RioTinto

KMP SO_2 EEM Program – Technical Memo D02

Atmospheric Sulphur Dioxide

Method for Estimating Dry Deposition: 2017 Update

(Update to 2016 Technical Memo D01)

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1 Overview

Under the Environmental Effects Monitoring (EEM) program, dry deposition of gaseous and particulate sulphur in the Kitimat valley will be estimated from empirical observations of gaseous sulphur dioxide (SO_2) and particulate sulphate (pSO_4^{2-}; see Technical Memo F01: Filter Pack Network for Particulate Sulphate) combined with modelled dry deposition velocities (V_d). The 'big-leaf' model developed by Environment and Climate Change Canada (ECCC: Zhang et al., (2001; 2003a; 2003b; Zhang and He, 2014) will be used to estimate region-specific V_d (see Technical Memo D01: Method for Estimating Dry Deposition).

This technical memo briefly describes the application of the V_d model in the Kitimat valley.

2 Deposition Velocity Model

The V_d model was obtained from ECCC as a FORTRON code (see Technical Memo D01: Method for Estimating Dry Deposition). This code has been compiled into a Windows executable program and verified, i.e., V_d have been modelled for 31 gaseous species and 3 particulate size classes for a range of land cover types using 'test' meteorological data.

The model requires two sets of input data, site specific variables (such as latitude and land cover) and meteorological forcing variables. While there are several meteorological stations in the Kitimat valley, only one station, i.e., Terrace A (YXT), measures and archives all required model inputs (Table 1). As such, a 'region-specific V_d' will be modelled using hourly data since 2000 from the Terrace A meteorological station, and combined with site-specific observations of gaseous SO_2 (obtained from passive samplers and active monitors) and particulate SO_4^{2-} (obtained from filter packs) to estimate dry deposition.

The V_d model requires thirteen meteorological forcing variables on an hourly resolution for the period of interest (Table 1). While the majority of these variables are available online (URL: climate.weather.gc.ca), several variable, i.e., solar radiation, snow depth and cloud cover, can only be obtained by request from Environment Canada's climate archive (at Climate West). Hourly (and daily) observations for all required variables (Table 1) have been requested from 2000 onwards for the Terrace A station.

Table 1. Meteorological variables required to model deposition velocity, their online availability (URL: climate.weather.gc.ca) and climate archive measurement codes.

Parameter (unit)	Online	Measurement code
Temperature (K)	Y	078 (HLY01)
Windspeed (m s^{-1})	Y	076 (HLY01)
RH fraction (0–1)	Y	080 (HLY01)
Solar irradiance (w m^{-2})		133 (HLY10) until 2002, and 179 (DLY02)
Precipitation rate (mm hr^{-1})	Y	123 (HLY03)
Surface pressure (mb)	Y	077 (HLY01)
Snow depth (cm)		275 (HLY01)
Cloud fraction (0–1)		082 (HLY01)

3 Model Application

The 'big-leaf' model developed by ECCC in combination with hourly meteorological data from the Terrace A station will be used to model gaseous and particulate deposition velocities. These estimates of region-specific V_d will be combined with site-specific observations of gaseous SO_2 (from active and passive samplers) and particulate SO_4^{2-} (from filter pack samplers) under the EEM to estimate dry deposition of sulphur in the Kitimat valley.

The *Terrace A station* is the only location within the Kitimat valley with the required meteorological data for the determination of dry deposition. Moreover, it *provides consistent long-term data since the 1970s, which is essential for the determination of historic hourly deposition velocities*. In the context of the EEM, historic refers to the estimation of dry deposition since 2012 to date. The installation of a new meteorological station will not meet this requirement; the Terrace A station is the only location that can provide consistent long-term data.

4 Literature Cited

Technical Memo F01: Filter Pack Measurements of Particulate Sulphate, June 2018. In, Sulphur Dioxide Environmental Effects Monitoring for the Kitimat Modernization Project, 2017 Annual Reports. ESSA Technologies Ltd, Vancouver, Canada.

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