GPC Newsletter
Issue #10
October 2018

IN THIS ISSUE

APS TOPICAL GROUP ON THE PHYSICS OF CLIMATE

Message from the Editor

This is the tenth GPC Newsletter, published twice per year. You, the GPC membership, can be of enormous value. We invite comments, event notices, letters, and especially specific suggestions for content. Any of the above, addressed to GPCnews@aps.org, will be gratefully acknowledged in a timely fashion.

Message from the GPC Chair

Michael Mann, Pennsylvania State University

Welcome to the Fall 2018 GPC Newsletter!

This newsletter contains a number of items of interest, including a conference report on the recent mini-Symposium and Focus Session on "Fluid Dynamics of Atmospheric Clouds", the results of the recent Topical Group on the Physics of Climate (GPC) elections, and some important opportunities for GPC students and early career researchers.

We are VERY excited about the upcoming March APS Meeting in Boston. The meeting will feature two formal scientific sessions sponsored by the GPC: an invited session and a focus session.

Continued on p. 2

2019 APS March Meeting

The GPC will be hosting one Invited Session and one Focus Session at the upcoming APS March Meeting 2019 in Boston, MA from March 4-8. The GPC Program Committee, Chaired by Chris Forest (Penn State, GPC Chair-elect), and consisting of members William Collins (LBL, GPC Vice Chair), Norman Loeb (NASA), Maria Rugenstein (ETH), and Mark Zelinka (LLNL) is tasked with nominating invited speakers. The choices will be described in detail in next Newsletter.

The Invited Session will be "Detecting Signals in a Noisy Climate System" and explore the basic understanding of three critical questions. First, what are the required capabilities of modeling the highly complex physical, biological, and biogeochemical systems of Earth to interpret the records of climate change? Second, what are the statistical methods for detecting signals in a system with forced and random signals; and can part of the signal be attributed to a certain

Continued on p. 2

Conference Report

Mini-symposium and Focus Session on "Fluid Dynamics of Atmospheric Clouds"

Raymond A. Shaw, Department of Physics, Michigan Technological University

Clouds may be the most familiar of turbulent flows, recognized by artistic kindergarteners and frequent fliers alike. And yet, due to their multi-phase and multi-scale nature, the representation of clouds in coarse-resolution computational models of the atmosphere remains a central challenge for weather forecasting and climate science. In that sense, they may be the iconic subgrid-scale phenomenon of turbulent fluid dynamics. Despite these challenges, real progress has been made in understanding and representing turbulence-cloud interactions; along the way, it has become apparent that cloud convection flows are a class of their own because of the interplay of processes such as internal latent heating and coupling between scalar fields and a

Continued on p. 2

Message from the GPC Chair – *continued from p. 1*

The topic of the Invited Session will be "Detecting Signals in a Noisy Climate System." Broadly defined, this topic deals with matters regarding the definition of signal and noise in the climate system, the nature of the null hypothesis and the role of anthropogenically-forced, naturally-forced and internally-generated climate variability and climate change. The topic of the Focus Session will be "Feedbacks in the Earth System," which will exam amplifying and mitigating feedback responses relevant both to understanding the behavior of Earth's climate system and to projecting future climate change. Both of these GPC sessions address topics where physics has critical and unique insights to contribute to our understanding of the climate system and climate change.

More details about the two scientific sessions can be found inside this Newsletter.

We would also like to encourage our members to vote in the upcoming GPC elections. And we would like to take this opportunity to thank our colleague Don Lucas, whose term as Secretary/Treasurer will end in 2018, for his hard work. We are indebted to Peter Weichman for his willingness to stay on for another term as Newsletter Editor. Peter has helped make the GPC Newsletters among the most engaging and informative of all of the APS topical groups and we are deeply appreciative of his ongoing efforts.

We are pleased to have more diversity on the GPC committees than ever before and the vital participation of early career scientists. We thank Katie Dagon of Harvard and Karen McKinnon of NCAR for their service on the Program Committee. We would also like to thank outgoing members-at-large Robert Ecke and Mary Silber for their service.

It has truly been a pleasure to serve as GPC Chair over the past year. I have done my best to make sure that both APS in general and GPC in particular play important roles in informing our scientific understanding of one of the greatest societal challenges we face—addressing human-caused climate change.

I would like to both thank prior chair Brad Marston for his generous assistance and mentorship and for continuing to be a powerful voice for GPC within APS. I would also like to welcome my esteemed Penn State colleague Chris Forest who will take over as GPC Chair this coming January, as Bill Collins transitions to Chair-Elect.

We look forward to seeing you in Boston! In the meantime, please follow us on twitter at **@APS_GPC** for key occasional announcements and items of interest.

2019 APS March Meeting – *continued from p. 1*

forcing? Third, what are the limits of observational uncertainties that constrain the detection and attribution of a forced signal? These questions are at the core of basic scientific discourse and the session will showcase the state of the science as it relates to the different components of the Earth System.

The Focus Session will be an open session on "Feedbacks in the Earth System" and cover any process which is able to change the global temperature. The complexity of the Earth system provides a plethora of feedbacks that include all components of the system, involving the physics and chemistry of the atmosphere and ocean, sea ice, ice sheets, and life on land and in the ocean. These feedbacks impact both the mean-state and extremes of the Earth system response to internal or external forcing. We invite talks on topics dealing with timescales ranging from paleo- to present-day climates and covering any feedback process shown to impact global temperature. The focus will be on *understanding* feedback processes in order to better constrain climate model projections of future climate change across the globe.

Contributed abstract submission deadline for the Focus Session is October 26, 2018.

We look forward to your contributions and seeing you in Boston in March.

Mini-symposium and Focus Sessions on "Fluid Dynamics of Atmospheric Clouds" – *continued from p. 1*

discrete, particulate phase. The multi-faceted nature of these flows has encouraged a wide and interdisciplinary range of fluid dynamicists, including atmospheric scientists, mechanical engineers, and physicists, to contribute to the field.

Current understanding and recent progress on the "Fluid Dynamics of Atmospheric Clouds" was covered in a series of focus sessions and a mini-symposium at the 70th Annual Meeting of the Division of Fluid Dynamics (November 19-21, 2017, in Denver, CO), co-sponsored by the APS Topical Group on the Physics of Climate (GPC). There were three focus sessions with a total of 28 talks, followed by a mini-symposium with 6 invited speakers. The sessions were organized by Rudie Kunnen from Eindhoven University, Lian-Ping Wang from University of Delaware, and your author (at that time serving as a member of the GPC Executive Committee).

The focus sessions illustrated the breadth of work taking place in the field. A unifying aspect of the diverse problems being worked on is turbulence: Studies of turbulent entrainment and mixing in clouds, dynamics of droplets and particles in turbulent flows, particle collision rates in turbulence, settling of particles in turbulent flows, cloud convection, and condensation growth of particle populations in turbulence. Some of many highlights included reports of Lagrangian particle accelerations in clouds sampled from a mountain-top station (Jan Molacek and colleagues from the Max Planck Institute for Dynamics and Self Organization), calculations of collision mechanisms and rates for non-spherical particles falling through turbulence (Alain Pumir from Ecole Normale Superieure de Lyon, and colleagues), simulations of growth of cloud droplets in turbulent Rayleigh-Benard convection (Izumi Saito and Toshi Gotoh from Nagoya Institute of Technology), and the theoretical studies of the influence of turbulence on cloud droplet formation from aerosol particles (Gustavo Abade and colleagues from University of Warsaw).

The mini-symposium was structured so that concepts cascaded from large to small scales. David Randall from Colorado State University provided an overview talk on "The fluid dynamics of atmospheric clouds". This presentation was motivated by the question, What about the atmosphere would be different without clouds? Several examples of large-scale atmospheric circulations and processes that are sensitively dependent on cloud formation and properties were given. For

example, recent work by several groups has convincingly shown that radiative cooling influences the aggregation of convective systems into large scale systems (e.g., see Figure 1, taken from Randall's talk). Furthermore, processes of relevance to the climate, such as the Madden-Julien oscillation, are sustained by cloud-related feedbacks.

Sam Stechmann from University of Wisconsin spoke on "Cloud regimes as phase transitions". This talk provided an overview of recent efforts to describe large-scale atmospheric and cloud properties using stochastic differential equations. The results suggest that, even without dynamics and coupling, radiative transfer, etc., some basic two-dimensional statistics of cloud layers can be captured with a stochastic model. Compelling analogies with the physics of phase transitions are emerging from that work (see Figure 2), providing an ideal area of overlap for physicists in GPC.

Jeremie Bec from Observatoire de la Côte d'Azur gave an overview of several aspects of "Turbulent growth of cloud droplets". Droplet growth takes place initially through vapor condensation, and later by collisions and coalescence (coagulation). The relevance of time scales for droplet evaporation and supersaturation

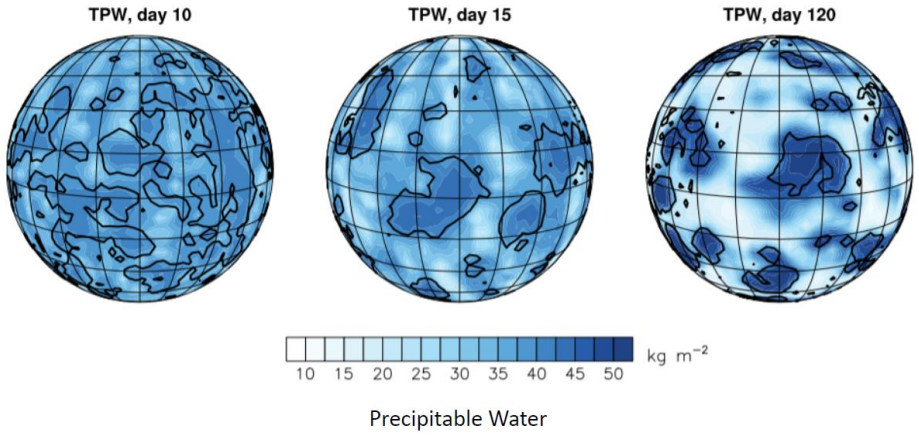

Figure 1: Total precipitable water in the Community Atmosphere Model with "super-parameterized" clouds, and with uniform sea-surface temperatures and no rotation. (From Arnold and Randall, 2015)

adjustment in the condensation growth problem were elucidated. The coagulation problem is particularly broad, having relevance not only to clouds, but systems ranging from atomic to astrophysical in scale. Bec showed intriguing results that suggest fluctuations dominate the coagulation equation, perhaps calling into question the widely-used Smoluchowski equation.

Ryo Onishi from Japan Agency for Marine-Earth Science and Technology gave a summary of "Direct Lagrangian tracking simulations of particles in vertically-developing atmospheric clouds". He described one of the most advanced direct numerical simulation (DNS) codes for studies of cloud particles in turbulent flow, including full hydrodynamic interactions. Such simulations usually are restricted to domains with spatial extent of order 1 m, but a creative, "Somen noodle" simulation with domain size of 1 cm x 1 cm x 3000 m was proposed. The resulting simulations show the full rain formation process involving condensation growth and coalescence of droplets. The simulation is

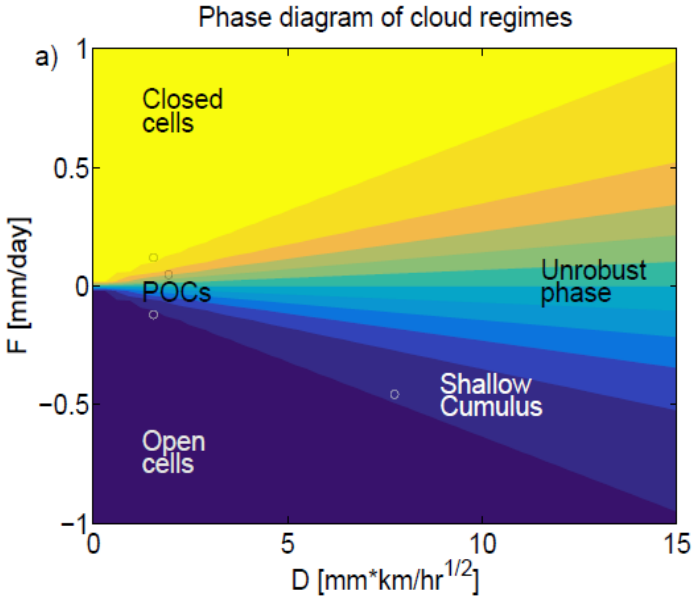

Figure 2: A phase diagram of cloud regimes from a stochastic model, ultimately providing a mean cloud area fraction, in analogy with mean magnetization in the Ising model. The two axes, not described in detail here, provide a space within which archetypal cloud systems are found, including closed and open cellular convection, separated by pockets of open cells (POC). (From Stechmann and Hottovy 2016)

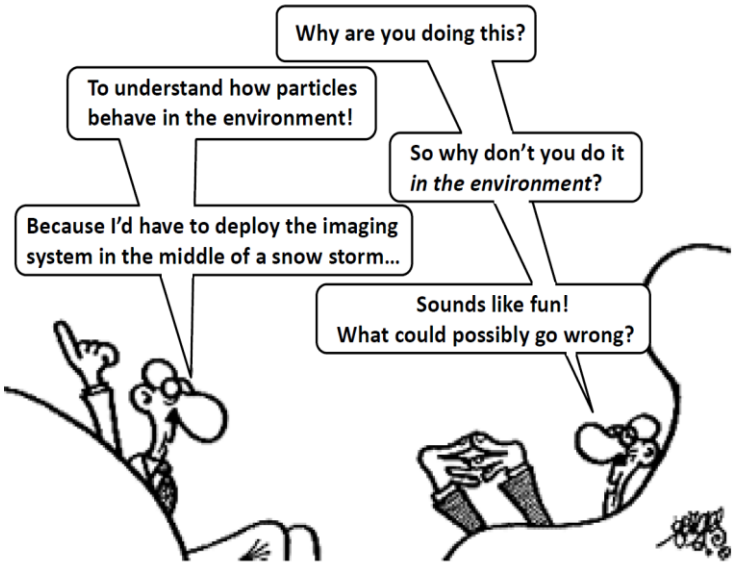

Figure 3: A bit of humor from Filippo Colleti, as the transition is made from describing results from a laboratory system, to those obtained for snowflakes in the natural atmosphere. Both studies suggest fall speeds can be several times larger for particles in turbulence compared to particles falling in quiescent air. (From Coletti 2017)

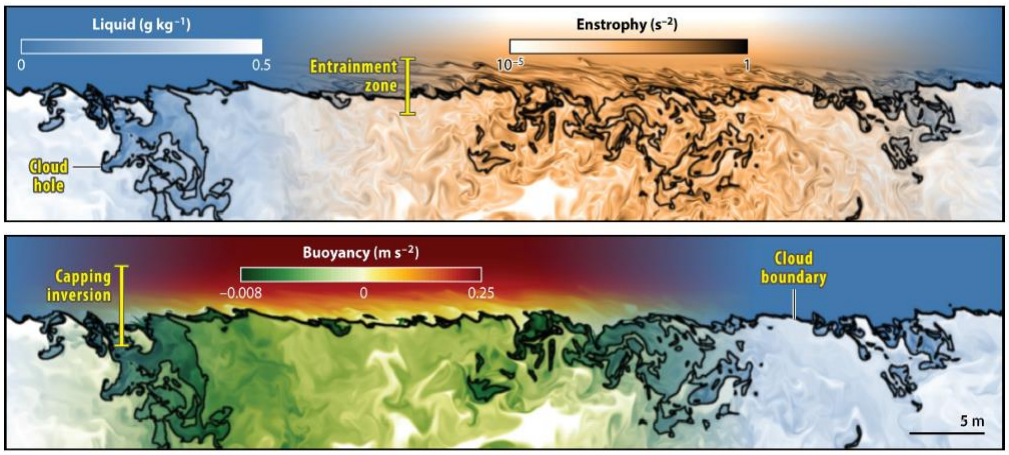

Figure 4: Detailed numerical simulation of the top-region of a stratocumulus cloud system. The combination of the cloud boundary, a turbulent interface, and a capping inversion lead to complex interplay between turbulence, radiation, and particle settling. (From Mellado 2017)

able to reproduce essential features of a bin model, and could be a first step to large-scale simulations that explicitly represent turbulence and its effects on cloud droplet dynamics.

Filippo Coletti from University of Minnesota presented fascinating results on "Particles and snowflakes falling through turbulence". The work involves two aspects: field studies of natural snowflakes falling within the turbulent atmosphere using large-scale particle-image velocimetry; and a new laboratory chamber capable of generating isotropic turbulence with a vertical extent over many large-eddy length scales, which allows steady-state sedimentation dynamics to be observed (Figure 3 provides motivation). The results suggest that settling dynamics are described by a dimensionless parameter proportional to the product of the particle Stokes number and settling parameter. The Stokes number is the ratio of a particle inertial response time to a turbulence time scale, and the settling parameter is the ratio of the gravitational settling speed and a turbulence velocity scale.

Juan Pedro Mellado from Max Planck Institute for Meteorology gave an overview of some of the rich and intertwined problems associated with climatologically important stratocumulus clouds. The talk, entitled "On the relevance of droplet sedimentation in stratocumulus-top mixing", showed results from direct numerical simulations (i.e., fully-resolved simulations) of stratocumulus convection (see Figure 4). These are challenging because of the need to resolve the Ozmidov scale of approximately 1 m in order for simulations to faithfully capture important features. Droplet sedimentation was shown to be important for determining the entrainment velocity, a result leading to dependence on the fifth moment of the droplet size distribution.

GPC Bylaws Changes and Elections

The proposed changes to the GPC bylaws were recently voted on and passed. One consequence is that there is now (for the first time) a slot reserved for a graduate student member of the executive committee.

The upcoming GPC election therefore not only features openings for Vice Chair, Secretary-Treasurer, and two regular Members-at-Large, but also one graduate student Member-at-Large. The election is to be held in October and elected candidates would begin their terms in January 1, 2019. We strongly encourage you to help shape your GPC by voting.

The Nominating Committee consists of members Cheryl Klipp (US Army), Paul Kushner (Toronto), Isabel McCoy (University of Washington), Morgan O'Neill (Stanford) and Brad Marston (Brown University) as Chair.

Prospective candidates will be considered for their scientific standing and activity, their history of involvement with GPC and the APS, their perspective on the activities of the Group, and their likelihood of service to GPC if elected. Diversity in the GPC leads to vitality and innovation.

The position of the Vice Chair of GPC (currently held by William D. Collins) is a four-year commitment: after a year as vice chair the officer becomes in successive years the chair-elect (currently Chris E. Forest), chair (currently Michael Mann), and then past chair (currently Brad Marston) – each with distinct duties. The chair officers play a crucial role in providing leadership in organizing the scientific content of the March Meeting and other meetings and in representing climate physics within the American Physical Society.

The position of Secretary-Treasurer (currently held by Donald D. Lucas) is a three year position, plus an additional year to aid in the transition of duties. The duties are to maintain the records of the GPC, and have responsibility for all GPC funds.

The members-at-large (two regular positions, replacing Robert Ecke and Mary Silber, and the new graduate student position) serve a three-year term; they constitute the fellowship committee, help select the invited symposia and invited talks for the March Meeting and provide advice on issues important to the GPC.

Identifying excellent candidates who can provide a broad view of the diverse field that is climate physics is key to maintaining the vitality of GPC.

GPC Students and Early Career Investigators Prizes

Last year, GPC created a scholarship for young GPC members to attend the APS March Meetings and participate in the GPC sessions.

This year we will make two awards of $500 to a graduate student and an early career investigator. In future years, the GPC may expand the award if the Physics of Climate community grows and continues its success.

The first award will be "The GPC Students Prize" and will be given to a graduate student member of the APS that is pursuing work related to the GPC mission. The second award will be "The GPC Early Career Investigators Award" and will be given to an early career investigator (less than 5 years out of Ph.D.) and be a member of the APS GPC. Both awards will help cover the costs to attend and participate at the March Meeting in a GPC related session.

To apply for the scholarship, applicants should submit a CV, an abstract for a contributed (10 minute) talk, and a short summary (200-300 words) of how their work fits with the GPC mission.

Please send these items to wdcollins@lbl.gov with the heading: "APS GPC Scholarship Application 2019"

Deadline for applications: December 15, 2018

The scholarship committee consists of the GPC Vice Chair (currently, William D. Collins) as the committee chair and three additional members.

For additional information, please contact Dr. Collins if needed.

Other News Links of Interest and Upcoming Events Calendar

1. Passing of Robert de Zafra, October 10, 2017. Bob served on the 2014 GPC Nominating Committee.
2. Passing of Robert Behringer, July 10, 2018. Bob served as 2014 GPC Chair.
3. SPARC 2018 General Assembly, 1-5 October 2018. Kyoto, Japan.
4. Pan Ocean Remote Sensing Conference, Jeju Island, South Korea November 4-7, 2018.
5. 71st Annual Meeting of the APS Division of Fluid Dynamics, Atlanta, GA, November 18-20, 2018. Includes a GPC cosponsored Focus Session: Fluid Dynamics of Atmospheric and Oceanic Extreme Events
6. 99th American Meteorological Society Annual Meeting: 'Understanding and Building Resilience to Extreme Events by Being Interdisciplinary, International, and Inclusive (III)', Pheonix, AZ, January 6-10, 2018.
7. 15th Conference on Polar Meteorology and Oceanography, Boulder, CO, May 20-23, 2019
8. AMOS-ICSHMO, June 11-15, 2019, Darwin Convention Centre, Darwin, Australia.
9. AGU Fall meeting, Dec. 10-14, 2018, Washington, DC.
10. 2020 Ocean Sciences Meeting, February 16-21, San Diego, CA.
11. European Geosciences Union General Assembly 2019, April 7-12, Vienna, Austria.