Scientific Report

Both scientists on this proposal (visiting: Dr. Brian Ward and host: Dr. Ilan Koren) are members of the Surface Ocean Lower Atmosphere Study (SOLAS) Scientific Steering Committee (SSC), and have developed a collaboration to advance SOLAS science using remote sensing tools.

This scientific report describes the activities that occurred during the STSM COST-STSM-ECOST-STSM-ES1402-280117-082331.

Day 1: Saturday January 28th

The visiting scientist (VS) traveled to Israel from Galway. Total travel time door-to-door was 14 hours and included travel by bus, plane, and car.

Day 2: Sunday January 29th

The VS presented a seminar to the Department of Earth and Planetary Science at the Weizmann Institute in their department seminar room. The VS was introduced to the Weizmann scientific community by the host scientis (HS).

The seminar was concerned with the air-sea fluxes of freshwater, and a summary of the presentation is as follows:

- **The Global Water Cycle is largely an ocean-atmosphere flux phenomenon with salinity a key indicator**
  - Most of the water cycle occurs over the oceans
  - Contain most of the water - 97%
  - Provide most of the evaporation - 86%
  - Experience most of the precipitation - 78%
  - A warmer atmosphere will carry more water vapor and an enhanced water cycle will change the distribution of salinity
- **Rain over the ocean**
  - Water fluxes much harder to quantify than heat due to spatial heterogeneity of atmospheric forcing – heat is uniform but water is associated with patchy cells
  - The salinity depression produced by rainfall is not only dependent upon the rainfall rate and duration but also **mixing due to turbulence**
  - Freshened surface water from rainfall might be freshened again by precipitation events before it recovers to its original salinity value – results in individual rain-induced low salinity water pools
- **Air-Sea Interaction Profiler**
  - Near-surface processes are diffcult to measure
  - Satellite observations of the ocean are restricted to the surface e.g. the optical pentration depth for salinity is $O(1\text{ cm})$

  - Standard ocean instruments cannot measure the surface as they typically lowered from ships
  - *Air-Sea Interaction Profiler (ASIP)* was funded to capture the small-scale physics at the air-sea interface

- **North Atlantic Cruise R/V Knorr 2011**
  - 4 rain events were captured with two of them being significant i.e. > 30 mm/hr
  - A comparison was made between the two significant rain events (RE3 and RE4) and the ocean response
  - RE3 was nighttime with RE4 occuring around 11:00 local time.
  - For RE3, there was a freshening of about 0.1 ppt over the upper 15m, whereas for RE4 the freshwater stratified layer remained within the upper 2m
  - There was a distinct difference in the ocean dissipation rate, with RE3 appearing to have little effect on the mixing layer depth (XLD), but the XLD reduced from 10 to 3 m upon the onset of the rain
  - There was also a comparison between the mean diffipation profile over the upper 25m for periods before and after RE4, and there was a reduction by a factor of about 5. This could also be seen in a PDF of the dissipation from 15-30m.

- **Conclusions**
  - ASIP is an autonomous Lagrangian instrument which provides high resolution *snapshots* of the upper ocean
  - The penetration of rain and ΔS is dependent both on rain rate and availability of turbulence in the surface ocean
  - **Air-Sea freshwater fluxes increases surface stratification thereby inhibiting turbulence: this can significantly impact air-sea exchange of mass and energy**
  - Rain is a highly localised forcing parameter and therefore it is critical to have co-located ocean and atmosphere observations
  - Freshwater pools can remain on the surface for significant periods of time – residence time of freshwater controlled by mixing processes (wind, waves, convection)
  - Salinity trends indicate significant changes are underway in the global water cycle, which is primarily an ocean-atmosphere phenomena, therefore SOLAS-relevant

The VS met individually with scientists from Weizmann and discussed some of the aspects of the presented science.

Day 3: Monday January 30th

The VS met individually with scientists from Weizmann and discussed some of the aspects of the presented science. There was also discussion with the group members of the HS, and a fruitful exchange of ideas.

Day 4: Tuesday January 31st

The VS spent the day with the HS and his group members in order to plan a workshop that will be concerned with implementing remote sensing tools for the explitation of SOLAS science. This workshop will be held in the USA in order to establish collaborations with scientists from NASA. Funding for this workshop has been provided by ESA as support to Future Earth, of which SOLAS is a core project.

Day 5: Wednesday February 1st

The VS and HS caught a flight to the Inter University Institute in Eilat. A seminar was presented by the VS at 12:00. This was followed by a lunch meeting with the PhD students at IUI who had an opportunity to discuss the scientific presentation. The remainder of the day was spent discussing topics of mutual interest with the faculty of IUI.

Day 6: Thursday February 2nd

The VS and HS spent the day at IUI in meetings with the faculty of the IUI and it was decided that we would look into oportunities for funding to conduct a field experiment in the Red Sea to capture the transition of the deep winter mixed layer to a thermally stratified situation, which occurs in early spring.

Day 7: Friday February 3rd

The VS returned to his home country using taxi, planes, and bus. The journey consumed 17 hours.