Appendix 5: ADI Task Force Survey

A link to an online community survey was sent to a broad range of scientists and stakeholders to understand the community's view on the AON design and implementation. A total of 120 responses were received and the results of the 16 questions pertaining to the AON follow below.

Survey analysis

The fixed-response questions were analyzed first as a whole, and then the affiliation of survey respondents were categorized into Academic, Agency and Other for analysis. Academic affiliations were subsequently analyzed in subgroups of whether the Principal Investigator (PI) was an AON PI or Co-PI.

The fixed responses were analyzed to compare differences between: 1) academic and agency scientists; 2) AON Principal Investigators and non-AON Principal Investigators. A chi-squared test for significant differences ($p < 0.1$) between the groups and subgroups (excluding the 'Other' category) was also conducted. Only observations for which we know affiliation, or know AON PI status were included in the analysis.

There were several questions where an open-ended response was possible. The survey responses from these were grouped into major categories and analyzed as a whole group.

Results

1. *What is your primary research field?(number in parentheses is actual number of responses)*

Atmosphere – 16.2% (19 responses)
Ocean and Sea Ice – 33.3% (39)
Terrestrial Ecosystems – 11.1% (13)
Hydrology and Cryosphere – 21.4% (25)
Human Dimensions – 6.8% (8)
Other – 11.1% (13)

Total number responded – 117
Total number skipped question - 3

2. *What is your sub-discipline within this field (e.g. biological oceanography, boundary layer meteorology, etc.)?*

Total number responded – 106
Total number skipped question – 14

3. *In your research, do you primarily conduct (select one):*

Modeling studies – 6.1% (7)
Observations – surface based – 66% (59.6)
Observations – airborne, in-situ, upper-air, or satellite remote sensing – 11.4% (13)
Analysis or synthesis of data sets collected by others – 13.2% (15)
Other – 9.6% (11)

Total number responded – 114
Total number skipped question – 6

4. *If possible, please provide a bibliographic reference(s) that you deem most relevant for design and optimization of the Arctic Observing Network (at a minimum name of fist author, year of publication, title of journal or book). Please indicate briefly as to why this publication is especially relevant.*

Table A1.Alphabetical list of all references considered relevant after review by the ADI Task Force.

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5. *How many scientific publications are you aware of that describe or discuss observing system design approaches (in the Arctic or elsewhere) relevant in your field?*

None -25.7% (28)
1 to 3 – 35.8% (39)
3 to 10 – 23.9% (26)
More than 10 – 14.% (16)

Total number skipped question – 11

6. *In thinking about designing and implementing an Arctic Observing Network, please state whether addressing the following challenges are critical, important, somewhat important or not important.*

The ADI survey included 10 questions asking respondents to rate the importance of different challenges. Answers could range from "critical" to "not important." The exact wording for each statement appears below:

- Sustaining **long-term** observations
- **Logistic** constraints
- Achieving a balance of observations across different **regions**
- Coordinating observations between different programs or projects at the **national** level
- Coordinating observations between different programs or projects at the **international** level
- **Prioritize** the type of observations made
- Achieving a balance of observations across different **disciplines**
- Applying **rigorous** approaches to observing system design
- **Optimizing** observations across AON scientific priorities
- Balancing the needs and goals of all **stakeholders**

Figure A3 graphs the mean response to each of these 10 questions, on a scale from 0 (not important) to 4 (critical). Most survey respondents agreed that sustaining long-term observations is critical. Logistic constraints, regional balance, and national-level balance also had high priority. Optimizing observations across AON scientific priorities, and balancing the needs and goals of all stakeholders appear less critical.

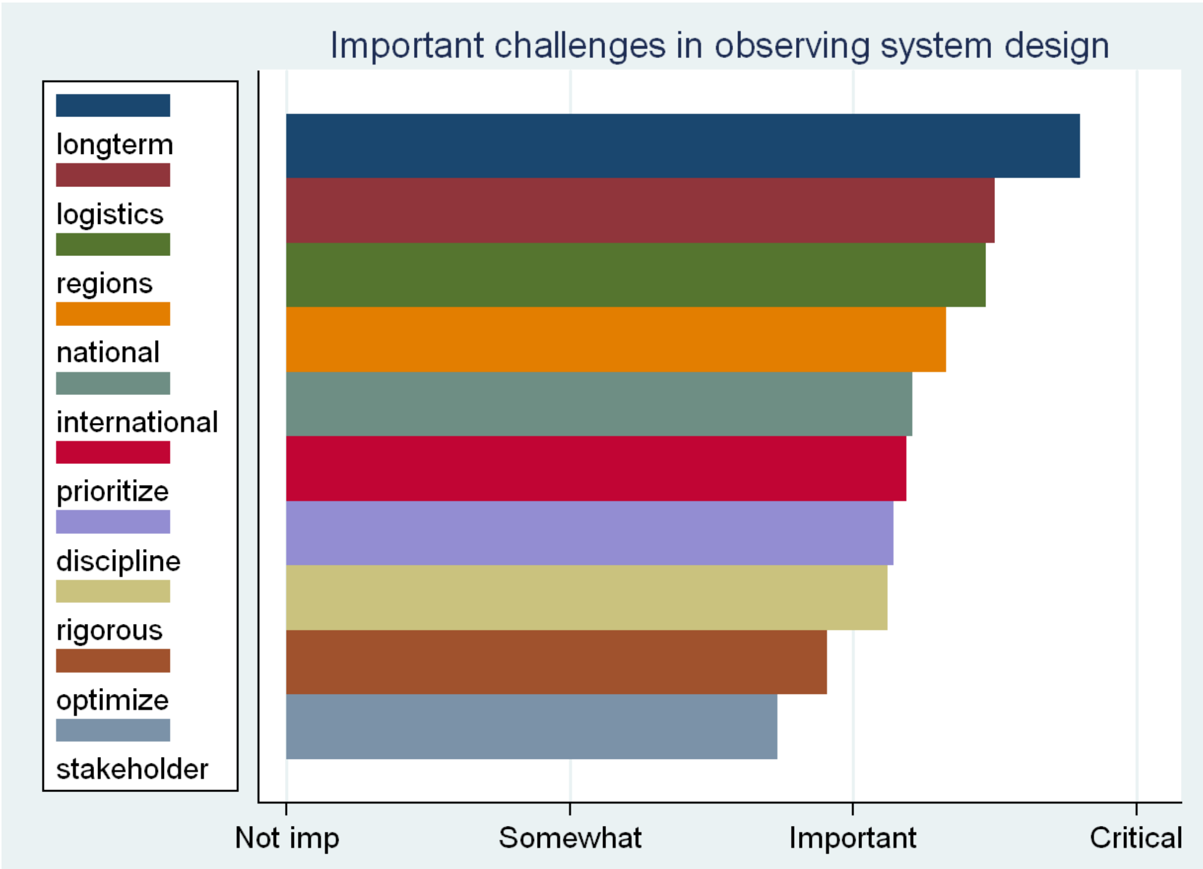

Figure A3. Summary of the mean responses on the importance of 10 challenges to observing system design. See text for details on the full statements of challenges (bold text in statements correspond to the description of each colored bar in figure).

Question 6 also had a category for Other (please specify),which was an open-ended response. Where comments were submitted in the "Other" category, they generally fell into the following major subcategories:

- Data Availability (6 responses)
  - *strong support of rapid data release, importance for management decisions*
- Observations (5 responses)
  - *metadata and data formats, standards and best practices of management were recognized as important, but no consensus on good models or proven approaches*
- Management (2 responses)
  - *need a valid management system with strong management links*
- Funding (2 responses)
  - *need for joint industry and government funding for sustained, long-term observations*
- Technology (2 responses)
  - *Developing appropriate, robust, efficient technologies*
- General comments (5 responses)

7. *In your opinion, how can the key challenges you identified in the previous question (Question 6) best be overcome - Open-Ended Response*

Responses could be grouped into the following major categories (see Table A2 for full comments in each category)

- Coordination (22 responses)
  - need for coordination highlighted by many: what is role of NSF, need for dedicated funding support with necessary longevity for such a program, coordination at national and international level different challenges, better inventory of ongoing activities, communication
  - more effective management structures needed with specific roles for agencies
- International coordination (12 responses)
- Funding (15 responses)
  - *Need for sustained long-term funding*
- Design and planning (14)
  - *support of bottom-up initiatives to achieve disciplinary and sectoral balance*
  - *logistical constraints are key in network, both because of momentum of existing flagship sites as well as due to challenges that already require close collaboration between individual groups*
- Data and observations (5 responses)
- Long-term issues (5 responses)
  - *adaption of measurements over time*
  - *community-based observations to address questions of relevance*
- Communication and meetings (4 responses)
  - *a number of contributors to survey asked for more workshops/meetings*
- Coordinated protocols for observations (3)
- Public education (2)

Table A2. Comments grouped into major categories for overcoming key challenges in observing system design.

Funding
Better funding opportunities. More workshops promoting interaction between different groups/disciplines.
Creating an endowment controlled only by scientists...
Dedicated funding just for collaboration/planning before actually implementing a program/network/project.
Funding is necessary to support longterm observations!
Funding, funding and funding. Education of the public is an element of support, since funds will be governmental. This country has to acknowledge that it is an arctic nation; that the arctic frontier is and will continue to be a frontier for industrial development, including the offshore
It always comes down to funding. Funding has to have a decadal time scale rather than annual.
Funding
It takes a commitment of man power and money.

Major funding is needed for a design problem of this complexity and importance. I would recommend using a process similar to NASA's approach to the current Earth Observation System. An organization like NASA Goddard Space Flight Center or JPL has the facilities and interdisciplinary expertise to host and facilitate a phase one design project at the scale of the AON. The phased process would require several years of design-review steps. I would suggest that other interested countries conduct a similar process. The final struggle would be a comparison of plans and negotiation of funding for various elements of the AON. Organizations like SEARCH, NRC committees, and other appropriate science organizations would be critical to the review and decision processes.
More balanced funding to include terrestrial observations that aren't just gas and energy flux.
Problems are best solved be dedicating appropriate resources to them and not by unfunded mandates.
Provide funds for design work and issue solicitation for proposals
Sustained funding
The issue is political and financial, not scientific. Well, I suppose it is partially scientific in that achieving some consensus among scientists as well as getting long-term funding and support from government.
The limiting factor is, and always has been, money. Too little funding just holds up the entire process. AON will not work without a budget that effectively matches the priorities. Within the US, the NAVY, NASA, NOAA, NSF, and other funding agencies have to show the same level of cooperation as the scientists. Many scientists are willing to work very hard and collaborate with each other, especially an amazing group of new younger scientists coming up right now. The agencies have to stop their bickering and start showing a sense of team synergy at the funding level. The scientists are ready and want to do this. The current AON initiatives are at funding survival thresholds only. A coordinated collaborative funding initiative is needed, The program managers need to take on active management of the larger programs so that the scientist can get the science done. Today, the scientists have to do all their budgets, administration, teaching (to keep a salary going), travel arrangements, and their science. To ask them to also coordinate huge international programs just spreads their abilities thinner still. In a management role, the scientist no longer does science and the system loses the abilities of its most advanced scientists to advising roles, rather than active contributors. A program manager should be held to the task of coordinating, in a SERVICE ROLE to promote the integration of scientific results. The problem basically boils down to a more effective management of knowledge gathering.
Within an international program with community by-in. The problem is to arrange international funding.
Clear, funded data management processes. Sustained funding agreements. Capacity building across nations. Specific workshops and other mechanisms to encourage interdisciplinary and international collaboration.
Data and observations
Open access to all data by all countries in a timely manner. - Investment in infrastructure - Recognize that the bulk of the public will want to put more funds into short term and geographically relevant measures such as local weather radar, tornado and hurricane watches.
Conduct geo-spatial inventory of observations to identify gaps
New observational areas to represent various landscapes and climate. Regular update of standard observations for entire pan-Arctic. Importance of scientific base for new observations. Creating online systems for distribution and analysis data by discipline. AON CADIS maybe good for archiving but useless for real data users.
Not considering in a network context ----the wide necessity for human dimension observations.
Well balanced sets of remote sensing and in situ observations maintained over the long term
Long-term issues
Long-term sustained measurements are most important. We change our minds on what is important over time, thus extensive coordination for a specific current topic is not helpful if what is important changes.
Long-term issues (continued)

The key challenge is to sustain observing efforts in the long-term, in particular for projects that rely on 3-5 year funding cycles. There should be a clear commitment by funding agencies for long-term support. This may include guidelines defining the require that have to be met by research projects to qualify for long-term support.
Through community-based research platforms working in partnership with local communities to support long-term capacity building for ongoing monitoring and systematic data collection efforts.
Through political commitments from Circum-Polar Countries to make long term monitoring.
Whatever suite/array of sensors is ultimately chosen, a commitment to its long-term (i.e. multi-decadal) deployment is essential to identifying a 'mean state' and variability from the mean.
Coordination
A coordinated and documented plan for the observation system is necessary.
By hiring and using qualified people and not just physicians, or politically appointed people that ate widely unqualified, e.g. for management and monitoring or in biology and ecology
Components of AON must be convincingly linked to the needs of economy and society, preferably via promotion of wealth generation, but elements targeted at risk reduction are also suitable. A demonstrated buy-in by clients is essential.
Coordination among stakeholders in the design and support of the observing network.
Coordination by standards developed cooperatively through groups like WMO, etc.
Coordination to use resources efficiently.
Creating an interdisciplinary virtual organization with a platform for design and prioritization decision making.
First, coordination is needed in the allocation of observational resources, rather than simply evaluating/approving/rejecting plans on an independent basis for observational platforms. Second, objective means are needed to evaluate plans for observations, so that will be a factor in addition to the unavoidable logistical issues.
For social data, direct involvement of government statistical agencies in the ADI effort is essential. I am not aware that any effort has been made to accomplish that in the United States.
I believe coordination and taking a long term view are vitally important.
I think coordination among projects has been the weakest aspect of AON thus far. More frequent (NSF sponsored) meetings among project PIs would help a lot. Also, more emphasis on coordination (how it will be achieved) at the proposal stage would be good.
Identification of ongoing programs and coordination with them, perhaps through a steering committee
Identify all stakeholders, planning, liaison, open communications, resources to do the work right, the first time.
input from stakeholders and investigators
Involvement in one way or another of all stakeholders in designing the most effective Arctic Observing System. Better coordination between various Funding Agencies and establishing a flexible funding strategy to guarantee continuation of important long-term observations
Involvement of all stakeholders in the effort. By stakeholders, I mean scientists (observationalists and observers), industry, regulators, NGOs, local communities, etc. And by involvement, I mean both in the design of the network and as contributors (of finances, resources or observations).
Lots of front end discussion with important stakeholders about the purpose of the system, the audience and format of the outputs, system design, data management, etc. Selection of the proposed monitoring targets/indicators based on information needs, ecological theory (key ecosystem components rather than enigmatic species), feasibility, and indicator theory (SMART, etc.).
Need to involve more of the scientific community.
Project PIs should be asked to meet and coordinate activities, identify data and technological needs, and assemble databases (to include past data not readily accessible today)
Relaxing barriers among various agencies, stakeholders, and industry
Coordination (continued)

The main difficulty for ocean based and ice based observations are the difficult logistics. Coordination among individual projects for ship time, helo time, etc. is highly desirable so that more people benefit from the logistics investments while recognizing the costs (expensive) that logistics requires. Let's not re-invent the wheel! AON per se has not provided any help in logistics per se; it has been done among certain projects on a case by case basis and because it is such a small research community
The practical experience of social and physical scientists on interdisciplinary (not just multidisciplinary) research projects is crucial. That's where you discover and solve problems.
International coordination
Collaborations (interdisciplinary/international)
Concerted coordination through high-level international organizations is critical. The World Meteorological Organization (WMO) World Weather Research Programme (WWRP) is currently drafting the implementation plan for a decade long Polar Prediction Project which could assist in coordinating operational needs/requirements for Arctic observations.
By an international coordinating committee
Coordination: International bodies working with national groups. Optimization: Funded efforts to assess observing system characteristics (geographic, which variables, etc.). This is application-dependent, of course, which makes it difficult. International measurement standards and methods.
I have worked with a network of established observatories in the Arctic. National and international coordination is critical for the PI's at each site to commit to observing and subsequent analysis and knowledge transfer.
Formal international agreements to fulfill commitments which in turn requires sustained national commitments. Increased Russian government commitment is needed.
International cooperation ,international projects
International coordination is what's most important to get the geographic coverage necessary to gain meaningful information about the Arctic, which has a rather unique capacity for defying generalization. Numerous pan-Arctic scientific and political bodies already exist, but it's not clear which, if any of them would be most effective at fostering a truly integrated observing network in the Arctic.
International panels, long-term funding commitments by agencies across the Arctic, implement legal mandates
Strong and insightful leadership at funding agencies and on international/national scientific panels/committees.
Planning and open discussions by international participants that encourage data sharing. Work to implement international agreements or procedures that facilitate data exchange. Consider uniform formats, parameter names, units that maximize ability to share data in the community
Do not reinvent the wheel or turn AON into a separate exercise but rather build upon existing international efforts and see how AON can contribute to these rather than overlap them. Also, I would suggest starting small choosing a key priority area that is currently underserved and focus on proof of concept.
Communication and meetings
AON sponsored workshops for funded and interested scientists. More decision making by NSF managers- and coordination among different national groups.
Face to face meetings with the proper people
Communication should be enhanced.
In terms of coordinating across programs, both nationally and internationally, it is important to communicate across groups as the programs are set (through workshops, meetings etc.).
Coordinated protocols
Well-defined and community adopted observing protocols. Clear, funded data management processes. Sustained funding agreements. Capacity building across nations. Specific workshops and other mechanisms to encourage interdisciplinary and international collaboration.
Coordinated protocols (continued)

Community consensus on protocols for data collection and archiving, callibration and reports on instrumentation optimization, transparency of research projects' progress from start to finish, avenues for finding out who is or has conducted research on a particular topic and where internationally and nationally.
Emphasizing and promoting monitoring network "best practices," such as, analyzing and interpreting data (get it out there), spending time on bibliographies and "backcasting" to earlier projects for relevant information, choosing at least some indicators that are relevant at the local level, creating partnerships, integrating communication of results into all research, directing at least 30% of resources to data management, analysis, and reporting, "stewarding" the data (from talk by John Gross, U.S. National Park Service, Fort Collins, Colorado.) While I agree there should be priority, no priority should outweigh supporting especially-well designed research or expertly collected observations. collaboration between researchers at all levels, publishing of research, periodic review of network operating procedures, promoting
Public education
Public awareness of the risks of offshore drilling is very low since the NEB held the recent review only in the north and did as little as possible to engage Canadian scientists and informed people in the review. The only way to get the required work underway and supported for the years that are needed is to bring the public into the equation. The possibility of a Gulf or Mexico type blowout is a real possibility and the consequences would be enormous and well beyond those from the G of M blowout.
Supporting and expanding the interdisciplinary and international networks of stakeholders, and taking advantage of social media and citizen science to establish a for sharing various forms of knowledge and datasets
Design and planning
Focus on a few key things to measure and do it well. AON can't be everything to everyone.
I think a survey like this helps to prioritize. "Debate is good, and in the end someone decides" R. Spinrad
I think more bottom-up, researcher led initiatives have to implemented before the AON will be successful. The program has too much old-fashioned top down thinking and it is heavily dominated, at least in the marine environment, by physical scientists.
Identify and prioritise key scientific questions, and then identify the observations needed to answer the questions.
Identify key areas of interest and develop long-term environmental observatories.
Identify realistic and implementable observation goals that can be maintained for the long-term.
Interdisciplinary approach between scientists and engineers in order to design "state of the art" system to reduce the logistic of operation for such a sensor network. For instance systems with minimal energy requirement, fault tolerance, no need for direct human interaction, etc. If scientist design systems on their own, they usually use off-the-shelve technology and as a result technology of 1-2 decades before. Engineers who have an stack in scientific measurement and collaborate with polar scientists, could design state of the art sensor networks which address many of the deficiencies of the current observation systems in polar region. Examples are systems like the references above.
Interdisciplinary design teams
Involved the right people in the study design.
It seems that a theoretical "system design" approach does not consider the realities of where there are existing facilities. Given the cost factors of establishing new facilities, it seems just an academic exercise if it is determined that from a "design" standpoint that a new location is needed or an existing location needs to be moved. Also, it does not seem that a theoretical design (presumably based on modeling) has sufficiently accurate models to solve the problem that is being posed.
National Academies study should be initiated to prioritize, optimize, and balance the U.S. Program.
Need clear questions about the whole Arctic System---an Arctic Observing Network to what purpose? The answers to question 6 depend strongly on what the Observing system is intended to do.
Design and planning (continued)

Things like this survey are key. There needs to be a planning effort that incorporates input from a number of arctic experts. There also needs to be dedicated and manageable smaller group of experts with broad geographical experience that works to address the challenges identified above. This smaller group then needs to be responsive to the wider arctic science community on a somewhat regular basis.
With better people and expertise involved than currently

8. *Please indicate if you agree or disagree with the following statements:*

The ADI survey also asked respondents whether they agree or disagree with a number of statements. Wording of these statements is given below:

- Prioritization of the different types of observations that are part of an AON needs to be based on **urgency** and/or importance of the science question the observations help answer.
- Observing system design needs to include input from those **using data** or information products derived from the observing system; the observing system cannot be designed solely based on criteria developed by the scientific community.
- An Arctic Observing System has to meet information needs of key **stakeholders** outside of the scientific community; it is not sufficient for the observing system to address only fundamental science questions.
- In my research field, design of an observing system is best done by those carrying out the **observations**.
- In my research field, rigorous **methods** exist to guide design of an observing system.
- **Prioritization** of the different types of observations that are part of an AON should be based on **stakeholder needs**.
- In my research field, design of an observing system is best done through the use of **modeling studies**, e.g., observing system simulation experiments, or other methods based on the theory of observing system design.
- Design and implementation of an Arctic Observing System should primarily be driven and supported by **government agencies** (such as the National Oceanic and Atmospheric Administration or the Fish and Wildlife Service) rather than investigators supported through the National Science Foundation.

Figure A4 charts the mean responses to these questions, scaled from 0 (strongly disagree) to 4 (strongly agree). Urgency of science questions, needs of data users, information needs of key stakeholders, and design by those carrying out the observations received the most agreement. Respondents less often agreed that observing system design is best done through modeling studies, or that design and implementation should be primarily driven and supported by government agencies.

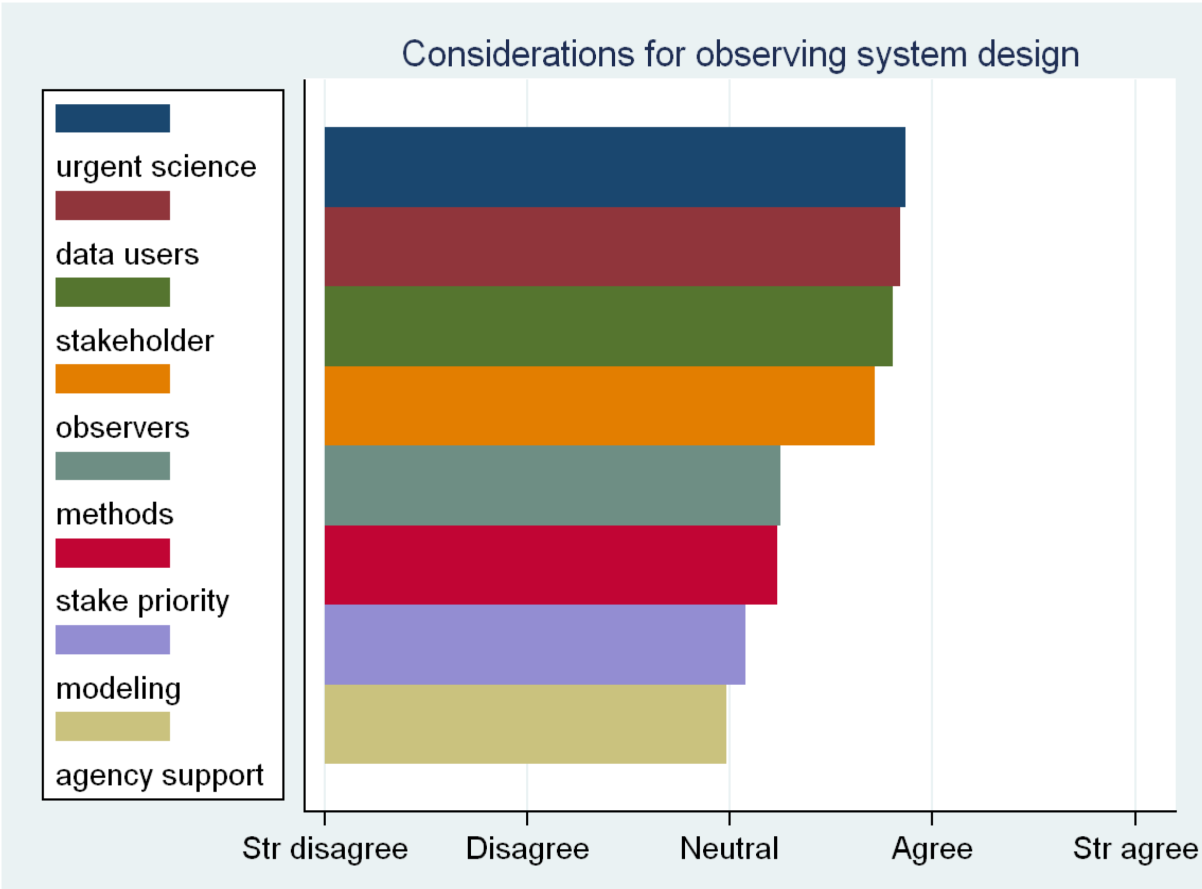

Figure A4. Summary of the mean responses on the agreement towards statements about observing system design. See text for details on the full statement (bold text in statements correspond to the description of each colored bar in figure)

Differences between subgroups (Questions 6 & 8):
Among the 120 survey respondents, 53 were identified as being either academic (40) or agency (13) scientists. Statistically significant differences between academic and agency respondents occur on three of these statements for Question 7:

- "Sustaining long-term observations" is much more often deemed critical by academic (93%) than by agency (46%) respondents.

- "Balancing observations across regions," on the other hand, appears less critical to academic (45%) than to agency (54%) respondents.

- "Applying rigorous approaches to observing system design" is much less critical to academic (20%) than to agency (62%) respondents.

Fifty-seven respondents were identified either as present/past AON Principal Investigators (44), or as not AON PIs (13). On two questions, we see statistically significant differences between these groups:

- "Prioritizing the types of observations made" is seen as important, but less often critical, by AON PIs (0%) compared with other respondents (30%).

- “Applying rigorous methods to observing system design” likewise does not appear critical to AON PIs (0%), although it is critical to 39% of non-PIs.

Statistically significant differences between agency and academic scientists also occurred on the top three questions in Figure A4 (Question 8).

- Agency respondents tend to strongly agree (69%, compared with 23% academic) that observing system design needs input from data users; and that an Arctic observing system has to meet the needs of stakeholders outside the scientific community (again, 69% agency compared with 23% of academic respondents).

- Academic respondents, on the other hand, are more likely to strongly agree that observing system design is best done by those carrying out the observations (25% of academics strongly agree and 50% agree, compared with 0 and 38% of agency respondents).

Respondents who are not AON PIs more often strongly agree that observing system design needs input from data users (43%, compared with none of the AON PIs).

The differences between all agency and academic responses, and AON PI and non-PIs for all of the fixed-response statements are presented in the following graphs:

Graphs of differences between academic and agency scientists:

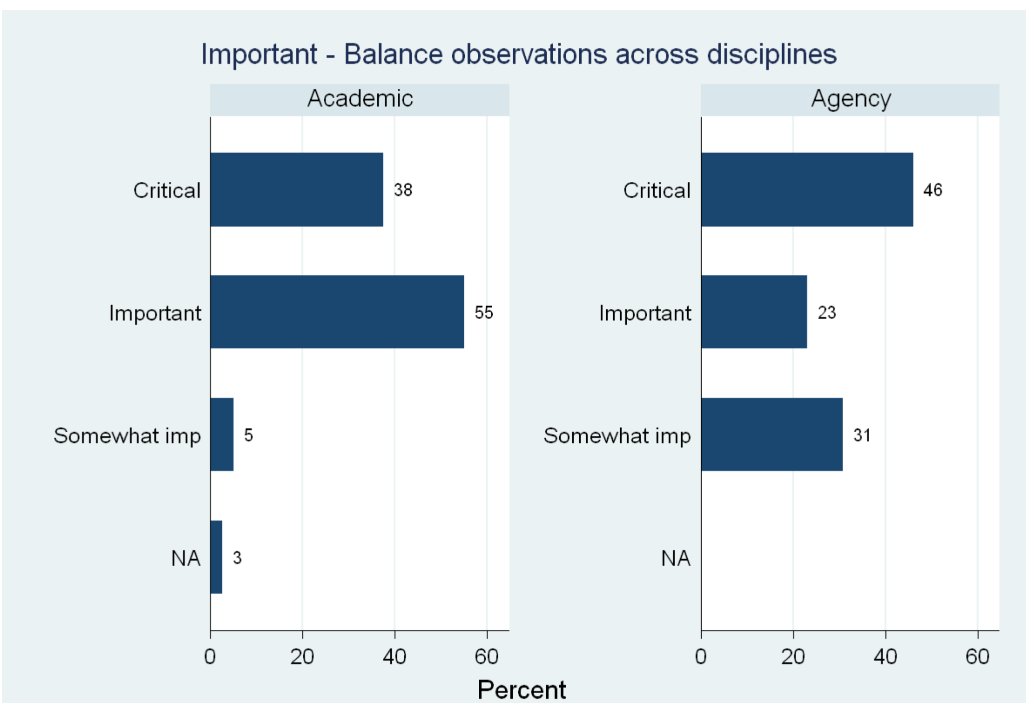

Figure A5. Mean difference between academic and agency responses regarding balance in observations across disciplines

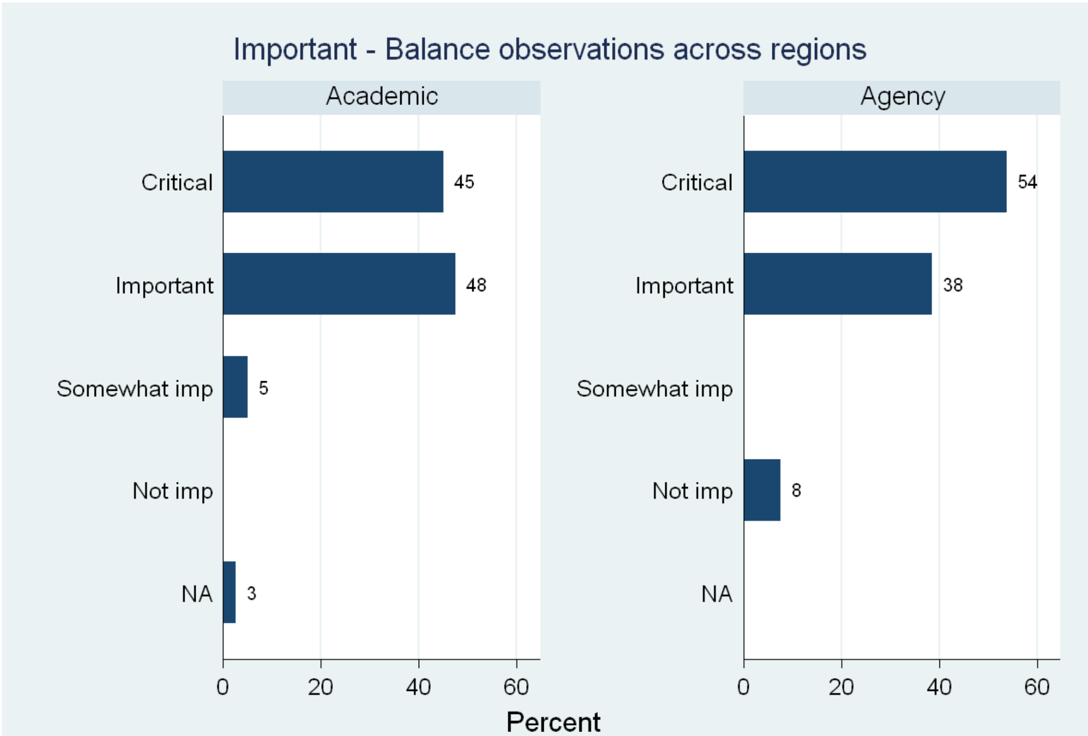

Figure A6. Mean difference between academic and agency responses regarding balance in observations across regions

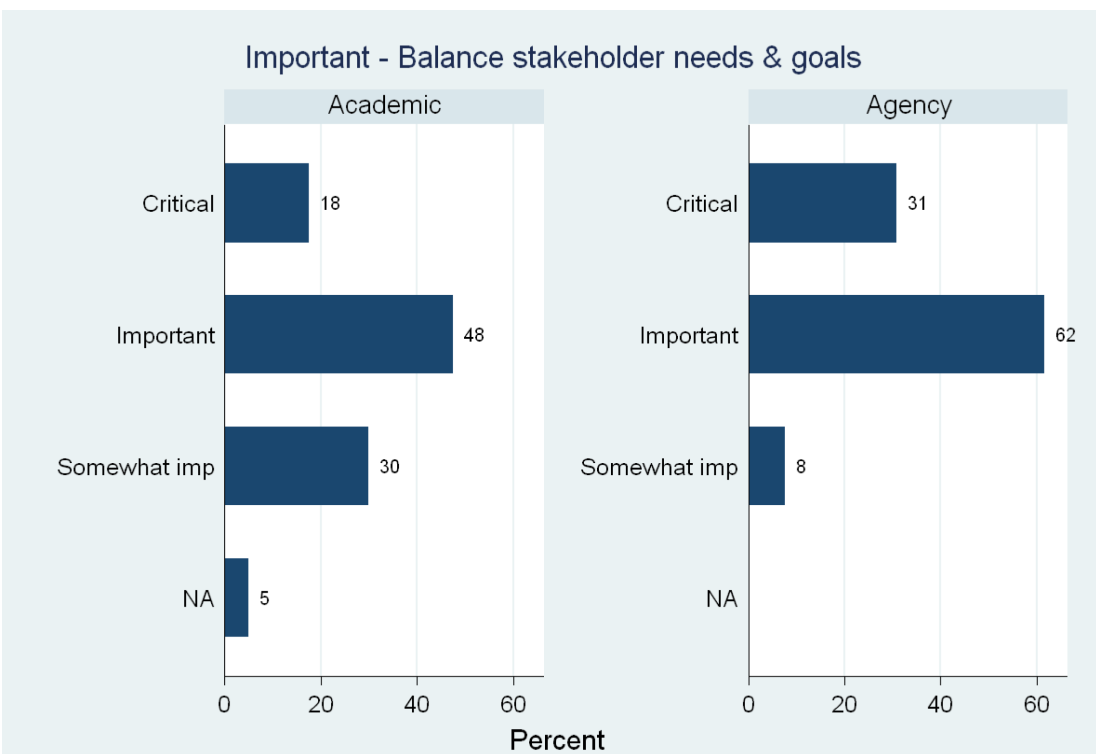

Figure A7. Mean difference between academic and agency responses regarding balance in stakeholder needs and goals

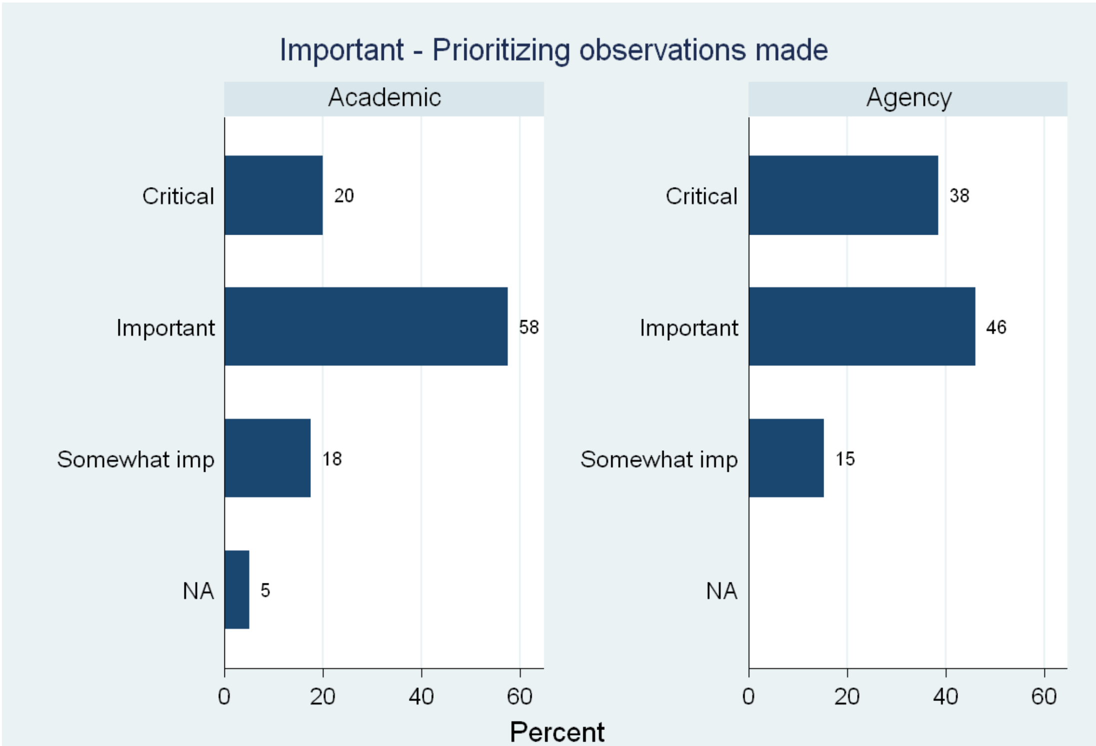

Figure A8. Mean difference between academic and agency responses in prioritizing observations made

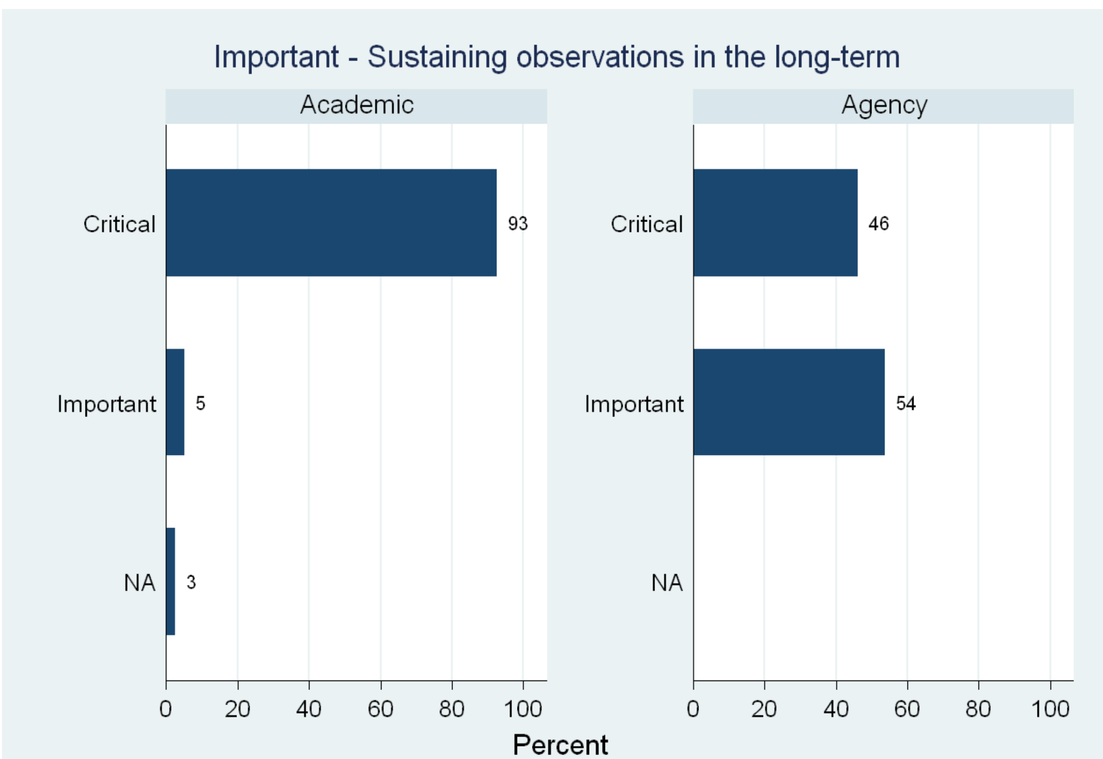

Figure A9. Mean difference between academic and agency responses in sustaining long-term observations

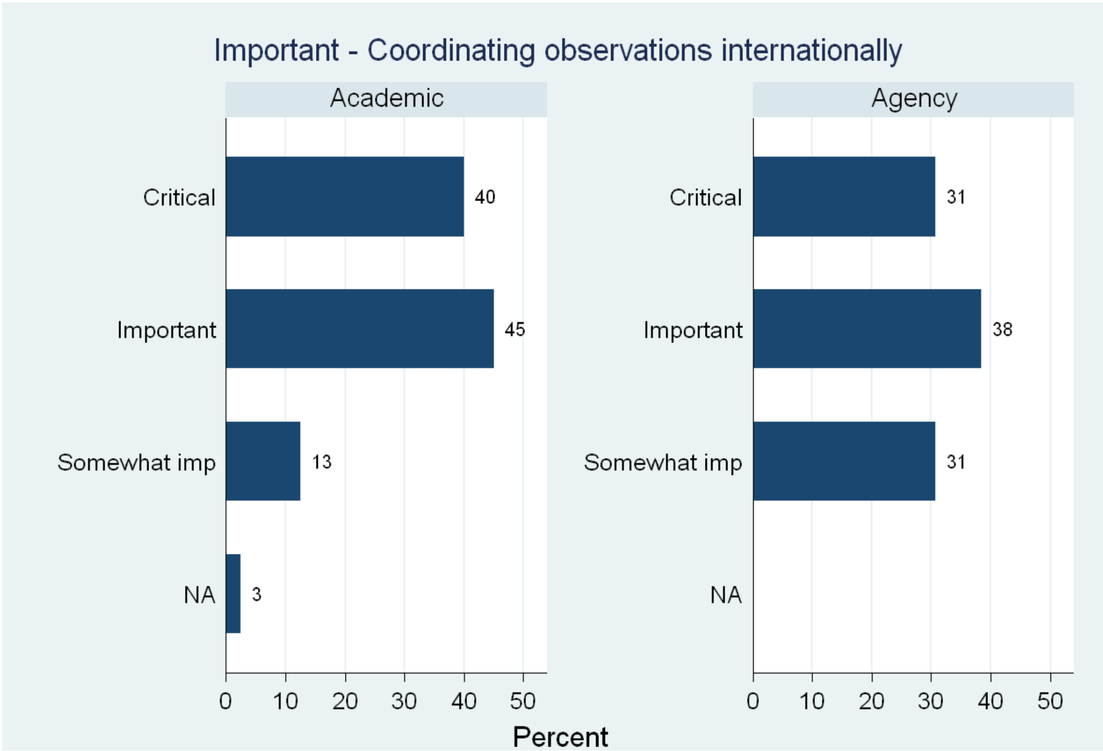

Figure A10. Mean difference between academic and agency responses in coordinating observations internationally.

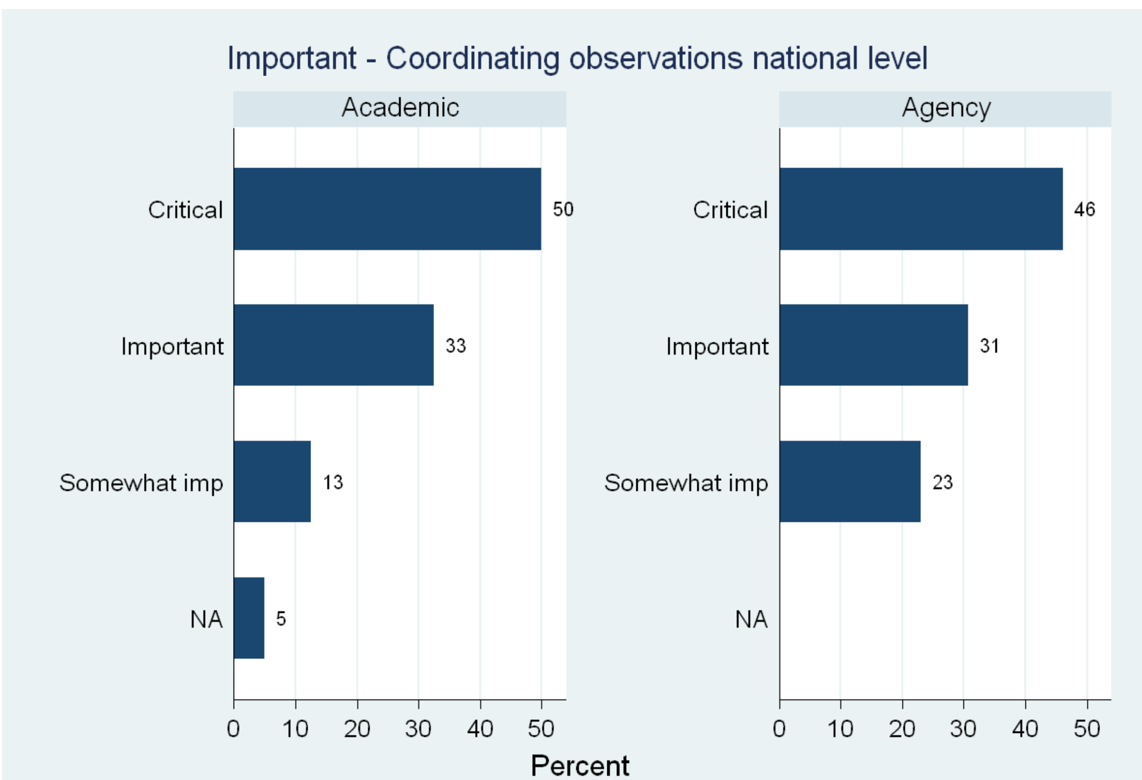

Figure A11. Mean difference between academic and agency responses in coordination observations nationally.

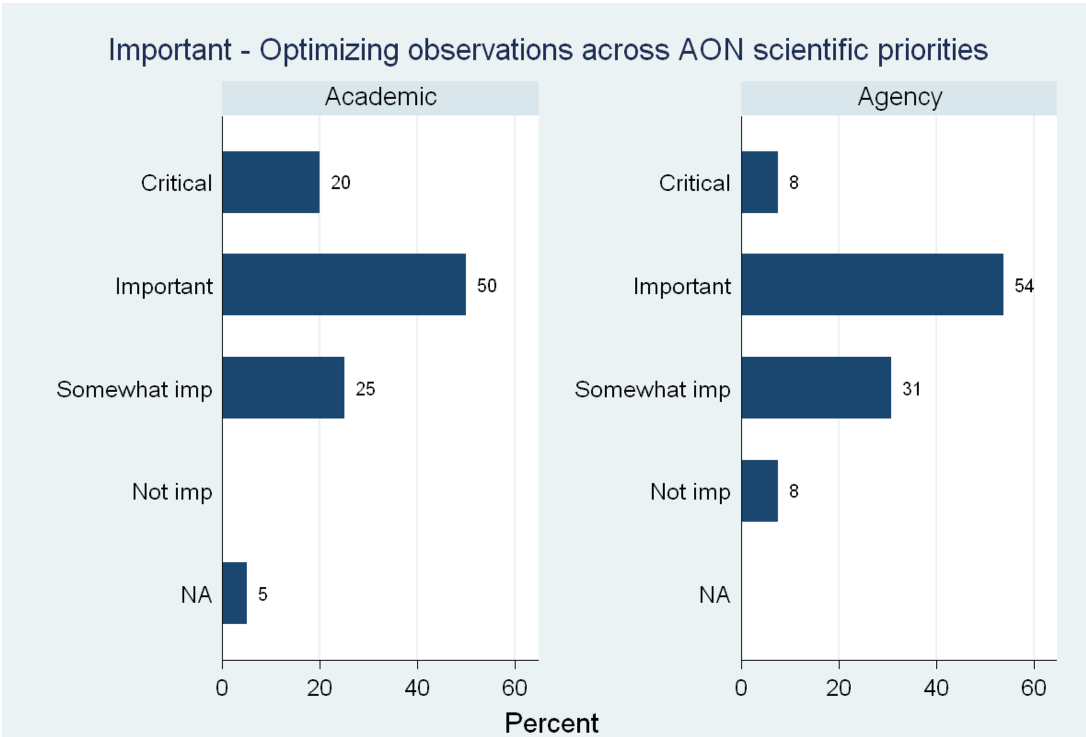

Figure A12. Mean difference between academic and agency responses in optimizing observations across AON scientific priorities

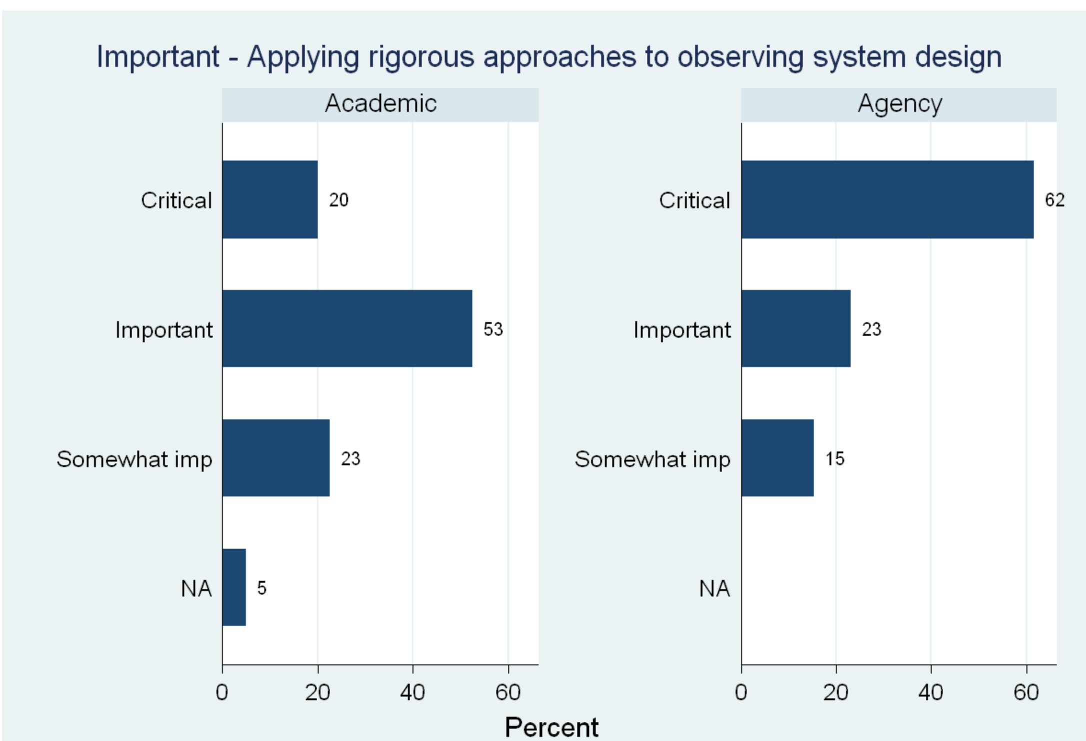

Figure A13. Mean difference between academic and agency responses in applying a rigorous approach to observing system design

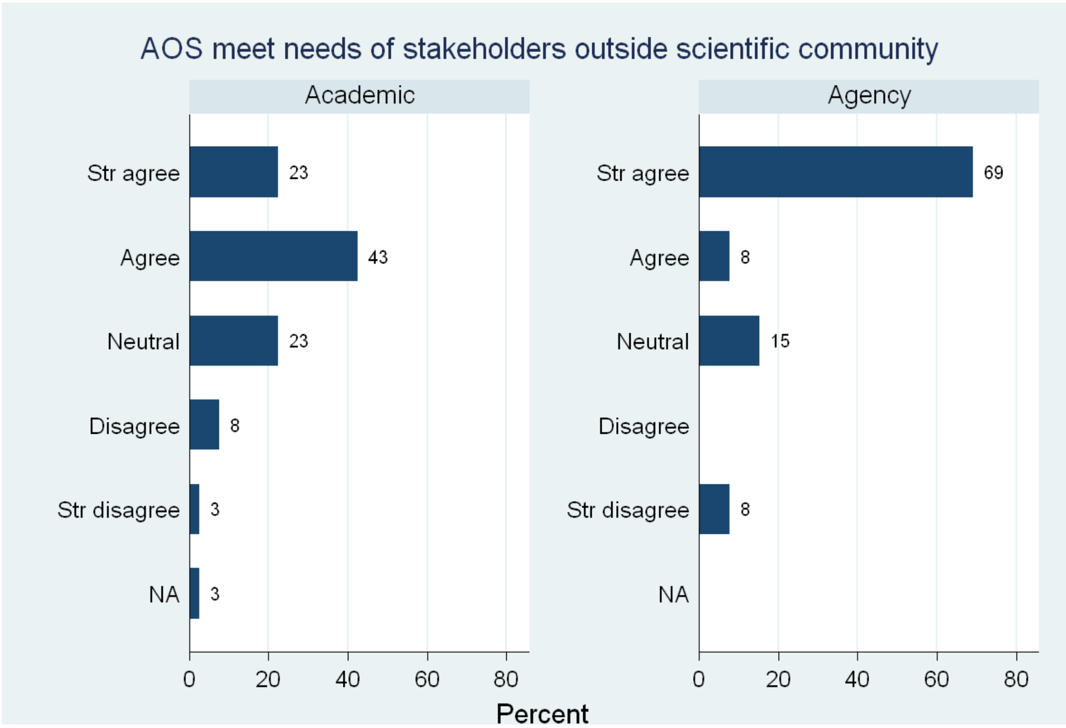

Figure A14. Mean difference between academic and agency responses in agreeing whether the Arctic Observing System meets the needs of stakeholders outside the scientific community

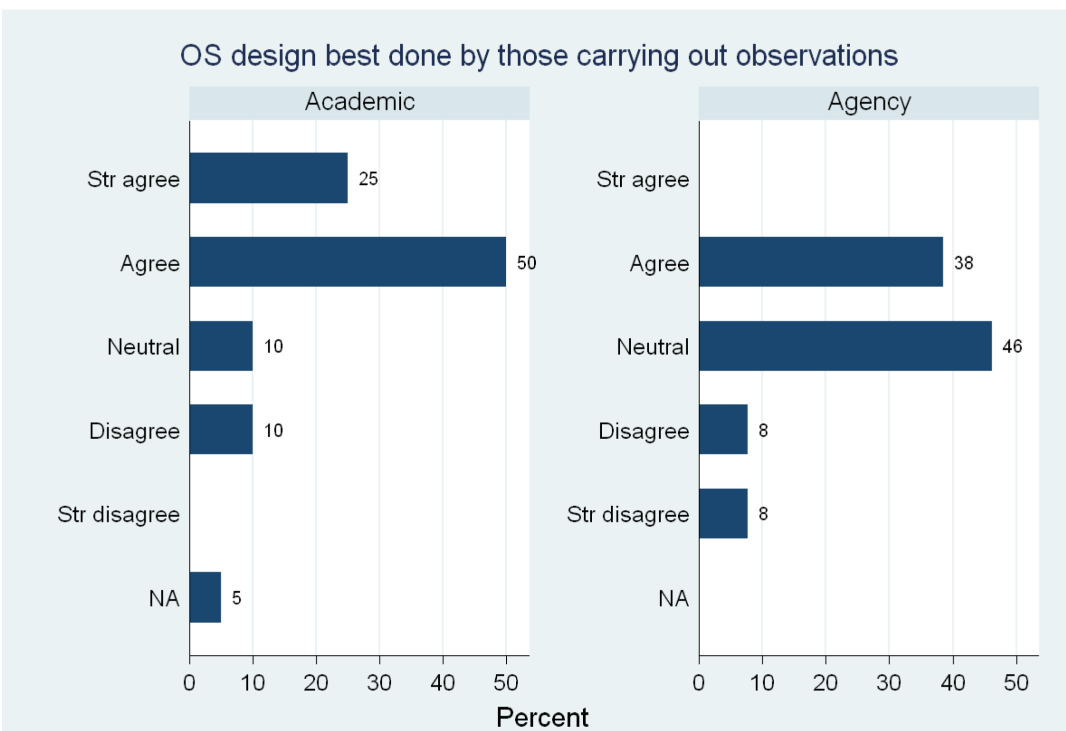

Figure A15. Mean difference between academic and agency responses in agreeing whether observing system design is best carried out by those conducting observations

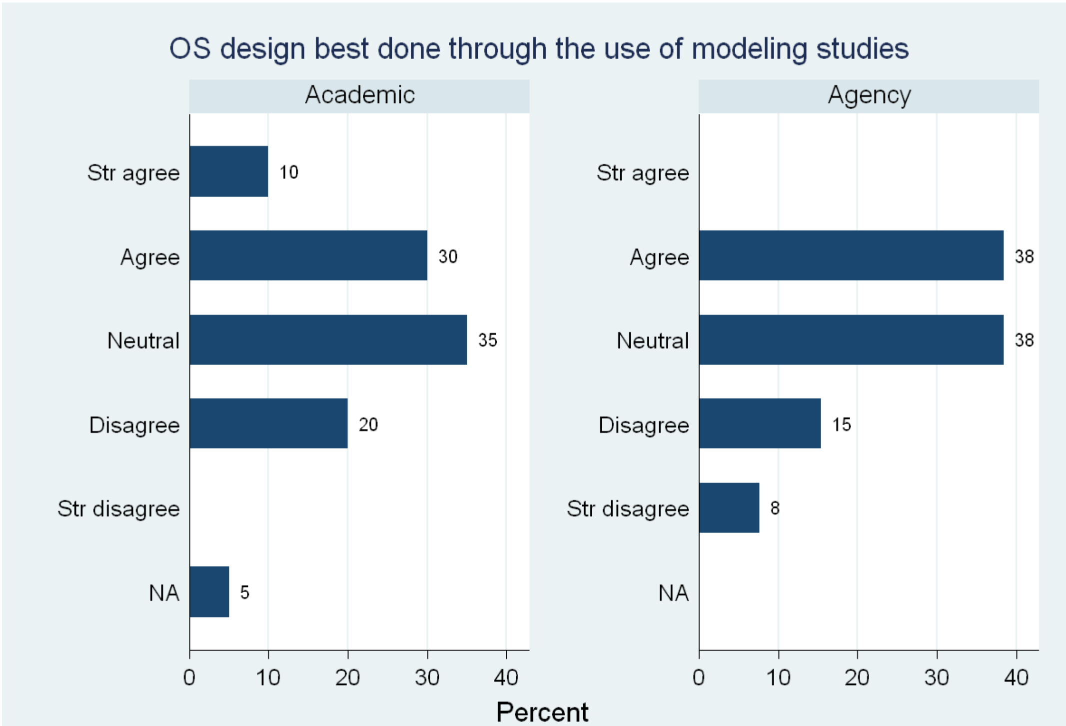

Figure A16. Mean difference between academic and agency responses on agreeing whether observing system design is best done through the use of modeling studies

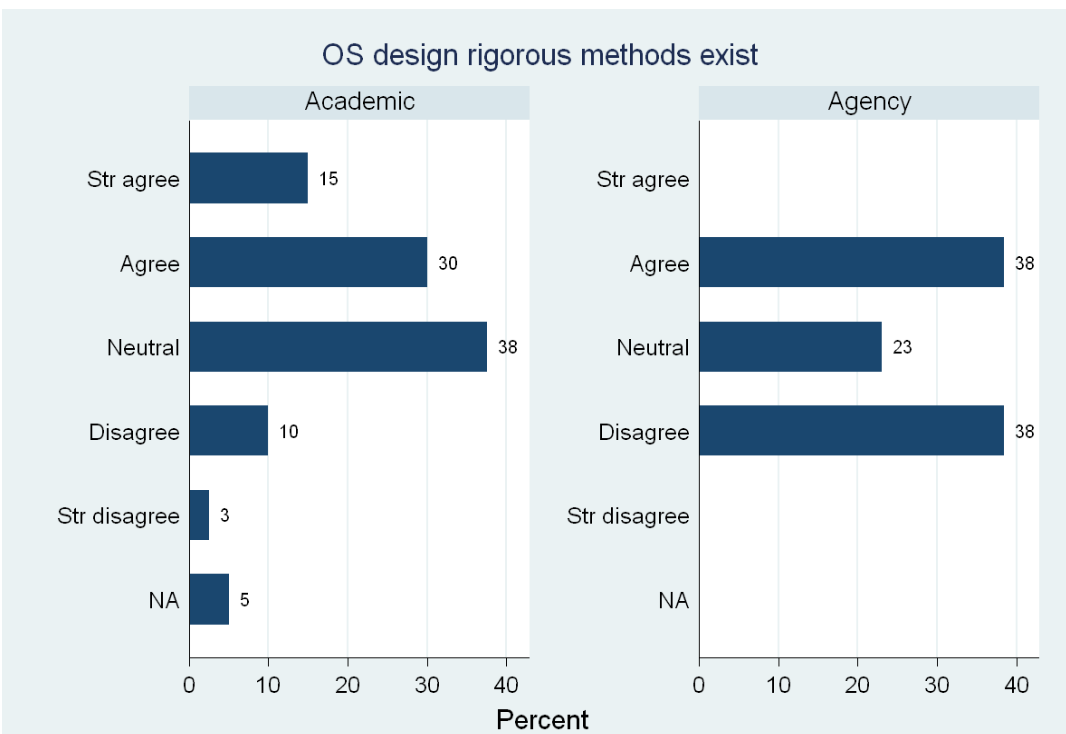

Figure A17. Mean difference between academic and agency responses on agreeing whether rigorous methods exist for observing system design

Graphs of differences between AON PIs and non-AON PIs:

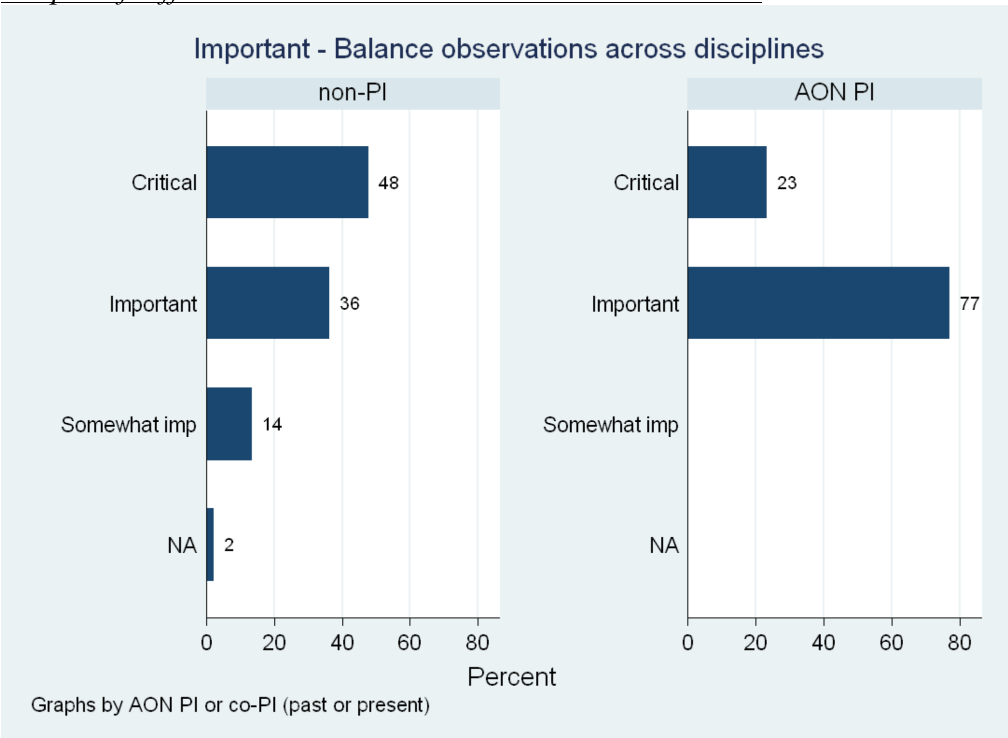

Figure A18. Mean difference in responses between non-AON PIs and AON PIs regarding balance in observations across disciplines

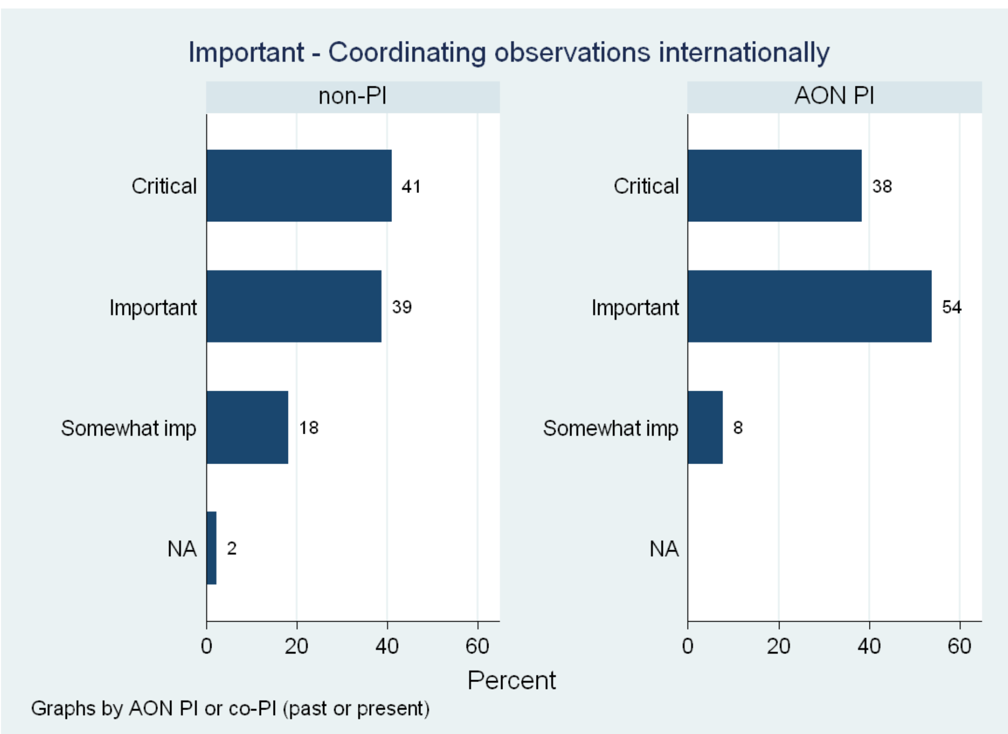

Figure A19. Mean difference in responses between non-AON PIs and AON PIs regarding coordination of observations internationally

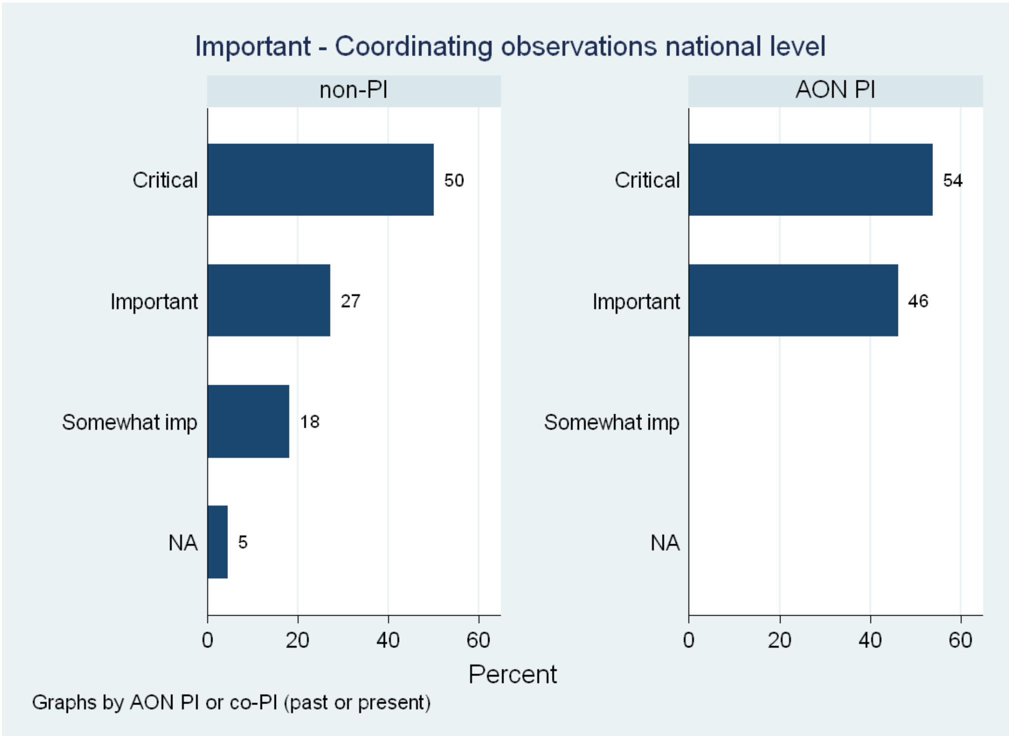

Figure A20. Mean difference in responses between non-AON PIs and AON PIs regarding coordination of observations nationally

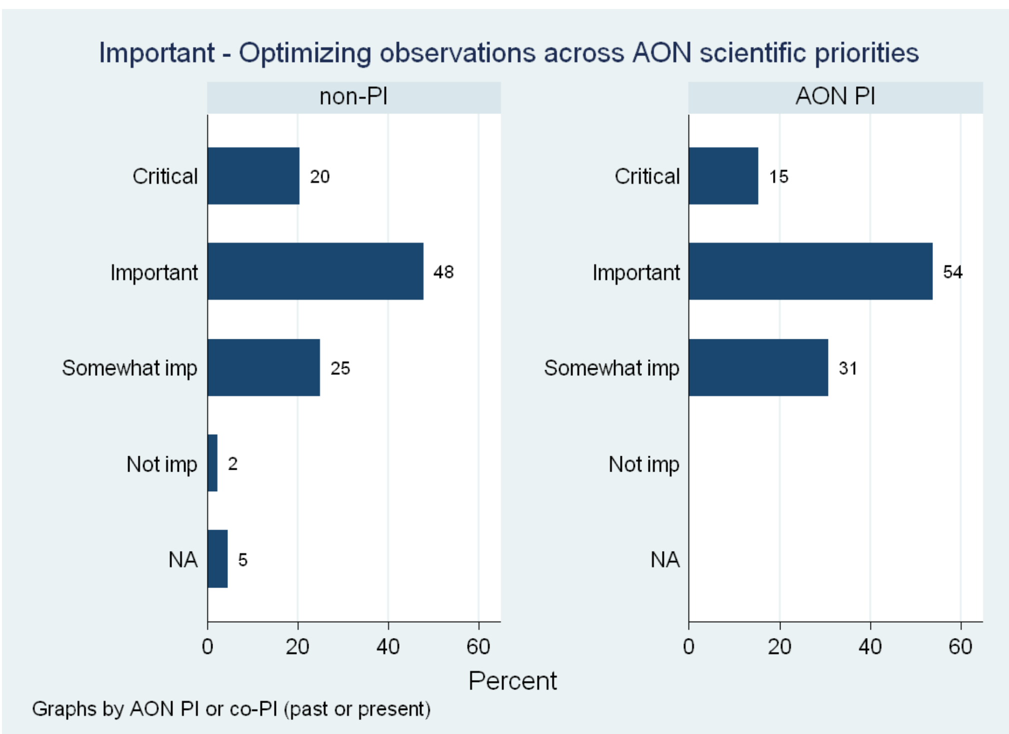

Figure A21. Mean difference in responses between non-AON PIs and AON PIs regarding optimizing observations across AON scientific priorities

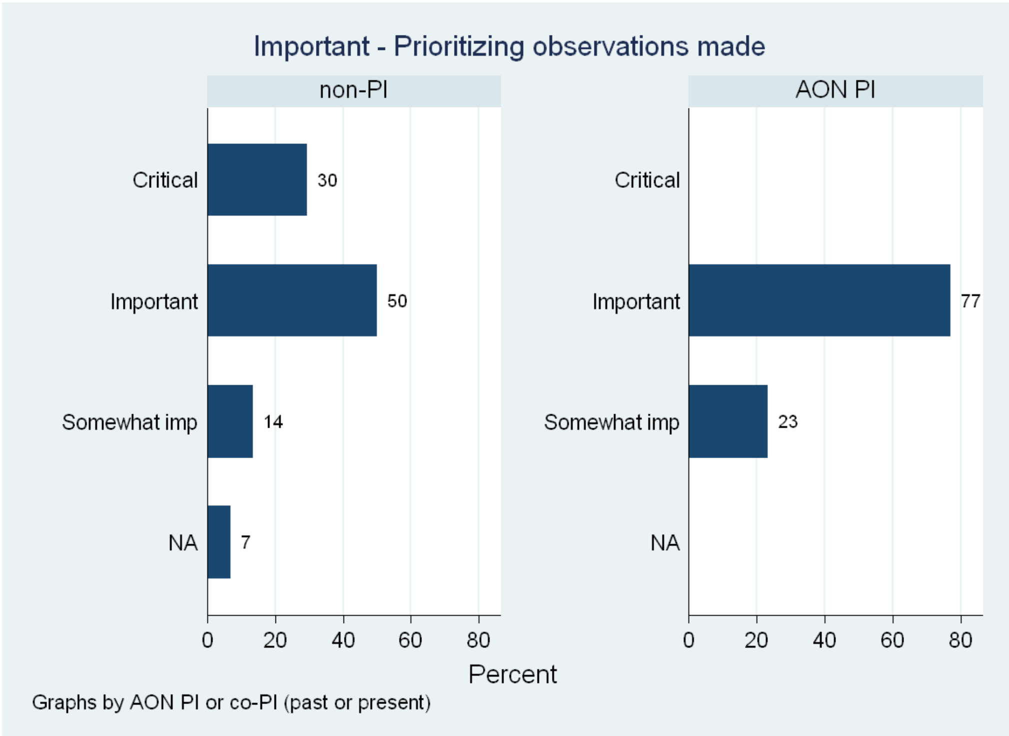

Figure A22. Mean difference in responses between non-AON PIs and AON PIs regarding prioritizing observations made

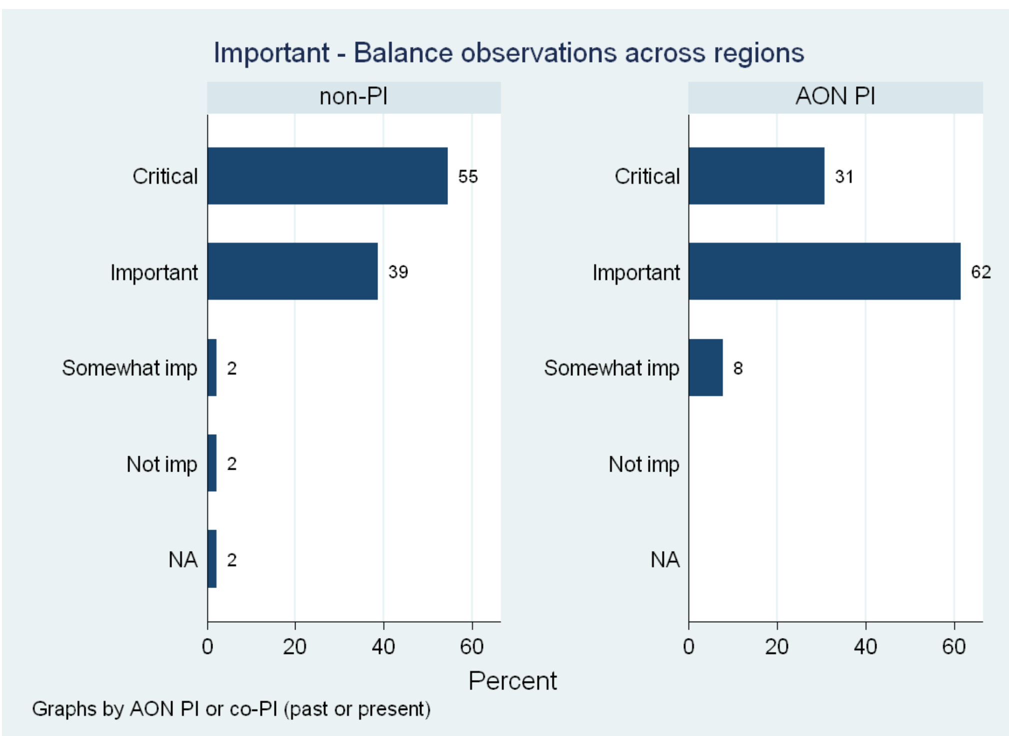

Figure A23. Mean difference in responses between non-AON PIs and AON PIs regarding balance in observations across regions

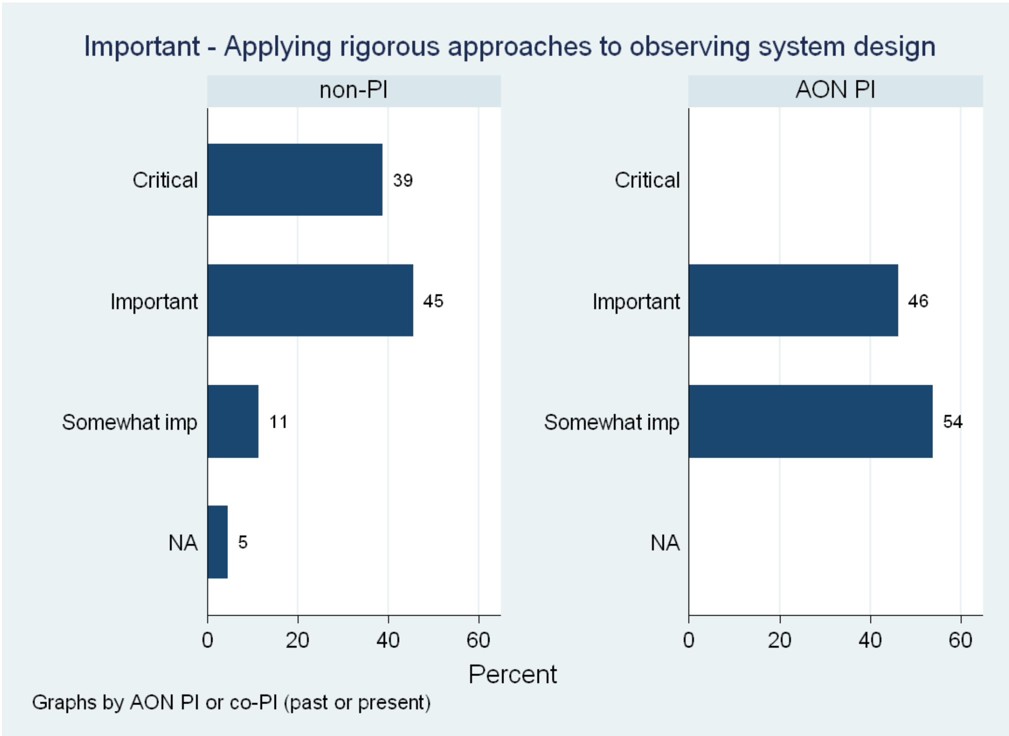

Figure A24. Mean difference in responses between non-AON PIs and AON PIs regarding applying rigorous approaches to observing system design

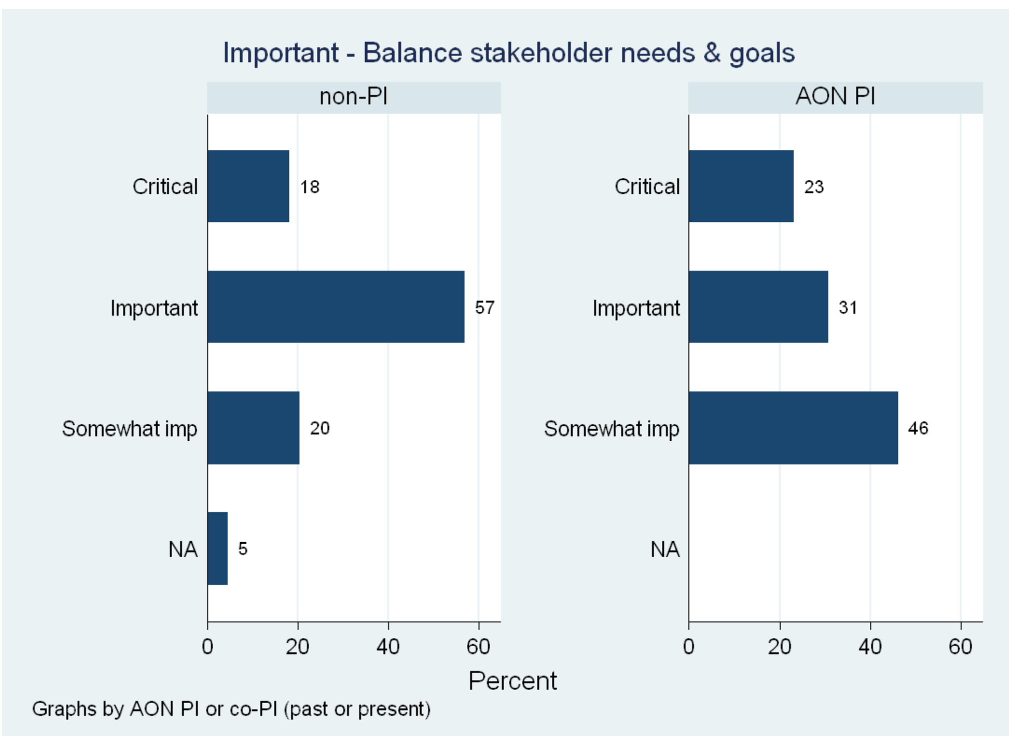

Figure A25. Mean difference in responses between non-AON PIs and AON PIs regarding balance between stakeholder needs and goals

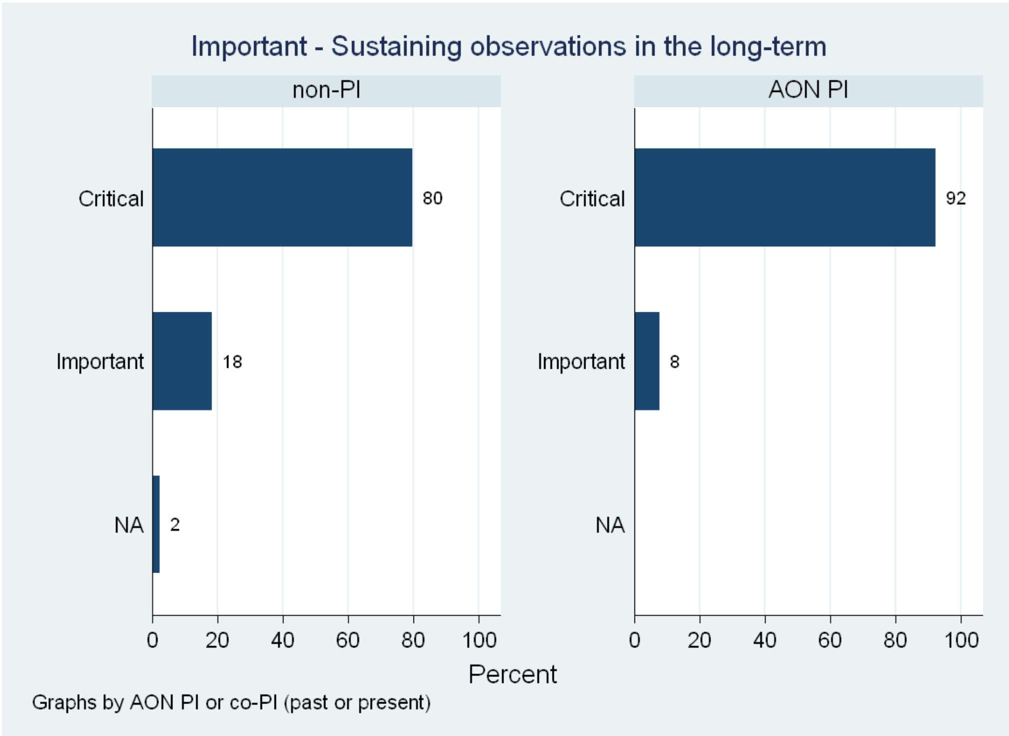

Figure A26. Mean difference in responses between non-AON PIs and AON PIs regarding the importance of sustaining long-term observations

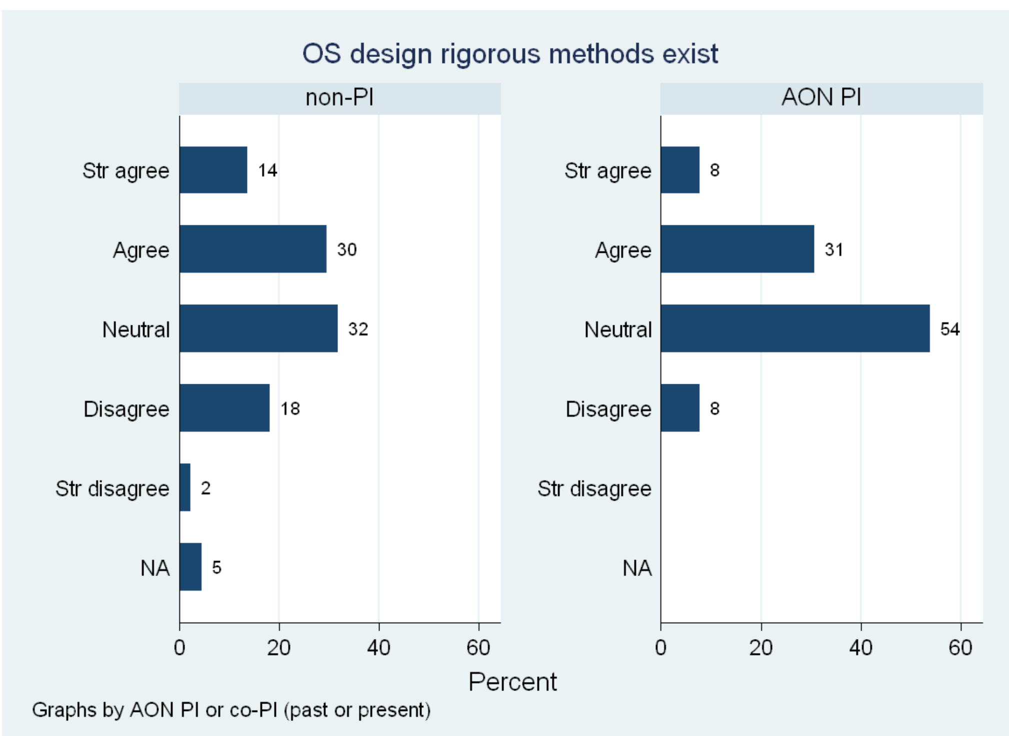

Figure A27. Mean difference in responses between non-AON PIs and AON PIs on agreeing whether rigorous methods for observing system design exist

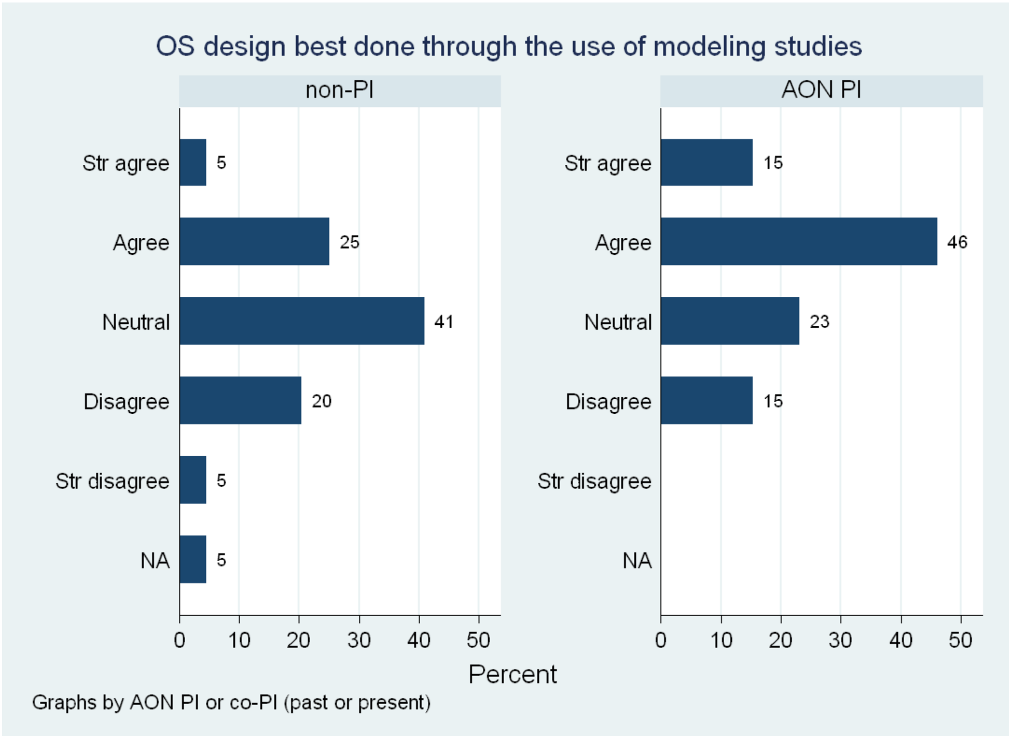

Figure A28. Mean difference in responses between non-AON PIs and AON PIs on agreeing whether observing system design is best done through modeling studies

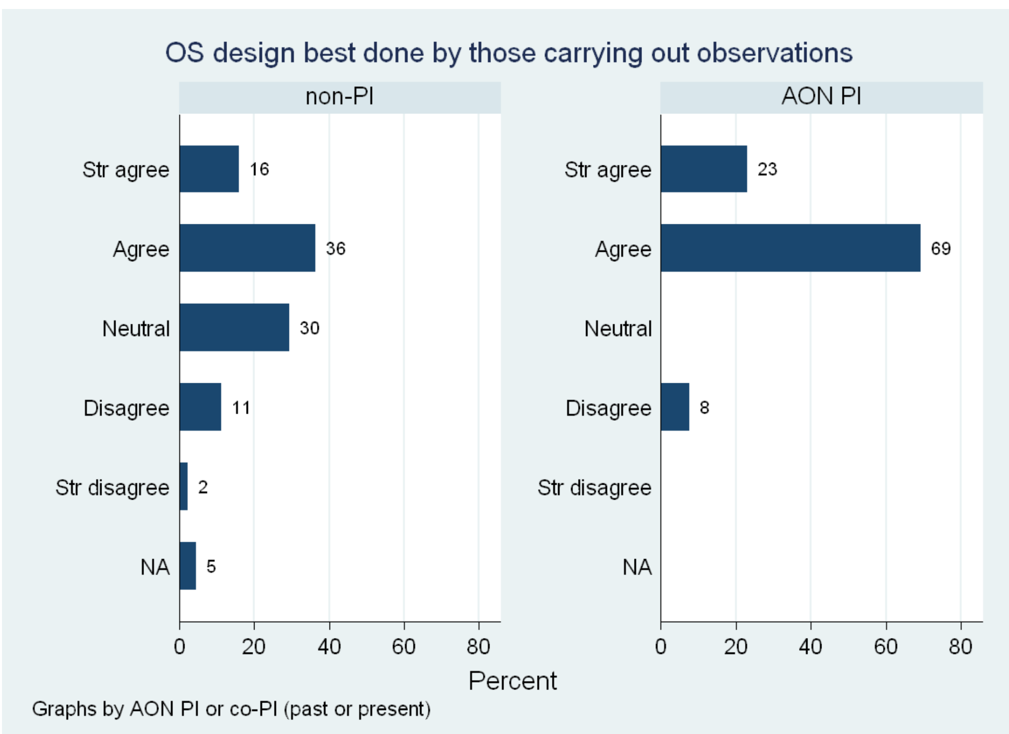

Figure A29. Mean difference in responses between non-AON PIs and AON PIs on agreeing whether observing system design is best done by those carrying out observations

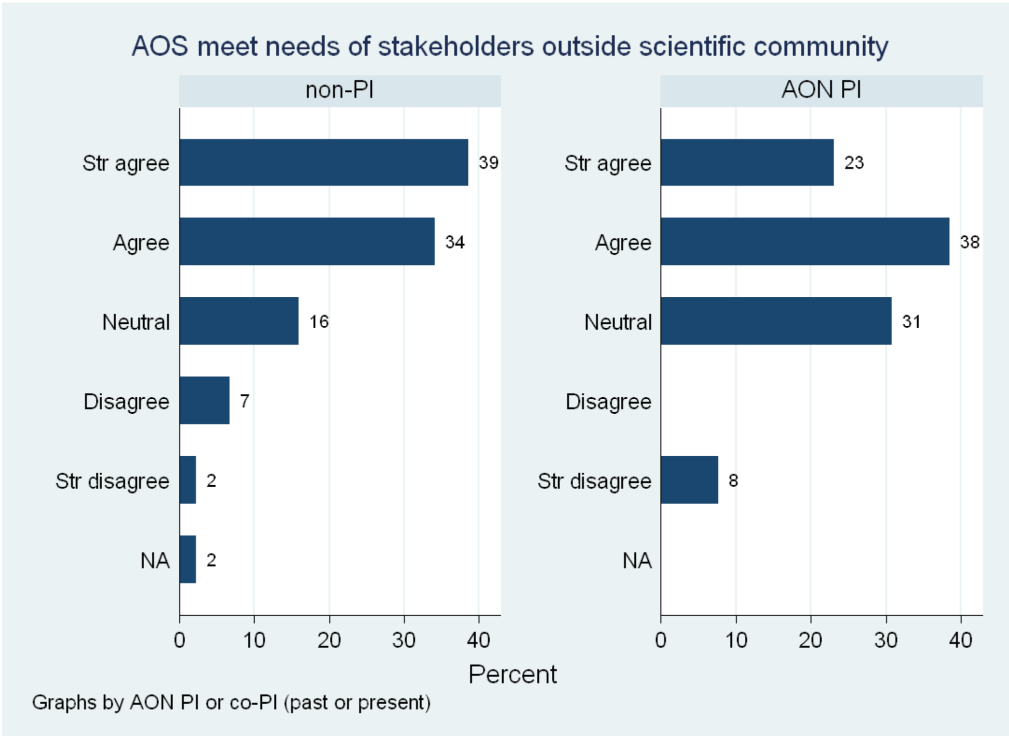

Figure A30. Mean difference in responses between non-AON PIs and AON PIs on agreeing whether the Arctic observing system meets the needs of stakeholders outside the scientific community

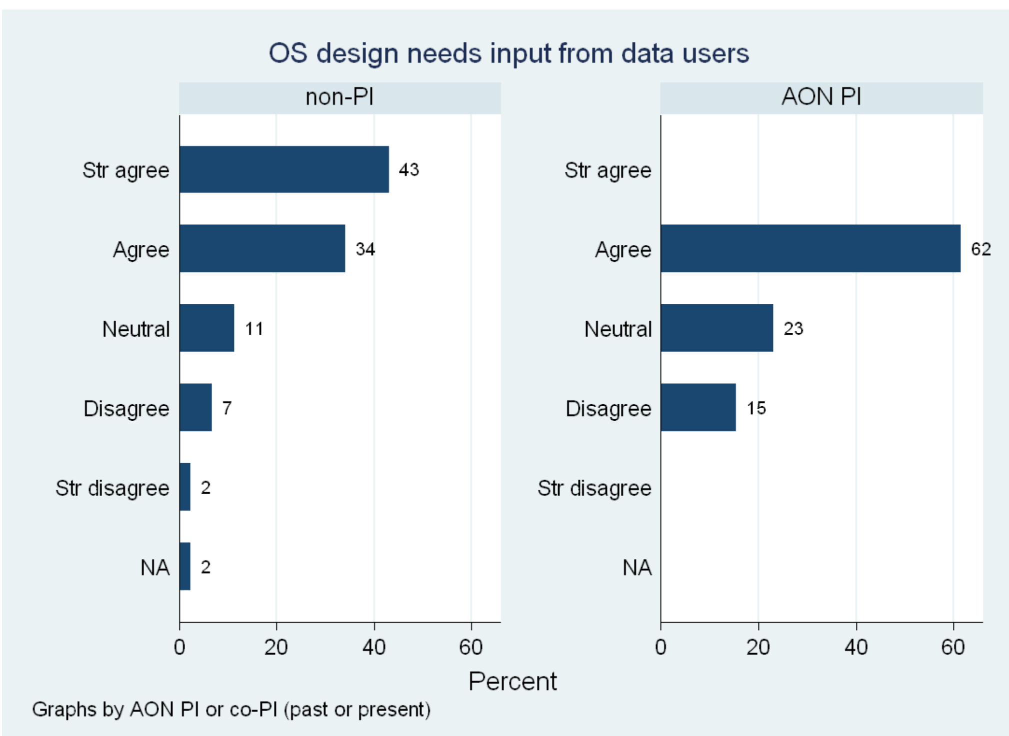

Figure A31. Mean difference in responses between non-AON PIs and AON PIs on agreeing whether observing system design needs input from data users

9. *Are you aware of an observing system effort either within or outside of the Arctic that holds important lessons for the design and implementation of an Arctic Observing Network?*

Yes – 62.9% (66)
No – 37.1% (39)

Other (please specify) – 11 responses

In the Other category, observing system efforts mentioned included: El Nino Toga Array, the International Arctic Buoy Program, military observation programs, the Canadian Network for the Detection of Atmospheric Change (CANDAC), ADF&G (Alaska Department of Fish and Game) Division of Subsistence for comprehensive subsistence research and NOAA Atmospheric Observatories.

10. If you answered yes, what is the name of that observing system or program (if possible please provide a relevant weblink or reference)? If possible, please also indicate what the most important lesson from that observing system is for the AON.

Table A3 provides a summarized list of the observing systems mentioned in the survey and any corresponding comments, grouped by major system.

Table A3. Observing systems and related comments on observing system design.

Observing System	URL	Comment
Oceans & Sea Ice		
Alaska Ocean Observation System	http://www.aoos.org/	New approaches to data management
ALERA		
AOOS	http://www.aoos.org/	
Arctic ROOS	http://arctic-roos.org/observations	Fram strait mooring array
ASOF program		Arctic Subarctic Ocean Fluxes; international coordination is possible, but must get buy in from individual scientists and let them pursue interesting science as well
Beaufort Gyre Observing System	www.whoi.edu/beaufortgyre	
Bering strait/Chukchi Sea observing array	http://psc.apl.washington.edu/HLD/Bstrait/IPYbstrait.html	
CTD/water sample surveys		Resolves freshwater composition documents variability in Atlantic and Pacific water large scale circulation
DAMOCLES/SIOS	http://www.damocles-eu.org/	
DBO	http://www.arctic.noaa.gov/dbo/	

Oceans & Sea Ice (cont.)		
El-Nino (Toga Array)	http://www.pmel.noaa.gov/pubs/docs/mcph1401.html	Mark Cain tried to tell all of us, in sea ice, at the 1996 climate meeting in Cancun, Mexico about effective ways to develop a network. He specifically told us to stop bickering and start cooperating and that was the key problem back then. The younger, less established, people got it but the senior people did not. Maybe the sea ice community is ready to listen now that we are at a generational switch. Mark would be a good person to talk to about this point. mcane@ldeo.columbia.edu
GLOBEC	http://www.globec.org/	
Gulf of Mexico COOS	http://gcoos.tamu.edu/	
HAUSGARTEN	http://www.awi.de/en/research/deep_sea/deep_sea_ecology/deep_sea_long_term_observatory_hausgarten/	
IABP (Arctic Buoy Program)	http://iabp.apl.washington.edu	My favorite, the International Arctic Buoy Program has over 30 years of experience developing and maintaining the basic observations of AON.
Ice-tethered observing system	http://www.whoi.edu/page.do?pid=20756	
IOOS	http://www.ioos.gov/	
NOAA/CO-OPS' National Water Level Observational Network (aka, long term tide stations)	http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml	
SCICEX		Ice draft measurements from submarines gold standard for this measurement
Sea Ice Buoys		Very reliable sea ice motion
Southern Ocean Observing System (SOOS)	http://www.scar.org/soos/	The Southern Ocean Observing System is just now being implemented
Atmosphere		
Antarctic Aeronomy Consortium		
Canadian Network for the Detection of Atmospheric Change (CANDAC)	http://www.candac.ca	Funding must be planned and carried out on a longer term than is typical for sponsered research. If not, every few years you end up investing great effort in replacing much of what was allowed to expire previously.
DOE ARM	http://www.arm.gov/	

Atmosphere (cont.)		
Fluxnet: network of eddy covariance towers		One important lesson learned from this is the importance of processing data from the sites in a similar manner, while also taking into account site differences.
GAW	http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html	While not Arctic-specific, I'm sure that something can be learned from GAW
International Radiosonde Network	www.wmo.int	Demonstrates the importance of international coordination to provide a robust and dependable observing network.
NASA/AERONET	http://aeronet.gsfc.nasa.gov/	
NDACC	www.ndacc.org	
NOAA/ESRL/GMD	http://www.esrl.noaa.gov/gmd/	High-quality long-term measurements with high visibility
SPARC-IPY	http://www.atmosp.physics.utoronto.ca/SPARC-IPY/	
Switchyard and NPEO aircraft		
TOGA TAO	http://www.pmel.noaa.gov/tao/	
USHCN	http://cdiac.ornl.gov/epubs/ndp/ushcn/ushcn.html	
(comment only)		NOAA atmospheric observatories certainly provide a basis, but is not applicable to most disciplines. My biased opinion is that TSP (includes CALM as defined by IPY program) is well established but need better geographic coverage.
Land		
Arctic Landscape Conservation Cooperative (FWS)	http://arcticlcc.org/home/news/arctic-lcc-website/	
Circumarctic (Terrestrial) Environmental Observing Network	http://www.ceon.utep.edu/	International coordination needs adequate support; online tools for collaboration should be utilized (Webinar software) to reduce travel.
GTOS	http://www.fao.org/gtos/	
INTER-ACT	http://www.eu-interact.org/	
LTER	http://www.lternet.edu/	Are locations too political or projects too provincial?//(loosely coordinated between sites though) - excellent long-term records for many things and specific sites.
NGEE	http://ngee.ornl.gov/	

Land (cont.)		
Thermal State of Permafrost	http://permafrost.gi.alaska.edu/project/thermal-state-permafrost	
UNAVCO	http://www.unavco.org/	Ability to facilitate community consensus amongst scientists involved in or interested in developing the technology
Land Ice		
Ice tethered profilers		Provides high quality T and S data, but does not provide spatially even coverage
POLENET	http://www.polenet.org/	
Human Dimensions		
ADF&G Division of Subsistence standard comprehensive subsistence research		The most important lesson from the past 30+ years of ADF&G Division of Subsistence human dimensions research is that Alaskan residents' hold invaluable information obtained through lifetimes of observing the natural environment and the resources upon which rural Alaskans depend and rely.
AMAP	http://www.amap.no/	
Arctic Observation Network Social Indicator Project	http://www.iser.uaa.alaska.edu/Projects/SEARCH-HD/index.htm	
ASI	http://www.svs.is/ASI/ASI.htm	
CERA	http://www.carseyinstitute.unh.edu/CERA/cera-home.html	
Fishery Resources Monitoring Program, U.S. Fish and Wildlife Service, Anchorage	http://alaska.fws.gov/asm/fis.cfml	The ideals of the Monitoring Program are admirable, supporting collaborative social science and fishery science research. These ideals are reflected in the guidelines.
National Park Service Inventory and Monitoring Program	http://science.nature.nps.gov/im/units/arcn/	
(comment only)		Subsistence and other harvesting monitoring programs administering by the Alaska Department of Fish and Game, including the Community Subsistence Information System and the Alaska Subsistence Fisheries database

(comment only)		The recent article in Arctic by Bockstoce et al. demonstrates the importance of obtaining historic 19th century ship log data to determine annual extent of sea ice - Lesson learned: historic archival data can provide significant insights on extent and duration of ice, climate, and water temperatures. Another recent publication by you and Ann Feinup-Riordan described interviews with indigenous people regarding changes in storms, sea ice conditions, etc. and effects on their lives. The human dimension is often overlooked but the veracity and relevance of informant data is genuine and can provide insights otherwise missed by science.
Other		
AGO/LPM		
Alberta Biodiversity Monitoring Institute	http://www.abmi.ca/abmi/home/home.jsp	
Arctic Great Rivers Observatory	http://arcticgreatrivers.org/	
CBMP	http://caff.is/monitoring	Most important lesson - learning from our mistakes and how to get from discussion to development, implementation and results.
GCOS	http://www.wmo.int/pages/prog/gcos/index.php?name=AboutGCOS	
GLEON	http://www.gleon.org/	
Global Seismographic Network	http://www.iris.edu/hq/programs/gsn	
GLOBE Program	http://globe.gov/	
GOOS	http://www.ioc-goos.org/	
IASOA	iasoa.org/iasoa/index.php?option=com_content&task=view&id=85&Itemid=123	
Long-term time series Hornsund fjord (Poland)	http://hornsund.igf.edu.pl/research.html	
NEON	http://www.neoninc.org/	Are locations too political or projects too provincial?// Lesson learned is that you can't do everything everywhere, and actually your money won't go as far as you had hoped
POLARCAT	http://www.polarcat.no/	
SAON	http://www.arcticobserving.org/	
SNOTEL	http://www.wcc.nrcs.usda.gov/snow/	Are the observations representative?
WMO weather stations		

(comment only)		Check history or monitoring, its flaws, and conservation literature
(comment only)		Based on CEDAR and IPY experience; 1) Observations in pan-Arctic require significant commitment on part of PIs from different countries who work in different funding cultures. The personal commitment at a PI level is critical for the success of the observations. 2) Laboratory-quality observatories are critical for maintaining multi-year observations that allow student participation as active observers.
(comment only)		There are many examples. What AON can learn from most of these examples is that ideas are cheap. Without dedicated mechanisms for financially supporting observing systems, they largely remain figments of our imagination
(comment only)		International Earth Observations from Space, Global Ocean Observations, and others.
The DEW line would be a good example of a system put in place and kept operating in the Arctic for decades. Think what it would have meant if in addition to the radar the sites had been ones of general scientific exploration over the same period!		Military observation systems are operated continuously for decades and our environmental observation systems should be modeled on these since the failure of catching environmental signals is at least as serious as missing a military threat.

11. *If you currently generate observational data or have in the past, please indicate whether you provide public access to these data - Other (please specify)*

Yes – 84.1% (90)
No – 5.6% (6)
N/A- 11.2% (12)

Other (please specify) – 15 responses.

In the "Other" category, responses either mentioned that:

- the availability of data depended on the type of data that could be disseminated
- described how public databases did not suit their needs for dissemination
- stated that the data would be made available after publication of result or
- mentioned future plans to make data available.

12. Do you generate observational data that are being disseminated by a data center or portal? - Other (please specify)?

Yes -74.3% (81)
Non – 18.3% (20)
N/A – 7.3% (8)

Other (please specify) – 9 responses

In the other category respondents mentioned that data generated were either:

- disseminated by both a data center and a portal,
- other collaborators disseminated the data,
- open access was provided,
- and two other responses mentioned specific examples used to disseminate the data (NSIDC).

13. If you answered yes to the previous question, do you track the use of your data by others? - If applicable, please list the data center/portal you use to disseminate your data

Yes – 36.1% (35)
No – 53.6% (52)
N/A – 14.4% (14)

If applicable, please list the data center/ portal you use to disseminate your data – 29 responses.

Table A4 provides a list of data portals respondents mentioned using to disseminate data removing duplicate answers:

Table A4. Alphabetical list of data portals used to disseminate data

Data Portal
CADIS -
arcticgreatrivers.org
www.permafrostwatch.org
Published papers, user reports
CUHASI HIS
GINA,
NPS Arctic Network website
http://alaska.datatransport.org/
http://toolik.alaska.edu/edc/
http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.main
http://research.iarc.uaf.edu/IPY-CTSM
www.ndacc.org
NBII
GBIF
CODATA
NSIDC
Own web server
NCDC

Data Portal
Project website at http://uv.biospherical.com / CADIS / World Ozone and UV Data Center / Network for the Detection of Atmospheric Composition Change
Visitor numbers on www.arcodiv.org
Fishery Resources Monitoring Program report series at http://alaska.fws.gov/asm/fis.cfml?fissel=5.
Subsistence monitoring: http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.harvest
WMO GTS
www.dmu.dk
AMAP
Mentioned would like to improve tracking

14. If you answered yes to the previous question, how do you track the use of your data? - Other (please specify)

Total number responded – 40
Total number skipped question – 80

Responses in the "Other" category tracked data use with AON CADIS, published papers or co-authorship in publications, data set citations, Google analytics and informal feedback.

15. What do you consider the most effective way of tracking the use of data provided by an observing system? - Open-Ended Response

The responses were grouped in larger categories and the number of responses in each category are provided in Figure A32.

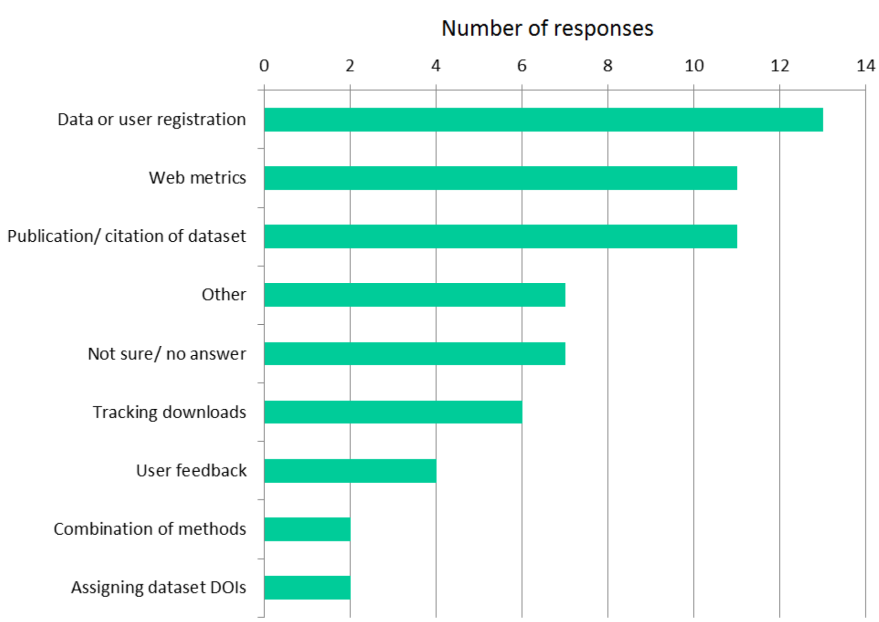

Figure A32**.** Number of responses in categories listing the most effective ways to track data

While a number of approaches are prevalent, the key challenge is to develop best practices that allow for a more consistent and less cumbersome approach in tracking use.

16. *Do you have any further comments or guidance for the AON Design and Implementation Task Force? - Open-Ended Response*

Responses could be grouped into the following major categories (see Table A5 for actual comments in each category):

- Comments related to stakeholder involvement (9 responses)
- Comments related to design and implementation (9 responses)
- Comments related to funding (3 responses)
- General comments (6 responses)

Table A5. Individual comments in each category for further comments and guidance for the ADI Task force:

Stakeholder involvement
Again, my comments as a social scientist likely have a different flavor. I think it's worth keeping the nature of social science data in view -- how it's organized, how publication is constrained, what it can and can't do.
Ensure linkages and consistency with the Circumpolar Biodiversity Monitoring Program, the International Arctic Science Committee and other international monitoring and coordinating committees for Arctic science.
Include technical support as a stakeholder at the table. This is the best way to ensure optimal support and potentially make limited funding go further.
Please involve, besides the core polar scientists, up to date engineers with new MEMS, Nano, novel platforms, networking, etc directly involve in decision making. Polar region does not have a direct and significant economical impact for engineering community to design better sensors, networks, platforms, etc just for the polar region. In order to get benefit from recent progress in these areas in engineering the polar community need to understand that spending a little money on designing proper engineered system for the polar region is MUCH better than designing systems by scientists that are old from engineering perspective. A major part of polar program budget goes to logistics for observation in harsh polar region. That could be reduce by orders of magnitude if state of the art sensors, platforms, networks, etc are used instead of current system designed mostly by scientists based on technology from a couple of decades ago. I have first-hand experience with such designs and associated problems and I found it frustrating that the community does not really engage new engineering at a basic level. I participated in several NSF observing system workshops going back to 2003 and I still see the same types of mistakes happening.
Please make the effort to include all parties living in the circumpolar north, be them native populations, settlers, or wildlife.
Please work with the Global Cryosphere Watch (GCW)! Contact Jeff Key and/or Barry Goodison.

Though stakeholders outside science are important, some AON may warrant implementation without current outside stakeholders. These observations should be at the forefront of science monitoring change; potential future stakeholders may become aware of important changes only after an AON is monitoring these
AON should be thoroughly and comprehensively guided by SAON.
It can be difficult to build a system that meets everyone's desires. I think it is better to pick a one or two specific user groups and start with a design that meets their needs. Science is a user group.
Design and implementation
1, Build on existing monitoring capacity & information 2. Start small & maintain focus 3. Keep it simple (simple organization) 4. Be Relevant - Link to reporting mandates (national, regional and international as well as providing information that Arctic communities can use) 5. Involve managers and funders and other data users in the development 6. Budget for data management, analysis and reporting 7. Show value of integration through results: Develop early, targeted products for policy makers, scientists and the public
As I've indicated above, the "best through models" versus "best by observationalists" is the wrong approach. The best is through collaborative efforts (both sides in the same room!) to gain better understanding of each sides' assets and limitations.
I'm not sure my comments from the last page made it or not-- when I hit Next it presented me with the same page again, but with blank fields. In any case, AON really needs an Arctic glacier observation network, at least in Alaska. Just because these glaciers are small compared to others in Alaska, doesn't mean their impact on the downstream ecosystems in negligible, and in terms of being 'canaries in the coal mine' I don't think there are better candidates.
Include biology, usually gets dropped or forgotten, because moorings and such do not work for biology. Facilitate data integration between disciplines through, e.g. providing basic mapping and analysis tools on portal.
Considerable environmental data is collected by industry and this should be made publicly available in the terms of the leasing arrangements.
Check the results of design tools against previous experience.
Long-term monitoring at a few sites is preferable to short-term monitoring at many sites
Don't forget about the technical side of the equation. Often the time allowed to develop solutions is quite constrained and thus solutions are not always optimal.
Scientific base/questions should guide observations; new regions for observation to better cover entire domain, priority to new field observations in places with available long-term records for other components of the natural system

Funding
Where researchers funding comes from (and what it was proposed to do) completely guides a researchers focus. It was not clear who 'stakeholders' are in this form?
Long term operations and maintenance costs are killers. As far as I know, only the Feds have made loooong term commitments to collect, disseminate, and archive field data. You will need backup hardware, and people to make this work. Not going to be easy. Also ask user base on how they would like data disseminated ... format, frequency. Also think of a good way to archive, and share archived data. See NDBC site for example. Also USGS is an example of how archived river data is saved and shared. Also, like NDBC, have someone do annual and seasonal stats on the data and serve this out also.
This challenge must be an ongoing process. The initial phase will be critical. It will require major funding and far longer than we hope for. Success will require dedicated funding, first-class project management, and dedicated instrument experts and scientists. The U.S. federal interagency process will have to be faster, better, and cheaper than was the case for the USGCRP.
General comments
I am just shocked by the naive questions, approach and constant waste of time. I have participated at least 10 times in such excercises. So far, it has resulted into nothing. The expertise reflected here shows me the same all over again. You really MUST add some ethical views here.
In oceanography, we are partly in exploration and partly basic research. We are a long way from utilizing data to help "stakeholders" whatever they are.
Our goal during the IPY was to establish active collaboration between scientists who are observing the middle atmosphere consistently (with laser radar or lidar) across the Arctic, on a scale where we could observe the atmosphere under different synoptic regimes (i.e., below polar stratospheric vortex, at boundary of vortex, outside vortex, below Aleutian anti-cyclone). Goal was to determine contributions of waves to general circulation as wave-mean flow interactions vary in different synoptic regimes. Thus we use the network to monitor different regimes in the whole circulation pattern to understand wave driving of that circulation. Based on IPY efforts, we established collaboration with colleagues using the "Whole Atmosphere Community Climate Model (WACCM)" at NCAR. Goal of collaboration is to understand regions of high wave activity (wave hot spots) in driving the circulation (e.g., is there preferential wave driving over Greenland Plateau) and understand the circulation in a full 3-D sense rather than a 2-D zonal-mean sense. Recent studies show systematic changes in circulation due to changes in greenhouse gas changes, this observation-model study where we have a pan-Arctic observation network allows us address and understand these changes by forcing consistency in different regimes across the Arctic.
I think that the AON ADI has not made a clear statement of what their expected outcomes are and how they are going to achieve them....my impression to date is that it will be a modeling study?
I see no questions re. CMBP, GBIF, GEOOS, GEOBON, ArcOD, IPY etc. How can that be?
Stay international!

Summary

Most survey respondents agreed that sustaining long-term observations is critical. Logistic constraints, regional balance, and national-level balance also had high priority. Optimizing observations across AON scientific priorities, and balancing the needs and goals of all stakeholders appear less critical.

Academic responses tended to place greater importance on balance of observations across disciplines, sustaining observations in the long-term, and greater agreement that OS design should be done by those carrying out observations than agency responses. Agency responses showed a greater importance placed on applying rigorous approaches to observing system design, greater agreement that AOS meets the needs of stakeholders outside the scientific community, and greater agreement that OS design needs input from data users compared to Academic responses.

Non-AON PIs placed a greater importance on the balance of observations across disciplines, prioritizing observations made, applying rigorous approaches to observing system design, and greater agreement that OS design needs input from data users than AON PIs.

Most respondents independently cited in the open-response questions that the key challenges to AON design and implementation can be overcome by better coordination (nationally and internationally), sustained funding, and careful design and planning of the AON.