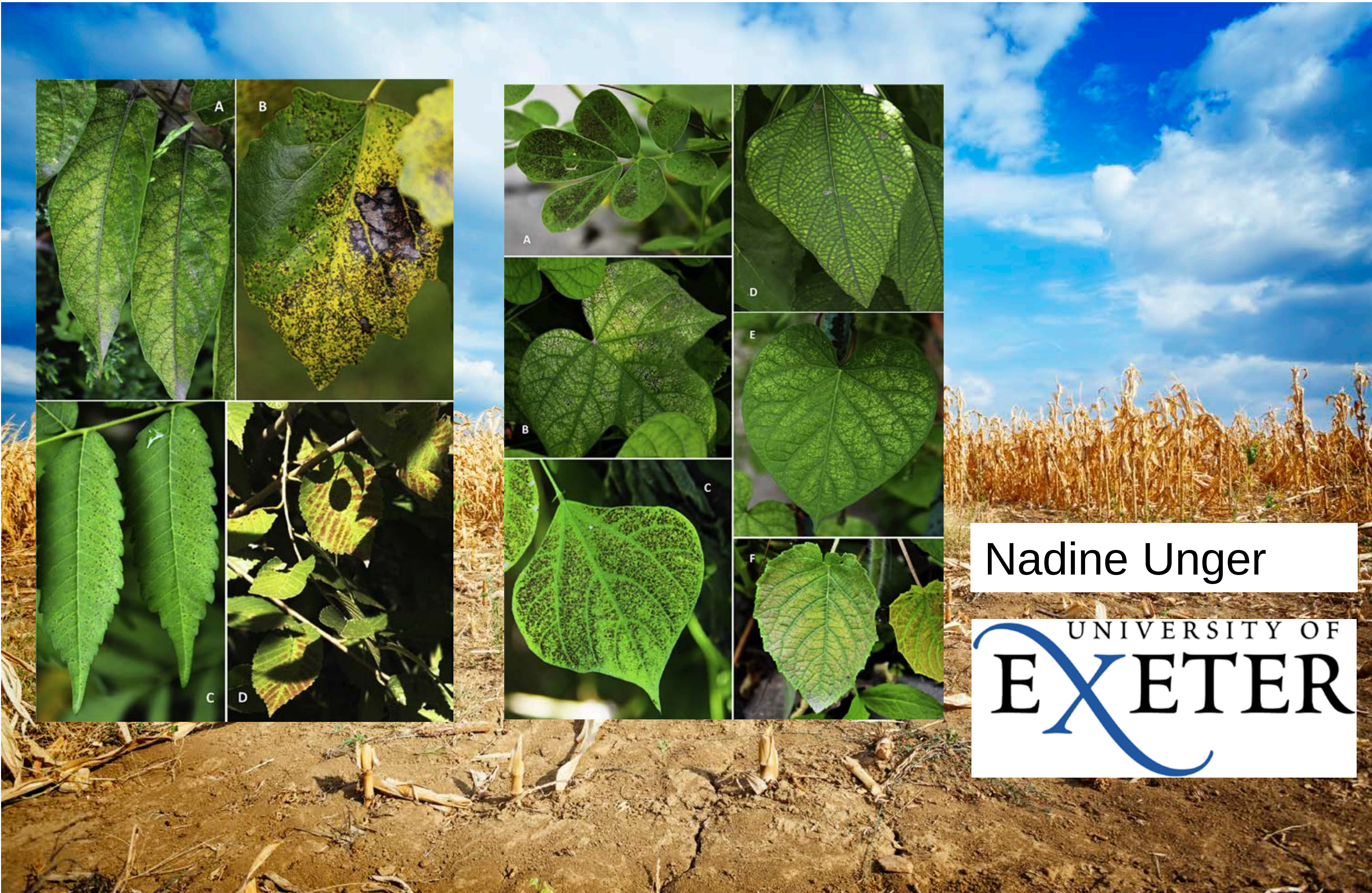
Ozone pollution impacts on forests and crops in China



Nadine Unger

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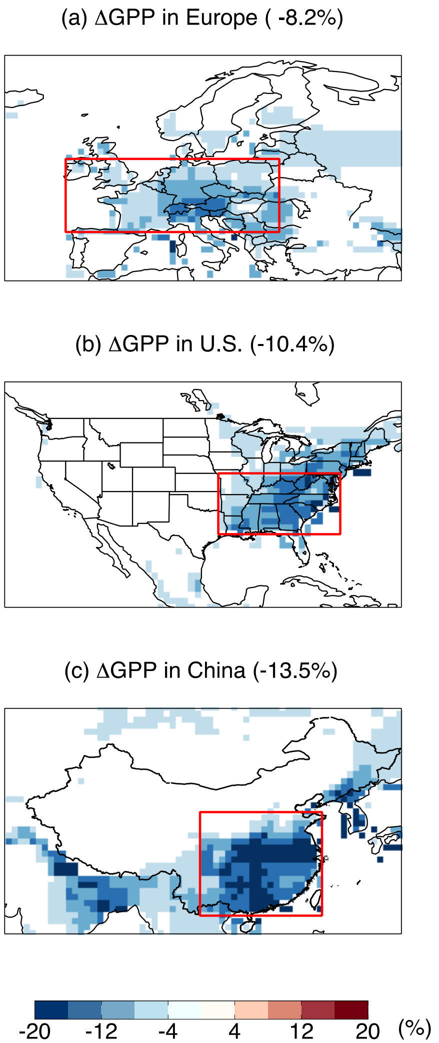
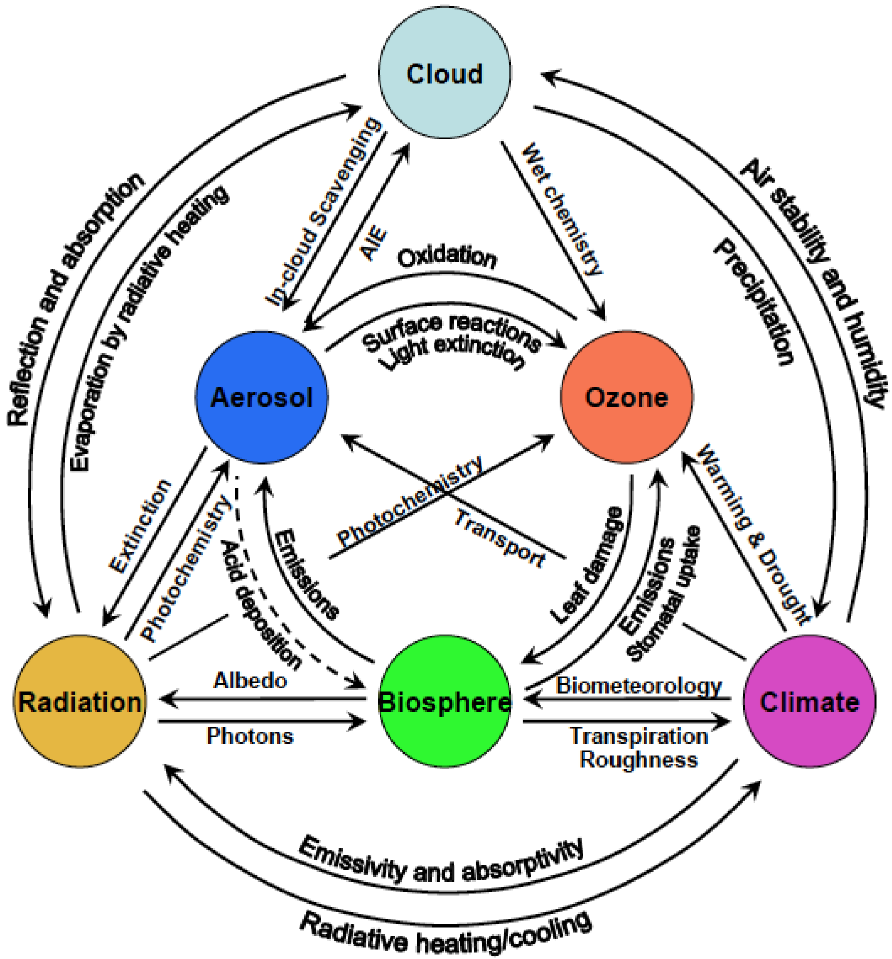
Air pollution effects on the terrestrial carbon cycle

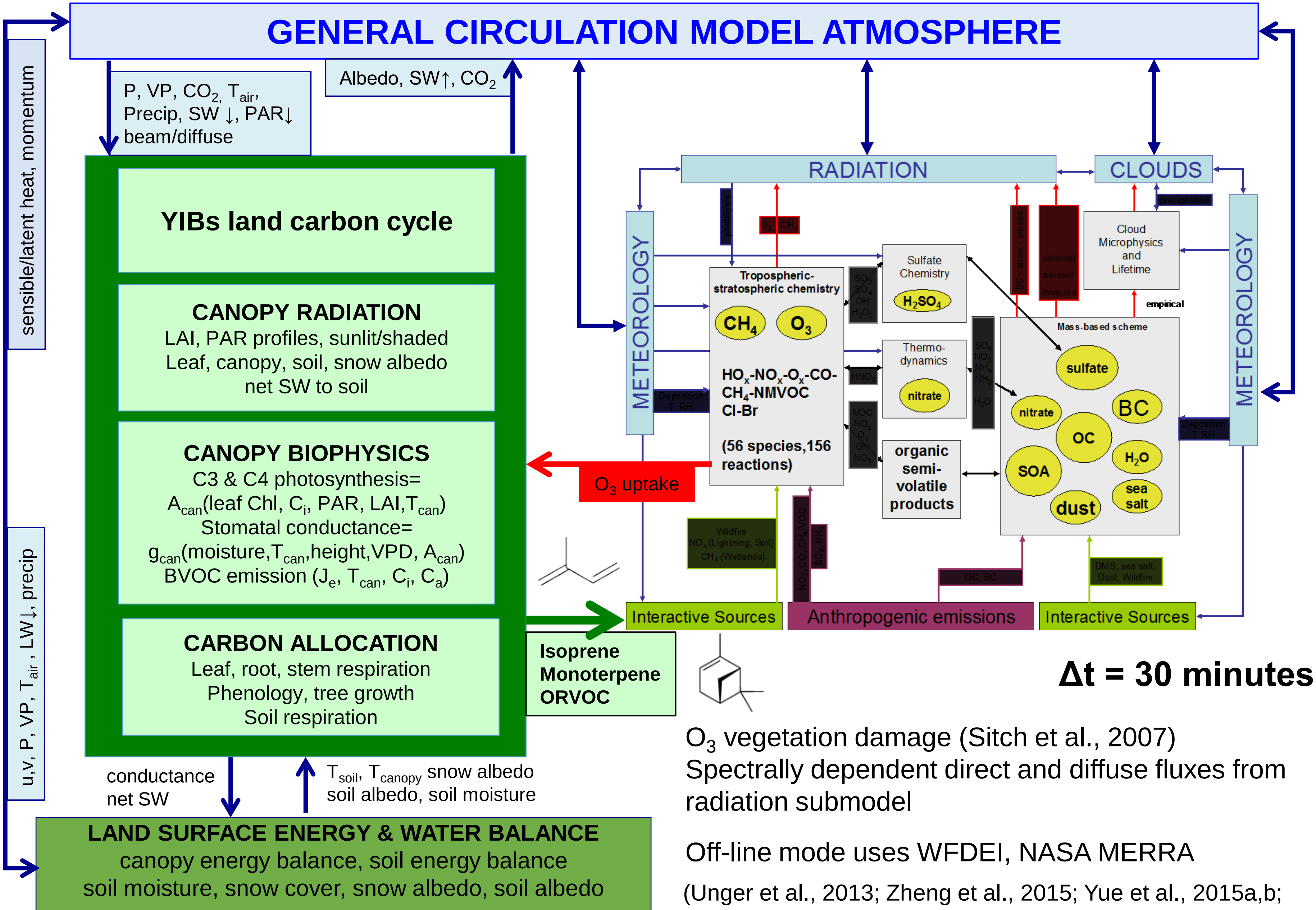
Chronic ozone exposure effects on
JJA GPP 2000-2011 in YIBs model





(Jones et al., 2003; Sitch et et al., 2007; Cox et al., 2008; Mercado et al., 2009; Huntingford et al., 2011; Mahowald et al., 2011; Yue and Unger, 2014; 2015, 2017; Yue et al., 2015; 2017; Lombardozzi et al., 2015; Rap et al., 2015; Strada and Unger, 2016)

NASA ModelE2-YIBS global carbon-chemistry-climate model



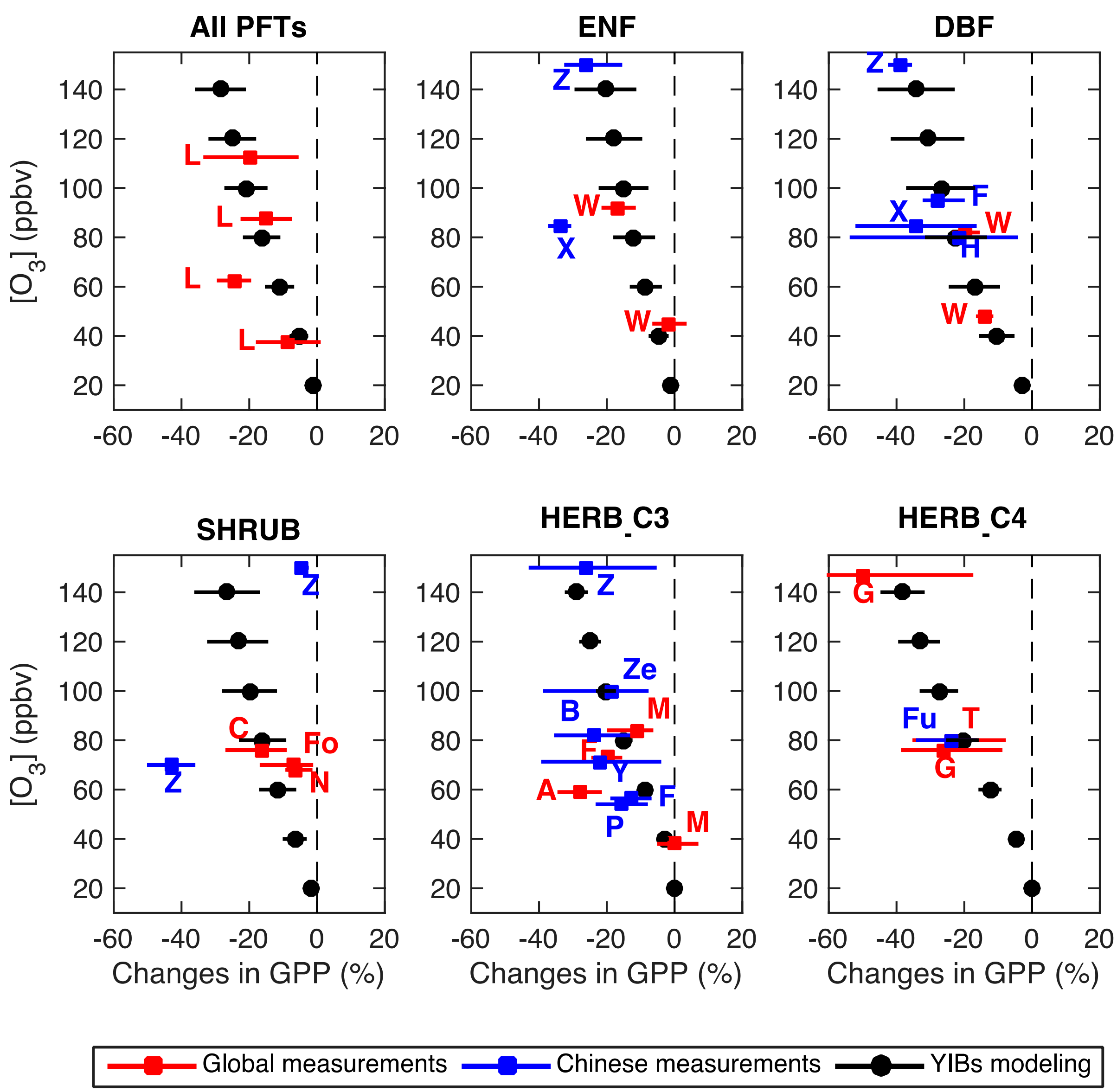
O_3 vegetation damage (Sitch et al., 2007)

Spectrally dependent direct and diffuse fluxes from radiation submodel

Off-line mode uses WFDEI, NASA MERRA

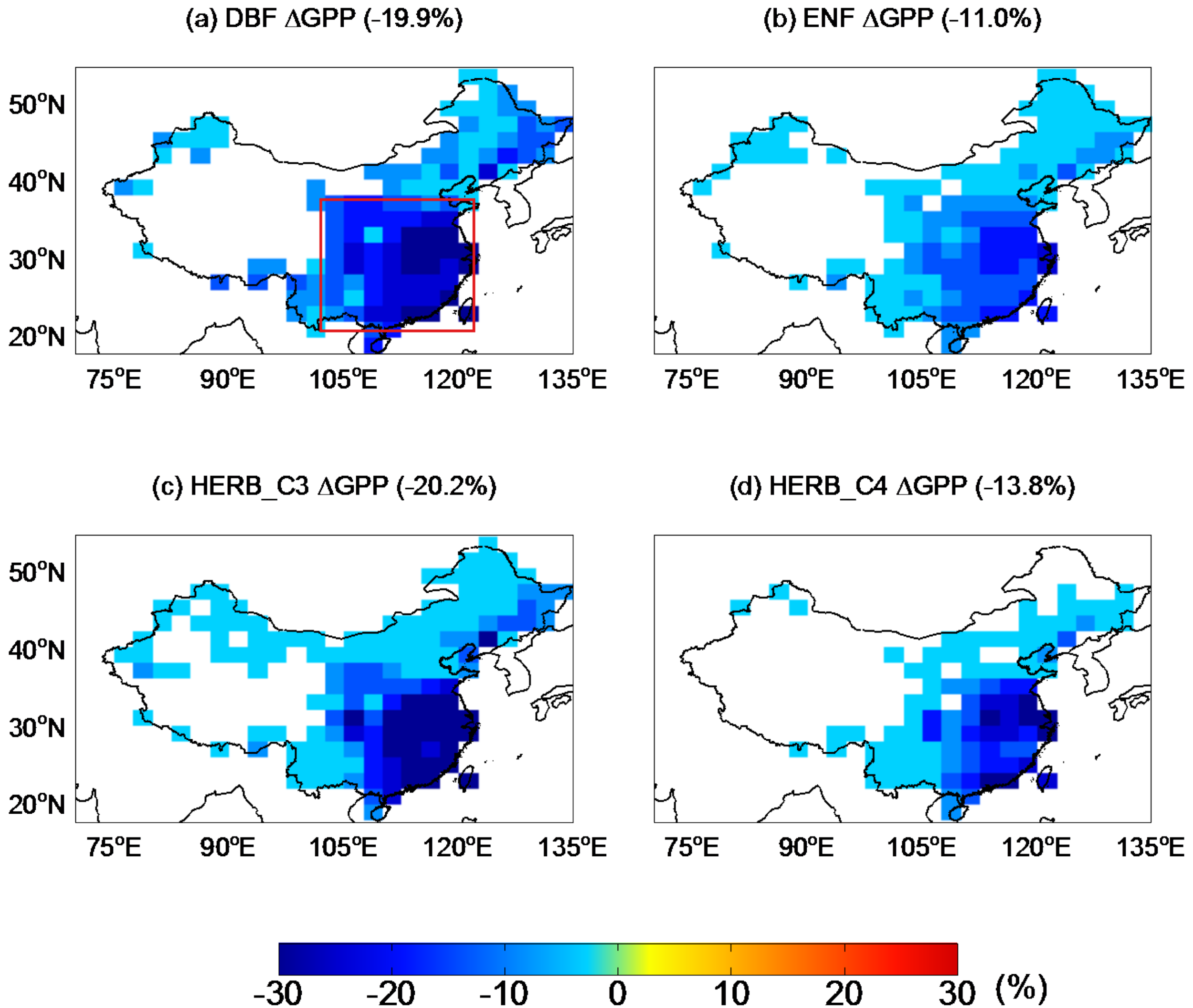
(Unger et al., 2013; Zheng et al., 2015; Yue et al., 2015a,b; Yue and Unger, 2014; 2015; 2017; Yue et al, 2017)

Ozone damage function is realistic compared with available measurement data



(Yue and Unger, ACP, 2014; Yue et al., ACP, 2017)

Ozone damage to GPP in China today



JJA

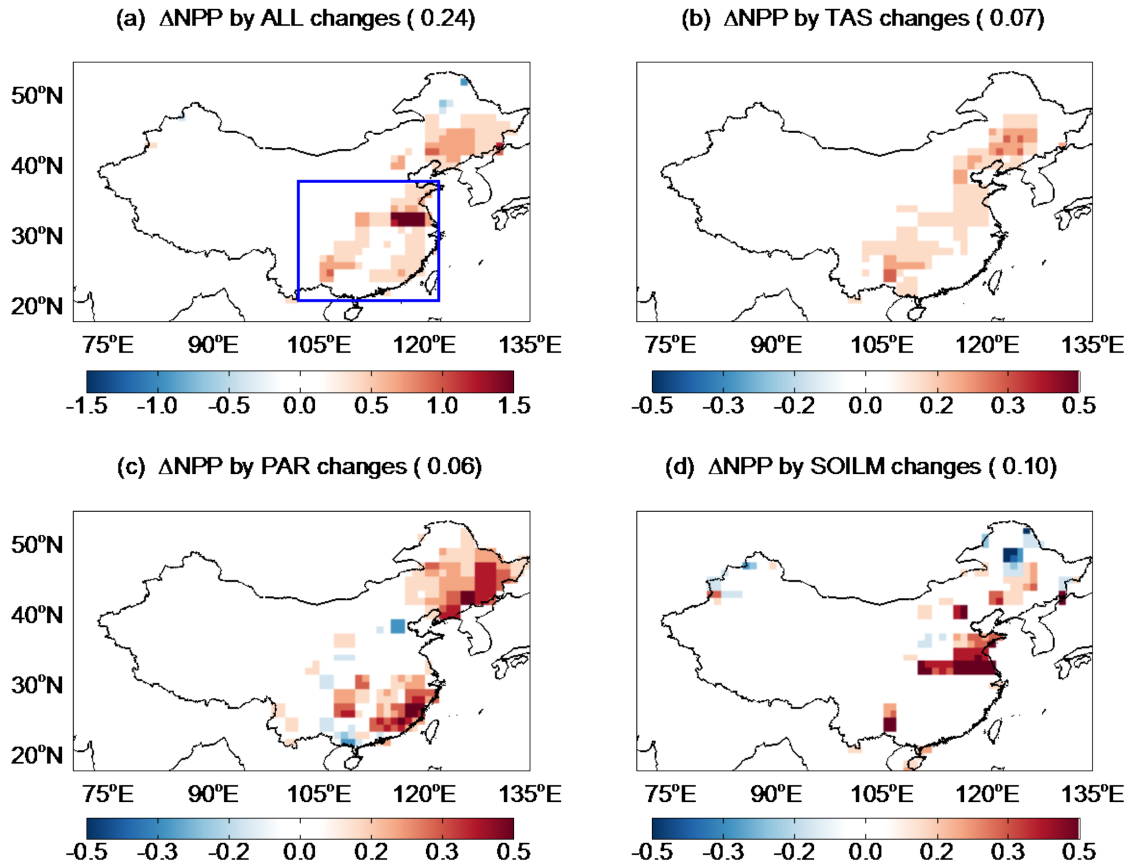
- Strong GPP damage in summer ozone season (20% losses for deciduous trees and C3 herbs)
- Annual average NPP reduction of 0.6 PgC/yr (0.4 - 0.8 PgC/yr; ~14%)

(Yue et al., ACP, 2017)

Aerosol-induced meteorological impacts on NPP in China

Units: gC m^{-2} day^{-1}

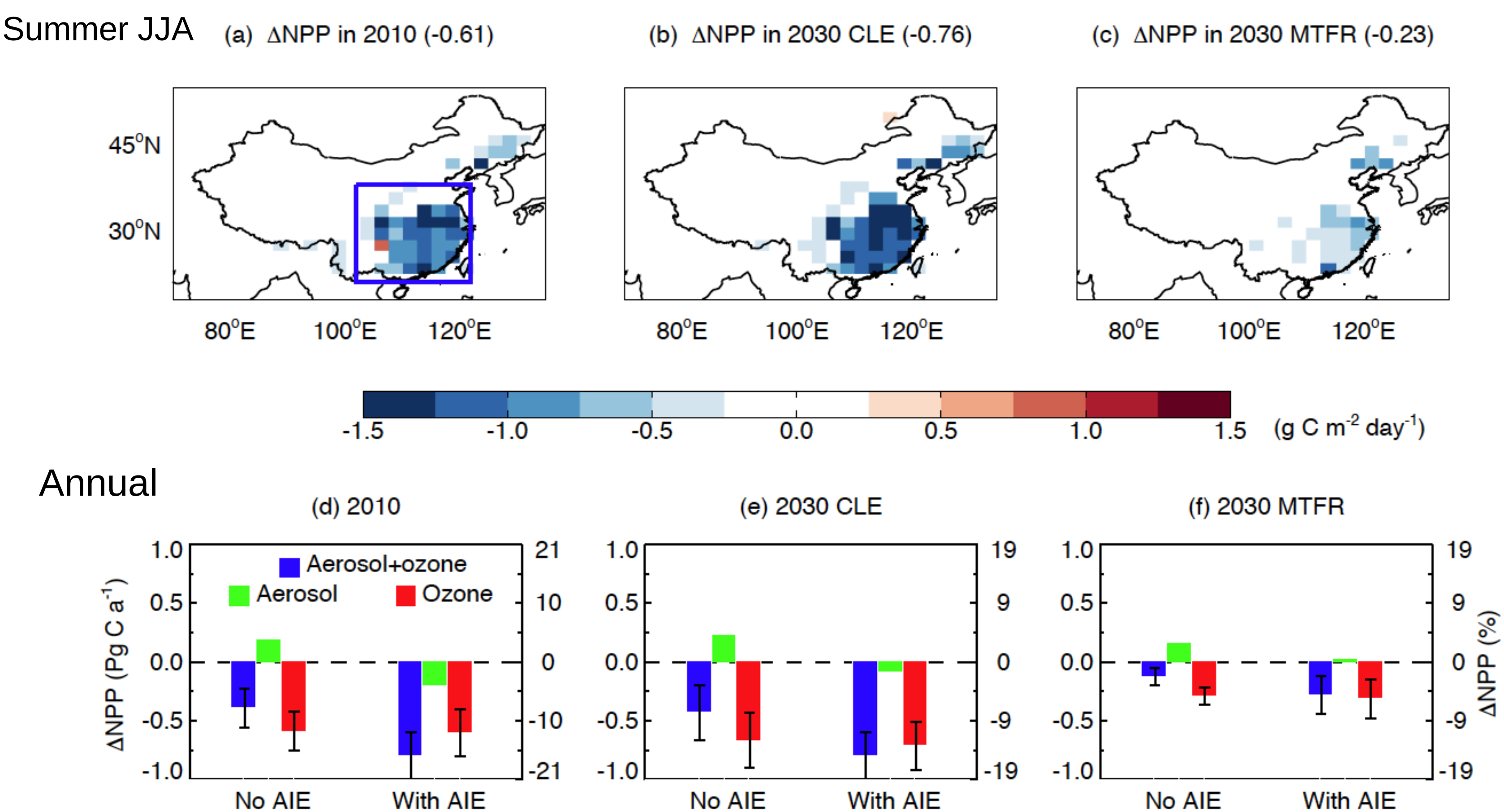
JJA



- Apply coupled model, allow meteorological feedbacks from aerosol pollution
- Factorial experiments to separate influences of ΔTAS, ΔPAR, ΔSOILM
  - Surface cooling enhances NPP over broad areas
  - DRF enhances NPP in Northeast and Southeast where AOD is moderate
  - Soil moisture increases enhances NPP in Central East (NCP) where C3 crops dominate

- Total aerosol impact on annual average NPP = +0.20 +/- 0.08 PgC yr^{-1} (~5%) benefit

Ozone and haze pollution weakens land carbon uptake in China



- **Today, air pollution combined reduces NPP by ↓ 0.39-0.80 PgC/yr (9% - 16%)**
- **By 2030, CLE scenario damage increases due to continuing ozone increases**
- **By 2030, MTFR scenario reduces current level of NPP damage by 70%**

(Yue et al., ACP, 2017)

Air Pollution Risk to Agriculture and Forest Health in China

Quantify the individual and combined effects of ozone and aerosol pollution on rice, wheat, maize and soybean crop yields and productivity over natural ecosystems in China

Calibrate/validate JULES and JULES-crop for China ecosystems

Multi-model multi-scale evaluation of China air quality simulation

Impacts of ozone and aerosols on crops and forests in China today

Attribution of air pollution vegetation impacts to source sectors/activities

Future air quality impacts on vegetation under range of global change scenarios

Improved understanding of the present and future air pollution threat to food security in China

Advance knowledge of regional carbon budget in China

Enhance UK-China integrated air pollution-vegetation-climate modelling capabilities

University of Exeter · IAP CAS · Peking University 1898 · Nanjing University of Information Science & Technology 1960 · Met Office · Newton Fund

The 1st "Air Pollution Impacts on Crops and Ecosystems (APICE)" Workshop

May 14, Beijing

IAP CAS

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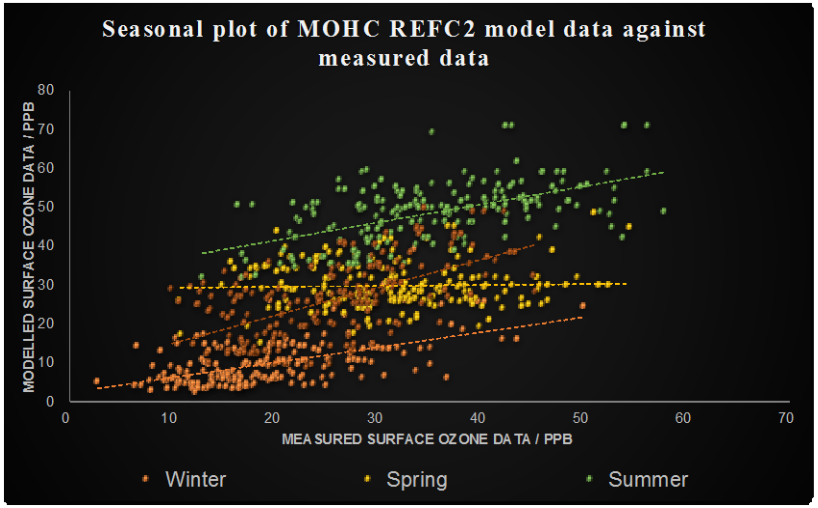
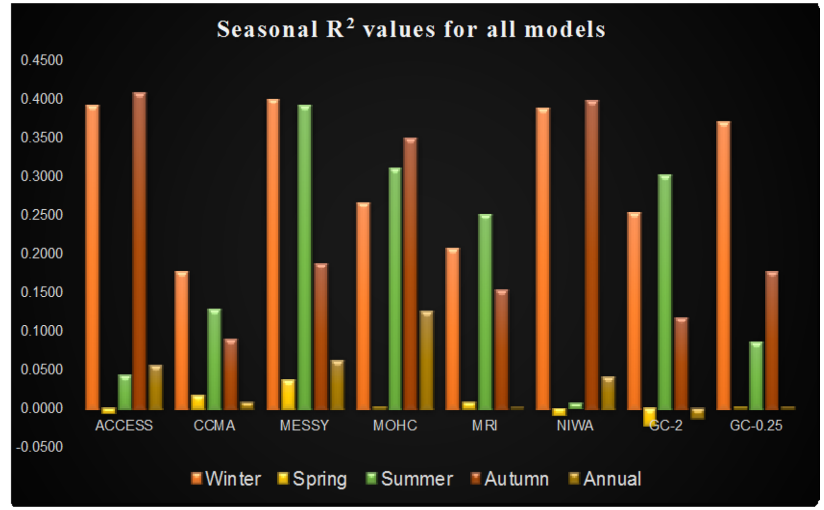
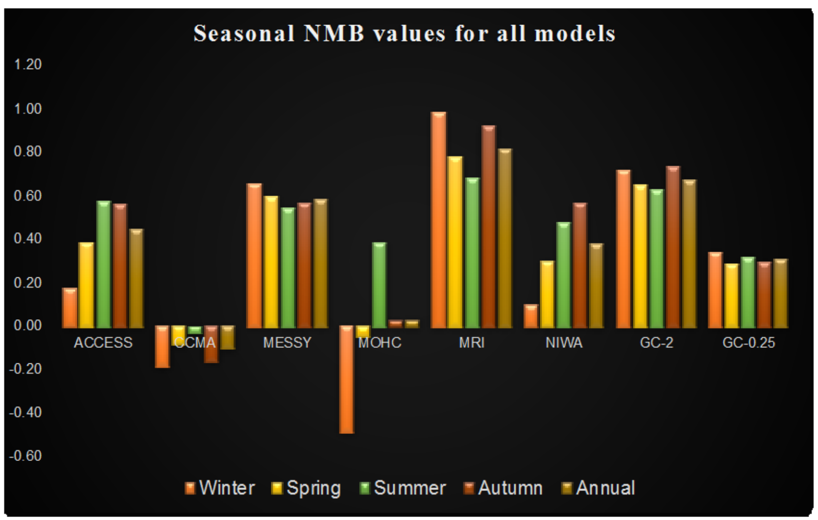
Met Office

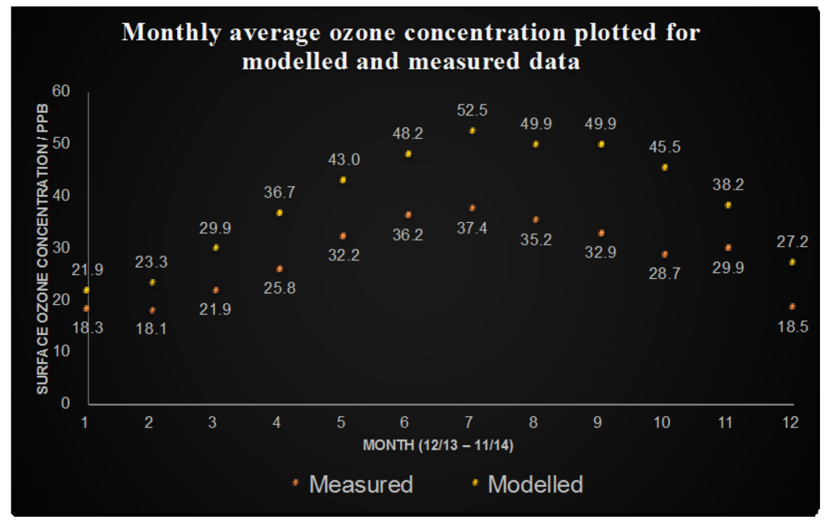
Newton Fund

Can global models simulate surface ozone in China?









- China MEP 188 urban sites 2014 http://www.aqicn.org/
- CCMI models and GC-2 + GC-0.25 (GC data from Lin Zhang, Peking U)
- Availability of any longer-term surface ozone measurements esp. rural?

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https://www.grc.org/biogenic-hydrocarbons-and-the-atmosphere-conference/2018/

2 fully funded PhD positions available

Ozone pollution impacts on tropical vegetation

NERC UK New measurements of tropical plant sensitivity to ozone
GEOS-Chem present and future simulations of damage risk
Advisors: N. Unger, S. Sitch, A. Tai (Exeter-CUHK)

Land-use change impacts on human health and climate

Link GEOS-Chem and DIMAQ (Data Integration Model for Air Quality)
Advisors: N. Unger and G. Shaddick

Contact N.Unger@exeter.ac.uk for more information

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