Stratéole 2: Long Duration Measurements of Aerosol Profiles in the TTL using RACHuTS and LASP OPC

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STRATÉOLE 2

A multinational effort to study the tropical tropopause layer (TTL) and the tropical lower stratosphere using long duration super pressure balloons. The major objectives of the campaign are to understand:

1. Atmospheric dynamics and characterization of gravity waves in the TTL
2. The role of cirrus clouds, aerosols, and tropical convection on hydration/dehydration processes in the TTL
3. Effects of Quasi-biennial Oscillation (QBO)
4. Transport processes between the tropical troposphere and stratosphere

Flight systems and operations are supported by CNES. *In situ* and remote sensing instrumentation that will be used at two flight levels were developed at both US and European Institutions (see table)

Instrument	Measurement Type	Institution	Altitude (km)
RACHuTS	Water Vapor, Temperature, Size Resolved Particle Number	LASP – NOAA	16-18
LOPC	Size Resolved Particle Number	LASP	18
LOAC	Size Resolved Particle Number	CNRS-LPC2E	18
FLOATS	Temperature Profile	LASP	16-18
TSEN	Pressure and Temperature	CNRS-LMD	18, 20
BOLD-AIR	Up-Welling Infrared Flux	CNRS-LATMOS	18
SAWfPHY	Water Vapor	CNRS-LMD	18
pico-SDLA	Water Vapor and CO_2	CNRS-GSMA	18
B-Bop	Ozone	CNRS-LMD	18
BeCool	Attenuated Backscatter (nadir)	CNRS-LATMOS	20
ROC	GPS Radio-Occultation	Scripps Institute	20

MISSION PLANS

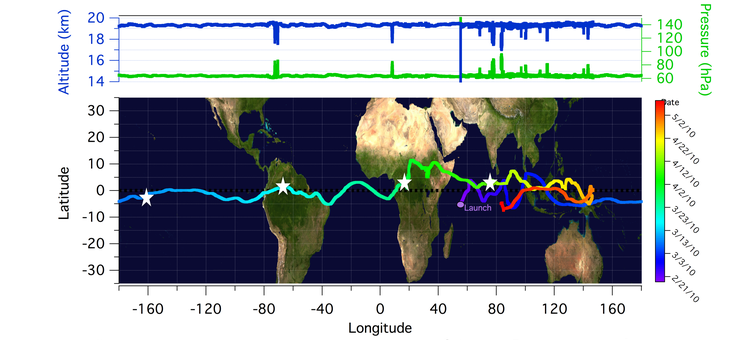
Three flight campaigns are scheduled for Stratéole 2 with the launch location from the Seychelles in the equatorial Indian Ocean.

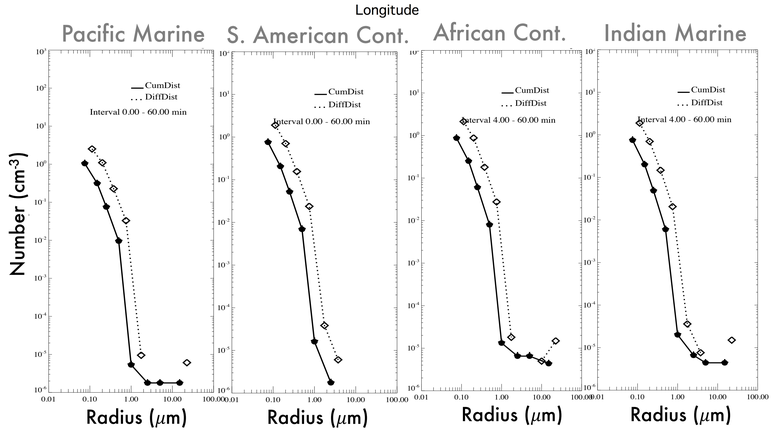
2018 Engineering Flight:
- 1 flight for each of the 5 gondola configurations
- proof of concept and testing

2020-2021 Science Flight:
- 3 to 6 balloons for each of the 5 gondola configurations
- >3 month flight duration

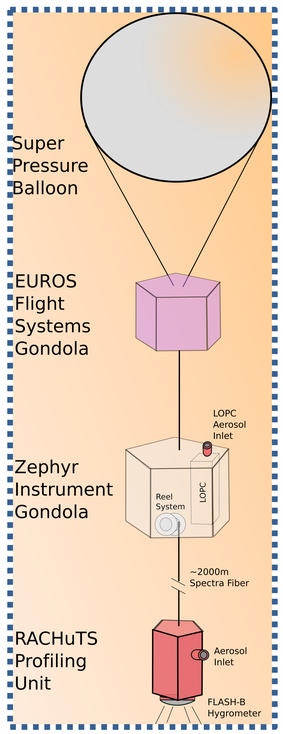
2023-2024 Science Flight:
- Same configuration as previous science flight
- Timeline based on QBO reversal

PRE-CONCORDIASI 2010





FLIGHT DESIGN



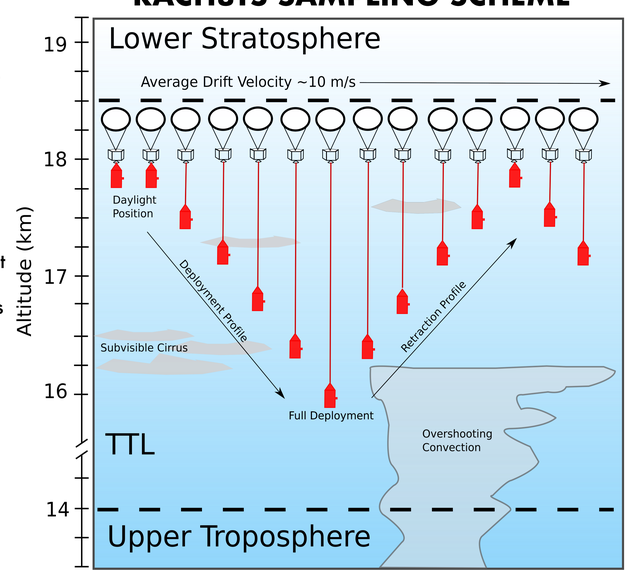
Super Pressure Balloon (Isopycnic) System
- Allows for quasi-Lagrangian measurements during flight
- Telemetry link through Iridium and InMarsat provide global coverage
- Ballast used to prevent over pressurization and compensate for gas leakage

Instrument Gondola
- Solar arrays and battery storage used to power and heat instruments throughout flight
- For RACHuTS a high performance, low mass reel system was developed at LASP

LASP Optical Particle Counter (LOPC)
- 20 size channels from 0.25 – 10 μm diameter and 1 hr integrated sampling

Reeldown Aerosol, Cloud Humidity, and Temperature Sensor (RACHuTS)
- 8 size channels from 0.3 – 10 μm diameter
- FLASH-B hygrometer for water vapor, TSEN for temperature and pressure, and GPS
- 4 – 10 nighttime profiles extending to 2 km below instrument gondola with adaptable speed and timing to suit science needs

RACHuTS SAMPLING SCHEME



-10° to 10° N Latitude

SCIENCE GOALS

Explain the role of subvisible cirrus clouds in water vapor transport
- *In situ* (*Peter et al., 2003, ACP*) and satellite observations (*Dessler and Yang, 2003, J. Clim.*) reveal subvisible cirrus near the tropical tropopause and are thought to regulate water vapor transport into the stratosphere (*Immler et al., 2007, JGR*)
- Coupled measurements of temperature, RH, and aerosol will address the role of water vapor saturation on cirrus cloud formation and the relationship between aerosol size and cloud nucleation in the TTL

Understand tropical deep convection
- Penetrating convection clouds transport water into TTL and stratosphere but its unclear if it moistens or dries the region due to lack of *in situ* observations of anvil ice particles (Rossow and Pearl, 2007, Geo. Res. Lett.)

Obtain high resolution aerosol size distributions
- The combination of a long duration drifting balloon with a vertical profiling unit will allow for unprecedented spatial and temporal resolution of distributions in the TTL
- Useful for validation of satellite and modeling products

Opportunity measurements of atmospheric events
- Long duration sampling allows for sampling of difficult to predict events that can influence the TTL and lower Stratosphere (i.e. volcanic eruptions, pyrocumulus, etc.)

More Information at strateole2.cnes.fr/fr or contact kalnajs@colorado.edu