

What determines the large seasonal cycle of CO₂ in the Arctic

Colm Sweeney

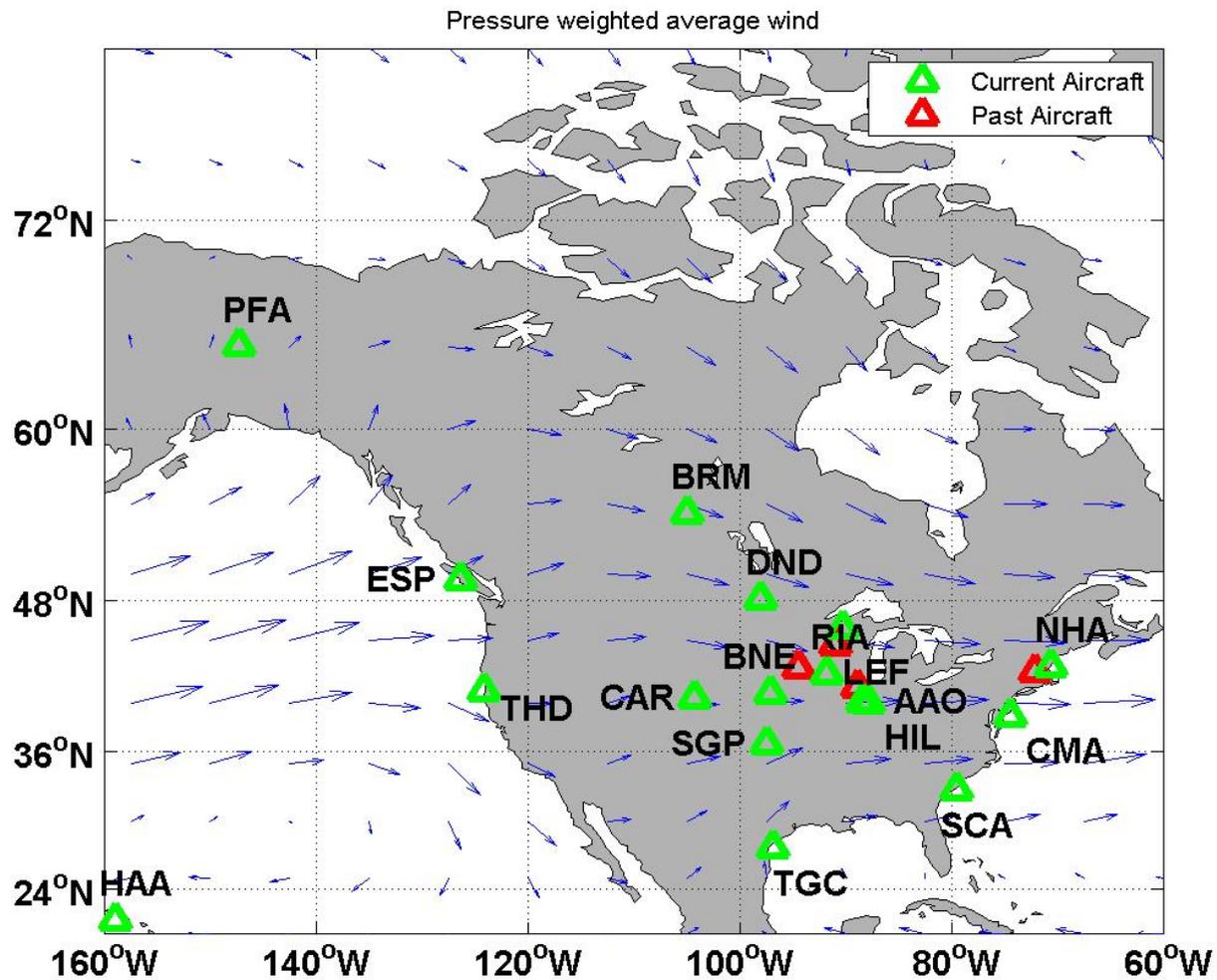
University of Colorado

NOAA/ESRL Global Monitoring Division

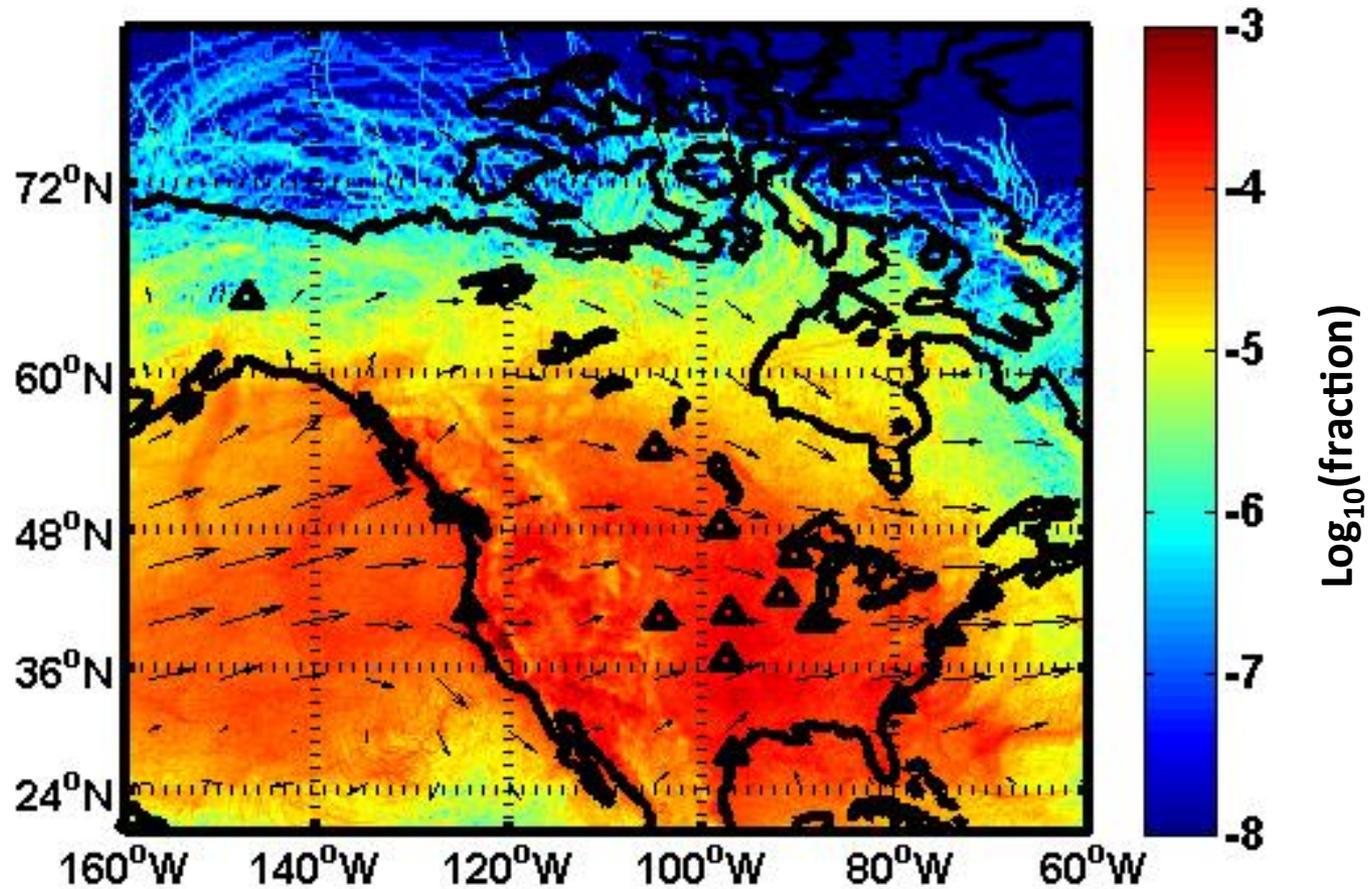
With contributions from:

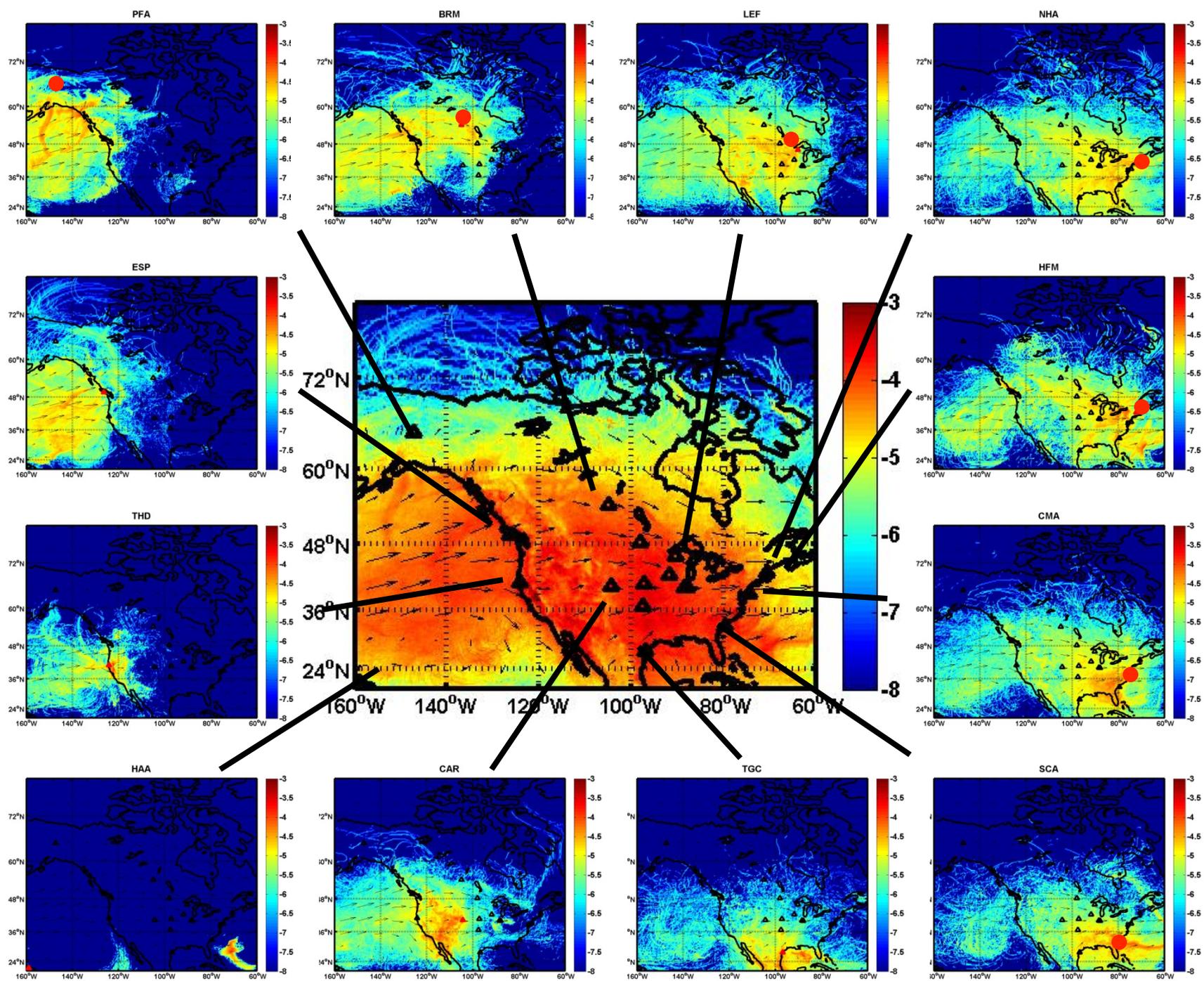
Pieter Tans, Steve Wofsy, Britt Stephens
John Miller, Anna Karion, Andy Jacobson

Current Aircraft Network

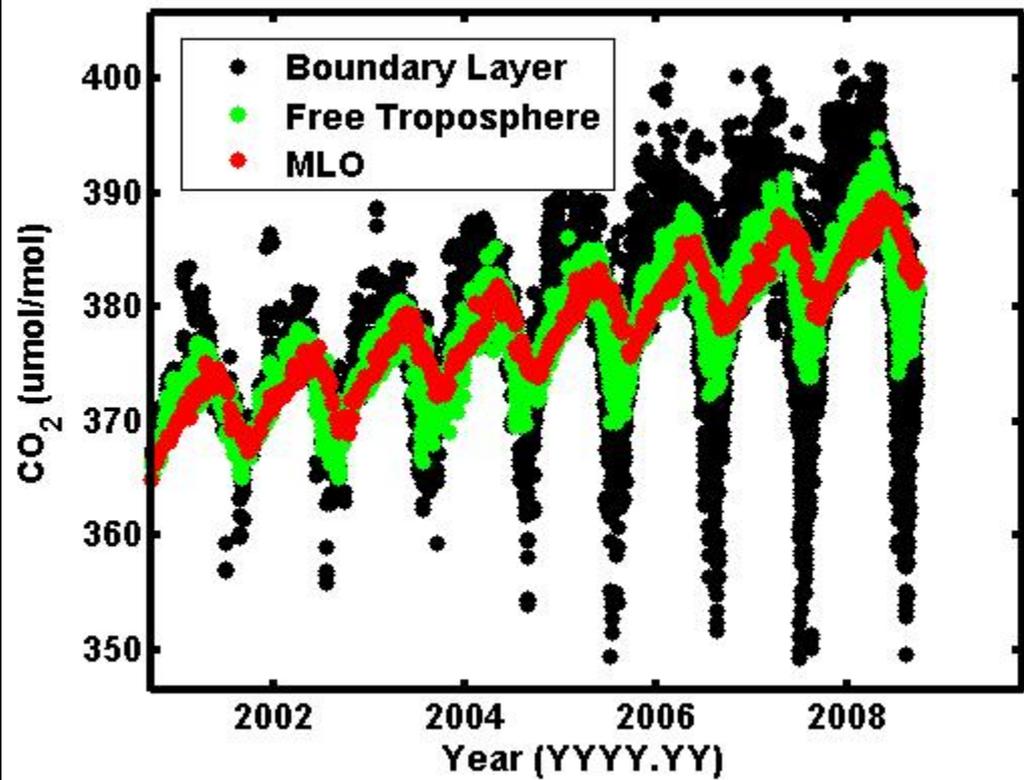


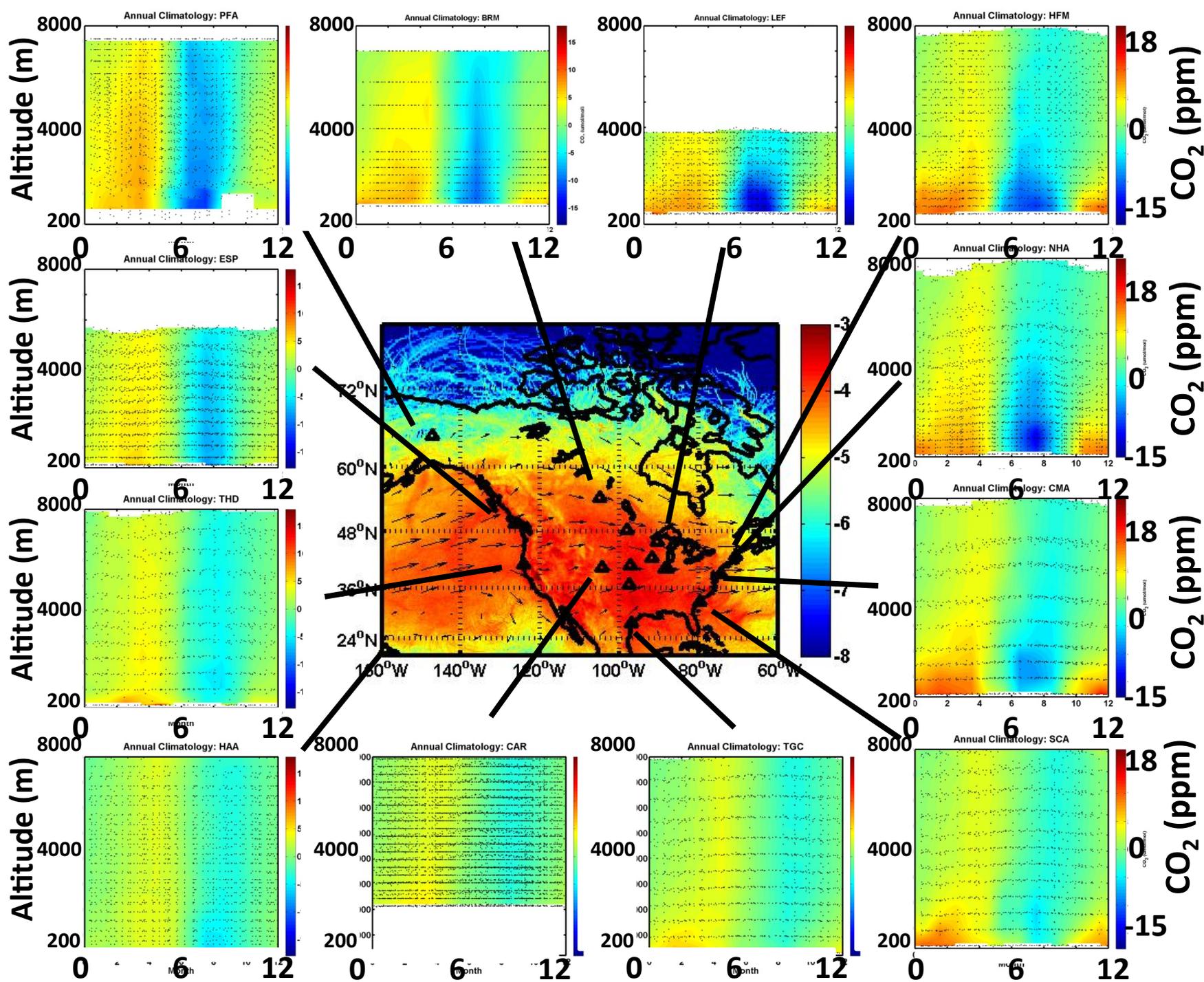
Current Aircraft Network



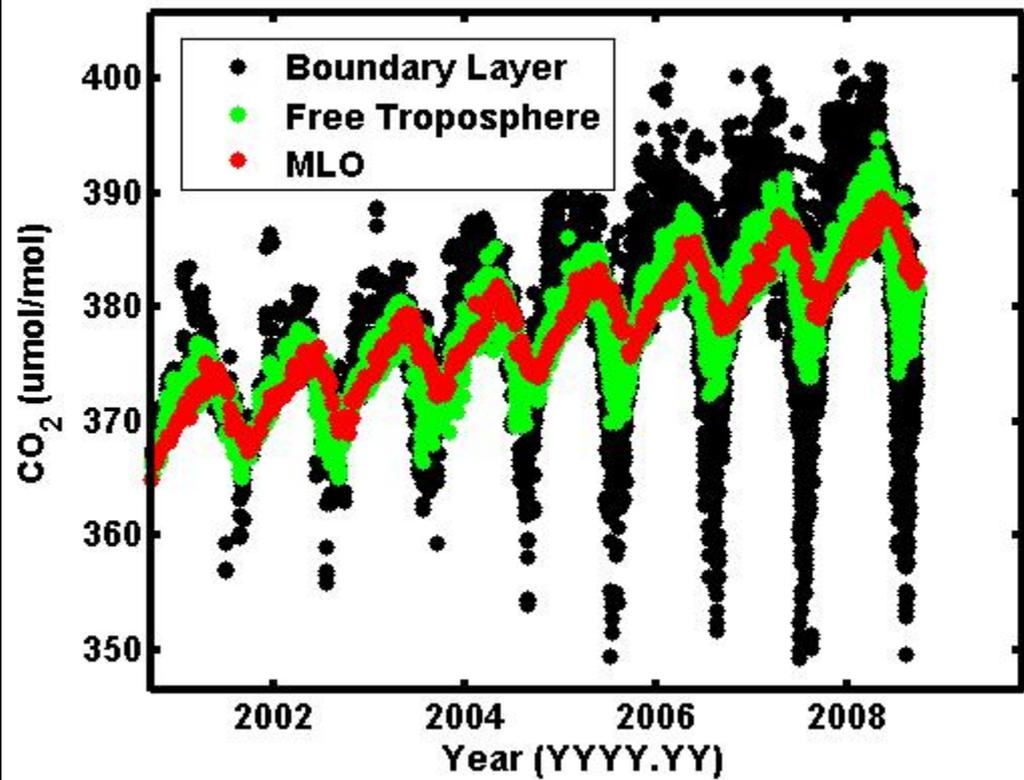


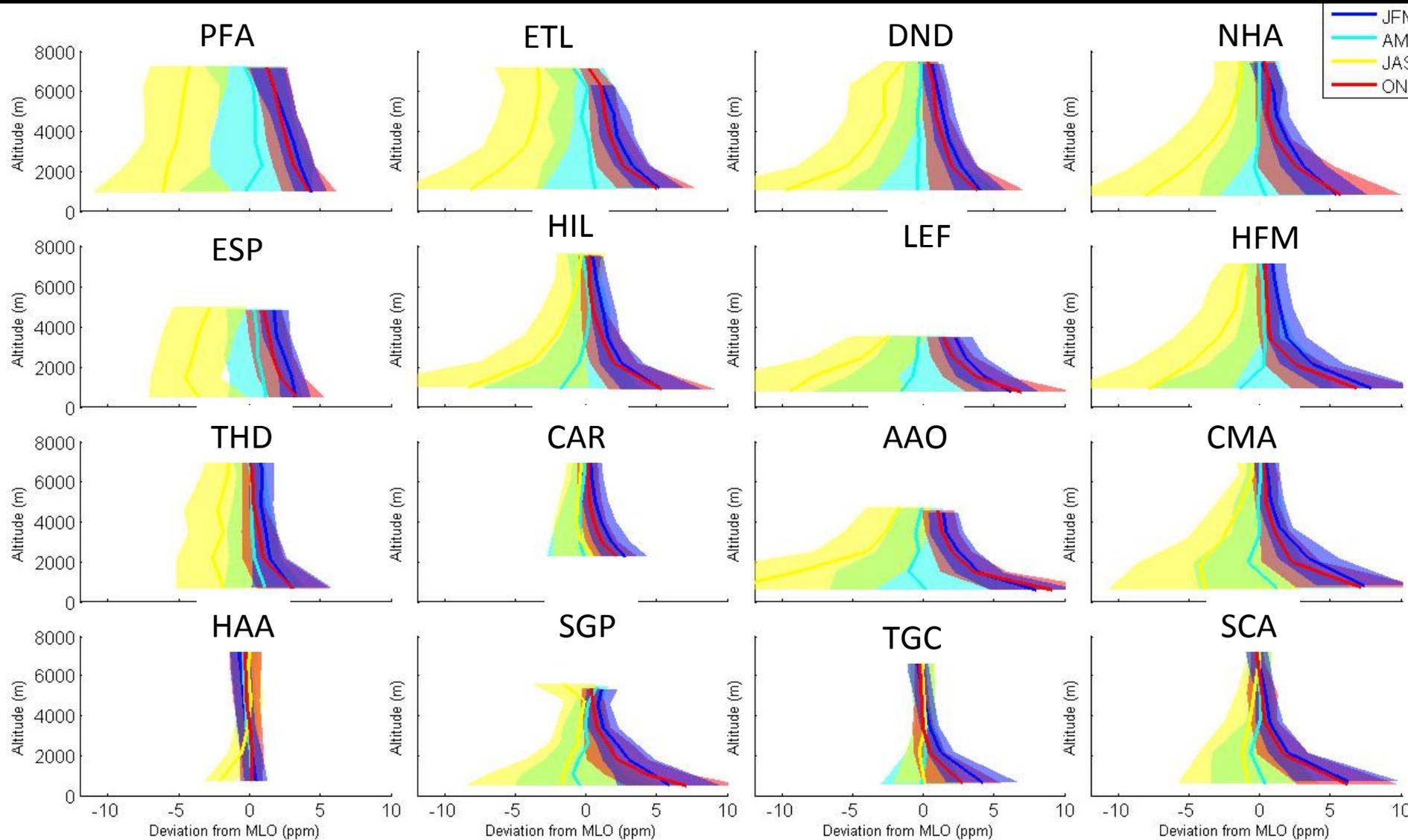
Aircraft Network Footprint

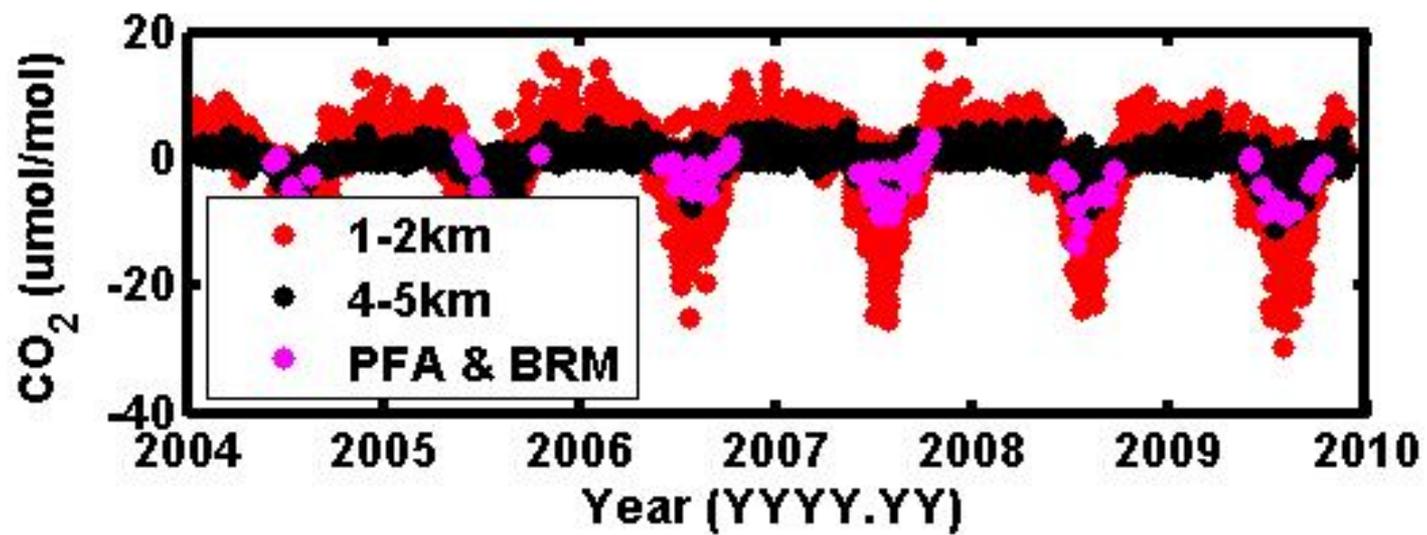
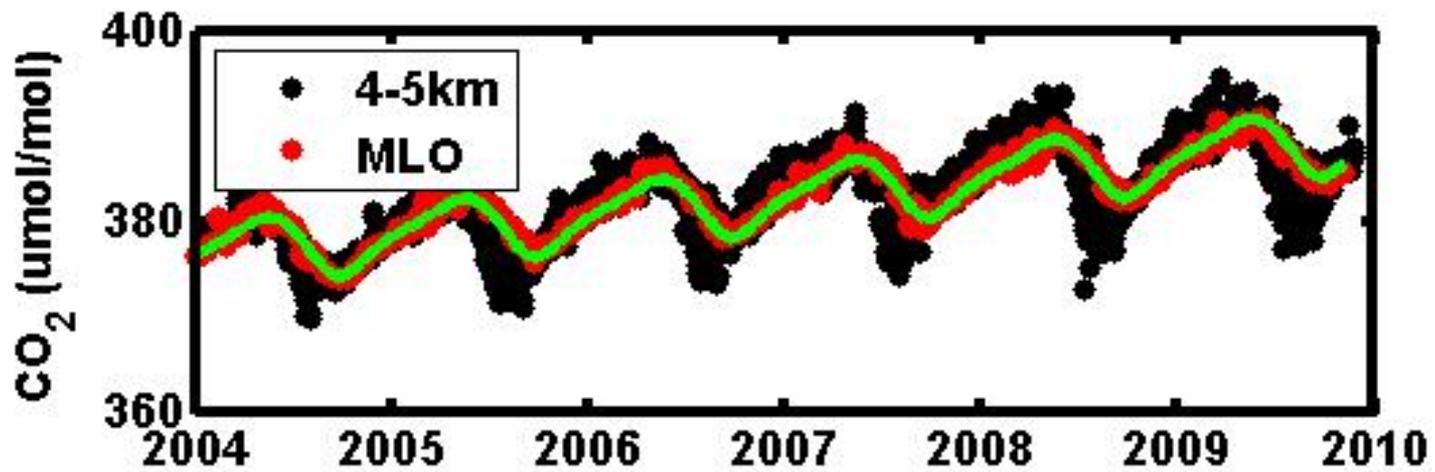




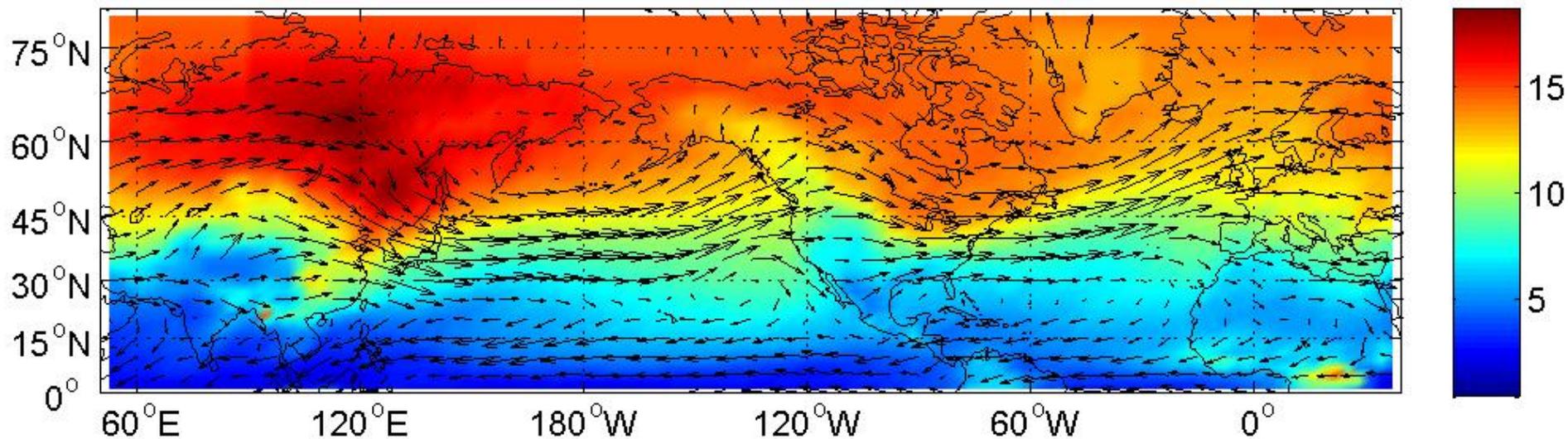
Deviation from global trend



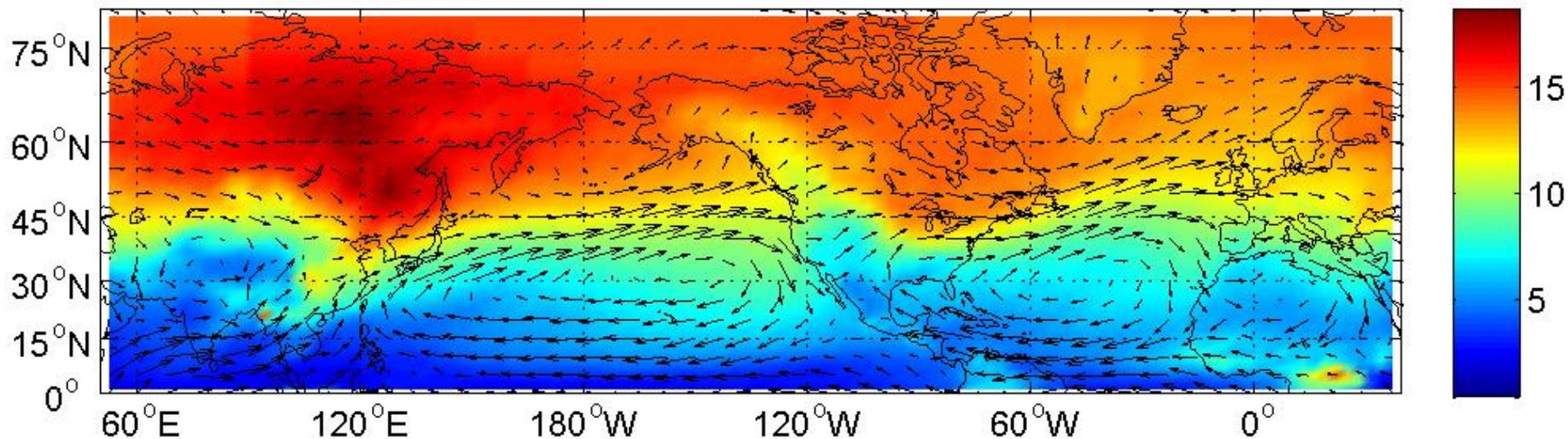




0-9km amplitude: Mass Transport (December)



0-9km amplitude: Mass Transport (June)



What is the cause of large amplitude in the Arctic ?

High latitude productivity?

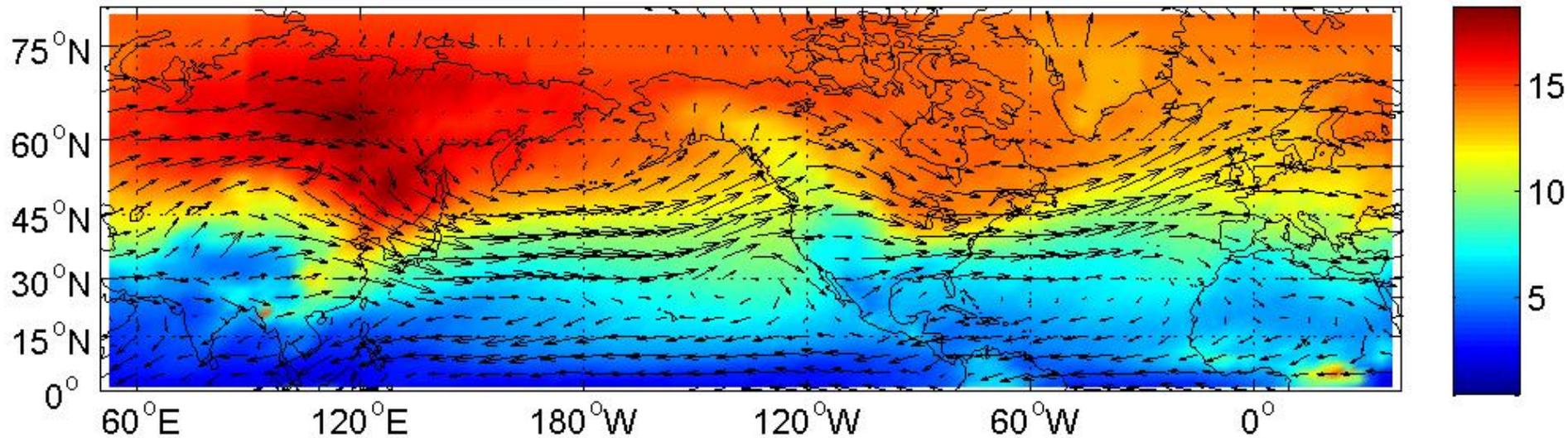
- Long summer days (Randerson, Keppel-Aleks etc.)
- Low winds (climology)
- Transport during the summer is not well supported

Transport from mid-latitudes?

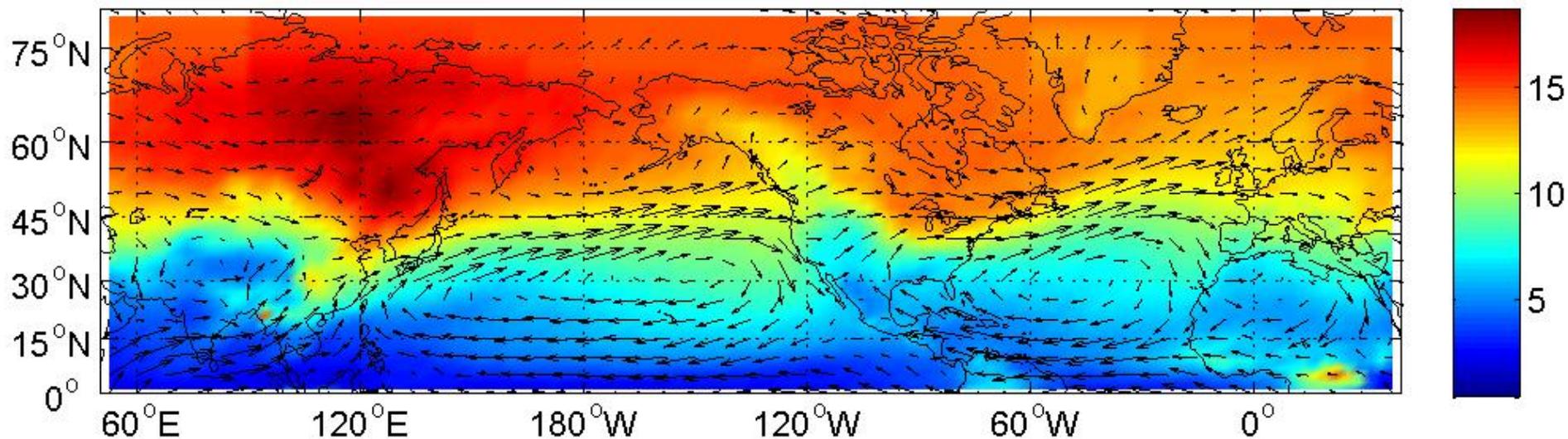
- CO and CH₄ suggest low latitude source
- transport is not well represented by models

Low winds

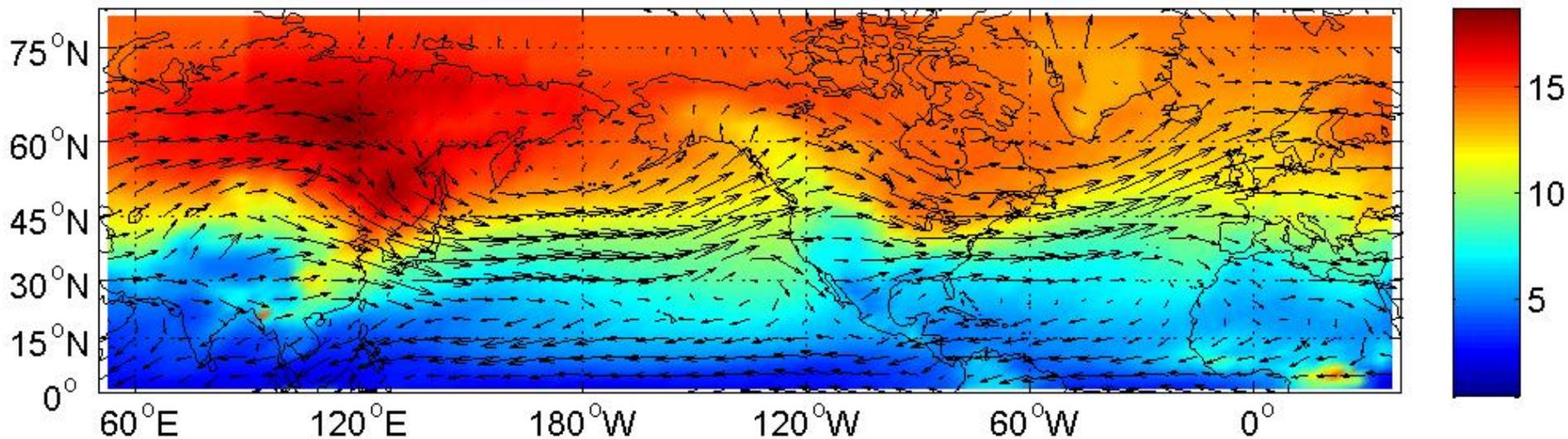
0-9km amplitude: Mass Transport (December)



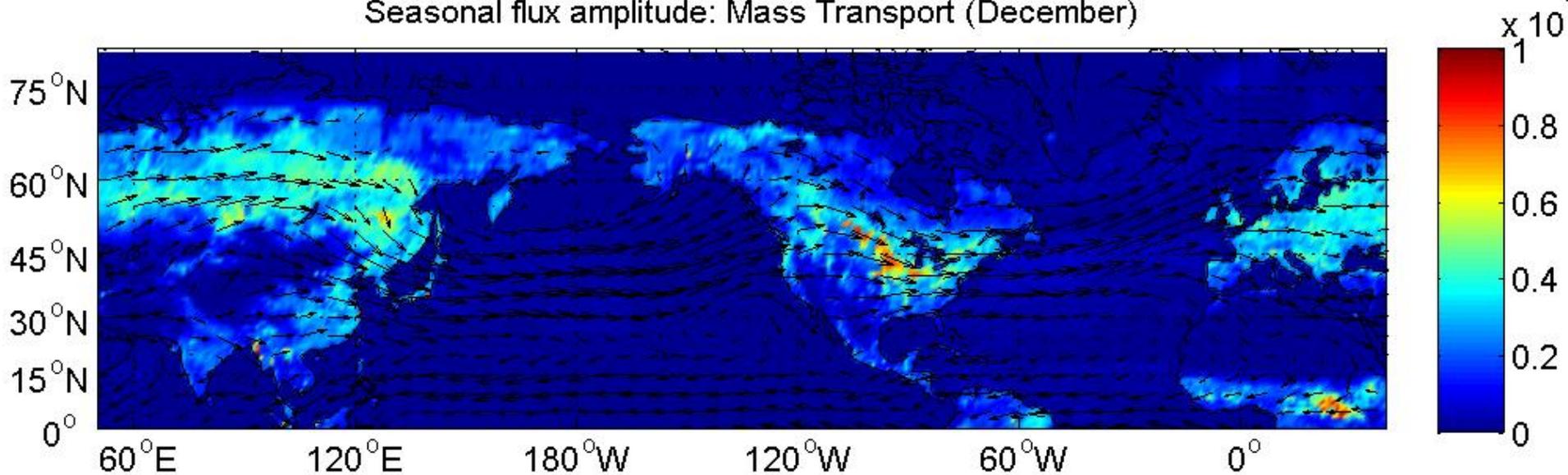
0-9km amplitude: Mass Transport (June)



0-9km amplitude: Mass Transport (December)

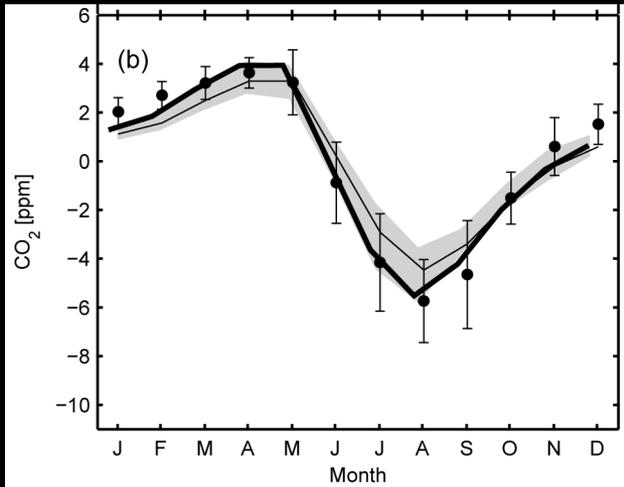


Seasonal flux amplitude: Mass Transport (December)

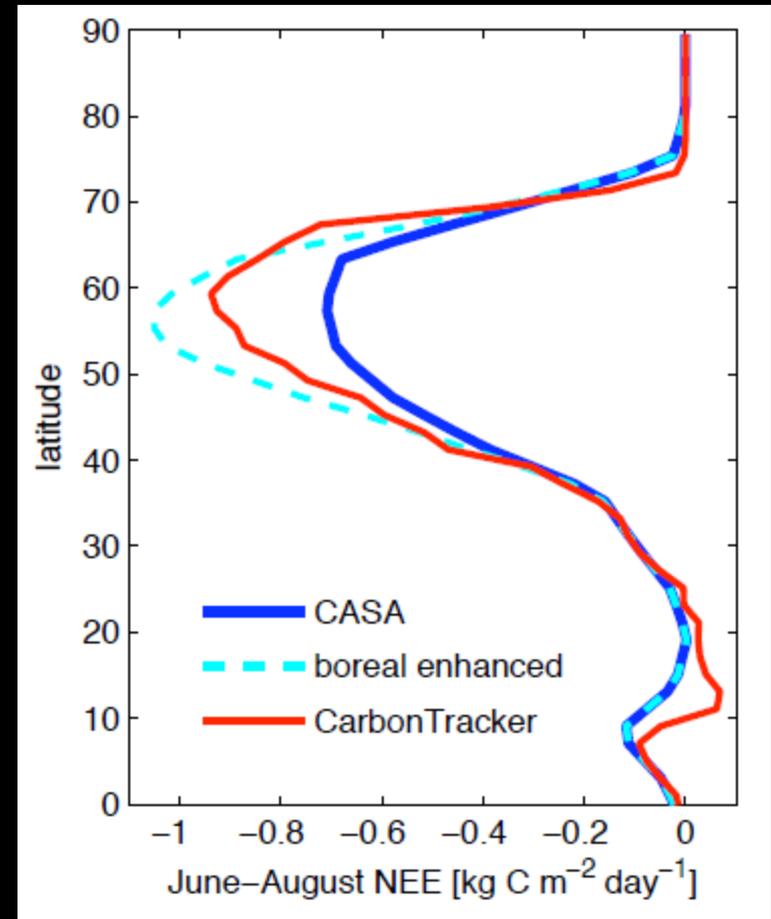


Big production in Boreal forest

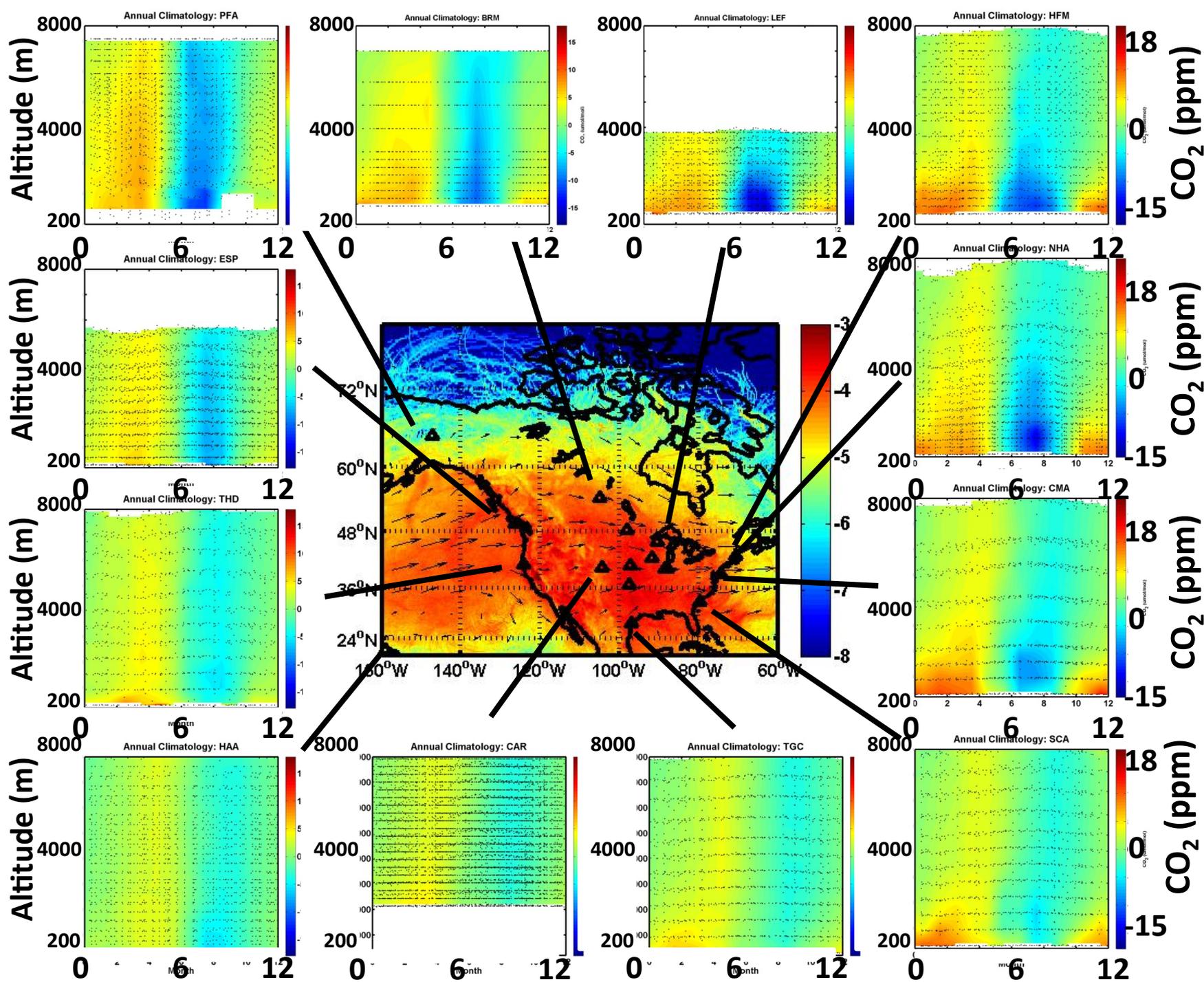
Past modeling efforts have never gotten the amplitude of the seasonal cycle in the full column right. This can be corrected with higher and earlier productivity in the boreal



Yang et al. 2007



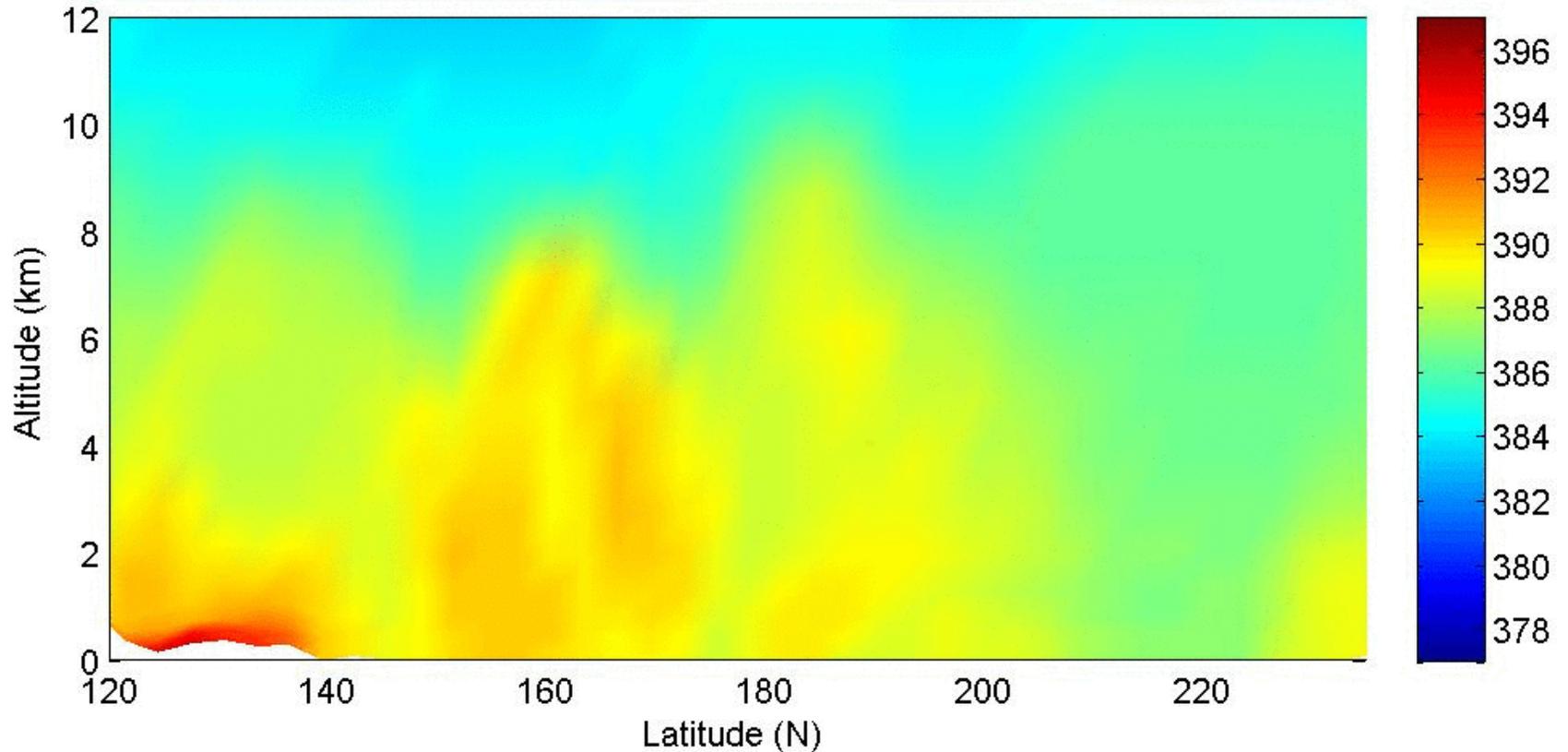
Keppel Aleks et al. 2012



Deviation from global trend

45N transect over Pacific

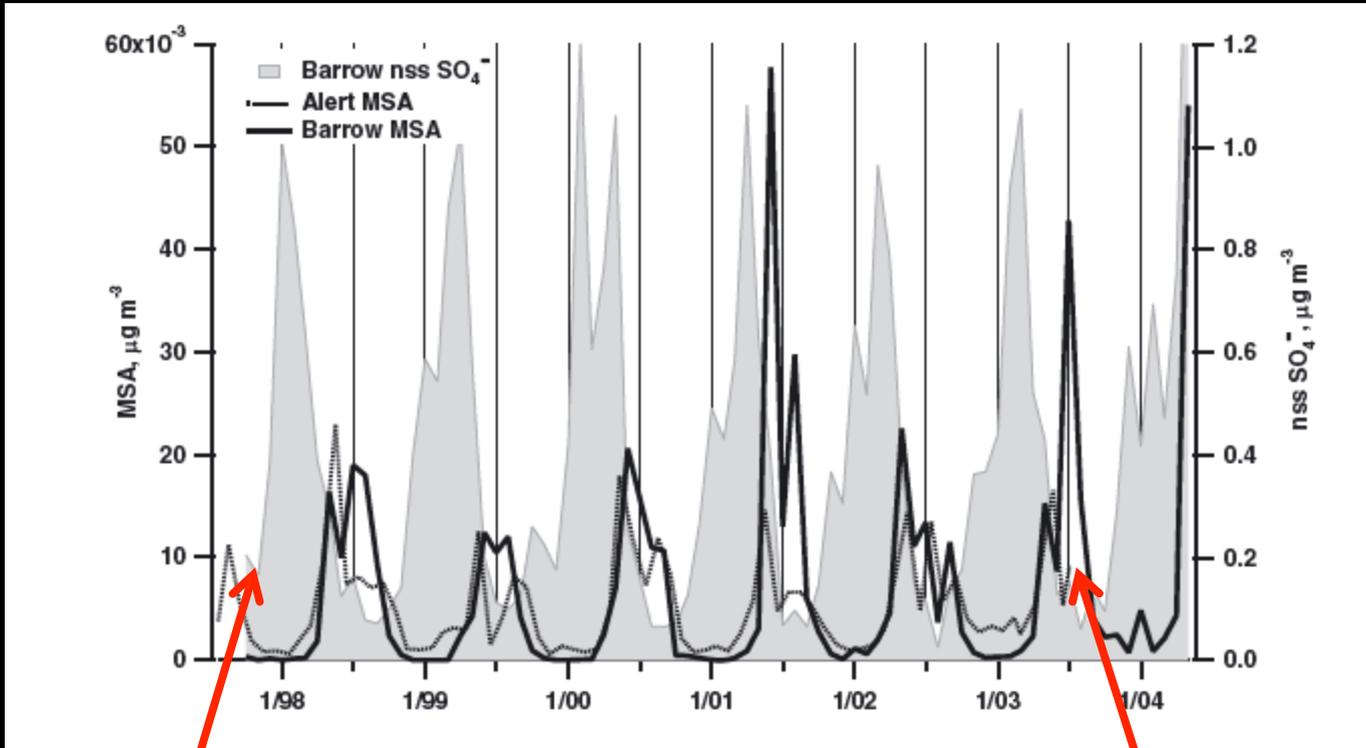
45°N 01-Jan-2009 01:30:00



Arctic Haze Transport

Winter – Long range transport

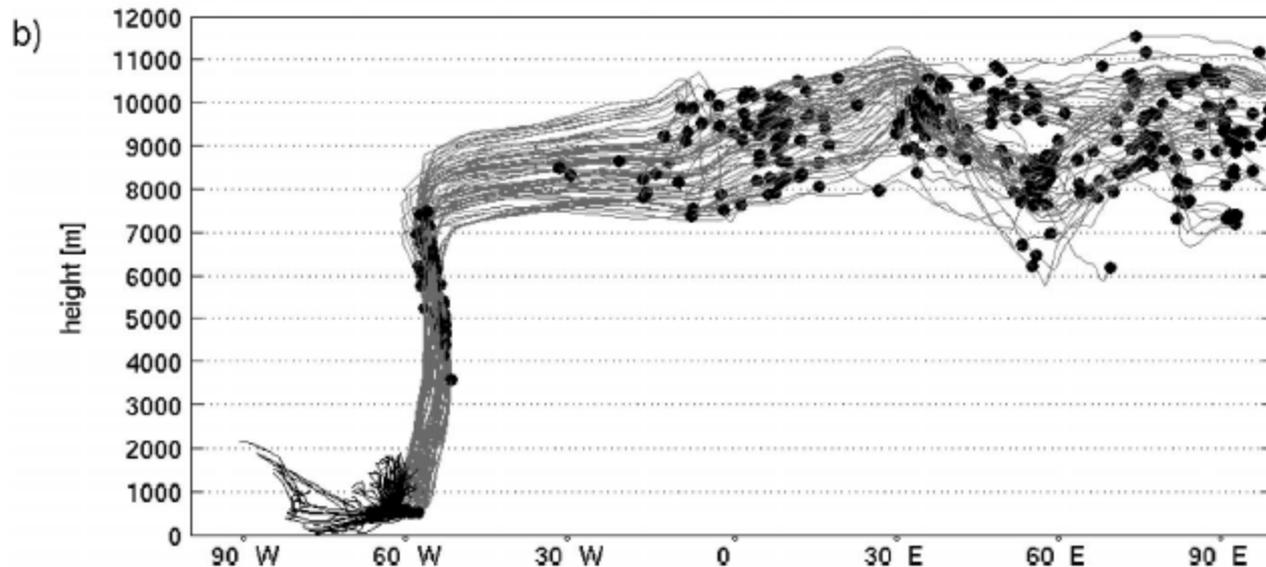
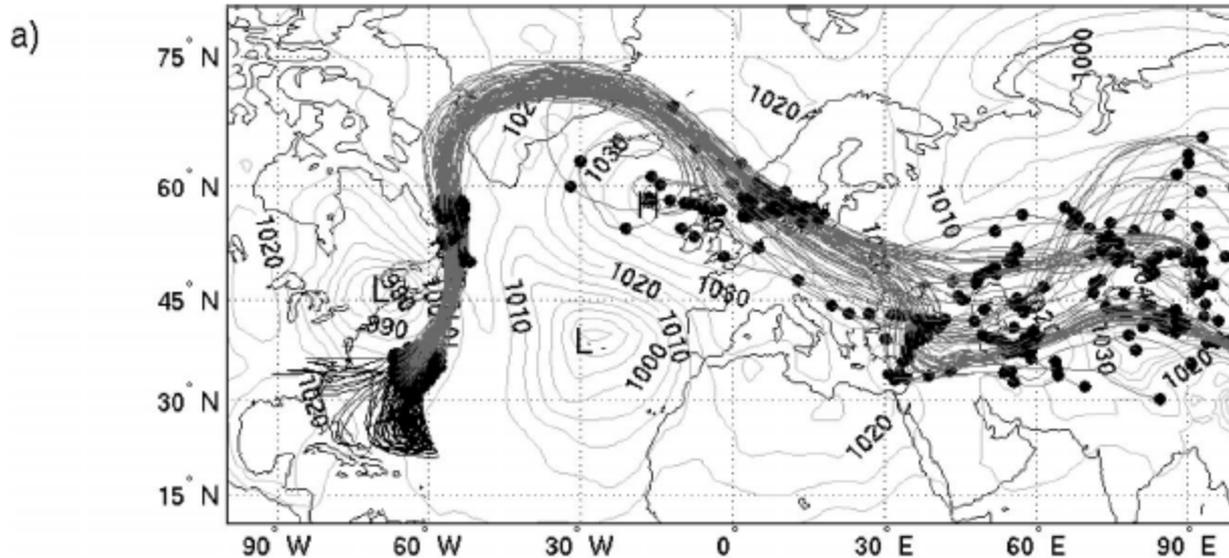
Summer – local transport



Anthropogenic pollutant – SO_4

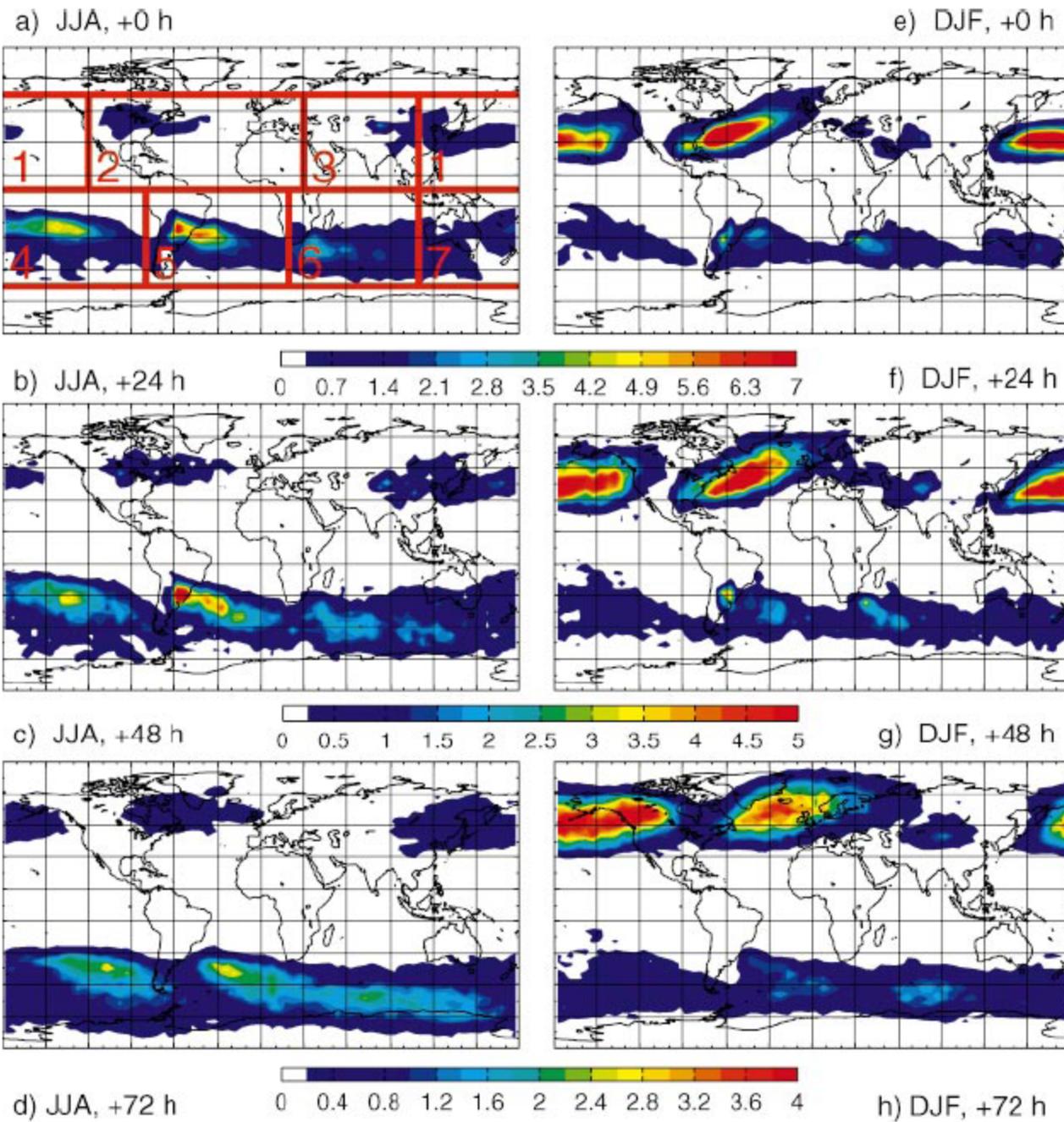
Natural (local) - methanesulfonic acid MSA^-

Warm Conveyor Belt (WCB)



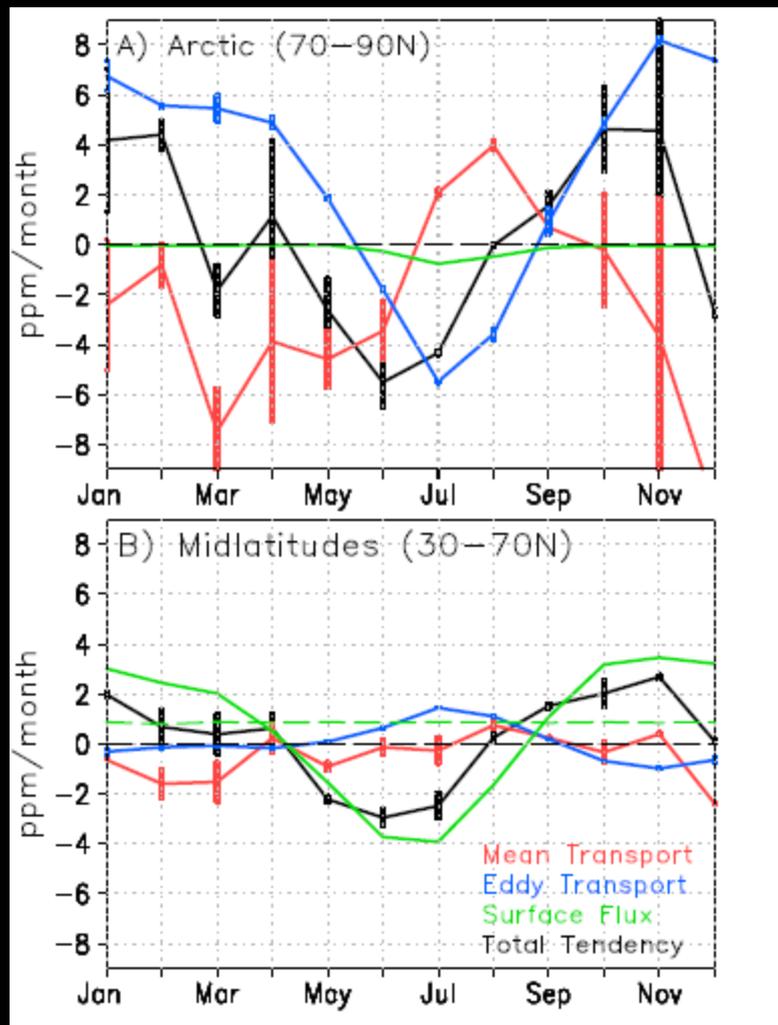
Rapid rise in
moist air
associated
with cyclone

Summer

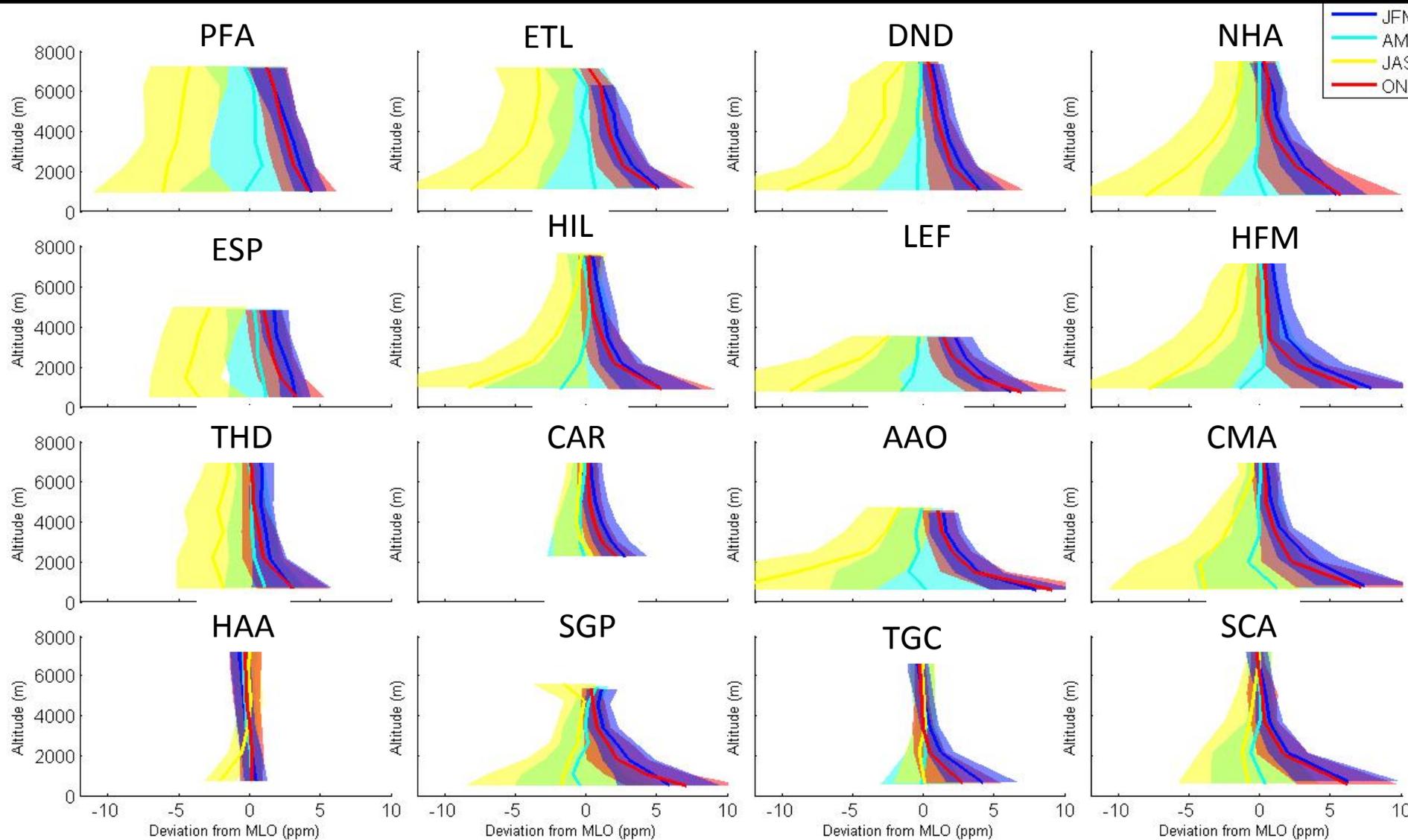


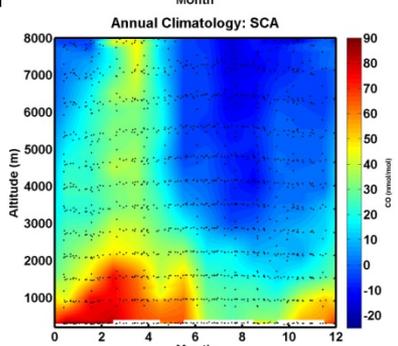
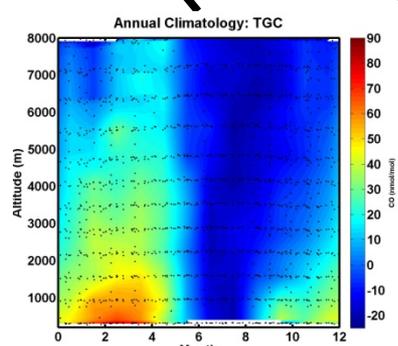
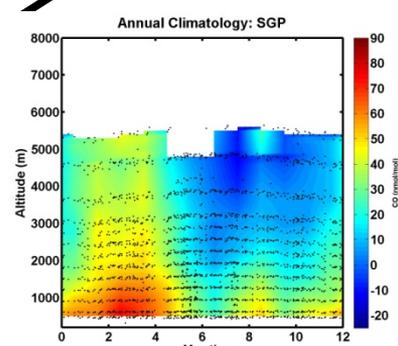
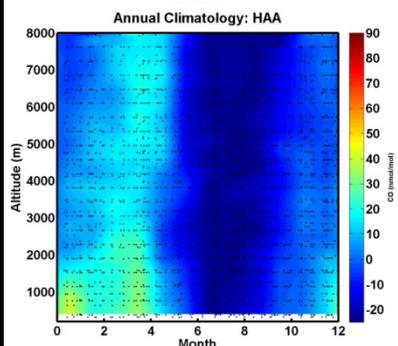
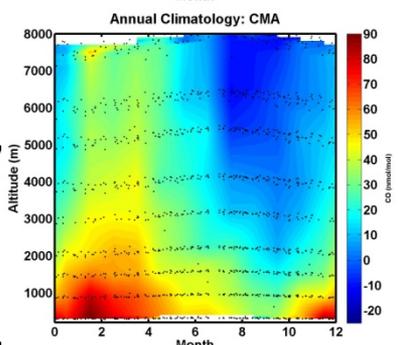
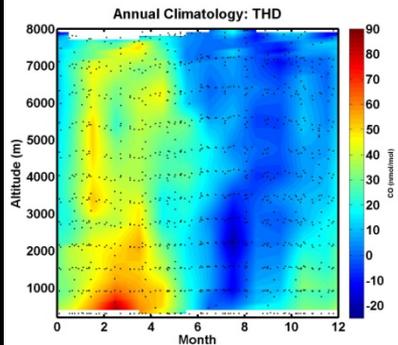
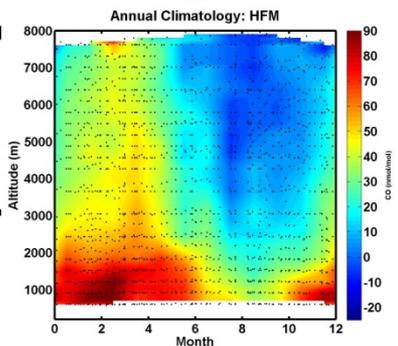
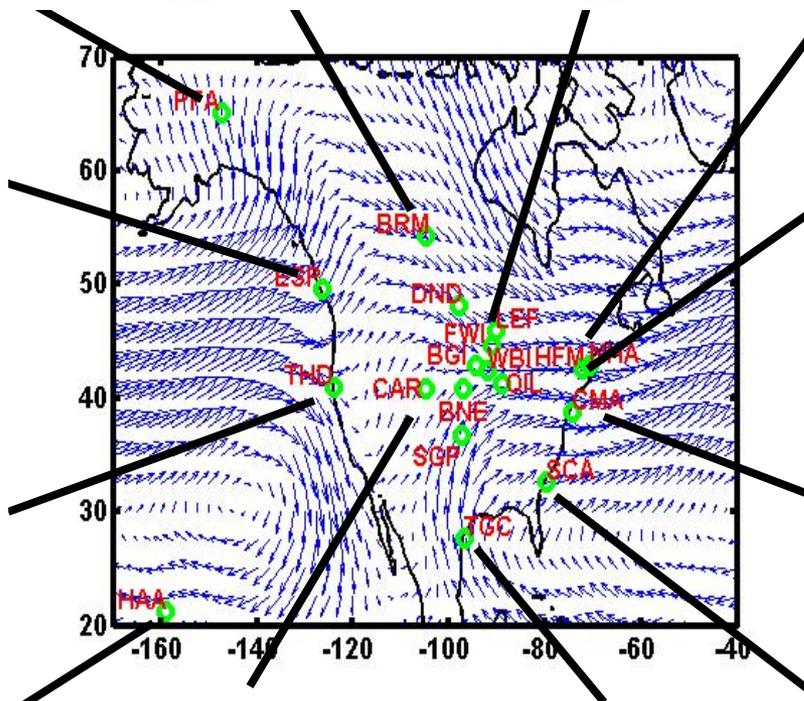
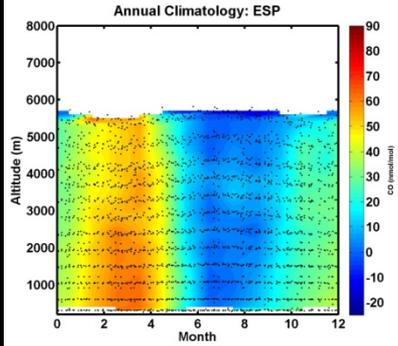
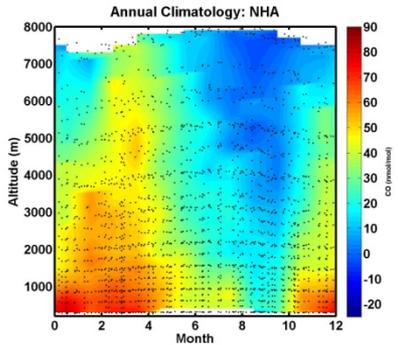
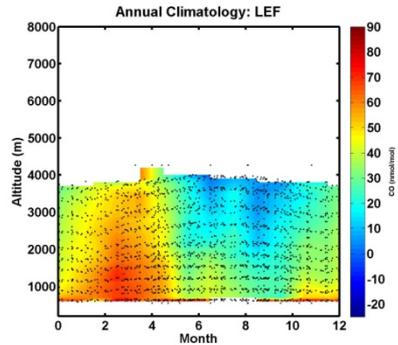
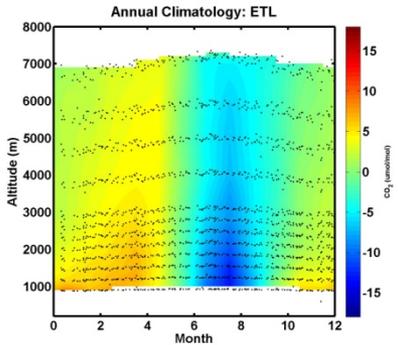
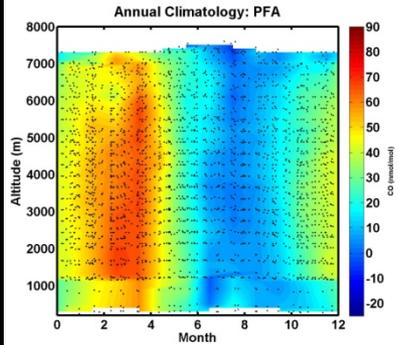
winter

Moist synoptic transport of CO₂ along the mid-latitude storm track

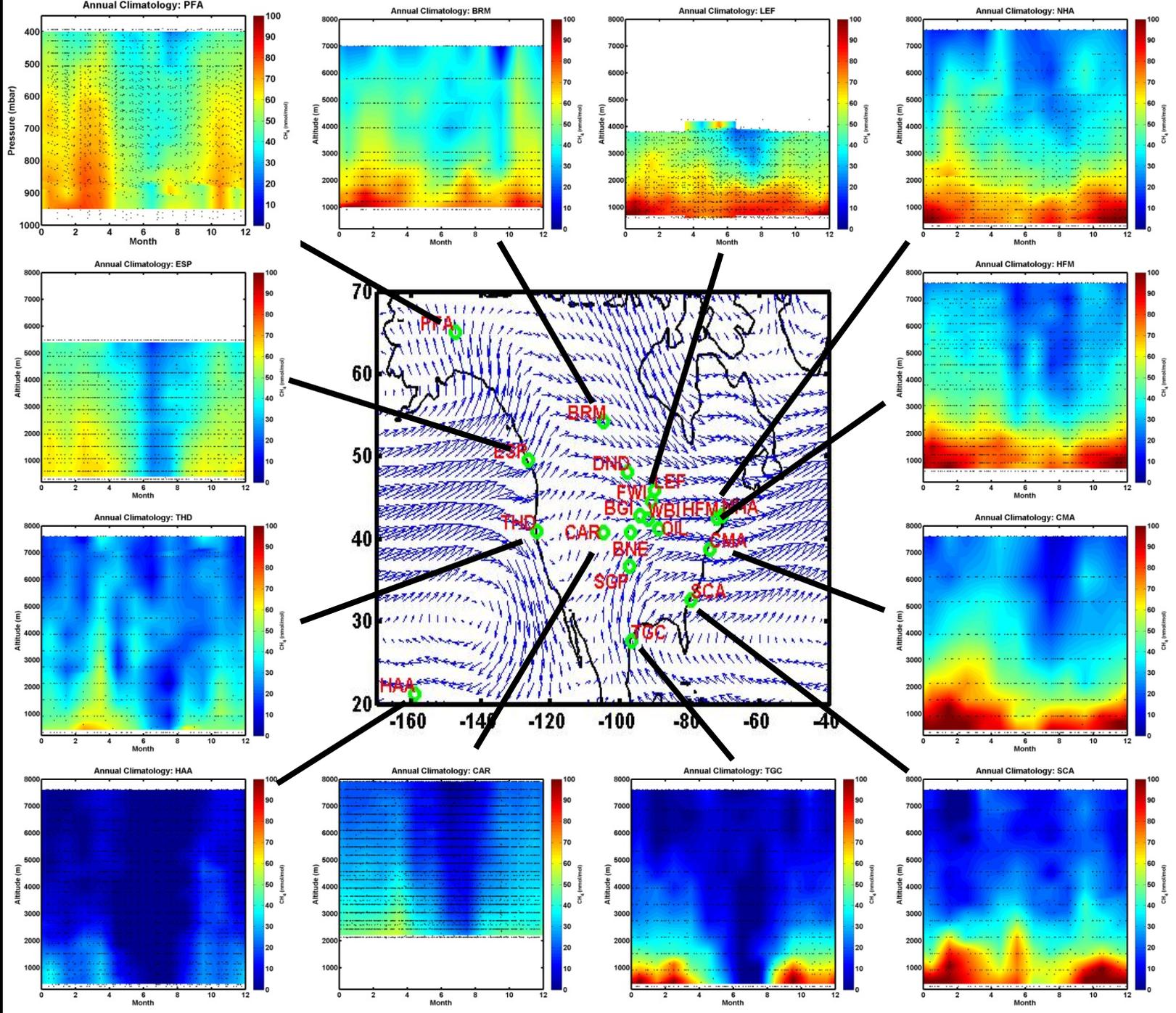


Eddy transport amplifies seasonal cycle of CO₂ in the Arctic and diminishes it in low latitudes





CO



CH₄

Conclusion

- Boreal production has a dominant role in the seasonal cycle but transport is clearly important but will need to be evaluated with higher resolution models that resolve eddies moist air transport of CO₂ seasonal cycle into the Arctic.