

WRF-SCM

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WRF-SCM: What for?

- Not very widely-used
- **Testbed** to test convective parameterisations
- **Flexible** architecture
 - Physics development (add / modify schemes)
 - Good support, documentation, open source (GitHub)
 - Output from WRF 3D simulations as input data to SCM
- Wide array of **options** for convection, PBL, MP and Radiation schemes
 - 15 options for convection scheme
 - Switch between schemes by changing namelist option
- **Idealised** runs
 - Radiative-Convective Equilibrium (**RCE**)
 - Standardised tests to test different conv. schemes in SCMs (e.g. Linear Response Function by Kuang)

WRF-SCM: Configuration & Format

- **Vertical grid** decided by user – even or stretched grid
- **Initial conditions**: read from a text file by the ideal-case initialization module
 - input_sounding: z, u, v, theta, qv
 - input_soil: z, soil_T, soil_M
- **Output**: NetCDF
- **Forcings**: read from NetCDF file using auxiliary input function
 - Temperature (theta), moisture (qv, ql), winds (u, v, w, u_g, v_g, w_subs), soil (T and moisture), surface fluxes (sensible + latent heat flux)
 - Time-dependent forcing on time-dependent height coordinates is possible
- **Forcing method**: upstream relaxation forcing

$$\frac{\partial X}{\partial t} = \underbrace{\frac{X_{in} - X}{\tau}}_{\text{Hor. Adv.}} - \underbrace{W_{subs} * \frac{\partial X}{\partial z}}_{\text{Vert. Adv.}}$$

WRF-SCM: Forcing variables

Quantity	Units	Description
z_force	m	height of forcing input
z_force_tend	m	tendency height of forcing input
u_g	m s-1	x-direction geostrophic wind
u_g_tend	m s-2	tendency x-direction geostrophic wind
v_g	m s-1	y-direction geostrophic wind
v_g_tend	m s-2	tendency y-direction geostrophic wind
w_subs	m s-1	large-scale vertical velocity (subsidence)
w_subs_tend	m s-2	tendency large-scale vertical velocity
Advective time scale		
th_upstream_x	K	upstream theta x-advection
th_upstream_x_tend	K s-1	tendency upstream theta x-advection
th_upstream_y	K	upstream theta y-advection
th_upstream_y_tend	K s-1	tendency upstream theta y-advection
qv_upstream_x	kg kg-1	upstream qv x-advection
qv_upstream_x_tend	kg kg-1 s-1	tendency upstream qv x-advection
qv_upstream_y	kg kg-1	upstream qv y-advection
qv_upstream_y_tend	kg kg-1 s-1	tendency upstream qv y-advection
ql_upstream_x	kg kg-1	upstream ql x-advection
ql_upstream_x_tend	kg kg-1 s-1	tendency upstream ql x-advection
ql_upstream_y	kg kg-1	upstream ql y-advection
ql_upstream_y_tend	kg kg-1 s-1	tendency upstream ql y-advection
u_upstream_x	m s-1	upstream u x-advection

u_upstream_x_tend	m s-2	tendency upstream u x-advection
u_upstream_y	m s-1	upstream u y-advection
u_upstream_y_tend	m s-2	tendency upstream u y-advection
v_upstream_x	m s-1	upstream v x-advection
v_upstream_x_tend	m s-2	tendency upstream v x-advection
v_upstream_y	m s-1	upstream v y-advection
v_upstream_y_tend	m s-2	tendency upstream v y-advection
tau_x	s	x-direction advective timescale
tau_x_tend		tendency x-direction advective timescale
tau_y	s	y-direction advective timescale
tau_y_tend		tendency y-direction advective timescale
Large-scale time scale		
th_largescale	K	SCM largescale theta
th_largescale_tend	K s-1	SCM tendency largescale theta
qv_largescale	kg kg-1	SCM largescale qv
qv_largescale_tend	kg kg-1 s-1	SCM tendency largescale qv
ql_largescale	kg kg-1	SCM largescale ql
ql_largescale_tend	kg kg-1 s-1	SCM tendency largescale ql
u_largescale	m s-1	SCM largescale u
u_largescale_tend	m s-2	SCM tendency largescale u
v_largescale	m s-1	SCM largescale v
v_largescale_tend	m s-2	SCM tendency largescale v
tau_largescale	s	SCM largescale timescale
tau_largescale_tend		SCM tendency largescale timescale
Soil forcing		
t_soil_forcing_val	K	Soil temp value for SCM forcing
t_soil_forcing_tend	K s-1	tendency soil temp for SCM forcing
q_soil_forcing_val		Soil moisture value for SCM forcing
q_soil_forcing_tend	s-1	tendency soil moisture for SCM forcing
tau_soil	s	SCM soil forcing timescale
soil_depth_force	m	SCM depth at center of soil layers in forcing file
Surface forcing		
hfx_force	W m-2	SCM ideal surface sensible heat flux
hfx_force_tend	W m-2 s-1	SCM ideal surface sensible heat flux tendency
lh_force	W m-2	SCM ideal surface latent heat flux
lh_force_tend	W m-2 s-1	SCM ideal surface latent heat flux tendency
tsk_force	K	SCM ideal surface skin temperature
tsk_force_tend	K s-1	SCM ideal surface skin temperature tendency

WRF-SCM: Cases

- **Idealised** cases:
 - RCE
- **Real** cases:
 - Default: GABLS II
 - 5 cases adapted from CCPP-SCM (script to translate CCPP-SCM IC & forcing files to WRF format)
 - TWPICE
 - ARM-SGP (summer 1997)
 - ASTEX
 - BOMEX
 - LASSO SGP