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Effects of climate change on air pollution impacts and response strategies for European ecosystems

SEVENTH FRAMEWORK PROGRAMME

Mark Sutton

Centre for Ecology & Hydrology, Edinburgh

ÉCLAIRE 3nd Annual Meeting, Zagreb, 22 October 2011

LRTAP

Long-range Transboundary Air Pollution

ÉCLAIRE objectives

- To provide robust understanding of air pollution impacts on European land ecosystems including soils under changing climate conditions.
- To provide reliable and innovative risk assessment methodologies for these ecosystem impacts of air pollution, including the economic implications, to support EU policy.
- Focus on O_3 and N, and where relevant their interactions with VOCs, aerosols and S.

Key questions for ÉCLAIRE

- How will climate change alter the threat of air pollution on ecosystems?
  - Changing emissions, transport and deposition of air pollutants?
  - Changing vulnerability of ecosystems for a given pollution dose?

Half-way point in ÉCLAIRE

- Your place in ÉCLAIRE should be clear – moving now to delivery
- Finding the emerging messages
- The Mid-way challenge:
  Resource enough? Can we do it? Balancing priorities.
- Working as a team

Two kinds of delivery in ÉCLAIRE

- The European Commission is watching – every promised deliverable checked!
  - Fine View: Complete the promised deliverables
  - Big View: Keep the big messages in mind

The big view: ÉCLAIRE Outreach

- EU Report Research Findings in Support of the EU Air Quality Policy Review
- Green Week ECLAIRE stand: "Menu for a Better Environment" + several talks & panels
- Presentations to the European Parliament
- Contribution to UNEP report "Our Nutrient World"

MENU FOR A BETTER ENVIRONMENT

Our menu choices from field to plate have the potential to improve both air quality and climate – Dr Clare Howard explains how we can get our 'just desserts' and the role of research.

50% of the global population is estimated to be alive due to the use of man-made nitrogen fertilisers in farming. Over the last century yields have improved, but at the same time losses of nitrogen to the environment have led to impacts on air and water quality, biodiversity and climate. The use of man-made fertilisers and manures in farming can be highly inefficient, with 80% of inputs eventually being lost. This shortens lives through impacts on air and water pollution, threatens biodiversity and drives climate damage.

More efficient use of nitrogen in farming is possible during the application of fertilisers and manures, in animal feeding, housing and manure storage. Injection of manures into the soil, can reduce ammonia emissions by 70%. There are many factors affecting the uptake of such measures, but it is important to recognise that there are potential co-benefits for business and industry: Keeping nitrogen in the farming system saves significantly on fertiliser costs. Innovative agricultural methods and 'nitrogen accounting' are central to developing the 'Green Economy' in European farming.

Our own choices as citizens are also important. Losses of nitrogen from farming systems are magnified as you move through the food chain – livestock require feed and excrete nitrogen– which increases losses. Nitrogen losses when you eat steak are higher than if you ate the cereals the cow ate. Decreasing our consumption of meat would have dramatic benefits on air and water quality.

Losses of nitrogen to the environment by animal product. Comparison of nitrogen in feed to nitrogen retained in final animal product, shows that less than 10% of the nitrogen cows consume from feed is retained in the meat, the rest is lost to the environment. (European Nitrogen Assessment, 2011, eds. Sutton M.A., Howard C.M. et al. Summary for policymakers http://www.nine-esf.org/ENA-Book)

Enter the role of research. We need to … the environment due to farming pract… including processes of nitrogen losses … to air pollution. As air pollution is intri… policymakers also need to understand … change is likely to have on air pollutio… ECLAIRE project, 'Effects of climate cha… response strategies for European ecos… range of measurement and modelling … projections of air pollution and climat… implications for mitigation strategies. … the final part of the chain, linking the … European policies.

As with any dilemma, the outcome … we make. Food security requires ni… minimise its environmental effects. … improved farm management practi… with a lower meat content, then a '… with improved climate is certainly …

Dr Clare Howard works at the NERC … as Project M… and the UNECE T…

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fertilizers europe

Forum on Fertilizers and Nutrients for Growth

28 May 10:00 - 13:00

Building: Altiero Spinelli (ASP), Room: A5G1

Register: conference@fertilizerseurope.com

Opening address

Chair
Britta Reimers MEP

Political Perspectives

Vice-Chair
Julie Girling MEP

Join the debate

Keynote speaker - Our Nutrient World

Prof. Mark Sutton, Center for Ecology and Hydrology, Edinburgh
Author of the UNEP report "One Nutrient World"
Professor Sutton is the author of the recent UNEP report Our Nutrient World: The challenge to produce more food and energy with less pollution. This Global Overview on Nutrient Management addresses the scientific complexity of how humanity can rise to these challenges and maximize the opportunities of improved nutrient management.

The EU Year of "Air Quality"

EU Air Pollution Policy Review 2011-2013
Alan Seatter,
Deputy Director General of DG Environment

How Fertilizers can provide a solution
Jacob Hansen,
Fertilizers Europe

From Parliament Magazine

- Green Week &
- EU Parliament Forum

June 2013

ÉCLAIRE goes global

UN says fertiliser crisis is damaging the planet

Scientists urge rich world to halve its meat consumption

The shape of nitrogen to come

An analysis reveals the huge impact of human activity on the nitrogen cycle in China. With global use of Earth's resources rising per head, the findings call for a re-evaluation of the consumption patterns of developed societies.

MARK A. SUTTON & ALBERT BLEEKER

Although Earth's atmosphere consists of nearly 80% dinitrogen (nitrogen

NO_x to the formation of ground-level ozone, which causes crop losses; increased emissions of nitrous oxide (N_2O), a greenhouse gas; and extreme levels of water pollution by nitrates

Nature doi:10.1038/nature11954

18 Feb 2013: *Independent* , *Guardian*, *Herald Tribune*, *Times of India* and 300 articles worldwide

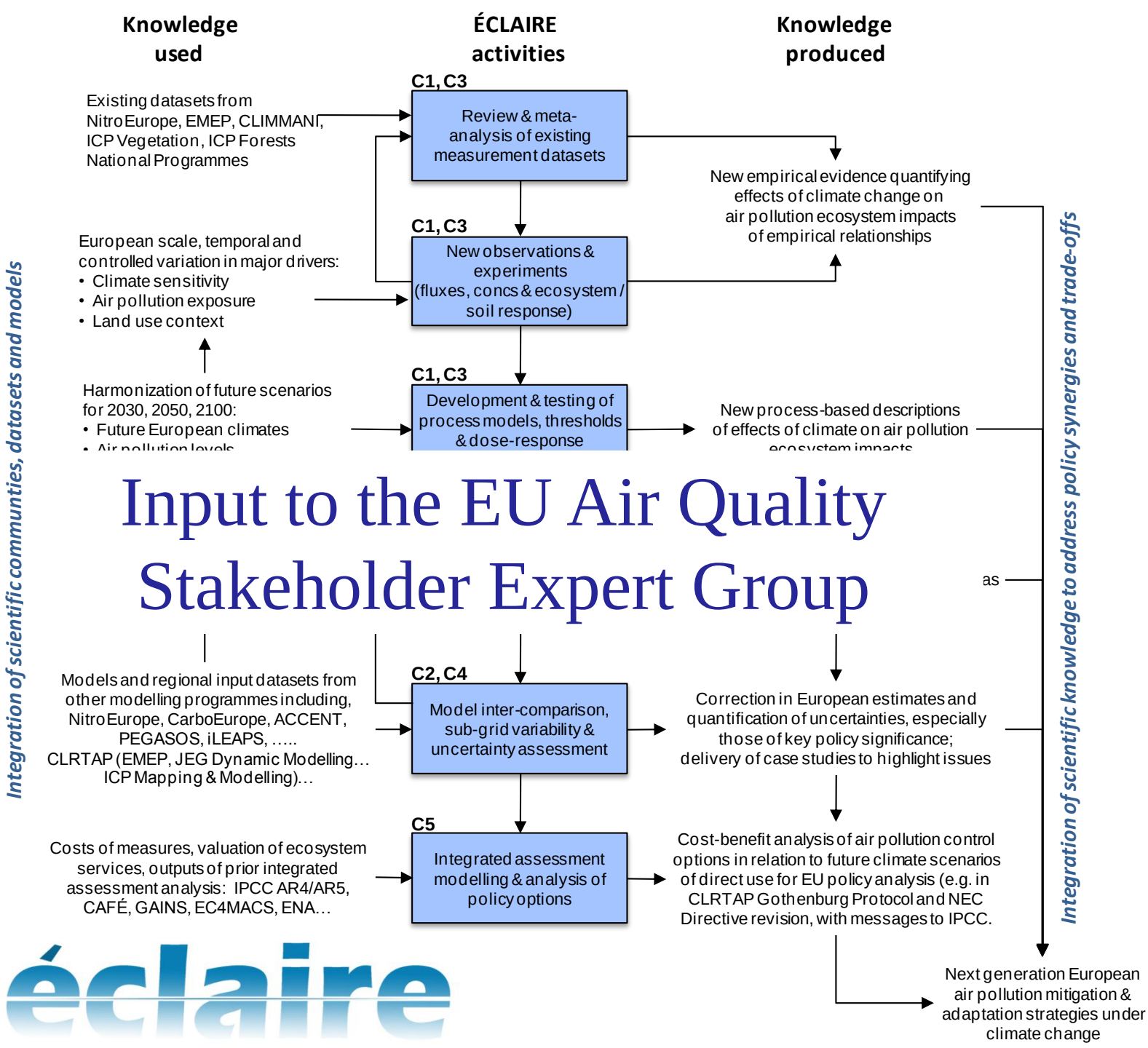
Global Overview on Nutrient Management

Our Nutrient World

The challenge to produce more food and energy with less pollution

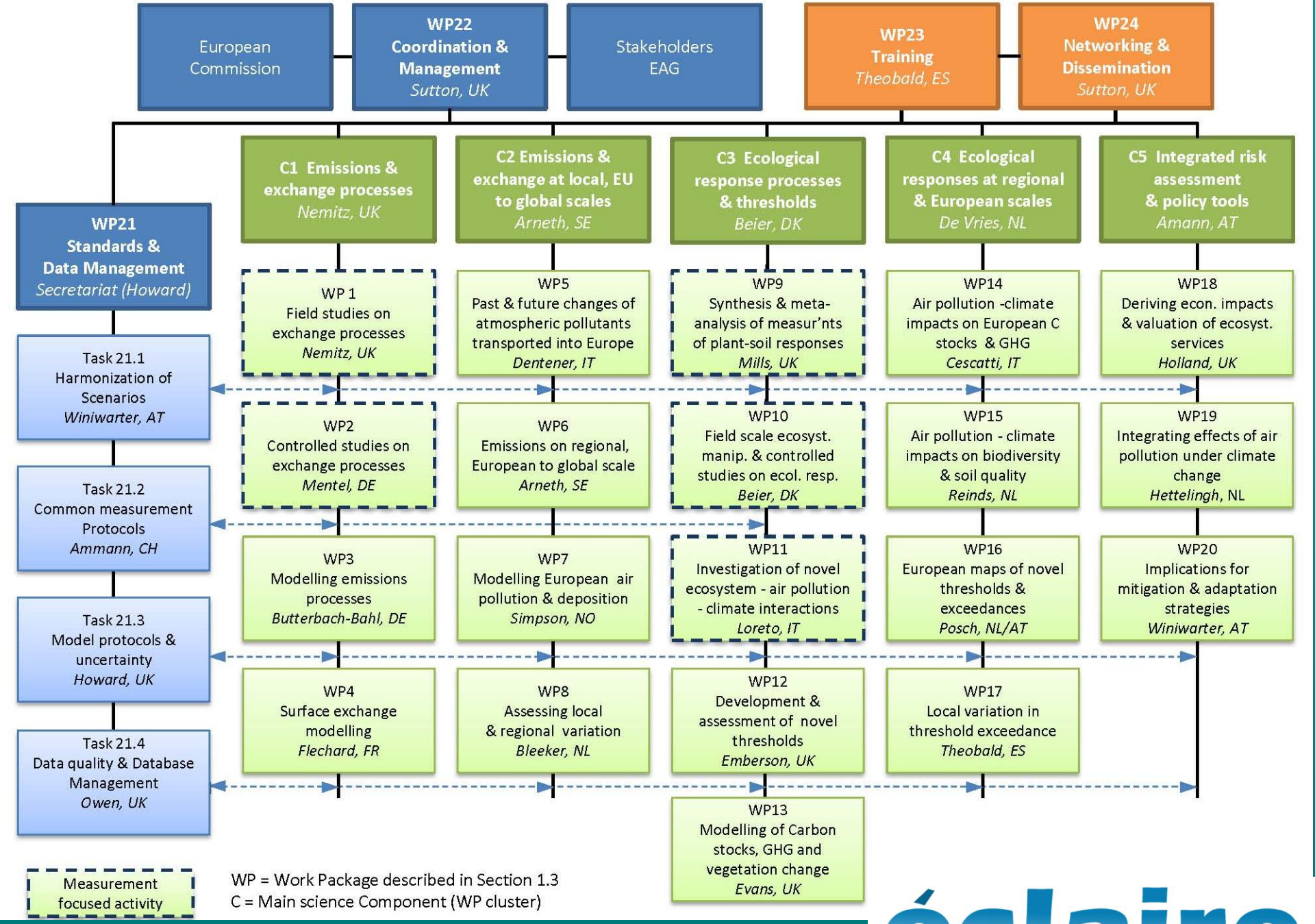
Prepared by the Global Partnership on Nutrient Management in collaboration with the International Nitrogen Initiative

ÉCLAIRE Delivery Path



Five core Elements to ÉCLAIRE

- C1: Emissions and exchange processes
- C2: Emissions and exchange at local, EU to global scales
- C3: Ecological response processes and thresholds
- C4: Ecological responses at regional and European scales
- C5: Integrated risk assessment and policy tools
- Data management, scenarios protocols etc.


European Commission
WP22 Coordination & Management Sutton, UK
Stakeholders EAG
WP23 Training Theobald, ES
WP24 Networking & Dissemination Sutton, UK
WP21 Standards & Data Management Secretariat (Howard)
C1 Emissions & exchange processes Nemitz, UK
C2 Emissions & exchange at local, EU to global scales Arneth, SE
C3 Ecological response processes & thresholds Beier, DK
C4 Ecological responses at regional & European scales De Vries, NL
C5 Integrated risk assessment & policy tools Amann, AT
Task 21.1 Harmonization of Scenarios Winiwarter, AT
Task 21.2 Common measurement Protocols Ammann, CH
Task 21.3 Model protocols & uncertainty Howard, UK
Task 21.4 Data quality & Database Management Owen, UK
WP 1 Field studies on exchange processes Nemitz, UK
WP2 Controlled studies on exchange processes Mentel, DE
WP3 Modelling emissions processes Butterbach-Bahl, DE
WP4 Surface exchange modelling Flechard, FR
WP5 Past & future changes of atmospheric pollutants transported into Europe Dentener, IT
WP6 Emissions on regional, European to global scale Arneth, SE
WP7 Modelling European air pollution & deposition Simpson, NO
WP8 Assessing local & regional variation Bleeker, NL
WP9 Synthesis & meta-analysis of measur'nts of plant-soil responses Mills, UK
WP10 Field scale ecosyst. manip. & controlled studies on ecol. resp. Beier, DK
WP11 Investigation of novel ecosystem - air pollution - climate interactions Loreto, IT
WP12 Development & assessment of novel thresholds Emberson, UK
WP13 Modelling of Carbon stocks, GHG and vegetation change Evans, UK
WP14 Air pollution -climate impacts on European C stocks & GHG Cescatti, IT
WP15 Air pollution - climate impacts on biodiversity & soil quality Reinds, NL
WP16 European maps of novel thresholds & exceedances Posch, NL/AT
WP17 Local variation in threshold exceedance Theobald, ES
WP18 Deriving econ. impacts & valuation of ecosyst. services Holland, UK
WP19 Integrating effects of air pollution under climate change Hettelingh, NL
WP20 Implications for mitigation & adaptation strategies Winiwarter, AT
Measurement focused activity
WP = Work Package described in Section 1.3
C = Main science Component (WP cluster)

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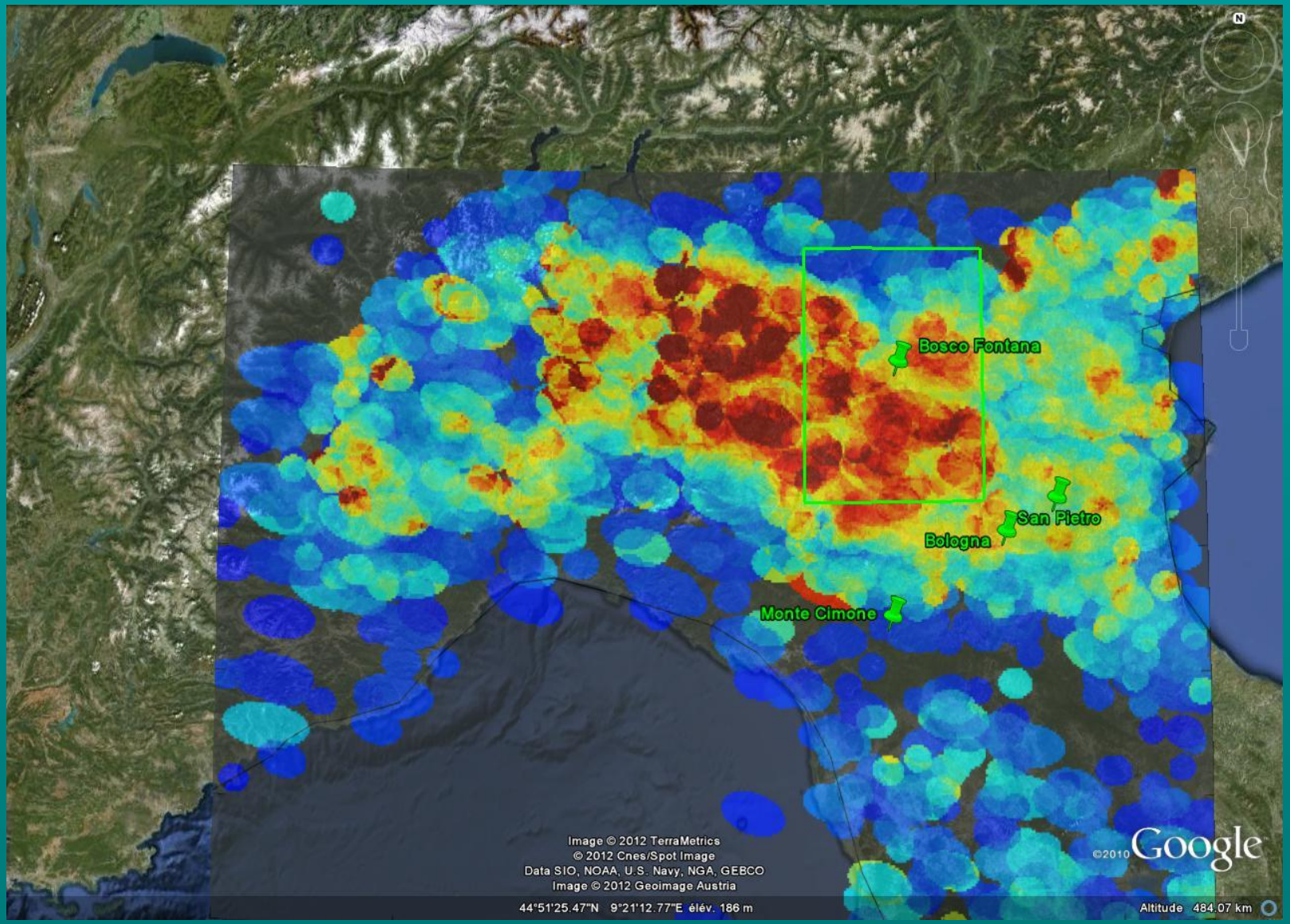
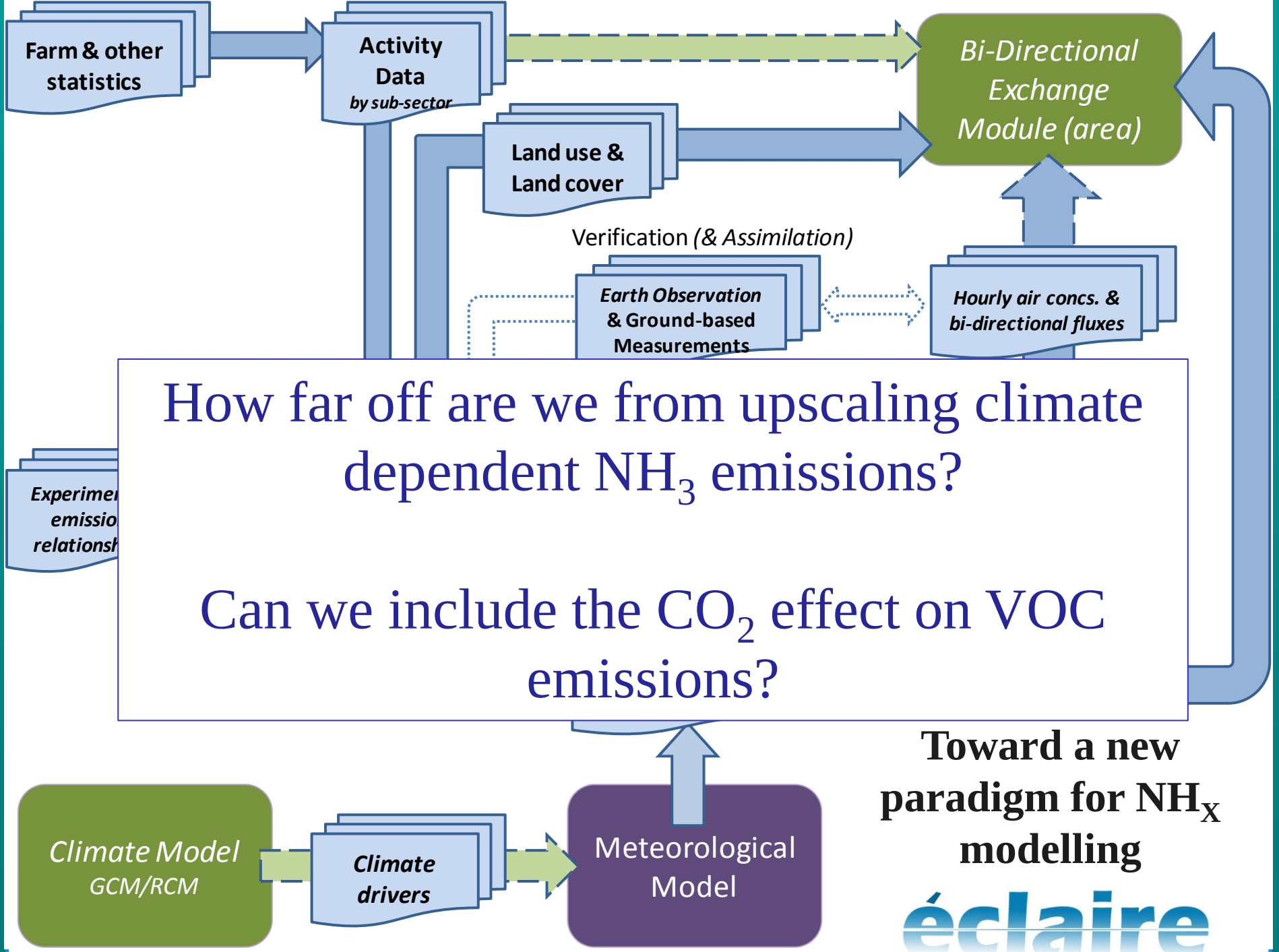
Processes : Example of Bosco Fontana

NH_3 column (June-August 2012)



Yasmine Ngadi and colleagues


Farm & other statistics
Activity Data
by sub-sector
Bi-Directional Exchange Module (area)
Land use & Land cover
Verification (& Assimilation)
Earth Observation & Ground-based Measurements
Hourly air concs. & bi-directional fluxes
Experimen emissio relationsh
How far off are we from upscaling climate dependent NH_3 emissions?
Can we include the CO_2 effect on VOC emissions?
Climate Model
GCM/RCM
Climate drivers
Meteorological Model
Toward a new paradigm for NH_X modelling
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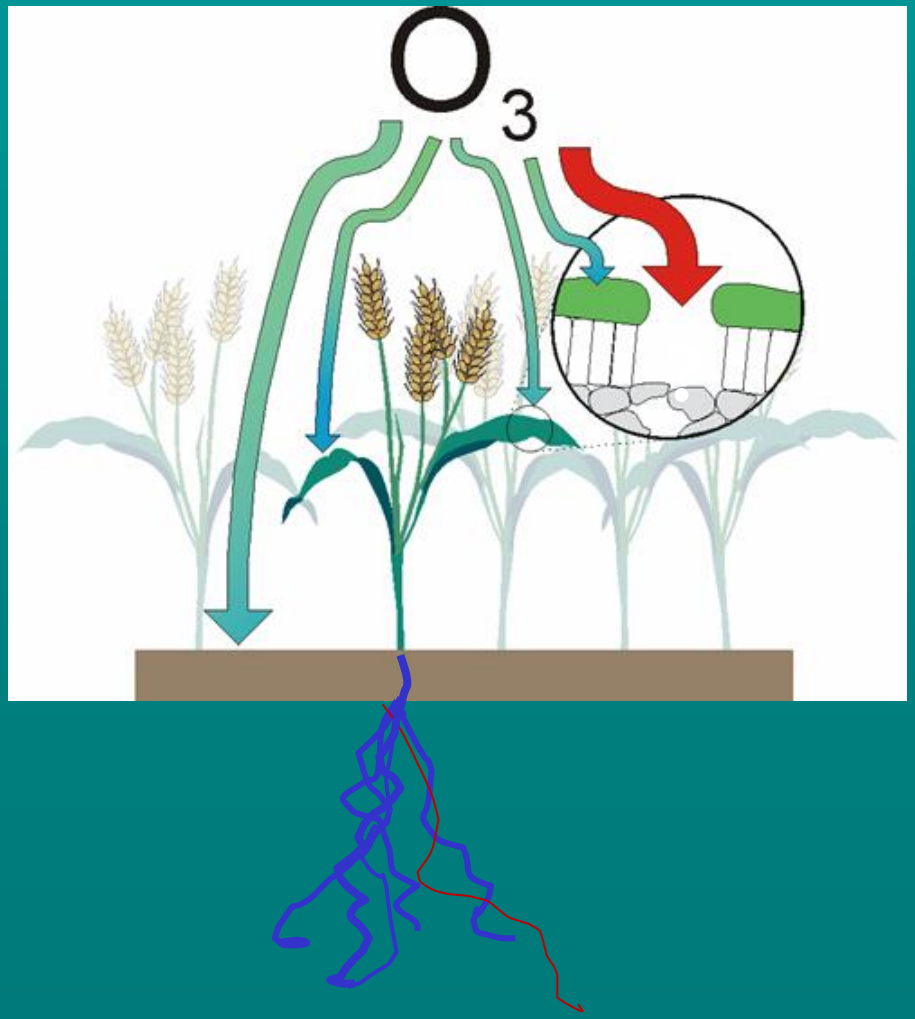
Ozone – what do we need to understand?

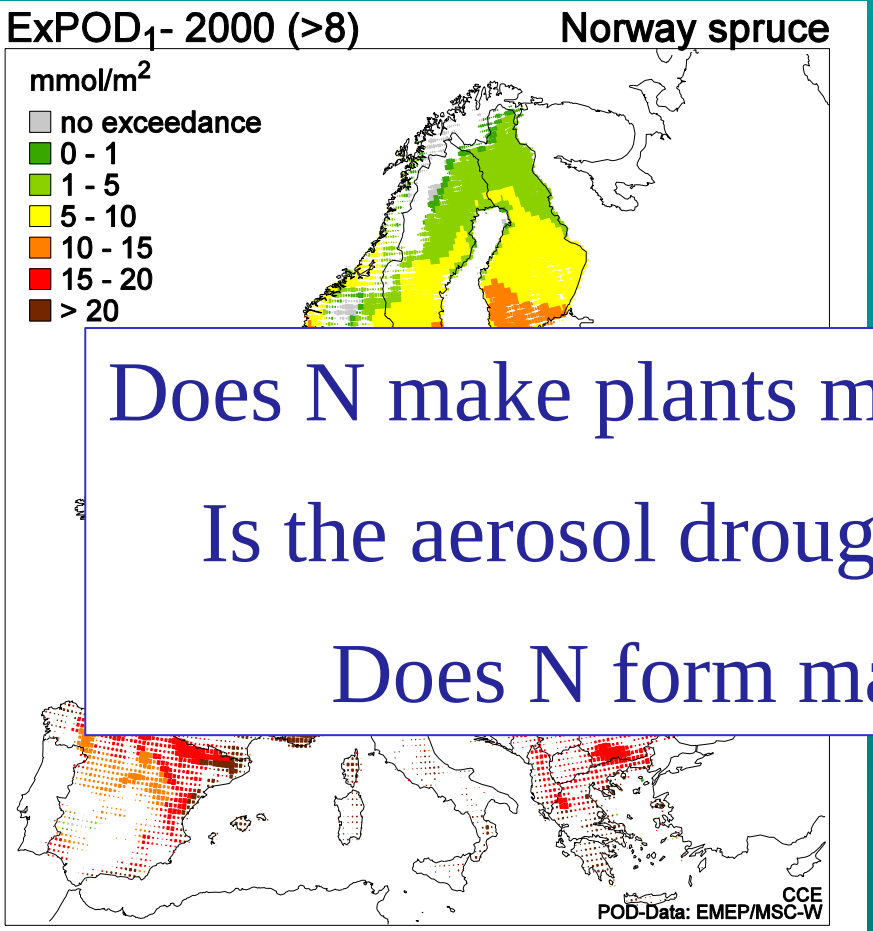


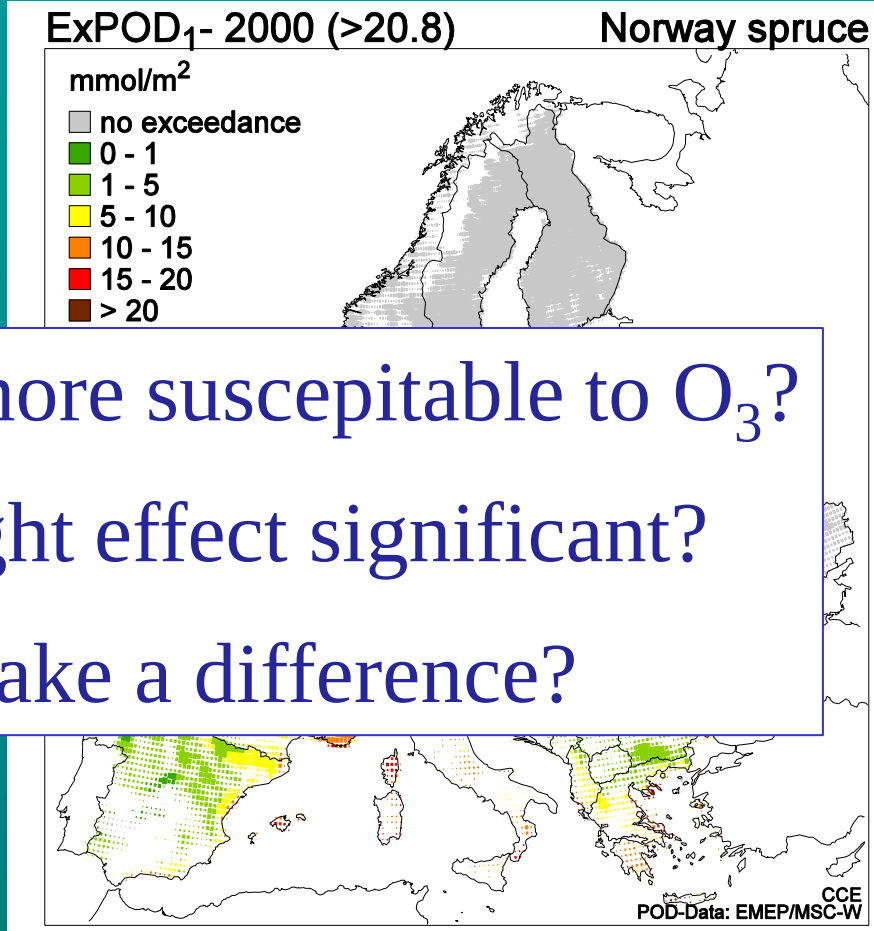
How do we know how much O_3 gets into the plant and how much impacts on the plant?

Depends on:

- ❑ Dry deposition to the leaf surface
- ❑ Stomatal functioning
- ❑ BVOC emissions
- ❑ Detoxification within leaf

Phytotoxic ozone dose





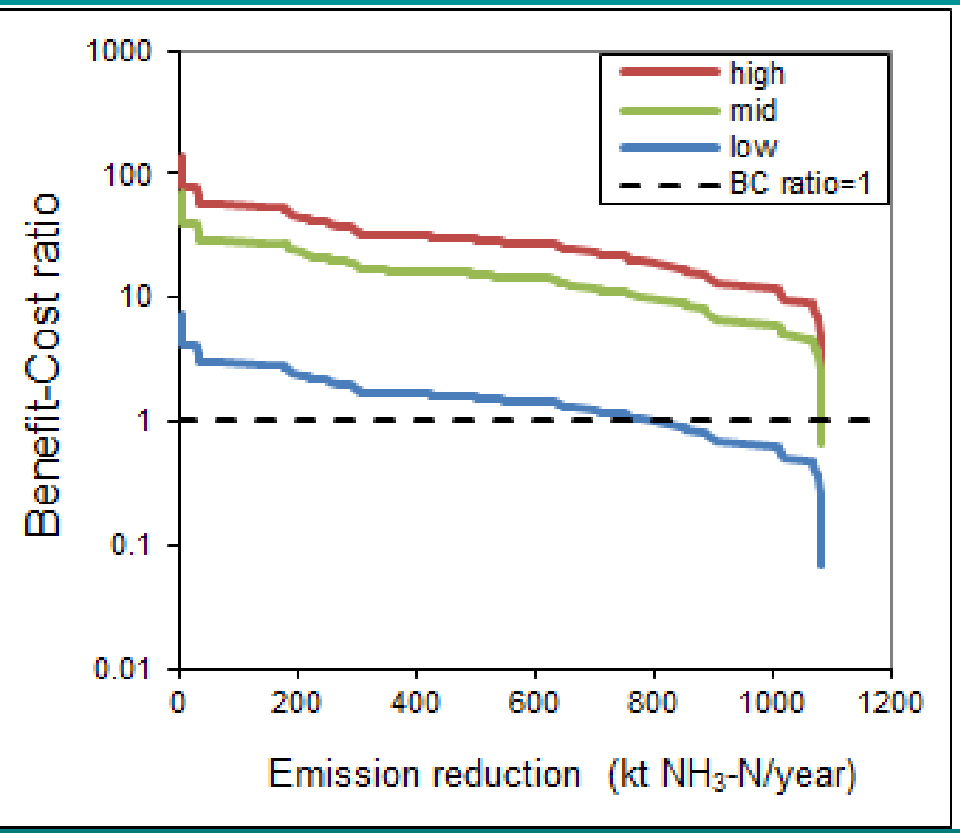
Does N make plants more suscepitable to O_3?

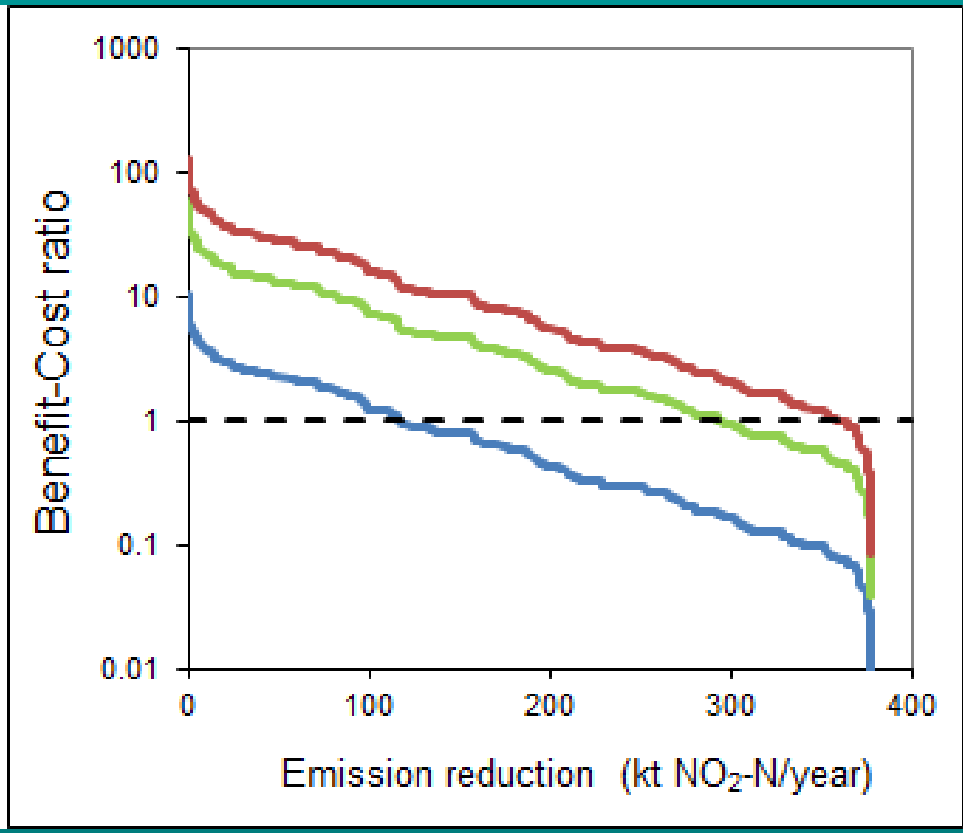
Is the aerosol drought effect significant?

Does N form make a difference?

Exceedances of POD1 for Norway spruce in 2000 (left: critical limit = 8; right: 20.8 mmol/m2 = 5% yield reduction) with cover-scaled grid cells

EU benefit-cost ratios for NH_3 and NO_x mitigation





Van Grinsven et al.
(*Environmental Science and Technology*, 2013)

LRTAP
Long-range Transboundary Air Pollution