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HAMM7: A MODAL AEROSOL APPROACH FOR IFS-COMPO

Vincent Huijnen[1], Ramiro Checa Garcia[1], Tommi Bergman[2], Thanos Tsikerdekis[1], Twan van Noije[1], Lianghai Wu[1], Harri Kokkola[2], Swen Metzger[3], Samuel Remy[4]

[1]KNMI, [2]FMI, [3]RC.io, [4]HYGEOS

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PROGRAMME OF THE EUROPEAN UNION

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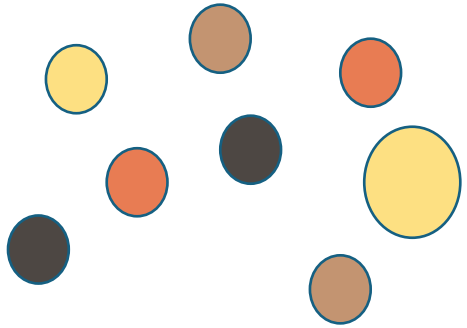
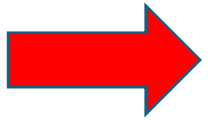
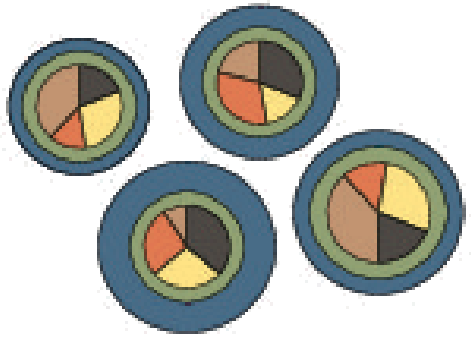
M7 – A MODAL AEROSOL APPROACH FOR THE GLOBAL MODEL

Current: IFS-AER



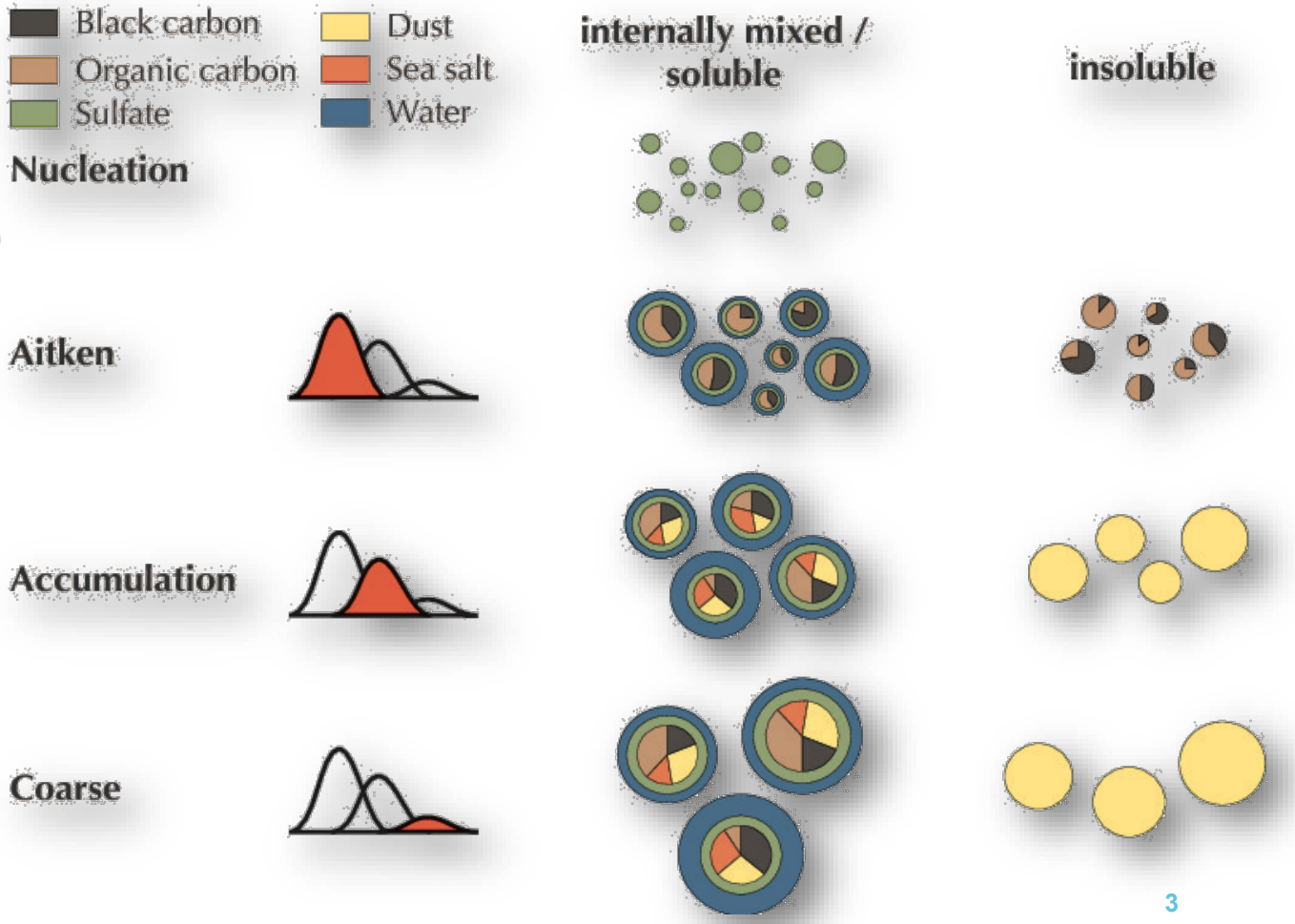


Proposed: IFS-HAMM7



M7 TRACERS IN THE 7 MODES

- 37 tracers (mass and number concentration)
- 7 modes (size / solubility)
- Extension with
  - SIA parameterization
  - SOA parameterization
- Comes with optics module



Vignati et al., (2004)

WHY DO WE NEED IFS-M7 ??

- Much improved information on particle size distribution
- Accounting for internal mixing: implications for aerosol optical properties and aerosol-cloud interaction..
- ..in turn implications on life cycle, and their direct and indirect radiative effects

- Connects CAMS and EC-Earth communities working on aerosol aspects in IFS

DEVELOPMENT PATHWAY FOR M7 INTO IFS

IFS-AER development cycles

Q4 2024 Q4 2025

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CY48R1 → CY49R1 → CY50R1

M7 in OpenIFS:

2023 Dec 2023 2024 Spring 2025

CY43R3 → 1st impl. → CY48R1 → 1st implementation → CY50R1

EC-EARTH FOCI

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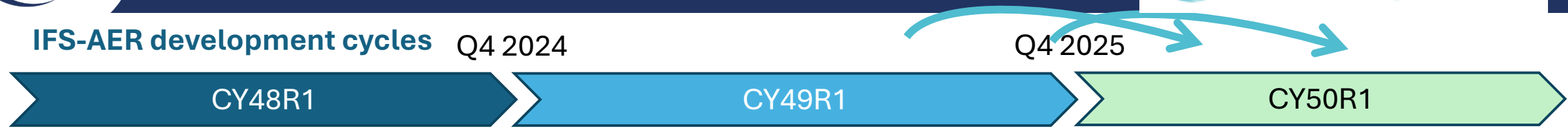
DEVELOPMENT PATHWAY FOR M7 INTO

Atmosphere Monitoring Service

IFS-AER development cycles



M7 in OpenIFS:

VERY TECHNICAL WORK..

Adaptations required across many parts of IFS-code

- IFS-test: *Testing functionality of IFS*
- IFS-scripts: *Preparation of input data and namelists*
- IFS-source:
  - *Coupling HAMM7 modules into IFS for aerosol tracers*
  - *integration with existing (chemistry) modules*
  - *Handling input / output; diagnostics*

- Diagnostics: *development of evaluation scripts*

HAMM7 EMISSIONS: ORGANIC MATTER

	AER	HAMM7
Anthro: CAMS-GLOB-ANT-v6.2	0.5 hydrophobic + 0.5 hydrophylic ; 1.8 Pre-scaling (OC->OM)	1.0* POM_KI; add KI_N r=30 nm; rho=1.8 gr/cm^3 *or: *also use 1.8 OC-OM conversion*
Fires: GFAS	0.5 hydrophobic + 0.5 hydrophylic ; 1.8 Pre-scaling (OC->OM) 1.5 additional scaling	1.0 POM_KI; add KI_N r=30 nm; rho=1.3 gr/cm^3 *New exp: also use 1.8 OC-OM conversion

HAMM7 EMISSIONS: BLACK CARBON

	AER	HAMM7
Anthro: CAMS-GLOB-ANT –v6.2	0.8 hydrophobic + 0.2 hydrophylic ;	1.0 BC_KI; add KI_N r=30 nm; rho=1.8 gr/cm^3
Fires: GFAS	0.8 hydrophobic + 0.2 hydrophylic ; 1.5 additional scaling	1.0 BC_KI; add KI_N r=30 nm; rho=1.8 gr/cm^3 *New exp: also use 1.5 additional scaling

HAMM7 EMISSIONS: SEA SALT AND DESERT DUST

	AER	HAMM7
Sea salt	Albert et al. (2016);	Gong (2003);
Desert dust	NDDUST=4: Same as NDDUST=2, (Nabat 2012) except use of surface roughness	NDDUST=3 Ginoux et al. (2001): Bin1 => acc-insol, Bins 2+3 => Coarse-insol * New exp: bug fix in number emissions

HAMM7 MICROPHYSICS AND CHEMISTRY

- Microphysics following Vignati et al. (2004) + updates:
  - Nucleation, coagulation, SO4 condensation, water uptake

- Log-normal size distribution, fixed std dev, variable median.

- coupled with precursor chemistry for SO_4, NO_3 and NH_4;
- (SOA coupling in development)

DRY AND WET DEPOSITION; SEDIMENTATION

- Wet deposition: size-dependent nucleation and scavenging (Croft et al., 2009; 2010)
- Dry deposition: size-dependent, following Zhang et al. (2012)
- Sedimentation: for accumulation and coarse mode; implicit approach as IFS-AER

A FIRST VERIFICATION

CY49R1 assessment of IFS-HAMM7 vs IFS-AER:

- 1-month experiment for December 2018;
- Resolution: T255 L137: ±70 km
- Default CAMS-GLOB emissions
- Run with CB05-precursor chemistry (SO_2, HNO_3, NH_3)

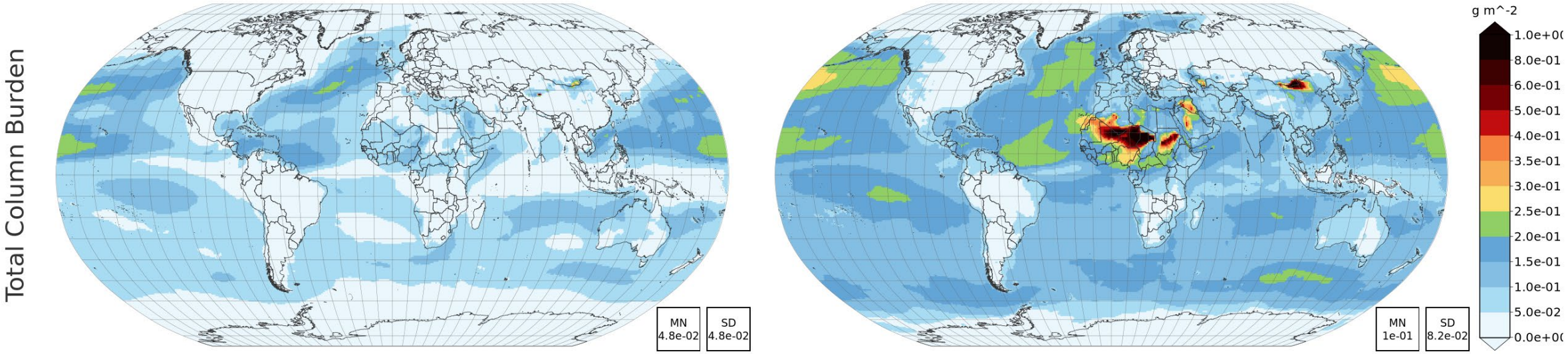
Experiment	Configuration
IFS-AER	Reference IFS-AER experiment
IFS-HAMM7-v0	First IFS-HAMM7 experiment
IFS-HAMM7-v1	revised IFS-HAMM7 experiment: alternative settings for emissions
IFS-HAMM7-v1b	as v1, but with SIA coupling activated

FIRST RESULTS:

Total column burden, average December 2018

IFS-HAMM7

IFS-AER



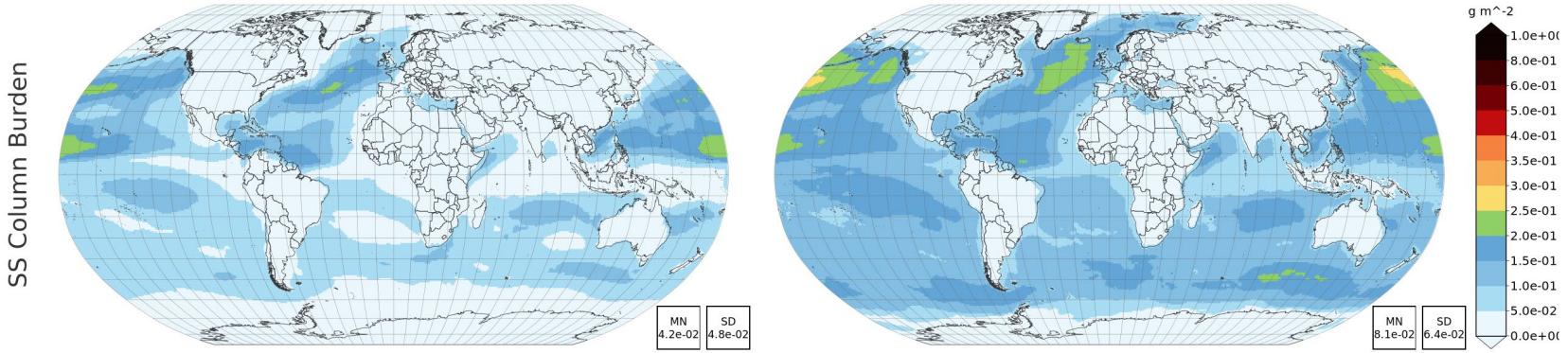
MASS CONVERSION BUDGETS

	Sea salt Aerosol type	HAMM7-v1 AS / CS	AER Bins 1 / 2 / 3
Production	Emission	9.0 / 2.0e4	0.3e3 / 1e4 / 3.6e5
	Net microphys. prod./loss	-	-
Loss	dry deposition	0.6 / 2.8e3	94 / 6.6e3 /3.3e4
	wet deposition	8.2 / 9.0e3	0.2e3 / 3.1e3 / 2.7e3
	sedimentation	- / 8.5e3	
	trop. burden [Tg]	0.048 / 26	2.1 / 22 / 17
	lifetime [days]	1.9 / 0.46	2.2 / 0.8 / 0.18

SEA SALT

- Large differences between schemes
- Similar distribution
- Shorter lifetime for HAMM7

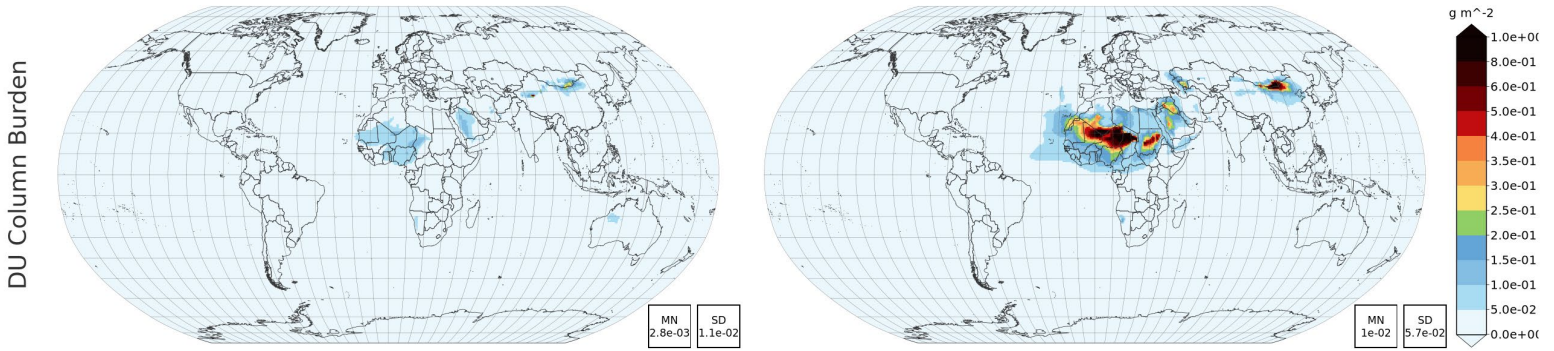
Sea salt Aerosol type	HAMM7-v1 AS / CS	AER Bins 1 / 2 / 3
Emission	9.0 / 2.0e4	0.3e3 / 1e4 /3.6e5
Net microphys. prod./loss	-	-
dry deposition	0.6 / 2.8e3	94 / 6.6e3 /3.3e4
wet deposition	8.2 / 9.0e3	0.2e3 / 3.1e3 / 2.7e3
sedimentation	- / 8.5e3	
trop. burden [Tg]	0.048 / 26	2.1 / 22 / 17
lifetime [days]	1.9 / 0.46	2.2 / 0.8 / 0.18



DESERT DUST

- Large differences in schemes
- Lower column values in HAMM7
- Shorter lifetime for HAMM7 tracers

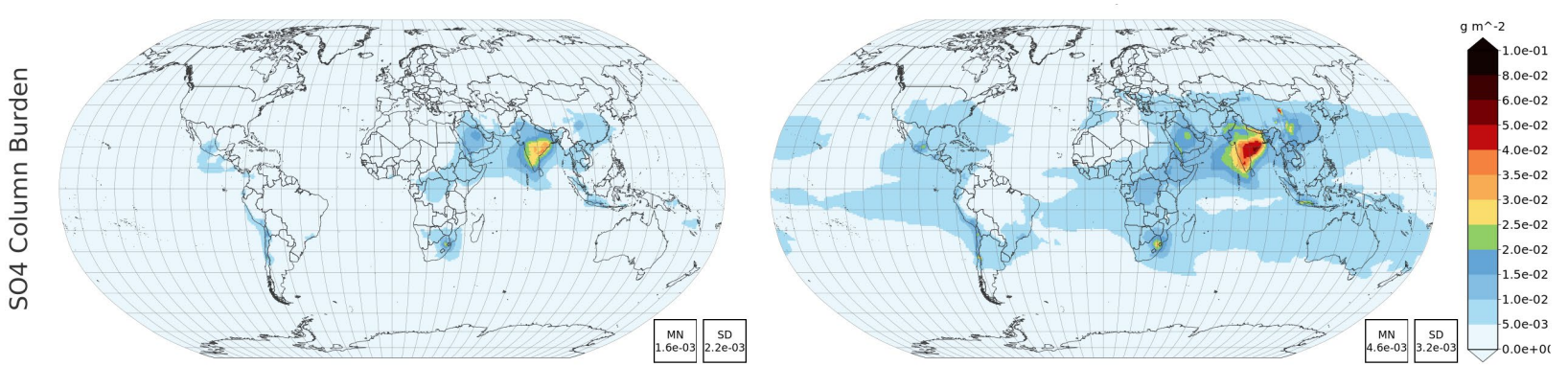
Desert dust Aerosol type	HAMM7-v1 *AI / AS / CI / CS*	AER *Bins 1 / 2 / 3*
Emission	49 / - / 97 / -	3.5 / 31 / 2.2e3
Net microphys. prod./loss	-43 /43 / -43 / 43	-
dry deposition	2 / 3.7 / 6.7 / 3.8	1.5 / 15 / 2.2e3
wet deposition	4.5 /34 / 11 / 20	1.7 / 16 / 1e2
sedimentation	0.9 / 0.3 / 42 / 17	
trop. burden [Tg]	0.35 / 0.8 / 0.6 / 0.4	0.06 / 0.6 / 5.0
lifetime [days]	17 / 7.3 / 3.8 / 3.4	7.0 / 6.5 / 0.8



SULFATE

- Mostly similar distribution
- Lower column values in HAMM7:
- Shorter lifetime for HAMM7 tracers

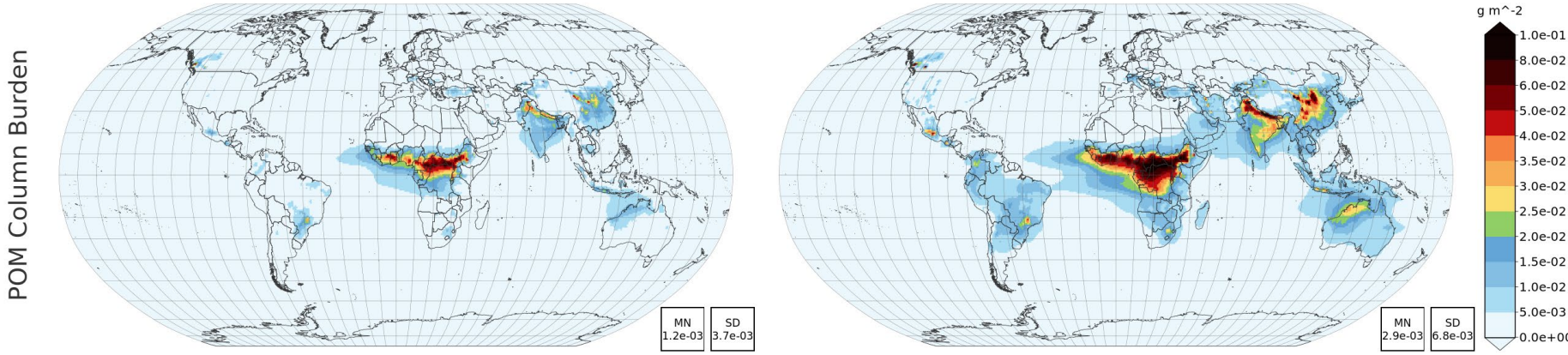
Sulfate Aerosol type	HAMM7-v1 *NS / KS / AS / CS*	AER
Emission	-	-
Net microphys. prod./loss	0 / 1.7 / 125 / 9.0	139
dry deposition	0 / 0.16 / 5 / 0.4	18
wet deposition	3e-3 / 1.9 / 115 / 6.6	119
sedimentation	- / - / 0.2 / 1.9	
trop. burden [Tg]	1e-3 / 0.1 / 1.1 / 0.03	1.9
lifetime [days]	- / 19 / 3.5 / 1.2	5.1



ORGANIC MATTER

- Lower column values in HAMM7
- Shorter lifetime for HAMM7 tracers

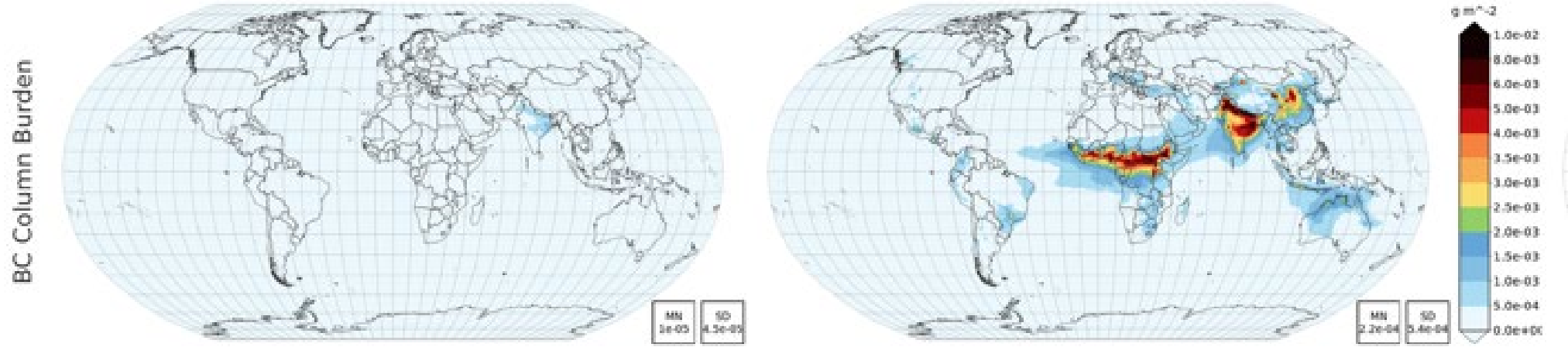
Organic Matter Aerosol type	HAMM7-v1 KI / KS / AS / CS	AER OM-phob / OM-phil
Emission	52/- / - / -	26 / 26
Net microphys. prod./loss	-48/1.5 / 46 / 0.06	-25 / 25
dry deposition	3.1/0.3 / 3.7 / 4e-3	1.1 / 11
wet deposition	1.5 /1.3 / 41 / 0.04	0.02 / 41
sedimentation	- / - / - / 0.02	
trop. burden [Tg]	0.1/0.05 / 0.1 /4e-4	1e-2 / 1.0
lifetime [days]	9.0/10 / 5.4 / 2.1	3.1/ 7.0



BLACK CARBON

- Much lower column values in HAMM7
- Problem with Black Carbon budget

Black Carbon Aerosol type	HAMM7-v1 KI / KS / AS / CS	AER BC-B / BC-A
Emission	7.0 / - / - / -	5.7 / 1.4
Net microphys. prod./loss	- / 0.02 / 0.6 /7e-4	-5.4 / 5.4
dry deposition	0.06/ 0.07 /0.06 /1e-4	0.2 / 1.5
wet deposition	0/01 / 0.5	4-e3 / 5.4
sedimentation	-/-/ 2e-3 / -	- / -
trop. burden [Tg]	0 / 3e-4 / 8e-3 / 0	2e-3 / 0.1
lifetime [days]	0 / 6.0 / 5.0 / 2.0	3.2 / 6.1

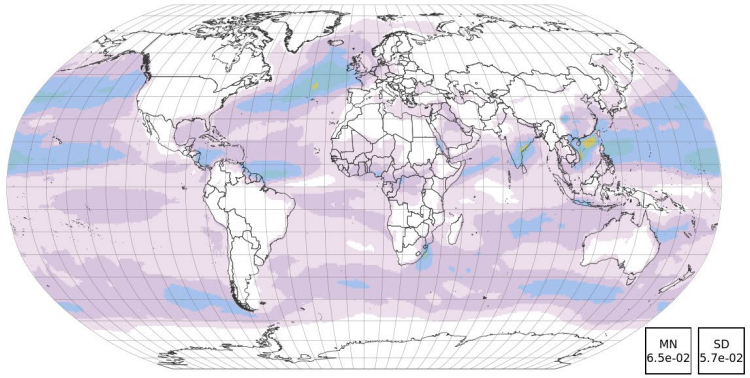


IMPACT ON AOD

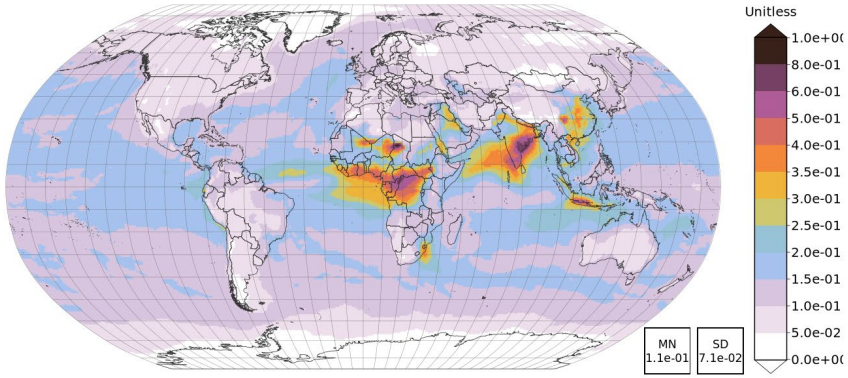
Monthly mean AOD

AOD 550nm

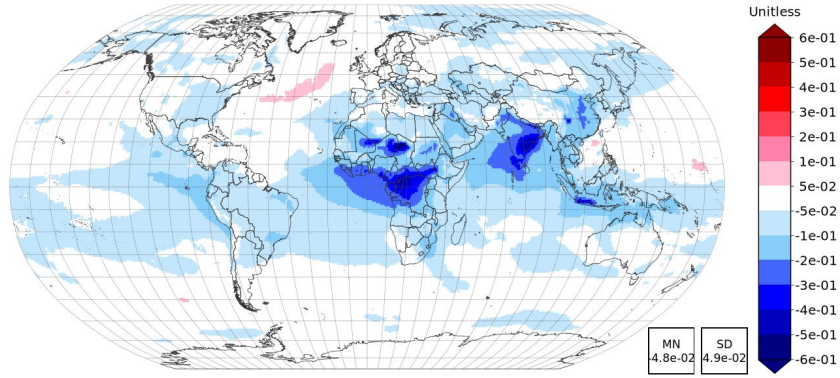
IFS-HAMM7



IFS-AER



HAMM7 - AER



SUMMARY

- First implementation of HAMM7 in IFS CY49R1 concluded, *including coupling to inorganic aerosol precursor*
- Variability similar to AER, but burden generally lower:
- Still lower emissions and/or higher deposition?

Future work:

- Checking parameterizations
- Code cleaning
- Expansion of capabilities

THANKS!

Swen Metzger