Effect of Biomass Fires on Atmospheric Mercury Concentrations and Deposition in the United States

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Mercury Emissions from Biomass Fires

- Wildfires and Prescribed burns
- Hg emissions from emission factors and fire data
- Estimated Total in 2002 = 29 Mg
- 75% Hg(0)
- 25% Hg(p) – predominantly $PM_{2.5}$
- Negligible RGM assumed
- Spatial distributions of Hg(0) and Hg(p) fire emissions for this paper were derived from distributions of fire emissions of CO and $PM_{2.5}$, respectively, modeled by Regional Planning Organizations using fire data.

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Modeling System

- AMSTERDAM – Advanced Modeling System for Transport, Emissions, Reactions and Deposition of Atmospheric Matter
- 3-D multi-pollutant model – O_3, PM, Mercury, other species
- Gas-phase: Hg(0) and RGM
- Particulate: Hg(p) (primary emitted + adsorbed)
- Wet and Dry deposition of Hg(0), RGM and Hg(p)
- Modeling domain – USA with 36 km horizontal resolution
- Time Period – July 2002
- Two scenarios – With and without biomass fire emissions

Hg emissions from biomass fires in July 2002

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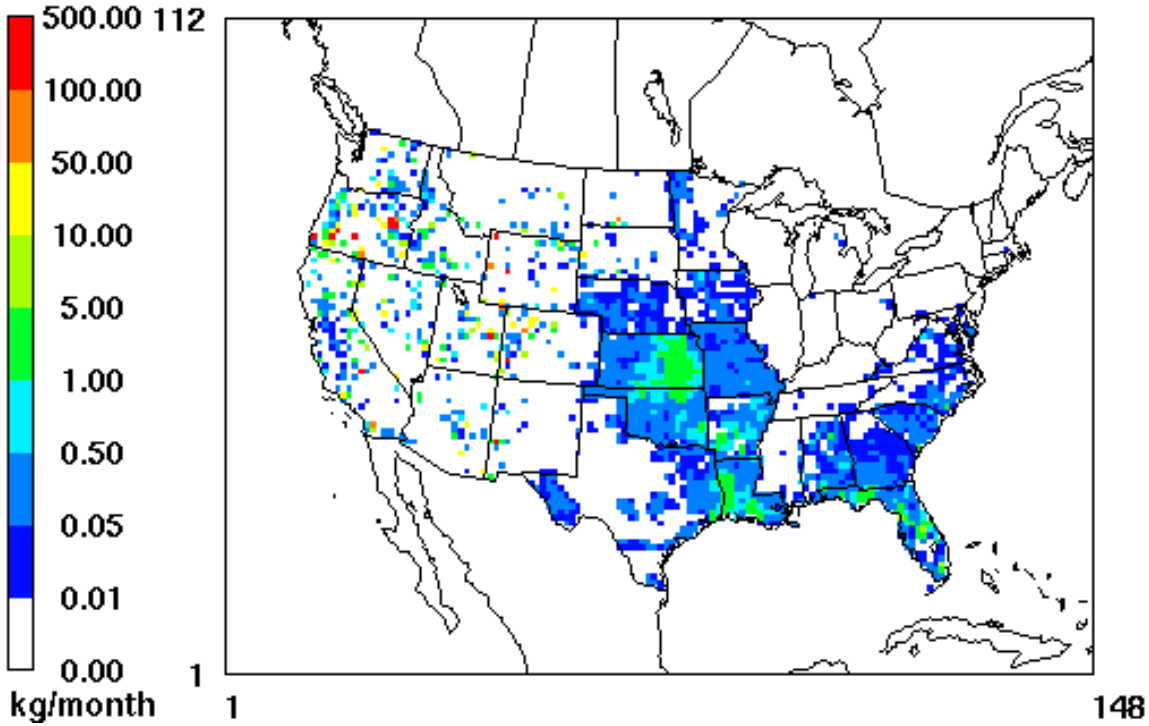
Hg emissions in each 36x36 km^2 grid cell



U.S. Biomass fire Hg emissions in 2002 = 29 Mg (5.7 Mg* in July)

For comparison, annual U.S. anthropogenic Hg ~ 110 Mg

* July total is for continental U.S. only

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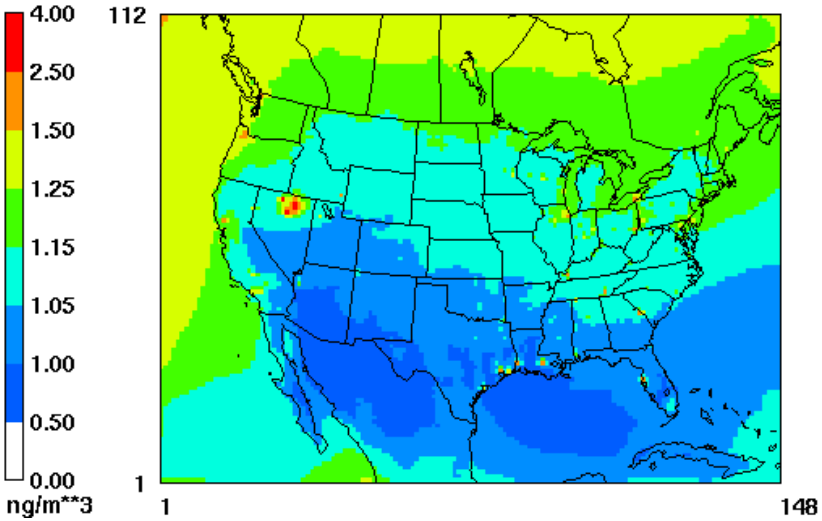
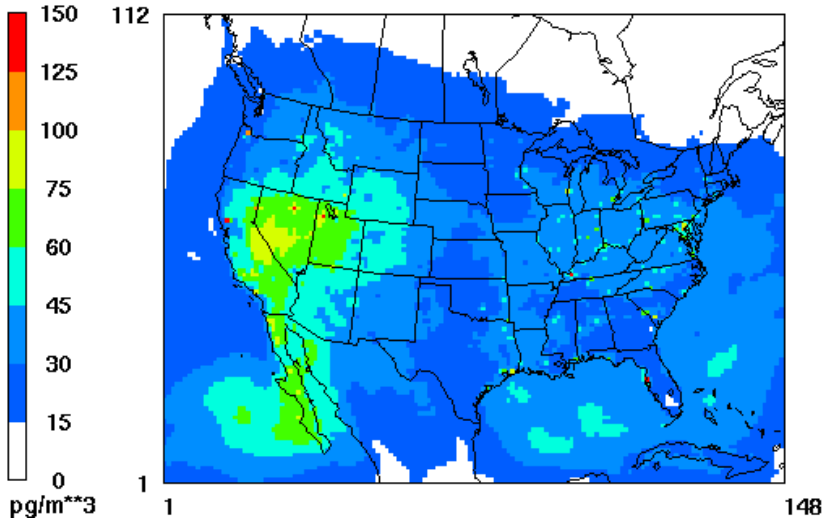
Simulated Surface Air Concentrations in July 2002 before accounting for Biomass Fires

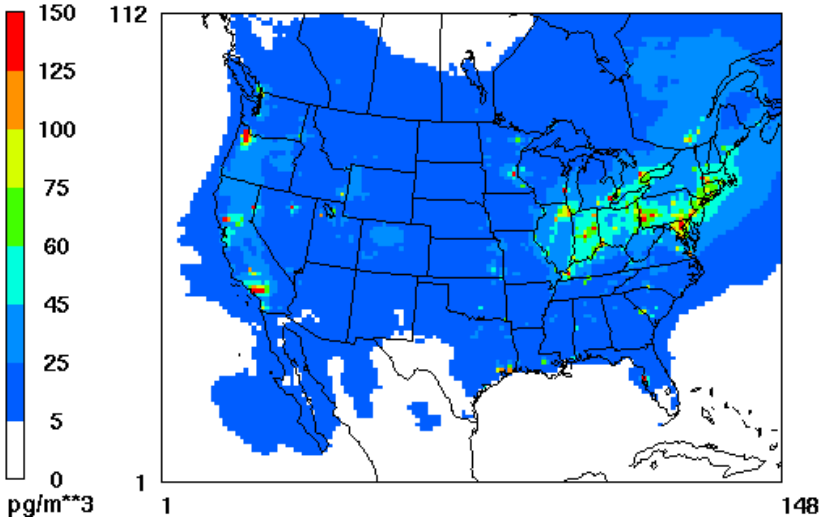
Hg(0)



RGM



Hg(p)



Relative Change in Surface Air Concentrations after accounting for Biomass Fires

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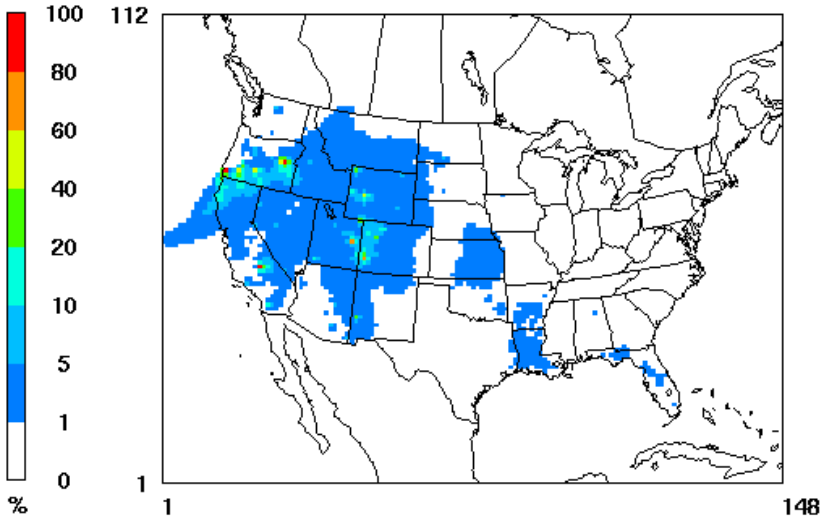
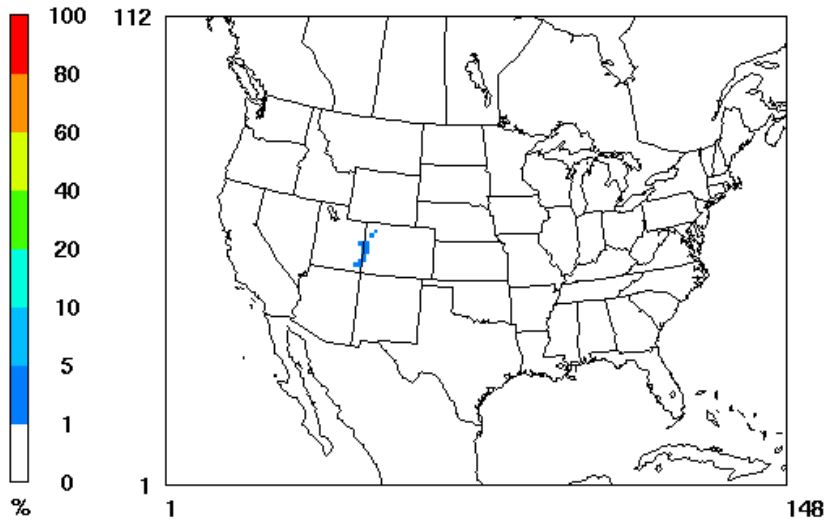
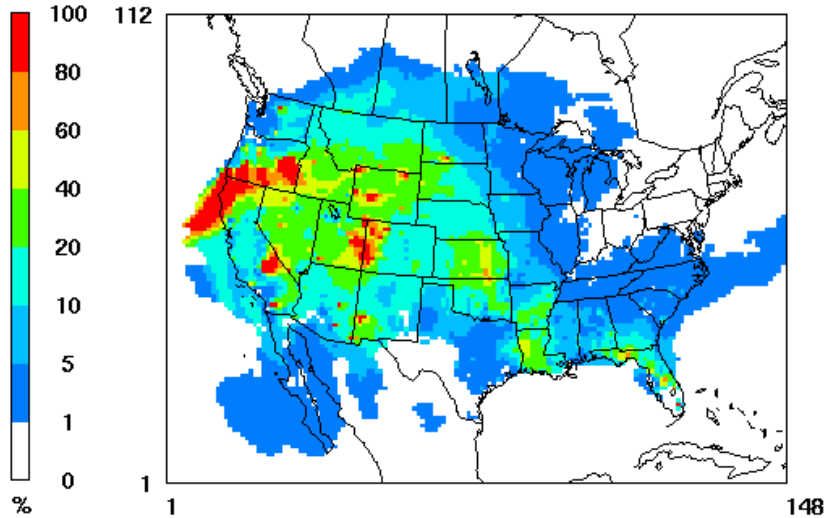
Hg(0)



RGM



Hg(p)



Simulated Hg Deposition in July 2002 before accounting for Biomass Fires

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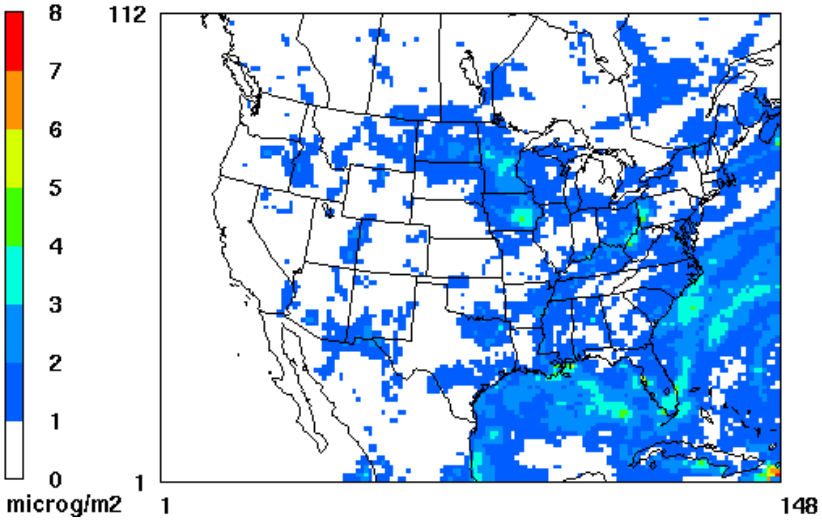
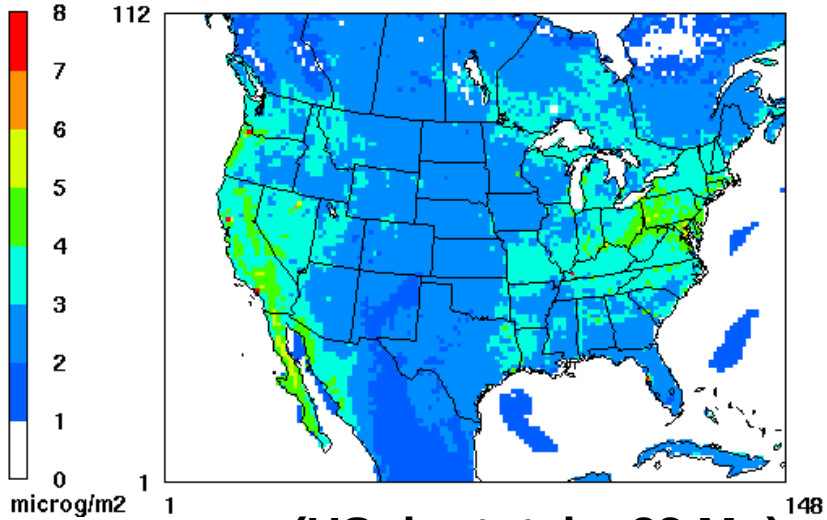
Wet Deposition



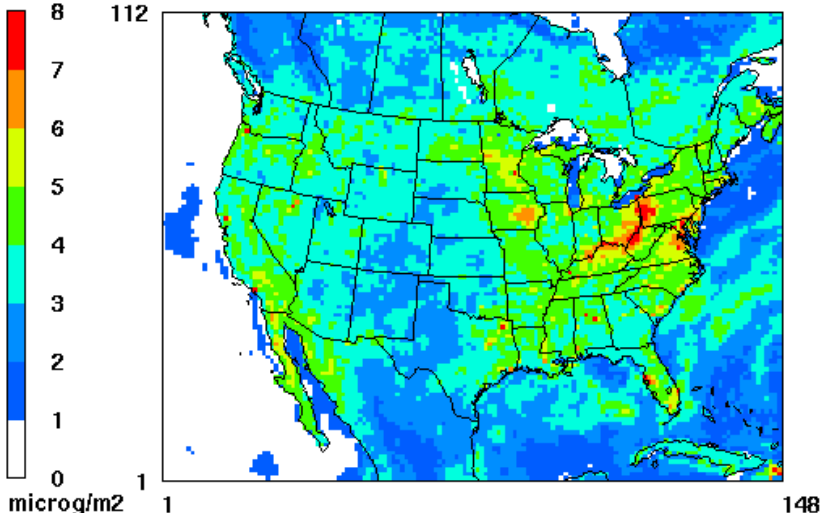
(US wet total = 8 Mg)

Dry Deposition



(US dry total = 23 Mg)

Wet + Dry Deposition (US total = 31 Mg)



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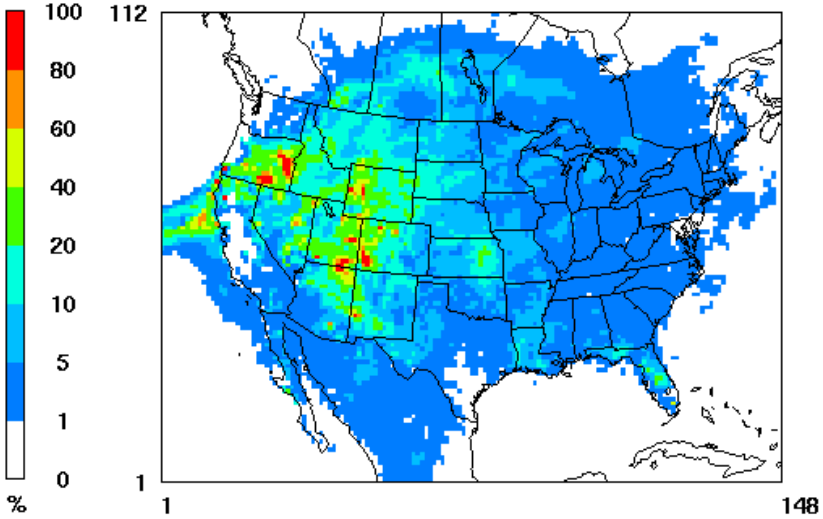
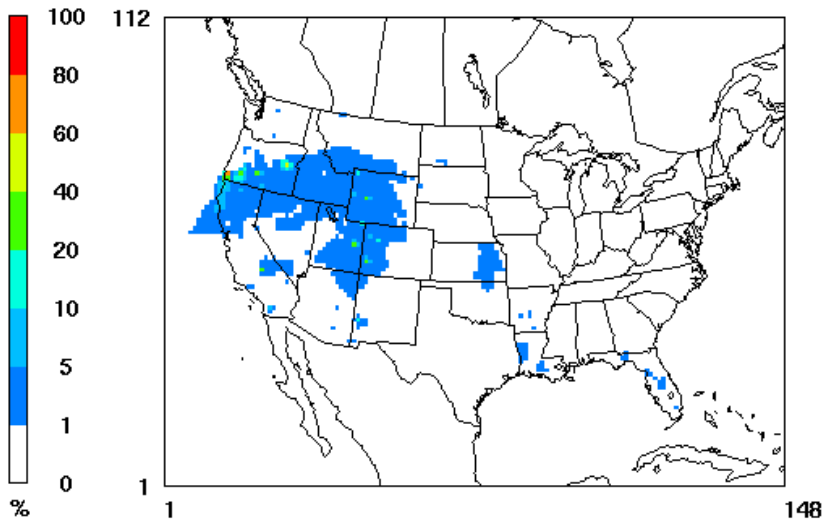
Relative Change in Hg Deposition in July 2002 after accounting for Biomass Fires

Wet Deposition



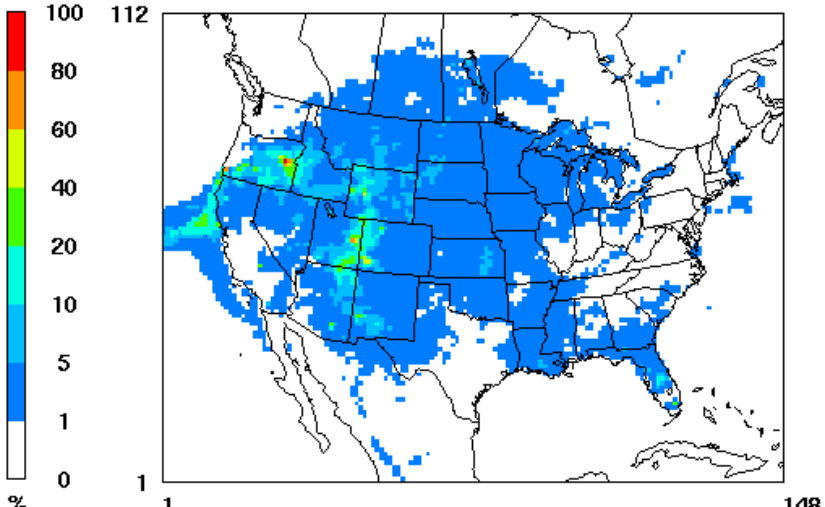
(US wet avg. increase = 8%)

Dry Deposition



(US dry avg. increase = 1%)

Wet + Dry Deposition (US avg. increase = 3%)



Comparison with MDN Wet Deposition Data

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Performance Statistics for July 2002 at 63 MDN sites

	No Hg emissions from biomass fires	**With Hg emissions from biomass fires**
Normalized mean gross error	49%	48%
Normalized mean bias	-17%	-14%
Correlation coefficient (r)	0.48	0.50

State-wide Average Contribution of Biomass Fires to Wet + Dry Mercury Deposition in July 2002

State	Average Contribution
Oregon	8%
Utah	7%
Wyoming	6%
Colorado	6%
Idaho	6%
New Mexico	4%
Montana	4%
South Dakota	3%
Arizona	3%
North Dakota	3%
Florida	3%
USA	**3%**

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State-wide Peak Contribution of Biomass Fires to Wet + Dry Mercury Deposition in July 2002

State	Peak Contribution in State
Oregon	50%
Utah	42%
Colorado	36%
Wyoming	32%
New Mexico	28%
California	22%
Idaho	21%
Arizona	21%
Florida	20%
Montana	15%
Nevada	8%

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Summary and Conclusions

- Biomass fire emissions comprise mostly Hg(0) and Hg(p).
- Hg emissions from biomass fires in the U.S. were derived from emission factors and fire data for 2002.
- Spatial distributions of Hg(0) and Hg(p) were based on spatial distributions of fire emissions of CO and $PM_{2.5}$.
- Hg fire emissions were incorporated in the multi-pollutant 3-D air quality model AMSTERDAM.
- AMSTERDAM was applied to simulate mercury atmospheric concentrations and deposition in the United States in July 2002.
- Model performance against MDN wet deposition data improved slightly after incorporating Hg emissions from biomass fires.
- The average contribution of biomass fires to Hg deposition in the U.S. is 3%.

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Summary and Conclusions

- Contributions of biomass fires to Hg deposition are highest in the western U.S. (8% average contribution in Oregon).
- Peak state-wide contributions are up to 50% in the western U.S. (in Oregon) and up to 20% in the Southeast (in Florida).
- These estimates reflect summer-time biomass fire activity. Contributions will be much lower in winter.
- Hg(p) was assumed to be mostly in fine PM. A greater fraction of coarse Hg(p) would increase the contributions of biomass fires to local Hg deposition.
- The speciation of the fire emissions [Hg(0) / Hg(p) / RGM] is another source of uncertainty.
- It is important to account for the contribution of biomass fire emissions in any mercury modeling study.

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Questions ?

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