Task 3.8 – GIA (correction) for hydrology
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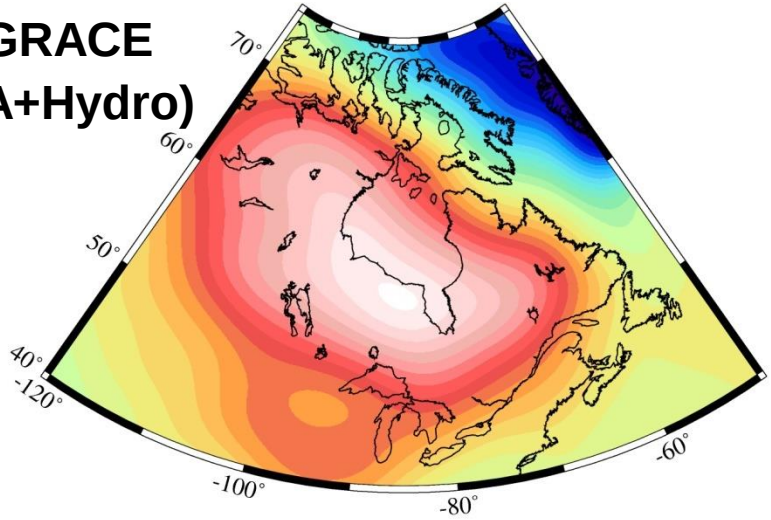
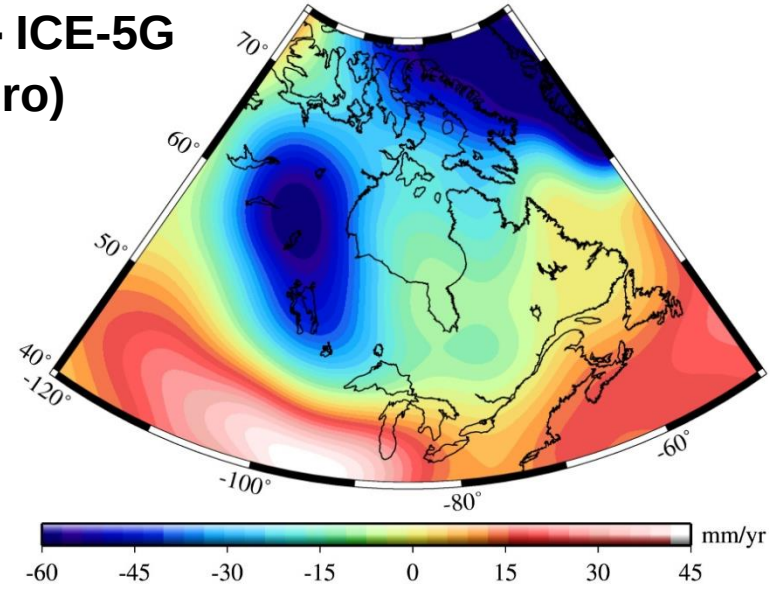
Background: water storage from GRACE

GRACE (GIA+Hydro)

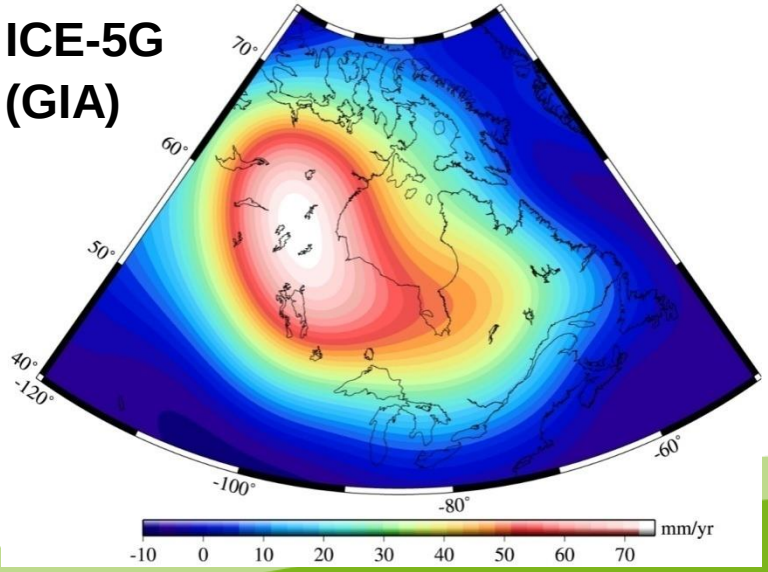


Common GIA correction using ICE-5G

GRACE – ICE-5G (Hydro)



ICE-5G (GIA)



(Wang et al. 2013, Nature Geosci.)

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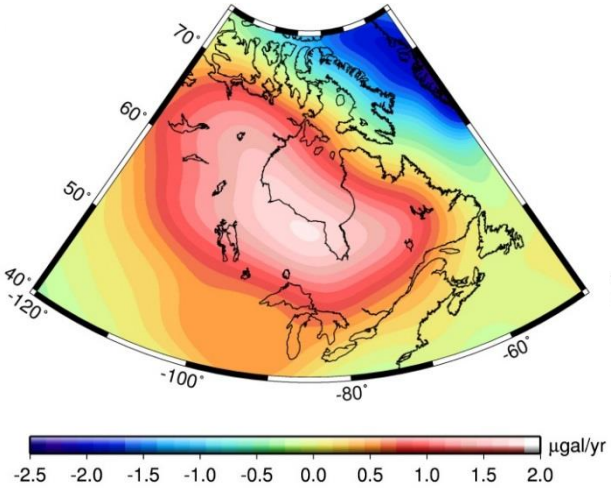
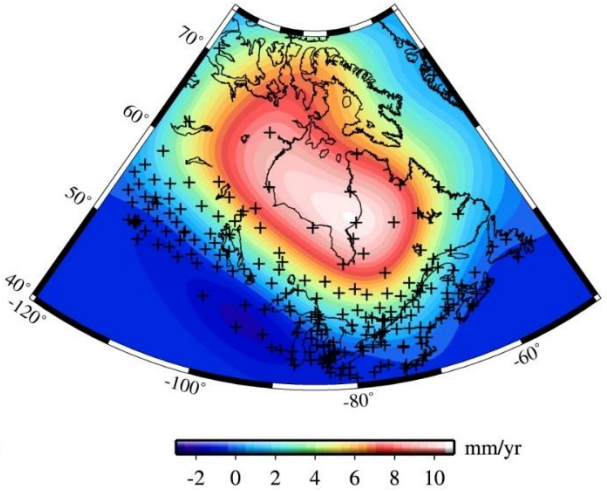
Hydrological trend in North America

GIA correction using GPS-observed GIA

CSR GRACE 2003-2011

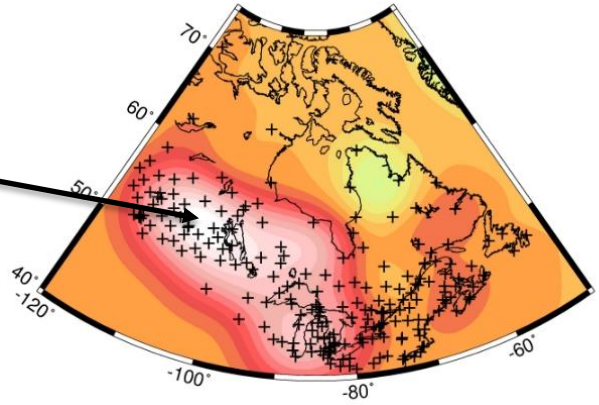


GPS 1993-2006 (Sella et al. 2007)

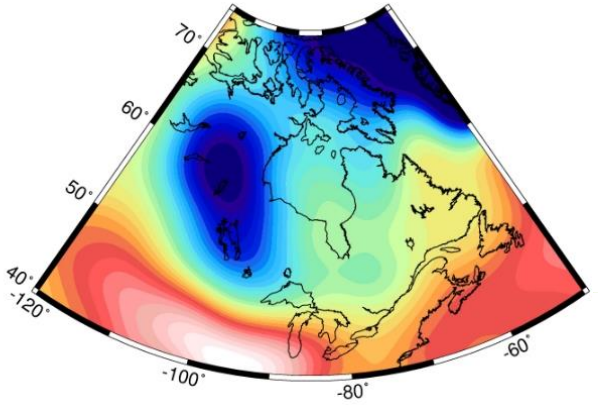


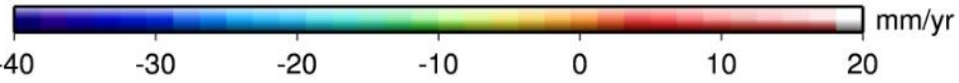
Peak A

GRACE - GPS



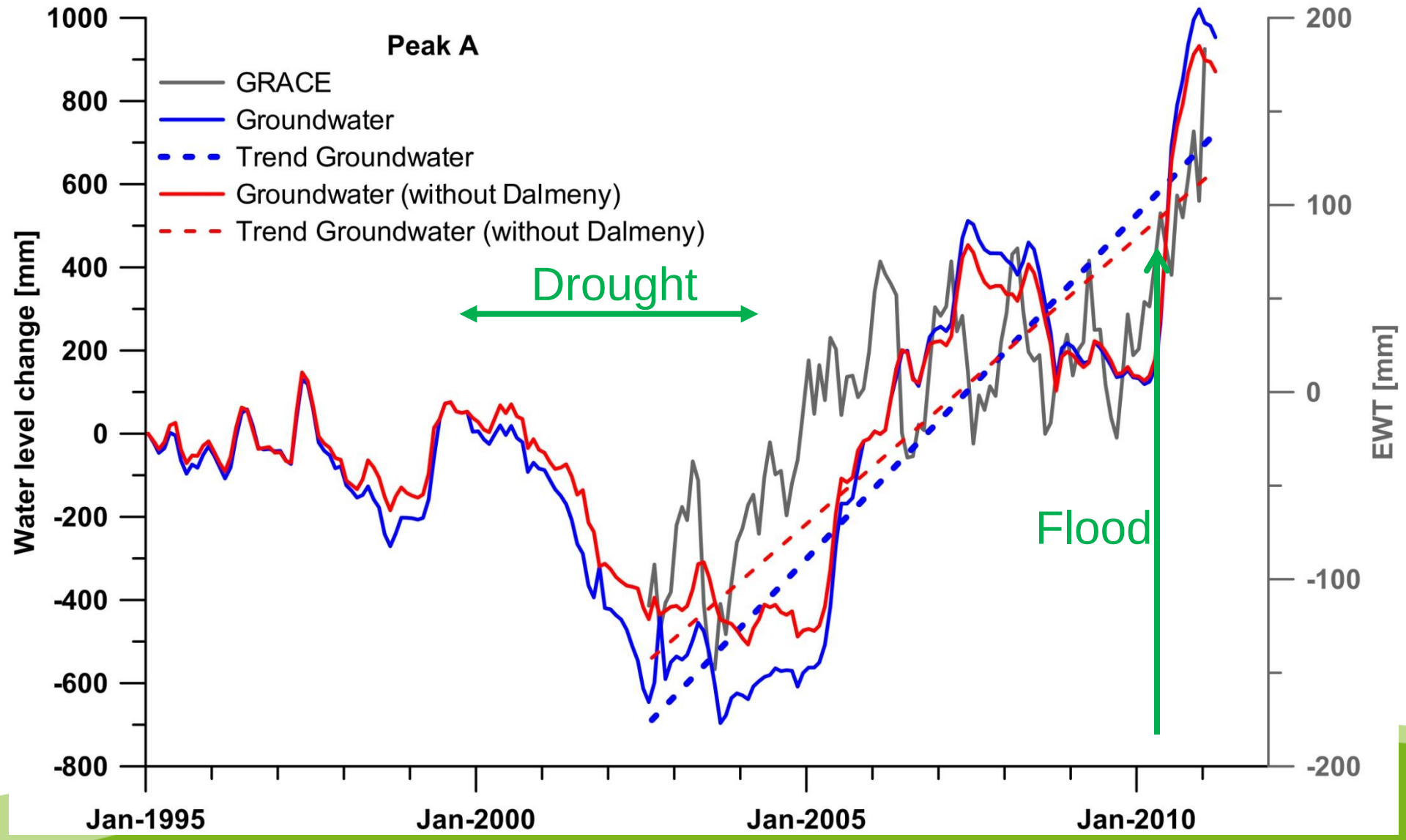
GRACE - ICE-5G





(Wang et al. 2013, Nature Geosci.)

Averaged groundwater vs. GRACE



(Wang et al. 2013, Nature Geosci.)

NKG and land uplift/GIA models for Fennoscandia

- Existing empirical land uplift model NKG2005LU will be substituted with a new one (test model NKG2015LU_test circulated in the Nordic countries)
- NKG (Nordic Geodetic Commission) land uplift workshop in Reykjavik 2013 with a wish to support development of a NKG **GIA model for Fennoscandia**
- Participating modellers of the NKG community : Valentina Barletta (DK, USA), Matt Simpson (N), Maaria Nordman (FIN), Karin Kollo (EST), Per-Anders Olsson & Holger Steffen (S) + help by Glenn Milne (CA)
- Ice model support by Lev Tarasov (CA); GLAC ice model
- **First results** to be presented at **EGU2016**

Suggested model set-up for first EGSIEM GIA correction

From Kick-off meeting 2015

- Ice models:
  - Best GLAC for Fennoscandia/Barents Sea, ICE-6GC, GLAC or Gowan for North America, Updated W12 for Antarctica, Lecavalier et al. (2014) for Greenland, rest from RSES (Kurt Lambeck), but no Tibet
- Earth model:
  - Dedicated earth model for each region, Maxwell rheology, using Wu (2004) 3D spherical FE model approach
  - Other model parameters (ice/water density, Earth radius, moments of inertia, π, etc.) as used in COST benchmark activity (see Spada et al. 2010)
- Observations:
  - New BIFROST 2015/16 release (currently in preparation with 100+ GPS stations)
  - EGSIEM GRACE result
  - Global RSL data (e.g. Barbados etc.) and Fennoscandian RSL data

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Ice models

A series of regional ice models was kindly provided by colleagues for this purpose:

- Greenland: HUY3 (Lecavalier et al. 2014)
- Fennoscandia and Barents Sea: GLAC (Hughes et al. 2015, Nordman et al. 2015, Root et al. 2015; updated chronologies from Lev Tarasov)
- North America: GLAC (Tarasov et al. 2012) and NAIce (Gowan, pers. comm./submitted)
- Antarctica (including Antarctic Peninsula): W12 (Whitehouse et al. 2012), IJ05_R2 (Ivins et al. 2013), GLAC (Briggs et al. 2014)
- High Mountain Areas & Patagonia: ANU-ICE (Lambeck et al. 2014)

Under consideration:

- Antarctic Peninsula: new model from Erik Ivins
- Patagonia: new model from Erik Ivins

Each model will be implemented in the GIA model with its corresponding earth model → lateral variation in lithospheric thickness and mantle viscosity!

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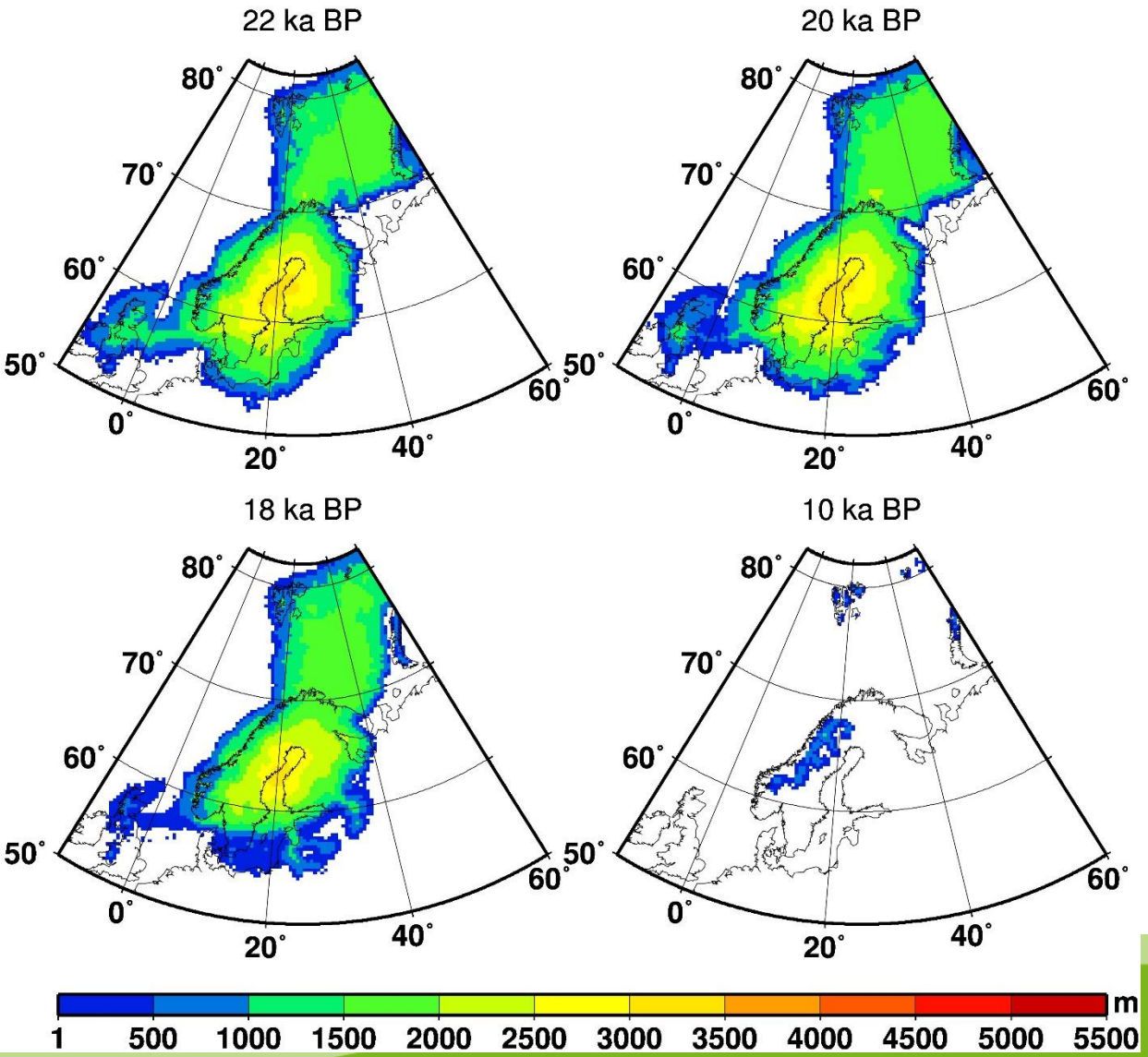
First step: define best GLAC for northern Europe



- Shown here: preliminary best-fitting ice history thickness [m] for four times applying VM2-like earth rheology
- 0.5x0.25 degree grid
- 120 ka – today
- Test with proglacial lake load in future

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Ice model combination is not easy

Ice models:

- Different grids (e.g. 0.5x0.25 vs. 0.7x0.7)
- Different start times and time intervals
- **The global combination will most likely not fit the expected sea-level equivalent of at least 120 m at LGM (missing ice problem)**

Corresponding earth models:

- Different lithospheric thicknesses
- Different mantle viscosities, different layers (number and/or depth interval)

- Which thicknesses and viscosities for the rest of the world?
- Shall we treat oceanic lithosphere separately?
- Inclusion of plate boundaries?
- Shall we use Maxwell rheology only?

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  - Other model parameters (ice/water density, Earth radius, moments of inertia, π, etc.) as used in COST benchmark activity (see Spada et al. 2010) Finite element software ABAQUS purchased by LM and tested
- Observations:
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- Earth model:
  - Dedicated earth model for each region, Maxwell rheology, using Wu (2004) 3D spherical FE model approach
  - Other model parameters (ice/water density, Earth radius, moments of inertia, π, etc.) as used in COST benchmark activity (see Spada et al. 2010)
- Observations:
  - New BIFROST 2015/16 release (currently in preparation with 100+ GPS stations) Results ready (~200 stations), paper to be submitted soon
  - EGSIEM GRACE result Tests with first solution (see Yoomin's talk)
  - Global RSL data (e.g. Barbados etc.) and Fennoscandian RSL data

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Work in progress as planned!

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