Recent work on UAV measurements and automation at Table Mountain

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Overview

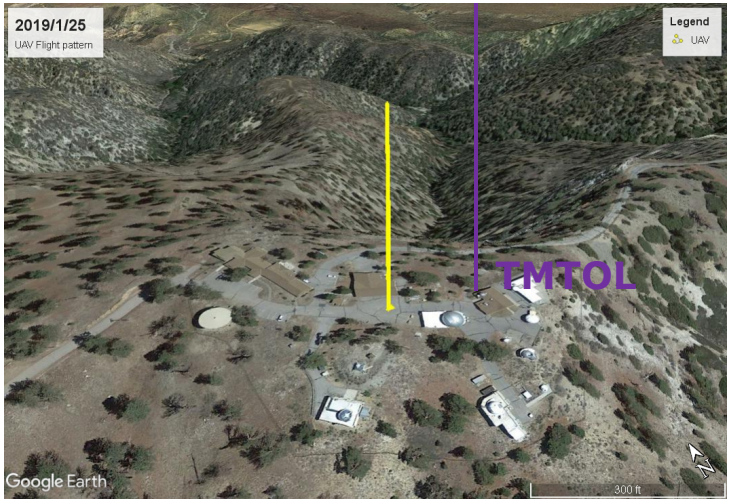
- **UAV measurements**
  - *Objective, setup and flight pattern*
  - *UAV timeline*
  - *First results*
  - *Issues*

- **Automation**
  - *First year of automated measurements*
  - *Migration to other JPL systems*

- **Upcoming work**
  - *Backscatter retrieval from TMTOL/TMWAL*
  - *Smoke/Ozone transport studies*
  - *HRRR vs RAP Smoke*

UAV measurements at TMF

- **Objectives**
  - *Further validate TMF tropospheric ozone lidar (TMTOL) near-range channel*
  - *Study near-ground high frequency ozone variability*
- **Setup**
  - *sUAS xFold Travel X8*
  - *Payload: iMet + ECC Ozonesonde (about 1 kg)*
- **Flight pattern**
  - *Vertical profile between 0-120 m AGL*
  - *Distance to TMTOL is about 200 feet*



UAV timeline at TMF

About 2 months

Pilot → Training → NASA approval

Only US citizens and permanent residents

- Practice on personal drone (3 x week – 30 min)
- Hubsan H501S
- GPS + Alt Hold + Manual

- Flight test at NASA Armstrong

About 3 months **About 7 months** **About 2 months**

UAV → FTP → Requisition → UAV Delivered

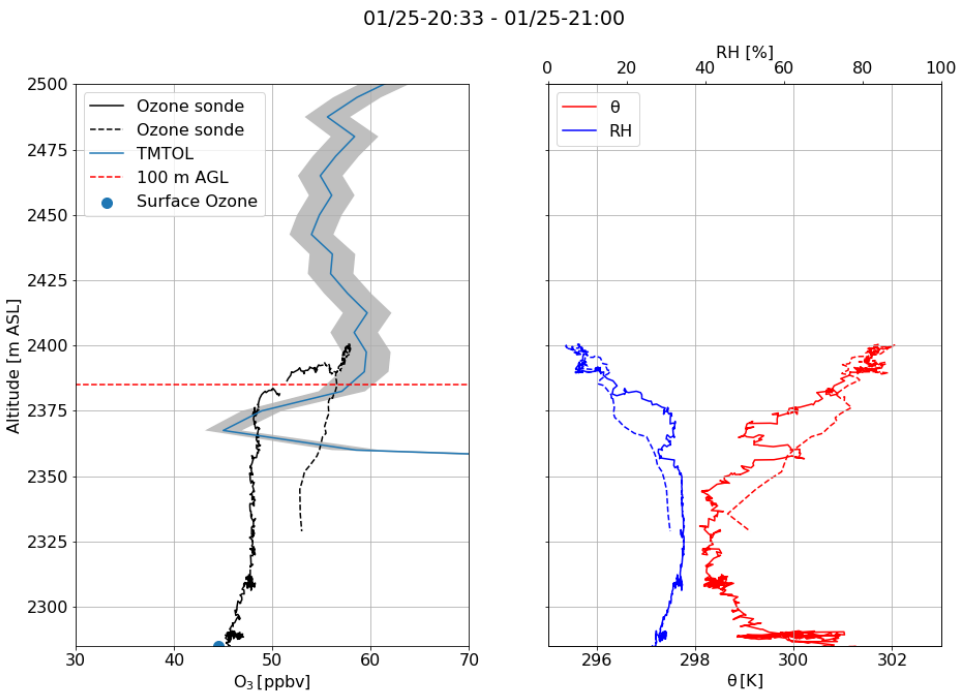
Find suitable UAV (no DJI)

- Determine operation procedures
- Risk management
- SOP for batteries

UAV measurements

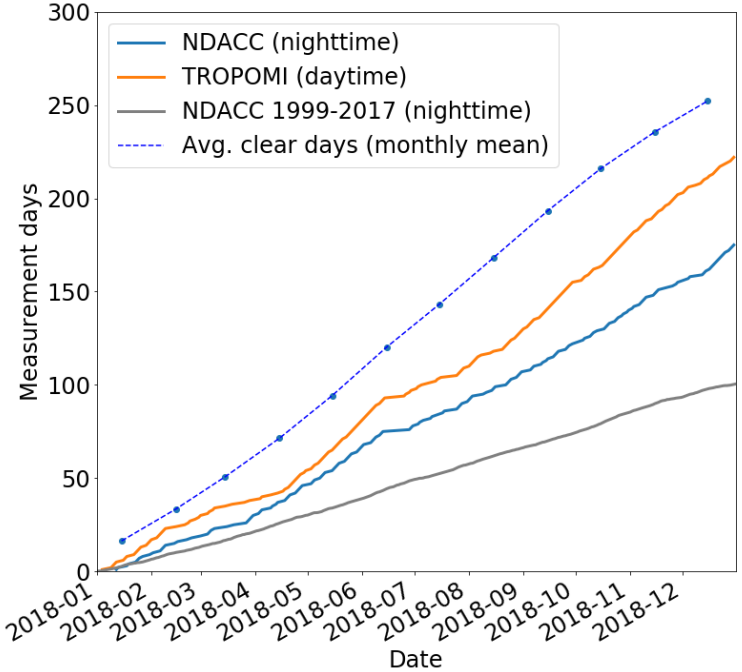
- **UAV vs TMTOL: First results**
  - *First test with scientific payload was conducted on 25th Jan 2019.*
  - *Results show very good agreement with TMTOL*
  - *After reaching ceiling (120 m AGL) the drone experienced an "uncontrolled" descend.*

- **UAV issues**
  - *After several tests, the most likely cause for the UAV problems was found to be the low thrust to weight ratio of the current configuration.*
  - *Tests with slightly bigger propellers and smaller batteries are planned for the near future.*



Lidar automation

- **First year of TMTOL automated runs**
  - *Temporal coverage of NDACC measurements during 2018 almost **duplicated** the mean of the 1999-2017 time period.*
  - *About **220** 1-hour measurement periods during TROPOMI overpasses were conducted.*



- **Automation of TMSOL and TMWAL**
  - *Following the experience of TMTOL, the other two lidars at TMF (Stratospheric ozone lidar and Water vapor Raman lidar) were also automated.*

- **Upgrade on MLSOL**
  - *New data acquisition system based on Licel hardware and a simplified version of the software used at TMF (no automation so far).*

Smoke and ozone transport studies

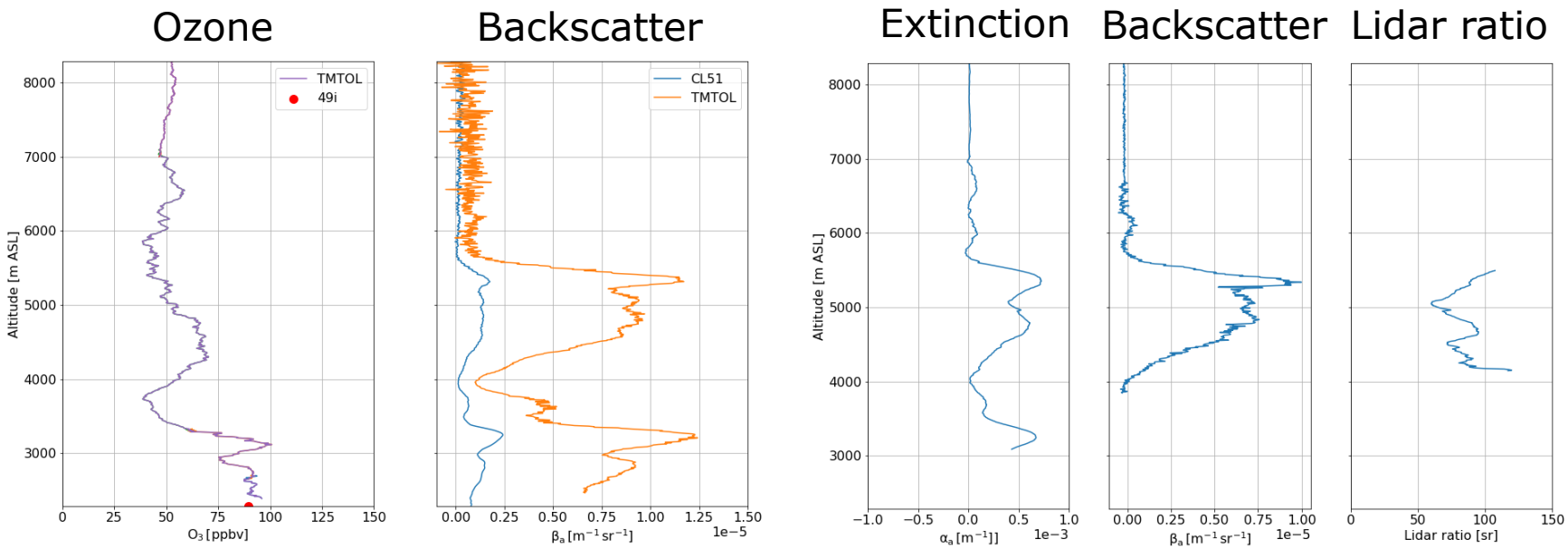
- **Methods**
  - *Ozone and backscatter coefficient retrieval from TMTOL*
  - *Backscatter and extinction coefficient retrieval from TMWAL*

- **Models (Resolution)**
  - *HRRR Smoke (3 km)*
  - *RAP Smoke (13 km)*
  - *RAP Chem (13 km)*

- **Objective**
  - *Analyze the performance of the models to reproduce smoke and ozone transport events*
  - *Investigate differences between HRRR Smoke and RAP Smoke*
  - *Extend the model evaluation to a TOLNet-wide analysis?*

Aerosol characterization (TMTOL/TMWAL)

- **Case study: 9th August 2018**
  - *TMTOL (289 nm), Water vapor Raman lidar (355 nm and 387 nm) and ceilometer (910 nm)*



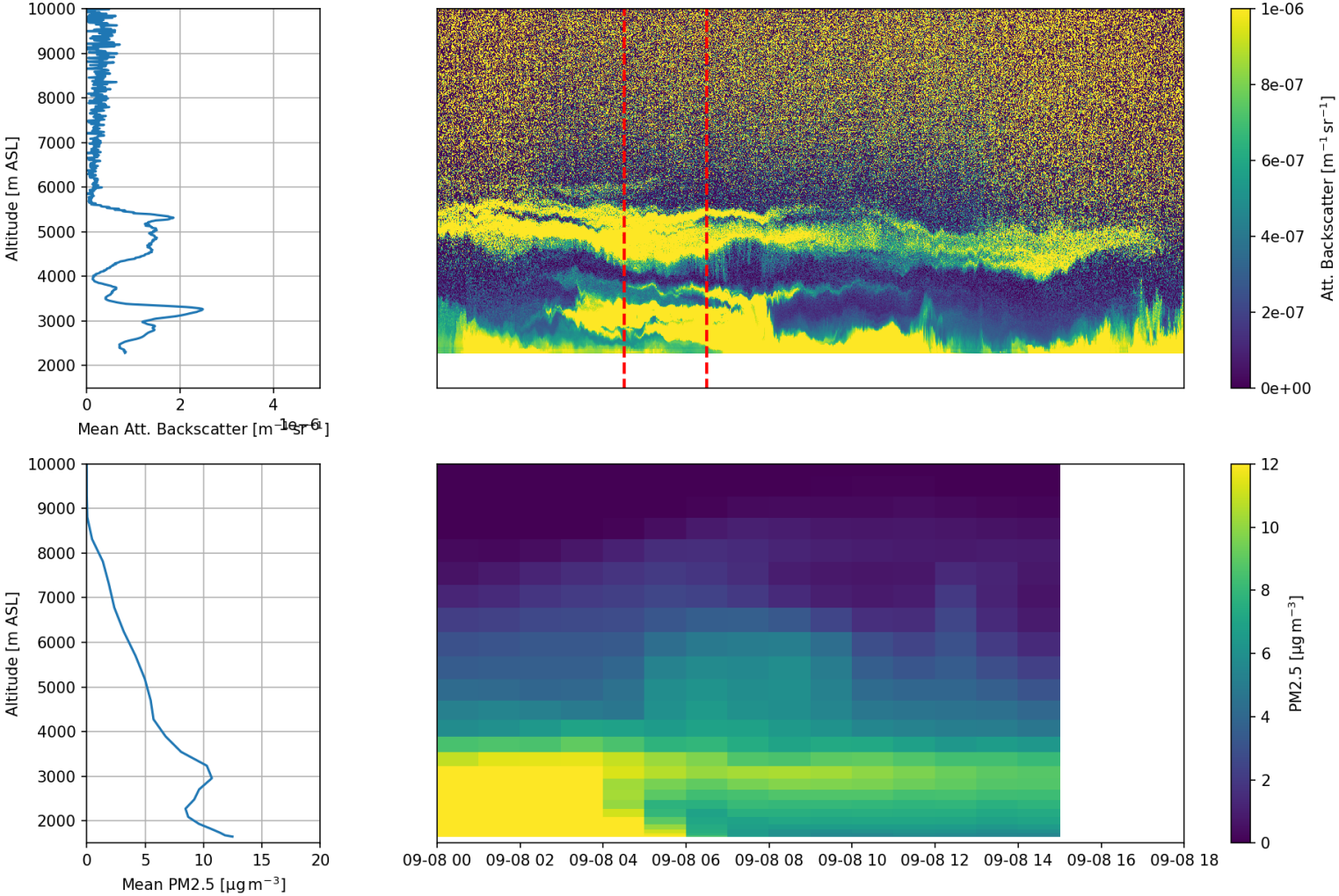
TMTOL + CL51

TMWAL

- **Findings**
  - *LR (75 sr) is compatible with previously reported fresh wildfire smoke (e.g.* Nicolae et al. 2013*)*
  - *Aerosol backscatter coefficient ratio (355/910) is about 5.7 -> AE = 1.8*

RAP Smoke vs Ceilometer

RAP Smoke vs. Ceilometer @ Table Mountain Facility (34.382N;117.6818W)



Upcoming work

- **UAV measurements**
  - *Test with new drone setup (lighter batteries and larger propellers)*
  - *Perform intensive validation of TMTOL near range channel*
  - *Use the UAV measurement capabilities to investigate high frequency ozone fluctuations near surface*

- **Automation**
  - *Implement additional functionality for enhanced lidar health diagnostic (i.e. send notifications when lidar signals don't look "normal")*

- **Smoke and ozone transport studies**
  - *Extend the lidar/model comparison to other case studies*
  - *Use other TOLNet datasets to further investigate the performance of RAP and HRRR models.*
  - *Start writing a publication on this subject.*