The ECHOZ (Ecuadorian Highlands Ozonesondes) Project
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Final Report

Summary of Activities

In August 2018, the Ozone Secretariat informed Ecuador that the ECHOZ project was approved to receive support from the Vienna Convention Trust Fund (VCTF) to monitor stratospheric ozone over the equatorial Andes. An agreement with the World Meteorological Organization was signed with USFQ and funding became available in September 2019. The project started with importation of supplies and equipment into Ecuador, but political unrest in October 2019 delayed acquisition of materials. Thus, ozone soundings at USFQ's Atmospheric Measurement Station (EMA, Spanish acronym) initiated on the 6th of March 2020. EMA's coordinates are -0.1964, -78.435, and 2414 masl (meters above sea level). It is important to remark that we executed the series of measurements in 2020-2021 in spite of the significant challenges imposed by the COVID-19 pandemic. Briefly, in March 2020 a state of sanitary emergency was decreed in Ecuador. Such circumstances submerged the country in a full lockdown that lasted 78 days beginning on 17 March 2020. Subsequently, there were various restrictions on mobility and access to facilities. Nevertheless, we did a major effort to resume launches as early as May 2020 and launched consistently, at a rated closest to 2 ozonesondes per month until June 2020.

A major limitation caused by the pandemic was to operate with reduced personnel. Originally we acquired 28 ozone sounding sets, that covered possible failures. One ozonesonde is kept in the lab for tests, while two others had technical failures and could not be launched. Due to university restrictions, we were unable to hire help for launches and data processing. As a result, we economized some budget and managed to acquire 5 additional ozonesondes with complementary USFQ funds for radiosondes. Thus, we plan to launch four additional sets in August 2021. Table 1, in the following section, shows the timeline of executed ECHOZ soundings. We launched and collected data successfully from 28. Due to the lack of sufficient personnel and pandemic difficulties, data processing has been delayed. At the moment, we are working on data processing for a publication that includes the entire time series to compare against satellite data. These data will be archived at https://observaciones-iia.usfq.edu.ec , where our 2014-2019 time series (38 soundings prior to VCTF) are already available.

At USFQ we are truly committed to contributing with ozone layer monitoring relevant to the Vienna Convention and the Montreal Protocol. Thus, we are glad to communicate to the Ozone Secretariat that, in order to ensure continuity of ECHOZ soundings, we recently established a collaboration with the NASA SHADOZ (Southern Hemisphere Additional Ozonesondes) network, which will provide supplies for four additional years from Quito from September 2021 to 2024. Furthermore, through this collaboration, we will begin launching ozonesondes from our Galapagos campus starting this year.

As presented, VCTF support has been instrumental to expanding and consolidating ozone observations in Ecuador not only in the stratosphere over the Andes, but also in the troposphere, where it is relevant for human health. Thanks to the VCTF, equipment and ozone observation capacity was augmented at our station. As a result, we managed to monitor substantial changes in ozone photochemistry near the surface during the onset of the COVID-19 pandemic. These

observations were published in a 2020 article. Below we include a section of the work that has been produced until the moment and the budget execution. Finally, the Annex includes some photographs of ECHOZ operations at EMA USFQ.

Table 1: Timeline and continuity of ECHOZ ozone soundings

2020-2021 ECHOZ LAUNCHES

Launch No.	Code	Date	Status	Civil Aviation authorization
1	ECHOZ_20200306_1	06/03/2020	Launched	Yes
2	ECHOZ_20200529_1	29/05/2020	Launched	Yes
3	ECHOZ_20200612_1	12/06/2020	Launched	Yes
4	ECHOZ_20200626_2	26/06/2020	Launched	Yes
5	ECHOZ_20200710_1	10/07/2020	Launched	Yes
6	ECHOZ_20200724_2	24/07/2020	Launched	Yes
7	ECHOZ_20200814_1	14/08/2020	Launched	Yes
8	ECHOZ_20200828_2	28/08/2020	Launched	Yes
9	ECHOZ_20200911_1	11/09/2020	Launched	Yes
10	ECHOZ_20200925_2	25/09/2020	Launched	Yes
11	ECHOZ_20201012_1	12/10/2020	Launched	Yes
12	ECHOZ_20201023_2	23/10/2020	Launched	Yes
13	ECHOZ_20201120_1	20/11/2020	Launched	Yes
14	ECHOZ_20201127_2	27/11/2020	Launched	Yes
15	ECHOZ_20201218_1	18/12/2020	Launched	Yes
16	ECHOZ_20210122_1	22/01/2021	Launched	Yes
17	ECHOZ_20210129_2	29/01/2021	Launched	Yes
18	ECHOZ_20210212_1	12/02/2021	Launched	Yes
19	ECHOZ_20210226_2	26/02/2021	Launched	Yes
20	ECHOZ_20210319_1	19/03/2021	Launched	Yes
21	ECHOZ_20210401_1	01/04/2021	Launched	Yes
22	ECHOZ_20210416_2	16/04/2021	Launched	Yes
23	ECHOZ_20210429_3	29/04/2021	Launched	Yes
24	ECHOZ_20210514_1	14/05/2021	Launched	Yes
25	ECHOZ_20210604_1	04/06/2021	Launched	Yes
26	ECHOZ_20210618_2	18/06/2021	Launched	Yes
27	ECHOZ_20210702_1	02/07/2021	Launched	Yes
28	ECHOZ_20210723_2	23/07/2021	Launched	Yes

4 additional ozonesondes acquired with VCTF are still available and planned to be launched in August and September until USFQ gets the new supply from NASA to join the SHADOZ network.

Work and presentations

Cazorla, M., The ECHOZ (Ecuadorian Highlands Ozonesondes) project: findings from ozone profiles above the equatorial Andes. 100th AGU Fall meeting. 12 December 2018.

Cazorla, M., Herrera, E. Palomeque, E., Saud, N., What the COVID-19 lockdown revealed about photochemistry and ozone production in Quito, Ecuador. *Atmospheric Pollution Research*, 12 (1), 124-133, https://doi.org/10.1016/j.apr.2020.08.028, 2020.

Cazorla, M., Herreram E., Effect of Pandemic-induced Mobility Restrictions on Surface Ozone in Quito, Ecuador: Results from Measurements and Modeling. American Geophysical Union Fall Meeting. December 2020.

Cazorla, M., Air quality observations in the east of Quito, Ecuador in 2018-2020: comparisons between pre- and post-COVID-19 conditions. Air Pollution 2021. Wessex Institute of Technology WIT Conference. September 2021. Accepted.
Cazorla et. al., ECHOZ-SHADOZ synergy: ozone observations throughout the atmospheric column from the Andes to the Galapagos islands. Ozone Quadrennial Symposium 2021. October 2021. To be submitted soon.

Budget execution

Budget: $49,800

Budget execution	31 December 2020	$45,526.63
Expenses March to June 2021	EN-SCI Ozonesondes, balloons, parachutes, and reels	$3,306.04
	Conference participation M. Cazorla: Air Pollution 2021 (Abstract accepted) Wessex Institute of Technology (WIT).	$967.33
Total execution	9 June 2021	$49,800
Balance	9 June 2021	$0.0

*Certification by USFQ's Financial Office pending.

For further questions, please contact PI. M. Cazorla (mcazorla@usfq.edu.ec).

Annex



Photograph 1: Preparations to launch the first ozonesonde of the ECHOZ project from Universidad San Francisco de Quito (USFQ) on 6 March 2020. On the picture, M. Cazorla and E. Herrera complete balloon filling with helium and anchoring ozonesonde-radiosonde package to platform prior to launching.



Photograph 2: Attendees to the first ozonesonde launch of the ECHOZ project on 6 March 2020 pose next to telemetry antenna. We were honored to have over at EMA USFQ the distinguished representatives from government institution, namely the Ministry of Production, Ecuador's Meteorological Service (INAMHI, Spanish acronym), and the Ecuadorian Civil Aviation Authority (DGAC, Spanish acronym) as well as USFQ professors and students.



Photograph 3: Ozonesonde ECHOZ_20200306_1 on board of high altitude balloon departs EMA USFQ at coordinates -0.1964, -78.435, and 2414 masl in search for stratospheric ozone over the equatorial Andes. This balloon reached an altitude of 30.7 km above sea level (10.6 hPa).