Geoffrey Toon, Jean-Francois Blavier, Keeyoon Sung
Jet Propulsion Laboratory, Caltech Institute of Technology

Not a primary NDACC site, so MkIV/JPL doesn’t show up in Jim’s reports, but dataset is still potentially useful

MkIV is now 29 years old, still with original KBr beamsplitter/compensator.

Instrument covers entire 650-5650 cm\(^{-1}\) region simultaneously (no filters) at 0.005 cm\(^{-1}\) resolution (117 cm MOPD) for ground-based obs.

~1000 days of ground observations, 22 balloon flights, and 30+ aircraft flights.

Ground-based dataset has many interruptions due to balloon/aircraft campaigns
Highlights of 2012

Repaired MkIV following damage from Sep 2011 balloon flight

Resumed ground-based measurements from JPL

Replaced 21-year-old SpectraPhysics reference laser with REO Model 32734. (Still working, but power was down by factor 2 and easily went into wait mode)

MkIV instrument continues to make measurements from JPL. Although this site is sometimes polluted, this expands the scientific usefulness of the measurements.

Submitted a single Ames-format file to Jeanette Wild covering 1985-2013 ground-based MkIV observations from 12 different locations. There are 3400+ observations acquired on ~1000 different days.
New MkIV ground-based dataset

Re-analysis covers 1985 to 2013 time period

~1000 observation days

6800+ observation (HgCdTe + InSb spectral pairs) covering 650 to 5650 cm\(^{-1}\)

12 measurement locations from 78S to 68N are included in single file

All data measured with same instrument (BS, detectors, etc) and analyzed with the same methodology (IPP, GFIT, linelist, etc)

- GFIT Version 4 analysis (same as used for TCCON)
- Tweaked spectroscopic linelist mostly based on HITRAN 2008

Dataset submitted to NDACC archive

Also available from: http://mark4sun.jpl.nasa.gov/ground.html
Ground-Based Observations

Between balloon and aircraft campaigns, the MkIV instrument is used to make ground-based observations. Although these measurements lack the vertical resolution that can never be made much more frequently - MkIV has averaged over 50 days of observation per year recently. Ground-based observations are an accurate method of which is the main purpose of NDACC.

MkIV Ground-based Vertical Column Abundances

Individual Column Abundances: (83 columns, 3417 rows)
Individual Column Abundances: (Ames-1001 format)
Daily Average Column Abundances: (83 cols, 923 rows)
List of windows: (225 rows)
Window-to-window biases:

Column observations

Daily Averages
MkIV dataset covers 12 locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Key</th>
<th>Nobs</th>
<th>Latitude (deg.)</th>
<th>Longitude (deg.)</th>
<th>Altitude (km)</th>
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<tbody>
<tr>
<td>Esrange, Sweden</td>
<td>ESN</td>
<td>160</td>
<td>+67.889</td>
<td>+21.085</td>
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<td>Ft Wainwright, Fairbanks, Alaska</td>
<td>FAI</td>
<td>124</td>
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<td>-147.614</td>
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<td>Lynn Lake, Manitoba, Canada</td>
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<td>-118.235</td>
<td>3.801</td>
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<td>ARC, Mountain View, California</td>
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<td>-122.080</td>
<td>0.010</td>
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<tr>
<td>Daggett, California</td>
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<td>33</td>
<td>+34.856</td>
<td>-116.790</td>
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<tr>
<td>Ft Sumner, New Mexico</td>
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<td>172</td>
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<td>TMF, Wrightwood, California</td>
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<td>475</td>
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<tr>
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<tr>
<td>McMuro, Antarctica</td>
<td>MCM</td>
<td>37</td>
<td>-77.847</td>
<td>+166.728</td>
<td>0.100</td>
</tr>
</tbody>
</table>

Nobs = Number of Observations; +ve Latitude = N; +ve Longitude = E

*MkIV dataset is unique in the sense that the same instrument and analysis method has been applied to 12 different locations, minimizing site-to-site biases.*
MkIV CO$_2$ Columns

Barcroft
Table Mountain
Ft Sumner

CO$_2$ column vs Year

JPL
Need to de-seasonalize the CO$_2$ (which is latitude- & altitude-dependent)
MkIV HDO & H$_2$O (color-coded by T)

Temperatures vary from -40C (blue) to +40C (Red)
OCS exhibits a springtime maximum and autumn minimum. Note also the large springtime variability compared with summer. Low values in polar winter vortices.
HCOOH and $H_2CO$
Surprising that these two gases correlate well given their different lifetimes. Different slope to correlation at clean (high) and dirty (low) sites.
Publications & Presentations

"Methane and Ethane Total Column Measurements in the Los Angeles Basin".
Wunch, Debra, Coleen Roehl, Jean-Francois Blavier, Norton Allen, Richard Treffers, Geoffrey Toon, Paul Wennberg,
AGU Fall Meeting, December 3-7, 2012

"Intercomparison of Total Column Ozone Observations From S-NPP OMPS and Ground-Based IR FTS During Summer and Fall of 2012",
Bhaswar Sen, Megan Novicki, Wen-Hao Li, Geoffrey Toon, Jean-Francois Blavier, Nicholas Jones, Clare Murphy, David Griffith, Mathias Palm, Justus Notholt and Lawrence Flynn,
American Meteorological Society Meeting, Jan 2013

“Carbonyl sulfide (OCS) variability with latitude in the atmosphere”
Gisèle Krysztofiak, et al.
Submitted to Atmosphere-Ocean, 2013
Ethane Emissions in the South Coast Air Basin

- The MkIV Fourier transform spectrometer has measured C$_2$H$_6$ and CO in the south coast air basin since 1988.
- Using the reported CARB CO emissions, C$_2$H$_6$ emissions can be calculated.
- Blue squares are in situ measurements reported in Hsu et al. (2010) and Wennberg et al. (2012); red triangle is from new measurements.

From Wunch et al., 2012
Relative Difference Between OMPS and Ground-Based FTIR Total Column Ozone Observations

From Sen et al., 2013
Other IRWG–related activities in past year

Participated in evaluation of HITRAN 2012 linelist. Used beta release to fit:
- MkIV Balloon & ground-based spectra (700-4800 cm⁻¹)
- TCCON ground-based (v> 4800 cm⁻¹)
- Kitt Peak Lab spectra

Reported large residuals or instances where fits got worse as compared with HITRAN 2008.

Generated Pseudo Linelists for:
- CH₃OH (900-1150 cm⁻¹) from lab measurements of Harrison & Bernath
- C₃H₈ (680-1550 cm⁻¹) from lab measurements of Sung et al
- C₃H₈ (2770-3075 cm⁻¹) from lab measurements of Harrison & Bernath
Conclusions

Late 2012, NASA continued funding of MkIV task for another 4 years.

Instrument continues to make high quality ground-based observations from JPL.

50 observation days in past 10 months.

Next balloon flight planned for September 2014.

Trends are more difficult to identify/quantify in MkIV dataset because instrument keeps changing location.

But dataset perhaps allows a more thorough evaluation of global models than could be achieved by a single fixed site.
HCl and HF (color-coded by latitude)
HCl/HF Ratio

![Graph showing HCl/HF ratio over years and days of the year.](image)