ICP Vegetation: Contributions to the review of the Gothenburg Protocol, including progress with ex-Post analysis

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1. Proving effects occur where flux is highest
2. Defining aspirational targets for TFIAM
3. Developing new and revising existing flux-based critical levels and dose-response functions
4. Liaising with TFIAM, EMEP, WGSR during review of Protocol
5. Future reports on effects on food security and C sequestration

Aspirational targets for 2050

There should be no O_3 effects on:

- The yield quantity and quality of agricultural and horticultural crops (including forage)
- The growth of individual species and biodiversity of (semi-)natural vegetation
- The leaf appearance and growth of forest trees
- The ecosystem services (including carbon sequestration) of vegetation

Interim targets for 2020, 2030

- Recommend these are achieved by gap closure

Progress with deriving flux-based critical levels for vegetation

ICP Vegetation Expert Panel Meeting

‘Flux-based assessment of ozone effects for air pollution policy’

9-12 November, 2009, JRC-Ispra, Italy

- 42 experts representing 12 Parties to the Convention, ICP Vegetation, ICP Forests, TFIAM, CIAM, EMEP, JRC, Convention Secretariat
- Agreed on methodology and further data analysis before TFM

23rd Task Force Meeting of the ICP Vegetation

1 – 3 February, 2010, Tervuren, Belgium,

- 53 delegates from 18 Parties to the LTRAP Convention
- Agreed 10 new flux-based critical levels and their application

New terminology: O_3 flux parameter - Phytotoxic Ozone Dose (POD)

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Procedure for deriving critical levels

(1) Collate data bases

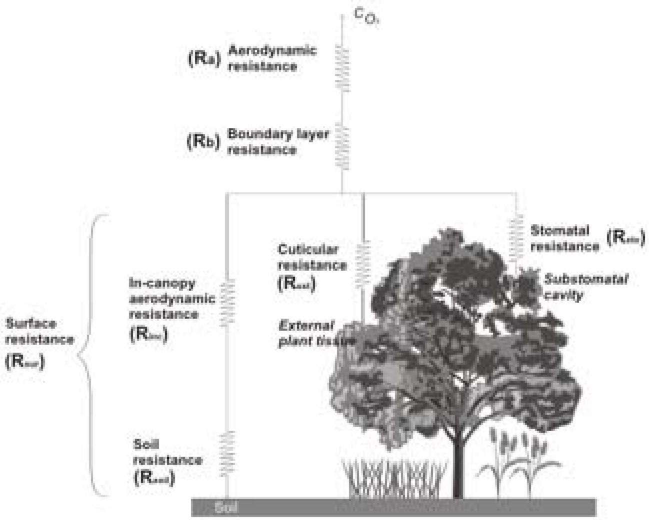
(2) Calculate fluxes using downloadable model, DO_3SE (Deposition of O_3 for Stomatal Exchange)

http://sei-international.org/index.php/tools

(3) Develop flux-effect relationships for a range of thresholds (Y in POD_Y)

(4) Agree on which “Y “ to use and which response functions are sufficiently robust

(5) Determine critical level as lowest flux at which a statistically significant detectable effect occurs



DO_3SE Model

Revised/new critical levels for effects of ozone on vegetation (mmol m^{-2})

Receptor	Effect (% reduction)	Parameter	Critical level (actual)	Critical level (Mapping Manual)
Wheat*	Grain yield (5%)	POD_6	1.2	1
Wheat	1000 grain weight (5%)	POD_6	1.2	1
Wheat	Protein yield (5%)	POD_6	1.8	2
Potato	Tuber yield (5%)	POD_6	3.9	4
Tomato	Fruit yield (5%)	POD_6	2.3	2
Norway Spruce	Biomass (2%)	POD_1	8.2	8
Birch and Beech	Biomass (4%)	POD_1	3.7	4
Productive grasslands (clover)	Biomass (10%)	POD_1	2.1	2
Conservation grasslands (clover)	Biomass (10%)	POD_1	2.1	2
Conservation grasslands (*Viola* spp), provisional**	Biomass (15%)	POD_1	6.3	6

* Mediterranean VPD parameterisation for wheat to be included in Mapping Manual
** Flux model to be added for Dehesa clover species

Crops: Recommendations for IAM

Full flux model

Critical level (and response function) for **security of food supplies**:

- Protein yield of wheat (POD_6 of 2)
- Tomato fruit yield (POD_6 of 2)

Generic crop flux model

Response function to show areas of highest potential damage (dose-response function)

Forests – Recommendations for IAM

- Critical level (full flux model), for protection against:

  (1) Loss of **carbon storage** in the living biomass of trees
  (2) Loss of **environmental protection** (e.g. soil erosion, floods, avalanches)

- Generic forest tree flux functions for generic deciduous and generic Mediterranean tree species

(Semi-)natural vegetation : Recommendations for IAM

Critical level (full flux model) for protection against**:**

Loss of **vitality and fodder quality** of pasture
Clover, POD_1 of 2 mmol m^{-2}

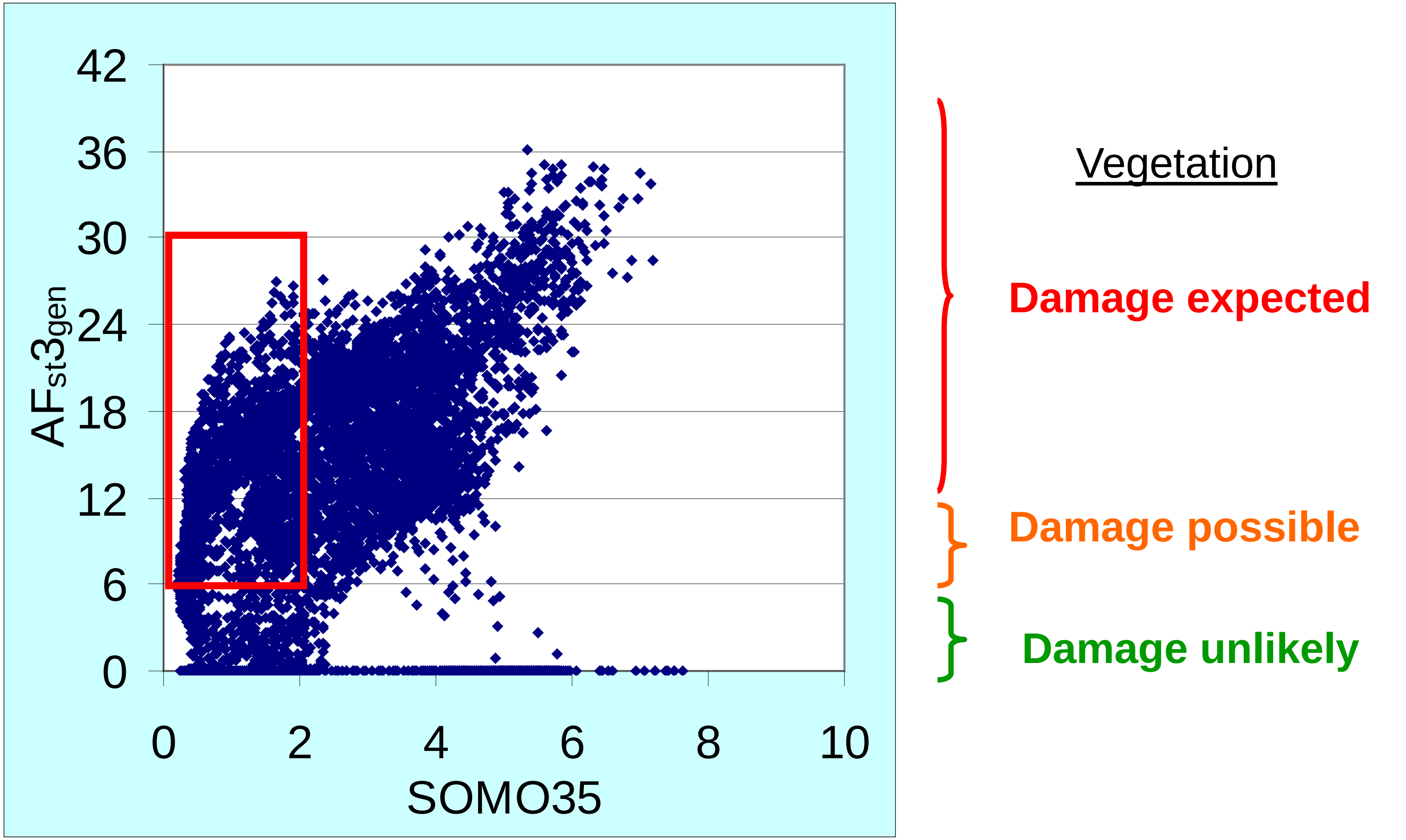
Loss of **vitality of natural species***
Clover, POD_1 of 2 mmol m^{-2}
Violets, POD_1 of 6 mmol m^{-2}

* May also protect against loss of biodiversity

Some further considerations for IAM

(1) The Optimization Process

What are the implications if health-based parameters are used?

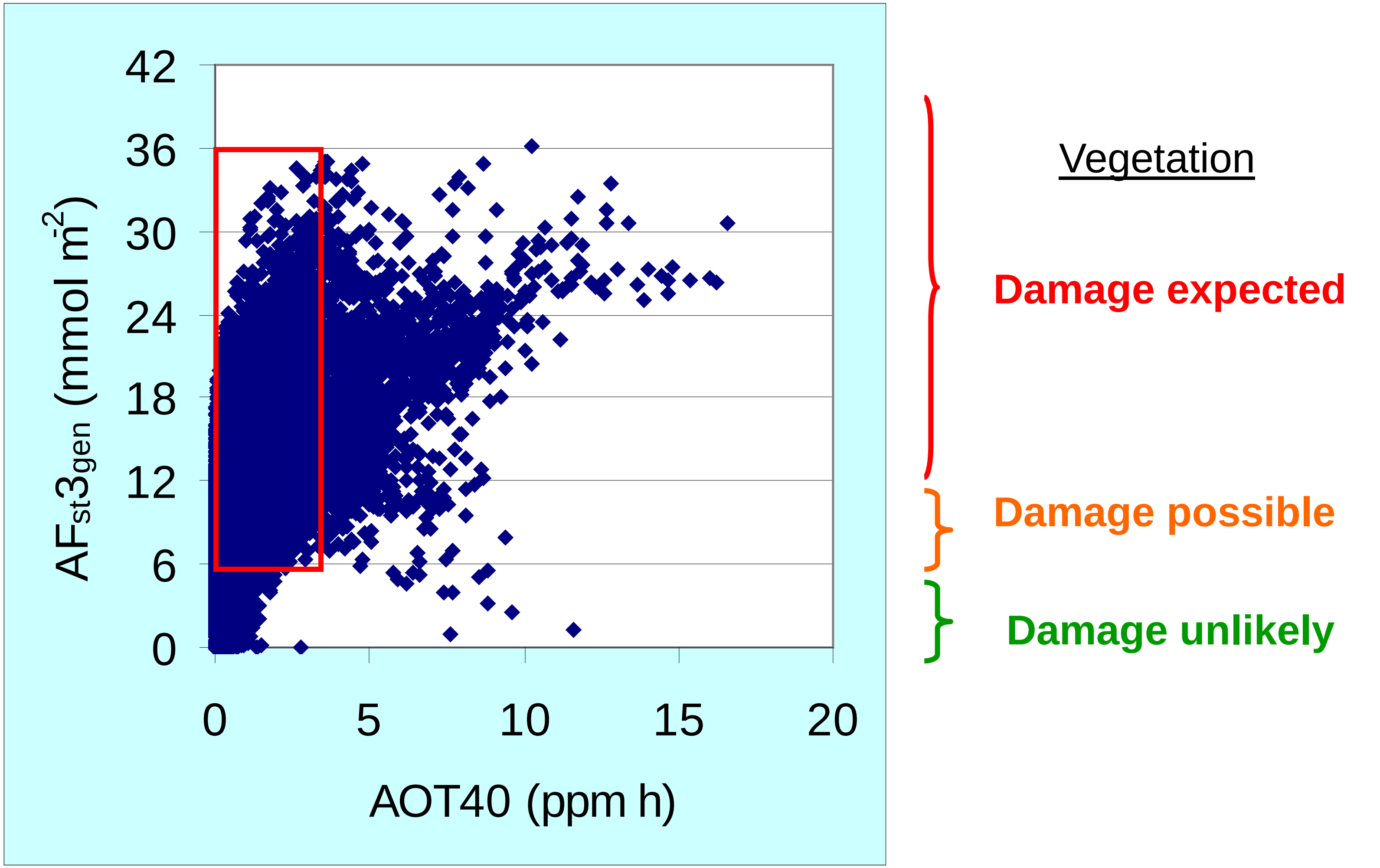


Example: **if the SOMO35 restriction for health is 2 ppm d, there is the potential for vegetation to be damaged in** **27% of grid squares**

* Each point is one on-land EMEP 50 x 50 km grid, 2006 map

17% for 12

What are the implications if an AOT40 of 3 ppm h is used?



<u>Example:</u> if the AOT40 critical level of 3 ppm h is the restriction for GAINS, there is the potential for vegetation to be damaged in <u>50% of grid squares</u>

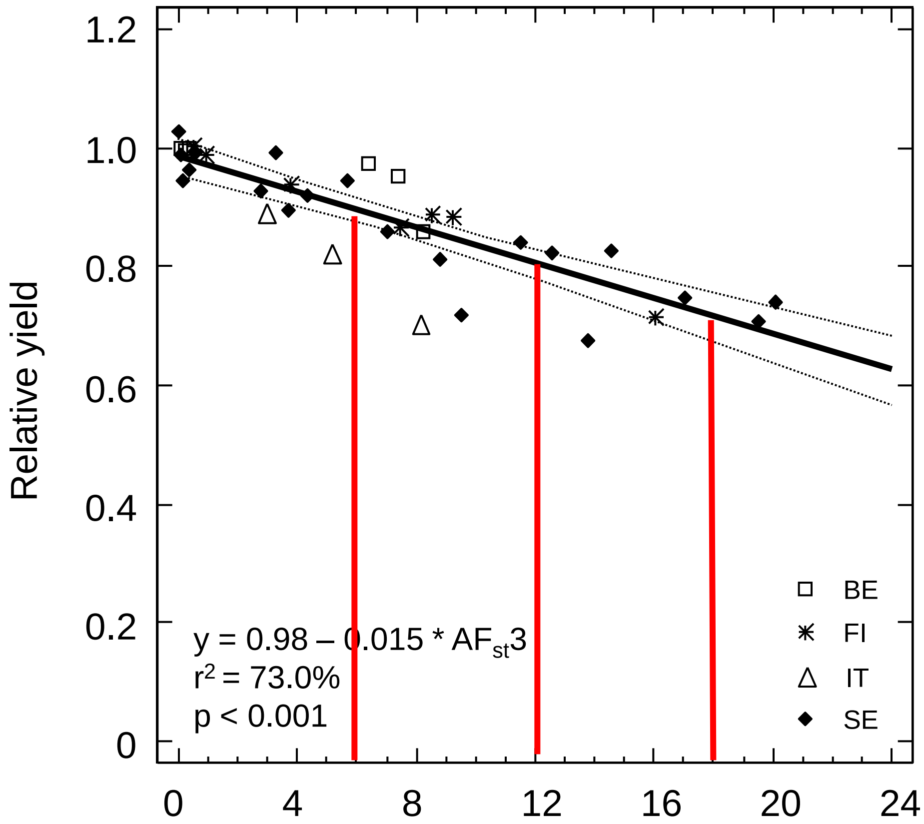
* Each point is one on-land EMEP 50 x 50 km grid, 2006

35% for 12

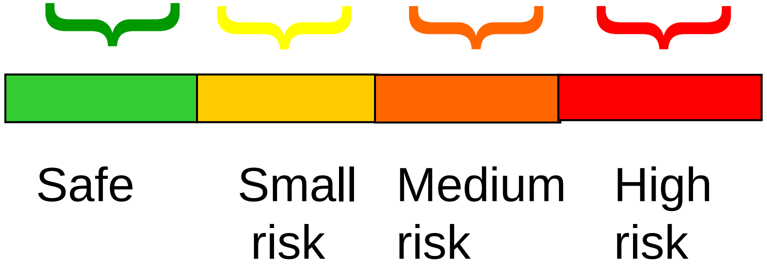
Some further considerations for IAM

(1) Ex-Post Analysis

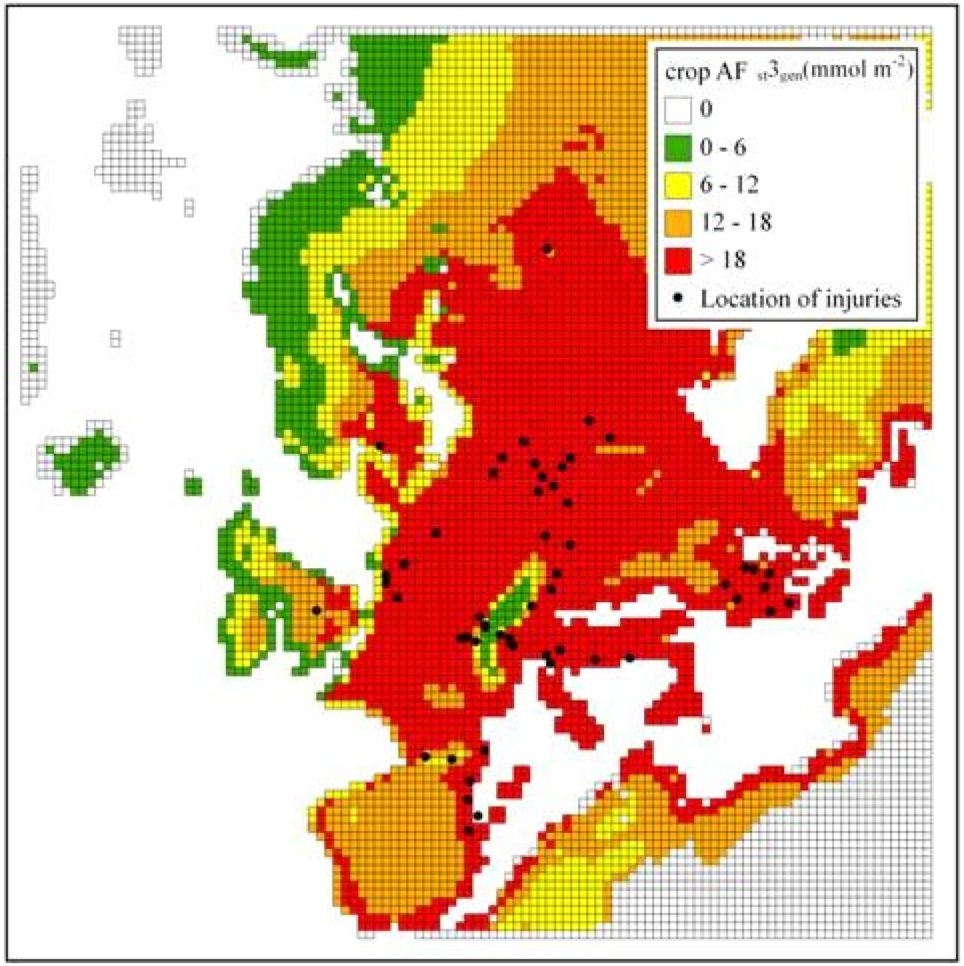
Suggested possible use of the generic crop function



For mapping:



Example: Use of generic crop function to show areas at greatest of damage



Post-TFM concerns raised by Spain
- flux model may be underestimating effects in Spain

Query: can we incorporate a “Med” parameterisation?

Ozone flux to a generic crop, 10 year mean, 1995 - 2004

Note: newer version of flux model will revise this map

Forthcoming reports from the ICP Vegetation*

* Subject to continuation of funding

ICP Vegetation

2010 State of Knowledge Report

Impacts of ozone on food security

Acharnes Attica, Greece, glasshouse lettuce, 100% commercial value loss of € 12500 overnight

- ❑ Ozone impacts on crops in Europe
  - Country reviews of issues
  - Flux-based yield quantity and quality
  - Market value of leafy salad crops
- ❑ Ozone impacts in Asia
- ❑ Ozone impacts in a changing climate (focus: drought)
- ❑ Global assessment
- ❑ Policy and research recommendations

*** To be completed in time for EB meeting in December this year**

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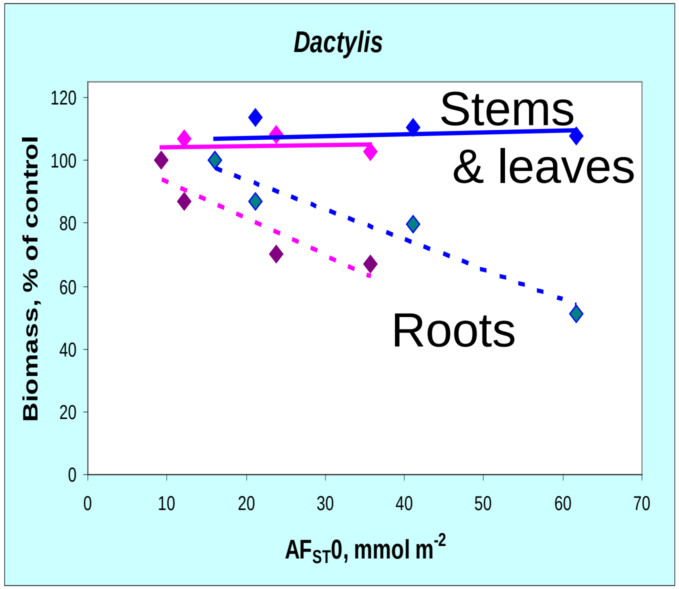
2011 State of Knowledge Report

Impacts of ozone on carbon sequestration, hydrology and climate



Ozone has a greater effect on below-ground C storage

- ❑ Review of current knowledge
- ❑ Modelling of ozone impacts on carbon storage in forests and grasslands at the following scales: (a) Europe, (b) Global

- ❑ Discussion, conclusions and future research needs
- ❑ Policy implications

ICP Vegetation: Summary of progress for ozone

In the last year:

- Set aspiration targets for 2050
- Derived flux-effect relationships for 10 receptor/effects
- Set new flux-based critical levels for crops, (semi-)natural vegetation and trees
- Made recommendations for IAM

In the next 6 months:

- Revise Mapping Manual
- Work with EMEP and TFIAM on Ex-Post analysis
- Write ozone and food security report

Thank you to the many people from ICP Vegetation who worked very hard to develop flux-effect relationships in time for the TFM

Including:

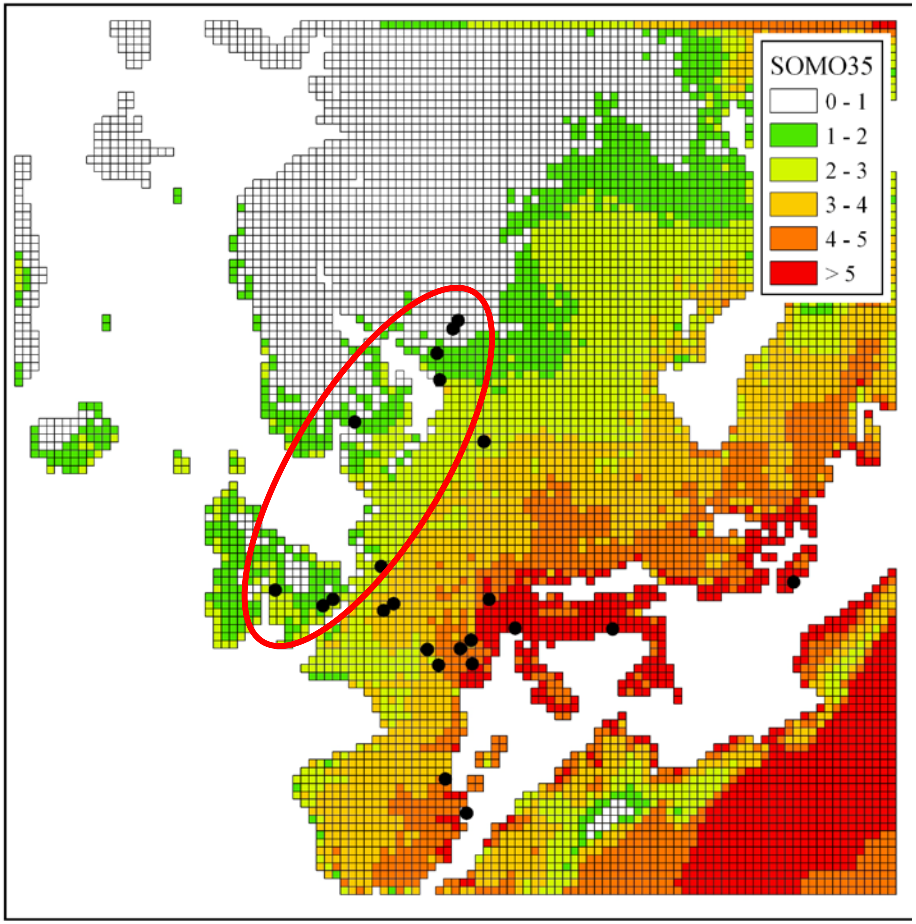
Crops: Håkan Pleijel, Helena Dannielsson, Ludger Grünhage, Karine Vandermeiren, Viki Bermejo (and Med. colleagues), Jürgen Bender

(Semi-)natural vegetation: Felicity Hayes, Patrick Büker, Ignacio Gonzalez

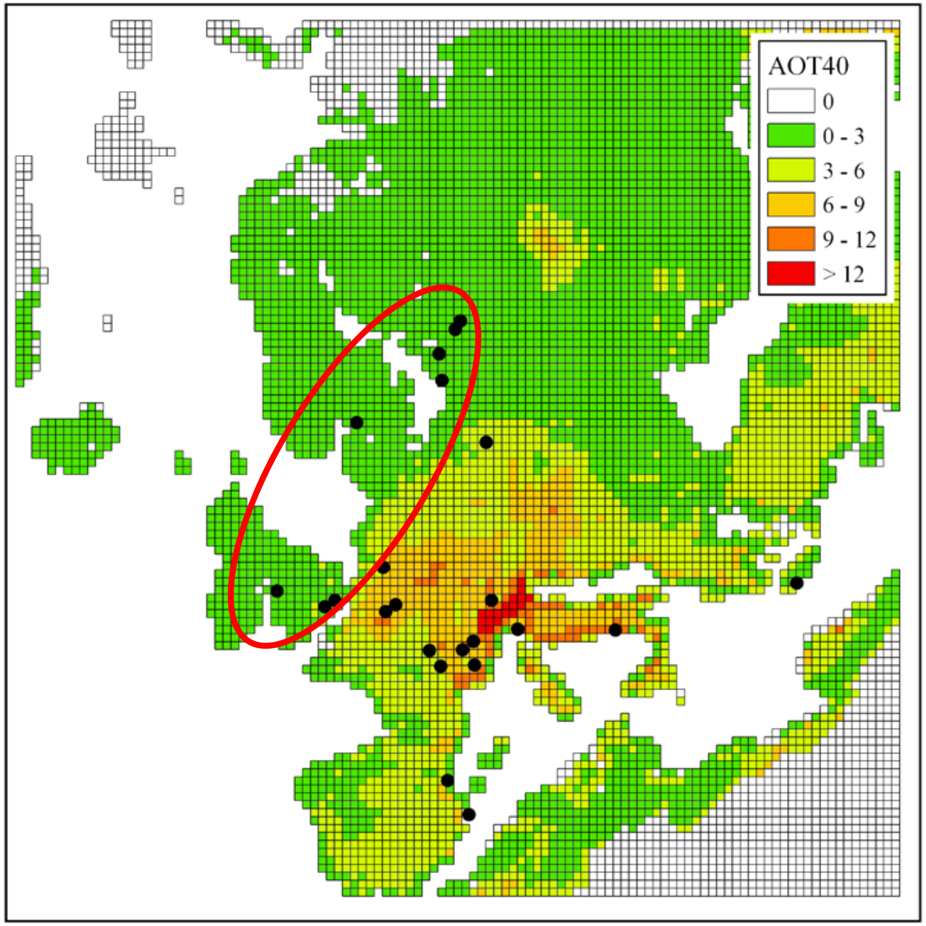
Forest trees: Sabine Braun, Patrick Büker, Lisa Emberson

And many more….

SOMO35, ppm d

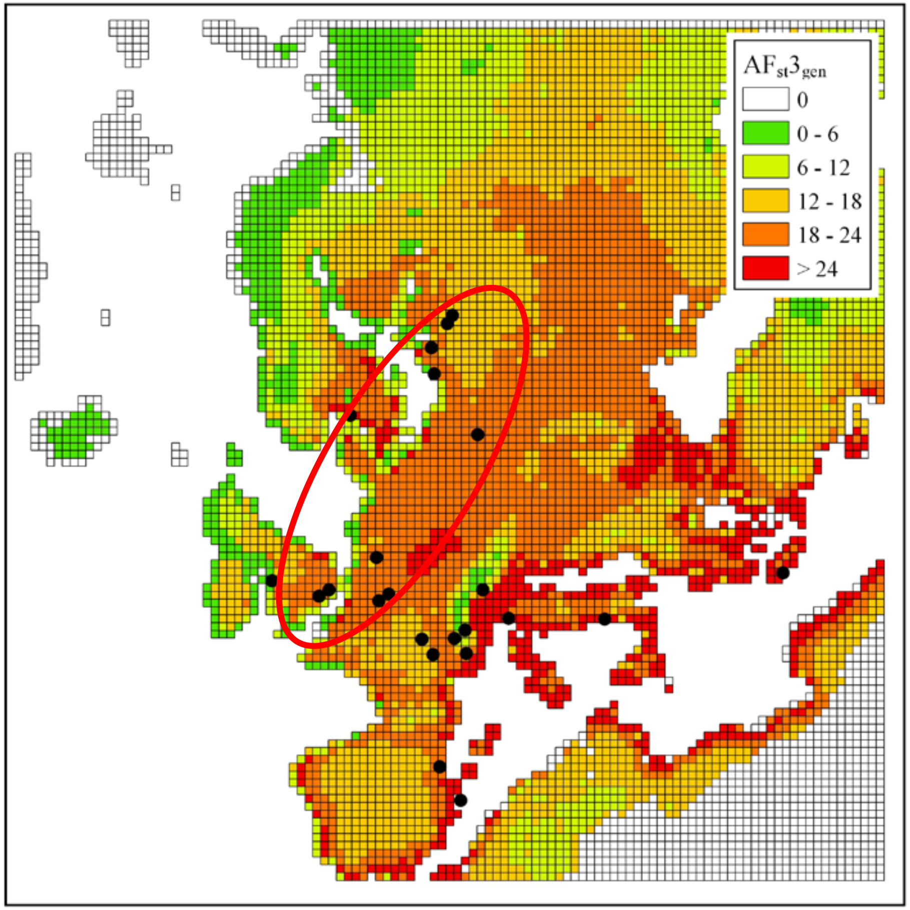


AOT40, ppm h

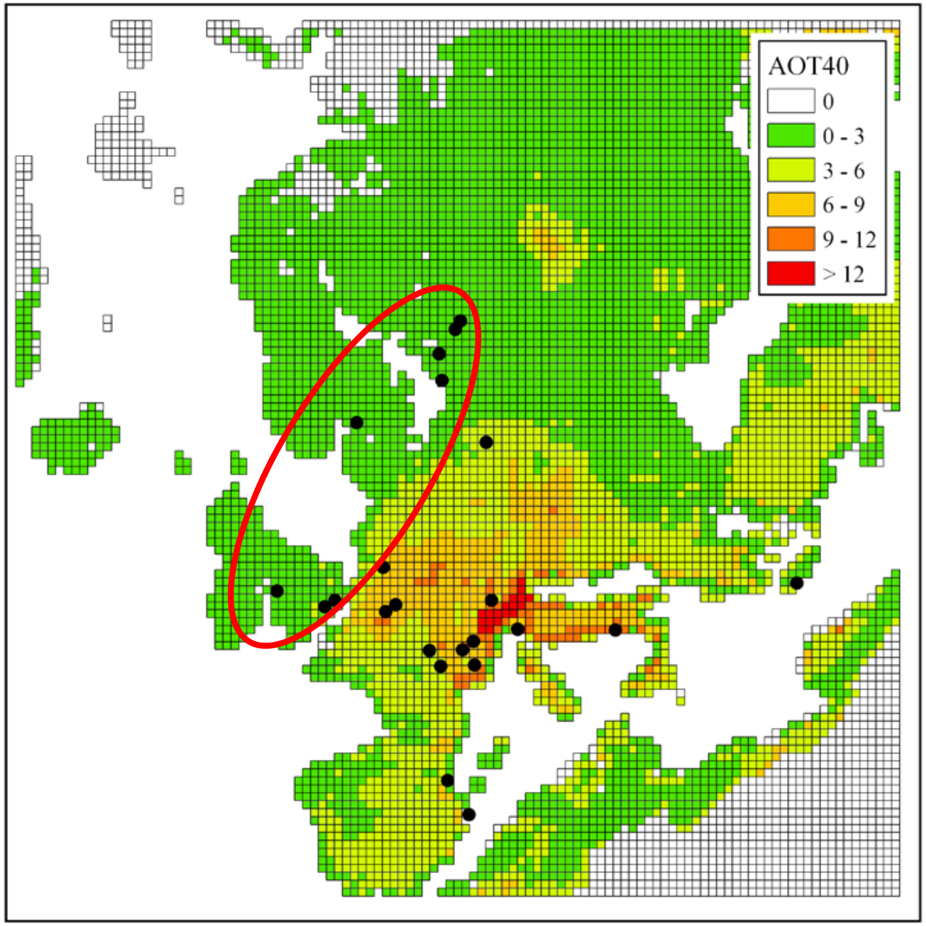


- Location of damage in 2006 (but only limited survey data available)

AFst3gen



AOT40, ppm h



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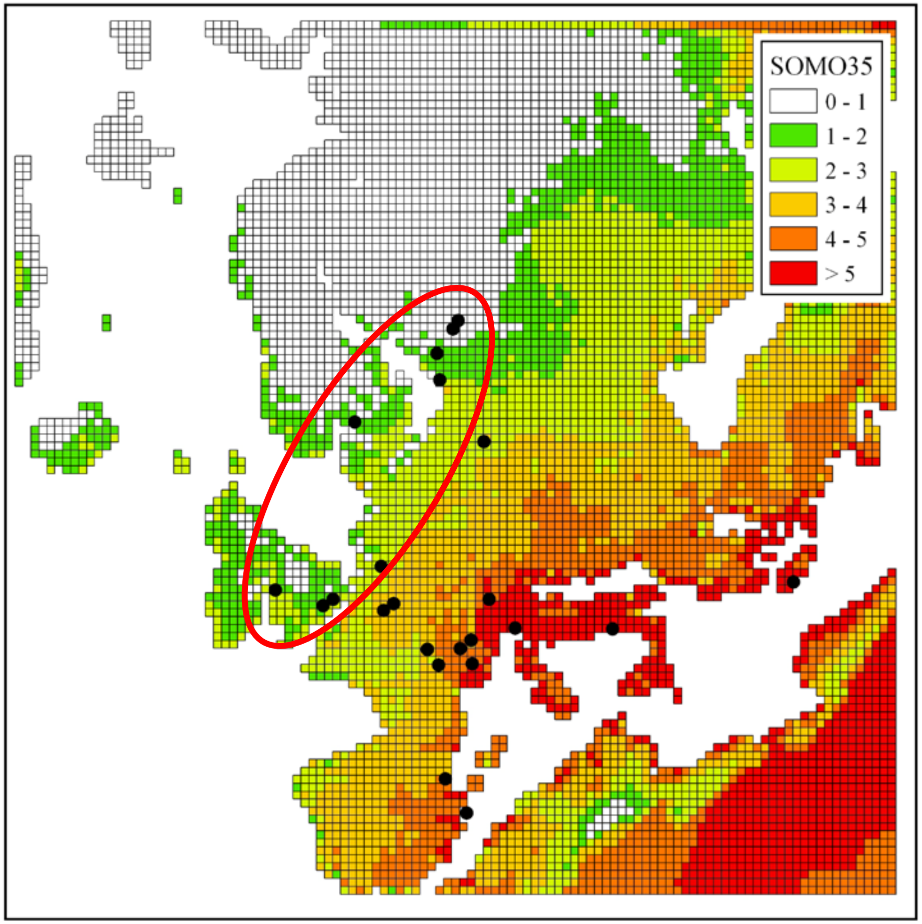
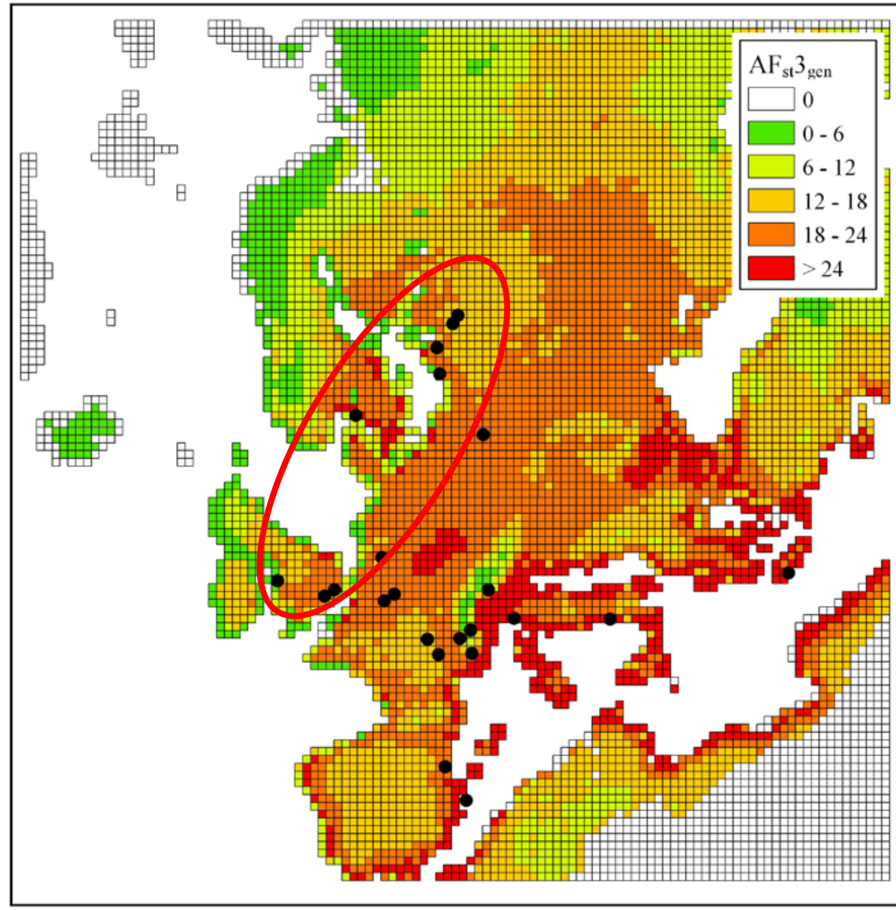
SOMO35, ppm d



O3 flux to crops (AFst3gen, mmol m-2)



- Location of damage in 2006 (but only limited survey data available)

Flux Models: background information

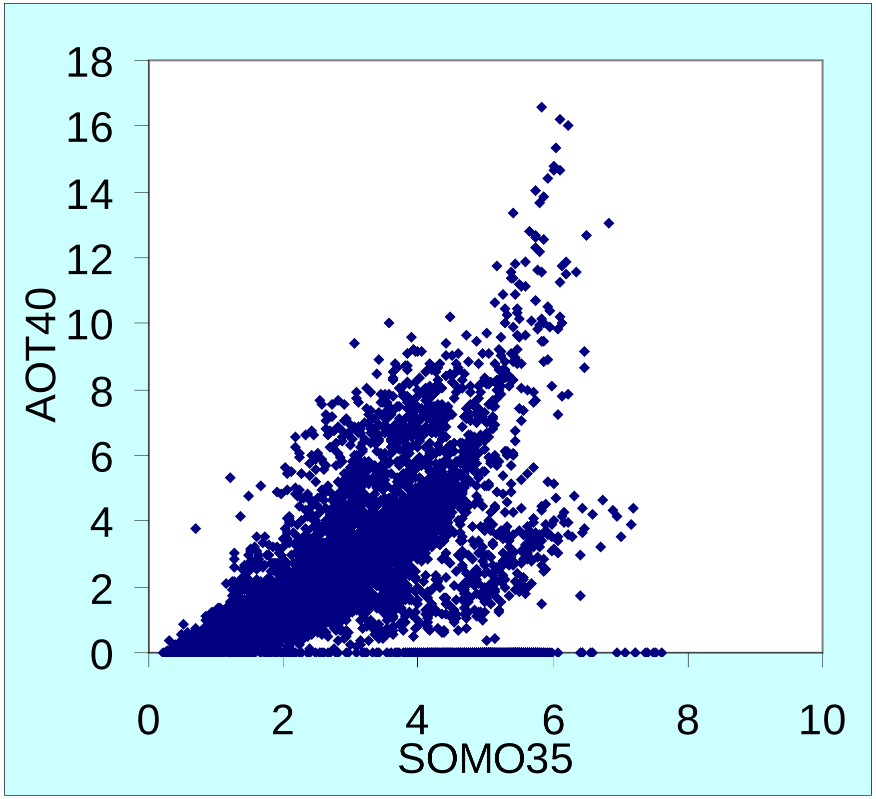
Functions included	Full flux model	Generic species model
Temperature	yes	yes
Humidity (VPD)	yes	yes
Light (PAR)	yes	yes
Soil moisture	yes	no
Ozone	(yes)	no
Phenology	yes	no

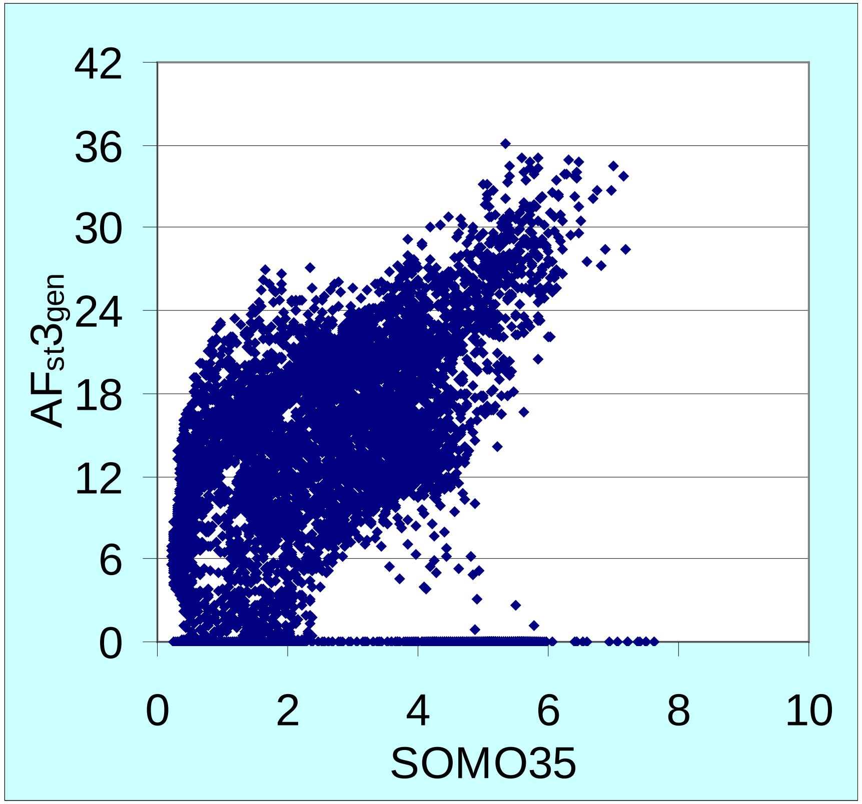
RAINS/GAINS restriction	% of on-land grid squares in AFst3gen category (crops)	
	>= 6 (Damage possible/ expected)	>= 12 (Damage expected)
SOMO35 of 1 ppm d	10.0%	4.4%
SOMO35 of 2 ppm d	27.3%	16.6%
AOT40 of 3 ppm h	35.3%	50.0%

2006 data

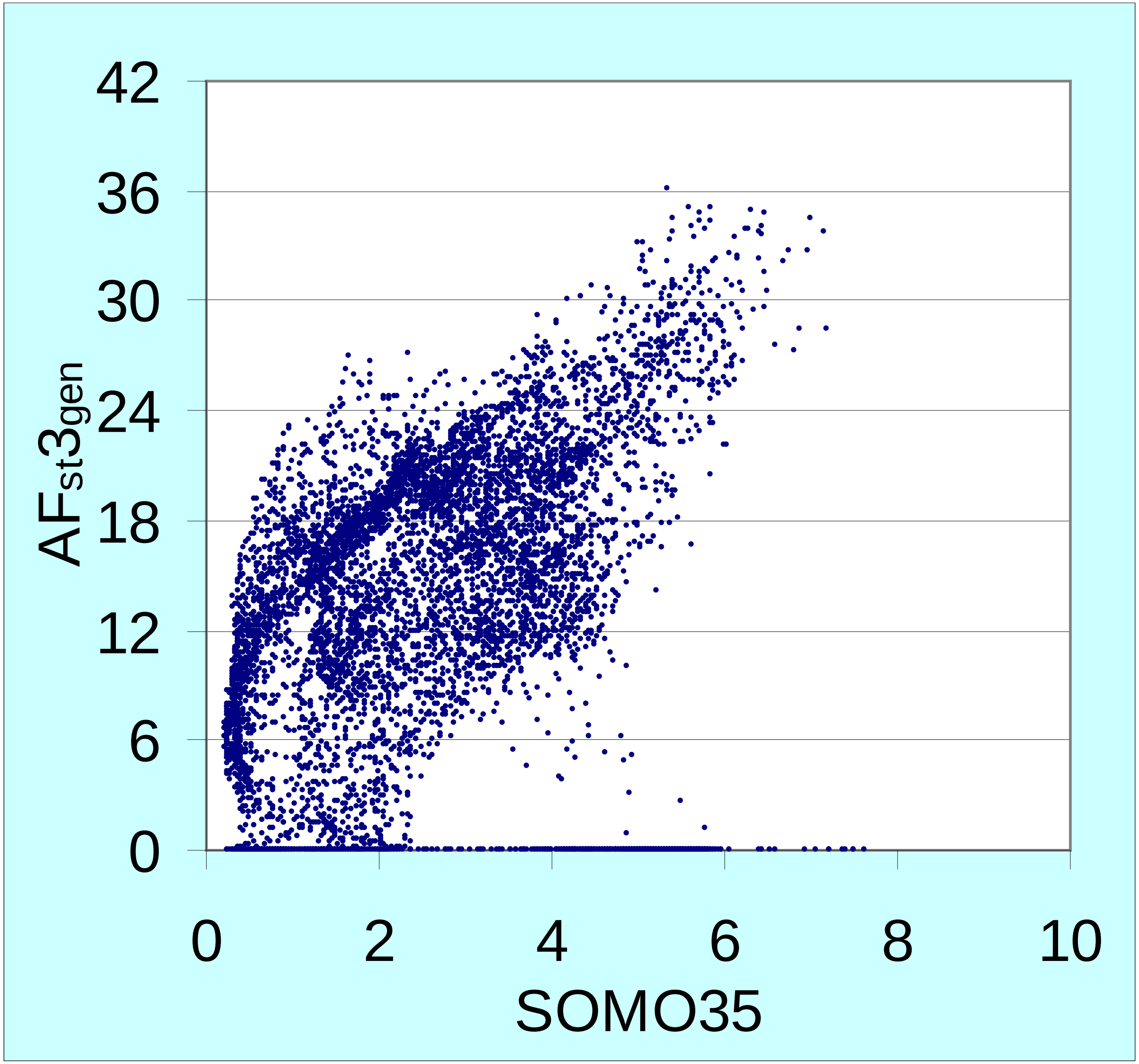
AFts3gen class (crops)	mean SOMO35 (ppm d)	Mean AOT40 (ppm h)
0 – 6 (damage unlikely)	2.95	0.19
6 – 12 (damage possible)	1.78	0.44
>= 12 (damage expected)	2.94	2.95

2006 on-land grid square values





2006 on-land grid square values



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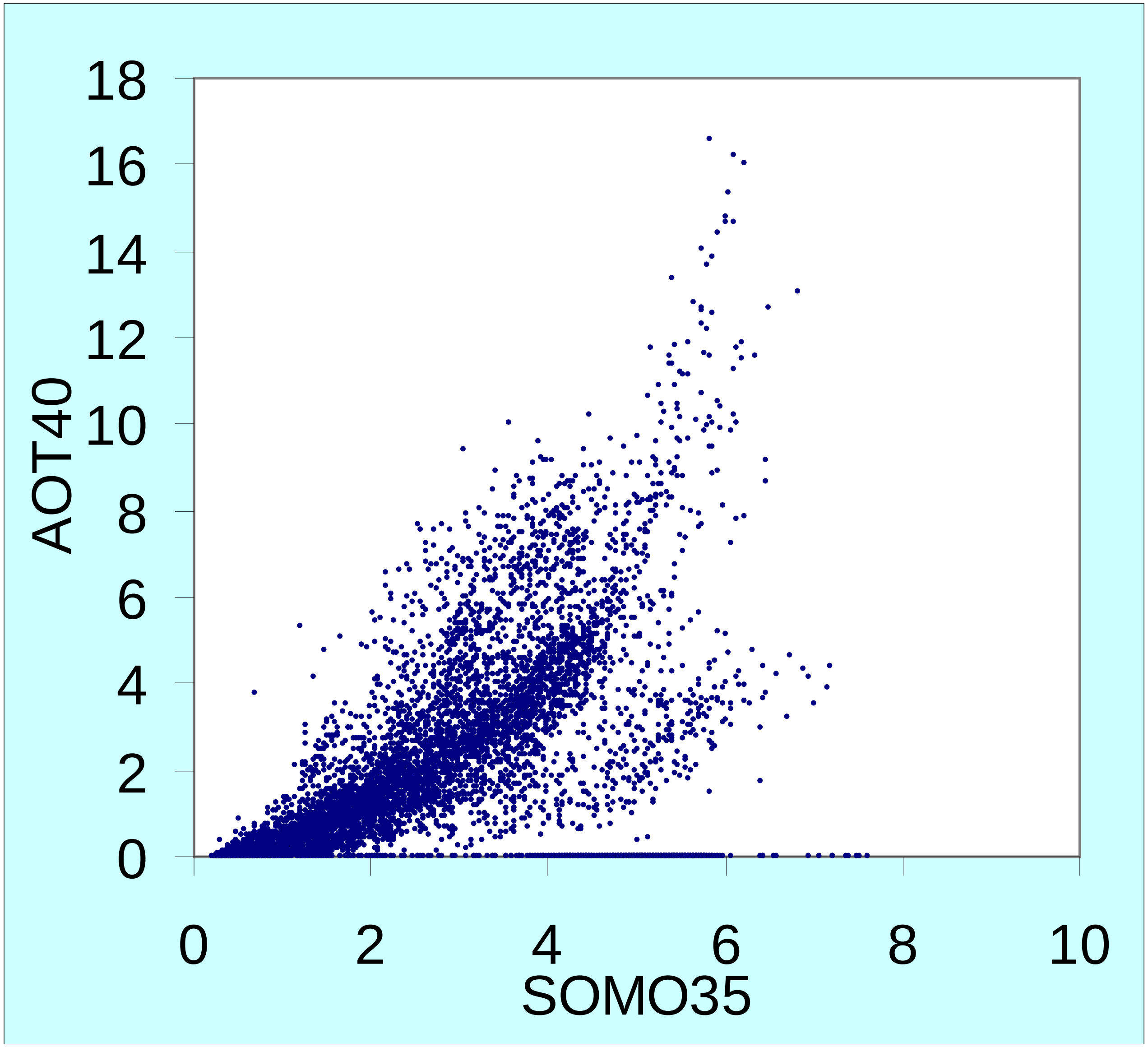
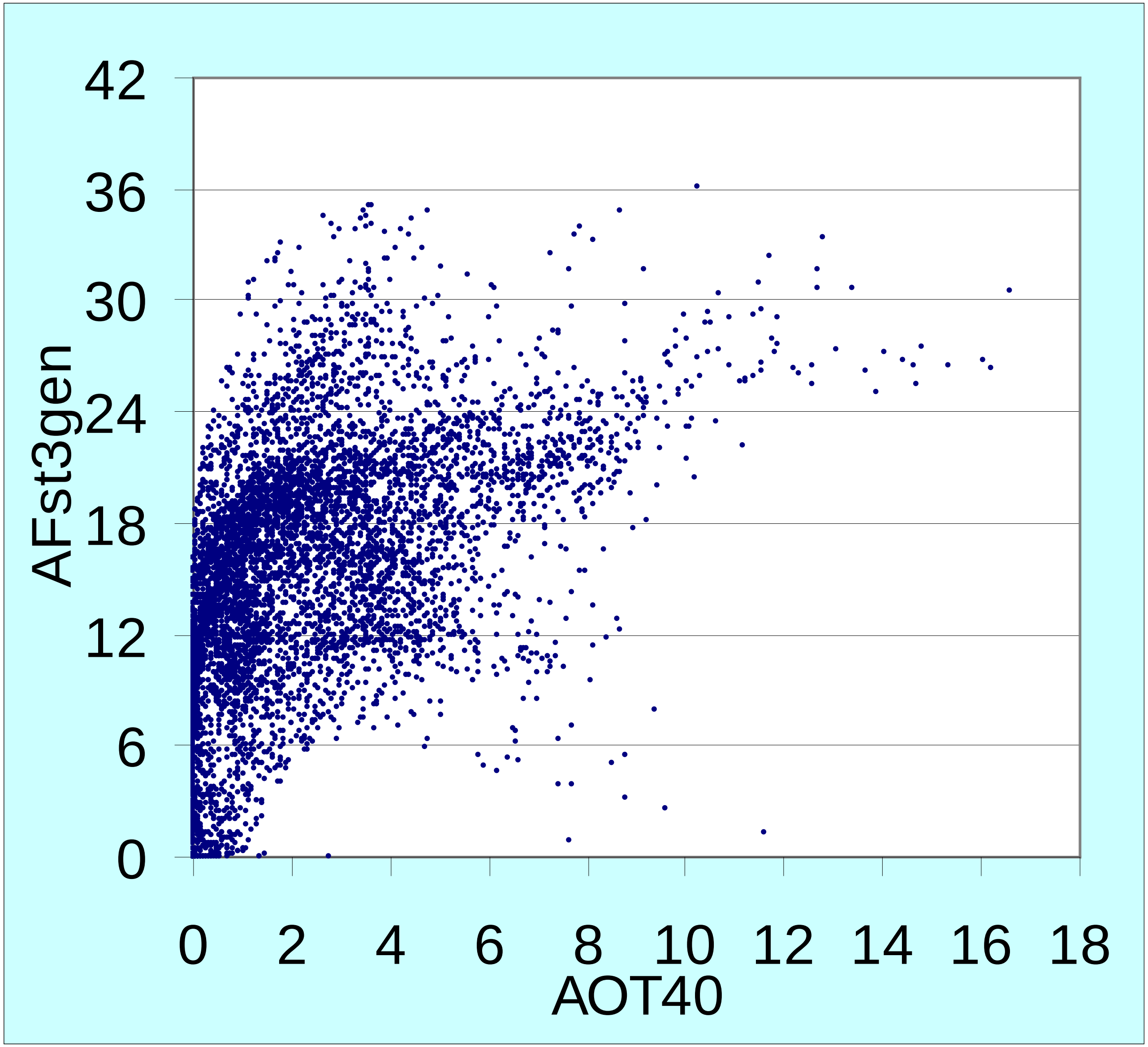
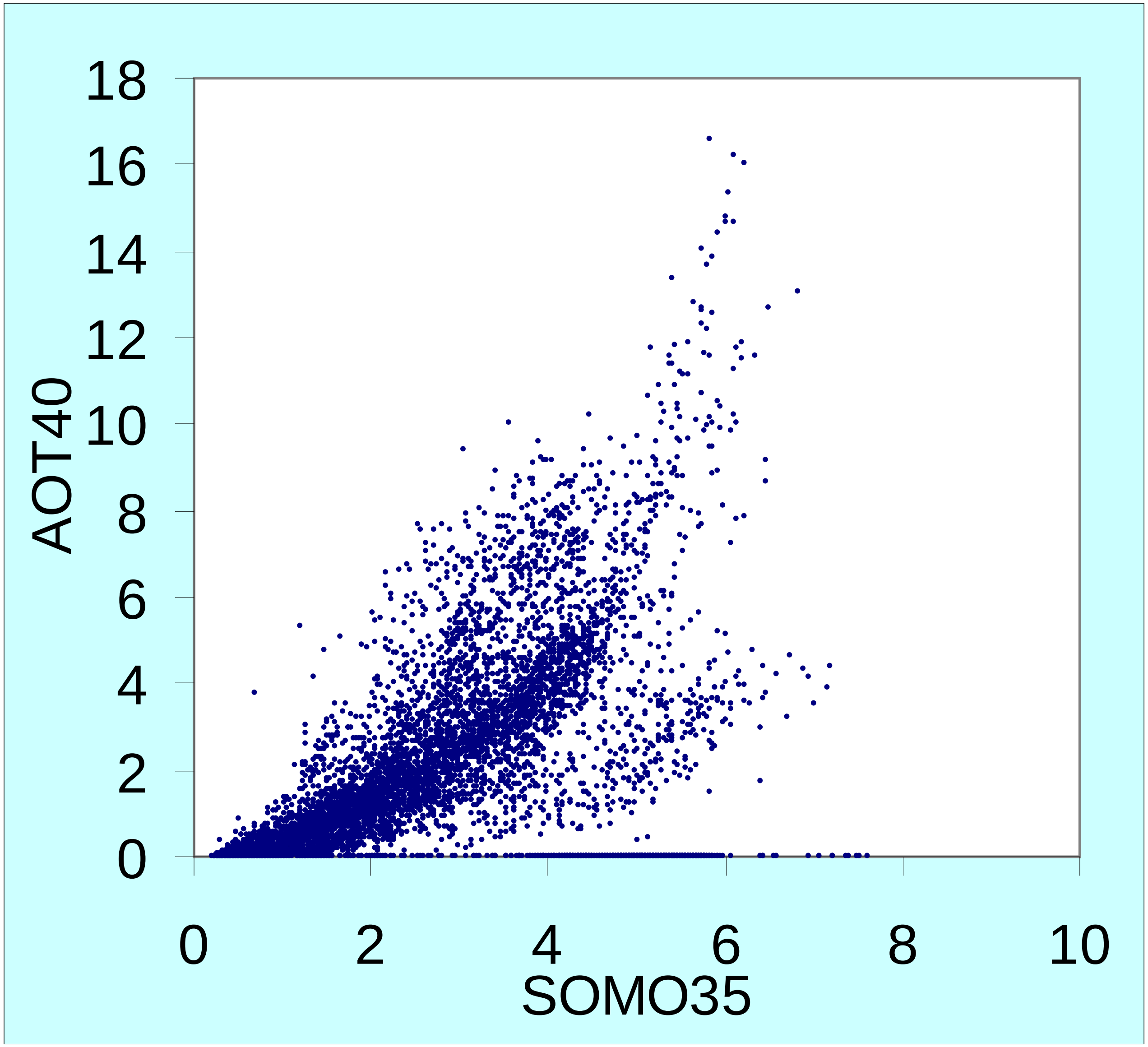
2006 on-land grid square values



2006 on-land grid square values



2006 on-land grid square values



Flux functions and CLs: Crops

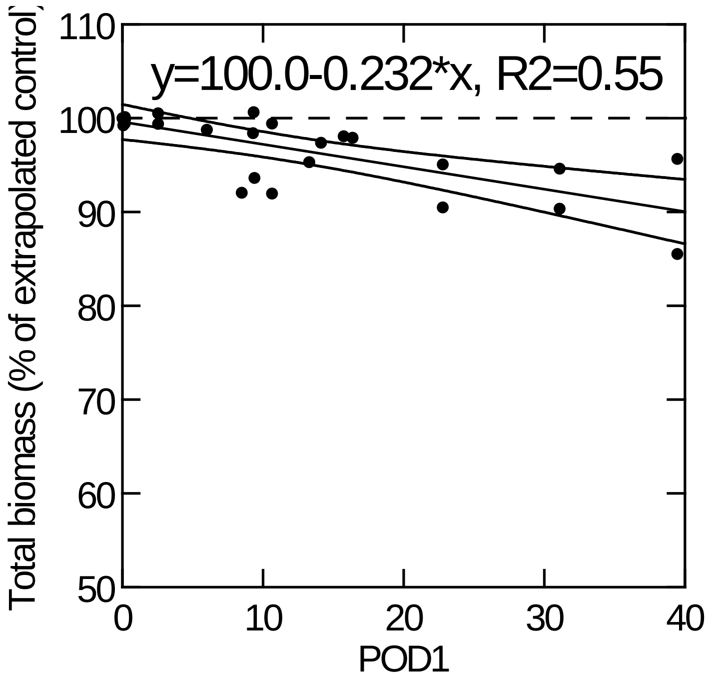
Crop	Flux-effect relation-ship?	Critical Level?	
		Yield	Quality
Wheat	*Yes*	*Yes*	*Yes*
Potato	*Yes*	*Yes*	
Beans	*Yes*		
Tomato	*Yes*	*Yes*	
Lettuce	*Yes*		
Oilseed rape	*Yes*		
Broccoli	*Yes*		

Forest trees

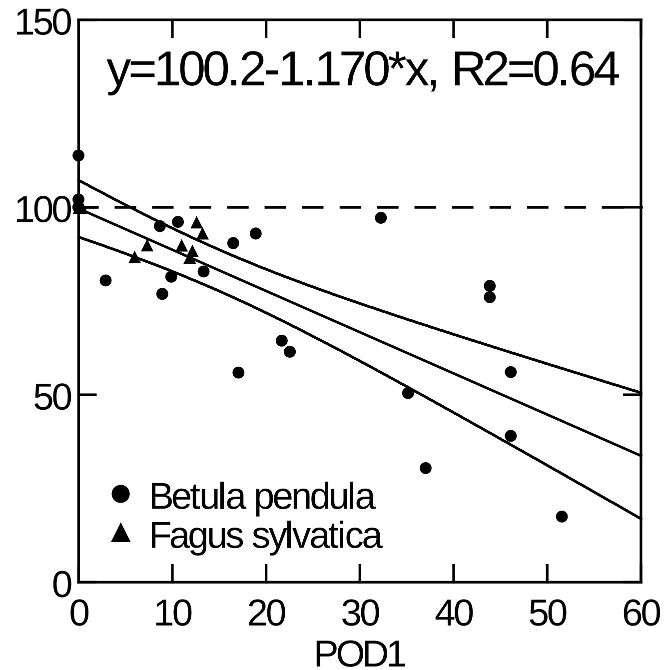
Species	Flux-effect relation-ship?	New Critical level?
Norway Spruce	*Yes*	*Yes*
Beech	*Yes*	*Yes*
Birch	*Yes*	
Sessile Oak		
Holm Oak	*Yes*	*Yes?*
Aleppo Pine	*Yes*	

Forest flux-effect functions used to derive critical levels

Norway Spruce



Beech and Birch



- From ozone exposure experiments conducted in Finland, France, Germany, Sweden and Switzerland

(Semi-)natural vegetation

- Flux-effect relationships are complex due to complex community structure

Productive grasslands

Grasslands of high conservation value

Unmanaged natural ecosystems (excluding forests)

New critical levels based on key individual species