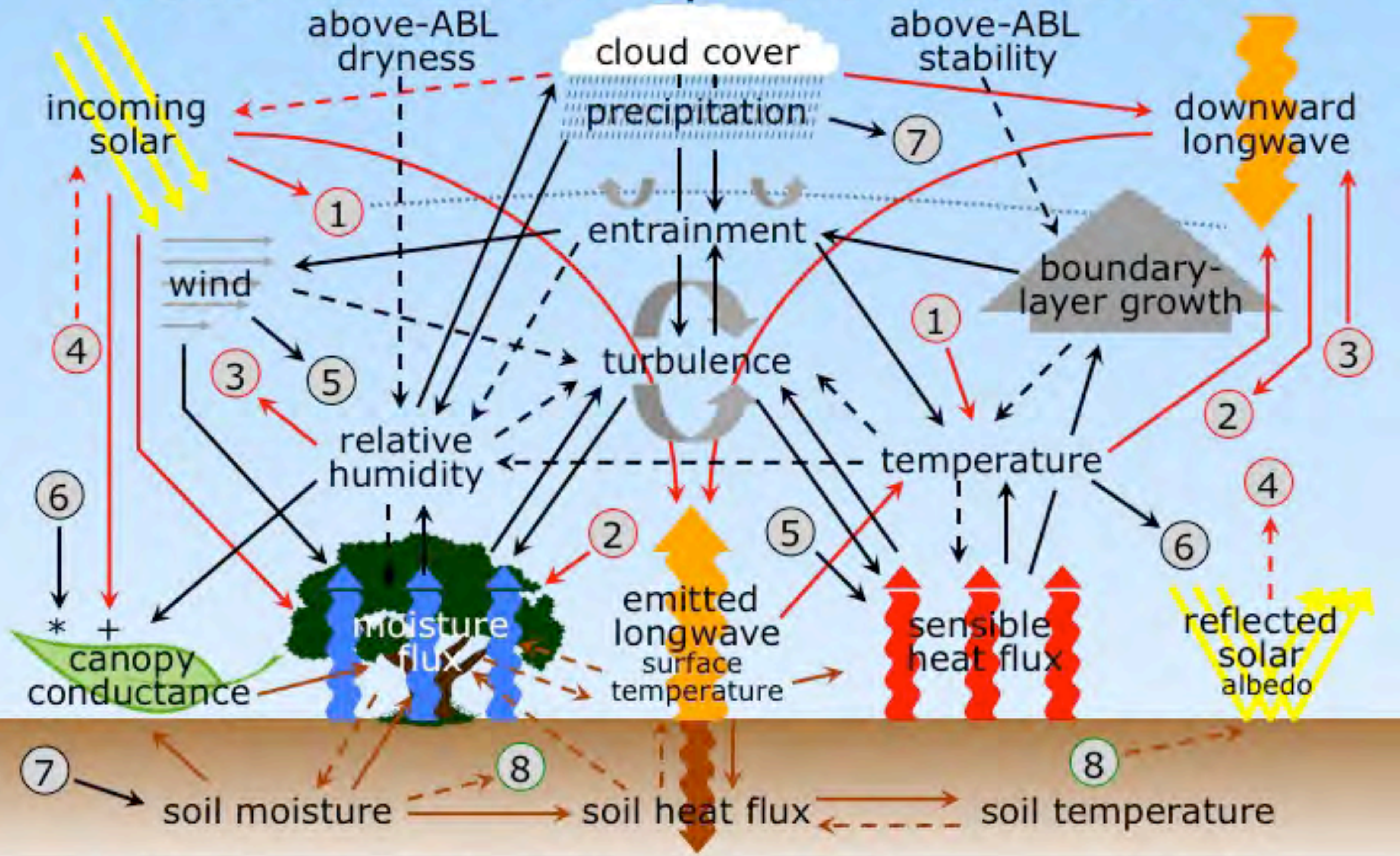
Cross-cuts:
New DICE (GABLS) initiative?
Other GLASS-GASS projects?
Other collaborations?

Some of the material from Gunilla Swensson's GABLS update for GEWEX SSG-29, China, Feb 2017

Local Land-Atmosphere Interactions



radiation — surface layer & ABL — land-surface processes — feedbacks:

+positive feedback for C3 & C4 plants, negative feedback for CAM plants — positive

*negative feedback above optimal temperature — negative

BACKGROUND: Diurnal land/atmosphere coupling experiment (DICE-1)

http://appconv.metoffice.com/dice/dice.html

Project started April 2013 to *study the interactions between the land-surface & atmospheric boundary layer*.

- Leads: Adrian Lock, Martin Best (UKMO).
- Joint activity between GLASS (land-surface modellers) and GASS (atmospheric boundary-layer modellers).
- 12 models participating.
- Follow-on to GABLS-2, where land-atmosphere coupling was identified as a important mechanism.

Workshops:

- 1st: 14-16 Oct 2013, UK Met Office.
- 2nd: 14-18 Jul 2014, GEWEX conf./Neth.
- 3rd: 20-22 May 2015, Météo-France.

Manuscript in preparation (for JHM).

CASES-99 Experiment (Southern Great Plains, USA)

GASS GEWEX WCRP Global Atmospheric System Studies

WOLVERINE Working Group on Land-Environment and Atmosphere Interaction

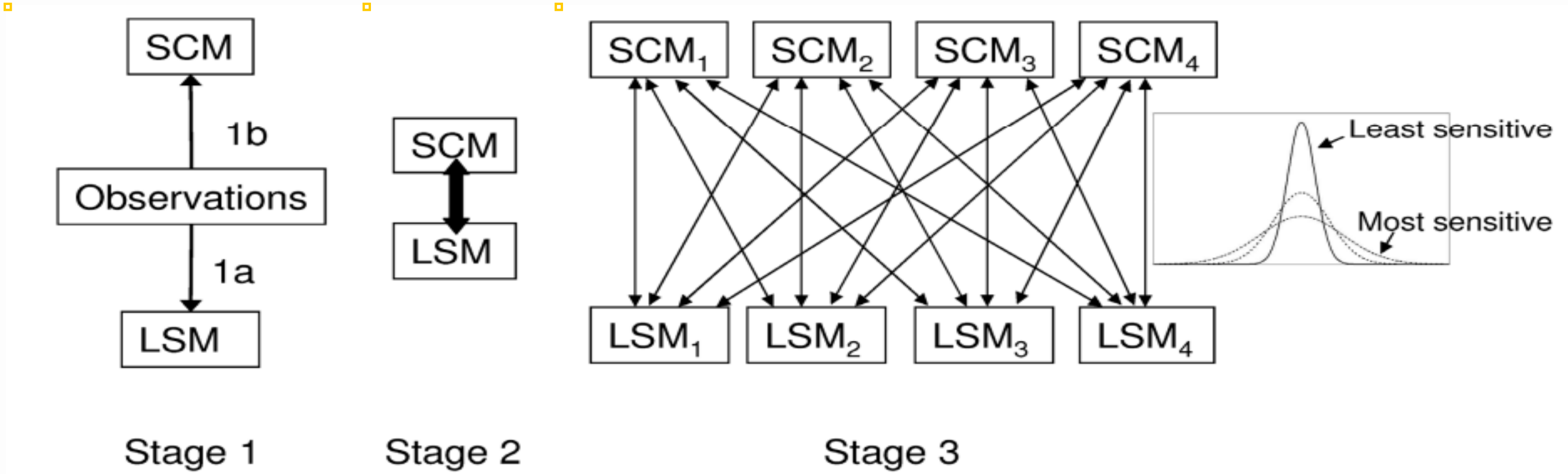
DICE-GABLS: Participants/Institutes/Contributions

Model	Contact scientist	Institute	Stages submitted	Levels	Sensitivity tests
Arome	Eric Bazille	Meteo France	All	60/70	resolution
Arpege	Eric Bazille	Meteo France	All	60/70	resolution
ECEARTH	Reinder Ronda	Wageningen	SCM only	91	LAI
GDPS3.0	Ayrton Zadra	CMC	All	79	
GFDL	Sergey Malyshev	Princeton	All	24	
GISS_E2	Ann Fridlind, Andy Ackerman	GISS	All	40	
IFS/HTESSEL	Irina Sandu, Gianpaolo Balsamo	ECMWF	All	137	LAI
MESO_NH	Maria Jimenez	UIB	All	85	Bare soil
UM/JULES	Adrian Lock, Martin Best	Met Office	All	70	Vegetation
WRF-NOAH	Weiguo Wang	NUIST	All	60	Lots!
WRF	Wayne Angevine	NOAA	?	119	PBL scheme
CAM5, CLM4	David Lawrence	NCAR	1a, 1b	?	
PBCM	Pierre Gentine	Columbia	Not yet		

DICE Experimental Design

Objective: Assess impact of land-atmosphere feedbacks.
Stage 1: stand alone land, and single column model (SCM) alone.
Stage 2: Coupled land-Single Column Model (SCM).
Stage 3: Sensitivity of LSMs and SCMs to variations in forcing.

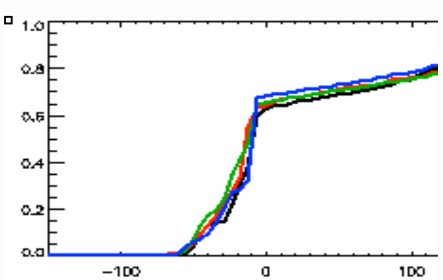
Data Set: CASES-99 field experiment in Kansas, 23-26 Oct 1999 using 2.5 days and 3 nights with intermittent turbulence (night one), continuous (two), radiatively-driven/no turbulence (three).

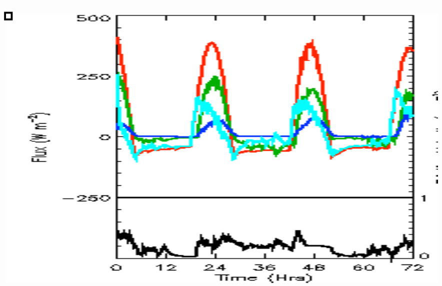


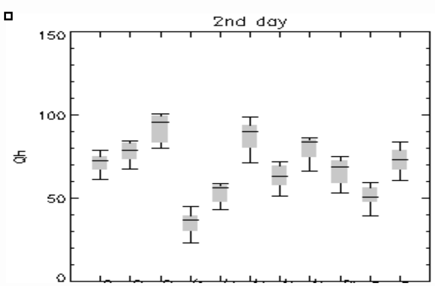
Martin Best and Adrian Lock (UKMO) et al.

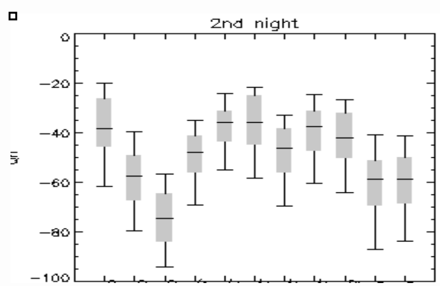
DICE Status/Summary

- 12 pages and 80 figures of results for stages 1, 2, 3!
- 9-year spin-up for LSMs.
- SCM: no relaxation of time-varying geostrophic wind (uniform with height); subsidence of T,q; horizontal advection of T,q,wind; radiation switched on in all simulations.
- Stage 1a (LSM): LHF generally far too large (LSMs didn't account for dead grass, adversely affecting bowen ratio); SHF and stress too large at night; 55m forcing too high for LSMs (vs 10m) especially for stable nighttime conditions.
- Stage 1b (SCM): Difficulty with wind profiles, particularly 1st night (intermittent turbulence); large differences in daytime parameterized entrainment; potential inaccuracy of (prescribed) large-scale forcing; SCM generally can be forced by observed fluxes and stresses.





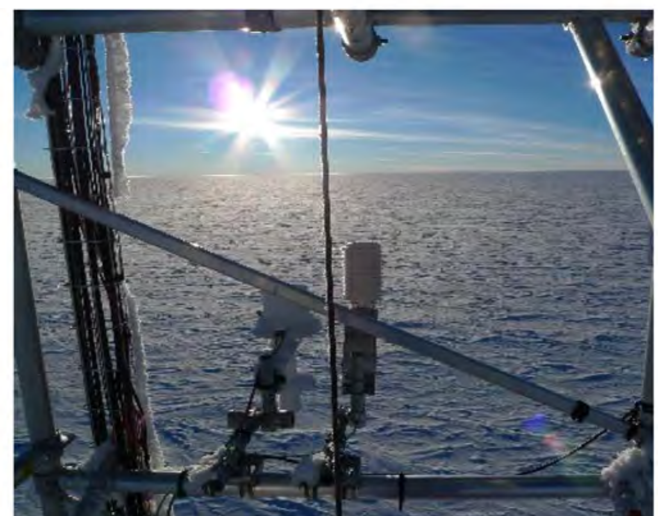




DICE Status/Summary (page 2)

- Stage 2 (LSM+SCM): excessive drag from LSMs generate deeper/less stratified SBLs; soil-surface coupling sensitivity at night; daytime PBL differences dominated by LSM surface fluxes, with RH dominated by SHF; more spread in PBL moisture; daytime PBL temperature evolution a "slave" to surface fluxes with PBL moisture more complicated.
- Stage 3a (LSM ensemble spread due to PBL variability forcing): largest variation in SHF during day & at night for more continuous turbulence.
- Stage 3b (PBL ensemble spread due to LSM variability forcing): day-time PBL: T, q dominated by sfc fluxes with variability between different SCMs similar, but sensitivity of inversion height very different.
- ***Summary: surface momentum flux and momentum profiles should be examined by DICE community; large errors in evaporation may dominate signal and the impact of coupling; further examine nocturnal fluxes and boundary layers and soil-surface coupling sensitivity.***
- ***Differences in different models' (LSM+SCM) sensitivity to changes in forcing are likely important in GCMs; needs to be better understood.***
- ***Repeat for many other sites (DICEs), e.g. GABLS project for Antarctica: GABLS4 or "DICE-over-ICE" (next page).***

http://www.umr-cnrm.fr/aladin/meshtml/GABLS4/GABLS4.html



GABLS4: "DICE-over-ice"

Project started in 2015 to *study the interactions between the ice/snow-surface & atmospheric boundary layer under conditions of strong stability*.

Leads: E. Bazile, F. Couvreux, P. Le Moigne (Météo-France)

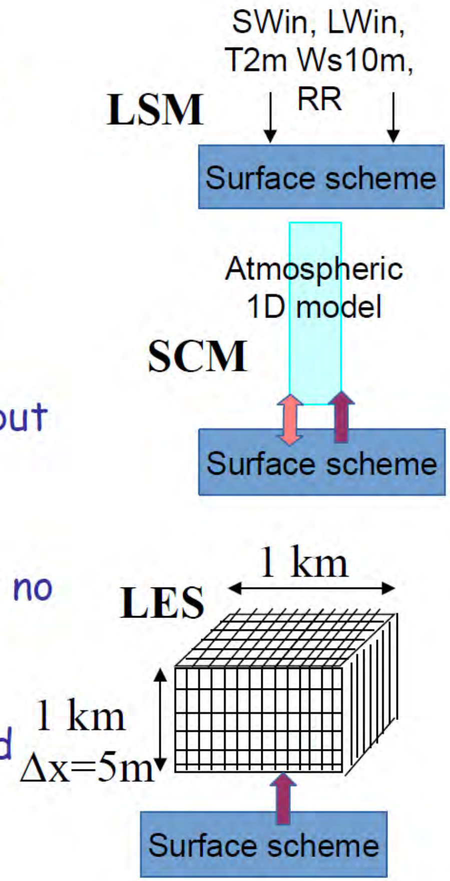
Dome C - Antarctica (Southern Great Plains, USA)

- Joint activity between GLASS and GASS.
- Several models/centers participating.
- Follow-on to earlier GABLS studies with ***focus on very stable conditions***, and a ***surface with low conductivity and high cooling potential over snow/glacier***, and following the earlier DICE experimental design, as well as including LES studies.
- Initial results presented at GABLS4-DICE Workshop, 20-22 May 2015, Météo-France.

http://www.cnrm.meteo.fr/aladin/meshtml/GABLS4/GABLS4.html

GABLS4: Case setup

- **Stage 0:** LSM (snow scheme) driven by observations for 15 days
- **Stage 1:** SCM with all the physics and surface interaction: 36h forecast starting the 11th Dec 2009
- **Stage 2:** LES and SCM, stage1 atmospheric forcing but the surface temperature is prescribed.
- **Stage 3:** LES and SCM. "ideal GABLS4" or simplified: no radiation, no specific humidity, constant geostrophic wind, no advection, Ts prescribed.
- Can we use stage3 with the LES results to understand the SCM deficiencies in stage2 and 1 ?



- 16 SCM participants
- 9 LES participants
- 7 LSM participants

GABLS4: Preliminary results

- The different sets of forcing of the SCM has been run to understand the model variability.
- The more idealized SCM simulations show more consistency with tower observations than running with model specific surface properties (e.g. surface roughness and albedo).
- LES results show relative good agreement during convective conditions and large differences during night that likely are related to the subgrid scale schemes.

Planned activities during 2017

- 1-day GABLS 4 LES workshop in Delft, Netherlands, in the international workshop on “Turbulence in Stably Stratified planetary boundary layers”, March 27th – 31st, 2017.
- Write-up of SCM and LES results for GABLS4.
- Workshop GABLS and WWRP PPP YOPP to discuss continuation of Lagrangian Arctic air formation experiment (Larcform) and other possible SCM & LES studies to aid model development in polar regions.

DICE updates/comments on DICE future

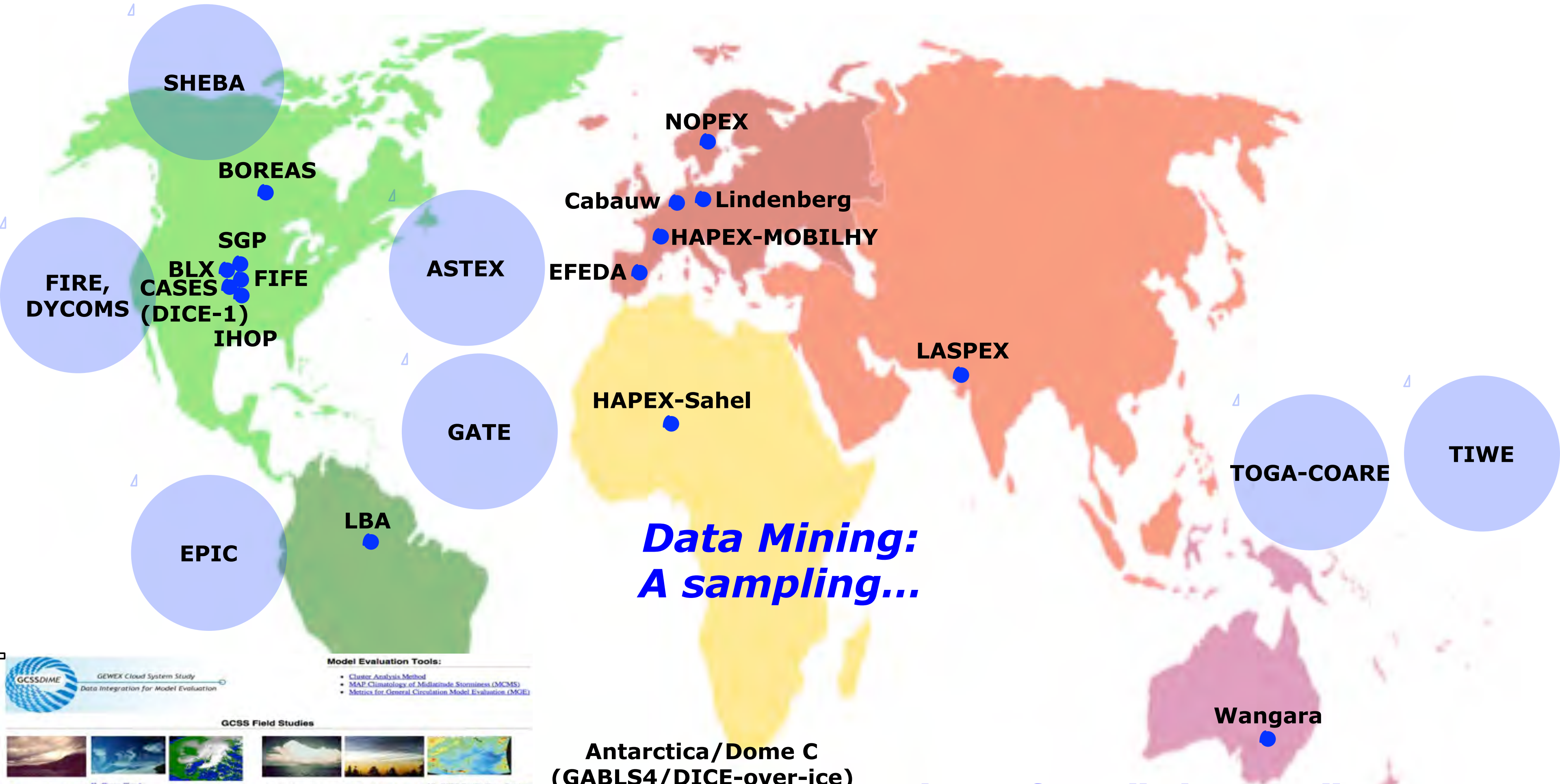
Martin Best:

- Adrian and I are still trying to write up some papers.
- More DICE sites: careful design needed to ensure you can get some proper results out of it, and not just that the models are different.
- Need to have good observational dataset with everything co-located.
- I am hoping that LIAISE can be set up to tackle this…
- We are thinking that some sort of surrogate experiment where we use LES to generate "obs" might be the way to go for the next DICE.

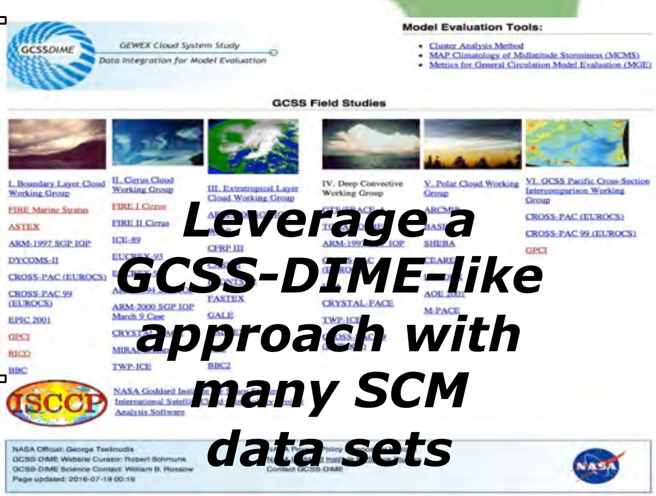
John Edwards:

- Traditionally GABLS (DICE) concentrated on process modelling (~1 day), while PALS/PLUMBER are focused on longer timescales. Focus on diurnal cycle, or do we want to go for the seasonal scale too?
- Need to keep LES studies onboard
- Stable boundary layers, heterogeneity
- Shopping list of cases: vegetated site w/nearly saturated soil (simpler hydrology/physiology), snow surface (beyond GABLS4?), very dry soil site, sparsely vegetated site (LIAISE?)--most focus on dense canopies.
- Benchmarks with better data or ways of initializing the model, like CASES-99, ARM data.

Possible Future DICE efforts: Field Programs for Model Physics Development, Surface-Atmosphere Interaction (land, ice, even ocean)



Data Mining: A sampling…



Leverage a GCSS-DIME-like approach with many SCM data sets

Land-Surface "Fluxnet", Tower data sets, Ship measurements, Radiosondes, Aircraft obs.

Physics Testing and Validation: ***"Simple-to-More Complex"***
Physics Parameterizations: ***Model Development Hierarchy***

Simulators

Radiation

Clouds & convection

Microphysics

Boundary-Layer

Surface-layer

Land

PALS/PLUMBER

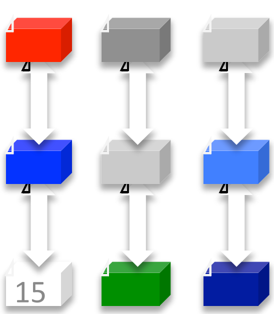
Sea-ice

Ocean, Waves

SURFACE

- Simulators: test submodel parameterizations at process level, e.g. radiation-only, land-only, etc.
- Testbed data sets to develop, drive & validate submodels: <u>observations</u>, <u>models</u>, <u>idealized/syn-thetic</u>, *w/"benchmarks" before adopting changes*.
- Submodel interactions, *w/same&add'l benchmarks*.
- Full columns, *with same & additional benchmarks*.
- Limited-area/3-D (e.g. convection) w/*benchmarks.*
- Regional & global NWP & seasonal climate, *with same and additional benchmarks.*
- **More efficient** model development, community engagement, R2O/O2R & computer usage.

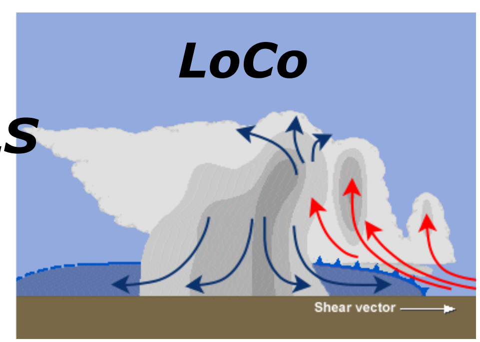
Interaction tests



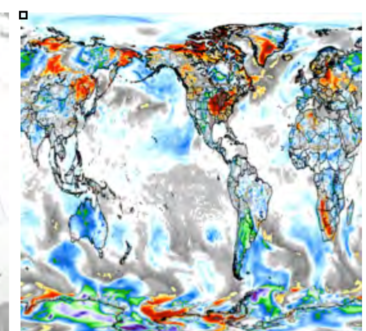
Column tests

DICE/GABLS

Limited-area



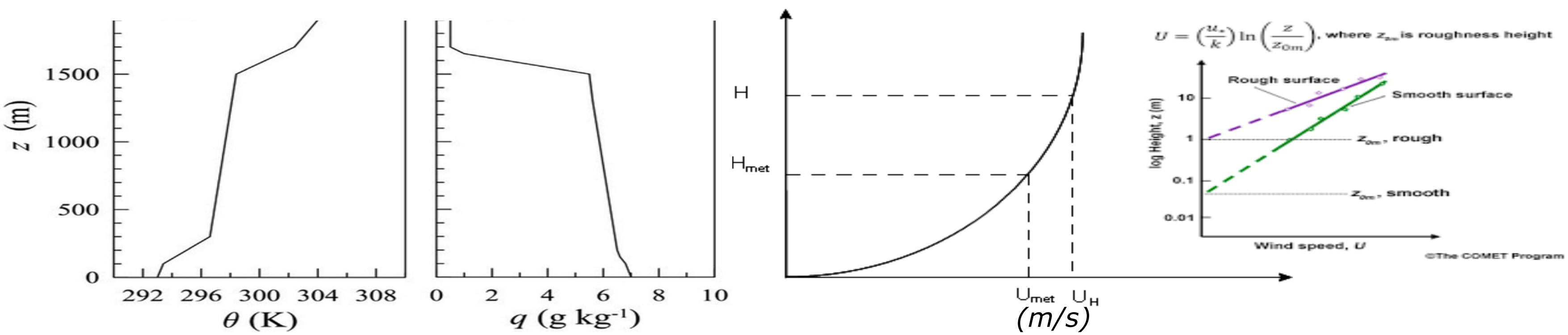
Regional & Global



GLASS

Testing and Validation: Surface-layer Simulator

- **GOAL**: Improve surface turbulence exchange coefficients.
- Surface-layer simulation (“SLS”) code simulates surface-layer param.
- Use observations to drive SLS (U,T,q and Tsfc) and compare with inferred Ch, Cd from independent “fluxnet” obs (H, LE, τ).
- **Finding (evaluation of obs.)**: *For example, bias in surface exchange coefficient for heat dependent on vegetation height.*
- **Action**: *For example, adjust thermal roughness coefficient (z0h/z0m).*



Temperature ***Moisture*** ***Wind***

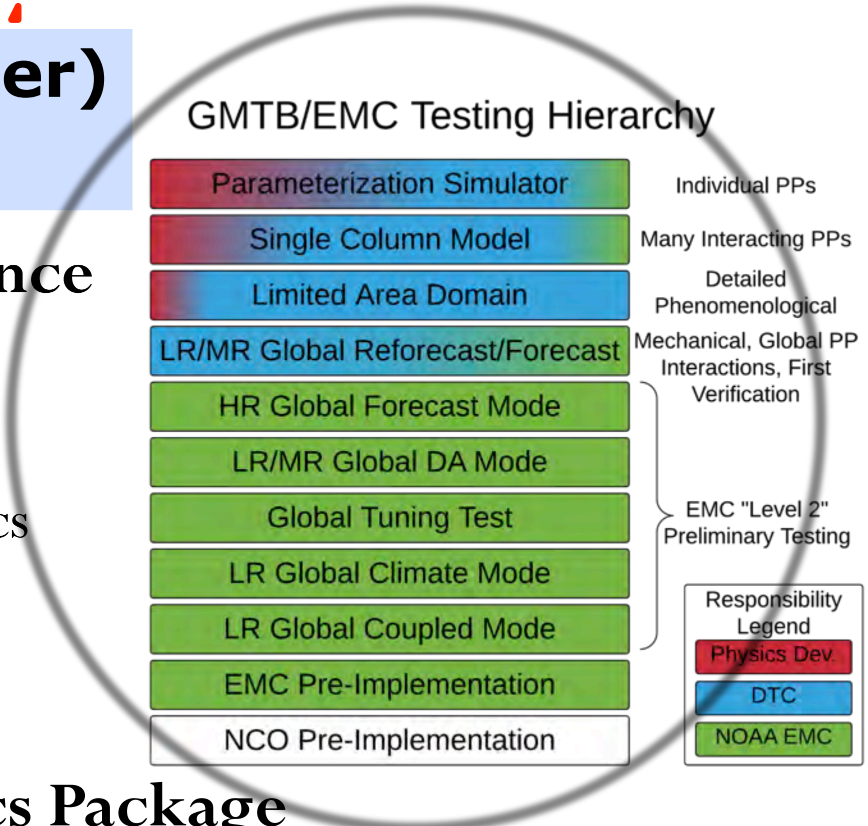
$$
\begin{aligned}
H &= \rho c_p C_h U (T_s - T_a), \\
LE &= \frac{\Delta(R_n - G) + \rho c_p g_a \delta e}{\Delta + \gamma(1 + g_a/g_c)}
\end{aligned}
$$

$$
\begin{aligned}
\tau &= \rho[(\overline{w'u'})^2 + (\overline{w'v'})^2]^{0.5} \\
&= \rho u_*^2, \\
&= \rho C_d U^2.
\end{aligned}
$$

The <u>Global Model Test Bed (GMTB)</u> is funded by the NOAA Next-Generation Global Prediction System to foster community involvement in the development of NCEP's global prediction systems

NCAR & NOAA Lab (Boulder) GMTB activities

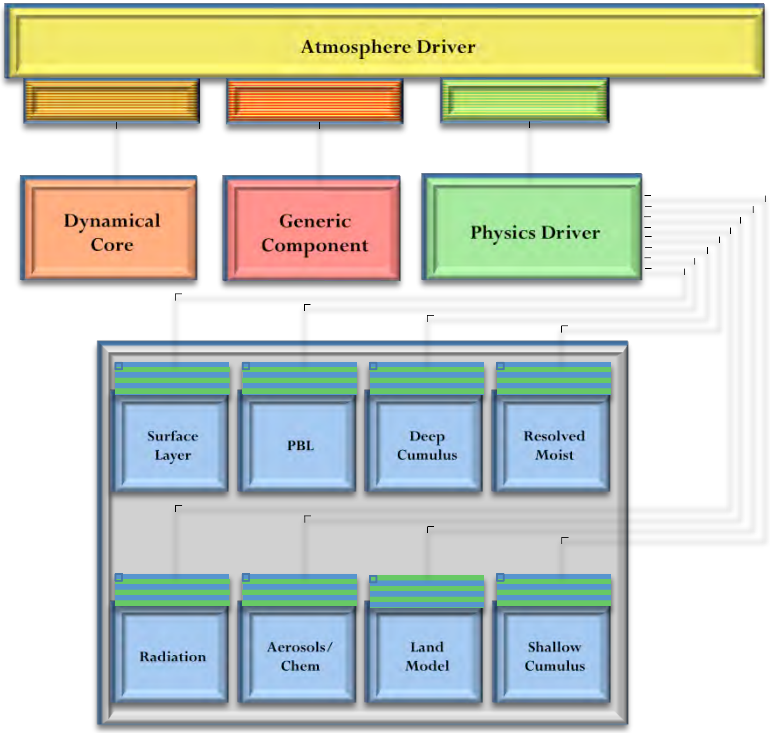
1. **Development and maintenance of testing infrastructure**
   - Single column model, global workflow, verification, diagnostics
2. **Testing and evaluation**



3. **Common Community Physics Package**
   - A collection of physical parameterizations, grouped in suites, that can be used with multiple dynamic cores
   - A framework that enables collaborative development and R2O

Way ahead: the Common Community Physics Package (CCPP)

A framework for community involvement in physics development. NOAA will benefit by having scientists in multiple institutions to run and develop a common set of physics



- CCPP is a collection of **dycore-agnostic**, **vetted**, physical parameterizations. There can be multiple of each type (PBL, cumulus etc.) to support various applications (high-res, climate etc.) and maturity level (operational, developmental)
- **Dycore agnostic** means that the parameterizations can be used with any dycore
- **Vetted** means that there is a process to determine what is included in CCPP at each layer

Year of Polar Prediction (YOPP)

"Extended period of coordinated intensive observational and modelling activities in order to improve polar prediction capabilities on wide range of time scales in both polar regions."

- 2017-2019 (preparation starting 2013, post activities through 2022).
- Key activity of WWRP Polar Prediction Project (PPP).
- Cooperation with WCRP Polar Climate Predictability Initiative (PCPI) and Climate and Cryosphere Project (CliC).
- YOPP Summit 13–15 July 2015 at WMO headquarters in Geneva.
- Mike Ek reviewed YOPP Implementation Plan, attended YOPP summit.
- *Key recommendations relevant to GLASS: Important topics of high-latitude land processes, hydrological cycle, land/ice-atmosphere interaction featured more prominently in revised Implementation Plan.*

Relevant to a GLASS-GHP-CliC-iLEAPS Cold Season Processes Project(?)

YOPP Summit 13–15 July 2015, WMO, Geneva

YOPP Objectives *(relevant to GLASS)*

http://www.polarprediction.net/yopp/

PPP WWRP WMO OMM

- Gather additional observations through field programmes aimed at improving understanding of polar key processes.
- Develop improved representation of polar key processes in uncoupled and coupled models used for prediction such as stable boundary layers.
- Develop improved data assimilation systems that account for challenges in the polar regions.
- Explore predictability on time scales from days to season.

Preparation Phase 2013 to mid-2017	YOPP Core Phase mid-2017 to mid-2019	Consolidation Phase mid-2019 to 2022
Community engagement	Special Observing Periods, field campaigns & satellite snapshots	Data denial experiments
Alignment with other planned activities	Dedicated model experiments	Model developments
Development of Implementation Plan	Coupled data assimilation	Dedicated reanalyses
Preparatory research	Research into use & value of forecasts	Operational implementation
Summer school Workshops	Intensive verification effort	YOPP publications
Fundraising & Resource mobilization	Summer school	YOPP conference

PPP

WWRP

WMO
OMM

YOPP in a nutshell