

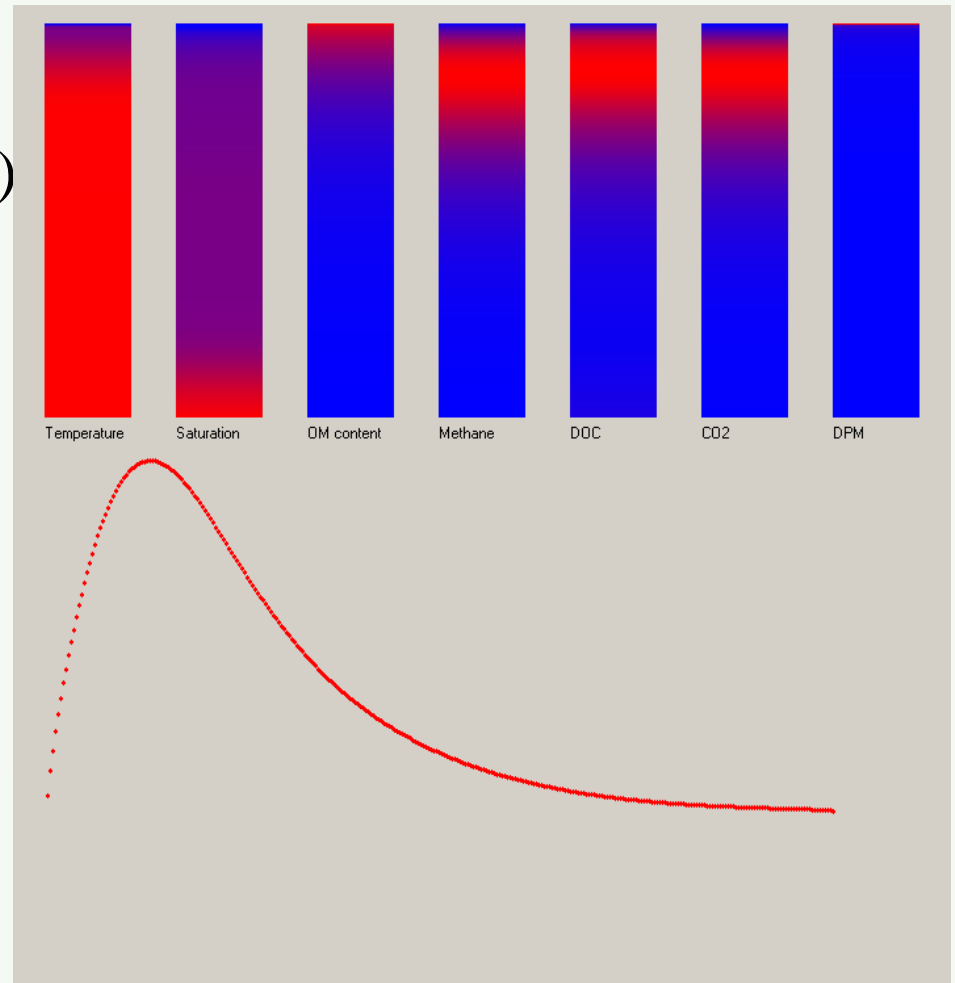
FAPHS (Function And Process Handling in Soil) model

Matt Aitkenhead

Helaina Black

General structure

- One-dimensional ‘pedon’
- Constructed of layers (1cm)
- Same parameters within each layer
- Processes operate within layers, flow of material between layers
- Processes take place in discrete time steps (minimum 1 minute)



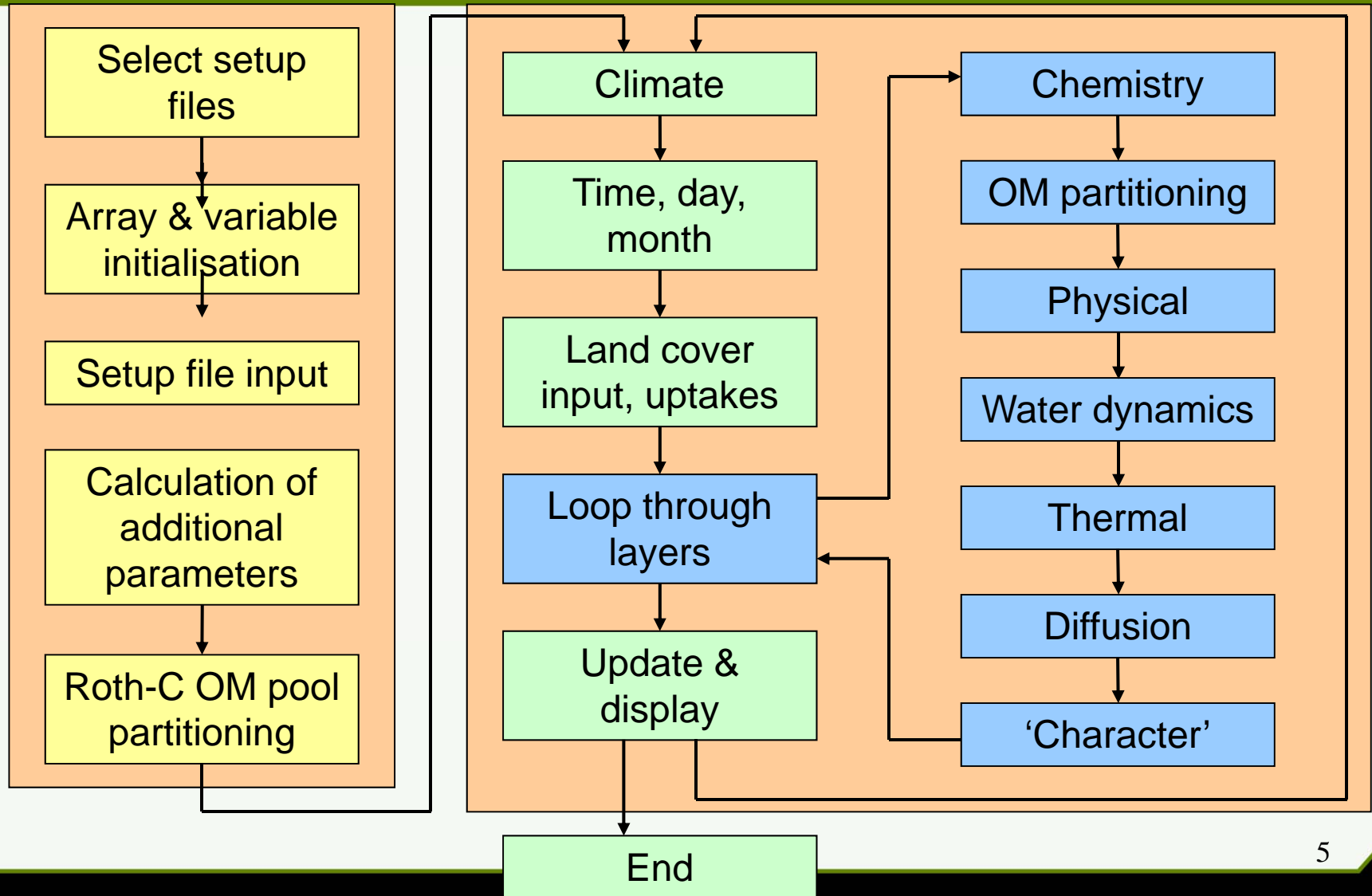
Layer parameters

- Physical (texture, water content, temperature, bulk density, porosity etc.) as discrete values or defined through component variables (e.g. sand, silt, clay)
- Chemical (pH, CH₄, CO₂, N) initialised and updated every timestep)
- Biological (DOC, DPM, RPM etc.) decomposition controlled by rate factors (T, pH, water content etc.)
- ‘Force’ parameters (e.g. matric potential, hydraulic conductivity) calculated using pedotransfer functions
- External parameters either given directly or calculated (e.g. temperature, rainfall, humidity, plant inputs, management factors)

Processes

- Model designed to allow processes to be ‘plugged in’
- Each process requires specific inputs, and influences specific parameters
- Development of model is process-driven
 - Identification of process to be included
 - Identification and inclusion of input parameters required
 - Identification and inclusion of parameters that are influenced
 - Implementation of process
- In order to determine a soil function, certain processes must be included

Operation



Inputs required

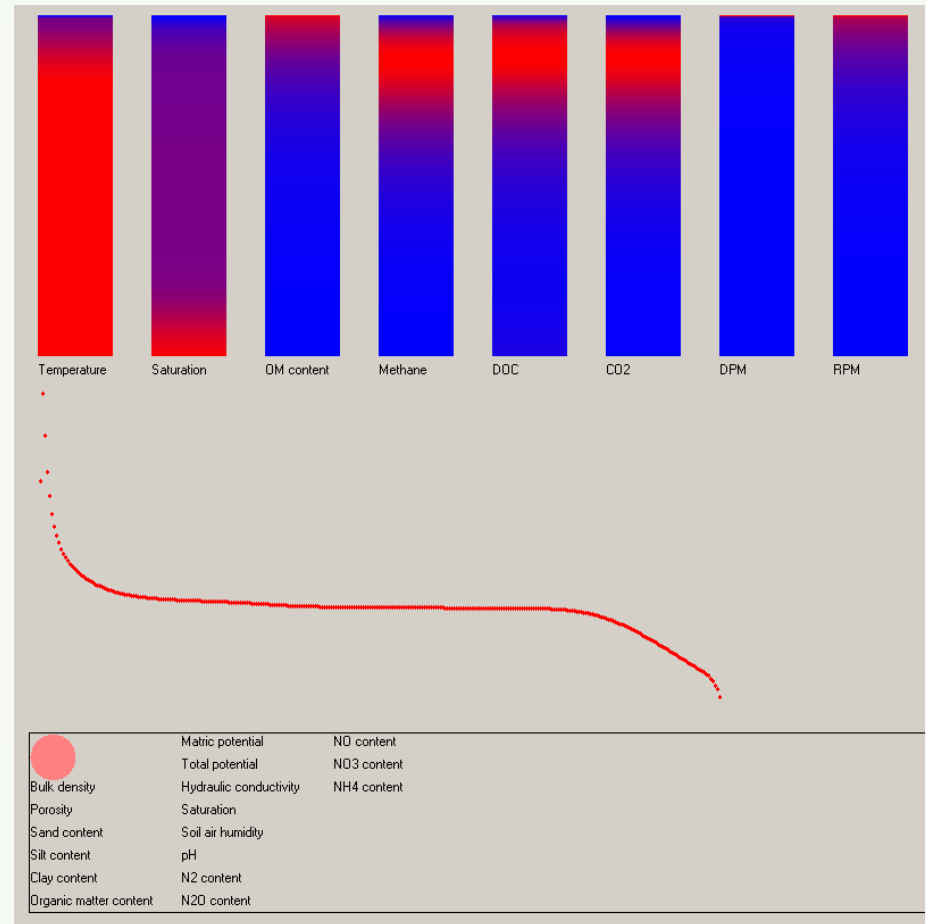
- Too many inputs, impossible to compare against limited field experiment data
- Too few inputs, cannot implement the important processes
- Climate & management not a problem, there is usually sufficient to drive the model
- Profile data often good enough, if not can be supplemented by ‘book values’ for soil types
- Parent material likely to need some work, as soil chemistry requires knowledge of mineral composition

Setup file 'library'

- Parameterisation of common 'types'
- Climate (daily values taken from climate categories)
- Profile (modal values of physical, chemical & biological parameters for major soil classes)
- Parent material (physical parameters & mineral content)
- Land cover (plant input/uptake rates, monthly activity)
- Management (site description, sowing/harvesting dates, fertiliser application)

Model outputs - 1

- Gross physical parameters (bulk density, OM content, porosity, saturation etc.)
- Organic matter partitioning (DPM, RPM, HUM, IOM, BIObacteria, BIOfungi, BIOfauna)
- Soil gases (CH₄, CO₂, N₂O) – including release rates
- Chemical equilibrium (Fe, Na, Al, etc. plus pH, redox)



Model outputs - 2

- Soil function characterisation
 - Hydrological
 - Carbon storage
 - Physical structure
 - Biomass production
 - Biological
 - Chemical
- Soil classification
 - By layer (i.e. each layer identified at horizon type)
 - By soil class (according to more than one classification system)

State of play

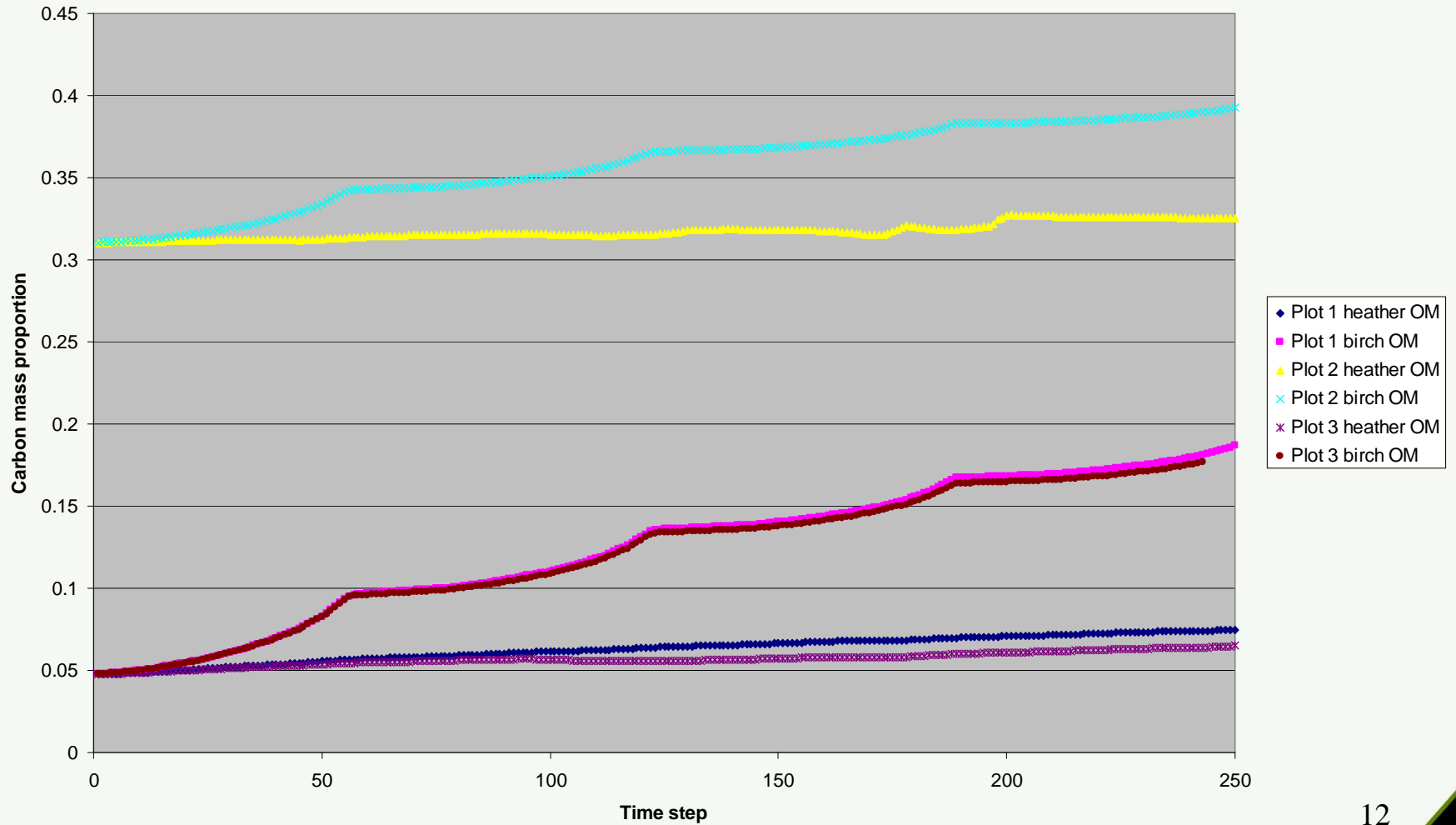
- Completed
 - Overall framework; gas diffusion; parameter display & saving; organic fraction decomposition; Roth-C initialisation; heat transfer; water movement; nitrogen dynamics; vegetation/soil interactions; addition/removal of layers
- In progress
 - Setup file library; horizon classification; profile classification; soil water chemistry
- Planned
 - Redox & pH; soil function characterisation; soil fauna mixing; freeze/thaw effects; parent material weathering; clay dynamics; leaching; OM 'fixing' of chemistry; GUI improvement; erosion; snow/ice cover

Validation

- Miles field trials
 - Three sites across Scotland
 - Heather moorland established
 - Soil sampled ~1978
 - Birch planted ~1982
 - Soil resampled (control & birch) 1987
 - Changes to soil OM, chemical composition investigated

Validation

OM



Validation

- Can the model simulate the reality?
 - Initial runs look good
 - Need to improve realism of setup files
 - Some problems with diffusion/time step sizes
 - Need to validate against other field trials