Snow: Obs and Models

Andrew Slater & Sean Swenson
SNOW! It’s Important Stuff
Where d'ya get your information from, huh?
### Nth Hemisphere Snow Mass/Depth Data

<table>
<thead>
<tr>
<th>Product</th>
<th>Native Resolution</th>
<th>Period</th>
<th>Product Type</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMSR-E</td>
<td>25km EASE Grid</td>
<td>2002-2009</td>
<td>Passive Microwave</td>
<td>Tedesco et al, 2004</td>
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<tr>
<td>SSMI</td>
<td>25km EASE Grid</td>
<td>2000-2007</td>
<td>Passive Microwave</td>
<td>Armstrong &amp; Brodzik</td>
</tr>
<tr>
<td>GlobSno</td>
<td>25km EASE Grid</td>
<td>2000-2009</td>
<td>Station data + Microwave</td>
<td>Takala et al, 2011</td>
</tr>
<tr>
<td>ERAI</td>
<td>0.75 x 0.75 Deg</td>
<td>2000-2009</td>
<td>Reanalysis, with depth analysis</td>
<td>Dee et al.</td>
</tr>
<tr>
<td>JRA</td>
<td>1.125 x 1.125 Deg</td>
<td>2000-2009</td>
<td>Reanalysis, with depth analysis</td>
<td>Onagi et al.</td>
</tr>
<tr>
<td>CFSRR</td>
<td>0.33 x 0.33 Deg</td>
<td>2000-2009</td>
<td>Reanalysis, with depth analysis</td>
<td>Saha et al.</td>
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<tr>
<td>NARR</td>
<td>32km (NCEP 221)</td>
<td>2000-2009</td>
<td>Reanalysis, with depth analysis</td>
<td>Messinger et al</td>
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<tr>
<td>ASR</td>
<td>30km WRF grid</td>
<td>2000-2009</td>
<td>Reanalysis, with depth analysis</td>
<td>Bromwich et al.</td>
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<tr>
<td>MERRA</td>
<td>0.5 x 0.666 Deg</td>
<td>2000-2009</td>
<td>Reanalysis, forecast</td>
<td>Reinecker et al.</td>
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<tr>
<td>CIRES</td>
<td>2.5 x 2.5 Degrees</td>
<td>2000-2009</td>
<td>Reanalysis, forecast</td>
<td>Compo et al.</td>
</tr>
<tr>
<td>CMC</td>
<td>~24km IMS grid</td>
<td>2000-2009</td>
<td>Station interpolation/analysis</td>
<td>Ross Brown</td>
</tr>
<tr>
<td>ETAC</td>
<td>1.0 x 1.0 degree</td>
<td>Pre-1988</td>
<td>Station interpolation</td>
<td>Foster &amp; Davey</td>
</tr>
<tr>
<td>GRACE</td>
<td>Big (ask Sean)</td>
<td>2002-2008</td>
<td>Gravity anomaly</td>
<td>Sean Swenson</td>
</tr>
</tbody>
</table>
Mean March SWE (~2000-2009)
March SWE : Spatial Correlation (2000-2009)
Satellite SWE: Beastie Boys are Unimpressed!

Beastie Boys: So What’cha want?, 1994
March SWE: Spatial Correlation (2000-2009)
So the models aren’t really that bad?

Beastie Boys: *So What’cha want?*, 1994
Arctic Basins

- Lena
- Yenesy
- Ob
- MacKenzie
2000 – 2009: Observations

LENAs SWE Climatology (~2000-2009)

MACKENZIE SWE Climatology (~2000-2009)

OB SWE Climatology (~2000-2009)

YENESY SWE Climatology (~2000-2009)
2000 – 2009: Observations + CMIP5 Models
2030 – 2039: CMIP5 Models

LEN A SWE Climatology (2030-2039)

RCP 4.5
RCP 8.5

MAC KENZIE SWE Climatology (2030-2039)

RCP 4.5
RCP 8.5

O B SWE Climatology (2030-2039)

RCP 4.5
RCP 8.5

YENESY SWE Climatology (2030-2039)

RCP 4.5
RCP 8.5
2060 – 2069 : CMIP5 Models

- **LENA SWE Climatology (2060-2069)**
  - RCP 4.5
  - RCP 8.5

- **MACKENZIE SWE Climatology (2060-2069)**
  - RCP 4.5
  - RCP 8.5

- **OB SWE Climatology (2060-2069)**
  - RCP 4.5
  - RCP 8.5

- **YENESY SWE Climatology (2060-2069)**
  - RCP 4.5
  - RCP 8.5
2090 – 2099: CMIP5 Models

LENA SWE Climatology (2090-2099)

MACKENZIE SWE Climatology (2090-2099)

OB SWE Climatology (2090-2099)

YENESY SWE Climatology (2090-2099)
Spatial Comparison

March SWE: Median Observations (2000-2009)

NPV = (Inter-Quartile Range)/Median
Summary

- Beware of what “observations” are used

- Arctic Basins:
  - Skewed seasonal cycle push to earlier peak
  - Snow mass increases to the north, decreases to south

- Alaska & Far East Siberia notable problem
Error (Difference) between Obs & Models

March SWE: Nth Hemisphere Root Mean Squared Error

AMSRE
SSMI
GLORSNO
CIRES
ERAI
JRA
MERRA
CFSRR
NARR
ASR
CMC
ETAC
GRACE
bcc-csm1-1
CanESM2
CCSM4
CNRM-CM5
iRO-Mk3-6-0
iFDL-ESM2M
GISS-E2-R
f_GCM2-CC
f_GCM2-ES
inmcm4
MIROC5
MIROC-ESM
MPI-ESM-LR
MPI-CGCM3
NorESM1-M

20 26 32 38 44 50 56 62 68 74 80 86 92 98 104 110 116 122 128 134 140 kg m⁻²
Error Across Observations (~2000-2009)

March SWE: Nth Hemisphere Root Mean Squared Error