	Reference	*Scientific Approach (model, lab, field, etc.)*	*Key Findings*
05/03/12	Charlson et al., 1987	Review – field observations, theory, to address the marine biological regulation of the climate system	Assuming only sulphuric acids and sulphate aerosols are significant contributors to CCN in MBL, and excluding anthropogenic emissions, marine DMS is predominantly responsible for CCN concentrations. SS concentrations at cloud heights are too low to represent substantial fraction of CCN. Organics are present, but mass is ~10% of NSS-SO4. **CLAW:** Increase in DMS from warmer temps → +NSS-SO_4 →+CCN → +N (while LWC held constant) → +Albedo → -Temp/-solar irradiance below cloud. **"It seams likely that DMS fluxes would inc CCN populations"**
05/03/12	Russell et al., 1999	Model – modified Pandis et al., 1994 model to follow DMS, SO_2, H_2SO_4, nucleation mode, and CCN in MBL for precipitating and non-precipitating clouds.	Linear dependence exists between CCN and DMS fluxes for typical clean MBL conditions. The system is not linear for low DMS fluxes due to scavenging of H_2SO_4 by sea salt aerosols. **Support for or against the CLAW hypothesis is subjected to uncertainties in nucleation rates and accommodation coefficients of H_2SO_4.**
05/03/12	Quinn & Bates, 2011	Review - 20 years of field observations, experiments, and model calculations to address the validity of the CLAW hypothesis	CLAW hypothesis was based on three assumptions: 1. Non-sea-salt sulphate was ubiquitous to marine aerosol 2. Sea salt aerosol was insignificant source of CCN 3. Organic aerosol was not considered at the time**. Twenty years of observations in MBL suggests that CLAW should be retired**: 1. Particle formation via DMS-derived sulfate contributes to CCN via nucleation in free troposphere (not MBL) and results in spatial decoupling of DMS production and CCN in MBL. 2. Sea salt makes up a large fraction of MBL CCN (50-60%). 3. Dissolved organic matter in ocean is a source of organic aerosol in MBL via: bubble bursting and sea-spray aerosol.

	Reference	*Scientific Approach (model, lab, field, etc.)*	*Key Findings*
(+ CLAW)	Shaw, 1983: "Bio-controlled thermostasis involving the sulfur cycle" *Climatic Change*	Theory, Climate Sensitivity "model"	Gaia Hypothesis – unspecified biological mechanism (proposed CO_2 regulation) of **thermostasis that has stabilized the terrestrial climate system, even when sun's radiant output has increased 25% since life emerged on the planet**. Proposed sulfate aerosol from DMS oxidation can regulate climate: particles with 0.1 um radius provide strongest interaction with sunlight per unit of mass, and this particle size also remains in the atmosphere for the longest time.
(- CLAW)	Schwartz, 1988; "Are global cloud albedo and climate controlled by marine phytoplankton?" *Nature*	Review of field measurements in NH and SH, DMS and SO_2 budgets, and global mean albedo in NH and SH.	Anthropogenic SO_2 emissions exceed DMS by a factor of 2 and confined largely to the NH for the past century. Sulfate concentrations in aerosol, precipitation, and ice cores in the remote NH exceeds those of the remote SH. Features in cloud albedo and temperature trends in the NH if sulfate aerosol is regulating climate. NH did not have enhanced cloud albedo relative to the SH, nor was there a cooling trend in the NH. **If anthropogenic sulfate does not control albedo, by extension neither will DMS emissions.**
(- CLAW)	Yoon & Brimblecombe, 2002: "Modeling the contribution of sea salt and DMS derived aerosol to marine CCN" *ACP*	Model – Adapted Pandis and Russell model → CCN in MBL was modeled from: DMS flux, sea salt emission, and aerosols entrained from free troposphere	Accommodation coefficient of H_2SO_4 is an extremely important parameter in modeling contribution of DMS to MBL CCN. Relationship between DMS and MBL CCN is non-linear due to mass transfer of H_2SO_4 onto SS CCN and FT CCN. SS CCN and FT CCN affected MBL CCN directly by supplying CCN and indirectly by providing a condensation sink for H_2SO_4. **SS CCN and FT CCN are more important sources of CCN in MBL than DMS CCN (only important in pristine regions with very low wind speeds).**

	Reference	*Scientific Approach (model, lab, field, etc.)*	*Key Findings*
(- CLAW)	Cavalli et al., 2004; "Advances in characterization of size-resolved organic matter in marine aerosol over the North Atlantic" *JGR*	Field- Mace Head, 2002, coinciding with seasonal phytoplankton blooms in North Atlantic	Submicron WSOC was found to be > nss-SO_4, suggesting the importance of organics as CCN in the clean MBL. **Total organic carbon fraction increases dramatically as particle diameter decreases.** WIOC is attributed to hydrophobic organic matter that accumulates in the surface film of the ocean and is transferred to the atmosphere via bubble bursting processes. **Overall, submicron soluble and insoluble organic carbon, along with sea alt, will largely contribute to CCN in the MBL**.
(+ CLAW)	Meskhidze & Nenes, 2006; "Phytoplankton and Cloudiness in the Southern Ocean" *Science*	Remotely sensed data (MODIS) over the Southern Ocean and a cloud parcel model to investigate isoprene SOA on CDNC.	CDNC was doubled and R_{eff} was reduced by 30% over biologically productive regions of the Southern Ocean. Change in CDNC and R_{eff} was the result of biological productivity and not changes in meteorological conditions (i.e wind speed → sea salt/ sea spray). Bloom conditions resulted in TOA short-wave radiation forcing of -15 W m^{-2}**. It was proposed that isoprene SOA accounted for changes in cloud properties over the bloom (up to 60% CDNC), and a cloud parcel model verifies.**
(- CLAW)	Vallina et al., 2007; "Weak response of oceanic DMS to upper shoaling induced by global warming" *PNAS*	Model – Ocean General Circulation Model coupled to a biogeochemistry model for a 50% increase in CO_2 to characterize DMS fluxes in a warming world.	DMS fluxes increase with solar radiation dose (SRD) and not temperature. Therefore, in a warming world, DMS concentrations will increase, as shoaling of ocean mixed layer will enhance. Model indicates on a global average, a DMS production increase of 1.2%, with summer conditions increasing to 1.8%. **DMS-climate feedback is temporally mismatched with global warming time scales. Instead, any sort of DMS-climate feedback will occur on a seasonal scale and < -0.3 W m^{-2}.**

	Reference	*Scientific Approach (model, lab, field, etc.)*	*Key Findings*
(-/+ CLAW)	Thomas et al., 2011: "Rate of non-linearity in DMS aerosol-cloud-climate interactions" *ACP*	Model – ECHAM5-HAMMOZ: end-to-end aerosol chemistry-cloud microphysics link (Southern Ocean with minimal anthropogenic influence)	**Doubling DMS emissions in current climate scheme results in non-linear responses to SO_2 and H_2SO_4 burdens due to inadequate OH oxidation**. H_2SO_4 increased by 28%, CDNC increased by 25% and resulted in an R_{eff} decrease of 3.4%: annual mean radiative forcing at TOA of -1.4 W m^{-2}.