Mercury in the Environment: Integrating Spatial and Temporal Source Signals

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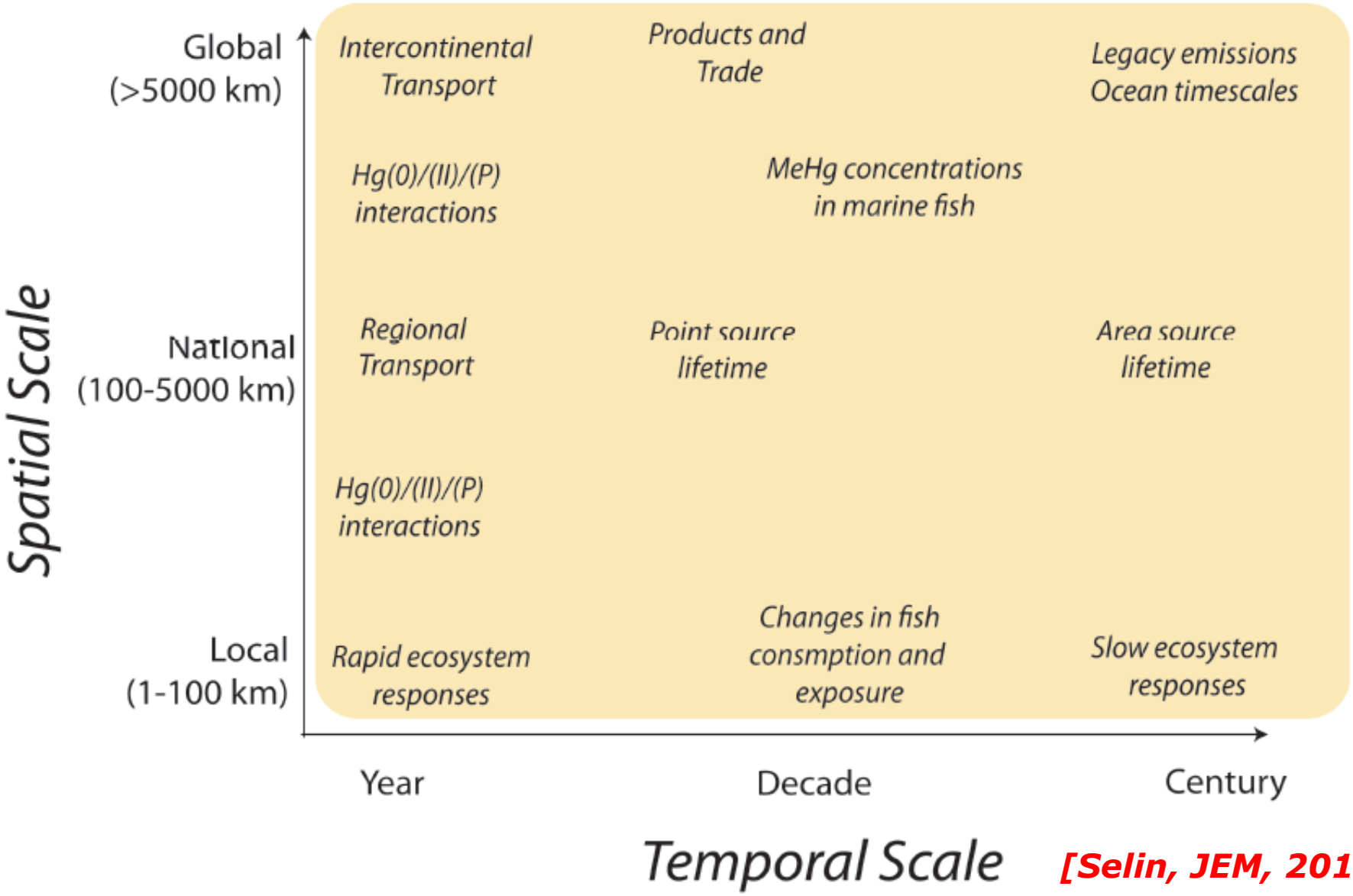
Mercury: Scales and Uncertainty

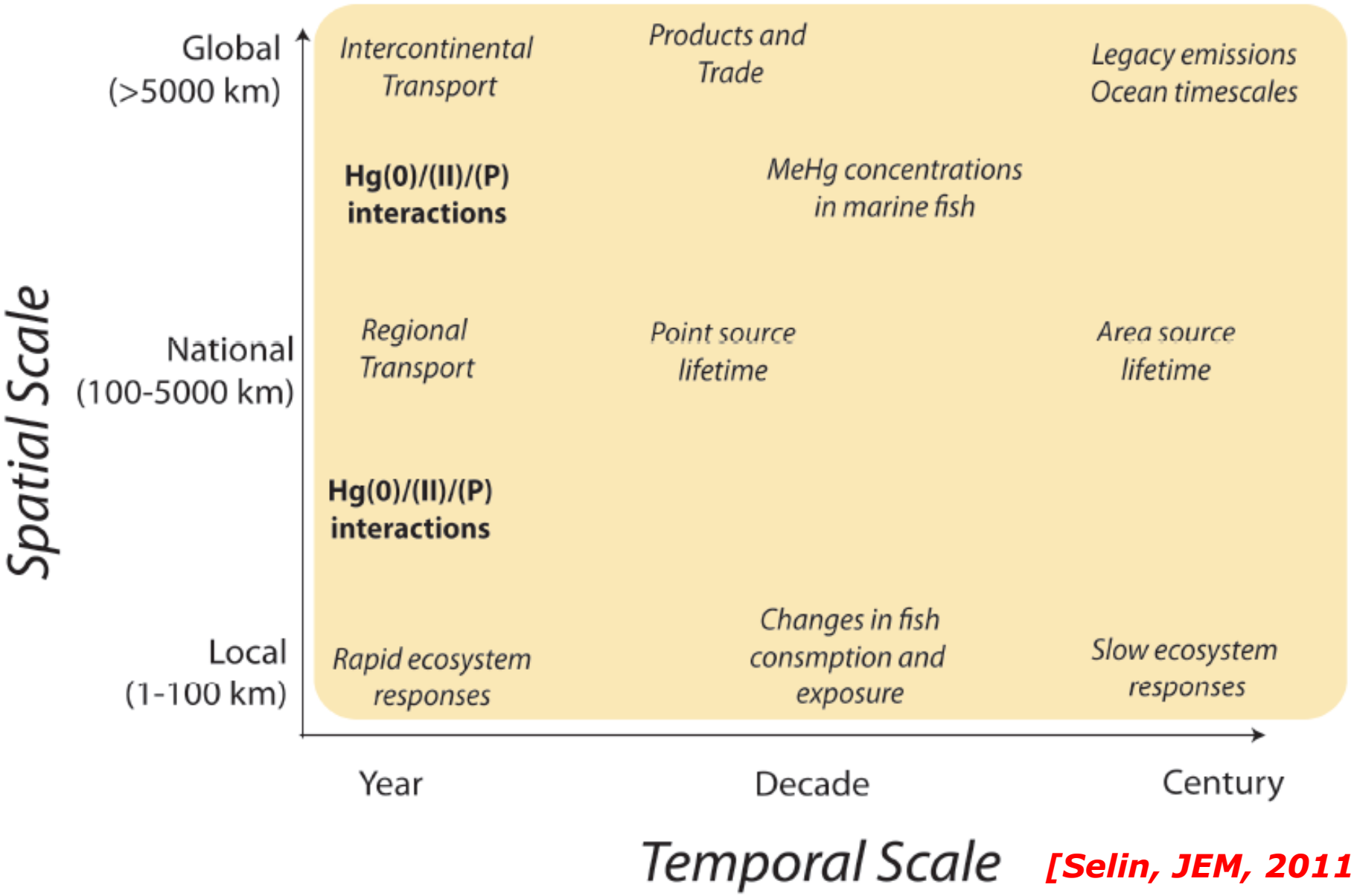
- The “Mercury Problem” occurs on multiple, interacting spatial and temporal scales
- These scales overlap only partially with policies to address mercury contamination
- Understanding these interactions is subject to substantial uncertainty

Mercury is a cross-scale science problem



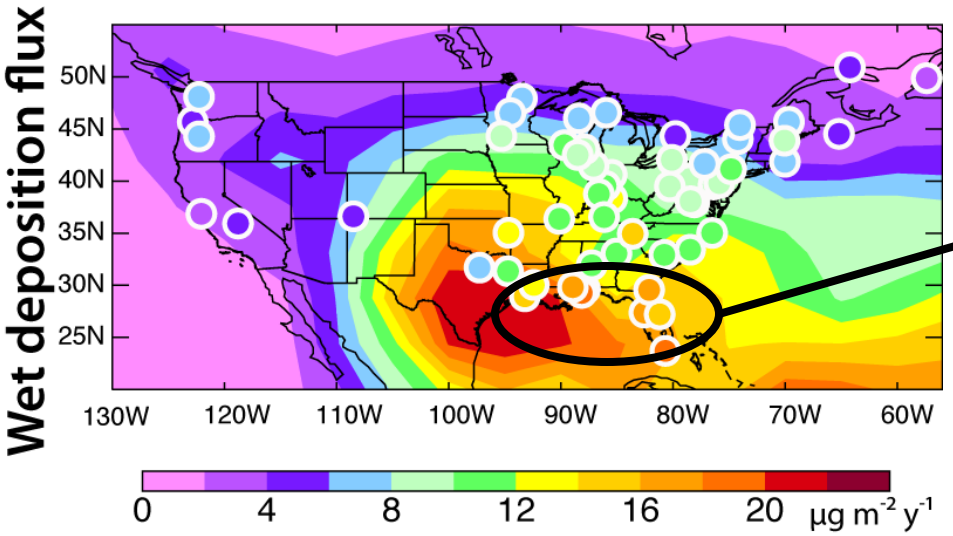
[Selin, JEM, 2011]

Spatial scales: Hg Species Interactions

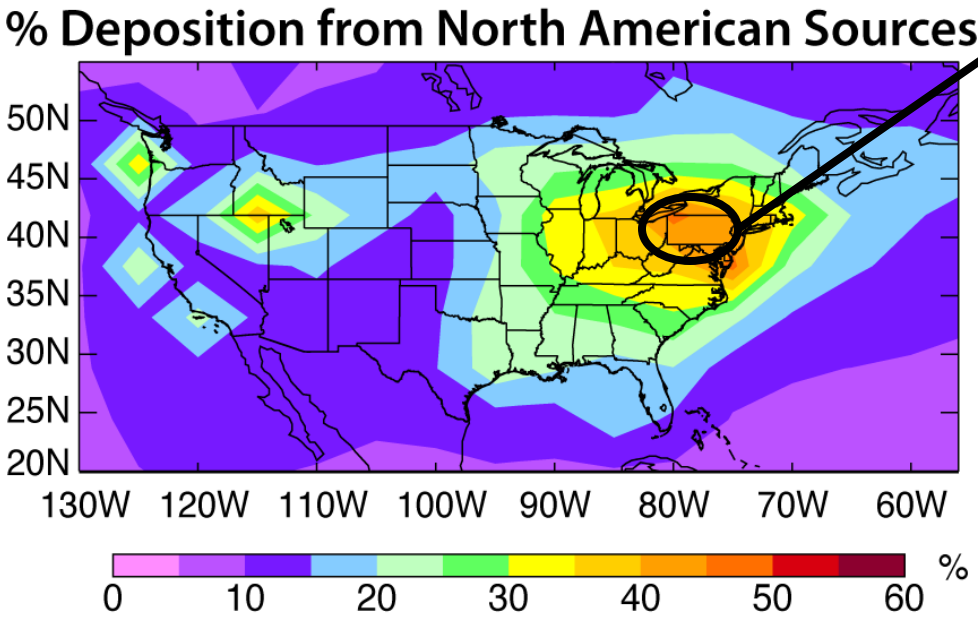


[Selin, JEM, 2011]

Spatial: Interaction between Hg(0), Hg(II), Hg(P)



Wet deposition highest here

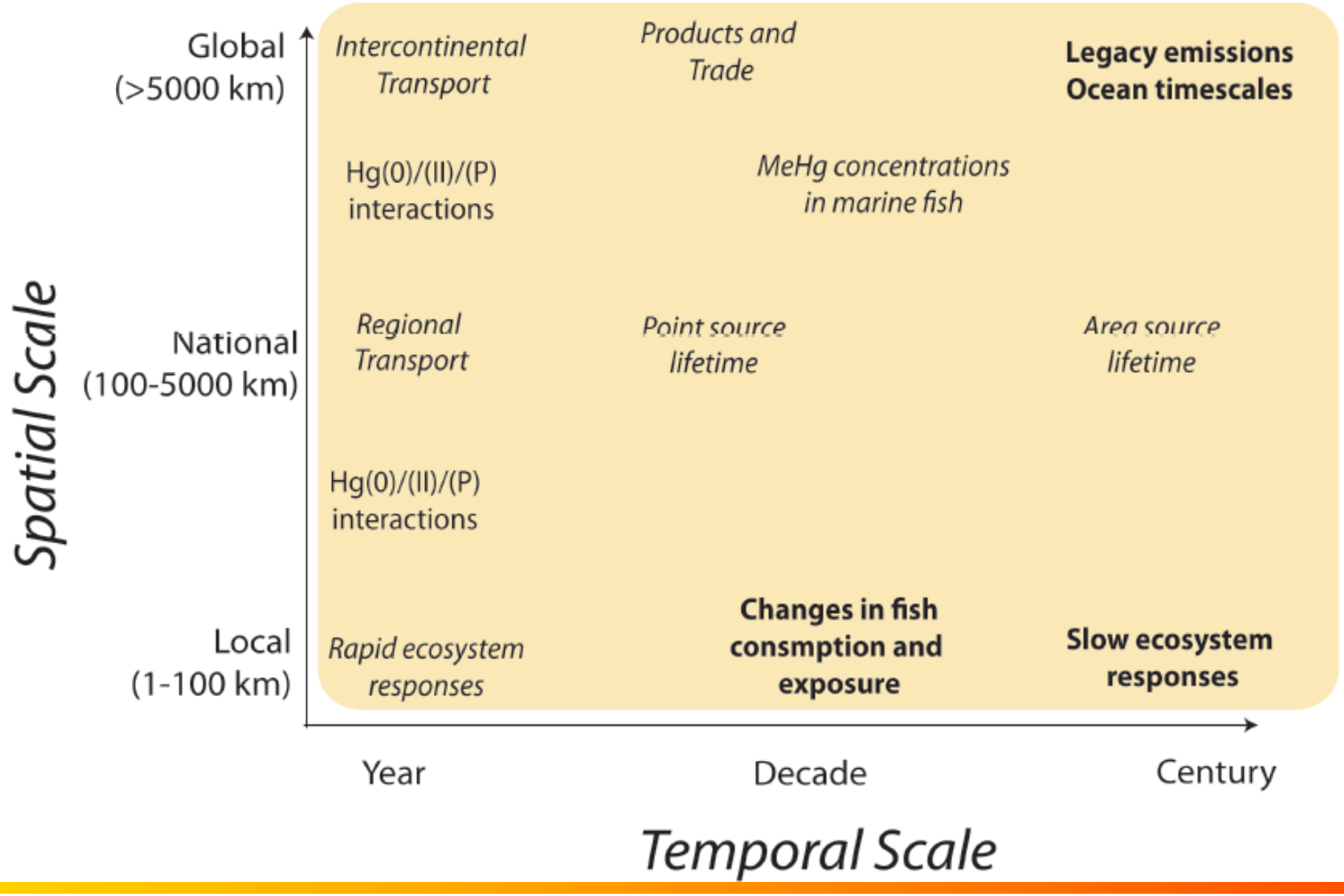


U.S. contribution is highest here

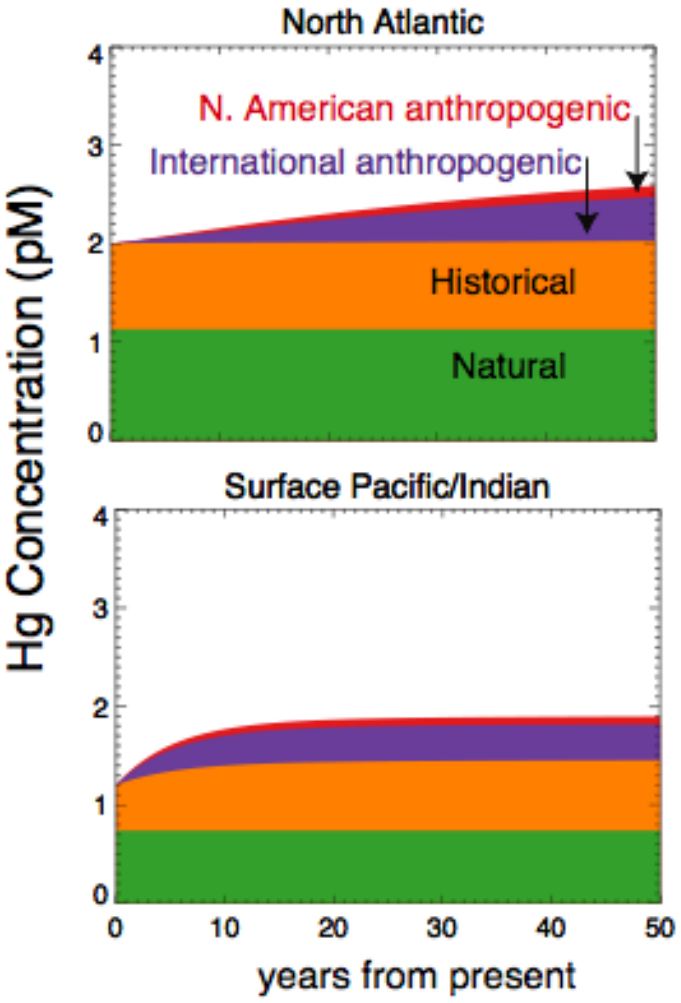
Hg(0), Hg(II), Hg(P) interactions, chemistry and meteorology combine to complicate deposition patterns

[*Selin & Jacob, Atmos. Env. 2008*]

Temporal Scales: Concentration Responses



Temporal: Slow oceanic response to deposition



"current emissions" scenario

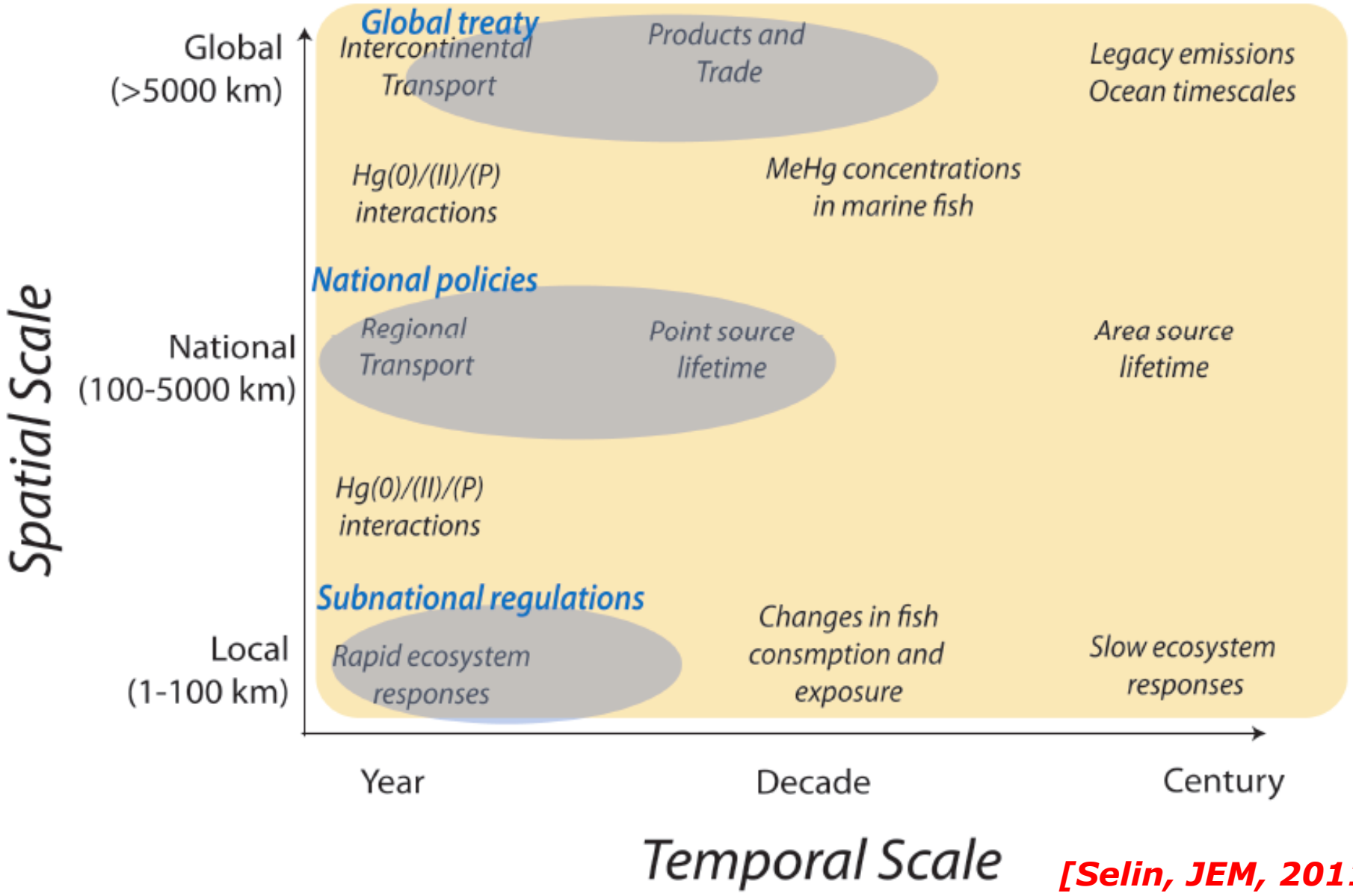
14-box ocean model: Sunderland and Mason, 2007

Elements of timescale response:

- Slow response time: oceans not yet at steady-state
- "Historical" emissions continue to deposit (re-volatilization from storage in land areas)

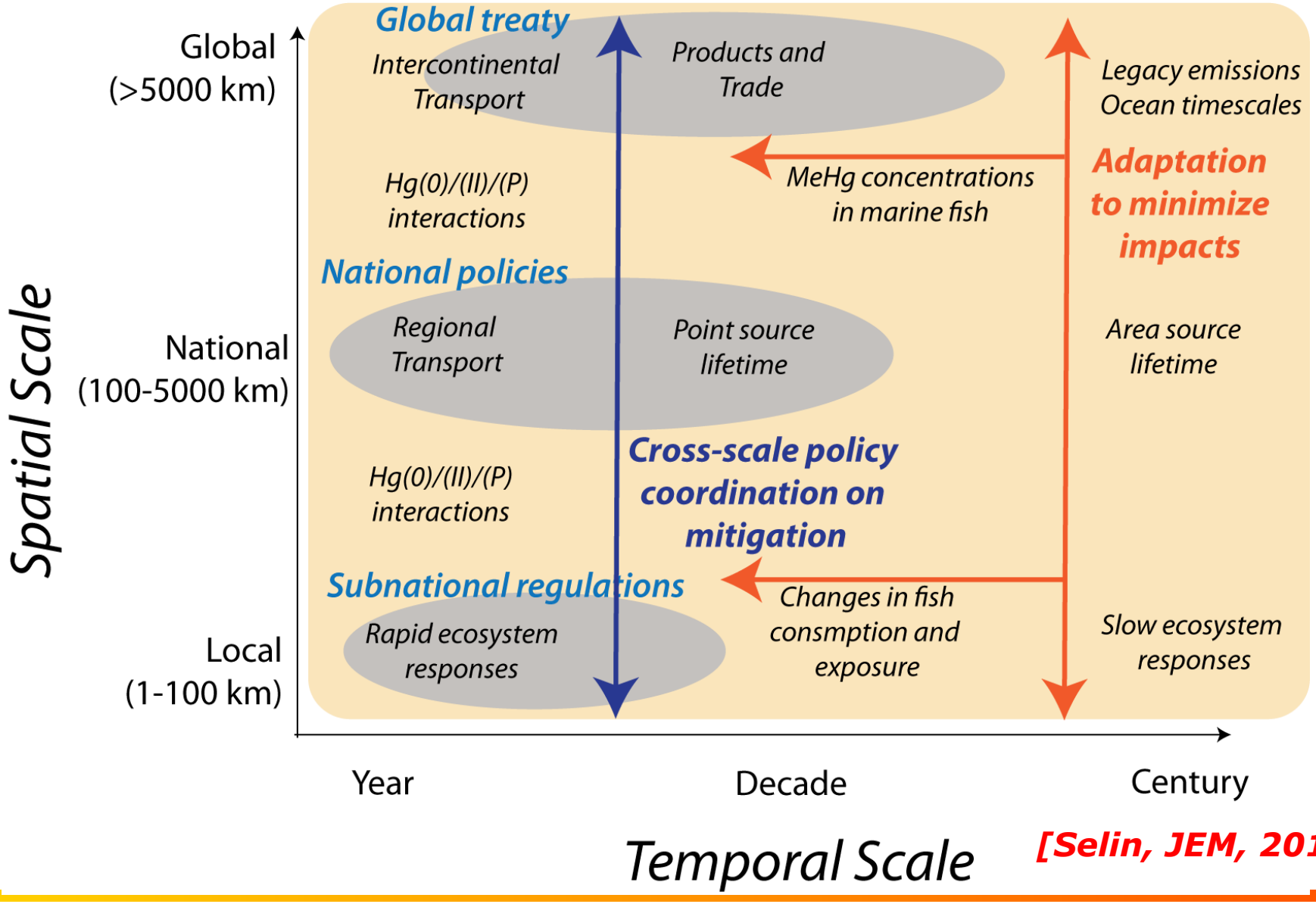
[*Selin et al., EHP*, 2010]

How well do policies cover these scales?



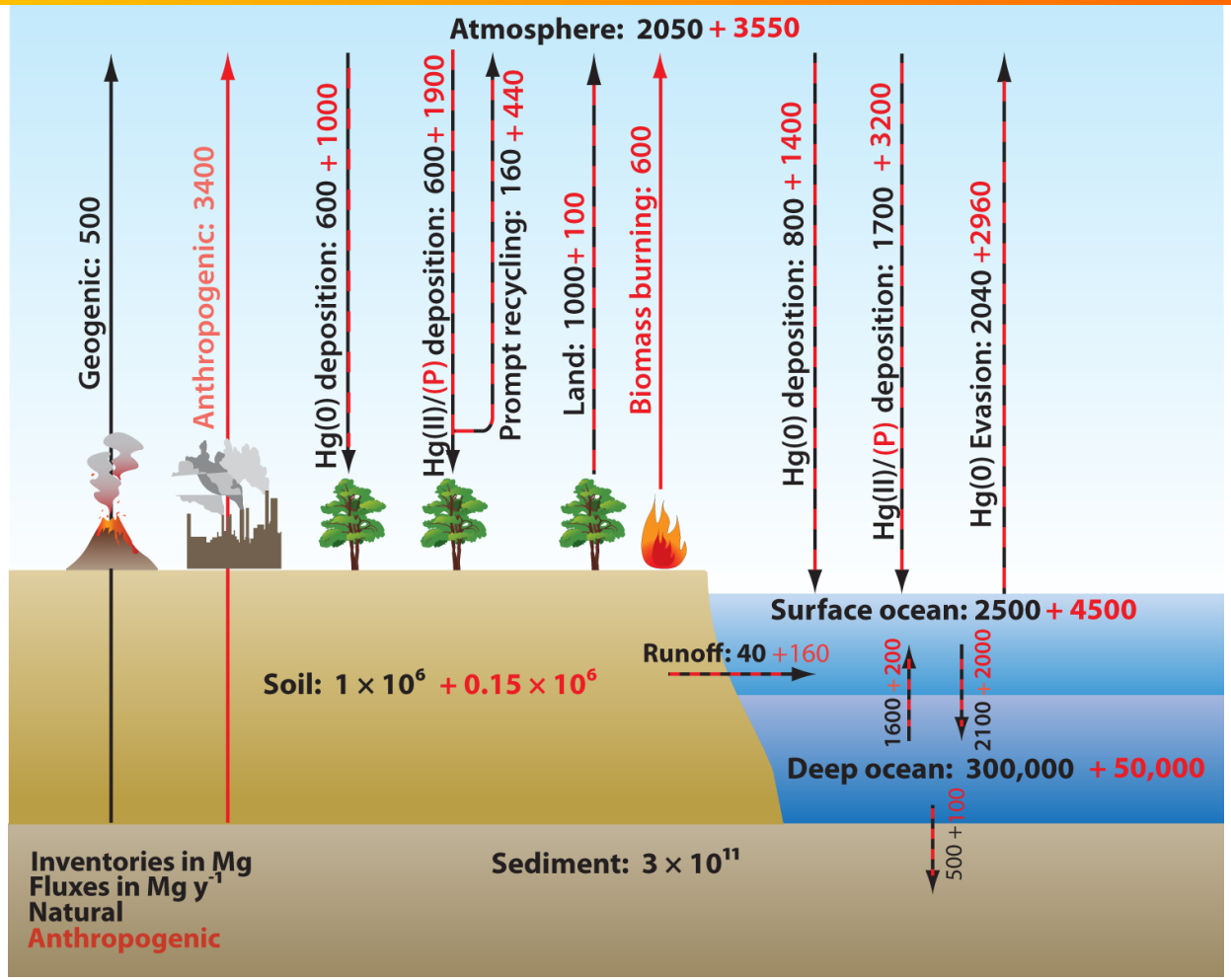
[Selin, JEM, 2011]

Policy options to address Hg across scales



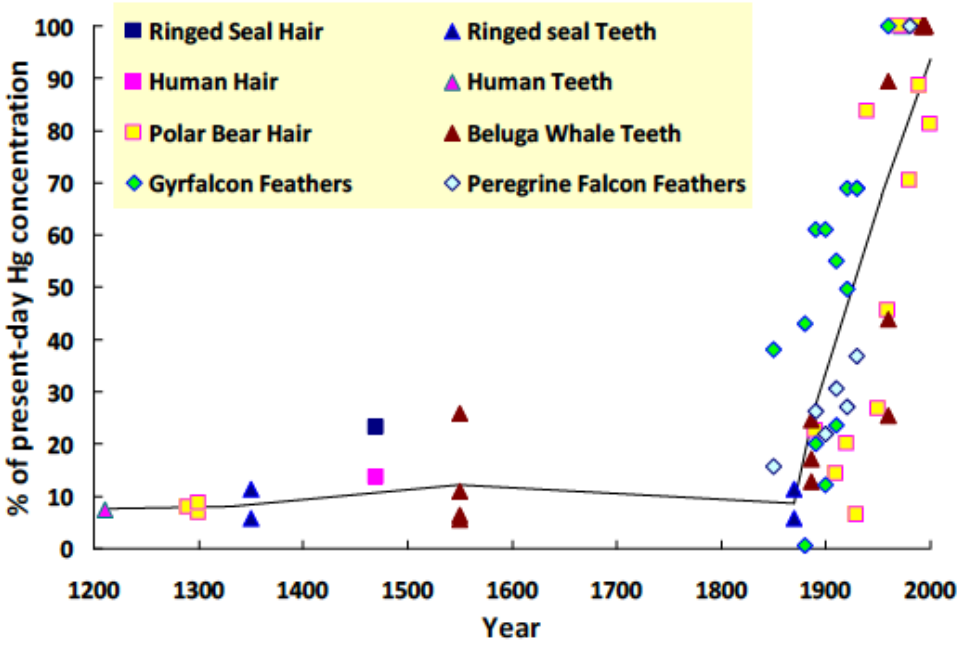
[Selin, JEM, 2011]

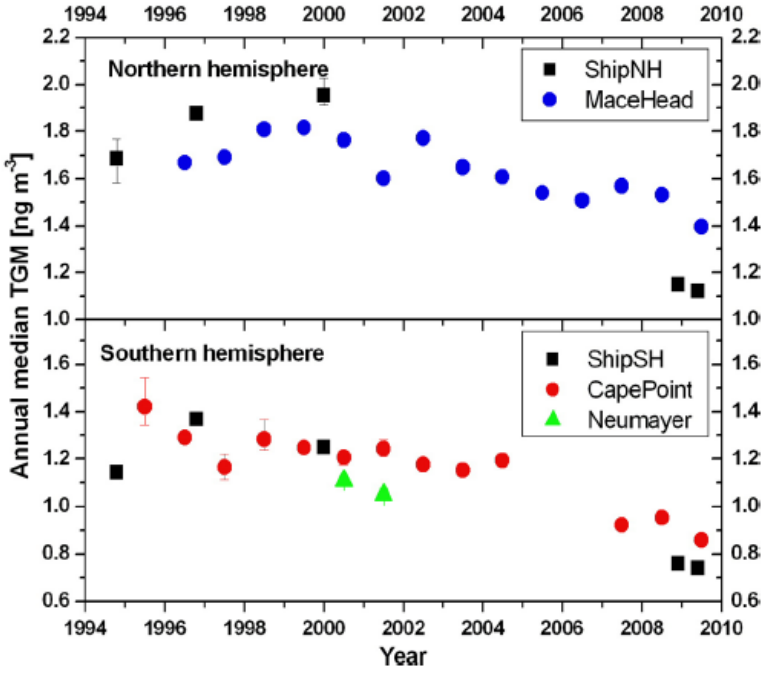
How well do we understand the interactions between temporal and spatial scales?



[*Selin, Ann. Rev. Env. Res., 2009*]

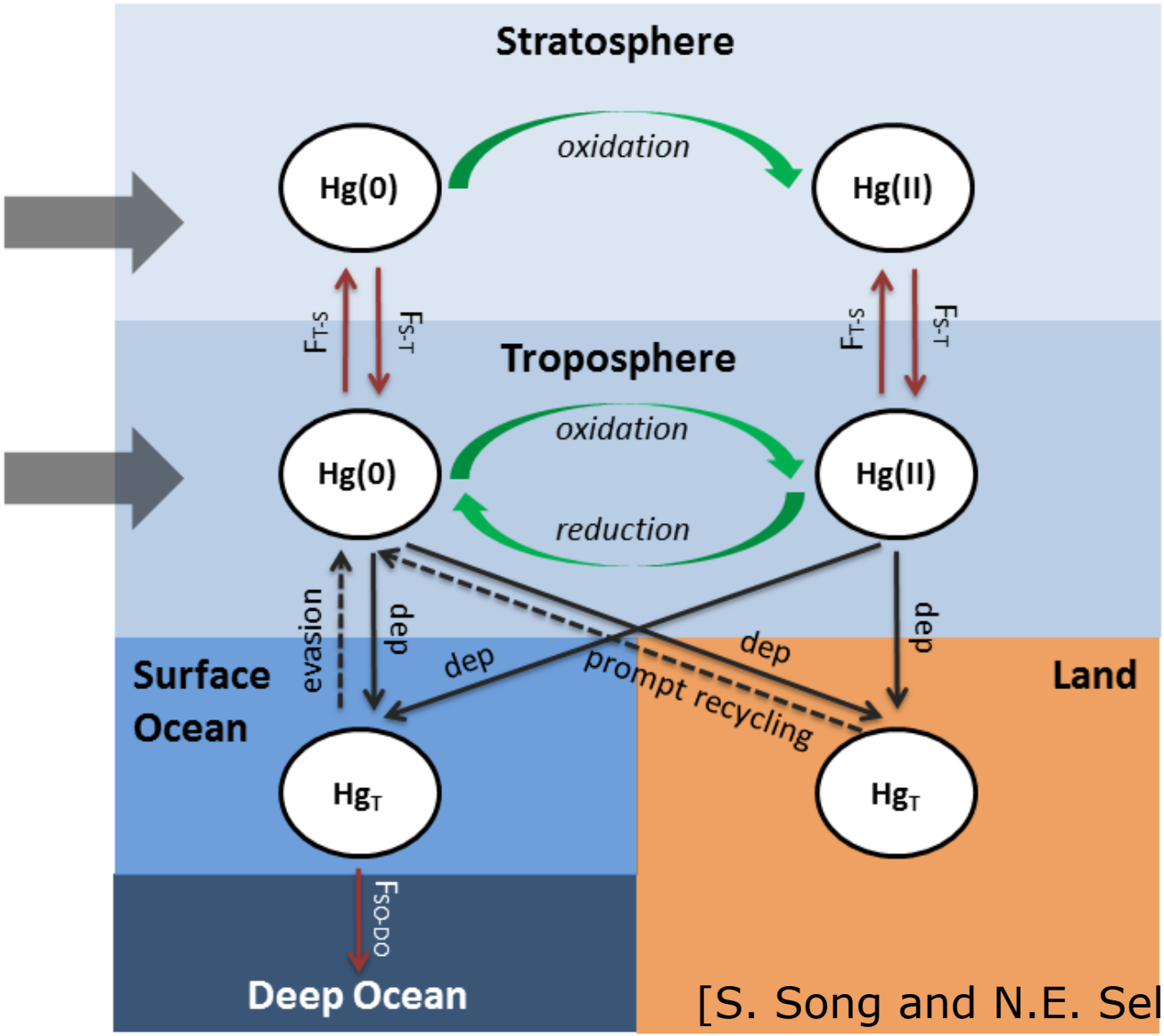
How does Hg vary across timescales?





- AMAP, 2011: order of magnitude Hg increase since pre-industrial
- 20% decrease in atmospheric Hg since 1995? (Slemr et al. 2011)

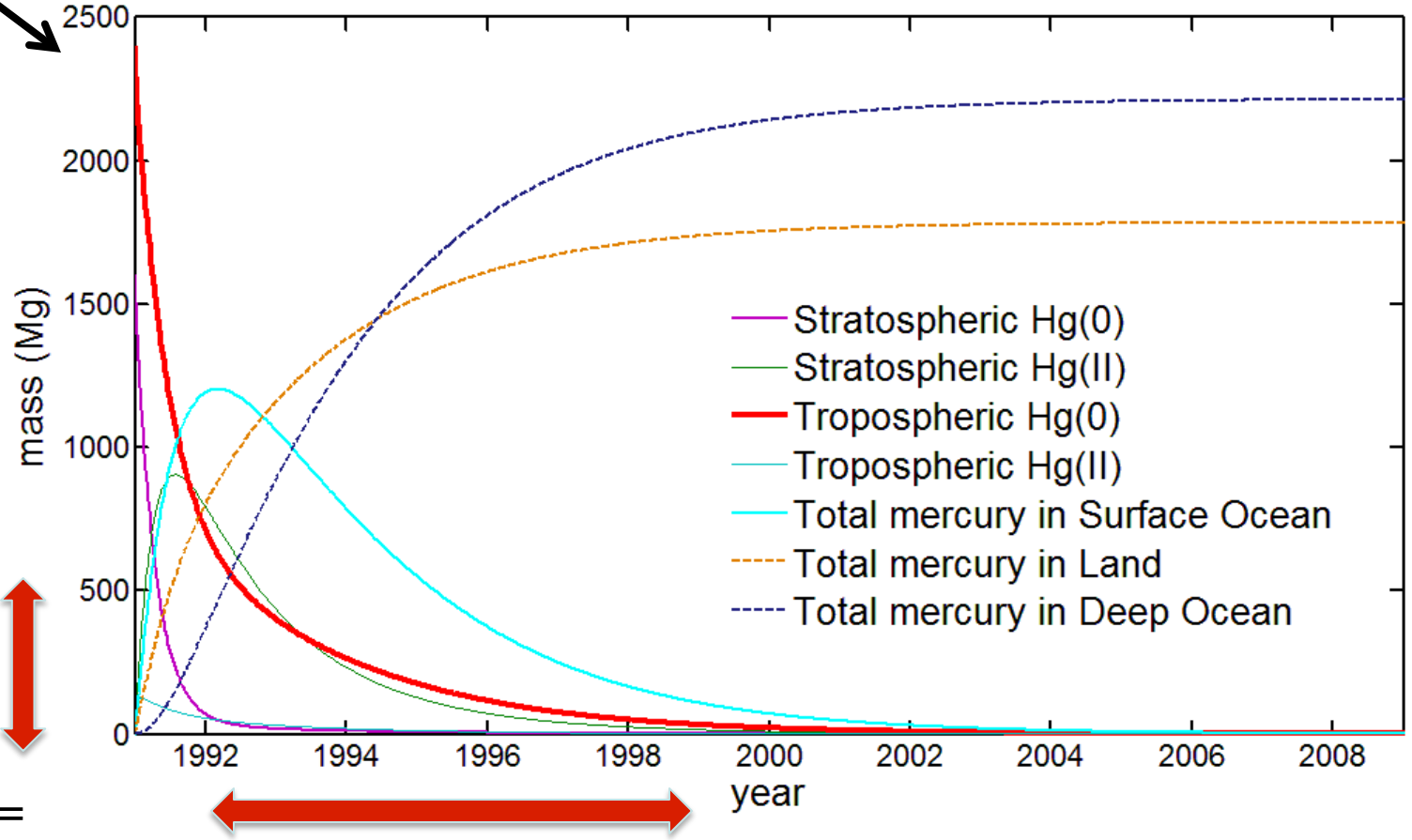
Examining timescales with a multi-box model



[S. Song and N.E. Selin in prep.]

Interacting timescales complicate analysis

Pinatubo eruption, using high estimate of Hg/S ratio



500 Mg=
10% of total
tropospheric mass

Decrease over 7-8 years in troposphere

[S. Song and N.E. Selin in prep.]

Summary of Key Points

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Acknowledgments: NSF Atmospheric Chemistry Program; Shaojie Song (MIT); GEOS-Chem Team Hg