Biological and physical controls on DMS production and emission during VOCALS

Patricia Matrai
Bigelow Laboratory for Ocean Sciences
Barry Huebert
University of Hawaii

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Nature, *326*, 655-661, 1987.

CCN = f(Biology)

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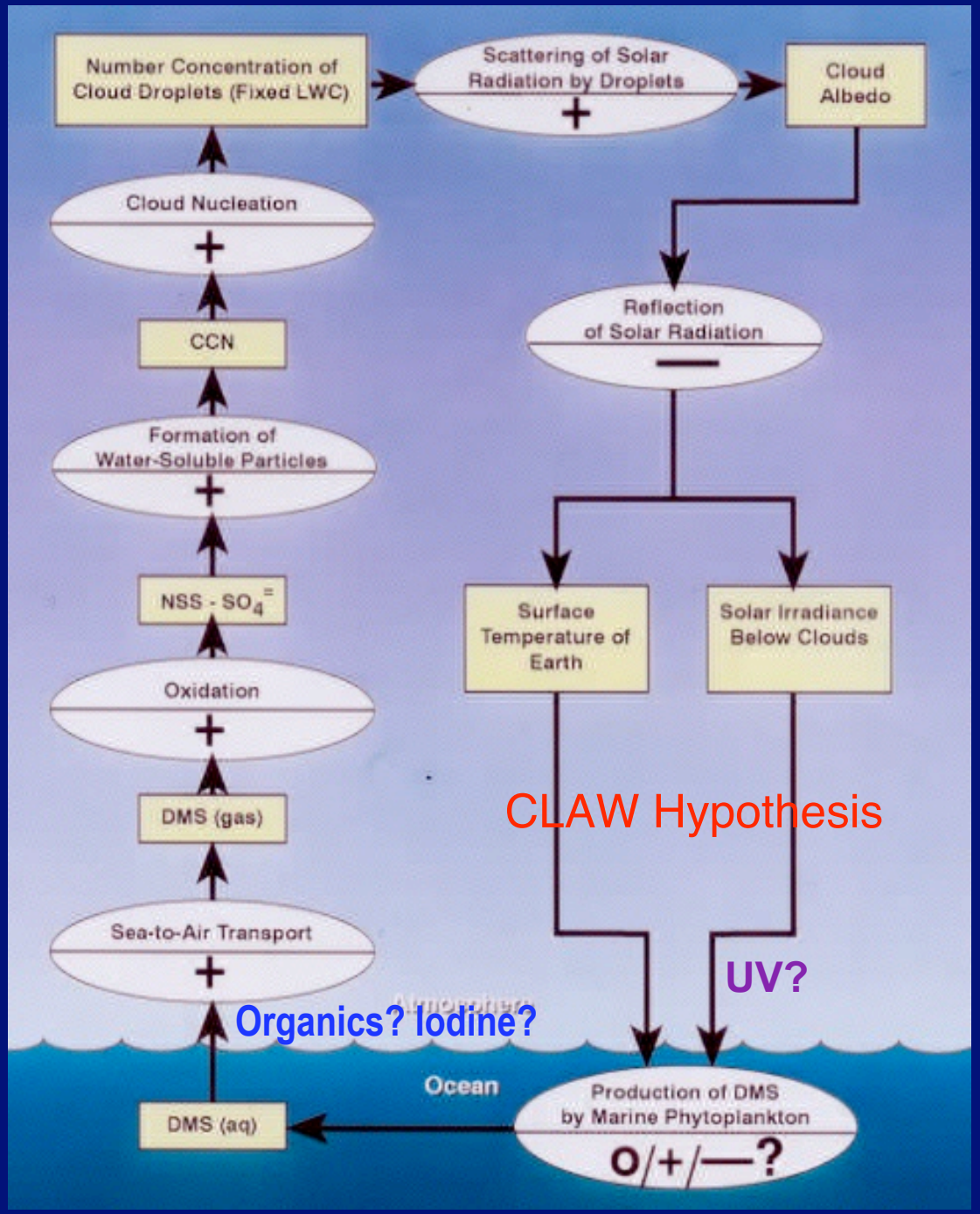
Cloud properties in remote regions are controlled in part by marine algae.

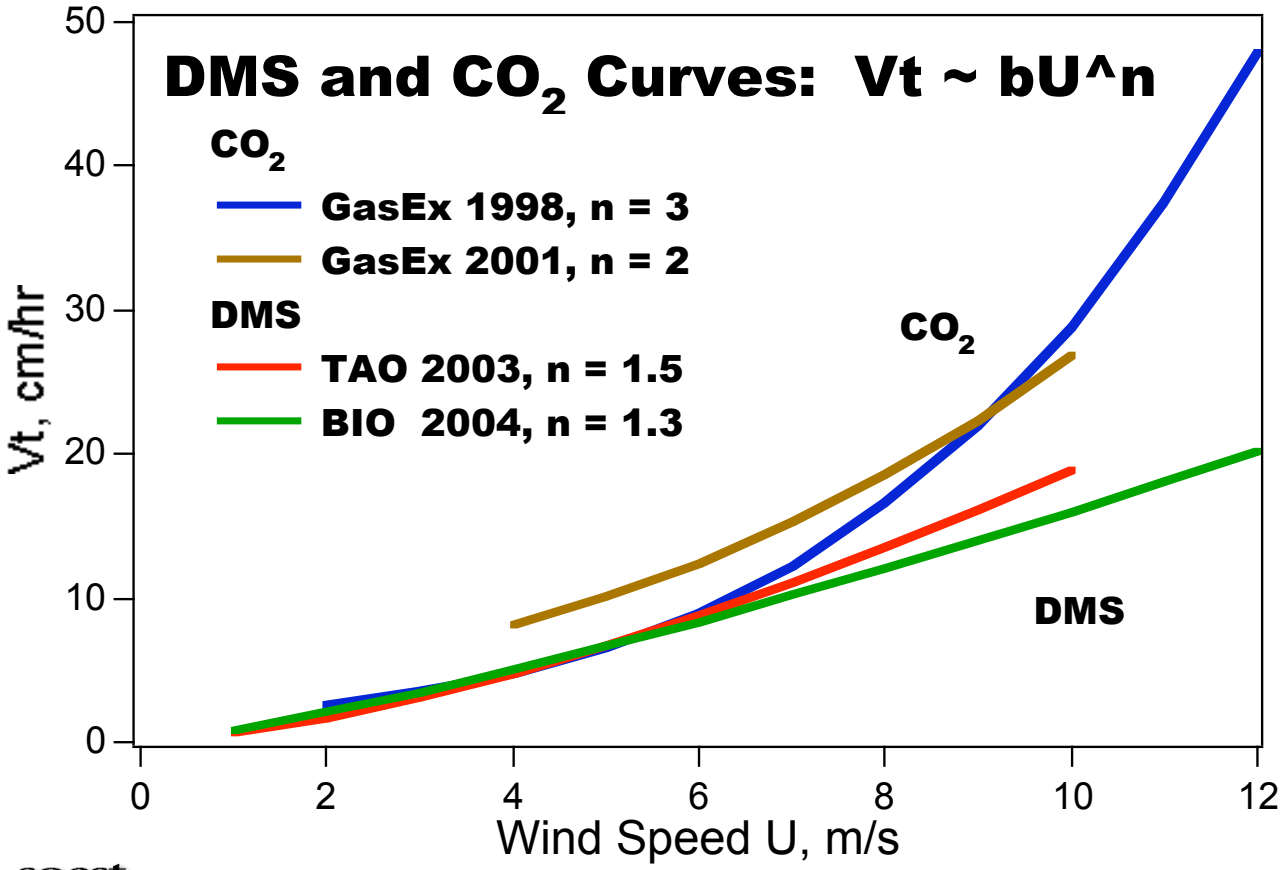
SOLAS scientists seek to quantify that linkage, so that models of changed climates will be realistic.

The controls on gas exchange rates are poorly understood.



Gas-Exchange Models are NOT Good Enough

Flux measurements have shown that V_t for DMS is less dependent on wind speed than is V_t for CO_2.



Measured V_t vs U

soest School of Ocean & Earth Science & Technology
university of hawai'i

solas

Blomquist, et al., 2006: DMS sea-air transfer velocity: Direct measurements by eddy covariance and parameterization based on the NOAA/COARE gas transfer model. *Geophys. Res. Lett.*, **33,** doi 10.1029/2006GL025735.

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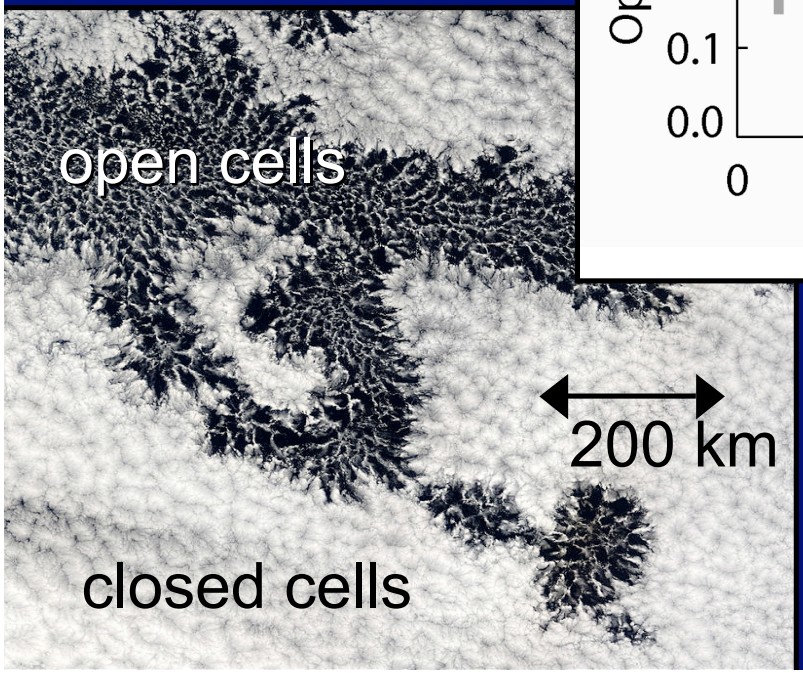
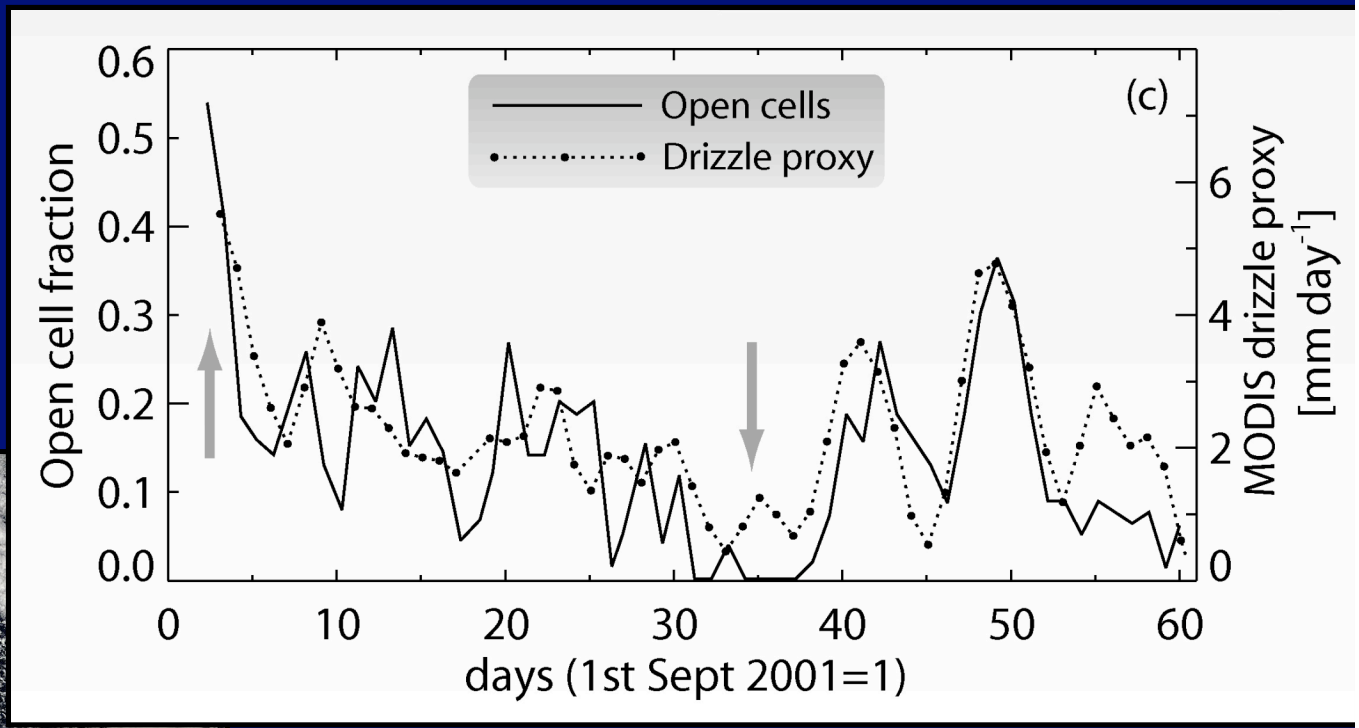
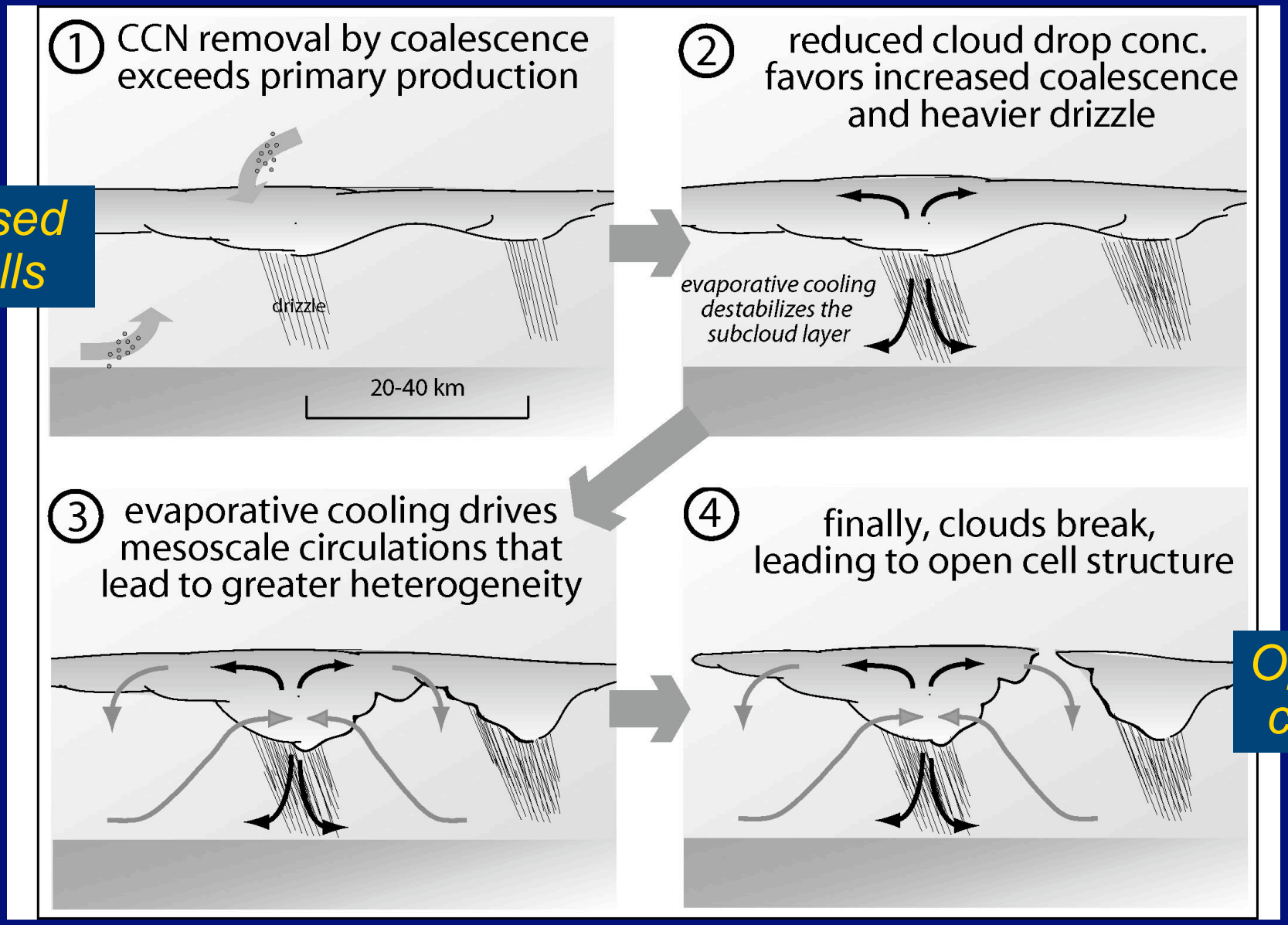
Do the Spatial Scales of Cells (20-40 km) and POCs (1-400 km) show up in Other Features? (e.g., fluxes, DMS concentrations, SST)





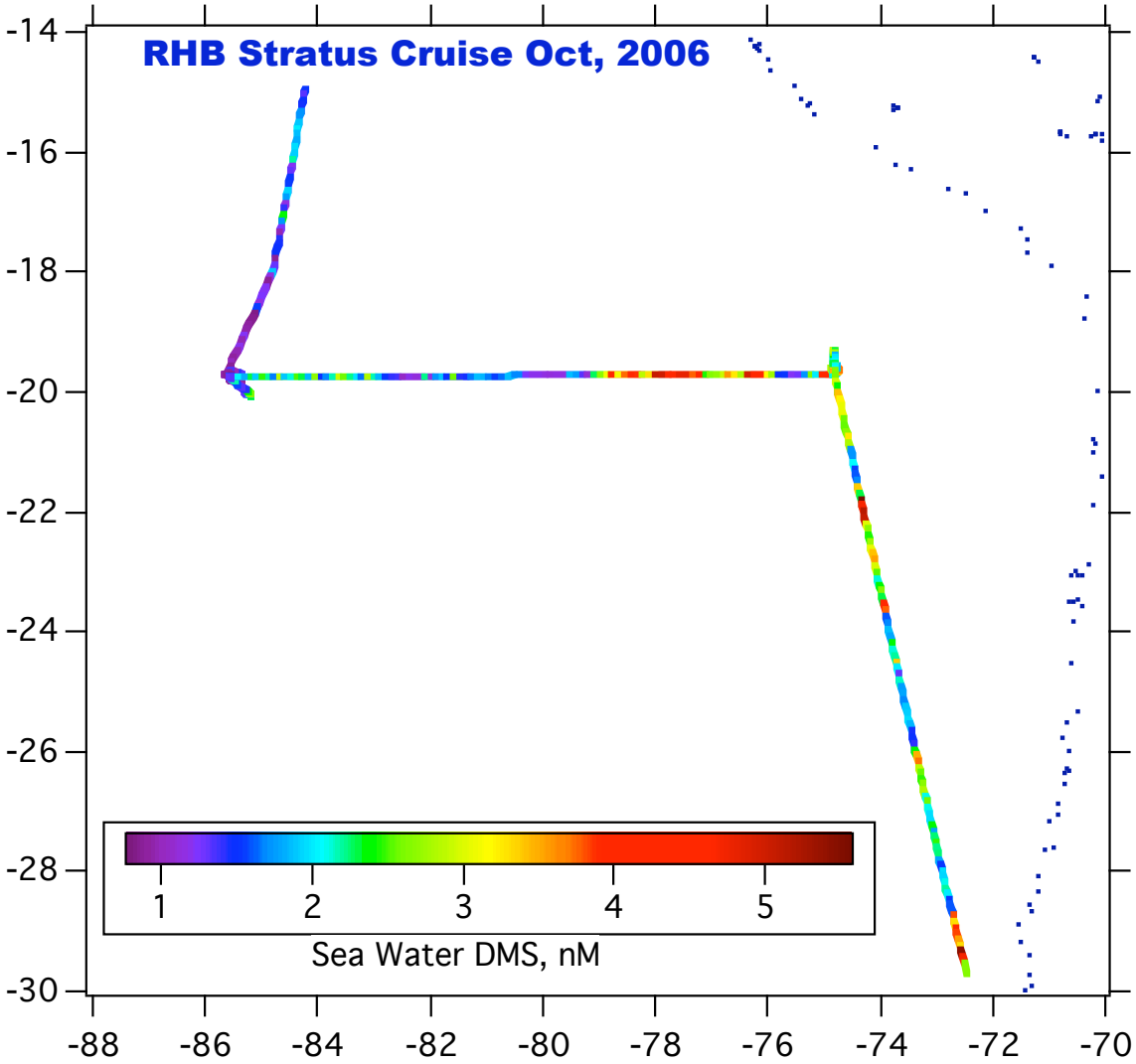
Wood et al. (2007)

Conceptual model of POC formation



Sea Water DMS is highly variable, also on the 10-20 km scale.

Related to cell scales?



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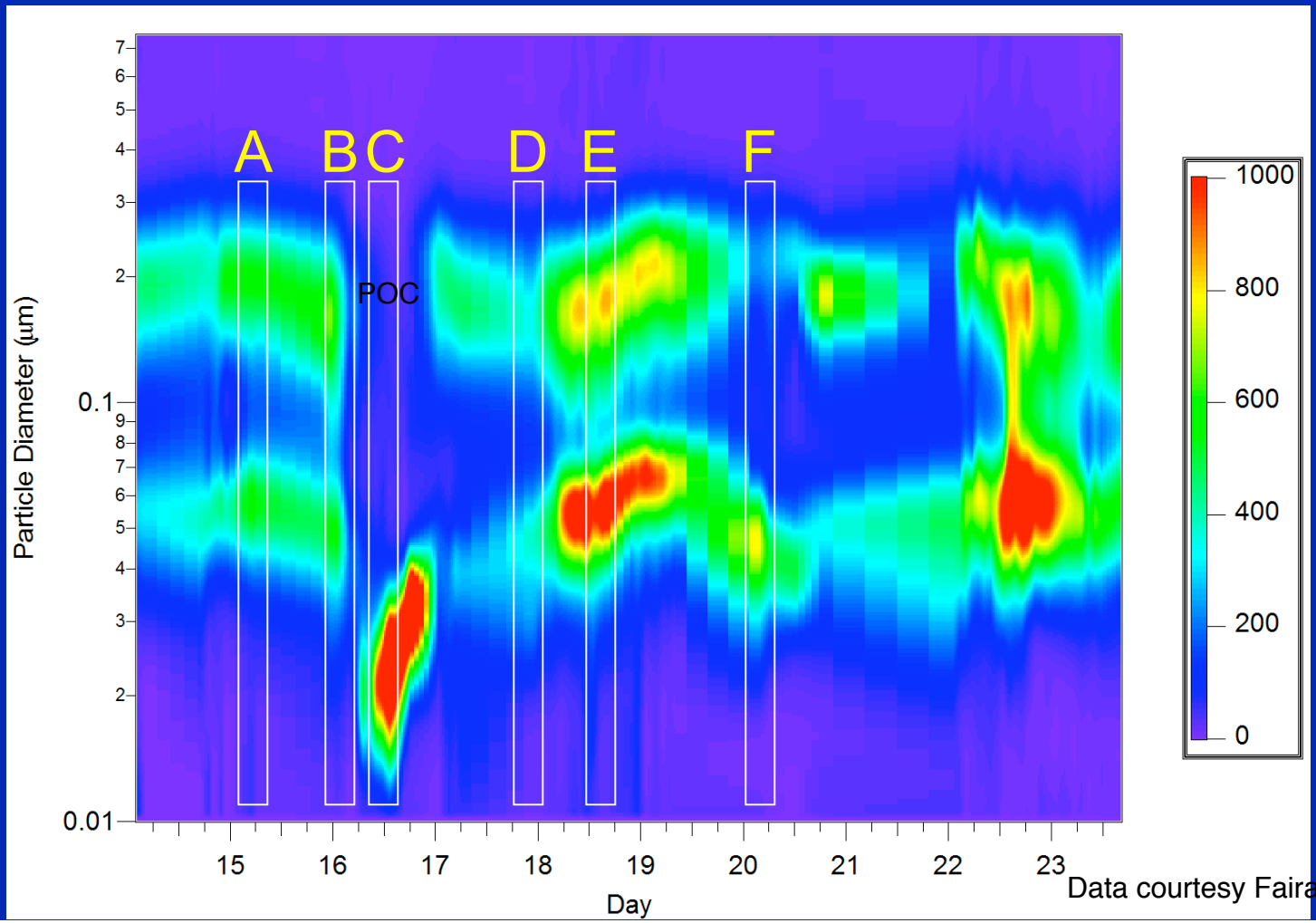
Drizzle Removal > Nucleation > *DMS-Controlled* Growth

How much of the recovery is from entrainment vs growth?

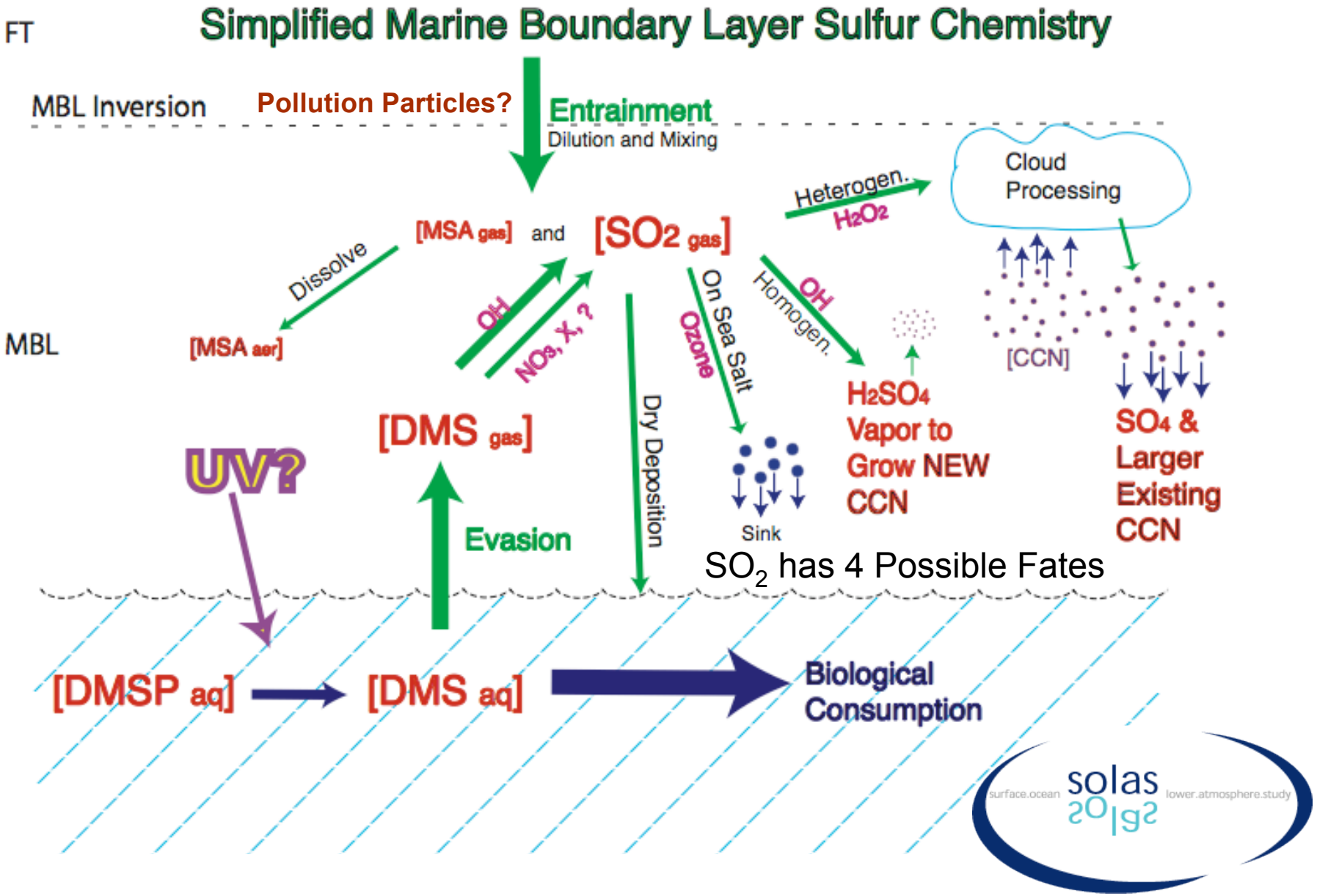
Could you diagnose when A, B, C, D, E, and F would occur, and under what circumstances?



Data courtesy Fairall & Collins

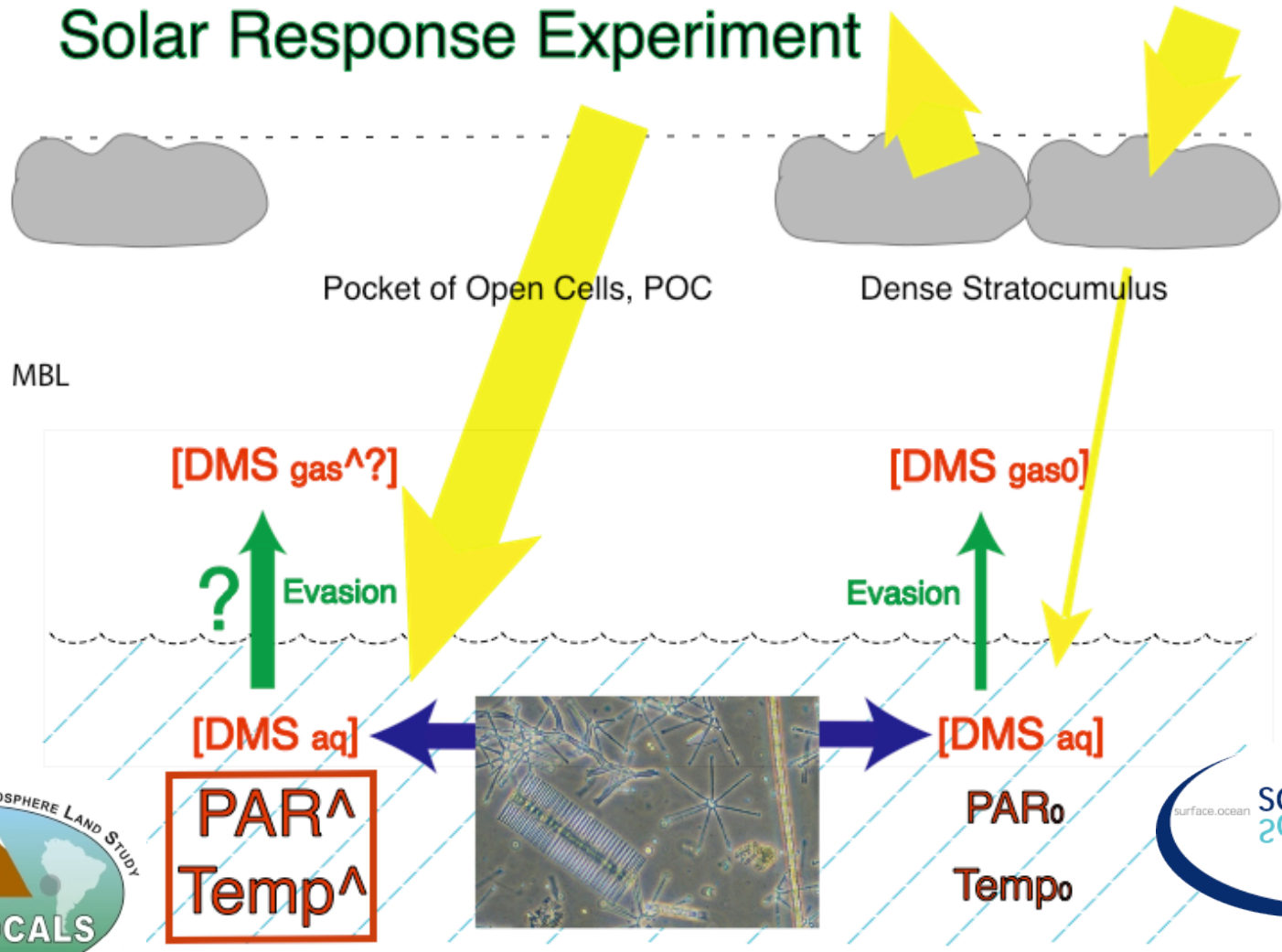
What Controls the Availability of New CCN?

These processes probably control the re-filling of POCs with clouds.



POCs should change irradiance (and thus SST) enough to allow a test of the light / temp > biology > DMS emissions parts of the CLAW Hypothesis.

(A separate SOLAS experiment along these lines is being discussed for 2009 or later)



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Matrai & Huebert will address the following themes:

(a) How do fewer clouds affect biological net DMS production and SW concentrations?

- (b) How do spatial gradients of SW DMS concentration and flux-controlling factors (e.g., winds) affect DMS fluxes to the atmosphere?
- (c) How far does the biogeochemical impact of upwelling extend offshore? A

Ultimately, the coordinated VOCALS REx effort:

- (d) How significant are biotic feedbacks in controlling the radiation budget of the SEP?

These questions fit these REx objectives:

- *1c) The small effective radii measured from space over the SEP are primarily controlled by anthropogenic, rather than natural, aerosol production...*

We will examine this hypothesis by measurements of biogenic net production and air-sea flux of SW DMS (and production of precursor DMSP) as a function of irradiance during a pre-, during, and post-POC event. DMS fluxes will bound the possible NSS production rate.

- *2a) Oceanic mesoscale eddies play a major role in the transport of heat and fresh water from coastally upwelled water to regions further offshore.*

In addition, eddies transport nutrients and coastal plankton offshore. We will examine this hypothesis by prediction of upper mixed layer SW DMS concentrations derived from an empirical relationship with solar radiation dose as a function of the pre-, during, and post-POC irradiance field while following an eddy.

- *2b) Upwelling, by changing the physical and chemical properties of the upper ocean, has a systematic and noticeable effect on aerosol precursor gases and the aerosol size distribution in the MBL over the SEP.*

We will examine this hyothesis by measurements of biogenic net production and air-sea flux of SW DMS (and production of precursor DMSP) within an eddy or filament of upwelled cold, nutrient-rich water, as it is transported offshore.

Work plan for 3 on-station samplings:

- (1) measure PAR continuously;
- (2) measure chlorophyll *a* continuously and discretely to normalize to biomass;
- (3) daily incubation for net DMS and DMSP production in subsurface PAR under UV-transparent (+photochemistry) and UV-opaque (-photochemistry) conditions, in flow through, simulated in situ incubators before, during and after a POC event (to be determined with remote sensing by other VOCALS team members). Incubators will be kept at irradiances corresponding to surface and 1% incoming PAR or the depth of the upper mixed layer. Light levels will be checked with irradiance measurements made by shipboard underwater vertical light profiles (as well as Seasoar), collected either by a Biospherical underwater profiling radiometer (Matrai) and/or an AC-9 to be deployed by the Paulsen, Letelier and Dever team (OSU).
- (4) The Huebert group will be measuring DMS air-sea fluxes as other VOCALS groups measure controlling factors such as capillary waves and wave slope. SW DMS will be measured continuously by Dr. T. Bates as part of his research.
- (5) We will measure nutrient concentrations during our experiments.

Variables measured:

- SW DMS and DMSP (discrete)
- DMS and DMSP net production rate
- DMS fluxes
- PAR (photosynthetically available radiation)
- Chlorophyll *a*
- Nutrients

and from the CTD and flow through instruments:

- T and S

Matrai – R/V Brown

- 2 (ideal) berths
- 1.5m linear feet bench space dry lab
- 1.5m linear feet bench space wet lab
- 2 m^2 of unshaded deck space for flow through incubators
- Access to dedicated flowing seawater on deck for cooling incubators (not scientific, clean SW)
- 120V, 20W for gas chromatograph
- Liquid N_2 (2@150L; 1 large dewar/Leg); it will transferred to 50L dewars in port, no pressurized cylinder on board)
- 6 gas cylinders UHP (2 each air, H_2, He)
- On board storage for shipping crates
- Shipping to SC to join R/V Brown; return shipping from Arica to Maine
- Travel and lodging for 2 (ideal) Portland, Me to Arica, Chile