Ozone impact and plant defense responses - is there a feedback to air quality?

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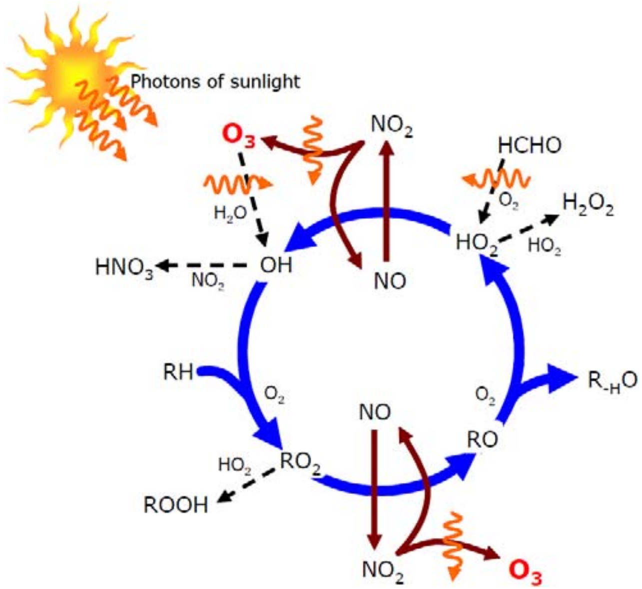
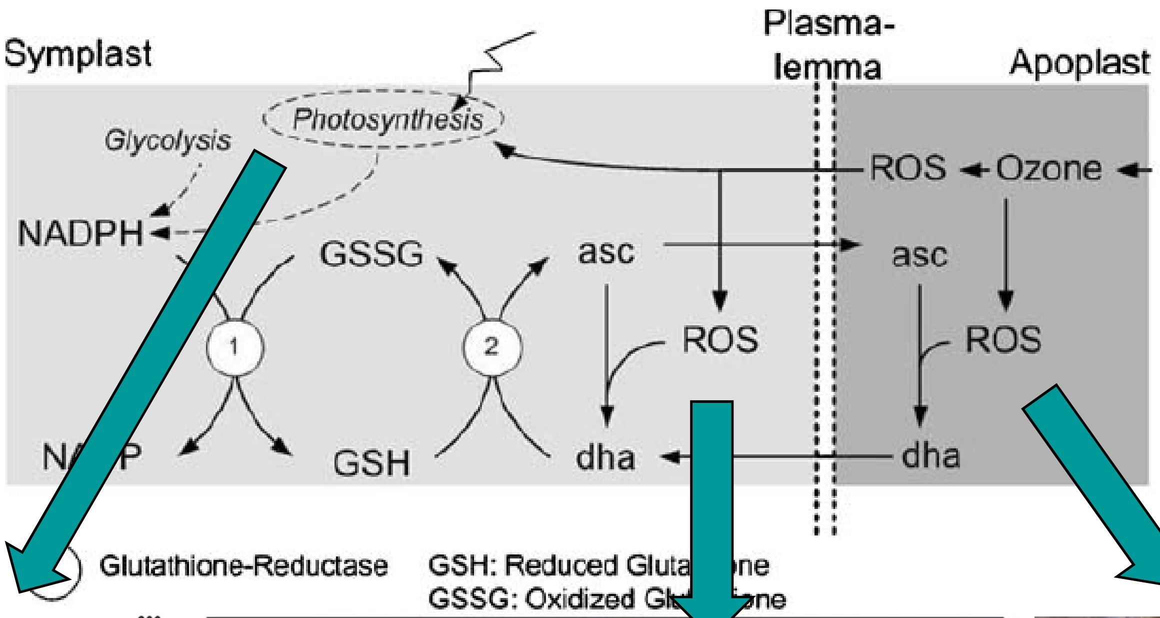
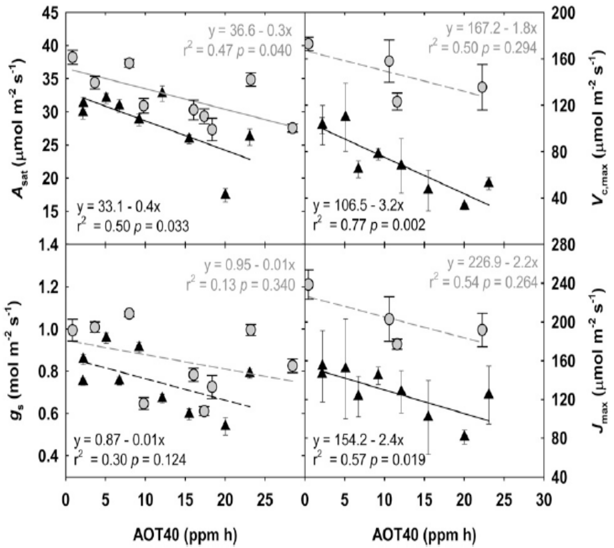


Ozone Plant Impacts

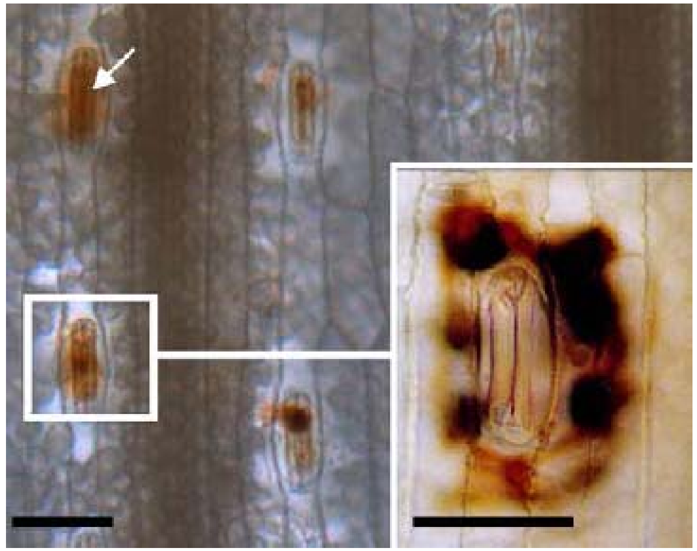


Fuhrer al. 2009 (Naturwiss.)



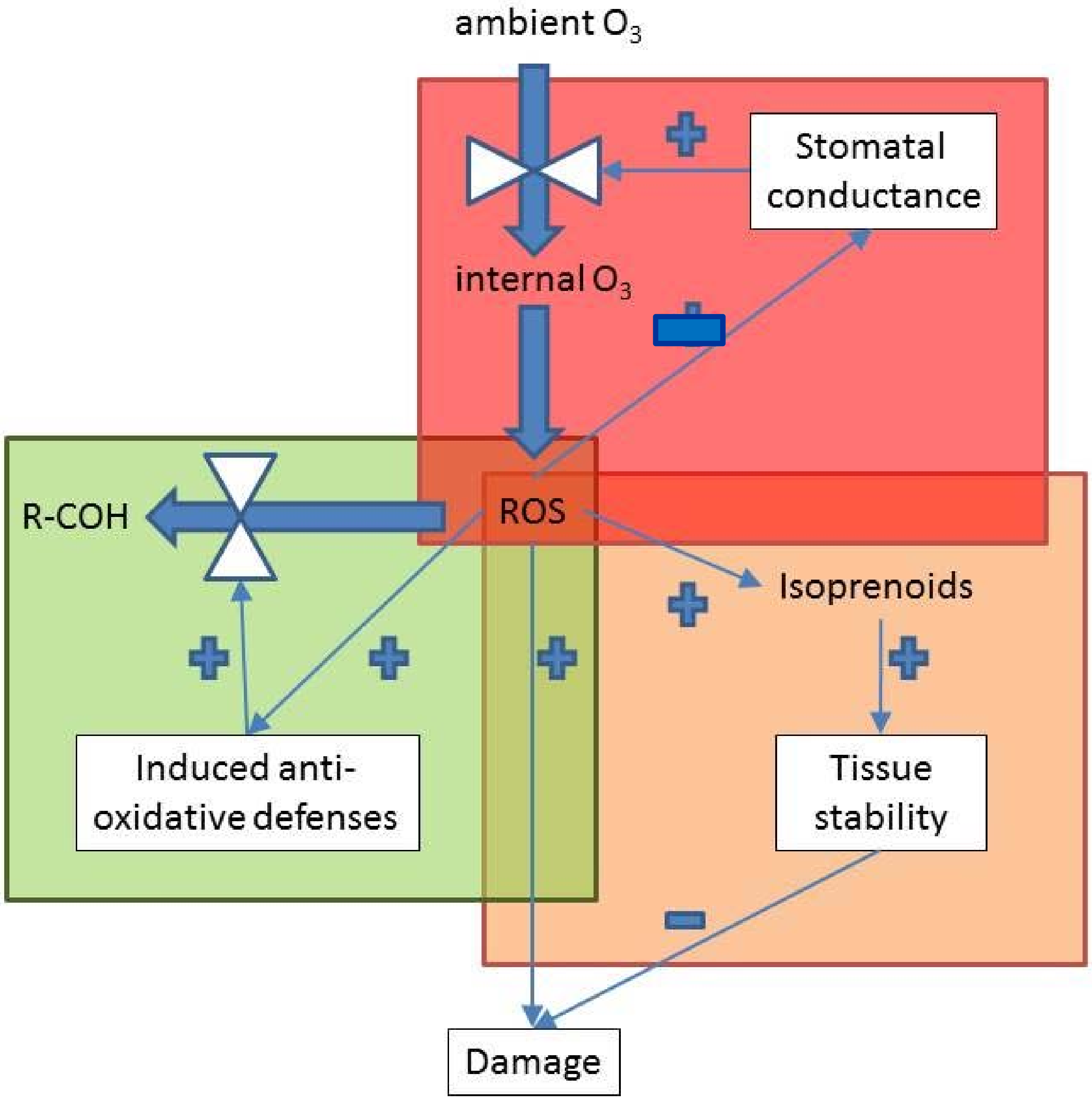
Betzelberger et al. 2012 (PP)

Credit: http://streaming.discoveryeducation.com/ecology-plus.com



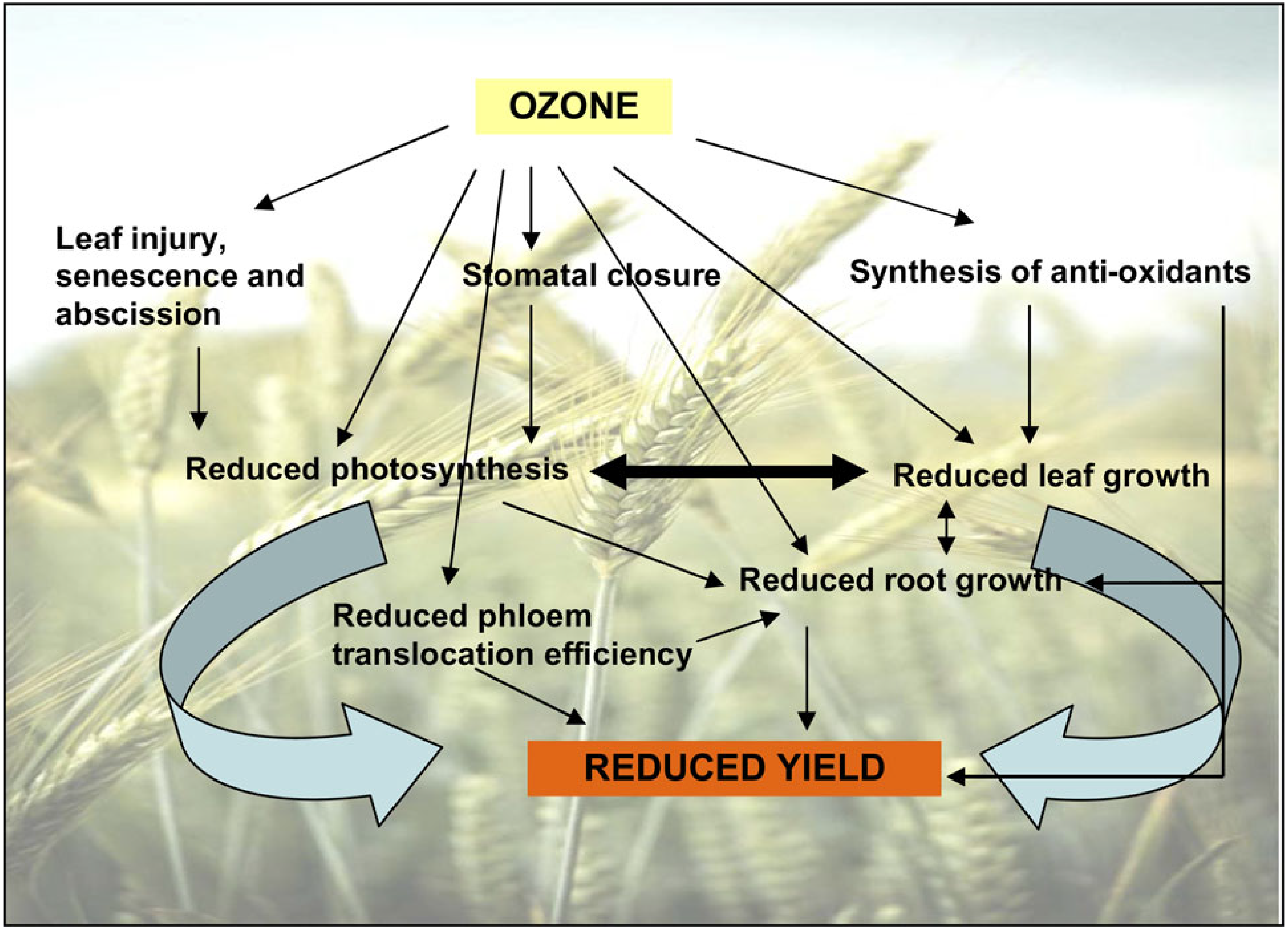
Picchi et al. 2010 (AEE)

Ozone Plant Impacts



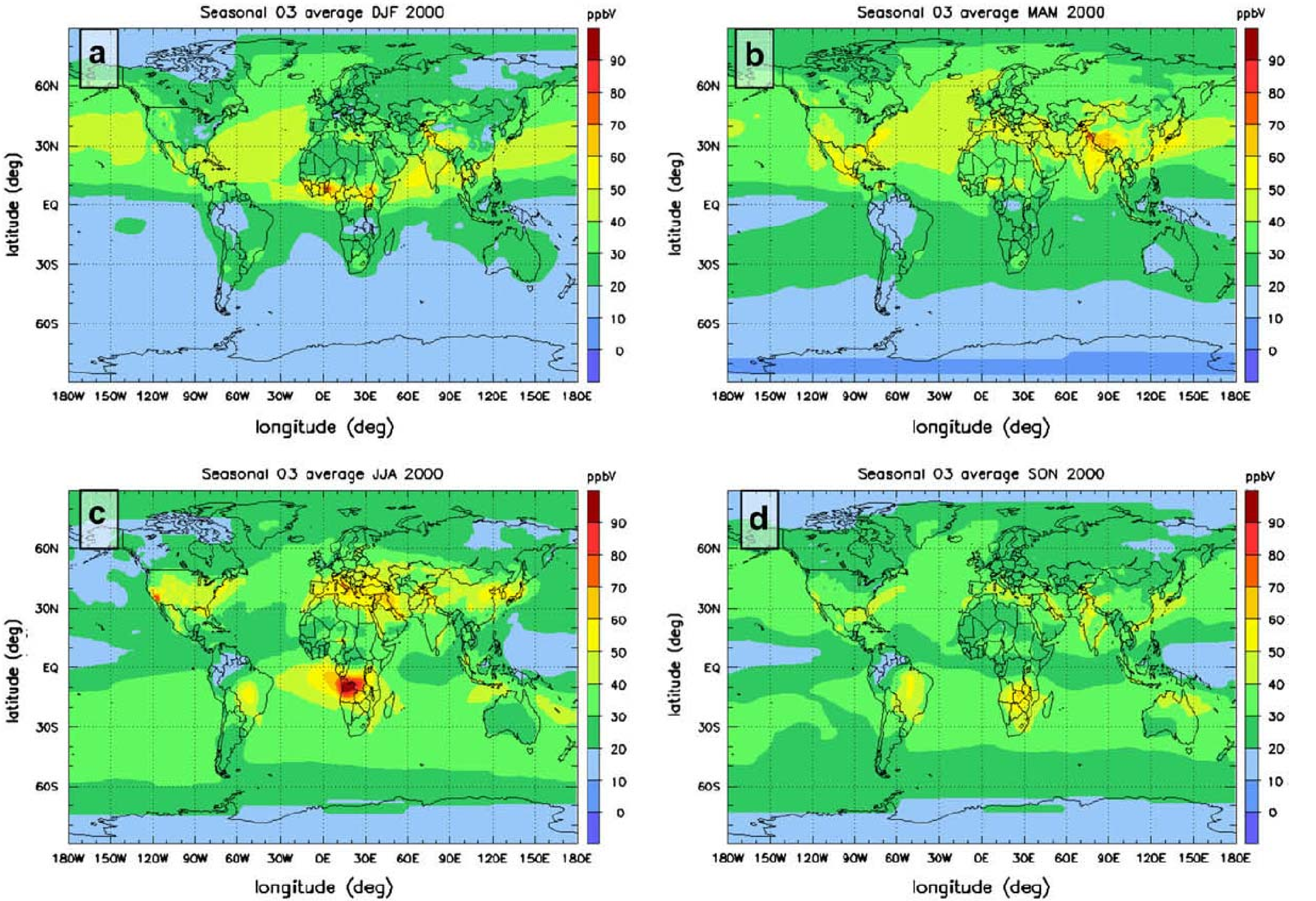
Feedbacks !

Ozone Plant Impacts



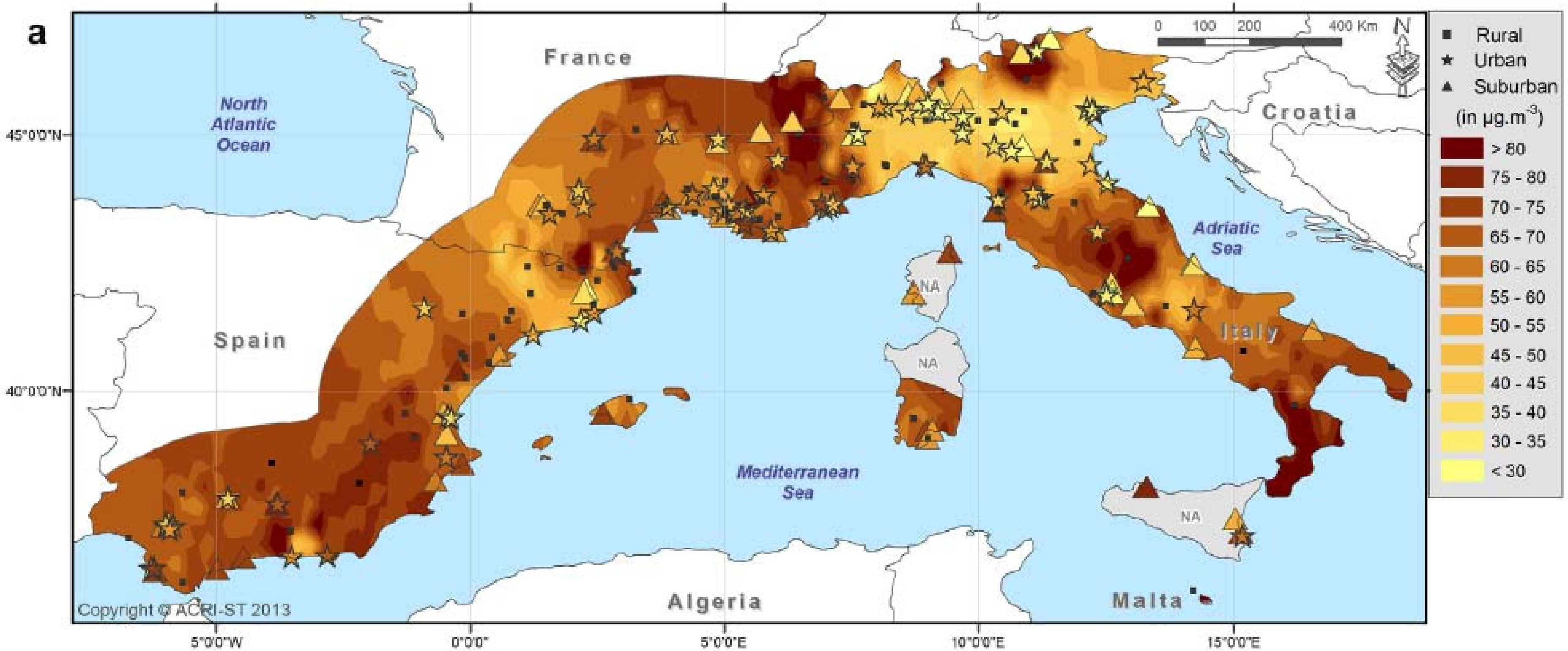
Wilkinson et al. 2012 (JEB)

Ozone Concentrations



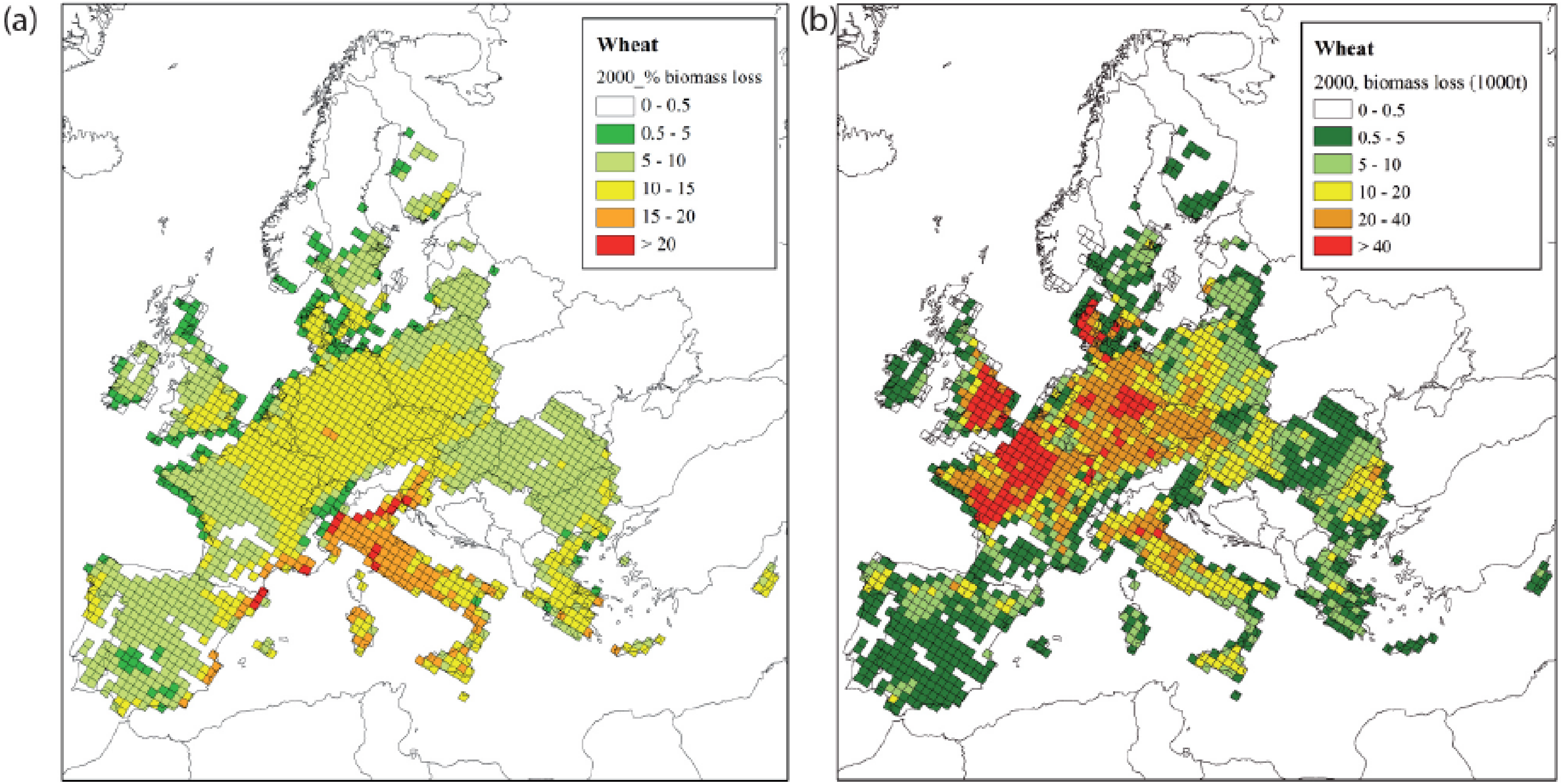
Van Dingenem et al. 2009 (AE)

Ozone Concentrations



Sicard et al. 2013 (AE)

Ozone Impacts



Pleijel et al. 2014 (BG)

Ozone Impacts

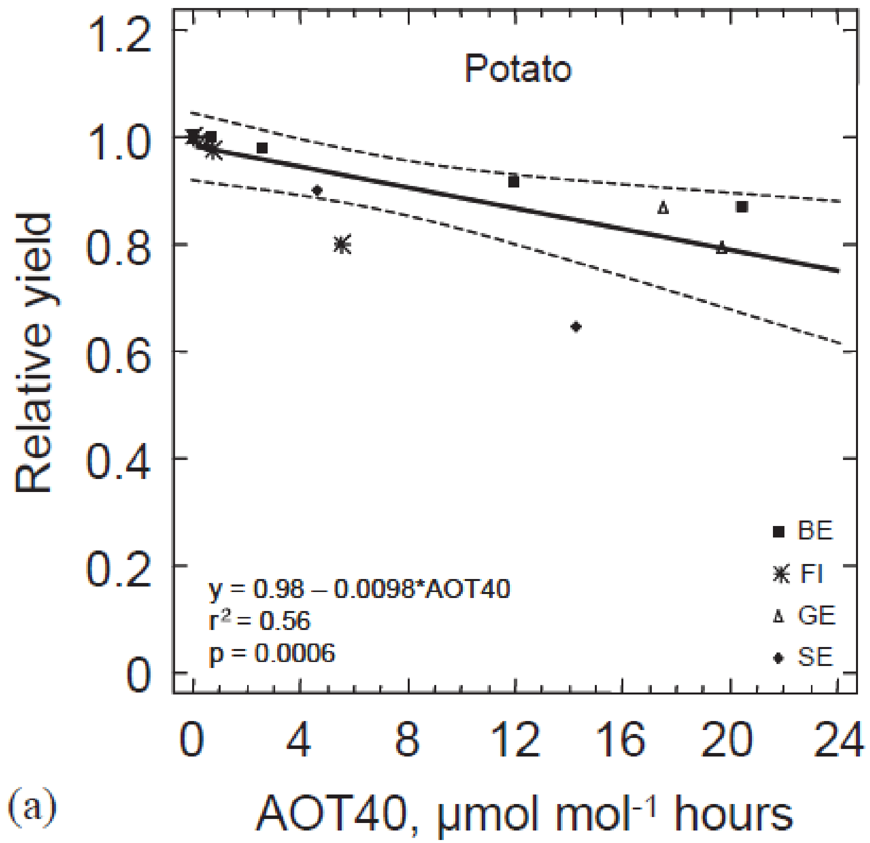
CONTROL	WORLD	N AMERICA	SE ASIA	EUROPE
Wheat				
AOT40	5.8 (6.2) %	6.7 (7.1) %	10.5 (10.4) %	2.0 (2.9) %
M7	3.2 (3.5) %	3.3 (3.8) %	4.5 (4.4) %	2.6 (3.2) %
W126	1.2 (1.5) %	1.4 (1.7) %	2.4 (2.7) %	0.2 (0.7) %
Rice				
AOT40	1.4 (1.4) %	3.2 (3.4) %	1.6 (1.6) %	0.7 (1.0) %
M7	0.9 (0.9) %	1.6 (1.8) %	1.1 (1.1) %	0.9 (1.2) %
Maize				
AOT40	2.5 (2.6) %	3.5 (3.7) %	3.1 (3.1) %	0.7 (1.0) %
M12	3.4 (3.7) %	3.9 (4.4) %	4.5 (4.5) %	2.6 (3.1) %
W126	0.04 (0.06) %	0.05 (0.08) %	0.07 (0.08) %	0.0004 (0.004) %
Soybean				
AOT40	7.1 (7.5) %	11.8 (12.5) %	8.6 (8.4) %	2.6 (3.8) %
M12	10.5 (11.4) %	15.1 (16.3) %	13.7 (13.5) %	10.3 (11.9) %
W126	2.6 (2.9) %	4.3 (4.9) %	3.0 (3.3) %	0.9 (1.9) %
Cotton				
AOT40	11.2 (12.0) %	16.1 (17.1) %	13.4 (13.2) %	7.9 (11.6) %
Potato				
AOT40	1.9 (2.0) %	2.5 (2.6) %	4.5 (4.4) %	0.4 (0.7) %

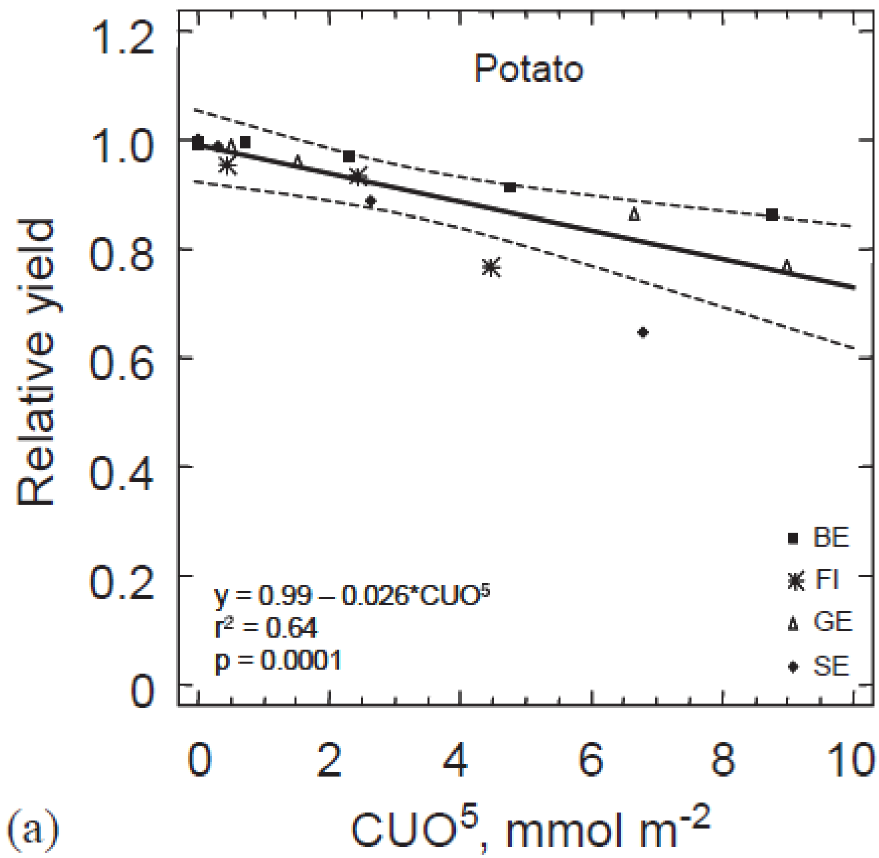
Global losses:

Maize: app. 3%
Wheat: app. 5%
Soybean: app. 8%

Hollaway et al. 2012 (BG)

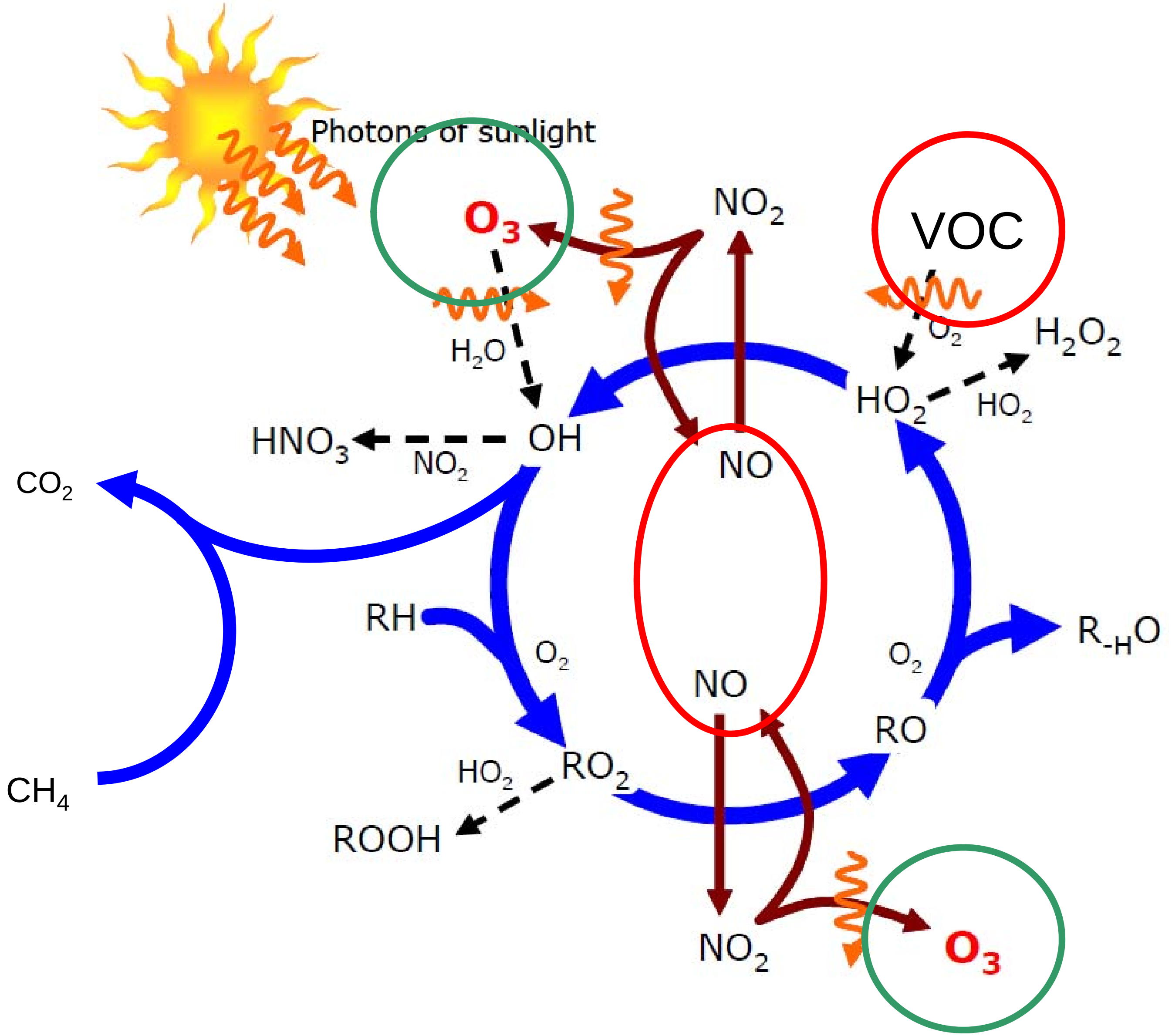
Ozone Impacts





Pleijel et al. 2004 (AE)

Ozone Formation



Ozone Formation

VOC = Volatile Organic Compounds

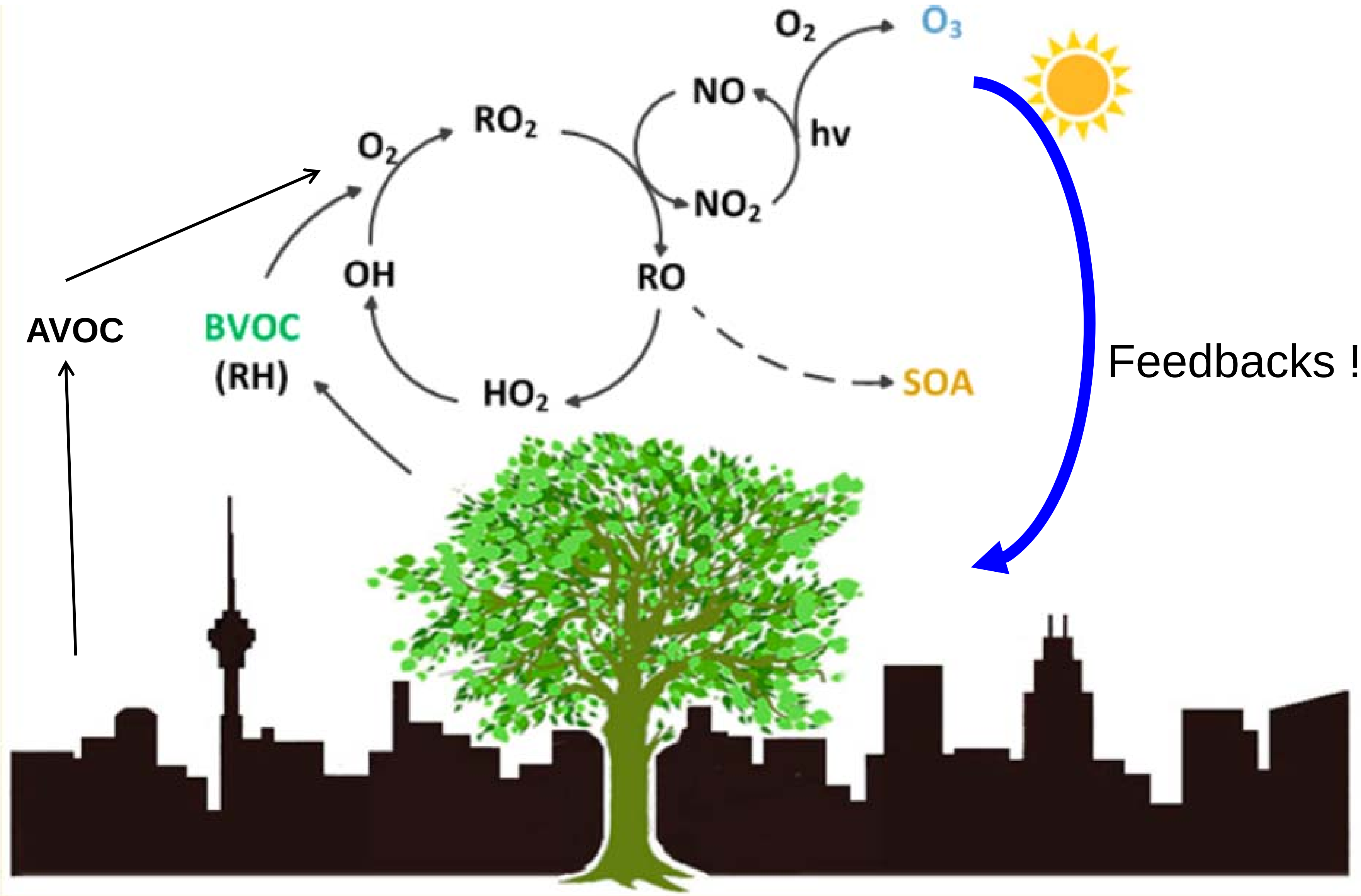
Ozone production potential of selected anthropogenic and biogenic VOCs. Data from (Carter, 1995; Carter, 2000).

Compound	Maximum Incremental Reactivity (MIR) ($g\ O_3 / g\ VOC$)
Carbon monoxide (CO)	0.057
Ethene	9.07
Propene	11.57
Benzene	0.81
Toluene	3.97
Formaldehyde	8.96
Acetaldehyde	6.83
Methanol	0.69
Isoprene	10.68
a-pinene	4.29
MBO	5.08
US urban mix	3.7

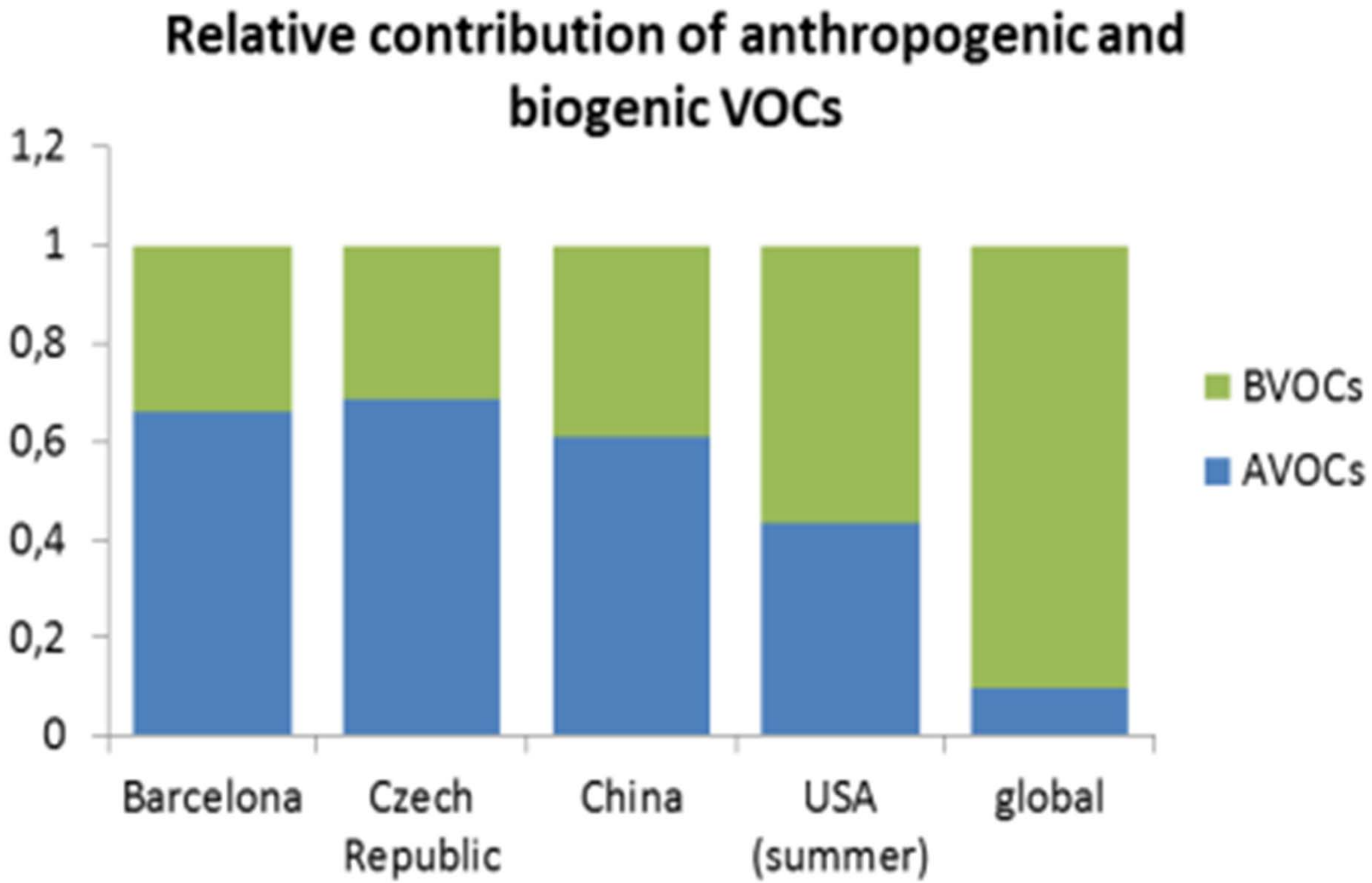
Anthropogenic (AVOC)

Biogenic (BVOC)

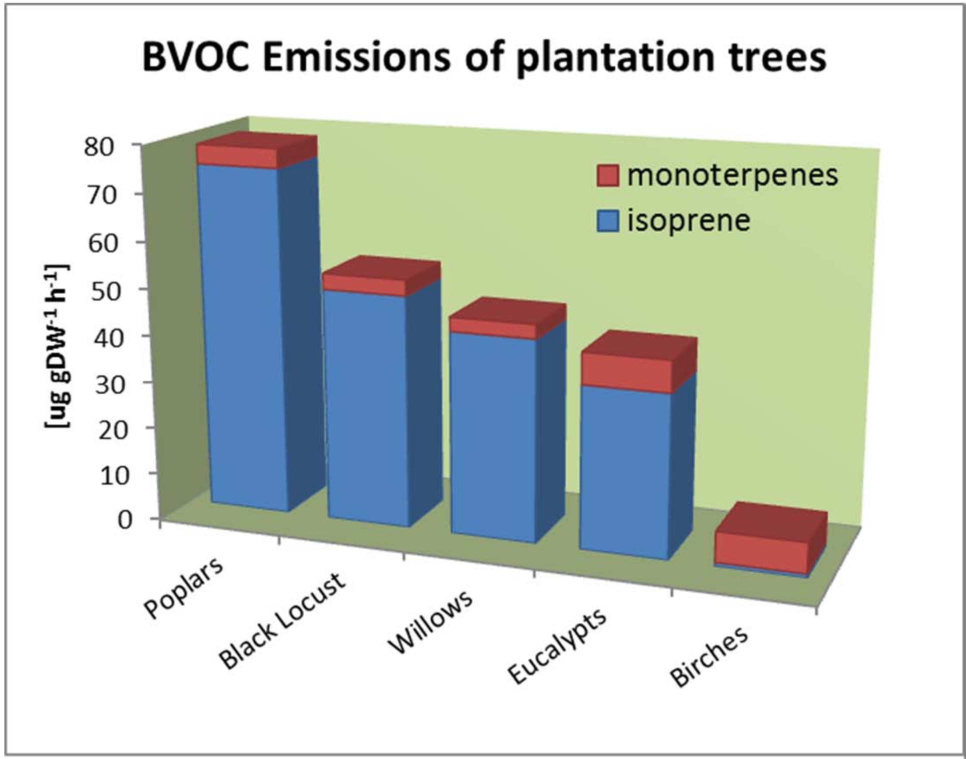
Plant – Atmosphere Feedback

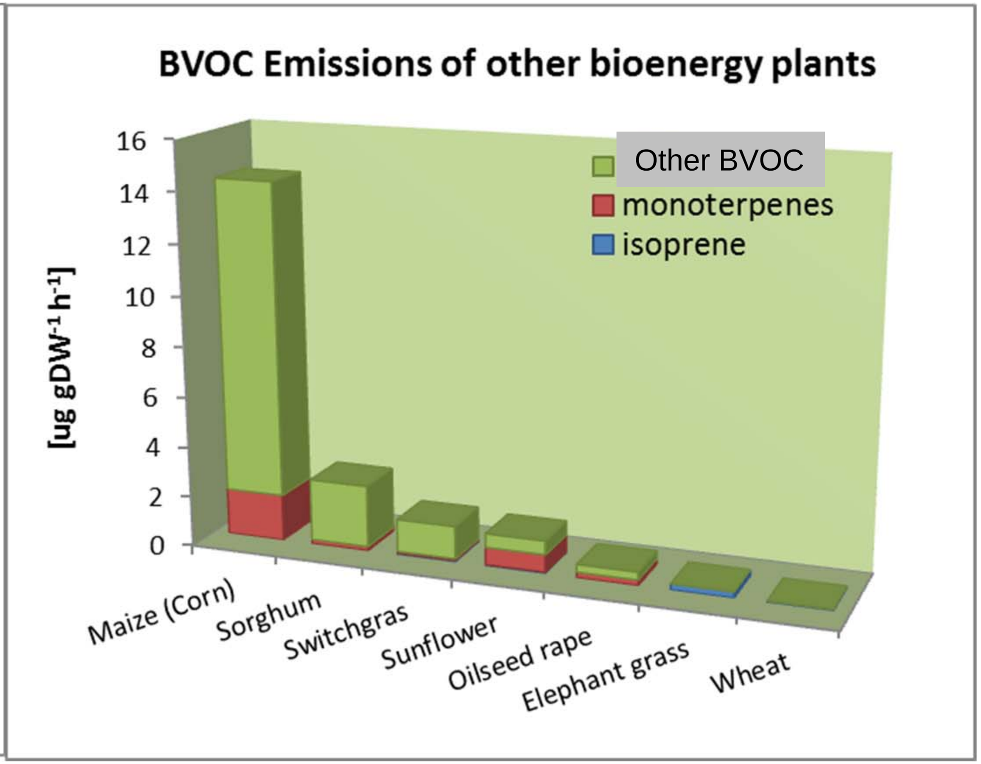


Plant – Atmosphere Feedback

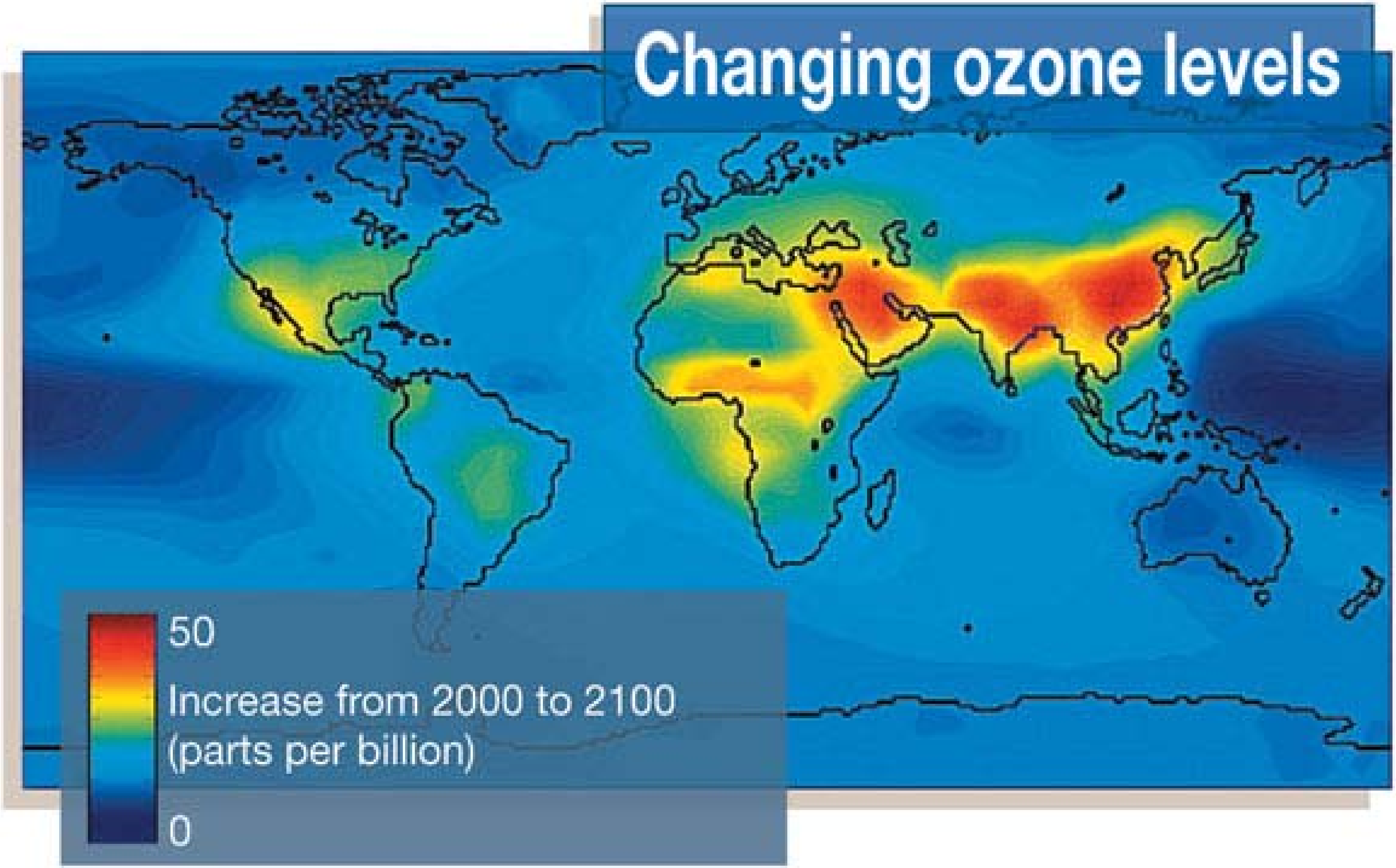


Plant – Atmosphere Feedback



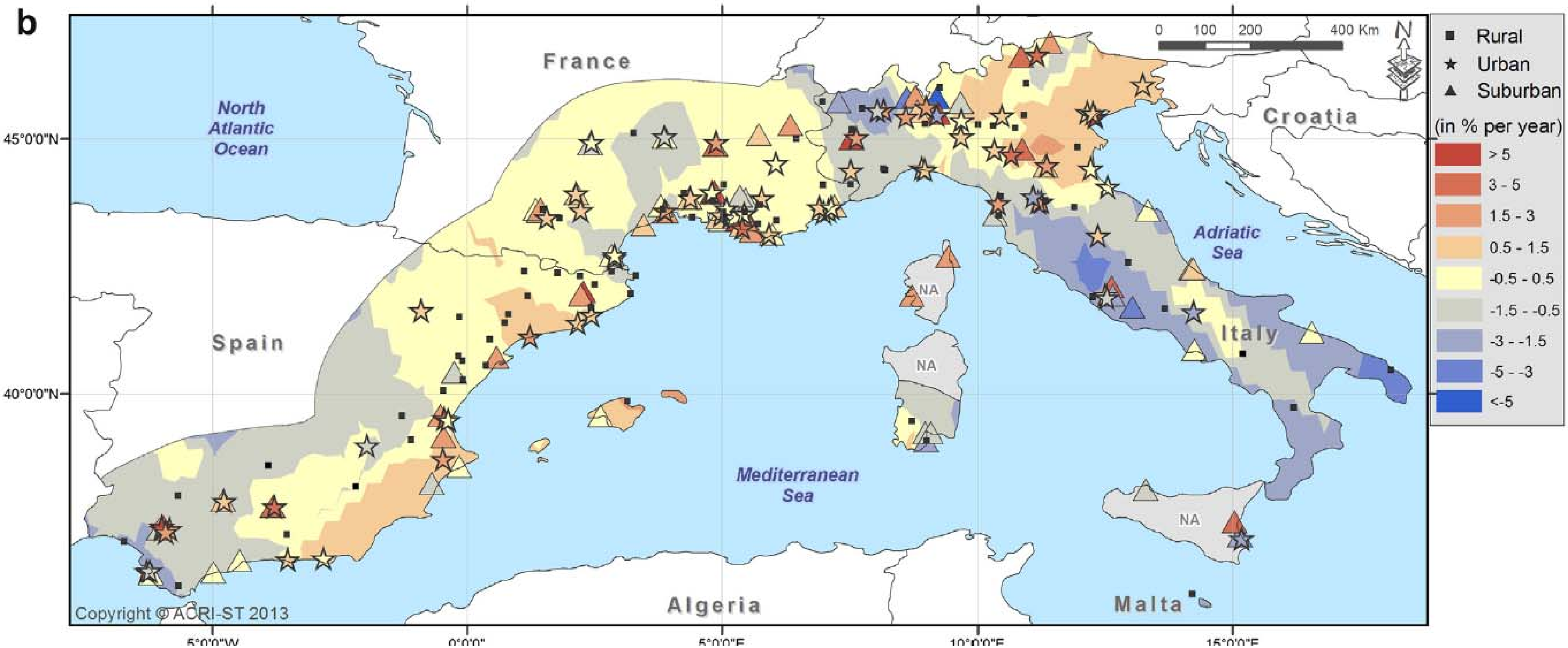


Developments



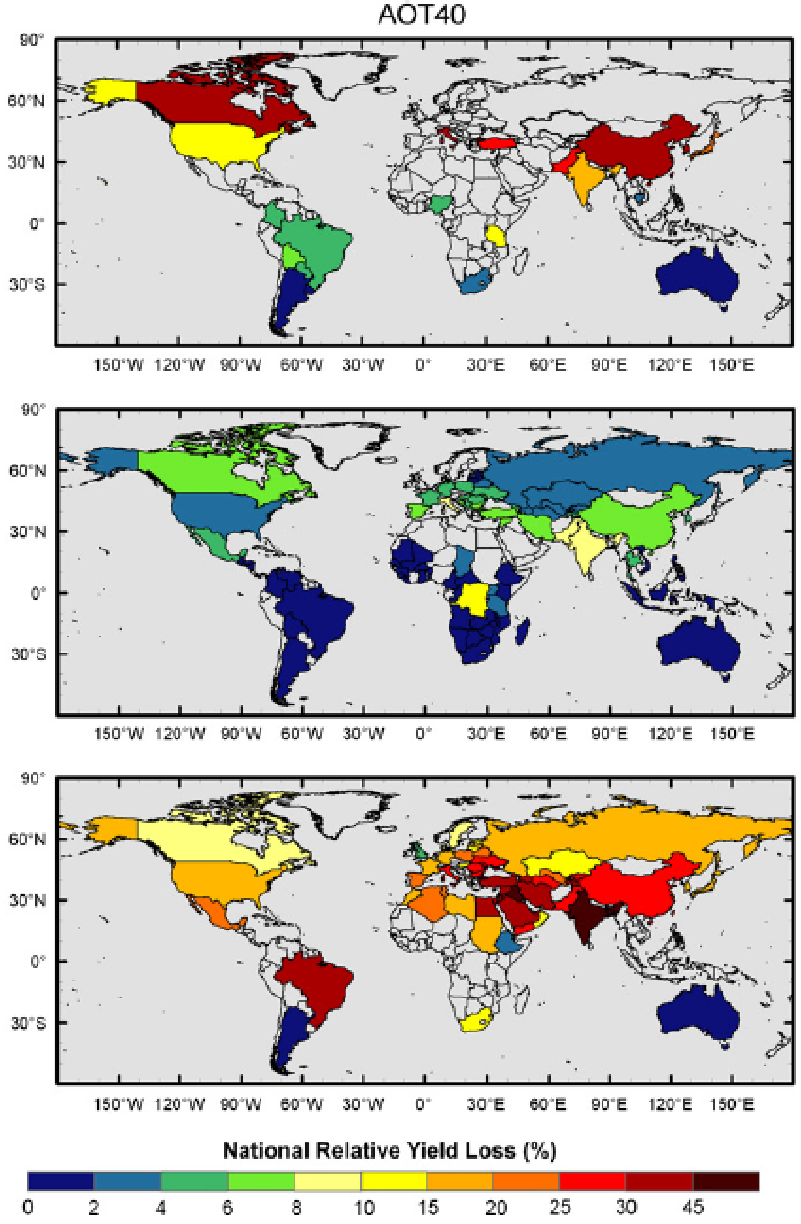
Giles 2005 (Nature)

Developments



Sicard et al. 2013 (AE)

Developments



Soybean

Maize

Wheat

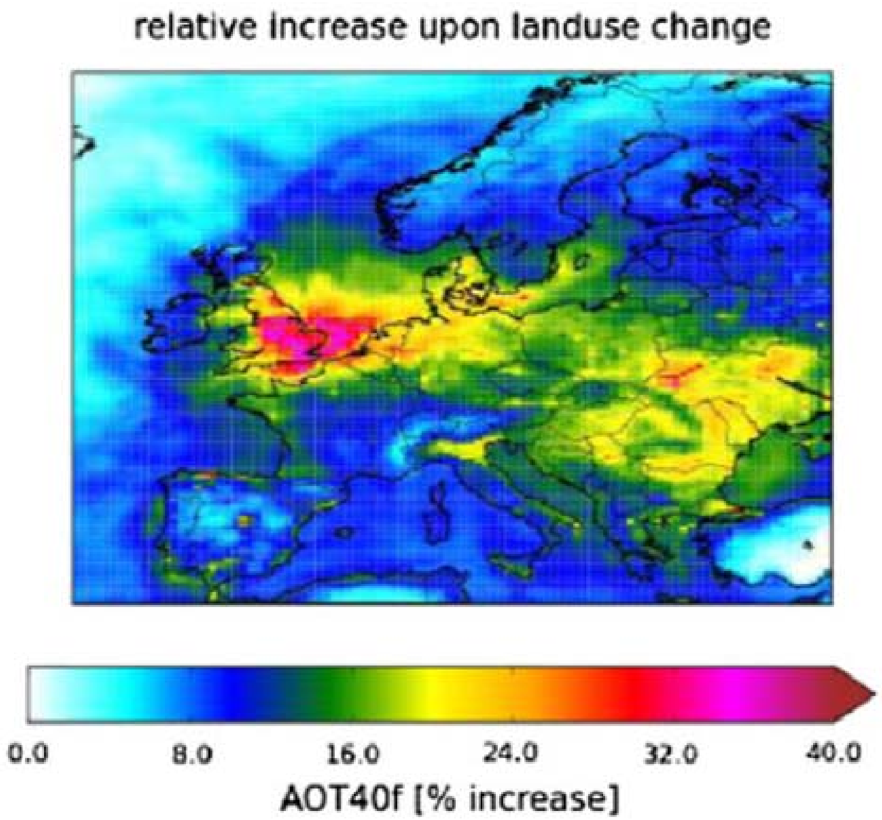
Global losses:

Maize: app. 5%
Wheat: app. 25%
Soybean: app. 19%

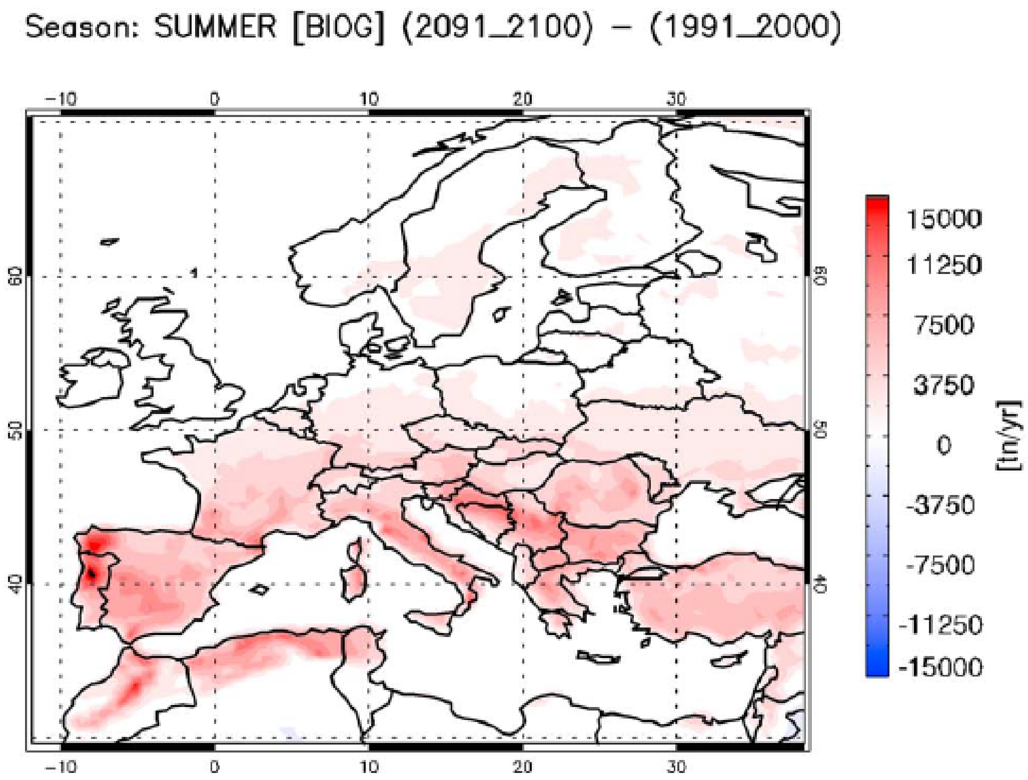
Avnery et al. 2011 (AE)

Developments

Land use change



Climate change



Beltman et al. 2013 (AE)

Katragkou et al. 2011 (JGR)

Conclusions

- Sensitivity to ozone is species specific

  (Stomatal regulation, induced defenses)

  → Adaptation: Plant BVOC emitters!

- Ozone will increase depending on climate change and land use

  (Forests > bioenergy plants > conventional agriculture)

  → Mitigation: Don‘t plant BVOC emitters!

- <u>Ozone losses are significant and will increase</u>

The End