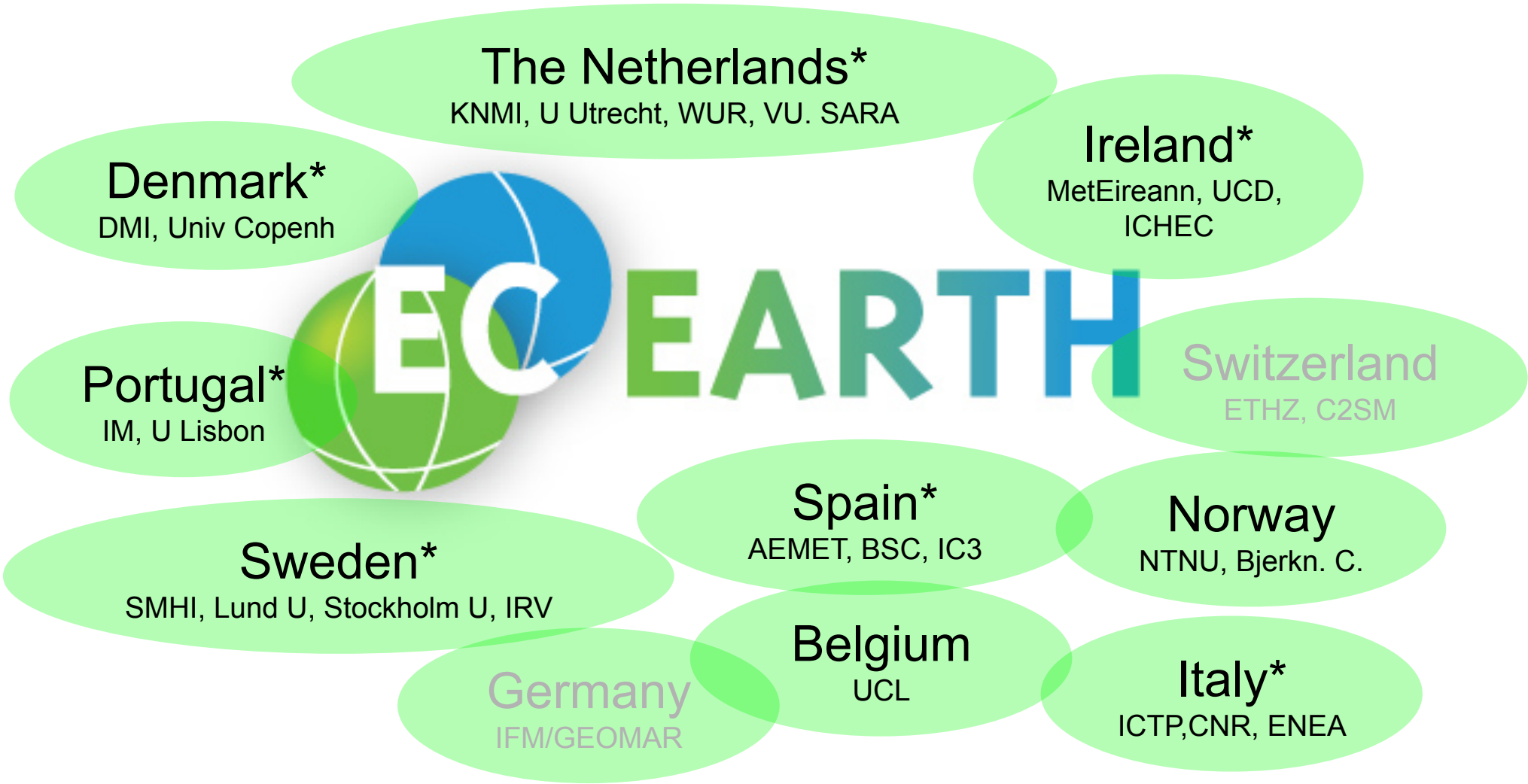
EC-Earth update, new developments and future priorities

Colin Jones (*formerly SMHI*), Wilco Hazeleger (*KNMI*)
Paco Doblas-Reyes (*IC3*) and Klaus Wyser (*SMHI*)

EC-Earth consortium



Steering group: W. Hazeleger (KNMI, chair), R. Doescher (SMHI), J. Hesselbjerg, Christensen (DMI), R. McGrath (Met Eireann), P. Viterbo (IM), E. C. Rodriguez (AEMET), A. Provenzale (CNR) observer E. Kallen (ECMWF), NEMO-representative

EC-Earth strategy

Take European Centre for Medium-Range Weather Forecasts (ECMWF) Forecast System …and build into climate prediction & ESM tool

- Bridge gap between weather forecasting and climate projections (seamless)
- State-of-the-art knowledge (world's best weather forecast model)
- Continuous development/updates
- Share resources & data *(CMIP5 performed on 6 different HPC systems)*

→ (Re)forecasts, predictions & projections (CMIP5), downscaling, science

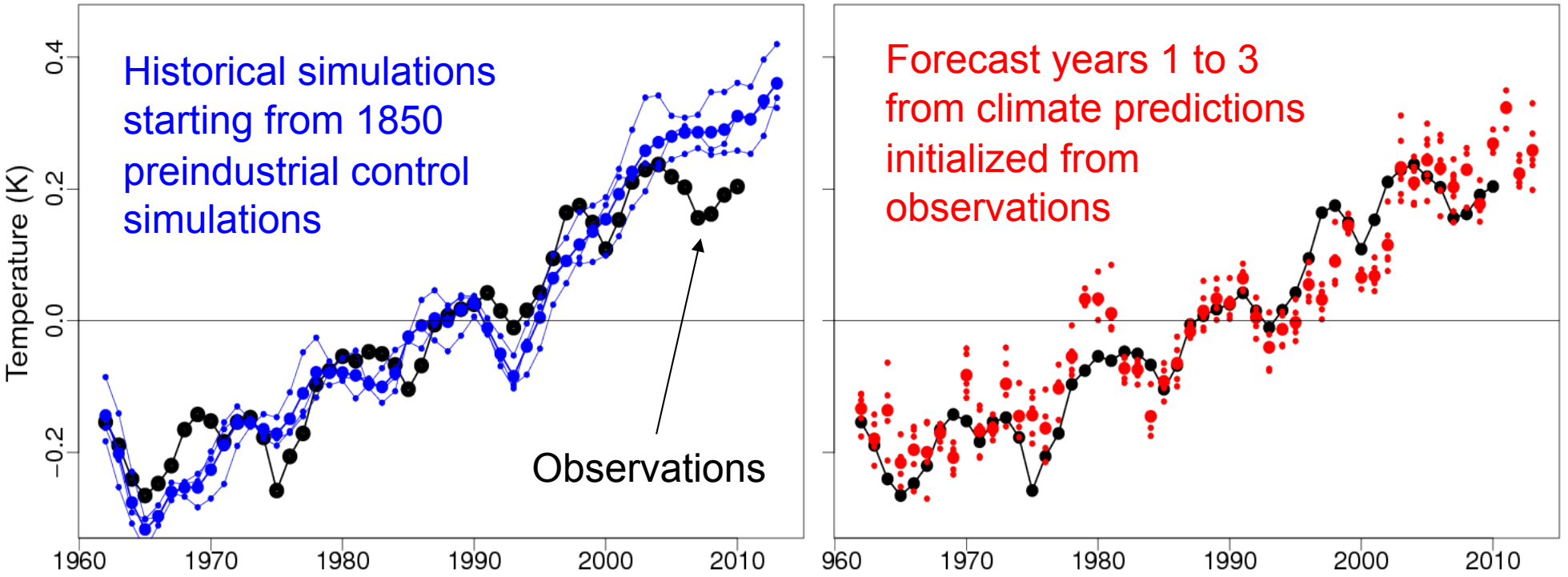
→ Climate services becoming increasingly important

→ National and EU projects (at least 15 FP7 projects)

Recent Highlights: Attribution: XXIst century hiatus

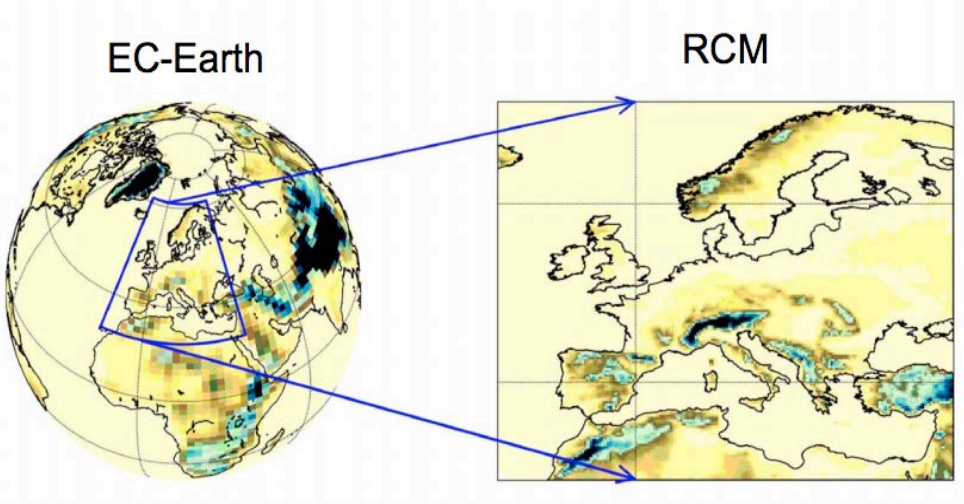
EC-Earth 2.3, global-mean SST

Role of internal variability

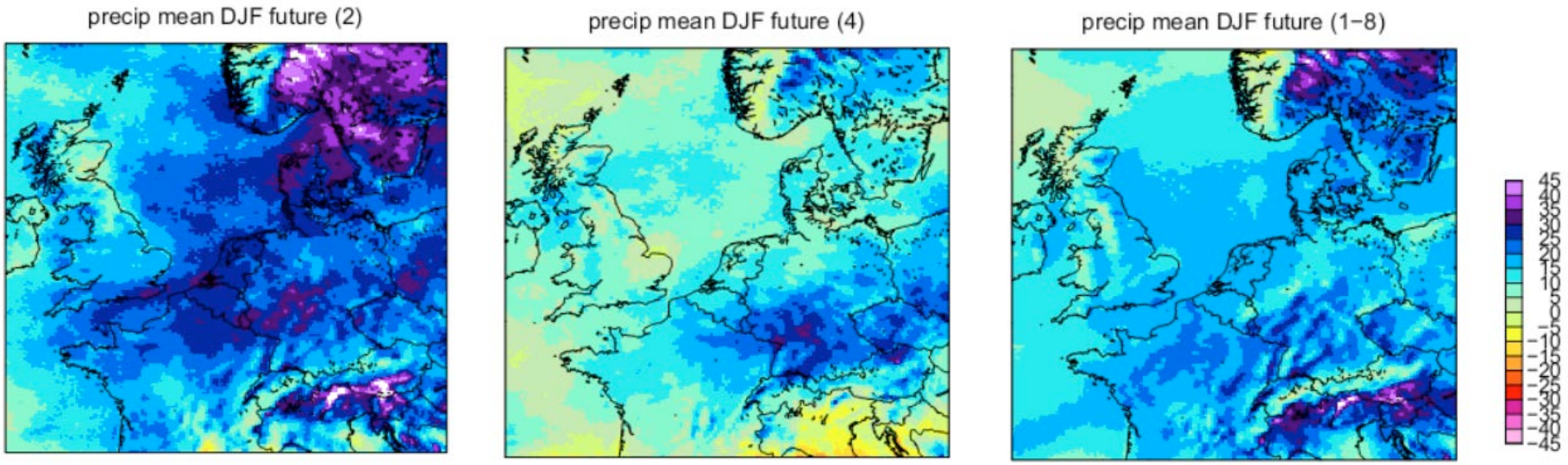


Guemas et al. (2013) Nature Climate Change

Regional downscaling in support of climate services

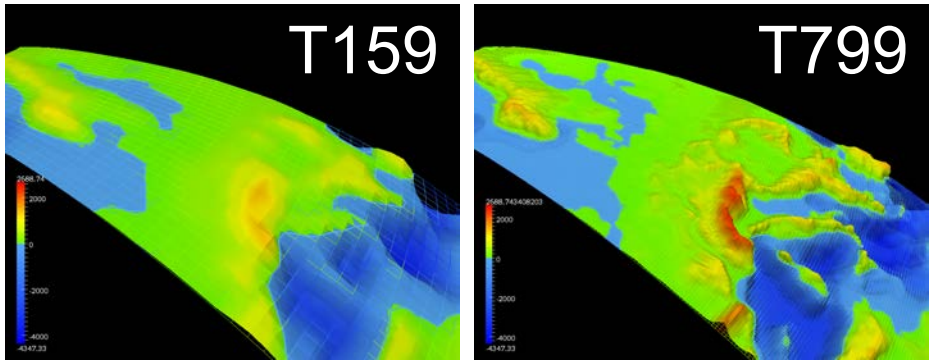


Lenderink and vd Hurk



Move towards 5-10km pan-Europe RCMs driving 2-3km national scale RCMs

EC-Earth versions



2008 Version 0 – IFS CY31 only (testing)

2009 Version 1 – IFS CY31^{+} + HTESSEL (tuning)

2011 Version 2.3 – IFS CY31^{+} + HTESSEL + NEMO2 + LIM2 (CMIP5)

2013 Version 2.4 – IFS CY31^{+} + HTESSEL + NEMO2 + LIM2 + TM5 + LPJ/GUESS

2013/2014 Version 3 – IFS CY36 + HTESSEL + NEMO3 + LIM3

2014/2016 Version 3.x – IFS CY36 + HTESSEL + NEMO3 + LIM3 + TM6 + LPJ/GUESS + OBGC

IFS resolutions from T159 to T799, 91 layers, and ocean from 1 deg to 0.25 deg, 46/75 layers

CMIP6: ***STDRES****: T255L91(A)/ORCA1°L46(O)*, ***HIRES****: T511/799L91/ORCA025°L75*

Updated components in v3

IFS cy31r1 with EC-EARTH additions → IFS cy36r4

- New convection scheme
- New radiation scheme with McICA
- New microphysics scheme with prognostic ice

NEMO2.? → NEMO 3.3.1

- Flexible domain decomposition
- LIM3 with 1 sea-ice category, 5 seaice categories in development

Modified settings for GWD parameterisation (as in S4, only T255L91)

New treatment of snow on ice sheets

”Calving glaciers” in Greenland and Antarctica

New Developments under progress

Oasis3 – MCT coupler

COSP simulator

1st and 2nd indirect aerosol effect

River routing scheme

New model components TM5 (chemistry) and LPJ-Guess (dynamic vegetation)

Results: AMIP style experiment

Atmosphere only, covering period 1979-2008

Forcing:

- v2: SST and sea-ice concentration from AMIP forcing dataset, sea-ice temperature from ERA-40
- v3: SST and sea-ice concentration from ERA-40/interim

Resolution is T159L62 with v2 and T255L91 with v3. Experiments with other resolutions show very similar results.

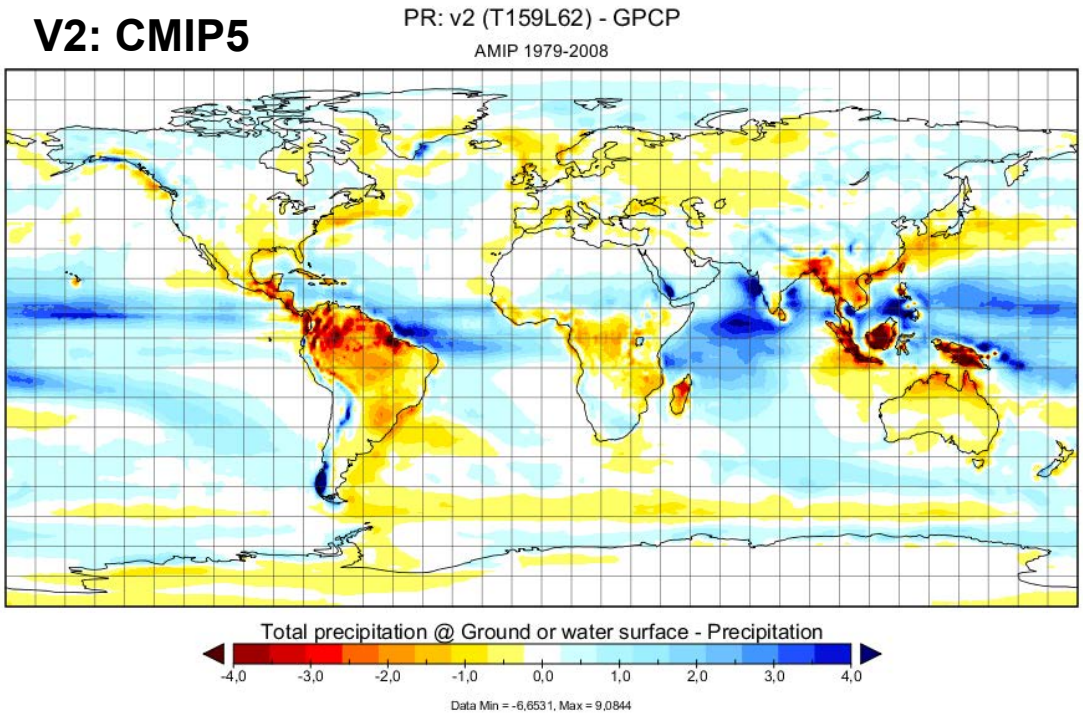
Pre-industrial spin up runs plus ensemble of CMIP5 historical runs now in progress at with EC-Earth v3 at 3 resolutions (2-year PRACE grant):

T255L91/ORCA1°L46 (T255 ~75km)

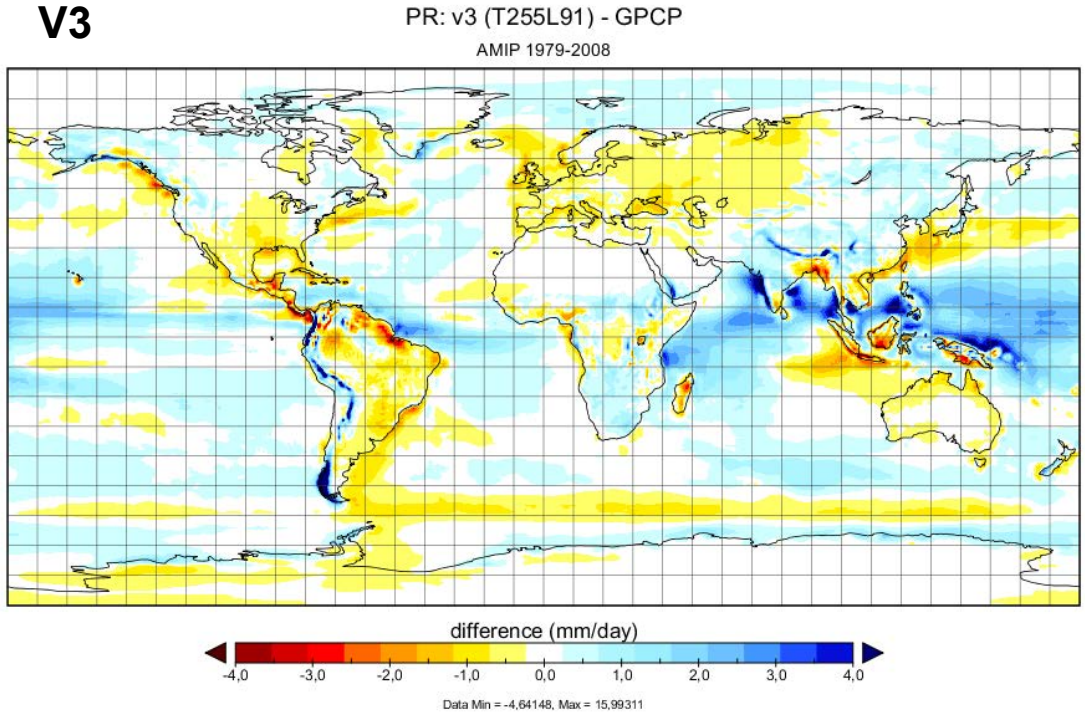
T255L91/ORCA0.25°L75

T511L91/ORCA0.25°L75 (T511 ~39km)

V2: CMIP5



V3



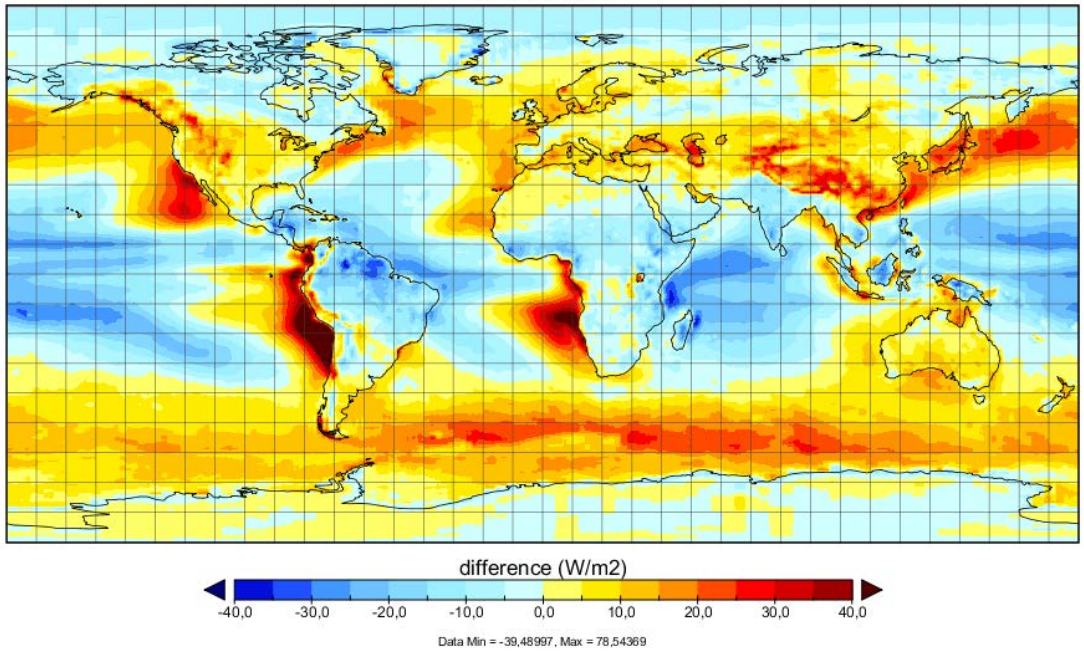
AMIP simulations

Total precipitation compared to GPCP

V3 shows improvements in the tropics, in particular the land-sea contrast is better respresented (less dry over land and less wet over the ocean)

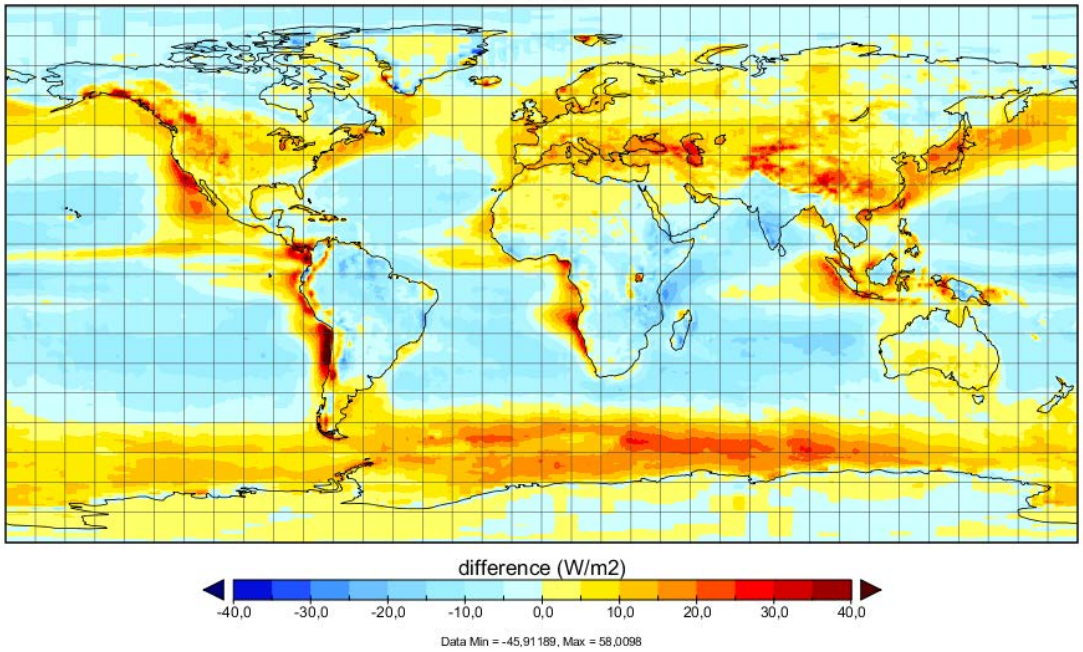
V2: CMIP5 SW cloud forcing at TOA: v32(T159L62) - CERES EBAF

AMIP 1979-2008



V3 SW cloud forcing at TOA: v3 (T255L91) - CERES EBAF

AMIP 1979-2008



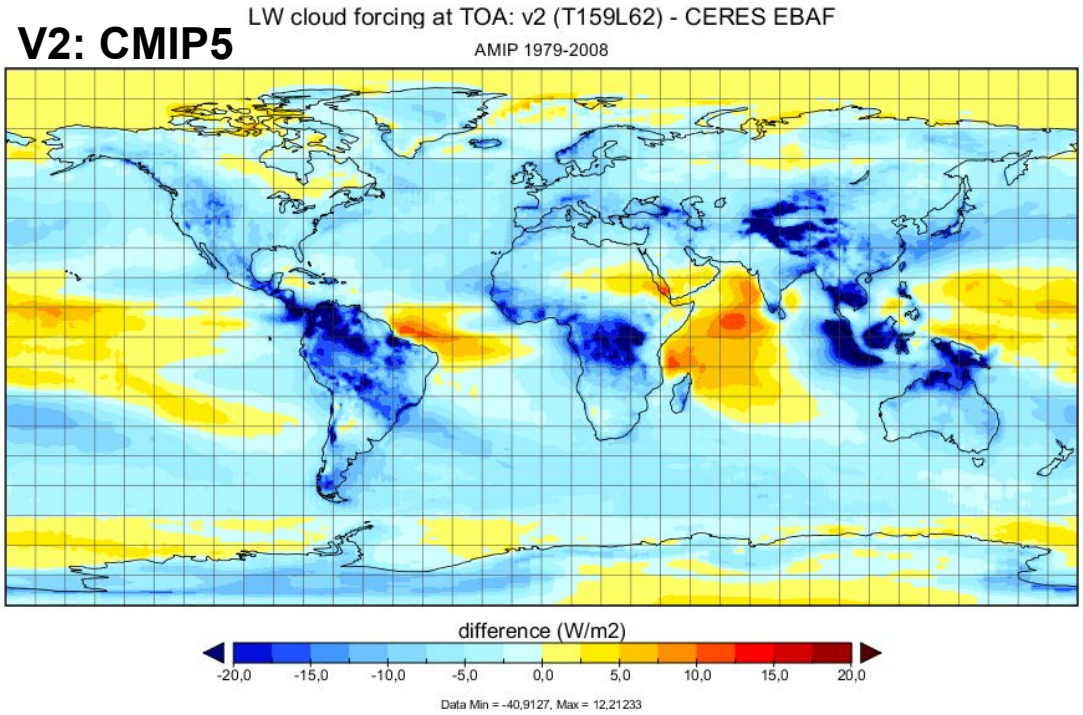
AMIP simulations

SW cloud forcing at TOA compared to CERES EBAF

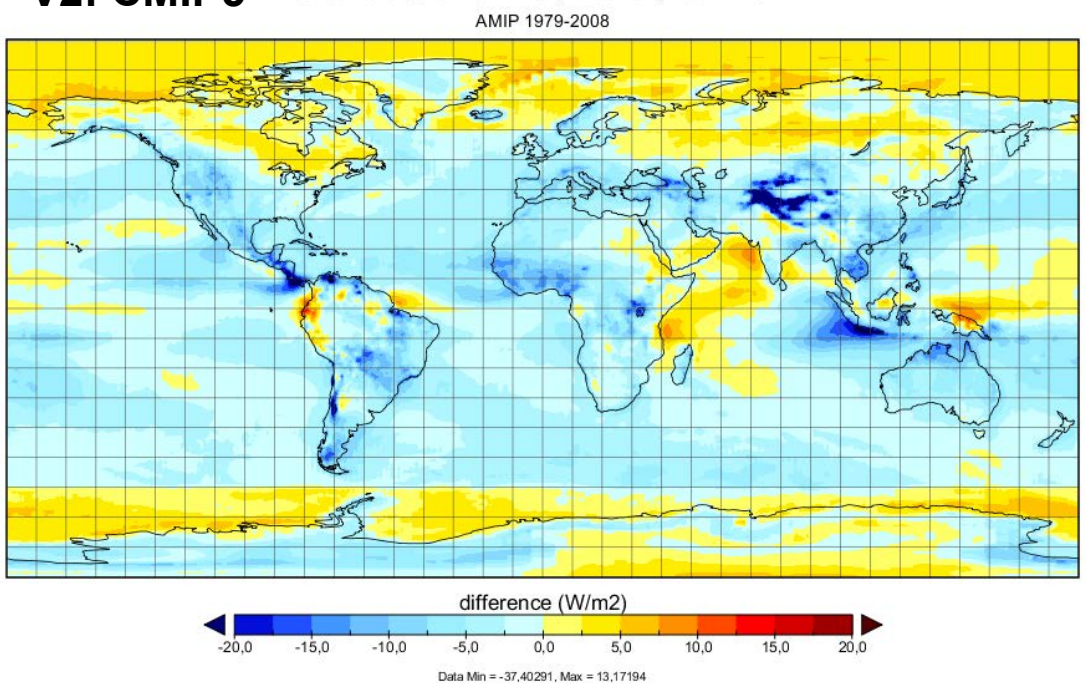
The bias is largely reduced in the marine Sc regions with v3. The same holds for the Southern Ocean and Northern mid-latitude storm tracks albeit the improvements are smaller.

Subtropical oceans and Southern Ocean biases beginning to improve via better aerosol-cloud-radiation interactions

V2: CMIP5



V2: CMIP5



AMIP simulations

LW cloud forcing at TOA compared to CERES EBAF

V3 reduces both positive and negative biases in the tropics. The positive biases at high latitudes become somewhat larger with v3.

Outlook towards CMIP6

Development towards **high resolution** Earth system model for initialized ensemble predictions and projections

High model resolution emphasized for improved description of natural variability & synoptic/extreme events (esp. provision of realistically energetic boundary conditions for downscaling e.g. over Europe)

Broader application in Earth system sciences (paleo studies, coupling to integrated assessment models)

Contributions to science and climate services with high resolution applications and downscaling to national scales a critical component

Crucial to have "realistic" projections and near-term predictions to inform policy and support climate services in consortium member states.
There is a push from the EU for climate services (EU to National scales)

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