Application for an International ISSI Team on "Remote observation of aerosol-cloud-precipitation-climate interactions" (SAT-ACPC)

Abstract

Interactions among the aerosol, clouds and precipitation are thought to shape the behavior of the climate system. The aerosol, in part through its interactions with clouds, has been widely identified as the leading source of uncertainty in the climate forcing of the anthropocene. Clouds are the largest source of uncertainty in estimates of equilibrium climate sensitivity. Clouds are affected in large part through their response to the aerosol-induced changes in precipitation forming processes; precipitation is perhaps the most poorly quantified yet essential climate variable. The aerosol, clouds and precipitation are a strongly coupled system, but the nature of this coupling and its sensitivity to perturbations in one of the elements is poorly understood. Recent developments in process understanding, modeling, and observational capabilities make it now possible to address the long-standing and fundamental questions as to the nature of the interplay between the aerosol, clouds and precipitation.

The main objective is to make significant strides in understanding the interplay among the aerosol, clouds and precipitation, and the way these interactions are forcing the climate system. This can be reached through multidisciplinary research in the framework of International ISSI Teams. As the forthcoming IPCC Assessment Report 5 will for the first time include a chapter on the role of aerosols and clouds in the climate system, the timeliness of this work is most appropriate.

The proposed multidisciplinary committed ISSI team will organize four 3-day ISSI Team meetings during 2010-2011 in order to identify ways to analyze the under-exploited existing satellite data, identify the required long term observations and missing key observations. The output includes compilation of applicable datasets, high-profile peer-reviewed science article; the Team will also plan, design and document new international initiatives, with comprehensive, coordinated and enduring space-borne and other measurements, targeting specific regimes and coupled to state-of-the-art modeling.

Scientific rationale

Environmental hazards in the form of air pollution, floods, and droughts affect a large part of the world's population. The atmospheric aerosol is an important contributor to air pollution, and is thought to play a role in determining important features of the hydrological cycle and other aspects of the climate system. The properties, amount and distribution of the atmospheric aerosol have changed greatly as a byproduct of industrialization and the accompanying explosion in human population. Recent studies suggest that increased aerosol loading, most evident at the regional scale, has changed the balance of radiant energy within the climate system and altered the hydrological cycle in ways that make the climate system more conducive to precipitation extremes.

Unfortunately, more definitive statements about the effects of changes in the atmospheric aerosol are limited by our incomplete understanding of the interplay between the aerosol, clouds and precipitation. This remains the principal barrier to advancing our ability to quantify the impact of the aerosol on precipitation and circulation systems from local to global scales. Hence, developing our understanding of this interplay is not just a major scientific challenge, but is also essential to the development of strategies for both adapting to, and mitigating, the deleterious effects of climate change.

New measurement and modeling capabilities provide unprecedented opportunities for studying aerosol-cloud-precipitation interactions. The advance in remote sensing (both space- and surface-based) is providing an unprecedented view of cloud micro and macro structure, and surface rain

rates across a range of space and time scales. When combined with surface networks of multi-parameter and multi-wavelength radars, lidars, and microwave radiometers, for example, the opportunities are staggering. Example of remote sensing capabilities are A-Train of satellites providing vertical profiles of aerosol, clouds and precipitation. Wealth of satellite based data is available but under-exploited.

For the first time, the forthcoming Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 will contain a separate chapter on the role of aerosols and clouds in the climate system. The work performed by this proposed ISSI Team during and in between meetings will be included in the IPCC report.

Main objectives

The main objective of the proposed ISSI Team "Remote observation of aerosol-cloud-precipitation-climate interactions" is to make significant strides in understanding the interplay among the aerosol, clouds and precipitation, and the way these interactions are forcing the climate system. This can be reached through multidisciplinary research in the framework of International ISSI Teams.

The main aims of the ISSI Team proposed in this application are to:

- Organize four 3-day ISSI team meetings gathering an international multidisciplinary group of scientists working on remote sensing of clouds, aerosols and precipitation, experts in clouds, aerosols and air chemistry physics and in Earth energy budget, and global circulation models.
- Identify ways to use the already available large amounts of under-exploited satellite data for understanding and quantifying the ways by which cloud-aerosol interactions affect cloud composition, precipitation and the ways they cascade to force the climate system as a whole.
- Identify which observations are required to be continued on a long term basis, and which missing key observations need to be included.
- Summarize, write and publish a peer-reviewed scientific article on space-borne measurements as a major component of our toolbox for understanding cloud-aerosol-precipitation-climate interactions on global, regional and process scales. The article will be submitted to a high profile publication.
- Plan a focused coordinated, comprehensive, extensive observational campaign to study aerosol-cloud-precipitation interactions coupled to state-of-the-art modeling and the way by which these processes can be detected and quantified by satellite and other remote sensing measurements.

Timeliness of the project

A variety of new measurement and modeling capabilities provide opportunities for studying aerosol-cloud-precipitation-climate interactions. The recent advances in remote sensing (both space- and surface-based) allow for examination of processes from a new perspective but the existing data is under-used. In order to make significant strides in understanding the interplay among the aerosol, clouds and precipitation, the proposed ISSI team will also plan new international initiatives, with comprehensive, coordinated and enduring measurements, targeting specific regimes and coupled to state-of-the-art modeling.

The forthcoming IPCC Assessment Report 5 will contain a new separate chapter on the role of aerosols and clouds in the climate system. In order to be included, the material must have been submitted for publication by 31 July 2012 and accepted for publication by 15 March 2013. The work performed by this proposed ISSI Team during and in between meetings will be available on time to be included in the IPCC report.

In addition, a workshop complementing this Team proposal is planned at ISSI, entitled "Observing and modeling Earth's energy flows", 10-14 January 2011.

Expected output

The expected main results from the proposed ISSI team on Remote observation of aerosol-cloud-precipitation-climate interactions are:

- Compilation of already available datasets along ways by which they can be used.
- Identification of missing observations.
- High-profile scientific paper on constraining quantitatively cloud-aerosol-precipitation interactions and their climate forcing by remote sensing.
- A blue-print document for organizing a focused coordinated observational and modelling campaign to study the aerosol-cloud-precipitation-climate interactions. The campaign will include ground-level, boundary layer and remote sensing measurements, combined with modeling at a variety of scales.

Added value provided by ISSI

The requirements of the ISSI Teams are in full agreement with the ISSI Team "Remote observation of aerosol-cloud-precipitation-climate interactions" (SAT-ACPC) proposed in this application. The work planned for the Team can only be reached through multidisciplinary research in the framework of International ISSI Teams. The main purpose of the proposed ISSI team on aerosol-cloud-precipitation-climate interactions is to ensure the long term availability and compilation of datasets and complementing the key missing observations, as well as publishing the results.

In order to summarize and synthesize results, regular gatherings of the proposed ISSI Team are essential. The work proposed here requires a team and a location where members can work concentrating on this specific task over an extended time period, in a comfortable location with all necessary facilities and equipment required for a smooth meeting in a larger group and also smaller sub-groups. The purpose of the four successive meetings is to compile data and write, but also to keep the team within planned time schedule and hence ensure progress and timely outcome of the project. The scheduled meetings also aid in establishing a timetable and goal for work also in-between meetings. ISSI meetings are very suitable for the work required from the participants to integrate new views and approaches for multidisciplinary research to elucidate the interactions between remote sensing techniques, aerosols, clouds, precipitation, and climate.

List of International Team members

The proposed ISSI Team leaders are Prof. Daniel Rosenfeld and Prof. Meinrat O. Andreae, the Team coordinator is Anni Reissell.

The following are members of the proposed SAT-ACPC ISSI Team:

1. Daniel Rosenfeld, The Hebrew University of Jerusalem, Jerusalem, Israel (Team co-leader)
2. Meinrat O. Andreae, Max Planck Institute for Chemistry, Mainz, Germany (Team co-chair)
3. Graham Feingold, NOAA's Earth System Research Laboratory, Boulder, Colorado, USA
4. Sandro Fuzzi, Consiglio Nazionale delle Ricerche Instituto di Scienze dell'Atmosfera e del Clima CNR, Bologna, Italy
5. Ralph Khan, NASA Goddard Space Flight Center, Maryland, USA
6. Markku Kulmala, University of Helsinki, Finland
7. Ari Laaksonen, Finnish Meteorological Institute, Helsinki, Finland
8. William Lau, NASA's Goddard Space Flight Center, Maryland, USA
9. A. Pier Siebesma, Regional Climate Division, Royal Netherlands Meteorological Institute (KNMI), The Netherlands
10. Bjorn Stevens, Max Planck Institute for Meteorology, Hamburg, Germany
11. Martin Wild, Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland

Anni Reissell, University of Helsinki, Finland (Coordinator)

All members of the Team hold a doctorate and are committed to their presence during the foreseen periods of activity at the institute. All members are available to participate in the activities

and meetings. The ISSI Young Scientist scheme is essential in enabling the participation of young scientists within this important work.

The Team will invite several (up to three) experts to the four scheduled meetings at ISSI. The experts will be those who develop future space missions for the various space agencies. An example of an invited expert for EarthCARE of ESA: Dr. David Donovan, Royal Netherlands Meteorological Institute, Climate Research and Seismology Department, Atmospheric Research Division.

Schedule of the project

1) First meeting at ISSI, late fall/early winter 2010 (3 days)

- Selection and surveying of available data.
- Start reviewing ending of presently active satellites and their continuation plans.
- Start reviewing planned future satellite missions.
- Start reviewing complementary surface and airborne measurements.
- Start reviewing existing integrative activities and plans that we can build on.
- Start planning of division of work between team members, sub-groups, defining work and timetable for the groups.

2) Time between the meetings

- The team members will have assigned tasks for continuing the started activities.
- After the first ISSI meeting video/skype/telemeetings will be held if required.
- The progress will be monitored by the Team leaders/Coordinator to ensure that a coherent and complementary effort by the team member will occur.
- Data samples for selected case studies will be made available for discussions at the second ISSI meeting.

3) Second meeting at ISSI, early spring 2011 (3 days)

- Finishing the tasks started at the first meeting.
- Integrating the various components to a comprehensive plan agreeable by the various team members representing the various disciplines.
- Outline for a scientific paper based on the achieved and agreed integrative plan. The paper will address the capabilities, questions, needs and remaining challenges.
- Fist cut at writing the scientific paper.

4) Time between meetings

- The team members will have assigned tasks for the writing process after the second ISSI meeting, video/skype/telemeetings will be held if required.
- The progress will be monitored by the Team leaders/Coordinator to ensure that a full draft document will be available for the third ISSI meeting.

5) Third meeting at ISSI, late spring/early fall 2011 (3 days)

- Finishing writing of the scientific paper.
- Outline and initiation of planning of a focused, coordinated and integrated observational and modeling campaign to study the aerosol-cloud-precipitation interactions that will validate remote sensing integrative measurements which in turn provide regional quantification of the parameters of interest (e.g., radiation budgets, hydrometeor types, precipitation amounts, cloud top properties, aerosol properties, temperature and moisture profiles, latent heating vertical profiles, air motions at various levels).
- Planning for campaign funding.

6) Time between meetings

- The team members will have assigned tasks for the planning of the campaign, the process after the third ISSI meeting, video/skype/telemeetings will be held if required.
- The progress will be monitored by the Team leader/Coordinator to ensure that a full draft field campaign planning document will be available for the fourth ISSI meeting.

7) Fourth meeting at ISSI, winter 2011 (3 days)
- Finishing writing of the planning document for the focused, coordinated and integrated observational and modeling campaign in a form of a white paper proposal that will be the basis for the remote sensing component of ACPC and become a basis for funding proposals.

Facilities required

The meeting facilities required includes rooms for plenary sessions and breakout group work:

- one plenary room equipped with a flap board, white/blackboard, overhead projector, projector and computer (PC) for presentations
- three smaller rooms for sub-group work
- wireless internet access
- facilities for teleconferences and for video-conferences using Skype/ConnectPro
- copy machine, color printer
- electric adaptors to the Swiss standard.

Financial support requested of ISSI

With this application, we apply for funding for the accommodation and per diem while residing in Bern for 11 Team members and coordinator of the proposed team, as well as travel costs for the Team leader or a member. Additional Experts invited by the Team leader are expected to participate in the work of the Team on a time limited basis at no cost to ISSI. Furthermore, some members may be able to secure full or partial financial support for their participation from alternative sources, which would allow for a larger Team to be set up.

Abbreviations

Abbreviations of research projects and programmes:

ACPC	Aerosol-cloud-precipitation-climate programme
IPCC	Intergovernmental Panel on Climate Change
SAT-ACPC	Remote observation of aerosol-cloud-precipitation-climate interactions

References

Also see Curriculum vitae of team members.

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Full contact information of team members

See Appendix A

Curriculum vitae of the team members

See Appendices

APPENDIX A

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