How to take into account blending height in surface fluxes and diagnostics

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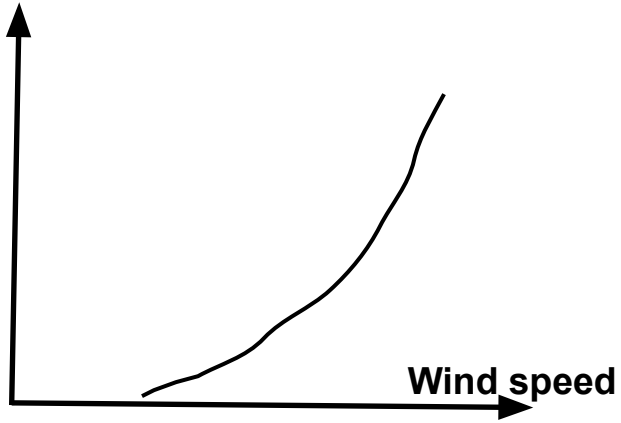
With acknowledgements to NWP and SURFEX colleagues!

The lowest atmospheric level

HARMONIE-AROME experience when introducing 2 patches over land...

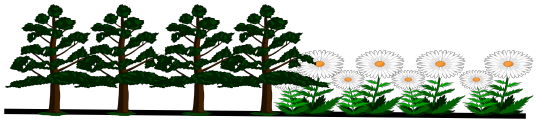


Lowest model level: 12 m
Grid size: 2.5km

U10mN1

NPATCH=1 (N1), i.e. all veg parameters averaged to one value.

U10mN2_forest **U10mN2_open**



NPATCH=2 (N2), i.e. forest and open land separated

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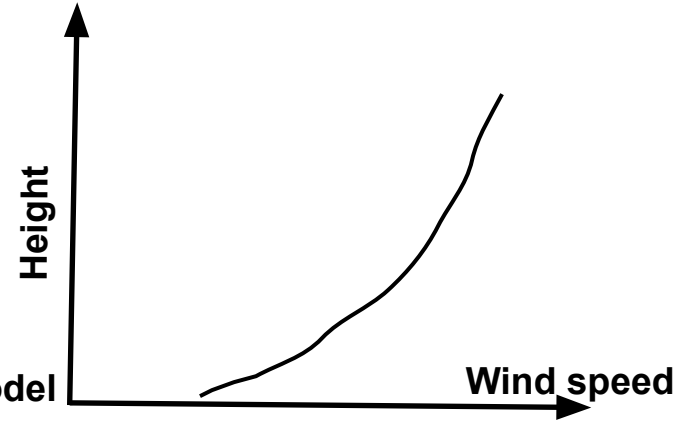

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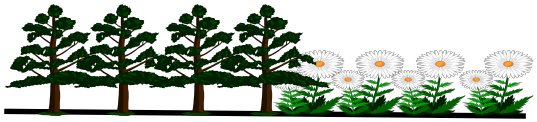

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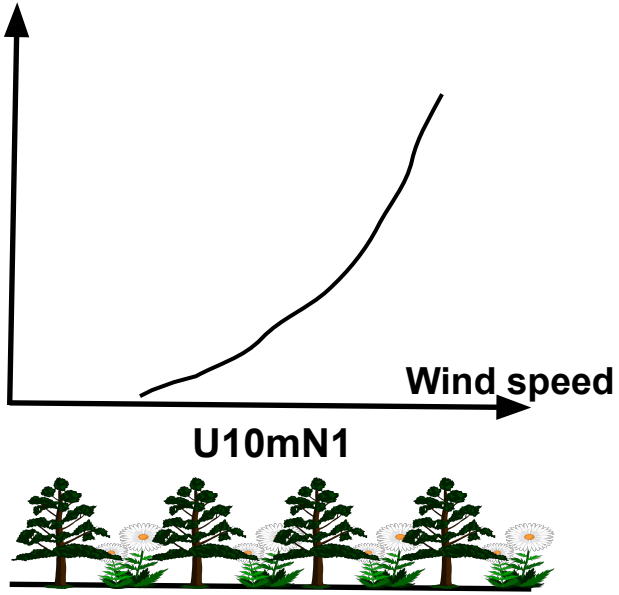

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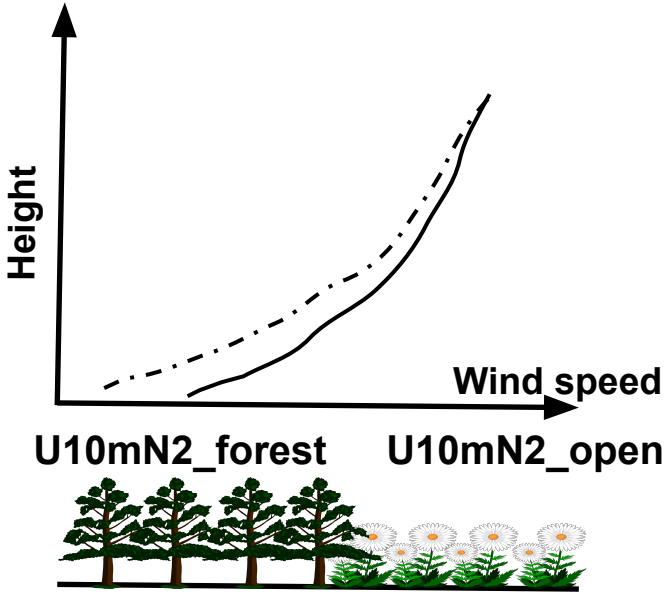

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Lower BL wind N1 > Lower BL wind N2

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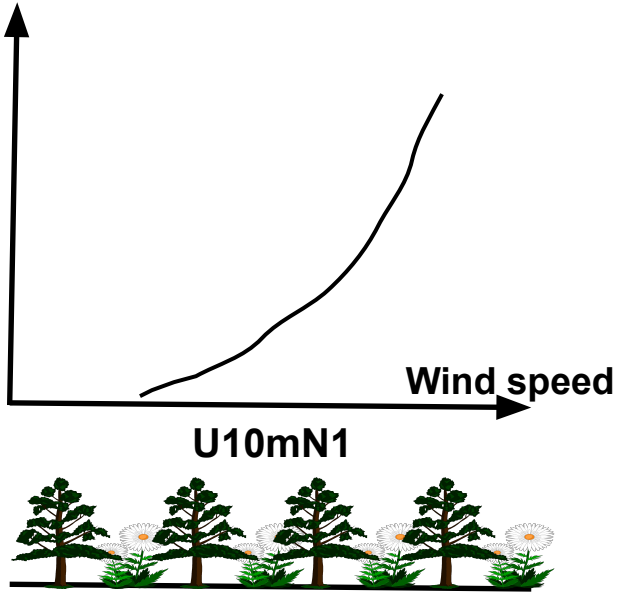

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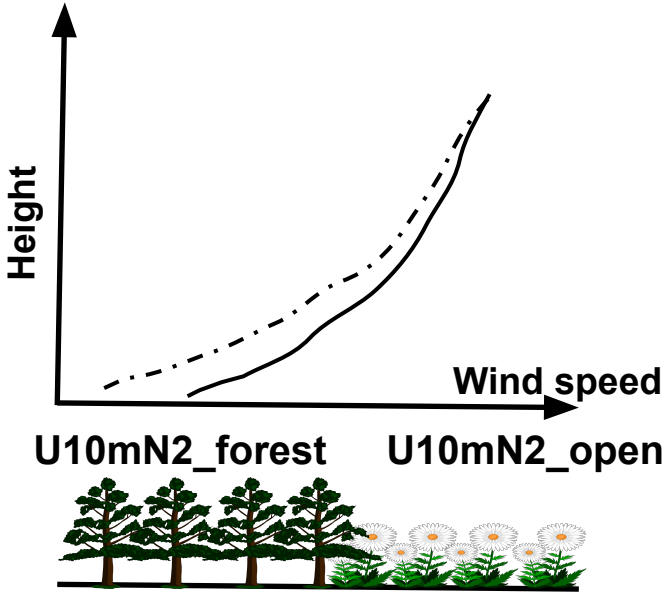

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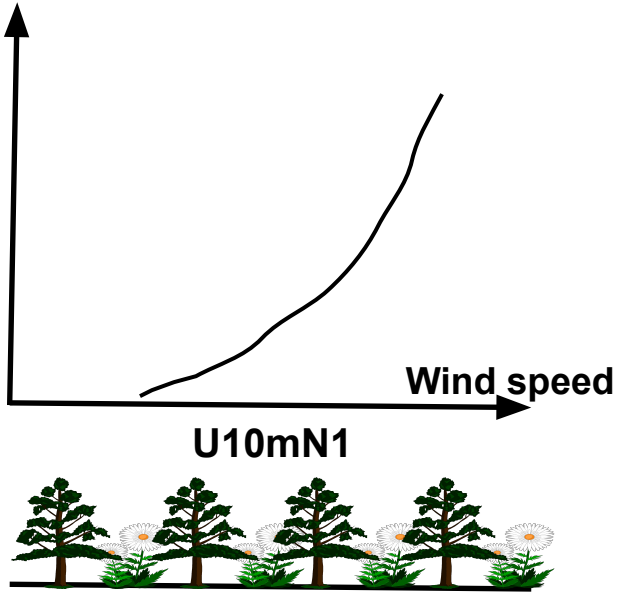

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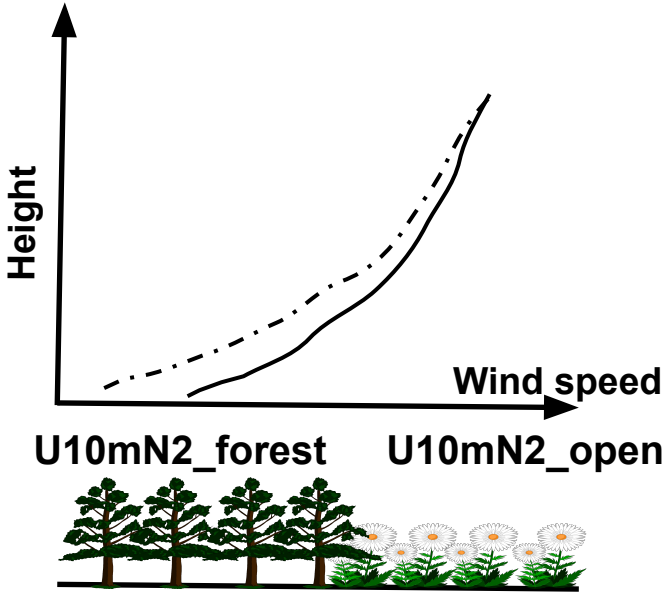

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U10mN2_forest ~ U10mN2_open

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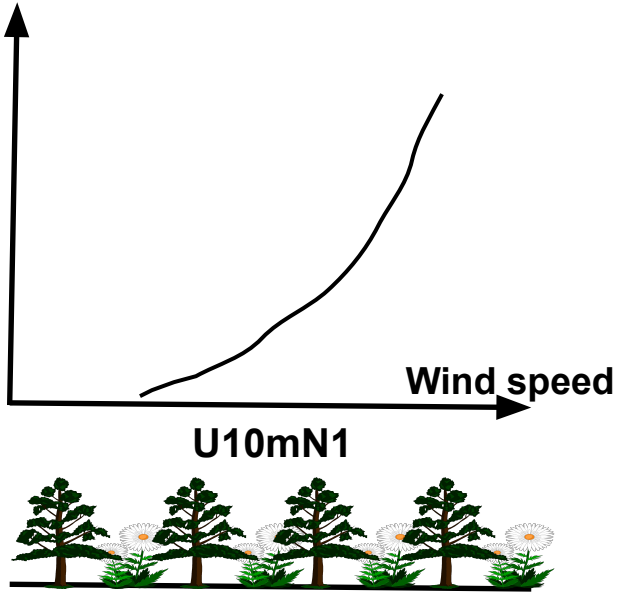

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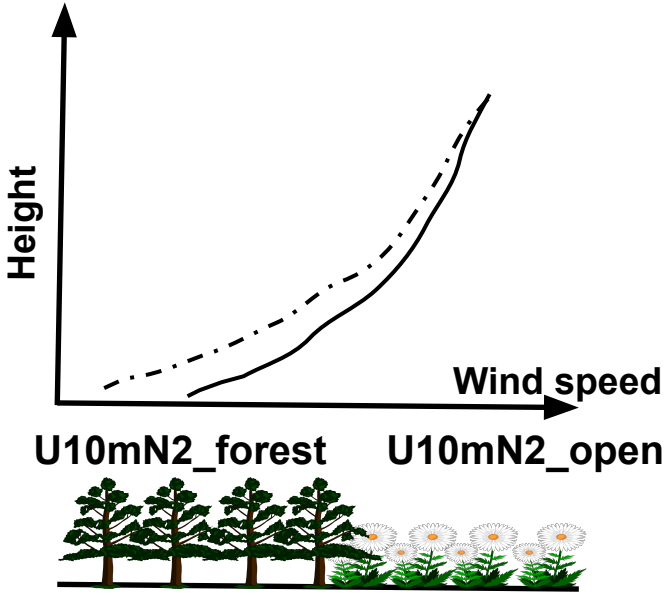

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Hmhm, it is not realistic to enforce horizontally homogeneous conditions close to the surface, independent on surface/atmospheric conditions … what to do?

The lowest atmospheric level

As stated by Essery et al. (2003), in principle, the lowest model level should be set to the "blending height";

- This is an approximate height scale (Mason 1988), high enough above the surface, that the temperature, humidity, and wind speed are nearly homogeneous but low enough that their profiles are nearly in equilibrium with the local surface.
- Blending heights depend on surface roughness, atmospheric stability, and heterogeneity length scales (degree of sub-grid heterogeneity in physiography).

Mason, P.J., 1988. The formation of areally-averaged roughness lengths. Quarterly Journal of the Royal Meteorological Society, 114(480), pp.399-420.

Essery, R.L.H., Best, M.J., Betts, R.A., Cox, P.M. and Taylor, C.M., 2003. Explicit representation of subgrid heterogeneity in a GCM land surface scheme. Journal of Hydrometeorology, 4(3), pp.530-543.

Shao, Y., Liu, S., Schween, J.H. and Crewell, S., 2013. Large-eddy atmosphere–land-surface modelling over heterogeneous surfaces: Model development and comparison with measurements. Boundary-layer meteorology, 148(2), pp.333-356.

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Shao et al. (2013) used a LES atmosphere–land model system at 60 m horizontal resolution to study the effect of heterogeneous land surface on atmospheric fluxes.

- Near the surface (below ~10 m), the flux patterns are closely correlated with the land-use patterns and remains identifiable to a level of over 60 m.
- Above, on average, the correlation between the flux and land-use pattern is quite strong and persistent in at least the lower half of the atmospheric boundary layer.

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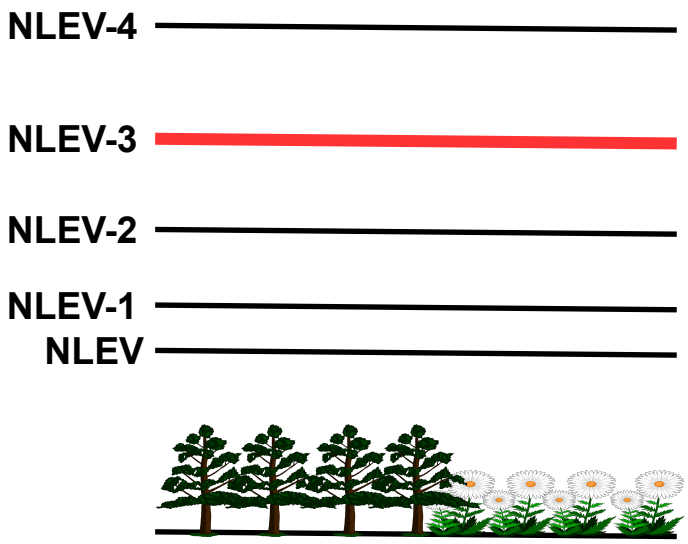
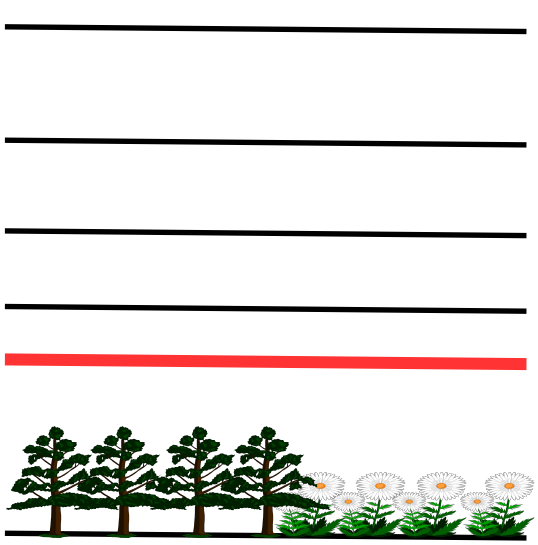
The lowest atmospheric level

Idea… worth testing….??

High blending height:



Low blending height:



- Use the blending height u,v,q,T as upper boundary condition (BC) for the surface model.

The lowest atmospheric level

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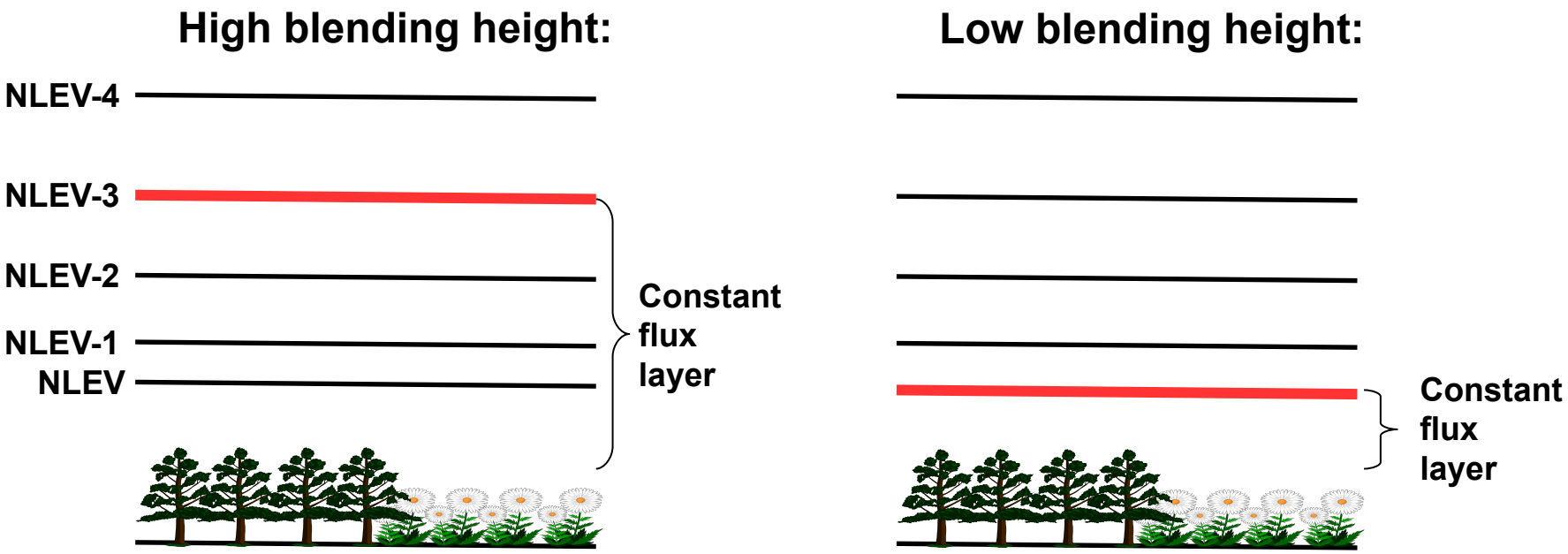

- Use the blending height u,v,q,T as upper boundary condition (BC) for the surface model.
- Assume constant flux layer below blending height which means that fluxes (momentum, heat, moisture) can still be used as lower BC for the atmosphere at NLEV.

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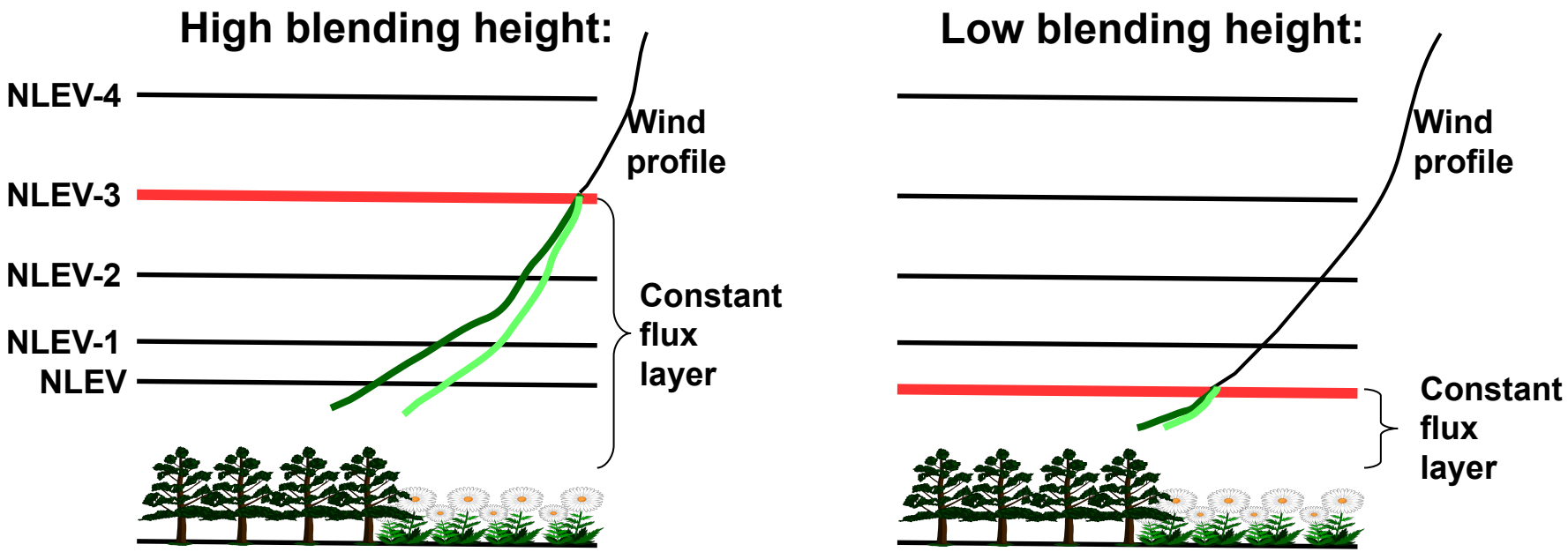

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- Assume constant flux layer below blending height which means that fluxes (momentum, heat, moisture) can still be used as lower BC for the atmosphere at NLEV.
- Sparate profiles below blending height over each patch, forest and open land, respectively.