VOCALS Model Assessment

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Global models had too low and often too diffuse an inversion at 20S 85W.

Analyses from operational forecast models did better than free-running climate models, because biases are constantly corrected by observations.
PreVOCA

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= Pre-VOCALS Assessment

http://www.atmos.washington.edu/~robwood/PreVOCA/index.html

GOAL: Assess the forecast skill and biases of global/regional model simulations of SE Pacific boundary-layer clouds and aerosols on diurnal and longer timescales.

WHAT? Daily hindcasts for October 2006 over the SE Pacific.

WHY? Learn how to optimally use REx, satellite and cruise data for model assessment and improvement.

WHO? 14 modeling groups using regional and global models, including climate models run in forecast mode.

WHEN? Data submission quasi-complete; analysis in progress, journal submission early 2009.
<table>
<thead>
<tr>
<th>Model</th>
<th>Levels</th>
<th>Resolution [km] (inner domain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRL COAMPS</td>
<td>42</td>
<td>81 (27)</td>
</tr>
<tr>
<td>COLA RSM</td>
<td>28</td>
<td>50</td>
</tr>
<tr>
<td>IPRC Reg_CM (IRAM)</td>
<td>28</td>
<td>~25</td>
</tr>
<tr>
<td>PNNL (WRF-Chem)</td>
<td>44</td>
<td>45 (15)</td>
</tr>
<tr>
<td>UCLA (WRF)</td>
<td>34</td>
<td>45 (15)</td>
</tr>
<tr>
<td>U. Chile (WRF)</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td>ECMWF oper. 3-12h forecast</td>
<td>91</td>
<td>~25</td>
</tr>
<tr>
<td>ECMWF 5-day forecast</td>
<td>91</td>
<td>~40</td>
</tr>
<tr>
<td>ECMWF coupled fcst ensemble</td>
<td>62</td>
<td>~125</td>
</tr>
<tr>
<td>GMAO GEOS-5 DAS</td>
<td>72</td>
<td>~56</td>
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<tr>
<td>JMA 24-30h forecast</td>
<td>60</td>
<td>~60</td>
</tr>
<tr>
<td>NCEP oper. 12-36h forecast</td>
<td>64</td>
<td>~38</td>
</tr>
<tr>
<td>UKMO oper. 12-36h forecast</td>
<td>50</td>
<td>~40</td>
</tr>
<tr>
<td>LMDZ</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>NCAR CAM3.5, CAM3.5+</td>
<td>26/30</td>
<td>250</td>
</tr>
<tr>
<td>GFDL</td>
<td>38</td>
<td>250</td>
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PreVOCA observational data

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<thead>
<tr>
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<tbody>
<tr>
<td>ISCCP FD</td>
<td>Radiative fluxes at surface, TOA</td>
</tr>
<tr>
<td>TMI</td>
<td>LWP, WVP</td>
</tr>
<tr>
<td>AMSR</td>
<td>LWP, WVP</td>
</tr>
<tr>
<td>MODIS</td>
<td>Cloud fraction, optical depth, droplet size, cloud-top height</td>
</tr>
<tr>
<td>NOAA ESRL Stratus Cruises</td>
<td>Temperature, moisture soundings, surface fluxes, drizzle properties, aerosols</td>
</tr>
<tr>
<td>QuikSCAT</td>
<td>Ocean surface winds</td>
</tr>
<tr>
<td>NCEP Reanalysis</td>
<td>Vertical velocity</td>
</tr>
<tr>
<td>CALIPSO</td>
<td>Cloud top height</td>
</tr>
<tr>
<td>COSMIC</td>
<td>Temperature soundings</td>
</tr>
<tr>
<td>CloudSat</td>
<td>Drizzle properties</td>
</tr>
</tbody>
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Analysis

Shown here: Monthly mean biases
In progress: Diurnal cycle incl. Andean subsidence wave
            Synoptic variability (projection onto SLP index)

PreVOCA analysis focus: Cloud and PBL structure and their
dynamical setting.
10 m vector wind (m s$^{-1}$) - models agree reasonably well
Omega at 850 hPa (Pa s\(^{-1}\)) - also mostly not too bad
Low Cloud Fraction - models shown among best

MODIS Total Cldfrac

IPRC

UKMO

ECMWF OPER
Liquid Water Path (g m$^{-2}$)
SW Downward Heat Flux (W m\(^{-2}\))
85W sounding comparisons

Regional models

Global models
Conclusions from PreVOCA

• Much scatter in PBL/Sc properties among models, esp. the regional models: Also an issue for chemical transport?
• UKMO and ECMWF models perform best overall, correctly capturing most geographic variations in PBL depth/structure and cloud cover.
• Sharpness of inversion (even in monthly-mean) is challenging to simulate even for the highest-resolution models.
From PreVOCA to VOCA...

- VOCA: Similar protocol to preVOCA using REx observations from 15 Oct -15 Nov 2008
- More focus on chemical transport, aerosol concentrations and $r_{\text{eff}}$ vs. in-situ and CALIPSO data.
- We will send out a detailed protocol early next year. All modeling groups are welcome (with or without chemical transport modeling capability).
REx real-time modeling

Products in field catalog from:
- UKMO (40 km/17 km/NAME)
- NCEP GFS (incl. UW trajectories)
- NRL COAMPS
- ECMWF
- FLEXPART
- U Chile WRF

We’ve done spot cloud/PBL evaluations of some forecasts
RF02 case

- 20S section (compare at 15Z 18 Oct.)
- Reality:
  - Sharp PBL top at 900-950 m (~930-940 hPa) over 70-85W
  - Solid Sc E of 78W, thinner/broken at 78-82W
- Compare UKMO, ECMWF, NCEP, WRF-Chile
UKMO (global, 40 km)

- Quite good overall
Both models predict cloud distribution well, including break at ~80W.
ECMWF (global, 30 km, L90)

Inversion is sharp and at correct height. Max LWC is reasonable. Not much thinning at 80W compared to other lons

20S 85 W  20S 80 W  20S 75 W
NCEP (global, 100 km, L64)

- What stratocumulus?
COAMPS

...soso LWP distribution. Gets ‘hole’ but not other features.
Inversion is highly diffuse (50 hPa thick)
RF03 (21 Oct 2008)

Sloped inversion: 1000m (70W) - 1500m (85W), solid Sc
**UKMO**

- UKMO underestimates peak LWP, but sees S edge of Sc
UKMO vertical profiles

40 km

17 km model does better job near coast
ECMWF

Correct inversion slope and decoupled structure at 85 W.

20S 85 W  20S 80 W  20S 75 W
NCEP - again no low cloud!

Low Cloud Cover 12hr (%)
valid 12Z 21 Oct
LWP slightly low and clearing to S is not reproduced.
Conclusions

• PreVOCA helped catalyze a healthy REx real-time modeling effort.
• VOCA should better assess state-of-the-art simulations of chemical/aerosol transport and its feedbacks with clouds.
• SE Pacific cloud variability and aerosol feedbacks are cutting-edge challenges to the best global and regional models - VOCALS should lead the way!