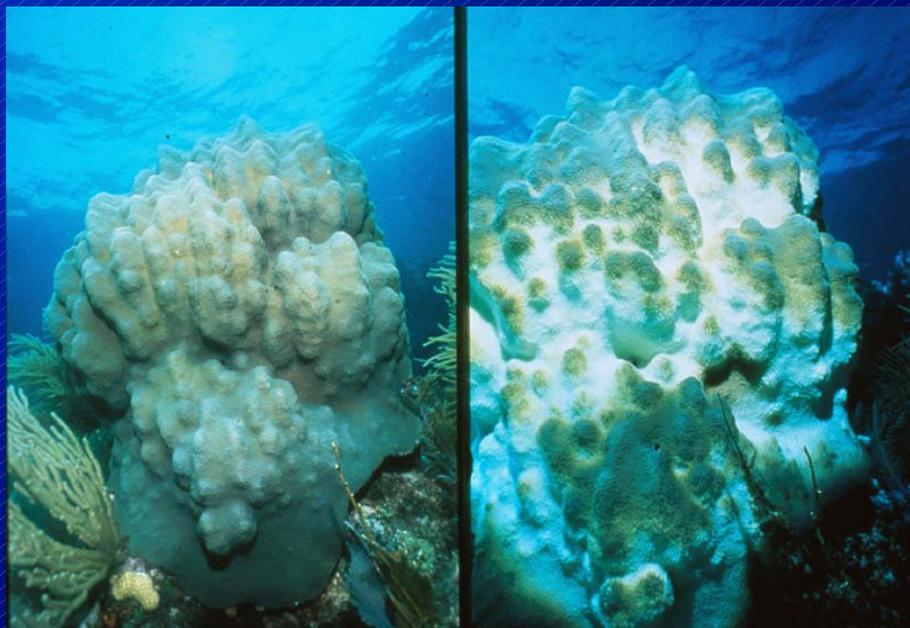


Shedding Light on Corals Health: Interactions of Climate Change and Solar Radiation with Bleaching



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**National Exposure Research
Laboratory**

Office of Research and Development

U.S. Environmental Protection Agency

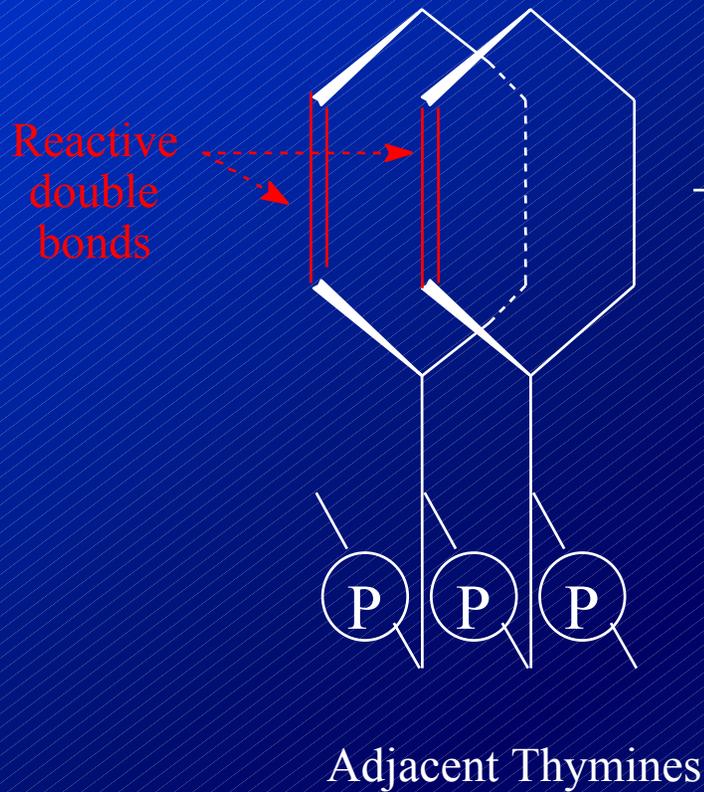
Athens, Georgia

Outline

- ✓ **Pathways for UV damage**
- ✓ **Corals UV exposure in Florida Keys**
- ✓ **UV absorbing substances over coral reefs and global ocean**

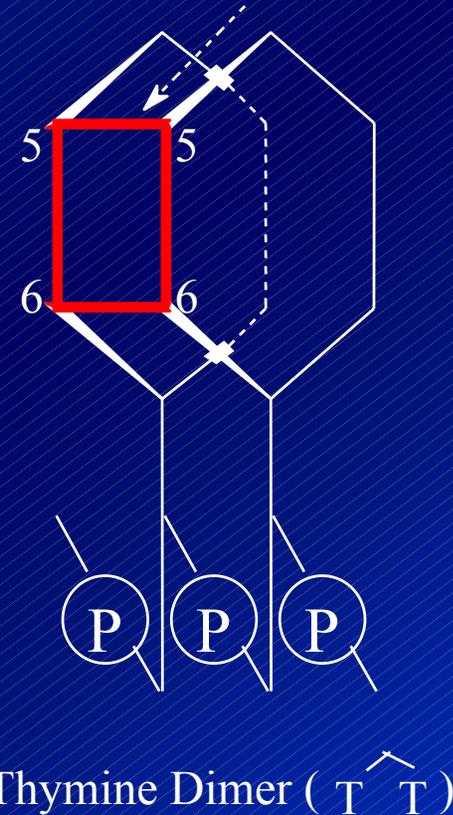
Pathways for UV Interactions

- ✓ **DNA damage**
- ✓ **Damage to other targets**
- ✓ **Indirect impacts**
 - **Microbiota**
 - **Nutrient availability**
 - **Metals bioavailability (Fe)**
 - **Pollutant phototoxicity**



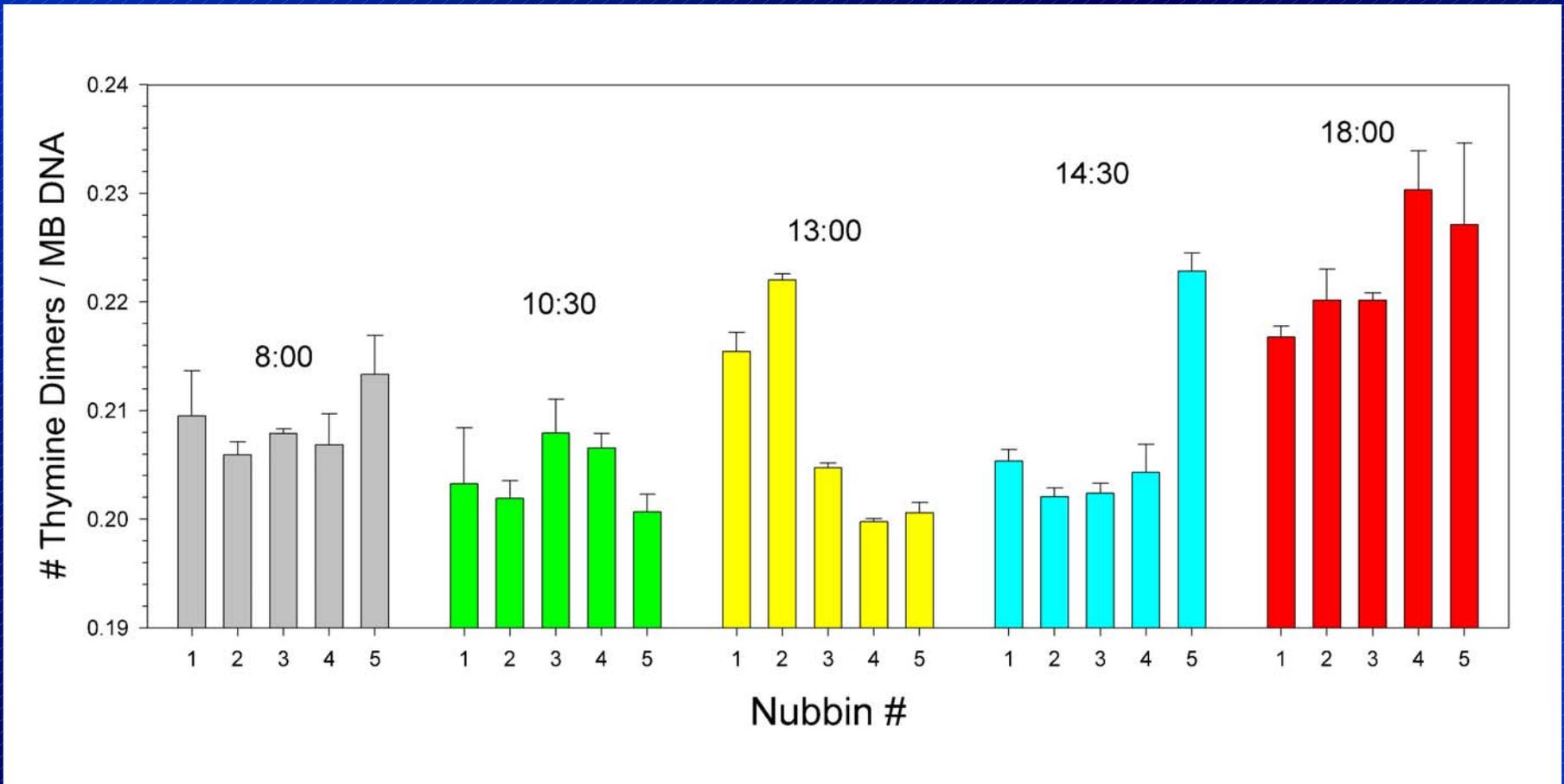
Ultraviolet Light

Linked across carbons 5 and 6 of each pyrimidine ring



Thymine Dimer Formation

Thymine Dimers from Colony 2 at Five Timepoints Data for Individual Nubbins (Anderson et al., 2003)



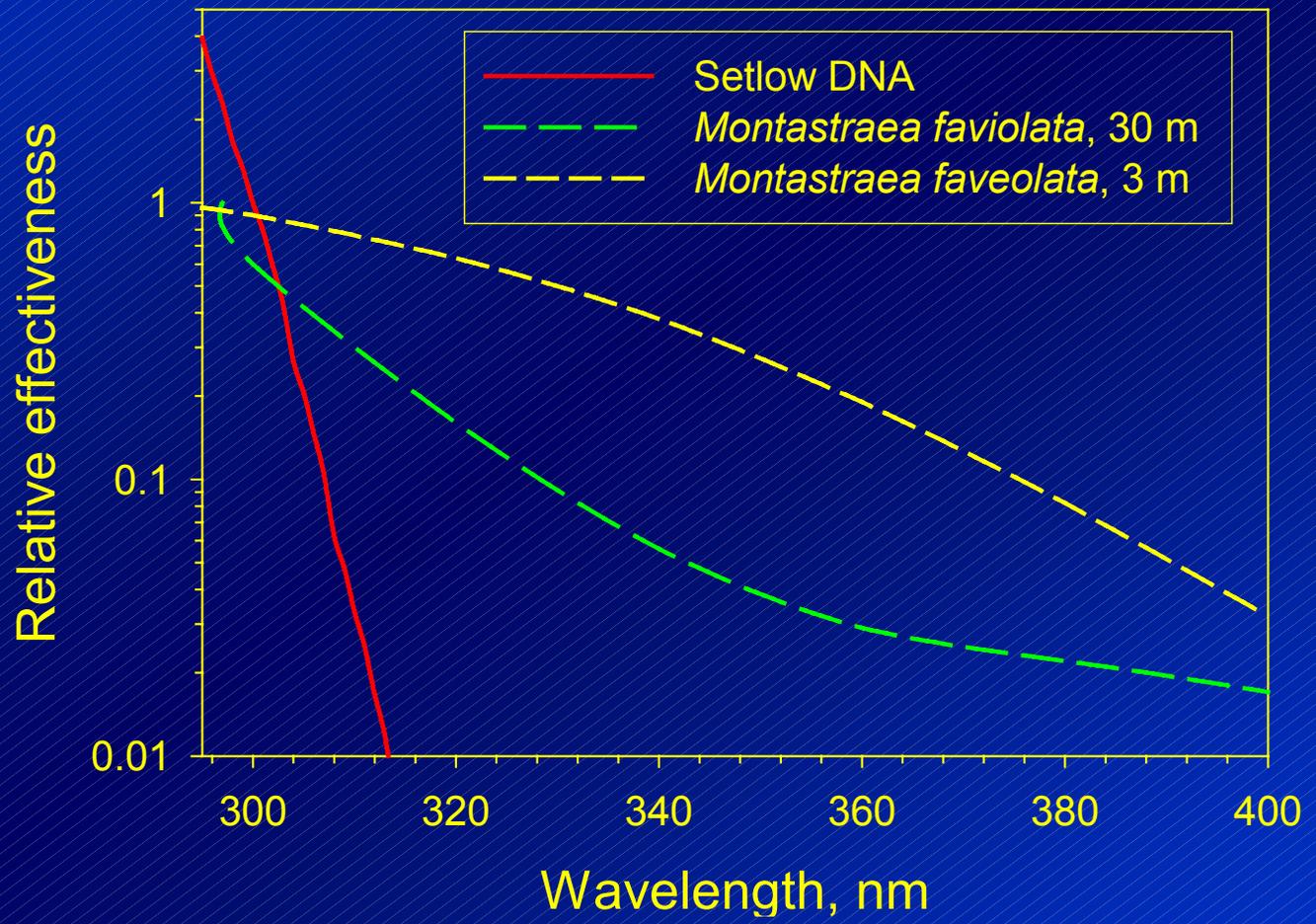
Protection Against UV Damage

- Pigments (MAAs, carotenoids, etc.)
- Repair
- ROS inhibition/scavenging (biotic, abiotic)

All exhibit light and temperature dependence
E.g. see Shick 2003; Vincent and Neale 2000

Biological Weighting Functions for DNA Damage and Photosynthesis Inhibition

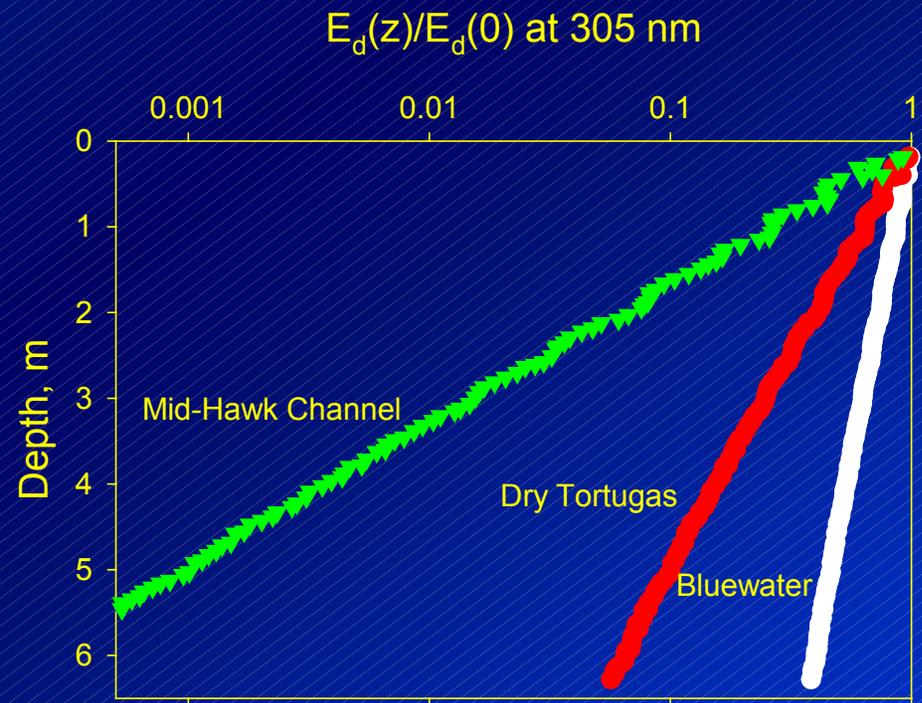
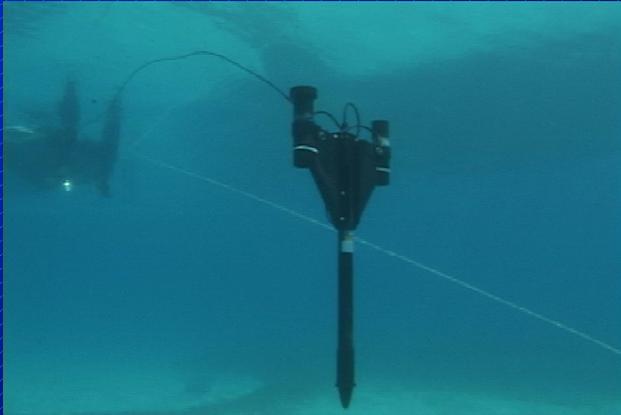
Montastraea faveolata data from Lesser, 2000



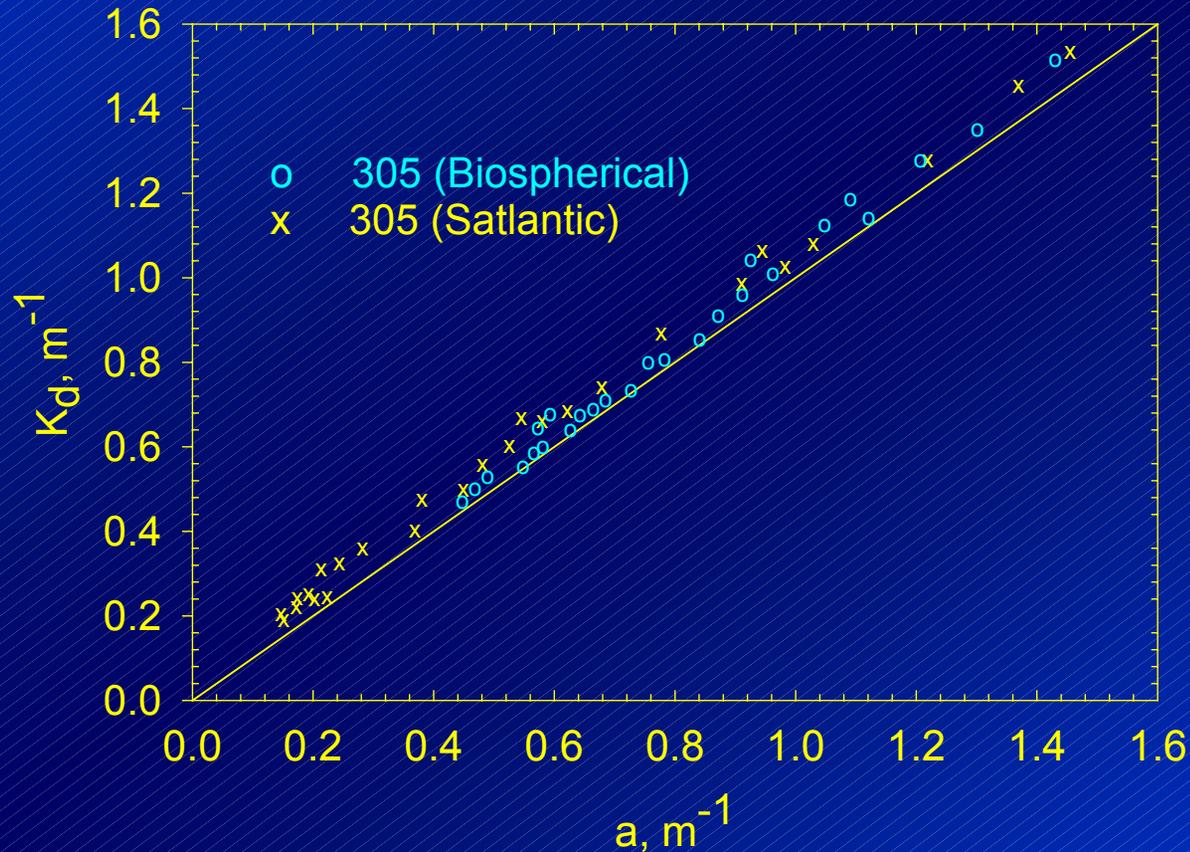
Map Illustrating Sites Investigated in Florida Keys



UV Irradiance vs Depth in the Florida Keys

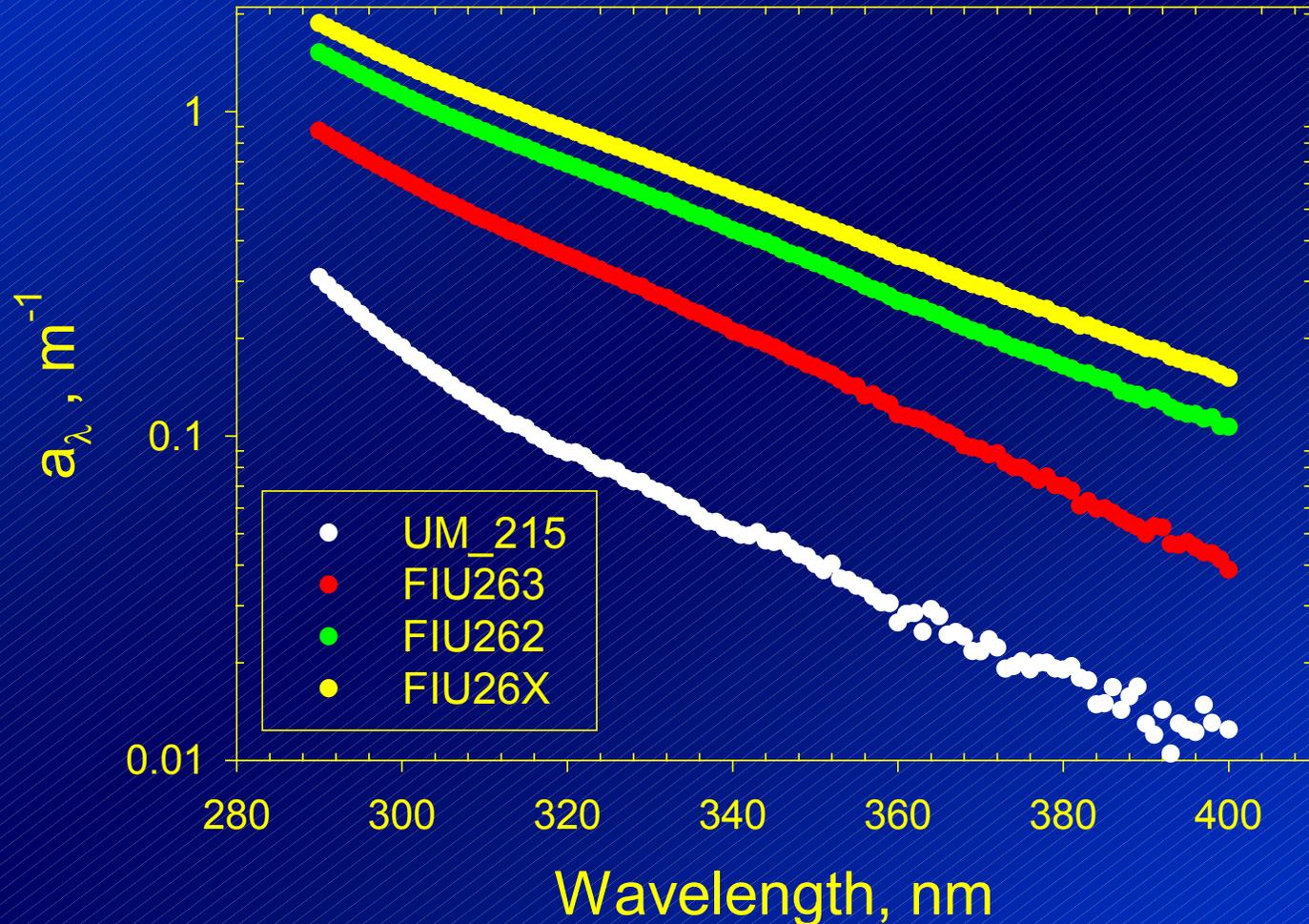


Comparison of Diffuse Attenuation and CDOM Absorption Coefficients For Florida Keys Sites (shows that CDOM controls UV-B penetration)

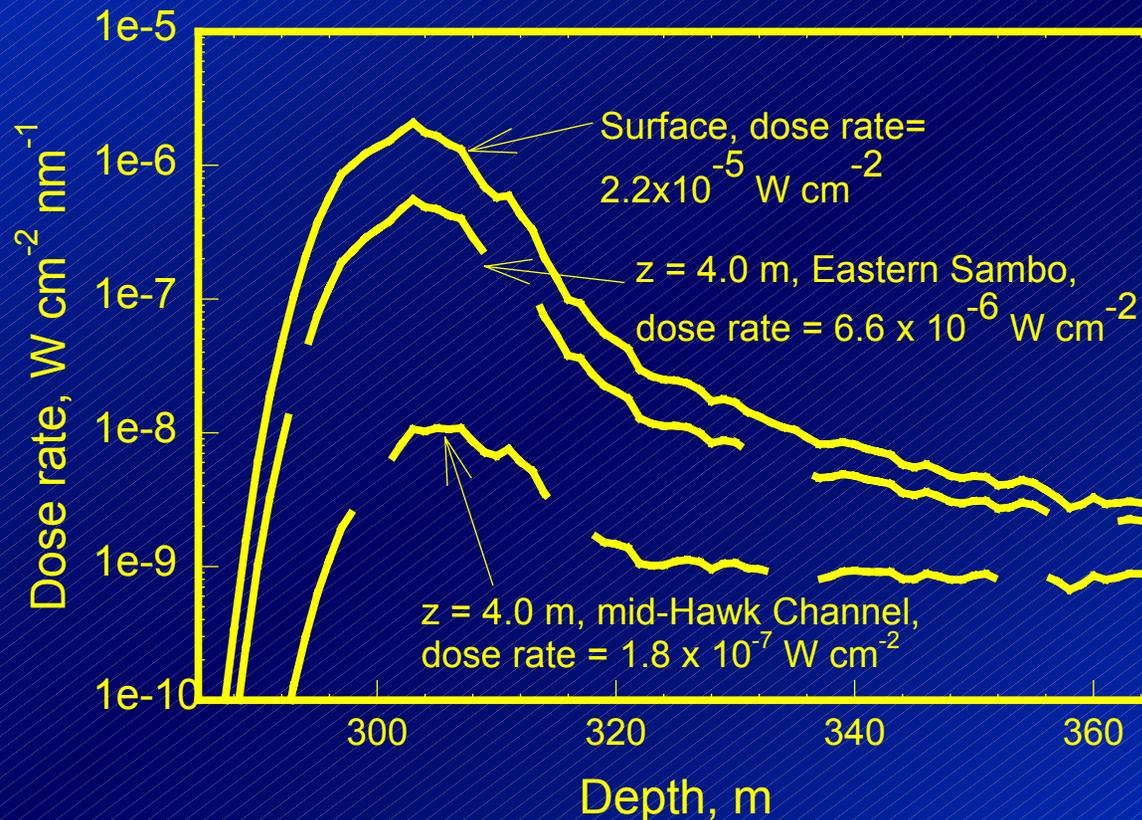


CDOM is UV absorbing component of dissolved organic matter

Absorption Spectra of Water Obtained Along S – N Transect Near Looe Key, Florida Keys

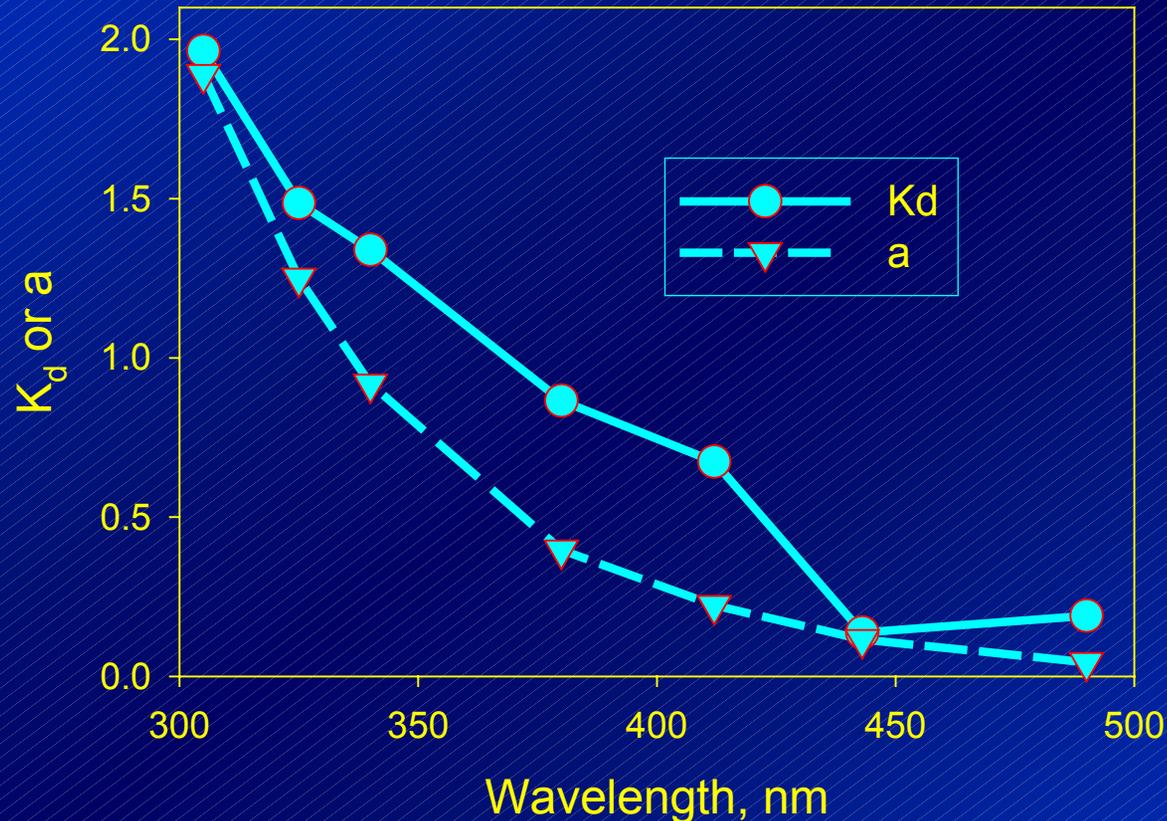


Estimated Exposure to DNA-Damaging Solar UV-B Irradiance Vs. Depth



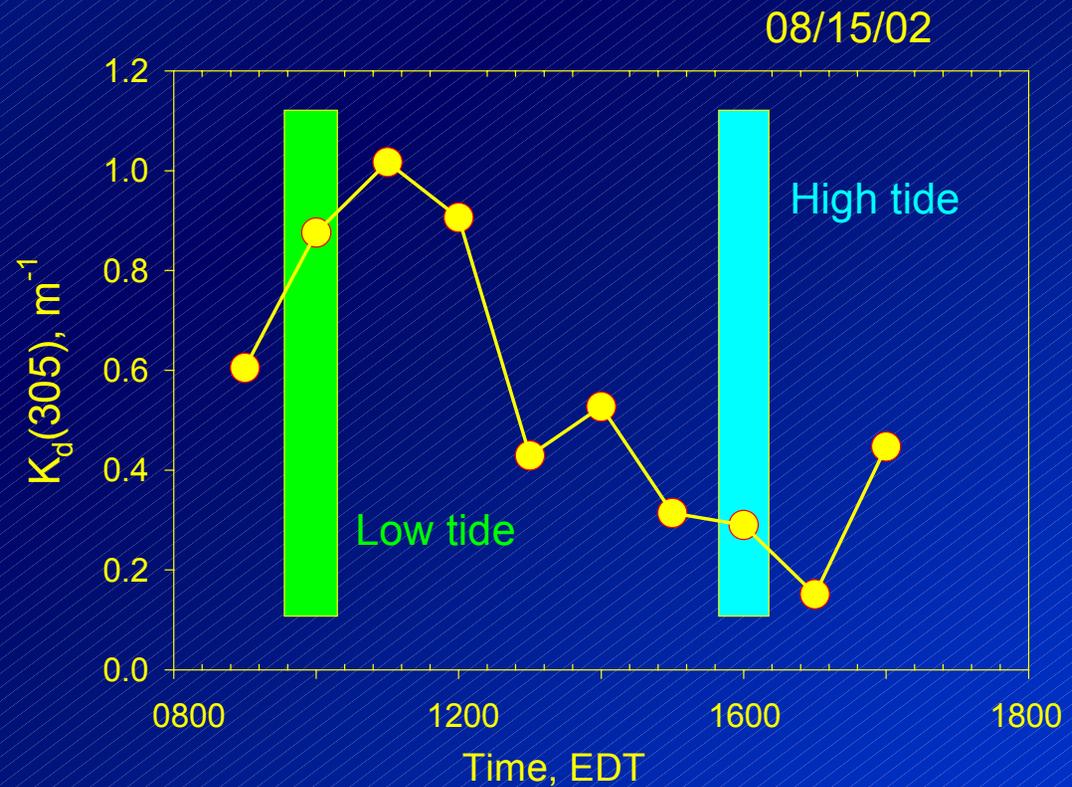
CDOM : 3% increase in damaging UV-B per 1% change
Ozone layer: 2% per 1% change

Diffuse Attenuation Coefficient Spectra Compared To Absorption Spectra for Mid-Hawk Channel

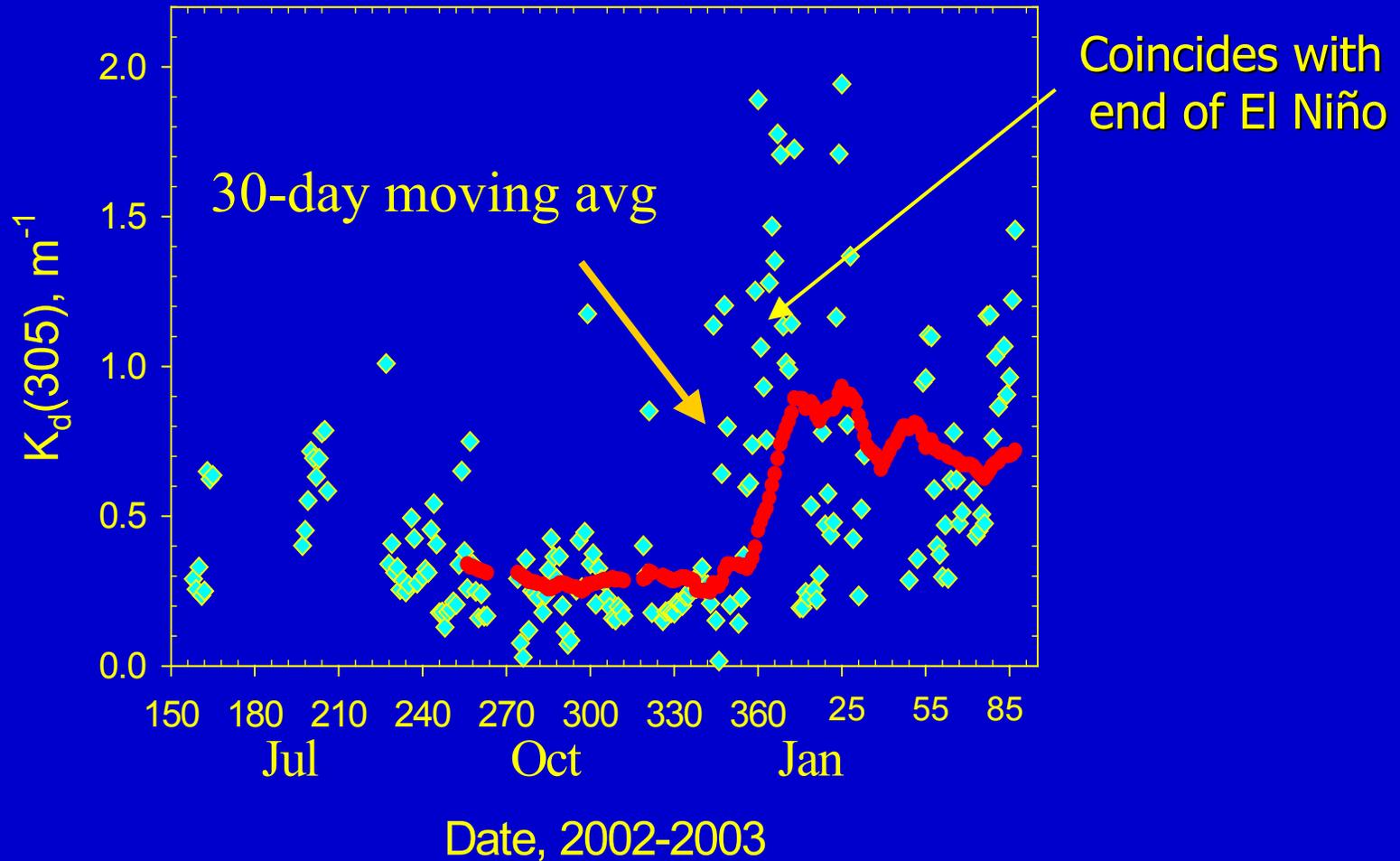


Shows that particles also involved in controlling UV-A/PAR exposure:
Possible explanation for patch reef success in Hawk Channel?

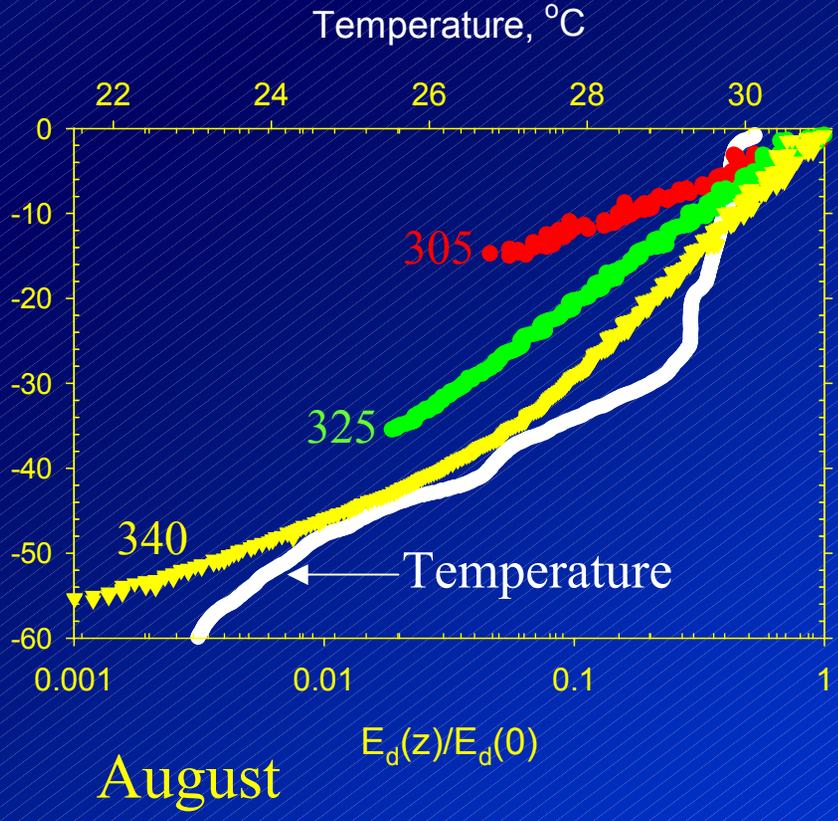
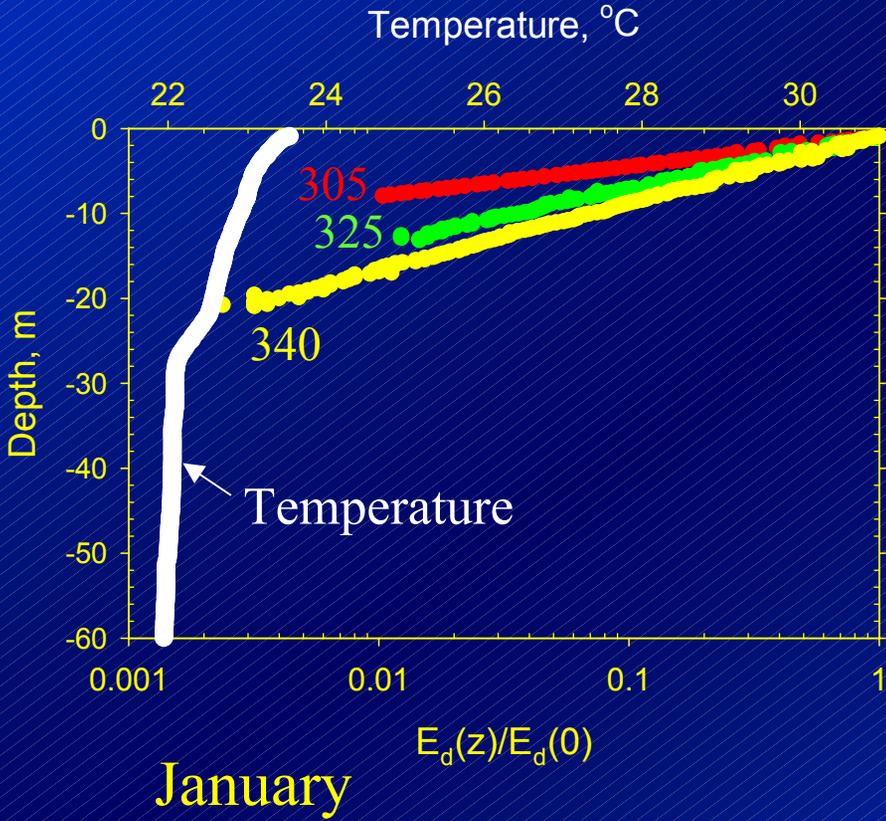
Diurnal Variation in UV-B Diffuse Attenuation Coefficient (305 nm) at Sombrero Reef



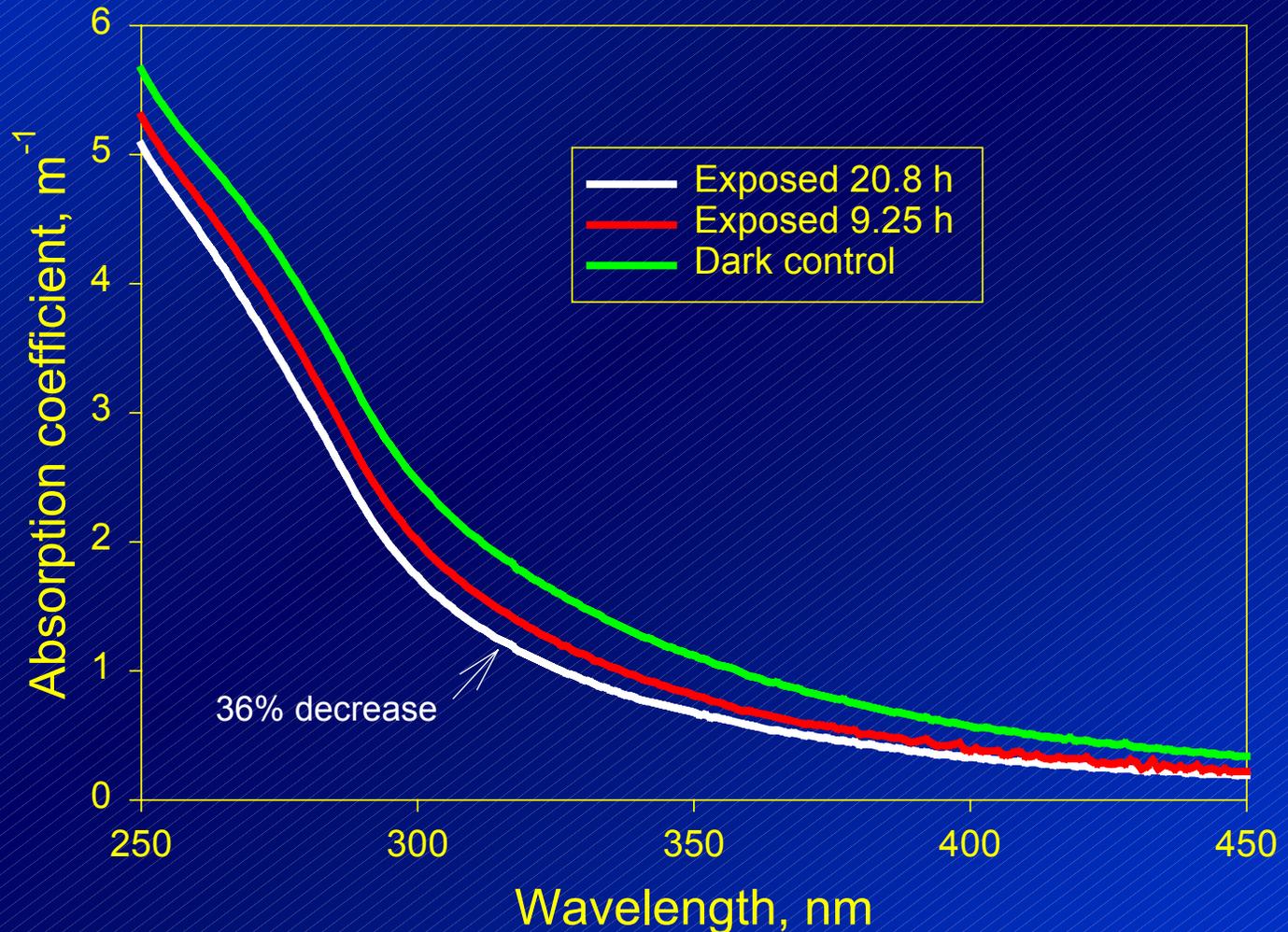
Midday UV-B (305 nm) Diffuse Attenuation Coefficients at Sombrero Tower



Seasonal Variation in the Temperature and UV vs Depth Profiles at a Site Near Looe Key, Florida Keys



Photobleaching of Water from Hawk Channel Exposed to Solar Radiation



Potential Sources of UV-Absorbing Substances in Water

- Local: Mangroves and underwater plants, e.g. sea grasses
- Transport of CDOM from Florida Bay and southwest Florida coast
- Detritus decay in bluewater outside reefs
- Particulates, e.g. detritus

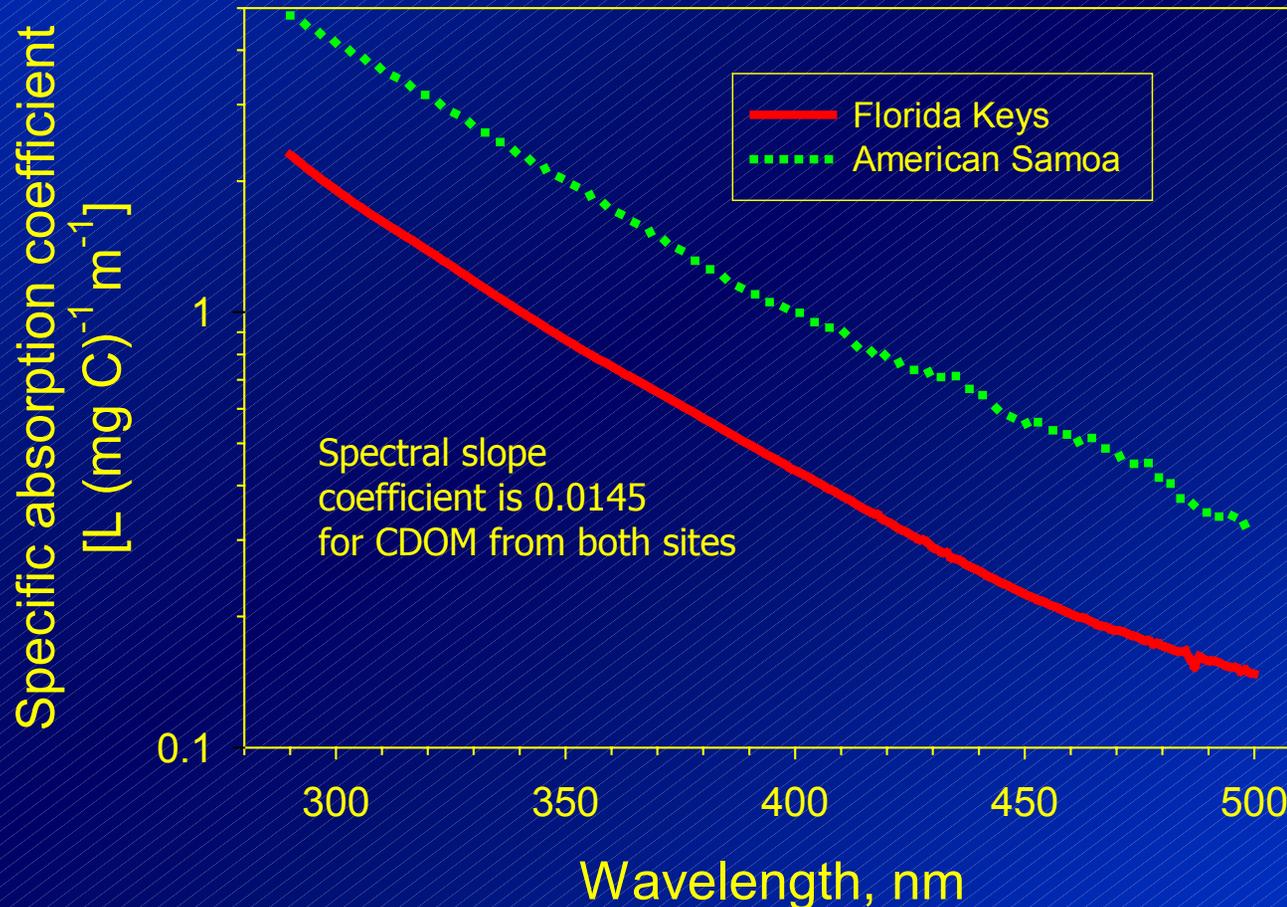
Focal point for management strategies!

Production of CDOM from *Thalassia testudinum*

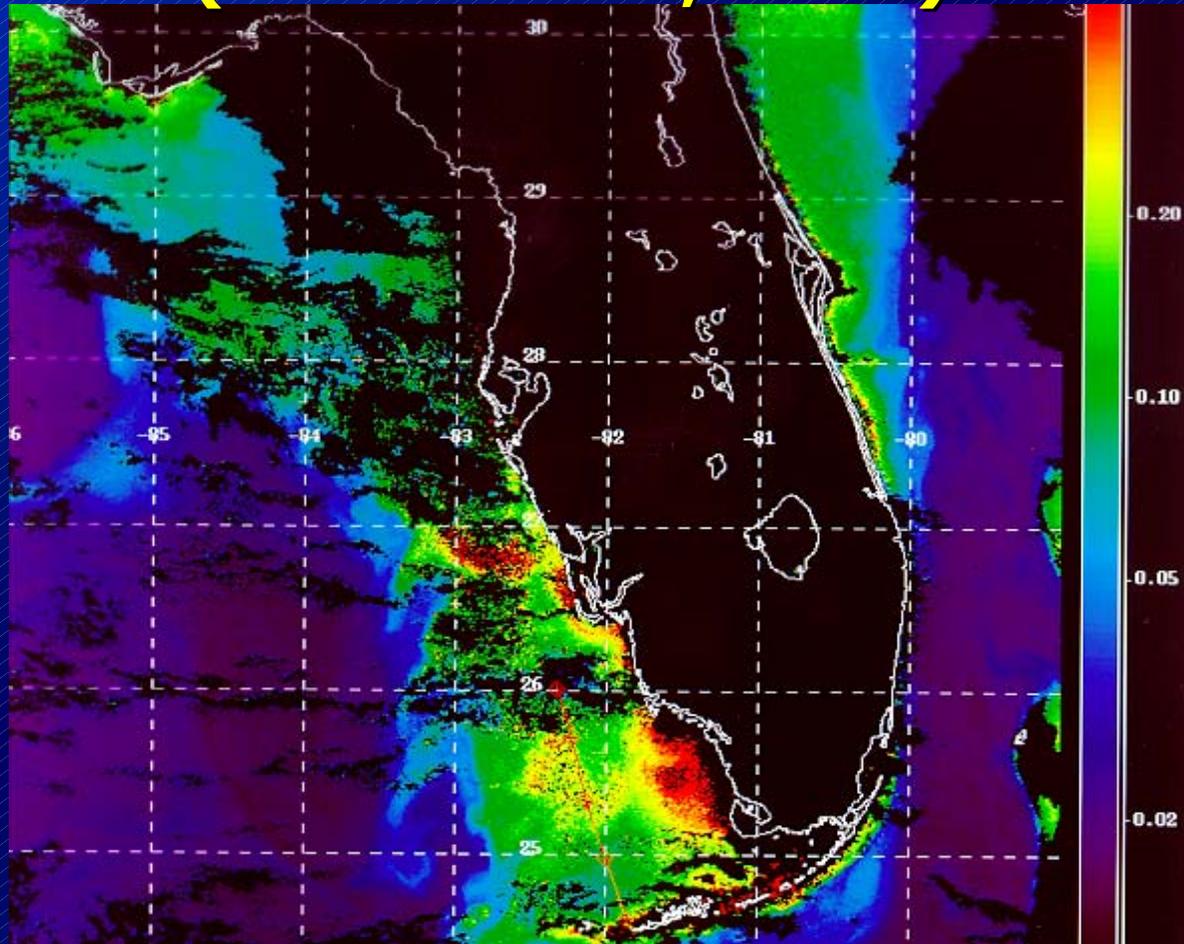


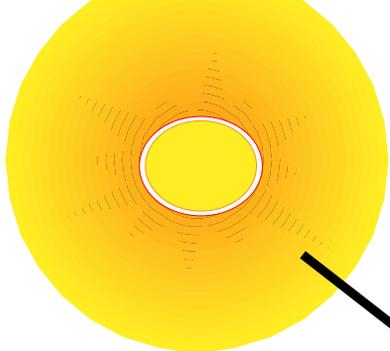
Absorption Spectra of CDOM Derived from Mangroves

American Samoa data from Mielbrecht, Hansen & Zepp



**Colored Dissolved Organic Matter (CDOM)
Estimated from SeaWiFS Data and Directly
Measured (June 2, 1998)
(Carder et al., 1999)**





Remotely sensed color

UV

CDOM

CDOM SINKS

- Photobleaching
- Microbial degradation

INCREASED UV EXPOSURE
TEMPERATURE INCREASES

CDOM SOURCES

- Seagrasses
- Mangroves
- Phytoplankton

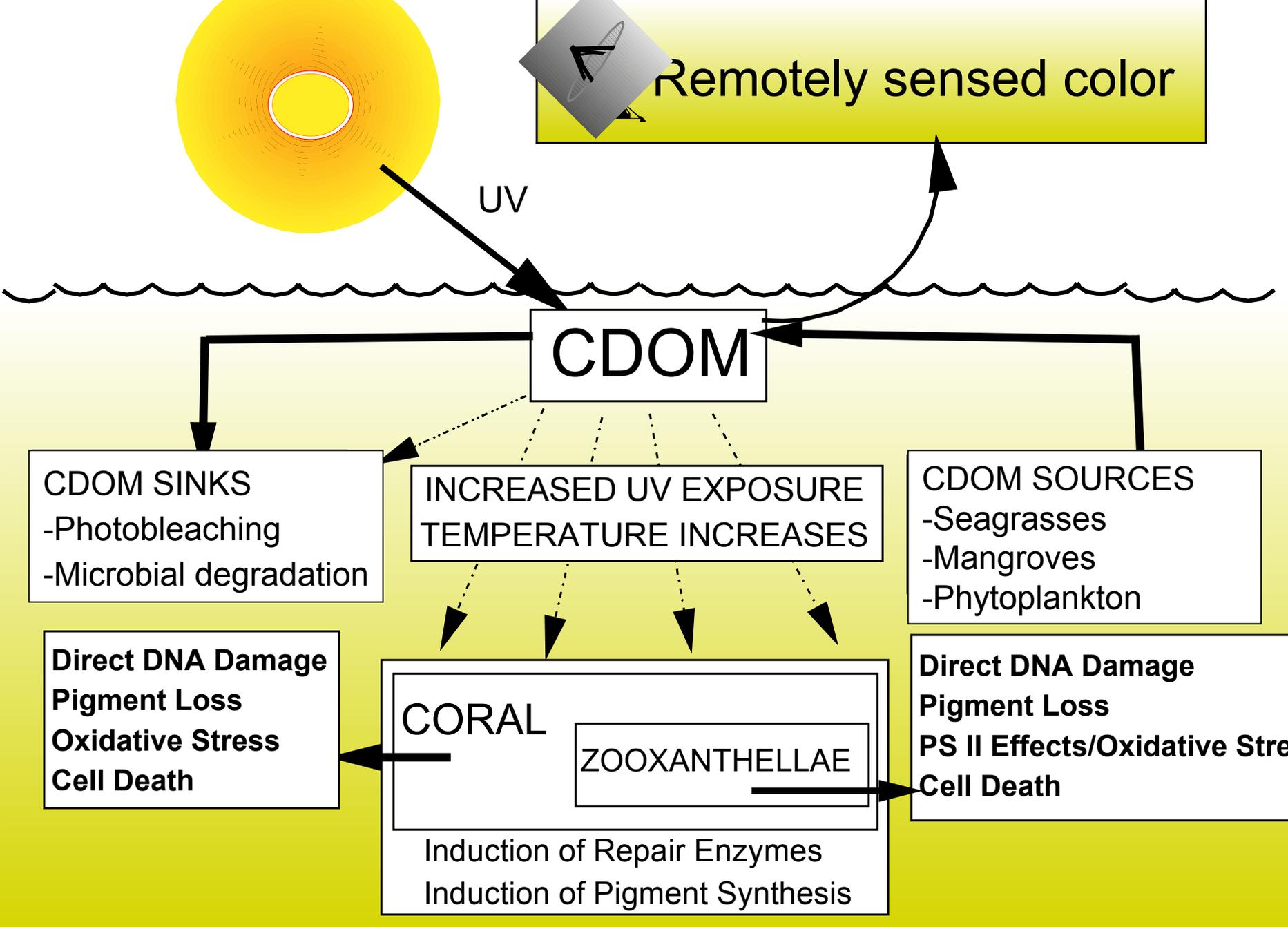
Direct DNA Damage
Pigment Loss
Oxidative Stress
Cell Death

CORAL

ZOOXANTHELLAE

Induction of Repair Enzymes
Induction of Pigment Synthesis

Direct DNA Damage
Pigment Loss
PS II Effects/Oxidative Stress
Cell Death



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