Manila Observatory CHECSM Site

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CHECSM Overview: History & Instrument Status

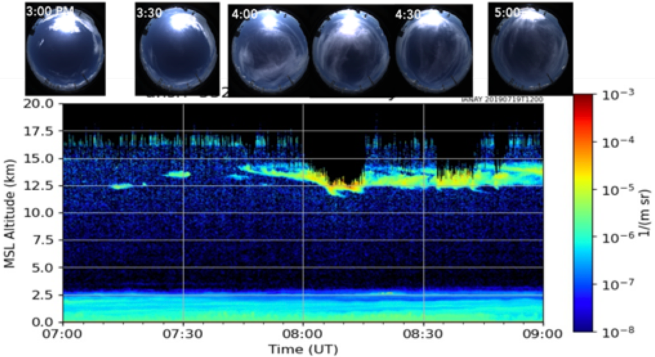
- Jul 2018 - U of Arizona team MOUDI installation and training of MO researchers
- Sep 2018 - Betsy Reid with US-NRL and U of Colorado instruments
- Dec 2018 - Ilya Razenkov UW-HSRL installation
- Jun 2019 - UC-Davis DRUM Sampler
- Aug - Oct 2019 - CAMP2Ex
- Jun 2020 - HSRL last measurements (pack-up and return TBA)
- Jun 2021 - MOUDI ship back to U of Arizona
- Ongoing measurements for most deployed instruments

Manila Observatory CHECSM Research

1. Clouds and Pollution
   a. **Cirrus Clouds**
   b. Manila **PBL Height**
   c. Factors affecting **Surface Aerosol Loading**
2. Monsoon Meteorology and Convection:
   a. **Disdrometer Rainfall Characteristics**
3. Radiation Measurements: Applications in Forecasting (Energy, Climate and Weather)
   a. Using the **broadband SPN data** for the Wet Bulb Globe Temperature (WBGT) **Heat Stress Index**
   b. Validation of **WRF-Solar Forecasts** over Manila Observatory using the broadband SPN data for clear and cloudy sky cases

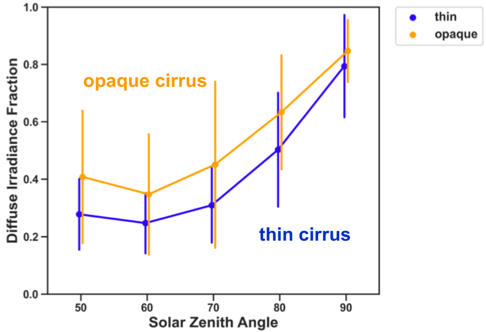
CHECSM: Cirrus Clouds

Zenith & Hemispherical Measurements



- Snapshot of the Hemisphere from July 19, 2019 3:00 to 5:00 PM PHT from the **All-Sky Camera** collocated with the **HSRL** and the **SPN1** and b) HSRL aerosol backscatter cross section measurements for the same time period with labels in UTC.
- Cirrus Cloud Detection Algorithm (Pagano et al., 2020)

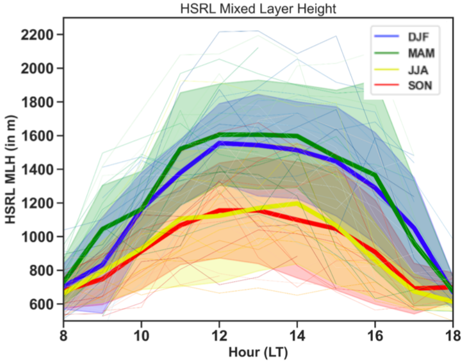
Diffuse Irradiance Fraction of Cirrus Clouds



- higher $F_{diffuse}$ as the solar zenith angle increases or when the sun is at closer to the horizon
- opaque cirrus have higher mean $F_{diffuse}$ than the **thin cirrus** for specified solar zenith angle range.
- next steps: cirrus cloud optical depth effects on PBL Height

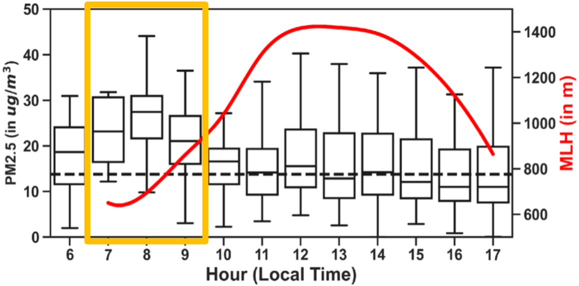
CHECSM Pollution: Manila PBL Height

2019 Seasonal PBL Height from HSRL



- lower PBLH from Jul- Nov 2019 (CAMP2Ex period)
- maximum PBLH from 1200 - 1400 across seasons

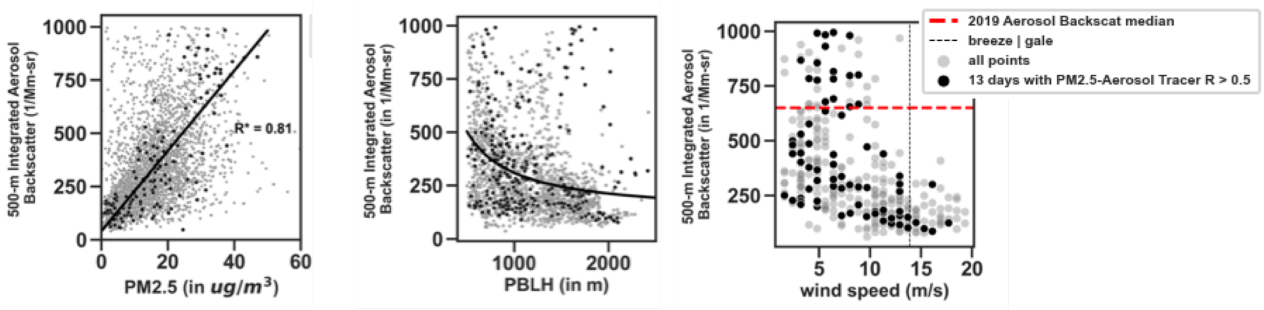
PBLH - PM2.5 relationship



- highest surface concentrations in the morning (0700-0900 LT) due to low PBLH and morning rush hour
- PBL continues to grow (slower) until 1200 LT; partially contributing to dilution of surface concentrations

CHECSM Pollution:
Factors affecting **Surface Aerosol Loading**

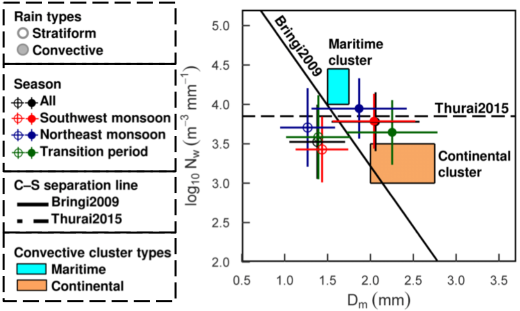
PBLH and Wind Effects on Surface Concentrations



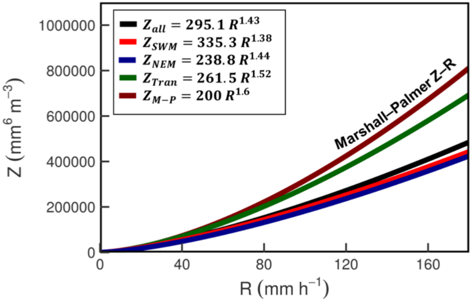
- 500 – m Integrated Aerosol Backscatter Cross Section (aerosol tracer) and surface PM2.5 decrease as the PBLH increases. Inverse-fit adapted from Su et al., 2018 and Xiang et al., 2019
- There is a general decrease in 500-m integrated aerosol backscatter as the PBL grows
- But observed better coupling with wind speeds for certain cases;
  as winds get stronger, less aerosols remain (by entrainment and horizontal advection)

Monsoon Meteorology and Convection: Disdrometer rainfall characteristics

Number-size distribution plot (N_w - D_m plot)



Empirical Marshall–Palmer and seasonal radar reflectivity–rain rate (Z–R) relations



- Metro Manila rainfall generally comes from warm clouds that exhibit both liquid and ice microphysical processes; convective rainfall in Metro Manila is related to both maritime and continental rainfall.
- **Northeast Monsoon period** - high number concentration of relatively smaller raindrops;
- **Transition period** - high number concentration of relatively larger raindrops;
- **Southwest Monsoon period** - rainfall characteristics is in-between NEM and Transition.

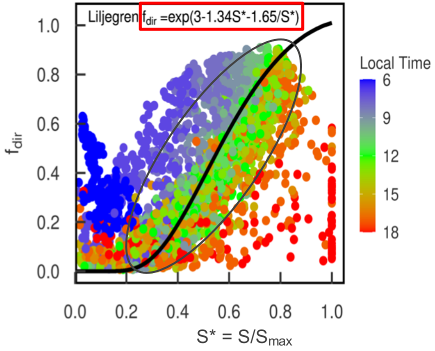
- The Marshall-Palmer Z–R relation is likely to underestimate heavy rains in Metro Manila especially during the two monsoon periods.

f_{dir}–S^* validation using SPN1 pyranometer for WBGT estimation

Heat warning for potential events that require **health-related actions**

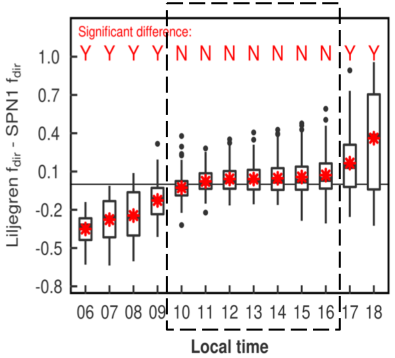
- **Wetbulb Globe temperature (WBGT):** heat stress index for outdoor conditions

SPN1 f_{dir}–S^* scatterplot with Liljegren f_{dir}–S^* curve



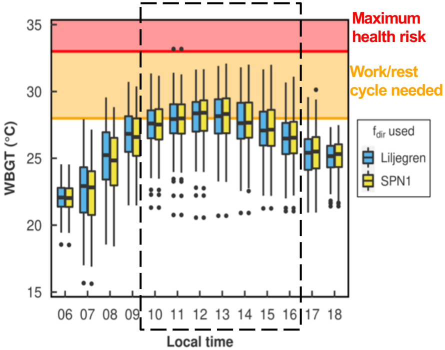
- Mid-day values follow Liljegren

Difference b/w SPN1 f_{dir} and Liljegren f_{dir}



- No significant difference from 10:00 - 16:00 LT

WBGT using Liljegren f_{dir} and SPN1 f_{dir}



- WBGT estimation using Liljegren good for mid-day, when max heat stress is expected

Validation of WRF-Solar Forecasts over Manila Observatory using SPN1 pyranometer

WRF-Solar v4.2.2

(Jimenez et al., 2016)
5 x 5 km horizontal grid resolution
input: NCEP GFS (0.25° grid, hourly)

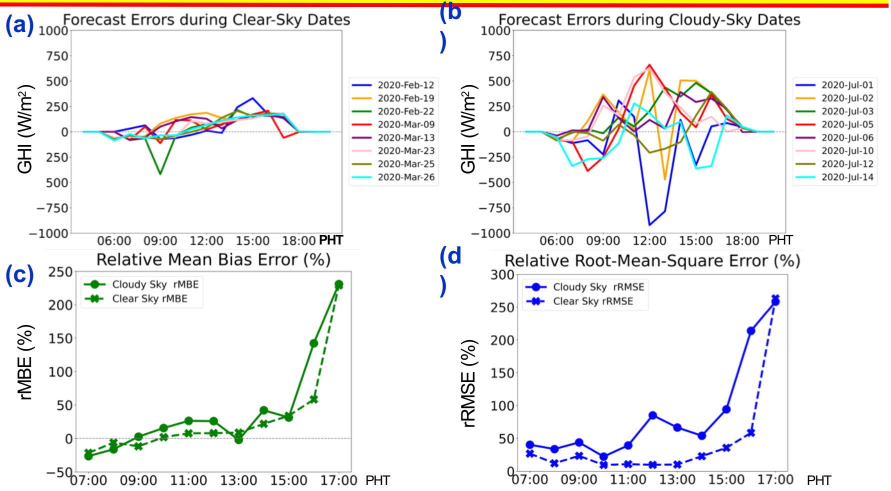
GHI=(DNI*COSZEN)+DHI

GHI: Global Horizontal Irradiance [W/m^2]
DNI: Direct Normal Irradiance [W/m^2]
DHI: Diffuse Horizontal Irradiance [W/m^2]
COSZEN: Cosine(Solar Zenith Angle)

Forecast Error = WRF - SPN1

$$rMBE = \frac{100}{N}\sum_{n=1}^{N}\frac{(f_n - r_n)}{\bar{r}}$$

$$rRMSE = \frac{100}{\bar{r}}\sqrt{\frac{1}{N}\sum_{n=1}^{N}(f_n - r_n)^2}$$



- (a) clear sky: WRF-Solar underestimates morning and overestimates evening observed GHI
- (b) cloudy sky: WRF-Solar mostly overestimates observed GHI
- (c,d) both cases: as the day proceeds, magnitude error increases (can be due to timing error)

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