Simulated lightning emissions

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E39/C Climate-Chemistry Model

ECHAM4.L39(DLR) = E39

Atmosphere circulation model
• Global spectral model with semi-Lagrangian advection of water vapour, cloud water and tracers
• Resolution: T30, 39 layers, top layer centered at 10 hPa (30 km)
• Parameterizations of radiation, clouds, precipitation, convection, diffusion

CHEM = C

Chemistry-Module (family concept)
• Transported species: $\text{H}_2\text{O}$, $\text{CH}_4$, $\text{N}_2\text{O}$, $\text{HCl}$, $\text{H}_2\text{O}_2$, CO, $\text{CH}_3\text{O}_2\text{H}$, ClONO$_2$, HNO$_3$+NAT, ICE, ClO$_x$, NOX, OX
• 37 species and 107 gas-phase reaction
• Methane oxidation, PSC formation, 4 heterogeneous reactions on PSCs
• Parameterization of dry/wet deposition, lightning and surface emissions

Interactively coupled at every timestep
Lightning parameterisation

Price and Rind, 1992
\[ FF = 3.44 \times 10^{-5} \times CTH^{4.9} \]

Grewe et al., 2001
\[ CTH = 0.85 \times MF \times CT^{\frac{1}{2}} \]

Grewe et al., 2001
\[ FF = 1.54 \times 10^{-5} \times (MF \times CT^{\frac{1}{2}})^{4.9} \]

Direct relation between Massflux (= „updraft“) and Flash Frequency over land

Is it also valid (reasonable) over oceans?
Modelled Lightning vs Observations

E39/C model
Dec-Jan-Feb

OTD Satellite data
Dec-Jan-Feb

Jun-Jul-Aug

Jun-Jul-Aug

[flashes km\(^{-2}\) yr\(^{-1}\)]

Kurz and Grewe, 2002
Modelled Lightning vs Observations

E39/C model

Mar-Apr-May

OTD Satellite data

Mar-Apr-May

Sep-Oct-Nov

Sep-Oct-Nov

Kurz and Grewe, 2002
IR versus CG lightning

E39/C model results
IC/CG parameterized with cold cloud area

Kurz and Grewe, 2002
The lightning NOx source

Dec-Jan-Feb

Tropical Convection

Air Traffic

Winter Storms

Summer Convection

Jun-Jul-Aug

Kurz and Grewe, 2002
Simulated evolution of cloud to ground lightning
1960 to 2000

El Nino events
Summary

- Lightning NOx emission simulated on the basis of a fully coupled CCM
- Years 1960 to 2000 available considering effects like El Nino, but not observed day-by-day meteorology
- Lightning occurrence reproduced by model,
- Lightning NOx emissions hard to validate