

Meteorology for physics-based nudging

Meteorology at 32 vertical levels in the finite volume simulations

Nudging is used when the aim of simulations is to reproduce the meteorology as close to reality as possible, for example when analyzing field campaigns or station data. Physics-side nudging is described in more detail in the CAM User's Guide, [Section 9.6](#). The default meteorology used is 3-hourly MERRA2 files on 32 levels. The power of physics-side nudging is we can choose to separately nudge different parameters (U, V, T, Q, PS) in different parts of the atmosphere, and for a set time range. The default set-up is to include zero nudging of surface pressure (PS) and specific humidity (Q), and nudge all other parameters (T, U, V) by the same amount everywhere (`nudge_{x}coef = 0.06`, `nudge_{x}prof = 1`). We recommended some updates to default values to improve model stability and performance:

- Change the frequency of nudging tendencies from the default value of every hour, to every half an hour (`model_times_per_day = 48`) for the 1 degree simulations. (This is a higher number in [MUSICAv0 regionally refined simulations](#)).
- Update the number of nudge times (i.e. how often the model reads the meteorology files) to every 3 hours (`nudge_times_per_day = 8`) to match the maximum available meteorology.
- Use an intermediate to long nudging strength defined by the nudging coefficient. The impact of nudging strength on simulation results has been evaluated in several papers: Gaubert et al. ACP, 2020 (<https://doi.org/10.5194/acp-20-14617-2020>), Davis et al., ACP, 2022 (<https://doi.org/10.5194/acp-22-197-2022>).

To define the meteorology check and adjust the following in `user_nl_cam`:

```
&nudging_nl
nudge_path          = '/glade/p/cesmdata/cseg/inputdata/atm/cam/met/nudging/MERRA2_fv09_32L/'
nudge_file_template = '%y/MERRA2_fv09.cam2.i.%y-%m-%d-%s.nc'
nudge_beg_day       = 1
nudge_beg_month      = 1
nudge_beg_year       = 2010
nudge_end_day        = 31
nudge_end_month      = 12
nudge_end_year       = 2020
nudge_times_per_day  = 8
model_times_per_day  = 48
/
```

Nudging will not occur outside of the time boundaries, i.e. the model will revert to free-running.

Note1: The nudging scheme currently requires one timestamp per meteorology file. If you have several timestamps per file, only one value will be read.

Note2: The default nudging coefficient of 0.06 is equivalent to 50-hour (or 1%) relaxation when used with using 3-hour meteorology. We recommend changing the default nudging coefficient for U, V and T to an intermediate value such as 0.25 (12 hour relaxation using 3-hour meteorology), adjusting other nudging parameters is recommended for advanced users. See the CAM User's Guide for information on additional parameters, in the [Namelist Values table](#).

```
&nudging_nl
nudge_ucoef          = 0.25
nudge_uprof          = 1
nudge_vcoef          = 0.25
nudge_vprof          = 1
nudge_tcoef          = 0.25
nudge_tprof          = 1
nudge_psccoef        = 0.00
nudge_pspcoef        = 0
nudge_qcoef          = 0.00
nudge_qprof          = 0
/
```

In regional refined simulations defining meteorology is similar, but a little more complicated: [regridding meteorology for MUSICAv0](#)

The old method of using "Specified Dynamics Nudging" can be found here: [Specified Dynamics Meteorology](#)

GEOS5 and MERRA2 meteorology files are available at multiple resolutions from the Research Data Archive:

32 Level Meteorology files:

MERRA2 1990-1992: <https://rda.ucar.edu/datasets/ds313.2>

(glade location: `/glade/p/cesmdata/cseg/inputdata/atm/cam/met/nudging/MERRA2_fv09_32L/`)

72 Level meteorology files (need to re-grid to model layers):

GEOS5 2004-2022: <https://rda.ucar.edu/datasets/ds313.0/>
MERRA2 1980-2021: <https://rda.ucar.edu/datasets/ds313.3/>