Real

Description of General Functions

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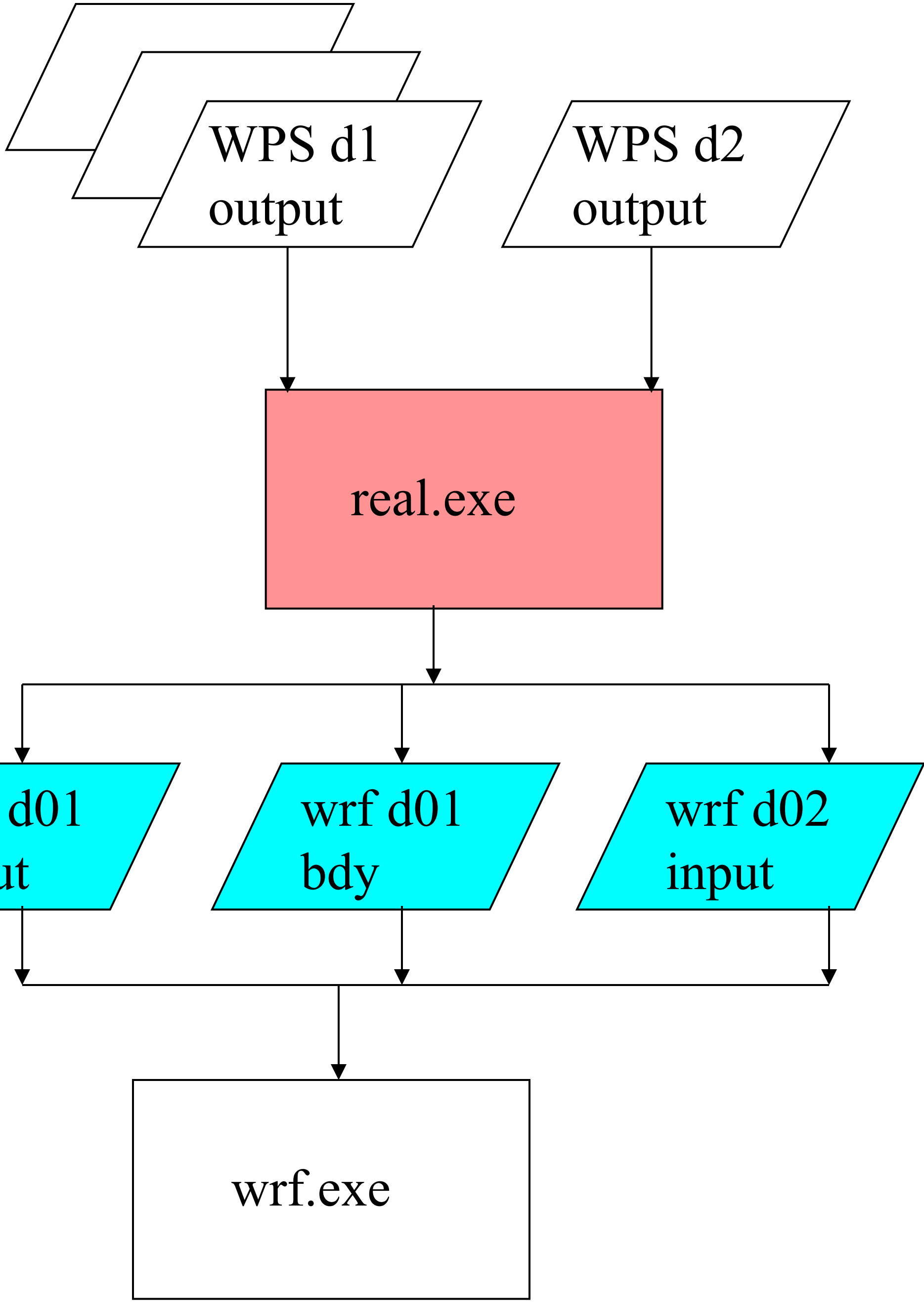

Real program in a nutshell

- Function
- Standard input variables
- Base State
- Standard generated output
- Vertical interpolation
- Soil level interpolation
- Nested processing

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Loads of definitions …

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From whence do they come?

What are the restrictions on metgrid vertical coordinates?

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Are there recommendations?

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Why is the surface layer scheme special compared to the other physics options?

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What is required in real to do nesting in WRF?

What is optional in real to do nesting in WRF?

Function

- The WRF model pre-processor is ***real.exe***
- The real.exe program is available ***serial*** or ***DM parallel*** (primarily for aggregate memory purposes, as opposed to timing performance)
- This program is automatically generated when the model is built and the requested use is for a real data case
- The real.exe program takes data ***from WPS*** and transform the data ***for WRF***
- Similar to the ARW idealized data pre-processor, real.exe is tightly coupled to the WRF model through the ***Registry***

Function

- ***3D forecast*** or simulation
- ***Meteorological input*** data that primarily originated from a previous forecast or analysis, probably via the WPS package
- Anticipated ***utilization of physics*** packages for microphysics, surface conditions, radiation, convection, and boundary layer (maybe usage of nudging capabilities)

Function

- A non-Cartesian ***projected domain***
  - Lambert conformal, Mercator, polar stereographic, rotated latitude/longitude (global or regional)
- Selection of ***realistic static fields*** of topography, land use, vegetation, and soil category data
- Requirement of ***time dependent*** lateral boundary conditions for a regional forecast

Function

- Generation of ***diagnostics*** necessary for assumed WRF model input
- Input field ***adjustment*** for consistency of static and time dependent fields (land mask with soil temperature, etc.)
- ARW: computation of ***reference*** and ***perturbation*** fields
- Generation of ***initial*** state for each of the requested domains
- Creation of a ***lateral boundary file*** for the most coarse domain
- ***Vertical interpolation*** for 3d meteorological fields and for sub-surface soil data

Standard Input Variables

- The metgrid program typically provides meteorological data to the real program.
- Coordinate:
  - The real program is able to input and correctly process any strictly monotonically oriented vertical coordinate
    - Isobaric: OK
    - Sigma: OK
    - Hybrid: OK

Standard Input Variables

- The metgrid program typically provides meteorological data to the real program.
- Mandatory:
  - 3d and surface: horizontal winds, temperature, relative humidity, geopotential height
  - 3d soil: soil temperature
  - 2d fields: surface pressure, sea-level pressure, land mask
- Optional (but desirable):
  - 3d soil: soil moisture
  - 2d fields: topography elevation of input data, SST, sea-ice, skin temperature

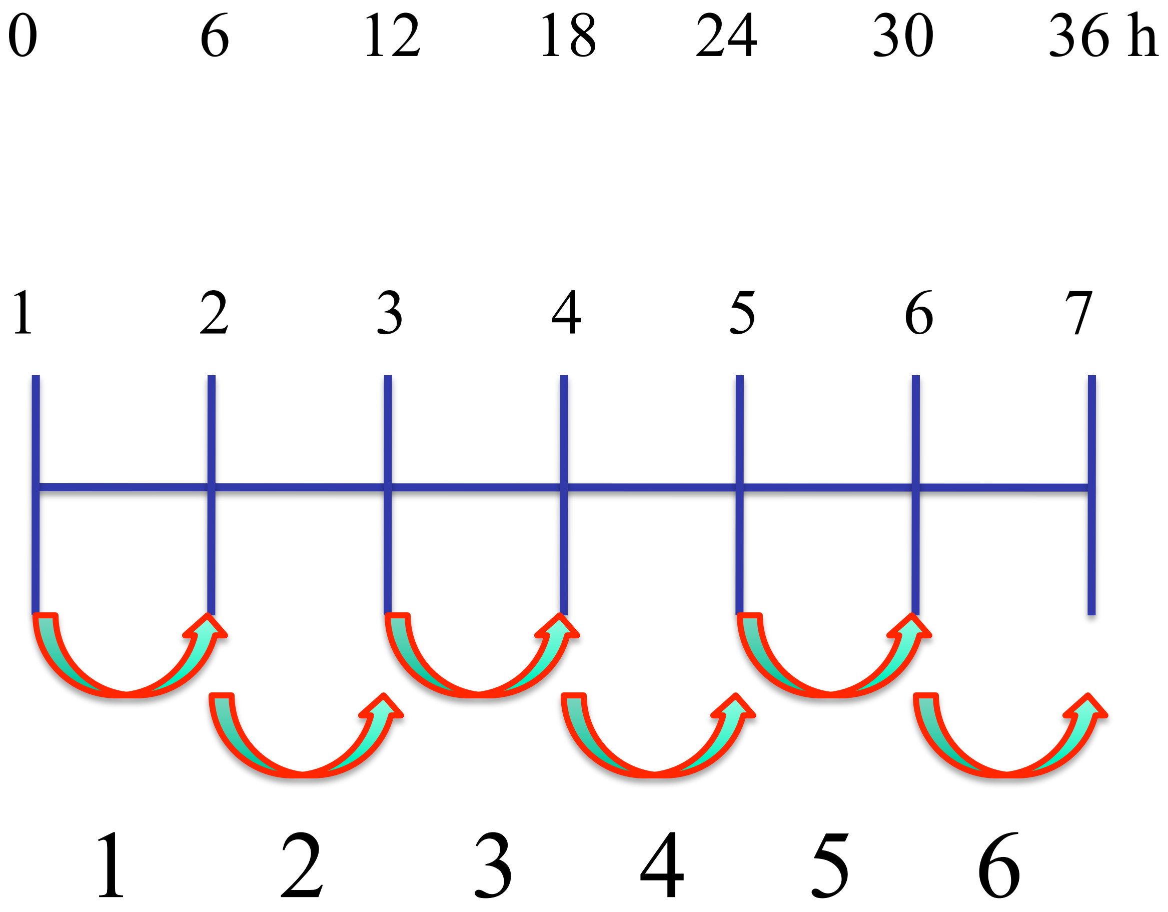
Base State

- Several of the mass-point fields are separated into a time-independent base state (also called a reference state) and a perturbation from the base state
- The base state fields are only functions of the topography and a few user-selectable constants
- If the topography changes, such as with a moving nest, the base state fields are modified
- Feedback for 2-way nesting also impacts base state fields through topographic averaging
- No base state computations are required prior to the real program

Standard Generated Output

- For regional forecasts, the real program generates both an both an initial (***wrfinput_d01***) and a lateral boundary (***wrfbdy_d01***)
- The boundary file is not required for global forecasts with ARW
- The initial condition file contains a single time period of data
- These files contain data used directly by the WRF model
- The initial condition file may be ingested by the WRFDA code (referred to as a *cold-start*)
- If ***n*** times were processed with WPS and real, the lateral boundary file contains ***n-1*** time slices

Lateral Boundary Condition Times

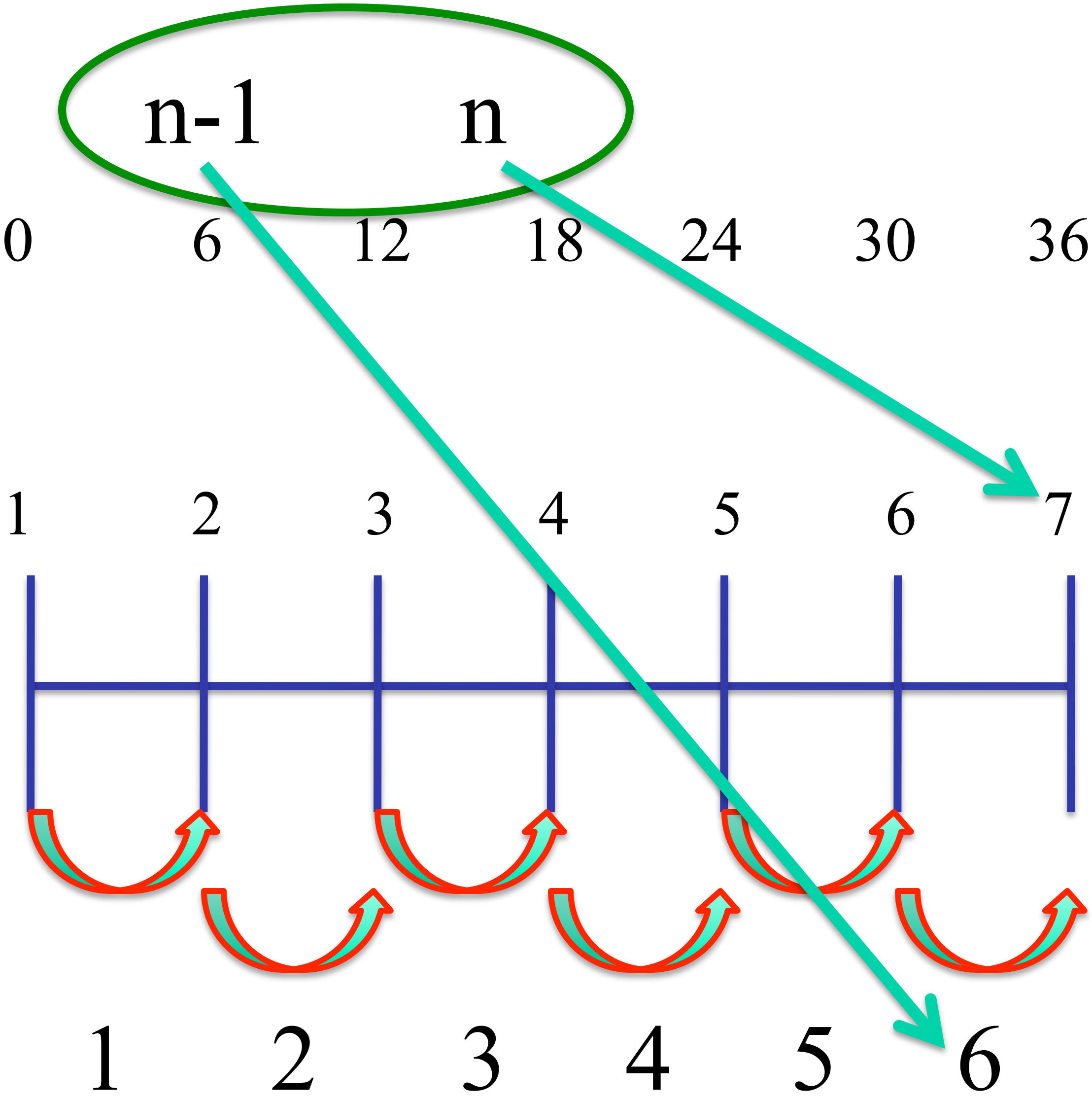


Time periods from WPS

Time slices from WPS

Boundary tendency steps

Lateral Boundary Condition Times

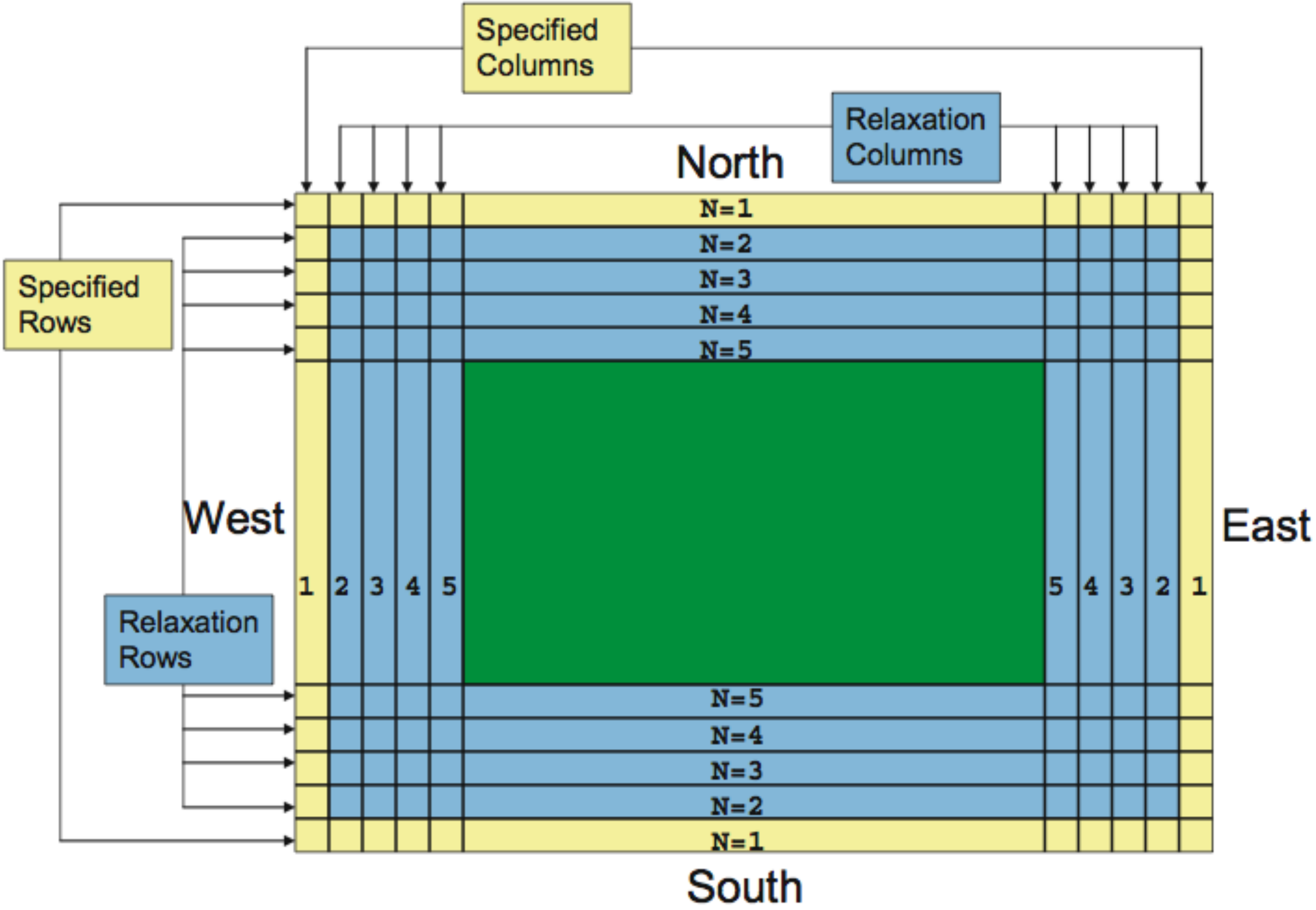


Time periods from WPS

Time slices from WPS

Boundary tendency steps

Real-Data Lateral Boundary Condition: Location of Specified and Relaxation Zones



Specified Columns

Relaxation Columns

North

Specified Rows

Relaxation Rows

West

East

South

N=1

N=2

N=3

N=4

N=5

1 2 3 4 5

5 4 3 2 1

N=5

N=4

N=3

N=2

N=1

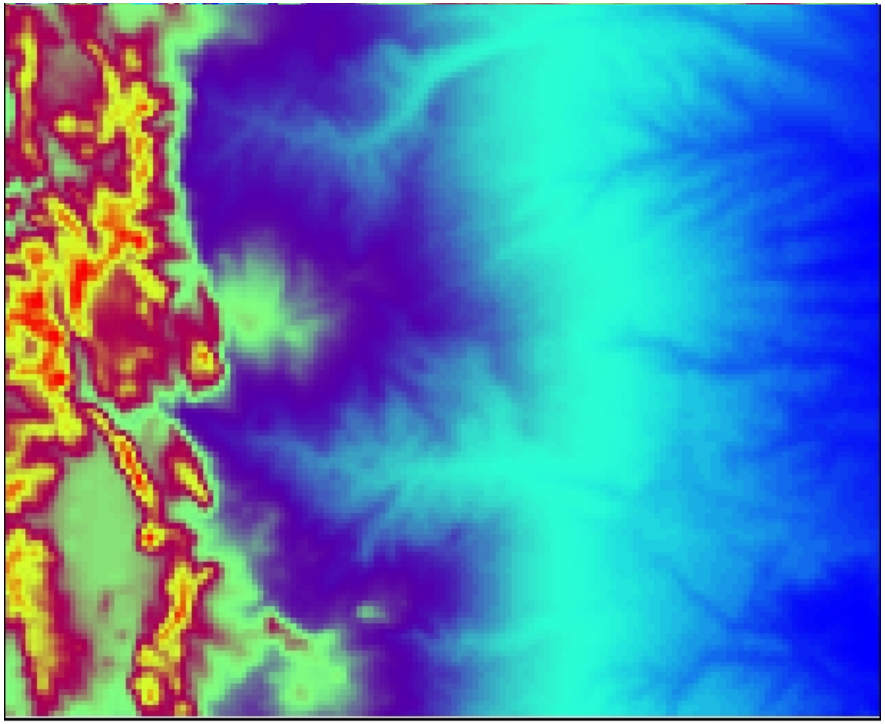
Vertical Interpolation

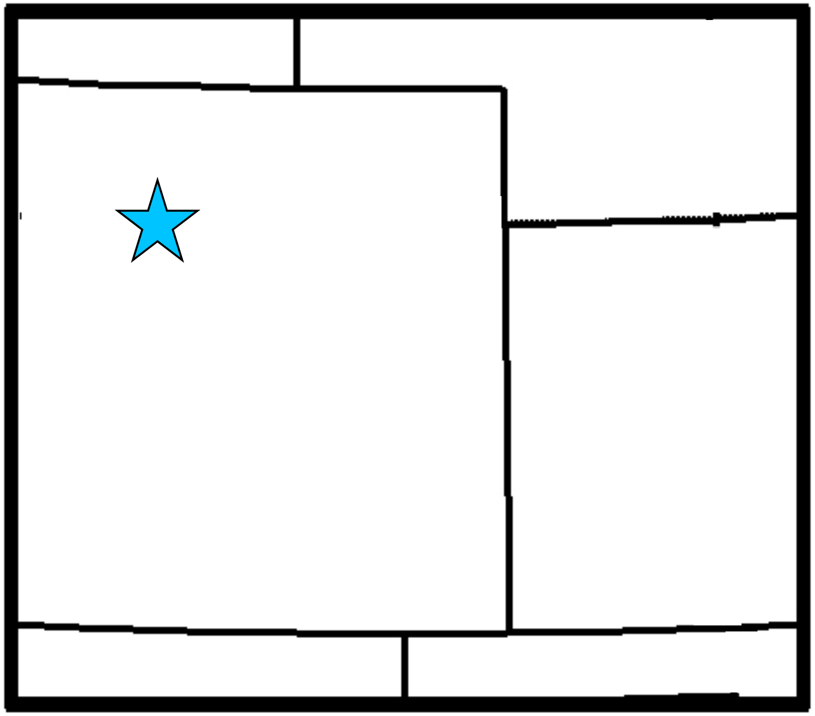
- A number of vertical interpolation options are available to users
- The options can have a significant impact on the initial conditions passed to the model
- More information is contained in the info file ***README.namelist*** in the ***run*** directory
- Options are located in the ***&domains*** namelist record of ***namelist.input***

Vertical Interpolation

- Impact: *Expected region of changes*
- *Non-standard setting*
- Which level is being viewed

- Topography and domain for difference plots, 160x140, 4 km, input = 40 km NAM

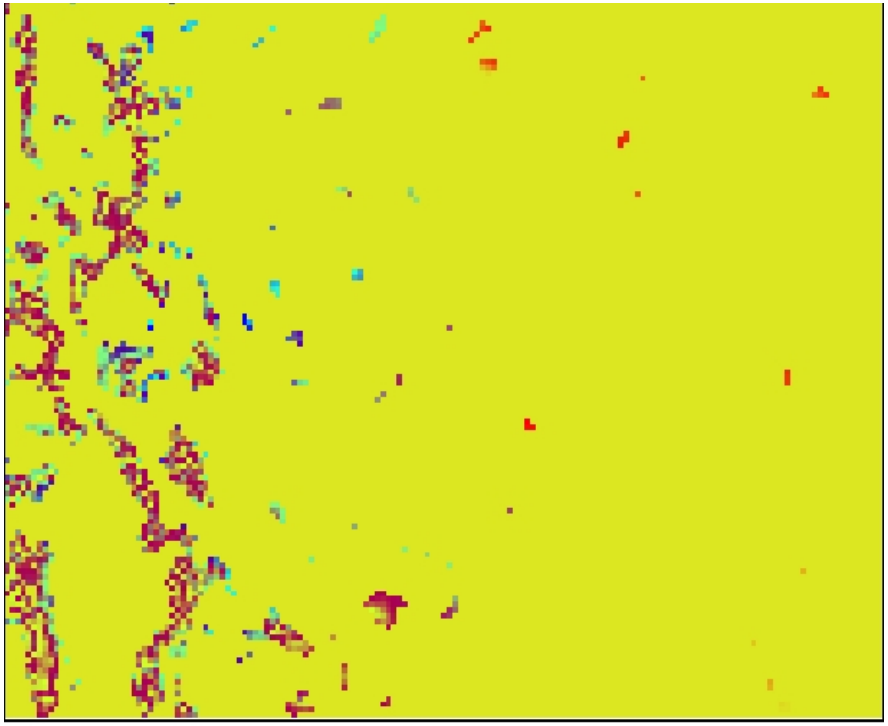




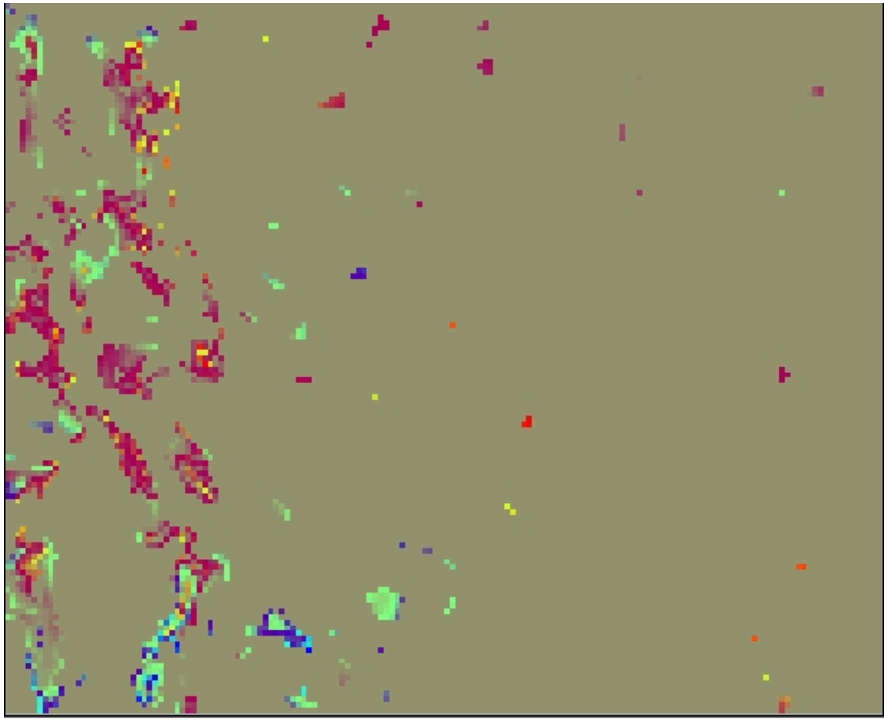
Vertical Interpolation

- Impact: few lowest levels only
- force_sfc_in_vinterp = 0
- η level 1

- Theta (-8 K blue, 0 K yellow)



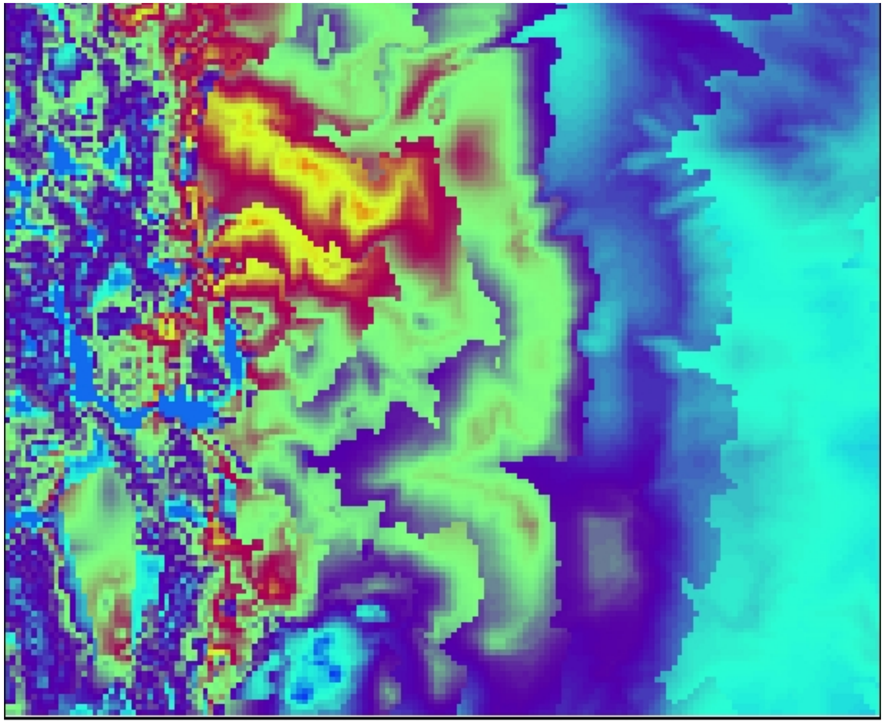
- U (-3 m/s blue, 2 m/s red)



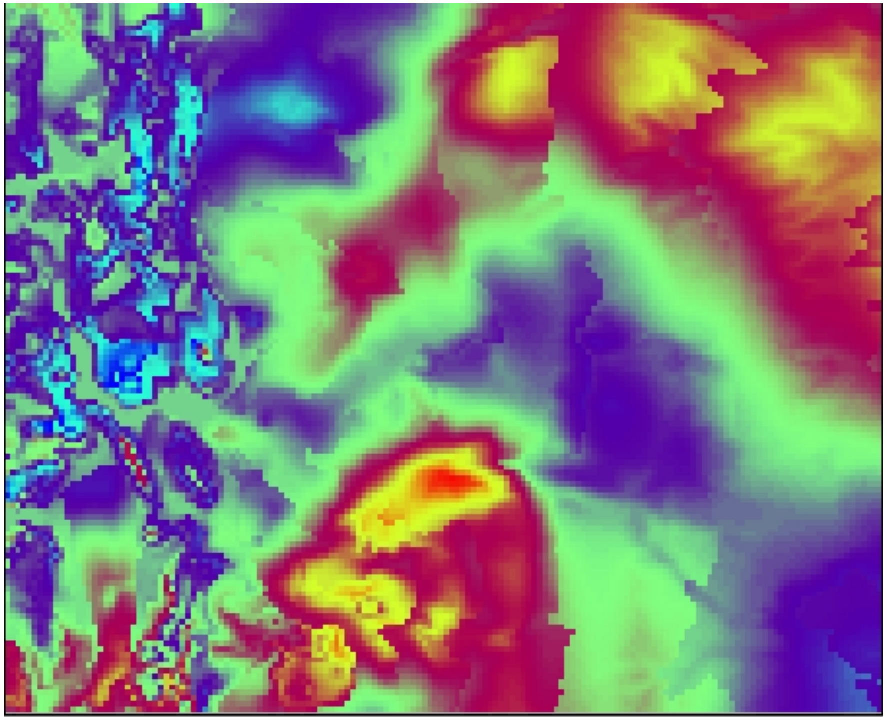
Vertical Interpolation

- Impact: few lowest levels only
- force_sfc_in_vinterp = 6
- η level 4

- Theta (0 K blue, 10 K red)



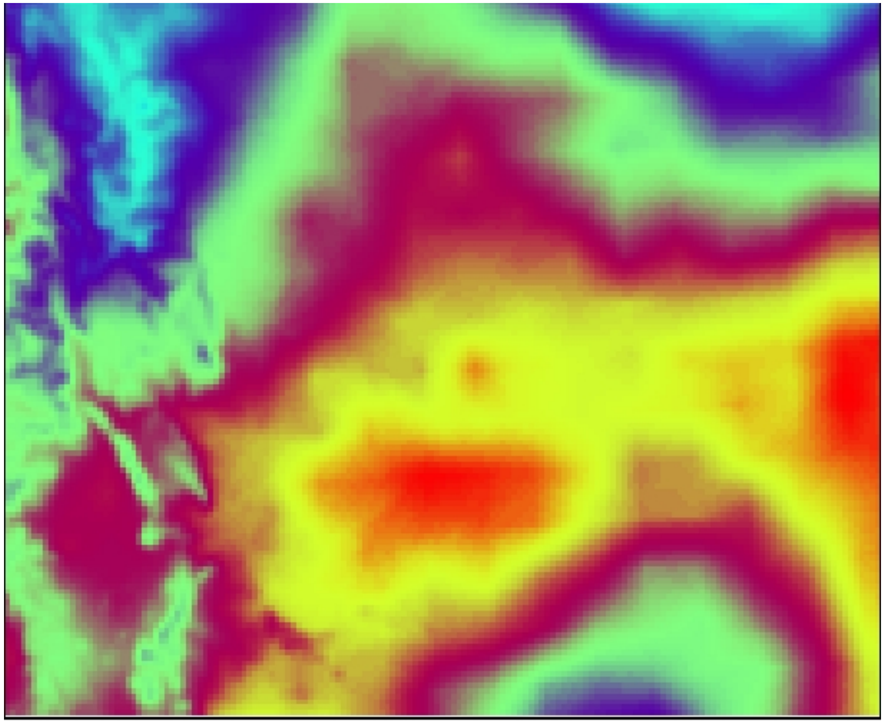
- U (-5 m/s blue, 6 m/s red)



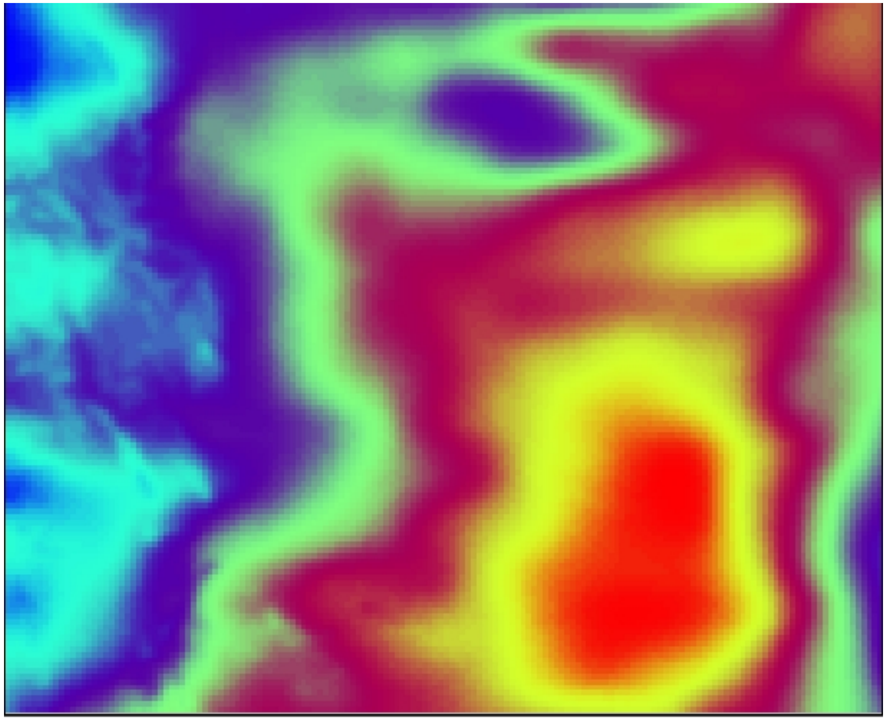
Vertical Interpolation

- Impact: above first 4 levels, most near tropopause
- lagrange_order = 2
- η level TOP

- Theta (0.7 K blue, 1.6 K red)



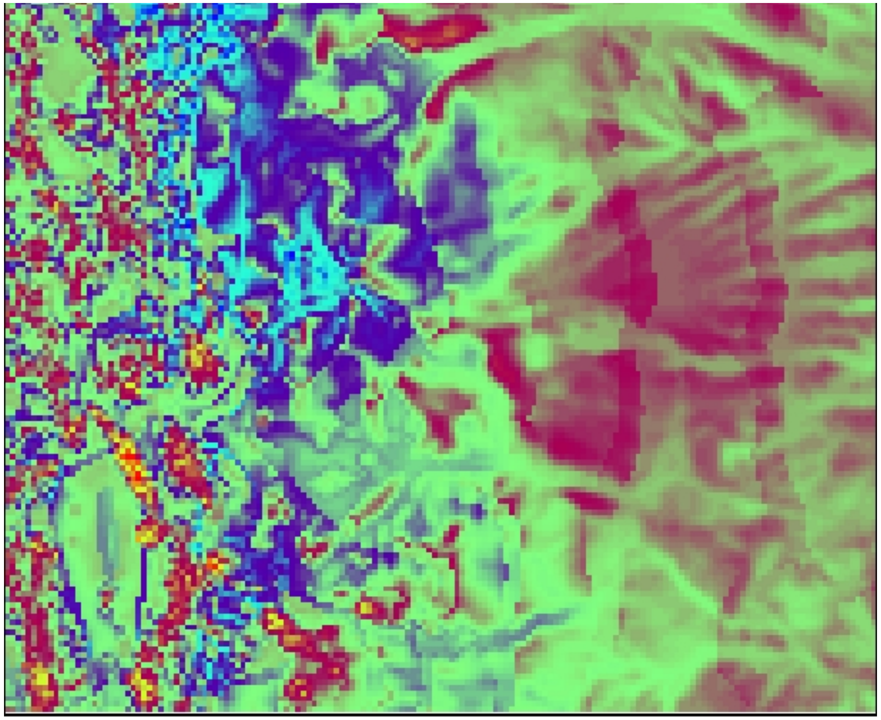
- U (0.4 m/s blue, 1.4 m/s red)



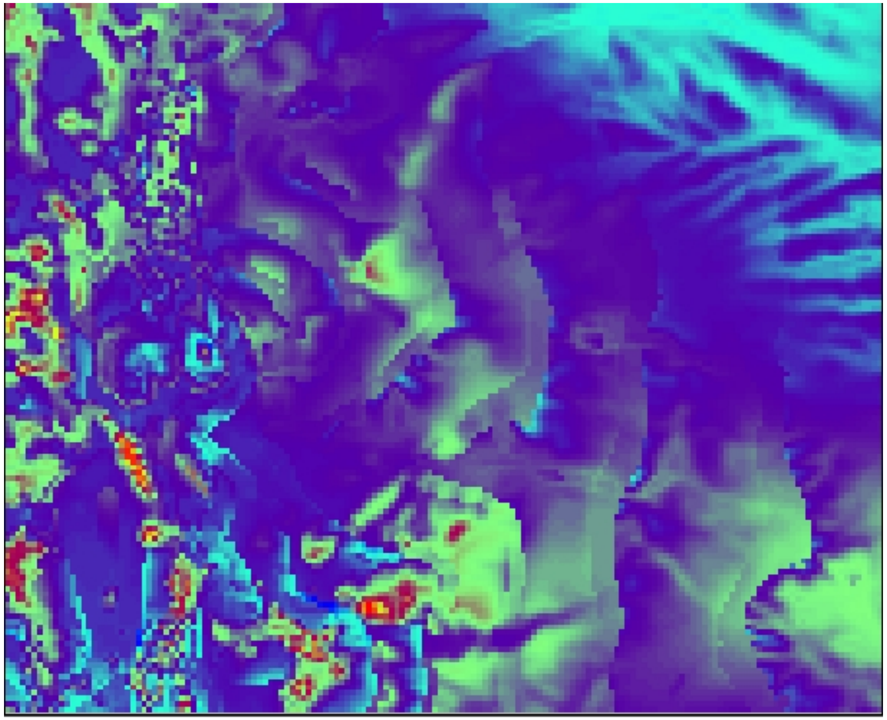
Vertical Interpolation

- Impact: lowest level only
- lowest_lev_from_sfc = T
- η level 1

- Theta (-10 K blue, 8 K red)



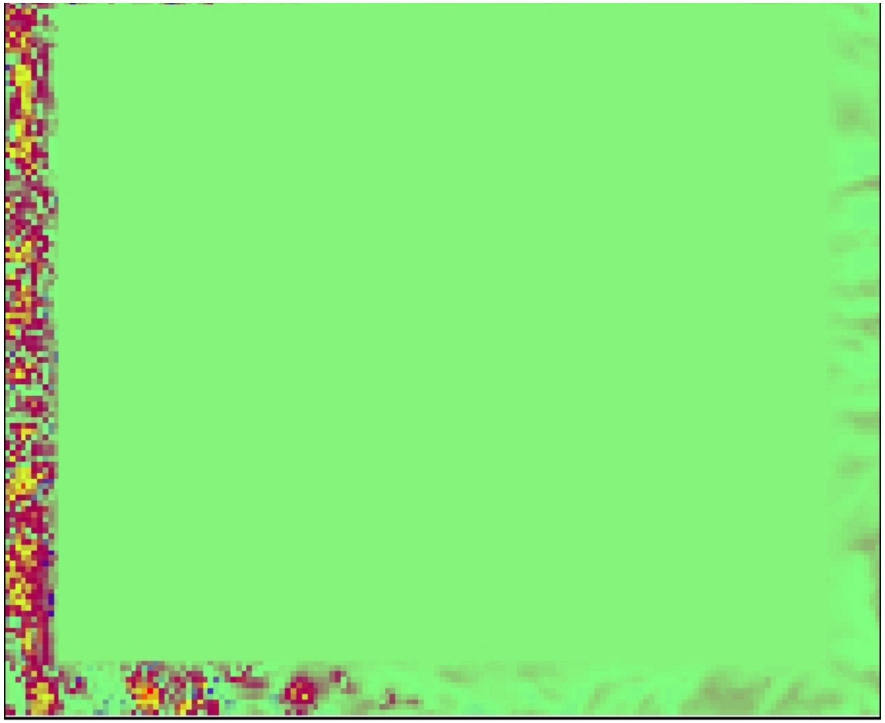
- U (-3 m/s blue, 7 m/s red)



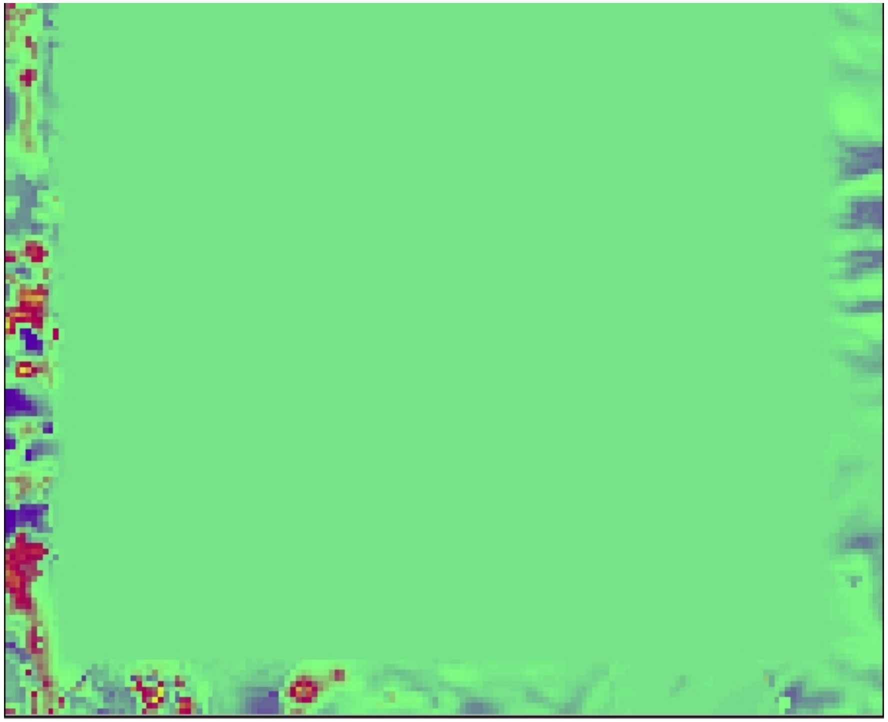
Vertical Interpolation

- Impact: outer few rows and column, amplitude damps upward
- smooth_cg_topo = T
- η level 1

- Theta (-10 K blue, 9 K red)



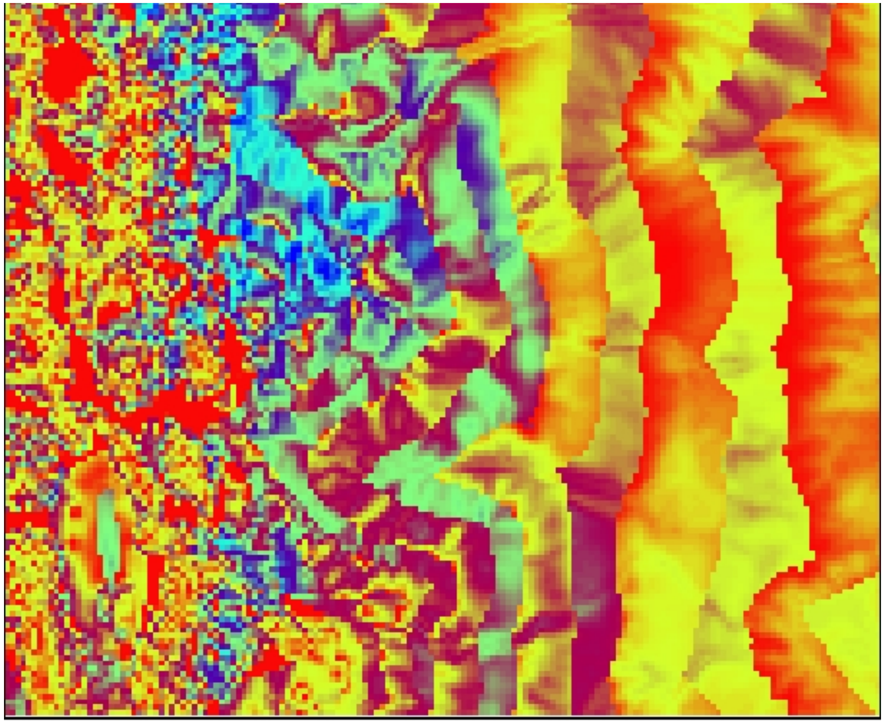
- U (-6 m/s blue, 6 m/s red)



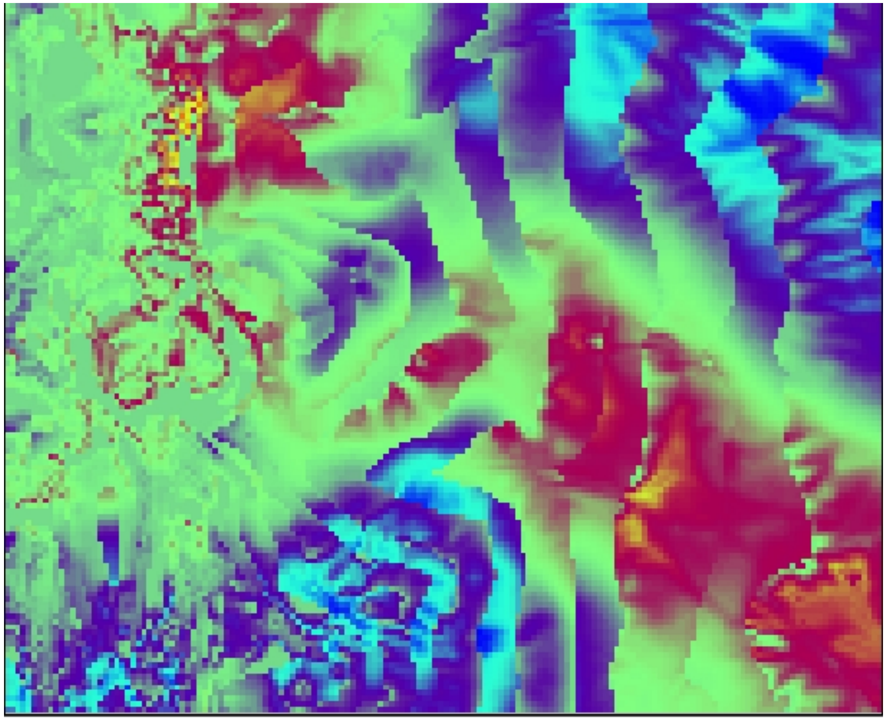
Vertical Interpolation

- Impact: lowest few levels
- use_surface = F
- η level 1

- Theta (-11 K blue, 0 K red)



- U (-3 m/s blue, 4 m/s red)



Vertical Interpolation

Make sure input data is vertically ordered as expected

Input 3-D pressure and T, topo, Z, moisture used to compute total surface pressure

Compute target vertical coordinate using normalized dry column pressure pressure

User specifies the selected η surfaces in the namelist (or can be computed)

Vertically interpolate input fields in pressure to the η surfaces in dry pressure: default all variables log

Vertical Interpolation

- Select reasonable η levels, or let the real program do it for you
- Verify that the "thicknesses" are acceptable, generally about the same value in the free-atmosphere and less than 1000 m
- It is SAFEST to NOT initially choose η values
  - Initially, select the number of η levels
  - Plot profiles of the resultant heights
  - Adjust the η levels accordingly
- A few namelist options, the terrain elevation, and eta levels completely define the model coordinate for the WRF code

Vertical Interpolation

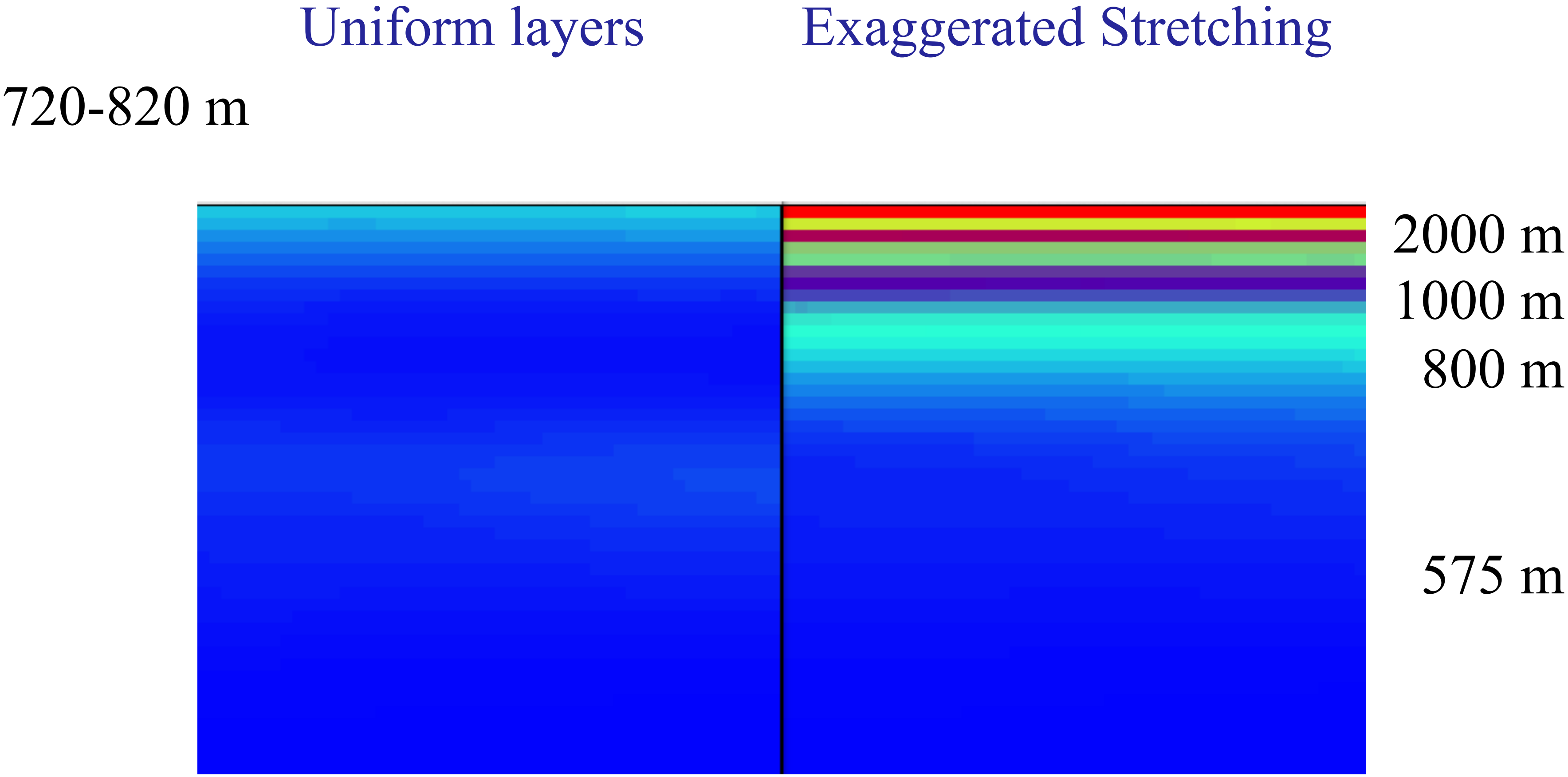
- Adjusted with a few parameters:

```
&domains
e_vert                = 50,    50,   50
p_top_requested       = 1000,

&dynamics
base_temp             = 290.
iso_temp              = 200
```

Vertical Interpolation

Vertical cross sections of model height field, with 50 vertical levels and ptop = 10 hPa, above the PBL.

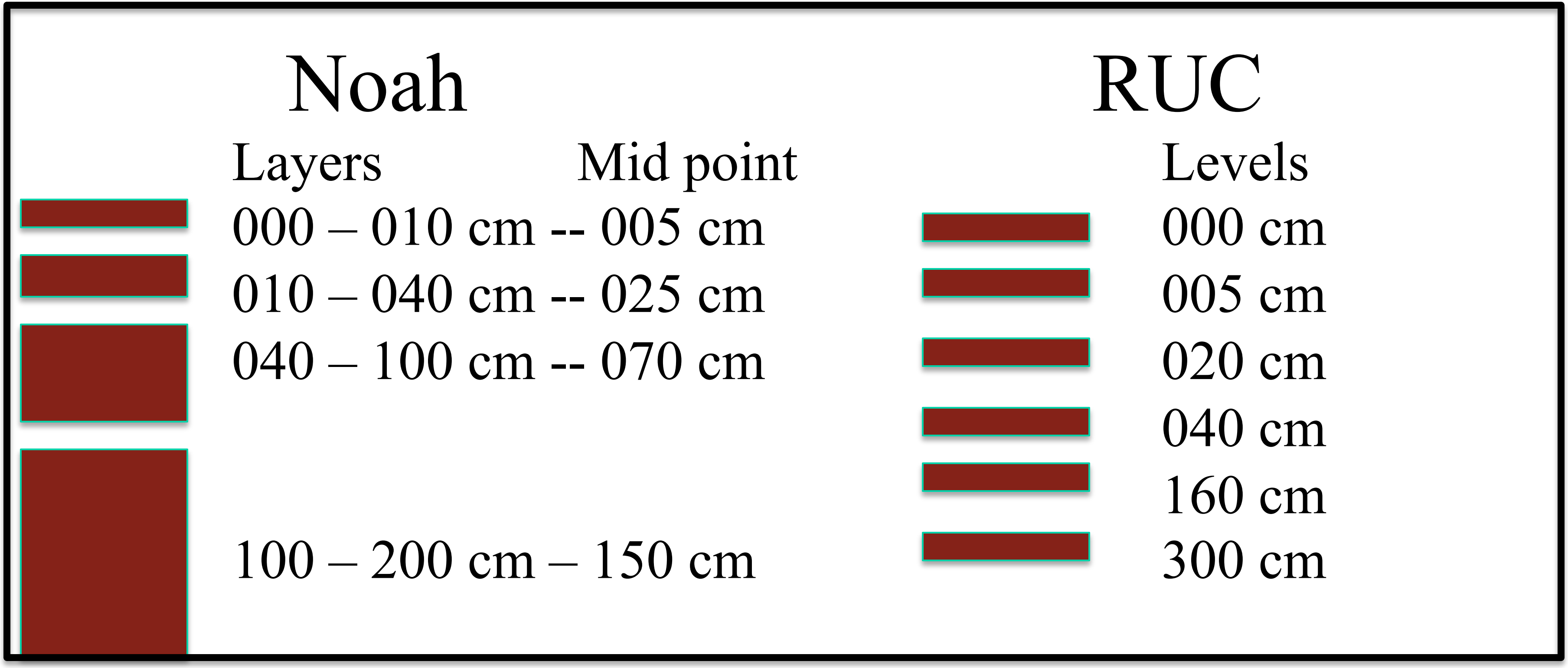


Physical Parameterization Settings

- The real program and the WRF model are tightly coupled
- Most physical parameterization settings in the namlist.input are IGNORED by real
- EXCEPT
  - sf_surface_physics
  - Land surface model (processes soil temperature and soil moisture)
  - Different schemes in WRF use differing numbers of layers
  - The layers are defined in real from the metgrid output

Soil Level Interpolation

- The WRF model supports several Land Surface schemes:
  - sf_surface_physics = 1, Slab scheme
  - 5 layers
  - Defined with thicknesses: 1, 2, 4, 8, 16 cm



Noah

Layers	Mid point
000 – 010 cm --	005 cm
010 – 040 cm --	025 cm
040 – 100 cm --	070 cm
100 – 200 cm –	150 cm

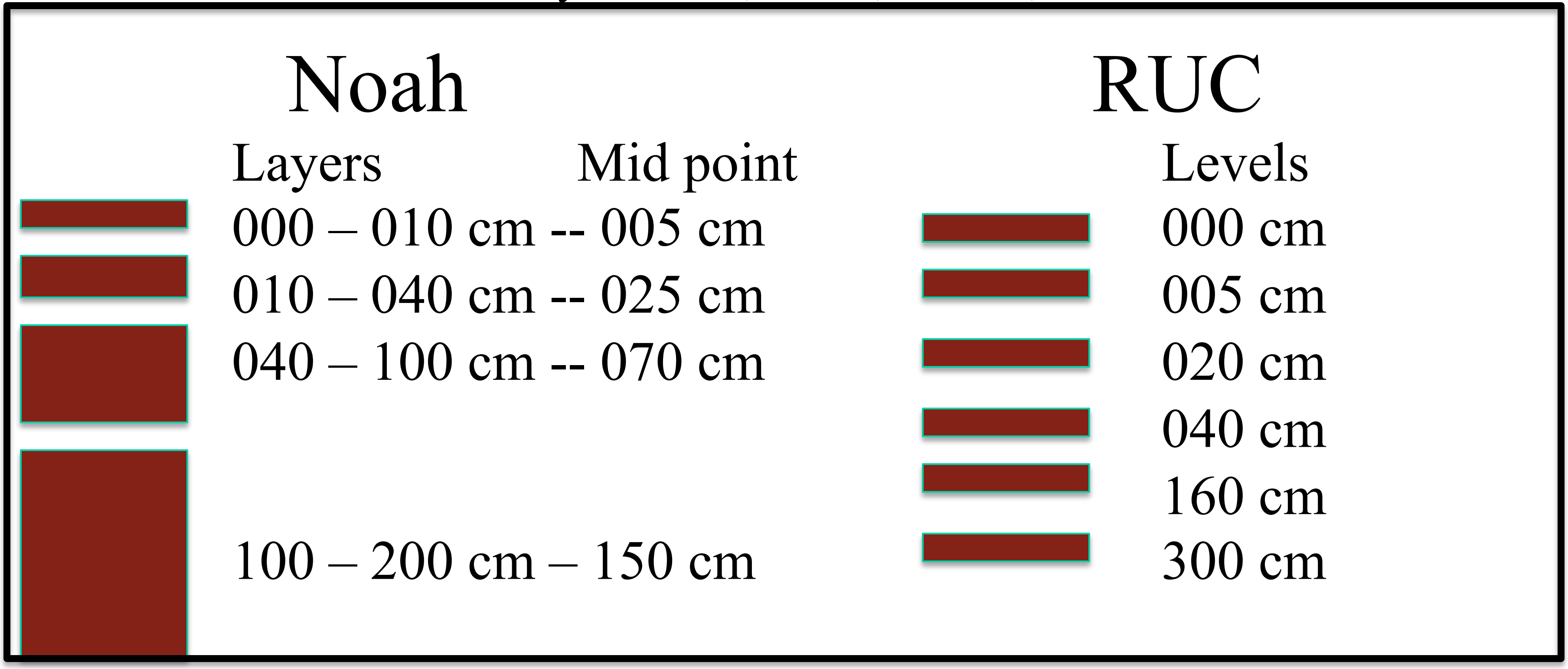
RUC

Levels

000 cm
005 cm
020 cm
040 cm
160 cm
300 cm

Soil Level Interpolation

- The WRF model supports several Land Surface schemes:
  - sf_surface_physics = 2, Unified Noah scheme
  - 4 layers
  - Defined with layers: 0-10, 10-40, 40-100, 100-200 cm



Noah

Layers Mid point

000 – 010 cm -- 005 cm

010 – 040 cm -- 025 cm

040 – 100 cm -- 070 cm

100 – 200 cm – 150 cm

RUC

Levels

000 cm

005 cm

020 cm

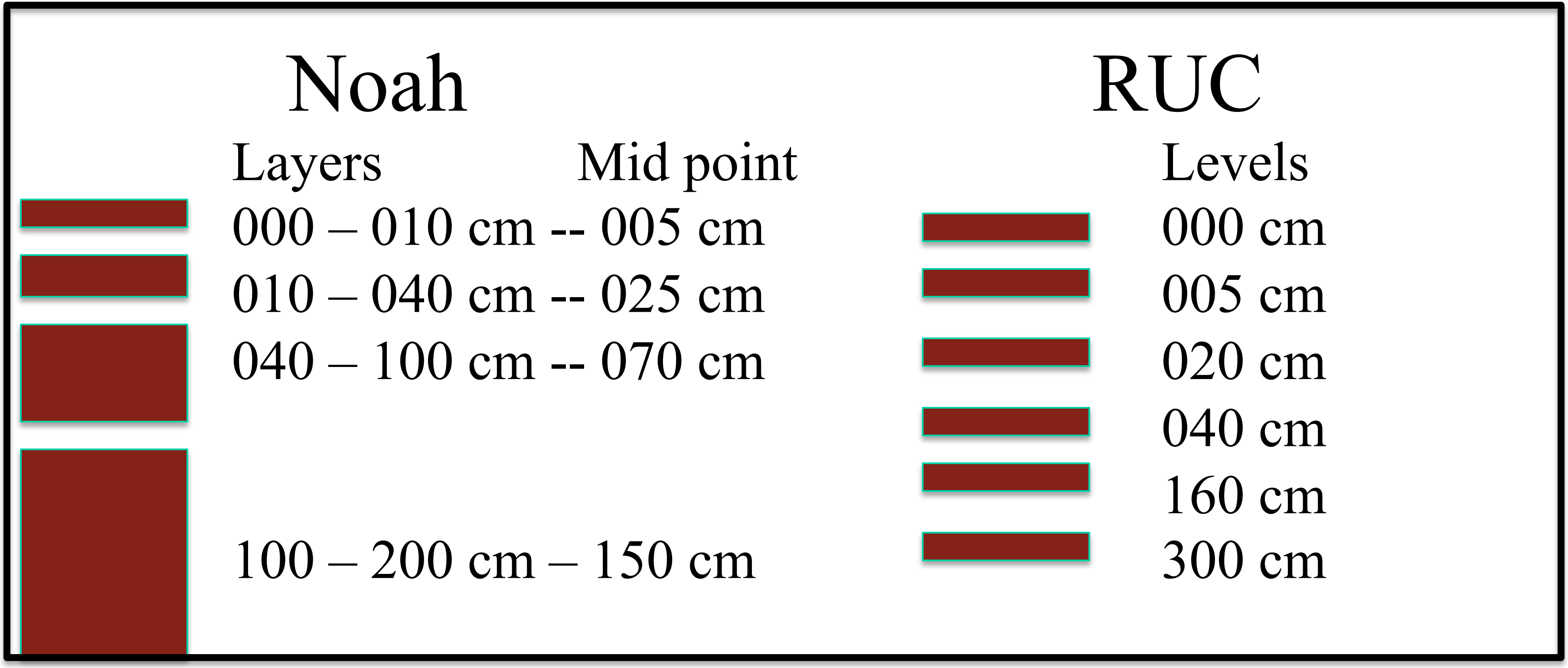
040 cm

160 cm

300 cm

Soil Level Interpolation

- The WRF model supports several Land Surface schemes:
  - sf_surface_physics = 3, RUC scheme
  - 6 levels
  - Defined at levels: 0, 5, 20, 40, 160, 300 cm



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RUC

Levels

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005 cm

020 cm

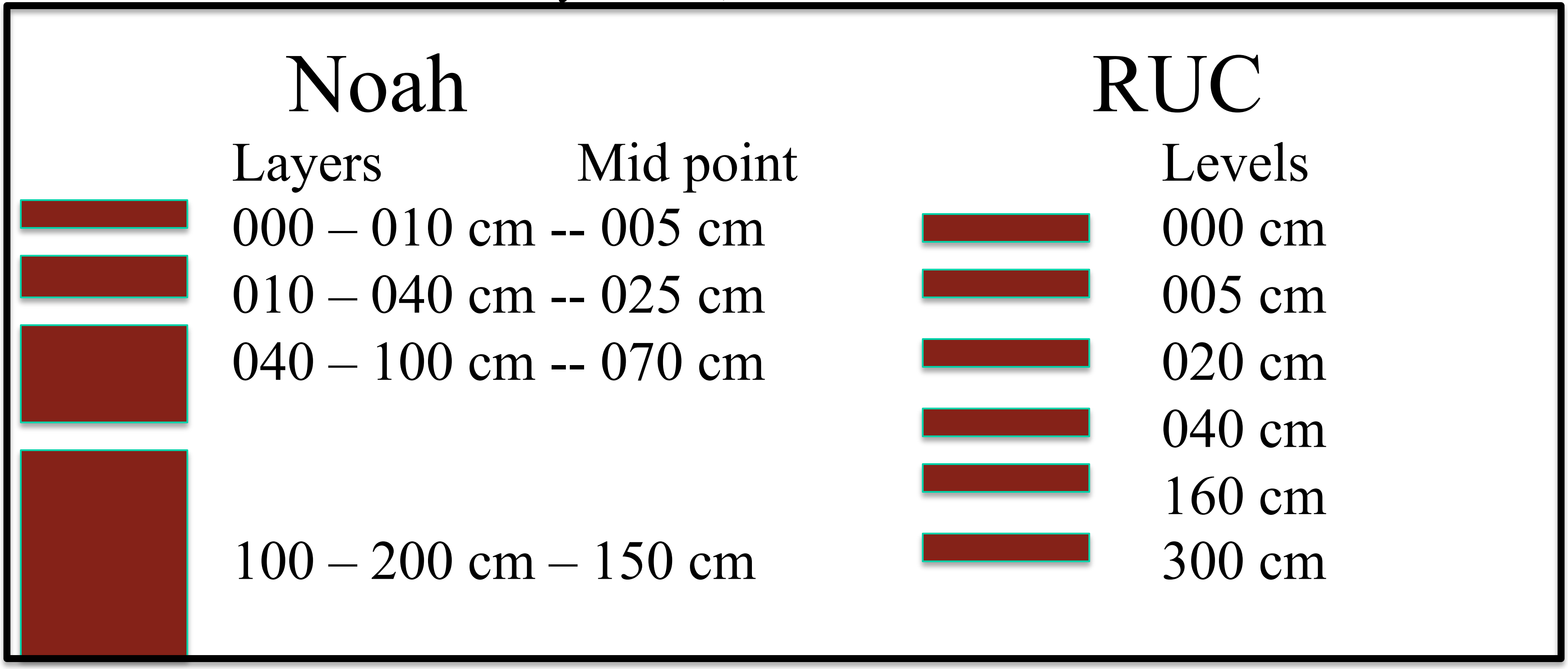
040 cm

160 cm

300 cm

Soil Level Interpolation

- The WRF model supports several Land Surface schemes:
  - sf_surface_physics = 7, PX scheme
  - 2 layers
  - Defined with layers: 0-1, 1-100 cm



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Nested Processing

- May read multiple domain input files from metgrid
- Requires only the initial time for the fine domains, unless doing nudging or SST update

- ***No horizontal interpolation from parent to child***

- No consistency checks between domains (handled in the feedback step for the WRF model)
- A ***wrfinput_d0x*** file is created for each processed input domain
- A lateral boundary file is created only for the most coarse domain

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(as close as possible, Klingon for *finis*)