Monsoon Circulation and variability in ECCO and SODA (beta-7)

Rena Schoenefeldt and Friedrich Schott
Ifm-Geomar
Leibniz Institut für Meereswissenschaften, Kiel University, Germany

• The monsoon circulation means

• Cross-equatorial cell

• Variability of the cross-equatorial exchange

• Variability of the Indonesian Throughflow

• Summary

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<table>
<thead>
<tr>
<th><strong>SODA (beta 7)</strong></th>
<th><strong>ECCO 1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td><strong>Description</strong></td>
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<tr>
<td>- MOM</td>
<td>- MIT GCM</td>
</tr>
<tr>
<td>- Domain: global (62°S-62°N)</td>
<td>- Domain: global (80°N-80°S)</td>
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<tr>
<td>- 0.5/1° x 1° tropics/midlatitude</td>
<td>- 1° x 1°</td>
</tr>
<tr>
<td>- 20 levels: 15m near surface</td>
<td>- 23 levels: 10m near surface</td>
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<tr>
<td>- monthly (1950-2002)</td>
<td>- monthly</td>
</tr>
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<td></td>
<td>preliminary: (1950-2002)</td>
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<tr>
<td><strong>Forcing</strong></td>
<td><strong>Forcing</strong></td>
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<tr>
<td>- COADS</td>
<td>- NCEP/NCAR</td>
</tr>
<tr>
<td><strong>Assimilation</strong></td>
<td><strong>Assimilation</strong></td>
</tr>
<tr>
<td>- „nudging“, i.e. artificial source/sink terms in heat equation</td>
<td>- adjustment of surface fluxes to match ocean observations</td>
</tr>
</tbody>
</table>
Budget of section-mean transports for SODA model
Budget of section-mean transports for ECCO model
Mostly seasonal sloshing back&forth across equator

ECCO

SODA
Schematic diagram of shallow Cross-equatorial Cell

- Cross-equ. transport ~6.5 Sv carried by
  - thermocline
  - Somali Current
  - Sverdrup/Ekman tr.

- how is northern upwelling distributed among the sites?

- in models
  ~ 1/3 in domes around India

Schott et al., 2002
At the equator (1992-2000)

Sverdrup transport
- **ECCO**
- **SODA**
- **NCEP**
- **ERS-Scat.**

Merid. transport
upper 100m
interior

Somali Current

$\sigma_\theta=26.9$ to mixed-layer
At the equator (1992-2000)

Sverdrup transp. anomalies
ECCO SODA NCEP
ERS-Scat.

Interior transport anomalies, upper 100m
SODA-7
ECCO
SODA-POP

Somali Current thermocline flow
($\sigma_\theta=26.9$ to mixed-layer)
SODA-7
ECCO
At the equator (1992-2000)

Merid. mass transport

-0-100m
-(or even 0-300m)
top to bottom
At the equator

Merid. mass transport
-0-100m
-top to bottom
Ekman transport 3°N
At the equator 

**Merid. mass transport**
-0-100m
-top to bottom

Ekman transport 3°N
Sverdrup transport

Our impression from the mean that **Ekman** and **Sverdrup** transport determine CEC, does not apply for the anomalies
Surface current & SSH anomalies

- Oct 1997
- Dec 1997
- Feb 1998
ECCO (left) vs. SODA (right)

**Annual mean**

**July mean**

**Nov mean**

**Nov 1997**

Meridional velocity along the equator

(Jay’s Wacky Cell)

- transports in upper 100m
- SC transports
Cross-equatorial heat flux (ECCO and SODA-7) 1950-2000

Seasonal cycles agree,...

but large differences in anomalies
Cross-equatorial heat flux (ECCO and SODA-7)

and at longer timescales
(5 yr-low pass on anomalies)
Indonesian Throughflow in SODA-7, ECCO and SODA-POP (1950-2000, in Sv)

Seasonal cycle

anomalies
Indon. Throughflow variability 1993-1999 in ECCO and SODA (upper 300m, in Sv)
Heat content 1990-99 in ITF (120E) in SODA

Above 20C isotherm
In upper 200m

Pacific Decadal Variability (PDV): can it affect Sumatra upwelling and SST (i.e. "dipole appearance")?
Summary

What can we learn from assimilation model output??

- **SODA**: „tweaks“ the physics by source terms in equations
- **ECCO**: adjusts surface fluxes to match the ocean observations
  huge Ekman/Sverdrup transports, what do they mean?

- **Interannual to decadal variability**: Large differences between both products re.
  --crossequatorial transports of mass, heat
  --Indonesian Throughflow

- **Cross-equatorial cell**: what are the respective roles of
  --northern offshore Ekman transports
  --vs. interior cross-equatorial Ekman/Sverdup forcing

- **Relation between throughflow heatflux/thickness and**
  --Sumatra SST?
  --western dome upwelling?