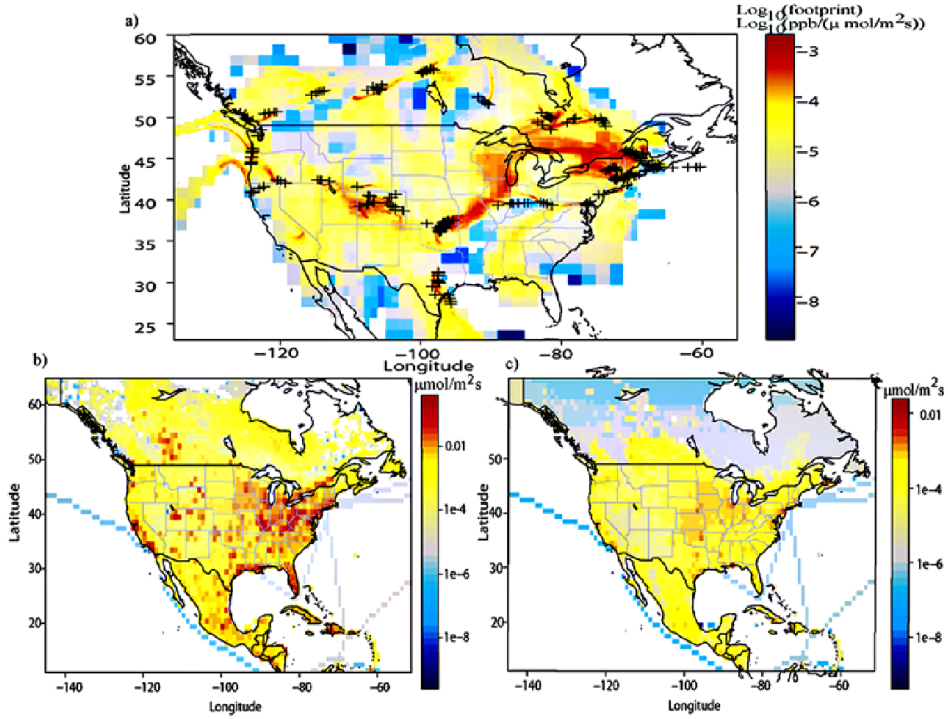
STILT Modeling Update

Martín Hoecker-Martínez

University of Michigan

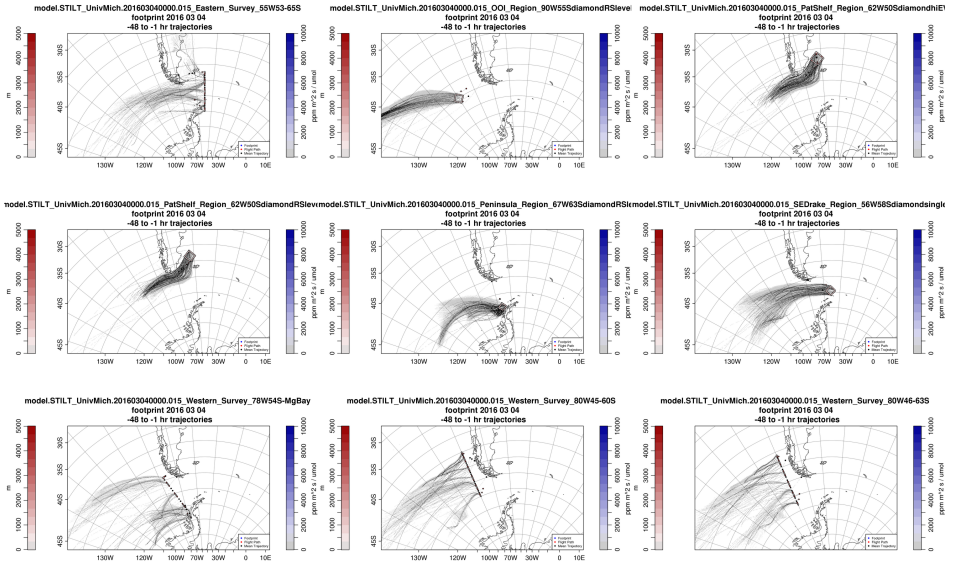
Prepared May 10, 2016

- Following Kort 2008
  - Aircraft Observations
  - $\sim$ 6 day Back Trajectories
  - Initial Condition from Model at 145°W
  - Flux Inventories
- Results
  - Refined Land Flux Estimate

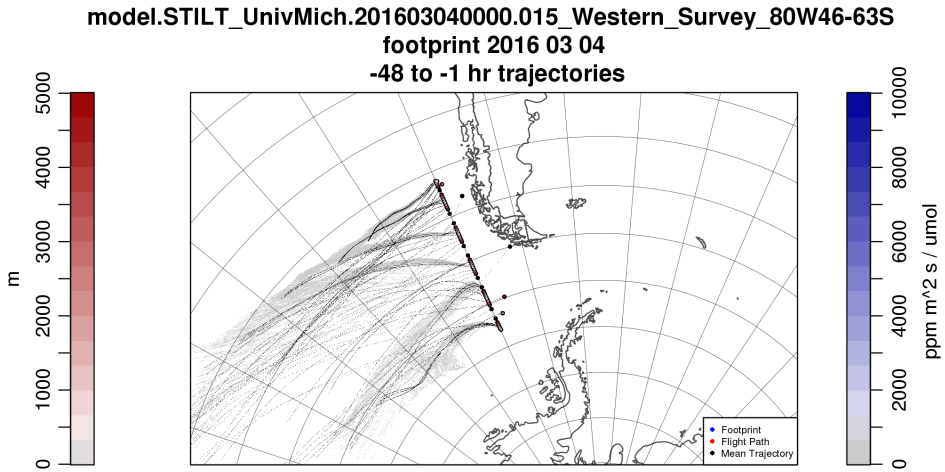


Kort et al. (2008)

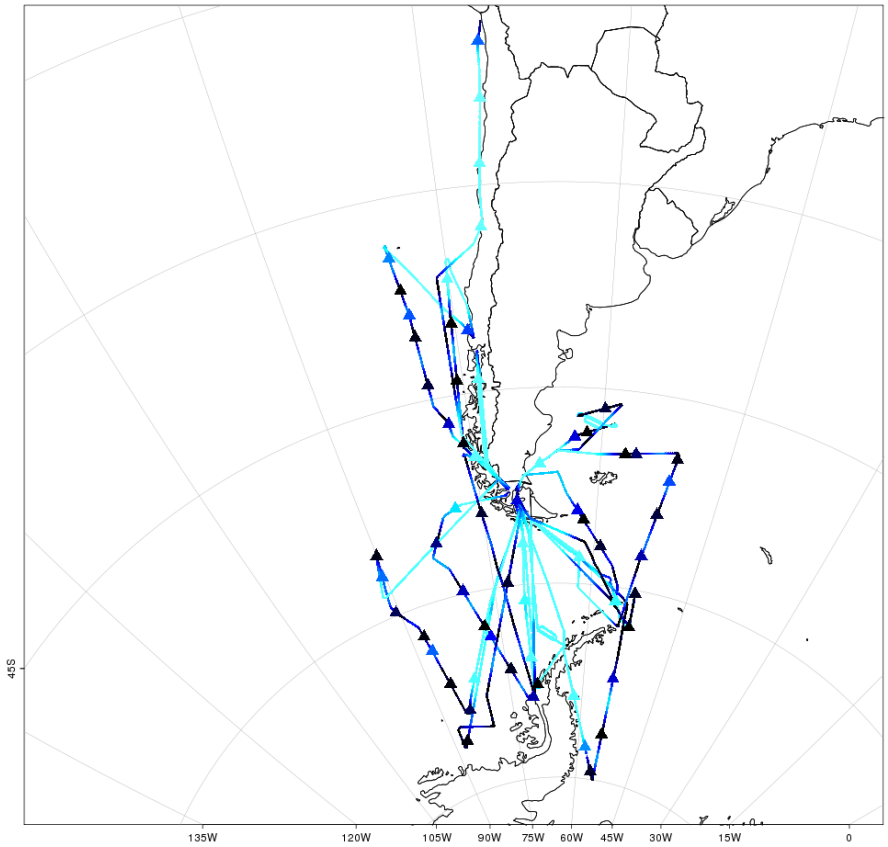
- Used Forecast Winds
- 48 hour back trajectories



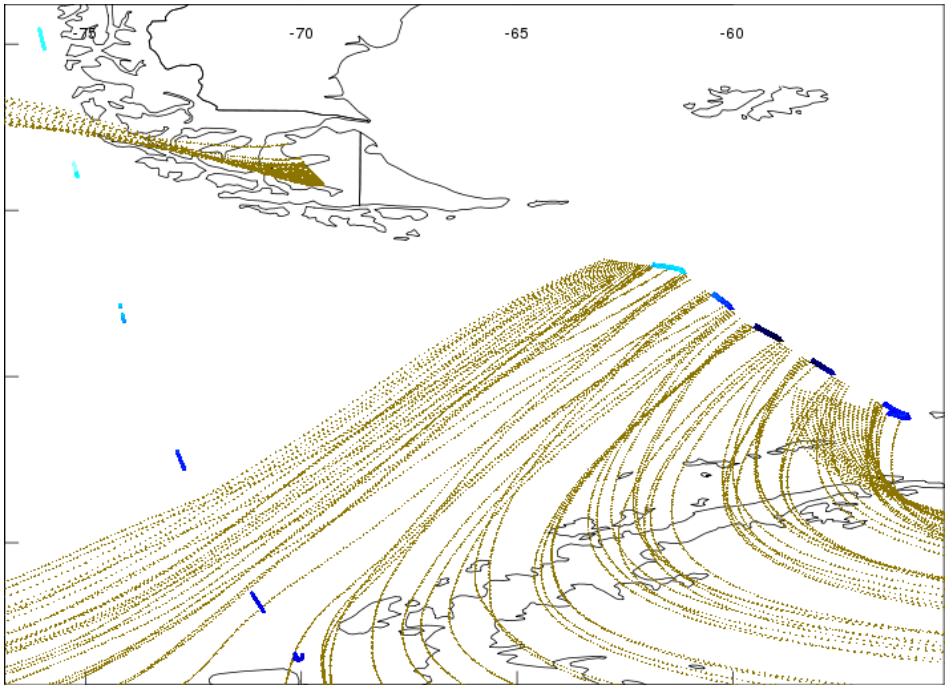
- Used Forecast Winds
- 48 hour back trajectories



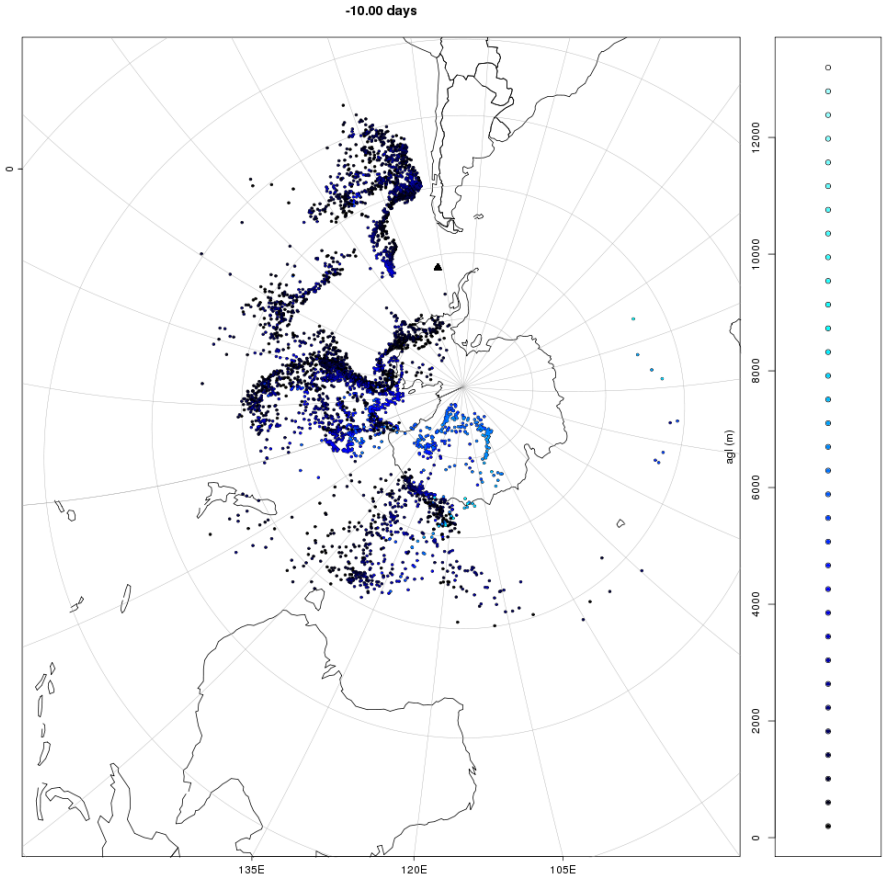
- Whole campaign $\sim$ 2 days
- Back to back flights $\sim$ 1 day
  - eg RF17 and RF18 CO_2
- Pacific Sector of Southern Ocean $\sim$ 10 days



- Whole campaign $\sim$ 2 days
- Back to back flights $\sim$ 1 day
  - eg RF17 and RF18 CO_2
- Pacific Sector of Southern Ocean $\sim$ 10 days



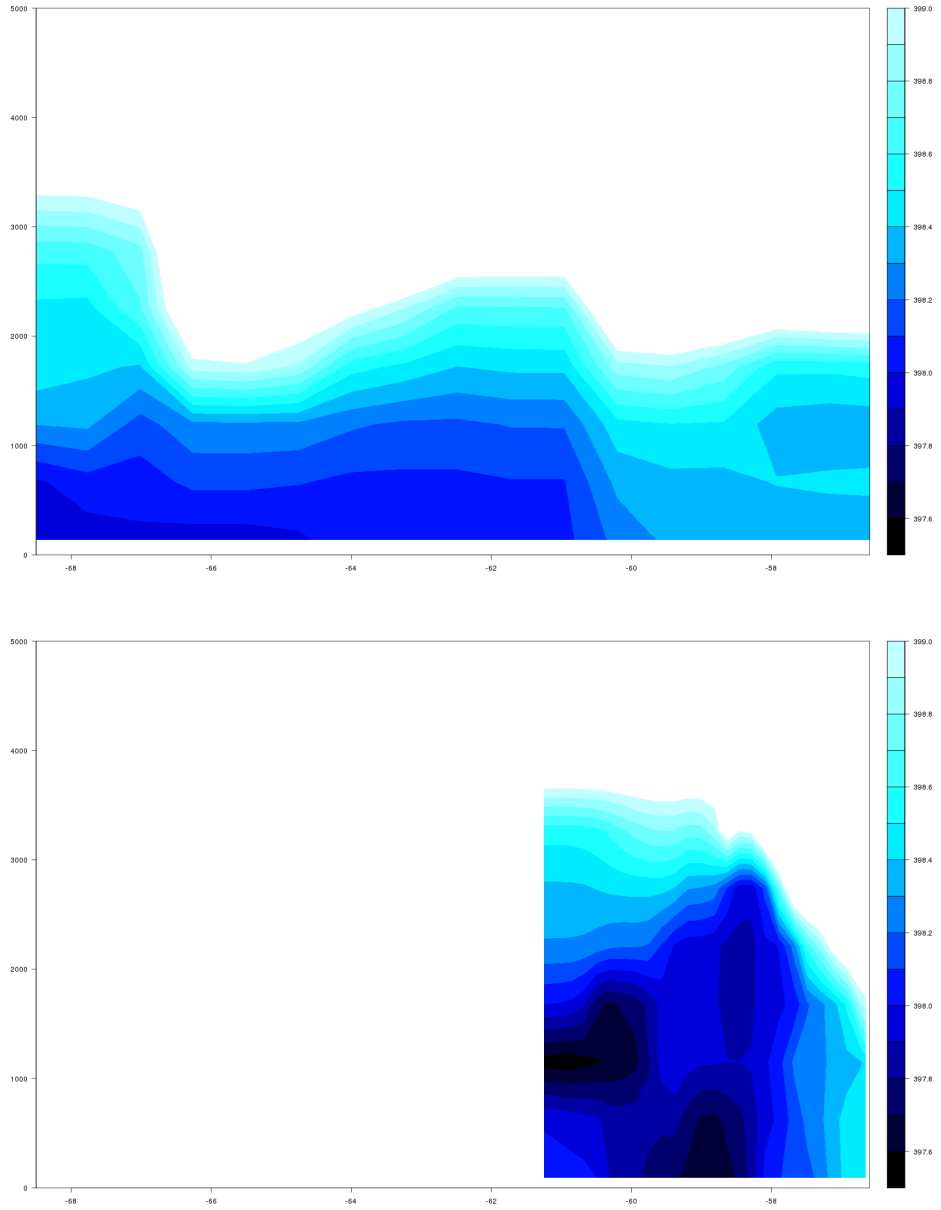
- Whole campaign $\sim$ 2 days
- Back to back flights $\sim$ 1 day
  - eg RF17 and RF18 CO_2
- Pacific Sector of Southern Ocean $\sim$ 10 days



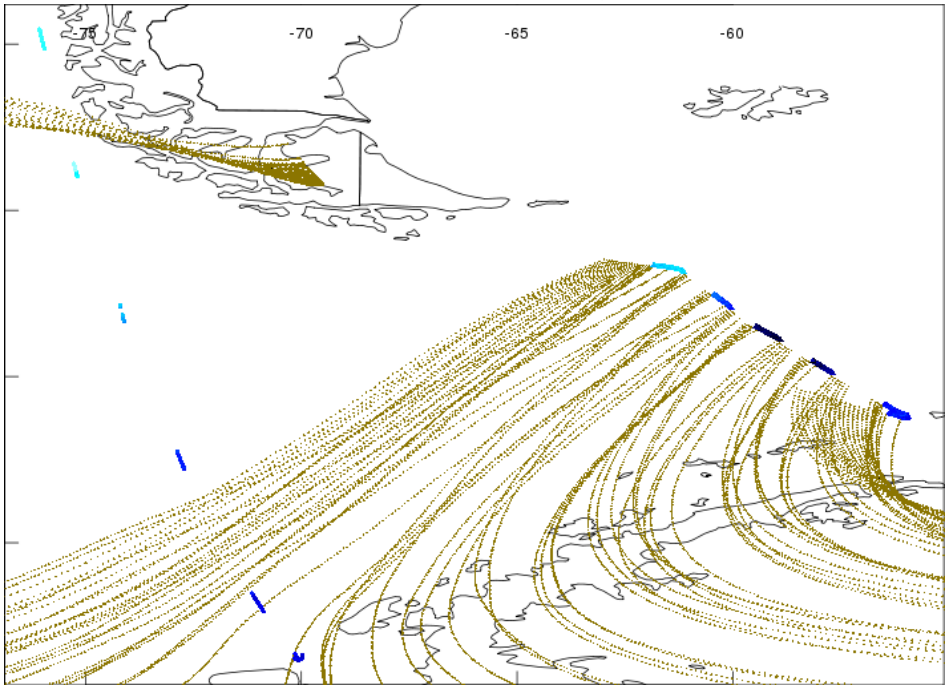
- Initial Optimized Flux Results
- Campaign scale $\mathrm{CO_2}$ & $\mathrm{O_2}$
  - Whole campaign Duration
  - 1^{st} vs 2^{nd} half?
- Back to back $\mathrm{CO_2}$ & $\mathrm{O_2}$ (RF 17&18)
- Compare with
  - CESM
  - Garcia and Keeling (2001), McNeil et al. (2007), Takahashi et al. (2002), ...

- Upwind Observations
  - Previous flight
  - Model output
  - Climatology
  - Upwind Observations
  - Other . . .
- Create a Curtain (Here CO_2)
- Connect Curtain with Observations

Alt. lat. CO_2 (color)



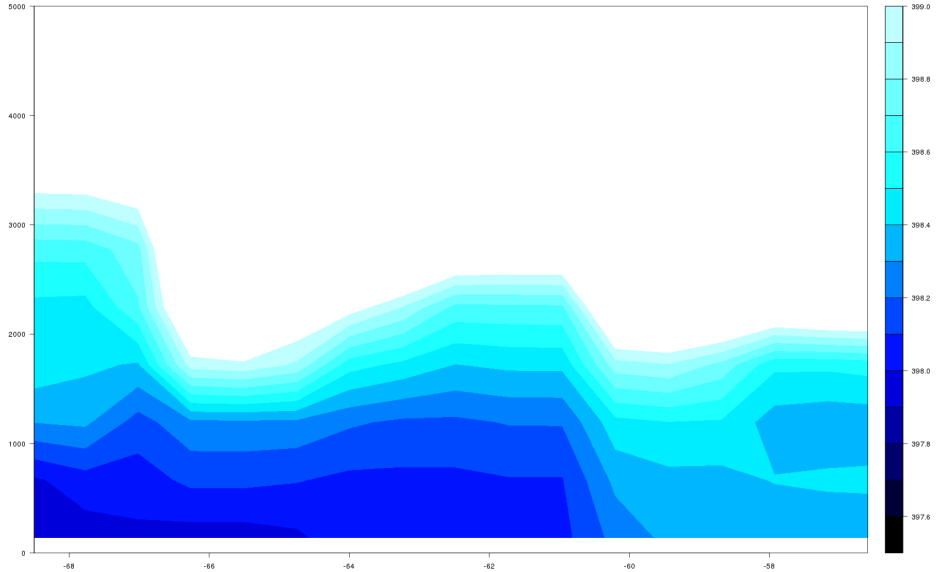
Connection between observations

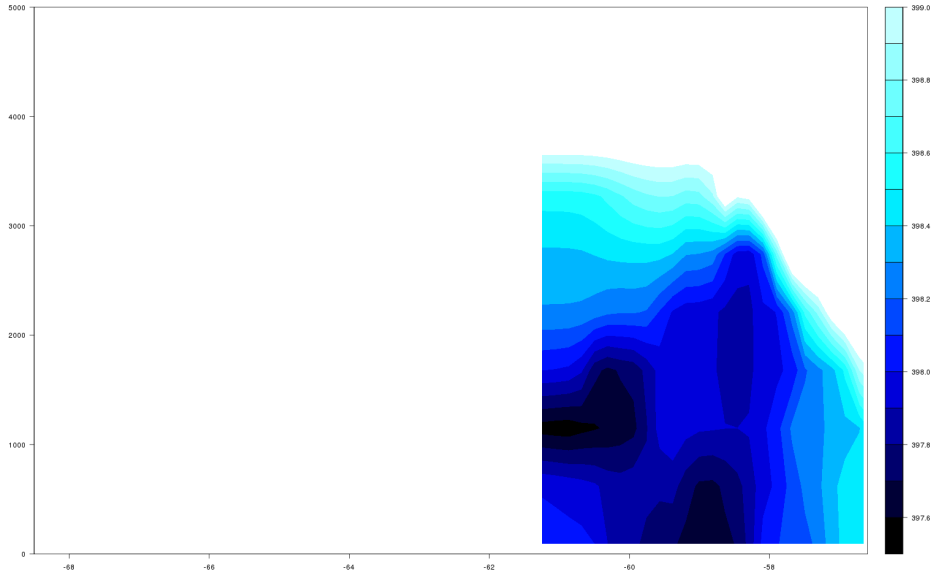


Altitude in blue

Trajectories in yellow

Alt. lat. CO_2 (color)

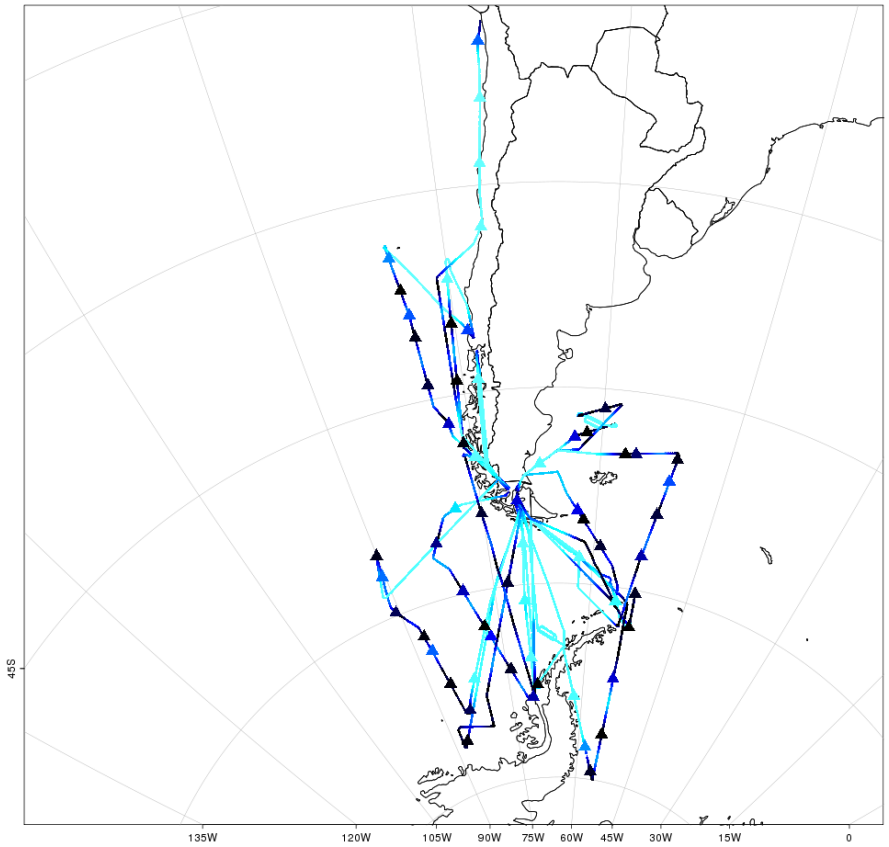




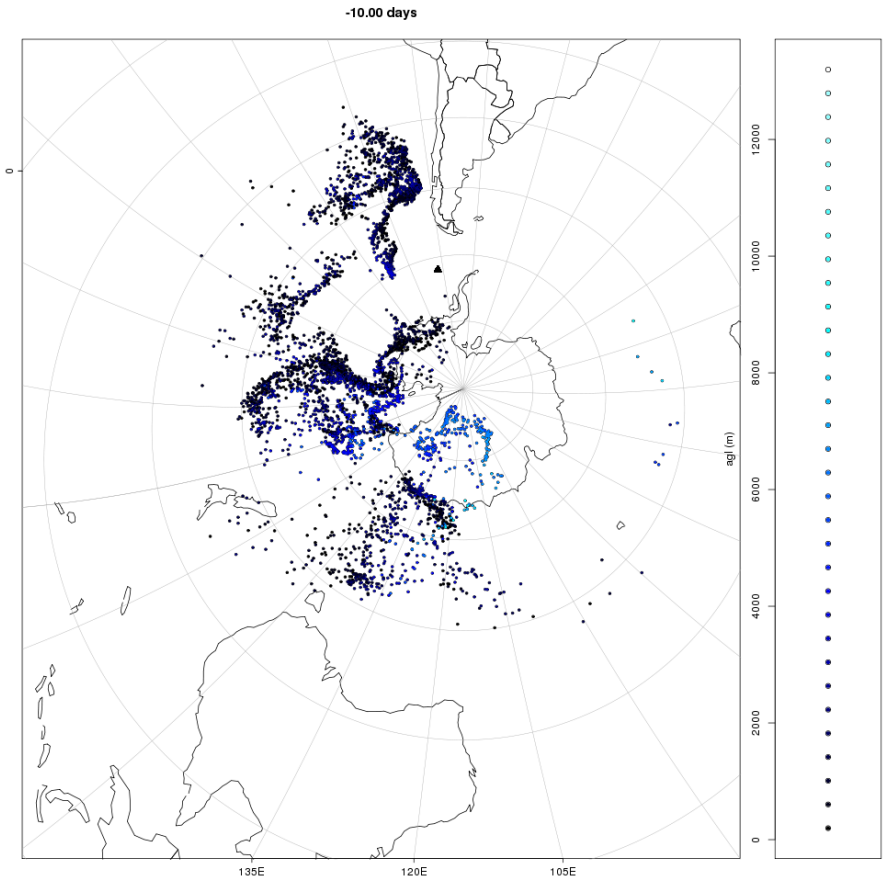
- Choose Initial Curtain
- *Prior* (Flux) Field Candidates
  - CESM Model CO_2/O_2 Flux
  - Climatologies
    - Garcia and Keeling (2001)
    - McNeil et al. (2007)
    - Takahashi et al. (2002)
    - ...
  - Physical Variables
    - Sea Surface Temp.
    - Salinity
    - Wind Speed
    - ...
- Modify to *Fit* Observed Values during ORCAS

Trial Runs

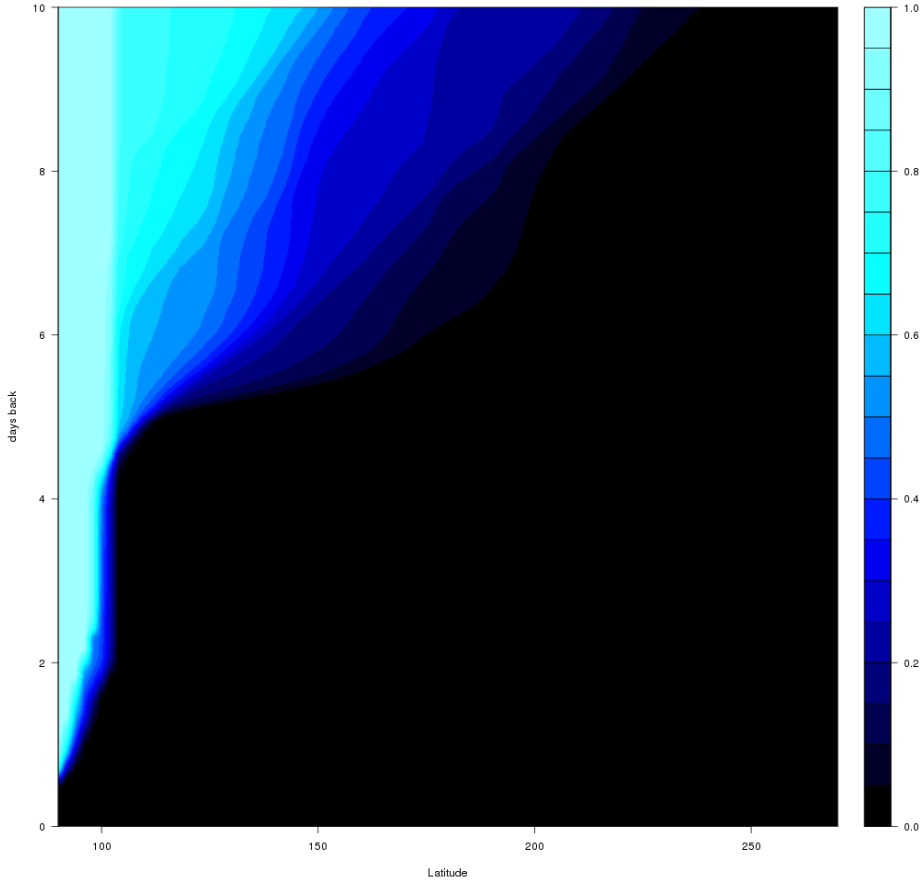
- 62 trial points
- 4096 particles
- $\leq$ 10 days back



Distribution at $T - 10$ days

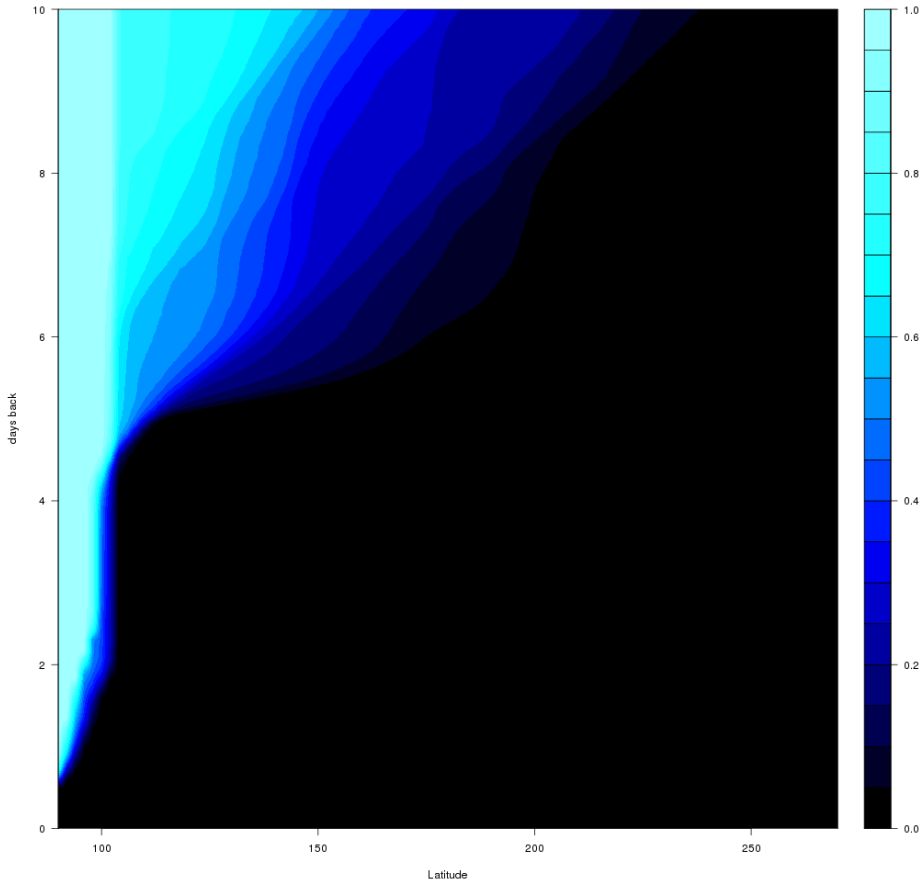


Latitude crossing fraction

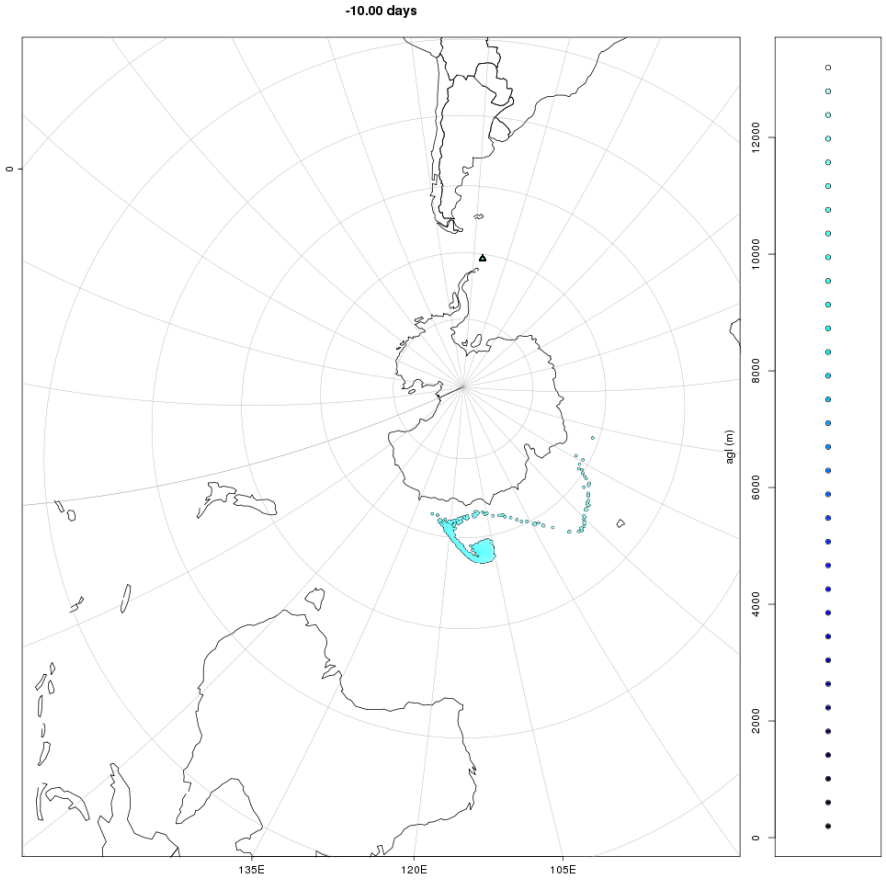


- Storms cause $\sim$ 2 day pauses

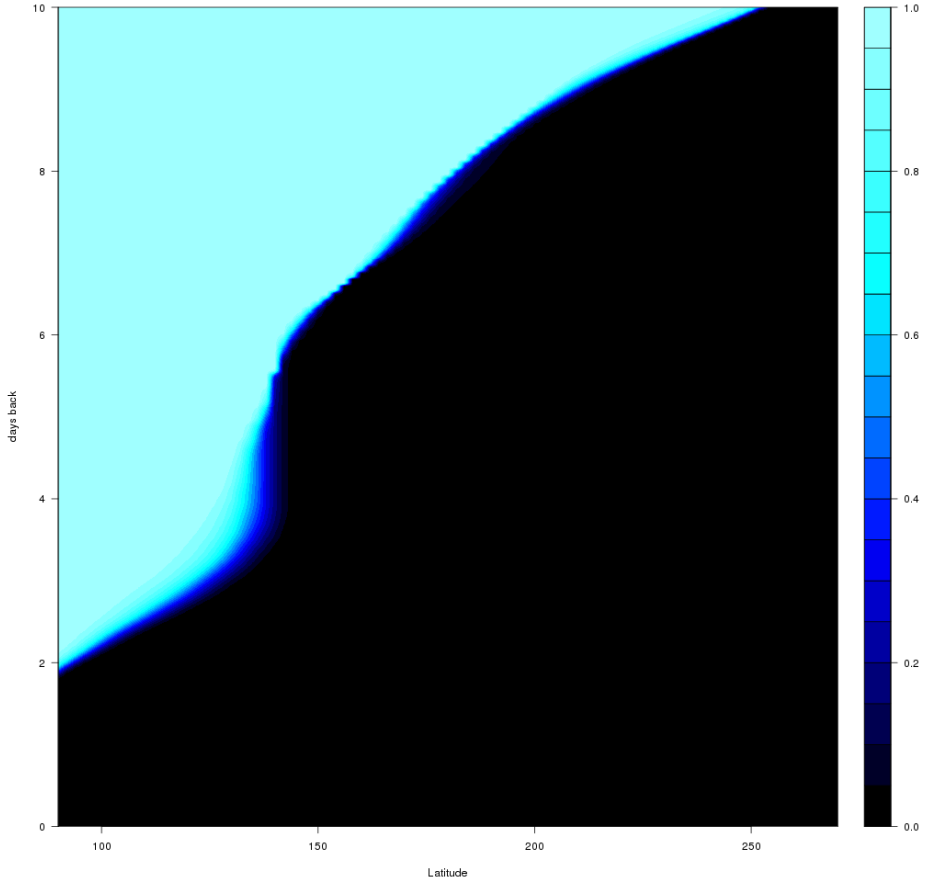
Latitude crossing fraction



Distribution at $T - 10$ days

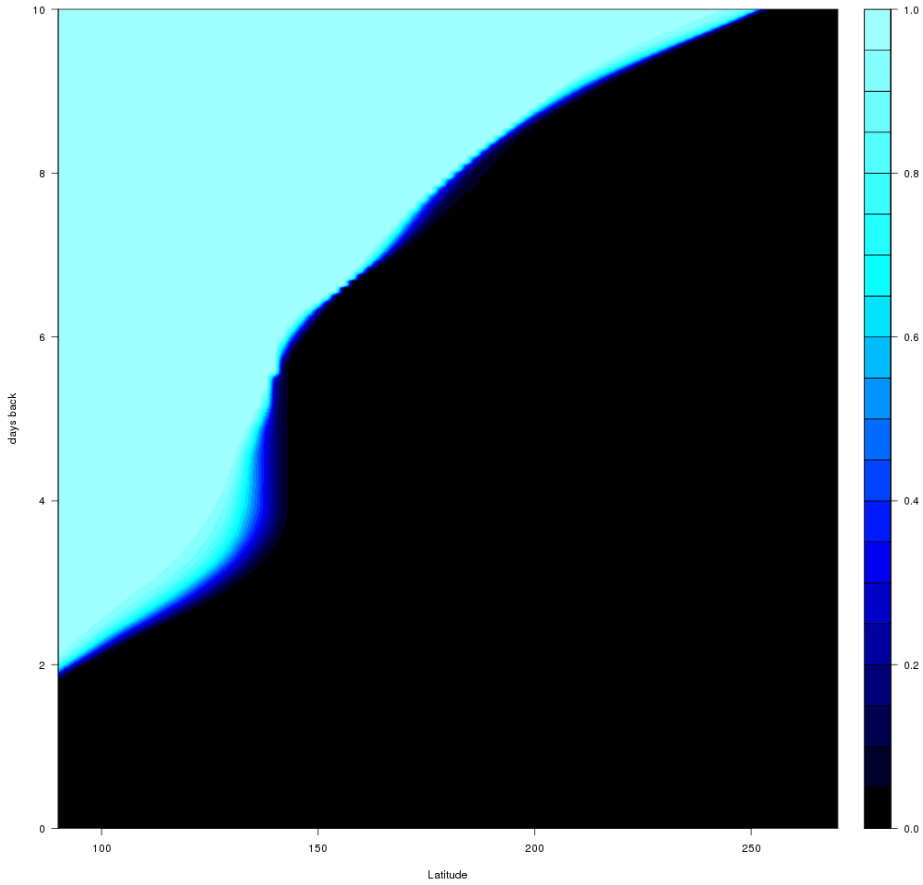


Latitude crossing fraction

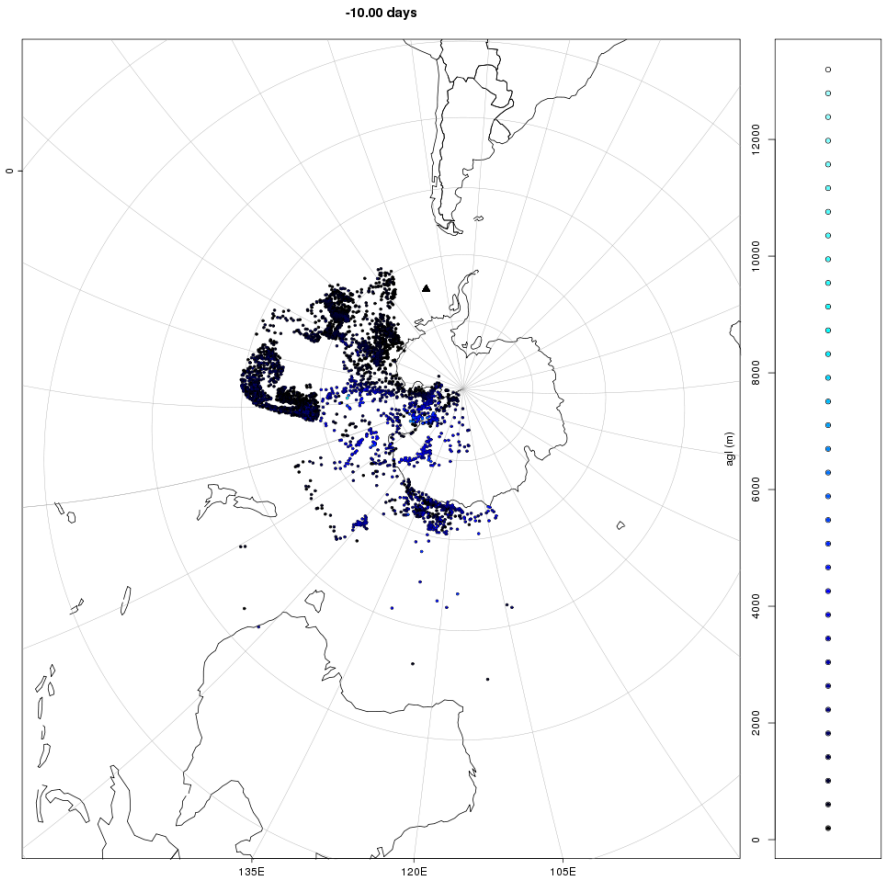


- Storms cause $\sim$ 2 day pauses
- High altitude winds are *fast*

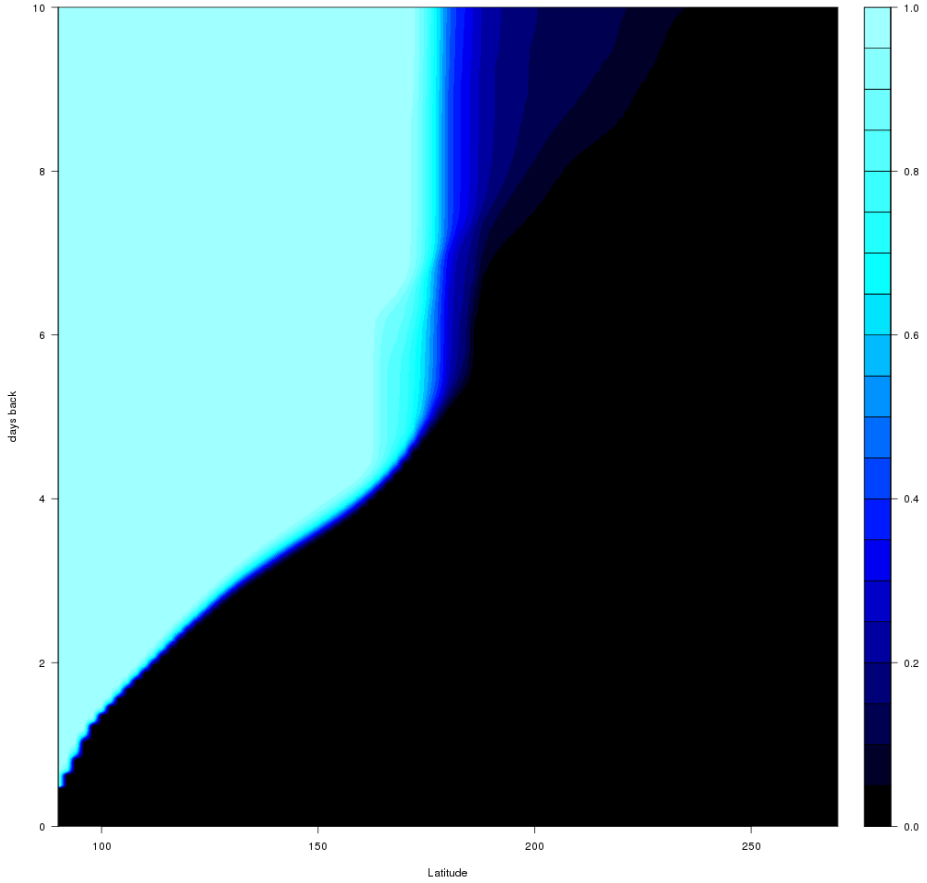
Latitude crossing fraction



Distribution at $T - 10$ days

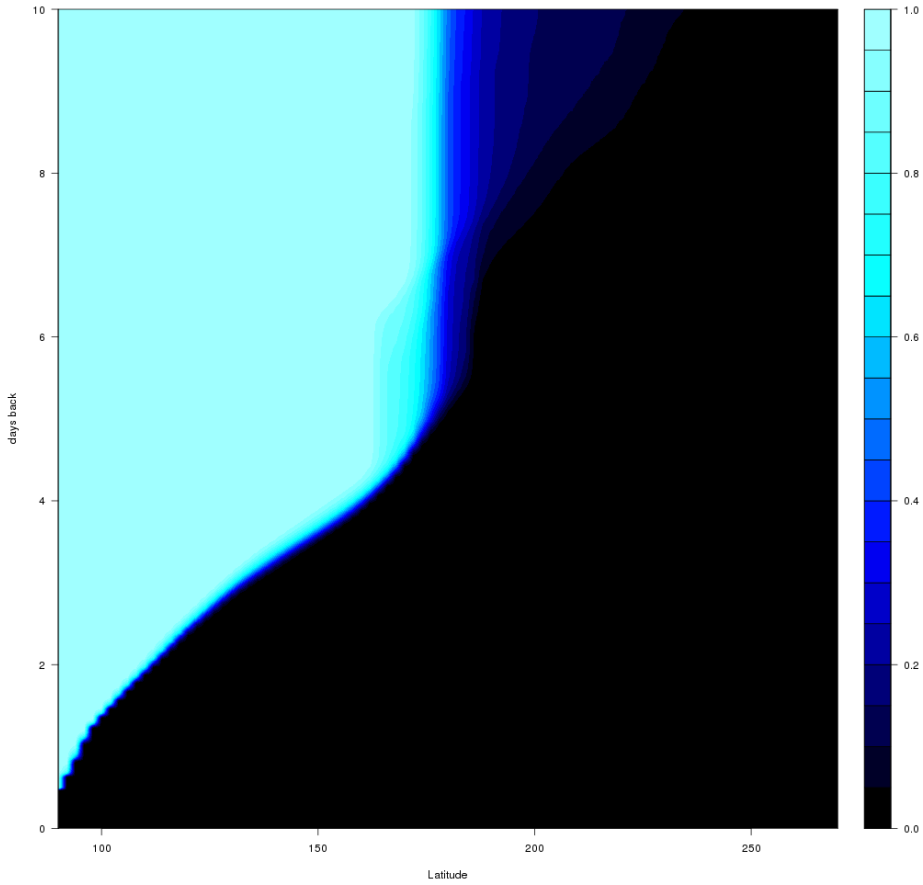


Latitude crossing fraction

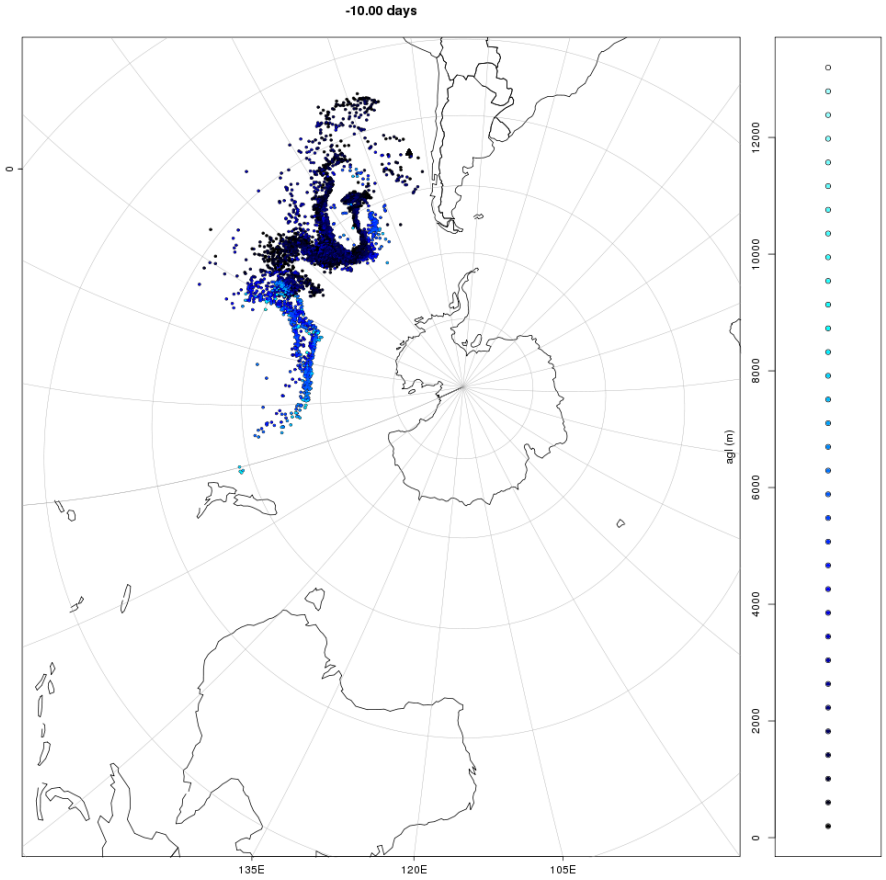


- Storms cause $\sim$ 2 day pauses
- High altitude winds are *fast*
- Sometimes you get stuck
- Low altitude winds can be *slow*

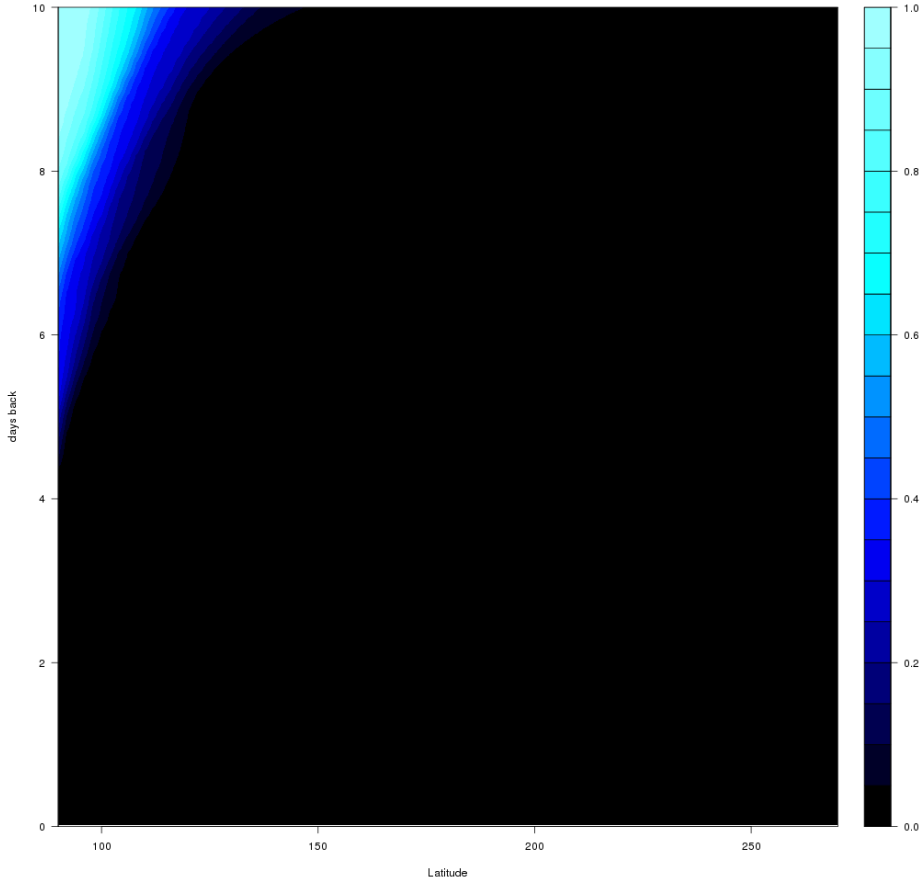
Latitude crossing fraction



Distribution at $T - 10$ days

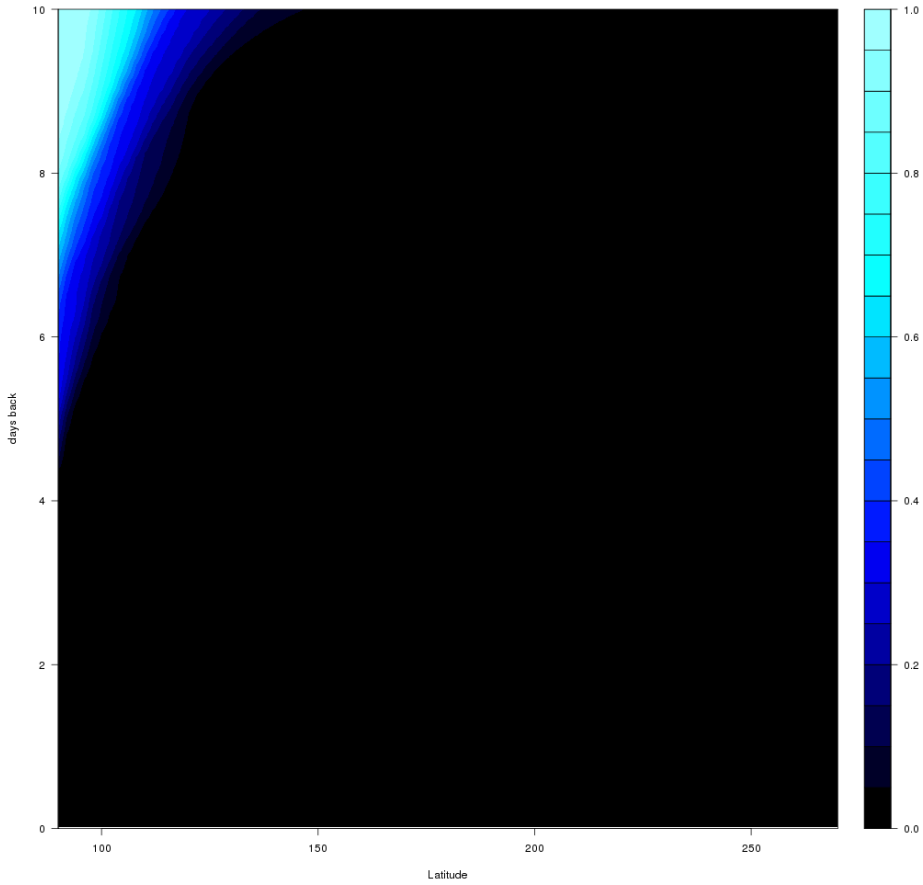


Latitude crossing fraction

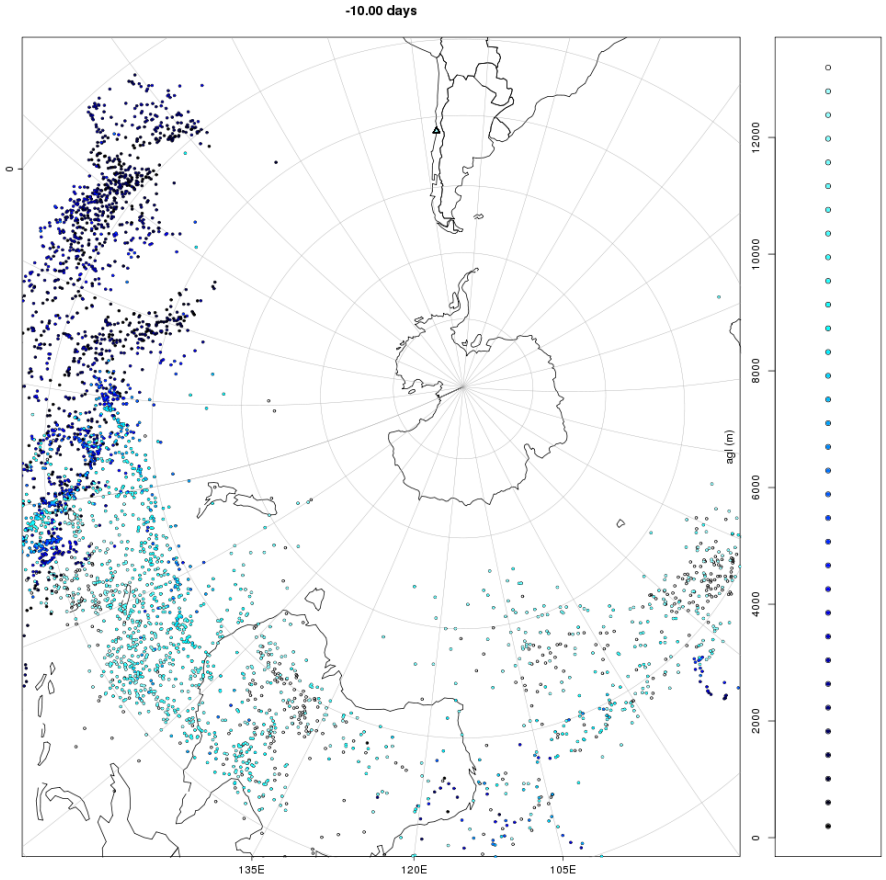


- Storms cause $\sim$ 2 day pauses
- High altitude winds are *fast*
- Sometimes you get stuck
- Low altitude winds can be *slow*

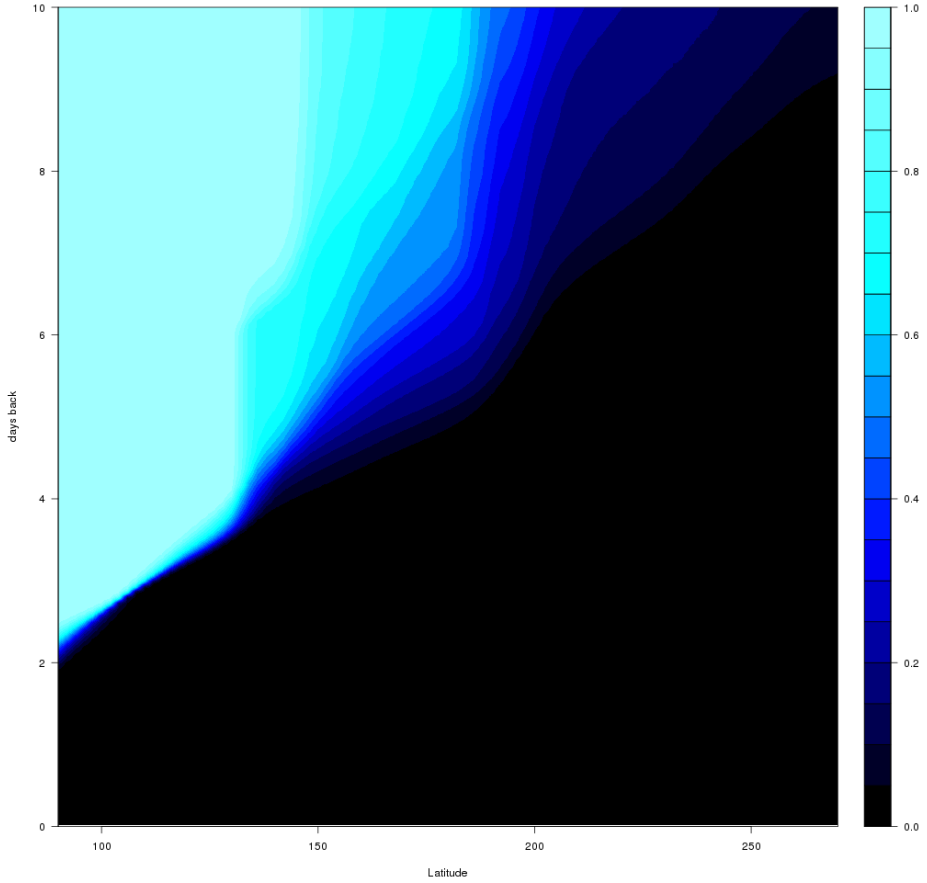
Latitude crossing fraction



Distribution at $T - 10$ days

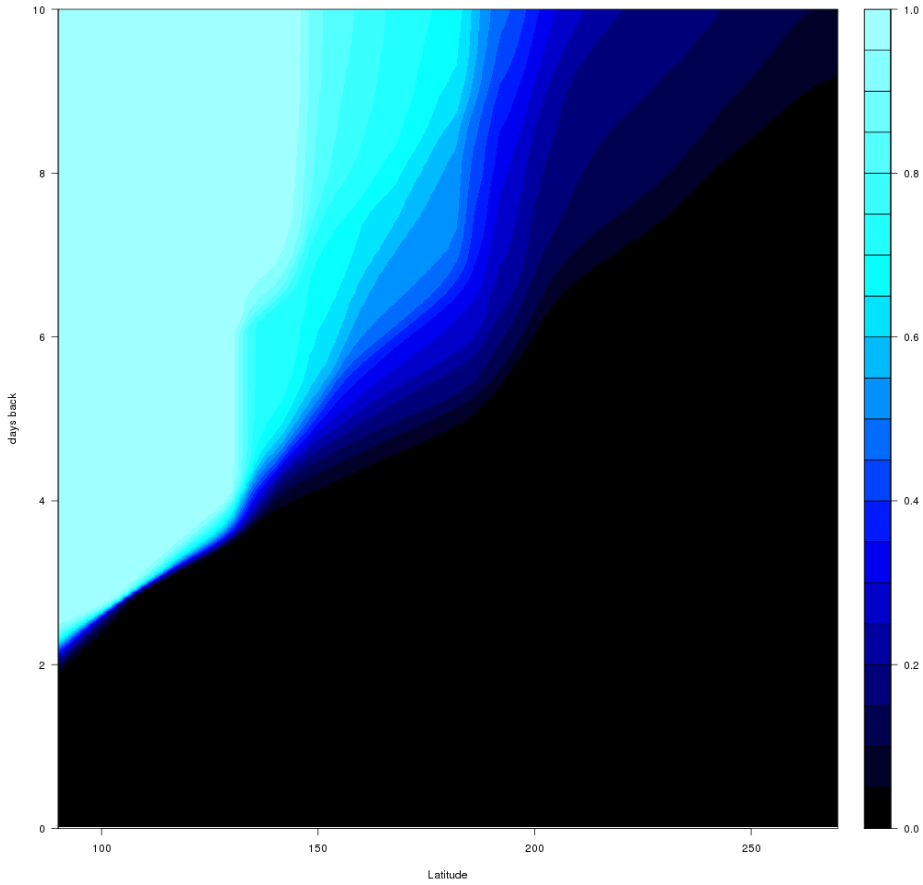


Latitude crossing fraction



- Storms cause $\sim$ 2 day pauses
- High altitude winds are *fast*
- Sometimes you get stuck
- Low altitude winds can be *slow*
- Dispersion can be huge

Latitude crossing fraction



- At flask sample locations
- Allow multiple curtains
  - Previous Flights
  - Whole Campaign
  - Model output
  - West Pacific Observations?
- Statistically stable, N$\gg 1$
- Computationally efficient, N~ 1

Thanks

Garcia, H. E. and Keeling, R. F. (2001). On the global oxygen anomaly and air-sea flux. *Journal of Geophysical Research. C. Oceans*, 106:31155–3166.

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.

McNeil, B. I., Metzl, N., Key, R. M., Matear, R. J., and Corbiere, A. (2007). An empirical estimate of the southern ocean air-sea co2 flux. *Global Biogeochemical Cycles*, 21(3).

Takahashi, T., Sutherland, S. C., Sweeney, C., Poisson, A., Metzl, N., Tilbrook, B., Bates, N., Wanninkhof, R., Feely, R. A., Sabine, C., et al. (2002). Global sea–air co 2 flux based on climatological surface ocean pco 2, and seasonal biological and temperature effects. *Deep Sea Research Part II: Topical Studies in Oceanography*, 49(9):1601–1622.