

Review of the manuscript

Declining, seasonal-varying emissions of sulfur hexafluoride from the United States point to a new mitigation opportunity

by Lie Hu et al.

General Comments:

Hu et al. present a careful top-down (TD) investigation of US SF₆ emissions and their changes, based on atmospheric observations and inverse modelling, and compare these estimates with emissions reported by bottom-up (BU) inventories from the national Environmental Protection Agency (EPA) and from EDGARv6.0. A decrease of SF₆ emissions as reported by the inventories is confirmed by the independent TD estimate. However, absolute values deviate significantly between BU and TD by more than a factor of two for part of the observational period. A significant seasonality in emissions is observed in the TD estimate, which is attributed to a seasonality of leakages from Electric power Transmission and Distribution (ETD) network (supposed to be high during winter at colder climate in the northern part of the US) and regular maintenance (more frequent during winter in southern parts of the US). Attributing the seasonality to the ETD source sector gives the reasoning to the title of the manuscript.

The manuscript is well written (but see my minor comments below), and fits the scope of EGU sphere. It convincingly shows that the TD approach gives important insights also into past emissions as well as into under-reporting. I see only one major shortcoming in the manuscript, which concerns the comparison of the US TD and BU emission estimates with EDGARv6.0, as presented in Fig. 1. The huge difference between the two BU inventories EDGARv6.0 and EPA of almost a factor of two around 1990 and more than a factor of four in more recent years (and also compared to the TD estimate) is rather worrying. Why is EDGARv6.0 supposedly so wrong in the US, particularly in recent years? Did the authors contact EDGAR scientists and discuss this issue with them? From my point of view, a thorough discussion on this issue needs to be added to the manuscript before it can be published.

Specific Comments:

Title:

The title creates huge expectations at the reader: Is it really a NEW opportunity to mitigate SF₆? Did power companies not know that their sealings may become brittle in the cold? I would have assumed that minimizing emissions of SF₆ from ETD during servicing must have been a well-known mitigation opportunity before the results of this study were available.

Abstract:

Lines 25-28: I suggest the sentence should read somehow like “BU *estimates* compare to TD *observations*”, not the other way round (at least from an atmospheric scientist’s perspective).

Line 33: ... that did not or *does* not report ...

Line 37: “These results ...” there is no direct relation to the sentence before and I would thus change to “The results of this study demonstrate ...

Introduction:

Line 51: ... is *the* greenhouse ...

Lines 75-77: You may want to cite here the early work by Maiss, M. and I. Levin (1994: Global increase of SF6 observed in the atmosphere. *Geophys. Res. Lett.* 21, 569-572) and Harnisch, J., et al. (1996: Tropospheric trends for CF4 and C2F6 since 1982 derived from SF6 dated stratospheric air; *Geophys Res. Lett.*, 23, 1099-1102, 1996).

Lines 94-96: "This large difference *likely* stems from different input emission activity data and estimated emission factors ..." Are there any other factors used to estimate BU inventories?

Lines 104-105: Which of these references describe the inverse model best? Hu et al., 2015? Then (only) this one should be cited here (to be consulted by the interested reader).

Methods:

Line 135: What means "US (CONUS)"?

Lines 160-161: See comment on Lines 104-105.

Line 175: What means "(Rodgers)"?

Results and Discussion:

Line 226: See general comment on huge deviation of EDGARv6.0 emissions from the other estimates.

Line 238: Define "GHGI".

Lines 243-245: Same comment as on Lines 25-28

Line 255: What means "GHGRP (16)"? Also Line in 267 and 269.

Line 306: "... (lbs of SF6 per ...)" Think metric !

Lines 342-358: When mentioning Fig 3, please also refer to "a, b, c"