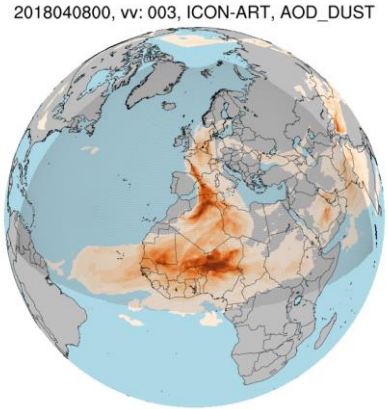
Karlsruhe Institute of Technology

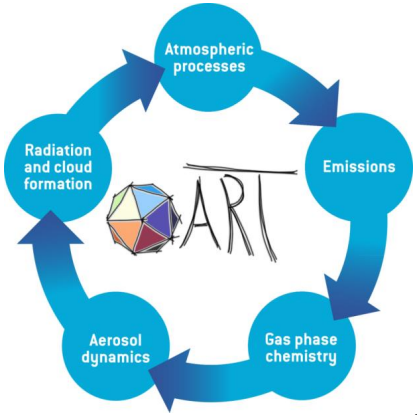
CONSORTIUM FOR SMALL SCALE MODELING
COSMO

COSMO GM, Basel, September 2025

ICON-ART

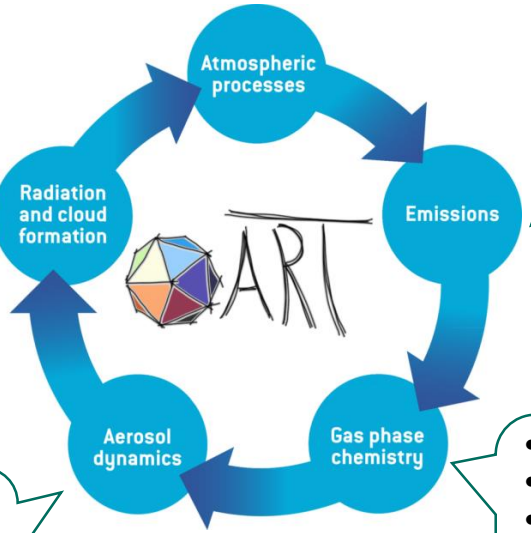
Ali Hoshyaripour and the ARTists





ICON-ART : open source release 2025.04

- Optics of all natural aerosols
- Optics of internally mixed aerosols
- Coupling with radiation (full and reduced grid)
- Warm and cold activation
- INAS ice nucleation scheme
- Multiple radiation call
- **Prescribed optics in nc files**



- Point source
- All natural aerosols
- Biomass-burning plumes
- Volcanic plumes (FPLUME)
- Online emission module
- MEGAN
- New BB Plumes

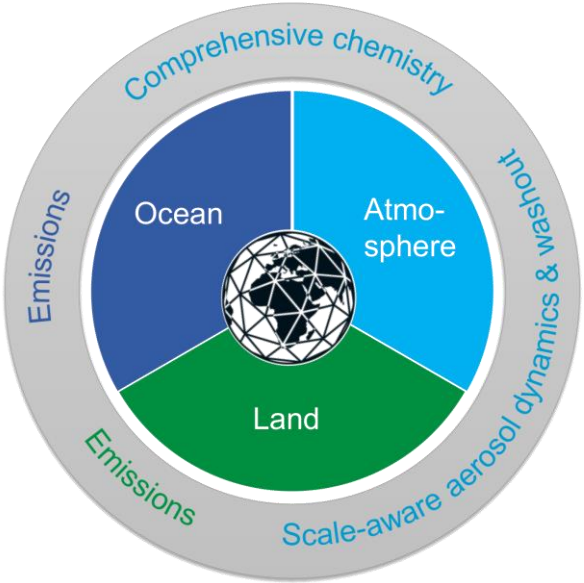
- Modal treatment
- AERODYN
- ISORROPIA
- Water uptake
- **Subpollen Particles (SPP)**

- Lifetime based
- Linearized schemes (LINOZ, N_2O-NOy)
- Simplified OH chemistry **+ O(1D)**
- MECCA/KPP (--enable-art-gpl)
- **Dry and wet deposition for gases**
- **LINOZ V3**

HErZ project (2023-2027) ICON-SmART

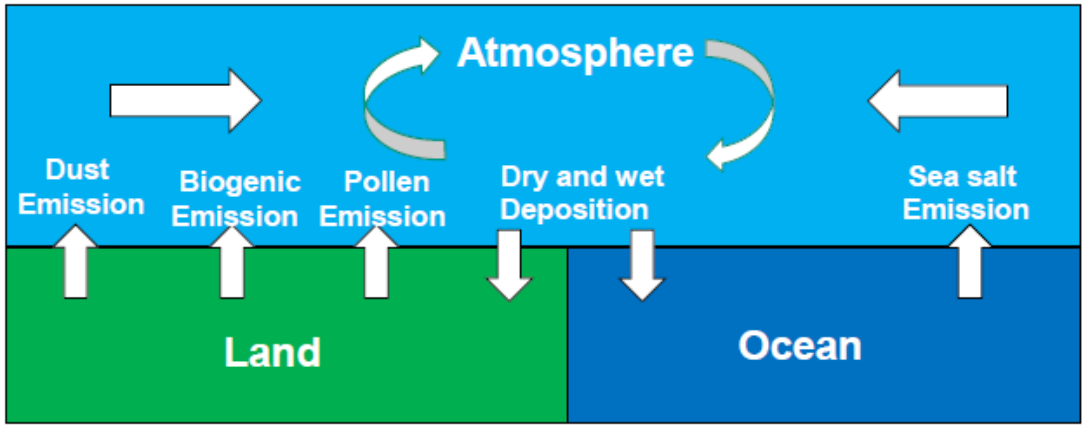
Preparing ICON-ART for **seasonal to decadal** climate predictions in **seamless regional to global** model configurations
→ ICON-Seamless + ART = ICON-SmART

- Emissions of natural aerosols and trace gases from **fully coupled** and interactive **ocean and land** modules
- **Comprehensive atmospheric chemistry** (troposphere and stratosphere) → optimization and acceleration
- **ML-based and scale-aware** aerosol dynamics and washout
- **Multi-year simulation** with full chemistry and aerosol treatment



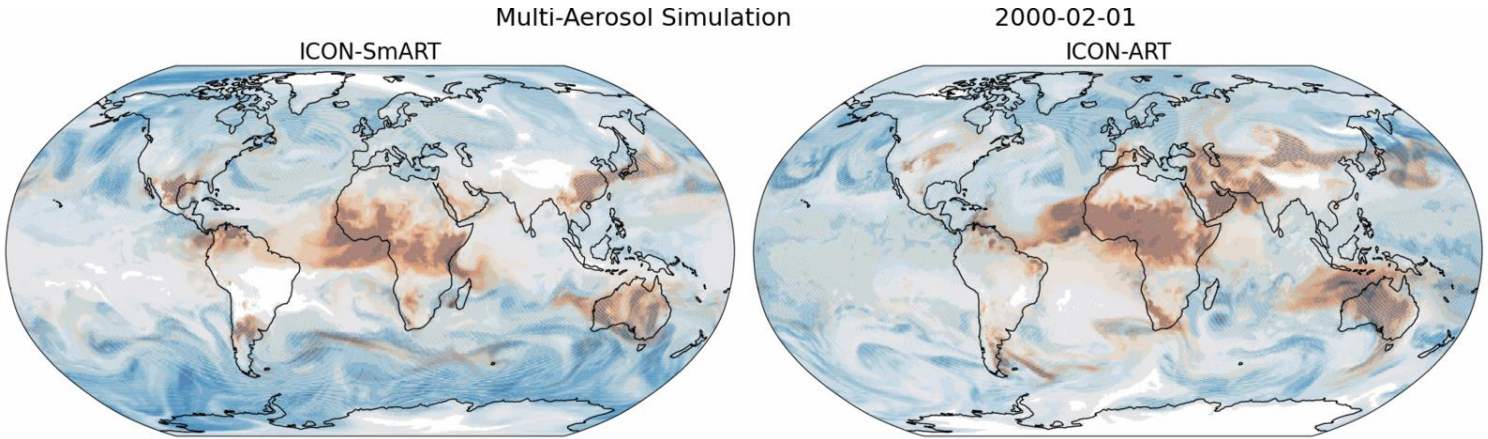
Coupling of ICON-Seamless and ART

- Solving the continuity equation for the concentrations of atmospheric species requires <u>boundary conditions</u> at the Earth's surface, the so called "surface fluxes"
- The **surface flux** is called
  - *Emission* when upward (the surface act as a source)
  - *Deposition* when downward (the surface act either as a sink)



ICON-SmART: Dust and sea salt emissions

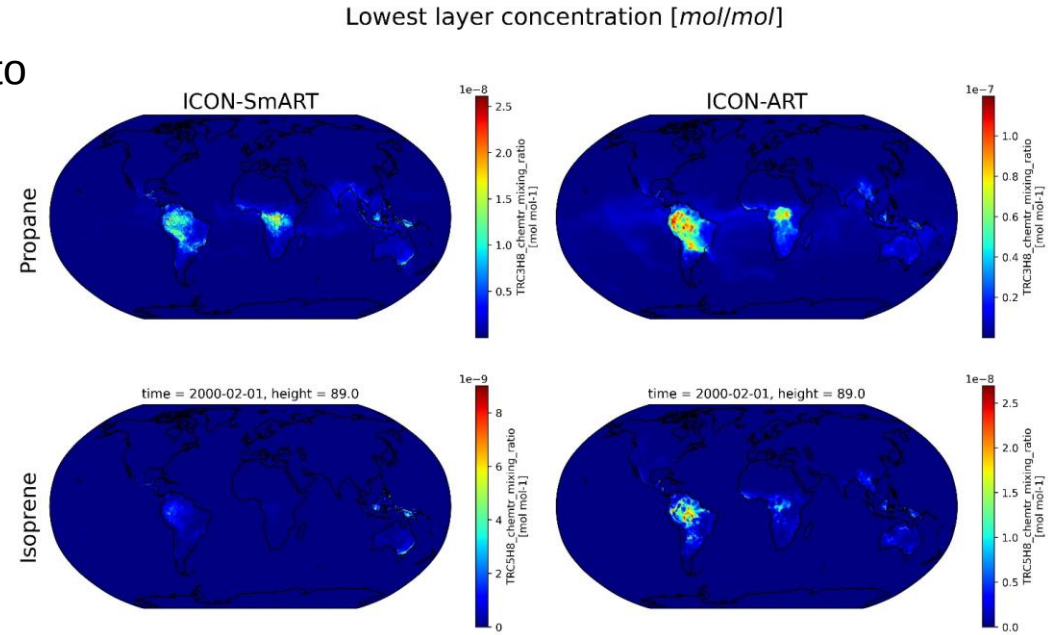
- R2B5 atmosphere and R2B6 ocean
  - Start date = 2000-01-01
  - End date = 2002-12-31



Tuning and validation are ongoing!

ICON-SmART: biogenic emissions

- BVOC parameterization according to MEGAN2.1 (Guenther et al., 2012)
- Emissions depending on:
  - Temperature
  - Radiation
  - Leaf age
  - Leaf area index
  - Plant functional types: PFT



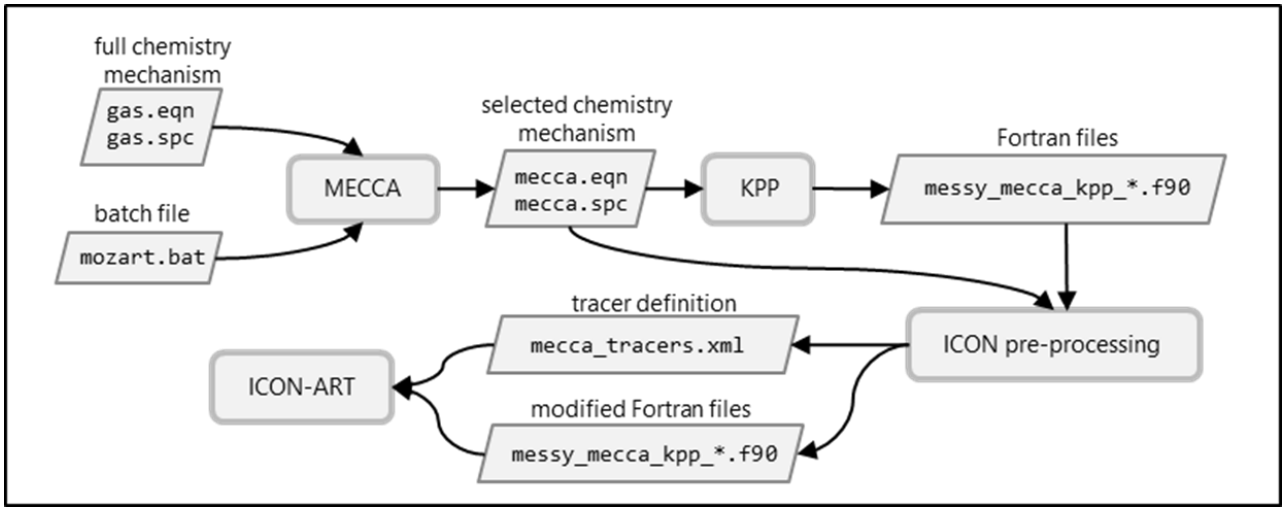
LAI and cover fraction are lower in JSBACH!
Tuning and validation are ongoing!

ICON-SmART: comprehensive chemistry

Requires:

- **Natural emissions** → e.g. wildfires, BVOCs with MEGAN
- **Anthropogenic emissions** → OEM extended for global applications
- **Chemistry mechanism** → MOZART (CAM-Chem) mechanism
- Species mapping …

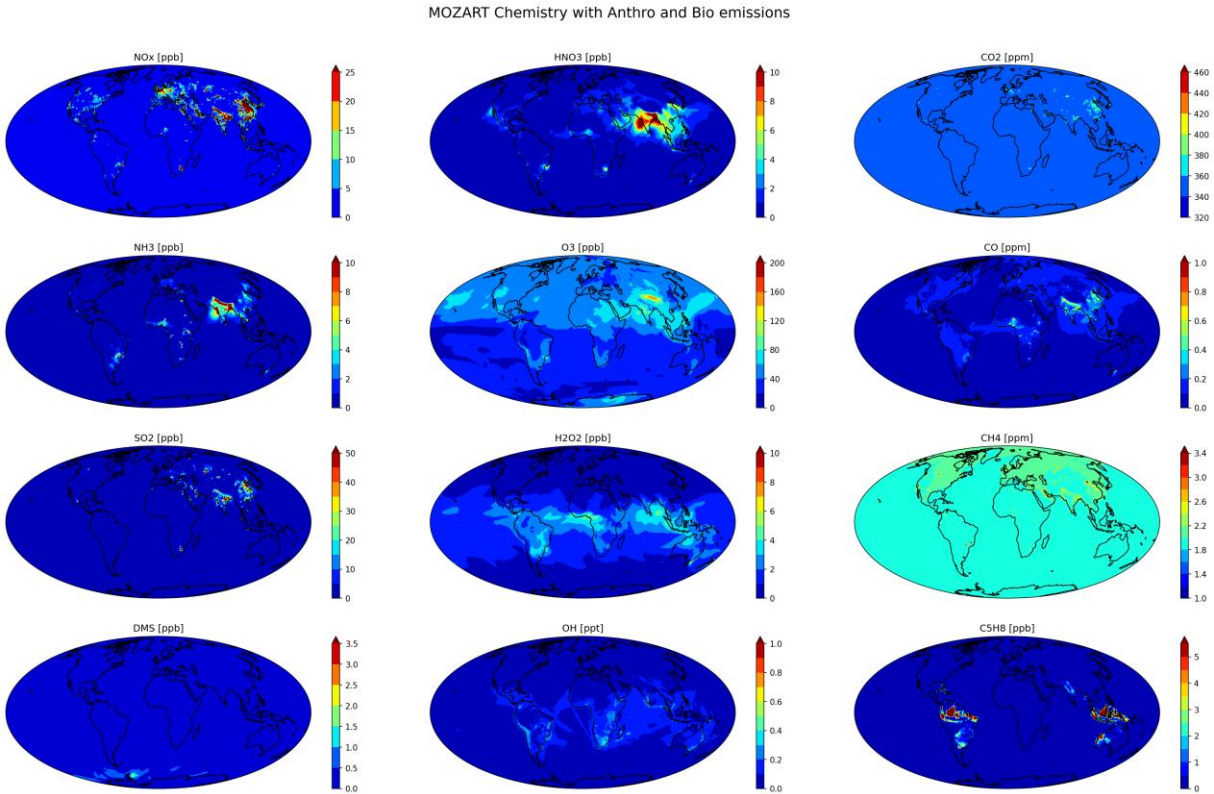
Big thank to EMPA for the assistance!



Hans-Ertel-Zentrum für Wetterforschung

ICON-SmART

Preliminary results: 5-days average surface conc.



Sanhita Ghosh

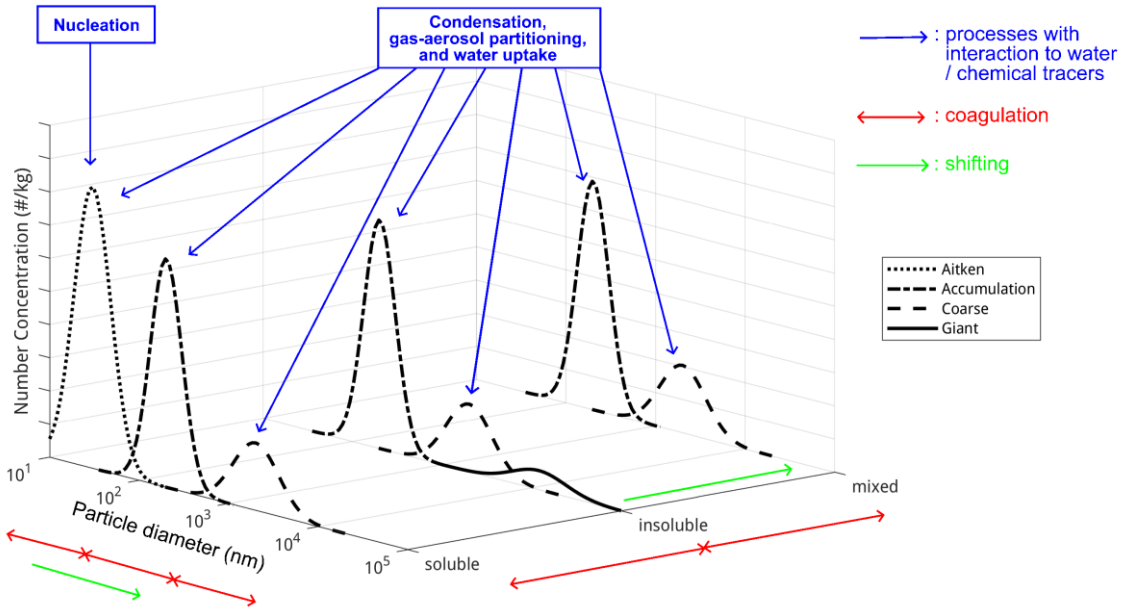
Hans-Ertel-Zentrum für Wetterforschung

ICON-SmART

ICON-SmART: comprehensive aerosols

Requires:

- **Natural emissions** → wildfires, dust, sea salt, DMS
- **Anthropogenic emissions**
- **Chemistry (simplified)**
- Aerosol dynamics
- SOA formation …



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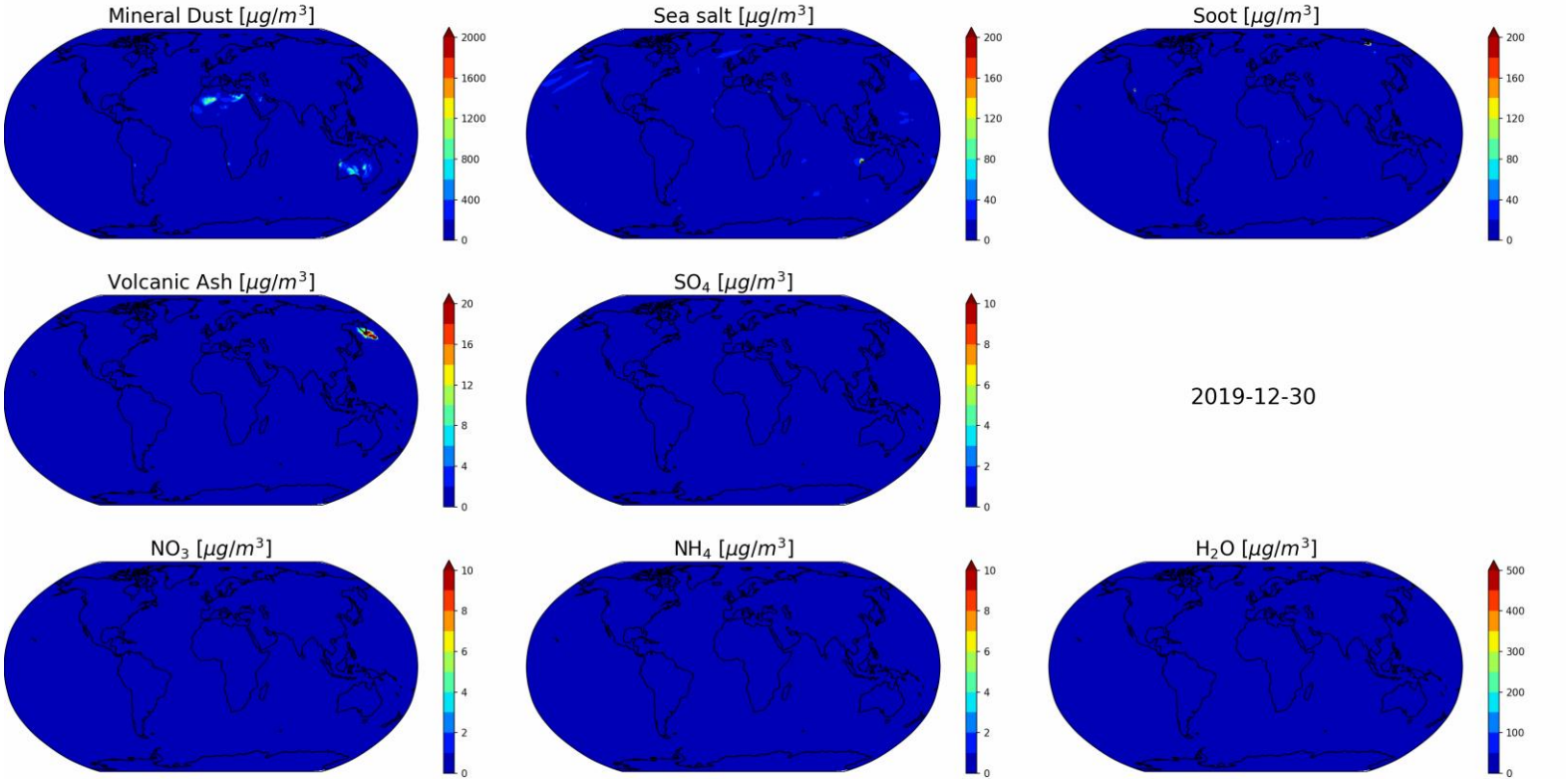
ICON-SmART

Preliminary results: aerosol surface concentrations



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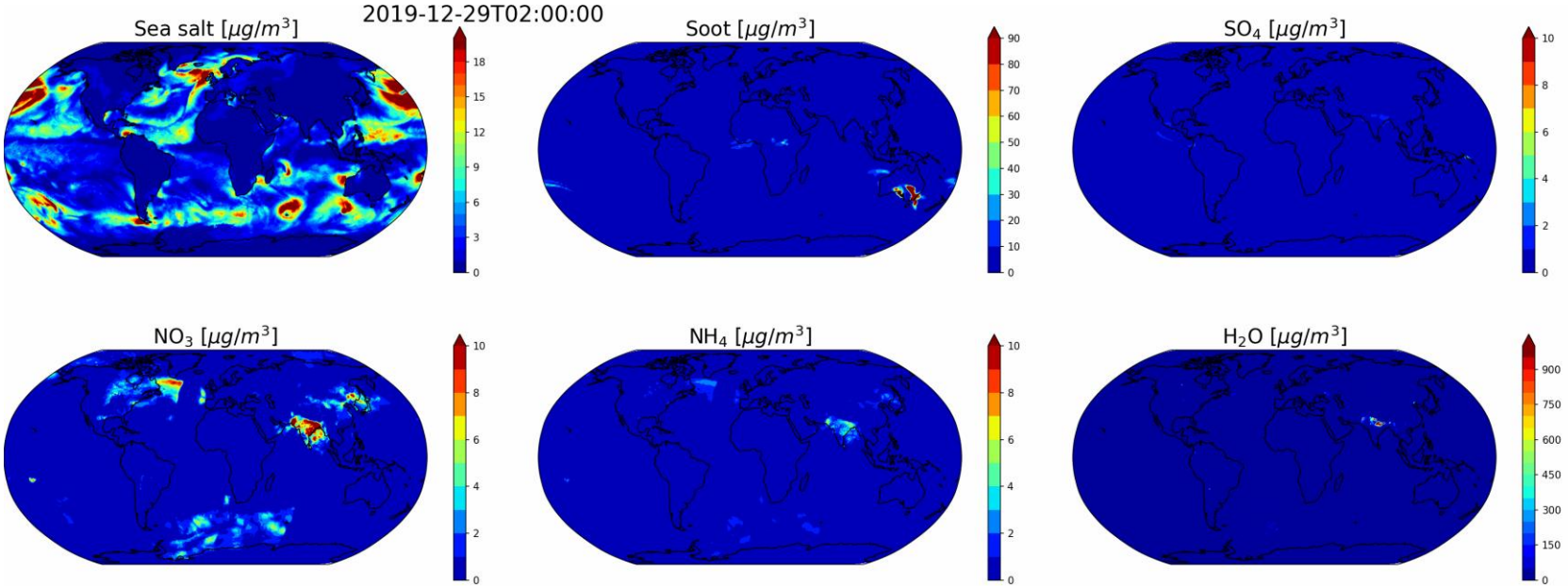
ICON-SmART

Preliminary results: aerosol + chemistry



This simulation is ~3-5 times slower that ICON-only!

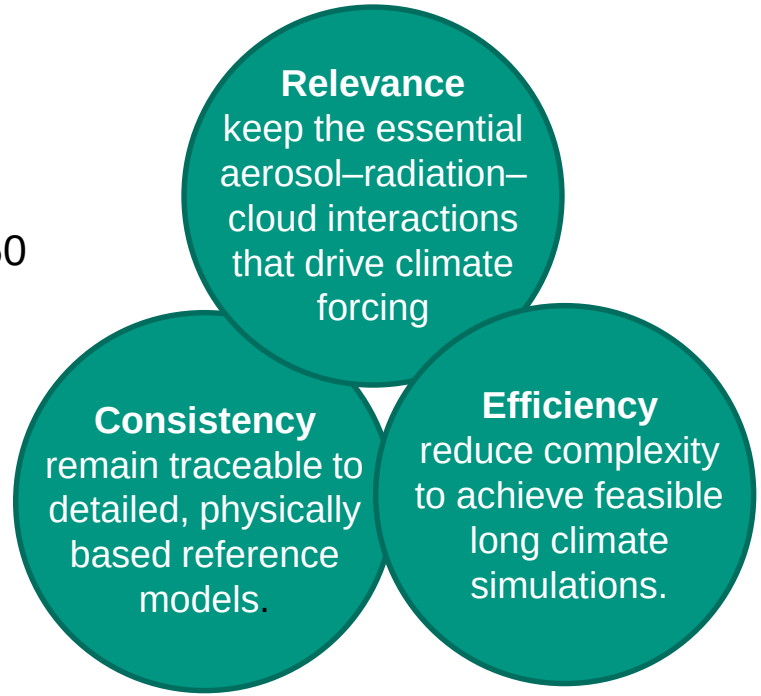
ICON-SmART: towards „fast“ chemistry and aerosols

Requires:

- **Natural emissions**
- **Anthropogenic emissions**
- **Efficient chemistry and aerosol dynamics**

  Emulation of ISORROPIA and Cloud-J

  Using ~10 aerosol species instead of ~50



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ICON-SmART

Community, support and training

- ICON-ART training organized as a part of DWD-NatESM ICON training in July 2025 in Hamburg
- Website including user guid: icon-art.kit.edu
- “ARTists forum” co-organized by KIT and EMPA 3-monthly meeting
- New mailing list: icon-art-community@lists.kit.edu

ICON-ART : OSR 2025.10 (preliminary)