

Intensity measure conversion of seismic fragility and vulnerability models

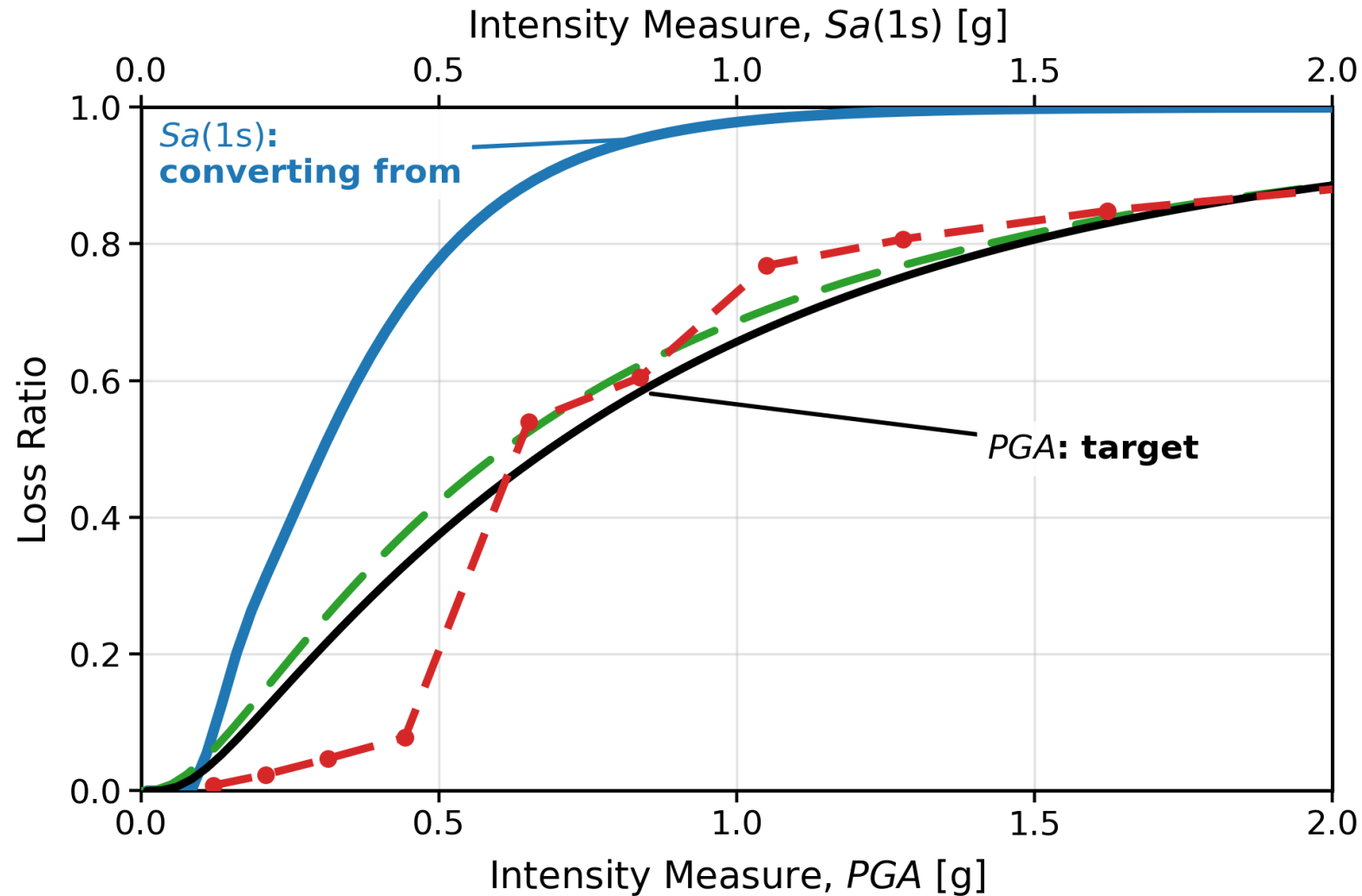
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Harmonising two models is possible - the answer depends on how you do it



Converting correctly means using total probability theorem, not scaling

$$P[DS \mid IM_2] = \int_{IM_1} \int_{Rup} \boxed{P[DS \mid IM_1]} \boxed{f_{IM_1 \mid IM_2, Rup}} \boxed{f_{Rup \mid IM_2}} dIM_1 dRup$$

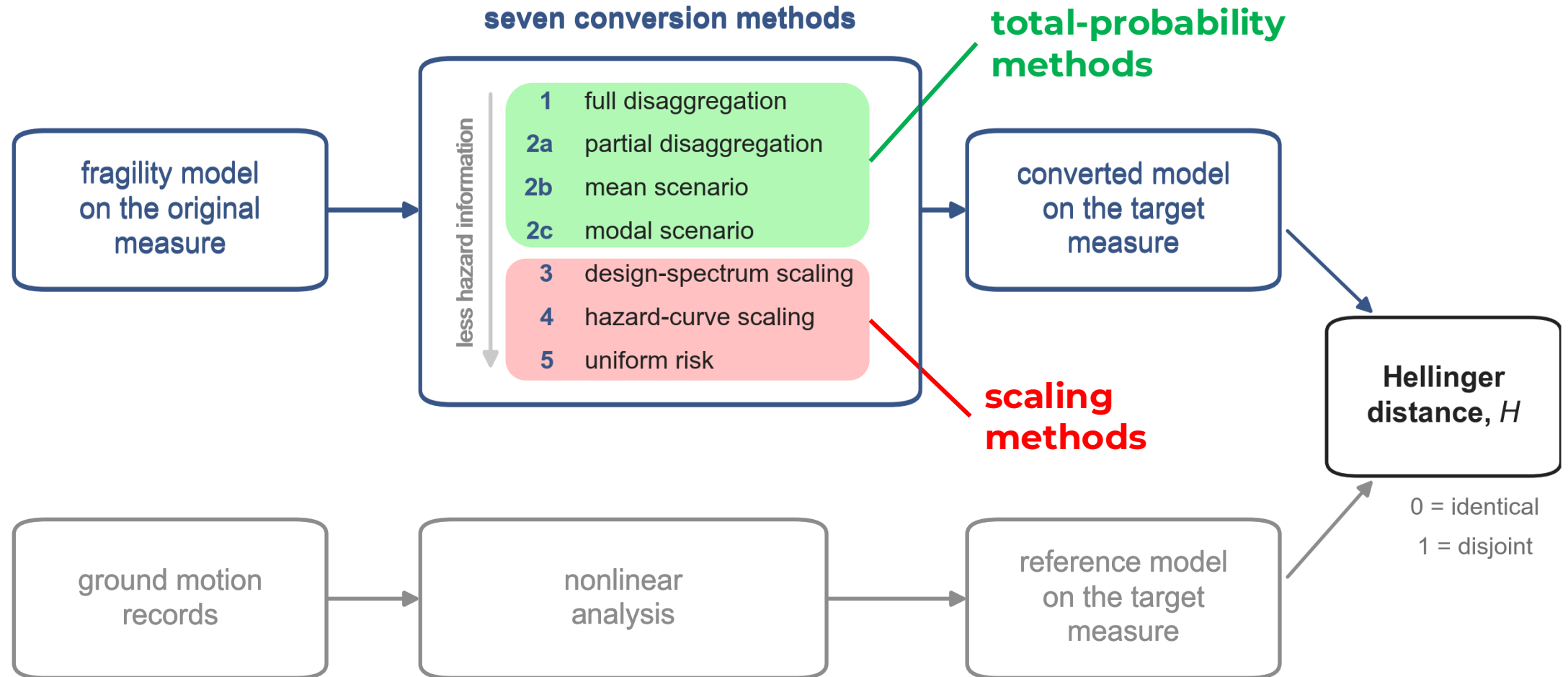
original
fragility
(known IM_1)
conditional
distribution
hazard
disaggregation

$$E[L \mid IM_2] = \int_{IM_1} \int_{Rup} \boxed{E[L \mid IM_1]} f_{IM_1 \mid IM_2, Rup} f_{Rup \mid IM_2} dIM_1 dRup$$

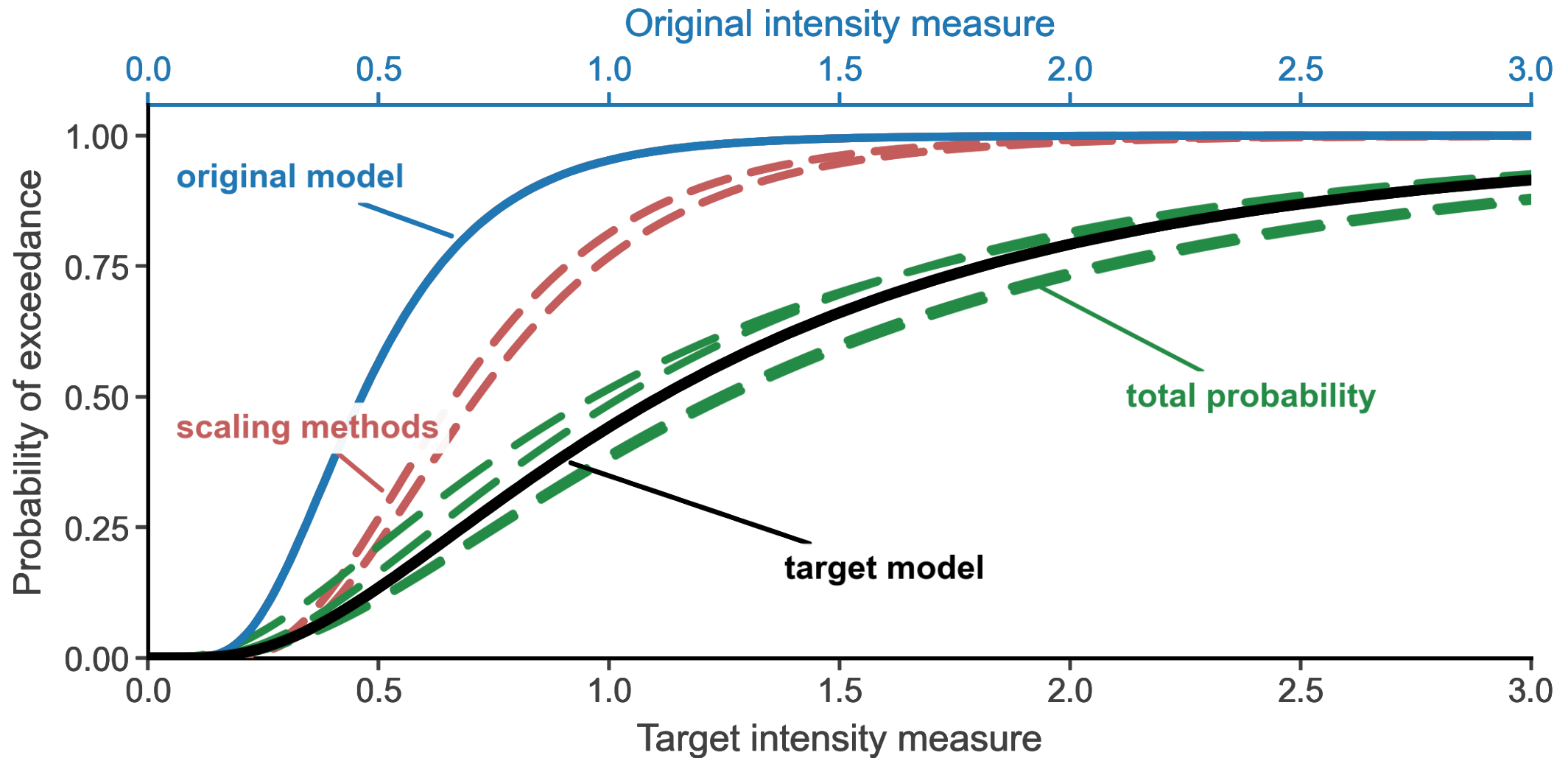
fragility → expected loss

Exactness follows how detailed the inputs are

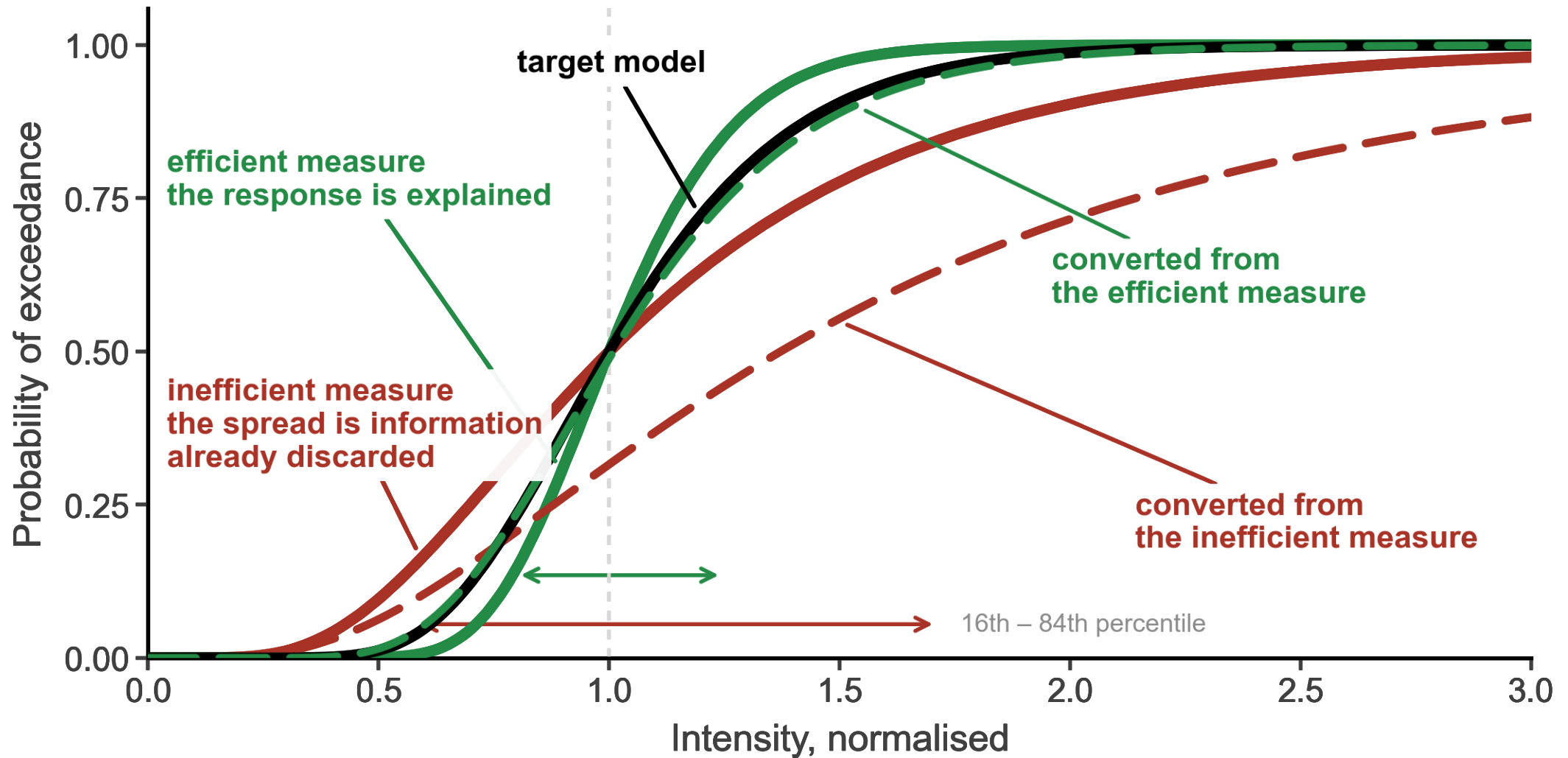
Every conversion is scored against a fragility model built directly in the target measure



Total probability is needed, not full disaggregation



No method recovers what an inefficient measure never captured

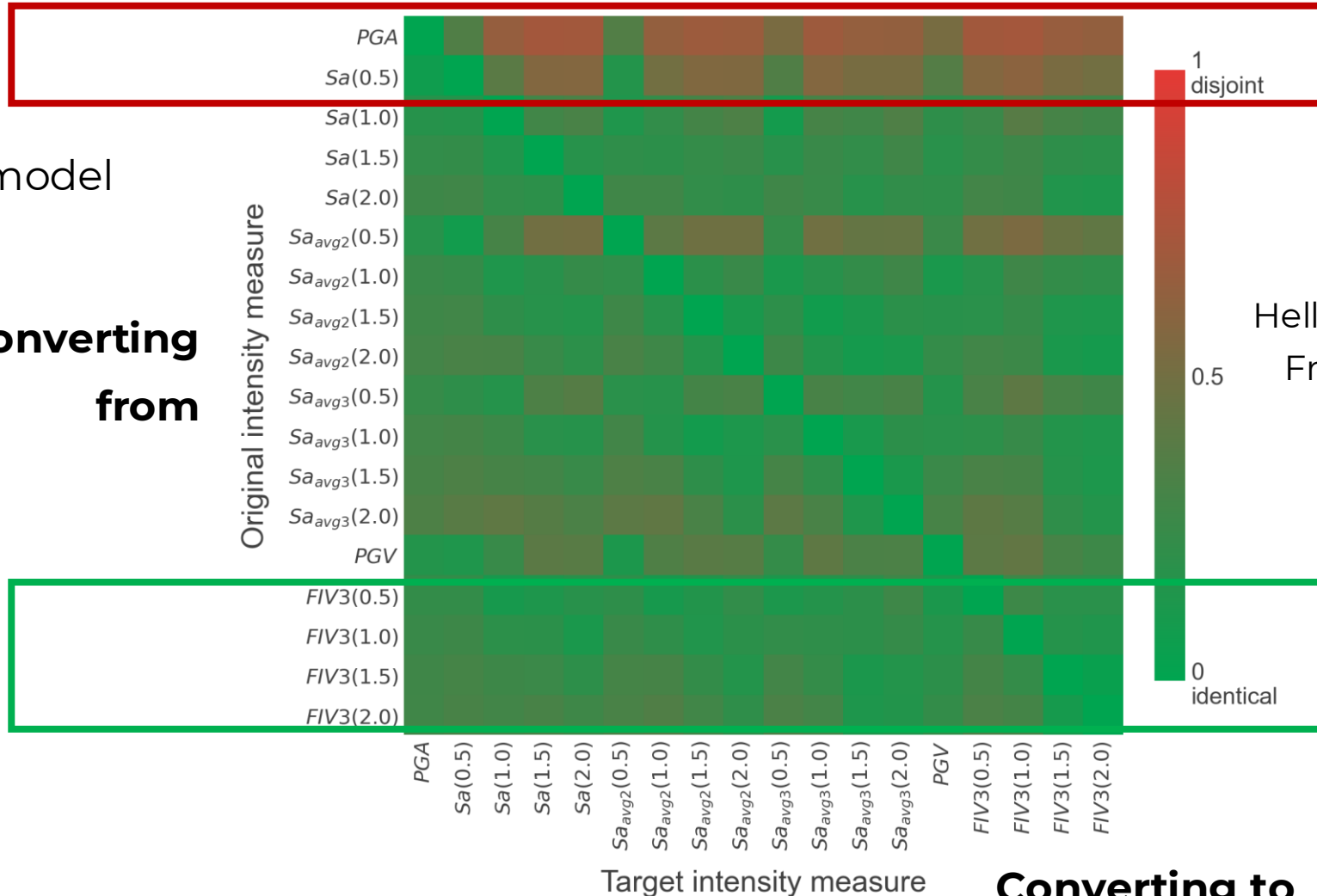


Everything converts into peak ground acceleration; nothing converts out of it

Tested on a model
with $T=1.0s$

Converting
from

Original intensity measure



Nothing converts
out of PGA

Hellinger distance, H
Fragility function
conversions

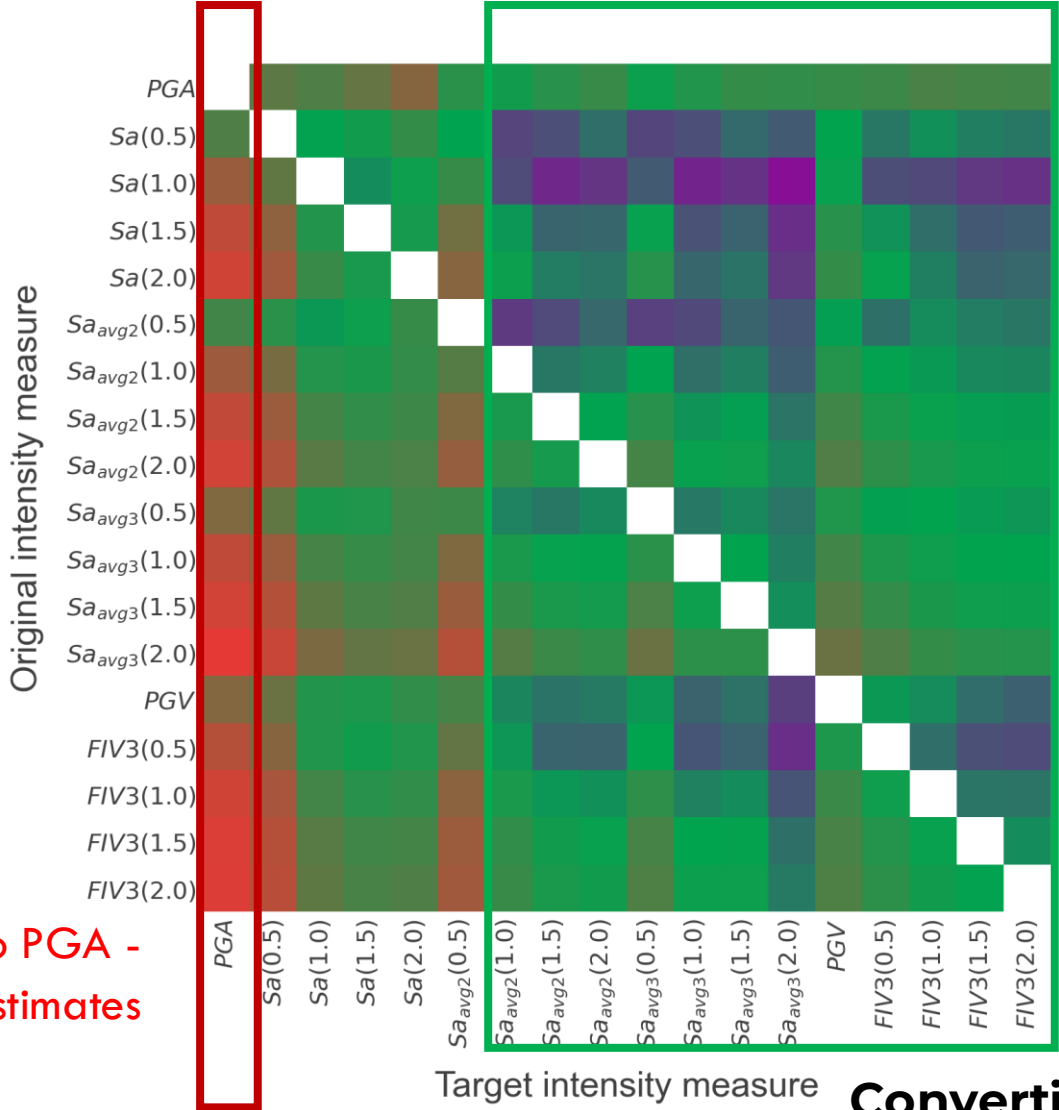
Everything converts
out of FIV3

Converting to peak ground acceleration matches the fragility curve and still overestimates annual loss

Tested on a model
with T=1.0s

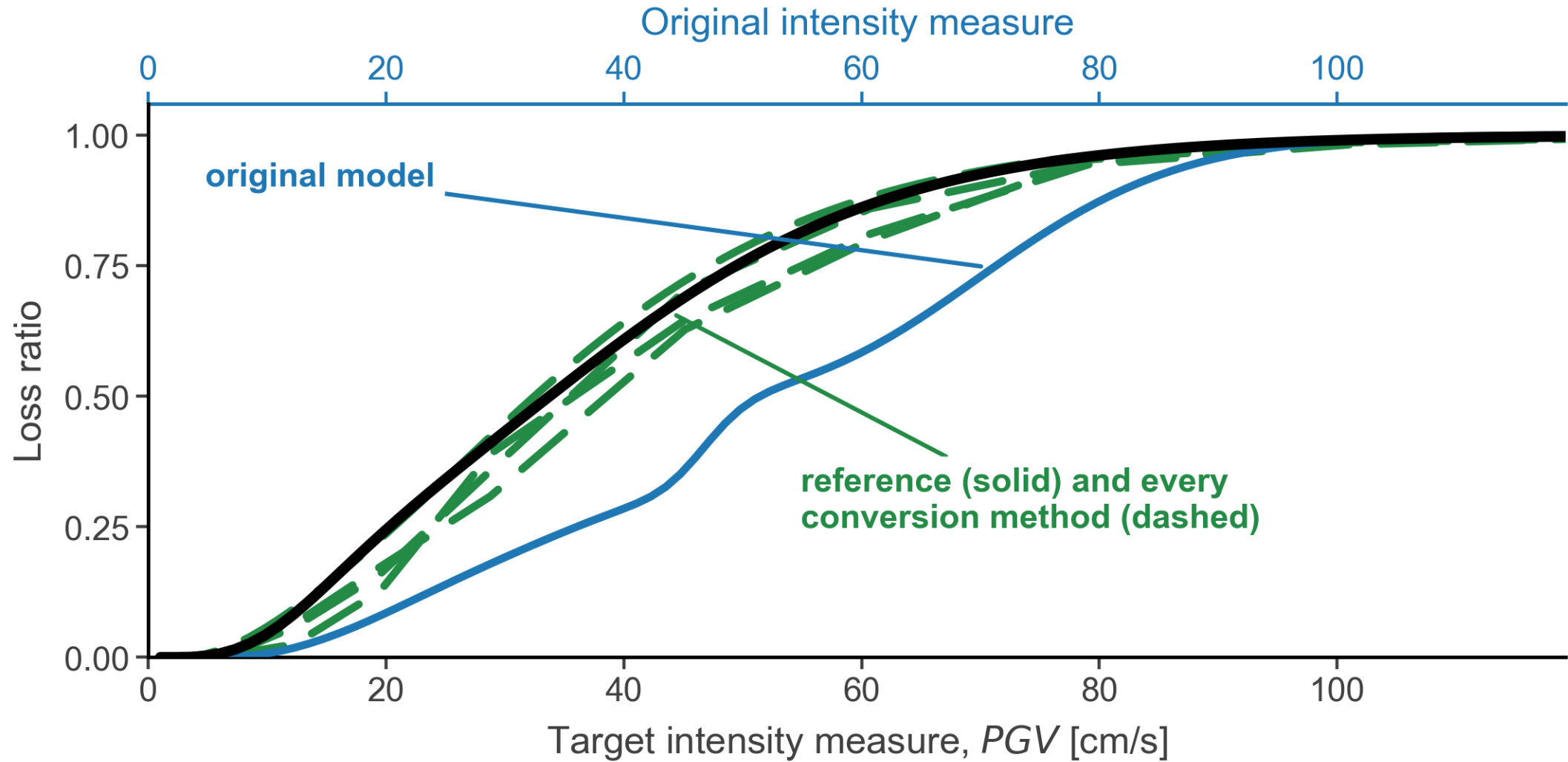
Converting
from

everything converts to PGA -
and every one overestimates
loss



converting to an efficient
measure: low loss error

Convert at the loss level, not the damage level



Build models on efficient measures and conversion stops being a problem

- A model is only as convertible as the measure it was built on
- Stop using peak ground acceleration for new models. It is convenient, but a dead end
- Losses convert more easily than damage

Open-Source
Python package



Give a star 

`pip install djura[im_conversion]`



O'Reilly, Gerard J.; Ozsarac, Volkan; Shahnazaryan, Davit (2026) "Intensity measure conversion of seismic fragility and vulnerability models", 18th European Conference on Earthquake Engineering, Berlin Germany.