Band Parameters

SFIT Retrieval Workshop

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Outline

- Review of band parameters
- Review of spectra parameters
- Summary

Band Parameters 1/6

- The Band Parameter section defines the regions to be fitted.
- There can be several bands. They are numbered 1, 2, … and should be numbered in increasing wavenumber order.
- The current value of MAXBND=125 (huh?!) set in **params.f90**
- Bandpass limits are used to determine range of lines stored by **hbin**
- Bandpass limits are used to create the spectra in the **t15asc** file

Band Parameters 2/6

Microwindows and their parameters from CO2 isotope example

```
band                                = 1
band.1.nu_start                     = 4872.000
band.1.nu_stop                      = 4888.000
band.1.calc_point_space             = 0.900E-03
band.1.wave_factor                  = 1.000
band.1.max_opd                      = 100.000
band.1.omega                        = 1.914
band.1.apodization_code             = 0
band.1.snr                          = 800.0
band.1.zshift                       = T
band.1.zshift.type                  = 1
band.1.zshift.apriori               = 0.000
band.1.zshift.sigma                 = 0.0100
band.1.beam                         = 1
band.1.beam.model                   = IP
band.1.beam.1.apriori               = 0.01161 1.97530 4882.98981 0.00000
band.1.beam.1.sa                    = 0.01 0.01 0.01 0.000
band.1.gasb                         = CO2 O13CO CO18O HDO H2O H218O
band.1.tempretb                     = F
```

Band Parameters 3/6

Microwindows and their parameters from CO2 isotope example

```
band                                = 1
band.1.nu_start                     = 4872.000
band.1.nu_stop                      = 4888.000
band.1.calc_point_space             = 0.900E-03
band.1.wave_factor                  = 1.000
band.1.max_opd                      = 100.000
band.1.omega                        = 1.914
band.1.apodization_code             = 0
band.1.snr                          = 800.0
```

Apodization Codes:

0 – Boxcar
1 -3 Norton Beer (weak, med., strng)
4 - Denver data
5 – Triangle
6 - Happ – Genzel
7 – KPNO Atmospheric Spectra A
8 – KPNO Atmospheric Spectra B
9 – Hamming function

- `calc_point_space` – **DN** – a desired spacing that the forward model will use for the monochromatic spectrum. Actual spacing will be the nearest value to this that is an integer multiple of the observed spectrum spacing in the **t15asc** file. All spectra in this band must have the same spacing. Keep track of **NSPAC**.
- `wave_factor` – **WAVFAC** – a scaling that can be applied to the spectra wavenumber values. (I never used this)
- `max_opd` – **PMAX** – optical path difference of this spectrum [cm]
- `omega` – **OMEGA** – aperture diameter / focal length [rad]
- `apodization_code` – **IAP** – defined in **BOBAPD**
- `snr` – **SCNSNR** – an snr for all spectra in this band, is overridden by value in **t15asc** (hence a default value)

Band Parameters 4/6

```
# Microwindows and their parameters from CO2 isotope example

band.1.zshift                          = T
band.1.zshift.type                     = 1
band.1.zshift.apriori                  = 0.000
band.1.zshift.sigma                    = 0.0100
band.1.gasb                            = CO2 O13CO CO18O HDO H2O H218O
band.1.tempretb                        = F
```

- `zshift` - **`F_ZSHIFT`** – flag to switch on a zero shift in this band
- `zshift.type` - **`IZERO`** – function code – see right ->
- `zshift.apriori` - **`ZSHIFT`** – initial zero shift
- `zshift.sigma` - **`SZERO`** – zero shift uncertainty required when retrieving
- `gasb` - **`GASB`** – list of gases to retrieve in this band
- `tempretb` - **`TRETB`** – flag to retrieve temperature using this band

IZERO Codes:

0 – zero shift the spectrum using the a priori value as given – do not fit
1 - retrieve zero level for this band
2 - use zero level from first band in list for this band

Important distinction between an absorption feature in a given bandpass and retrieving it. In short, if a gas is in the **GASB** list, then there is a block the **K** matrix for that gas / wavenumber remember $\mathbf{K} = \partial \mathbf{F}/\partial \mathbf{x}$. **F** is the forward model ie. spectrum and, **x** is the state vector. **GASB** is used to build the K matrix.

Band Parameters 5/6

Microwindows and their parameters from CO2 isotope example

```
band.1.beam                          = 1
band.1.beam.model                    = PS
band.1.beam.1.apriori                = 0.01161 1.97530 4882.98981 0.00000
band.1.beam.1.sa                     = 0.01 0.01 0.01 0.000
```

- `beam` - `NBEAMS` - number of beams in this bandpass, (`MAX_NUM_OF_BEAMS = 20` – way too many)
- `model` - `CHANNEL_MODEL_OF_BAND` - model for implementation of a realized channel spectrum
  - PS: phase shifted reflecting model or
  - IP: interferogram perturbation model
- `apriori` - `CCIPARM` - parameters used:
  - Amplitude of channel [fractional value]
  - Frequency [cm-1]
  - Wavenumber of zero amplitude [cm-1]
  - Linear scale to a change in amplitude [fractional/wavenumber]
- `sa` - `SCHAN_SCALE` - uncertainty of each parameter – if value is zero it will not be fit.

Band Parameters 6/6

Note on NSPAC

- Ratio between the spacing of the observed spectrum and monochromatic spectrum
- A cross-section value is calculated at each monochromatic point / layer / gas. So it s computationally expensive to have NSPAC large.
- For high resolution work where point spacing is already very small a value of 3-4 seems to work well.
    - ✓ Note smaller spacing reduces interpolations during the wavenumber shifts
- For lower resolution e.g. 1 cm-1, a much higher value seems to work better, why?

Spectrum Parameters 1/2

```
# spectrum parameters

 sp.snr                              = 1 2
 sp.snr.1.nu_start                   = 4882.0
 sp.snr.1.nu_stop                    = 4888.0
 sp.snr.1.snr                        = 200.0
 sp.snr.2.nu_start                   = 4884.3
 sp.snr.2.nu_stop                    = 4884.5
 sp.snr.2.snr                        = 0.01
```

- `snr` - `NSNR` – List of number of snr ranges (MAXSNR = 20)
- `nu_start` - `WWV0` – Low wavenumber for this snr range
- `nu_stop` - `WWV1` – High wavenumber for this snr range
- `Snr` - `GSTNR` – Constant SNR for this range

This functionality was first implemented to de-value a section of a spectrum in the fit. For instance a feature that is has a bad line parameter can have a low **SNR** (=0.01 ?) set and its poor fit will largely have no effect on the retrieval.

It can be used to override the **SNR** in the **t15asc** file

Spectrum Parameters 2/2

Note on SNR

In the OE method the statistics S_a on the state vector **x** and S_e on the measurement **y** are of ultimate importance. After the SNR for each point in the observed spectra is defined per rules listed above $S_e = 1/SNR$. But the Gaussian noise on an FTIR spectrum constant and can be measured. Hence be very aware that any change will manipulate the retrieval.

Summary

- The band parameters provide a lot of flexibility to tailor your retrieval.
- Some parameters are still there but may not serve a contemporary use in one's view but may still have utility for some users.
- As with all parameters it's the users responsibility to know what to use and what affect a default value is having.
- Its important to know how the S_a values 'mix' in the retrieval.

end