



Preliminary assessment of the UM Sc forecast during VOCALS

Second VOCALS Science Meeting, UW, Seattle – 12/07/2009

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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

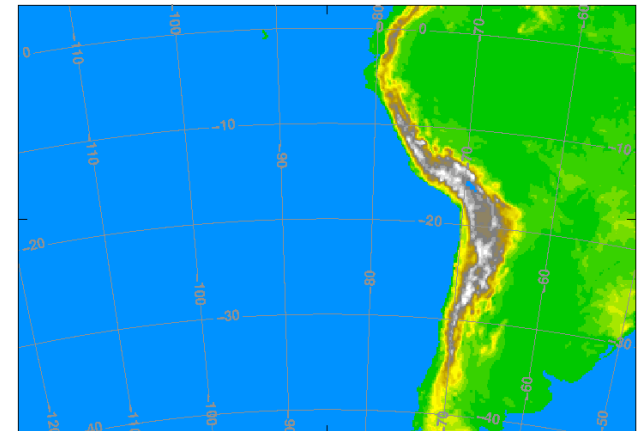
<http://catalog.eol.ucar.edu/vocals/index.html>

- *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



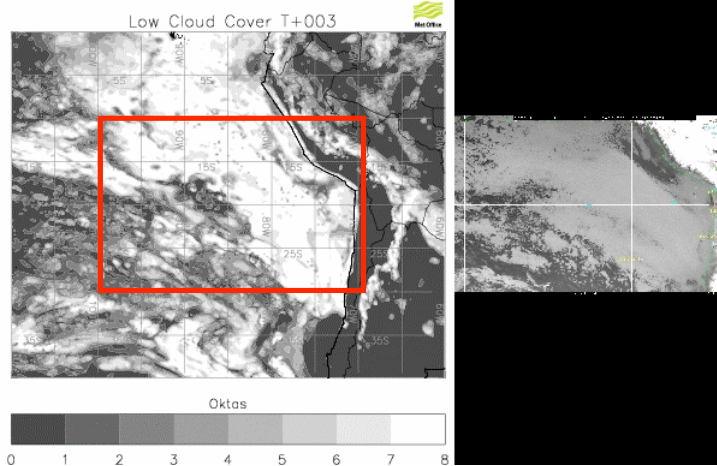
LAM ~17km/ 38 Levels

- 48 hour forecast once/day

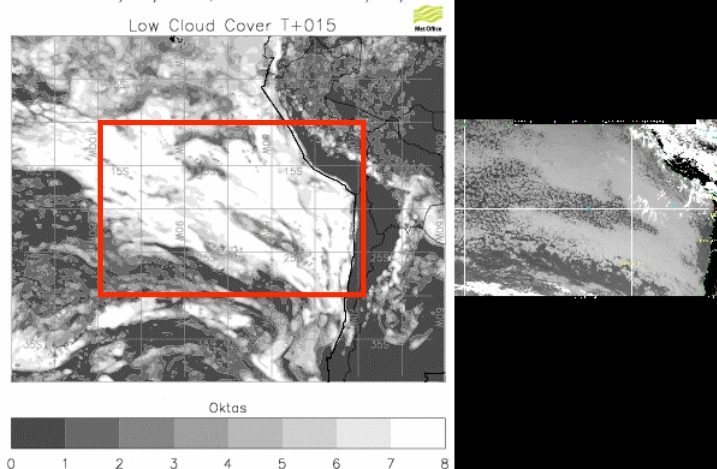


UM typical behaviours (observations from the field)

Met Office Regional Model Cloud
At 03Z on 27/10/2008, from 00Z on 27/10/2008



Met Office Regional Model Cloud
At 15Z on 27/10/2008, from 00Z on 27/10/2008



- 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

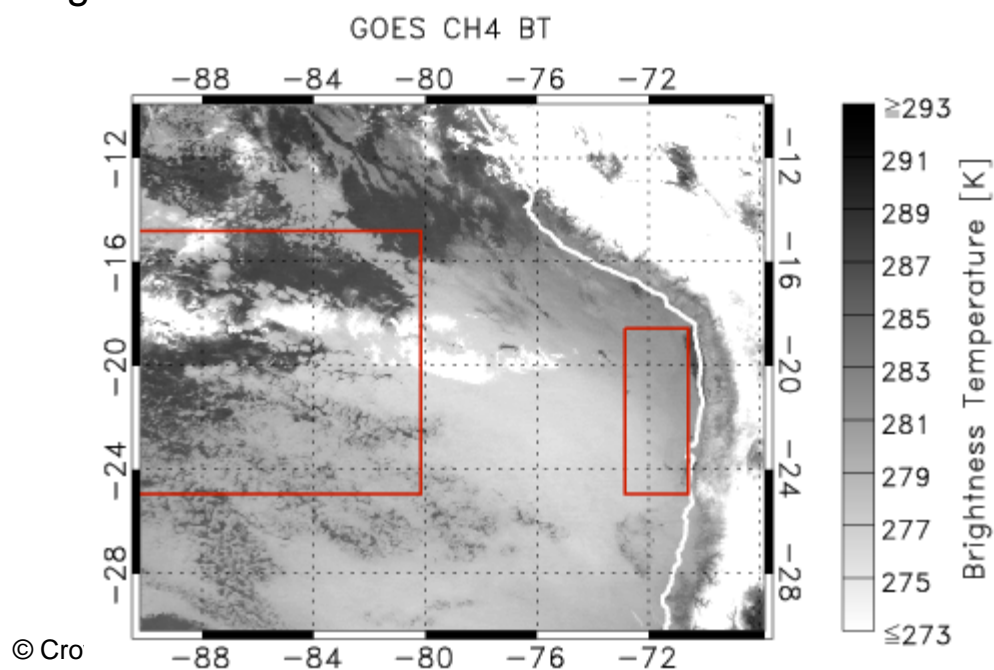


Model assessment against observations from VOCALS

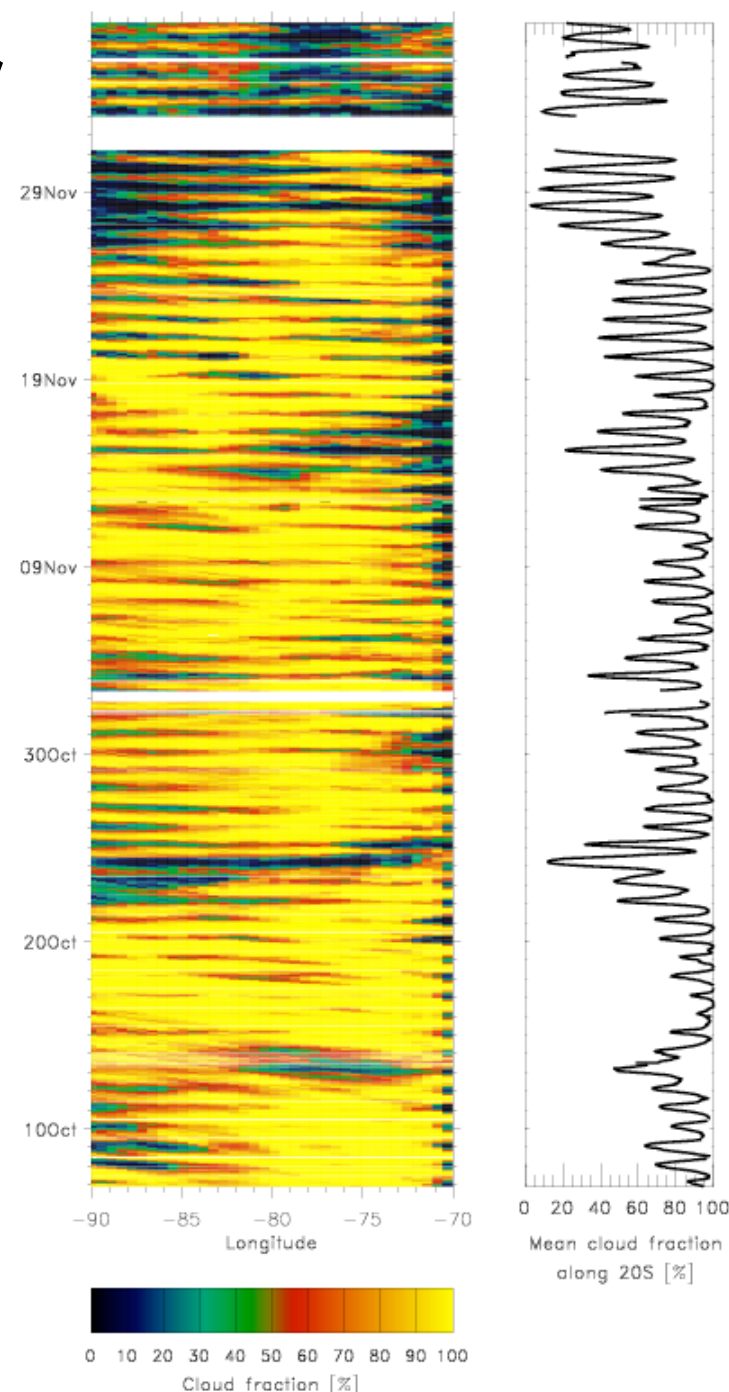
- Ongoing work – show a flavour of the type of comparisons that we are/planning on looking at
- Comparison against satellite data e.g.
 - **Cloud cover**
 - **LWP**
 - **Cloud top height/pressure**
- Comparison against soundings and aircraft in-situ observations
- Boundary layer structure – Paul Barrett's talk (session 4B)
- Ship based observations, long term buoy's?

GOES cloud cover

- 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



20 S cloud cover





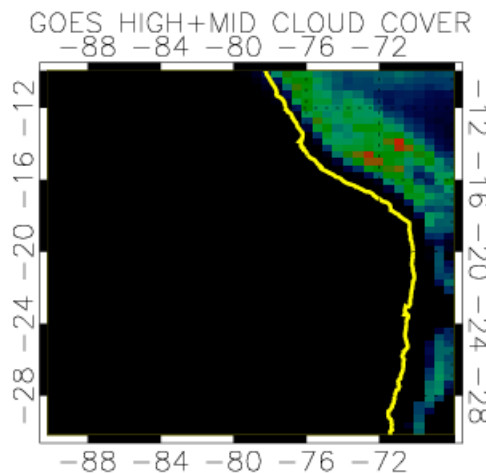
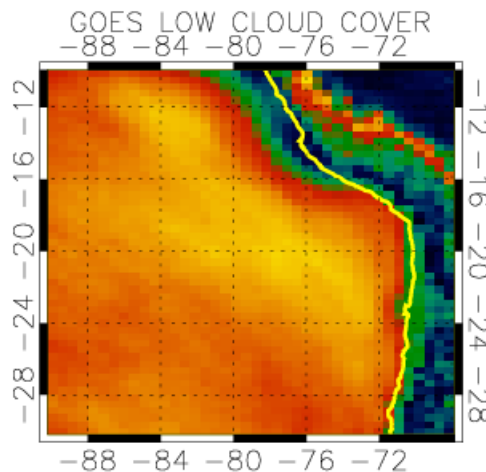
Mean cloud cover for the period 15 Oct - 15 Nov 2008

Coastal clearing of cloud not captured in the UM

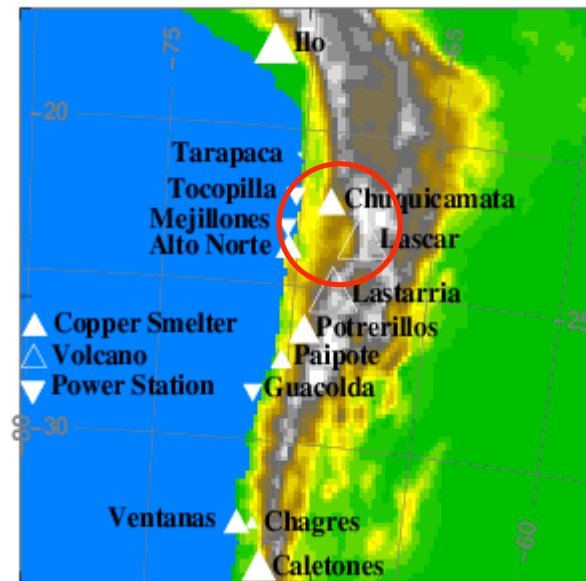
LAM has slightly lower cloud cover along coast than global

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

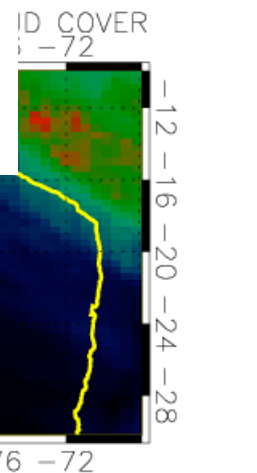
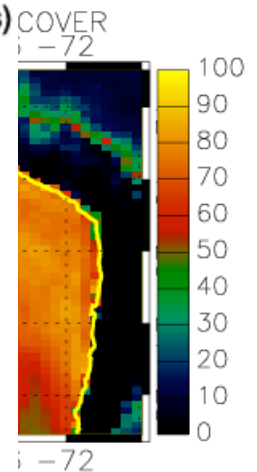
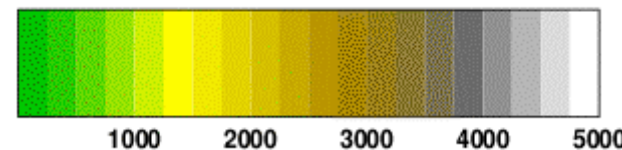
UM appears to have more mid-high cloud, LAM does better over Peruvian Andes



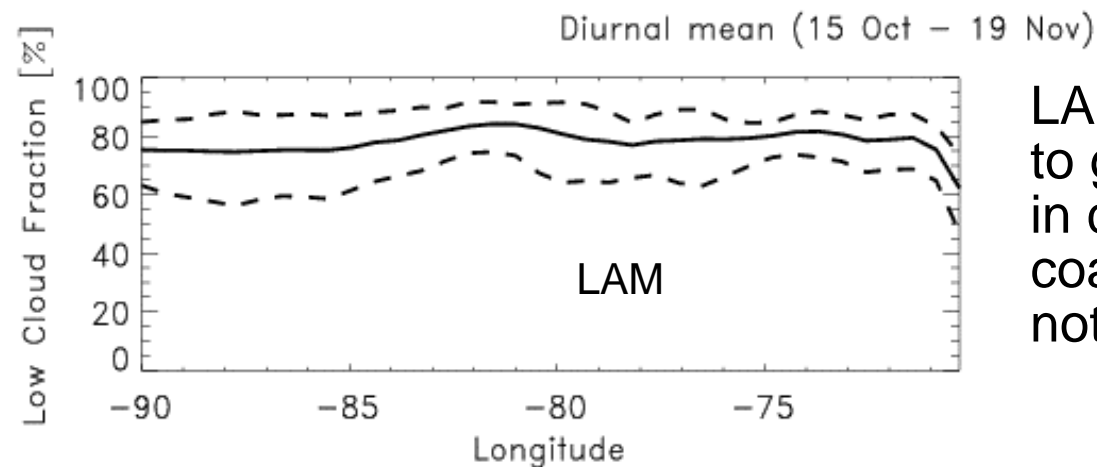
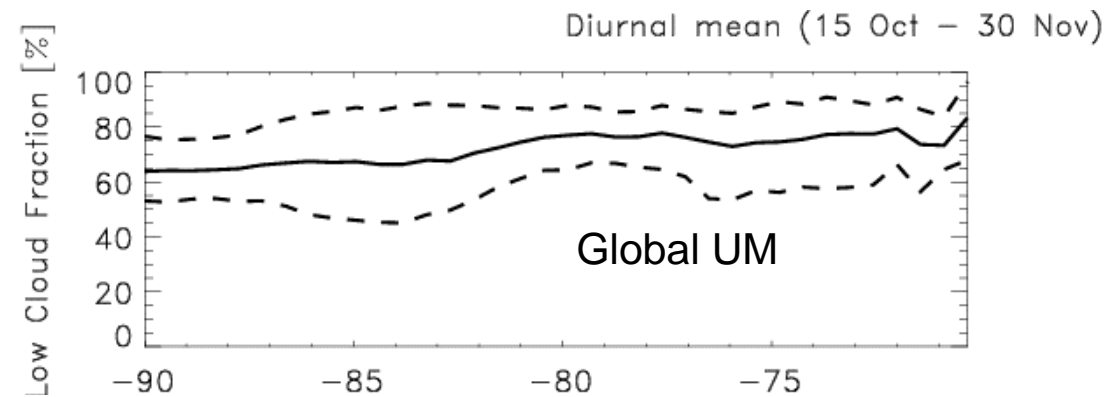
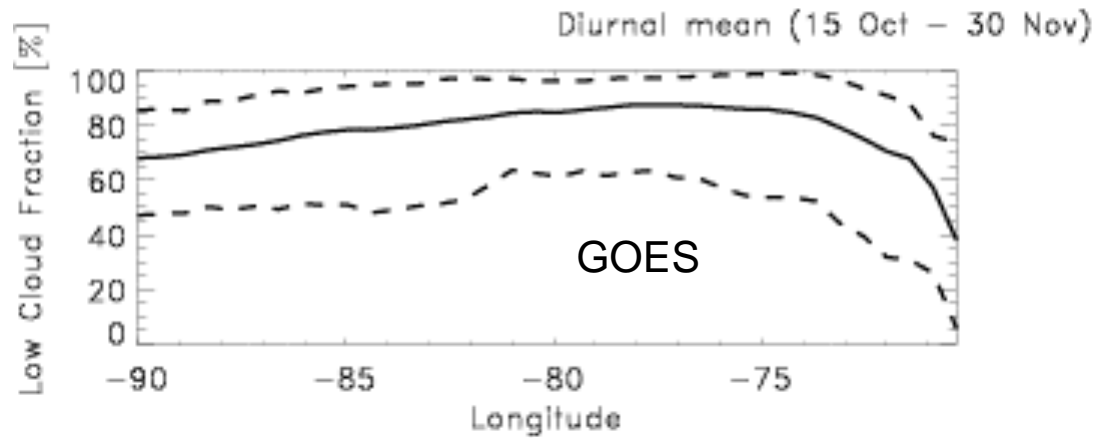
VOCALS point source locations (scaled to SO₂ emissions)



Regional Model Orography [m]

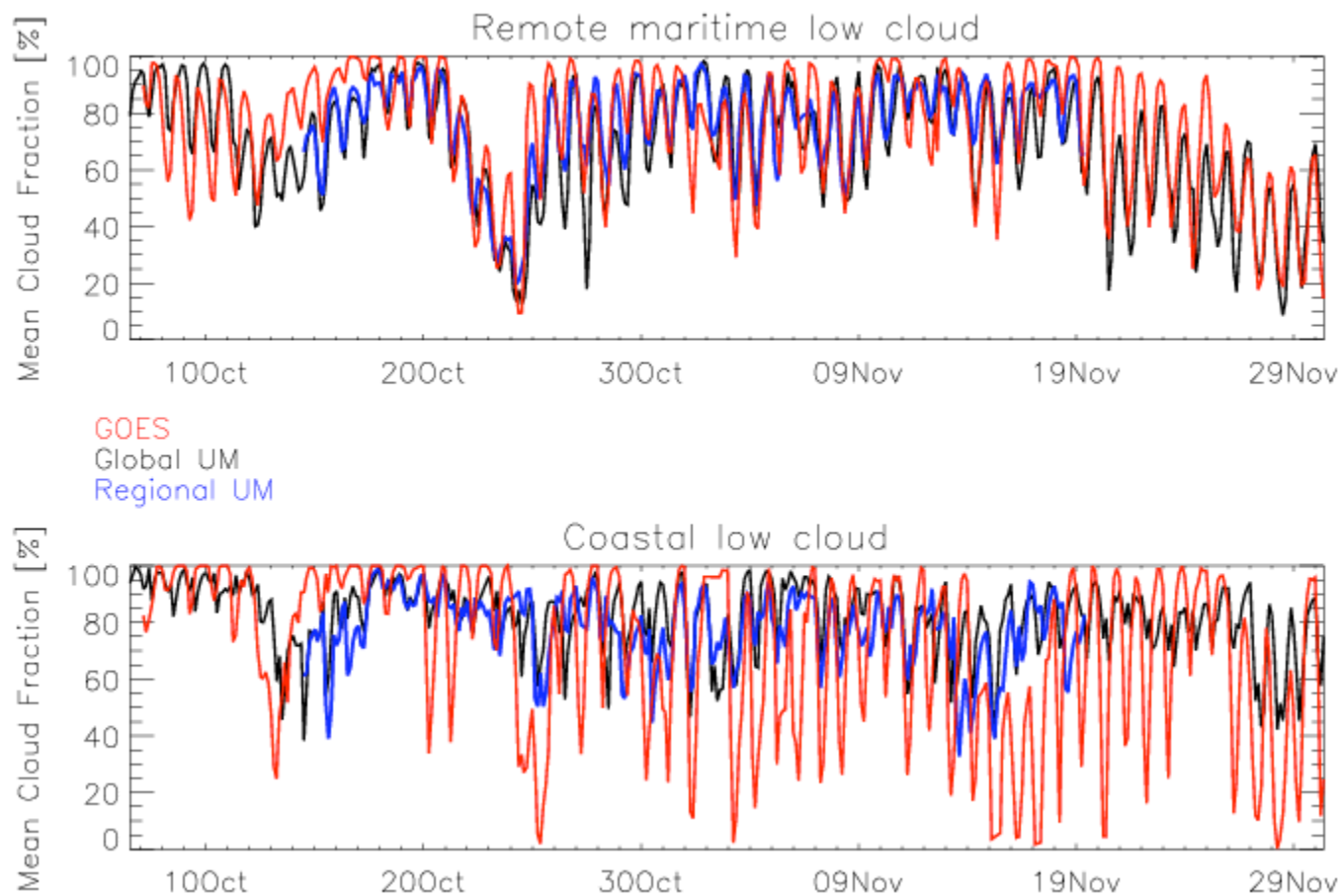


Cloud cover along 20S

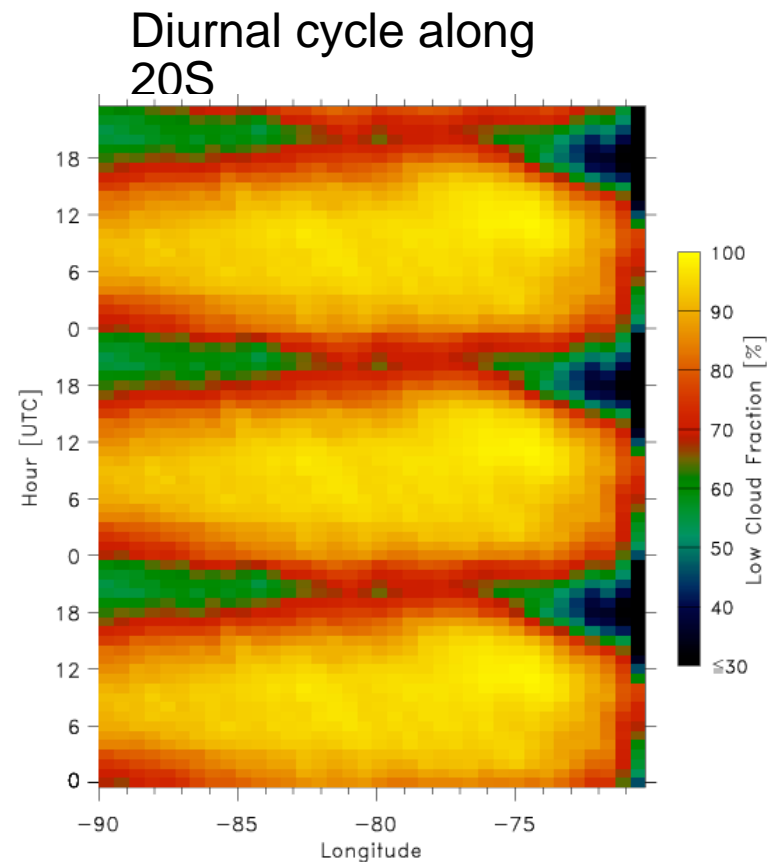
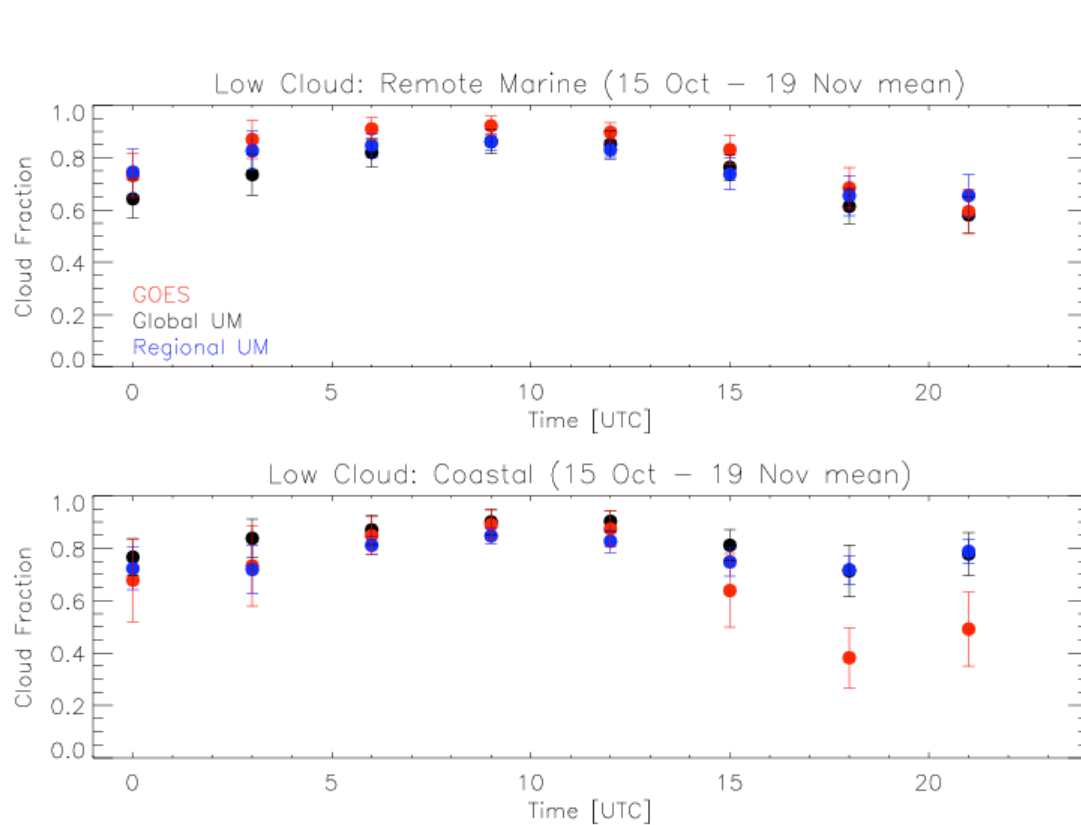


LAM beginning to get reduction in cloud near coast although not enough

Time series of cloud cover

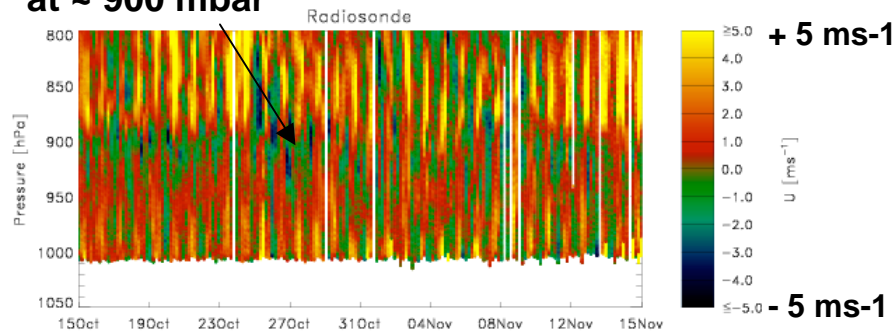


Diurnal cycle in cloud cover

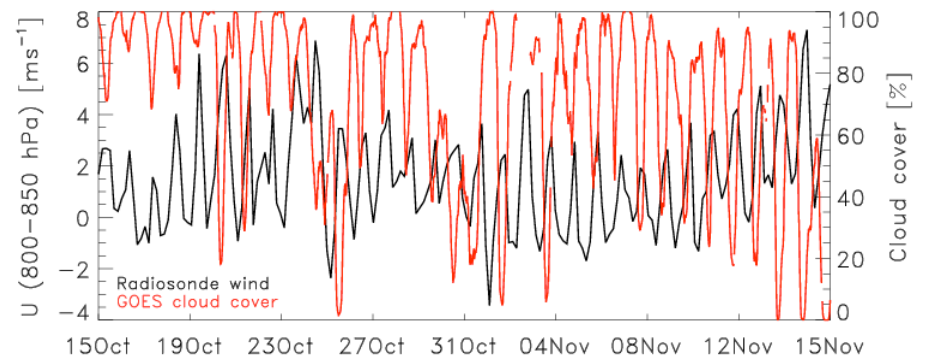


What controls the cloud cover near the coast?

**Inversion height at Iquique
at ~ 900 mbar**

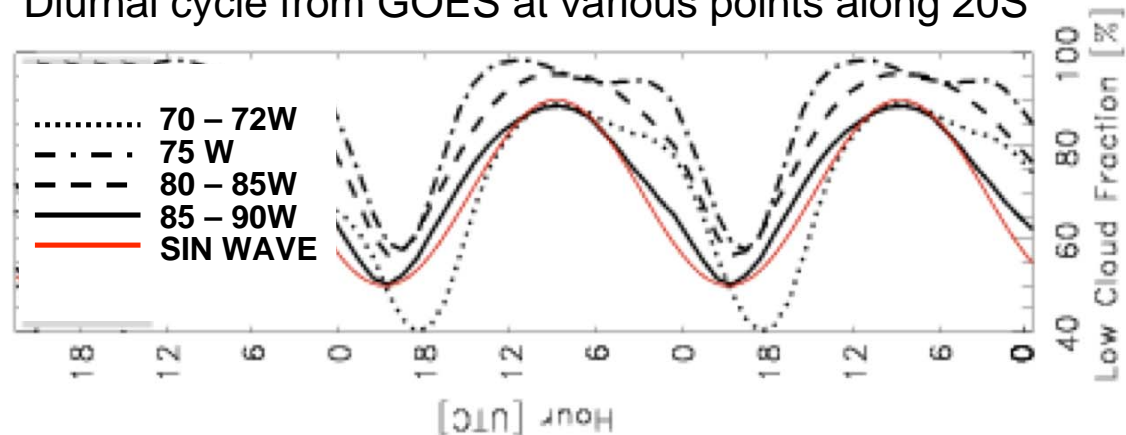


How well does the model capture the flow near the coast?



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

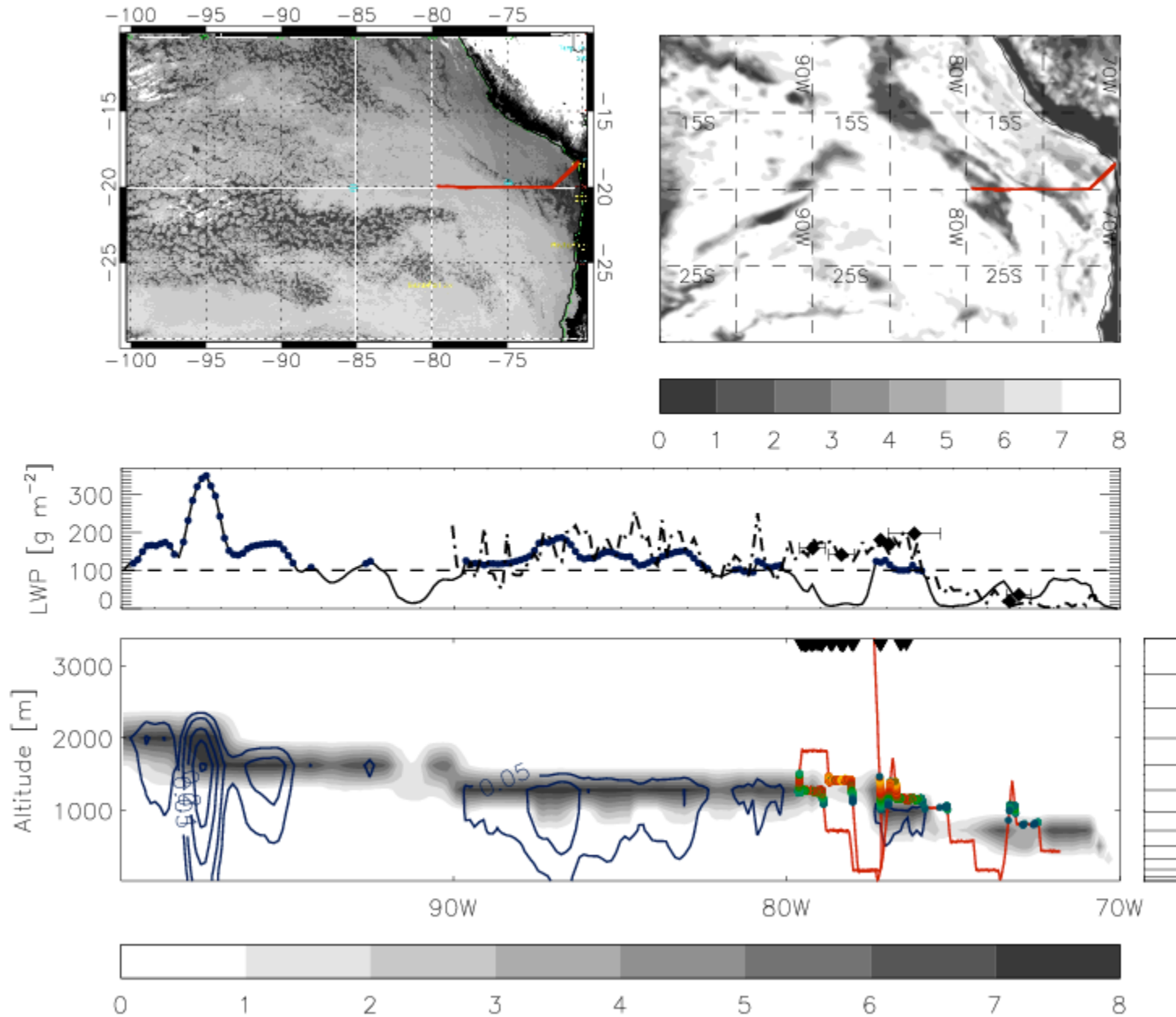
Diurnal cycle from GOES at various points along 20S



31st Oct

B412

Sat image: 1258 GOES LWP: 1245
Model from: 1200 - 1300
Aircraft data from: 10:19:52 - 14:20:03



UM does not capture open cellular regions

Gaps where cloud changes level

Captures increase in cloud top height away from the coast

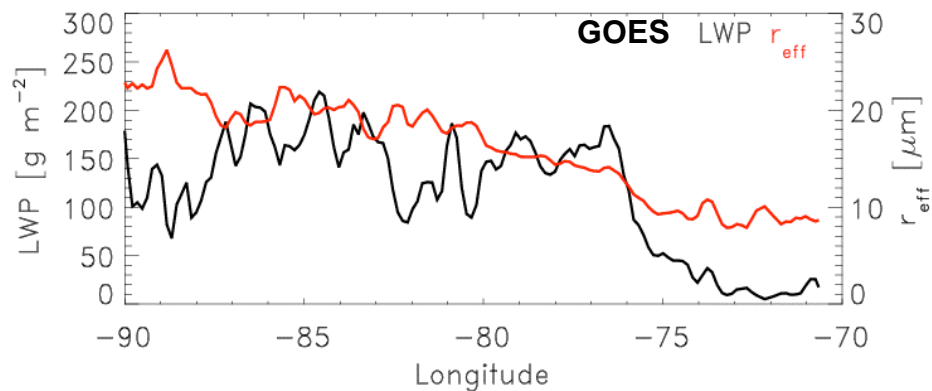
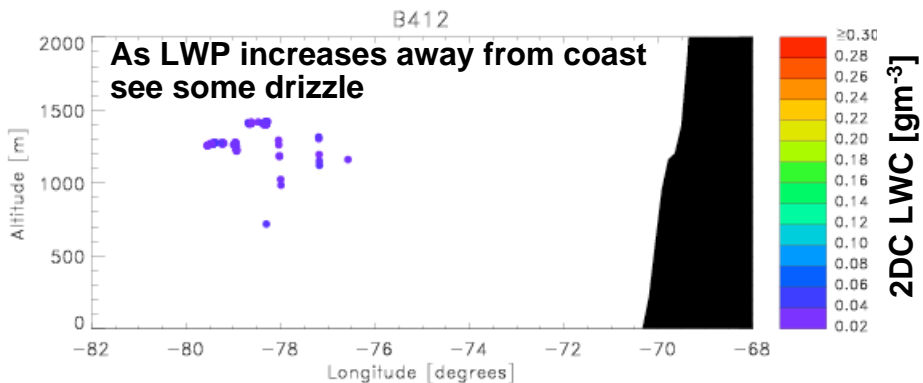
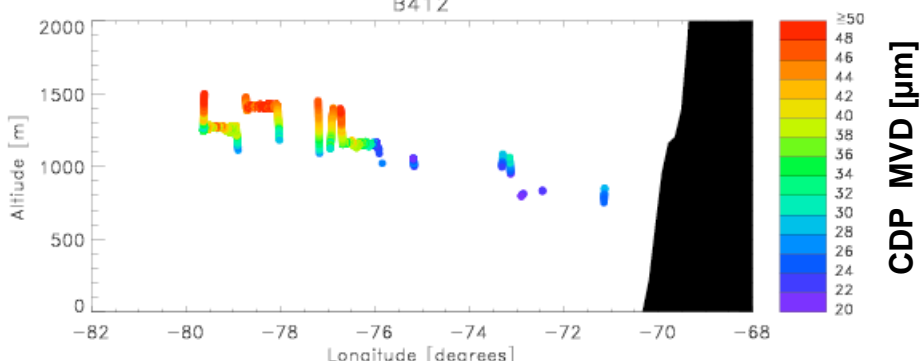
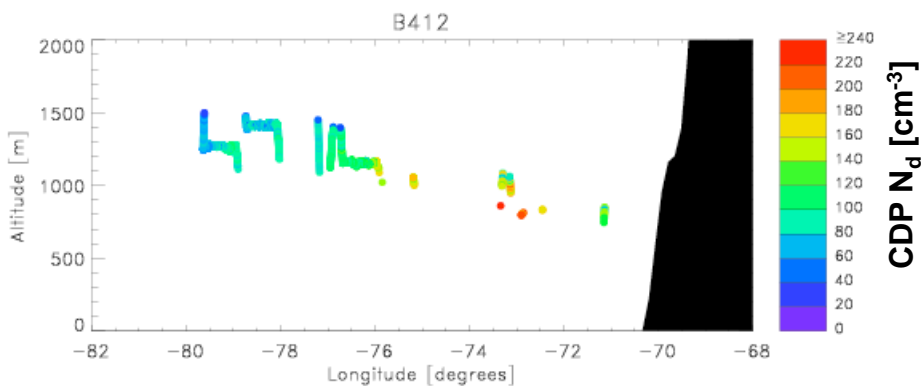
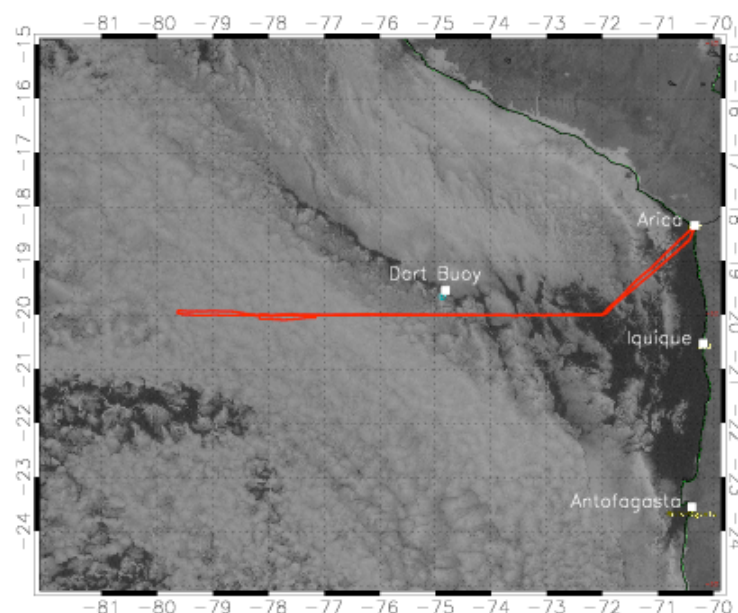
LWP and location of drizzle look reasonable

Drizzle “switched on” in the model when $\text{LWP} > \sim 100 \text{ gm}^{-2}$. Linked to fixed cloud droplet concentration



Data Examples: 20S cross section 31/10/08

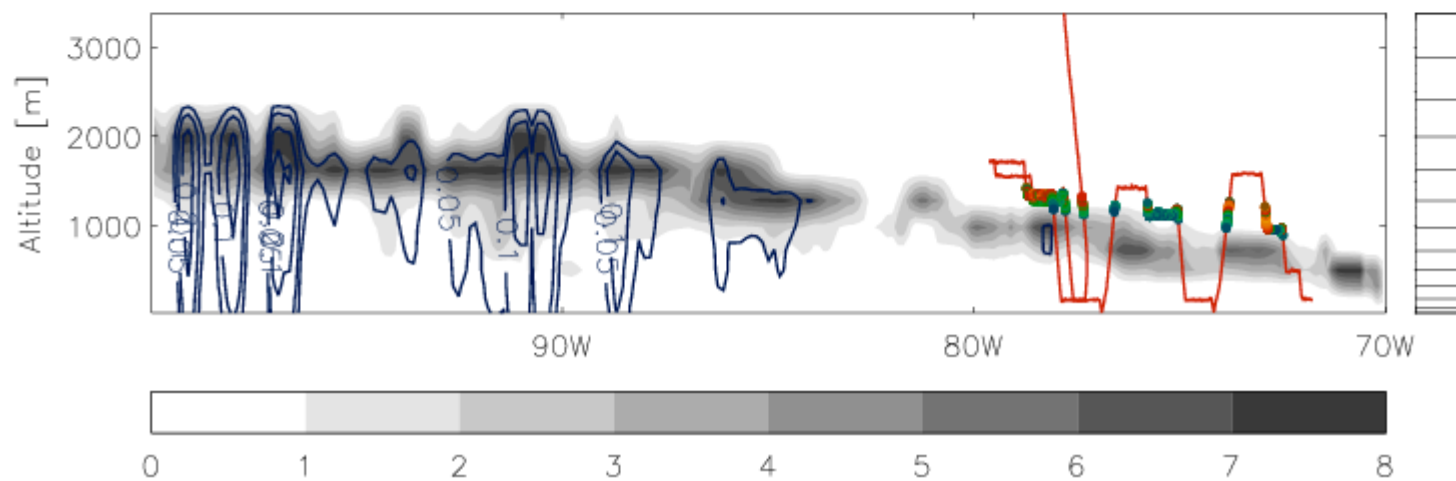
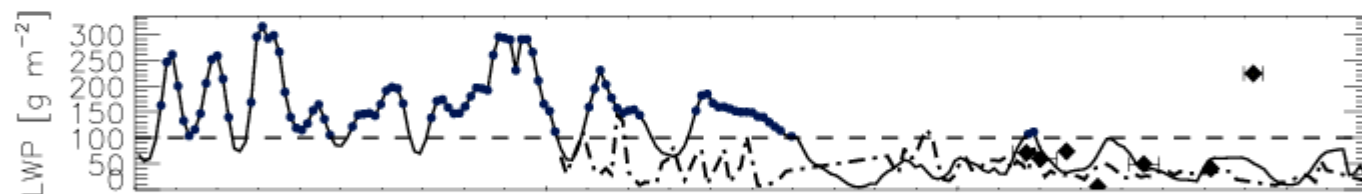
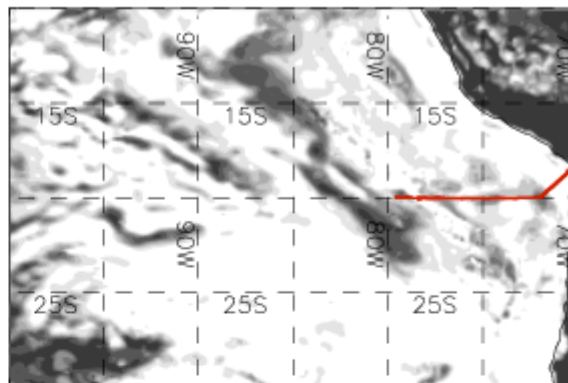
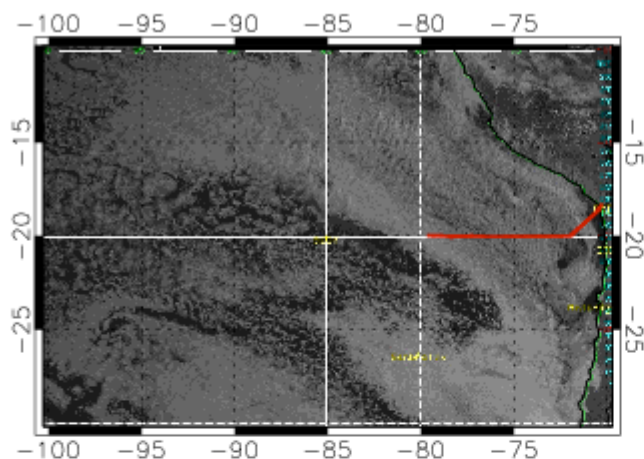
b412 flight track overlaid on ops.goes-10.200810311258.ch1_vis_big.jpg



4th Nov

B414

Sat image: 1258
Model from: 1200 – 1300
Aircraft data from: 10:16:37 – 14:25:09



UM does not capture POC

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

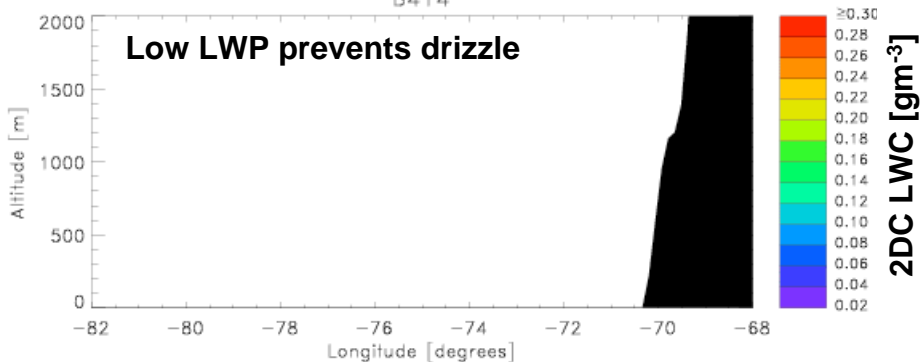
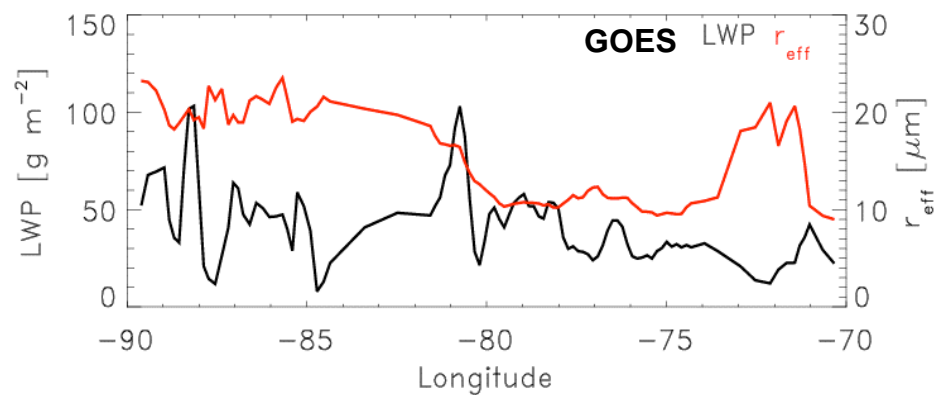
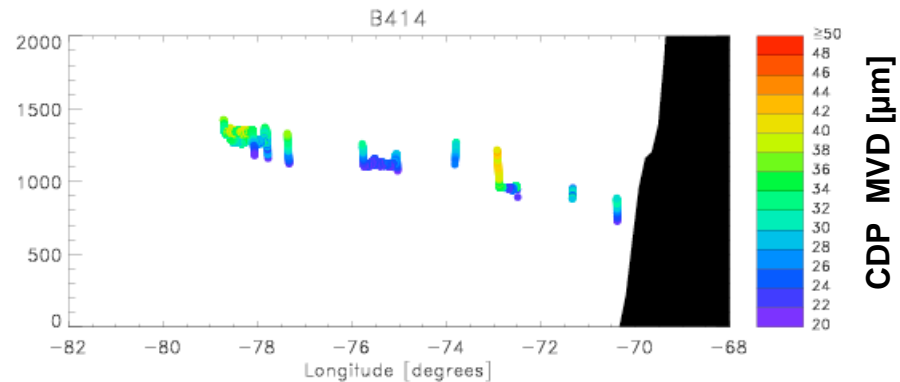
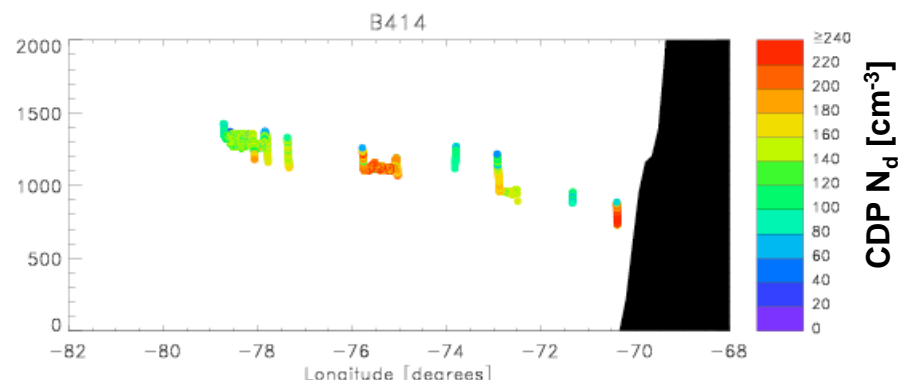
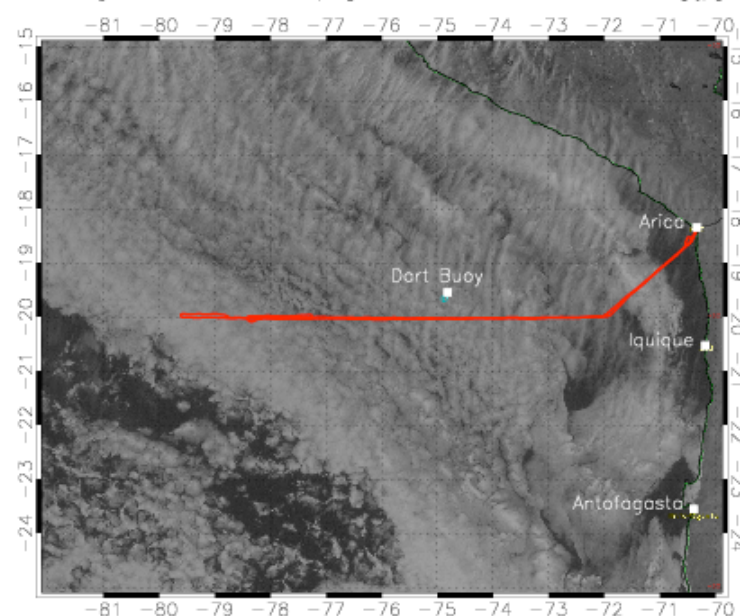
LWP looks reasonable until POC region. One high point in observations

No drizzle in aircraft obs and model



Data Examples: 20S cross section 4/11/08

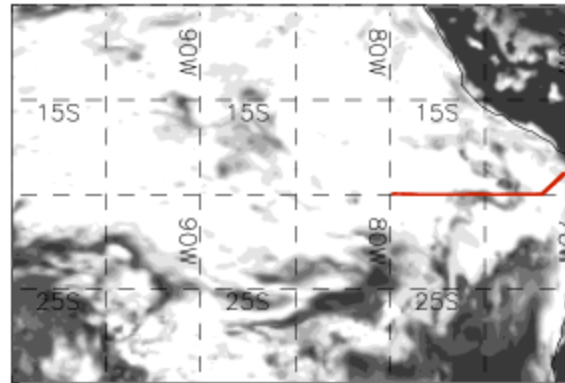
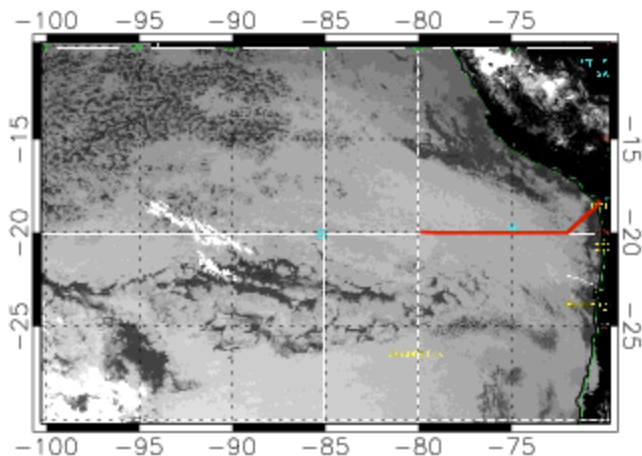
b414 flight track overlaid on ops.goes-10.200811041258.ch1_vis_big.jpg



9th Nov

B417

Sat image: 1258
Model from: 1200 – 1300
Aircraft data from: 10:32:01 – 14:46:58

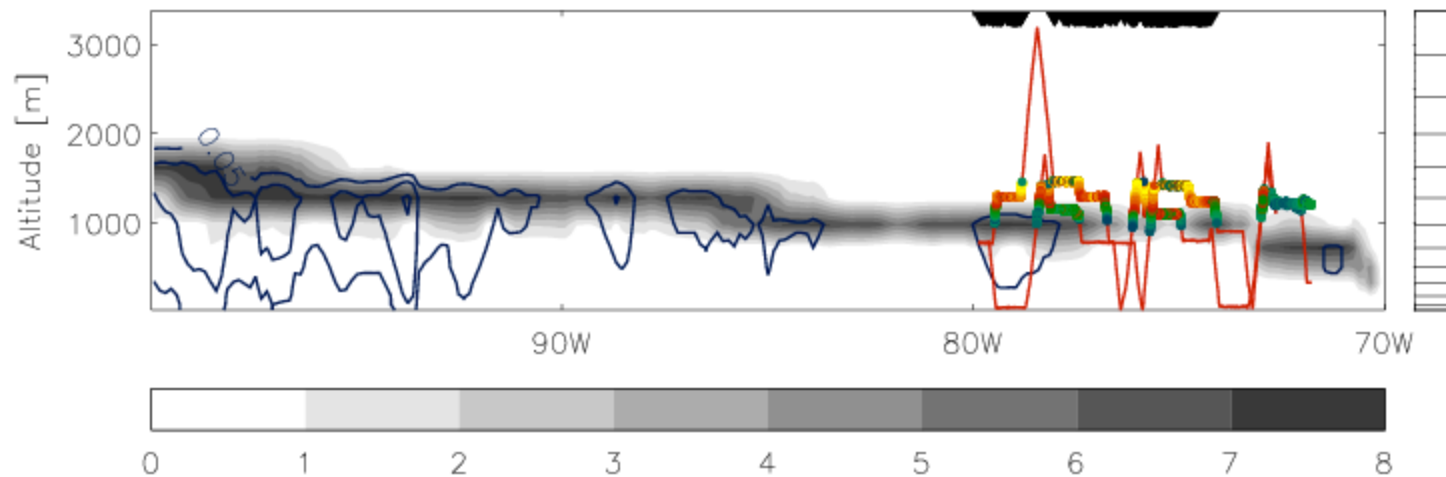
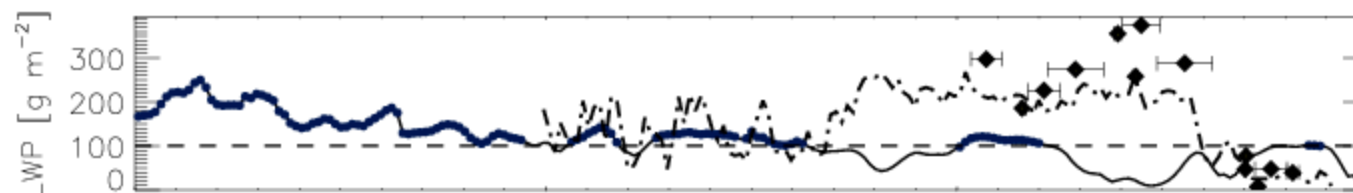


UM does not capture POC

BUT does capture large scale breaks in cloud to South

Cloud tops fairly constant away from coast in obs and UM

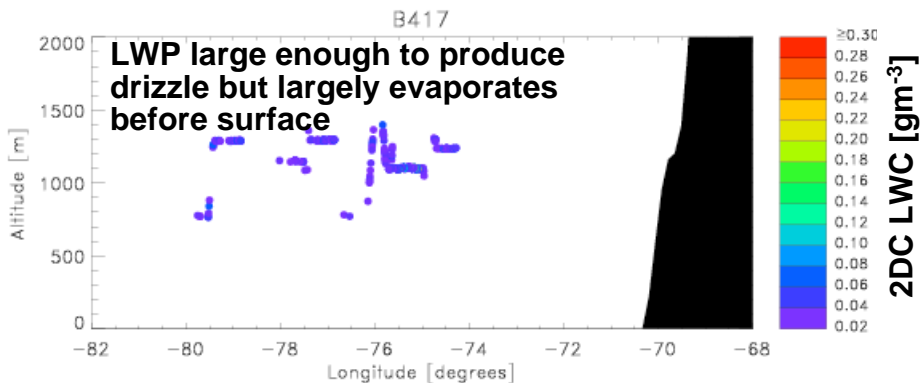
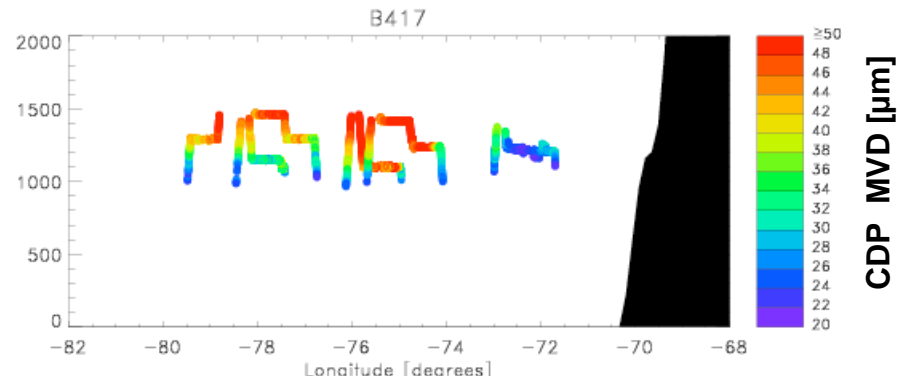
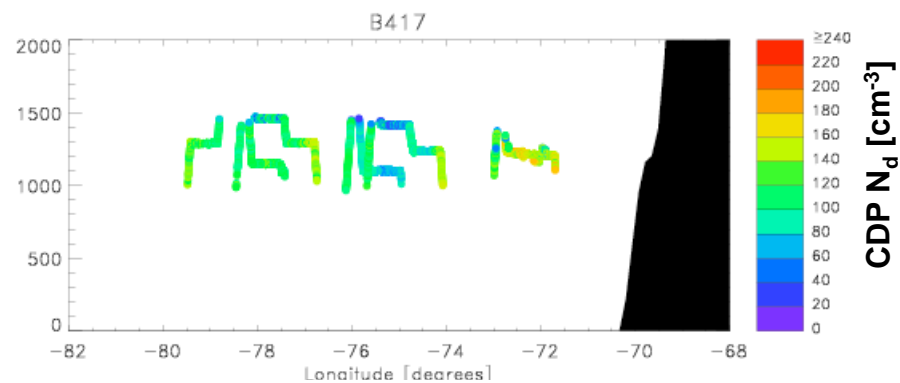
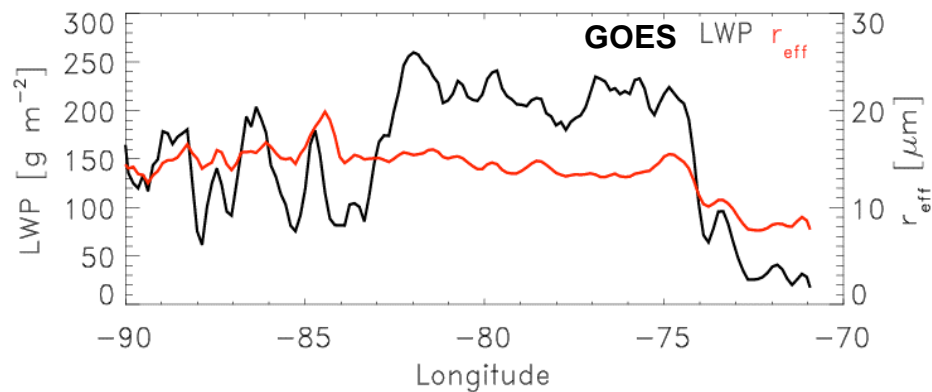
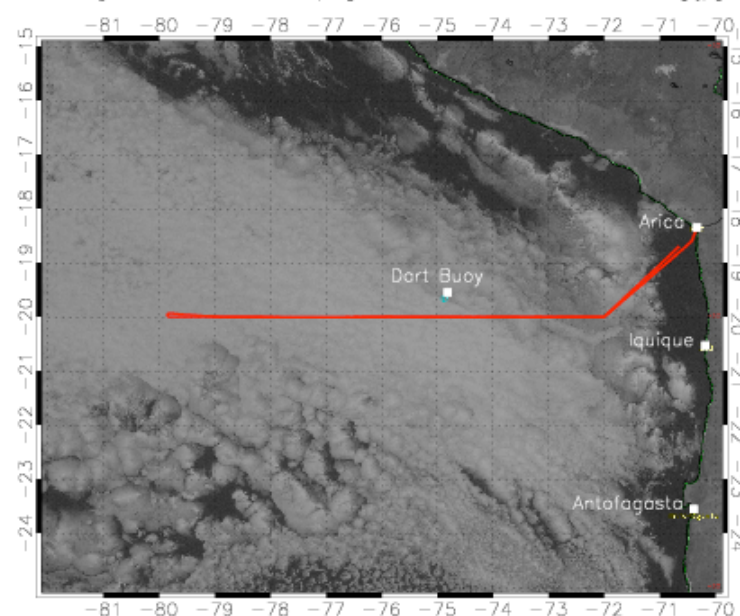
LWP and drizzle underestimated in UM



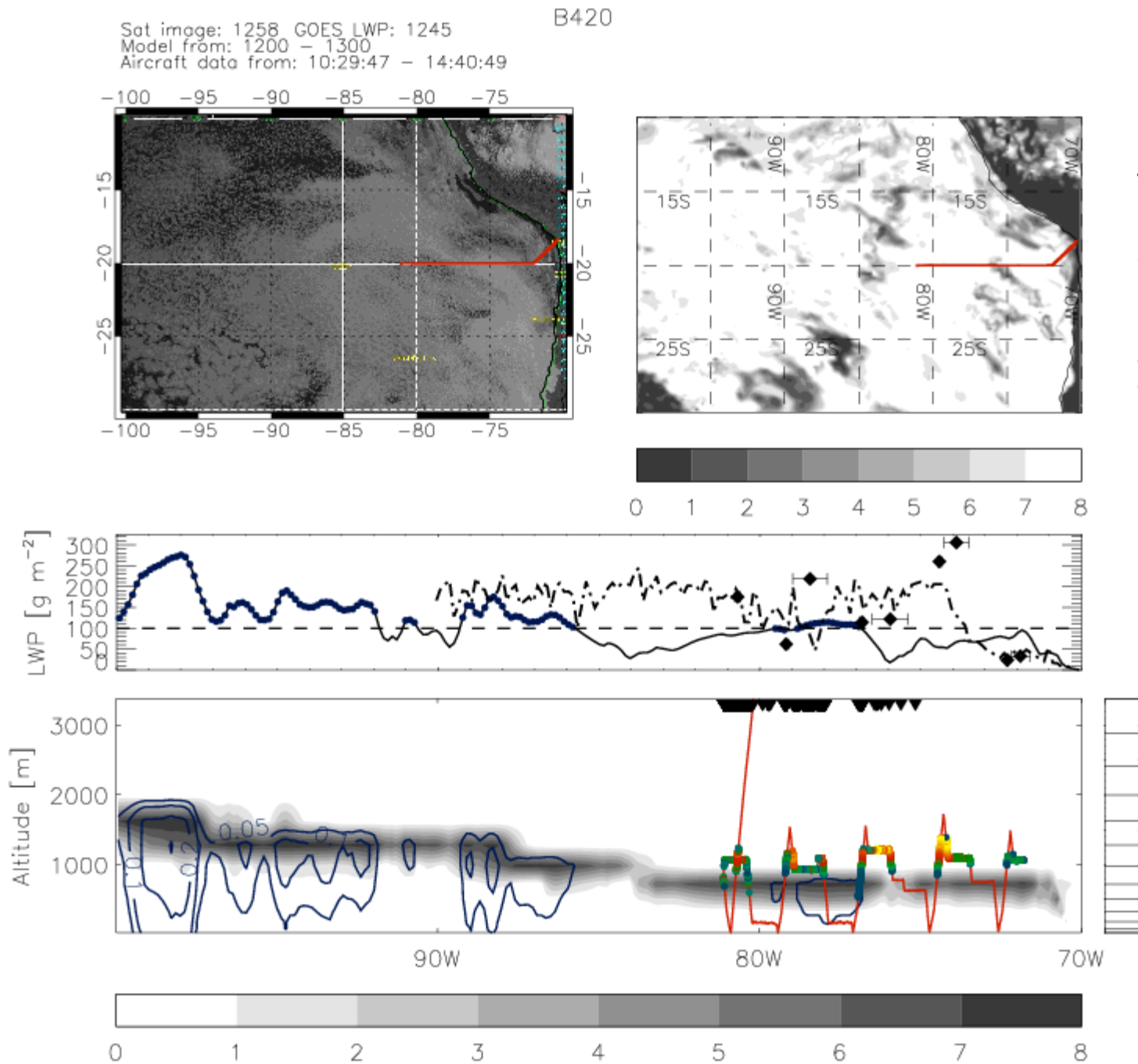


Data Examples: 20S cross section 9/11/08

b417 flight track overlaid on ops.goes-10.200811091258.ch1_vis_big.jpg



13th Nov



UM does not capture
POC's including the one
the BAe-146 measured

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

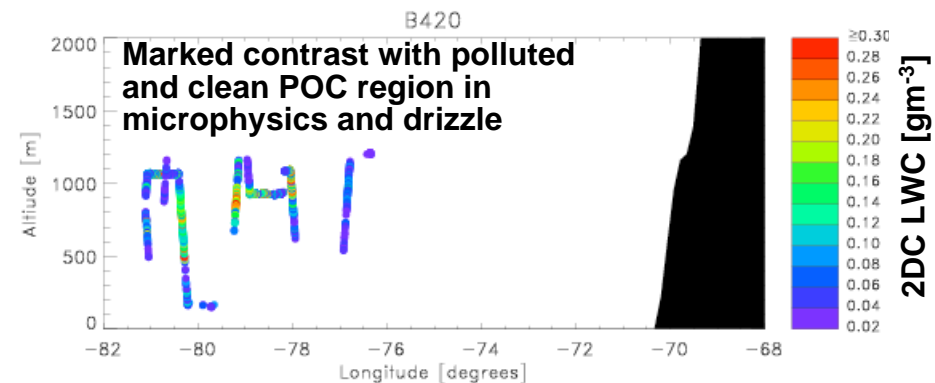
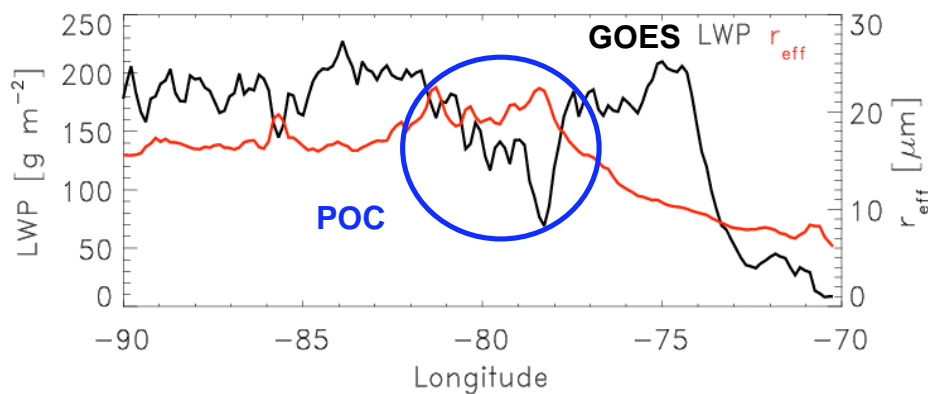
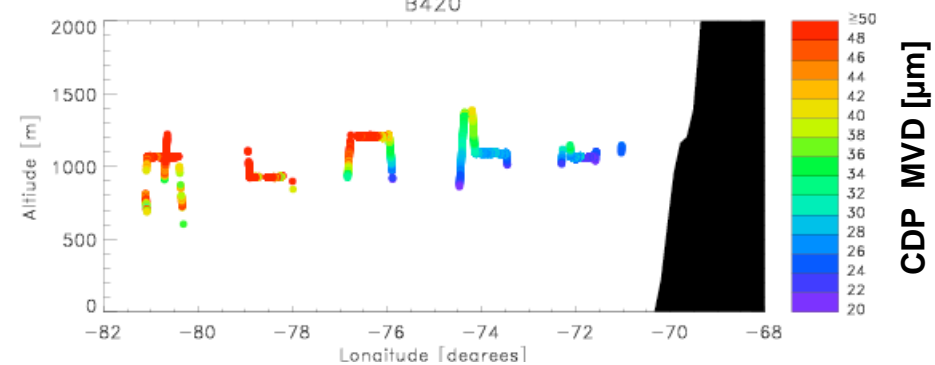
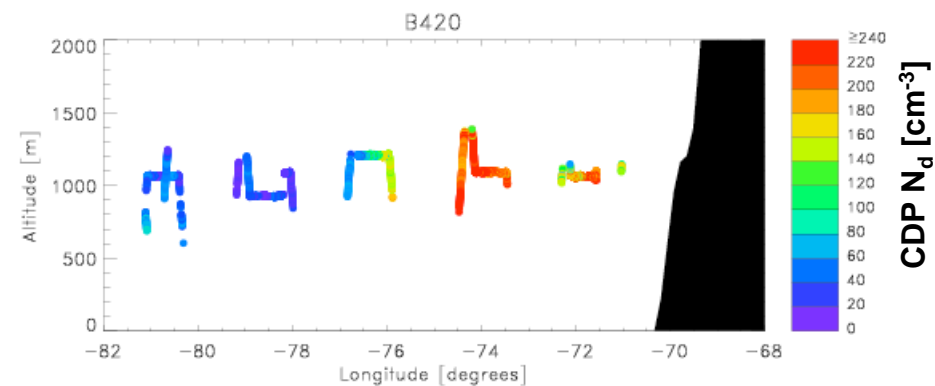
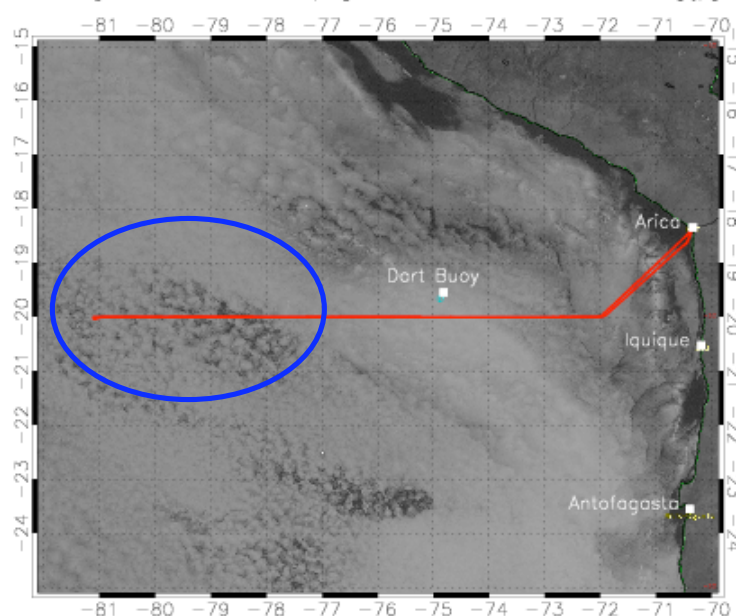
Cloud tops fairly constant
away from coast in obs
and UM. Cloud too low in
UM.

LWP and drizzle
underestimated in UM



Data Examples: 20S cross section 13/11/08

b420 flight track overlaid on ops.goes-10.200811131258.ch1_vis_big.jpg





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)