Impact of Argo, SST and altimeter data on an eddy-resolving ocean reanalysis

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CSIRO Marine and Atmospheric Research
Talk Outline

• The Bluelink System
• SST and altimeter: complimentary? or redundant?
• Observing System Experiments, impact on SST, SLA, T(z), S(z) and mesoscale circulation
• System dependence
• Conclusions
The Bluelink System

Ocean Model

• OFAM
• MOM4p0d
• Global model
• 10 m vert res over top 200 m
The Bluelink System

Ocean Model
- OFAM
- MOM4p0d
- Global model
- 10 m vert res over top 200 m

Data Assimilation
- BODAS
- EnOl
- 120 member ensemble
- Localised covariances

- Assimilates along-track ALTIM, coastal SLA, SST & in situ T and S

Oke, P. R., G. B. Brassington, D. A. Griffin and A. Schiller 2007: The Bluelink Ocean Data Assimilation System (BODAS) Ocean Modelling, accepted.
The Blue Link Forecast System became operational in August 2007

Sea level anomaly and currents, New South Wales

Sea Surface Temperature (SST)
The temperature of the sea surface (or sea surface temperature - SST) is an
important indicator of conditions that may affect many types of activity
on or near the ocean's surface, or where it can be used to infer properties
of the ocean environment in the zone just below the surface.

The BLUElink SST products depict the temperature of the sea surface
commencing at a given start date and stepping forward by 24 hours each
step out to 5 days. The first chart is based on actual observations of
temperature sourced from a variety of temperature sensors based on ship
flotsams, drifting and moored buoys, coastal stations and satellites, which
BLUElink system, to produce the basic analysis of the SST prevailing at
those projected future times. The ocean model is used to provide forecasts of
SST at daily intervals based on the information from the current
sea surface temperature and salinity fields.

The graduated colour scale indicates the temperature values in degrees C

Sea Surface Salinity (SSS)
The sea-surface salinity (SSS) is the measure of the concentration of
suspended salt in the sea water at or very close to the ocean surface. The
SSS is an important variable indicating how freshwater input and outgoing
is an important variable affecting the ocean's dynamics. Variations in SSS
can be anticipated from variations in the flux of freshwater into the ocean
(atmospheric, discharge and evaporation) and over the ocean (which can be
directly or indirectly monitored). For example, the melting of ice in the
ocean. Rainfall and snow over the ocean and discharge from river
systems add freshwater, and thereby locally decrease the salinity of the
ocean.
SST and altimeter data: complimentary? or redundant?

Analysis increments for:
- SST
- SLA
- sub-surface T
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Analysis increments for:
- SST
- SLA
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... when we assimilate

- only altimeter data
- only SST data
- altimeter & SST data
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<table>
<thead>
<tr>
<th></th>
<th>No Assim</th>
<th>ALTIM</th>
<th>SST</th>
<th>ALTIM + SST</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST</td>
<td>0.9</td>
<td>0.9</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>SLA</td>
<td>13.1</td>
<td>4.4</td>
<td>11.5</td>
<td>4.8</td>
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- SST
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... when we assimilate
- only altimeter data
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- SLA and SST often contain different and complementary information
- advantage of multivariate assimilation
Observing system Experiments: withholding experiments

- **Reanalysed period:**
  Dec 2005-May 2006

- **Assimilate every 7-days**

- **Assimilate:**
  AMSR-E SST: 1 day in 7
  Along-track altimetry: 11-day time window
  Argo T and S: 7-day time window

- **OSE experiments include:**
  ALL = ALTIM + SST + Argo
  NONE
  Argo + SST
  ALTIM + SST
  ALTIM + Argo

- **Quantitative assessment by RMS differences with:**
  AMSR-E SST
  Along-track altimetry
  Coastal SLA (tide gauges)
  Argo T and S assimilated withheld

- **Qualitative assessment:**
  6-day average SST vs 6-day composite AVHRR SST
Observing System Experiments: Impact on SST

NONE (No assimilation)

ALL (ALTIM+Argo+SST)

Argo+SST

ALTIM+SST

ALTIM+Argo

Std of Observations

RMS residuals (Deg C)
Observing System Experiments: Impact on SLA

NONE (No assimilation)  ALL (ALTIM+Argo+SST)  Argo+SST

(a)  (b)  (c)

ALTIM+SST  ALTIM+Argo  RMS of Observations

(d)  (e)  (f)

RMS residuals (m)

0  0.05  0.1  0.15  0.2  0.25
Observing System Experiments: Impact on T(z) and S(z)

3159 profiles assimilated
Observing System Experiments: Impact on $T(z)$ and $S(z)$

600 profiles withheld
Observing System Experiments: Impact on mesoscale circulation
Observing System Experiments: Impact on mesoscale circulation

- January 2006 (Obs, NONE, ALL, Argo+SST, ALTIM+SST, ALTIM+Argo)
- February 2006
- March 2006

SST (Deg C)

18 19 20 21 22 23 24 25 26 27 28
Observing System Experiments: Impact on mesoscale circulation
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Table 1. Area-Averaged RMS Residuals Between Observed and Modelled SLA, SST, and All T and S Profiles Over the Top 500 m

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<th>T (z)</th>
<th>S (z)</th>
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<tr>
<td>ALL</td>
<td>7.9</td>
<td>4.9</td>
<td>0.66</td>
<td>0.69</td>
<td>0.80</td>
<td>0.14</td>
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<tr>
<td>NONE</td>
<td>14.9</td>
<td>6.1</td>
<td>1.8</td>
<td>1.7</td>
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*SLA, cm; SST, °C; T, °C; S, psu. Coastal SLA (cSLA) is based on comparisons with tide gauges and coastal SST (cSST) is based on comparisons where the bottom depth is less than 200 m. The observed standard deviation is shown for each variable. Area averages are computed for the region 90°–180°E and 60°S–10°N.*
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Dependence on assimilation system:

... same data, same model, different initialisation
Conclusions

- The Bluelink system constrains the mesoscale circulation
- Different observation types bring complementary information to the GOOS
- Some redundancy at broad-scales
- Mesoscale circulation requires all observation types, particularly altimetry
- SST particularly important for shallow regions, not covered by ALTIM and Argo
- Argo is the only observation type that constrains salinity


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• Model bias indicates problems with mean sea-level
Latency of altimetry remains a challenge for operational products.