Digital Vertically Integrated Liquid (DVIL)

Introduction

The Digital VIL (in this case "digital" means 8-bit Overview as opposed to legacy VIL which is 4-bit) product is not a replacement for the existing gridded VIL product (see the next section). Although it uses the same equation as VIL to convert reflectivity to kg/m^2, the finer data resolution (1° by 1 km polar format), and lack of truncation has a substantial impact on the value. There have been instances where a value of 40 to 45 kg/m^2 on the VIL product equated to a value of 80 kg/m^2 on the DVIL product. Any empirical study using VIL (e.g., VIL Density, VIL of the Day, etc.) should *not* be used with the DVIL product.

Vertically Integrated Liquid (VIL)

<u>Overview</u>

VIL values represent reflectivity data converted into equivalent liquid water values. The original intent of the product was to estimate liquid water content, though it was clearly unable to accurately do so. VIL is really nothing more than integrated reflectivity, not a storm's precipitable water content.

VIL Equation

The VIL equation is:

$$M = 3.44 \times 10^{-3} Z^{4/7}$$

where M = liquid water content (g/m^3) and Z = radar reflectivity ($mm^{6/} m^3$). The values are derived for each 4 x 4 km (2.2 x 2.2 nm) grid box, then vertically integrated. VIL values are output in units of mass per area (kg/m^2). The algorithm assumes reflectivity returns are from liquid water, only using reflectivity values greater than 18 dBZ.

As stated previously, VIL was intended to estimate liquid water content, thus it was designed to remove any effects of hail from the calculated values. Reflectivity returns from hail are non-linear and would result in unrealistically high values, so all reflectivity greater than 56 dBZ are truncated to 56 dBZ.

Characteristics

See Figure 1 for an example of the VIL product.

<u>Legend Description</u>

- RPG ID: kxxx
- PRODUCT NAME: Vert Integrated Liquid
- DATE: Day of week, time (UTC) & date.

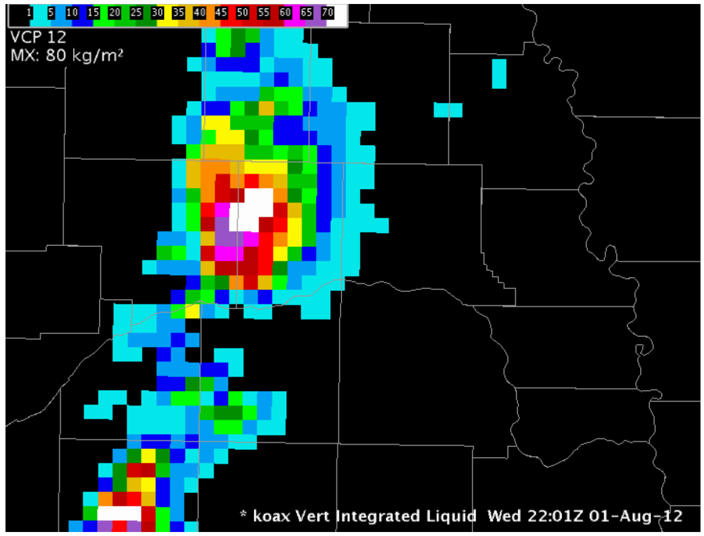

Figure 1. Vertically Integrated Liquid (VIL) product

Product Annotations

• VCP: 11, 12, 21, 121, 211, 212, 221, 31 or 32

• MX: This is the maximum value in kg/m^2. The location of this value is unknown.

Limitations

1. VIL values are biased by drop size (Fig. 2).

2. Grid VIL values will differ from Cell-Based VIL values.

3. VIL values used as warning thresholds change daily and perhaps across the warning area on a given day. Values are air mass dependent (Fig. 3).

4. VIL values within 20 nm of radar are underestimated. This is due to the cone of silence.

5. VIL values for a strongly tilted or a fast moving storm will be lower than if the storm is vertically erect or moving slowly. The upper portion of the storm may extend into another grid box (Fig. 4).

6. May be contaminated by non-precipitation echoes.

7. More VIL fluctuation with VCPs 21, 121, and 221 than VCPs 11, 211, 12, or 212. There are fewer gaps in VCPs 11/211 and 12/212. This is mainly within 60 nm of the radar. Fig. 5 shows the results of a study comparing VIL values for a single storm from VCPs 11 and 21.

8. VIL values at distant ranges (> 110 nm) are unreliable. The reflectivity value at 0.5° is integrated down to the radar level. At distant ranges the beam may be cutting through the highly reflective hail cores in the mid levels of a storm producing an overestimation of VIL, or overshooting the convection and underestimating VIL.

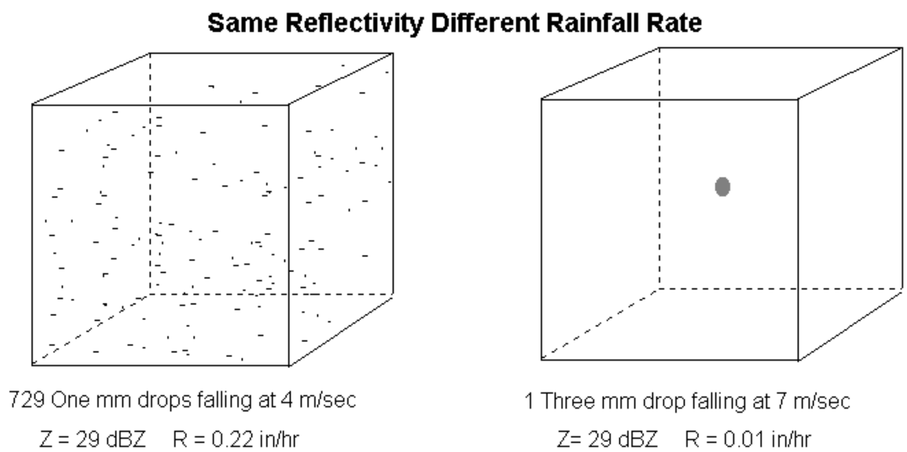

Figure 2. Effect of drop size on target reflectivity

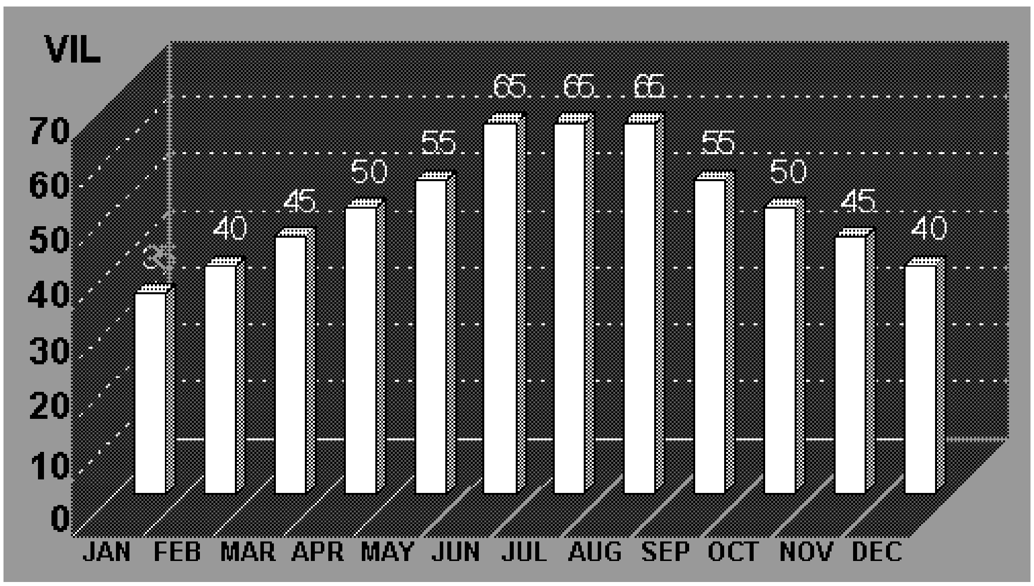

Figure 3. Estimated VIL values needed for severe hail in Oklahoma.

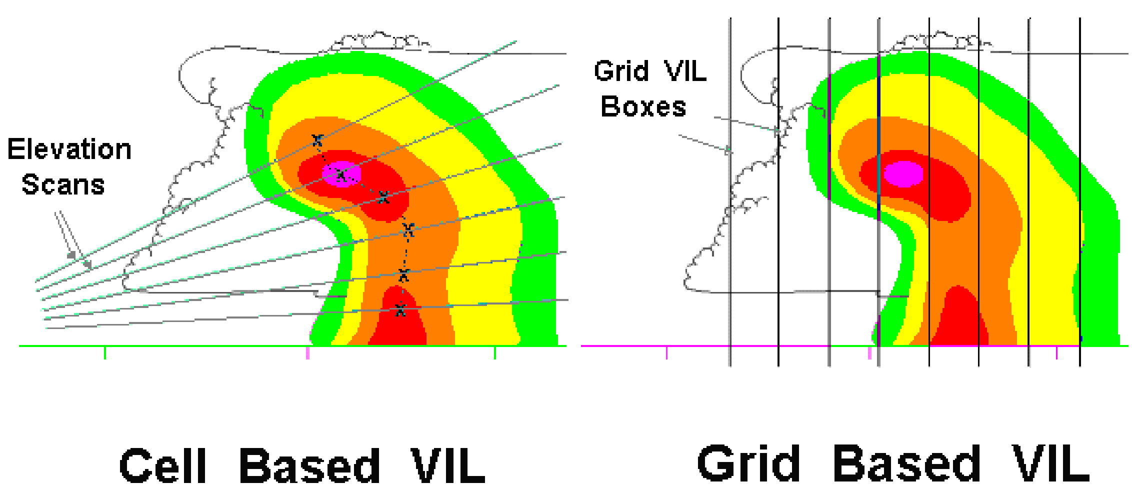

Figure 4. Cell-based vs. Grid-based VIL.

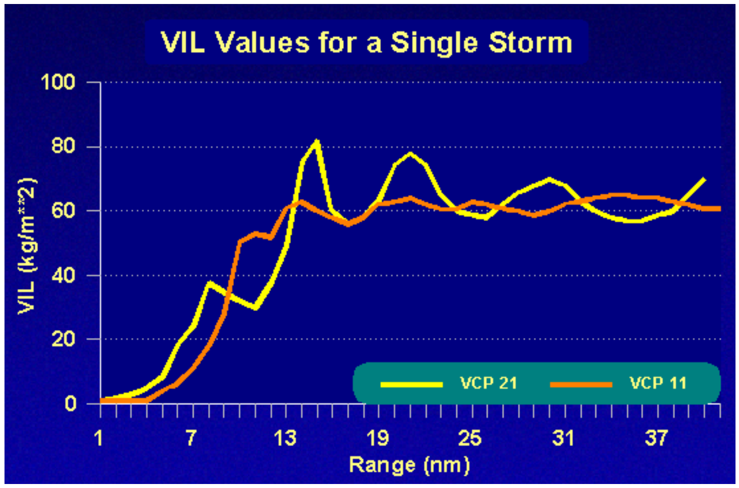

Figure 5. This study is from measurements of a single storm using two different volume coverage patterns. The results of the study show that a storm moving toward or away from the RDA will have more fluctuation in VIL values in VCP 21 than in VCP 11. This is due to the fact that there are more gaps in VCP 21 than in VCP 11.

Applications (Strengths)

1. Locate storms with more significant reflectivity cores. High VIL values correspond to deep areas of high reflectivity indicative of strong updrafts. VIL Density (VIL divided by Echo Tops - see Amburn and Wolf 1997) has also shown some skill identifying significant hailstorms, and can be loaded from the SCAN menu under the submenu for “Hail Diagnosis Grids”(see Fig. 6). These are produced on the fly by the SCAN processor and do not come from the RPG. Limitations of VIL previously listed (e.g., storm tilt and fast moving storms) and Echo Tops should always be considered when using these values.

2. Can be used to distinguish storms likely to contain severe hail once meaningful values have been established. Once meaningful values have been established (by real-time comparison with reflectivity structures and spotter reports) forecasters can infer that storms in the same environment will likely have similar characteristics. Issues regarding the impacts of sampling should always be considered, however. This should be used only as a reality check after base data have been analyzed.

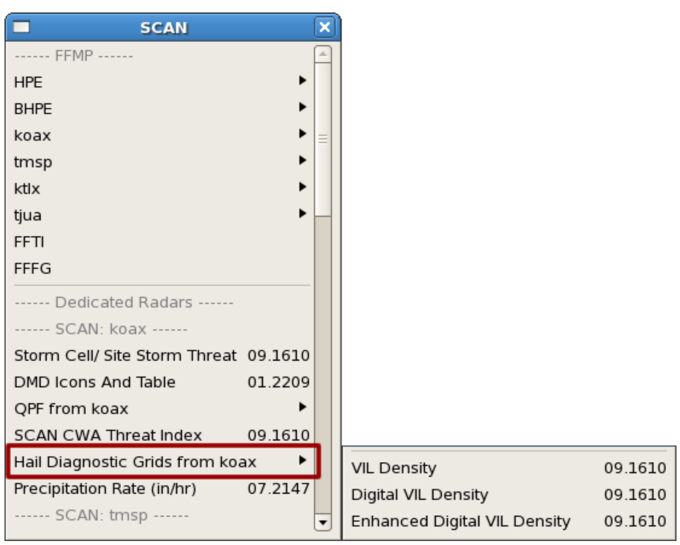

Figure 6. AWIPS-2 menu where you can load VIL Density and other Hail Diagnosis products.