HIWeather (WWRP core project)

Michael Riemer

(Steering group member HIWeather)

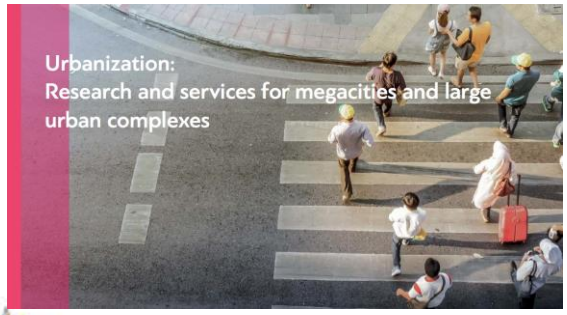
Johannes Gutenberg-Universität Mainz, Germany

with material from Paolo Ruti and Brian Golding

What to expect:

- Brief general motivation and HIWeather intro
- HIWeather “key concept” and approach
- HIWeather general interests
- HIWeather specific activities
- Discussion?

WWRP foci of Earth System Science



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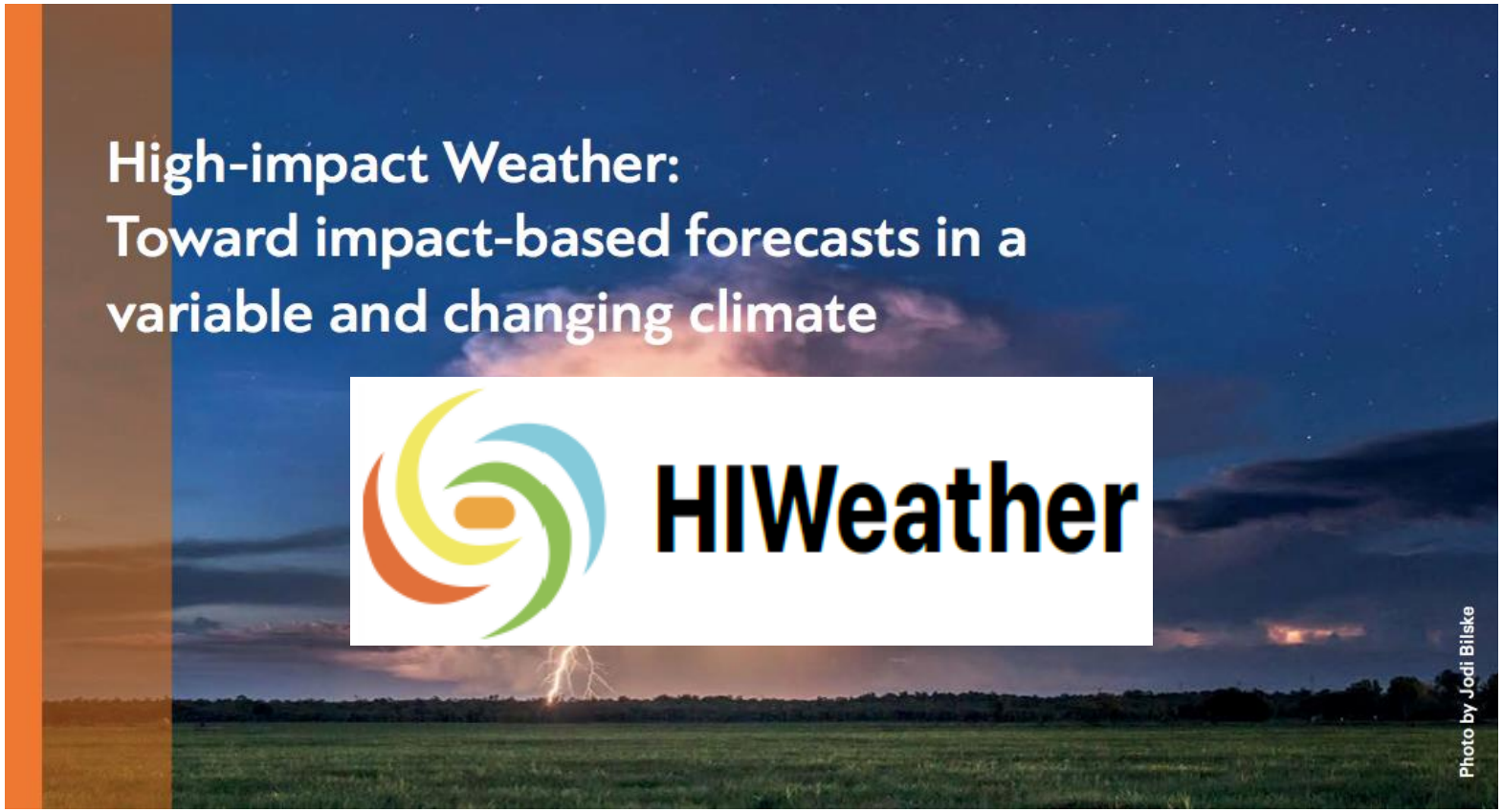

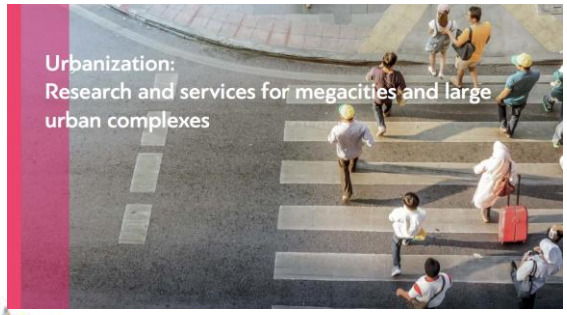

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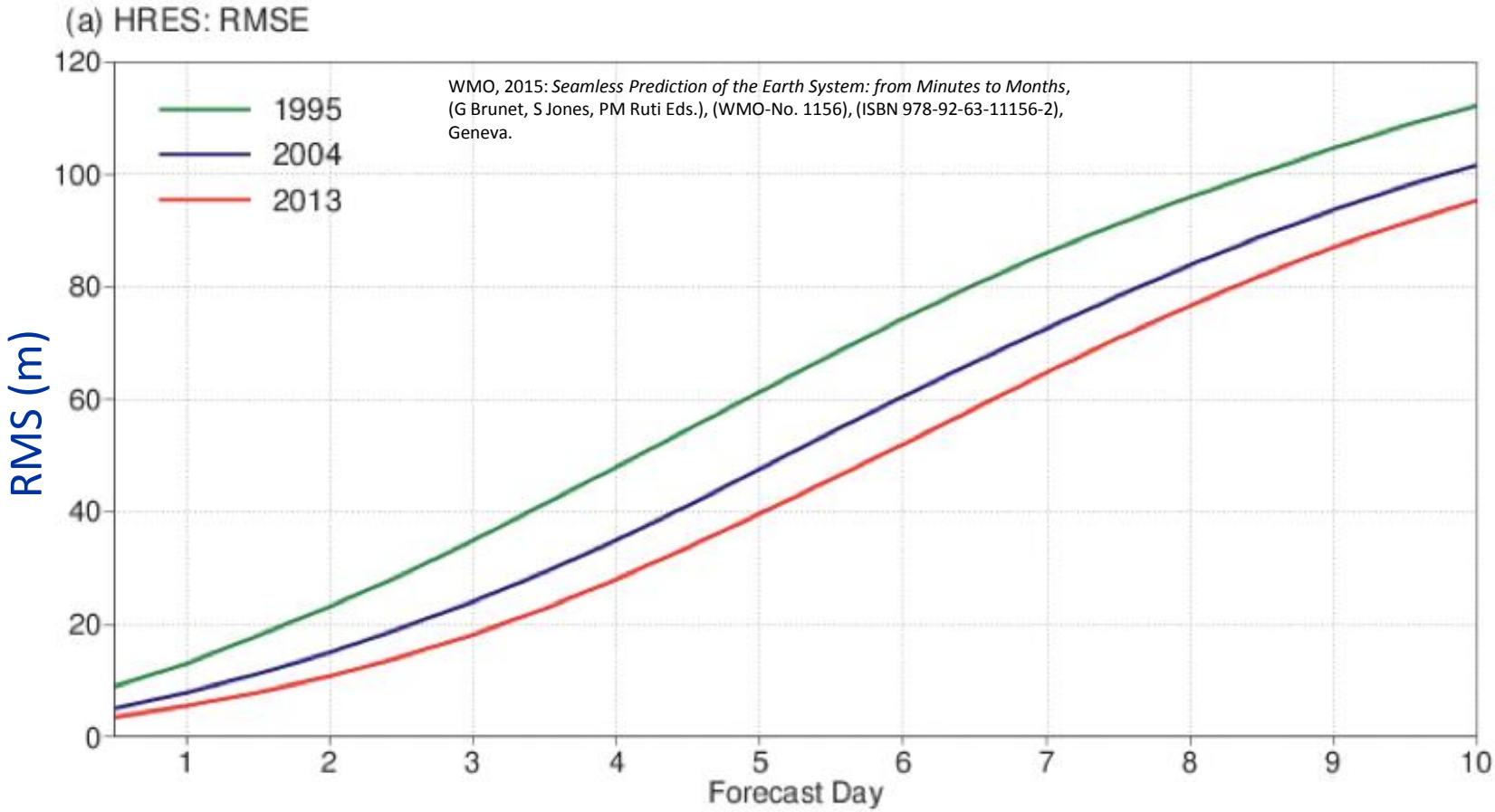
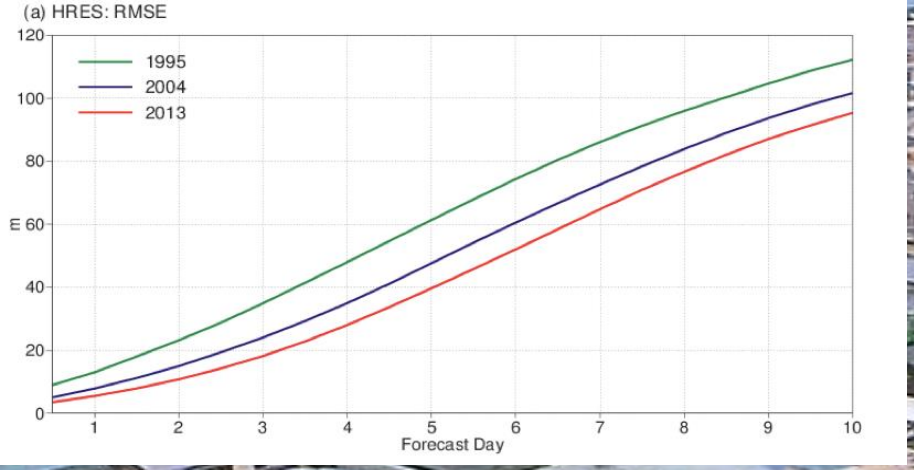
Improving the skill

ECMWF's forecast Z500hPa extra-tropical error growth over the last two decades



WMO, 2015: *Seamless Prediction of the Earth System: from Minutes to Months*, (G Brunet, S Jones, PM Ruti Eds.), (WMO-No. 1156), (ISBN 978-92-63-11156-2), Geneva.

WMO OMM



In 2017, despite dramatic improvements in *weather forecasts*, *communication technology* and *disaster management*,

weather-related disasters

- ☠ Killed ten thousand people
- ☠ Affected one hundred million people
- ☠ Caused three hundred billion dollars of damage

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HIWeather

- Promote cooperative international research
- to achieve a dramatic increase in resilience to high impact weather, worldwide,
- through improving forecasts for timescales of minutes to two weeks and
- enhancing their communication and utility in social, economic & environmental applications

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HIWeather hazards

Urban Flood:
Mortality, morbidity, damage & disruption from flood inundation by intense rain, out-of-bank river flow, coastal wave & surge overtopping and from consequent urban landslides.

Disruptive Winter Weather:
Mortality, morbidity, damage & disruption from snow, ice and fog to transport, power & communications infrastructure.

Wildfire:
Mortality, morbidity, damage & disruption from wildfires and their smoke.

Urban Heat Waves & Air Pollution:
Mortality, morbidity & disruption from extreme heat and pollution in the megacities of the developing and newly developed world.

Extreme Local Wind:
Mortality, morbidity, damage & disruption from wind and wind blown debris in tropical & extra-tropical cyclones, downslope windstorms and convective storms, including tornadoes.

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Warning Value Chain and Interdisciplinary Approach

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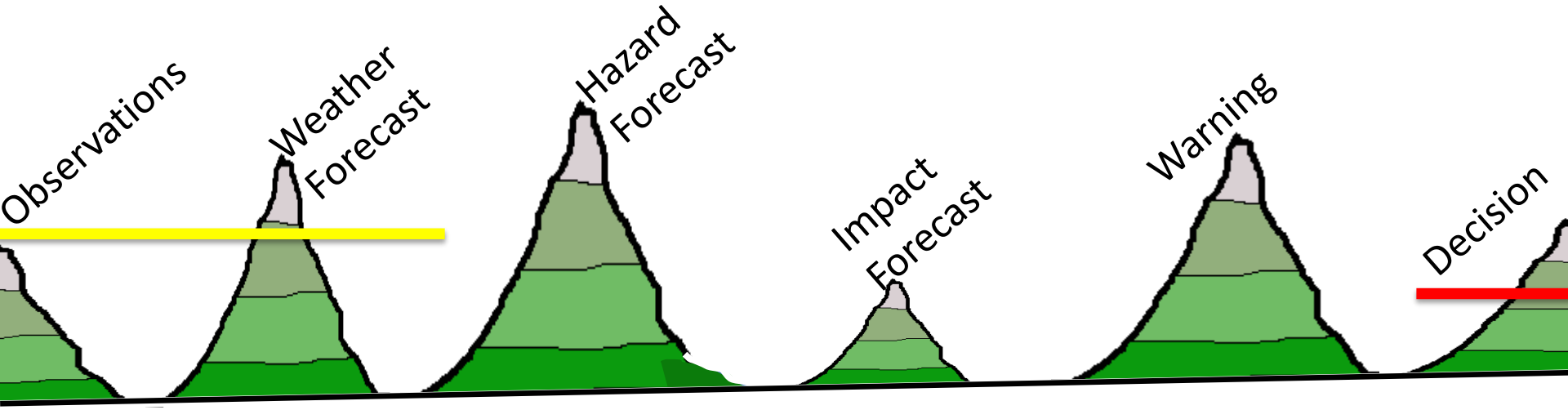
Warning Value Chain



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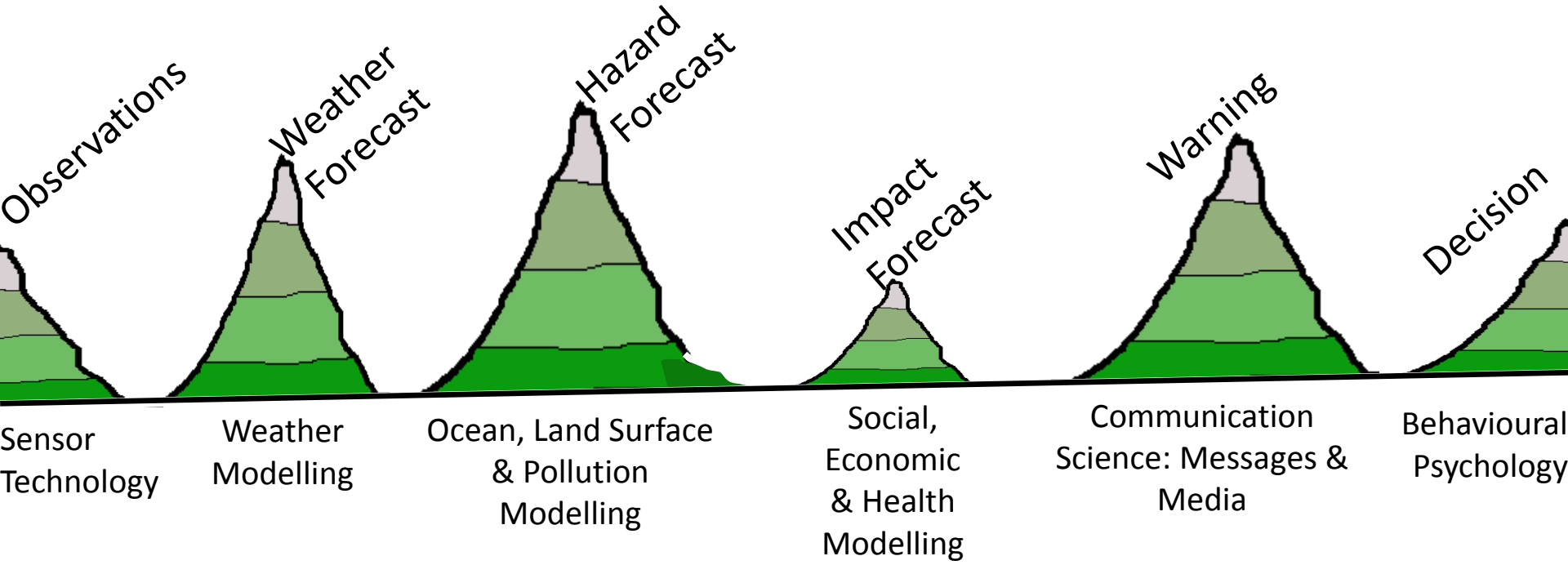

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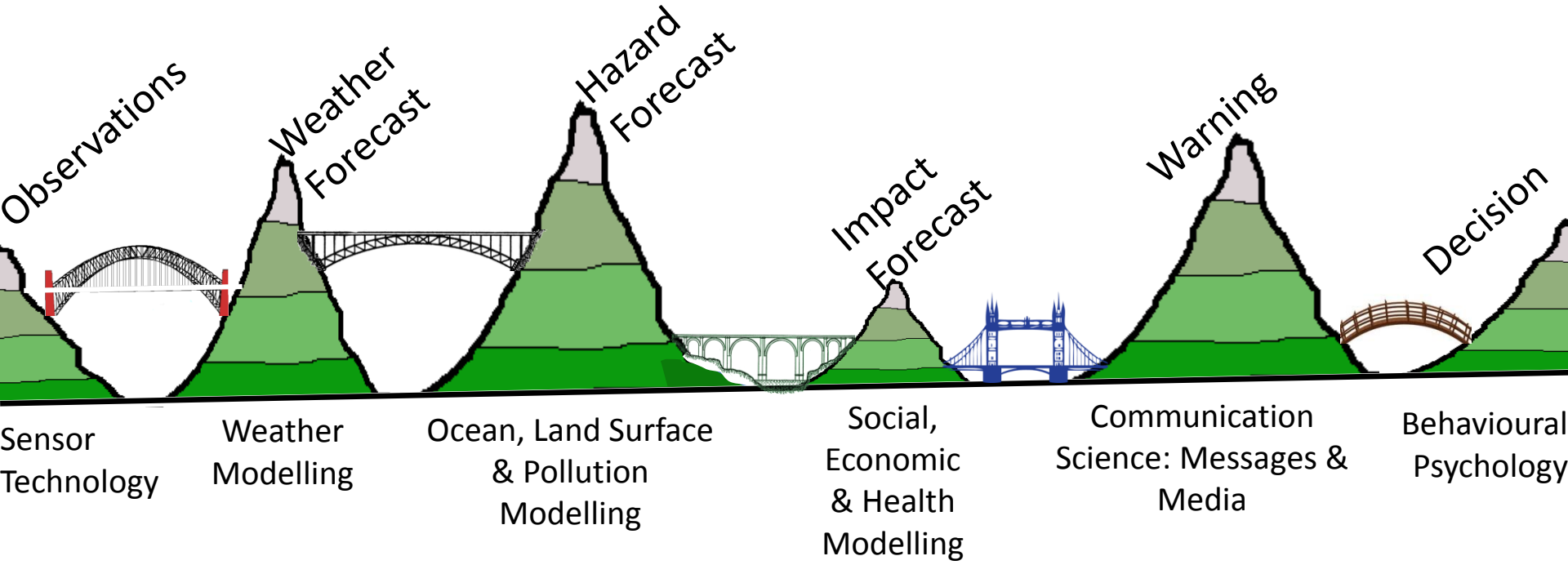

Bridges represent inter-disciplinary &/or inter-agency communication

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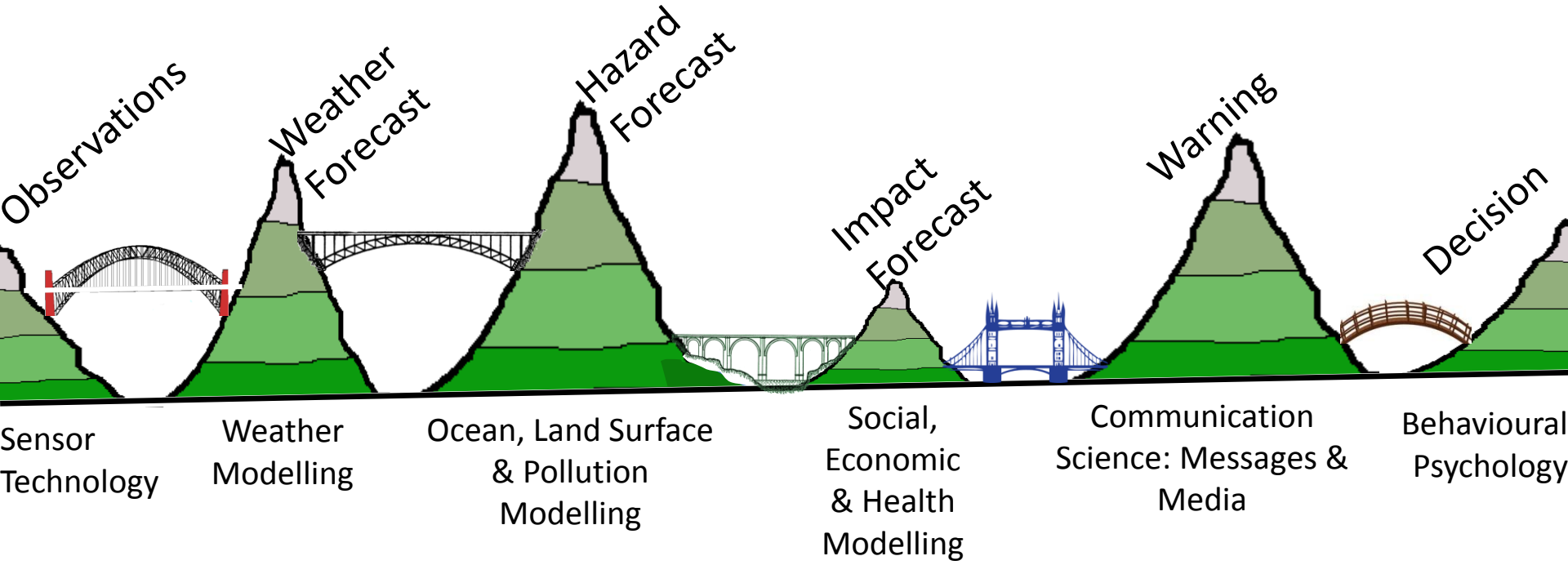
Warning Value ~~Chain~~ Cycle (Squid?)



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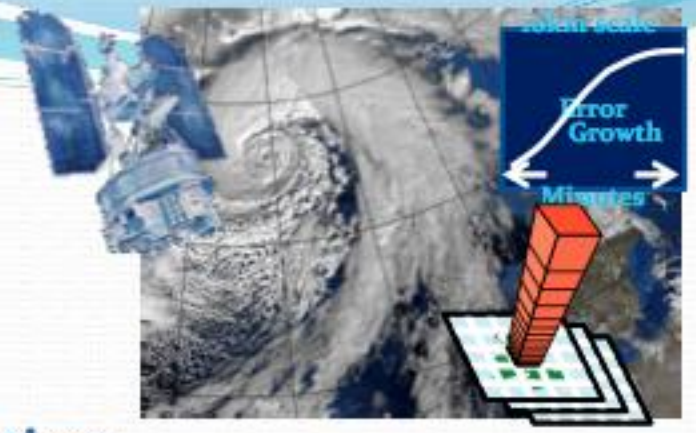
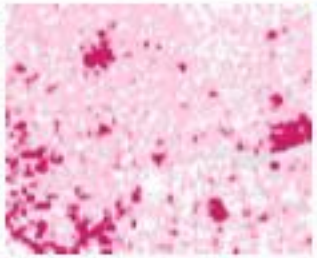
HIWeather

Research Areas



Predictability & Processes:

Initiation and evolution of hazard-related weather systems and associated predictability

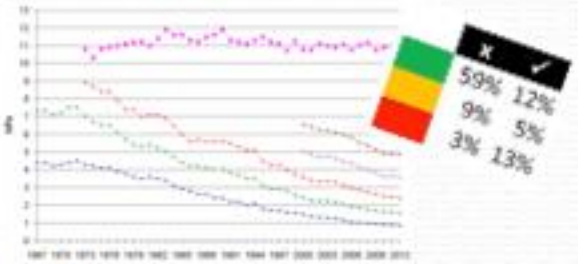


Multi-scale Forecasting:

Multi-scale prediction of weather hazards in coupled modelling systems

Human Impacts, Vulnerability & Risk:

Hazard impacts on individuals, communities and businesses, assessing their vulnerability and risk



Evaluation:

Measure skill and value of forecasts and warnings at all stages of production to focus research in weak areas and support users in developing responses

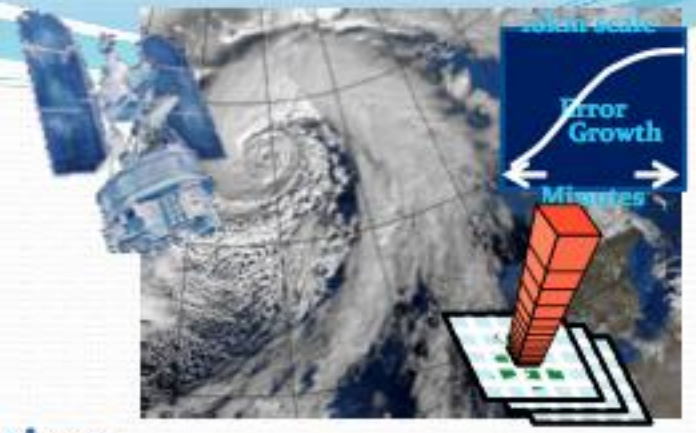
Communication:

Achieving more effective responses to forecasts through better communication of hazard risk warnings

HIWeather

Research Areas

Physical sciences



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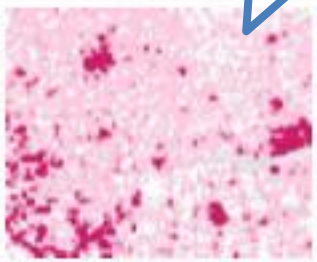

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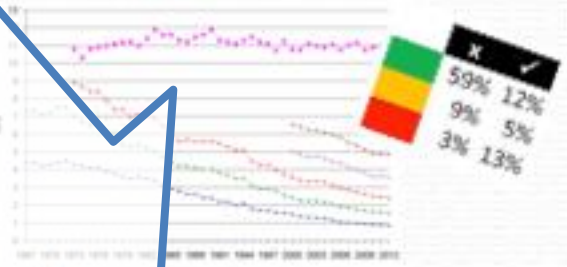

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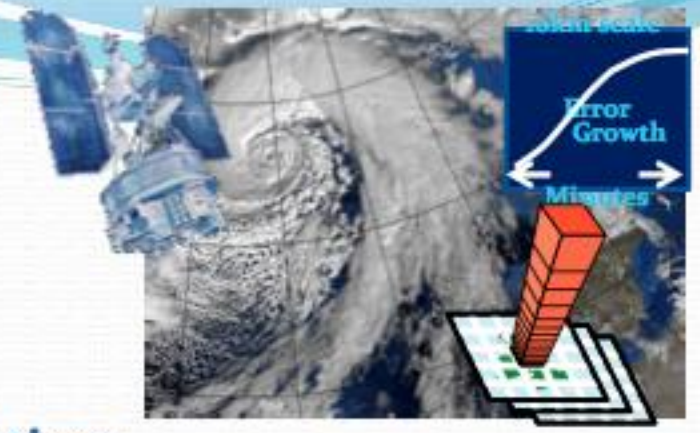

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Inter-disciplinary approach is unique potential of HIWeather … but also a challenge.

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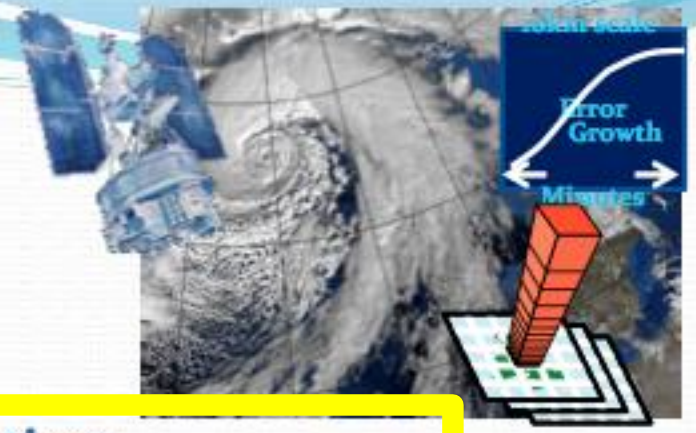

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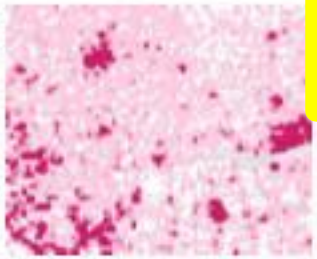

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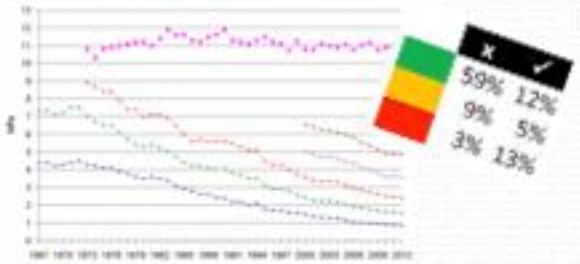

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HIWeather The project and the people

WWRP core project (10-year project, kick-off 2016)

Co-chairs: Brian Golding, UK and David Johnston, New Zealand
ICO: Qinghong Zhang, Liye Li, China

Steering Group:
Processes & Predictability (P&P) theme – lead: Michael Riemer, Germany
Multi-Scale coupled Forecasting (MSF) theme – lead: Jenny Sun, USA
Human Impacts, Vulnerability & Risk (HIVR) theme – lead: Brian Mills, Canada
Communication theme – co-leads: Andrea Taylor, UK & Shannon Panchuk, Australia
Evaluation theme – lead: Beth Ebert, Australia
SURF (Study of Urban-Impacts on Rainfall and Fog/Haze) and East Asian Reanalysis System: Xudong Liang, China

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What are HIWeather's general interest?

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HIWeather (general) interests

Processes and predictability of high-impact weather:

- **convective-scale predictability** and large-scale processes
- predictability of **hazardous weather relative to "normal" weather**
- association with forecasts with **high sensitivity to initial state**
- role of **diabatic heating**, the **boundary layer** and **land surface**
- **pre-conditioning of the land surface** for hazards

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- whole prediction chain needed to forecast the hazards
- prediction at **convective scale** (<3km), coupled modeling and **ensembles**

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Physical hazard and the human impact (led by social scientists)

Communication: choices of information **content, language, format and media channels** used, spatial and temporal precision, timeliness and context (led by social scientists)

User-oriented evaluation**:** accuracy and value **through the warning value cycle**; emphasis on the **information required by decision makers**

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Which HIWeather activities may relate to WGNE?

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HIWeather activities

Review the current state of nowcasting & forecasting high impact weather

Leads: Sharan Majumdar and Jenny Sun

Document current state of high impact weather nowcasting/forecasting; identify gaps

The writing team is being assembled and it is planned to submit to BAMS in 2019.

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Intercomparison of km-scale DA & nowcast/forecast systems

Lead: Jenny Sun

Demonstrate **state-of-the-art of km-scale DA & nowcast/NWP systems** for HIW warning with an emphasis on floods & high winds

Had email discussion with co-chairs of the Data Assimilation and Observations System (**DAOS**) working group regarding the possible collaboration on an high-resolution HIW forecasting system intercomparison project.

HIWeather links to larger projects

SCMREX (*Southern China Monsoon Rainfall Experiment,* ***WWRP RDP)***
Lead: Yali Luo
The China Meteorological Administration (CMA) initiated a nationally coordinated research project, SCMREX, for pre-summer rainy season **extreme rainfall** (up to 500mm/12h). Consists of four major components: field campaign, database management, studies on physical mechanisms of heavy rainfall events, and **convection-permitting numerical experiments** including impact of **data assimilation**, evaluation/improvement of **model physics**, and **ensemble prediction**.

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MOUNTAOM (RDP *alongside the 2022 Winter Olympic Games in Beijing****)***
Chinese Meteorological Administration research to develop capability in forecasting relevant weather parameters in area of 2022 Winter Olympic Games (mountains northwest of Beijing). The project has six research themes. It is planned to mount an annual field programme. **LES modelling experiments** are being conducted with **nested grids from 1km down to 37m.** The project has an International Advisory Committee, the chair of which is Prof Joe Fernando.

HIWeather links to larger projects (cont.)

UK Environmental Prediction (UKEP) project

Lead: Huw Lewis

The UK Environmental Prediction initiative is a national collaboration led by the Met Office, Centre for Ecology & Hydrology, National Oceanography Centre and Plymouth Marine Laboratory. It **develops and evaluates** the UK's first **fully coupled regional prediction system at kilometre scale, encompassing atmosphere, ocean, wave, land surface, and biogeochemistry model components and their interactions**. The aim of the initiative is to enable multi-disciplinary research on Earth system processes at high resolution and to improve future operational applications.

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Development of High Resolution Data Assimilation Techniques and East Asia Atmospheric Reanalysis Datasets
Lead: Xudong Liang, CAMS
A **3km grid**, decade long **reanalysis** for East Asia.

Development of Seamless Weather-Climate Model Dynamic Core on Unstructured Grid
Lead: Jian Li, CAMS
Develop numerical core suitable for future supercomputing architectures.

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HIWeather links to larger projects (cont.)

Waves to Weather (Peter Knippertz)
Large German Collaborative Research Project (~30 PIs); Underpinning science for next-generation weather forecast systems; Organized in three research themes: **Upscale error growth**, **Cloud-scale uncertainties**, and Predictability of local weather

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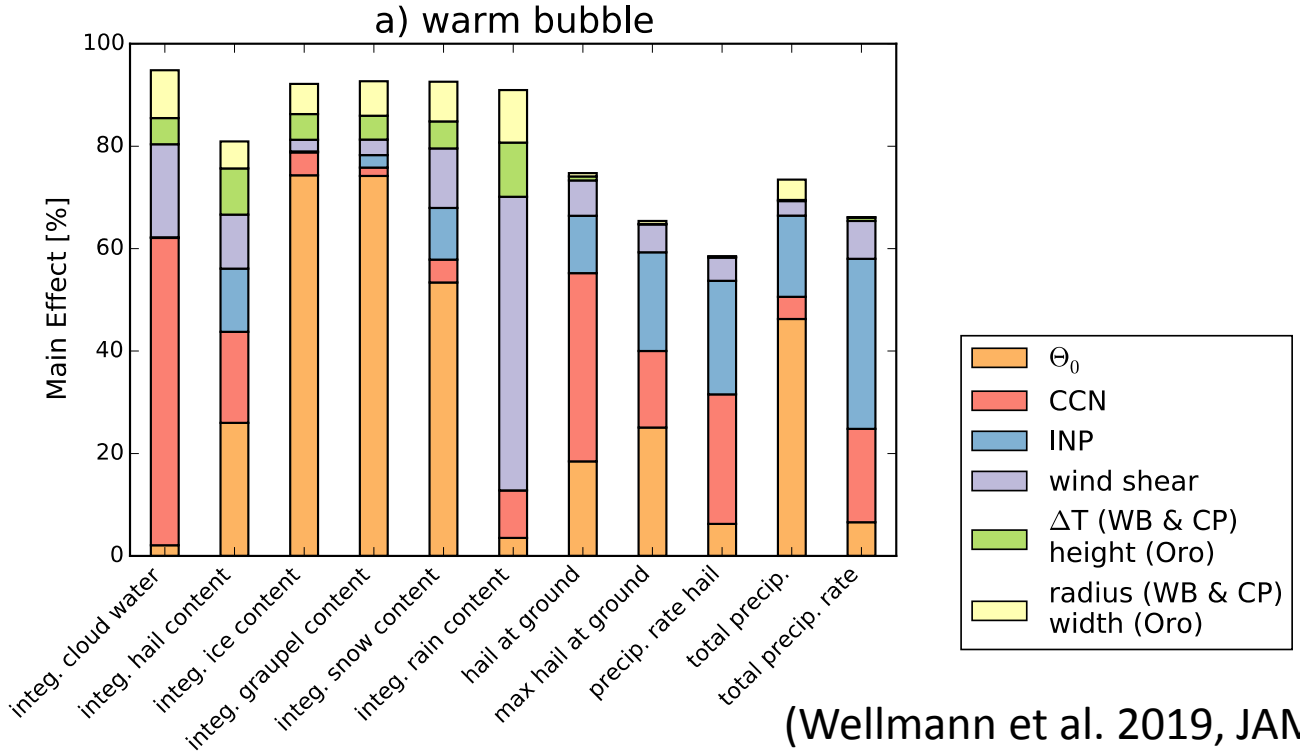
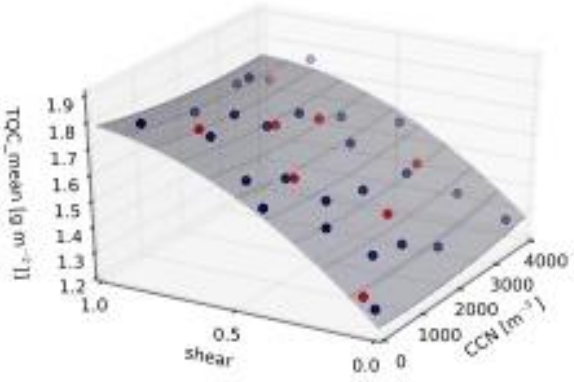
Cloud-scale uncertainties: Highlight

- Most relevant **uncertainties of microphysical processes in deep convection**: identification, **comparison to uncertainties in environment, impact on larger scales**





Mapping sensitivity space using *emulators*

(Wellmann et al. 2019, JAMES)

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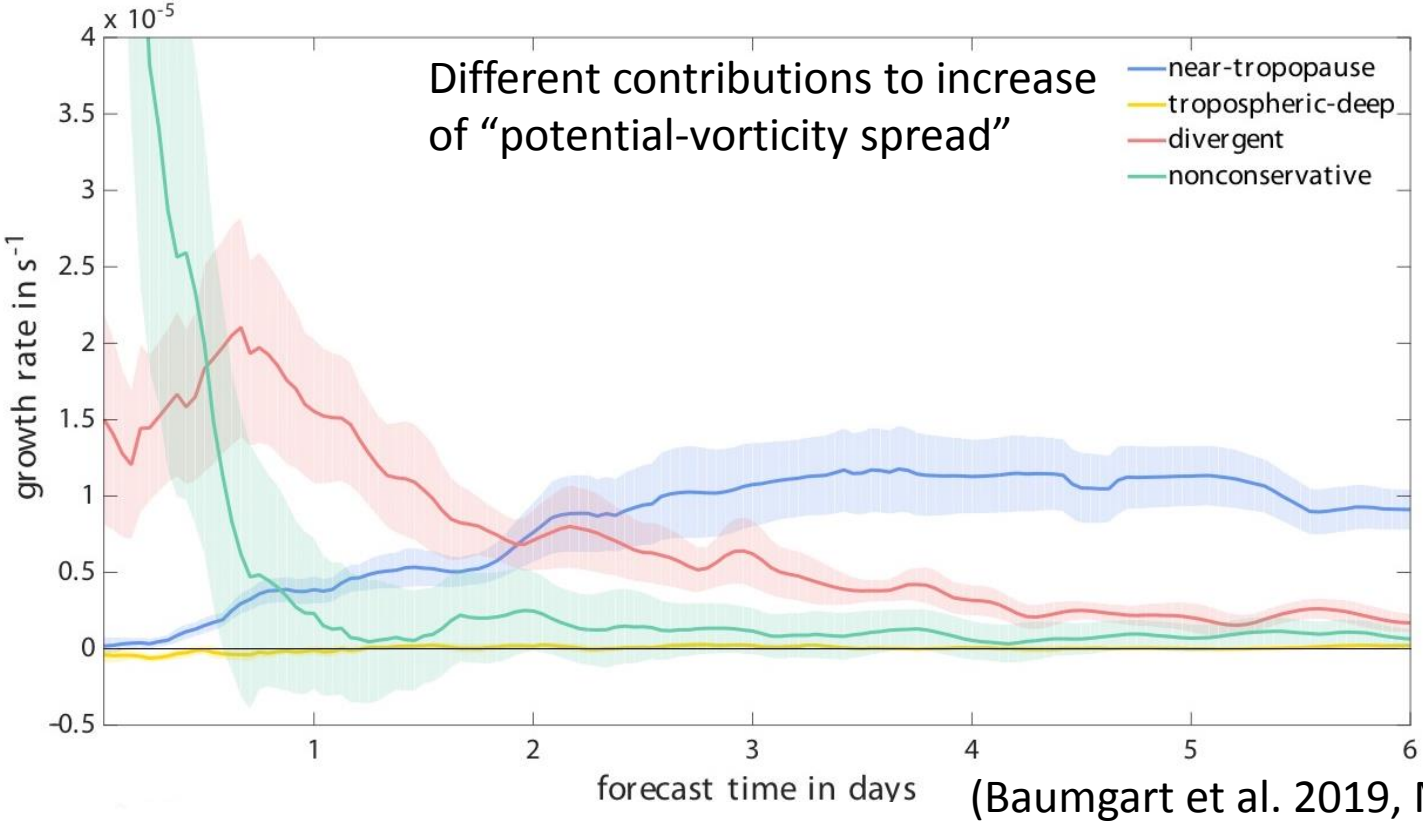
Quantification of mechanisms governing multi-stage error growth



Upscale-error-growth experiment (ICON) with Plant-Craig scheme; Initial differences only in stochasticity

(Baumgart et al. 2019, MWR)

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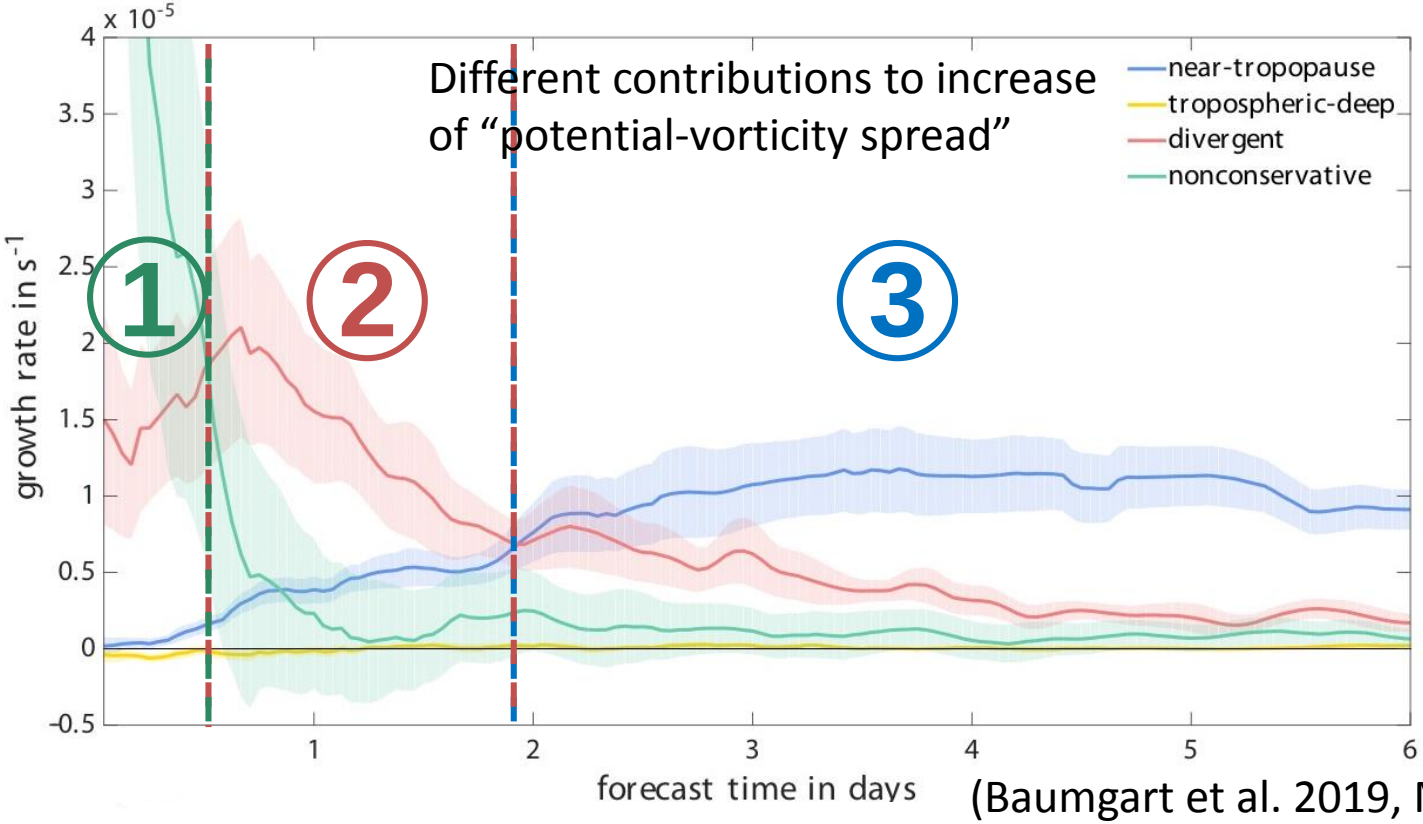

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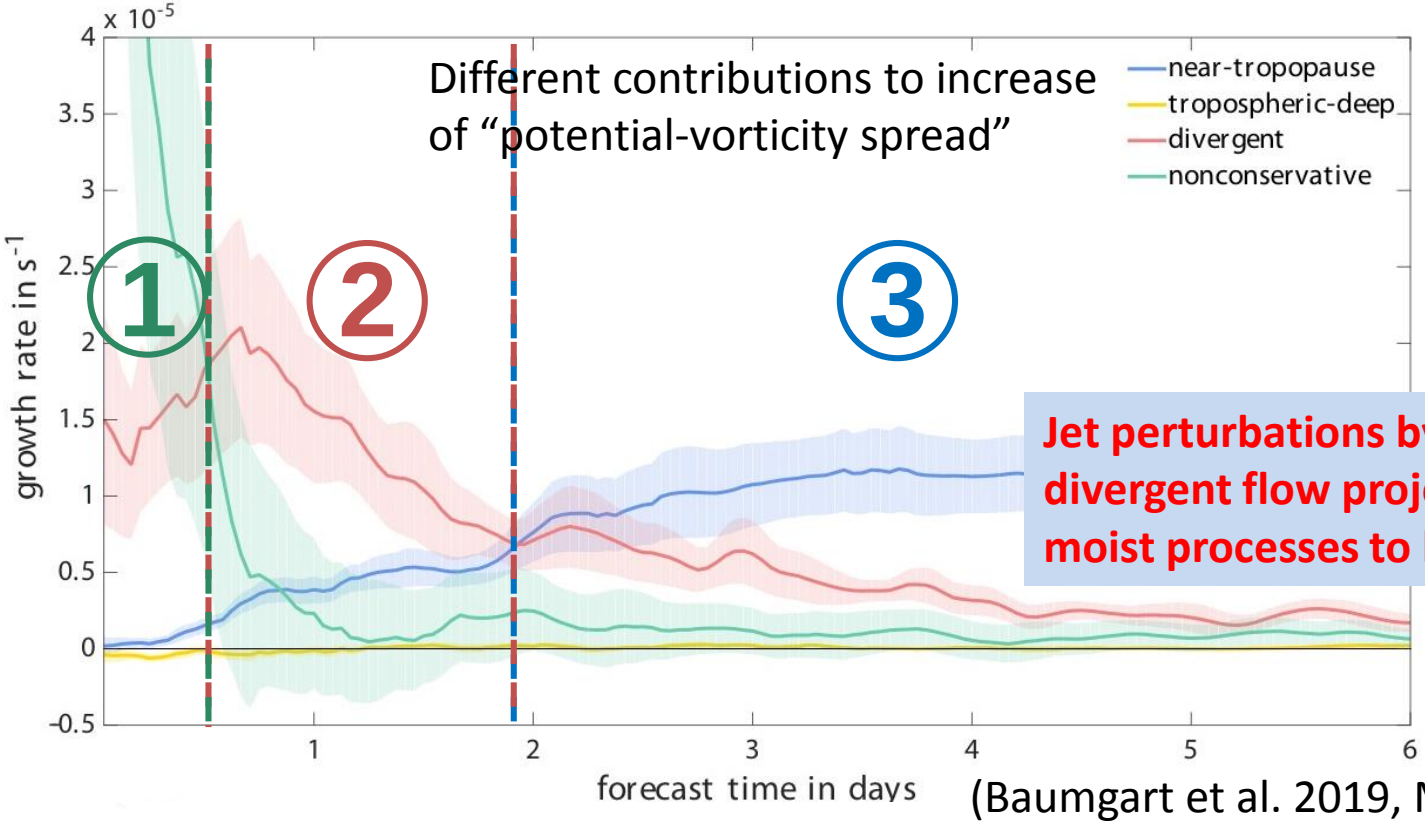

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Jet perturbations by upper-tropospheric divergent flow projects uncertainty in moist processes to larger-scale circulation.

(Baumgart et al. 2019, MWR)

WGNE – HIWeather: How can we coordinate/collaborate?

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