Real Time Reference Monitoring (RTRM), and Scattering Detection

Presented By,

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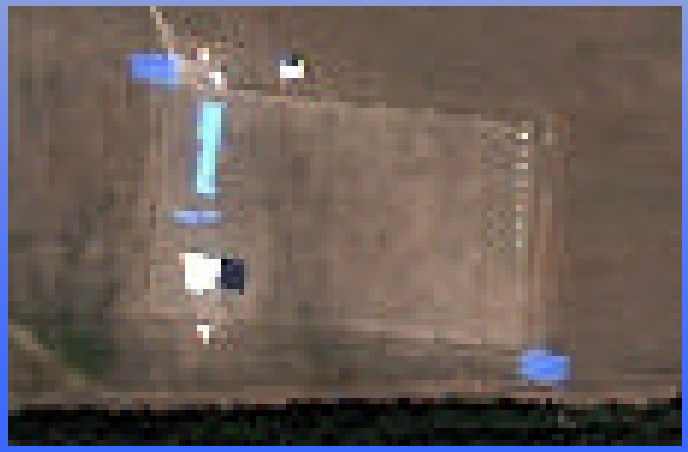
Background

- Currently SDSU's Electrical, and Physics Departments are working on projects to calibrate different platforms in space.
  - Many different targets are deployed in a grass field south of the 3M Factory in Brookings,SD

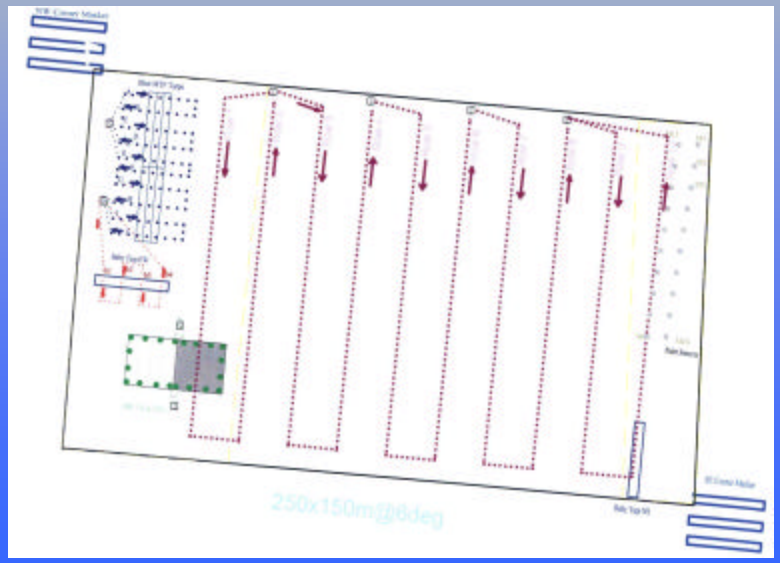
The area of interest is maintained grass area in the middle of the picture, used by the physics department for radiometric calibration of the different sensors.



Background

During an overpass of a satellite, ground based spectral data is taken in the field, with a ASD Field Spectrometer (350 – 2500nm)

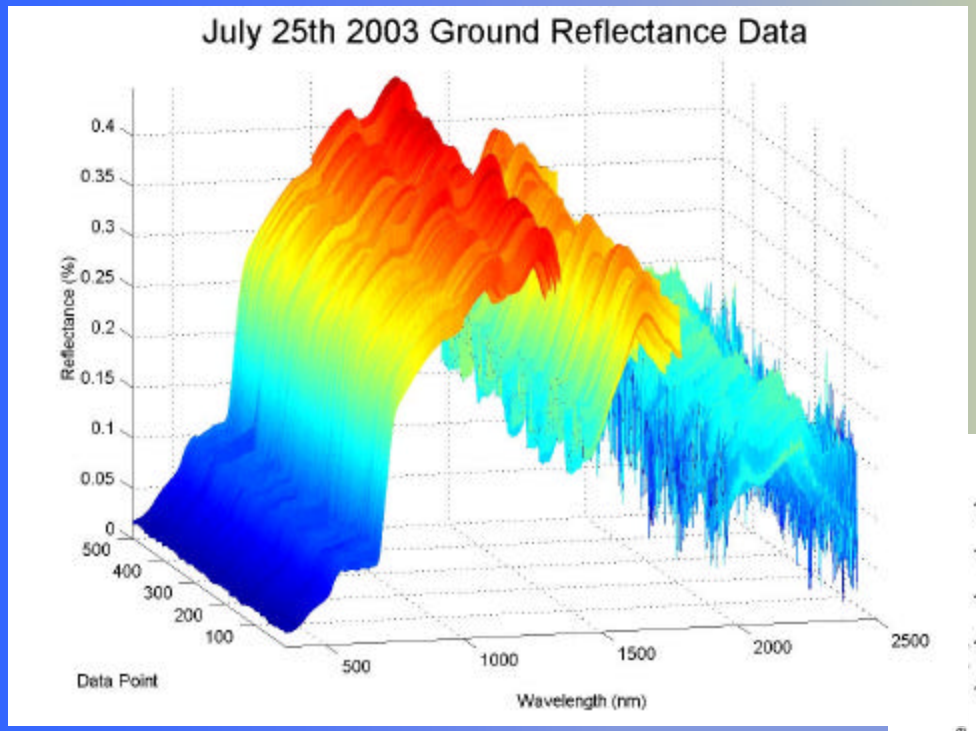
The data consists of a white panel reference, then the down and back walking of the spectrometer, then another shot at the white reference panel, this is done so that a reflectance value can be determined, which is the value of interest.
(total time between panel shots ~ 5mins)



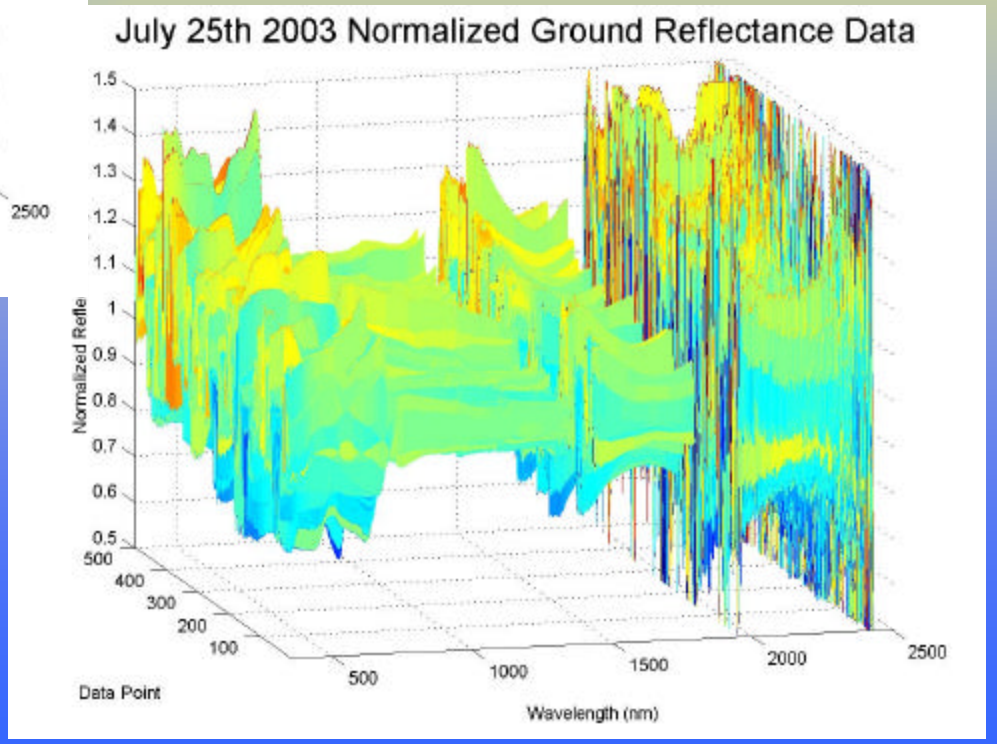
The Problem…

- As spectral data is collected out in the field things change.
- The thing that changes is the “amount” of down dwelling solar radiance. This is due to many things such as cloud, and atmospheric fluctuations.
- Why are these fluctuations important, in the satellite calibration world we deal in reflectance which requires both down dwelling data, and reflected up dwelling data. Previously down ward data was collected on a much more limited basis.

Example of the problem.



Grass "Target" area Taken on July 25th 2003 reflectance based on reference data taken every ~ 5 min.



Normalized reflectance data, notice fluctuations of as much as 40% is this all due to the variation in the ground target or is some of it because of the "lack" of down dwelling information??

So what is the RTRM supposed to do?

- Main goal of the RTRM is to reduce variation in the calculated reflectance of a target area.
  - Due to cloud variation and changing amounts of adsorbing material in the atmospheric
- Account for scattered light levels.
  - Similarly some light isn’t absorbed but instead is redirected from other “locations”

So what is the solution?

- Well simply let's monitor the down dwelling stuff more often.
  - The simplest way is to develop a system that automatically takes spectral data every so often. So as to "track" changes in the atmosphere due to clouds and fluctuations in the make up of the atmosphere.
  - Also while we are at it, let's look at a number of other atmospheric "properties"
    - Scattered light "levels"
    - Meteorological Properties

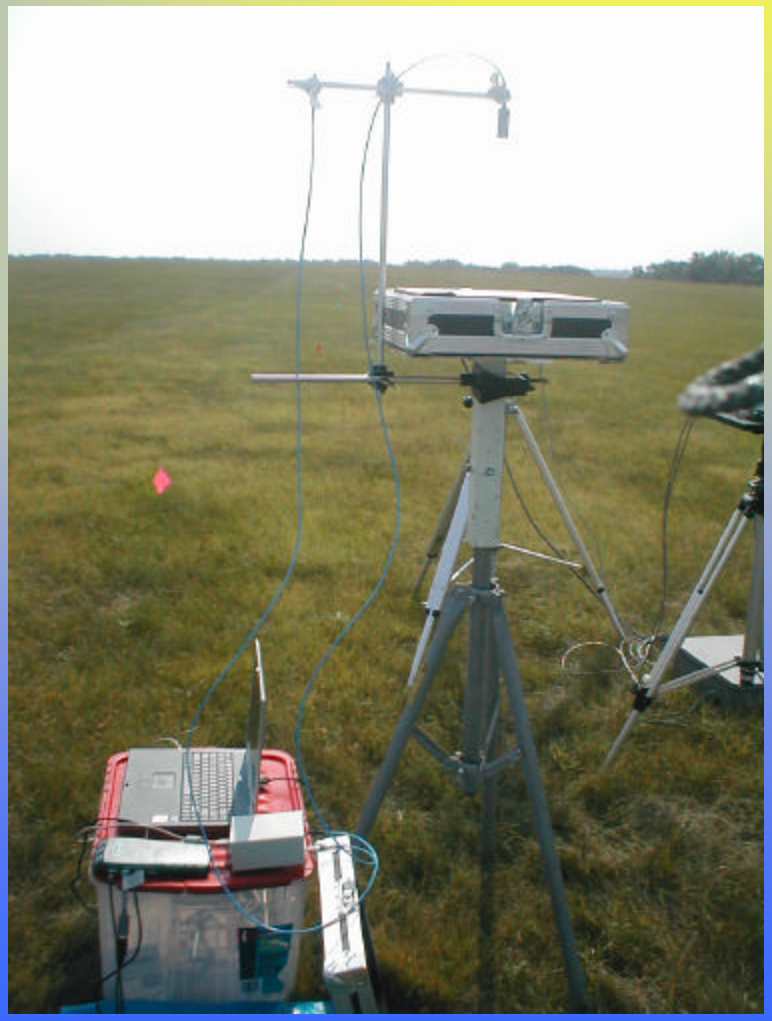
      (Temperature, Pressure, and Humidity)

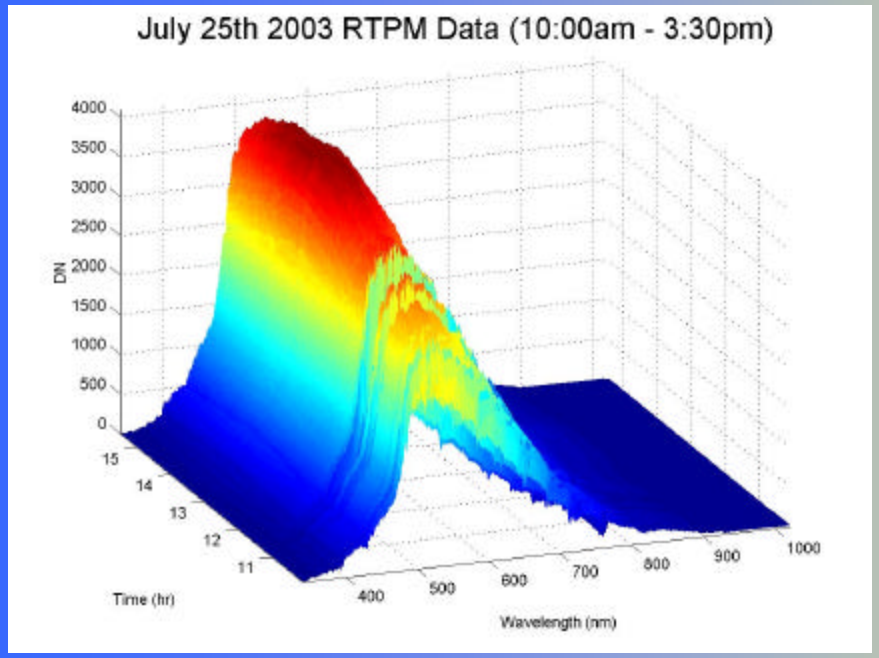
How is this done?

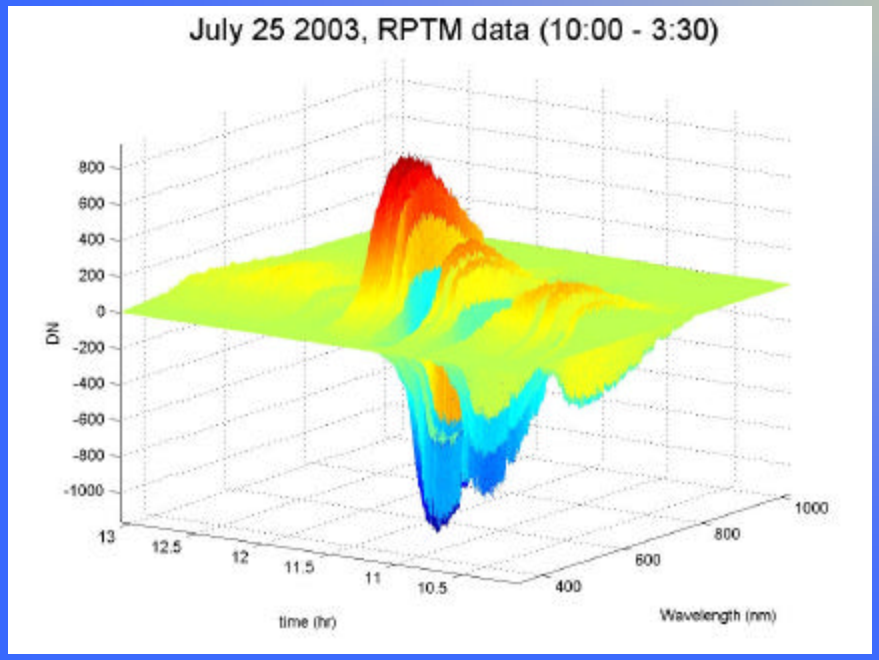
- A Dual Channel Ocean Optics Spectrometer is used to take measurements, from 350nm to 1025nm, @ 0.33nm
  - Channel 1 Looks down at a 75% reflectance Spectralon panel
  - Channel 2 (not operational yet) will look up via a modified shadow band to determine global diffuse values.

  Support equipment include windows based machine running LabView, which controls all the hardware and acquires and stores the data, currently every 30secs.

  Also connected to the machine via a Labpro data terminal are sensors to monitor Temperature, Pressure and Humidity, along with output controls for the shadowband.

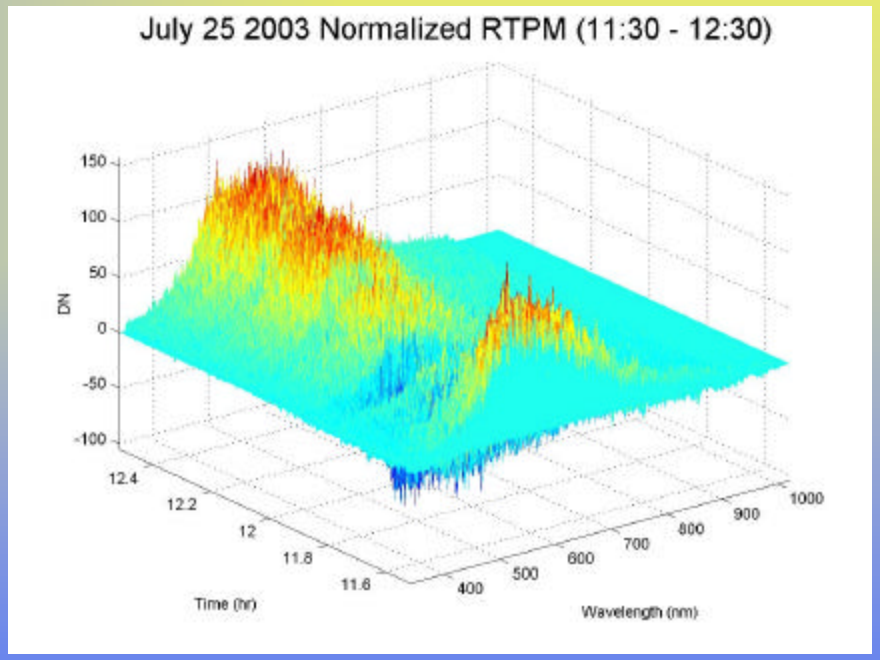






Normalized data from 10:00 - 3:30

Real-time data collected July 25th 2003 over the course of 5 hours from 10:00am to 3:30 pm every 30secs.

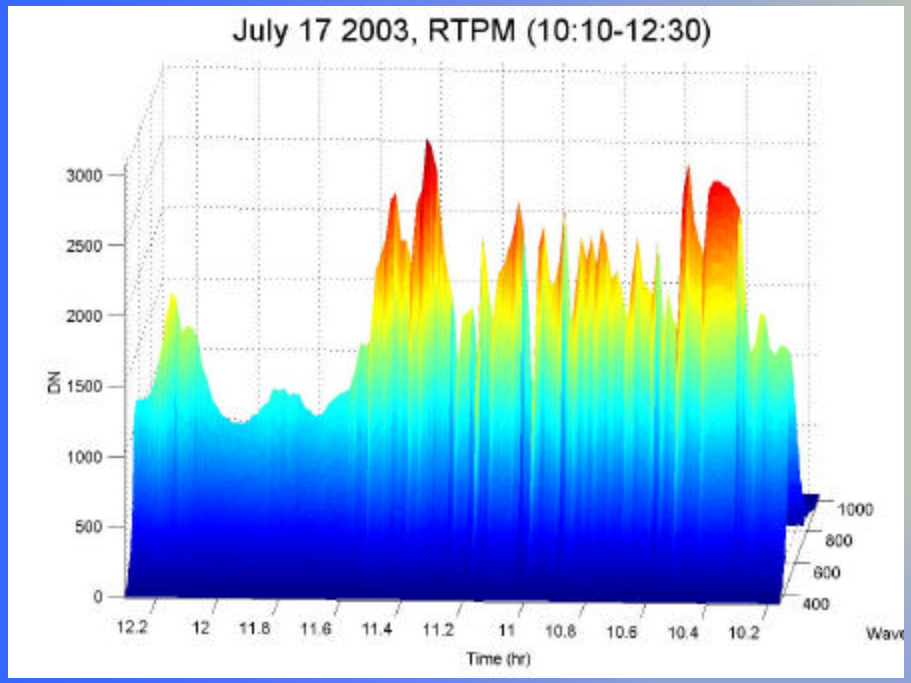


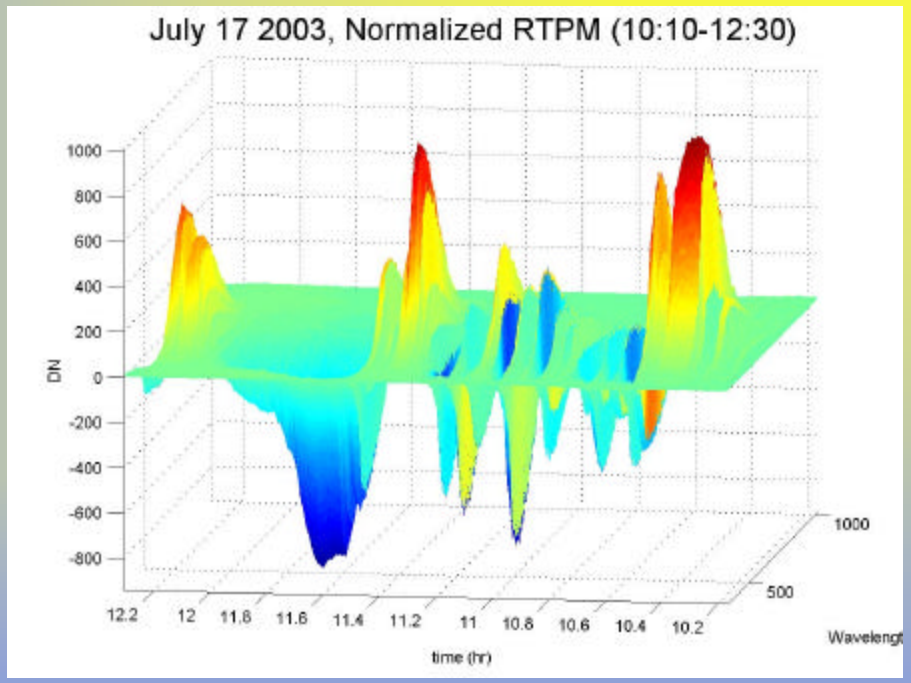
Normalized data from 11:30 - 12:30

(Time of over pass 11:59)

Doesn't appear to fluctuate much, less so if you focus on the late afternoon time frame.

How about a bad day?





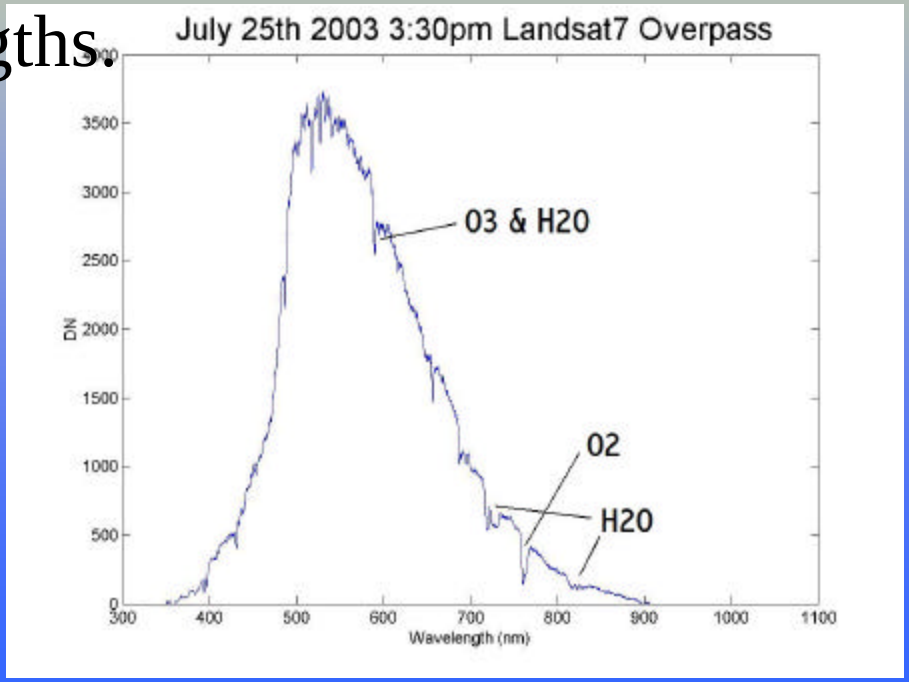
Notice the big changes fluctuations that only appear to last for minutes, “information” that surely would be missed under the previous data collection scheme.

What still needs to be done?

- Problems still exist in the collection of data due to saturating of the spectrometers.
  - Cleanest solution, purchase of some “in-line” filters for the fiber optic cables to attenuate the signal.
- Global Diffuse spectrometer setup still needs finishing.
- Finalize the software interface.
- Write / Rewrite Matlab software to utilize the Ocean Optics Spectrometer data to be used in the reflectance calculation.

What is in store for the future?

This unique collection of software and hardware, I believe, it will allow for the real time “determination” of atmospheric constituents, based on the adsorption amounts in different wavelengths.



This could lead to a more accurate atmospheric post modeling process (or even a real time atmospheric model generation) and more accurate calibration of satellites.

This all sounds good, but is it possible?

- With the current set of hardware and software, preliminary results for the calculation of water vapor has already been accomplished, with what appears to be very favorable results.
  - Extending this to Ozone, Oxygen, Rayleigh scattering amounts, and Turbity values, should be able to be accomplished in the same manner.
  - Just a matter of a deeper understanding of the adsorption properties, and more imbedded programming, to determine the information.

Other additions.

- Would like to add on additional spectrometers, to extend the range of the spectrum collected to the Near-Infrared, and add more data sources.
  - Currently the ground data is collected with 350-2500 nm ASD Spectrometers, the RTPM only collects data from 350-1025 nm.
  - This would allow for better data correlation, and allow for more information to be used in determine adsorption quantities of other atmospheric materials
  - Additional channels could be added to calculate Bi-Directional Reflectance Functions (BRDF).
    - BRDF appears to account for a sizable amount of error in satellite imagery BRDF is related to sun angle, and satellite look angle.

And…

- Could see extending the system into a more weather proof, automated system that would be left in the field to monitor multiple points in a field to build a more accurate spectral model of a plant at all it's stages of growth.
  - Leading to a better understanding of plant biology.
  - Better model for use in generating a spectral signature, for the purpose of crop identification and "health" determination from space.
- Could also extend the system into a atmospheric pollution monitoring system.

Conclusion

- This relativity cheap (< $10,000) and very unique collection of software and hardware could be extended into a multitude of areas, for little or no cost. To automatically monitor a number of metrological and atmospheric properties, along with plant physiology.