The vertical and spatial structure of fog events in the Namib Desert (EGU2019-13918)

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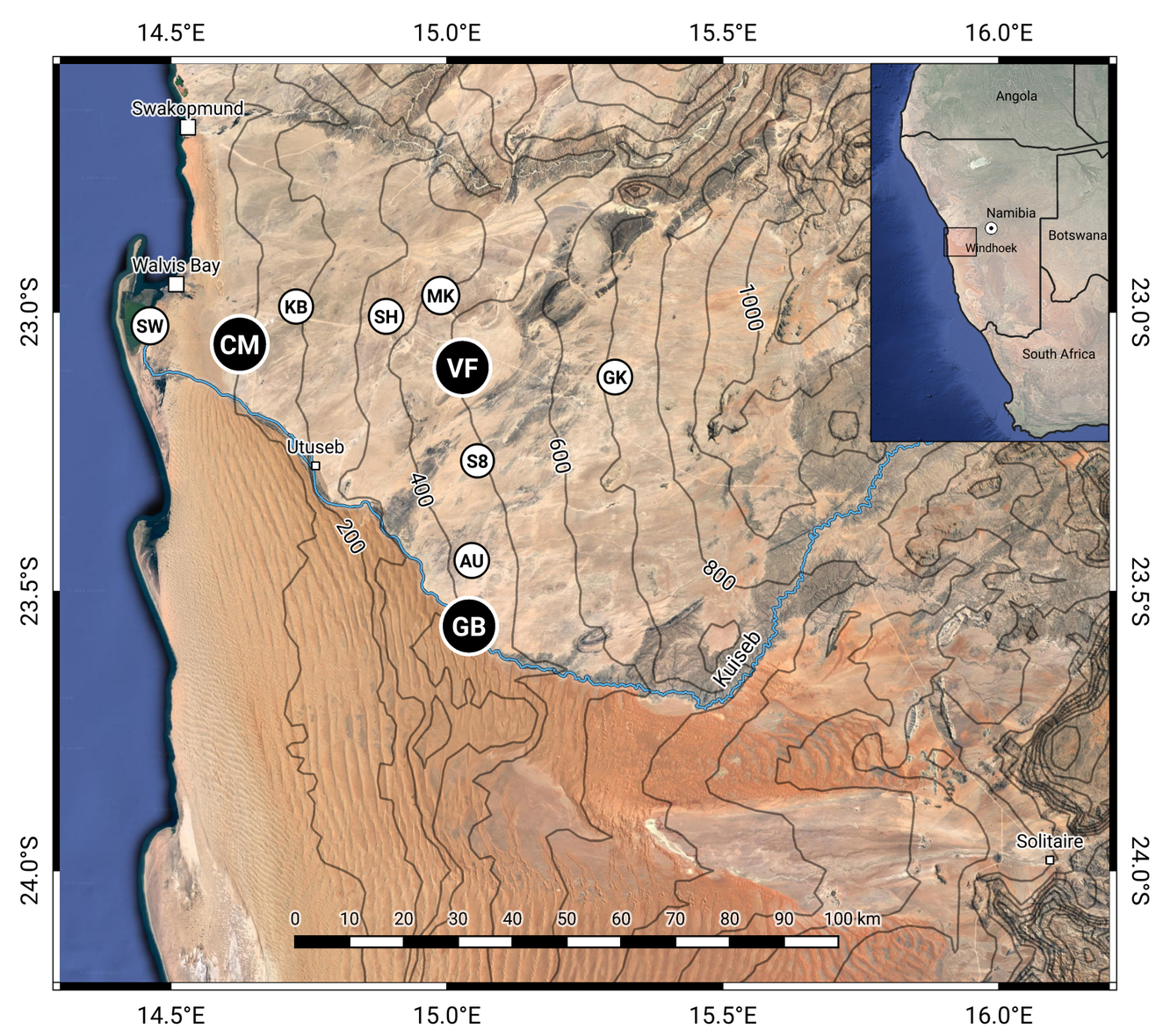
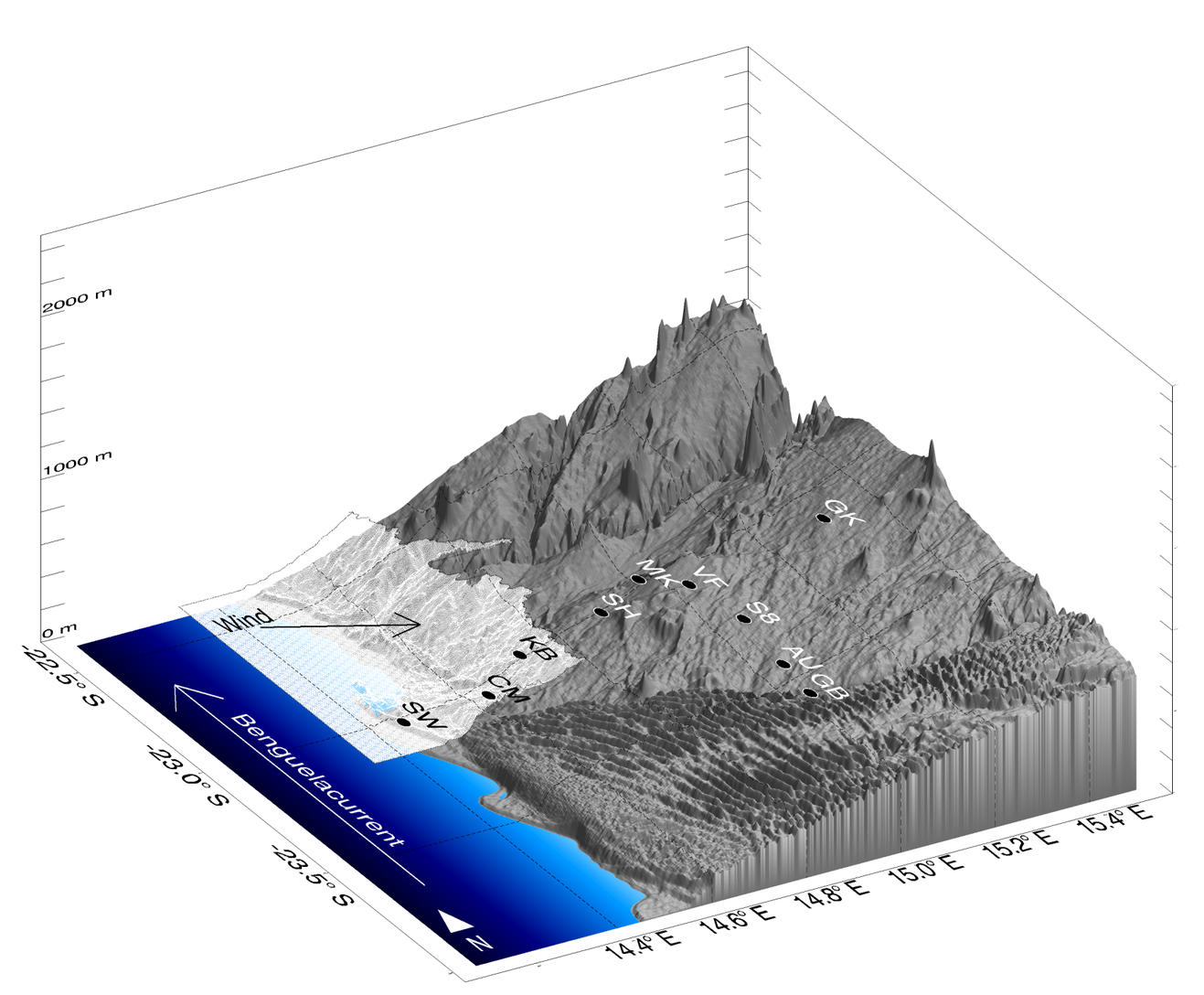
Photography encouraged

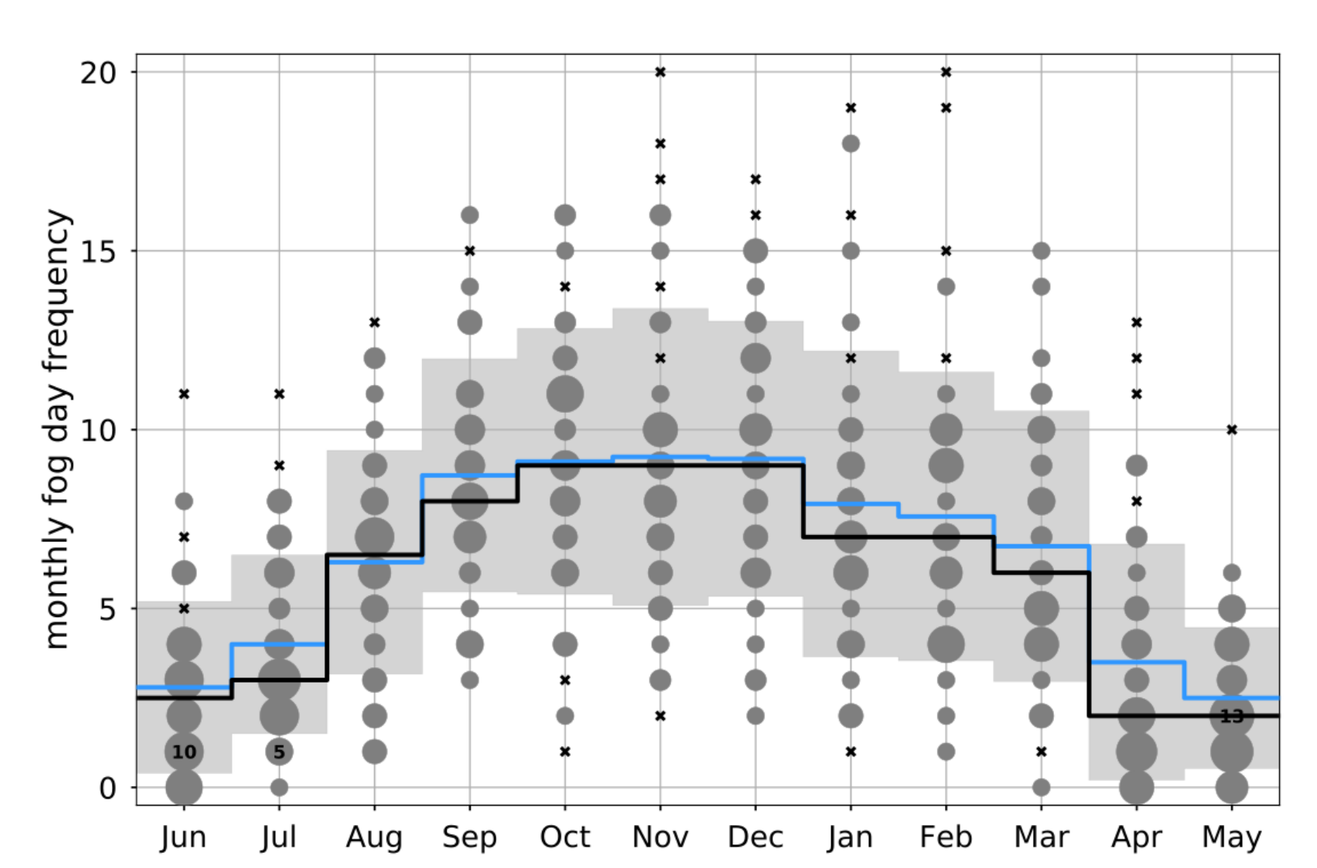
1) Probing fog in the Namib Desert



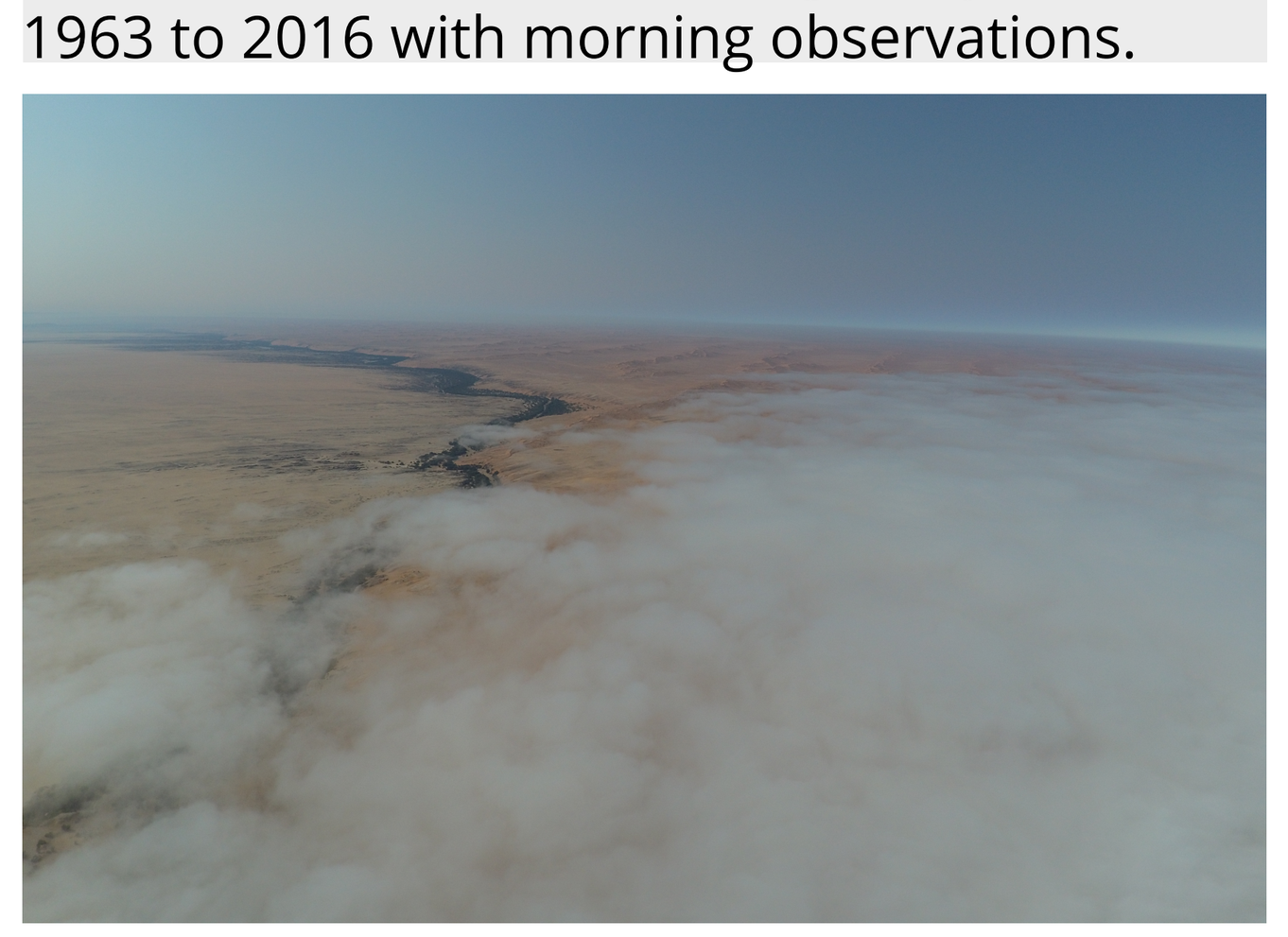
F1: Research area and FogNet stations (IOP locations in black) in the central Namib desert



F2: Sketch of typical wind before/during fog events. Stratus is located off the coast and reaches inland, possibly intercepting the ground. Elevation Data from SRTM.



F3: Monthly fog day frequency 56 km inland at GB at 400 m ASL covering the years from 1963 to 2016 with morning observations.



F4: View from 500 m AGL at Gobabeb in the morning hours after a fog event. The dark band is the Kuiseb river, separating gravel plains and Namib Sand Sea (UNESCO).

The primarily **nocturnal fog is a main water input in the hyperarid Namib desert**[7,9,10]: The quasi-permanent stratus deck[12] over the South Atlantic Ocean is advected over land where it intersects with the ground[4,5].

The **Namib Fog Life Cycle Analysis (NaFoLiCA)** project strives to better quantify the fog deposition and to understand the drivers of fog/stratus in the Namib by employing a scale-spanning approach: Groups using satellite data[1,2,3], forecasting models and ground data are working together as partner projects.

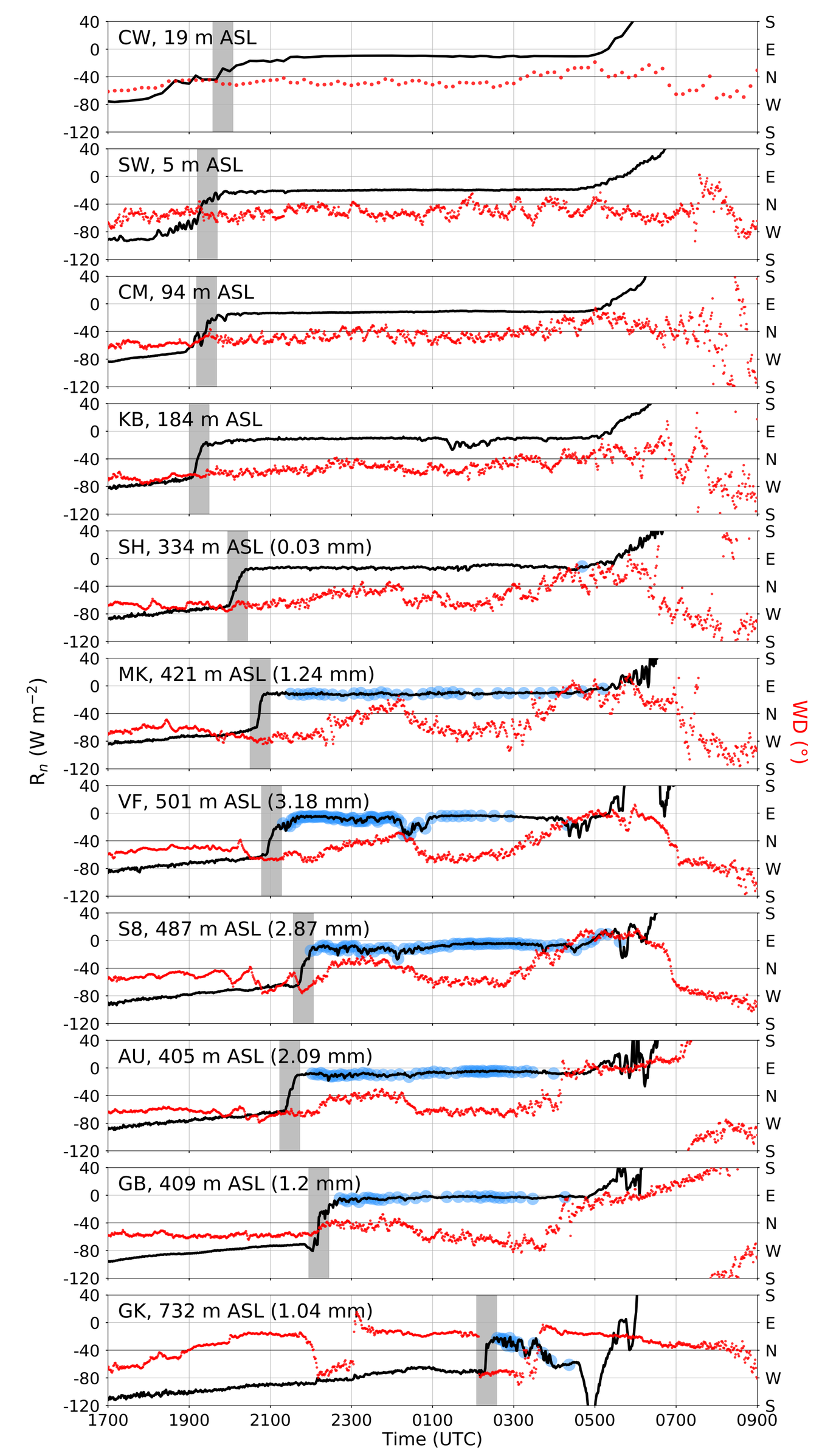
An intensive observation period (IOP) was conducted to gather data about the vertical structure of the fog. Sampled profiles are **supplemented by FogNet**, a measurement network (F1), whose stations served in part as locations for devices during the IOP. Stations are located either with increasing elevation (west-east) and between 400 to 500 m ASL (north-south) to catch the full extent.

The IOP took place **in the high fog season**[8,11,13] **in September/October** (F3). Manual vertical sampling of fog/stratus was conducted during 5 nights (ION). A UAV and a tethered balloon sonde (TBS) recorded T/RH/Wind up to 800 m. Radiosondes were released at fixed intervals. Vertical profilers (SODAR/Ceilometer/Microwave profiler) at the coast and inland, microlysimeters and a cloud droplet probe ran continuously.

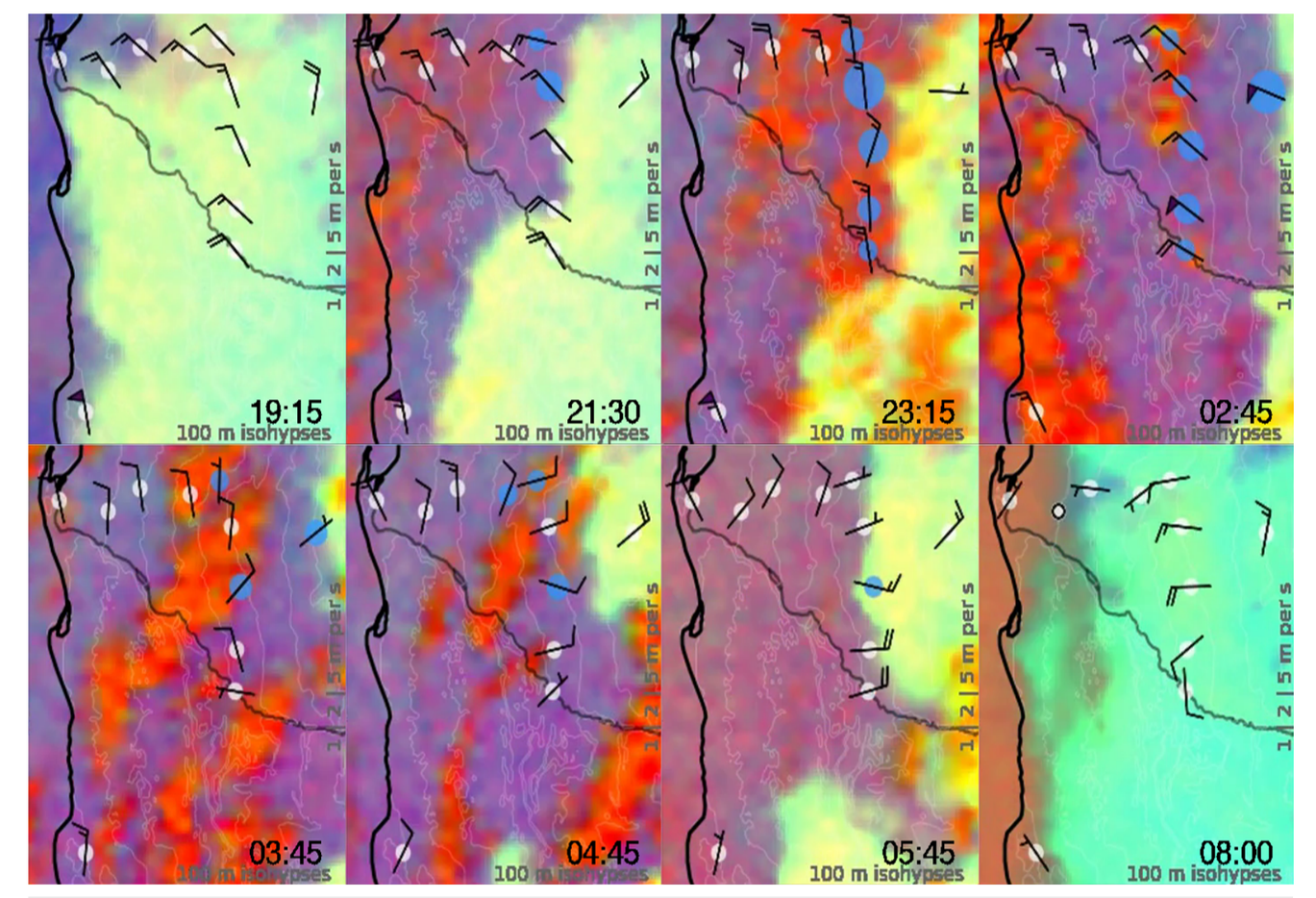
FogNet measurements of T/RH/Wind/Radiation and fog precipitation by Juvik type collectors served as the backbone in the IOP. The networks considerable spatial extent helps in **tracking the progress of fog** across the landscape.

Since fog generally reaches inland at night, sampling began at 17 UTC with fog occurring around midnight. UAV and TBS were operated throughout the night until 7 UTC. Both TBS and UAV reached up to 800 m, well above the upper limit of the stratus of roughly 400 m. The dissipation of the fog can last well into the morning (F4).

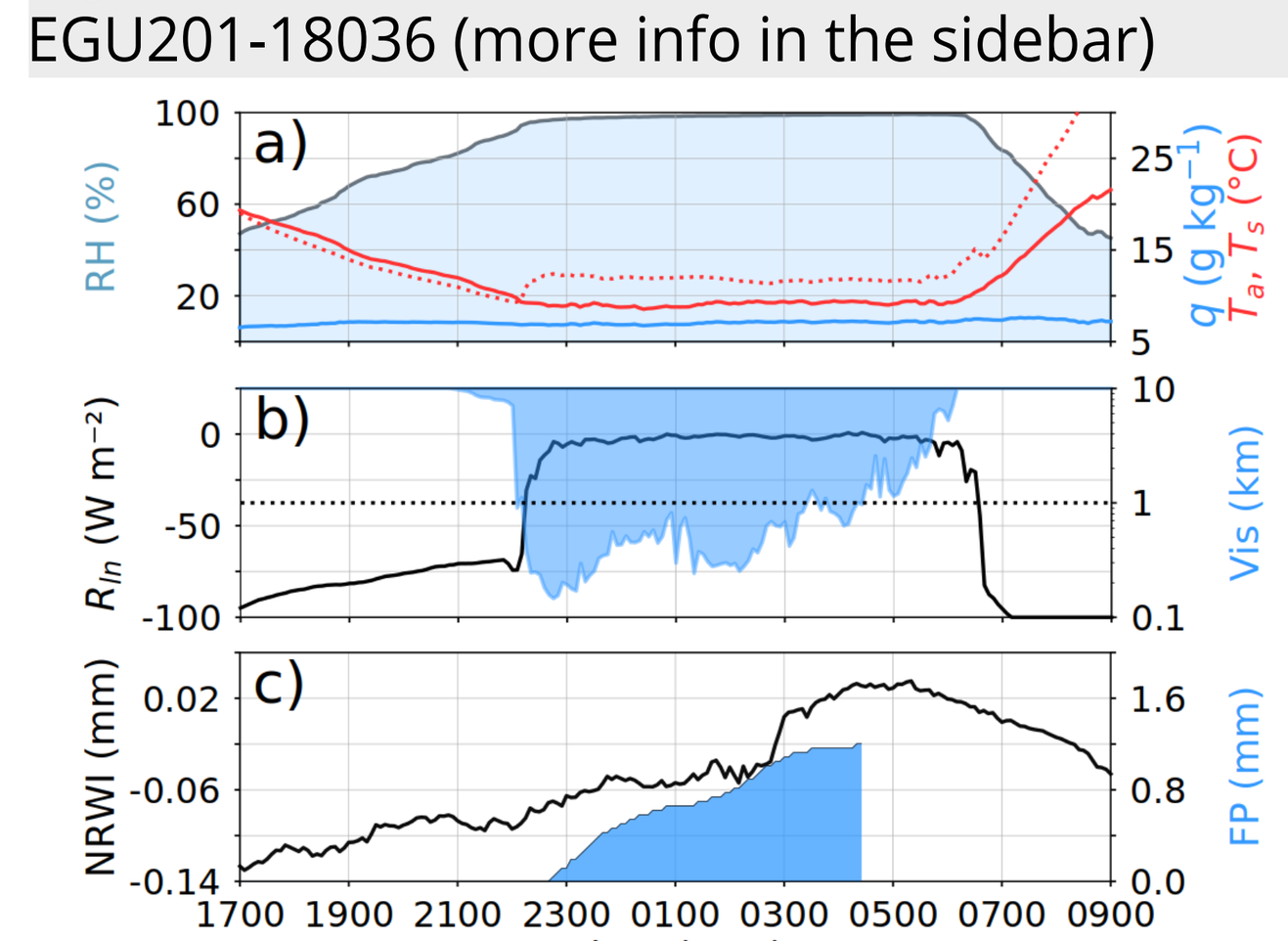
2) Spatial extent of fog



F5: Longwave radiation balance and wind direction during the fog event of ION4 at FogNet stations ordered by elevation/distance to the coast. Blue markers indicate fog precipitation, the grey bar indicates stratus/fog appearance.



F6: Dust composite (MSG) with wind vanes and fog precipitation (blue) at FogNet stations during ION4 at selected times during the night. For information about MSG see event EGU201-18036 (more info in the sidebar)



F7: Selected meteorological variables on ION4. Visibility threshold for fog of 1 km (dotted) in b), NRWI in c) is relative to IOP begin.

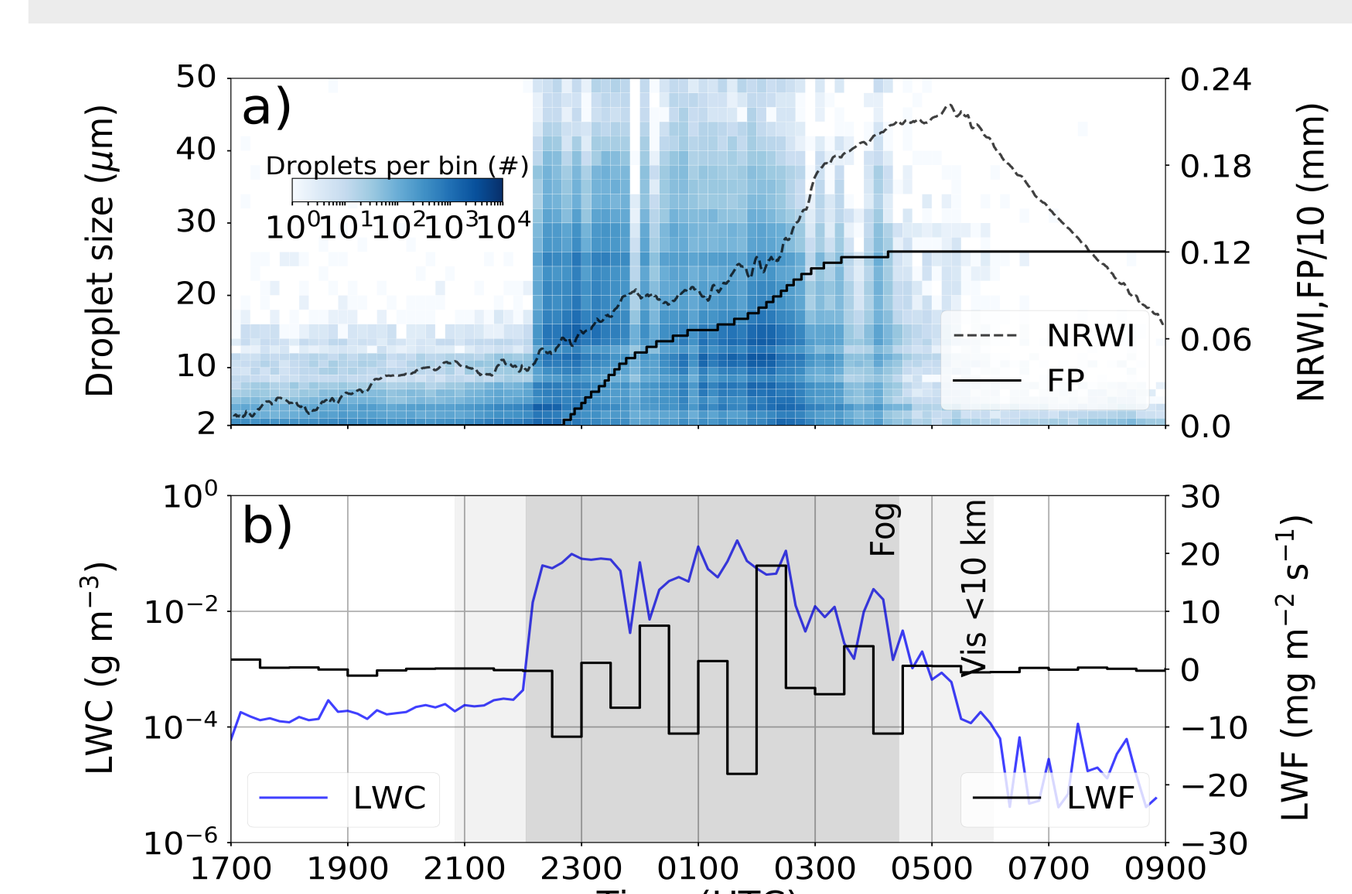
The stratus first appeared at stations **closest to the coast** (F5) shortly after 19 UTC on ION4, the 27/9/2017. Fog precipitation indicates that **contact with the ground began at above 400 m** AGL after 21 UTC (MK). The timing of fog appearance generally followed the distance from the coast. The range of stations with fog precipitation suggests a stratus thickness of 300 m.

Satellite data from Meteosat (F6) **suggest that fog/stratus is advected.** Wind at the ground came from a northern sector and intermittently to the east around 5 UTC and from the west during dissipation at 7 UTC. Fog precipitation occurred on the whole north-south transect, but not at stations at lower elevations.

In Gobabeb (F7), a gradual reduction in visibility occurred already before fog arrival while **first fog precipitation lagged by 20 minutes**. Non-rainfall water input (NRWI) as measured by the microlysimeters shows deviation from the diurnal course, i.e. deposition by the fog. Two phases of fog deposition and fog precipitation were observed.

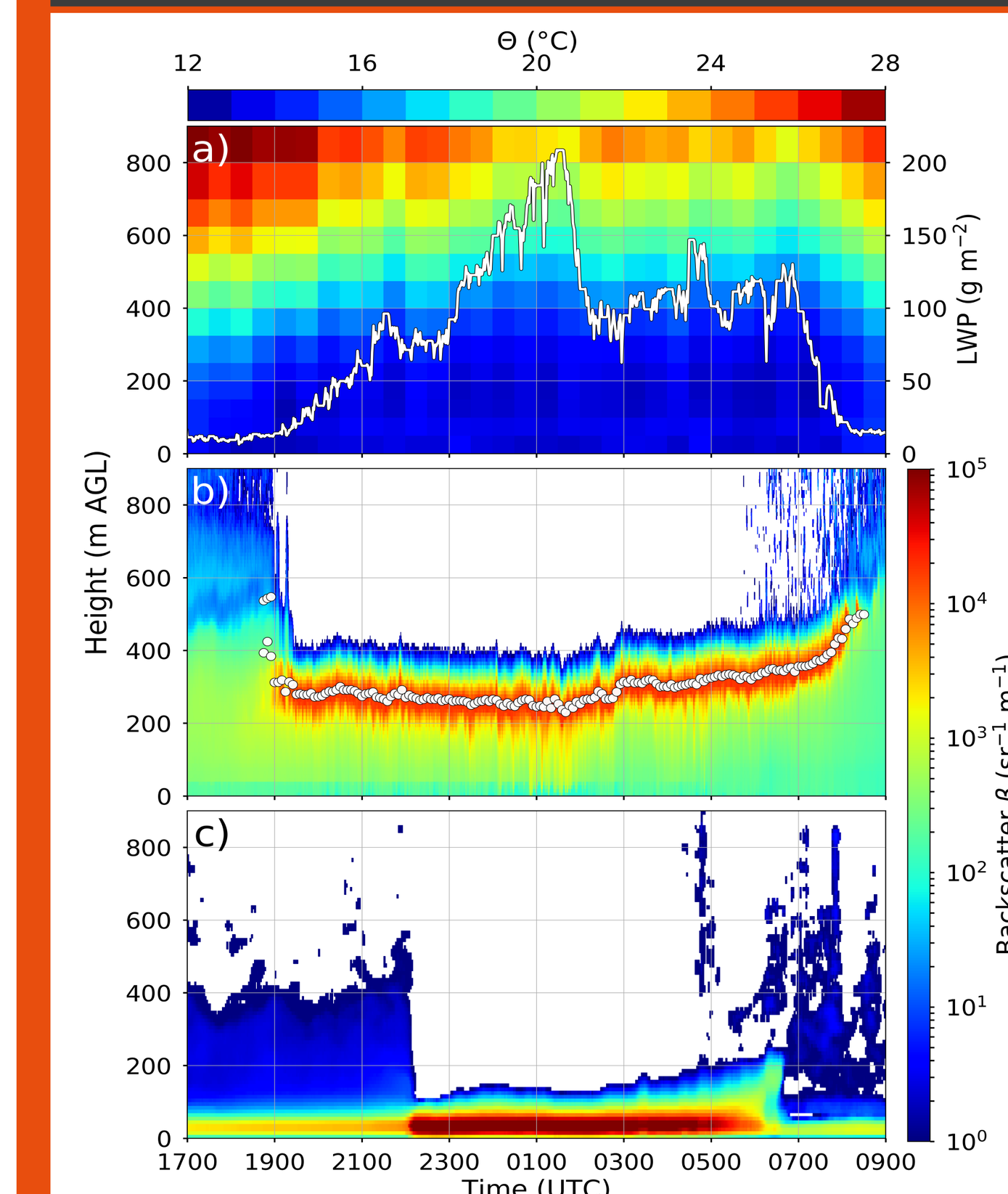
Droplet counts (F8a) increased on fog arrival and preceded fog precpitation as well. Derived liquid water content (LWC) and liquid water flux (LWF) are in the same order of magnitude as NRWI and fog precipitation. A net flux towards the surface resulted.

Correlation between fog deposition and fog precipitation is lacking and subject to further studies (see EGU2019-4907, more info in the sidebar).

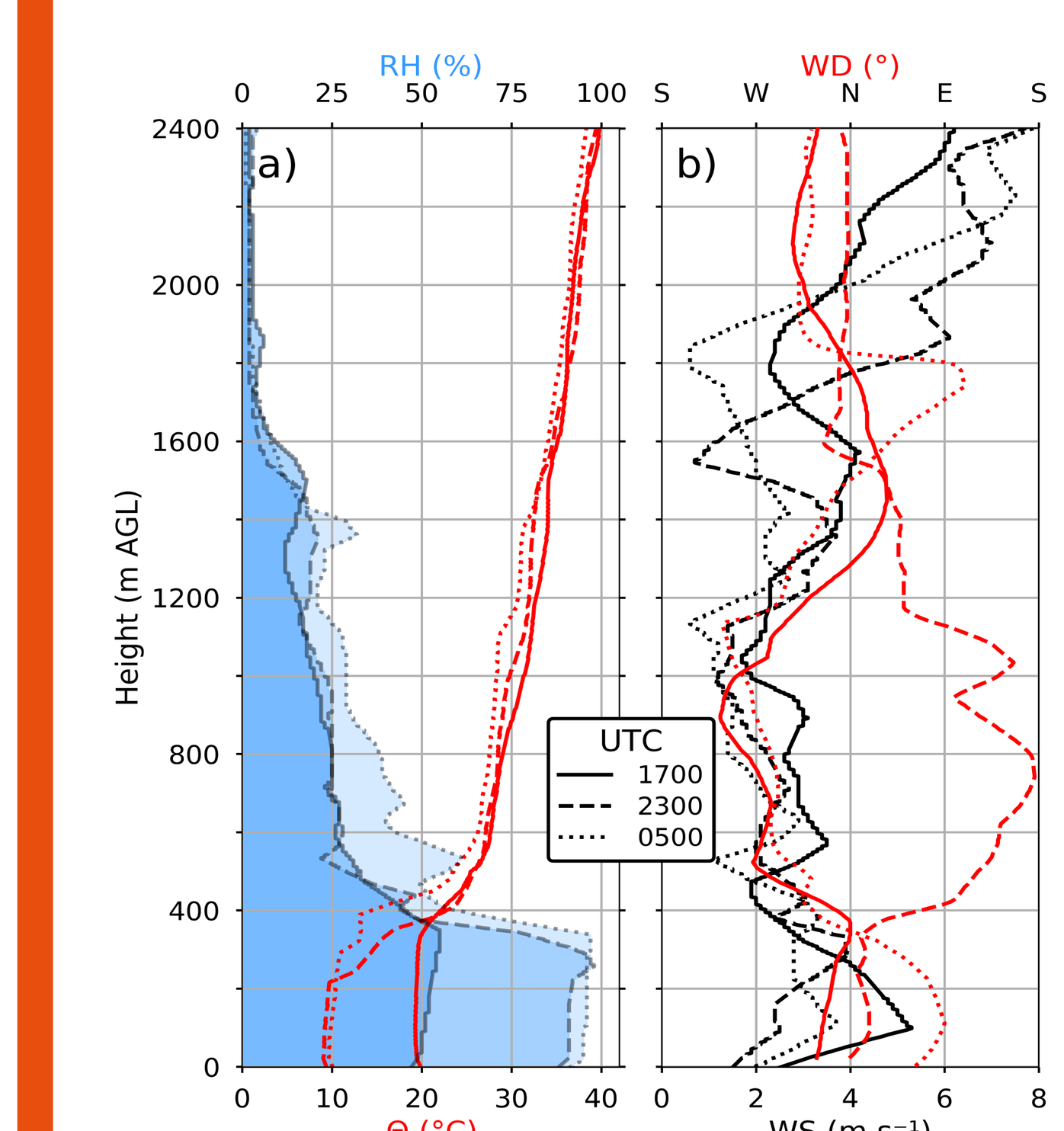


F8: Droplet counts during ION4 in a) and derived liquid water flux (LWF) in b). NRWI relative to 15 UTC in a)

3) Vertical structure



F9: Potential temperature and backscatter/cloud base height at CM and GB (c)



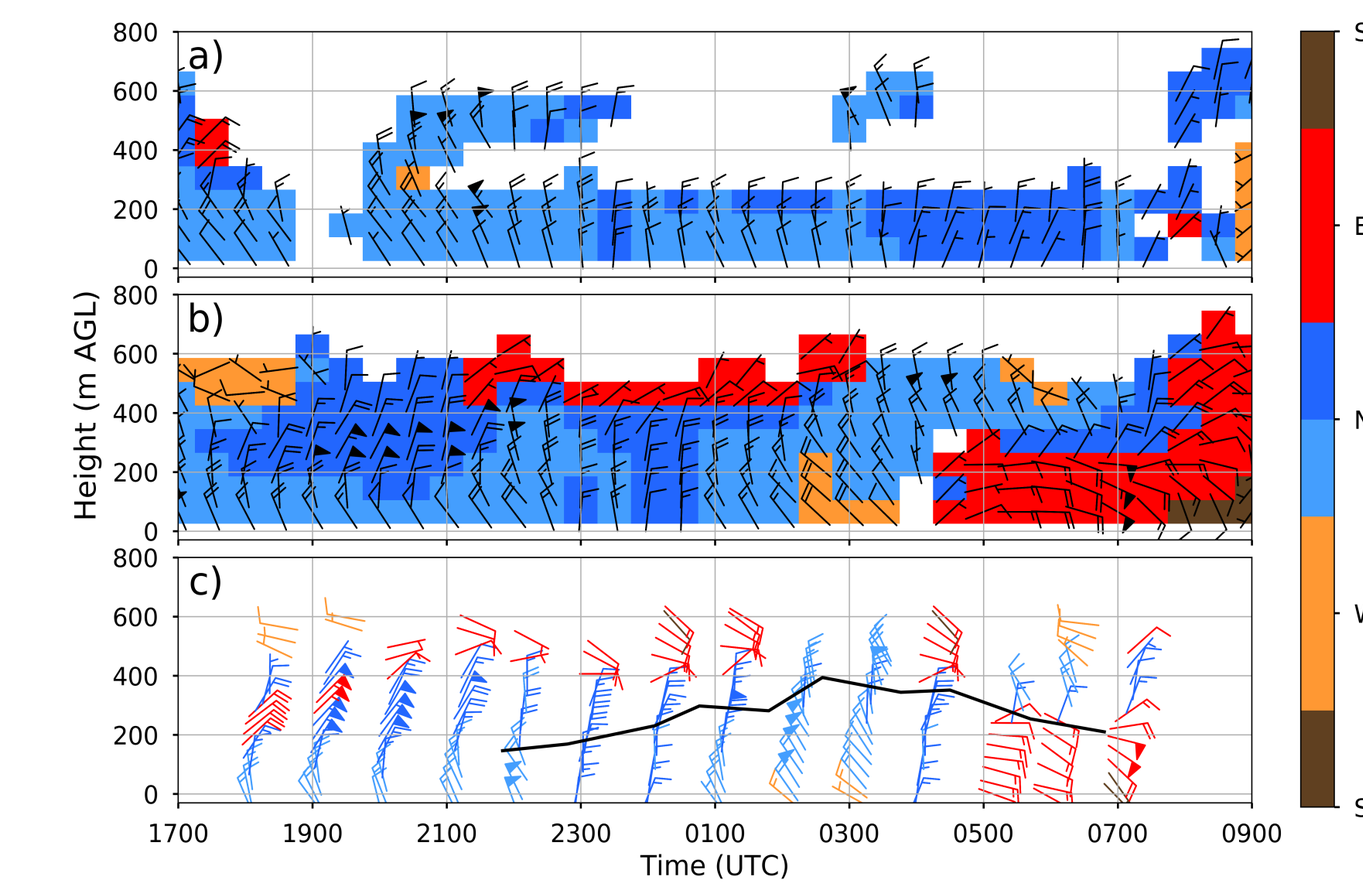
F10: Radiosonde ascents in GB on ION4

Potential temperature (F9a) within the lowest 300 m was constant, as was the stratus base (F9b) at the coast (CM). Inland (GB, F9c), fog lasted from 22 UTC to 6 UTC when dissipation set in.

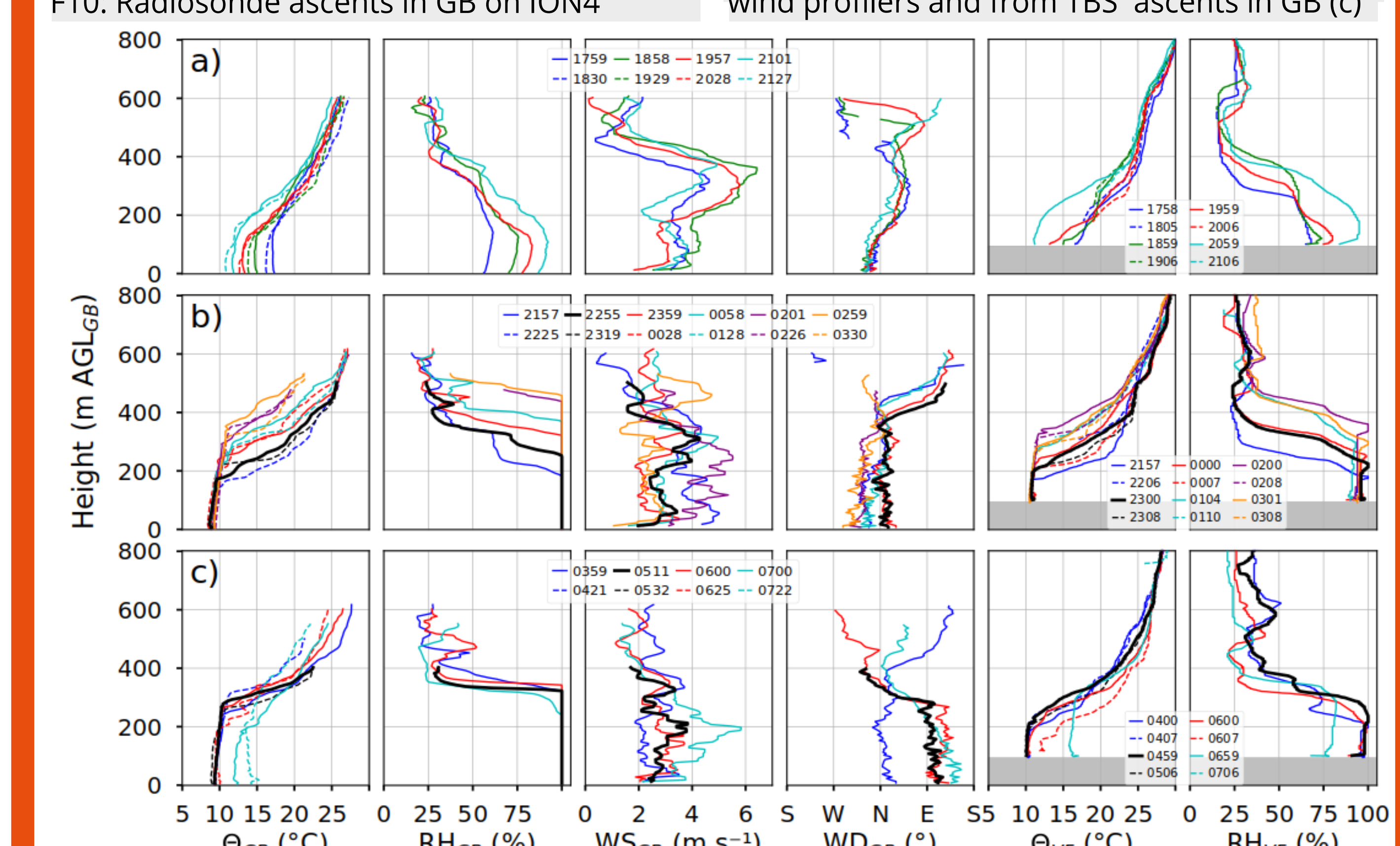
Radiosondes (F10a) inland recorded a temperature inversion and thus a **fog layer thickness of 400 m** (F10a). A change of wind directon above the fog (F10b) indicates a decoupling of layers.

A **small jet** of 4 $m\ s^{-1}$ from a northern sector between 200 and 400 m AGL **advects fog to GB** (F11b/F12a). The TBS resolved the steady growth and decay of the fog over the course of the night (F11/F12b). After onset of a local mountain breeze, fog dissipated gradually (F12c).

The observed vertical structure of the ION4 fog event suggests advective drivers rather than radiative ones[6] **reported recently.**



F11: Wind at CM (a) and GB (b) from SODAR wind profilers and from TBS ascents in GB (c)



F12: Tethered balloon sonde (GB, panel 1-4) and drone profiles (VF, panel 5&6, offset by elevation difference) during three phases of the fog event made distinct by the wind direction.

Further Information

Selected references

[1] Andersen, H., and J. Cermak, 2018: First fully diurnal fog and low cloud satellite detection reveals life cycle in the Namib. *Atmos. Meas. Tech, 11, 5461–5470, doi:10.5194/amt-11-5461-2018.*

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Thursday, 11 April 2019, 08:45-09:00

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