



High-resolution isotopic simulations from **ECHAM6-wiso nudged with ERA5** reanalyses: new products for isotopic model-data comparisons

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Why doing atmosphere stand-alone nudged simulations?

- Nudging: to constrain simulated fields of (in our case) surface pressure, temperature, divergence and vorticity to the corresponding reanalysis fields.
- The use of Atmospheric General Circulation Models (AGCMs) nudged with weather • forecasts reanalyses is a powerful way to obtain model outputs under the same weather conditions than at the sampling time of observations.
- The production of simulations from isotope-enabled AGCMs with this technique combined with isotope observations from precipitation, water vapor or various natural archives significantly helped to a better understanding of the processes ruling the water cycle.
 - \rightarrow Interpretation of the water isotope records and exploration of the mechanisms controlling the variability of the surrounding water isotopic composition.





ERA5

- ERA5 climate reanalysis dataset [Copernicus Climate Change Service (C3S), 2017]: data processing is carried out by European Centre for Medium-Range Weather Forecasts (ECMWF), using ECMWFS' Earth System model IFS, cycle 41r2.
- Currently available for the period 1979-2019, planned to go back to 1950.
- Improved temporal and spatial resolutions compared to its predecessor ERA-Interim [Dee et al., 2011] : from 6-hourly in ERA-Interim to hourly in ERA5, and from 79 km in the horizontal dimension and 60 levels in the vertical to 31 km and 137 levels in ERA5.



ECHAM6-wiso

- Atmosphere component of the isotope-enabled coupled GCM MPI-ESM-wiso [Cauquoin et al., 2019].
- It includes the land/vegetation component JSBACH.
- New updates: constant kinetic fractionation factor for the evaporation over ocean (smooth wind regime) + isotopes in snow on sea-ice [Bonne et al., 2019] \rightarrow see the presentation by Werner et al., session AS4.6, D3032 | <u>EGU2020-</u> <u>13131</u>.
- Side note: ECHAM6-wiso is also used for paleoclimate studies \rightarrow see the • presentation by Paul et al., session CL4.3, D3489 | EGU2020-10622.

Session CL1.4 – D3674 | EGU2020-12319



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ECHAM6-wiso nudged with ERA5: simulations performed and evaluation

- We present here the new simulations products from ECHAM6-wiso nudged with the last reanalyses dataset from the ECMWF, ERA5, over the period 1979-2018.
- Sea surface temperatures (SSTs) and sea-ice (SIC) fields were set to the ERA5 SSTs and SIC for the respective year.
- Time step of the model outputs: 6h.
- 2 spatial resolutions:
 - T63L47: 1.875° of horizontal resolution and 47 vertical levels.
 - T127L95: 0.9° of horizontal resolution and 95 vertical levels.
- Evaluation against observations:
 - Global Network of Isotopes in Precipitation (GNIP) dataset [IAEA].
 - Antarctic observational database compiled by Masson-Delmotte et al. [2008].
- Impact of the reanalyses on our simulations: ECHAM5-wiso simulations [Werner et al., 2011; Butzin et al., 2014] nudged with ERA-Interim and ERA5 reanalyses, at T63L31 spatial resolution.
- All the simulations have been previously run into equilibrium during 30 model years at the 1979 climate conditions.

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$\delta^{18}O_p$ in precipitation: global scale



ECHAM5-wiso ERAIA



ECHAM6-wiso T63L47







ECHAM6-wiso T127L95: best model-data agreement.

Modeled spatial relationships with surface temperature in very good agreement with the observations.



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ECHAM5-wiso ERA5



Seasonal variability at GNIP stations





Halley Bay: the nearest grid point is an ocean mesh in ECHAM6 T63L47 setup. The seasonal variations of the different variables are globally well reproduced by ECHAM-wiso.

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Antarctica





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ERA5 vs. ERA-Interim



- Annual mean difference of the 2 ECHAM5-wiso simulations nudged with ERA5 and ERA-Interim reanalyses:
 - the 2m-temperatures over land are globally lower with ERA5 nudging,
 - the rainfall is substantially different over the tropics (more precipitation over Amazon).
- Consequences on water vapor transport at different pressure levels will be investigated (much improved troposphere in ERA5 compared to ERA-Interim [C3S, 2017]).

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Conclusions and perspectives

- Good to very good agreement with the observations at seasonal and annualmean timescales.
- These new simulation products could be a useful contribution to the isotopic data community \rightarrow see the presentation of Stenni et al., session CL1.14, D3367 <u>EGU2020-8610</u>.
- ERA5 has better global balance of precipitation and evaporation, and better precipitation over land in the deep tropics [C3S, 2017]: expected improved performance of modeling of water isotopes over this area.
- Analyses on near-surface water vapor at hourly/daily timescale are planned.



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