Current work on topography in parallel VVM

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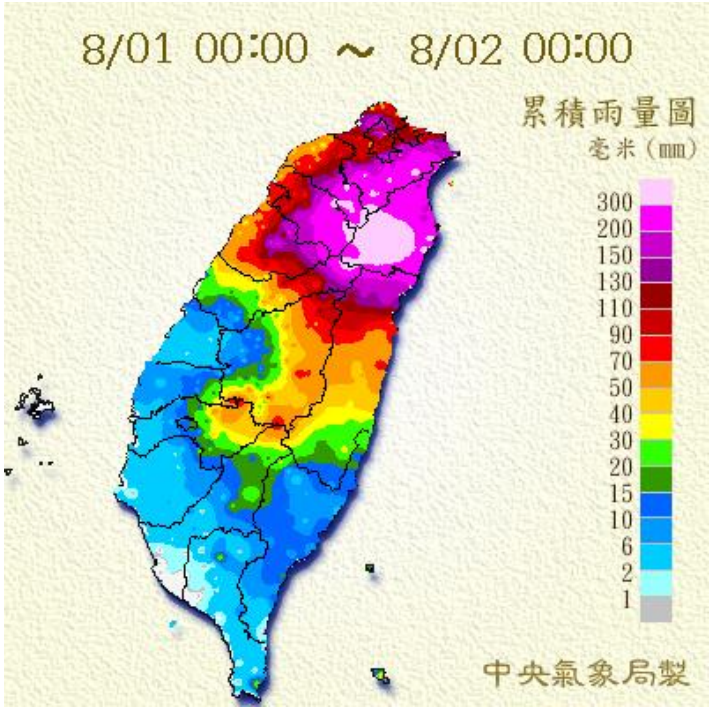
CURRENT WORK ON TOPOGRAPHY IN PARALLEL VVM

High-resolution simulation of flow over complex topography is necessary in understanding atmospheric processes in Taiwan.

Daily precipitation during typhoon SAOLA



400 km

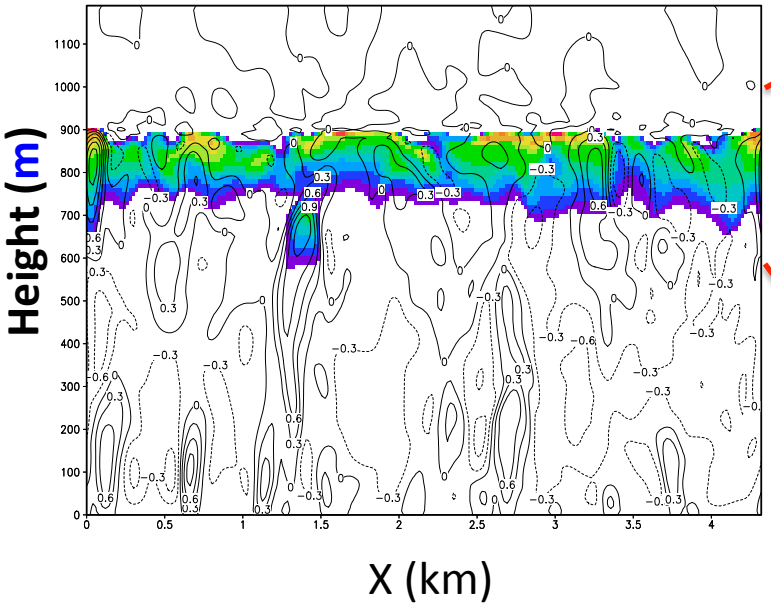
150 km

HIGH RESOLUTION SIMULATION IN PARALLEL VVM

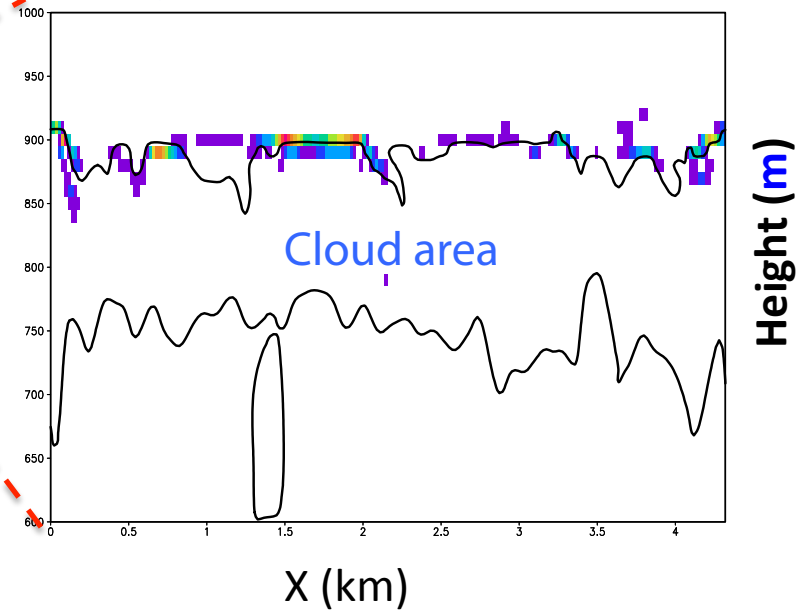
Stratocumulus(DYCOMS case)

Δx=Δy=2Δz=20m, 6 hr simulation

Liquid water content (shaded), vertical velocity (m/s)



Enstrophy (shaded), Liquid water content (contour)

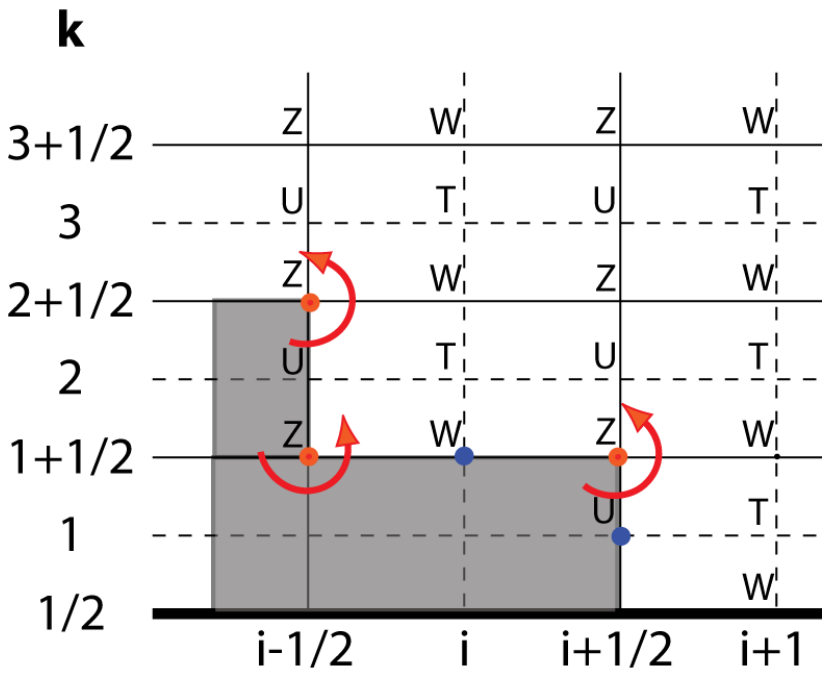


pVVM is capable of simulating fine structure of stratocumulus.

Determining the vorticity at the corners of the topography

•The strength of the vorticity at the corners is determined through vorticity definition.

$$\eta_b = \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x} \qquad u_b = w_b = 0$$



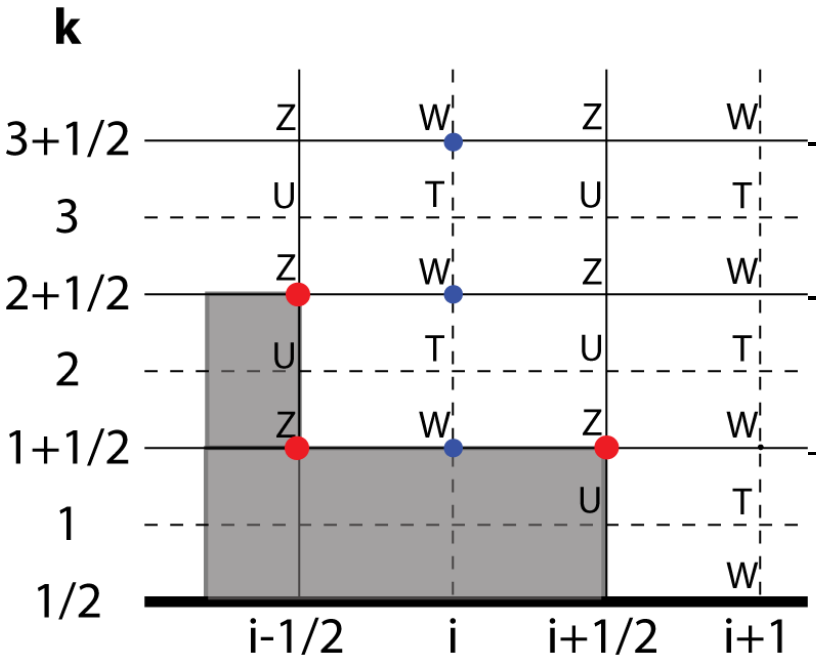
$$(\eta_b)_{i,1+1/2} = \frac{u_{i,2} - (u_b)_{i,1}}{\Delta z} - \frac{w_{i+1/2,1+1/2} - (w_b)_{i-1/2,1+1/2}}{\Delta x}$$

$$(u_b)_{i,1} = (w_b)_{i-1/2,1+1/2} = 0$$

Solving the relaxed w-equation in VVM

•Solving the relaxed w-equation with the addition of vorticies at the corners

$$\mu\frac{\partial w}{\partial t}+\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)w+\frac{\partial}{\partial z}\left[\frac{1}{\rho_0}\left(\frac{\partial}{\partial z}\rho_0 w\right)\right]=-\frac{\partial \eta}{\partial x}+\frac{\partial \xi}{\partial y}$$



First term of RHS=

$$-\left\{\frac{\eta_{i+1/2,k+1/2}-\eta_{i-1/2,k+1/2}}{\Delta x}\right\}$$

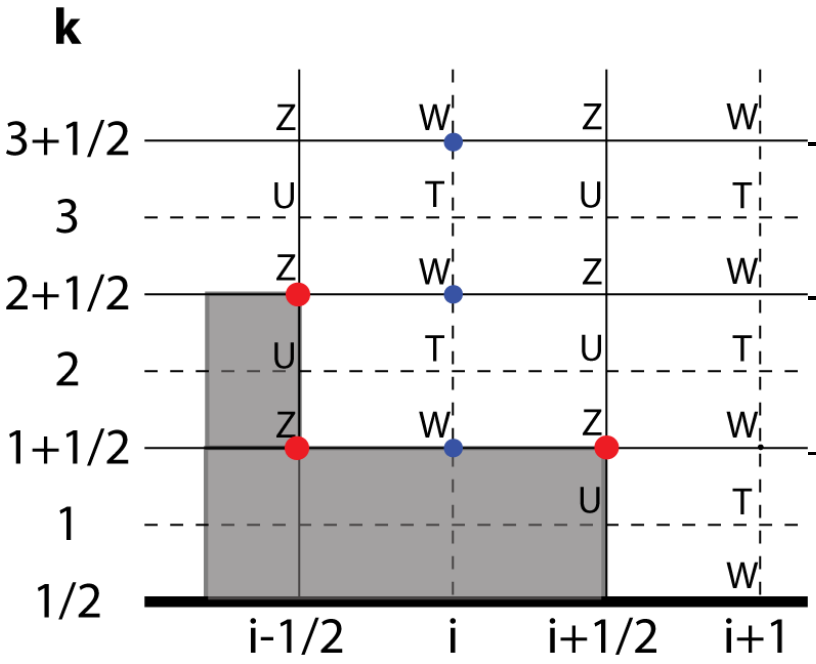
$$-\left\{\frac{\eta_{i+1/2,2+1/2}-(\eta_b)_{i-1/2,2+1/2}}{\Delta x}\right\}$$

$$-\left\{\frac{(\eta_b)_{i+1/2,1+1/2}-(\eta_b)_{i-1/2,1+1/2}}{\Delta x}\right\}$$

Solving the elliptic w-equation in Parallel VVM

- Solving the relaxed w-equation with the addition of vorticies at the corners

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)w+\frac{\partial}{\partial z}\left[\frac{1}{\rho_0}\left(\frac{\partial}{\partial z}\rho_0 w\right)\right]=-\frac{\partial \eta}{\partial x}+\frac{\partial \xi}{\partial y}$$



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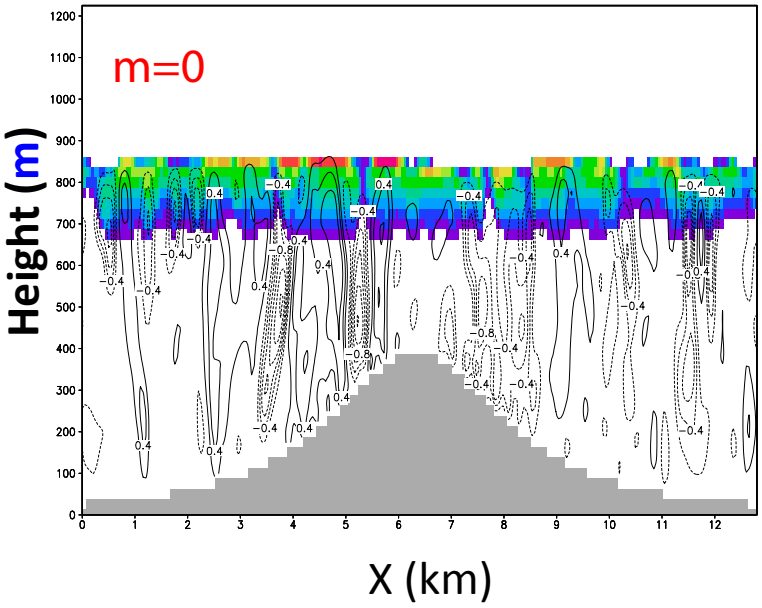
$$-\left\{\frac{(\eta_b)_{i+1/2,1+1/2}-(\eta_b)_{i-1/2,1+1/2}}{\Delta x}\right\}$$

STRATOCUMULUS OVER SMOOTH TOPOGRAPHY IN PARALLEL VVM

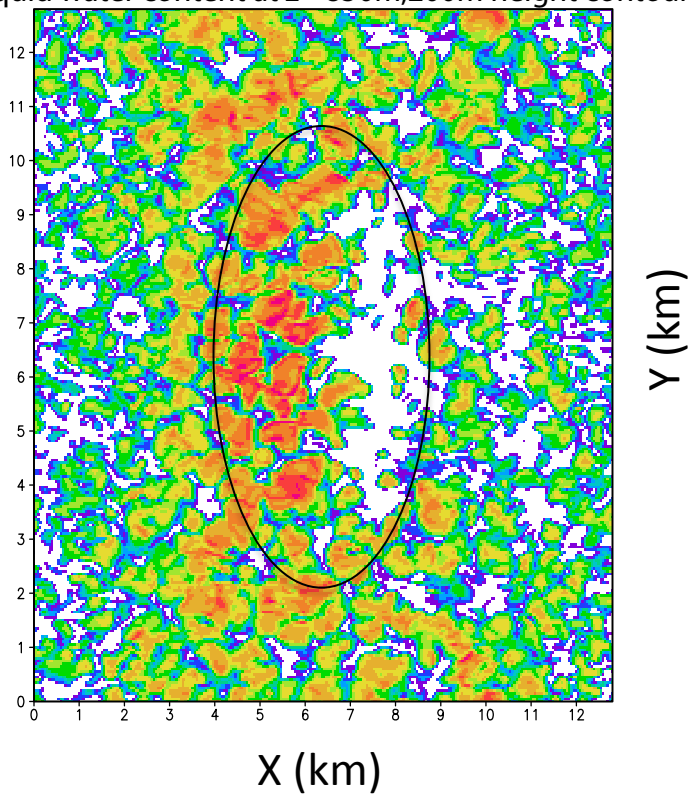
Stratocumulus with elliptic shaped mountain, no surface fluxes

Δx=Δy=2Δz=50m, 6 hr simulation

Liquid water content, vertical velocity (m/s)



Liquid water content at z= 850m,200m height contour



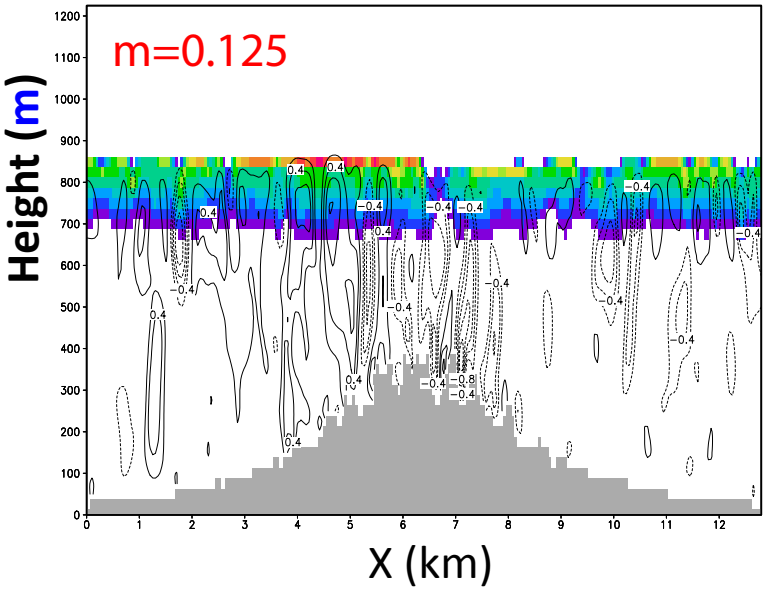
m: an index for the roughness of the topography

STRATOCUMULUS OVER RUGGED TOPOGRAPHY IN PARALLEL VVM

Stratocumulus with elliptic shaped mountain, no surface fluxes

$\Delta x=\Delta y=2\Delta z=50$m, 6 hr simulation

Liquid water content, vertical velocity (m/s)



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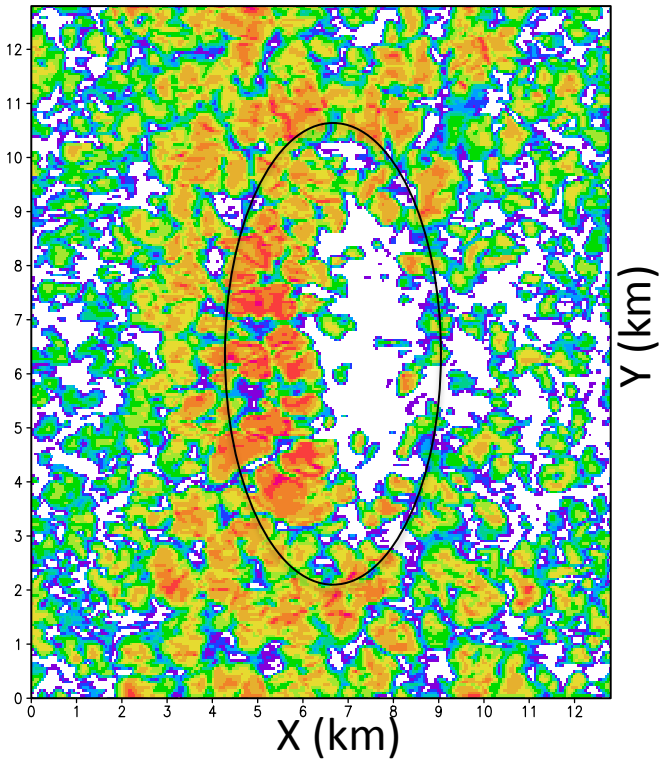
Liquid water content at z= 850m,200m height contour



Topography is implemented in the pVVM successfully under high-resolution stratocumulus simulation.

FUTURE WORK

The topography is implemented in pVVM with only barrier effects. Future work will focus on implementation of turbulence, radiation, and land-surface processes near the bottom topography.

Cloud Forest