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A User's View of HITRAN

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Introduction

HITRAN is an indispensable resource for anyone doing remote sensing

HOWEVER

It's not (yet) perfect!

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Priority One

WATER VAPOR CONTINUUM

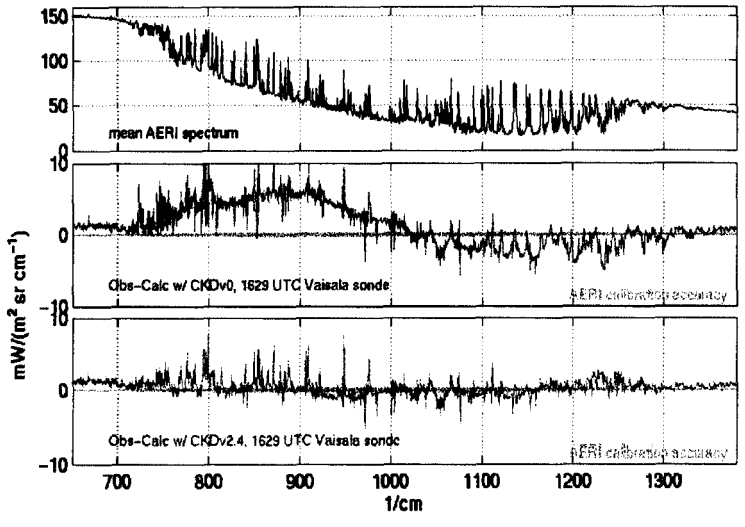
The largest single source of systematic error in atmospheric retrievals remains the water vapor continuum.

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.

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?

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Priority Three

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.

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Priority Three (cont)

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

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

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Priority Four

CARBON MONOXIDE

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

Yes, folks, CO in HITRAN is a problem.

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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.

Priority Four (cont)

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.

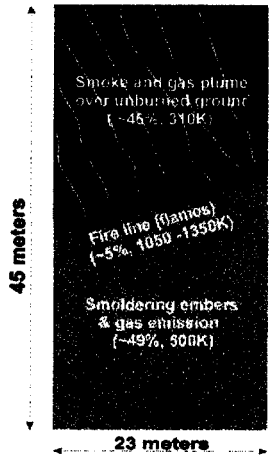
Spectroscopy is the way to do this. Radiometers persistently underestimate fire temperatures due to non-uniform illumination and partial filling of the field-of-view.

Spectroscopically, one only needs to determine relative emission strengths. The field-of-view does not enter into the determination.

WILDFIRE MODEL

Biomass burning is an important target for both TES and AES

This is the surface model used in the analysis of two wildfires in 1994



The radiative transfer environment is extremely complex, leading to serious difficulties in the spectroscopy.

Within a single footprint there are many different thermal environments

BIOMASS BURNING

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.

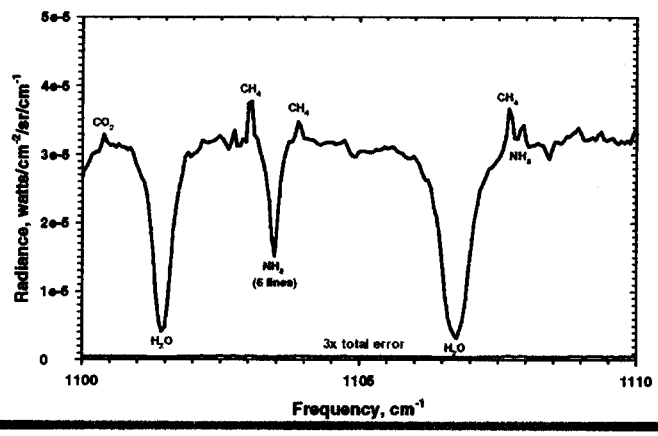
For example, N_2O and O_3 are rapidly decomposed by

$$N_2O \longrightarrow N_2 + O$$
$$O_3 \longrightarrow O_2 + O$$

Whereas H_2O, CO, CO_2 and CH_4 can survive intact and form emission lines.

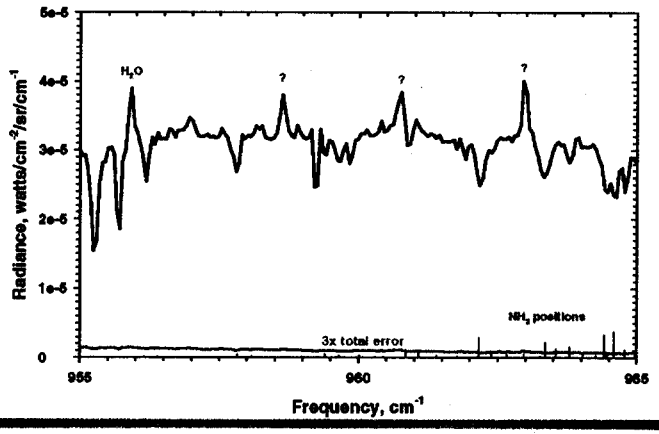
AES WILDFIRE SPECTRA

San Luis Obispo Brush Fire, August 1994



AES WILDFIRE SPECTRA

San Luis Obispo Brush Fire, August 1994



A SUGGESTION

Merge HITEMP into HITRAN

It would simplify my life!

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THE END

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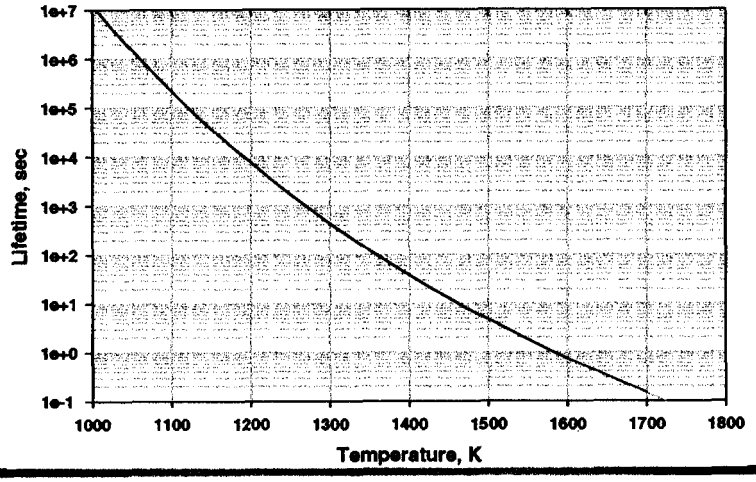
BACKUP SLIDES

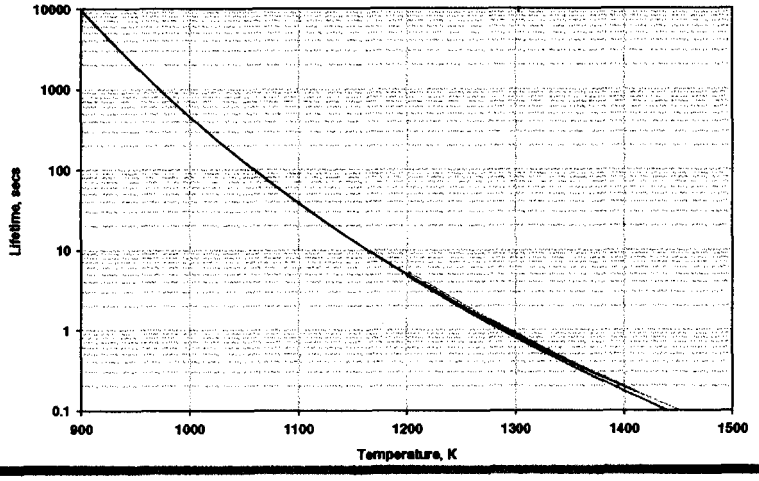
Backup 1

Lifetime of CH_4 ($CH_4 \rightarrow CH_3 + H$)



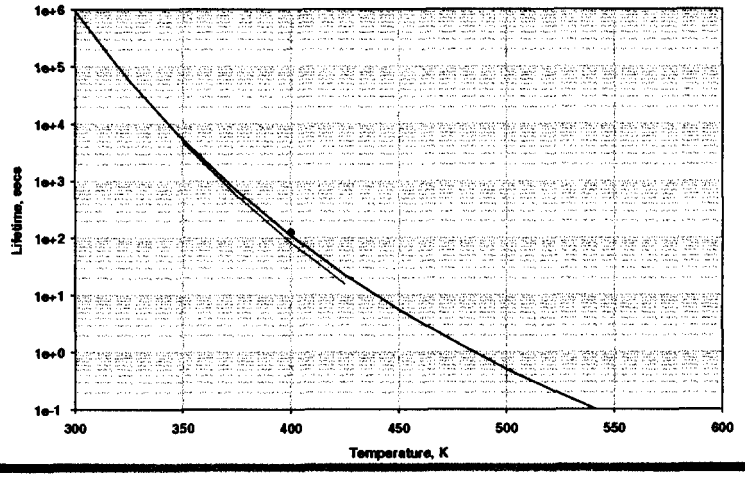
Backup 2

Lifetime of N_2O ($N_2O \rightarrow N_2 + O$)



Backup 3

Lifetime of O_3 ($O_3 \rightarrow O_2 + O$)



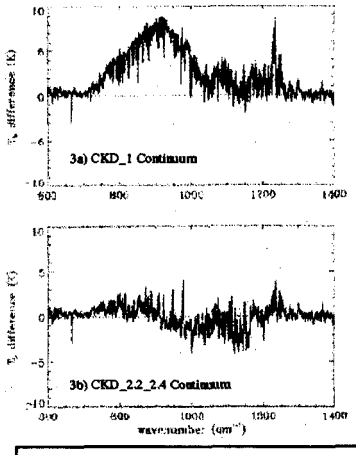


Figure 3. Spectral residuals from modeling of downwelling radiance for a tropical atmosphere. [Han et al., 1997].

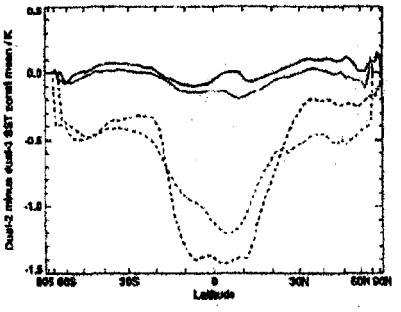
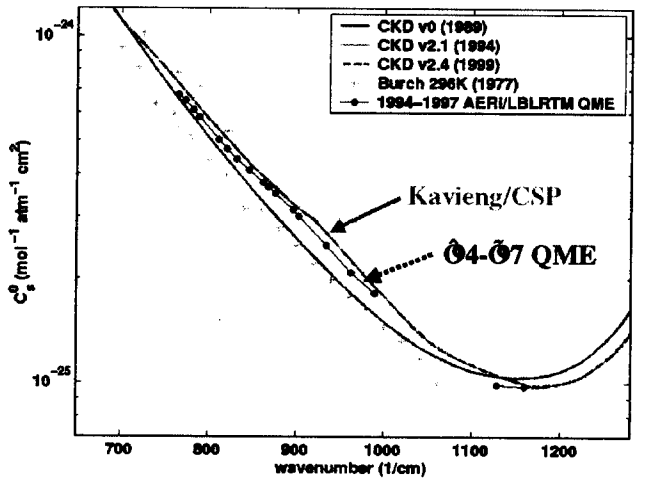
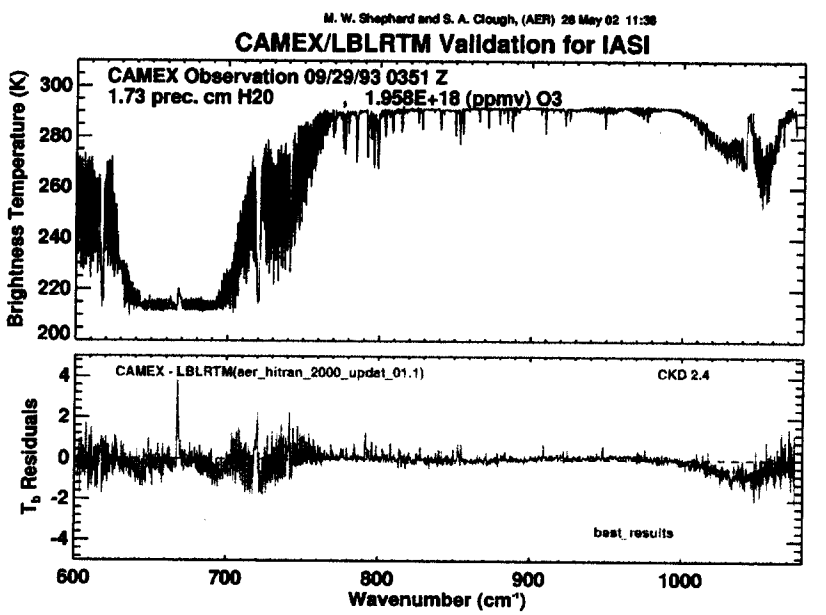
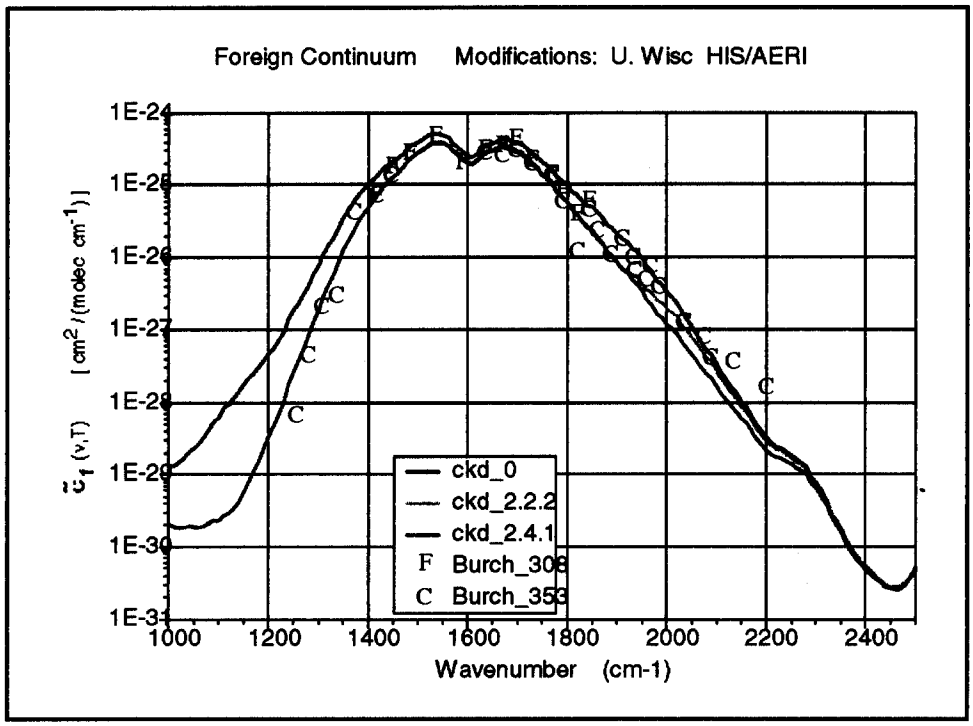


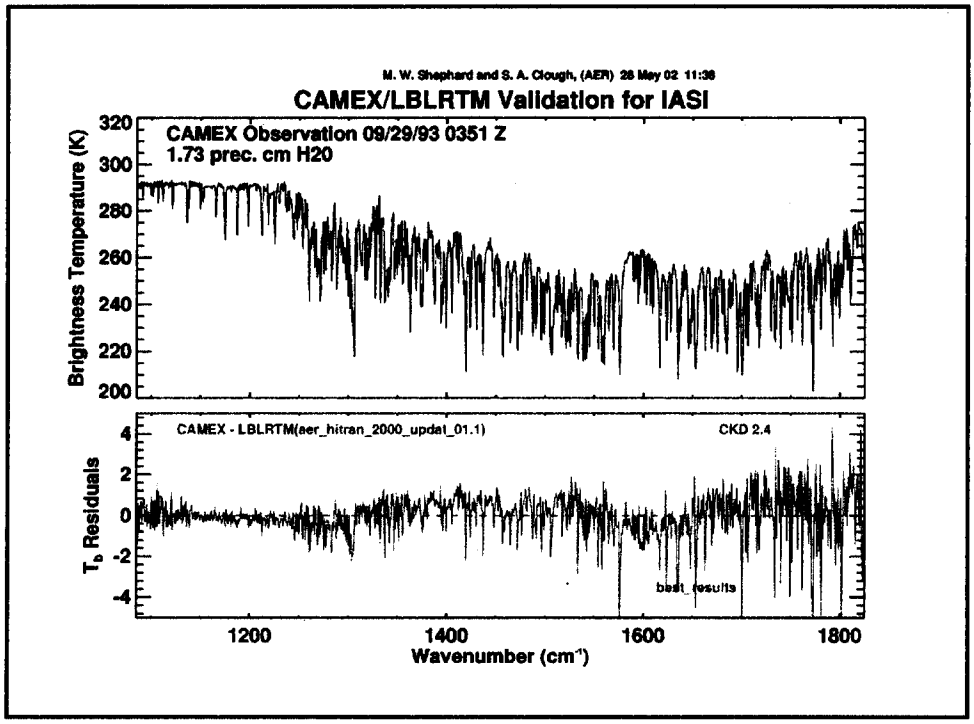
Figure 4. Zonal SST biases for new (solid) and prelaunch (dashed) schemes for October 1991 (thick) and May 1992 (thin) [Merchant et al., 1999].

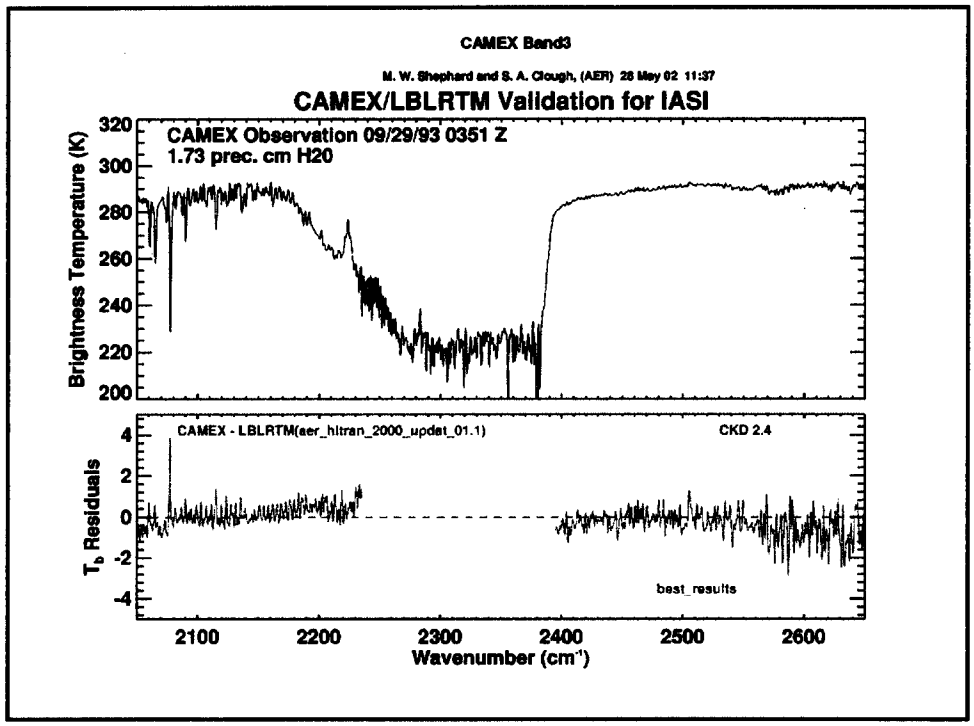
AERI/LBLRTM QME : Implications for refining the Water Vapor Self Continuum






Foreign Continuum Modifications: U. Wisc HIS/AERI
1E-24
1E-25
1E-26
1E-27
1E-28
1E-29
1E-30
1E-31
$\tilde{c}_f$ (ν,T) [cm^2/(molec cm^{-1})]
1000
1200
1400
1600
1800
2000
2200
2400
Wavenumber (cm-1)
ckd_0
ckd_2.2.2
ckd_2.4.1
F Burch_308
C Burch_353


M. W. Shephard and S. A. Clough, (AER) 28 May 02 11:38
CAMEX/LBLRTM Validation for IASI
CAMEX Observation 09/29/93 0351 Z
1.73 prec. cm H20
Brightness Temperature (K)
320
300
280
260
240
220
200
CAMEX - LBLRTM(aer_hitran_2000_updat_01.1)
CKD 2.4
T_b Residuals
4
2
0
-2
-4
best_results
1200
1400
1600
1800
Wavenumber (cm^{-1})


CAMEX Band3
M. W. Shephard and S. A. Clough, (AER) 28 May 02 11:37
CAMEX/LBLRTM Validation for IASI
CAMEX Observation 09/29/93 0351 Z
1.73 prec. cm H20
Brightness Temperature (K)
320
300
280
260
240
220
200
CAMEX - LBLRTM(aer_hitran_2000_updat_01.1)
CKD 2.4
T_b Residuals
4
2
0
-2
-4
best_results
2100
2200
2300
2400
2500
2600
Wavenumber (cm^{-1})