JAIVEX

1d-Var Retrieval Using Data from JAIVEX

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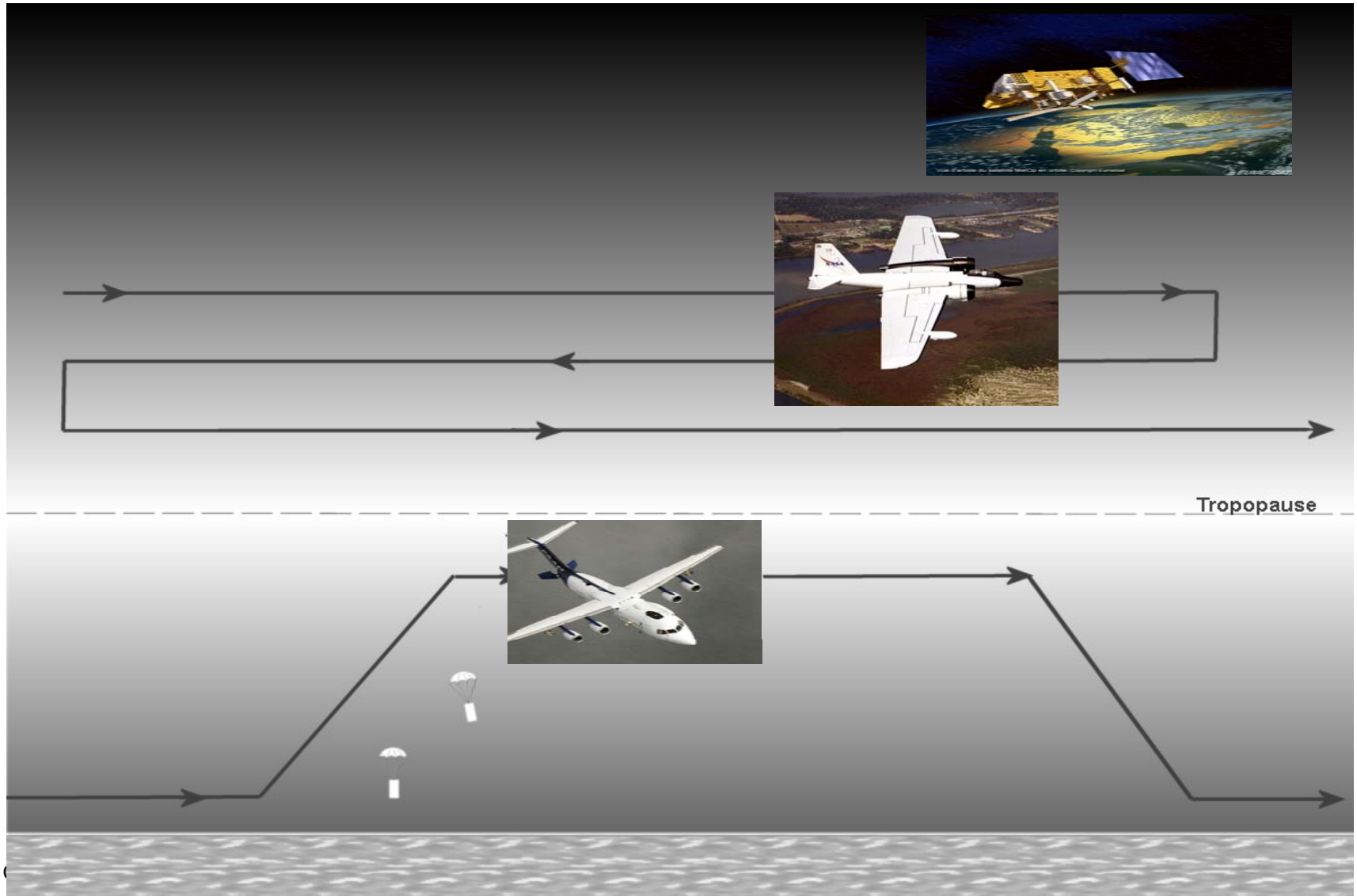
JAIVEX Objectives

- To validate and characterize the radiometric performance of IASI
- To validate the performance of different algorithms designed to retrieve temperature, humidity, ozone and carbon monoxide profiles from IASI spectral radiance measurements over land and ocean and under cloudy as well as clear sky conditions
- To gather a diverse set of IASI spectra with co-located airborne and *in situ* observations to further the development of innovative techniques to assimilate IASI data into numerical weather prediction models, utilizing as many channels as possible, over land and ocean and under cloudy as well as clear sky conditions

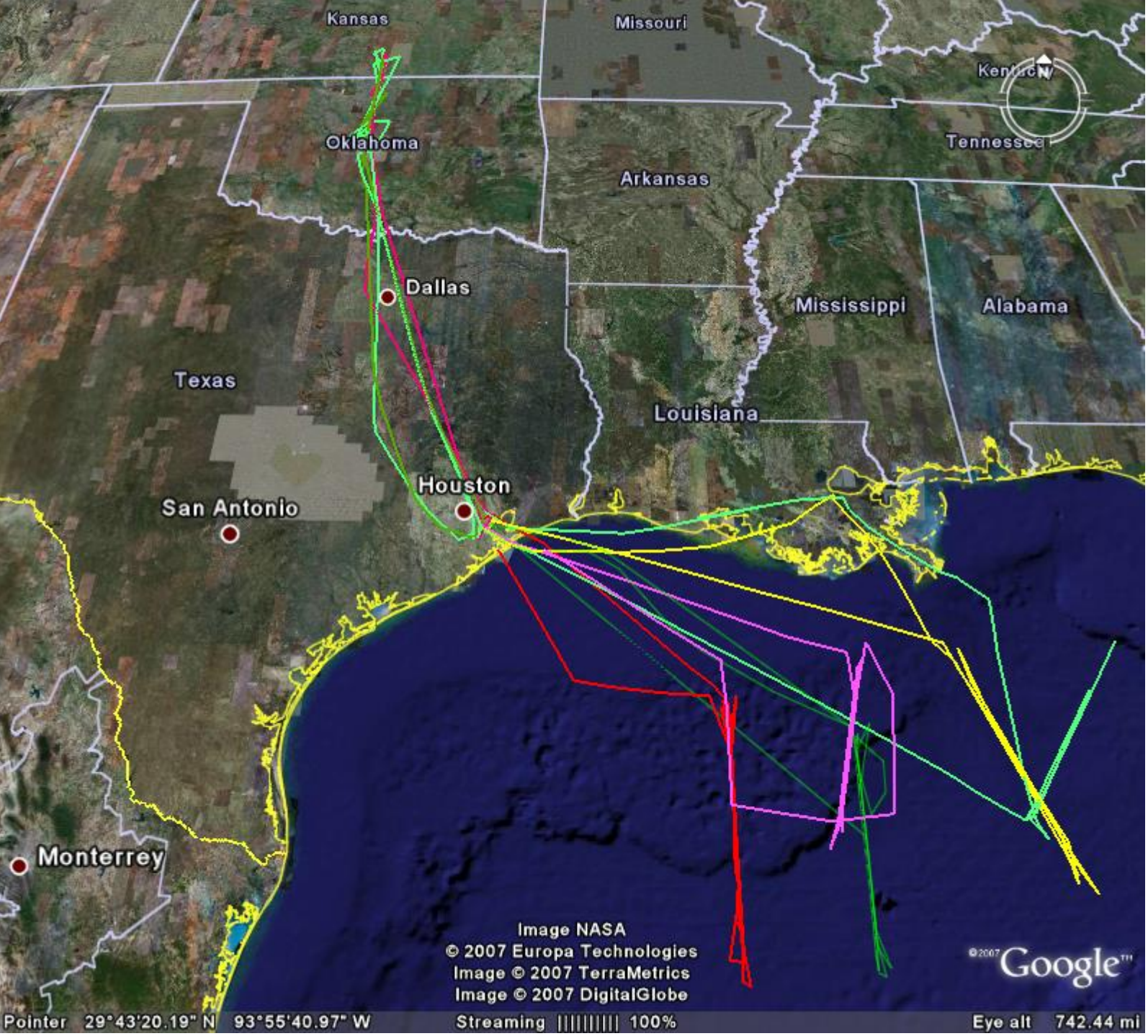
Flight Coordination



Summary of Flights

Date	Flight number	Day/night	No. dropsondes	Location
18-04-2007	B284	night	11	Oklahoma
19-04-2007	B285	night	12	Gulf of Mexico
27-04-2007	B287	day	13	Oklahoma
28-04-2007	B288	day	10	Oklahoma
29-04-2007	B289	day	21	Gulf of Mexico
30-04-2007	B290	day	12	Gulf of Mexico
2-05-2007	B291	day	10	Oklahoma
4-05-2007	B292	day	15	Gulf of Mexico

Table 1. Description of the eight dedicated FAAM 146 flights made in conjunction with MetOp overpasses.



JAIVEX Campaign

Assimilation of IR satellite sounder data

AIRS instrument on Aqua satellite, IASI on MetOp and soon CrIS on NPOESS all measure the upwelling radiance at 1000's of wavelengths.

Current NWP assimilation uses fast codes that can only deal with ~200 channels – the limit being computational time and issues associated with correlated errors when trying to simulate all channels.

Currently only assimilate data over ocean in cloud free conditions.

We would like to assimilate data over any surface (land, sea ice or ocean) and in the presence of clouds and through thin cirrus.

Principal Component Radiative Transfer

The Havemann –Taylor Fast Radiative Transfer Code (HT-FRTC) has been developed:

Benefits

- **Fast:** computes entire IASI spectra (~8500 channels) in 0.06s
- **Accurate:** has been compared with 14 other codes and is just as good.
- **More Information:** simulating 8500 channels means that information on surface and clouds can be assimilated plus multiple channels giving same information about temperature and water vapour structure act to reduce the noise of the measurement.

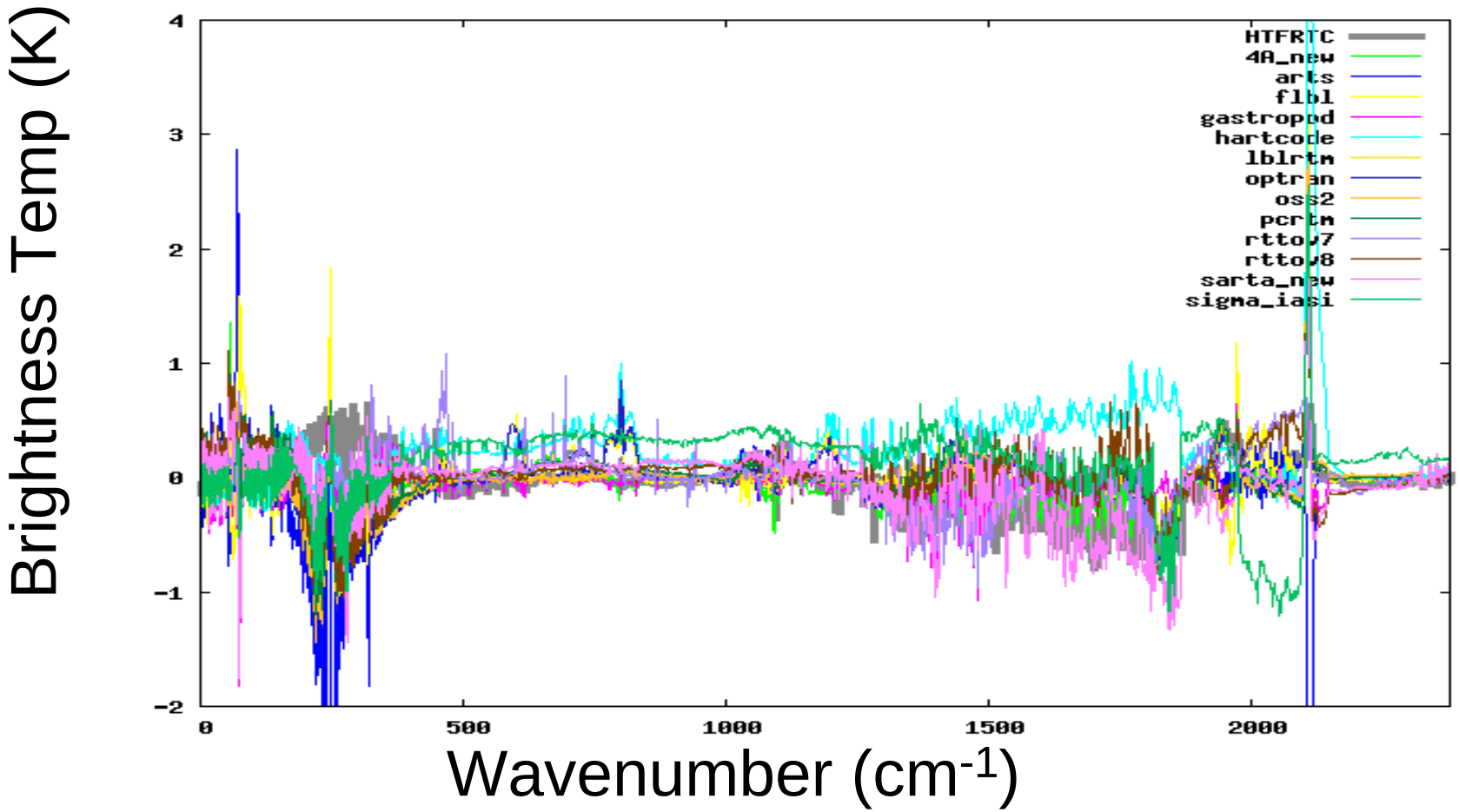
Results of model intercomparison

Intercomparison of 14 line-by-line or fast radiative transfer models (Roger Saunders et al)

Simulated AIRS spectra (2378 channels in IR)

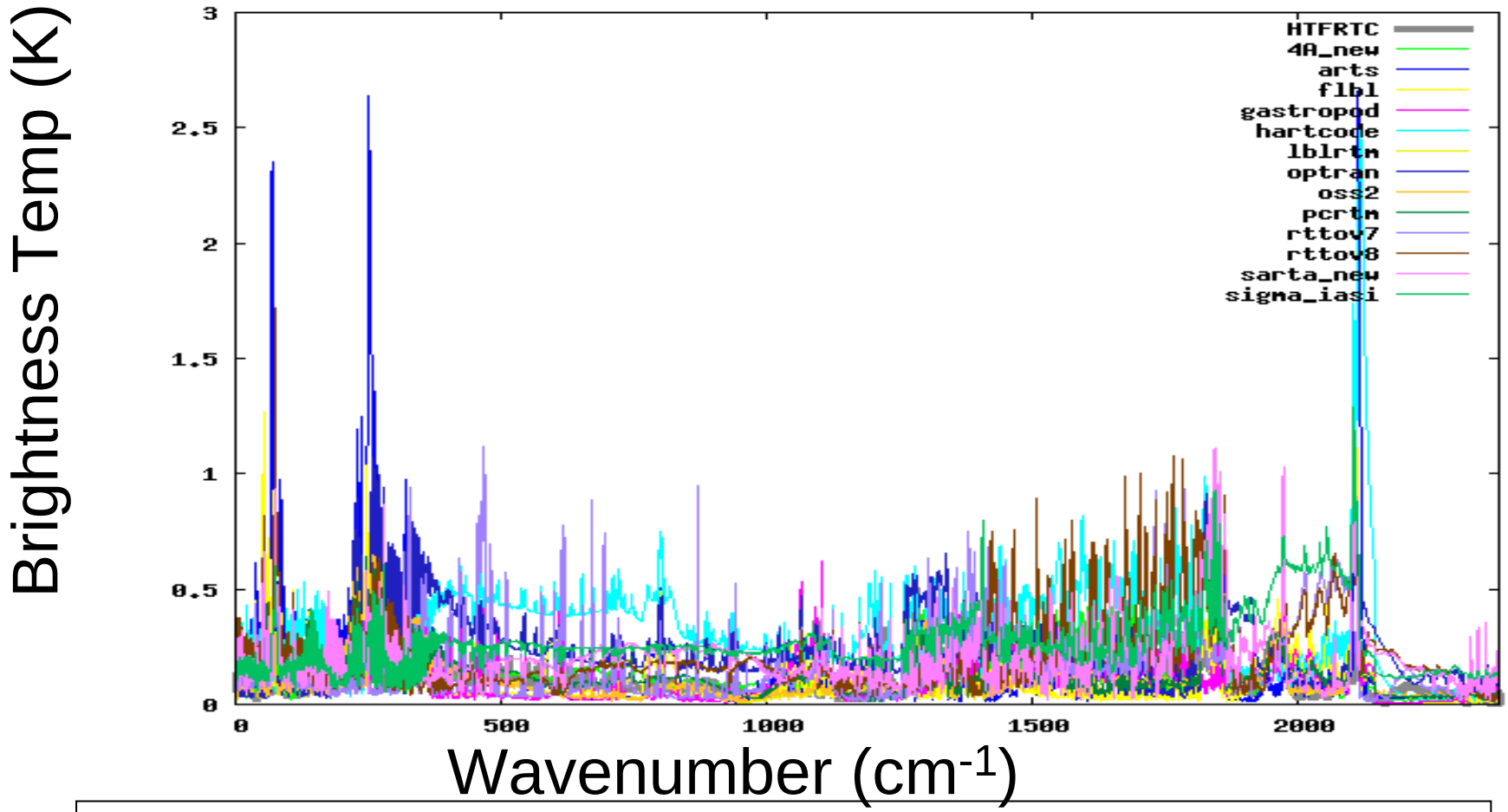
Diverse test set of 52 different atmospheric profiles of temperature, humidity and ozone, with different surface temperatures and surface pressures, with fixed surface emissivity 0.99, with no solar contribution and clear sky

Model Intercomparison : Biases



HTFRTC based on GENLN2, Ozone variable

Model Intercomparison : STDEV



HTFRTC based on GENLN2, Ozone variable

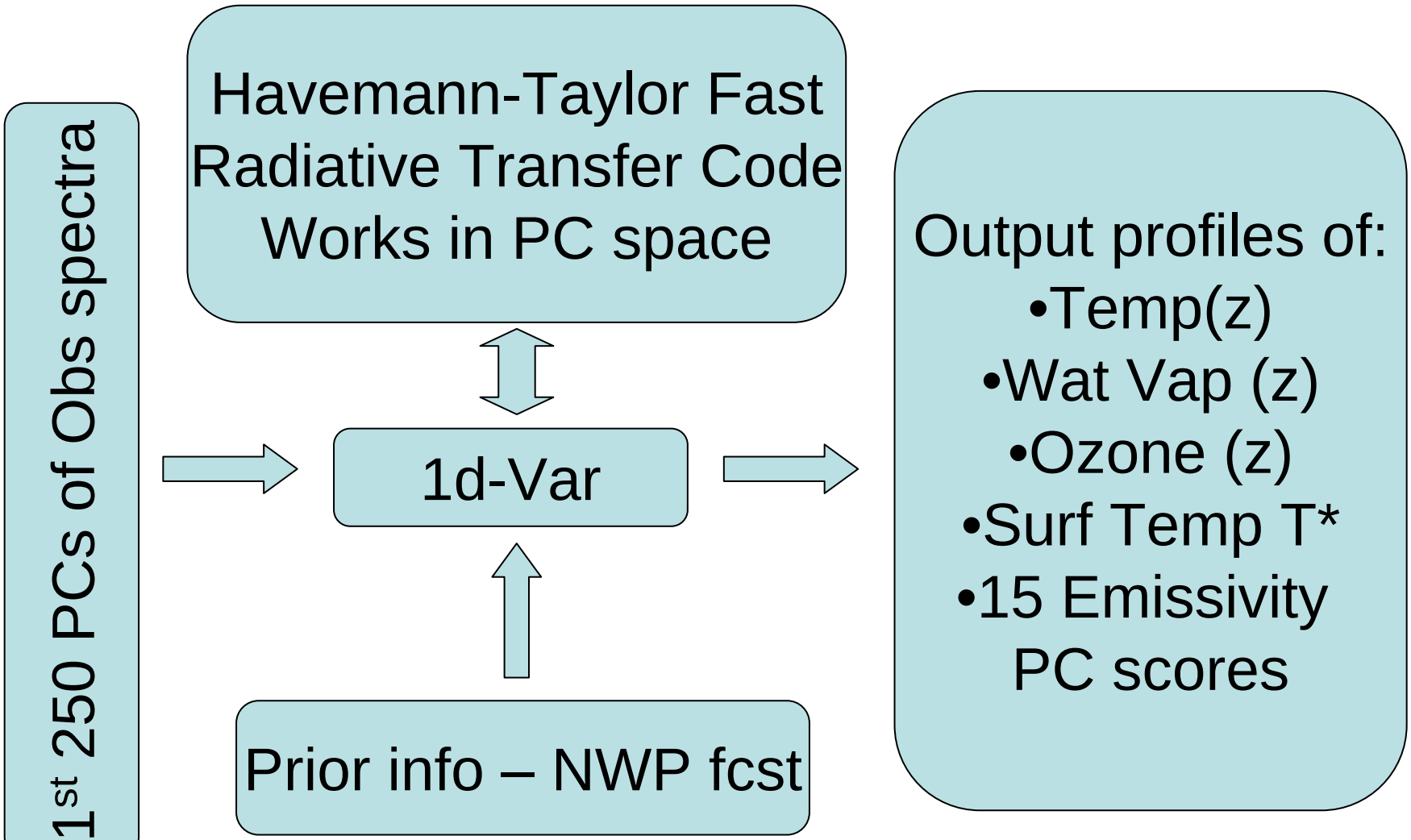
HT-FRTC – how does it work?

Perform Singular Value Decomposition on training set of profiles – the resulting Empirical Orthogonal Functions are fixed: They represent the basic spectral physical characteristics of gases / surfaces / aerosols / clouds and the instrument

PC scores depend on the actual atmosphere state:
Only they need to be re-calculated
('Calculation *in EOF space*') – dealing in Principal Components means by definition there are no issues with correlated errors.

So represent ~8500 channels with ~200 leading Principal Components.

Couple HT-FRTC to 1d-Var



HT-FRTC: 1D-Var retrieval scheme

The B-matrix extended to include a block matrix with the error covariances of the surface emissivity PC scores

An R-matrix constructed to include the error covariances of the sum of the observational and model errors in Principal Component space

Flight B284 18 Apr 2007 ARM Site – Night time.

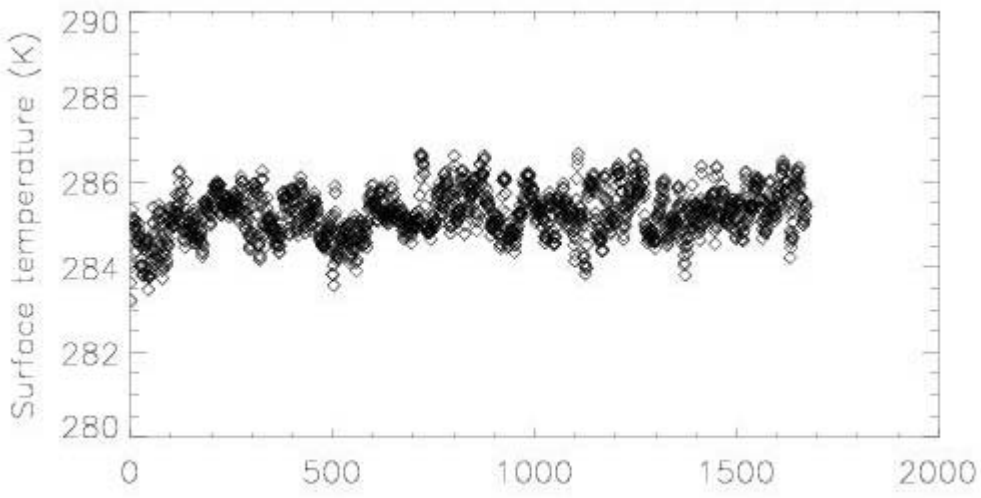
- Low level run at 3000ft, Emissivity and Surf temp retrieval using upwards and downwards views with ARIES interferometer.

- Profile from 3000 ft to 35,000 ft measuring T, q, O_3, CO , aerosols etc.

- Run at 35,000 ft coordinated with WB-57 and IASI overpass, dropped 11 dropsondes.

- Will show 1d-Var results using ARIES data gathered at 35,000 ft.

Surface Temperature Retrieval



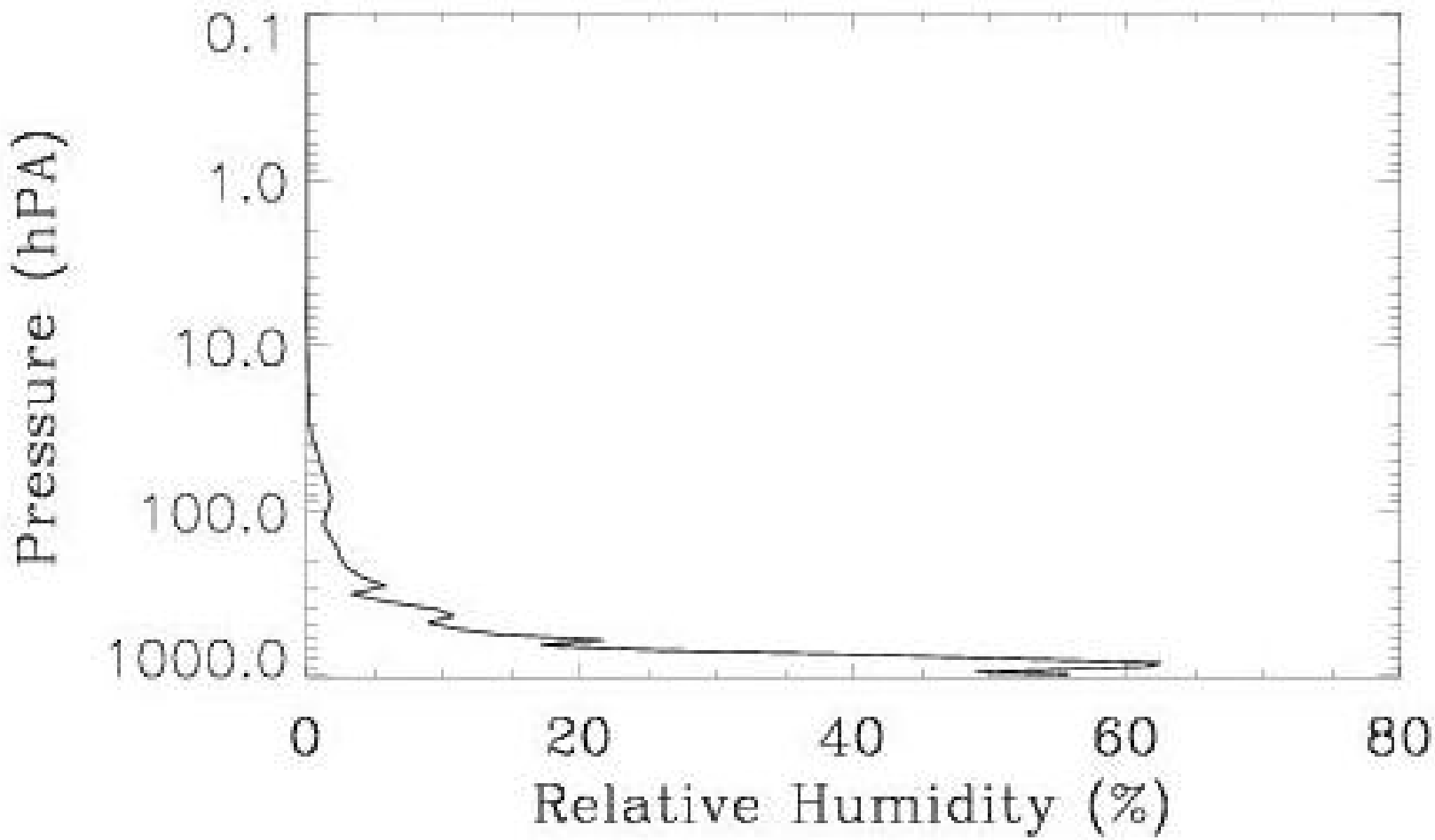
- Low level data before high level run showed surf temp = 286.2 +/- 1.6 K
- Low level data after high level run showed 283.6 +/- 1.4 K
- Interpolating to time of overpass gives 284.7 K

1d-Var Retrieval from 35,000 ft

1st guess is 287 K

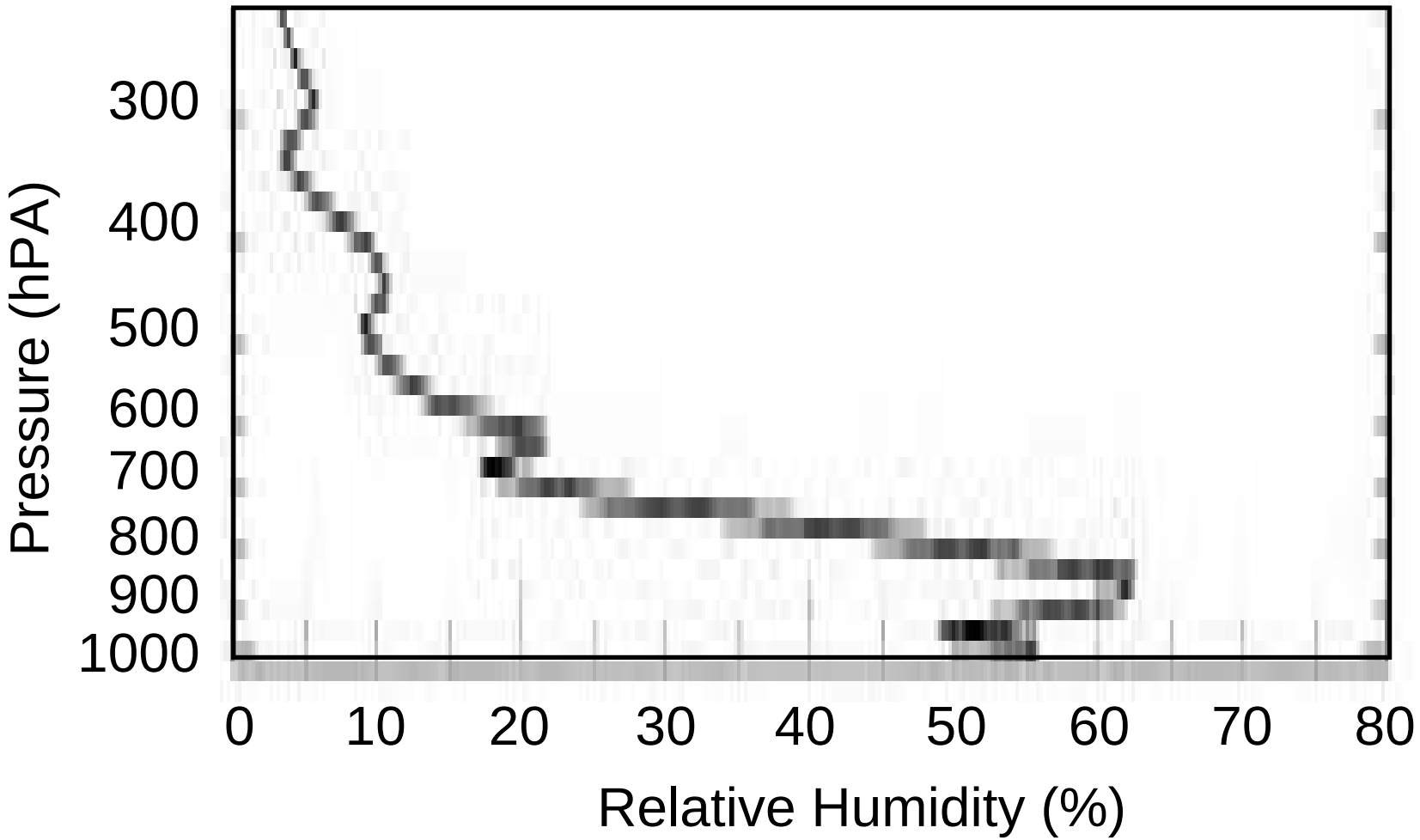
1d-Var Retrieval Using Data from JAIVEX

Background Profiles



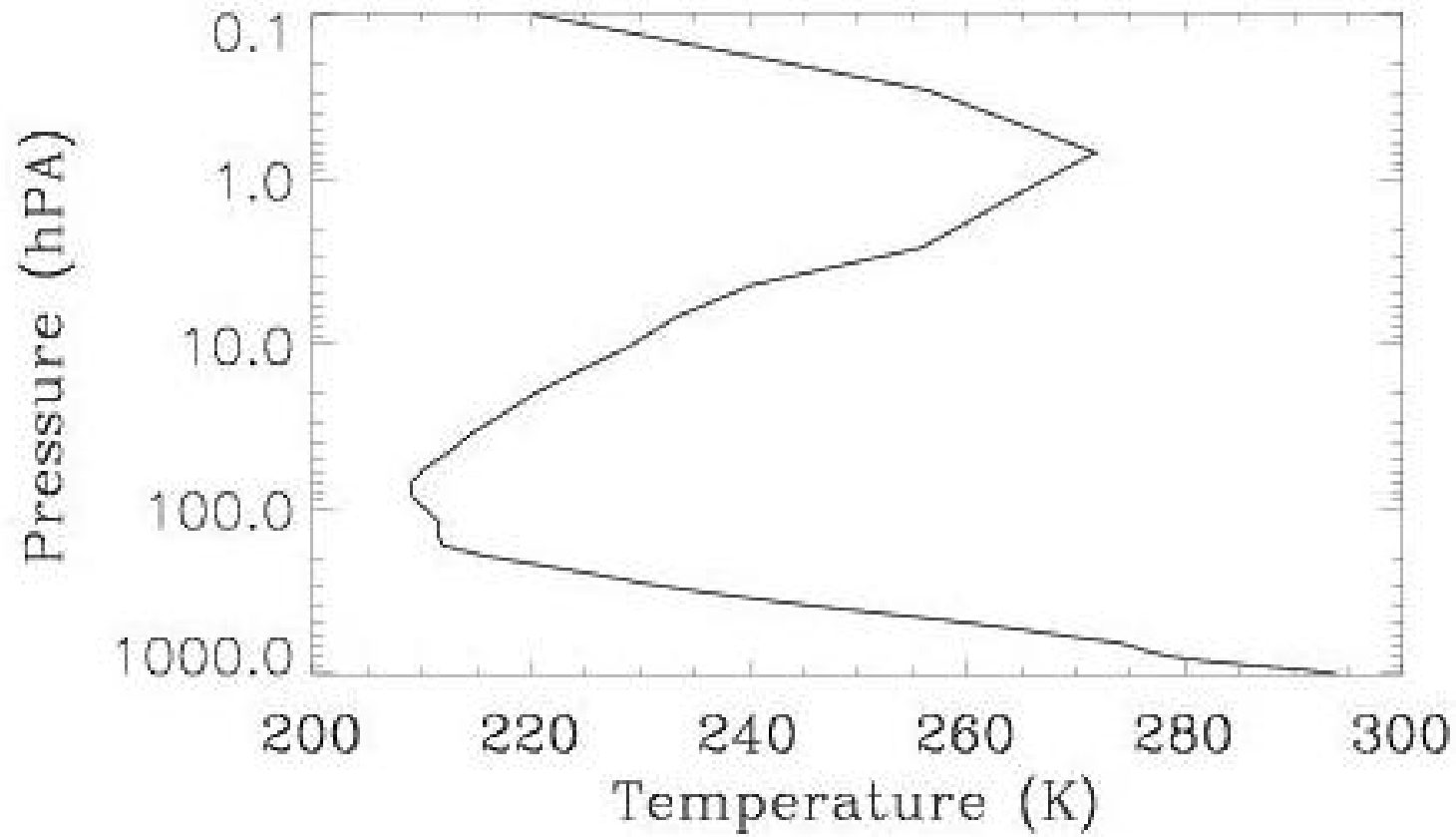
1d-Var Retrieval Using Data from JAIVEX

Background Profiles



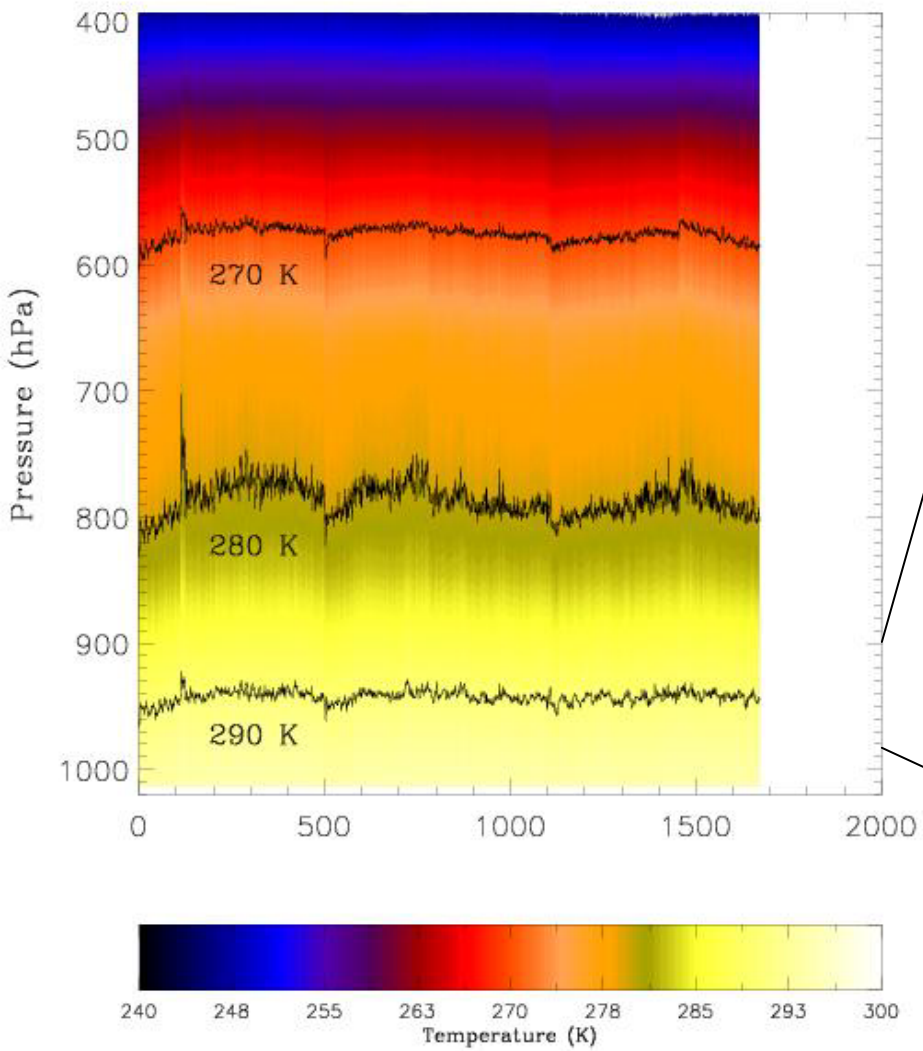
1d-Var Retrieval Using Data from JAIVEX

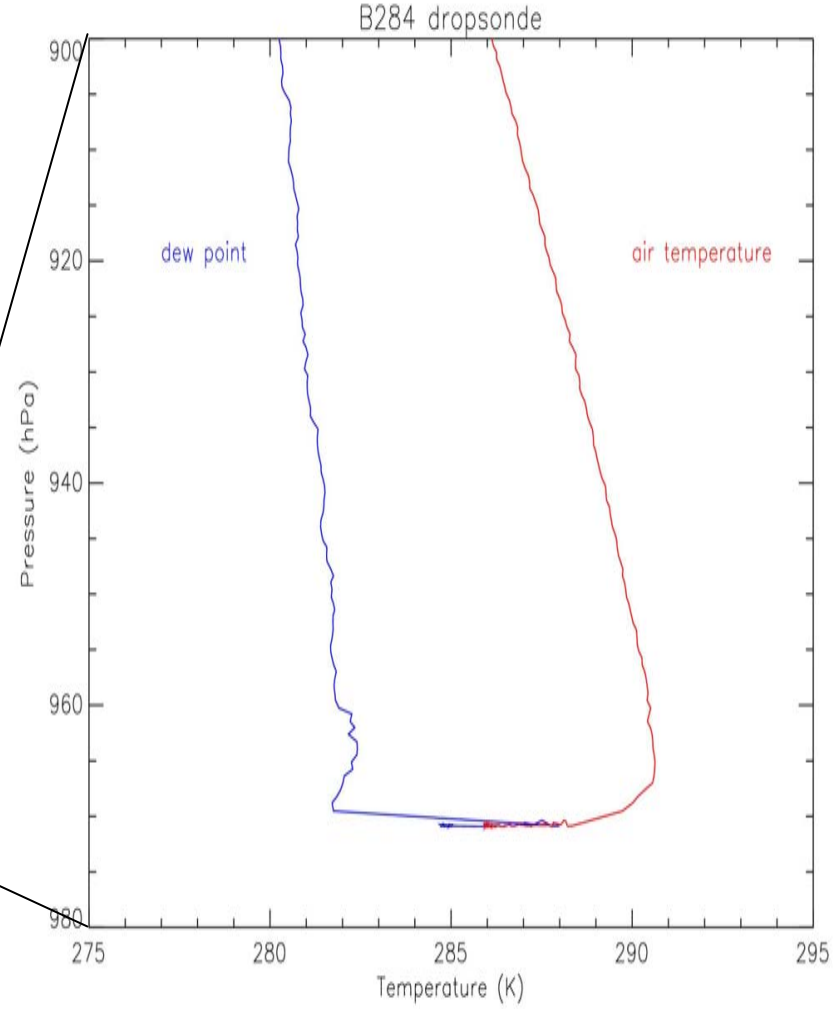
Background Profiles



1d-Var Retrieval Using Data from JAIVEX

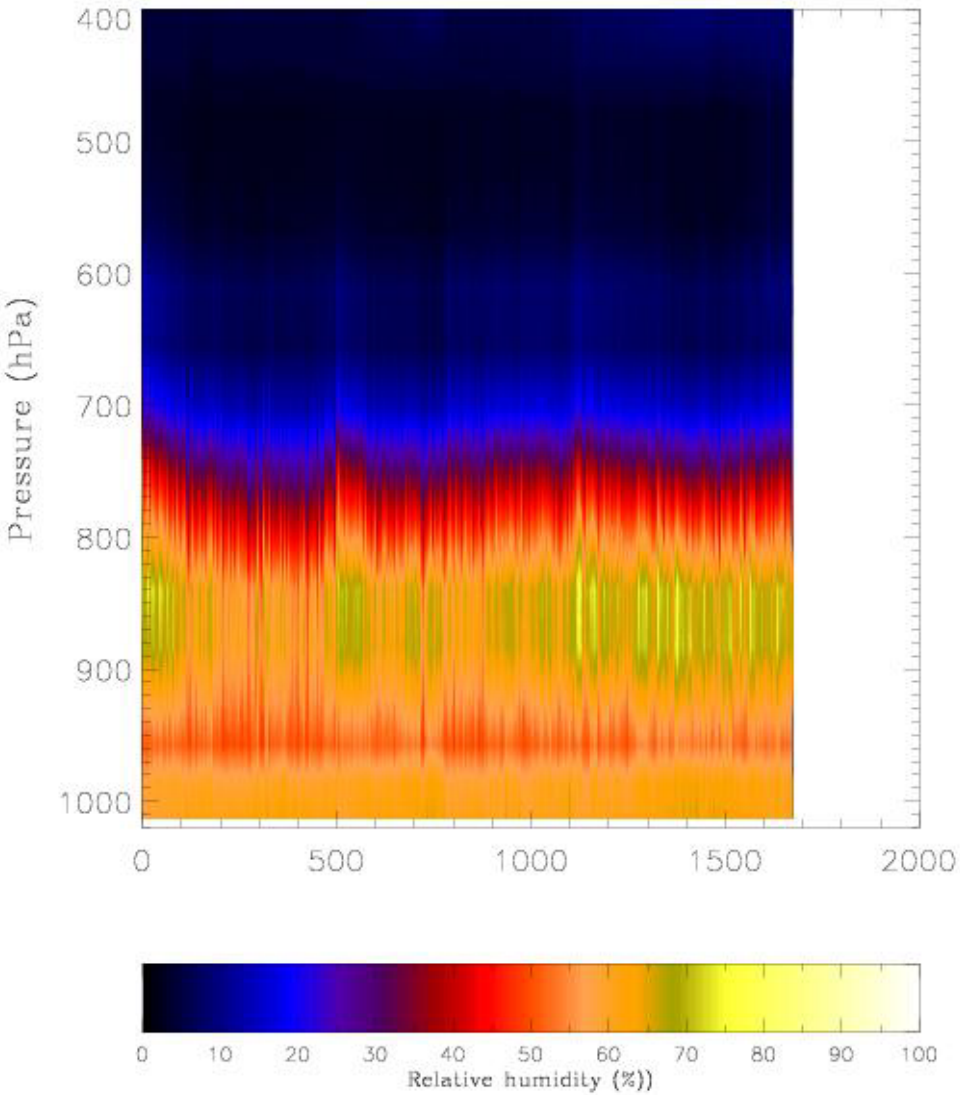
Temperature Retrieval

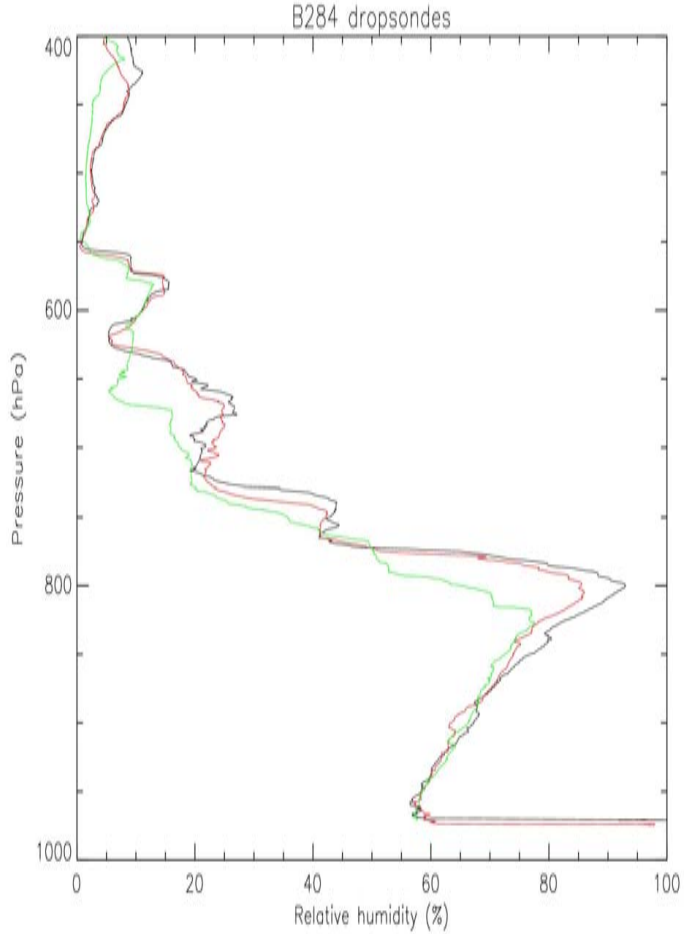




1d-Var Retrieval Using Data from JAIVEX

Water Vapour Retrieval

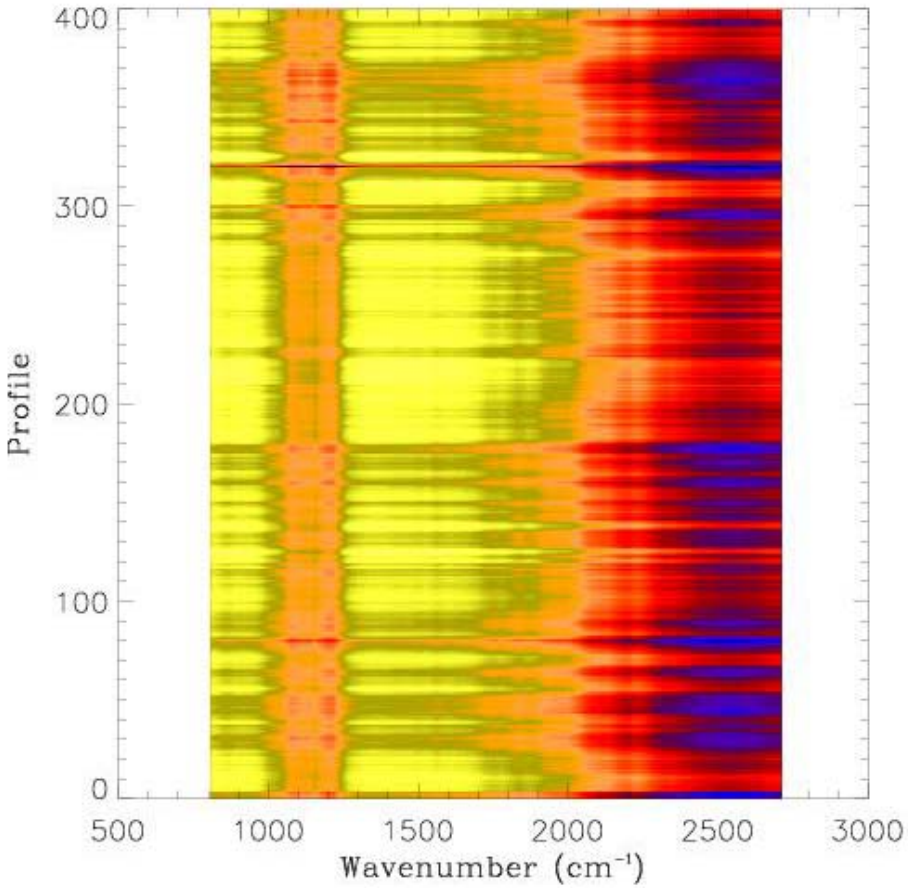


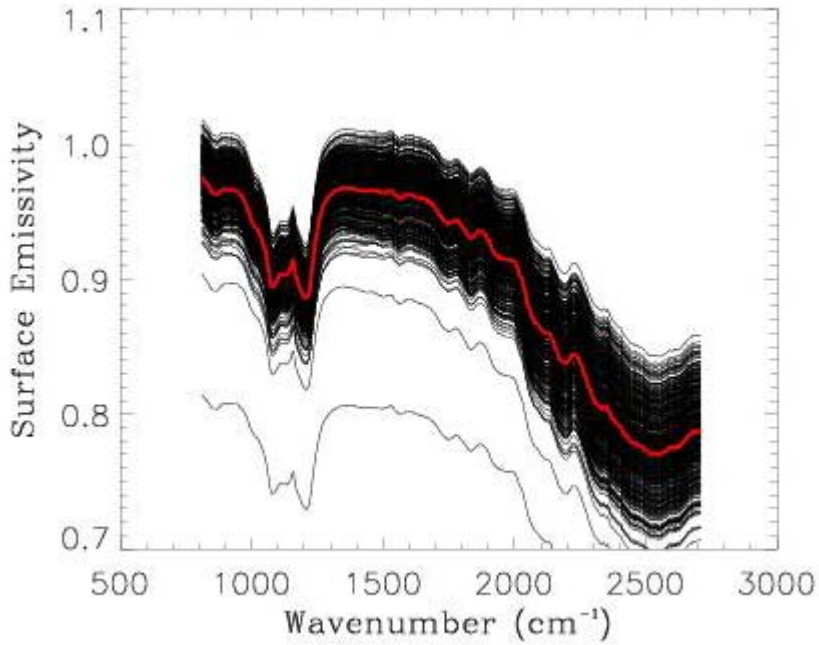


1d-Var Retrieval Using Data from JAIVEX

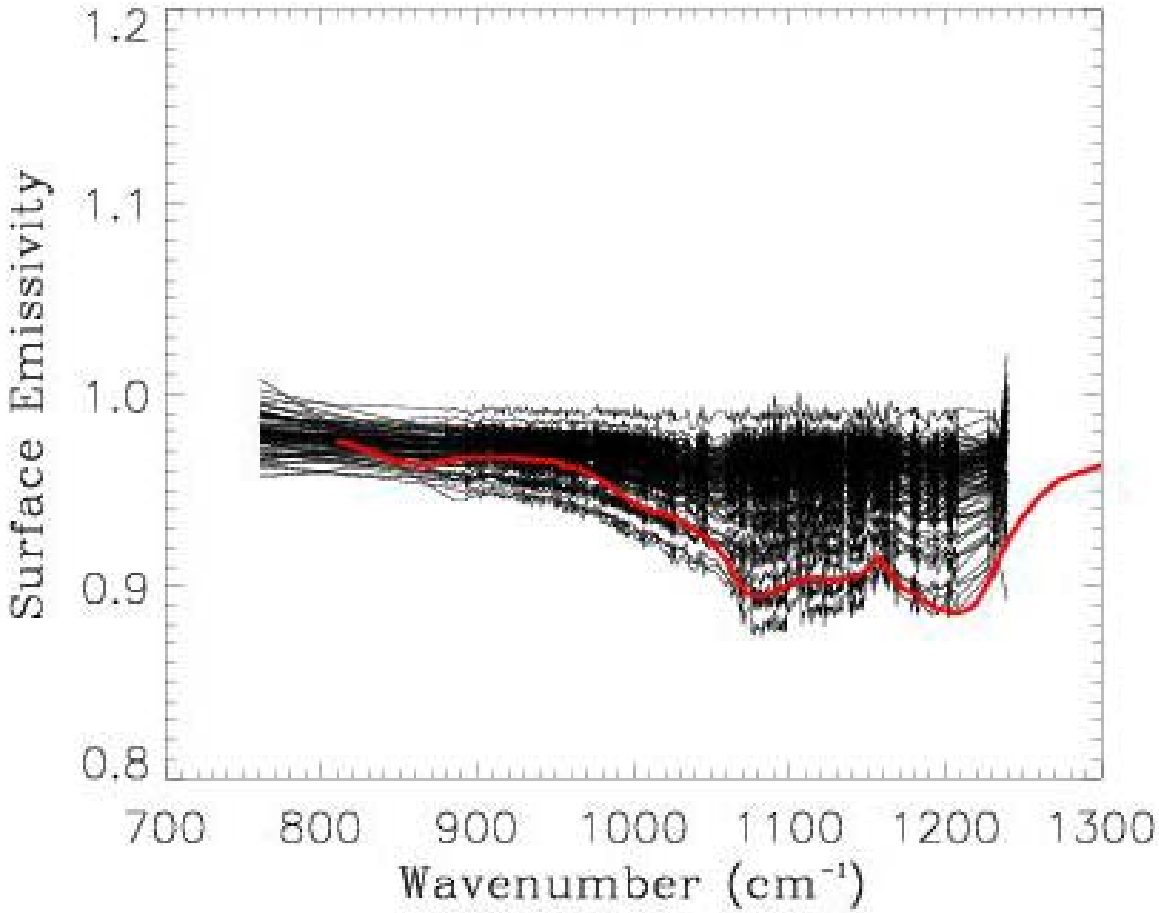
Emissivity Retrieval

Red line is average of 1st 400 retrievals





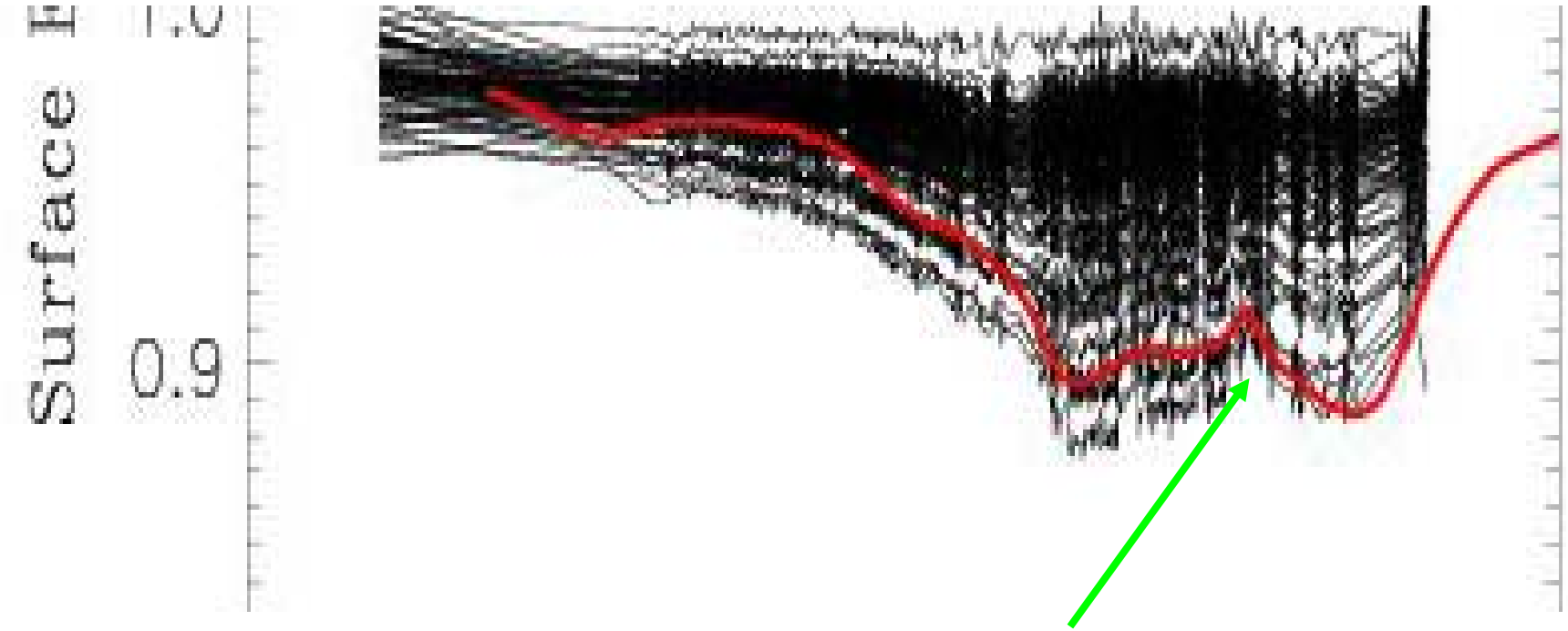
Emissivity Retrieval (2)



Black lines are retrieved during low level run using up and downward views by ARIES

Red line is average from 1D-Var retrieval at 35 000 ft.

Emissivity Retrieval (3)



See detail of emissivity retrieval is excellent

Summary

- HT-FRTC code performing well
- Successfully coupled HT-FRTC with 1D-Var Scheme
- Ability of BAe146 to fly low over surface allows measurement of surface emissivity
- 1d-Var retrievals from high level (~10 km) show skill in T, q, T* and emissivity retrievals
- Shows that it is possible to use hyperspectral sounder data over land subject to resolving issues like cloud detection

Future Developments

1D-var scheme being further tested with aircraft observations – initial results look very encouraging

Direct comparisons with dropsondes, ARM data and aircraft profiles

Run 1d-Var retrieval scheme for IASI data

Full treatment of scattering now included in HT-FRTC

Inclusion of cloud/aerosol properties in the 1D-Var control vector.

Thank you

Any Questions?

http://www.faam.ac.uk