Review of EGUsphere_2026-2194

This paper describes that there are challenges for adopting S2S forecasts in particular in the agricultural sector, and then describes developing a game to both familiarize these potential users with the forecasts as well as to collect information to improve the useablility of forecasts.

Overall, as a reviewer, I'm intrigued with their game methodology as a way to introduce and familiarize potential users with S2S forecasts. Trying out a product is something that's documented to help uptake (see Rogers, 1995, (a meta analysis of many other studies about use of innovations). Roger Pielke Jr also discusses that a limitation of seasonal forecasts is that in contrast to weather forecasts, which we experience many times, we have fewer opportunities to experience seasonal forecasts - may take several years to accumulate this experience. I can't quickly lay my hands on this article, it's probably from about 2000. Games are one way to increase experience in shorter than natural time. I also laud their co-production process, discussion of two-way learning, and appreciate their point and intent that the interaction between researchers, forecasters and agricultural producers can inform the development of forecast services.I also appreciate their point (~line 55) about non-economic forecast benefits. While this is not a major focus of their article, I think it would be worthwhile to describe any they observed, which I'm guessing might include reducing stress in planing and opportunities for coordination. The addition of a 5th type of use is also a nice contribution.

I like the idea of using a game, which has parallels with the tabletop expercises that others are using for drought (e.g. by the US NIDIS and NDMC https://drought.unl.edu/scenarioguide/Resources/PastEvents.aspx), and for heat (https://heat.gov/tools-resources/introduction-to-heat-tabletop-planning-and-coordination/) Because I'm not an expert on developing and implementing a game, I'll leave that to others. I also acknowledge that there may be a lot of assumptions that go into things like the calculation of production and economic resources (~ line 210), I'm not an expert in that.

First, although I acknowledge space limitations in an article, it would have been useful to have a bit of background on the context, including what kinds of agriculture and crops - there's no information on what kinds of crops. Also useful, would be back ground on the forecasts, spatial scale, variables forecast, etc. This might go in an appendix if space is constrained. Fig 7 doesnt make this clear, and as part of the game, might not have been intended to.

I'll focus on the results they found related to their goal to ID "key factors affecting the relevance and use of S2S forecasts in Norwegian Ag" (line 93), and the findings they lay out in the abstract, including supporting forecast services co-production (line 19). Overall, the authors do have a lot of information on what might be wanted and how to improve, but it's often not concise, and thus missed opportunities to make the factors they uncovered more clear and inform their own agency, as well as to inform other met services. These factors and other findings are often buried in the text in a way that as a reader, it took time to parse out.

Here are a few ways I'd recommend to improve the article, many of which relate to being more concise about findings, such as putting them in a table or list not just in prose: often, there are a number of places where there's language like "could include more specific parameters, such as the growing degree days" (line 297). How about a table or other list of parameters desired, and what they're used for?

Clarify Decisions: The article would be much improved and the results more potentially transferable if the cycle of decisions and forecast uses/needs and lead times needed to support decisions these agricultural users was more clear. This might vary for some groups of crops. They've cited decision calendars, I'd suggest they consider creating one or more calendars (in appendix if necessary). Suggest looking at the agricultural decision calendars of Klemm and McPherson 2018 (https://doi.org/10.1175/JAMC-D-17-0246.1) which are circular, might be appropriate, or a linear calendar like those in Corringham for wildfires (see suggested cites at the end), or Ray and Webb that they cite.

They might also (or instead) provide this information in a table of the kinds of decisions and needed forecast information and lead times. Some planning and decisions mentioned include, ""Useful general idea of coming month's decisions:, Line 314 " and "How to prioritize resources and activities" - provide some details on what and when, will help understand timing of needs for information. Line 312-13 says "usually" and "often" use it but not what those mean.

A calendar might help alleviate another concern is that some of the examples of decisions are inconsistent/don't line up with the lead time with the S2S information that I think would influence those decisions. For example (~line 198), "building a drainage system to reduce the vulnerability of the pastures to heavy rain events and buying watering equipment to increase resilience in case of drought." These seem to me to be capital expenses that might be undertaken because of regularly having these problems, or anticipating them as ongoing in the future. I suspect that it would be late to make these decisions and implement them based on a March Forecast of AMJ (Fig 7a) – although perhaps they're referring to a different lead time foreast. Also, seasonal forecasts can't give a risk of heavy rain events, only that there might be above average rain. I suspect those decisions might be influenced by longer term climate projections, or a trend in these conditions over the past few years. In the Dakotas in the US. farmers invested in drainage systems because of a trend of wet years (see Yocum et al 2019). A calendar would help line up the general types of decisions they refer to (eciding when to fertilize, harvest or water the pastures) that seem more likely to be influenced by a 10 or 21 day forecast, and others that might be influenced by a 1-month, 1-3 or longer outlooks.

I'm also curious whether they probed for decisions that might be undertaken earlier (from my understanding of ag context in the US) like ordering fertilizer, deciding on type or variety of crop (e.g. type of wheat or barley given the seasonal foreast) which may happen months ahead of spring. I'm also curious whether the farmers talked about refinement of decisions. This might be partly what's referred to in the discussion of service integration. Suggest expanding on integration of different forecast lead times, which is significant and buried l~ine 317.

Scale: The article would also be improved if the authors are more clear in what they mean by some terms and use them consistently. Line 10 and elsewhere, what do they mean by "coarse spatial and temporal resolution" – they do refer to the resolution of the forecast, or that they are coarse compared to what users have said they want? Around line 385, the different resolution of different lead times of forecast is discussed, but not what the resolutions are. A short description of the forecasts they're studying would be useful, partly because although I'm familiar with these in the US, I had trouble pulling these up on the NMI webpage and finding the spatial scale. I might not have been looking in the right place – help the reader, perhaps with footnotes with links. This might be a small table with the several forecasts they focus on, 10-, 21-day, 1 month, 1-3 month, a suggested link, spatial scale – perhaps this info was provided to the participants.

Then, be specific and clear about what was observed. In several places, seasonal and 10- and 21-day forecasts are discussed in a way that isn't clear to me which is being referred to. Would make a stronger paper to clarify which findings in terms of "months" (line 319) vs those that are about 10-21 days. One example is in the discussion of memories – clarify that forecast wind info is from the shorter range forecast? I don't think winds are in the 10 or 21 day forecast. I do appreciate the importance of "accumulated local knowledge."

Line 287 – refer to low spatial resolution without giving either what the spatial resolution is, or saying what would be an improvement, or what is wanted. Also - do their participants realize that high/low/ average temperature generally doesn't vary at fine resolution in terms of a daily or weekly average, except for a microclimate or elevation? We've shown producers maps of how temperature varies and they realize in many cases that the scale available does largely meet their needs. Does the typical size of a farm managed matter? Precipitation is harder to forecast spatially, especially in summer in much of the US bc of convection - I'm not familiar with the drivers of uncertainty in the far north.

Low "temporal resolution" is also used - what temporal resolution is wanted? Is this about forecast issuance cadence? I think it would be more useful to phrase this in terms of lead times and not resolution.

Key factors affecting the relevance and use of S2S forecasts in Norwegian Ag (Line 93). In some key places, they use a **summary phrase but then don't give details or only 1-2 examples when I suspect they have more.** I'd like to see the findings more clear, but they're buried in the text in a number of cases. For example, sector specific variables, and what narrative description would be useful (in table 2)

- **Relevance** (~93 and elswhere)**,** suggest collect findings into concise tables or bullets, regarding their findings on what makes a forecast relevant, for what kinds of decisions and what lead times, with as many specifics as they found. That might go in Section 3 Results. This might pair with decision calendars.
- **Challenges in visualizing: (line** ~280) How prob info is visualized. They observed that "not always clear" this challenge of probabilistic info is well documented BUT - what do they recommend, if anything, based on these users? Just saying that its not clear isn't

enough. Communicating probabilistic forecasts has been studied a lot in the US, they might look at the papers on FACETS, and in addition to Ripberger, there's been some good work by Jane Strachan of the Uk Met office, and sessions at the AMS, often organized by the NOAA Weather Program Office.

- **Table 2 could be enhanced**, or refer to a different decision calendar or table of what's wanted
- **Unavailability of references** – (l 282, p 13) is mentioned, but not what kinds of references would be useful. Probably not journal articles, but maybe a user guide?

A few things I'd challenge them on:

- **Confidence vs uncertainty.** What's meant by "high uncertainty" (line 10 and elsewhere) in the forecasts? How does that change with shorter lead time and was that discussed? Fig 7a shows a 3-category forecast, would they prefer a 5 category? 7b-c are deterministic, so how is the forecast range depicted, and thus what was the discussion of uncertainty? Consider "confidence" as well as uncertainty, e.g. line 374, how about with "increasing confidence" vs "different uncertainty." As scientists, we are taught often to talk about uncertainty, and it often reinforces what we dont know, while missing an opportunity to talk about how/when we have more confidence. With weather time scales vs long-term climate, what's generally happening is that confidence increases, as lead time decreases, or able to say, convective storms likely, but can't pin down where in a larger area. This might be what you mean by different uncertainty. Or confidence increases because of larger scale high or low pressure systems. This article generally focusses on uncertainty - and we often do users a disservice, I'd argue, by not talking about what we're confident in and how that's evolving, focussing on uncertainty.
    - A related point is their observation (~Line 320) "every source of info is welcome " which others have also noted, and following text which is worth a new para to highlight these points
- Is there any followup evidence that this game influenced how/whether the participants later used the forecast (in any of the 5 ways)? Or do they have a plan to collect such evidence? I acknowledge that this work and the new forecasts occurred in parallel, but to argue that this effort was effective.
- What is the evidence that these results are being used in forecast services planning and development? By specifying a finding of "supporting forecast services co-production," I'd like to see evidence (may be anecdotal or qualitative) that the Norwegian met service is considering these results, and may have used it.
- Getting this game used – I'd challenge them to make stronger recommendations regarding next steps. Making it available "on request," is the equivalent of the "loading dock" strategy that Cash (2006) described, and admittedly, we've all been working to improve on ever since. Can they make any recommendations on the game being implemented? Do they have plans? They're with the Met service, which I'd hope has some capacity. I acknowledge that climate services in the US are still limited and via Universities (see new special issue in Climatic Change https://link.springer.com/collections/jiffjgfjdf), Are there similar things in Norway or a Norwegian equivalent of the US ag extension service that might take advantage of this?

A few references and authors I suggest: They're corroborating findings of some others, which is valuable. Apologies that I'm not finding the full references for some, I'm not in my office and don't have access to sign in to some reference lists unless I am. You might also look at the speakers at the NOAA climate prediction assessments workshops, held annually for many years.

Cash et al. 2006. (much cited) Countering the Loading-Dock Approach to Linking Science and Decision Making: Comparative Analysis of El Niño/Southern Oscillation (ENSO) Forecasting Systems. https://doi.org/10.1177/0162243906287

Corringham, T.W., Westerling, A.L. & Morehouse, B.J. (2008) Exploring use of climate information in wildland fire management: a decision calendar study. Journal of Forestry, 106, 71–77.

Kenney, Melissa, and Michael D. Gerst, – you might look at their work ~2018-2020 on how to make the NOAA CPC S2S to seasonal outlooks more useful including for the agricultural sector, including at least two talks at the US AMS, which I believe were later in journals. – "Identifying Users, Diagnosing Understandability Challenges, and Developing Prototype Solutions for NOAA Climate Prediction Center's Temperature and Precipitation Outlooks"– I'm only finding the AMS 2018 talk

Klemm and McPherson 2018 (https://doi.org/10.1175/JAMC-D-17-0246.1)

Hartmann et al (and others by those authors), 2002 CONFIDENCE BUILDERS: Evaluating Seasonal Climate Forecasts from User Perspectives
May 2002 BAMS 83(5):683-698
DOI: 10.1175/1520-0477(2002)083<0683:CBESCF>2.3.CO;2

Rogers, E.M. (1995) Diffusion of Innovations. 4th Edition, the Free Press, New York. – also notes the importance of peer networks

Yocum, H.M., et al. Climate information to support wildlife management in the North Central United States. Reg Environ Change 19, 1187–1199 (2019).
https://doi.org/10.1007/s10113-019-01474-y