VOCALS emissions & regional chemical transport

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Towards understanding and quantifying chemical transport in the Southeast Pacific region

Science objectives…

- Develop a regional emissions inventory, employing adjoint chemical transport modeling to optimize anthropogenic SO_2 and marine DMS emissions, incorporating VOCALS REx aircraft observations, in-situ monitors, and remote sensing retrievals
- Identify contributions of local urban areas, point sources, long-range transport from megacities, and marine biota on atmospheric burdens and deposition of trace gases and aerosols and resultant ocean acidification in the VOCALS study area
- Characterize the role of ocean-land-atmosphere coupling in pollutant fate (focus on aerosol removal in marine clouds)
- Estimate impacts of aerosol composition on marine stratocumulus clouds, continental precipitation, and regional climate, including source contributions and pre-industrial conditions

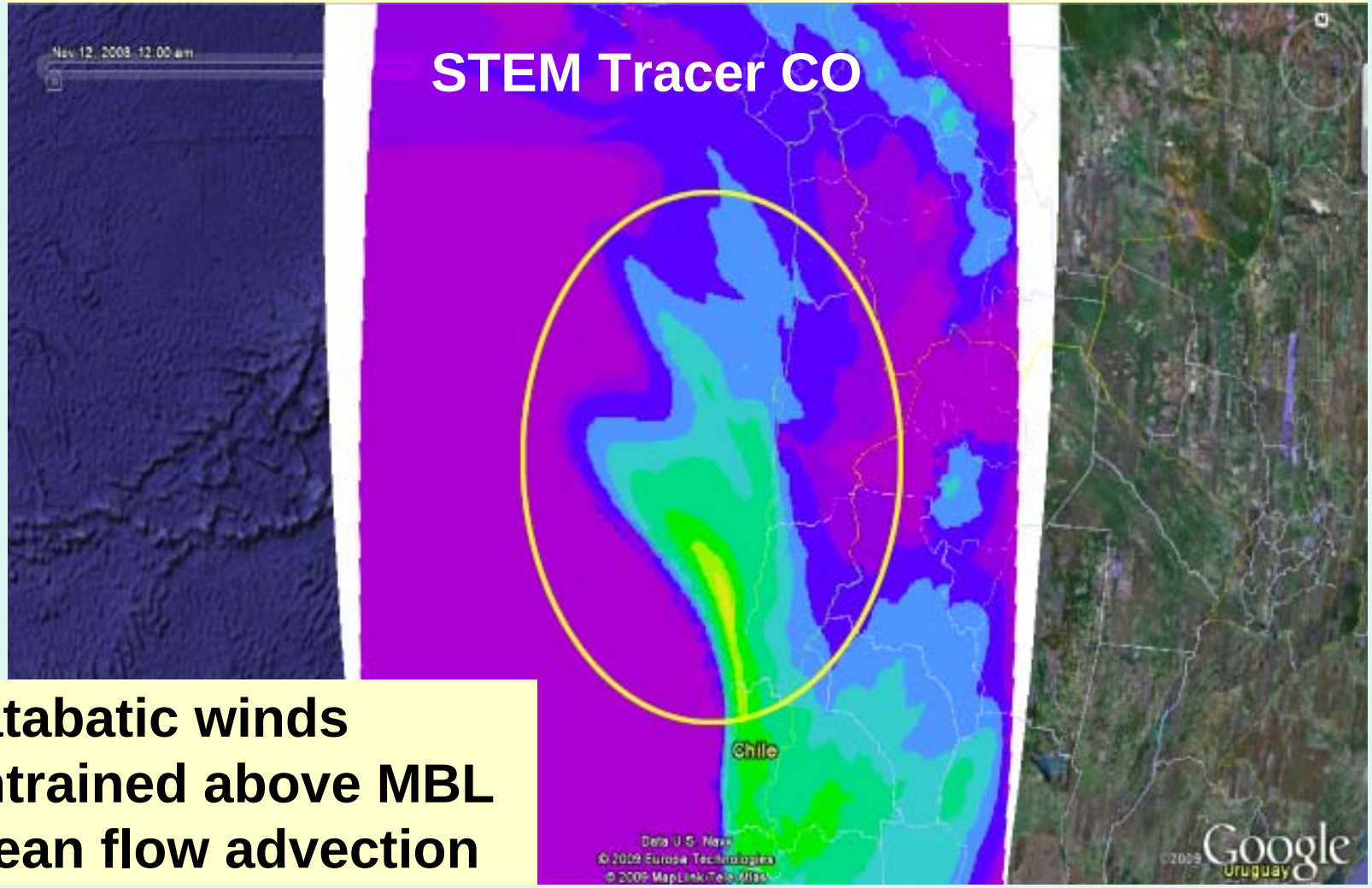
Towards understanding and quantifying chemical transport in the Southeast Pacific region

…in support of VOCALS research

- Forecast for VOCALS-REx chemistry and weather
- Compile the best available regional emissions inventory
- Provide a model-based regional context for airborne & in-situ observations of gas-phase chemistry and aerosols and their optical properties
- Provide high resolution regional chemistry and meteorology model inputs to VOCALS modeling groups

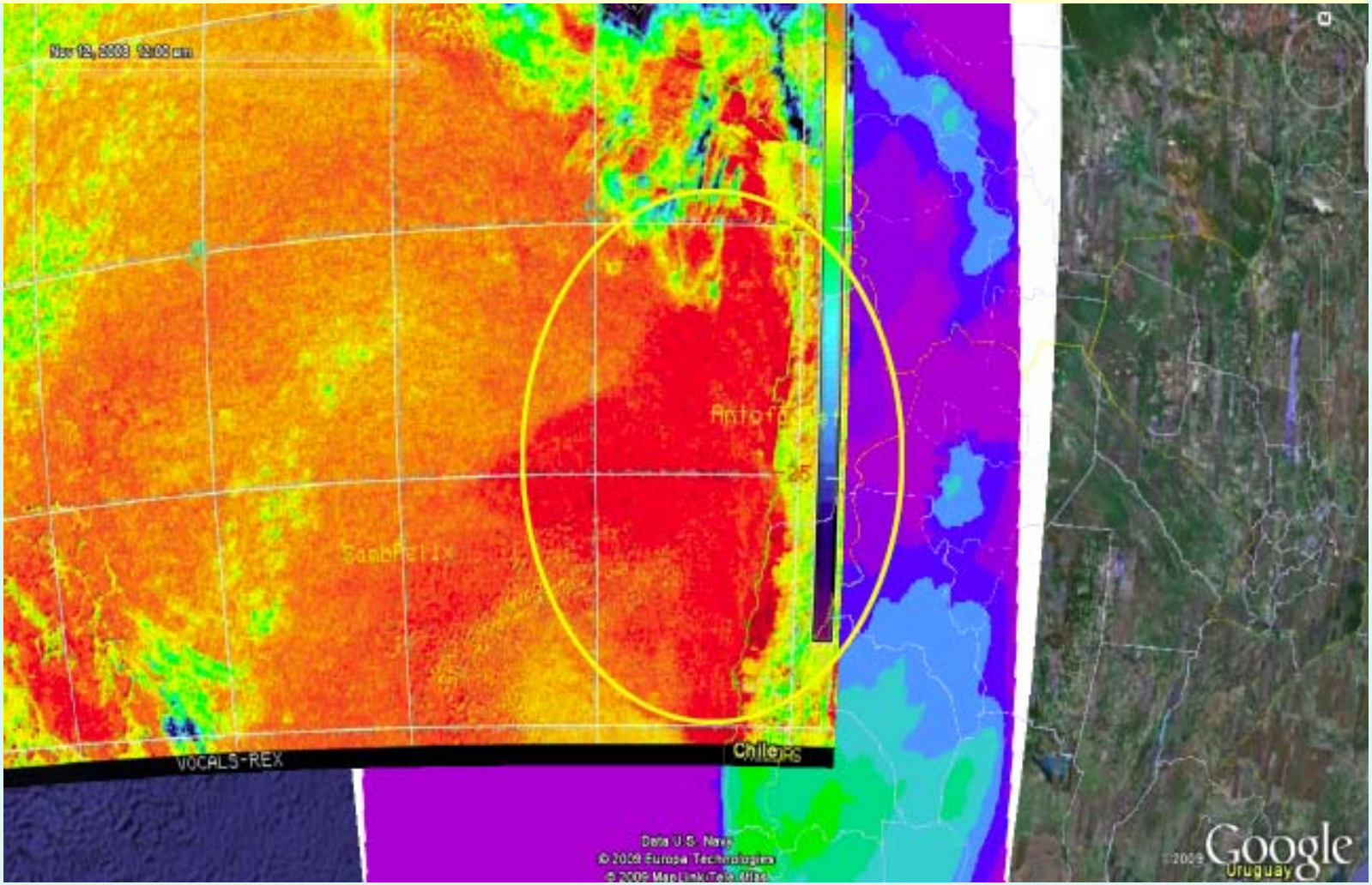
RF12 (11/11/2008)

Pollutant outflow from central Chile

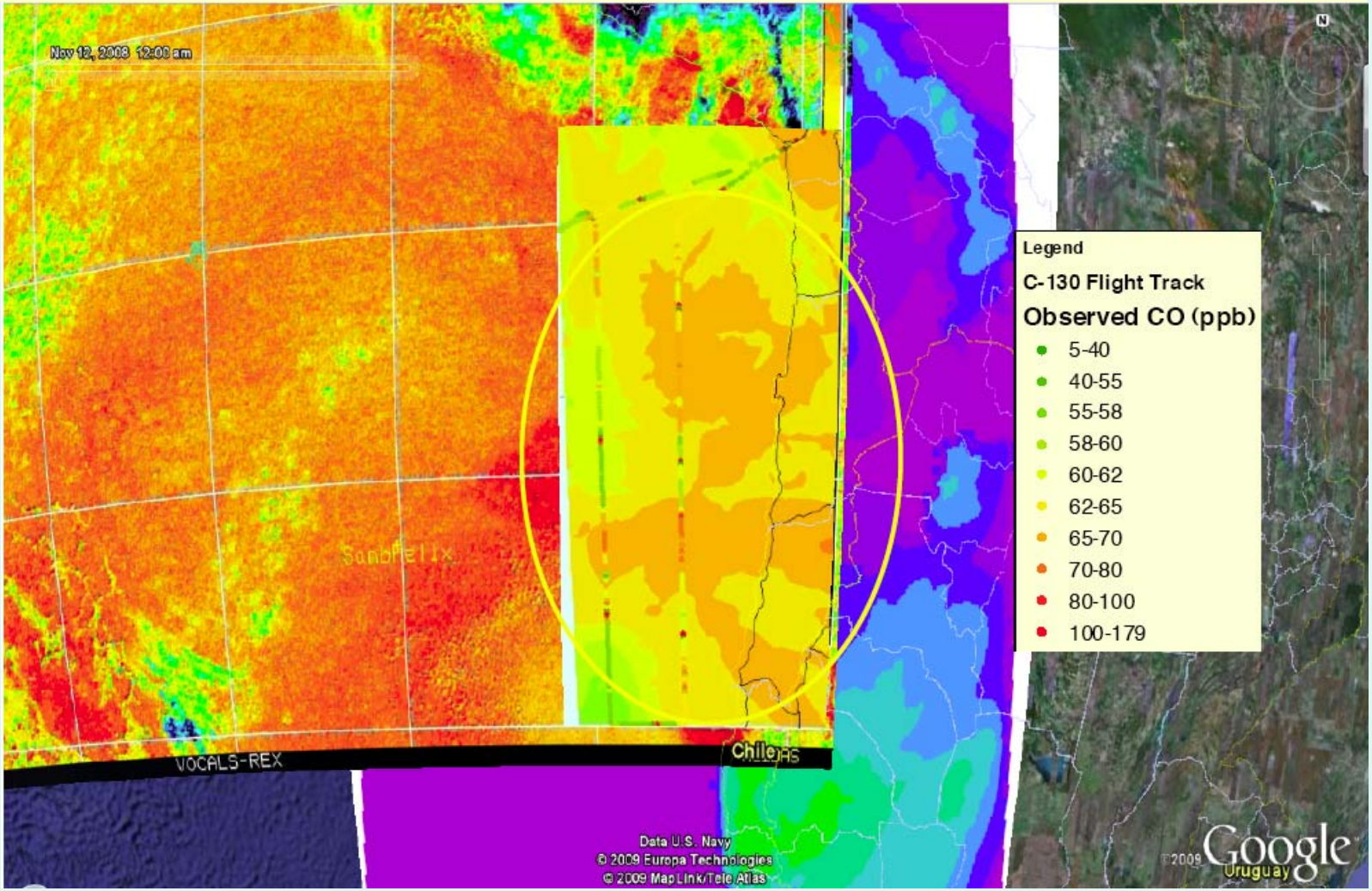


catabatic winds
entrained above MBL
mean flow advection

CO outflow correlated w/ GOES bright tongue (low effective radii)

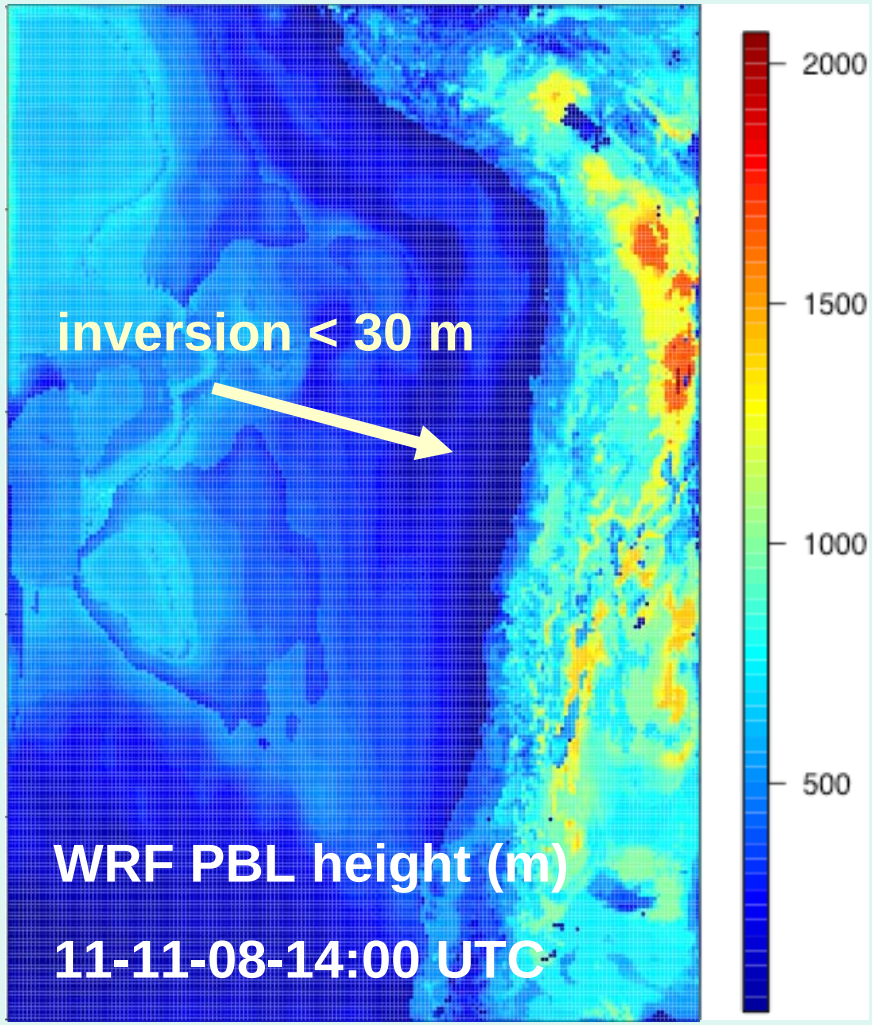


Forecast STEM spatial gradients consistent w/C-130 observations



Meteorology for Chemical Transport

- Updated to WRF3.1
- Expanded 12 km domain
  - full coverage for 20º S flight legs
  - south to fully capture Central Chile emissions & coastal flow
  - 4km sub-nests
- New physics configuration
  - optimized for chemical transport and vertical mixing
  - Pleim-Xu LSM, ACM2 PBL
  - more realistic marine inversion, cloud height, diurnal PBL & land-sea cycle

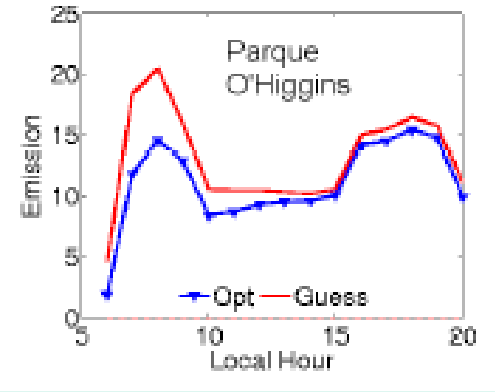


Emissions Inventory Evolution

	VOCALS-REx Forecasting	VOCALS 2.0
Large Point Sources	2000-2005 (Gallardo/U. Chile)	2008 reported (CODELCO, CONAMA)
Anthropogenic Area Sources	1º EDGAR 2000 w/BC & OC (Tami Bond) distributed to modeling grid by LandScan 2006 population surrogates	added Chile residential and mobile sectors for 2008 (CONAMA): CO, NOx, VOCs, SO_2, BC, OC, PM_{25}, PM_{10}, NH_3
Biogenics	None	Terrestrial: MEGAN Ocean: DMS (Grassian)
Caveats	• no biogenic emissions • changes in LPS emissions controls and uptime from 2007?	Not yet constrained by adjoint inversion of observations (DMS, SO_4, SO_2)
Status	Available; suitable for tracer & sulfur studies only	In QA/QC for release later in ***Q3 2009***

Notable Emissions Changes

- lower Chilean area emissions overall relative to EDGAR 2000
- updated CONAMA area emissions are realistic: total CO over Santiago within 8% in adjoint inverse dispersion modeling (*Saide et al.*, *ACPD*, 2009)
- higher LPS SO_2 emissions



Saide et al. (2009)

LPS Sector Definition	VOCALS-REx Forecasting	VOCALS 2.0	Notes
13 Largest Sources	416,568 tons/year	616,203 **(+48%)**	Negligible change at 7 of 13 sites
Total	416,568 tons/year	931,755 **(+124%)** now 1463 sources	no new Ilo estimates yet

What we can provide

- **Model Meteorology**
  - 12km regional WRF for all of 2008
  - nesting to higher-resolution studies
- **Emissions**
  - evaluated and QC'd (2009)
  - SO_2 & DMS constrained by inversion of VOCALS-REx observations and NASA OMI SO_2 (2010)
- **Model Chemistry (STEM/WRF-CHEM)**
  - source attribution and tracers
  - hourly gas phase & aerosol concentrations, aerosol size distribution, and AOD (Q4 2009)
  - adjustments to deposition velocities for marine stratocumulus and POC areas