Minimizing the effects of aerosol swelling and wet scavenging in ECHAM6-HAM2 for comparison to satellite data

D. Neubauer\textsuperscript{1}, M. Christensen\textsuperscript{2}, C. Poulsen\textsuperscript{2}, U. Lohmann\textsuperscript{1}

\textsuperscript{1}ETH Zurich, \textsuperscript{2}RAL Space

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Cloud contamination in satellite products enhances the aerosol indirect forcing estimate

- Near cloud aerosol retrievals possibly influenced by: aerosol swelling; misclassification of cloud particles; 3D effects near cloud edges
- Marked reduction in aerosol forcing by excluding near cloud aerosol

Figures from Christensen et al., 2017, ACP, accepted
Aerosol swelling

- Global model resolution is typical 100x100 km
- Water uptake of aerosol is known → dry aerosol index (AIdry)

low liquid clouds; 3-hourly instantaneous data; 1995-2012; susceptibilities are computed for each season and grid point; 60°N-60°S
Wet scavenging

- Removing raining scenes reveals the cloud lifetime effect
- Moderate and heavy precipitation cause a lasting impact on AIdry

ECHAM6-HAM2_Ref – dln(LWP)/dln(AIdry)

non-raining (precipitation < 0.5 mm / day)
Environmental regime composites

Regimes defined by:

- Precipitation state: Non-raining: precip. < 0.5 mm/day; Raining: precip > 0.5 mm/day
- Free tropospheric relative humidity ($RH_{FT}$): Dry: $RH_{FT} < 40\%$; Moist: $RH_{FT} > 40\%$
- Lower tropospheric stability (LTS): Unstable: LTS < 17K; Stable: LTS > 17K

Average over global oceans

MODIS-CERES data from Christensen et al. (2016)
In-cloud aerosol processing

- Aerosol processing increases aerosol size
- AODdry depends less on size than Aldry → less negative susceptibilities

ECHAM6-HAM2_AProc – dln(LWP)/dln(Aldry)
non-raining (precipitation < 0.5 mm / day)

ECHAM6-HAM2_AProc – dln(LWP)/dln(AODdry)
non-raining (precipitation < 0.5 mm / day)
Prognostic vs. diagnostic precipitation scheme

\[ ACI_L = \frac{d \ln LWP}{d \ln AOD/AI} \]

- Low liquid clouds in this study
- Prognostic precipitation (PP) leads to increased susceptibilities although the accretion/autoconversion ratio is increased (Sant et al., 2015)
- Shift from rain to drizzle of marine stratocumulus
Effective radiative forcing (ERFaci) of low liquid clouds (average over global oceans)

\[
\text{intrinsic } ERF_{aci} = \overline{LCC_m} \left[ \frac{d\alpha_{clr}}{d \ln AI} - \frac{d\alpha}{d \ln AI} \right] \Delta a_{AI} F_d
\]

Neubauer et al. (2017), ACP, accepted

AATSR-CAPA and MODIS-CAPA data from Christensen et al. (2017), ACP, accepted
MODIS-CERES data from Chen et al. (2014)
Summary and Outlook

- Better to compare the dry aerosol from model simulations to (artefact reduced) satellite data for studying susceptibilities

- Smaller $\text{ACI}_L$ susceptibility in ECHAM6-HAM2 than in previous studies due to reduced RH impact

- Smaller $\text{ERF}_{aci}$ in ECHAM6-HAM2 for dry than for humid aerosol

- Wet scavenging and aerosol processing have an impact

- $\text{ACI}_L$ is negative in non-raining scenes for MODIS-CERES but positive for AATSR-CAPA and ECHAM6-HAM2

Thank you for your attention!