

Instability in WRF?

A sign of instability has been detected in WRF wind fields. During the simulation of a prescribed burn with a plume model that uses a single wind profile extracted from WRF, we noticed that the plume did not align with field observations. When we examined the WRF wind fields, we discovered that the surface winds displayed a strange pattern during the burn period. We repeated the WRF run under more close surveillance but we got the same exact pattern. From 1500 to 2000 Z on April 15, 2008, the east-west wind component oscillates, creating north-northwesterly and north-northeasterly winds at consecutive grid points around Ft. Benning, Georgia (Figure 1).

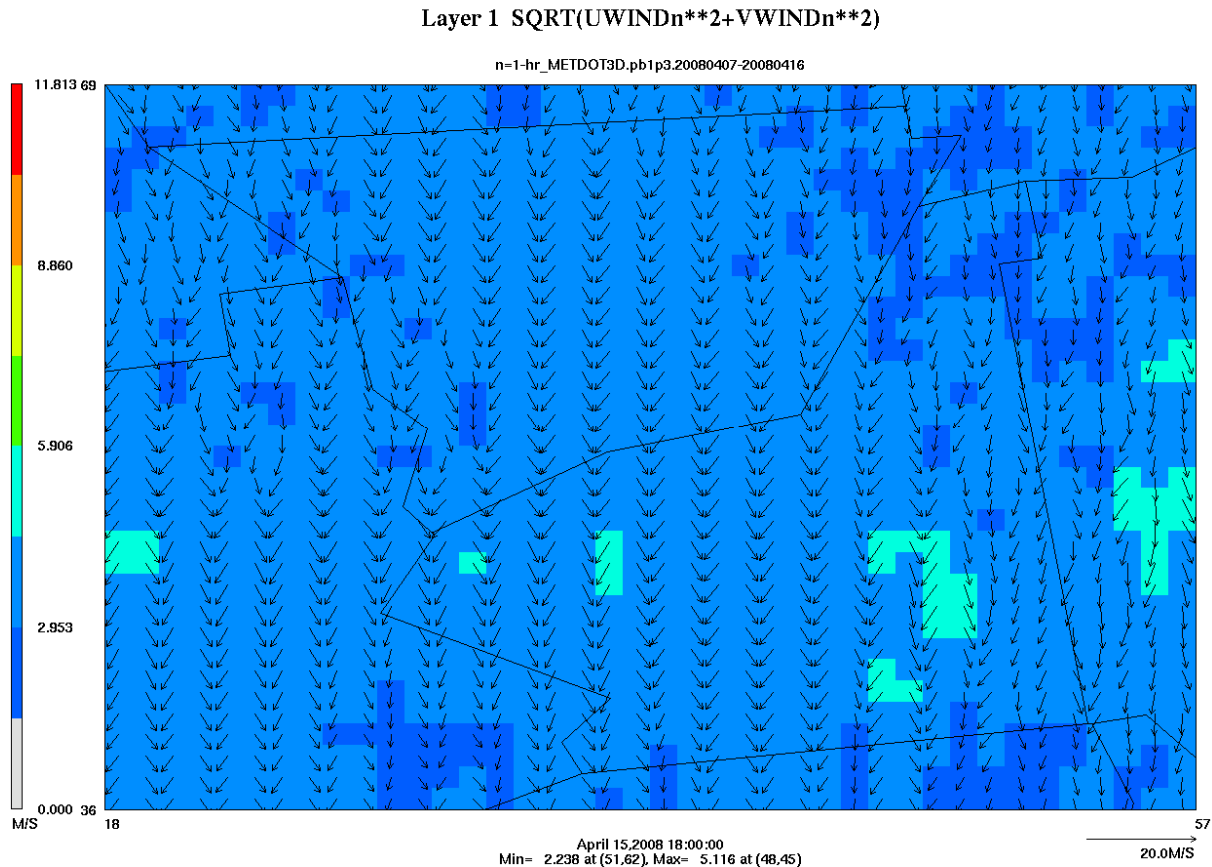


Figure 1. Surface winds over Ft. Benning GA on April 15, 2008 at 1800 Z. The wind speed is from 3 to 4.5 m/s. Wind vectors are shown at every grid point. Note the oscillation of the east-west wind component, which appears to be a sign of instability in WRF.

The pattern seen in Figure 1 appears to be a classic odd-even decoupling of the solution. To our knowledge, this is one of the targets of damping in WRF, therefore it should not happen. However, if the coefficients for the added damping were calibrated for typical mesoscale grid spacings in the horizontal but the grid spacing here (1333 m) were much smaller than the ones WRF damping is calibrated for, then the amount of damping may be insufficient to suppress the oscillations. It appears that the present damping in WRF does not take effect at small scales and relatively benign conditions such as the one we discovered. Ideally, the damping should be a

function of grid spacing and should get rid of any oscillations before they grow to detectable proportions.

The attached “namelist” file describes the configuration we used for the WRF run. This was a run with WRFV3.0 on 4 CPUs. The simulation is a 10-day episode in April 2008 (7th through 16th) focusing on central Georgia with 3 nests of 12-, 4-, and 1.333-km resolution, respectively, with feedback from nest to parent (i.e., two-way nesting). The time step for the 1.333-km grid was 8 seconds (24s for 4-km and 72s for 12-km, respectively). We used 35 levels in the vertical.

We can provide the outputs (and inputs) if you are interested in analyzing this problem. We did not see any warnings in the log files which would point to this problem.

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&time_control
run_days           = 10,
run_hours          = 0,
run_minutes        = 0,
run_seconds        = 0,
start_year         = 2008, 2008, 2008,
start_month        = 04, 04, 04,
start_day          = 07, 07, 07,
start_hour         = 00, 00, 00,
start_minute       = 00, 00, 00,
start_second       = 00, 00, 00,
end_year           = 2008, 2008, 2008,
end_month          = 04, 04, 04,
end_day            = 17, 17, 17,
end_hour           = 00, 00, 00,
end_minute         = 00, 00, 00,
end_second         = 00, 00, 00,
interval_seconds   = 10800
input_from_file    = .true.,.false.,.false.,
history_interval   = 60, 60, 60,
frames_per_outfile = 24, 24, 24,
restart            = .false.,
restart_interval   = 4320,
io_form_history    = 2
io_form_restart    = 2
io_form_input      = 2
io_form_boundary   = 2
debug_level        = 0,
auxinput1_inname   = "met_em.d<domain>.<date>"
/

&domains
time_step          = 72,
time_step_fract_num = 0,
time_step_fract_den = 1,
max_dom            = 3,
s_we               = 1, 1, 1,
e_we               = 79, 124, 97,
s_sn               = 1, 1, 1,
e_sn               = 79, 100, 100,
s_vert             = 1, 1, 1,
e_vert             = 35, 35, 35,
num_metgrid_levels = 40
dx                 = 12000, 4000, 1333.333,
dy                 = 12000, 4000, 1333.333,
grid_id            = 1, 2, 3,
parent_id           = 0, 1, 2,
i_parent_start     = 0, 16, 30,
j_parent_start     = 0, 20, 14,
parent_grid_ratio   = 1, 3, 3,
parent_time_step_ratio = 1, 3, 3,
feedback           = 1,
smooth_option       = 0
interp_type         = 1
lagrange_order      = 1
zap_close_levels    = 500
lowest_lev_from_sfc = .false.
force_sfc_in_vinterp = 1
p_top_requested     = 5000
eta_levels          = 1.0000, 0.9975, 0.9950, 0.9900,

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0.9800,	
0.9000,	0.9700, 0.9600, 0.9400, 0.9200,
0.7550,	0.8750, 0.8500, 0.8200, 0.7900,
0.5800,	0.7200, 0.6850, 0.6500, 0.6150,
0.4000,	0.5450, 0.5100, 0.4750, 0.4400,
0.2000,	0.3600, 0.3200, 0.2800, 0.2400,
0.0000,	0.1600, 0.1200, 0.0800, 0.0400,
/	

&physics	
mp_physics	= 2, 2, 2,
ra_lw_physics	= 1, 1, 1,
ra_sw_physics	= 1, 1, 1,
radt	= 10, 10, 10,
sf_sfclay_physics	= 1, 1, 1,
sf_surface_physics	= 2, 2, 2,
bl_pbl_physics	= 1, 1, 1,
bldt	= 0, 0, 0,
cu_physics	= 1, 1, 0,
cudt	= 5, 15, 60,
isfflx	= 1,
ifsnow	= 0,
icloud	= 1,
surface_input_source	= 1,
num_soil_layers	= 4,
mp_zero_out	= 0,
maxiens	= 1,
maxens	= 3,
maxens2	= 3,
maxens3	= 16,
ensdim	= 144,
/	

&fdda	
grid_fdda	= 1, 0, 0,
gfdda_inname	= "wrffdda_d<domain>",
gfdda_end_h	= 240, 240, 240,
gfdda_interval_m	= 360, 180, 180,
fgdt	= 0, 0, 0,
if_no_pbl_nudging_uv	= 0, 0, 0,
if_no_pbl_nudging_t	= 1, 1, 1,
if_no_pbl_nudging_q	= 1, 1, 1,
if_zfac_uv	= 0, 0, 0,
k_zfac_uv	= 8, 8, 8,
if_zfac_t	= 0, 0, 0,
k_zfac_t	= 8, 8, 8,
if_zfac_q	= 0, 0, 0,
k_zfac_q	= 8, 8, 8,
guv	= 0.0003, 0.0003, 0.0003,
gt	= 0.0003, 0.0003, 0.0003,
gq	= 0.0003, 0.0003, 0.0003,
if_ramping	= 0,
dtramp_min	= -60.0,
io_form_gfdda	= 2,

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/

&dfi_control
dfi_opt = 0
dfi_nfilter = 0
dfi_write_filtered_input = .false.
dfi_write_dfi_history = .false.
/

&dynamics
w_damping = 1,
diff_opt = 1,
km_opt = 4,
base_temp = 290.
khdif = 0, 0, 0,
kvdif = 0, 0, 0,
non_hydrostatic = .true., .true., .true.,
/

&bdy_control
spec_bdy_width = 5,
spec_zone = 1,
relax_zone = 4,
specified = .true., .false., .false.,
nested = .false., .true., .true.,
/

&namelist_quilt
nio_tasks_per_group = 0,
nio_groups = 1,
/

&grib2
/

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