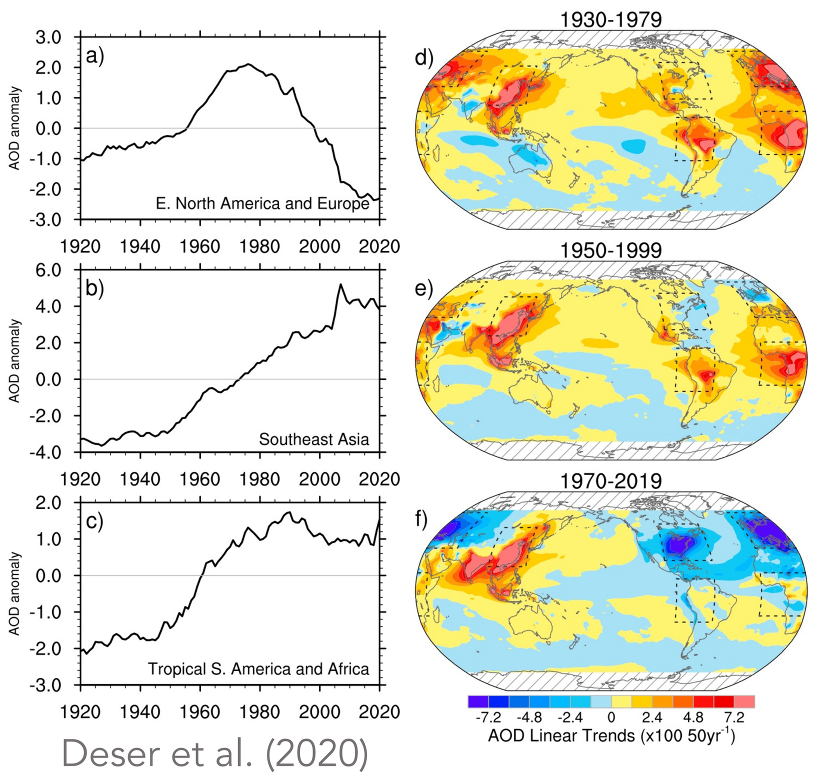
Towards a role for anthropogenic aerosols in the pattern effect?(???) https://utexas.zoom.us/j/95342702844

Geeta G. Persad[1] (geeta.persad@jsg.utexas.edu) and Clara Deser[2]

[1]The University of Texas at Austin, [2]NCAR

Question: Does the evolving spatial pattern of aerosol emissions contribute to the time evolution of the pattern effect?

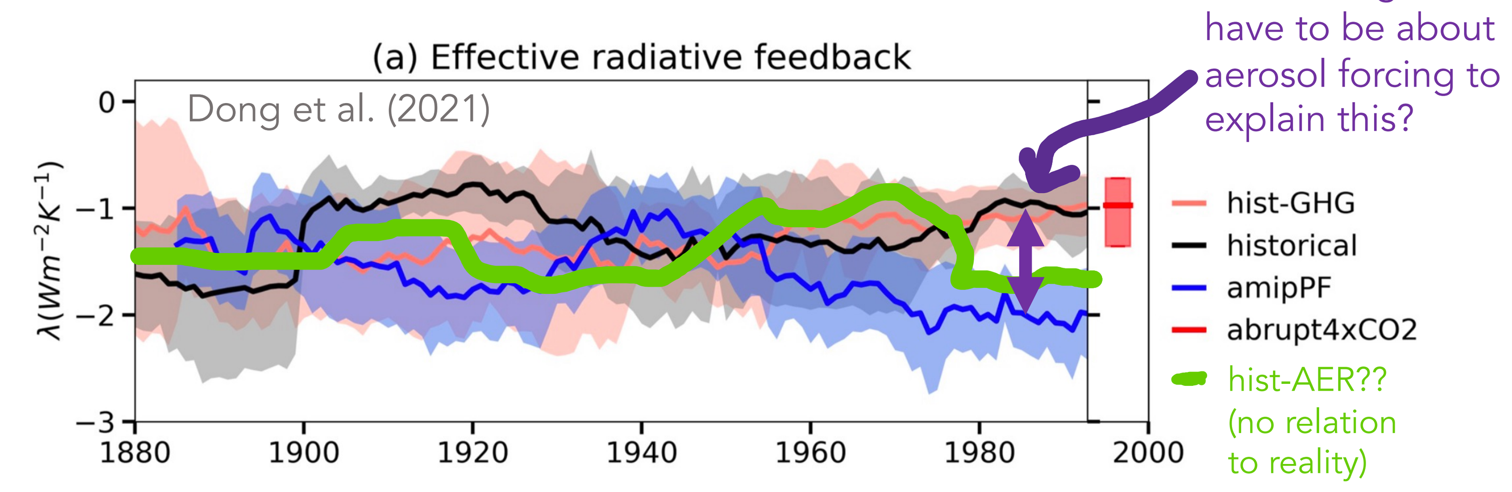


Deser et al. (2020)

Historical-mean aerosol forcing produces more strongly amplifying feedbacks than historical GHG forcing, but model uncertainty is high (Marvel et al., 2016; Dong et al, 2021; Salvi et al., 2022).

Aerosols' spatial pattern is not static through time (Deser et al., 2020), which is obscured in the historical-mean.

How wrong do we have to be about aerosol forcing to explain this?



How does this contribute to the historical time evolution of the feedback parameter?

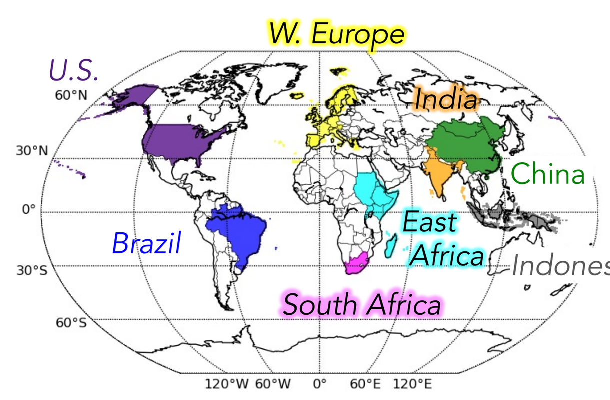
Aerosol efficacy and feedbacks depend on emission spatial pattern

Persad and Caldeira (2018): five-fold range in forcing efficacy of aerosols emitted from different regions

Test climate influence of identical aerosol emissions from 8 different past, present, or projected major emitting regions

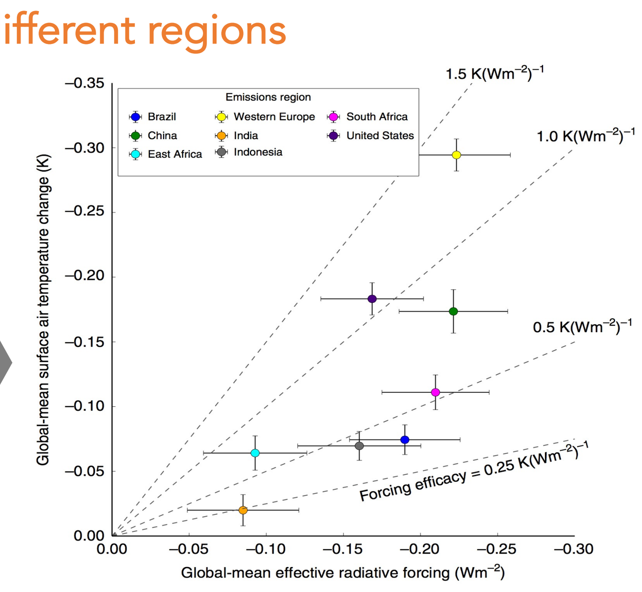
NCAR CESM1.4 (CAM5 + Slab Ocean)

- *Control*: 100 year repeating annual cycle simulation
  - Year 2000 conditions with anthropogenic aerosols at 1860 levels.
- *8 Perturbation Experiments*: 100 year repeating annual cycle simulations
  - *Identical total annual aerosol emissions* in 8 regions

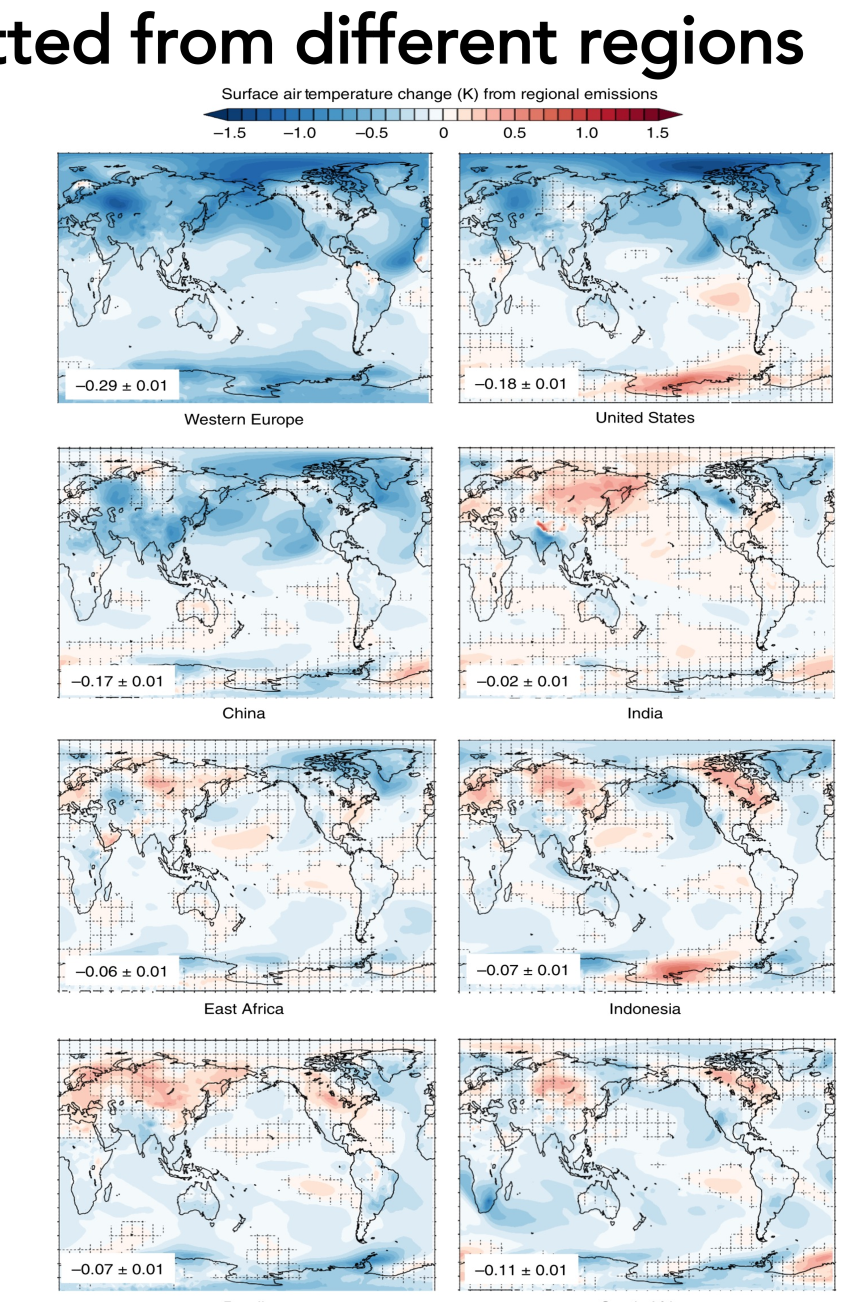


Total emissions change in each region = China year 2000 emissions
22.4 Tg sulfate precursor
1.61 Tg black carbon
4.03 Tg organic carbon

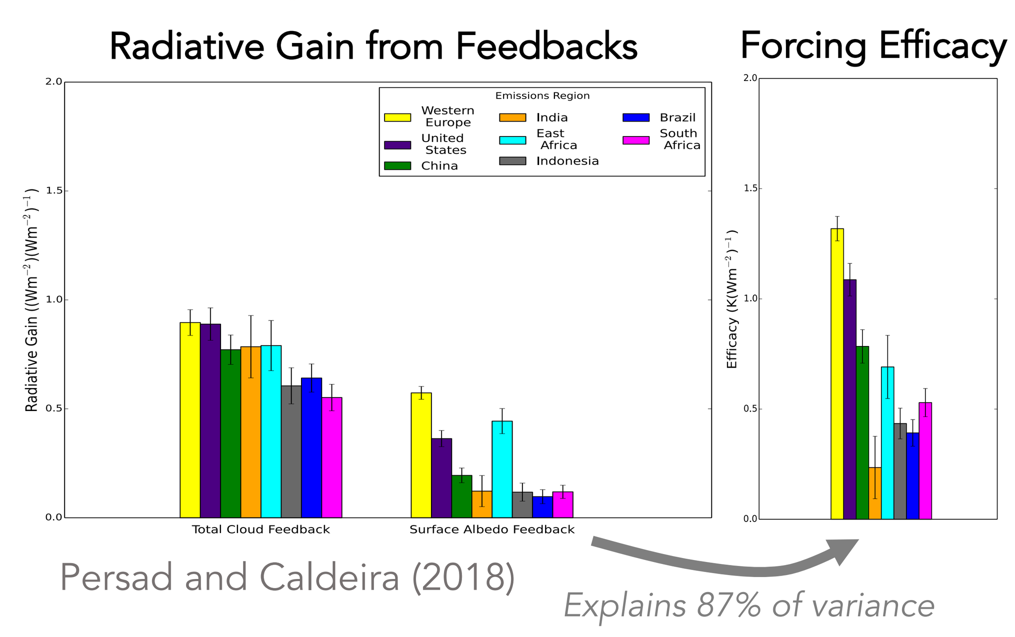
Divergent forcing and efficacy strength and spatial patterns in response to identical aerosol emissions from different regions



Persad and Caldeira (2018)



Partially explained by differing strength of remote cloud and sea ice feedbacks generated by forcing from each regional emission



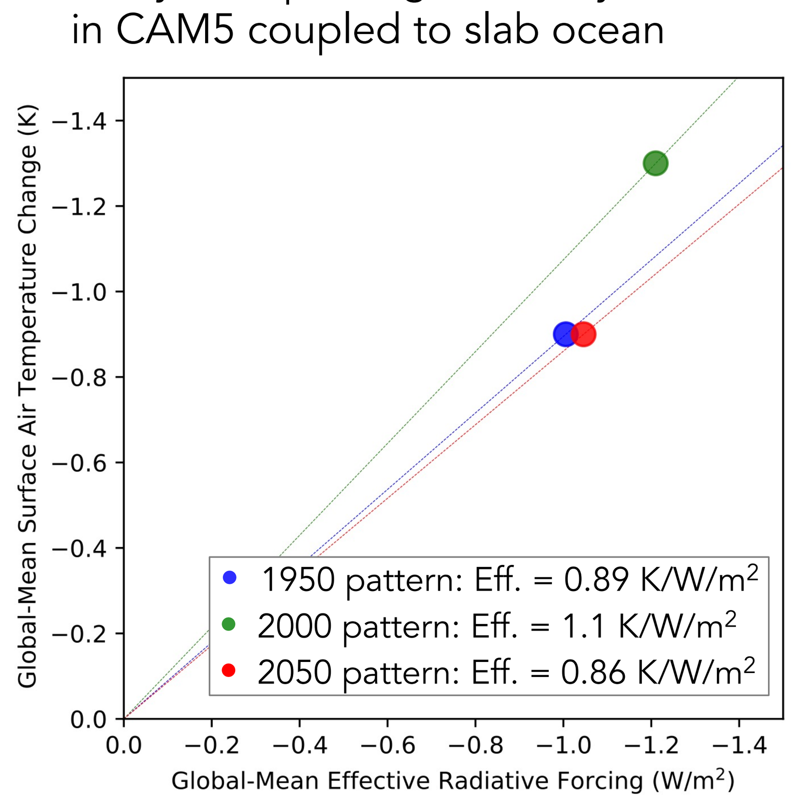
Persad and Caldeira (2018)

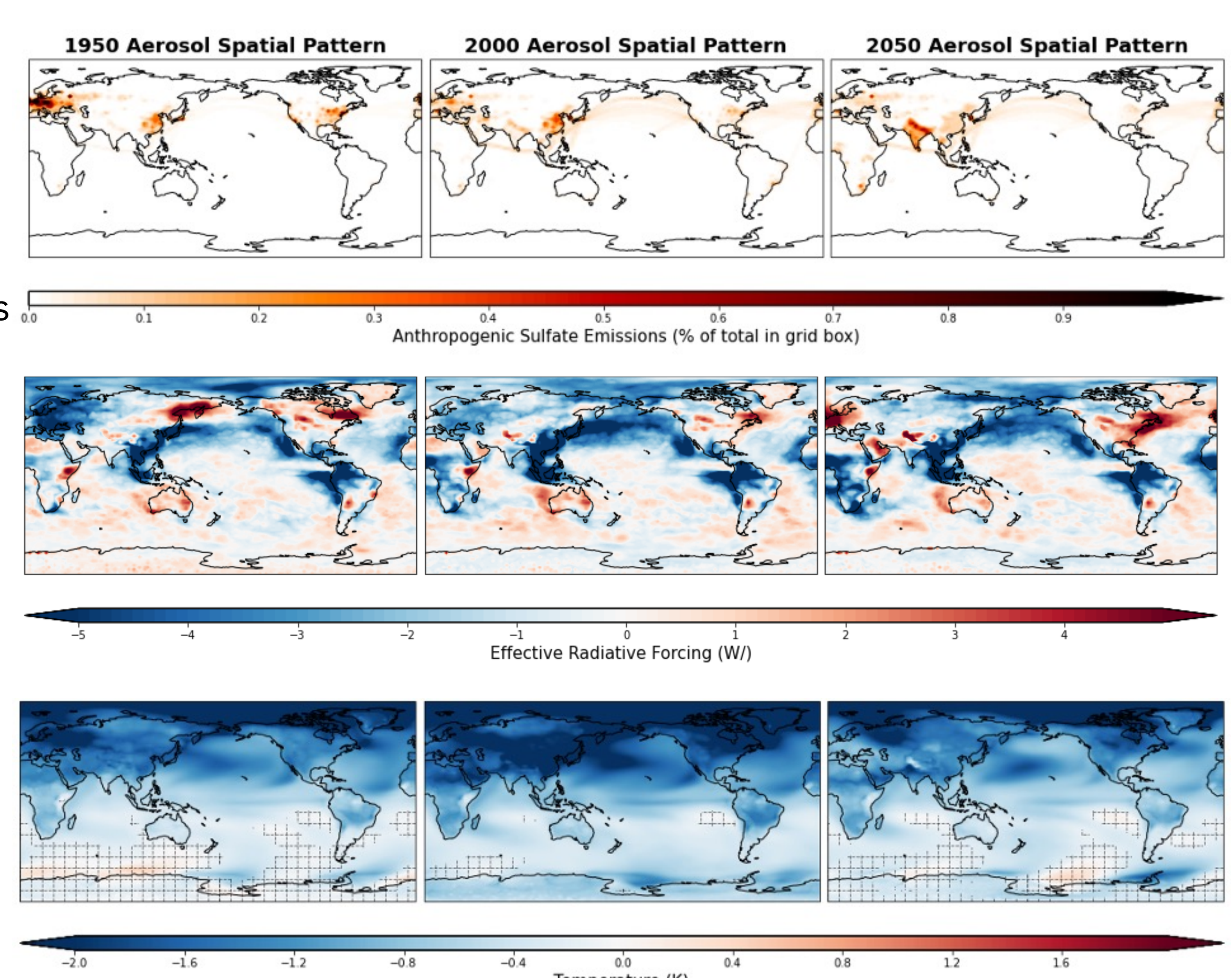
Explains 87% of variance

What does that mean for efficacy of global aerosol emissions over time?

Test climate response to change in global spatial pattern of emissions with amount fixed

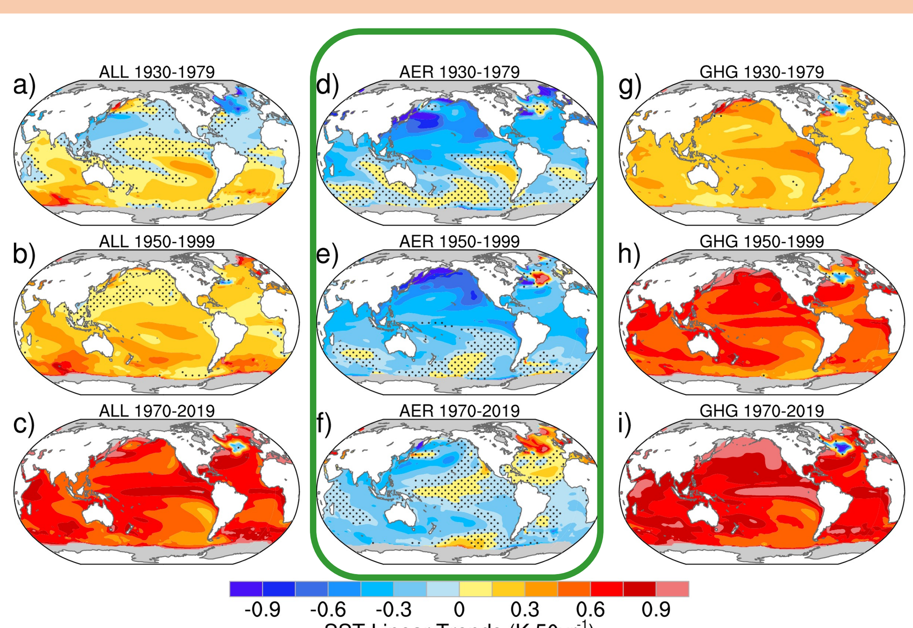
- Year 2000 total global BC+OC+SO2 distributed according to mid-20th and mid-21st century spatial patterns
- 100-year repeating annual cycle simulations in CAM5 coupled to slab ocean





Persad (*in prep.*)

Connecting aerosol spatial dependence to the pattern effect



Deser et al. (2020)

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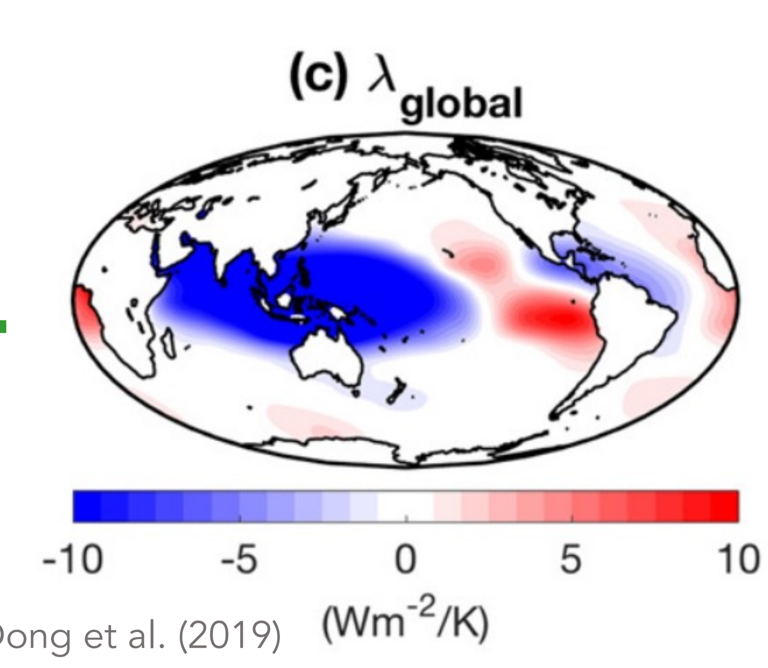

Dong et al. (2019)

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Next steps:

- What is the contribution of aerosols to the time evolution of the feedback parameter in historical AOGCM simulations?
- What portion is SST pattern driven versus atmospheric forcing pattern driven?
- Does this provide any useful insight into the simulated vs. observed pattern effect mismatch in recent decades?
- What are the associated implications of expected future aerosol emission changes?

References
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Acknowledgements
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