Easy Aerosols

Identifying and studying robust aerosol effects on the general atmospheric circulation within the WCRP Grand Challenge

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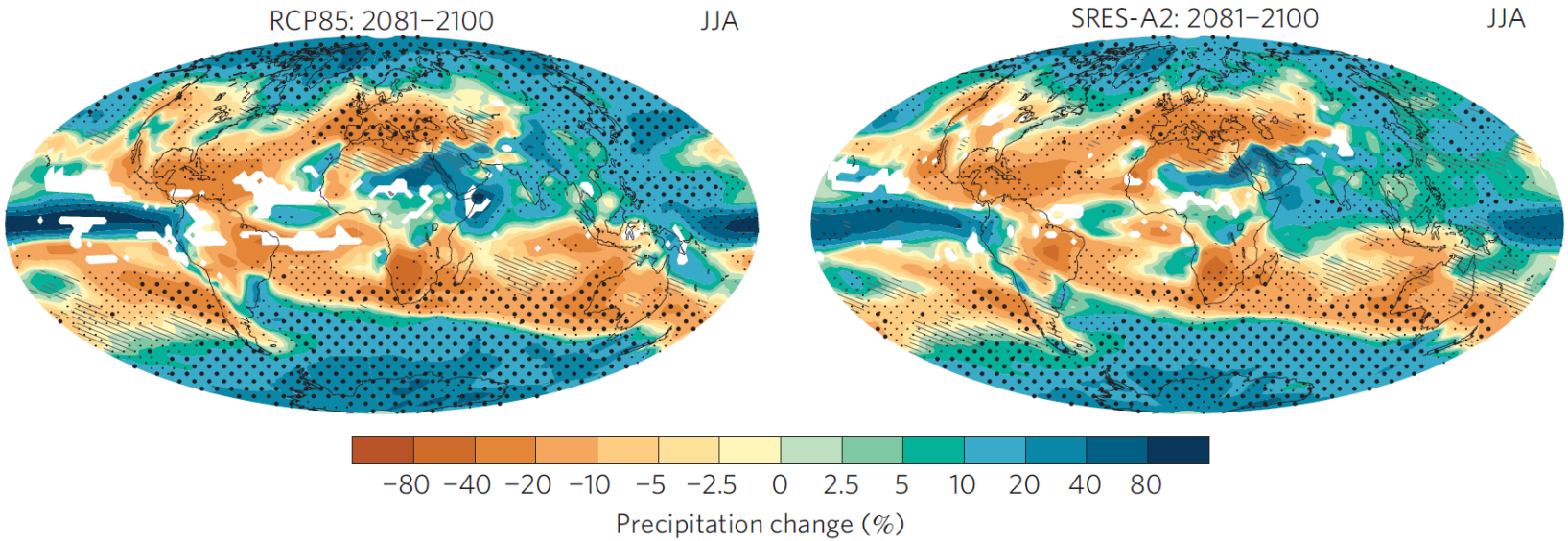
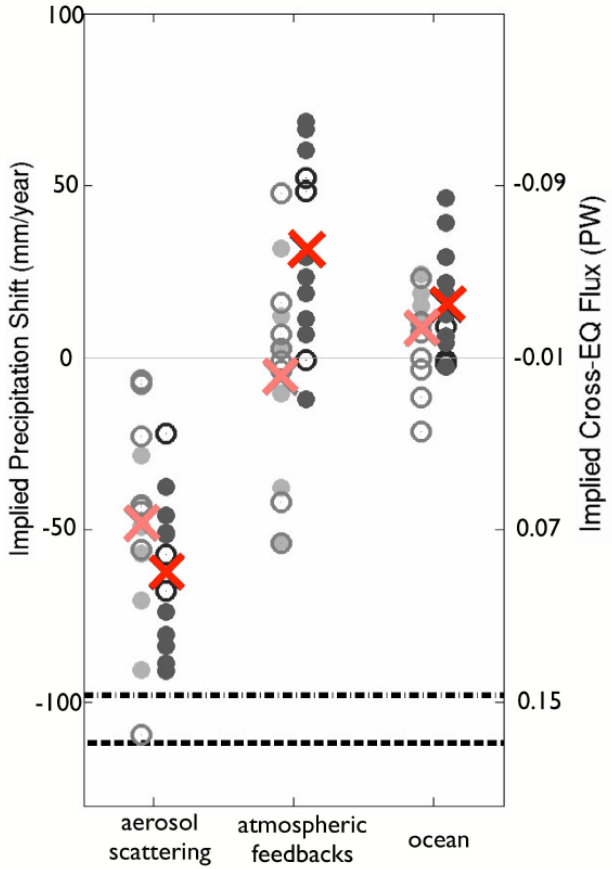
Changing patterns

- Led by Ted Shepherd & Adam Sobel
- Better anticipate response of general circulation to anthropogenic forcings
- Identify robust responses and sources of uncertainty
- Assess the impact of model biases and shortcomings on regional responses

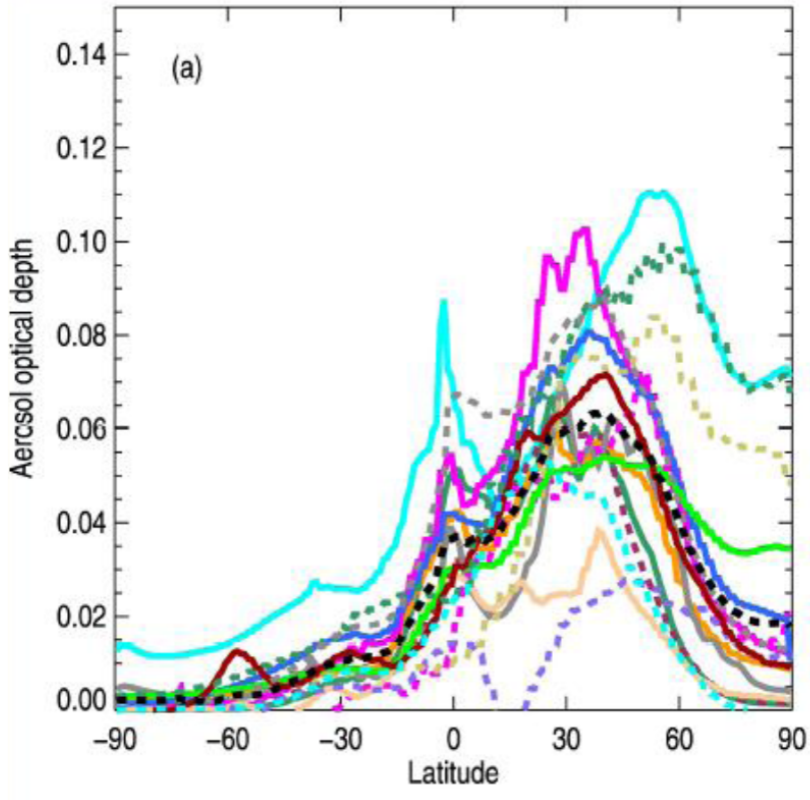


Knutti & Sedlacek 2012

Anthropogenic aerosol as a driver of changing patterns: ITCZ shifts

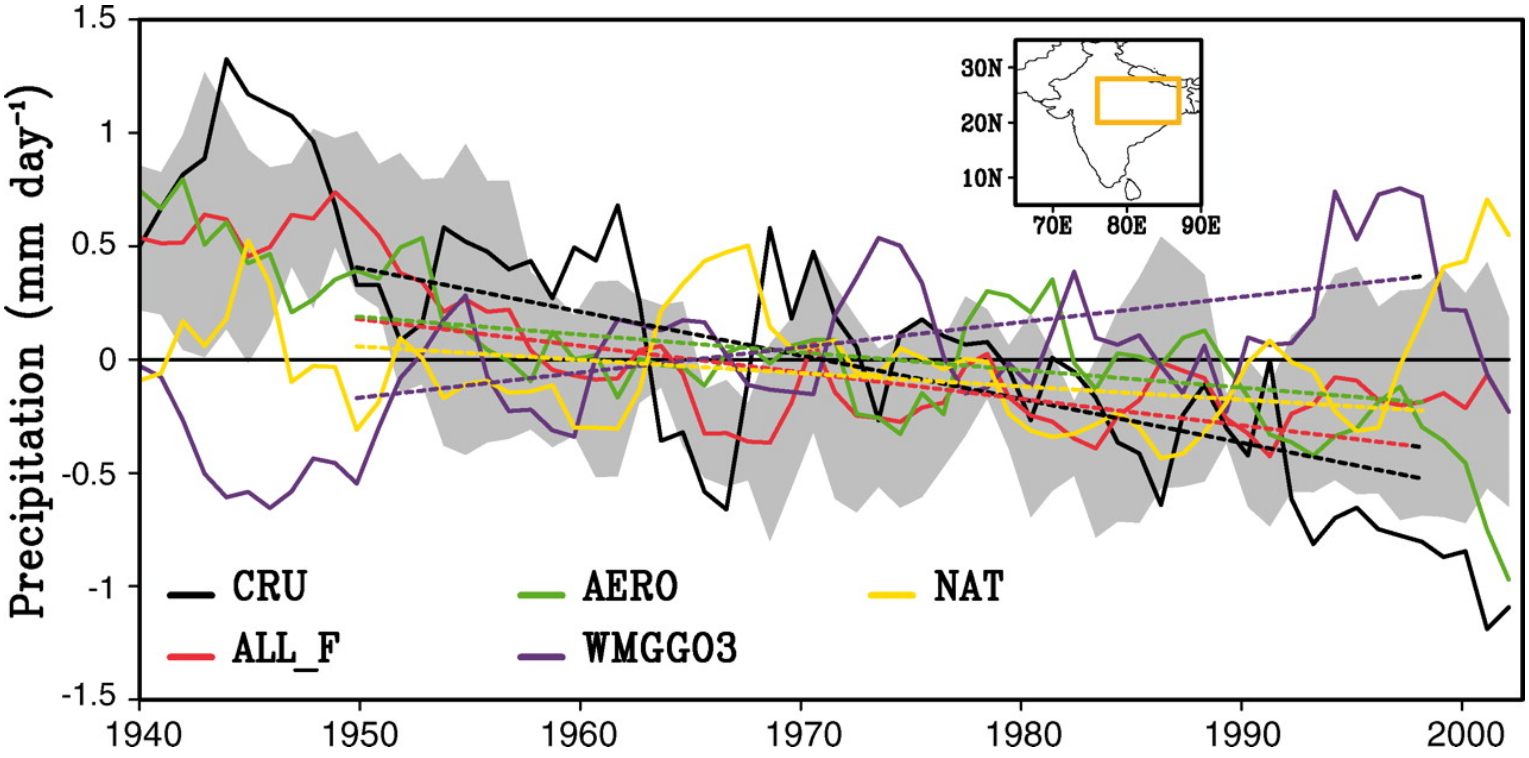


Hwang et al. 2013



Myhre et al. 2013

Anthropogenic aerosol as a driver of changing patterns: monsoons



Bollasina et al. 2011

Easy Aerosols in a nutshell

- *Are single-model results on aerosol-induced regional changes robust?*
- *Are differences in the magnitude of consistent changes explained by differences in the assumed anthropogenic aerosol?*
- Easy Aerosols challenges comprehensive models with the same anthropogenic aerosol forcing to test these questions.

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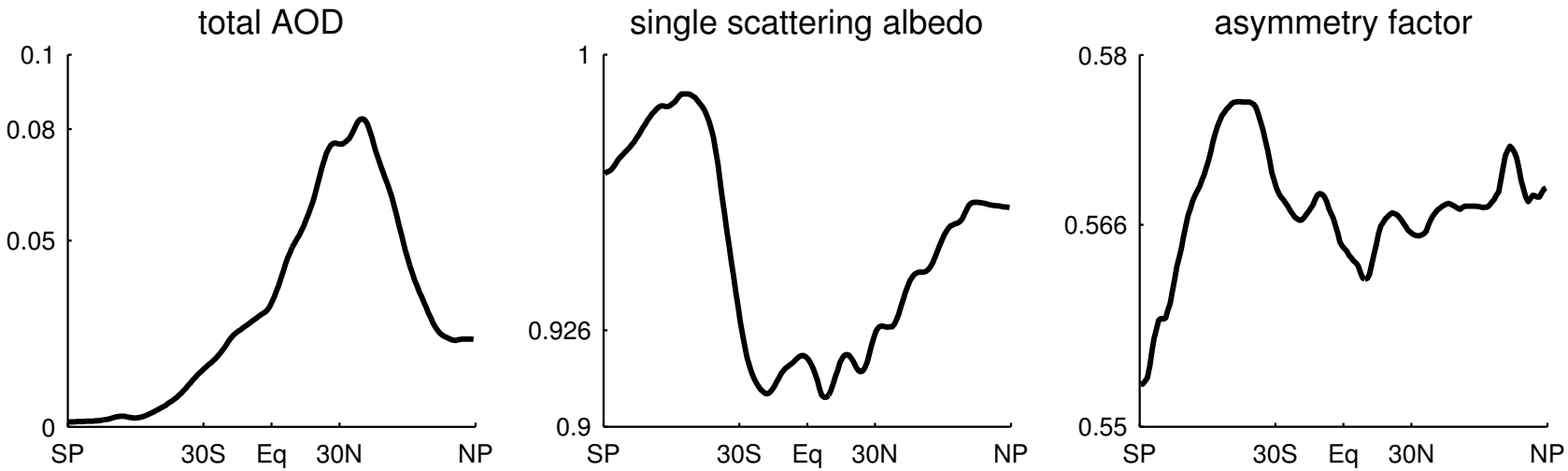
Easy Aerosols is easy because:

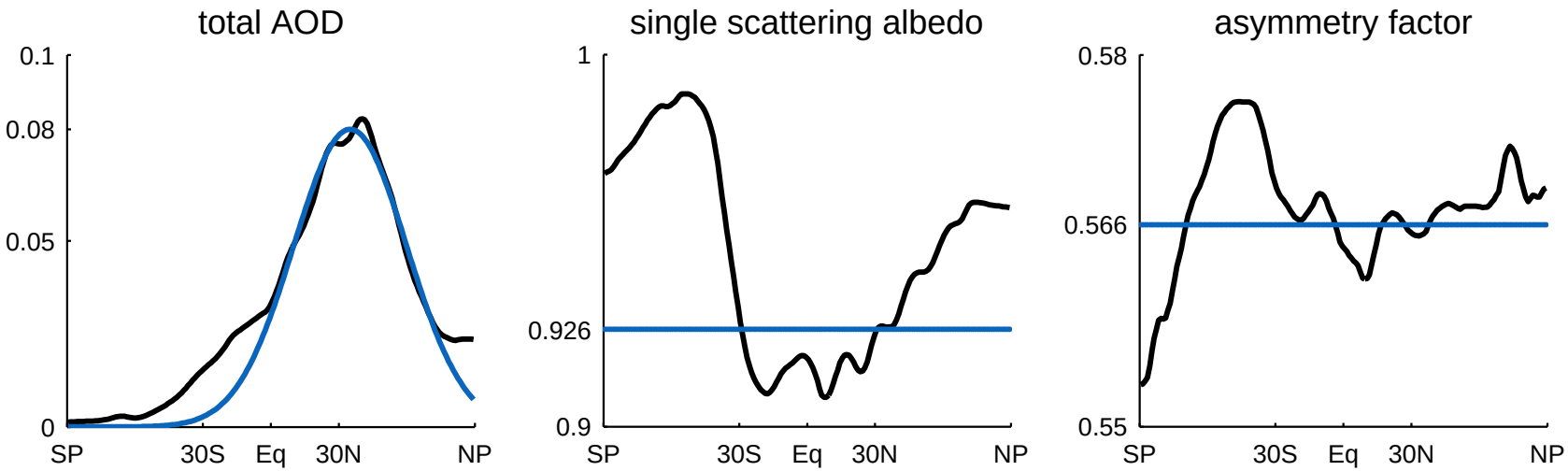
- it focuses on aerosol-radiation interaction, thereby emphasizing the role of aerosol as an agent of local diabatic heating
- it uses an idealized aerosol that captures the gravest mode of the anthropogenic aerosol

The Easy Aerosol in the horizontal



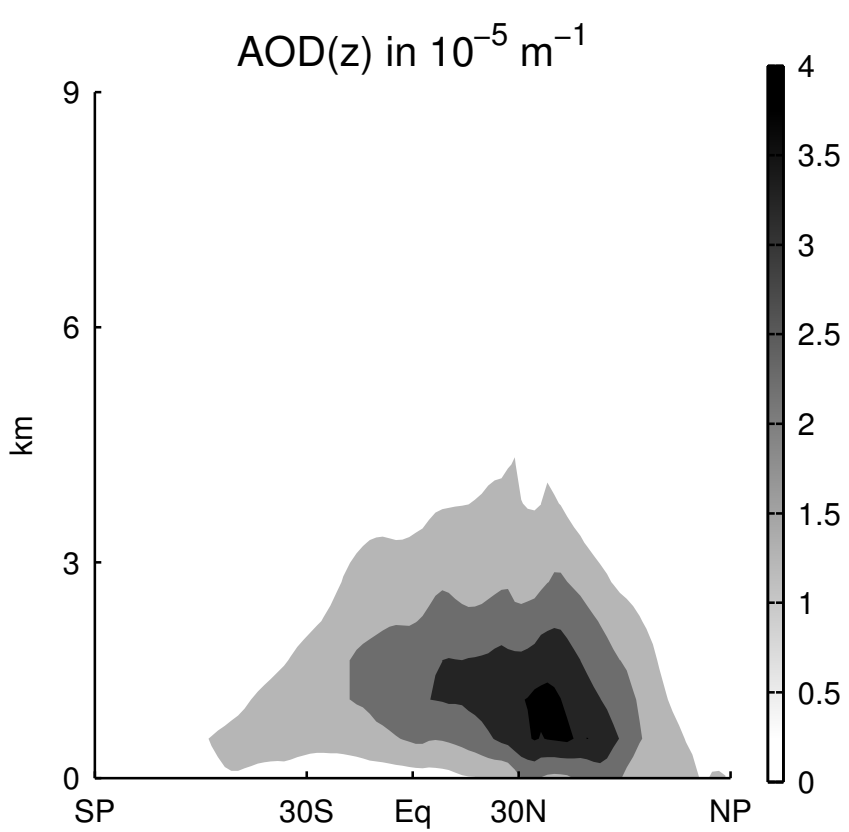
- based on S. Kinne's year 2000 aerosol climatology at 550 nm

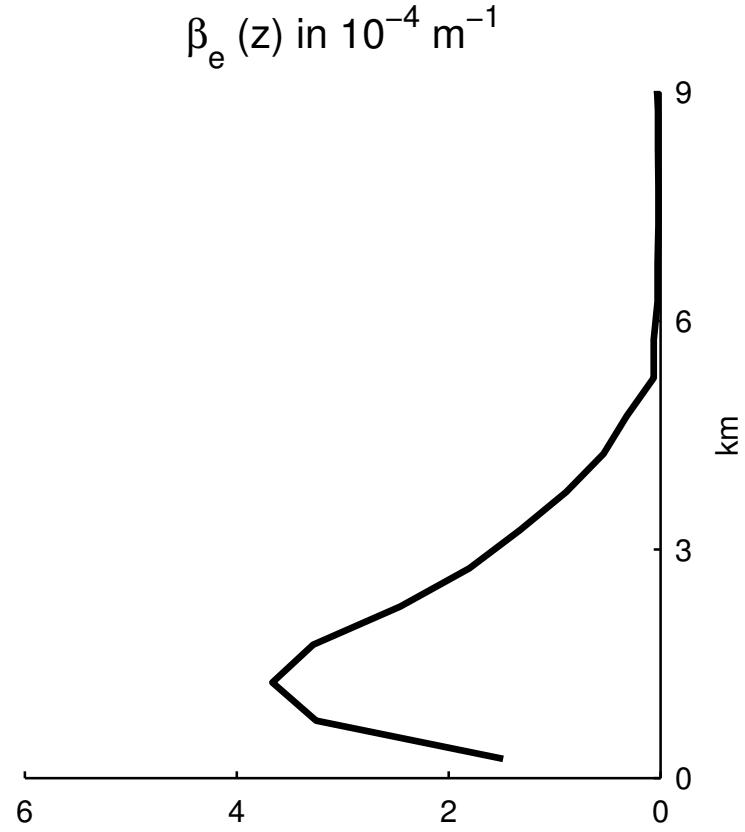
The Easy Aerosol in the horizontal



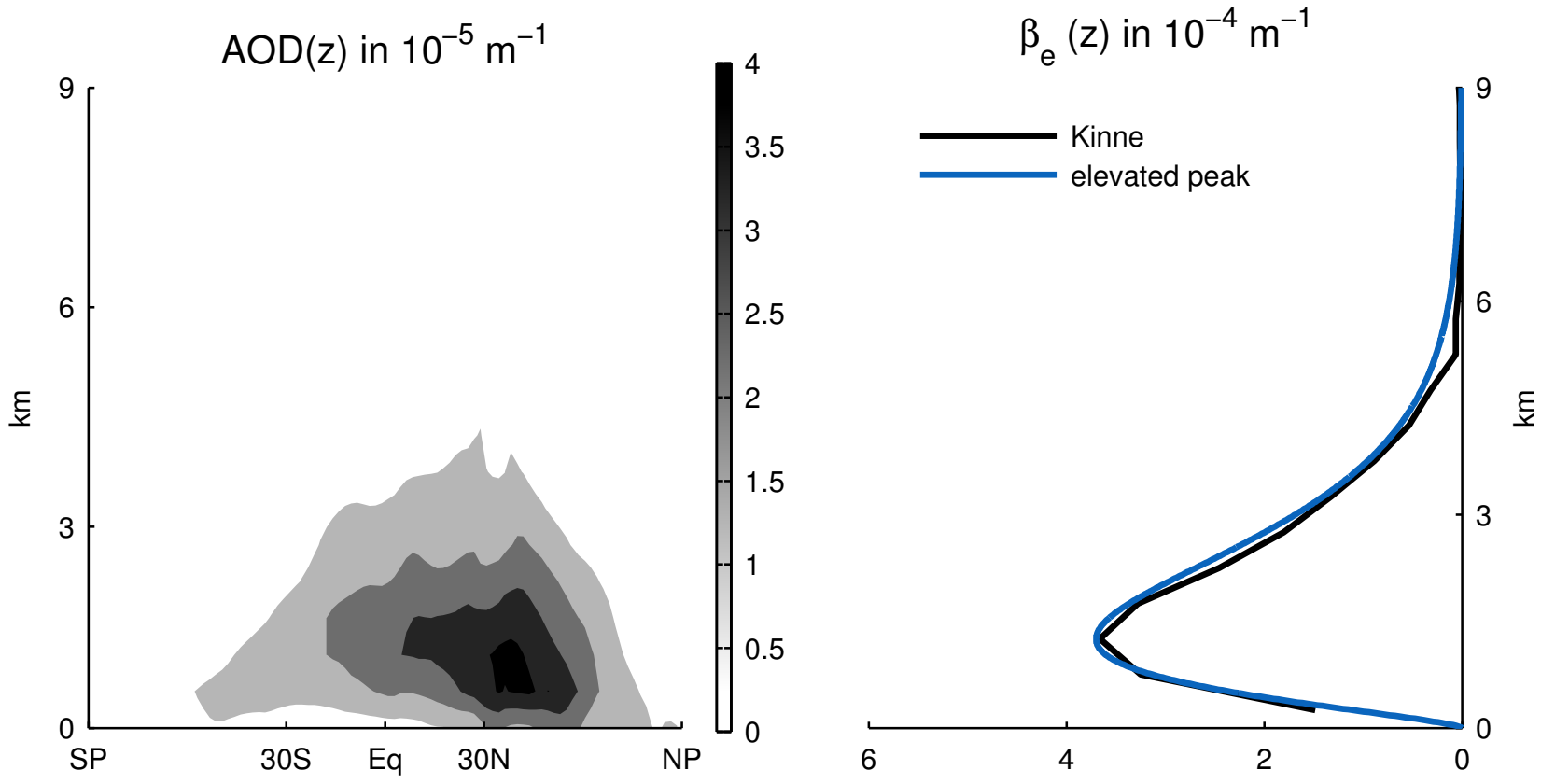
- based on S. Kinne's year 2000 aerosol climatology at 550 nm
- $AOD_{tot} = AOD_0 \exp\left(-(\varphi - \varphi_0)^2 / 2\sigma_\varphi^2\right)$
- constant in time, Angstroem coefficient of 1.8
- cases with zonally-symmetric aerosol as well as three plumes over North America, Europe, and China

The Easy Aerosol in the vertical



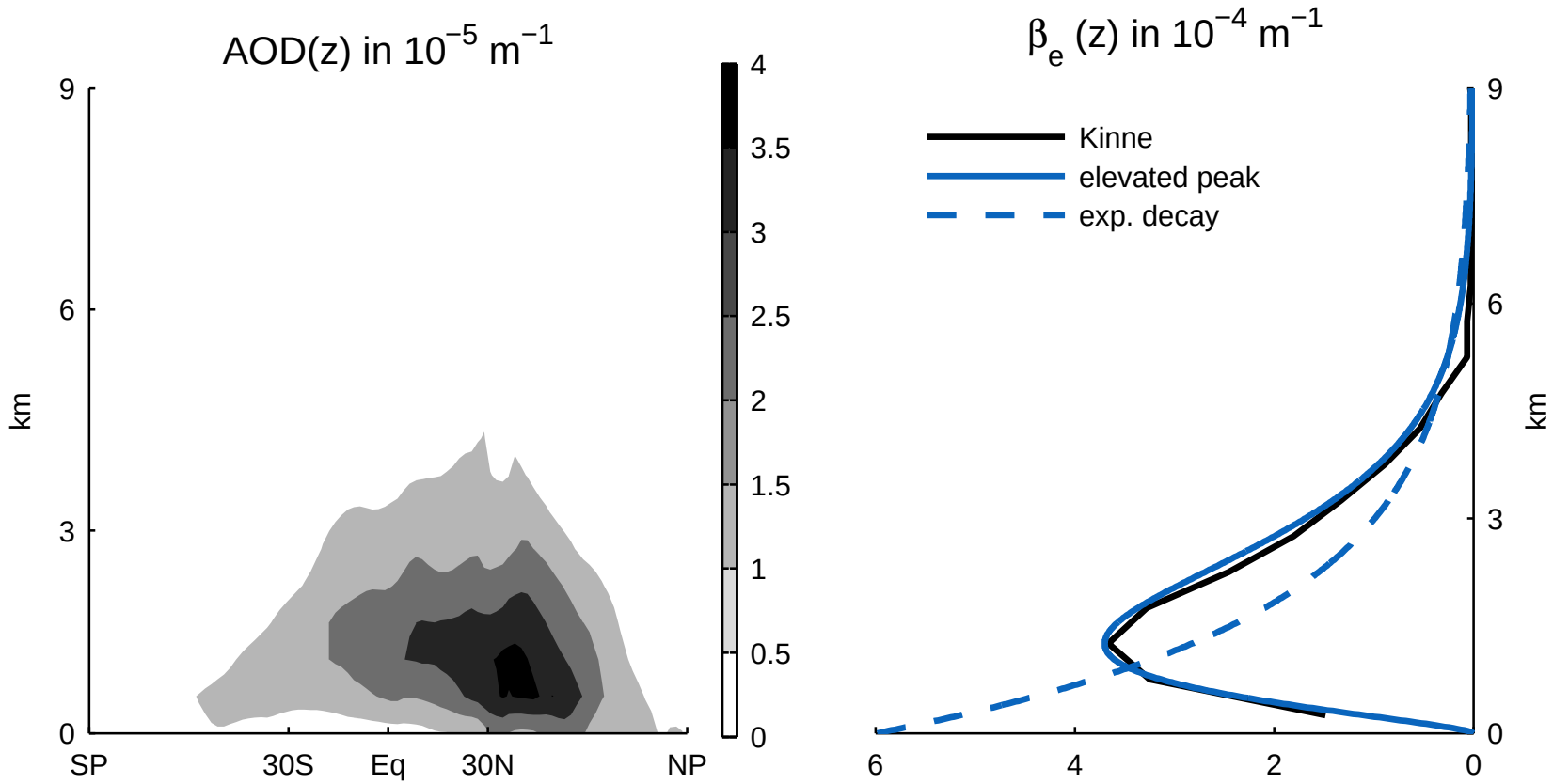


The Easy Aerosol in the vertical



$$\beta_e(z) = az^b \exp(-cz) \tag{1}$$

The Easy Aerosol in the vertical



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Technical implementation of Easy Aerosol

Easy Aerosol is implemented through a Fortran90 module:

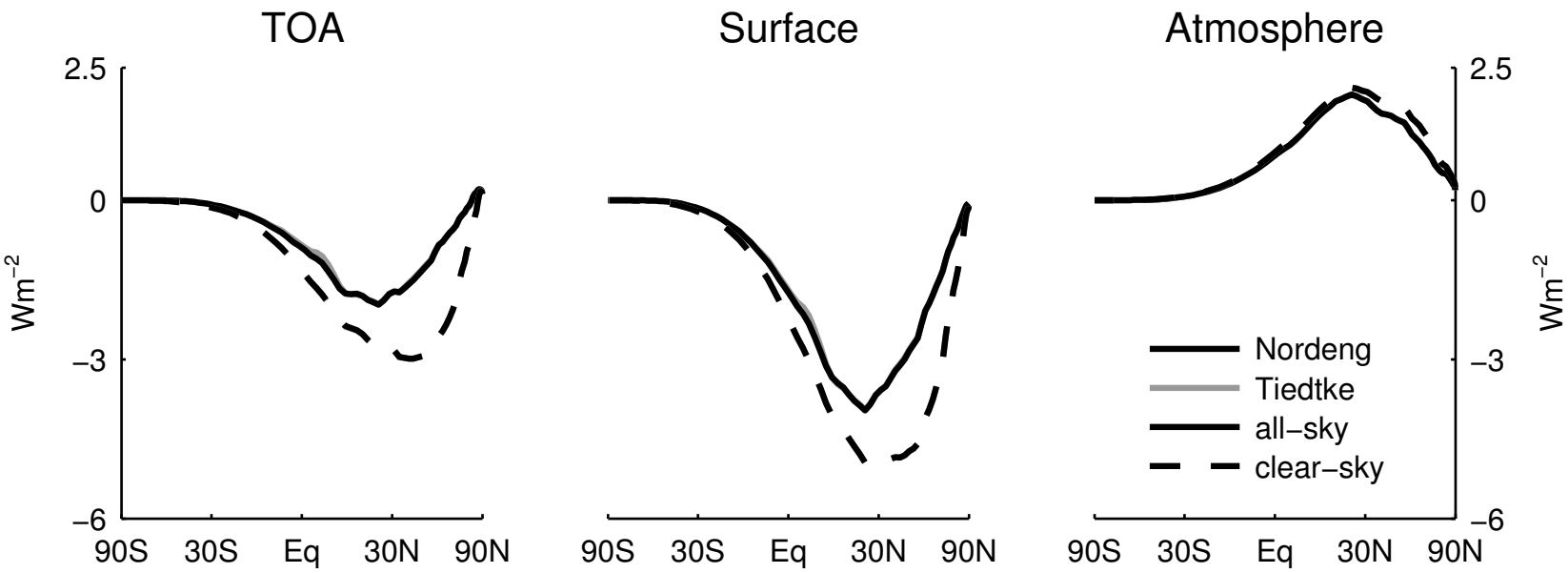
- Input: geographical location, altitude above sea-level, level thickness, frequency of shortwave bands
- Output: vertical profile of AOD, SSA, and ASY for each of the shortwave bands
- Based on the analytical expression given above and defined via namelist
- The module is currently implemented in ECHAM6 and LMDz, and is ready to be implemented in other models.

Anticipated simulations

- AMIP simulations with zero aerosol and the Easy Aerosol
  - Do models see similar aerosol radiative forcing?
  - Which circulation changes are induced purely by absorption and land changes?

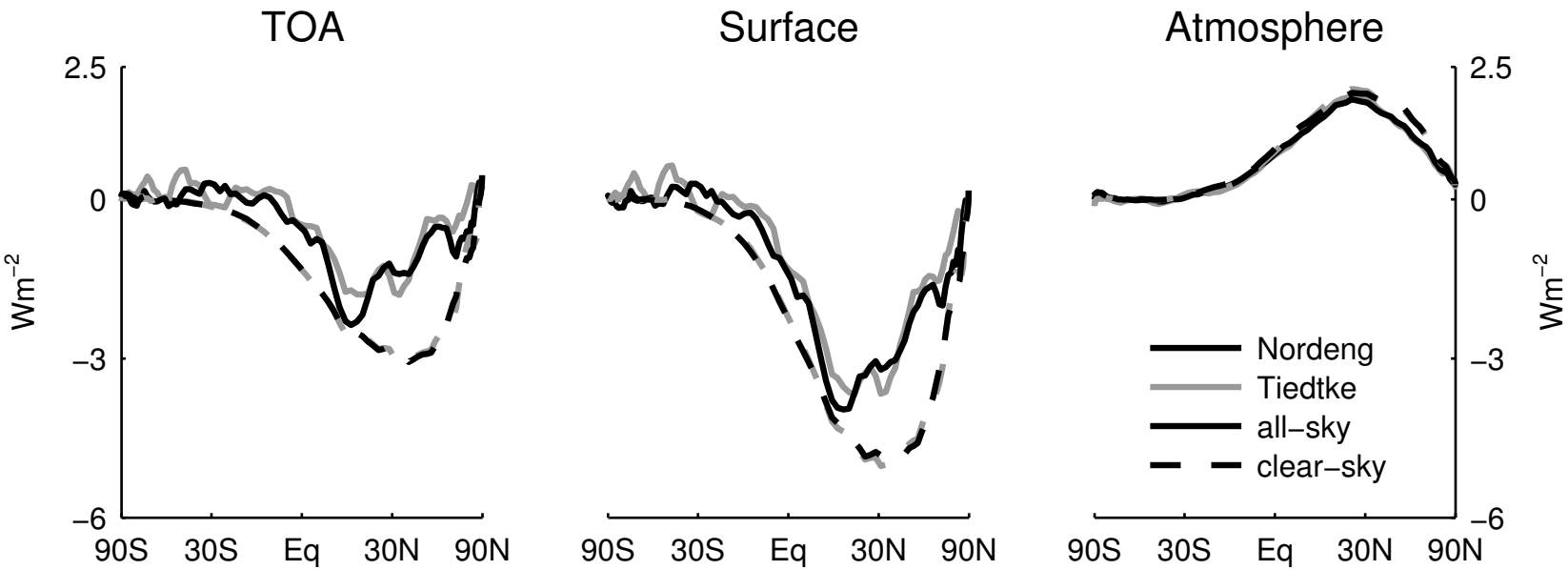
- "AMIP + ΔSST" simulations with the Easy Aerosol
  - Emulate aerosol surface cooling by SST perturbation.
  - If models agree on the aerosol radiative forcing, do they translate the forcing into consistent circulation responses?

Initial Easy Aerosols results with ECHAM6: aerosol radiative effect



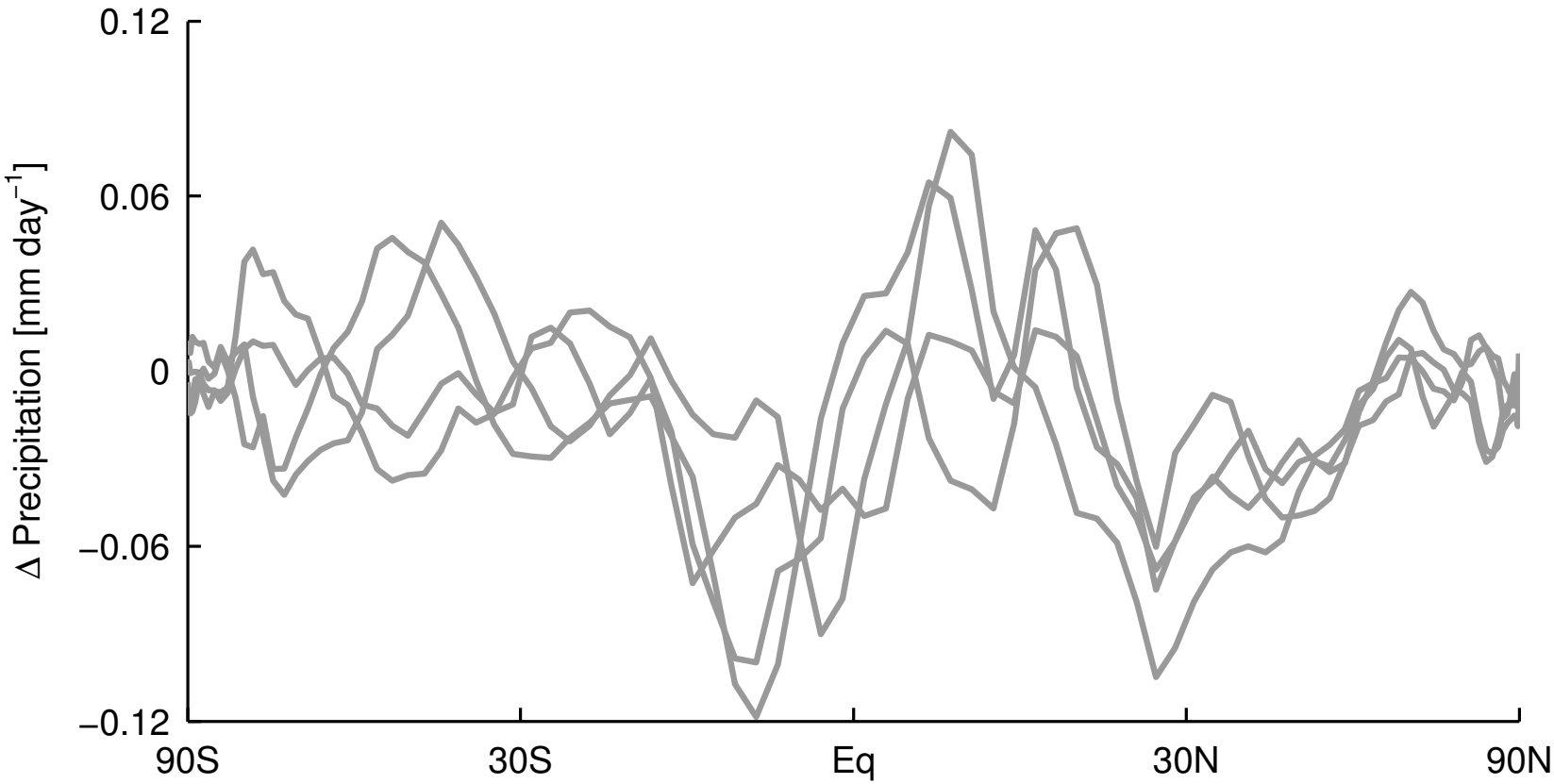
- Within the range estimated by AEROCOM *(Myrhe et. 2013)*
- Differences in clouds do not necessarily cause differences in the aerosol radiative effect.

Initial Easy Aerosols results with ECHAM6: net shortwave fluxes



- Change in net SW fluxes estimates aerosol radiative effect with good accuracy.
- Absorption not inflicted by cloud differences, maybe robust across models.

Initial Easy Aerosols results with ECHAM6: precipitation



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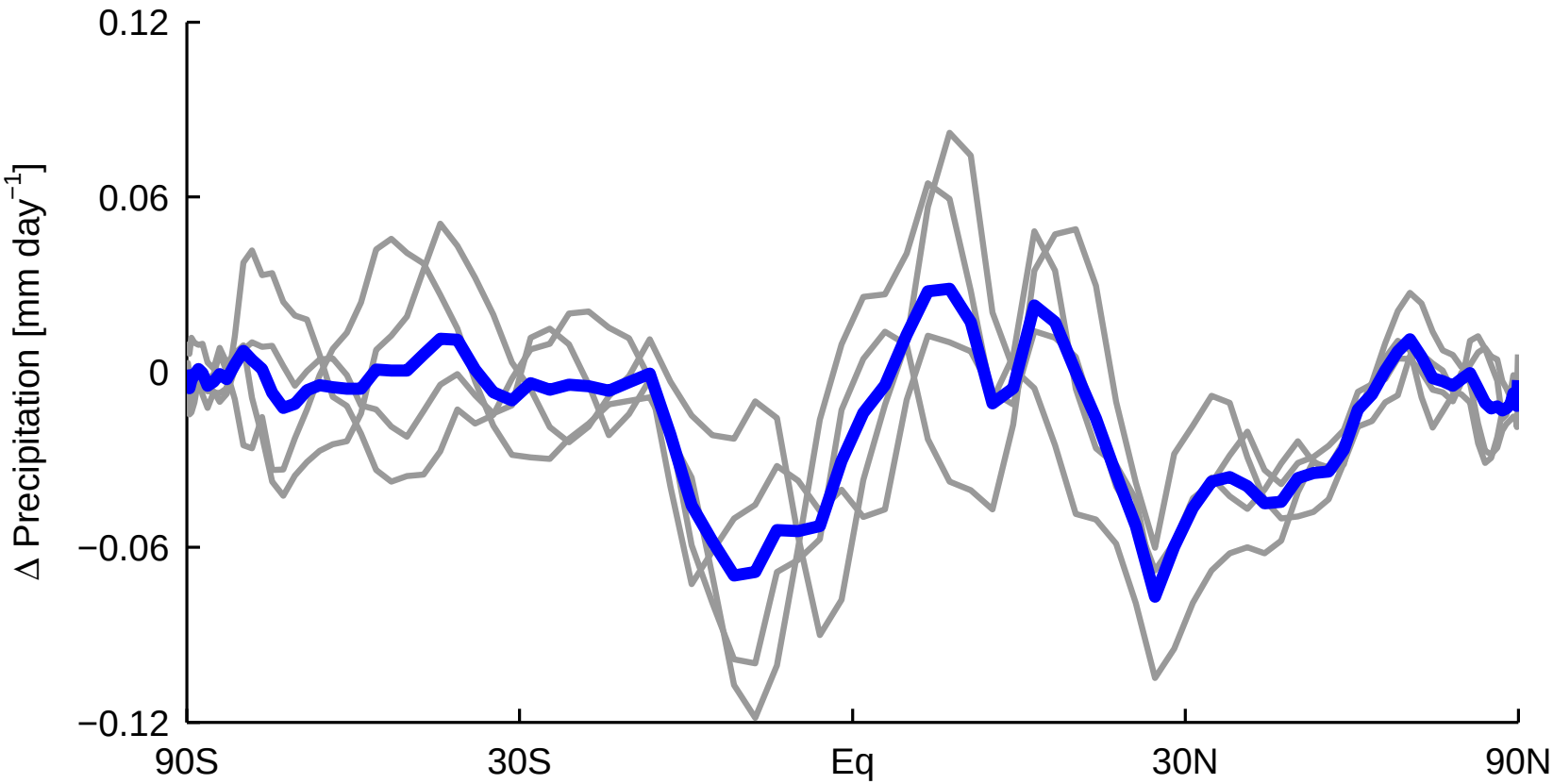

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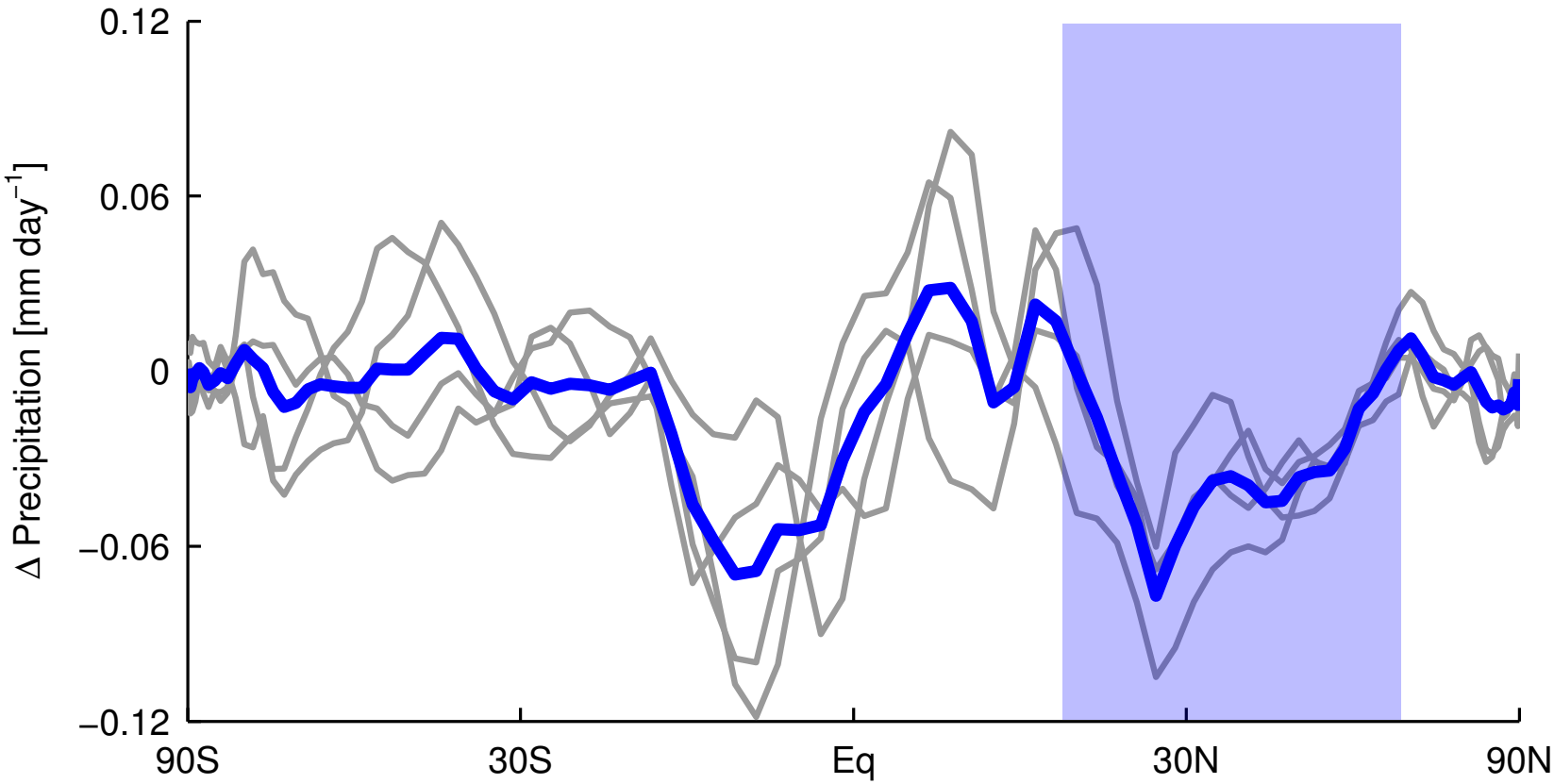
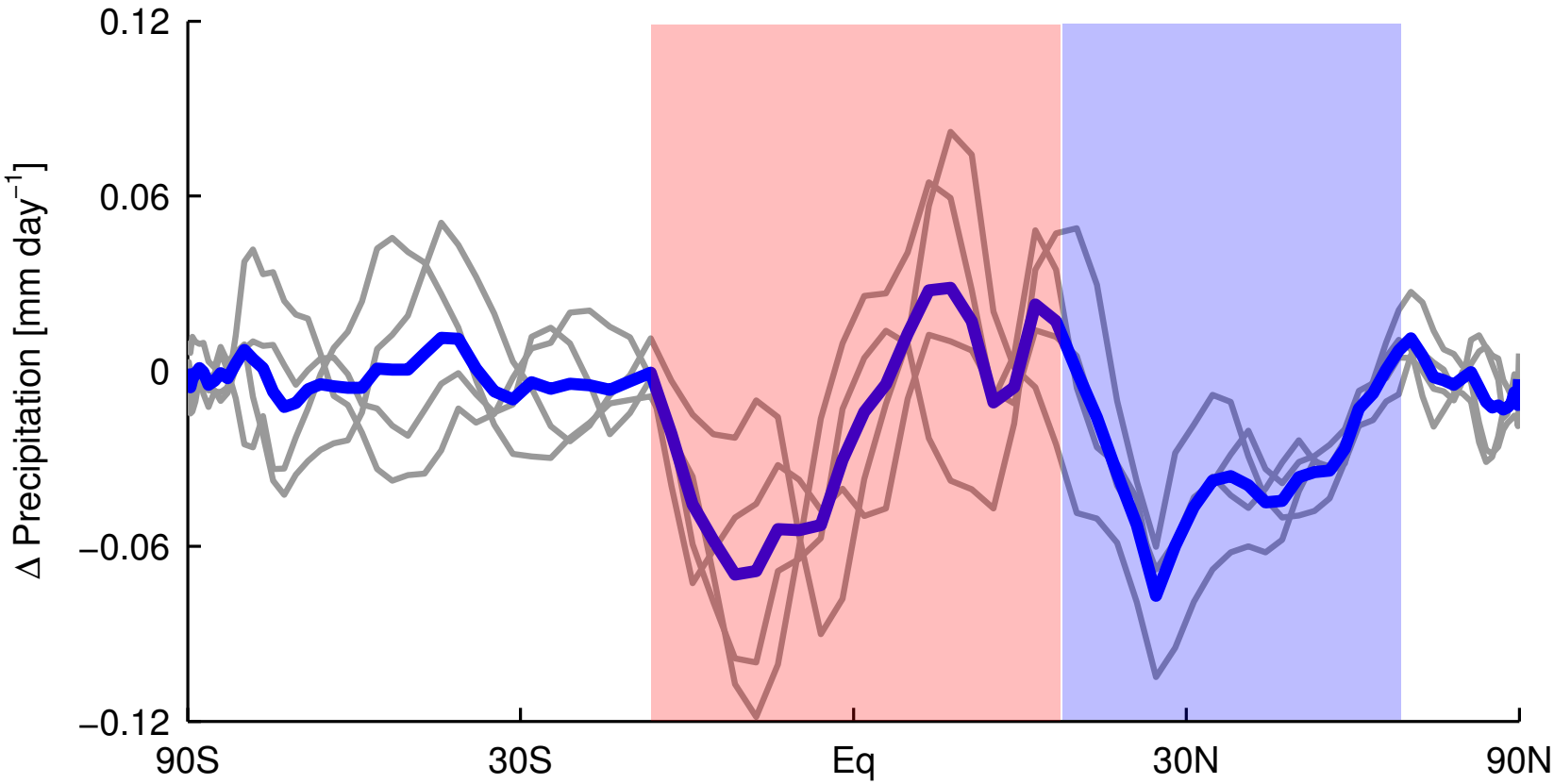


- Less precipitation around center of aerosol plume

Initial Easy Aerosols results with ECHAM6: precipitation



- Less precipitation around center of aerosol plume
- Northward shift of tropical rain belt

Plus on est de fous, le plus on rit!*

- Final experimental protocol distributed by end of August 2013
- Contact person: Aiko Voigt, LMD Paris, aiko.voigt@lmd.jussieu.fr

* LMD speak: Join the Party!