Climate and Cryosphere (CliC) Update

Walt Meier
NASA Goddard Space Flight Center

WDAC Meeting, Reading, UK
2 July 2015
**CliC Structure**

**Limited Lifetime Targeted Activities**
(Core and Grand Challenge)

- Arctic Freshwater Synthesis
- Antarctic Ice Sheet / Ocean Interactions
- ESM Snow Model Intercomparison
- ESM Ice Sheet Model Intercomparison
- Polar CORDEX Analysis / Arctic Regional Climate Scenarios
- Polar Jet Stream Variability and Extremes
- Improved Greenland Mass Balance Estimation
- Carbon cycle feedbacks in a changing Arctic climate

- *Glacier volume change monitoring*
- *Interactions between cryospheric elements*

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**Scientific Steering Group**
G. Flato and G. Krinner, Co-Chairs

**ICPO**
J. Baeseman, Director
Hosted by Norwegian Polar Institute

**ASPeCt**
Joint with SCAR

**Arctic Sea Ice Working Group**

**Sea Ice and Climate Modelling Forum**

**Polar Climate Predictability Initiative (PCPI)**
Joint with SPARC

**Ice Sheet Mass Balance and Sea Level**

**ISMASS**
Joint with SCAR and IASC

**Permafrost Carbon Network**
Joint with IASC

**Permafrost and Climate Modelling Forum**

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http://climate-cryosphere.org
CliC Activities

- 11th Science Steering Group (SSG) workshop held in Boulder, CO, 9-12 February 2015
  - Presentations: http://www.climate-cryosphere.org/meetings/ssg11/downloads

- Shift in focus of CliC to modeling, including contributing to MIPs, CMIP6, etc.:
  - Polar CORDEX: regional atmospheric climate model projections [J. Cassano, Univ. Colorado]
  - MISOMIP: Marine Ice Sheet-Ocean MIP [D. Holland, NYU], formerly W. Antarctica Glacier-Ocean Modeling
  - SIMIP: Sea Ice MIP [A. Jahn, Univ. Colorado, and D. Notz, Univ. Hamburge], diagnostic MIP (analysis of MIP output; SIMIP requested variables)
  - GlacierMIP: proposed [R. Hock, Univ. Alaska-Fairbanks, and B. Marzeione, Univ. Innsbruck]
Ice Sheet Model Intercomparison Project for CMIP6

- Ice sheets responding much faster than expected, major contributor of SLR and uncertainty in future SLR projections
- July 2014 workshop at NASA Goddard
- Proposal submitted to include ice sheet MIP in CMIP6
  - S. Nowicki, NASA Goddard, PI
  - Proposal approved, plans underway

Drawing courtesy of C. Rodehacke

ISMIP info courtesy S. Nowicke, NASA Goddard
Experimental framework

CMIP6 DECK (any AOGCM)

Forcings
Requires analysis of climate over and surrounding ice sheets

Stand-alone ice sheets models

Coupled AOGCM-ISM

Feedbacks
How do dynamic ice sheets affect climate?

Projections
Historical and future sea level due to ice sheets, and associated uncertainty due to ice sheets.

ISMIP info courtesy S. Nowicke, NASA Goddard
Next steps

• Identify variables that need to be saved in CMIP6
• Identify needed observations
• Develop ISM experiments
• Run models and analyze
• Communication with ISMASS and other ice sheet mass balance efforts

**CMIP6 exp to be used by ISMIP6 (all AOGCM)**

- Pre-industrial control
- AMIP
- Historical Simulation
- 1% per yr CO2 to 4xCO2
- ScenarioMIP SSP5-8.5 (up to year 2300?)

**New proposed ISMIP6 exp (coupled AOGCM-ISM)**

- Pre-industrial control
- 1% per yr CO2 to 4xCO2
- ScenarioMIP SSP5-8.5 (up to year 2300?)

**Standalone ISMIP6 exp (ISM only)**

- ISM control
- ISM for last few decades (AMIP)
- ISM for the historical period
- ISM for 21st / 23rd century sea level forced by SSP5-8.5
- ISM forced by 1% per yr CO2 to 4xCO2
- ISM specific experiments to explore uncertainty in sea level
ESM-SnowMIP

- Goals of SnowMIP
  - Improve representation of snow in earth system models
  - Better quantify snow-related climate feedbacks
- Simulation protocol developed – interest and feedback from community being solicited
- Plan to initiate local and global-scale simulations in 2016; coupled models in 2018, after CMIP6
- Observation super sites, satellite data sources for model evaluation being identified

Figure from A. Slater, NSIDC
Sea Ice Prediction Network

- U.S. supported project (NSF, ONR, DOE, NASA): http://www.arcus.org/sipn
- Focus on seasonal sea ice prediction
  - Sea Ice Outlook: http://www.arcus.org/sipn/seaiceoutlook
  - Framework for model intercomparison and evaluation
  - Provide resource for observations to initialize and validate models: http://nsidc.org/data/sipn/
  - Design metrics to assess model performance
- Will collaborate with other prediction efforts
  - WCRP Polar Climate Predictability Initiative
  - WMO Polar Prediction Project
  - Year of Polar Prediction (YOPP)
    - mid-2017 to mid-2019
    - Summit, 13-15 July 2015 ➔ report to be presented on CliC contributions (including SIPN)
    - http://www.polarprediction.net

Figure from Stroeve et al., Eos, 2015
Sea Ice Outlook 2015

June 2015 Sea Ice Outlook contributions by method (total $n = 30$)

- **Heuristic**: $n = 4$
- **Statistical**: $n = 12$
- **Modeling**: $n = 11$
- **Mixed**: $n = 3$

September mean sea ice extent, million km$^2$

2014 observed
MOSAiC

- Multidisciplinary drifting Observatory for the Study of Arctic Climate
- http://www.mosaicobservatory.org
- Focus on transfer of heat, moisture, density, momentum, and nutrients through the Arctic system
- Intensive international field campaign
  - Icebreaker frozen in for a full year with various surrounding observing platforms
  - Follow-on from SHEBA – update from 20 years ago, particularly dramatic changes in ice cover (e.g., loss of multi-year ice)
- IASC and CliC sponsors
- Plan for 2017 or 2018 deployment
- Science plan draft published
- Implementation workshop, 22-24 July 2015, Potsdam, Germany
Global Cryosphere Watch

Mission: to provide authoritative, clear, and useable data, information, and analyses on the past, current, and future state of the cryosphere

globalcryospherewatch.org

WMO Executive Council

Users and Applications
research, operational and service centres, security, impacts, adaptation

Outreach, Education, Capacity Building

Steering Group

GCW Portal and Website
integrating data and information

Working Groups

GCW Information and Analysis
anomaly tracking, hot-spots, variability and change, global and regional products

Coordination Office

Observations
CryoNet, contributing networks, satellites

Cryosphere Products
operational products, reanalyses, research datasets

Partners
- met centres
- satellite agencies
- data centres
- specialized organizations

GCW info courtesy J. Key, NOAA/NESDIS
GCW Activities

- developing a network of surface observations called "CryoNet", which builds on existing networks;
- developing measurement guidelines and best practices;
- refining observational requirements for the WMO Rolling Review of Requirements;
- engaging in and supporting intercomparisons of products, e.g., the GCW Snow Watch project, and sea ice thickness;
- creating unique products, e.g., the SWE Tracker, in collaboration with partners;
- engaging in historical data rescue (e.g., snow depth);
- building a cryosphere glossary;
- providing up-to-date information on the state of the cryosphere;
- providing access to metadata and data through a portal.
25 June 2015: strong endorsement by 17th World Meteorological Congress

- Polar and high mountain monitoring one of seven WMO priorities for 2016-2019
- GCW to be operationalized in support of polar monitoring
- Priority to implement CyroNet, 36 sites approved for pre-operational testing phase
  - Data and metadata accessibility through GCW Data Portal is a requirement for CryoNet

GCW info courtesy J. Key, NOAA/NESDIS
Arctic Freshwater Synthesis

- Assess freshwater sources, fluxes, storage, and effects
- Water vapor transport, P/E, river flow, glacier and ice cap ablation, sea ice melt/growth, ocean salinity/density transports
- IASC and AMAP are co-sponsors
- T. Prowse (Univ. Victoria), Chair
- Final science meeting 12-14 May 2015
- Papers submitted to peer-reviewed journal special issue July 2015

http://www.climate-cryosphere.org/activities/targeted/afs

Image from Francis et al., JGR-Atm, 2009
ICARP III

- Third International Conference on Arctic Research Planning
  - Toyama, Japan, 23-30 April 2015
  - http://assw2015.org
  - Goals
    - Identify Arctic science priorities for the next decade
    - Improve coordination of various Arctic research agendas
    - Inform policymakers, Arctic residents, and the global community
    - Build constructive relationships between producers and users of knowledge
  - CliC was a co-sponsor with IASC (lead sponsor), AMAP, APECS, IACS, FARO, IPA
IARPC

- Interagency Research Policy Committee
  - Goal is to foster collaboration between U.S. federal agencies, and with national and international part
  - Several collaborations, open to all
  - http://www.iarpccollaborations.org

- New initiative: SIRTA, Sustained Improvements to Reanalyses of the Arctic
  - Chaired by NOAA and NASA
  - Evaluate current Arctic reanalyses and potential to improve
  - Potential interaction with YOPP and CMIP6