Marine microbiology from space

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Marine microbes through the microscope: small but many

Photo: Dominique Marie, Station Biologique de Roscoff, CNRS
Many microbes

Very few microbes
The many troubles of a well meaning satellite
Electronic signal in each pixel

Level 0: Each pixel with position and time

Level 1: Radiance at the satellite per pixel

Sensor calibration

Atmospheric correction with masks and flags

Level 2: Radiance at Earth’s surface

Algorithms

Level 2: Biogeophysical data

Level 3: Data in bins

Http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/classic_scenes
Phototrophic microbes visible thanks to Chlorophyll a

A ship would take 10 years of continuous sampling to get the same amount of data points
Marine phytoplankton produce DMSP for its role in:

- osmoregulation
- cryoprotection
- anti-oxidant
- methyl donor
- overflow of excess S and reducing power
- chemosensory and chemotactic behaviour

ubiquitous in the oceans!
**DMSP**: dimethylsulphoniopropionate

\[(\text{CH}_3)_2\text{S}^+\text{-CH}_2\text{-CH}_2\text{-COO}^-\]

is transformed into

**DMS** : dimethyl sulphide

\[(\text{CH}_3)_2\text{S}\]

main biological source of S to atmosphere
Microbes contribute to climate regulation through DMS production

Earth without clouds
Earth with clouds: albedo is VERY important
The % of DMSP converted to DMS depends on Mixed Layer Depth

**CHL** : SeaWiFS 1997-2000

W. Gregg (GSFC, NASA)

monthly

**MLD** : Samuels & Cox (Levitus)

$\Delta \sigma_t = 0.125 \text{ kg m}^{-3}$

monthly
Validation of the algorithm: average values from world’s oceans

\[ R^2 = 0.8255 \]

- North Atlantic
- Gulf of Mexico
- East China Sea
- East Mediterranean
- West Mediterranean
- Sargasso Sea
- Southern ocean (SOIREE)
- Equatorial Pacific (IRONEX II)
- Equatorial Pacific

Simó & Dachs, Global Biogeochem. Cycles, 2002
SST : ATSR-2

monthly

WIND SPEED : NOAA SSM/I

monthly, Weibull correction

Sea-to-air flux:

\[ F = k \cdot \Delta [\text{DMS}] \]
ANNUAL OCEAN-TO-ATMOSPHERE EMISSION OF DMS

23 - 32 Tg S y^{-1}

anthropogenic ~ 67
volcanic ~ 7
MODIS

AEROSOL OPTICAL DEPTH (AOD)

POTENTIAL CLOUD CONDENSATION NUCLEI (CCN)
COEFF. CORRELATION

CCN vs DMS conc

annual series, 7x7°
ATMOSPHERIC SAMPLING STATIONS (Univ. Miami) + Cape Grim + Amsterdam Island

DMS predicted
CCN MODIS
MSA measured