Short-term and persistent impacts on socio-economic indicators
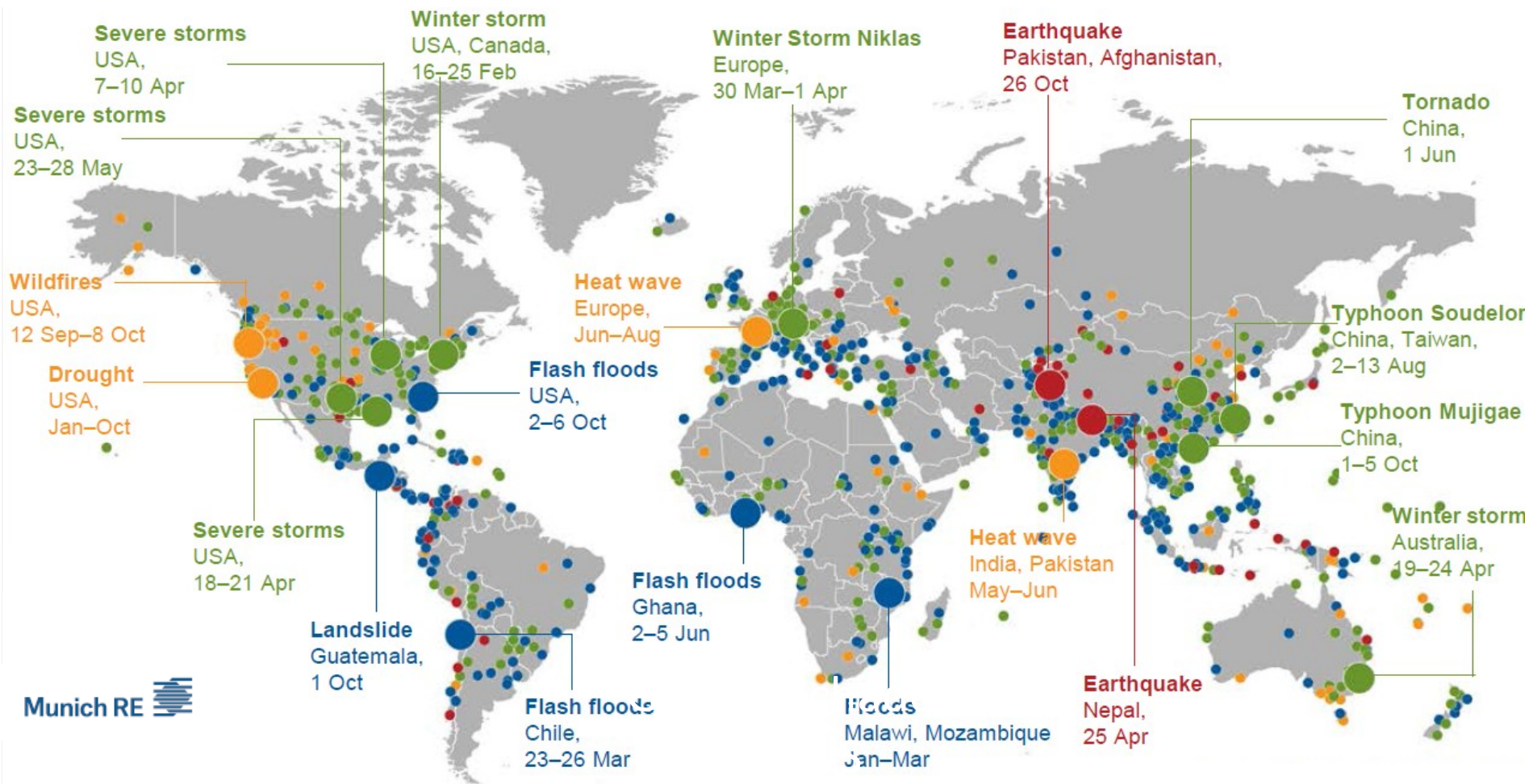
Tobias Geiger

Potsdam Institute for Climate Impacts Research

ISI-MIP workshop - 23 June 2016

Natural disasters 2015

Severe storms
USA,
7–10 Apr

Severe storms
USA,
23–28 May

Winter storm
USA, Canada,
16–25 Feb

Winter Storm Niklas
Europe,
30 Mar–1 Apr

Earthquake
Pakistan, Afghanistan,
26 Oct

Tornado
China,
1 Jun

Wildfires
USA,
12 Sep–8 Oct

Drought
USA,
Jan–Oct

Heat wave
Europe,
Jun–Aug

Flash floods
USA,
2–6 Oct

Typhoon Soudelor
China, Taiwan,
2–13 Aug

Typhoon Mujigae
China,
1–5 Oct

Severe storms
USA,
18–21 Apr

Heat wave
India, Pakistan
May–Jun

Winter storm
Australia,
19–24 Apr

Landslide
Guatemala,
1 Oct

Flash floods
Ghana,
2–5 Jun

Flash floods
Chile,
23–26 Mar

Floods
Malawi, Mozambique
Jan–Mar

Earthquake
Nepal,
25 Apr

Earthquake
Nepal,
25 Apr

Munich RE

Average annual weather
losses 100 billion $US

● **Geophysical events**
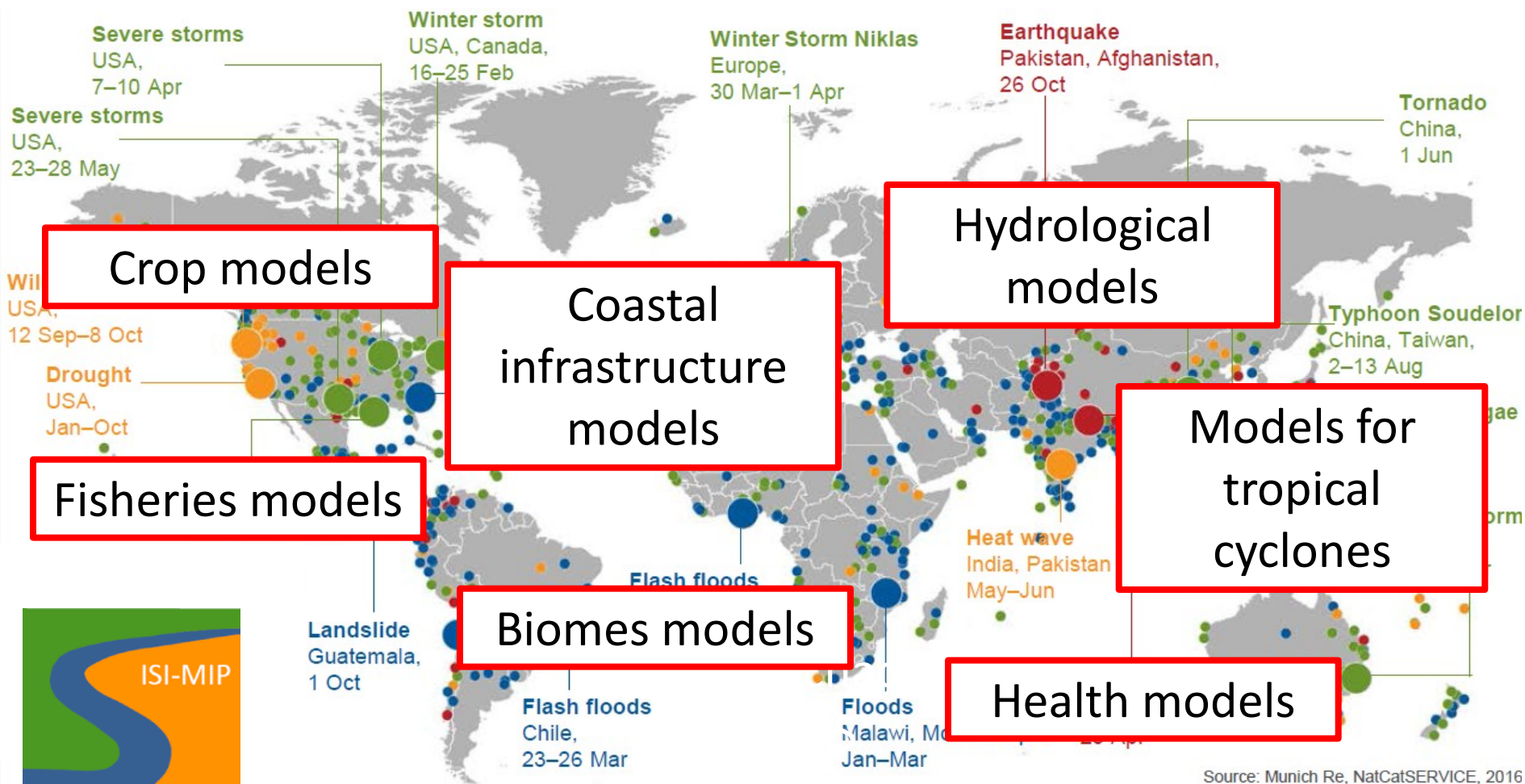(Earthquake, tsunami, volcanic activity)

● **Hydrological events**
(Flood, mass movement)

● **Meteorological events**
(Tropical storm, extratropical storm,
convective storm, local storm)

● **Climatological events**
(Extreme temperature, drought, wildfire)

Natural disasters in a 2°C-world?

Crop models

Coastal infrastructure models

Hydrological models

Fisheries models

Biomes models

Models for tropical cyclones

Health models

Severe storms
USA,
7–10 Apr

Severe storms
USA,
23–28 May

Wil...
USA,
12 Sep–8 Oct

Drought
USA,
Jan–Oct

Winter storm
USA, Canada,
16–25 Feb

Winter Storm Niklas
Europe,
30 Mar–1 Apr

Earthquake
Pakistan, Afghanistan,
26 Oct

Tornado
China,
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China, Taiwan,
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India, Pakistan
May–Jun

Landslide
Guatemala,
1 Oct

Flash floods

Flash floods
Chile,
23–26 Mar

Floods
Malawi, Mc...
Jan–Mar

Source: Munich Re, NatCatSERVICE, 2016

ISI-MIP

P I K

Estimating economic losses

- **short-term impacts**
  - **Direct $ losses, fatalities**
  - **Damage functions**
  - **Disaster- & region-specific**

- **long-term impacts**
  - **indirect $ losses, health, education**
  - **Econometric analysis**
  - **Cross-sectoral impact**

Hurricane Sandy 2012

before   after

Growth impact of TCs

Hsiang et al., 2014
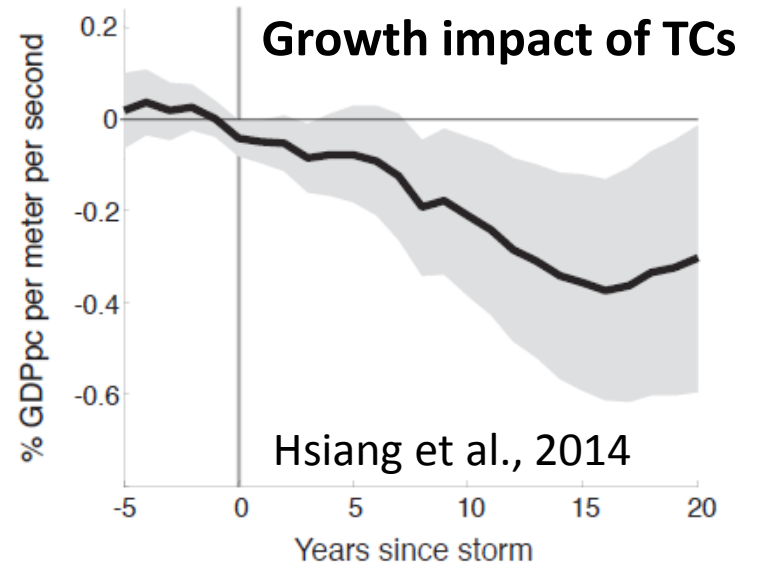
Global river flood impacts

- **Daily Run-off simulation from ISI-MIP**
  - **1970-2012 driven by observed weather**
  - **present-2100 driven by 5 GCMs, all RCPs**

- **Floodplain flow scheme -> CaMaFlood [1]**
  - **Daily river discharge (0.25°)**
  - **Return period via annual max**
  - **choose flood protection -> FLOPROS [2]**
  - **flooded areas & depth from DEM (0.01°)**
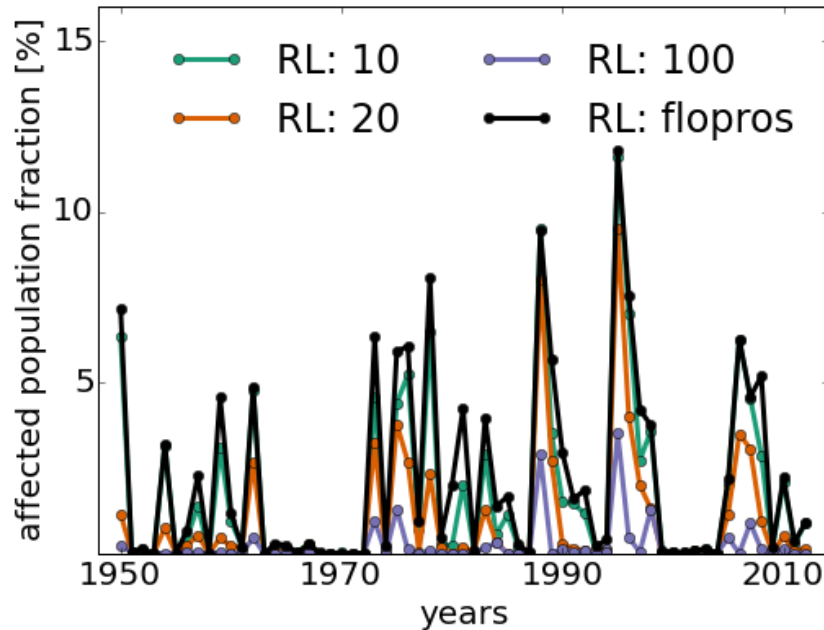
- **Validation in progress -> Fang's presentation**

Model: LPJml
Input: Princeton

Flooded fraction

Indus 2007
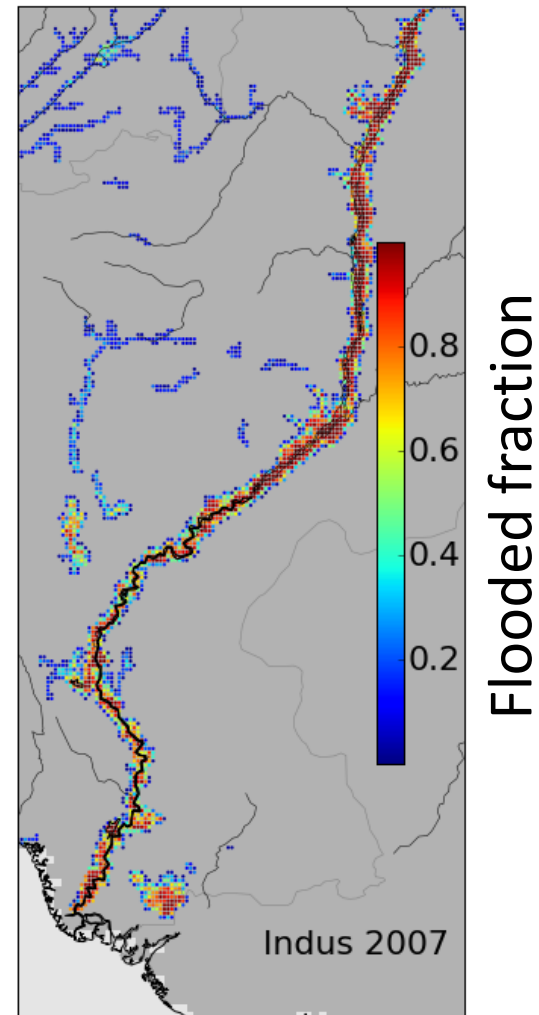
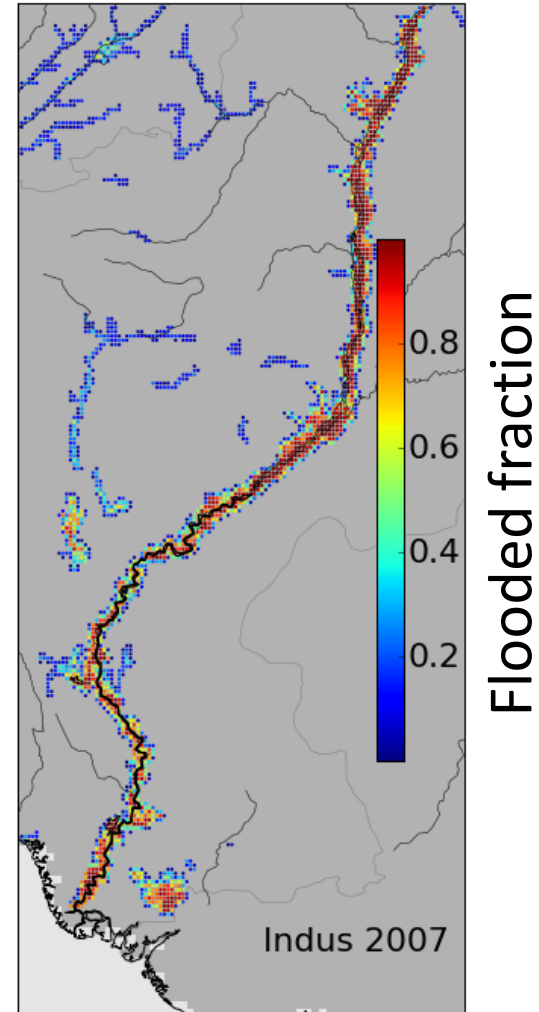[1] D. Yamazaki et al. (2011), [2] P. Scussolini et al.,(2016)

Global river flood impacts

- **Match with socio-economic grids**

  - **Exposed people (e.g. Pakistan)**

  - **Stock losses**

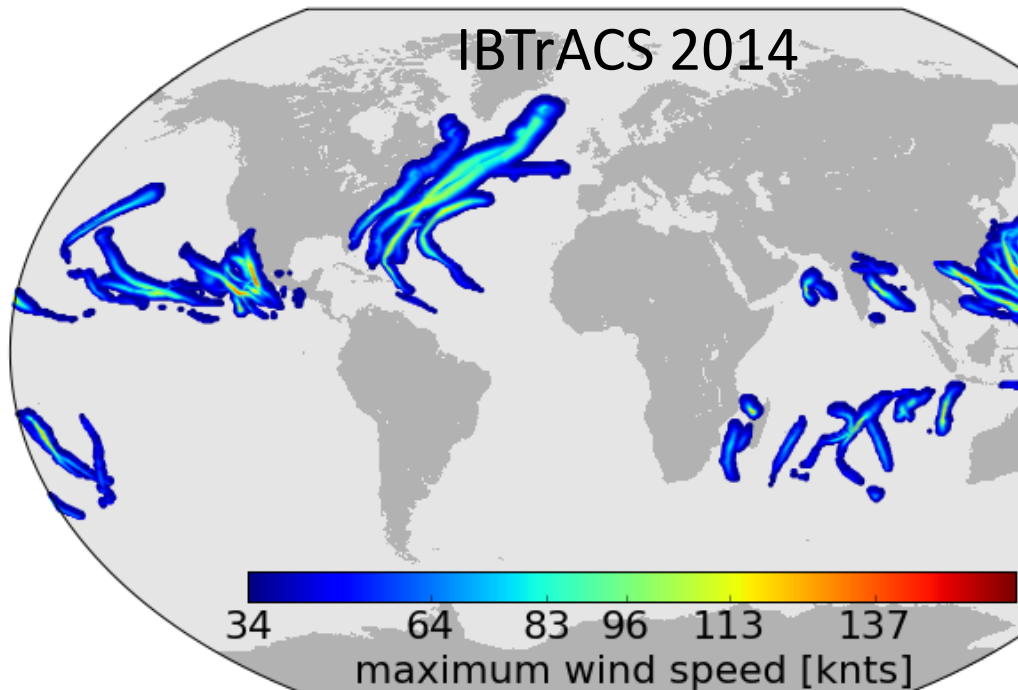   - **New global damage functions set [1]**
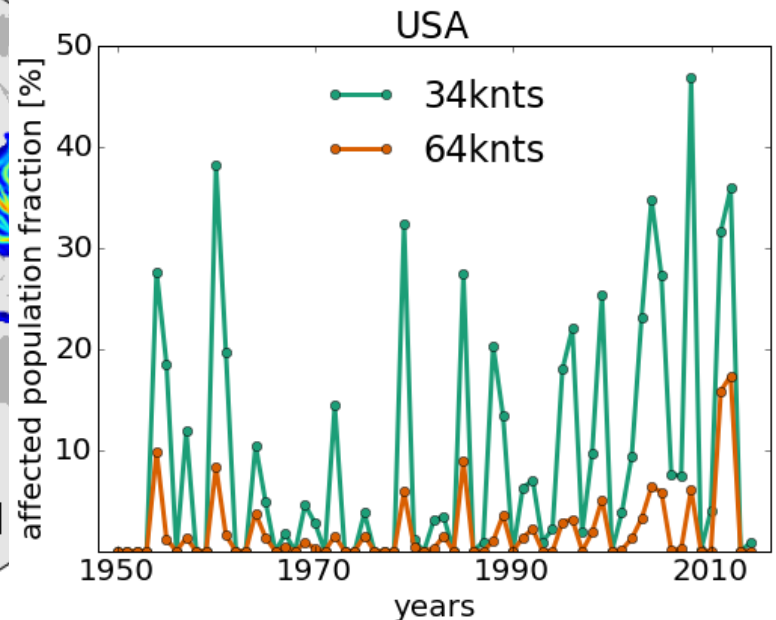
Model: LPJml
Input: Princeton

[1] J. Carlos et al. (submitted 2016)

Global tropical cyclone impacts

- **Global best track archive IBTrACS**
- **540k cyclone tracks from dynamical downscaling [1]**
  - **6 GCMs: 1950-2005 & 2006-2100 (RCP 8.5)**
- **TC extension via wind field model [2]**

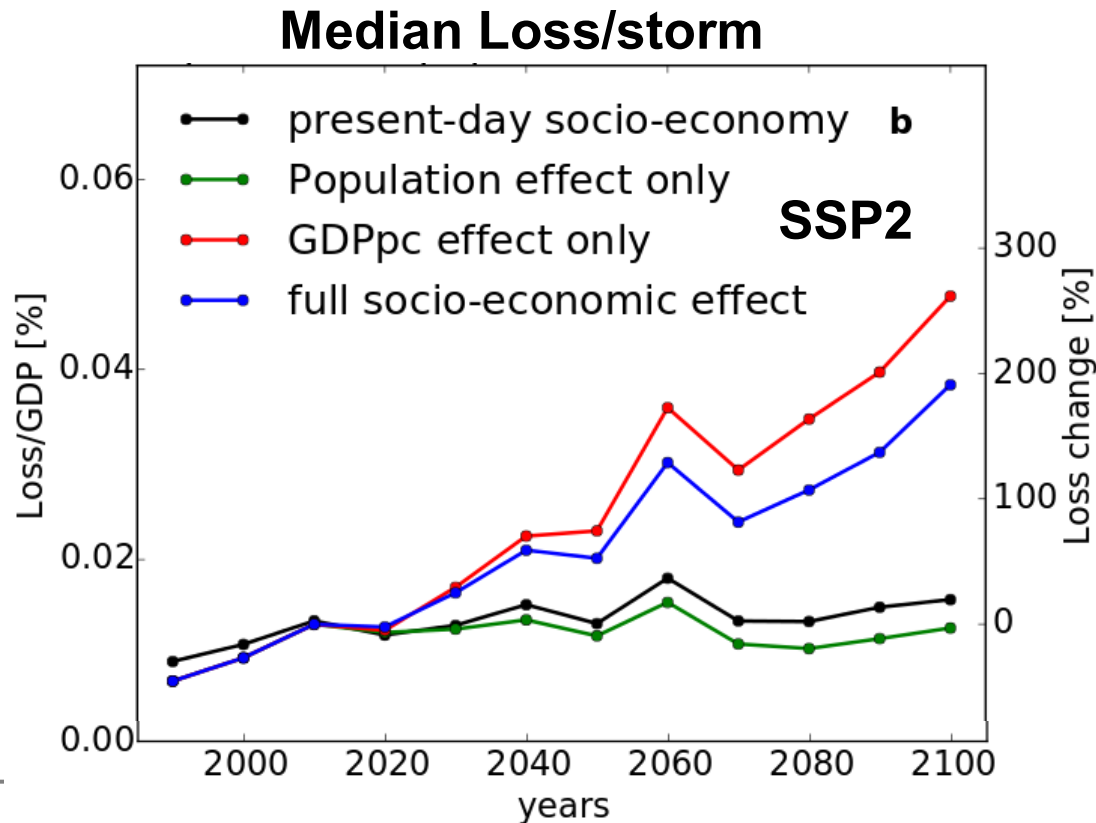IBTrACS 2014

Exposed people: USA

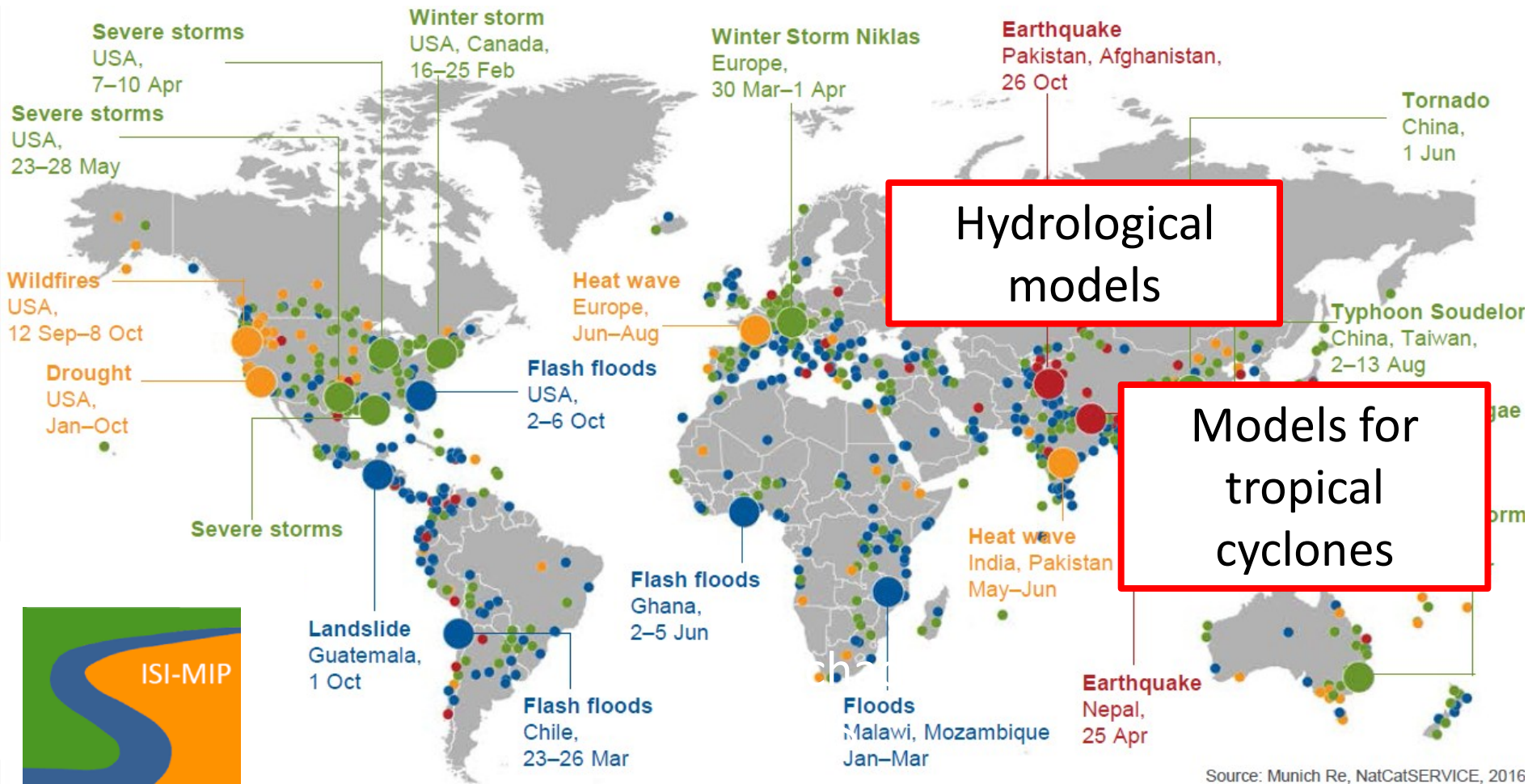[1] K. Emanuel (2013), [2] G. Holland (2008)

Projecting future losses for USA

- **Simulated TC tracks (Emanuel, 2013)**
- **Sensitivity analysis across 8 damage functions & 6 GCMs**
- **Non-linear response of losses to socio-economic change**

Median Loss/storm

T. Geiger et al. (in review, 2016)

8

Natural disasters in a 2°C-world !

Severe storms
USA,
7–10 Apr

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USA,
23–28 May

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USA, Canada,
16–25 Feb

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Earthquake
Pakistan, Afghanistan,
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USA,
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Europe,
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models

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USA,
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Models for
tropical
cyclones

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Landslide
Guatemala,
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Chile,
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Malawi, Mozambique
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Earthquake
Nepal,
25 Apr

ISI-MIP

Source: Munich Re, NatCatSERVICE, 2016

Extreme impacts have long-term effects

- **Cross-sectoral impact data to quantify growth effect**

- **Identify channels of growth impact**
  - **Capital stock destruction?**
  - **Labor stock effects?**

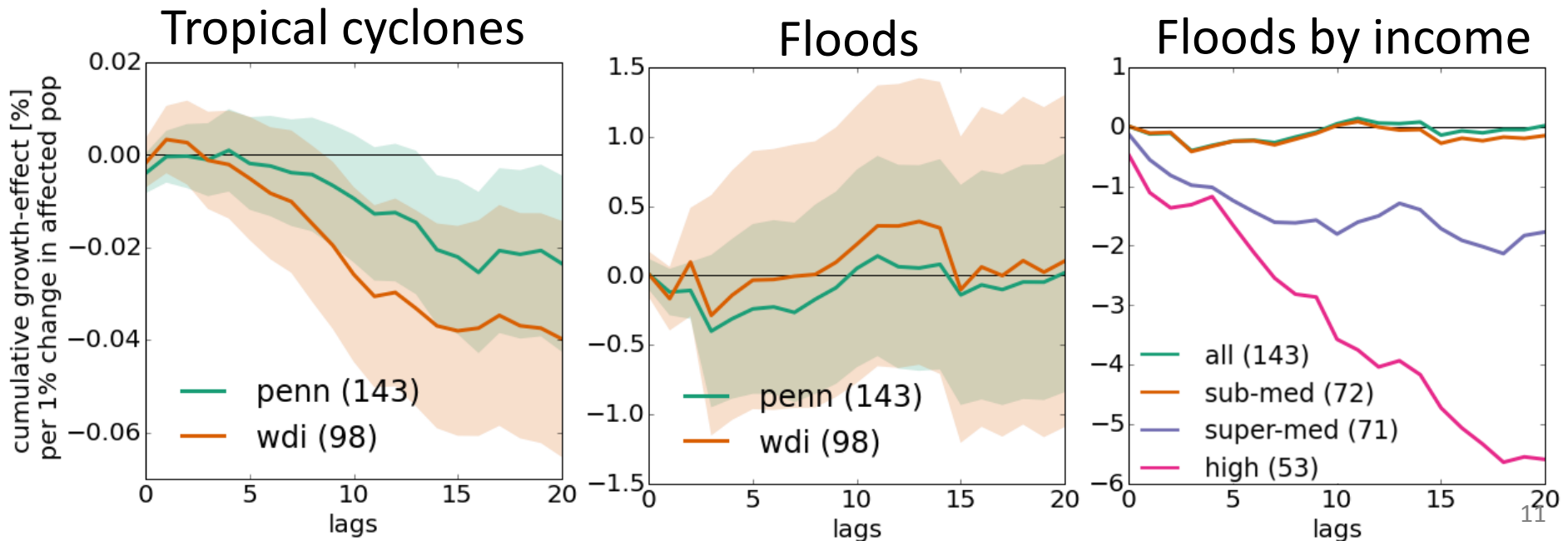- **Future projections of growth effect using impact projections**

Growth impact of TCs

Hsiang et al., 2014

Growth impact of all Munich Re disasters

Von Peter et al., 2012
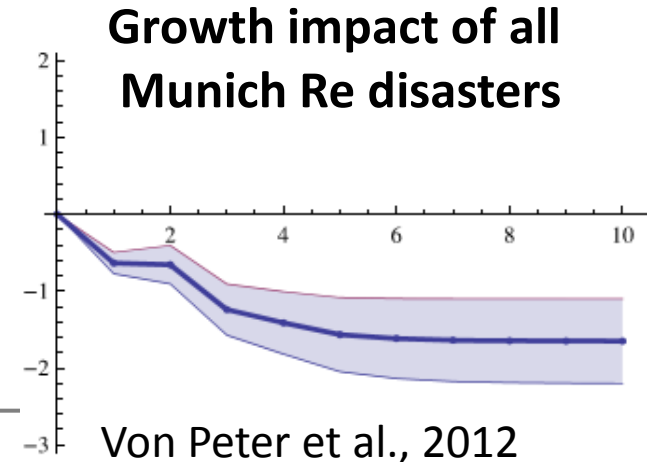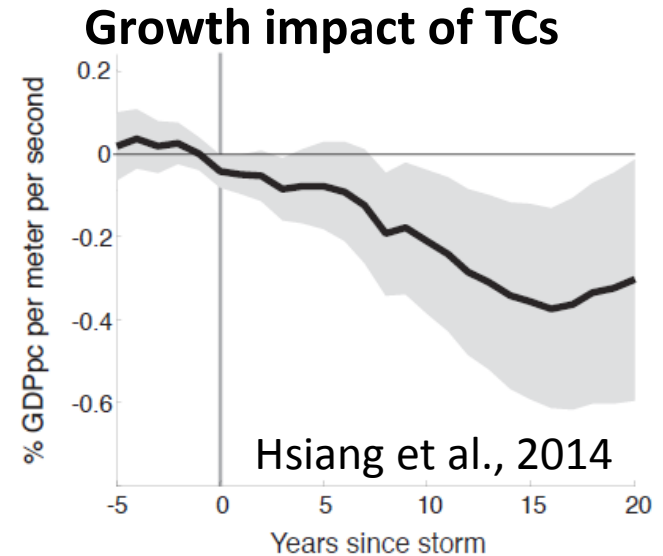
Long term growth effects across impacts

- **Unified predictor across impacts: Exposed population**

lags

various controls

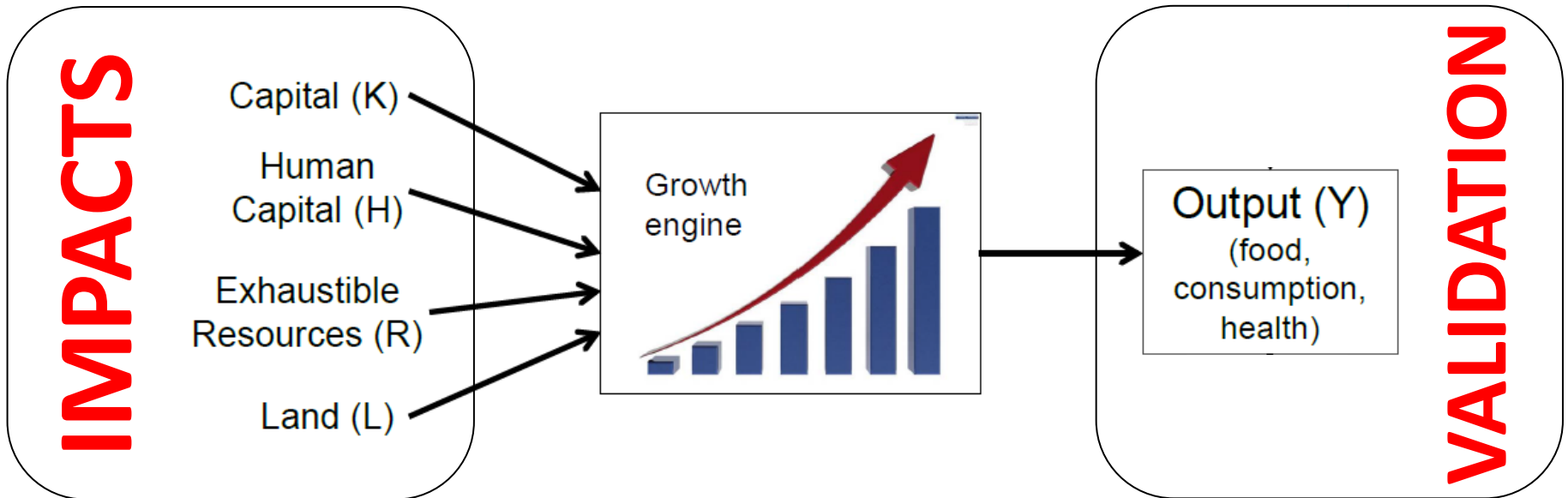$$\Delta GDP_{i,t} = \sum_{L=0}^{k} \left[\beta_L \times D_{i,t-L} \right] + C_{i,t} + \varepsilon_{i,t}$$

exposed population

Response of economic models to high-quality impact data

Thank you!