

Primary Marine Sources of CCN

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Task: Primary Marine Sources of CCN

- 1) Distribution of number concentration and composition with dry size of emitted particles
- 2) Dependence of emission rate on surface water and atmospheric conditions

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- 1) Distribution of number concentration and composition with dry size of emitted particles

$dN/d\log d_{\text{dry}}$ (or $dN/d\log r_{80}$) as a function of composition

- 2) Dependence of emission rate on surface water and atmospheric conditions

$dF_{\text{eff}}/d\log r_{80}$ as $f(\text{environmental factors})$

Sources of Marine Primary Particles

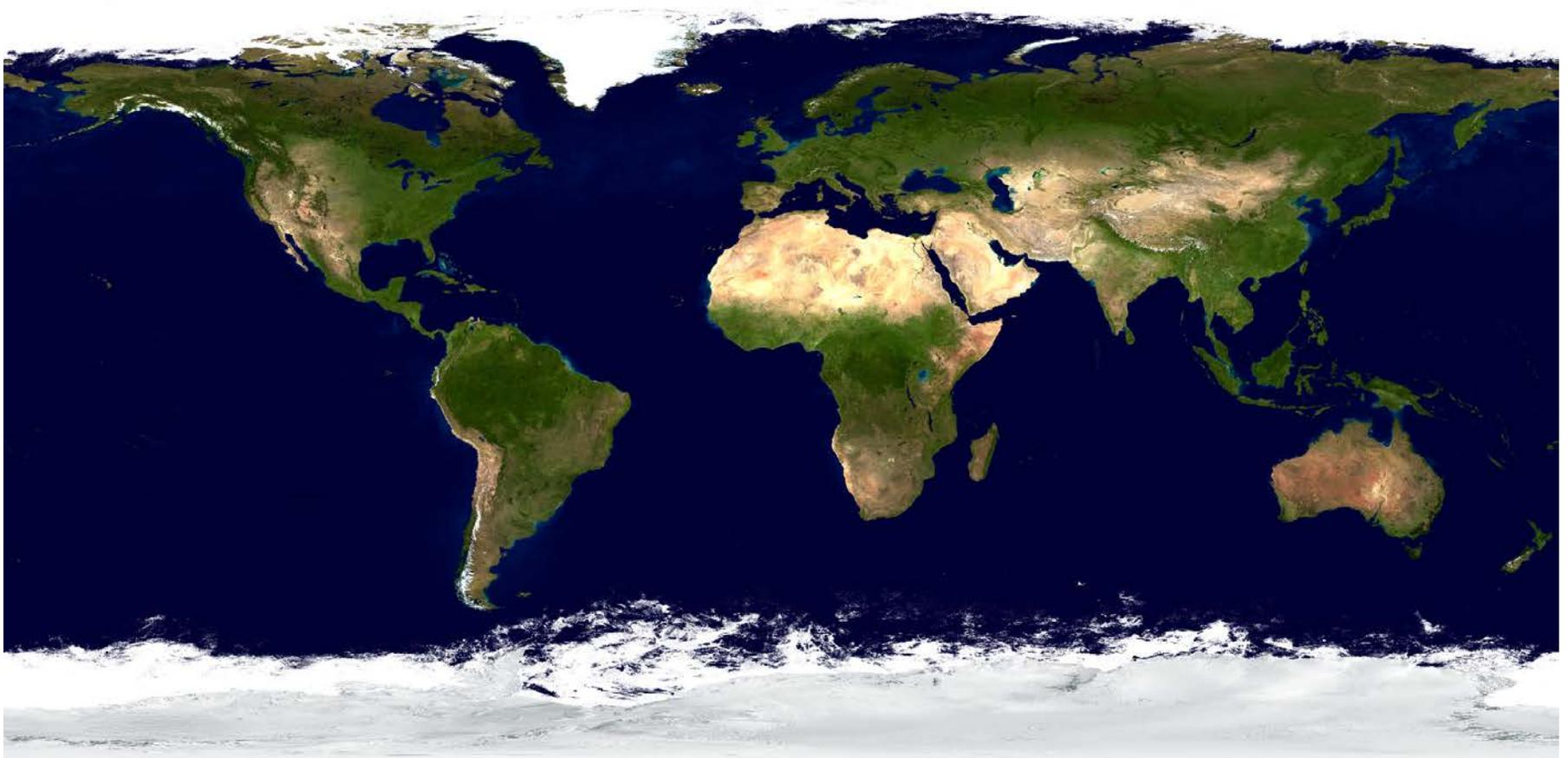


Natural



Anthropogenic

Oceans Cover 70% of Earth's Surface



Factors Affecting Particle Production from Ocean Surface

Wind speed (major factor; most parameterizations based only on this)

"Sea state" (whatever that may mean)

Composition (i.e., organics)

Sea temperature

Atmospheric stability

Lots of other factors often listed that probably aren't important (i.e., salinity) and are difficult to quantify

Little confidence in any given dependence on these factors.

Marine Particle Concentration

Concentration is the cumulative effect of:

- production
- transport
- processing
- removal

and thus may have little relation to local conditions.

Attempts to infer production flux from measured concentration will have additional uncertainty from these other processes.

SSA (2004 viewpoint)

Lewis and Schwartz, Sea Salt Aerosol Production, 2004:

"**Sea salt aerosol** is defined as that aerosol component consisting of **seawater drops and dry sea salt particles**."

$r_{80} = 0.1-1 \mu\text{m}$

total sea salt number concentration $\sim 10 \text{ cm}^{-3}$

large contribution from other aerosol types

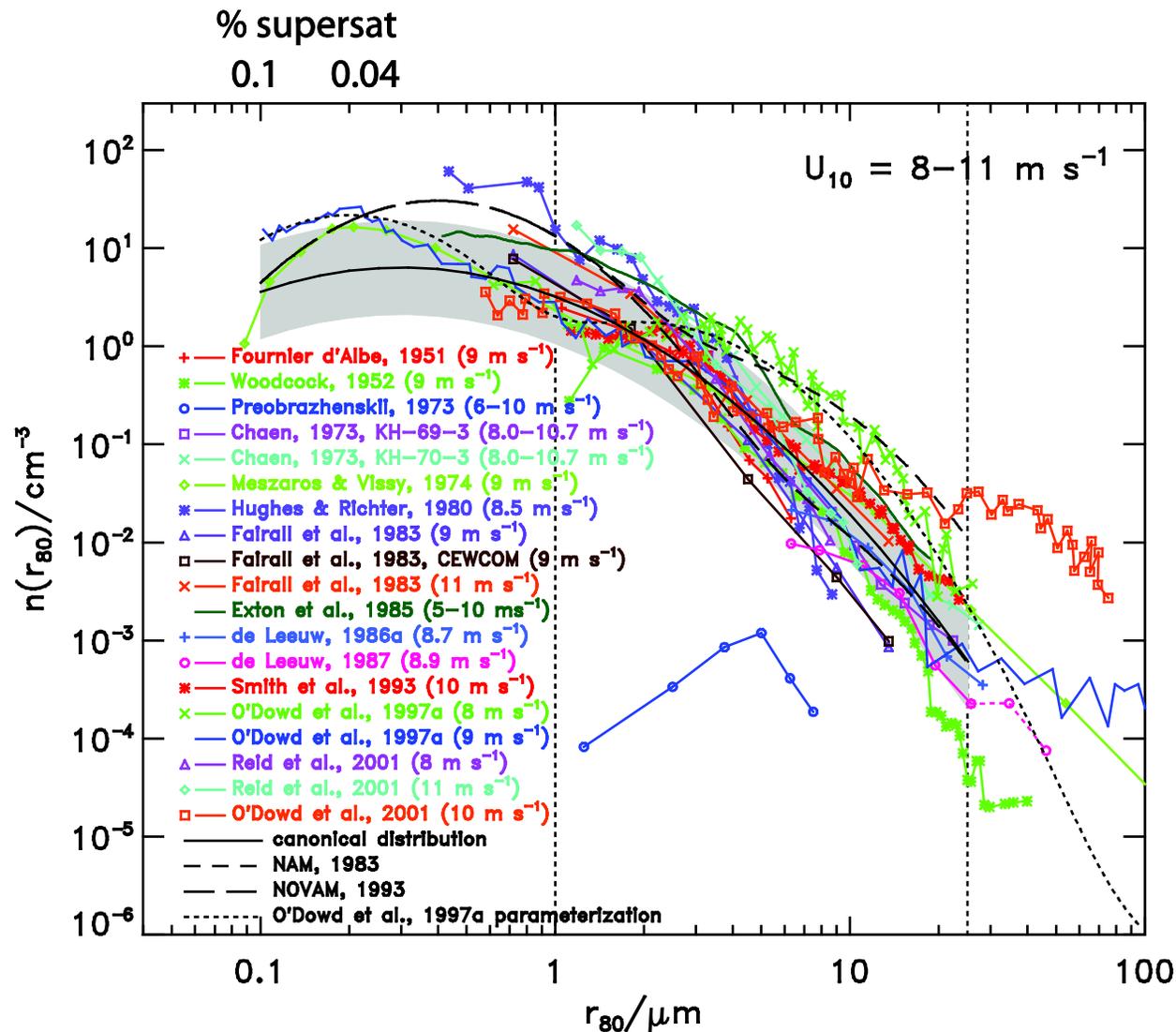
$r_{80} < 0.1 \mu\text{m}$

low sea salt number concentration

sea salt not dominant component

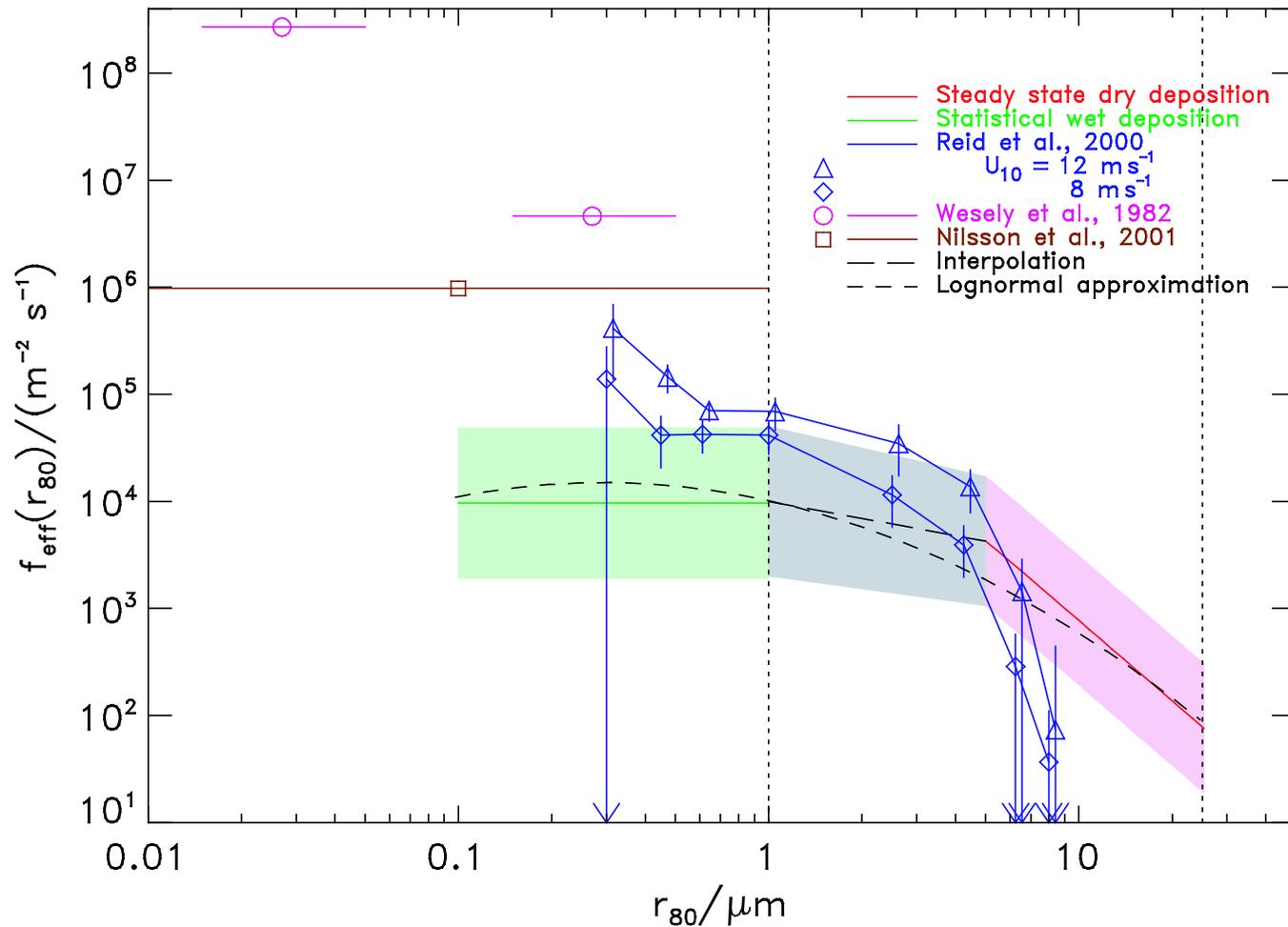
and thus sea salt is not very important in this size range

Sea Salt Concentrations (2004)



Concentrations have large (order of magnitude) spread at same wind speed.

SSA Production Flux Estimates (2004)



Large uncertainties in flux estimates (ranging over > an order of magnitude).

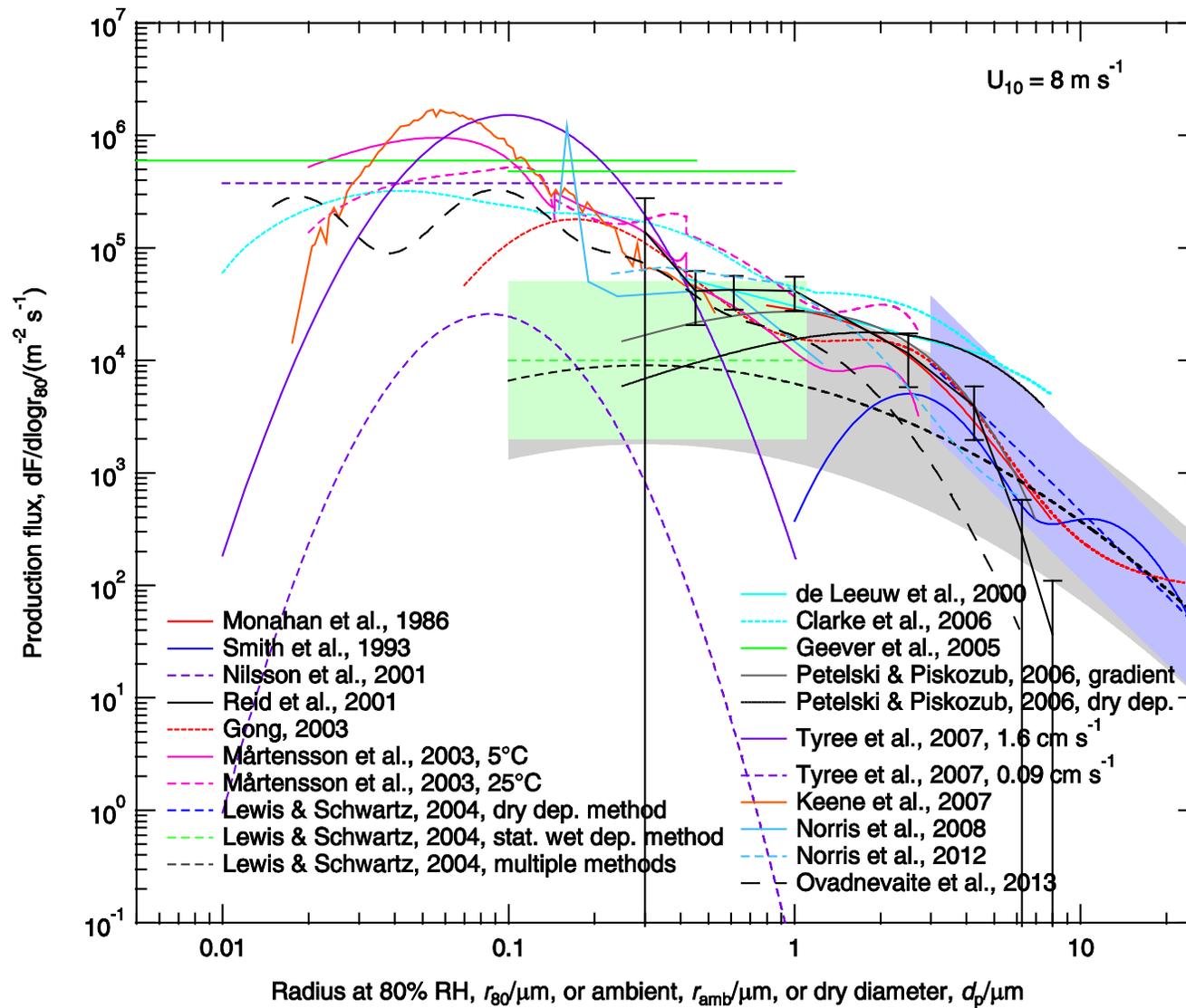
SSA (> 2008 viewpoint)

O'Dowd et al., *Geophys. Res. Lett.*, 35, 01801, 2008

"... we should define **sea-spray** as the hydrated droplets encapsulating **dissolved sea-salt** and **entrained organic matter**."

Thus, "sea spray" = "sea salt" + organics!

SSA Production Flux Estimates (2014)



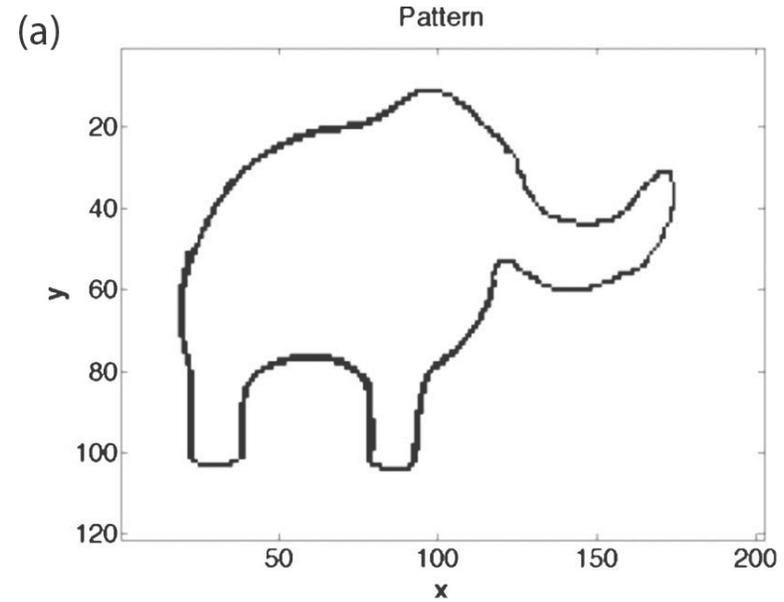
Even greater range in flux estimates!



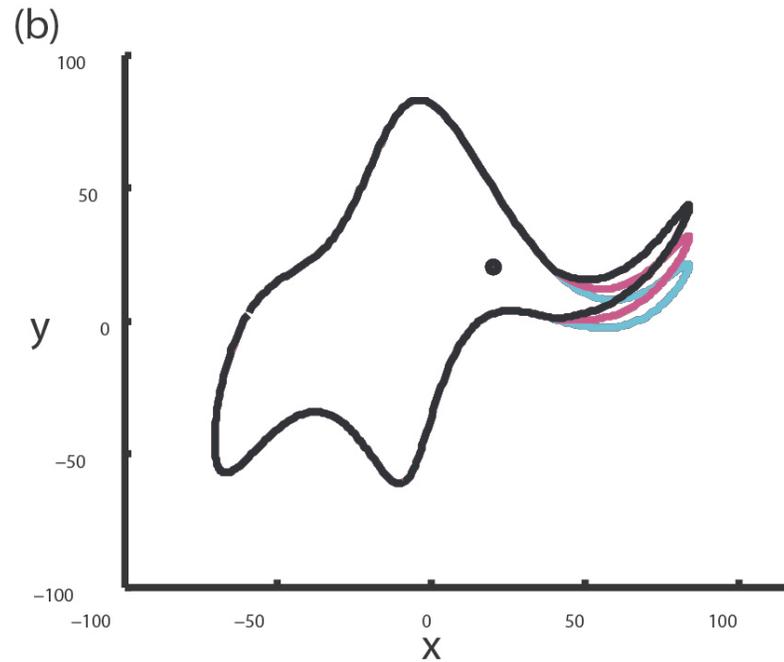
"With four parameters I can fit an elephant;
with five I can make him wiggle his trunk"

John von Neumann

pattern →



5 parameters →



Mayer et al., American Journal of Physics, v. 78, 2010

Simple Budget

Number production flux = $10^6 \text{ m}^{-2} \text{ s}^{-1}$

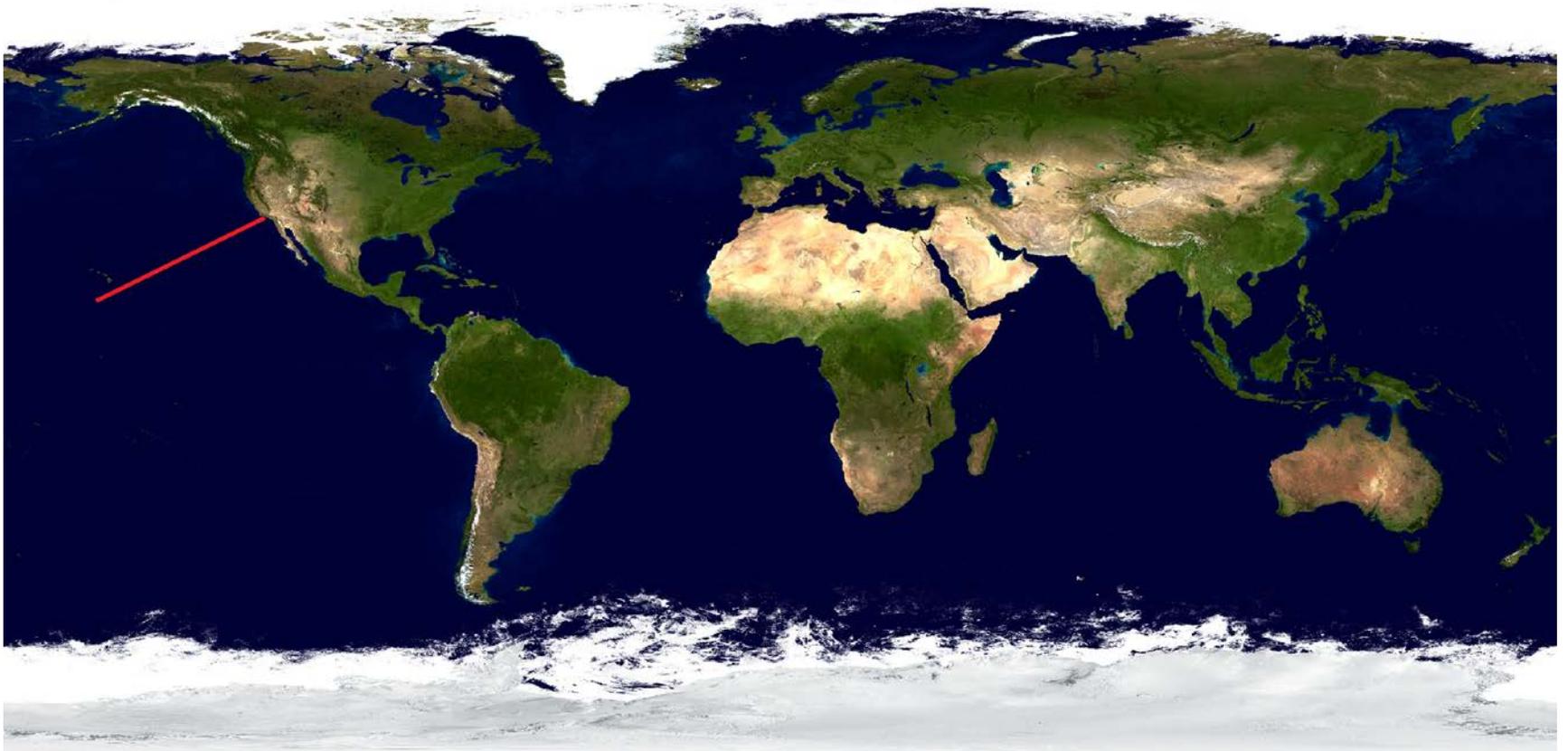
+

Uniformly distributed over an MBL of height 1 km

=

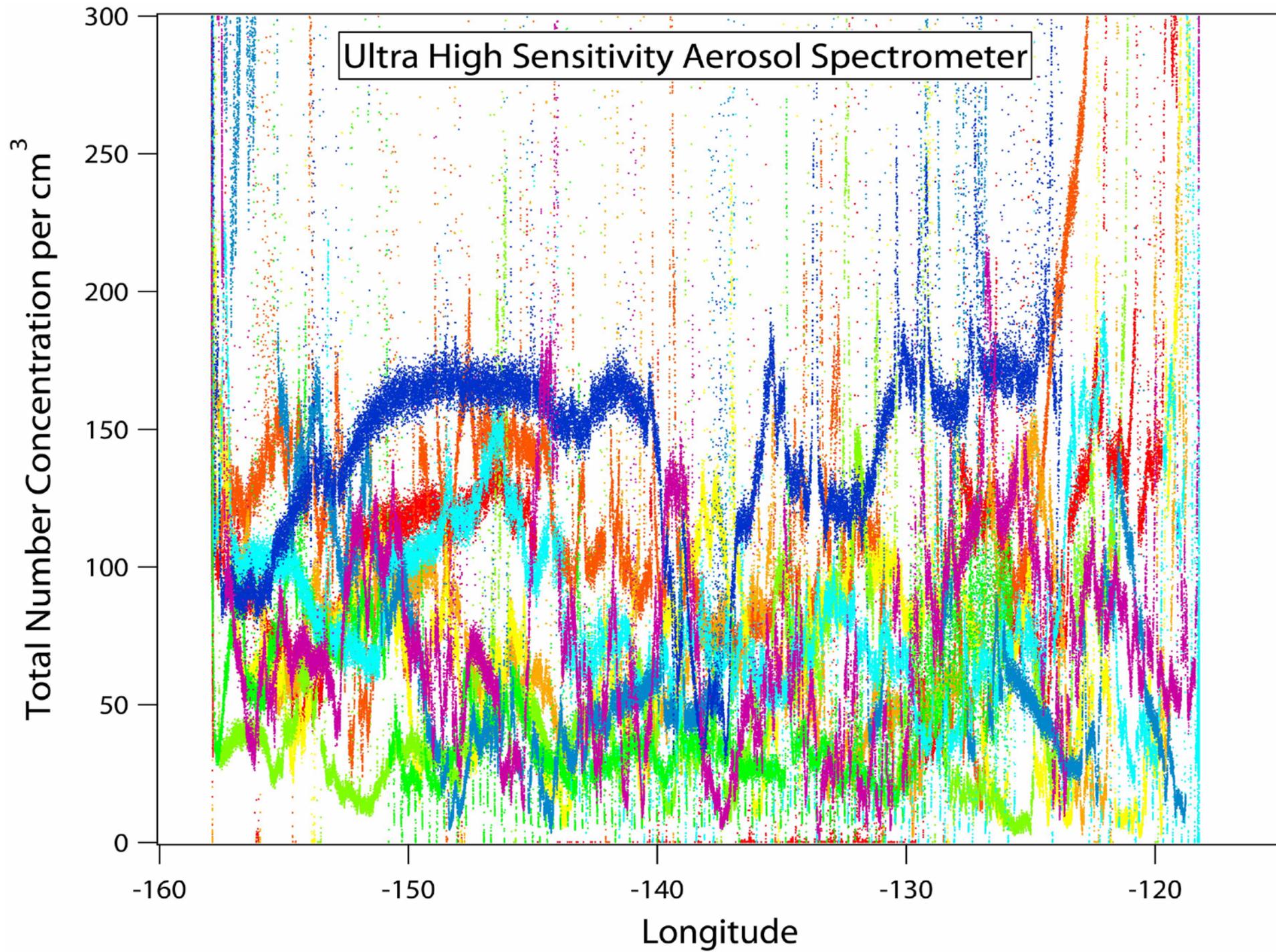
Daily increase in concentration of $\sim 100 \text{ cm}^{-3}!!!$

MAGIC



HORIZON LINES





Aerosol Samples Collected During MAGIC

~75 24-hr samples and ~50 3-hr samples were collected

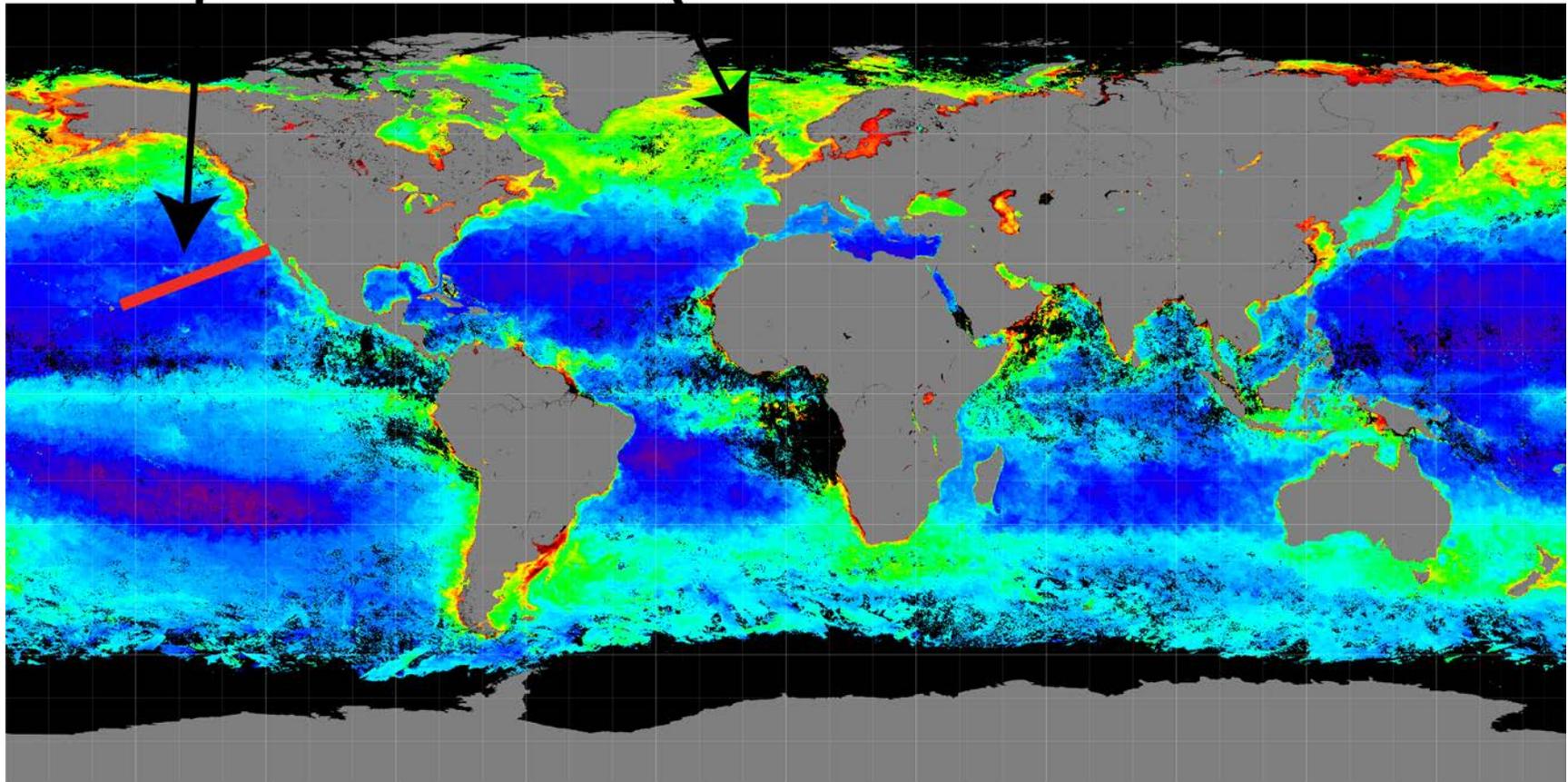
Unfortunately, these analyses weren't funded by ASR.

Final Thoughts

MAGIC

Mace Head

September, 2014



Chlorophyll a concentration (mg / m³)

