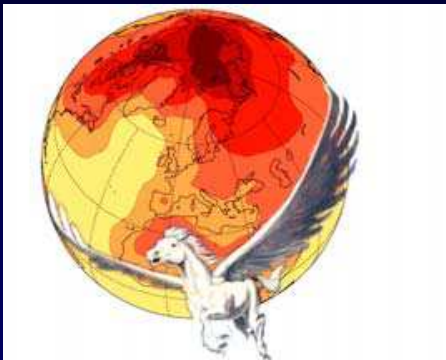


Metingen van luchtkwaliteit en grenslaagprocessen met een Zeppelin boven Nederland: de PEGASOS 2012 veldcampagne



*Laurens Ganzeveld, Earth System Sciences
Maarten Krol, Meteorology and Air Quality, WU
Thomas Mentel, Astrid Kiendler-Scharr, Frans Rohrer
Forschungszentrum Juelich, Ankie Pieters, KNMI
et al. (TNO, UU, RIVM, ECN, BIRA, Leiden Universiteit)*



PEGASOS

(Pan-European Gas-AeroSOIs-climate interaction Study)

Airborne Studies with Zeppelin

de Telegraaf
Oplage: 648.958
van: 12-05-2012

Pagina: 38

mediawaarde: € 8.163,63
cm2: 298,00

SNUFFELZEPPELIN

Mocht er komende week een enorme zeppelin boven je hoofd hangen dan is dat hoogstwaarschijnlijk de PEGASOS. Het luchtschip meet vanaf woensdag tien dagen lang de luchtkwaliteit boven ons land.

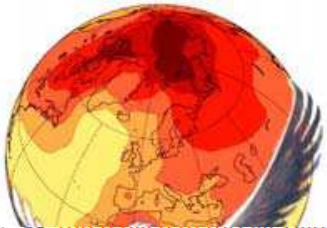
PEGASOS is een Europees project waarin wetenschappelijke instituten en universiteiten uit 15 landen samenwerken en dat zich richt op het vergroten van onze kennis over de interactie tussen luchtkwaliteit en klimaat. Tijdens de campagne wordt

grond. PEGASOS kost ons weliswaar 10 miljoen euro, dat bedrag staat nog altijd in schril contrast tot de 100 miljard euro die we in Europa jaarlijks kwijt zijn aan kosten voor gezondheidszorg en milieu, gerelateerd aan slechte luchtkwaliteit.

De zeppelin vliegt over onder andere het stedelijk gebied Rotterdam, over Cabauw, waar de meteorologische meetmast van het KNMI staat en over de Veluwe.

De meteorologische onderzoekssite Cabauw fungeert als locatie waar de verschillende onderzoeksgroepen verbonden aan PEGASOS hun instrumenten en expertise bij elkaar brengen en gezamenlijk zullen gaan meten. Naast het KNMI zijn het RIVM, TNO, TU Delft, Universiteit Utrecht en Uni-





Airborne Studies with Zeppelin

Sent: di 22-5-2012 15:40

To: Ganzeveld, Laurens; Krol, Maarten

En hierbij nog een selectie van internetberichten. Als je ze allemaal zou lezen, kun je de route boven Nederland zo op een kaart zetten. Ik kan me niet voorstellen dat er nog mensen zijn die er niet van gehoord hebben....

<http://forum.fok.nl/topic/1819417>

<http://www.nufoto.nl/fotos/285103/zeppelin-boven-driebergen.html>

<http://www.gelderlander.nl/voorpagina/devallei/11077226/Zepelin-meet-luchtkwaliteit-Wageningen.ece>

http://www.rotterdamnieuws.net/nieuws/2012-05-21-4348-zeppelin-in-de-regio.html?utm_source=www.hetnieuws.in&utm_medium=embed&utm_content=

<http://www.omroepgelderland.nl/web/Nieuws-1/1550631/Klimaatonderzoek-met-grote-zeppelin.htm>

http://arnhem.dichtbij.nl/berichten/20120519_zeppelin Onderzoekt de hollandse luchten

<http://www.nu.nl/wetenschap/2810315/zeppelin-meet-nederlandse-luchtkwaliteit.html>

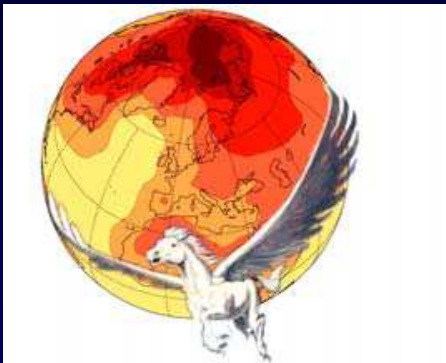
<http://regio18.nl/?p=4604>

<http://www.lopik.nl/index.php?simaction=content&mediumid=1&pagid=220&stukid=42893>

<http://www.ad.nl/ad/nl/4561/Wetenschap/article/detail/3255401/2012/05/14/Zepelin-meet-Nederlandse-luchtkwaliteit.dhtml>

<http://omroepzuidplas.nl/artikel/2012/5/19/zeppelin-pegasos-vloog-over-nieuwerkerk>

<http://www.ijssemondnieuws.nl/zeppelin-boven-rotterdam-meet-luchtkwaliteit/>

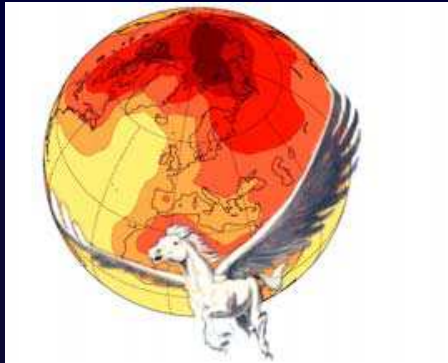


EU-FP7 integrated project:
PEGASOS
**(Pan-European Gas-AeroSOls-climate
interaction Study)**

What is this whole project about?

- To quantify the magnitude of feedbacks between atmospheric chemistry and a changing climate and to reduce the corresponding uncertainty of the major ones.
- To identify mitigation strategies and policies to improve air quality while limiting climate change.

Workpackage 7:
Field observations over contrasting biomes. Airborne Studies



EU-FP7 integrated project:
PEGASOS
(Pan-European Gas-AeroSOls-climate
interaction Study)

Workpackage 7:
**Field observations over contrasting (European)
biomes, Airborne Studies**

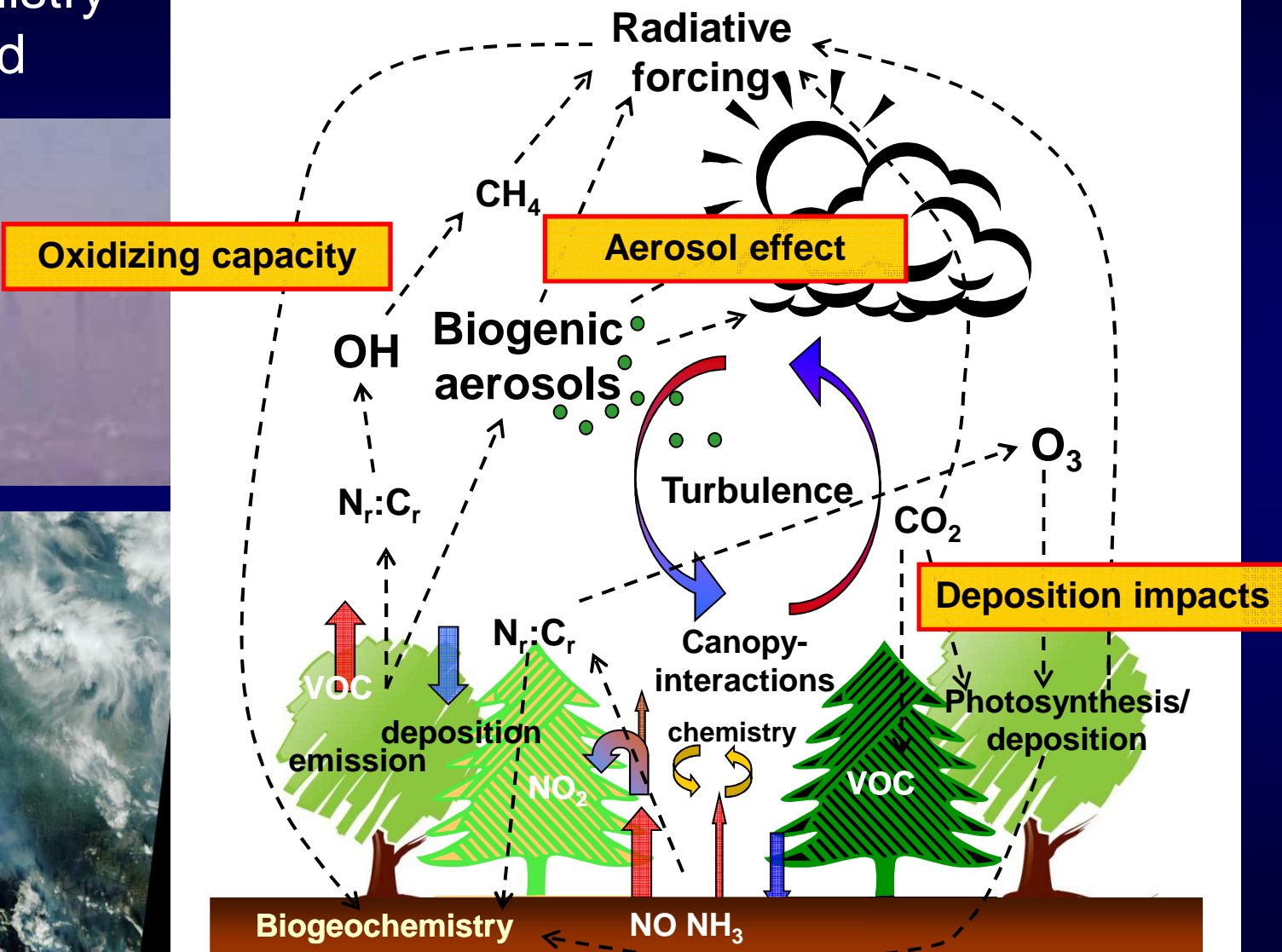
Atmospheric chemistry in a changing world



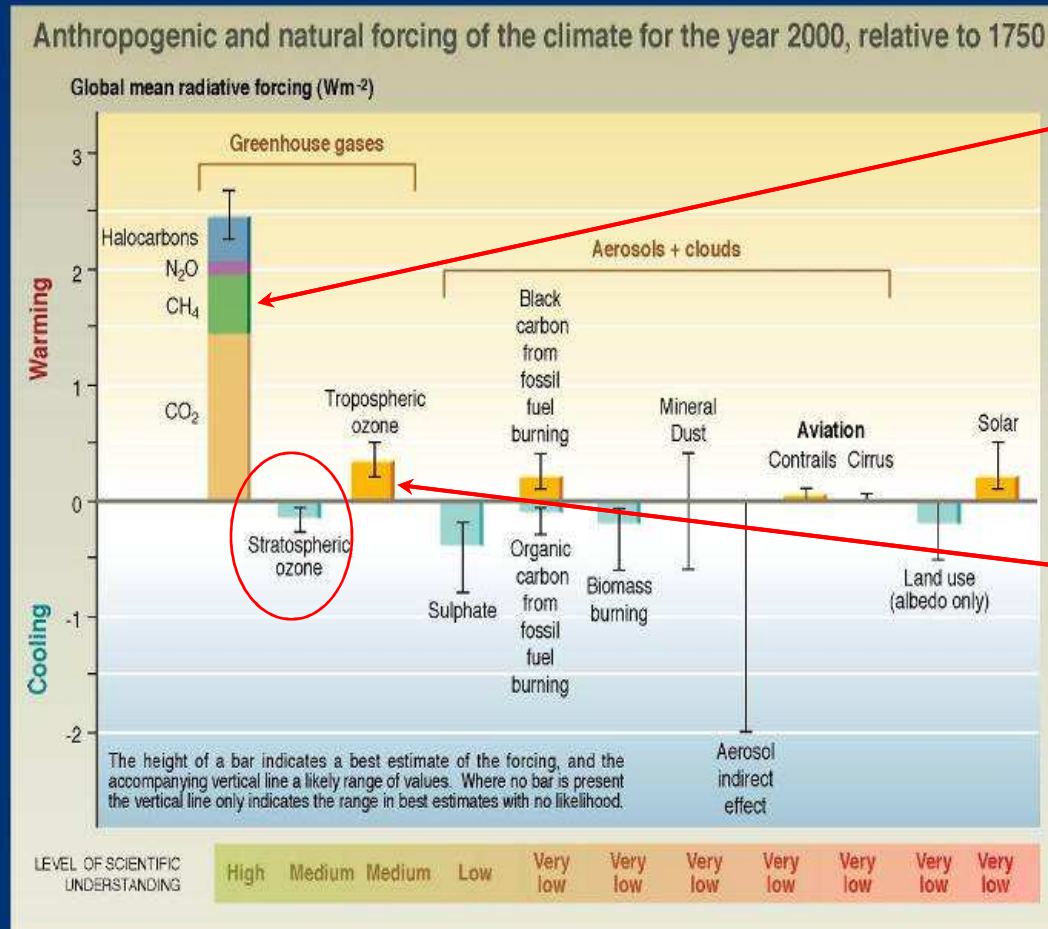
nadir

15-September-2002

70-degree forward

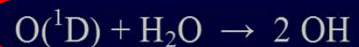
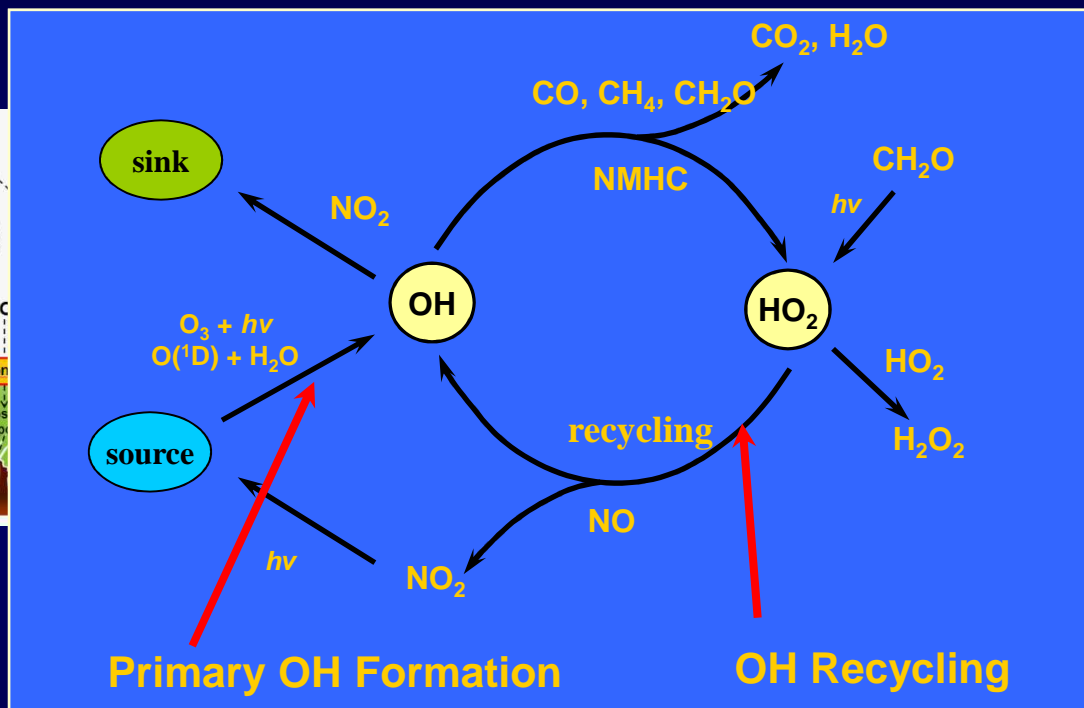
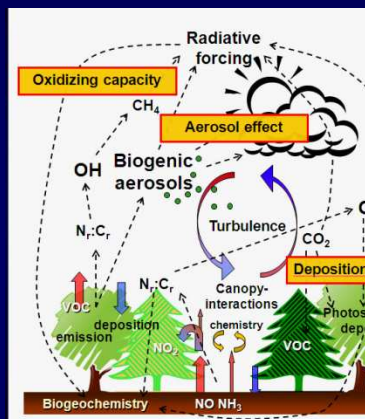


Atmospheric chemistry in a changing world



- **Atmospheric chemistry controls lifetime of greenhouse gases such as CH_4 and pollutants: oxidizing capacity**
- **Some reactive gases affect radiation, e.g, ozone**
- **and aerosols....**

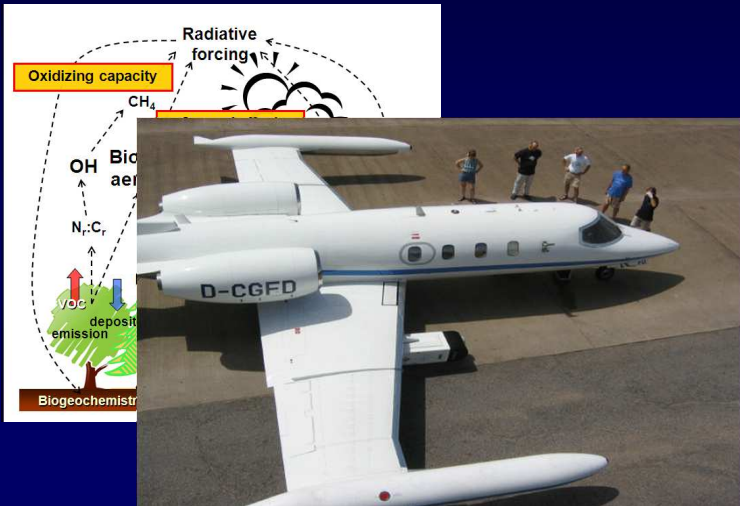
Atmospheric chemistry: OH radical, the atmosphere's detergent



The OH oxidizes CH₄, CO, CH₂O and NMHC

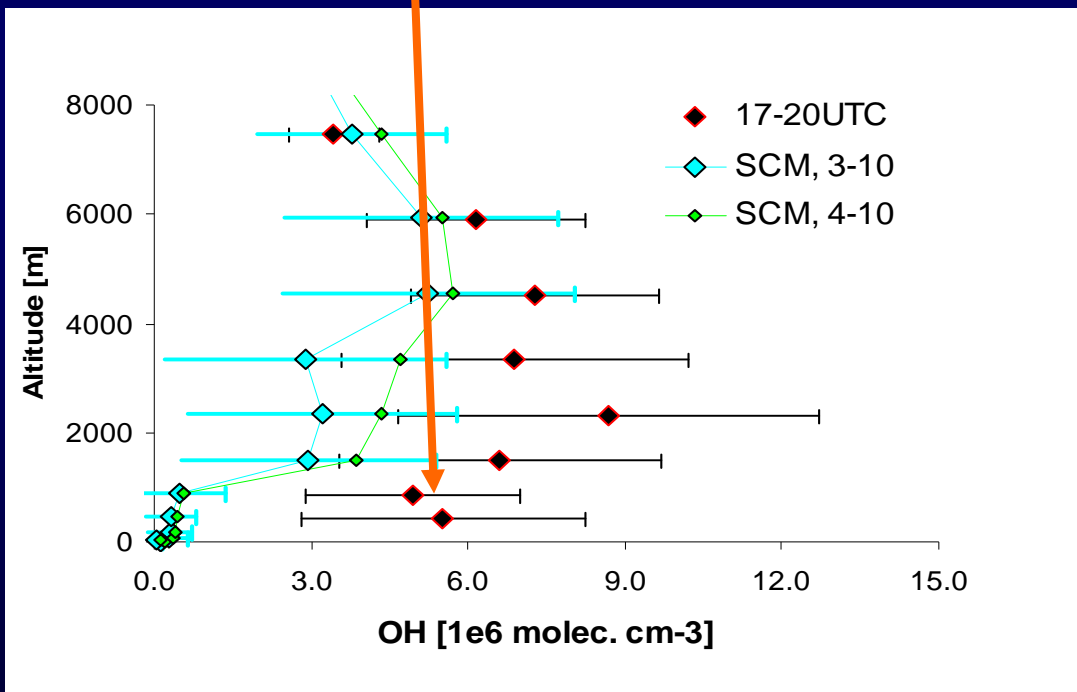
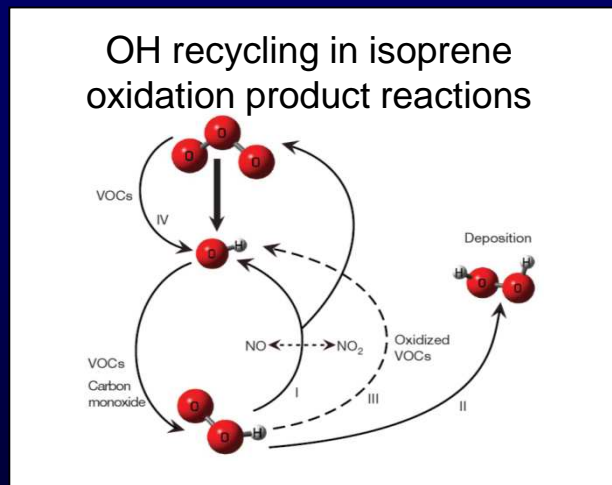
Resulting in the formation of HO₂ and recycling of OH

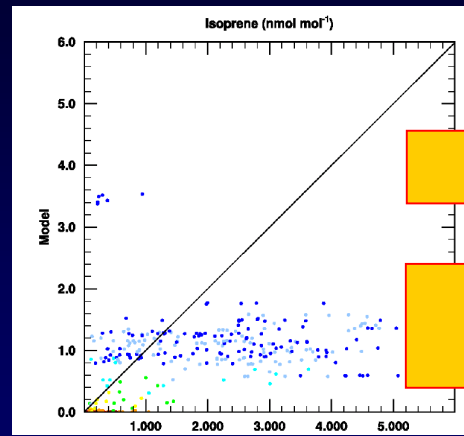
GABRIEL Campaign over South American rainforest: Surprisingly high atmospheric oxidizing capacity over tropical forest:



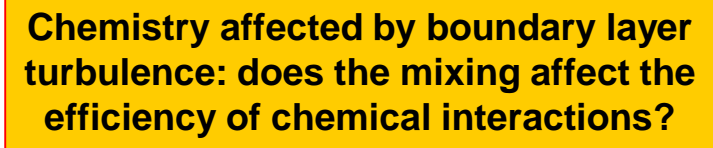
Lelieveld et al., Atmospheric oxidation capacity sustained by a tropical forest, Nature, doi:10.1038/nature06870, 2008.

Observations of OH concentrations in the BL much higher than simulated in any state-of-the-art atmospheric chemistry and transport model.





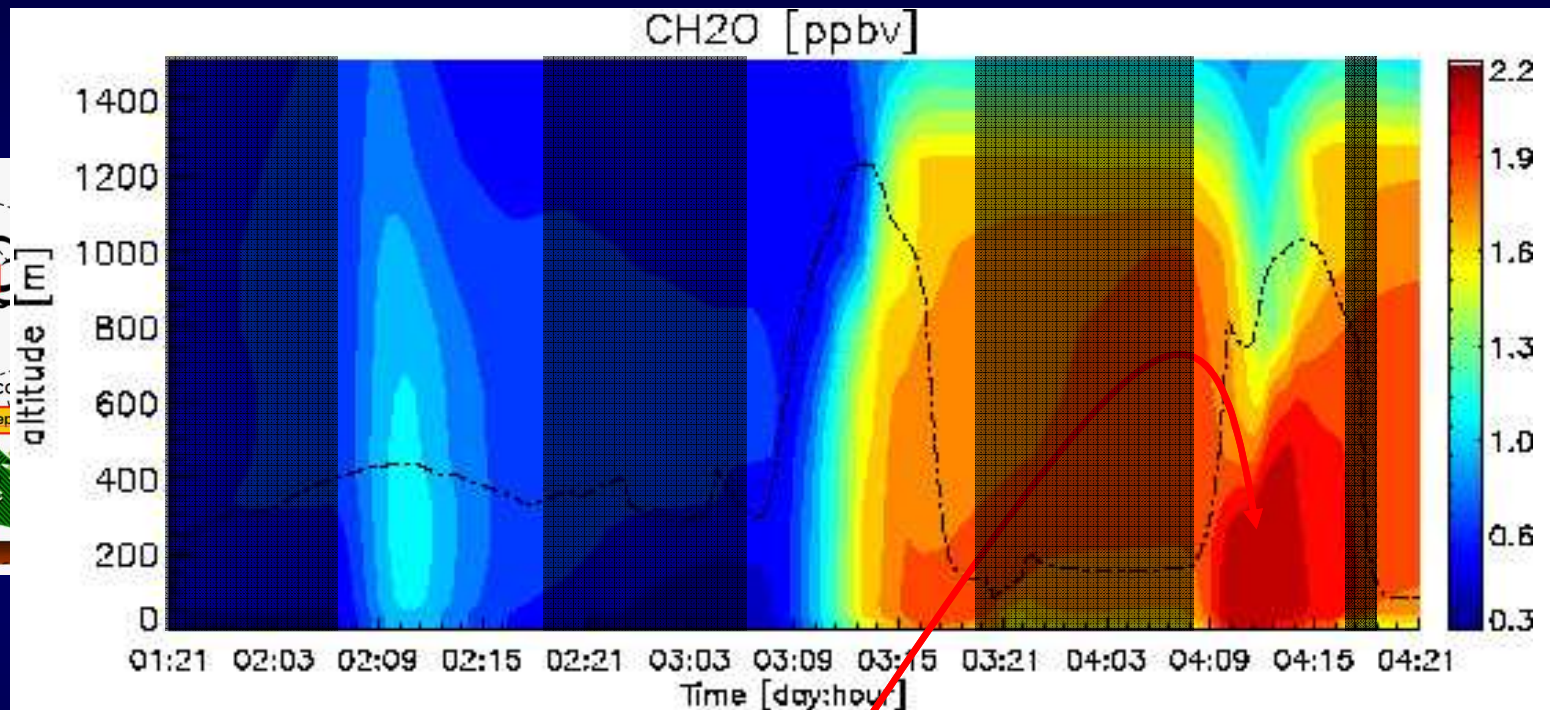
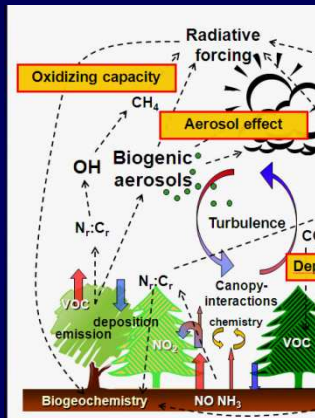
**Too large isoprene oxidation:
Decrease in $R_{OH-ISOP}$ of 50%**



Courtesy: Si-Wan Kim, NCAR

Diurnal cycle in BL dynamics – Atmospheric chemistry

Simulated formaldehyde concentrations, tropical forest



Nocturnal build-up of isoprene oxidation products relevant to daytime chemistry?

How does nocturnal residual layer chemistry and removal change in response to changes in turbulent exchanges?

Importance of residual layer and FT in organic aerosol studies

ACPD

12, 9331–9375, 2012

Effects of surface conditions, dynamics and chemistry on SOA-evolution

R. H. H. Janssen et al.

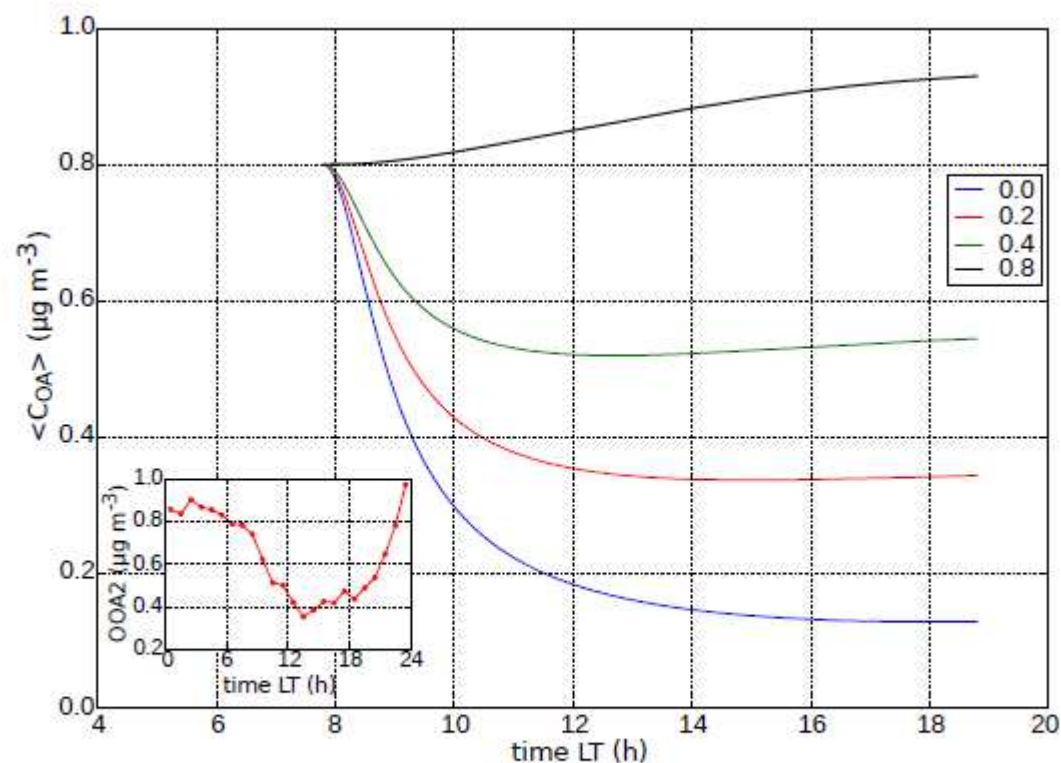
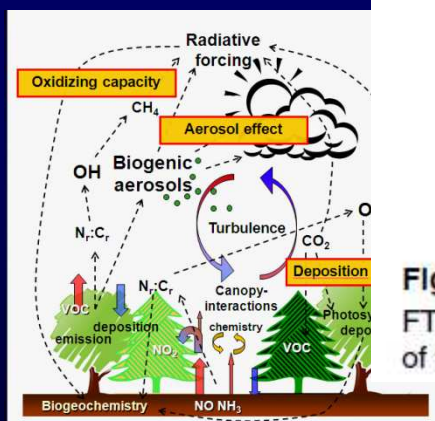
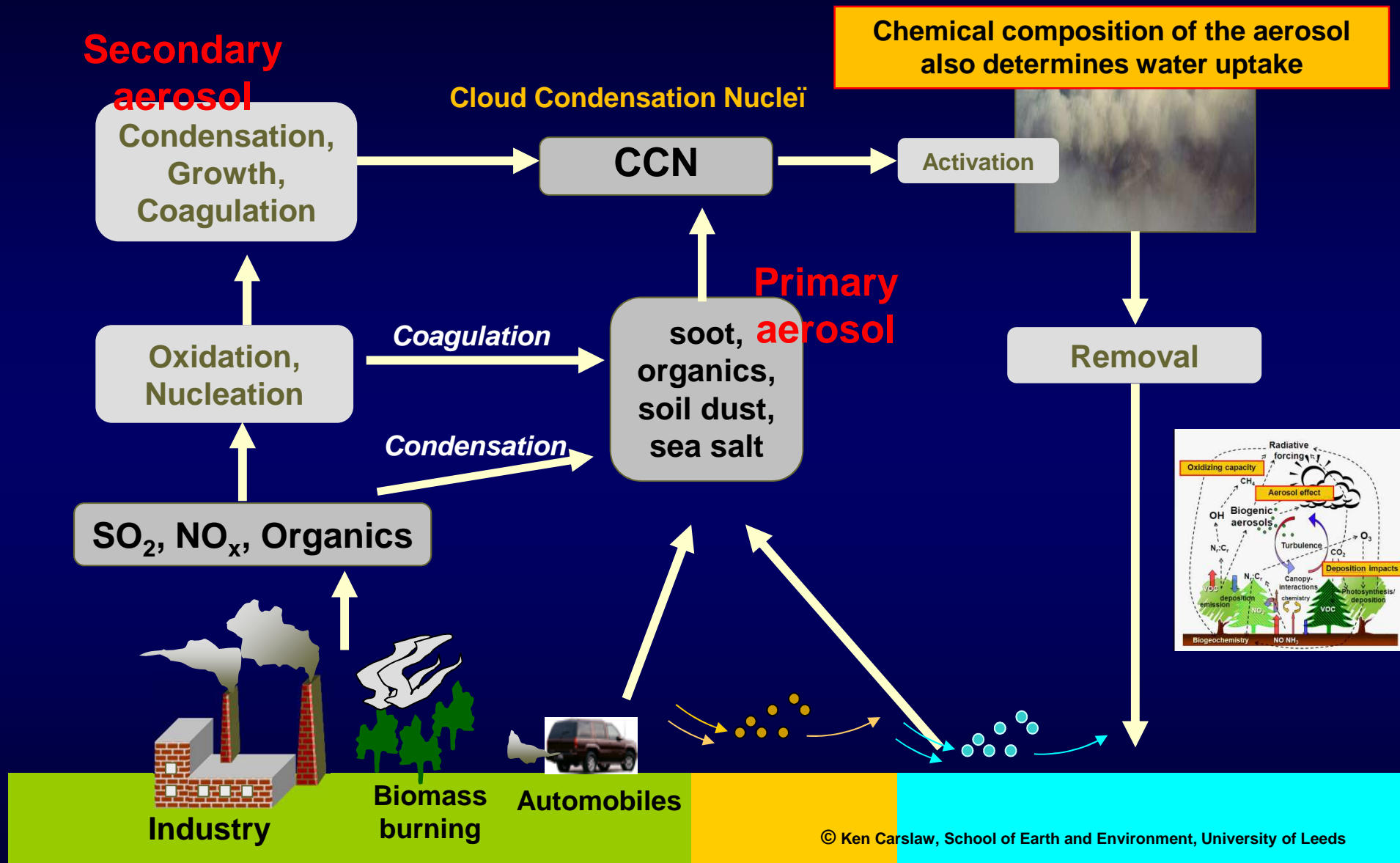
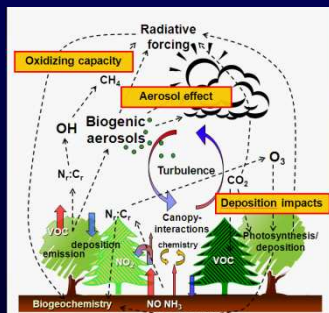
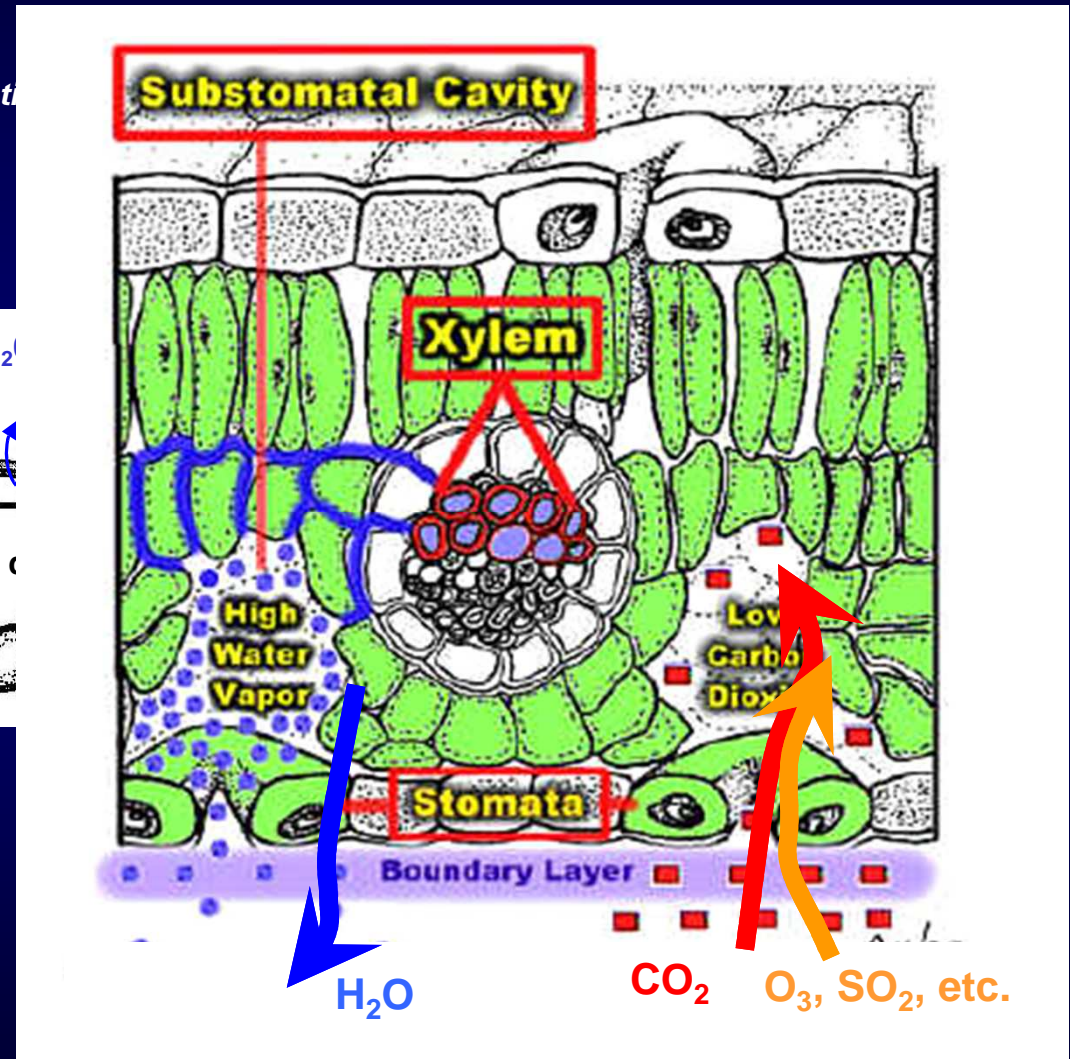
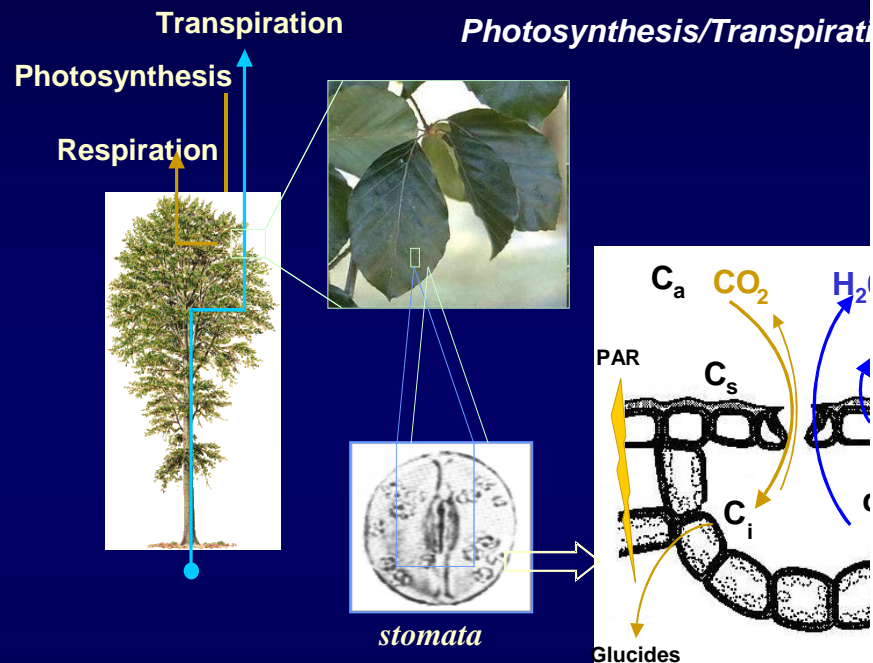


Fig. 6. Organic aerosol concentration C_{OA} for the case study, including the sensitivity to different FT background OA-concentrations (0.0, 0.2, 0.4, 0.8 $\mu\text{g m}^{-3}$). The inset shows the diurnal cycle of the measured OOA2-concentration, averaged over 15 days.



Atmospheric chemistry: deposition impacts



Atmospheric chemistry: deposition impacts and carbon sequestration

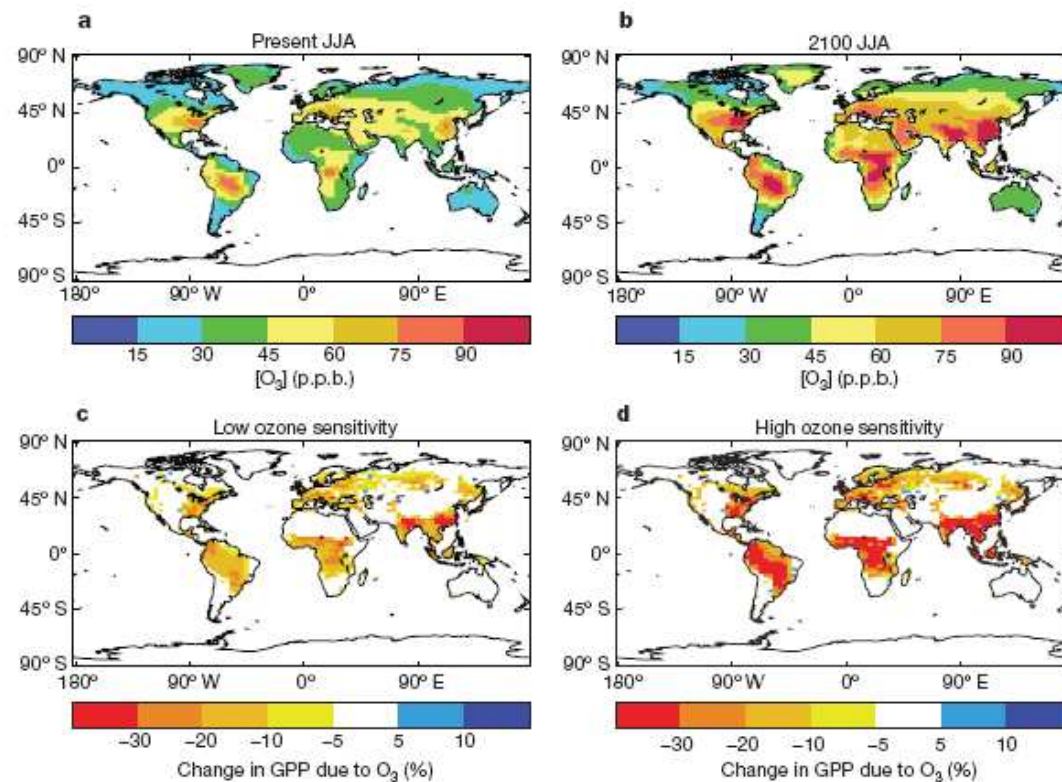
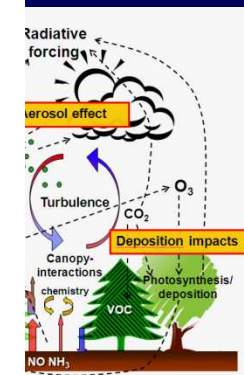
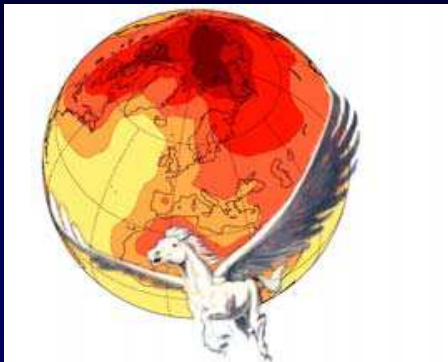


Figure 1 | Temporal changes of modelled ozone concentrations and gross primary productivity. a, b, Modelled diurnal (24-h) mean surface $[O_3]$ in p.p.b. averaged over June, July and August (JJA) for the present day (a) and the year 2100 under the SRES A2 emissions scenario (b). c, d, Simulated

percentage change in gross primary productivity (GPP) between 1901 and 2100 due to O_3 effects at fixed pre-industrial atmospheric $[CO_2]$ for 'low' (c) and 'high' (d) ozone plant sensitivity.



Sitch et al., Nature 2007, Indirect radiative forcing of climate change through ozone effects on the land-carbon sink



- To quantify the magnitude of feedbacks between atmospheric chemistry and a changing climate and to reduce the corresponding uncertainty of the major ones.
- To identify mitigation strategies and policies to improve air quality while limiting climate change.

- **Enhancement of carbon sequestration through reducing pollutants**
- **Reducing aerosol resulting in enhanced warming**
- **Impact of improved urban air quality on oxidizing capacity**
- **Climate change induced changes in hydrological cycle and its impact on wet and dry deposition**
- **Impact of reduced nutrient deposition on GHG emissions**



EU-FP7 integrated project:
PEGASOS
(Pan-European Gas-AeroSOls-climate
interaction Study)

Workpackage 7:

Field observations over contrasting biomes: Airborne Studies

- **To address some of the remaining key open issues on the representation of atmospheric chemistry-climate interactions in models to assess air quality or/and climate change**

Mission Objectives:

- **HO_x recycling**
 - Explore *spatial variability and the chemical regimes of HO_x recycling*
 - Detect *key compounds for HO_x recycling*
 - Quantify related *formation of photo-oxidants and air pollutants*
 - *Formation of new particles*
 - *Formation and chemical aging of secondary aerosols*
- **Boundary layer dynamics and atmospheric chemistry**
 - *Spatial and vertical gradients of medium long-lived trace gases: dispersion of pollutants downward of main source regions*
 - *Early morning transition in BL mixing in atmospheric chemistry*

EU-Project PEGASOS 2012 / 2013

Overview of conducted/planned Campaign routes





Main Tool: Zeppelin Airship

Top Platform:
OH, HO₂, T_{OH}, j-values

Boom:
T, rH, p, 3d-wind

Cabin:
O₃, NO_x, CO, HCHO, HONO, VOC,
Aerosols, Soot, HG, Natural Ions,
Clusters, j-values

ZEPPELIN NT

Scientific payload	1 ton
Flight speed	0 – 115 km/h
Operating altitude	20 – 3000 m (ASL)
Max. flight endurance	20 hours

Major advantage of Zeppelin Platform:

- Regional distribution of trace gases and related processes with high spatial resolution (slowly moving platform)
 - ⇒ during *transfer flights* to stations
 - ⇒ *transects* near stations
- Vertical distributions of trace gases and related processes
 - ⇒ Detailed and low-altitude (~50m) *vertical profiles* near stations
- Time evolution of air masses
 - ⇒ *Lagrangian type experiments* near stations



Major advantage of Zeppelin Platform:

- **Regional distribution of trace gases and related processes**

- Anticipated maximum flight altitude: ~1200m.
- During the campaign it turned out to be limited to a maximum of ~500m (also due to weather conditions)
- Implying that you can only sample the lower part of a typical summer maximum BL of 1500m
- No daytime FT samples
- But early morning transition measurements
- Unfortunately only some of these also due to relative bad and windy conditions (no build up of strong nocturnal inversions)

- **Time evolution of air masses**

⇒ *Lagrangian type experiments near stations*



Partners in Airborne Study WP of PEGASOS

Forschungszentrum Jülich GmbH, Germany

University of Helsinki, Finland

Paul Scherrer Institut, Switzerland

Fa. AIREL, Estland

University of Leicester, United Kingdom

CNRS, Nat. Res. France

NERC, Nat. Res. United Kingdom

Zeppelin LT, Germany

Complemented by a great Dutch team of partners!!

KNMI, ECN, TNO, RIVM, Leiden University

and PEGASOS partner WUR to organize, to communicate with the press and measurements with the SkyArrow

Measurements of air-quality and climate interactions over NL with Zeppelin



along the tower: in-situ
measurements NO , NO_2 , CO ,
 CH_4 , CO_2 , N_2O

Trace gas measurements during PEGASOS (KNMI, RIVM, BIRA, ECN)

Zeppelin



2 MAXDOAS
instruments (NO_2
columns)

Weather balloon, with
 NO_2 sonde



NO_x analysers

FTIR (columns of CO ,
 CH_4 , N_2O)

NO_2 lidar (profiles of
 NO_2)

Ankie Pieters, KNMI

Cabin Layouts; selection based on anticipated events and limited payloads

Default:

TOP PLATFORM: OH, HO₂, τ_{OH} , j-values (\uparrow)

BOOM: T, rh, p, 3d wind

CABIN: Avionik, GPS

CO, NO, NO₂, O₃, j-values (\downarrow)

Particles (#, d_p : 1 nm – 5 μ m)

CL8 – Photo-chemistry CL5 – SOA

VOC, OVOC

HONO

Formaldehyde

VOC, OVOC

AMS - aerosol comp.

Soot

Hygroscopic growth

CL-9 NUC

Neutral and charged clusters

Natural ions

EURAD-IM

Model based mission planning

- **Forecast Products (Datasets)**

Hourly 3D-fields

Gas-phase concentrations

O₃, NO_x, CO, Isoprene, HCHO, OH,...

Aerosol concentrations and integrated values

PM₁₀, PM_{2.5}, PM_{0.75}, organic PM₁, PND (Particle Number Density), NO₃⁻, ...

Reactivities and photolysis-rates

k_{OH} (VOC[+CO] / SO₂ / aromatics), J(O^{1D}), J(NO₂),...

Chemical characterisation

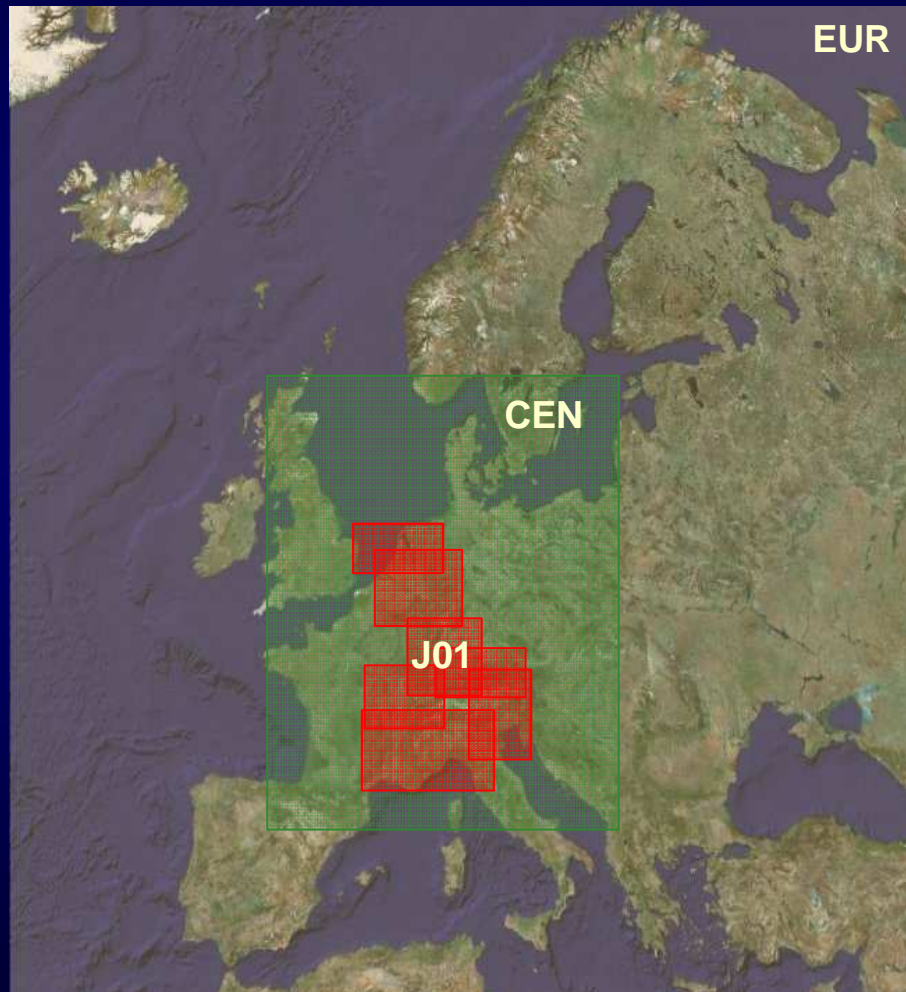
k_{OH} (VOC+CO) / NO_x, Anthropogenic Enhancement, k_{OH} (SO₂) / VOC-Turnover (as nucleation indicator),...

Meteorological parameters

Temperature, relative humidity, winds,...

EURAD-IM

Model based mission planning

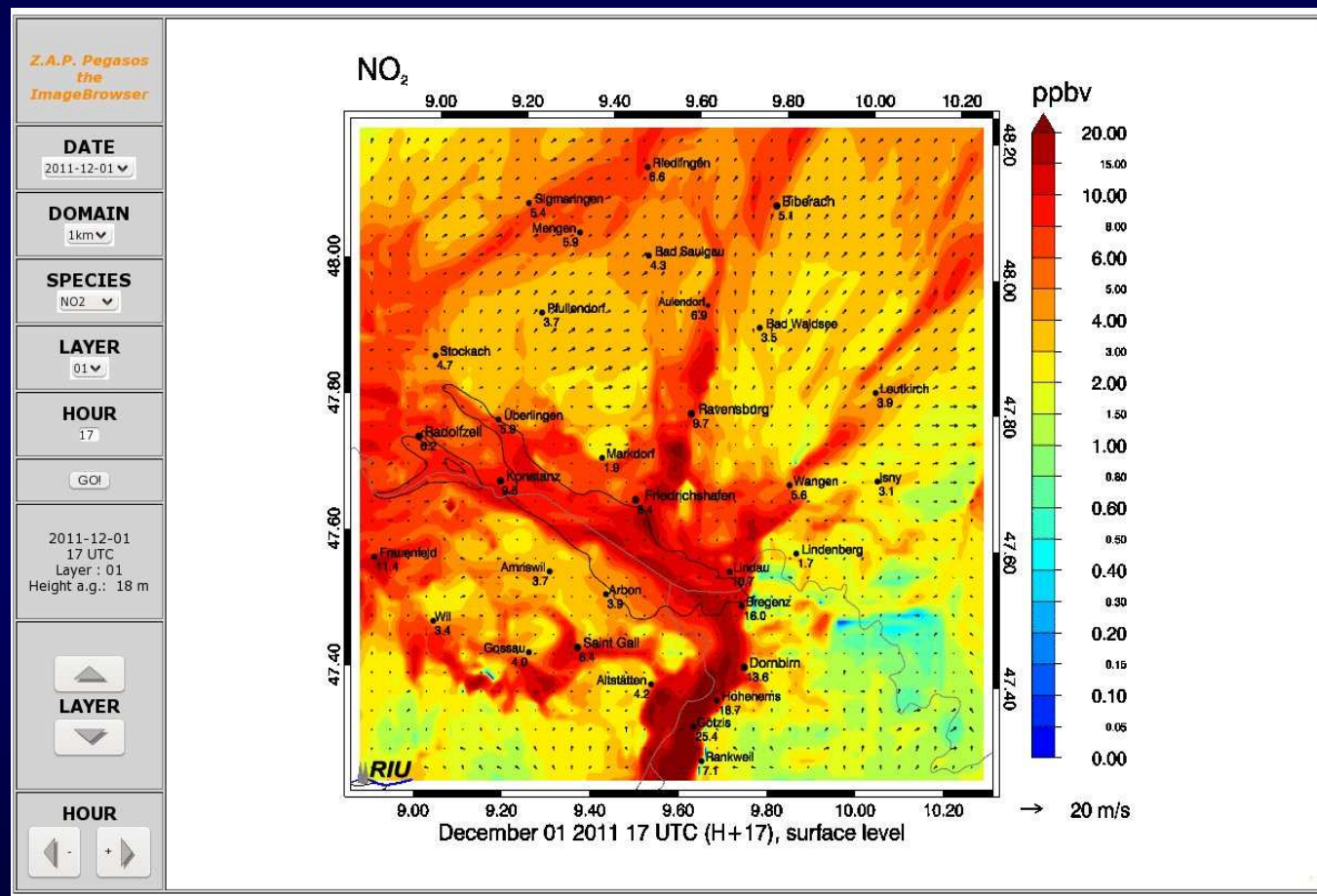


Daily 72 h forecast for nested grids

- Europe (EUR) 349x287 15 km
- Central Europe (CEN) 316x388 5 km
- Jumping Grid (J01) 1 km

Flexible grid to be placed on area of interest

EURAD-IM based mission planning: Chemical forecasting



The actual campaign: Transfer Flight to Cabauw



Mission Cabauw



Measurements of air-quality and climate interactions over NL with Zeppelin



Results: Aerosol Mass Spectrometry – Flight track

