Coupled WRF/Unified Noah LSM

Fei Chen, Mukul Tewari, Jimy Dudhia

NCAR

This document provides information about WRF routines that need to be modified to accommodate the unified Noah LSM (most useful for users wanting to modify LSM routines)

1 General Information

1.1 WRF physics calling order

1.1.1 SOLVER

1. Set up

   Set leapfrog or runge-kutta solver (2nd or 3rd order)
   CALL get_ijk_from_grid
   Compute these starting and stopping locations for each tile and number of tiles
   CALL set_tile

2. Physics
   CALL radiation_driver (calculate T tendency)
   CALL surface_drive (call surface layer and LSM to calculate surface fluxes and skin temperature, update soil moisture, temperature, snow)
   CALL pbl_drive (calculate T,q tendency)
   CALL cumulus_drive (calculate T,q tendency)
   CALL calculate_phy_ten (sum up all tendencies)

3. Dynamics
   Updates dry dynamic variables (u,v,theta,geopot. height, W)
   Update scalers (qv, qc, TKE)
   Advection, working on updated variables, to update everthing

   CALL update_phy_ten
   CALL vertical_diffusion
   CALL horizontal_diffusion

CALL rk_tendenc

3. Microphysics
   CALL microphysics_drive

2 Modified Routines for Noah LSM

2.1 Physics routines

/main:

WRF.F (no LSM related change)
USE module_intergrate

/frame:

module_intergrate.F (no LSM related change)

Call solve_interface

/share:

solve_interface.F (no LSM related change)

CALL solve_em

CALL solve_nmm

/dyn_em:

solve_em.F

CALL radiation_driver (EMISS,
XLAND,TSK,HTOP,HBOT,CUPPT,VEGFRA,SNOW, …)

CALL surface_driver (lots of changes)

Call pbl_driver (TSK,XLAND,ZNT,HT,PBLH, HFX,QFX,REGIME,
GRDFLX, u_phy,v_phy,th_phy,rho, AKHS, AKMS,
THZ0,QZ0,UZ0,VZ0,QSFC, PSIM, PSIH, GZ1OZ0, WSPD, BR,
CHKLOWQ,…)

CALL cumulus_drive (add RAINC,RAINCV)

CALL microphysics_driver (add RAINNCV variables)

/phys:

module_radiation_drive.F

SUBROUTINE radiation_drive

module_surface_drive.F

SUBROUTINE surface_drive

CALL SFCLAY(XLAND, HFX,QFX,TSK,FLHC, FLQC,
QGH, U10,V10,TH2,T2,Q2)

CALL MYJSFC

CALL lsm (dz8w,moist(ims,kms,jms,P_QV),p8w,rho,
t_phy,th_phy,TSK,CHS, HFX, QFX, QGH, GSW,
GLW, ELFLX, SMSTAV,SMSTOT,SFCRUNOFF,
UDRUNOFF, IVGTYP, ISLTYP, VEGFRA,
SFCEVP, POTEVP, GRDFLX, SFCEXC,
ACSNOW, ACSNOM, SNOPCX, ALBSF, TMN,
XLAND, XICE,QZ0, th2, q2, SNOWC, CHS2,
QSFC, TBOT, CHKLOWQ, RAINBL,
num_soil_layers, DTBL, DZS,itimestep, SMOIS,
TSLB, SNOW,CANWAT,CPM,RCP, ALBEDO,
SNOALB,SMLIQ,SNOWH, ..)

CALL SFCDIAGS (HFX, QFX, TSK, QSFC, CHS2, T2,
TH2,Q2…)

module_pbl_drive.F

SUBROUTINE pbl_driver (list chage)

CALL MRF (…, ZNT, UST, ZOL, HOL, PBLH, REGIME,
PSIM, PSIH, XLAND, HFX, QFX, TSKOLD, GZ1OZ0,
WSPD…)

CALL MYJPBL

module_cumulus_driver.F

SUBROUTINE cumulus_drive (list change)

CALL KFCP

CALL BMJDR

CALL KF_ETA_CP

microphysics_driver.F

SUBROUTINE microphysics_driver (add RAINNCV)

CALL kessle (add RAINNCV)

CALL lin_et_al (add RAINNCV)

CALL ncloud3 (add RAINNCV)

CALL ncloud5 (add RAINNCV)

CALL ETAMP_NEW (add RAINNCV)

/phys:

physics_drive.int

SUBROUTINE pbl_driver(add variables in the list)
add RAINNCV in the SUBROUTINE microphysics_driver ???

/phys:

module_physics_init.F

SUBROUTINE phy_init **(** add LSM variables)

CALL landuse_init(lu_index, snowc, albedo, albbck, avail, emiss, znt, Z0, thc, xland, julday, cen_lat, iswater, mminlu_loc, …)

CALL lsminit(…..)

2.2 Initialization routines

/dyn_em:

start_em.F

CALL phy_init (…, GLW,GSW,EMISS,LU_INDEX,
ALBEDO,ALBBCK, JULDAY, TMN,XLAND,ZNT,Z0,
HFX,QFX,RAINBL, TSLB,ZS,DZS,num_soil_layers,warm_rain,
XICE,VEGFRA,SNOW,CANWAT,SMSTAV, SMSTOT,
SFCRUNOFF,UDRUNOFF,GRDFLX,ACSNOW,
ACSNOM,IVGTYP,ISLTYP, SFCEVP,SMOIS, SH2O, SNOWH)

CALL lsminit (…)

module_initialize_real.F

CALL adjust_soil_temp_new (…, tsk , ht , toposoil , landmask ,
flag_toposoil , st000010 , st010040 , st040100 , st100200 ,
st010200, flag_st000010 , flag_st010040 , flag_st040100 ,
flag_st100200 , flag_st010200 , soilt000 , soilt005 , soilt020 ,
soilt040 , soilt160 , soilt300 , flag_soilt000 , flag_soilt005 ,
flag_soilt020 , flag_soilt040 , flag_soilt160 , flag_soilt300…)

CALL process_soil_real (tsk , tmn , xland , landmask , sst , st_input ,
sm_input , sw_input , st_levels_input , sm_levels_input ,
sw_levels_input , zs , dzs , tslb , smois , sh2o , flag_sst , …)

module_si_io_em.F

! 2D - for LSM, seaice and snow, maybe runoff is later.

```
IF ( .NOT. ALLOCATED ( seaice_input)      ) ALLOCATE ( seaice_input(ix,jx) )
IF ( .NOT. ALLOCATED ( snow_input)        ) ALLOCATE ( snow_input(ix,jx) )
IF ( .NOT. ALLOCATED ( canwat_input)      ) ALLOCATE( canwat_input(ix,jx) )
IF ( .NOT. ALLOCATED ( landuse_input)     ) ALLOCAT ( landuse_input(ix,jx) )
IF ( .NOT. ALLOCATED ( landmask_input)    ) ALLOCAT(landmask_input(ix,jx))
```

Etc.

/share

module_soil_pre.F

For bl_surface_physics .EQ. 2
CALL init_soil_depth_2 (zs , dzs , num_soil_layers)
CALL init_soil_2_real (tsk , tmn , smois , sh2o , tslb , st_input ,
sm_input , sw_input , landmask , sst , zs , dzs , st_levels_input ,
sm_levels_input , sw_levels_input , num_soil_layers ,
num_st_levels_input , num_sm_levels_input , num_sw_levels_input ,

num_st_levels_alloc , num_sm_levels_alloc , num_sw_levels_alloc , flag_sst , …)

2.3 Registry

/Registry:

Registry.EM

Add LSM variables: ZS, DZS, TSLB, SMOIS, SH2O, SNOW, SNOWH, CANWAT, IFNDSNOW, IFNDSOILW, TMN

2.4 Namelist

/test/em_real

namelist.input

num_soil_layers = 4 (Noah)

bl_surface_physics = 2 (Noah)

2.5 Tables

/run:

LANDUSE.TBL

SOILPARM.TBL

VEGPARM.TBL

2.6 Makefile

Each makefile in the directories described above