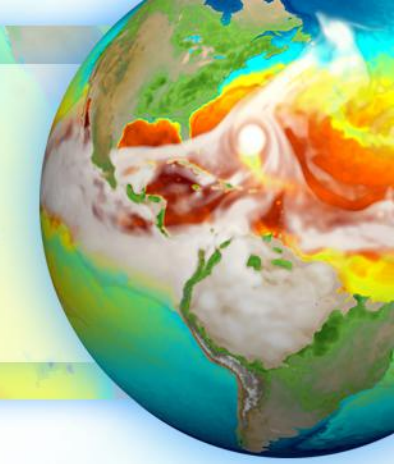
Ice sheet model mesh-resolution dependence of damage advection and calving



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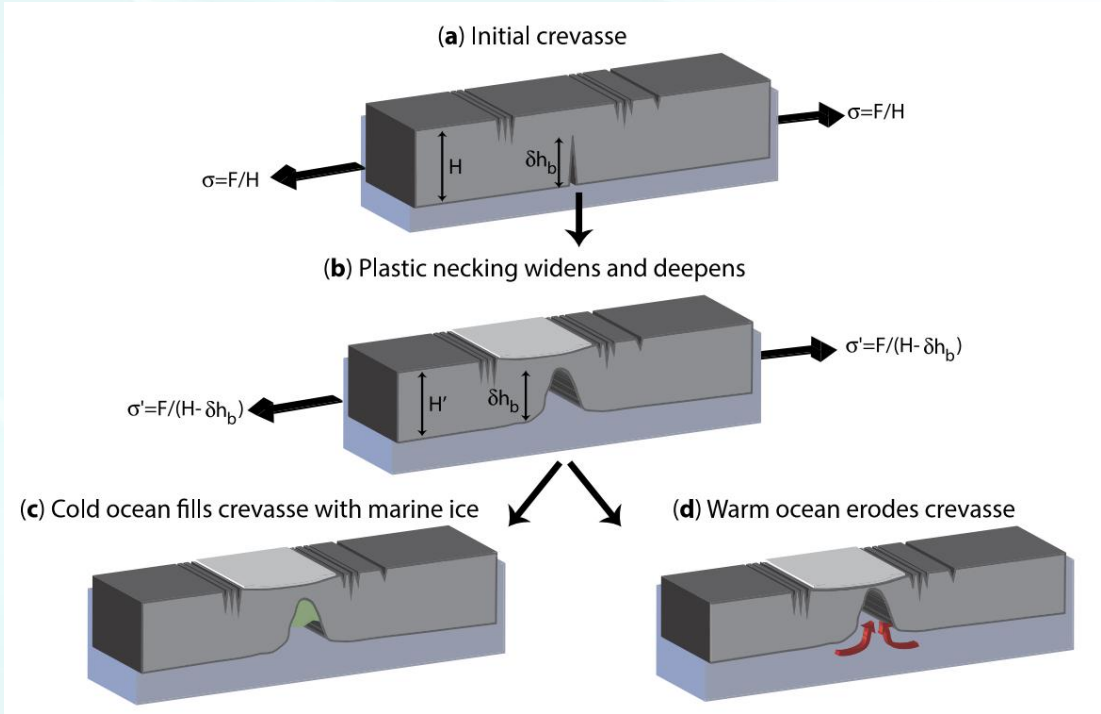
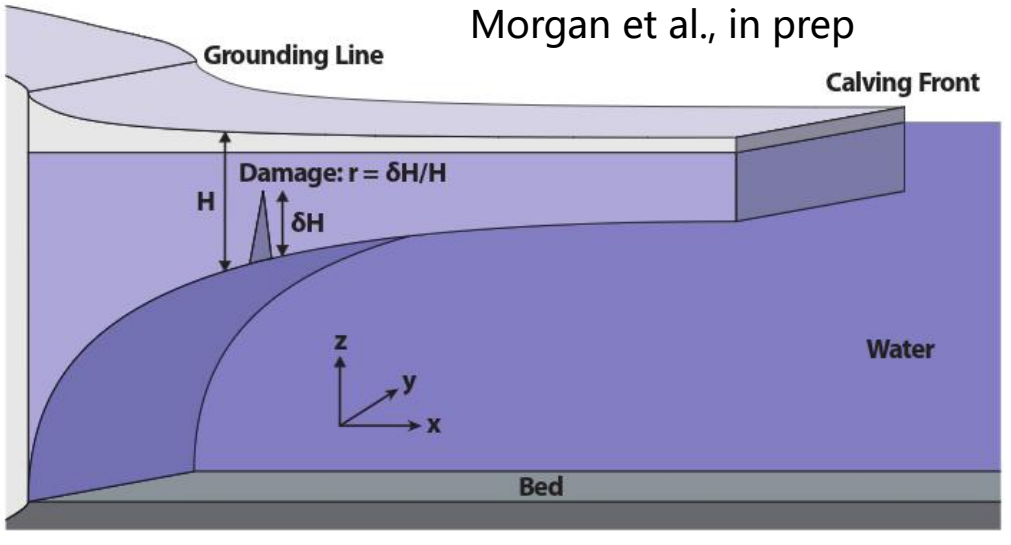
damage model



Schematic showing the necking instability (Basis & Ma, 2015)

Morgan et al., in prep

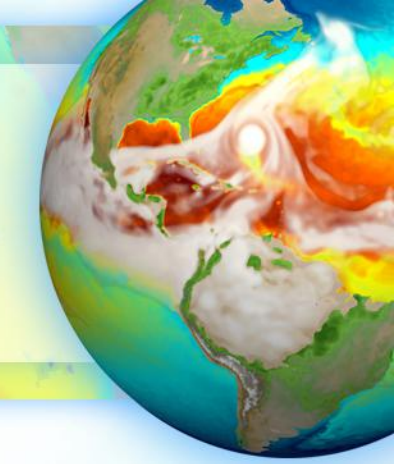


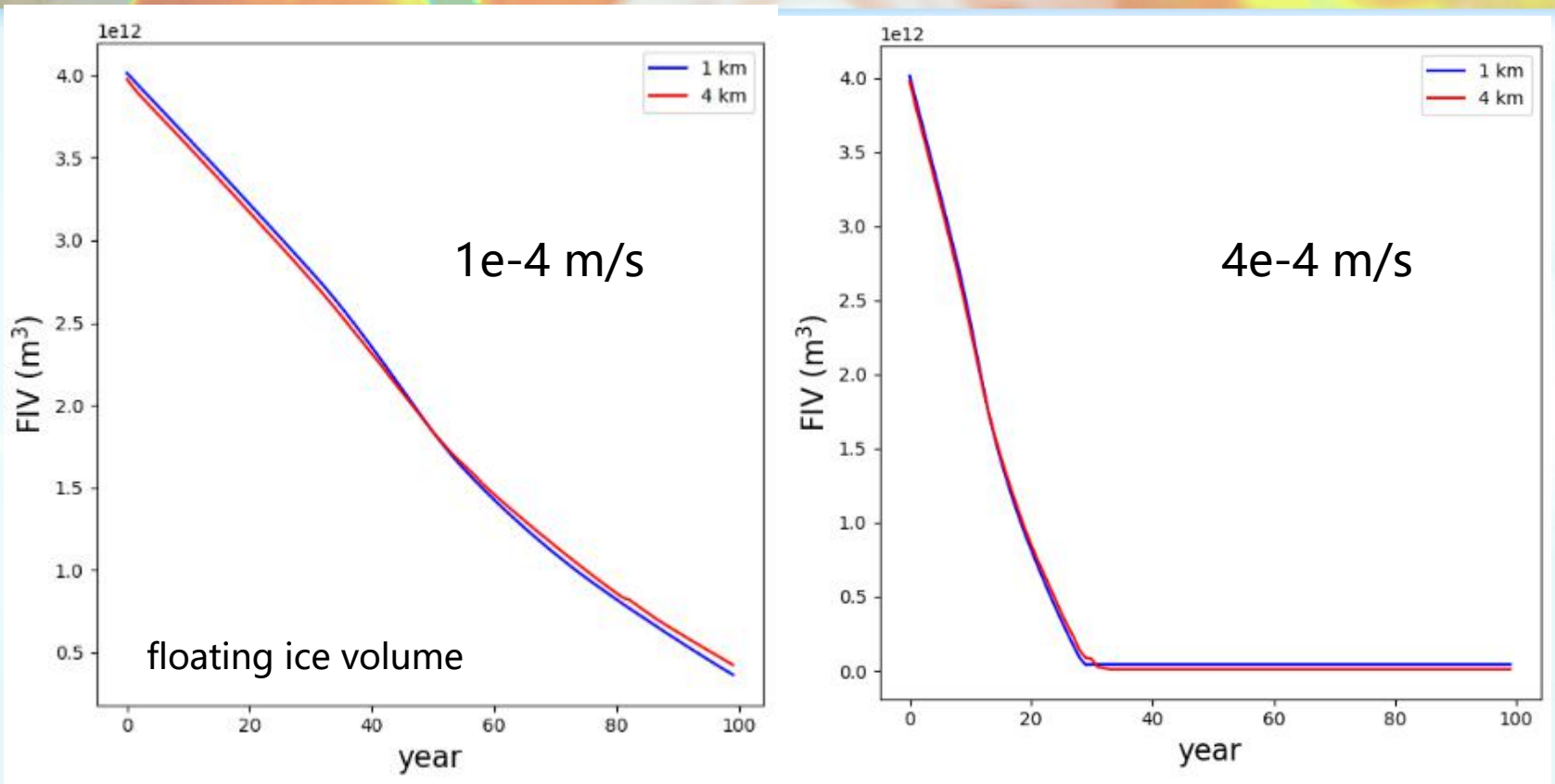
damage eq:

$$\frac{dr}{dt} = \left[n^* (1 - S_0)\, \dot{\epsilon}_{xx} + \frac{\dot{m}}{H} \right] r$$

calving speed = k * r

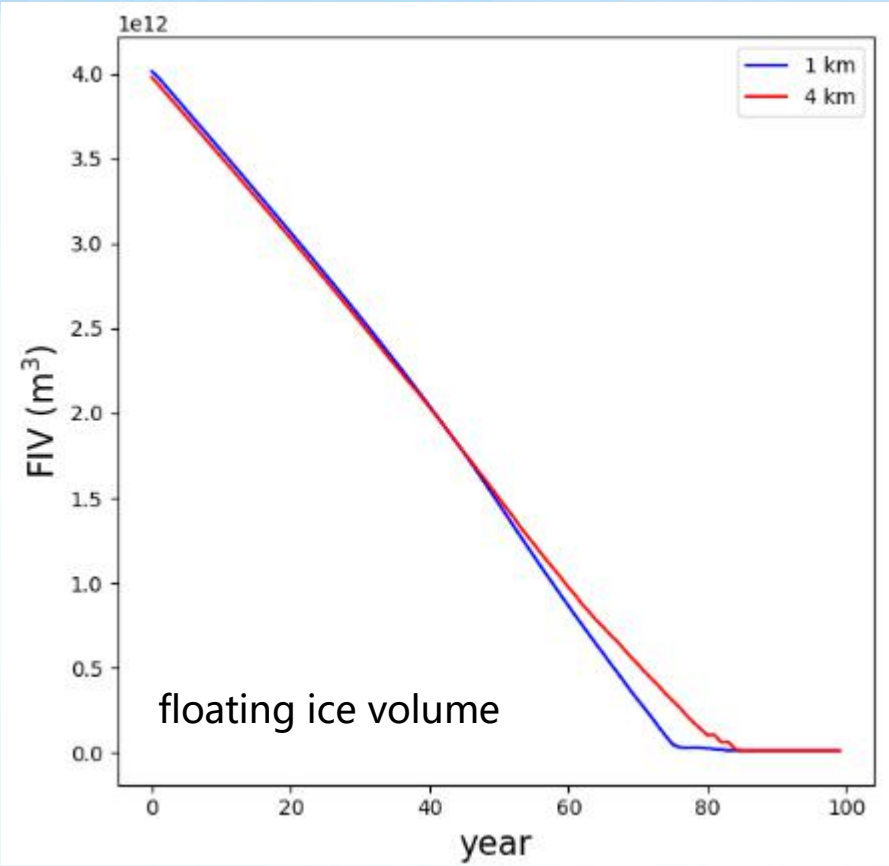
mesh independence of calving algorithm

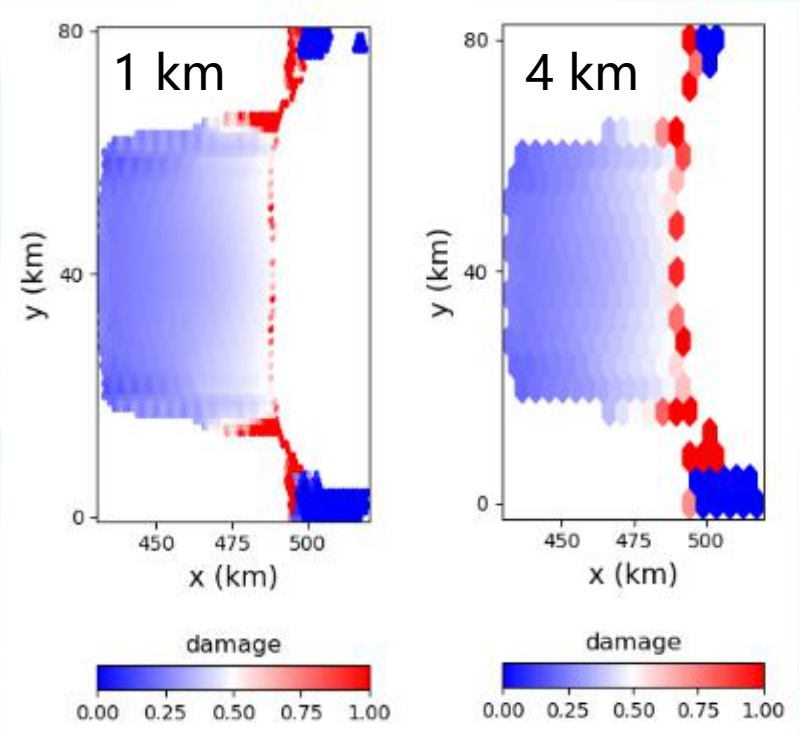




- different calving parameters, 1e-4 and 4e-4 m/s, respectively.
- turn off the first-order velocity and advection solver.
- same damage field
- calving is the only process that controls shelf retreats
- MALI’s calving algorithm can generate very good and consistent calving front retreat for different meshes.

impact of damage calculation

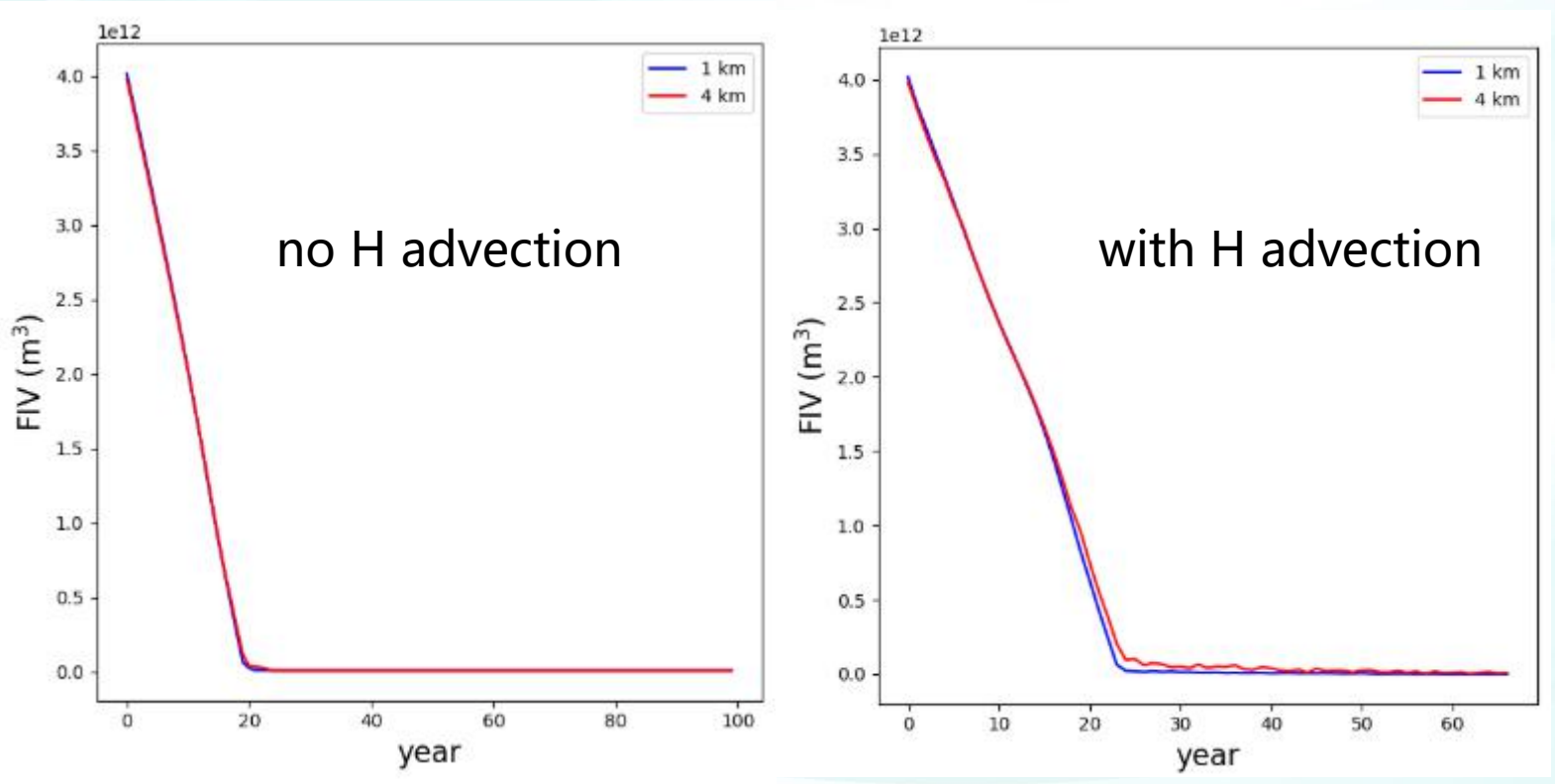




damage field at year 50

- When the calving front retreats to near the GL, the damage calculation for the 1 km and 4 km meshes gets more difference
- The finer mesh shows larger calving speed close to the GL

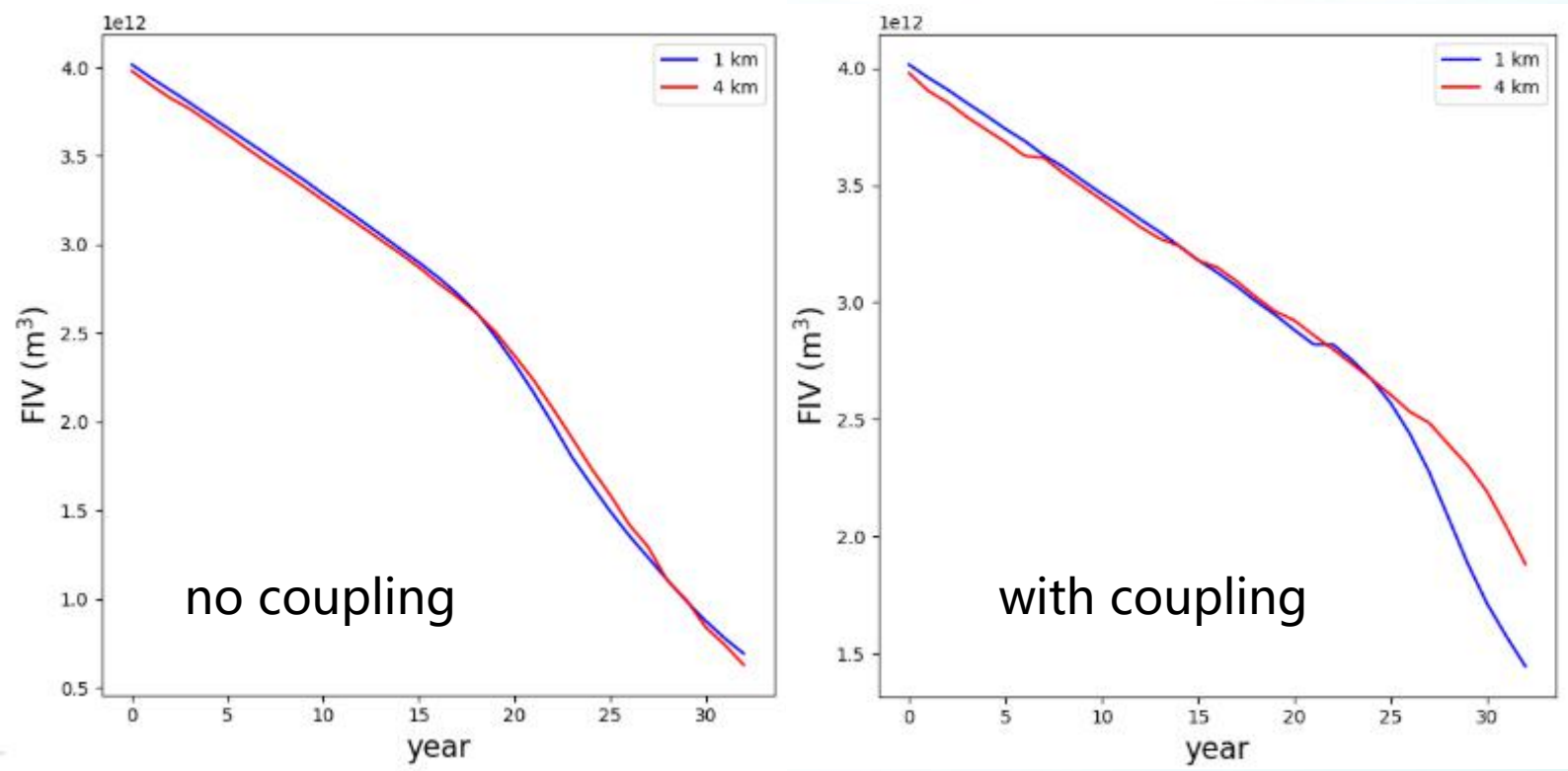
impact of thickness advection



the difference between the 1 km and 4 km mesh run result gets larger

- if we include the thickness advection
- if the calving front retreats to near the GL

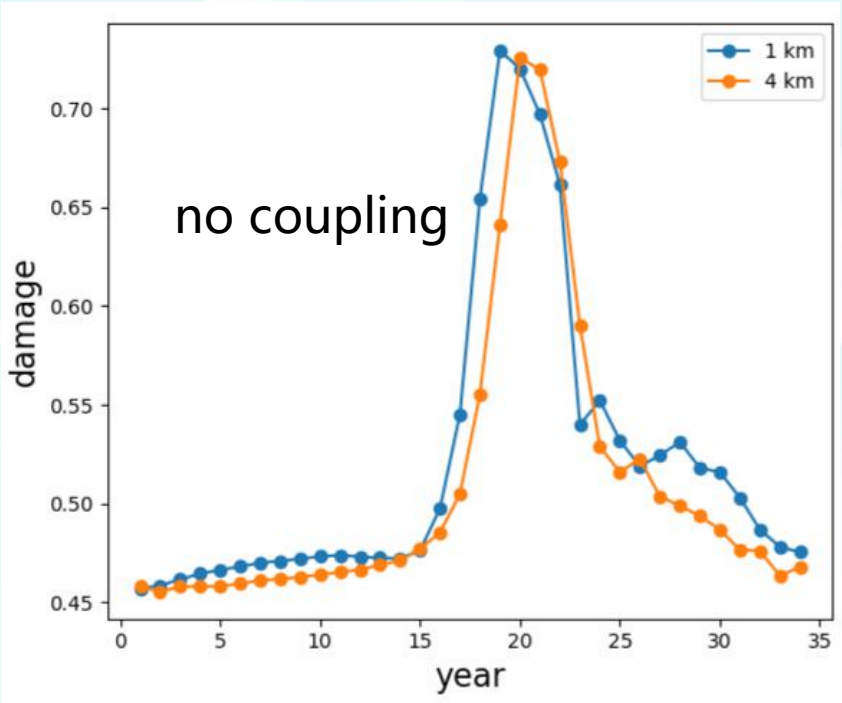
impact of damage-rheology coupling

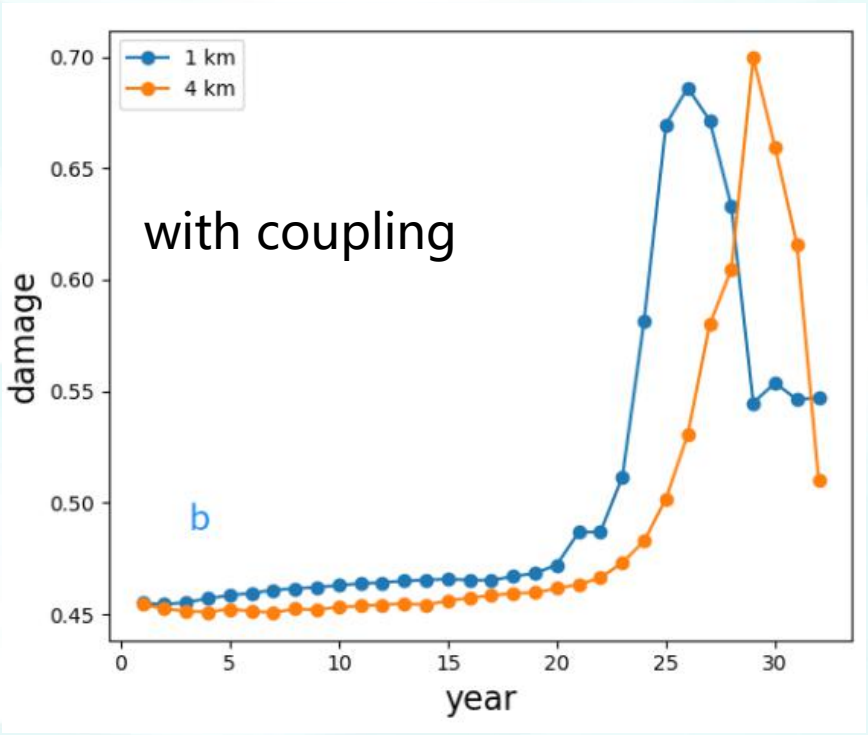


the difference between the 1 km and 4 km mesh run result gets larger from yr 23

- if we include the damage-rheology coupling
- if the calving front retreats to near the GL

impact of damage-rheology coupling

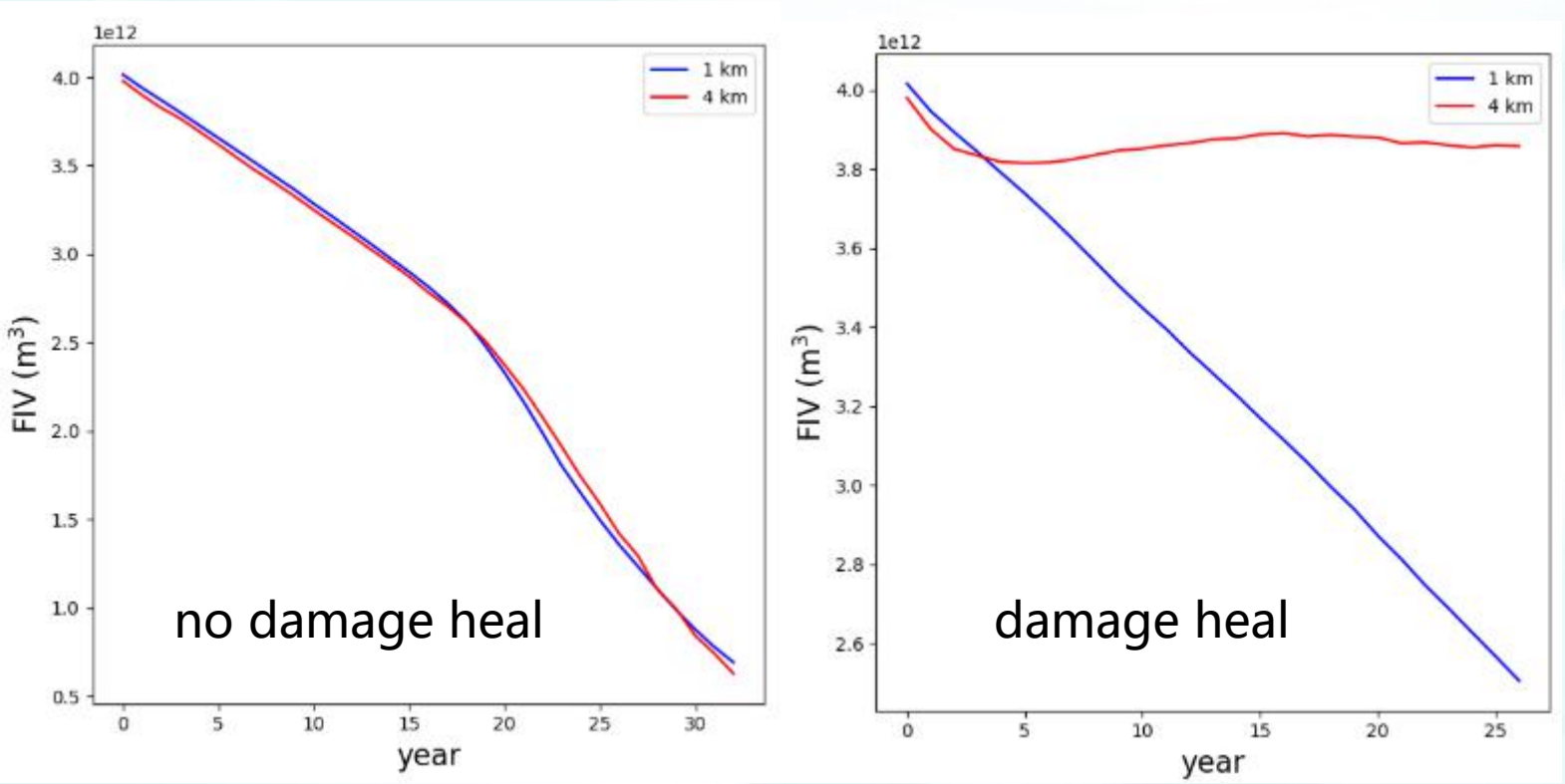




mean damage along the calving front for the cases of

- no damage-rheology coupling
- with damage-rheology coupling

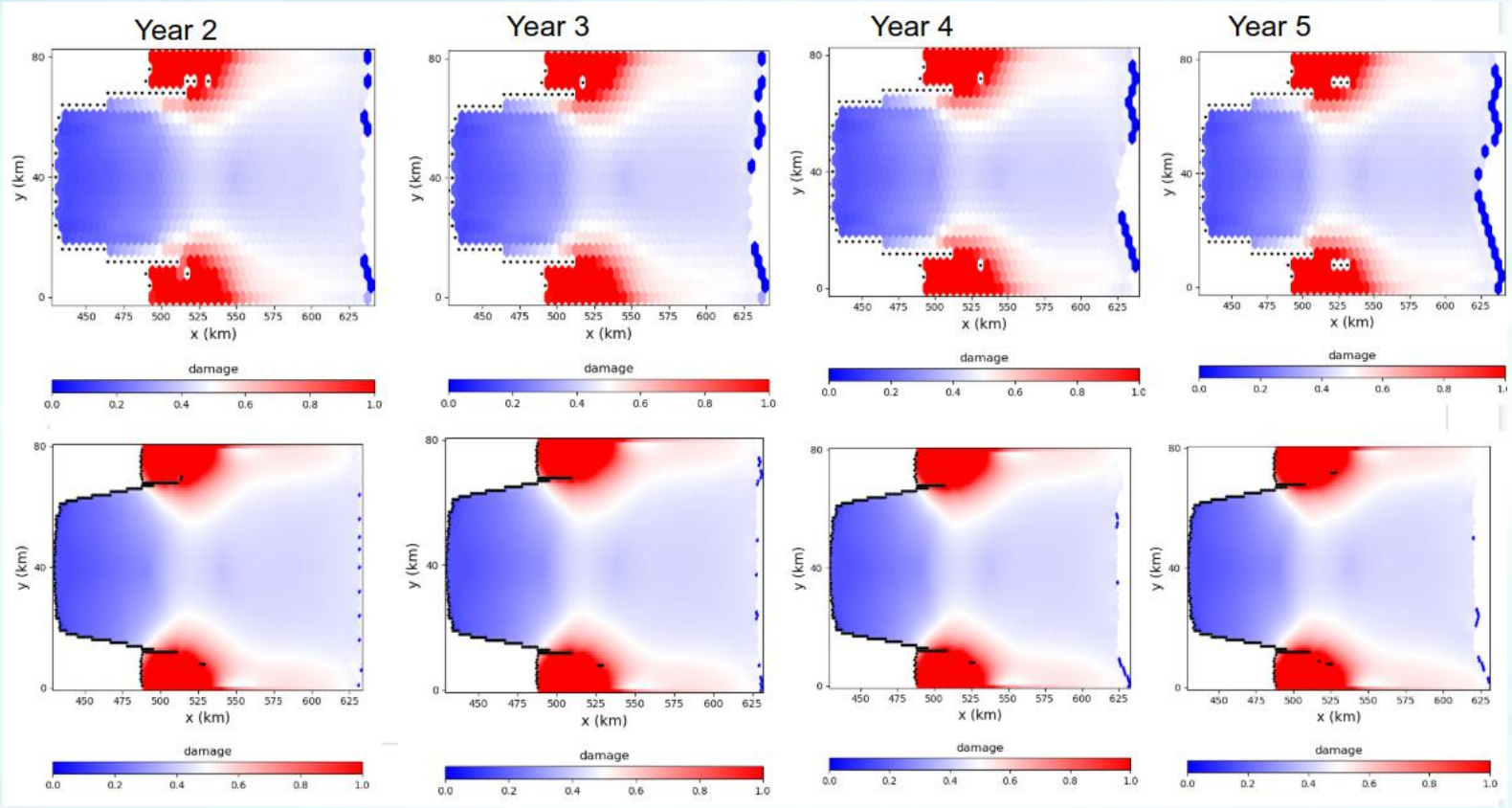
Impact of damage heal



large difference occurs when we allow damage to heal during the run

for the 4 km run, the shelf stays stable after a couple of years

Impact of damage heal



For the coarse (4 km, above) mesh run, the damage at the calving front is much smaller than that for the fine mesh (1 km, below)

this leads to a slow shelf retreat for the 4 km mesh run