2016-10-13, ACC-12
Yonsei University, Seoul

The Pandonia network for ground validation of satellite-derived trace gas products

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for the Pandora team

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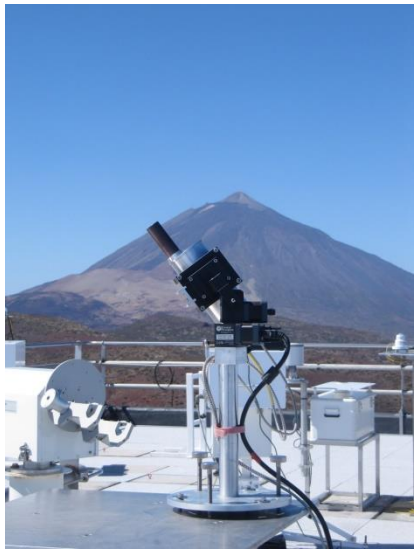
Pandonia

- Ground-based remote sensing network for air pollution monitoring and satellite validation
- Uses Pandora-2S and Pandora as core instruments

MOTIVATION:
Long, uninterrupted, well-maintained, homogeneously calibrated time-series of ground-based remote sensing atmospheric ozone measurements have been and still are the backbone for the validation of ozone columns measured from satellite (e.g. TOMS, OMI). There is no comparable network for other satellite-derived trace gas measurements (e.g. NO_2).



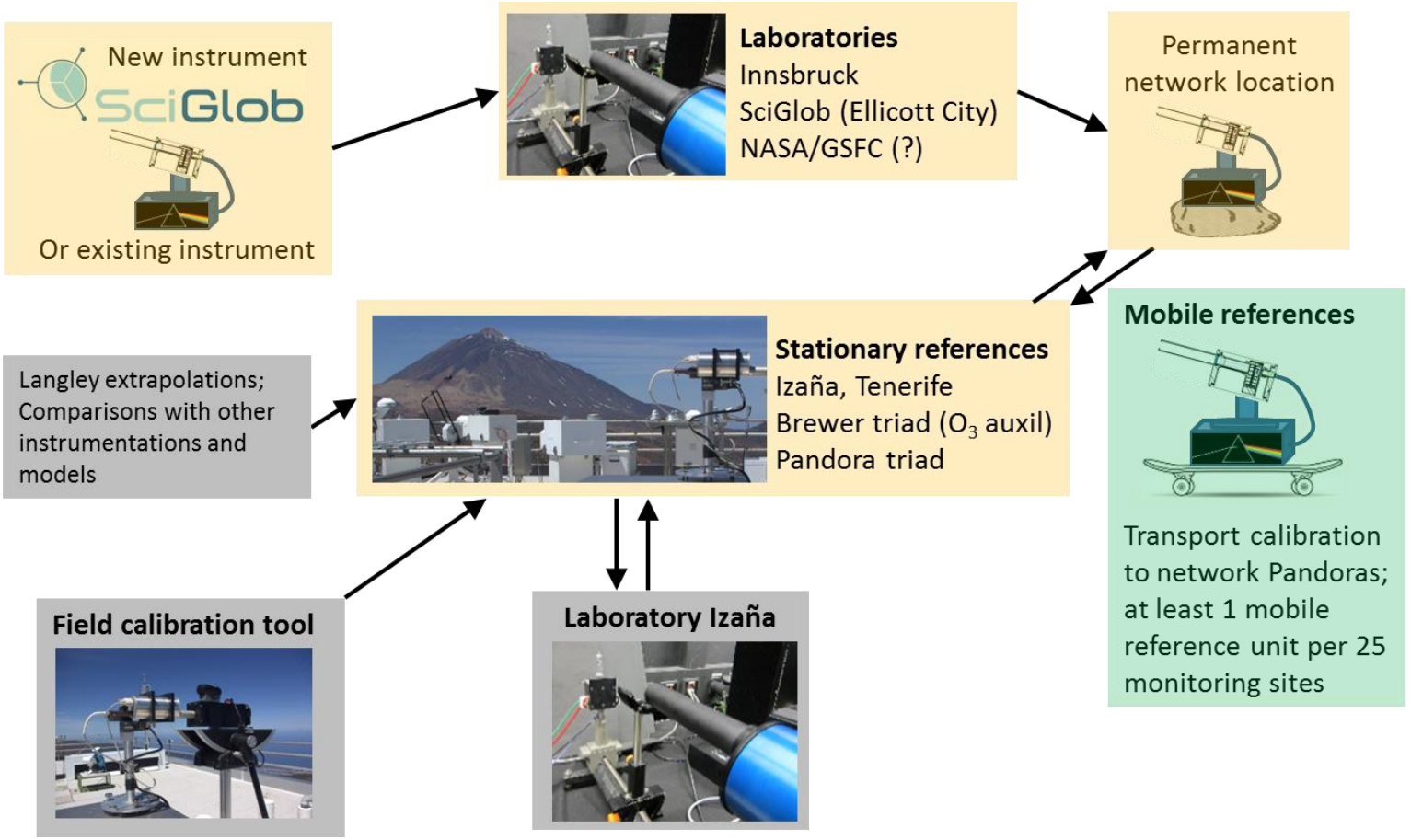
Pandonia stations

PANDONIA REAL TIME
PANDONIA SOON
NASA STATIONARY

Pandonia calibration plan

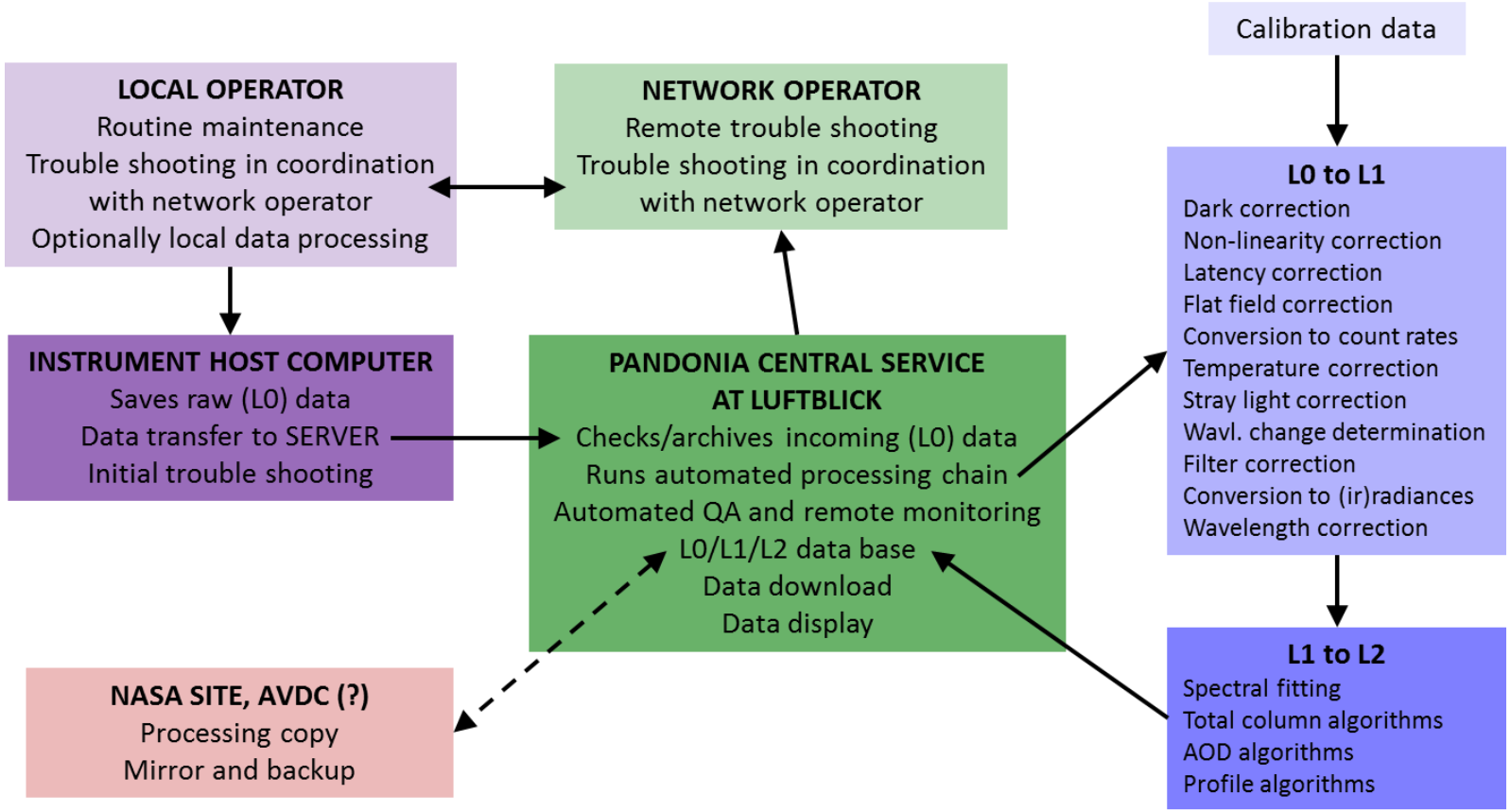
There is an extensive network calibration plan, which is not fully implemented yet. The key points are:

- Instruments undergo a detailed initial lab-calibration
- Location instruments are visited by mobile reference unit and FCT (Field Calibration Tool) to minimize data interruptions.



Pandonia operation and data processing

- Blick Software Suite for data operation, transfer, processing etc.
- All written in Python and freely distributed including source code
- Emphasis on versioning and meta data
- BlickP (processing software) has been tested during CINDI-2 and will be operational soon (in 2016)



pandonia-frm

Precision for Pandora direct sun total columns

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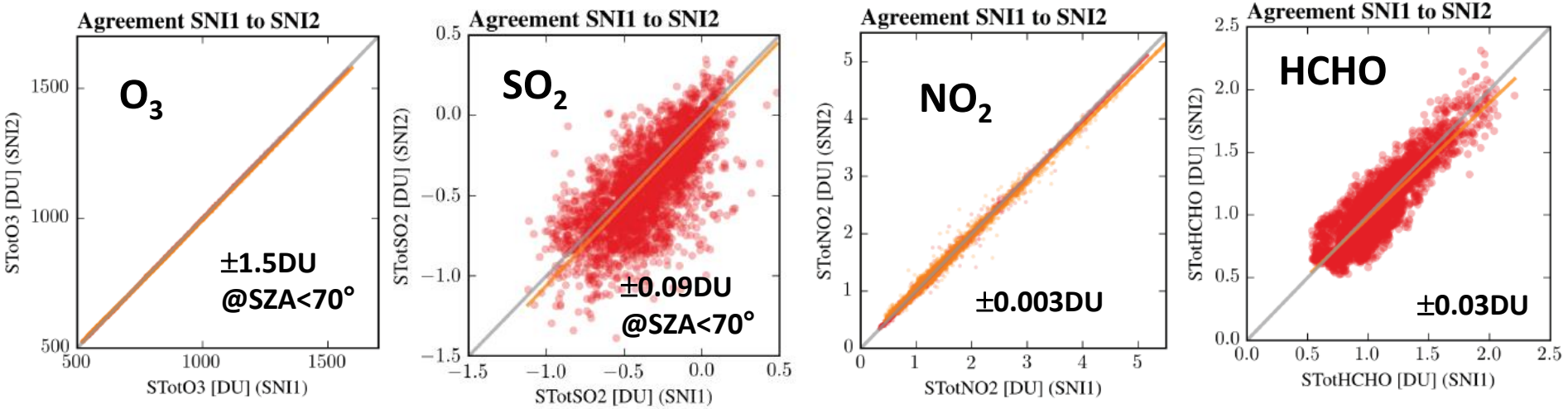
- "Single measurement" (40s) near real time retrievals (operational)
- This is not accuracy, just precision (=1-sigma standard deviation of the difference between measurements of Pandoras, which have been calibrated in the same way).
- At SZA>70° precision decreases due to stray light → ongoing project for sophisticated stray light correction algorithm in collaboration with WRC using tunable laser

Product	Precision (1 sigma)
O_3	1.5DU @SZA<70°
O_3 temp	2.3K @SZA<70°
NO_2	0.003DU
SO_2	0.09DU* @SZA<70°
HCHO	0.03DU

** Fioletov et al., 2016, AMT, list precision of 0.17DU for two separately calibrated Pandoras*

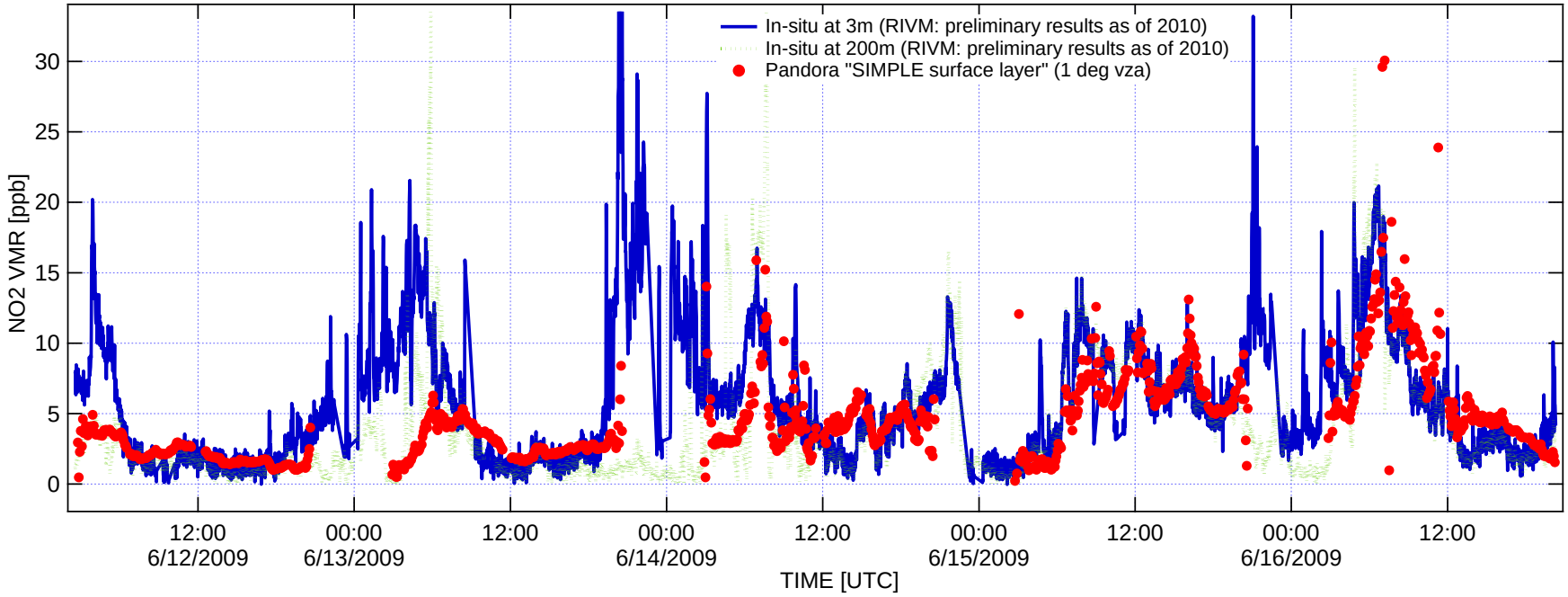


pandonia-frm

Surface concentrations from sky radiances

- The new processing software BlickP includes a real time surface concentration algorithm, which is based on measurements at viewing zenith angles 0, 60, 75, 88, 89° (total measurement duration 120s).
- Differently to in-situ data, this is the average surface concentration over a distance of 5 to 20km from the measurement site.

CINDI-1 campaign results (2009)



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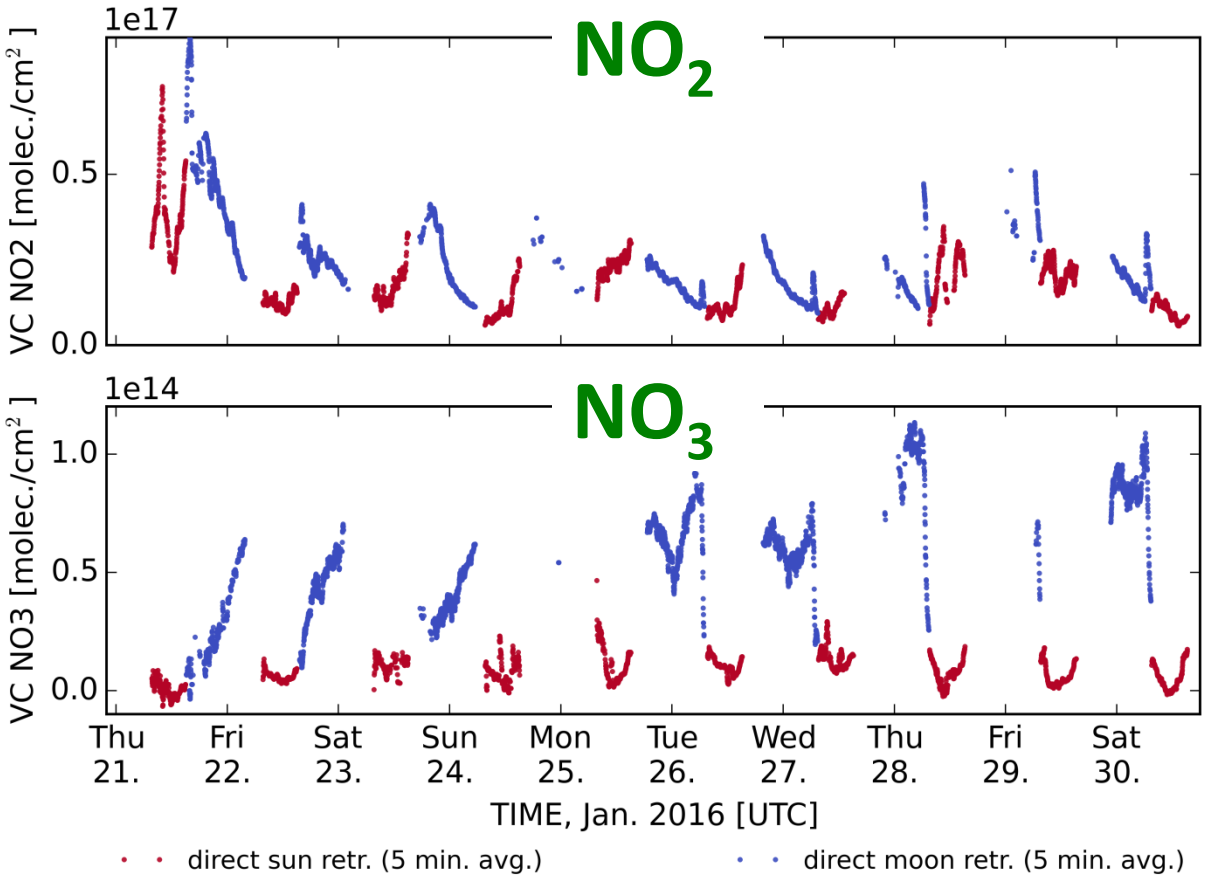
Direct moon total columns

- Automatic moon tracking using sophisticated alignment algorithm
- Successful tests for NO_2 and NO_3 columns (see figure)
- Will also work for other gases, e.g. O3
- Improves time-coverage especially at high latitude stations

Data from Innsbruck, Austria



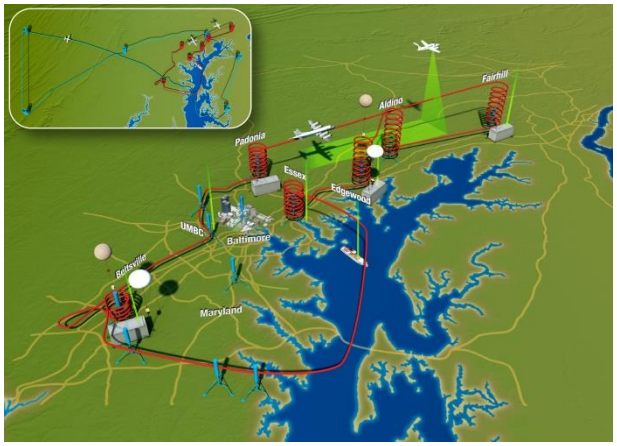
Note:
This is the air in the city.
When you are skiing
in the mountains of
Tirol, the air is much better!

pandonia-frm

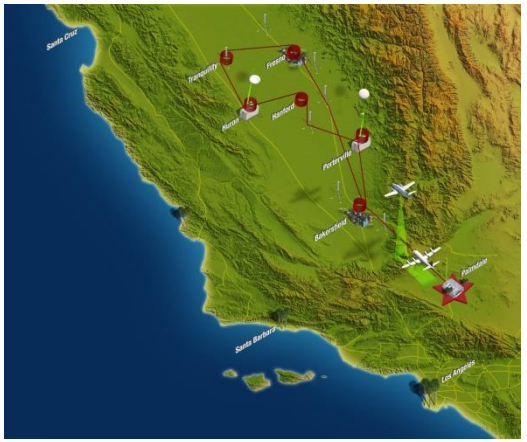
Pandora at DISCOVER-AQ & KorUS

- 8 to 12 Pandoras at each of the separate campaign for a few weeks
- For Pandonia the instruments will be stationary!

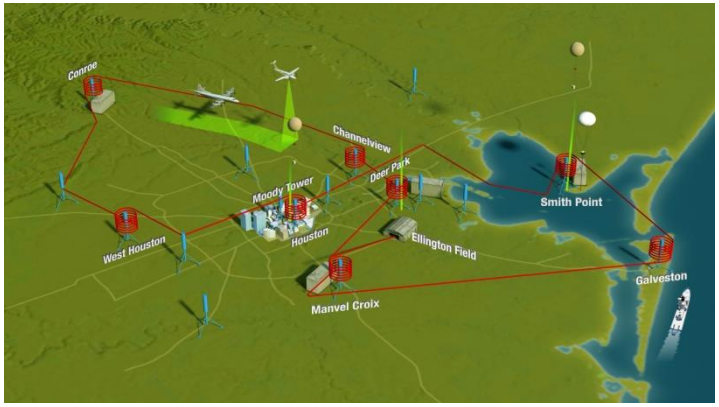
MARYLAND 2011



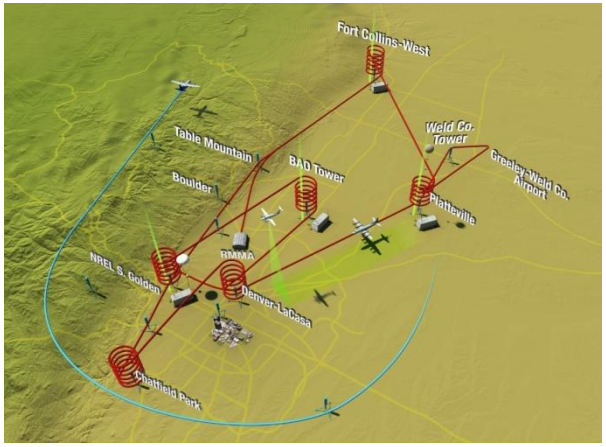
CALIFORNIA 2013



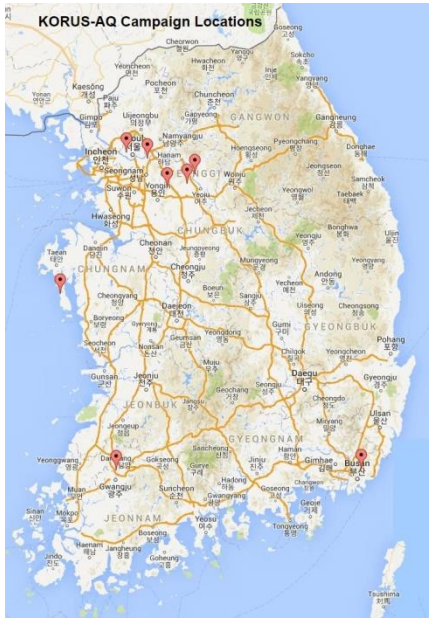
TEXAS 2013



COLORADO 2014



KorUS 2016



Pandoras at CINDI-2

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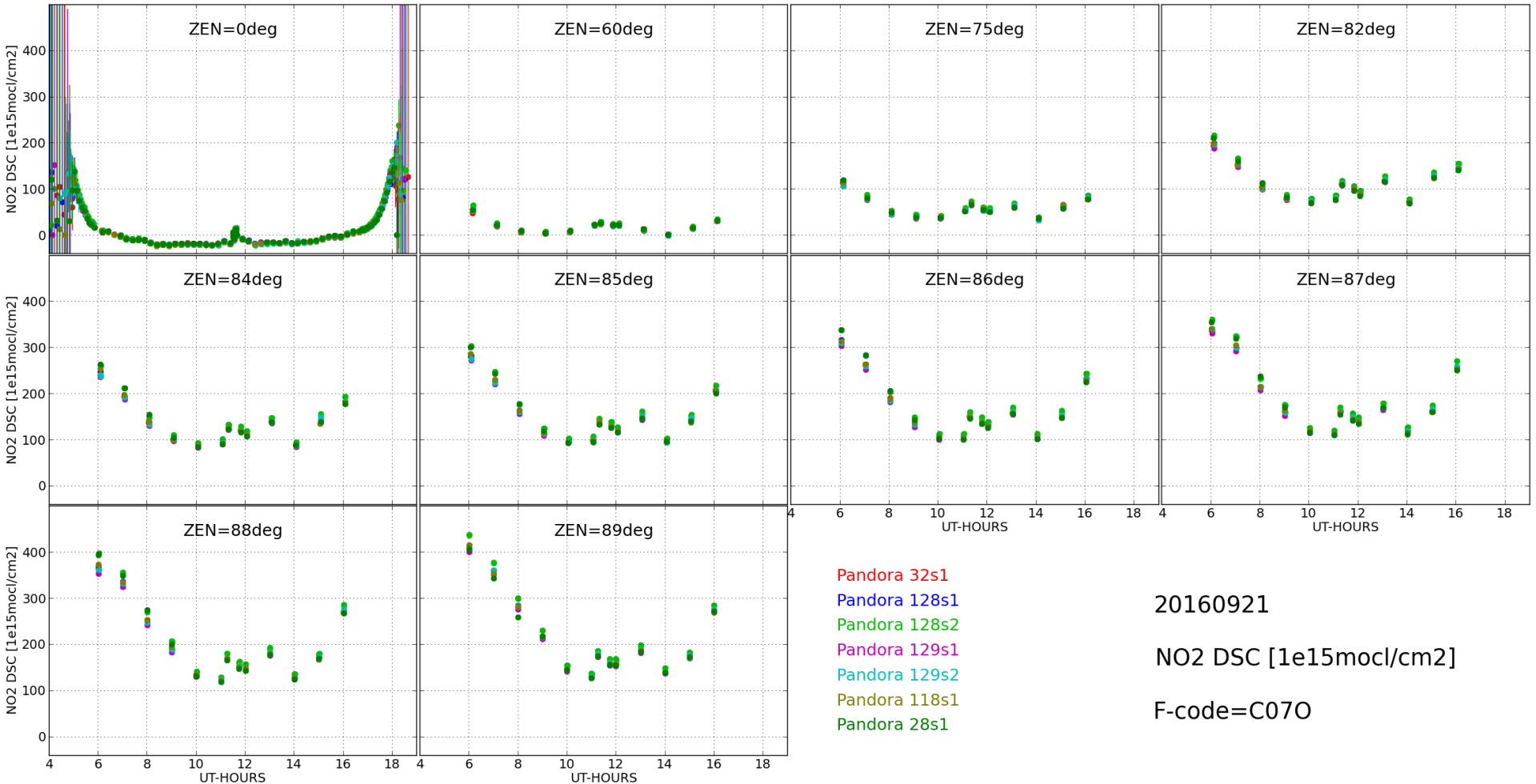
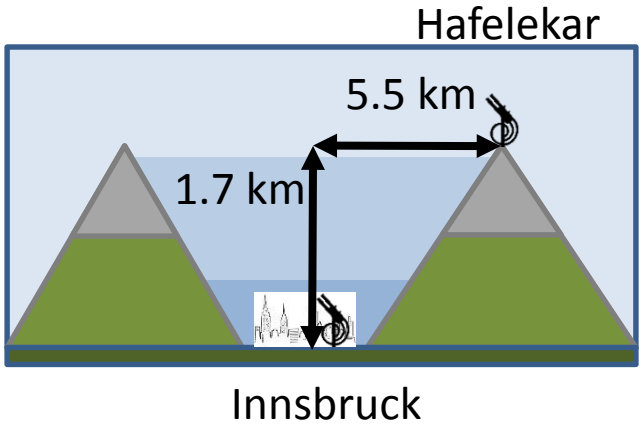
- 3 Pandora-1S + 2 Pandora-2S at CINDI-2 → 7 spectrometers
- Pandoras agree with each other
- Differences to other instruments are being investigated

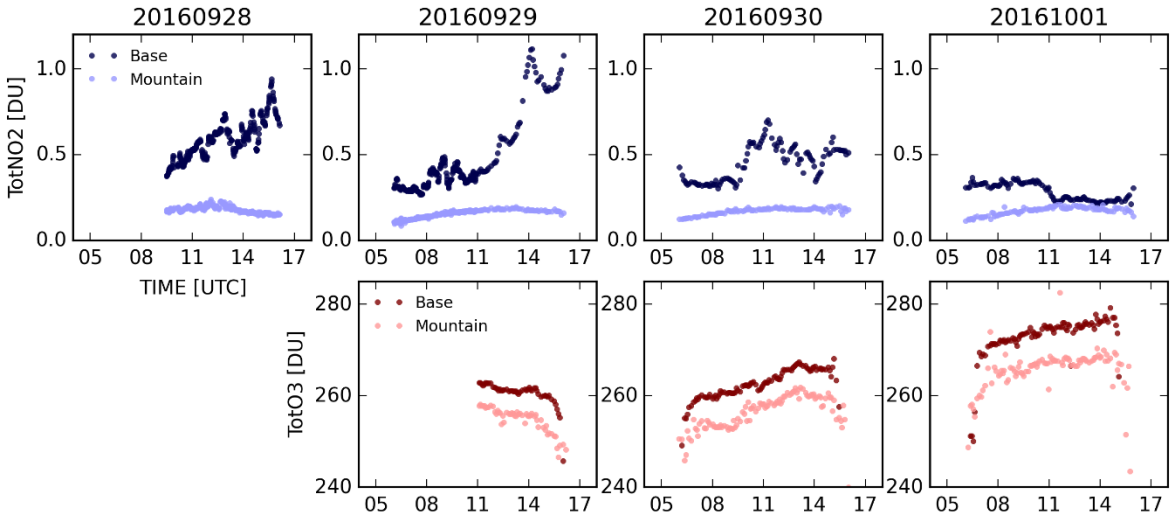


Innsbruck closure experiment

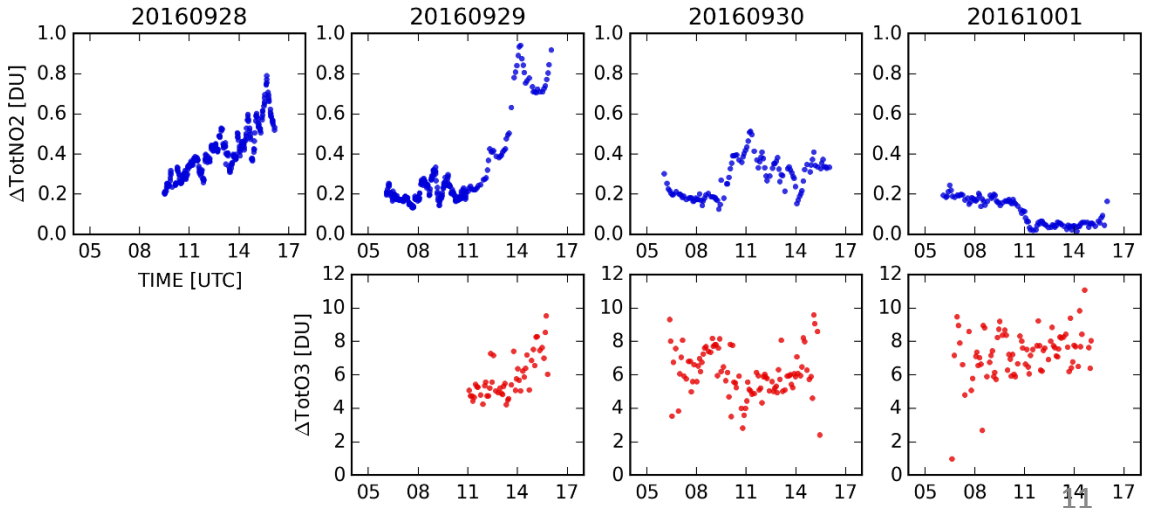


- Pandora measurements at Innsbruck (616 m a.s.l.) and Hafelekar (2275 m a.s.l.)
- Data interpretation will include the information from additional instrumentation at Innsbruck such as in-situ data of trace gases and aerosols, Lidar data, etc.

Total columns Innsbruck and Hafelekar



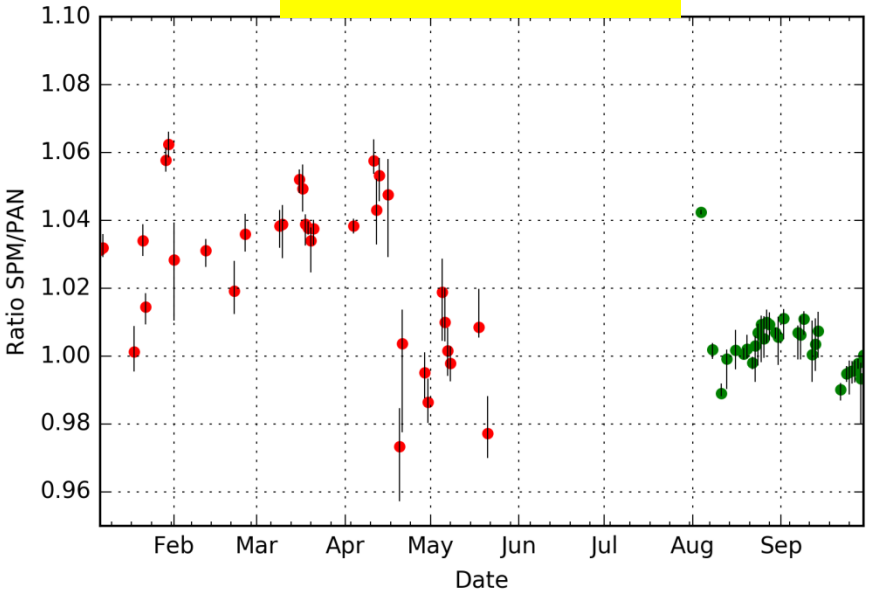
Δ Total columns = column valley atmosphere



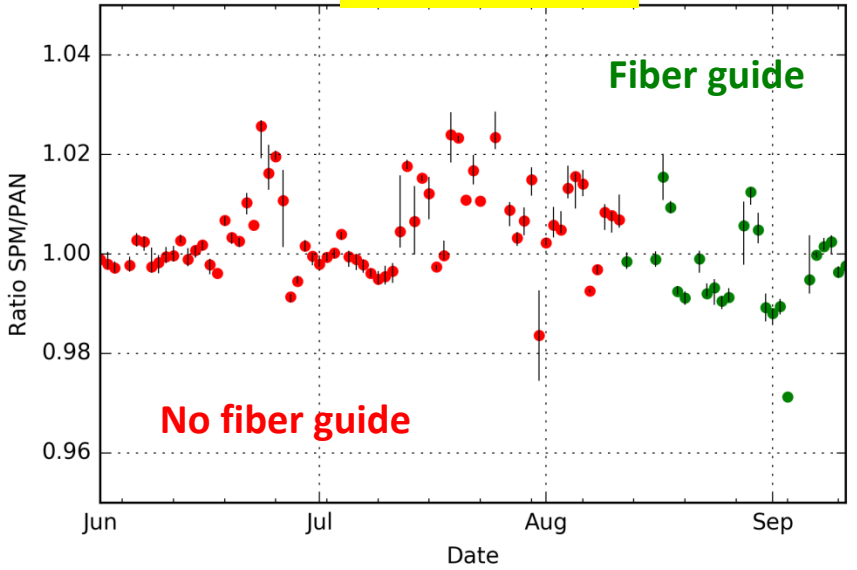
Aerosol properties

- Problems with stability of absolute irradiances → error in AOD
- We developed a 'fiber guide' which fixes bending of the first meter of the fiber
- First fiber guides installed at Innsbruck and Izaña
- Preliminary comparison with sun photometer s shows improvement after installing the fiber guide
- In a future ESA project (starts end of 2016) Pandora data will be applied to the GRASP algorithm to retrieve aerosol properties

Pan110 Innsbruck



Pan121 Izaña



Tracker

- Current commercial Pandora tracker has several deficiencies
- New tracker prototype has been developed as part of an ESA project
- Major improvements:
  - Full zenith angle motion range (can look straight down)
  - Encoders return the correct position
  - Stronger stepper motors can carry more weight
  - Acceleration and de-acceleration also for short movements

Thank you