Sounding Science Meeting Notes

May 7th, 2009
Beckman Auditorium, Caltech

Bjorn Lambrigtsen introduction and discussion

Joel Susskind asked Bjorn L. about NPP re-compete, if its related to Aqua re-compete – answer is not sure – white paper that emanates from this mtg may help dictate this

Andy Dessler: AIRS should get "credit" for papers based on model re-analyses as opposed to direct use of radiances or derived products (L2 and L3). MERRA will be widely used.

Eric Fetzer: 2 documents we should pay attention to: Decadal Survey and the IPCC Report – need to confront sdg sci future ideas w/ these reports – potential disconnect between these two documents – NPP and NPOESS not up to task and neither is CLARREO.

Bjorn L.: Panels for pre-NRC decadal survey, perception that sounding was "mature" – bad perception

Andy Dessler talk

The primary place of importance for water vapor feedback is in the tropical UT – lower atm and higher lats are not as important

dT ~ 1.2 K for doubled CO2

All feedbacks lead to 2-4 K of warming

Dick Lindzen hypothesis – downloaded a lot (1990 BAMS)

Detrainment altitude controls water vapor amount in UT (Dessler and Minschwaner 2007). In future, higher altitude of detrainment, also higher T, thus higher UT WV. Const RH not required.

What determines the UT H2O? Detrainment or large-scale advection?

Subsidence rate + WV conc + detrainment intimately coupled

Eric F.: Asked about what is assumed in study (was it adiabatic, but no assumption about constant RH)

To test WV vapor feedback, look at processes on shorter time scales – e.g., Dessler et al. 2008

Evan Fishbein: Q: Tropopause effects w.r.t. Dessler et al. 2008 work and WV feedback

A: trop ht. not important for WV feedback b/c conc of WV so low for WV near tropopause

Volcanoes + ENSO + inter-annual + seasonal cycles + decade-scale warming – all good test beds for water vapor feedback

Looks like ENSO WV feedback stronger than long-term warming – spatial dist of WV feedback response differs

Feedback of WV depends on phenomena – can have different characteristics

Alex Ruzmaikin: Q: Are these global or local feedbacks? A: Global.

Need different strategies for different feedbacks

Need short-term variations (e.g., ENSO) to help test long-term feedback – but could have different character and data record not long enough to assess trends

Spencer and Lindzen given up on WV feedback skepticism

On to clouds …

Soden and Held (2006): Small change in clouds can offset or amplify CO2 effects – will solar or IR dominate?

Lindzen et al. (2001) BAMS: Arthur Hou (3rd author) is very evasive, may not believe results of paper

Spencer et al. (2008), GRL: with warming, clouds increase cooling – neg feedback, but a regional analysis, not necessarily globally applicable

SW and LW terms ~ 100 Wm-2, but the diff is on the order of 1 Wm-2 – very hard to deal with, and T and WV effects must be dealt with

<u>If we are wrong about clim change, it will be because of cloud feedback.</u>

For WV feedback, no credible evidence for neg feedback – could be differences btw long-term decadal trend and seasonal/inter-annual/regional feedbacks

Brian Kahn: Q: Sfc vs. midtrop T vs. cld freq in Spencer paper, can it affect results?

A: Some neg correl w/ midtrop T and sfc T (Dessler repeated results for both T's)

Baijun Tian: Q: Requirement of time scale for test of feedback? Can we use diurnal cycle?

A: Need global tests. Diurnal cycle – maybe regional/local tests. Should look at spectrum of scales (time/space) to test feedbacks. Must be a global response.

Alex R.: Q: How to separate cld from other feedbacks?

A: Can do it well in a model (not necessarily with data)

Yuk Yung: Q: Do data show opposite prediction of models for feedbacks?

A: Not sure. Spencer work not a global result.

Eric F.: Models don't always embody phenomena.

Evan F.: Q: Clr sky + all sky OLR – assume properties about clouds – impact usefulness of AIRS OLR?

A: (Joel S.) AIRS agrees very well with CERES

A: (Andy D.) Using all OLR products, see what overall story is. Cross-checking and validation. Multiple data sources.

Hui Su: Q: What processes most relevant for long-term warming?

A: Not sure, trends hard to discern with limited CDRs at this time. Best current strategy to test against shorter-term processes.

George Aumann: Q: Objection to use SST as proxy for feedback test?

A: Not sure if there are objections to it. Need a global response.

Andrew Gettelman talk

Key uncertainties in modeling and how to use obs to reduce them

Ch. 10, IPCC 2007

Climate sensitivity depends on parameterized processes

Monsoons, TCs, NAO, AO (polar modes), ENSO – how will these change in the future? Big societal impacts. Increase in ENSO variance in last several decades.

Vecchi and Knutson (2008), J. Climate: TC trends

Gen circ changes: Seidel et al. (2008), Nature Geosci, jets, O3 pattern, OLR, trop height all expand: width of trop/subtrop epanding – change in precip patterns

Lots of drying in subtrop – moistening in trop and high lats

An example of a (potential) tipping point: Greenland. Controlled by atmos processes.

Don't have coupled ice physics in climate models – 5-10 years down the road

Another tipping point: Arctic sea ice

Uncertain processes: q, clouds (feedbacks and processes), coupled system feedbacks

Gettelman and Fu (2008), J. Climate

Response of UT WV consistent with const RH hypothesis

Positive feedback (certain)

Very structure of WV feedback is key

Key region: response of low clouds to CO2 forcing (Soden 2005 J. Clim figure)

Different models show diff clim sensitivities w/ clouds – the biggest uncertainty

Midlat/subtrop low strat clouds

Arctic low clouds

Kay and Gettelman (2009): MODIS vs. MISR vs. CSat/CAL – all see different cld types – all are "right" but disagree

Aerosol effects on clouds need to be observed and modeled

Key obs: q, radiation, clouds, aerosols, vertical resolution, high freq spatial and temporal sampling key (including diurnal cycle)

Diffs in RH between CAM and AIRS leads to differences in rad fluxes – globally 1 Wm-2, locally 5-15 Wm-2 in OLR. Also, differences at surface ~ 1 Wm-2. Thus, large uncertainty for attrib processes

Clds – diurnal cycle

Huge diffs in diurnal cycle btw TRMM and CAM 3.6

Not getting organization in models for clds – conv complexes done poorly

Modes of variability missed in Tropics in models – shown w/ AIRS data (RH)

No MJO in CAM – see some modes moving west (Kelvin waves). Wrong type of convective organization.

Aerosols: Models show much larger indirect effects than obs studies: not certain why this is

Summary: cld feedbacks a major issue, Arctic feedbacks, need multi-instrument, multi-spectral obs

Vertical structure is critical

Microphysics: especially ice microphysics in UT tropics

Diurnal sampling crucial – need to do a better job – A-train can't do it right b/c/ only up to 2 local samples per day.

Future obs:

Continuity and CDRs are key … how do we build in continuity?

Vertical structure (clouds, H2O, aerosols, T), active sensors, diurnal cycle (conv organization, LT precession)

Try and salvage NPOESS for CDRs, continuity?

Obs that can resolve diurnal cycle – capture conv/organizational modes

Joel S.: Q: Usefulness of AIRS-like instrument on geostationary?

A: Yes, would be useful if we can do accuracy, noise characteristics right

Steve Marcus: J. Hansen says that clim sensitivity is "nailed". Any comments?

A: Not necessarily nailed. Paleoclim obs not necessarily reflective of actual clim sens – unresolved

Joao Teixeira: Diurn cyc of TRMM vs. CAM. What are causes of oscillation in ocean in CAM in Tropics and storm tracks?

A: Could be sampling – model samples like TRMM

Baijun T.: 3-hr model output from model good enough to resolve diurnal cycle

Bjorn L.: Q: Subgrid scale obs., how important vs. global obs at larger scales?

A: You need both. Small scale PDFs and global coverage. Importance of ARM sites. In situ is still very important. Calibrated CDRs that are reliable.

Evan F.: Q: How do we know that obs are right in TRMM and not in CAM?

A: Relative diffs w.r.t. time not that uncertain. Large averaging period, so TRMM probably pretty good.

Baijun T.: Q: Diurnal phase is different between ITCZ and subtropics over the oceans from TRMM data. Why? (color on CAM vs. TRMM plot)?

A: Lots of subtleties.

Brian K.: Q: Importance of vert. structure of microphysics and size/habit dist?

A: Even top of cld re and De are a good start.

Joao Teixeira talk

Subgrid scale processes in obs and models

Stephens (2005): Cloud feedbacks the largest uncertainty

Why is cld feedback problem so complicated for low Stratus clouds?

B. Stevens figure: diagram of cldy bdry layer, well mixed, driven by LW cooling at cld top

Very sharp gradients in T and q – unable to resolve w/ current sdg capabilities (unable to model well, either)

Battle btw subsidence (large-scale) and small-scale turb

Duynkerke and Teixeira (2001): Obs of Stratus @ San Nicolas Is. Compared to ECMWF (before ERA-40): severe underestimation in low clouds

Nature organizes into regimes – need to observe diff vert structures from space

Can have similar cloud properties, but T(z) and q(z) can vary widely between each regime as well as within each regime

Even though clouds are the leading order problem, need T and q to do the clouds better – very key point

Andy Dessler: Q: What about AIRS in the PBL?

A: Comparing against RICO data, looks pretty good.

Essence of problem: simultaneous estimation of PDFs of u, v, T, and q

Also classic problem of turb + radiation + phase transitions + rainfall/snowfall + gravity waves + spectrum of scales – complex problem

10^-3 m to 10^6 m

Characterizing the variance of thermodyn prop is critical to address cloud parameterization development

PDF models should be at the core of models, but not yet the case

Use satellite data to attack this problem

Stratocumulus ~ Gaussian; transition to Cu ~ skewed; this is the case in LWP PDFs from GOES (Kawai and Teixeira paper)

Thus, not always a Gaussian PDF, need obs to capture richness in regimes

Summary:

Need to observe T and q to predict cloud structure at subgrid scales

Turbulence at small scales

What do we need in future? Global high-resolution models + high resolution satellite observations – "turbulence" from space

Eric Wilcox: Q1: What are tech limitations for high vert res? Q2: Can we capture right distributions in models with regard to low clouds?

A2: Use obs to constrain types of PDFs to calculate in model

A1: This is purpose of workshop (in part) – need to focus "talent" in boundary layer

Hui Su: Q: How does climate GCM use PDF information?

A: ECMWF testing PDF schemes. Need to explore co-existence of traditional (e.g., Arakawa-Schubert) parameterizations w/ new PDF approach

Alex R.: Q: How similar/different is bdry layer around the world?

A: They can be different. Hard to generalize approach. 6 types of boundary layers in Tropics. Also, need to "transition" between them.

Evan F.: Q: "Typing" or "categorizing" patterns of convection. How to do it?

A: Patterns may appear based on different variables, e.g., clds, T, and q

Yuk Y.: Q: Separate water vapor lines vs. water vapor continuum – can you use continuum to nail bdry layer WV better?

A: Yes. How to do it? But, we need to go beyond that: ask "what do we need"? Define needs.

Feiqin Xie: Q: Horiz, vert, temp resolution requirements? What is highest priority?

A: Don't know what is more/less important. Need to explore.

Steve M.: Q: Clouds (low Sc types) impacted by large-scale subsidence?

A: Not been answered. Why do cloud patterns change? Still an open question.

Brian K.: Q: Calc vertical velocity from sat obs?

A: Yes, can try with AIRS.

Stan Kidder talk

"Weather" emphasis vs. "climate" perspective – point of view from forecaster

VIS + IR from LEO and GEO

MW from LEO

Ground-based radar and rain gage estimates

NOAA/NESDIS rainfall hydroestimator – from VIS/IR channels

QMORPH rain rate at NOAA CPC, combines cloud vector winds and TRMM rainfall

Forecasters think that data > 3 hrs old is useless for nowcasting

Possible sol'n: constellation of LEO – 2 sats in each of 7 orbital planes ~ global 50 m resolution

But: can do GEO MW ~ 15-30 min res globally

Close to maximizing utility of current data sets for forecasting applications

Eric F.: Q: Spatial res from GEO to resolve conv features?

A: Get down to 20 km will be very helpful. Need somewhat decent resolution and retrievals, but clim quality not necessary.

Unknown: Q: Assimilation of precip to impact precip forecast?

A: Not at this time, least able to forecast it and assimilate it – not very mature

Joe Turk: Q: Combination of sensors for cold season precip?

A: higher freq MW obs could help

Joel S.: Don't know how important cold season precip rates is at this time

Feiqin X.: Q: Goal of more precip obs for assim or just for obs/fcstg activities?

A: Focused on nowcasting. Precip adjoints don't really exist – not sure on how the modelers assim precip (if at all)

Alex R.: Q: Precip extremes useful for clim model eval?

A: Yes.

Eric Fetzer talk

Measures effort

Merged WV-centric record using A-train and also reconcile w/ TOVS-era obs

Key for decadal-scale WV trends and change in ENSO variance in 70s

Joel S.: TOVS pathfinder products have discontinuities

Link of WV observing/sampling by clds, climate state (IR vs. the MW vs. etc.)

No guarantee that certain cld type has universal T(z) and q(z) .. not true w/ low clouds (Teixeira talk) and also not seen in AIRS/CloudSat data

Influence of clds on WV seem to be in free trop

Fetzer et al. (2006): Yield can vary strongly by cld/clim regime type … how well do we sample?

Max sampling in subtropics/trade wind Cu regime

Sampling bias in AIRS strongest over low clds (relative to AMSR-E) --- low or high --- depends on mechanism of cld formation (St near bdry current or cold air outbreak over ocean)

In the Tropics, AIRS is essentially unbiased

AIRS T(z) and q(z) by CloudSat cloud classes

Yields for shallow clds ~ 80%; Yields for deep clouds ~ 2-63%

Huge diffs in q(z) as a function of cld state; Diffs btw warm/cool pools in Trop Pac.

Sc in TWP and TEP – much more moist in TWP than TEP in free trop – similar idea that Joao discussed – no universal q(z) profile for the same cloud type/regime

Alex R.: Q: Other obs like SST help?

A: Maybe … need to pull in other variables

Andy D.: Try including 500 hPa vert vel … probably better related to water vapor and cld type

Joel S.: Fixated on TWV column flag

Eric F.: Moved beyond flags …ask science q's

Evan F.: Cld typing in radar based MW, AIRS in IR, mis-match in information. How to reconcile?

A: Don't look at single data set ... look at multi-data sets simultaneously

<u>Duane Waliser talk</u>

Sat obs now make it possible to document and examine complete hyd cycle of MJO

Nice diagrams of MJO composite fields

Evap effects in midlats much higher in extratropics than Tropics w/ MJO (Baijun's work) – extratropical effects can be large

dW/dt = -P + MC + E

Eric F.: Pos ice phase anomaly in pre-cond phase of MJO?

A: No, in wet phase

Brian Kahn talk

Scale-dep. of WV: V. important @ small scales; V. important re. observing systems

T: High ratio sigma(large-box)/sigma(sml-box) @ mid-lat; Low ratio @ EQ & Polar

q: Low ratios @ high-lat, but high ratios otherwise widely scattered/distributed

Cirrus IWC: variable skewness (from CloudSat)

Break in power-density spectrum near 500-800 mb (-3 pwr > 800, -5/3 <400)

LWP: -5/3 power at all scales

T&q: steepest slopes @ mid-trop (T); q does not show scaling breaks

Next: compare model scalings vs. obs.; consider obs. sampling issues; constrain model physics

AIRS: extrapolate to <150 km? Little aircraft evidence of T/q scale breaks at <150 km, but that's the case for cld prop's

Open discussion

Andy D: Measurement requirements needs to be tightly coupled to science q's.

Bjorn L.: AGU session – June 12th deadline – session based on subject of this workshop

How many "meaty" talks vs. "boutique" talks? TBD

Eric F. and Andy D. will run AGU session in SF (they both volunteered)

Base session on interesting science q's

Town Hall session (in the evenings) a crapshoot – do a real session

Decadal Survey + CLARREO + NPP – who advocates what missions? How do they sell message to powerful voices/decision-makers?

"Sounding science" a place-holder for now – need a better name

Andy D. calls himself a "data analyst"

Stan K.: Town Hall mtg at AGU about "What is missing in Decadal Survey"?

Eric F.: What isn't in D.S., we should be hammering and exploiting this area

Tom Pagano: Says that CLARREO folks don't sell themselves for process studies – its in the realm of the "sounding community" (e.g., us!!)

Clim variab, clim processes, trends, all spatial/temporal scales – this is how we should frame ourselves scientifically

More urgently, what are we going to do about NPP? Where do we fit into the overall picture?

No clim researchers on NPP team – no real way to impact instrument requirements for climate needs

Bill Irion: Need to focus on customer needs – e.g., modelers

Mous Chahine: NASA did not participate in NPP because they wouldn't sign on to "non-interference pact"

Jim Gleason: short wavelength decision based on early bad decision – impossible to re-do.

Shutting down lots of activities b/c of budget constraints. "VIIRS bled them dry"

Better chance at impacting Charlie 2 (2nd flight) – possible AIRS/Charlie 2 overlap given the health of AIRS

Need to articulate new requirements for UT WV. Didn't sign up for CO requirement … but, for the 2nd flight, can re-make requirements

ATMS in Charlie 1 and 3, but not on Charlie 2. Took sdg package off of the 530 am bird.

Bjorn L.: Taken years to do/come close to "climate quality" products with AIRS

Evan F.: "cherry picker fruit". Requirements of cloud products in the presence of water vapor regimes, etc.

Loss of cld product quality w/ loss of CO2 slicing channels

Jim G.: Someone along the line decided to scratch CO2 slicing channels b/c of budget constraints – not getting proper feedback from those who know better – hard to influence the NOAA part of NPP, which is in control of the flight bird

Don't bother to advocate for CO2 slicing channels – too much money, politics, VIIRS is ……. (possible expletive) anyway.

NPP and EOS science teams – separate budget lines, but last ROSES, they were merged – will be time in FY10, too…

Will be an FY10 call – need to throw together a white paper to influence the call – need to get it in front of people by late summer and/or early Fall

Bjorn L.: really need high spatial resolution obs for (perhaps) data assimilation and climate model parameterization efforts. Can we do this with aircraft campaigns?

Brian K.: Probably not … but probably both sats and aircraft both have contributions to make

Bjorn L.: (at least) 2 things to do quickly: (1) e-mail list for ongoing disc, (2) AGU session and/or Town Hall, (3) prep for white paper to influence ROSES FY10 call (and future NPOESS requirements? --- Brian K. insert)

-- Combine notes together, send out to e-mail list

-- Could meet again at Greenbelt, MD AIRS mtg