GLOFRIM

Coupling of hydrologic and hydrodynamic models across scales for improved flood simulations

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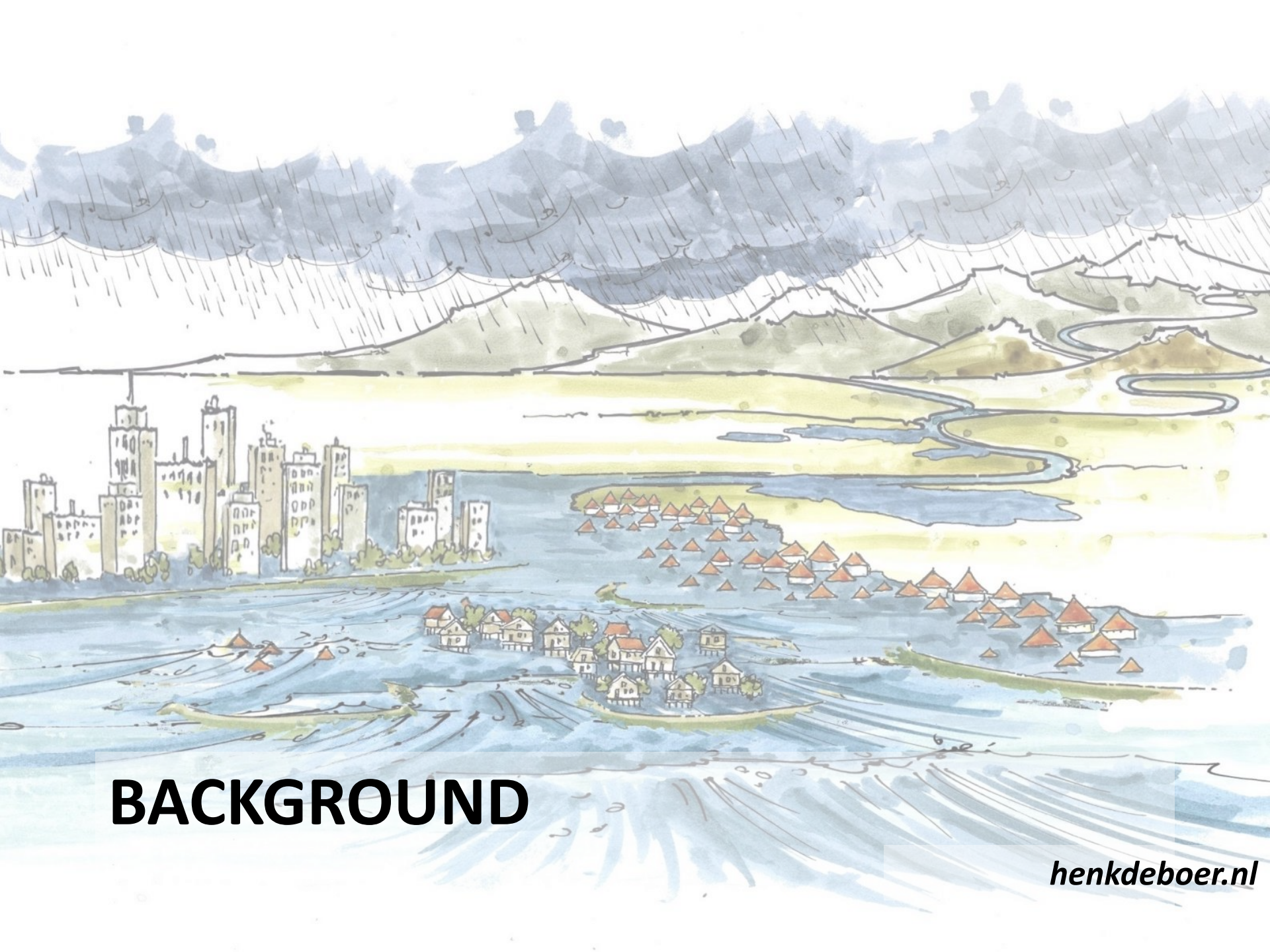T: @DirkEilander

W: www.compoundevents.org

BACKGROUND

henkdeboer.nl

Compound Flooding

Thailand floods: Bangkok 'impossible to protect'

20 October 2011 | Asia-Pacific

Aerial footage shows flooding in some Bangkok districts

Bangladesh cyclone kills hundreds

At least 600 people are reported to have died after a powerful cyclone smashed into Bangladesh's coast, levelling villages and uprooting trees.

Hundreds of thousands of people were

When multiple flood drivers combine to affect flood impact

STORYLINE › HURRICANE HARVEY

NEWS
HURRICANE HARVEY
AUG 30 2017, 7:33 PM ET

Hurricane Harvey: How Many Billions of Dollars in Damage Will Historic Storm Cost?

by ELIZABETH CHUCK

The Martinez family evacuates the apartment complex they live in on August 30, 2017 near the Energy Corridor of west Houston, Texas. Erich Schlegel / Getty Images
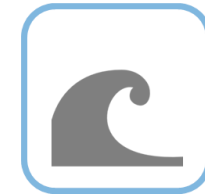
(Global) Flood Modelling Status Quo

Fluvial   **OR**   **Coastal**
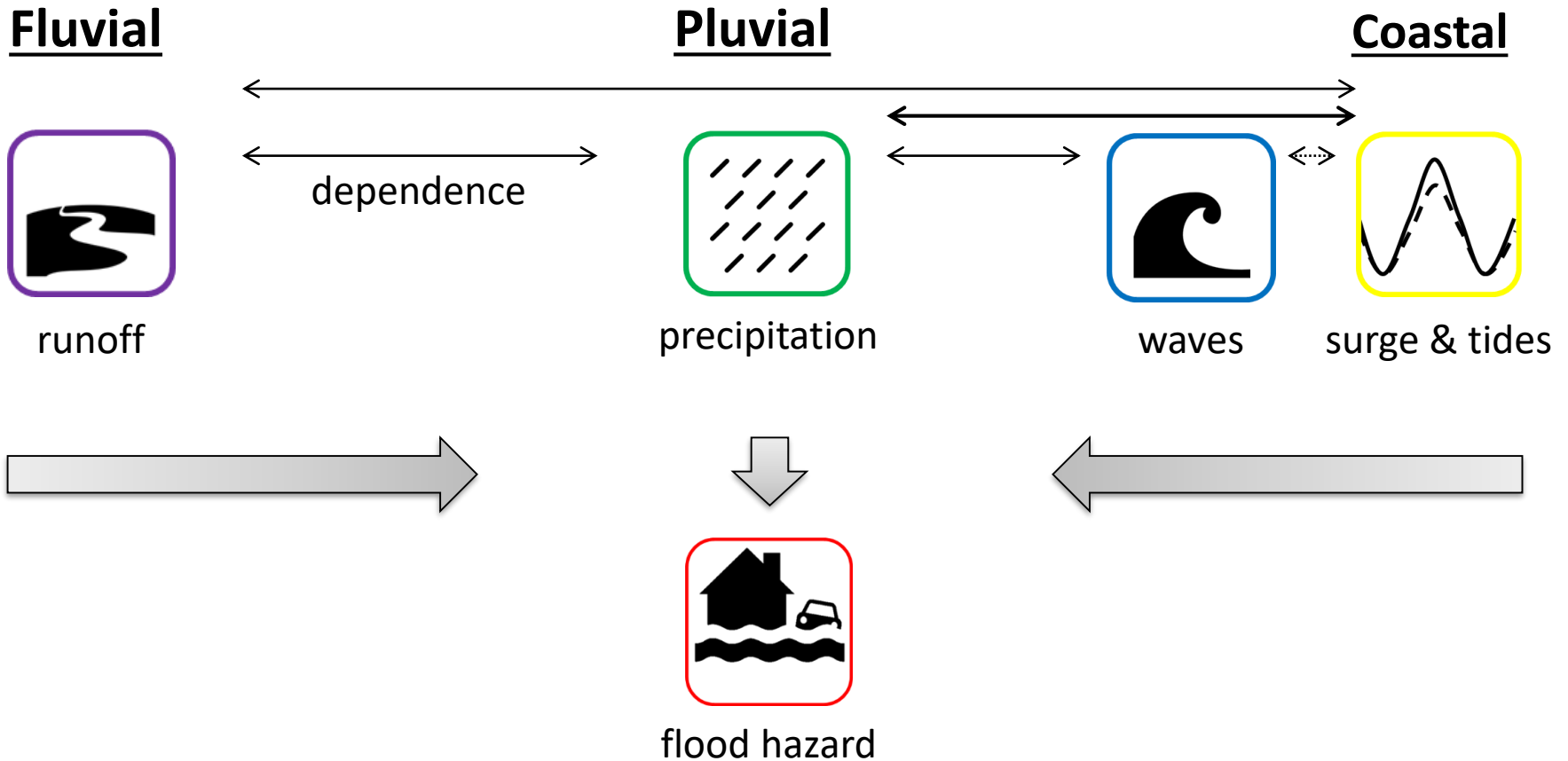
runoff   waves   surge & tides

flood hazard   flood hazard

> Potentially underestimating risk

(Global) Flood Modelling
Compound Flooding

Fluvial   **Pluvial**   **Coastal**

runoff   dependence   precipitation   waves   surge & tides

flood hazard

> Impact of combined flood drivers, taking into account dependence
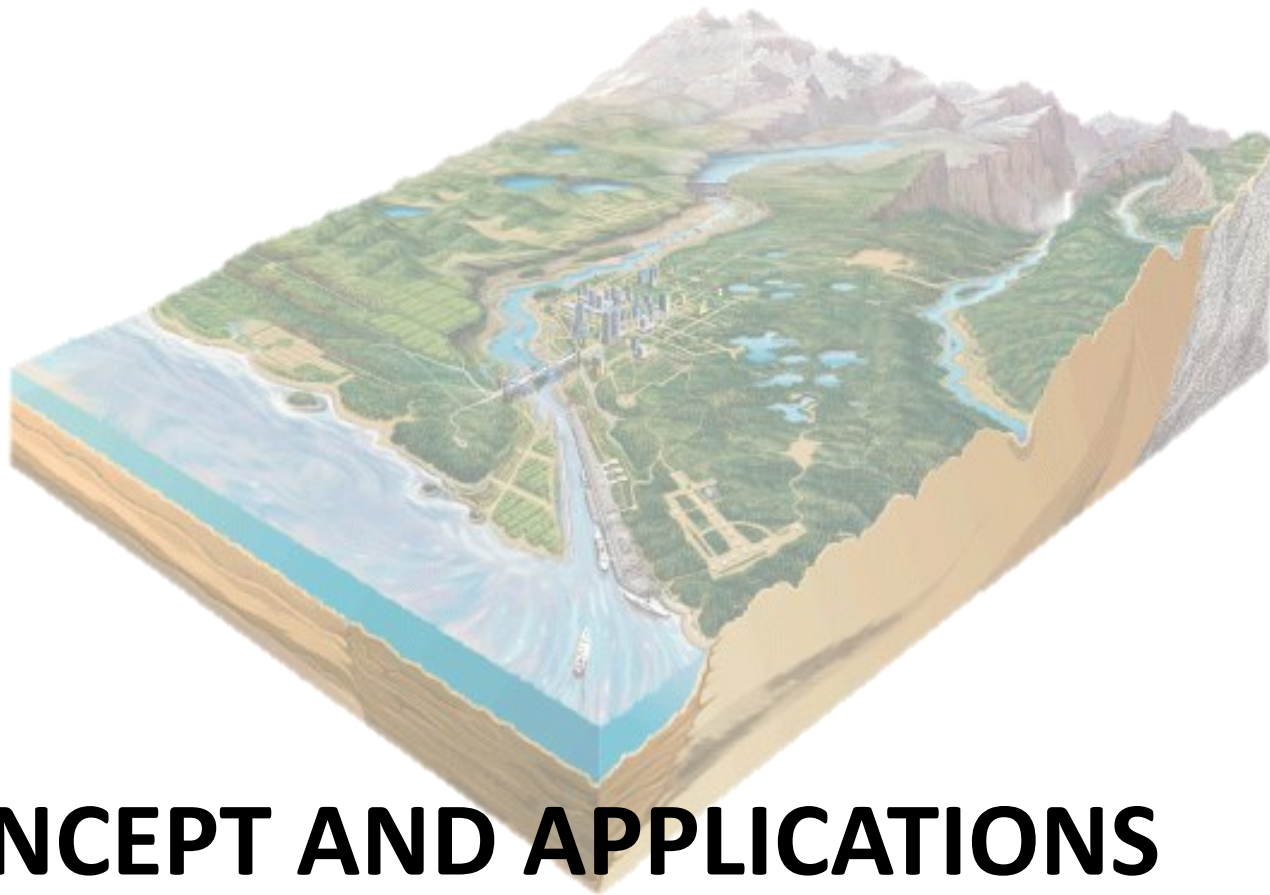
How to address compound floods?

Integration!

> communities

www.compoundevent.org
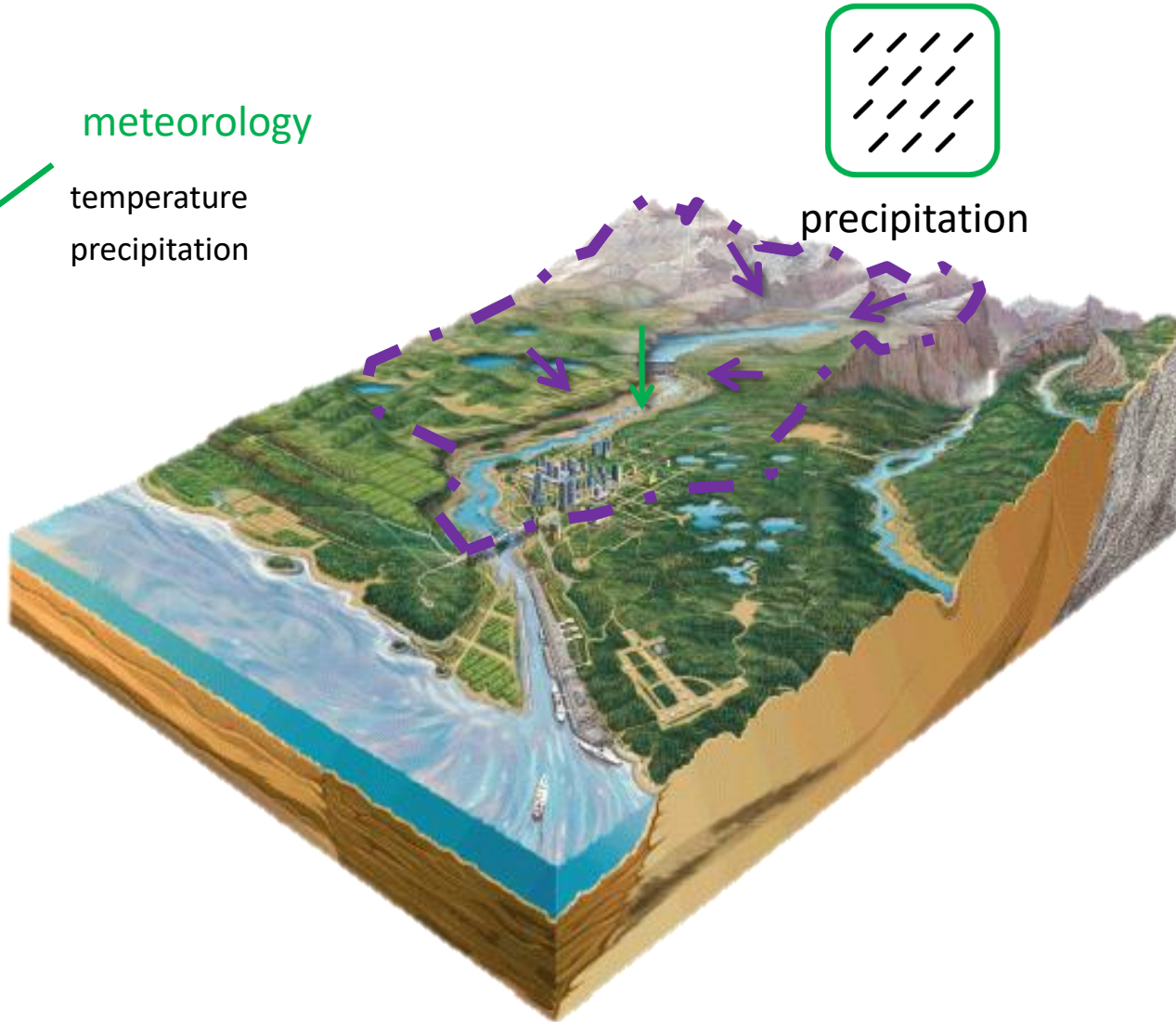
> models

Facilitating seamless coupling

CONCEPT AND APPLICATIONS

Integrated Modelling Framework
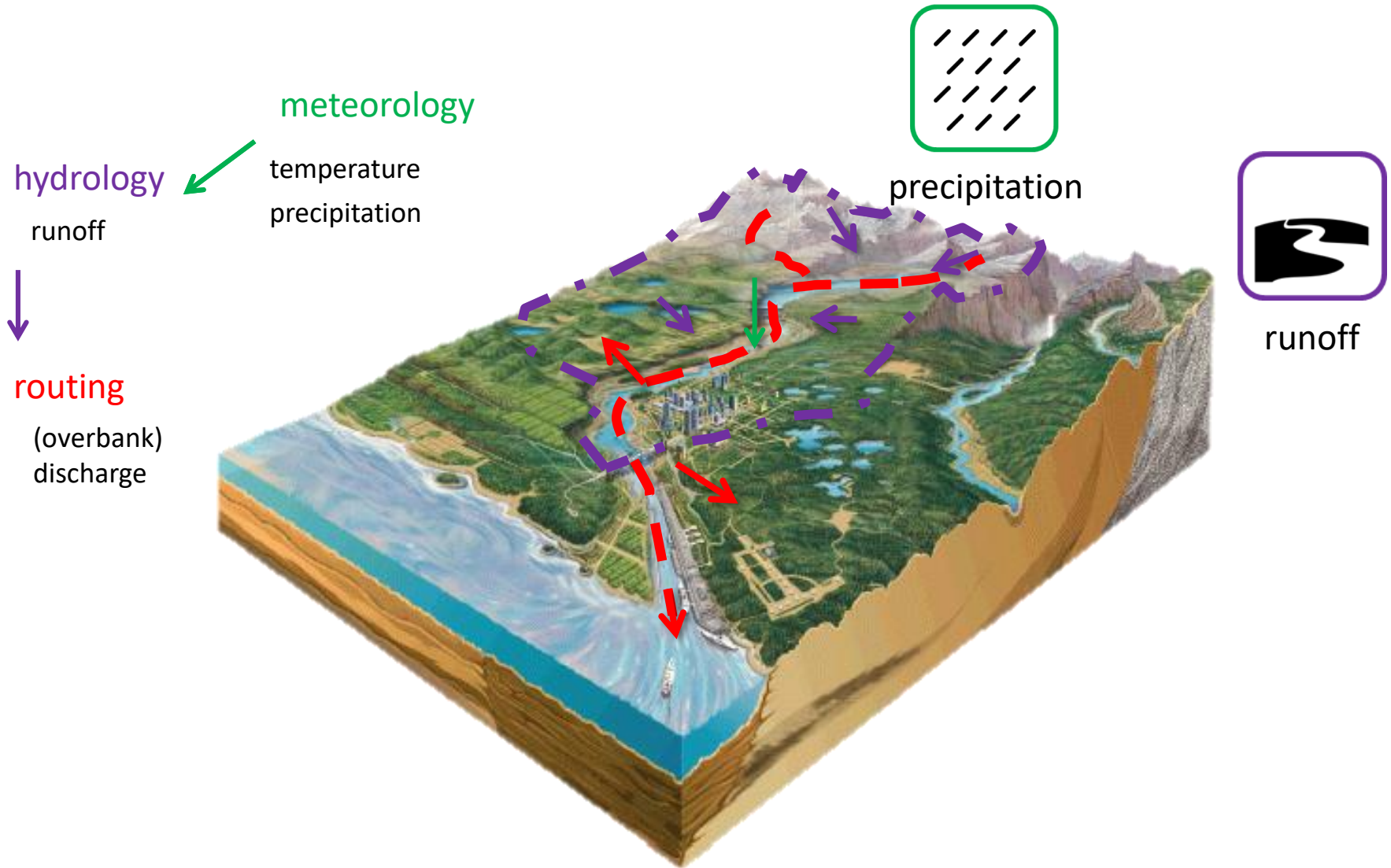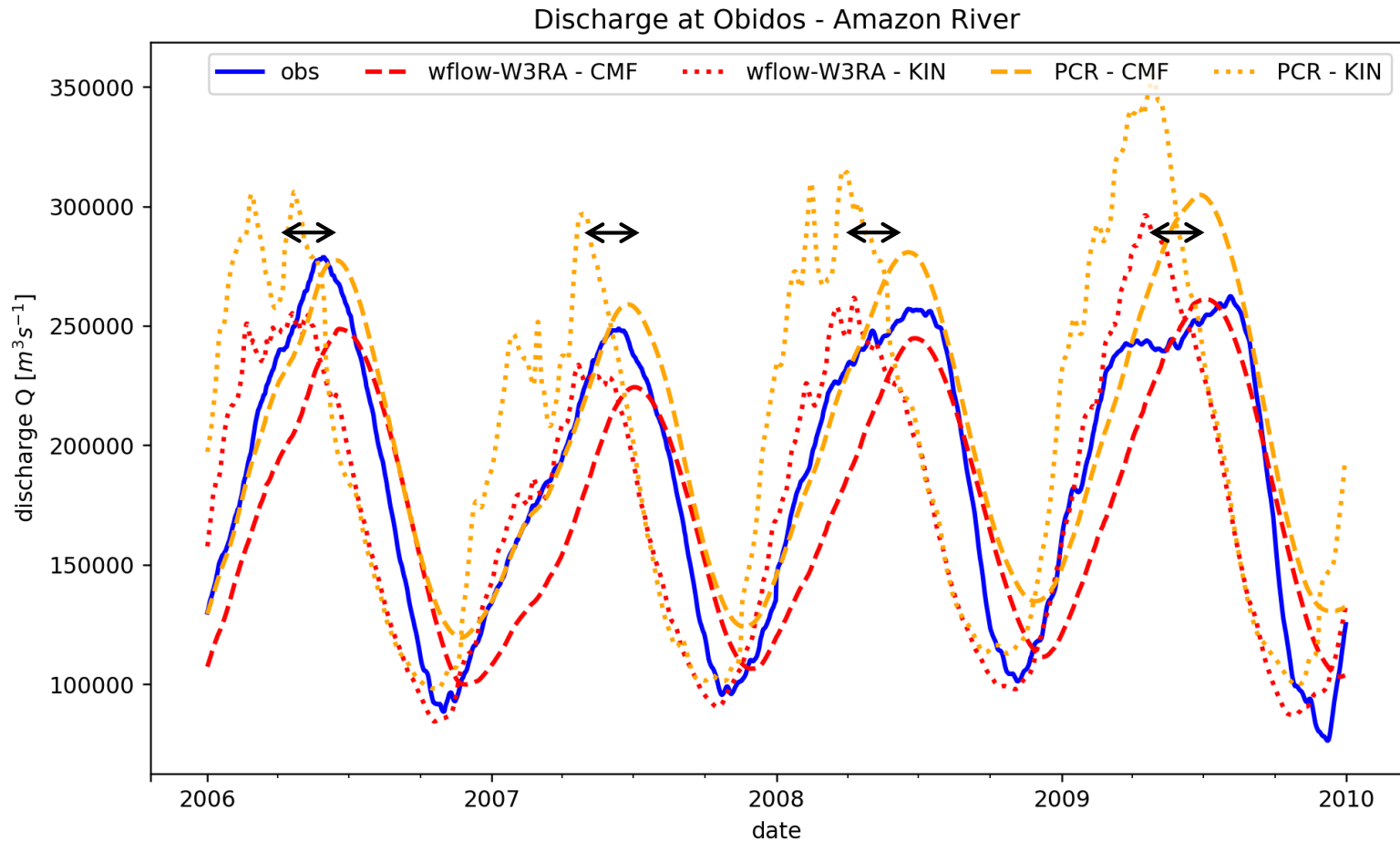
meteorology

hydrology

temperature
precipitation

runoff

precipitation

runoff

Integrated Modelling Framework

Benchmark Routing – Amazon

Discharge at Obidos - Amazon River

Hoch, Eilander & Ikeuchi, in preparation
AGU poster

Integrated Modelling Framework

meteorology

hydrology

routing

offshore + nearshore
hydrodynamics

temperature
precipitation

runoff

(overbank)
discharge

nearshore
water levels

precipitation

runoff

waves

surge & tides
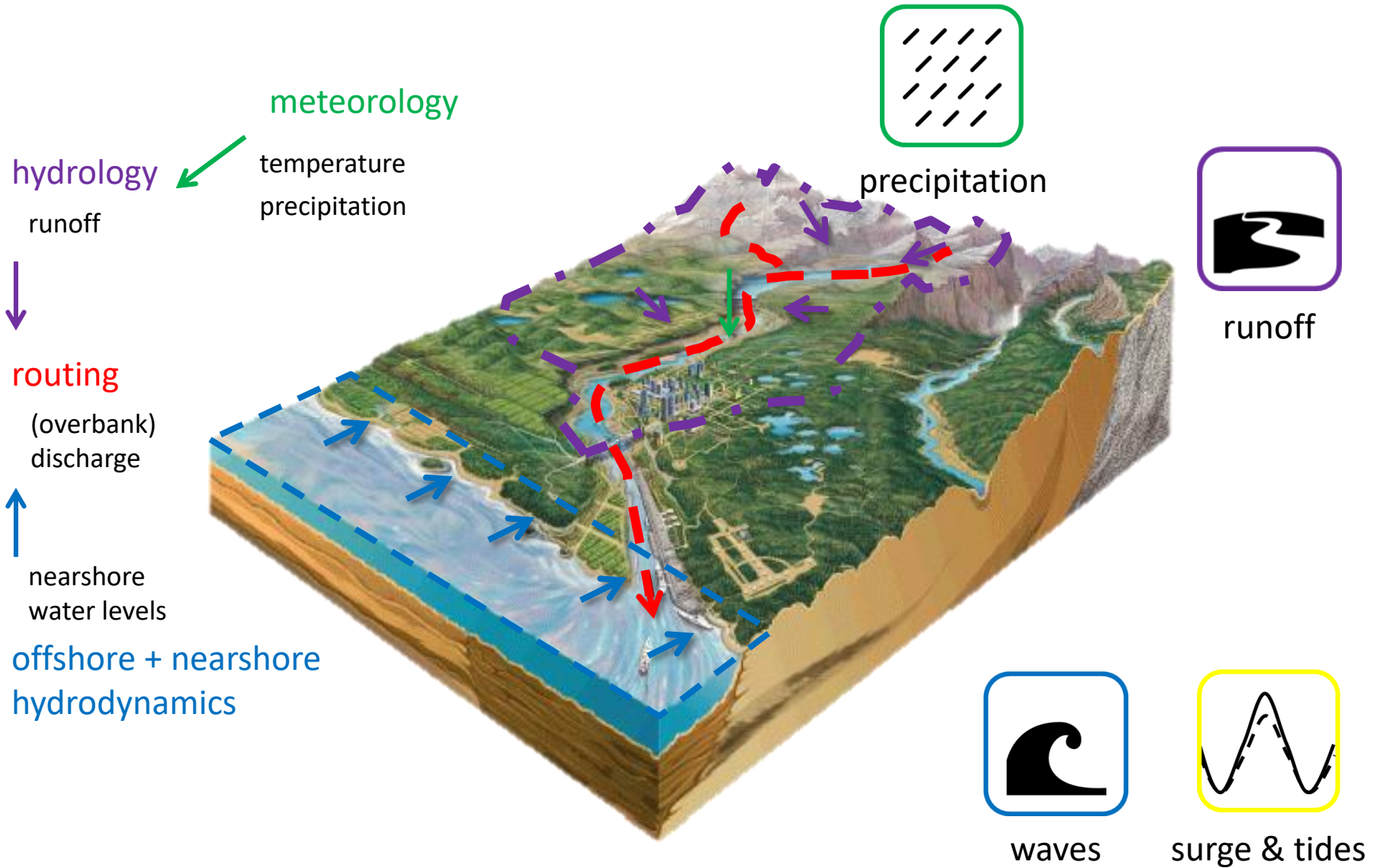
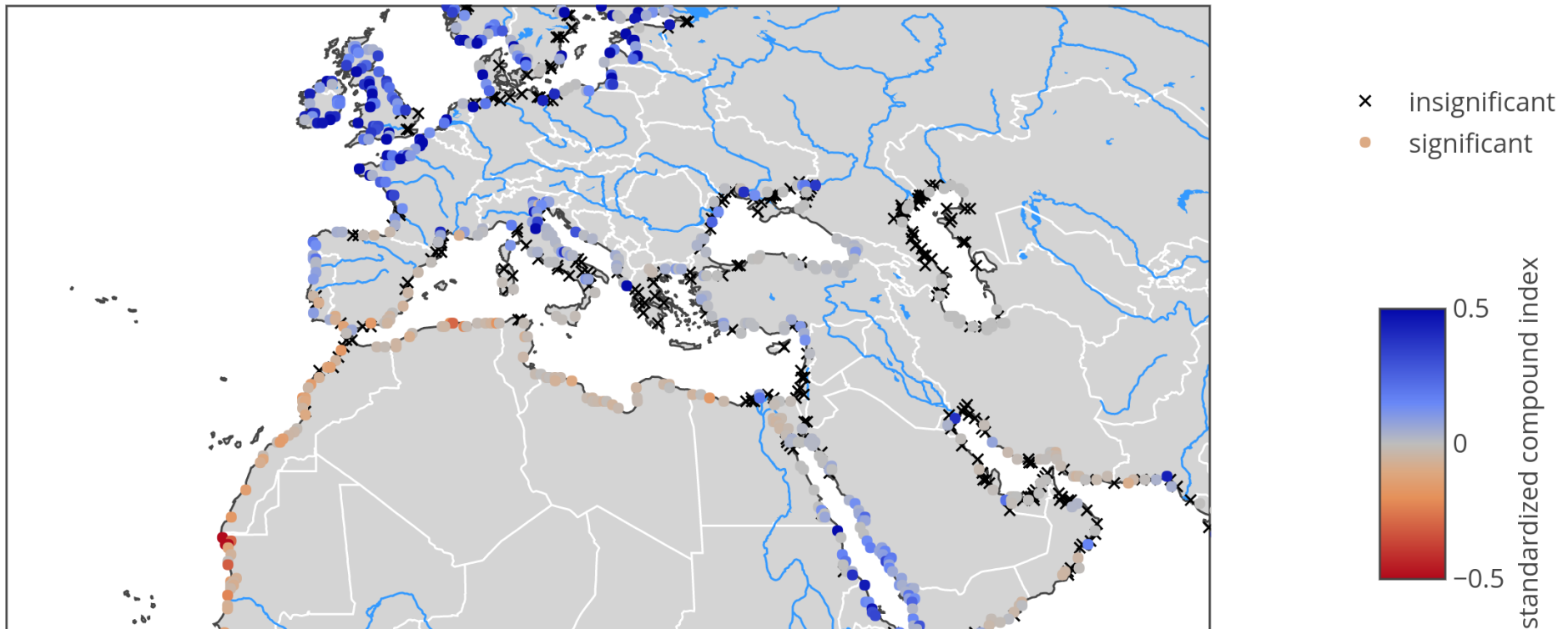# Global CaMa-Flood – GTSM Coupling

Eilander, in preparation
AGU presentation

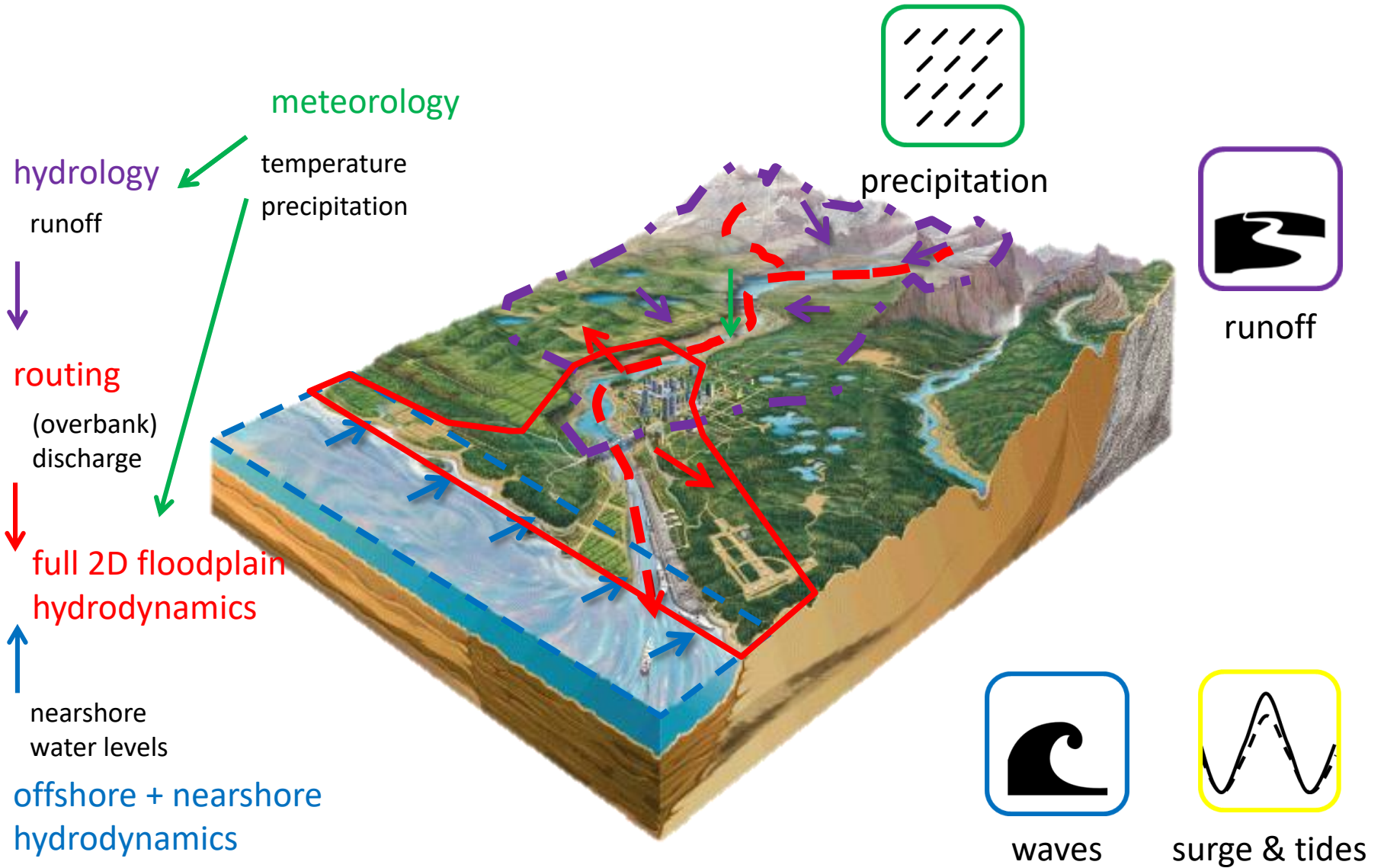# Global CaMa-Flood – GTSM Coupling
preliminary results

River mouth water level peaks

Eilander, in preparation
AGU presentation

Integrated Modelling Framework

meteorology

temperature
precipitation

hydrology

runoff

routing

(overbank)
discharge

full 2D floodplain
hydrodynamics

nearshore
water levels

offshore + nearshore
hydrodynamics

precipitation

runoff

waves

surge & tides

Integrated Modelling Framework

evaporation   meteorology

hydrology   temperature
             precipitation
runoff

         floodplain
         volume

routing

(overbank)
discharge

nearshore
water levels

offshore + nearshore
hydrodynamics

precipitation

runoff

waves   surge & tides

GLOFRIM

Basic Model Interface (BMI)

API for component based integration of models

```python
1    # initialize model
2    bmi.initialize_model()
3
4    # get variable (numpy array)
5    bmi.get_value('variable_name')
6
7    # set variables
8    bmi.set_value('variable_name', variable)
9    bmi.set_value_at_indices('variable_name', [1, 2, 23], variable)
10
11   # run models for one time step
12   bmi.update()
13
14   # finalize model
15   bmi.finalize()
16
```
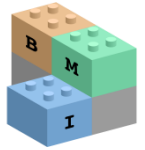
A component-based approach to integrated modeling in the geosciences: The design of CSDMS

Scott D. Peckham [a], Eric W.H. Hutton [a,*], Boyana Norris [b]

https://github.com/csdms/bmi

GLOFRIM v1.0

> Python scripts based on BMI

>> for specific hydrological and hydrodynamic models

>> Spatially explicit

>> Online coupling

GLOFRIM v1.0 – A globally applicable computational framework for integrated hydrological-hydrodynamic modelling

Jannis M. Hoch[1,2], Jeffrey C. Neal[3], Fedor Baart[2], Rens van Beek[1], Hessel C. Winsemius[2,4], Paul D. Bates[3], Marc F.P. Bierkens[1,2]

GLOFRIM v2.0

> Generic framework

> Based on BMI + thin python layer for homogeneity

> 2-step initialization

> Support for several grid types

> New models easily added (if BMI API), now supporting

>> PCRGLOB-WB, wflow (hydrological)

>> CaMa-Flood, Lisflood-FP, Delft3D-FM (hydrodynamic)

GLOFRIM v2.0

GLOFRIM configuration file example


```
[models]
# reference to model config files
PCR=path/to/prcglobwb.ini
CMF=path/to/camaflood.nam

[coupling]
# time step for exchanges [sec]
dt=86400

[exchanges]
# PCR runoff [m] to CMF runoff [m]
PCR.runoff=CMF.roffin
```

GLOFRIM runner script

python glofrim_runner.py run /path/to/glofrim.ini

GLOFRIM v2.0

```python
1    from glofrim import Glofrim
2    from datetime import datetime
3
4    # initialize combined bmi
5    cbmi = Glofrim()
6
7    # initialize configuration
8    cbmi.initialize_config(config_fn='path/to/config.ini')
9
10   # possible to edit configuration. e.g. set start times accross models
11   cbmi.set_start_time(datetime(2000,1,1))
12
13   # initialize models
14   cbmi.initialize_model()
15
16   # interact with individual models
17   cbmi.bmimodels['PCR'].get_value('variable_name')
18
19   # run combined models & exchange data at each timestep
20   cbmi.update_until(cbmi.get_end_time())
21
```

Next steps

> Release v2.0 with accompanying paper late-2018/ early 2019

> v2.x

>> Xarray based NetCDF adaptor. For 1 way coupling

& to tap into online data!

>> Test two-way coupling schemes

>> Add regridding options (xesmf ?)

Questions ?? / Suggestions !!

https://github.com/openearth/glofrim

https://glofrim.readthedocs.io/en/latest/

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