

The tail pipe of North America



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Karion

Outline

1) Introduction and Motivation

- Location
- Advantages to an ocean tower

2) Time series analysis

- Analysis of atmospheric CO₂ measurements

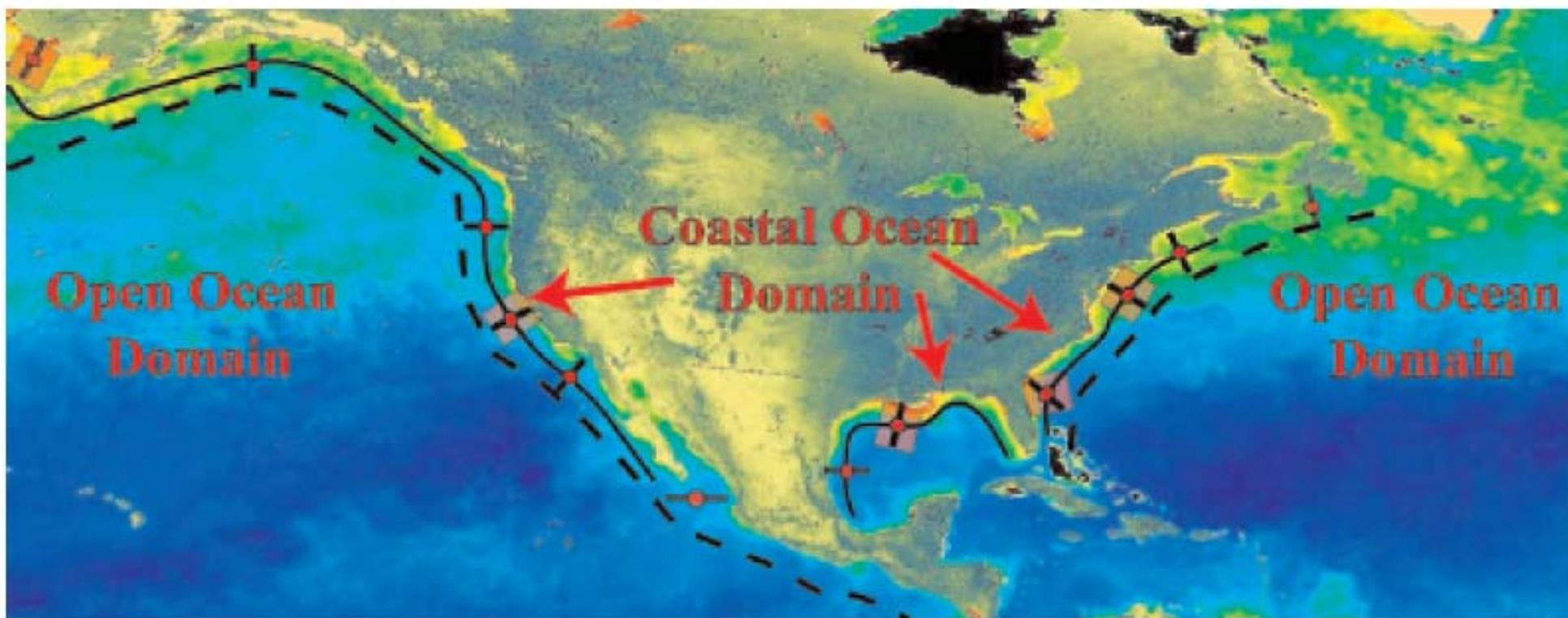
3) Comparison with other results

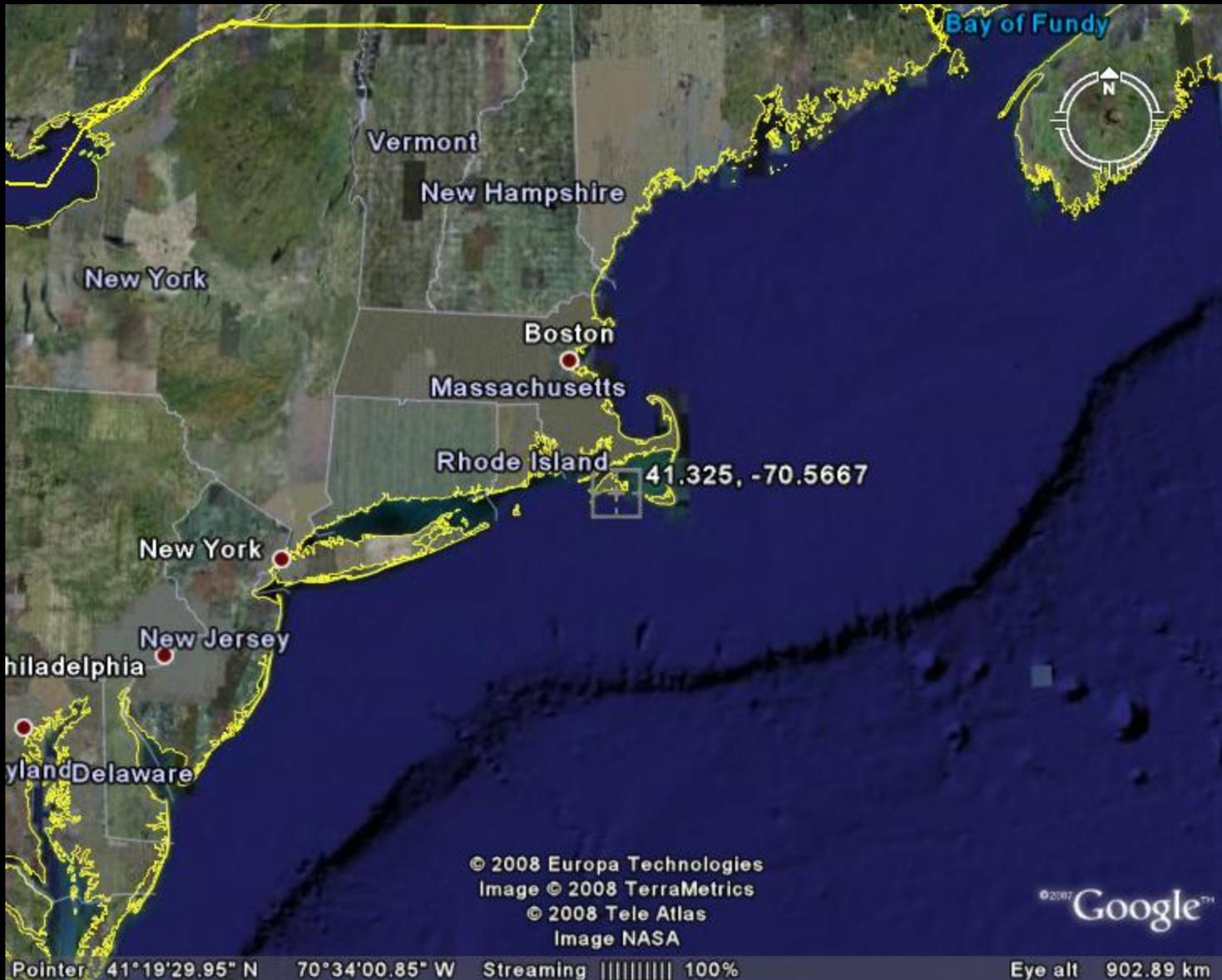
- CarbonTracker and Legrangian comparison

4) Conclusions

Motivation

Science Implementation Strategy for the
North American Carbon Program (NACP)





Bay of Fundy

Vermont

New Hampshire

New York

Boston

Massachusetts

Rhode Island

41.325, -70.5667

New York

New Jersey

Philadelphia

Maryland Delaware

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Pointer 41°19'29.95" N 70°34'00.85" W Streaming ||||| 100%

Eye alt 902.89 km



Providence

Warwick

Rhode Island

Martha's Vineyard

41.325, -70.5667

Block Island

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Image NASA

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Pointer 41°19'29.95" N 70°34'00.85" W elev 0 m Streaming ||||| 100% Eye alt 158.83 km



Dukes

Chappaquiddick Island

Skiffs Island (historical)

41.325, -70.5667

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Image NASA

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Pointer 41°19'09.48" N 70°33'46.68" W elev 0 m Streaming ||||| 100% Eye alt 16.91 km



Dukes



41.325, -70.5667

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Image NASA

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Pointer 41°19'10.39" N 70°33'46.68" W elev 0 m Streaming ||||| 100% Eye alt 10.15 km



Air and Water System

In situ atmospheric CO₂ System



**NOAA/GMD
12 pack system**



Water system



-Low Power (60W)

- **Passive temperature modulation**
- **Mole sieve dryer and gravity feed condensate removal.**

-Low standard and gas usage

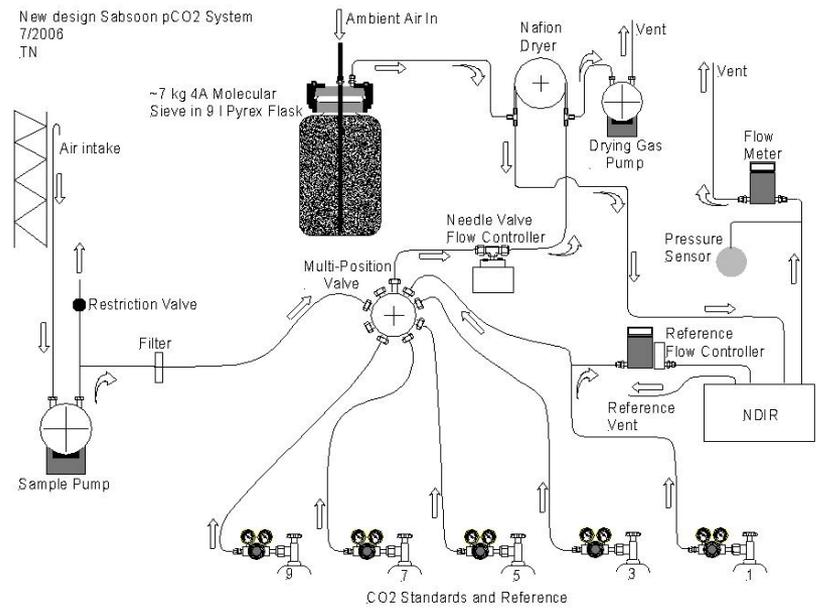
- **Stop flow system gives 3 year life to each std.**

- Remote control

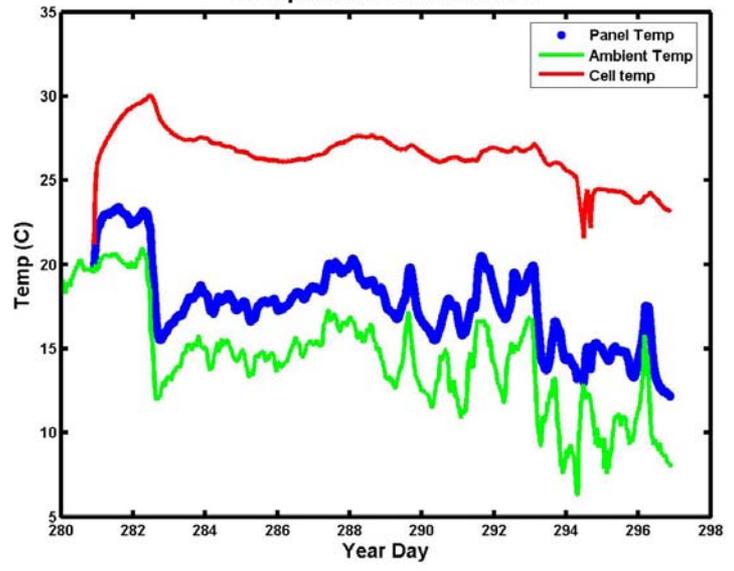
- **completely operable remotely**



New design Sabsoon pCO₂ System
7/2006
TN

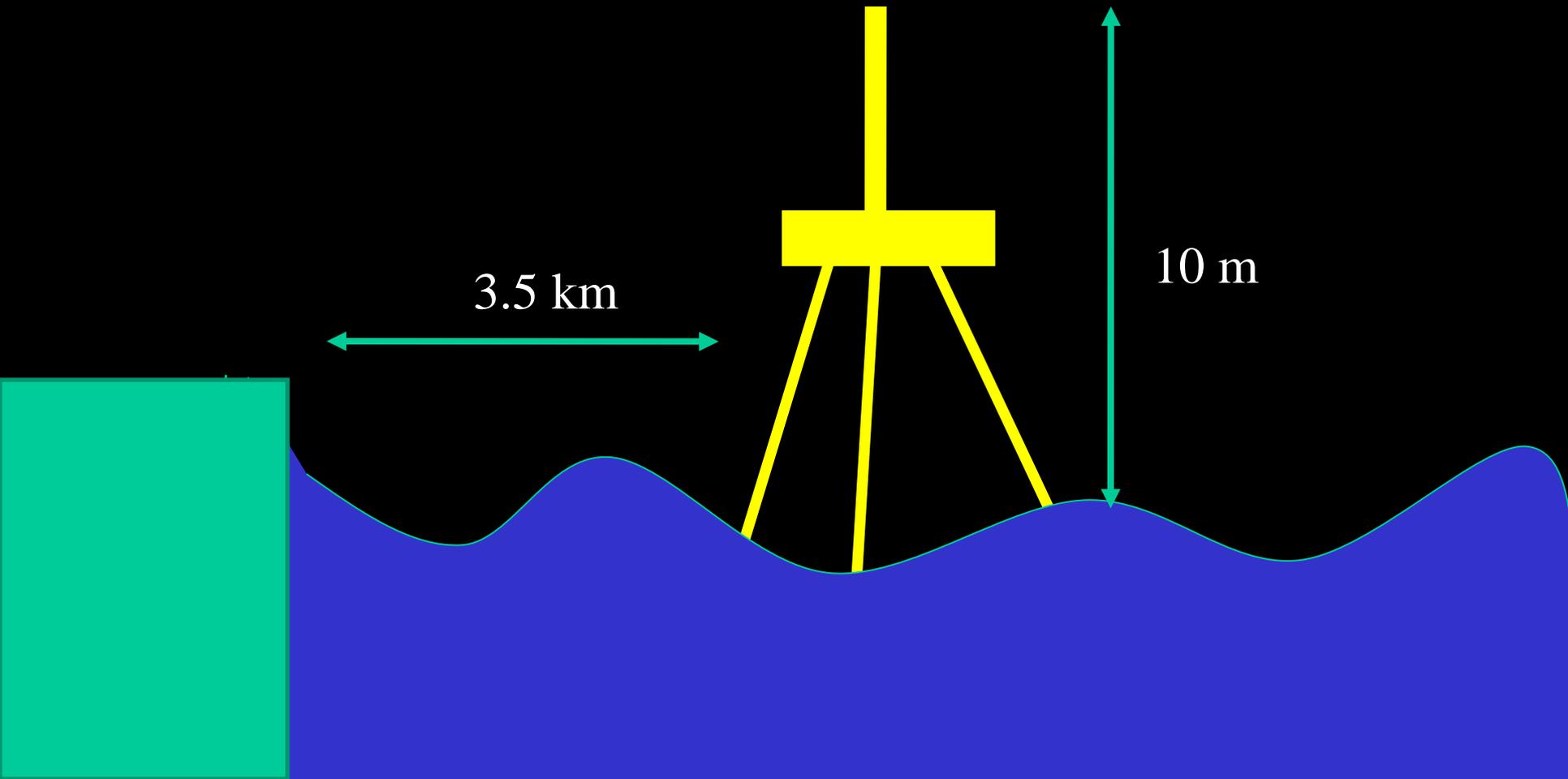


Temperature Modulation



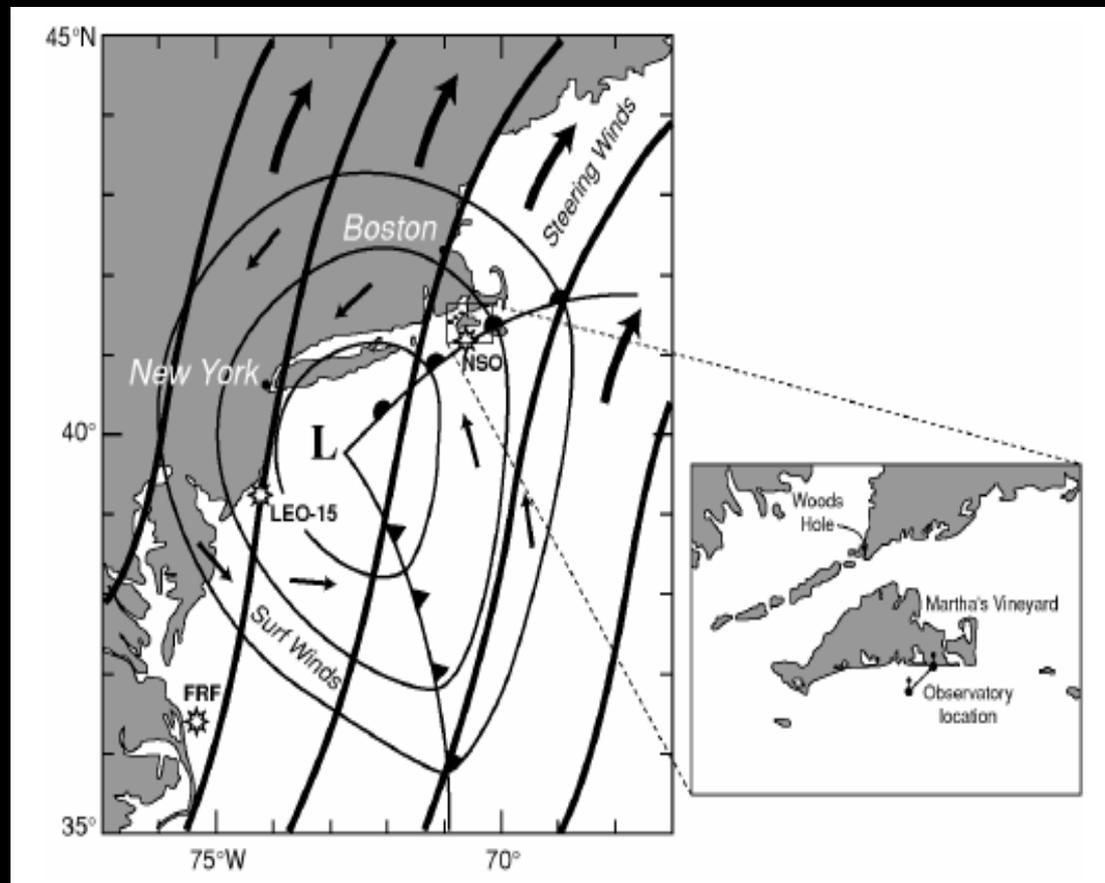
Motivation

Small Local Footprint



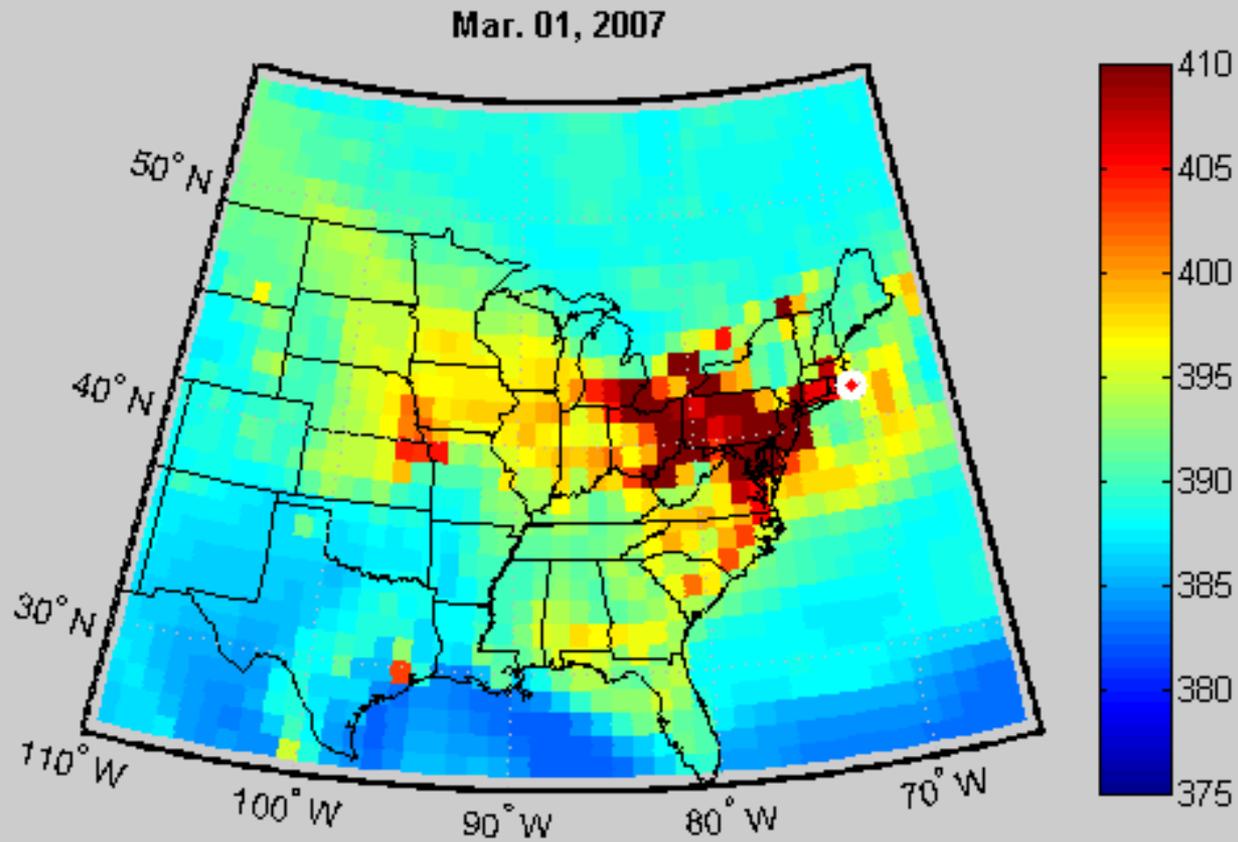
Motivation

**Synoptic scale transport drives
variability at tower**

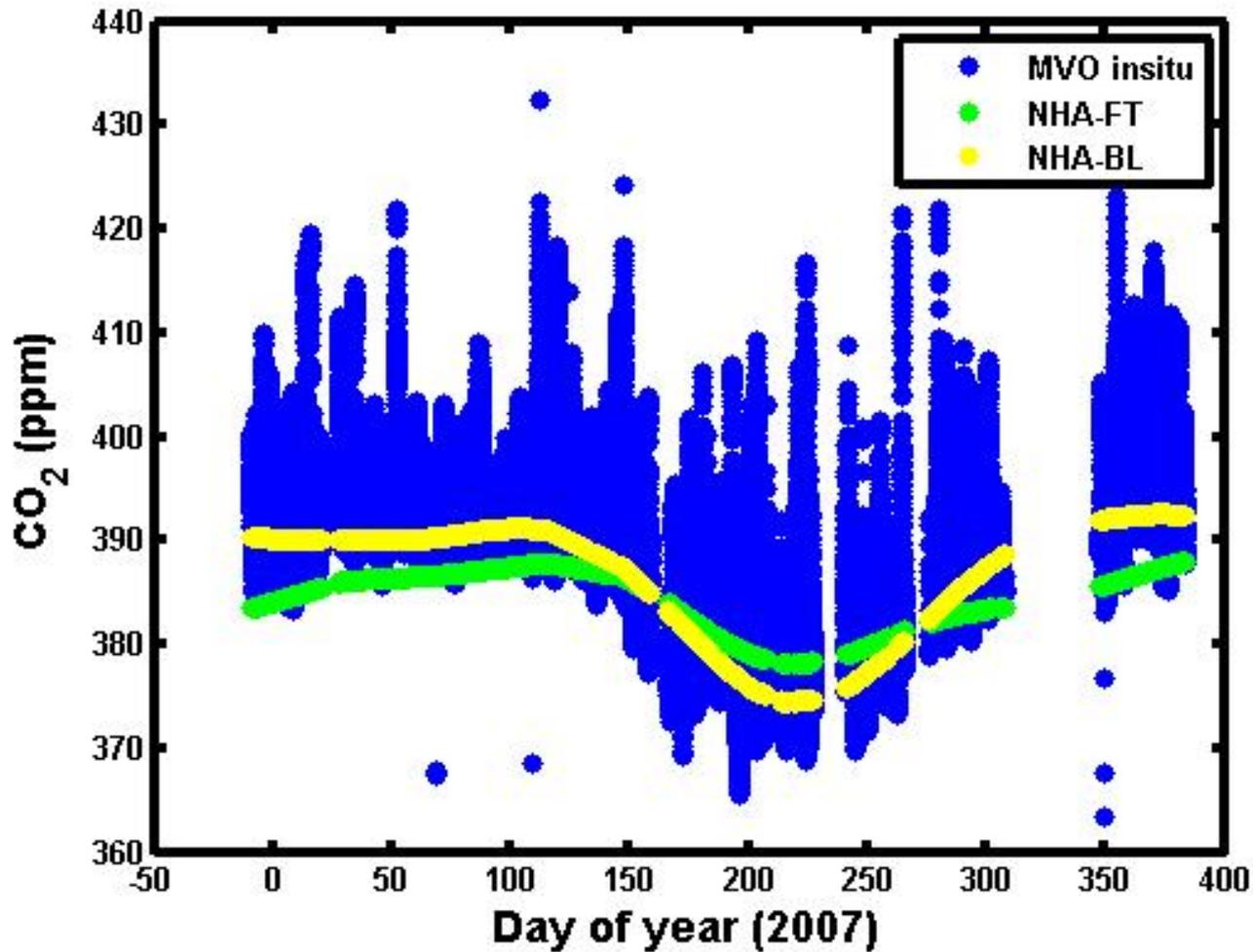


Motivation

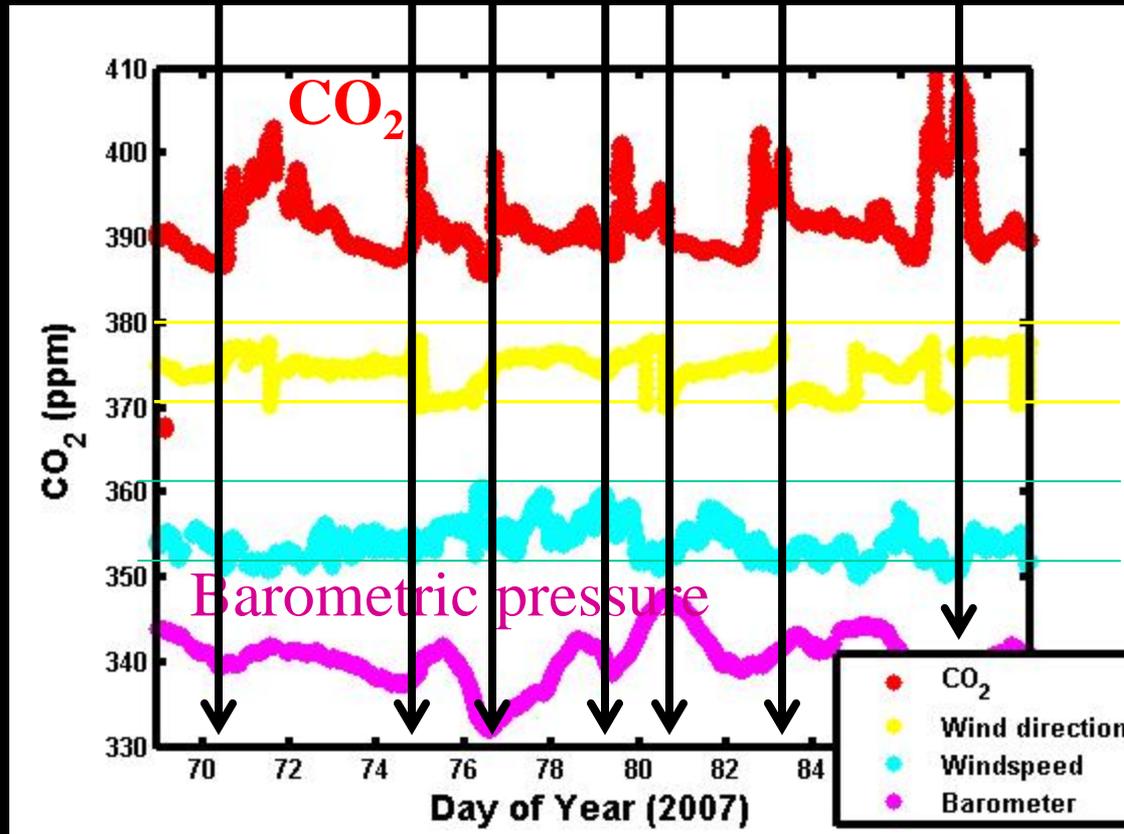
Location



Martha's Vineyard CO₂ Record



Time Series



360
0 Wind dir.

10
0 Wind spd.

March 2007

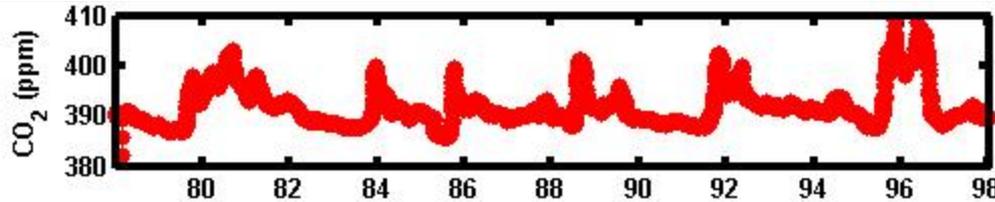
Time Series

Amplitude \searrow Phase \swarrow

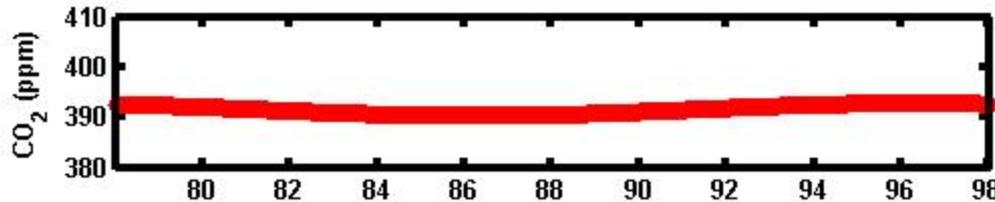
Fourier Analysis \rightarrow

$$\sum_{j=1}^{\leq n/2} A_j \cos(k_j x + \varphi_j)$$

Original
time series

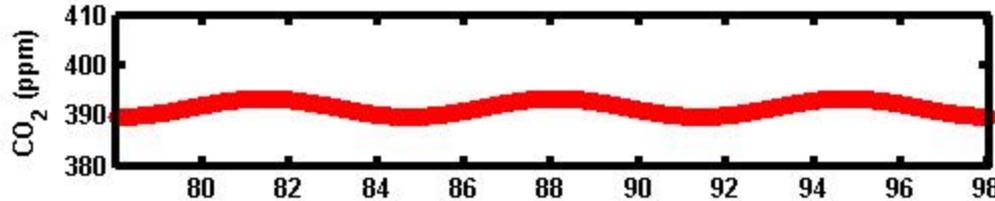


1st Harmonic



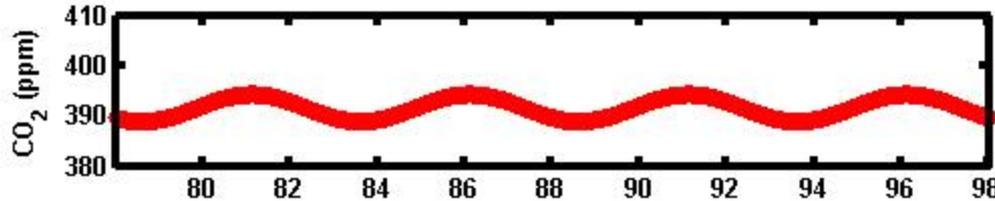
20 days

3rd Harmonic



5 days

4th Harmonic

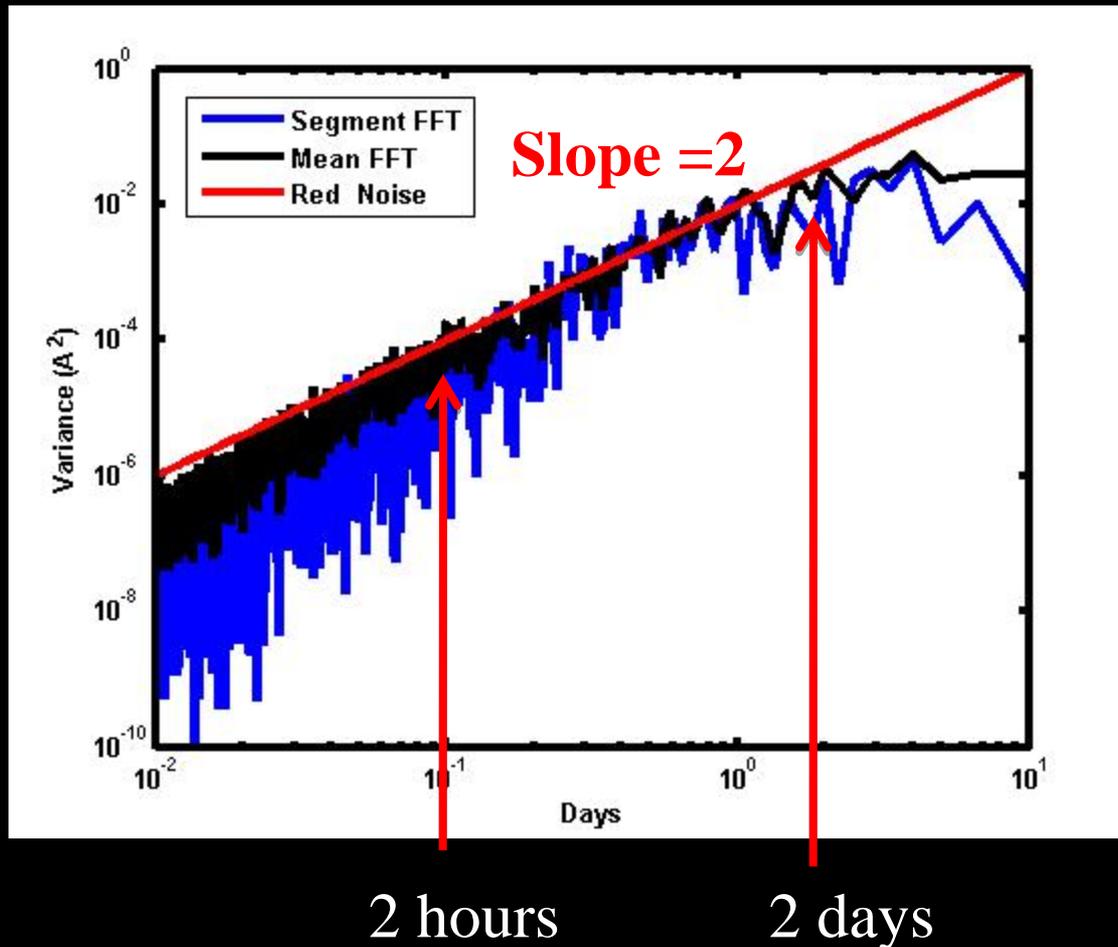


2.5 days

Frequency Spectrum

Parseval's Theorem \rightarrow

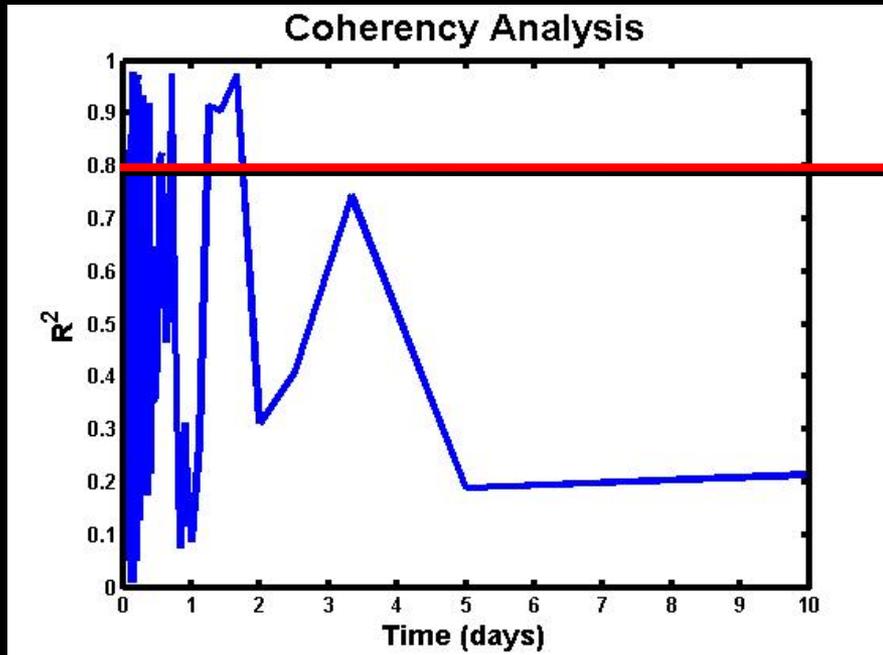
$$\sigma^2 = \sum_{j=1}^{\leq n/2} A_j^2$$



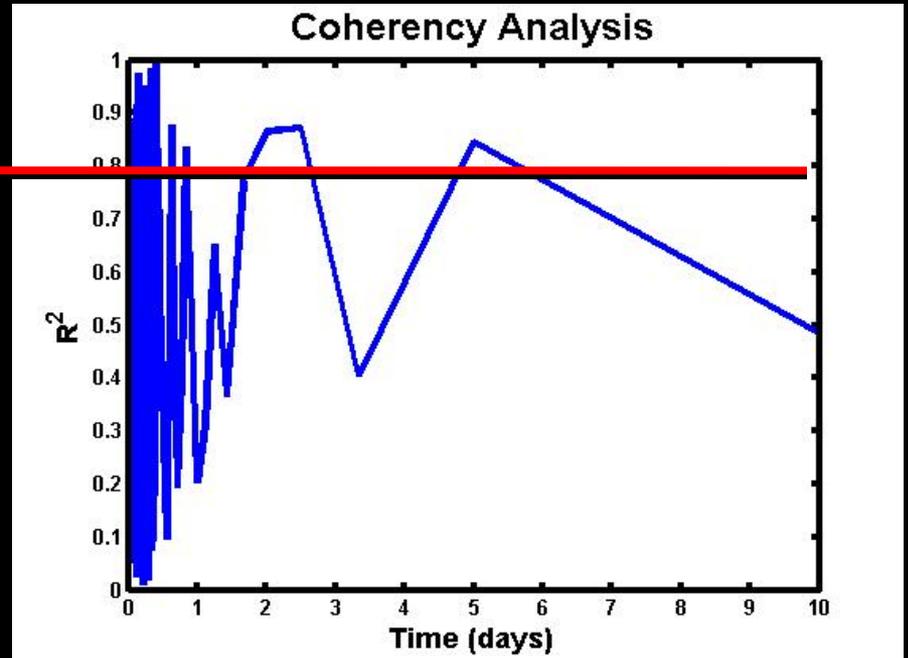
Coherence Spectrum

Phase

$$\sum_{j=1}^{\leq n/2} A_j \cos(k_j x + \varphi_j)$$

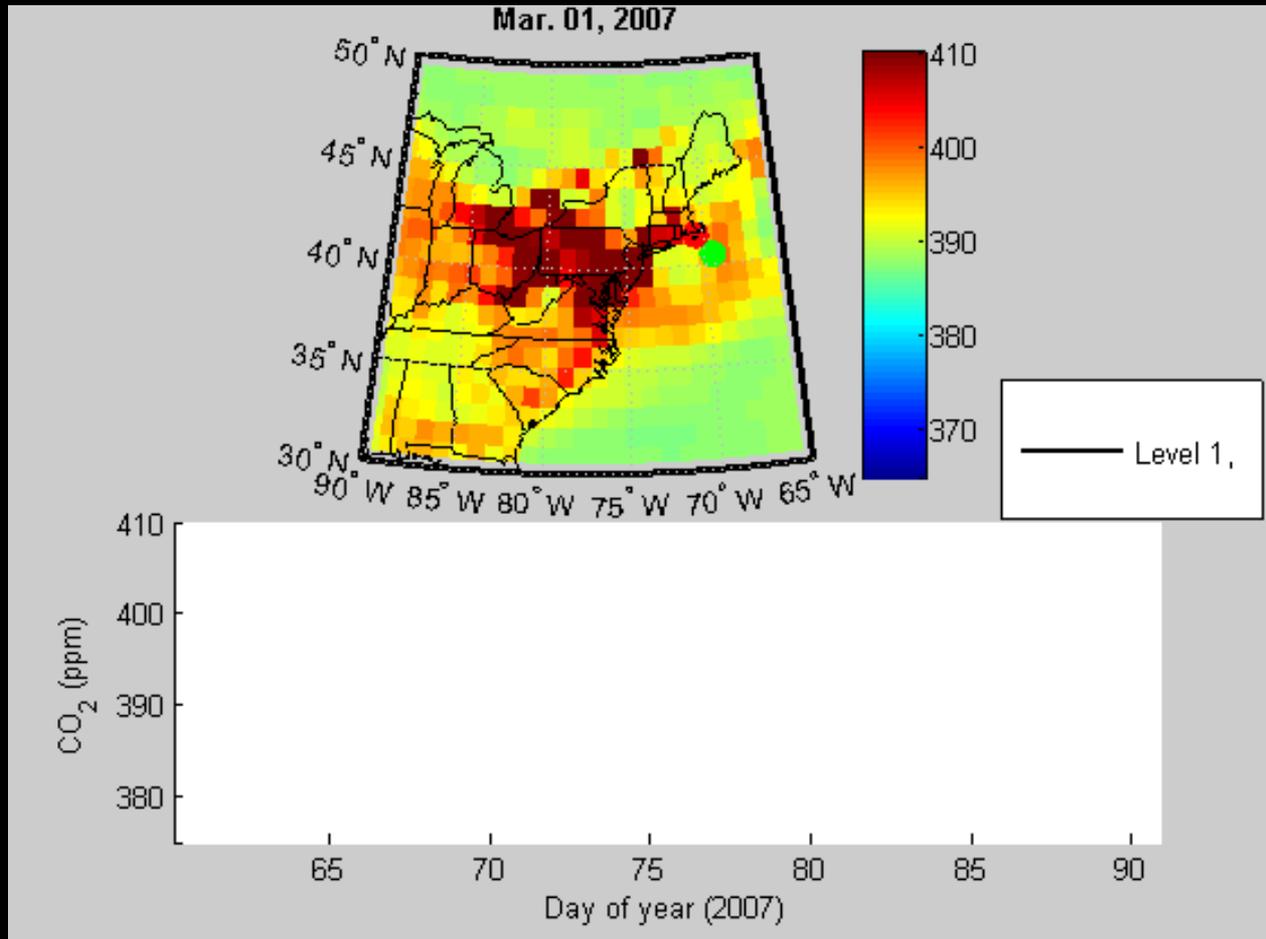


CO₂ and Wind Direction



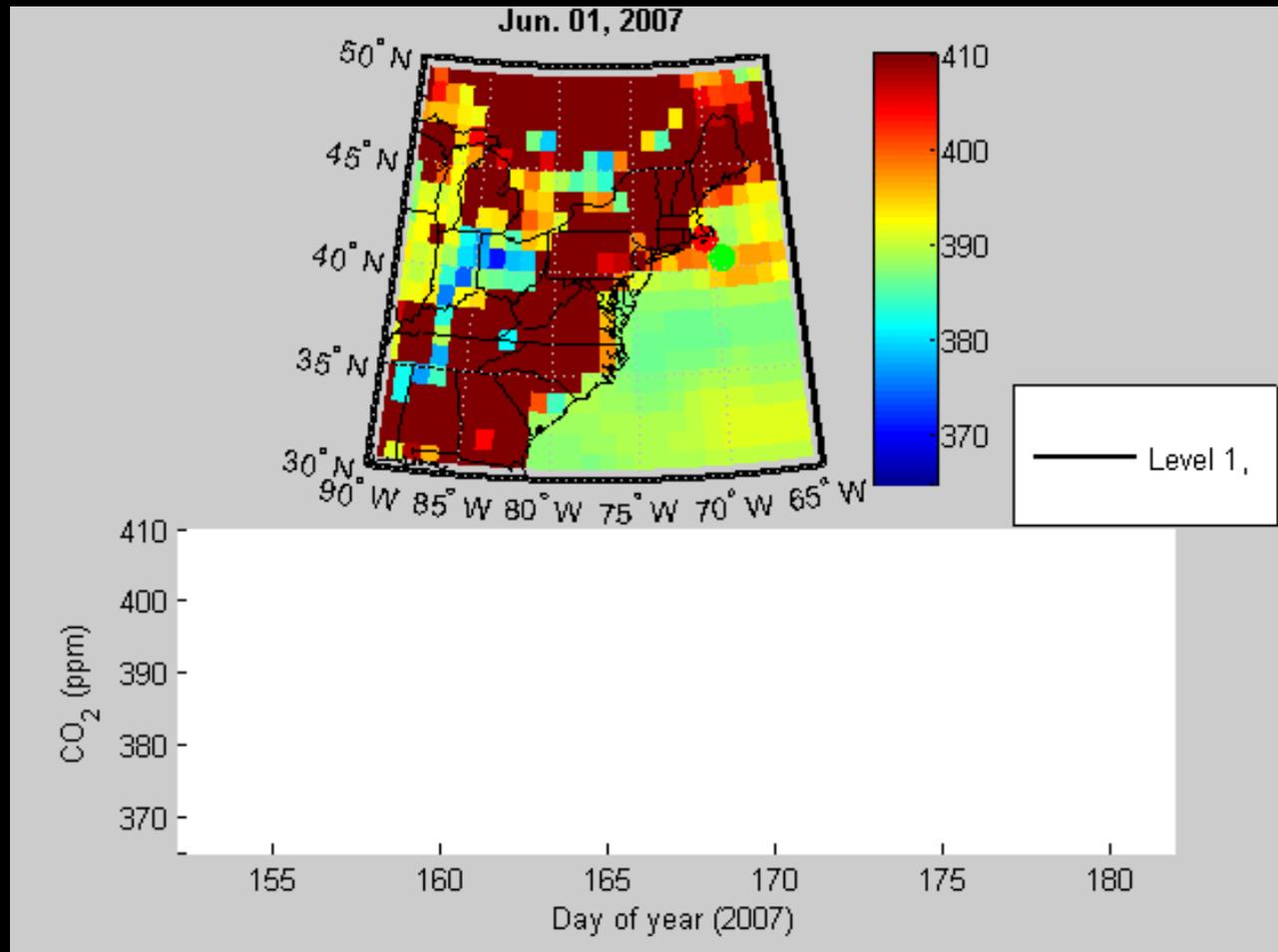
CO₂ and Barometric Pressure

CarbonTracker



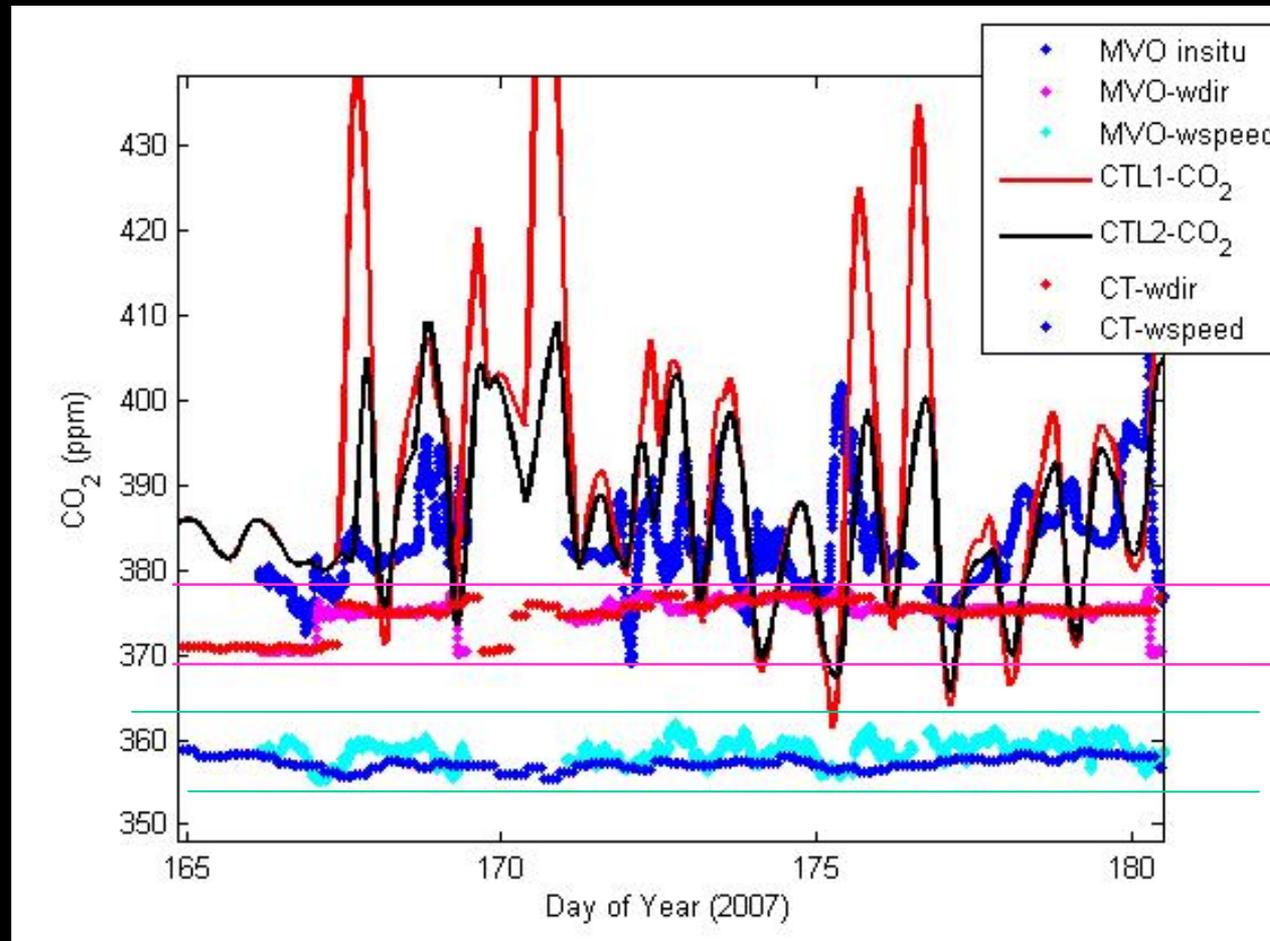
March 2007

CarbonTracker



June 2007

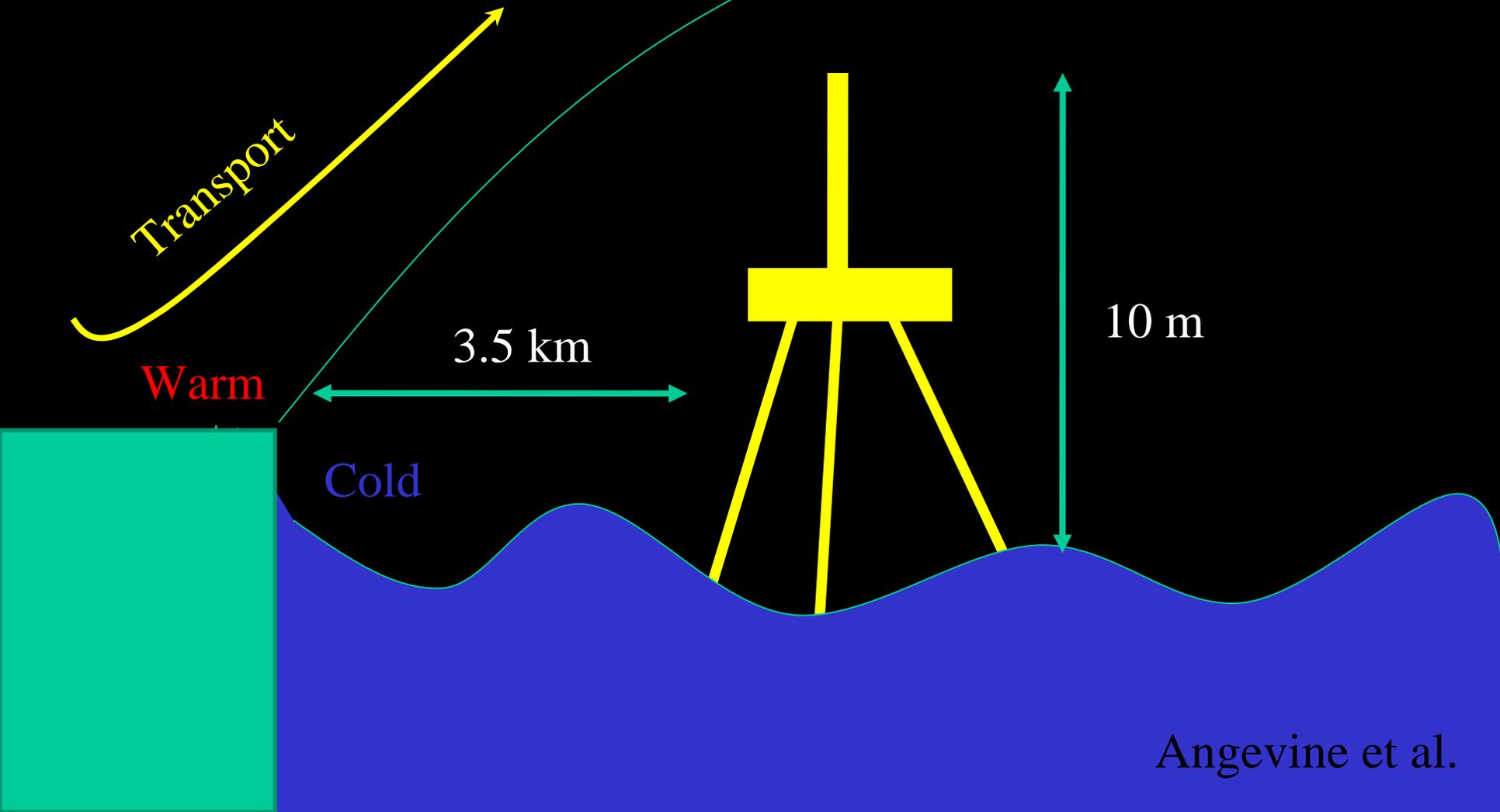
Tower is **not** capturing diurnal variability



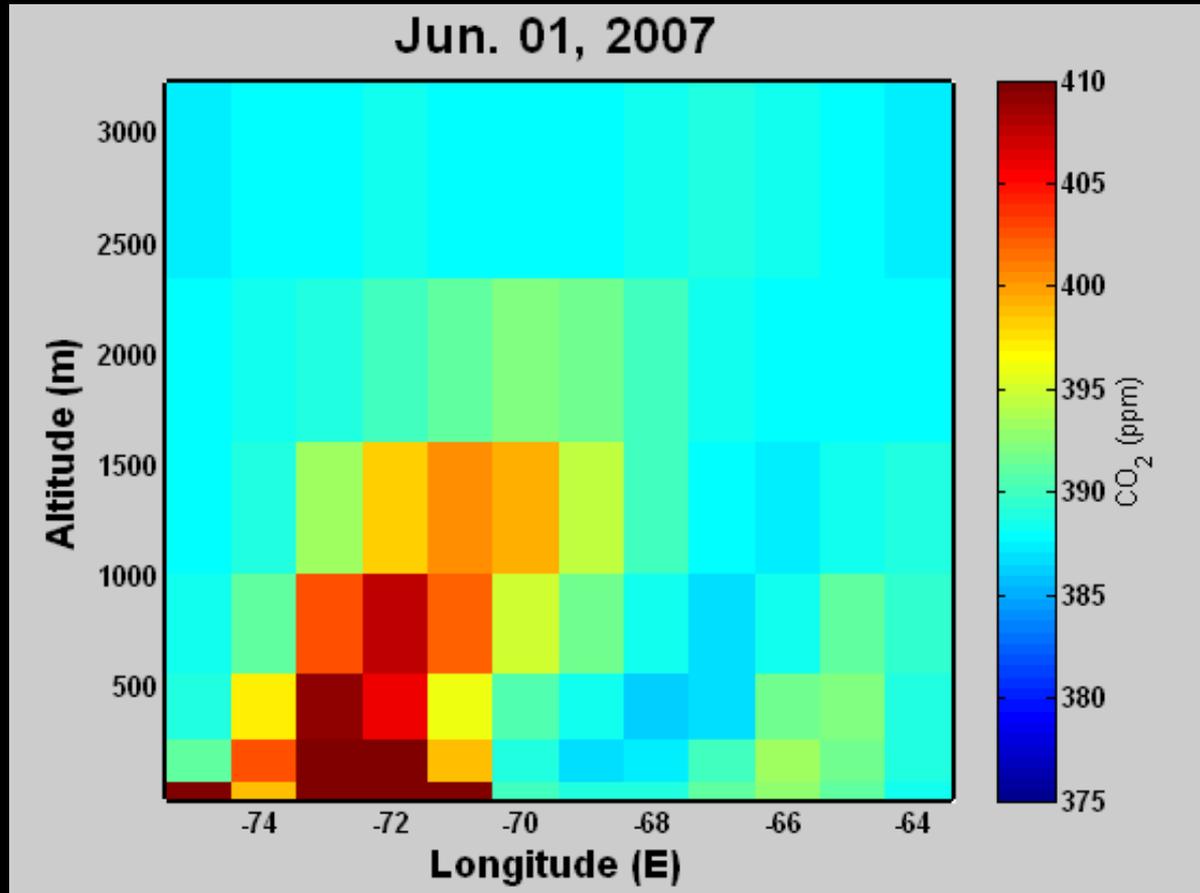
360
0 Wind dir.
10
0 Wind spd.

Transport is replicated by CarbonTracker

Marine Boundary Layer



Transport over Marine Boundary Layer



MVY

Conclusion

1. **Small local footprint:** Large (synoptic) scale variability dominates CO₂ signal at Martha's Vineyard tower.
2. **Location:** MVY provides a strong constraint on off-shore and on-shore flow along N.E. coast of US for most of the year. Strong marine boundary gradients makes summer time observations difficult to assimilate.
3. **Representation:** Transport at the tower is well represented by large scale models like CarbonTracker (TM5/ECMWF) and Fluxpart (GFS)

