Subsidence

Subsidence is an essential parameter for determining the entrainment velocity at the top of the boundary layer. So far the airplanes of Scientific Aviation do not measure vertical wind so we are left to find another method. Previously we used omega (pressure velocity; w) obtained from North American Regional Reanalysis Dataset (NARR) with ~35 km horizontal resolution and surface pressure data from stations in the region (see equation below). This method can be seen in a forthcoming publication Trousdell et al. 2016 also see Albrecht et al. 2016 for a similar usage of reanalysis data. Currently due to the absence of NARR data for our current flights we have attempted to use WRF model runs to acquire this data. Some have insisted that subsidence can be seen from the CABOTS TOPAZ ozoneidar data shown form appear to be the subsiding “layers” of ozone. Using a graphical technique we estimated subsidence from the lidar data by dividing it by what WRF has predicted above Visalia (See figures below).

The vertical velocity values seen across the SJV vary significantly even becoming positive in places (see Figure below). We are still unsure as to what this leads to all of the variation.

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z} \left( \frac{\partial h}{\partial t} \right)$$

For our current study between Fresno and Visalia, Ca in the valley we have four entrainment values ranging from about 3 to 6 cm/s with an average of 4.3 cm/s. These flights took place in late July and early August 2016.

To be precise we include the advection of ABL height, h, when calculating the local time rate of change of height.

$$\frac{dh}{dt} = \frac{\partial h}{\partial t} + U \frac{\partial h}{\partial x}$$

The advection of boundary layer height has been shown to be significant (Trousdell et al. 2016) on order of 1 cm/s in the very southern end of the San Joaquin Valley.

$$\frac{\partial O_3}{\partial t} = \frac{\partial}{\partial z} \left( \frac{\partial A_t}{\partial z} \right)$$

Using Airborne Flux Observations, Faloona et al. 2016 for a similar usage of reanalysis data. Currently due to the absence of regional ozone photochemical production rates and methane emissions. The flights are from late July and early August 2016 during the California Baseline Ozone Transport Study (CABOTS). The flights take place across the San Joaquin Valley (SJV) around Fresno and Visalia. Concurrently in flights take place across the San Francisco Bay Area (SFB). The SJV includes the counties of Madera, Yosemite, Mariposa, Tulare, and Kern. The SFB includes the counties of Contra Costa, Marin, San Francisco, Solano, and Alameda.

Subsidence from the subsiding “layers” of ozone. Using a graphical technique we estimated from the CABOTS TOPAZ ozone runs to acquire this data. Some have insisted that subsidence can be seen from the CABOTS TOPAZ ozoneidar data shown form appear to be the subsiding “layers” of ozone. Using a graphical technique we estimated subsidence from the lidar data by dividing it by what WRF has predicted above Visalia (See figures below).

The entrainment velocity is parameterized as the difference between the Lagrangian growth in the boundary layer height and the subsidence at the ABL top. The entrainment velocity is the rate at which the boundary layer is growing by incorporating free tropospheric air, which in fair weather is subsiding. See more info about determining about determining vertical velocity or subsidence at the top of the boundary layer in the subsidence section. During the winter in the SJV near Fresno we found entrainment average at 1.5 cm/s and max out at 2.4 cm/s. In the summer near the southern end of the SJV we found an average of 3 cm/s and a max of 6.5 cm/s (Trousdell et al. 2016). Similar values have been reported in the Sierra Foothills, the Netherlands, and the Ozark Mountains (see Karl et al. 2013, Villa-Guerra de Aranuilo et al. 2004 and Wolfe et al. 2015 respectively).

$$w_e = \frac{\partial h}{\partial t} - W$$

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