Angles between conjugate LKFs with sea ice VP rheologies

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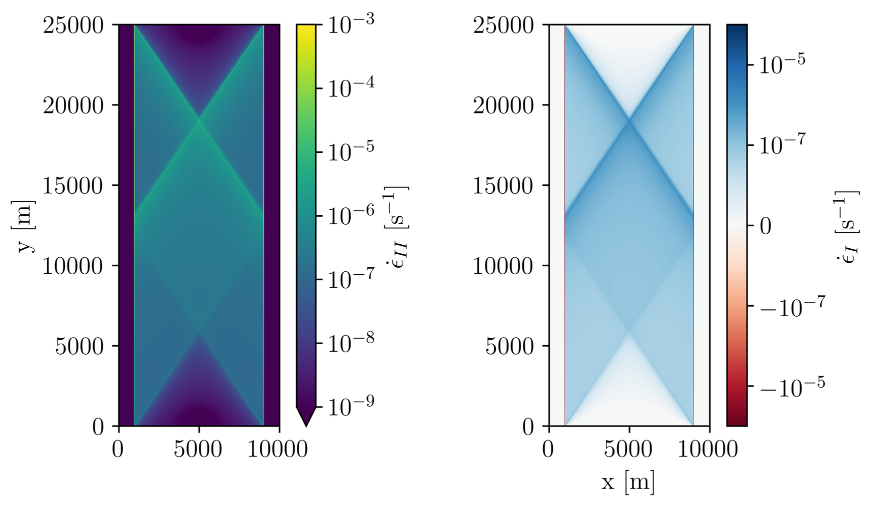
Introduction

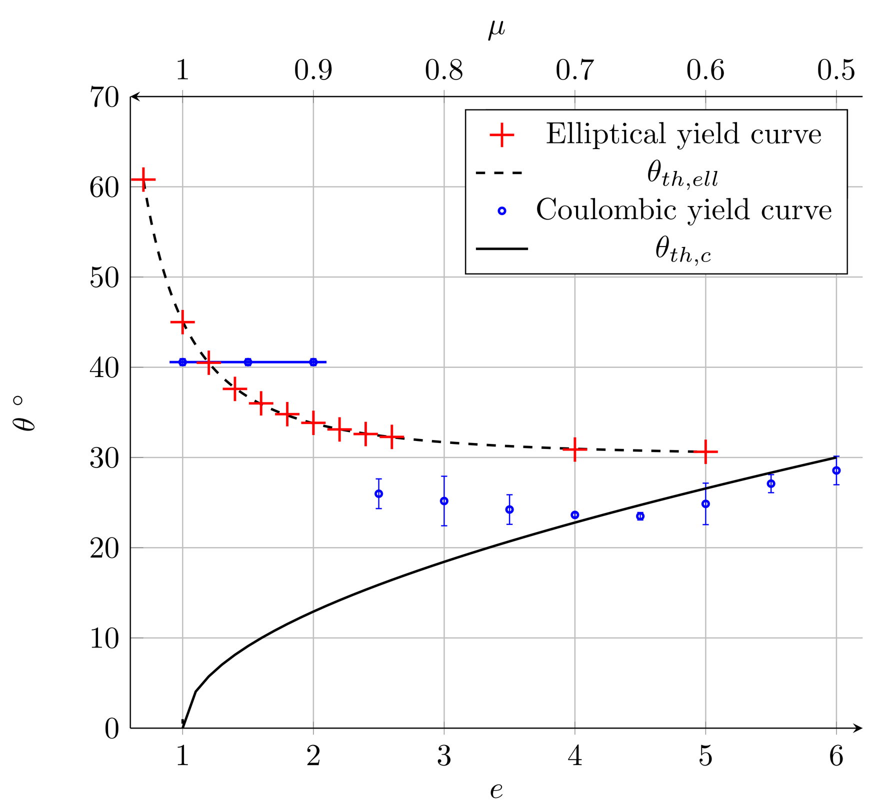
- Linear Kinematic Features (LKFs) influence the heat exchange, mass balance, and ice dynamics in the Arctic Ocean.
- Most sea ice models use Hibler VP formulation with an elliptical yield curve.
- Recent high resolution simulations (1 km) feature LKFs with intersection angles larger than observed.

We use an idealized compression experiment to investigate the link between yield curves (elliptical and Coulombic) and fracture angles.

Fracture pattern with $e = 2$



Modeled fracture angles



Conclusions

- Elliptical yield curve cannot model angles below 30°.
- A new yield curve and flow rule are necessary for smaller fracture angles in sea ice simulation.
- Kinks on a yield curve bring instabilities.

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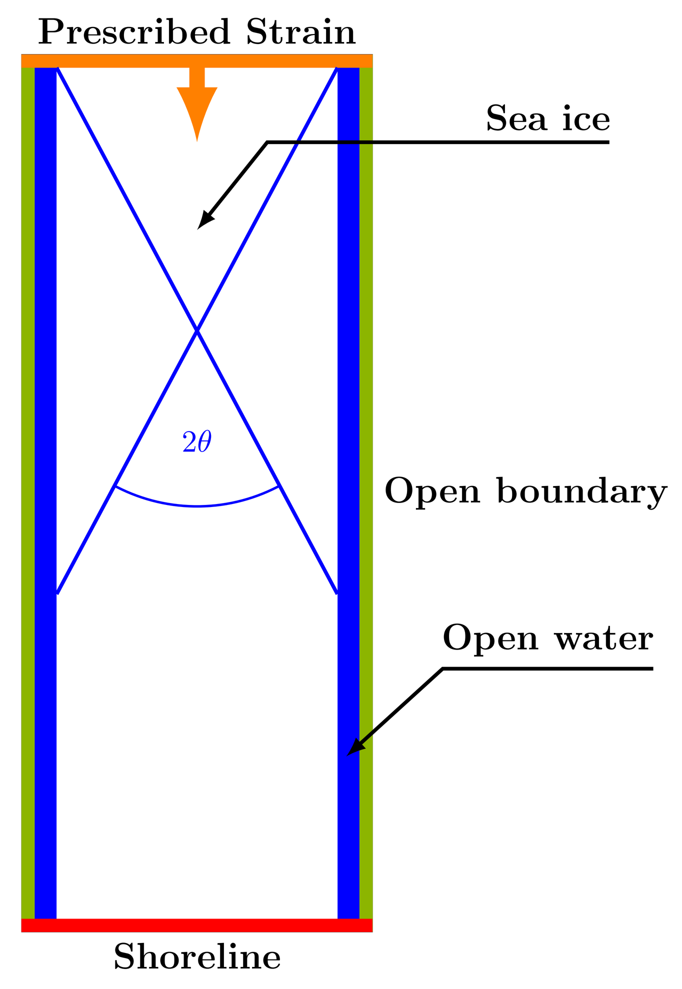
In **Viscous-Plastic** models with **elliptical** yield curves, fracture angles are **too large** to represent sea ice **granular behavior**.

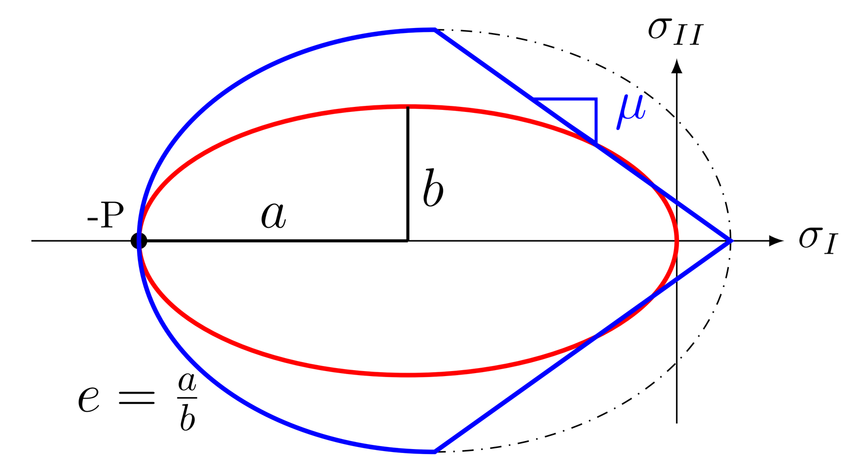
Scan to access a video of a fracture experiment

Scan to access the full paper

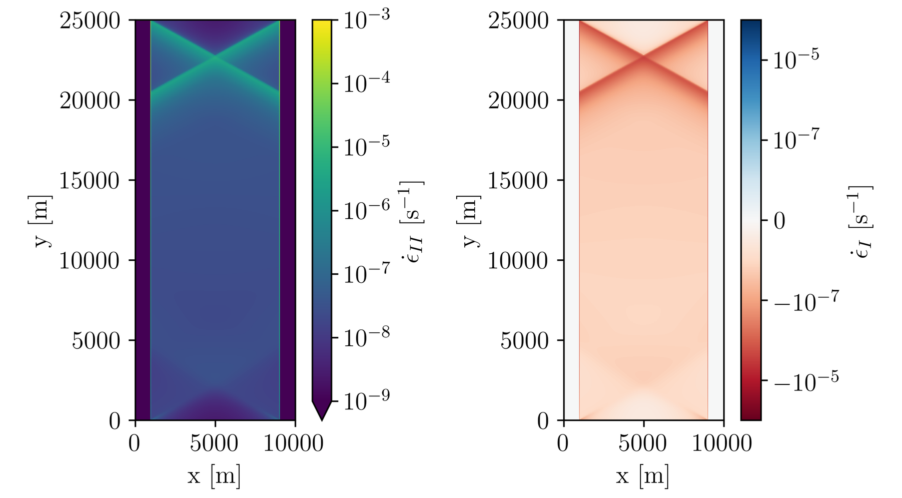
Idealized Compression Experiment



Yield Curves



Fracture pattern with $e = 0.7$



Theoretical fracture angle

For the elliptical yield curve:

$$\theta_{th,ell}(e) = \frac{1}{2}\arccos\left[\frac{1}{2}\left(1 - \frac{1}{e^2}\right)\right]$$

For the Coulombic yield curve:

$$\theta_{th,c}(\mu) = \frac{1}{2}\arccos(\mu)$$