National Radio Astronomy Observatory
Tucson, Arizona

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MEMORANDUM

TO: Spectral Line Observers

FROM: J. M. Payne & B. Stobie

SUBJECT: Optical Depth Measurements

The present method of determining the optical depth from an antenna tip seems to be overcomplicated. We have implemented a simpler scheme that has the following advantages and is available to observers on a trial basis.

1) The measurement is made in switched power rather than total power so the stability of the receiver when tilted is not so critical.

2) The astronmer is not required to enter any parameters.

3) The fitting of the data is simpler.

Description of Method

The antenna is tipped in elevation to the elevation angles that have previously been used in sky tips. At each elevation angle data is taken from the total power channel of the receiver as follows. First the total power voltage with the ambient temp vane over the receiver feed is taken (V_{HOT}). Next the total power voltage with the ambient temp vane removed is taken (V_{SKY}).

Let $(V_{HOT} - V_{SKY}) = \Delta$

then $\Delta = T_{AMB} - T_{AMB}\,(1 - e^{-T/\mathrm{SIN\ EL}})$

where T_{AMB} = ambient temperature

EL = elevation angle

T = optical depth

$$\text{so} \quad \log_e \Delta = \log_e T_{AMB} - T/\text{SIN EL}.$$

If $\log_e \Delta$ is plotted against $\frac{1}{\text{SIN EL}}$ the result should be a straight line the slope of which is $-T$.

Analysis

During tipping scans the control system now integrates the total power of the receiver with the vane and then without the vane for the specified length of time (SEC) and records the difference between these values (Δ) for the same elevation angles as previously used.

The data is analyzed in the continuum programs CONDR1 or CONDR2. The procedure, NTIP, which must be INSTALLed in the program performs a linear fit to $\text{Log}_e \Delta$ as a function of secant Z by linear regression. The resulting slope = $-T$.

To use the procedure type:

```
RUN CONDR1
INSTALL  NTIP
SCAN#  NTIP
```

The procedure will ouput the following:

```
RESULTS OF TIP
TAU = x.xxxx     FCF = x.xxxx
where FCE  (fit confidence factor) = 1 for a perfect fit.
See examples below.
```