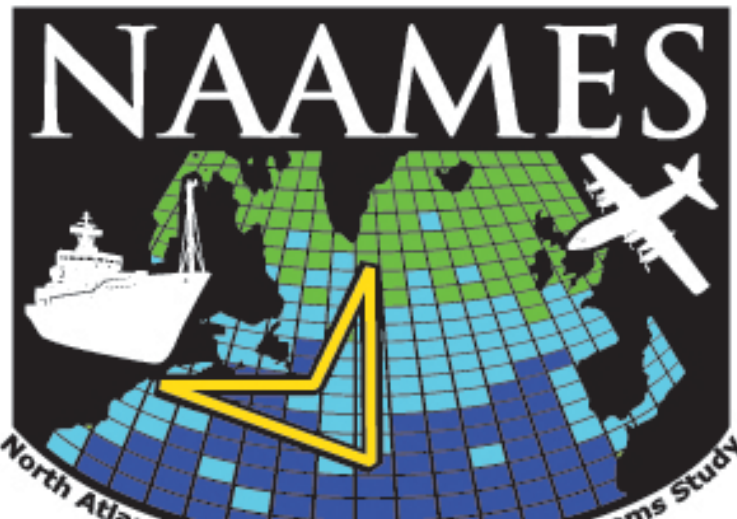
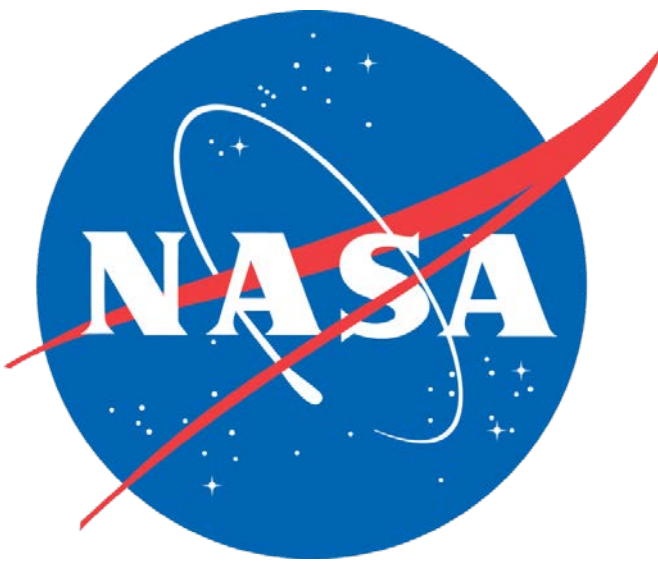




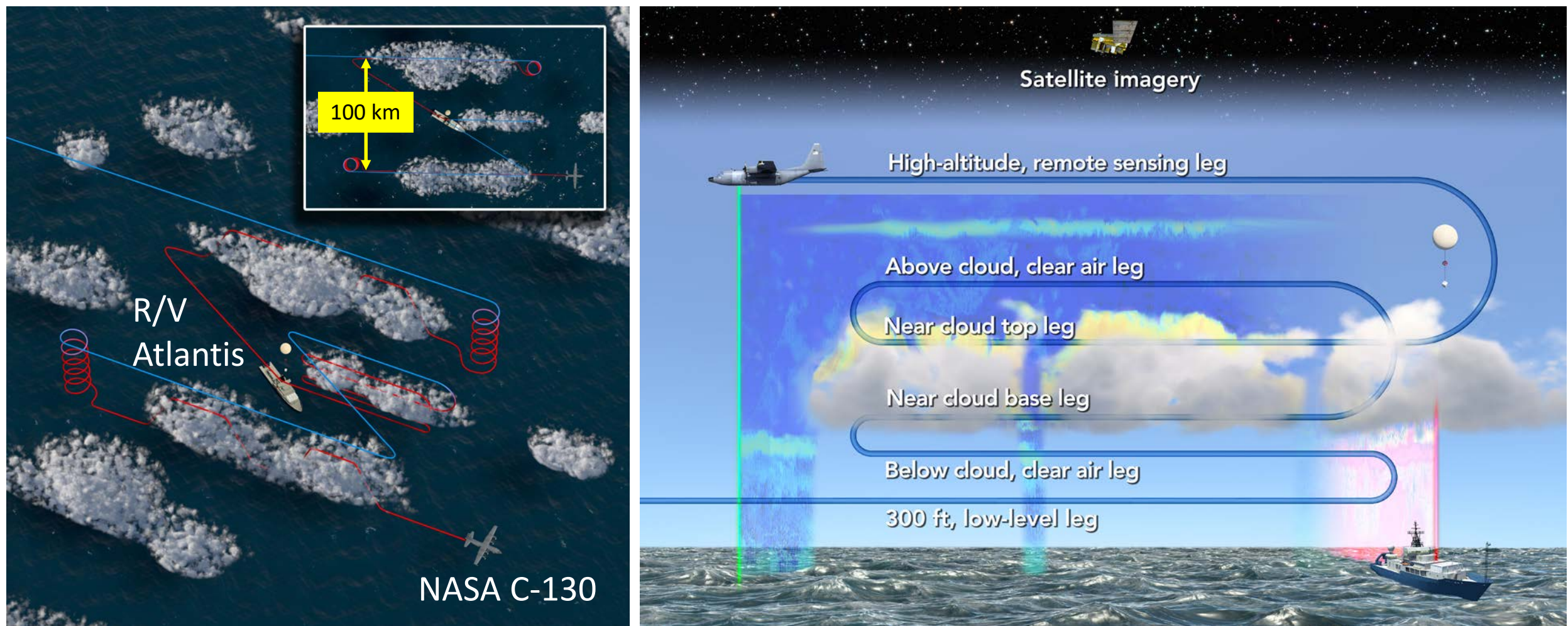
The North Atlantic Aerosols and Marine Ecosystems Study:

A Multi-Year Data Set of Marine Aerosol-Cloud In Situ and Remote Sensing Observations



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Summary: We present aerosol and cloud observations obtained from the satellite-, aircraft- and ship-based measurements of the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES). The data span three seasons (November 2015, May 2016, and September 2017), which correspond to substantial variation in ocean ecosystem characteristics, continental long-range transport, and local aerosol-cloud microphysics and meteorology. For example, below-cloud aerosol number concentrations in November 2015 were of order $10\text{-}50\text{ cm}^{-3}$, while concentrations observed in May and September were of order $100\text{-}500\text{ cm}^{-3}$. Here, we focus on 20 cloud sampling flight modules carried out during NAAMES, which encompass approximately 27 flight hours of the more than 220 NAAMES project flight hours.



Standard Z flight pattern executed by the C-130 aircraft in the vicinity of the ship. Blue coloring denotes high-altitude legs at approx. 6.5 km altitude, while red legs are lower in altitude.

The nominal cloud module pattern (shown above) consists of a series of 5-6 vertically-stacked, horizontal flight legs of 10-15 minute duration (~50-90 km in length) that profile the near-surface (300 ft. altitude) and below-cloud aerosol characteristics, the cloud properties near cloud base and top, the aerosol properties above cloud, and finally a high-altitude remote sensing leg that characterizes the cloud top and above-cloud atmosphere. Ship-based aerosol and ceilometer measurements provide the below-cloud context over time, while GOES satellite imagery and cloud retrieval products fill in the above-cloud story. Finally, periodic ship-launched radiosondes provide important constraints on cloud boundary layer structure. This comprehensive, end-to-end sampling strategy is a unique and powerful aspect of the NAAMES cloud module data set, which enables future studies seeking to understand the sensitivity of clouds to aerosol and meteorological drivers in the remote marine atmosphere.

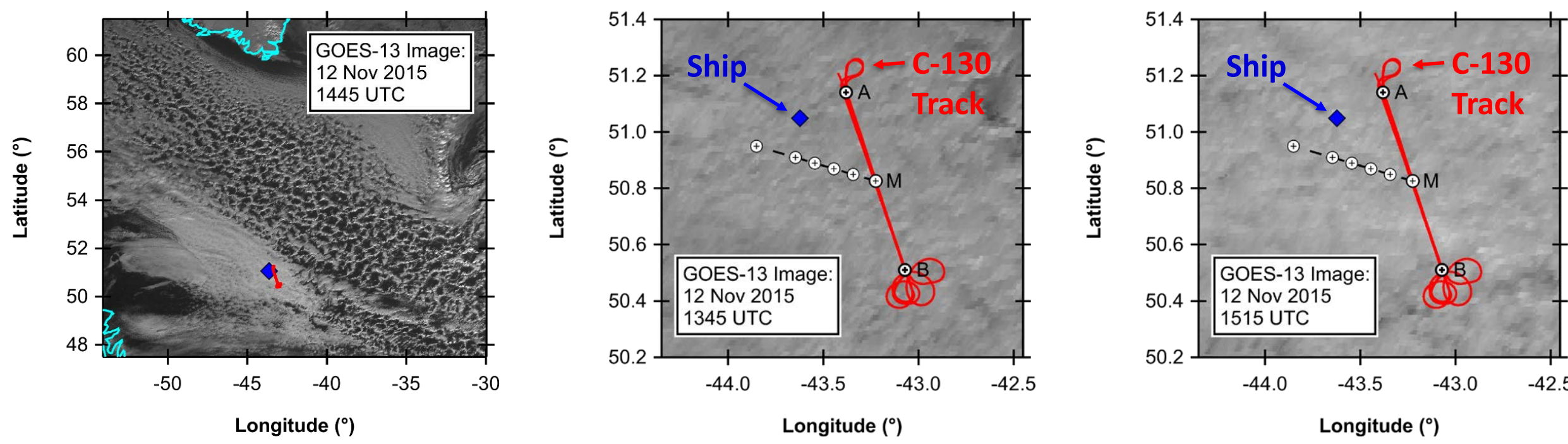
Data Archival and Public Accessibility: NAAMES data are freely and publicly available through two Distributed Active Archive Centers (DAACs): the Ocean Biology DAAC (doi:10.5067/SeaBASS/NAAMES/DATA001) and the Atmospheric Science DAAC (doi:10.5067/Suborbital/NAAMES/DATA001). Additional relevant satellite and model reanalysis data sets are available from their providers and include <https://cloudsway2.larc.nasa.gov/> and <https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/>, among others. Subsetted satellite and model data are provided in the NAAMES archive.

NAAMES-LARGE-	NAAMES-PTRTOP-NMHCs	NAAMES-HsKping	NAAMES-MERRA2	NAAMES-GOES-PIXEL
- Microphysical — CNg13nm — CNg10nm — CNg10nm_novot - CCN — CCN21 — CCN30...CCN65 - LAS — IntegN_90to7500nm_PSL_LAS — LAS_Bin01...LAS_Bin26 - APS — nAPS — APS_Bin01...APS_Bin13 - SMPS — nSMPS — vSMPS — SMPS_Bin01...SMPS_Bin30 - CDP — DropletNum — vCDP — CDP_Bin00...CDP_Bin29 - CIP — nCIP — vCIP — CIP_Bin00...CIP_Bin62 - Winds — w_ms-1 — WPSD_ms-1 — WDIR_deg — u_ms-1 — v_ms-1 — RH%	— methanol_ppbv — acetonitrile_ppbv — acetaldehyde_ppbv — methanethiol_ppbv — acetone (propanal)_ppbv — dimethyl sulfide_ppbv — isoprene_ppbv — MEK (butanal)_ppbv — dimethyl sulfoxide_ppbv — benzene_ppbv — toluene_ppbv — C8-alkylbenzenes_ppbv — C9-alkylbenzenes_ppbv — monoterpenes_ppbv	— Latitude — Longitude — GPS_Altitude — Altitude — Static_Air_Temp — Static_Pressure	— inst3_3d_aero_Nv — Dimethylsulphide mixing ratio (DMS) — Methanesulphonic acid mixing ratio (MSA) — Sulphur dioxide mixing ratio (SO2) — Sulphate aerosol mixing ratio (SO4) — Sea salt mixing ratio (bins 001...005) — Dust mixing ratio (bins 001...005) — Black carbon aerosol mixing ratio (BC) — Organic carbon aerosol mixing ratio (OC) — Relative humidity after moist (RH) — inst3_3d_chm_Nv — Carbon monoxide (CO) — Ozone mass mixing ratio (O3) — lavg1_2d_rad_Nx — Total aerosol extinction AOT (550 nm) — Sulphate extinction AOT (550 nm) — Sea salt extinction AOT (550 nm) — Dust extinction AOT (550 nm) — Black carbon extinction AOT (550 nm) — Organic carbon extinction AOT (550 nm) — Sulphate surface mass concentration — Sea salt surface mass concentration — Dust surface mass concentration — Black carbon surface mass concentration — Organic carbon surface mass concentration — SO2 surface mass concentration — DMS surface mass concentration	— Cloud droplet number concentration (CND) — Effective radius (Reff) — Optical depth (Tau) — Liquid water path (LWP) — Ice water path (IWP) — Cloud phase (PHAS) — Multichannel image (RGB) — Broadband albedo (BBAL) — Broadband longwave flux (BBLW) — 0.65um reflectance (R_65) — 10.7um brightness temperature (T-11) — 8.9-11.2um brightness temp. diff. (T2-4) — 11.2-12.4um brightness temp. diff. (T4-6) — Effective cloud temperature (Teff) — Cloud base pressure (Pbot) — Effective cloud pressure (Peff) — Cloud top pressure (Ptop) — Cloud base height (Zbot) — Effective cloud height (Zeff) — Cloud top height (Ztop) — Iceing potential (ICNG)
NAAMES-RUSSELL-	NAAMES-PMEL-	NAAMES-DMTCCN	NAAMES-FLEXPART	
- CPC — Particle_Number_Concentration — SP2MassSizeDistribution — dNdiagDp_59nm — dNdiagDp_72nm - SEMSNumberSizeDistribution — SEMS_Total_Conc — dNdiagDp_10000pm — dNdiagDp_896130pm - OPS — dNdiagDp_300nm — dNdiagDp_8032nm - AMS-MassConc — Organic — Sulfate — Nitrate — Ammonium — Chloride - FTIR-Ambient — Alcohol — Alkane — Carbonyl — Amine — Acid - ETSingleParticleCluster — f_Sulfate1 — f_Sulfate2 — f_Sulfate3 — f_OOA1 — f_OOA2 — f_HOA1 — f_HOA2 — f_Seasalt — Total_particle	- CN — CN_5 — CN_13 - NSD-DMPs — dNdiag100p - APS — NumSizeBins — dNdiag100p - Radon — Radon - Met — AirTemp — RH — BaroP — RainRate - NAWWIND — WindS — Windd — WindV - SST-Sal — SST — Salinity	- SS - Np	— Release Julian time (time) — Upwind Julian time (time) — Latitude (lat) — Longitude (lon) — Vertical level in meters (lvl) — Level intervals in meters (lvlnt) — Residence time in seconds (RT)	
NAAMES-ATLANTIS-MET_SONDES				
— Latitude_deg — Longitude_deg — Altitude_mAGL — Pressure_hPa — Temperature_C — RelHumidity_percent — WindSpeed_mps — WindDirection_deg				

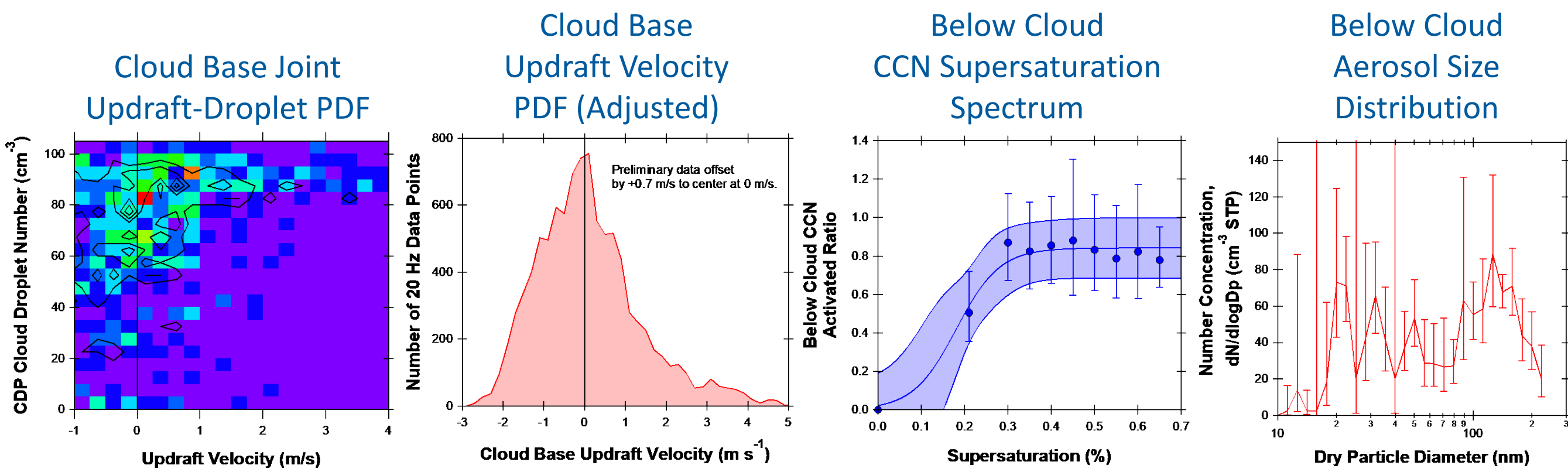
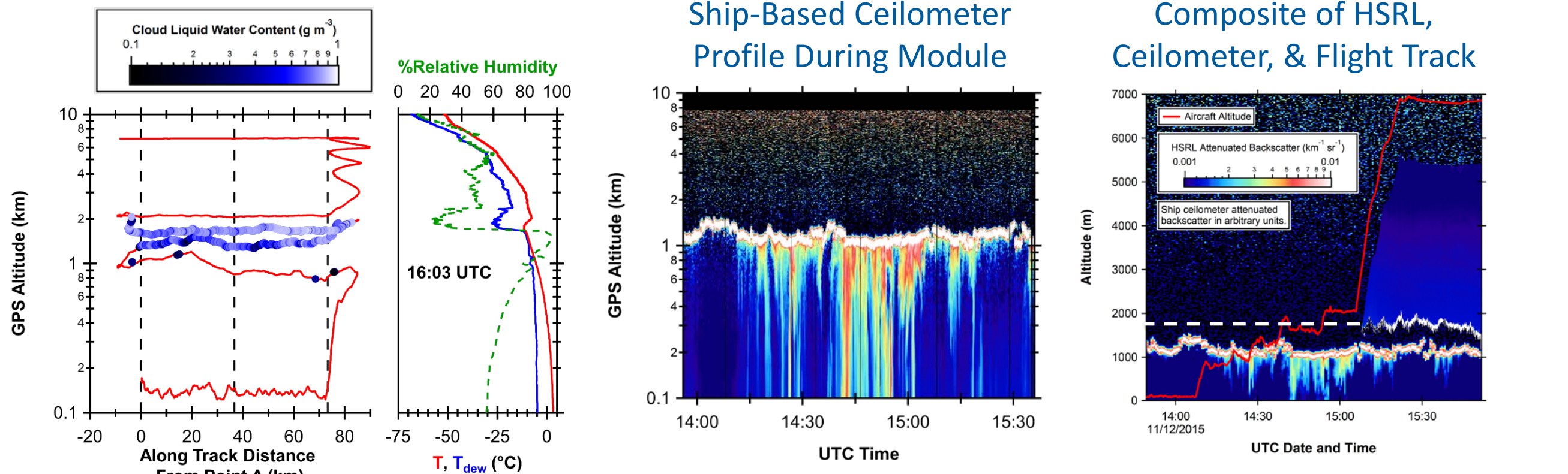
Data file name IDs (boxes) and variable names (trees) are shown here for relevant aerosol-cloud parameters. Clockwise from bottom-left are the NAAMES R/V Atlantis measurements, the NAAMES C-130 measurements, and selected model and satellite data products. Black text indicates in situ measurements, blue text indicates remote sensing measurements, and red text indicates model simulation results. A collection of merges is also available at 1-, 10-, and 60-second intervals for the aircraft data. Merge file users are encouraged to consult the original data file headers for the most complete metadata information and to ensure that a newer revision has not been released since the merge was generated.

Example Cloud Module Summary:

12 November 2015, 13:56 – 15:36 UTC (1:40 Duration and 73.4 km Leg Lengths)



Flight track showing in-cloud portion (left) and radiosonde profile (right)



Example Result: Simulating Cloud Conditions With the Georgia Tech Droplet Parameterization:

