Effects of elevated tropospheric ozone concentrations on loblolly pine decline

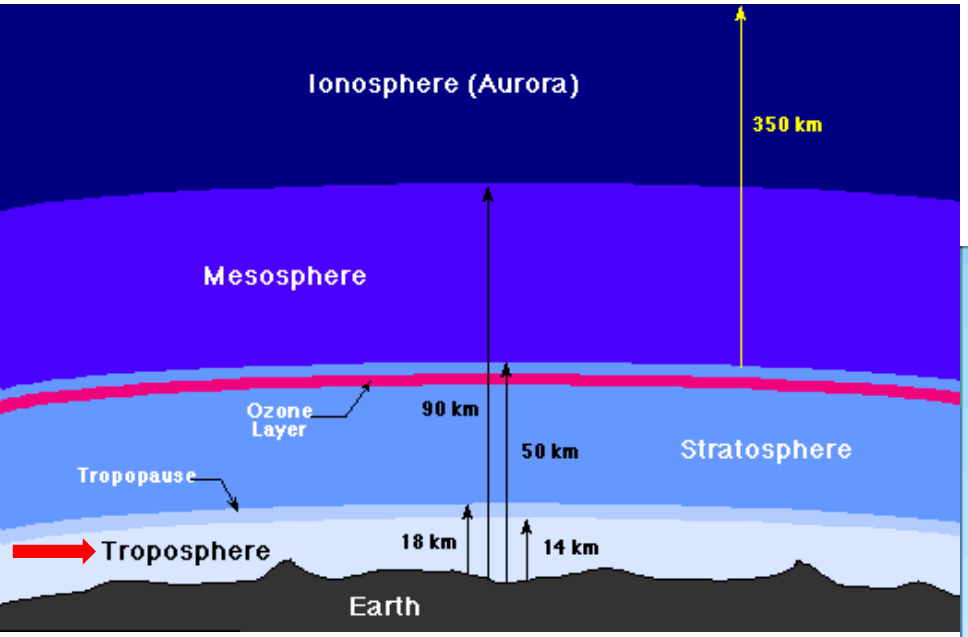
Jeff Chieppa[1,2], Arthur Chappelka[1], Lori Eckhardt[1,2]

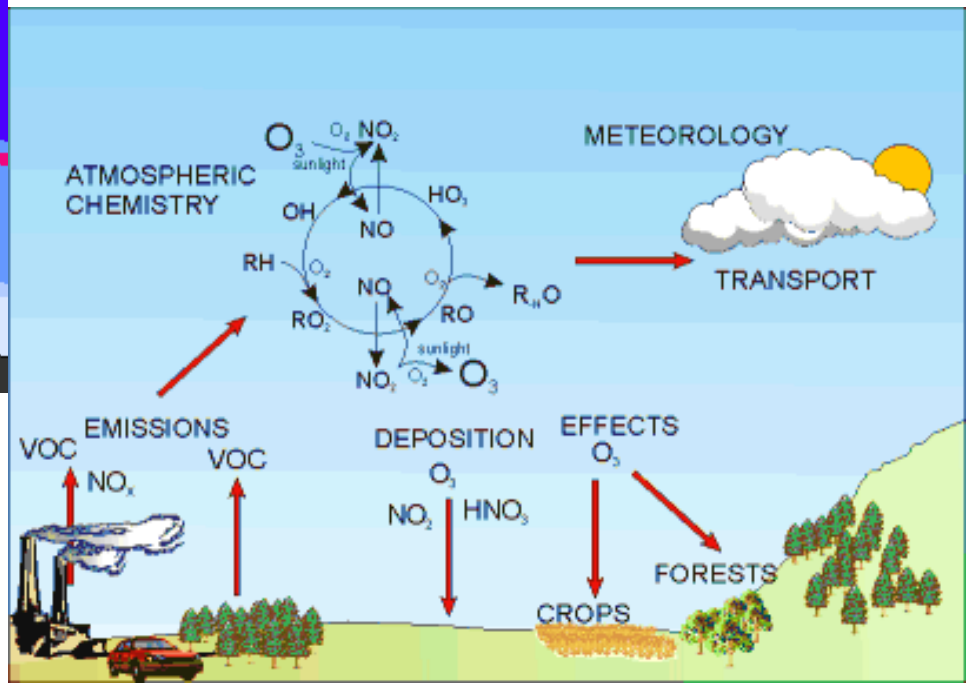
[1]School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL, USA
[2]Forest Health Dynamics Laboratory, Auburn University, Auburn, AL, USA

Presenter: Dr. Ryan Nadel

Loblolly Pine Decline

Tropospheric Ozone Formation





Tropospheric Ozone

<u>Symptoms on loblolly pine:</u>

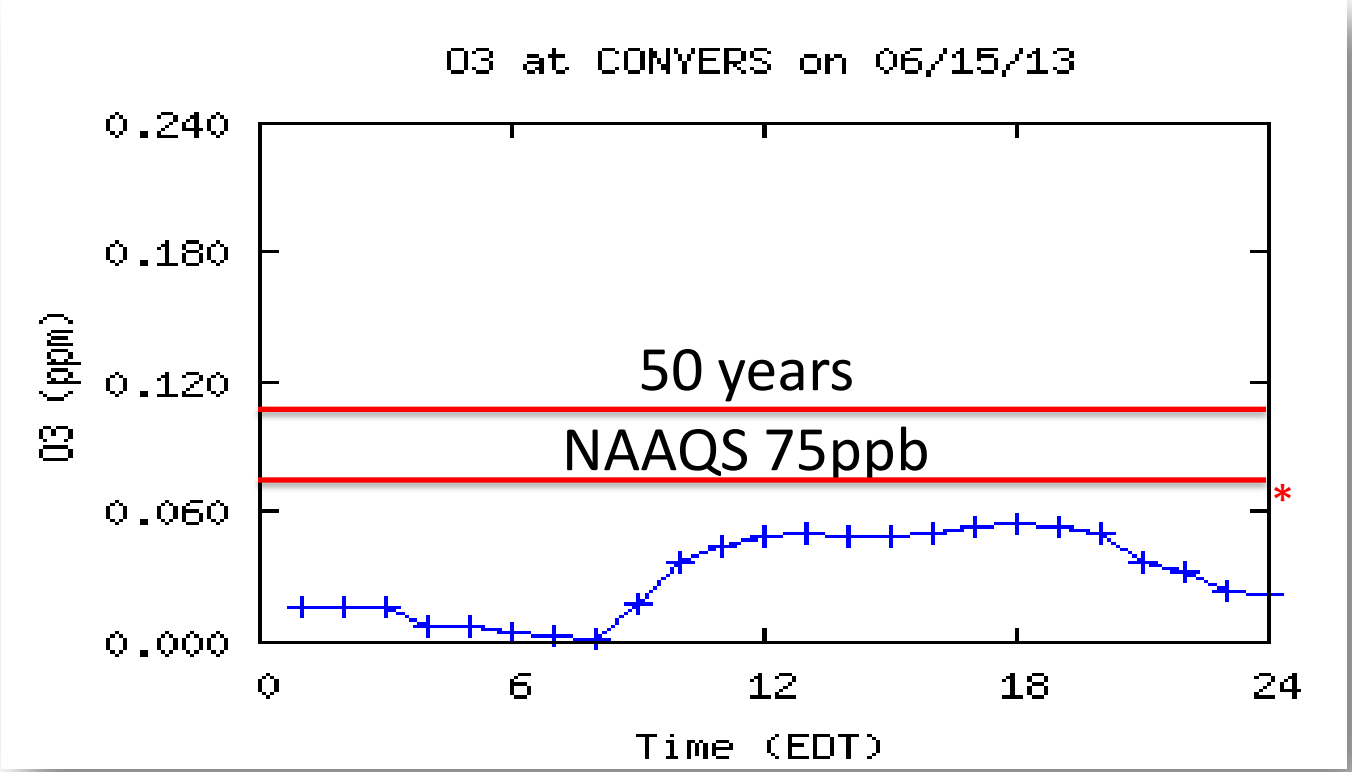
- Chlorotic mottling
- Decreased photosynthesis
- Overall health deterioration

Preindustrial levels ~20ppb

Today ~30-50ppb (average)

NAAQS 75ppb – 2013: in Auburn, AL 71ppb

Ozone Reference



Saturday June 15th 2013

Atlanta ~60ppb

Similar Research

Cobb et al. 1968

Linked ozone exposure to increases in beetle infestations in ponderosa pines

James et al. 1980

Concluded chronic ozone injury increases the rate of colonization of annosum root rot in Ponderosa and Jeffrey pines

Lackner and Alexander 1983

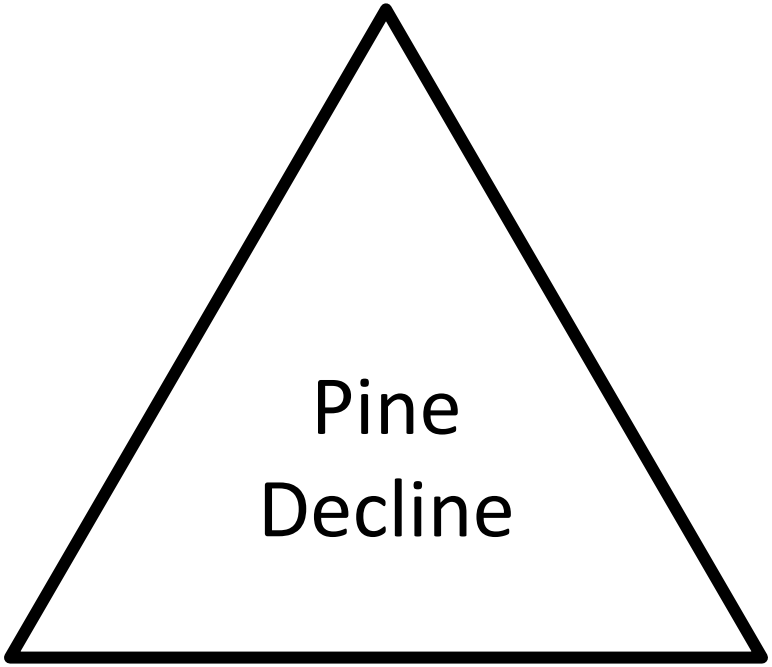
Eastern white pines showing ozone injury were more susceptible to procerum root disease and beetle infestations

Carey and Kelley 1992

Pitch canker fungus, loblolly pine seedlings, ozone up to 2.5X Ambient in OTCs
Seedlings exposed to ozone were more sensitive to PCF

Objective

Pathogen: *Ophiostomatoid Fungi*



Host:
Loblolly Pine

Environment:
Increasing Ozone

Study Site

Auburn University Atmospheric Deposition Site

Study Site

Atmospheric Deposition Site

Open-Top Chambers

Materials & Methods
9 Open-Top Chambers

3 Ambient
If 40ppb

3 Charcoal Filtere
Then ~20-30ppb

3 2X Ambient
Then 80ppb

Materials & Methods

- Planted January 2013
- 4 families of *P. taeda*
  - 2 Tolerant
  - 2 Susceptible

    Singh *et al*. 2014

    Ozone sensitivity unknown
- 675 pine/family
- 300 pine/chamber
- 9 chambers
- 2700 total pine

Materials & Methods

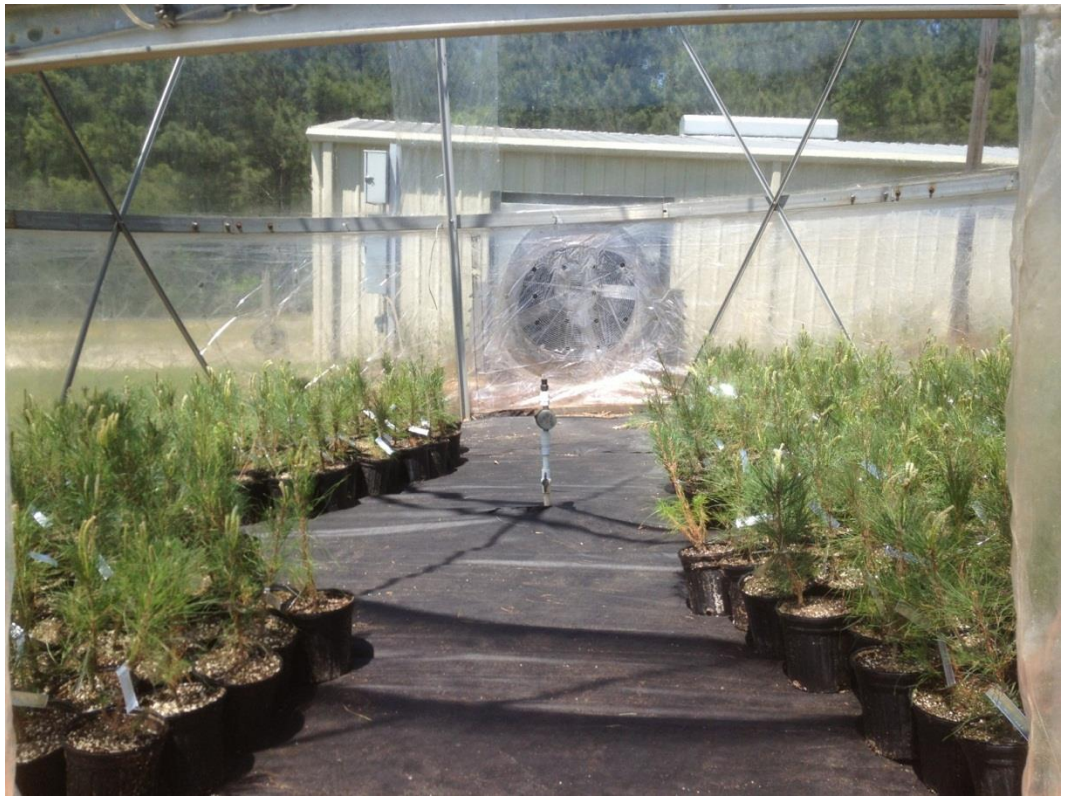
Stem Inoculations with Ophiostomatoid Fungi

- May 27th-31st 2013

- 5 Treatments
  - *L. terebrantis* (native)
  - *G. huntii* (non-native)
  - Wound + sterile media
  - Wound
  - No wound

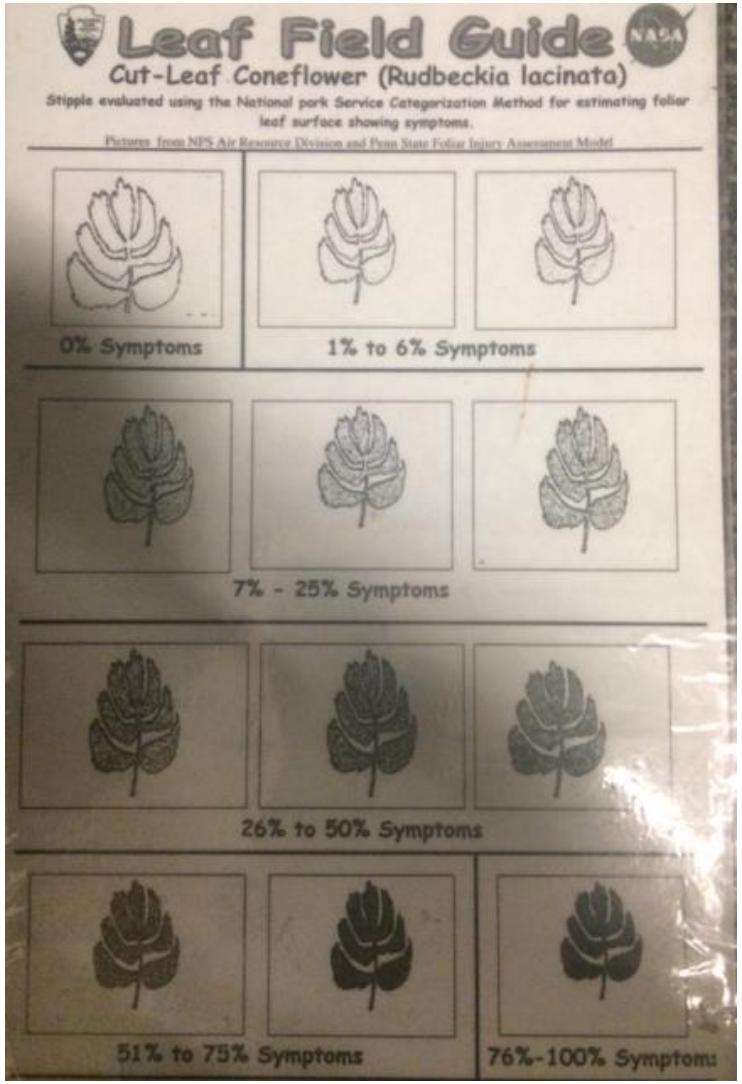
Materials & Methods
Ozone Fumigation

- June 3rd – August 26th
  - 12 weeks



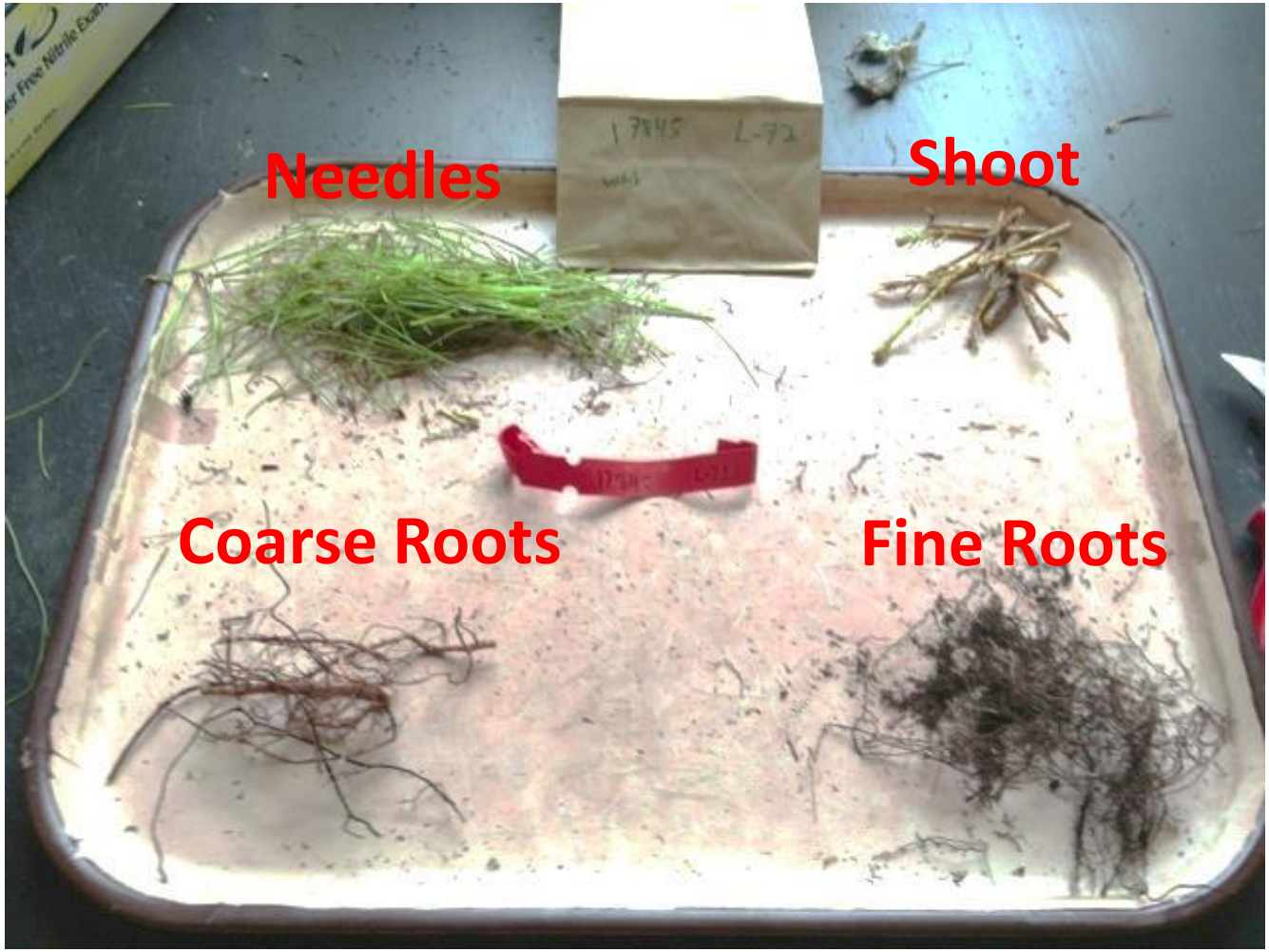
Materials & Methods
RCD & Height for Volume

Materials & Methods
Visible Ozone Injury Survey

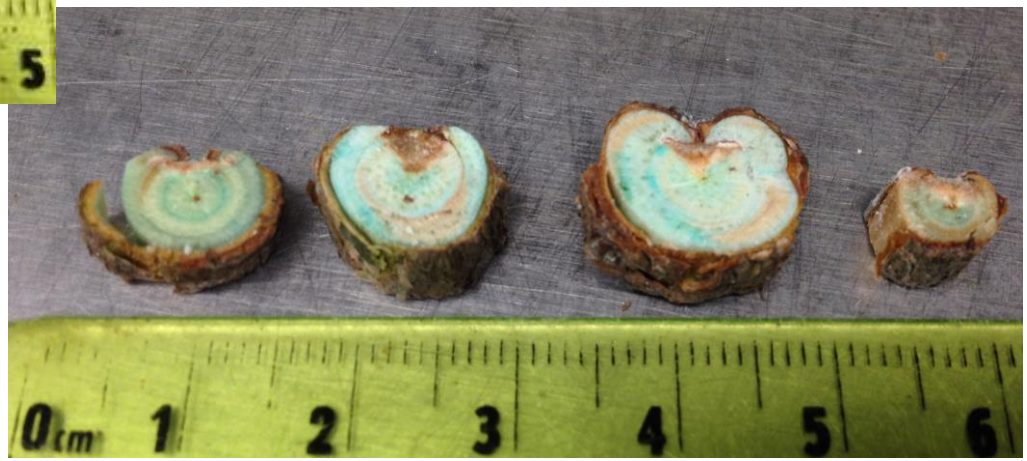


- Plant Severity
- Needle Severity

Materials & Methods
Dry Weight Biomass



Materials & Methods
Lesion Characteristics
Re-isolation



Materials & Methods
Other Measurements

SPAD Meter

Pressure Bomb

Results

Recorded Ozone Concentrations

Means (ppb) and Maximum Ozone Concentrations					
Month	**CF**	**Ambient**	**2X**	**Avg. Daily Max (2X)**	**Avg. Monthly Max. (2X)**
Apr	17	26	41	90	97
May	19	29	48	99	154
Jun	15	23	39	88	140
Jul	12	19	30	73	140
Aug	9	16	28	79	102

Results

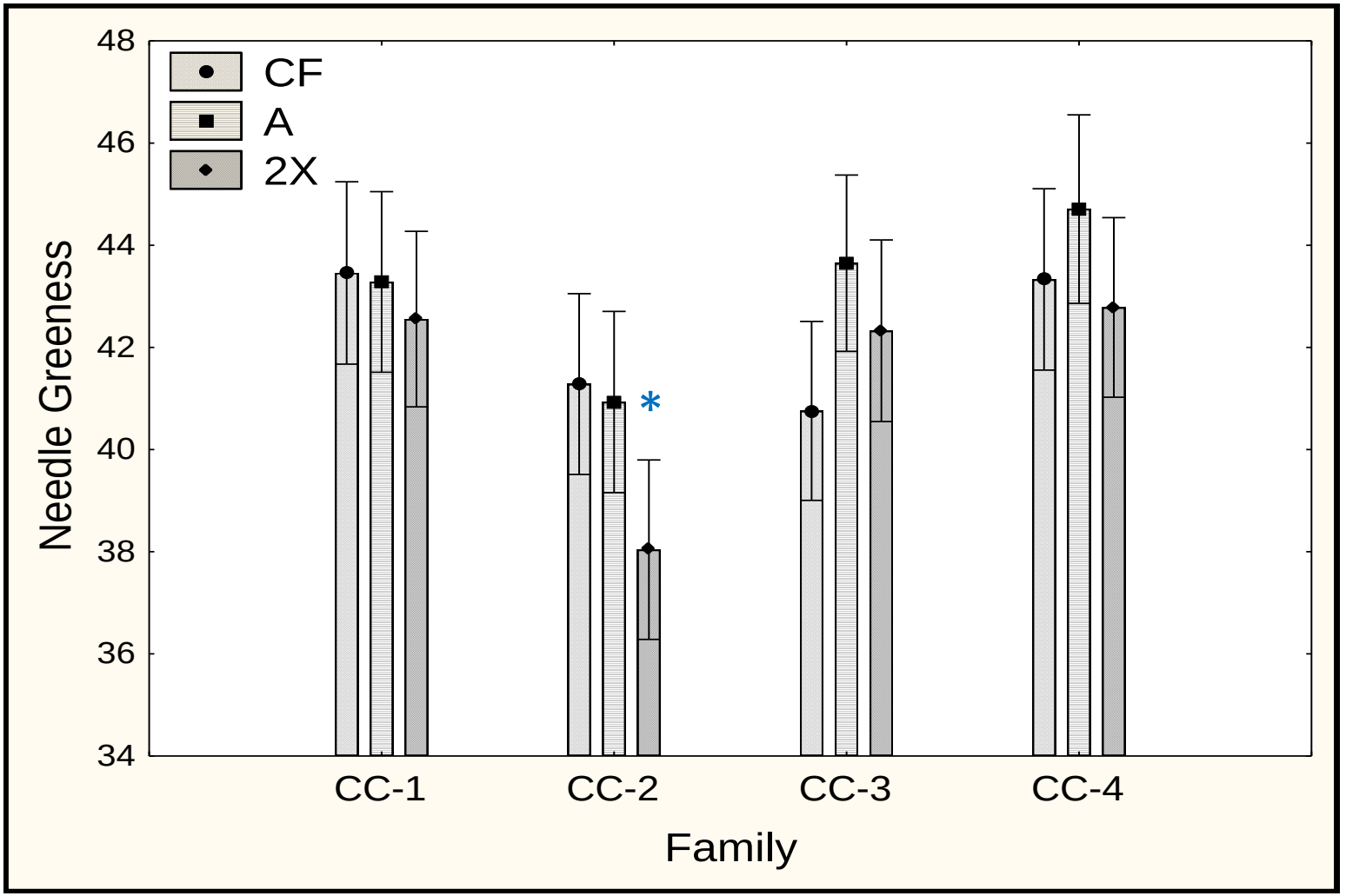
Incidence of Visible Ozone Injury

$$Maximum\ Ambient\ Ozone\ Concentration = 71\ ppb$$

Incidence of Visible Ozone Injury			
Family	CF	A	2X
CC-1 – S	0	13	87
CC-2 – S	0	31	90
CC-3 – T	0	6	42
CC-4 – T	0	6	50

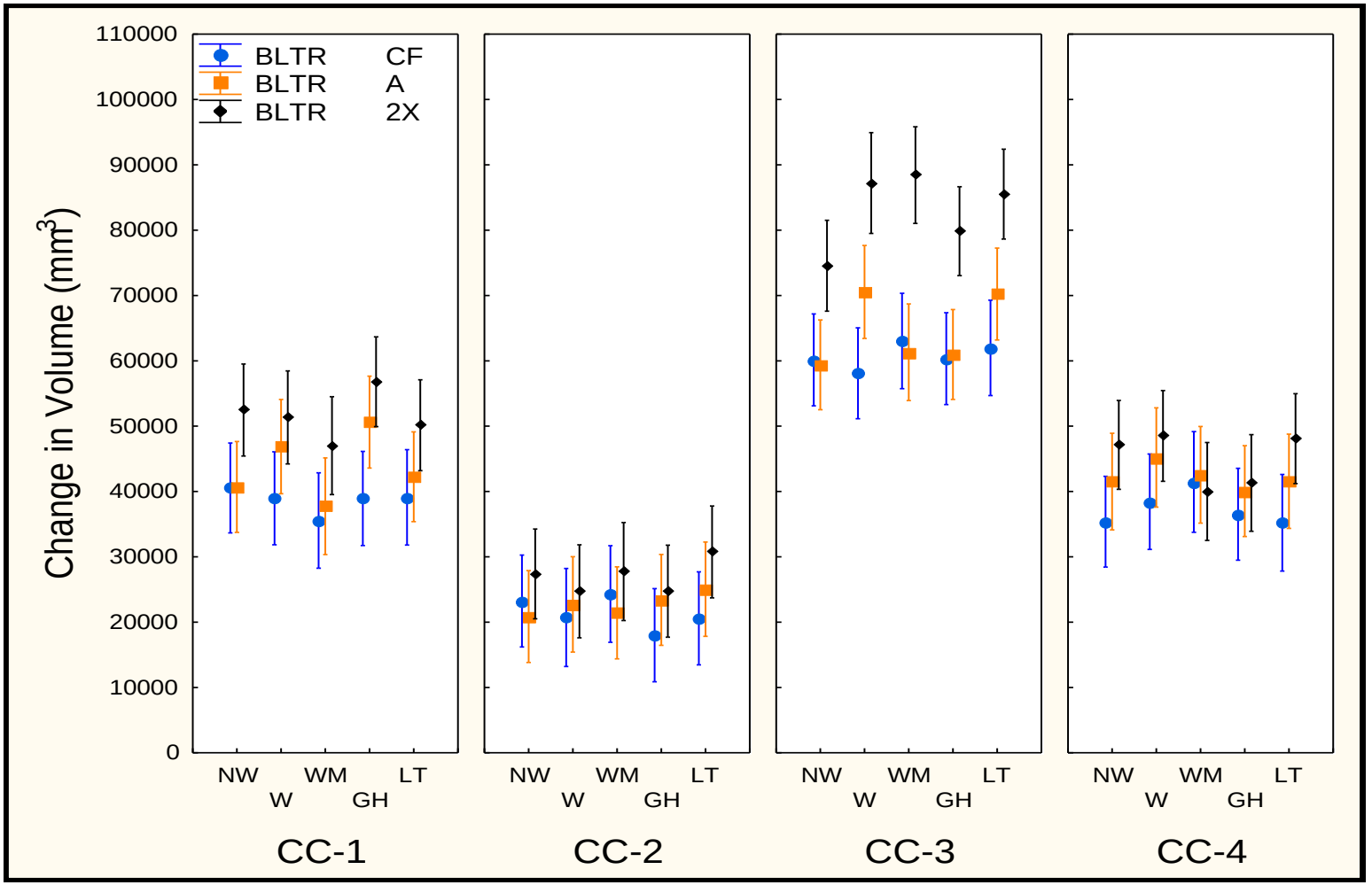
Results

Needle Greenness by Family and Chamber



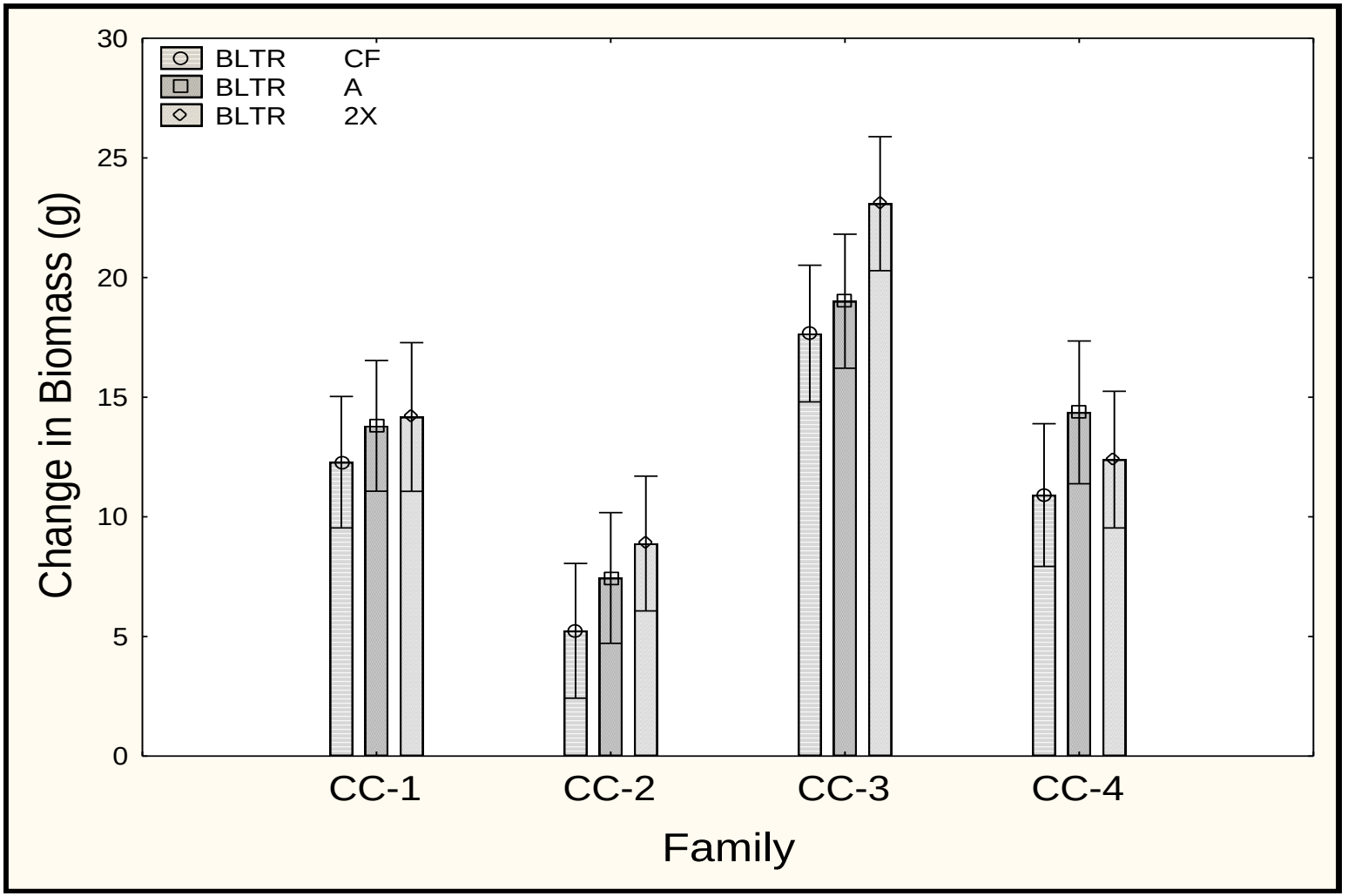
Results

Change in Volume by Family, Chamber and Inoculation Treatment



Results

Change in Dry-Wt Biomass by Family and Chamber



Results

Lesion Volume by Family and Treatment

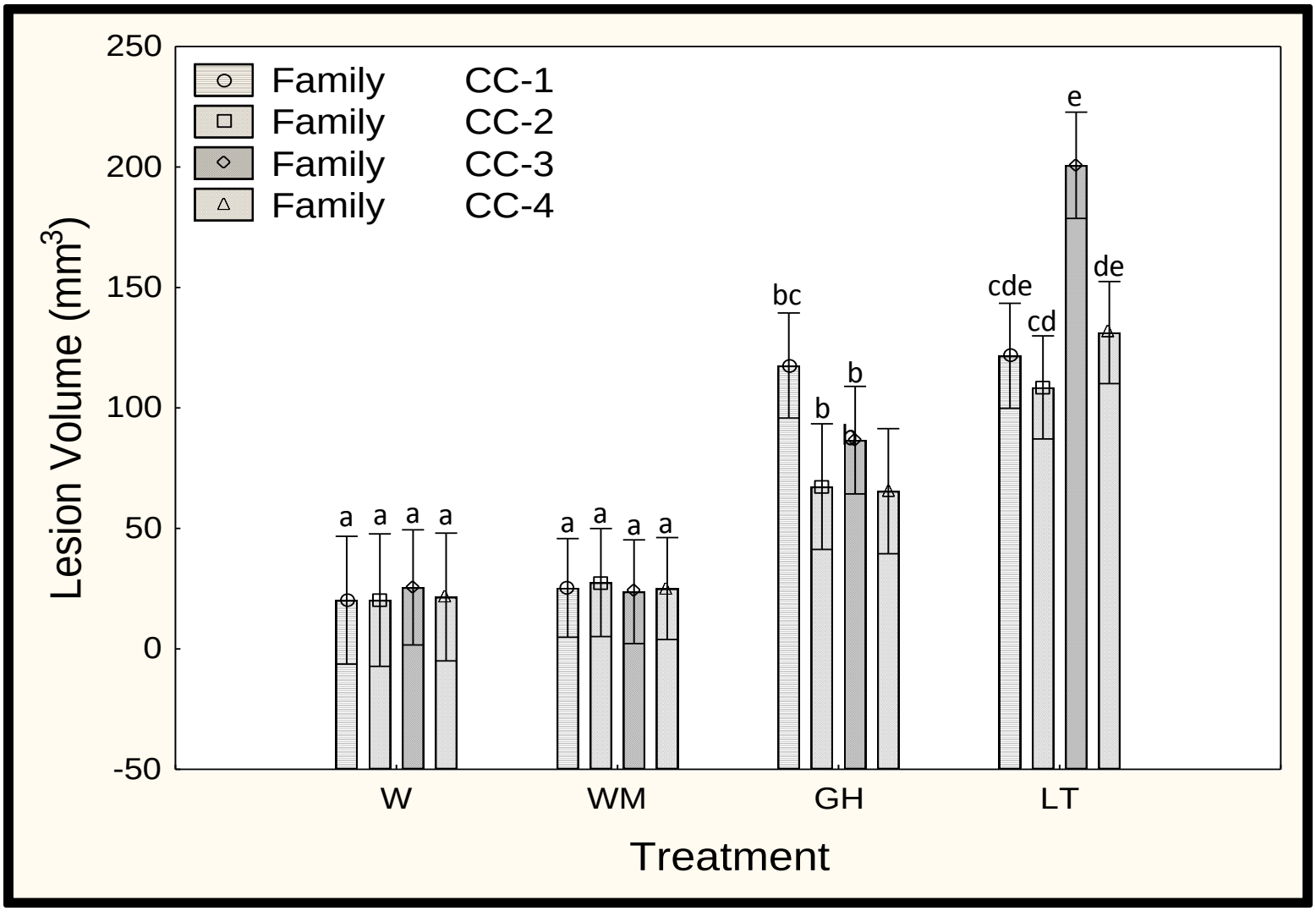
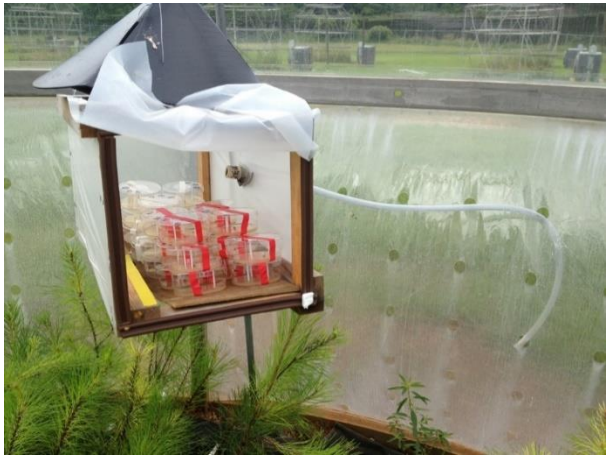


Plate Growth Study

- Cyclohexamide-Streptomycin + MEA + glycerol
  - *Leptographium terebrantis*
  - *Grossmannia huntii*

Plate Growth Study



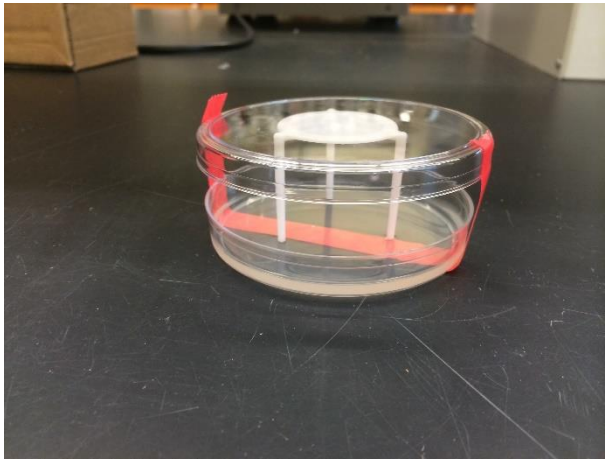


Plate Growth Study

- Observe radial growth of fungi in the presence of the various ozone treatments after days 1, 3 and 5

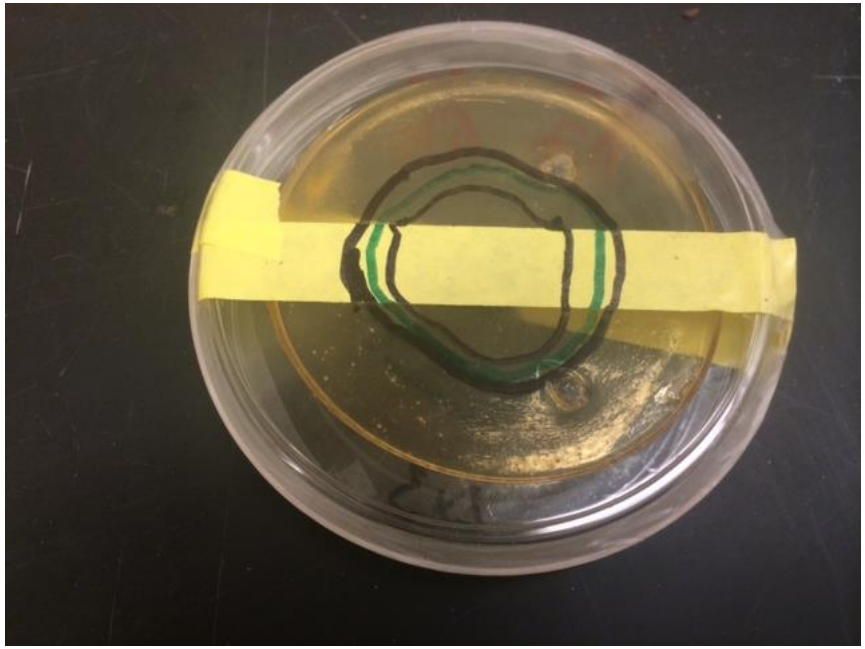
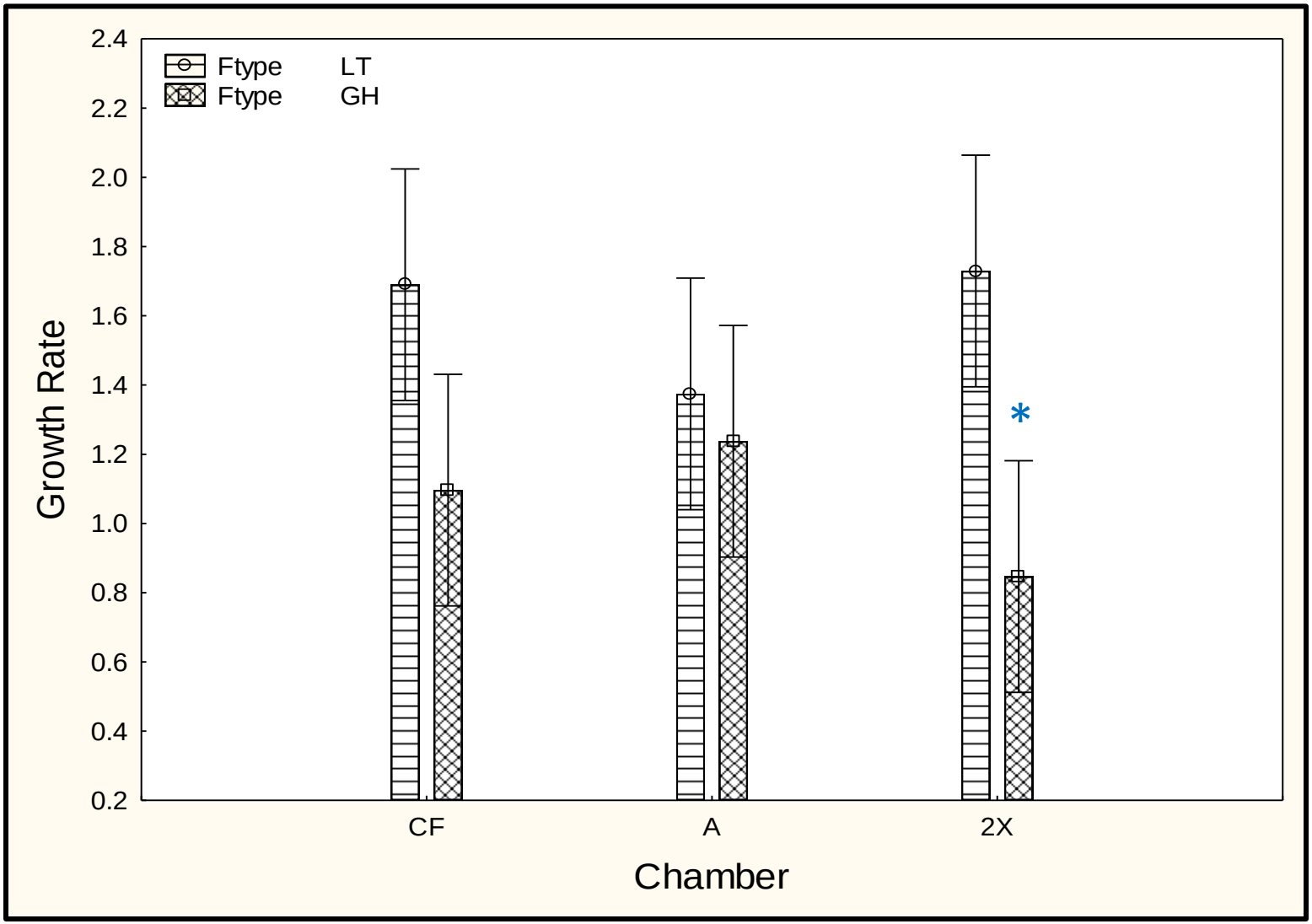


Plate Growth Study



Discussion

- Loblolly pine families that are sensitive to ophiostomatoid fungi may also be sensitive to changes in air quality
  - An understanding of this mechanism may give insight into other plant-disease-climate interactions
- Alterations in biomass production could be of concern to forest owners and managers
  - Wood products, quality, yields
- Finding resistance to forest tree pathogens may become increasingly difficult given large-effects of climate change and extensive ranges of some tree species

Impacts of Research

- Assisting planting programs managers with providing information as to the susceptibility of current loblolly pine families to ophiostomatoid fungi in the presence of predicted future ozone concentrations in the southeastern United States

- Provide insight for managing planting programs and predicting future yields of loblolly pine grown, mitigating the potential impact of predicted elevated ozone concentrations

- Analyzing the interactions of biotic and abiotic stresses will provide insight into disease complexes and how climate may play a role in pathenogenesis

Acknowledgements

- Advisors and Committee Members
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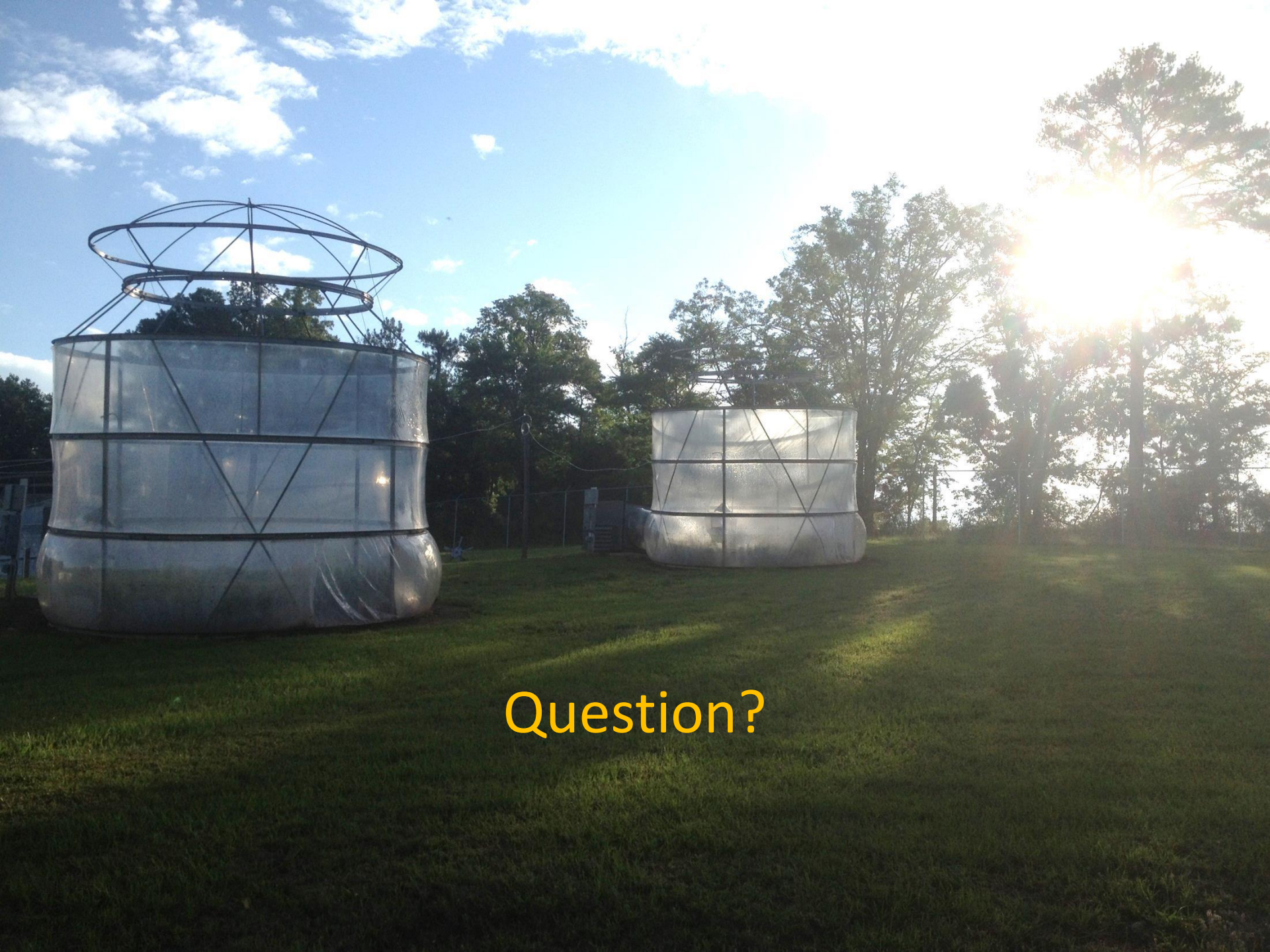
- Alabama Agricultural Experimental Station - HATCH
- Rayonier & Arborgen


Question?