

A white glider is shown in flight, viewed from a low angle from behind. The glider is white with a long, slender fuselage and a high-wing configuration. It is flying over a landscape that appears to be a mix of fields and water, with a clear blue sky and some scattered white clouds. The text is overlaid on the upper portion of the image.

Detecting Thermals Remotely: Initial Results

**Nilton Renno, Stephen Rogacki,
Michael Parker, Brian Russell, Robb
Gillespie, and William Rogers**

e-mail: renno@alum.mit.edu

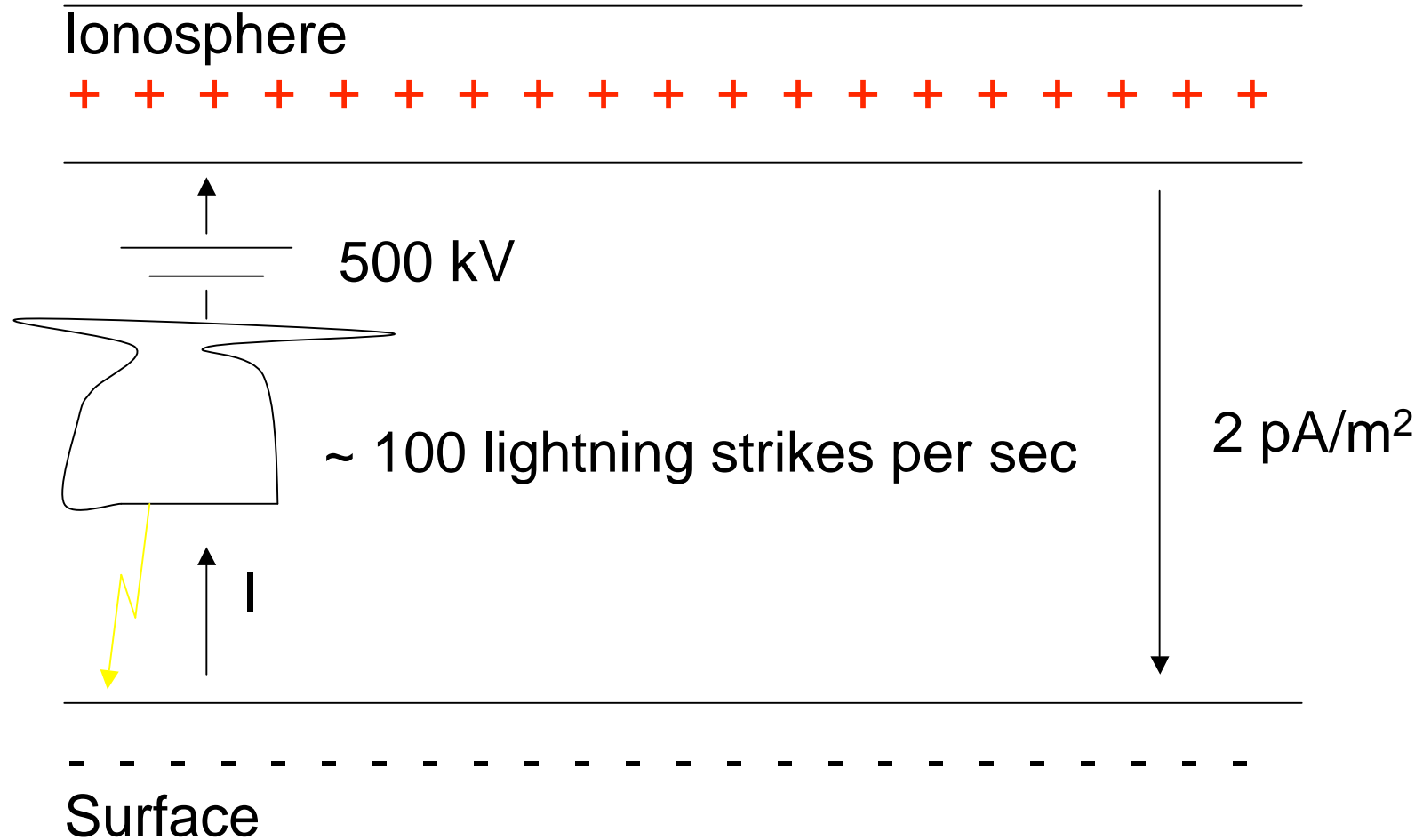
Outline

- **Fair weather electric fields**
 - The global electric circuit
 - Electric field in thermals
 - Previous investigations
 - Theoretical predictions
- **Our new electric field sensor**
- **Measurements**
 - From the ground
 - Airborne
- **Conclusions**

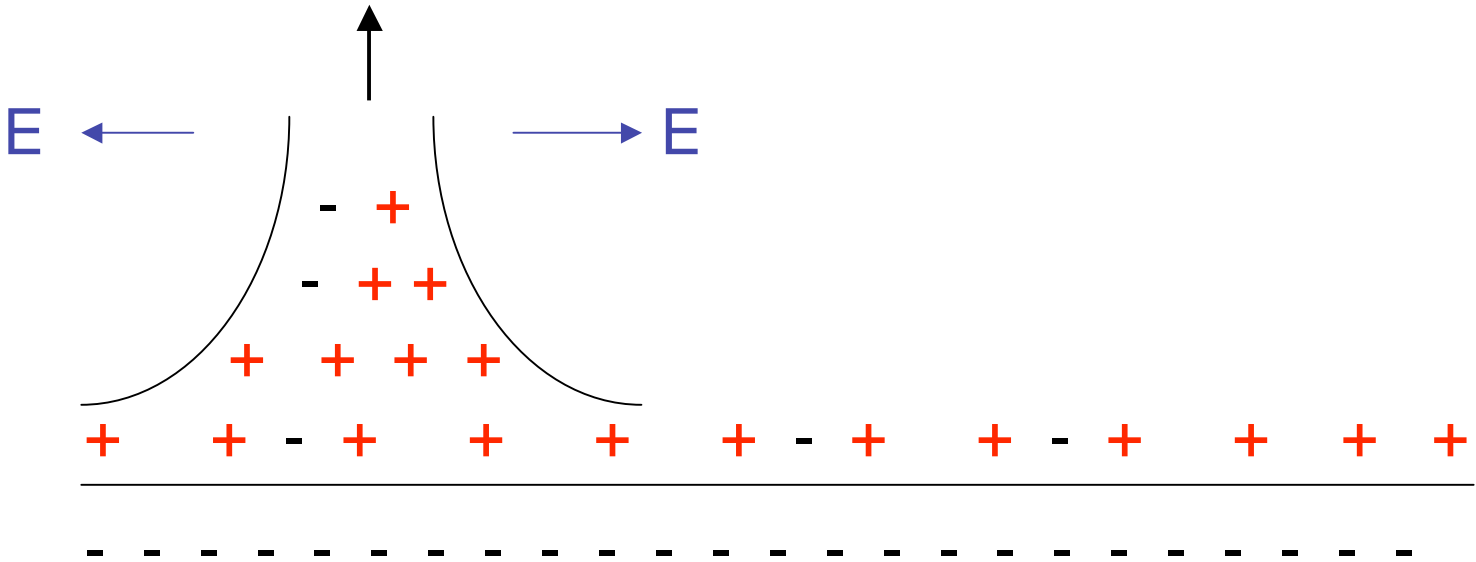
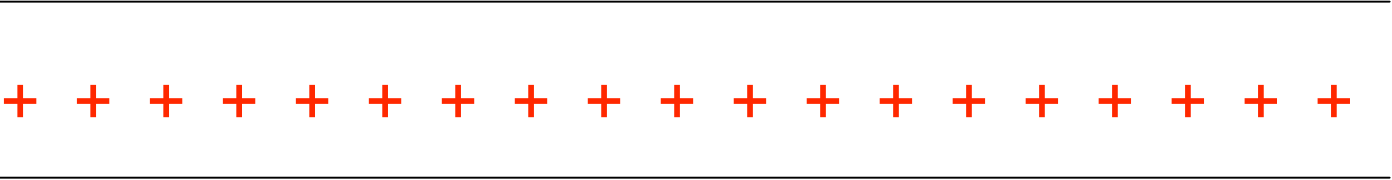
A photograph of a bright blue sky filled with various white clouds. The clouds are scattered across the frame, with some larger, more prominent ones and many smaller, wispy ones. The overall scene is clear and bright, representing fair weather.

**Fair weather
electric fields**

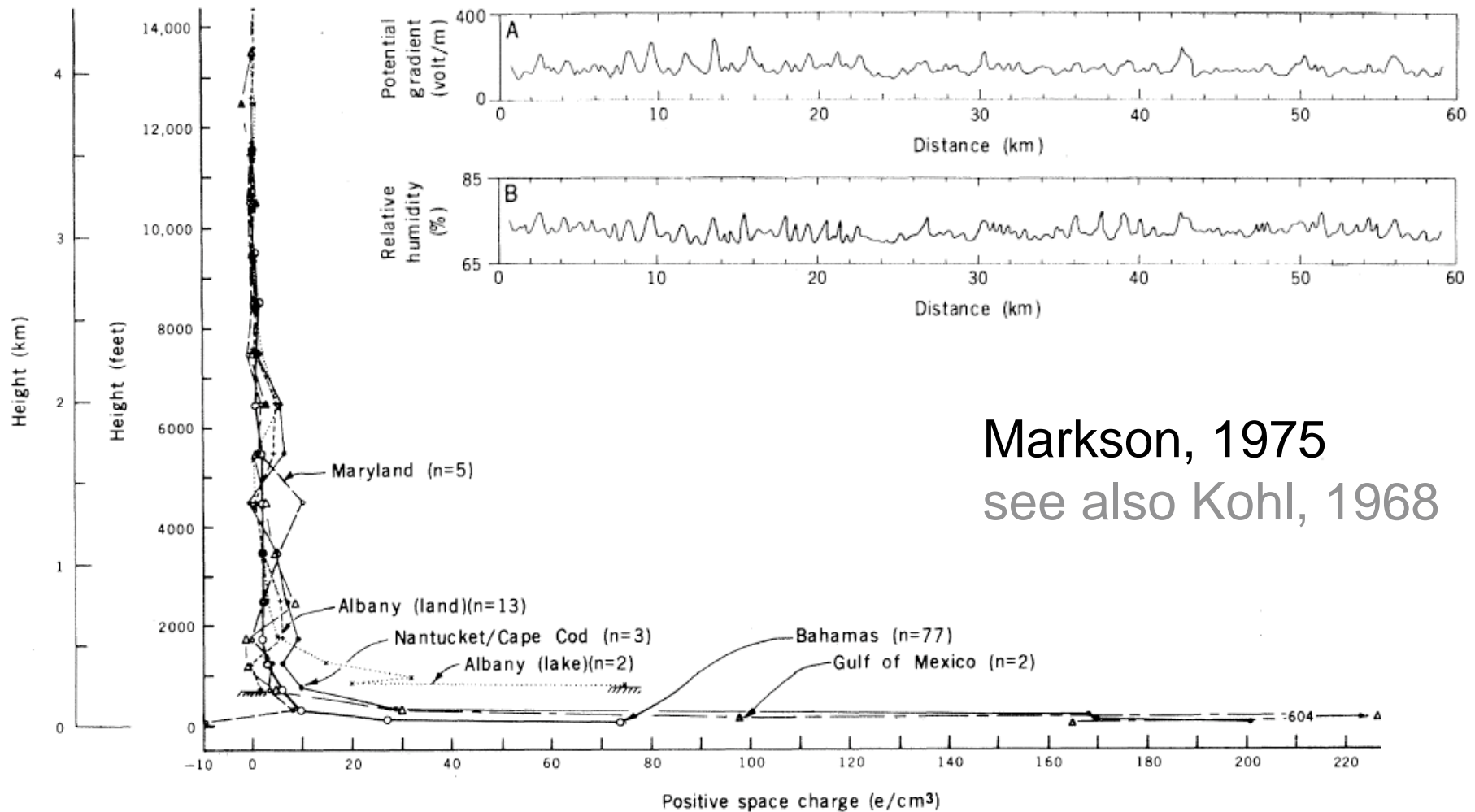
The global electric circuit



Electric fields in thermals



Results of previous investigations



Markson, 1975
see also Kohl, 1968

Theoretical predictions

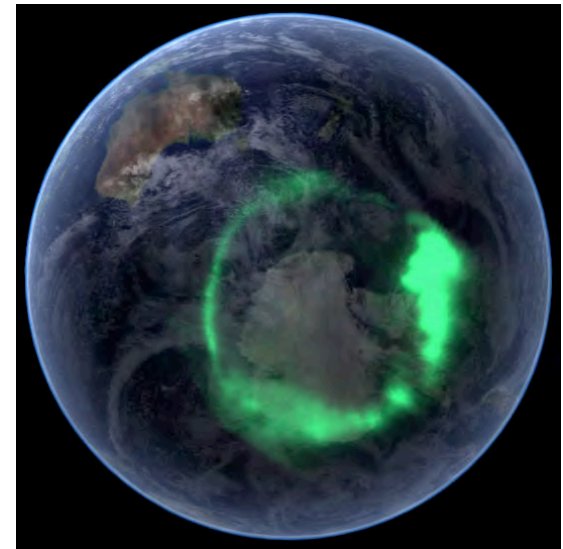
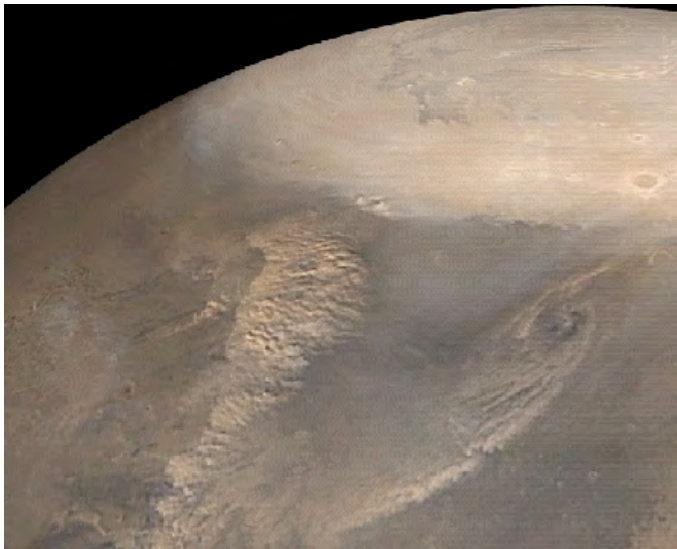
- **Assuming that thermals are uniformly charged (-100 e/cm³), infinitely long cylinders of ~100 m of radius, we get**

$$E \approx \frac{10^4 \text{ V}}{d \text{ m}}$$

where d is the distance from the thermal (in m).

- **Thus, the electric field at 1 km from the thermal is ~10 V/m.**

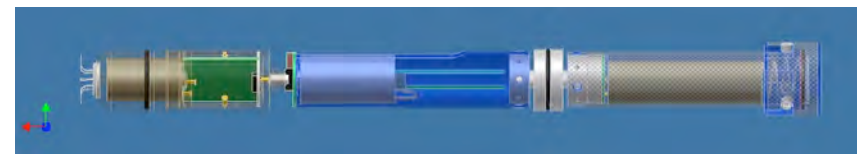
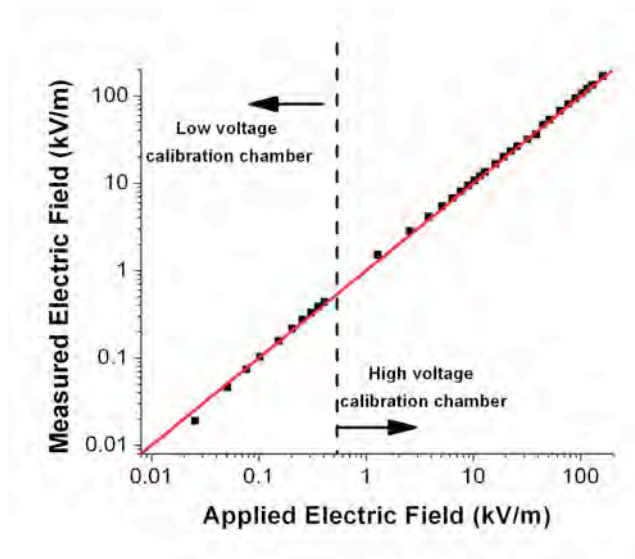
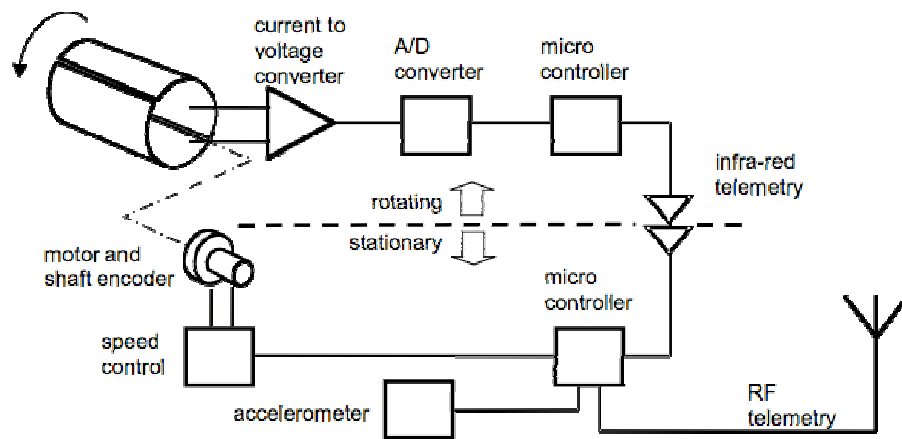
Our new electric field sensor



Requirements

- **To distinguish the ambient space field from the effects of charged particles colliding with the sensor**
 - Vary the rotation rate during measurements (Maruvada *et al.* 1983)
 - Add sharp points to limit the sensor potential
- **To measure the electric fields ~ 1 cm from the surface**
 - Instrument diameter ~ 1 cm

Our sensor (patent pending)



Sensor characteristics

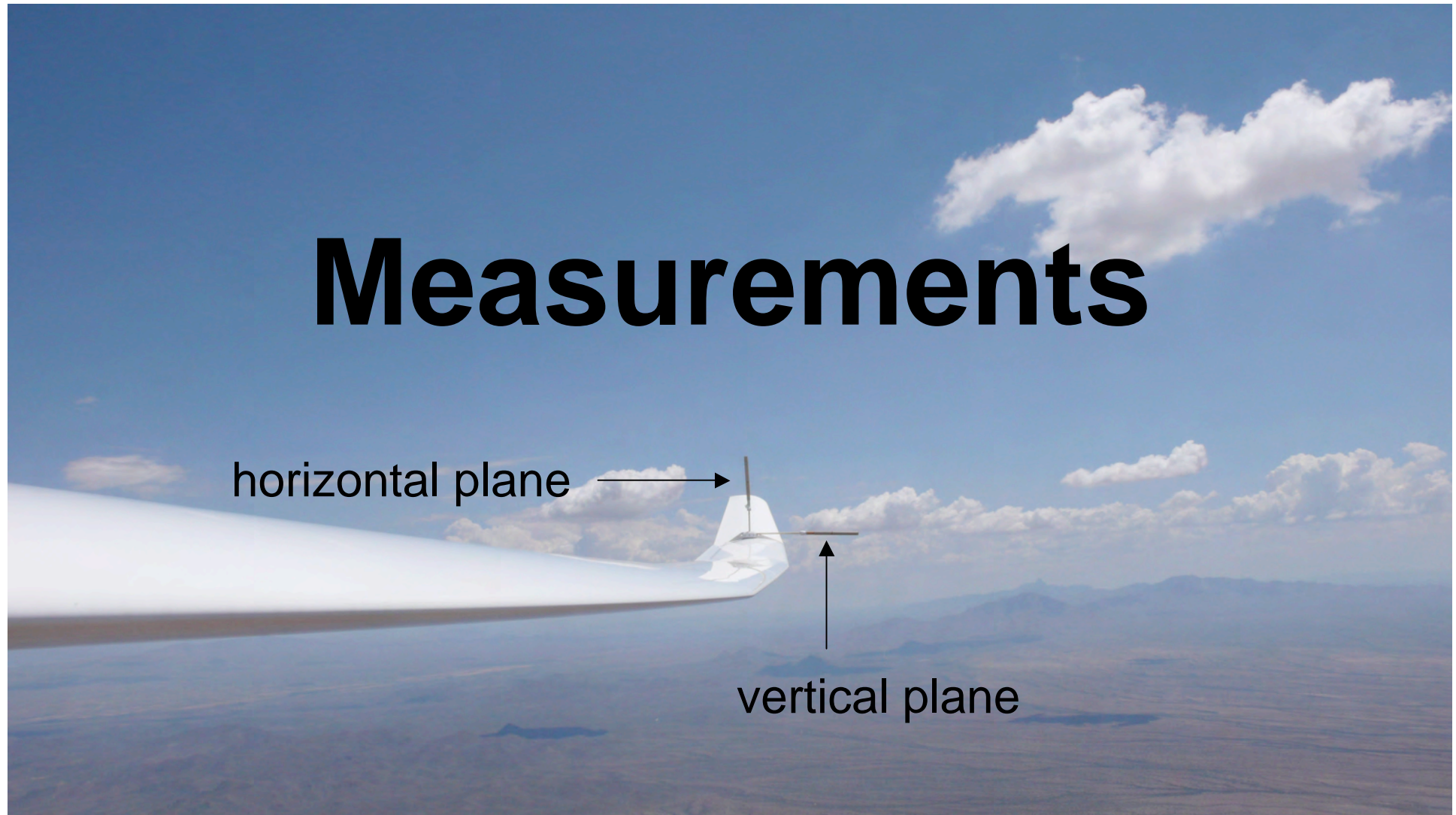
- DC to > 10 Hz
- Range: 1 to 10^6 V/m
- Resolution: 1 V/m
- 2-d vector field (plane of rotation)

- A version of the sensor for gliders might be developed
 - The idea of installing it inside a winglet or the fin might be studied

Installation on EP



Measurements



relative to the glider

Measurements at the ground

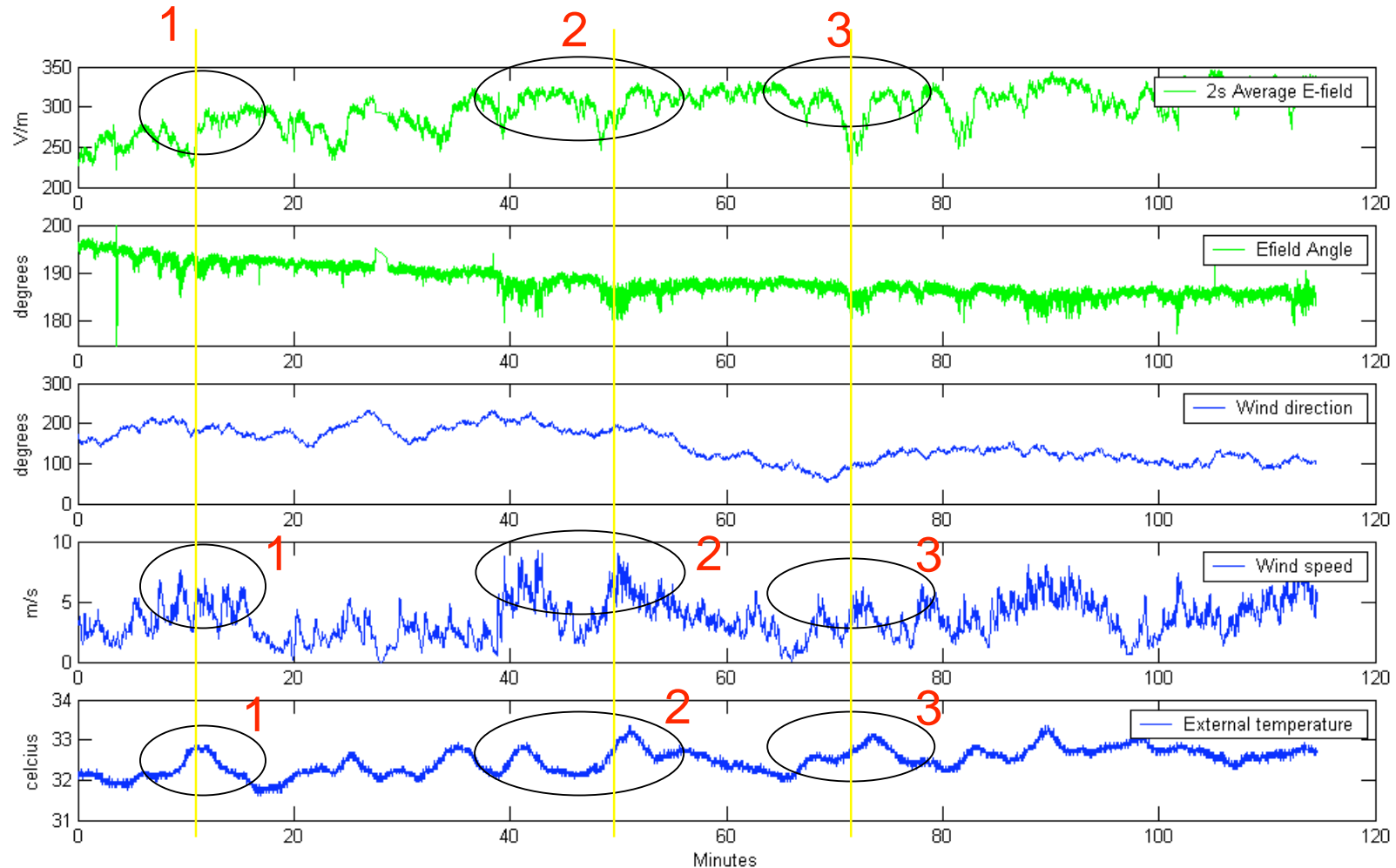


Ground Measurements

May 28, 2008

from 14:16:25 to 16:11:00 local time

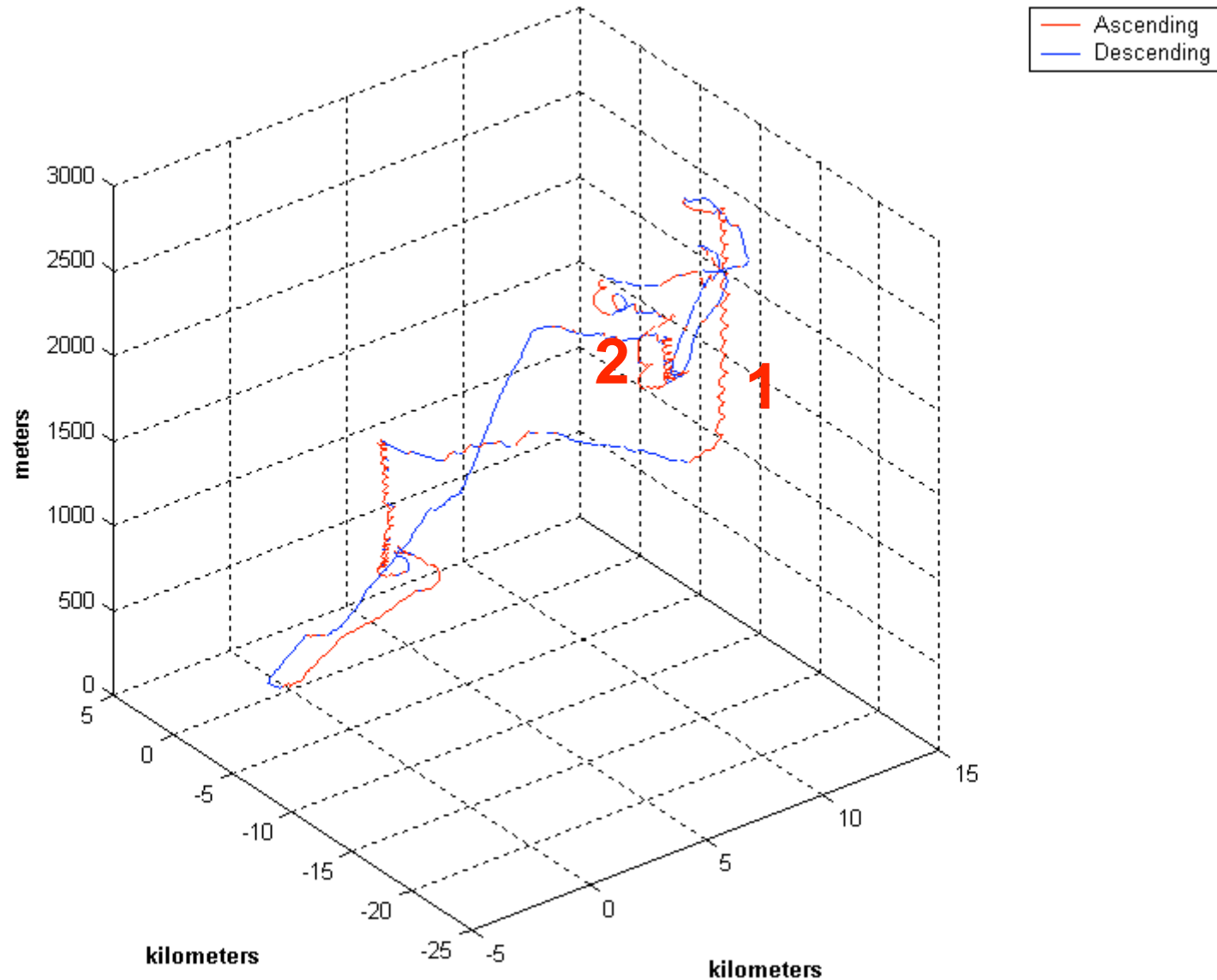
Thermals selected for study



Flights at the TuSC in Arizona



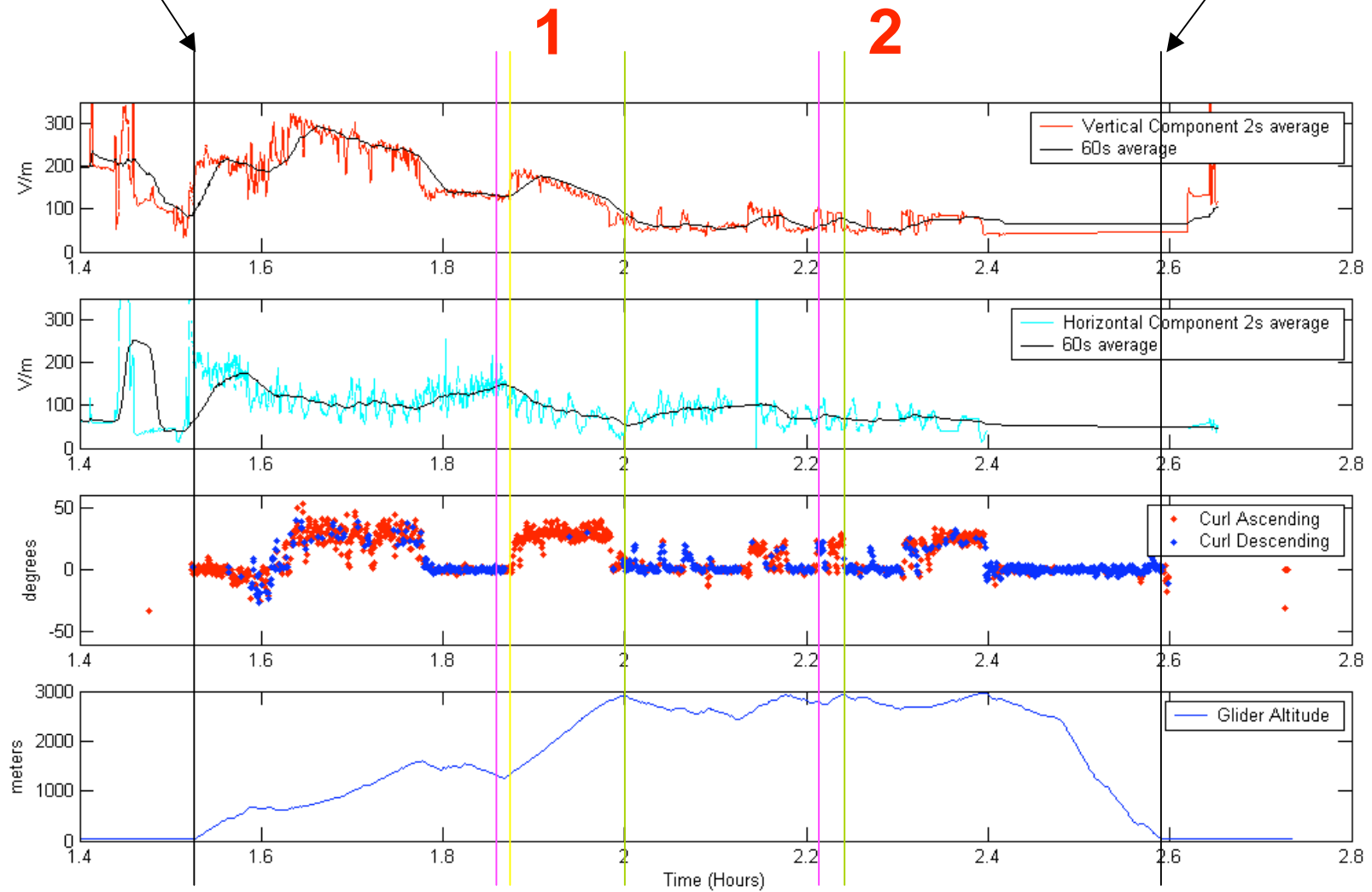
Flight Path July 02, 2008



July 02, 2008

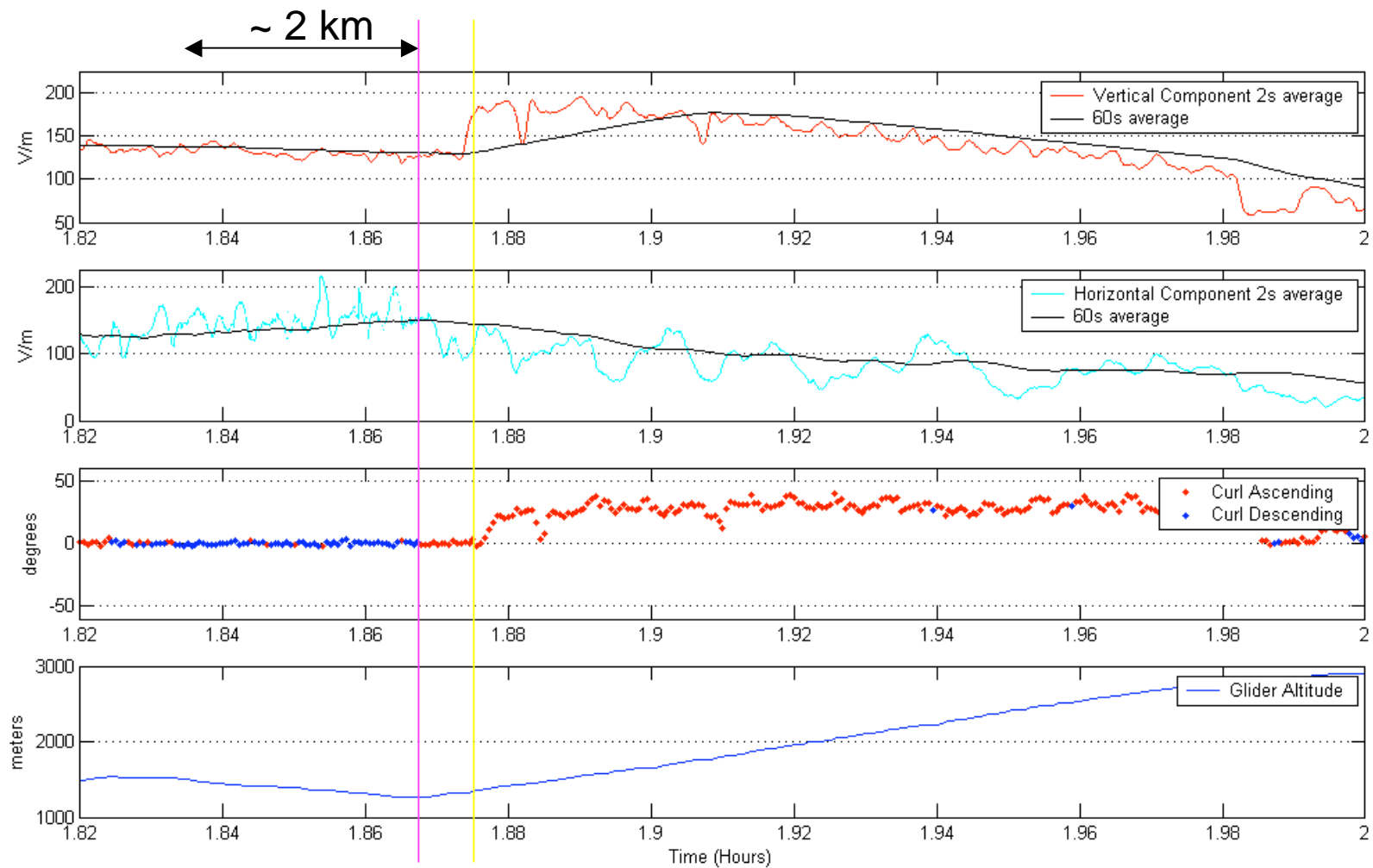
Start of flight

End of flight



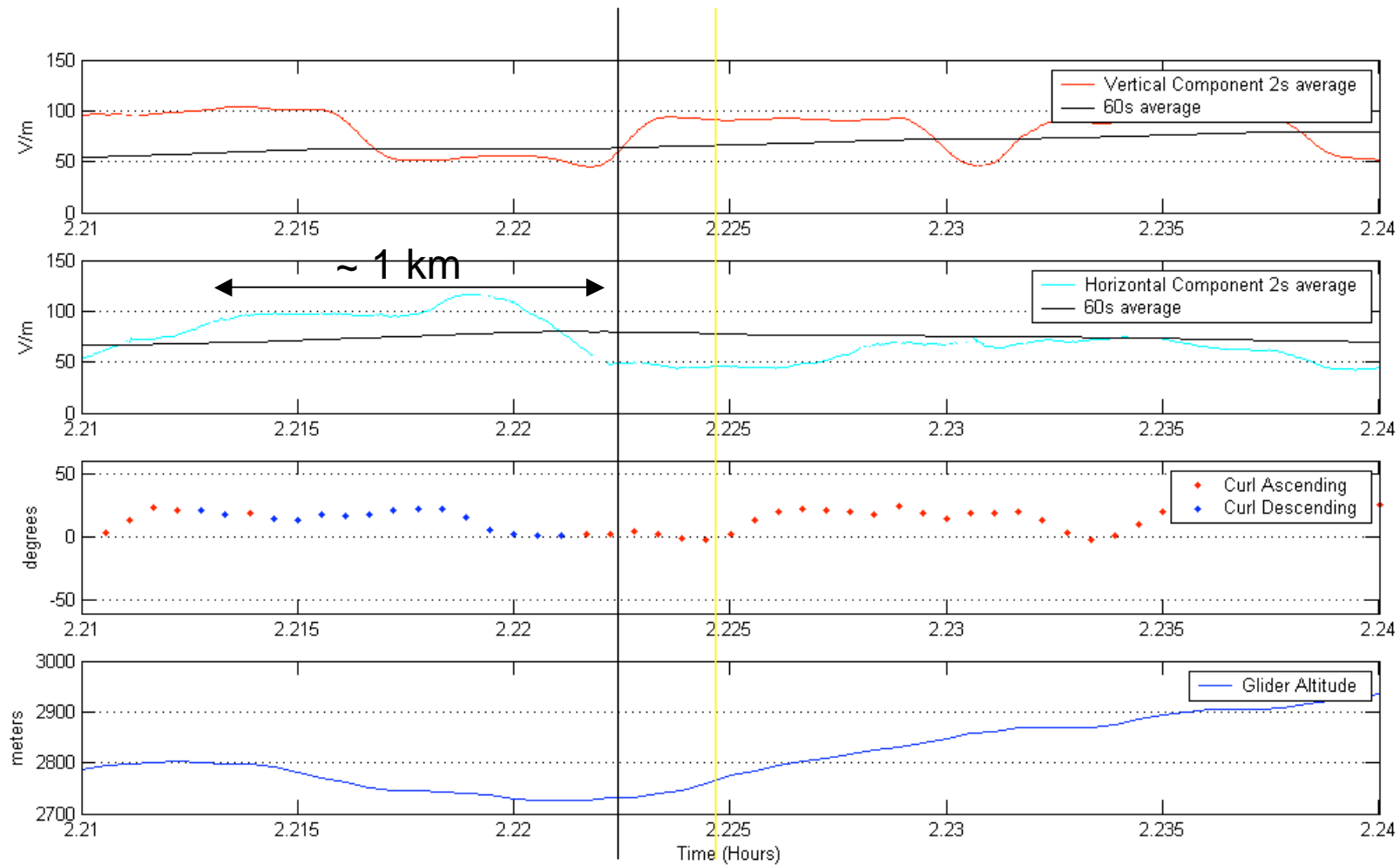
July 02, 2008

Thermal #1

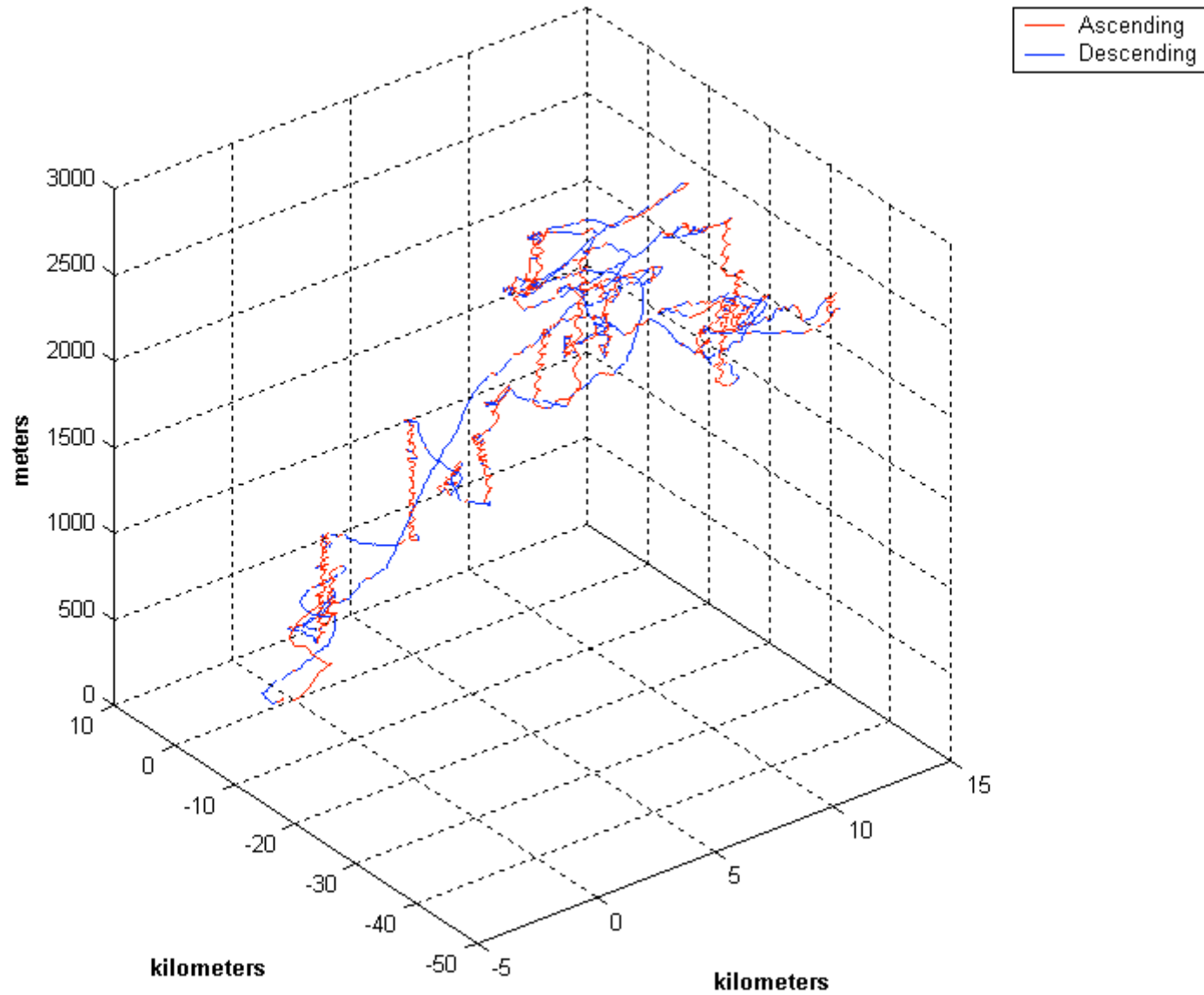


July 02, 2008

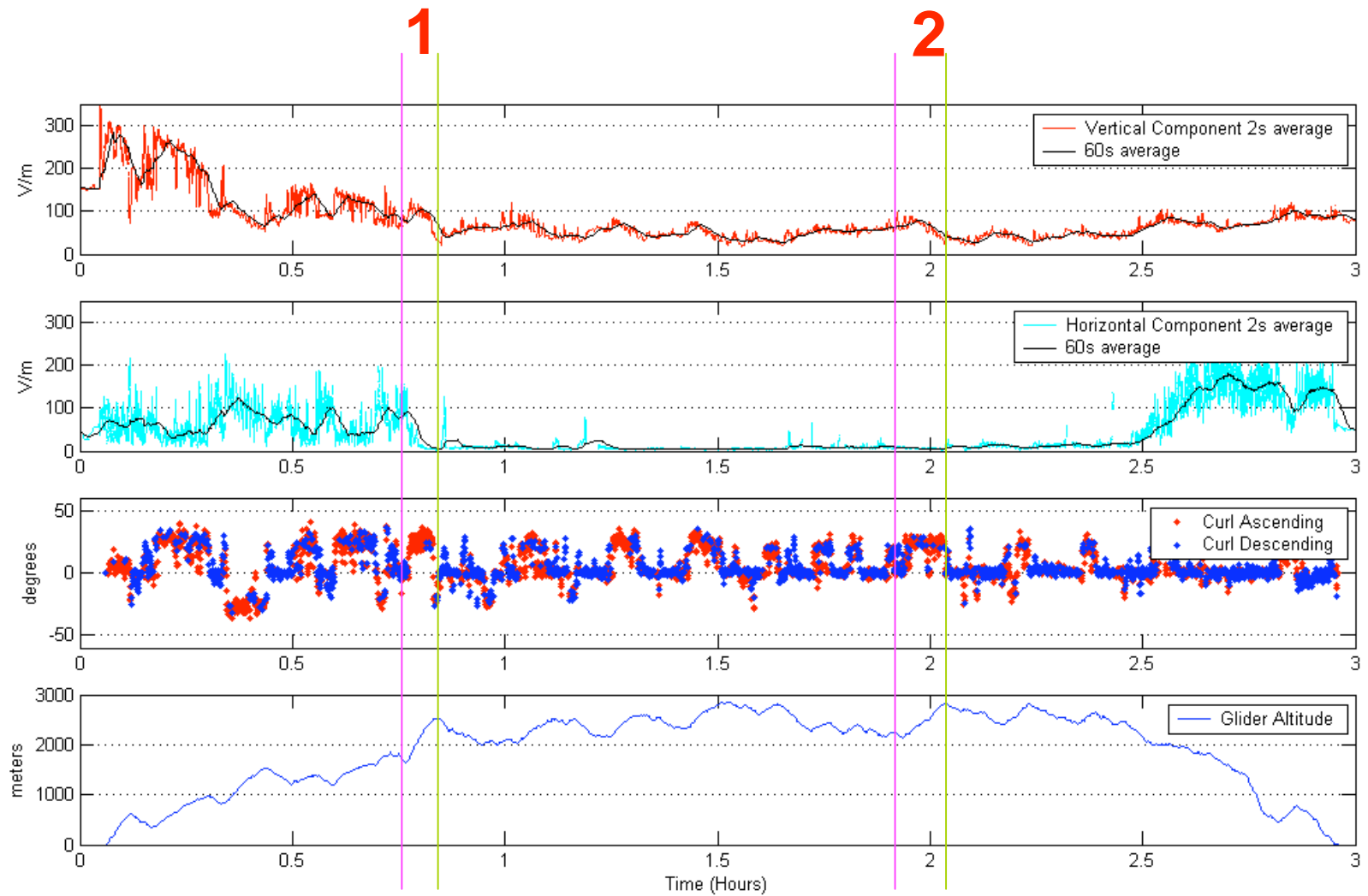
Thermal #2



Flight path July 04, 2008

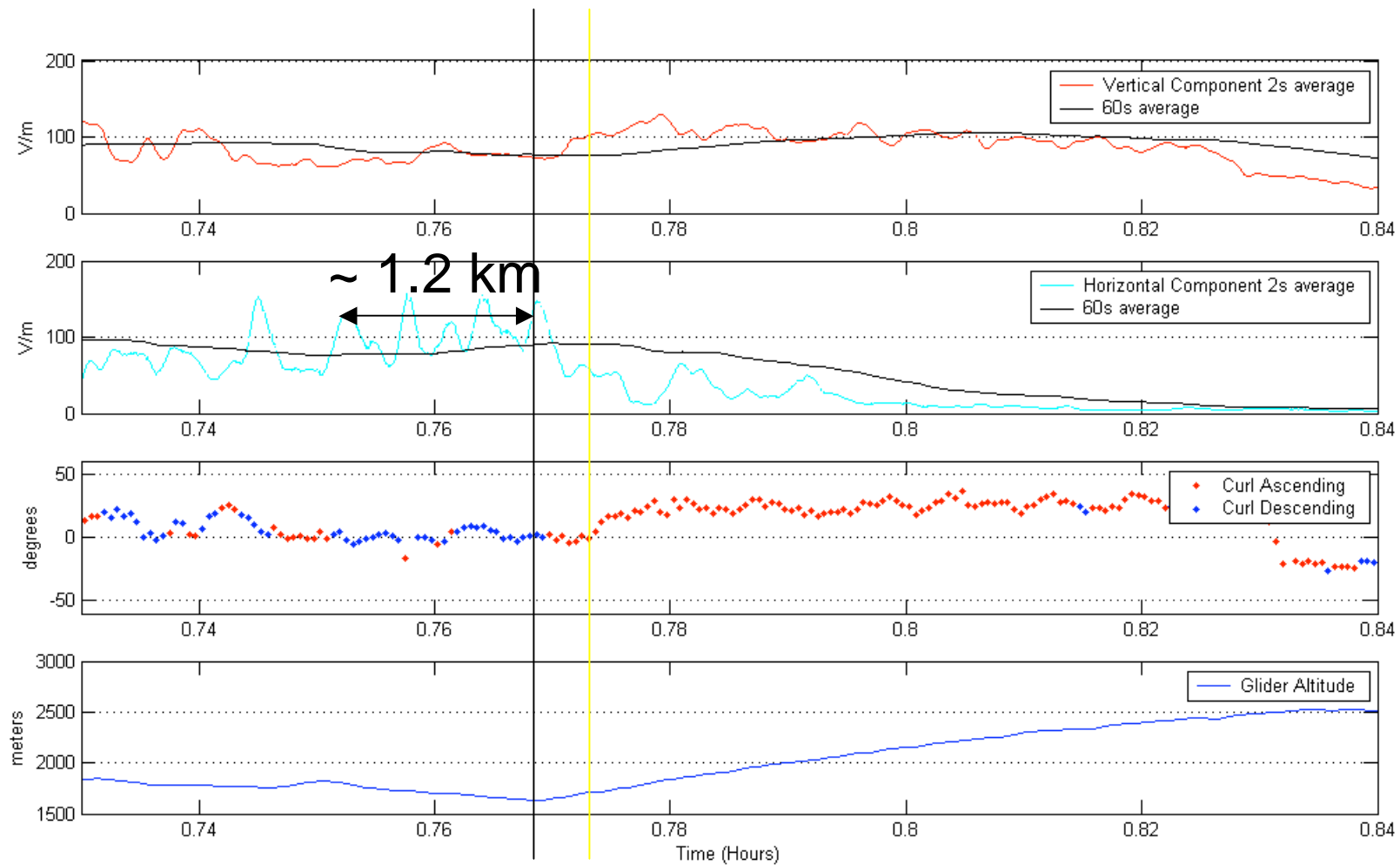


July 04, 2008



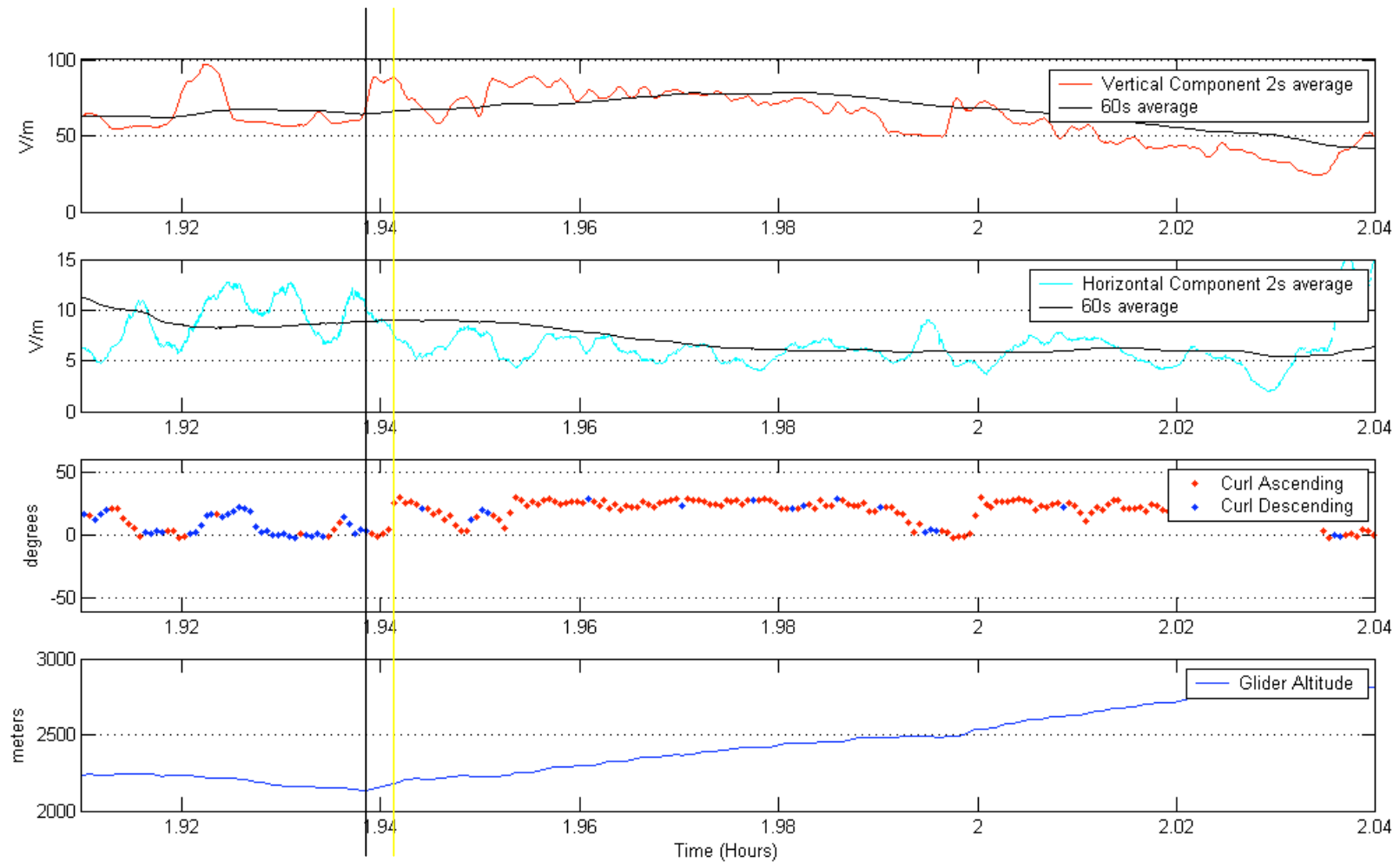
July 04, 2008

Thermal #1



July 04, 2008

Thermal #2



Conclusions

An aerial photograph taken from the window of a commercial airplane. The view shows a vast, arid desert landscape with a complex network of dry riverbeds and winding roads. The terrain is a mix of light brown and tan colors. In the upper portion of the image, there are scattered white clouds against a clear blue sky. On the right side, the curved white fuselage of the aircraft is visible, along with a dark window frame and some internal components like a blue cylindrical object and a small antenna.

- **These were our first measurements**
 - There were problems with the direction of the e-field
 - The frame of reference was the glider
- **Theory and our initial measurements suggest that thermals can be detected remotely with a passive electric field sensor**
 - The signal is much larger than the sensitivity of the sensor
- **The 60 s average electric field increases steadily toward thermals**
 - The first derivative of the electric field might be a good indicator of the approach of a thermal
 - The direction of the local field might be a good indicator of the direction of the thermal

- **There are theoretical and observational indications that the electric field contain information about the nature (e.g., dust and moisture content) of the local air-mass**
 - It might contain information about regional circulations (shear lines, organization of thermals, sea breezes, etc)
 - This will be investigated

Plans for the future

- **Additional measurements will be conducted:**
 - In an inertial frame of reference
 - Including the direction of the electric field
 - In various regions and weather conditions
- **The position of the glider with respect to the thermals will be analyzed**
 - The idea of using the electric field to locate (find the direction) the thermals will be tested

Thanks!

