# Linking submesoscale fronts and air-sea heat fluxes in the Southern Ocean: Results from the first Saildrone circumnavigation of Antarctica

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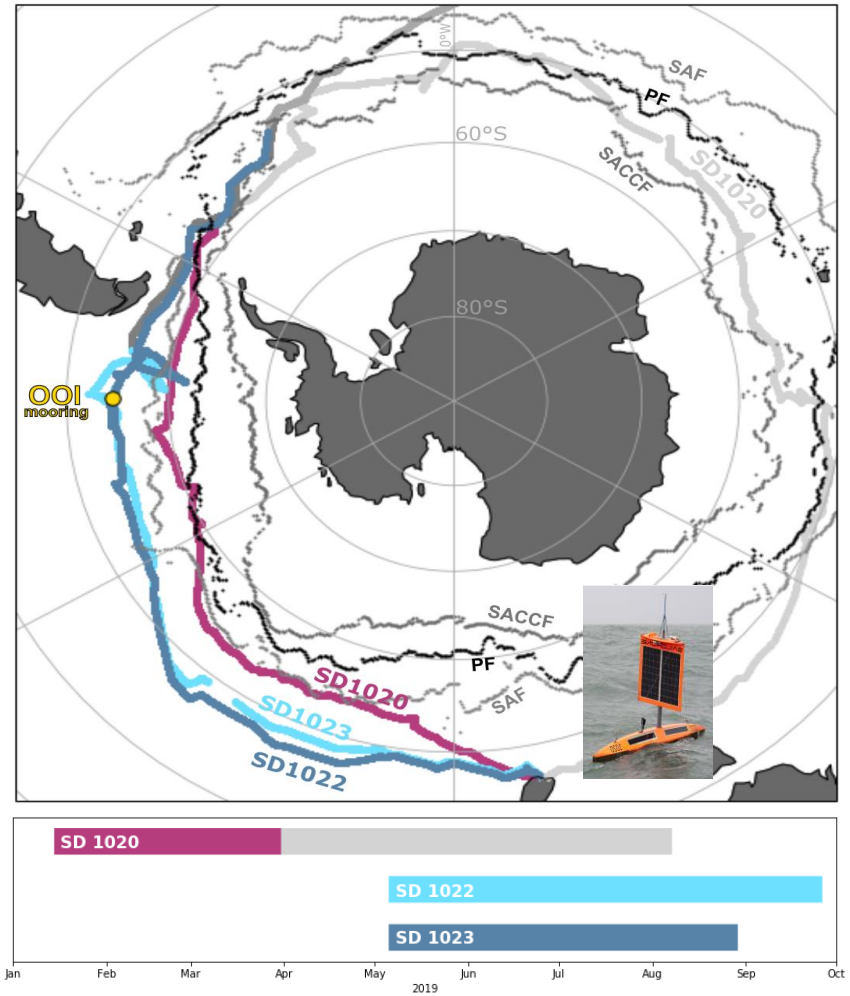


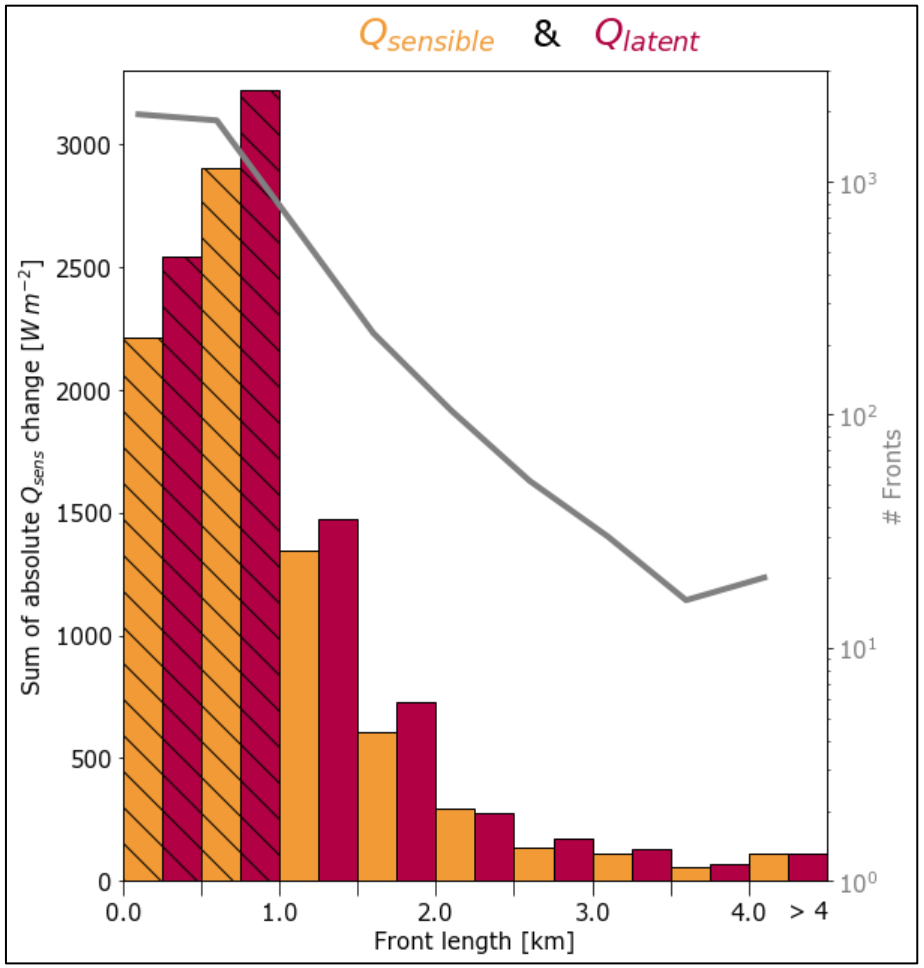


**66 %** of the sensible and **74%** of the latent heat flux changes detected over (uncompensated temperature) fronts were due to fronts smaller than 1 km in length scale.

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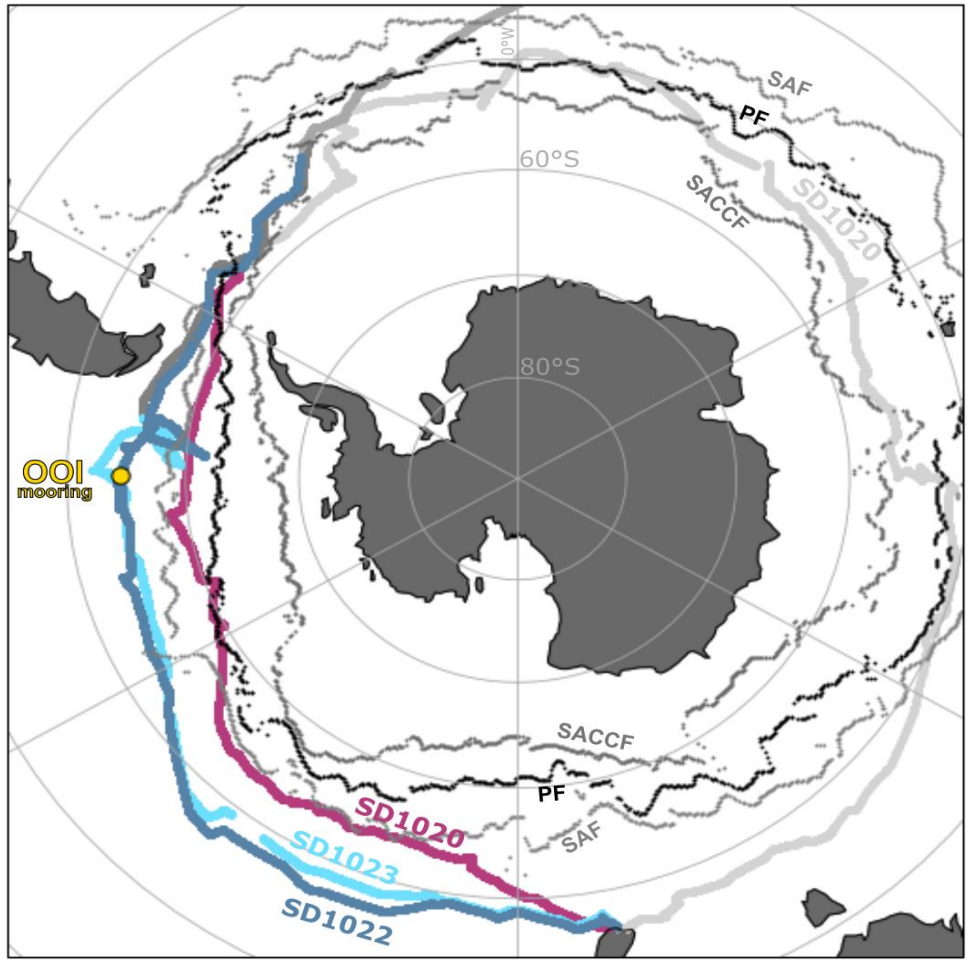
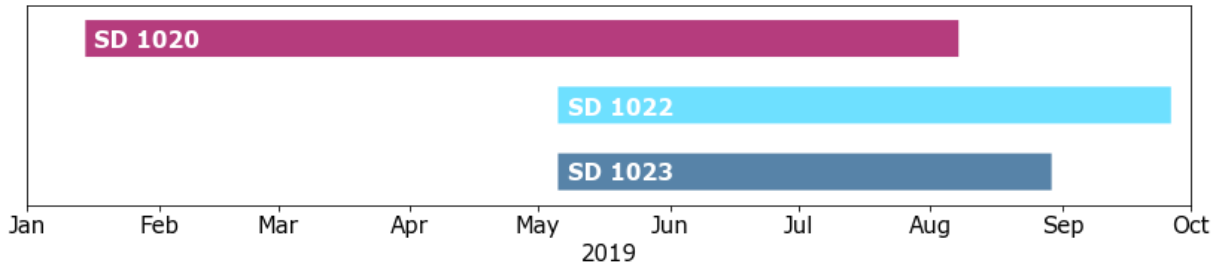
# What was the mission?




Over 630 000 measurements from 3 Saildrones Circumnavigating Antarctica in 2019.

1 min resolution was measured.

5min rolling mean resolution was used in this study to minimize the influence of rapid motion in highly dynamic Southern Ocean conditions.

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# How were the Saildrones equipped?

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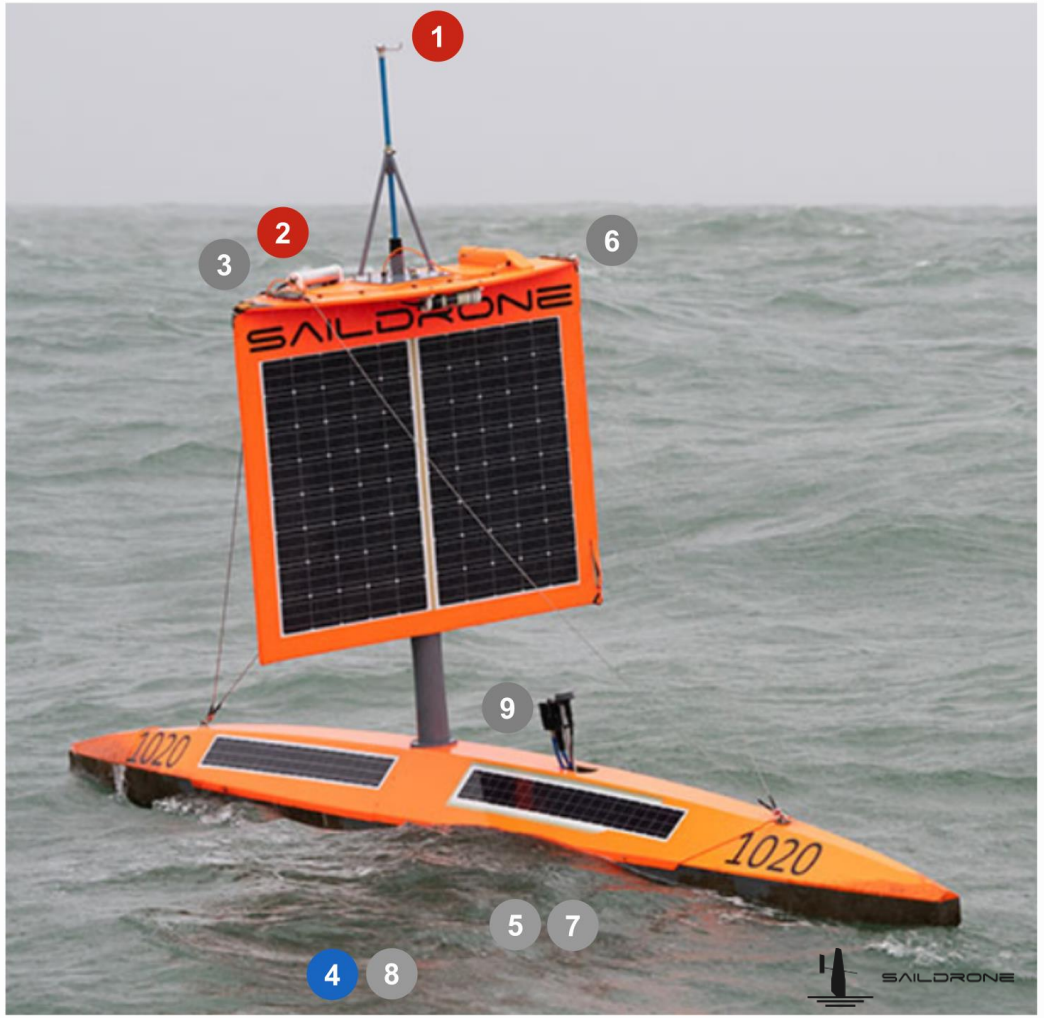
## Atmospheric Measurements

- Wind Speed, Wind Direction → 1 **Anemometer @ +5.2 m** — Gill Windmaster 3D ultrasonic 20Hz
- Air Temperature, Relative Humidity → 2 **Meteorological Probe @ +5 m** — Rotronic HC2 - S3
- Pressure → 3 **Digital Barometer @ +5 m** — Vaisala BAROCAP PTB210

## Ocean Measurements

- Water Temperature, Salinity → 4 **Thermosalinograph @ -0.5 m** — RBR CTD
- Chl - *a*, CDOM Concentration, Red Backscatter → 5 **Fluorometer @ -0.2 m** — Sea-bird Scientific WET labs
- Skin Temperature → 6 **SST IR Pyrometer @ +5 m** — Heitronics CT15.2
- Ocean Currents → 7 **ADCP @ -0.2 m** — Teledyne RDI Workhorse 300Hz
- Dissolved Oxygen → 8 **Oxygen Optode @ -0.5 m** — Aanderaa 4831
- $pCO_2$ → 9 **$CO_2$ System @ -0.5 m** — PMEL map$CO_2$

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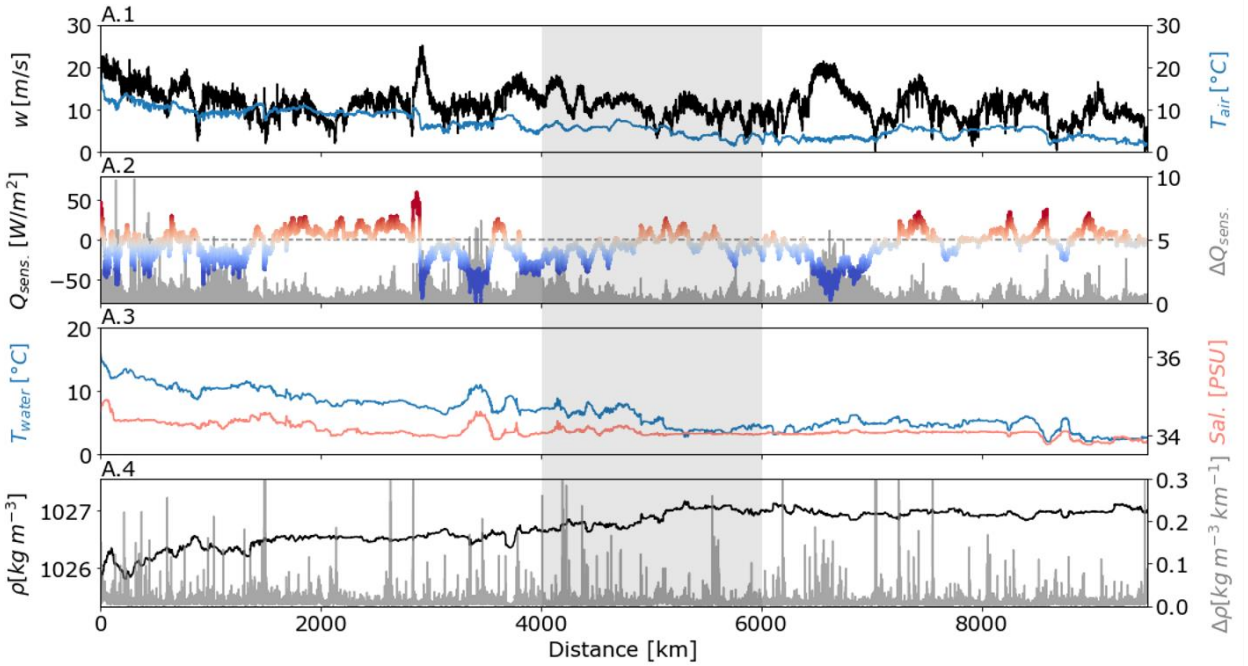
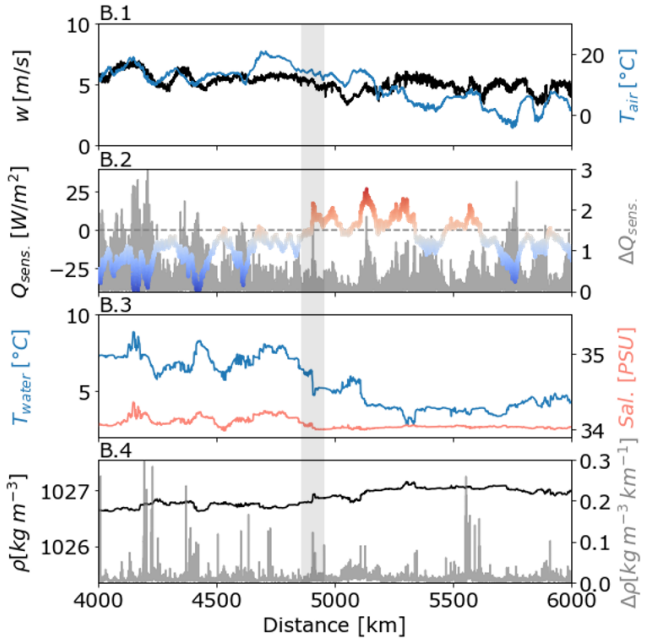
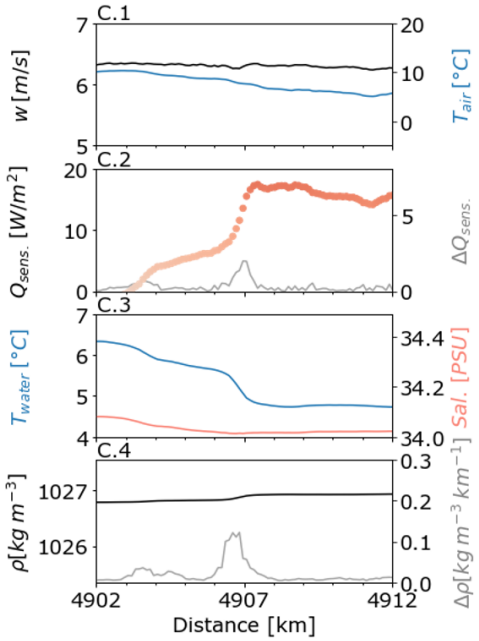
# What does the data look like? What fronts were we looking for ? – a case study

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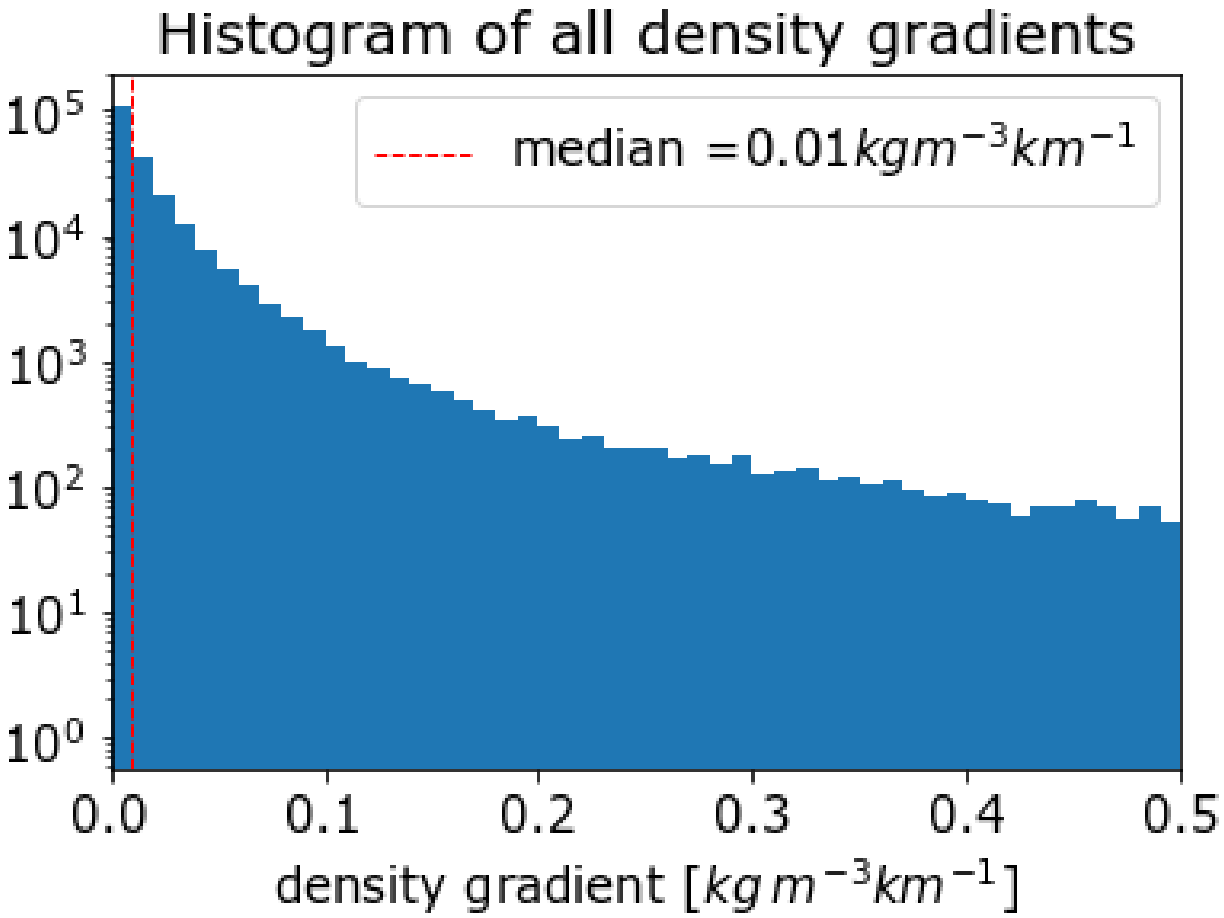
# What horizontal density gradients were measured?




99th percentile: 0.43 kg $m^{-3}$ $km^{-1}$
Minimum : 9x $10^{-9}$ kg $m^{-3}$ $km^{-1}$
Maximum: 4.4 kg $m^{-3}$ $km^{-1}$

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# How did we detect the SST driven fronts?

START is where:

Density gradient > 0.01 kg $m^{-3}$ km $^{-1}$

STOP is where:

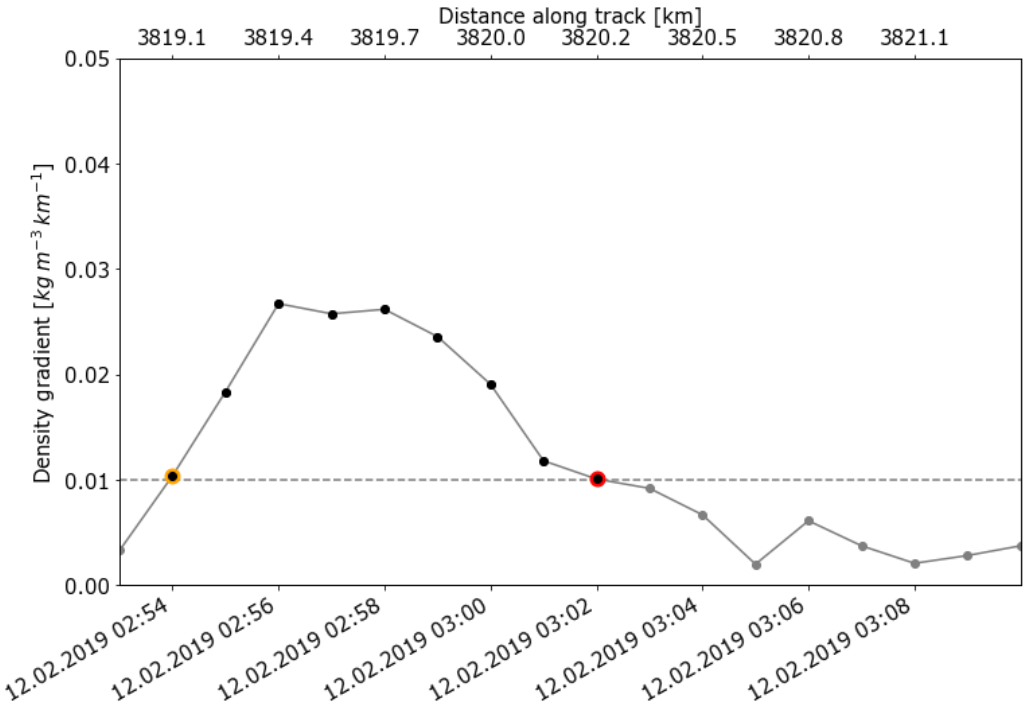
Density gradient < Density gradient @ Start

Front is while:

Atmospheric changes have little impact (i.e. Wind speed changes no more than 0.4 m/s and air temperature changes no more than 0.04 °C)

At least 5 measurement that are at least 15 m apart

SST is driver in horizontal density gradient (i.e. R <1)

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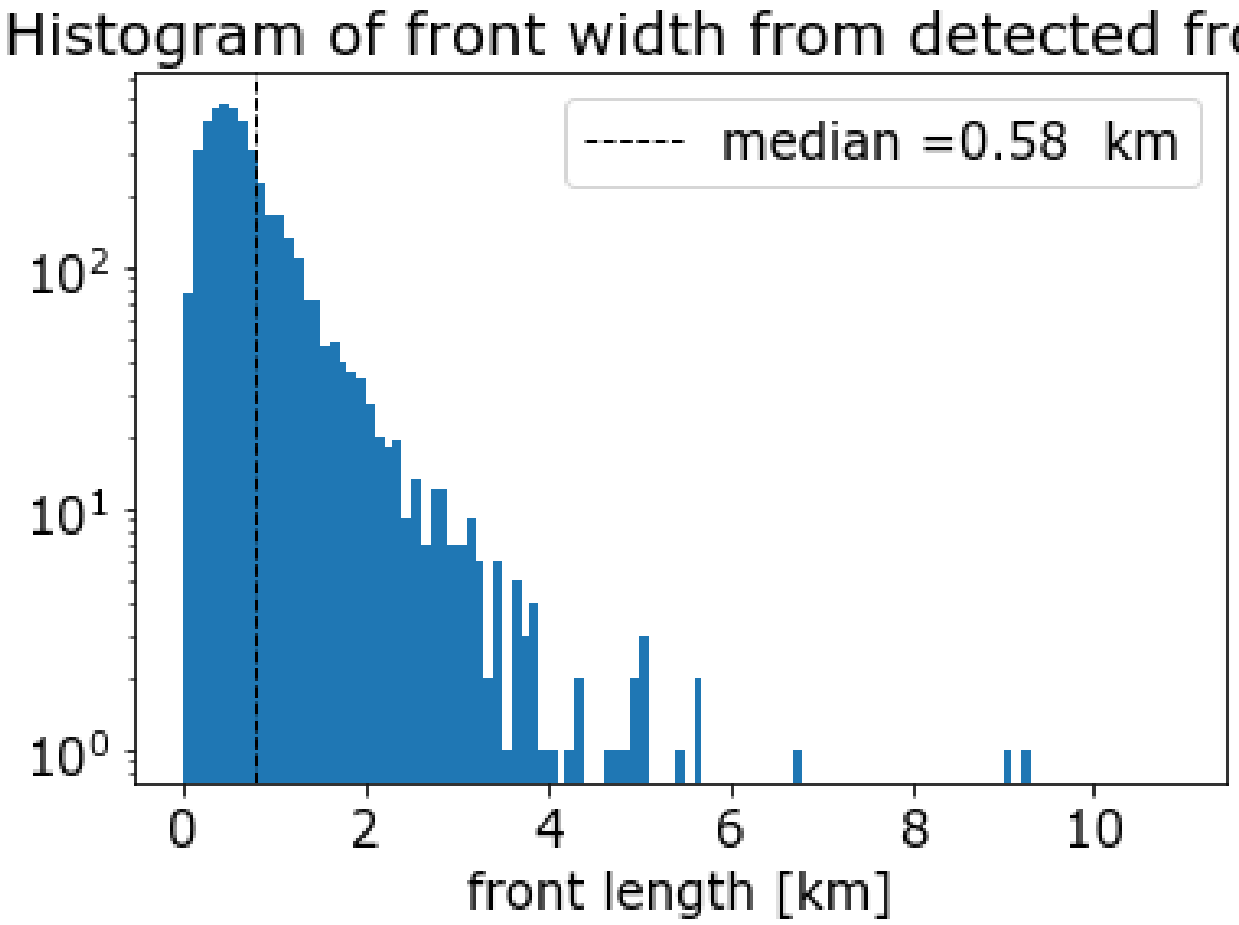
# What SST fronts did we detect ?




Fronts with a length scale from 62m to 9km were detected.

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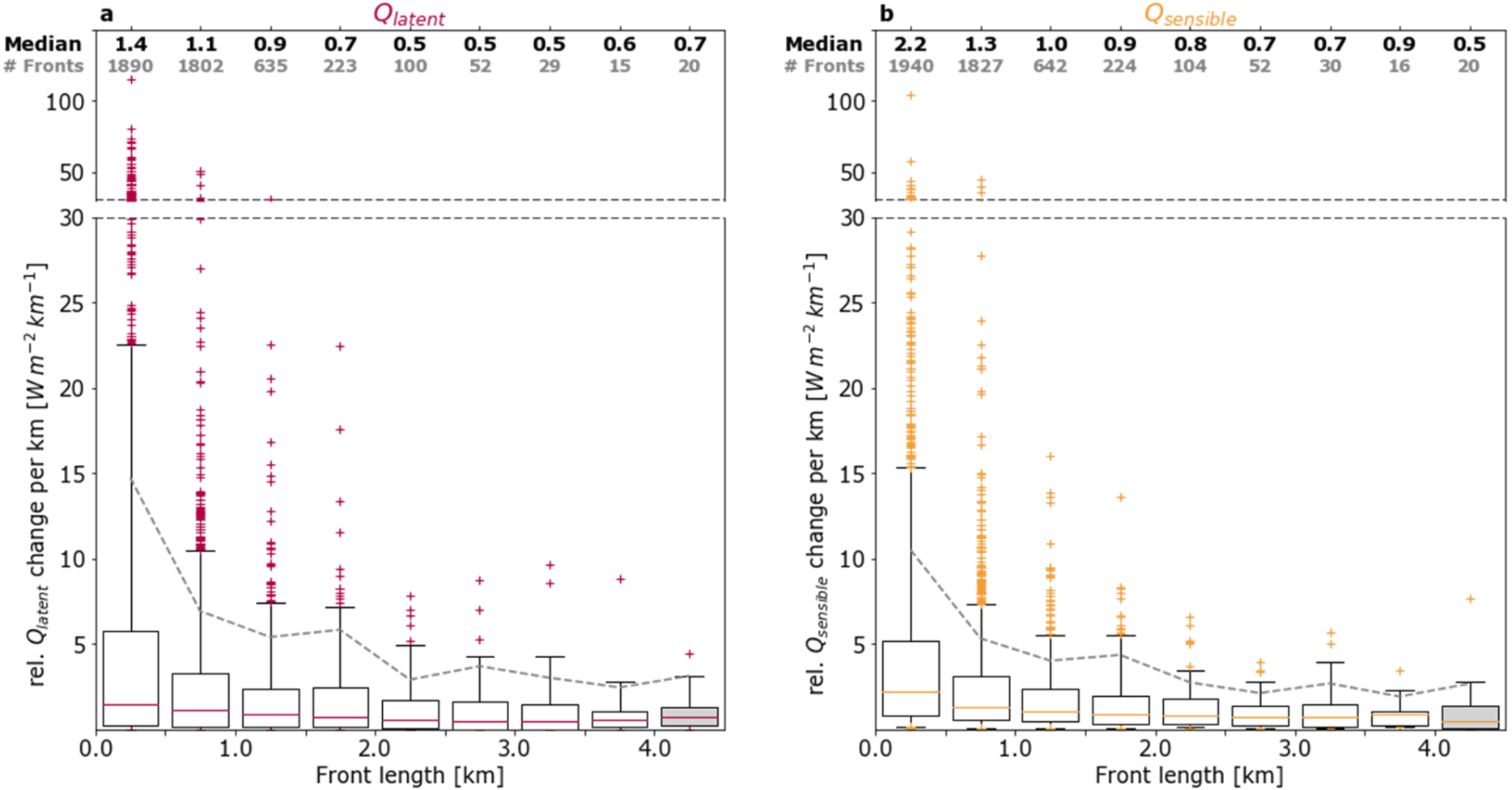
# Relative Heat fluxes: $Q_{change}$ over front divided by front length

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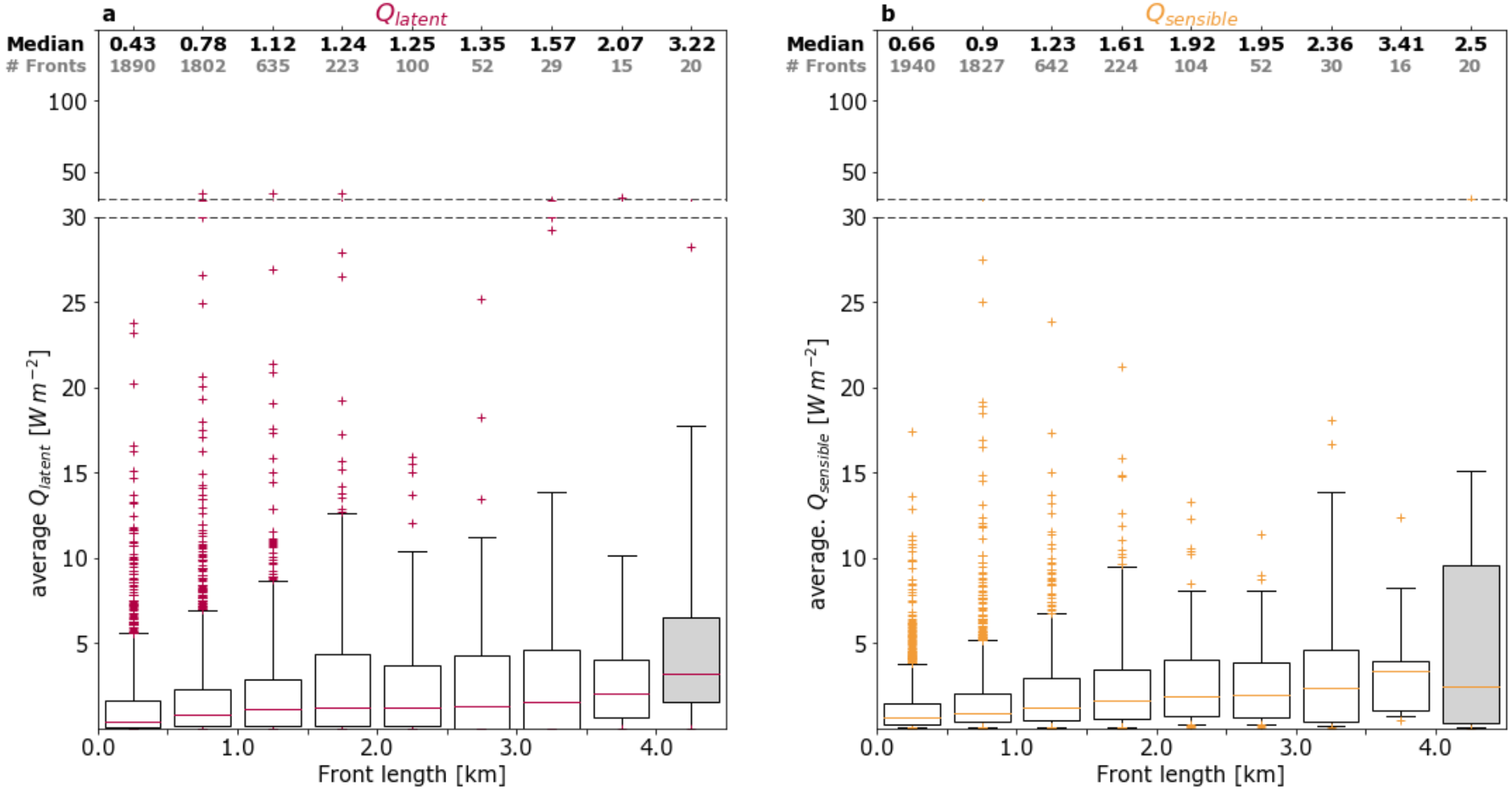
# How do the heat flux changes over individual fronts look like ?

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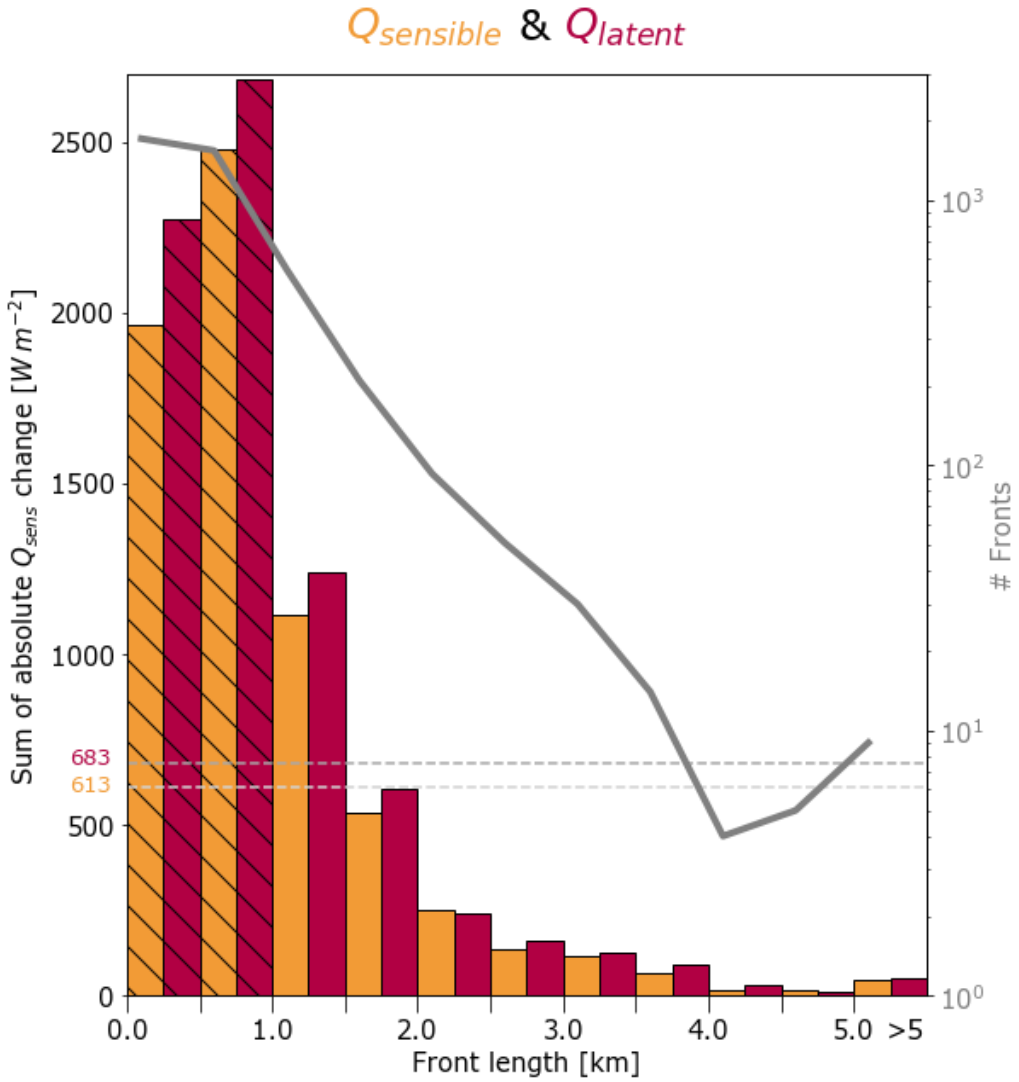
# Why are small fronts important?

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