

CCPP Training

College Park, MD, March 12-13, 2019

# New horizons: adding new schemes, modifying or constructing suites

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# Outline of Talk

- Adding a new scheme to a suite
- Changing or constructing suites

# A simple new scheme: qgrs\_debug

Suppose some process (scheme) is writing bad data to the 4-dim. tracer array: bad physics? memory leak?

The “old” way:

- put print statements in GFS\_physics\_driver (and others)
- use Fortran `.inc` file to avoid making repeated changes
- requires searching and editing multiple files, recompiling

The “new” way:

- write a simple CCPP scheme
- add calls to suite definition file (runtime configurable!)

# CCPP scheme qgrs\_debug

```
...
!! \section arg_table_qgrs_debug_run
!! | local_name | standard_name          | long_name | ...
!! |-----|-----|-----|...
!! | qgrs      | tracer_concentration  | ...      | ...
!! | errmsg    | ccpp_error_message    | ...      | ...
!! | errflg    | ccpp_error_flag      | ...      | ...
!!
subroutine qgrs_debug_run(qgrs,errmsg,errflg)
  real(kind_phys), intent(in) :: qgrs(:, :, :)
  character(len=*), intent(out) :: errmsg
  integer, intent(out) :: errflg
  errmsg = ''
  errflg = 0
  write(0,*) 'qgrs: ', minval(qgrs), maxval(qgrs)
end subroutine qgrs_debug_run
...
```

# Add scheme to CCPP prebuild

- Edit `ccpp/config/ccpp_prebuild_config.py`

```
...  
SCHEME_FILES = {  
    ...  
    'ccpp/physics/physics/qgrs_debug.F90' : \  
        [ 'slow_physics' ],  
    ...  
}  
...
```

- No changes required for `SCHEME_FILE_DEPENDENCIES` or `OPTIONAL_ARGUMENTS` in this case
- Compile code in CCPP dynamic/standalone mode

# Done.



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# Changing or constructing suites

A few things to keep in mind

- While CCPP allows changing the order of schemes in the suite definition file, this doesn't guarantee that the physics will be correct
- In particular, interstitial code needs to be checked and quite often modified
- “Good” interstitial code (modular, depending on one scheme only, with documentation) will bring you back to the beach quicker, but will make the suite definition file longer
- `CCPP_VARIABLES_FV3.{tex,pdf}` helps identifying which schemes read from or write to a variable

# Example: replace Zhao-Carr MP

```

suite_FV3_GFS_2017_updated.xml | suite_FV3_GFS_2017_updated_gfdlmp.xml
<?xml version="1.0" encoding="UTF-8"?> | <?xml version="1.0" encoding="UTF-8"?>
<suite name="FV3 GFS 2017 updated" lib="ccppphys" ver="2"> | <suite name="FV3 GFS 2017 updated gfdlmp" lib="ccppphys" ver="2">
  <!-- <init></init> --> | <!-- <init></init> -->
  <group name="time vary"> | <group name="fast physics">
    <subcycle loop="1"> | <subcycle loop="1">
      <scheme>GFS_time_vary_pre</scheme> | <scheme>fv_sat_adj</scheme>
      <scheme>GFS_rrtmg_setup</scheme> | </subcycle>
      <scheme>GFS_rad_time_vary</scheme> | </group>
      <scheme>GFS_phys_time_vary</scheme> | <group name="time vary">
      <scheme>stochastic_physics</scheme> | <subcycle loop="1">
      <scheme>stochastic_physics_sfc</scheme> | <scheme>GFS_time_vary_pre</scheme>
    </subcycle> | <scheme>GFS_rrtmg_setup</scheme>
  </group> | <scheme>GFS_rad_time_vary</scheme>
  <group name="radiation"> | <scheme>GFS_phys_time_vary</scheme>
    <subcycle loop="1"> | <scheme>stochastic_physics</scheme>
      <scheme>GFS_suite_interstitial_rad_reset</scheme> | <scheme>stochastic_physics_sfc</scheme>
      <scheme>GFS_rrtmg_pre</scheme> | </subcycle>
      <scheme>rrtmg_sw_pre</scheme> | </group>
      <scheme>rrtmg_sw</scheme> | <group name="radiation">
      <scheme>rrtmg_sw_post</scheme> | <subcycle loop="1">
      <scheme>rrtmg_lw_pre</scheme> | <scheme>GFS_suite_interstitial_rad_reset</scheme>
      <scheme>rrtmg_lw</scheme> | <scheme>GFS_rrtmg_pre</scheme>
      <scheme>rrtmg_lw_post</scheme> | <scheme>rrtmg_sw_pre</scheme>
      <scheme>GFS_rrtmg_post</scheme> | <scheme>rrtmg_sw</scheme>
    </subcycle> | <scheme>rrtmg_sw_post</scheme>
  </group> | <scheme>rrtmg_lw_pre</scheme>
  <group name="physics"> | <scheme>rrtmg_lw</scheme>
    <subcycle loop="1"> | <scheme>rrtmg_lw_post</scheme>
      <scheme>GFS_suite_interstitial_phys_reset</scheme> | <scheme>GFS_rrtmg_post</scheme>
      <scheme>GFS_suite_stateout_reset</scheme> | </subcycle>
      <scheme>get_prs_fv3</scheme> | </group>
      <scheme>GFS_suite_interstitial_1</scheme> | <group name="physics">
      <scheme>dcyc2t3</scheme> | <subcycle loop="1">
      <scheme>GFS_surface_generic_pre</scheme> | <scheme>GFS_suite_interstitial_phys_reset</scheme>
      <scheme>GFS_suite_interstitial_2</scheme> | <scheme>GFS_suite_stateout_reset</scheme>
    </subcycle> | <scheme>get_prs_fv3</scheme>
  <!-- Surface iteration loop --> | <scheme>GFS_suite_interstitial_1</scheme>
  <subcycle loop="2"> | <scheme>dcyc2t3</scheme>
    <scheme>sfc_ex_coef</scheme> | <scheme>GFS_surface_generic_pre</scheme>
    <scheme>GFS_surface_loop_control_part1</scheme> | <scheme>GFS_suite_interstitial_2</scheme>
  </subcycle> | </subcycle>

```



# Example: replace Zhao-Carr MP

```
</scheme>GFS_surface_loop_control_part2</scheme>
</subcycle>
<!-- End of surface iteration loop -->
<subcycle loop="1">
  <scheme>dcyc2t3_post</scheme>
  <scheme>sfc_diag</scheme>
  <scheme>sfc_diag_post</scheme>
  <scheme>GFS_surface_generic_post</scheme>
  <scheme>GFS_PBL_generic_pre</scheme>
  <scheme>hedmf</scheme>
  <scheme>GFS_PBL_generic_post</scheme>
  <scheme>gwdps_pre</scheme>
  <scheme>gwdps</scheme>
  <scheme>gwdps_post</scheme>
  <scheme>rayleigh_damp</scheme>
  <scheme>GFS_suite_stateout_update</scheme>
  <scheme>ozphys</scheme>
  <scheme>GFS_DCNV_generic_pre</scheme>
  <scheme>get_phi_fv3</scheme>
  <scheme>GFS_suite_interstitial_3</scheme>
  <scheme>samfdeepcnv</scheme>
  <scheme>GFS_DCNV_generic_post</scheme>
  <scheme>gwdc_pre</scheme>
  <scheme>gwdc</scheme>
  <scheme>gwdc_post</scheme>
  <scheme>GFS_SCNV_generic_pre</scheme>
  <scheme>samfshalcnv</scheme>
  <scheme>samfshalcnv_post</scheme>
  <scheme>GFS_SCNV_generic_post</scheme>
  <scheme>GFS_suite_interstitial_4</scheme>
  <scheme>cnvc90</scheme>
  <scheme>GFS_MP_generic_pre</scheme>
  <scheme>zhaocarr_gscond</scheme>
  <scheme>zhaocarr_precpd</scheme>
  <scheme>GFS_MP_generic_post</scheme>
  <scheme>sfc_sice_post</scheme>
</subcycle>
</group>
<group name="stochastics">
  <subcycle loop="1">
    <scheme>GFS_stochastics</scheme>
  </subcycle>
</group>
<!-- <finalize></finalize> -->
</suite>
```

```
</scheme>GFS_surface_loop_control_part2</scheme>
</subcycle>
<!-- End of surface iteration loop -->
<subcycle loop="1">
  <scheme>dcyc2t3_post</scheme>
  <scheme>sfc_diag</scheme>
  <scheme>sfc_diag_post</scheme>
  <scheme>GFS_surface_generic_post</scheme>
  <scheme>GFS_PBL_generic_pre</scheme>
  <scheme>hedmf</scheme>
  <scheme>GFS_PBL_generic_post</scheme>
  <scheme>gwdps_pre</scheme>
  <scheme>gwdps</scheme>
  <scheme>gwdps_post</scheme>
  <scheme>rayleigh_damp</scheme>
  <scheme>GFS_suite_stateout_update</scheme>
  <scheme>ozphys</scheme>
  <scheme>GFS_DCNV_generic_pre</scheme>
  <scheme>get_phi_fv3</scheme>
  <scheme>GFS_suite_interstitial_3</scheme>
  <scheme>samfdeepcnv</scheme>
  <scheme>GFS_DCNV_generic_post</scheme>
  <scheme>gwdc_pre</scheme>
  <scheme>gwdc</scheme>
  <scheme>gwdc_post</scheme>
  <scheme>GFS_SCNV_generic_pre</scheme>
  <scheme>samfshalcnv</scheme>
  <scheme>samfshalcnv_post</scheme>
  <scheme>GFS_SCNV_generic_post</scheme>
  <scheme>GFS_suite_interstitial_4</scheme>
  <scheme>cnvc90</scheme>
  <scheme>GFS_MP_generic_pre</scheme>
  <scheme>gfdl_cloud_microphys</scheme>
  <scheme>GFS_MP_generic_post</scheme>
  <scheme>sfc_sice_post</scheme>
</subcycle>
</group>
<group name="stochastics">
  <subcycle loop="1">
    <scheme>GFS_stochastics</scheme>
  </subcycle>
</group>
<!-- <finalize></finalize> -->
</suite>
```

# Example: suite2 (PBL, h<sub>2</sub>O/o<sup>3</sup>-phys)

```
<scheme>GFS_surface_loop_control_part2</scheme>
</subcycle>
<!-- End of surface iteration loop -->
<subcycle loop="1">
  <scheme>dcyc2t3_post</scheme>
  <scheme>sfc_diag</scheme>
  <scheme>sfc_diag_post</scheme>
  <scheme>GFS_surface_generic_post</scheme>
  <scheme>GFS_PBL_generic_pre</scheme>
  <scheme>hedmf</scheme>
  <scheme>GFS_PBL_generic_post</scheme>
  <scheme>gwdps_pre</scheme>
  <scheme>gwdps</scheme>
  <scheme>gwdps_post</scheme>
  <scheme>rayleigh_damp</scheme>
  <scheme>GFS_suite_stateout_update</scheme>
  <scheme>ozphys</scheme>
  <scheme>GFS_DCNV_generic_pre</scheme>
  <scheme>get_phi_fv3</scheme>
  <scheme>GFS_suite_interstitial_3</scheme>
  <scheme>samfdeepcnv</scheme>
  <scheme>GFS_DCNV_generic_post</scheme>
  <scheme>gwdc_pre</scheme>
  <scheme>gwdc</scheme>
  <scheme>gwdc_post</scheme>
  <scheme>GFS_SCNV_generic_pre</scheme>
  <scheme>samfshalcnv</scheme>
  <scheme>samfshalcnv_post</scheme>
  <scheme>GFS_SCNV_generic_post</scheme>
  <scheme>GFS_suite_interstitial_4</scheme>
  <scheme>cnvc90</scheme>
  <scheme>GFS_MP_generic_pre</scheme>
  <scheme>gfdl_cloud_microphys</scheme>
  <scheme>GFS_MP_generic_post</scheme>
  <scheme>sfc_sice_post</scheme>
</subcycle>
</group>
<group name="stochastics">
  <subcycle loop="1">
    <scheme>GFS_stochastics</scheme>
  </subcycle>
</group>
<!-- <finalize></finalize> -->
</suite>
```

```
<scheme>GFS_surface_loop_control_part2</scheme>
</subcycle>
<!-- End of surface iteration loop -->
<subcycle loop="1">
  <scheme>dcyc2t3_post</scheme>
  <scheme>sfc_diag</scheme>
  <scheme>sfc_diag_post</scheme>
  <scheme>GFS_surface_generic_post</scheme>
  <scheme>GFS_PBL_generic_pre</scheme>
  <scheme>satmedmfvdif</scheme>
  <scheme>GFS_PBL_generic_post</scheme>
  <scheme>gwdps_pre</scheme>
  <scheme>gwdps</scheme>
  <scheme>gwdps_post</scheme>
  <scheme>rayleigh_damp</scheme>
  <scheme>GFS_suite_stateout_update</scheme>
  <scheme>ozphys_2015</scheme>
  <scheme>h2ophys</scheme>
  <scheme>GFS_DCNV_generic_pre</scheme>
  <scheme>get_phi_fv3</scheme>
  <scheme>GFS_suite_interstitial_3</scheme>
  <scheme>samfdeepcnv</scheme>
  <scheme>GFS_DCNV_generic_post</scheme>
  <scheme>gwdc_pre</scheme>
  <scheme>gwdc</scheme>
  <scheme>gwdc_post</scheme>
  <scheme>GFS_SCNV_generic_pre</scheme>
  <scheme>samfshalcnv</scheme>
  <scheme>samfshalcnv_post</scheme>
  <scheme>GFS_SCNV_generic_post</scheme>
  <scheme>GFS_suite_interstitial_4</scheme>
  <scheme>cnvc90</scheme>
  <scheme>GFS_MP_generic_pre</scheme>
  <scheme>gfdl_cloud_microphys</scheme>
  <scheme>GFS_MP_generic_post</scheme>
  <scheme>sfc_sice_post</scheme>
</subcycle>
</group>
<group name="stochastics">
  <subcycle loop="1">
    <scheme>GFS_stochastics</scheme>
  </subcycle>
</group>
<!-- <finalize></finalize> -->
</suite>
```

# Example: "suite2" → "suite4"

```
<?xml version="1.0" encoding="UTF-8"?>
<suite name="suite FV3 GFS suite2" lib="ccppphys" ver="2">
  <!-- <init></init> -->
  <group name="fast physics">
    <subcycle loop="1">
      <scheme>fv_sat_adj</scheme>
    </subcycle>
  </group>
  <group name="time vary">
    <subcycle loop="1">
      <scheme>GFS_time_vary_pre</scheme>
      <scheme>GFS_rrtmng_setup</scheme>
      <scheme>GFS_rad_time_vary</scheme>
      <scheme>GFS_phys_time_vary</scheme>
      <scheme>stochastic_physics</scheme>
      <scheme>stochastic_physics_sfc</scheme>
    </subcycle>
  </group>
  <group name="radiation">
    <subcycle loop="1">
      <scheme>GFS_suite_interstitial_rad_reset</scheme>
      <scheme>GFS_rrtmng_pre</scheme>
      <scheme>rrtmng_sw_pre</scheme>
      <scheme>rrtmng_sw</scheme>
      <scheme>rrtmng_sw_post</scheme>
      <scheme>rrtmng_lw_pre</scheme>
      <scheme>rrtmng_lw</scheme>
      <scheme>rrtmng_lw_post</scheme>
      <scheme>GFS_rrtmng_post</scheme>
    </subcycle>
  </group>
  <group name="physics">
    <subcycle loop="1">
      <scheme>GFS_suite_interstitial_phys_reset</scheme>
      <scheme>GFS_suite_stateout_reset</scheme>
      <scheme>get_prs fv3</scheme>
      <scheme>GFS_suite_interstitial_1</scheme>
      <scheme>dcyc2t3</scheme>
      <scheme>GFS_surface_generic_pre</scheme>
      <scheme>GFS_suite_interstitial_2</scheme>
    </subcycle>
  <!-- Surface iteration loop -->
  <subcycle loop="2">
    <scheme>sfc_ex_coef</scheme>
    <scheme>GFS_surface_loop_control_part1</scheme>
  </subcycle>
</suite>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<suite name="FV3 GSD" lib="ccppphys" ver="2">
  <!-- <init></init> -->
  <group name="time vary">
    <subcycle loop="1">
      <scheme>GFS_time_vary_pre</scheme>
      <scheme>GFS_rrtmng_setup</scheme>
      <scheme>GFS_rad_time_vary</scheme>
      <scheme>GFS_phys_time_vary</scheme>
      <scheme>stochastic_physics</scheme>
      <scheme>stochastic_physics_sfc</scheme>
    </subcycle>
  </group>
  <group name="radiation">
    <subcycle loop="1">
      <scheme>GFS_suite_interstitial_rad_reset</scheme>
      <scheme>GFS_rrtmng_pre</scheme>
      <scheme>rrtmng_sw_pre</scheme>
      <scheme>mynnrad_pre</scheme>
      <scheme>rrtmng_sw</scheme>
      <scheme>rrtmng_sw_post</scheme>
      <scheme>rrtmng_lw_pre</scheme>
      <scheme>rrtmng_lw</scheme>
      <scheme>mynnrad_post</scheme>
      <scheme>rrtmng_lw_post</scheme>
      <scheme>GFS_rrtmng_post</scheme>
    </subcycle>
  </group>
  <group name="physics">
    <subcycle loop="1">
      <scheme>GFS_suite_interstitial_phys_reset</scheme>
      <scheme>GFS_suite_stateout_reset</scheme>
      <scheme>get_prs fv3</scheme>
      <scheme>GFS_suite_interstitial_1</scheme>
      <scheme>dcyc2t3</scheme>
      <scheme>GFS_surface_generic_pre</scheme>
      <scheme>GFS_suite_interstitial_2</scheme>
    </subcycle>
  <!-- Surface iteration loop -->
  <subcycle loop="2">
    <scheme>sfc_ex_coef</scheme>
    <scheme>GFS_surface_loop_control_part1</scheme>
  </subcycle>
</suite>
```

# Example: "suite2" → "suite4"

<pre> &lt;subcycle loop="2"&gt;   &lt;scheme&gt;sfc_ex_coef&lt;/scheme&gt;   &lt;scheme&gt;GFS_surface_loop_control_part1&lt;/scheme&gt;   &lt;scheme&gt;sfc_nst_pre&lt;/scheme&gt;   &lt;scheme&gt;sfc_nst&lt;/scheme&gt;   &lt;scheme&gt;sfc_nst_post&lt;/scheme&gt;   &lt;scheme&gt;lsm_noah&lt;/scheme&gt;   &lt;scheme&gt;sfc_sice&lt;/scheme&gt;   &lt;scheme&gt;GFS_surface_loop_control_part2&lt;/scheme&gt; &lt;/subcycle&gt; &lt;!-- End of surface iteration loop --&gt; &lt;subcycle loop="1"&gt;   &lt;scheme&gt;dcyc2t3_post&lt;/scheme&gt;   &lt;scheme&gt;sfc_diag&lt;/scheme&gt;   &lt;scheme&gt;sfc_diag_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_surface_generic_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_PBL_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;satmedmfvdif&lt;/scheme&gt;   &lt;scheme&gt;GFS_PBL_generic_post&lt;/scheme&gt;   &lt;scheme&gt;gwdps_pre&lt;/scheme&gt;   &lt;scheme&gt;gwdps&lt;/scheme&gt;   &lt;scheme&gt;gwdps_post&lt;/scheme&gt;   &lt;scheme&gt;rayleigh_damp&lt;/scheme&gt;   &lt;scheme&gt;GFS_suite_stateout_update&lt;/scheme&gt;   &lt;scheme&gt;ozphys_2015&lt;/scheme&gt;   &lt;scheme&gt;h2ophys&lt;/scheme&gt;   &lt;scheme&gt;GFS_DCNV_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;get_phi_fv3&lt;/scheme&gt;   &lt;scheme&gt;GFS_suite_interstitial_3&lt;/scheme&gt;   &lt;scheme&gt;samfdeepcnv&lt;/scheme&gt;   &lt;scheme&gt;GFS_DCNV_generic_post&lt;/scheme&gt;   &lt;scheme&gt;gwdc_pre&lt;/scheme&gt;   &lt;scheme&gt;gwdc&lt;/scheme&gt;   &lt;scheme&gt;gwdc_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_SCNV_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;samfshalcnv&lt;/scheme&gt;   &lt;scheme&gt;samfshalcnv_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_SCNV_generic_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_suite_interstitial_4&lt;/scheme&gt;   &lt;scheme&gt;cnvc90&lt;/scheme&gt;   &lt;scheme&gt;GFS_MP_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;gfdl_cloud_microphys&lt;/scheme&gt;   &lt;scheme&gt;GFS_MP_generic_post&lt;/scheme&gt;   &lt;scheme&gt;sfc_sice_post&lt;/scheme&gt; &lt;/subcycle&gt; &lt;/group&gt; </pre>		<pre> &lt;/subcycle&gt; &lt;!-- Surface iteration loop --&gt; &lt;subcycle loop="2"&gt;   &lt;scheme&gt;sfc_ex_coef&lt;/scheme&gt;   &lt;scheme&gt;GFS_surface_loop_control_part1&lt;/scheme&gt;   &lt;scheme&gt;sfc_nst_pre&lt;/scheme&gt;   &lt;scheme&gt;sfc_nst&lt;/scheme&gt;   &lt;scheme&gt;sfc_nst_post&lt;/scheme&gt;   &lt;scheme&gt;lsm_ruc&lt;/scheme&gt;   &lt;scheme&gt;GFS_surface_loop_control_part2&lt;/scheme&gt; &lt;/subcycle&gt; &lt;!-- End of surface iteration loop --&gt; &lt;subcycle loop="1"&gt;   &lt;scheme&gt;dcyc2t3_post&lt;/scheme&gt;   &lt;scheme&gt;sfc_diag&lt;/scheme&gt;   &lt;scheme&gt;sfc_diag_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_surface_generic_post&lt;/scheme&gt;   &lt;scheme&gt;mynnedmf_wrapper&lt;/scheme&gt;   &lt;scheme&gt;gwdps_pre&lt;/scheme&gt;   &lt;scheme&gt;gwdps&lt;/scheme&gt;   &lt;scheme&gt;gwdps_post&lt;/scheme&gt;   &lt;scheme&gt;rayleigh_damp&lt;/scheme&gt;   &lt;scheme&gt;GFS_suite_stateout_update&lt;/scheme&gt;   &lt;scheme&gt;ozphys_2015&lt;/scheme&gt;   &lt;scheme&gt;h2ophys&lt;/scheme&gt;   &lt;scheme&gt;GFS_DCNV_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;get_phi_fv3&lt;/scheme&gt;   &lt;scheme&gt;GFS_suite_interstitial_3&lt;/scheme&gt;   &lt;scheme&gt;cu_gf_driver_pre&lt;/scheme&gt;   &lt;scheme&gt;cu_gf_driver&lt;/scheme&gt;   &lt;scheme&gt;GFS_DCNV_generic_post&lt;/scheme&gt;   &lt;scheme&gt;gwdc_pre&lt;/scheme&gt;   &lt;scheme&gt;gwdc&lt;/scheme&gt;   &lt;scheme&gt;gwdc_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_SCNV_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;GFS_SCNV_generic_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_suite_interstitial_4&lt;/scheme&gt;   &lt;scheme&gt;cnvc90&lt;/scheme&gt;   &lt;scheme&gt;GFS_MP_generic_pre&lt;/scheme&gt;   &lt;scheme&gt;mp_thompson_hrrr_pre&lt;/scheme&gt;   &lt;scheme&gt;mp_thompson_hrrr&lt;/scheme&gt;   &lt;scheme&gt;mp_thompson_hrrr_post&lt;/scheme&gt;   &lt;scheme&gt;GFS_MP_generic_post&lt;/scheme&gt;   &lt;scheme&gt;cu_gf_driver_post&lt;/scheme&gt; &lt;/subcycle&gt; &lt;/group&gt; </pre>
---	--	--

# Wrap up

- Adding a new scheme to a suite is easy
- Changing or constructing suites may require changing, adding or replacing interstitial code
- Note: things get a little more complicated when variables required by the new scheme don't exist yet (next session)