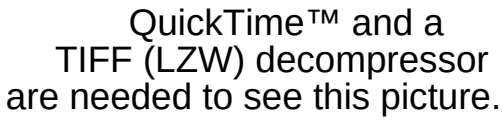
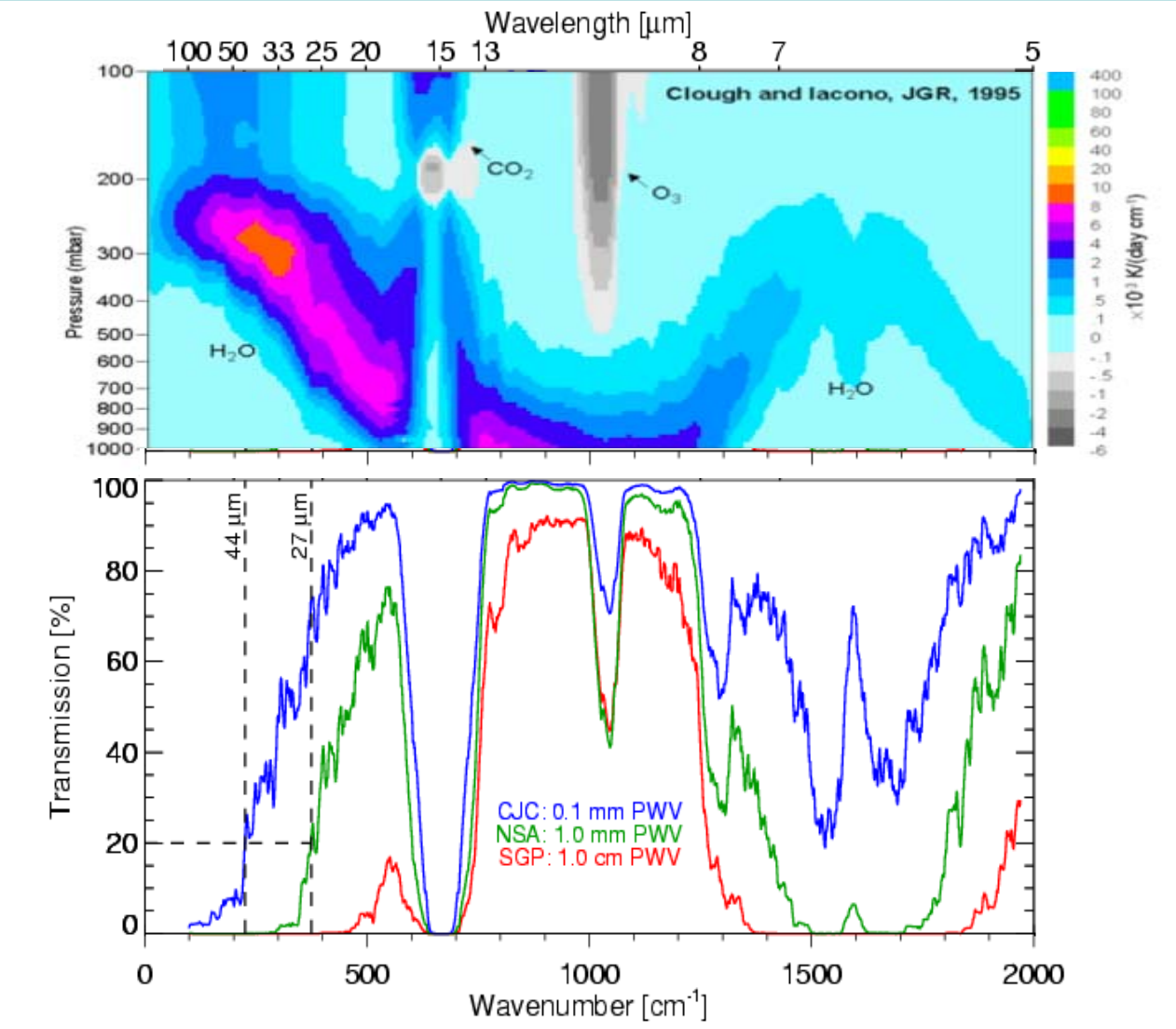


Status of the RHUBC-II Campaign

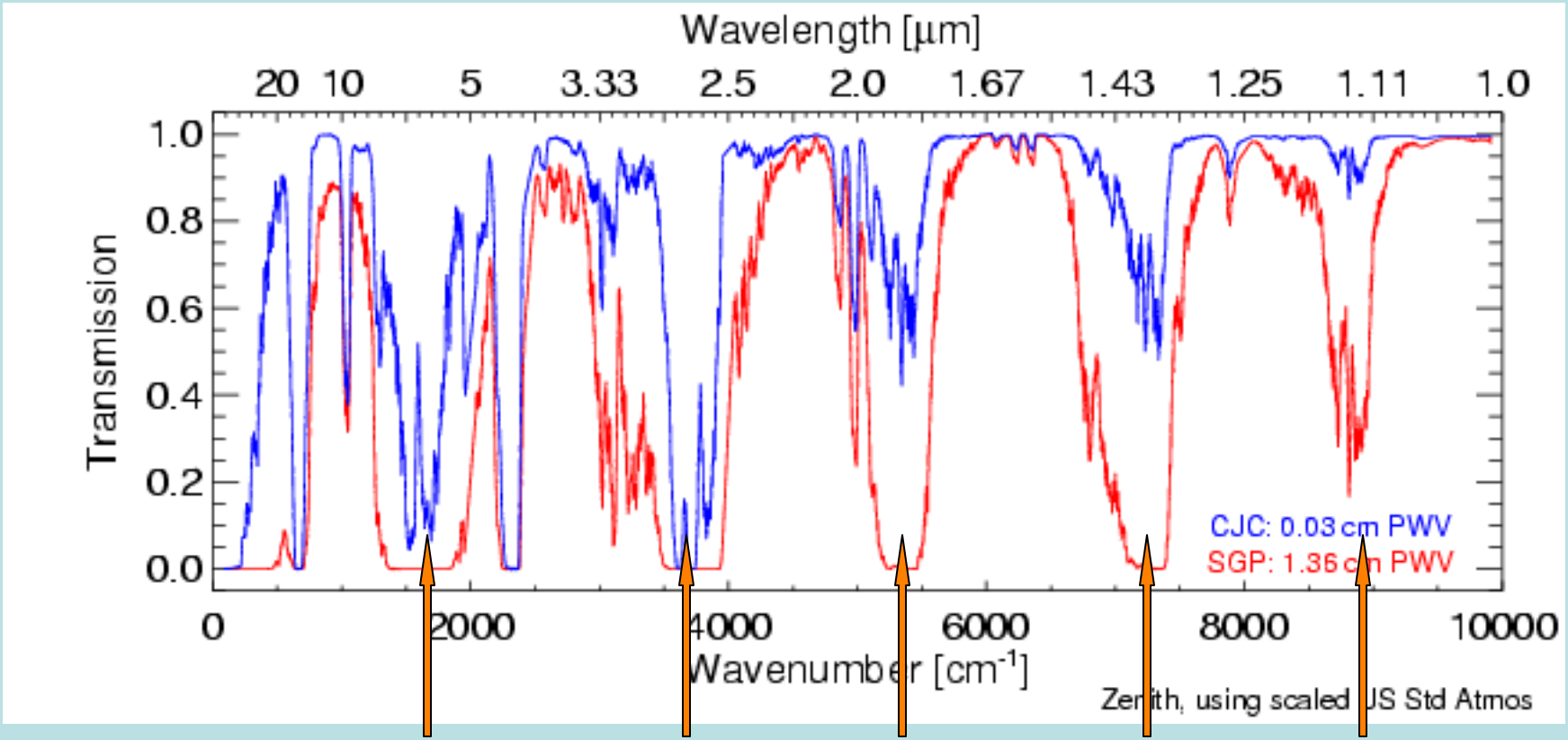
PIs: Dave Turner and Eli Mlawer

The Importance of Underexplored Spectral Bands

Thermal Radiation



Transparency of the Atmosphere in the Near-Infrared



0.10 0.32 0.35 0.44 0.08

Heating rate ~400 mb = 1.45 K/d

Motivation for Radiative Heating in Underexplored Bands Campaign (RHUBC)

- Radiative heating/cooling in the mid-troposphere modulate the vertical motions of the atmosphere
  - This heating/cooling occurs primarily in water vapor absorption bands that are opaque at the surface - **essentially unvalidated**

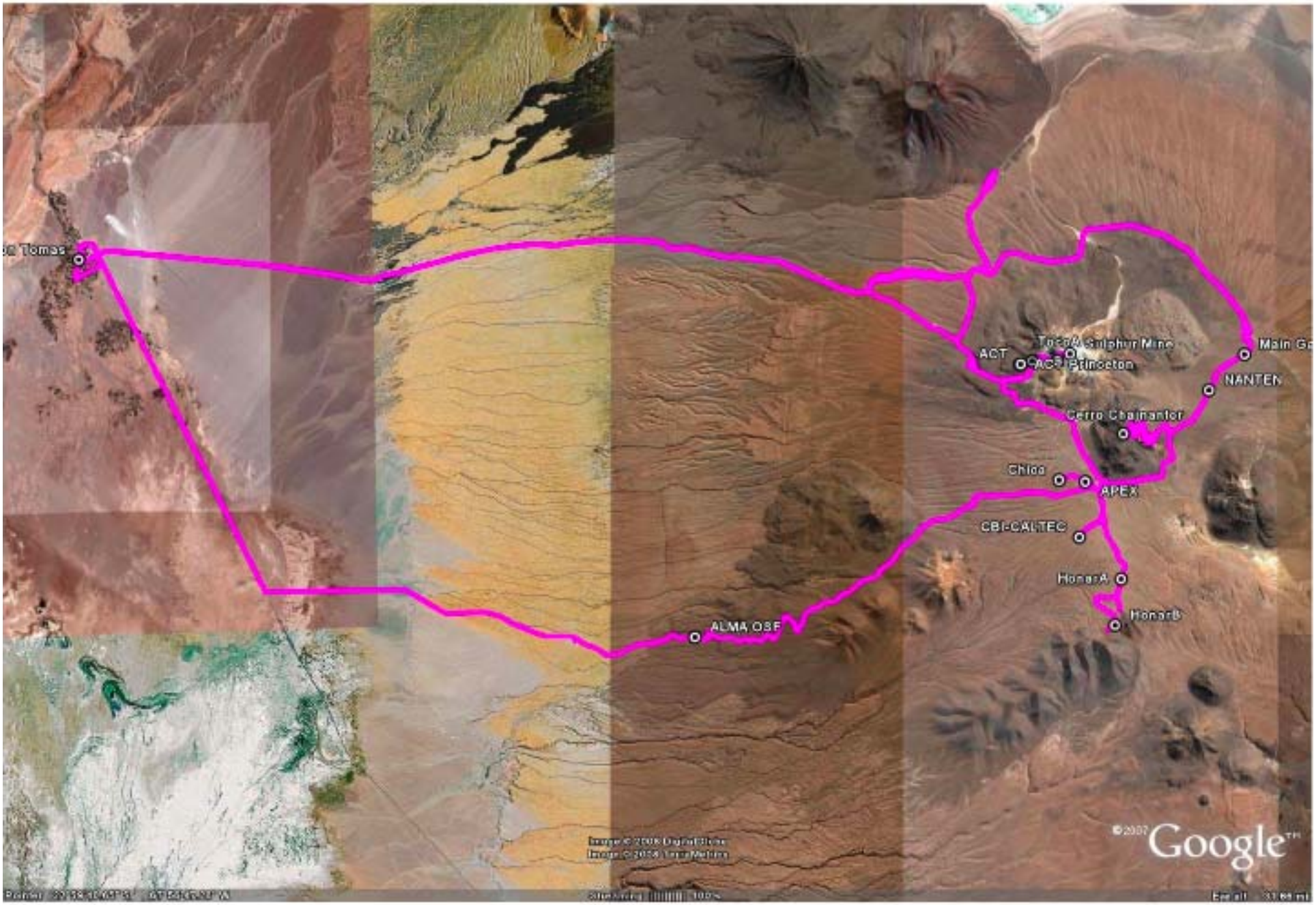
- Approximately 40% of the OLR comes from the far-IR
  - Until recently, the observational tools were not available to evaluate the accuracy of the far-IR radiative transfer models
    - Spectrally resolved far-IR radiances, accurate PWV

RHUBC-II Essential Facts

- August - October 2008
- Cerro Toco (~5400 m), Atacama Science Preserve, Chile
  - Expected water vapor column amounts - 0.3 mm (as low as 0.1?)
- Scientific objectives
  - Conduct clear sky radiative closure studies in order to reduce uncertainties in WV spectroscopy
    - Line parameters (e.g. strengths)
    - WV continuum models
  - Investigate the radiative properties of cirrus in the far-IR (few cloudy cases expected - 85% clear)


Lima
La Paz
Bolivia
Asuncion
Chile
Cordoba
Uruguay
Santiago
Buenos Aires
Montevideo
Argentina
N

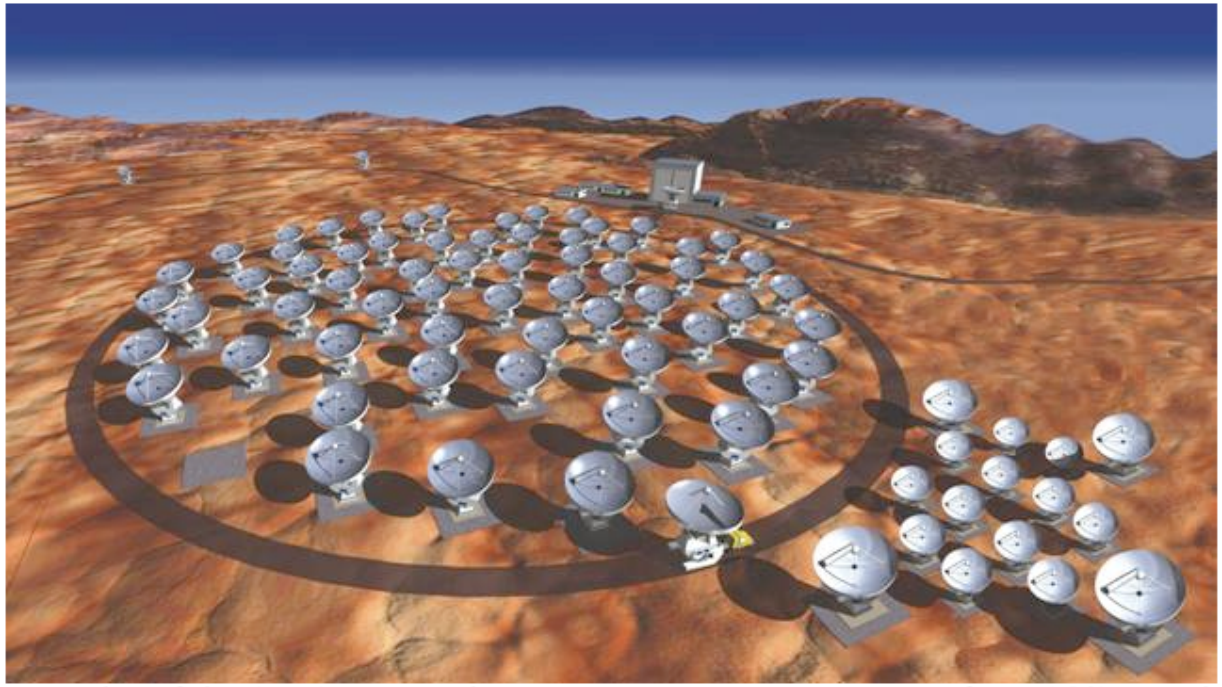

1
21
Calama
5
23
25
San Pedro de Atacama
Atacama Science Preserve
Isla Santa Maria
Segunda Region De Antofagasta
Antofagasta


ACT
Princeton
NANTEN
Cerro Chajnantor
Chilbo
APEX
CBI-CALTEC
HonarA
HonarB
ALMA OSF
Google

Atacama Large Millimeter / Submillimeter Array - Taiwan

ALMA IS THE WORLD'S LARGEST, MOST SENSITIVE RADIO TELESCOPE OPERATING AT MILLIMETER WAVELENGTHS:

The Atacama Large Millimeter/Submillimeter Array (ALMA) is the largest ground based, international astronomical observational facility ever built. It is currently under construction in the Chajnantor area in the Atacama desert in northern Chile. ALMA is designed to cover the wavelength range from 0.3mm to 9mm with an angular resolution of up to 0.004 arcsec. The baseline project consists of the 12-m array of up to 64 12-m telescopes, and the Atacama Compact Array (ACA) of 4 12-m telescopes and 12 7-m telescopes. ALMA will be studying a broad range of exciting science, such as weather patterns on solar system planets, the formation of planets and stars in our galaxy, the motions within active galactic unclei , and the formation of the earliest galaxies at z~10.

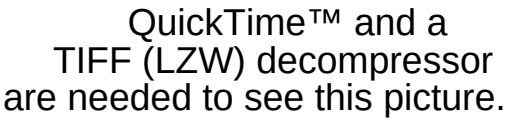


Artist's conception of the ALMA antennas in a compact array. Image courtesy of NRAO/AUT and ESO. ALMA/Chajnantor Video Clip, Backgrounds & Photos (from ESO Press Release, 10 June 1999)


SCIENCE PRESERVE
RESERVA CIENTIFICA
OSF: 27 Km.
OSF RD
TOCO RD
ACT
12.9 Km.
CBI
11.3 Km.
APEX
9.7 Km.
AOS
RD
11.9 Km.
ALMA Intersection
CCAT
TAO
TAO RD
5.0 Km.
O
S
N
E
PAMPA
LA BOLA
RD
2.3 Km.
ASTE
NANTEN 2
0 Km.
BARRERA
0
1
2
3
4
5
Km

RHUBC-II Trip Objectives

1) Evaluate sites for experiment	Cerro Toco site approved
2) Develop contacts with government, scientists	CONICYT, Univ. de Chile
3) Contacts with area astronomical installations	ALMA, CBI, …
4) Evaluate local technical infrastructure	Contract with Astronorte
5) Assess altitude health issues	Heartrate, O2 data for 4 people
6) Evaluate local area accommodations, etc.	Astronorte ‘dorm’, Patagonia


QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

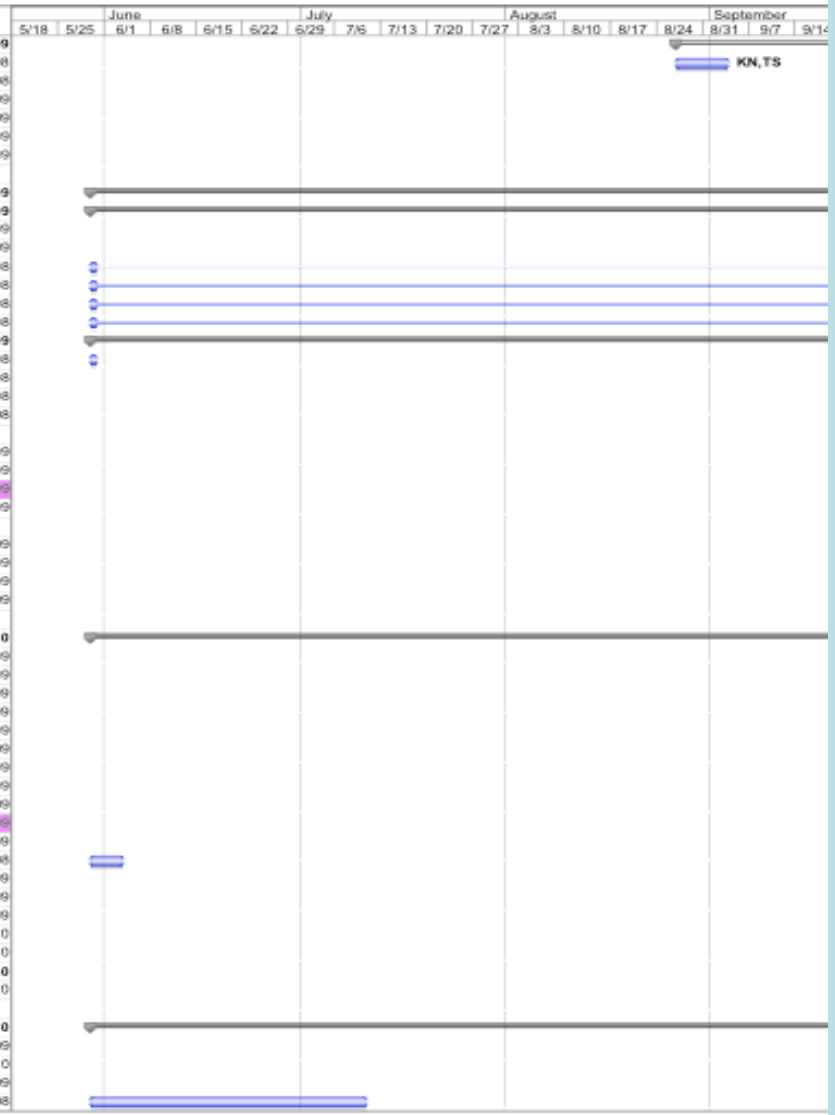
RPWG Meeting. Princeton, 11/08


Sulphur Mine
ACT
ACT-Princeton
ToccB
ToccA
Cerro Chajnantor
Chilca
APEX
Google


ARM

Detailed Planning for RHUBC-II Has Begun

ID	Task Name	Duration	Start	Finish
1	**Management**	**323 days?**	**Wed 8/27/08**	**Fri 11/20/09**
2	Contracts visit	6 days	Wed 8/27/08	Wed 9/3/08
3	RFP sent from LANL	1 day?	Mon 12/15/08	Mon 12/15/08
4	Proposal Due	1 day?	Mon 2/2/09	Mon 2/2/09
5	Contract Signed	1 day?	Mon 2/16/09	Mon 2/16/09
6	Site works inspection	3 days	Wed 2/25/09	Fri 2/27/09
7	Contracts closeout	5 days	Mon 11/16/09	Fri 11/20/09
8				
9	**BUILD & TEST**	**287 days?**	**Fri 5/30/08**	**Mon 7/6/09**
10	**Instrumentation**	**220 days?**	**Fri 5/30/08**	**Fri 4/3/09**
11	Guest instrument arrival	0 days	Fri 4/3/09	Fri 4/3/09
12	ARM Ex-China	1 day?	Mon 2/16/09	Mon 2/16/09
13	ARM aquired	1 day?	Fri 5/30/08	Fri 5/30/08
14	Power generator	1 day?	Fri 5/30/08	Fri 5/30/08
15	O2 concentrators	1 day?	Fri 5/30/08	Fri 5/30/08
16	S5 tools and spares van	1 day?	Fri 5/30/08	Fri 5/30/08
17	**Rough-in (PS)**	**287 days?**	**Fri 5/30/08**	**Mon 7/6/09**
18	Ship M1/2 to PS	1 day?	Fri 5/30/08	Fri 5/30/08
19	Electrical	10 days	Mon 9/29/08	Fri 10/10/08
20	Mechanical	10 days	Mon 9/29/08	Fri 10/10/08
21	Ship to SGP	5 days	Wed 11/5/08	Tue 11/11/08
22				
23	AstroNorte arrival at SGP	0 days	Sun 4/19/09	Sun 4/19/09
24	Equipment install	10 days	Mon 4/6/09	Fri 4/17/09
25	Beta Operations	5 days	Mon 4/27/09	Fri 5/1/09
26	Training	10 days	Mon 4/20/09	Fri 5/1/09
27				
28	Acceptance	1 day?	Mon 5/4/09	Mon 5/4/09
29	Pack-up	4 days	Tue 5/5/09	Fri 5/8/09
30	Transport to Dock	5 days	Mon 5/11/09	Fri 5/15/09
31		1 day?	Fri 7/3/09	Mon 7/6/09
32				
33	**Deployment**	**429 days?**	**Fri 5/30/08**	**Wed 1/20/10**
34	Customs export release	5 days	Mon 5/18/09	Fri 5/22/09
35	Transport to Chile	30 days	Mon 5/25/09	Fri 7/3/09
36	Arrival Antofagasta	0 days	Wed 7/1/09	Wed 7/1/09
37	On-site (Toco A)	0 days	Wed 7/15/09	Wed 7/15/09
38	Transport to site	3 days	Wed 7/8/09	Fri 7/10/09
39		3 days?	Thu 11/5/09	Mon 11/9/09
40	Unpack	3 days	Wed 7/15/09	Fri 7/17/09
41	Install	5 days	Mon 7/20/09	Fri 7/24/09
42	Commission	4 days	Mon 7/27/09	Thu 7/30/09
43	RHUBC-II Operations	65 days	Mon 8/3/09	Fri 10/30/09
44	Decommission	3 days	Mon 11/2/09	Wed 11/4/09
45	Pack-up	3 days	Fri 5/30/08	Tue 6/3/08
46	Transport to Antofagasta	2 days	Tue 11/10/09	Wed 11/11/09
47	Customs export release	5 days	Thu 11/12/09	Wed 11/18/09
48	Transport to ConUS	30 days	Thu 11/19/09	Wed 12/30/09
49	Customs import clearance	10 days	Thu 12/31/09	Wed 1/13/10
50	Transport to SGP	5 days	Thu 1/14/10	Wed 1/20/10
51	**Arrive SGP**	**0 days**	**Wed 1/20/10**	**Wed 1/20/10**
52	At Export dock	0 days	Wed 1/20/10	Wed 1/20/10
53				
54	**Remediation**	**430 days?**	**Fri 5/30/08**	**Thu 1/21/10**
55	Site cleanup	1 day?	Tue 11/10/09	Tue 11/10/09
56	Unpack at SGP	1 day?	Thu 1/21/10	Thu 1/21/10
57	Customs import clearance	1 day?	Tue 7/7/09	Tue 7/7/09
58	Beta Test (SGP)	30 days?	Fri 5/30/08	Thu 7/10/08



ARM Instruments for RHUBC-II

GVRP

MPL

AERI-ER

Radiometers

Vaisala Ceilometer

MFRSR

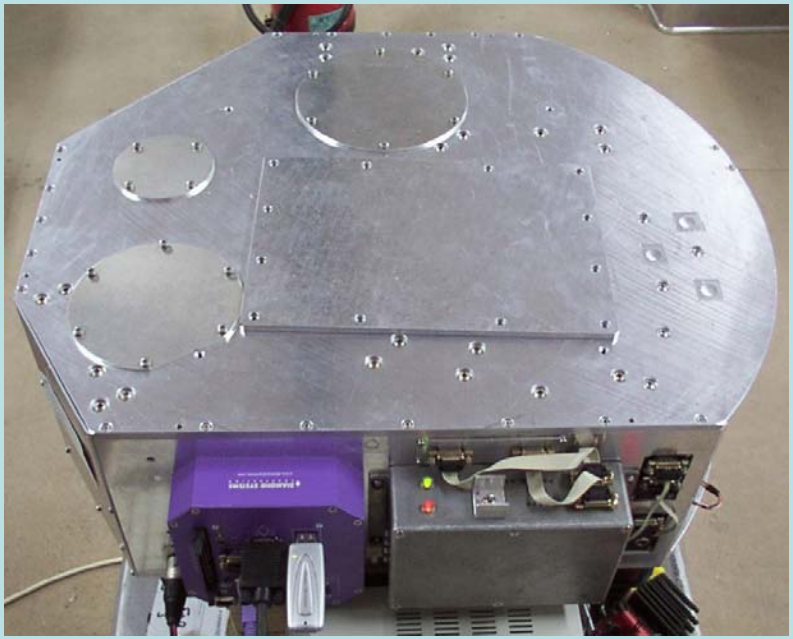
Sondes

Met station

Far-infrared Spectroscopy of the Troposphere (FIRST)

- PI - Marty Mlynczak, NASA-LaRC
- Michelson interferometer
- 100 - 1600 cm^{-1}
- Unapodized resolution ~ 0.64 cm^{-1}
- Cooled by liquid helium, nitrogen
- Successful high-altitude balloon flight in 2005 from NM - first time the nearly complete thermal emission spectrum of the Earth was observed from a space-like vantage point

Radiation Explorer in the Far Infrared (REFIR)



- Developed - Italian collaboration
- Fourier Transform Spectrometer
- 100 - 1500 cm^{-1}
- Resolution ~ 0.50 cm^{-1}
- Detectors do not need cooling
- Data from balloon showed good agreement with IASI in overlapping spectral region

Tropospheric Airborne Fourier Transform Spectrometer (TAFTS)

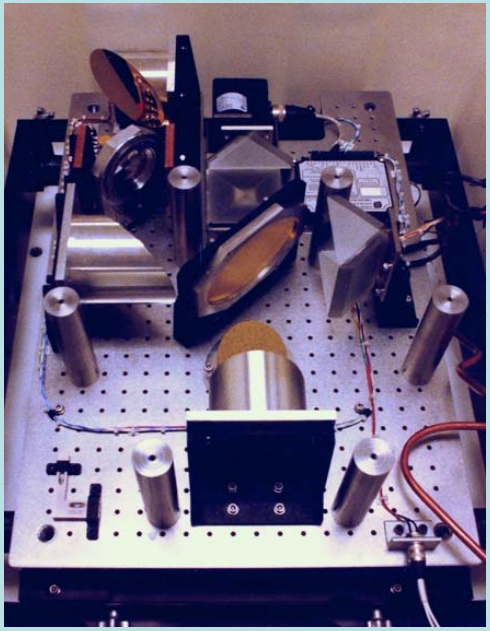
- PI - Paul Green, Imperial College
- Martin-Puplett polarizing FTS
- 80-650 cm^{-1}
- Resolution ~ 0.12 cm^{-1}
- Cooled by liquid helium, nitrogen
- Primarily an aircraft instrument
- Participated in RHUBC-I

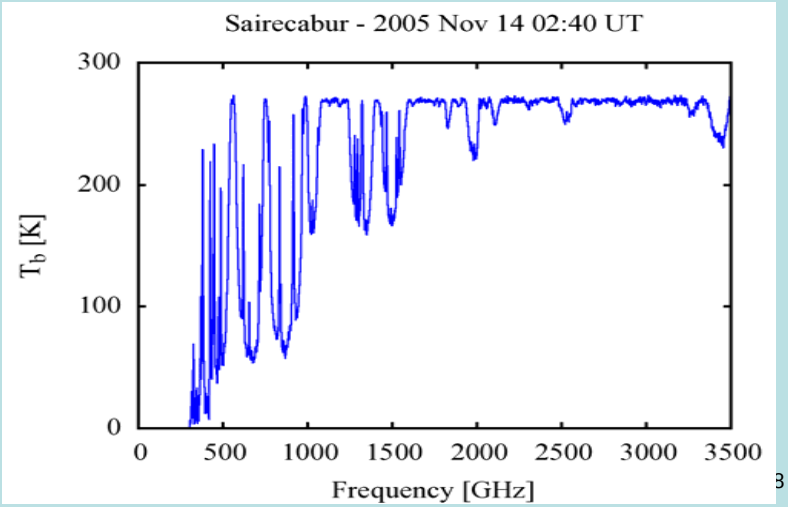
Absolute Solar Transmittance Interferometer (ASTI)

- PI - Tom Hawat, Univ. of Denver
- 2000 - 10000 cm^{-1}
- Resolution ~ 0.6 cm^{-1}
- Views central 16% of solar disk
- Calibrated using a reference tungsten lamp with a maximum temperature of 2800 K.
- Absolute uncertainty < 5%; relative uncertainty ~ 1%.
- Data from SGP used to determine O_2-O_2 continuum (Mlawer et al., 1998)

Smithsonian Astrophysical Observatory FTS

- PI- Scott Paine
- Polarizing Michelson FTS
- 300 GHz – 3.5 THz
- Apodized resolution: 3 GHz
- Typical SNR at 650 GHz, 100 K:
  ~30 in 10 minutes at full resolution
- Sairecabur (5525 m) 2000 – 2008
- Outdoor operation to -25 C





Upcoming Milestones

- Contract arrangements for Chilean contractors being negotiated through University of Chile
- Decisions on guest instruments' funding and participation
- Beta test for two weeks April-May 2009 at the Pagosa Springs (CO) Staging Facility
  - instrument vans are being prepared and modified at the PSSF
  - oxygen enrichment units and power generators have been purchased and are being integrated into the 'Portable Instrument Platform' (PIP)
- Health, safety, and operations procedures being developed

Safety!

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Safety!!


RHUBC-II: A Unique Location For a Remarkable Campaign