Ticosonde: Over 15 years of Balloon-borne Water Vapor and Ozone Profiling in Costa Rica

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University of Maryland and NASA/GSFC

SAGE III/ISS Science Team Meeting

20 October 2020, 330 pm
Talk Roadmap

• A Brief History of Ticosonde and Quick Facts

• Ticosonde Water Vapor and Ozone Science

• Data Caveats and Issues
  1. Ozonesonde stratospheric “dropoff”
  2. Water vapor drift relative to Aura MLS

• What’s Next for Ticosonde?
The History of Ticosonde

- Soundings began during TCSP in July 2005 under leadership of **Holger Vömel** with launches at La Universidad Nacional (Jessica Valverde; UNA)

- Monthly water vapor soundings as well as intensive campaigns in January-March 2006 in conjunction with CR-AVE, in July-August 2006, and in July-August 2007 in conjunction with TC4

- March 2011: New PI **Rennie Selkirk**, sounding program moved to Universidad de Costa Rica (UCR) GasLab under **Jorge Andres Diaz**, where it continues today

- Current PI **Susan Strahan**. Launching 2-4 ozonesondes per month, and 1 CFH water vapor sonde per month
Ticosonde Quick Facts

• Ozonesonde Profiles (SHADOZ): 614
• CFH Water Vapor Profiles (NDACC): 221

• Only long-term *in-situ* tropical (10° N) water vapor sounding data set in existence

• Cryogenic Frostpoint Hygrometer (CFH) water vapor soundings are currently coordinated with SAGE III/ISS occultations

• Featured annually in the *AMS State of the Climate Report*

• Website: https://acd-ext.gsfc.nasa.gov/Projects/Ticosonde/index.html
Ticosonde Ozone and Water Vapor Science
Ticosonde Water Vapor

• The *in-situ* water vapor profiles help characterize tropical dynamics with unmatched vertical resolution

• Figure on right shows monthly $H_2O$ climatology and **cold-point tropopause** temperature

• The tropical water vapor tape recorder is prominent, which relates tropopause temperature to stratospheric water vapor content

• Slanted minima and maxima (**arrows**) quantifies the rate of ascent of stratospheric air

Stauffer Ticosonde, SAGE III/ISS STM
Taking a step beyond a simple climatology, we can use a clustering technique (self-organizing maps) to identify “prototype” water vapor profiles.

Note that clusters 1 and 4 show profiles that are particularly dry and wet, and in the UT/LS.

We can use these clusters to identify how model and satellite biases are related to geophysical processes.
Ticosonde Ozone

- Maximum tropospheric ozone in July to October
- Minimum tropospheric ozone in November to February
- The greatest tropospheric $O_3$ amounts occur during the wet season, and the lowest tropospheric $O_3$ occurs during the dry season
- This is atypical compared to other SHADOZ stations. Another ozone paradox??

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Data Caveats and Issues
Ozonesonde “Dropoff” Problem

Comparisons with Aura MLS on MLS pressure levels. Red = sonde higher, Blue = sonde lower

Costa Rica Ozonesonde, Satellite Comparisons

Total O$_3$ drop of ~6 %

Total O$_3$ comparisons with OMI, OMPS, and GOME2A and 2B overpasses (and moving averages)
Global Ozonesonde “Dropoff” Problem

- The dropoff issue is not unique to Costa Rica. Over a dozen sites, which similarly use one of the two major ozonesonde manufacturers, are affected.

- The largest low biases are found in the stratosphere and are 5-10% or more.

- It is critical to be aware of this issue if using Ticosonde ozone to validate stratospheric satellite measurements.
MLS H$_2$O Drift?

Comparisons with Aura MLS on MLS pressure levels. **Green** = MLS higher, **Brown** = MLS lower

- A global survey of frost point sonde comparisons with the Aura MLS record (Hurst et al., 2016) showed a positive drift in MLS of ~1%/year

- The drift was less severe at Costa Rica than at mid-latitude sites...but is that changing?

Moving average suggests that MLS wet bias may be increasing at the 56.2 hPa MLS pressure level
What’s Next for Ticosonde?

• Proposal submitted to NASA ROSES UACO program for continued 2021-2024 water vapor and ozonesonde profiles

• Highlighting the Equatorial Americas, including the reactivation of the San Cristobal SHADOZ station (stoppage since 2016)

• Proposal PI/Co-I Team:
  • R. Stauffer (PI, NASA)
  • A. Thompson (Co-I, NASA)
  • A. Diaz (Co-I, UCR)
  • M. Cazorla (Co-I, USFQ)
  • H. Vömel (Co-I, NCAR)
Thanks!

Select References:


Data:

• SHADOZ Ozone: https://tropo.gsfc.nasa.gov/shadoz/CostaRica.html
• AVDC SO₂: https://avdc.gsfc.nasa.gov/pub/tmp/TICOSONDE_SO2_archive/data/