# Near-surface dynamics during Fog Events: An approach to connect fog precipitation with fog deposition at the Gobabeb Namib Research Institute (P-2-09)

NAFOLICA

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## Introduction and instrumentation

Organisms in the hyper-arid region of the Central Namib rely on fog as an essential water source. The regular occurrence of fog in this region is closely linked to the formation of a stratocumulus (Sc) cloud deck over the ocean, which intercepts the inland area through advection processes. The determination of the microphysical properties of this highly dynamic fog is quite difficult and requires a multitude of meteorological measurement devices. The Gobabeb Namib Research Institute (fig. 1, GB), situated in the heart of the central Namib provides ideal surroundings for this task. Of particular interest are methods to measure and quantify fog water, which influences the surface water balance. Surface water input is presumably caused by suspended fog droplets which impact the surface, and/or by light precipitation in the form of drizzle.

The estimation of water amount associated with suspended fog droplets, so far called fog precipitation (FP), is derived from three different types of passive fog collectors (i.e. Juvik-type, Grunow-type, Klemm-harp). Catch characteristics of these three fog collectors were studied. For comparison their daily, respectively monthly yields were normalised with the projected areas as well as with the windward exposed fraction of impermeable material, further referred to as their initial interception areas (figure 2).

Figure 2: Grunow-type, Juvik-type, harp (from left to right), A: schematic drawing of the surface, which is incorporated in the calculation for the projected areas (whole area is considered), B: schematic drawing of impermeable material which is incorporated in the calculation for the initial interception areas (only solid fraction is considered)

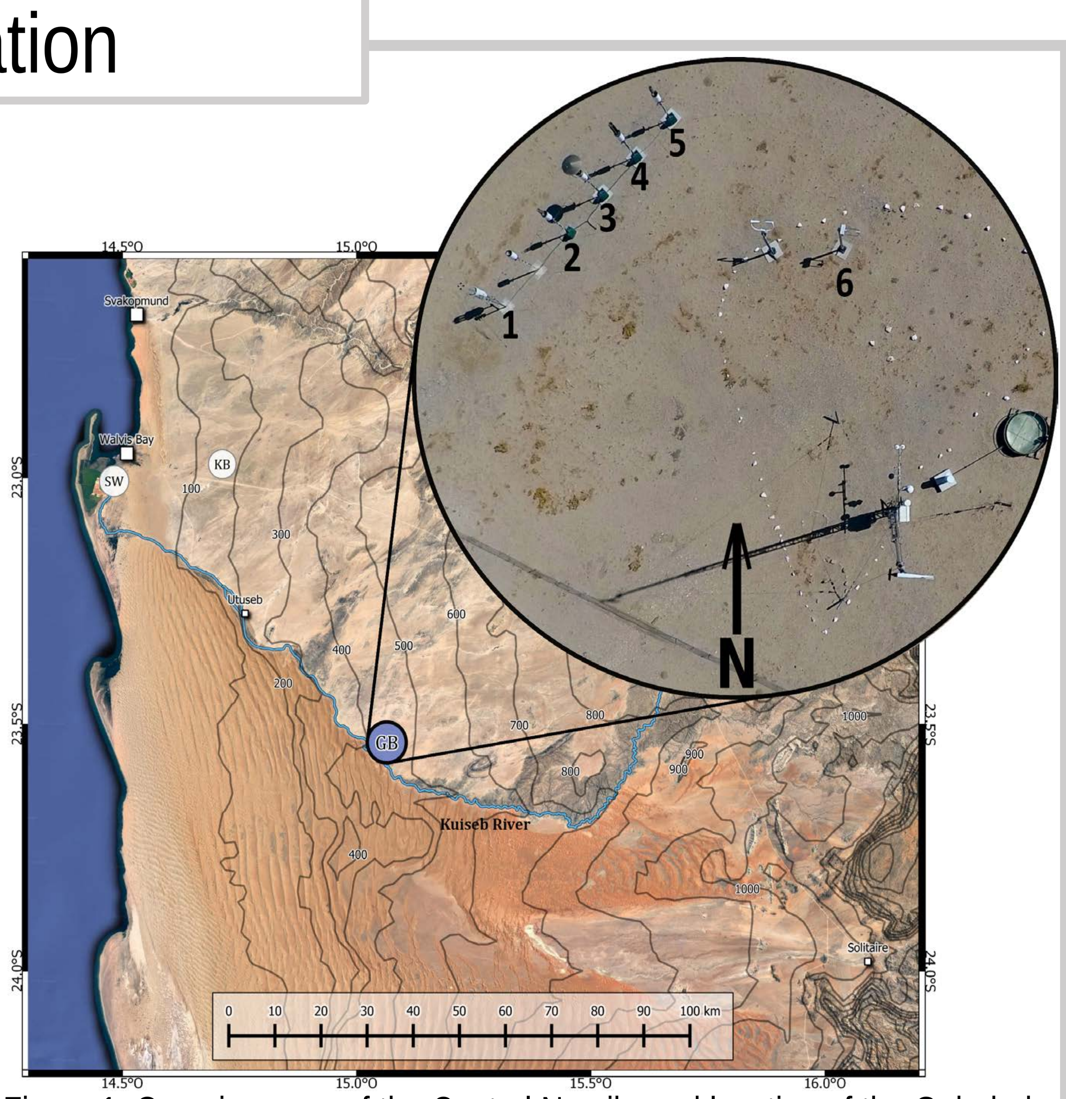

Figure 1: Overview map of the Central Namib, and location of the Gobabeb Namib Research Institute (GB). Upper right circle shows the measurement station in GB (birdview); 1: Harp, 2+5: Grunow-type, 3+4: Juvik-type fog collectors, 6: Thies Laser Precipitation Monitor

Drizzle during fog is very common in the Central Namib. However, intensities are very low, hence, measurement devices like tipping buckets are not able to detect interpretable precipitation amounts. Therefore, a Thies Laser Precipitation Monitor (TLPM) was installed at GB in early 2018 (fig. 3). The TLPM is capable of measuring even lowest intensities and provides extensive information about drop size distribution (DSD) and fall speed from the drizzle range to heavy rain. Every particle detected, is classified in 1 out of 22 drop diameter bins, where the smallest 4 correspond to the drizzle range (tab. 1). To verify TLPM measurements their totals were compared to microlysimeter (ML) readings, which directly detect surface non rainfall water input (NRWI). A detailed description about ML function and data output is available on the IFDA Poster P-2-07. The robust design of the TLPM and its relatively low need of maintenance make it ideal to reliably quantify the small precipitation amounts in question.

Figure 3: TLPM at GB

Table 1: TLPM drizzle drop classes

| Class | Drop diameter | Class width |
|---|---|---|
| 1 | >0.125 mm | 0.125 mm |
| 2 | >0.250 mm | 0.125 mm |
| 3 | >0.375 mm | 0.125 mm |
| 4 | >0.500 mm | 0.250 mm |

## FP normalised

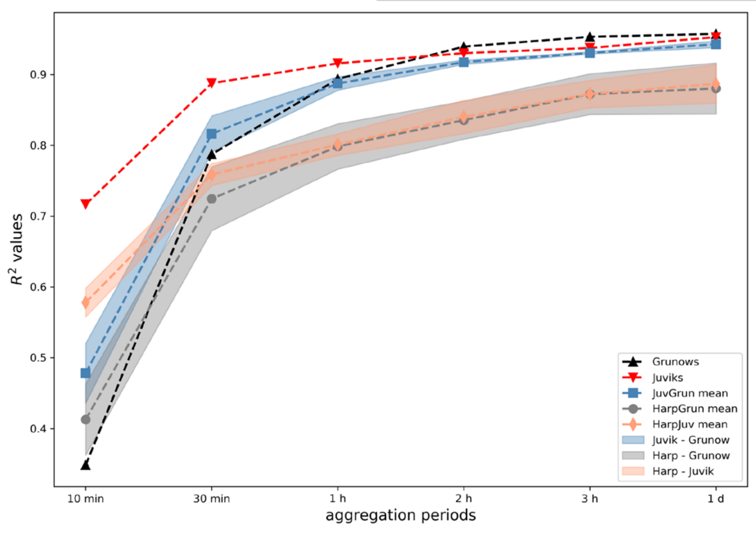

Figure 4: $R^2$ values for FP totals for 10 min to daily aggregation periods

- The variable nature of fog results in relatively low $R^2$ values for short aggregation periods (fig. 4)
- If daily aggregation periods are considered, catch characteristics of the Grunow and Juvik are nearly uniform
- Generally lowest $R^2$ between the harp and both other devices are directly associated with their different designs

- initial interception areas seem to be better suited for FP normalisation (fig. 5)
- Generally higher values of the harp from Dec to Mar, indicate fog DSD changes throughout the year

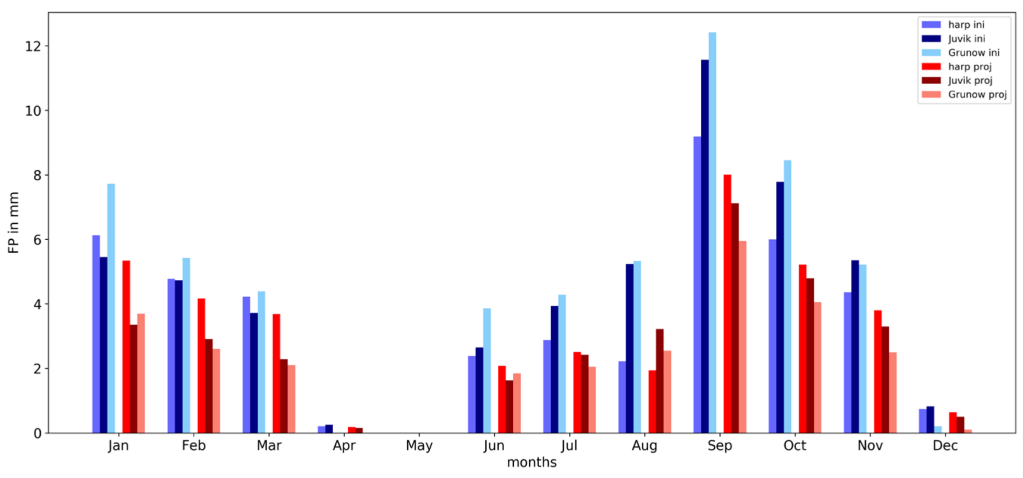

Figure 5: monthly FP normalised with the initial interception areas of the collectors (blue bars) and their projected areas (red bars)

- TLPM Drizzle measurements correlate well with non-rainfall water input (NRWI) measurements from MLs (fig. 6)
- Precipitation measurements below 0.005 mm from both devices are too uncertain for interpretation

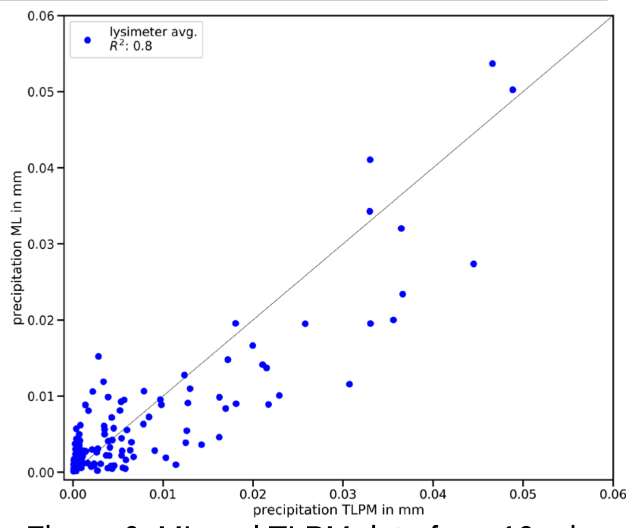

Figure 6: ML and TLPM data from 10 min. aggregation periods

- Comparison between daily drizzle and NRWI totals allow the assumption that surface water deposition associated with low stratocumulus cloud bases and fog can be estimated with ML, as well as TLPM measurements (fig. 7)
- NRWI during such events consists predominantly of drizzle drops, while contribution from surface intercepting fog droplets seems to be negligible

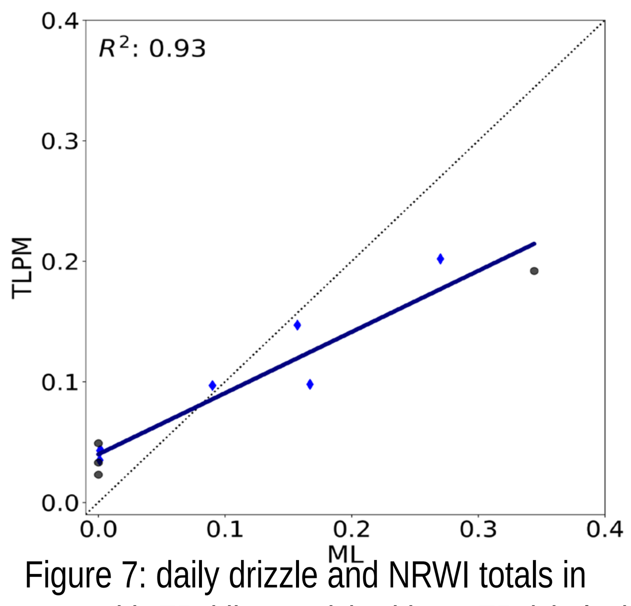

Figure 7: daily drizzle and NRWI totals in mm, with FP (diamonds) without FP (circles)

## Drizzle measurements

- No easy correlation between FP and drizzle measurements can be seen
- Drizzle measurements, regarding drop counts and precipitation intensity, during fog events generally have a simultaneous peak as FP, but increase and decrease later than FP measurements (fig. 8)
- Highest drop counts and intensities before sunrise around 04:00 are most likely directly associated with Sc thickness, which is greatest during this time
- drizzle measurements where no FP is registered are less common and associated with very low Stratocumulus cloud base heights

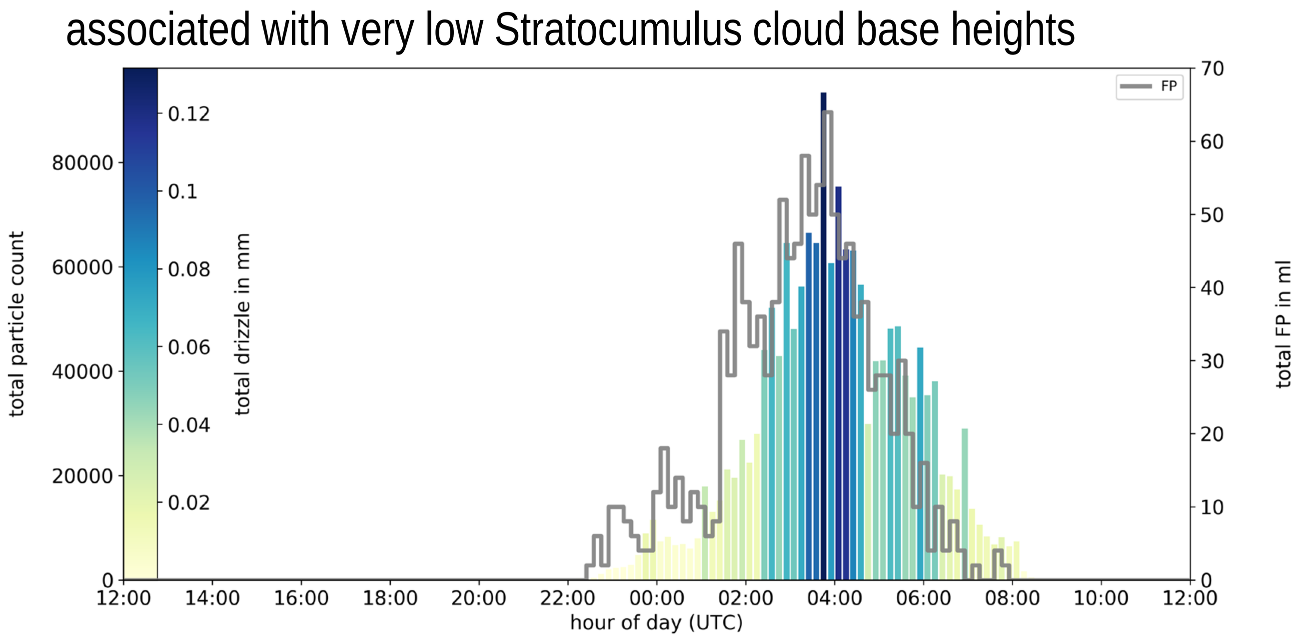

Figure 8: diurnal courses of FP and drizzle, height of the bars correspond to particle counts, colours to drizzle amount.

- Yearly drizzle amount (2.8 mm) is around 10 times less than registered FP amount (28 mm) (fig. 9)
- Drops from the second diameter class contribute most to total drizzle amount
- As first FP is registered in June, significant drizzle occurrence starts in August, and highest drizzle amounts per fog day are registered in February and March → likeliness for greater drizzle drops increases towards the end of fog season
- Organisms require adaptions to collect more fog water that the above baseline amount registered

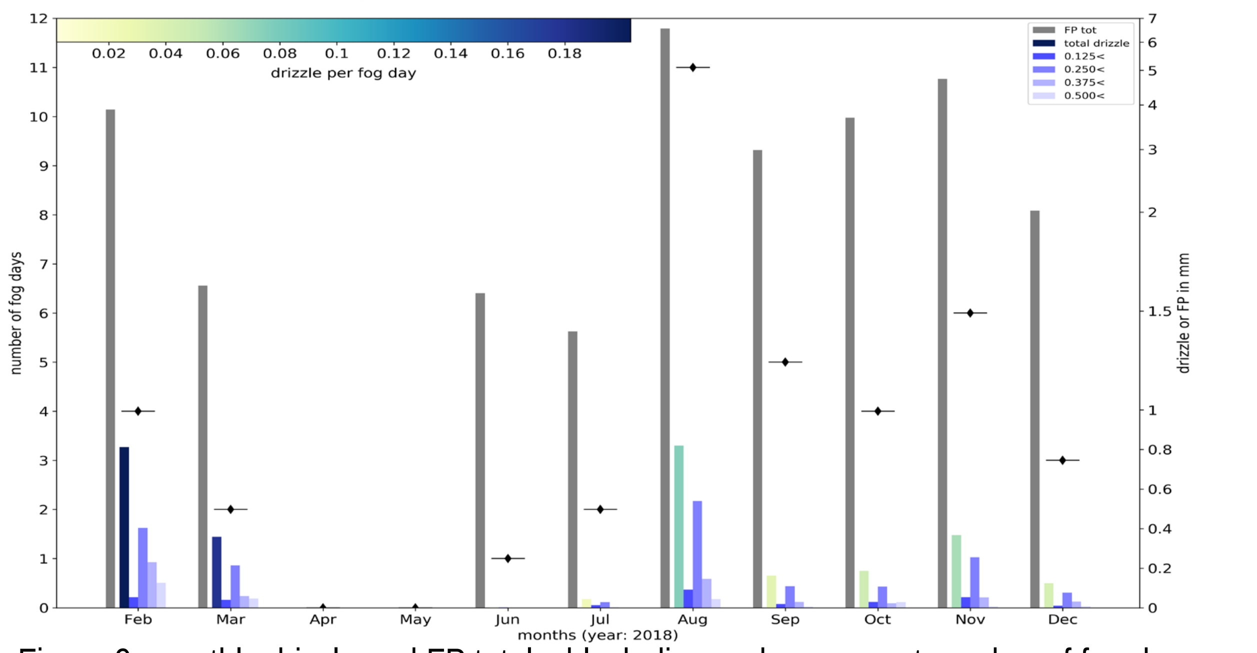

Figure 9: monthly drizzle and FP totals, black diamonds represent number of fog days per month.

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O-1-3:
Understanding fog in a coastal desert: The Namib Fog Life Cycle Analysis (NaFoLiCA) Project
O-1-4:
New insights on fog and low clouds in the Namib

P-1-18:
Fog droplet distributions and liquid water fluxes in the hyper-arid Namib
P-1-21:
Lifting the fog in the central Namib – where did it come from?
P-2-07:
Microlysimeter and fog collector measurements in the Namib desert
P-3-08:
Modeling the life cycle of fog in the Namib desert with COSMO-PAFOG

## Acknowledgements

We are grateful for the loan of the harp. We appreciate support of the Gobabeb Namib Research Institute staff.

## More Info

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