



YMC

***Proposed* Met Office Observational Field  
Campaign**

FAAM Bae146 Detachment and MRU Ground Station

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# Met Office Links in the Region

- Existing Links with Met Service Singapore (MSS)
- **MSS** to use **UM** for operational NWP by 2017/18: SINGv, **1.5km**, **80 levels**, high vertical resolution (~500m) up to **16km** (convective tops) (based on UK High res config.). Domain extends to include all of Sumatra to the west.
- By 2018/19: MSS use of high res. ensembles, convective scale DA?
- So: High res. forecasting support for the Singapore region
- Opportunity to improve convective scale forecasting with case studies,
- Existing links National Met Services with Indonesia, Philippines, Thailand, S. Korea, Australia, and many others
- Ongoing collaborations (mainly climate related) across the region



# Observational Interest in YMC

- Convection in Maritime Continent
- Diurnal Cycle of Convection
- Land – Sea breezes
- Land Sea contrasts, heating, (land use? Hyperspectral imaging?)
- Boundary Layer Characterisation prior to initiation of convection
- Surface fluxes and boundary layer flux profiles
  - Turbulence: momentum, latent heat, heat
  - Radiation: SW and LW broad band IR
- Cloud Microphysics of early stages of development
  
- *Gravity waves from diurnal heating of land? Secondary Triggering of convection*
- *Aerosol characterisation, including Black Carbon, AMS, CCN, INC*
- *TTL component – Global Hawk?: similar to CARTA proposal (Baran, Vaughan)*



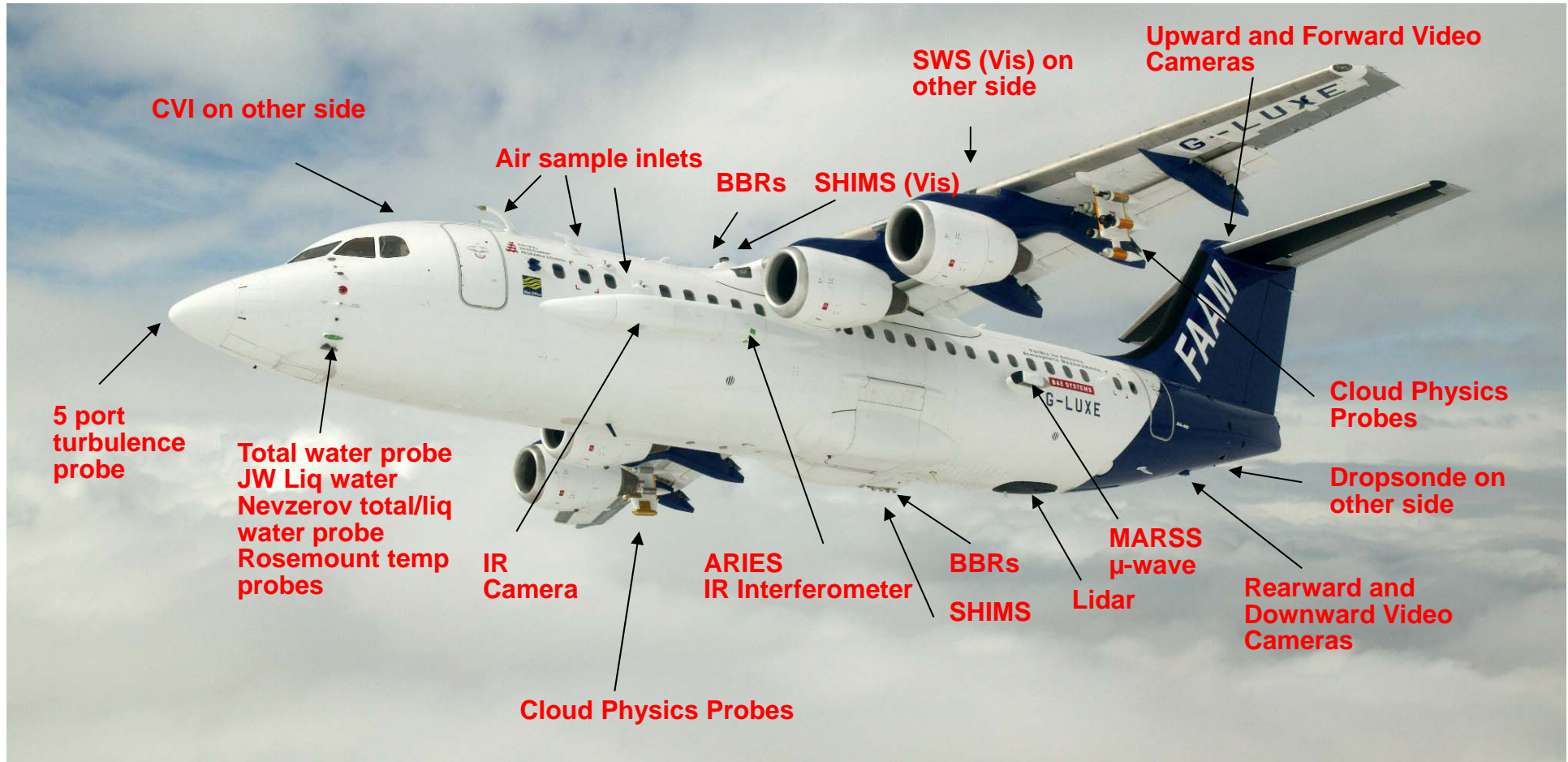
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# FAAM BAe146 Large Research Aircraft

Facility, Operational capability, Instrumentation



# FAAM BAe146-301 ARA Instrumentation





# Aircraft Characteristics

Crew	Two Pilots, 18 scientists
Altitude Range	50 ft up to < 35 kft (11 km)
Range	3,700 km (2000 nm)
Endurance	Up to 5.5 Hours
Science Speed	100 m s <sup>-1</sup>
Instrumentation	Turbulence and Thermodynamics Cloud and Aerosol Microphysics Radiometer Suite (IR, Vis, $\mu$ -wave) (Chemistry)

## Limitations

Range and maximum altitude reduced in tropics  
No Access to Deep Convection\*  
Max updraught of ~15m/s, No Hail, No Lightning,  
etc







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# Met Research Unit: MRU

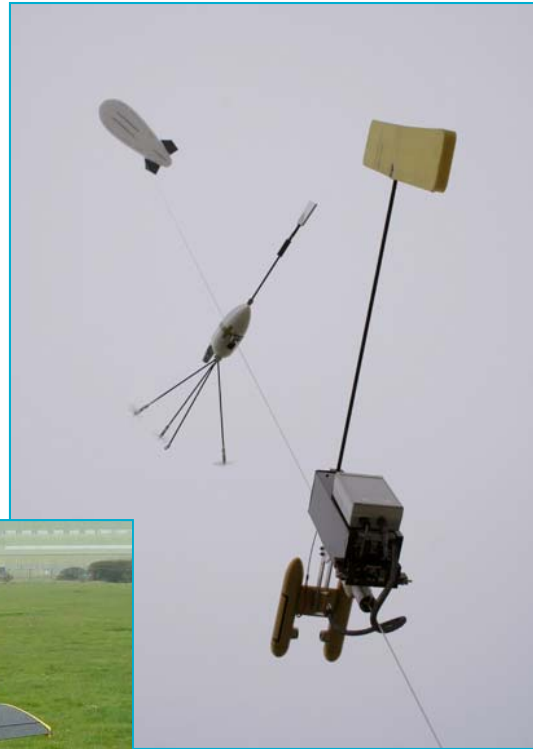
Ground Based observations, Masts, Radiometers, UAVs, Tethered Balloon



# MRU: Met Research Unit

## Ground Based Observations

Tethered Balloon



UAS



50m Mast, 10m Mast



# MRU Ground Based Capability

## Ground based Observations

- **Tethered Balloon**, turbulence, cloud droplet spectra, winds
- Flux towers up to 50m height, including radiation and soil fluxes
- Cloud Radar 94 Ghz
- Doppler LIDAR
- Microwave Radiometers

## 3rd party equipment

- See also: Cathryn Birch Talk
- Portable Weather Radar
- FGAM wind profiler, NCAS

## UAS

- Autonomous ~30 min duration
- Ceiling (5000ft +)
- Airspeed nom. 14m/s
- PTU and wind profile flights conducted.
- Future: turbulence, aerosol and cloud spectrometers, and thermal imaging capability





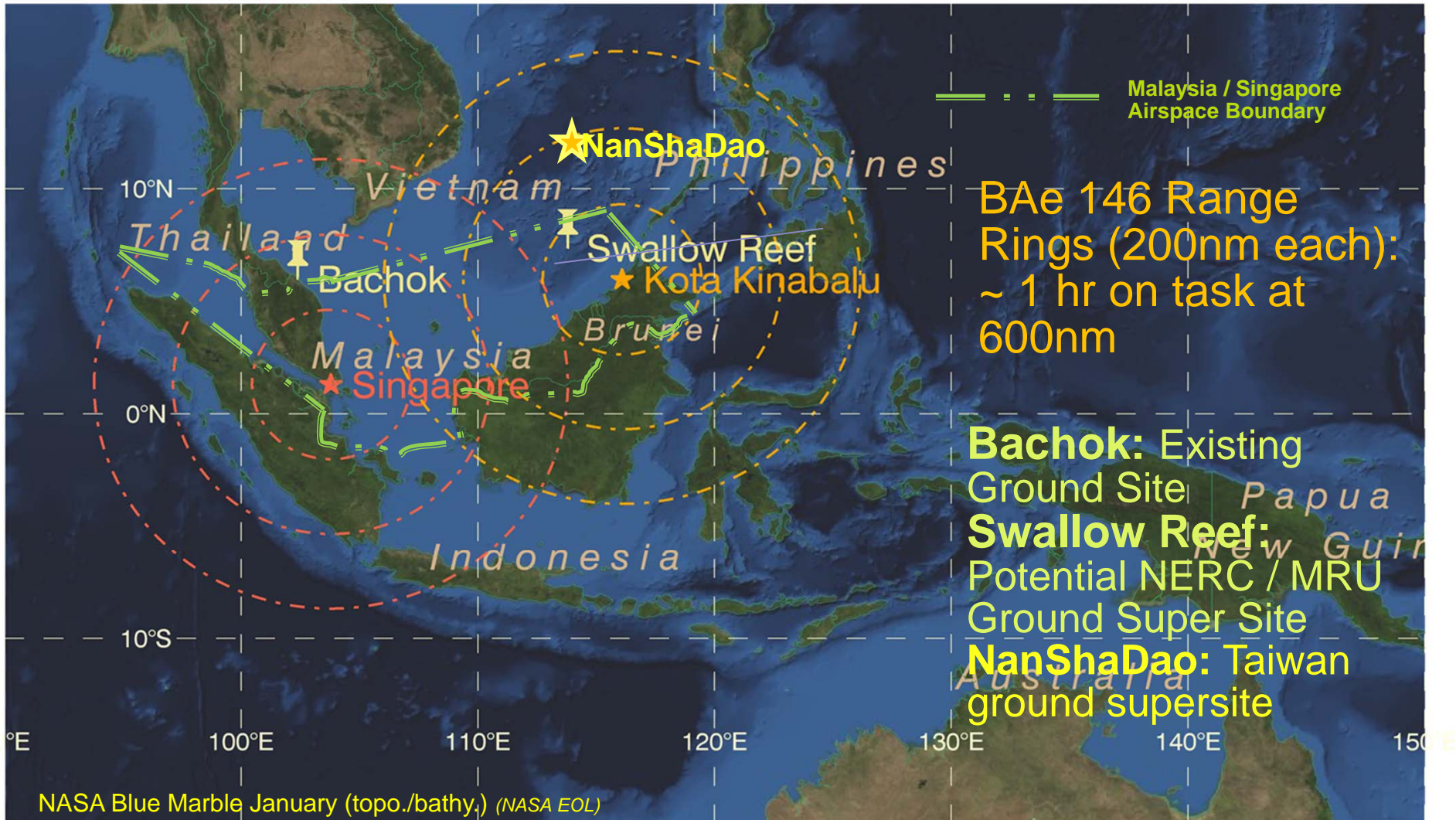
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# Proposed Measurement Campaign



# Potential Operating Locations





# Field Campaign Options

## FAAM BAe146

- Base: Singapore, KK, Indo?
- Work Singapore to KK (previous campaign: OP3)
- Access to Bachok, Swallow Reef, overflights (1 hr on task at 600 nm range)
- 3 to 5 weeks, 10 to 15 flights, 5 hours
- 2018? NDJ *Potential Conflict with YOPP*
- Good Fsxx Support around Malaysian Peninsula
- Opportunity to improve UM in the region, Global to 1.5km

## Ground Based Super Site

- Ground Super-Site for Intensive Operating Period (IOP) at same time as Aircraft Campaign
- Longer term measurement site possible with involvement from local Met Service or University staff: routine instrument operators
- Swallow Reef: oceanic site
- Observations mast and ground based instrumentation
- Over-flight with BAe146 from KK



# Science Objectives

*also Cathryn Birch talk*

## FAAM BAe146

- Boundary Layer Characterisation prior to initiation of convection
- Land Sea contrasts, heating, (land use? Hyperspectral imaging?)
- Land – Sea breezes
- Surface fluxes and boundary layer flux profiles
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- Cloud Microphysics of early stages of development

## Ground Based Super Site

- Turbulent flux measurements
- Boundary layer structure: wind profiler, Doppler lidar, sondes
- Diurnal Cycle of Convection
- Aerosol characterisation, including Black Carbon, AMS, CCN, size, number etc.
- Dispersion Modelling Component



# Timeline (January 2015)

- Explore potential operating bases in the region,
  - Inc. Singapore, Malaysia, Indonesia, Philippines
- Define time of year for airborne campaign (science objectives)
  - original plan for NDJ, but
  - need weak winds to explore land / sea breezes
  - stay out of organised convection
- Define measurement strategy and detailed sortie plans
- Define scientific integration with other aircraft / RVs
- Bring in Met Office Collaborators, Convective Scale Modeling and Parametrisation (and MSS), Data Assimilation, Land Use Group, Dispersion
- Bring in external UK collaborators for additional BAe146 instrumentation (cloud microphysics, aerosols, etc)
- Decide on ground supersite equipment, location, duration
- Explore potential for and extended ground station by collaboration with local scientist operators





# Summary



- **Science Case to be Presented to Met Office for**
- Intensive 1 month airborne campaign, 10 to 15 flights, FAAM BAe146
- Intensive Ground station obs., MRU / NERC
- Potential long term ground obs



- Boundary Layer thermodynamics and turbulence structure, fluxes
- Land / Sea breezes
- Initiation of convection
- Diurnal Cycle of Convection
- Microphysics in early development stages



# Extra Slides



# BAe146 Instrumentation 1/3

## Basic Meteorology / Standard Measurements

- T, P (32Hz),  $q$  (~0.5 Hz)
- Wind components, turbulence and fluxes (32Hz)
- LWC, IWC, (32Hz)
- Total Water Content  $q_t (=q_v+q_l+q_i)$  (64Hz)
- Position, attitude (32Hz)
- Sea Surface Temperature
- **Drosondes**, T,q,winds - RS 93
- Video Cameras (4)
- Satcom communications

## Cloud and Aerosol Microphysics

8 probes from (covers full spectra, 0.1  $\mu\text{m}$  to 6 mm:

- CDP, CAPS: CAS
- PCASP
- **SID2, (SID3)**
- CIP15, CAPS: CIP15, CIP100, (2DC)
- **CPI, (3V-CPI (future)), 2DS**
- **HALO-HOLO (future)**



# BAe146 Instrumentation 2/3

## Radiometers

- **LIDAR**: Leosphere ALS450, Backscatter and D-pol, UV, 455nm
- **BBR** – Broad Band Radiometer - irradiance measurements, 0.3-3.0 $\mu\text{m}$ , 0.7-3.0 $\mu\text{m}$  and 4-50 $\mu\text{m}$
- **SWS** - Short Wave Spectrometer - 303.4 - 1706.5 nm pixel resolution 3.2 nm up to 948.7 nm, 6.3 nm thereafter.
- **SHIM** - Spectral Hemispheric Irradiance Measurement - 303.4 - 1706.5 nm pixel resolution 3.2 nm up to 948.7 nm, 6.3 nm thereafter
- **IR Sensor**– 8-9  $\mu\text{m}$
- **ARIES** - infrared interferometer - 3.3-16 $\mu\text{m}$  max OPD = 1.037cm ( $\sim 0.5\text{cm}^{-1}$ ) – hyperspectral: 4800 channels
- **MARSS, Deimos** - passive microwave radiometers - 24, 50, 89, 157, 183GHz – same as AMSU.
- **ISMAR**: International Sub-millimeter Airborne Radiometer



# BAe146 Instrumentation 3/3

## Aerosols and Particulates

- TSI 3 channel nephelometer,
- Particle Soot Absorption Photometer,
- Cloud Condensation Nuclei Counter (static diffusion chamber),
- Ice Nuclei Counter (continuous-flow diffusion chamber type),
- Condensation Particle Counter,
- Millipore filter system,
- [Aerosol Mass Spectrometer](#),
- Counterflow Virtual Impactor (CVI) for size-selective cloud particle measurements.

## Chemistry

- CO, Ozone, NO, NOX, SO<sub>2</sub>,
- [CO<sub>2</sub>, Methane \(FGGA\), PAN,](#)
- [Formaldehyde, HOX, Hydrocarbons,](#)
- [CFCs etc. etc.](#)
- Species can be sampled in Teflon Flasks



# Size range of cloud physics instruments

