

# SOAP

*compiled by Cliff Law*

Notes:

Reporting Period is January 2011 – December 2011

Information will be used for: reporting, fundraising, networking, strategic development & outreach

## 1. Key scientific SOLAS-relevant highlights/findings (you may include figures and references)

Secondary organic aerosol in the Southern Pacific Ocean

Marine biologically active regions are known to produce a range of compounds that interact with the atmosphere directly and indirectly affecting particle production, composition, and properties in marine atmosphere. While the CLAW hypothesis (Charlson *et al.*, 1987) suggests the importance of marine biological activity in ultrafine ( $d < 100\text{nm}$ ) particles composition and the potential importance of secondary sulphate production, this hypothesis does not take into account the secondary organic fraction in the composition of the ultrafine particles. To date, observations of the presence of a marine origin secondary organic fraction in ultrafine particles have been indicated down to nucleation mode size particles ( $d < 15\text{nm}$ ) in Atlantic coastal waters (Vaattovaara *et al.*, 2006), ice edge waters in the Arctic (Vaattovaara *et al.*, ICNAA 2009), and sub-tropical Pacific Ocean waters (Modini *et al.*, 2009). In spite of the importance of secondary particles to atmospheric radiatively active sizes, the composition of marine produced particles is still uncertain in other marine biologically active locations around the world.

This study of the composition of nucleation ( $d < 15\text{nm}$ ) and the lower end of Aitken ( $20\text{nm} < d < 60\text{nm}$ ) modes particles is focused on particle production at one such region, at the Chatham Rise (New Zealand; latitude  $42^{\circ}\text{S}$ - $44^{\circ}\text{S}$ , longitude  $174^{\circ}\text{E}$ - $177^{\circ}\text{W}$ ) during the PreSOAP (Pilot Surface Ocean Particle Production) voyage during the austral summer. The region of the southern Pacific Ocean includes a sub-tropical front characterised by intensive austral summers phytoplankton blooms. The ultrafine particles composition was studied using the UFO-TDMA and the VH-TDMA methods onboard the RV Tangaroa (NIWA, Wellington, New Zealand). Auxilliary data were collected from the ship weather station and marine information observations, SMPS particle distribution measurements, total particles count CPC measurements with 5 nm and 10 nm cut-off sizes, and black carbon measurements. Marine biological activity was established using MODIS satellite data, and supported by a range of *in situ* parameters including chlorophyll and dissolved DMS. Marine air masses origin was followed with HYSPLIT trajectories.

The TDMA measurements showed nucleation and Aitken mode sized particles including a clearly detectable organic fraction. During intensive solar radiation periods secondary organic contribution is highly probable in those ultrafine particles. Furthermore, the comparison between *in situ* bubble burst chamber and atmospheric particles composition measurements strongly support a secondary origin of the atmospherically observed ultrafine particles. Comparison with the secondary organic fraction observations on Atlantic, Arctic, and Pacific oceans reveals that although the secondary organic fraction clearly exists in ultrafine particle phase, the properties of the fraction can be dependent on the marine area conditions.

P.Vaattovaara, L.Cravigan, N.Talbot, G.Olivares, C.Law, M.Harvey, Z.Ristovski and A.Laaksonen. Secondary organic aerosol on southern Pacific Ocean, EAC 2011, Manchester, UK, 4-9/9/11.

## 2. Activities/main accomplishments (research projects, cruises, special events, workshops,

**remote sensing used, model and data intercomparisons etc)**

The Pre-SOAP voyage was carried out in February 2011 as a pilot study for the 2012 SOAP voyage. Sampling strategy around the productive Chatham Rise region east of New Zealand was informed by ocean colour images, and determined in real time by underway data collection (chl-a, pCO<sub>2</sub>, pH, DMS, backscatter). Over 11 days three different types of phytoplankton blooms (diatom, dinoflagellate & coccolithophore – dominated), with unique biogeochemical characteristics, were sampled. Surprisingly, the coccolithophore bloom (high underway back-scatter, low pCO<sub>2</sub> & high Chl-a) had the lowest DMS signal. A number of instruments, sensors and sampling designs were successfully trialled during PreSOAP. Of particular note were the performance of the in-line sensor suite, real-time output on the ships DAS system, the SCD-GC for measuring atmospheric DMS, the aerosol particle size suite which identified several pulses of new particle formation, the flux catamaran for measurement of CO<sub>2</sub> and DMS flux at distance from the ship, new microlayer sampling techniques, and the identification of ultrafine particle formation including an organic fraction in shipboard measurement and bubble burst experiments with detection by TDMA (see above highlight).

**3. Human dimensions (outreach, capacity building, public engagement etc)**

**4. Top 10 publications in 2011 (Reports, articles, models, datasets, products, website etc)**

P.Vaattovaara, L.Cravigan, N.Talbot, G.Olivares, C.Law, M.Harvey, Z.Ristovski and A.Laaksonen. Secondary organic aerosol on southern Pacific Ocean, EAC 2011, Manchester, UK, 4-9/9/11.

Z.Ristovski, L.Cravigan, P.Vaattovaara, N.Talbot, G.Olivares, C.Law, M.Harvey, and A.Laaksonen Sea spray aerosol production via bubble bursting during the Surface Ocean Aerosol Production (SOAP) study. EAC 2011, Manchester, UK, 4-9/9/11.

C. Law et al. 2011. Surface Ocean Aerosol Production pilot study (Pre-SOAP) Voyage report (TAN1102). NIWA Internal Report.

**5. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities etc)**

Planning for SOAP voyage in February 2012, with international participation:-

NIWA (NZ), QUT, CSIRO (Australia), UEF (Finland), UC Irvine, U Chapman (USA), IfM-Geomar (Germany) and U. Laval (Canada).

**6. Goals, priorities and plans for future activities/events**

Completion of SOAP voyage in February 2012, with presentation of selected data at the SOLAS OSC in May 2012.

**7. Other comments**