FLARECAST User Workshop

Introduction

David Jackson

Bob Gunby, Catherine Burnett, Caroline Patterson, Lesa Rodgers

Exeter, 12-13 January 2017

Welcome & Housekeeping

- Facilities
- Mobile Phones
- Wifi and power
- Taxis

- Photographs – please let us know if you are shy
- Confidentiality

User Workshop Aims

- Provide a background to space weather (specifically solar flares), ability to forecast flares
- Discuss user requirements
- Use these requirements to help develop roadmap for future developments
  - Independent experts offer FLARECAST-independent critical assessment of the roadmap

Who is here?

- 41 attendees
  - 23 Users (of which 12 defence, 5 aviation)
  - 18 scientists (of which 11 FLARECAST)

User Workshop Aims

- Breakout Session I: engage with users to determine current and future requirements
- Breakout Session II: formulate roadmap for R&D leading to improved flare forecasts and associated services
  - Driven by user requirements
  - Guided by involvement of non-FLARECAST flare experts
  - Extend beyond scope of current FLARECAST project
    - Next 3-5 years in detail?
    - Coordination not via projects (time/scope limited) but via events such as ESWW?

Workshop Agenda – Day 1

1000-1030: Space weather, flares, and their impact (Manolis Georgoulis)

1030-1100: How do we forecast flares? (Sophie Murray)

1100-1130: GROUP PHOTO + Coffee Break

1130-1200: What is FLARECAST? (Shaun Bloomfield)

1200-1315: Breakout I: User Requirements

- 1200-1230: Scene Setter – User Survey results and questions arising (David Jackson)
- 1230-1330: Divide into 4 x groups – What are user needs? What do they want to see from the Workshop?

1330-1415: Lunch

1415-1515: Summarise Break out findings - 4 x rapporteurs

1515-1615: Break: coffee, tours of MOSWOC

1615-1630: Synthesised results from Breakout I (summariser)

1630-1715: Solar Active Regions: flare and CME activity through their lifetimes (Lucie Green)

1730-2000: Drinks reception followed by dinner

Workshop Agenda – Day 2

0900-0915: A recap of yesterday (David Jackson)

0915-0945: What are we looking for in a flares forecasting roadmap? (Manolis Georgoulis)

0945-1100: Breakout II: Roadmap for future R&D

- How do we progress science and user products to meet needs?
- How should we put this in a roadmap?
- Discussion in 4 x groups led by Science expert

1100-1115: Coffee

1115-1200: Summarise Break out findings 4 x rapporteurs

1200-1330: Lunch

1330-1500: Key points (summariser + Hanna Sathiapal) and write bullet point outline of Roadmap (all)

1500-1530: Break

1530: Review Roadmap and next steps (Manolis and Shaun)

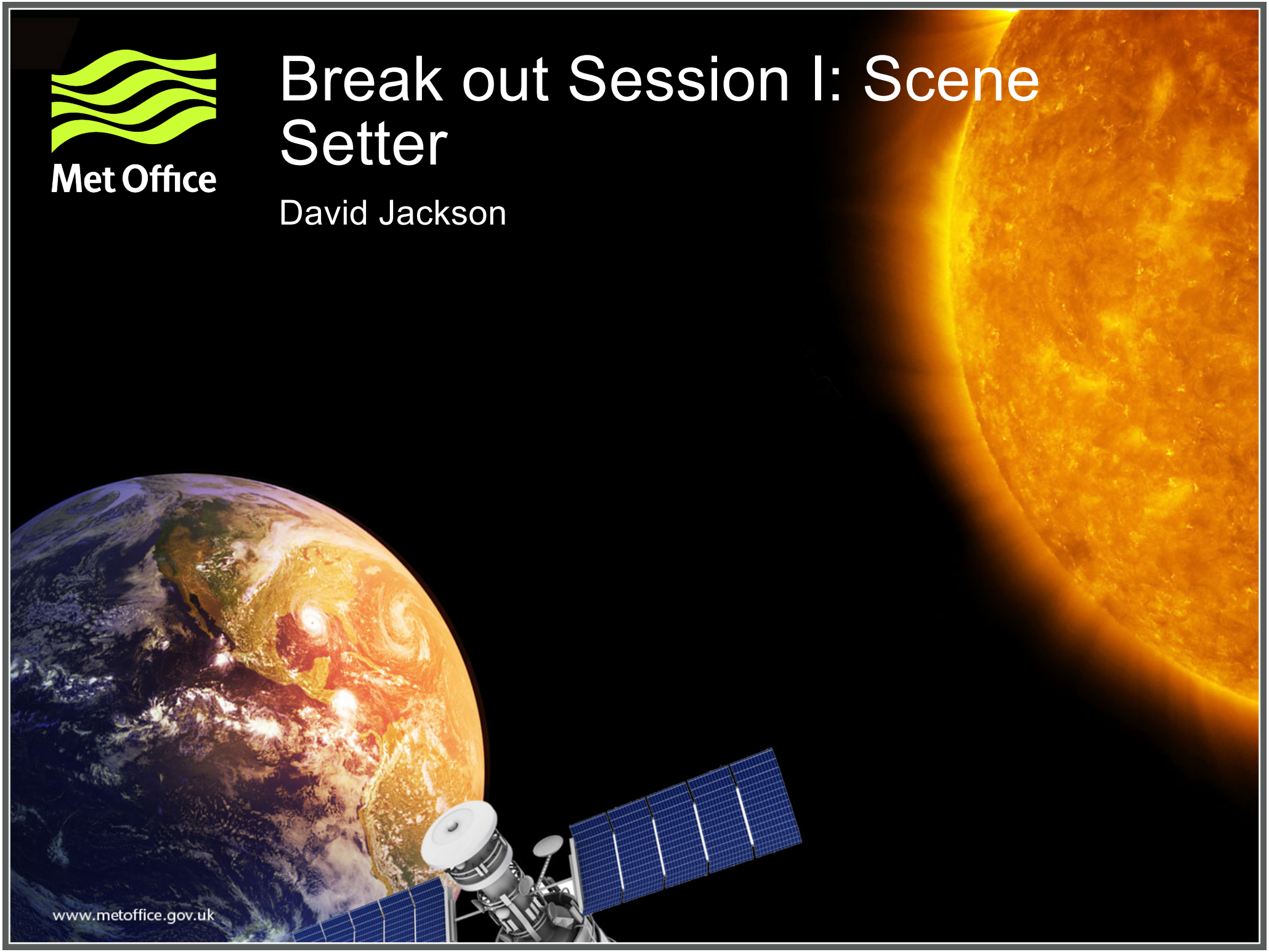
1600 End

Break Out I Groups

1 (Defence Focus)	2 (Aviation Focus)	3 (Civil Contingencies / general focus)	4 (sats / comms / GNSS focus)
Gemma Attrill (leader)	Klaus Sievers (leader)	Alessia Morris (leader)	Tamitha Skov (leader)
Yousaf Butt	Colin Hord	Mark Allen	Alan Grant
David Bennett	Bryn Jones (rapporteur)	Fraser Lott (rapporteur)	Michael Jagger (rapporteur)
Klaus Börger	Kevin Morgan	Mark McGachy	Kent Miller
Trevor McMaster	Marc Troller	Robertus Erdelyi	Bob Gunby
David Pearson	David Jackson	Manolis Georgoulis	Nicole Vilmer
Marianna Korsos (rapporteur)	Luc Dame	Michele Piana	Hanna Sathiapal
Shaun Bloomfield	Anna Maria Massone	Chloe Guennou	Sophie Murray
Simon Machin	Marco Soldati	Graham Barnes	Andrew Sibley
Lucie Green	Misha Balikhin	Roberto Destefanis	Neal Hurlbert
		Ewan Haggerty	

Break out Session I: Scene Setter

David Jackson



Overview

- Review of User Survey
- Questions arising from this
- Composition of Break out groups

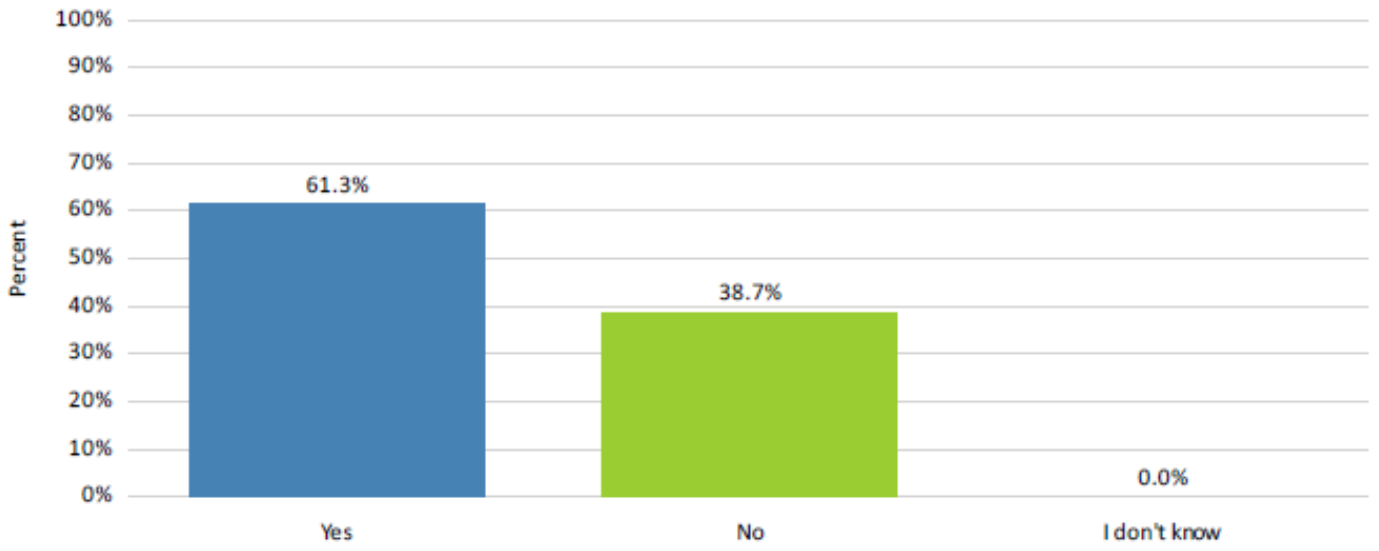
FLARECAST user survey

31 responses

1. Do you currently use flare forecast or alert services?

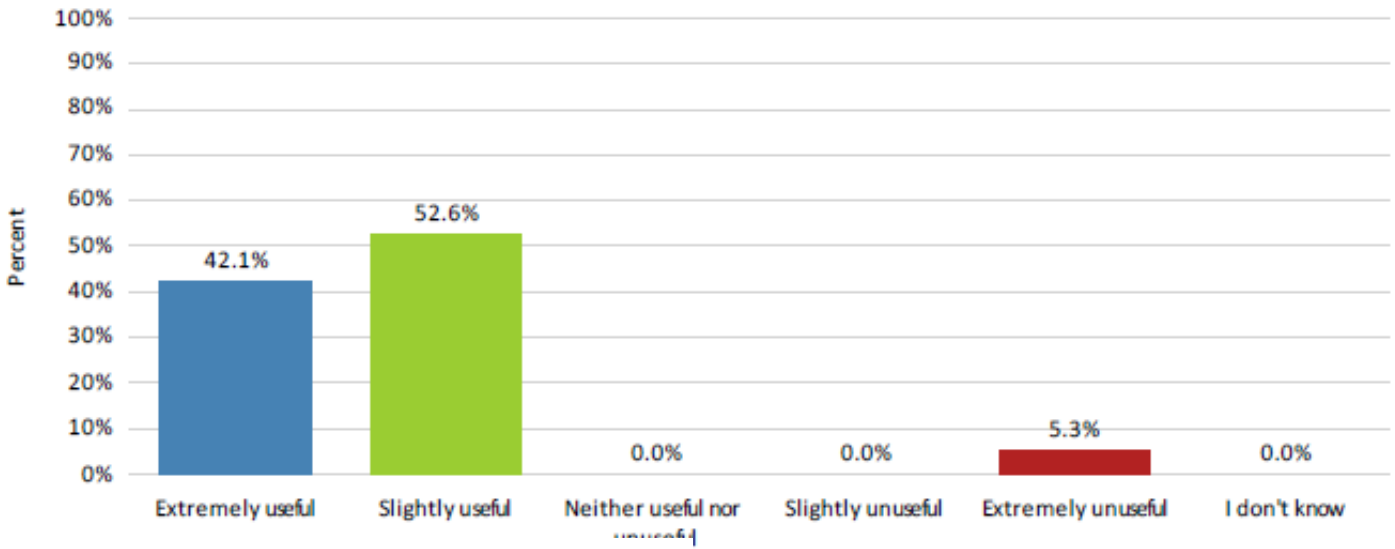
About the FLARECAST project

The FLARECAST consortium partners are: Academy of Athens (Greece); Trinity College Dublin (Ireland); Università degli Studi di Genova (Italy); Consiglio Nazionale delle Ricerche (Italy); Centre Nationale de la Recherche Scientifique (France); Université Paris-Sud (France); Fachhochschule Nordwestschweiz (Switzerland); Met Office (UK) and Northumbria University (UK).



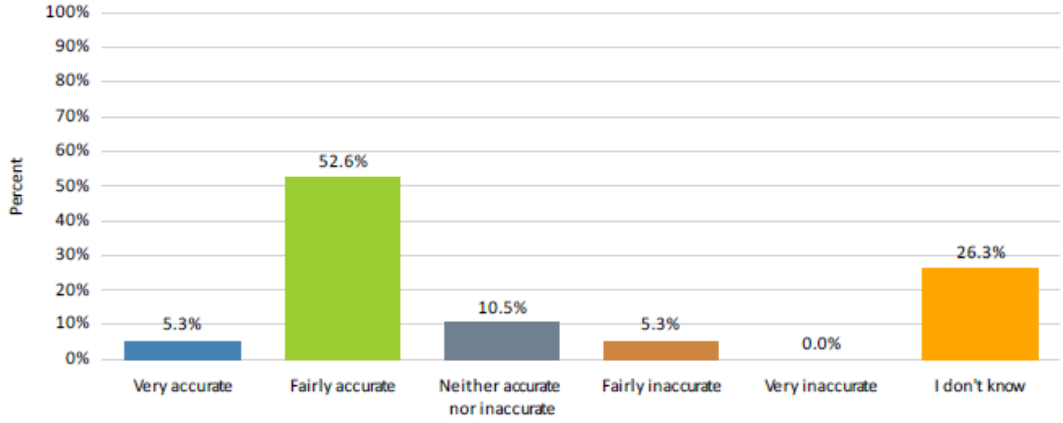
Name	Percent
Yes	61.3%
No	38.7%
I don't know	0.0%
N	31

2. How useful or unuseful are these services?



Name	Percent
Extremely useful	42.1%
Slightly useful	52.6%
Neither useful nor unuseful	0.0%
Slightly unuseful	0.0%
Extremely unuseful	5.3%
I don't know	0.0%
N	19

3. How accurate or inaccurate do you find this service to be?



Name	Percent
Very accurate	5.3%
Fairly accurate	52.6%
Neither accurate nor inaccurate	10.5%
Fairly inaccurate	5.3%
Very inaccurate	0.0%
I don't know	26.3%
N	19

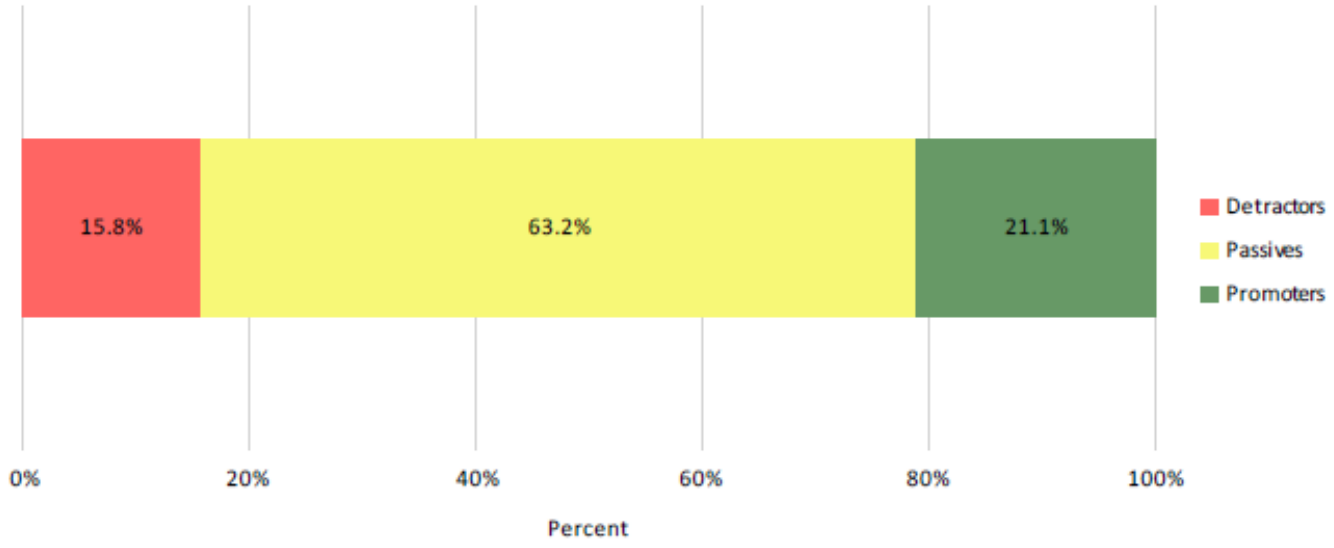
- Mainly thought useful
- 1/4 don't know if it's any good

“shrugs shoulders”

4. Based on your experience of this service, how likely is it that you would or would not recommend it to a colleague? (using a scale from 0 to 10, where 0 means you definitely would not recommend and where 10 means you definitely would recommend it).

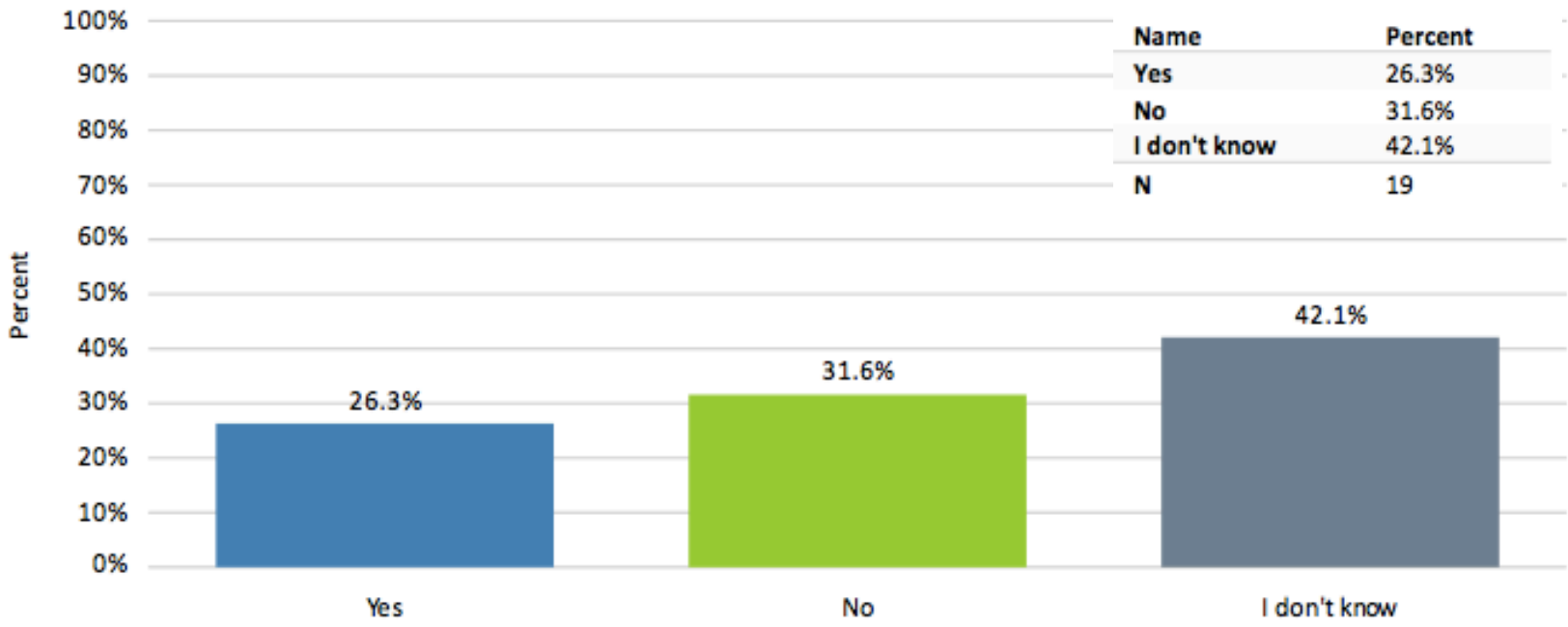
5

NPS™ Score



Name	Percent
Detractors	15.8%
Passives	63.2%
Promoters	21.1%
N	19

5. Are you planning to use the service differently in the future?



Name	Percent
Yes	26.3%
No	31.6%
I don't know	42.1%
N	19

6. You answered yes, please can you provide further details of how you are planning to do this?

We will be developing our Operation Response to Space Weather Events, and as new technologies yield different forecasting capabilities we will change our practices to take advantage of increased precision and advance warning afforded.

Comparison with other flare prediction Tools such as ASSA

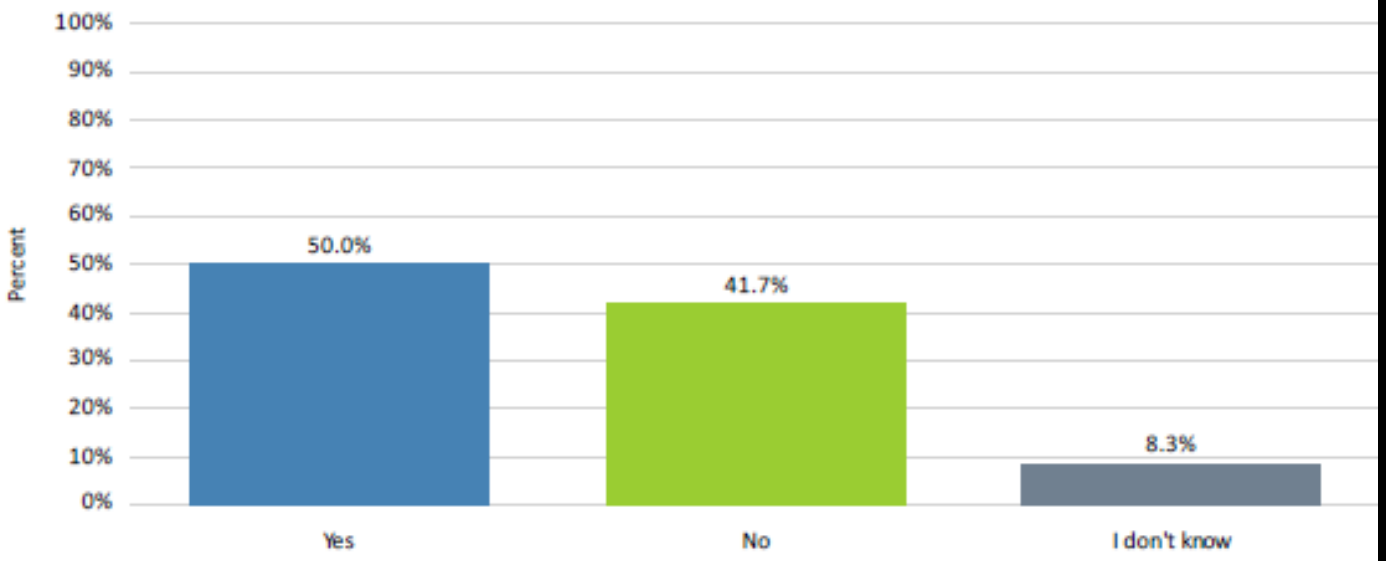
As MOD Lead for Skynet, the MOSWOC Services come in to Airbus (MOD's PFI Partner for Skynet Satellite Constellation). I will let Airbus tailor the Services for their Spacecraft Control aspects

To check the impact of space weather disturbances on GNSS systems

Of interest are correlations between flare occurrence and the state of the ionospheric TEC.

Out of 5 – 1 satellite and 1 (maybe 2) GNSS users

7. Has your organisation, or your customers' organisations, ever been affected by solar flare disruptions, other disruptions related to HF (High Frequency)?



Name	Percent
Yes	50.0%
No	41.7%
I don't know	8.3%
N	12

istomers' organisations have

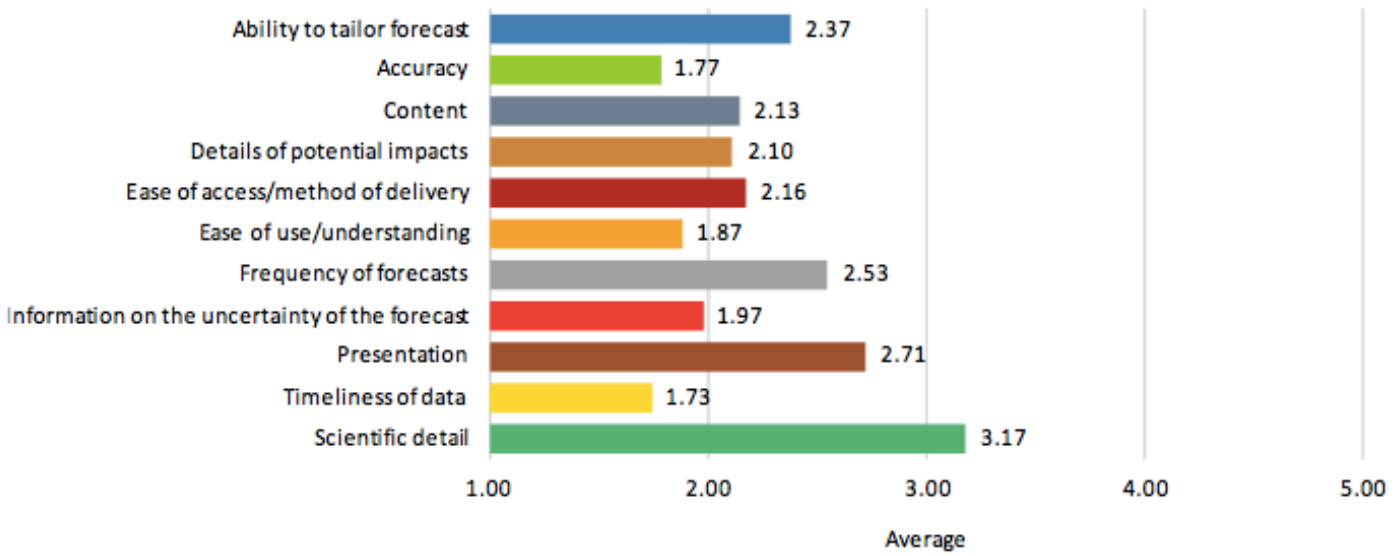
SATCOM and radar interference, GPS impacts, satellite operations/location issues

Disruptions vary from a lower signal strength to complete loss in communication using HF and SatCom and Navigation using GPS. Furthermore an offset in the GPS coordinates were observed.
Unfortunately, no further studies of these disruptions exists to give more Details.

I do space weather forecasts for the general public. During solar flares I have had many people reach out to me from multiple professions. These "stakeholders" include GPS operators such as precision farmers, taxi and private pilot services, and civil UAV pilots. Also, amateur radio disruptions are a persistent problem on the dayside and near the gray line even during modest solar flares (i.e. C-class). I have been contacted by civilian, emergency responders, and members of the maritime mobile service net.

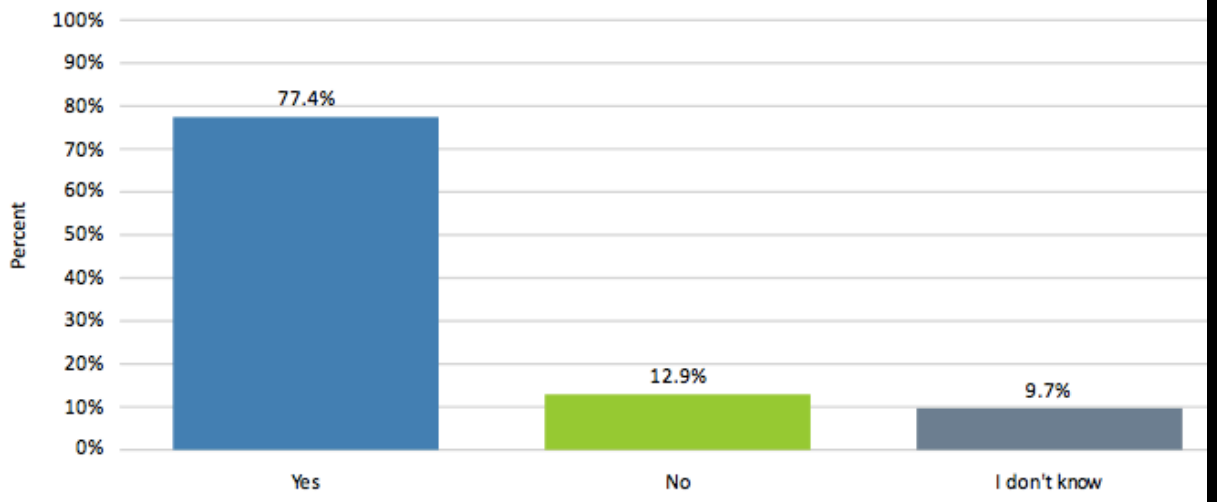
- Lowest score = most important
- So Timeliness and Accuracy most important
- Scientific details least important

9. Which factors are/would be important to you in a flare forecasting service? (please score the importance of each in the grid below).



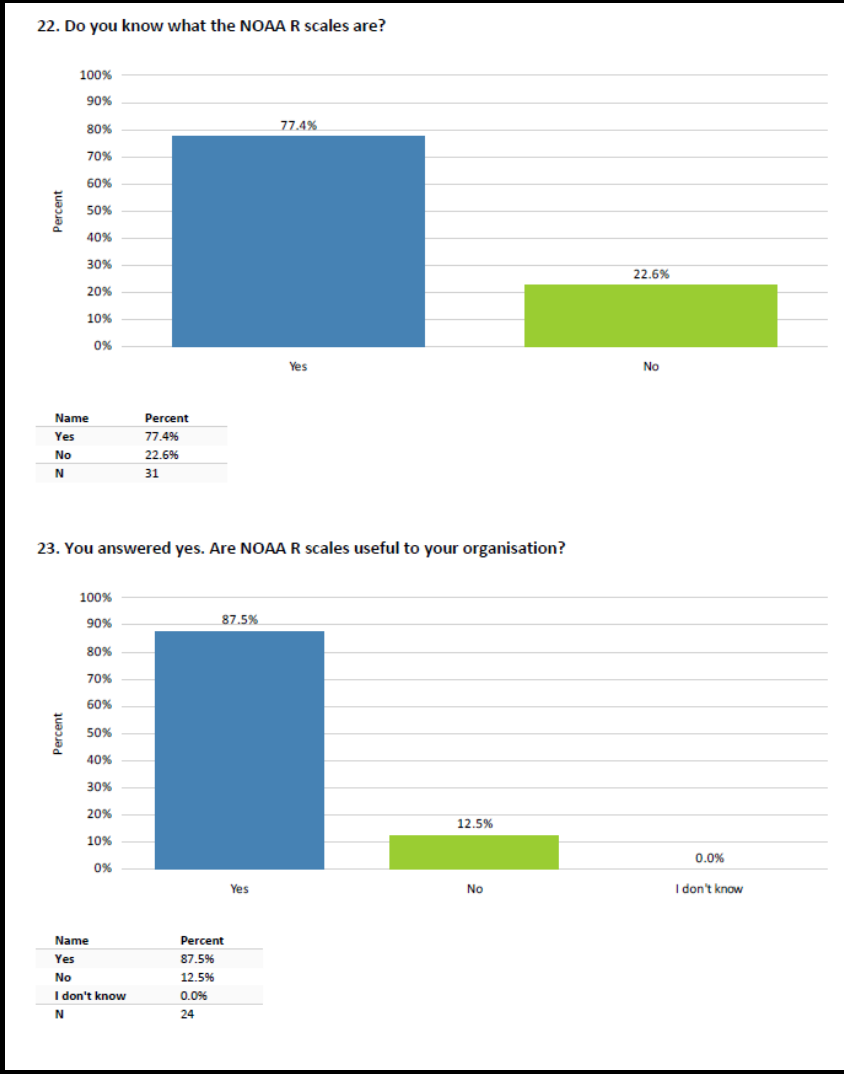
Question	Average	N
Ability to tailor forecast	2.37	31
Accuracy	1.77	31
Content	2.13	31
Details of potential impacts	2.10	31
Ease of access/method of delivery	2.16	31
Ease of use/understanding	1.87	31
Frequency of forecasts	2.53	30
Information on the uncertainty of the forecast	1.97	31
Presentation	2.71	31
Timeliness of data	1.73	30
Scientific detail	3.17	30

21. Would 'all clear' forecasts (i.e. no flares predicted) be useful to your organisation?



Name	Percent
Yes	77.4%
No	12.9%
I don't know	9.7%
N	31

NOAA Scales



For those who said “No”, why?

- Whilst they rate impacts to radio systems such as HF, Microwave and GPS they are of some interest as we are a Telecoms company, we are also interested in impacts to other systems such as Power distribution (GIC etc.)

- The scale is useful globally, but too coarse at local (country) level

- Currently we are not reacting to NOAA Scales, the decision taken to react to MOSWOC sourced indices.

Survey Conclusions

¼ not sure about accuracy – more education needed?

- If so, what do you want to hear from experts (eg lectures)? What should be online?

~60% passive regarding recommending forecast services – why?

Timely, accurate, easy to use forecasts (with uncertainty estimates) most important

Forecasting “all clear” periods important

Task 1: Review the above (and the other results of the survey). Do you agree with the findings?

The survey came up with suggestions of other points to be to be covered in Workshop (roadmap) discussions

- Details of verification results/methods

- Explanation for non-scientists; international coordination to raise awareness

- Couple to D-RAP; specific Solar Radio Burst forecasts/alerts

- The state of the science and roadblocks for forecast developments

- Better understanding of impact / consequence of space weather events, and presentation of this for non-experts

- Presentation of uncertainty

Task 2: How important are the above to you? What other issues need to be added?

Possible questions from the FLARECAST team

How timely should a flare forecast be, in terms of : forecast window (hours/days), latency, refresh rate?

What kind of information (scientific / technical) would you like to see accompanying the forecasts? What explanations would you need to understand this information?

Besides flare-class forecasts (ie M-class, X-class), would you like associated information such as, say, connection to the NOAA storm scales (R-, S-, G-)?

How would you like to see the forecast confidence appearing in the service? What do you care about most, false alarms, or missed flare occurrences?

Would you be willing to train yourself, or your personnel, to use the service?

In predicting solar flares, would you prefer a simple YES / NO, or a flare occurrence probability instead?

What additional feature(s) would make the service more attractive, in your opinion? How useful would an “all-clear” or “green-light” forecast be?

Task 3: Are the above important to you?

Wrap up

Task 4:

Highlight the requirements or questions from Tasks 1-3 that are important and which you would like to see included in the Roadmap discussions (prioritise if possible)

Add in any other points which are not covered in these background slides

Note to Scientists – let the users speak!

Break Out I Groups

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		Ewan Haggerty	

FLARECAST User Workshop:

Now-1800: Drinks

1800-2000: Dinner

Buses back to City Centre:

- 1955, 2025, 2055 (Red Park and Ride)
- 1953, 2022, 2029, 2052, 2122 (4/4A)

Please return your name badge to reception when you leave (and pick it up again tomorrow)

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FLARECAST User Workshop:

If you need a taxi later in the day, talk to me at the morning coffee break and I'll book one for you.

Break Out II Groups

A	B	C	D
Lucie Green (Science Expert)	Graham Barnes (Science Expert)	Misha Balikhin (Science Expert)	Neal Hurlbert (Science Expert)
Klaus Sievers	Colin Hord	Bryn Jones	-Shaun Bloomfield
Robertus Erdelyi	Simon Machin	-Hanna Sathiapal	Trevor McMaster (rapporteur)
Mark Allen	-Ewan Haggerty	Anna Maria Massone	Tamitha Skov
Paul Williams(rapporteur)	David Bennett	Klaus Börger (rapporteur)	-Fraser Lott
Michele Piana	Andrew Sibley (rapporteur)	Michael Jagger	Marco Soldati
Sophie Murray	Nicole Vilmer	David Jackson	Marianna Korsos
	Manolis Georgoulis		

Workshop Agenda – Day 2

0900-0915: A recap of yesterday (David Jackson)

0915-0945: What are we looking for in a flares forecasting roadmap? (Manolis Georgoulis)

0945-1100: Breakout II: Roadmap for future R&D

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1100-1115: Coffee

1115-1200: Summarise Break out findings 4 x rapporteurs

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1330-1500: Key points (summariser + Hanna Sathiapal) and write bullet point outline of Roadmap (all)

1500-1530: Break

1530: Review Roadmap and next steps (Manolis and Shaun)

1600 End

FLARECAST User Workshop: Summary of Day 1

David Jackson,

Exeter, 12-13 January 2017

Space Weather, Flares and their Impact

FLARECAST First Stakeholders Workshop

Manolis K. Georgoulis

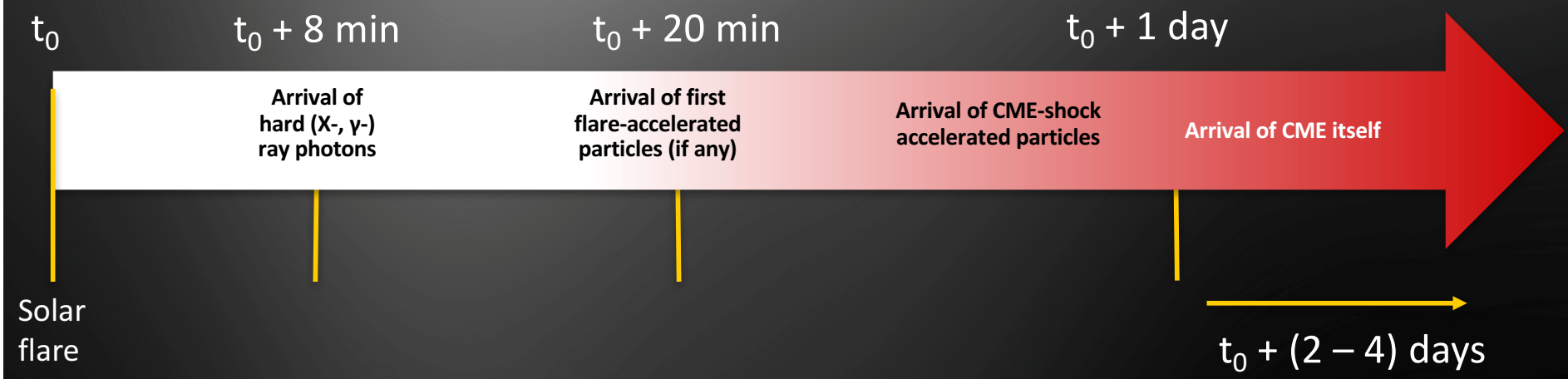
Project Coordinator, FLARECAST

RCAAM of the Academy of Athens

12 – 13 January, 2017

H2020-PROTEC-2014 RIA; Project No.: 640216

So... Why do we need advance flare prediction?



- There is no early warning for flare X- and γ-ray photons
- There is a slim (few min) early-warning window for possible flare-only particulate
- From the flare class, one can effectively proceed to CME prediction for major flares
- Flares are the primary agents for solar radio bursts
- Dot-connecting exercises (from predicted flare location, surroundings, orientation) can be made to assess possible eruption impact and combine with other SWx prediction efforts (CMEs, SEPs)

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Flare forecasting: a beginners guide

Sophie A. Murray

First FLARECAST User Workshop

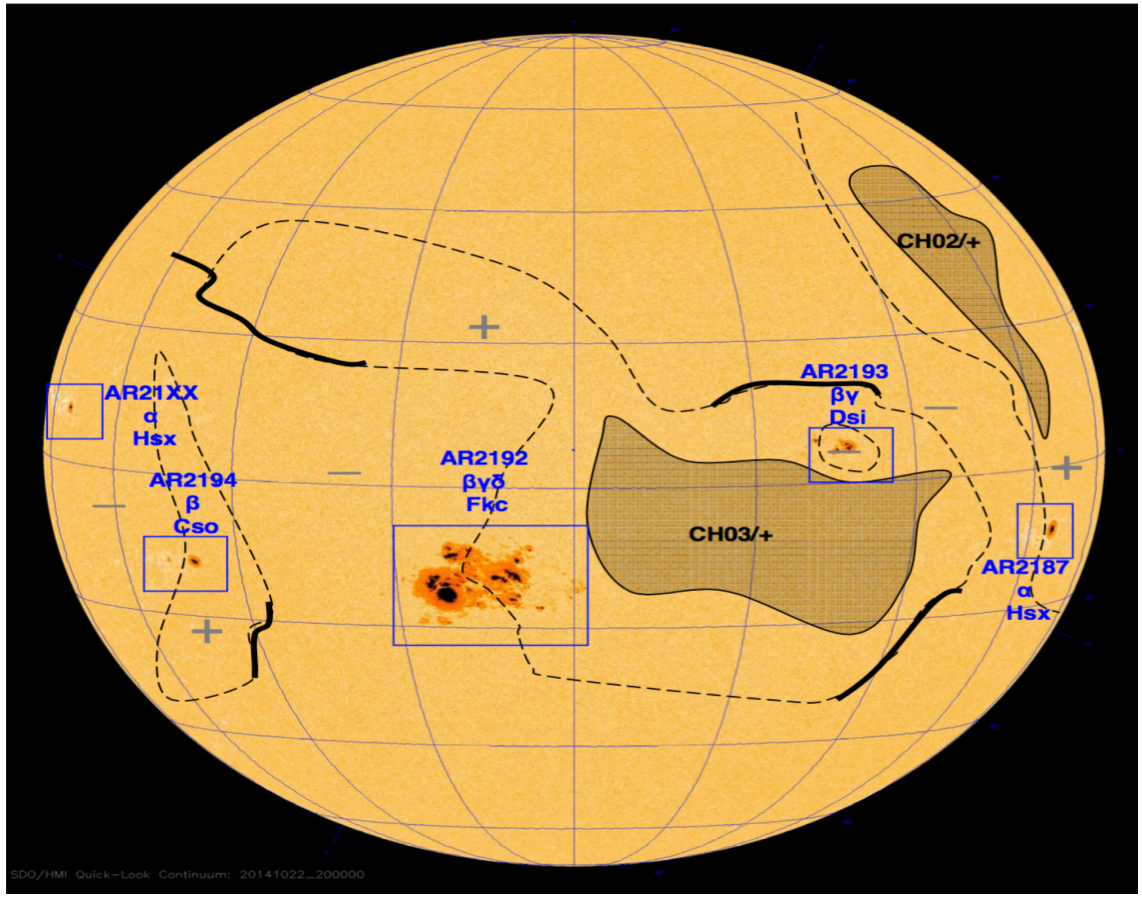
2017-01-12

FORECAST TYPES

- Continuous: **Soft X-ray flux over the next 24 hours.**
- Probabilistic: **There is a 20% chance of an M-class flare in the next 24 hours.**
- Yes/no: **There will be NO M-class flare in the next 24 hours.**

MAKING A FORECAST

- Identify property related to flaring
- Parameters to characterise this property
- Method to convert parameter values to a forecast, and to quantify the result



MOSWOC Solar Synoptic Map

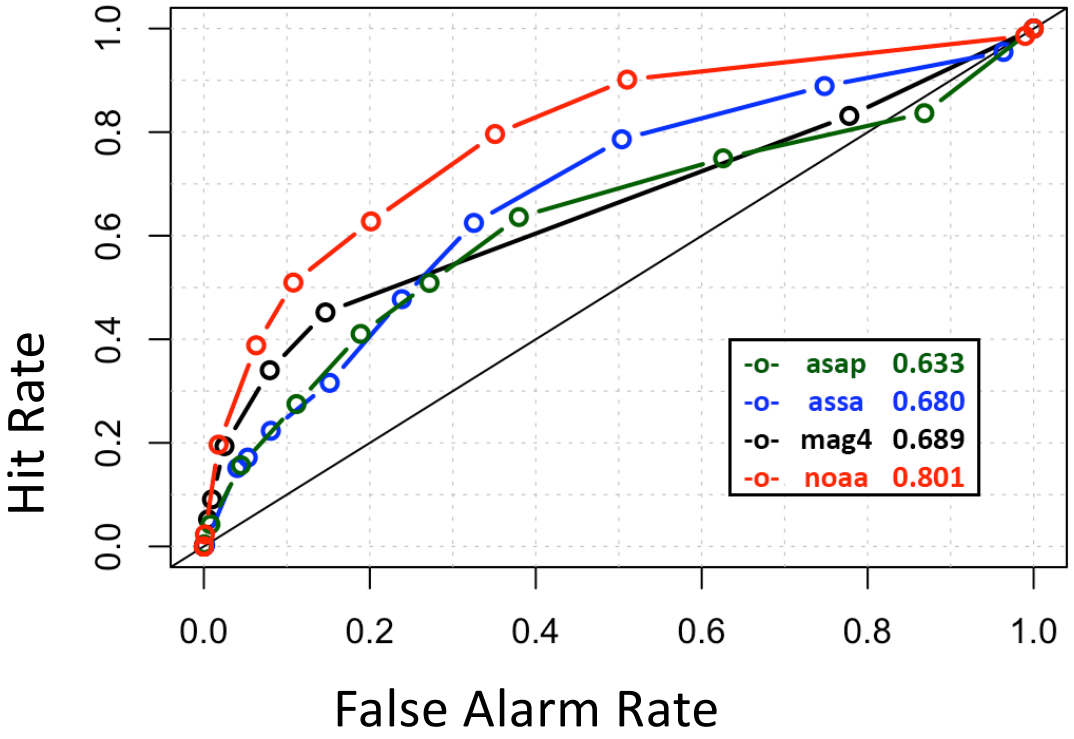
Calculating the probability

- Historical database of several decades of active region classifications and solar flare events
  - Calculate average flare rate for each classification
- Probability of flare occuring in next 24 hours is calculated from a simple equation using this rate
- Combine each active region's probability to calculate a full-disk probability

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	35	35	35	35

Operational Results

Human vs machine



Guerra et al

Science Advances

Ensembles

FLARECAST: A project overview

D. Shaun Bloomfield (Northumbria University, UK)

FLARECAST Consortium (Europe)

Aims and Objectives

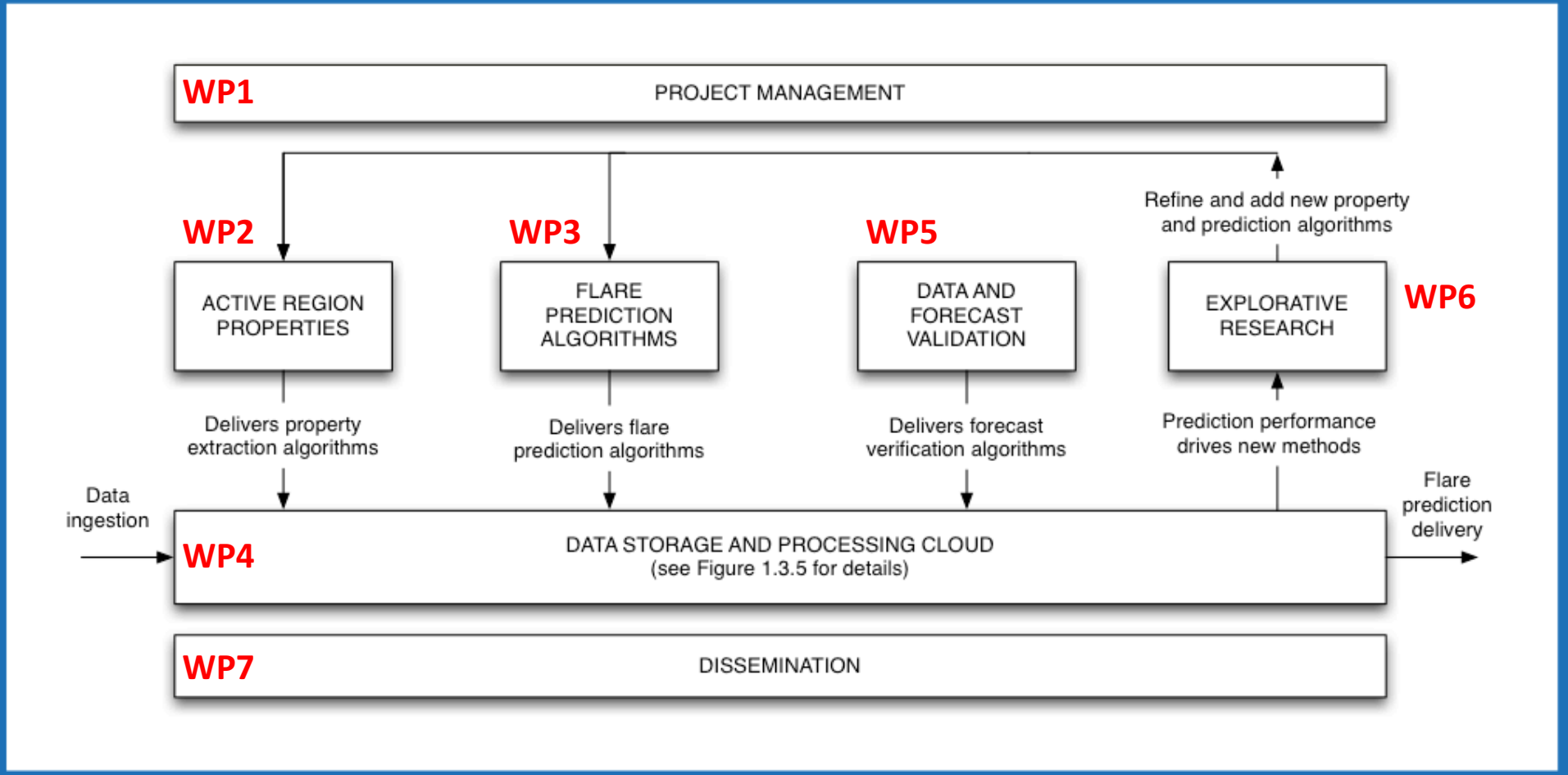
- The Flare Likelihood And Region Eruption foreCASTing (FLARECAST) project aims to:

  1. understand the drivers of flare activity and improve flare prediction

  2. provide a globally accessible flare prediction service that facilitates expansion

  3. engage with space-weather end users and inform policy makers and the public

Project Structure



Final Thoughts

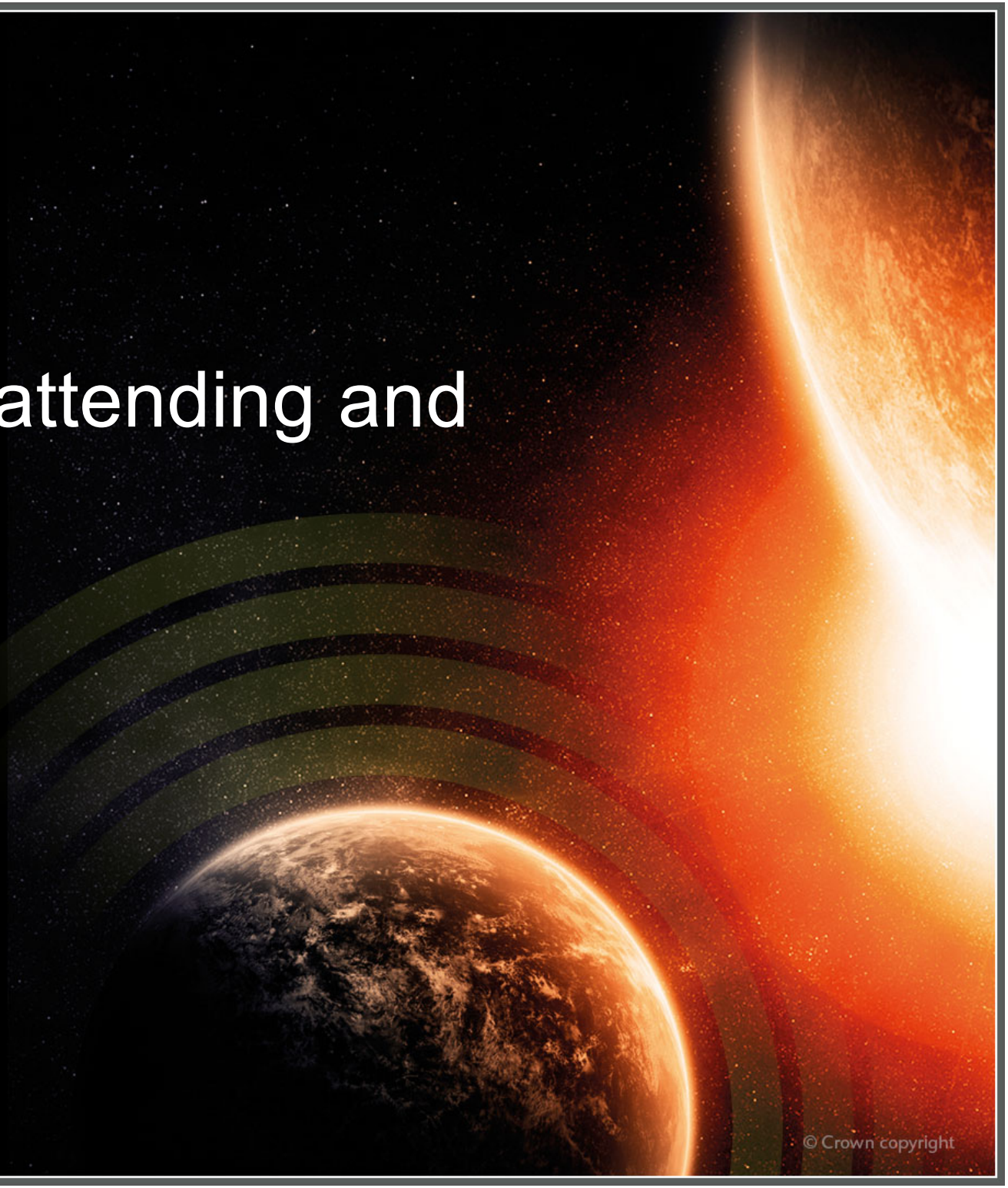
- Project progressing nominally
  - property DB (**designed**); property extraction algorithms (**integrated**)
  - prediction DB (**designed**); prediction algorithms (**being integrated**)
  - forecast DB (**undergoing design**); verification algorithms (**being tested**)

Solar ARs – Lucie Green

- Size, complexity and evolution of ARS give different CME and flaring characteristics eg
  - 20 bipolar (quite simple) ARs give small flares but 14/20 give CMEs
  - Examining ARs over 5 solar rotations showed most flaring typically in first rotation but CME rate more evenly distributed
- Evolution of magnetic field structure in “S” shape possible precursor
- Idealised flux rope models (eg Kliem) – next step could be to initialise with observations => better understanding and maybe another step towards predictability

Met Office

Thank you for attending and contributing



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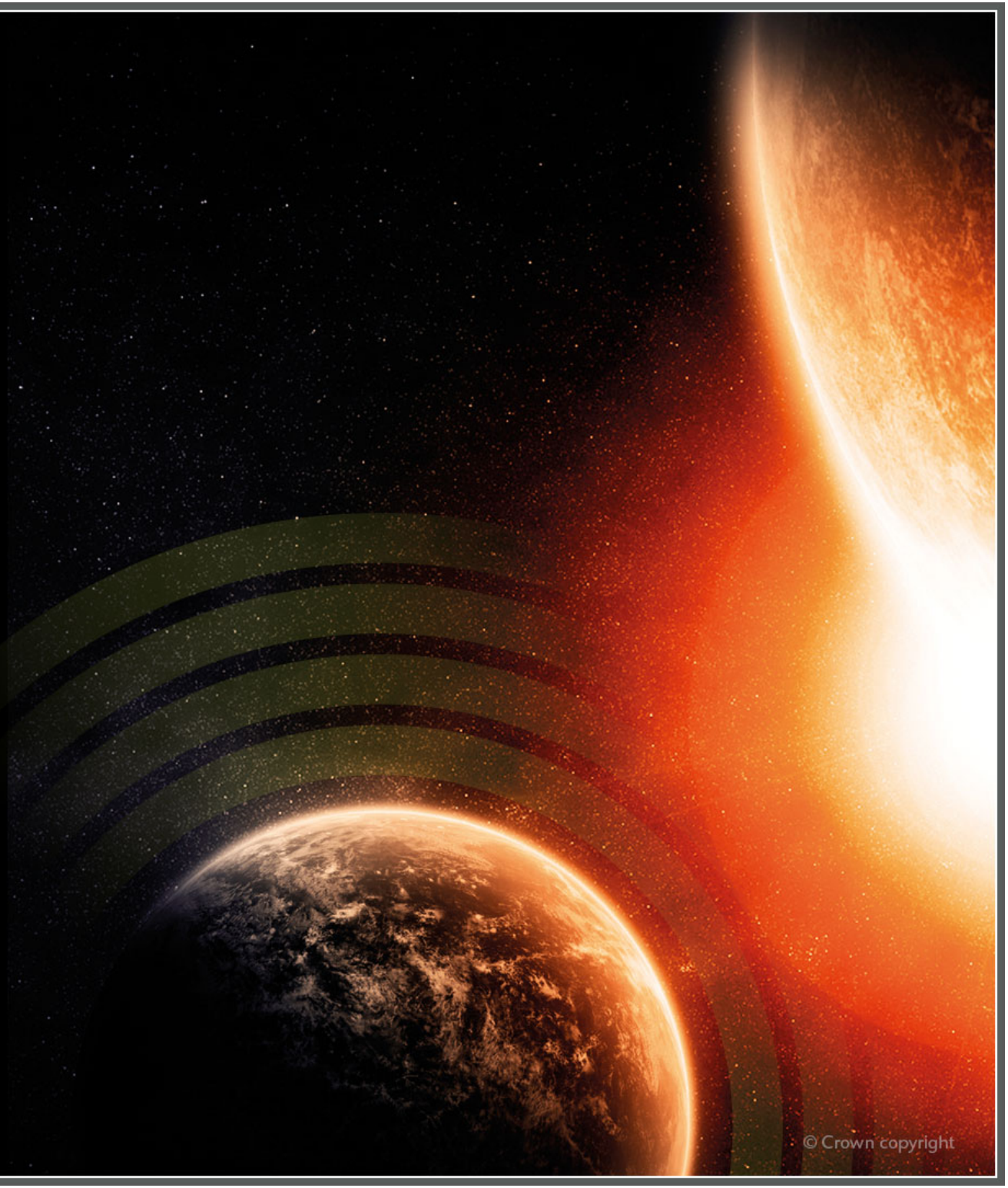
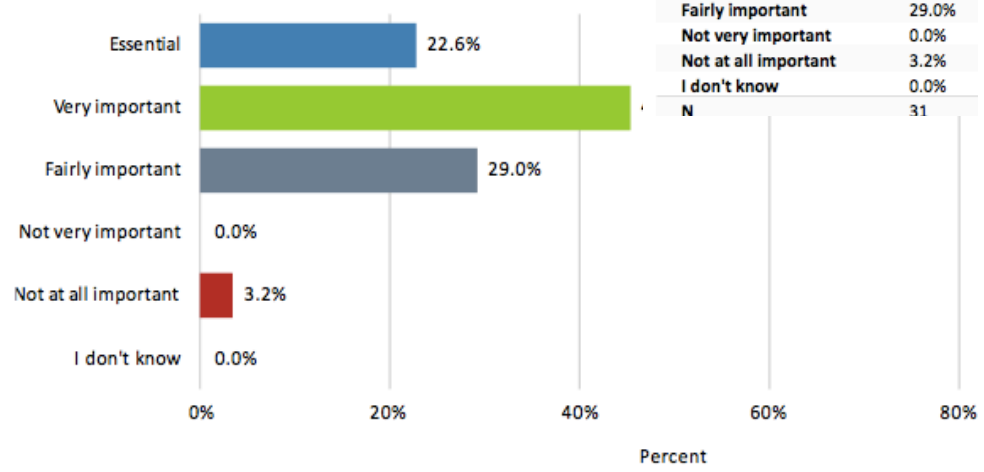
Extra slides

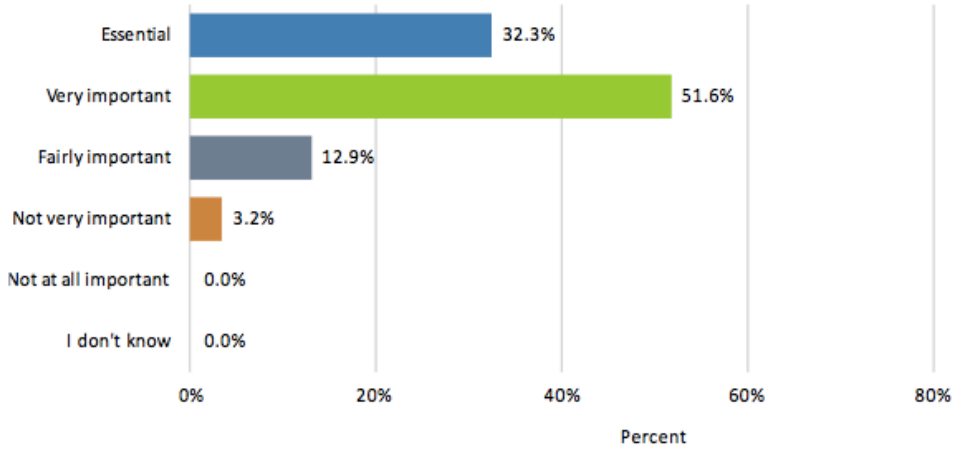


14. Ease of access/method of delivery



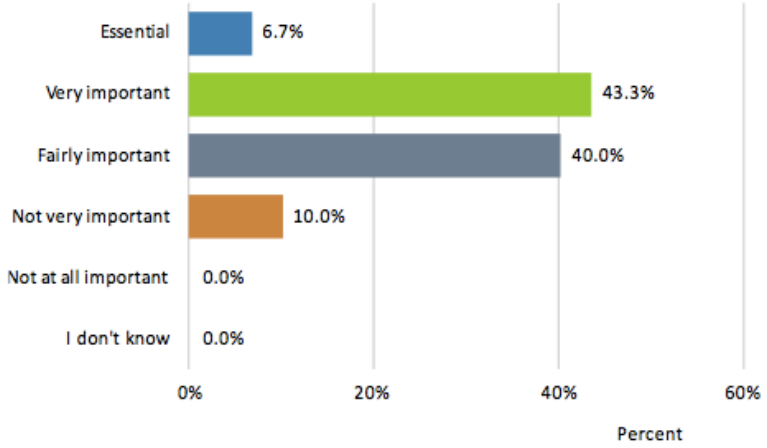
Name	Percent
Essential	22.6%
Very important	45.2%
Fairly important	29.0%
Not very important	0.0%
Not at all important	3.2%
I don't know	0.0%
N	31

15. Ease of use/understanding



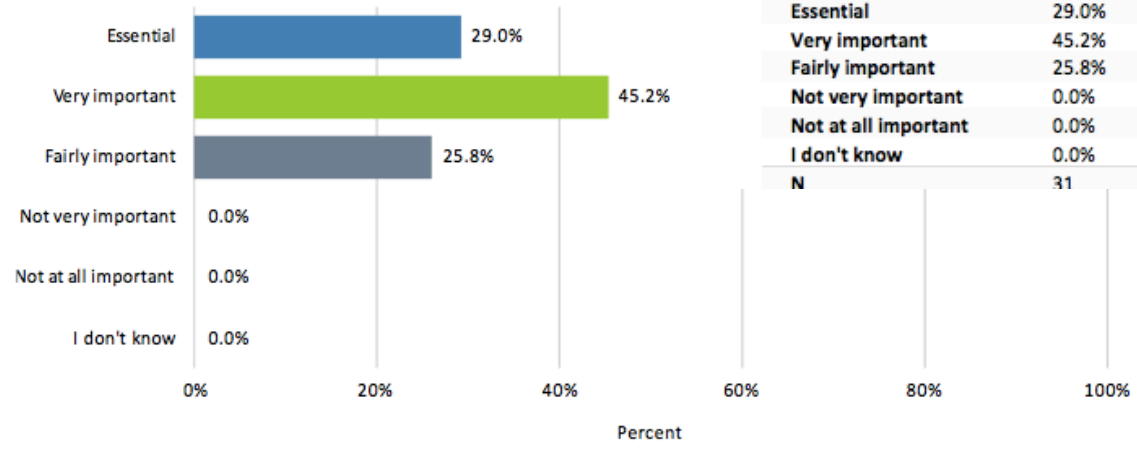
Name	Percent
Essential	32.3%
Very important	51.6%
Fairly important	12.9%
Not very important	3.2%
Not at all important	0.0%
I don't know	0.0%
N	31

16. Frequency of forecasts



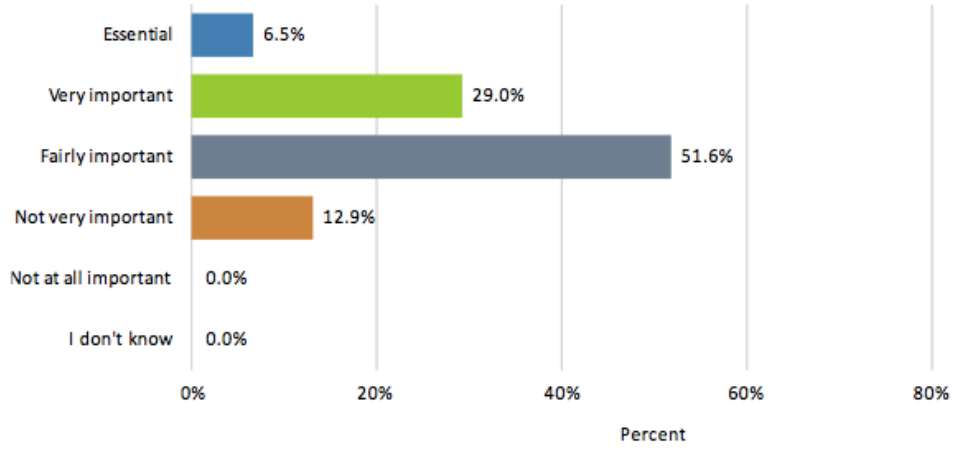
Name	Percent
Essential	6.7%
Very important	43.3%
Fairly important	40.0%
Not very important	10.0%
Not at all important	0.0%
I don't know	0.0%
N	30

17. Information on the uncertainty of the forecast



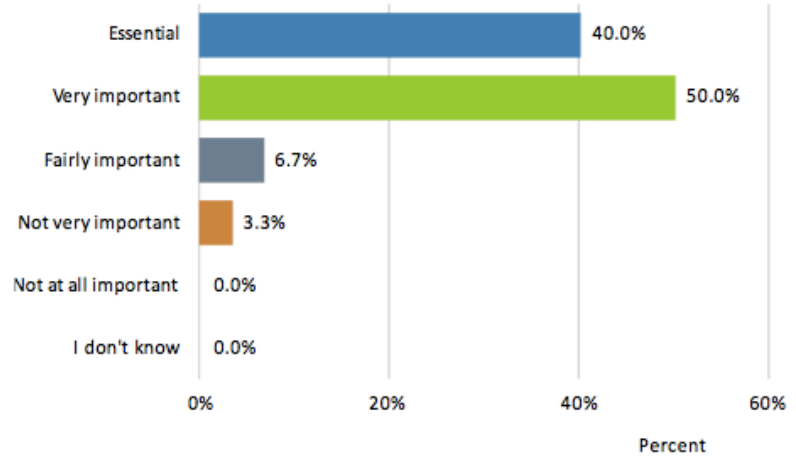
Name	Percent
Essential	29.0%
Very important	45.2%
Fairly important	25.8%
Not very important	0.0%
Not at all important	0.0%
I don't know	0.0%
N	31

18. Presentation



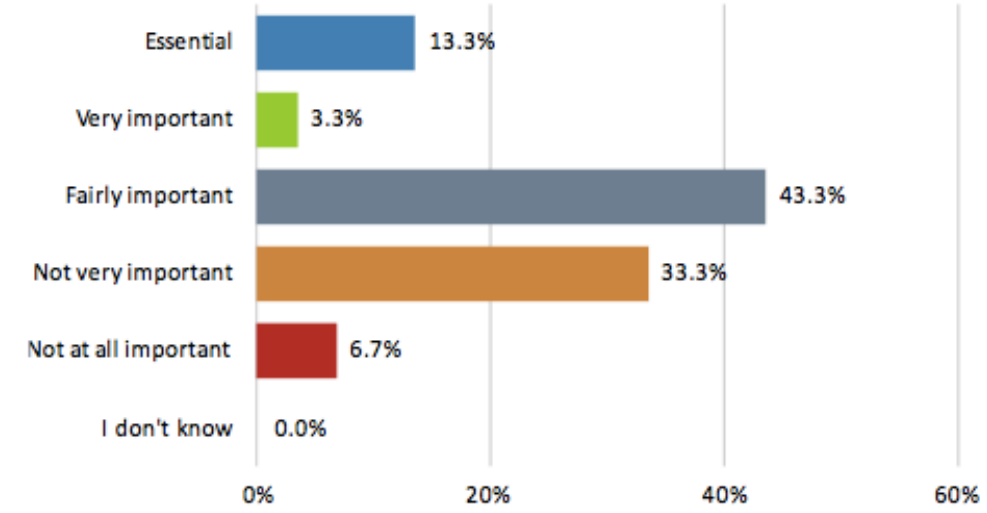
Name	Percent
Essential	6.5%
Very important	29.0%
Fairly important	51.6%
Not very important	12.9%
Not at all important	0.0%
I don't know	0.0%
N	31

19. Timeliness of data



Name	Percent
Essential	40.0%
Very important	50.0%
Fairly important	6.7%
Not very important	3.3%
Not at all important	0.0%
I don't know	0.0%
N	30

20. Scientific detail



Name	Percent
Essential	13.3%
Very important	3.3%
Fairly important	43.3%
Not very important	33.3%
Not at all important	6.7%
I don't know	0.0%
N	30