Zugspitze FTIR Site Report

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Tobias Borsdorff (PhD student)
Frank Forster (PhD Student)

47 °N, 11 °E, 2964 m a.s.l.

Research Center Karlsruhe
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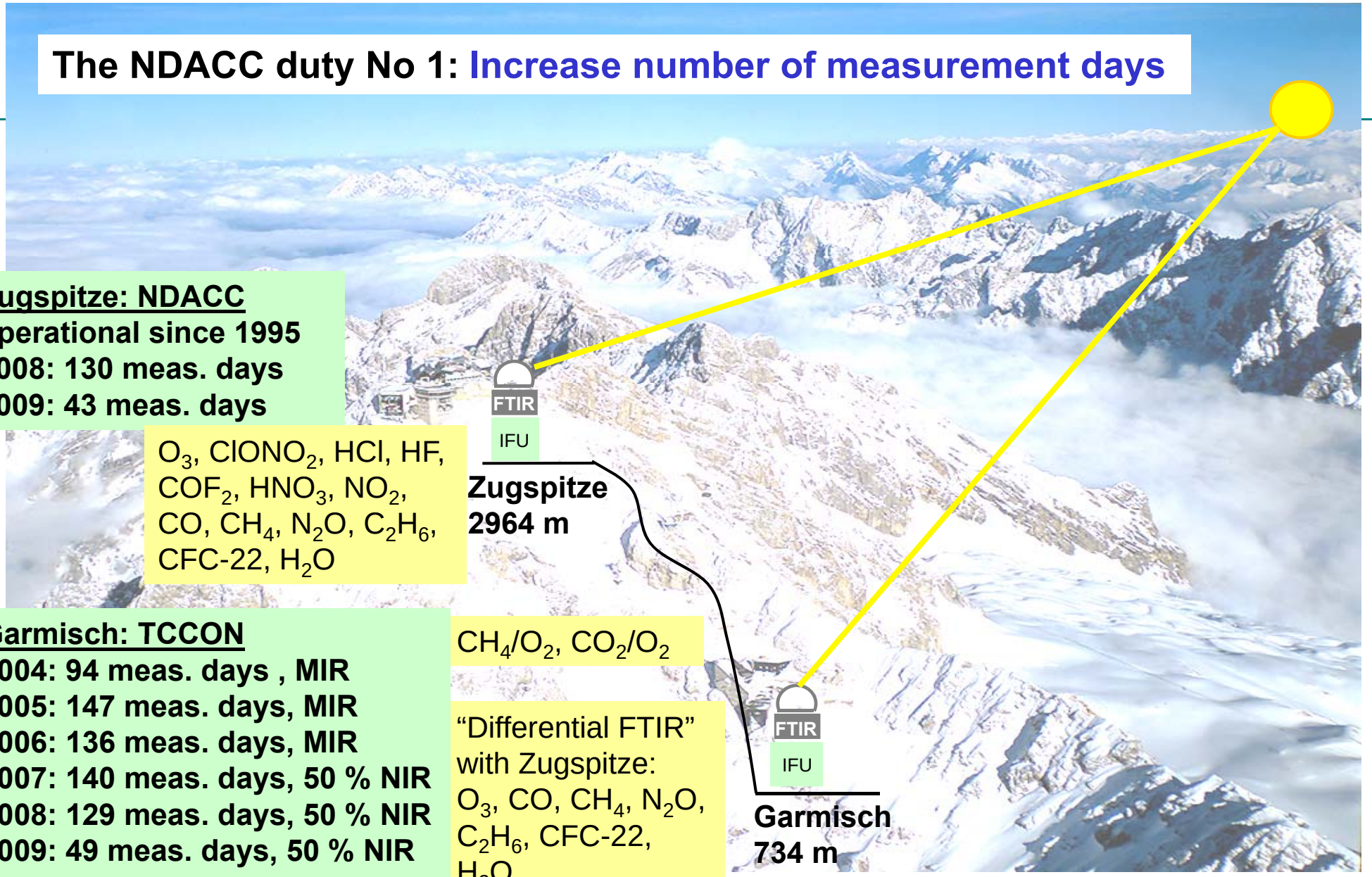
The NDACC duty No 1: Increase number of measurement days



Zugspitze: NDACC
operational since 1995
2008: 130 meas. days
2009: 43 meas. days

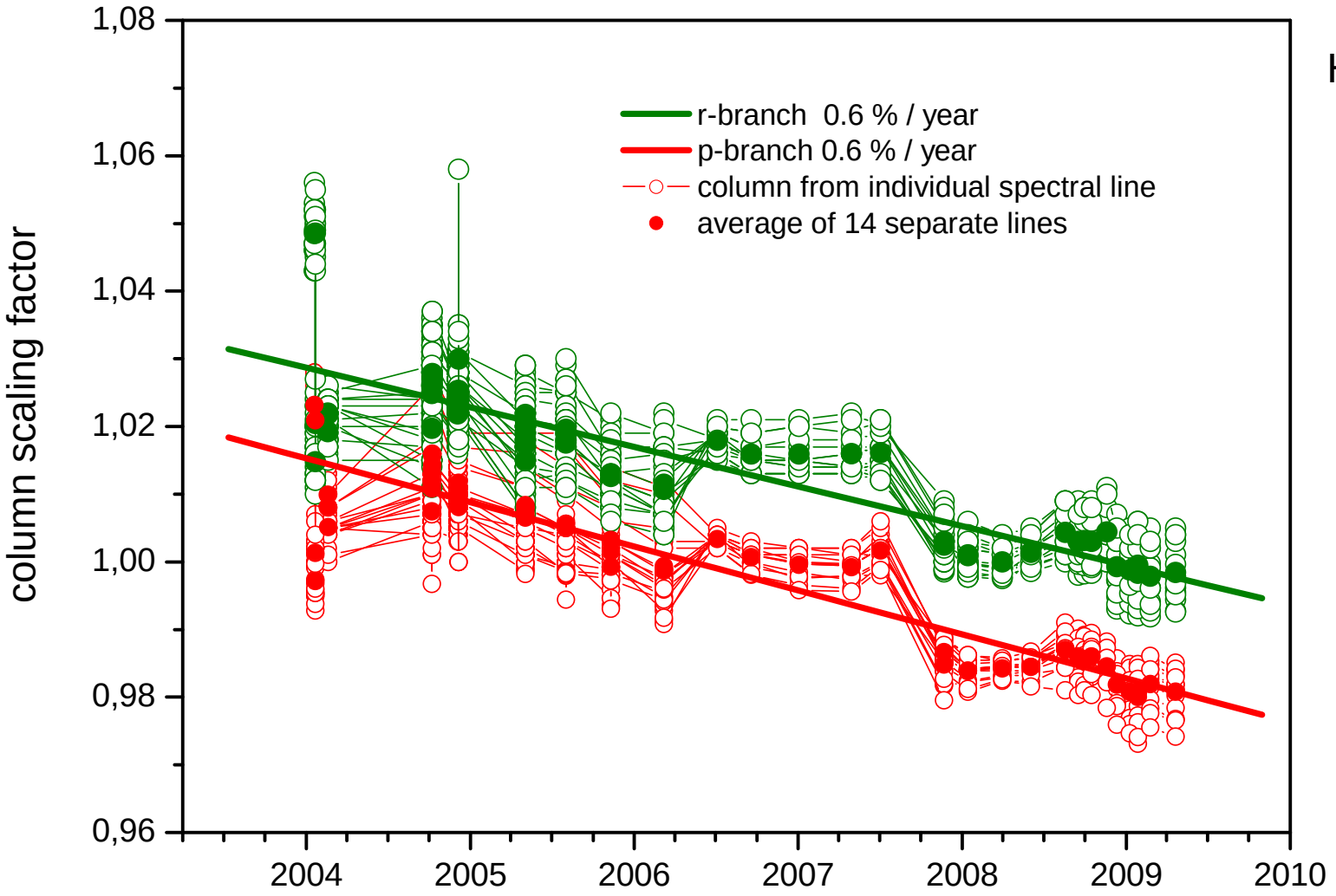
O_3, $ClONO_2$, HCl, HF, COF_2, HNO_3, NO_2, CO, CH_4, N_2O, C_2H_6, CFC-22, H_2O

Garmisch: TCCON
2004: 94 meas. days , MIR
2005: 147 meas. days, MIR
2006: 136 meas. days, MIR
2007: 140 meas. days, 50 % NIR
2008: 129 meas. days, 50 % NIR
2009: 49 meas. days, 50 % NIR

CH_4/O_2, CO_2/O_2

"Differential FTIR" with Zugspitze: O_3, CO, CH_4, N_2O, C_2H_6, CFC-22, H_2O

You forgot what NDACC duty No 2 was about? Ask Frank and Mike ☺



The NDACC duty No 3: Archiving

Period(s) covered in data archiving at NDACC DHF:

recently updated full Zugspitze series (1995 up to now) for CO, O3, HF, COF2, HCl, ClONO2, CH_4, N2O, and H2O

tried to archive in new NDACC HDF database, but

were stopped by a problem with ASC2HDF:

- after conversion of the input data the resulting HDF-File contains the variable "DATA_START_DATE" in the wrong format MJD2000.

- the NDACC database only accepts the ISO8601 format "yyyymmddThhmissZ".

- if the date is entered in the metadata in the right (ISO) format before conversion it is changed to (the wrong) MJD2000.

Zugspitze FTIR Site Report: Intercomparisons

Name, date, and location of last intercomparison and/or validation:

- 1996 intercomparison with Jungfraujoch: coincident measurements and blind independent analyses of HF, HCl. Agreement within 2 per cent
- In 2001 evaluation of the Zugspitze time series since 1995 of HCl and $ClONO_2$, and comparison to the Jungfraujoch series; showed very good overall agreement!
- In 2002 we compared in preparation for ENVISAT Validation columns of N_2O, CO, CH_4, NO_2, O_3 to coincident Jungfraujoch data. E.g., N_2O agreed within 1 %!
- Intense 3 months water vapor validation campaign at Zugspitze (mid Aug – mid Nov 2002) with permanent FTIR water vapor measurements compared to 4 radio sondes launched on site daily and permanent GPS water column measurements on site. Very good agreement of FTIR to sonde columns within a few per cent! Detailed FTIR validation study also relative to GPS measurements performed.
- In spring 2003 comparison of the Zugspitze time series (1996-2002) of CO to the Jungfraujoch series; showed very good overall agreement!
- N_2O trop. columns trend (1995-2004): Zugspitze 0.18 %/yr, Jungfraujoch 0.23 %/yr
- 2005: Initial SCIAMACHY validation: learned much about precision of CO, CH_4, NO_2 measured by FTIR
- 2007: Comparison of Zugspitze HF, COF_2, HCl and $ClONO_2$ to KASIMA model (issue of fall FTIR-ClONO2 enhancements)
- 2007/08: Validation of maturated SCIA CH_4 data: precision of MIR retrievals (prior impact, annual cycle issue)

Zugspitze FTIR Site Report: Intercomparisons

Name, date, and location of last intercomparison and/or validation:

- Comparing Zugspitze CH_4 to Jungfraujoch: Pefect agreement of annual cycle
- 2008/09: first FTIR retrieval of a meso CO annual cycle above mid-latitudes: compared Zugspitze FTIR to Garmisch FTIR, to Bremen FTIR, and to WACCM model (⇒Tobias´ talk)
- 2008/09: Developed H2O column retrieval compared matched to coincident radiosondes (transferred retrieval to ISSJ in a harmonized way,analyzed ISSJ side-by-side intercomparison of H2O columns).
- Ongoing : Lead retrieval strategy/harmonization effort for CH4 and N2O retrievals and perform global SCIA validation versus 13 participating g.-b. stations (2 SCIA algorithms)

Zugspitze FTIR Site Report: Publications

List of conference contributions during the reporting period:

Ruhnke, R., Blumenstock, Th., Duchatelet, P., Hamann, K., Hase, F., Kouker, W., Kramer, I., Mahieu, E., Mikuteit, S., Notholt, J., Reddmann, Th., Schneider, M., Sinnhuber, B.-M., Sussmann, R., Velazco, V., Warneke, T., Wiehle, M.: Measured and modelled trends of stratospheric Cly and Fy column amounts in the northern hemisphere, Abstracts of the Quadrennial Ozone Symposium, Tromsø, Norway, June 29 – July 5, 2008.

Sussmann, R., Borsdorff, T., Rettinger, M., Ruhnke, R.: Variability and trends of total O3, Cly and Fy in relation to the Montreal Protocol from long-term FTIR observations at the NDACC Primary Station Zugspitze, Abstracts of the Quadrennial Ozone Symposium, Tromsø, Norway, June 29 – July 5, 2008.

Borsdorff, T., Sussmann, R., and Rettinger, M.: First measurements of stratomesospheric CO at midlatitudes derived from ground-based FTIR measurements at Zugspitze and Garmisch-Partenkirchen, Verhandl. DPG (VI) 44, 2009, UP 2.4, http://www.dpg-verhandlungen.de/2009/hamburg/up2.pdf, (Poster).

Borsdorff, T., Sussmann, R., and Rettinger, M.: First detection of a seasonality of stratomesospheric CO above mid-latitudes via solar FTIR measurements. Analysis of one decade of observations at the NDACC Primary Station Zugspitze, Geophysical Research Abstracts, Vol. 11, EGU2009-5053-10, 2009, http://meetingorganizer.copernicus.org/EGU2009/EGU2009-5053-10.pdf, EGU General Assembly 2009 (Poster).

Zugspitze FTIR Site Report: Publications

List of conference contributions during the reporting period:

Sussmann, R., Borsdorff, T., Rettinger, M., Camy-Peyret, C., Demoulin, P., Duchatelet, P., and Mahieu, E.: New multi-station and multi-decadal trend data on precipitable water. Recipe to match FTIR retrievals from NDACC long-time records to radio sondes within 1 mm accuracy/precision, Geophysical Research Abstracts, Vol. 11, EGU2009-10617-2, 2009, http://meetingorganizer.copernicus.org/EGU2009/EGU2009-10617-2.pdf, EGU General Assembly 2009 (Poster).

Sussmann, R., Forster, F., Borsdorff, T., M. De Mazière, Dils, B., Vigouroux, C., Blumenstock, T., Buchwitz, M., Burrows, J.P., Demoulin, P., Duchatelet, P., Frankenberg, C., Hannigan, J., Hase, F., Jones, N., Klyft, J., Kramer, I., Mahieu, E., Mellqvist, J., Notholt, J., Petersen, K., Schneising, O., Strandberg, A., Strong, K., Taylor, J., Wood, S.: Satellite validation of column-averaged methane on global scale: ground-based data from 15 FTIR stations versus last generation ENVISAT/SCIAMACHY retrievals, IGAC 10th International Conference - Bridging the scales in Atmospheric Chemistry: Local to Global, Annecy, France, 7 to 12 September 2008 (Poster).

Zugspitze FTIR Site Report: Publications

List of conference contributions during the reporting period:

Sussmann, R., F. Forster, T. Borsdorff, B. Dils, M. De Mazière, C. Vigouroux, T. Blumenstock, M. Buchwitz,J.P. Burrows, P. Duchatelet, C. Frankenberg, J. Hannigan, F. Hase, N. Jones, J.Klyft, E. Mahieu, J. Mellqvist, J. Notholt, K. Petersen, O. Schneising, K. Strong, J. Taylor, Satellite validation of column-averaged methane on global scale: Harmonized data from 13 FTIR ground stations versus last generation ENVISAT/SCIAMACHY retrievals, Verhandl. DPG (VI) 44, 2009, UP 10.5, http://www.dpg-verhandlungen.de/2009/hamburg/up10.pdf (Poster).

Sussmann, R., F. Forster, T. Borsdorff, B. Dils, M. De Mazière, C. Vigouroux, T. Blumenstock, M. Buchwitz,J.P. Burrows, P. Duchatelet, C. Frankenberg, J. Hannigan, F. Hase, N. Jones, J.Klyft, E. Mahieu, J. Mellqvist, J. Notholt, K. Petersen, O. Schneising, K. Strong, J. Taylor: A novel Tikhonov-based approach for harmonized high-accuracy retrieval of methane columns and profiles from NDACC FTIR network measurements. Application to global validation of ENVISAT/SCIAMACHY biases, Geophysical Research Abstracts, Vol. 11, EGU2009-7869-2, 2009, http://meetingorganizer.copernicus.org/EGU2009/EGU2009-7869-2.pdf, EGU General Assembly 2009 (Talk).

Sussmann, R., F. Forster, T. Borsdorff, B. Dils, M. De Mazière, C. Vigouroux, T. Blumenstock, M. Buchwitz,J.P. Burrows, P. Duchatelet, C. Frankenberg, J. Hannigan, F. Hase, N. Jones, J.Klyft, E. Mahieu, J. Mellqvist, J. Notholt, K. Petersen, O. Schneising, K. Strong, J. Taylor, Satellite validation of column-averaged methane on global scale: Harmonized data from 13 FTIR ground stations versus last generation ENVISAT/SCIAMACHY retrievals, Fifth International Symposium on Non-CO2 Greenhouse Gases (NCGG-5) Science, Reduction Policy and Implementation, Wageningen, The Netherlands, June 30 - July 3, 2009 (Lead Session Talk).

Zugspitze FTIR Site Report: Publications

List of peer review publications that appeared during the reporting period:

Clerbaux, C., George, M., Turquety, S., Walker, K. A., Barret, B., Bernath, P., Boone, C., Borsdorff, T., Cammas, J. P., Catoire, V., Coffey, M., Coheur, P.-F., Deeter, M., De Mazière, M., Drummond, J., Duchatelet, P., Dupuy, E., de Zafra, R., Eddounia, F., Edwards, D. P., Emmons, L., Funke, B., Gille, J., Griffith, D. W. T., Hannigan, J., Hase, F., Höpfner, M., Jones, N., Kagawa, A., Kasai, Y., Kramer, I., Le Flochmoën, E., Livesey, N. J., López-Puertas, M., Luo, M., Mahieu, E., Murtagh, D., Nédélec, P., Pazmino, A., Pumphrey, H., Ricaud, P., Rinsland, C. P., Robert, C., Schneider, M., Senten, C., Stiller, G., Strandberg, A., Strong, K., Sussmann, R., Thouret, V., Urban, J., and Wiacek, A.: CO measurements from the ACE-FTS satellite instrument: data analysis and validation using ground-based, airborne and spaceborne observations, Atmos. Chem. Phys., 8, 2569-2594, 2008.

Gardiner, T., Forbes, A., de Mazière, M., Vigouroux, C., Mahieu, E., Demoulin, P., Velazco, V., Notholt, J., Blumenstock, T., Hase, F., Kramer, I., Sussmann, R., Stremme, W., Mellqvist, J., Strandberg, A., Ellingsen, K., and Gauss, M.: Trend analysis of greenhouse gases over Europe measured by a network of ground-based remote FTIR instruments, Atmos. Chem. Phys., 8, 6719–6727, 2008.

Vigouroux, C., De Mazière, M., Demoulin, P., Servais, C., Hase, F., Blumenstock, T., Kramer, I., Schneider, M., Mellqvist, J., Strandberg, A., Velazco, V., Notholt, J., Sussmann, R., Stremme, W., Rockmann, A., Gardiner, T., Coleman, M., and Woods, P.: Evaluation of tropospheric and stratospheric ozone trends over Western Europe from ground-based FTIR network observations, Atmos. Chem. Phys., 8, 6865-6886, 2008.

Zugspitze FTIR Site Report: Publications

List of peer review publications that appeared during the reporting period:

Dupuy, E., Walker, K.A., Kar, J., Boone, C.D., McElroy, C.T., Bernath, P.F., Drummond, J.R., Skelton, R., McLeod, S.D., Hughes, R.C., Nowlan, C.R., Dufour, D.G., Zou, J., Nichitiu, F., Strong, K., Baron, P., Bevilacqua, R.M., Blumenstock, T., Bodeker, G.E., Borsdorff, T., Bourassa, A.E., Bovensmann, H., Boyd, I.S., Bracher, A., Brogniez, C., Burrows, J.P., Catoire, V., Ceccherini, S., Chabrillat, S., Christensen, T., Coffey, M.T., Cortesi, U., Davies, J., De Clercq, C., Degenstein, D.A., De Mazière, M., Demoulin, P., Dodion, J., Firanski, B., Fischer, H., Forbes, G., Froidevaux, L., Fussen, D., Gerard, P., Godin-Beekman, S., Goutail, F., Granville, J., Griffith, D., Haley, C.S., Hannigan, J.W., Höpfner, M., Jin, J.J., Jones, A., Jones, N.B., Jucks, K., Kagawa, A., Kasai, Y., Kerzenmacher, T.E., Kleinböhl, A., Klekociuk, A.R., Kramer, I., Küllmann, H., Kuttippurath, J., Kyrölä, E., Lambert, J.-C., Livesey, N.J., Llewellyn, E.J., Lloyd, N.D., Mahieu, E., Manney, G.L., Marshall, B.T., McConnell, J.C., McCormick, M.P., McDermid, I.S., McHugh, M., McLinden, C.A., Mellqvist, J., Mizutani, K., Murayama, Y., Murtagh, D.P., Oelhaf, H., Parrish, A., Petelina, S.V., Piccolo, C., Pommereau, J.-P., Randall, C.E., Robert, C., Roth, C., Schneider, M., Senten, C., Steck, T., Strandberg, A., Strawbridge, K.B., Sussmann, R., Swart, D.P.J., Tarasick, D.W., Taylor, J.R., Tétard, C., Thomason, L.W., Thompson, A:M., Tully, M.B., Urban, J., Vanhellemont, F., Vigouroux, C., von Clarmann, T., von der Gathen, P., von Savigny, C., Waters, J.W., Witte, J.C., Wolff, M., and Zawodny, J.M.: Validation of ozone measurements from the Atmospheric Chemistry Experiment (ACE), Atmos. Chem. Phys., 9, 287–343, 2009.

Zugspitze FTIR Site Report: Publications

List of ACPD open-peer-reviews that appeared during the reporting period:

Sussmann, R.: Interactive comment on "Validation of ACE-FTS N2O measurements" by K. Strong et al., Atmos. Chem. Phys. Discuss., 8, S1288–S1293, 2008.

Sussmann, R.: Interactive comment on "Simultaneous atmospheric measurements using two Fourier transform infrared spectrometers at the Polar Environment Atmospheric Research Laboratory during spring 2006, and comparisons with the Atmospheric Chemistry Experiment-Fourier Transform Spectrometer" by Fu et al., Atmos. Chem. Phys. Discuss., 8, S1834–S1841, 2008.

Zugspitze FTIR Site Report: Publications

List of peer review publications accepted or submitted during the reporting period:

Sussmann, R., Borsdorff, T., Rettinger, M., Camy-Peyret, C., Demoulin, P., Duchatelet, P., Mahieu, E., and Servais, C.: New trends in column-integrated atmospheric water vapor. Method to harmonize and match long-term records from the FTIR network to radiosonde characteristics, Atmos. Chem. Phys. Discuss., 9, 2009.

Borsdorff, T. and Sussmann, R.: First detection of significant seasonality in stratomesospheric CO above mid-latitudes via solar FTIR spectrometry, submitted 2009.

Zugspitze FTIR Site Report: Publications

Peer review publication and book article in preparation:

Sussmann., R., Forster, F., Borsdorff, T., Dils, B., De Mazière, M., Vigouroux, C., Blumenstock, T., Buchwitz, M., Burrows, J.P., Duchatelet, P., Frankenberg, C., Hannigan, J., Hase, F., Jones, N., Klyft, J., Mahieu, E., Mellqvist, J., Notholt, J., Petersen, K., Schneising, O., Strong, K., Taylor, J.: Satellite validation of column-averaged methane on global scale: ground-based data from 13 FTIR stations versus last generation ENVISAT/SCHIAMACHY retrievals, Atmos. Meas. Tech. in preparation 2009.

Schneider, M., Notholt. J., and Sussmann R., and contributing authors: Fourier Transform Infrared Spectrometry, in: "Sounding techniques for atmospheric water vapor monitoring", Kämpfer, N. et al. eds., Book Series of International Science Space Institute (ISSI), Bern,Switzerland, in preparation 2009.

Zugspitze FTIR Site Report: Publications

List of conference contributions during the reporting period:

Duchatelet, P., E. Mahieu, R. Sussmann, F. Forster, T. Borsdorff, P.F. Bernath, C.D. Boone, K.A. Walker, M. De Mazière, and C. Vigouroux: Determination of isotopic fractionation 13C of methane from ground-based FTIR observations performed at the Jungfraujoch, Geophysical Research Abstracts, Vol. 11, EGU2009-9914-1, 2009, http://meetingorganizer.copernicus.org/EGU2009/EGU2009-9914-1.pdf, EGU General Assembly 2009 (Poster).

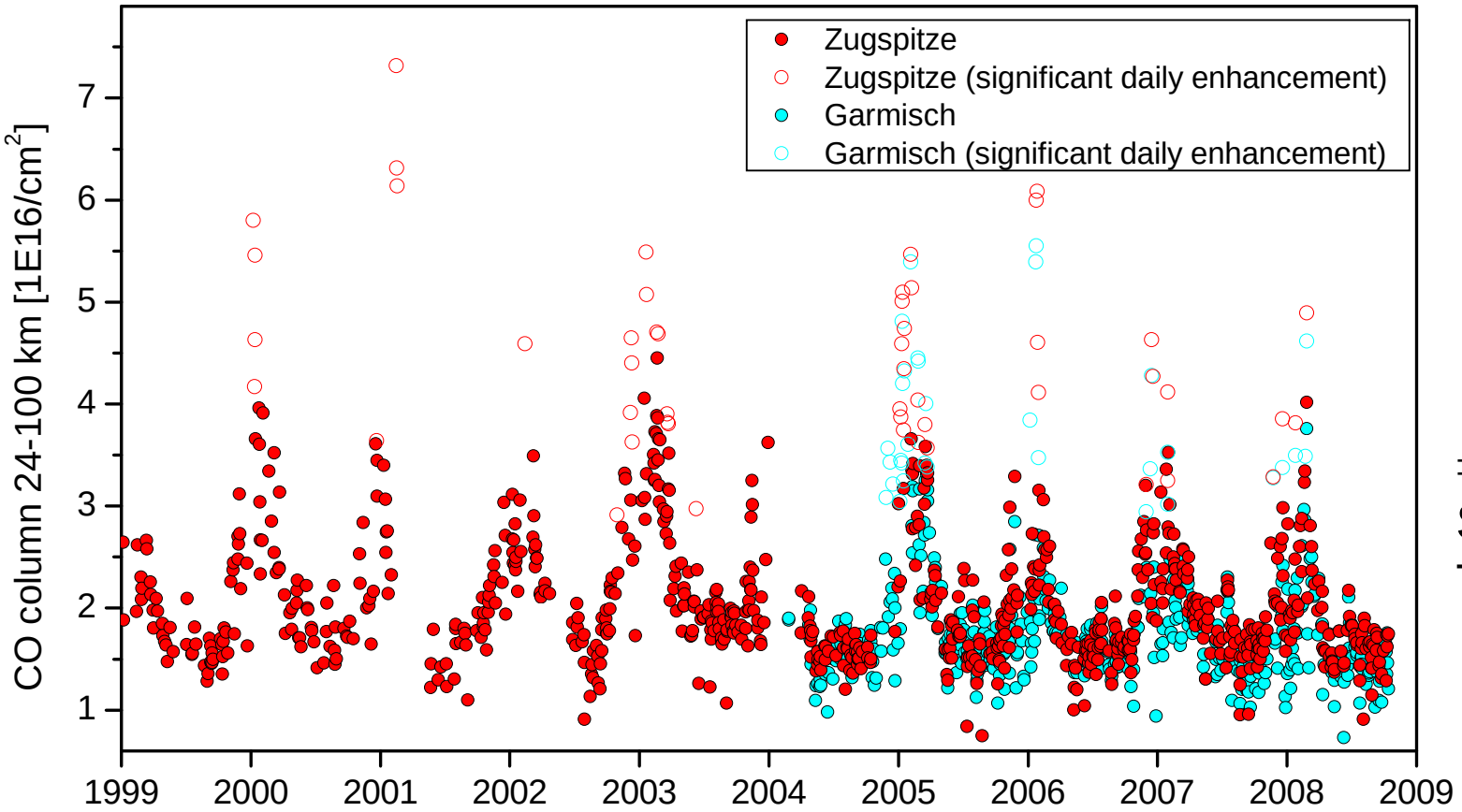
Zugspitze FTIR Site Report: Funding

Funding status (instrument and facility): good

- Permanent 80 % basic funding by Helmholtz Society of German Research Centers
- plus funded projects:

- EC-HYMN (CH_4, N_2O, since 2006, ongoing)
- EC-GEOMON (Cl_y, F_y, since 2006, ongoing)
- SATVAL-A (German Space Agency, SCIA Validation: CH4, ongoing)

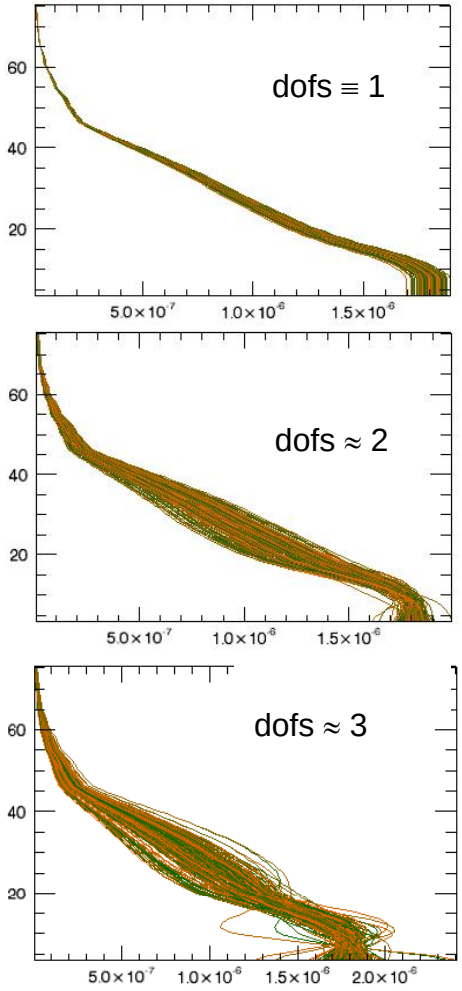
Stratomesospheric CO above Zugspitze and Garmisch: New for mid-latitudes

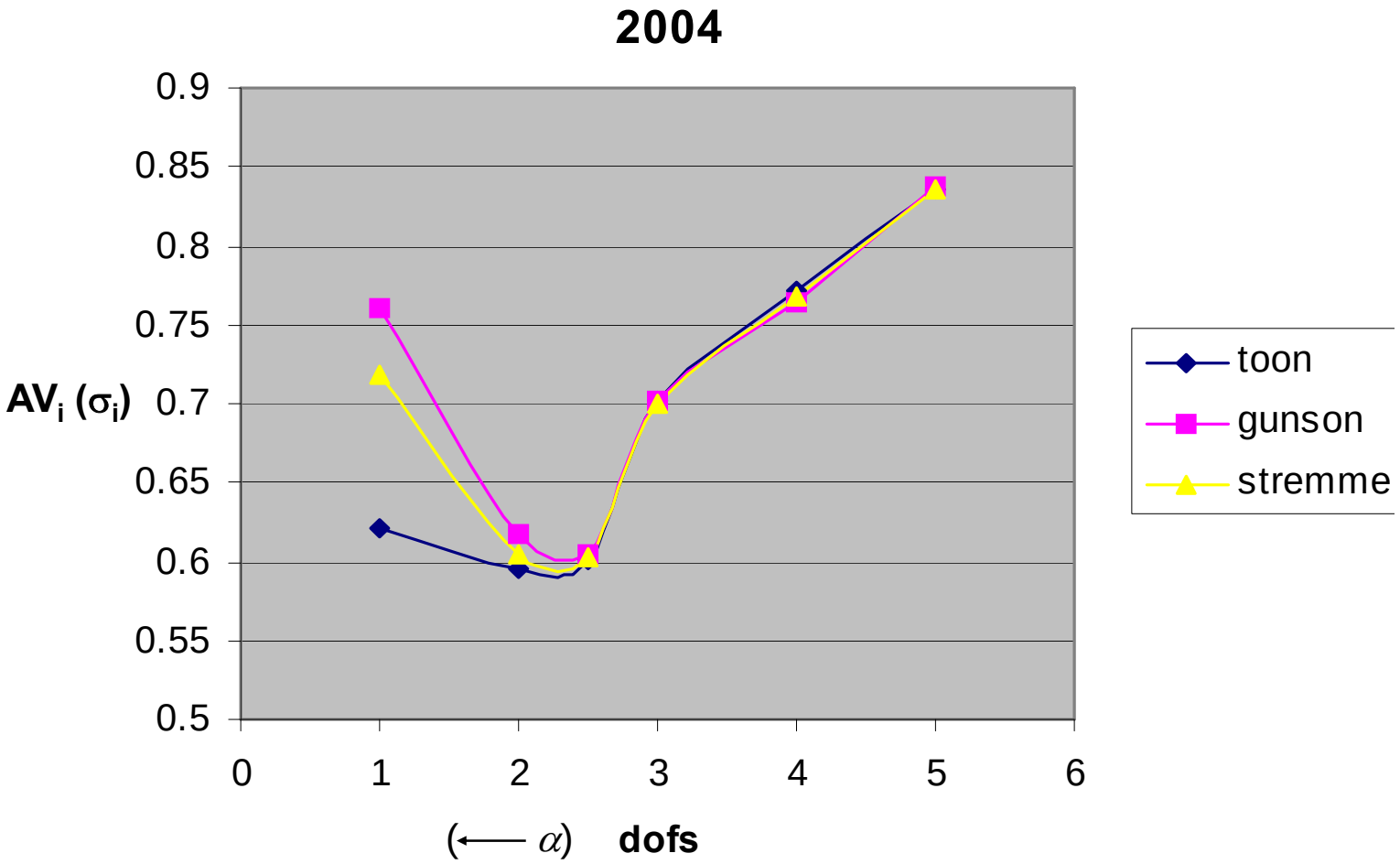


Borsdorff, Sussmann, submitted 2009

⇒ Science talk by Tobias Borsdorff

Finally: Tikhonov L1 on %-VMR scale suggest ed at IRWG 2008 for CH4 …





Finally: Tikhonov L1 on %-VMR scale has gotten many "babies ☺" last year …

CH4 & N2O official HYMN strategy

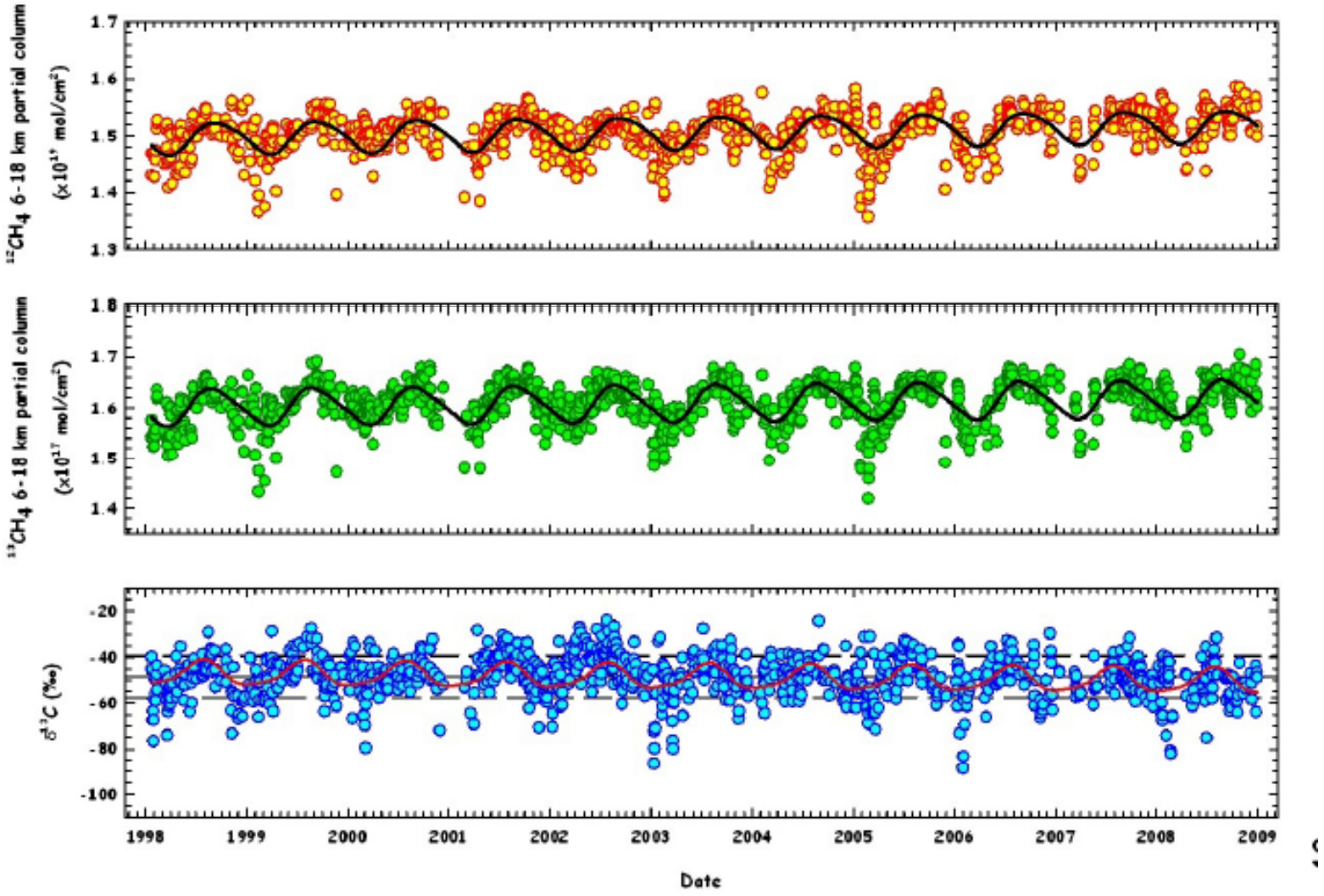
It was decided in Oct 2008 at the Garmisch HYMN meeting that
Tikhonov L1 on the %-VMR is adopted for both CH4 and N2O
as the official strategy for revised NDACC time series within the EC-HYMN project

Sussmann et al., D4.4 document on HYMN retrieval strategy for CH4 and N2O
http:\\... type "HYMN" to google

Finally: Tikhonov L1 on %-VMR scale has gotten many "babies ☺" last year …

$\delta^{13}C$

Duchatelet, P., E. Mahieu, R. Sussmann, F. Forster, T. Borsdorff, P.F. Bernath, C.D. Boone, K.A. Walker, M. De Mazière, and C. Vigouroux: Determination of isotopic fractionation 13C of methane from ground-based FTIR observations performed at the Jungfraujoch, Geophysical Research Abstracts, Vol. 11, EGU2009-9914-1, 2009



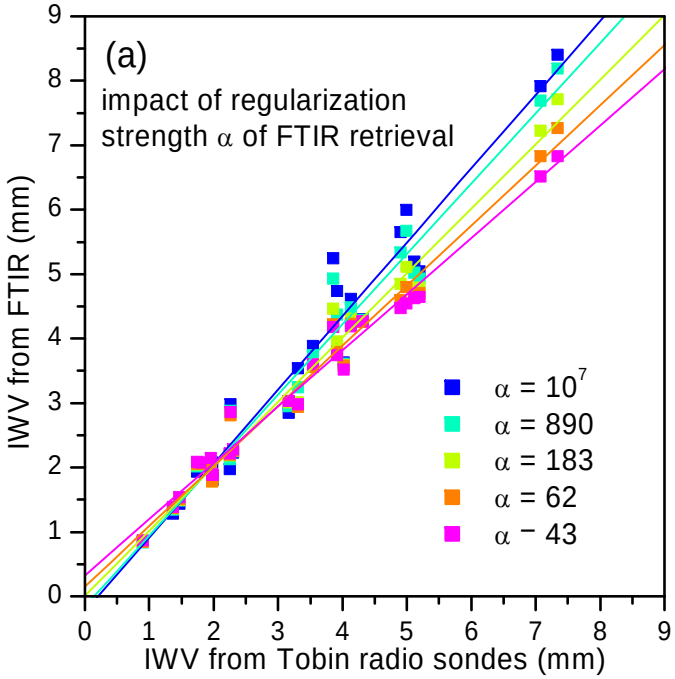
Research Center Karlsruhe, IMK-IFU Garmisch-Partenkirchen

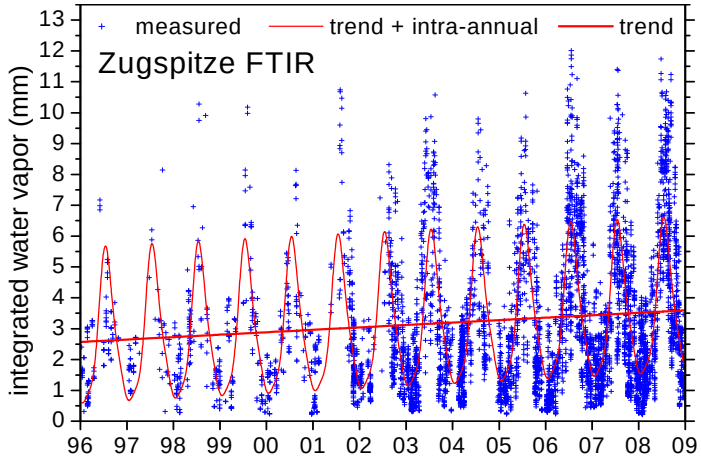
Ralf Sussmann: Zugspitze Site Report

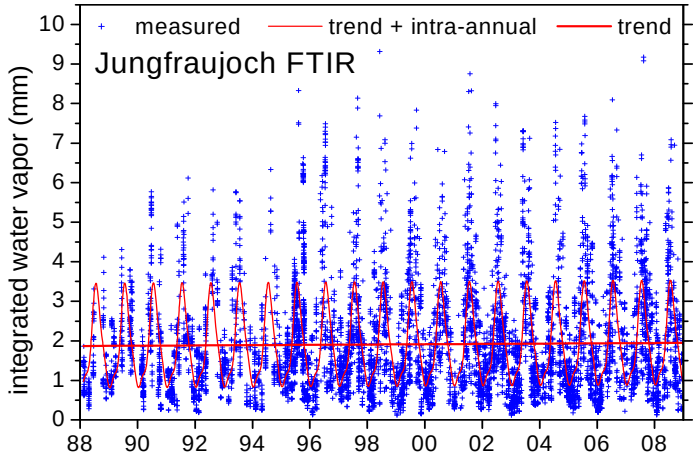
Finally: Tikhonov L1 on %-VMR scale has gotten many "babies ☺" last year …

- decadal trends in column-integrated water vapor

Sussmann, R., Borsdorff, T., Rettinger, M., Camy-Peyret, C., Demoulin, P., Duchatelet, P., Mahieu, E., and Servais, C.: New trends in column-integrated atmospheric water vapor. Method to harmonize and match long-term records from the FTIR network to radiosonde characteristics, Atmos. Chem. Phys. Discuss., 9, 2009.







Finally: Tikhonov L1 on %-VMR scale has gotten many "babies ☺" last year …

... i.e., was applied by various groups to various species

1) Liege group: 13CH4 (EGU 2009, Duchatelet et al.)
2) IMK-IFU & Liege group: water vapor (ACPD, 9, 2009)
3) BIRA group: H2CO (science talk, paper in prep.)
4) BIRA group: IASI retrievals

Seems that Tikhonov L1 on %-VMR scale is on its way to become a IRWG standard default / reference regularization approach (esp. for dofs ≈1-2 cases) ...

Summary – Zugspitze FTIR Site Report

- 130 measurements days in 2008, well funded
- updated full Zugspitze series for CO, O3, HF, COF_2, HCl, $ClONO_2$, CH_4, and N_2O, H_2O
- paper on stratomesospheric CO variability submitted ⇒ science talk
- lead retrieval optimization/hamonization for CH_4 and N_2O profile retrievals with 13 stations
- lead global validation of SCIAMACHY XCH4 with 13 stations ⇒ paper in preparation
- lead retrieval optimization/harmonization for columnar H2O at Zugspitze and ISSJ
- ACPD paper on water vapor trends ⇒ science talk
- Tikhonov-L1 on %-VMR scale demonstrated at IRWG 2008 for CH4 has got babies: N2O, $^{13}CH4$, H2O, H2CO, IASI retrieval, …