A User’s View of HITRAN

Reinhard Beer
Earth & Space Sciences Division
The Jet Propulsion Laboratory
California Institute of Technology
PASADENA, CA

Reinhard.Beer@jpl.nasa.gov

12 June 2002

Introduction

HITRAN is an indispensable resource for anyone doing remote sensing

HOWEVER

It’s not (yet) perfect!

12 June 2002

7th Biennial HITRAN Conference
The largest single source of systematic error in atmospheric retrievals remains the water vapor continuum.

Not a HITRAN issue?

It ought to be.

Self-broadened WV Continuum improved substantially from ARM observations

- Combined Sensor Cruise Case Study (near Nauru, 18 March 1996)
Priority One (cont)

Continuum measurements are difficult and their interpretation uncertain. All the more reason to do them.

We need an improved version of CKD 2.4. The planned CKD 3.0 was never released.

We also need a much better understanding of the physics of the continuum. A complete quantitative formulation for the continuum (including temperature and mixing ratio effects) requires a sound theoretical basis which we currently lack.

12 June 2002

7th Biennial HITRAN Conference

Priority Two

NITRIC ACID

Nitric Acid around 880 cm\(^{-1}\) appears to sit on a continuum.

In any case, fitting atmospheric spectra in this region is a difficulty of long standing, not helped by the band(s) being bracketed by CFC11 & CFC12.

Is this a solved problem?
CARBON DIOXIDE

The issue here is line mixing/coupling in the Q-branches (especially in the 650 – 850 cm\(^{-1}\) region).

The region is critical, because that is where much of our information about the lower atmosphere temperature profile is obtained. Without a good temperature profile, all species retrievals are compromised.

The situation is improving, but we still see systematic residuals in atmospheric retrievals.

Please put a lot of effort into providing better coupling coefficients.
CARBON MONOXIDE

Just when you thought it was safe to leave the lab!

Yes, folks, CO in HITRAN is a problem.

WHY?

Priority Four (cont)

Because biomass burning shows CO emission features from highly excited rotational and vibrational states.

HITRAN stops with the first excited vibrational state (3-2).

We need to have 4-3 & 5-4 added because there are unidentified emission features in the spectra that are almost certainly CO but cannot currently be quantified.
It is from these CO features that we determine the flame temperature.

- AES measurements provided values in excess of 1300K.
- The flame temperature is a valuable parameter both for firefighting and for assessments of the impact of biomass burning on the atmosphere.

Spectroscopy is the way to do this. Radiometers persistently underestimate fire temperatures due to non-uniform illumination and partial filling of the field-of-view.

Spectroscopically, one only needs to determine relative emission strengths. The field-of-view does not enter into the determination.
Biomass burning provides both an oxidizing and a reducing environment, generating an astonishing variety of species!

Furthermore, ambient air is entrained into the flames. Some of it, of course, becomes involved in reaction processes.

For example, $\text{N}_2\text{O}$ and $\text{O}_3$ are rapidly decomposed by

$$\text{N}_2\text{O} \rightarrow \text{N}_2 + \text{O}$$

$$\text{O}_3 \rightarrow \text{O}_2 + \text{O}$$

Whereas $\text{H}_2\text{O}$, $\text{CO}$, $\text{CO}_2$ and $\text{CH}_4$ can survive intact and form emission lines.
A SUGGESTION

Merge HITEMP into HITRAN

It would simplify my life!
THE END

BACKUP SLIDES
Figure 3. Spectral residuals from modeling of downwelling radiances for a tropical atmosphere [Hae et al., 1997].

Figure 4. Zonal SST biases for new (solid) and prelaunch (dashed) schemes for October 1991 (thick) and May 1992 (thin) [Merchant et al., 1999].
AERI/LBLRTM QME: Implications for refining the Water Vapor Self Continuum

![Graph showing comparison of CKD v0 (1990), CKD v2.1 (1994), CKD v2.4 (1999), Burch 290K (1977), and 1994-1997 AERI/LBLRTM QME with Kavieng/CSP and 1974-1977 QME.]

M. W. Shephard and B. A. Cough (AERI) 10 May 62 11:36

CAMEX/LBLRTM Validation for IASI

![Graph showing CAMEX Observation 09/29/93 Q31 Z 1.73 prcm cm H2O 1.958E18 (ppmv) Z3 and CKD 2.4 residuals.]

12
Foreign Continuum Modifications: U. Wisc HIS/AERI

Wavenumber (cm⁻¹)

CAMEX/LBLRTM Validation for IASI

M. W. Shepard and S. A. Clough, (AER) 06 May 03 11:08

CAMEX Observation 09/29/93 0351 Z
1.73 prec. cm H2O

Brightness Temperature (K)

CAMEX - LBLRTM(ser_hitran_2000_upd1_01.1)

Residuals

Wavenumber (cm⁻¹)
CAMEX Band 0
M. W. Shepherd and S. A. Clough, (JERI) 28 May 02 11:27
CAMEX/LBLRTM Validation for IASI

CAMEX Observation 09/29/93 0351 Z
1.73 prec. cm H₂O

CAMEX - LBLRTM (ser_hitrans_2000_update_01.1) CKD 2.4
best results

Brightness Temperature (K)

T_ Residuals

Wavenumber (cm⁻¹)