1.

1. **Ship name**: Falkor
2. **Cruise Dates - Day Departed**: 11/20/2019
3. **Cruise Dates - Day Returned**: 12/22/2019
4. **Cruise Number**: FK191120
5. **Departure Port**: Suva, Fiji
6. **Arrival Port**: Suva, Fiji
7. **Mid-Cruise Port Call (if any)**: N/A
8. **Mid-Cruise Port Call (if any)**: N/A
9. **Participating Organizations, Institutions, Foundations, Government Agencies, etc.**:
   Lamont-Doherty Earth Observatory of Columbia University
   University of Oldenburg
   L3 Harris
   University of Massachusetts, Boston
   Georgia Tech
   San Francisco State University
   Gordon and Betty Moore Foundation
   Schmidt Ocean Institute
10. **Funding Sources**: Schmidt Ocean Institute (Development & Logistics)
    Gordon and Betty Moore Foundation
    Lamont-Doherty Earth Observatory of Columbia University
    Deutsche Forschungsgemeinschaft (DFG); RI3176/1-1; Carbon microcycle.
11. **Describe all of the geographical area(s) where the science occurred**: Within the regional box demarcated by 10 to 25 S, 175 E to 170W.
    We were mostly within the territorial waters of Fiji, Wallis and Futuna, and Tonga

12. **Name of Chief Scientist**: Christopher J Zappa
14. **Organization**: Lamont-Doherty Earth Observatory of Columbia University
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Name of Co - Chief Scientist: Ajit Subramaniam

22. **Organization**: Lamont-Doherty Earth Observatory of Columbia University
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13. **Cruise Objectives**:
31. Understanding physical, chemical, and microbiological processes related to atmosphere-ocean interaction in the presence of cyanobacteria (Trichodesmium) at a multitude of spatial and temporal scales using unmanned aerial vehicles (UAVs), drifters, remotely-operated surface vehicles (ROSVs), profiling spectrometers, surface spectrometers, and ship-based imaging systems.
14. **Cruise Summary**:

Our daily operation was to use satellite data to guide us to possible features of interest on the open ocean. The daily schedule highlighted the use of UAVs for reconnaissance to find features of interest that included a large temperature front, a discovery of floating pumice on the ocean surface likely the remnants of an undersea volcanic eruption near Tonga, and the discovery of a number of gigantic *Trichodesmium* blooms. Once we were able to target the feature of interest, we mobilized all the assets available and have the ship get to the targeted location to re-deploy the drifters and catamaran.

There were no complete days lost to weather or breakdowns. The catamaran had a broken vertical arm for one day, which was fixed and replaced for the next day. The Van Dorn sampler was leaking on two days. Sniffle did not have CO2 measurements the last two days; probably issue of power due to issues with charger. At the end, there were only completely lost days due to weather; on the days due to broken equipment, we continued with the other measurements.

Two days of UAV operations lost due to weather (Note all dates are UTC):

- 23 Nov – VNIR was flying but was brought down after 30 mins due to weather (rain)
- 17 Dec – RAD was ready to fly but was aborted before launch due to rain

Three science UAV days were lost due to lost/broken/delayed science party provided science equipment:

- 24 Nov – the issue with the fuel being too hot started, but at the time they didn't know the problem and it required a full day to troubleshoot
- 6 Dec – UAV had a late launch due to weather; it cleared up but then had a bad launch with the MET(when the foot broke) due to the ship being underway
- 17 Dec – PCC software had conflicting GPS-vs-commanded altitude and would not launch the UAV; this was a very nuanced issue that required a change in their launch SOPs

Shipboard (Infrared imaging, turbulent fluxes, radiative fluxes, SST, waves) & SPIP-2 drifting buoy systems lost no days due to weather or broken science equipment.

15. **Did you collect Measurements or Samples, including biological specimens?** Yes
16. **Did you deploy and/or recover any Moorings, Bottom Mounted Gear, or Drifting Systems?** Yes
17. **Equipment Used**: Types of samples and measurements Methods to be used Instruments to be used

    Sea surface temperature imagery with 8 um - 14 um longwave IR high-resolution imagery (1024 by 768) up to 30 Hz, with noise-equivalent temperature difference of 0.05 Â°C. Flying of Unmanned Aerial Vehicles (Latitude model HQ-90B) above the ocean surface equipped with infrared imaging instrument payload. Sofradir-EC Atom1024 LWIR Microbolometer.

    Surface visible imagery mapping in the 400 nm - 800 nm visible high-resolution swath up to 15 Hz. Flying of Unmanned Aerial Vehicles (Latitude model HQ-90B) above the ocean surface equipped with infrared imaging instrument payload. Imperx Bobcat 6MP Visible Camera

    Surface-emitted radiance (400 nm - 1000 nm) with horizontal 32Â° field-of-view (12mm), 10.5 mm slit length, 1.86 nm spectral resolution (601 bands), 1004 spatial pixels. Sky-emitted irradiance (350 nm - 1000 nm) Sky-emitted radiance (350 nm - 1000 nm) Total Surface Radiance (350 nm - 1000 nm) Flying of Unmanned Aerial Vehicles (Latitude model HQ-90B) above the ocean surface equipped with hyperspectral imaging instrument payload. Headwall Micro-HyperSpec VNIR A-Series Imaging Spectrometer. OceanOptics USB2000 Irradiance Spectrometer (Up-Looking). OceanOptics OceanFX Radiance Spectrometer (Up-Looking). OceanOptics OceanFX Radiance Spectrometer (Down-Looking).

    Net solar irradiance and albedo with 285 nm - 3000 nm shortwave hemispheric solar irradiance in W m-2 at fast 1 s response time. Net longwave/IR irradiance with 4.5 um - 40 um hemispheric longwave irradiance in W m-2 at fast 1 s response time. Surface visible imagery mapping with 400 nm - 800 nm visible high-resolution swath up to 15 Hz. Flying of Unmanned Aerial Vehicles (Latitude model HQ-90B) above the ocean surface equipped with the broadband radiation instrument payload. Hukseflux SR03 Pyranometer (Up- and Down-Looking) Hukseflux IR02 Pyrgeometer (Up- and Down-Looking) Imperx Bobcat 5MP Visible Camera

    Turbulent momentum flux using 3D Air Velocity at 100 Hz. Turbulent latent heat flux

using Water vapor at 100 Hz. Turbulent sensible heat flux using Air temperature at 50 Hz. Surface topography using distance ranging up to 500 m (Â±0.02 m) and up to 2 kHz Mapping capabilities, orthorectification of all imagery and MET datastreams using GPS Timing, Position, Angular Rotations & Rates, fiber-optic gyro IMU angle accuracy of 0.001 Â°, 100 Hz post-processed position with 5 cm accuracy. Flying of Unmanned Aerial Vehicles (Latitude model HQ-90B) above the ocean surface equipped with the meteorological flux instrument payload. Aeroprobe 5-port Gust Probe and Logger. Krypton KH20 Fast Response Hygrometer. Opsens OTG-F Temperature Probe. ULS LiDAR. Novatel OEM719 + KVH1700 IMU.

Turbulent momentum flux Turbulent sensible flux Turbulent latent flux Mean wind speed, air temperature, air pressure, humidity. Direct covariance technique deployed from a boomed mast at the bow of the ship. Bulk mean properties at same location. Continuous measurements CSAT-3 sonic anemometer and Licor 7500 hygrometer

Ocean skin temperature (calibrated and sky-corrected) Infrared Radiation Pyrometers mounted to the ship both up-looking and down-looking at 20-degree incidence angle for continuous measurement. Calibrated Wintronics model KT-15 pyrometers

Sea surface temperature imagery with 7.7-9.53 um longwave IR high-resolution (640x512) imagery up to 100 Hz with noise-equivalent temperature difference of 0.02 Â°C Ship-mounted from the sky bridge deck. Infra-Red (IR) camera was a long wave SOFRADIR-EC, INC; MiTie-640L High Performance Miniature Thermal I

Downwelling solar irradiance and albedo with 285 nm - 3000 nm shortwave hemispheric solar irradiance in W m-2 at fast 1 s response time. Downwelling longwave/IR irradiance with 4.5 um - 40 um hemispheric longwave irradiance in W m-2 at fast 1 s response time. Mounted to the main mast for continuous measurement. Kipp and Zonen model CMP22 pyranometer and model CGR4 pyrgeometer.

Surface topography using distance ranging up to 50 m (Â±0.02 m) and up to 2 kHz LIDAR mounted to the boomed mast at the bow of the ship for continuous measurement. Riegl model LD90-3100VHS LIDAR

Near-surface Temperature, Salinity, & Current Profile Bulk Atmospheric Measurements Drifting Spar Buoy NBOSI CT Sensor Seabird SBE37SMP CTD Sensor Nortek Aquadopp HR Current Profiler MaxiMet GMX541 Met Station

Sea surface microlayer sampling of temperature, salinity, CDOM, UV-absorbing substances, fluorescence spectra, chlorophyll-a, and photosynthetic parameters, and

photosynthetically active radiation. Remote-controlled surface catamaran-style vessel with rotating glass disk samplers of the sea surface microlayer using capillary action. Catamaran is equipped with flow-through sensors Catamaran takes discrete water samples from the SML and 1 m depth can be collected remotely in bottles placed in a rotating carousel (total 24 bottles) for detailed analysis. CTD

Measuring CO2 gas exchange rates and turbulence kinetic energy Floating chamber buoy with sensors (SNIFFLE: 100cm x 100cm x 200cm)

Hyperspectral surface reflectance and inwater multispectral light field Spectroradiometers Spectroradiometers

18. **Total number of CTD casts completed during the cruise: 35**
19. **Total number of AUV dives completed during the cruise:** 0
20. **Total number of ROV dives completed during the cruise:** 0
21. **Total number of ROV samples collected during the cruise:** 0
22. **Total number of Unmanned Aerial Vehicle (UAV) or other vehicle deployments during the cruise: 44 Flights with over 250 science hours using 3 UAVs.**
23. **Total amount (TBs) of data collected during the cruise: 42**
24. **Other interesting facts about the cruise: Encountered pumice that likely was produced by a recent undersea volcano eruption near Tonga and that drifted Westward.**