Ice Sheet System Model
Sensitivity of Pine Island Glacier to external forcing

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Outline

1. Introduction
2. Glacier evolution
3. Increased ocean melting
4. Ice front retreat
5. Change in surface mass balance
Introduction

Objectives

1. Run transient evolution of Pine Island
2. Study its response to external changes
   - Increase in ocean induced melting rates
   - Ice front retreat
   - Change in surface mass balance

Files and Data

- Files in: MeltingSensitivity/
- Data in: Data/
Step 1: Evolution over 10 years

1. Load model from the Pig tutorial

```matlab
5   md = loadmodel(['../Pig/Models/PIG_Control_drag']);
```

2. Apply basal melting rate

```matlab
7   md.basalforcings.groundedice_melting_rate=zeros(md.mesh.numberofvertices,1);
8   md.basalforcings.floatingice_melting_rate=25*ones(md.mesh.numberofvertices,1);
```

3. Specify length or run and time steps

```matlab
10  md.timestepping.time_step=0.1;
11  md.timestepping.final_time=10;
```

4. Indicate what modules of the transient should be activated

```matlab
13  md.inversion.iscontrol=0;
14  md.transient.ismasstransport=1;
15  md.transient.isstressbalance=1;
16  md.transient.isgroundingline=1;
17  md.transient.ismovingfront=0;
18  md.transient.isthermal=0;
```

5. Request additional outputs and solve transient solution

```matlab
20  md.transient.requested_outputs={'default','IceVolume','IceVolumeAboveFloatation'};
21  md=solve(md,TransientSolutionEnum);
```
Step 1: Evolution over 10 years
Evolution of velocity and grounding line over 10 years
Step 2: Increased basal melting rate
Increase basal melting under floating ice

```matlab
31 md.basalforcings.floatingice_melting_rate=60*ones(md.mesh.numberofvertices,1);
```
Step 3: Retreat Ice Front Position

1. Create Contour of Region to remove: \texttt{RetreatFront.exp}

   → Use \texttt{exptool}

2. Extract a subdomain using \texttt{extract}

   ```
   md2 = extract(md, 'FrontRetreat.exp');
   ```

3. Reset boundary conditions with \texttt{SetMarineBC}

   ```
   md2 = SetMarineIceSheetBC(md2);
   ```

4. Solve the new model

   ```
   md2 = solve(md2, TransientSolutionEnum);
   ```
**Step 3: Evolution over 10 years**

Evolution of velocity and grounding line over 10 years

![Velocity t=0 years](image1)

![Velocity t=10 years](image2)

![Floating ice t=0 years](image3)

![Floating ice t=10 years](image4)
Step 4: Change Surface mass balance

Change surface mass balance

```plaintext
8  md.smb.mass_balance=2*md.smb.mass_balance;
```

![Velocity comparison at t=0 and t=10 years](image1)

![Floating ice comparison at t=0 and t=10 years](image2)
Impact on Volume Above Floatation

Ice Volume Above Floatation

Volume Above Floatation (m$^3$) × 10$^{14}$

- Transient
- Hight Melt
- Front Retreat
- Surface Mass Balance

Time (years)
Thanks!