S2S Forecasts: Applications considerations

Andrew W Robertson
awr@iri.columbia.edu

International Research Institute
for Climate and Society
Earth Institute | Columbia University

Advanced School and Workshop on Subseasonal to Seasonal (S2S) Prediction and Application to Drought Prediction, ICTP, Trieste, Nov 23 – Dec 4, 2015

Outline

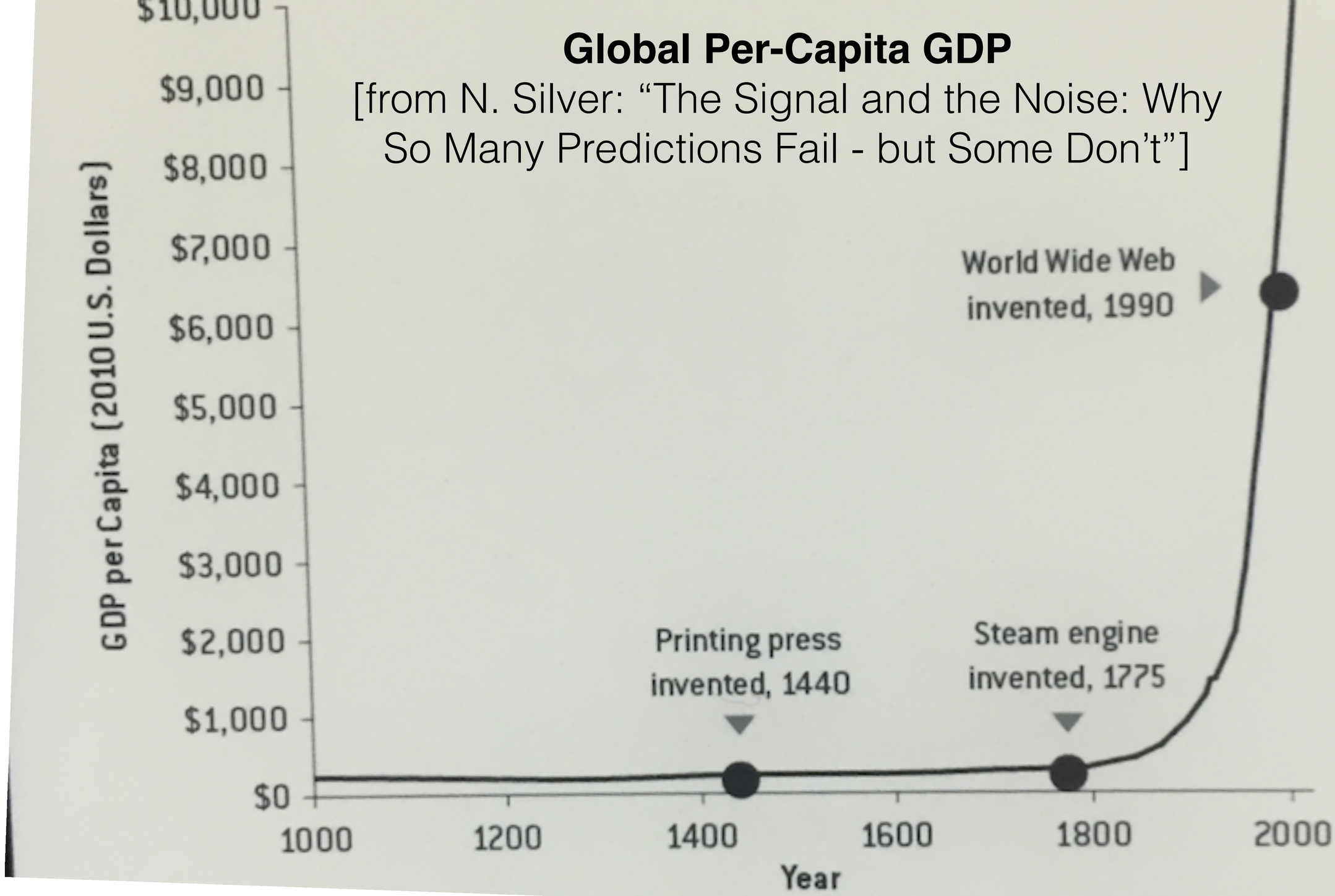
1. Types of forecast user and application

2. What makes forecast information valuable to a user?
   – Salience, Timeliness, Credibility, Understandability, Legitimacy

Can we translate scientific information into useful knowledge?

Global Per-Capita GDP

[from N. Silver: “The Signal and the Noise: Why So Many Predictions Fail - but Some Don’t”]



Types of forecast user and application

- Hazard early warning - enhancing preparedness to high-impact weather events
- Management decisions in weather-sensitive operations
- Large range of users, from sophisticated to general

gfcs-climate.org

YR WebofSci DOCP seminars HIW Lamont weather TimeZone IRIcloud irap IRI_intranet ECMWFdata EI C&G Bascmp DL EI grants IRI Wiki CourseWorks RoomRes IRImail FYEffort Wikipedia

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Search this website...

WMO OMM

Home | About GFCS | Priority Areas | Governance | Partnership | Projects | Events | Documents | News & Info

GFCS provides a worldwide mechanism for coordinated actions to enhance the quality, quantity and application of climate services.

Previous Resume Next

Priority areas

Agriculture and food security

Disaster risk reduction

Health

Water

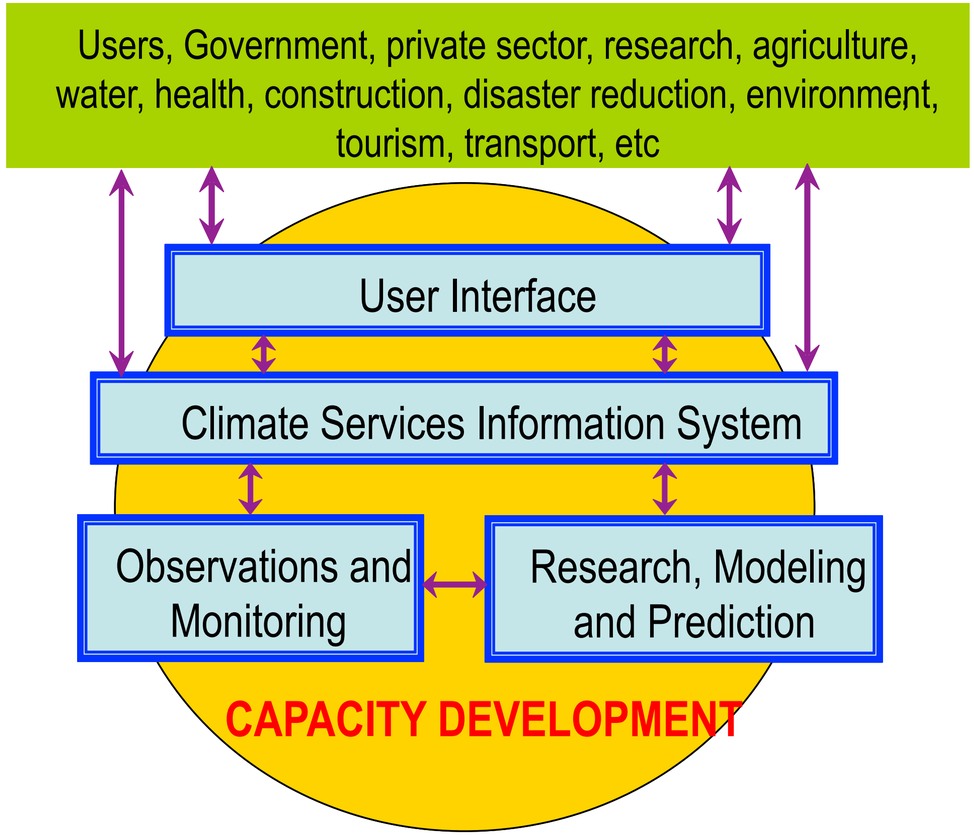
GFCS in action

Latest Contributions

The International Climate Assessment and Dataset (ICA&D)
Submitted on: March 11, 2015

Pillars of GFCS

- **User Interface Platform** - to provide a means for users, user representatives, climate researchers and climate service providers to interact
- **Climate Services Information System** - to collect, process and distribute climate data and information according to the needs of users and according to the procedures agreed by governments and other data providers
- **Observations and Monitoring** - to ensure that the climate observations necessary to meet the needs of climate services are generated.
- **Research, Modelling and Prediction** - to assess and promote the needs of climate services within research agendas
- **Capacity Development** - to support systematic development of the necessary institutions, infrastructure and human resources to provide effective climate services.



Courtesy of R. Kumar Kolli, WMO

- http://cordex2013.wcrp-climate.org/index.shtml

How farmers around the world are making decisions based on weather and climate information

As climate change threatens food production, climate information services are helping farmers in Africa and South Asia make better decisions in the short and long-term to adapt to changing growing conditions.

	Type of information	Vehicles for delivering information	Farmer decisions affected
WEATHER Days to weeks	• Observed rainfall and temperature • Daily forecasts up to one week ahead of time • Alerts on pests and diseases • Early warning of extreme weather events	• Mobile phones • Radio • Television	• Timing of planting and harvest • Timing of fertilizer, pesticide, and irrigation application • Protecting lives and property from extreme events
CLIMATE VARIABILITY Months to Years	• Probabilities for seasonal rainfall and temperature conditions • Seasonal climate variables targeted to particular agricultural risks (dry spells, rainy season start date, etc) • Historical variability of climate variables	• Workshops with experts • Conversations with agricultural extension agents (farm educators)	• Selecting crops and varieties • Livestock stocking rates and feeding strategies • Intensity of input use (fertilizer, pesticides) • Labor or marketing contracts • Intensifying and diversifying crops • Diversifying sources of income
CLIMATE CHANGE Decades or longer	• Projections of future rainfall and temperature • Historical trends in rainfall and temperature • Historical changes in extreme events	• Workshops with researchers, agricultural extension agents, and meteorological services.	• Major capital investments (buying or expanding landholding, irrigation systems, farm equipment etc) • Changing farming system or livelihood strategy • Deciding whether or not to farm

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

	Type of information	Vehicles for delivering information	Farmer decisions affected
WEATHER **Days to weeks**	 • Observed rainfall and temperature • Daily forecasts up to one week ahead of time • Alerts on pests and diseases • Early warning of extreme weather events	 • Mobile phones • Radio • Television	 • Timing of planting and harvest • Timing of fertilizer, pesticide, and irrigation application • Protecting lives and property from extreme events
CLIMATE VARIABILITY **Months to Years**	 • Probabilities for seasonal rainfall and temperature conditions • Seasonal climate variables targeted to particular agricultural risks (dry spells, rainy season start date, etc) • Historical variability of climate variables	 • Workshops with experts • Conversations with agricultural extension agents (farm educators)	 • Selecting crops and varieties • Livestock stocking rates and feeding strategies • Intensity of input use (fertilizer, pesticides) • Labor or marketing contracts • Intensifying and diversifying crops • Diversifying sources of income

Challenges to achieving seasonal forecast value

Forecast needs to be:

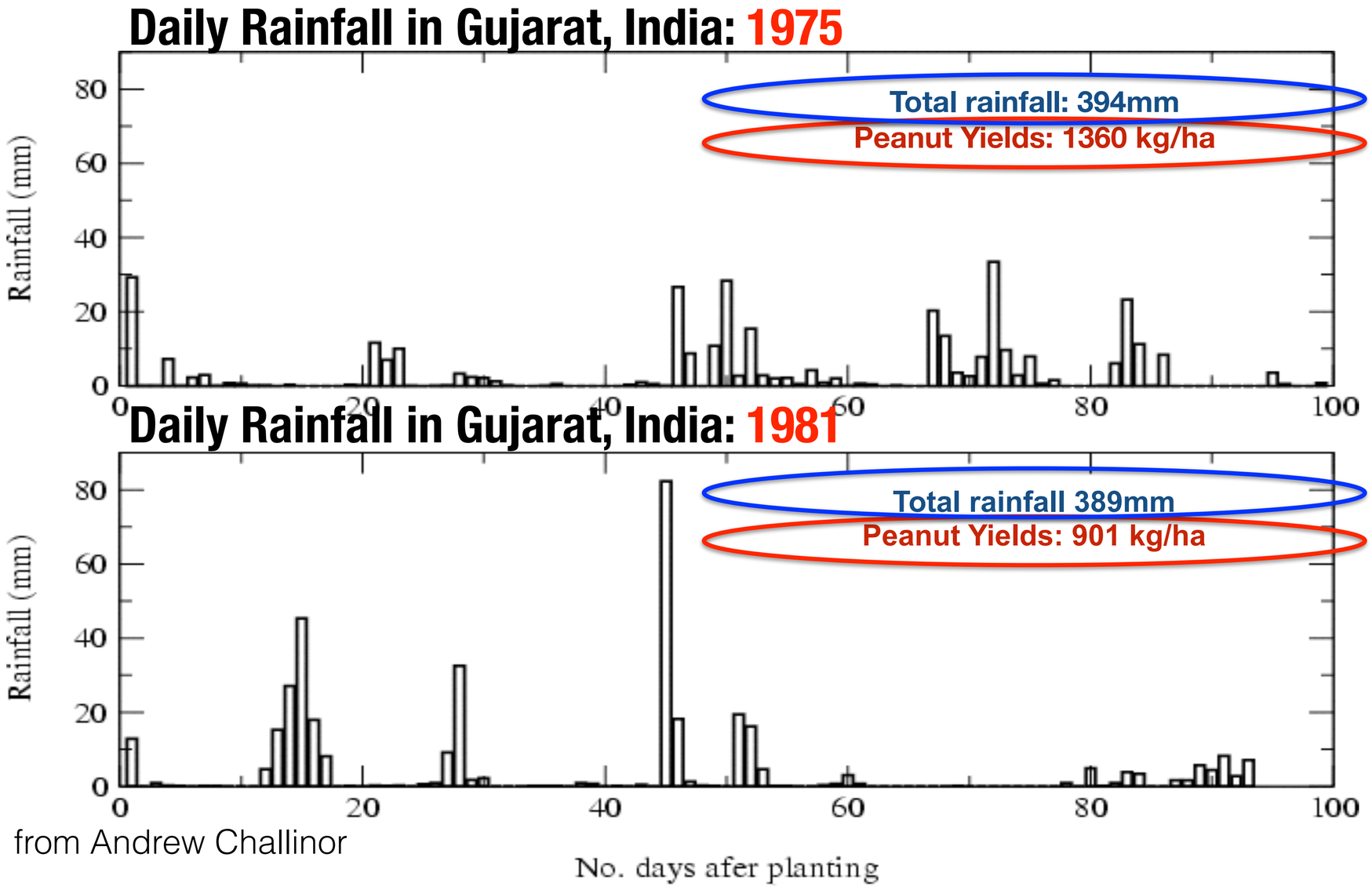
- Salient: meet user's needs
- Credible
- Understandable
- Legitimate: Come from a trusted source

(often these concepts overlap)

Some Aspects of Salience

- Should be specific and timely – opportunities for S2S
- Should address decision-relevant variables, e.g. characteristics of local daily rainfall, monsoon onset date, river flow, drought – tailoring of forecast information

Agricultural relevance of *daily* rainfall

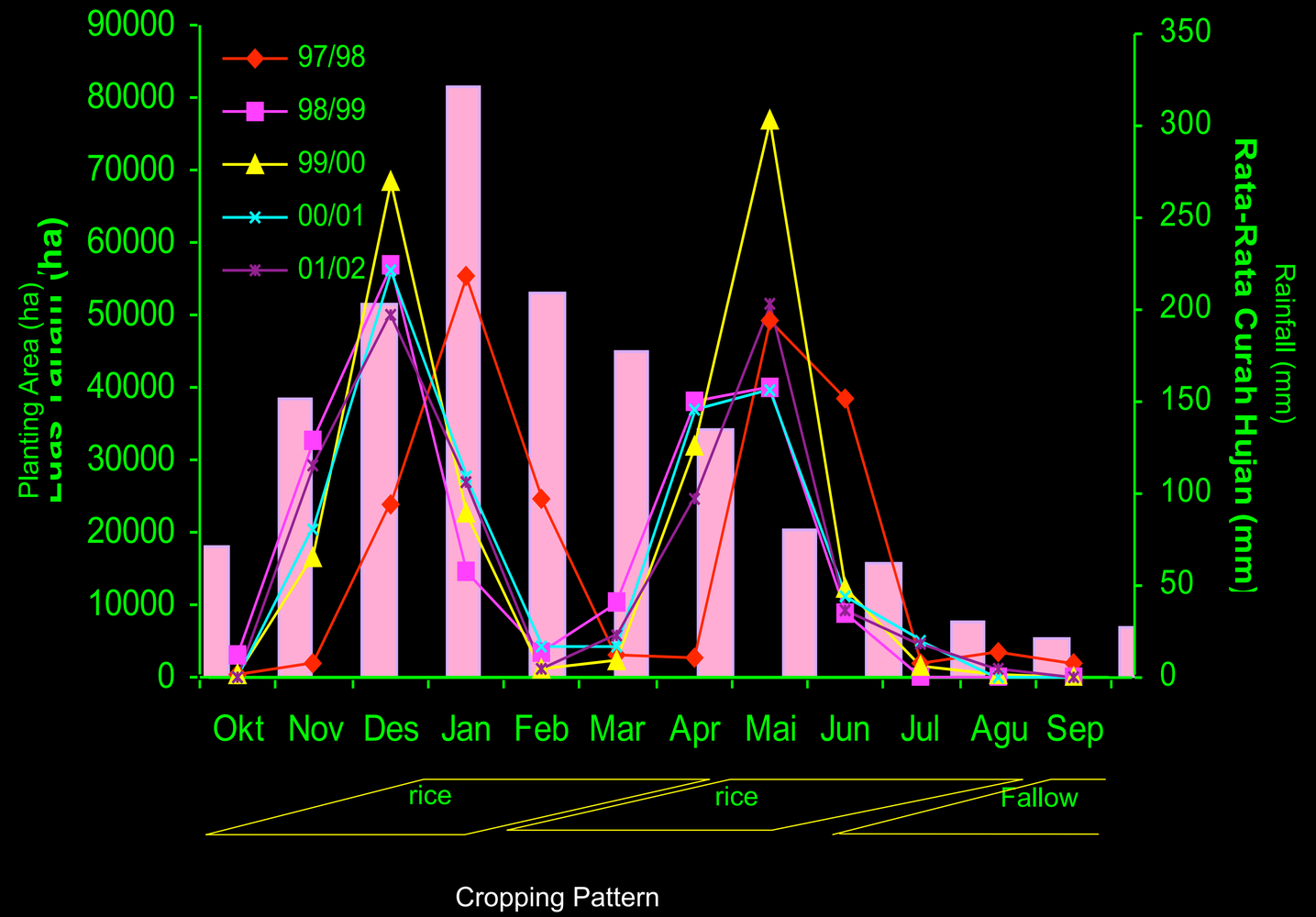


from Andrew Challinor

Peanut yields and rainfall in Gujarat, India

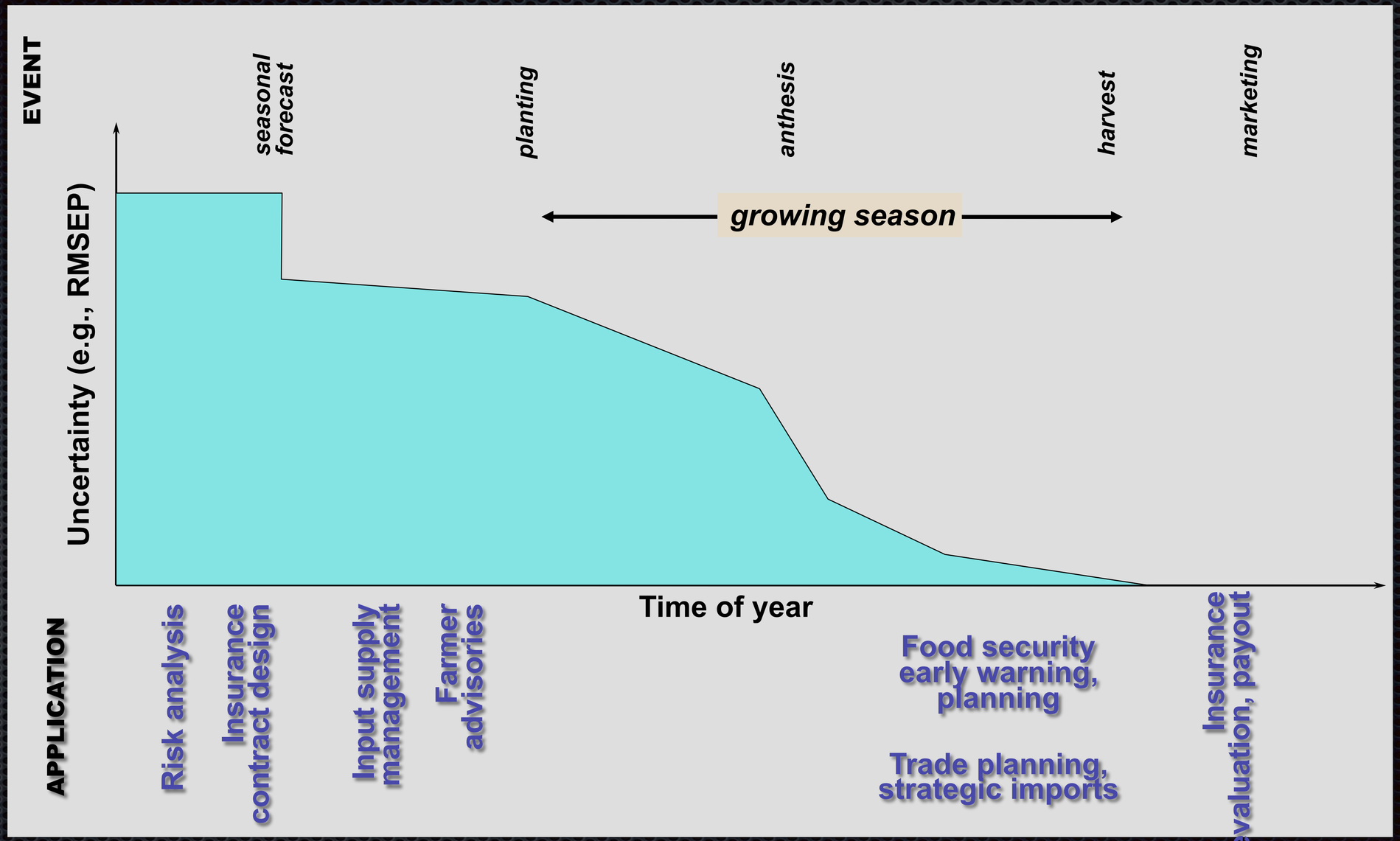
Monsoon Onset and Rice-planting area in Indramayu, Java

Source: Boer et al. (2004)



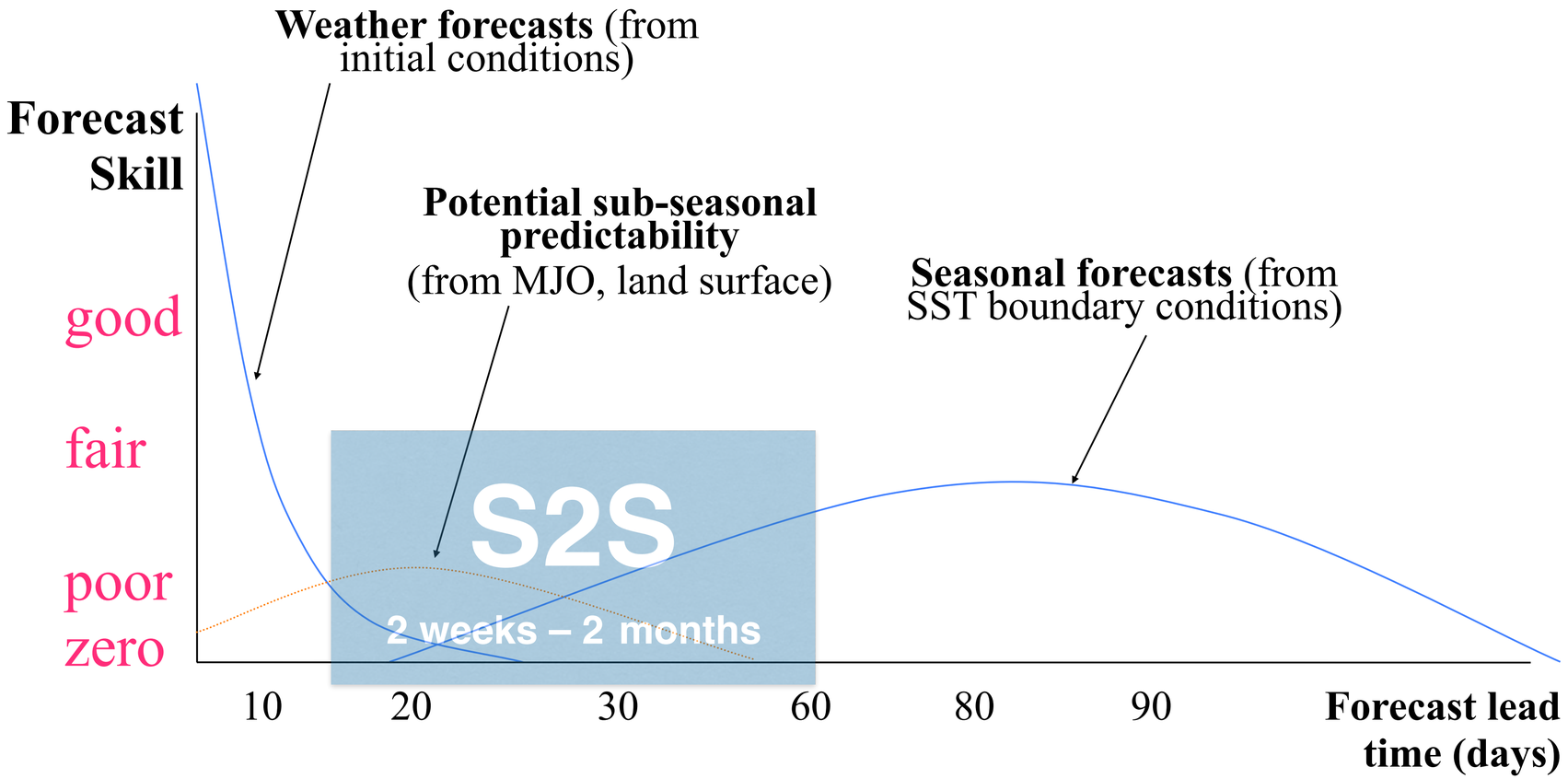
Start of planting changes from time to time, in planting season 97/98, start of planting delayed 1 month due to delay onset of rainfall, increasing drought risk for the second crop, except in La-Nina years

Timeliness: The agricultural risk & planning calendar

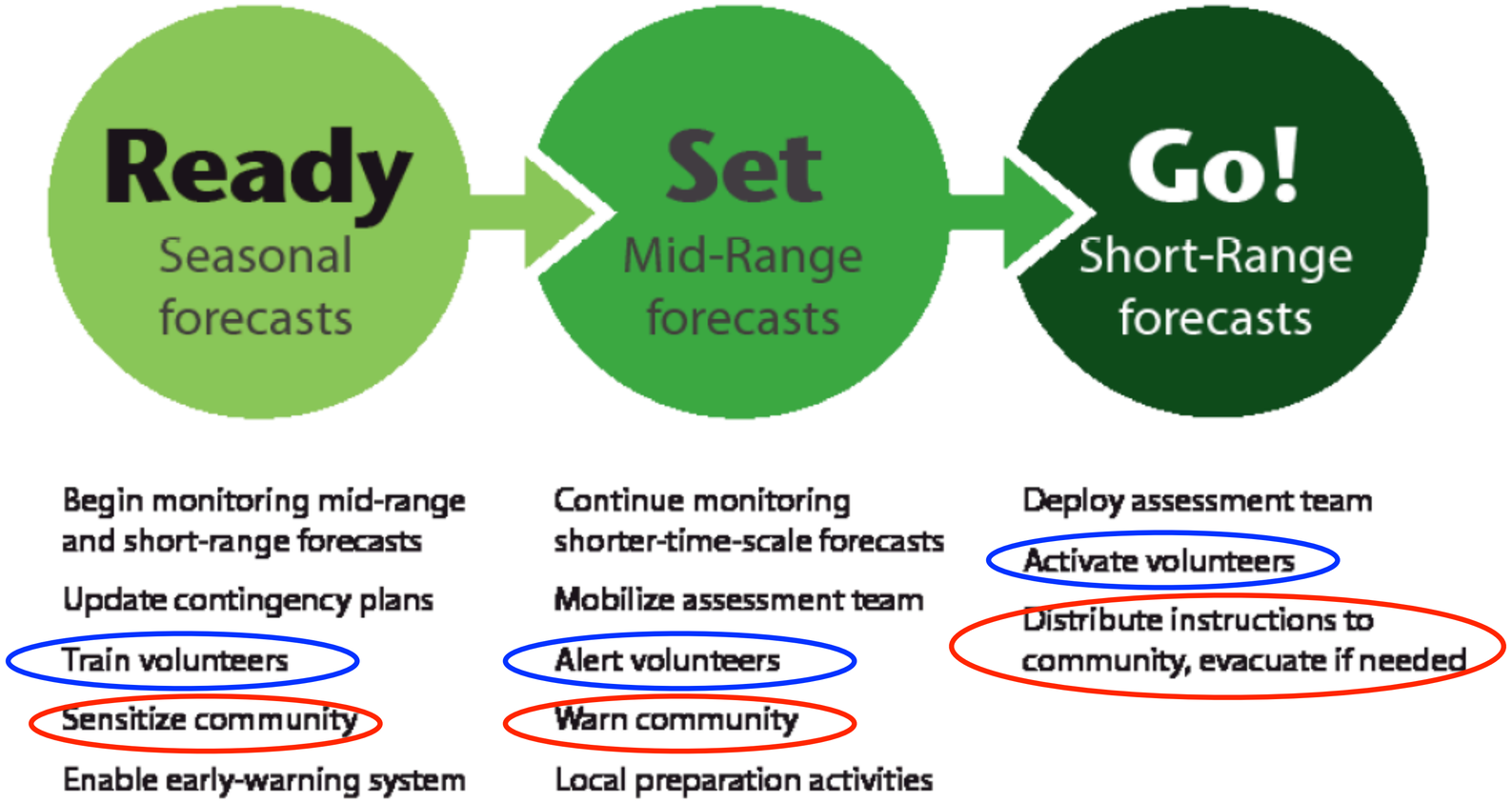


J. Hansen et al. (IRI)

Forecast Lead Times



IFRC/IRI Humanitarian Aid Example

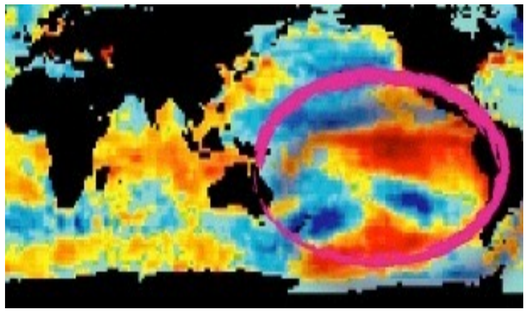


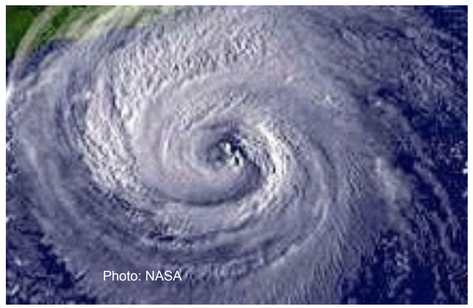
Source: M. Daly

Using information across time-scales...

more specific information

Long Lead Time





Short Lead Time

more time to reduce risk

Climate change
rising risks, trends, more surprises

Decades, end of century

Seasonal forecasts
level of risk in coming months

next 3-6 months

Weather forecasts
impending hazard

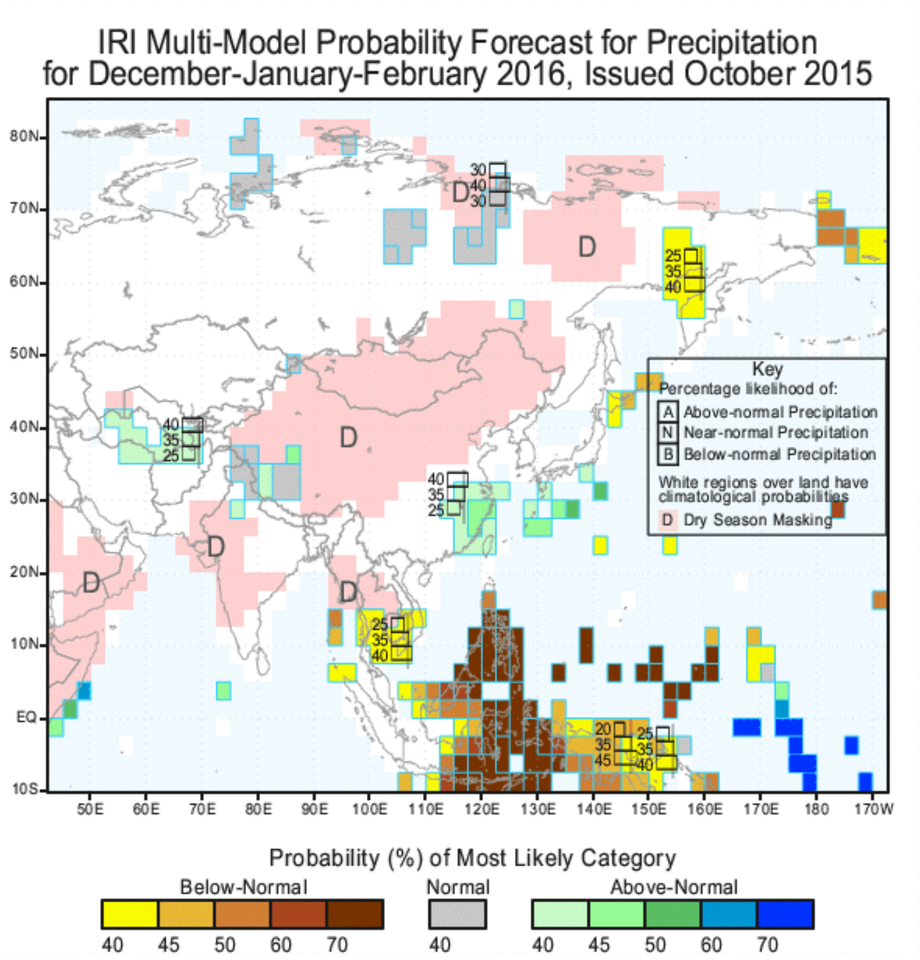
10 days or less

Source: Erin Coughlan

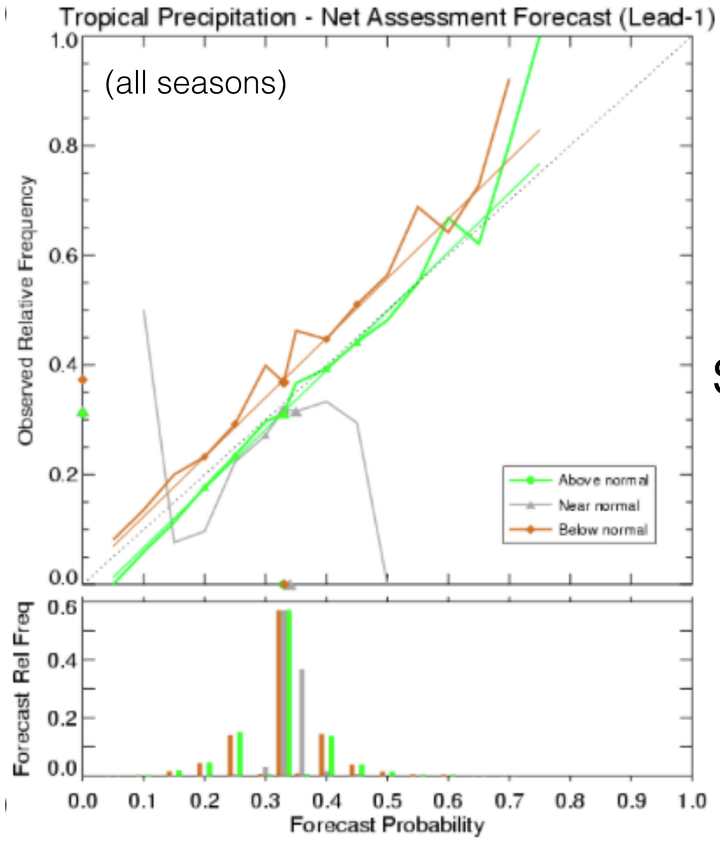
Credibility – Can I trust the forecast?

- Must be well calibrated
- Must convey forecast uncertainty: probabilistic forecasts
- User needs access to forecast verification information

Calibration and Verification



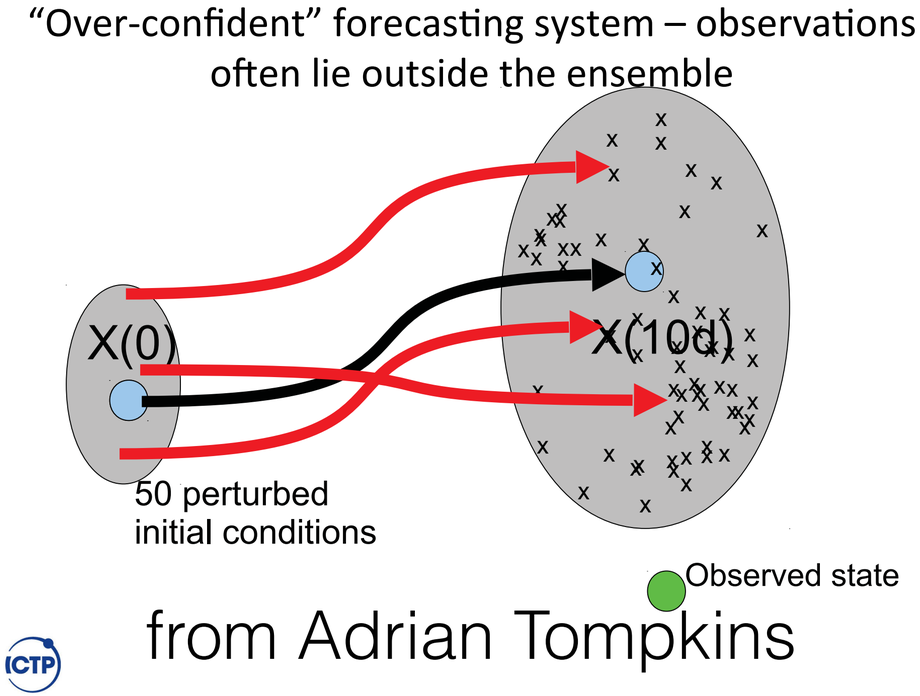
Calibration: Forecast probabilities must be correct on average (no bias)



Skill information should be easily accessible

Understandability: Probabilistic or deterministic?

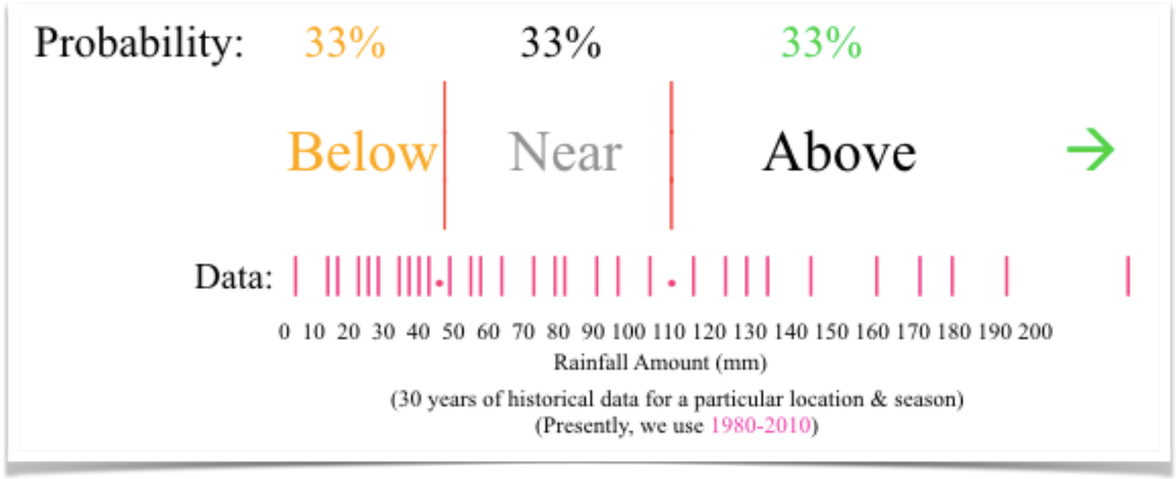
- People are not used to being presented with probabilistic information
- Casual forecast users will prefer your best guess since they typically have many considerations (e.g. economic) to assimilate into their decisions
- But this conveys no information about uncertainty
- Thresholds (and probability of meeting them) can provide a user-centric probability format that makes sense



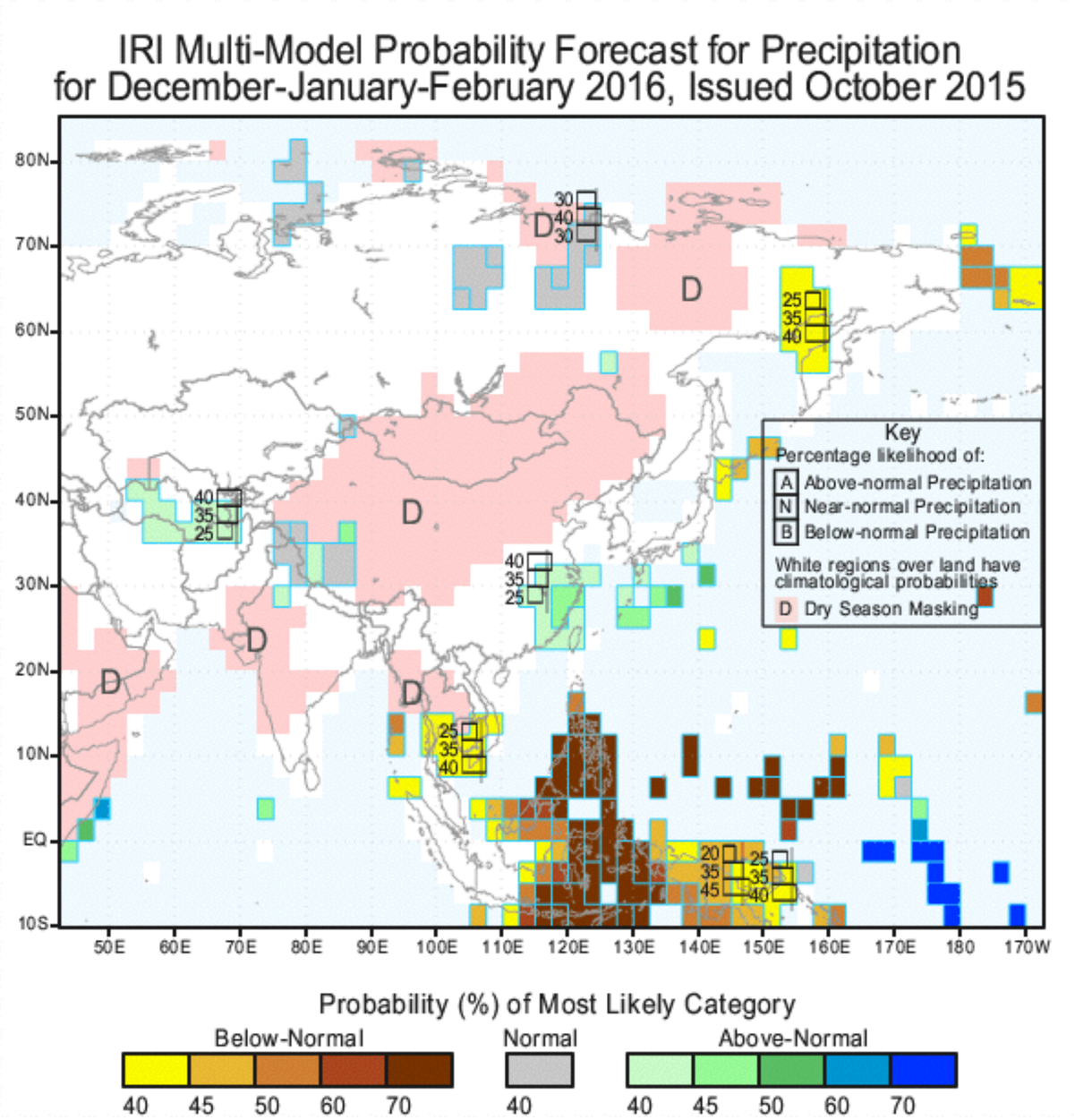
from Adrian Tompkins

Thresholds

- More user-specific information about the forecast distribution can be presented using thresholds
- May be more understandable than terciles



rather than this …



Flexible Format Probabilistic Forecasts

iridl.ldeo.columbia.edu

ECMWF-S2Smtg YR training S2SMME MURI WebofSci DOCP seminars HIW Lamont weather TimeZone IRIcloud irap IRI_intranet

Climate: Forecasts | Flexible Forecasts: Precipitation Flexible Seasonal Forecast | Region: Asia | Model: Forecast

Target Time: Dec 2015 - Feb 2016 | Climatology (1979 to 2011): 1981 to 2010 | Probability: exceeding Percentile 50.0 %-ile | Precipitation Units: mm

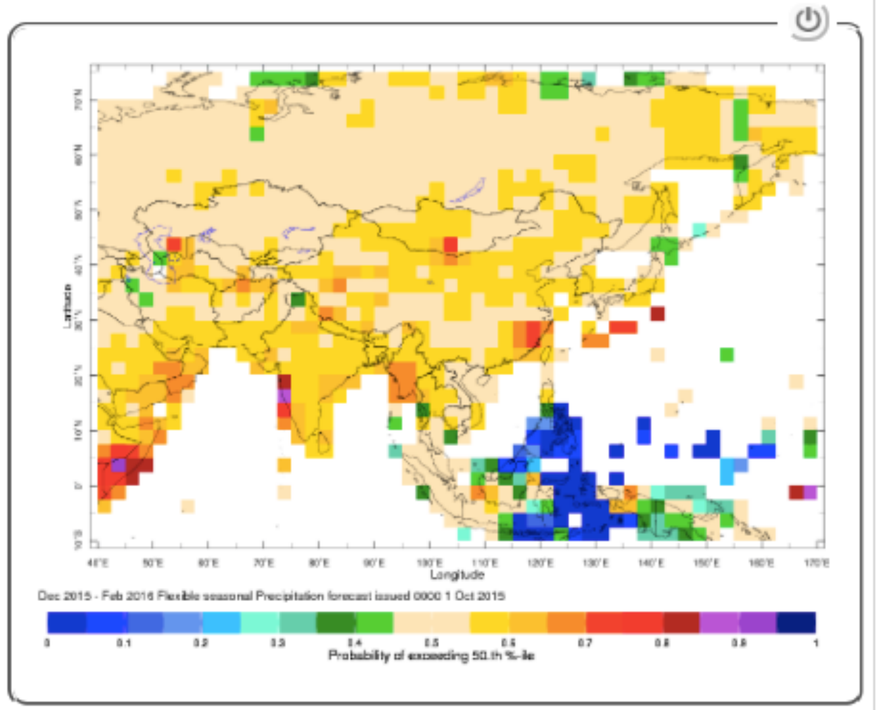
Description | Dataset Documentation | More Information | Instructions | Contact Us

Precipitation Flexible Seasonal Forecast

This seasonal forecasting system consists of probabilistic precipitation seasonal forecasts based on the full estimate of the probability distribution.

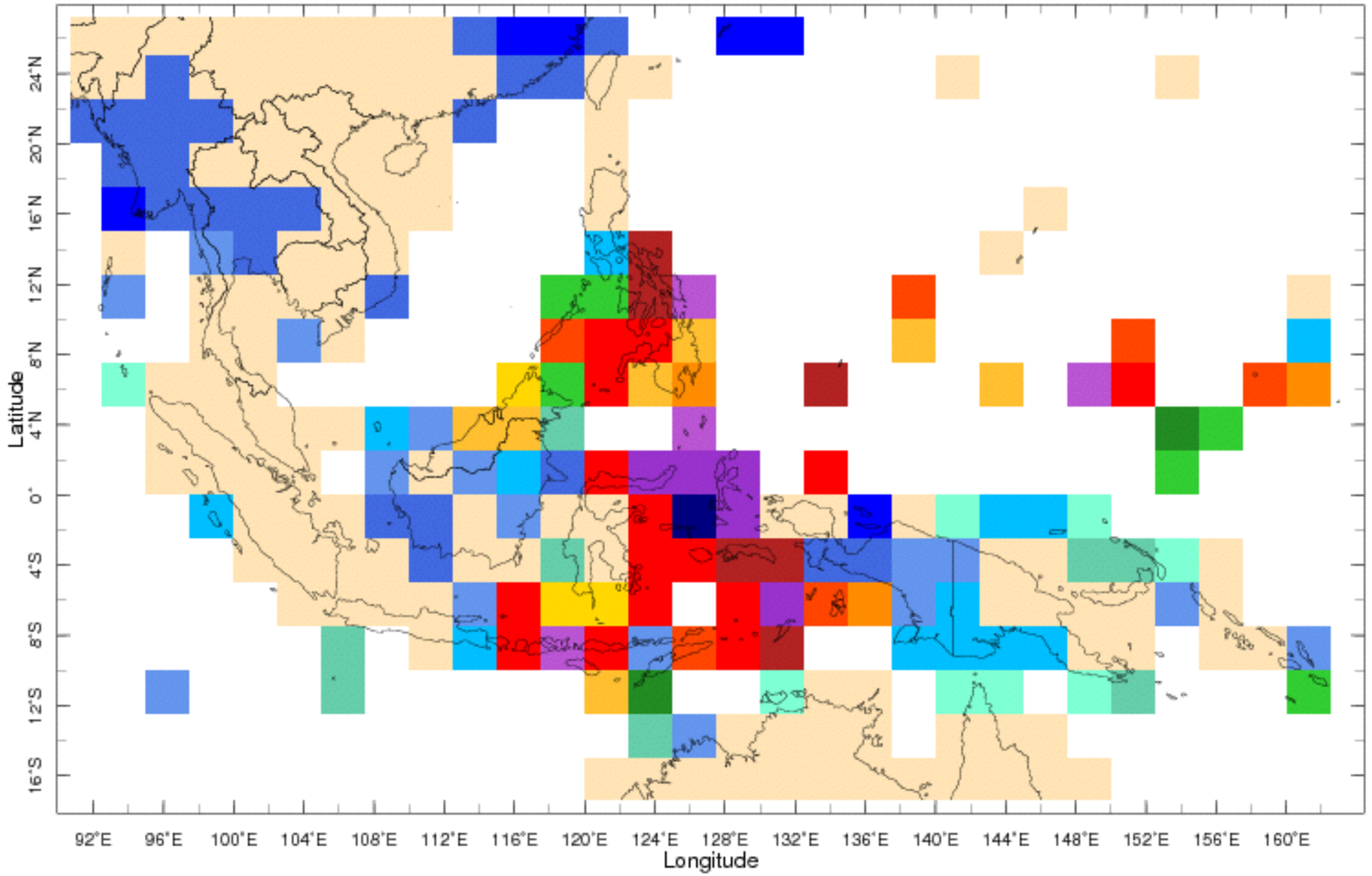
Probabilistic seasonal forecasts from multi-model ensembles through the use of *statistical recalibration*, based on the historical performance of those models, provide reliable information to a wide range of climate risk and decision making communities, as well as the forecast community. The flexibility of the full probability distributions allows to deliver interactive maps and point-wise distributions that become relevant to user-determined needs.

The default map shows globally the seasonal precipitation forecast probability (colors between 0 and 1) of exceeding the 50th percentile of the distribution from historical 1981-2010



DJF Forecast:

Probability of 1-in-5 year drought



Dec 2015 - Feb 2016 Flexible seasonal Precipitation forecast issued 0000 1 Oct 2015

Probability of non-exceeding 20.0th %-ile

Climate: Forecasts
Flexible Forecasts: Precipitation Flexible Seasonal Forecast
Region:
Model: Forecast
Target Time: Dec 2015 - Feb 2016
Climatology (1979 to 2011): 1981 to 2010
Probability: non-exceeding | Percentile | 20.0 %-ile
Precipitation Units: mm

Description | Dataset Documentation | More Information | Instructions | Contact Us

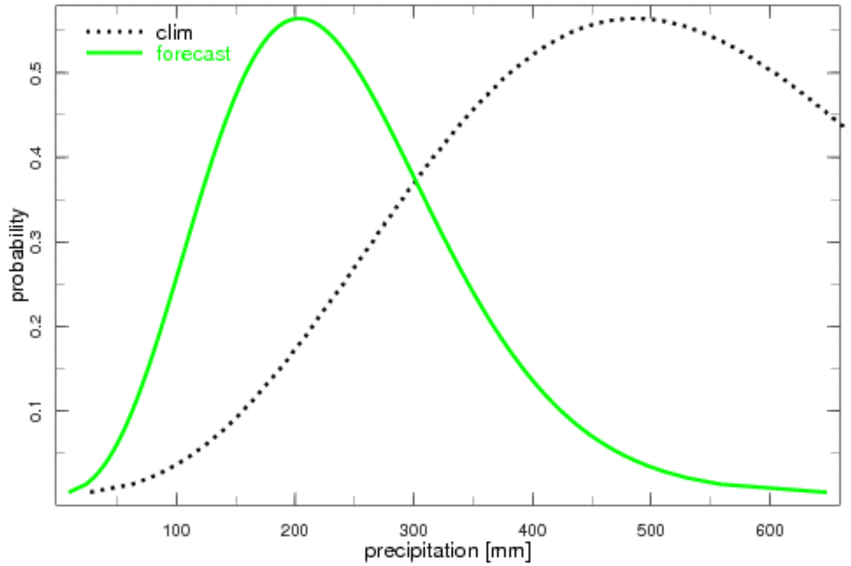
clicking on a point over Philippines …

Download as PDF GIF JPG

Target Date	Issue Date	Lead Time
Dec 2015 - Feb 2016	0000 1 Oct 2015	3.5

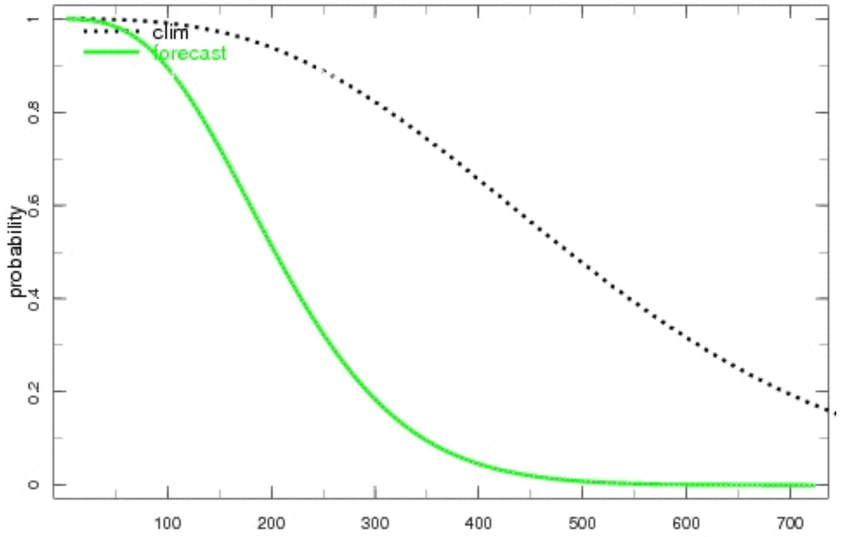
Forecast made for **[122.5E-125E, 10N-12.5N]**
located in , **Ilocos , Philippines**

Full PDF



lead 3.5 months S 0000 1 Oct 2015

CDF



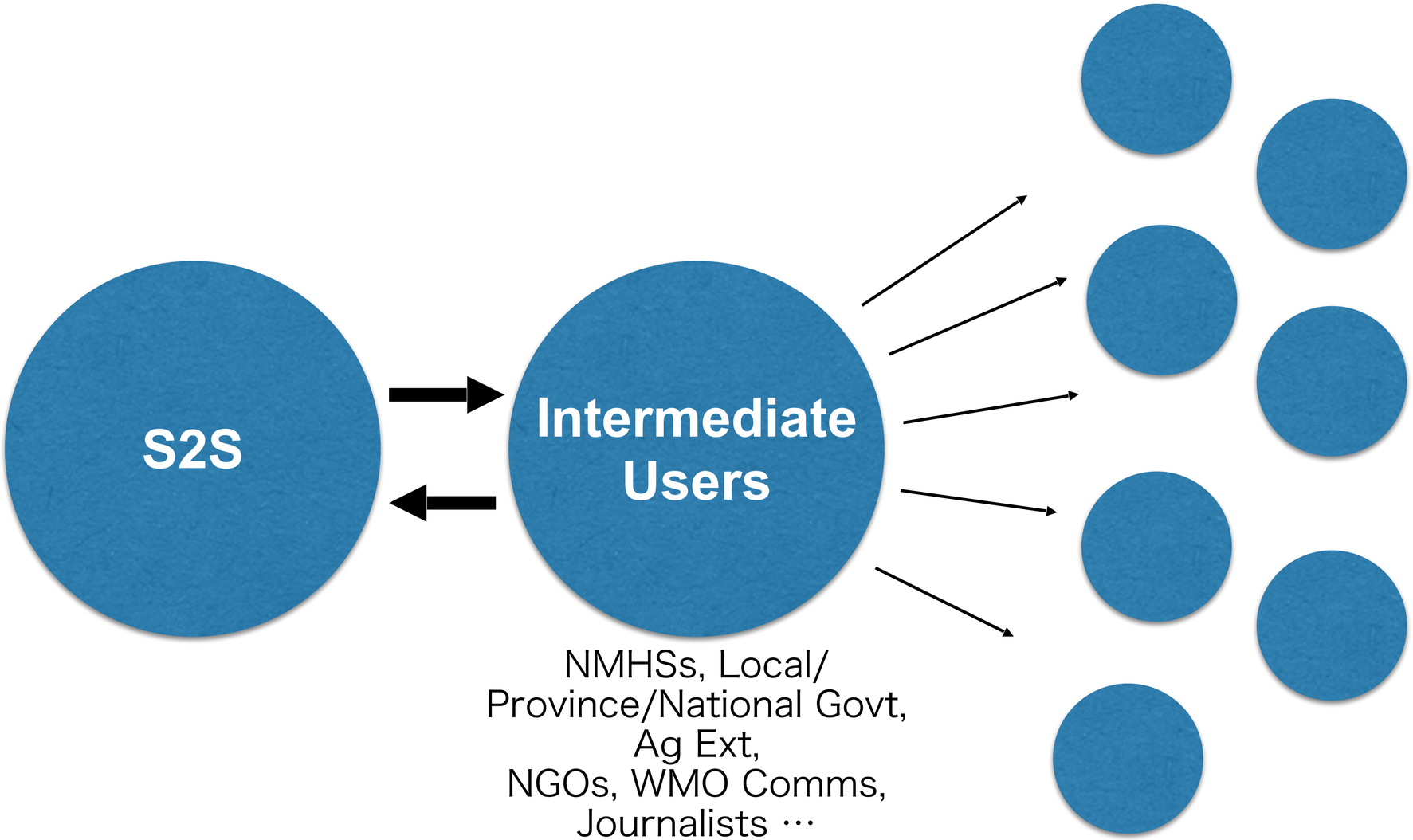
Dec 2015 - Feb 2016 issued 0000 1 Oct 2015 at (123.75E,11.25N)

Credibility and Understandability

- Proper dissemination of forecasts and communicating their meaning is critical
- Co-production of forecasts with intermediary agencies can help e.g. IFRC, WFP, National Met Services, Regional climate centres, agricultural extension services, agricultural universities …
- Training courses organized by ICTP, WMO, APCC, IRI …

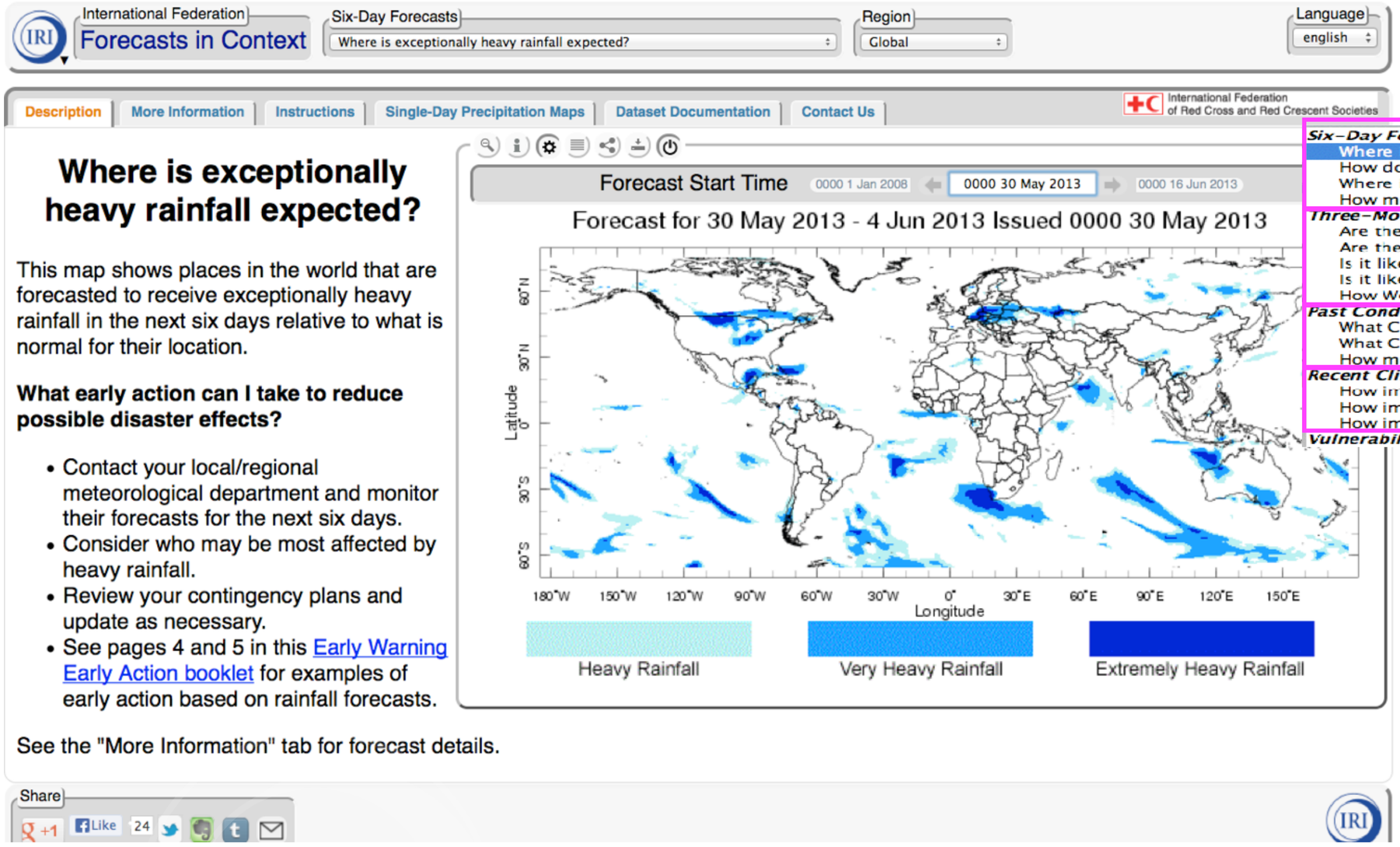
	Type of information	Vehicles for delivering information	Farmer decisions affected
WEATHER **Days to weeks**	 • Observed rainfall and temperature • Daily forecasts up to one week ahead of time • Alerts on pests and diseases • Early warning of extreme weather events	 • Mobile phones • Radio • Television	 • Timing of planting and harvest • Timing of fertilizer, pesticide, and irrigation application • Protecting lives and property from extreme events
CLIMATE VARIABILITY **Months to Years**	 • Probabilities for seasonal rainfall and temperature conditions • Seasonal climate variables targeted to particular agricultural risks (dry spells, rainy season start date, etc) • Historical variability of climate variables	 • Workshops with experts • Conversations with agricultural extension agents (farm educators)	 • Selecting crops and varieties • Livestock stocking rates and feeding strategies • Intensity of input use (fertilizer, pesticides) • Labor or marketing contracts • Intensifying and diversifying crops • Diversifying sources of income

Important Entry Points with Users



Indirect Link with End Users via Intermediaries

Maprooms for Humanitarian Aid



developed in a partnership between IRI and IFRC

Source: IRI

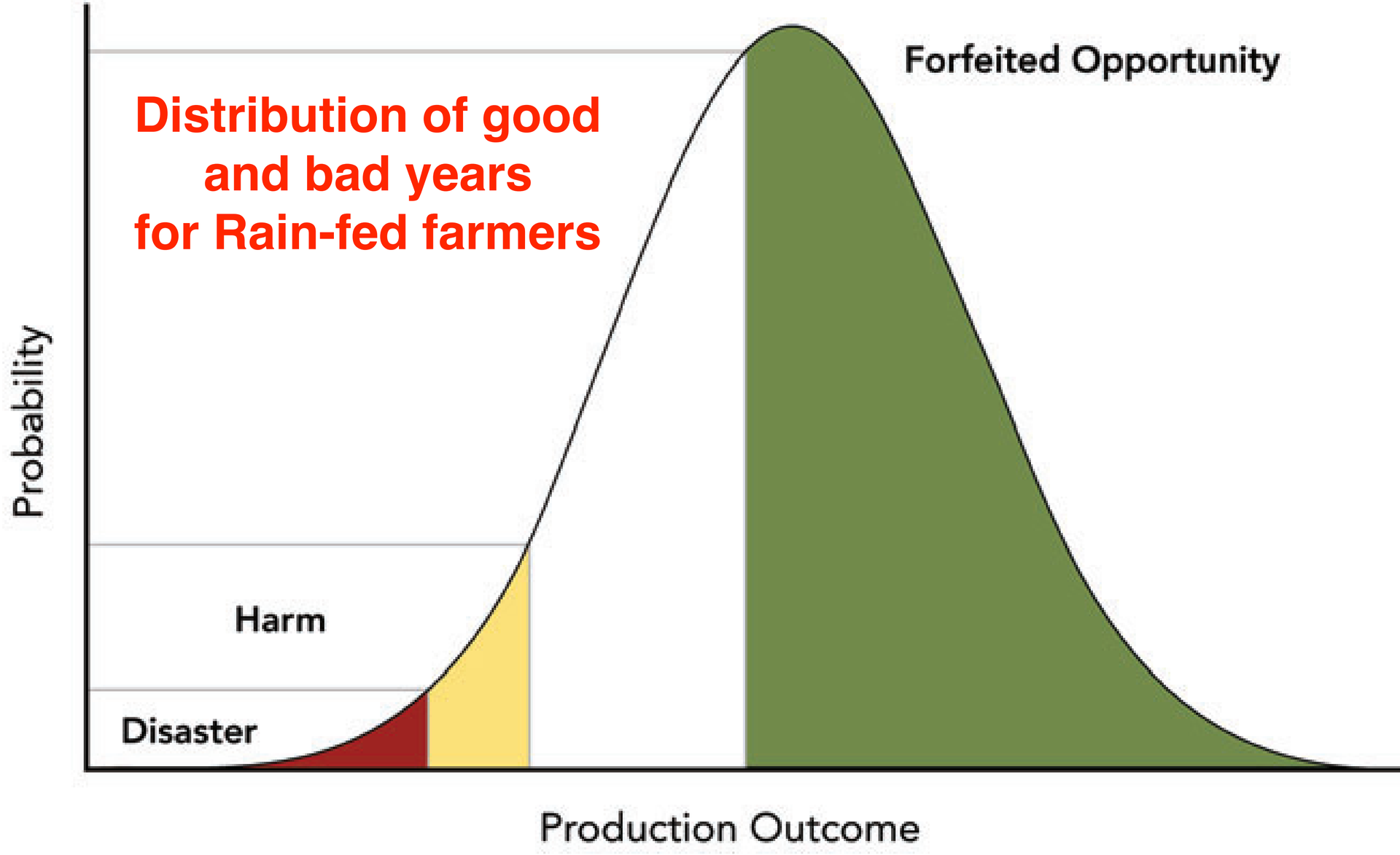
Legitimacy

- The forecasts need to come from a trusted source
- In the WMO system, the National Met Services play this role
- The WMO Lead Centre is the intermediary between global producing centers (GPCs) and the NMSs

Outlook

Can a [S2S] climate forecast help farmers avoid harm and disaster?

Or take advantage of a good year?



Summary of main points

- “Applications” is a highly multi-faceted area
- Much hinges on effective communication of what forecasts can and can’t say. This includes training.
- Proper calibration and verification become critical for people to be able to act on a forecast
- There is much to be done on all the above in the new field of seamless forecasting!