Ice age: So What?

- Can be deduced from satellite observations
- Related to ice physical properties (albedo, salinity, thickness)
- Might be useful for prediction of near-future ice pack
- Seasonal ice pack implies simpler logistics/shipping
- Ecosystem ramifications
September 1981

September 2002
Observations

- All use satellite-derived ice concentration
- Most use ice velocity (buoy, AVHRR, etc.)
- Some use ice thickness (elastic-gravity waves, laser altimeter)

Thickness proxy

Maslanik et al., Geophys. Res. Lett. 34, 2007
<table>
<thead>
<tr>
<th>version 3.14</th>
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<tbody>
<tr>
<td>energy conserving, multi-layer thermodynamics</td>
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<tr>
<td>ice thickness distribution with 5 categories and open water</td>
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<tr>
<td>variables/tracers (for each thickness category):</td>
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<tr>
<td>- ice area fraction</td>
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<tr>
<td>- ice/snow volume in each vertical layer</td>
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<tr>
<td>- ice/snow energy in each vertical layer</td>
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<td>- surface temperature</td>
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<td>elastic-viscous-plastic (EVP) dynamics</td>
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<td>incremental remapping advection</td>
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<td>energy-based, multi-category ridging and ice strength</td>
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<td>nonuniform, curvilinear, logically rectangular grids</td>
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<td>Fortran 90</td>
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<td>parallelization via the Message Passing Interface (MPI)</td>
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<td>netCDF or binary input/output</td>
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<td>users in 12 countries, dozens of institutions</td>
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<tr>
<td>multi-layer snow</td>
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<td>multiple-scattering radiation</td>
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<td>ice age</td>
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<td>melt ponds</td>
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<td>algal ecosystem</td>
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<td>tripole grids</td>
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<td>regional configuration</td>
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<td>cache-based decomposition</td>
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<td>more coupling/forcing options</td>
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available: web, subversion repository
Configuration and Forcing

$320 \times 384 \ (1^\circ) \text{ displaced-pole grid}$

- air temperature
- humidity
- wind
- precipitation

\{ modified \text{CORE atmo forcing} \}
\[ 1958 - 2006 \]

- SST
- salinity
- deep ocean heat flux

\{ CCSM/POP ocean output \}
\[ \text{monthly climatology} \]

- radiation

AOMIP
trends per decade
1977–2006

-0.13

seasonal area
-0.61

perennial area
-0.62

total area
-0.13

age (yr)
-0.01
March ice thickness and age

1976

1986

1996

2006
September total area of age $N$
4-year running mean

March cumulative area $\geq age N$

March age in Fram Strait
Summary

— a consistent simulation of sea ice age, dynamics, and thermodynamics —

In agreement with observations:

• accelerating loss of perennial ice over last 3 decades
• a large spatial-scale, multi-year, average sea ice thickness–age relation holds
• anomalously high flushing of older ice through Fram Strait in high-index AO years led to declining average ice age

In addition:

• age is not a good proxy for sea ice thickness at smaller scales
• during more neutral AO years, age recovers but area, thickness and volume do not
• younger ice classes have again declined since 2000

In coming decades, it is possible that the age of the Arctic ice pack will fluctuate between younger and older ice types, sometimes exhibiting bimodal age distributions, before becoming completely dominated by seasonal ice.
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Ice age: a diagnostic

- reasonably simple to implement
- comparable with observations
- additional insight for model comparisons?