

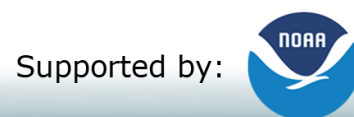
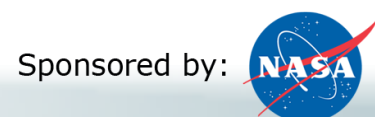


# The O<sub>3</sub> Pollution Problem

Impacts on plants, ecosystems, & climate

Danica Lombardozzi  
National Center for Atmospheric Research

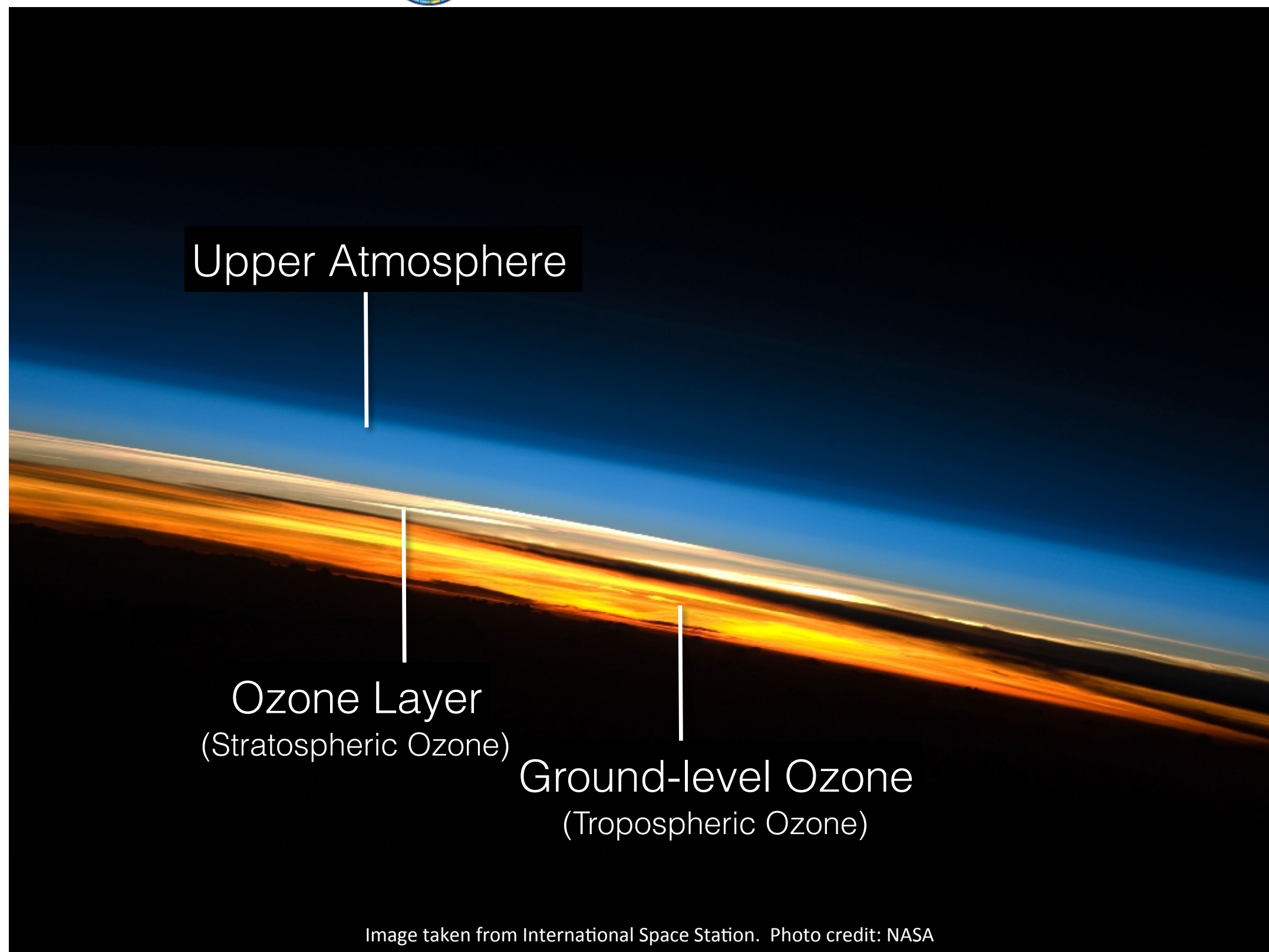
July 20-21 2016



Implemented by:  UCAR














# Ozone ( $O_3$ ) Formation:

Nitrogen Oxides ( $NO_x$ )

Volatile Organic Compounds (VOCs)



Sunlight 

Ground-level Ozone ( $O_3$ )

I Smog



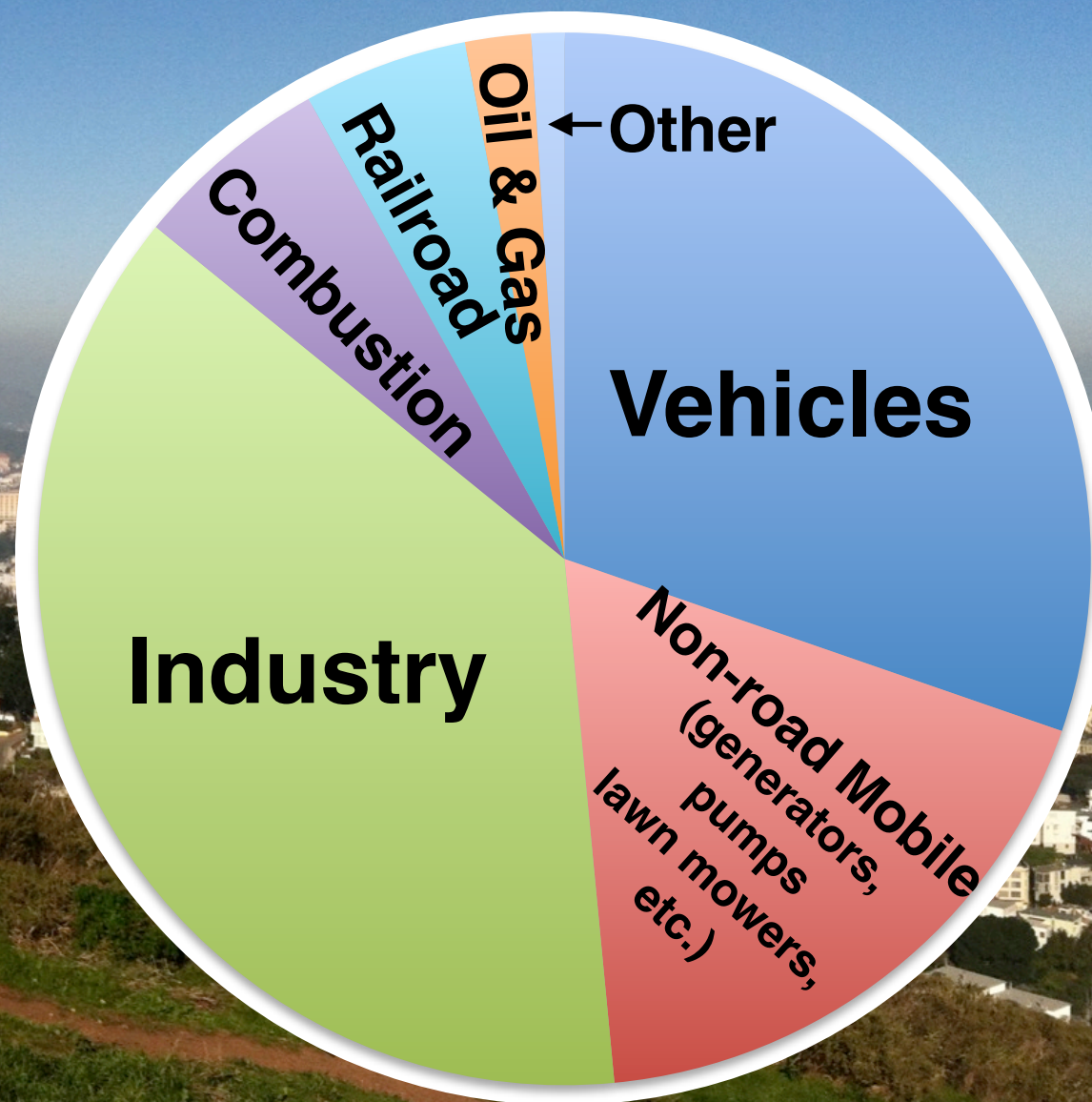


# Ozone ( $O_3$ ) Formation:

Nitrogen Oxides ( $NO_x$ )

Boulder County, Human-made sources

I Smog






# Ozone ( $O_3$ ) Formation:

Nitrogen Oxides ( $NO_x$ )

Volatile Organic Compounds (VOCs)



Sunlight 

Ground-level Ozone ( $O_3$ )

I Smog





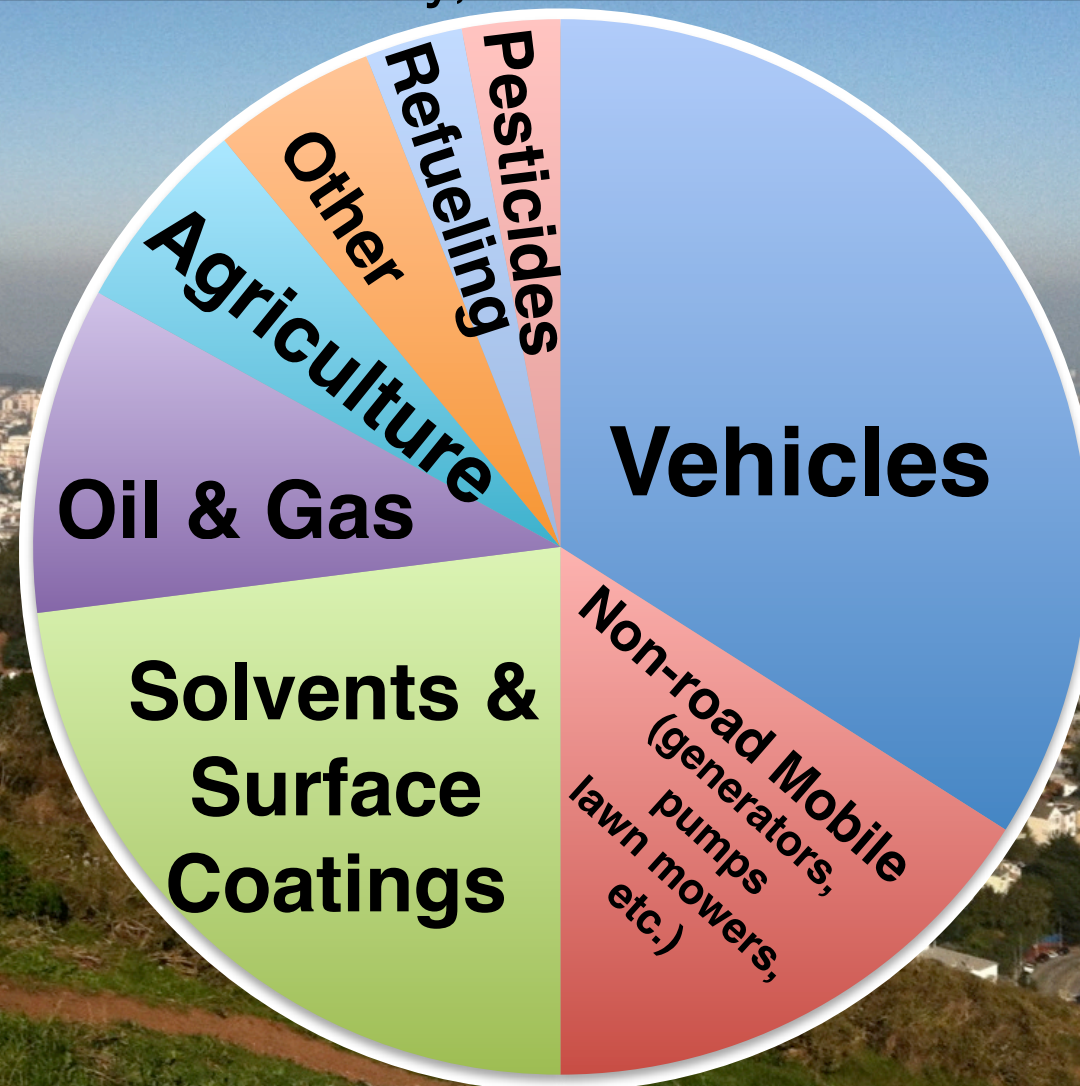
# Ozone ( $O_3$ ) Formation:

Nitrogen Oxides ( $NO_x$ )

**Volatile Organic Compounds (VOCs)**

Boulder County, Human-made sources

I Smog






# Ozone ( $O_3$ ) Formation:

Nitrogen Oxides ( $NO_x$ )

Volatile Organic Compounds (VOCs)



Sunlight 

---

Ground-level Ozone ( $O_3$ )

I Smog







Pentax Medical Company



<http://www.campaignforcleanair.org>

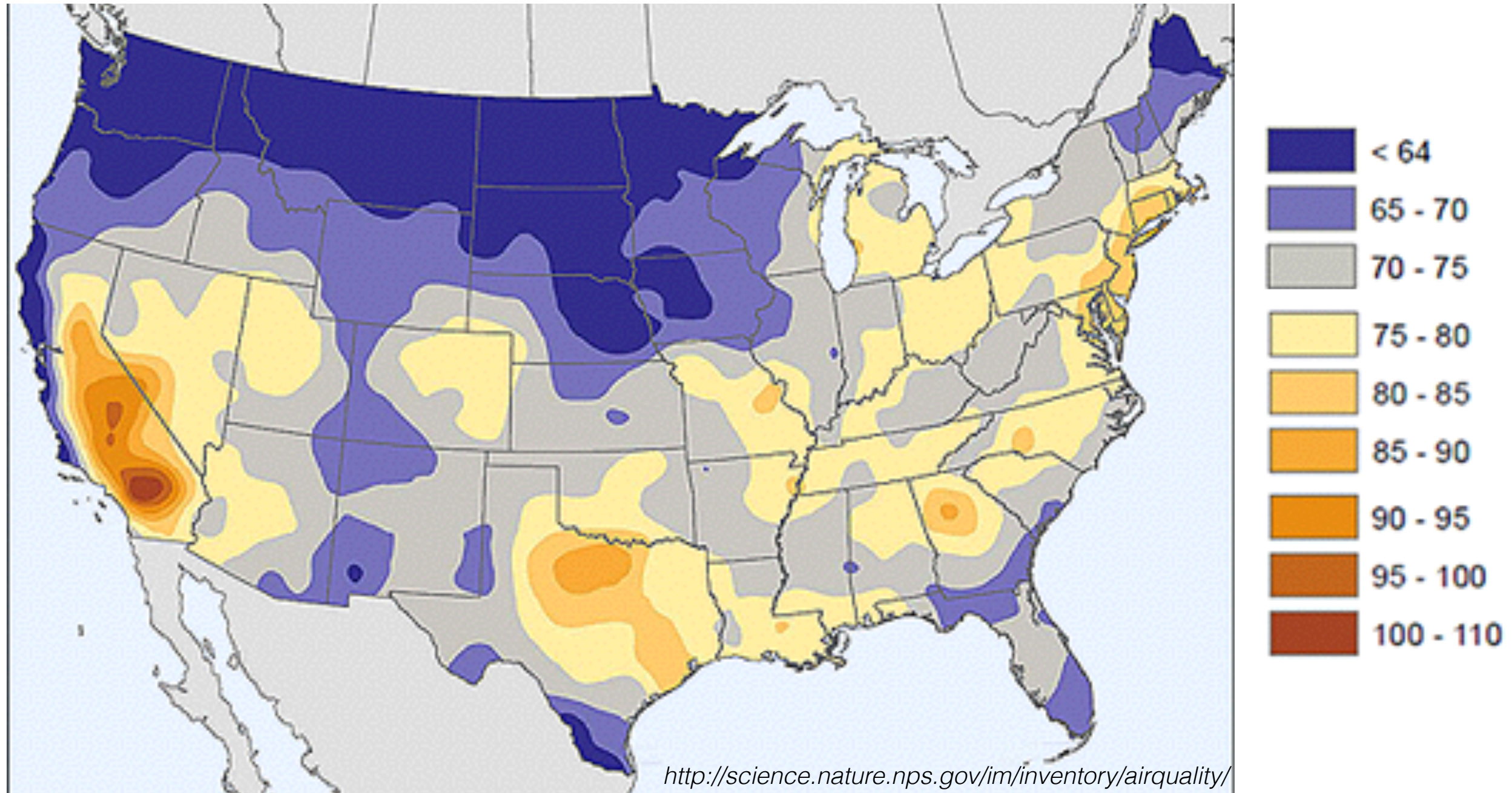


EPA limit for **ozone**: 75 ppb over 8 hours\*  
(less than 1 cup of water in an olympic-size pool)

\* In 2015, Congress approved a lower standard of 70 ppb



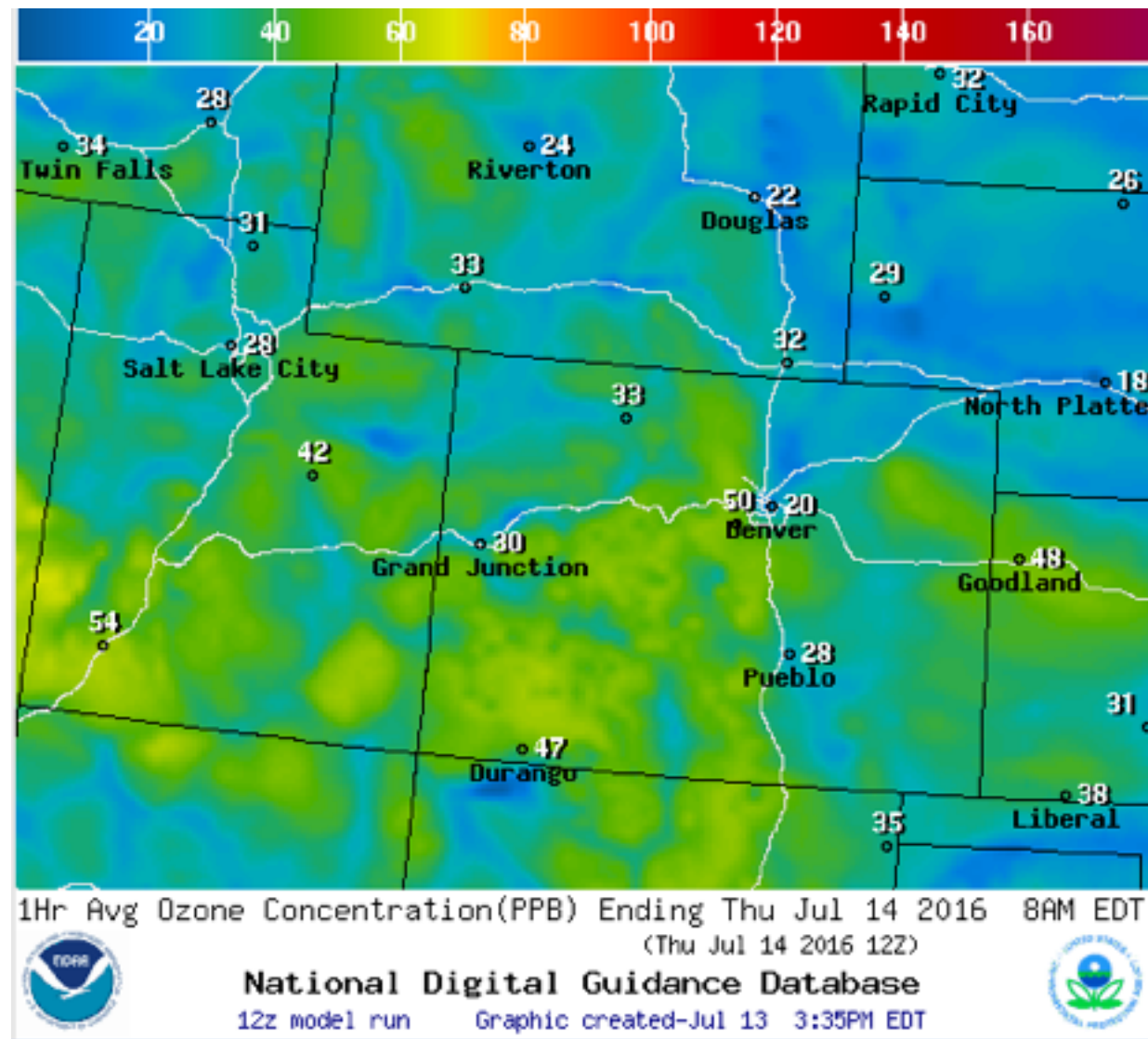
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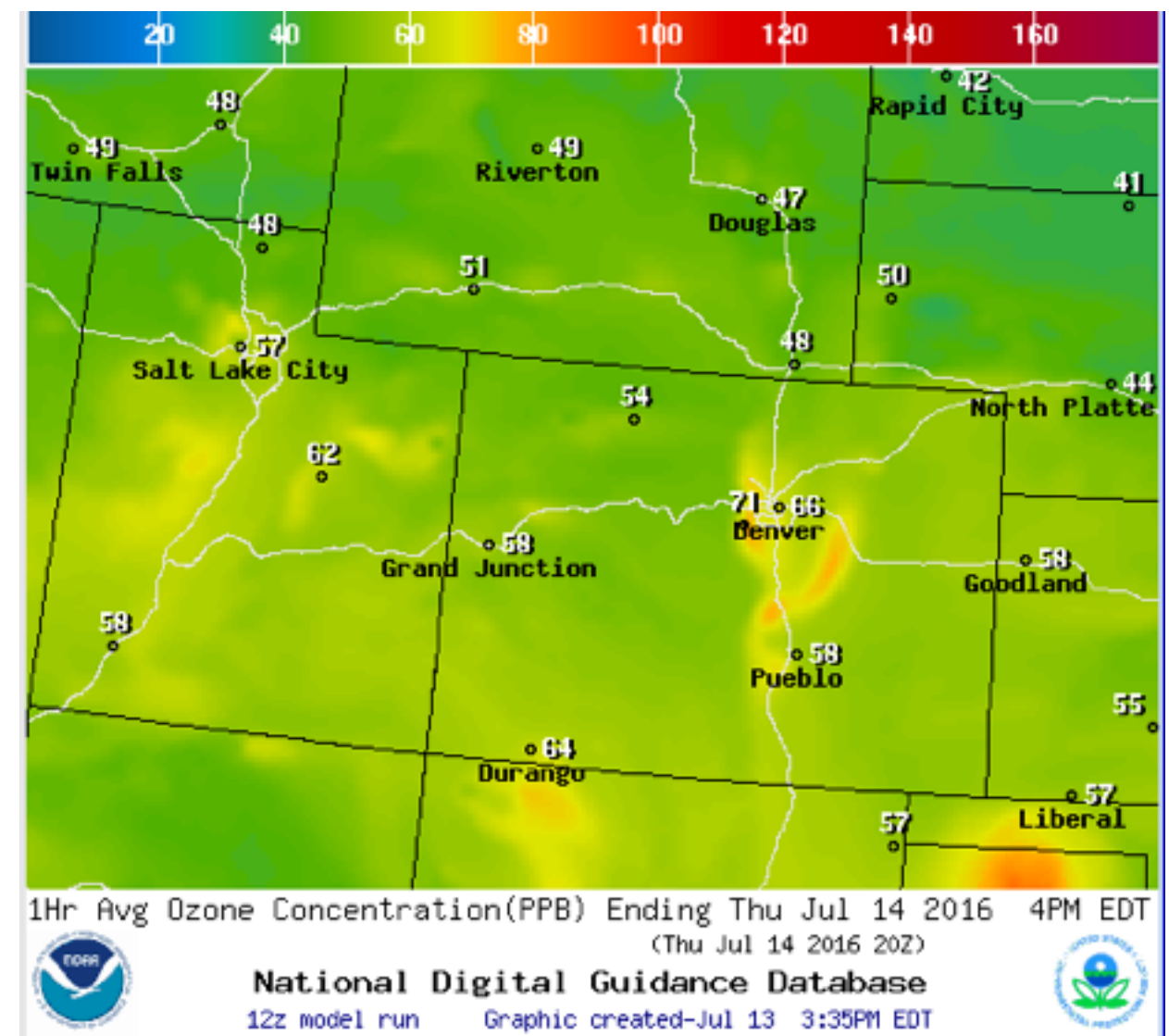
\* In 2015, Congress approved a lower standard of 70 ppb



8:00 am



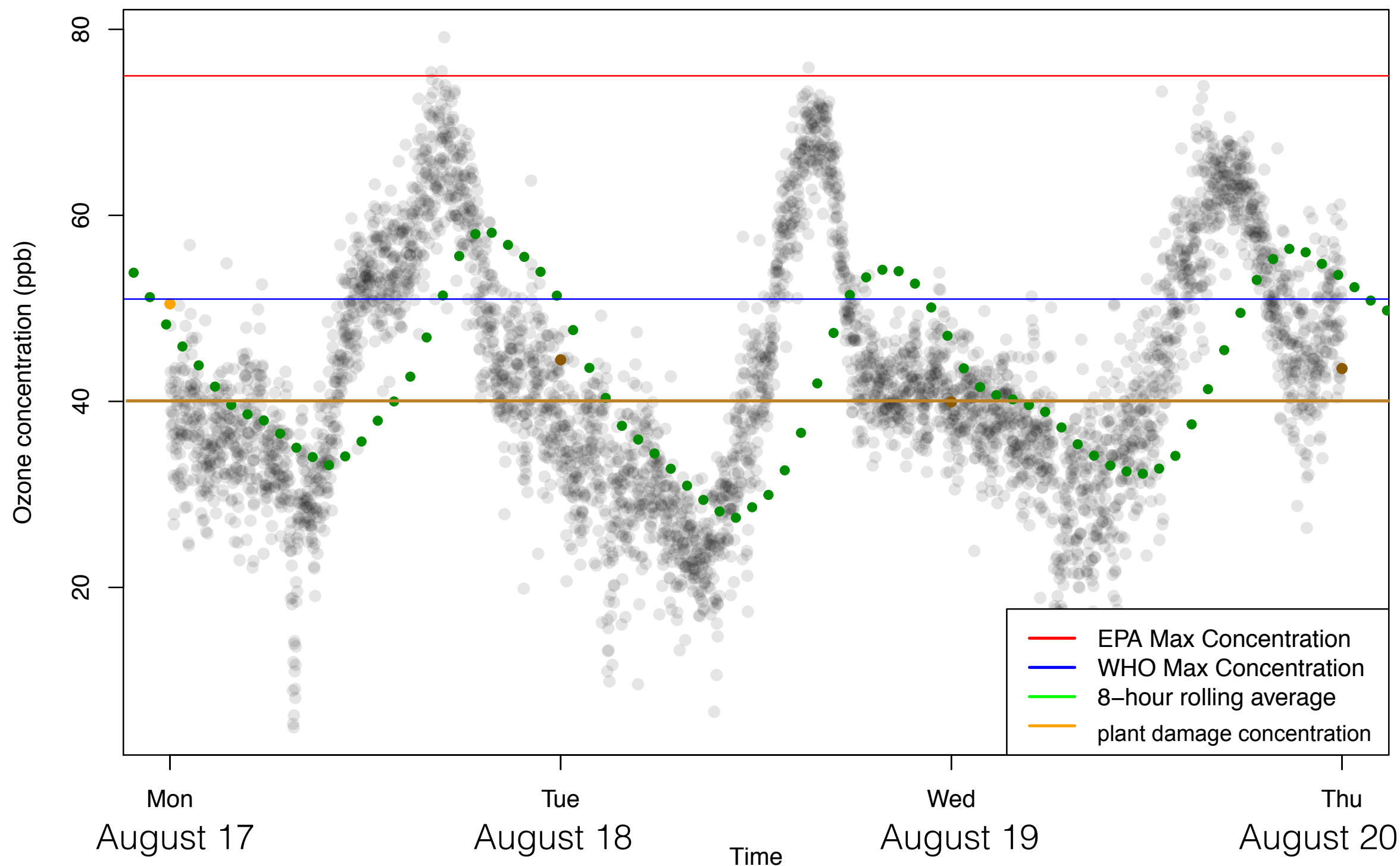
5:00 pm



<http://airquality.weather.gov/sectors/centrockiesLoop.php#tabs>

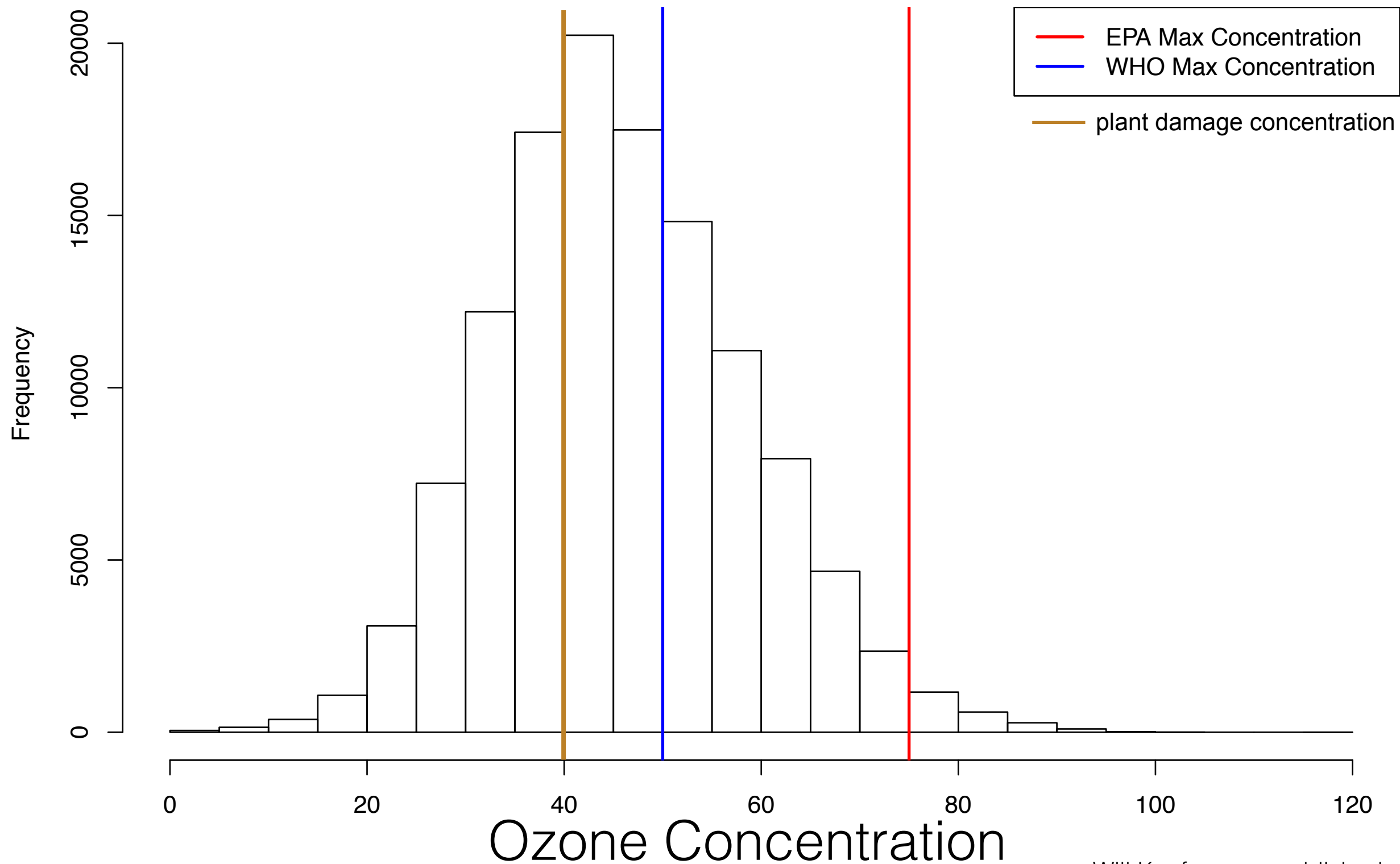


# 2015 ozone concentrations at NCAR



Will Kaufman, unpublished data





Will Kaufman, unpublished data









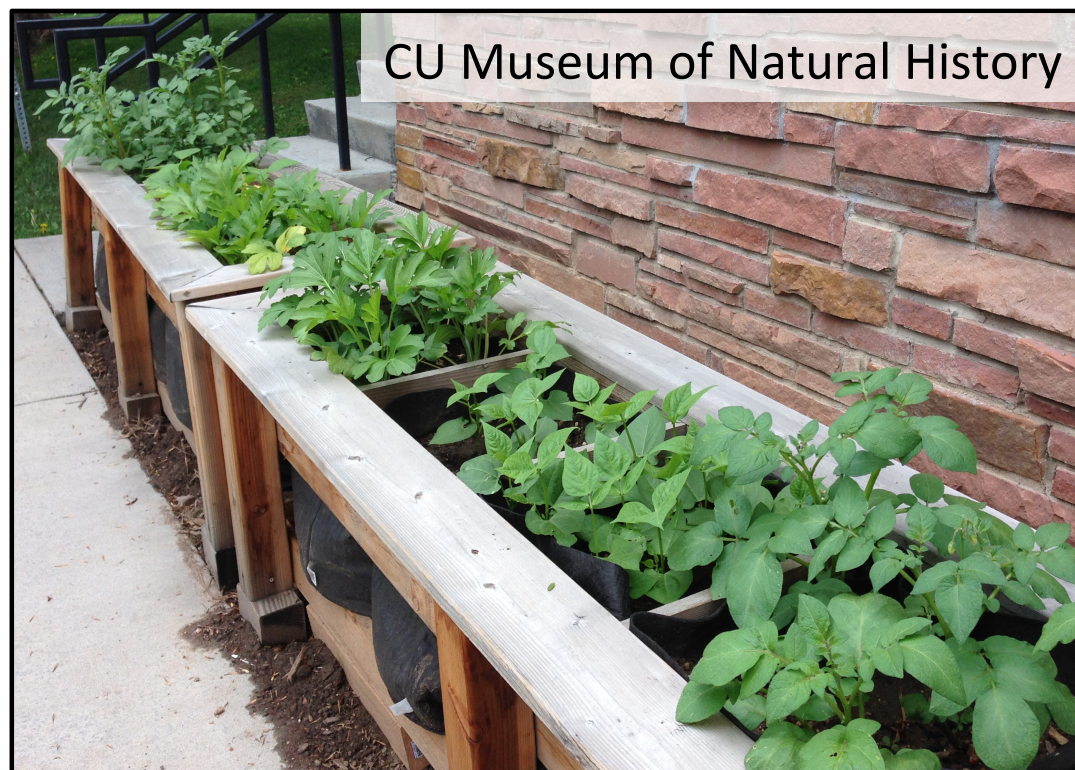




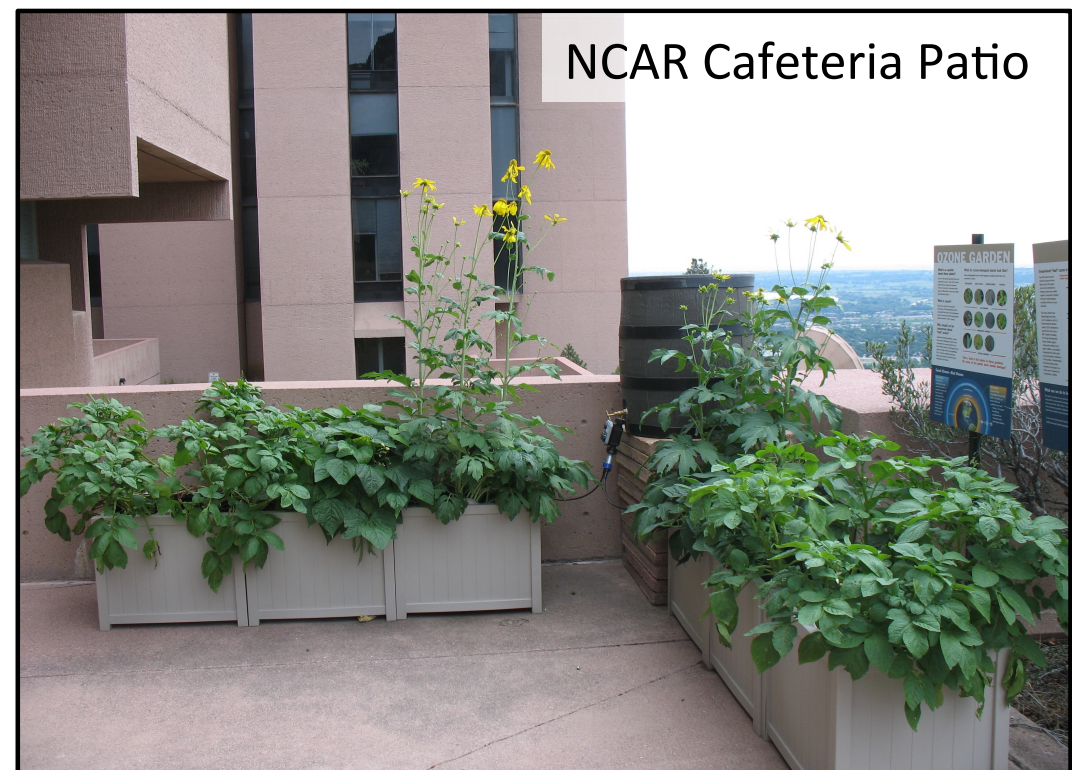
NCAR Front Entrance



CU Mountain Research Station



CU Museum of Natural History



NCAR Cafeteria Patio

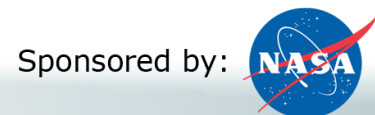


August 4 2014



#GLOBEInCO2016

# Potato, var. LaChipper



Supported by:



Implemented by: UCAR



August 4 2014



#GLOBEInCO2016

# Potato, var. LaChipper

August 28 2014



Sponsored by:



Supported by:



Implemented by:  UCAR



August 4 2014



#GLOBEInCO2016

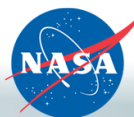
# Potato, var. LaChipper

August 28 2014

September 9 2014



Sponsored by:



Supported by:



Implemented by:  UCAR





Potato



Snap Bean

July 2, 2015



July 24, 2015



Sept. 3, 2015





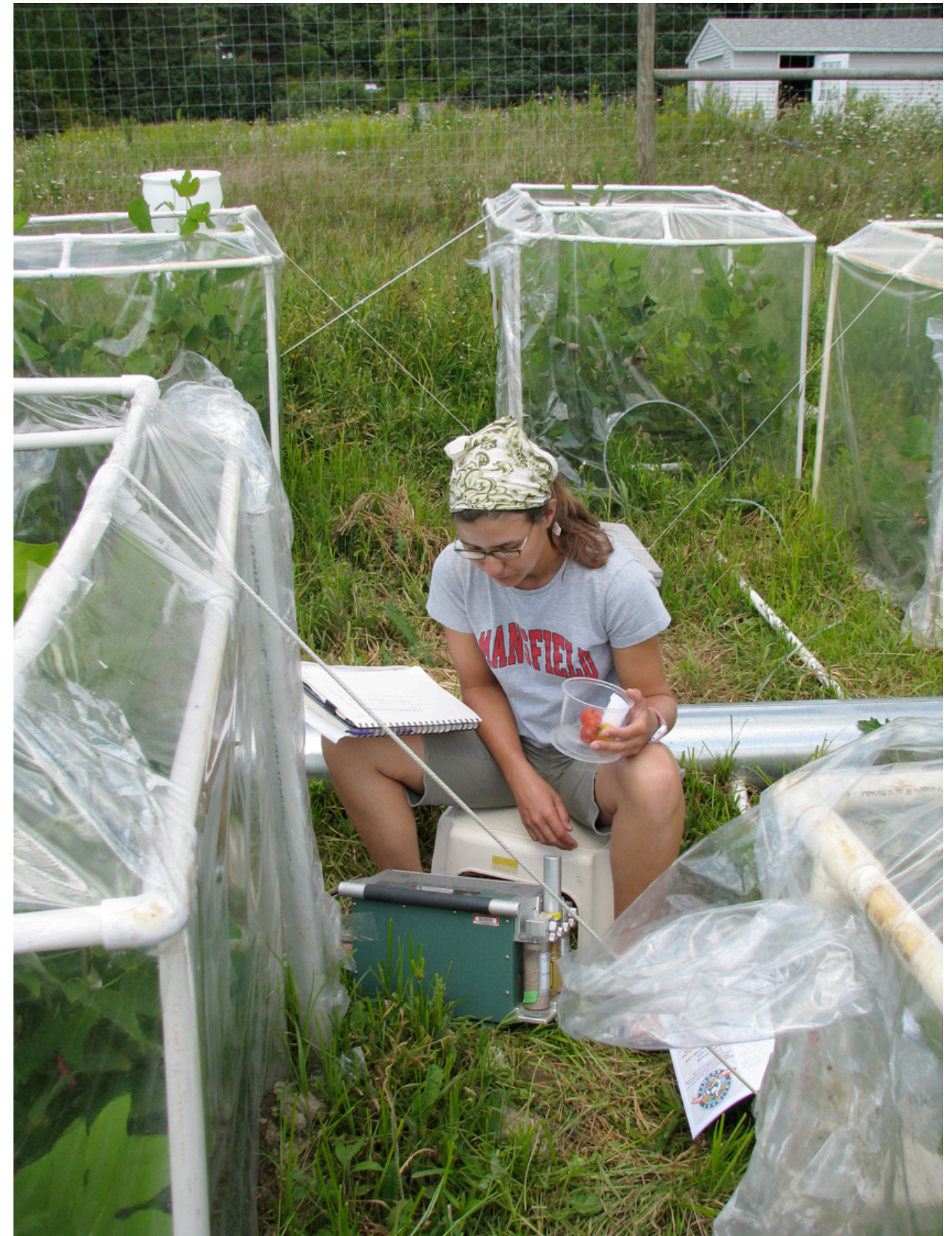


Cutleaf Coneflower  
*Rocky Mountain  
National Park*  
August 2015



Cutleaf Coneflower  
*Red Feather Lakes*  
August 2015



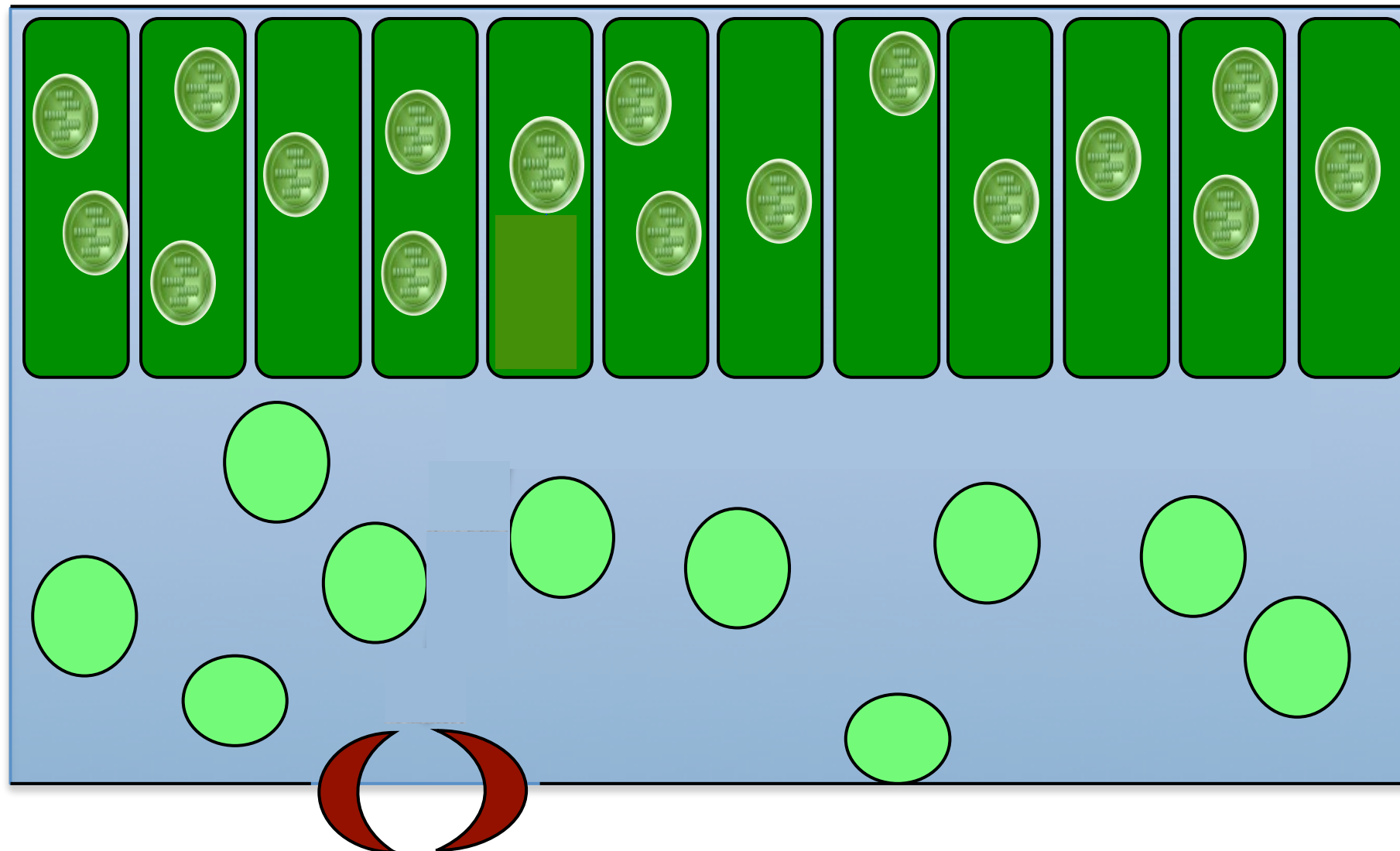




# How does ozone damage a plant?

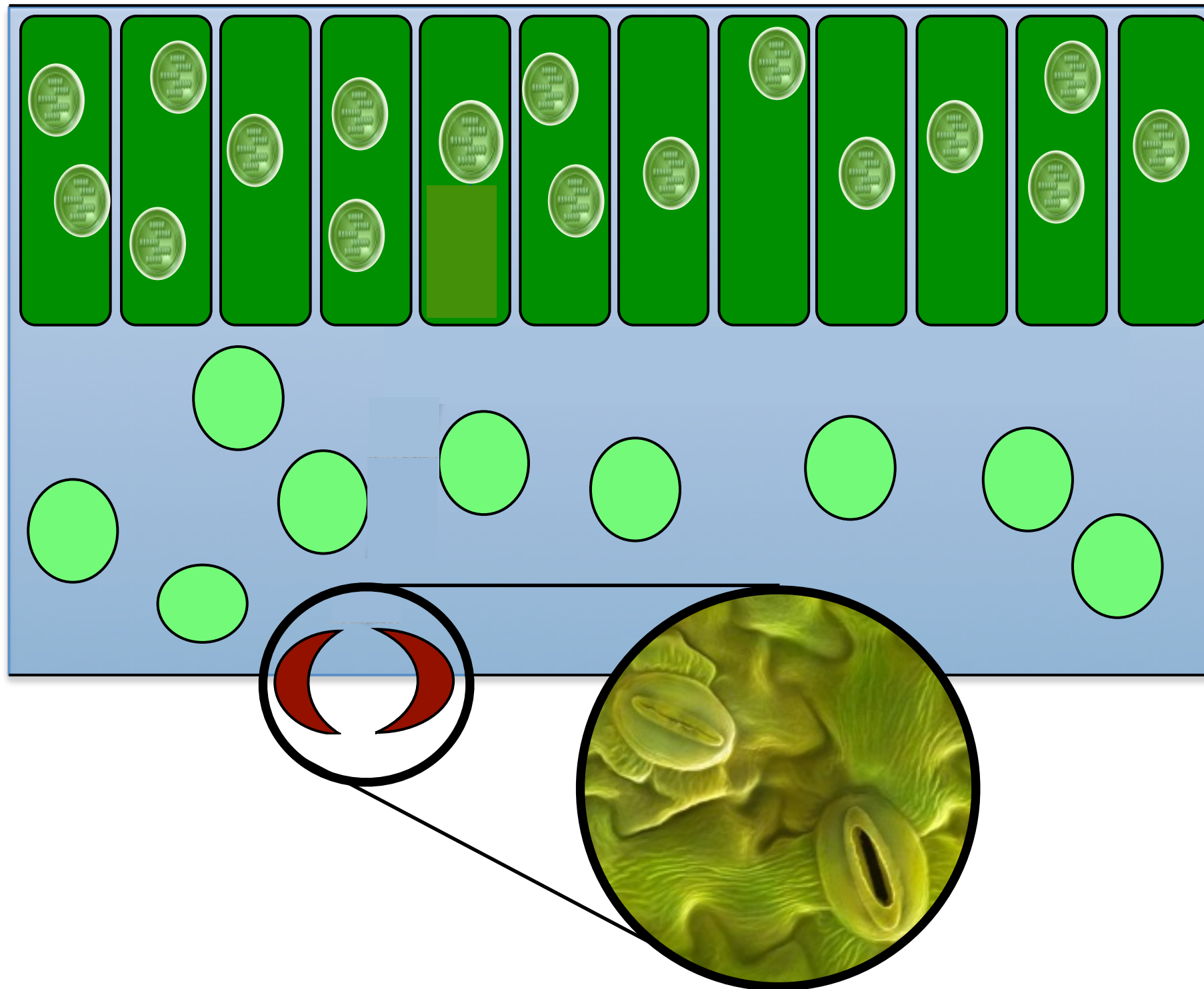


# Leaf Cross-section



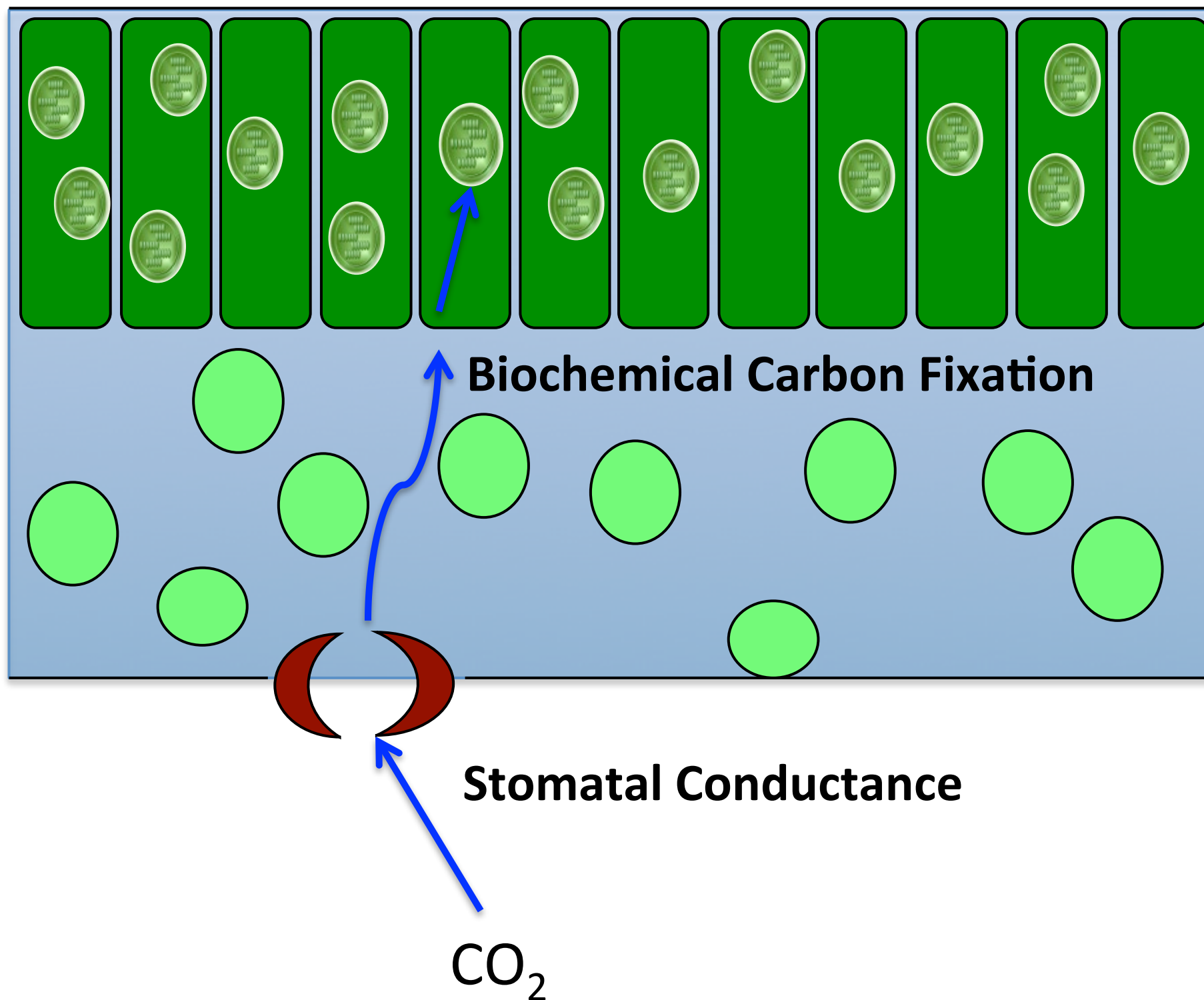


# Leaf Cross-section



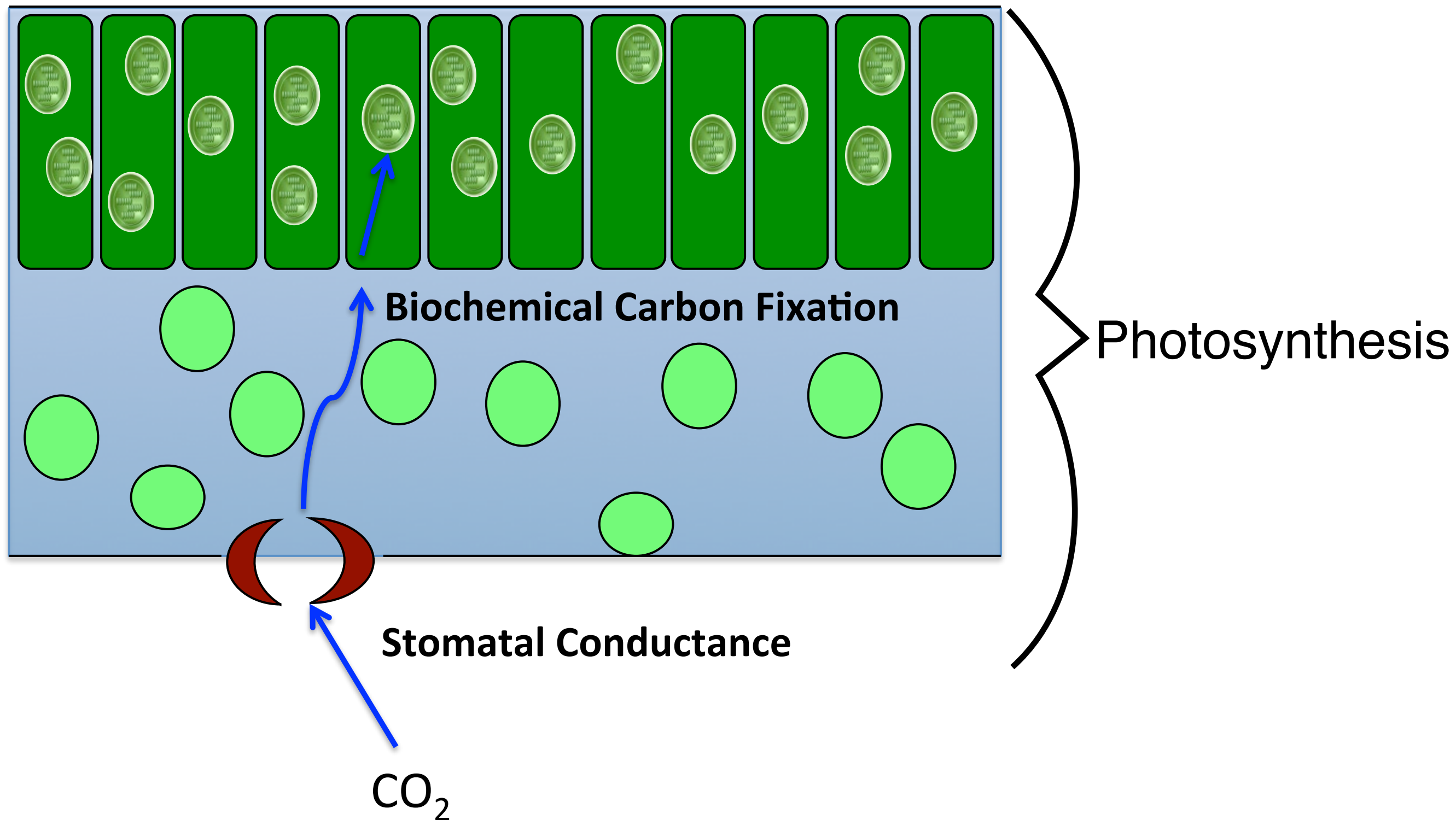


# Leaf Cross-section



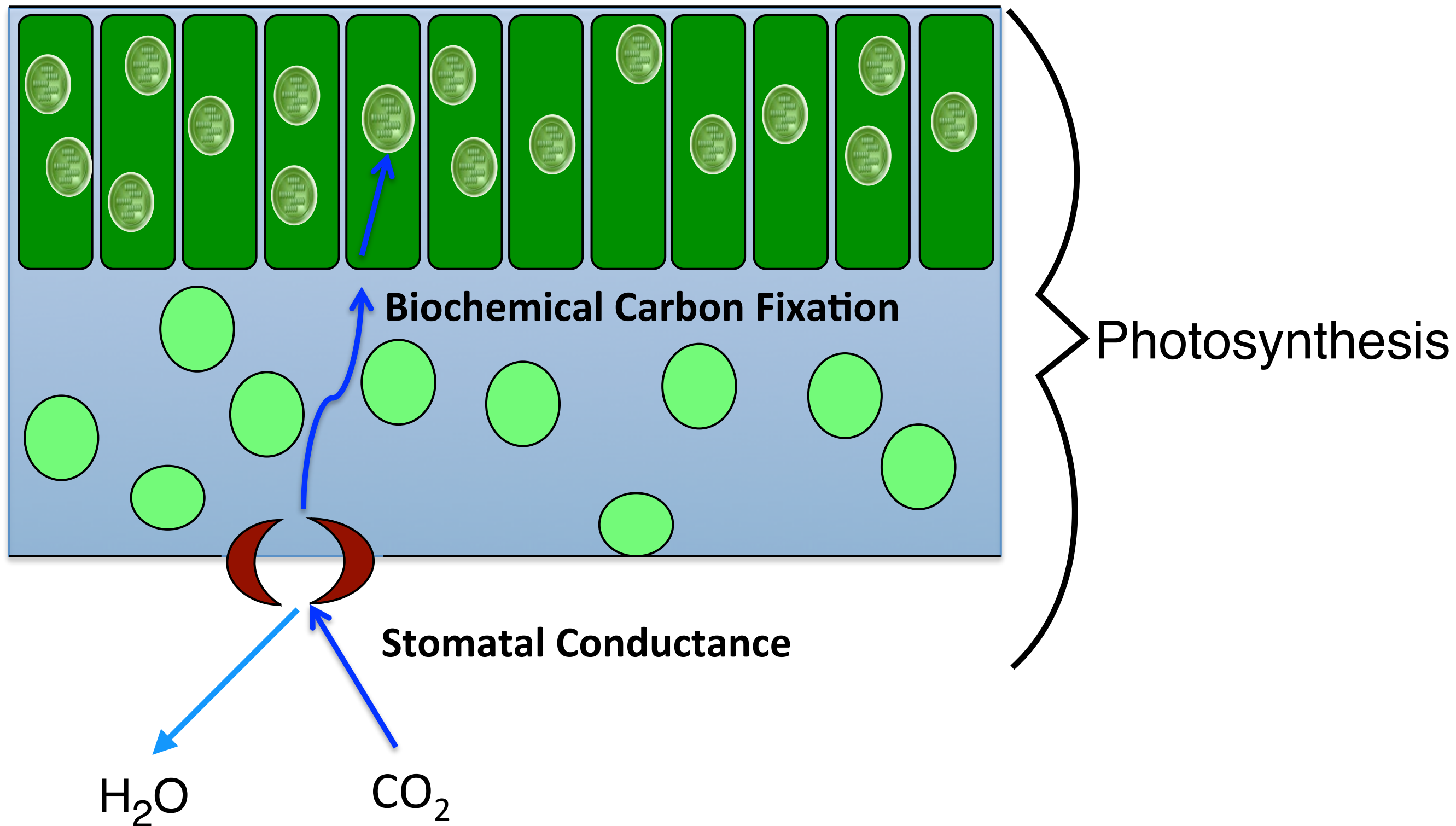


# Leaf Cross-section



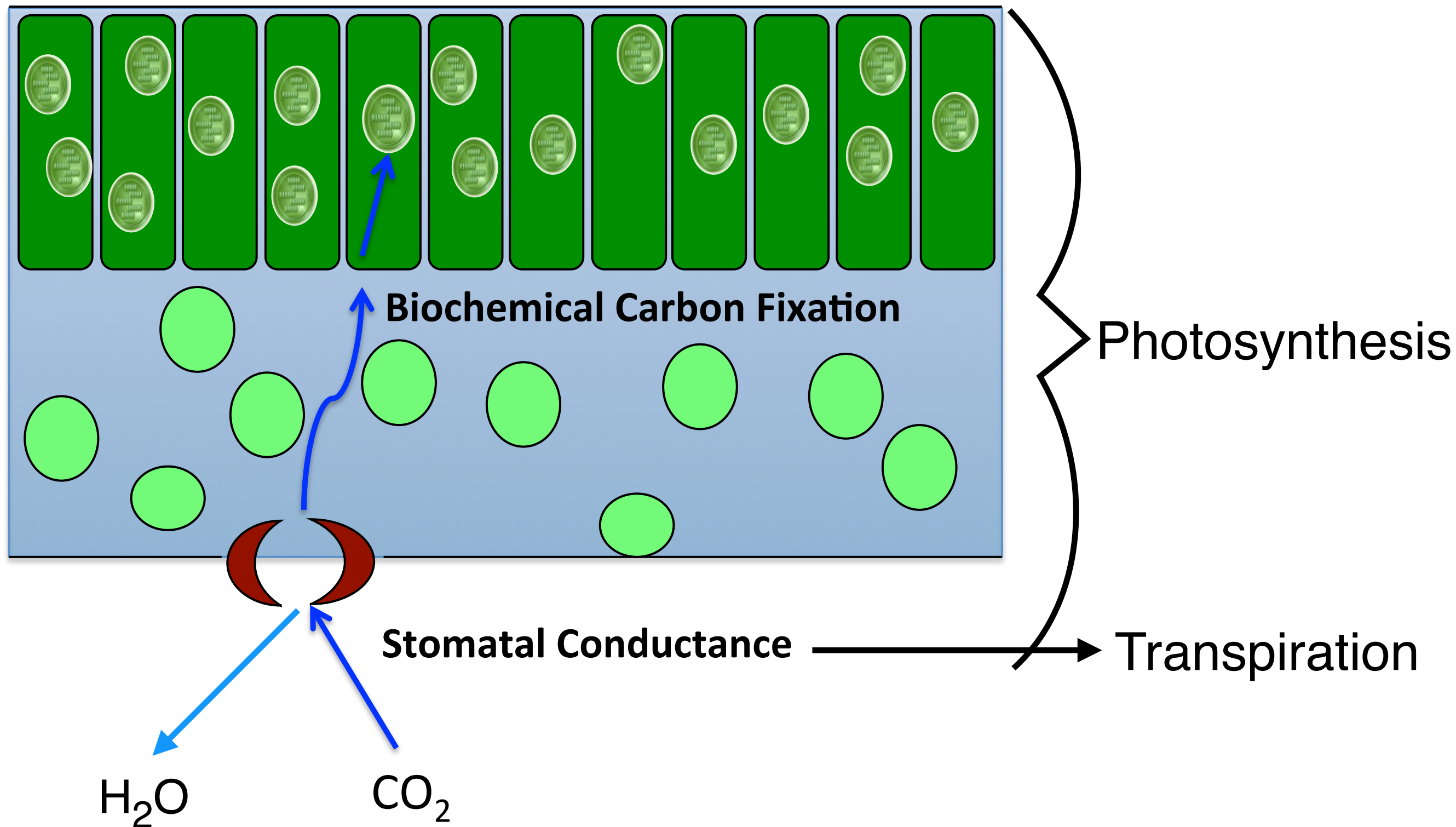


# Leaf Cross-section



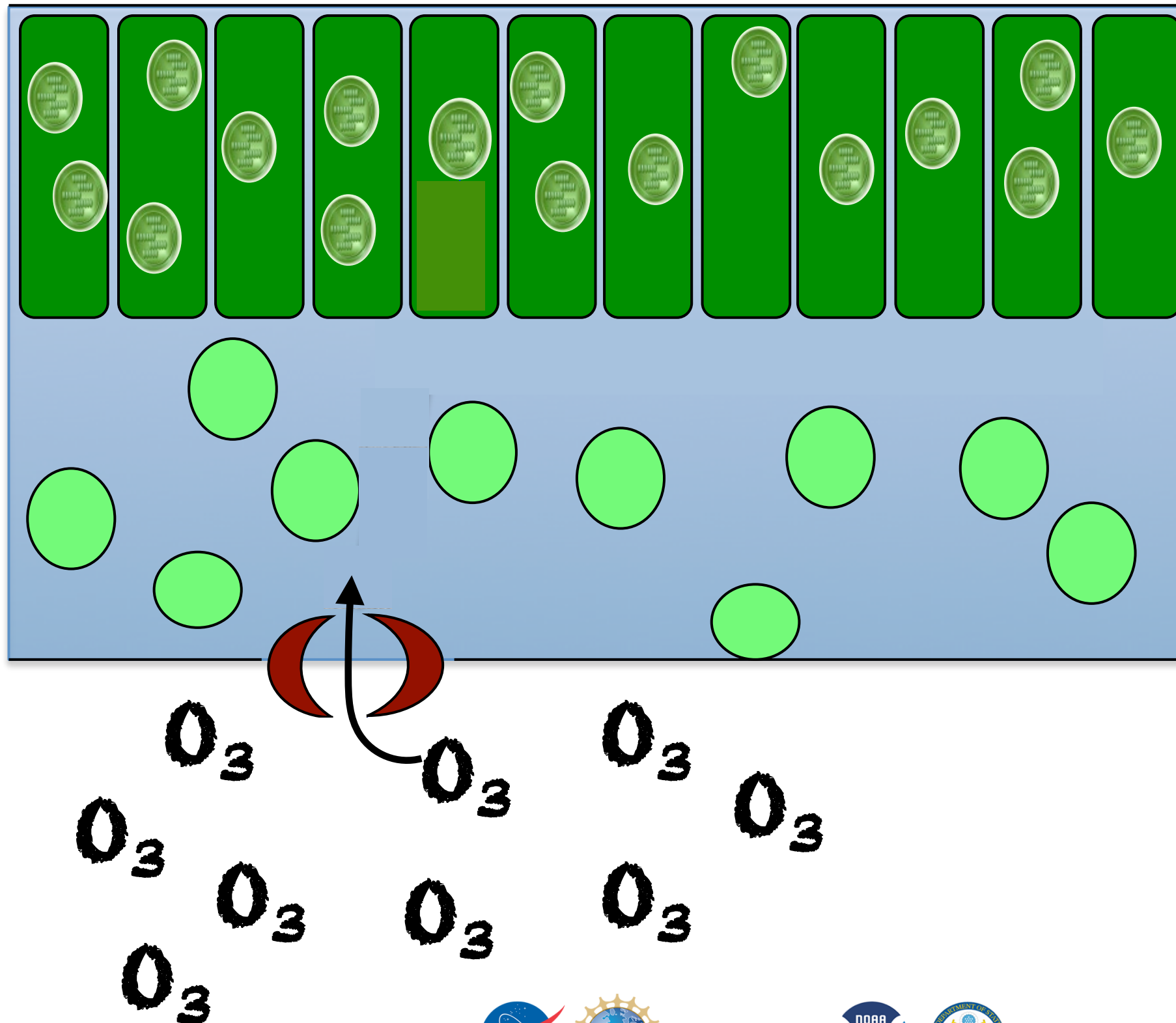


# Leaf Cross-section



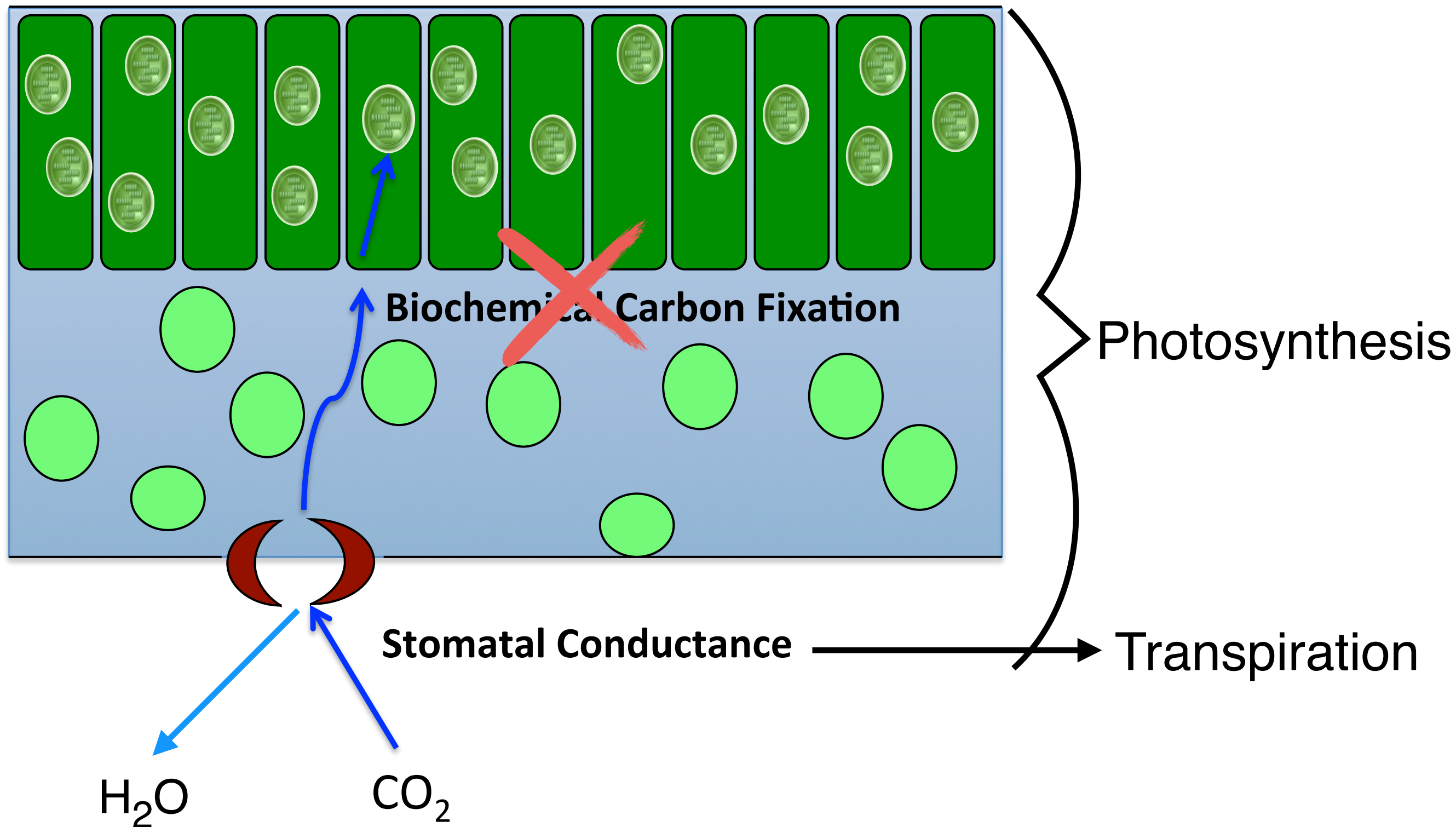


# Leaf Cross-section



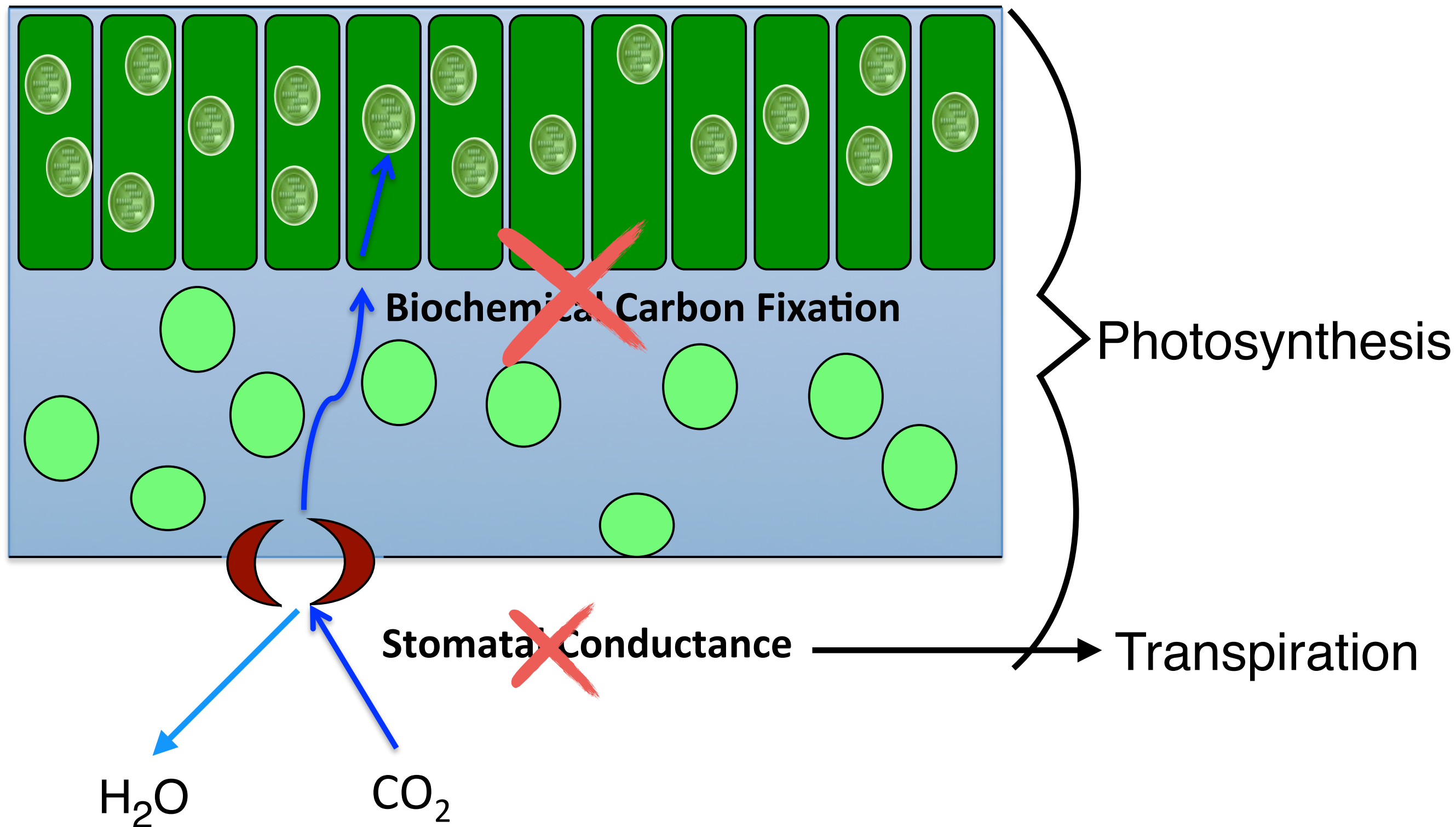


# Leaf Cross-section





# Leaf Cross-section





# Why does plant damage matter?



