WRF Physics Options

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WRF Physics

- Turbulence/Diffusion (diff_opt, km_opt)
- Radiation
  - Longwave (ra_lw_physics)
  - Shortwave (ra_sw_physics)
- Surface
  - Surface layer (sf_sfclay_physics)
  - Land/water surface (sf_surface_physics)
- PBL (bl_physics)
- Cumulus parameterization (cu_physics)
- Microphysics (mp_physics)

Turbulence/Diffusion

Sub-grid eddy mixing effects on all fields

diff_opt=1

- 2nd order diffusion on model levels
  - Constant vertical coefficient (kvdif)
  - Or Use with PBL
- km_opt
  - 1: constant (khdif and kvdif used)
  - 2: 1.5-order TKE prediction (not recommended with diff_opt=1)
  - 3: Smagorinsky (deformation/stability based K) (not recommended with diff_opt=1)
  - 4: 2D Smagorinsky (deformation based on horizontal wind for horizontal diffusion only)

diff_opt=2

- 2nd order horizontal diffusion
- Allows for terrain-following coordinate
- km_opt
  - 1: constant (khdif and kvdif used)
  - 2: 1.5-order TKE prediction
  - 3: Smagorinsky (deformation/stability based K)
  - 4: 2D Smagorinsky (deformation based on horizontal wind for horizontal diffusion only)

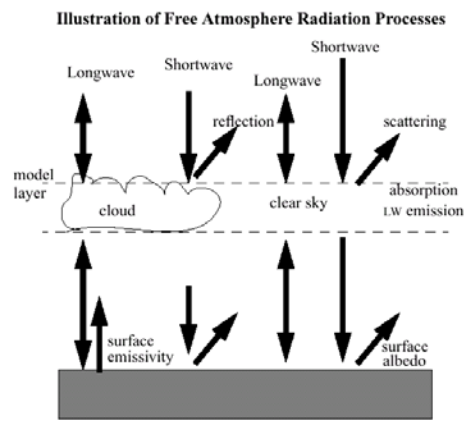
damp_opt=1

- Upper level damping layer
- Enhanced horizontal and (only for diff_opt=2) vertical diffusion at top
- Cosine function of height
- Uses additional parameters
  - zdamp: depth of damping layer
  - dampcoef: nondimensional maximum magnitude of damping

Radiation

Atmospheric temperature tendency

Surface radiative fluxes



ra_lw_physics=1

RRTM scheme

- Spectral scheme
- K-distribution
- Look-up table fit to accurate calculations
- Interacts with clouds
- Ozone/CO_2 from climatology

ra_lw_physics=99

GFDL longwave scheme

- used in Eta
- Spectral scheme from global model
- Also uses tables
- Interacts with clouds
- Ozone/CO_2 from climatology

ra_sw_physics=1

MM5 shortwave (Dudhia)

- Simple downward calculation
- Clear-sky scattering
- Water vapor absorption
- Cloud albedo and absorption

ra_sw_physics=2

Goddard shortwave

- Spectral method
- Interacts with clouds
- Ozone effects

ra_sw_physics=99

GFDL shortwave

- Used in Eta model
- Ozone effects
- Interacts with clouds

Surface schemes

Surface layer of atmosphere diagnostics (exchange coeffs)

Soil temperature/moisture/snow, etc.

sf_sfclay_physics=1

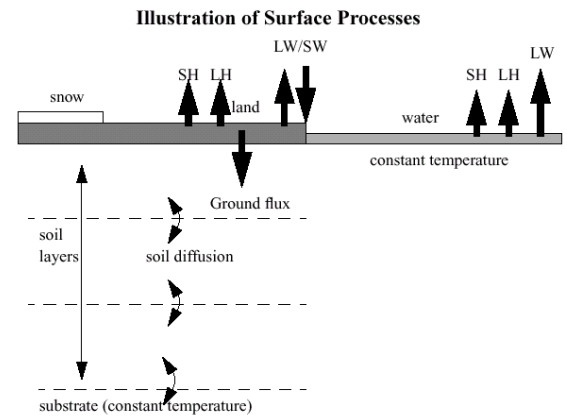
Monin-Obukhov similarity theory

- Taken from standard relations used in MM5 MRF PBL
- Provides exchange coefficients to surface (land) scheme
- Should be used with bl_pbl_physics=1

sf_sfclay_physics=2

Monin-Obukhov similarity theory

- Modifications due to Janjic
- Taken from standard relations used in Eta model, including Zilitinkevich thermal roughness length
- Should be used with bl_pbl_physics=2



sf_surface_physics=1

5-layer thermal diffusion model from MM5

- Predict ground temp and soil temps
- Thermal properties depend on land use
- No effect for water
- Provides heat and moisture fluxes for PBL

sf_surface_physics=2

Noah Land Surface Model

- Vegetation effects included
- Predicts soil temperature and soil moisture in four layers
- Predicts snow cover and canopy moisture
- Handles fractional snow cover and frozen soil
- Diagnoses skin temp
- Provides heat and moisture fluxes for PBL

sf_surface_physics=3

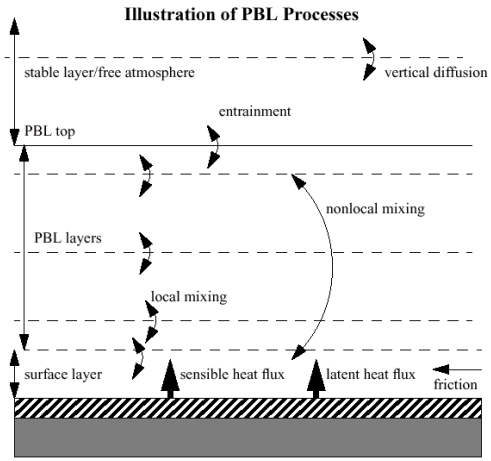
RUC Land Surface Model (Smirnova)

- Vegetation effects included
- Predicts soil temperature and soil moisture in six layers
- Multi-layer snow model
- Provides heat and moisture fluxes for PBL

Planetary Boundary Layer

Boundary layer fluxes (heat, moisture, momentum)

Vertical diffusion



bl_pbl_physics=1

YSU PBL scheme (Hong and Noh)

- Non-local K mixing in dry convective boundary layer
- Depth of PBL determined from thermal profile
- Explicit treatment of entrainment
- Vertical diffusion depends on Ri in free atmosphere

bl_pbl_physics=2

Mellor-Yamada-Janjic (Eta) PBL

- 1.5-order, level 2.5, TKE prediction
- Local K vertical mixing in boundary layer and free atmosphere

bl_pbl_physics=99

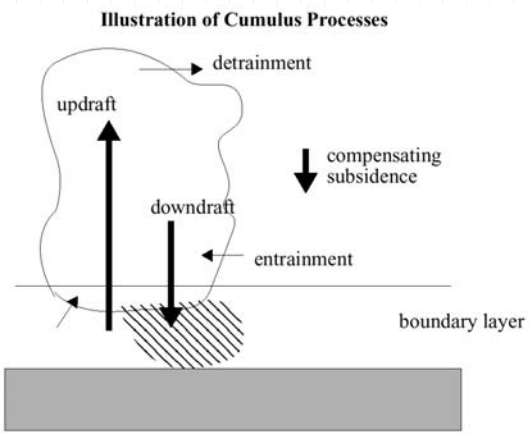
MRF PBL scheme (Hong and Pan 1996)

- Non-local K mixing in dry convective boundary layer
- Depth of PBL determined from critical Ri number
- Vertical diffusion depends on Ri in free atmosphere

Cumulus Parameterization

Atmospheric heat and moisture/cloud tendencies

Surface rainfall



cu_physics=1

New Kain-Fritsch

- As in MM5 and Eta test version
- Includes shallow convection
- CAPE removal time scale
- Mass flux type with updrafts and downdrafts, entrainment and detrainment
- Includes cloud detrainment

cu_physics=2

Betts-Miller-Janjic

- As in Eta model
- Adjustment type scheme
- No explicit updraft or downdraft

cu_physics=3

Grell-Devenyi Ensemble

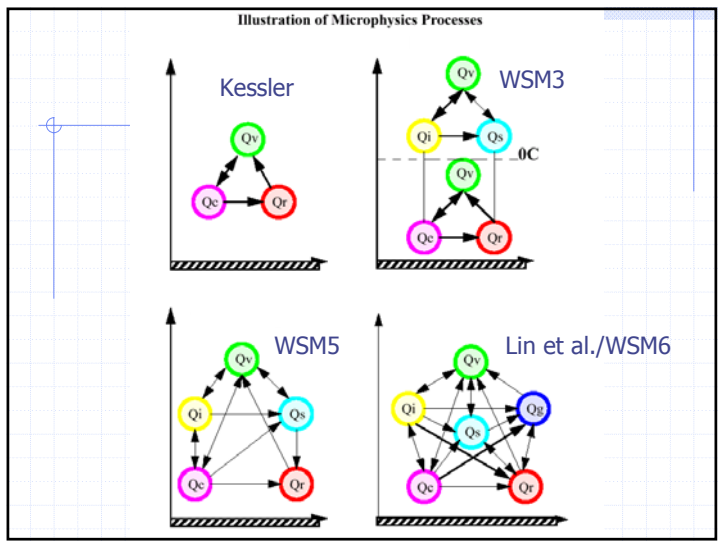
- Multiple-closure (e.g. CAPE removal, quasi-equilibrium)
- Multi-parameter (e.g maximum cap, precipitation efficiency)
- Explicit updrafts/downdrafts
- Mean feedback of ensemble is applied
- Weights can be tuned (spatially, temporally) to optimize scheme (training)

Microphysics

Atmospheric heat and moisture tendencies

Microphysical rates

Surface rainfall



mp_physics=1

Kessler scheme

- Warm rain – no ice
- Idealized microphysics

mp_physics=2

Purdue Lin et al. scheme

- 5-class microphysics including graupel
- Includes ice sedimentation

mp_physics=3

WSM 3-class scheme

- From Hong, Dudhia and Chen (2004)
- Replaces NCEP3 scheme
- 3-class microphysics with ice
- Ice processes below 0 deg C
- Ice number is function of ice content
- Ice sedimentation

mp_physics=4

WSM 5-class scheme

- Also from Hong, Dudhia and Chen (2004)
- Replaces NCEP5 scheme
- 5-class microphysics with ice
- Supercooled water and snow melt
- Ice sedimentation

mp_physics=5

Ferrier (current Eta) scheme

- One prognostic total condensate variable
- Designed for efficiency
- Diagnostic ice and water species and liquid fractions

mp_physics=6

WSM 6-class scheme

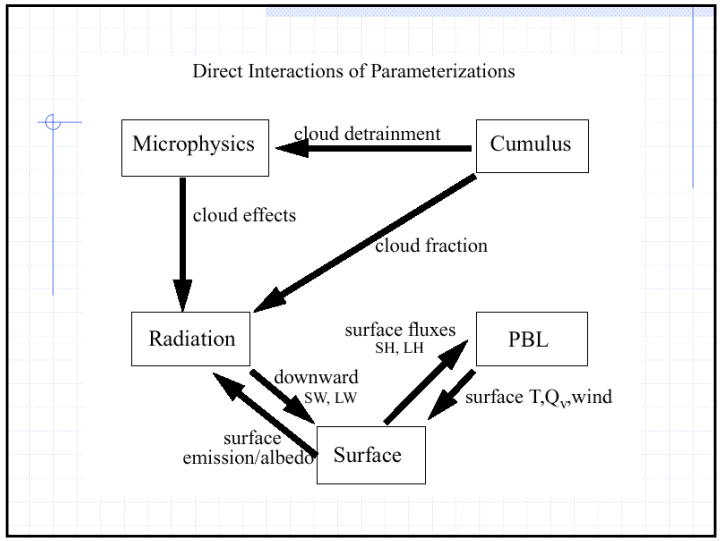
- From Hong and Lim (2003 workshop)
- 6-class microphysics with graupel
- Ice number concentration as in WSM3 and WSM5
- Modified accretion

mp_physics=98,99

NCEP3,NCEP5

- Old options from Version 1.3 still available for comparison
- To be phased out later

Physics Interactions



Physics Summary and Plans

Subgrid Turbulence

IN	WORKING ON	PLANNED
(1) Level 2.5 TKE (2)3d Smagorinsky (3) Const. coeffs. (4)2d Smagorinsky (mesoscale)		

Microphysics

IN	WORKING ON	PLANNED
(1) Kessler (2) Lin et al. [Purdue] (3) WSM3 (4) WSM5 (5) Eta (Ferrier) (6) WSM6	Reisner 2+	Goddard

Radiation

	IN	WORKING ON	PLANNED
Long	(1) RRTM (2) Eta (GFDL)	CAM lw	Goddard lw
Short	(1) Dudhia [MM5] (2) Goddard (3) Eta (GFDL)	CAM sw	RRTM sw

Boundary Layer

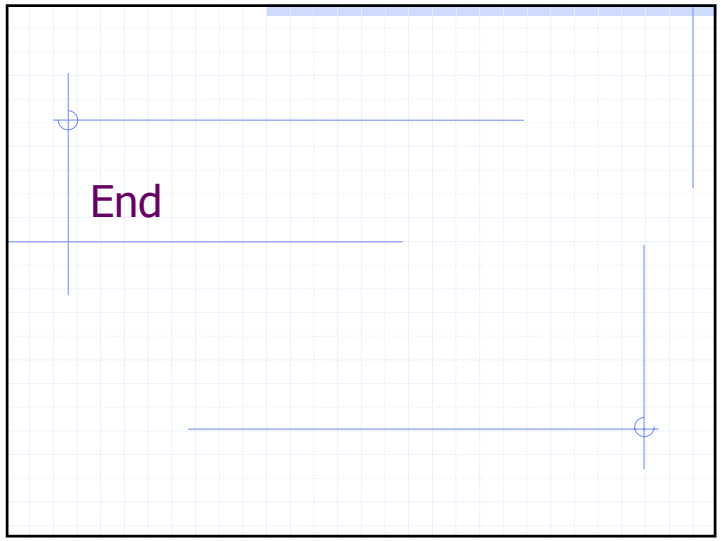
IN	WORKING ON	PLANNED
(1) YSU (2) M-Y-Janjic (3) MRF		

Surface

	IN	WORKING ON	PLANNED
Surface layer	(1) MRF Similarity (2) Eta Similarity		
Land surface	(1) 5-layer soil temp (2) Noah LSM (3) RUC LSM	CLM	

Cumulus

IN	WORKING ON	PLANNED
(1) New Kain-Fritsch (2) Betts-Miller-Janjic (3) Grell-Devenyi		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