Strateole 2
Long-duration stratospheric balloons providing wind information

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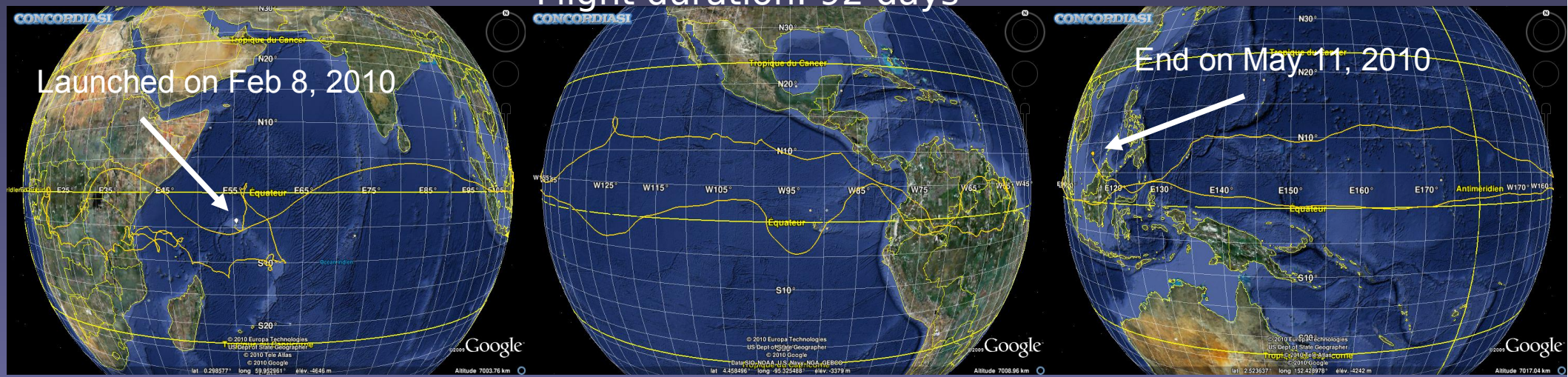
Long-duration balloons

- Made of plastic (instead of rubber for weather balloons)
- Once fully inflated (at float level),
  advected by the wind on constant-density surfaces
  at ~ 50-70 hPa (18.5 - 21 km)
- Balloons can typically fly for 2-3 months
- Data transmitted to the ground through satellite phone
- The flight duration is limited by:
  - Gas leak through the balloon envelope
  - End of energy onboard
    (but we us rechargeable batteries now!)
  - Dramatic events (mountain waves) that can make the balloon bursts
  - Political/safety considerations

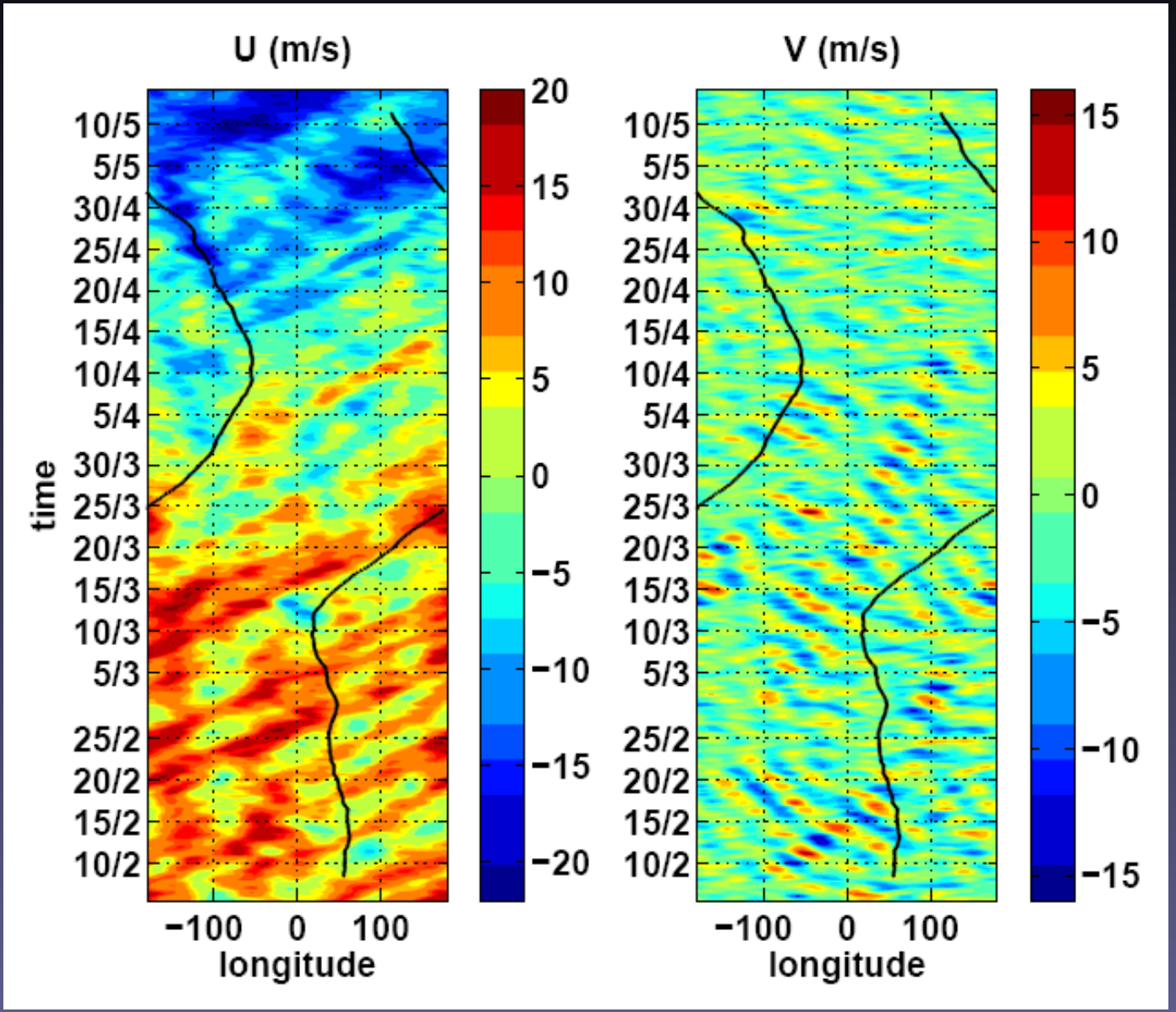
Pre-Concordiasi (2010)

- Preparation of Concordiasi (Antarctica)
- 3 flights, 3-month long
- 30-s meteorological observations
  - GPS: positions (1.5 m) and winds (from successive balloon positions, 0.1 m/s)
  - Pressure (0.1 hPa)
  - Temperature, (0.2 K)
- Comparisons w/ ECMWF operational analyses and NASA/MERRA reanalyses
- Balloon observations were not assimilated by NWP systems

Flight duration: 92 days

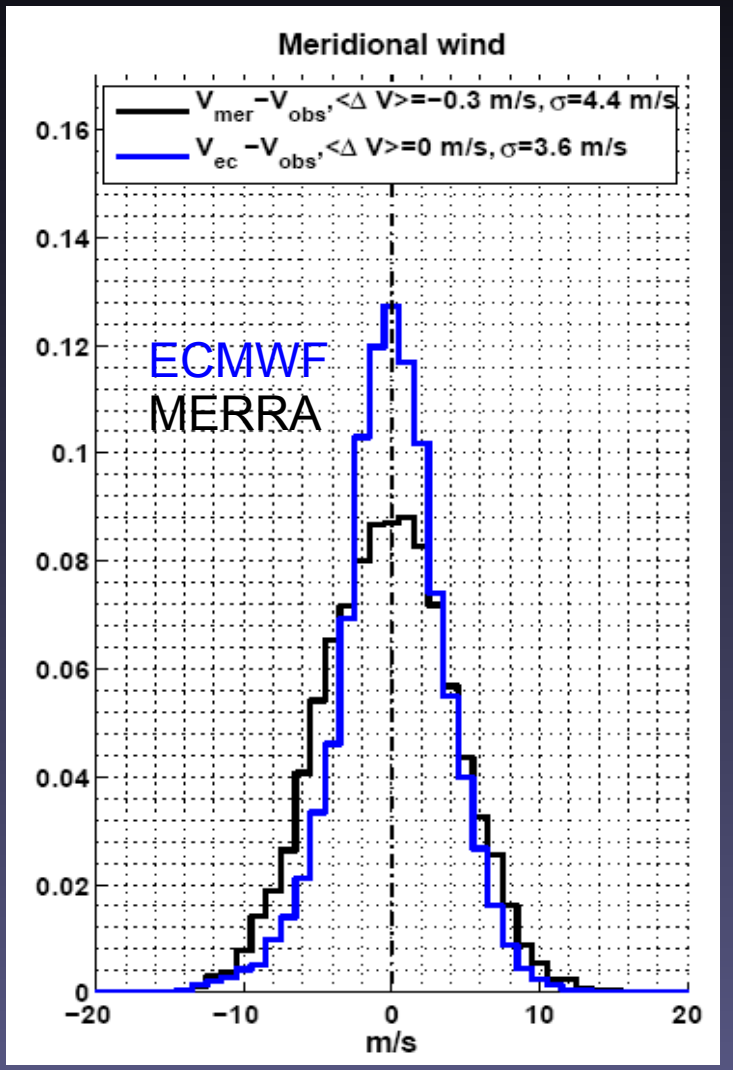


Dynamical context



Hovmöller diagram of ECMWF winds @ 57 hPa during the campaign:
QBO shift, Kelvin and Rossby-gravity (Yanai) waves

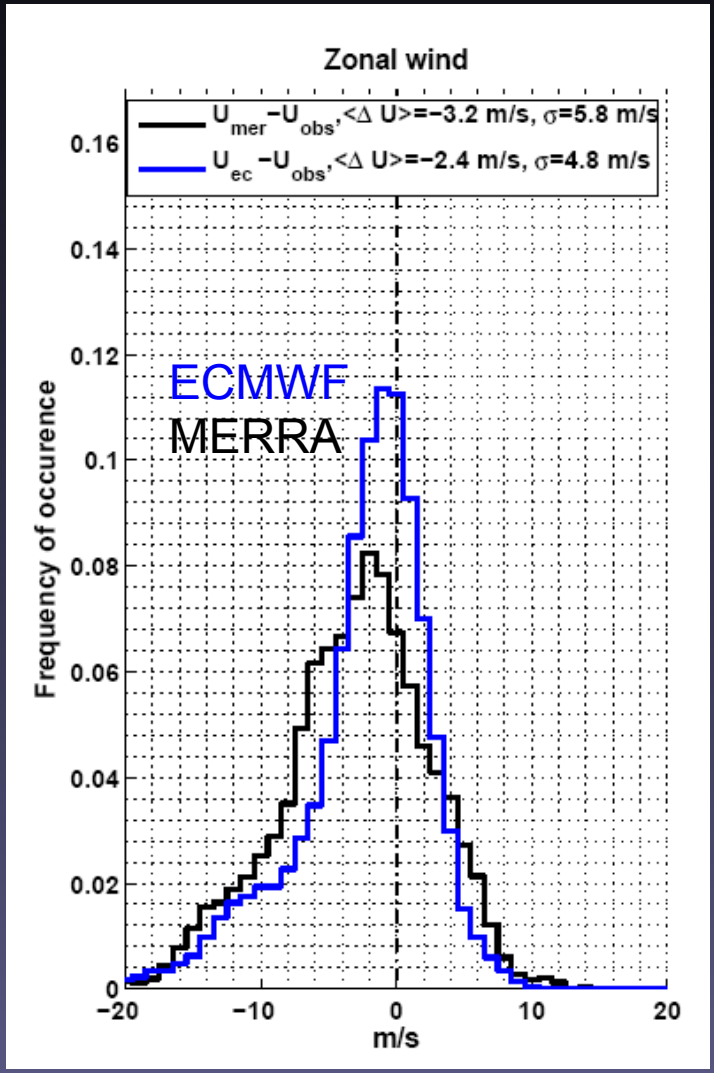
Difference statistics

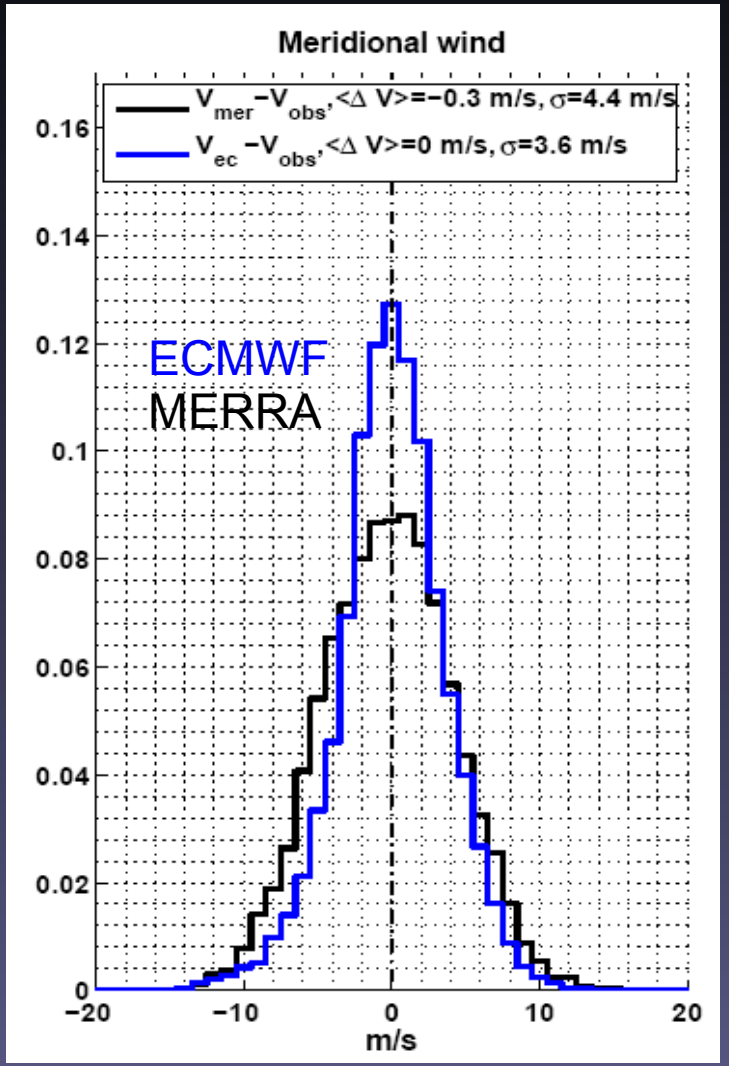


Part of this difference is associated with unresolved small-/meso-scale motions in the analyses...

(Podglajen et al., 2014)

Difference statistics





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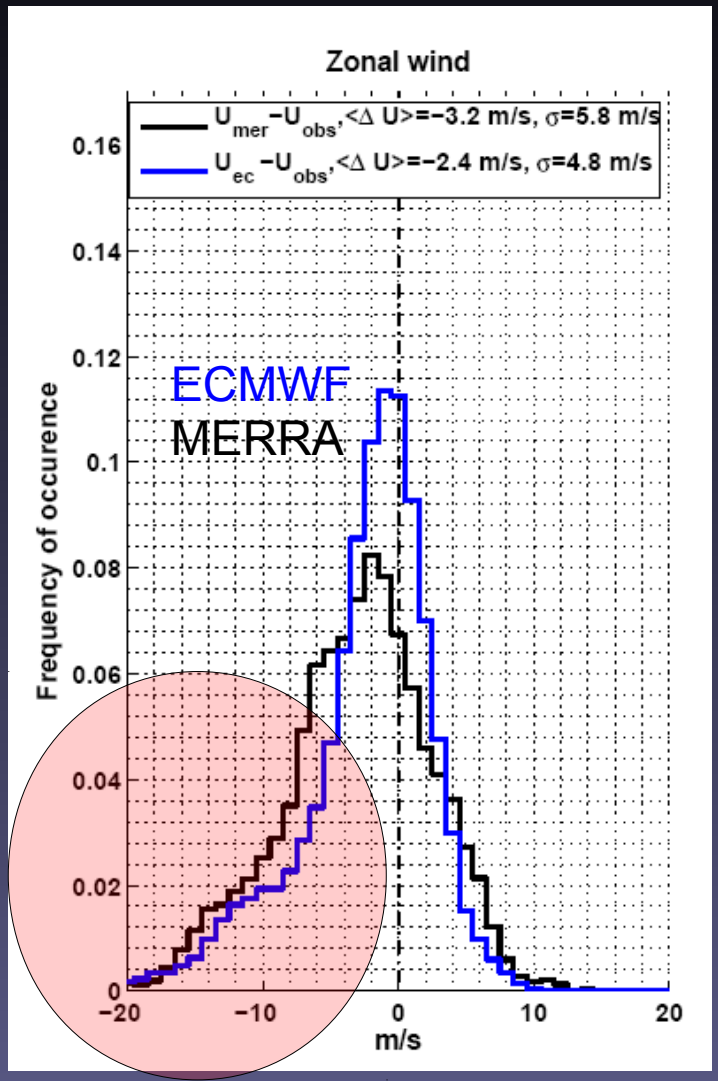
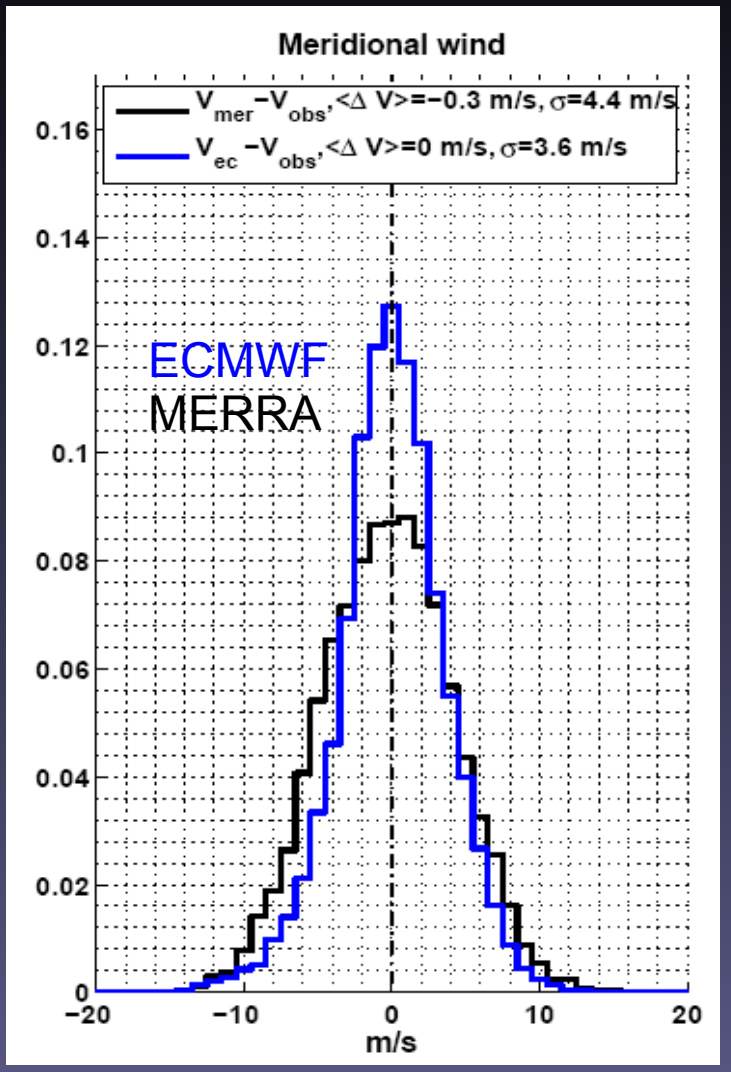
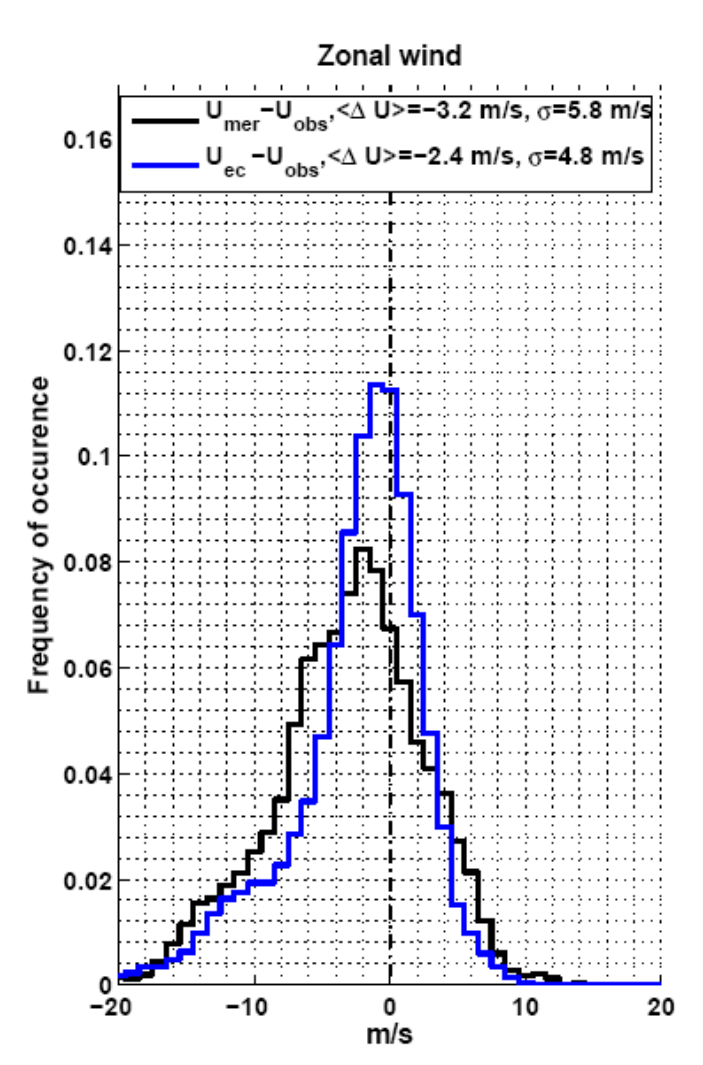
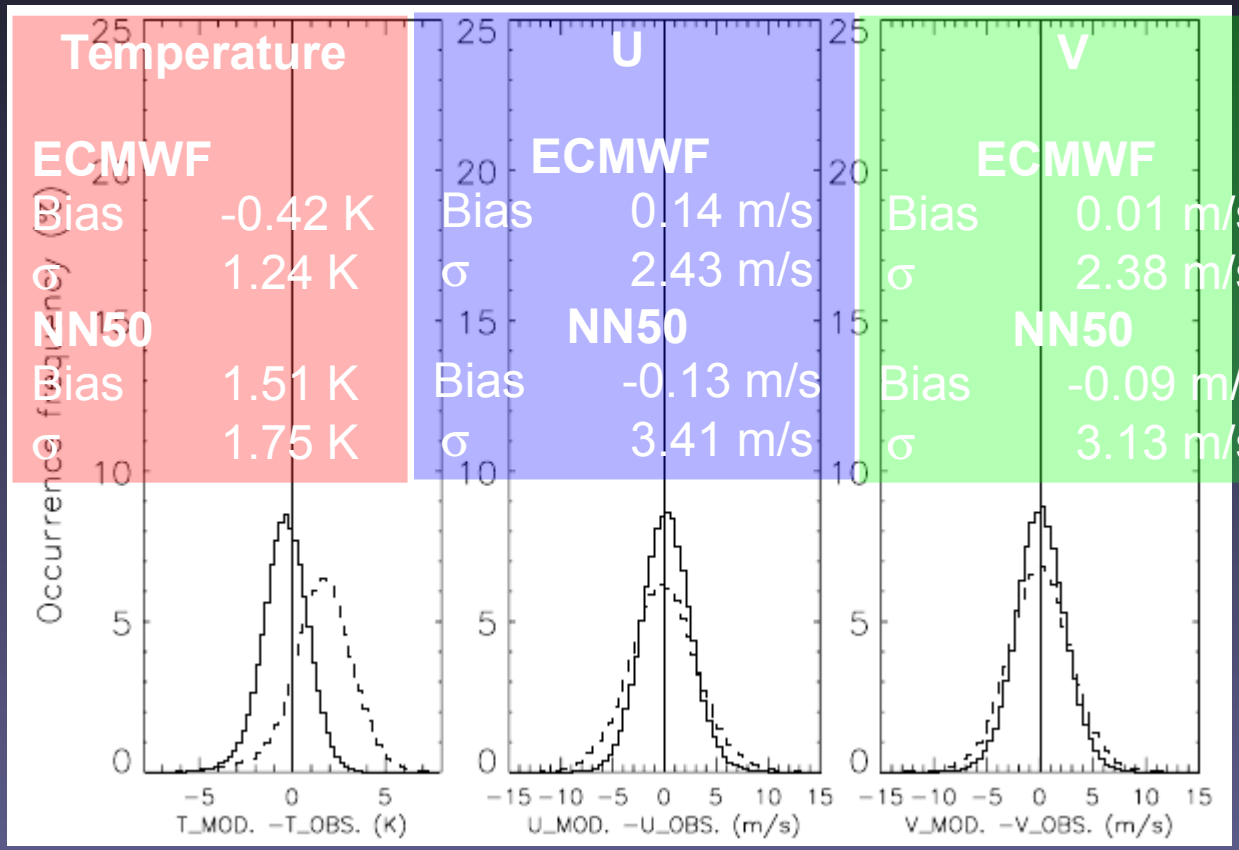




Comparisons with high-latitude observations

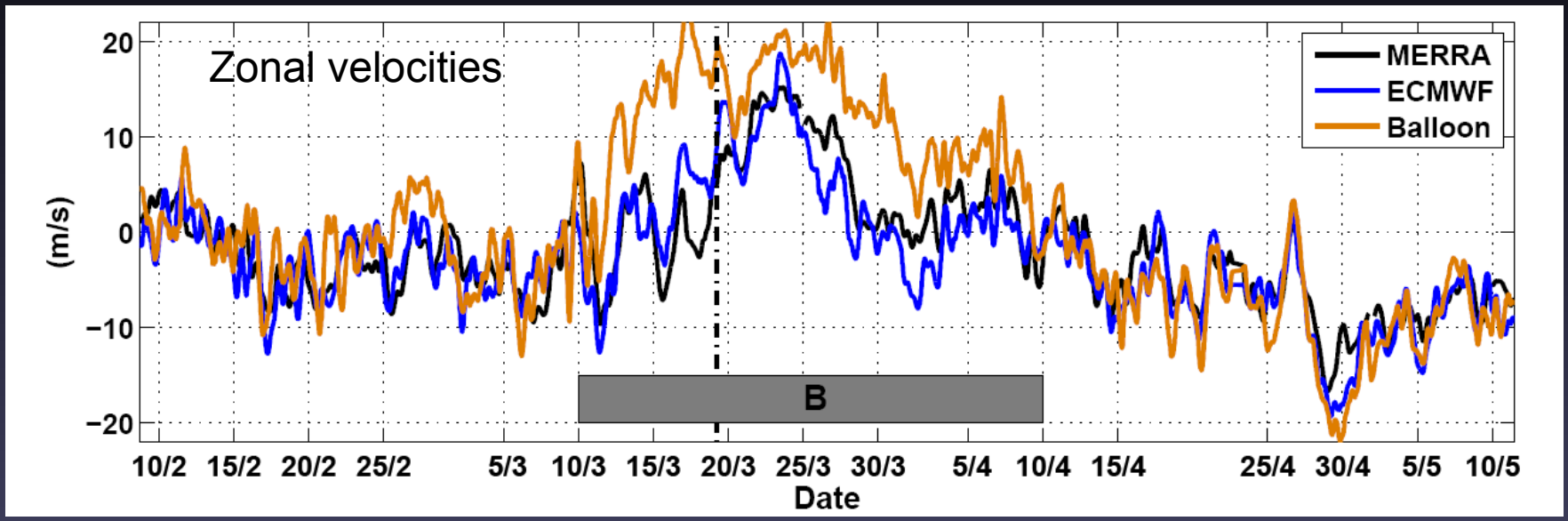


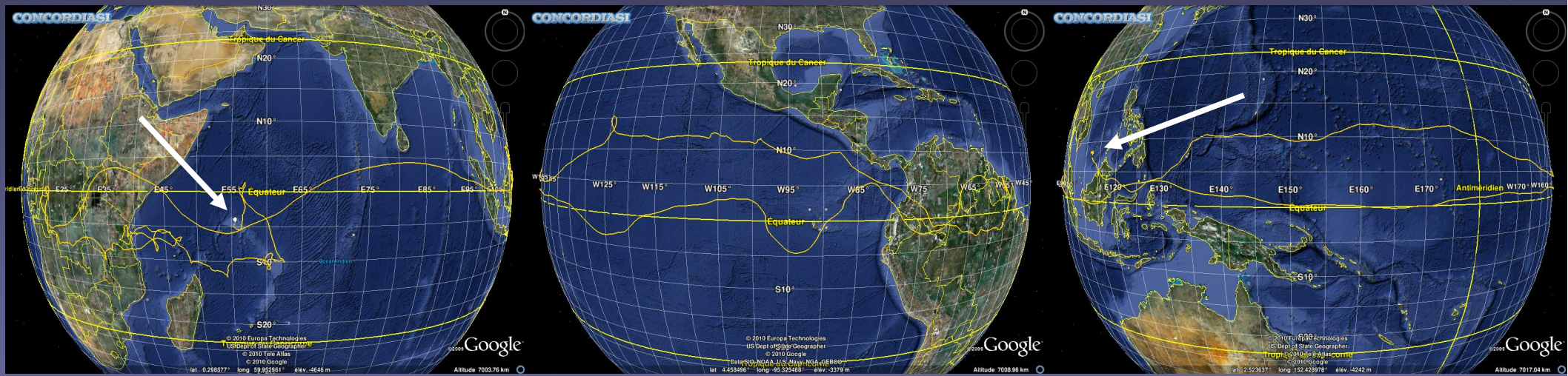
Pre-Concordiasi, 2010, tropics



Vorcore campaign, 2005, Antarctica (Boccara et al., 2005)

Wind timeseries

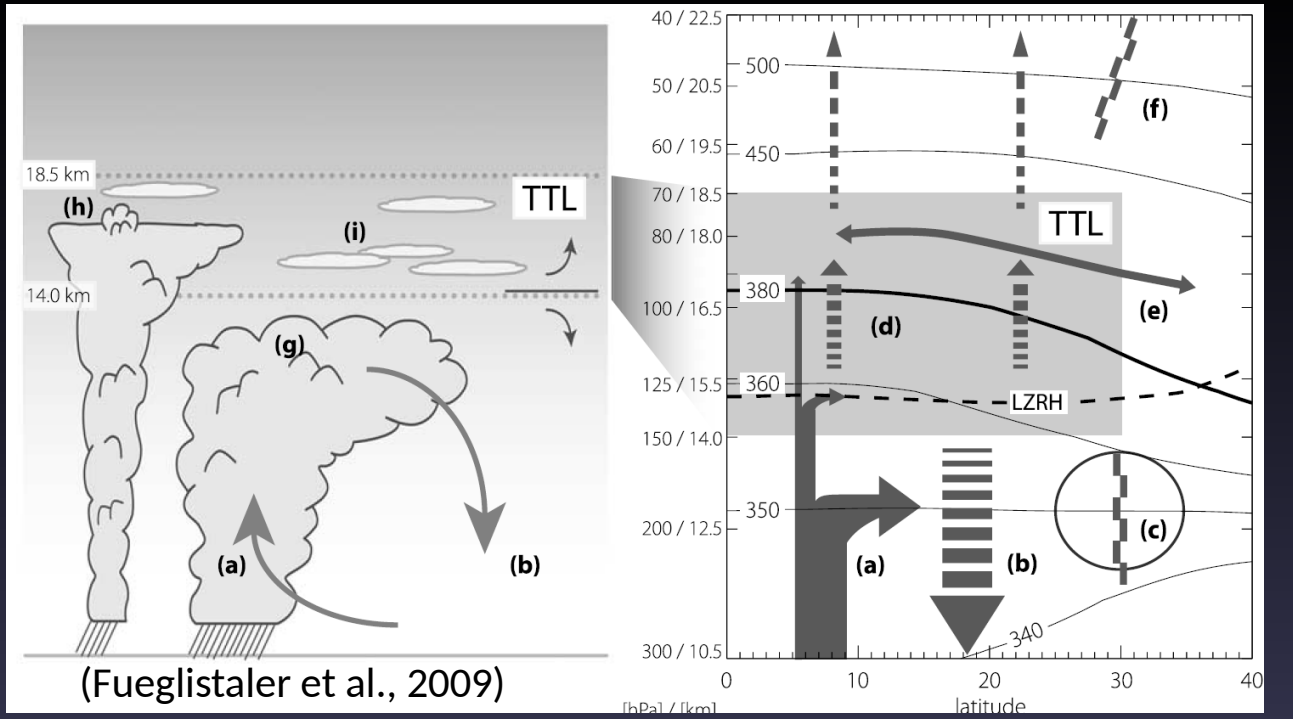




Strateole 2 project

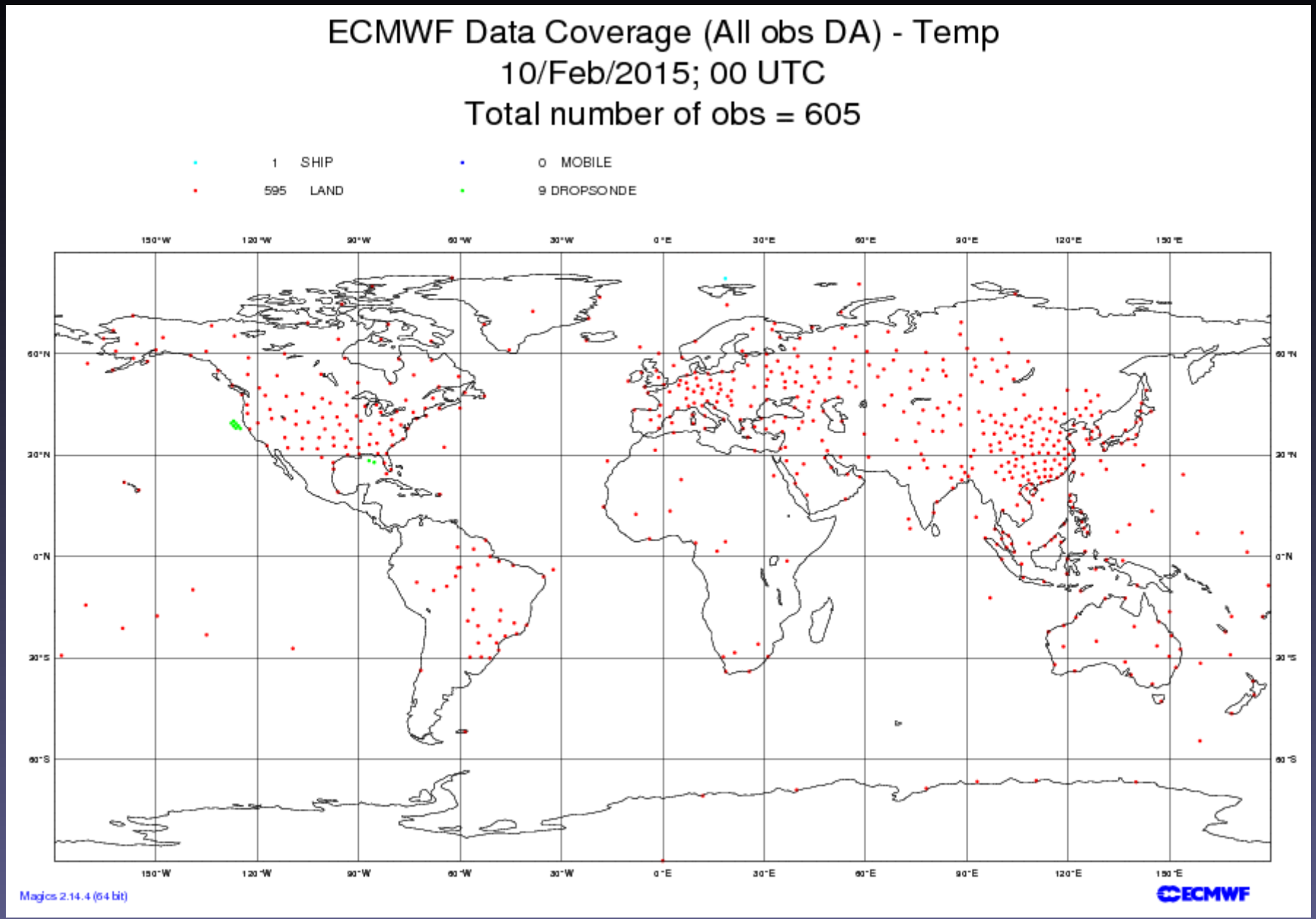
- Our next long-duration balloon project
- French-US initiative focused on the deep tropics
- Schedule
  - 5 flights late 2018
  - 20 flights late 2020
  - 20 flights late 2023
- Treated like a real space project at CNES
  - Entered phase C last spring
  - Active work currently done (instruments and flight systems)
  - Confident in the calendar

Strateole 2 Motivations



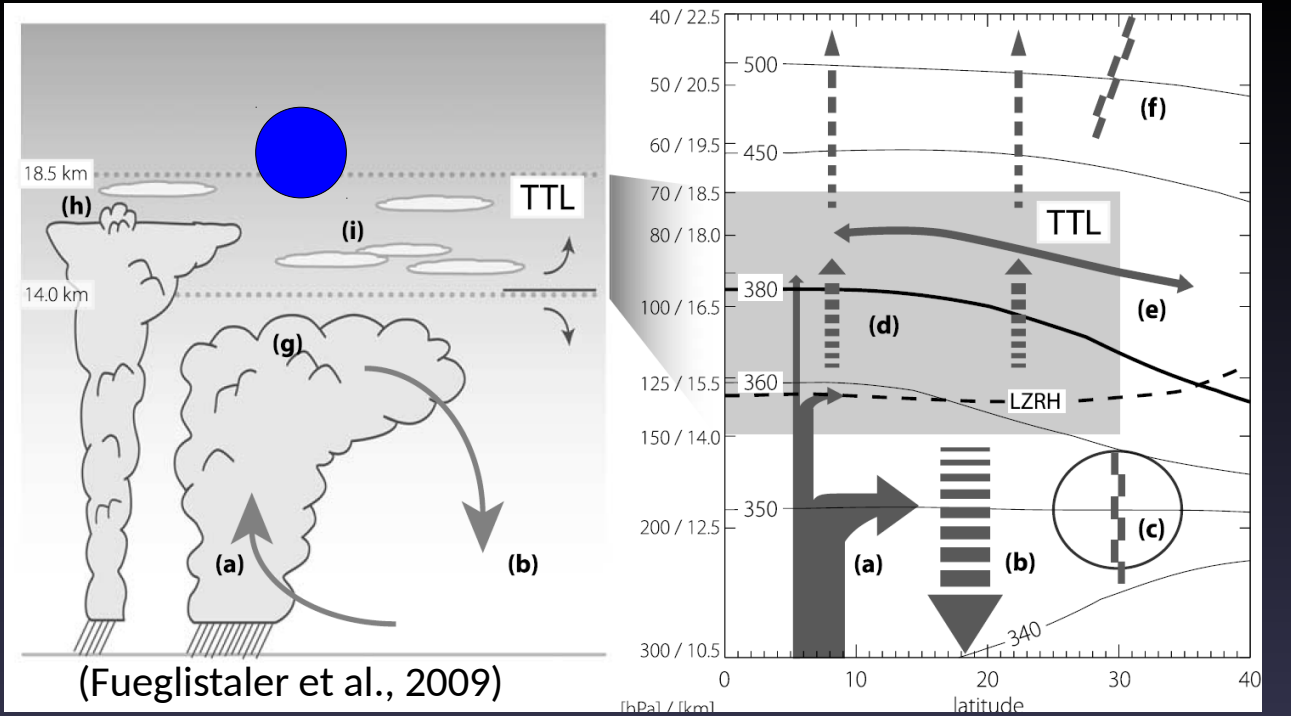
(Fueglistaler et al., 2009)

- Study of the equatorial UTLS or Tropical Tropopause Layer (TTL)
  - Transition region between the troposphere (rapid vertical transport, Hadley/Walker circulation, deep convection) and the stratosphere (slow vertical transport, Brewer-Dobson circulation, QBO)
  - Important role of meso-/small-scale processes that have implications at global-scale: convective systems, penetrative convection, waves, cirrus and dehydration
  - Entrance gate to the stratosphere for tropospheric species
- Analyses are widely used to study transport in the TTL...
  - … but (upper-air) wind observations are quite scarce in the tropics
  - And tropical winds are not as simply tied to the mass field as in the extra-tropics



Few radiosoundings are assimilated by current NWP systems at low latitudes
Void areas over the Indian/Eastern Pacific/Atlantic Oceans and Africa

Strateole 2 Motivations



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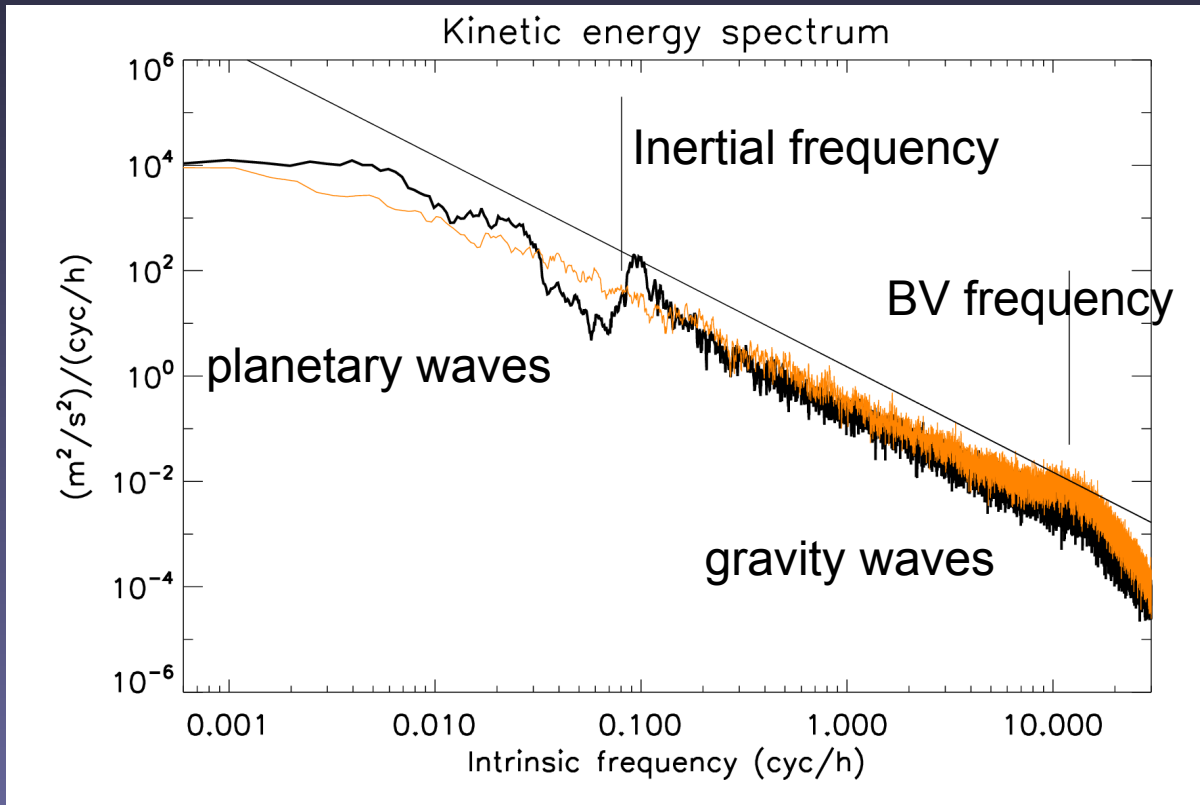
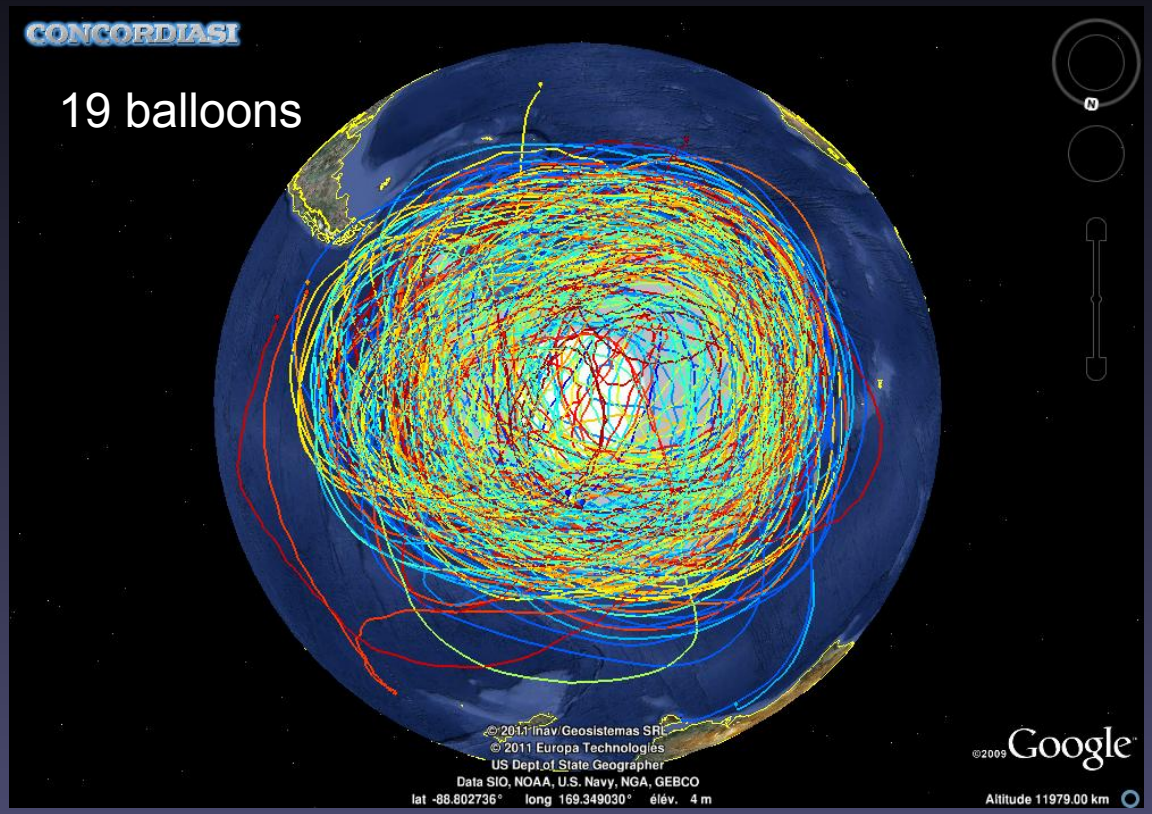
Long-duration balloon assets

- Provide a global picture of the equatorial belt
  - Flights above continents/oceans, convection/clear sky
- Observations are performed in the frame of reference that moves with the wind
  - Quasi-Lagrangian behavior
- 30-s resolution resolves the whole atmospheric wave spectrum → provide observational constraints to GCM parameterizations



Gravity waves
Concordiasi (2010)



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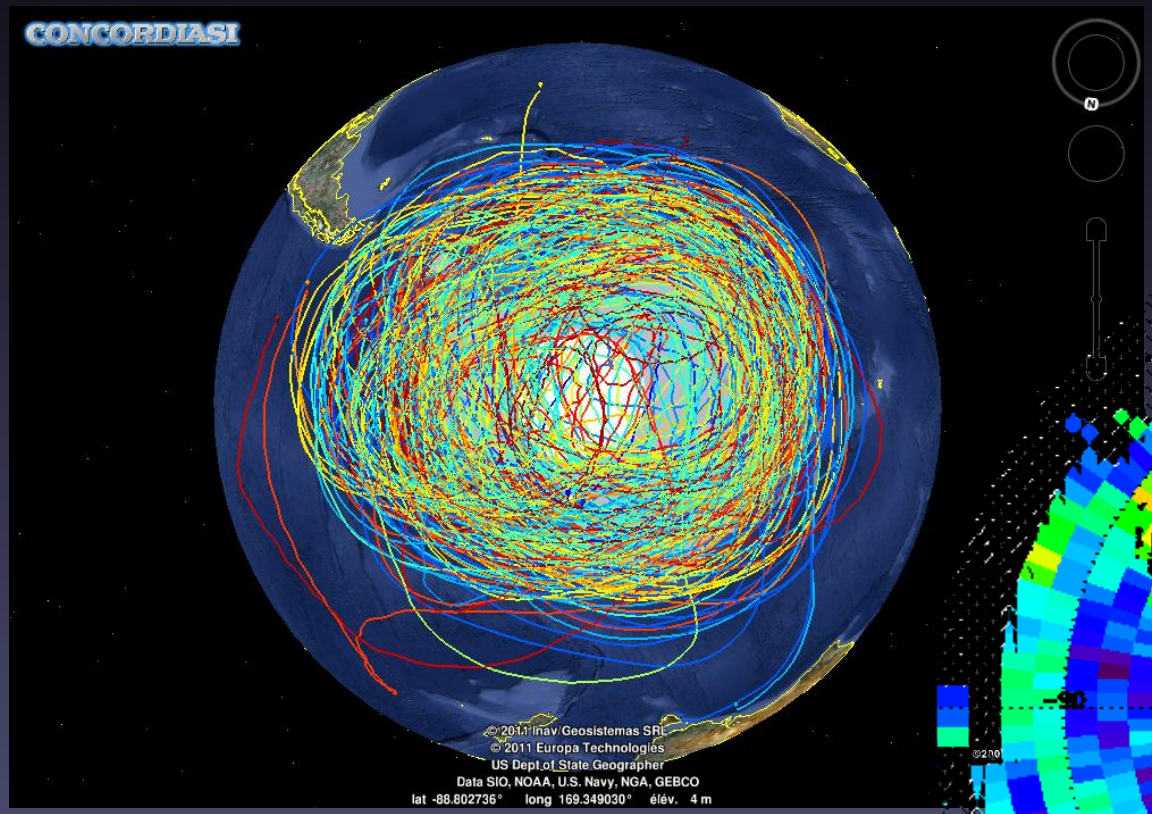

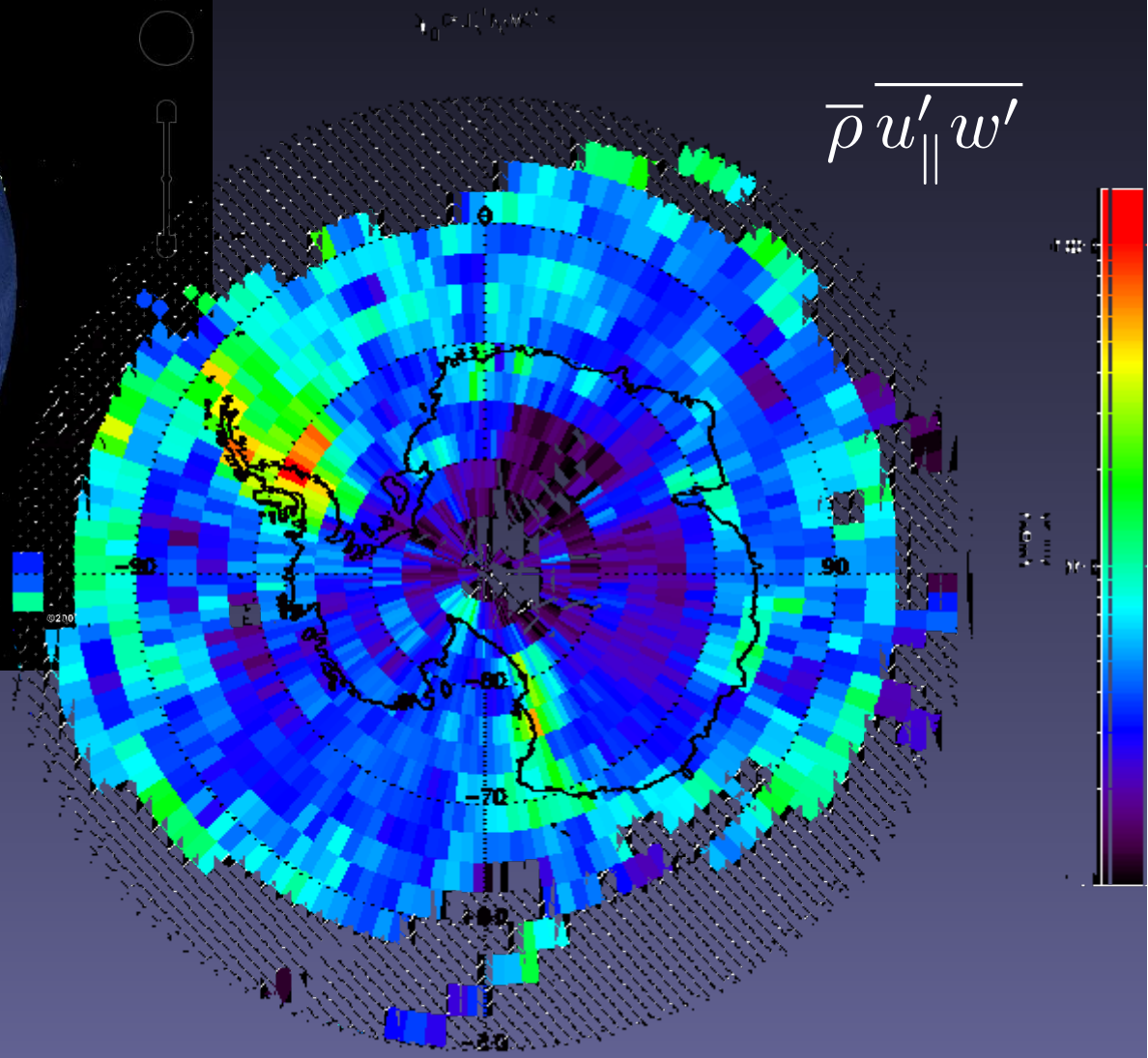

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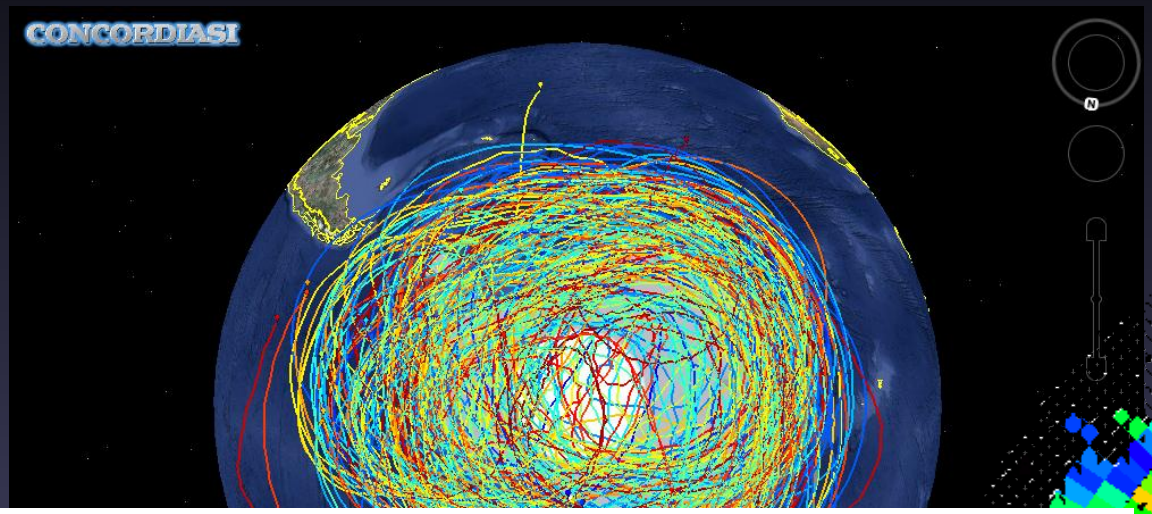

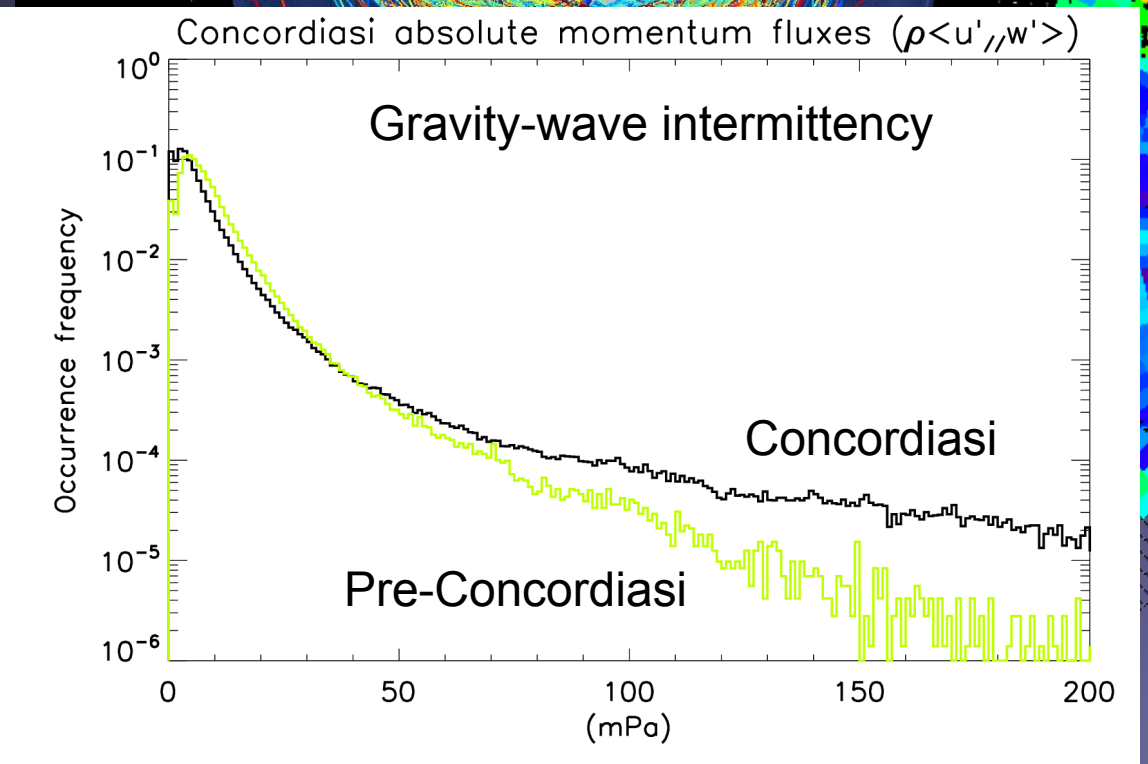

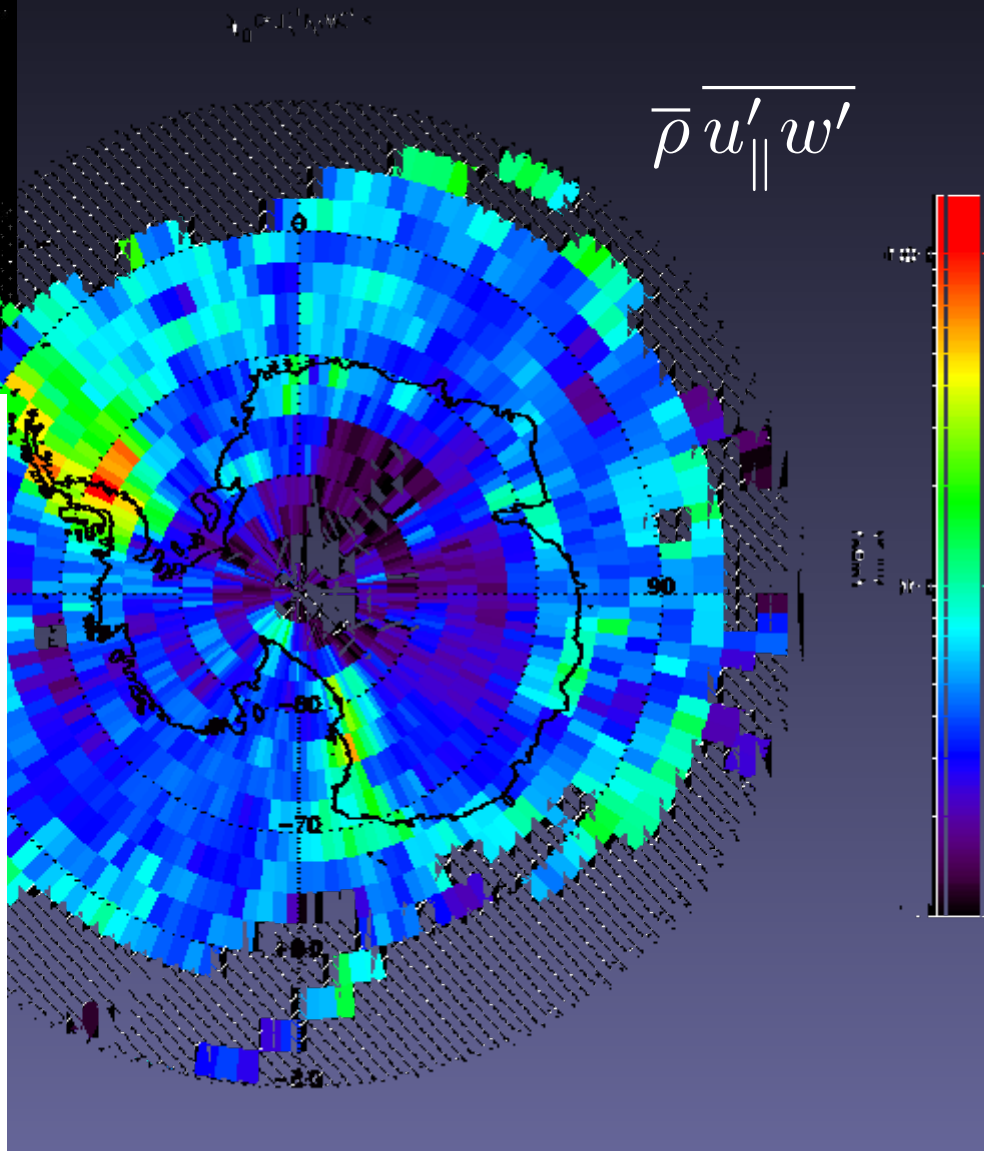

Strateole 2 measurements

- Flight-level meteorological observations
  - P, T, winds @ 50 **and** 70 hPa
  - Will be disseminated on the GTS in near real time (through a collaboration with Meteo-France)
- Sounding capabilities
  - Profiles of T down to 2 km below the balloon, with a vertical resolution of ~ 1 m and a time resolution of ~ 10 min (LASP FLOATS instrument)
  - Nighttime profiles of water vapour and aerosols (LASP/NOAA Rachuts instrument)
  - 850-nm cloud lidar measurements (LATMOS BeCOOL instrument)
- Chemical species at flight-level
  - Water vapour, carbon dioxide, aerosols

Conclusions

- Previous observations performed on long-duration balloons have revealed large, long-lasting errors in the representation of the equatorial lower-stratosphere dynamics in current NWP products
- Strateole 2 (2018-2023) is aimed at observing the equatorial UTLS with these balloons
  - possibly contributes to improving NWP analyses and forecasts (assimilation, parameterization)
  - contributes to ADM cal/val activities in a region where the impact of ADM observations to numerical forecasts is expected to be large (about 300 co-locations in 2018, 1 000 in 2020)
  - feedbacks on how to best implement the campaign most welcomed!
- Google Loon project could be another source of high-altitude winds in the tropics