Using STILT to Estimate $\Delta\ P_{CO_2}$, P_{O_2}

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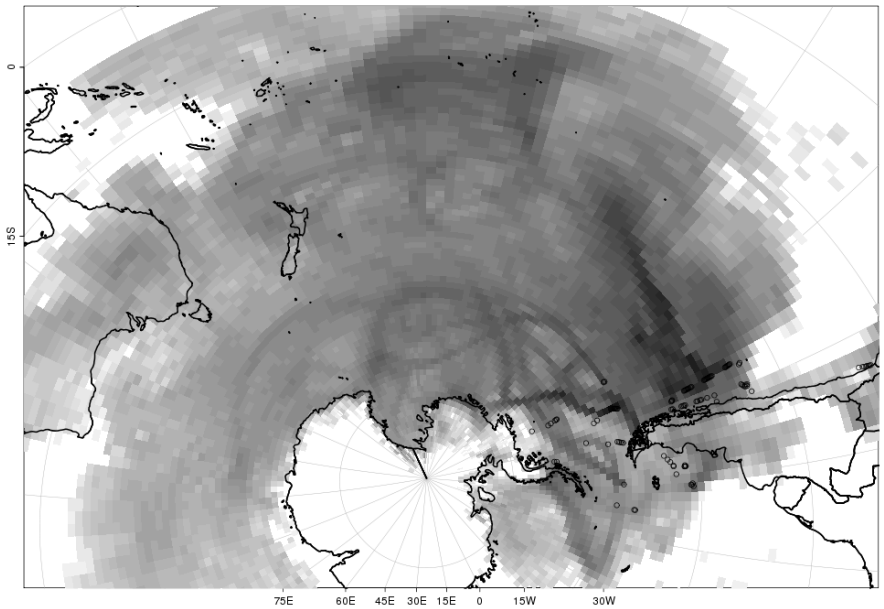
Climate & Space
College of Engineering
University of Michigan

September 7, 2016

1. STILT
2. TOGA Footprint
3. Convolution
4. Transport Estimation
5. Coming Attractions



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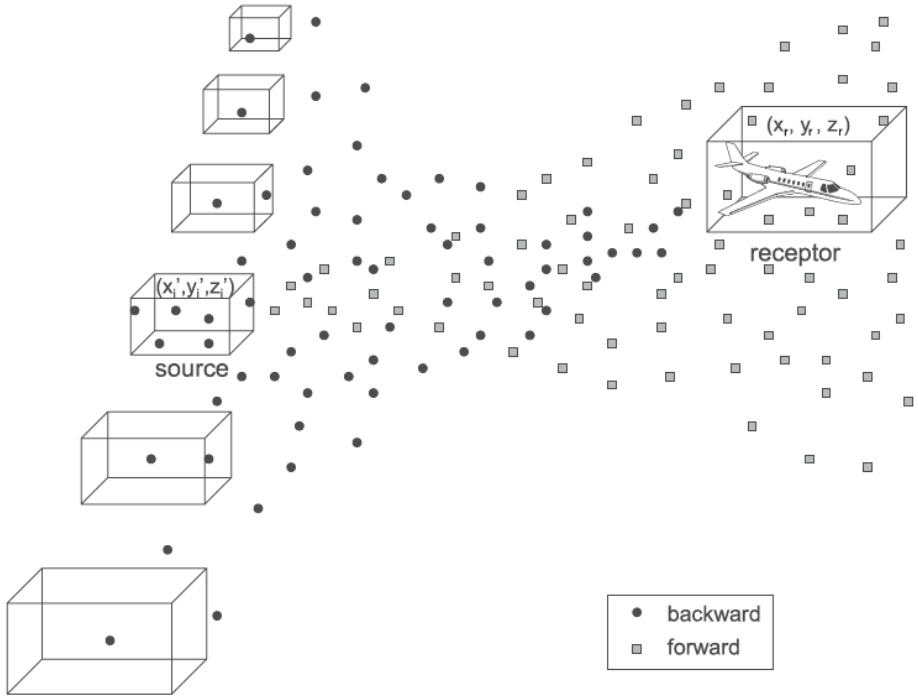
- STILT Leverages the HYSPLIT Model from NOAA ARL Stein et al. (2015)
- Air-Sea interaction footprints are calculated using STILT
- Footprint $= \Delta$Concentration/flux



Lin et al. (2003)

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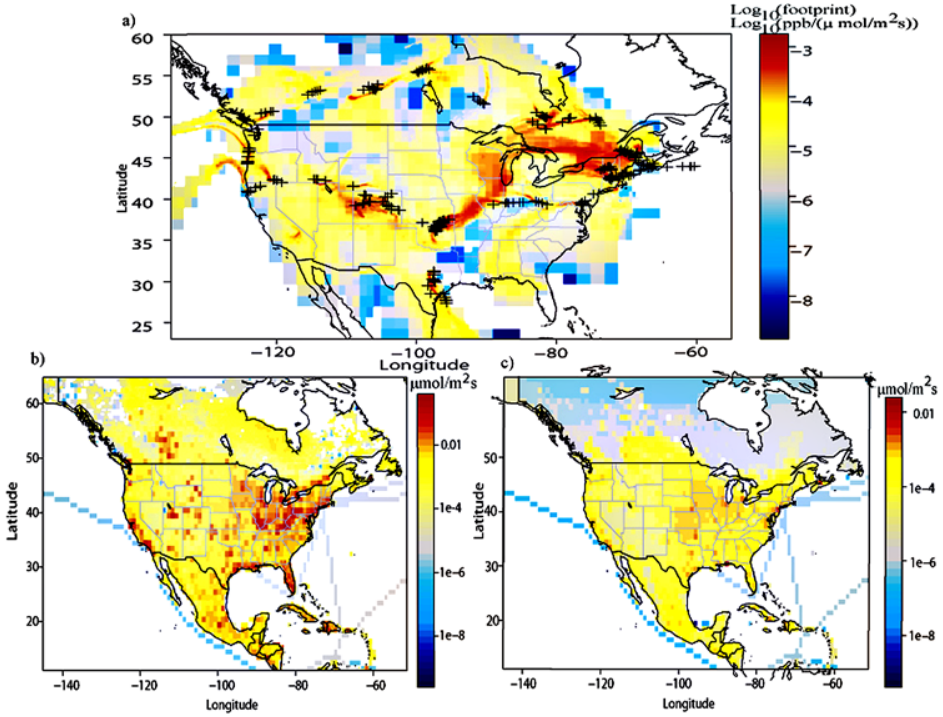

Kort et al. (2008)

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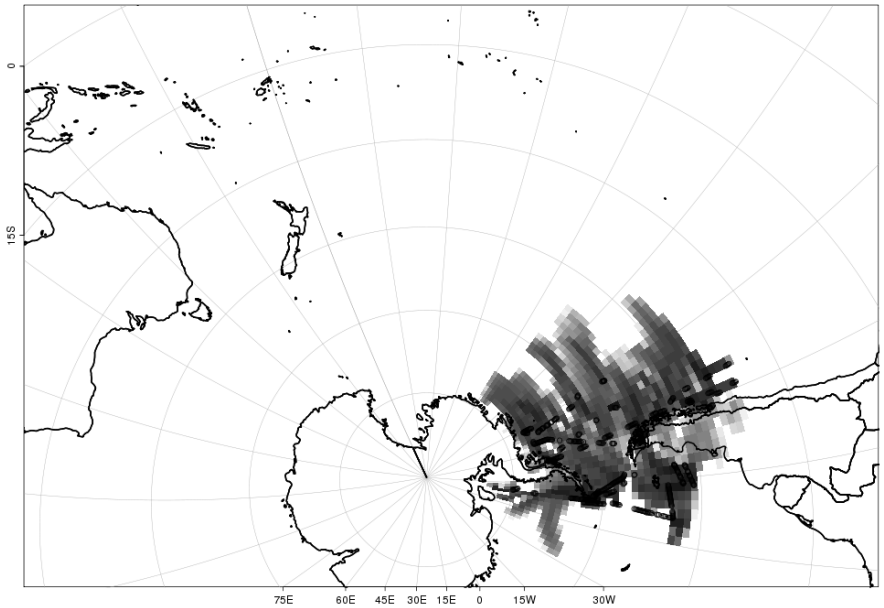
- Receptors at TOGA Observations
  - Non-zero footprints plotted
- 4096 Particles
- 0.5° GDAS Re-analysis wind Field
- Some long simulations fail : (

One (1) Day Area of Influence



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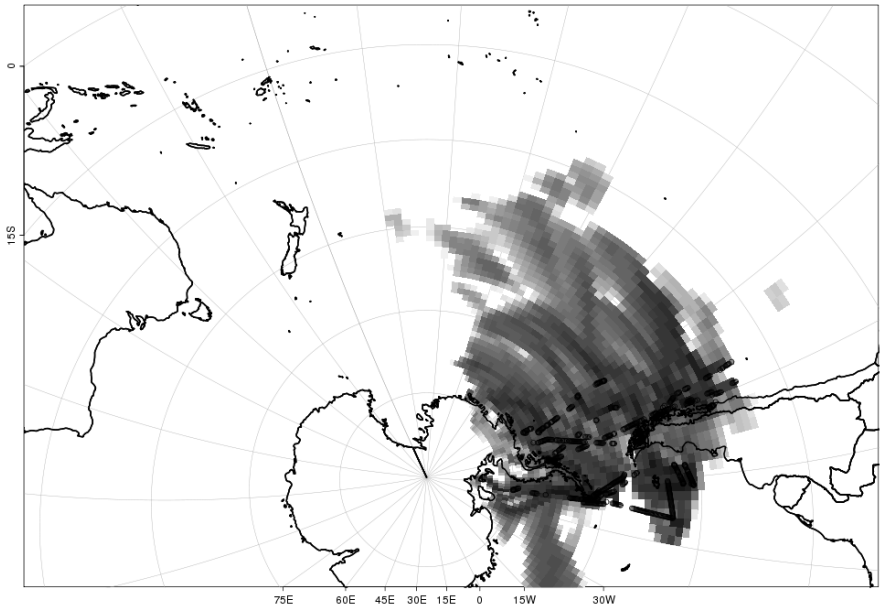
Two (2) Day Area of Influence



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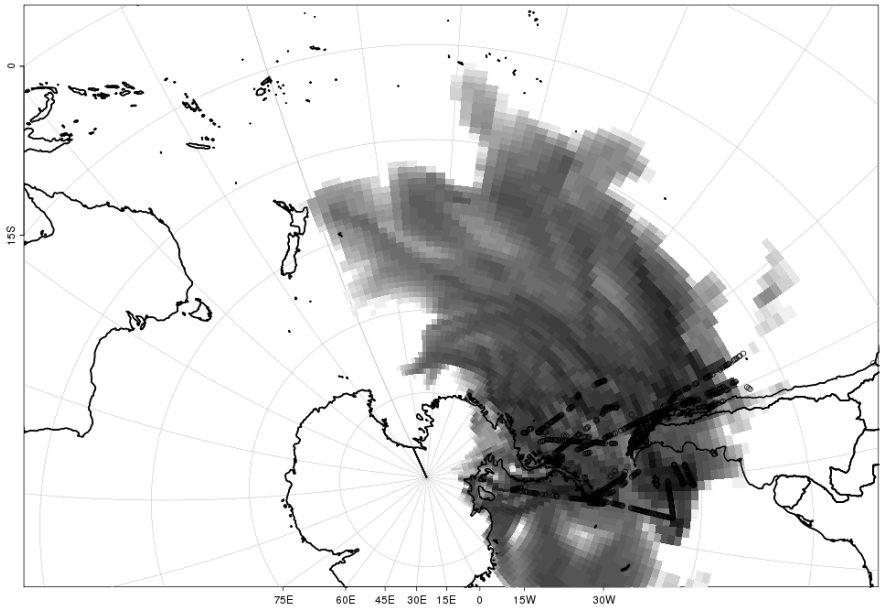
Three (3) Day Area of Influence



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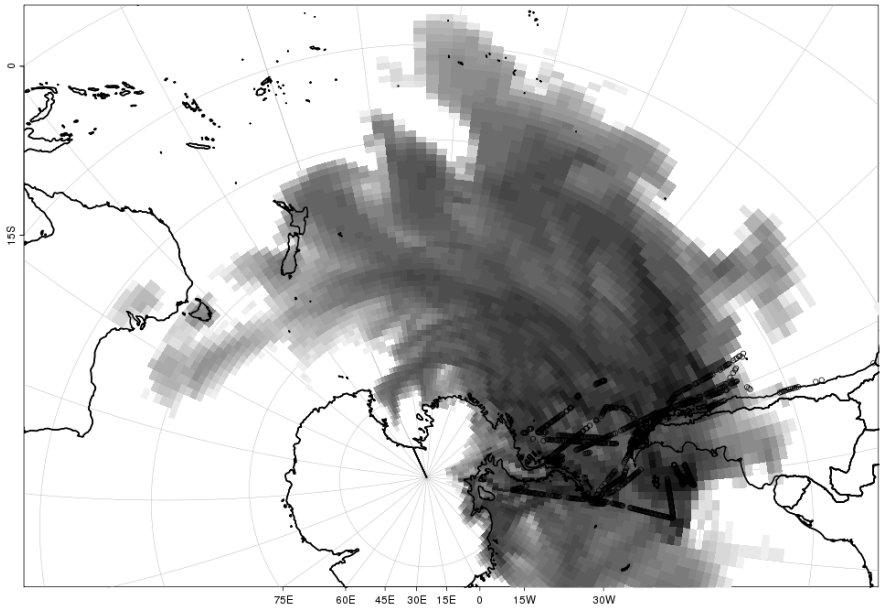
Four (4) Day Area of Influence



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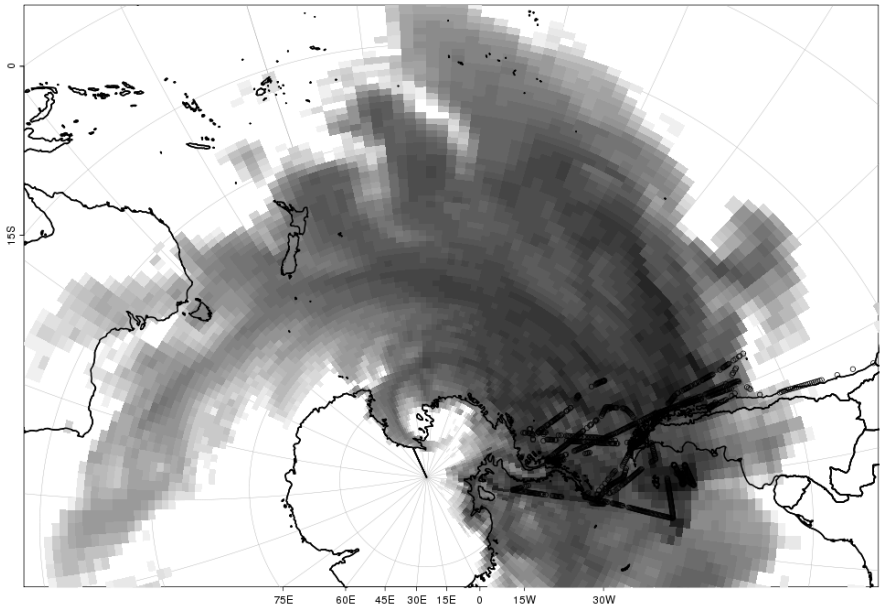
Five (5) Day Area of Influence



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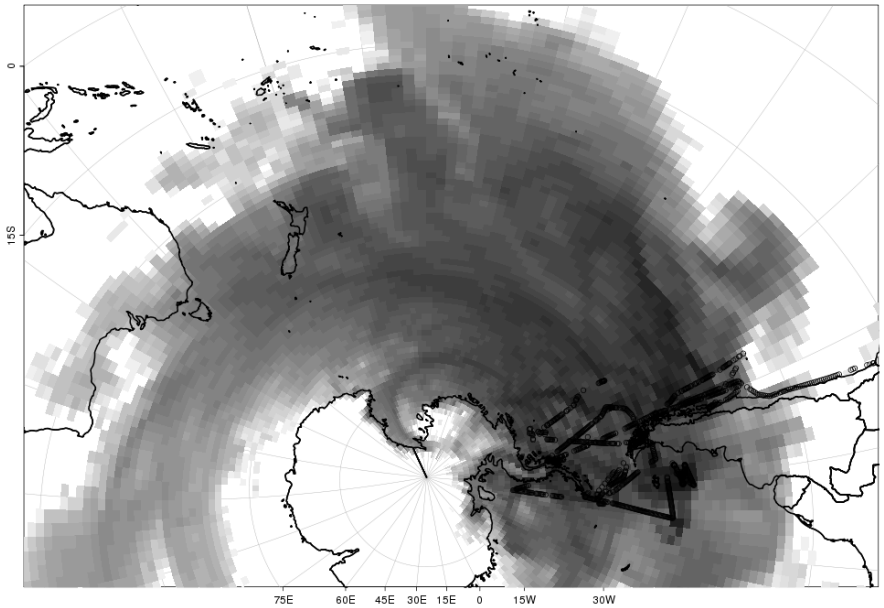
Six (6) Day Area of Influence



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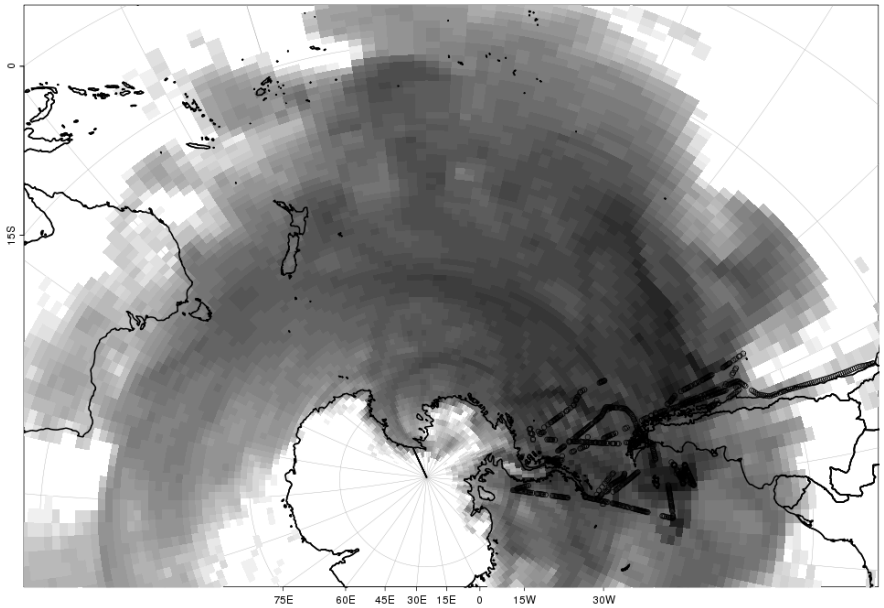
Seven (7) Day Area of Influence



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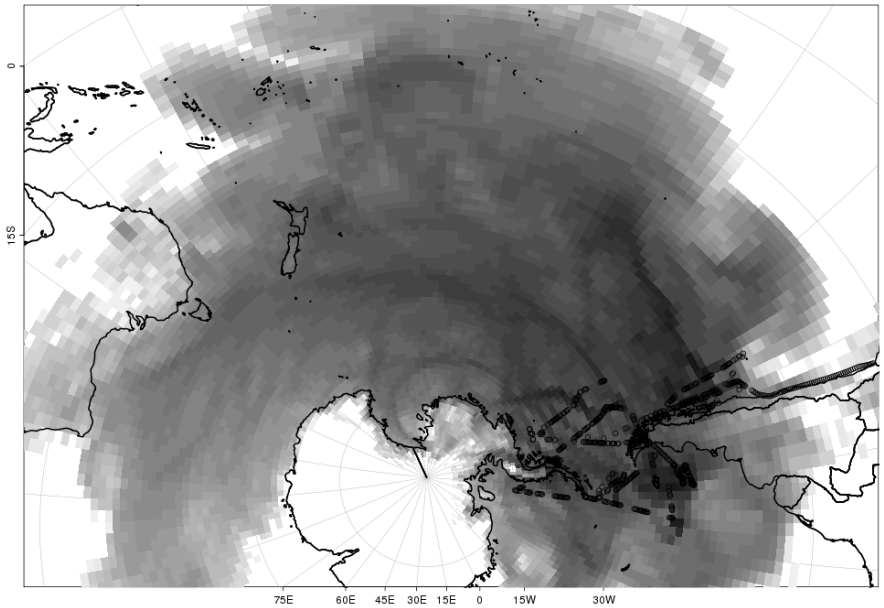
Eight (8) Day Area of Influence



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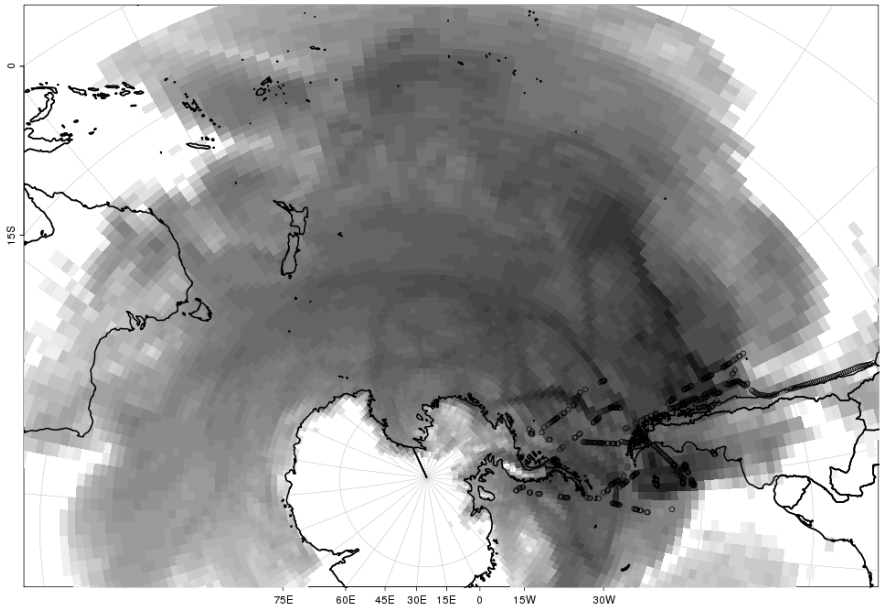
Nine (9) Day Area of Influence



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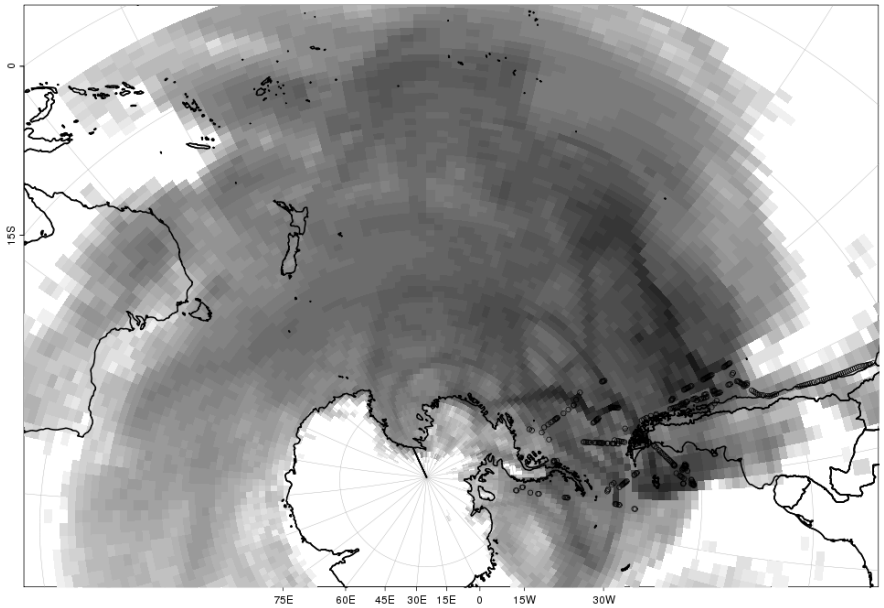
Ten (10) Day Area of Influence



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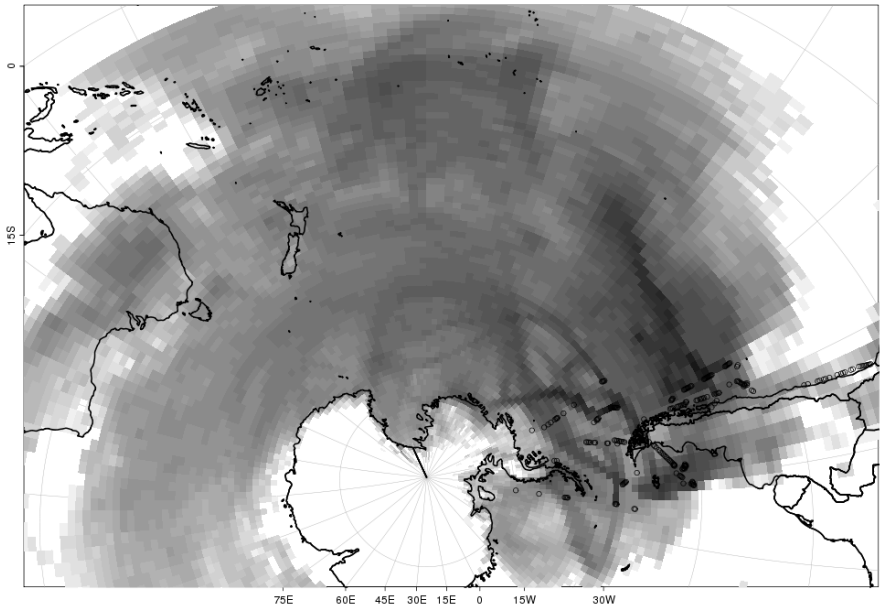
Eleven (11) Day Area of Influence



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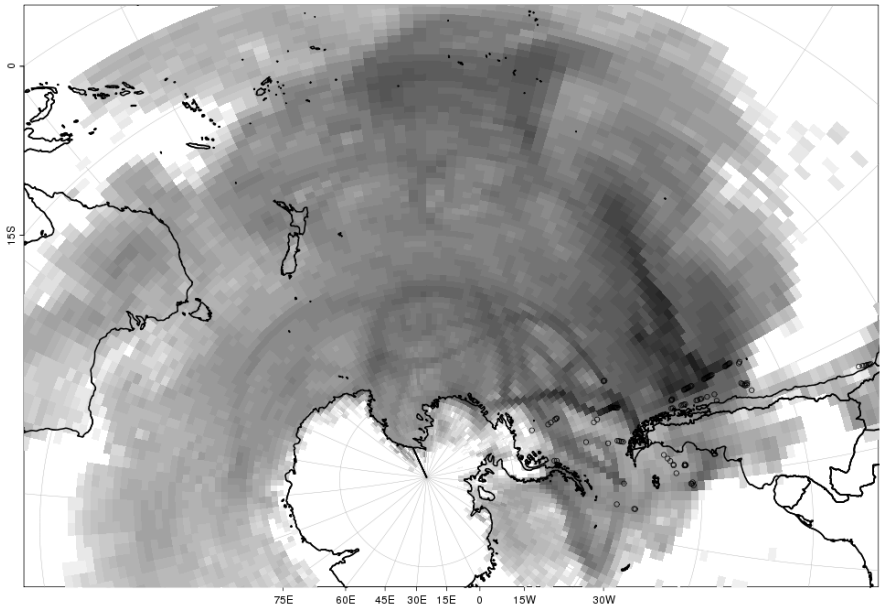
Twelve (12) Day Area of Influence



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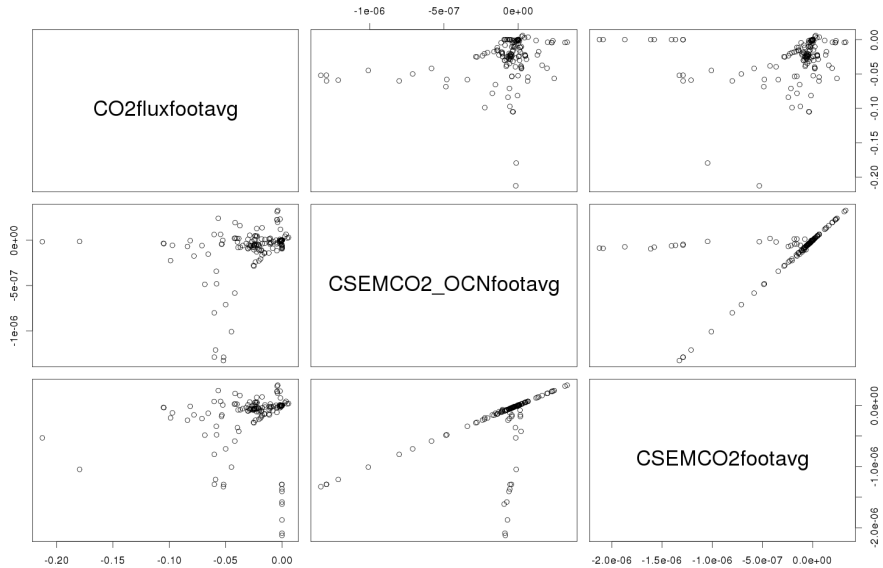
- Convolove Footprint with
  - CO_2, O_2 flux Climatologies
  - CSEM fluxes
  - O_2 surface saturation concentration
  - Sea Surface Salinity/Temperature
  - ...
- Estimate ΔCO_2 and ΔO_2



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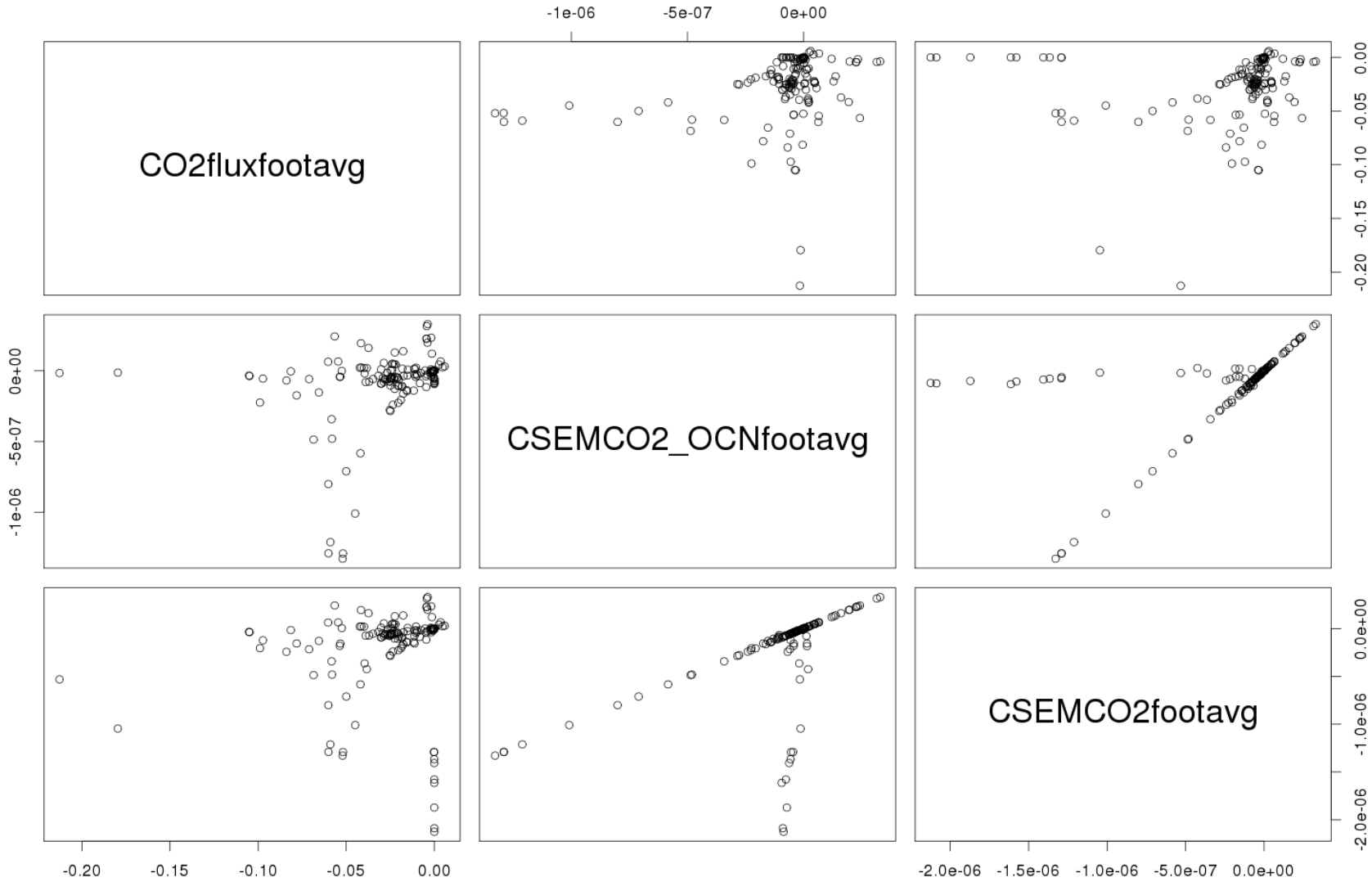
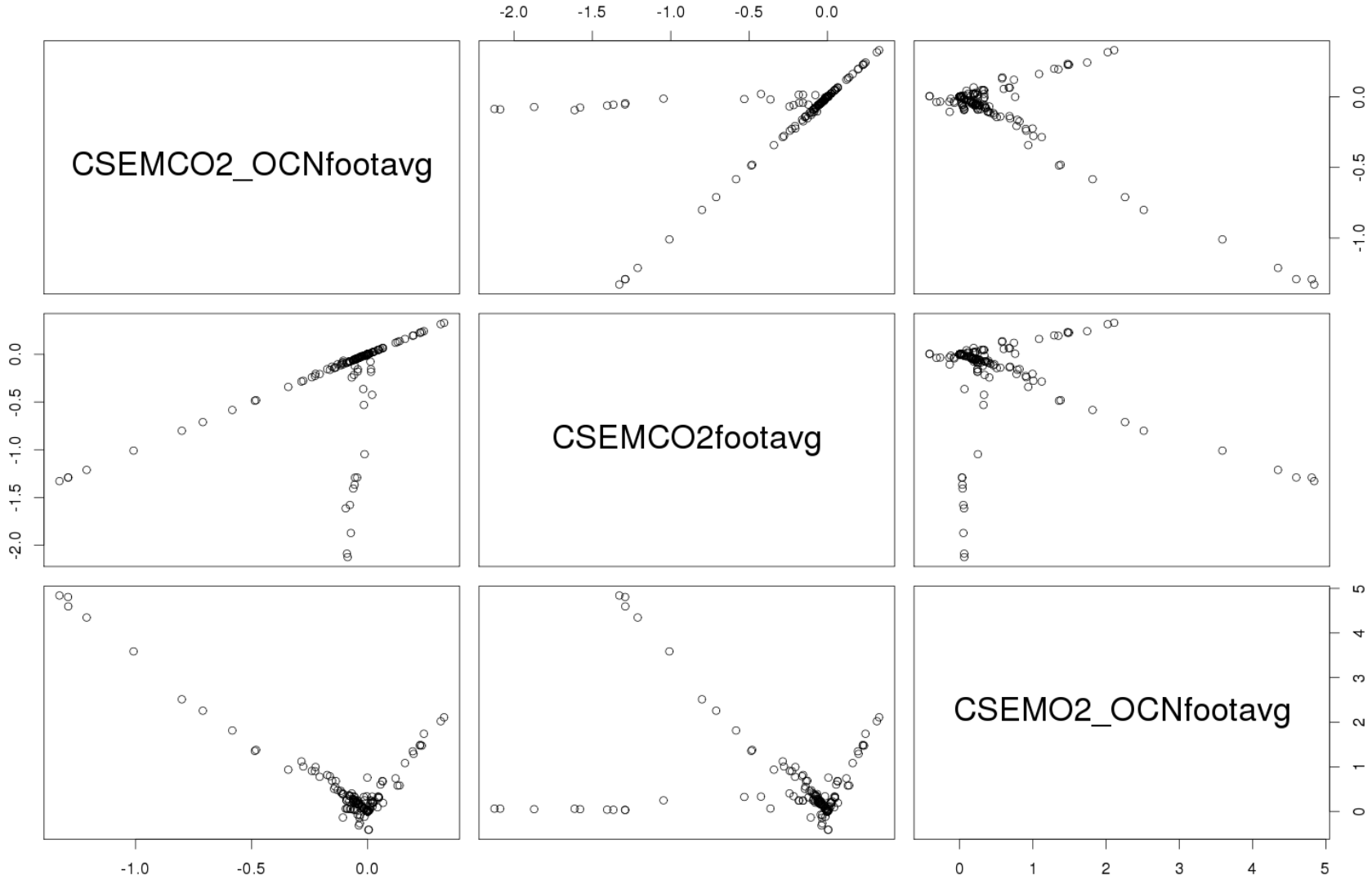
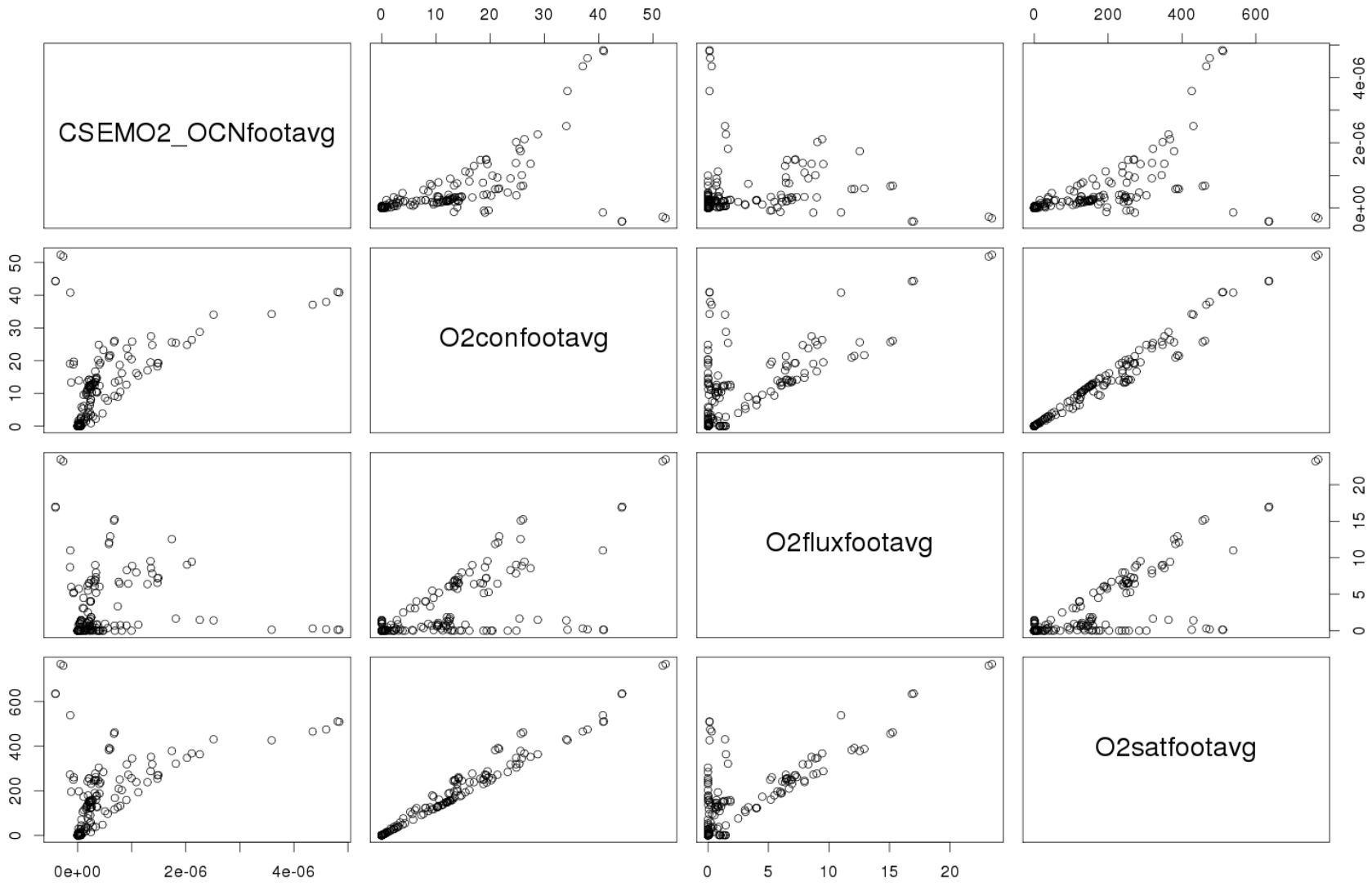
CO_2 fluxes


CO2fluxfootavg
CSEMCO2_OCNfootavg
CSEMCO2footavg
-1e-06
-5e-07
0e+00
-0.20
-0.15
-0.10
-0.05
0.00
-2.0e-06
-1.5e-06
-1.0e-06
-5.0e-07
0.0e+00

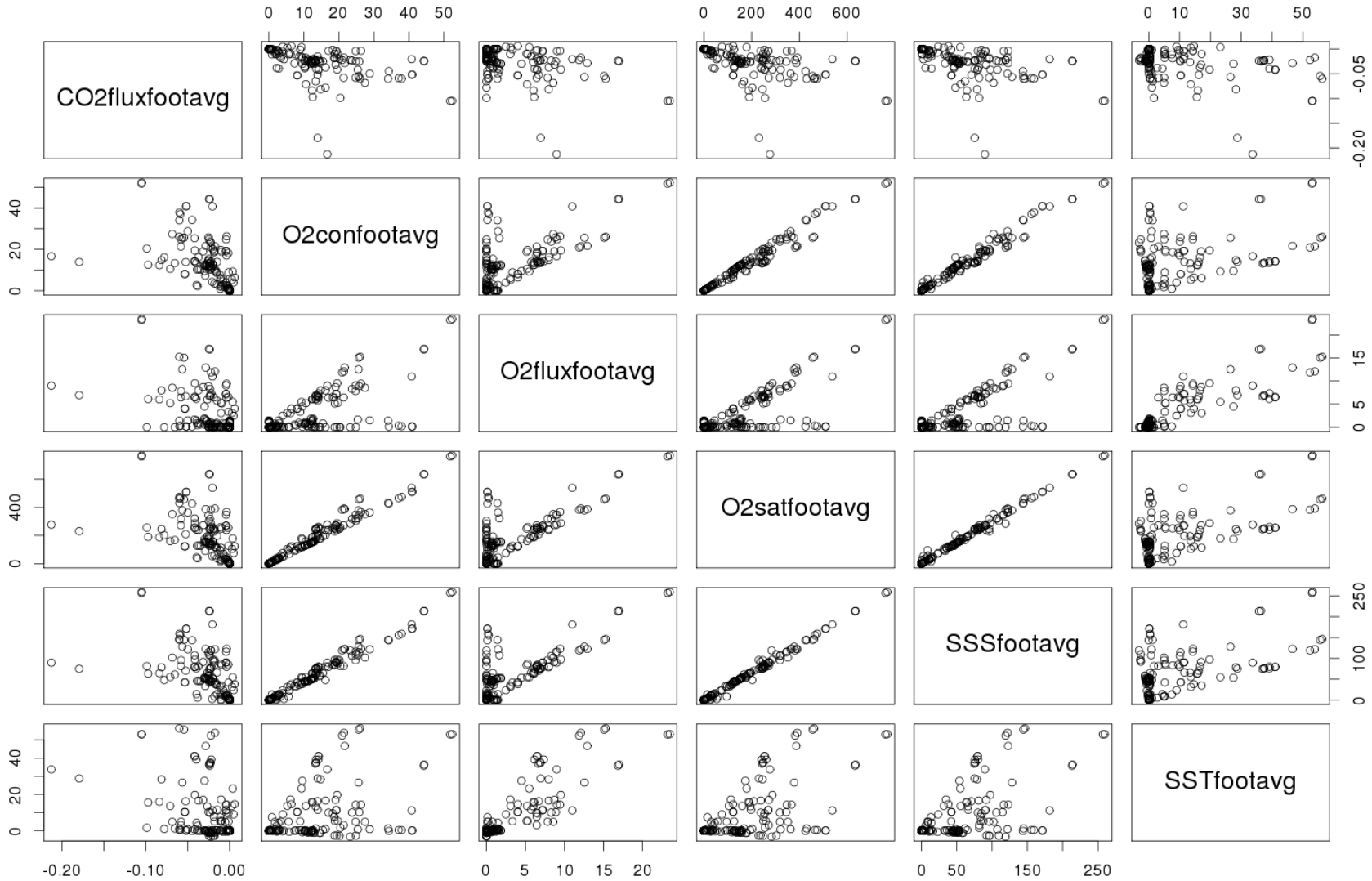
CSEM fluxes


CSEMCO2_OCNfootavg
CSEMCO2footavg
CSEMO2_OCNfootavg
-2.0
-1.5
-1.0
-0.5
0.0
0
1
2
3
4
5

O_2 fluxes

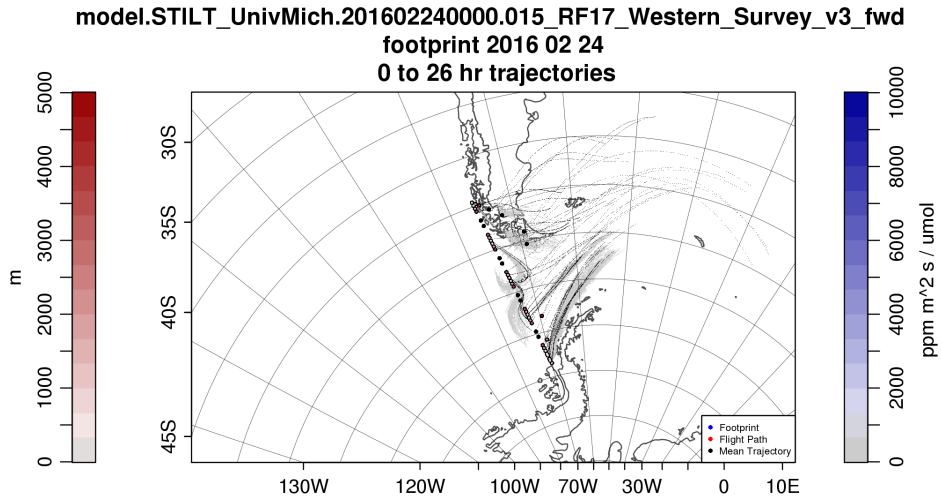

CSEMO2_OCNfootavg
O2confootavg
O2fluxfootavg
O2satfootavg
0
10
20
30
40
50
0
200
400
600
0e+00
2e-06
4e-06
0
5
10
15
20

Climatology



Test Case

- Lagrangian Bracket flights
- February 24, and 25 2016
- Spans Palmer Long Term Ecological Research Network
- Observed $\sim$ 0.1 ppm Draw Down



ORCAS Field Catalog `http://catalog.eol.ucar.edu/orcas`

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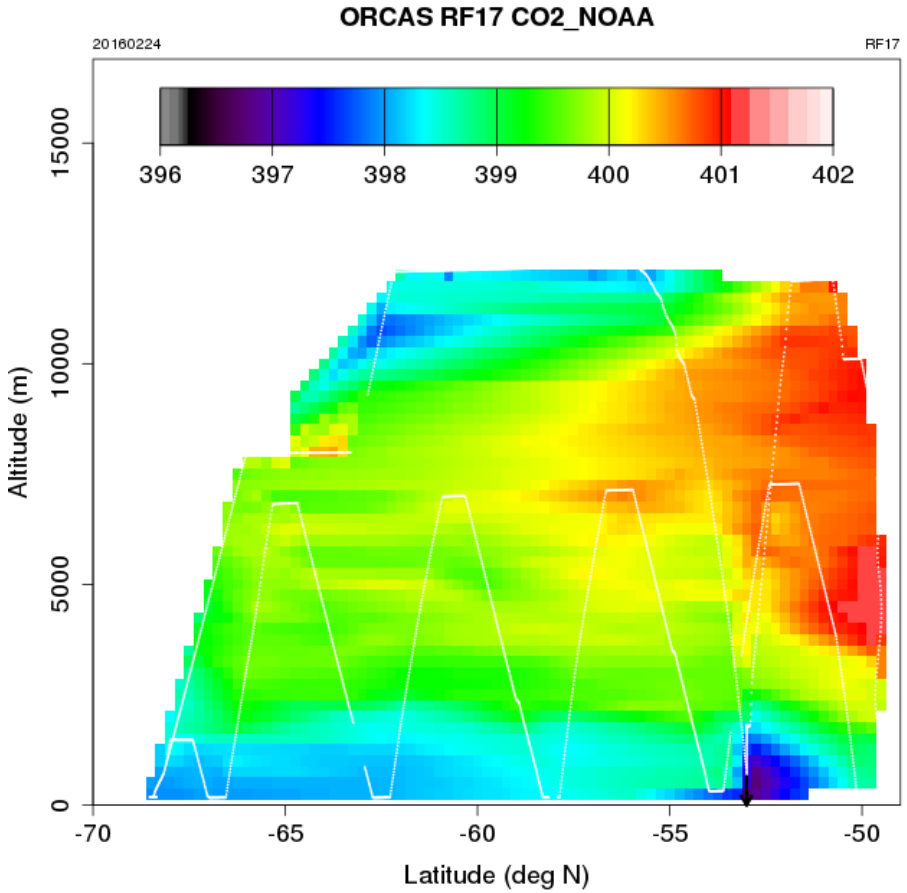

B. Stephens *Preliminary ORCAS Data*

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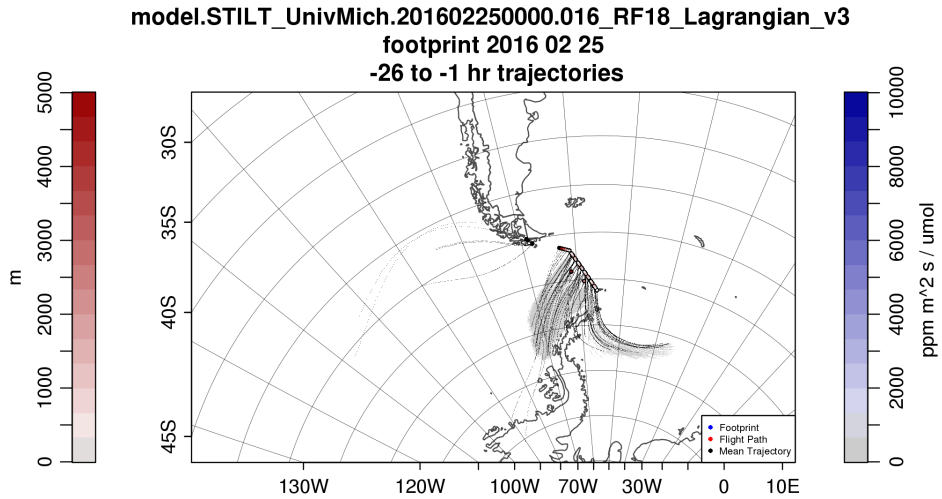

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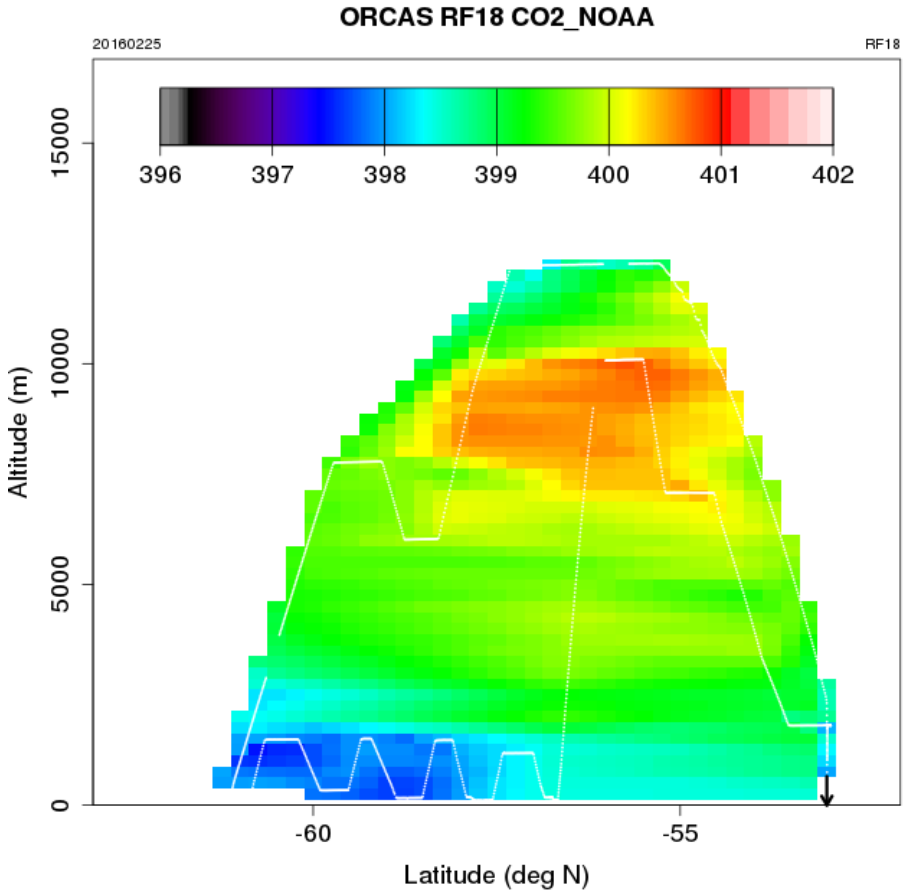

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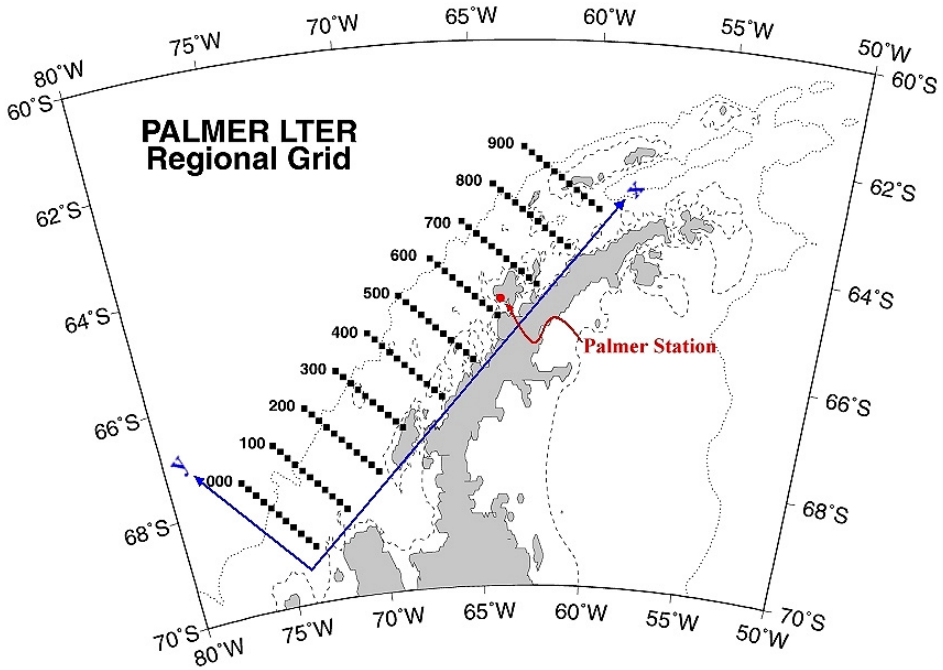

Palmer Long-Term Ecological Research Network

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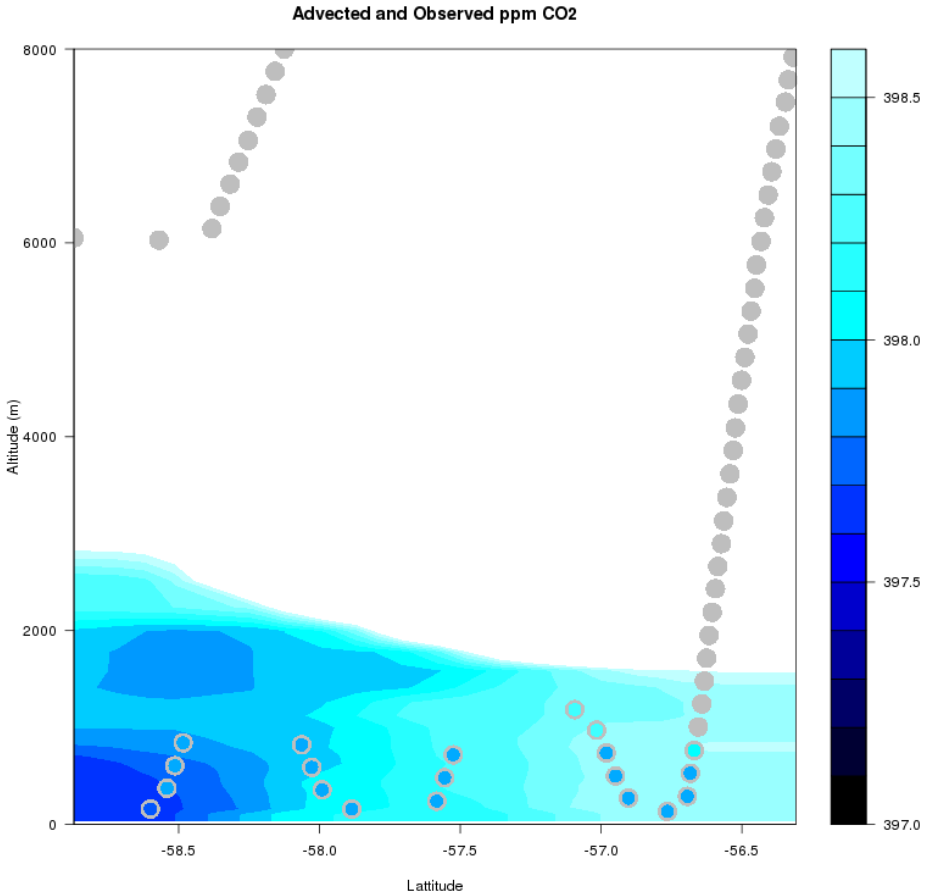

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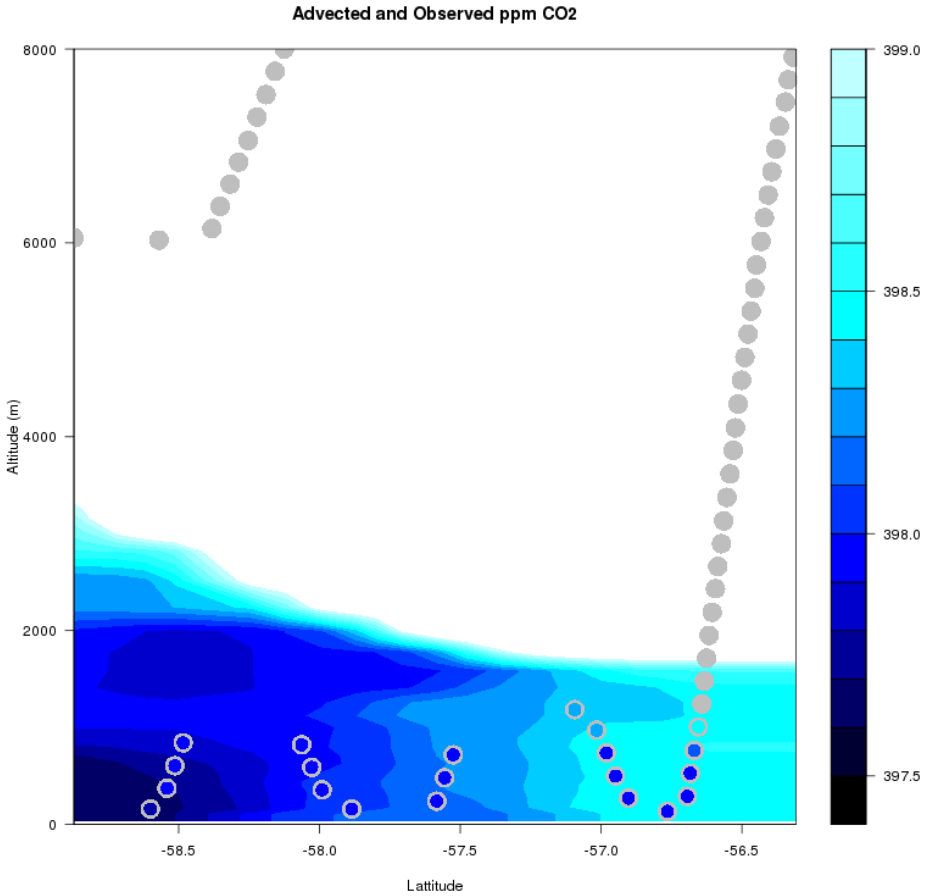

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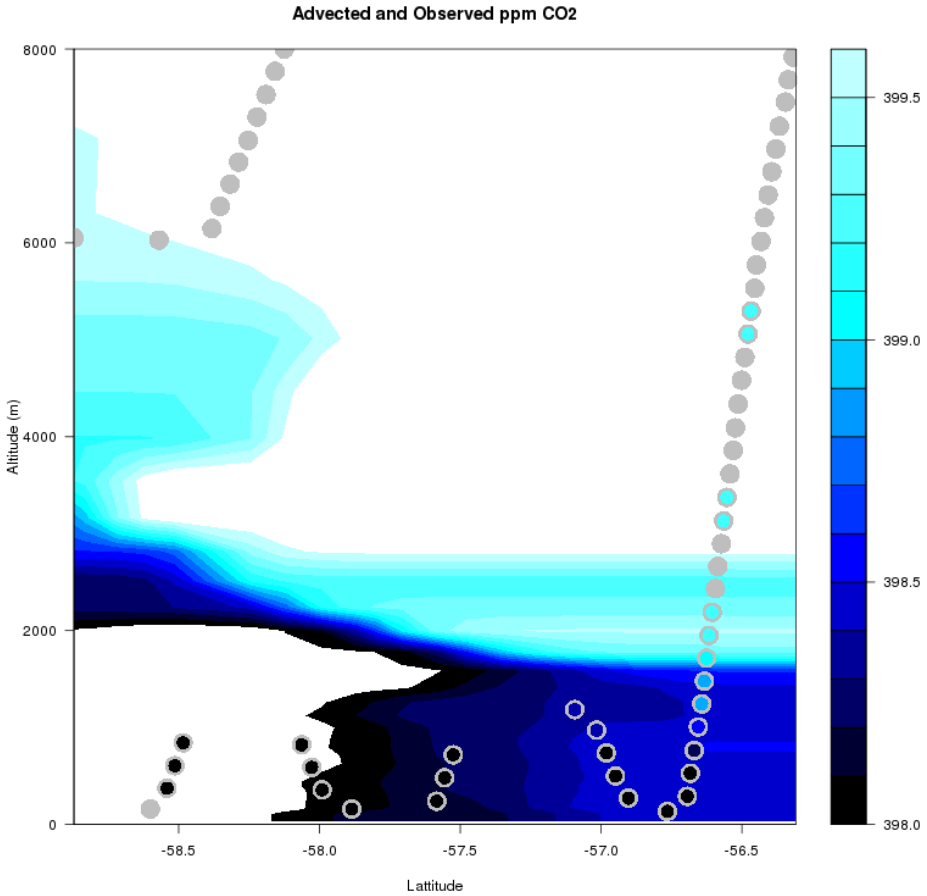

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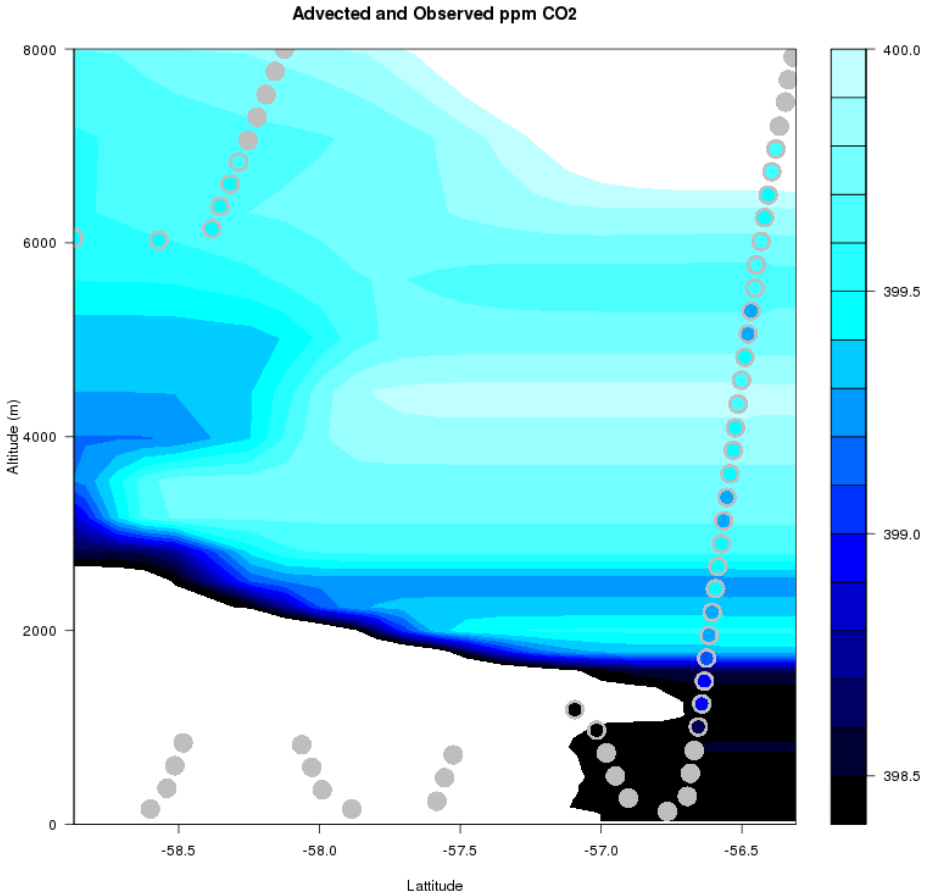

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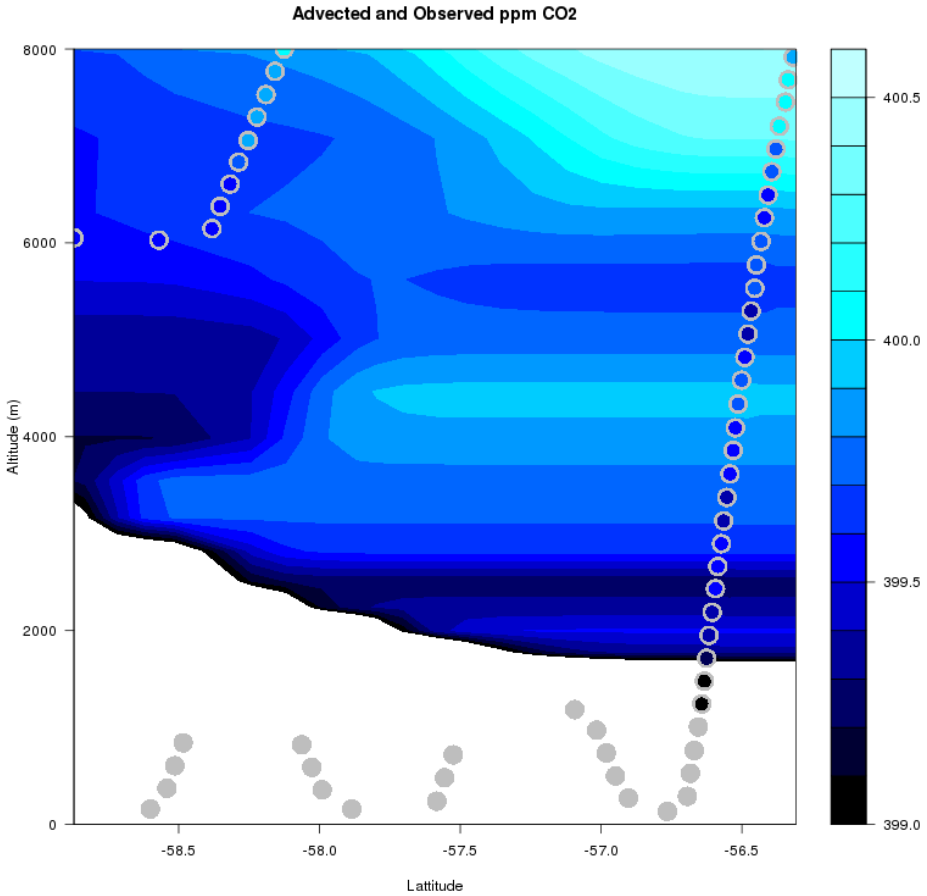

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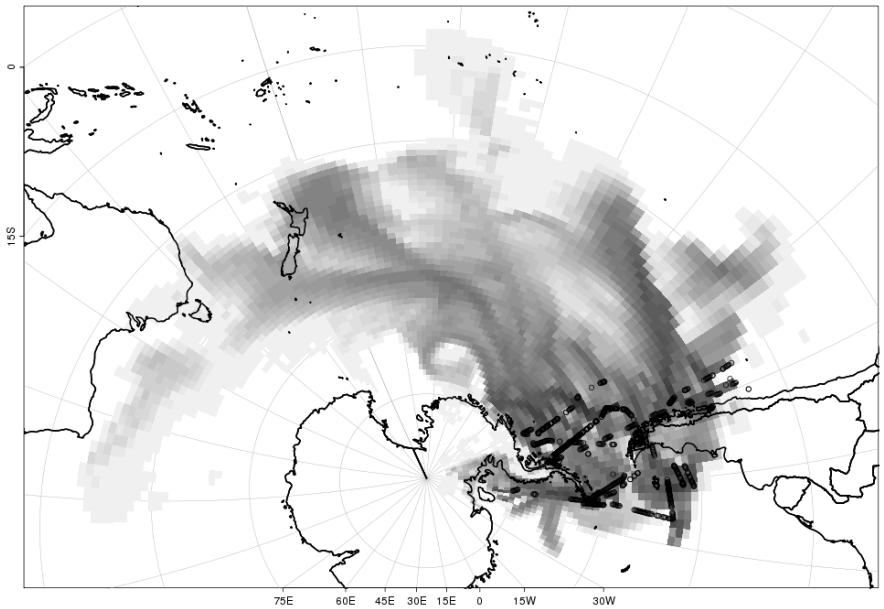
- Constrain Fluxes
  - 24 hour time scale
  - week time scale
- Other Initial Conditions
  - Upwind Ground stations
  - ORCAS Free Troposphere Obs.
  - Model Output
  - *Other Suggestions?*



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Questions

Kort, E. A., Eluszkiewicz, J., Stephens, B. B., Miller, J. B., Gerbig, C., Nehrkorn, T., Daube, B. C., Kaplan, J. O., Houweling, S., and Wofsy, S. C. (2008). Emissions of CH_4 and N_2O over the United States and Canada based on a receptor-oriented modeling framework and COBRA-NA atmospheric observations. *Geophysical Research Letters*, 35(18):n/a–n/a. L18808.

Lin, J., Gerbig, C., Wofsy, S., Andrews, A., Daube, B., Davis, K., and Grainger, C. (2003). A near-field tool for simulating the upstream influence of atmospheric observations: The stochastic time-inverted lagrangian transport (stilt) model. *Journal of Geophysical Research: Atmospheres*, 108(D16):n/a–n/a. 4493.

Stein, A. F., Draxler, R. R., Rolph, G. D., Stunder, B. J. B., Cohen, M. D., and Ngan, F. (2015). Noaas hysplit atmospheric transport and dispersion modeling system. *Bulletin of the American Meteorological Society*, 96(12):2059–2077.