



The implementation of lateral flows in stand alone JULES

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Overview

- What are lateral flows?
- Why?
- How?
- First results
- Future work

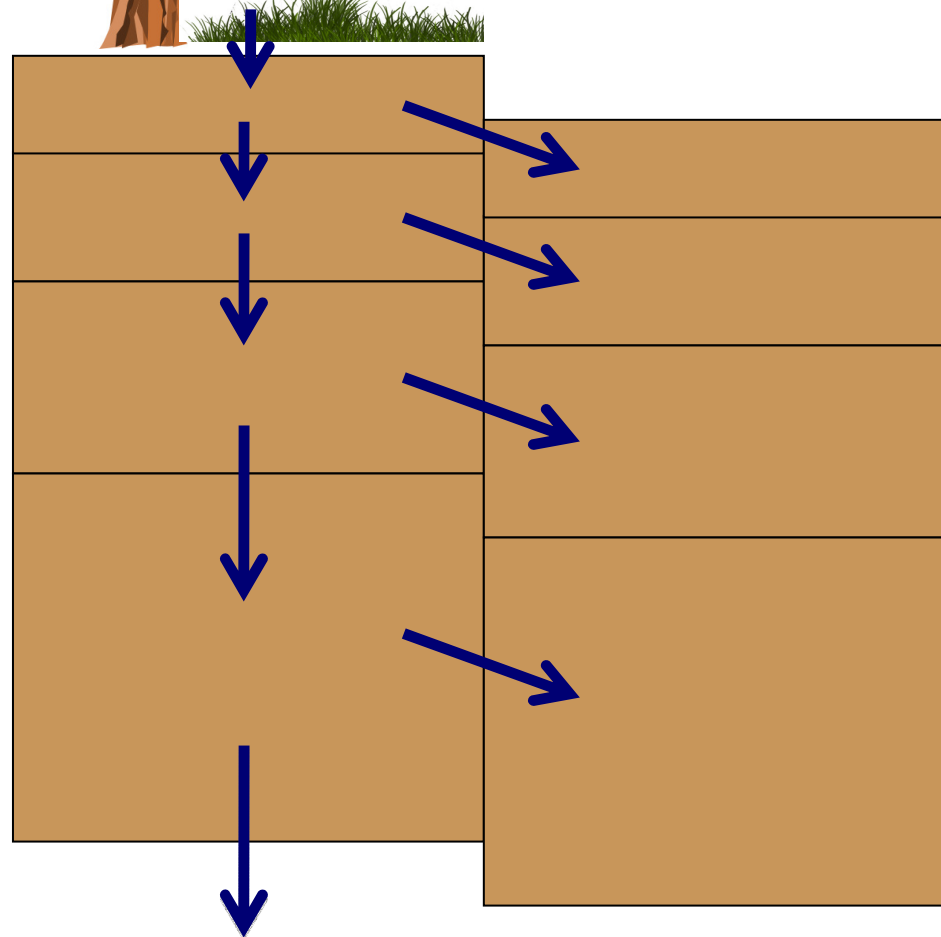


What do I mean by “lateral flows”?



**JULES
Vertical
Flow**

$$W_z = K \left(1 + \frac{\partial \psi}{\partial z} \right)$$



**Lateral
flow**



Motivation?

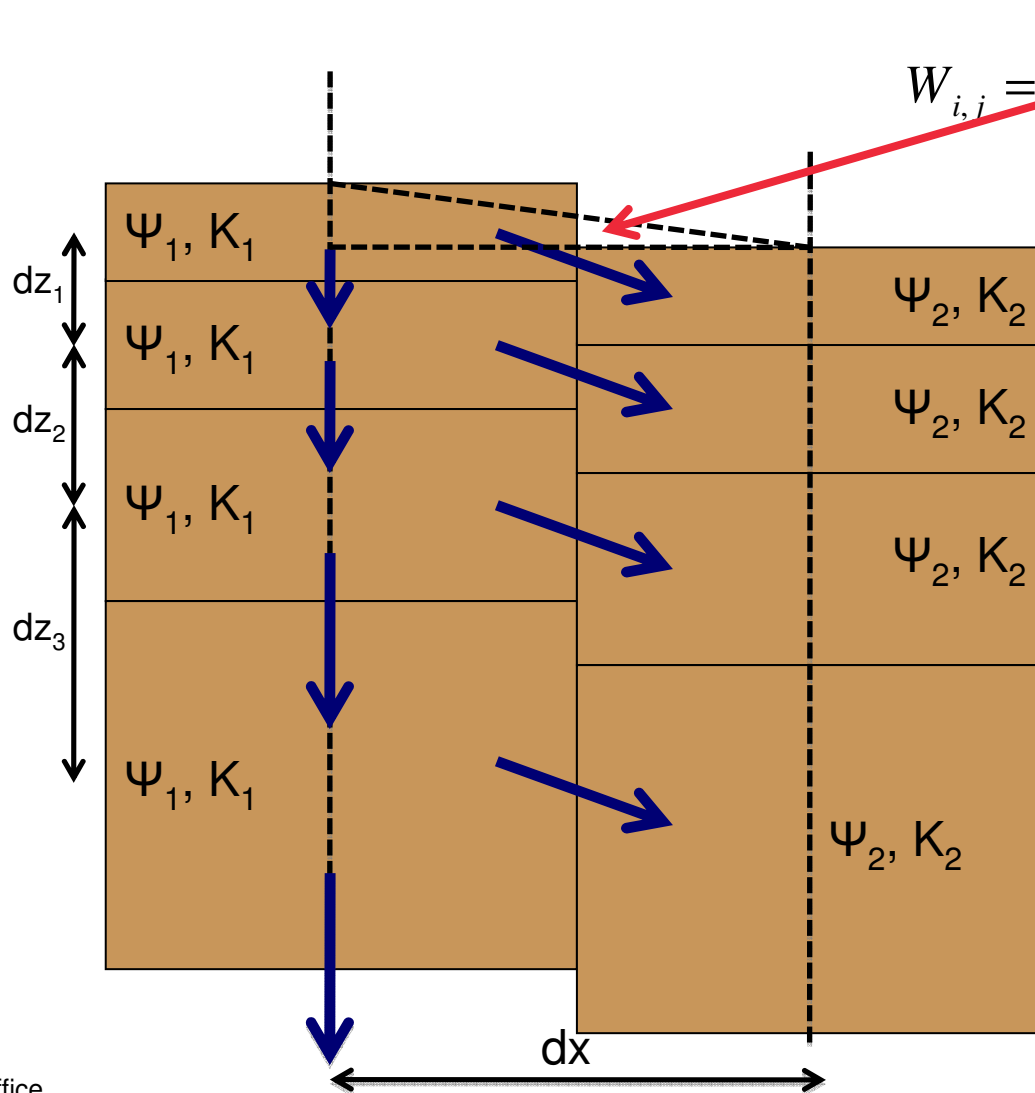
- High resolution soils need lateral flows
 - NWP models at high resolution (1.5km)
 - Plans to test impact of running high resolution soil in low res model (EMBRACE)
- Orography is resolvable
 - Orographic enhancement & wet valleys
- Continental warm bias?
- Impacts on things we care about...
 - River flow, inundation, surface water flooding



How?...

**JULES
Vertical
Flow**

$$W_z = K \left(1 + \frac{\partial \psi}{\partial z} \right)$$



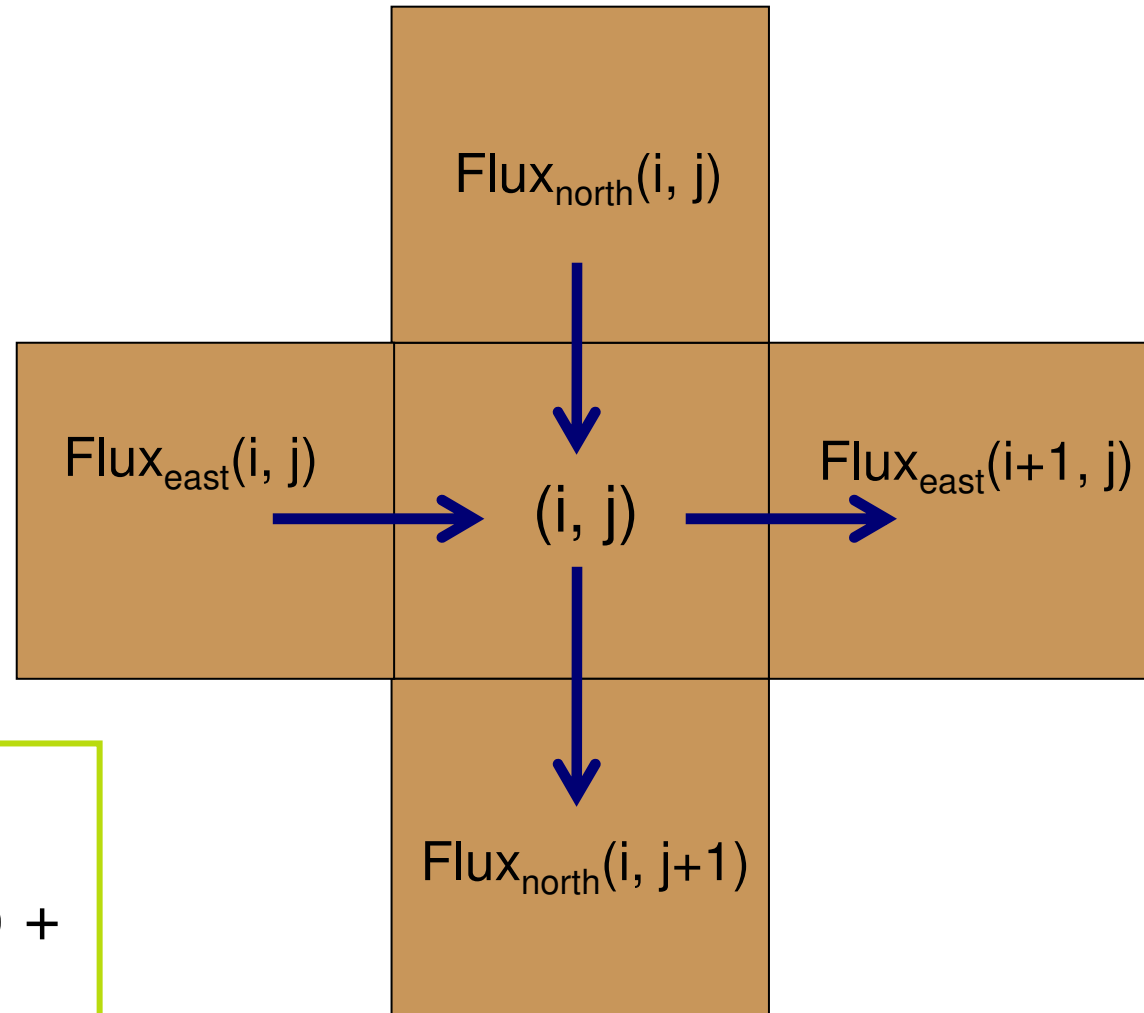
$$W_{i,j} = K_{\min} \left(\sin \alpha + \frac{\partial \psi_{i,j}}{\partial x} \right)$$

**Lateral
flow**



How?...

- Fluxes converge
- Explicit increment added to soil_hyd
- Vertical flows deal then with super sat.



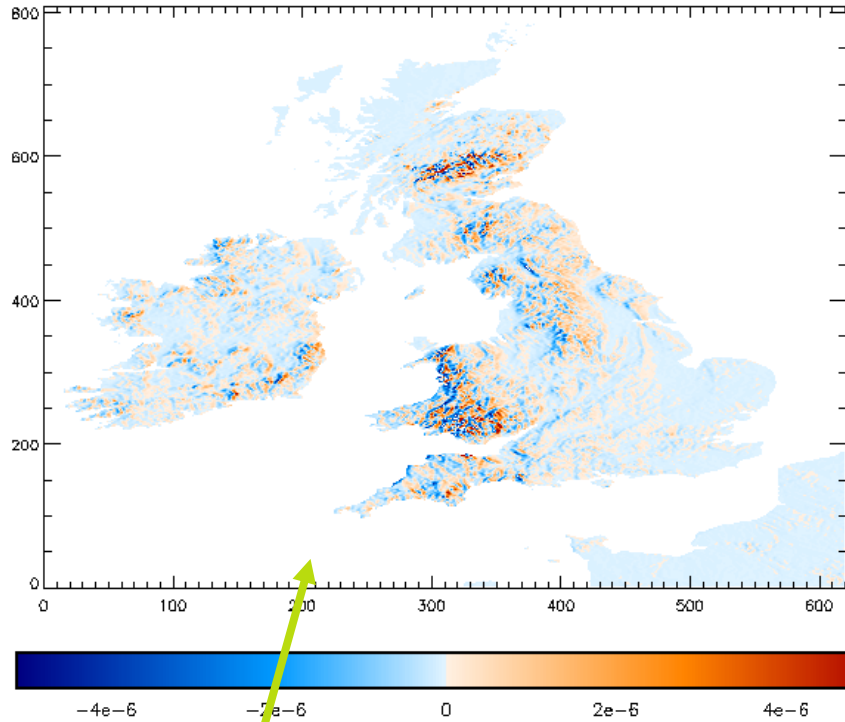
$$\begin{aligned} \text{Lateral flow inc}(i,j) = \\ \text{flux}_{\text{east}}(i,j) - \text{flux}_{\text{east}}(i+1,j) + \\ \text{flux}_{\text{north}}(i,j) - \text{flux}_{\text{north}}(i,j+1) \end{aligned}$$

- Tested using MetUM UKV driven JULES
- Surface water flooding event in Wales...



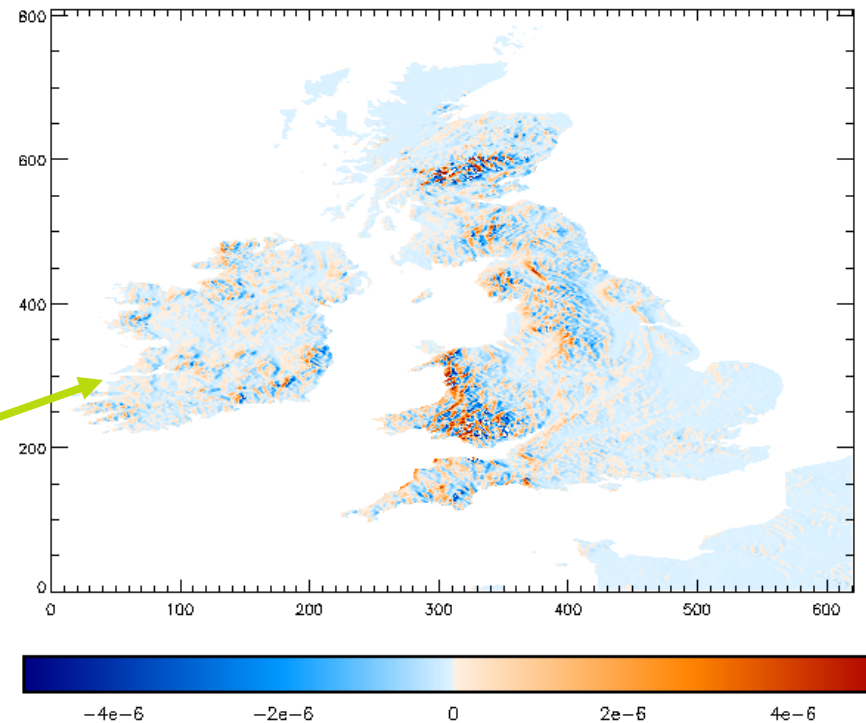
Results – Slopes & Lateral Fluxes

East Flux



- Similar, but opposite sign
- Slope more important than $\left(\frac{\partial \psi_{i,j}}{\partial x}\right)$

East Slope * K_{\min}



$$W_{i,j} = K_{i,j} \left(\sin \alpha + \frac{\partial \psi_{i,j}}{\partial x} \right)$$

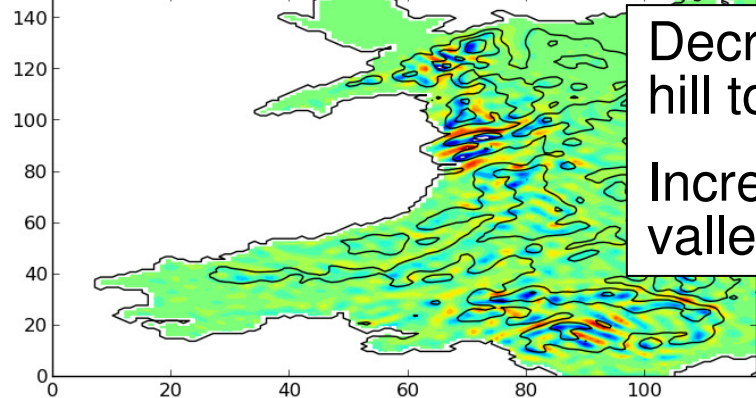


Results: Cumulative water fluxes

Contours – UKV 1.5km Orography (source: DTED 1km)

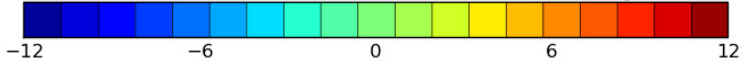
M

Total column soil moisture (with minus without lat flow) [kgm⁻²]

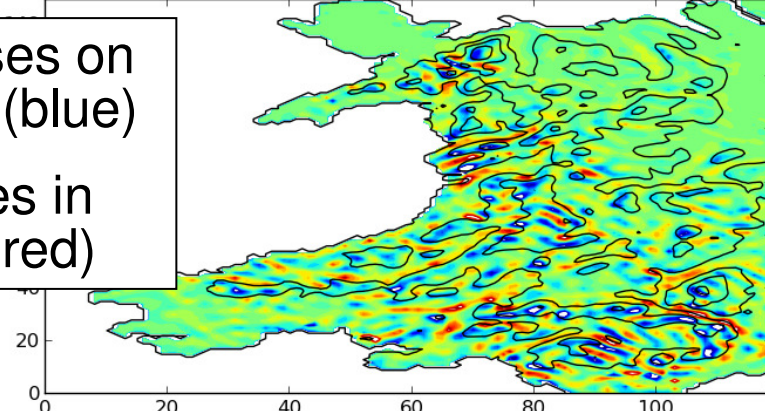


Decreases on hill tops (blue)
Increases in valleys (red)

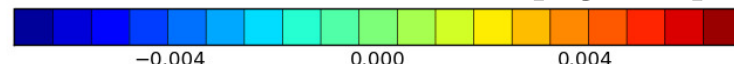
Total column soil moisture [kg m⁻²]



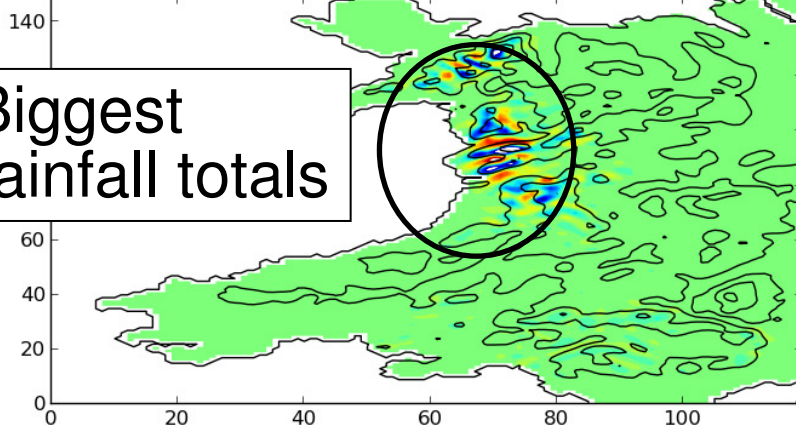
Gridbox moisture flux from surface (with minus without lat flow) [kgm⁻²]



Surface moisture flux [kg m⁻²]

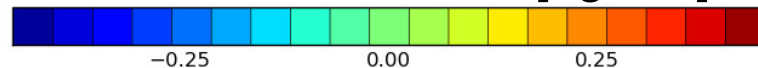


Total Surface Runoff (with minus without lat flow) [kgm⁻²]

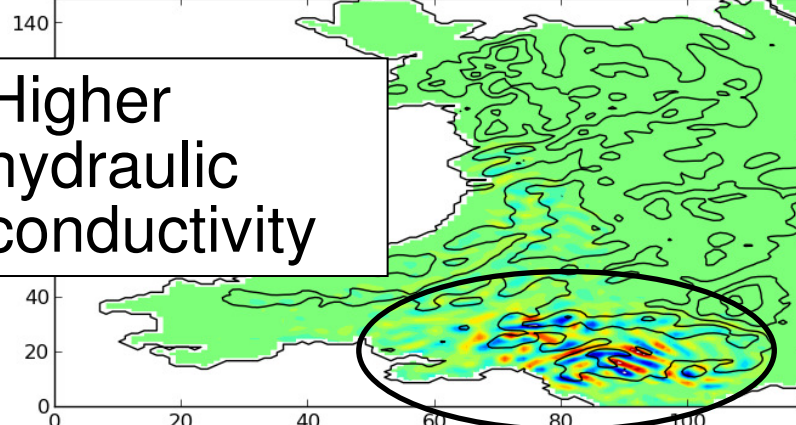


Biggest rainfall totals

Total Surface runoff [kg m⁻²]

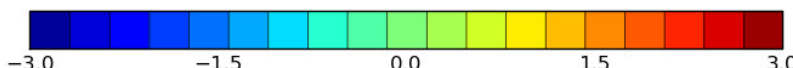


Total Sub Surface Runoff (with minus without lat flow) [kgm⁻²]



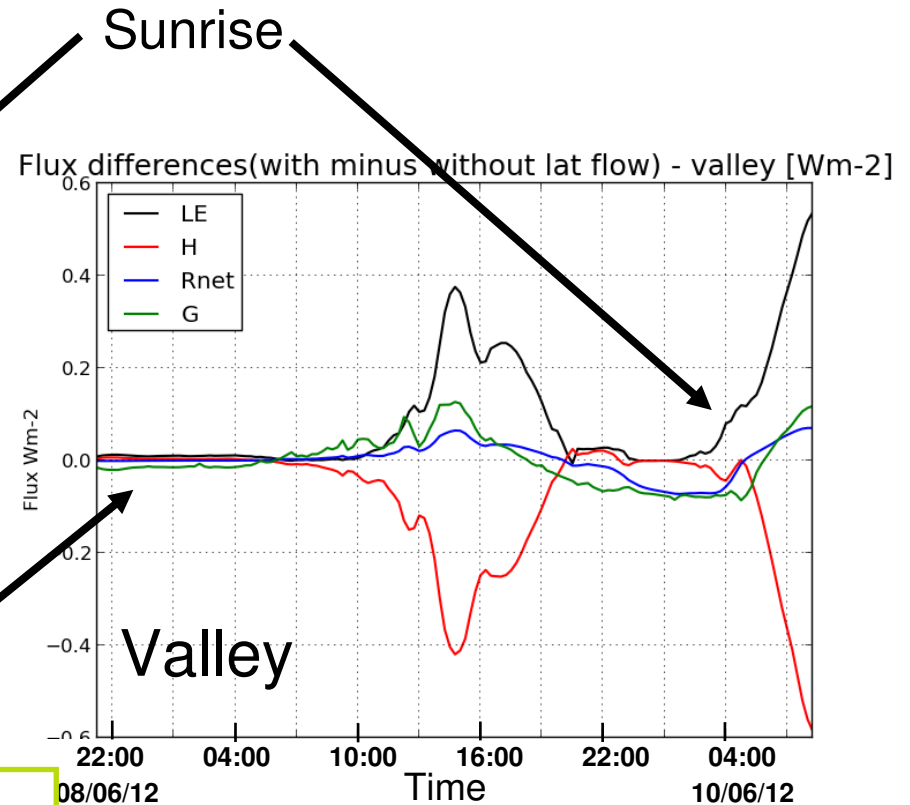
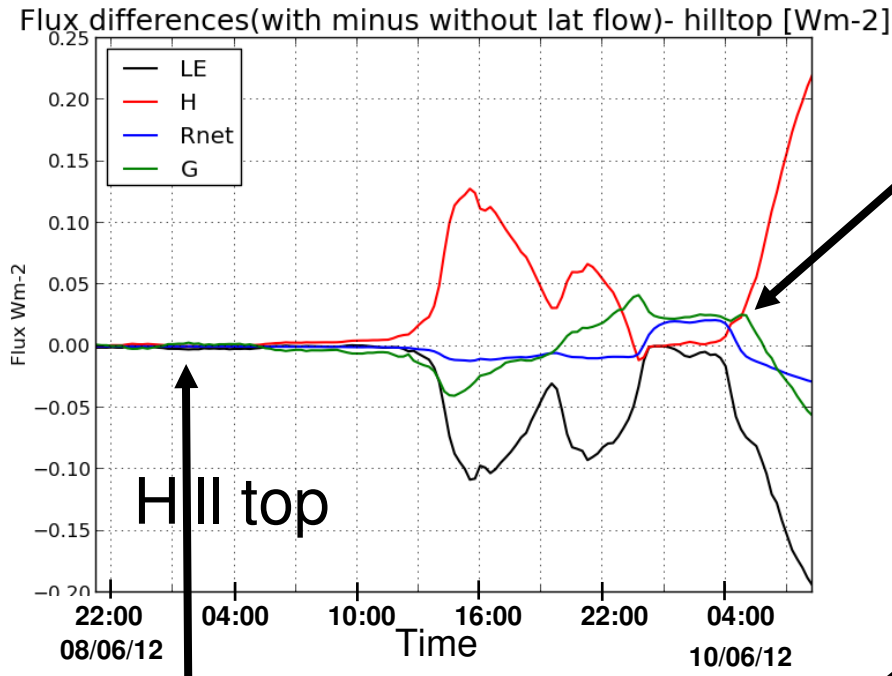
Higher hydraulic conductivity

Total Sub-Surface runoff [kg m⁻²]





Results: Time series of surface energy fluxes differences



Very little change until rain stops

Overall, small change
Hilltops - LE decrease, H increase
Valleys - opposite

$$LE + H = R_n - G$$



Future Work

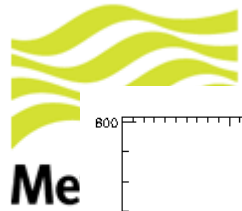
- Standalone JULES running with high res soils & lateral flows forced with WFDEI
- Integrate high res soils & lateral flows into UM
 - Parallelization?
- Aggregating over soils?



Met Office

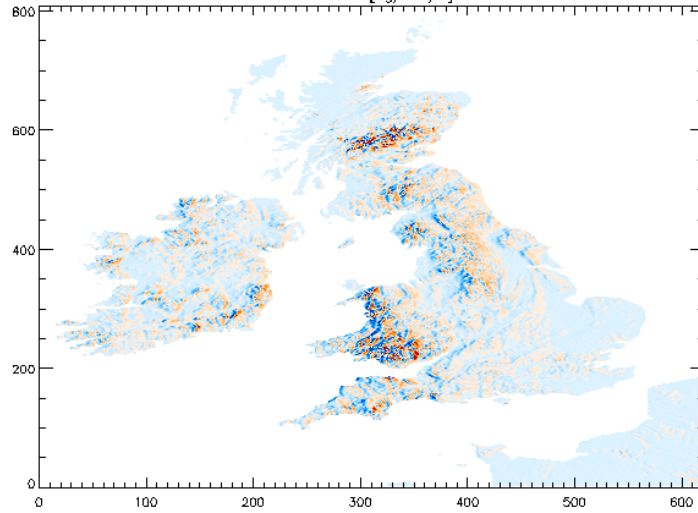


Any Questions?

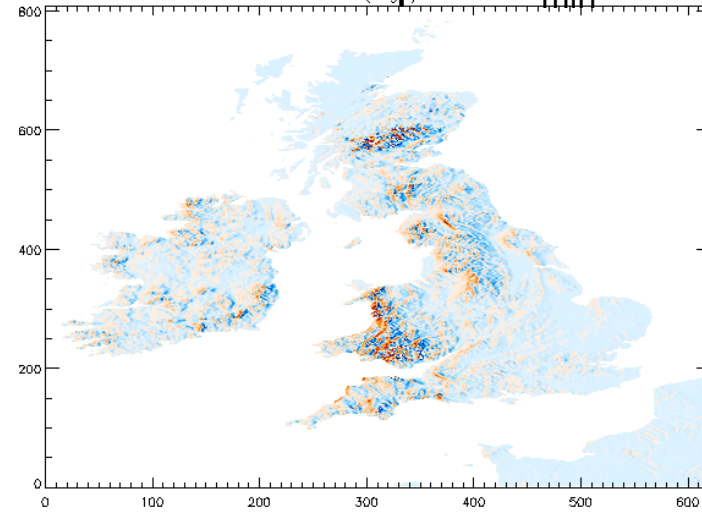


Results – Slopes & Lateral Fluxes

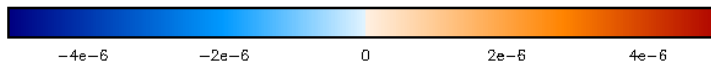
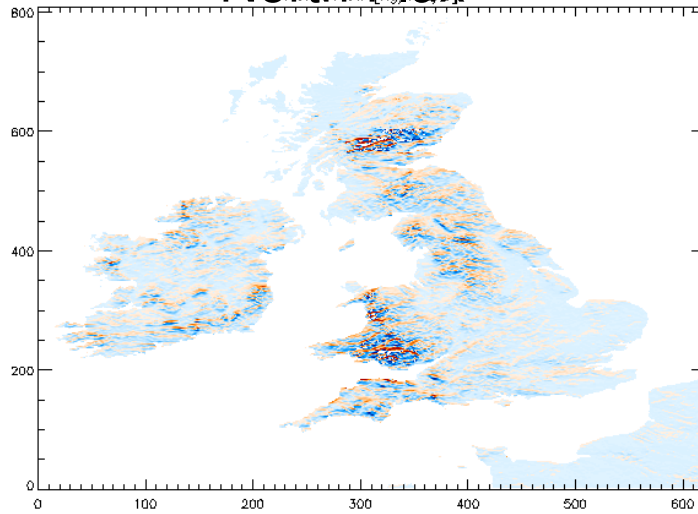
East Flux
East Slope (kg/m²/s)



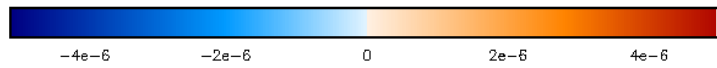
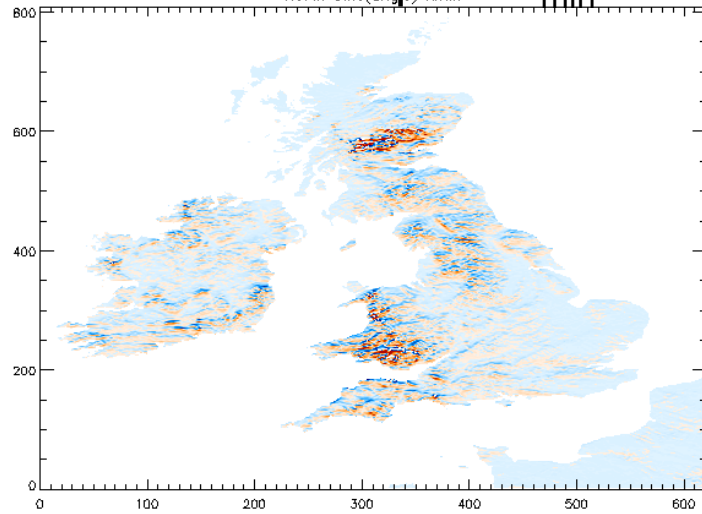
East Slope * K_{min}
East Slope (kg/m²/s) * K_{min}



North Flux
North Flow (kg/m²/s)

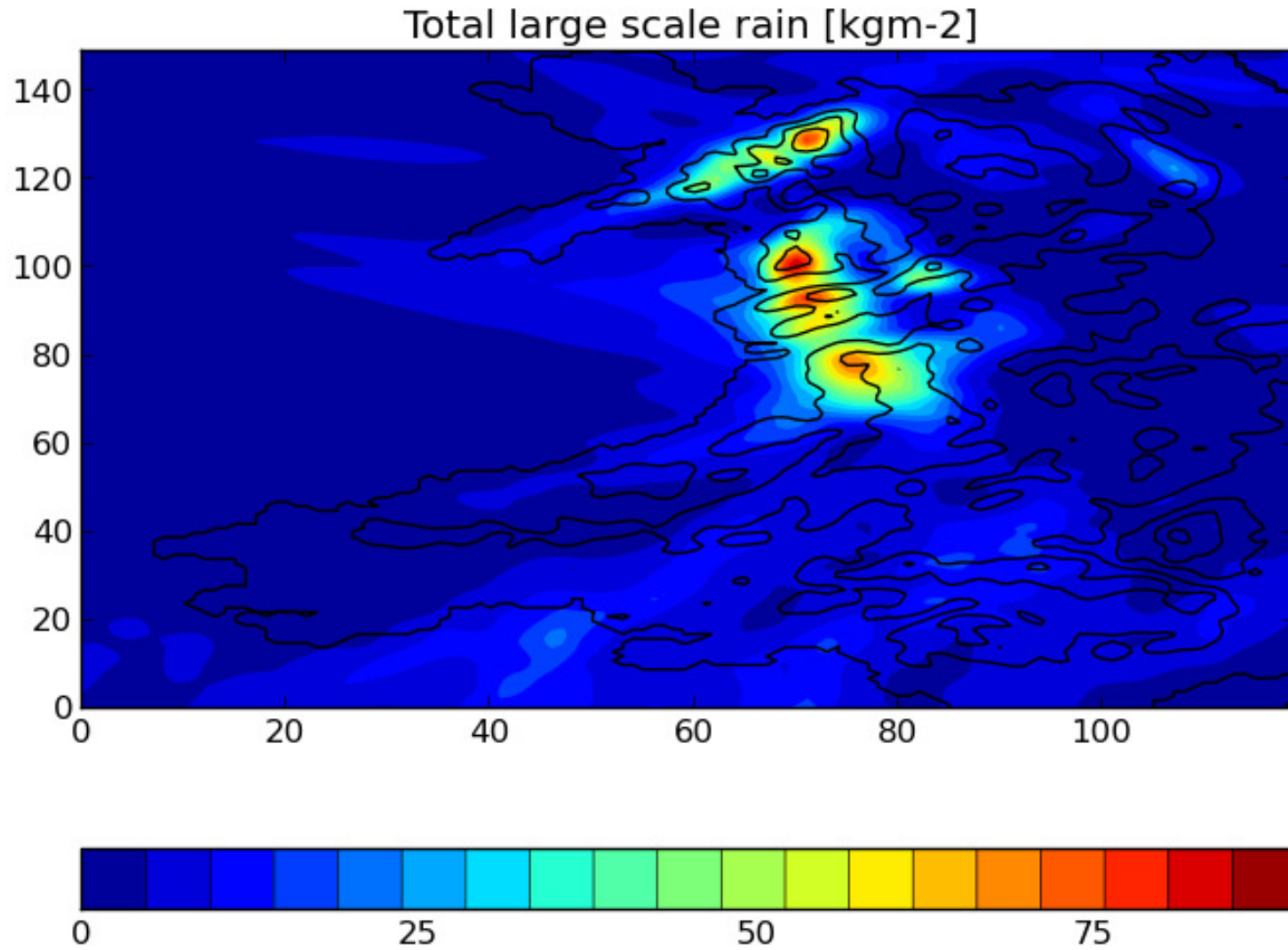


North Slope * K_{min}
North Slope (kg/m²/s) * K_{min}



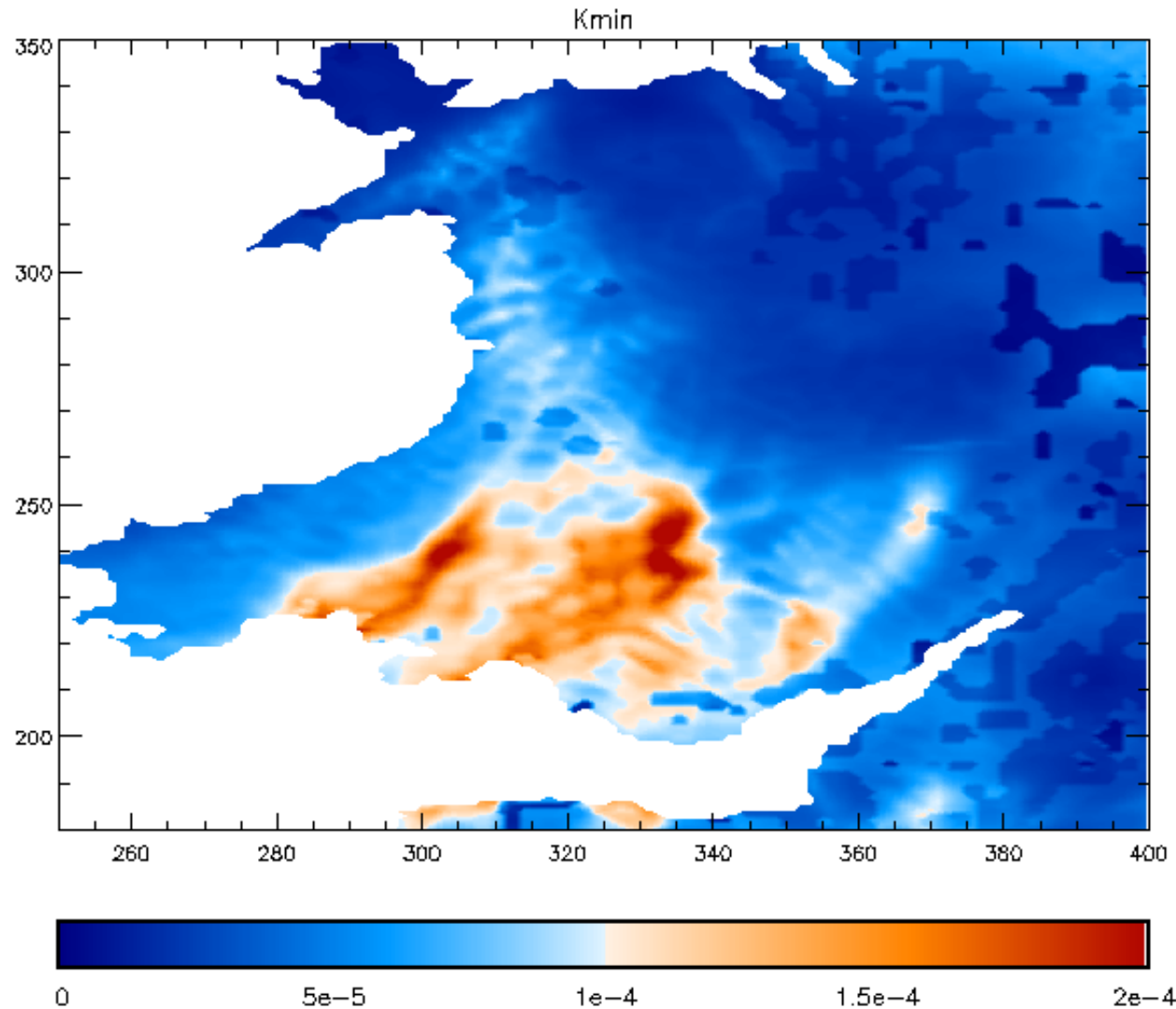


Total Large Scale Rain



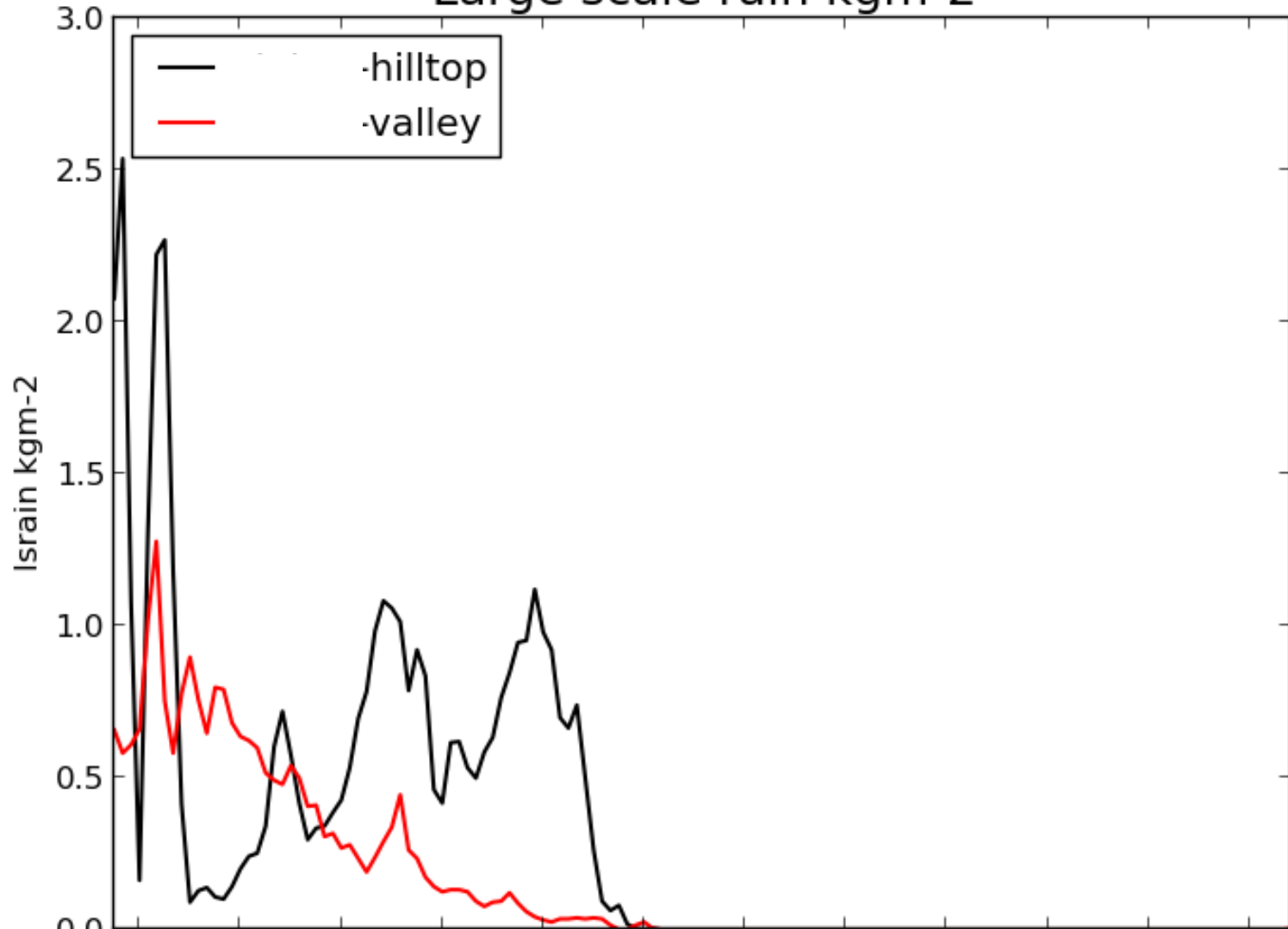


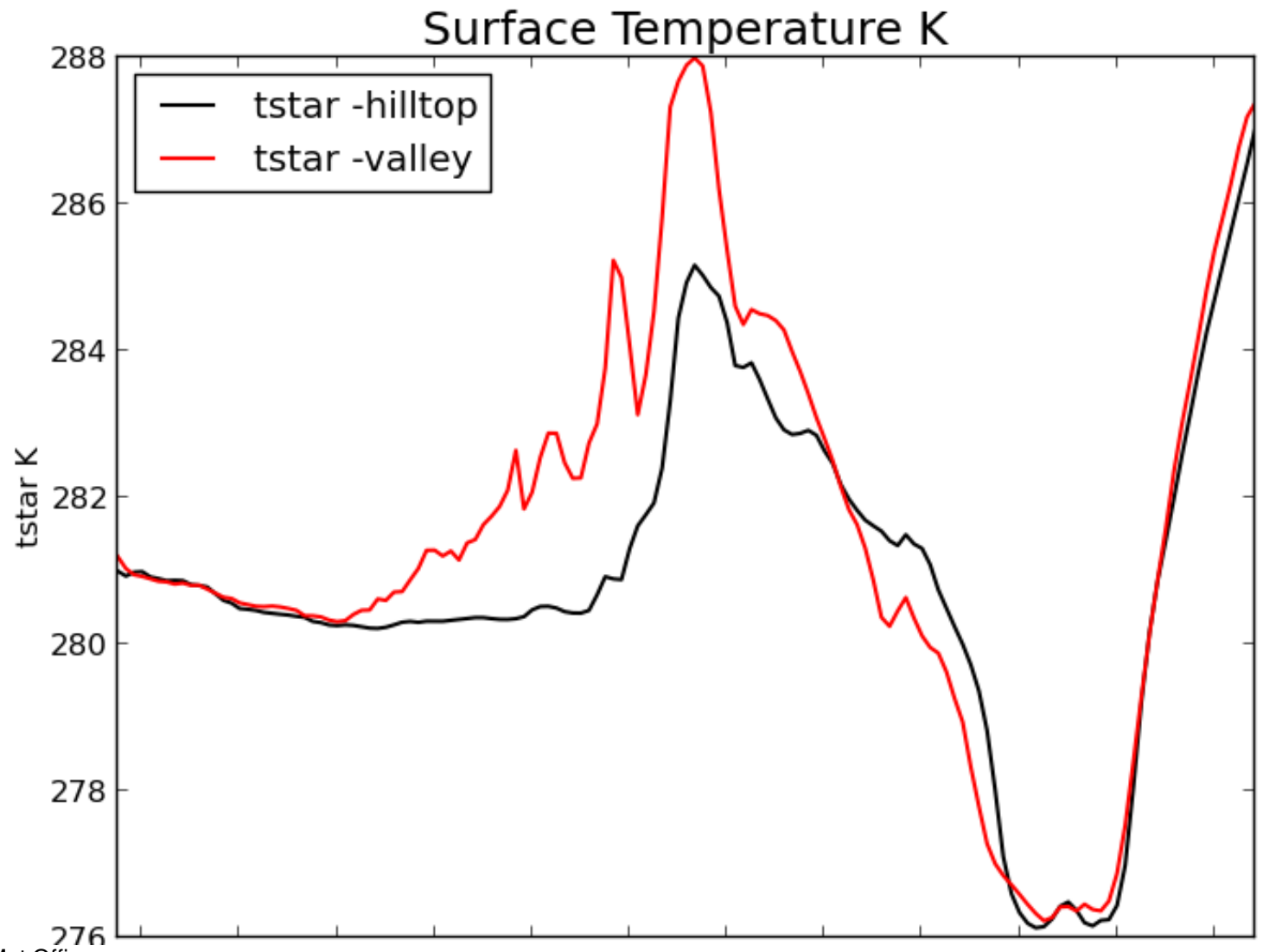
Hydraulic conductivity (K_{\min}) [$\text{kgm}^{-2}\text{s}^{-1}$]





Large scale rain kgm-2







Met C

Surface Temperature K (with minus without lat flow)

