

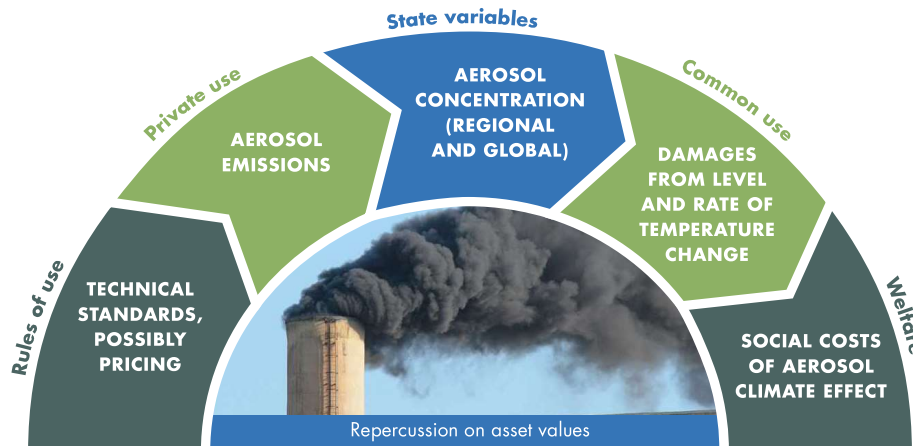


ACCOUNTING FOR AEROSOLS IN CLIMATE MITIGATION PATHWAYS AND ON FINANCIAL MARKETS

THOMAS BRUCKNER
INTEGRATED ASSESSMENT MODELLING

JOHANNES QUAAS
CLIMATE MODELLING

GREGOR WEISS
FINANCE AND SUSTAINABILITY

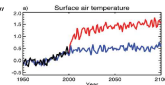


AEROSOL-CLIMATE MODELLING

Johannes Quaas, Gregor Weiß

Title: "Aerosol mitigation impacts for integrated assessment"

- Regional temperature and precipitation changes (amounts and rates) from climate modelling
- Coupled simulation of IAM PhD scenario vs. standard
- Simulation and joint assessment of socio-economic impacts



Second cohort title "Aerosol event attribution for climate finance assessment"

- Kilometre-resolution simulations to identify contribution of aerosols to heavy rain
- Statistical extrapolation to global scale
- Joint assessment of economic impact

INTEGRATED ASSESSMENT MODELLING

Thomas Bruckner, Johannes Quaas

Title: "Joint integrated assessment modelling"

- Explicit consideration of aerosol reduction as a control variable in integrated assessment of global climate change
- Consideration of constrained adaptation opportunities by inclusion of the rate of global mean temperature change in the determination of climate damages

Second cohort title: "Spatial effects of aerosols in integrated assessment modelling"

- Inclusion of spatial aerosol forcing heterogeneity in integrated assessment modelling exercises
- Derivation of policy implications

CLIMATE FINANCE AND AEROSOLS

Gregor Weiß, Johannes Quaas

Title: "Climate Finance and Aerosols"

Effects of firm-made aerosol pollution on asset prices, with special focus on

- (weather-linked) Derivatives
- Stock returns

Combine observational / market / IAM / textual analysis data.

Second cohort title: "Aerosols and Local Economic Activity"

Theme	PhD title	year 1	year 2	year 3	year 4	year 5	phase II
Aerosol-climate modelling	1. Aerosol mitigation impacts for IAM	regional change amounts and rates due to aerosol	aerosol-climate 21st century, non-climate effects	closure simulation on optimised scenario			
	2. Aerosol event attribution for finance		climate extremes due to aerosols & impacts				
Integrated assessment modelling	1. Endogenise aerosols in IAM	include rates of change and aerosol forcing	optimise aerosol mitigation pathway	include other short-lived forcers (methane)			
	2. Regionalise IAM		spatially-explicit IAM including aerosol				
Climate finance	1. Aerosol-climate effects in stocks	textual analysis to identify sectors and firms	combined aerosol measurement - stock analysis	analysis of influence mechanisms			
	2. Aerosols in derivatives and insurance contracts		analyse derivatives / insurance contracts, focus on extreme events				

SHARED METHODOLOGY:

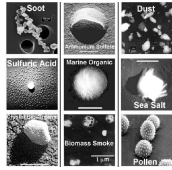
Earth system and integrated assessment modelling; atmospheric-financial data analysis



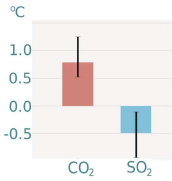
ICP AEROSOLS

THOMAS BRUCKNER, JOHANNES QUAAS, GREGOR WEISS

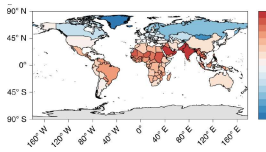
AEROSOLS ≈ CLIMATE AS NATURAL COMMONS



- Aerosols:**
- Liquid or solid particles
 - 100 nm – 1 µm in size
 - Natural sources (erosion, sea spray, vegetation, volcanoes, fires) + anthropogenic (fossil and bio fuels)
 - Lifetime ~1 week



- Second-most important climate change forcing
- Impacts climate also directly (e.g. fog, heavy rain)



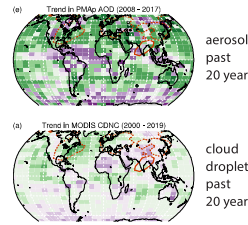
UNEVEN EFFECTS

- In space: Aerosol cooling beneficial in some places, other impacts harmful
- In time: Taking out aerosol implies warming (large rates)

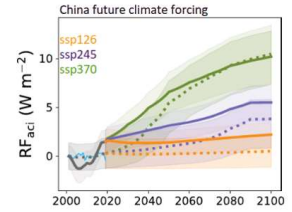
COLLABORATION WITH OTHER ICPs IN ECO-N

- ICP Regional climate - heat waves particularly affected by aerosol reductions
- ICP Urban air – (i) air quality (≈ human health, agricultural yields) driver of aerosol mitigation; (ii) companies' land-use reports and real estate prices as metrics
- ICP Soils, ICP Forests – aerosols may feed back to ecosystems via effects on climate

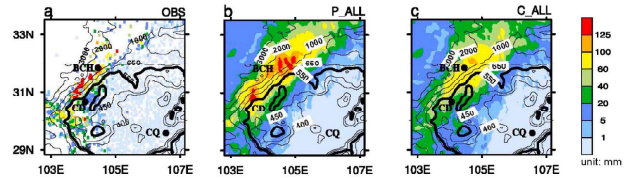
PHD PROJECT 1: METEOROLOGY



- Due to air quality regulation, large declines in aerosols and cloud droplets in past 20 years
- Implies 1/3 of the aerosol cooling already removed, 0.3 to 0.4°C warming "in the pipeline"



- Regionally the effect may be very large
- E.g. in China the cleaning will lead to large warming especially at the end of the century



Fan et al., Geophys. Res. Lett. 2015

- Aerosols lead to (subtle) shift from frequent light to rarer intense events
- E.g. in Southeast China rain rates for an event 8–9 July 2013 were much more intense than they would have been 30 years earlier
- Similar result also for Germany

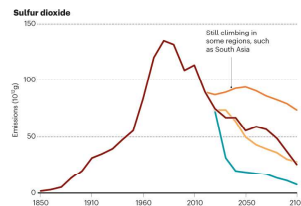
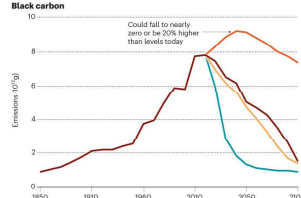
PHD PROJECT 2: INTEGRATED ASSESSMENT MODELLING

- As a side-effect of accelerated efforts for achieving "net zero greenhouse emissions" by 2050, strong and fast aerosol reductions will occur
- The "removing of the aerosol mask" might lead to an intermediate strong increase in the rate of global mean temperature change.
- Conventional cost-benefit integrated assessment models do not take into account the aerosol precursor emissions as a control variable
- They typically do not treat non-CO₂ emissions (e.g. short-living methane) as control variables
- They relate climate damages to the relative global mean temperature change
- Adaptation costs which depend on the rate of temperature change typically are not considered

DRASTIC UNCERTAINTY

Black carbon and sulfur dioxide, the two key aerosol types, have implications for climate change that could alter in wildly different ways up to 2050 and beyond.

— SSP1-1.9 — SSP2-4.5 — SSP3-7.0 — Historical & SSP5-8.5



Persad et al. (2022, Nature)

PHD PROJECT 3: CLIMATE FINANCE

- Aims at identifying the climate-related effect of aerosols on asset prices. Starting point will be financial weather-derivatives
- The PhD project will use time-series data on prices for financial derivatives and the output of climate models from the meteorological PhD project to identify the much more specific and tangible link from aerosol concentration to the climate-related impact on these financial derivatives



- In a second step, the PhD project will specifically look at economic sectors of particular interest (agriculture, tourism) with the goal to identify a signal in asset prices linked to these sectors
- One strategy to identify the effect of aerosols is to exploit regional and time phase differences in the patterns of aerosol concentrations and confounding factors
- The output from climate simulations, supplied by the meteorological PhD, will help to identify such patterns (e.g. aerosol data from US IMPROVE network)