

# Mesoscale atmospheric inversion of the CO<sub>2</sub> natural fluxes in Amazonia using GeoCarb and MicroCarb data

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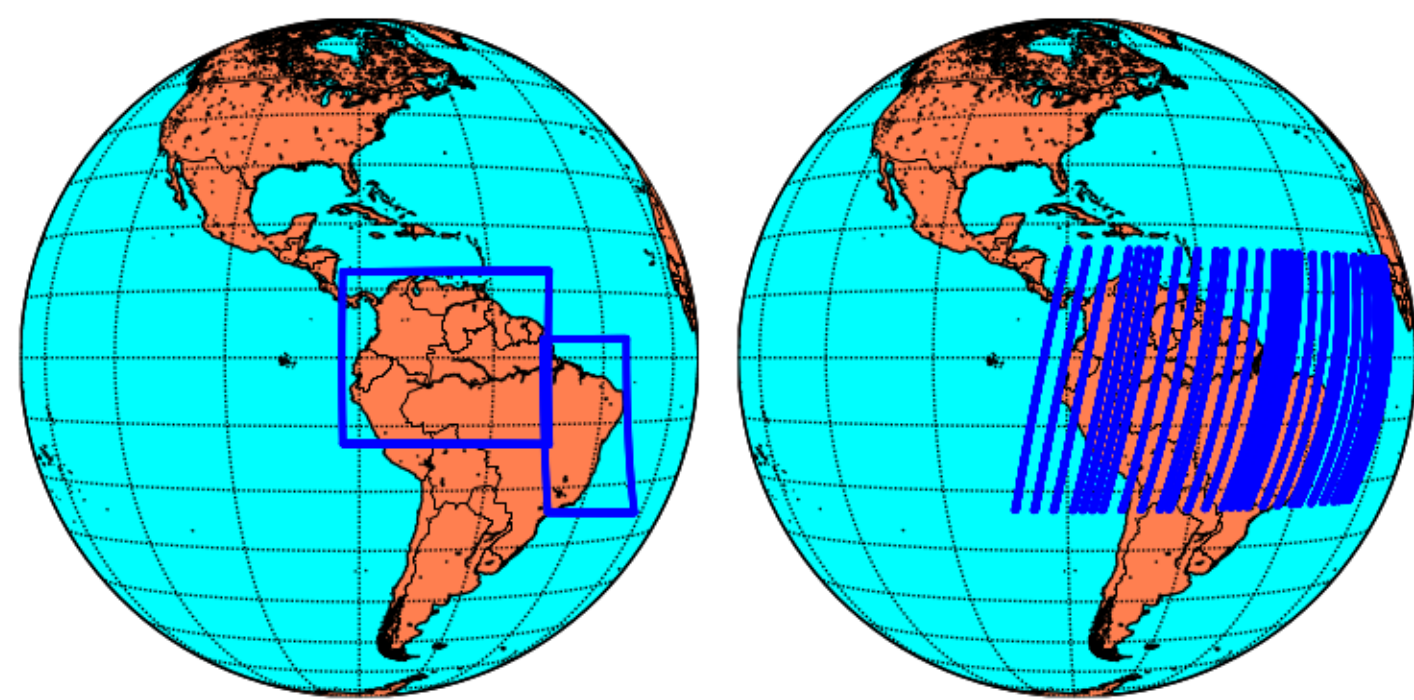
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## Motivation

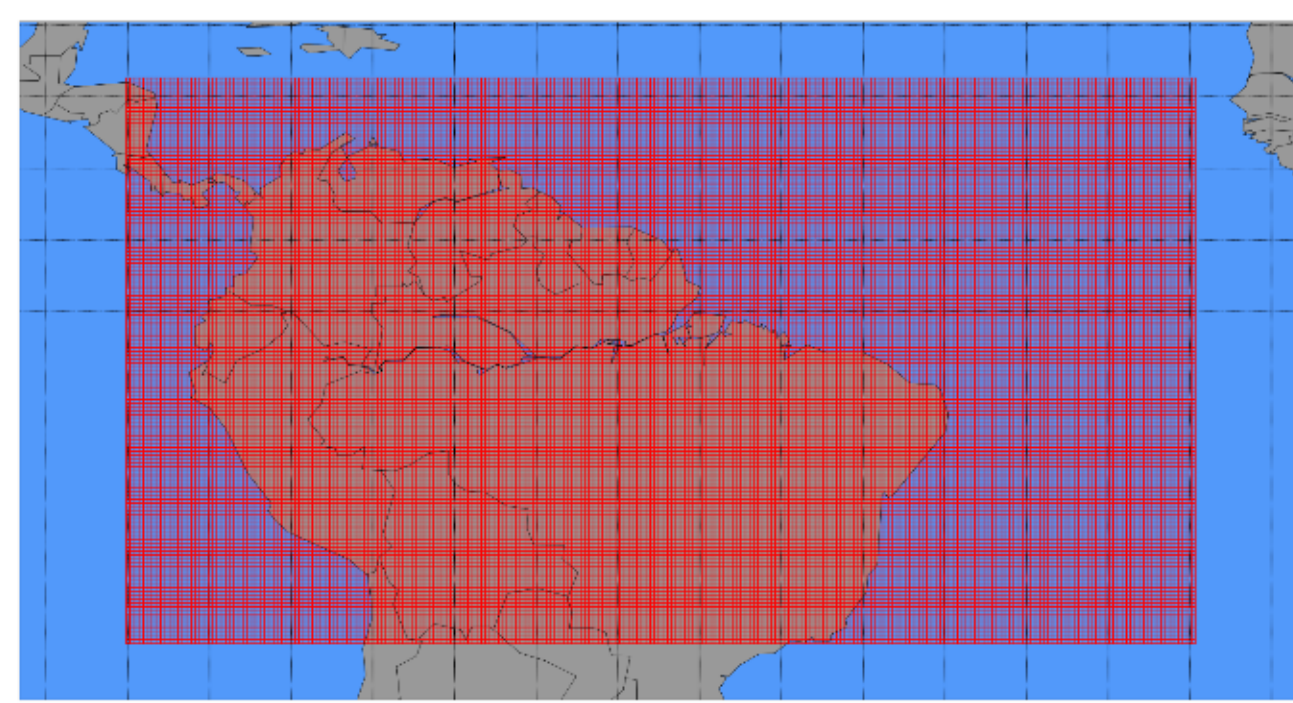
To investigate the potential of assimilating GeoCarb and MicroCarb Observations in a regional inverse modelling system for the estimate of the CO<sub>2</sub> Net Ecosystem Exchange (NEE) in Amazonia based on Observing System Simulation Experiments (OSSEs).

## GeoCarb & MicroCarb



- West scan [82.49°W - 49.65°W] & [-13.03°N - 13.03°S]
- East scan [51.77°W - 22.95°W] & [2.89°N - 25.42°S]
- Ignoring cloud cover
- Lon resolution ≈ 6km
- Lat resolution ≈ 3km
- 3 ppm measurement error
- Ignoring cloud cover and restrictions to the modelling domain
- [16°N - 23°S] & [85.1°W - 19.7°E]
- 19 tracks over Amazonia in 10 days
- Along track resolution: 9km
- 3-pixel wide across track
- Across track resolution: 4.5km
- 1 ppm measurement error

## CHIMERE Model Configuration



- Domain: [16.3°N - 23.1°S] & [85.1°W - 19.7°W]
- [Nx, Ny] = [247, 153]
- 29 vertical levels
- Lat/Lon Resolution : ≈ 35 Km
- ECMWF & BRAMS Meteorology
- Simulation time: 6-15 Jan 2010

## Net Ecosystem Exchange CO<sub>2</sub>

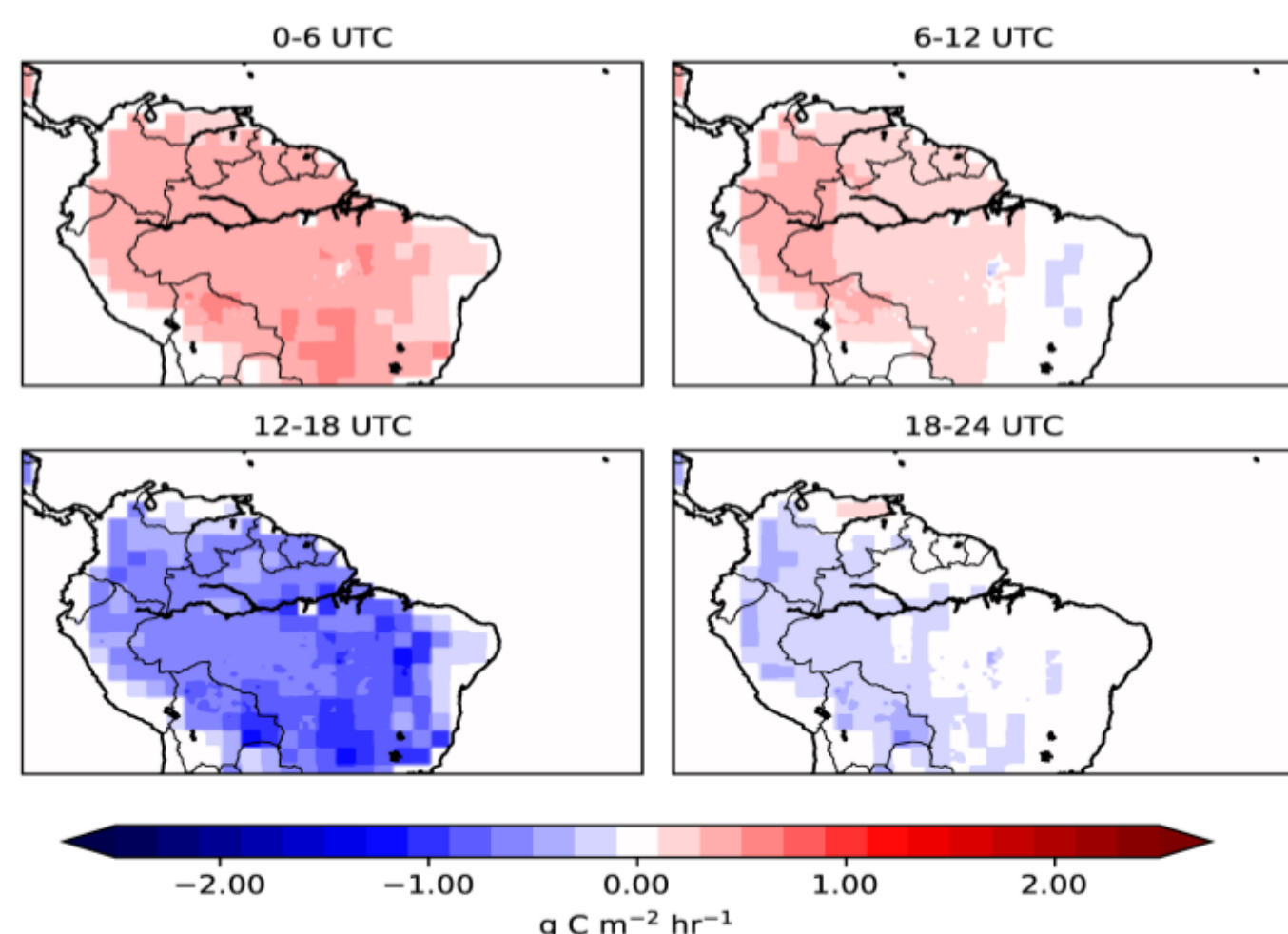


Figure 1: 6-hr mean (over 10 days) NEE budget from ORCHIDEE model.

## Transport Error

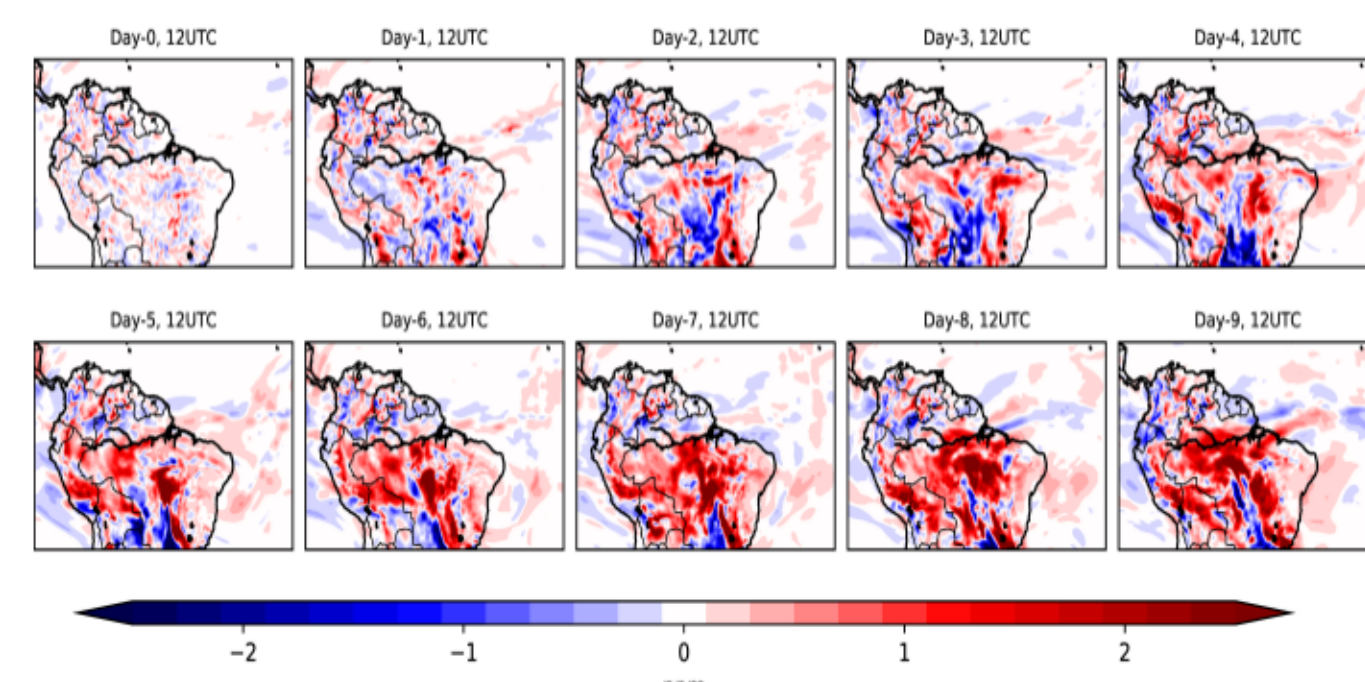


Figure 2: XCO<sub>2</sub> differences (XCO<sub>2</sub><sup>ECMWF</sup> - XCO<sub>2</sub><sup>BRAMS</sup>) using ECMWF and BRAMS meteorology. Day-0: 06 January 2010.

## GeoCarb Inversion

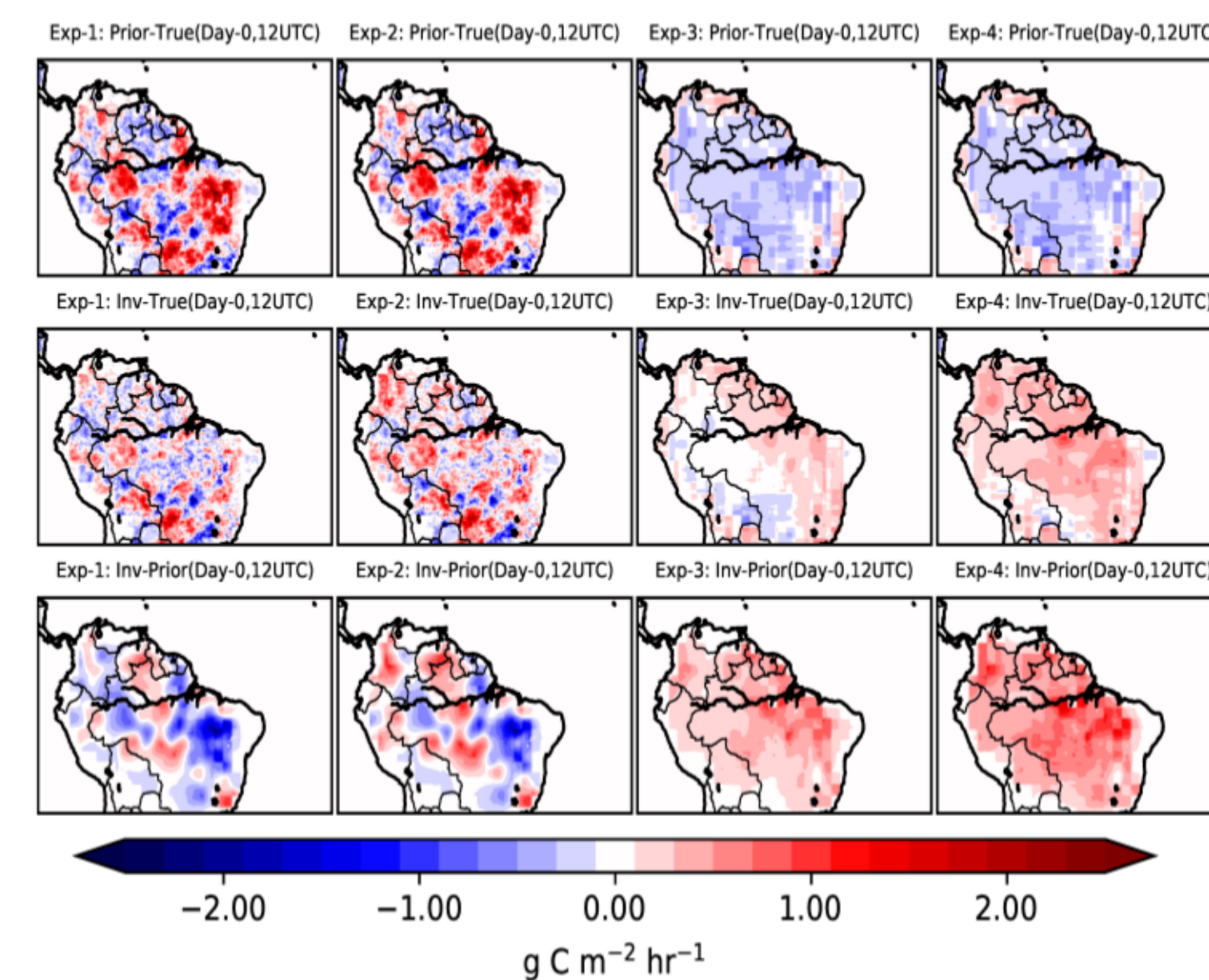


Figure 3: Six hourly (12-18 UTC) mean residuals. Day-0:6Jan2010.

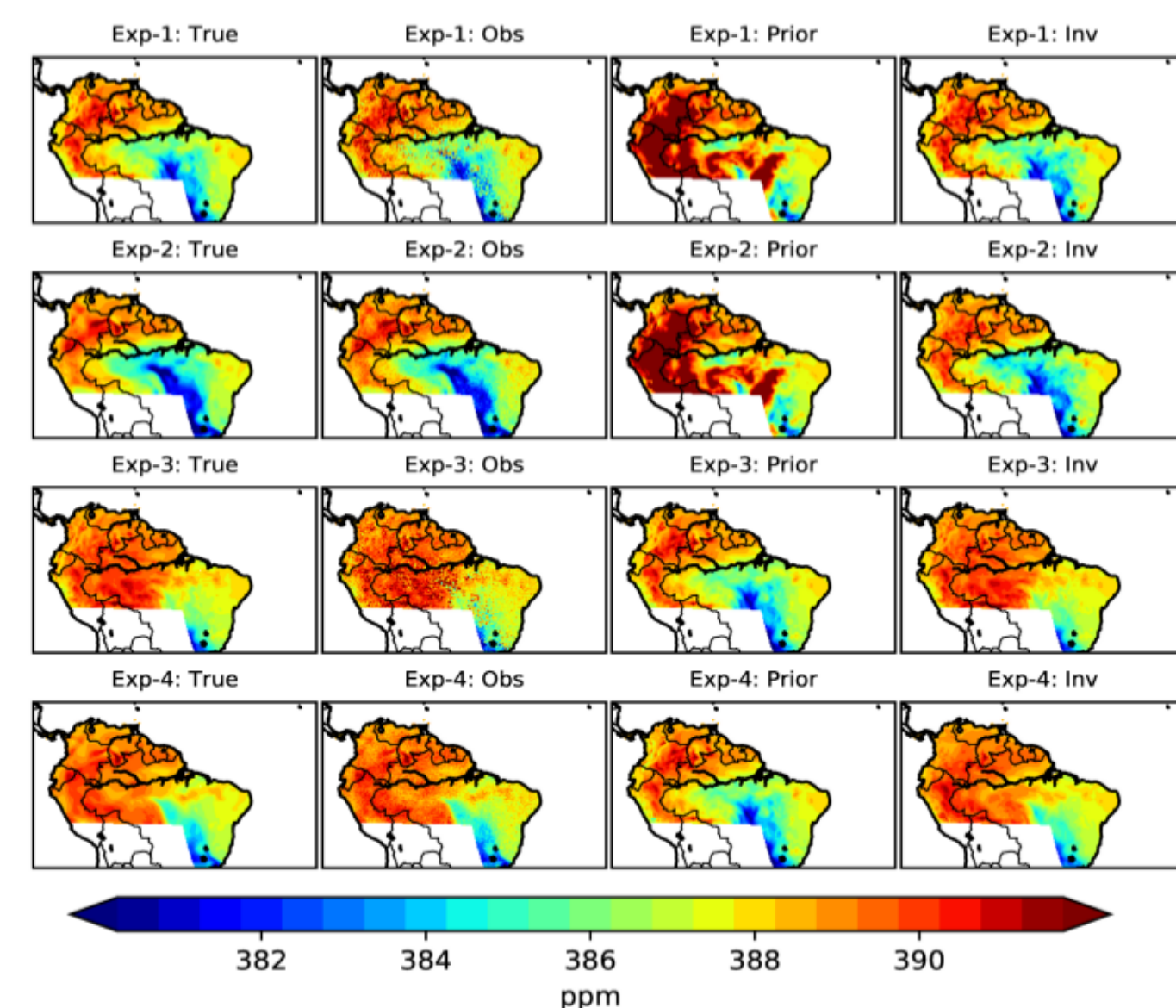


Figure 4: Truth, prior, observed and inverted XCO<sub>2</sub> using GeoCarb.

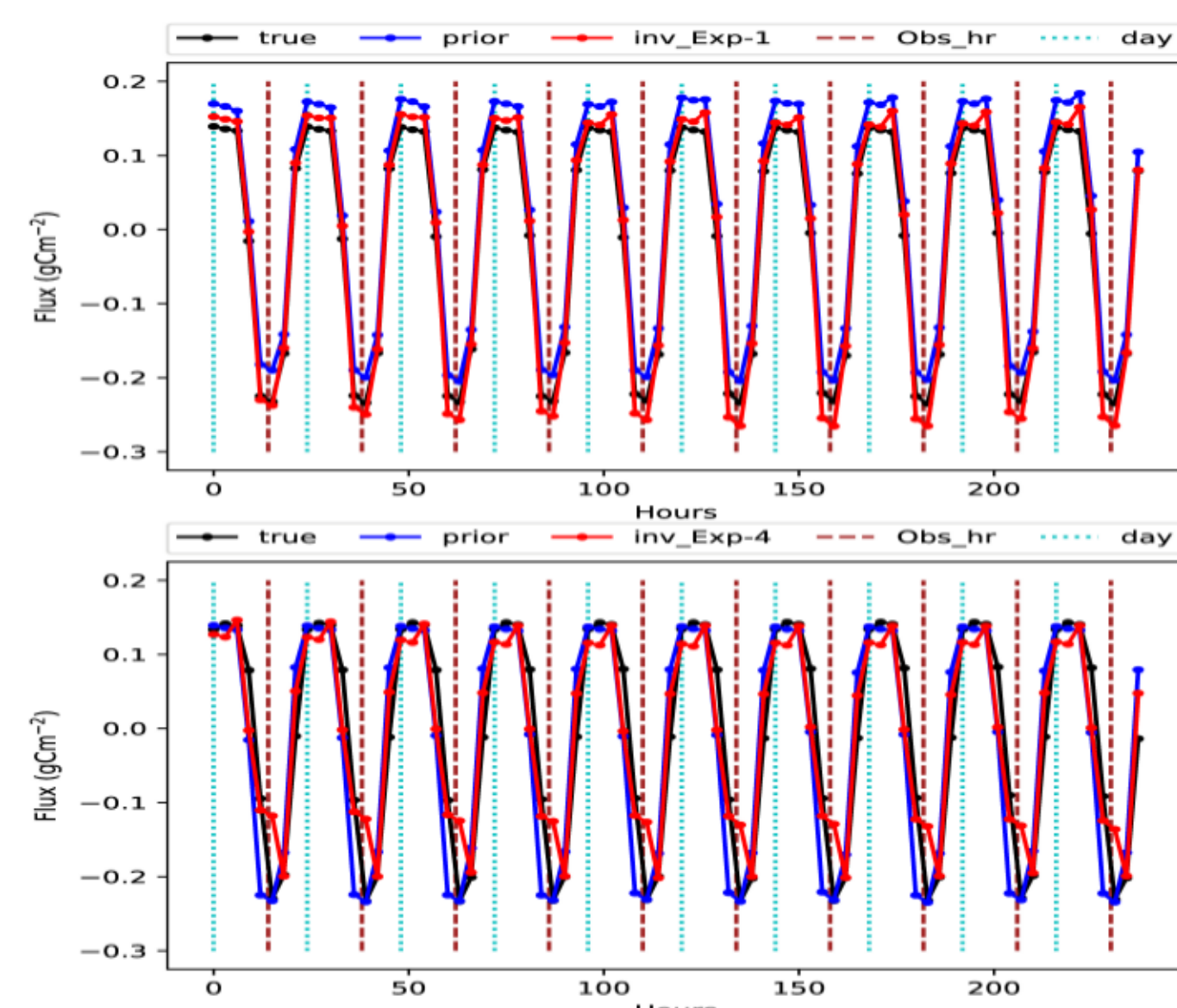


Figure 5: Spatial mean NEE flux.

## Variational inversion-PYVAR

- Inversion duration: 06-15 Jan 2010 (i.e. 10 days).
- GeoCarb Obs: 1 scan/day at 14hr ( $N_{obs}=131190$ )
- MicroCarb Obs: 19 tracks ( $N_{obs}=2461$ )
- Obs error covariance matrix  $\mathbf{R}$  is diagonal.
- $\mathbf{R} = [r_{ij}^2]$  where  $r_{ii}^2 = \frac{\sigma_{microCarb,i}^2}{N_i^{superObs}} + \sigma_{model,i}^2$  and  $r_{ij}^2 = 0$  for  $i \neq j$
- where  $N_i^{superObs}$  is number of obs falling in a model cell.
- Prior uncertainty for six hour interval is 40% of the six hourly mean of NEE budget.
- Flux correction on 6 hour budget for every pixel.
- Prior error covariance matrix  $\mathbf{B}$ 
  - $\tau_{land} = 250\text{km}$ ,  $\tau_{sea} = 1000\text{km}$ ,  $\tau_{time} = 31\text{days}$  ( $\tau$  is Correlation length)
  - No correlation between consecutive six hour time windows.

## MicroCarb Inversion

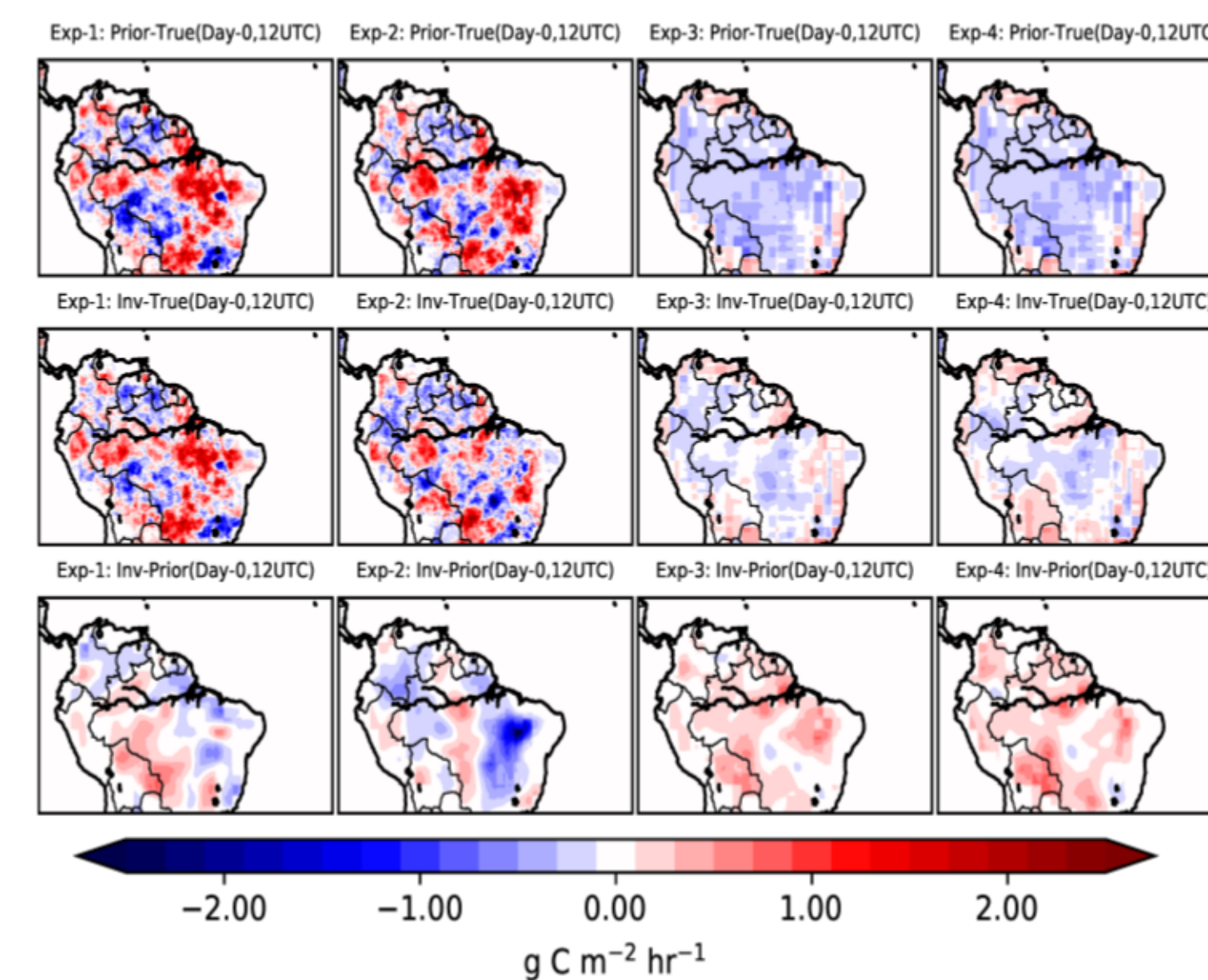


Figure 6: Six hourly (12-18 UTC) mean residuals. Day-0:6Jan2010.

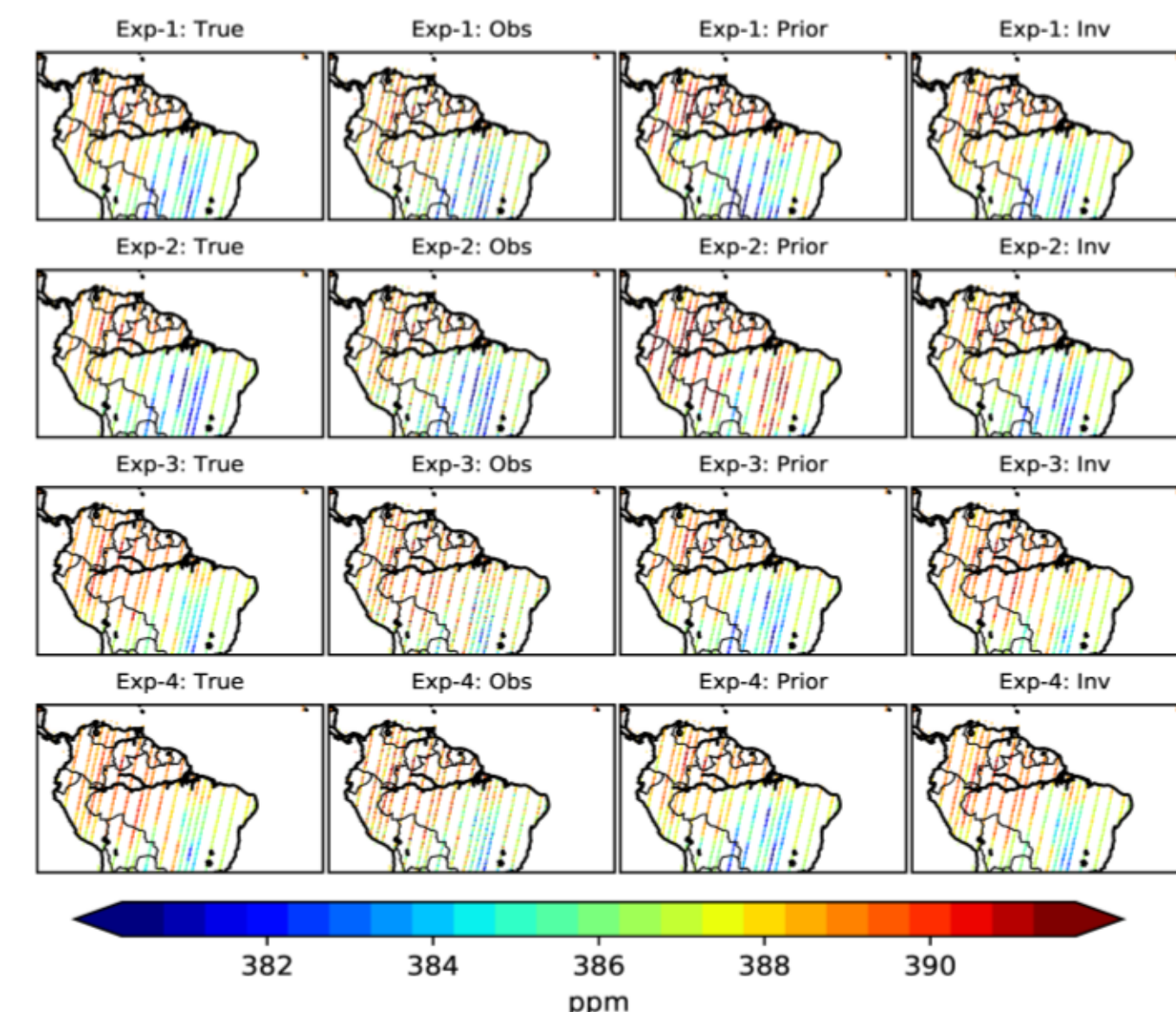


Figure 7: Truth, prior, observed and inverted XCO<sub>2</sub> using MicroCarb.

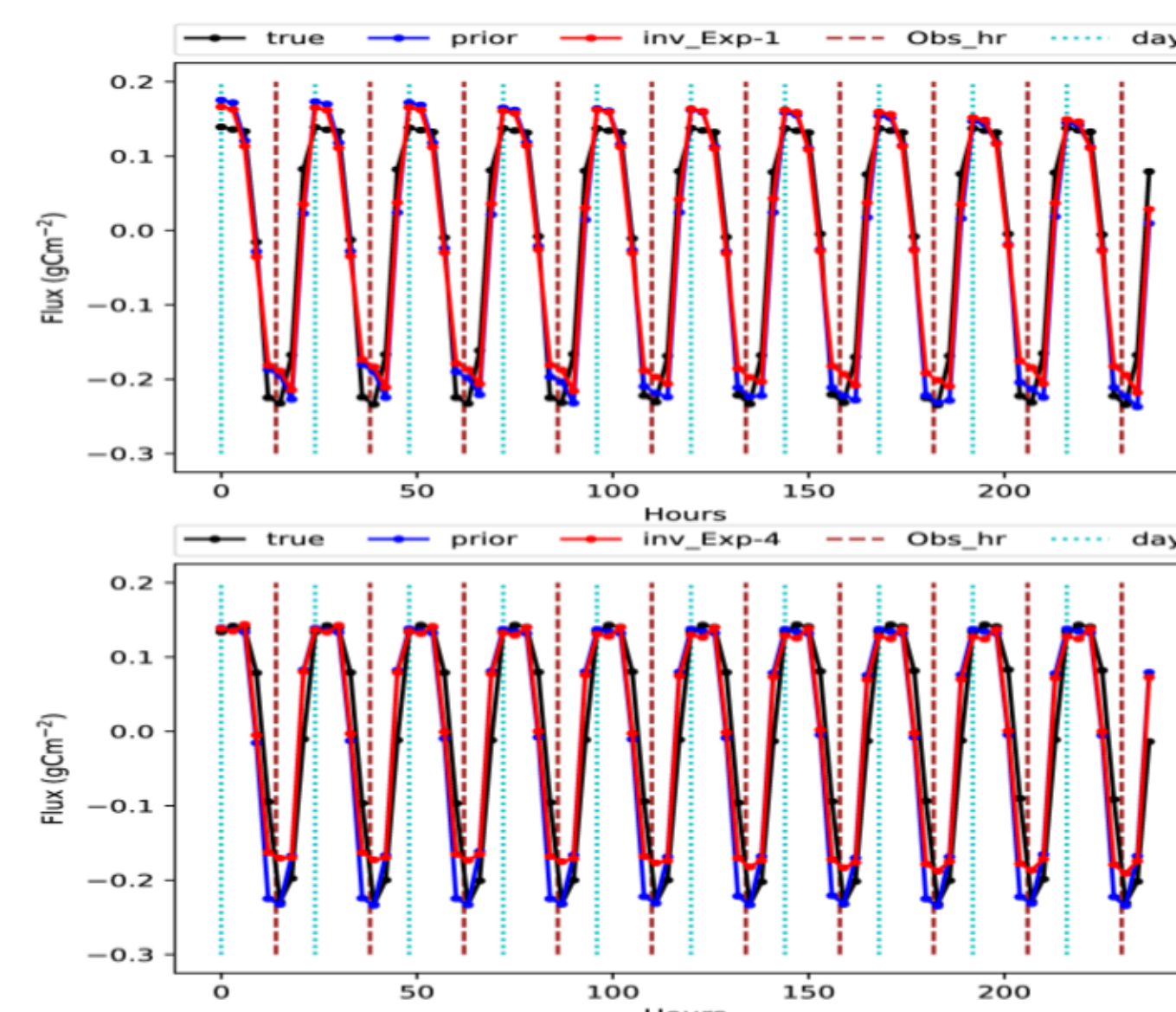
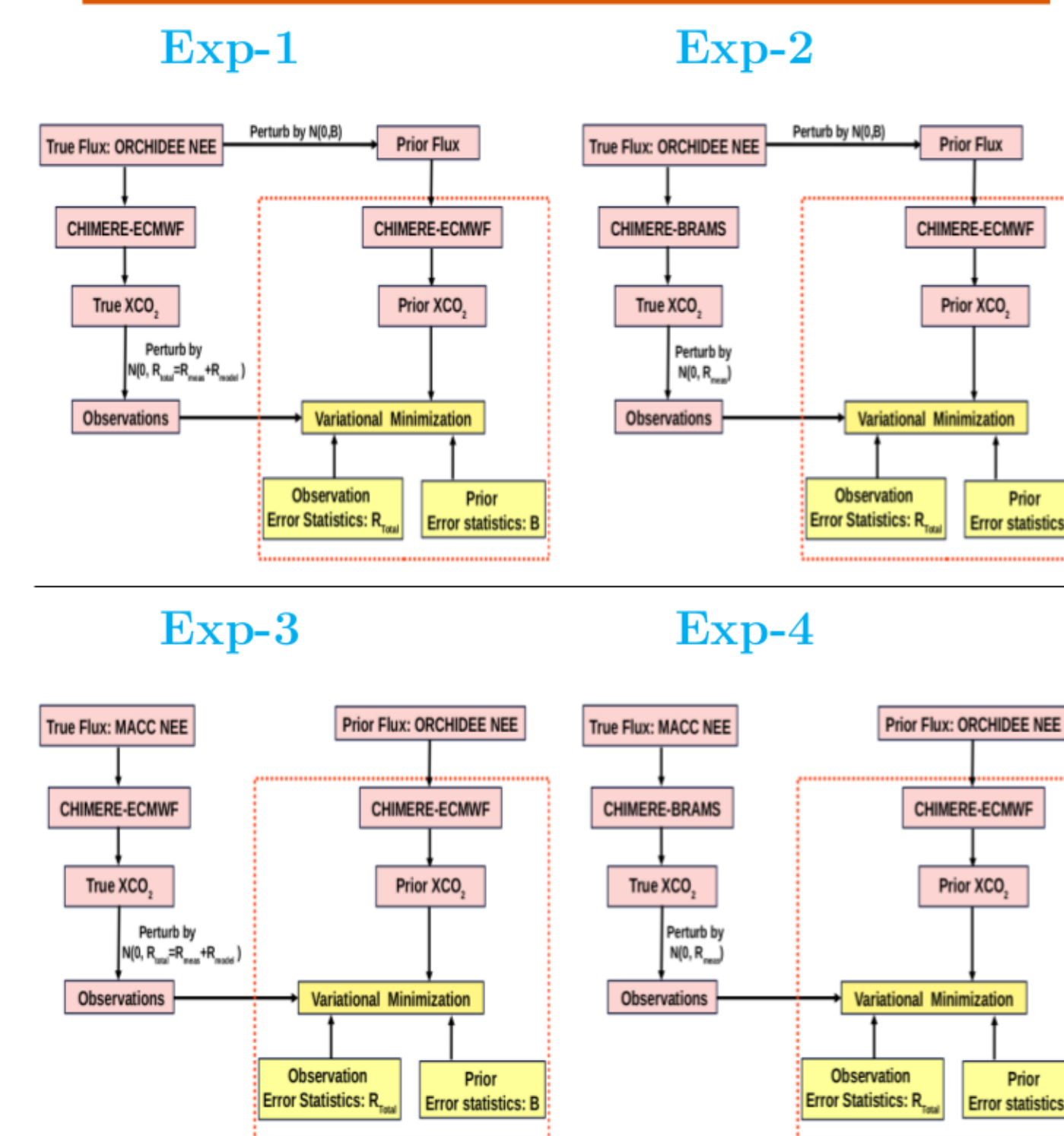


Figure 8: Spatial mean NEE flux.

## Observation System Simulation Experiments

|       |                                                                                |
|-------|--------------------------------------------------------------------------------|
| Exp-1 | Perfect setup of inversion.                                                    |
| Exp-2 | Inversion poorly informed about statistics of transport errors.                |
| Exp-3 | Inversion poorly informed about statistics of prior errors.                    |
| Exp-4 | Inversion poorly informed about statistics of both transport and prior errors. |



## Discussion

- Optimistic results ignoring cloud cover and systematic errors.
- Larger uncertainty reductions when assimilating GeoCarb than MicroCarb data.
- Uncertainty in inversion is significant even when system is perfectly informed about actual errors.
- Fluxes are biased when system is not well informed about transport or prior errors.
- Large impact of realistic errors in priors.
- Need for development of a method which can exploit spatial coverage of GeoCarb images to decrease the need for accurate priors.

## Acknowledgements

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