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CMIP6 Verbund 2 „Chemie“

Modular Earth Submodel System

CMIP6 kick-off meeting

July 19, 2016, DKRZ Hamburg

Patrick Jöckel,
German Aerospace Center (DLR), Oberpfaffenhofen

DLR

CMIP6+

Verbund 1 "DICAD"

- …
- DKRZ work-flow & data management
- DLR Evaluation

Verbund 2 "Chemie"

- **T**eil**P**rojekt 1: CMIP6 simulations with EMAC: DECK/hist. AerChemMIP
- **T**eil**P**rojekt 2: ICON/MESSy development & MESSy-Consortium coordination

01 July 2016 – 30 June 2020

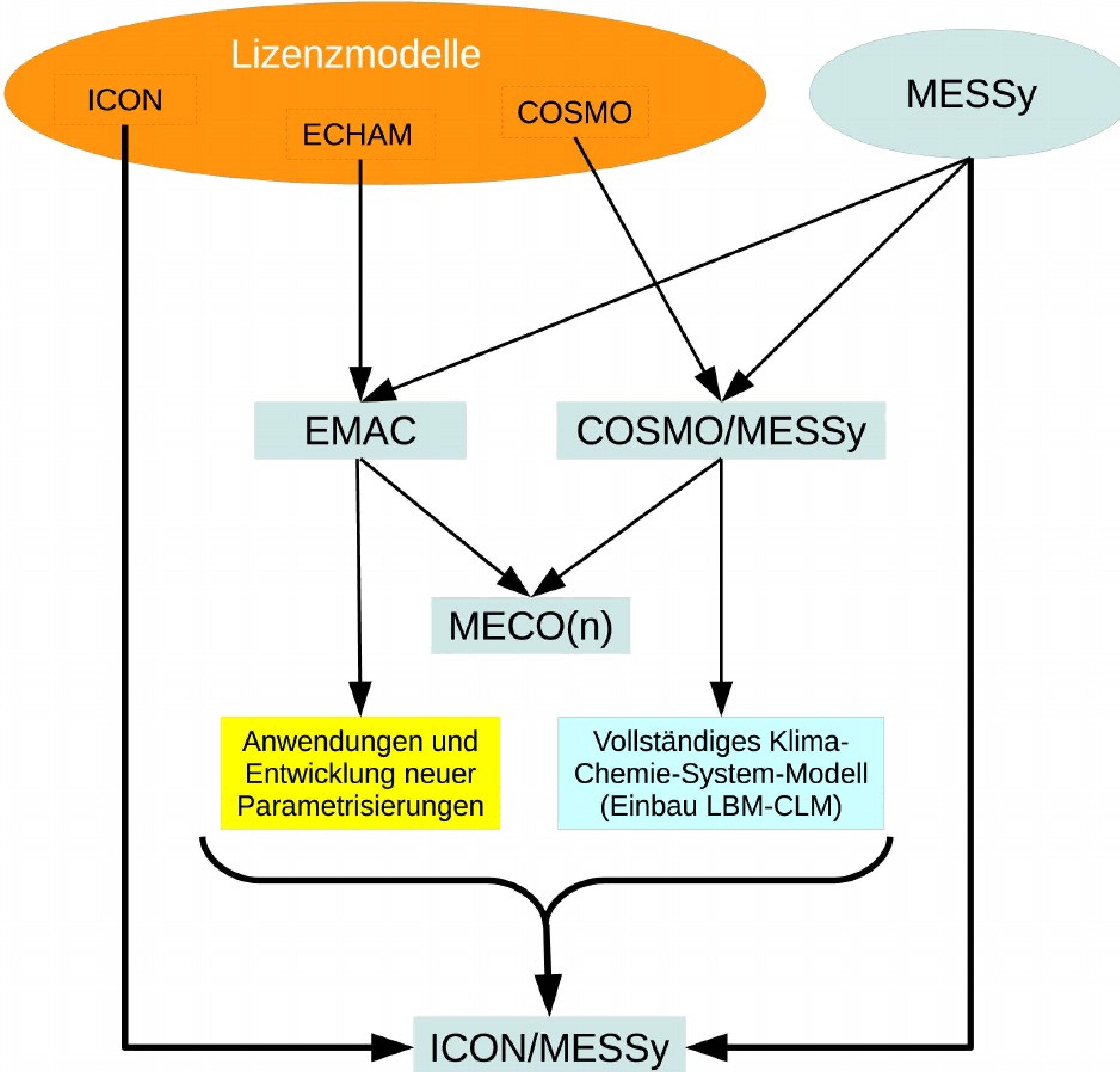
1 py / y @ DLR

→ Patrick Jöckel, PI (0.0)
→ Duy Cai (1.0)

1.5 py / y @ Uni Bonn

→ Astrid Kerkweg, PI (1.0)
→ Christiane Hofmann (0.5)

… towards the next generation C-ESM ...



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Atmosphärenchemie im Erdsystem – AerChemMIP mit EMAC

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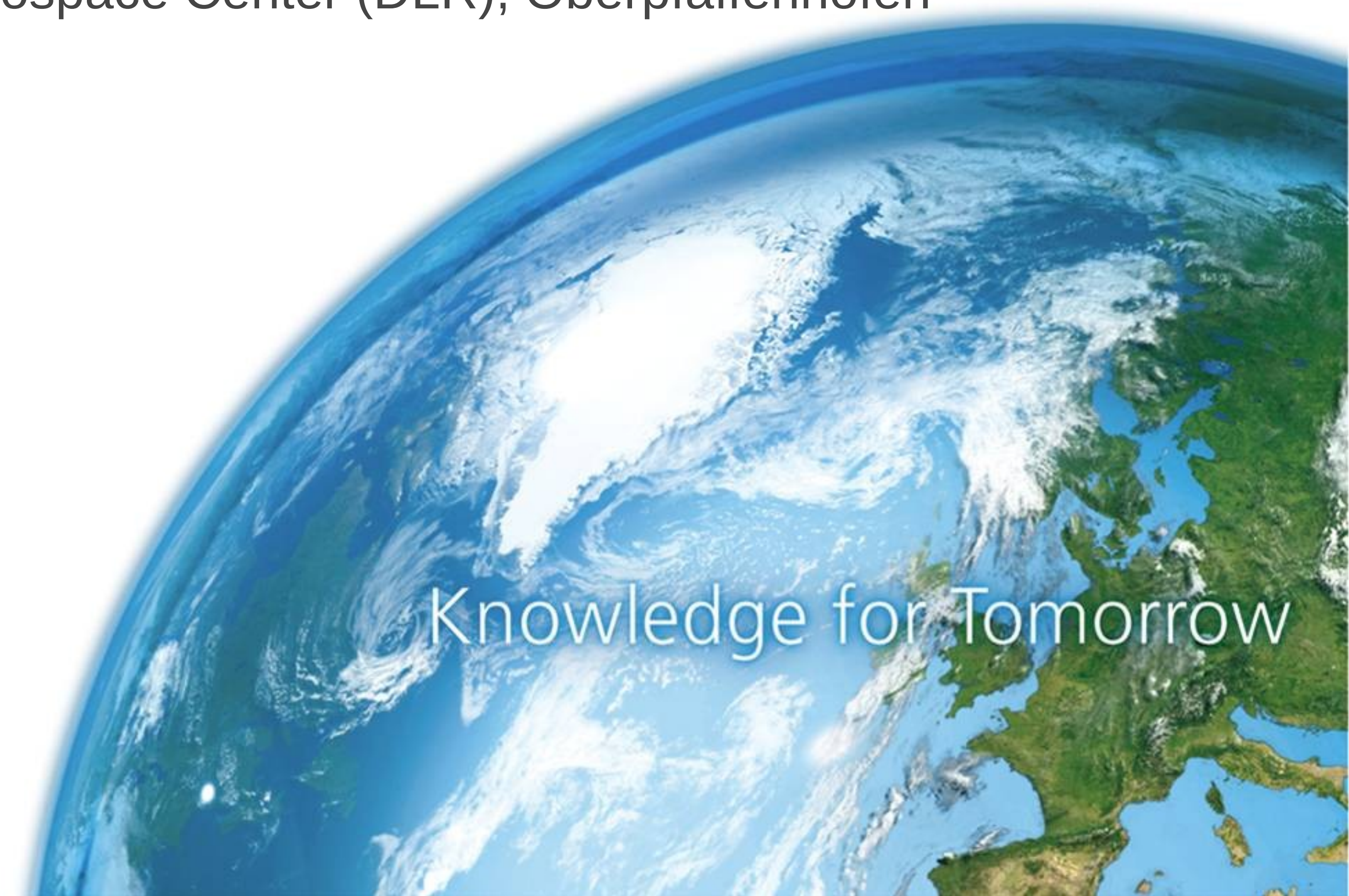


...

These are designed to quantify the **climate** and **air quality** impacts of **aerosols** and **chemically-reactive gases** in the climate models that are used to simulate past and future climate.

...

Abstract. The Aerosol Chemistry Model Intercomparison Project (AerChemMIP) is endorsed by the Coupled-Model Intercomparison Project 6 (CMIP6) and is designed to quantify the climate and air quality impacts of aerosols and chemically-reactive gases. These are specifically near-term climate forcers (NTCFs: tropospheric ozone and aerosols, and their precursors), methane, nitrous oxide and ozone-depleting halocarbons. The aim of AerChemMIP is to answer four scientific questions:

1. How have anthropogenic emissions contributed to global radiative forcing and affected regional climate over the historical period?
2. How will future policies (on climate, air quality and land use) affect these species and their climate impacts?
3. Can the uncertainties associated with anthropogenic emissions be quantified?
4. Can climate feedbacks occurring through changes in natural emissions be quantified?

These questions will be addressed through targeted simulations with CMIP6 climate models that include an interactive representation of tropospheric aerosols and atmospheric chemistry. These simulations build on the CMIP6 Diagnostic, Evaluation and Characterization of Klima (DECK) experiments, the CMIP6 historical simulations, and future projections performed elsewhere in CMIP6, allowing the contributions from aerosols and chemistry to be quantified. Specific diagnostics are requested as part of the CMIP6 data request to evaluate the performance of the models, and to understand any differences in behaviour between them.

Collins et al., GMDD (2016); doi:10.5194/gmd-2016-139

We have some experience from a recent project ...

Earth System Chemistry integrated Modelling (ESCiMo)

A contribution to the Chemistry Climate Modelling Initiative

(CCMI)

powered by

EMAC @

DKRZ

DEUTSCHES KLIMARECHENZENTRUM

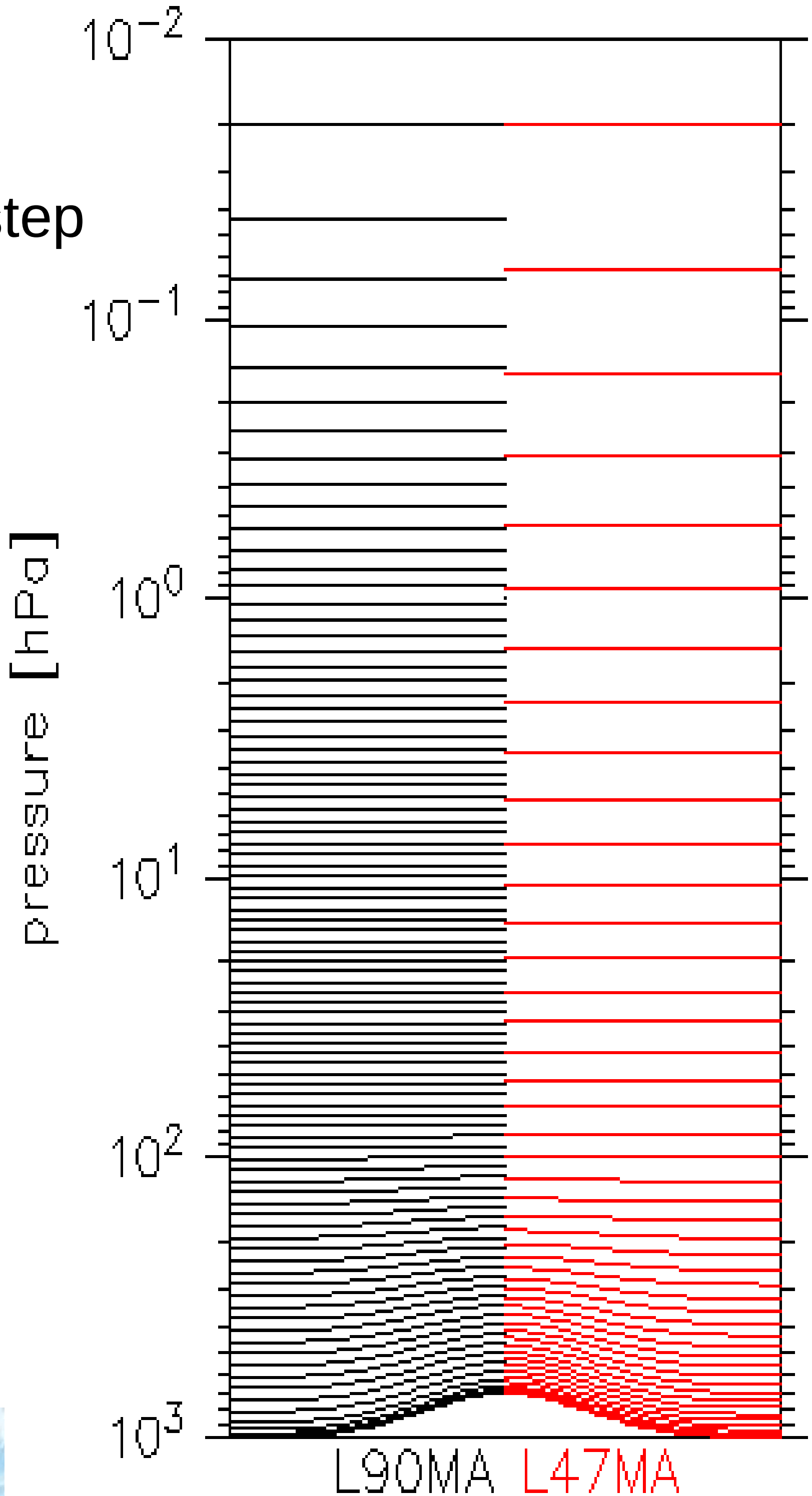
The MESSy Consortium

http://www.pa.op.dlr.de/~PatrickJoeckel/ESCiMo/

http://www.geosci-model-dev.net/9/1153/2016/

EMAC model setup

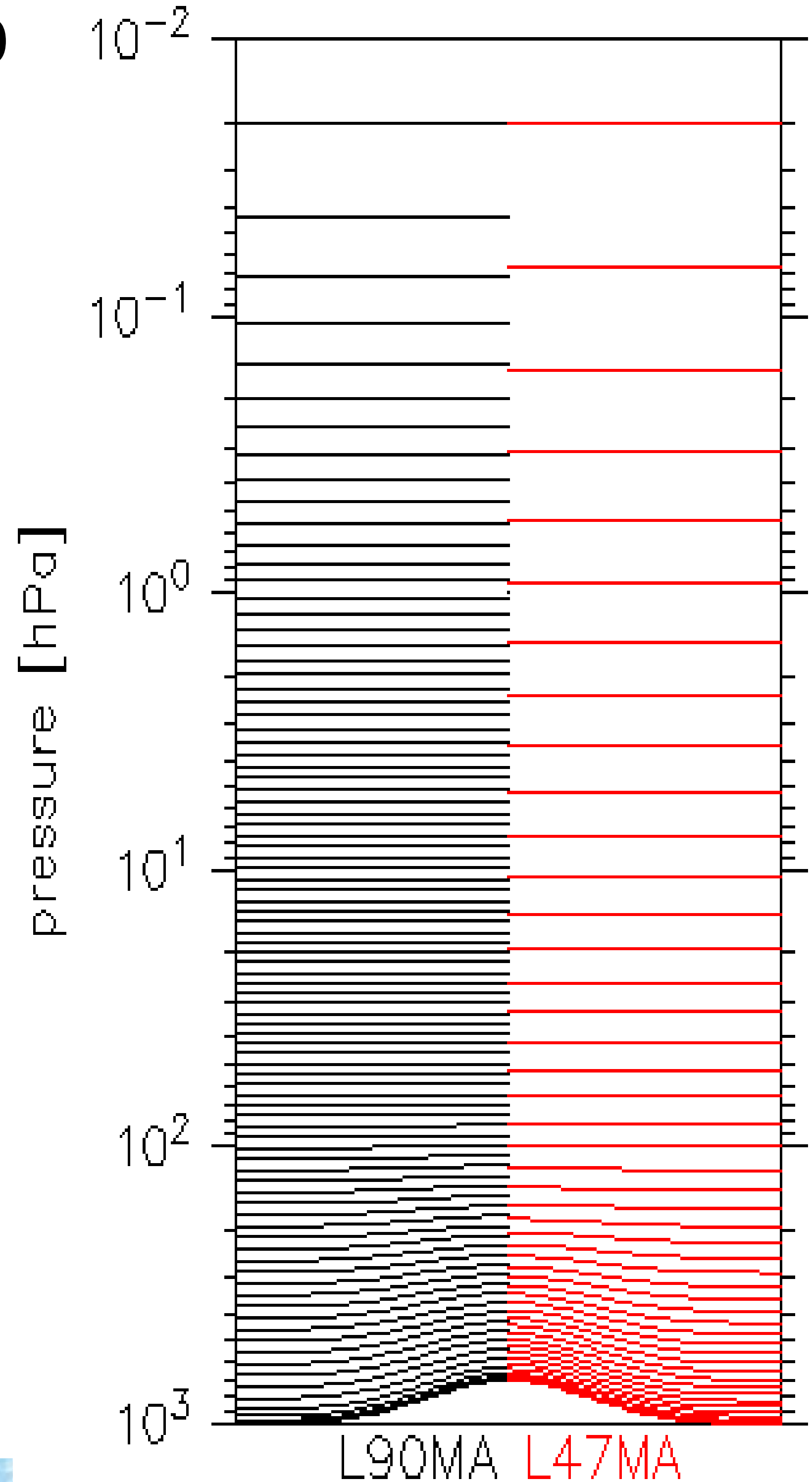
- T42L90MA T42L47MA (~ 2.8° x 2.8°, 90 / 47 levels up to 0.01 hPa), 12 min time step
- 1950 … 1960 … 1979 … 2011 … 2099
- three configurations:
  - SD: nudging (up to 10 hPa) towards ECMWF operational analysis data
  - free-running with prescribed SST/SIC
  - with coupled ocean model
- stratospheric and tropospheric chemistry (including NMHC chemistry: C4 + Isoprene)
  - 160 species in 321 reactions (gas phase & PSC)
  - 90 species in 140 reactions (aqueous phase)
  - 50 diagnostic species



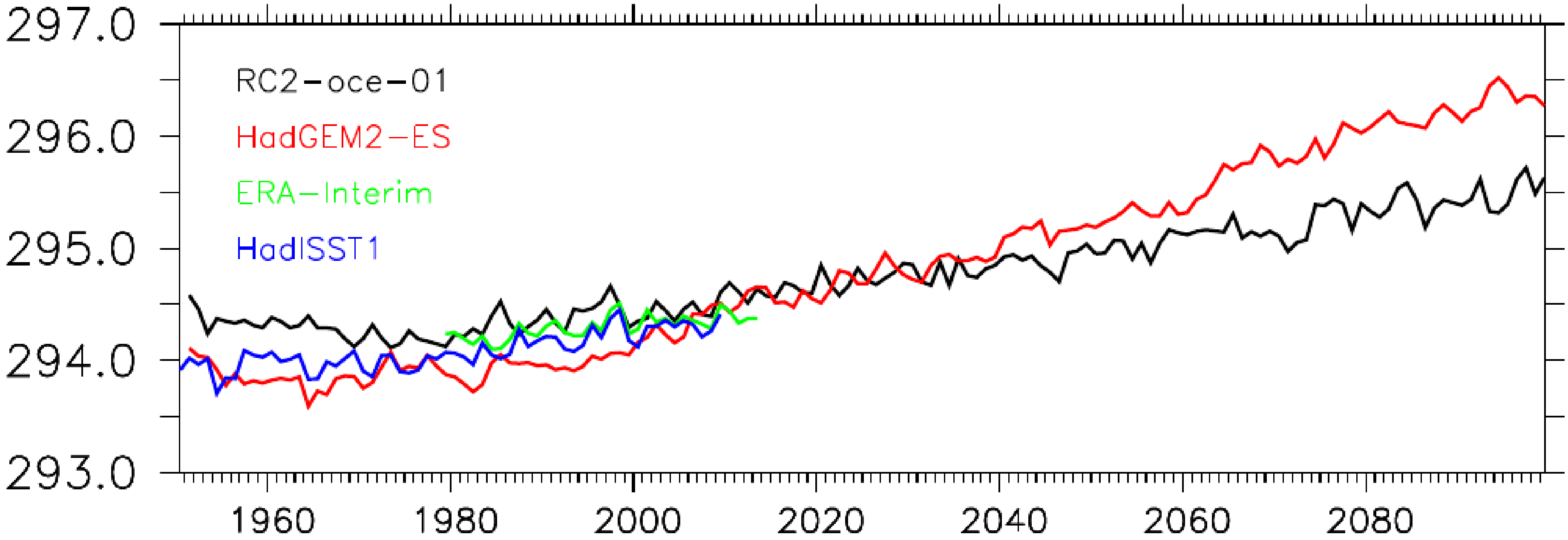
(Jöckel et al., GMD, 2016)

EMAC model setup

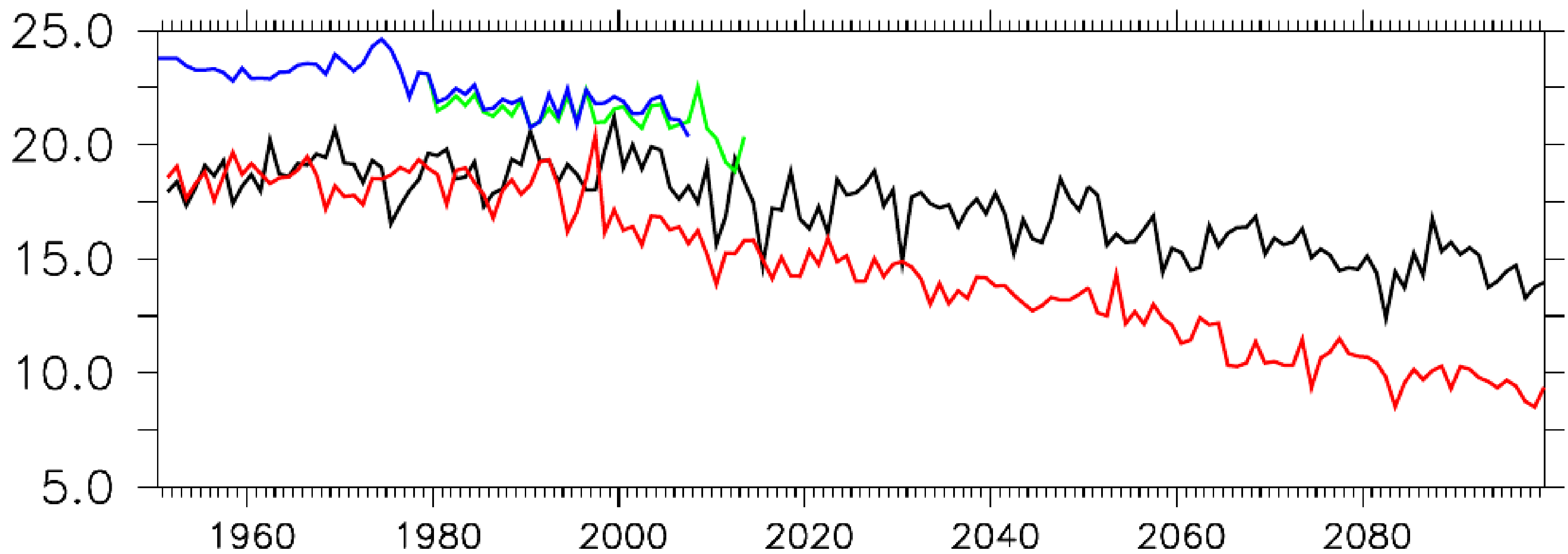
- Newtonian relaxation at lowest layer:
  GHG: N2O, CH4, CO2,
  CFC: CFCl3, CF2Cl2, CH3CCl3, CCl4
  HCFC: CH3Cl,CH3Br
  Halons: CF2ClBr,CF3Br
  special: SF6, H2
- VSLS emissions: CHCl2Br, CHClBr2, CH2ClBr, CH2Br2, CHBr3
- Br release from sea-salt (on-line)
- on-line air-sea gas exchange of isoprene, DMS, methanol (CH3OH)
- (background) volcanic SO2
- terrestrial DMS
- NH3
- biogenic emissions (GEIA)
- on-line calculation of NO from soil and lightning
- on-line calculation of isoprene from plants
- biomass burning emissions from GFED (v3.1)
- tropospheric background aerosol prescribed
- stratospheric (H2SO4) background aerosol prescribed



(Jöckel et al., GMD, 2016)

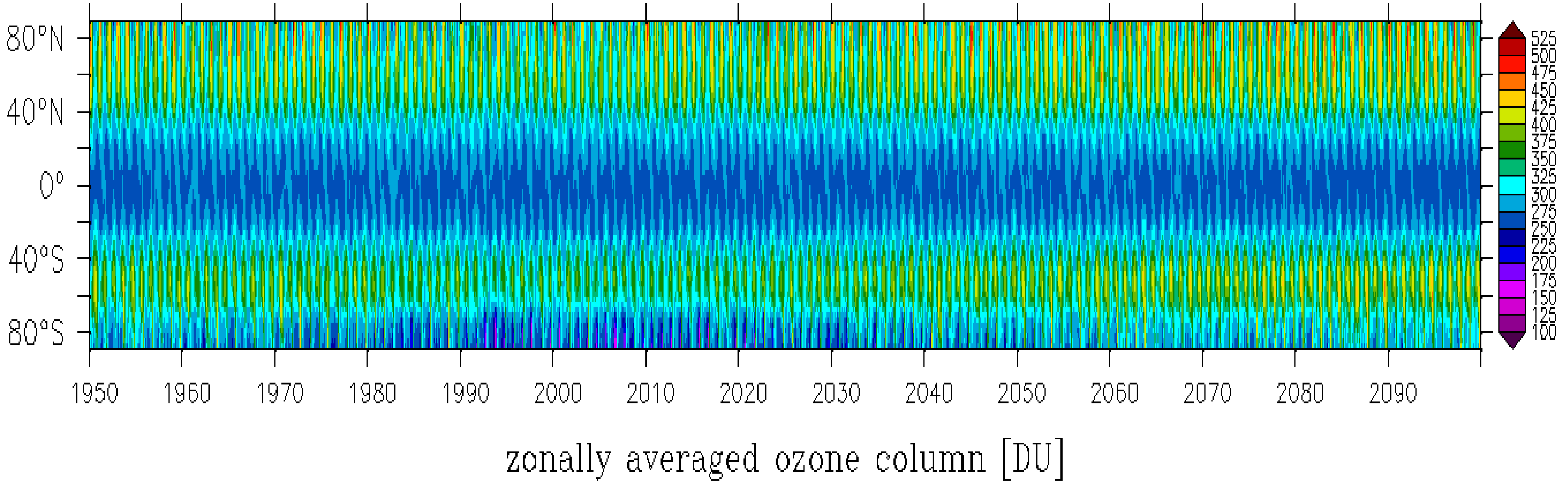


Global average ice–free sea surface temperature (K)

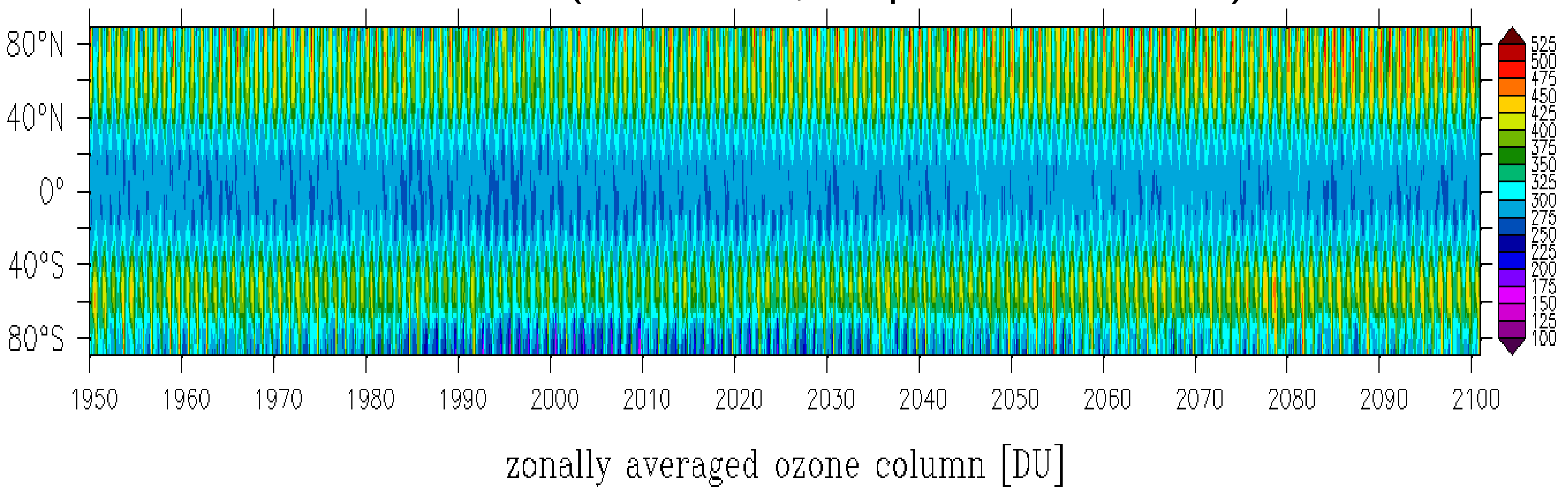


Global sea–ice coverage (10^{12} m^2)

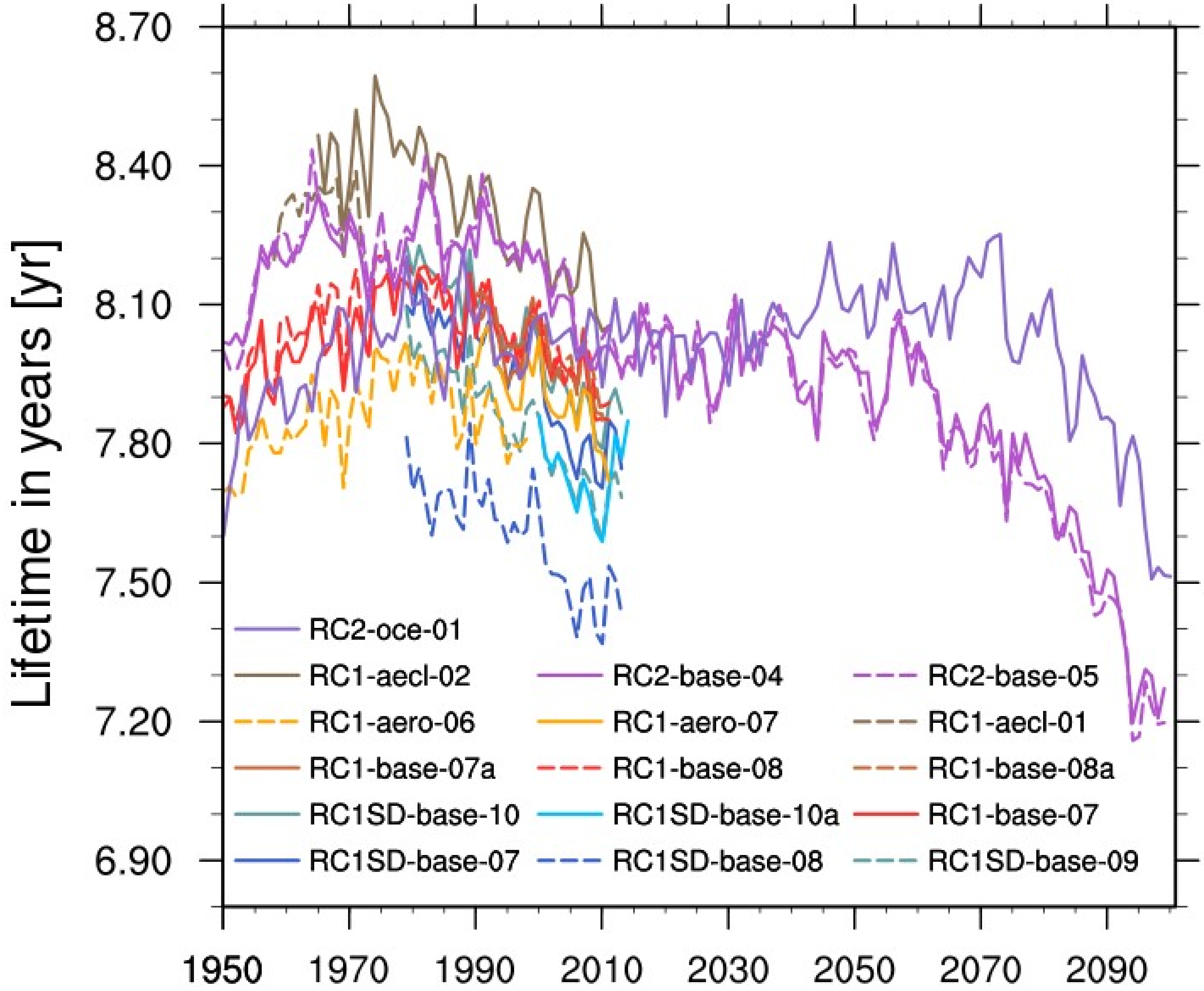
RC2-base-04 (T42L90MA, prescribed SST/SIC)



RC2-oce-01 (T42L47MA, coupled ocean model)



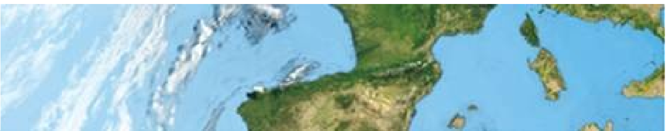
Tropospheric mean lifetime of methane towards OH



2000 — 2004:
(8.0 ± 0.6) years

(Jöckel et al., GMD, 2016)

$$\tau_{\mathrm{CH_4+OH}}(t) = \frac{\sum_{b \in B} M^b_{\mathrm{CH_4}}(t)}{\sum_{b \in B} k^b_{\mathrm{CH_4+OH}}(t) \cdot c^b_{\mathrm{air}}(t) \cdot \mathrm{OH}^b(t) \cdot M^b_{\mathrm{CH_4}}(t)}$$



Thank you very much for your attention!