



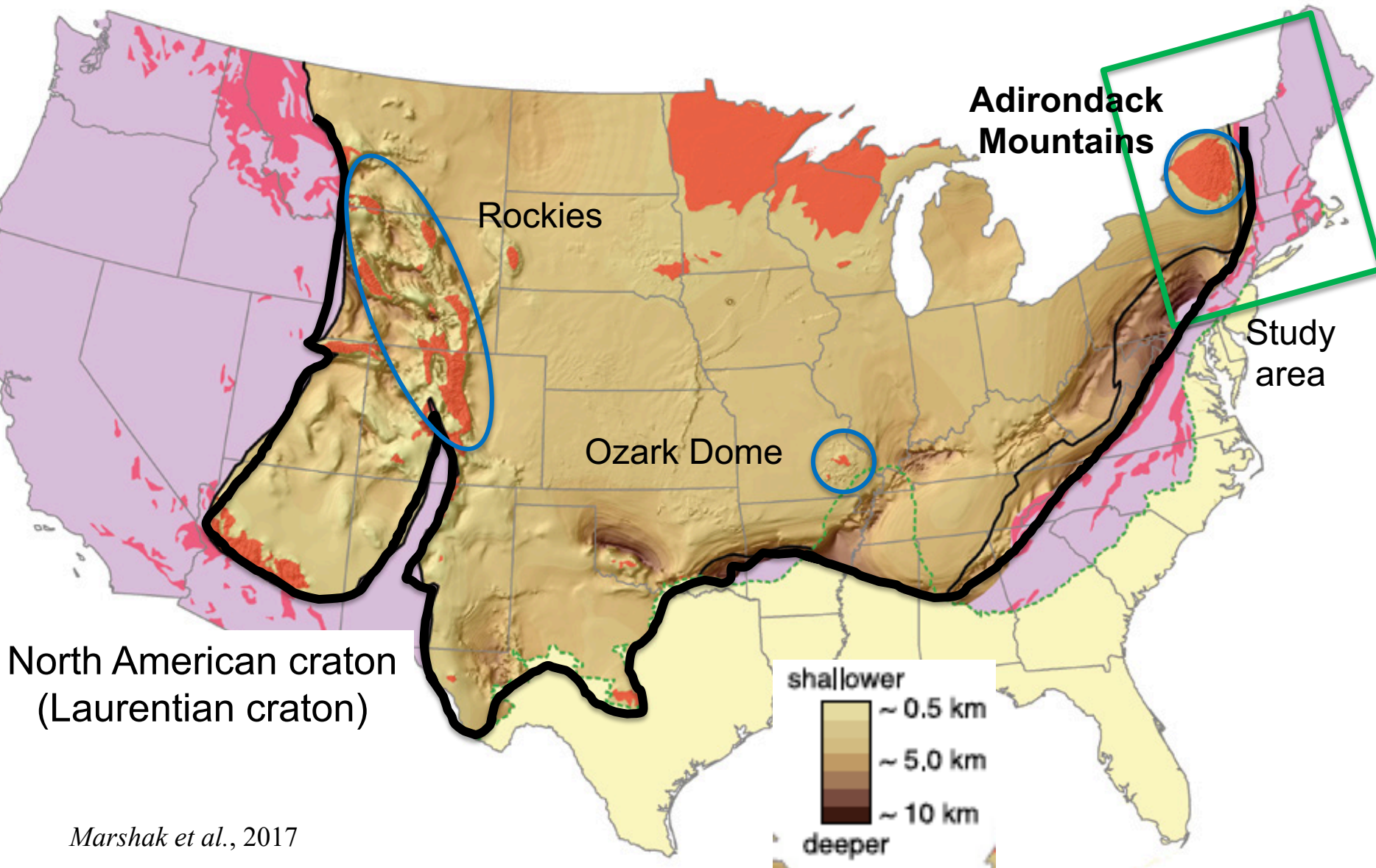
# **Uplift of the Adirondack Mountains ~~Driven by Asthenospheric Upwelling~~**

**Xiaotao Yang and Haiying Gao**

Department of Geosciences  
University of Massachusetts Amherst

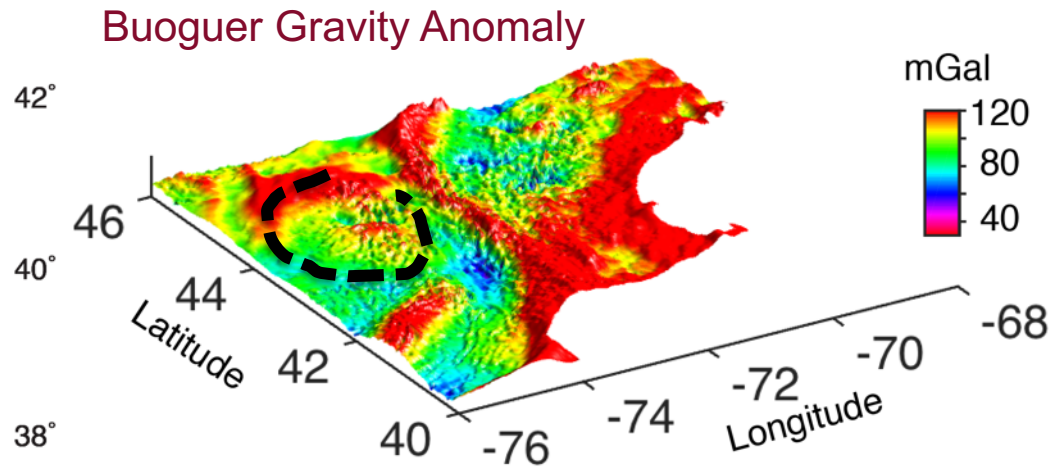
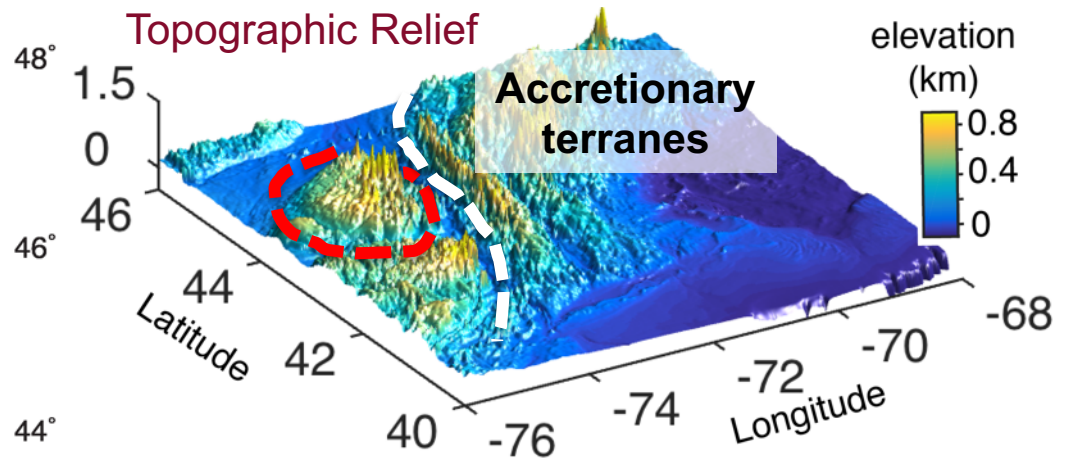
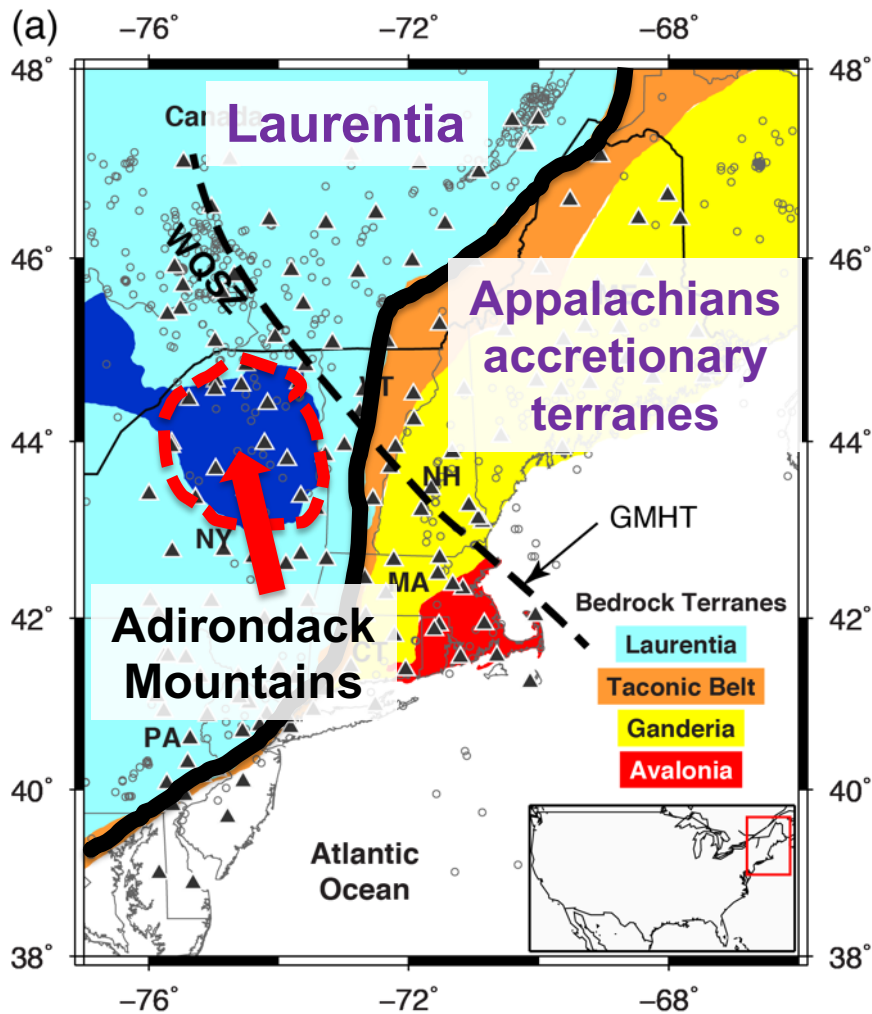
**May 18, 2017**

# Elevation of the Great Unconformity



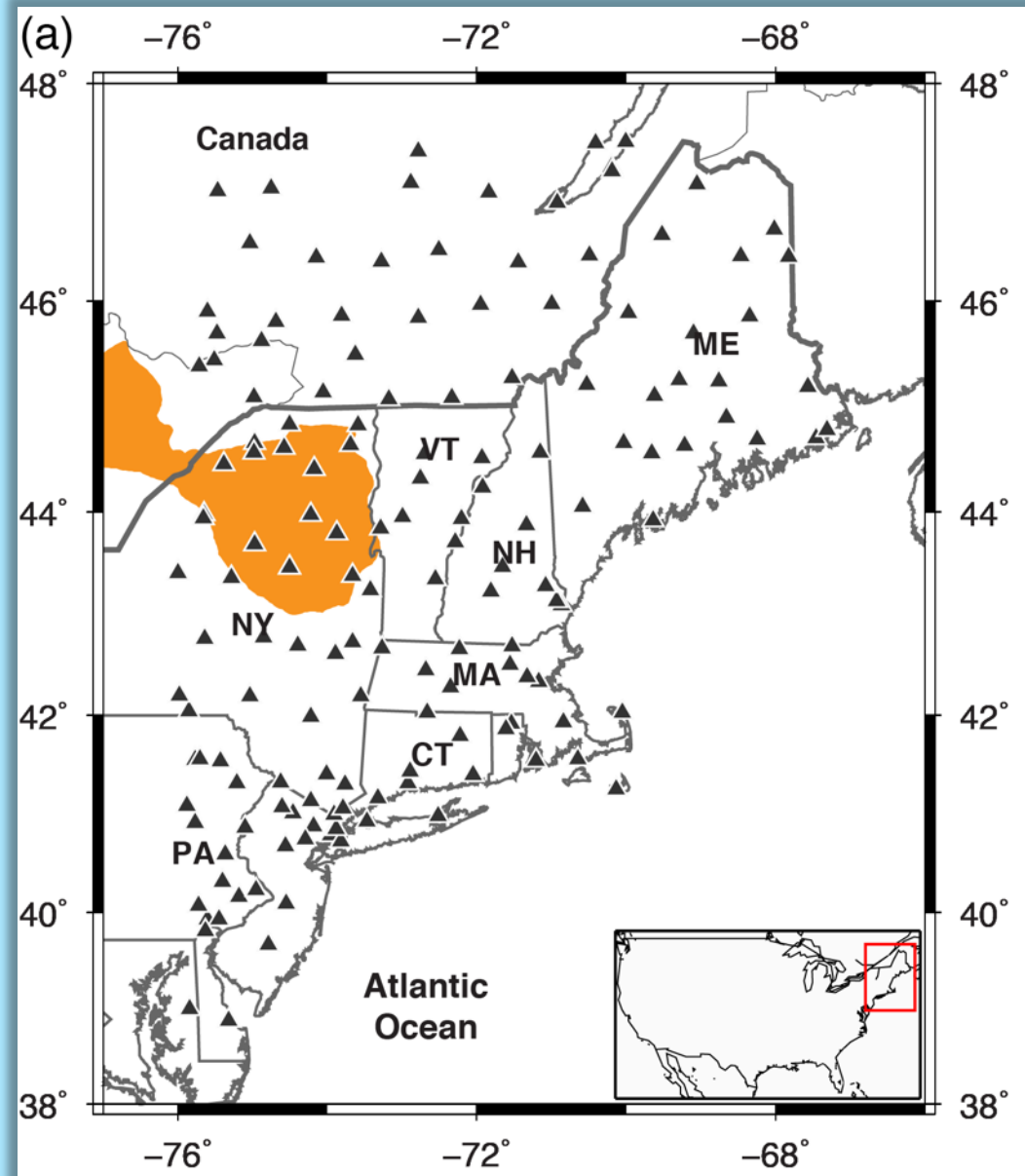
*Marshak et al., 2017*

# Surface Bedrock Terranes



## Data and Method

- **Data from 2005-2015**, including EarthScope USArray TA and many other networks
- Full-wave simulation and inversion for shear velocities
- Rayleigh waves extracted from ambient noises between station pairs

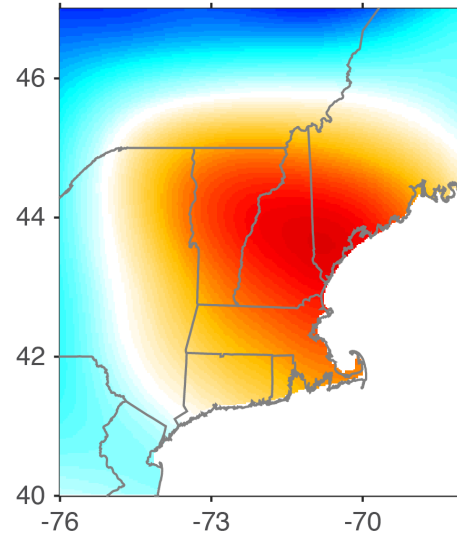
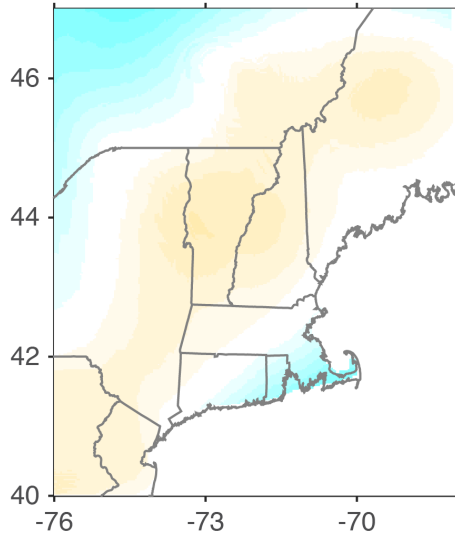
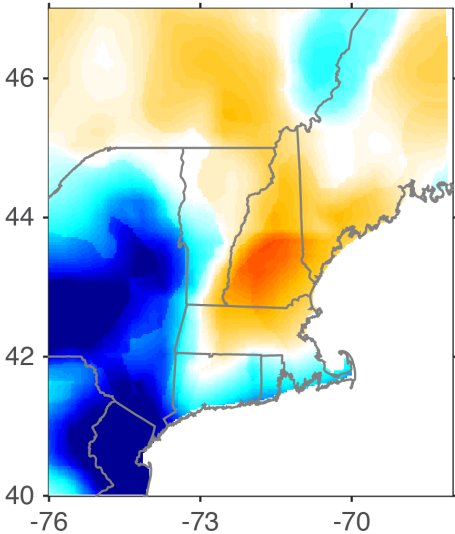


# Model Improvements

### Lower crust

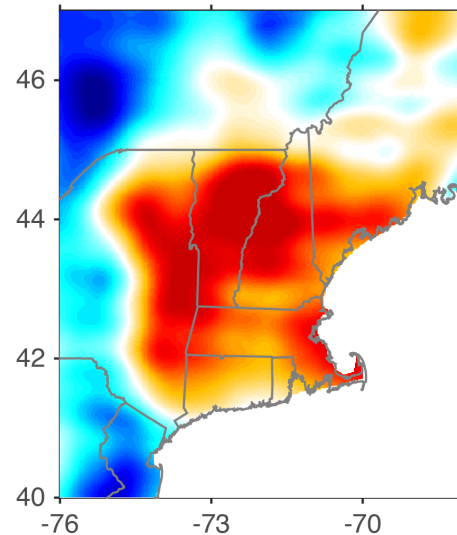
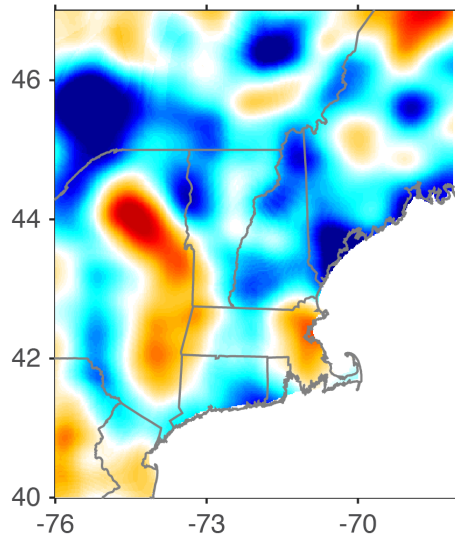
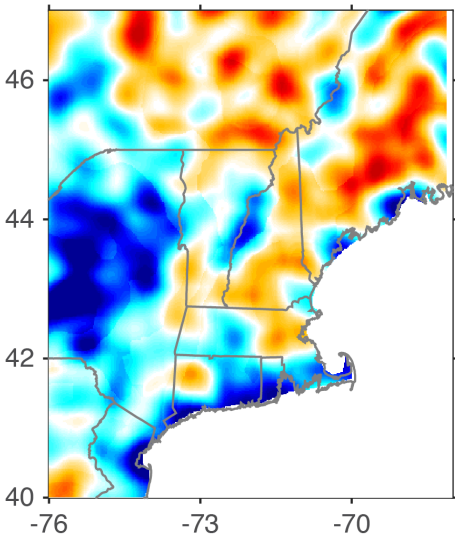
### Moho to 65km

### 65km to 90km

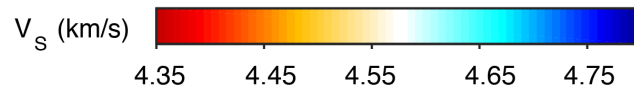
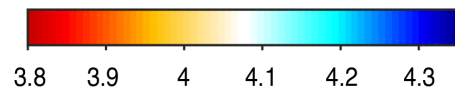


← Initial Model

- 0-70 km: CUB (*Shapiro and Ritzwoller, 2002*)
- >70 km: NA07 (*Bedle and van der Lee, 2009*)

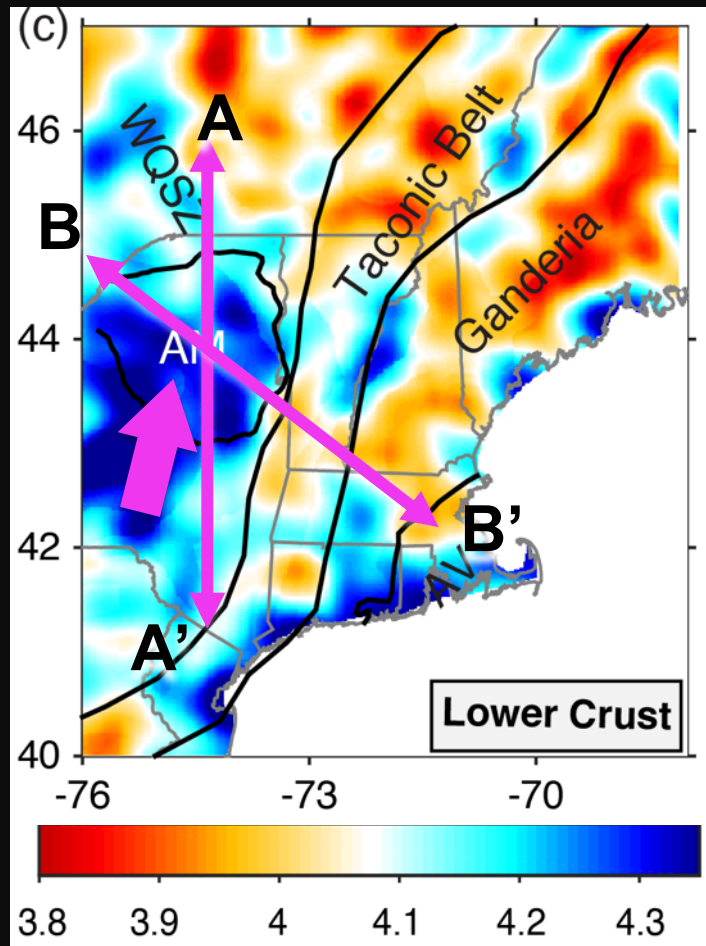


← Final Model

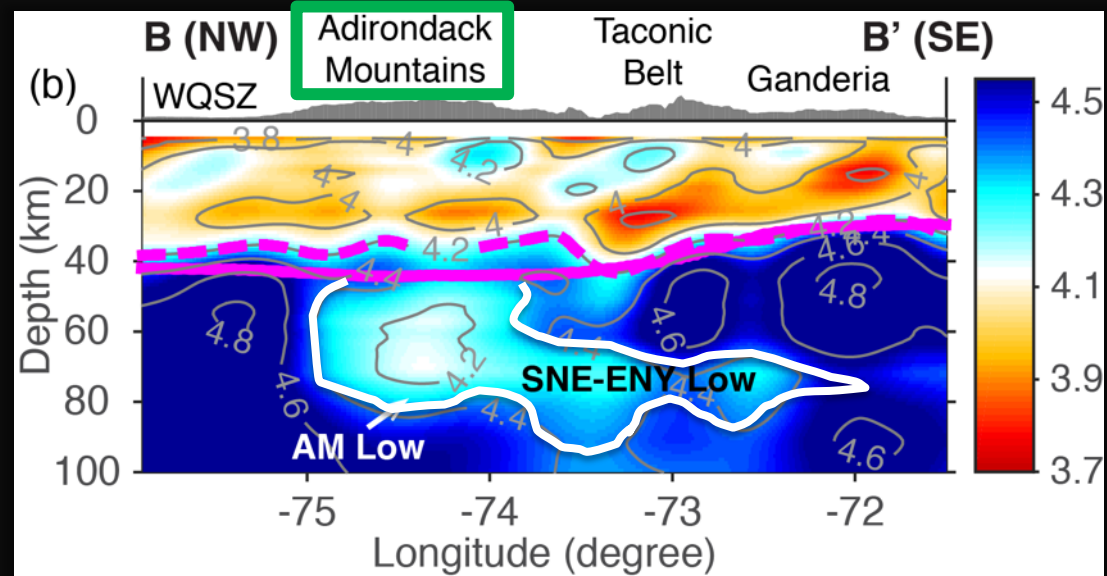
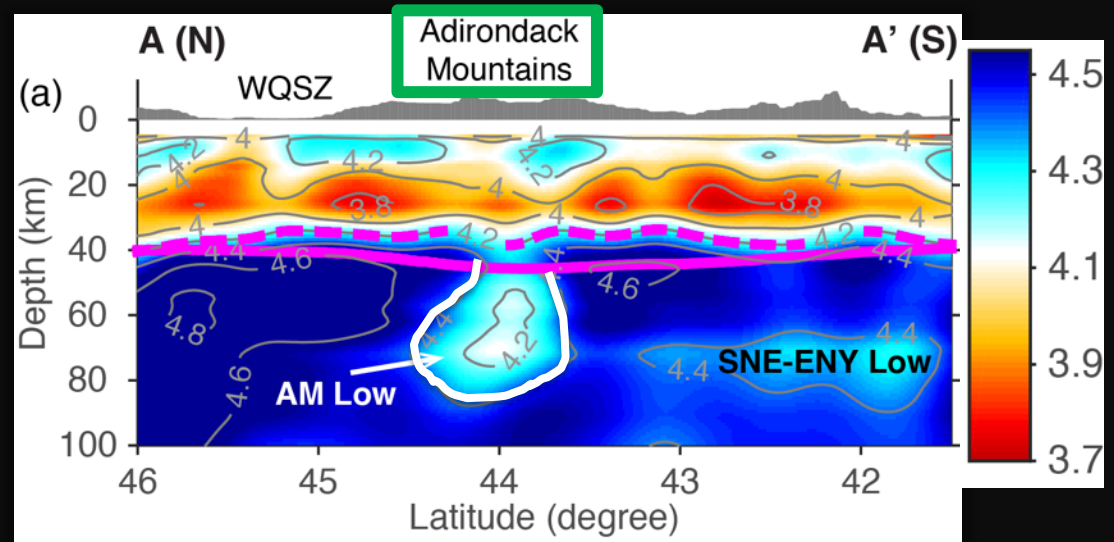


Upper mantle velocities

# Shear velocity model

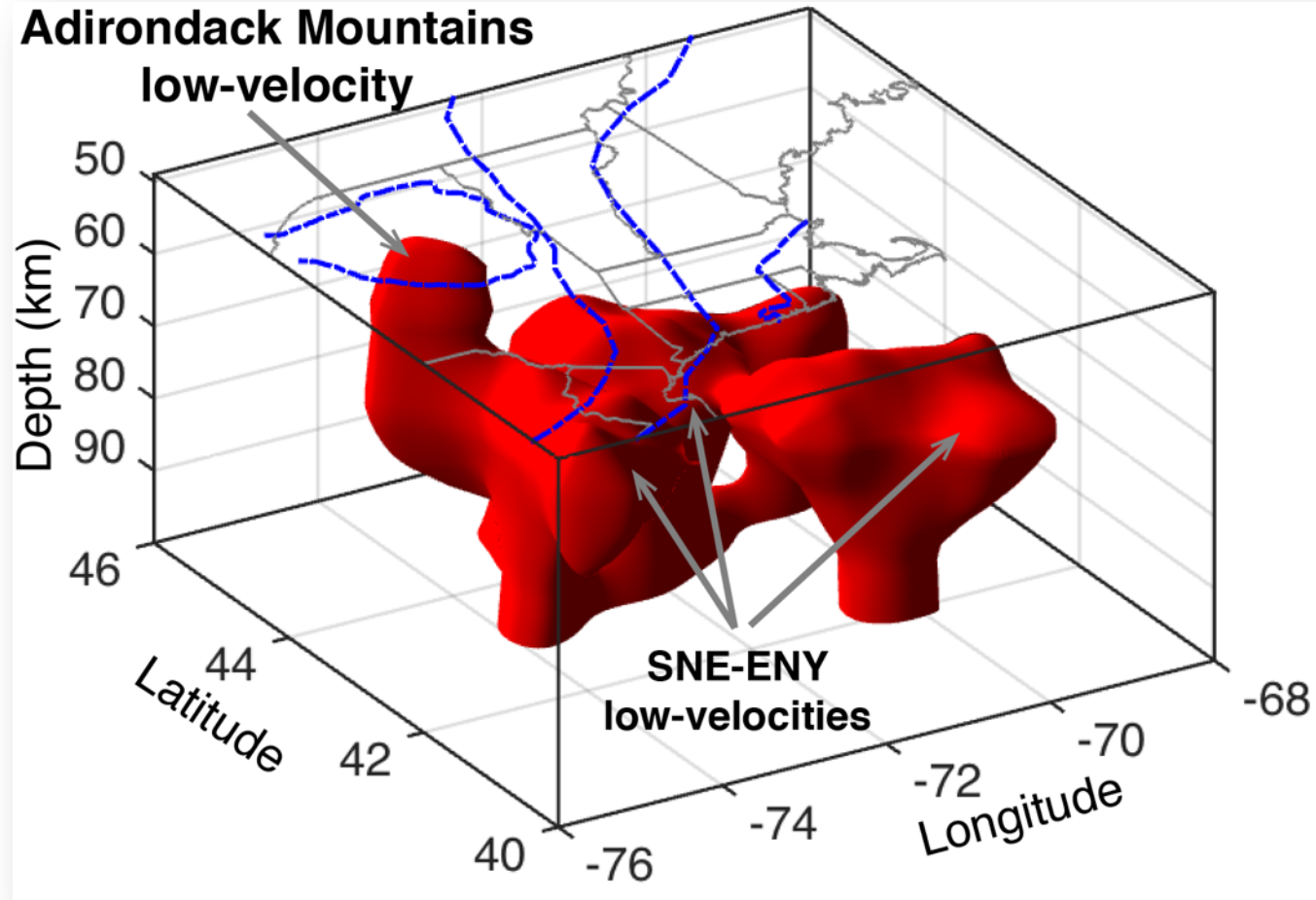


**SNE-ENY: Southern New England – Eastern New York**  
 Moho from *Schmandt et al., 2015*

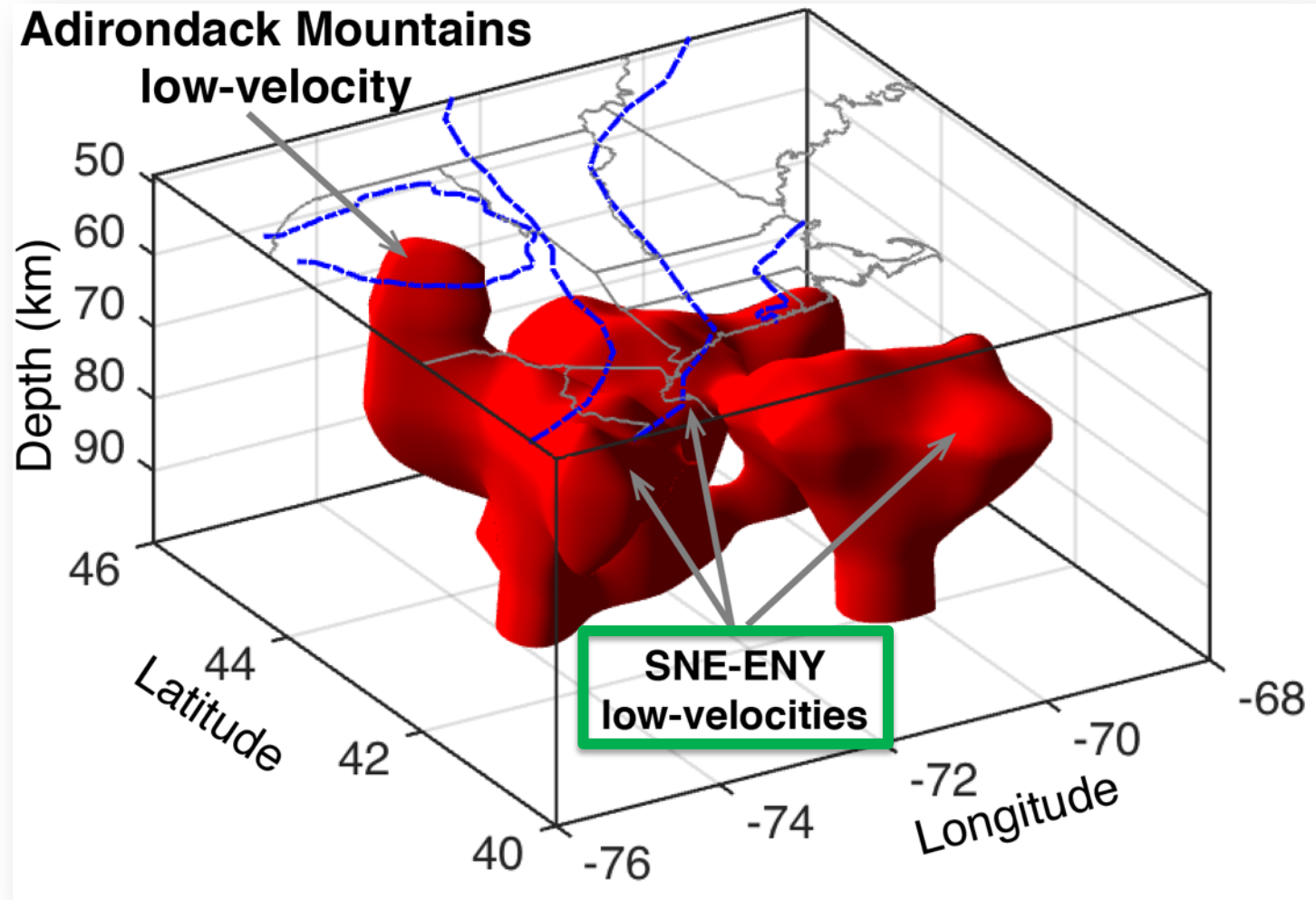


# What are the factors contributing to the observed shear velocity reductions (4% - 8%)?

- 1) Temperature: 2.5%
- 2) Partial melt: 7.9% (1% partial melt)
- 3) Enriched mantle: 2.5%
- 4) Water: 2%

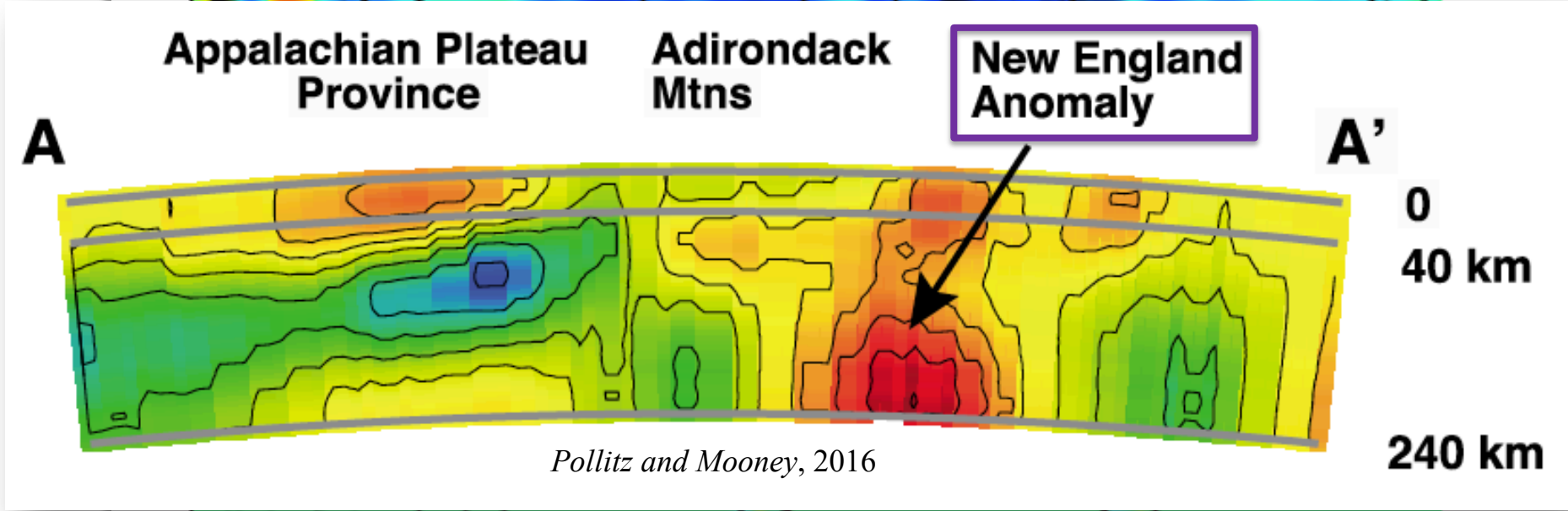
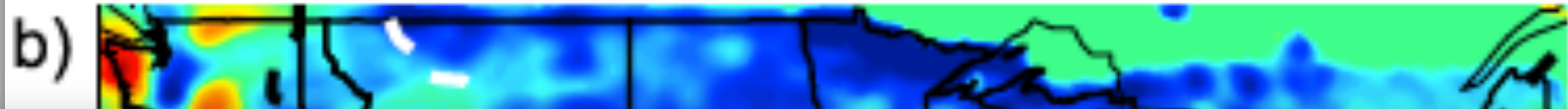


# Low-velocity anomaly beneath SNE-ENY: Hotspot or Asthenospheric upwelling?





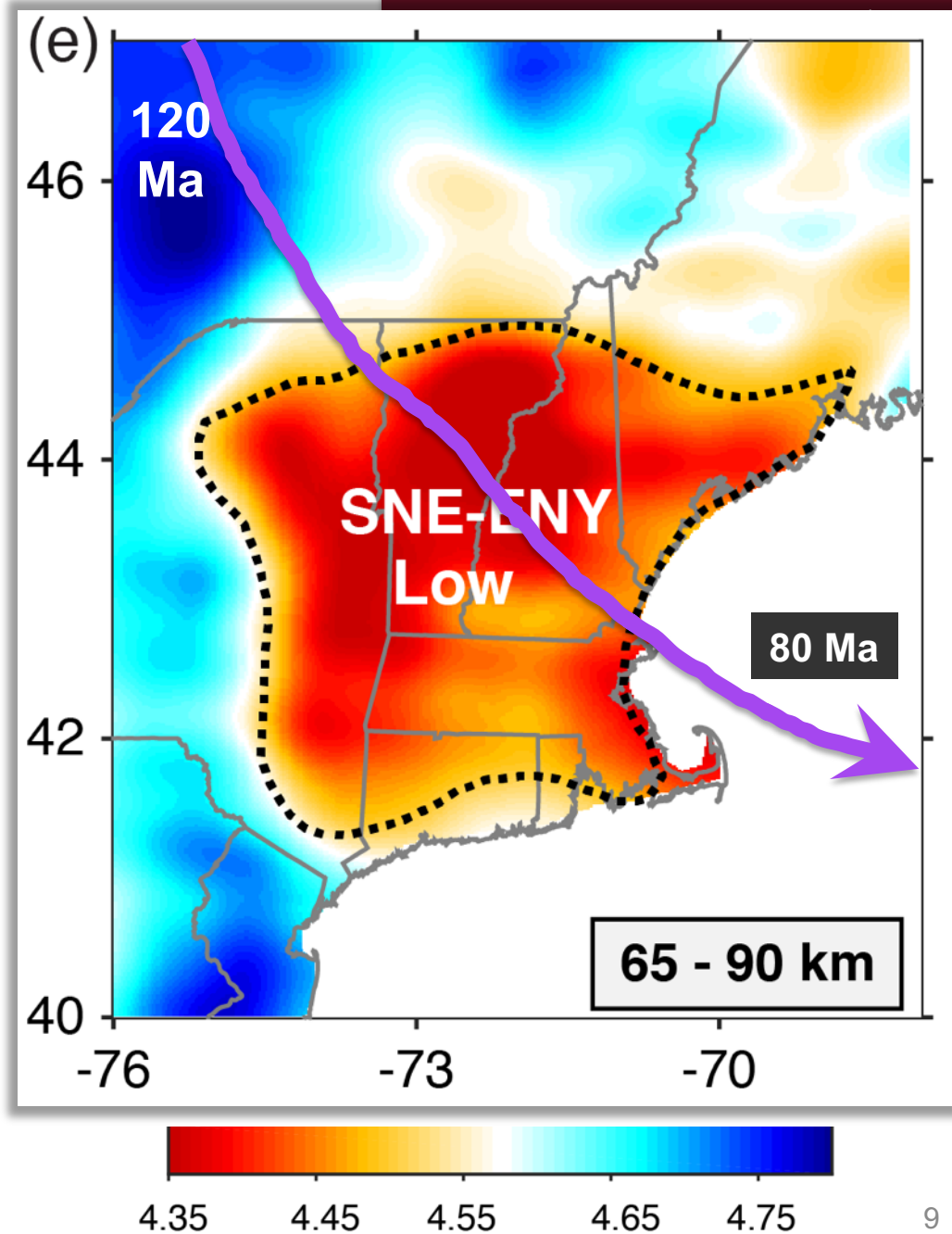
# Northern Appalachian Anomaly



*Schmandt and Lin, 2014*

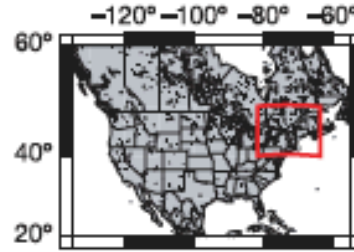
- Hotspot related

## Great Meteor Hotspot Track (120 Ma – 80 Ma)

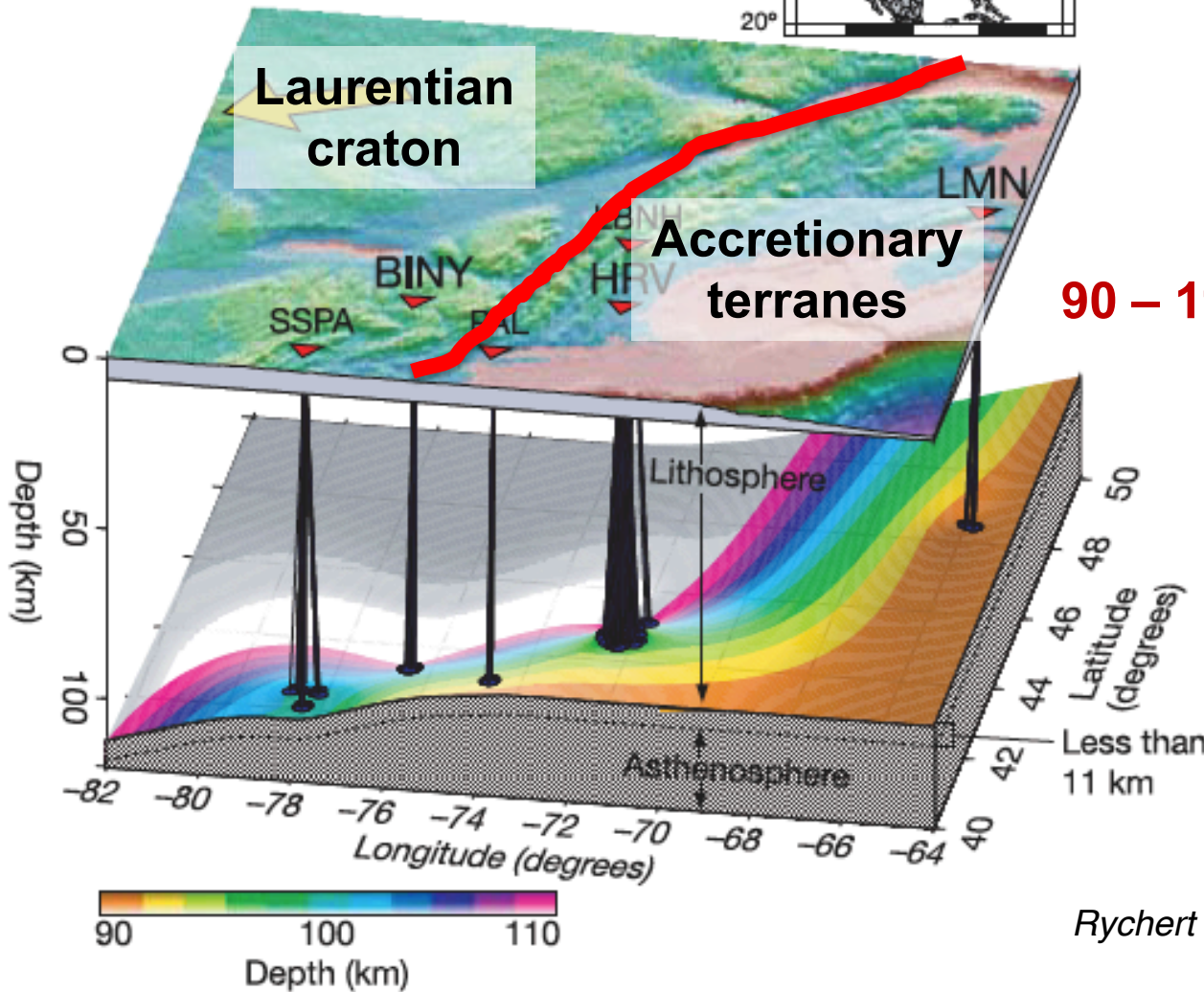


*Heaman and Kjarsgaard, 2000*

**Lithospheric thickness  
150 – 200 km**



- Upwelling due to edge-driven convection



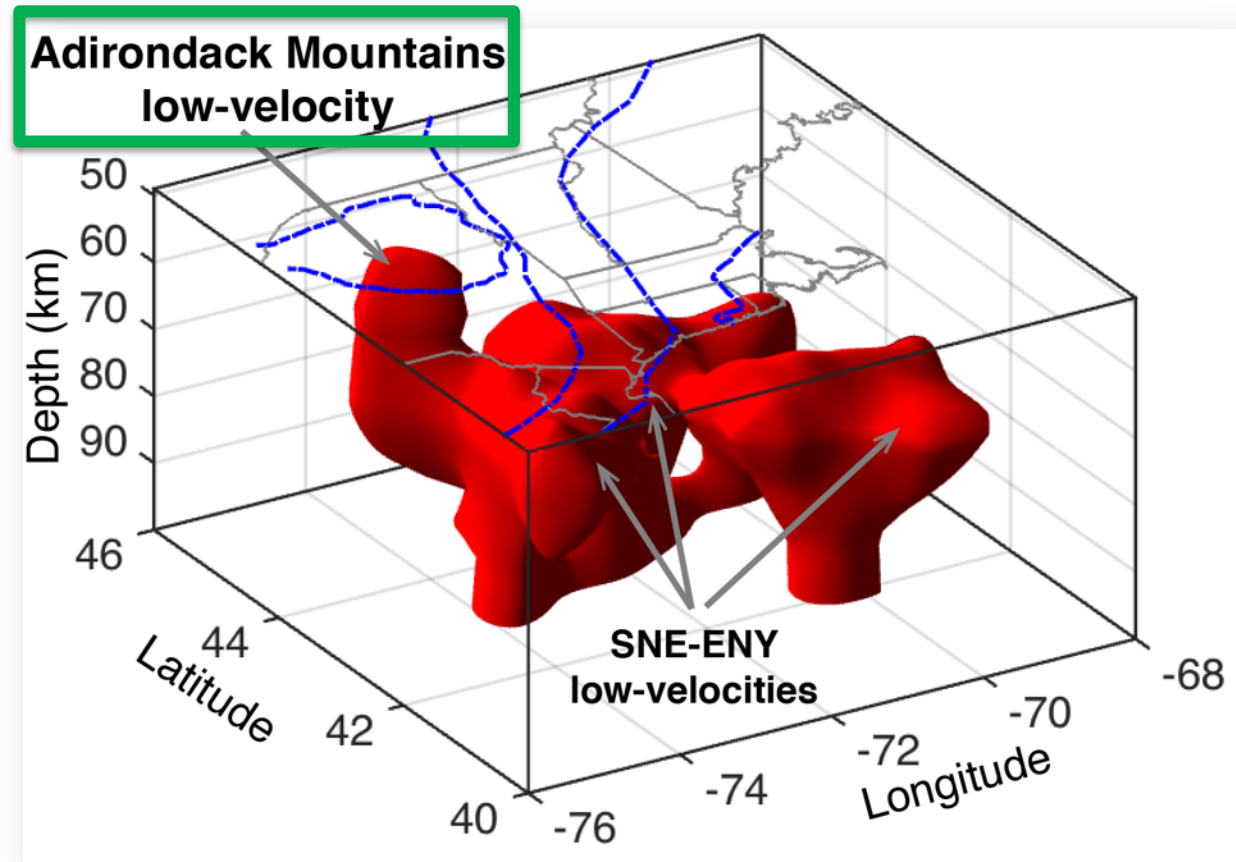
**90 – 110 km**

*Rychert et al., 2005*

# Low velocity beneath the Adirondacks?

## Hypothesis-1

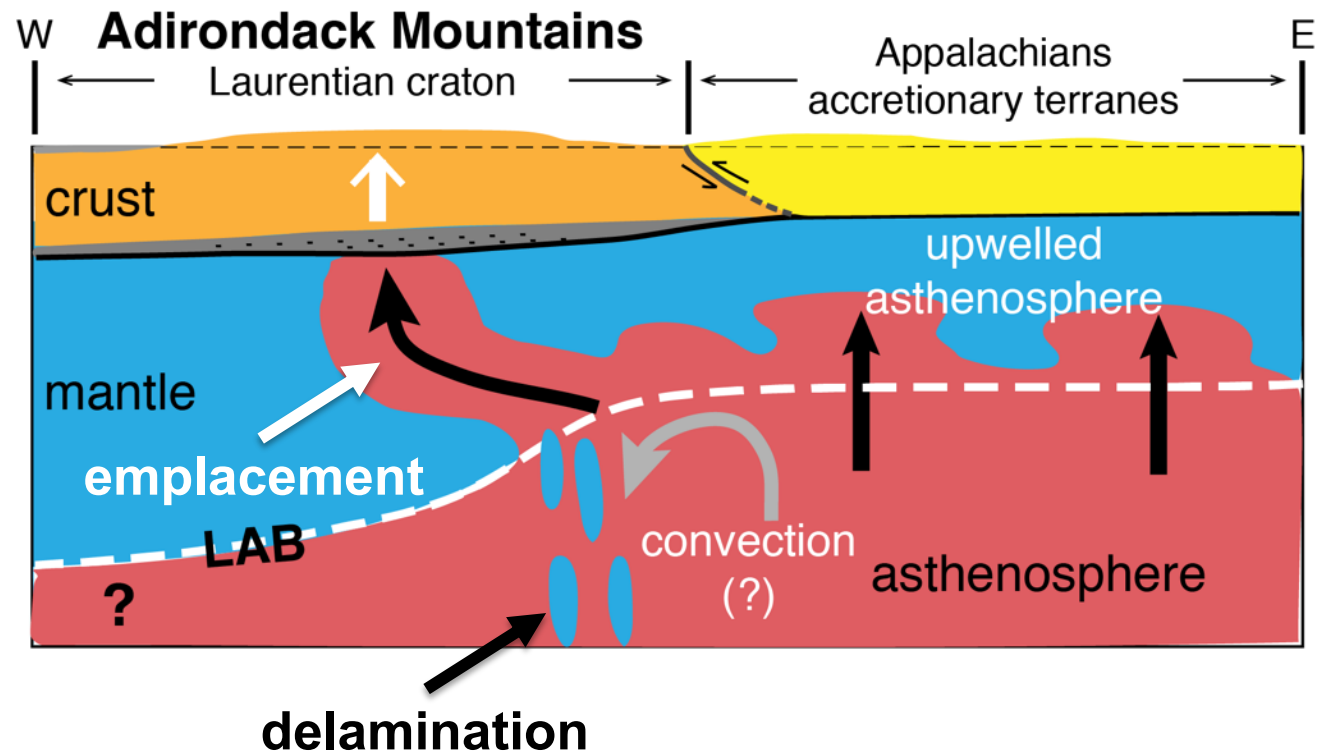
- Lithology



# Low velocity beneath the Adirondacks?

## Hypothesis-1

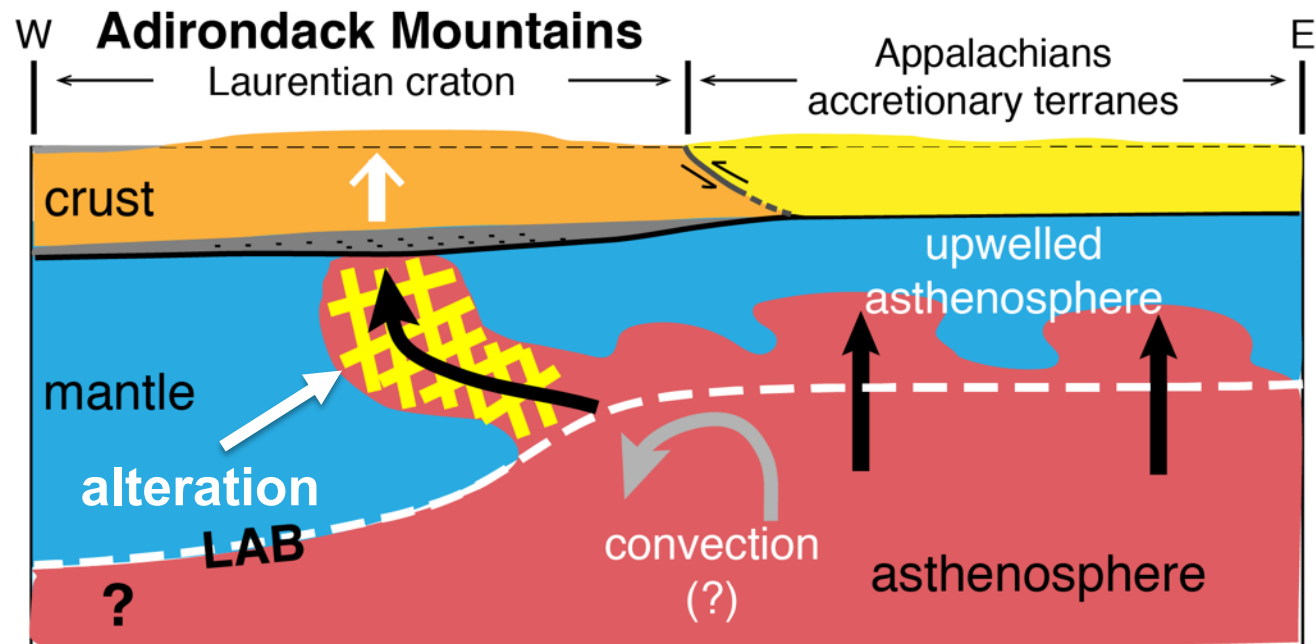
- Lithology
  - Emplaced asthenosphere
- Process
  - Lithospheric delamination



# Low velocity beneath the Adirondacks?

## Hypothesis-2

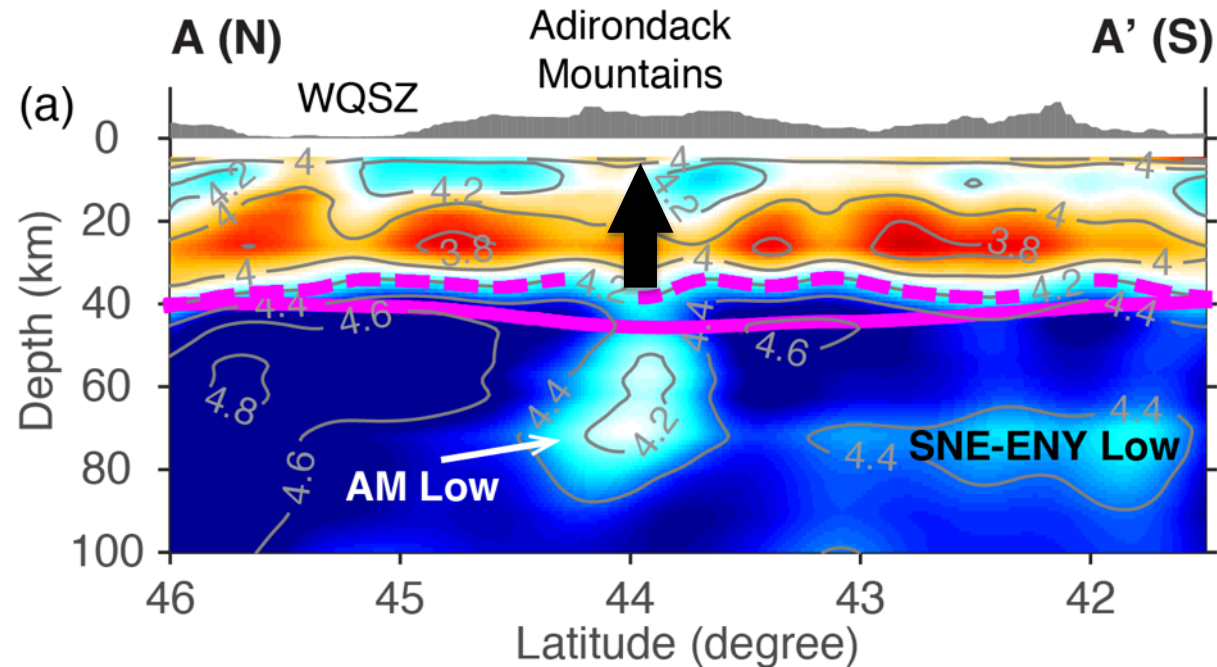
- Lithology
  - Altered mantle lithosphere
- Process
  - Fluid transportation
  - Thermal conduction



# What is the driving force for the Adirondacks uplifting?

## 1) Conditions

- 1 - 1.6 km relief
- 1 – 2 mm/year contemporary uplift
- Thick, underplated lower crust
- Underlain by localized hot, buoyant, partially molten material

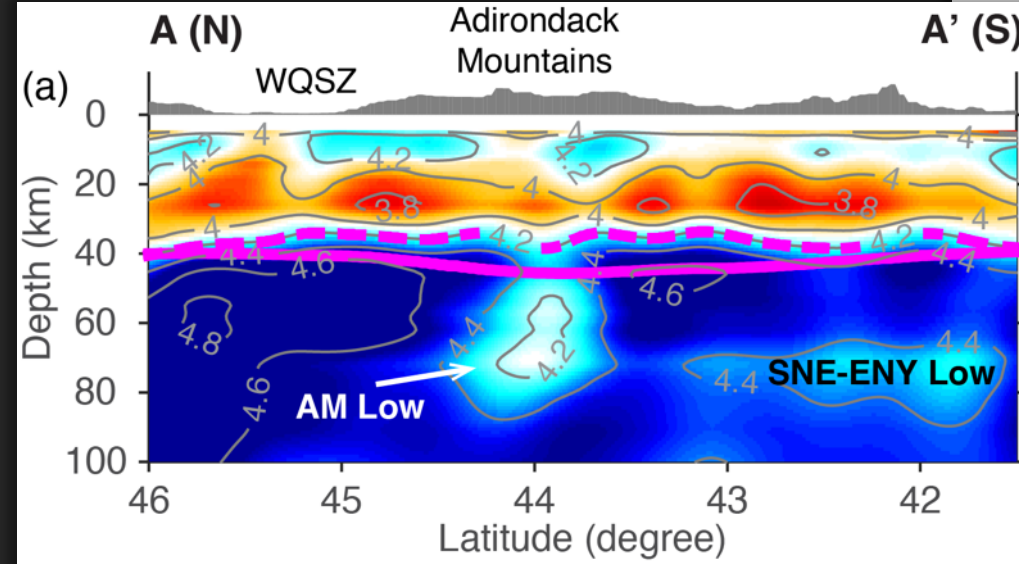
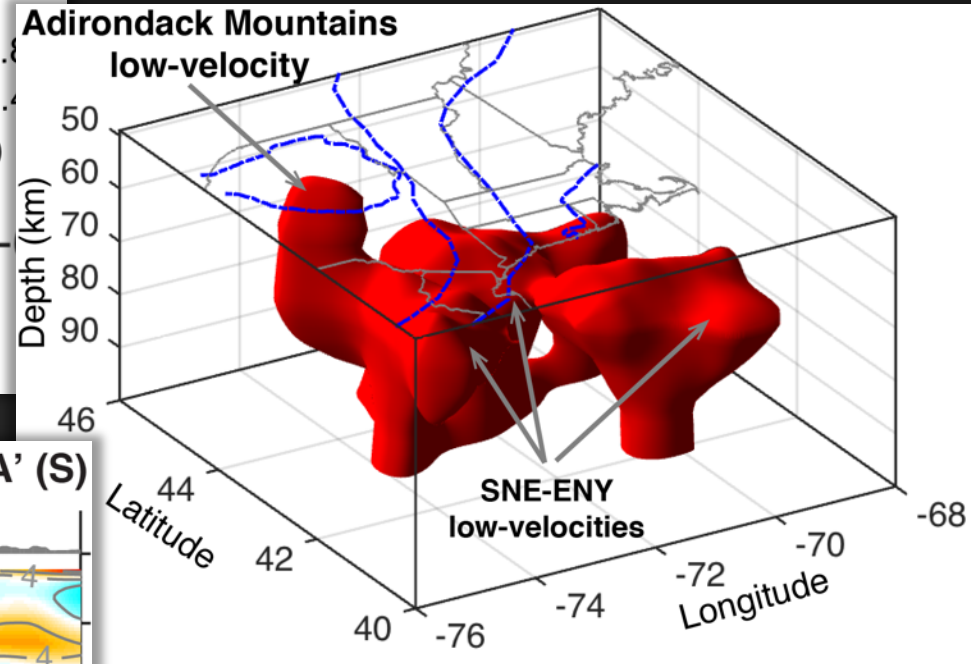
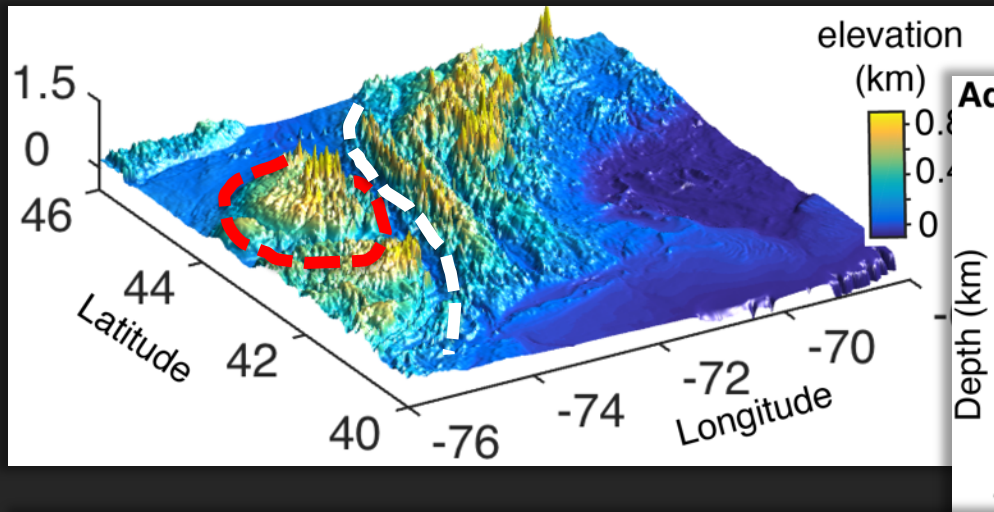


## 2) Mechanisms

- **Buoyancy**
- **Thermal expansion**

# Topographic Relief

# Summary

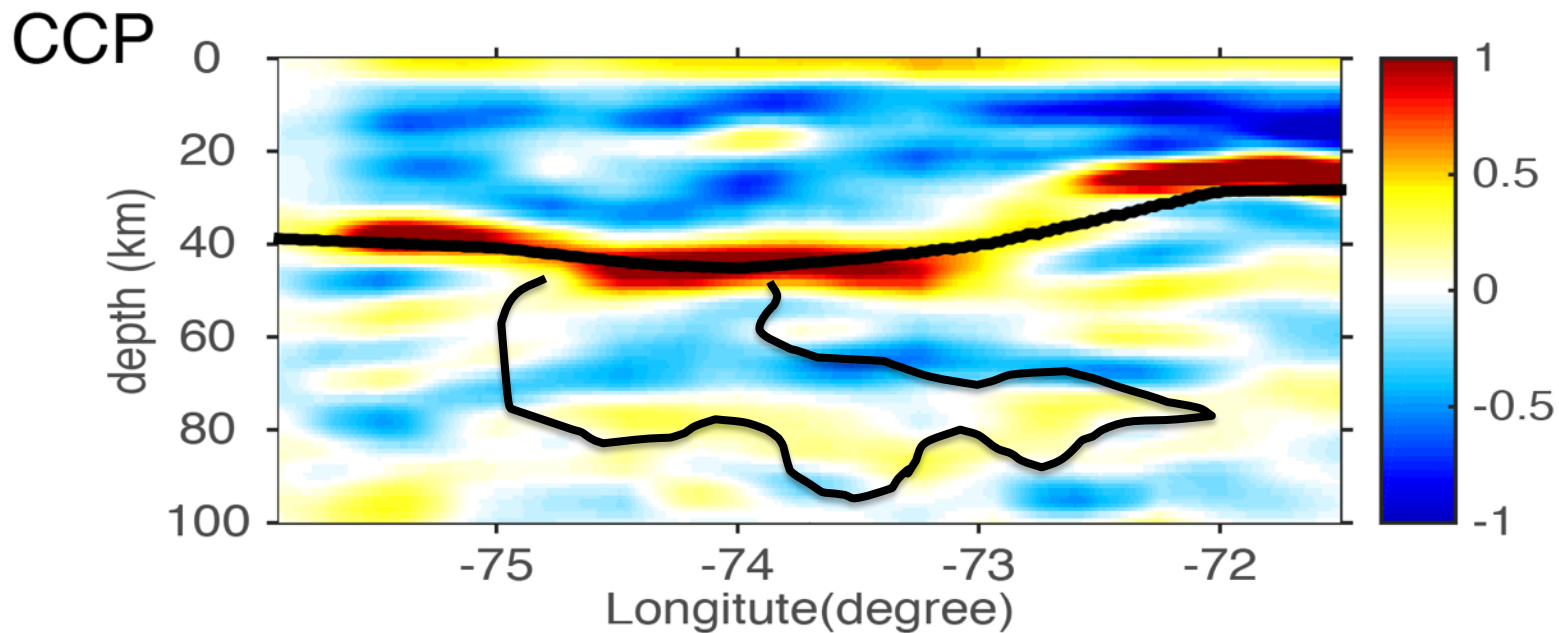
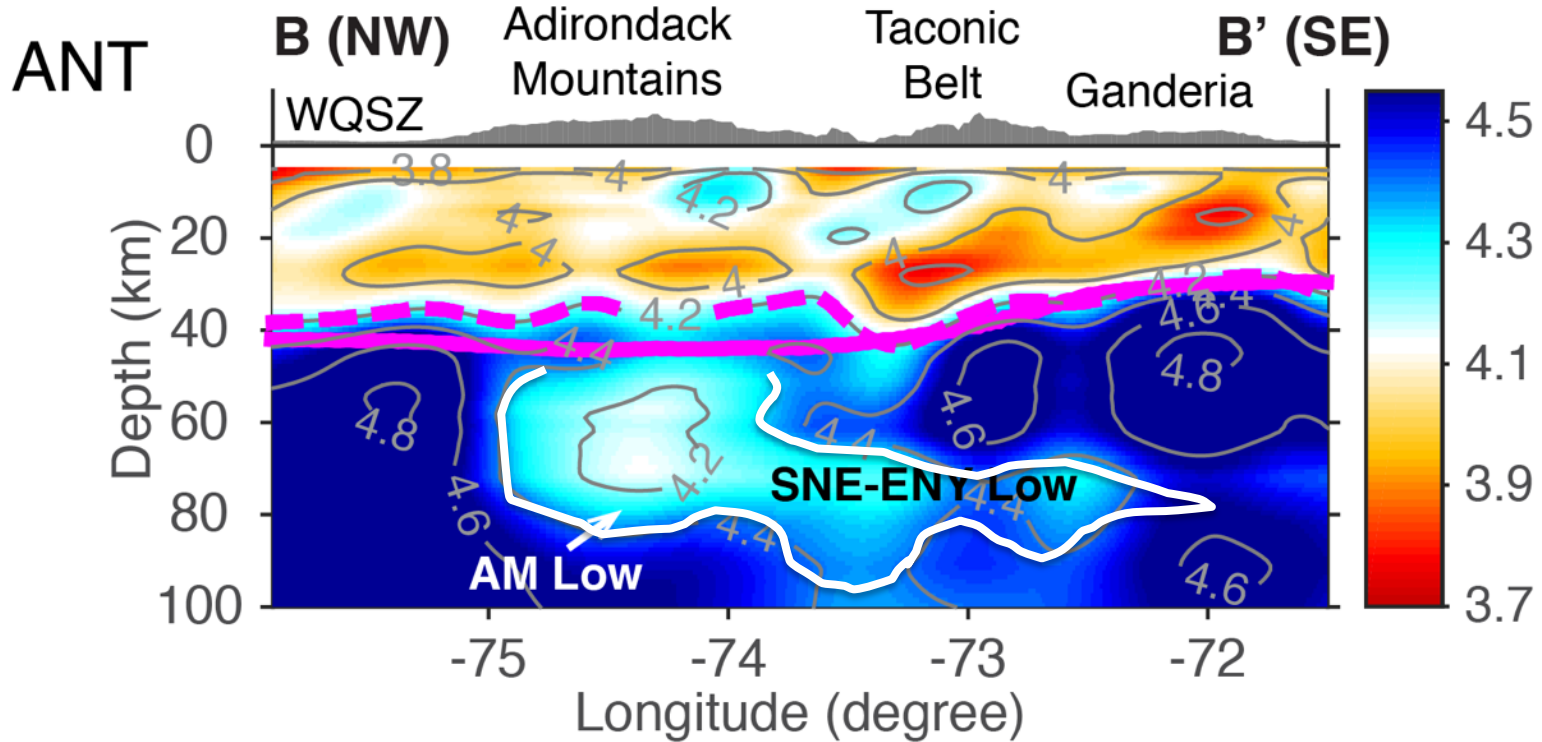


- Uplifting of the Adirondacks**
- Buoyancy
  - Thermal expansion

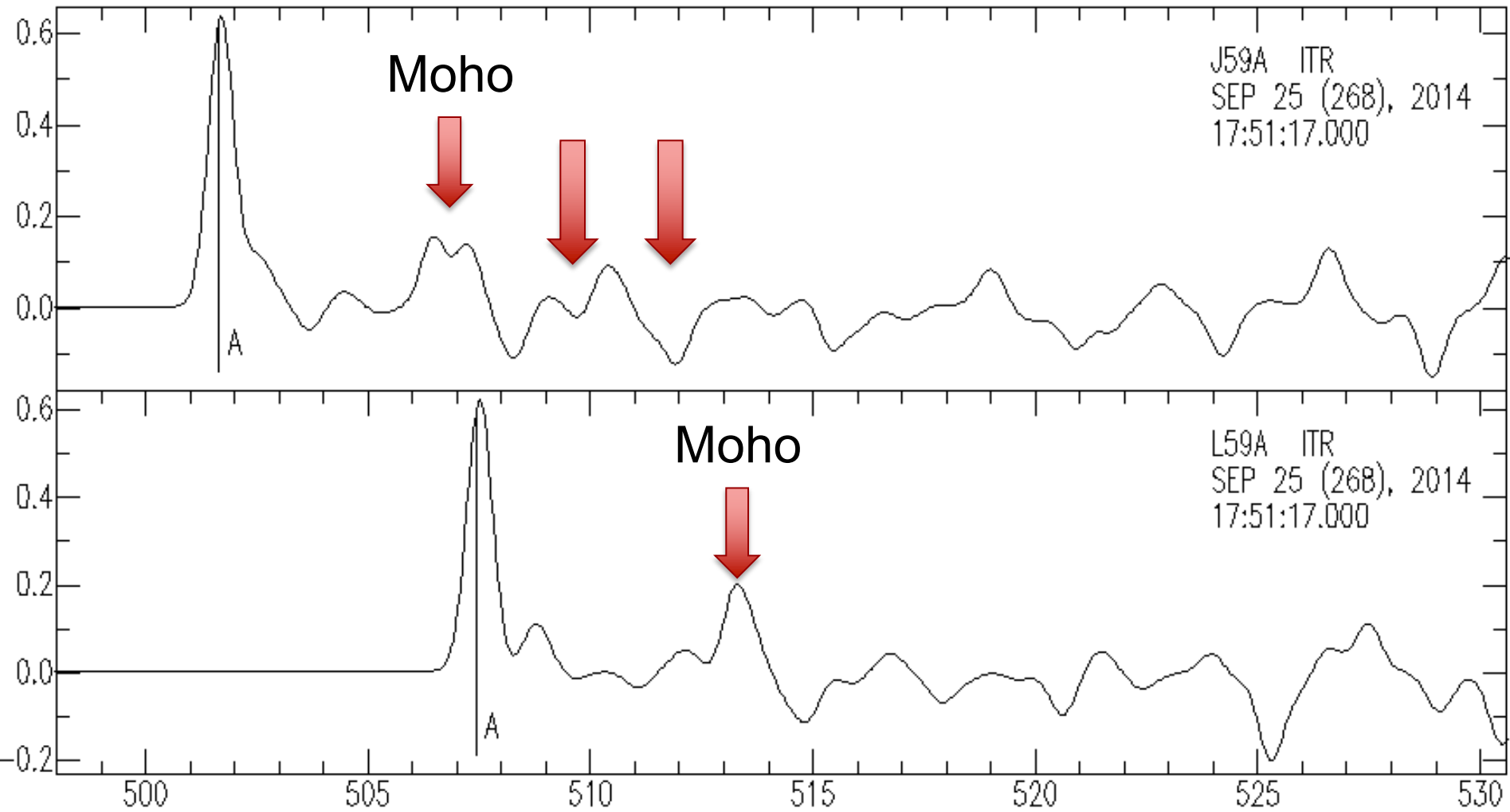


Thank You!

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# Station at the Adirondacks

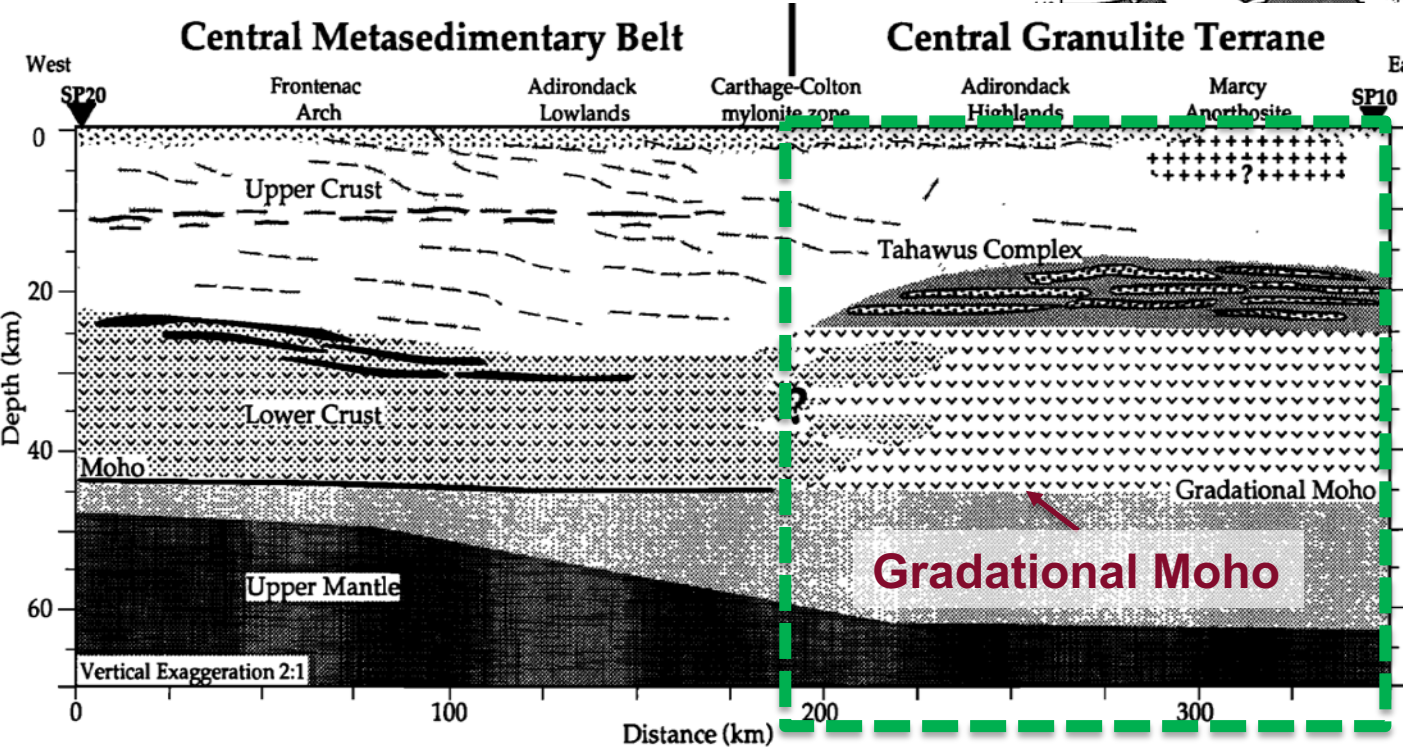
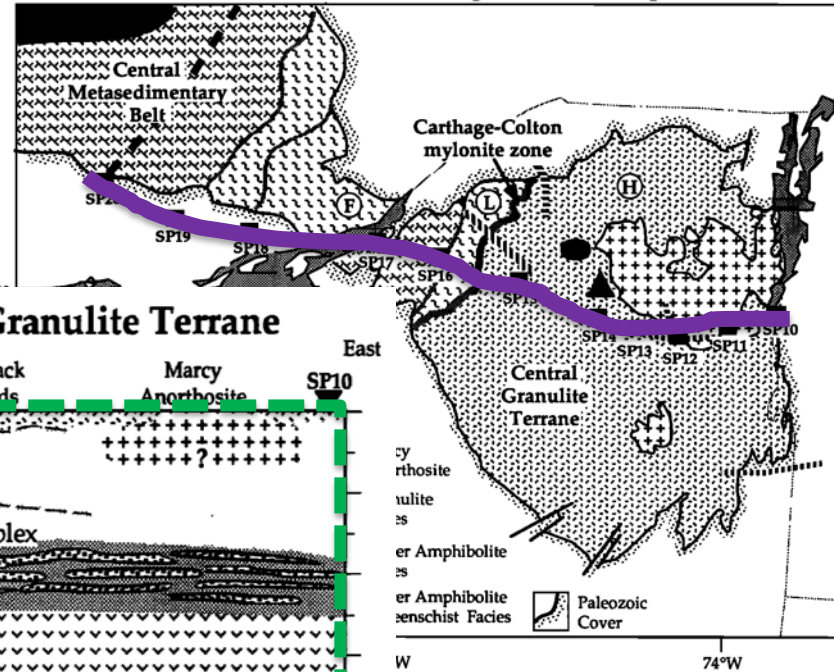


# Station in the craton to the northwest

# Seismological Studies

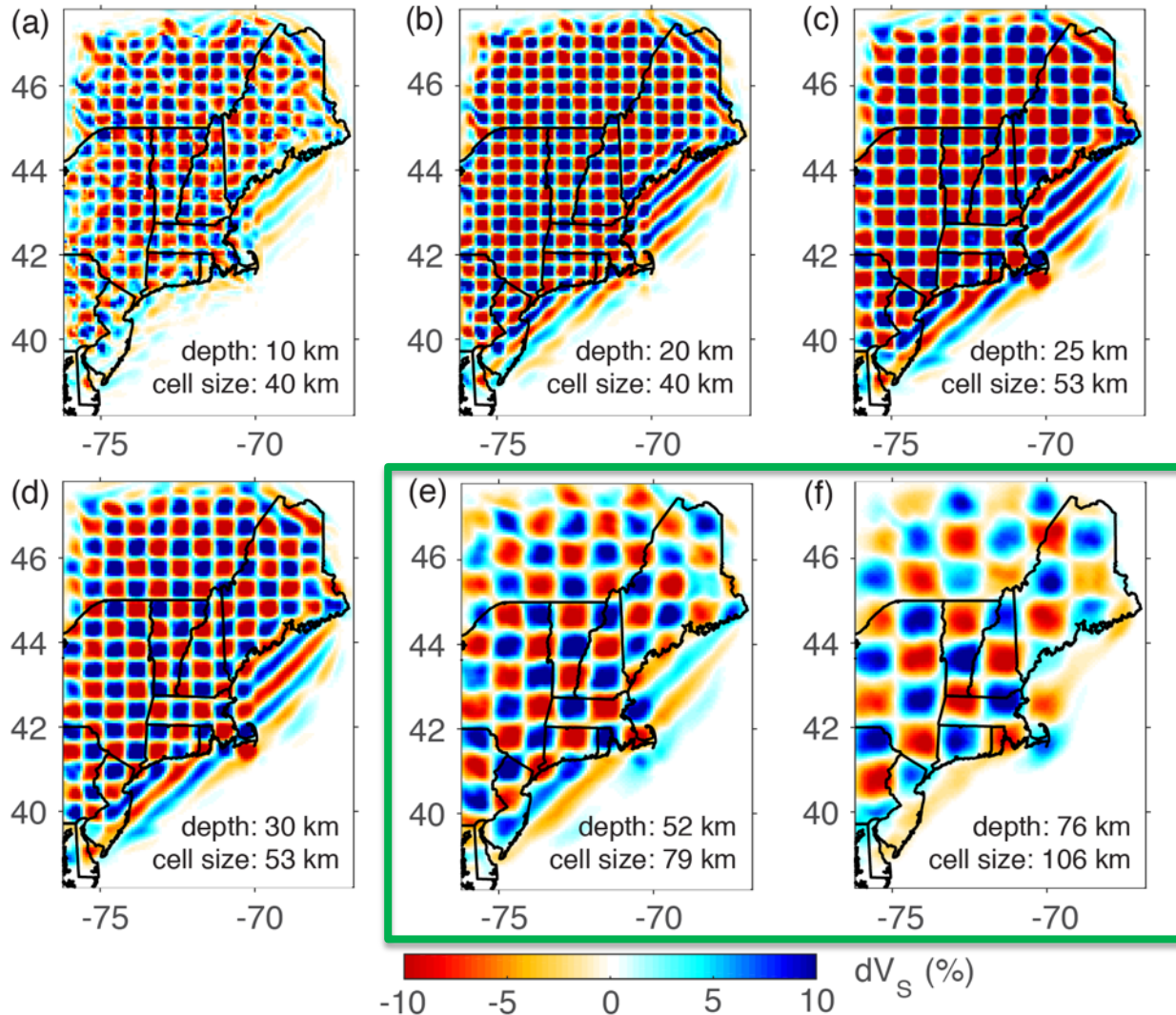
- 2-D seismic reflection and refraction lines

The Ontario-New York-New England Seismic Experiment



Adirondacks

Hughes and Luetgert, 1992



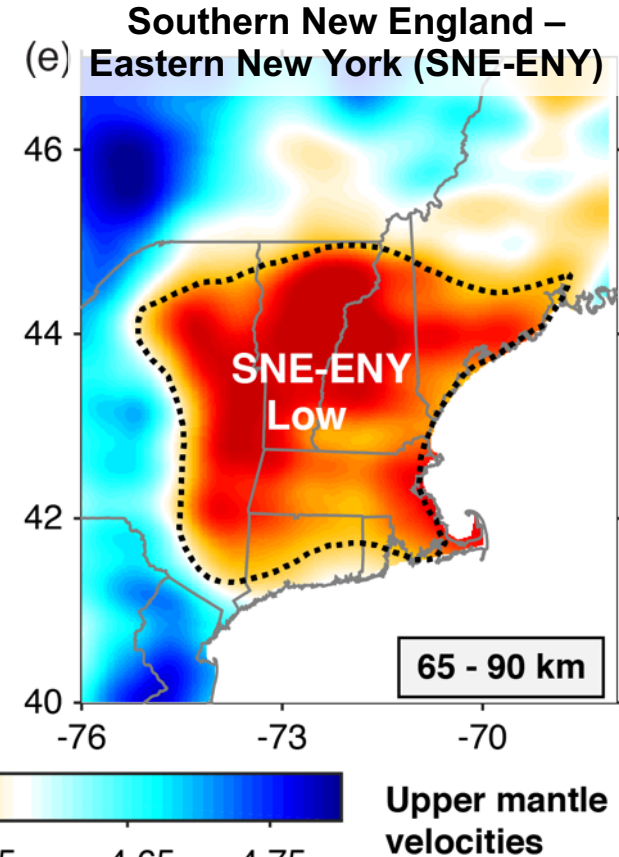
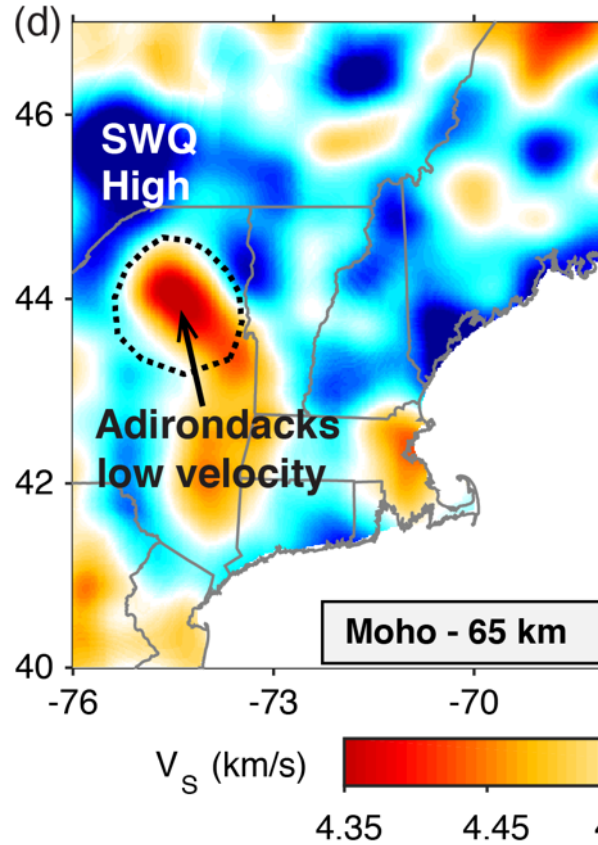
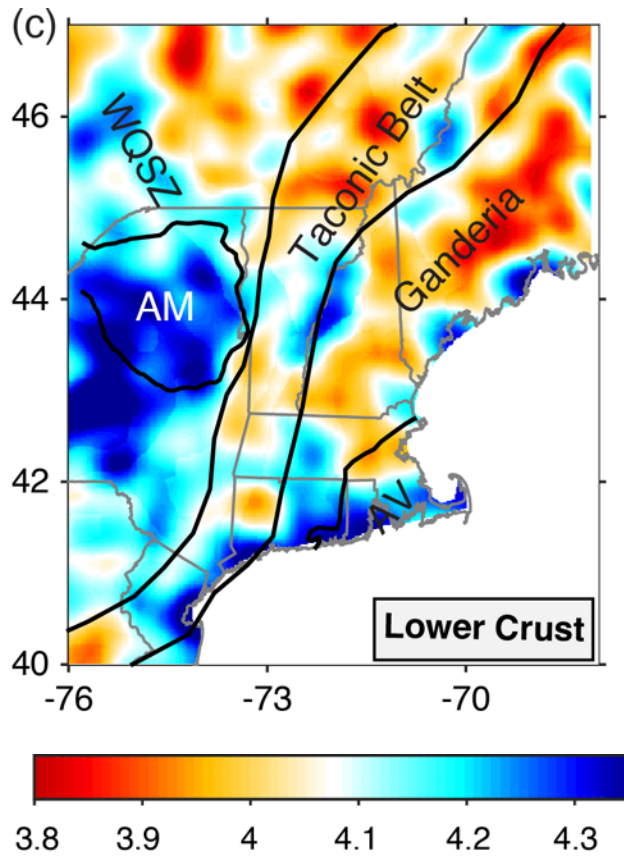
## Resolution

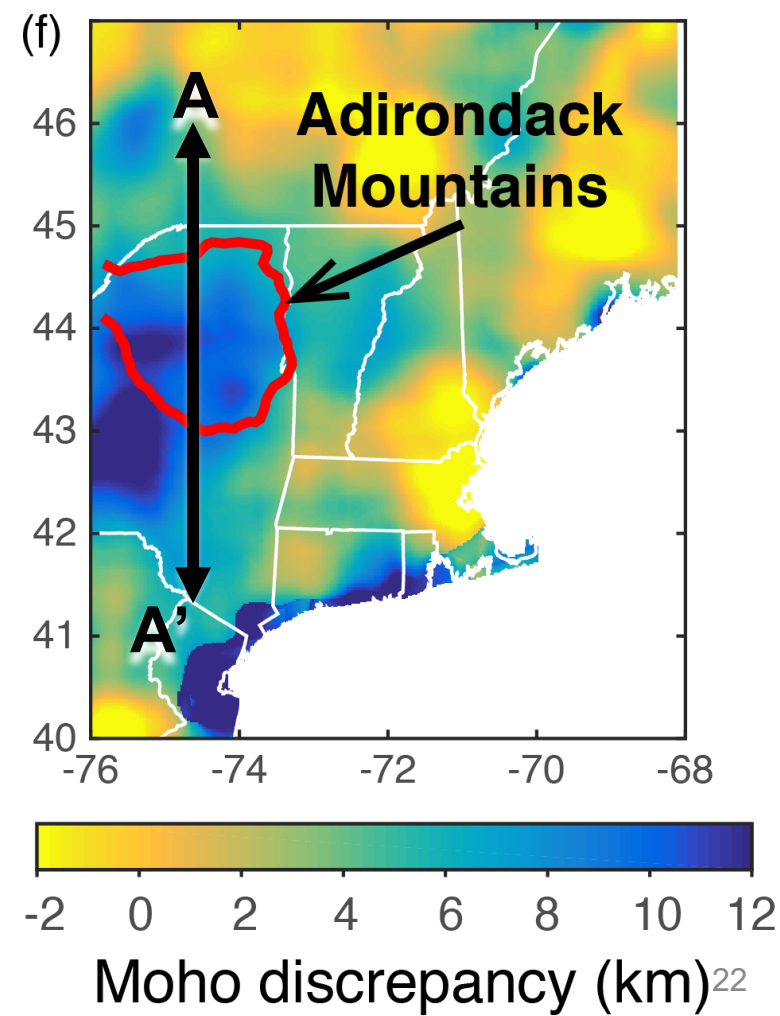
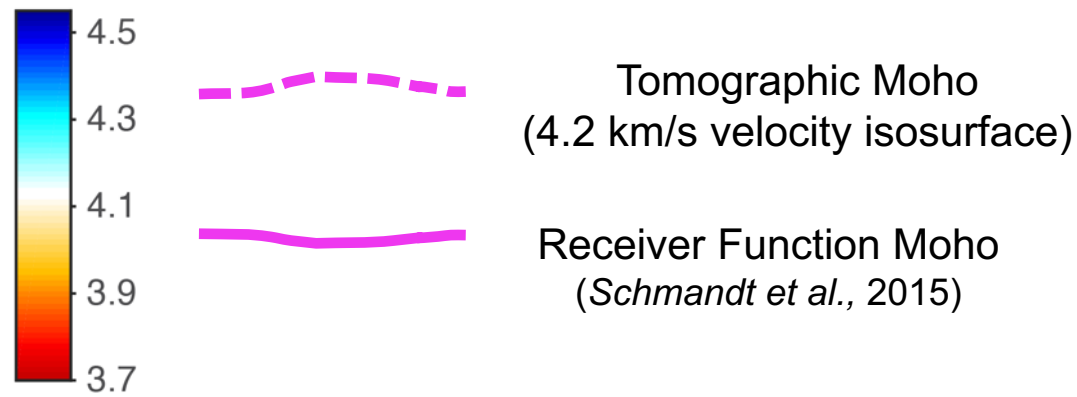
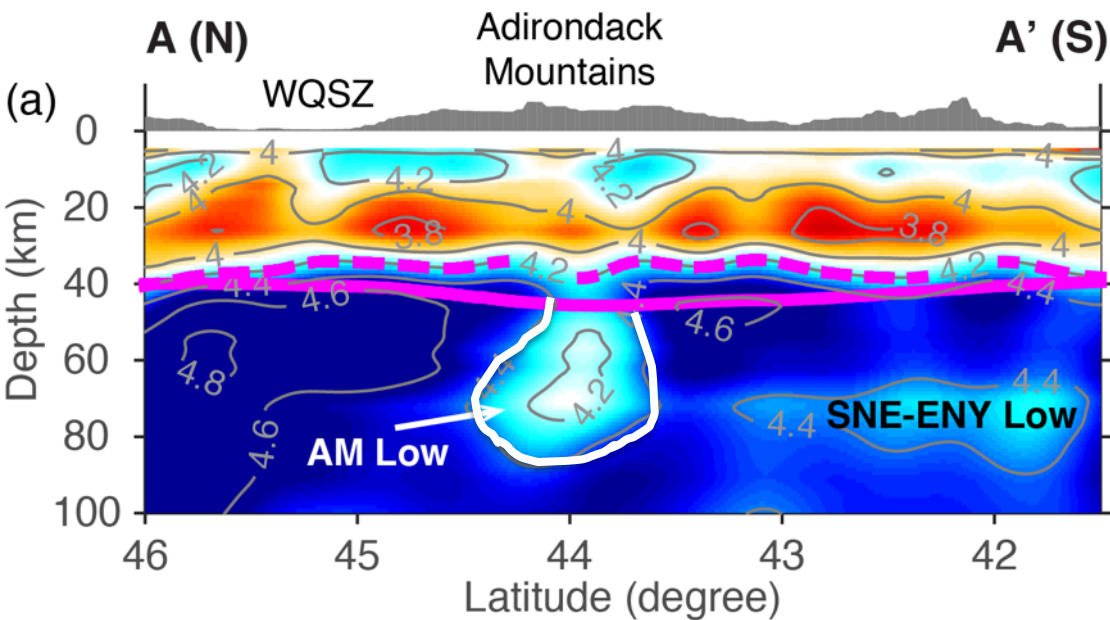
- ~ 8% perturbation, with input perturbation of 10%
- Higher resolution: ~ 20 – 50 km in crust, ~ 60 – 100 km in uppermost mantle

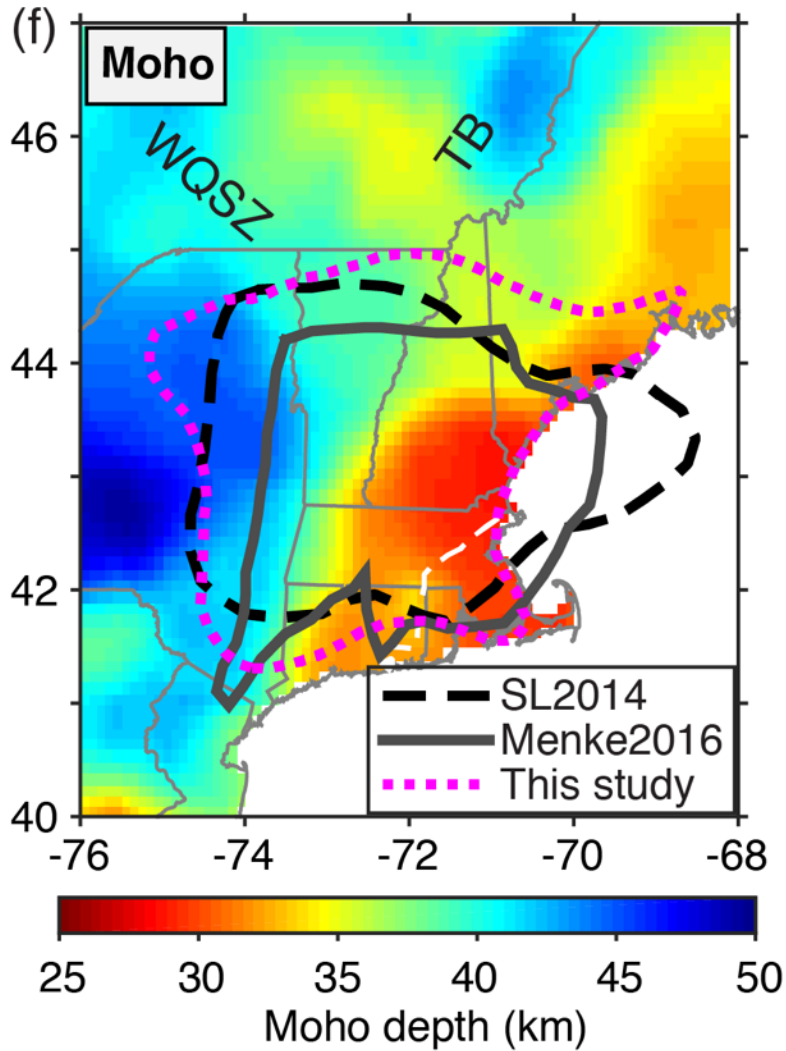
Upper mantle

# Results

- Low-velocity beneath Adirondacks







- Similar outline of the SNE-ENY anomaly with other studies

SL2014: *Schmandt and Lin, 2014*

Menke2016: *Menke et al., 2016*

Moho map from: *Schmandt et al., 2015*

