The VOCALS Assessment (VOCA)

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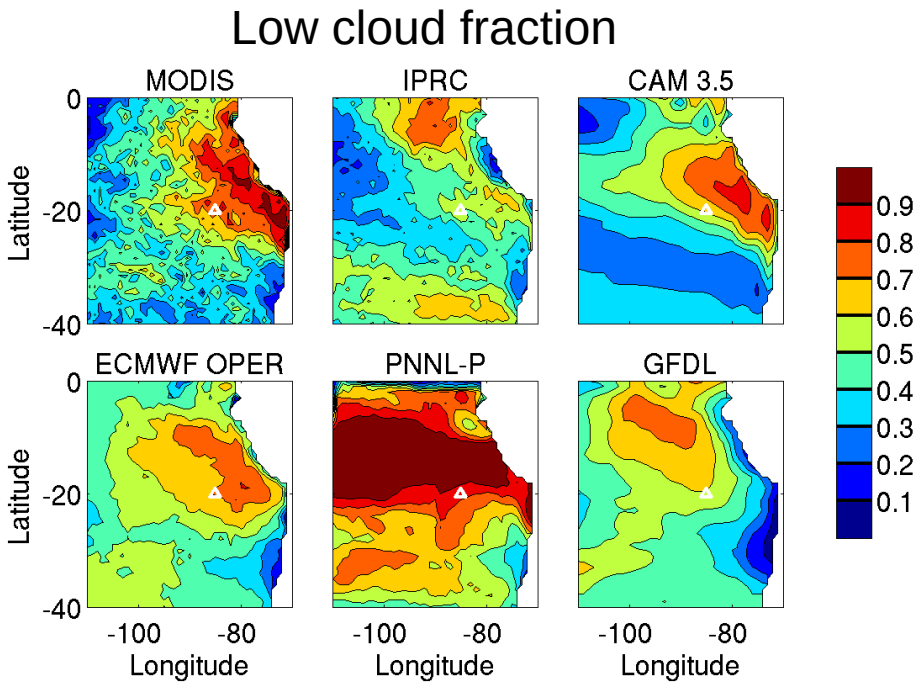
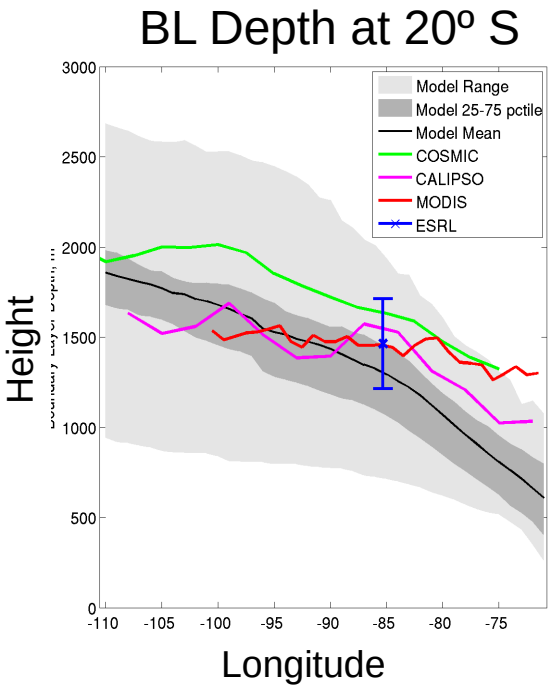
VOCA modeling groups (without which there's nothing to say)

Pre-VOCA

Wyant et al., 2010, ACP



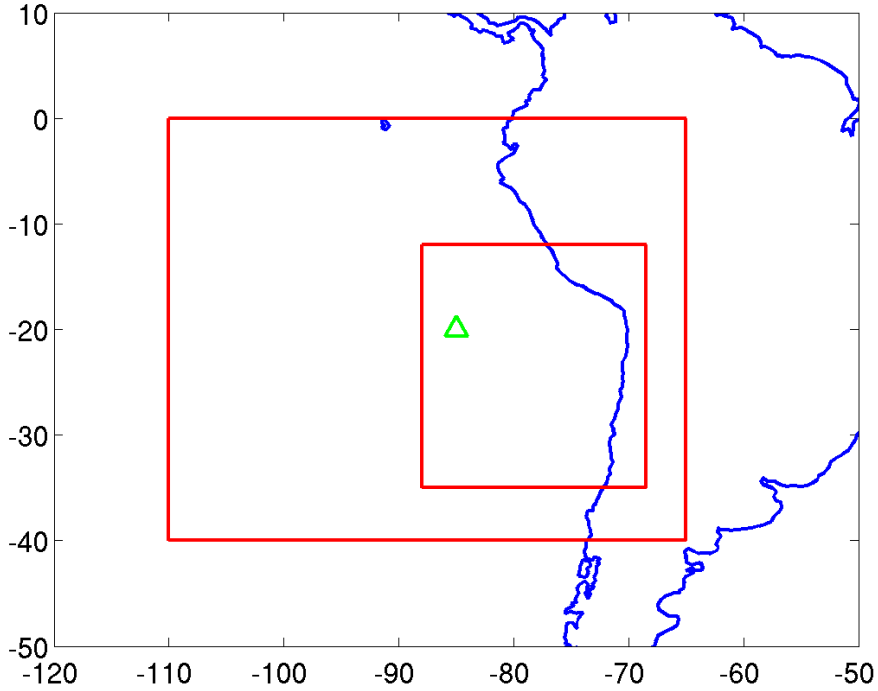


- PreVOCA compared 15 regional, weather forecast, and climate models (in forecast mode) for October 2006 in the VOCALS region.
- Many models had large errors in distribution of low cloud cover, though ECMWF and UKMO performed well.
- Most models produced a marine BL too shallow near the coast at 20S.
- Most models qualitatively captured diurnal and day-to-day variability of the cloud and BL despite mean biases.
- Global models outperformed most regional models.

The VOCALS Assessment (VOCA): Motivations

- Make use of extensive REx in-situ aircraft/ship datasets
- Emphasize chemical/aerosol transport, cloud-aerosol interaction.
- Do models simulate the variation of droplet concentration N_d along 20S?
- Is anthropogenic sulfate the main contributor to geographic N_d variation?
- What controls N_d in remote ocean regions?
- What is the simulated indirect effect due to anthropogenic aerosols perturbing clouds and net TOA radiative flux in the VOCALS domain?

VOCA Overview



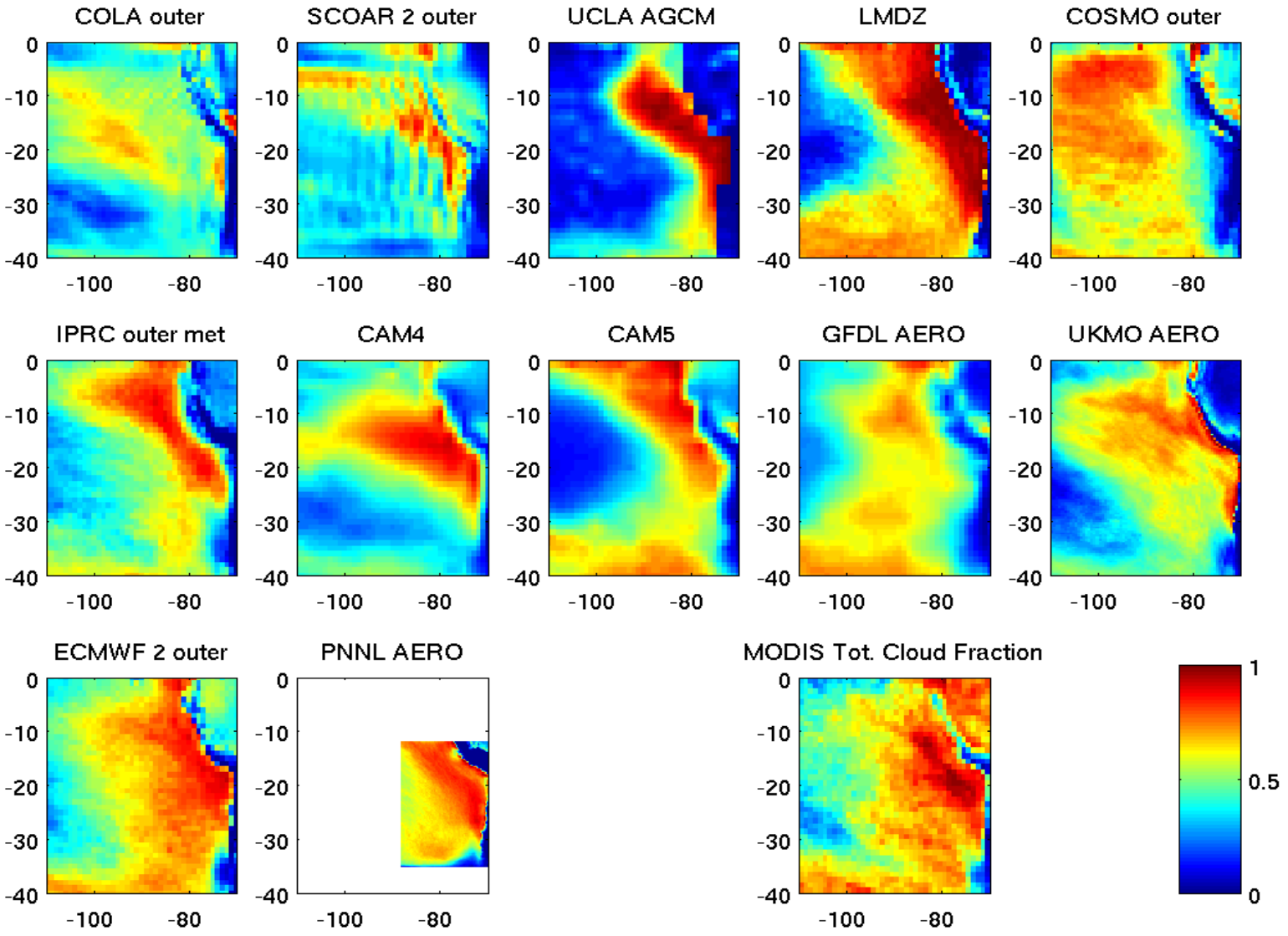
- Similar protocol to PreVOCA.
- REx period: 15 Oct -15 Nov 2008.
- Aerosol Species: SO_4, sea salt, dust, black carbon, organic carbon
- Gas Species: SO_2, DMS, CO, O_3
- Emissions of aerosol and gas species are specified in a standard protocol for regional models.
- Compare aerosol and gas concentrations to in-situ measurements.
- Compare cloud-top effective radius with satellite.
- Geoengineering experiment: Set N_d = 375 cm^{-3} everywhere.
- Initial results are coming in now.

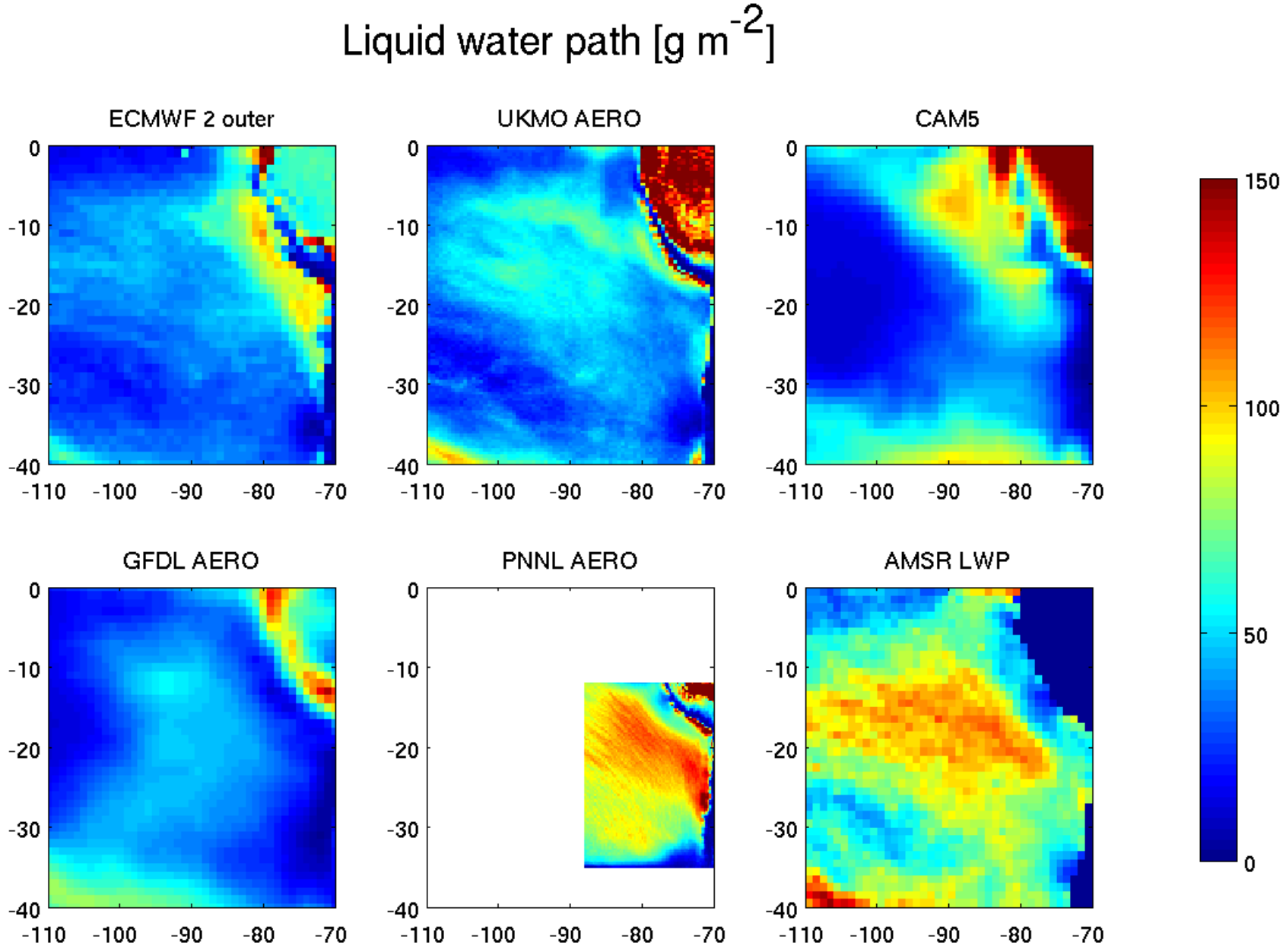
Participating Models

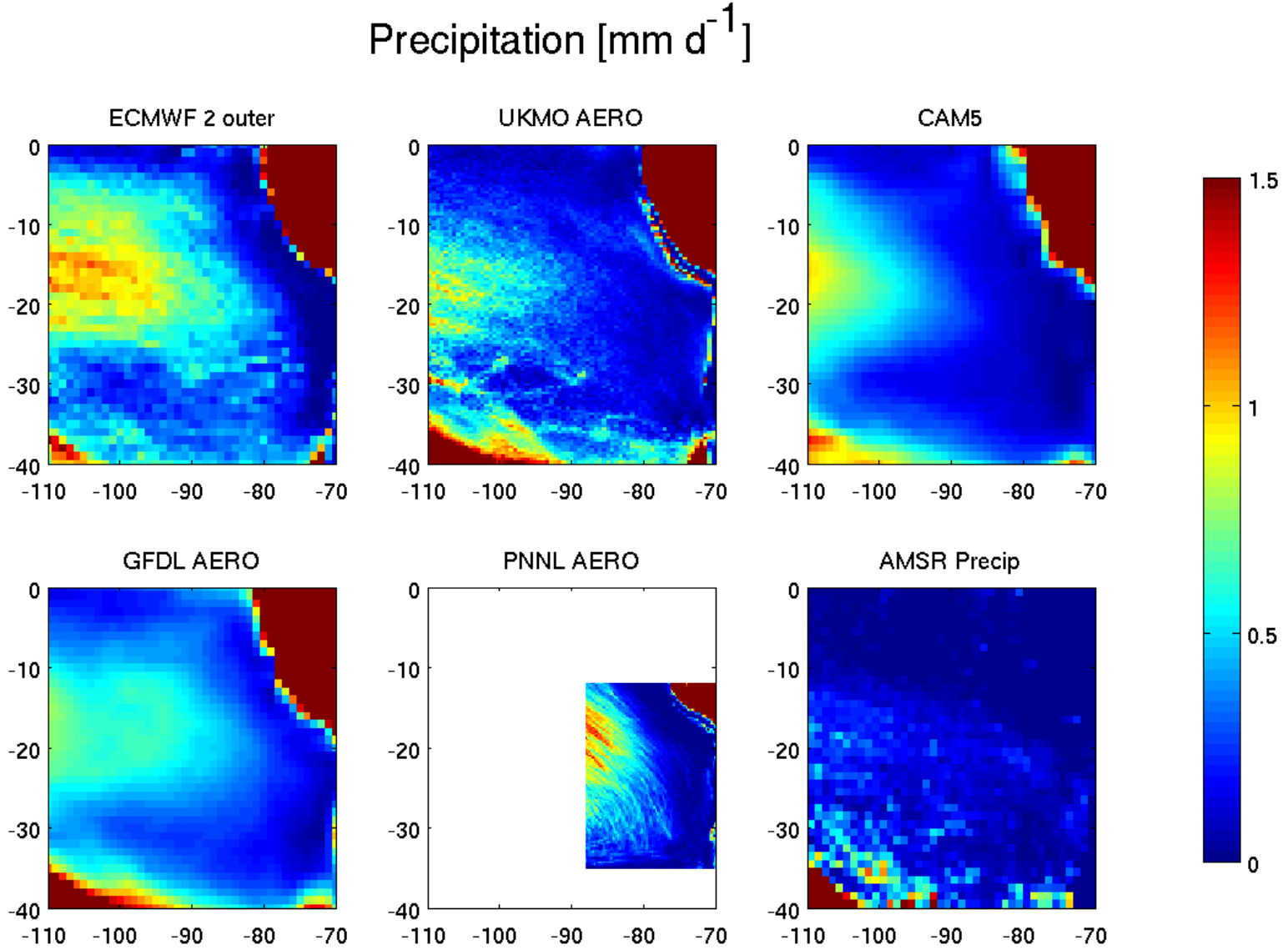
Interactive Aerosols

Center or Group	Model (Regional or Global)
PNNL	WRF-Chem
U. Iowa	WRF-Chem
ECMWF	ECMWF CY33r1
UK Met Office	UKMO
NCAR	CAM4 and CAM5
GFDL	AM 3p9
UW	COSMO
UCLA	WRF-ROMS
UCSD	RSM (coupled)
COLA	RSM
IPRC	iRAM
NRL	COAMPS
UCLA	UCLA AGCM
LMD	LMDZ
UWiscM	WRF-CLUBB

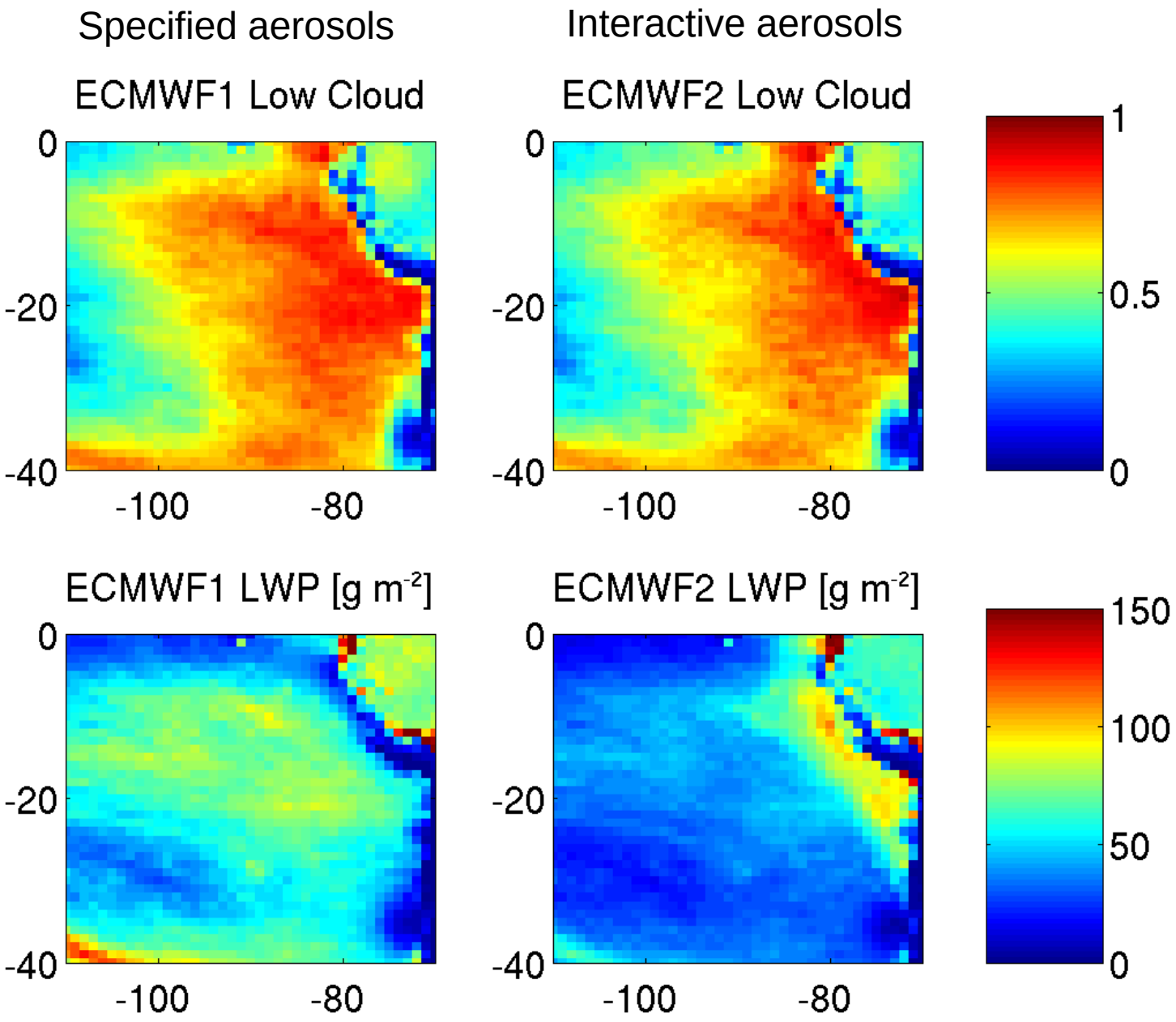
Monthly-mean results (16 Oct – 15 Nov 2008)
Low cloud fraction



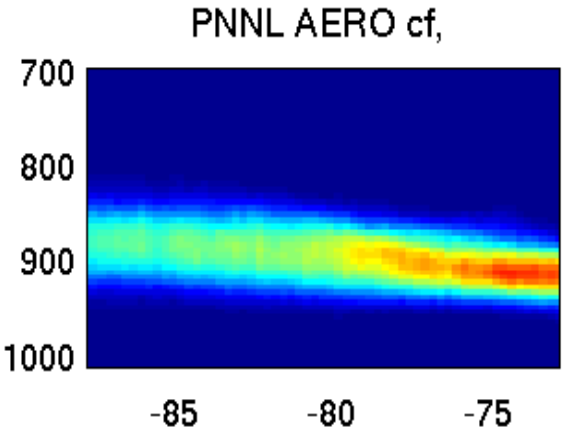

Liquid water path [g m-2]
ECMWF 2 outer
UKMO AERO
CAM5
GFDL AERO
PNNL AERO
AMSR LWP
0
-10
-20
-30
-40
-110
-100
-90
-80
-70
150
100
50
0

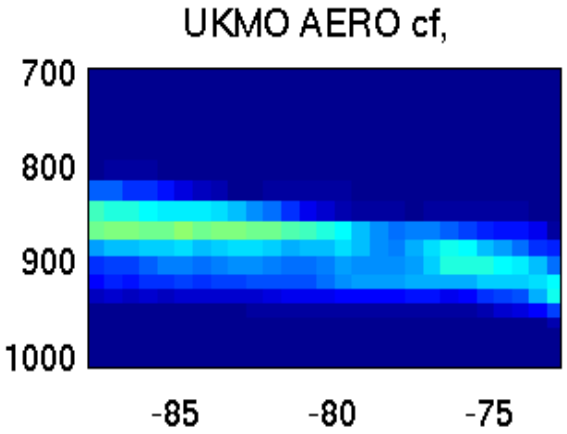


In-situ on 20S: 0.1-0.5 mm/d at 80-85W, negligible at 70-75W (Breth et al. 2010).


Specified aerosols
Interactive aerosols
ECMWF1 Low Cloud
ECMWF2 Low Cloud
ECMWF1 LWP [g m-2]
ECMWF2 LWP [g m-2]
0
-20
-40
-100
-80
1
0.5
0
150
100
50
0

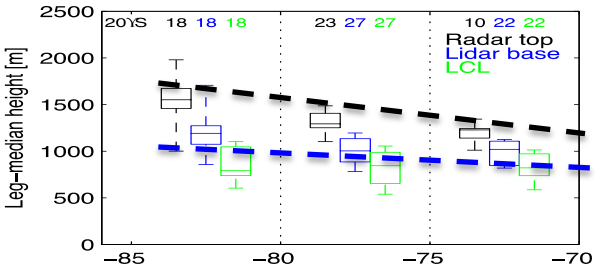
Mean 20S cloud fraction cross-section

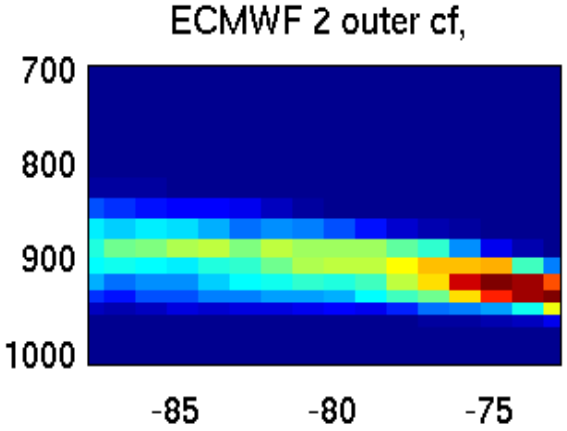


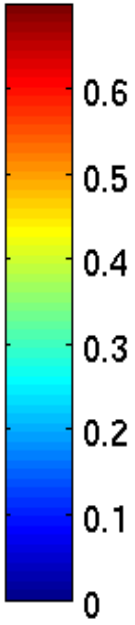


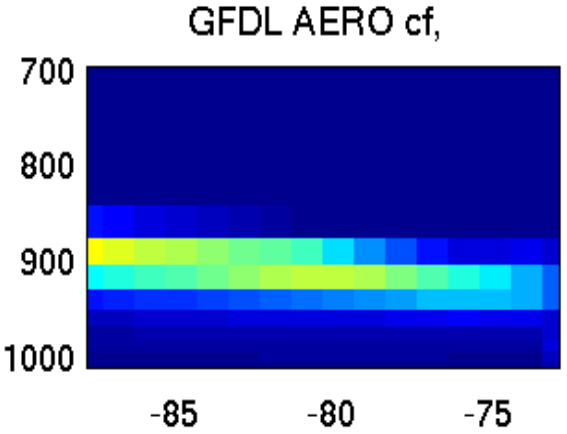
Inv too low at coast: CAM5, GFDL, UKMO

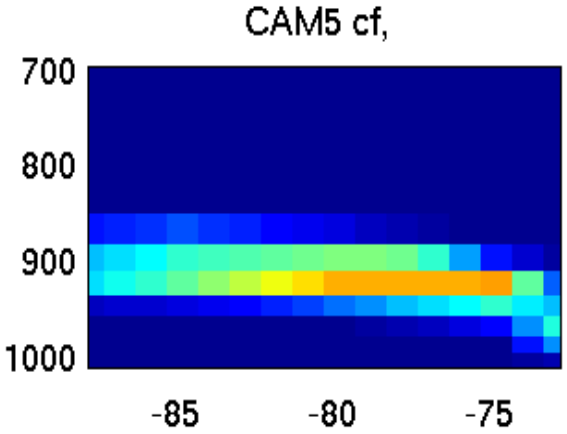
Bretherton et al. 2010





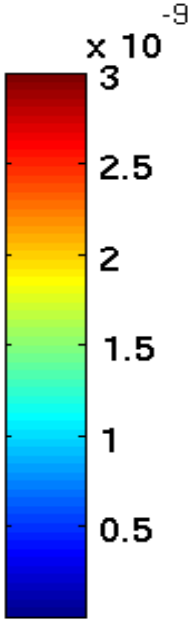


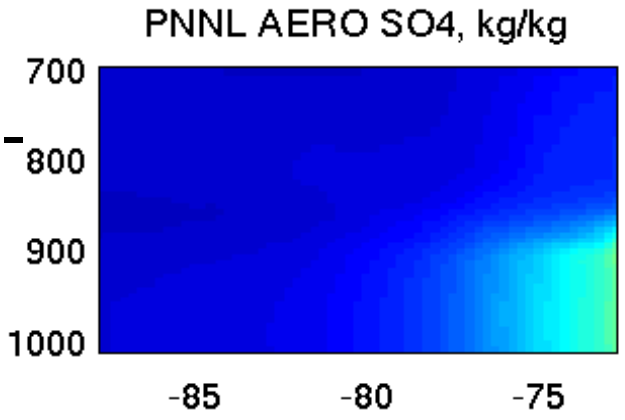


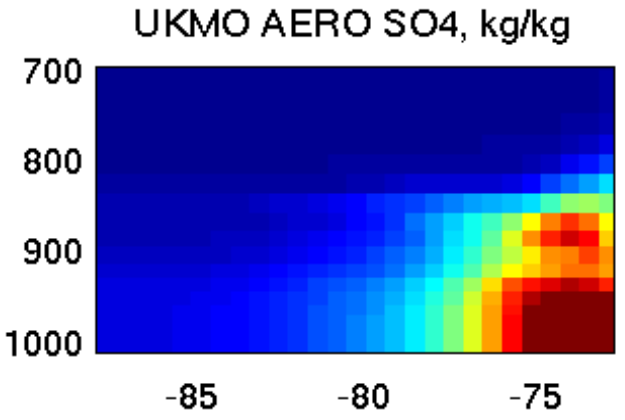


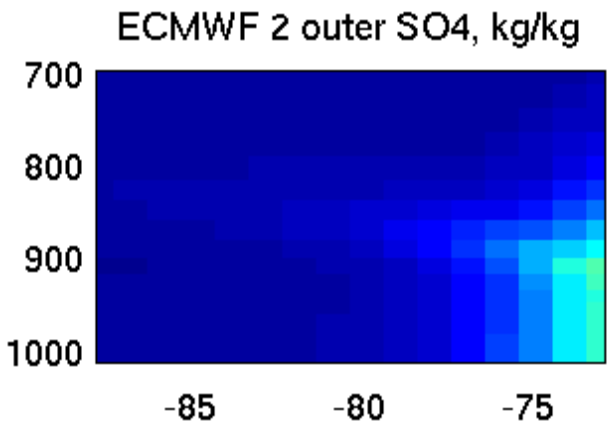
Inv somewhat low offshore: GFDL, CAM5

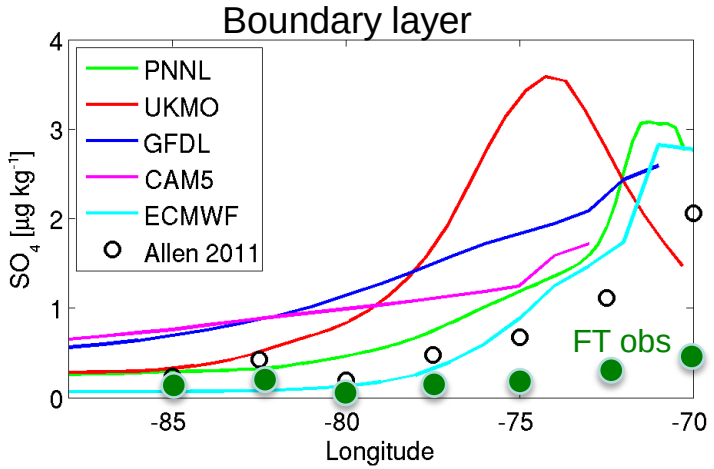
Mean 20S sulfate cross-sections

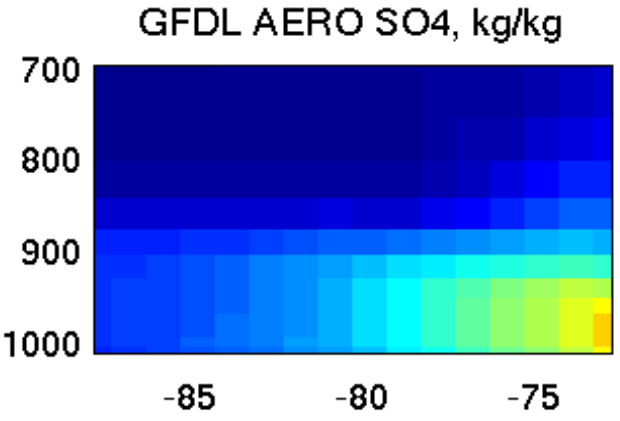


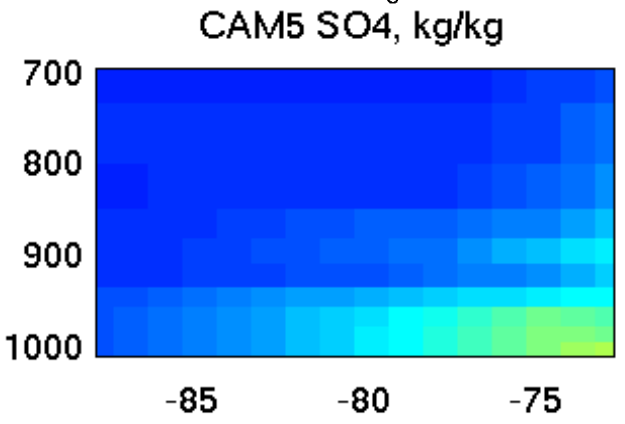






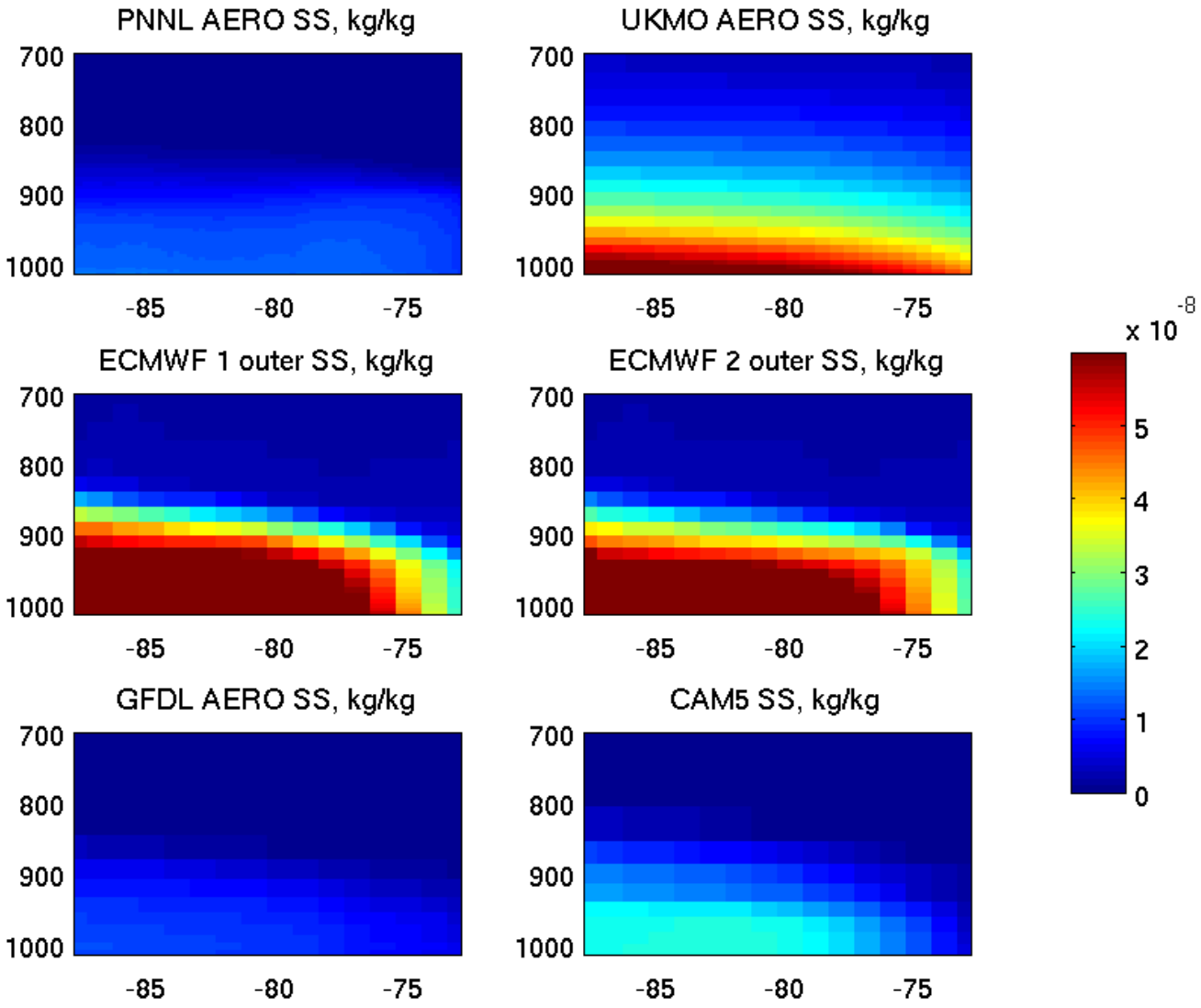






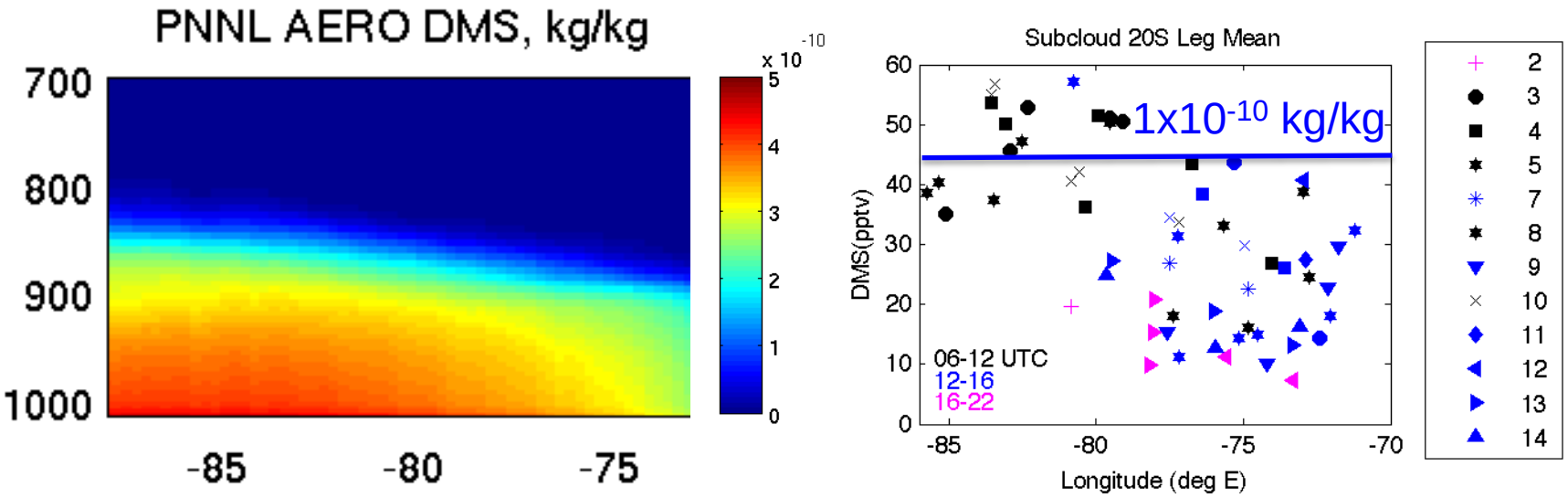
PNNL, ECMWF good

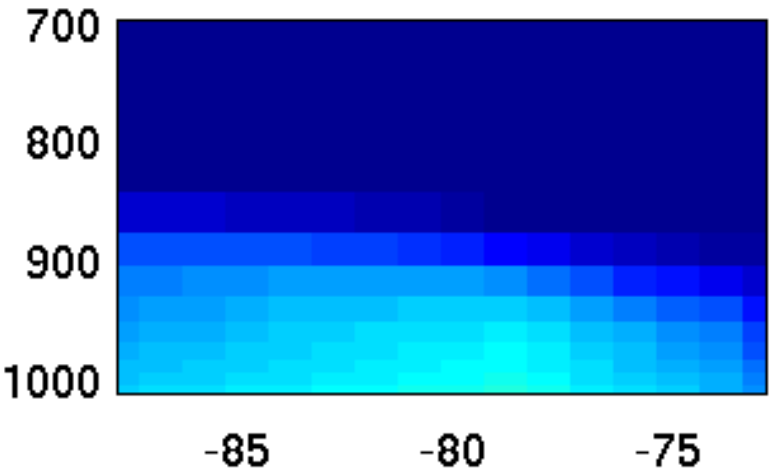
Mean 20S sea-salt cross-sections

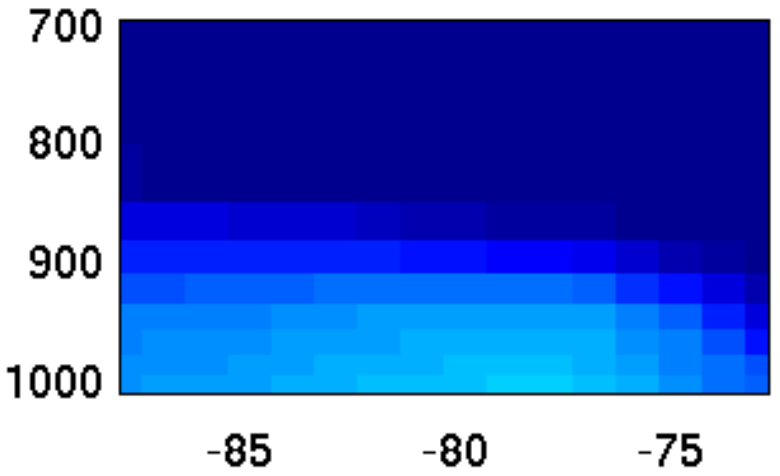


- Do we have suitable VOCALS observations?
- Caveat: number is as important as mass.

Mean 20S DMS cross-sections

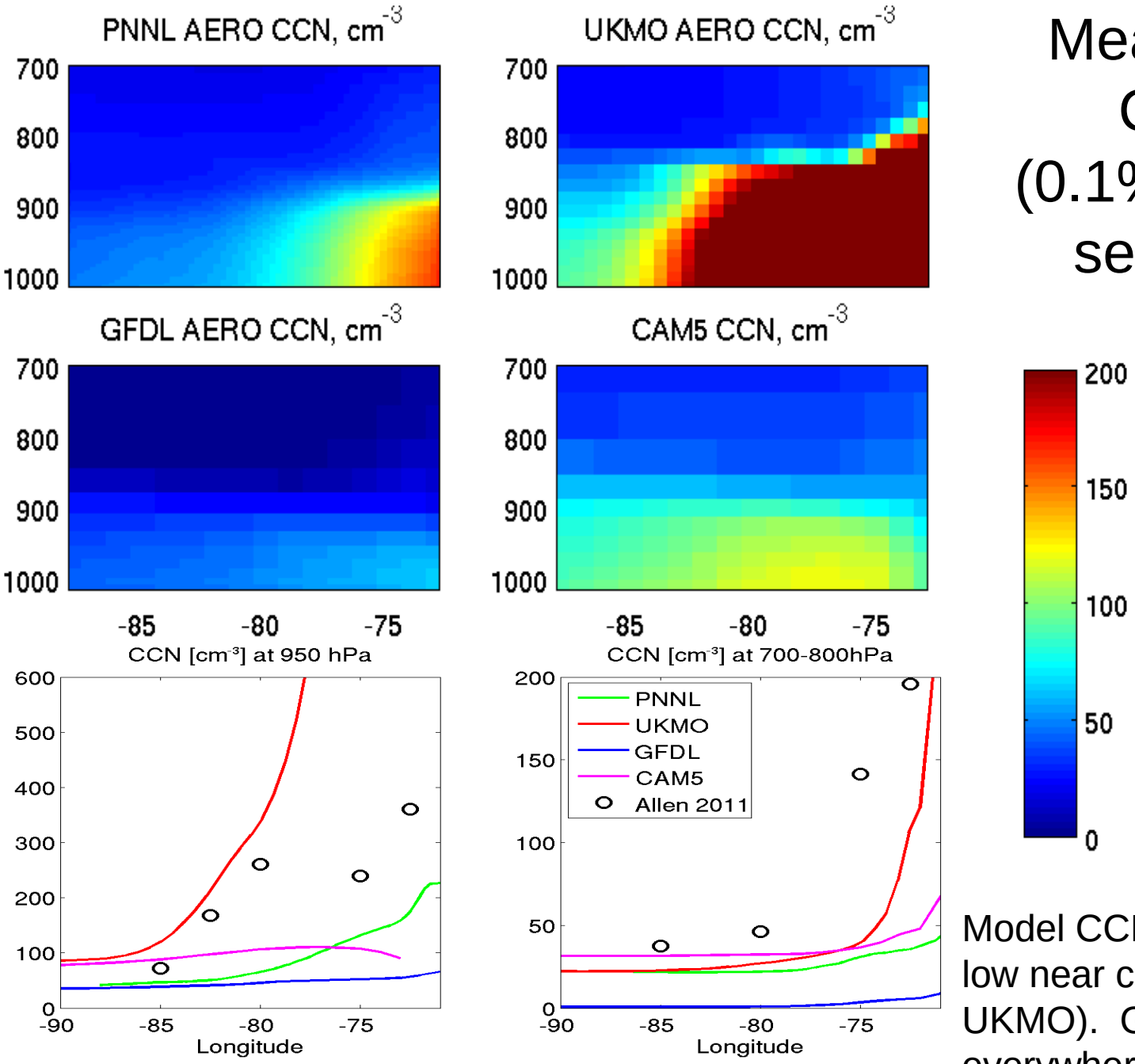






PNNL much too high, CAM5 and GFDL somewhat high

Caveat: observations don't cover the diurnal cycle



Mean 20S CCN (0.1%)cross-sections

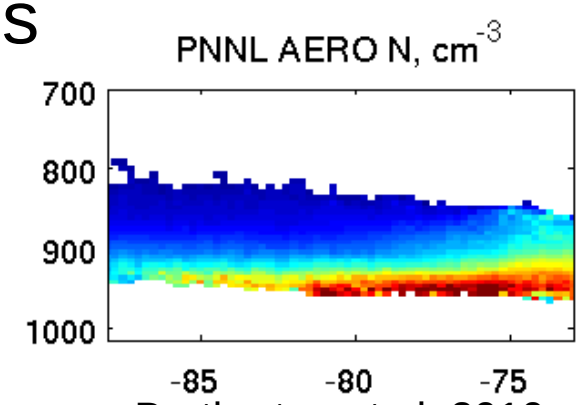
Model CCNs mostly too low near coast (except UKMO). GFDL too low everywhere.

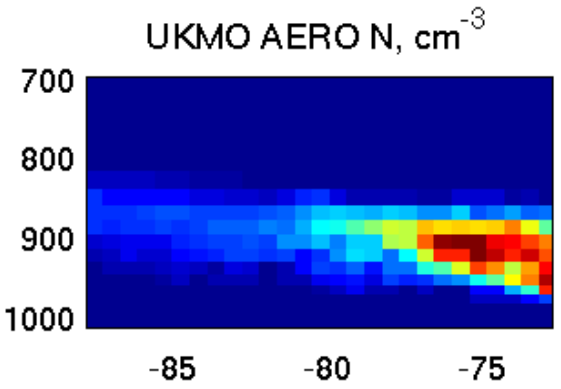
Mean 20S N_d cross-sections

Huge differences
- GFDL very low,
- CAM and PNNL have strange profiles,
- UKMO may include clear air

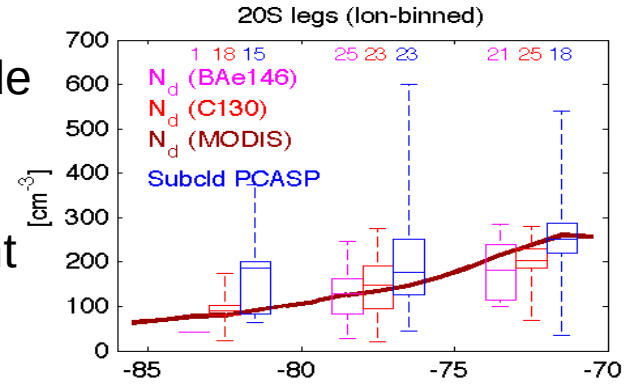
Surprisingly different from CCN fields

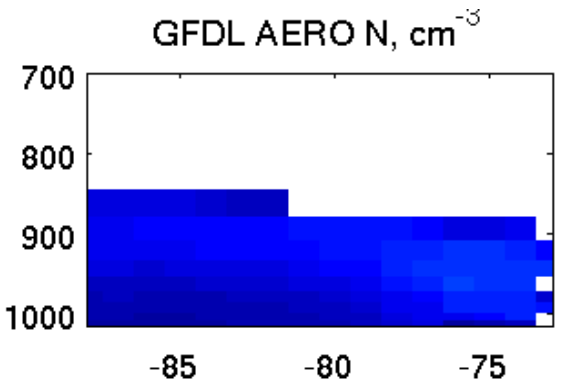
Is model output really the mean in-cloud N_d?

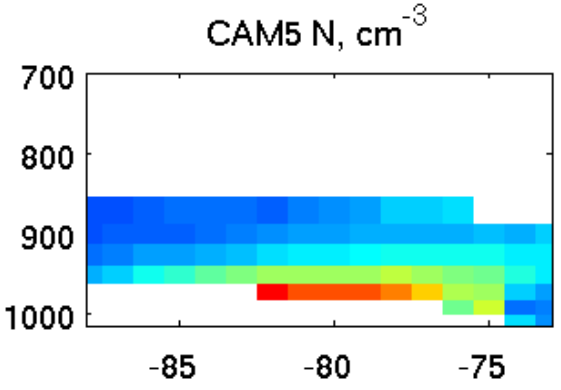


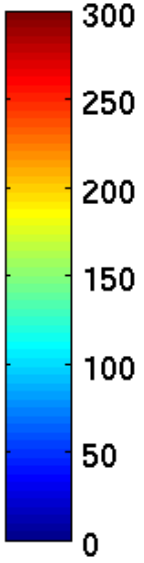


Bretherton et al. 2010

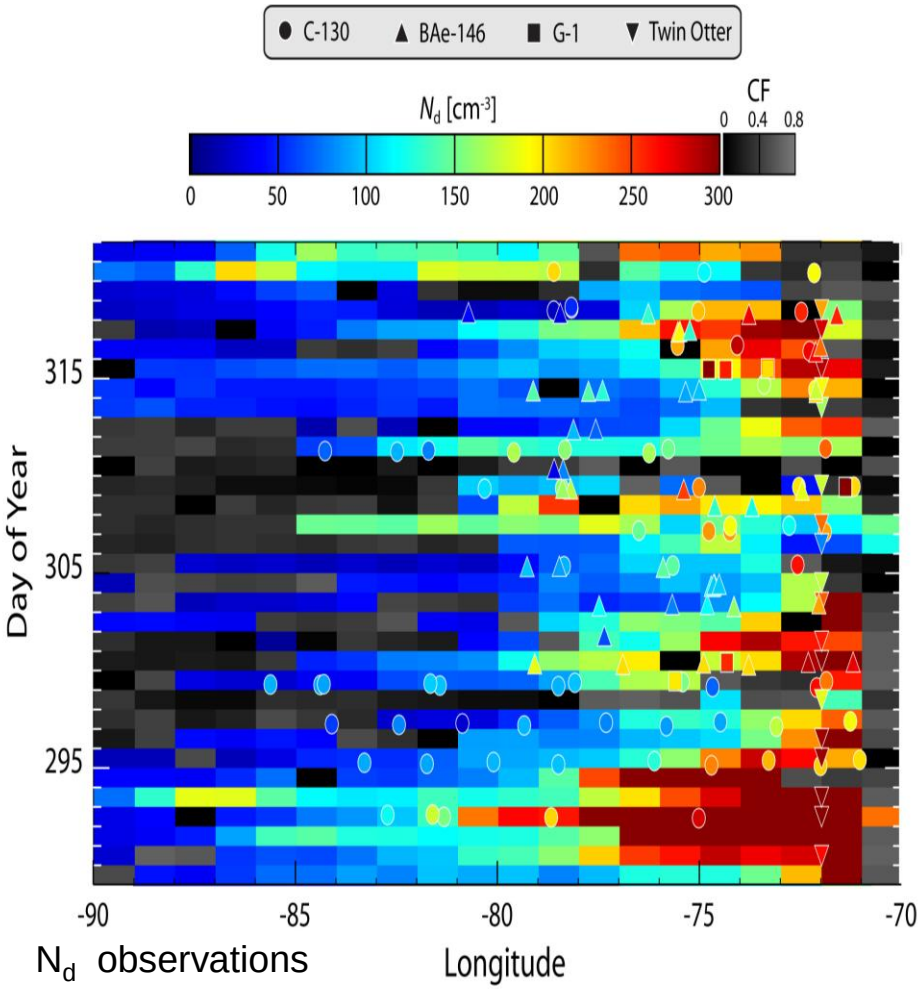






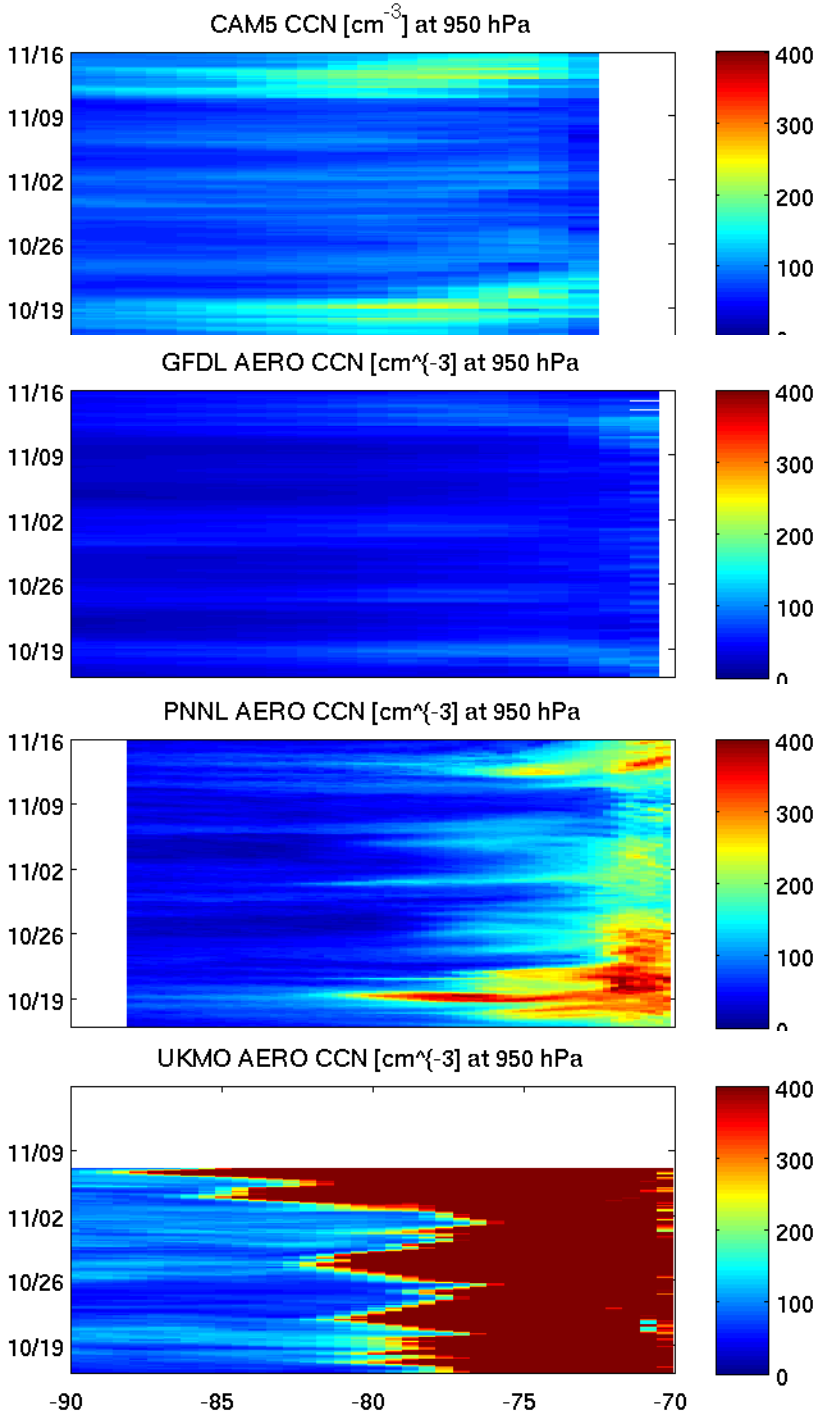


Temporal variability



N_d observations
Bretherton et al. 2010

Models pick up pollution peaks associated with offshore flow, but mean biases are overwhelming (except PNNL)



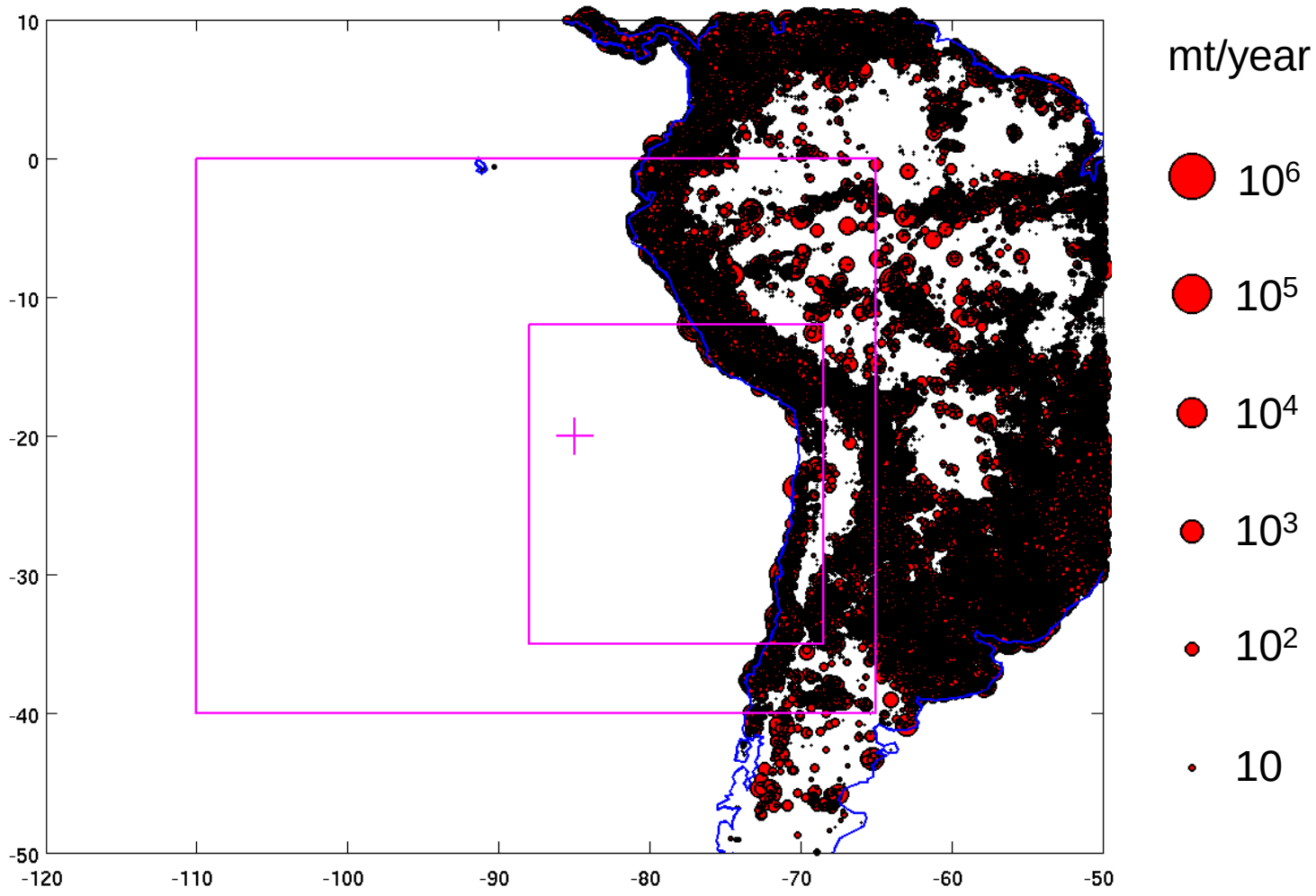
Conclusions

- VOCA is a stringent observational test of model-simulated clouds and aerosol-cloud interaction in SE Pacific.
- Results presented here are still preliminary!
- The comprehensive REx dataset indicates a diverse set of parameterization issues in all models, hopefully pointing the way to an intensive phase of model improvement.

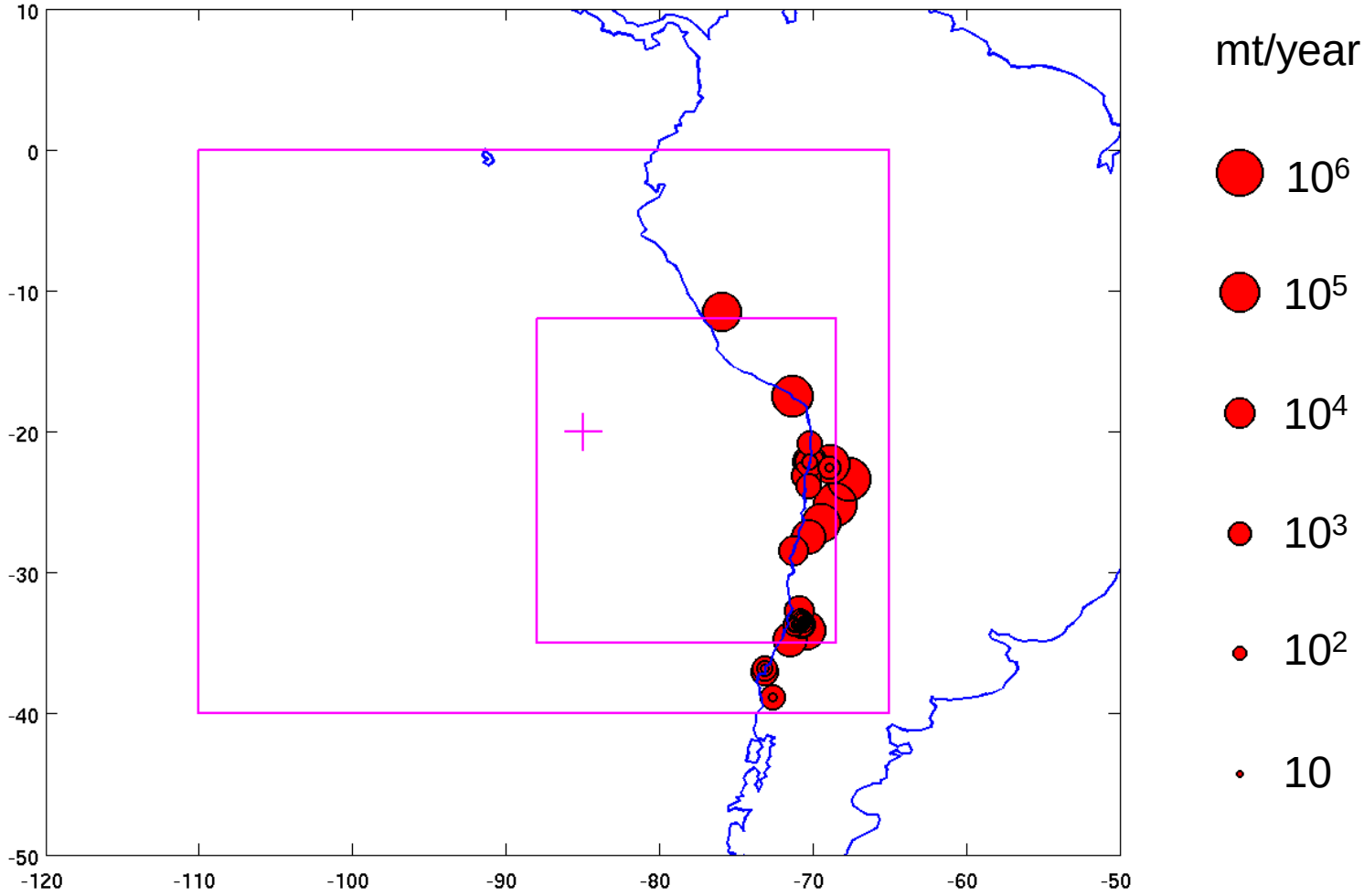
Emissions Inventory (Scott Spak)

- SO_2, VOCs, CO
- CONAMA Chilean Inventory point sources, municipal mobile, residential sources
- SO_2 Peruvian smelters and volcano estimates from OMI PBL SO_2
- Elsewhere use global inventories: EDGAR FT 2000 and Bond et al. (2004) for black carbon and organic carbon.
- Inclusion of daily biomass emissions using MODIS detection of fires from C. Wiedinmyer is being investigated.

SO_2 Area Sources



SO_2 Point Sources



VOCALS: A CLIVAR study of SE Pacific cool ocean/Sc region.

REx: Large field expt off N Chile
- **Oct.-Nov. 2008**
- **cloud/aerosol/land interactions**
- **role of mesoscale ocean eddies**

PreVOCA: Atmospheric model assessment for Oct. 2006 using SE Pac satellite, ship obs.