Preliminary assessment of the UM Sc forecast during VOCALS

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Unified Model

- Operational Global NWP to 6 days ahead
- Limited Area Model (LAM) to 2 days at ~17km resolution. Domain 0-40S, 60-100W (far enough east so Andes is fully in domain)
- Range of diagnostics were available for flight planning and are archived in the VOCALS field catalogue

[Link to catalog: http://catalog.eol.ucar.edu/vocals/index.html]

- Global UM data archived every 3 hours (limited set of diagnostics)
- The LAM has now been re-run for the VOCALS REx period with additional diagnostics archived on an hourly basis

Global 40km/ 50 Levels
- 144 hour forecast twice/day

LAM ~17km/ 38 Levels
- 48 hour forecast once/day
UM typical behaviours
(observations from the field)

- Reasonable skill in forecasting the Sc – useful for flight planning purposes
- Generally reproduces large-scale breaks in the Sc sheet
- Generally an insufficient daytime thinning of cloud nearer the coast
- Absence of “realistic” POC-like structures
- Cloud breaks associated with changes in BL depth
Model assessment against observations from VOCALS

- Ongoing work – show a flavour of the type of comparisons that we are/planning on looking at

- Comparison against satellite data e.g.
  - Cloud cover
  - LWP
  - Cloud top height/pressure

- Comparison against soundings and aircraft in-situ observations

- Boundary layer structure – Paul Barrett’s talk (session 4B)
- Ship based observations, long term buoy’s?
GOES cloud cover

Met Office

- Cloud fraction derived from the GOES Ch4 brightness temperature

- High and mid level cloud is defined as having a brightness temperature < 270 K and low level cloud is derived from pixels with a brightness temperature in the range of 270 - 283.5 K

- Red boxes define a “remote maritime” and “coastal” region
Mean cloud cover for the period 15 Oct - 15 Nov 2008

Coastal clearing of cloud not captured in the UM

LAM has slightly lower cloud cover along coast than global

Satellite has higher cf over land e.g. at 23S

UM appears to have more mid-high cloud, LAM does better over Peruvian Andes
Cloud cover along 20S

LAM beginning to get reduction in cloud near coast although not enough
Time series of cloud cover

Remote maritime low cloud

Coastal low cloud

GOES
Global UM
Regional UM
Diurnal cycle in cloud cover

Diurnal cycle along 20S

Low Cloud: Remote Marine (15 Oct – 19 Nov mean)

Low Cloud: Coastal (15 Oct – 19 Nov mean)
What controls the cloud cover near the coast?

Timing of the double peak in cloud cover appears to be consistent with the modelled upsidence wave in Garreaud and Munoz, 2004.

Inversion height at Iquique at ~ 900 mbar

How well does the model capture the flow near the coast?

Diurnal cycle from GOES at various points along 20S
UM does not capture open cellular regions

Gaps where cloud changes level

Captures increase in cloud top height away from the coast

LWP and location of drizzle look reasonable

Drizzle “switched on” in the model when LWP > ~ 100 gm⁻². Linked to fixed cloud droplet concentration.
As LWP increases away from coast see some drizzle.
UM does not capture POC

Captures increase in cloud top height away from the coast although cloud too low

LWP looks reasonable until POC region. One high point in observations

No drizzle in aircraft obs and model
Low LWP prevents drizzle
UM does not capture POC
BUT does capture large scale breaks in cloud to South
Cloud tops fairly constant away from coast in obs and UM
LWP and drizzle underestimated in UM
Data Examples: 20S cross section 9/11/08

LWP large enough to produce drizzle but largely evaporates before surface.
UM does not capture POC’s including the one the BAe-146 measured

BUT does capture large scale breaks in cloud to South-West

Cloud tops fairly constant away from coast in obs and UM. Cloud too low in UM.

LWP and drizzle underestimated in UM
Marked contrast with polluted and clean POC region in microphysics and drizzle
Summary

• VOCALS will provide extensive data on structure and evolution of Sc and the response to changes in aerosol inputs and large-scale forcing.

• UM captures the large-scale temporal variability in Sc cloud cover throughout the VOCALS period away from coast BUT does not simulate realistic POC’s or the diurnal cycle in cloud cover in the coastal region. Inversion is often too low near the coast.

• In situ-observations show that accumulation mode aerosol concentrations (or, alternatively higher droplet concentrations) play a role in drizzle as well as LWP e.g. POC’s.

• However the model drizzle is primarily controlled by the LWP and has a fixed cloud droplet concentration over the Sea.

• Development of improved links between model aerosol cloud droplets and drizzle production - move to have prognostic aerosols in global NWP in future.

• Future modelling will look at higher vertical resolution (L70 and L150) plus high horizontal resolution (~1.5 km over domain of ~10x10 degrees).