What will the doctor prescribe ?

(A look at weather modification)

A simple medical story:

- patient with ailment of some sort
- examination and diagnosis
- prescription for treatment
- checkup to test progress
- cure

A more complex situation:

- diagnosis doesn't point to a known cause
- more testing is necessary (some type of cancer)
- comparisons are made with other cases
- research hospitals/institutes get involved
- clinical trials may be conducted of promising treatments

Personal physician may recommend

- getting involved with clinical trial
- tries his own ideas for treatment
- wait for more definitive results

Patient may

- listen to his/her physician
- go to other physician
- try "folk remedy"

The ideal outcome:

Research and the clinical trials identify the cause of the illness

It is the valid explanation for a wide range of patients

One, or a range of different treatments are devised

Treatments result in cure for at least the large majority of cases

But, even so:

Not all patients respond positively, due to natural variations among individuals

Complications may arise in several cases due to multiple ailments occurring at the same time.

the analogy

patient	agriculture hydroelectric power community water supply transportation
ailment	draught or water shortage (increase in use) hailstones cloudiness
doctors	scientists, institutes, governments
folk remedies	folk remedies
outcome	a number of adaptable treatments
caveat	large natural variability and differing responses

weather modification projects

1) operational projects

analog: prescribe an approved medicine

goal: immediate relief; maximize the desired outcome

method: apply the best practice learned from previous, similar, attempts

result: not distinguishable from natural variations; has palliative effect

2) full-scale trials - FSTs (randomized experiments)

analog: clinical trial

goal: to establish a *proven method* for a restricted set of conditions

method: randomized testing of treatment(s)

result: confidence limits in specific treatment(s)

weather modification projects

3) exploratory research; feasibility study ("prospecting")

analog: determine prevalence of ailment

goal: search for "seedable clouds"

method: look for conditions based on some hypothesis

4) basic research:

analogs: molecular biology, human genome, new drugs, new diagnostic tools

elements: cloud physics
instrument development
models
evaluation methods

status of weather modification

status of weather modification - I

operational projects

produce much practical experience, and advanced technologies

a few projects of very long duration show significant results

they employ available scientific information and their findings feed back to scientific research

transferability of the results to other areas or cloud types is very limited

future performance of projects may differ from the past

status of weather modification - 2

full-scale trials - FSTs (clinical trials)

yielded some positive results, but most are contested and lack full physical explanation

are very costly and require strong committment

best promise is believed to be the possibility to augment snowfall from wintertime orographic clouds

transferability of results depends on narrowness of criteria

status of weather modification - 3

exploratory projects:

large investment, but can avoid more costly errors

WMO - PEP in 1979-81 was the most detailed such effort

results are interpreted in light of social/political concerns and the cost to benefit comparison

status of weather modification - 4

basic research:

elements of cloud processes that lead to precipitation are reasonably well understood

ice initiation is a major puzzle

little predictive capability of necessary details for specific instances on the scale that modification attempts may be undertaken

relationship between deliberate and inadvertent cloud seeding poses new questions to explore

global and regional climate change may have to be considered

- **policies**
- **funding**
- **licensing**
- **treaties**

109th U.S. Congress (2005-2006)

S. 517[109]: Weather Modification Research and Development Policy Authorization Act of 2005

A bill to establish a Weather Modification Operations and Research Board, and for other purposes.

Go to... Bill Status | Summary | Floor Speeches | Other Info

Status: Scheduled for Debate

This bill was proposed in a previous session of Congress. Sessio
years, and at the end of each session all proposed bills and r
passed are cleared from the books. This bill never

In the Blog

3 com

Bill Overview

Introduced: Mar 3, 2005

Sponsor: Sen. Kay Hutchison [R-TX] (no cosponsors)

Last Action: Dec 8, 2005: Placed on Senate Legislative Calendar under General Orders. Calendar No. 319.

ETHERIC RAIN ENGINEERING

- ERE Intro
- About Us
- Airborne ERE Overview
- Airborne ERE Q&A
- What the Pilots Say
- ERE OP SEGAMAT
- ERE OPS Summary
- PINCER II
- CLINCHER
- Clincher Article
- Clincher Gallery
- Hurricane Control
- Maritime Experience
- Radar in ERE
- Radar Gallery
- Lightning in ERE
- Lightning Gallery
- Photo Gallery
- Acknowledgments
- Ether Research
- Webmaster Speaks

Revolutionary Develo

ETHERIC RAIN ENGINEERING

Effective airborne etheric translators were design
revolutionary advance in etheric rain engineerin
four feet long, with small cross-section and ligh
no change in flight characteristics from wing st
these powerful translators to evoke violent we
locales, necessitated in-flight deactivation of
less. Modified devices were moved INSIDE th
procedure permitted in-flight deactivation.

Airborne tests in Hawaii and Malaysia, pro
techniques developed in 14 years of high
far more effective in the airborne mode.
horizon from the air, and infinite headin
reactions and rainfall with unprecedente
area also became feasible. 1998 Malay

NO CHEMICALS, ELECTRIC POWER C
FORM ARE UTILIZED. THESE NATUR
PURE.

Etheric rain engineering now has a
territories in equatoria may now b
engineering. Existing clouds are
own clouds, from zero if need be
tropical droughts in the here-no
and experience to apply these resour

WORLD HISTORICAL RENOWN AWAITS THE VISIO
USES THIS TECHNOLOGY AGAINST DROUGHT PROBLEMS
DEFEATED AND HUMILIATED CONVENTIONAL "HI TECH."

PRESS RELEASES

U.S. PATENTS

ARTICLES

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EASTLUND SCIENTIFIC ENTERPRISES CORPORATION

E-MAIL INFO@EASTLUNDSCIENCE.COM

WEATHER MODIFICATION WITH HIGH POWER ELECTROMAGNETIC RADIOTION

ESEC has recently completed a contract with the European Space Agency to review the weather modification potential of the HAARP facility in Alaska and to perform numerical simulations of tornado suppression with high power electromagnetic radiation produced with Solar Power Satellites. Two papers, available below, have been published. They are:

- SYSTEMS CONSIDERATIONS OF WEATHER MODIFICATION EXPERIMENTS USING HIGH POWER ELECTROMAGNETIC RADIATION, published in Proceedings of "Workshop on Space Exploration and Resources Exploitation-EXPLOSPACE," 20-22 October, 1998, Cagliari, Sardinia, Italy.

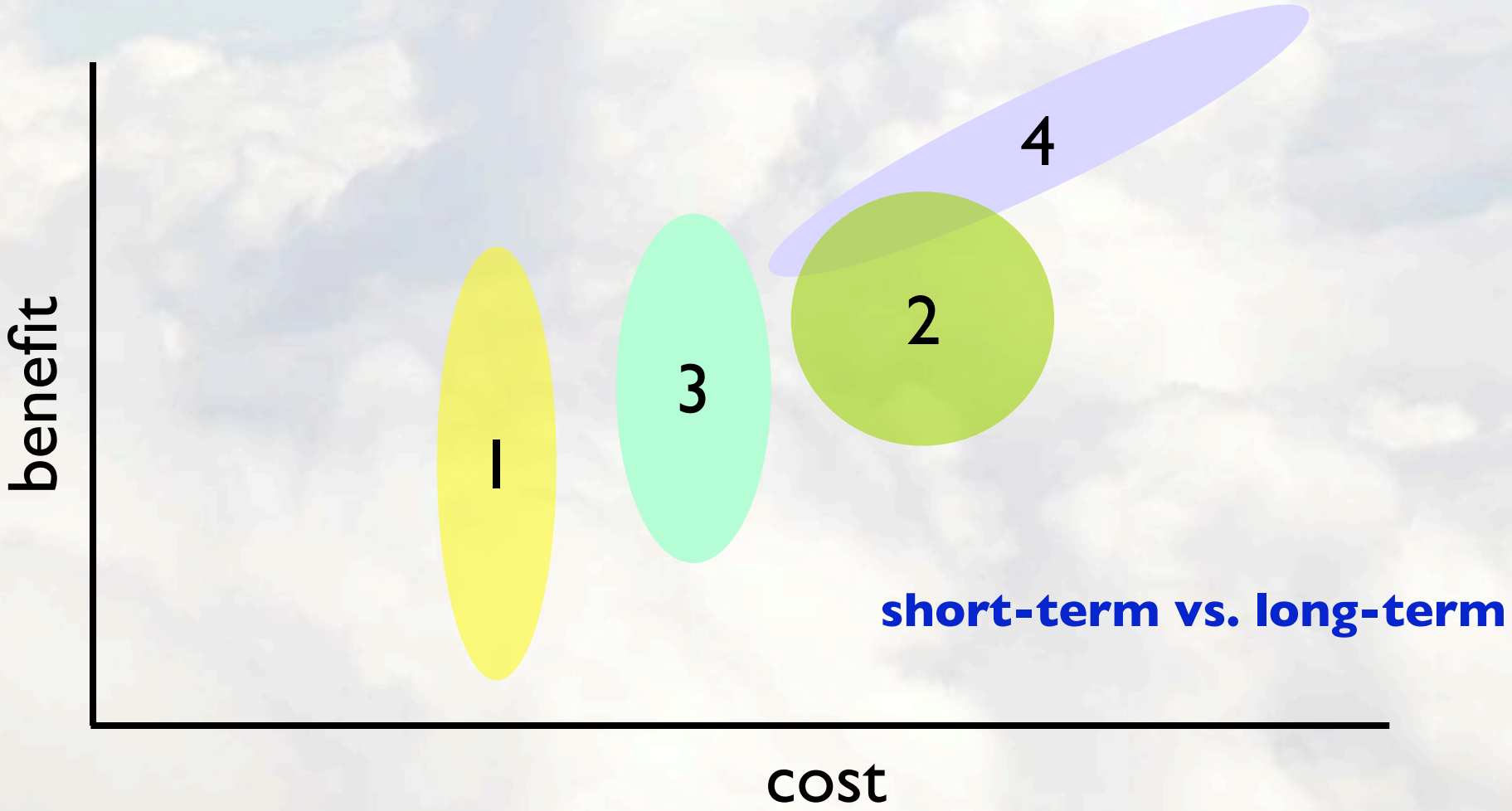
- MESOCYCLONE DIAGNOSTIC REQUIREMENTS FOR THE THUNDERSTORM SOLAR POWER SATELLITE CONCEPT, Published in the Proceedings of "The Second Conference on the Applications of Remote Sensing and GIS for Disaster Management," January 19-21, 1999.

Some of the highlights contained in these reports are:

- HAARP
- MISSILE SHIELD ANTENNA (terrawatt phased array antenna)
- NORTH SLOPE GAS CONCEPT WEATHER MODIFICATION
- OZONE HOLE MITIGATION
- HIGH POWER SOLAR SATELLITES FOR WEATHER MODIFICATION
- POWER RELAY IONOSPHERIC MIRROS
- INTERVENTION IN TORNADOGENESIS
- SAFETY

what to prescribe ?

1- operations 2 - FSTs 3 - exploratory 4 - basic research



Where does weather modification science stand?

The positives

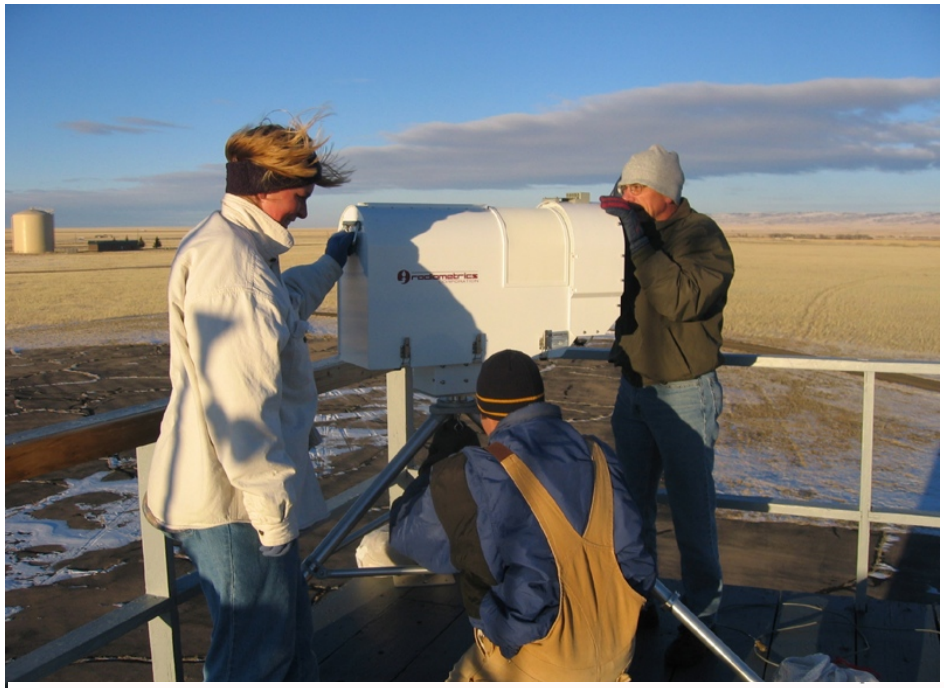
- We do have an arsenal of seeding materials and generators, both for glaciogenic and hygroscopic seeding.
- We do have theories to explain how precipitation forms, and models to describe cloud evolution.
- There are good tools for observing precipitation quantity (radars).
- There are good aircraft instruments to observe detailed cloud properties.
- Forecasts of major weather events are quite reliable over several days.
- Satellites provide much real-time information.

Where does weather modification science stand?
The negatives

- We do not know, with precision comparable to what seeding effects may be, what are desirable seed concentrations. Neither do we know well the factors that determine that desirable or optimum number under given conditions.
- There are many problems in spreading the seeding material into the cloud in a predictable fashion.
- Seeding effects can be clearly diagnosed only at the earliest stages of evolution of precipitation.
- Forecasts cannot predict marginal cloud events and cloud characteristics.
- Remote sensing of LWC, N(D), etc. is not well developed.
- Downwind effects of seeding, or their absence, are not known.

What are the best opportunities for advances?

- Observational capabilities:
  - radars with Doppler, polarization, and combinations of various wavelengths
  - lidars, radiometers
  - nucleus counters
- Models
- Winter orographic clouds have long (hours) duration and are subject to forced lifting. Those factors favor seedability. But, ...
- Cumulus clouds are better defined entities, have "parcels". Thus, they are better represented in models. But, ...



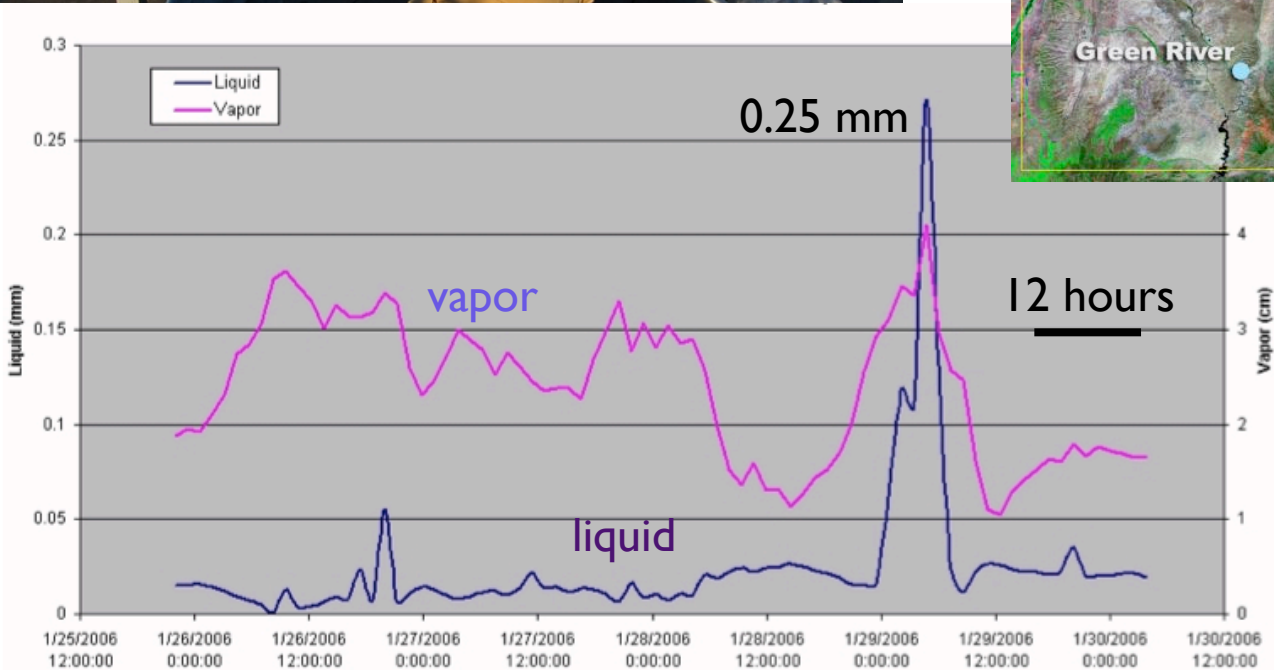


Figure 37. The integrated water vapor (magenta) and liquid water (navy) observed over the Medicine Bow Range from noon on January 25 through noon on January 30, 2006, by the WMI radiometer sited near Encampment. The left-hand axis, in mm, applies to the liquid water. The right-hand axis, in cm, applies to the water vapor. (Graphic courtesy of Dan Breed, NCAR/RAL)

source:
Dan Breed
Bruce Boe

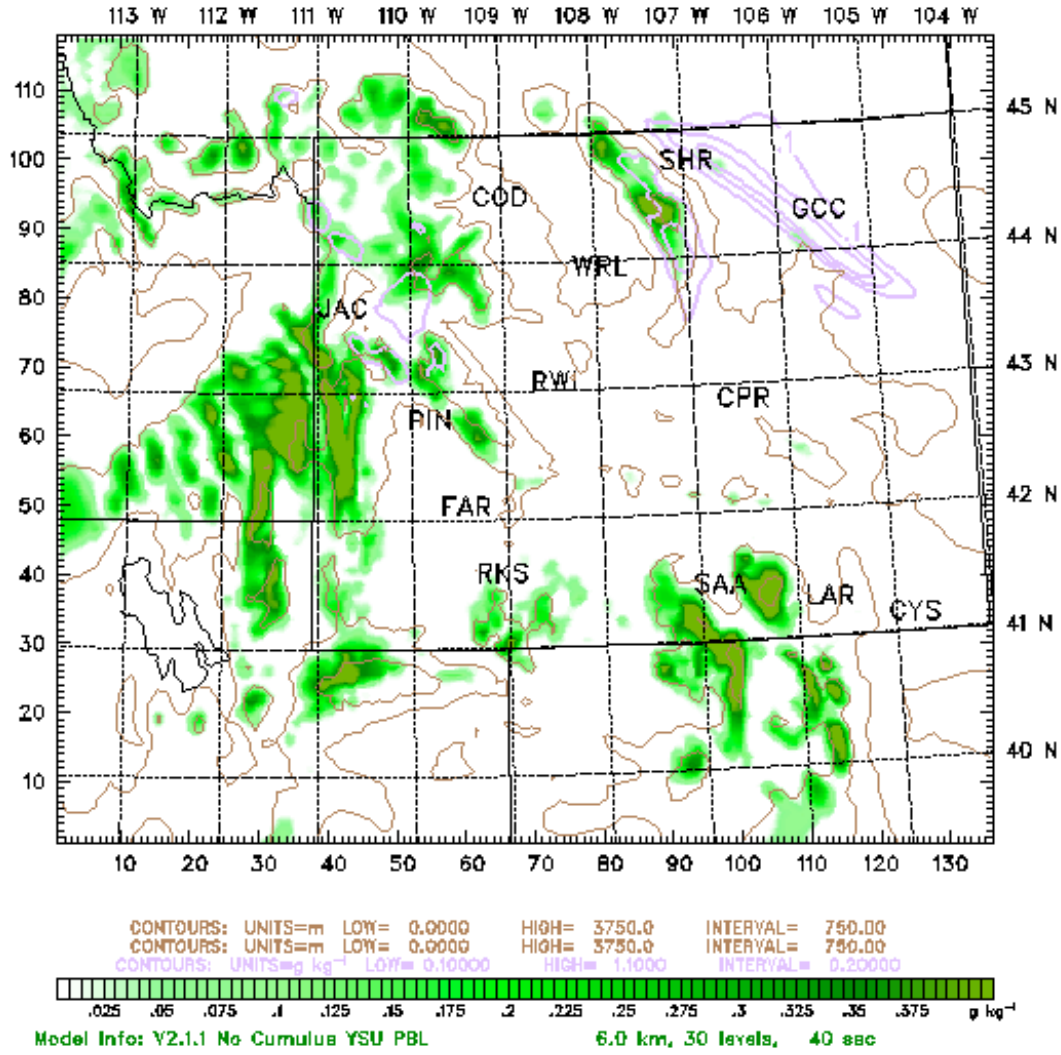
Precipitation Enhancement Studies Model Visualization

Disclaimer: This model is a prototype for this region. It is based on 4DWX RT-FDDA but has been modified to support our field project.

Real-Time Mode ○ Refresh Images

Plot Type:	Field:	Domain:	Date:	Hour:	Movie:	Current BTraj:
Cld/Precp	Cld Ice/Water 100mAGL	Two (6.0 km grid)	20070108	17Z	○ Start ◉ Stop	Domain4 Domain5

Wyo RT-FDDA Domain 2 Cycle= 2007010818
Fcst: 149.00 Valid: 1700 UTC Mon 08 Jan 07 (1000 MST Mon 08 Jan 07)
Cloud water mixing ratio at k-index = 27
Snow mixing ratio at k-index = 27

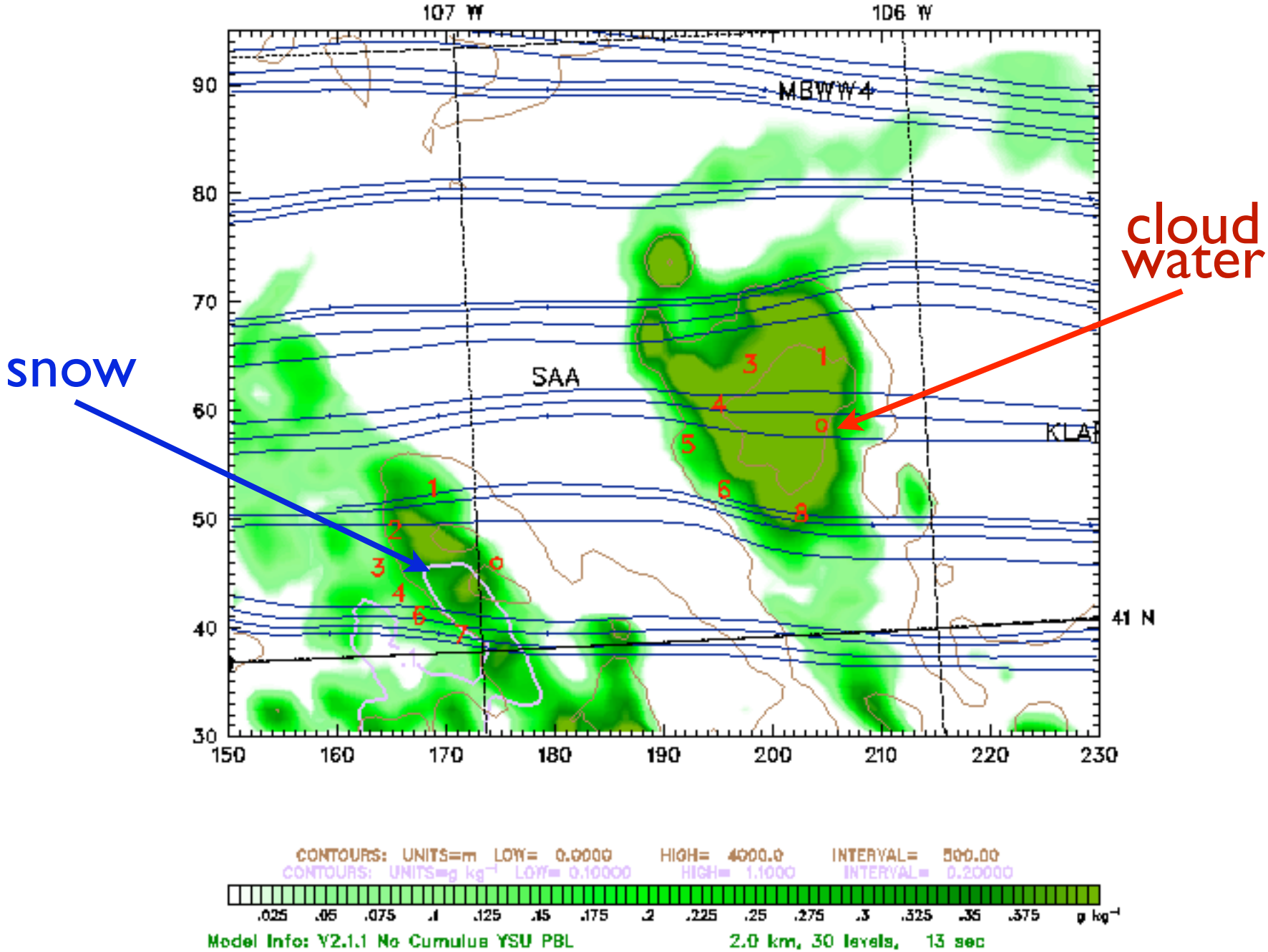


4DWX RT-FDDA

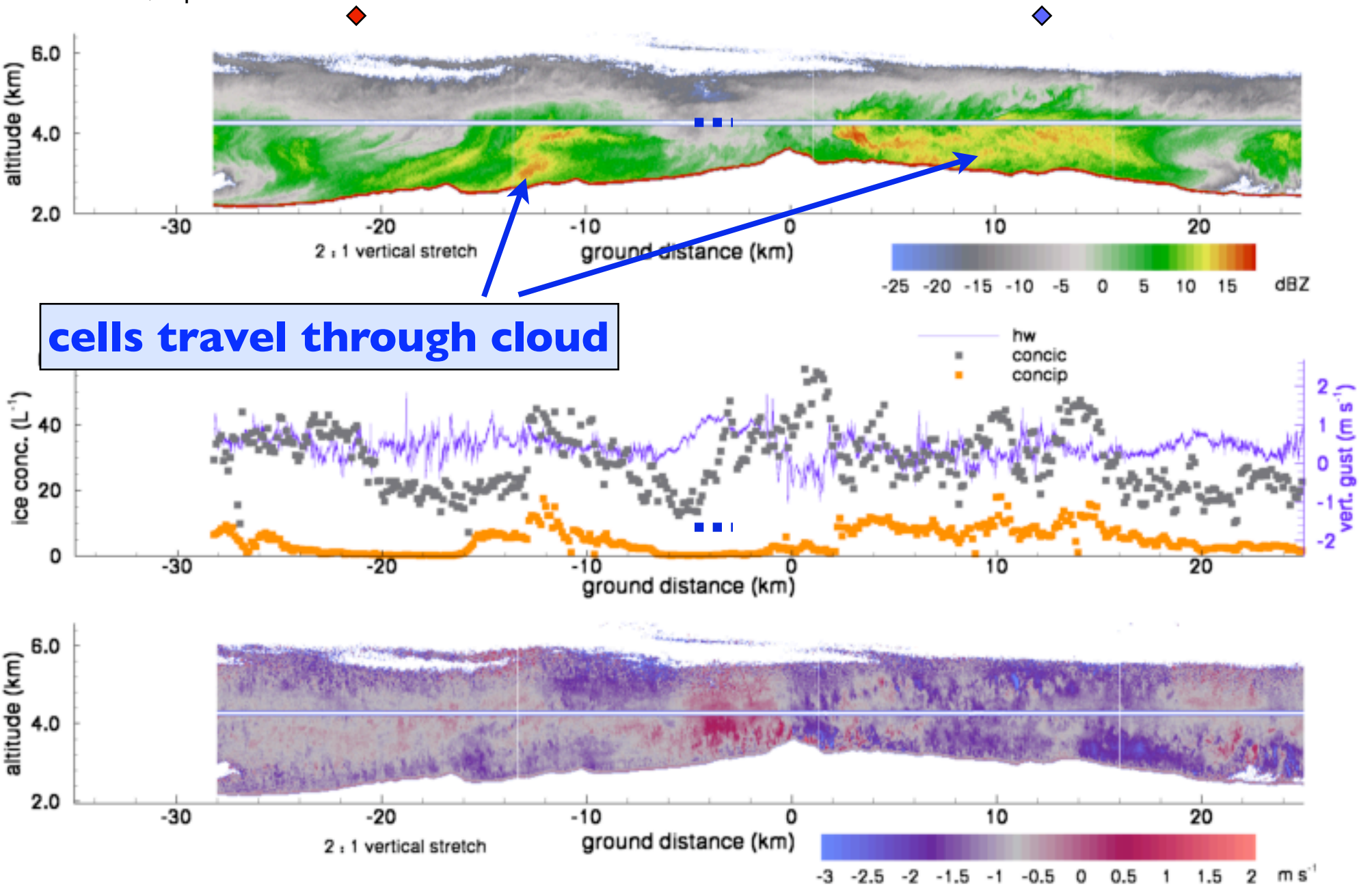
http://www.ral.ucar.edu/cgi-bin/ugui_wyo?range=wyoming

Tsukuba - February 2007

http://www.ral.ucar.edu/cgi-bin/ugui_wyo?range=wyoming

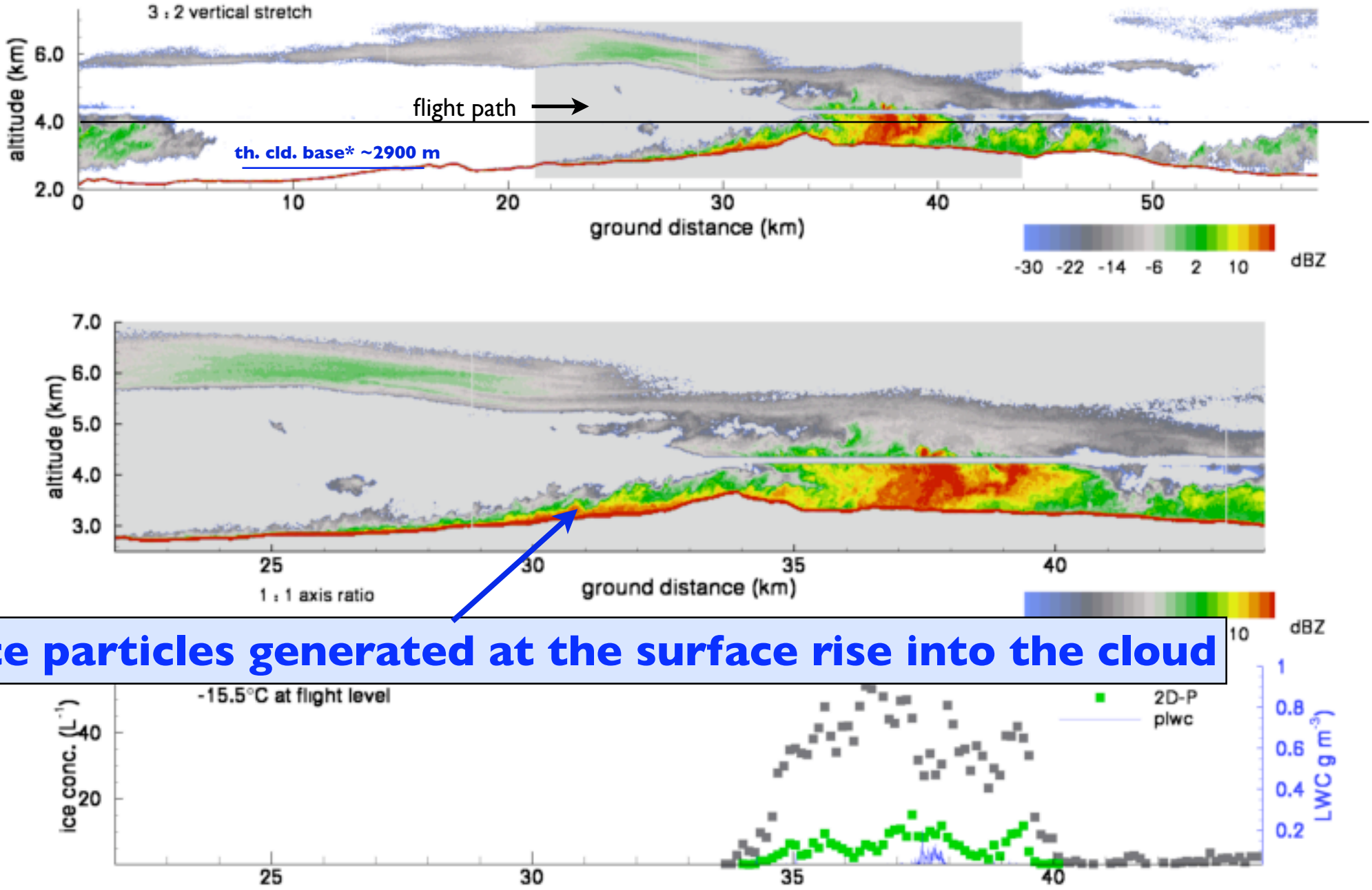


Source: G.Vali, unpublished



+4 01:44 +11

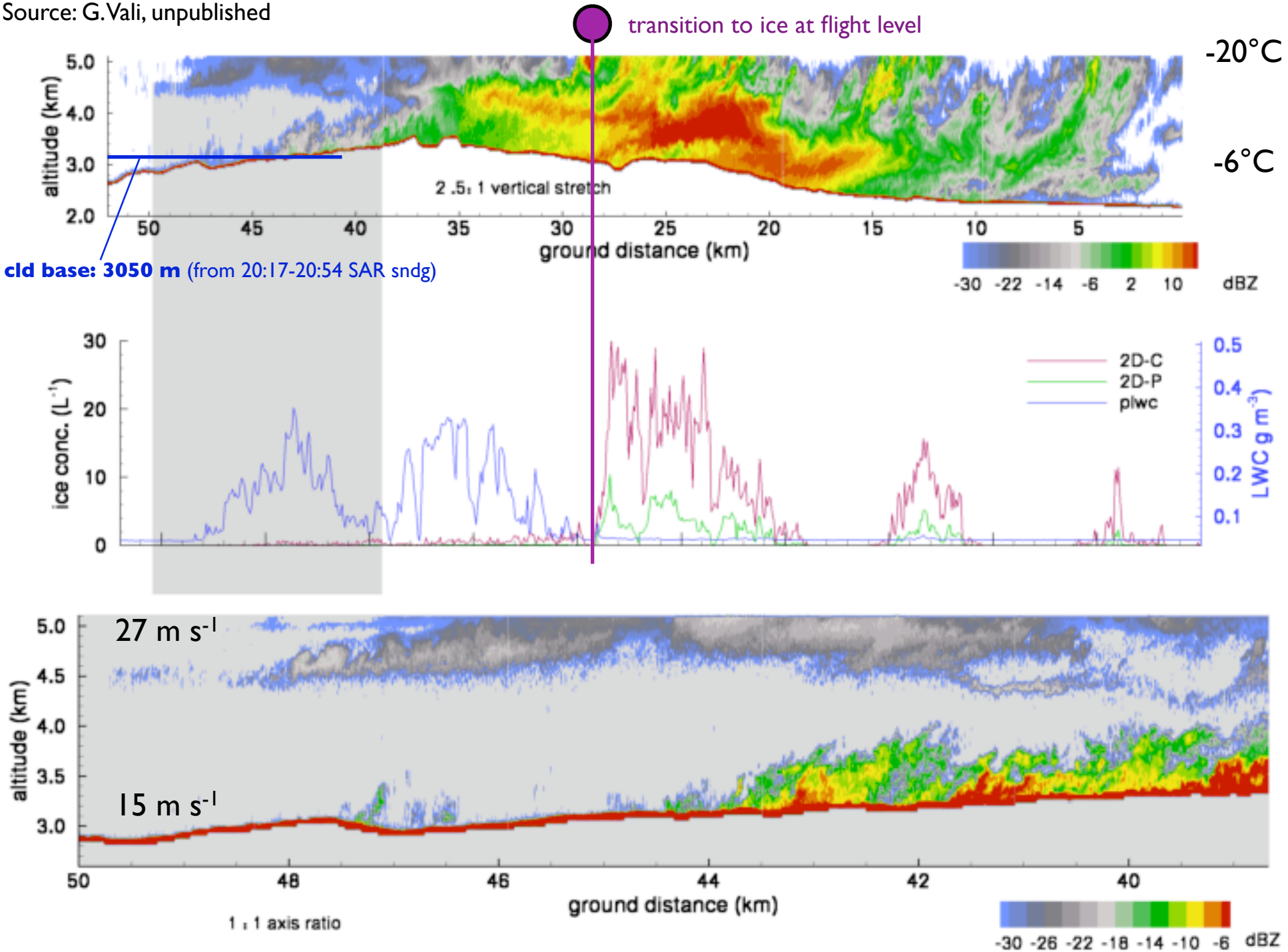
Source: G.Vali, unpublished



* cloud base estimated from 02:25-02:45 SAR sounding

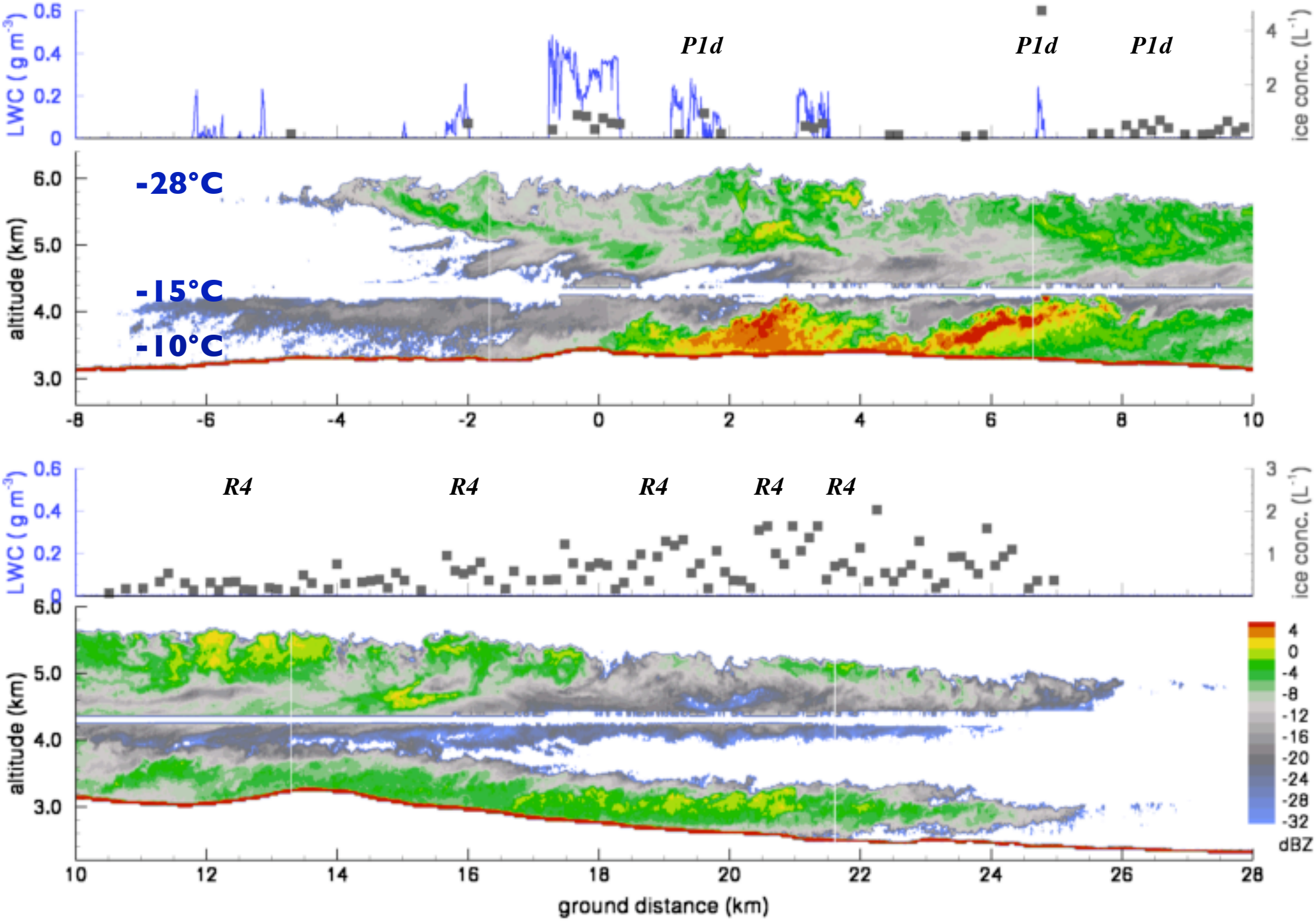
NASA06 jan 27 22:22 - 22:31; across MB Range on 080° heading; winds from 233° at flight level

Source: G.Vali, unpublished



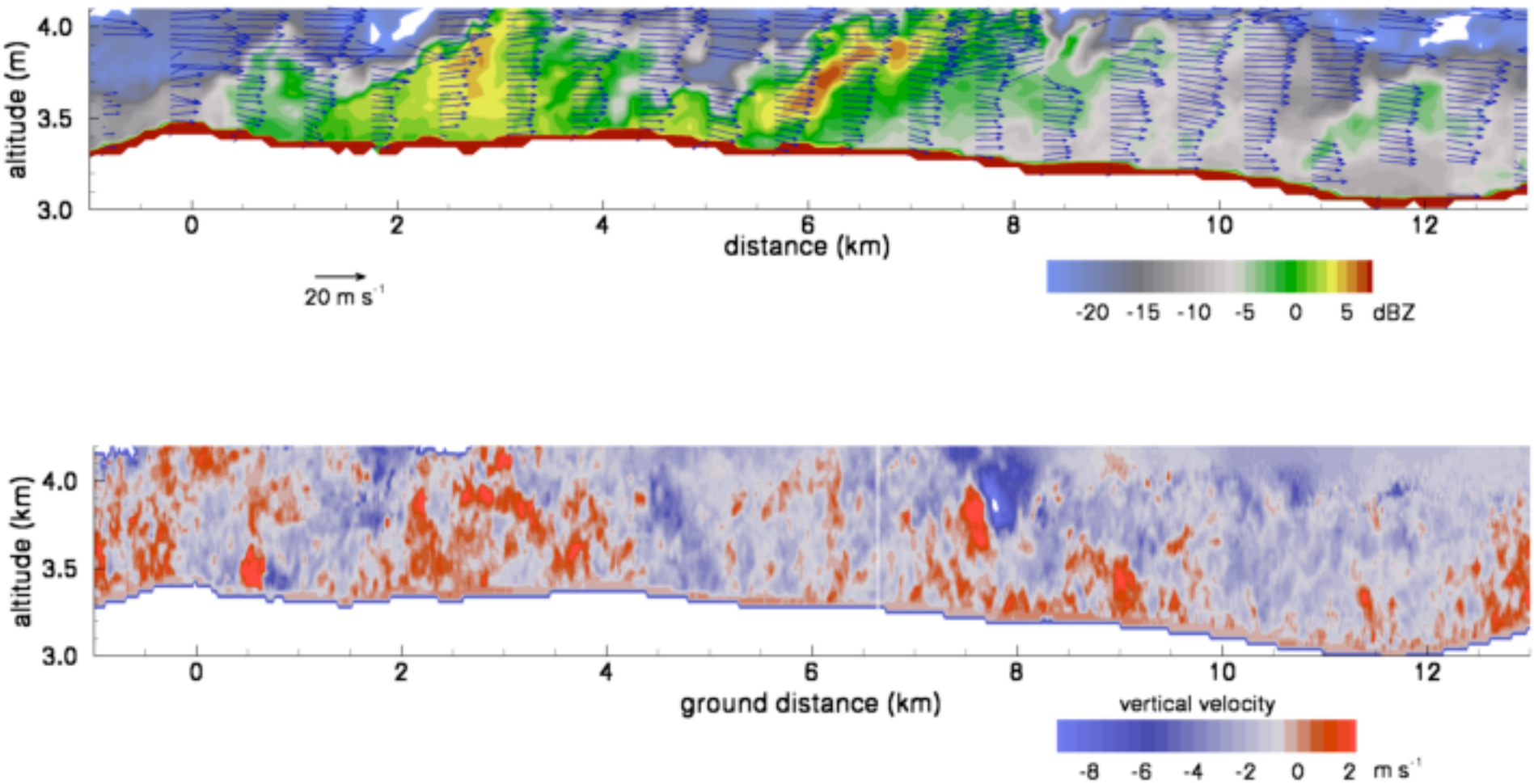
NASA06 jan18 22:09 - 22:22; across MB Range on 262° hdg.; into the wind

Source: G.Vali, unpublished



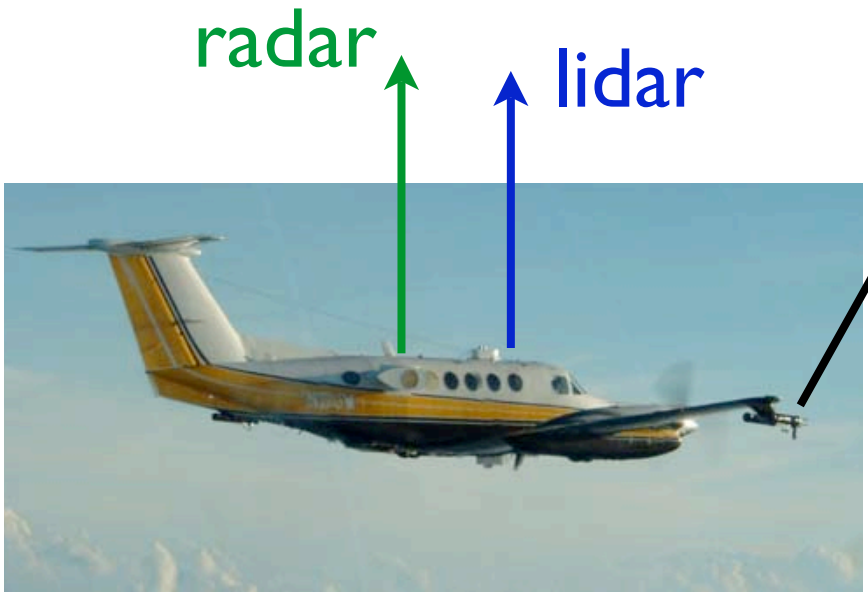
NASA06 jan18 22:44 - 22:50, across MB Range on 078° hdg., along the wind

Source: G.Vali, unpublished

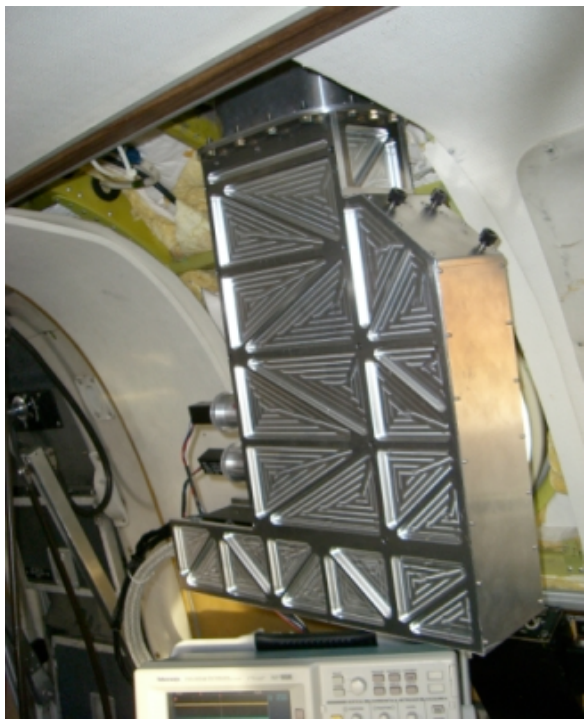


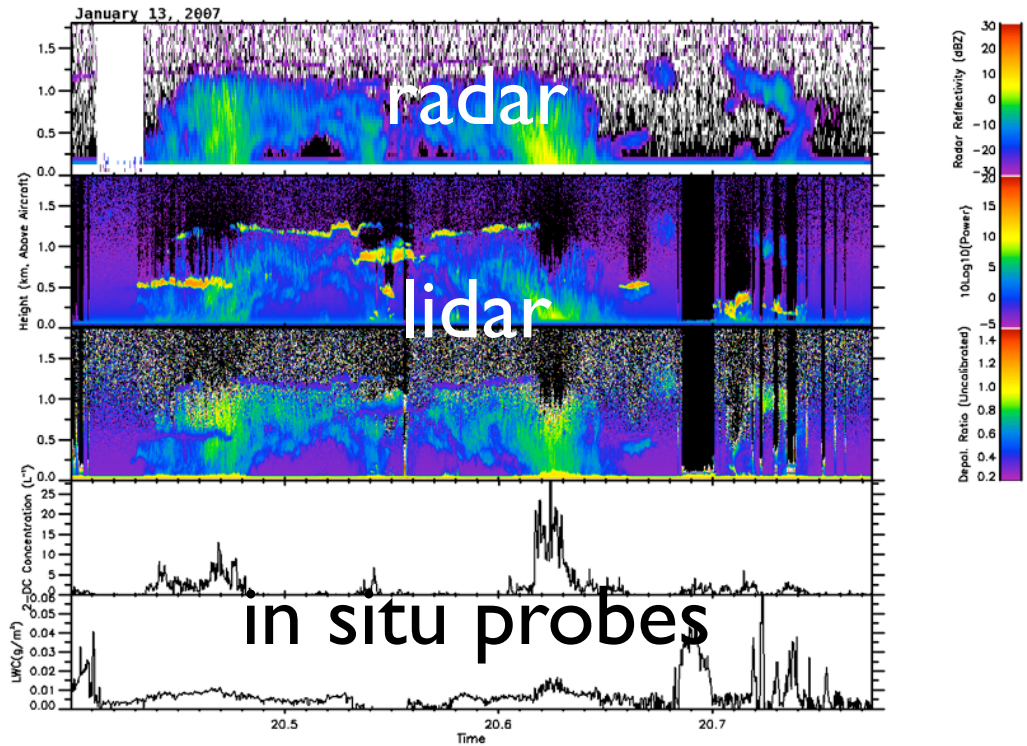
nasa06 jan18 22:45 - 22:48 detail

upper panel contours are reflectivity and arrows are U + W
lower panel contours are W

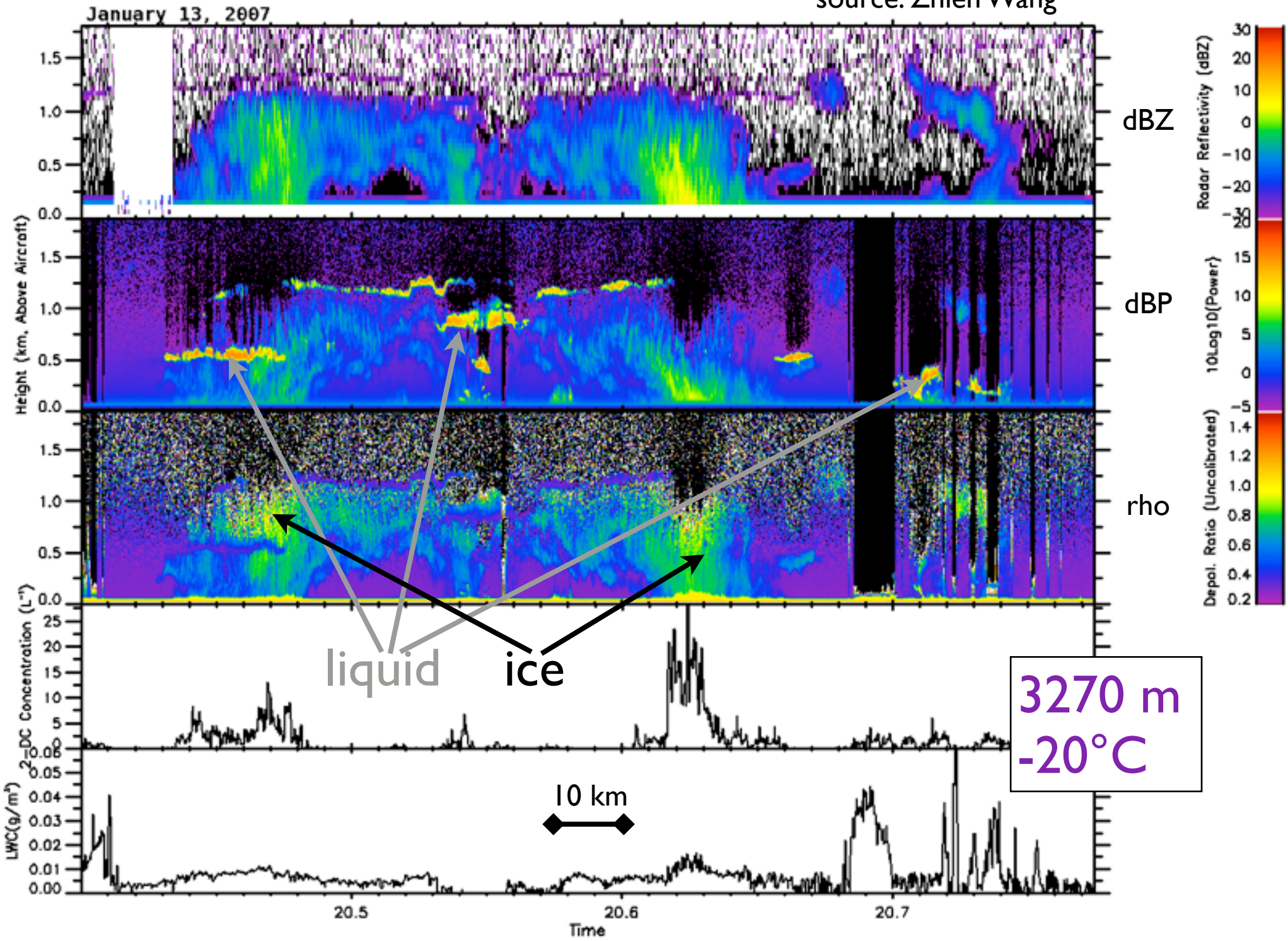


in situ probes



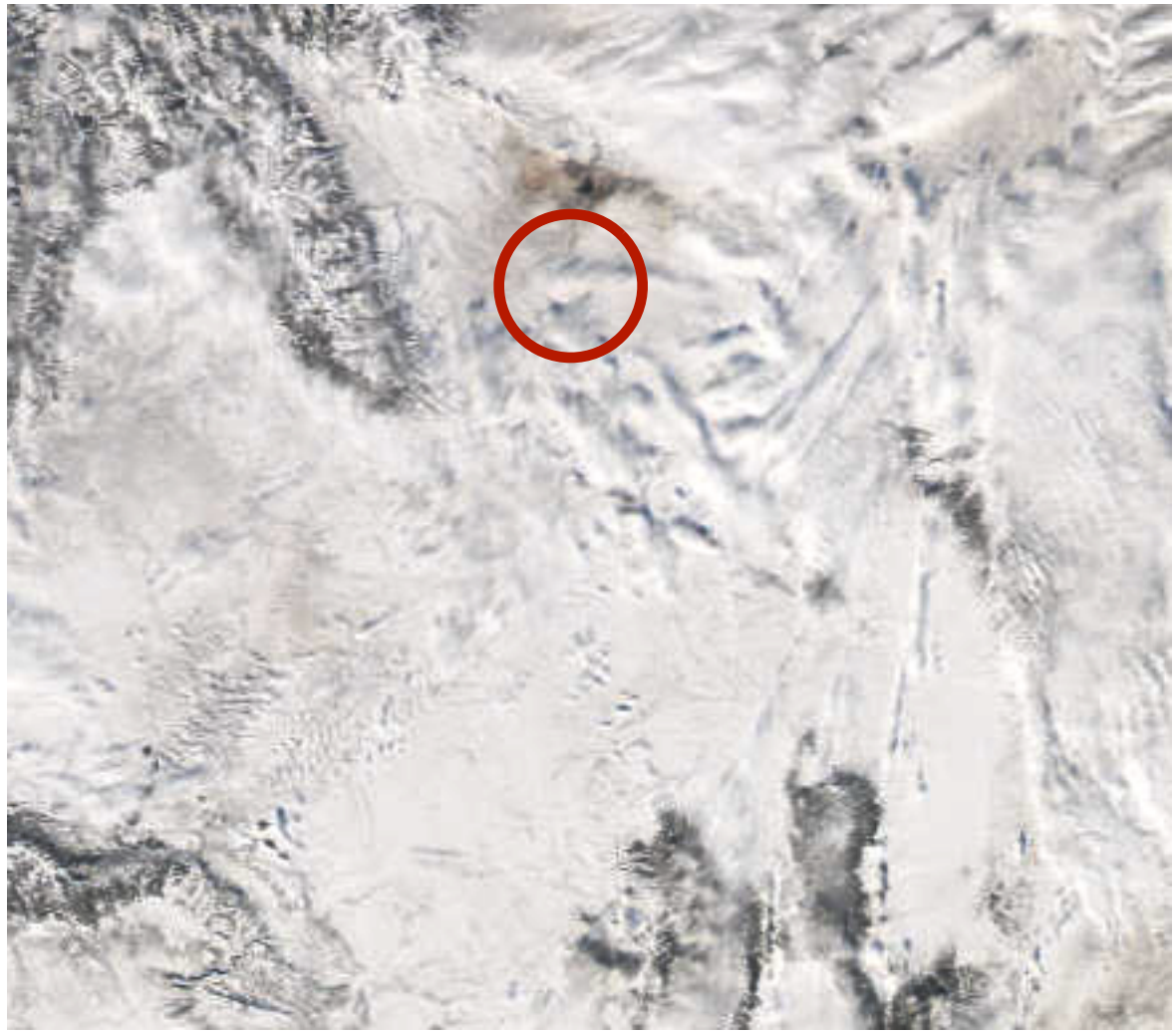


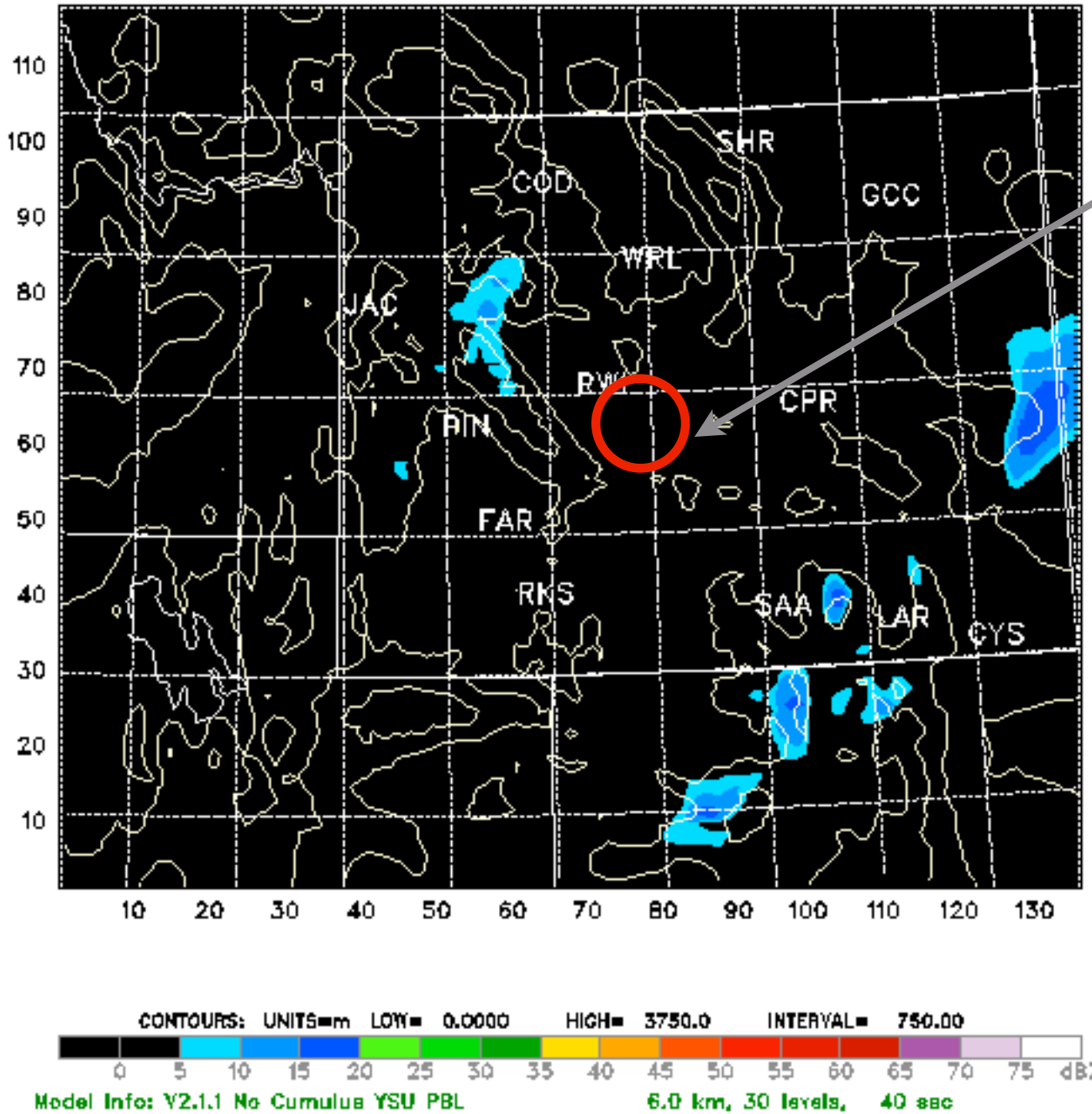
source: Zhien Wang



3270 m
-20°C

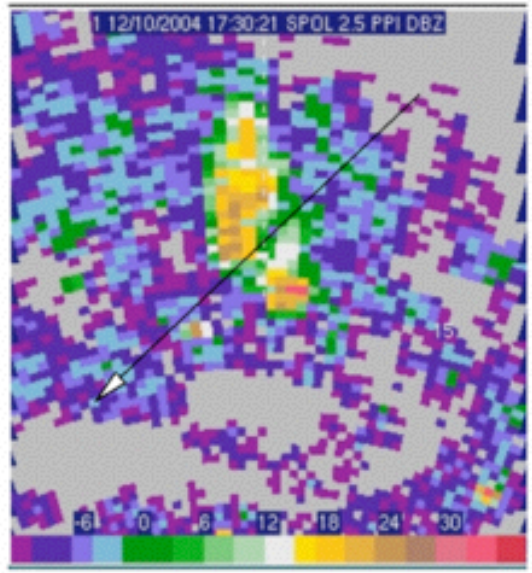
Source: MODIS http://rapidfire.sci.gsfc.nasa.gov/



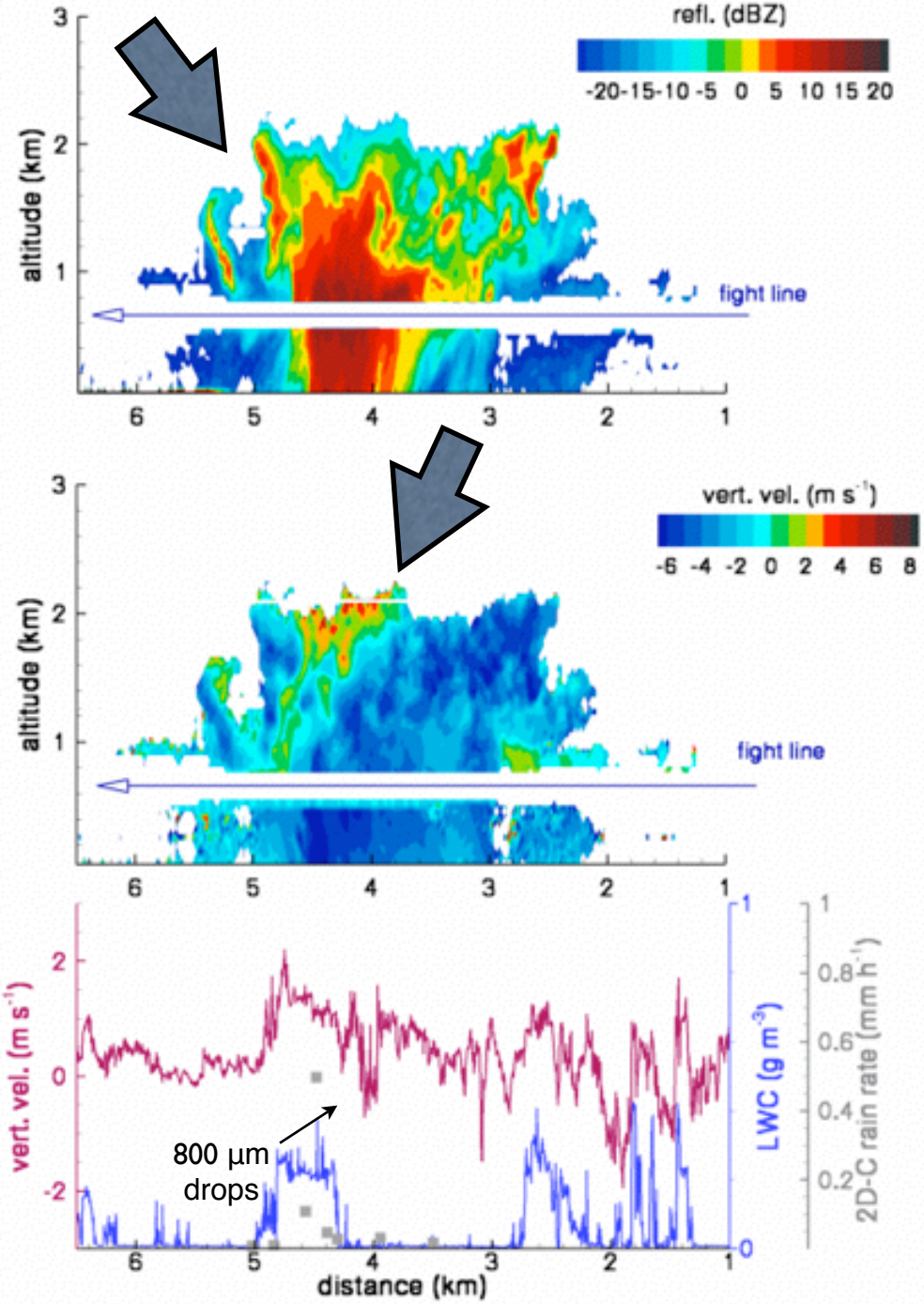

flight
area
SHR
COD
GCC
WRL
JAC
CPR
RIN
FAR
RKS
SAA
LAR
CYS
110
100
90
80
70
60
50
40
30
20
10
10 20 30 40 50 60 70 80 90 100 110 120 130
CONTOURS: UNITS=m LOW= 0.0000 HIGH= 3750.0 INTERVAL= 750.00
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 dBZ
Model Info: V2.1.1 No Cumulus YSU PBL
6.0 km, 30 levels, 40 sec

Source: G.Vali, unpublished

RICO 20051210 17:28:26 - 17:29:52
656 m altitude
Pass along 245° heading.



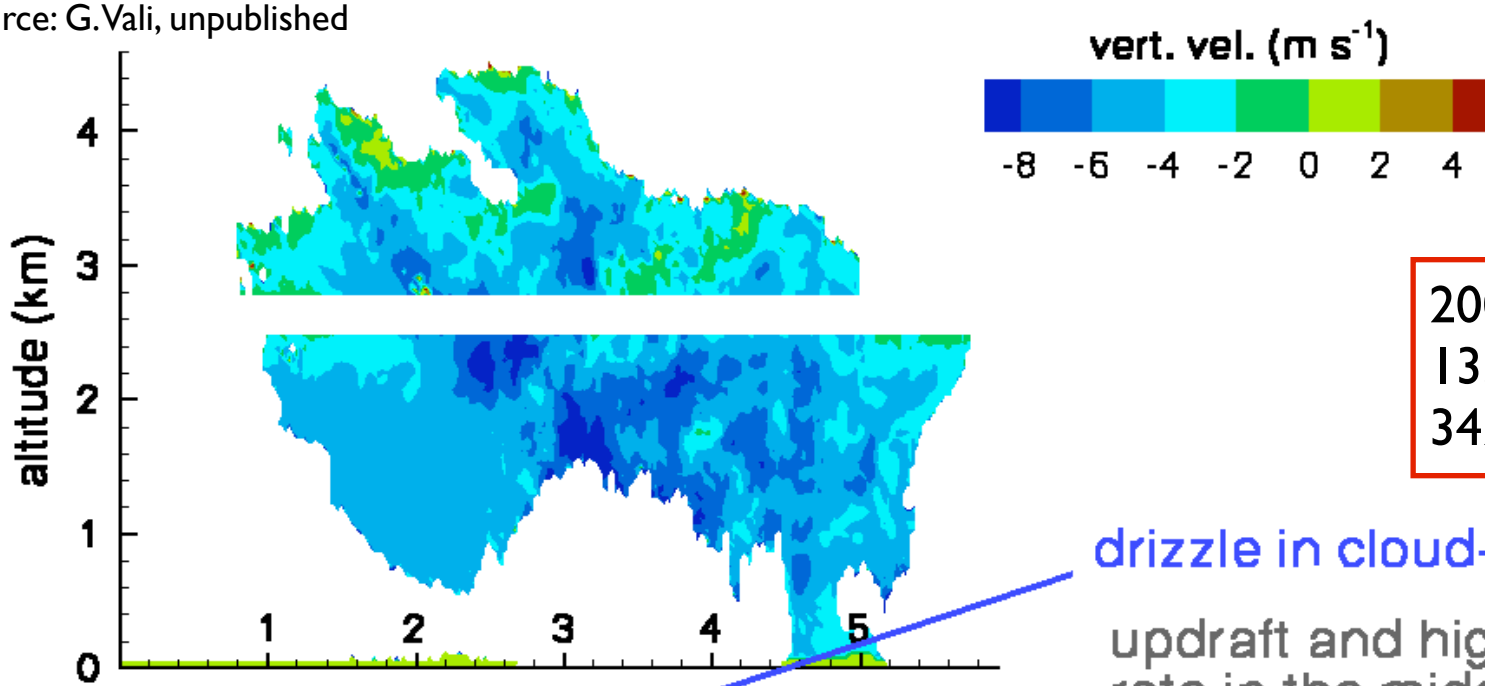
SPol 17:30:35 2.5° ~ 0.7 km



dec10/zv_1728; 16 Jan 2006 18:11:38

2007

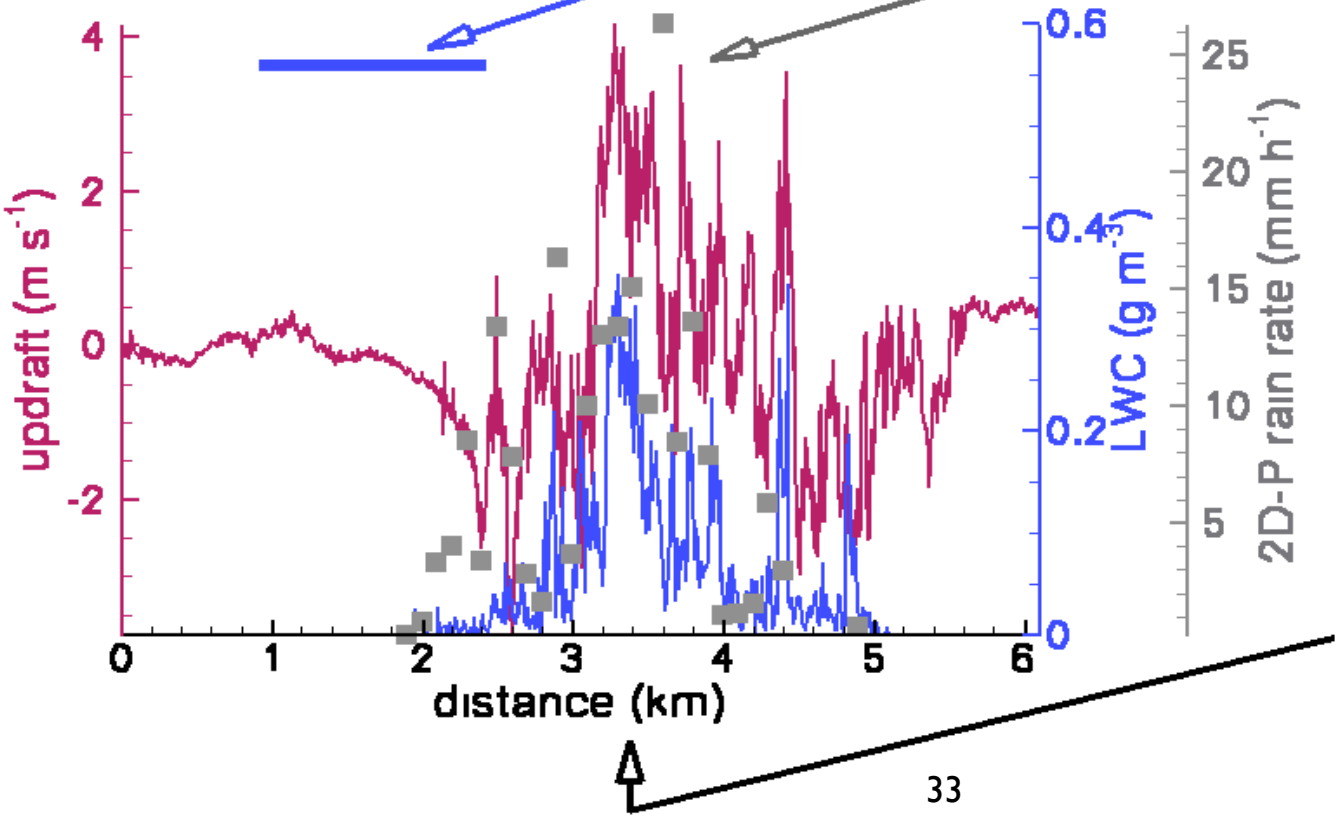
Source: G.Vali, unpublished

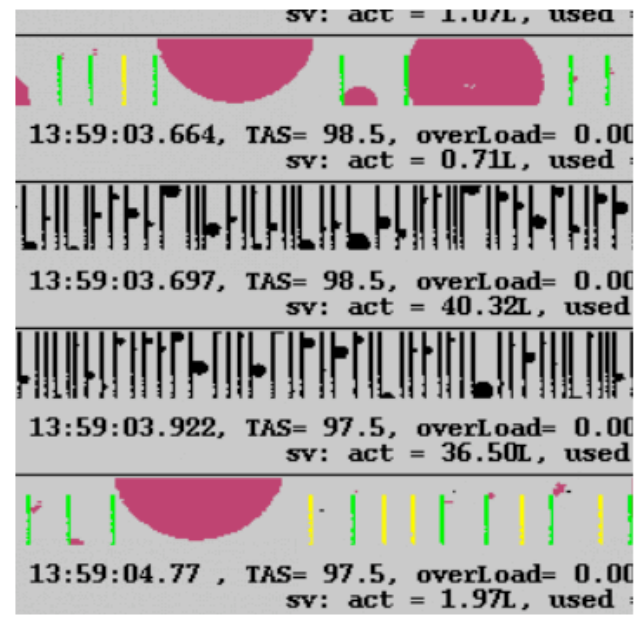


20050117
13:58:30-13:59:30
342° heading

drizzle in cloud-free air

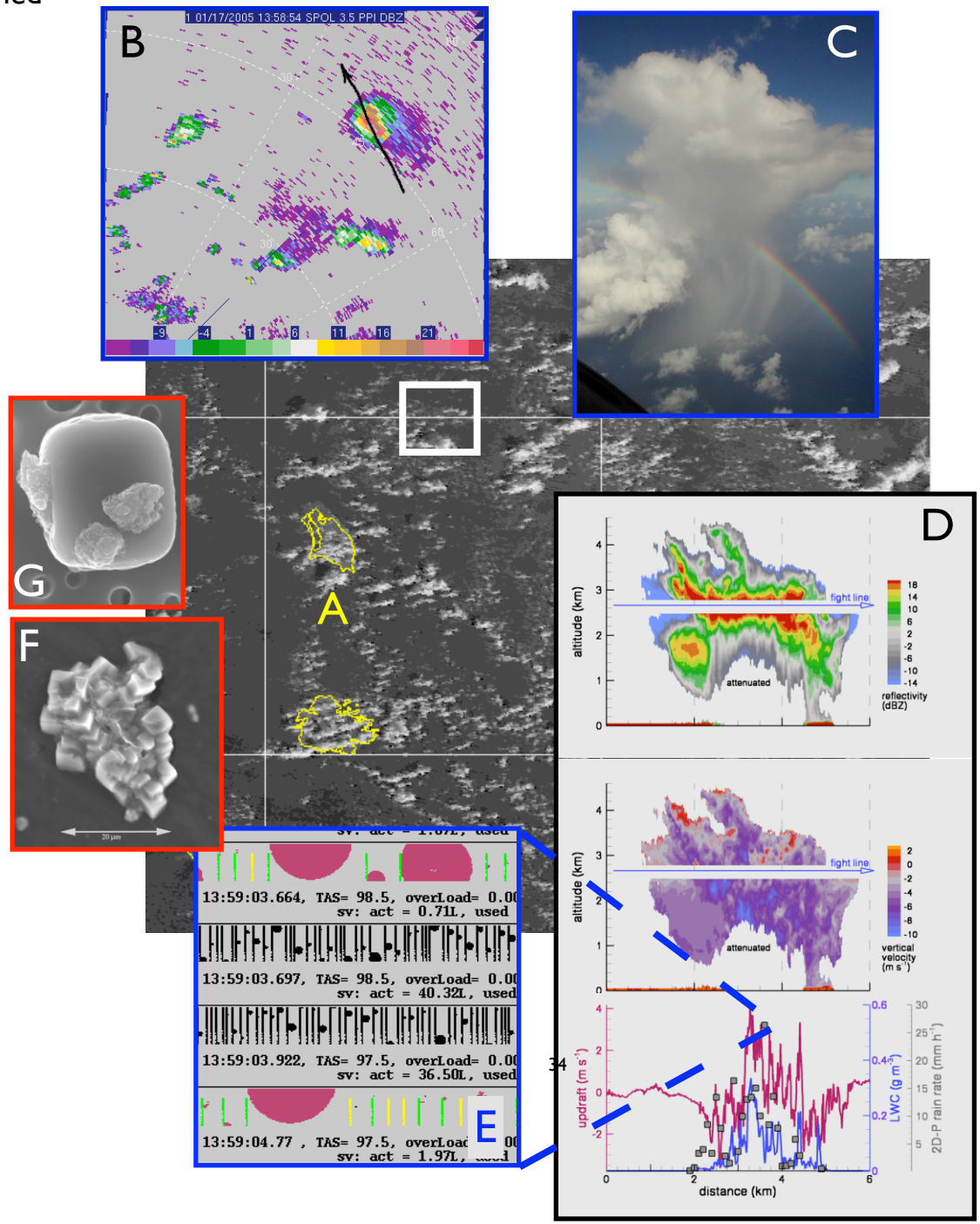
updraft and highest drizzle rate in the middle of precip.





max. 2-mm drops

Source: G. Vali, unpublished



The weather modification dilemma:

When to initiate some cloud seeding activity, knowing that we lack knowledge of all the details, and that we face poorly predicted cloud conditions? (*When did we test enough?*)

The answer will be a result of negotiation between users, administrations, politicians, and scientists. (*The scientists can only offer advice.*)

a final note from the medical doctors:

When confronted with some uncertainty in making a diagnosis (almost always the case), doctors are susceptible to unconscious emotions and biases: "representativeness" "availability" "caring"

" ... how doctors think can affect their success as much as how much they know, or how much experience they have." "The implicit assumption in medicine is that we know how to think. But we don't."

quotes from article by Dr. Groopman "What is the trouble?" in the New Yorker, Jan 29, 2007.