Project started June 2010

Creating UTH-Related FCDRs inter-calibrated by *in situ* measurements from commercial aircraft

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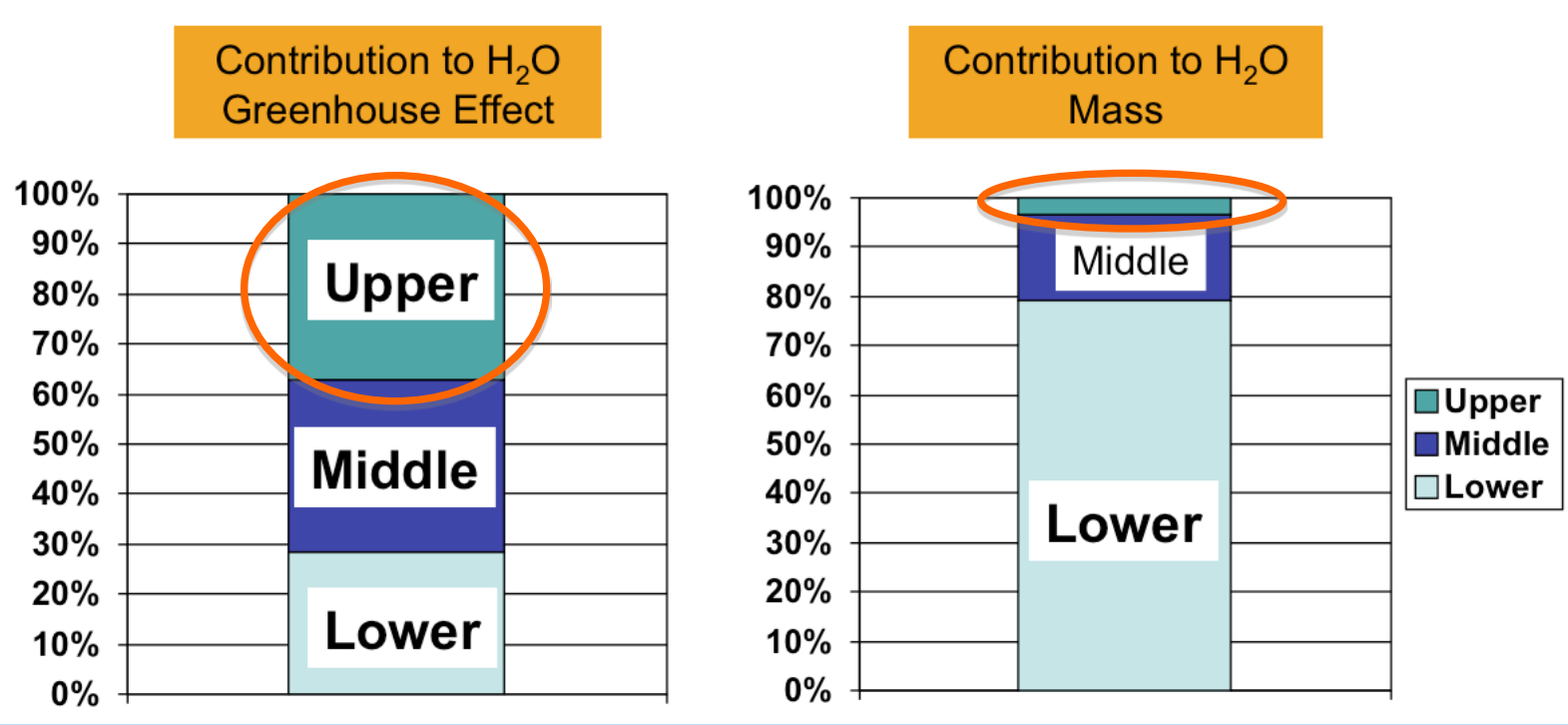
Outline

- Brief Project Overview
- Approach (1-2 slides)
- Results/Accomplishments (1-3 slides)
- Validation Strategy/Results (1-2 slides)
- Algorithm/Product Maturity
- Issues/Risks & Work-Off Plans
- Schedule
- Transition Plan
- Societal Benefits (2 slides)
- Resources (1-2 slides)

Background

Upper-tropospheric humidity (UTH)

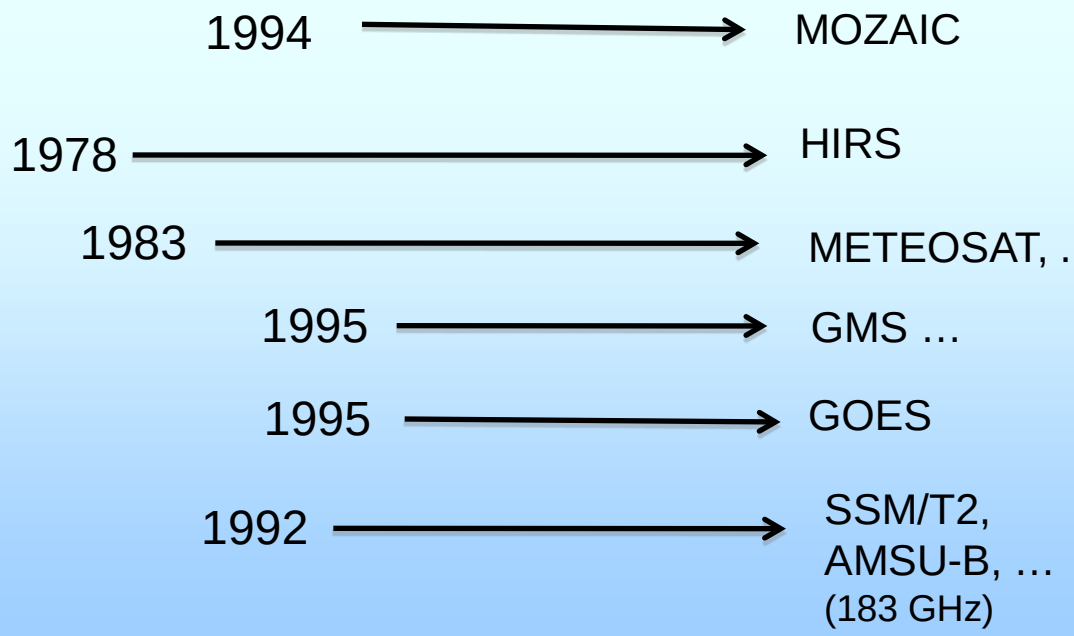


Upper: 500-200 hPa; Middle: 700-500 hPa; Lower: 1000-700 hPa

Overview

- Goal: "…bring together all the ***UTH- related radiance*** data from multiple satellites and process them to establish a long-term, global, inter-calibrated radiance record from which UTH can be retrieved and UTH research can be conducted."

- Source Data
  1. HIRS ch12 (6.7 μm)
  2. Geostationary wv channel (6.3-6.5 μm):
  3. SSM/T2, SSMIS, AMSU-B (~183 GHz)
  4. *MOZAIC (Measurement of ozone and water vapour by Airbus in-service aircraft)*



Overview

- Deliverables

1. Granularized (one per orbit) & calibrated SSM/T2 & AMSU-B UTH radiances in netCDF format
2. Gridded & calibrated SSM/T2 & AMSU-B UTH radiances in netCDF format
3. Complementary cloud information from new ISCCP pixel-level product (3 hr & 10 km)
4. Calibration subsets: 1) matched MOZAIC and satellite measurements, 2) SNO data points, etc.

Overview

- ECVs addressed: water vapor.
- Review Product Description matrix
  - You can find your product description on the NCDC CDR web site at:
    http://www.ncdc.noaa.gov/cdr/grants.html
    It is listed in the column labeled "Links"
  - Is it still valid? Yes, except that we decided to use netCDF instead of HDF.

Approach

1. ***Rescue & archive SSM/T2 data***

2. ***Bring in all other UTH radiance data, primarily from microwave sensors (e.g., AMSU-B) but also including IR (e.g., HIRS* and geostationary satellites)***

1. ***Perform various ways of calibration (e.g., SNO, MOZAIC in situ measurements + CRTM)***

2. ***Label each UTH radiance with cloud information from new ISCCP pixel-level data (3hr & 10 km)***

*HIRS Ch12 is already an operational CDR (http://www.ncdc.noaa.gov/cdr/operationalcdrs.html); contact: L. Shi and J. Bates

Results/Accomplishments

new_var_netcdf

```
NetCDF F14199909241409.nc {

dimensions:
        Position = 28 ;
        Scan = 764 ;
        Count = 4 ;

variables:
        // Preference 'PRESERVE_FVD':  false,
        // dimensions consistent with ncBrowse, not with native MATLAB netcdf package.
        single Latitude(Position,Scan), shape = [28 764]
                Latitude:Units = "Degrees {-90 to 90}"
                Latitude:Long_Name = "Latitude"
        single Longitude(Position,Scan), shape = [28 764]
                Longitude:units = "Degrees {0 to 360}"
                Longitude:Long_Name = "Longitude"
        int16 Epoch_Day_of_Year(Scan), shape = [764]
                Epoch_Day_of_Year:units = "Days"
                Epoch_Day_of_Year:Long_Name = "Day of the Year { 1 to 366 }"
        int16 Epoch_Second_of_Day(Scan), shape = [764]
                Epoch_Second_of_Day:units = "Seconds"
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        single Gain_150_1(Scan), shape = [764]
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                Gain_150_1:Long_Name = "Gain 150 +/- 1 GHz"
        single Gain_183_1(Scan), shape = [764]
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```
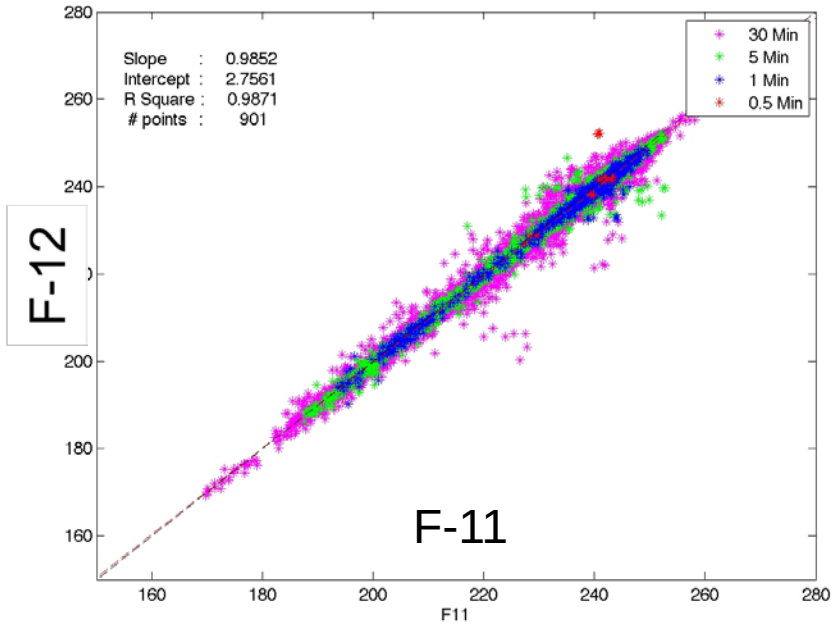
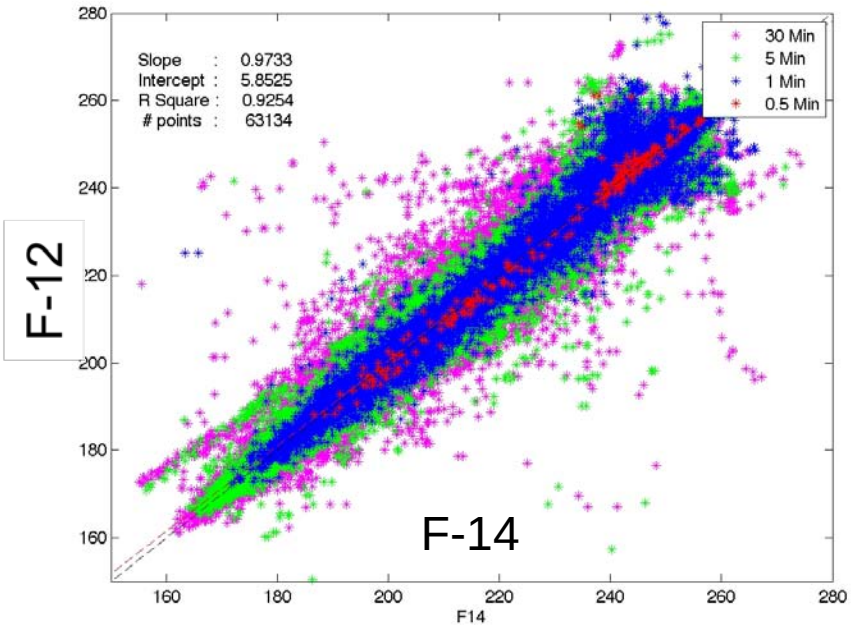
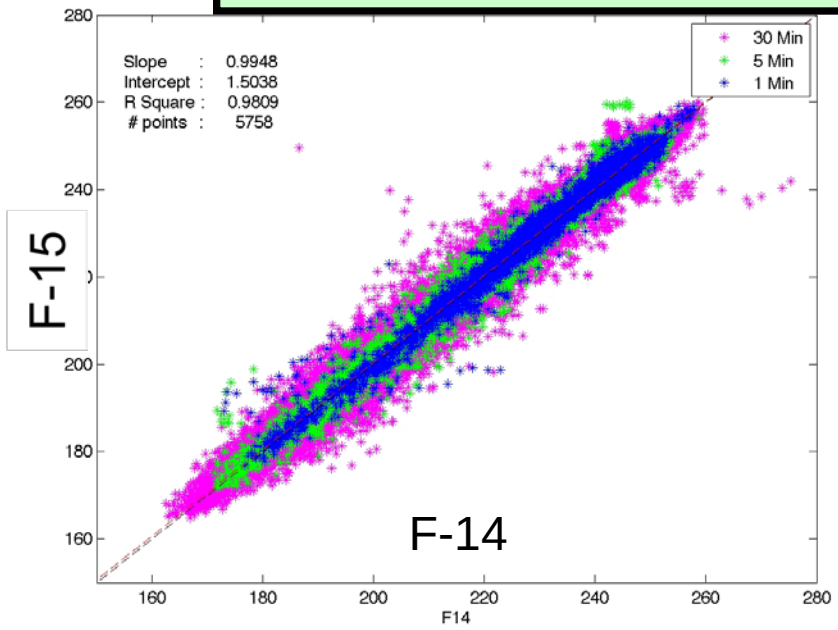
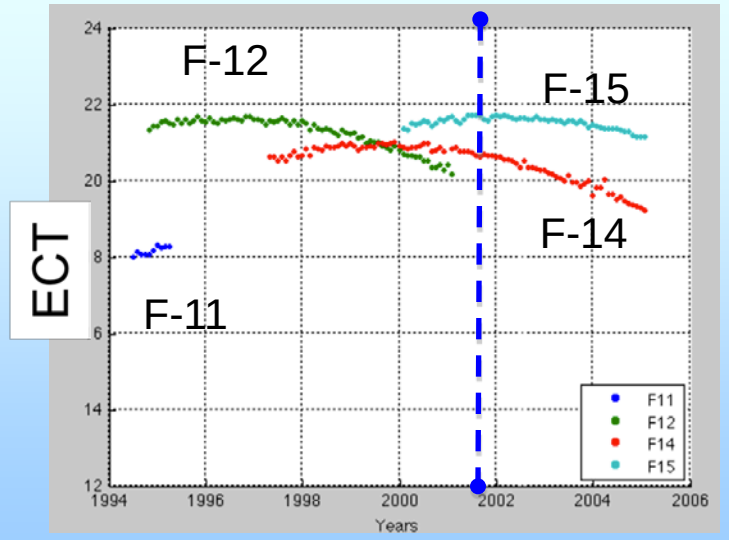

Rescuing & re-archiving SSM/T2 data (netCDF)





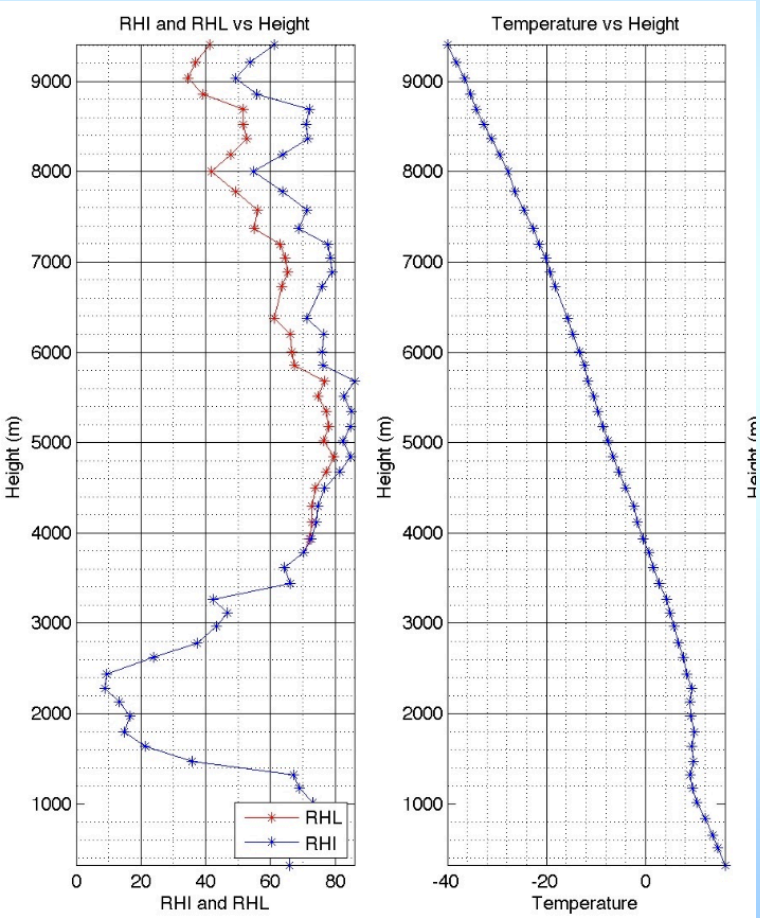
Calibration of SSM/T2, method #1: Simultaneous Nadir Overpass (SNO)

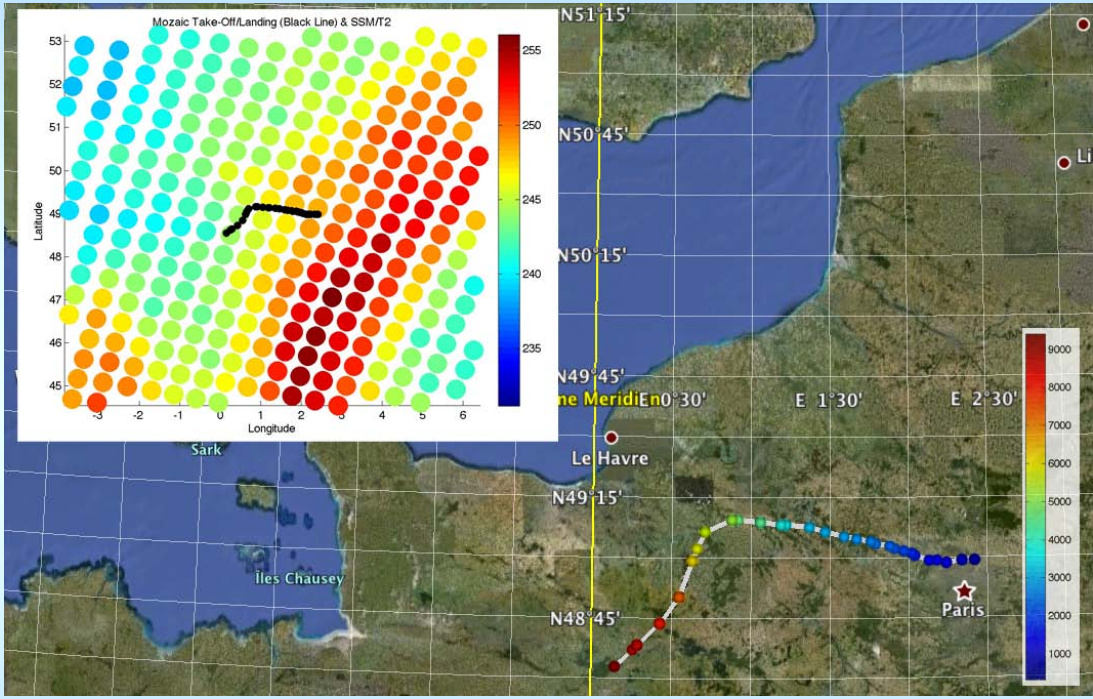




Results/Accomplishments

Calibration of SSM/T2, method #2: MOZAIC profiles & CRTM

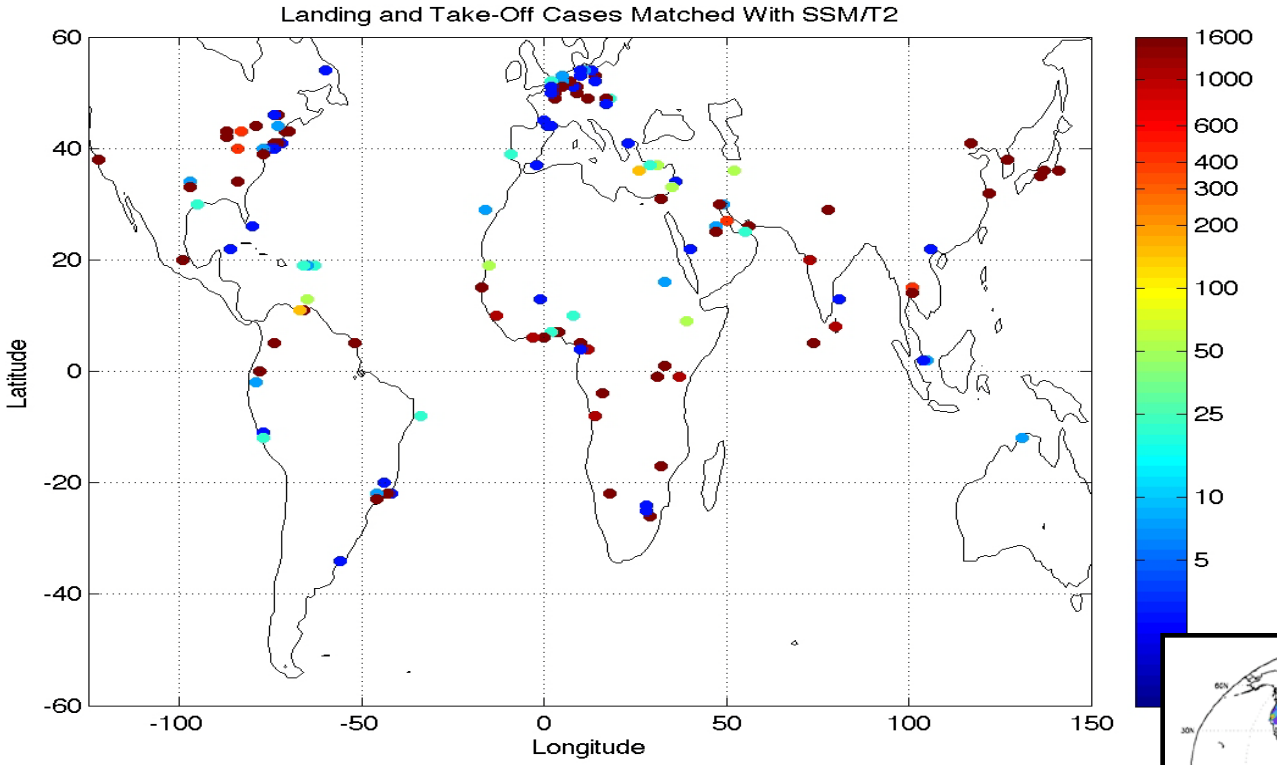


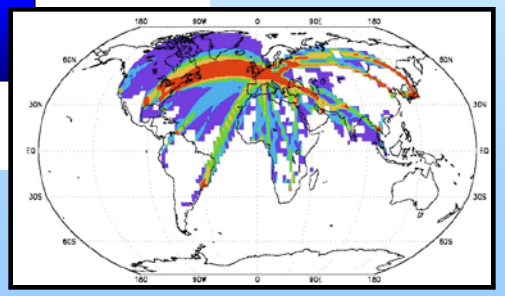


Results/Accomplishments

Calibration of SSM/T2, method #2: MOZAIC profiles & CRTM

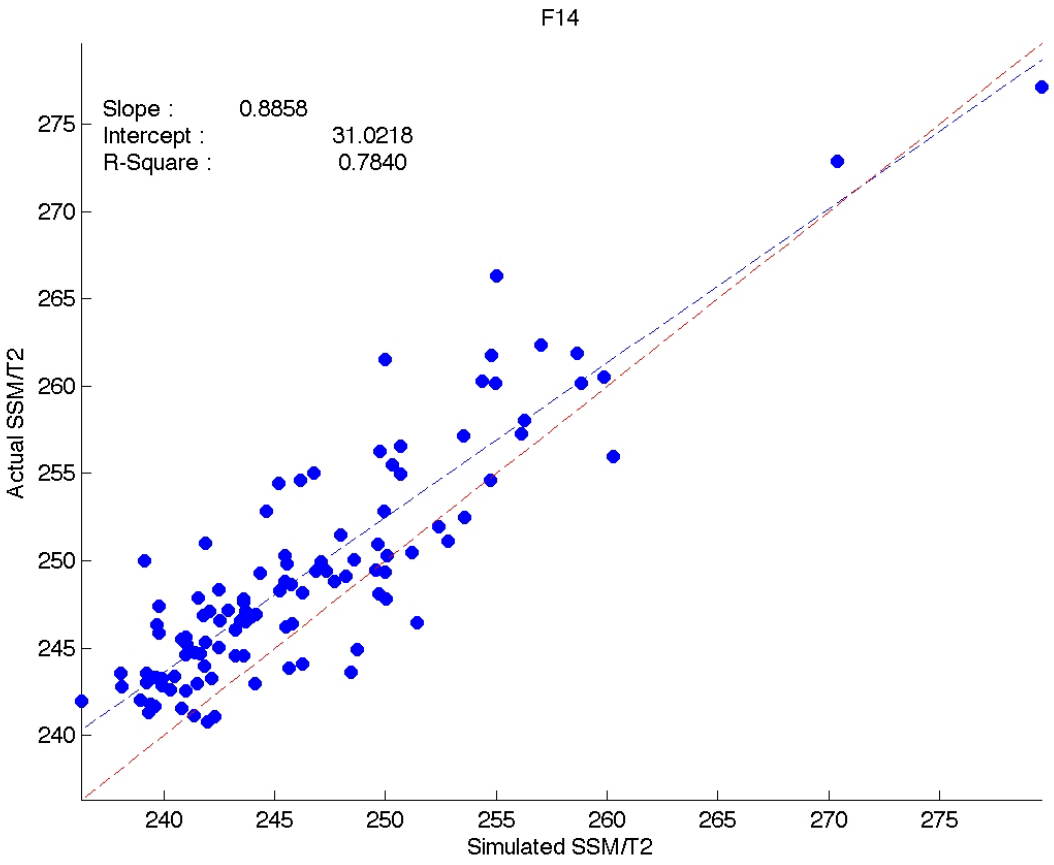
Number of MOZAIC ascent/descent matched with SSM/T2





Results/Accomplishments

Calibration of SSM/T2, method #2: MOZAIC profiles & CRTM



We are still trying to understand the cause of the apparently large scatter.

Validation Strategy/Results

MOZAIC profiles + CRTM to calibrate SSM/T2 represents an absolute calibration attempt.

High-quality temperature/humidity sounding data (e.g., Raman lidar at ARM site) + RTM is another way to validate our calibration.

Issues/Risks & Work- Off Plans

Rescuing SSM/T2 data is challenging. It is very poorly documented (e.g., undocumented change in factor/offset). Trial-and-error approach is what we are adopting.

Re-archiving them in netCDF is the first step. Checking data consistency and inter-calibration is ongoing.

Schedule

(**Year 1**)

1. Explored various methods to calibration SSM/T2 (SNO, MOZAIC+CRTM);
2. Started the effort of rescuing and re-archiving SSM/T2 data.

(**Year 2**)

1. Continue to rescue and re-archive SSM/T2;
2. Bring in other microwave UTH data (e.g., AMSU-B) and inter-calibrate them against SSM/T2.

(**Year 3)**

1. Bring in IR UTH data (e.g., HIRS, GEOs);
2. Append collocated cloud information to each UTH radiance

Transition Plan

- DOCUMENTATION (Estimated date of delivery)
  - Climate Algorithm Theoretical Basis Document (C-ATBD)
    - See CDR web site: http://www.ncdc.noaa.gov/cdr/guidelines.html
    - C-ATBD template is listed under "Development Guidelines"
  - Data Flow Chart and Maturity Matrix
    - See CDR web site: http://www.ncdc.noaa.gov/cdr/operationalcdrs.html
    - Examples are in the right column
- DATA SET(S)
  - What format are you using (note: prefer NetCDF)
  - Quality of Metadata
  - Size of data set: (SSM/T2) ~ a few MB per orbit and ~ 14 orbit/day - ~ 200 GB for the whole 17 years
- SOURCE CODE
  - Level of Documentation
  - Language
  - README
- CONCERNS (Risks)

Benefit to the Science Community

- Discuss science user communities who will benefit.

1. GCM groups (e.g., those participating in IPCC assessment report); they need to verify their simulations of UTH;
2. Researchers studying Earth's radiation balance (e.g., CERES, GEWEX), upper tropospheric water processes and cirrus (e.g., CALIPSO) and stratospheric water processes.

- Give several practical examples where your data will make a difference –i.e. how? References and citations would be appreciated.

A high-impact paper by Soden et al. (2005; Soden, B. J., D. L. Jackson, V. Ramaswamy, M. D. Schwarzkopf, and X. Huang, 2005: The radiative signature of upper tropospheric moistening. *Science*, 310(5749), 841-844) discussed the moistening of the upper troposphere as predicted by GCMs. But to trust these models, it is important to first test them against multi-decades of satellite observations. Soden et al. (2005) used HIRS channel 12, but we believe microwave data give a less biased sample of UTH because of their insensitivity to clouds.

Benefit to Society

Public:

Community outreach to minority students: during each summer, City College of New York (CCNY) host outreach activities to NYC high school and college students. Participants are mostly under-represented minorities. The UTH products developed by our team (sponsored by CDR program) were used this year as an example to educate students on climate variability and climate change. At the end of this summer, two students who worked with me presented their research results at University of Texas System *Louis Stokes Alliance for Minority Participation* (LSAMP) (ref: http://research.utep.edu/Default.aspx?alias=research.utep.edu/lsamp).

Resources

- Number of personnel employed for project

  Johnny Luo (PI), Bill Rossow (co-I), Dieter Kley (co-I), and Jeyavinoth Jeyaratnam (programmer/Research Associate)

- Key equipment or observatories used (bullets)

  Linux workstation, Mac machines and RAID systems

- Key collaborating projects or personnel

  Ralph Ferraro (NESDIS), John Bates (NCDC)

- NOAA points-of-contact or collaborators, as applicable

  Jeff Privette (NCDC), John Bates (NCDC), Hilawe Semunegus (NCDC)

- Target NOAA Data Center: NCDC

- How can the CDR Program Office help you?