Sea ice modelling with LIM
Recent advances
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on behalf of the LIM team
A. Barthélemy, S. Bouillon, T. Fichefet, H. Goosse, O. Lecomte, O. Lietaer, P. Mathiot, A. Pestiaux, M. Vancoppenolle, G. Vergé-Dépré

Arctic CLIC sea ice working group meeting
NSIDC, Boulder, Colorado – 31st October 2011
Simulated sea ice extent (NEMO-LIM + atmospheric reanalyses)

10^6 km²

1979-2000 Av. ± 2 std
Arctic sea ice thickness
(Louvain-la-Neuve sea Ice Model)

September climatology (1979-2000)

Volume $\approx 26,000 \text{ km}^3$

September 2011

Volume $\approx 10,000 \text{ km}^3$

Lowest minimum of the model
1. Assessment & understanding
- Statistical reanalyses
- Sensitivity experiments

2. Developments
- Sea ice-ocean interactions
- Sea ice-atmosphere interactions
- Snow-on-ice scheme
- New parameterizations

3. Climate Forecasts
- Embedding in GCMs
- Seasonal-to-centennial predictions/projections
1. Assessment & understanding
1. Assessment & understanding

- Ensemble Kalman Filtering

Trends of Antarctic sea ice thickness
(1983-2007, NEMO-LIM2 + assim. ice conc.)

Arctic sea ice volume as reconstructed by NEMO-LIM2

Mathiot et al., in prep.

Massonnet et al., in prep.
1. Assessment & understanding

- Model evolution assessment
  – Performance metrics for sea ice models

<table>
<thead>
<tr>
<th>Arctic</th>
<th>LIM2</th>
<th>LIM3</th>
<th>μ</th>
<th>σ</th>
<th>trend</th>
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<tbody>
<tr>
<td>concentration</td>
<td>0.97</td>
<td>0.79</td>
<td>1.03</td>
<td>0.77</td>
<td>1.03</td>
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<tr>
<td>extent</td>
<td>1.33</td>
<td>0.43</td>
<td>1.22</td>
<td>0.61</td>
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<tr>
<td>draft (thick.)</td>
<td>0.94</td>
<td>0.67</td>
<td>0.72</td>
<td>0.32</td>
<td>0.39</td>
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<tr>
<td>drift</td>
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<td>0.76</td>
<td>0.34</td>
<td>0.9</td>
<td>0.44</td>
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<tr>
<td>Fram strait export</td>
<td>1.14</td>
<td>0.82</td>
<td>0.09</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>

« Lower is better »

(Massonnet et al., The Cryosphere, 2011)
2. Developments

The DC-3 of paper airplanes!

- Folds progressively thicker where the wing joins the fuselage prevents distortion during windy days.
- Long tail gives directional stability.
- Can be flown with or without a tail.
- Upturned wingtips prevent wingtip vortex.
- Flight is similar to a balsa wood plane rather than a paper airplane.
- Multiple folds of paper concentrate the center of gravity well below and forward of the wings for hang-glider stability.
2. Developments

- « Super-parameterizations » for ice-ocean coupling (A. Barthélemy)

  From Campin et al., 2011

- New sea ice rheology (S. Bouillon)

  Observed shear rate (RGPS; Kwok, 1998)

  From Girard et al., 2011
2. Developments

- New snow scheme (O. Lecomte)

- Pancakes parameterization (M. Vancoppenolle)

- Sea ice biogeochemistry (M. Vancoppenolle)

- Finite-elements modelling (O. Lietaer, A. Pestiaux)
3. Climate forecasts

(in class experiment)
3. Climate forecasts

LIM is involved in large-scale General Circulation Models Coupling of the latest version under way (G. Vergé-Dépré, K. Wyser -SMHI)

G. Philippon, pers. comm.
1979-2006 trends of Arctic sea ice extent +/- 2 std
Christmas is only 2 months away

Folks, what can I bring to you for 2012?
Observational needs

- **Errors** are as much important as the products
- Antarctic sea ice + snow thickness, continuing the ASPeCT data set (Worby et al., 2008)
- Sea ice flux estimates (other than Fram Strait)
- When possible: gridded data
- Data format
Conclusions

- is not a paper plane
- Assessment, development and forecasts
- Focus on both hemispheres
- For more information:

  www.climate.be/lim

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