Balloon airborne measurements during YMC

- Strateole 2 Experiment (2017-2019)
  (CNES, CNRS, NCAR, U. Colorado, U. Wyoming, Scripps, ISAC/ENEA)
  - Stratospheric pressurized balloons with dropsondes
  - UTLS-TTL

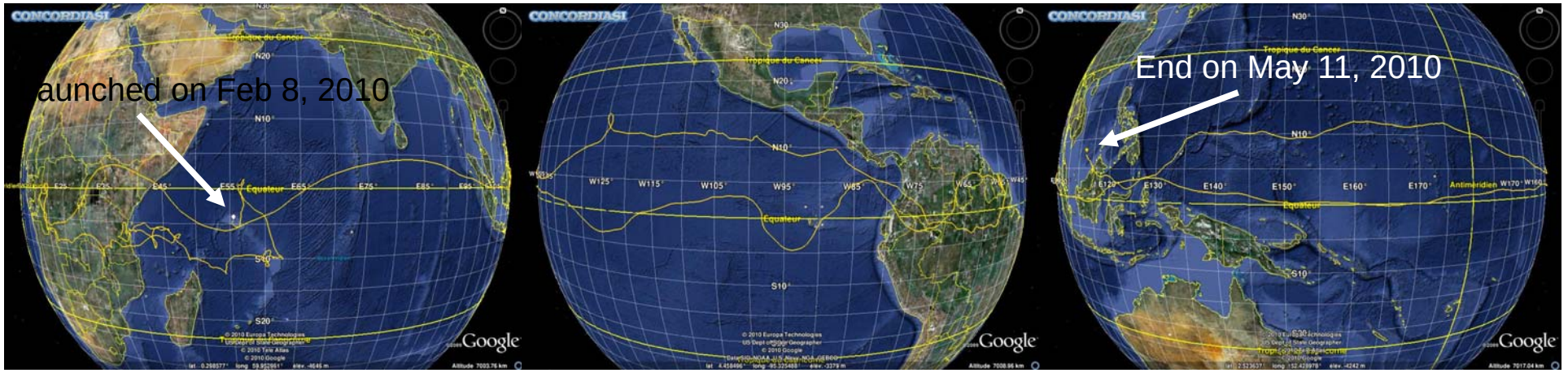
- Aeroclipper development
  (CNES, CNRS, JAMSTEC)
  - Atmospheric surface layer balloons (30-50m)
  - Air-sea fluxes
  - Tropical cyclone monitoring

Strateole 2
A long-duration balloon campaign at the Equator

Albert Hertzog & Riwal Plougonven
LMD, Palaiseau, France

http://tinyurl.com/strateole

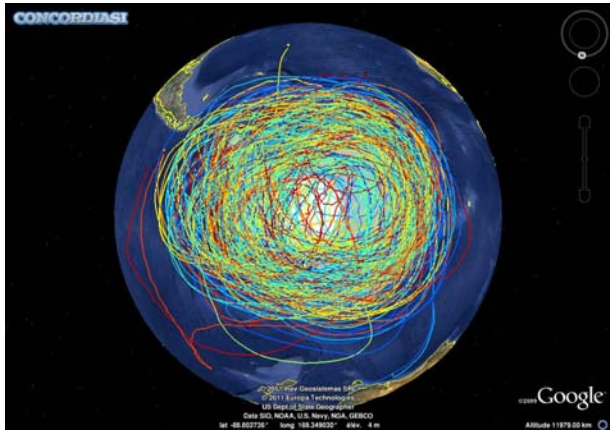
Superpressure balloon flight example: Pre-Concordiasi campaign



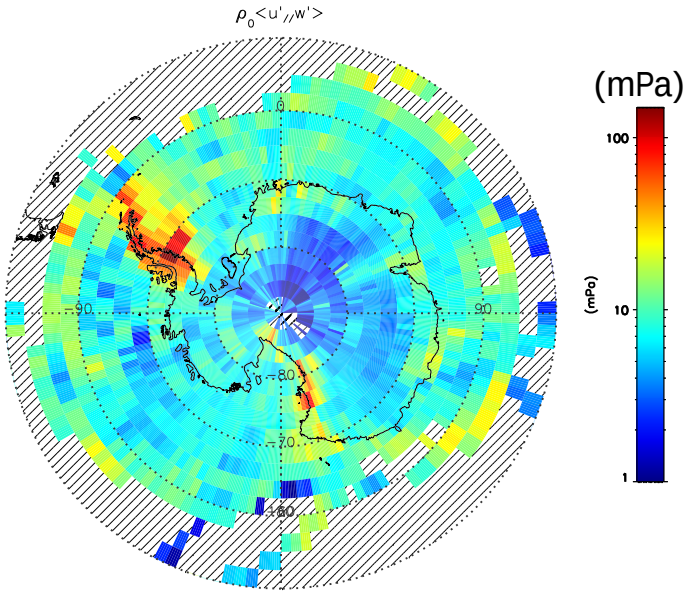
Flight duration: 92 days

Strateole 2

- One rehearsal campaign
  - Late 2017 (~ 4 flights)
- Two Scientific campaigns
  - Late 2018 and 2019 (~ 24 flights x 2)
  - Flights in the upper TTL (around 18 km) and in the lower stratosphere (around 20 km)
  - Launch from an equatorial site (TBD) => balloons will stay in the 'tropical pipe' and provide observations representative of the whole equatorial belt
  - In-situ and sounding observations
- Ojectives
  - Dynamics of the equatorial middle atmosphere: driving of the QBO (planetary/gravity waves), wave generation by convection, gravity-wave parameterization in GCMs
  - Transport and dehydration: occurrence of overshooting convection, cirrus microphysics & aerosol loading, cloud/dynamics interactions
  - Operational meteorology: analyses accuracy, observations put on the GTS
  - Satellite validation (ADM/Aeolus, Earth Care)



Concordiasi
19 flights, Sept-Jan 2010



Gravity-wave momentum flux

Dropsoundings from the balloons

- **About 10-12 flights per campaign will carry the “Driftsonde” gondola (developed by NCAR), with 50 dropsondes per gondola**
  - Observations of P, T, Hu, GPS winds from the balloon to the ground (standard Vaisala sensors)
  - Transmission of observations in real time to the gondola, and near real time (within 2 hrs) to the ground
  - Dropsoundings are commanded on demand from a web-based interface, knowing balloon positions and trajectory forecasts (also available on a web interface)
  - Typical limitation of 4 dropsondes/day/gondola (sounding < 1 hr)

- **Use of dropsonde observations in Strateole 2**
  - Vertical structure of equatorially-trapped and gravity waves
  - Provide profiles of the atmosphere from 20 km to the ground for trop-strat water vapor transport
    - Thermal structure of the TTL
    - Diagnostics on convective processes
  - Wind profiles to be assimilated by NWPs and compared with satellite products (ADM/Aeolus)

- **Dropsounding strategy yet to be defined and can therefore includes additional objectives raised by YMC**

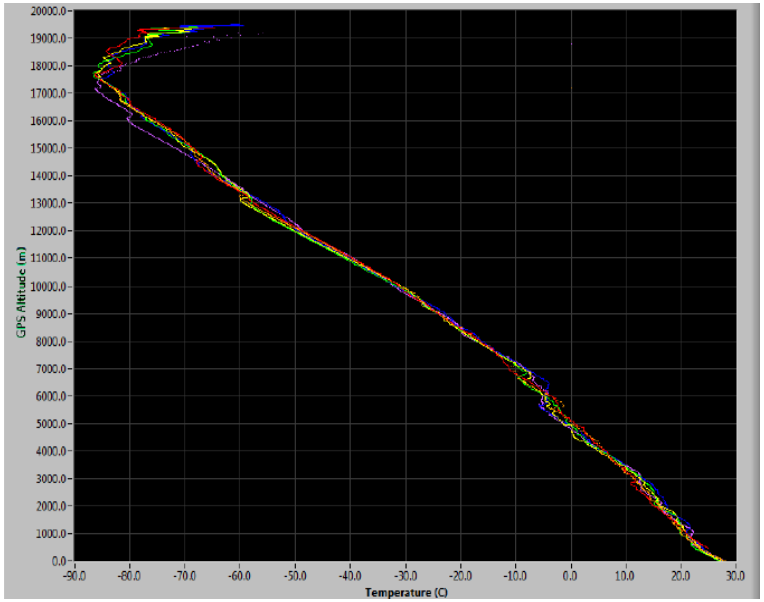
Balloon Instrumentation

- **In-situ instruments**
  - Meteorological sensors (LMD): P & T (every 30 s)
  - GPS (CNES): Position & Wind (every 30 s)
  - Ozone (LMD & U. of Colorado)
  - Optical Aerosol Counters (LPC2E & U. of Wyoming)
  - Water Vapour (LMD & GSMA)
  - CO2 (GSMA)
  - OLR (Latmos)

- **Remote sensing instruments**
  - Dropsondes (NCAR): ~600 dropsondes/campaign
  - GPS Radio-occultation (Scripps)
  - Backscattering lidar (ISAC/ENEA)
  - Distributed Temperature Sensor (U. of Colorado)

- **All observations are transmitted in near real time to the ground (Iridium)**

(Courtesy NCAR)

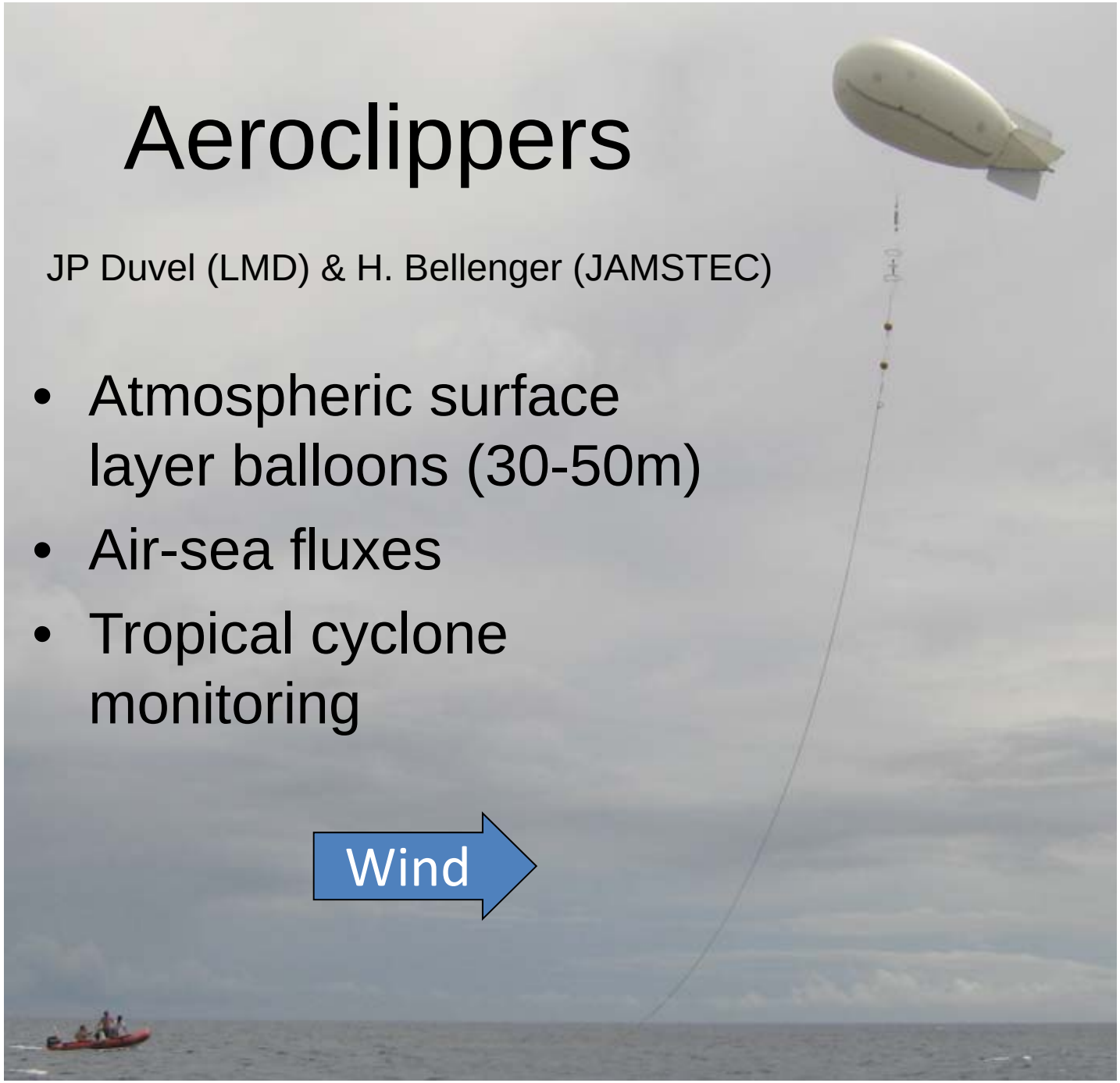


Dropsonde temperature profiles
(Pre-Concordiasi 2010)

Aeroclippers

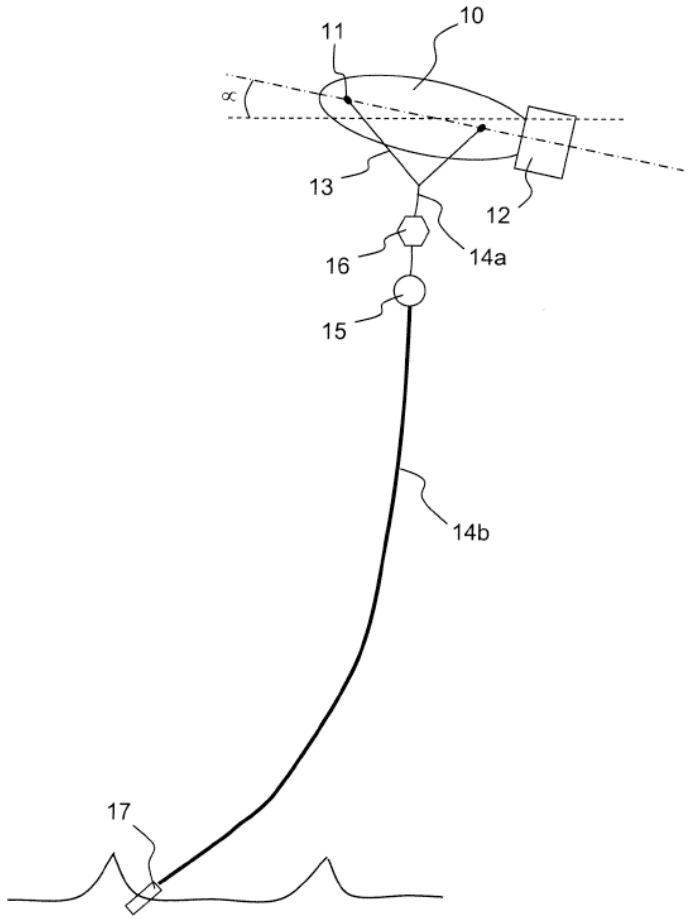
JP Duvel (LMD) & H. Bellenger (JAMSTEC)

- Atmospheric surface layer balloons (30-50m)
- Air-sea fluxes
- Tropical cyclone monitoring



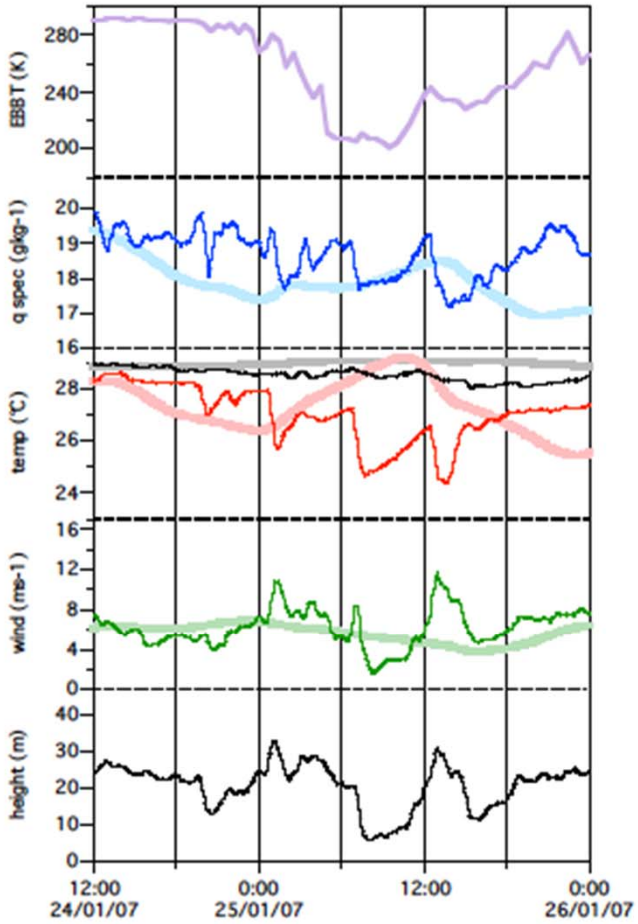
Measurements

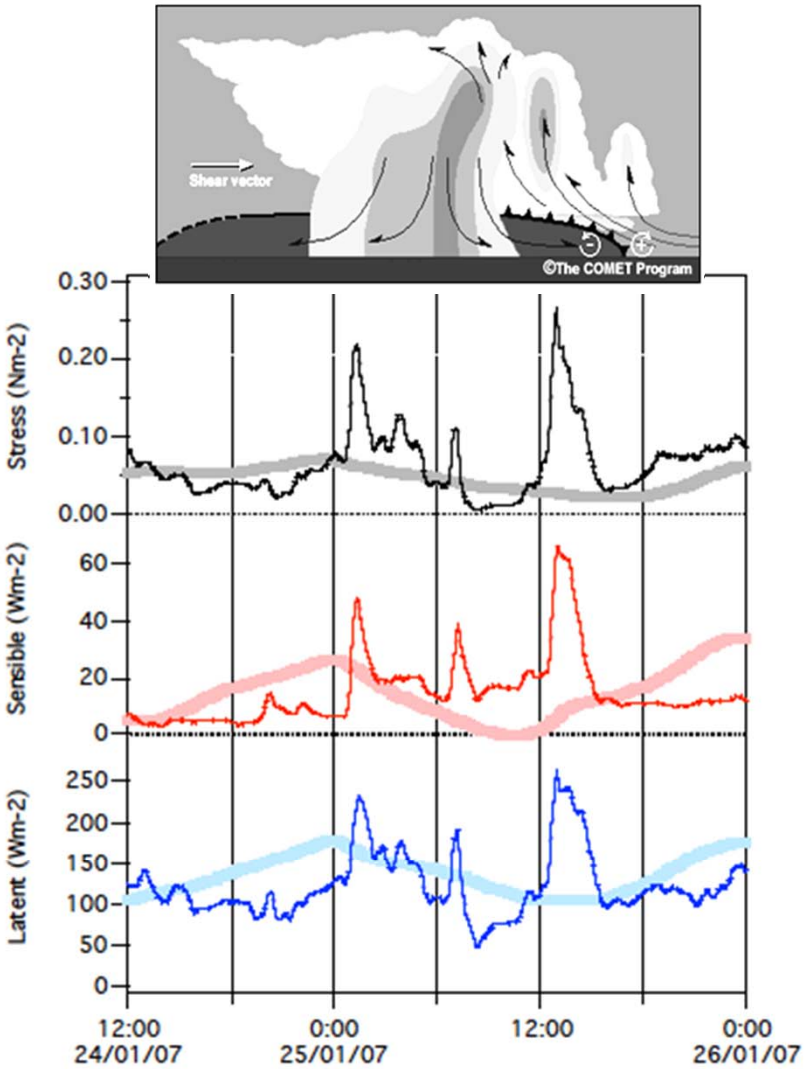
- Strength (16) and direction of the wind
- Surface pressure (16)
- T and RH (16)
- SST
  - in situ (17)?
  - Radiometer (16)?



Convective cold pools over the ocean

- Cold pools statistics
- Air-sea fluxes

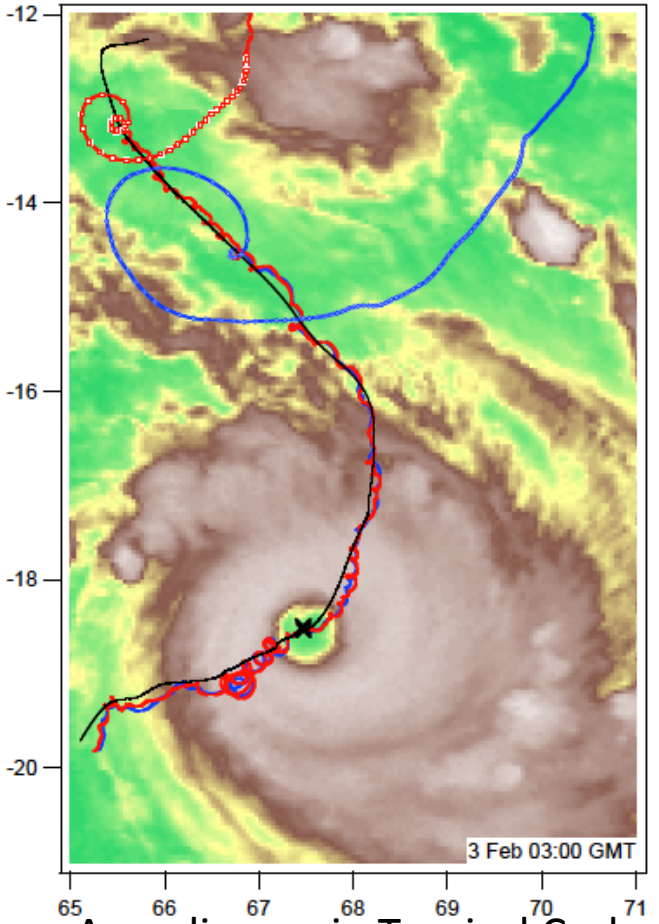




Duvel et al. 2009

Tropical depressions and tropical cyclones

- The balloon is trapped into the TC eye and then send realtime parameters (surface air pressure, temperature, moisture, SST)
- The balloon converges toward the eye from long distances
- Balloon deployement from remote islands or coasts

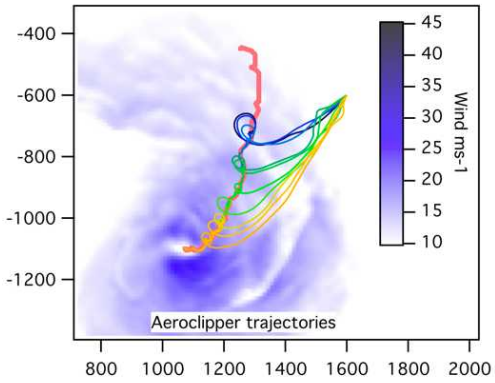


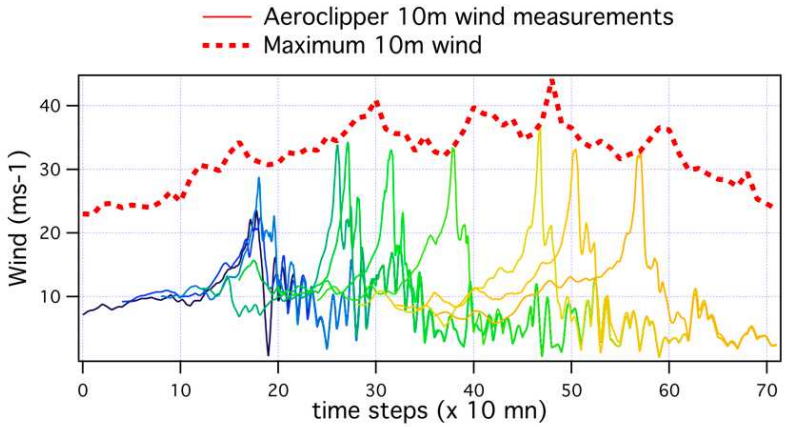
Aeroclippers in Tropical Cyclone Dora (02/2007)

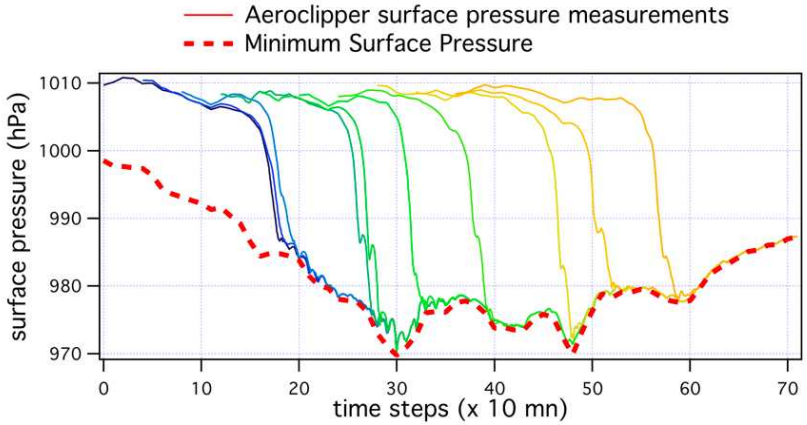
Duvel et al 2009

Mesoscale model simulations

- Aeroclipper behavior
- Good estimate of:
  - Minimum pressure
  - Maximum wind during the convergence







New Aeroclipper

- Lighter and smaller balloon
- IRIDIUM/GPS
- Same sensors (P, T, U, RH)
- Oceanic gondola or IR rdiometer for the SST?

- New Aeroclipper prototypes tested in 2015-2016, possibly in the Indonesian region

Aeroclipper TC measurements
Main objectives

- Real time monitoring of the cyclone intensity, including rapid intensification or dissipation:
  - Surface pressure and surface dynamic in the eye.
- Possible improvement the forecast (trajectory and intensity) given by the assimilation of Aeroclipper continuous time series of surface parameters.
- In trajectories converging toward the eye of a cyclone:
  - Structure of the surface wind, ratio between the tangential and the radial wind at the surface.
  - Variation of the low-level moist enthalpy of the surface air converging toward and into the cyclone eye.
- Low-level moist enthalpy in the eye:
  - This low-level moist enthalpy may supplement the energy coming from the outer core of the cyclone and give “superintensity” (Persing and Montgomery, 2003), i.e. cyclone exceeding their Potential Intensity, as define by Rotuno and Emmanuel (1987).
- Surface air circulations and turbulent heat fluxes during the cyclogenesis.

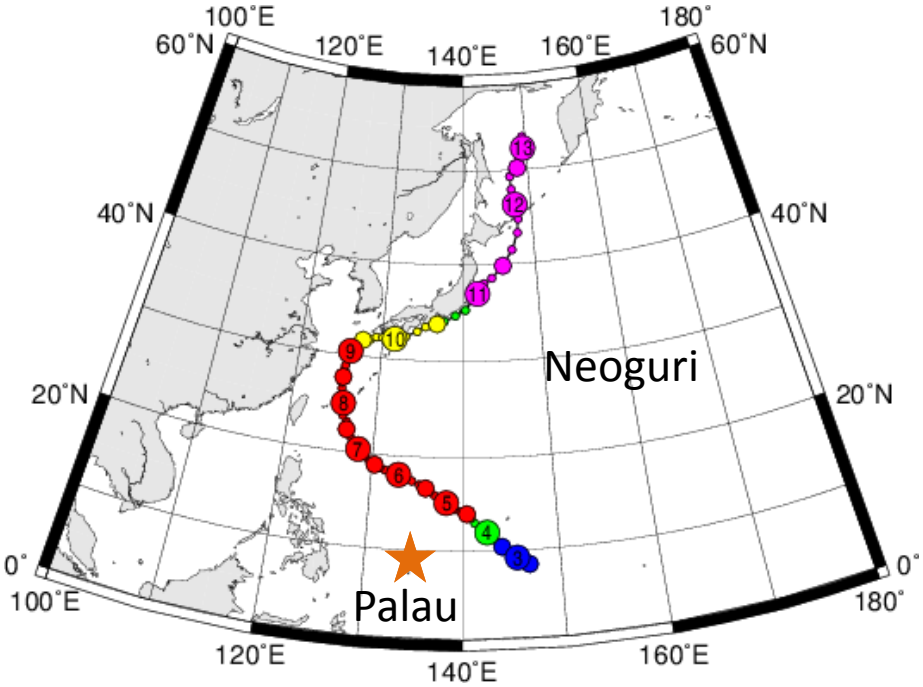
Northwestern Tropical Pacific

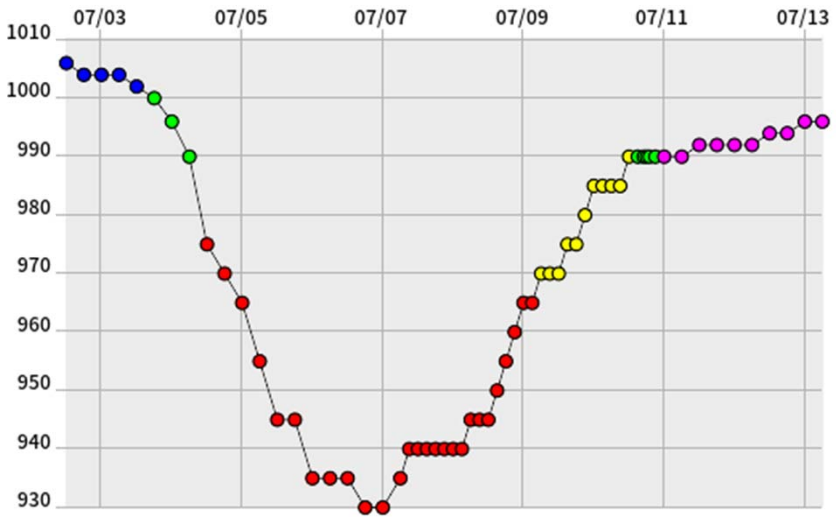
The most active cylonic basin

Prediction issues: Cyclogenesis from tropical depressions and typhoon evolution

Ex: Class 5 Typhoon Neoguri (07/2014)

Launch site: Palau (15 years of JAMSTEC presence)





Northwestern Tropical Pacific

Flight duration over 6 days for all aeroclippers

11 aeroclippers in Neoguri!
= launch window of 11 days!