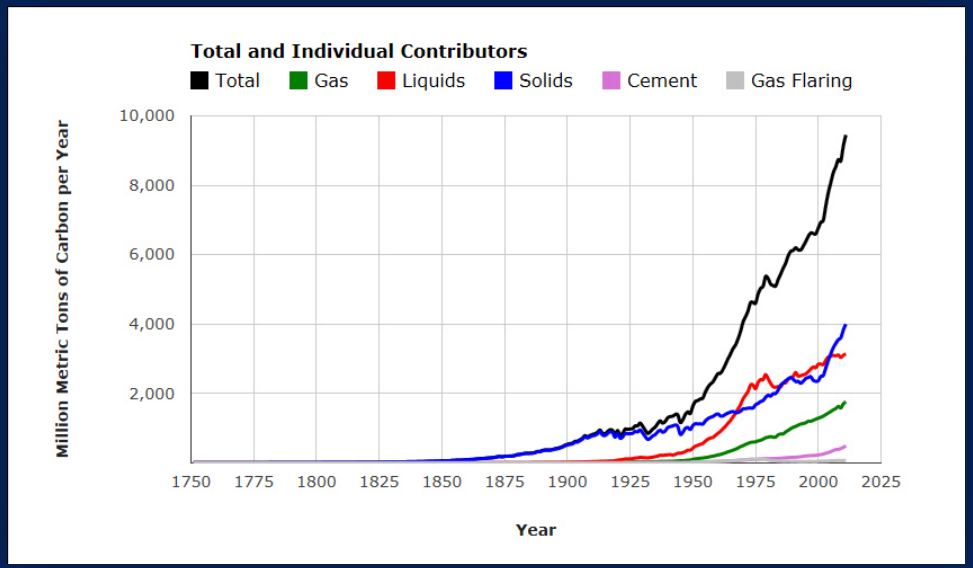
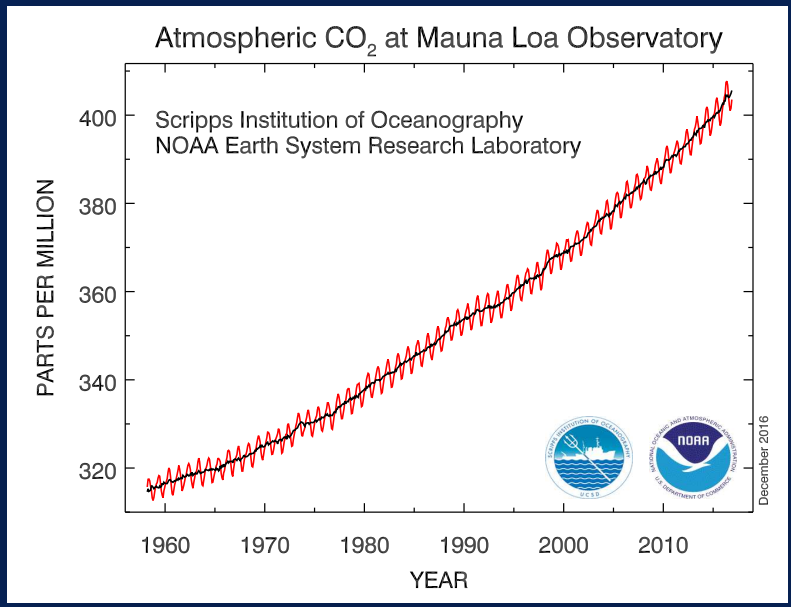
Carbon dioxide sources and sinks: What do we need to estimate them, and what do we currently have?

Hans Chen, Fuqing Zhang, Richard Alley, Thomas Lauvaux, Ken Davis, and ACT-America collaborators

The rate of human CO_2 emissions have accelerated, faster than the rise of atmospheric CO_2

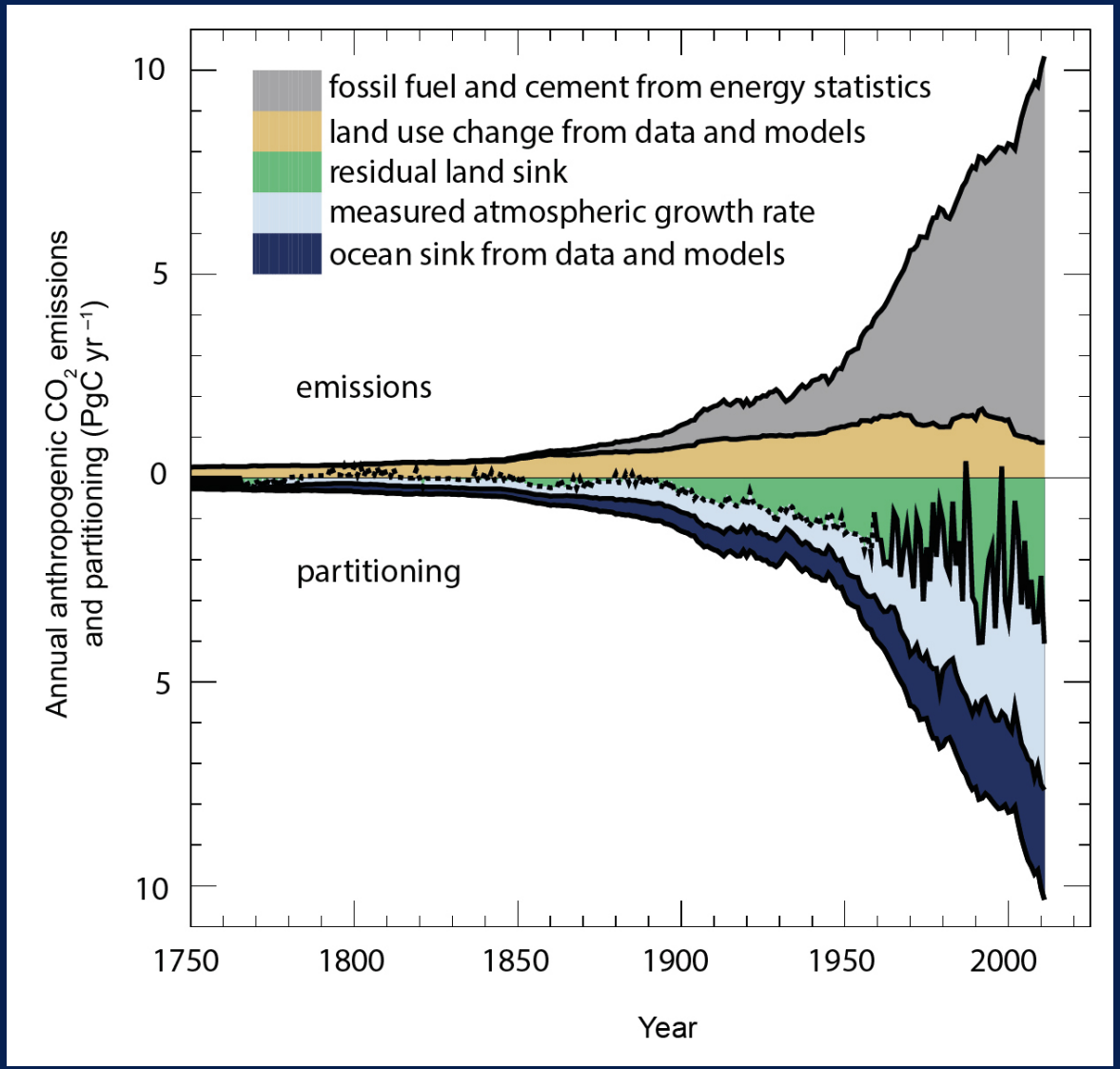


Fossil-fuel carbon emissions [CDIAC]



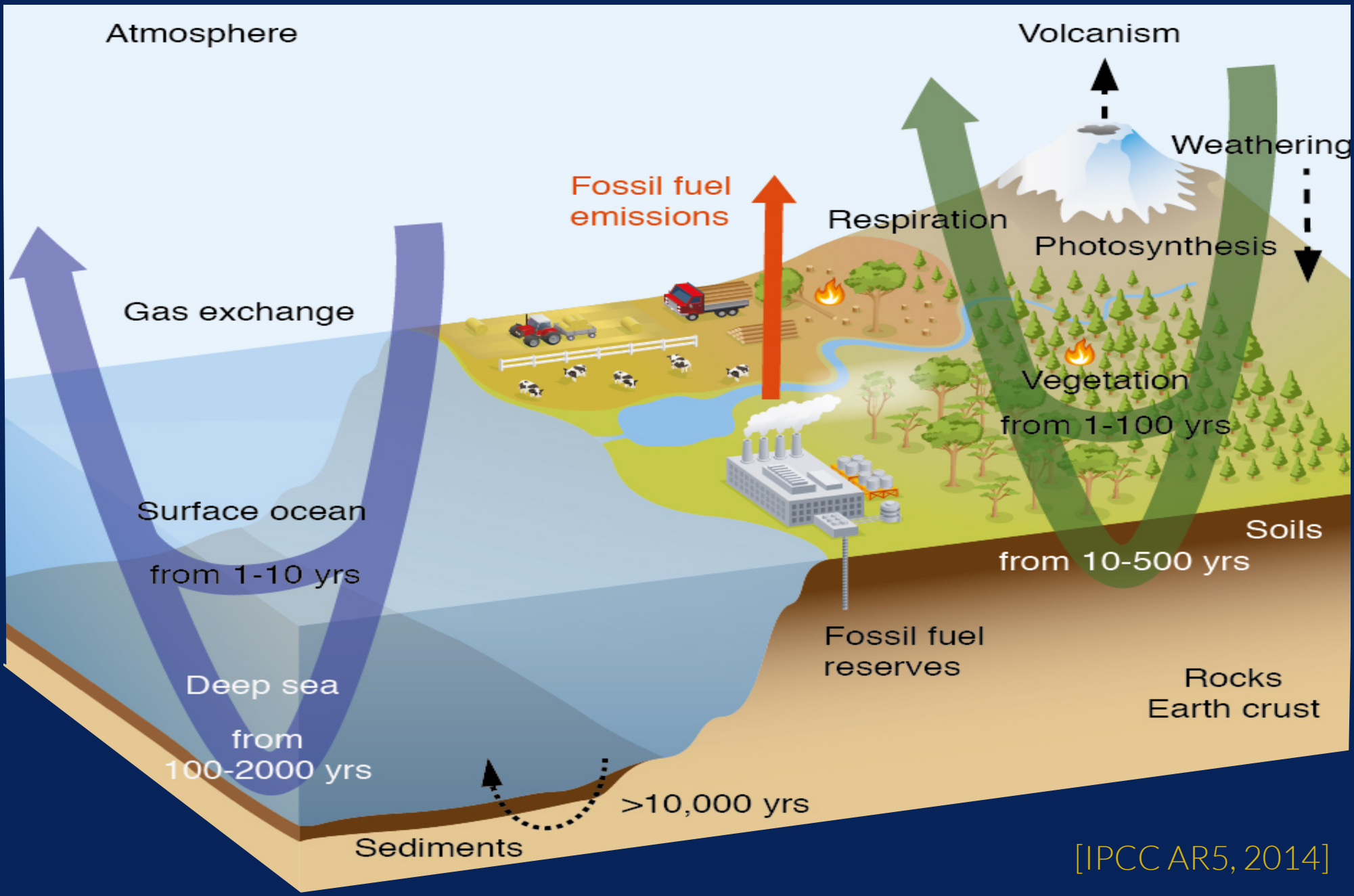
Atmospheric CO_2 [NOAA]

Where has the CO_2 gone? The atmosphere, land and ocean as CO_2 sources and sinks



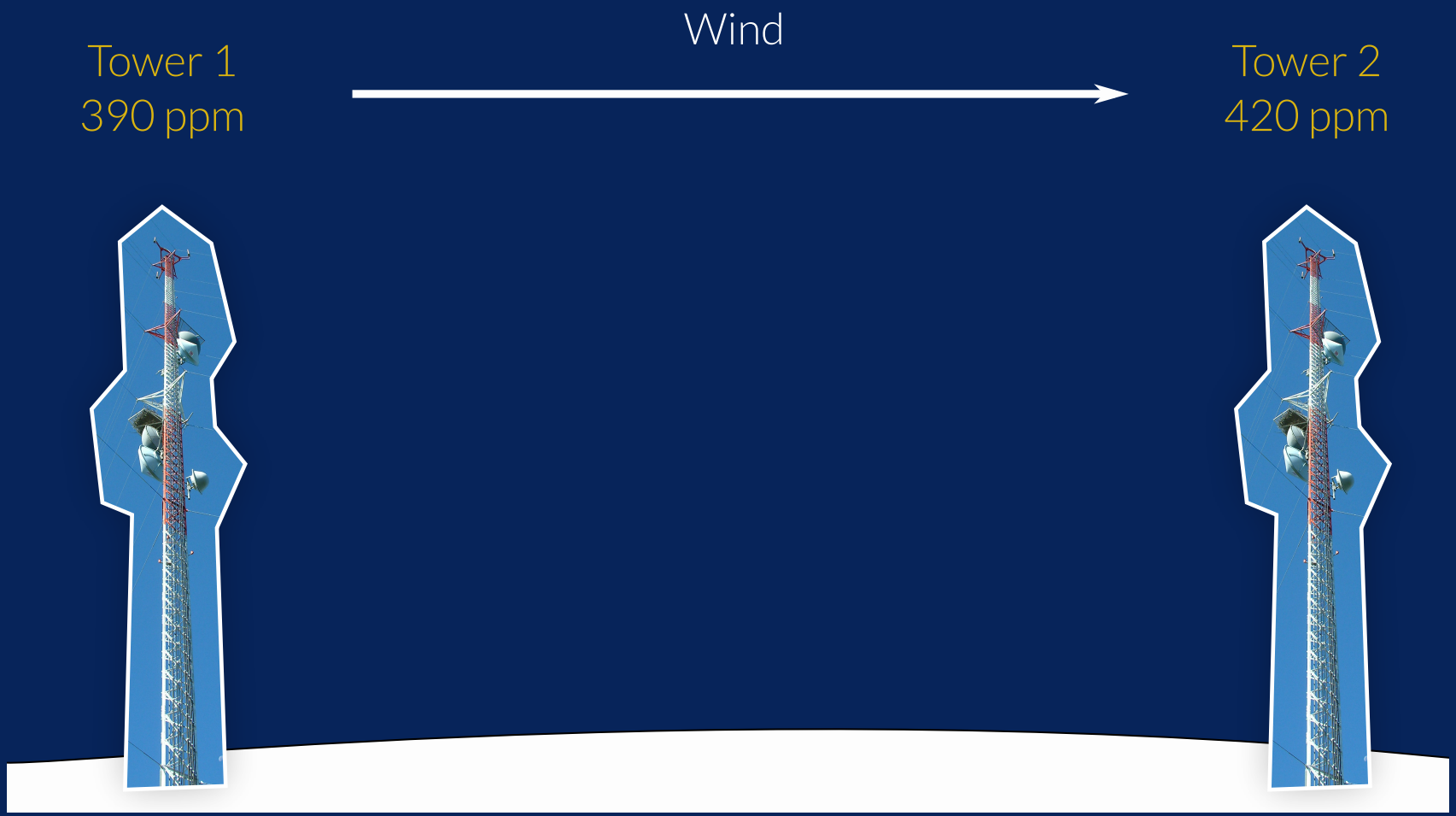
[IPCC AR5, 2014]

How can we estimate CO_2 sources and sinks?

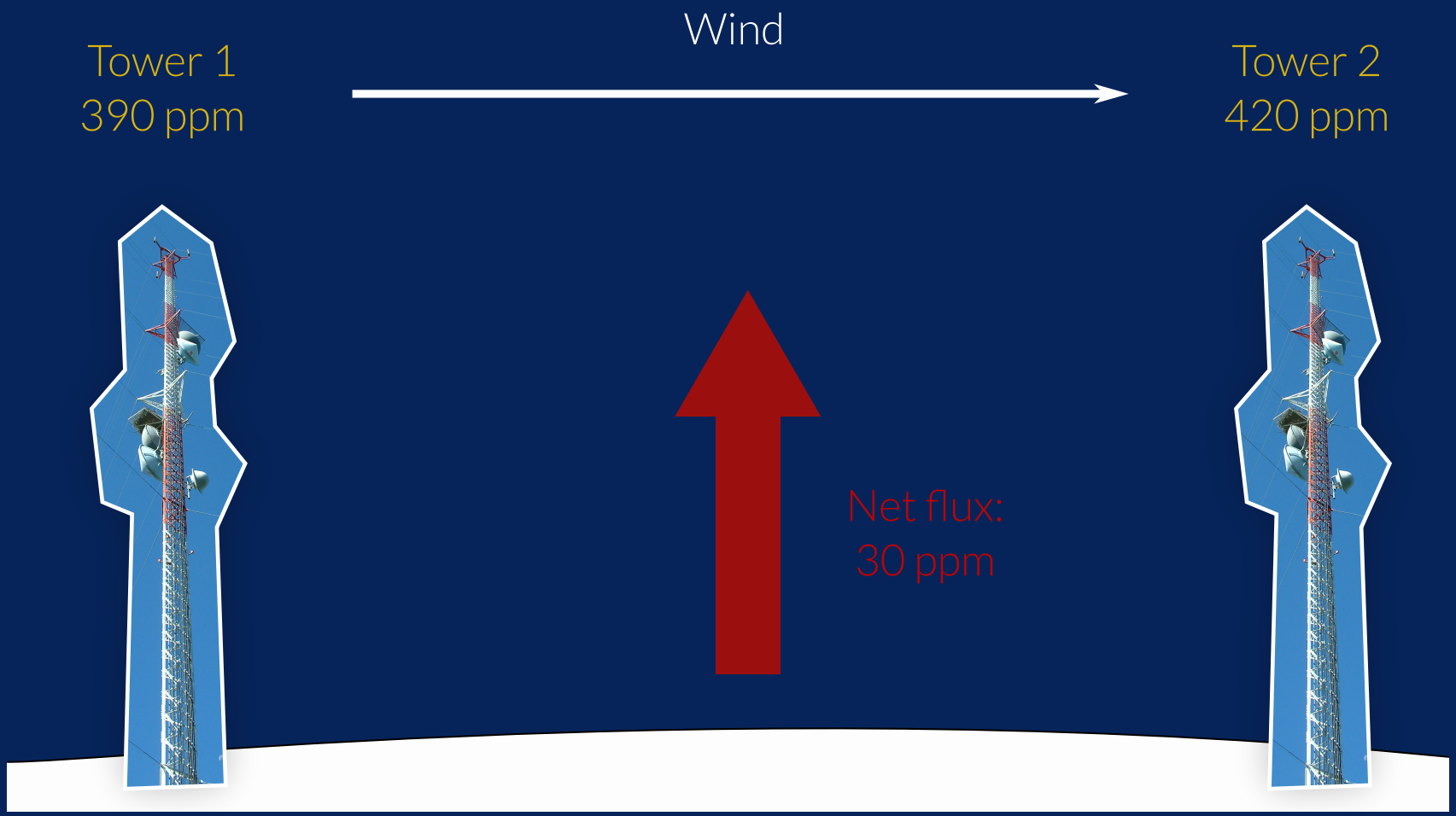


[IPCC AR5, 2014]

Can we estimate CO_2 fluxes using observations of atmospheric CO_2 concentration?

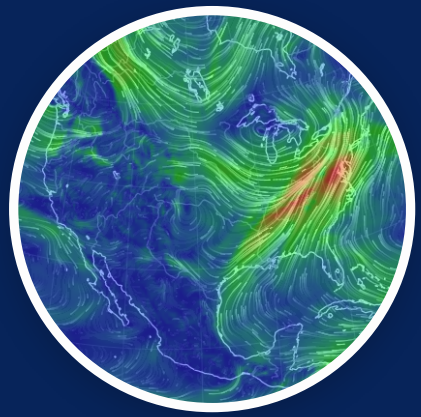


Can we estimate CO_2 fluxes using observations of atmospheric CO_2 concentration?

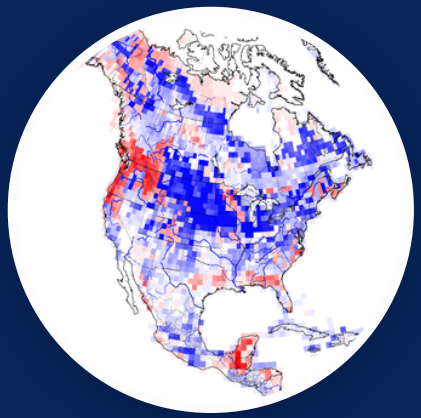


Three essential components to estimate CO_2 fluxes

Observations



Transport



Prior fluxes

ACT-America: Airborne missions to study the transport of atmospheric CO_2 and methane

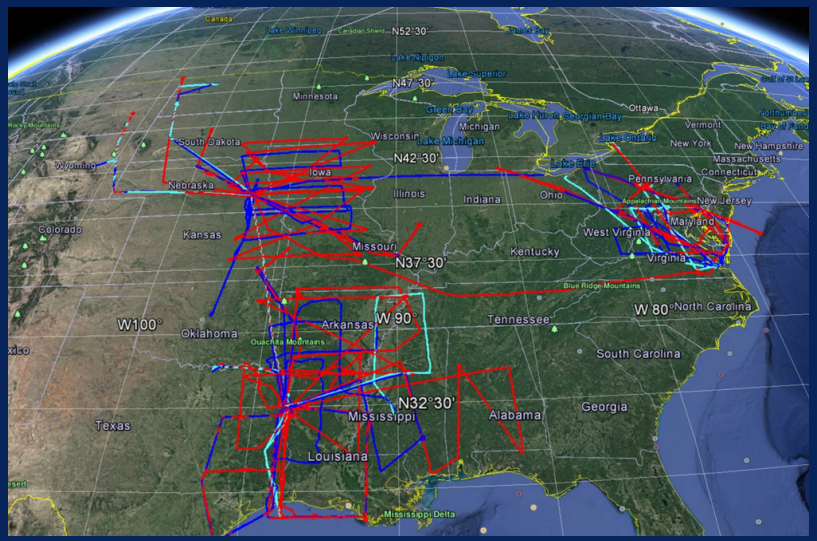
Atmospheric Carbon and Transport — America


N436NA

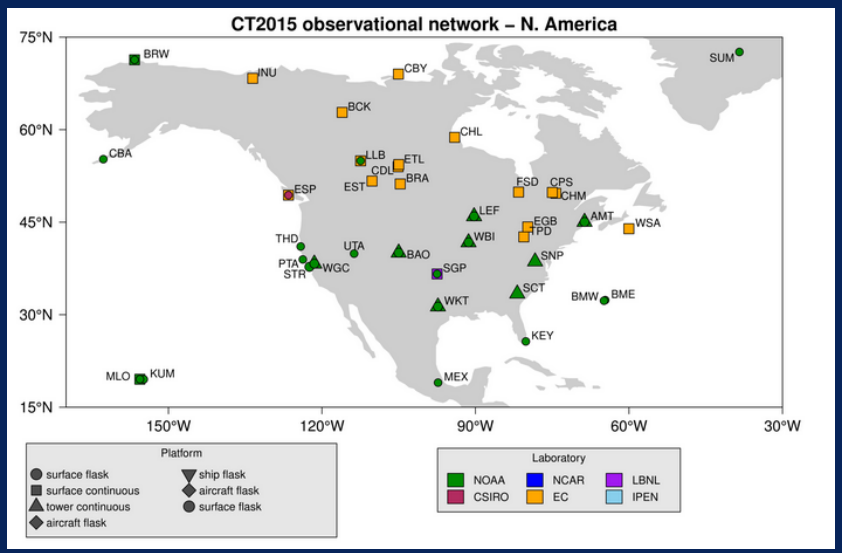

DANGER


DANGER

Observations: Aircraft measurements, towers, and satellite



Flight tracks (courtesy of Sandip Pal)

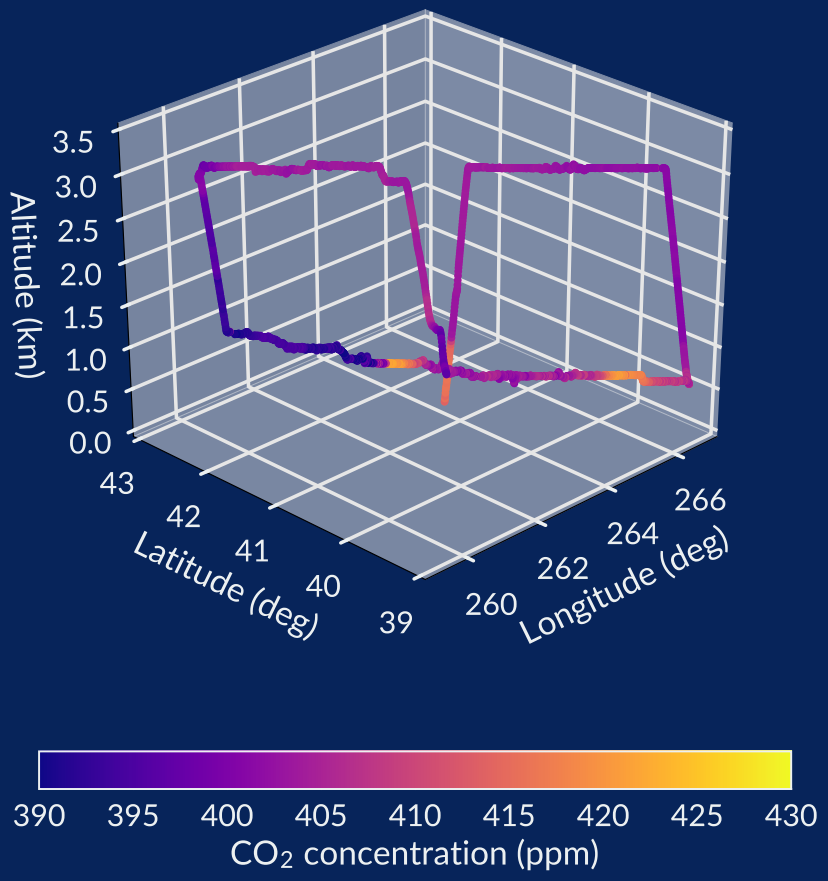


Observational network

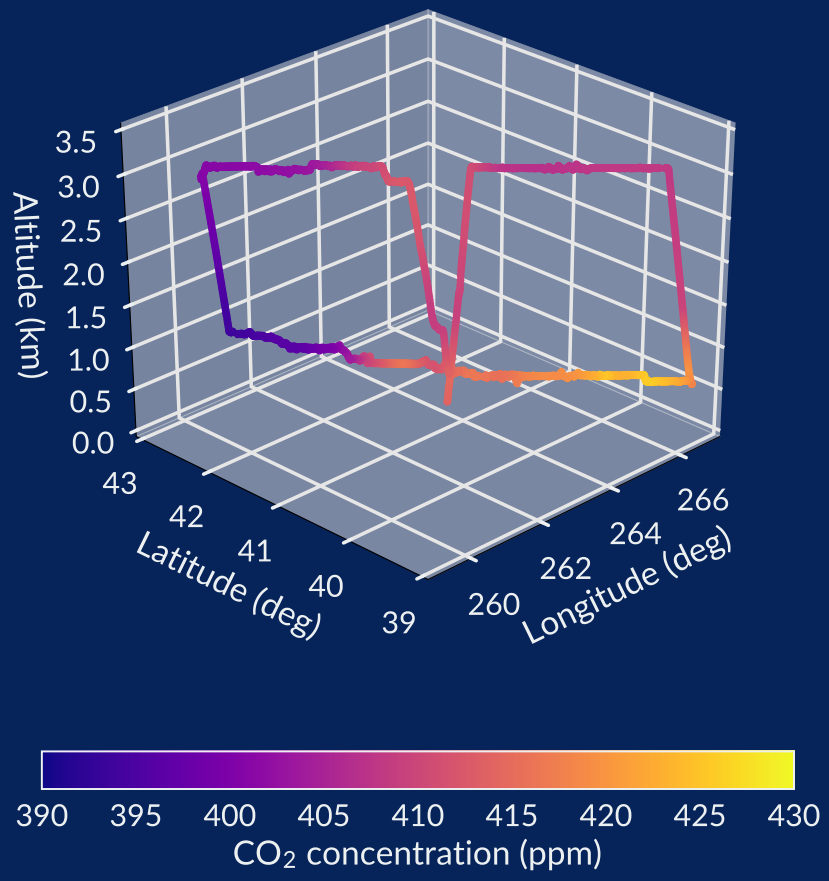
OCO-2 satellite

Transport models: Good agreements with observed CO_2 concentration

Observed CO_2 from B200

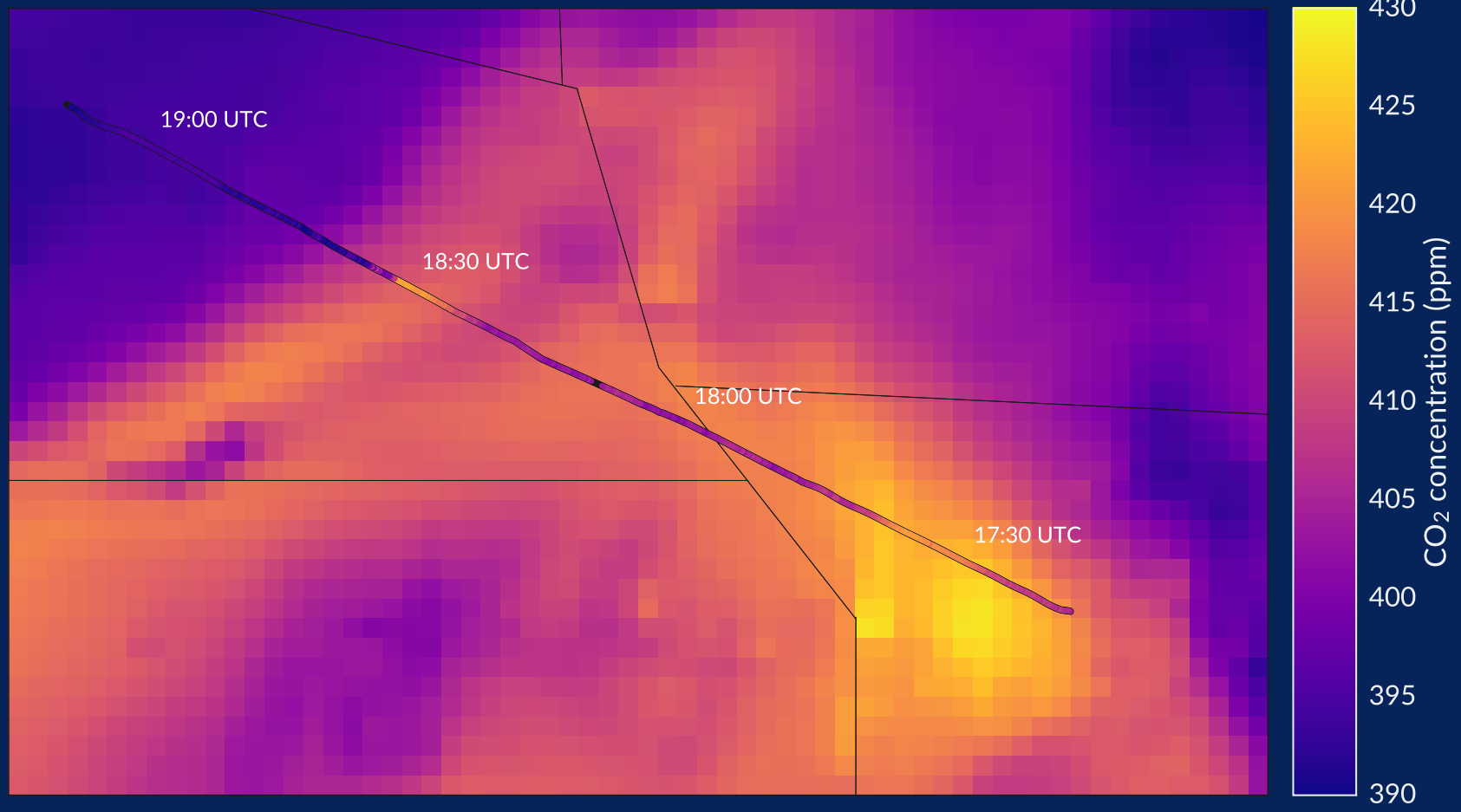


Modeled CO_2 from ECMWF



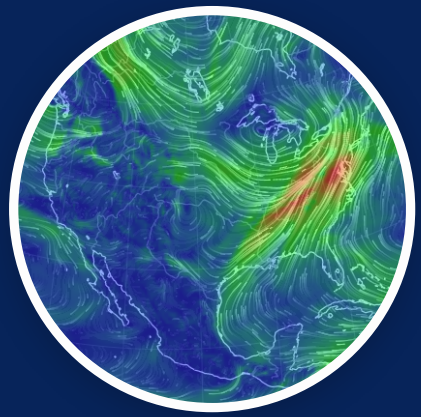
Transport models: Good agreements with observed CO_2 concentration

Observed CO_2 (track) and modeled CO_2 from ECMWF (shading)

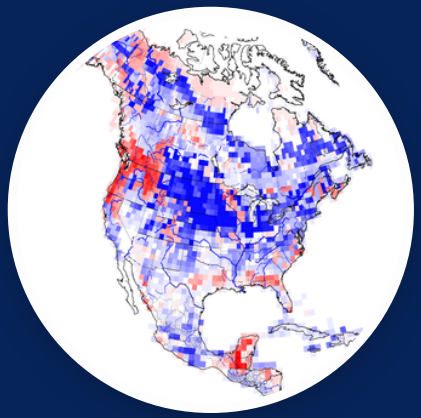


The missing piece to connect everything together

Observations



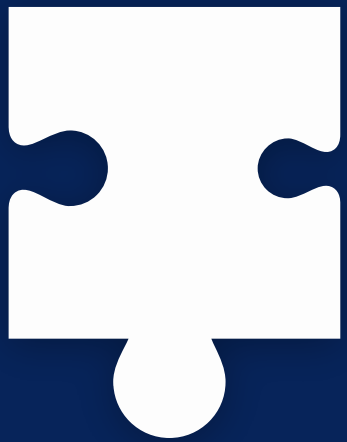
Transport

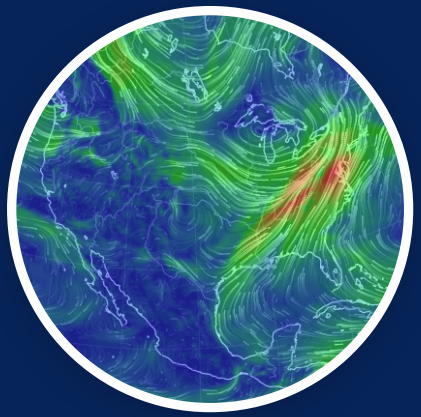


Prior fluxes

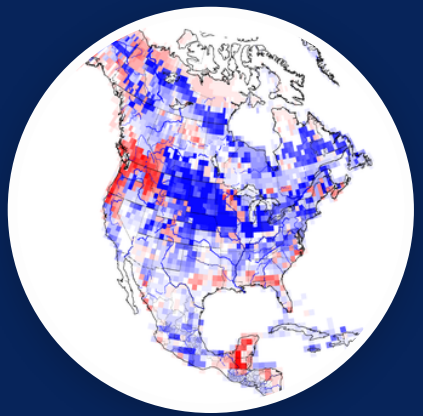
The missing piece to connect everything together

Observations





Transport

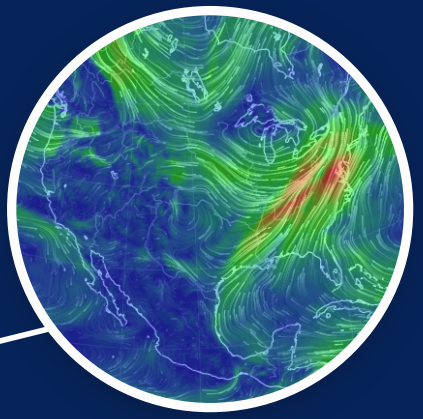


Prior fluxes

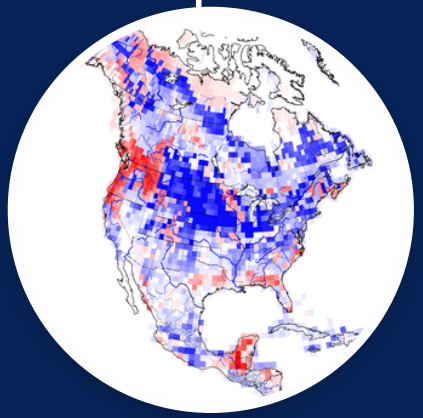
The missing piece to connect everything together

Observations

Ensemble Kalman Filter



Transport



Prior fluxes