

## Introduction

The Perlan 2 glider soars in stratospheric waves, setting subsonic aircraft altitude records while collecting atmospheric data in pursuit of advancing aeronautical and meteorological knowledge. 2019 was Perlan 2's fourth season flying in the lee of the Southern Andes, a hotspot for stratospheric wave activity<sup>1</sup>. The 2019 season featured seven stratospheric flights during a unique Southern Hemisphere Sudden Stratospheric Warming (SSW) event<sup>2</sup>.

## 2019 Glider and Instruments

Instrument	Rate	Measurements/Systems
LX 9000	1 Hz	GPS position; computes airspeed and altitude from digital temperature compensated pressure sensor pitot-static ports
VectorNav VN300	20 Hz	GPS position, velocity, and orientation using two GPS antennas
Control Measurer	20 Hz	Elevator and airbrake controls positions; elevator and aileron forces; airspeed from pitot-static ports
Control Deflections	10 Hz	Aileron, elevator, and rudder positions
Flutter System	100 Hz	In-flight flutter excitation compared against ATA Perlan flutter model
RTD OAT	.5 Hz	Resistance temperature detector measured outside air temperature
Digital OAT	.5 Hz	Digital open-air temperature sensor
POM	.5 Hz	Personal Ozone Measurer measures ozone in ppb
Science OAT	.5 Hz	Thermistor measured open air temperature sensor
UVA/UVB	.8 Hz	Photodiode with integrated UV filter
5-hole air data probe	100 Hz	Raw pressure measurements from one static and four differential pressure sensors. Computes airspeed, angle of attack, and side slip at 20 Hz
ARMAS FM6002	.1 Hz	Accumulated radiation dose

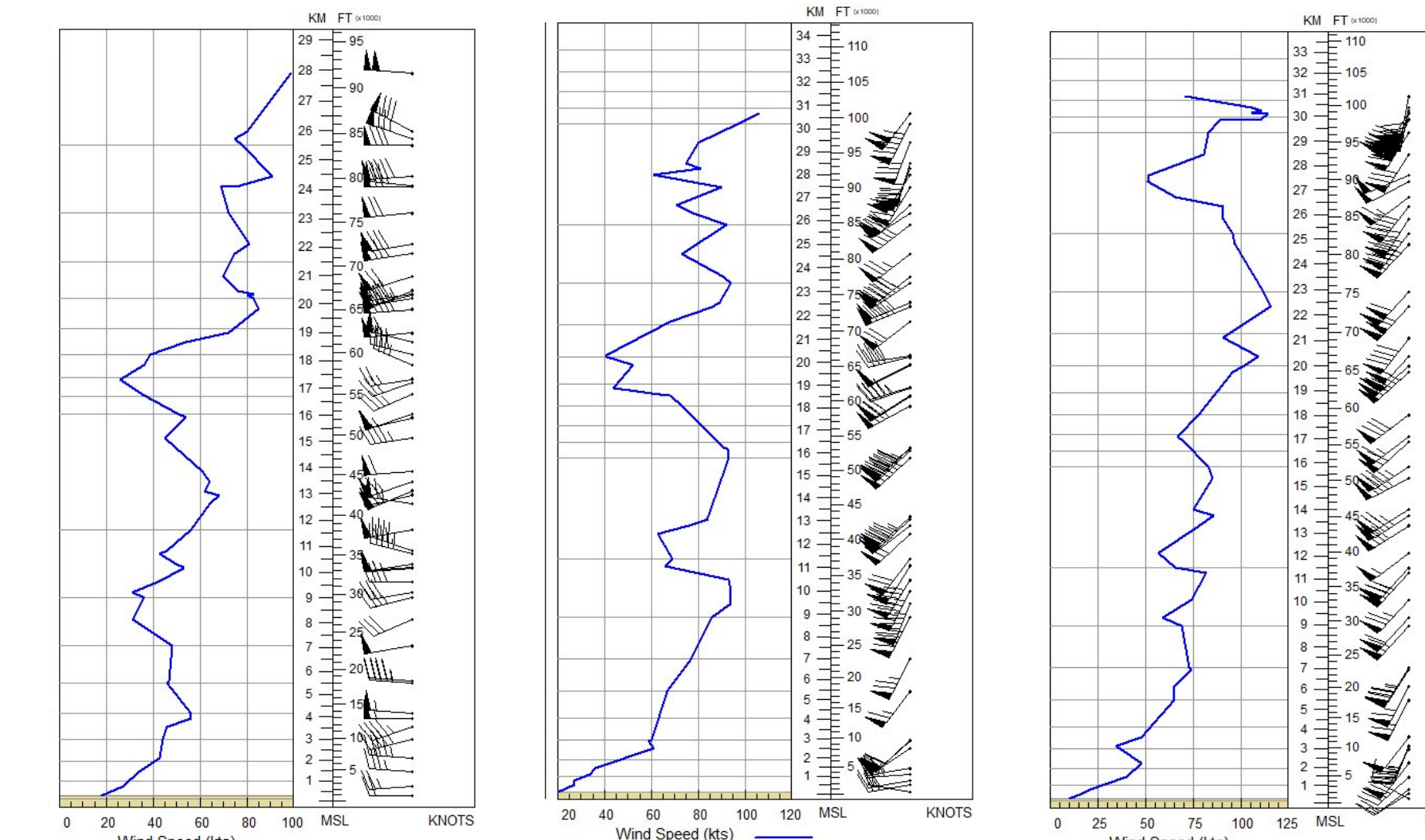


## 2019 Accomplishments

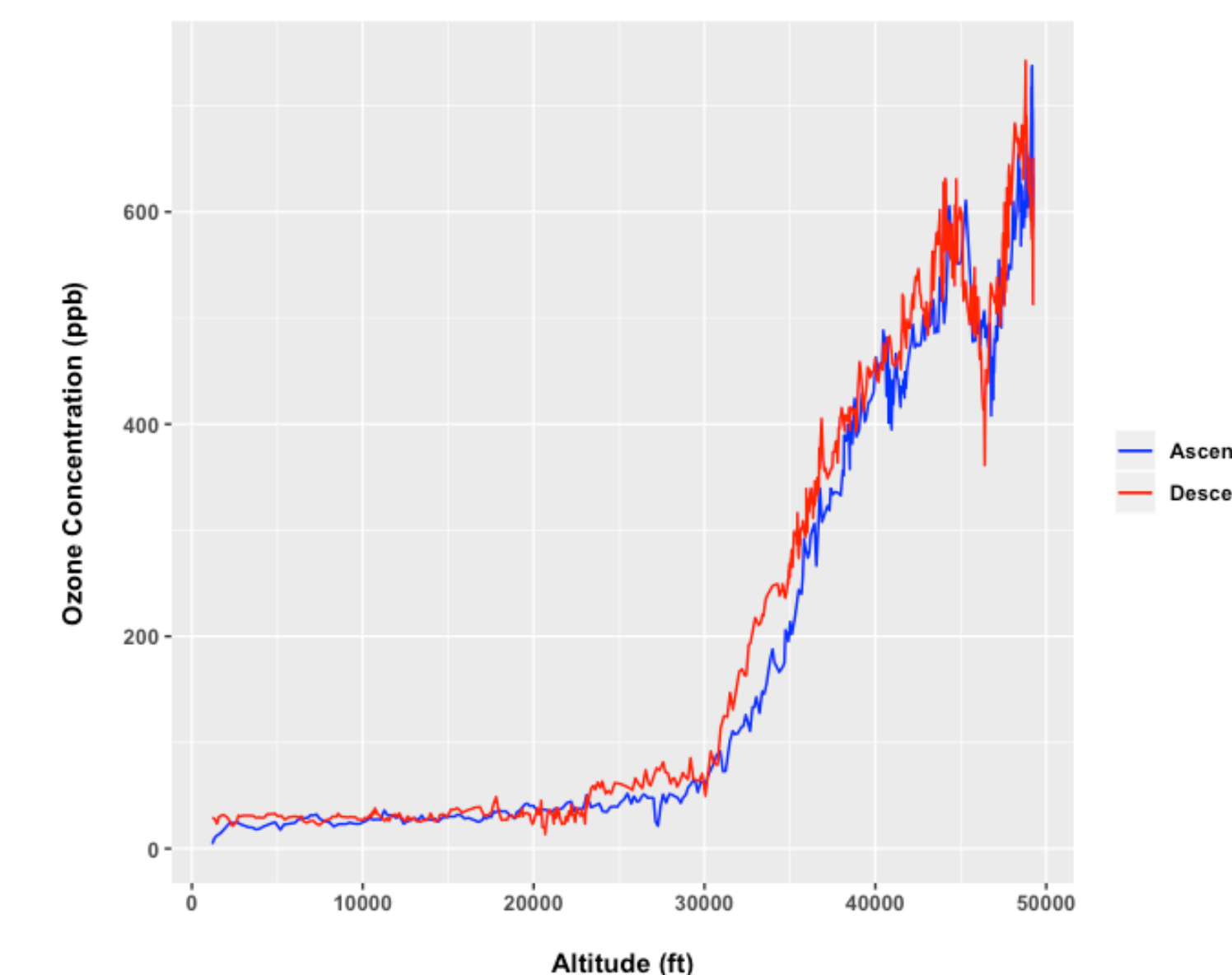
Perlan Flight Number	Date	Release Altitude (ft)	Maximum Altitude (ft)	Altitude Gain (ft)	Flight Time (hrs)
0059	20 Aug	12,100	---	---	1.2
0060	28 Aug	45,500	46,800	1,300	3.8
0061	31 Aug	46,600	56,300	9,700	3.9
0062	06 Sep	42,000	---	---	3.1
0063	11 Sep	47,100	50,600	3,500	5.6
0064	14 Sep	45,100	49,200	4,100	3.3
0065	17 Sep	45,100	65,000	19,900	5.5

The Perlan 2 flew seven stratospheric flights, for a total of 26.4 hours, including one systems-check flight on August 20 and a calm air flight on September 6 to collect aircraft performance data invaluable to atmospheric data analysis.

- 29 weather balloons launched in a region where direct observations are sparse, atmospheric model performance is poor, and multi-scale dynamics are not well understood
- Extensive data collected to expand the understanding of high-altitude wing-borne flight
- Direct atmospheric observations of stratosphere under unprecedented stratospheric warming event in the Southern Hemisphere
- Gathered data up to FL650 with an improved suite of atmospheric instrumentation



Vertical profiles of windspeed recorded by radiosondes launched from El Calafate, Argentina September 11 1700Z, September 17 1100Z, and September 19 1730Z during stratospheric wave activity into the downstream wave field



Atmospheric ozone profile recorded during September 14 stratospheric flight.

## 2020 and beyond

Perlan Project scientists and engineers are performing data cataloging, instrument and model validation, and data integration and analysis to make sense of the effects of stratospheric wave activity on atmospheric dynamics and aviation systems. The Perlan Project is actively seeking funding to extend the campaign in Argentina to continue to push the frontiers of wing-borne flight to the edge of space.

## Literature cited

1. Hoffmann, L., A. W. Grimsdell, and M. J. Alexander, 2016: Stratospheric gravity waves at Southern Hemisphere orographic hotspots: 2003–2014 AIRS/Aqua observations. *Atmospheric Chemistry and Physics*, 16, 9381-9397.
2. Hendon, H. H., D. W. J. Thompson, E.-P. Lim, A. H. Butler, P. A. Newman, L. Coy, and A. Scaife, 2019: Rare forecasted climate event under way in the Southern Hemisphere. *Nature*, 573, 495-495.

## Acknowledgments

Acknowledgment goes to Chief Engineer Morgan Sandercock and Dr. Pat Arnott for their work engineering and integrating the 2019 Perlan 2 instrumentation suite.

## Open Source Data

The Perlan Project's in-flight measurement and balloon sounding database is available online at [perlanproject.cloud/data/](https://perlanproject.cloud/data/)