VOCALS Model Assessment

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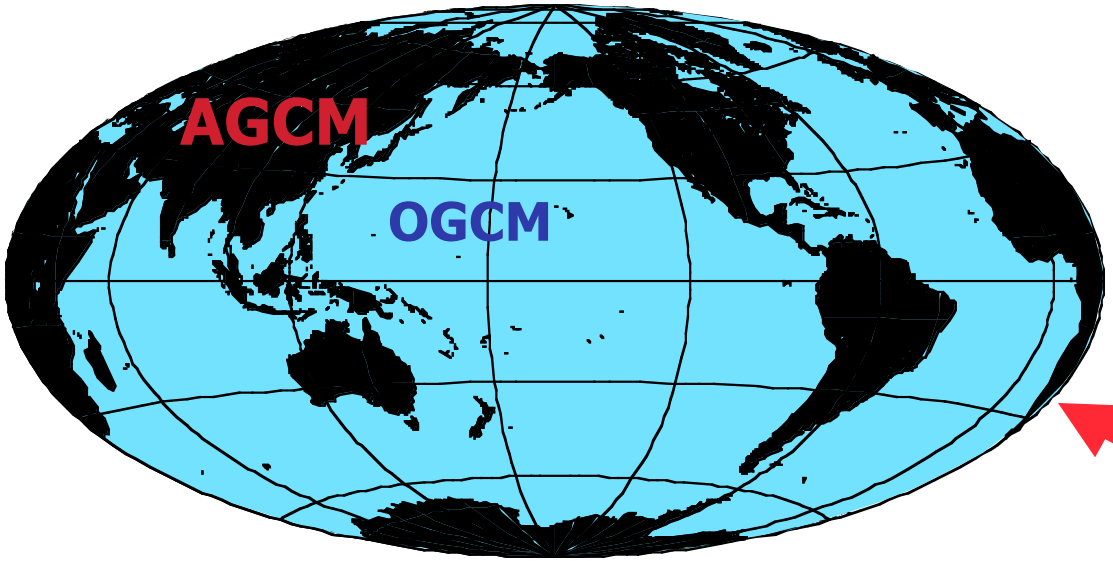
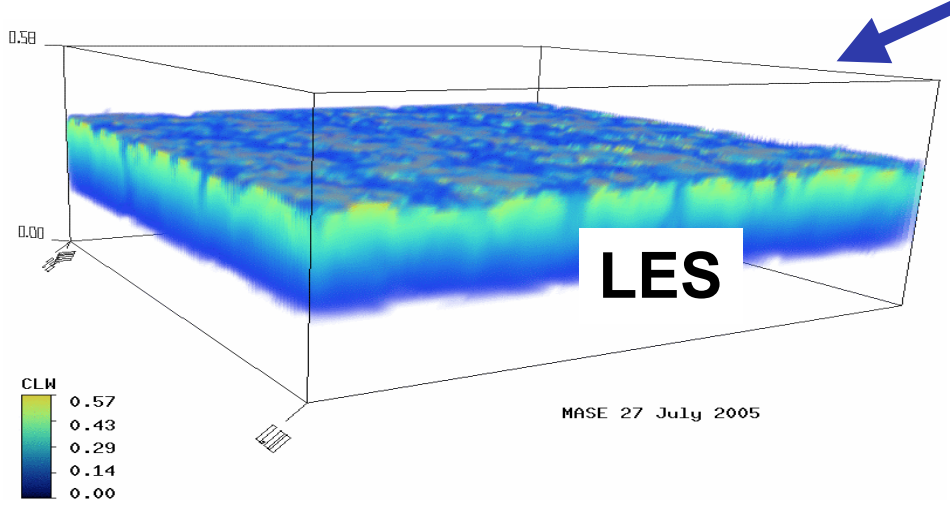
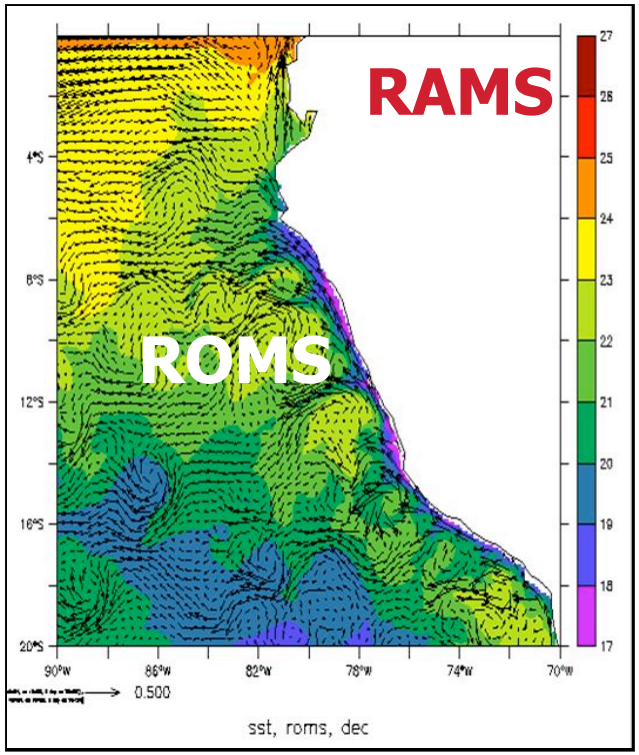
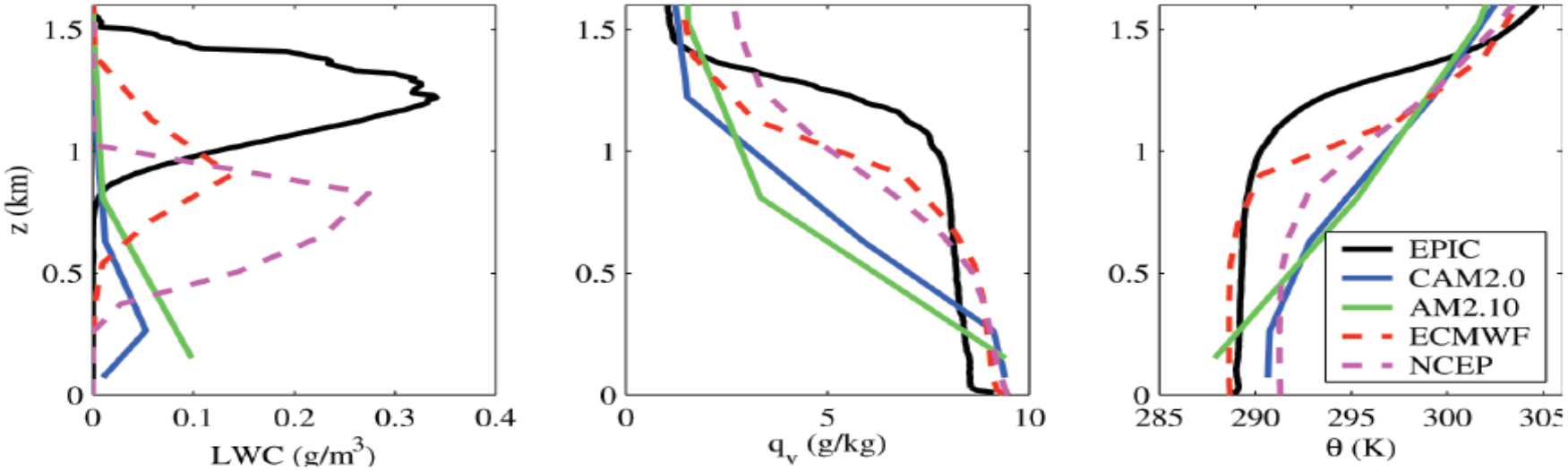






EPIC Models, 85W 20S, Oct 16-21 2001



Bretherton et al. 2004

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

M. Wyant, C. Bretherton, C. R. Mechoso, and R. Wood

= **Pre-VOC**ALS **A**ssessment

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.

Model	Levels	**Resolution** [km] (inner domain)
NRL COAMPS	42	81 (27)
COLA RSM	28	50
IPRC Reg_CM (IRAM)	28	~25
PNNL (WRF-Chem)	44	45 (15)
UCLA (WRF)	34	45 (15)
U. Chile (WRF)	43	45
ECMWF oper. 3-12h forecast	91	~25
ECMWF 5-day forecast	91	~40
ECMWF coupled fcst ensemble	62	~125
GMAO GEOS-5 DAS	72	~56
JMA 24-30h forecast	60	~60
NCEP oper. 12-36h forecast	64	~38
UKMO oper. 12-36h forecast	50	~40
LMDZ	38	50
NCAR CAM3.5, CAM3.5+	26/30	250
GFDL	38	250

PreVOCA observational data

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

Analysis

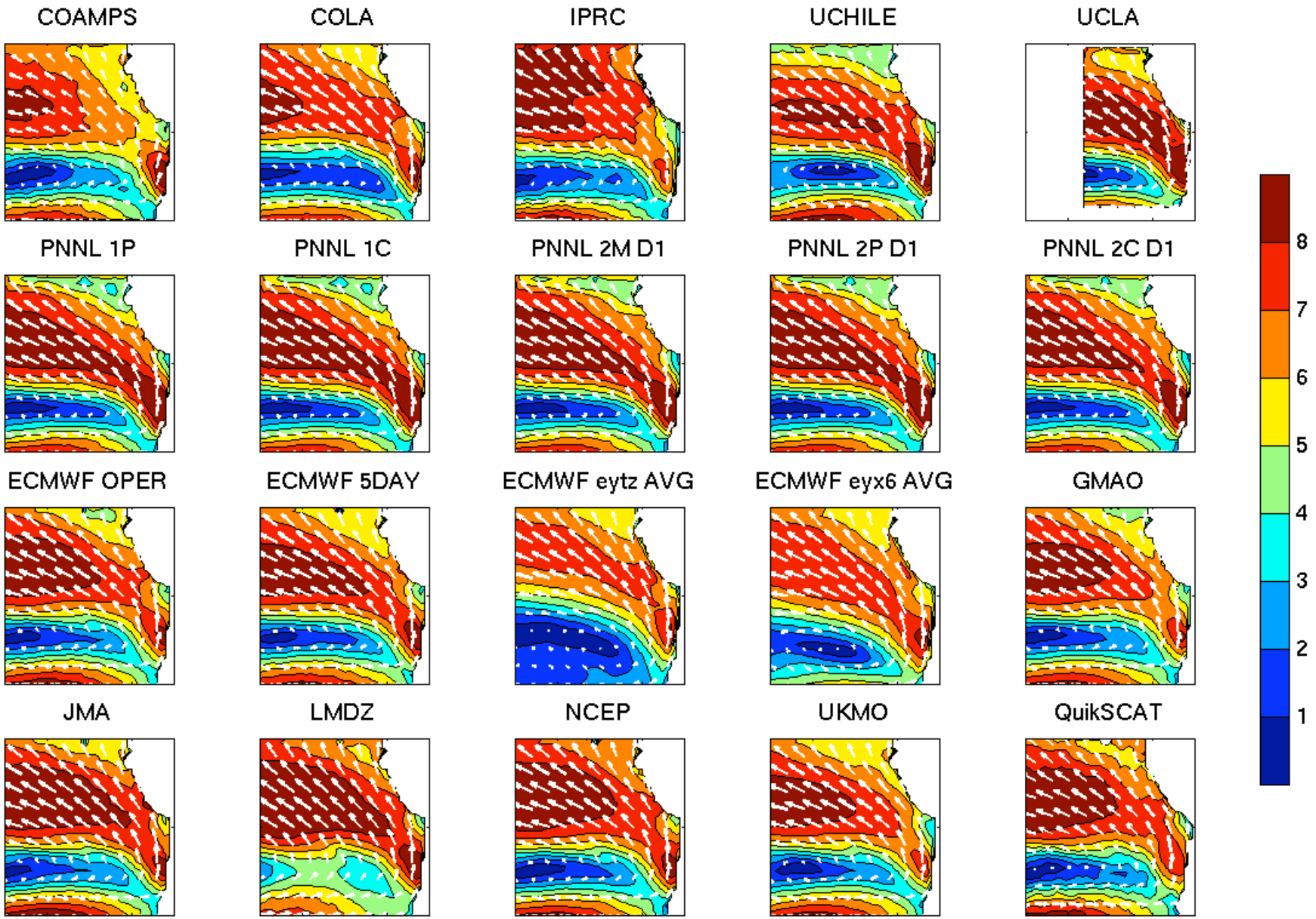
Shown here: Monthly mean biases

In progress: Diurnal cycle incl. Andean subsidence wave

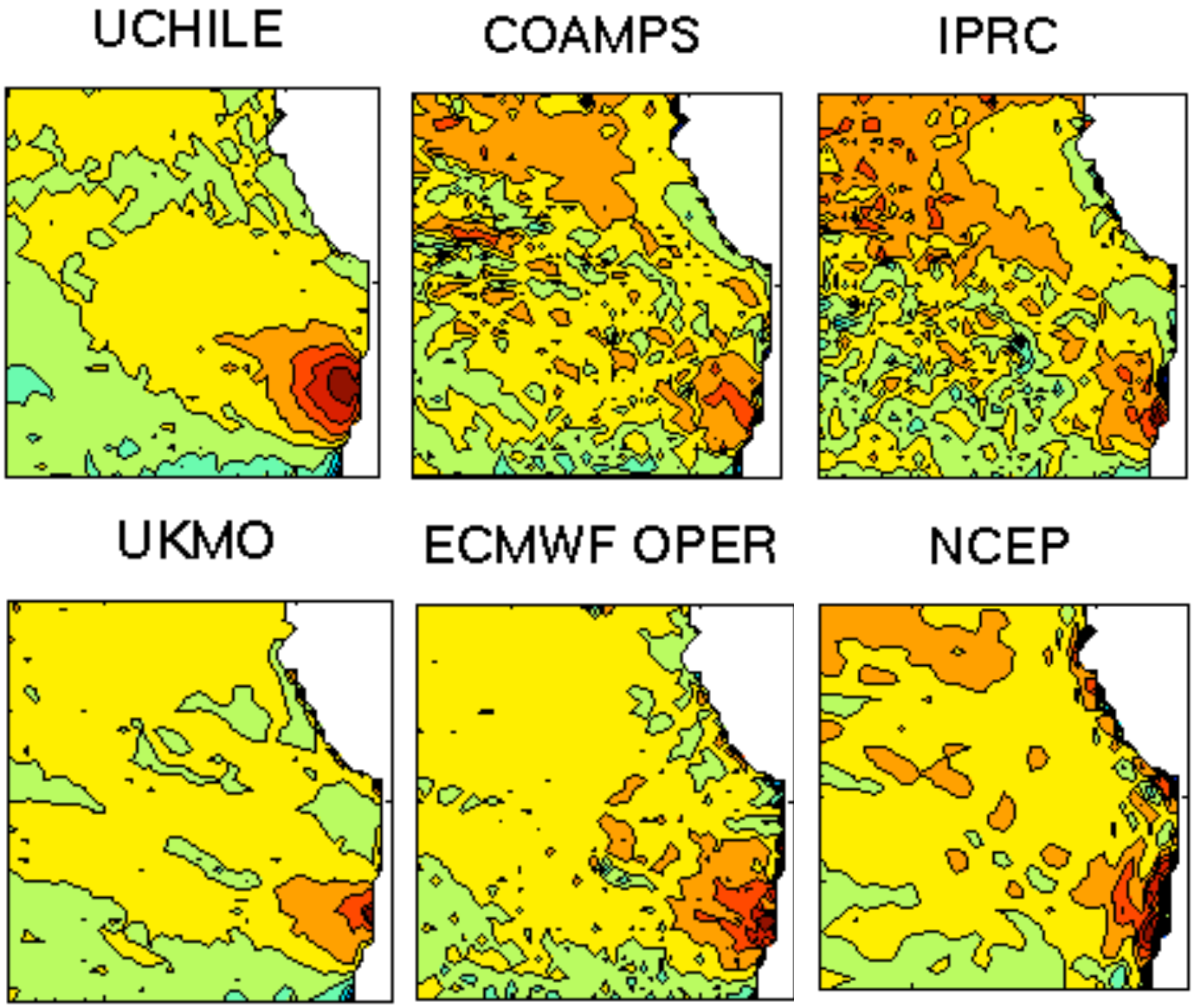
Synoptic variability (projection onto SLP index)

PreVOCA analysis focus: Cloud and PBL structure and their dynamical setting.

10 m vector wind (m s^{-1}) - models agree reasonably well

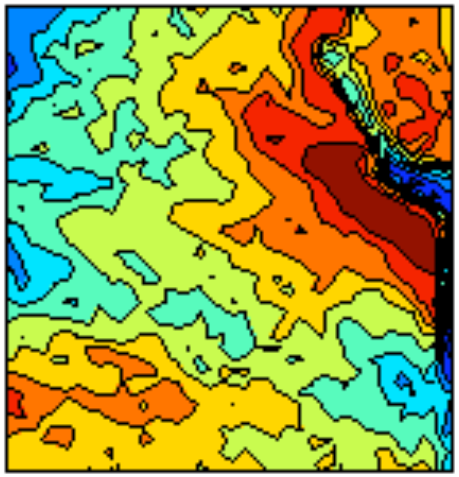


Omega at 850 hPa (Pa s^{-1}) - also mostly not too bad

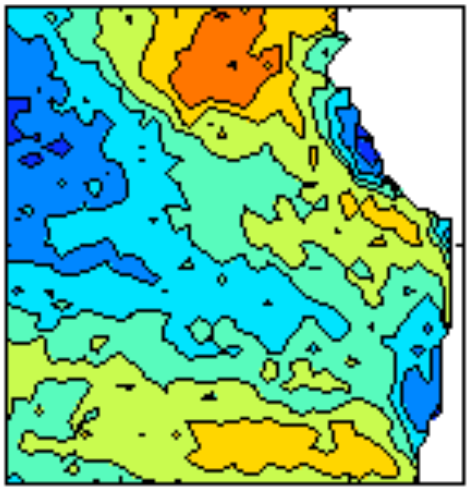


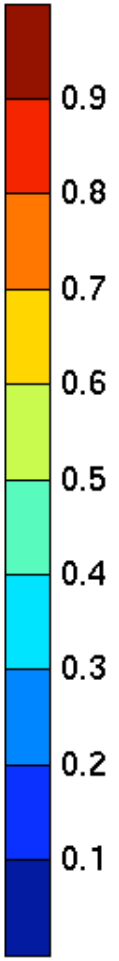
Low Cloud Fraction - models shown among best

MODIS Total Cldfrac

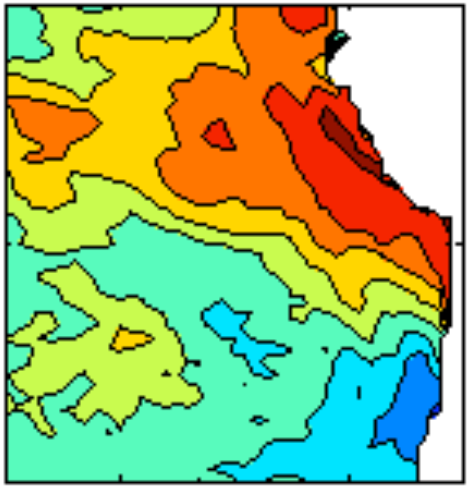


IPRC

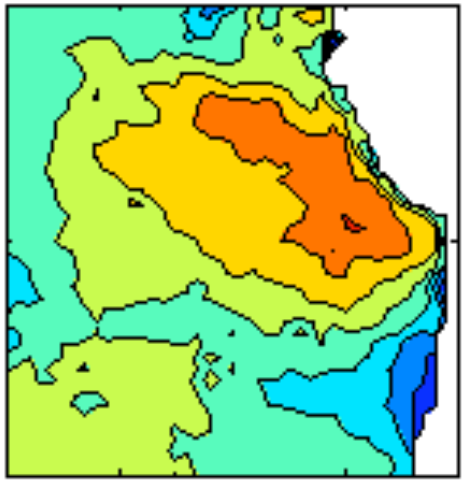




UKMO

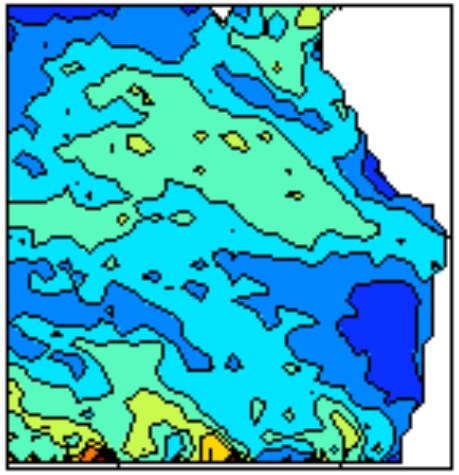


ECMWF OPER

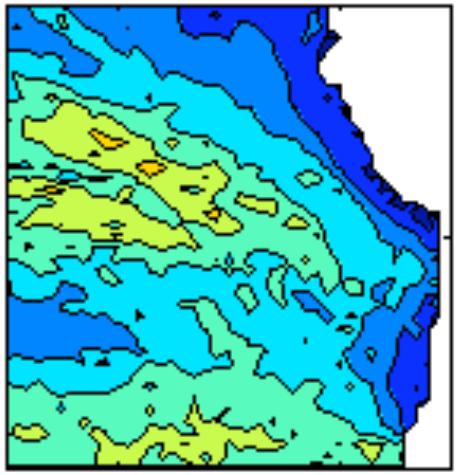


Liquid Water Path (g m^{-2})

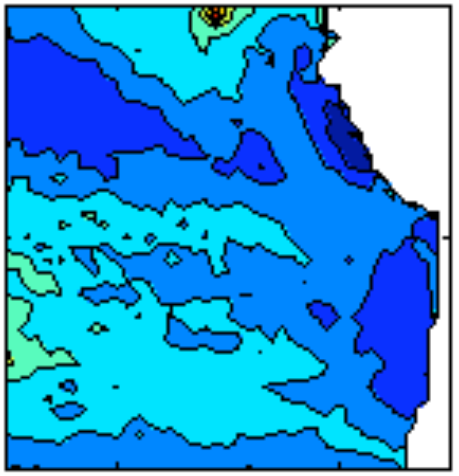
TMI Observed

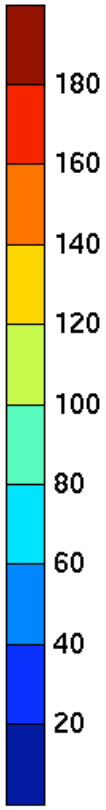


COAMPS

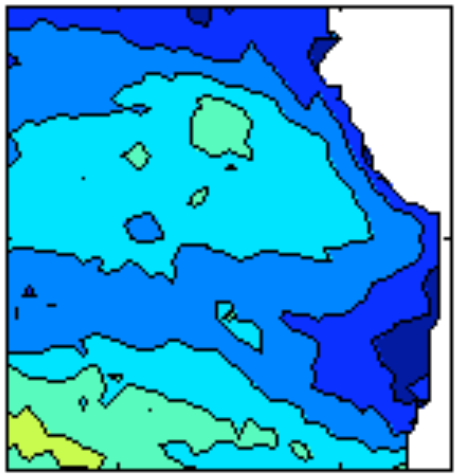


IPRC

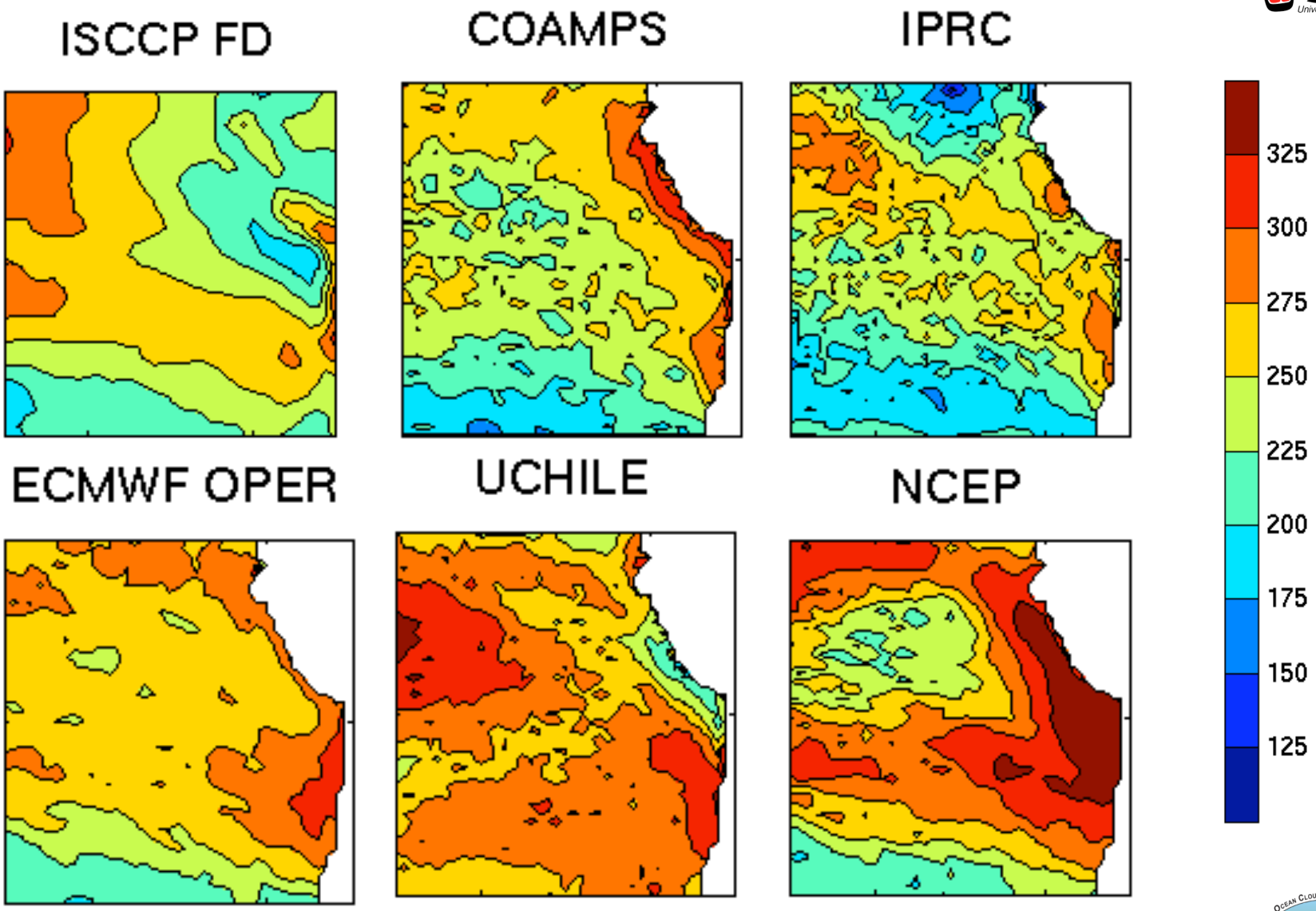


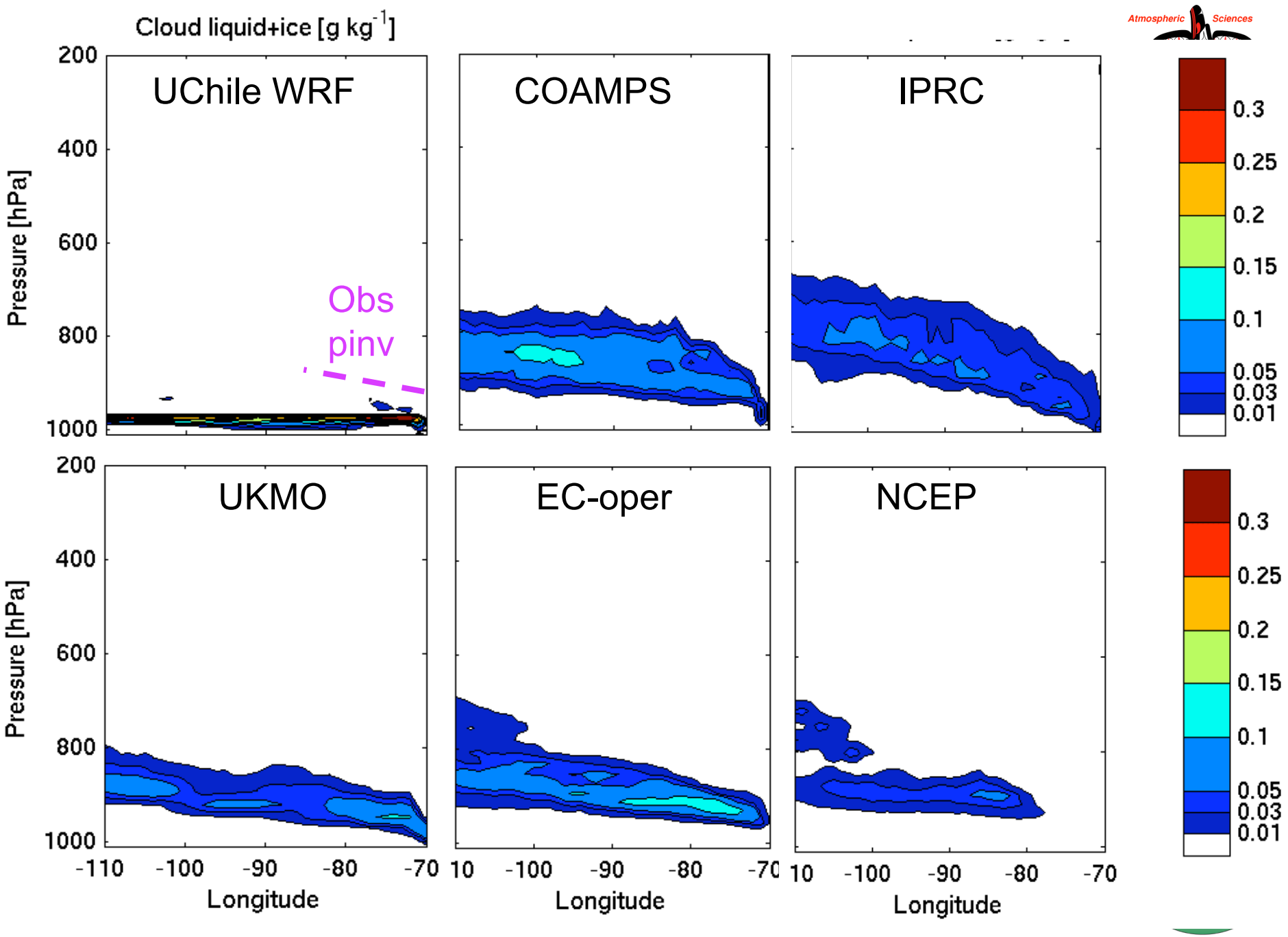


ECMWF OPER

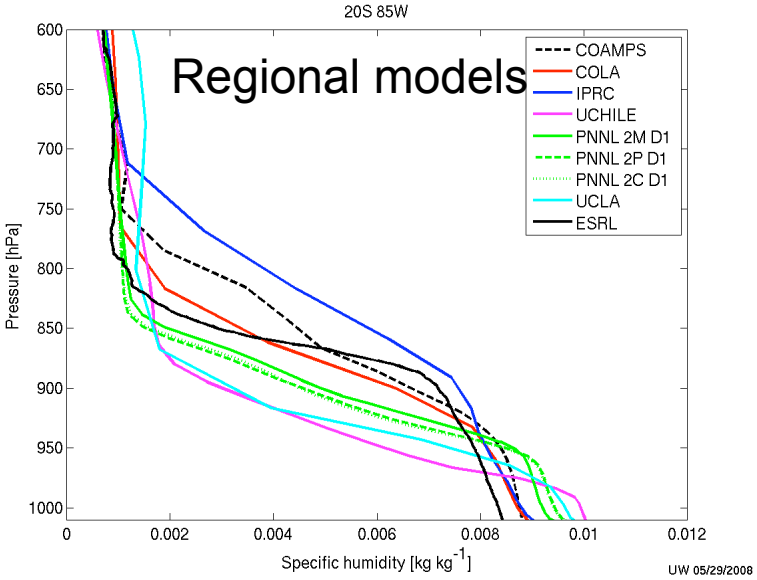


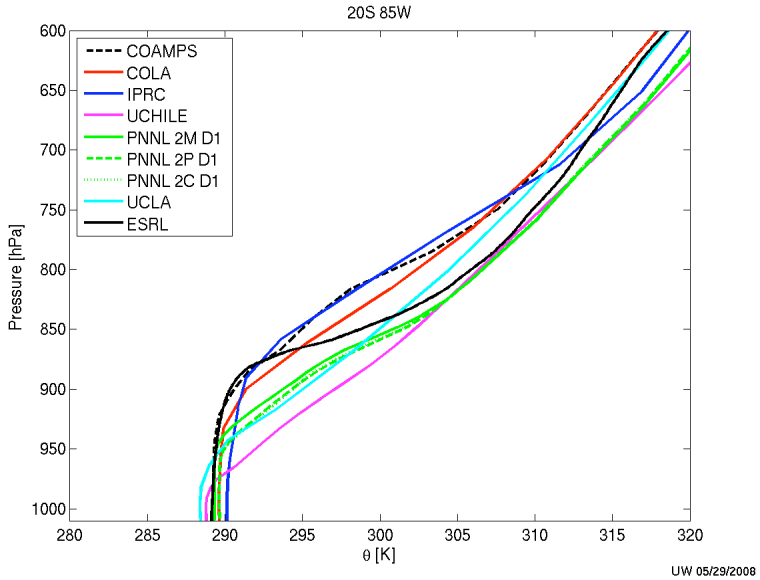
SW Downward Heat Flux (W m^{-2})

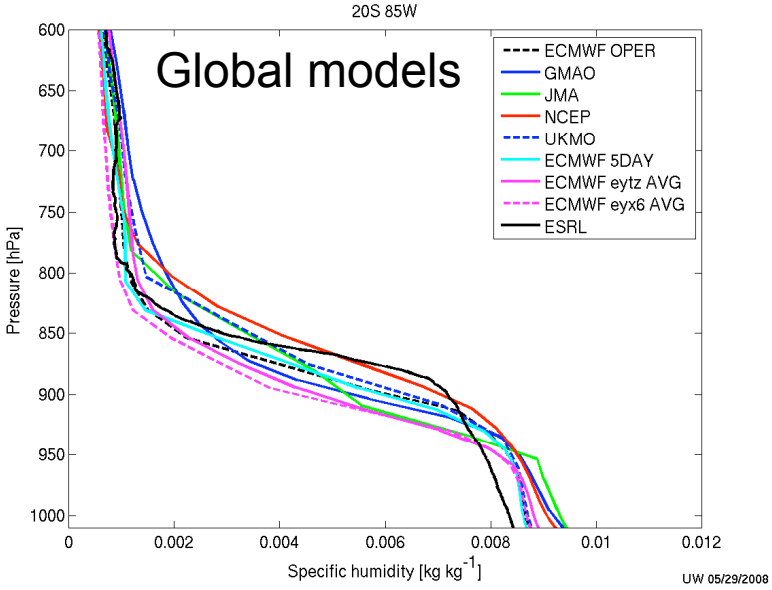


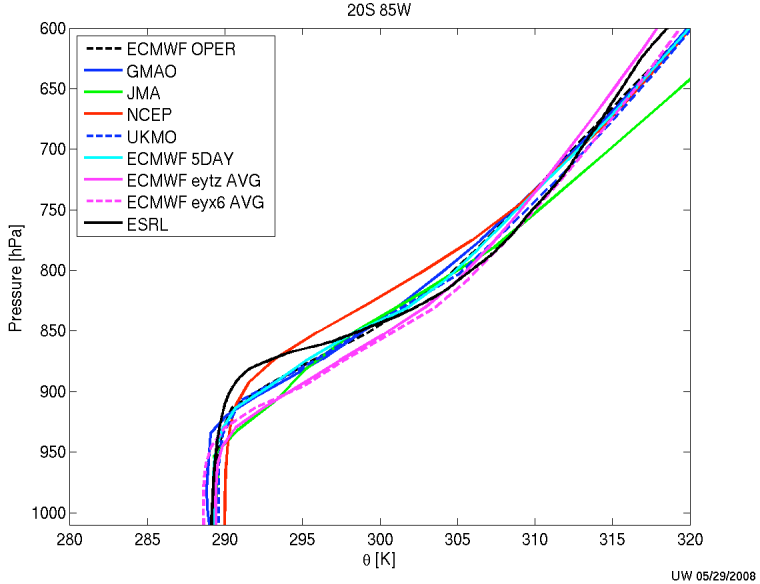

Cloud liquid+ice [g kg^{-1}]
UChile WRF
COAMPS
IPRC
UKMO
EC-oper
NCEP
Obs
pinv
Pressure [hPa]
200
400
600
800
1000
-110
-100
-90
-80
-70
10
Longitude
0.3
0.25
0.2
0.15
0.1
0.05
0.03
0.01

85W sounding comparisons









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_{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

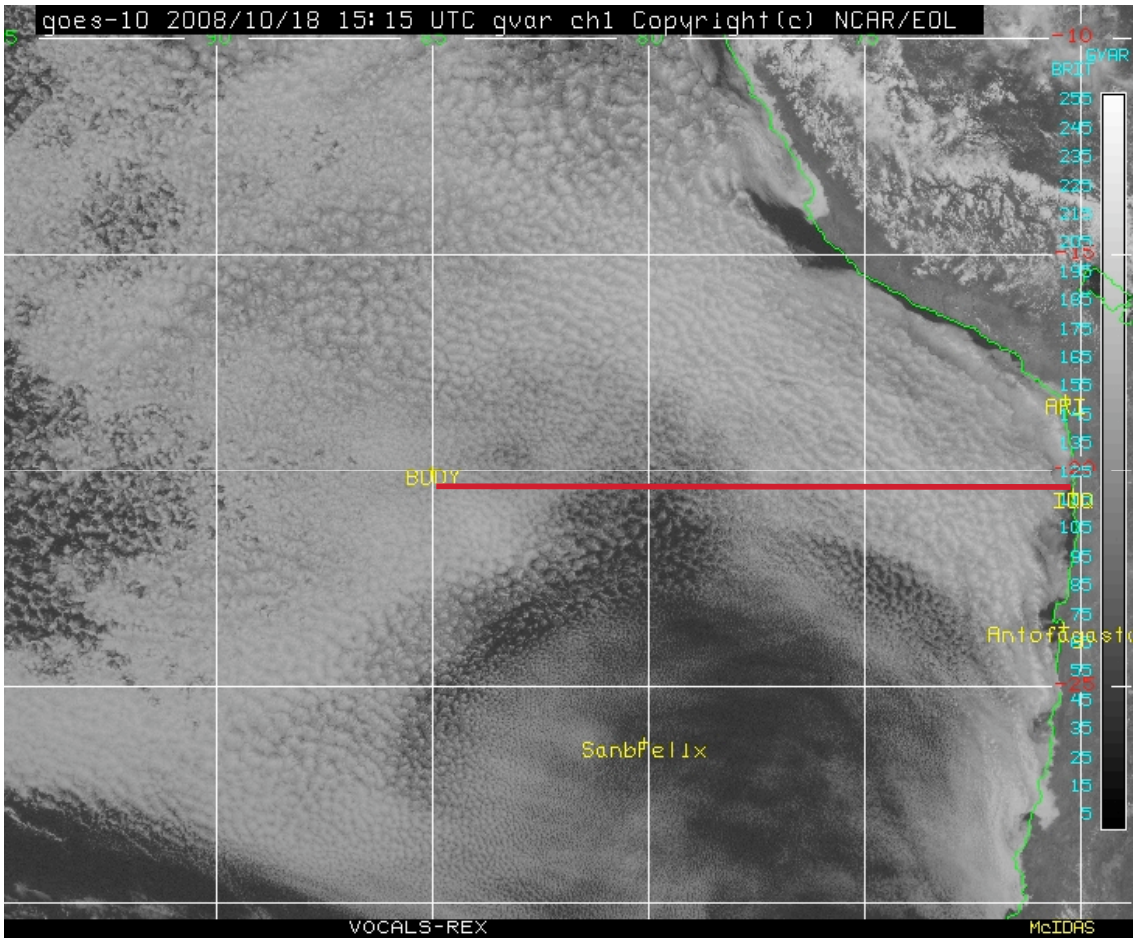
Products in field catalog from:

- 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

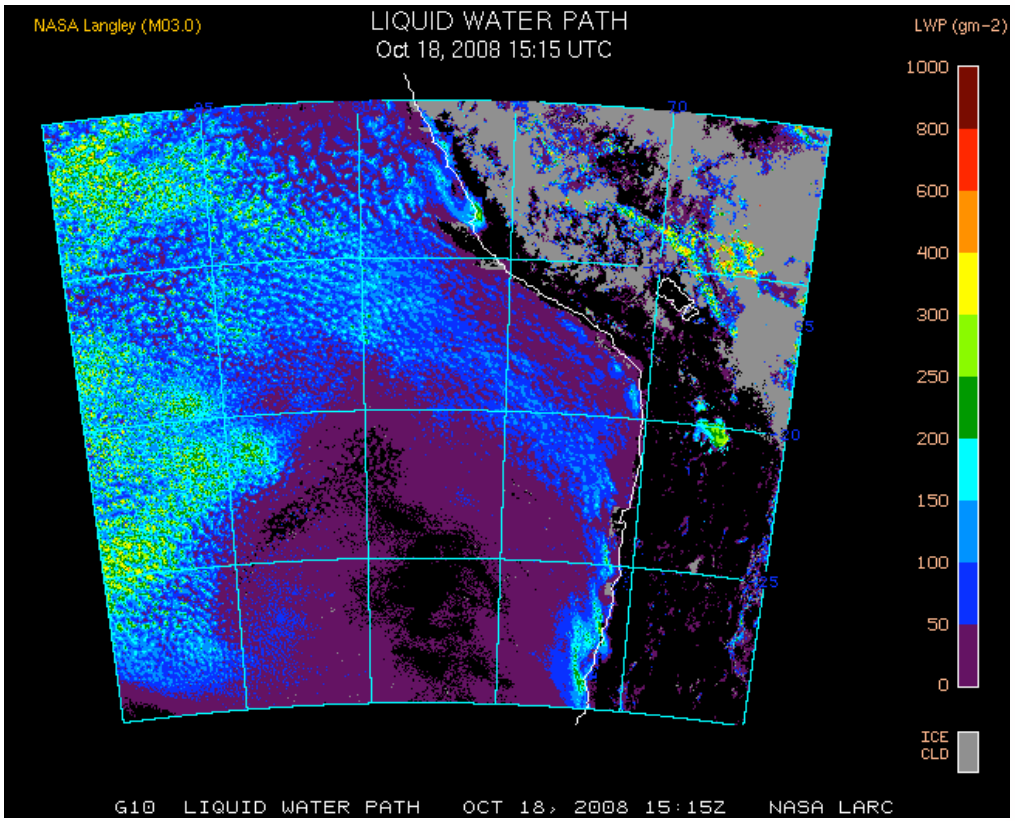
RF02 case

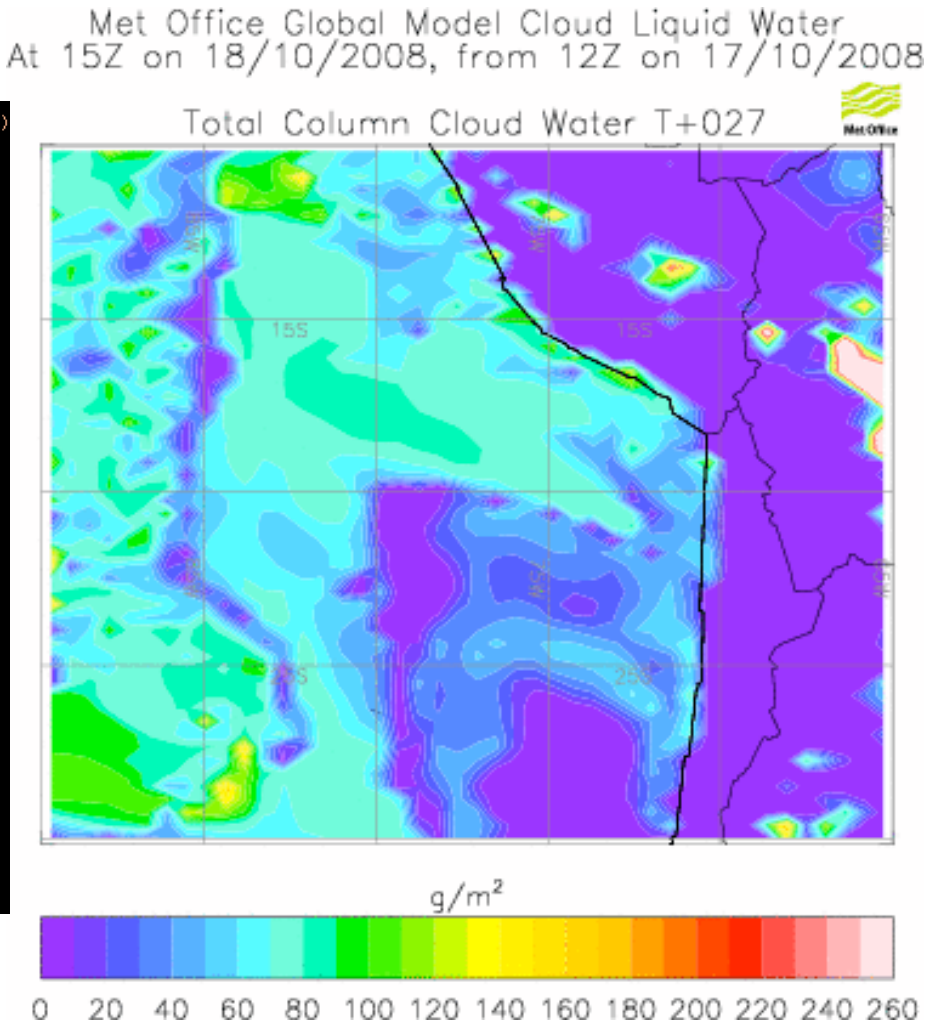
- 20S section (compare at 15Z 18 Oct.)
- Reality:
  - Sharp PBL top at 900-950 m (~930-940 hPa) over 70-85W
  - Solid Sc E of 78W, thinner/broken at 78-82W
- Compare UKMO, ECMWF, NCEP, WRF-Chile



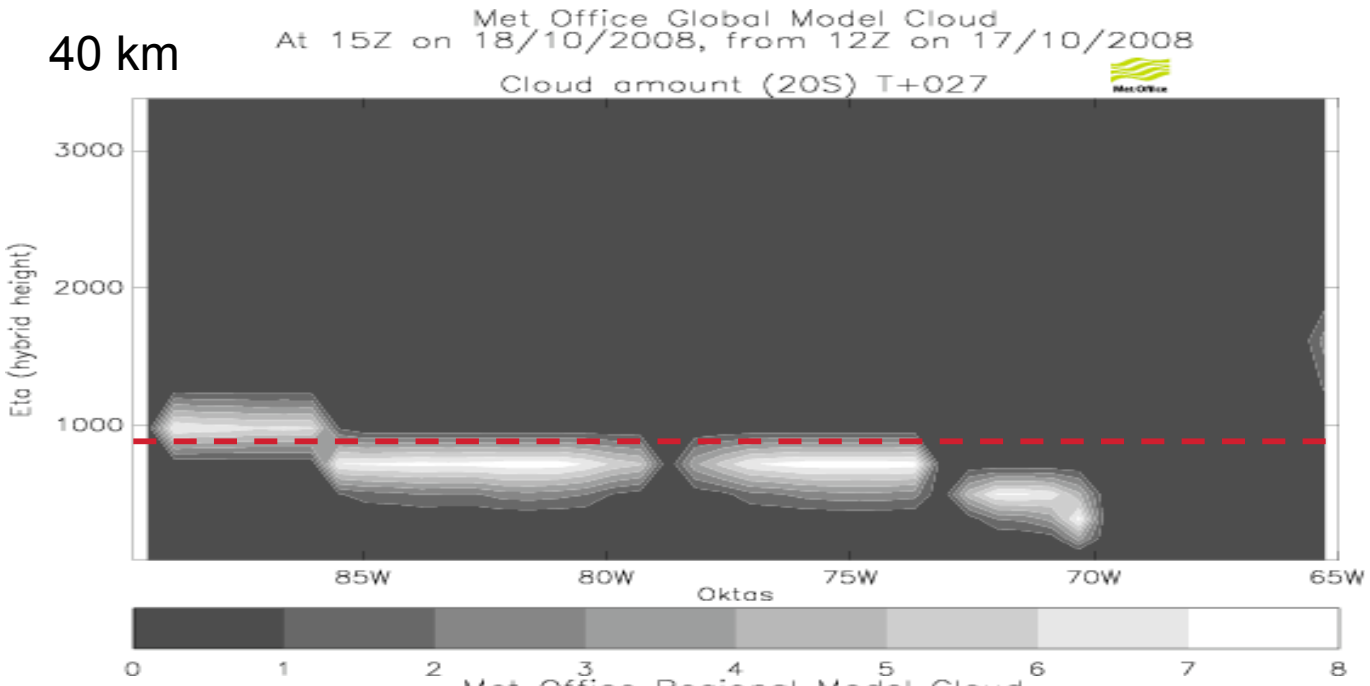
UKMO (global, 40 km)

- Quite good overall

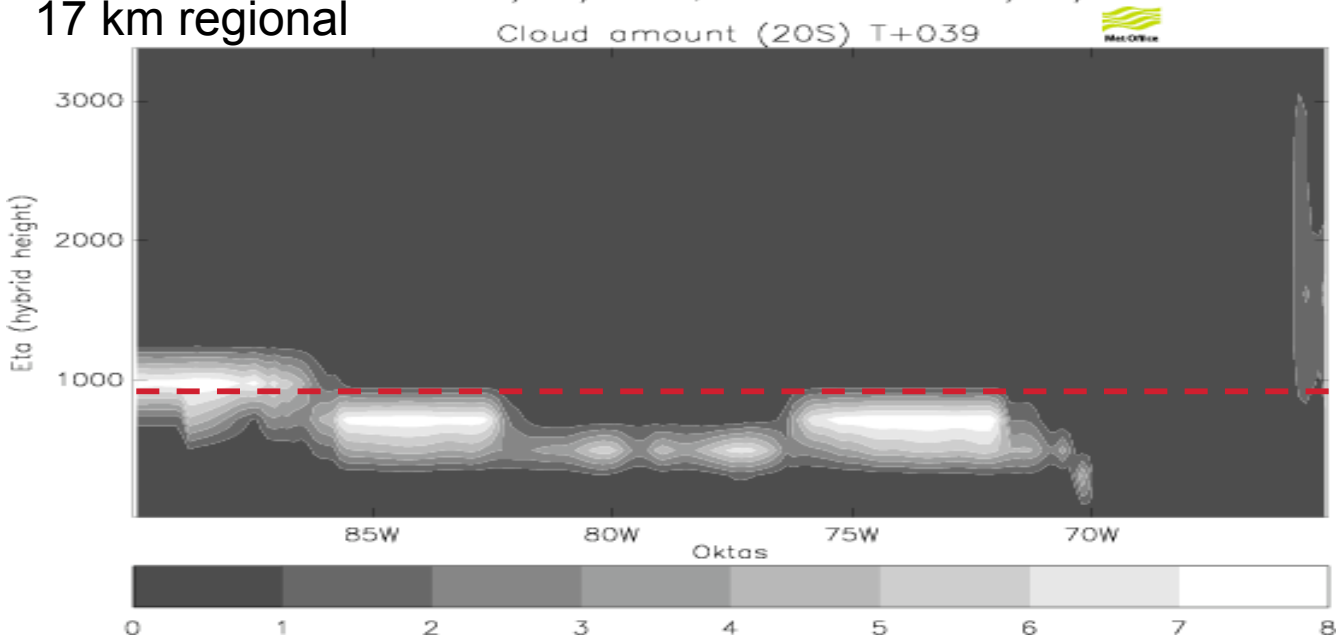




40 km



17 km regional



UKMO

Atmospheric Sciences
University of Washington

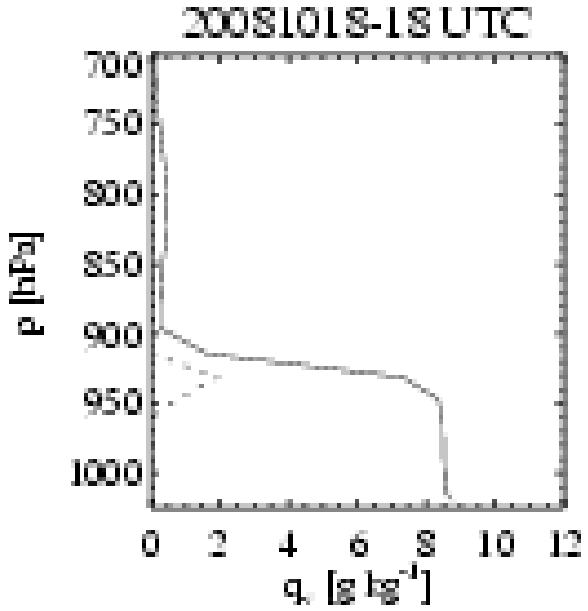
Both models predict cloud distribution well, including break at ~80W.

VAMOS Ocean Cloud Atmosphere Land Study
VOCALS

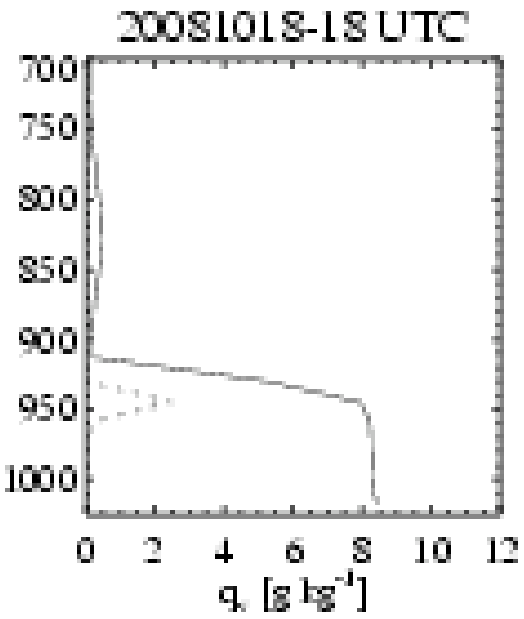
ECMWF (global, 30 km, L90)

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

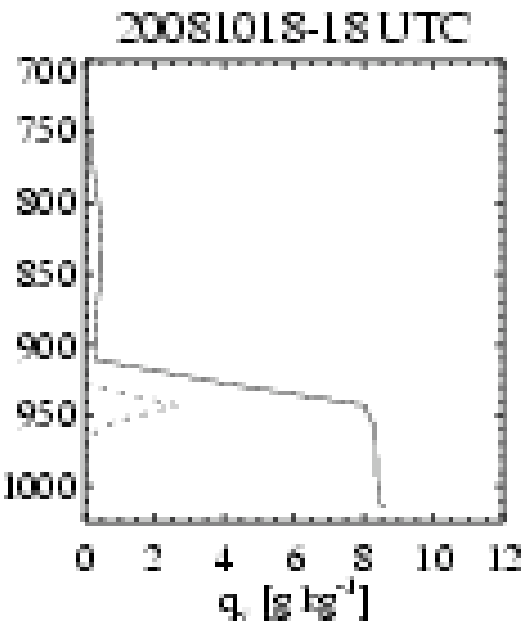
20S 85 W



20S 80 W

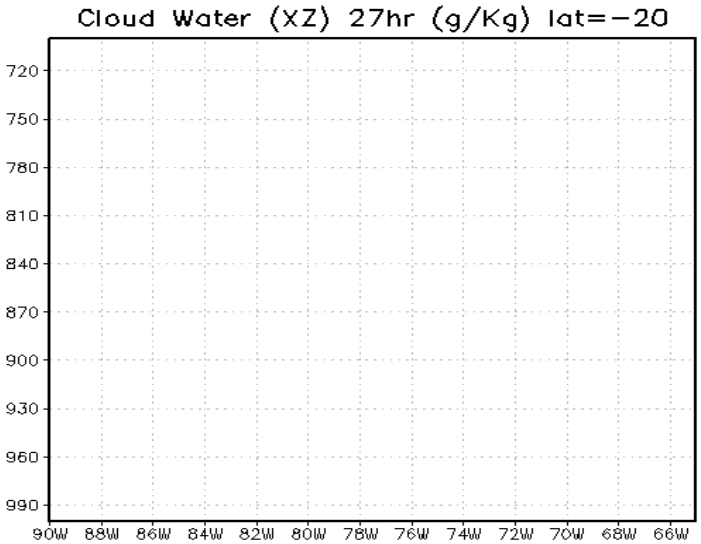


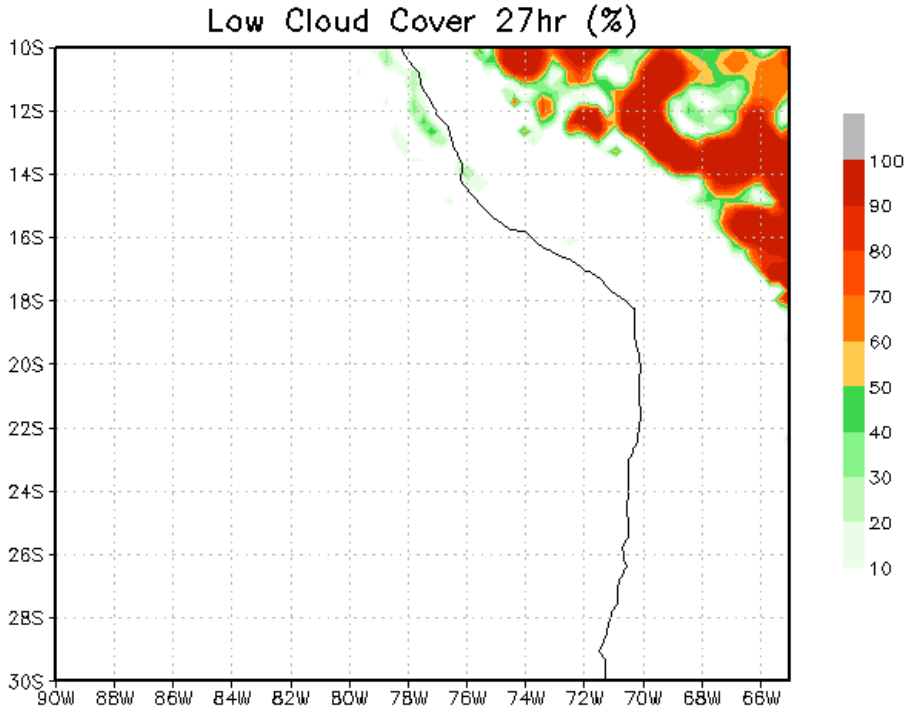
20S 75 W



NCEP (global, 100 km, L64)

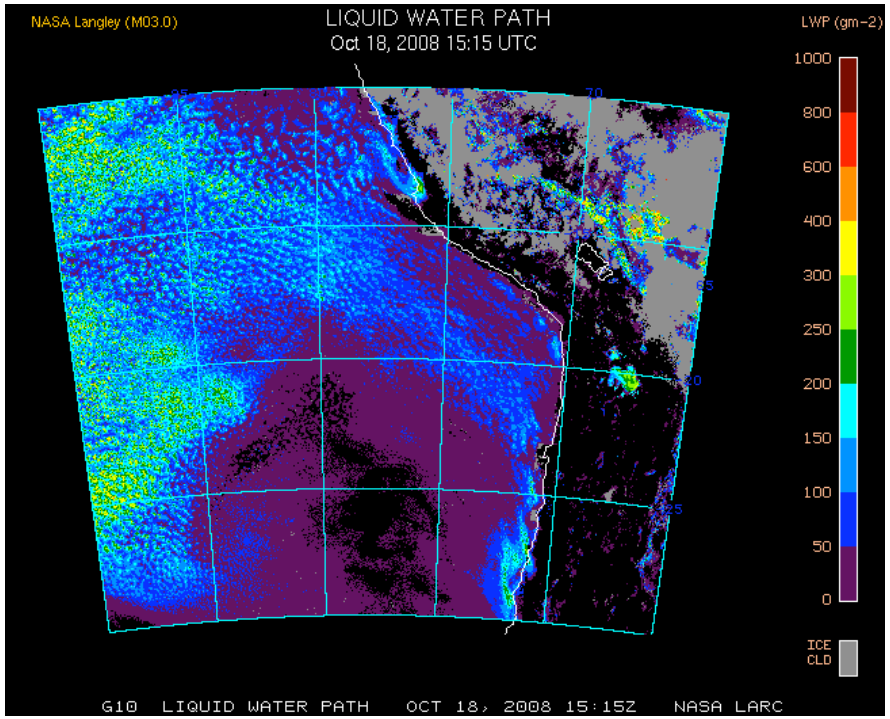
- What stratocumulus?

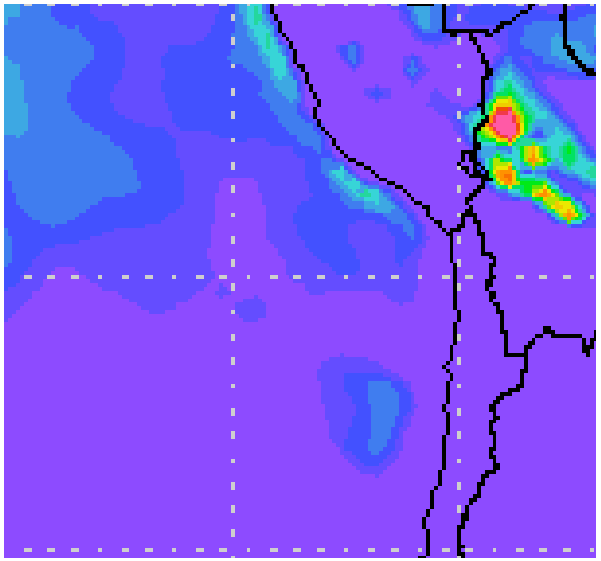


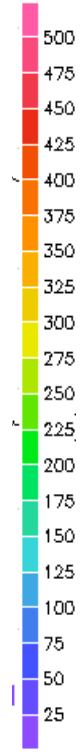


COAMPS

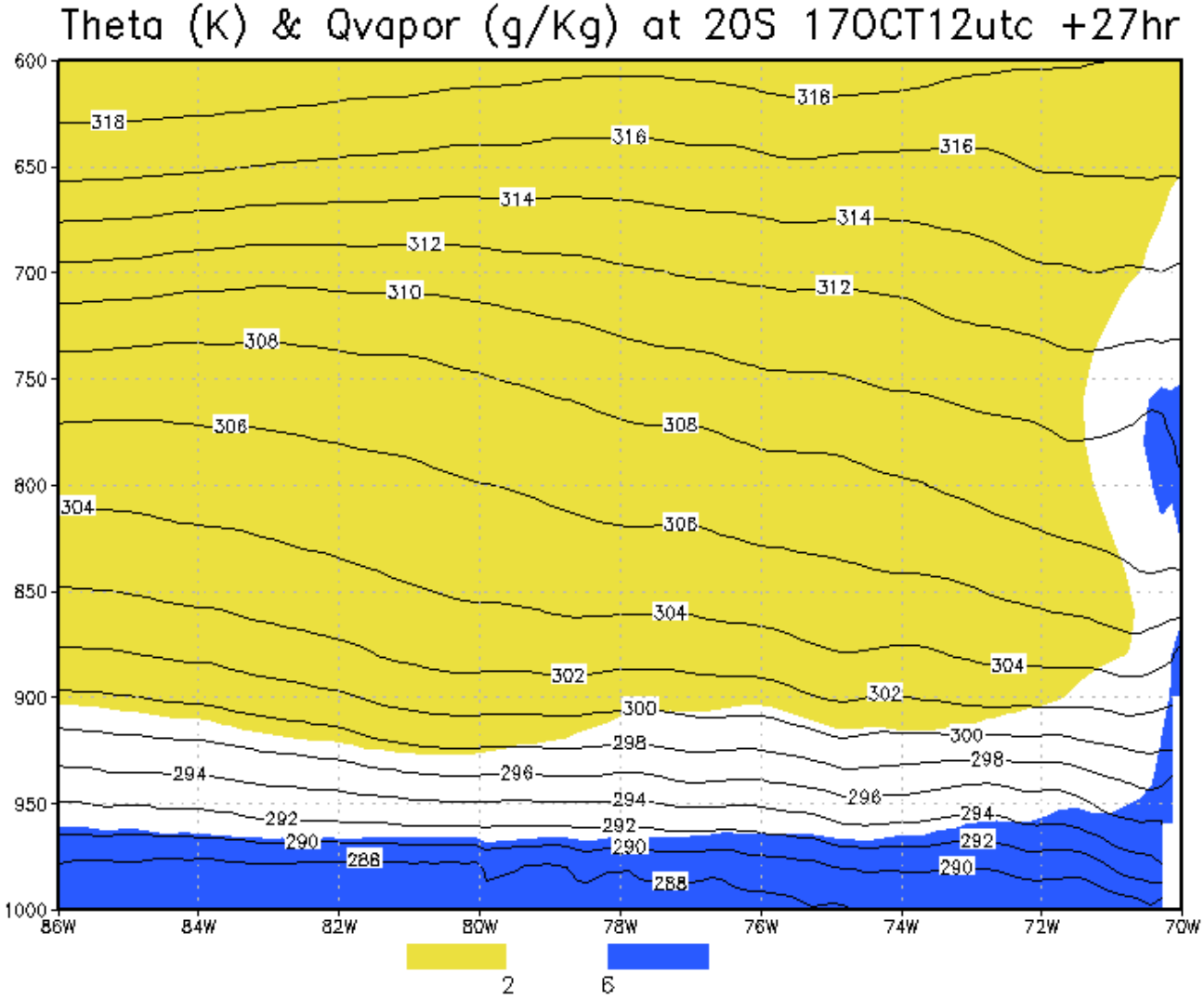
...soso LWP distribution. Gets ‘hole’ but not other features.







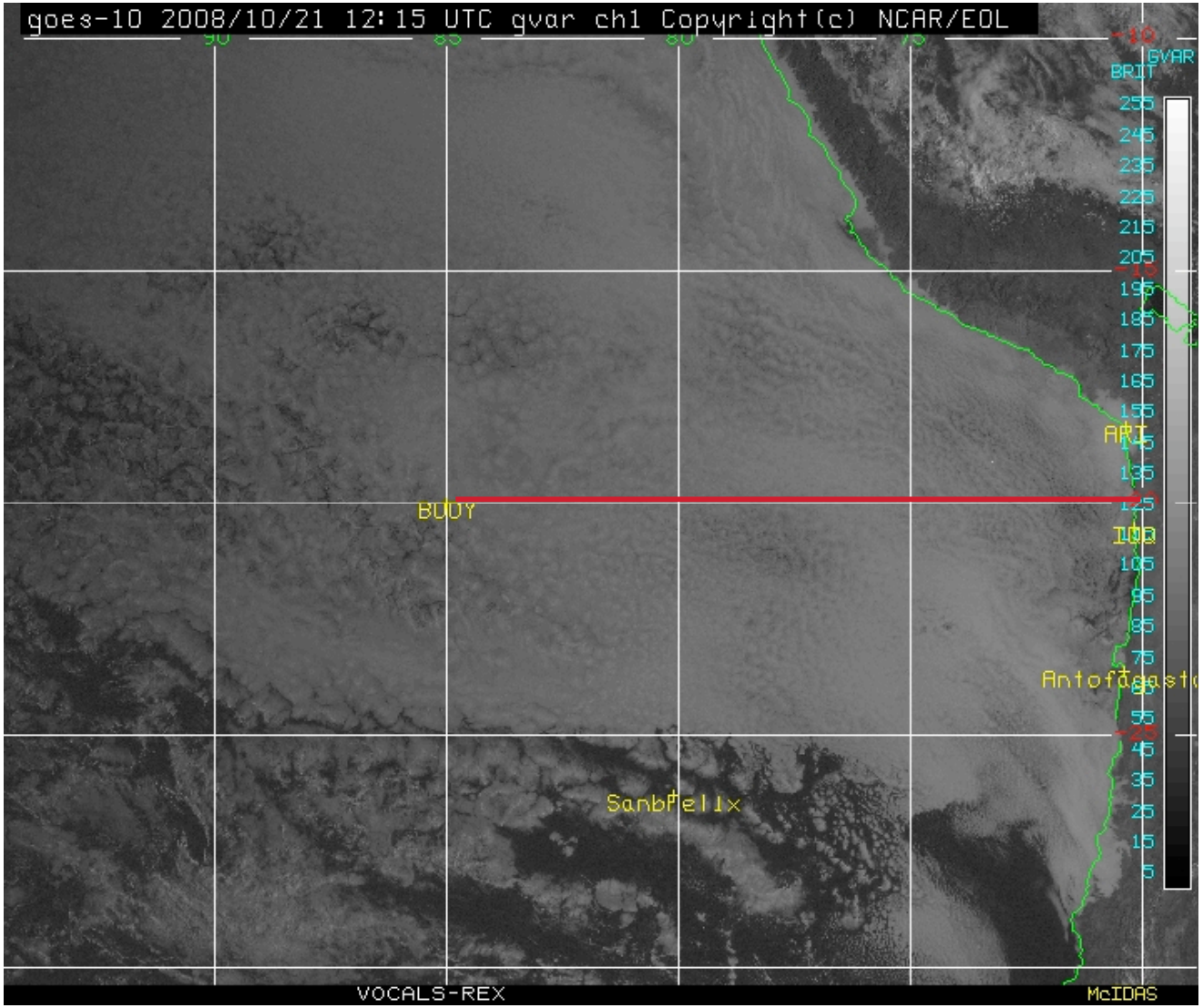
WRF-U Chile



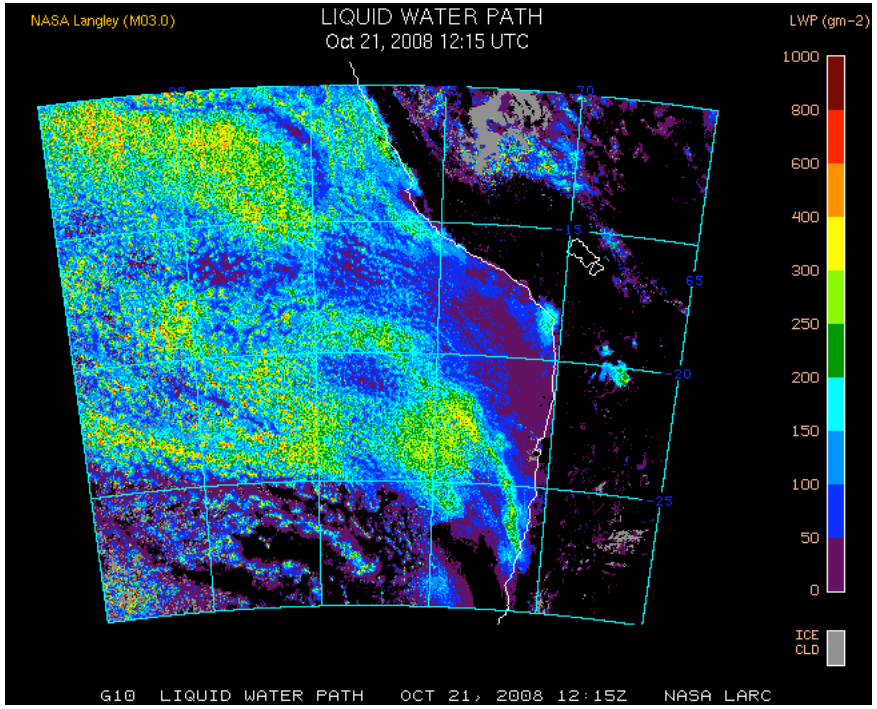
Inversion is highly diffuse (50 hPa thick)

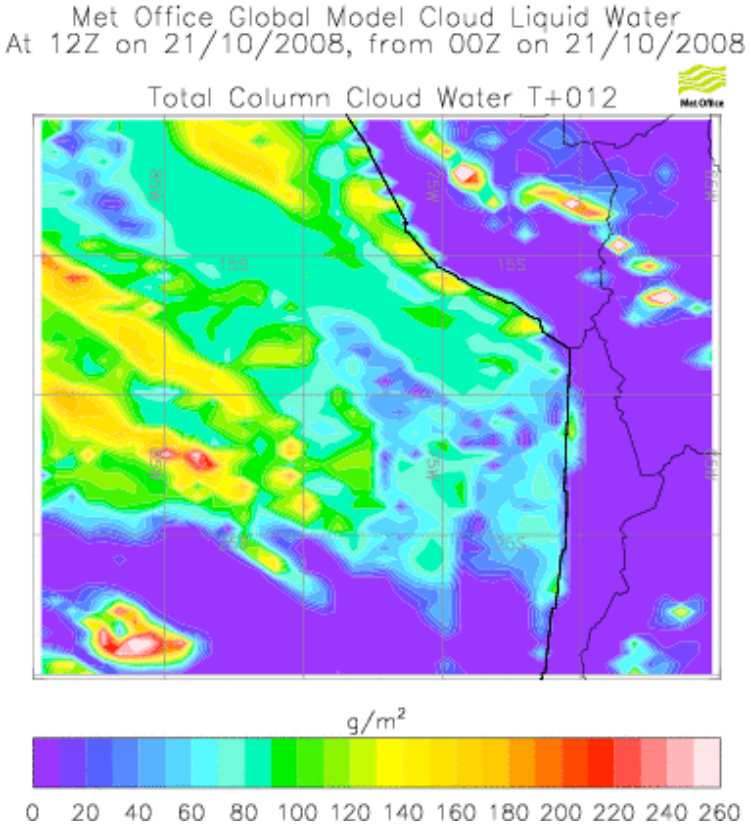
RF03 (21 Oct 2008)

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



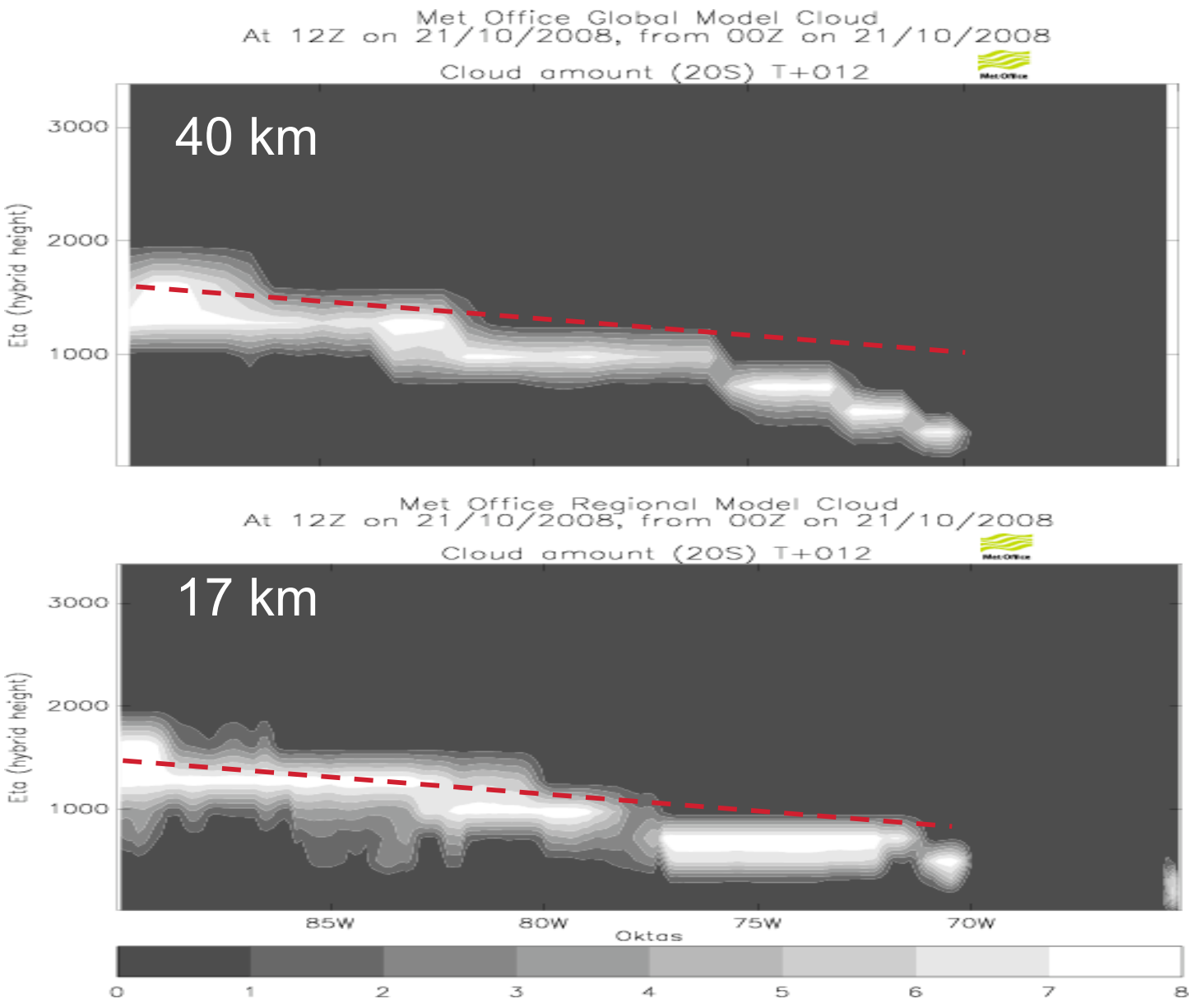
UKMO





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

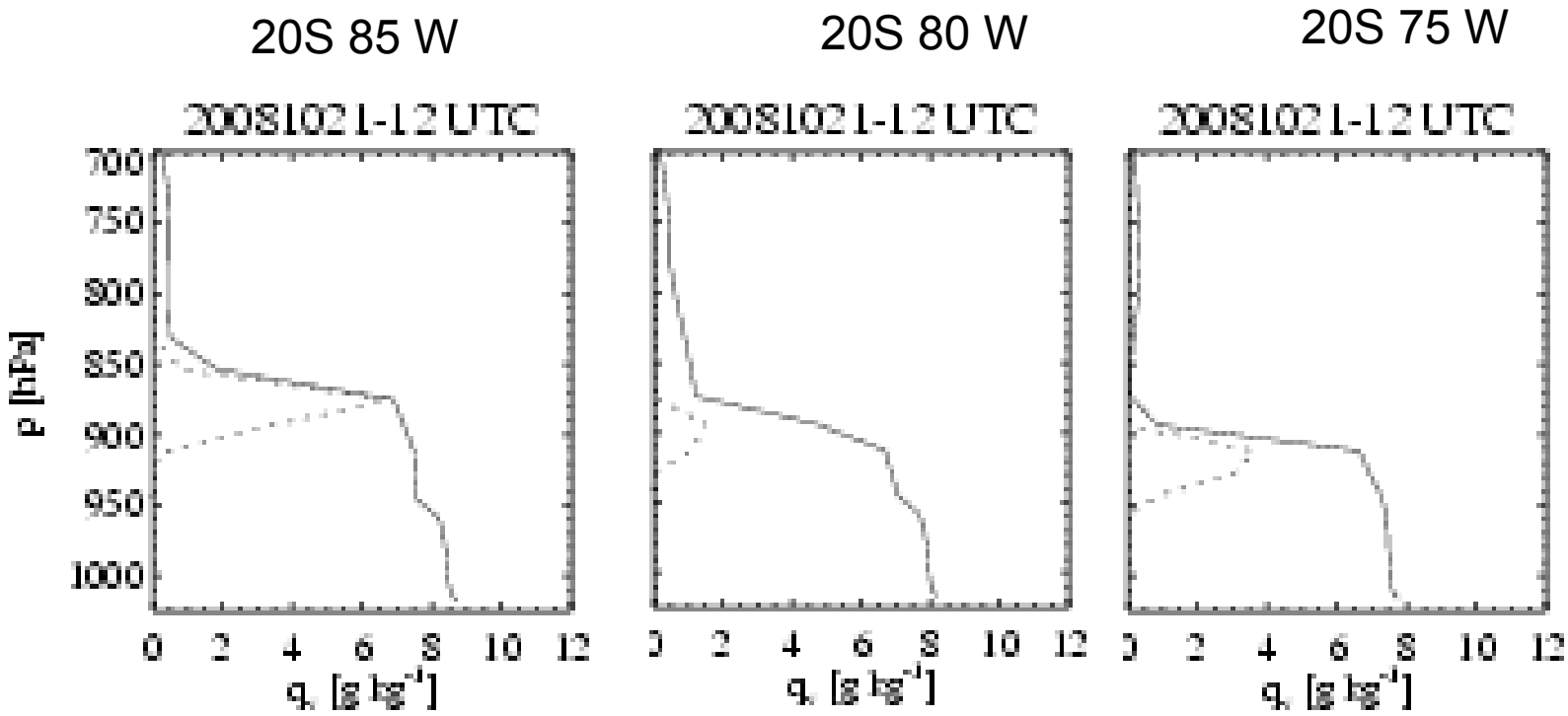
UKMO vertical profiles



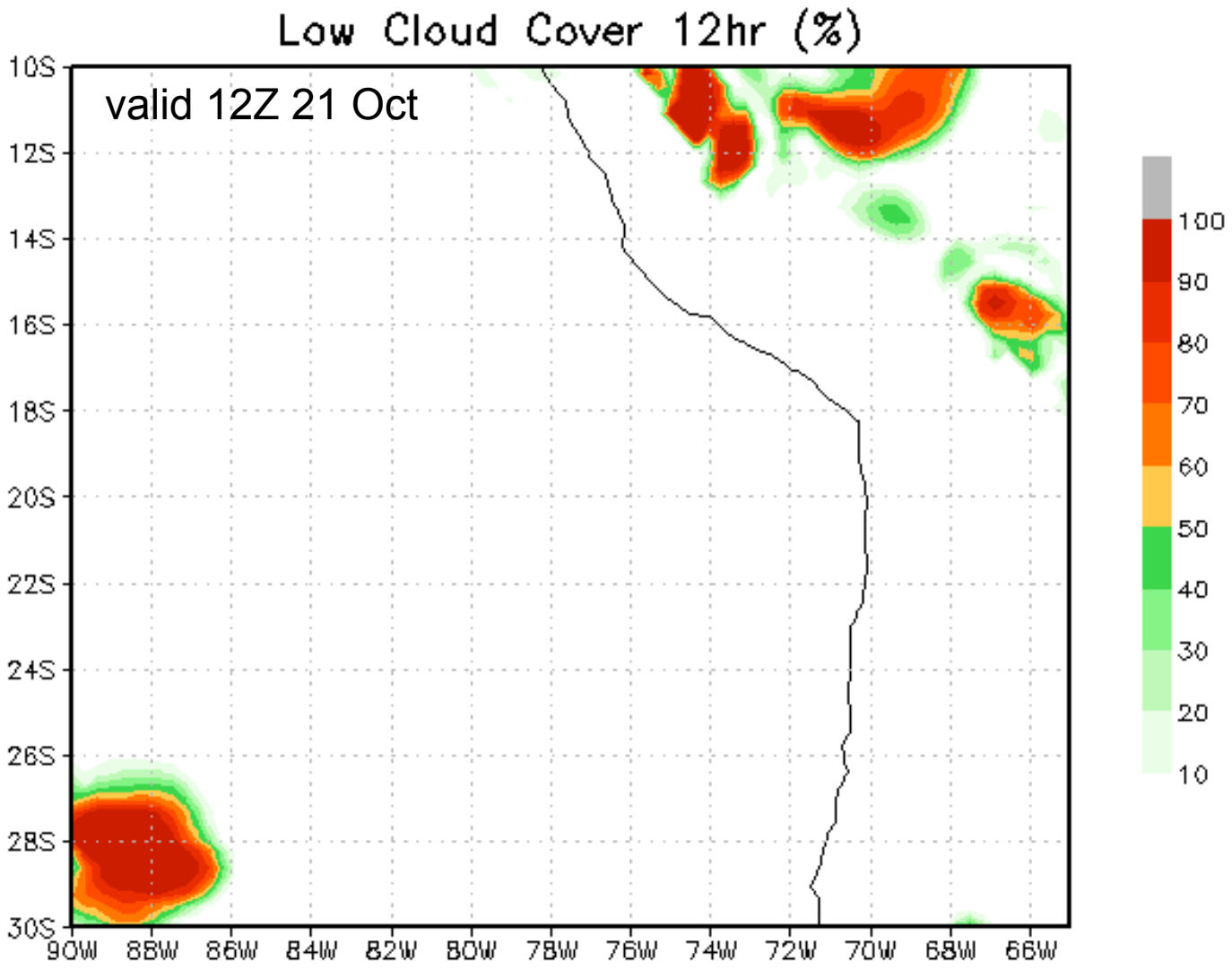
17 km model does better job near coast

ECMWF

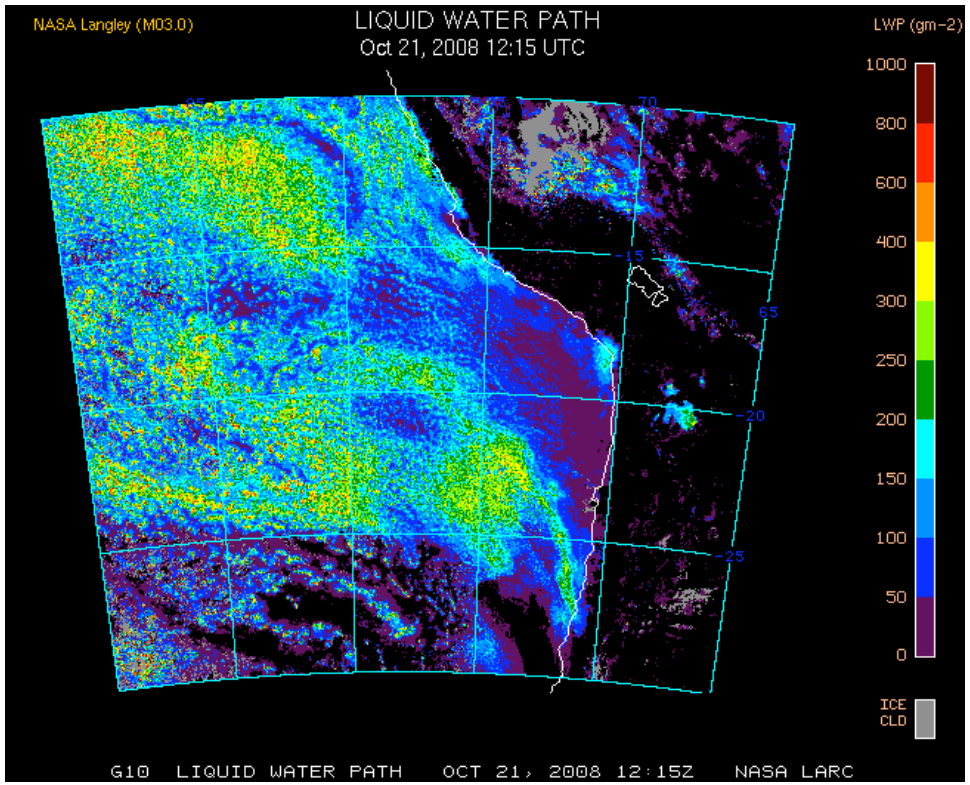
Correct inversion slope and decoupled structure at 85 W.

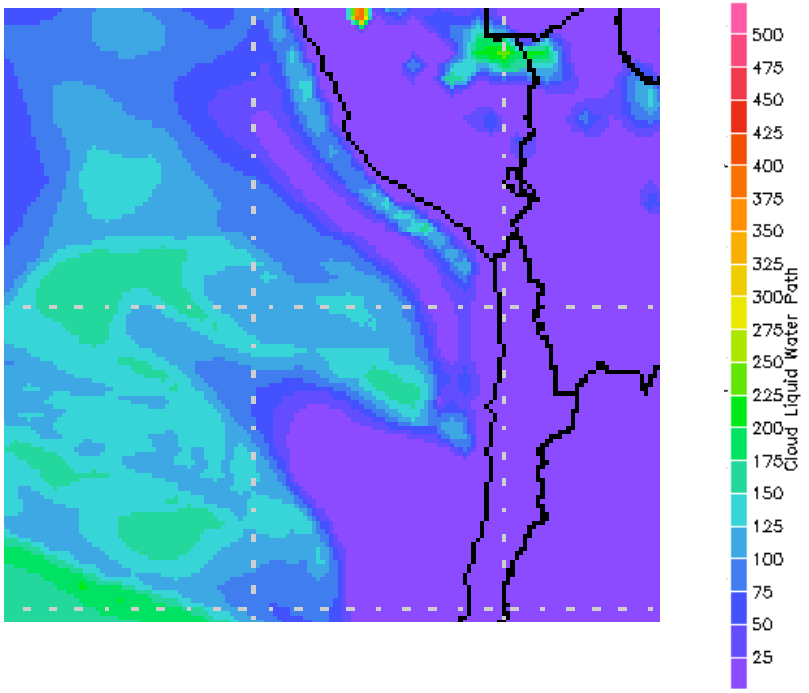


NCEP - again no low cloud!



COAMPS





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!