README: Domain- and Time-Averaged Profiles

Updated 27 July 2022
Replacing version from 25 May 2022 (which replaced 16 January 2021 version)

Updates in 27 July 2022 version:
- Updating citation to Stauffer and Wing (2022). Only this document has changed, the profiles are as they were in the previous version.

Updates in 25 May 2022 version:
- Added specific humidity profiles
- Added new re-calculated cloud fraction profiles

NetCDF files of domain- and time-averaged profiles of temperature and relative humidity, for each model, in the small and large domain simulations at each SST. The file structure is as follows:

0-models-list.txt: Provides a list of models included and their identifier, $MODEL
RCE_large (folder for RCE_large simulations):
    $MODEL_RCE_large$SST_cfv$X-profiles.nc
RCE_small (folder for RCE_small, RCE_small_vert, and RCE_small_LES simulations):
    $MODEL-VER/LES_RCE_small$SST_cfv$X-profiles.nc

The filenames indicate which version of cloud fraction is included. The time averages are taken neglecting the first 75 days of each simulation, except for RCE_small_les for which an average over Days 25-50 are used. The variables are as follows, each with the dimension of z_avg.

%cfv0-profiles.nc files

Variable	Name	Units
cfv0_avg	Cloud fraction cfv0	-
ta_avg	Temperature	K
pa_avg	Pressure	hPa
tw_avg	Total cloud water (cloud ice + cloud liquid)	g/g
hur_avg	Relative humidity	%
hus_avg	Specific humidity	g/kg
Cr	RGBA Red color for Wing et al. 2020 color scheme	-
Cg	RGBA Green color for Wing et al. 2020 color scheme	-
Cb	RGBA Blue color for Wing et al. 2020 color scheme	-
Ca	RGBA Alpha color for Wing et al. 2020 color scheme	-
zg_avg	Height	km

%cfv1-cfv2-profiles.nc files

Variable	Name	Units
cfv1_avg	Cloud fraction cfv1	-
cfv2_avg	Cloud fraction cfv2	-

ta_avg	Temperature	K
pa_avg	Pressure	hPa
tw_avg	Total cloud water (cloud ice + cloud liquid)	g/g
Cr	RGBA Red color for Wing et al. 2020 color scheme	-
Cg	RGBA Green color for Wing et al. 2020 color scheme	-
Cb	RGBA Blue color for Wing et al. 2020 color scheme	-
Ca	RGBA Alpha color for Wing et al. 2020 color scheme	-
zg_avg	Height	km

If a height or pressure dimension was not provided in the 1D output, the domain- and time-average height and pressure are included here instead.

Cloud Fraction

- **cfv0:** From Wing et al., (2020). The original cloud fraction output provided by each model. This was supposed to be based on the output of a cloud scheme for models employing such a scheme or defining the presence of a cloud using a threshold value of $(cw + ci) > min(0.01q_{s,w}, 10^{-5}\ gg^{-1})$, where *cw* is the cloud liquid water condensate, *ci* is the cloud ice condensate, and $q_{s,w}$ is the saturation mixing ratio over water. However, subsequent to Wing et al., (2020) it was determined that this definition was not consistently applied across the participating models.

- **cfv1:** From Stauffer and Wing (2022). A re-calculation of the RCEMIP protocol definition of cloud fraction for models with explicit convection, based on the 3D instantaneous output. A cloud is defined where $(cw + ci) > min(0.01q_{s,w}, 10^{-5}\ gg^{-1})$.

- **cfv2**: From Stauffer and Wing (2022). A re-calculation of cloud fraction using an alternate definition for models with explicit convection, based on the 3D instantaneous output. A cloud is defined where $(cw + ci) > 10^{-5}\ gg^{-1}$.

See Stauffer and Wing (2022) for more information, including codes archived at https://doi.org/10.5281/zenodo.6323552

Relative Humidity

The relative humidity is calculated based on each model's formation for saturation over water and ice. Thus, different formulations may be used in different models, but each formulation is consistent with how that model's clouds respond to and regulate relative humidity. Several models (ICON-NWP-CRM, ICON-LEM-CRM, IPSL-CM6, WRF-CRM, WRF-COL-CRM, and WRF-GCM) inadvertently reported relative humidity with respect to saturation over water at all temperaures. Therefore, here, we correct those calculations to relative humidity with respect to saturation over ice at temperatures below freezing.

For ICON-NWP-CRM and ICON-LEM-CRM, the correction is performed by multiplying the 3D relative humidity output, which is relative humidity over liquid, by the saturation vapor pressure over liquid and dividing by the saturation vapor pressure over ice whenever the temperature is below freezing. To calculate saturation vapor pressure, the Tetens equation is used following its usage in ICON. The new 1D relative humidity profiles are computed based on averages of the corrected 3D 6-hourly snapshots over the last 25 days.

For ISPL-CM6 and WRF-CRM, the correction is performed by using the Wagner and Pruß (2002) and Wagner et al. (2011) formulations to correct the 1D (domain-averaged) temperature, specific humidity, and pressure data. The original relative humidity is multiplied by the computed relative humidity over liquid or ice (depending on the temperature) and divided by the relative humidity over liquid. The latter cancels with the original relative humidity, except for a residual associated with the different formulas for saturation and non-linearity in the calculation affecting the order of domain-averaging, to achieve an estimate of relative humidity over liquid and ice.

For WRF-COL-CRM and WRF-GCM, the correction is performed by using the Wagner and Pruß (2002) and Wagner et al. (2011) formulations to compute relative humidity over liquid when temperatures are above freezing and over ice when temperatures are below freezing, using the 3D temperature, specific humidity, and pressure data. The new 1D relative humidity profiles are computed based on averages of the corrected 3D 6-hourly snapshots over the last 25 days.

References

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