RV *Investigator* Voyage Scientific Highlights

Voyage #:	**IN2019_V06**		
Voyage title:	Tropical observations of atmospheric convection, biogenic emissions, ocean mixing, and processes generating intraseasonal SST variability		
Mobilisation:	Darwin, 18-19 October 2019		
Depart:	Darwin, 2000 LT, 19 October 2019		
Return:	Darwin, 0630 LT, 17 December 2019		
Demobilisation:	Darwin, 17 December 2019		
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Chief Scientist:	Susan Wijffels (Leg 1) Alain Protat (Leg 2)		
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Principal Investigators:	Matthew Wheeler, Charmaine Franklin, Eric Schulz, BoM Susan Wijffels, Ruhi Humphries, CSIRO Todd Lane, Robyn Schofield, Jason Monty, Alex Johnson, University of Melbourne Christian Jakob, Monash University Robin Robertson, Xiamen University Malaysia Zhiyu Liu, Xiamen University Fadli Syamsudin, BPPT, Indonesia Urip Haryoko, BMKG, Indonesia Po-Hsiung Lin, National Taiwan University, Taiwan Damien Callahan, Deakin university Zoran Ristovski, Queensland University of Technology		

Chief Scientist (Leg 1)

Dr Susan Wijffels, CSIRO Oceans and Atmosphere/Woods Hole Oceanographic Institution

Susan aims to quantify and understand the role of the ocean in climate, key aspects of the large-scale ocean circulation and global ocean change. She also is recognised for her contributions to the design, implementation and exploitation of the Global Ocean Observing System (GOOS). Susan received a B.Sc. Hons (First Class) from the Flinders University of South Australia in 1986, and a PhD in 1993 from the Massachusetts Institute of Technology – Woods Hole Oceanographic Institution's Joint Program in Oceanography and Oceanographic Engineering, USA. She was with the CSIRO's Marine Laboratory from 1994, becoming a principle senior researcher, before joining WHOI in July 2017. She currently has a joint appointment with CSIRO and WHOI.

During the voyage, Susan focussed on the mixing between Indonesian Throughflow and South Indian Ocean waters, as well as the dynamics of diurnal cycling in the upper ocean and its relationship to air-sea fluxes.

Chief Scientist (Leg 2)

Dr Alain Protat, Australian Bureau of Meteorology

Alain Protat leads the "Radar Science and Nowcasting" Team at BOM. He uses radars at different frequencies and on different platforms (ground, ship, aircraft, satellite) to better understand cloud and convection (storms) processes. He then exploits this better understanding of clouds and convection to evaluate and improve the representation of clouds and convection in numerical weather prediction and climate models. He has co-authored 134 peer-reviewed papers on these research themes (as of December 2019).

His main contributions to the project were to derive 3D winds from the two weather radars (Berrimah and RV *Investigator* OceanPOL) and to contribute to the understanding of processes responsible for the development and propagation of coastally-induced convection.

Title

Tropical observations of atmospheric convection, biogenic emissions, ocean mixing, and processes generating intraseasonal SST variability

Purpose

The objective of this proposal was to improve the parameterization of tropical moist convection in the atmosphere and vertical mixing driven by internal tides in the ocean, which are still major road blocks for producing accurate daily to seasonal weather forecasts and climate predictions. Our associated observational aims were to:

1. Over a period of >30 days, in order to sample different phases of the Madden-Julian and/or other monsoon oscillations, extensively characterize the 3D mesoscale atmospheric dynamics of a target coastal location in Northern Australia that has a large diurnal cycle of precipitation.
2. Characterise in detail the diurnal through monthly evolution of the upper ocean and near surface structure at the target site to advance our understanding of atmosphere – upper ocean coupling.
3. Construct detailed datasets of clouds, air-sea fluxes and atmospheric turbulence and make all datasets available to the international Years of Maritime Continent (YMC) science community, to expedite progress in improving parameterizations of convection, clouds, and the boundary layer.

Contribution to the nation

Results from this voyage will provide the fundamental scientific knowledge upon which our weather forecasting and climate models will be improved to better simulate tropical convection and ocean – atmosphere coupling, with a focus on storms forming and growing over land into mesoscale convective systems (=bigger storms) and subsequently propagating offshore for hundreds of kilometres.

As a result of this voyage

1. We have collected unprecedented oceanic and atmospheric observations in this tropical region.
2. We have launched an unprecedented number of soundings to capture the basic atmospheric state in which storms are forming in this region.
3. We have found that current models correctly simulate the formation of convection over land but not the upscale growth and propagation offshore.
4. We have developed a suite of radar tools to post-process and display in real-time RV *Investigator* OceanPOL data on board and on shore.
5. In-the-field training has been provided to 19 Ph.D. students.
6. We captured detailed observations of diurnal warming and a strong buildup of heat in the near surface ocean under low wind/clear sky conditions typical of the build up to the monsoon convection.
7. We measured ocean dissipation, shear and through a spring-neap tidal cycle along the Australian shelf break.
8. We collected unique observations in the coastal regions off the Tiwi Islands, which are of interest for biological and tidal power impacts.

9. We measured extensive trace gas and aerosol characteristics in a variety of tropical conditions, including both continental outflow and convective regimes.
10. We made important measurements for the cross-validation of RV Investigator's GAW station with those of the NT Baseline Air Pollution (GAW) Station at Gunn Point.
11. We collected live phytoplankton cultures and successfully isolated unialgal cultures while on-board for further studies of biogenic emisions and have created a living phytoplankton bio-bank from this region.
12. We collected a wide range of biological samples for metagenomics from both Legs.