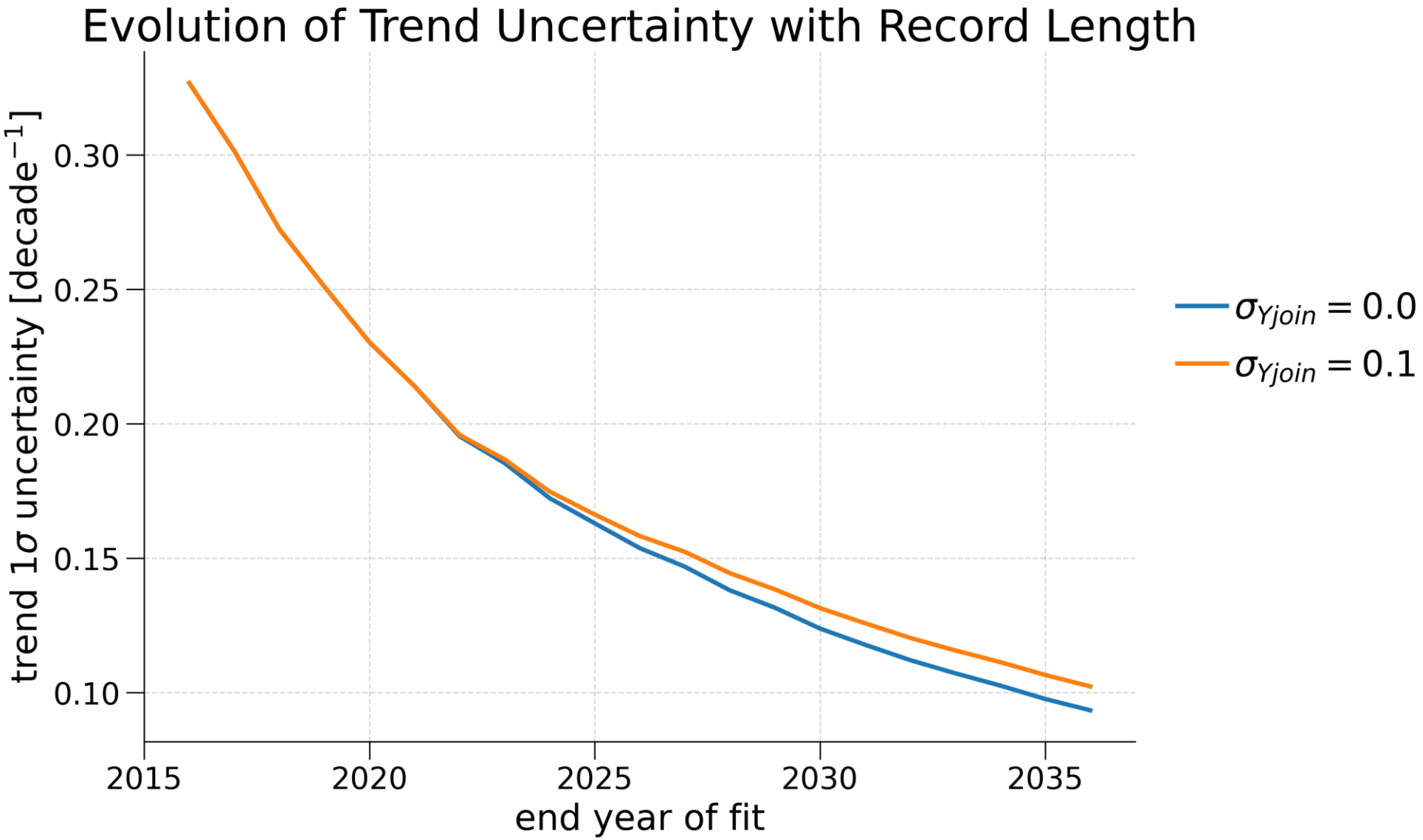
An obvious big jump/drift has an obvious big effect on trends.

(Provable) Assertion: The *uncertainty* in the size of that jump/drift can be trace to *uncertainty* in trends.

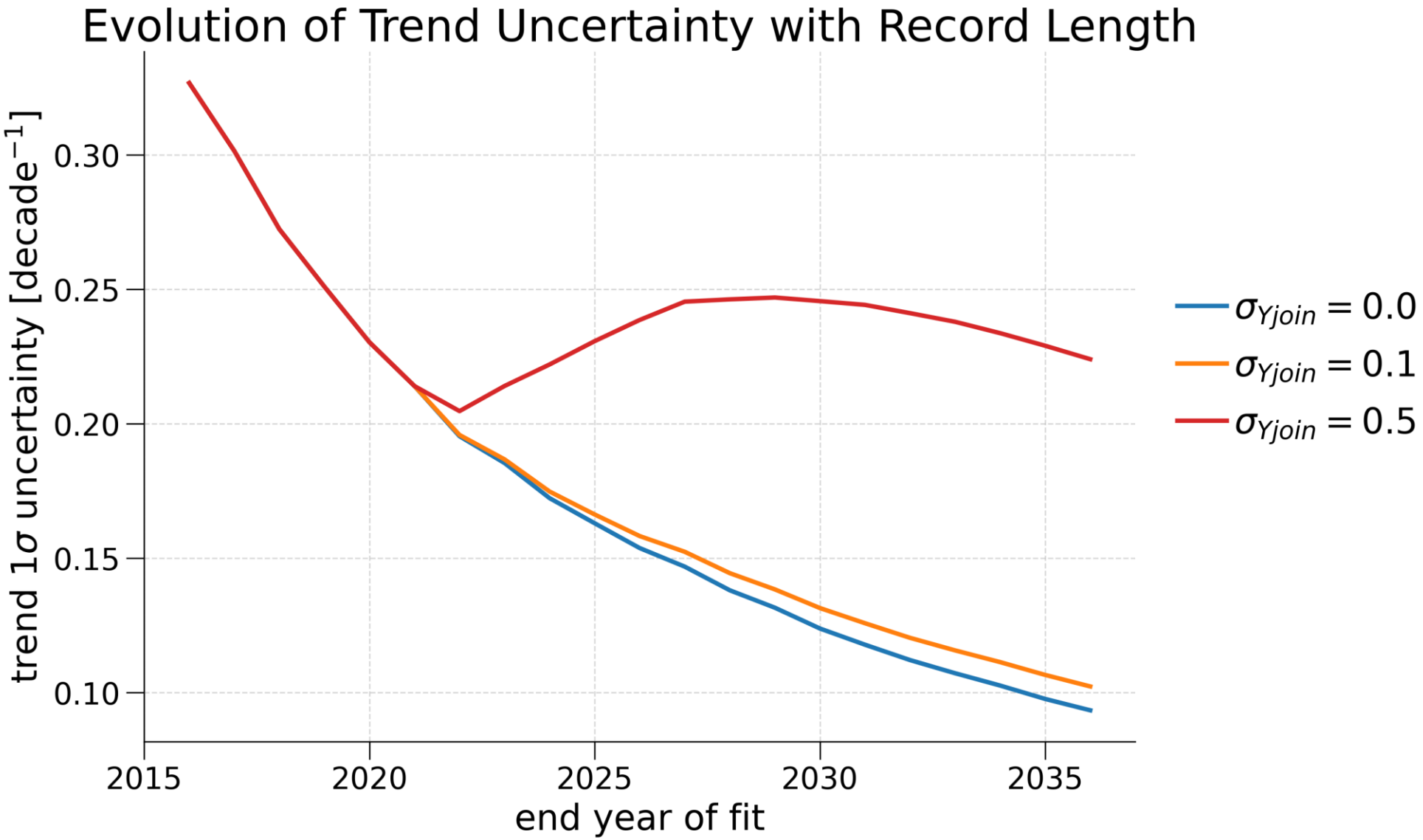
Trend starting in 2000: as the record lengths, trend uncertainty shrinks



If "stitching" uncertainty has 10% of system noise, not a big deal:



If "stitching" uncertainty has 50% of system noise, ***loss of confidence****:*



Example science questions

- What is the trend (if any) in EEI?
- Is hemispheric albedo symmetry stable?
- Is the mixed-phase cloud feedback triggering southern ocean ERB trends?
- What is the split in clear-sky versus cloudy components of ERB related to Arctic amplification?

Every question looks at statistics at different *scales*

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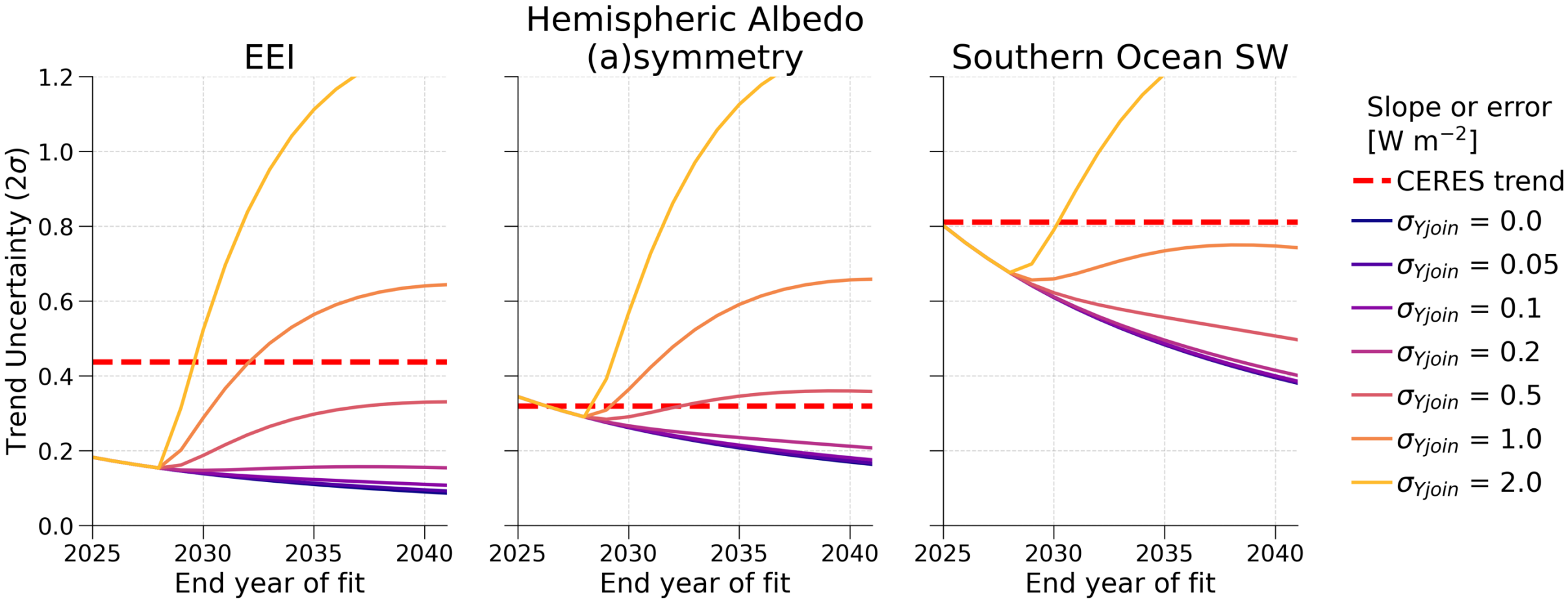
Example application: CERES EEI, error shift in 2028.

(Libera launch late 2027)

CERES trend (red-dash) and its detectability given different join errors for CERES-Libera



Conclusion: we have tools to relate science questions to a product requirement.