

Monitoring of MPI-ESM, MPI-ICON and EMAC CMIP6 Simulations with the ESMValTool

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Projekttreffen CMIP6-DICAD

DKRZ Hamburg

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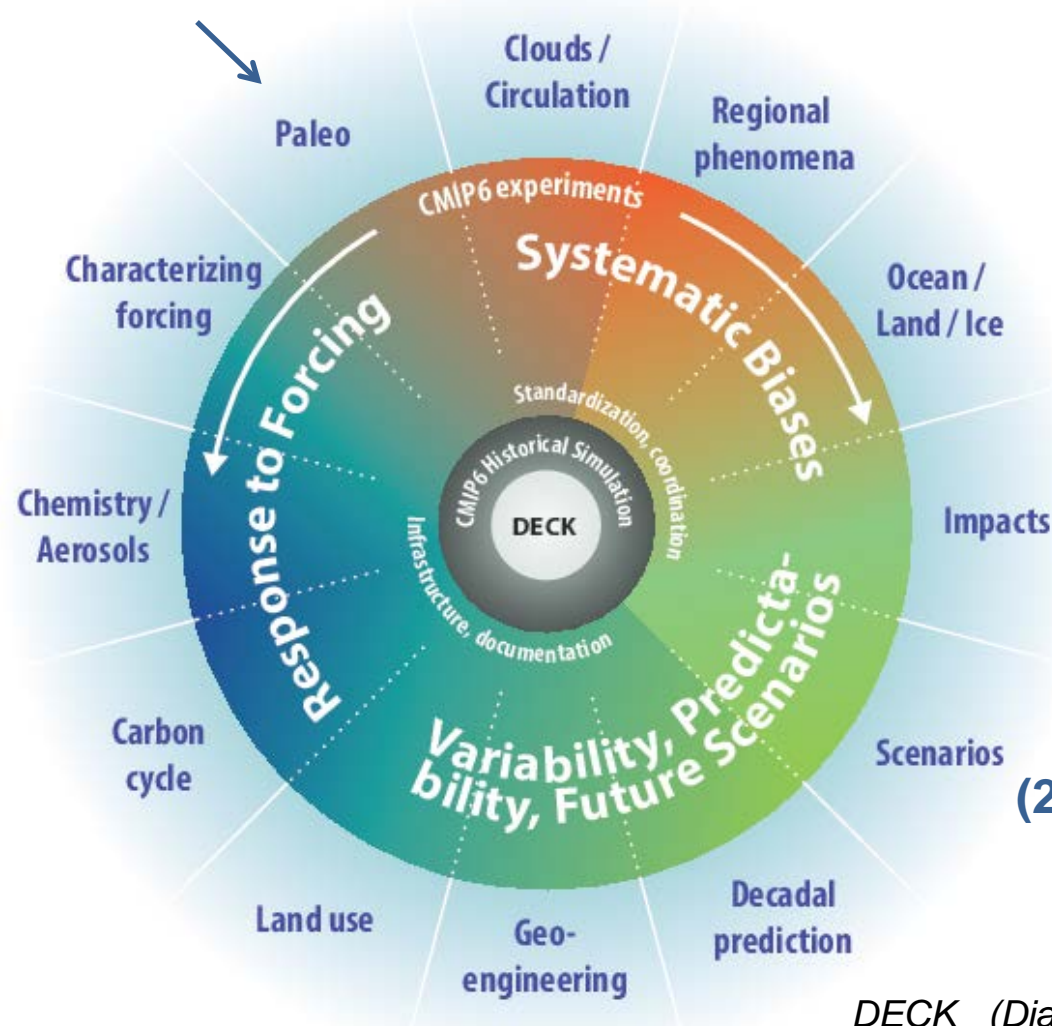


Knowledge for Tomorrow



CMIP: a More Continuous and Distributed Organization

(3) CMIP-Endorsed Model Intercomparison Projects (MIPs)



(1) A handful of common experiments

DECK (entry card for CMIP)

- AMIP simulation (~1979-2014)
- Pre-industrial control simulation
- 1%/yr CO₂ increase
- Abrupt 4xCO₂ run

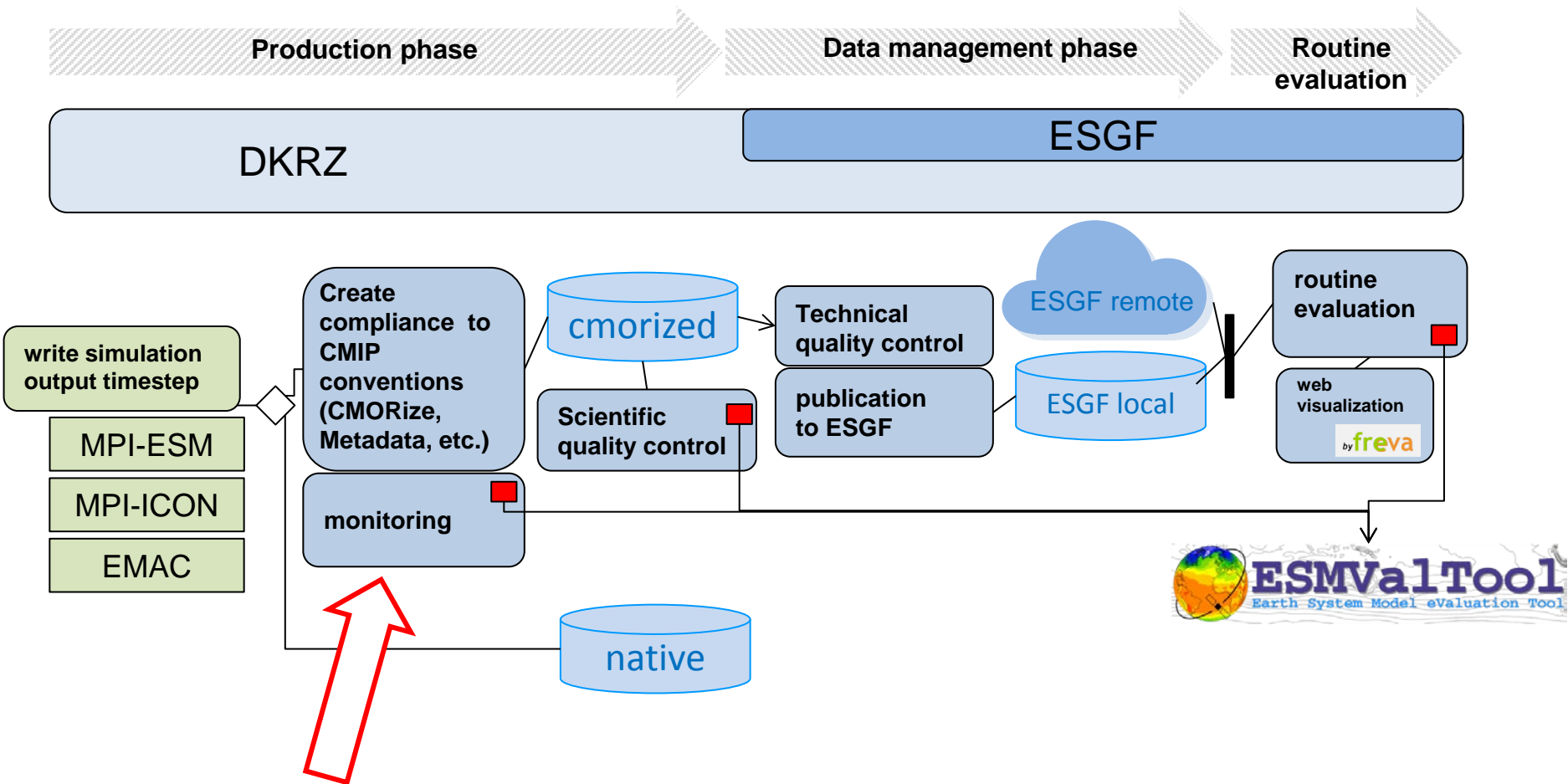
CMIP6 Historical Simulation (entry card for CMIP6)

- Historical simulation using CMIP6 forcings (1850-2014)

(2) Standardization, coordination, infrastructure, documentation

DECK (Diagnosis, Evaluation, and Characterization of Klima) & CMIP6 Historical Simulation to be run for each model configuration used in CMIP6-Endorsed MIPs

CMIP6 Workflow with the ESMValTool at the DKRZ*

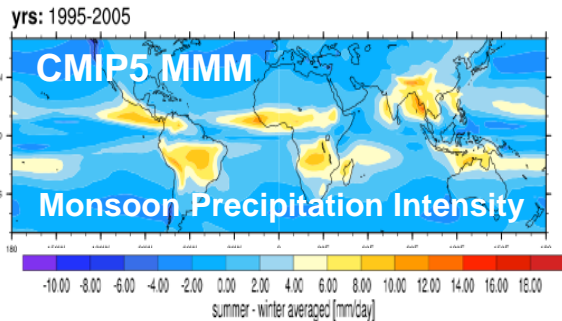


*Defined in the Project CMIP6-DICAD
freva: <https://freva.met.fu-berlin.de>



Example diagnostics for the monitoring of historical and AMIP simulations

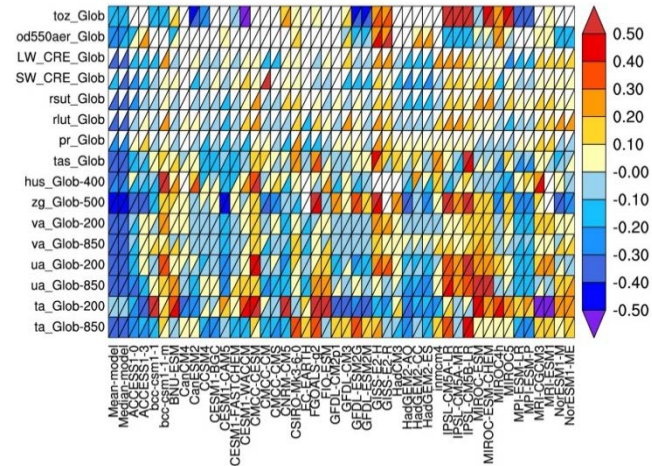
Similar to **Figure 9.7** of AR5



**Broad Characterization
of Model Behavior**
(incl. IPCC AR5 Chap 9 & 12
diagnostics in ESMValTool)

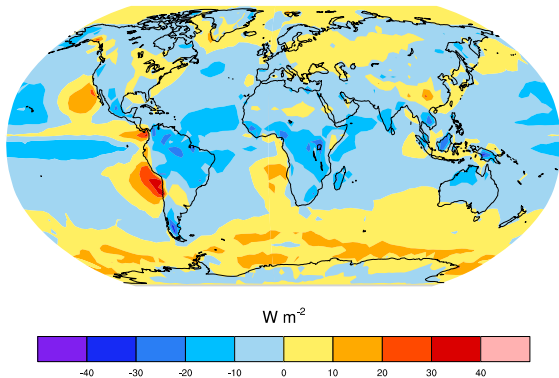
**Running alongside
the ESGF**

RMSD - Global



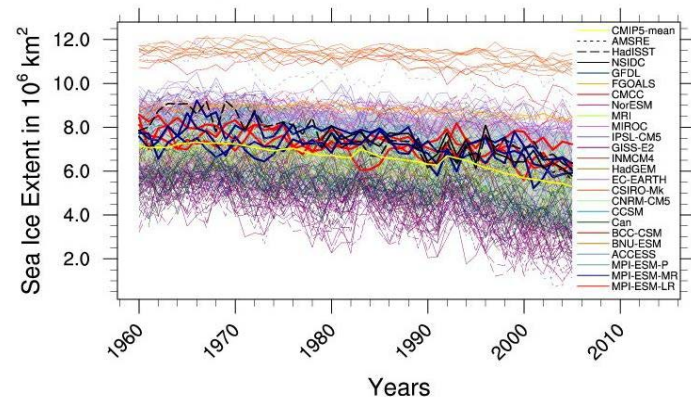
Similar to **Figure 9.5** of AR5

Net Cloud radiative effect against CERES EBAF

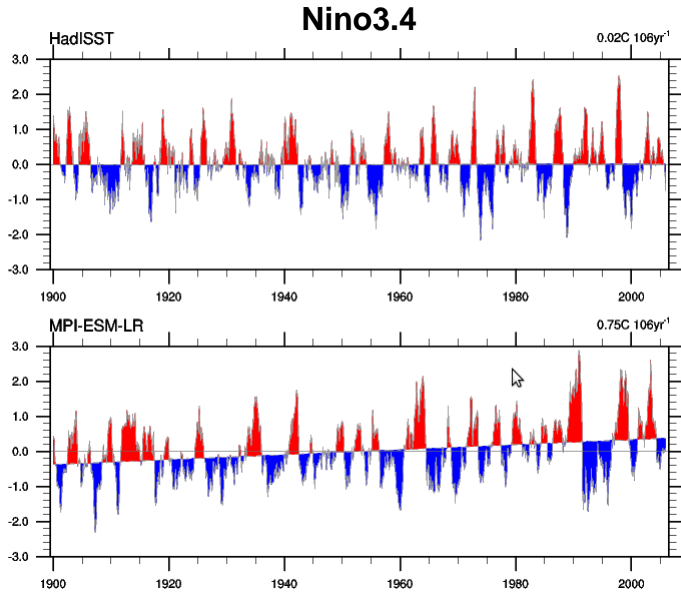


Similar to **Figure 9.24** of AR5

September Mean Arctic Sea Ice Extent

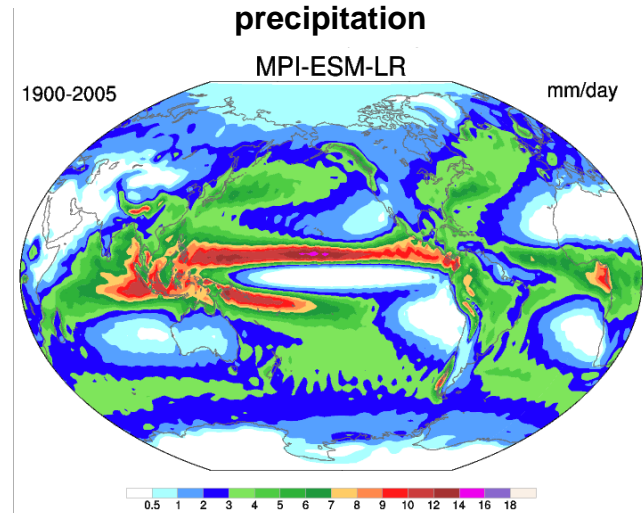


NCAR Climate Variability Diagnostic Package (CVDP)

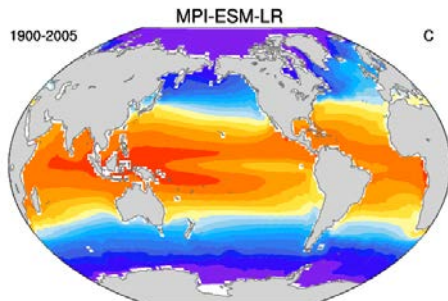
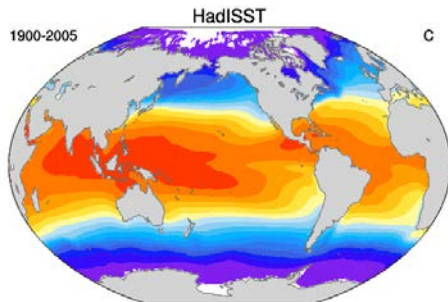


Phillips et al., EOS, 2014

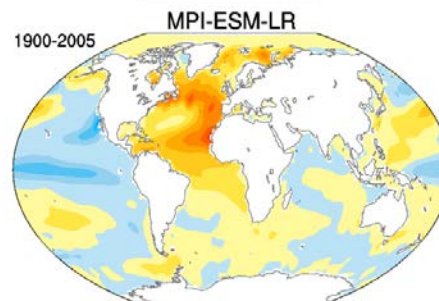
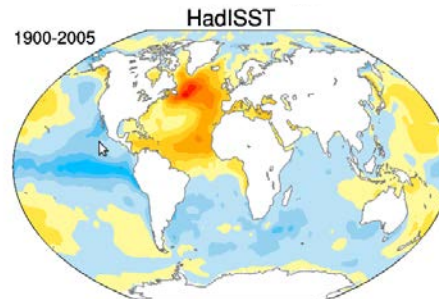
Niño3.4, NAM, SAM, NAO, PDO, PNA, NPO, PSA1, PSA2, AMOC, SST, TAS, PR, SIC SH, SIC NH, Niño1+2 Timeseries, Niño3 Timeseries, Niño4 Timeseries



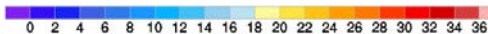
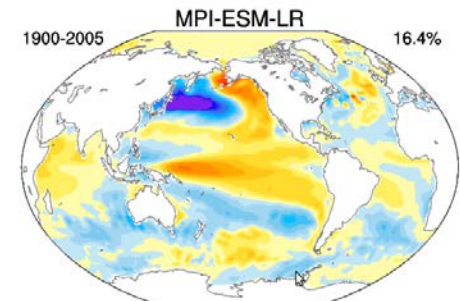
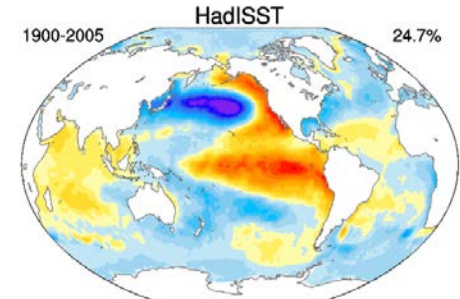
sea surface temperature



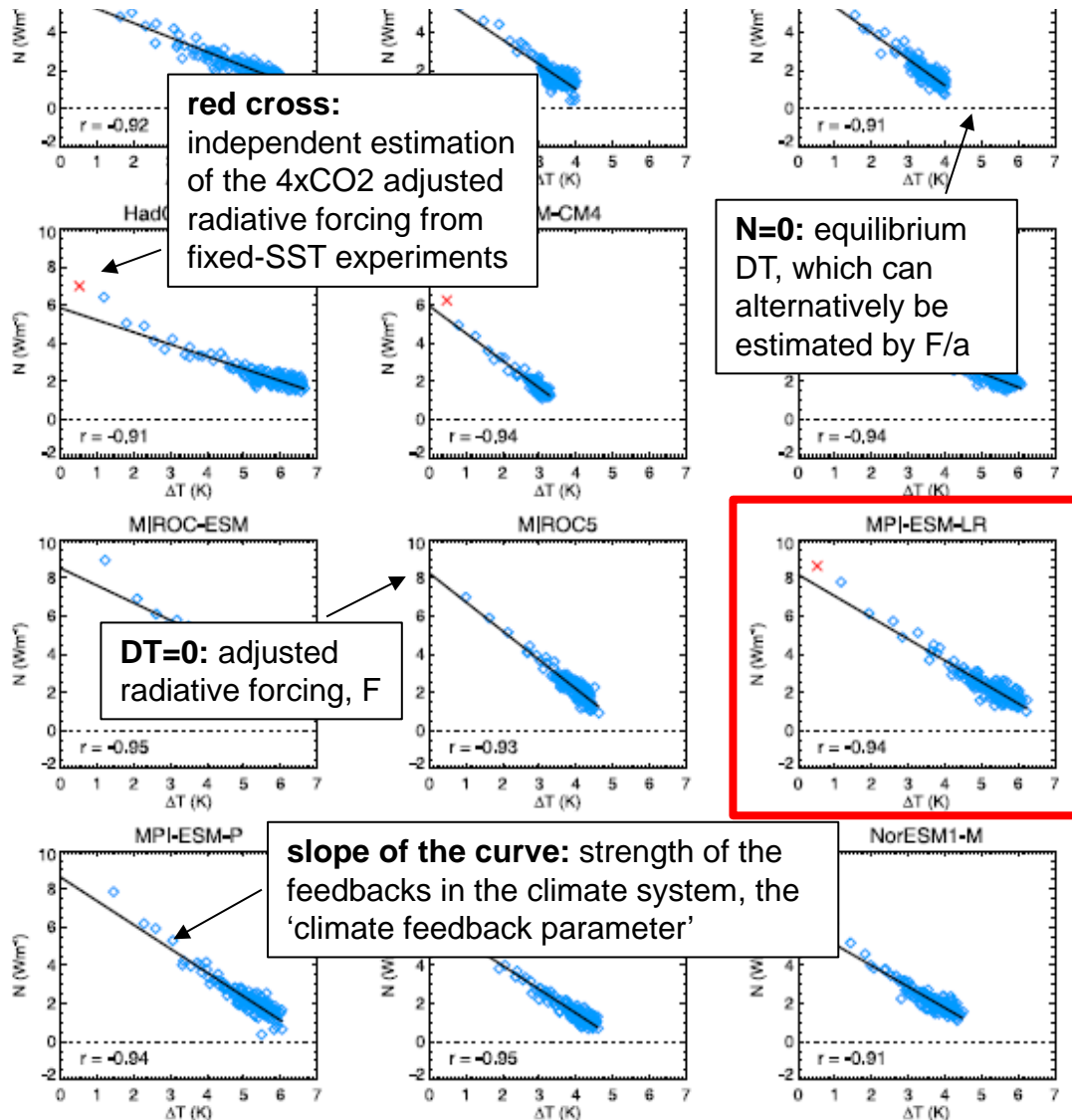
AMO



PDO



Example diagnostic for the monitoring of idealized simulations: calculation of equilibrium climate sensitivity from piControl and 4xCO₂ simulations



Relationships between the change in net top-of-atmosphere radiative flux, N, and global-mean surface-air-temperature change, DT, after an instantaneous quadrupling of CO₂.



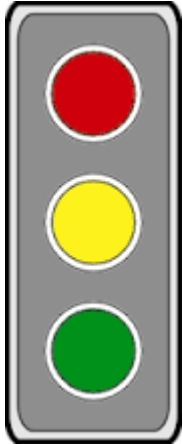
Monitoring of Emissions



- Anthropogenic Reactive Gas Emissions: SO₂, NO_x, NH₃, CH₄, CO, NMVOC, BC, OC
- Fossil Carbon Dioxide
- Open burning emissions: aerosol (BC,OC) and aerosol precursor and reactive compounds (SO₂, N₂O, NO_x, NH₃, CH₄, CO, NMVOC) and CO₂
- Land use
- GHG Concentrations
- Stratospheric Aerosols
- Ozone
- Nitrogen Deposition
- Solar
- AMIP Boundary Forcing: Sea Surface Temperature and Sea Ice Datasets



Monitoring: Dashboard



Warning system

- Check if gridbox values of variables lie in the range of valid min and valid max value given by CMIP6 data request (with contribution of Martin Jukes, CEDA)
(ta, tas, tos, pr, prw, ps, psl, ...)
- Other important checks:
 - radiation balance
 - global tracer mass
 - ... (further input of modeller groups is needed)

	Experiment	ta	tas	tos	ps	...	F _{net}
Run1	piControl	Green	Green	Green	Red	Green	Green	Green	Green
Run2	historical	Green	Green	Green	Green	Green	Green	Green	Green
...									



Monitoring: Dashboard



CMOR Variable	Title	Min	Max
clivi	Ice Water Path	-1.872e-06 s	1.535 s
clt	Cloud Amount	-0.001 r	100.001 r
clwvi	Condensed Water Path	-3.827e-06 s	3.364 s
hfls	Surface Upward Latent Heat Flux	-90.0 r	850.0 r
hfss	Surface Upward Sensible Heat Flux	-400.0 s	1200.0 s
hur	Relative Humidity	-2.642 s	135.7 s
hus	Specific Humidity	-0.000299 s	0.02841 s
mrro	total runoff	-0.0002019 s	0.001065 s
mrsos	Moisture in Upper Portion of Soil Column	-2.008 s	146.5 s
pr	Precipitation	-1e-06 r	0.0015 r
prw	Column water vapor	0.0 r	90.0 r
ps	Surface Air Pressure	47500.0 r	112000.0 r
psl	Sea Level Pressure	91000.0 r	109000.0 r
rsds	Surface Downwelling Shortwave Radiation	-0.1 r	550.0 r
rsdt	TOA Incident Shortwave Radiation	0.0 s	580.4 s
rsus	Surface Upwelling Shortwave Radiation	-0.1 r	480.0 r
rsut	TOA Outgoing Shortwave Radiation	-0.1 r	480.0 r
rsutcs	TOA Outgoing Clear-sky Shortwave Radiation	-0.1 r	480.0 r
snd	Snow Depth	0.0 s	962.9 s
ta	Temperature	157.1 s	336.3 s
tas	Near-Surface Air Temperature	170.0 r	350.0 r
tauu	Surface Downward Eastward Wind Stress	-10.0 r	10.0 r
tauv	Surface Downward Westward Wind Stress	-10.0 r	10.0 r
tos	Sea Surface Temperature	257.4 s	325.2 s
ua	Eastward Wind	-68.65 s	136.6 s
va	Westward Wind	-71.1 s	69.93 s
zg	Geopotential Height	-719.7 s	34370.0 s

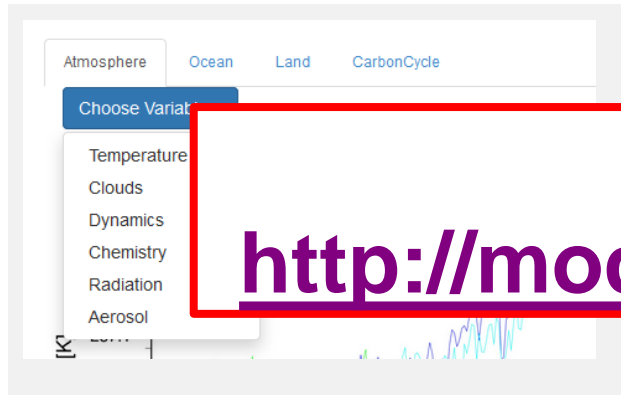
Online demonstrator

Navigation:

Atmosphere Ocean Land CarbonCycle

Choose Variable

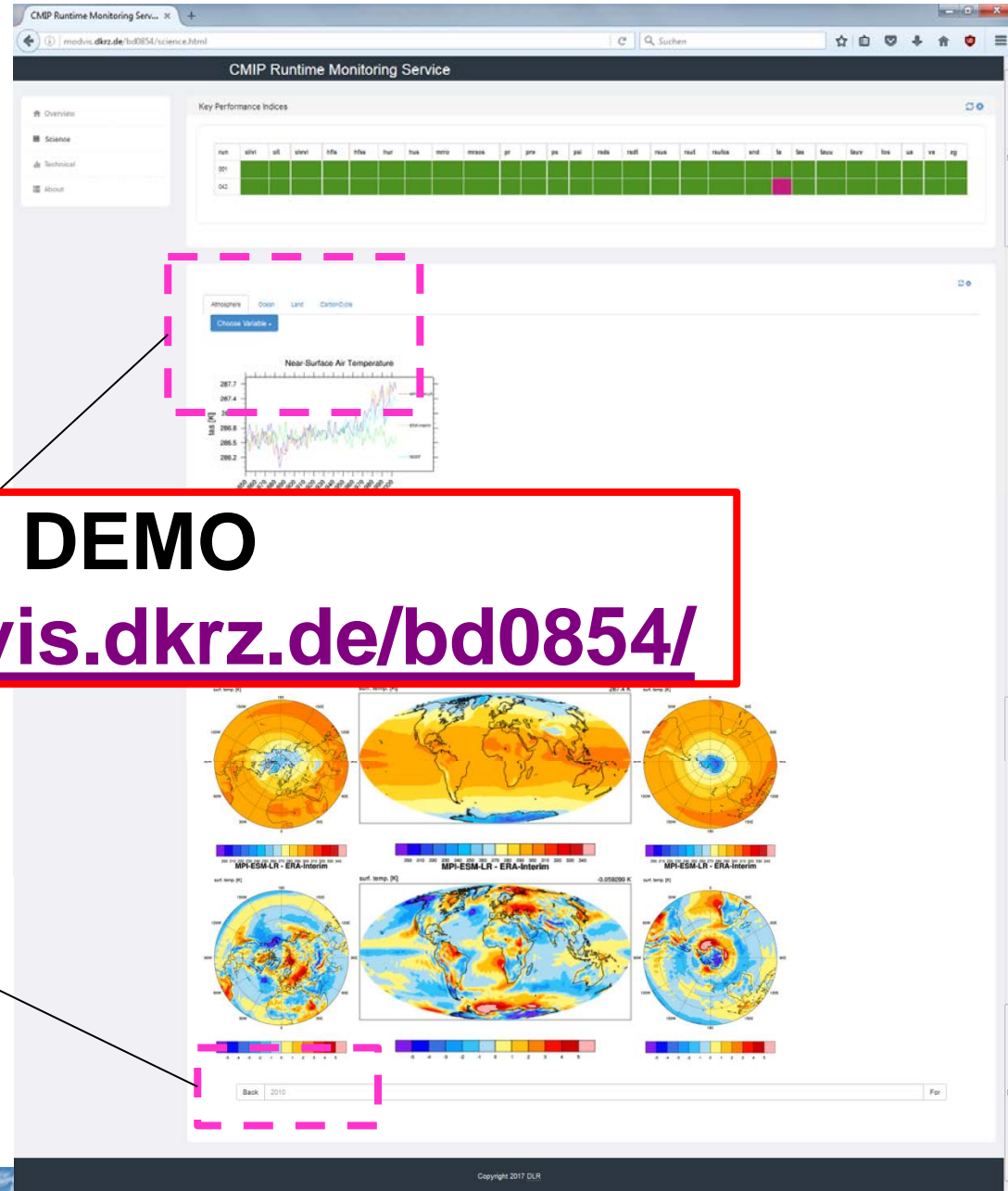
- Temperature
- Clouds
- Dynamics
- Chemistry
- Radiation
- Aerosol



Back 2010

DEMO

<http://modvis.dkrz.de/bd0854/>



CMP Runtime Monitoring Service

Key Performance Indices

rank	sim1	sim2	sim3	sim4	sim5	sim6	sim7	sim8	sim9	sim10	sim11	sim12	sim13	sim14	sim15	sim16	sim17	sim18	sim19	sim20
001	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
002	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█

Atmosphere Ocean Land CarbonCycle

Choose Variable

Near Surface Air Temperature

surf temp [K]

Back 2010

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Monitoring with ESMValTool

Advantages

- Direct comparison with observations and previous simulations
- Several additional diagnostics of the ESMValTool can be used in the monitoring (e.g. NCAR CVDP)
- Dashboard: fast detection of errors in the simulations
- New: monitoring of emissions

Way ahead

- First complete version should be finished by end of January for review by EMAC and MPI-ESM model groups
- Checks on the dashboard: further input from model groups needed



ESMValTool Related Milestones in CMIP6-DICAD

- Standardisierte Diagnostiken und Modellevaluation (AP6) -

- M1: Entwurf mit ausführlicher Spezifikation zum Portal [**Monat 6**, FUB]
- M2: Prototype ESMValTool Version läuft in der ESGF DKRZ Infrastruktur [**Monat 9**, DKRZ]
- M3: ESMValTool steht zur operationellen Laufüberwachung in der DKRZ Infrastruktur zur Verfügung [**Monat 12**, DLR] **AP 6.2 Milestone**
- M4: Lauffähiger und getesteter Prototype für das Portal [**Monat 15**, FUB]
- M5: ESMValTool mit erweiterten Diagnostiken auf CMIP5 Modelldaten angewandt [**Monat 18**, DLR]
- M6: ESMValTool mit CMIP6 Modelldaten und Beobachtungsdaten vollständig integriert in der ESGF DKRZ Infrastruktur [**Monat 24**, DKRZ]
- M7: MPI-ESM1/2 und EMAC2 mit erweiterter ESMValTool Version evaluiert und mit anderen CMIP6 Modellen verglichen [**Monat 36**, DLR]
- M8: Produktionssystem des Portals ist installiert [**Monat 36**, FUB]



=> Work in AP6.2 on time

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