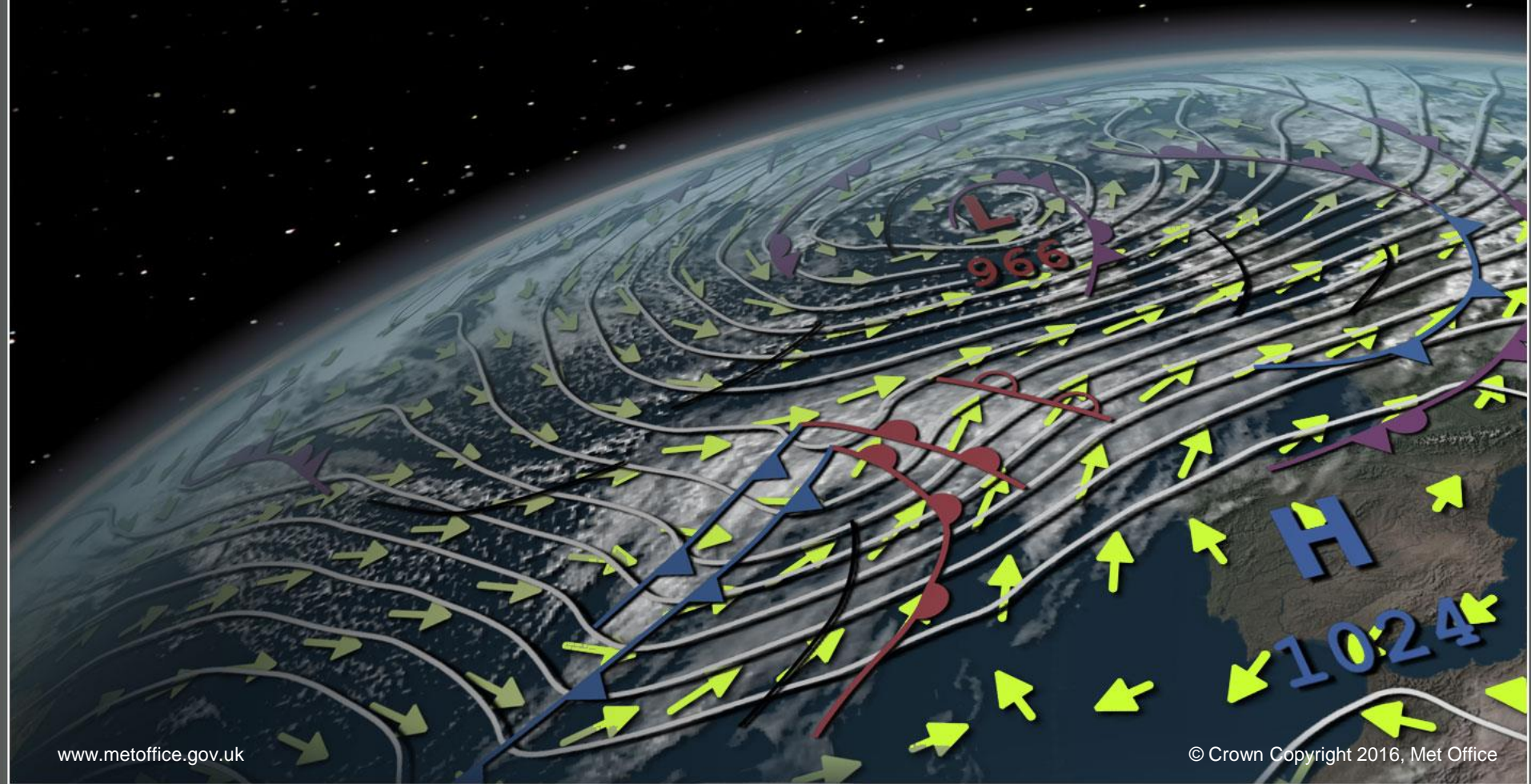


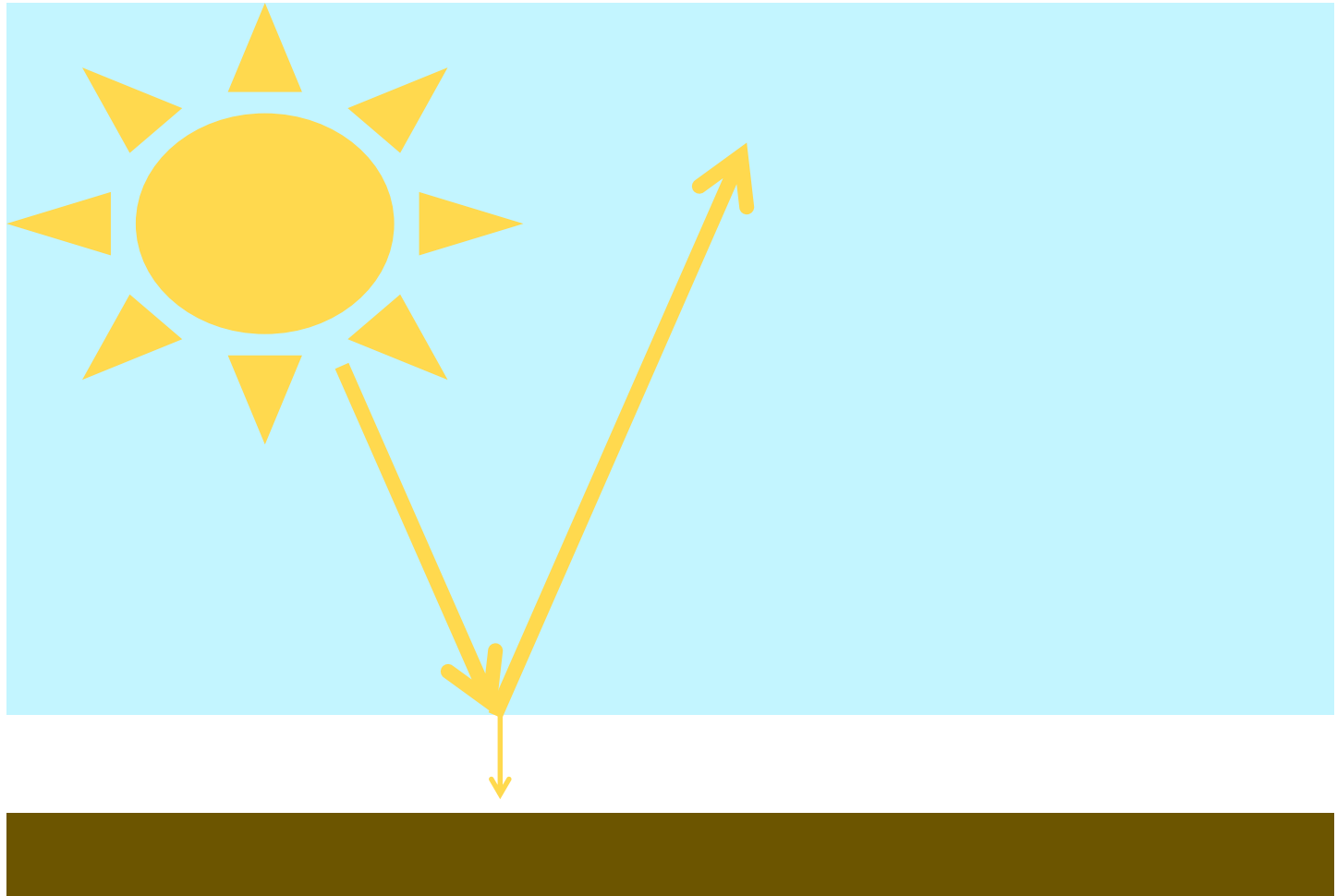
Representing the snow darkening effect of black carbon within the JULES land surface model

Helen Johnson

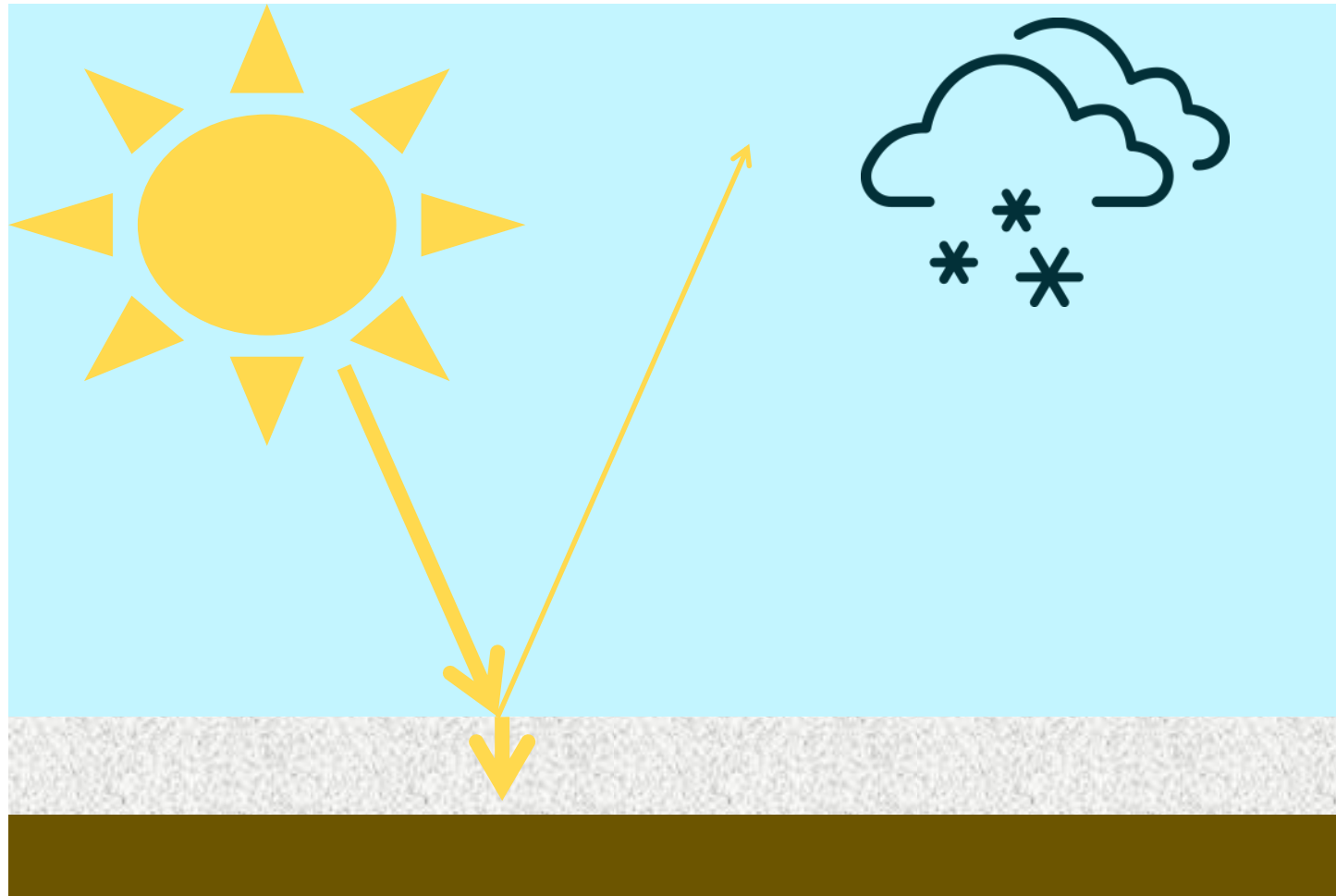
26th June 2017



Fresh snow reflects a lot of incoming radiation



Black carbon in the atmosphere can get deposited onto snow, making it darker



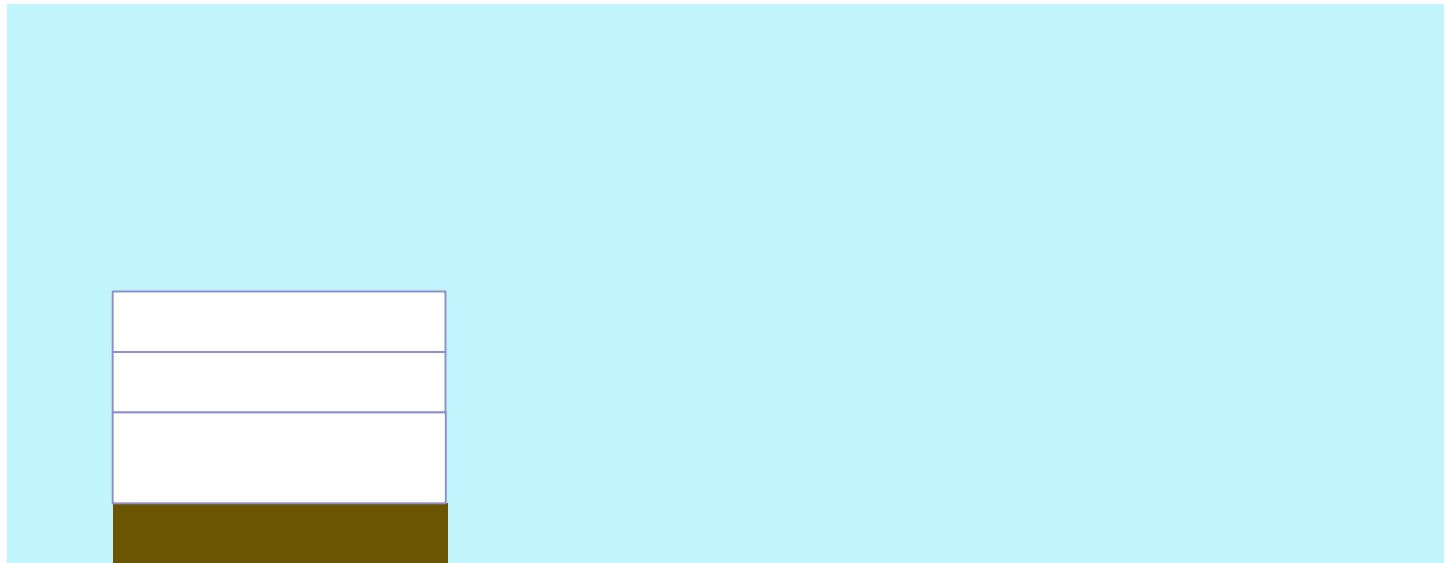
What is black carbon?

- 
- Dark particles emitted during carbon combustion processes



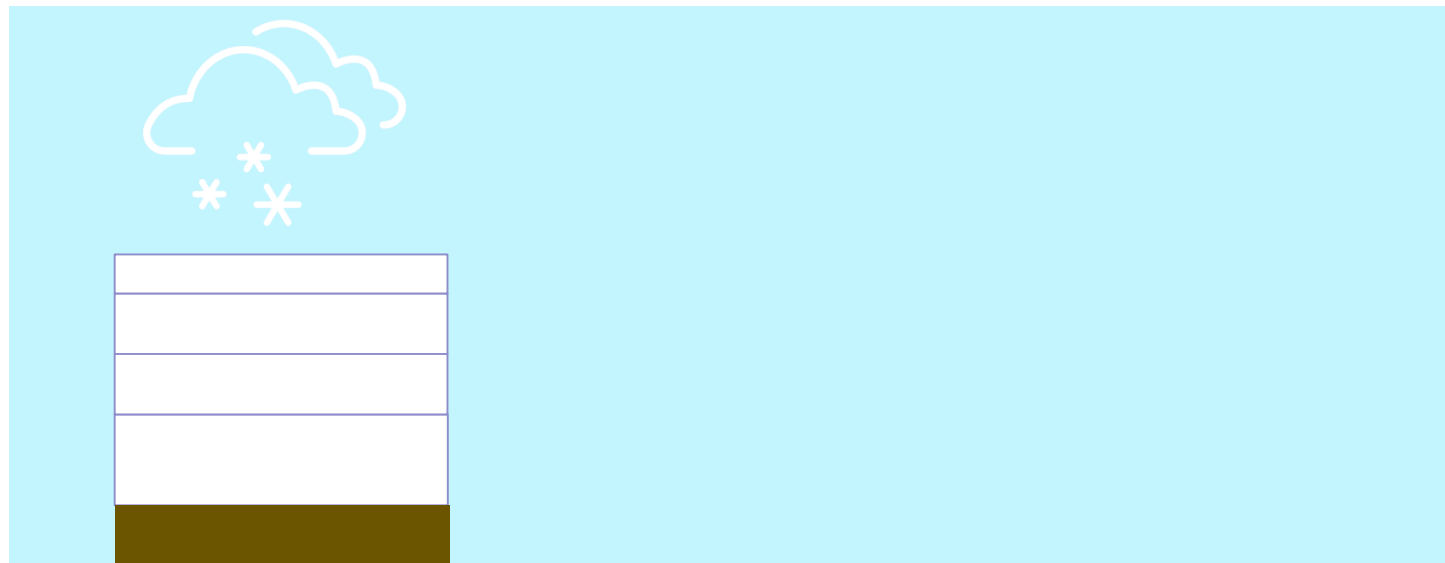
Existing multi-layer snow scheme in JULES

- The snowpack is represented as a series of snow layers, each layer has these properties:
 - Frozen water content
 - Liquid water content
 - Snow crystal size
 - Snow layer depth
 - Temperature



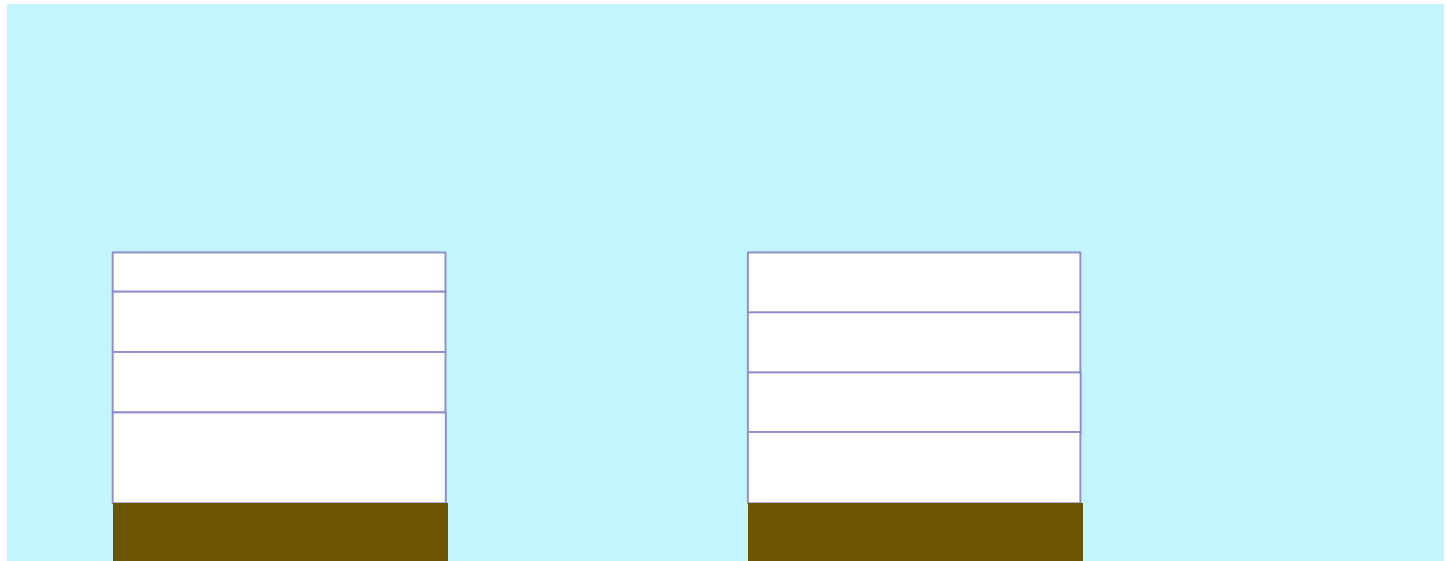
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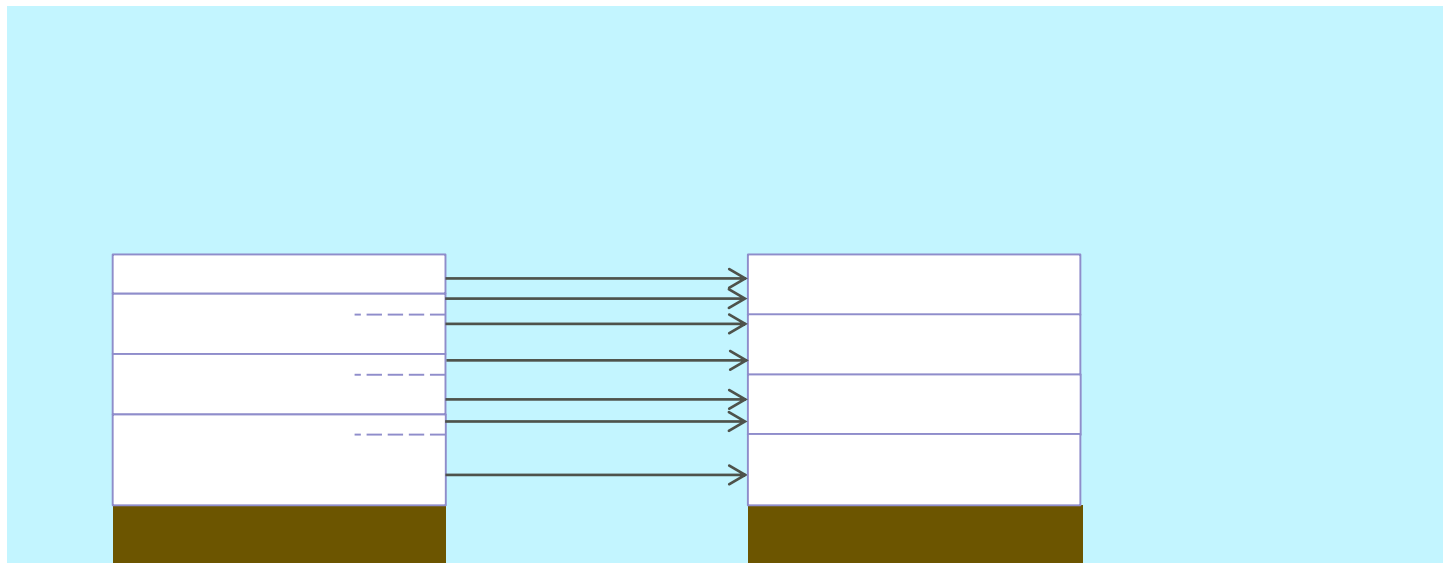
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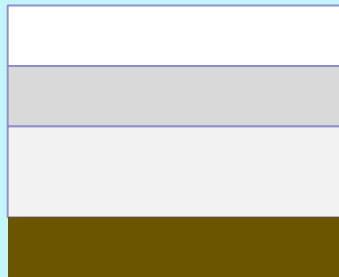
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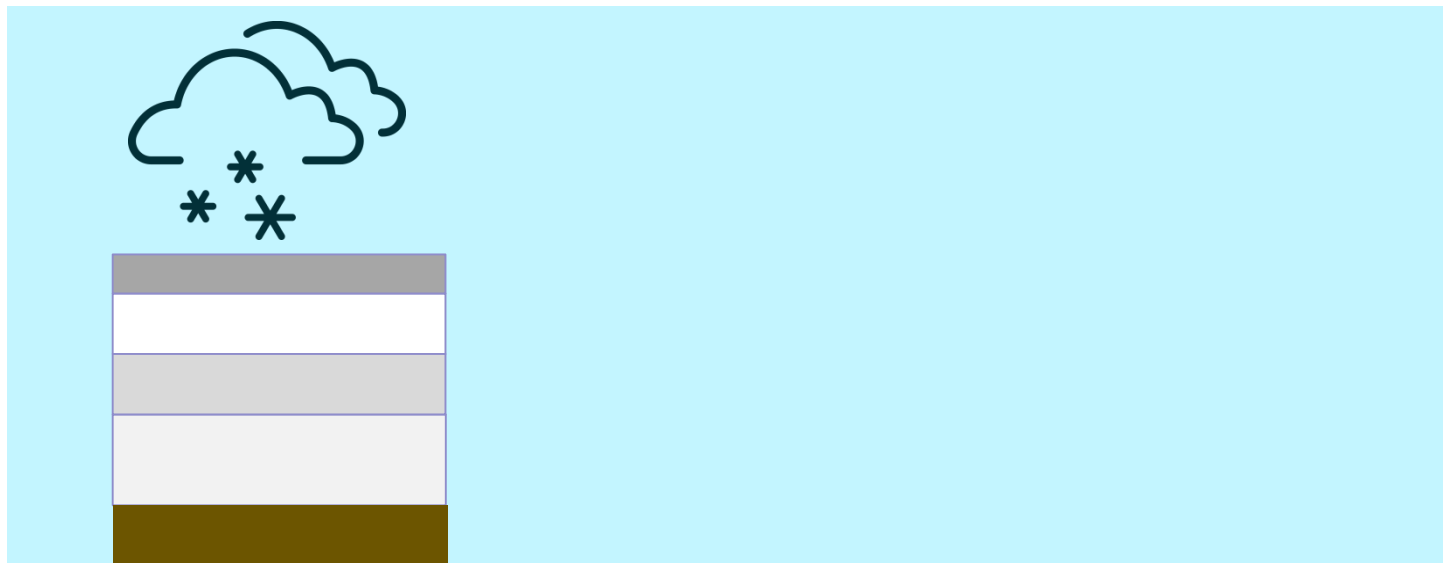
Adding Black Carbon to Snow

- BC is assumed to be evenly distributed throughout a snow layer.
- BC makes no contribution to the mass or density of snow in a layer.
- Only the BC in the top snow layer is considered when calculating snow albedo.



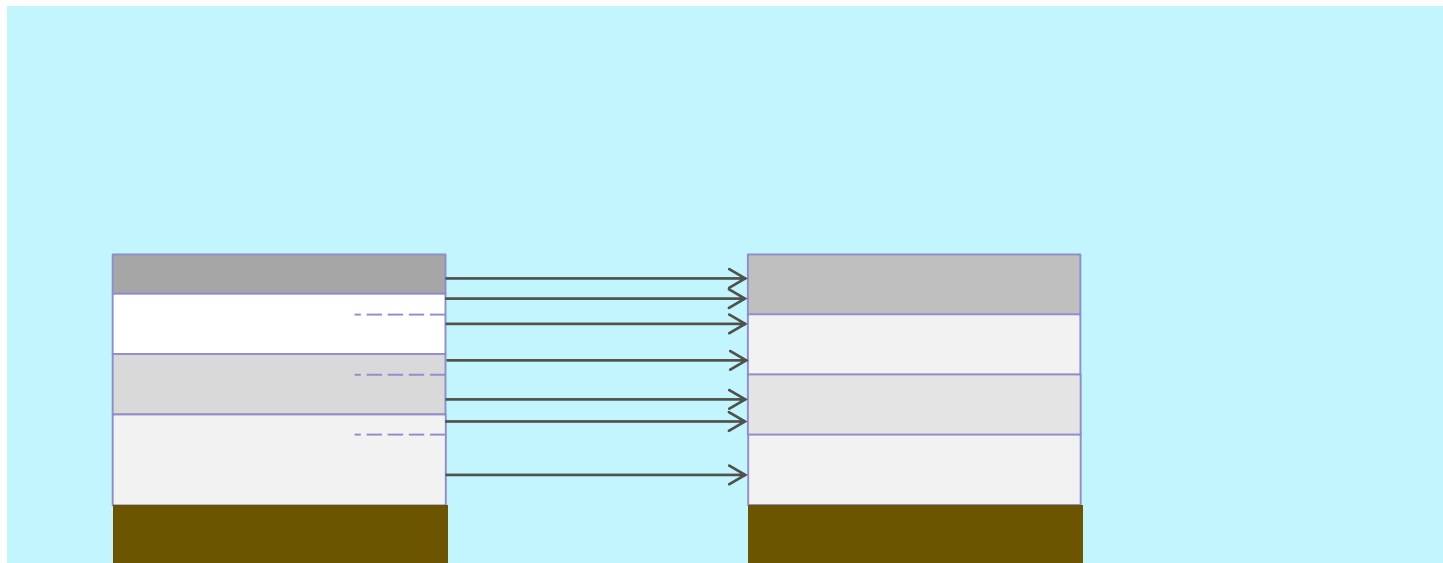
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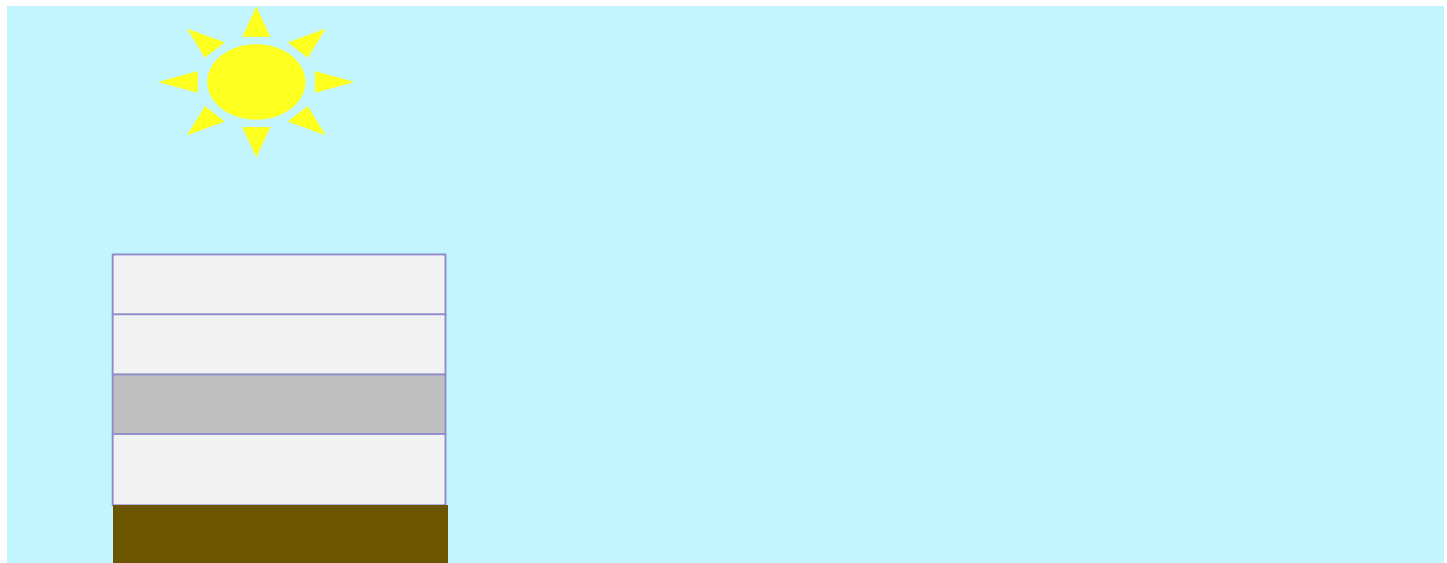
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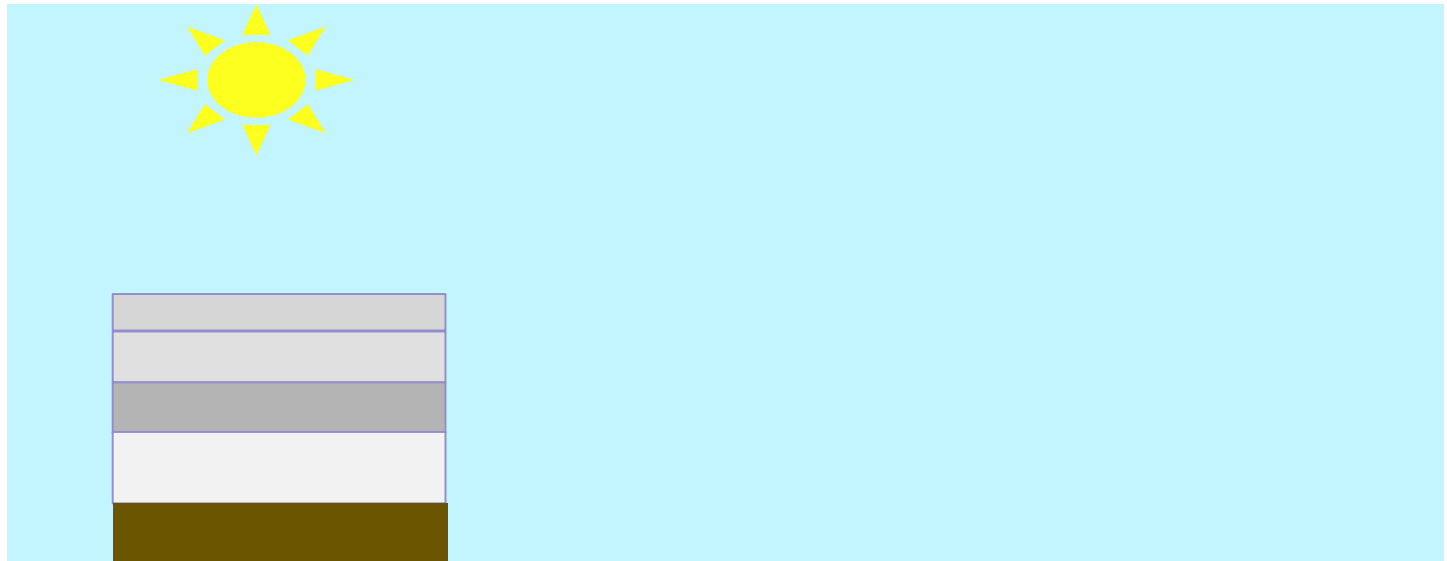
Depleting snowpack

- Snow can be removed from the snowpack through sublimation or melting as the snow warms.
- There is a limit to how much liquid water can be held in a snow layer. Once a layer is saturated, excess water moves to the layer below.
- BC can be scavenged with snowmelt.



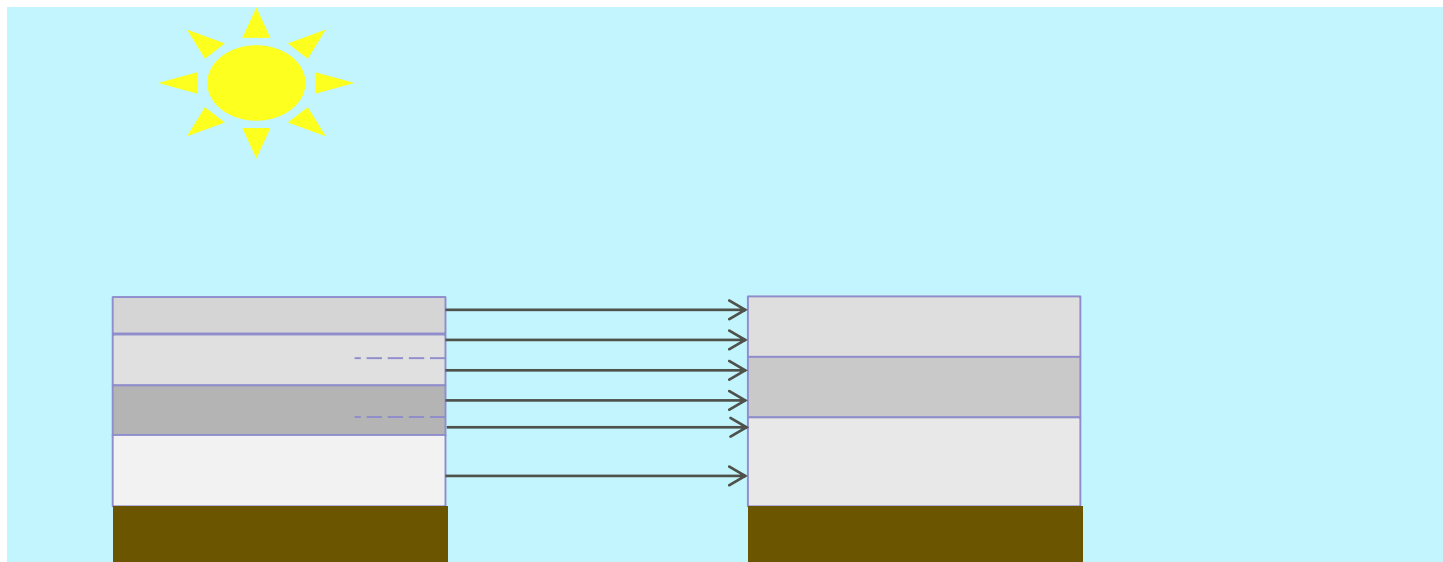
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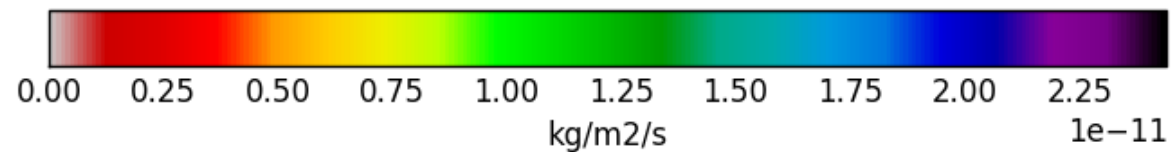
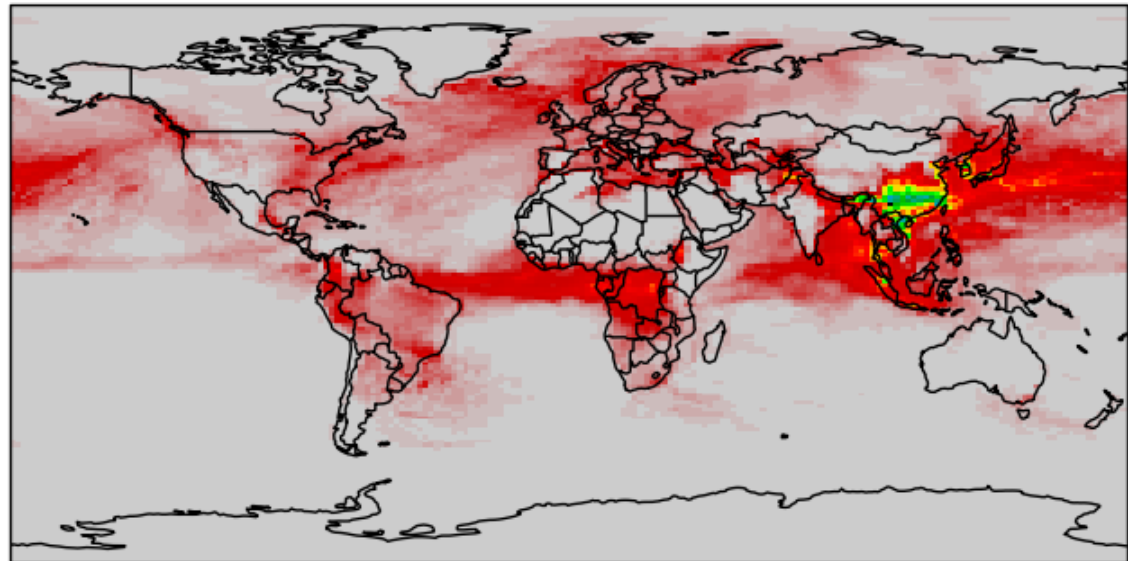


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Black carbon deposition from CLASSIC UM run



An example of the black carbon deposition flux fields produced from CLASSIC UM run output. Monthly mean values for February 2008.

Set-up for offline JULES runs

- Ran for one year (October 2007 – October 2008)
- Used a 'UKV' configuration but with multi-layer snow scheme switched on.
- Forced the runs with WFDEI driving data (Watch Forcing Data methodology applied to ERA-Interim data).

Sites studied

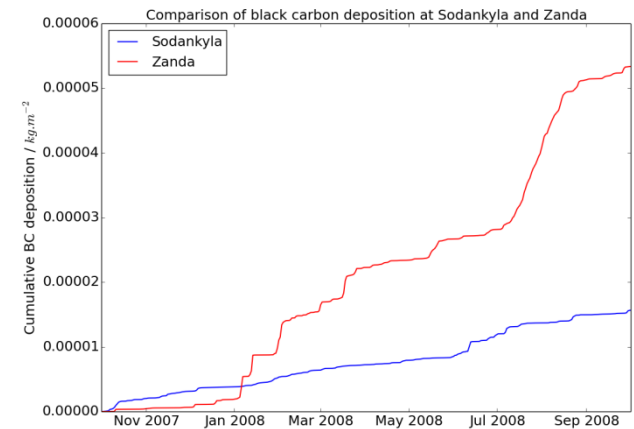
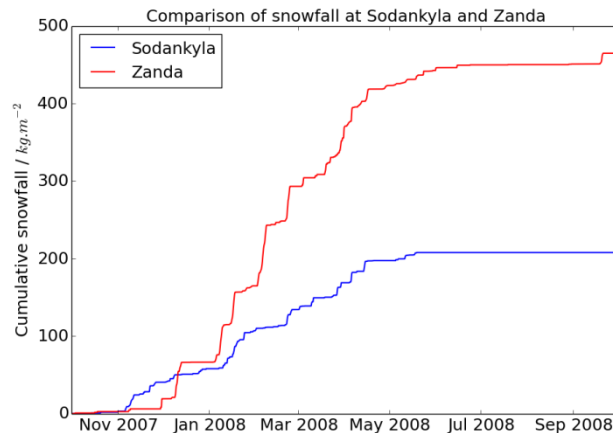


Sodankyla:

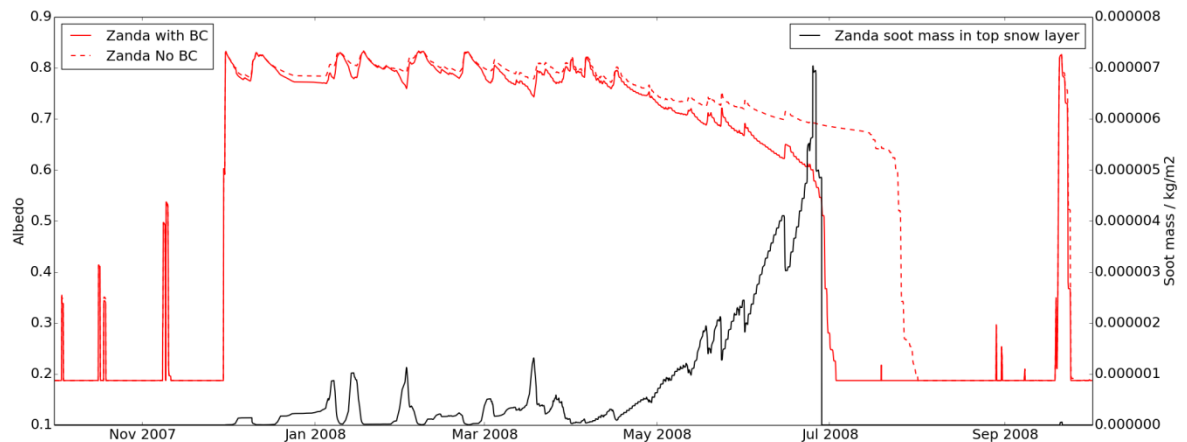
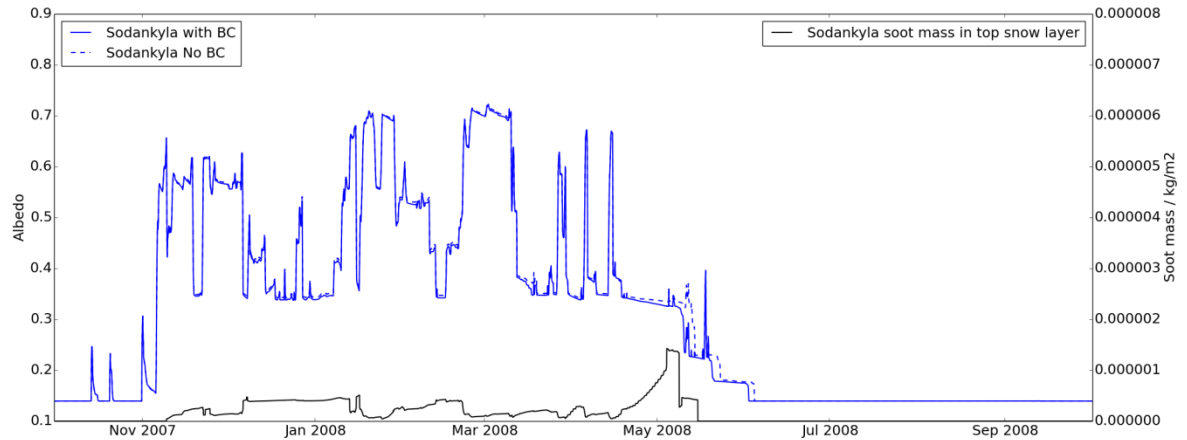
- 67.36N, 26.64E
- Predominantly evergreen needleleaf trees

Zanda:

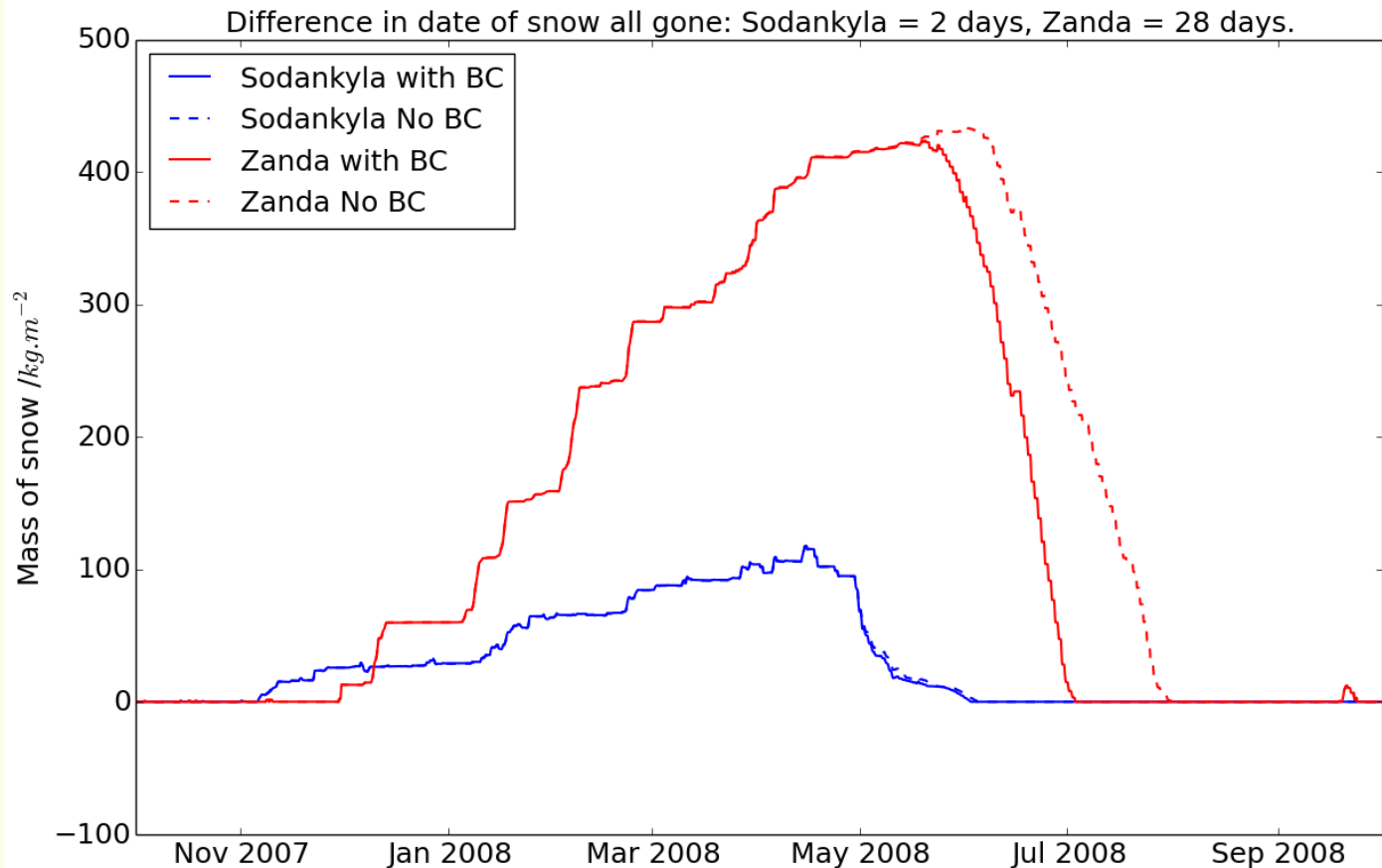
- 32.25N, 77.75E
- Predominantly bare soil



Differences in albedo from including black carbon



Differences in snowmass timeseries from including BC



Summary

- Using JULES to investigate the influence of black carbon (BC) on snowmelt timing.
- Added infrastructure to JULES to read in BC deposition values and to evolve the black carbon concentration through the snow pack.
- Ran a UM atmospheric simulation with the CLASSIC aerosol scheme to produce plausible deposition values that may be input into JULES runs.
- Ran JULES at two sites with and without BC applied and found that including BC in model runs can cause snowpack to disappear as much as 28 days earlier.
- Validation is required to determine the accuracy of this scheme but it is clear that including BC can have significant impacts on snow hydrology so needs to be included in our models.



Met Office

Thanks for listening,
any questions?

