Influences of the primary organic marine component on sea-spray composition and climate

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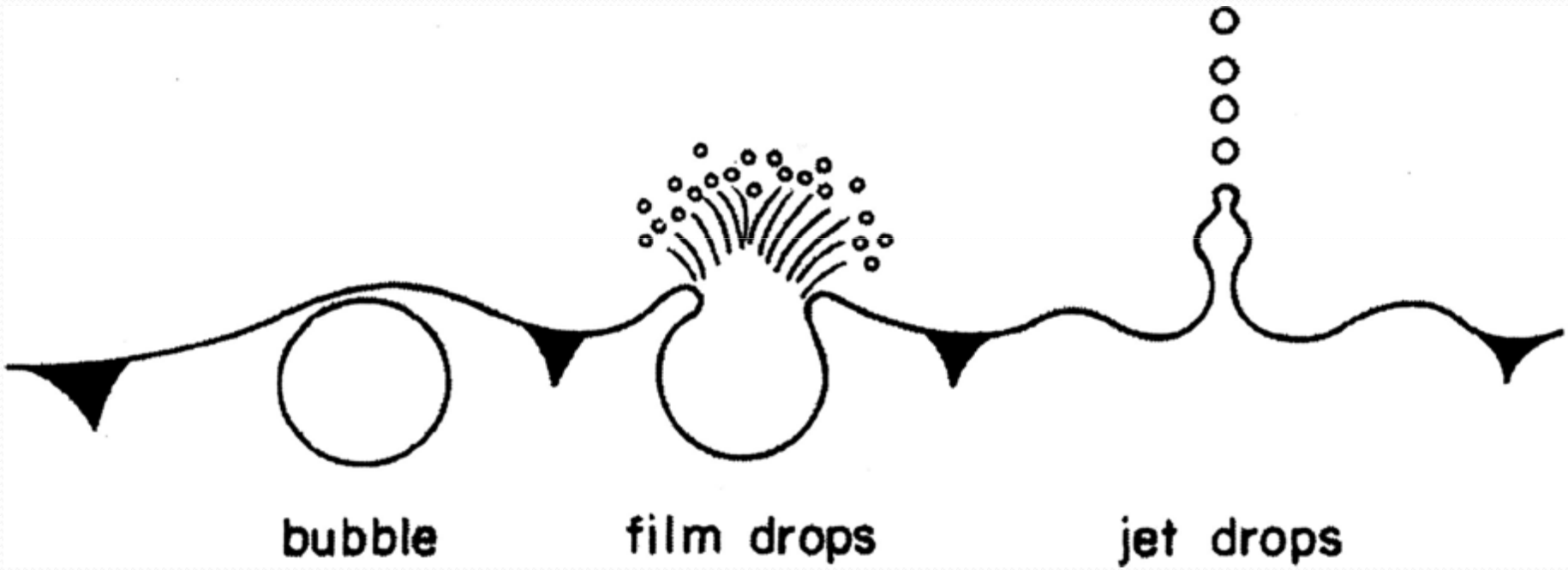
BERKELEY LAB

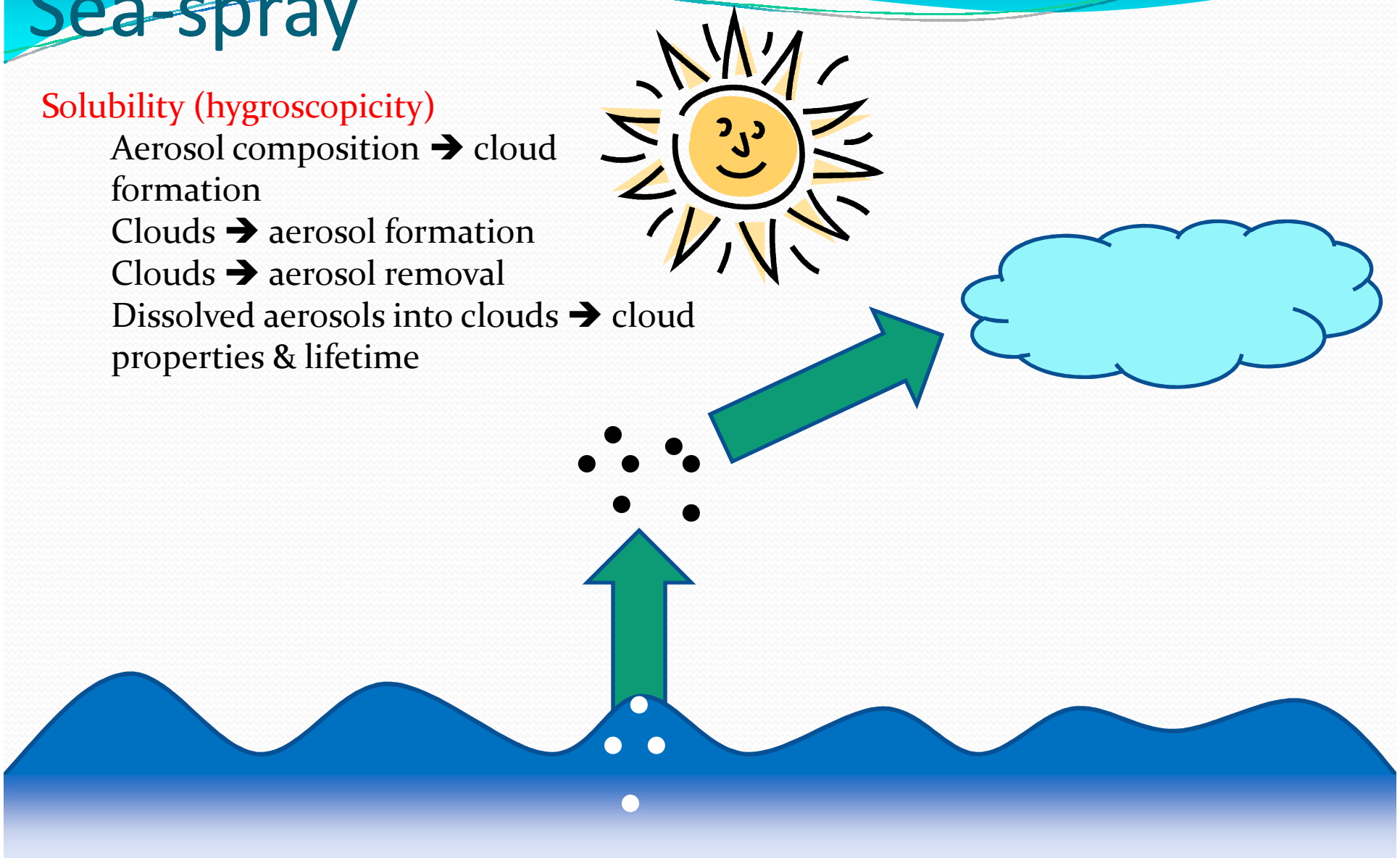
Sea-spray



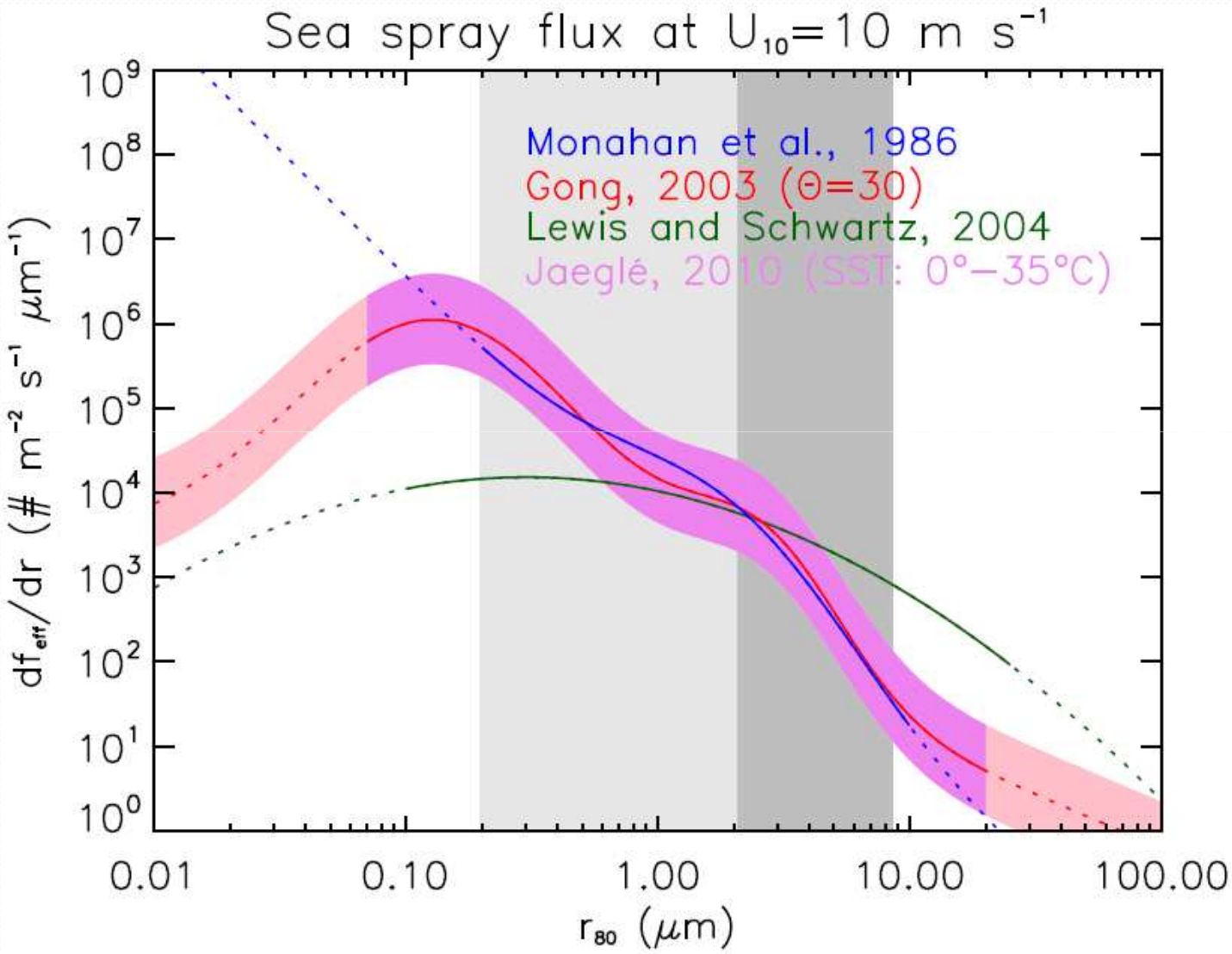
Sea-spray

Solubility (hygroscopicity)

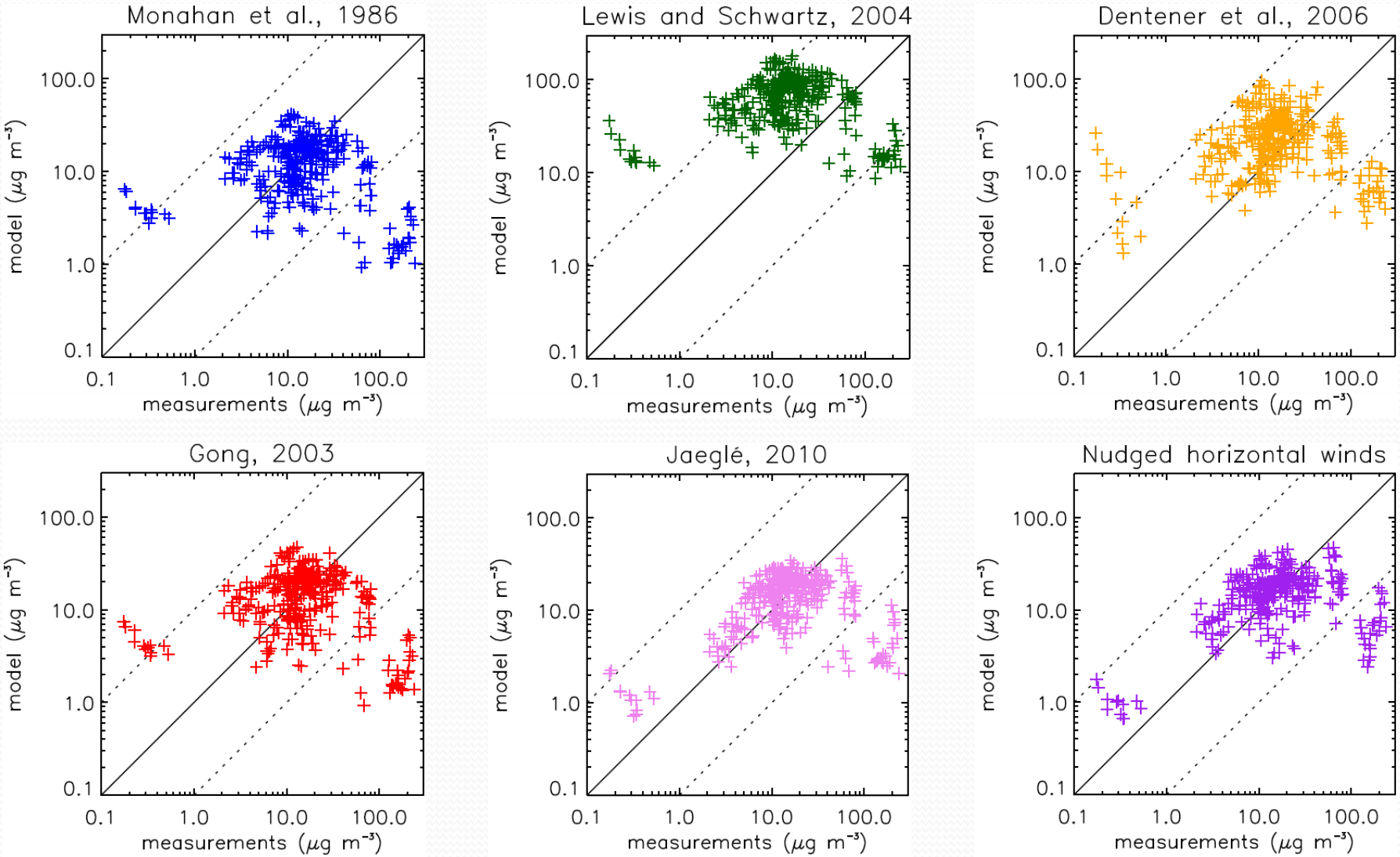
- Aerosol composition ➔ cloud formation
- Clouds ➔ aerosol formation
- Clouds ➔ aerosol removal
- Dissolved aerosols into clouds ➔ cloud properties & lifetime



Sea-spray source

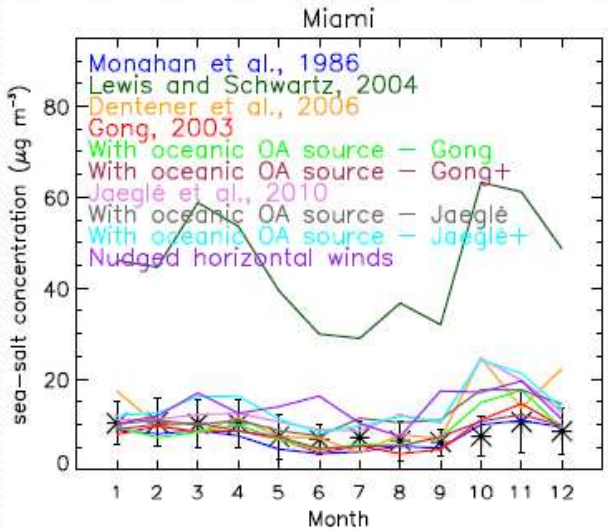


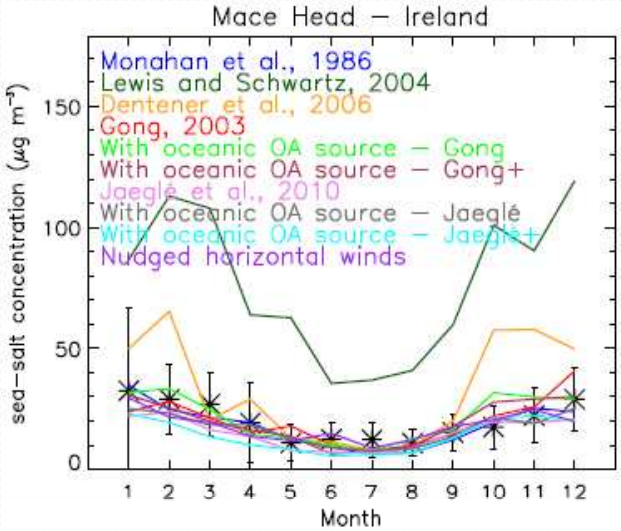
Sea-salt comparison with measurements

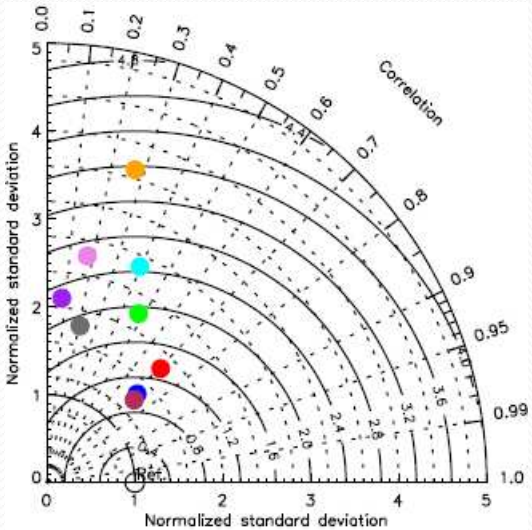


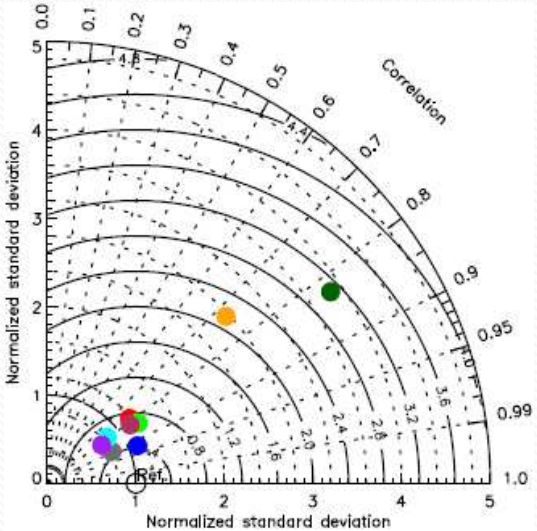
Prospero and Savoie dataset, University of Miami

Sea-salt comparison with measurements

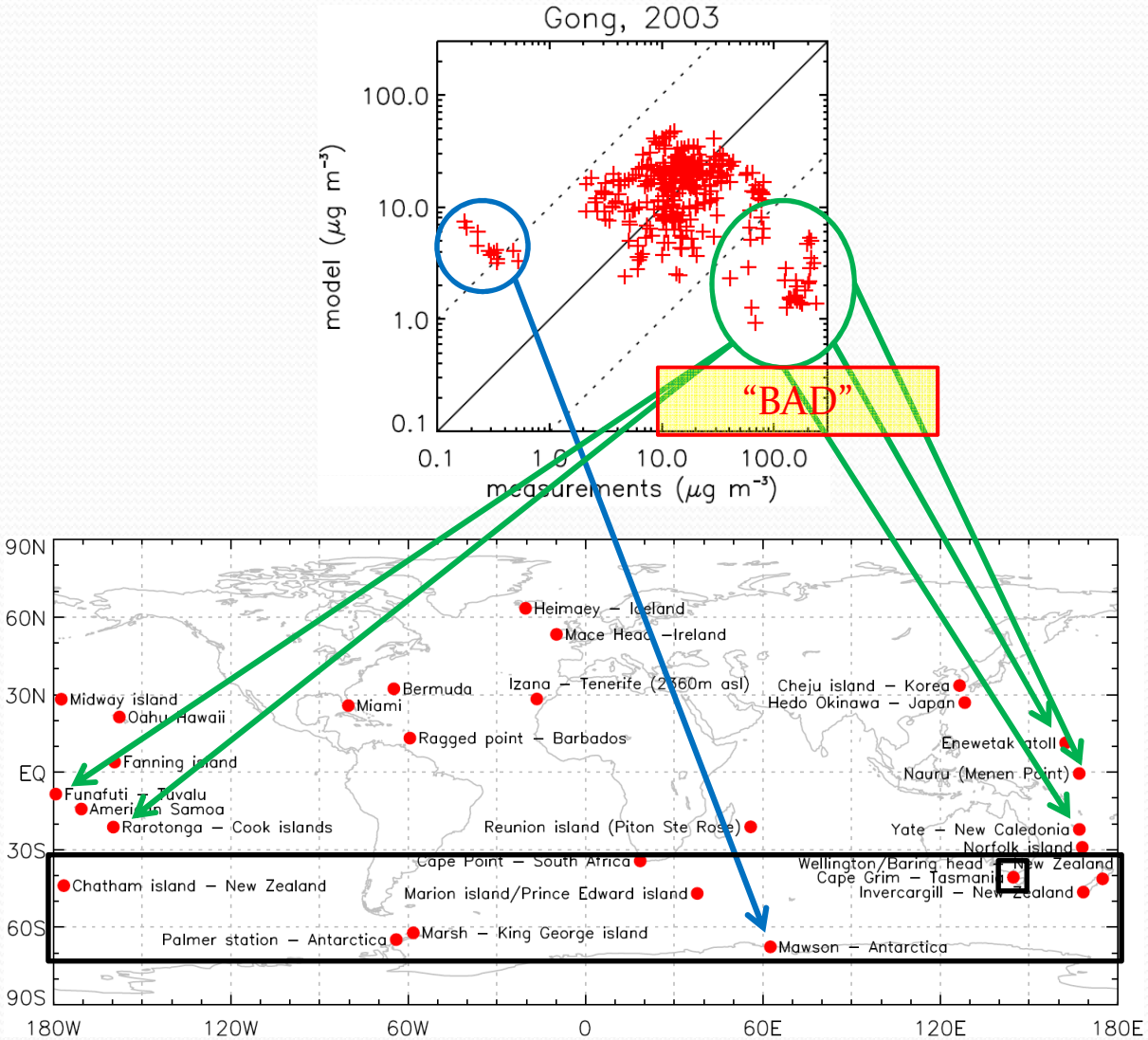








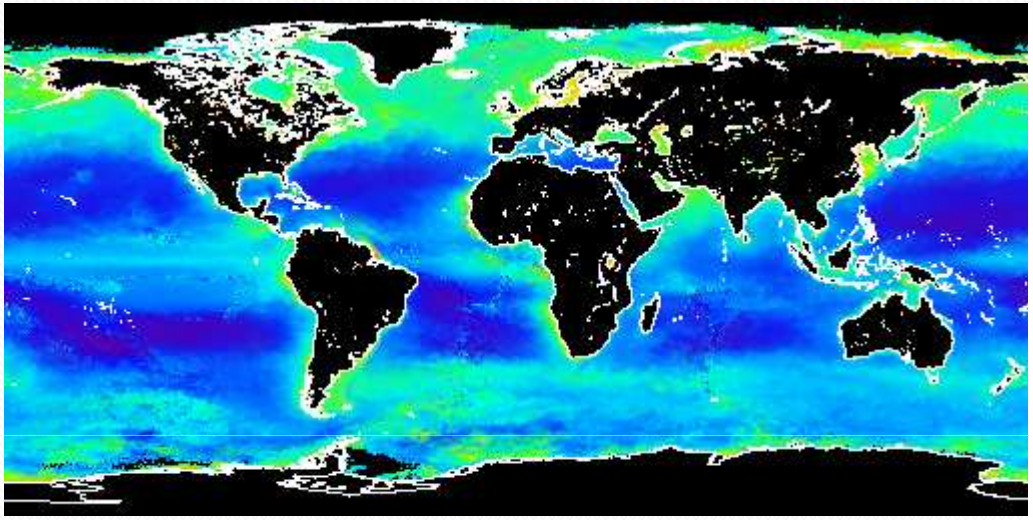
Sea-salt comparison with measurements



Prospero and Savoie dataset, University of Miami

Sea-spray organic enrichment

SeaWiFS, 2000



O'Dowd et al., 2008

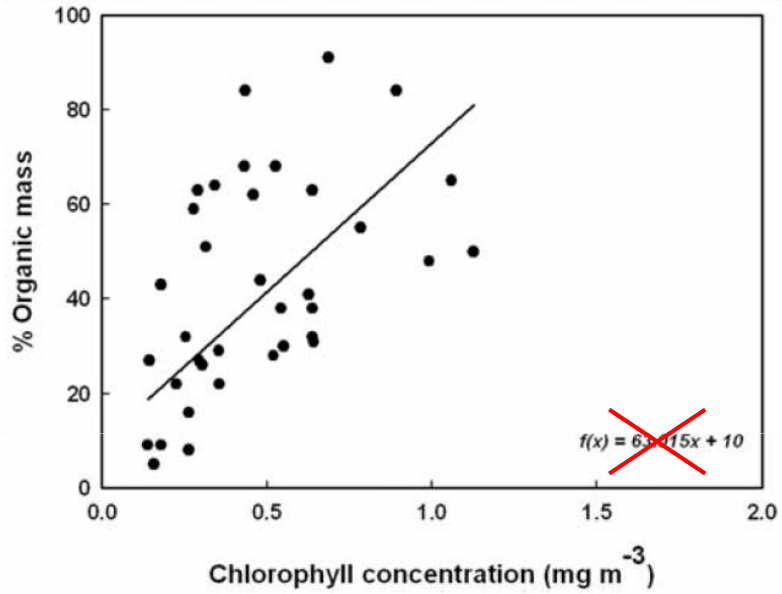
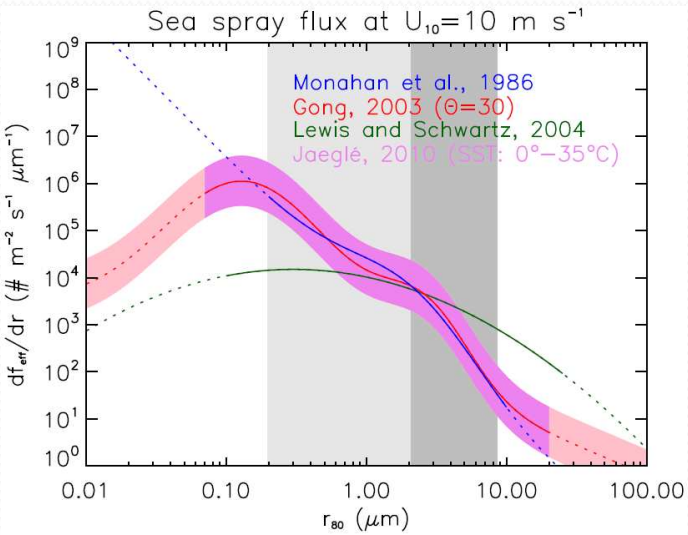


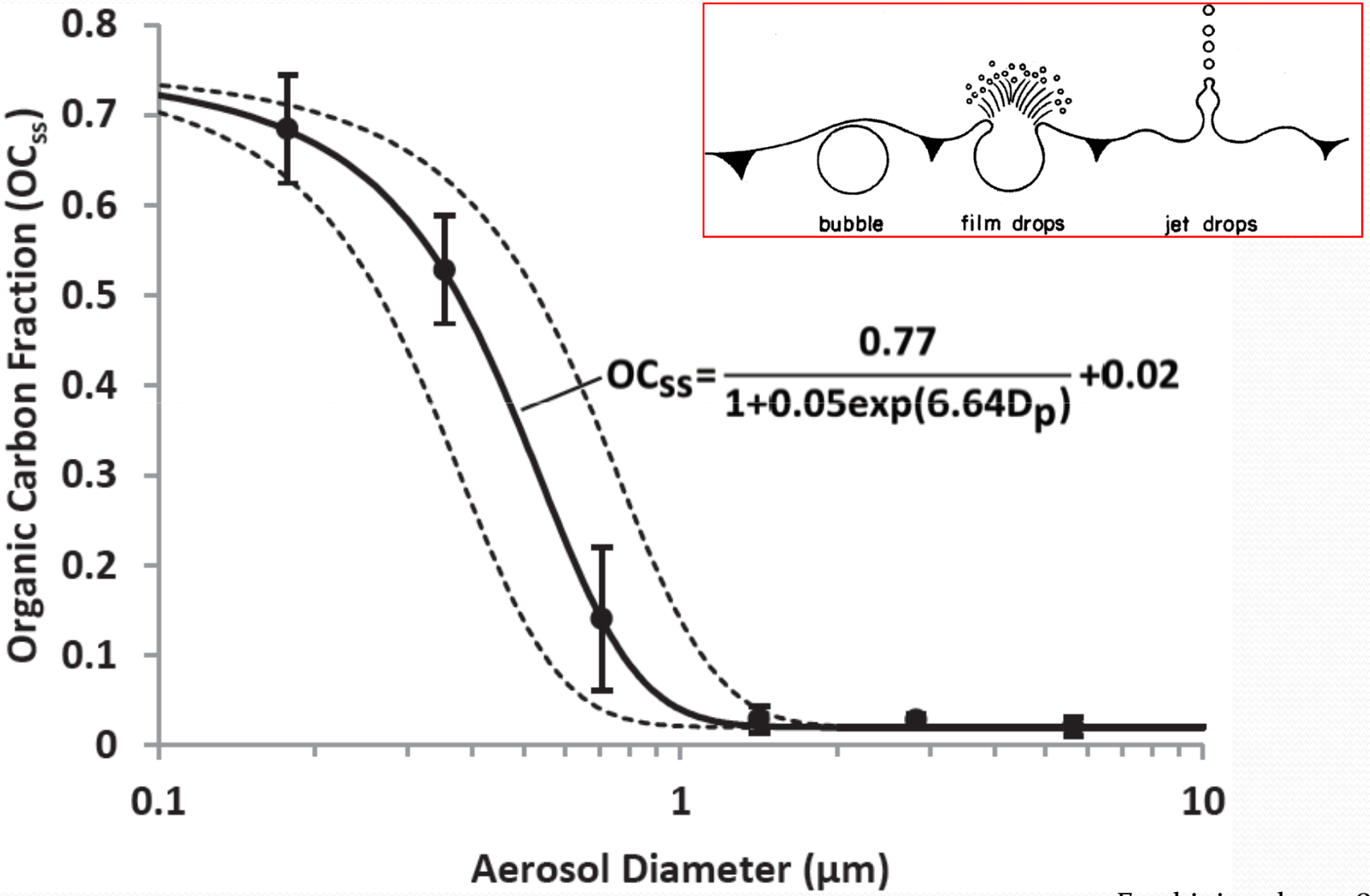
Figure 2. Correlation between fractional WIOC component of sea-spray as a function of grid-average chlorophyll-a concentration.



Vignati et al., 2010

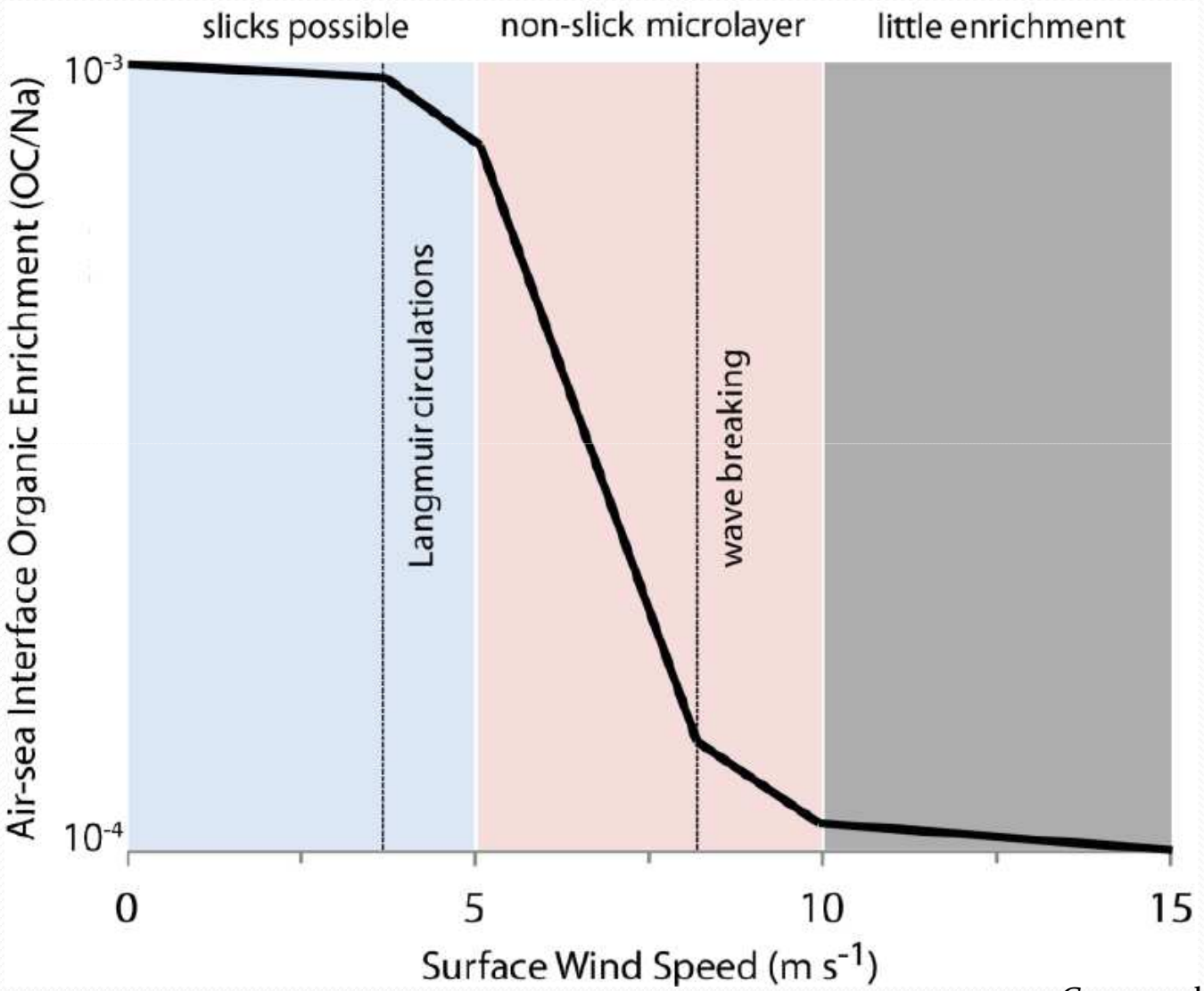
$$\%\,\text{organic mass} = 43.5 * \text{Chl}\ [\text{mg m}^{-3}] + 13.805,$$
$$\text{Chl} < 1.43\ \mu\text{g m}^{-3}$$

Sea-spray organic enrichment



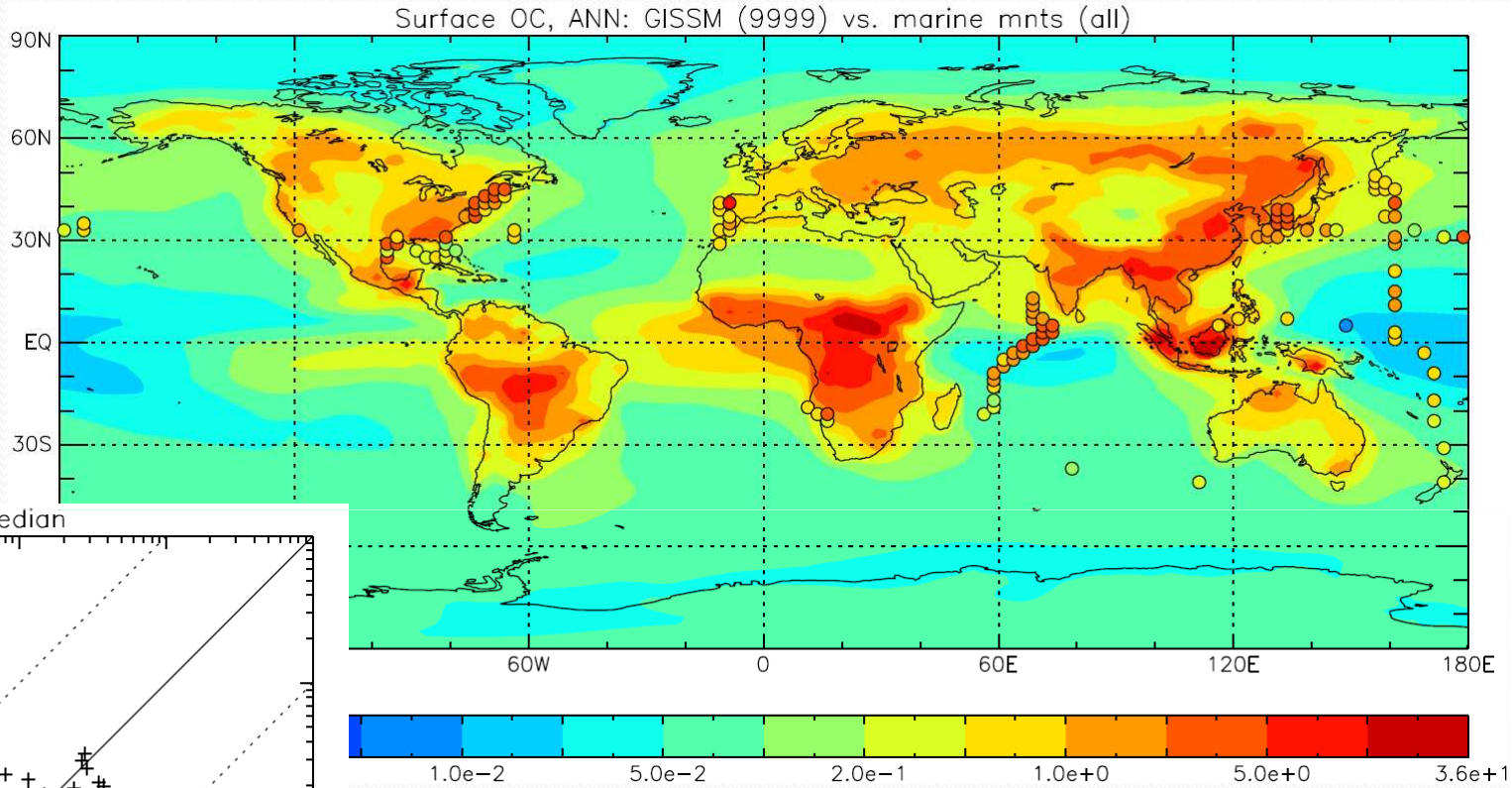
Facchini et al., 2008

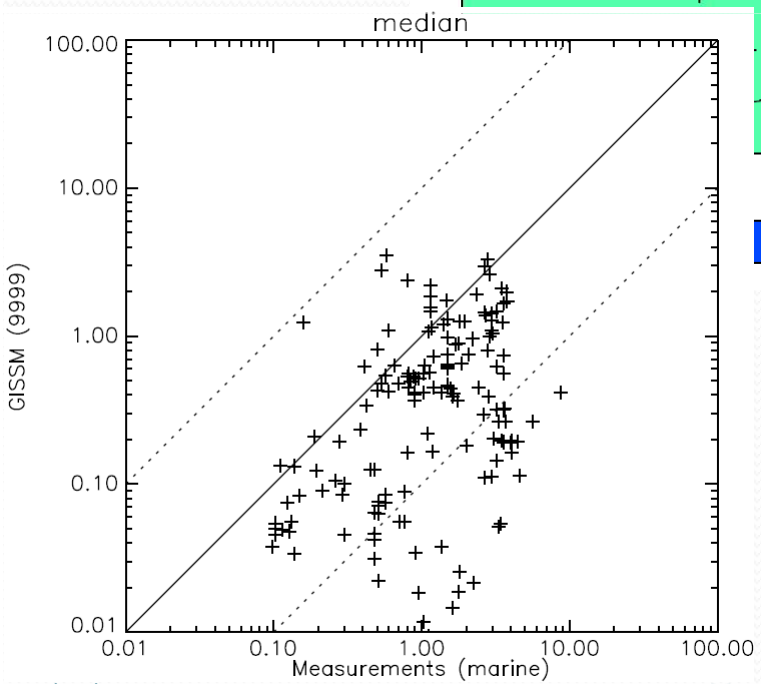
Sea-spray organic enrichment



Gantt and Meskhidze, 2011

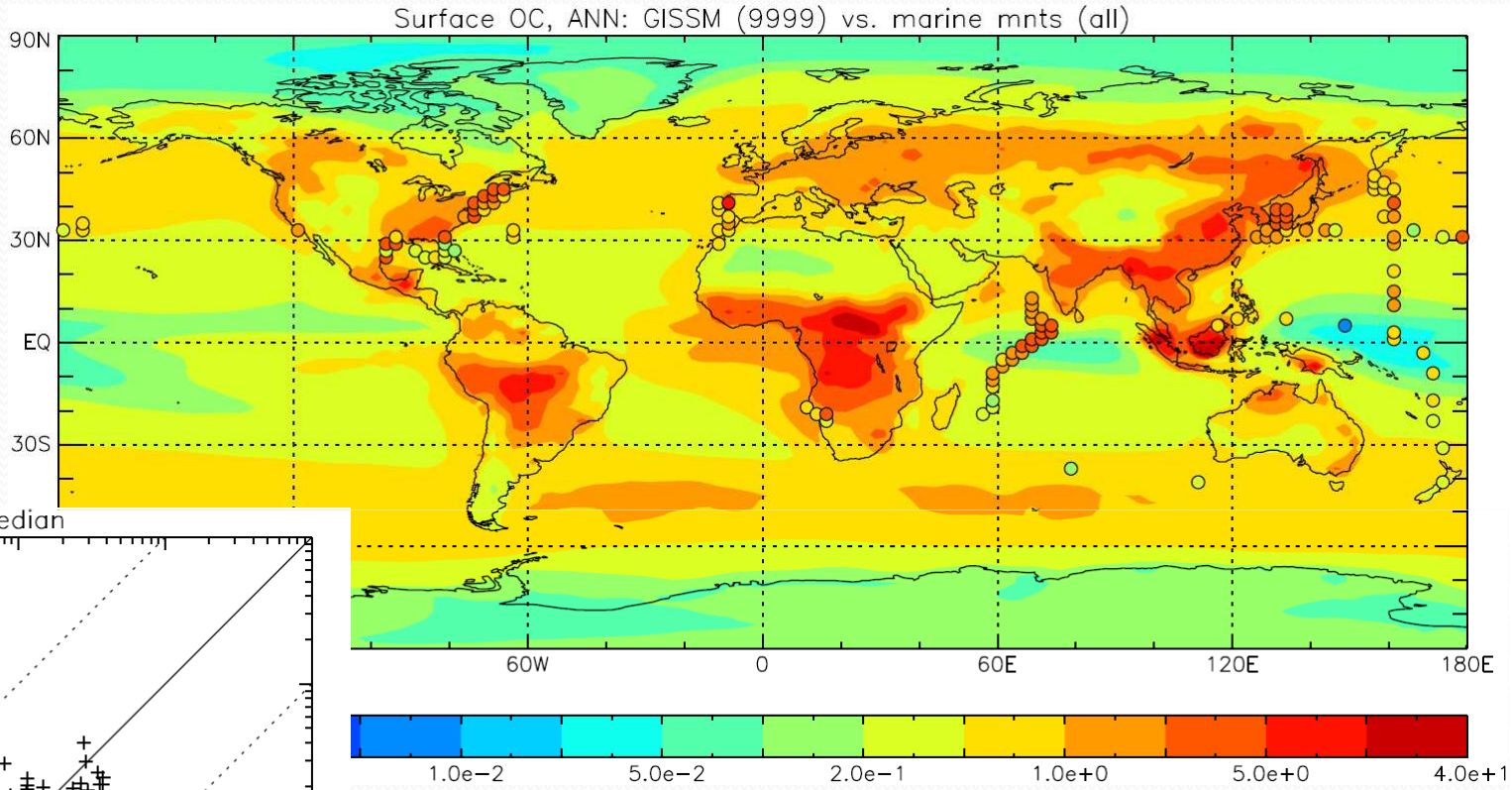
Organics comparison with measurements

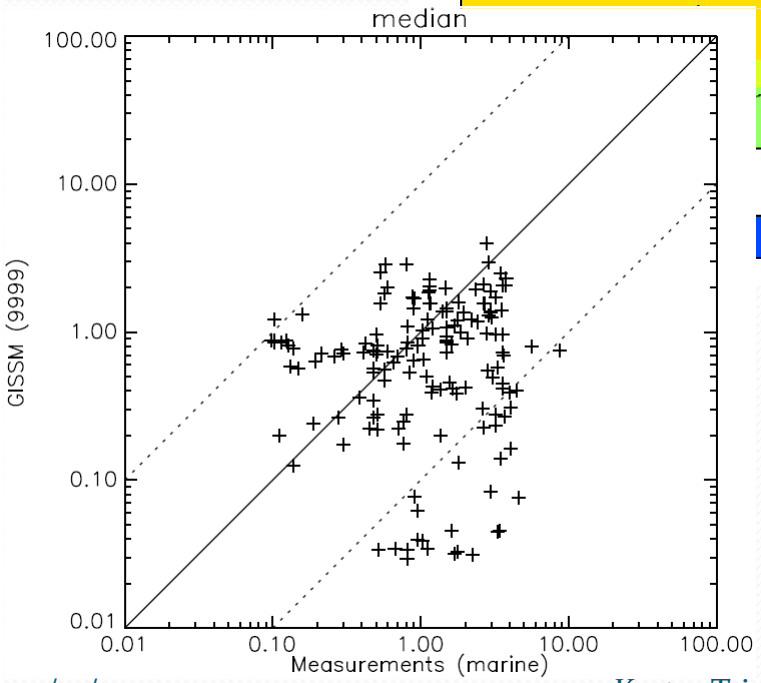




Without oceanic organics

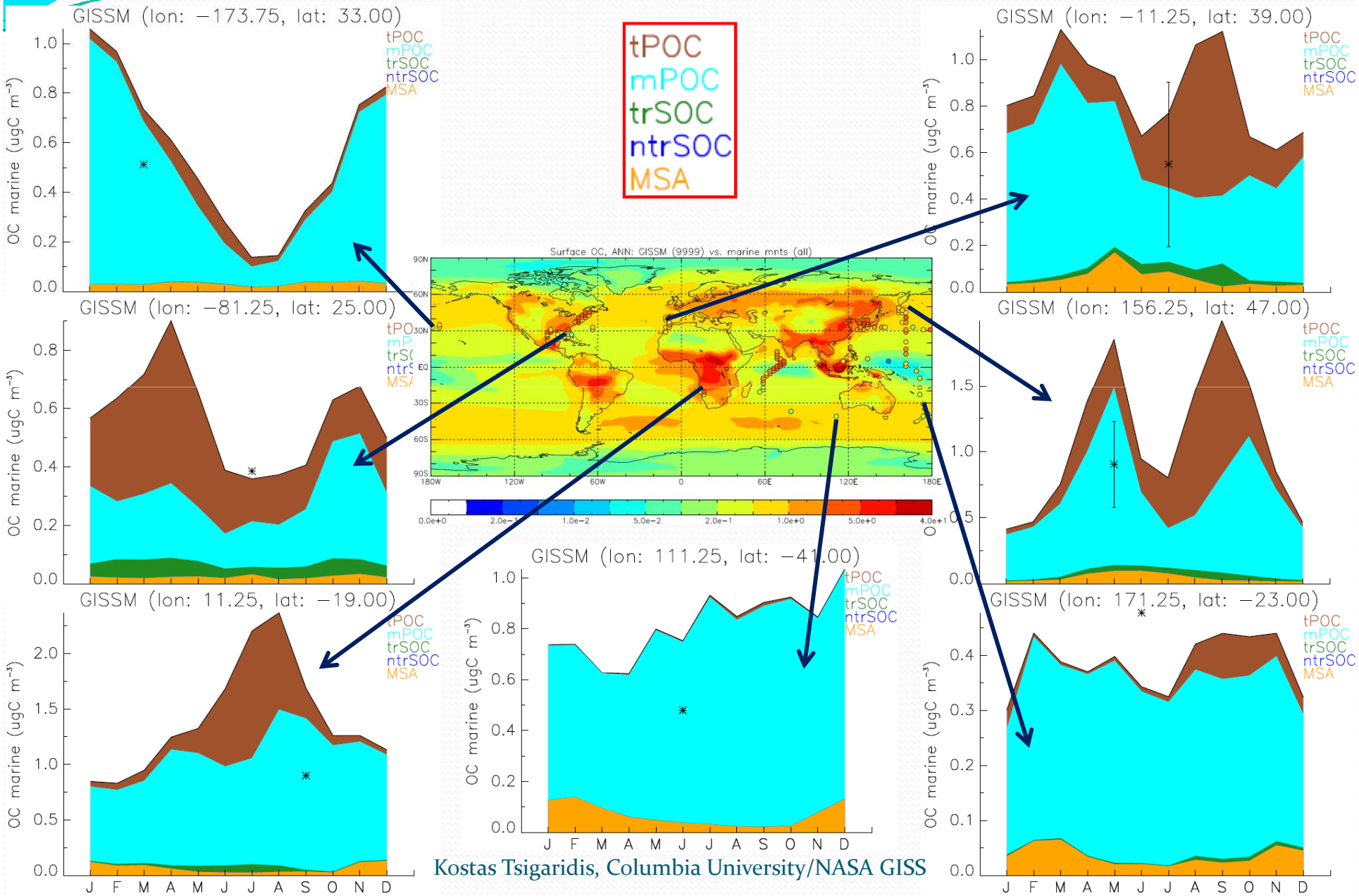
Organics comparison with measurements





With oceanic organics

Organics comparison with measurements



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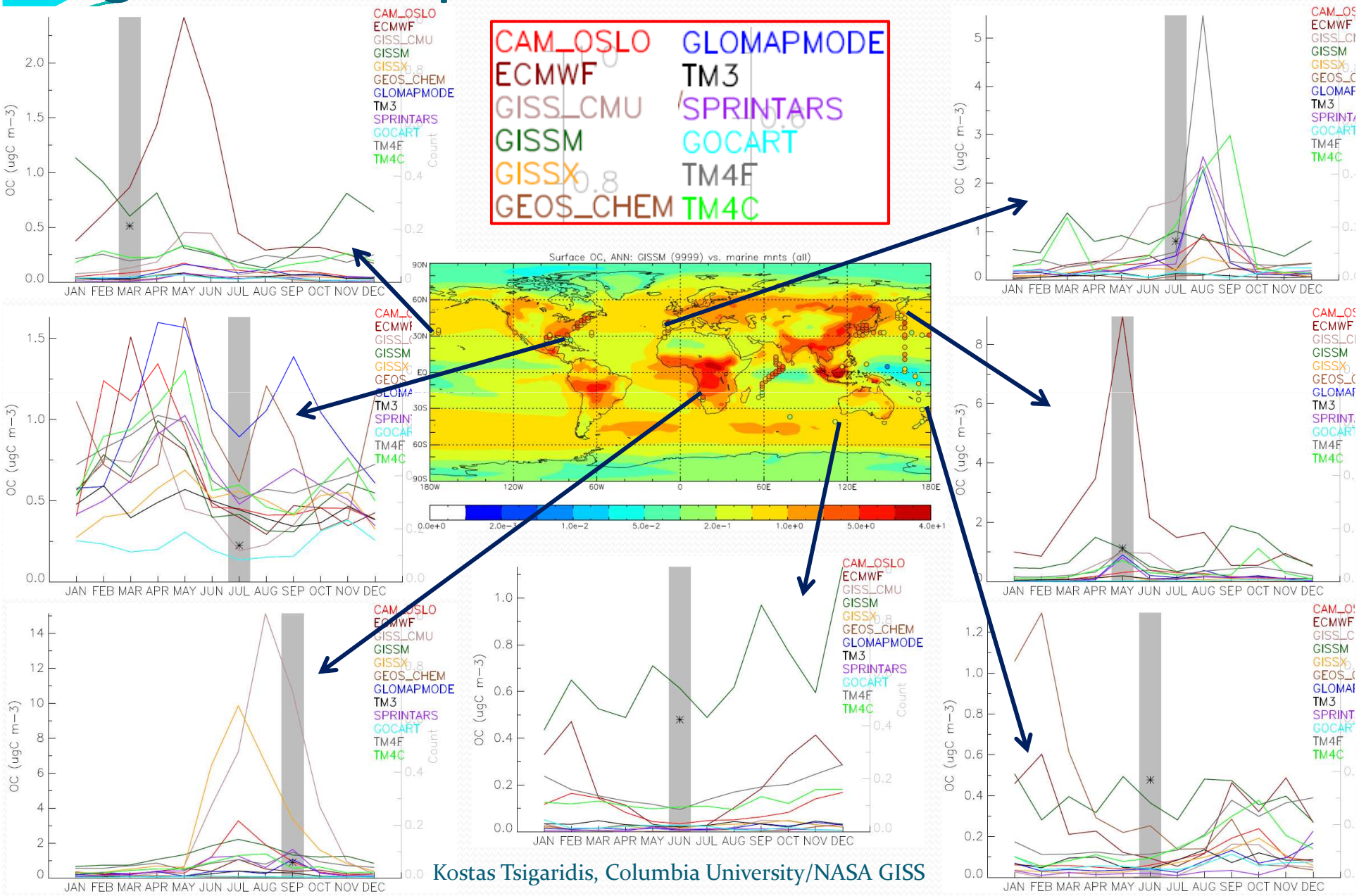
Organics comparison with measurements



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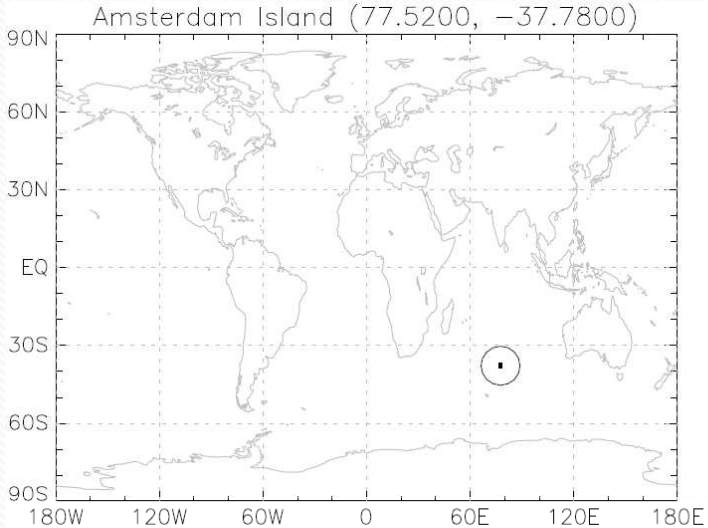
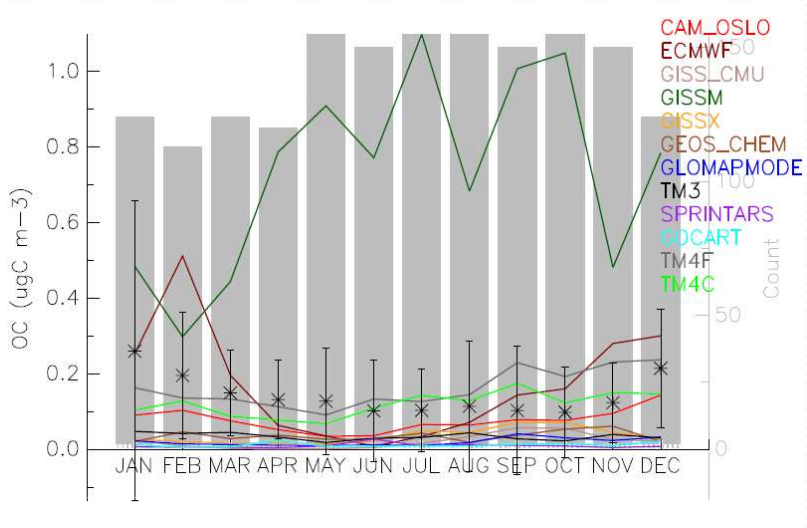
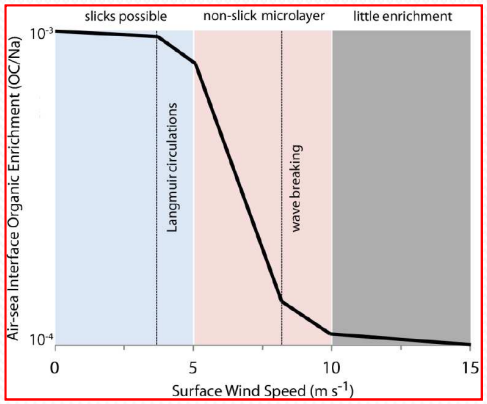
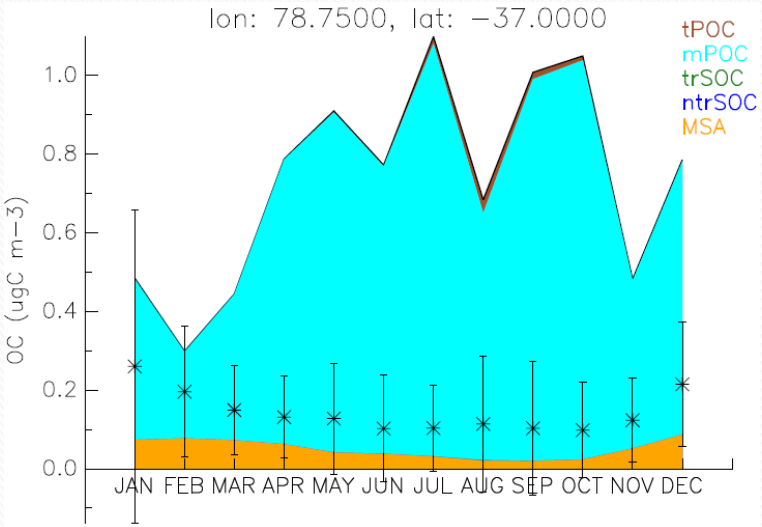
Amsterdam Island

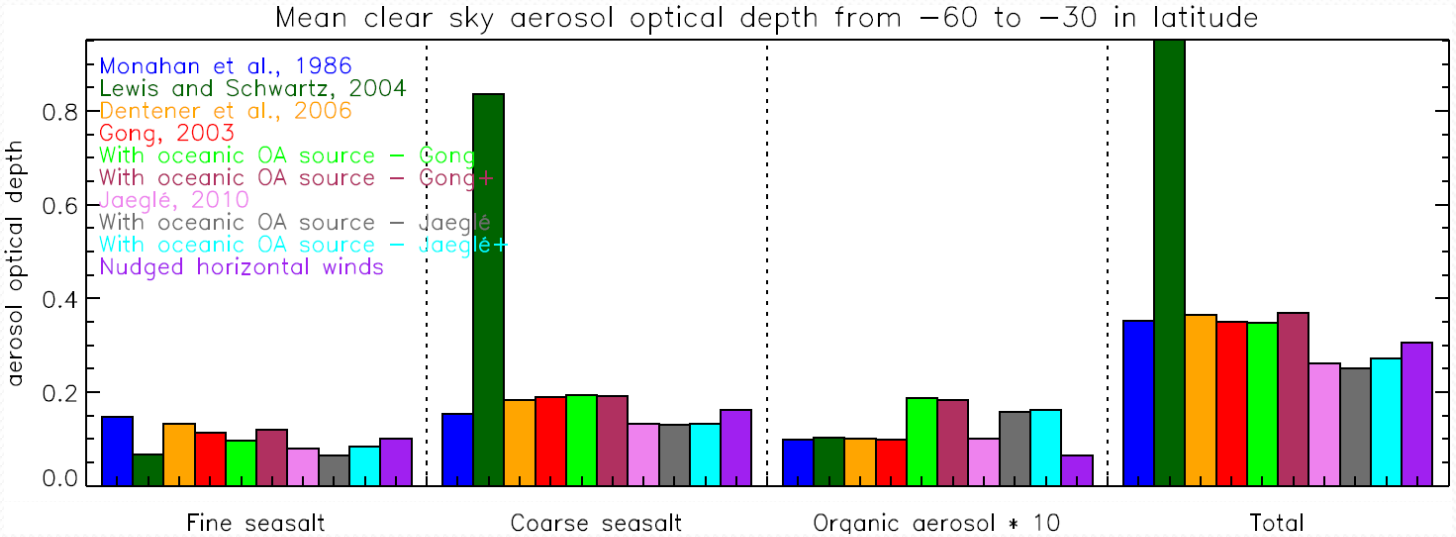


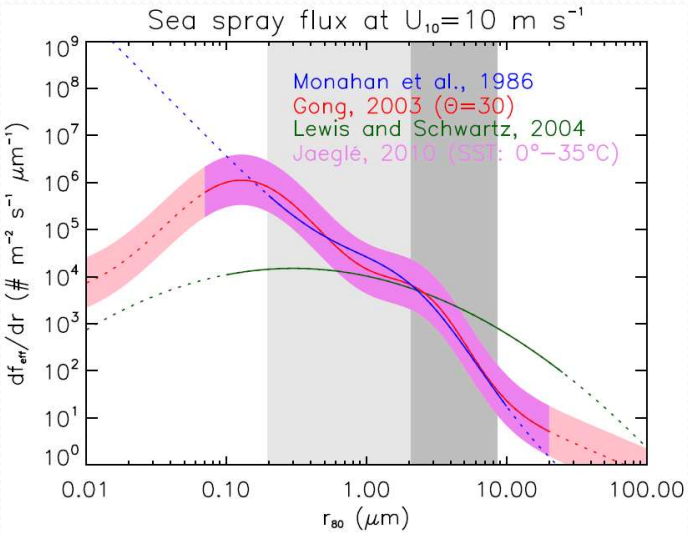




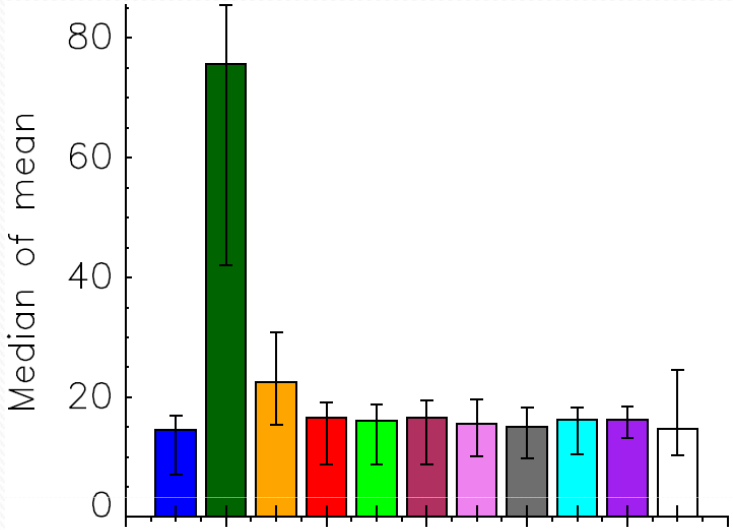


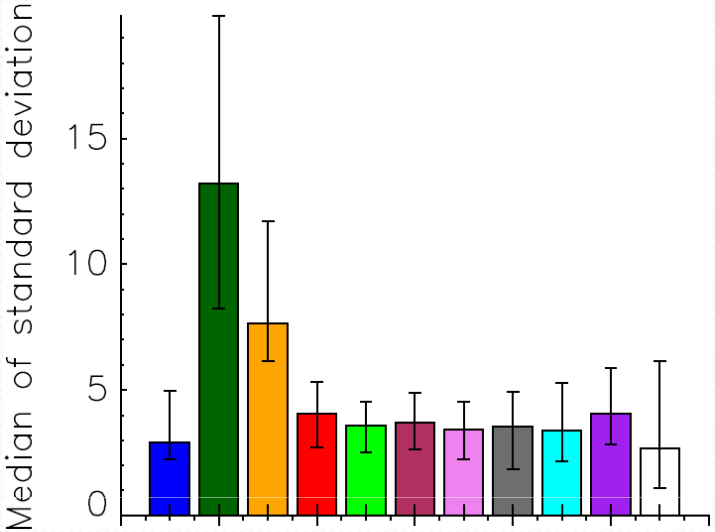
Southern ocean optical depth

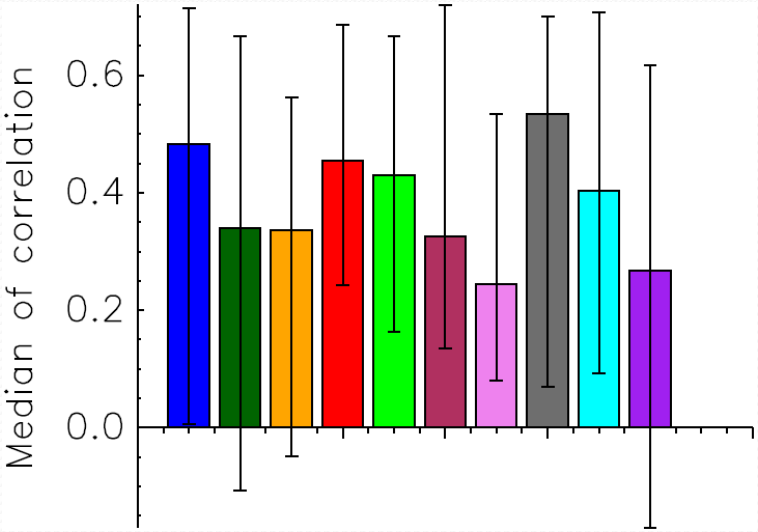




Statistics – sea salt







Monahan et al., 1986
Lewis and Schwartz, 2004
Dentener et al., 2006
Gong, 2003
With oceanic OA source – Gong
With oceanic OA source – Gong+
Jaeglé, 2010
With oceanic OA source – Jaeglé
With oceanic OA source – Jaeglé+
Nudged horizontal winds

Oceanic aerosol budget

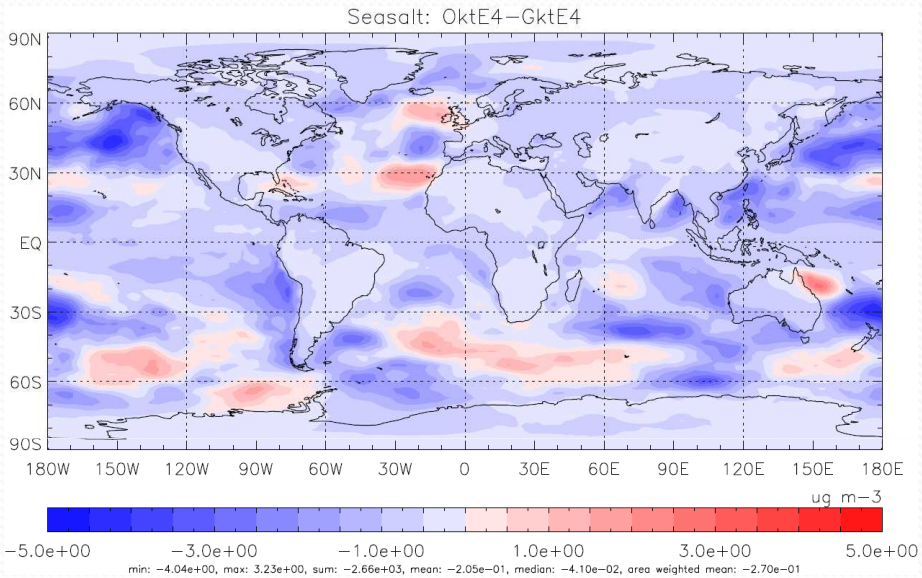
Tracer	Source ($Tg\ a^{-1}$)	Burden (Tg)	Lifetime (days)
Oceanic OA	63-73	0.25-0.30	1.5
Sea-salt	240-279+ 1970-2286	0.91-1.10+ 5.9-6.9	1.4-1.5, 1.1
Fine ss*	308-348	1.10-1.27	1.3-1.4

*Without sea-spray organic enrichment

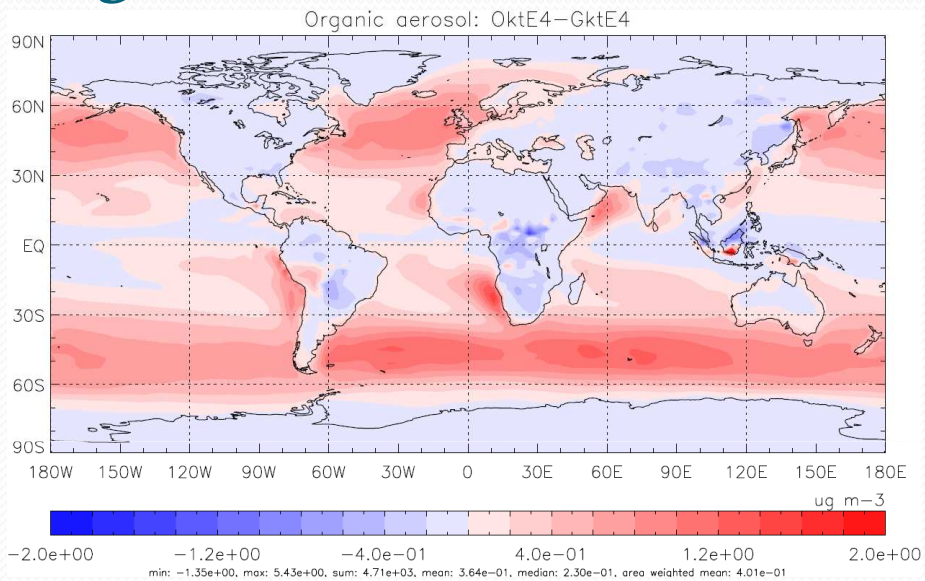
Tracer	Source ($Tg\ a^{-1}$)	Burden (Tg)	Lifetime (days)	Reference
Sea-salt	6297			Vignati et al., 2010
Sea-salt	6290	2.4		Myriokefalitakis et al., 2010
Sea-salt	59+2229	0.3+5.9	1.03, 0.5	Jaeglé et al., 2010
Oceanic OA	8.2	0.05	2.2	Vignati et al., 2010
Oceanic OA	7-8	0.12	4.5	Myriokefalitakis et al., 2010
Oceanic OA	8 ($TgC\ a^{-1}$)			Spracklen et al., 2008
Oceanic OA	75 ($TgC\ a^{-1}$)			Roelofs, 2008
Oceanic OA	22.3 ($TgC\ a^{-1}$)			Gantt et al., 2009

Aerosol concentration changes

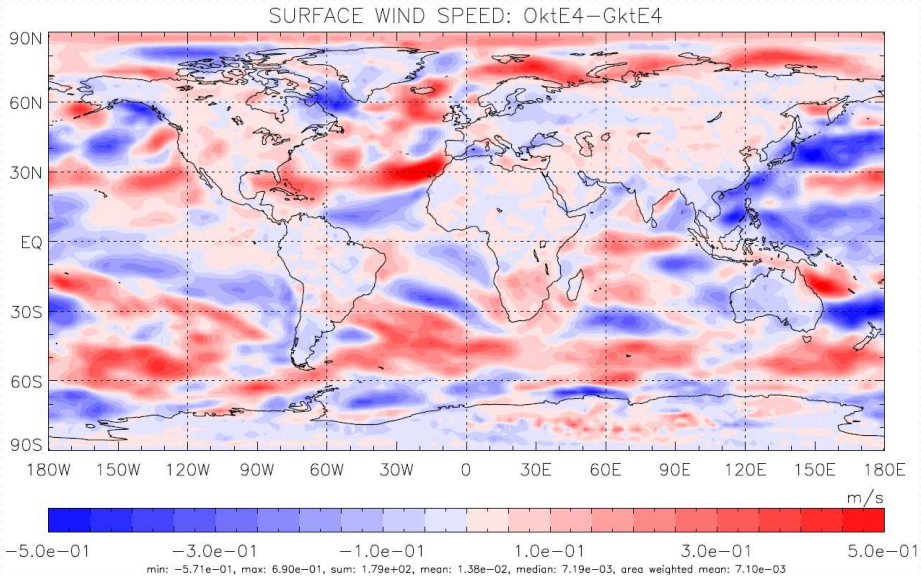
Sea salt



Organic aerosol

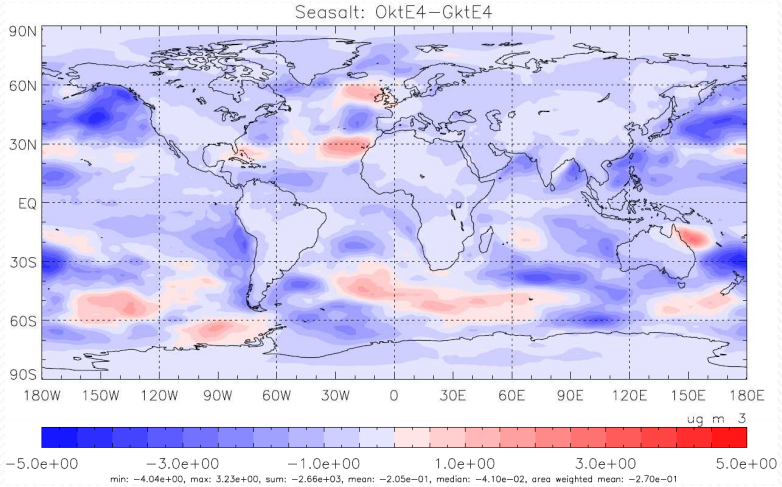


Wind speed

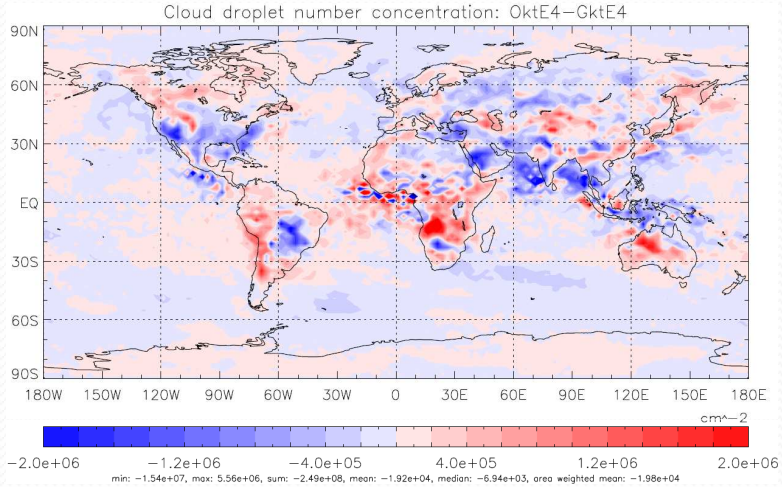


Effect on clouds

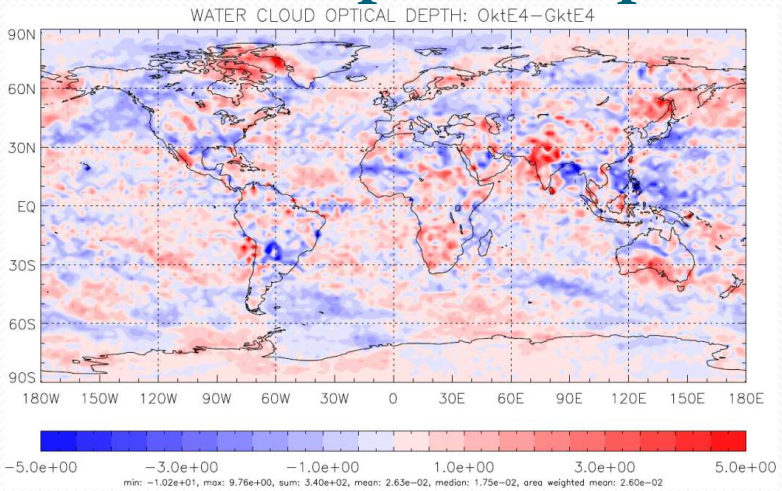
Seasalt



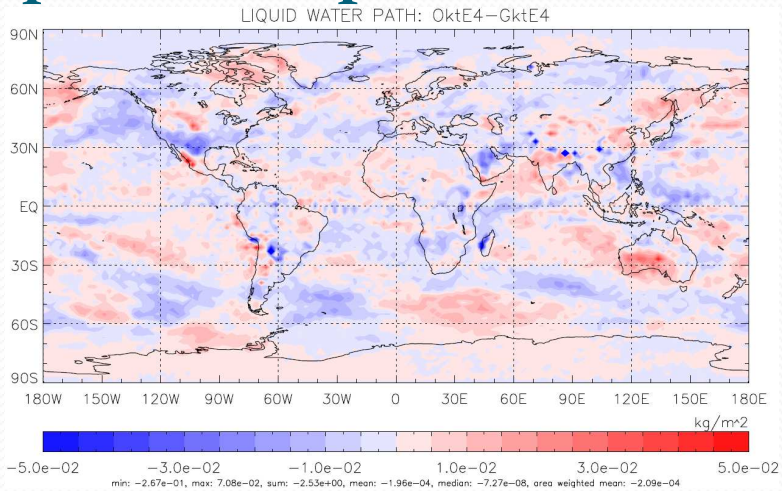
CDNC



Water cloud optical depth



Liquid water path



Pending questions

- Hygroscopicity of the mixed aerosol
- Mixing state
- Aging of organics
- Volatility
- Coupling with oceanic biology

Concluding remarks

- Oceanic sources
  - Sea-spray source very important on oceanic OA flux
  - Oceanic OA source is very uncertain and differs by an order of magnitude between models; sea-salt source is among the ones to blame

- Effects on climate
  - Oceanic OA affect winds, affecting sea spray source, affecting oceanic OA
  - Sea spray changes and OA presence affect CDNC, affecting clouds, affecting sea salt and oceanic OA removal