The VOCALS Assessment (VOCA)

Matt Wyant, Chris Bretherton, Rob Wood
Department of Atmospheric Sciences
University of Washington

Scott Spak, U. Iowa (Emissions)
Cecile Hannay, NCAR (CAM5)
Yanluan Lin, GFDL (AM3)

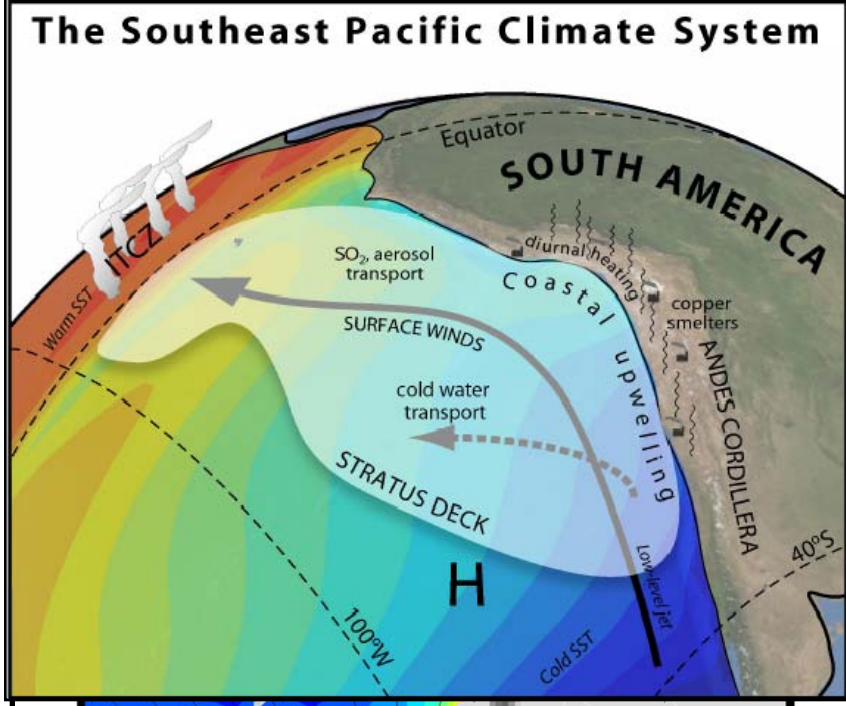
Other modeling groups

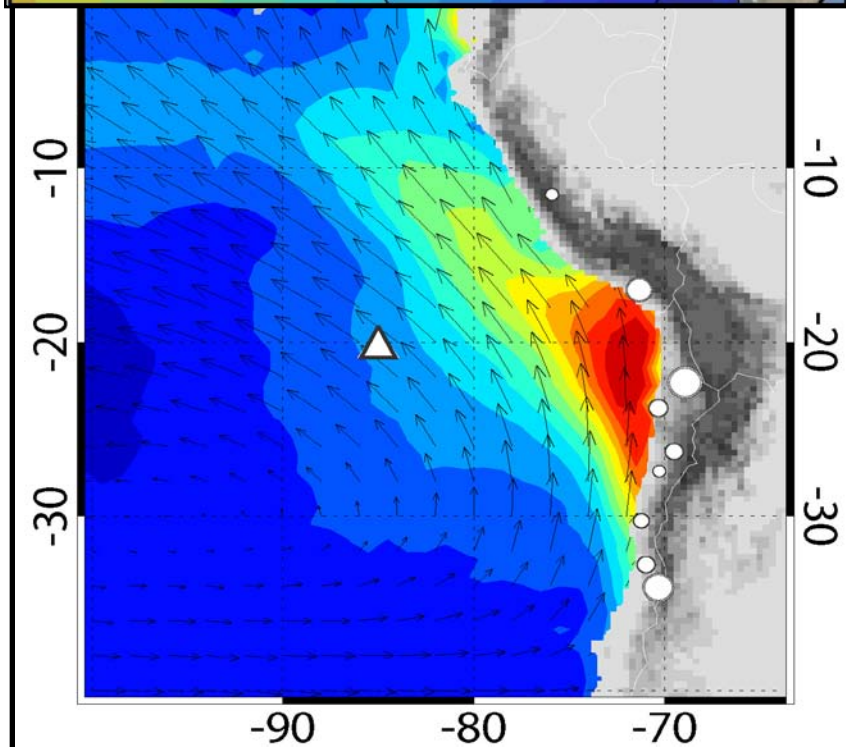
VOCALS: A CLIVAR study of SE Pacific cool ocean/Sc region.

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.

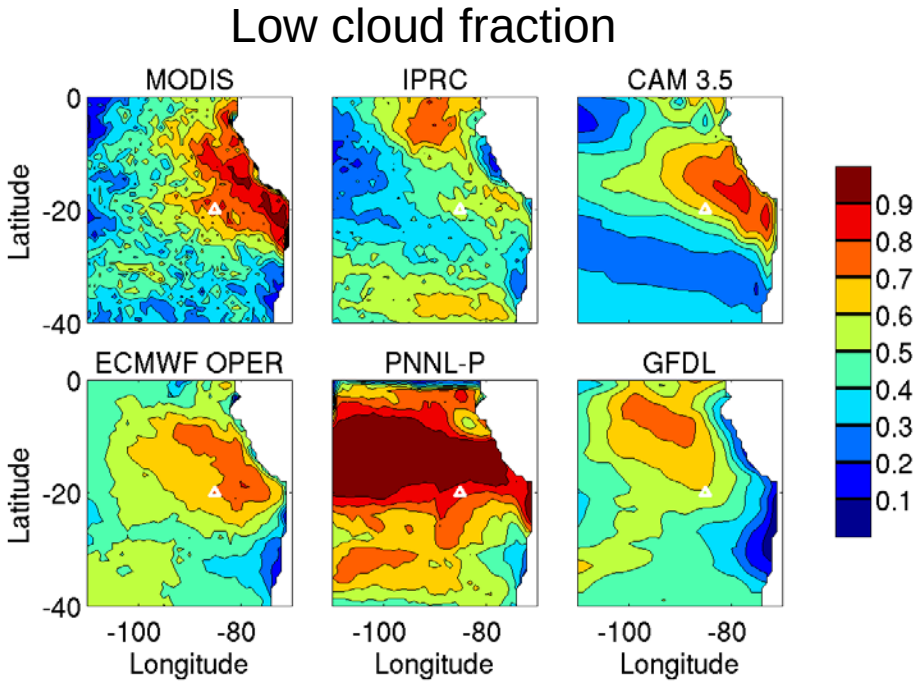
VAMOS OCEAN CLOUD ATMOSPHERE LAND STUDY
VOCALS
WCRP/CLIVAR/VAMOS-GEWEX

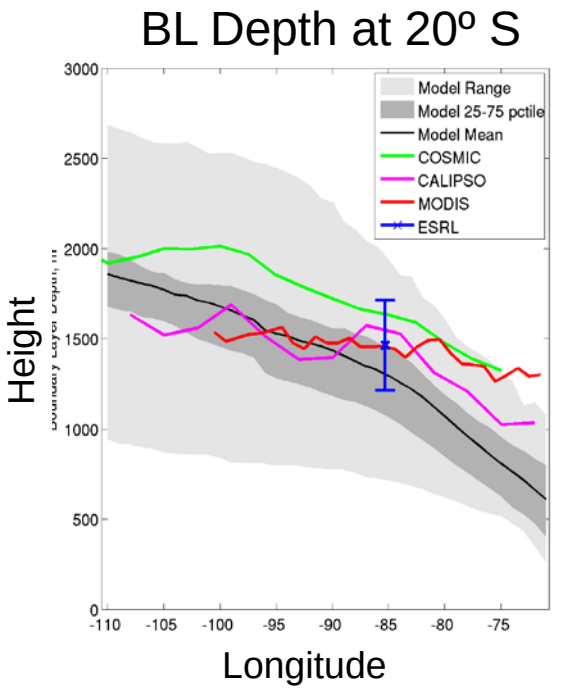




Pre-VOCA

Wyant et al., 2010, ACP



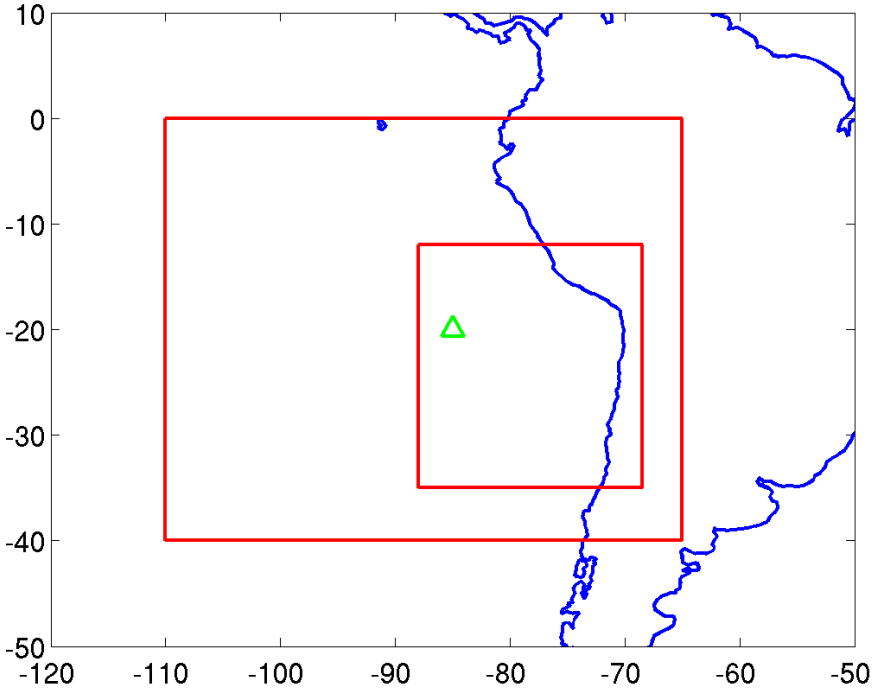


- PreVOCA compared 15 regional, weather forecast, and climate models (in forecast mode) for October 2006 in the VOCALS region.
- Many models had large errors in distribution of low cloud cover, though ECMWF and UKMO performed well.
- Most models produced a marine BL too shallow near the coast at 20S.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



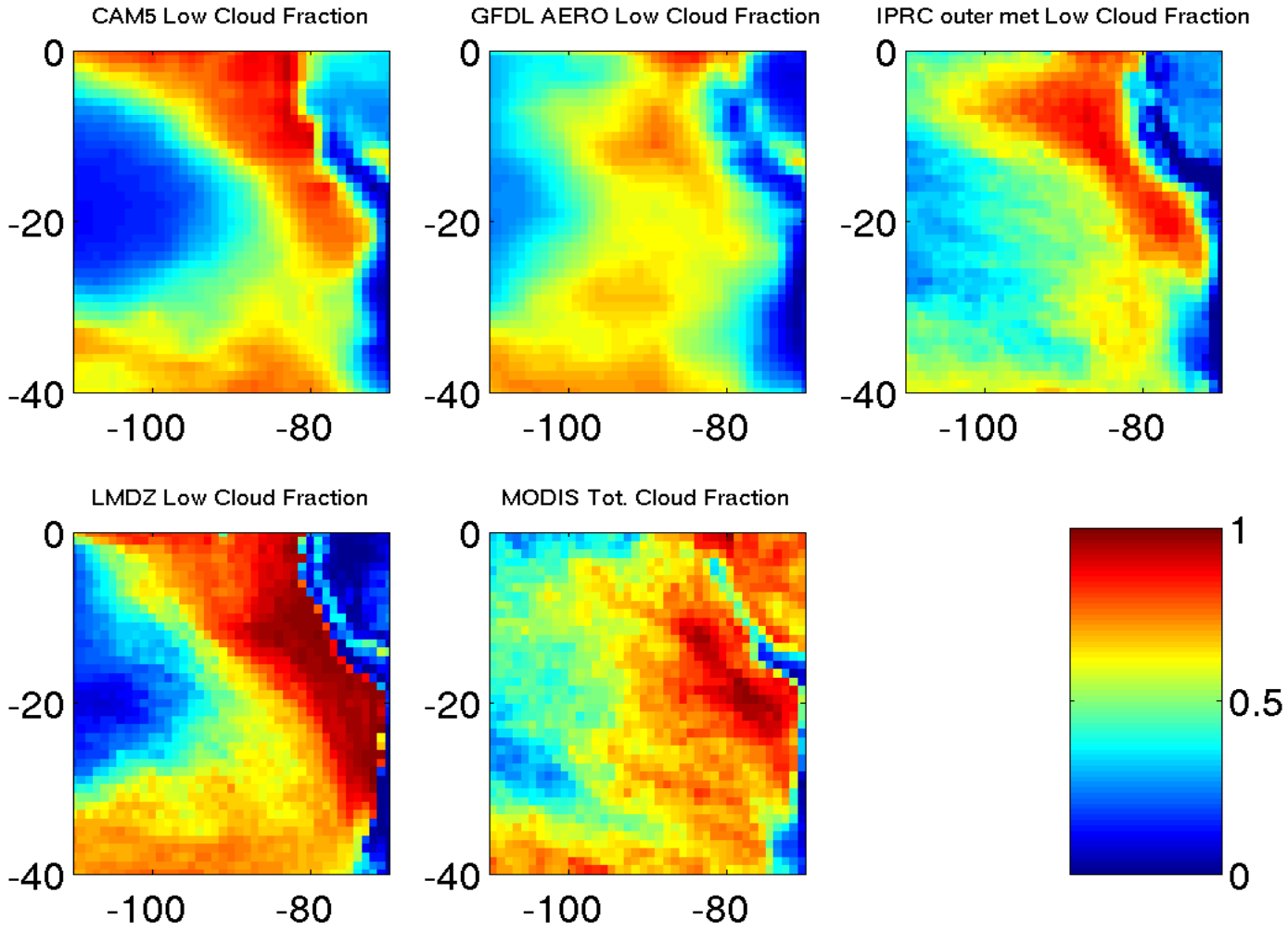
- Similar protocol to PreVOCA.
- REx period: 15 Oct -15 Nov 2008.
- Aerosol Species: SO_4, sea salt, dust, black carbon, organic carbon
- Gas Species: SO_2, DMS, CO, O_3
- Emissions of aerosol and gas species are specified in a standard protocol for regional models.
- Compare aerosol and gas concentrations 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

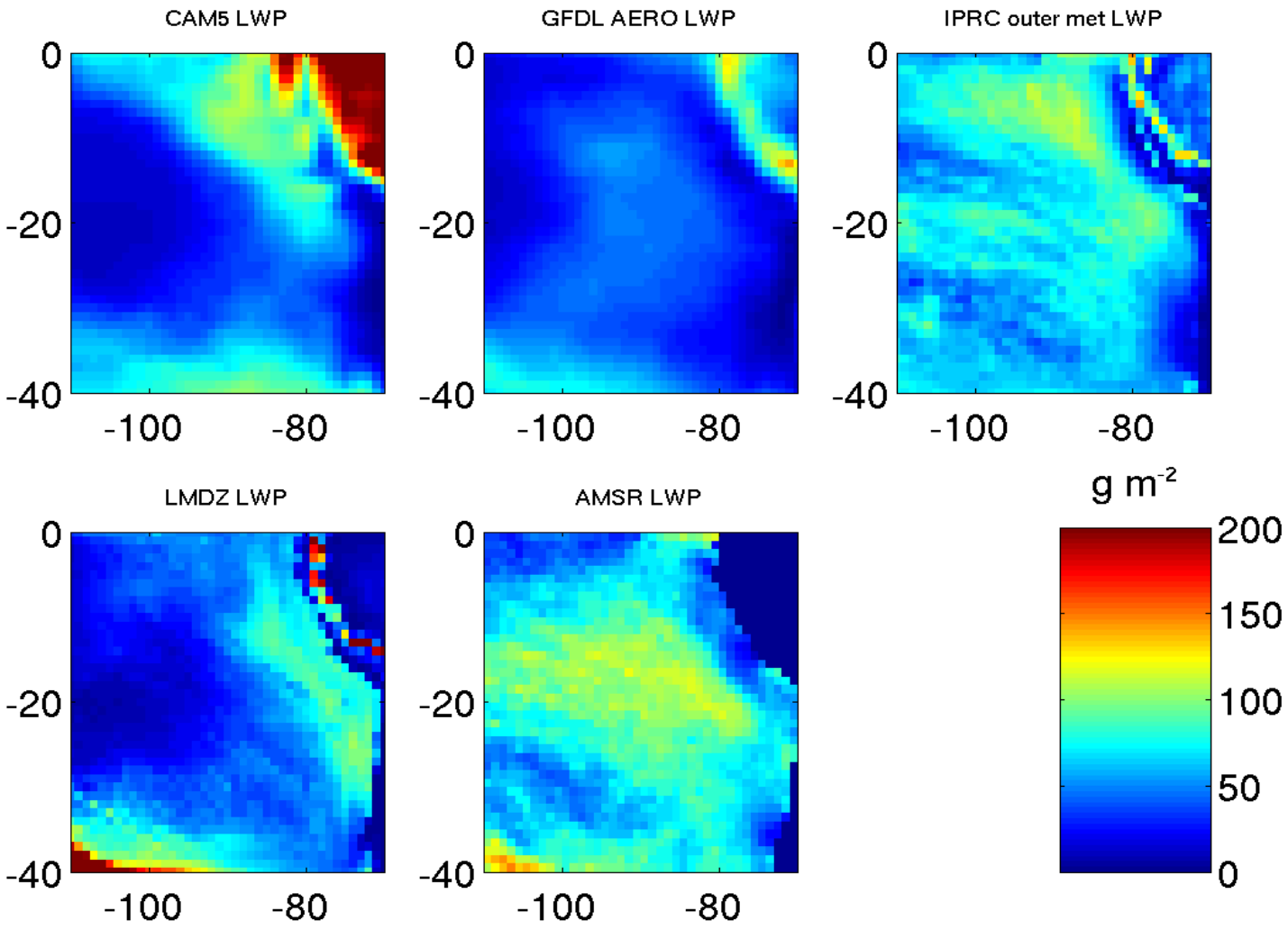
Interactive Aerosols

Center or Group	Model (Regional or Global)
PNNL	WRF-Chem
U. Iowa	STEM
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

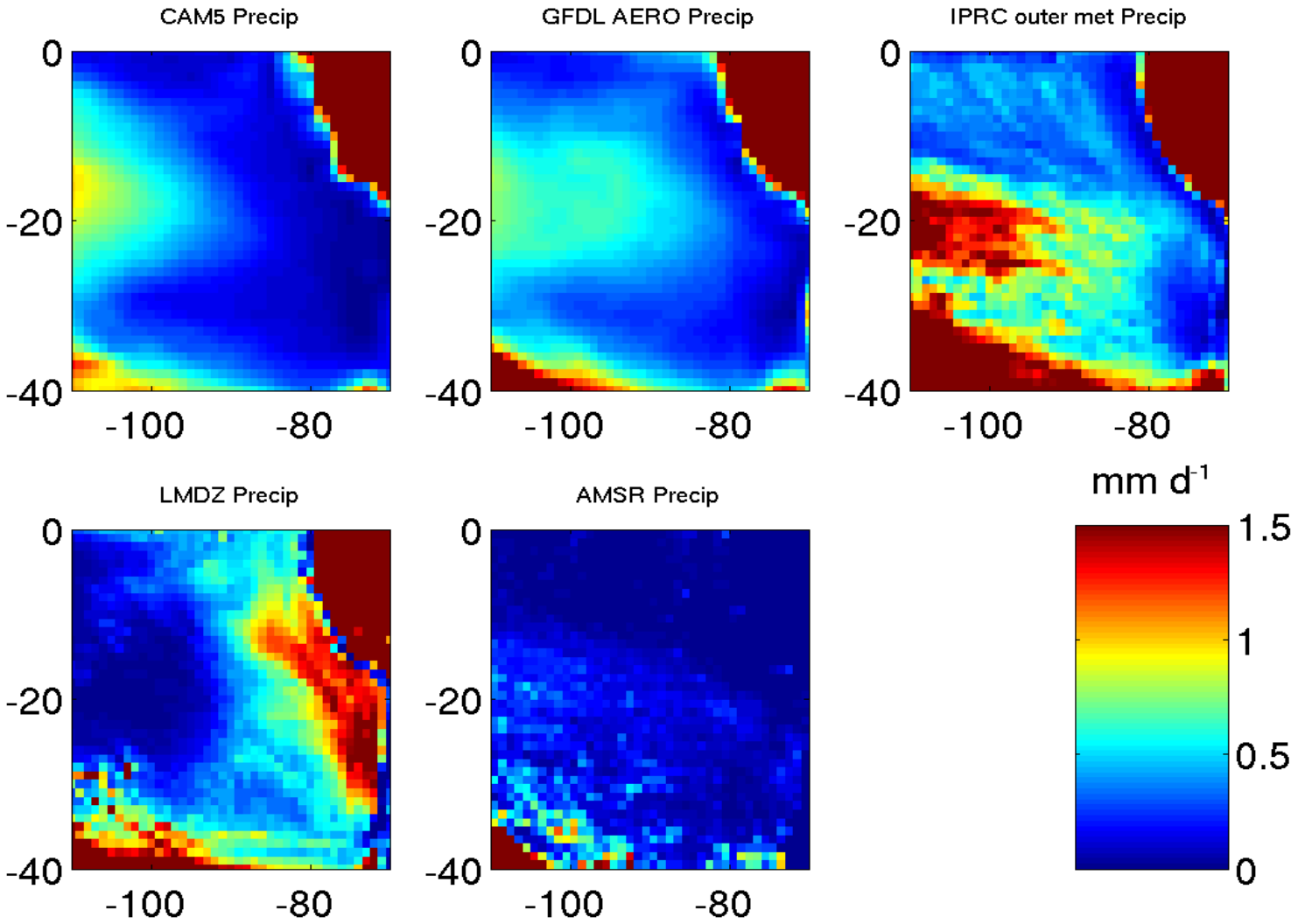
Monthly-mean results (16 Oct – 15 Nov 2008)
Low cloud fraction



Liquid water path

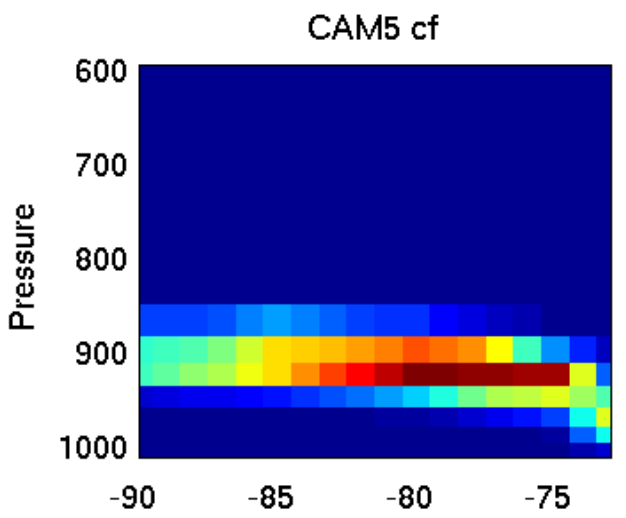


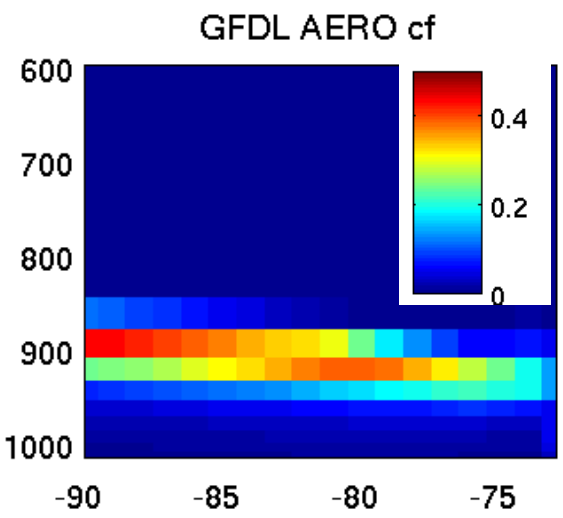
Surface precipitation

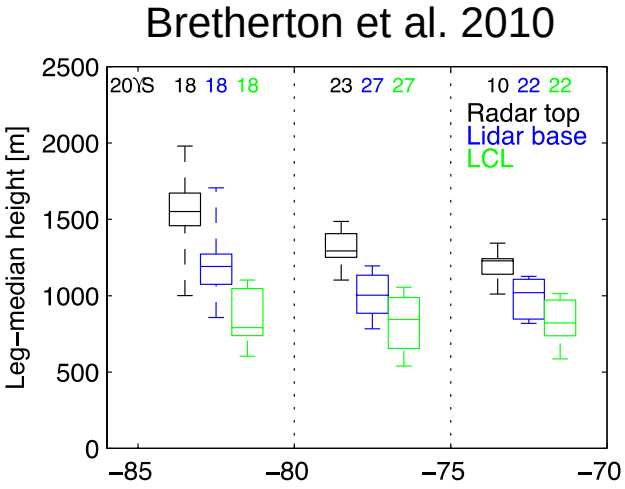


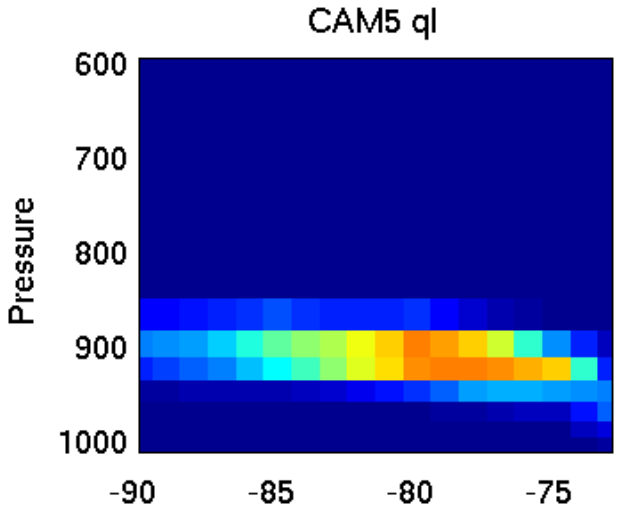
In-situ on 20S: 0.1-0.5 mm/d at 80-85W, negligible at 70-75W (Breth et al. 2010).

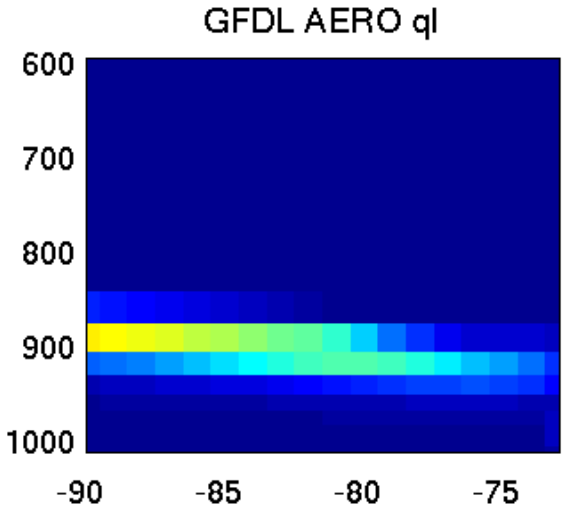
Mean 20S cross-sections – cld frac and LWC

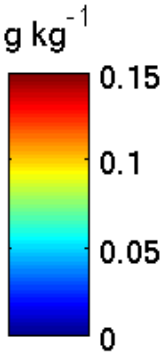




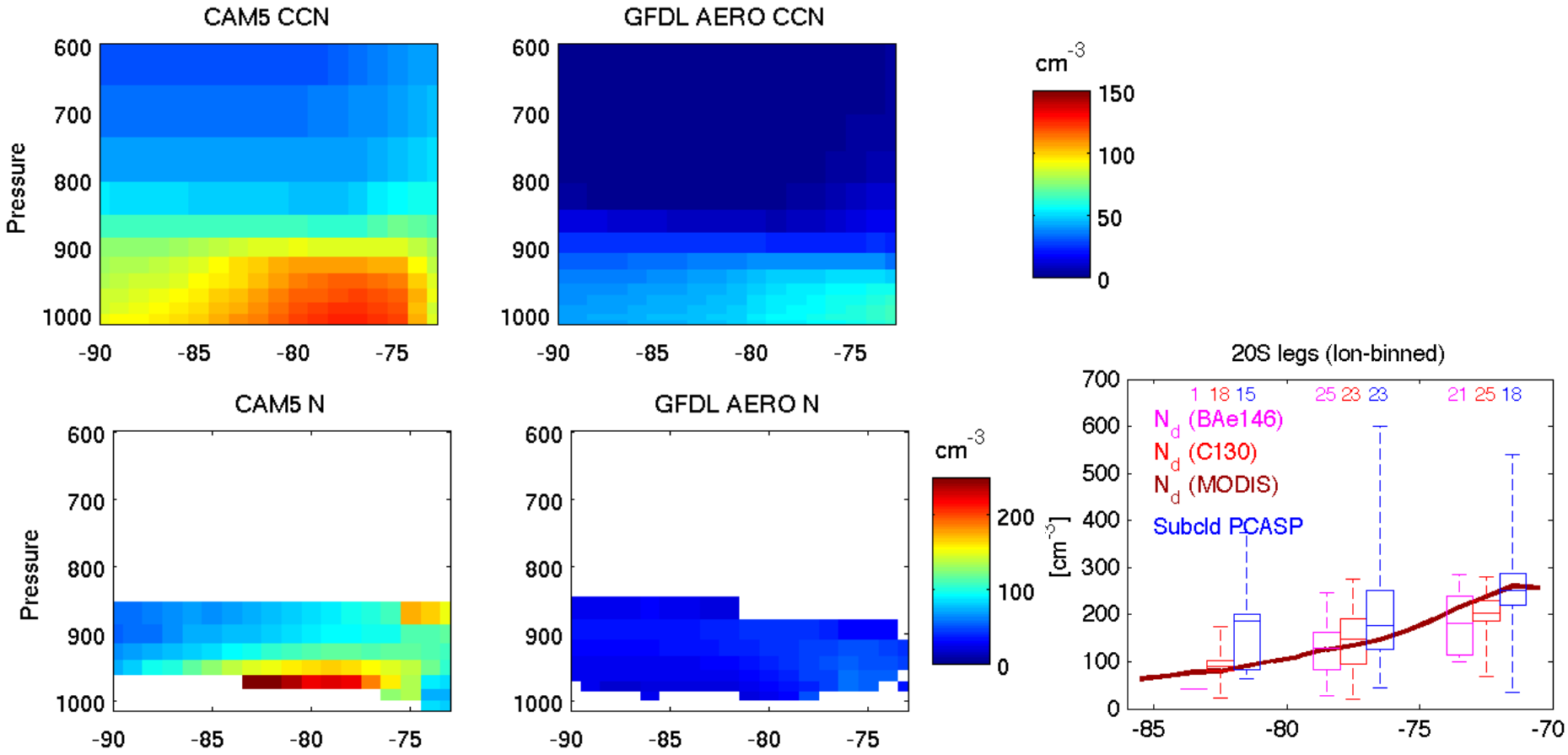






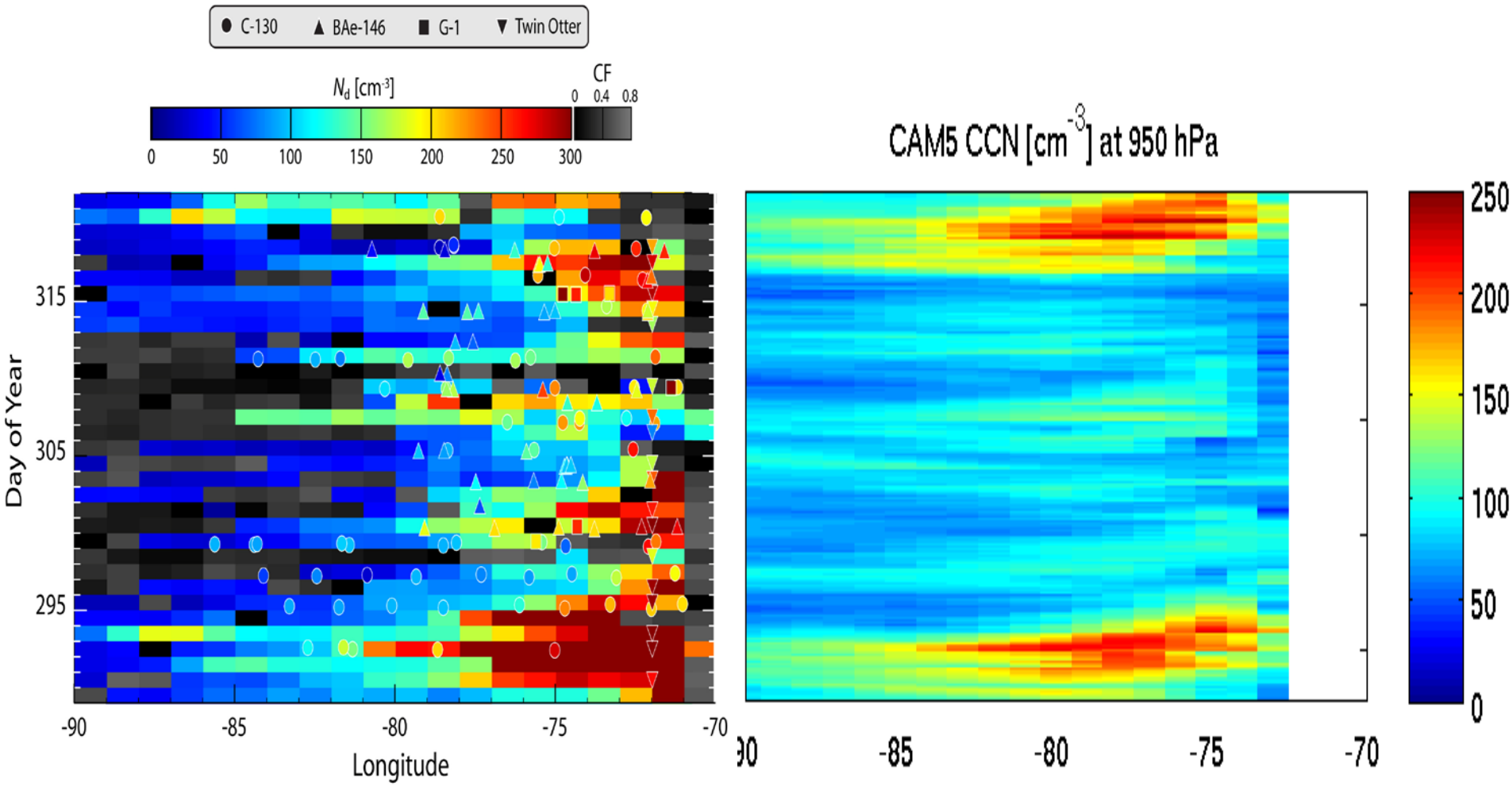


Mean 20S cross-sections – CCN and N_d



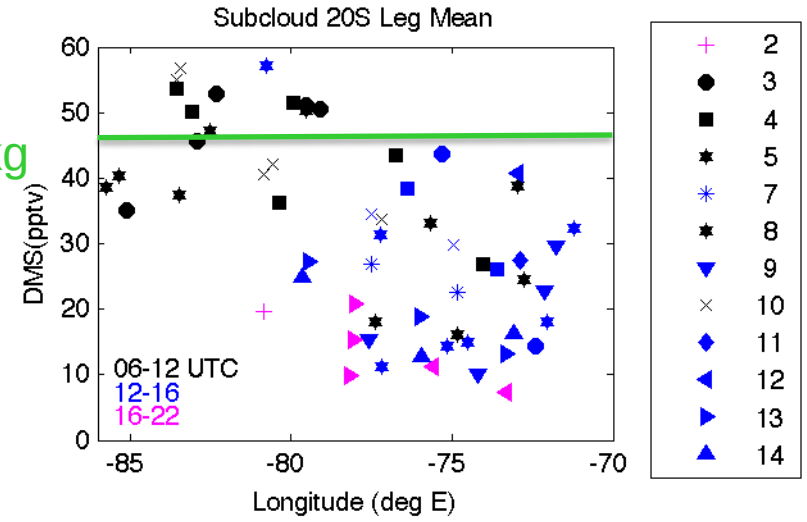
Bretherton et al. 2010

Temporal variability

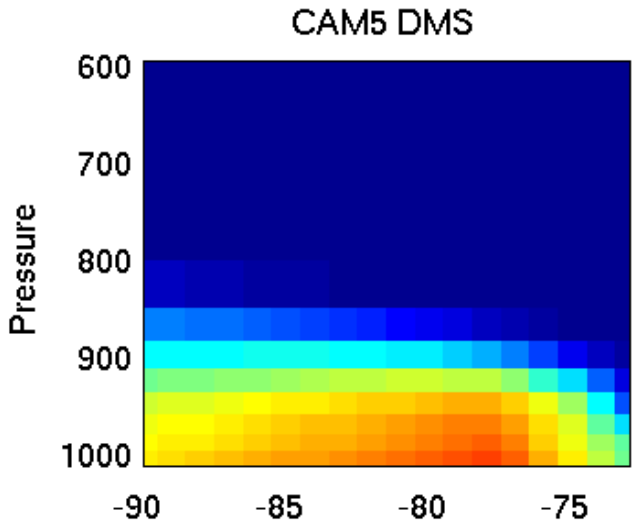


Bretherton et al. 2010 ACP

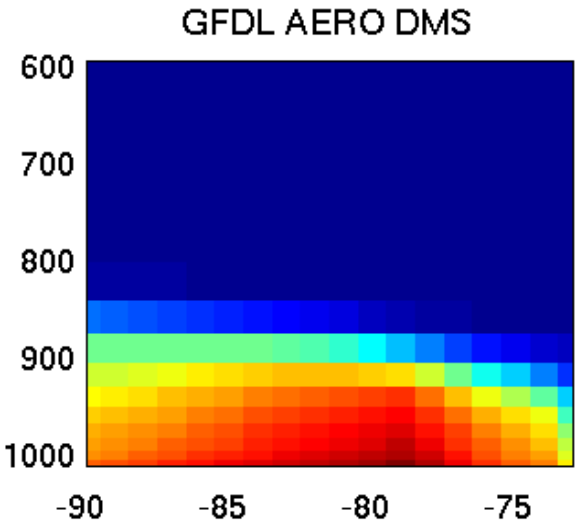
DMS (no SO2/sulfate plots available yet)



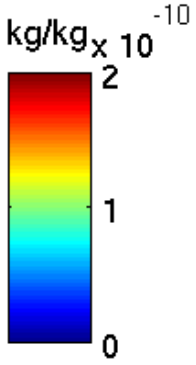
$1x10^{-10}$ kg/kg



Somewhat high



High



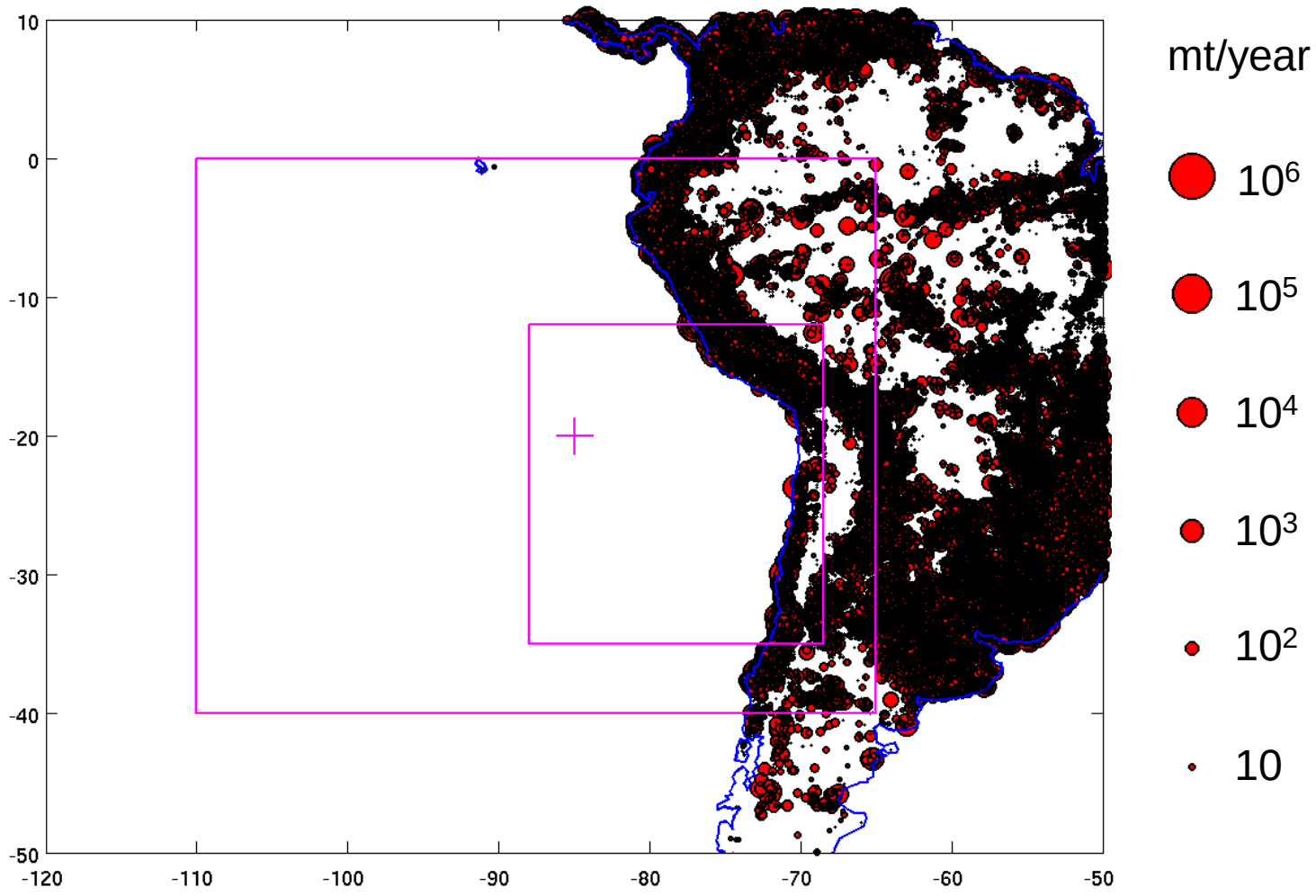
Conclusions

- VOCA suggests that CAM5 is doing a fairly good job with SE Pacific clouds and aerosols compared to observations.
- There may be issues with droplet number concentration.
- VOCA should be a valuable resource/protocol for further CAM5 testing and 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