Microlysimeter and fog collector measurements in the Namib desert (P-2-07)

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Microlysimeter specifications, functionality and evaluation

Calibration

- calibration weights of 2, 5 and 10 g placed in the center of dishes (fig. 2b)
- calibration steps/sequence: 0, 2, 7, 17, 15, 10, 0 g
- raw data scaled to mm (l m^{-2})
- no drift in calibration coefficients was observed

Microlysimeter technical specifications (see also fig. 2a)	
Large soil dishes (GB, VF, CM)	∅ 250 mm , depth 65 mm
Small soil dishes (GB only)	∅ 130 mm , depth 35 mm
Material	PVC, box with aluminum bottom
Load cell	Tedea Huntleigh 1042 with 7(large) and 1 kg capacity, 0.02% of rated
Output	
Load cell amplifier(ADC)	Sparkfun HX711 24-bit
Controller	Arduino Pro Mini 5V/16MHz
Temperature/RH	DHT 22, accuracy ± 0.5°, ± 2% RH
Resolution	~ 1.7 mg/0.02mg for large/small MLs ~ 3.2e-5/1.7e-5 mm precipitation
Measurement frequency	1 Hz, averaged to 1 min.
Data transmission	RS232
Data aquisition	data logger Campbell CR6

Evaluation

- **diameter of soil-dish has no impact on performance**
- microlysimeters are well suited for the purpose of NRWI deposition in arid regions
- no temperature dependence of electronics and load cell (tested by covering one device and comparison to 3 uncovered devices)
- able to record even smallest NRWI inputs accurately
- **sensitive to external distortions (aeolian deposition, insects)**
- needs frequent visual survey
- needs complete reset after heavy rainfall (no drainage)

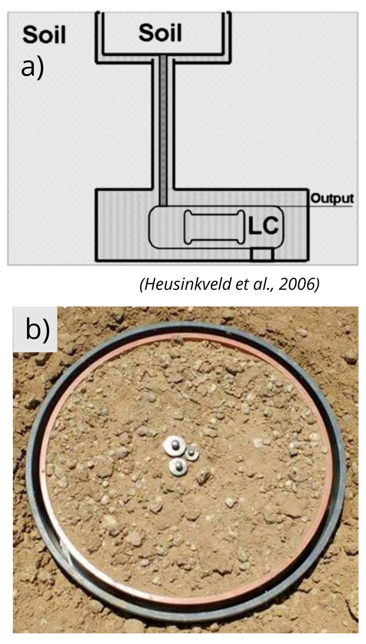


Figure 2: *a) Microlysimeter functionality and b) with calibration weights.*

Introduction and research area

Non-rainfall atmospheric water input (NRWI) consisting of fog, dew and soil water adsorption is an important water source for fauna and flora in (semi-)arid environments. Its measurement is extremely challenging as it requires instruments that are accurate enough to detect even smallest amounts of water input of less than 0.01 mm. **Microlysimeters**, if regularly serviced, have been proven to provide robust and high precision data of NRWI . In the frame of the **Namib Fog Life Cycle Analysis (NaFoLiCA)** project, aiming to improve the knowledge of the temporal and spatial patterns of fog in the Namib region, three out of 10 stations of ten **FogNet measurement network** have been equipped with pairs of microlysimeters (in-house construction after Heusinkveld et al., 2006). Data from 9-9-2017 until 10-13-2017 are analyzed, covering the period of the NaFoLiCA IOP (Spirig et al., 2019, BAMS, in revision)

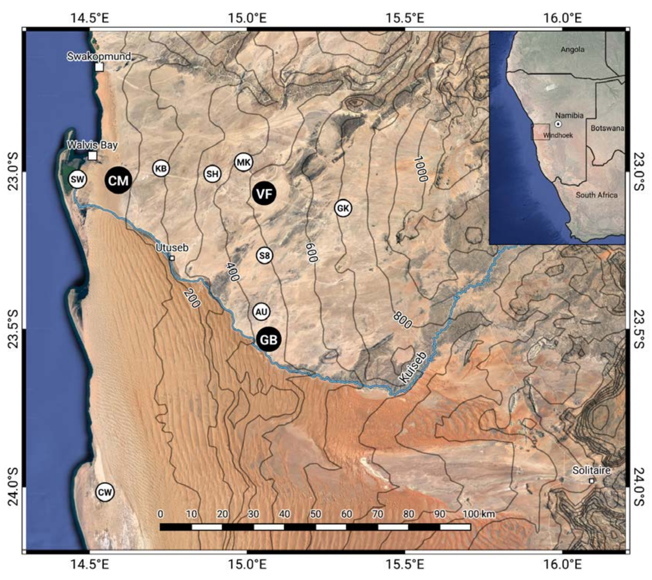


Figure 1: *Research area and FogNet stations. Black sites are equipped with microlysimeters.*

Microlysimeter performance

Mean diurnal NRWI variation during no-fog days

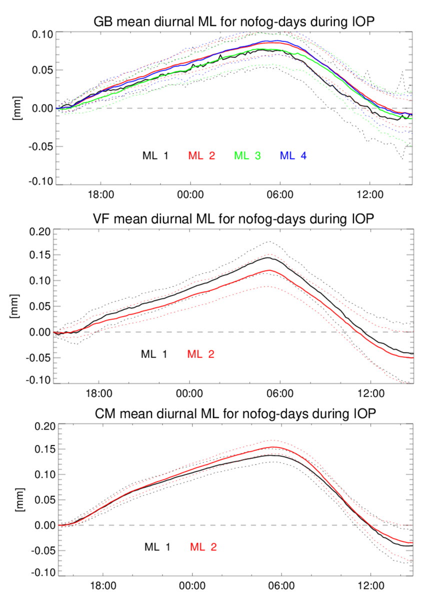
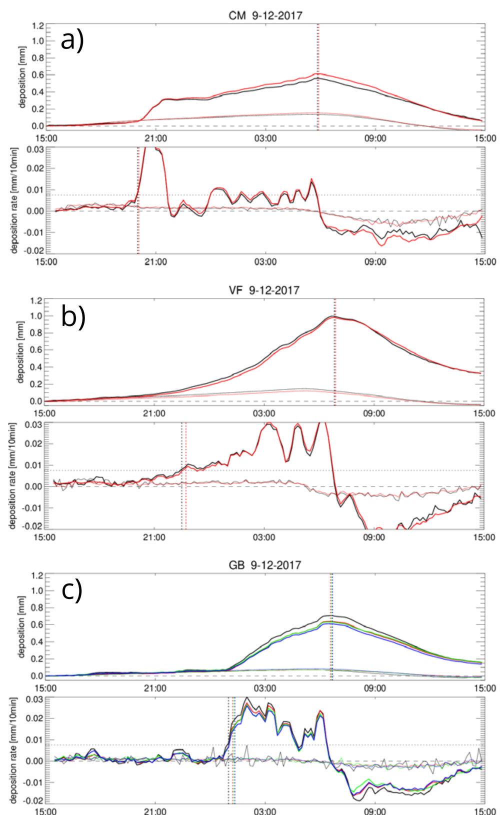


Figure 3: *Mean diurnal course of microlysimeter readings du-ring no-fog nigths at FogNet stations GB, VF and CM (from top to bottom). Dashed lines denote standard devi-ation. Time refers to UTC.*

- regular shape with amplitudes up to 0.15 mm
- minimum in the afternoon, maximum just before sunrise
- actual water deposition through adsorption/dew and loss through daytime evaporation

Duration of fog deposition



- start: fog deposition rate rises above threshold (0.0075 mm/10 min.)
- end: the time of the maximum deposition

Figure 4: *a) determination of fog deposition duration at CM. Upper panel: end of fog deposition at max. value. lower panel: start of fog deposition when deposition rate threshold is reached the first time (example for 12 SEP 2017). b) and c): as a) but for VF and GB, respectively. Time is UTC.*

Performance of microlysimeters and fog samplers during selected fog events

- fog events in the investigation area are generally characterized by **advected stratus/low clouds from the coast and eventually touching the ground at elevated inland stations (interception)**
- fog samplers (Juvik-Type, fig. 5) measure fog precipitation, microlysimeters measure fog deposition
- fog precipitation signals coincide with the time of stratus/low cloud interception with the ground
- fog deposition also occurs during drizzle events (no interception)
- other variables such as humidity, radiation, visibility and leaf wetness support the interpretation of fog events

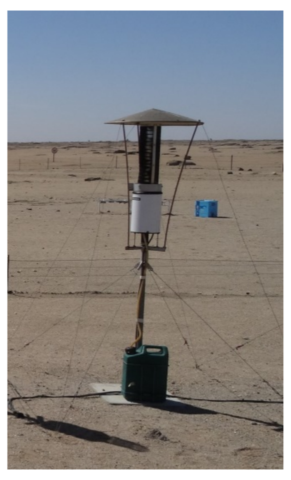


Figure 5: *Juvik-type fog sampler*

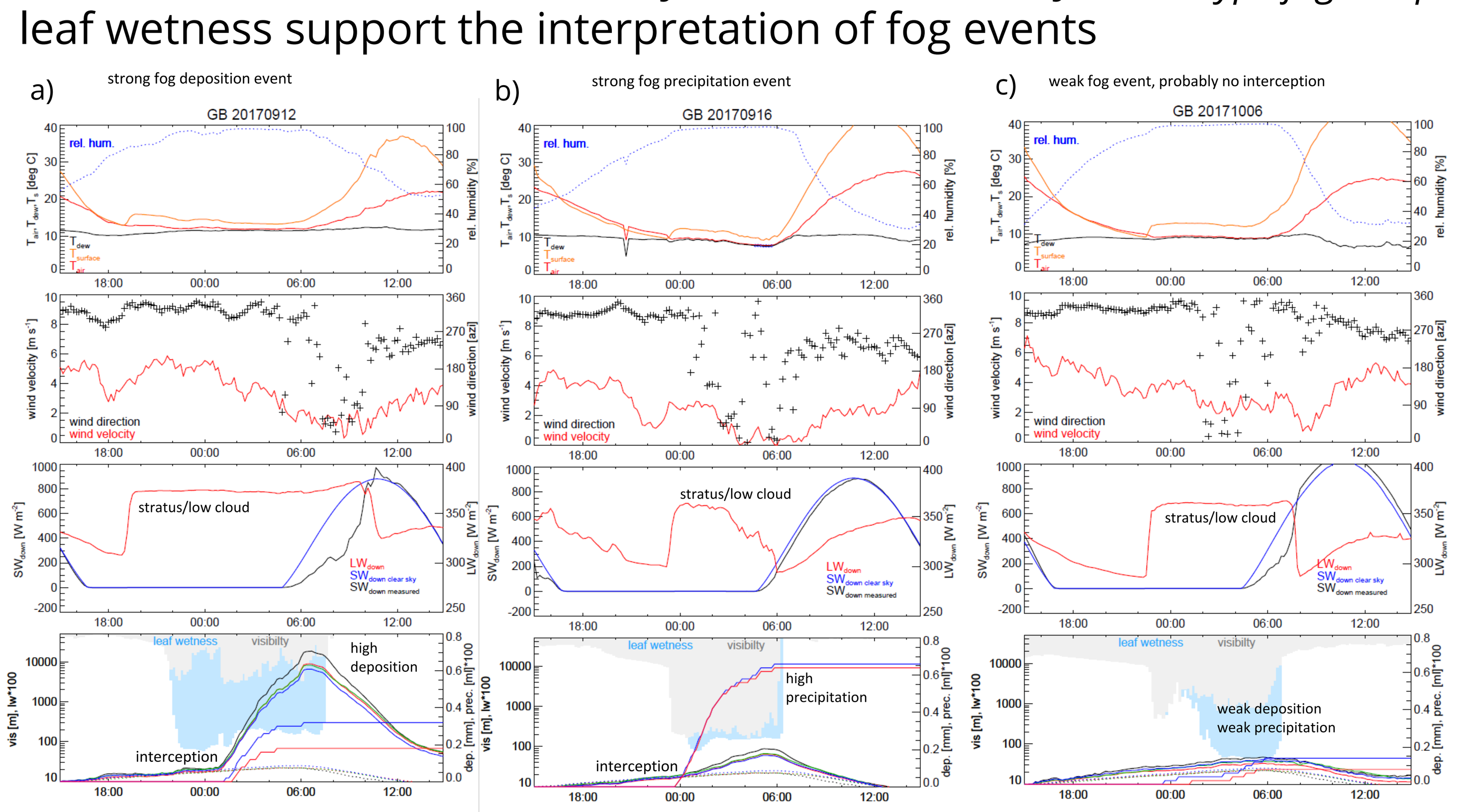


Figure 6: *Selected fog events with different characteristics. a) stratus arrives early, interception occurs 6 hrs later, high deposition. b) arrival of stratus/low cloud and precipitation/deposition occur simultaneously, high precipitation. c) only short interception of stratus/low cloud, weak precipitation and weak deposition.*

Duration of stratus and fog events

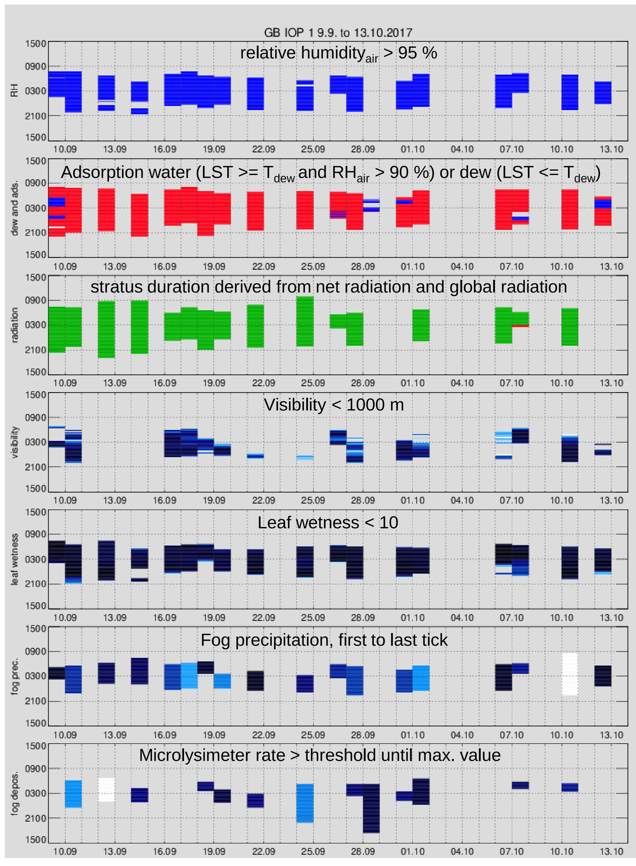


Figure 7: *Duration of stratus/low cloud and fog events. Dark blue and white colors refer to low/high values, respectively. Time refers to UTC.*

Duration of stratus/low cloud and fog events derived for various parameters (fig. 7). The beginning and end of stratus/low cloud duration can be accurately detected by the analysis of the nightly net radiation (and short-wave downward radiation, if stratus dissolves after sunrise). Fog events by stratus interception occur when fog precipitation is measured by the Juvik-type fog samplers and/or fog deposition is exceeding the mean diurnal variation of no-fog days (figs. 3 and 4). Humidity, adsorption water and dew, visibility and leaf-wetness provide additional information about fog event durations. The different duration times of fog precipitation and fog deposition (lowest panels) suggest that the two parameters are not well correlated.

Conclusions

- Microlysimeters are able to detect even smallest amounts of NRWI (non-rainfall water input), i.e. adsorption water, dew and fog deposition. **The diurnal variation during no-fog days/nights is very consistent (Fig. 3). This allows to determine the duration of fog deposition during fog events.**
- Fog deposition starts when the deposition rate exceeds a threshold of 0.075 mm/10 min and ends with the maximum of microlysimeter reading (Fig. 4).
- Stratus/low cloud occurrence is always required for a fog event and can be easily detected in the radiation signal. However, stratus/low clouds do not always reach the ground (interception) at inland stations such as e.g. GB (Fig. 6c).
- Fog event duration is determined by the ongoing occurrence of fog precipitation and/or fog deposition together with low visibility, low cloud base and high leaf wetness (Figs. 6 and 7). For a long-term analysis of stratus/low cloud duration refer to IFDA Poster P-1-21.
- **No correlation was found between fog precipitation (measured by Juvik-type fog samplers) and fog deposition. Nights with fog precipitation but without fog deposition were observed and vice versa.**
- Measurements of total droplet counts by disdrometer correlate well with fog drizzle deposition rate suggesting that disdrometer data can be used to define fog deposition, if microlysimeters are not available. See IFDA Poster P-2-09.

Partners

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Understanding fog in a coastal desert: The Namib Fog Life Cycle Analysis (NaFoLiCA) Project

O-1-4:
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P-2-09:
Near-surface dynamics during Fog Events: An approach to connect fog precipitation with fog deposition at the Gobabeb Namib Research Institute

P-3-08:
Modeling the life cycle of fog in the Namib desert with COSMO-PAFOG

References

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Spirig, R., Vogt, R., Larsen, J.A., Feigenwinter, C., Wicki, A., Franceschi, J., Parlow, E., Adler, B., Kalthoff, N., Cermak, J., Andersen, H., Fuchs, J., Bott, A., Hacker, M., Wagner, N., Maggs-Kölling, G., Wassenaar, T., Seely, M.K., 2019. Probing the Fog Life Cycle in the Central Namib Desert. *Bull. Am. Meteorol. Soc.*, in revision.

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