Natural, biogenic formaldehyde in wood

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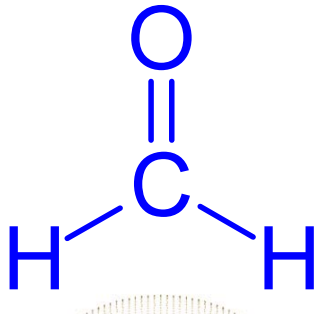
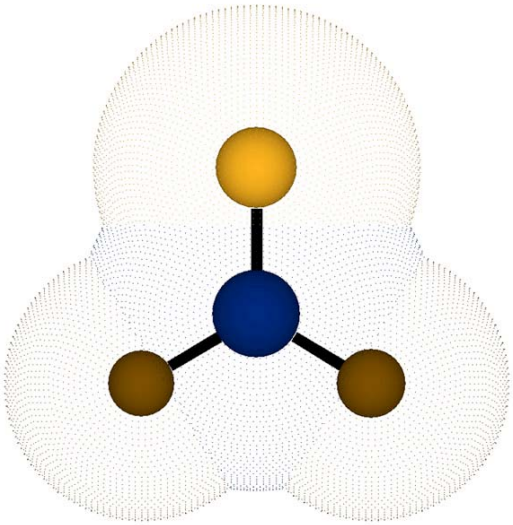




Natural, biogenic formaldehyde

Regarding the natural formaldehyde in wood:

- Humans have known of it since at least 1978.
- Before 2006 (CARB), I had no personal knowledge of it.
- 2009 is when I first became aware of it.

2010 the WBC, I/UCRC was established

Wood-based Composites Center Industry/University Cooperative Research Center

- U.S. National Science Foundation grant:
  I/UCRC at Virginia Tech and Oregon State University.

- Annually, the NSF provided $120,000.

- Annually, industry members provided at least $300,000.

- Industry service in the form of research...
  - Conceived & requested by the industry.
  - Directed by the industry.
  - Conducted by students.

WBC

WBC members requested biogenic formaldehyde (CH_2O) research

September 2010:

- WBC members initiated biogenic CH_2O research with $21,500.

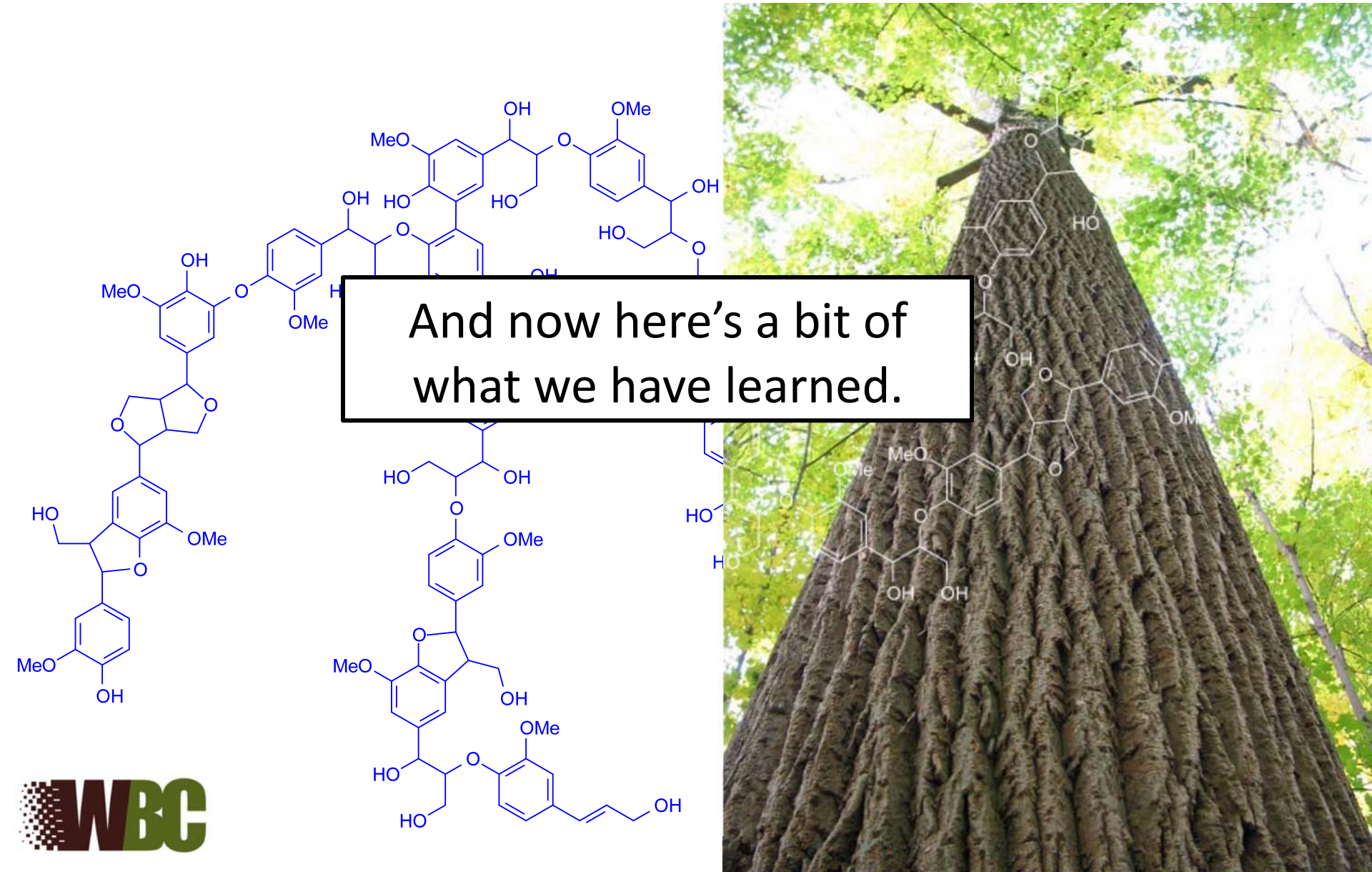
August 2011:

- NSF granted Virginia Tech $200,000 to study wood-generated CH_2O.

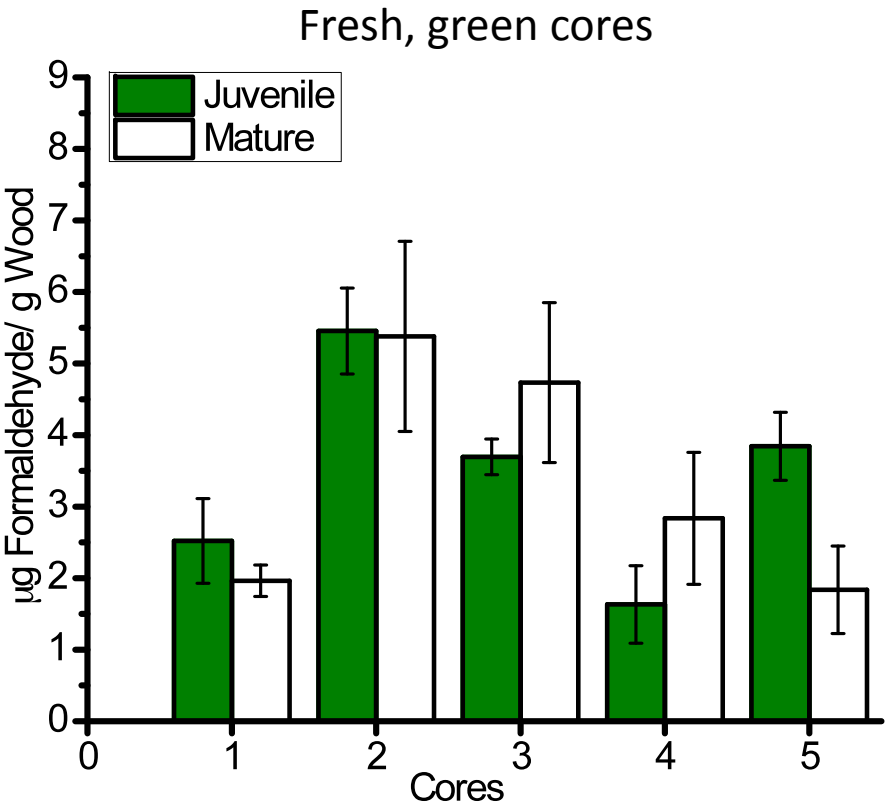
As of April 2016:

- WBC industry members have spent $334,424 on biogenic CH_2O.

Natural, biogenic formaldehyde

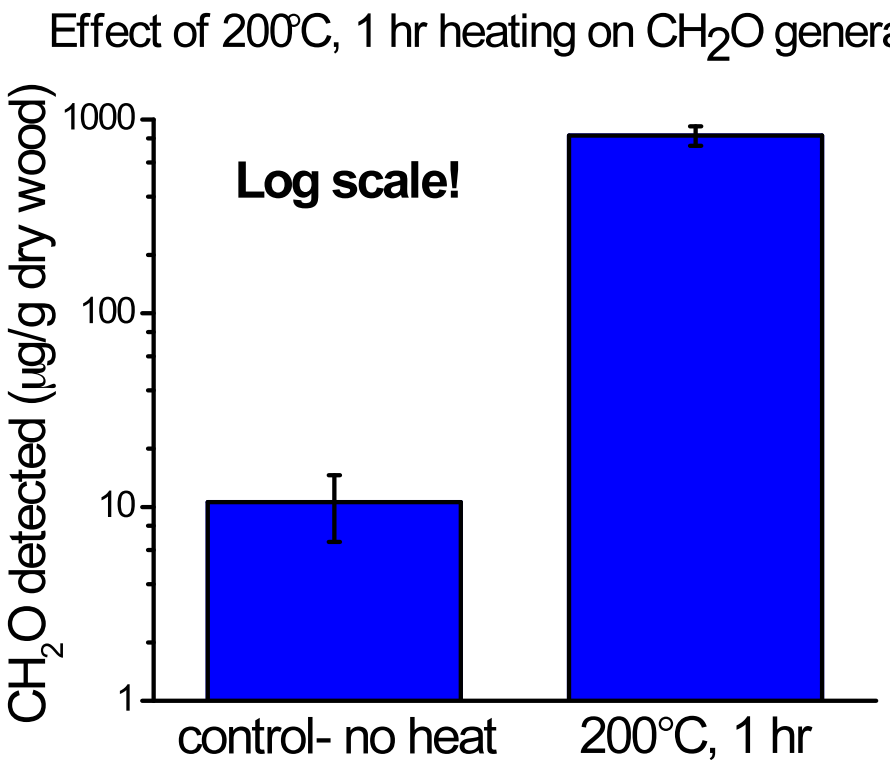


Living trees contain CH_2O



60 yr old Virginia pine (*Pinus virginiana*)
Juvenile: 1st 8 rings, Mature: last 12 rings

Heat generates much more CH_2O



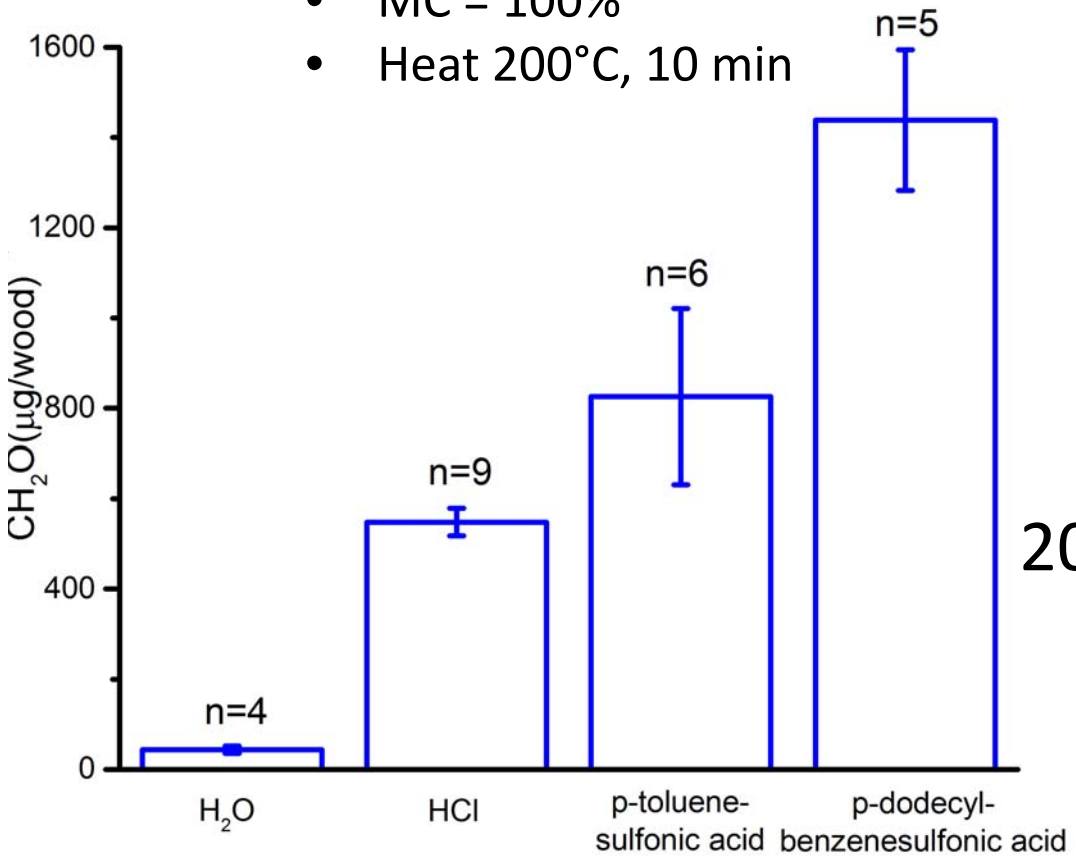
150°C (302°F)

200°C (392°F)

Effect of heating Virginia pine wood.

Acids catalyze CH_2O generation

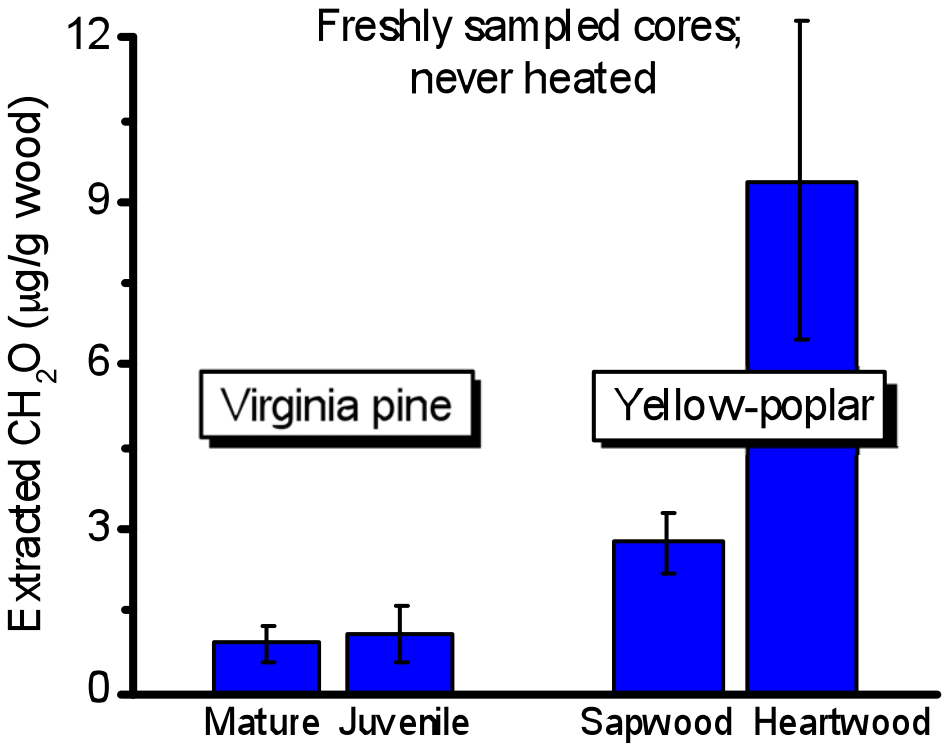
- 10mmol acid
- MC = 100%
- Heat 200°C, 10 min



200°C = 392°F

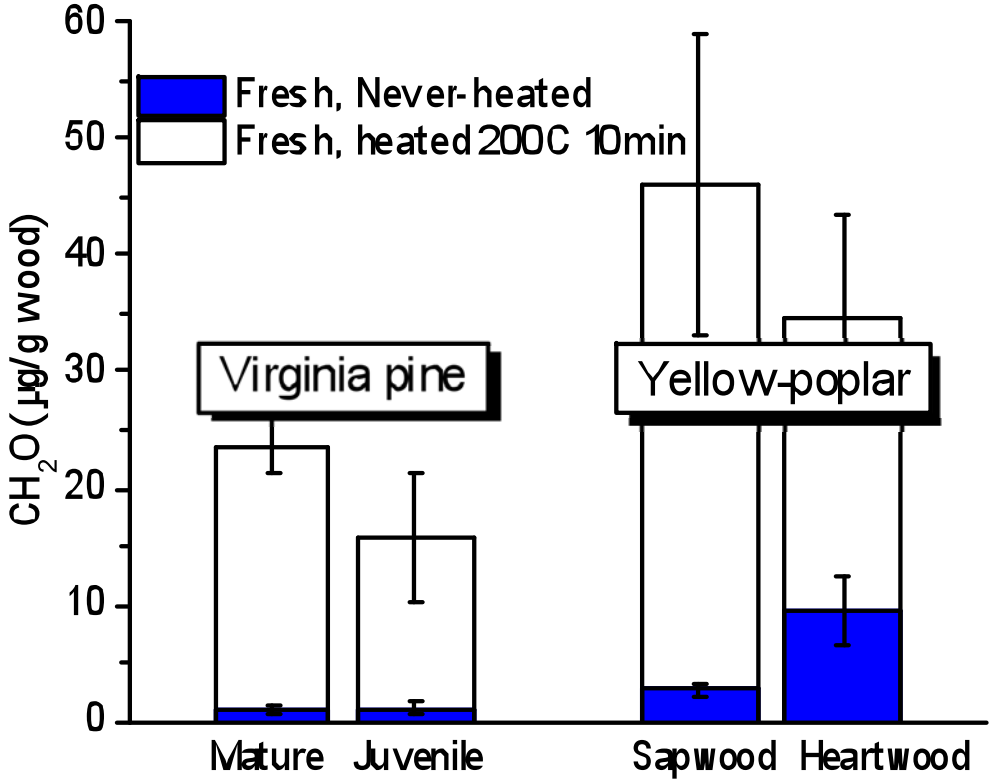
Effect of heating Virginia pine wood with and without acid catalysis.

Tree species has a big effect



CH_2O in fresh, green cores;
never heated

Heat generates more CH_2O; but the effects of heat vary by species



CH_2O in fresh, green cores and then heated at 200°C, 10 min.

200°C = 392°F

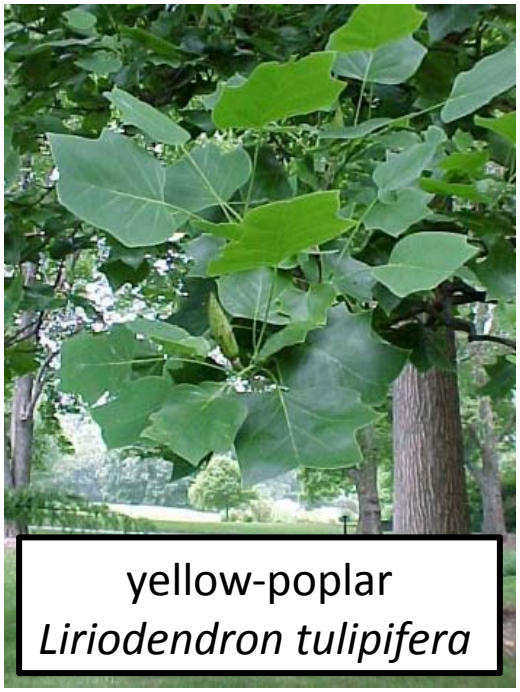
How much formaldehyde?

No catalysis:

- 0.5 - 1g CH_2O/kg wood, or
- 1 - 2 lb CH_2O/ton wood

Tree species studied to date…

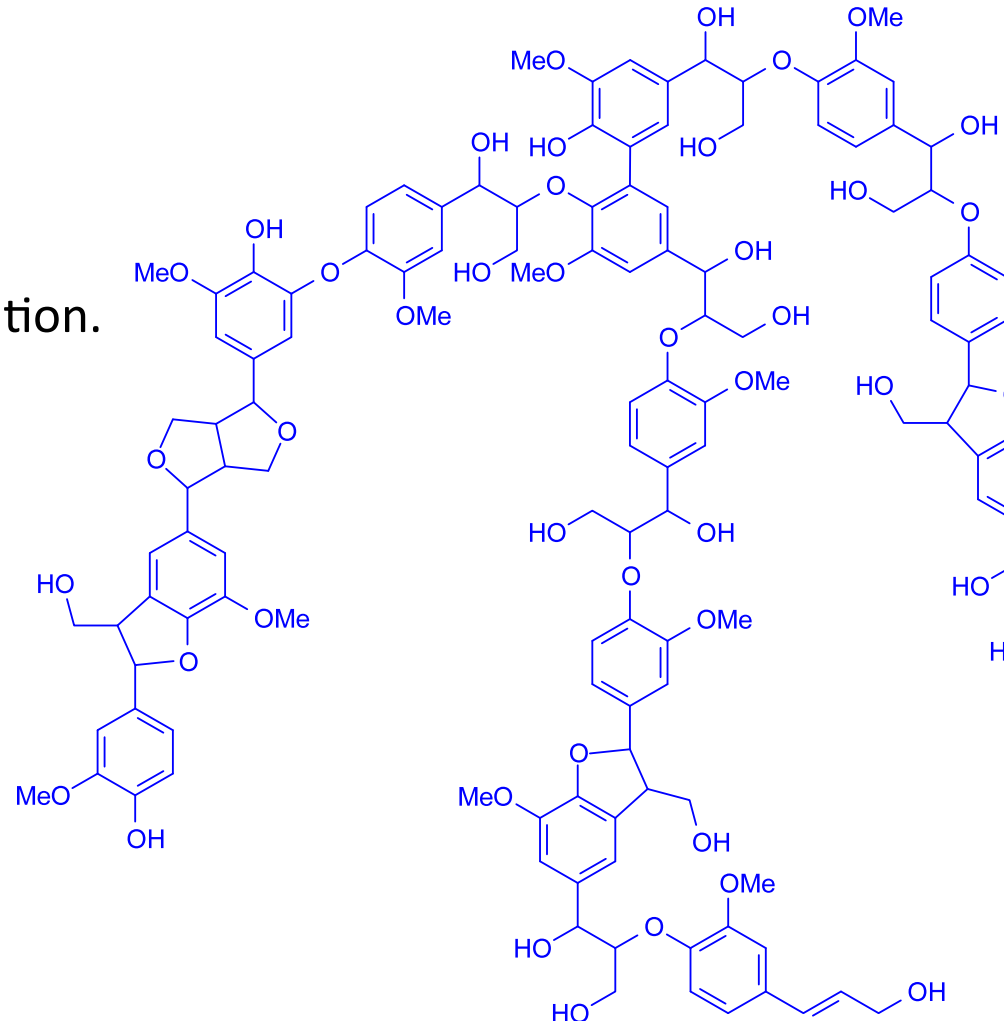
- Virginia pine
  Pinus virginiana
- Radiata pine
  Pinus radiata
- Yellow-poplar
  Liriodendron tulipifera



What creates biogenic CH_2O in wood?

A major objective has been to understand the chemical mechanism so that we might devise a way to control it.

1. Cellulose has a minor contribution.
2. Hemicellulose has a minor contribution.
3. Lignin has a major contribution.
4. Extractives play a complex role.



Understand this!

- We have not measured emissions!
- We measure what is generated within the wood.
- All CH_2O we measure is free to emit...
  as a function of wood moisture content.
- Dry wood tends to retain CH_2O.
- Wet wood releases CH_2O.

Accomplishments

- Devised (practical?) recommendations for our members.
- Learned to control the chemical mechanism to a degree.
- Started a systematic data base.
- Raised technological and scientific impact of the Center.

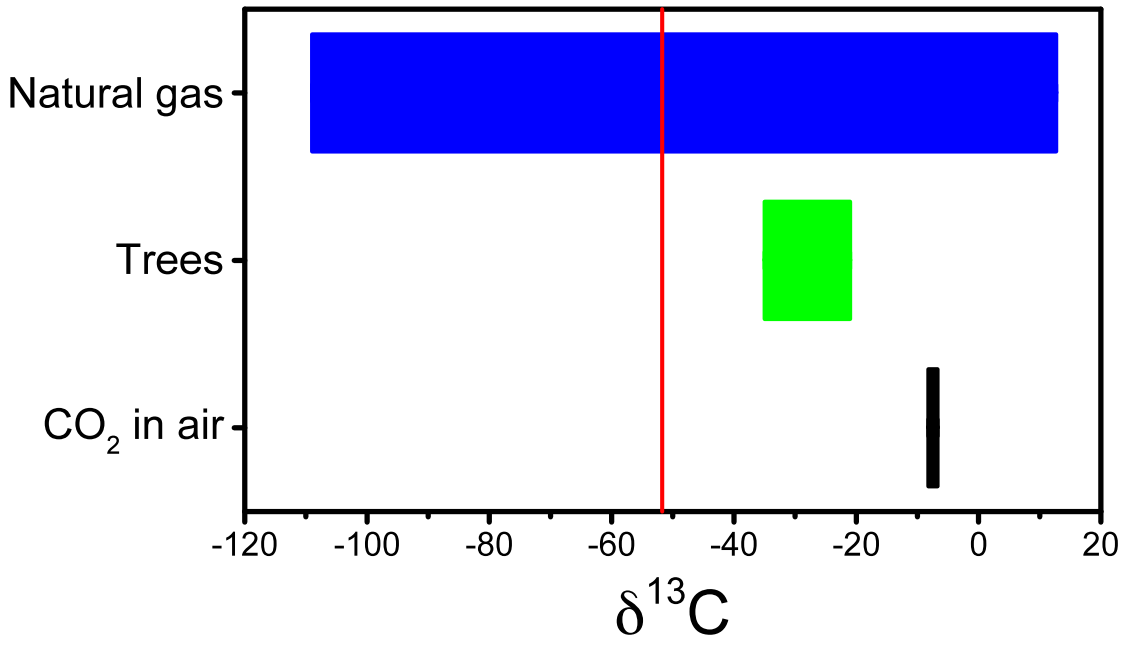
What's next?

- Document more tree species.
- When CH_2O is emitted from a product,
  how much is synthetic and how much is biogenic?
  - Carbon isotope ratios make this possible.

How much is synthetic and how much is biogenic?

Carbon isotope ratio: $^{13}C/^{12}C$

$$\delta^{13}C = \frac{(^{13}C/^{12}C)_{sample} - (^{13}C/^{12}C)_{PDB}}{(^{13}C/^{12}C)_{PDB}} \times 1000$$



Acknowledgements

Acknowledgements

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