
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

# ICON for climate simulations

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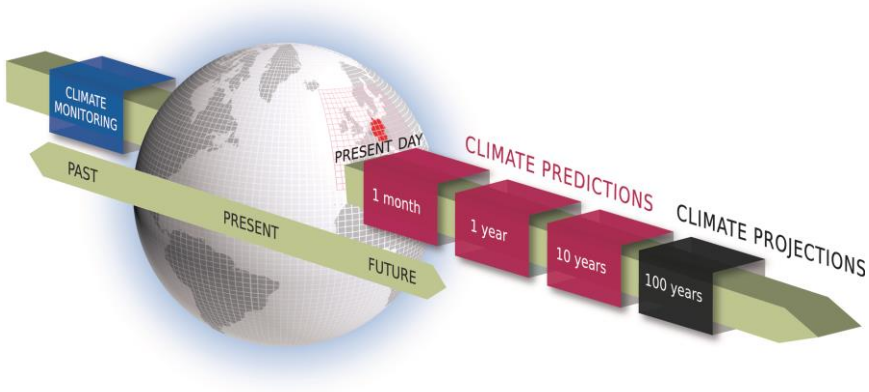
# ICON for Climate Simulation




# ICON-Seamless - Uniform model for weather and climate

*ICON-Seamless* = model and data assimilation for

- ✓ **Numerical Weather Prediction** (NWP)
- ✓ **Climate Prediction** (seasonal, decadal)
- ✓ **Climate Projections** (global and regional)

based on NWP physics

→ in collaboration with **MPI-M, KIT, DKRZ, MPI-BGC** and many more…

- One **consistent model** including atmosphere, ocean, land, air chemistry
- **Configurations** for different applications
- Project started in November 2020

# Goals

**2024:** *pre-operational* system for **seasonal** and **decadal climate predictions**

**2025:** experimental version for *new ICON-Land* for **NWP** and **climate**

**2025+:** further development to allow *global climate projections* &

*coupling of regional mode with ICON-O-LAM*

# ICON-Seamless Governance

**Coordination Group – W. Müller & P. Korn (MPI-M), R. Potthast & B. Früh (DWD)**


Atmosphere


Land-Atmosphere


Ocean-Atmosphere


Data Assimilation

Fotos Pixabay

- formed with participants from DWD, MPI-M, KIT, DKRZ, MPI-BGC, MeteoSwiss, UHH and many more
- intention:
  - work in parallel as much as possible,
  - allow experiments as early as possible
  - achieve computing performance of ICON-Seamless approx. 100y/d



# Expert Group Atmosphere – Ongoing & Future Activities

## Transient Aerosol

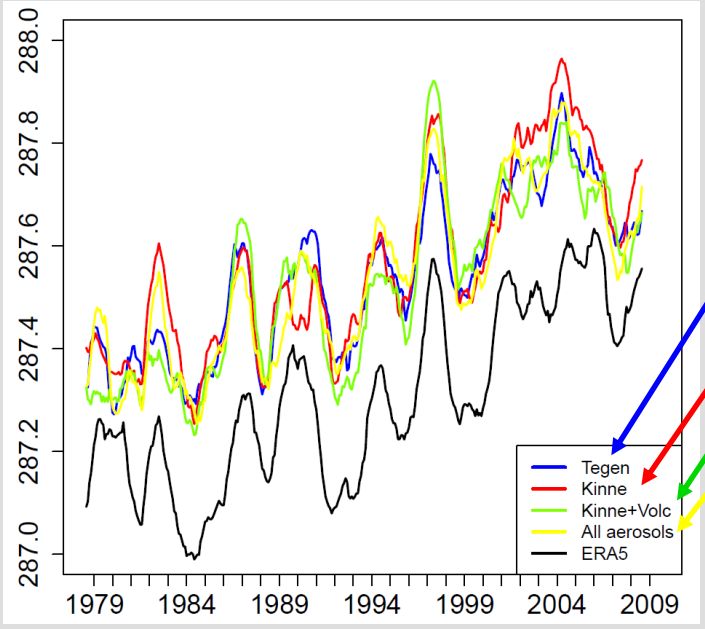
- Kinne aerosol, CMIP6 volcanic aerosol and simple plume anthropogenic aerosol implemented ✓
- aerosol input data characterize optical depth, single scattering albedo & asymmetry factor to facilitate implementation of additional aerosol data

## Next steps:

- Tests and evaluation

# AMIP experiments

Temperature 1979 - 2009




- R2B4 (NWV grid), 160 km
- namelist irad_aero
  - 6: Tegen Climatology
  - 13: Kinne Climatology
  - 15: Kinne + volcanic (…96)
  - 18: Kinne … (Simple Plum…

TALK on time dependent aerosol at 10:00 today

Trang Van Pham et al.



# Expert Group Atmosphere – Ongoing & Future Activities

## Transient Ozone

- Module migrated from ICON-ECHAM to ICON-NWP

## On going work:

- First tests (1979-2009, R2B4) ongoing
- Implementing transient solar radiation



# Expert Group Land-Atmosphere – Ongoing & Future Activities

## JSBACH + VDIFF in ICON-Seamless

- implementation completed ✓

## On going work:

- generation + reading of initial data
- evaluation of performance of JSBACH+VDIFF for NWP and climate
- integration of JSBACH external parameters (boundary conditions) into EXTPAR
- further work on the interface atmosphere – land is foreseen (ICON consolidated & Warmworld)
- stand-alone capability kept in mind

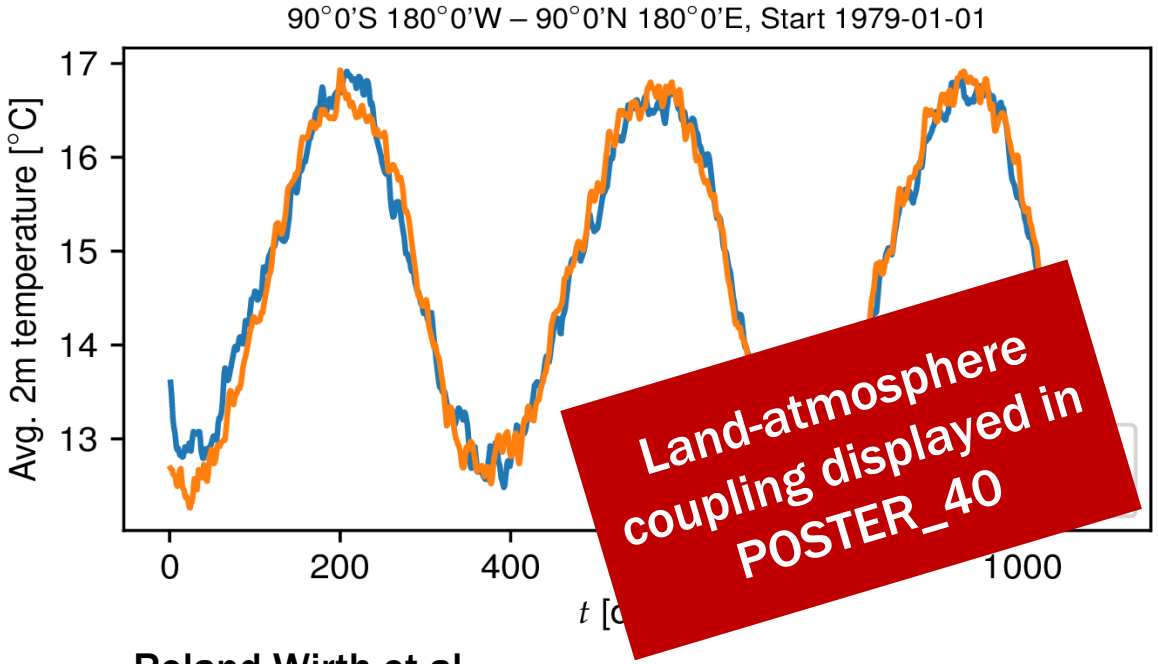


# ICON-NWP with JSBACH – Climate

- JSBACH + VDIFF integrated ✓
- Similar averages to TERRA without additional tuning
- 30% slower than TERRA

## Next steps:

- Tests and evaluation



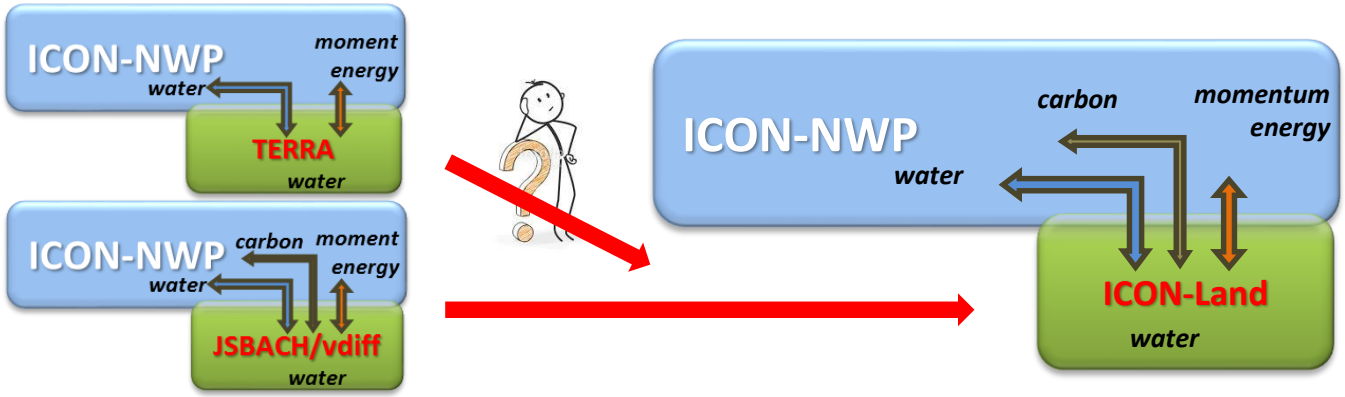

Roland Wirth et al.



# Expert Group Land-Atmosphere - Future Activities

## ICON-LAND will be the land component of ICON

- ICON-LAND as software architecture, currently holds JSBACH
- inclusion of modular code parts into ICON-LAND

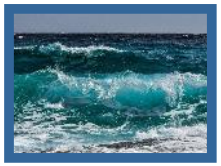




# *Expert Group Ocean-Atmosphere – Prototype 1 (Common Grid) Status & Outlook*

## *ICON-O/ICON-NWP coupled model on common grid in coarse resolution (R2B4/160km)*

- Up to 120 years long simulations, no “unreasonable” results, no enhanced analysis yet
- technical improvements in sea-ice thermodynamics and restart capability
- Speed still not optimal, but currently working solution
- No closed water cycle yet – river runoff is missing

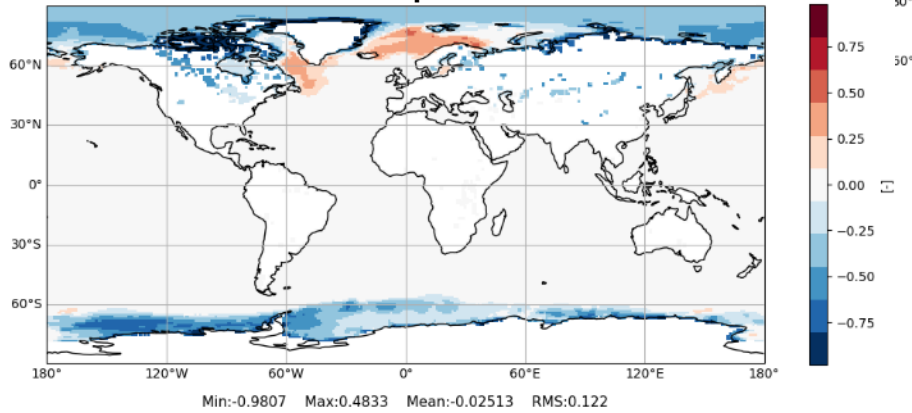




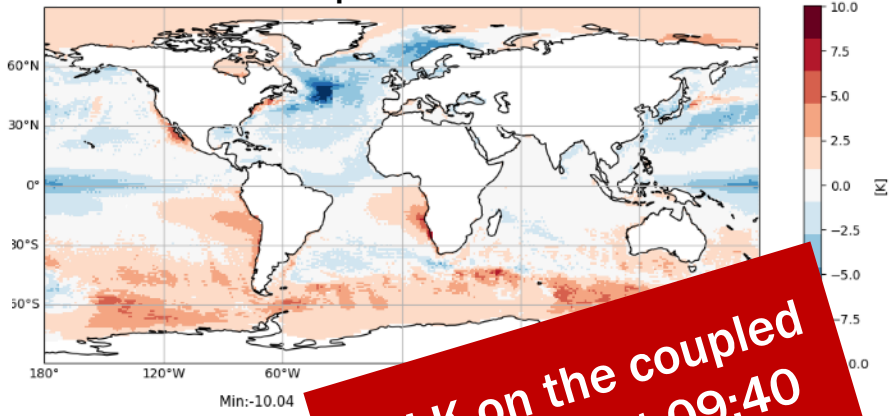
# ICON-A+O Prototype on Common Grid (R2B4)

- land-sea-mask from ocean
- YAC coupler
- 20 years – no in depth analysis yet

**sea-ice fraction** coupled ICON – ERA5




**SST** coupled ICON – ERA5




**fi**

**TALK on the coupled prototype at 09:40 today**

*Martin Köhler, … hz, Rene Redler, MPI*
*with help of Jürgen … Daniel Reinert, Dmitrii Mironov*
*and many others*



# Expert Group Data Assimilation – Ongoing & Future Activities

- PDAF and ICON-Seamless (Prototype1) are running in BACY
- ocean-only assimilation experiments with coupled ICON-Seamless completed (1960-2015, full-field and anomaly methods)
- atmosphere-only assimilation experiments (nudging ERA5) with coupled ICON tested

***Next steps:***

- external forcing like in historicals + projections also necessary
- increase resolution of ICON-Seamless
- produce a set of seasonal and decadal hindcasts to assess the prediction skill



# Ocean Data Assimilation with ICON-ESM (160km/40km)

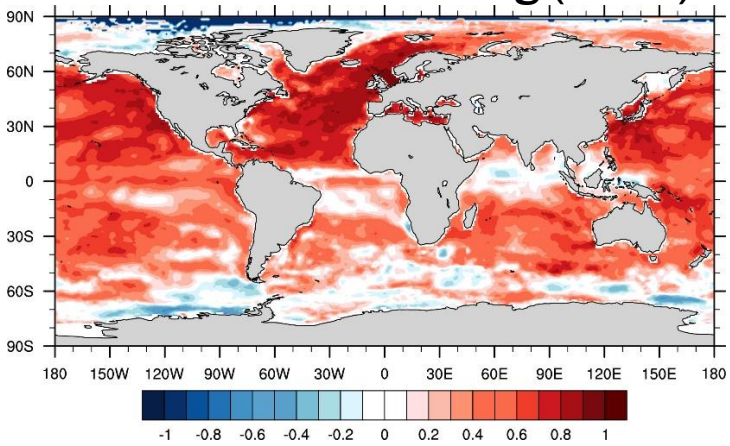
**System1** (1960-2013)

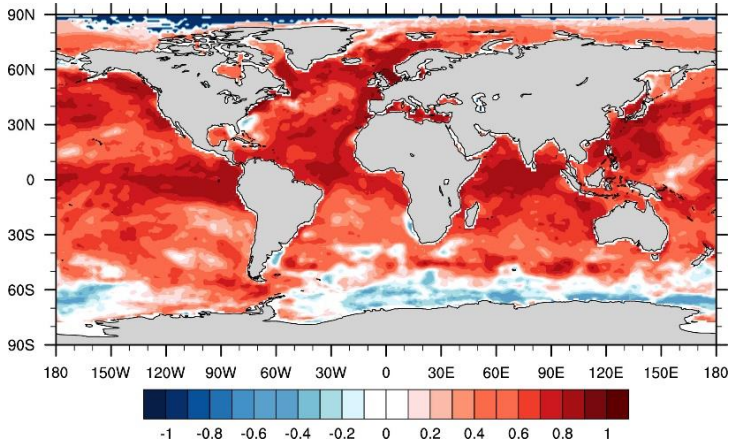
- PDAF EnKF full-field T & S
- Constant external forcing (1850)

**System2** (1960-2013)

- PDAF EnKF anom T & S
- CMIP6 external forcing

**SST correlation with obs** (HadISST):




Holger Pohlmann, Christine Sgoff et al.



# Ocean Data Assimilation with ICON-ESM (160km/40km)

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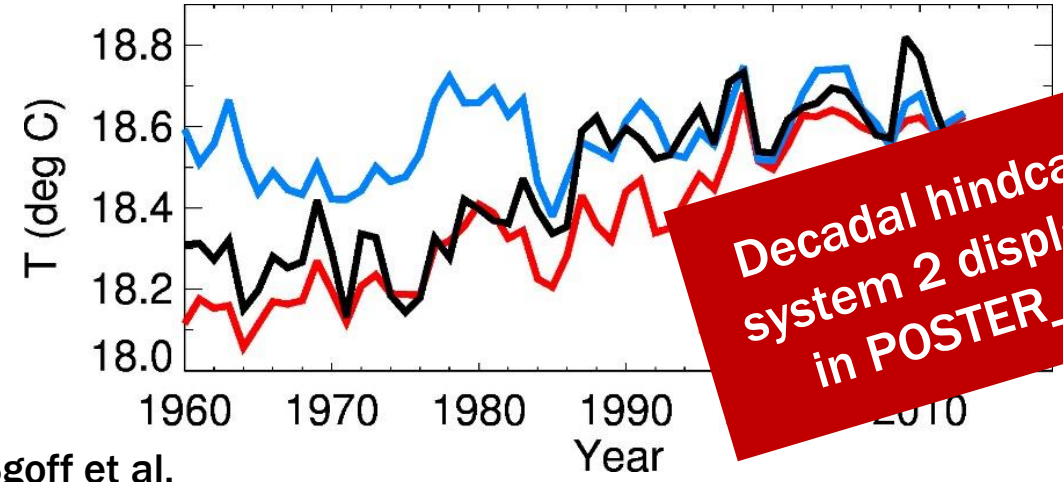
**System2** (1960-2013)
- PDAF EnKF anom T & S
- CMIP6 external forcing

Ensemble mean
global annual
**SST**




Decadal hindcasts system 2 displayed in POSTER_03

Holger Pohlmann, Christine Sgoff et al.

70 Jahre
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

# *Ocean Data Assimilation with ICON-Seamless (160km/160km)*

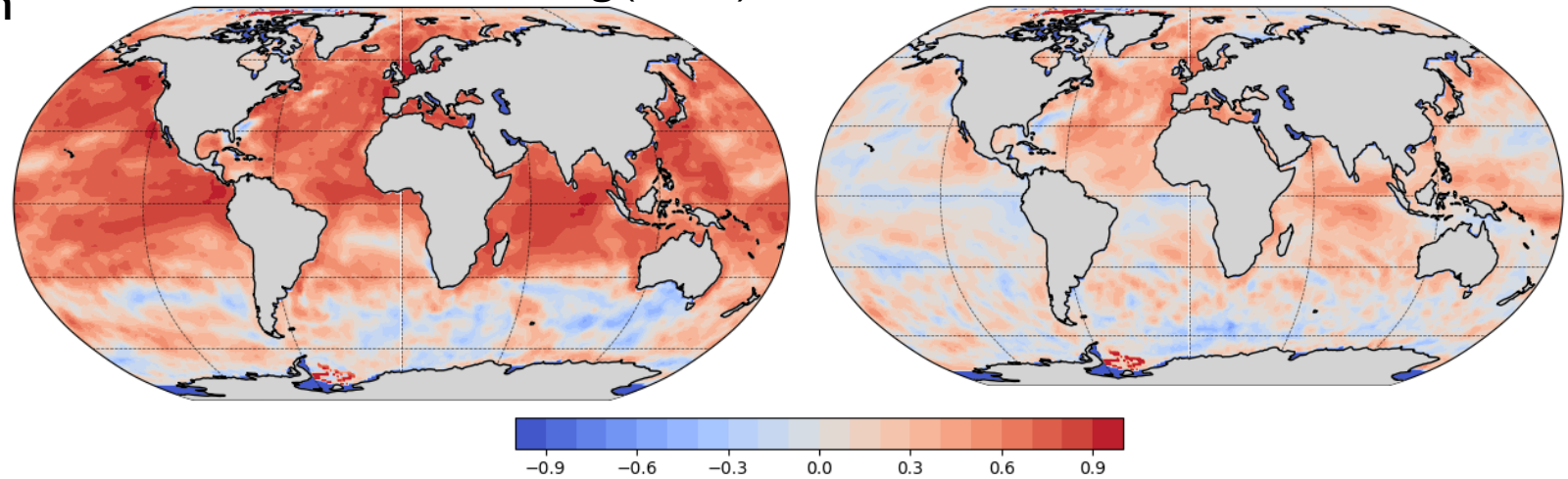
**Assimilation** (1960-2015)

- PDAF EnKF full-field T & S
- Constant external forcing (1850)

**Reference** (1960-2015)

- no assimilation
- Constant external forcing

**SST correlation with obs** (HadISST)

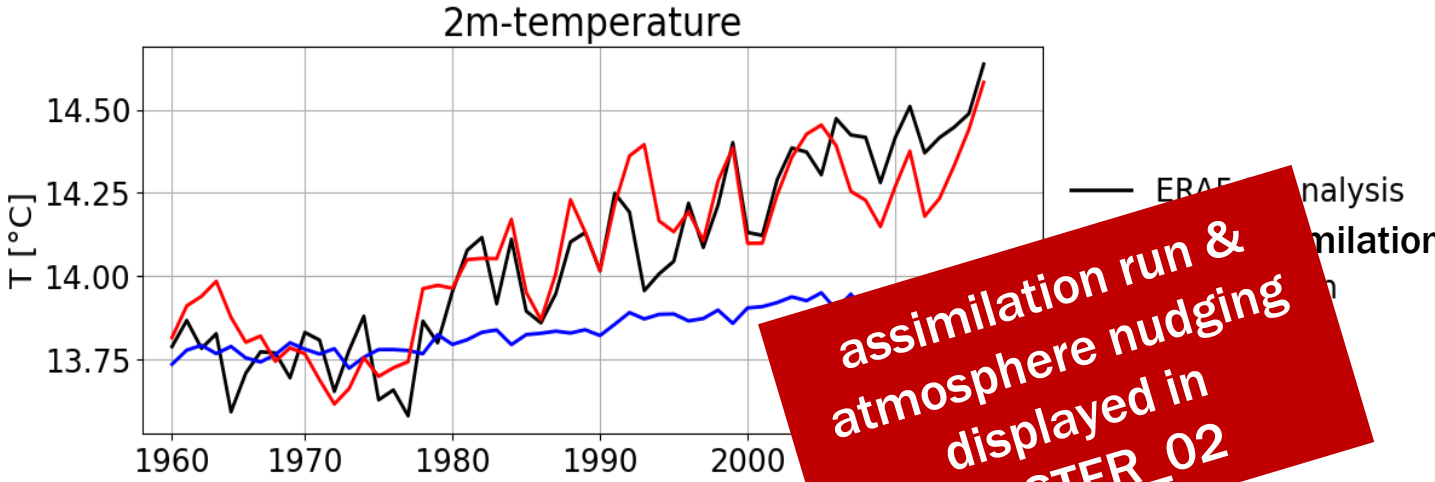



Christine Sgoff, Holger Pohlmann et al.



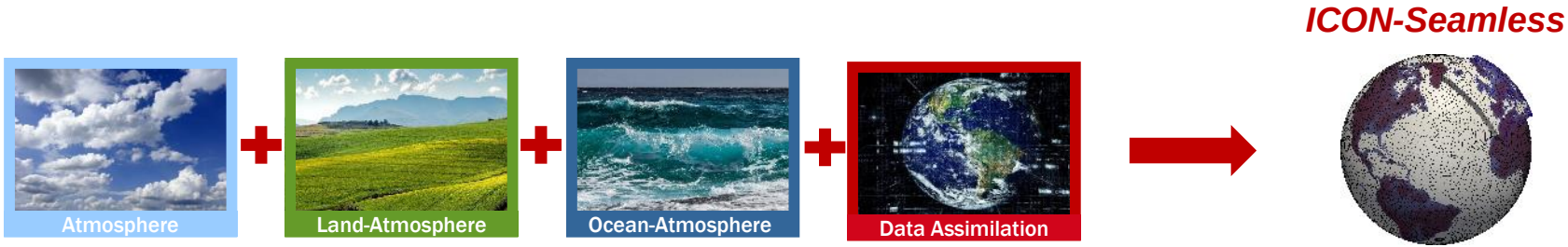
# Ocean Data Assimilation with ICON-Seamless (160km/160km)

Ensemble mean global annual temperature




Christine Sgoff, Holger Pohlmann et al.

# *Towards a seamless model for weather and climate prediction and projection*




- many implementations also relevant for ICON-CLM will be realized in the course of ICON-Seamless
- it will be important taking the opportunities and reviewing the functionality for ICON-CLM
- contributions are very much appreciated

# ICON-CLM development – What has been done so far?

- ***Administrative*** (code access for community members, workflow for developments)
  - → clarified & development partnership agreement between DWD and CLM-Community signed in January 2021
- ***SPICE*** (Starter Package for ICON-CLM Experiments, Version 1.0.1)
  - → runtime environment for ICON-CLM released
  - → available for community members
  - → Information/documentation: https://spice.clm-community.eu
- ***EVA Suite*** (tool for standardized evaluation) integrated in SPICE
- ***ICON-CLM development*** made progress (thanks esp. to colleagues from BTU and Hereon and Daniel[2] for support from DWD/ICON consortium);
  - → regular task force meetings took place every month

# ICON-CLM development – Changes from CLM-Community

- *Input*
  - → Implementation of time dependency of
    - SST
    - sea ice
    - greenhouse gas concentrations
- *Output*
  - → Implementation of
    - precipitation & runoff accumulation over output interval
    - sunshine duration
  - → Additional variables and correction of soil moisture budget

# ICON-CLM development

- Changes and additions for ICON 2.6.5
  - → New compiler flags in the CLM wrapper
  - → Variable lower boundary for hydrologically active soil layers
  - → Snow melt rate
  - → Output variable height of planetary boundary layer (HPBL) -> next release
- Tests for preliminary setup in project NUKLEUS
- Work on buildbot test for CLM functionality started

# Next steps

- ***COPAT2 (COordinated PArameter Tuning 2)***
  - → Improve preliminary setups of COSMO 6.0 and ICON-CLM
  - → Analyse first reference simulations and fix problems if necessary
  - → Test different settings for some sensitive parameters

- ***CMIP6 downscaling – CORDEX***
  - → CLM-Community will contribute with COSMO-CL
    CORDEX – CMIP6
  - → Coordination of activities in WG Climate Projectio

Discussion on CMIP6 downscaling in WG CP meeting
THU 11-12:30 CET

# *ICCARUS meetings related to ICON for climate simulations*


**ICON-Seamless Workshop**
**THU 15-18 CET**

Everyone interested is very much welcome!

**PG ICON meeting**
**THU 13-15 CET**

## Very good progress in the development of ICON for climate simulations!

- Implementation of transient external parameters almost finished
- Coupling of ICON-NWP with ICON-O technically completed
- Coupling of ICON-NWP with JSBACH technically completed
- ICON-CLM is almost ready for simulating regional climate projections

## Now the work starts....


*Thank you very much for your attention!!!*