Climate-chemistry interactions

LMDz-INCA-ORCHIDEE global model

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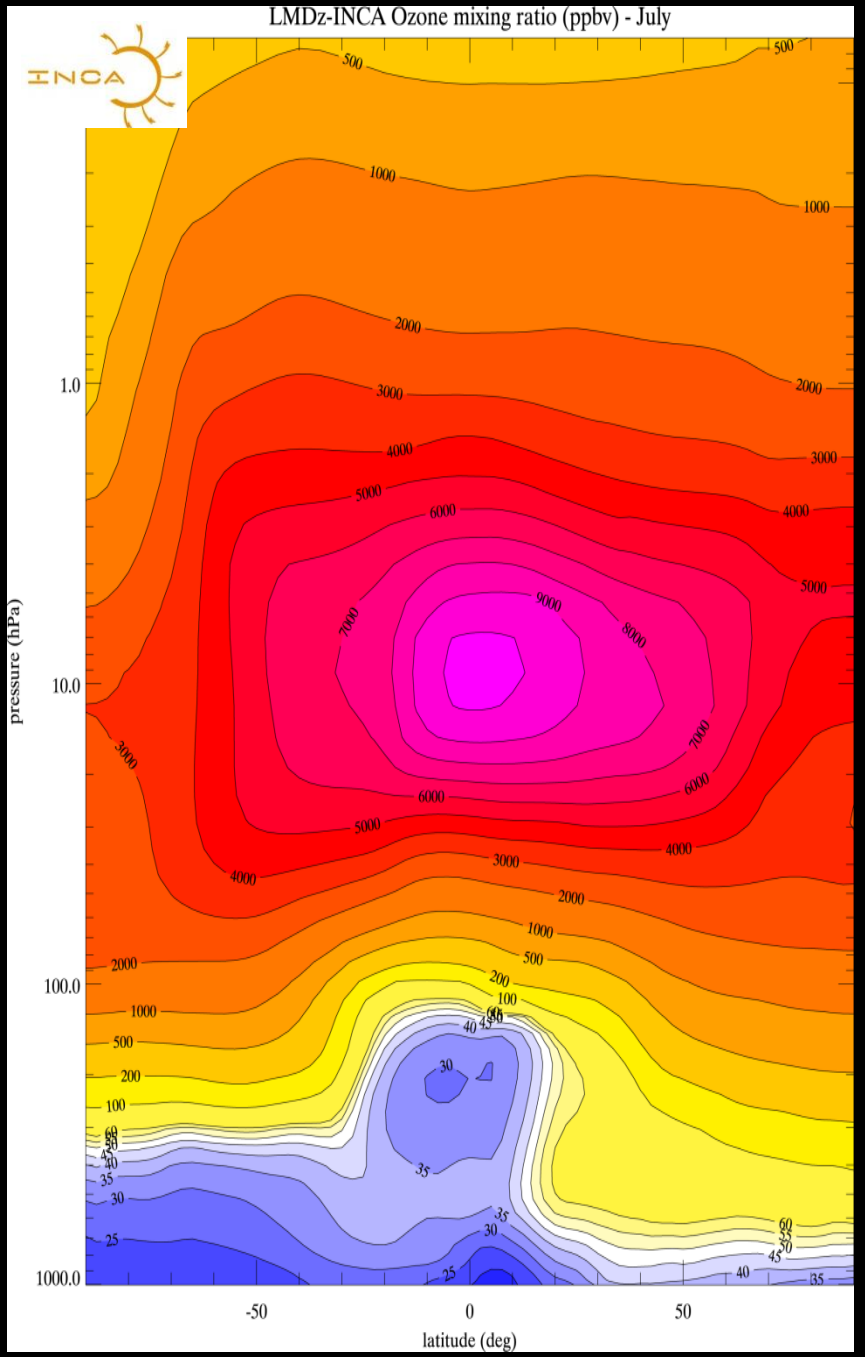
LMDz-INCA chemistry-climate model

- On-line chemistry model in LMDz
- Resolution: 3.75° long. x 1.9° (19-39 lev)
- NMHC gas phase chemistry (about 100 tracers)
- Different aerosol types (SO_4, BC, OC, Dust, Seasalt, Nitrates)
- Interactive dry deposition scheme
- Van-Leer (1977) advection; K. Emanuel convection; Louis (1972) boundary layer mixing (Hauglustaine et al., 2004)

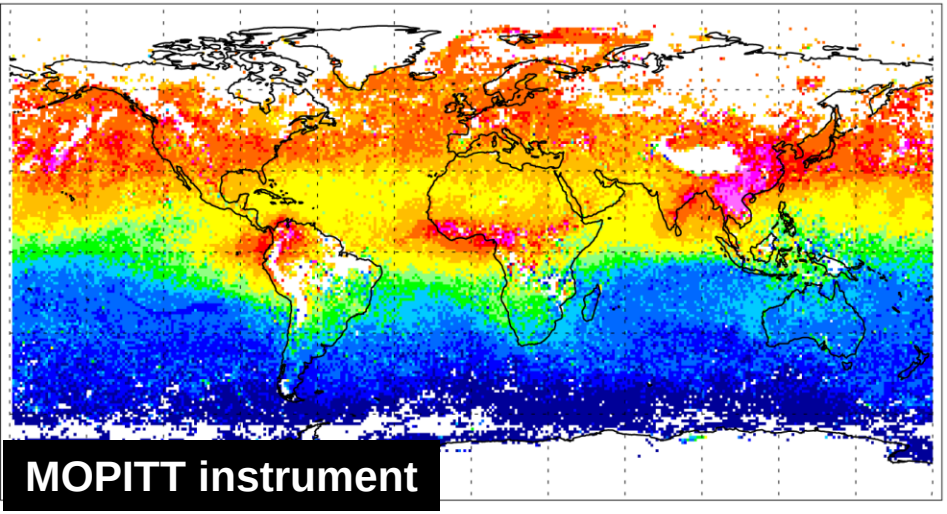
ORCHIDEE

- Dynamical global vegetation model: seasonal phenological cycle - carbon cycle, latent and sensible heat fluxes. Dynamical vegetation model (Krinner et al., 2004)
- Biogenic NMHC emission parameterization (LAI, PFT emissivities, temperature, PAR, leaf age, CO_2) (Lathière et al., 2006)
- NO and NH_3 soil emissions (soil temperature and moisture, precipitation pulses, fertilizers)



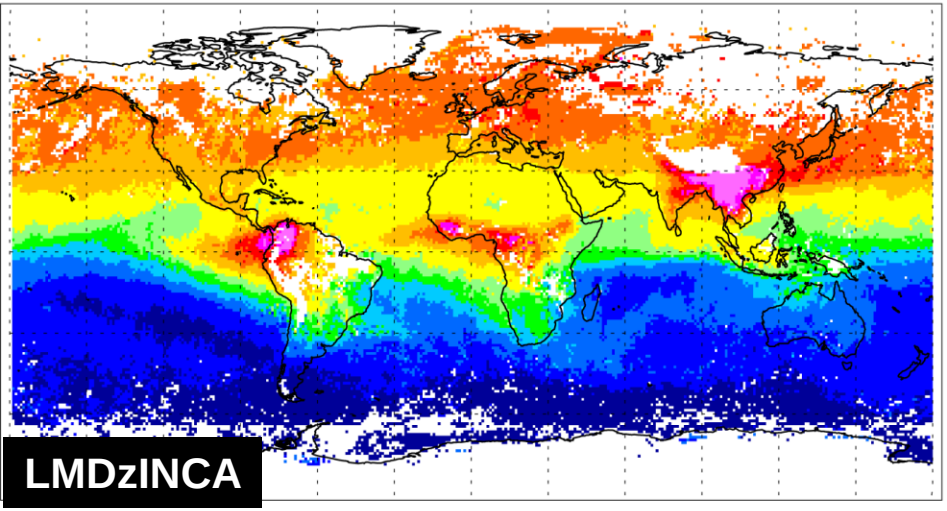
Model evaluation : Use of satellite data

MOPITT CO Day 700hPa: 200103

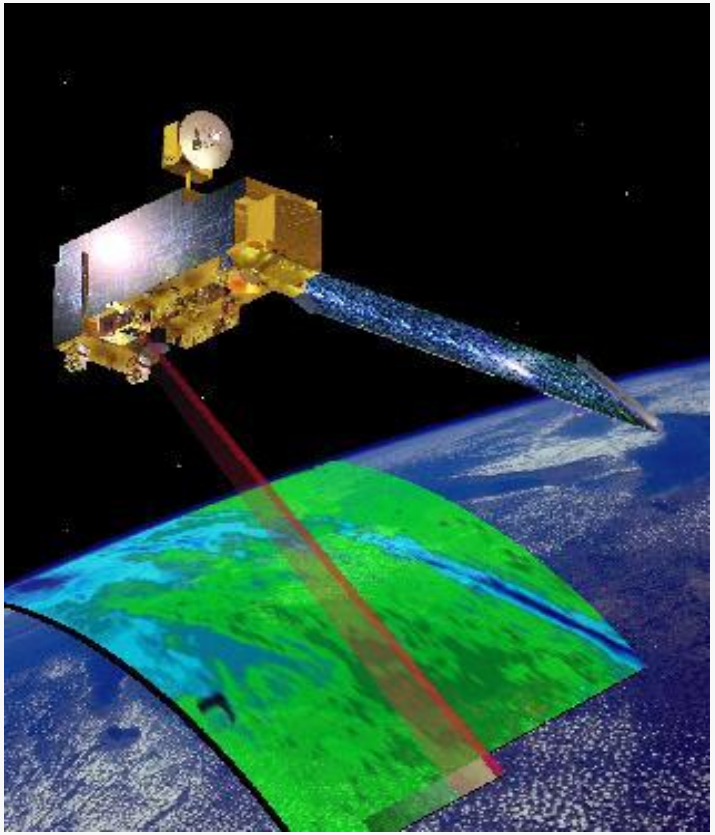


MOPITT instrument

LMDz-INCA 24h 700hPa: 200103

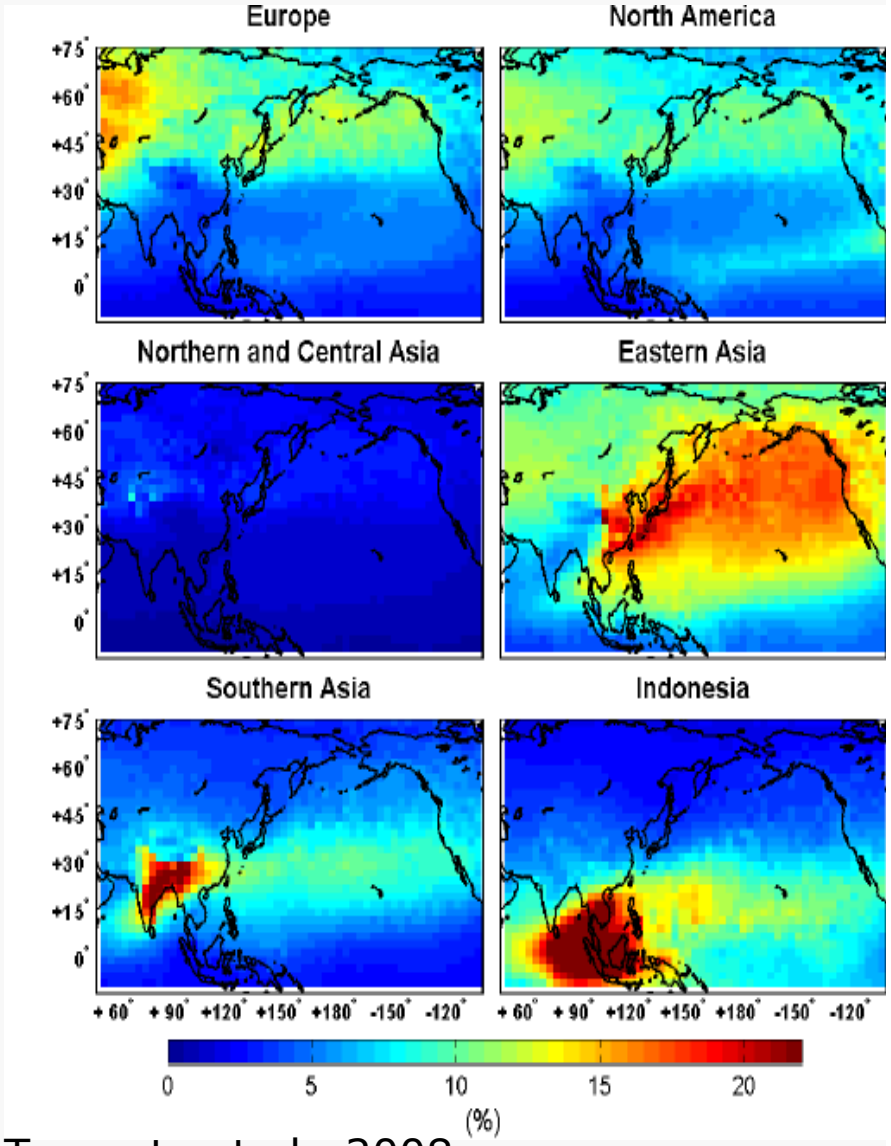


LMDzINCA

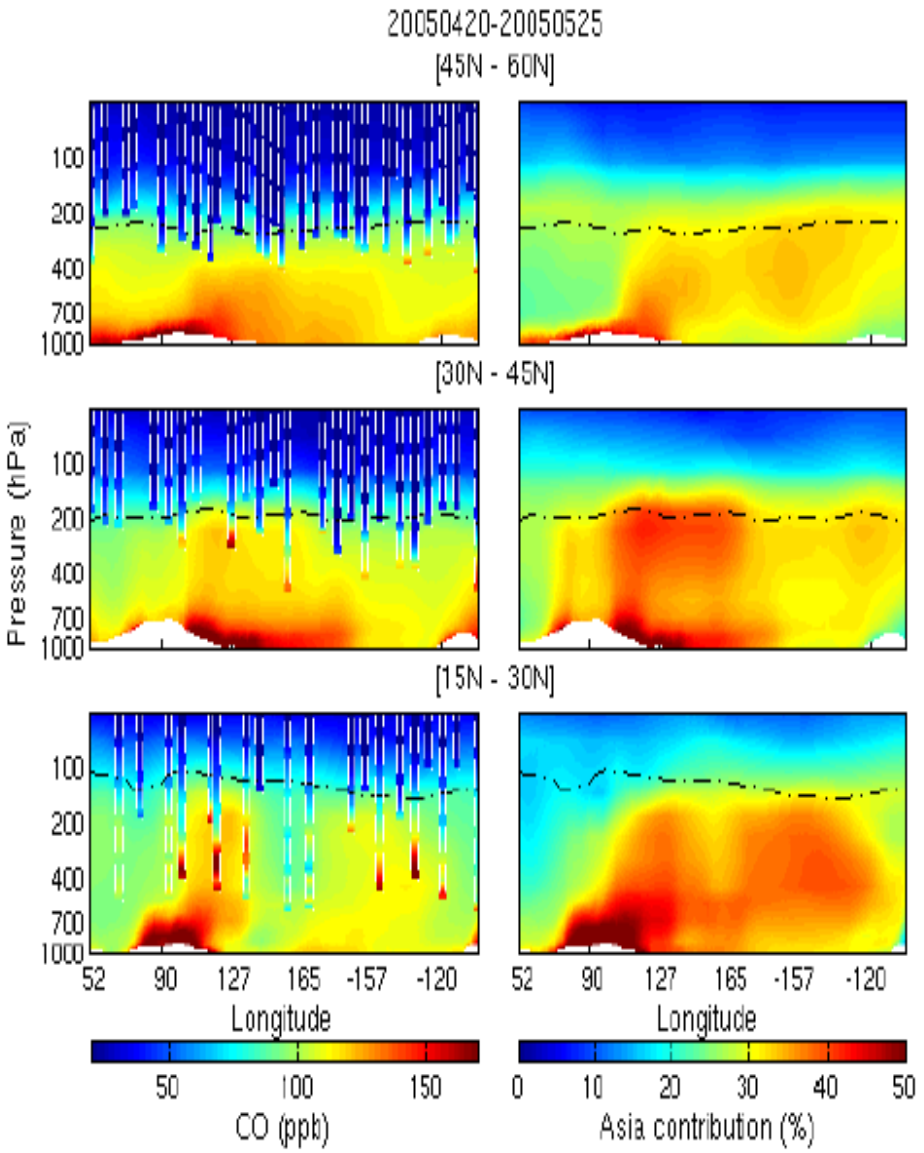


CO emissions and export from Asia

Relative contributions to the total column CO for March-April-May 2005

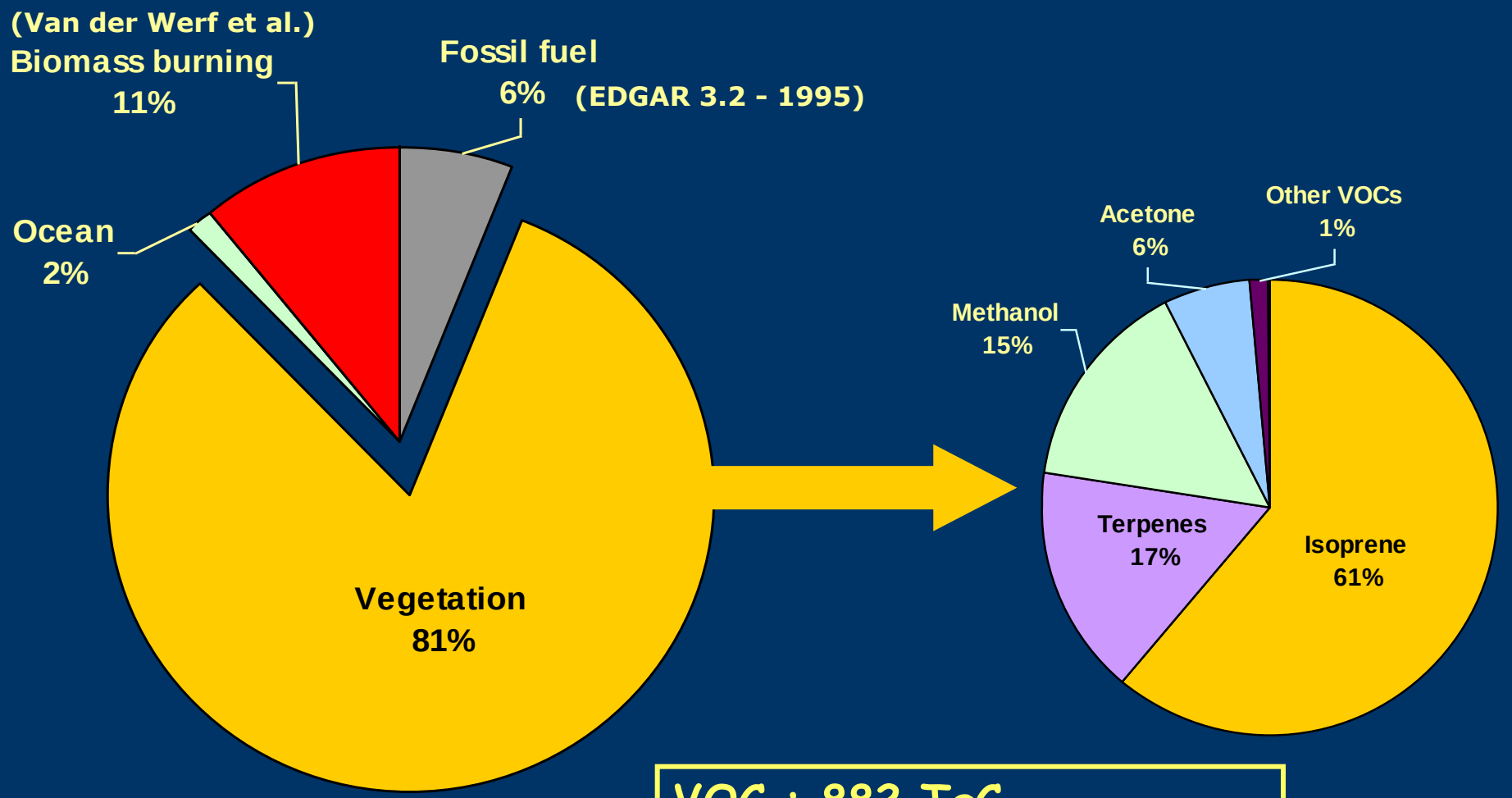


Cross section of the model CO averaged over three latitude bands



Turquety et al., 2008

Global emissions of Biogenic Volatile Organic Compounds (BVOCs)



VOC : 882 TgC
CO : 514 TgC
CH_4 : 422 TgC
Total : 1818 TgC (1.8 PgC)

Spatial and seasonal variations of BVOC emissions

BVOC emissions derived from the ORCHIDEE vegetation model

Monoterpenes

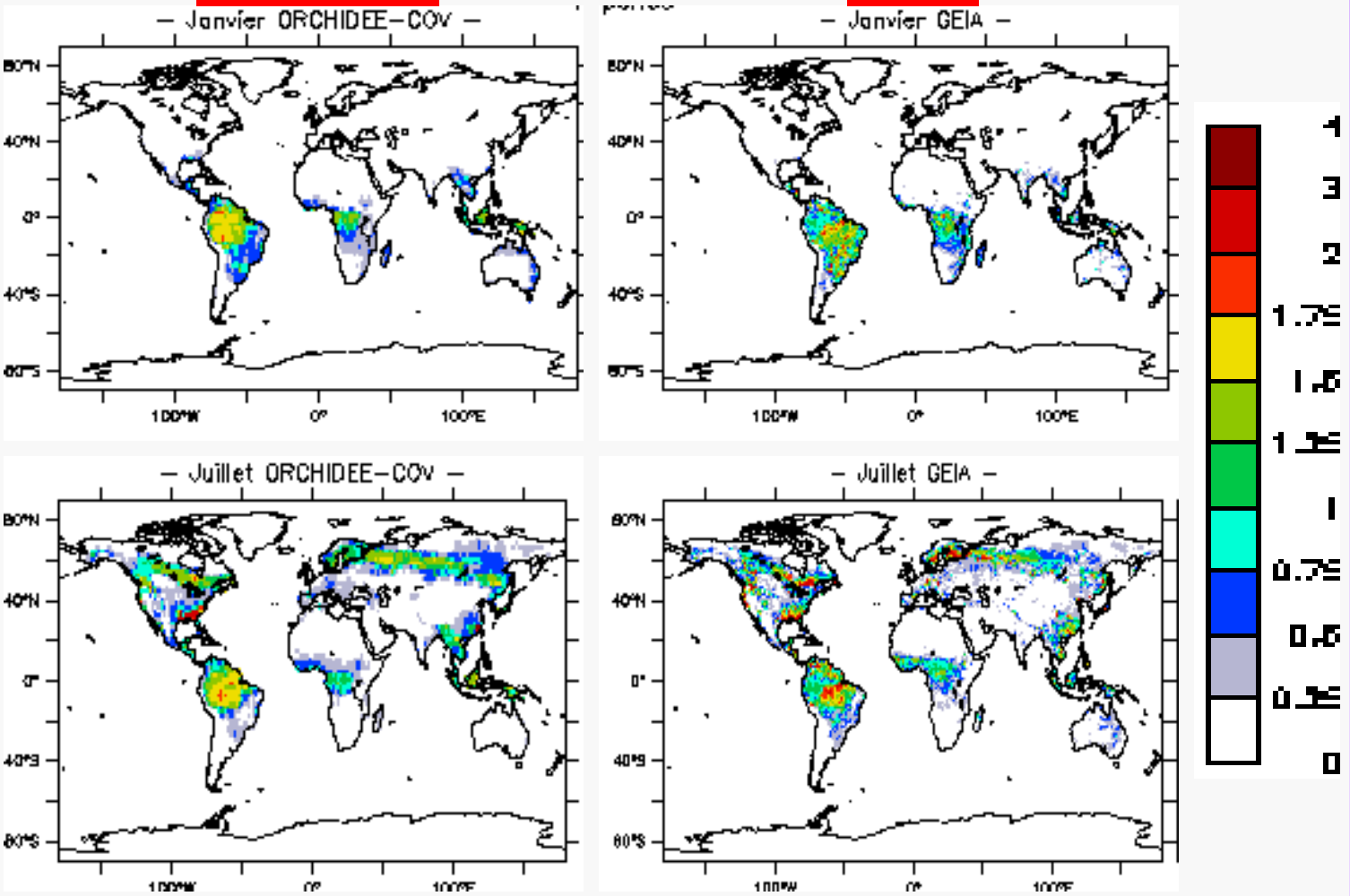
10^{-10} kgC/m²/s

ORCHIDEE

GEIA

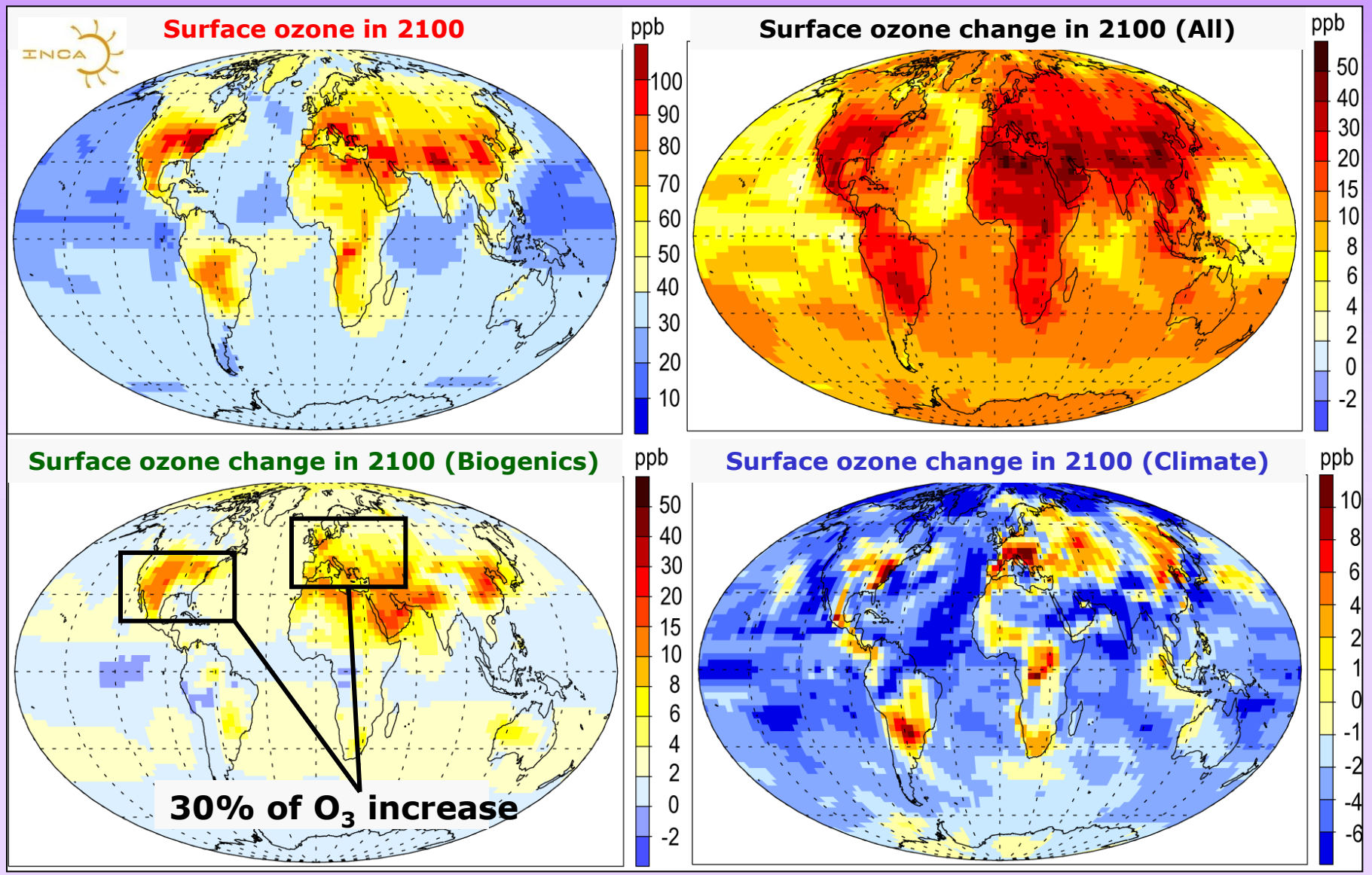
January

July



Lathière et al., 2006

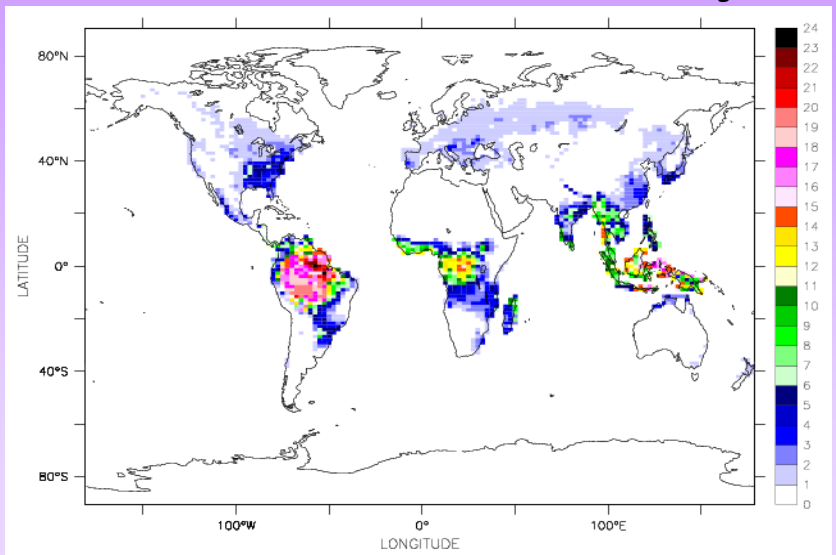
Natural emissions: another climate-chemistry coupling



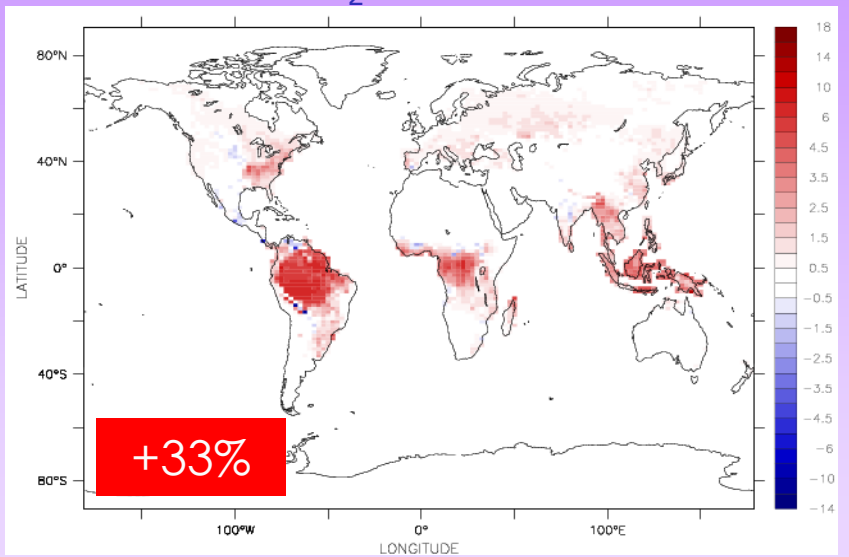
Hauglustaine et al., 2005

Future evolution of BVOC emissions simulated with ORCHIDEE

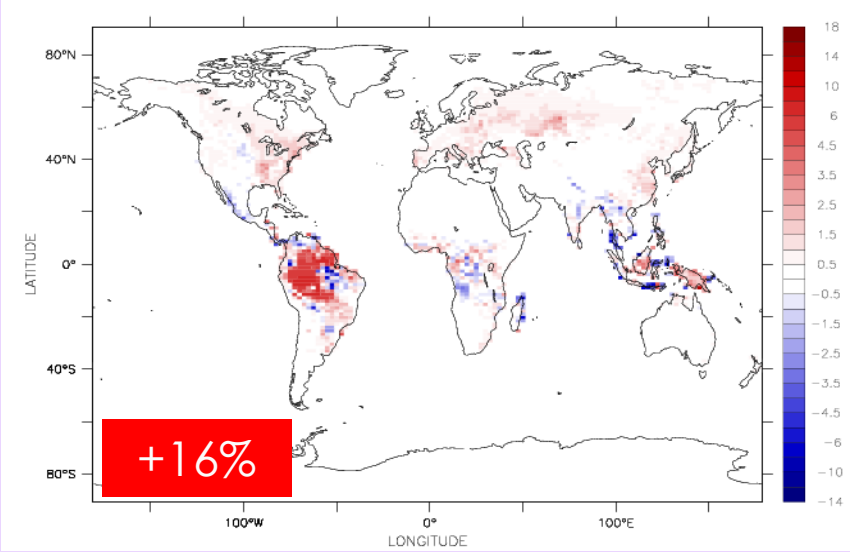
Present day isoprene emissions



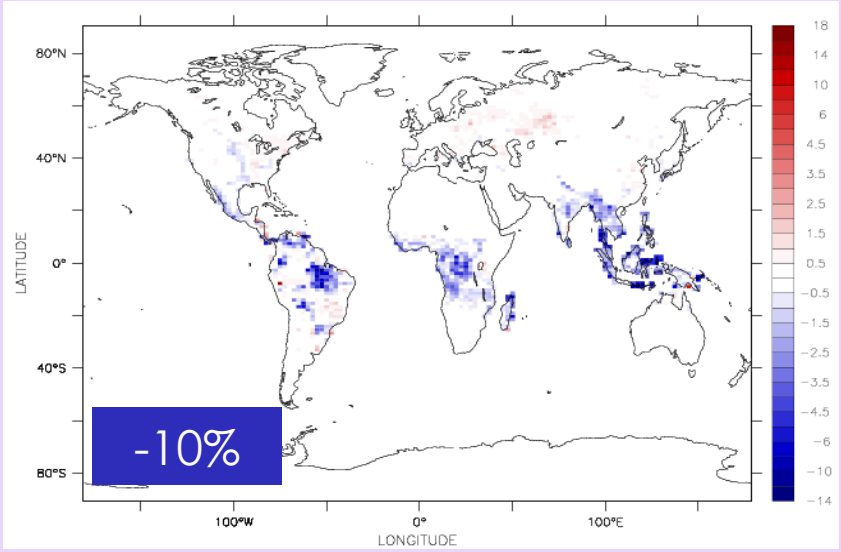
2050 climate - CO_2 fertilisation



2050 climate - CO_2 fertilisation - landuse



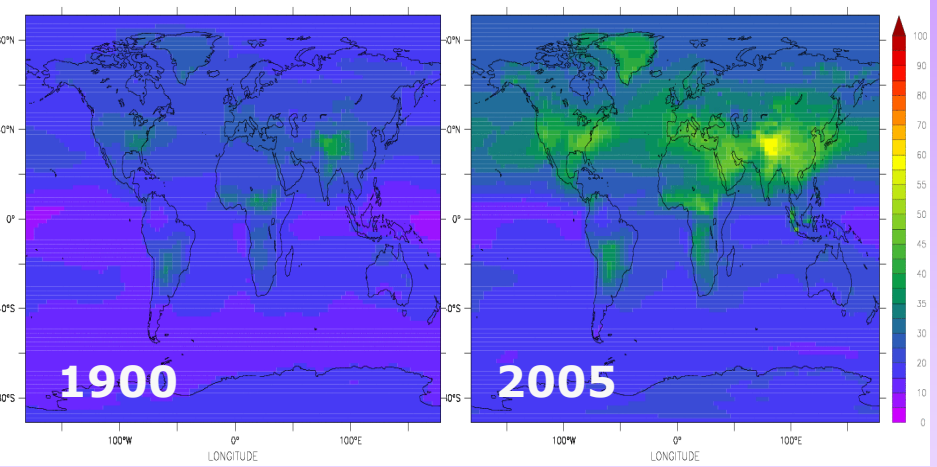
All + CO_2 inhibition effect



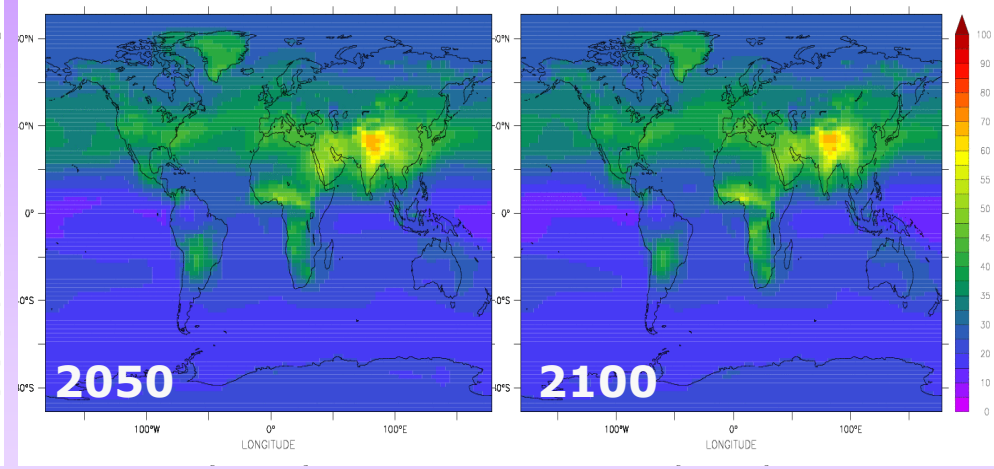
Lathière et al., 2011

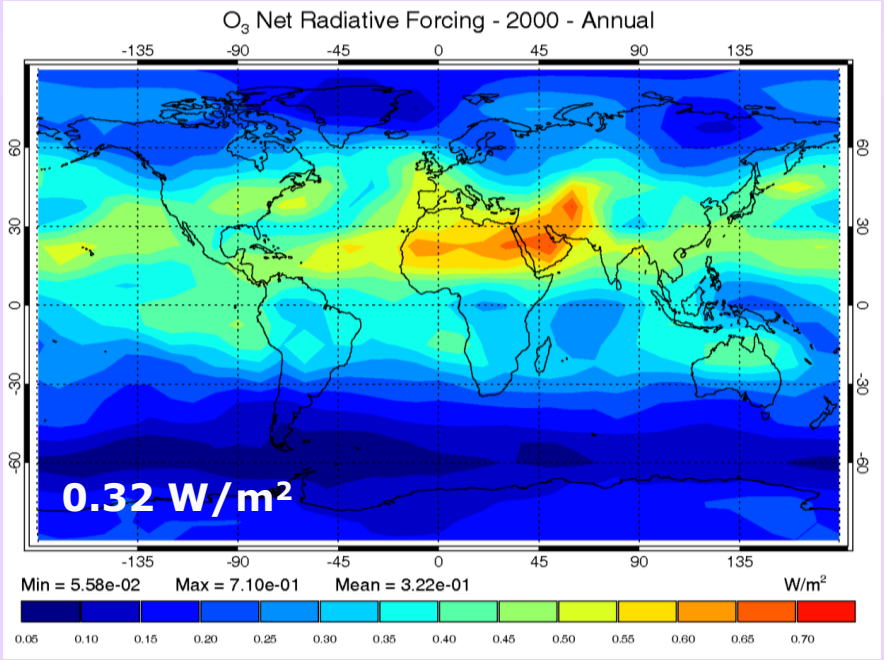
IPCC AR5 simulations : impact of emissions and climate change on composition (1/2)

Surface ozone (ppbv)

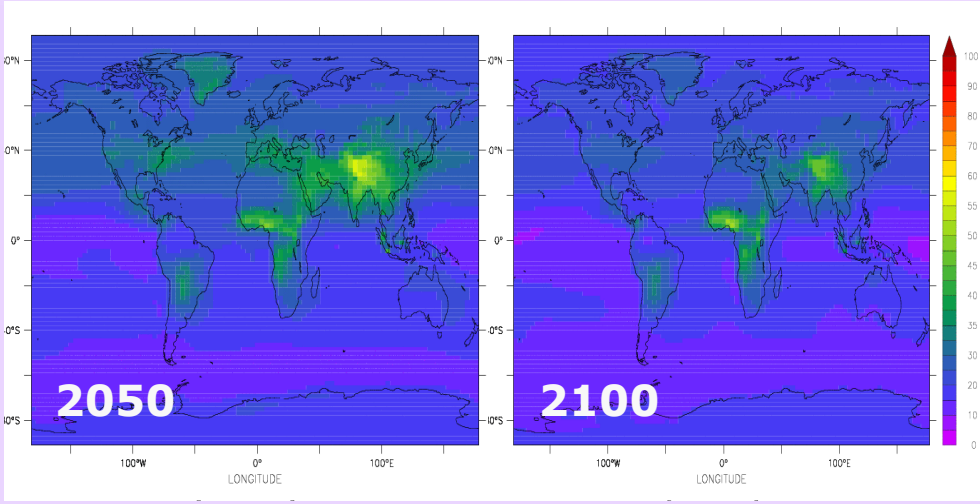


RCP85





RCP26

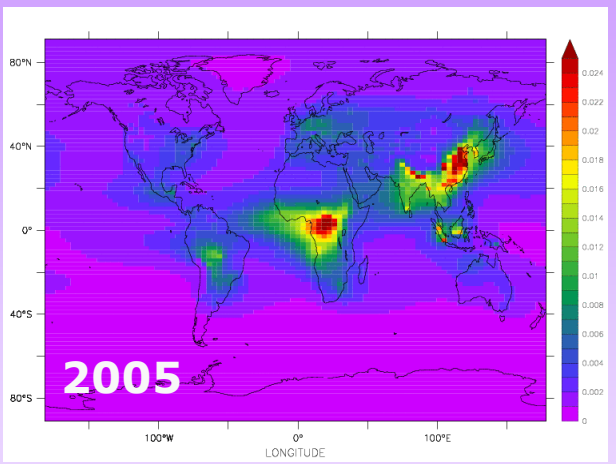


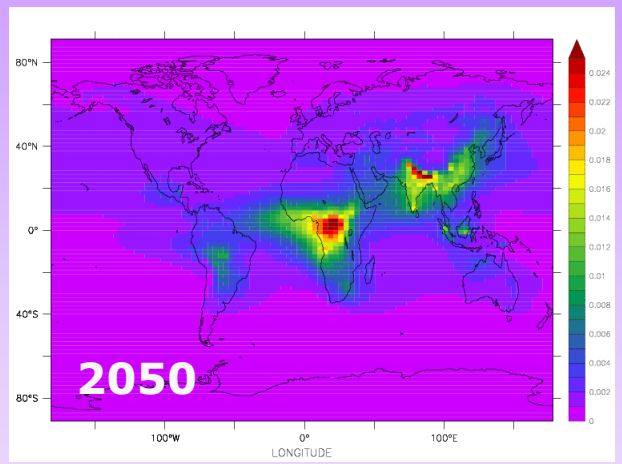
Szopa et al., 2011

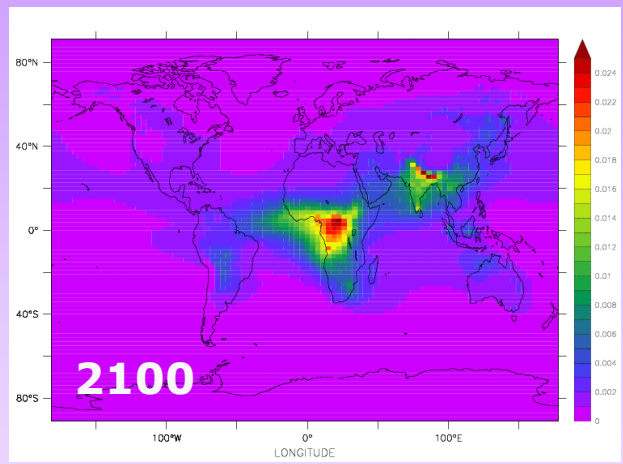
IPCC AR5 simulations : impact of emissions and climate change on composition (2/2)

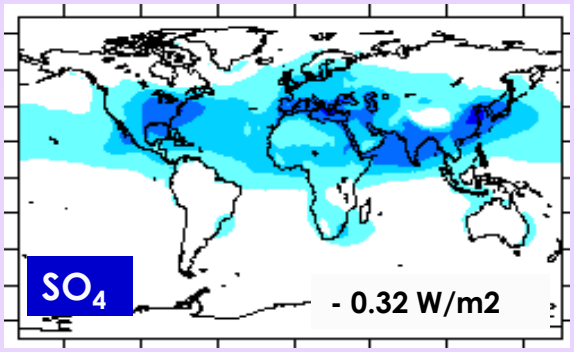
Black Carbon (BC) optical depth

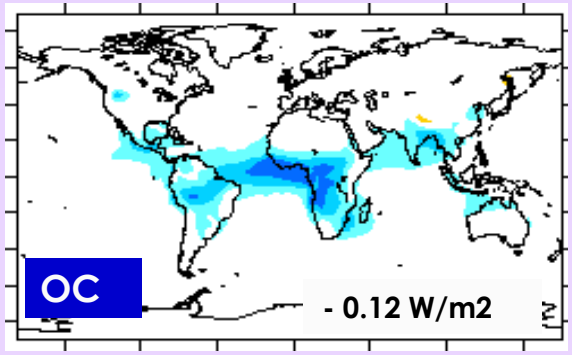
RCP85

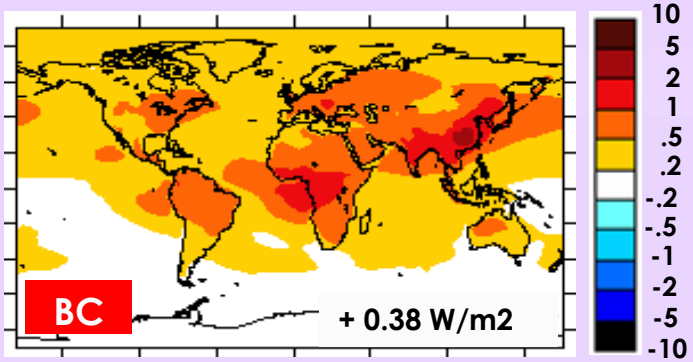




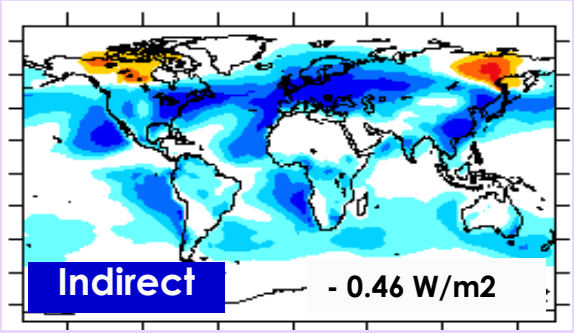








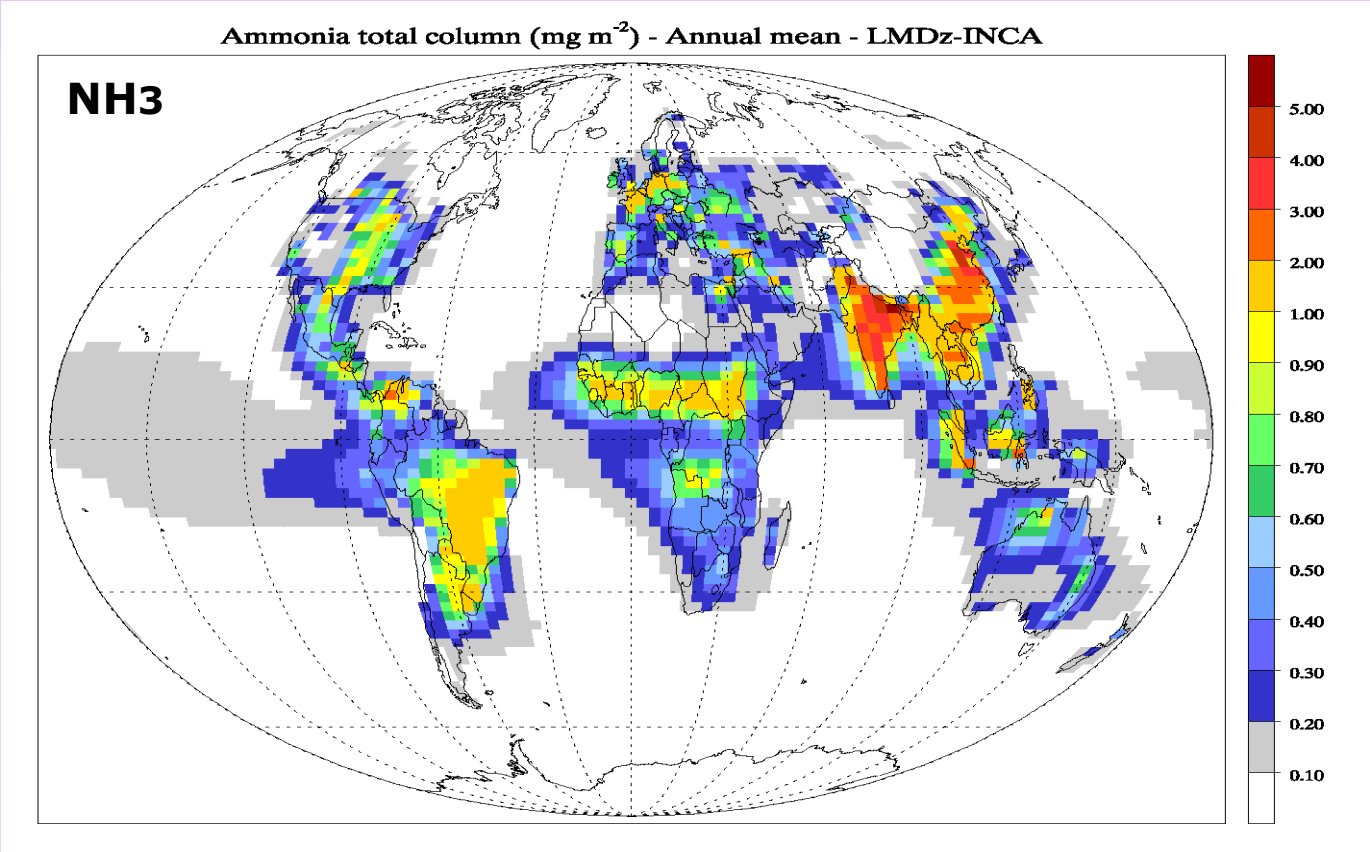
Present-day aerosol forcing



Szopa et al., 2011

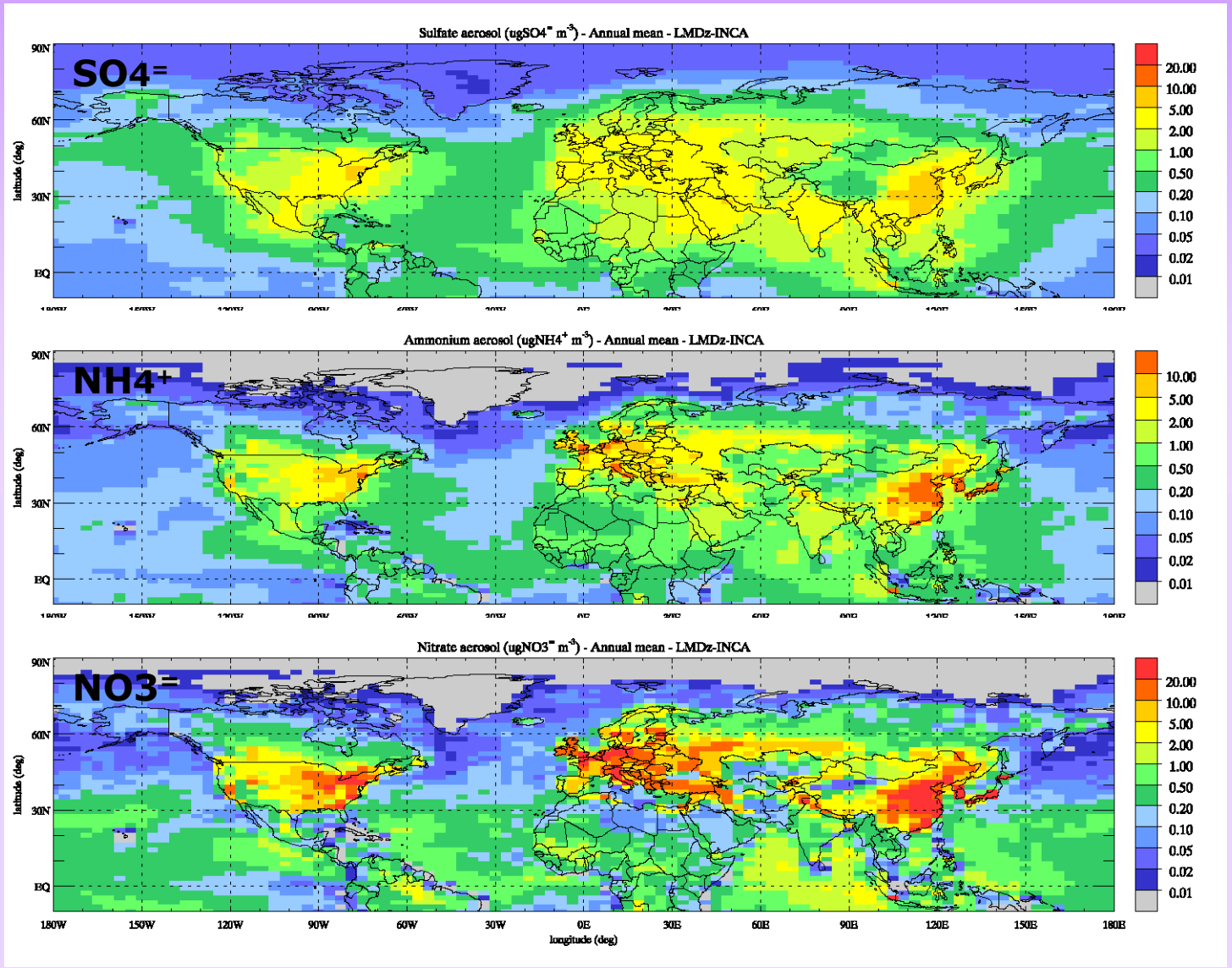
Nitrogen cycle in LMDz-INCA (1/3)

Reactive nitrogen is emitted into the atmosphere as 1) nitrogen oxide and rapidly converted into other oxides of nitrogen **NO_y (45 TgN/yr)** and as 2) ammonia **NH_3 (44 TgN/yr)** and converted to particulate ammonium $NH4^+$.



Nitrogen cycle in LMDz-INCA (2/3)

Surface aerosol concentration (µg /m3)



Total (dry + wet) surface deposition

mg /m² / yr

63 TgS

52 TgN

62 TgN