Dynamical downscaling of Orographic Precipitation

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GeoExtreme (NFR)

Motivation

Westcoast of Norway, September 2005

Motivation

Brig-Sveits - 1993

Geo-Extremes

- Many types of geo-extremes depend on (orographic) precipitation

Precipitation - types

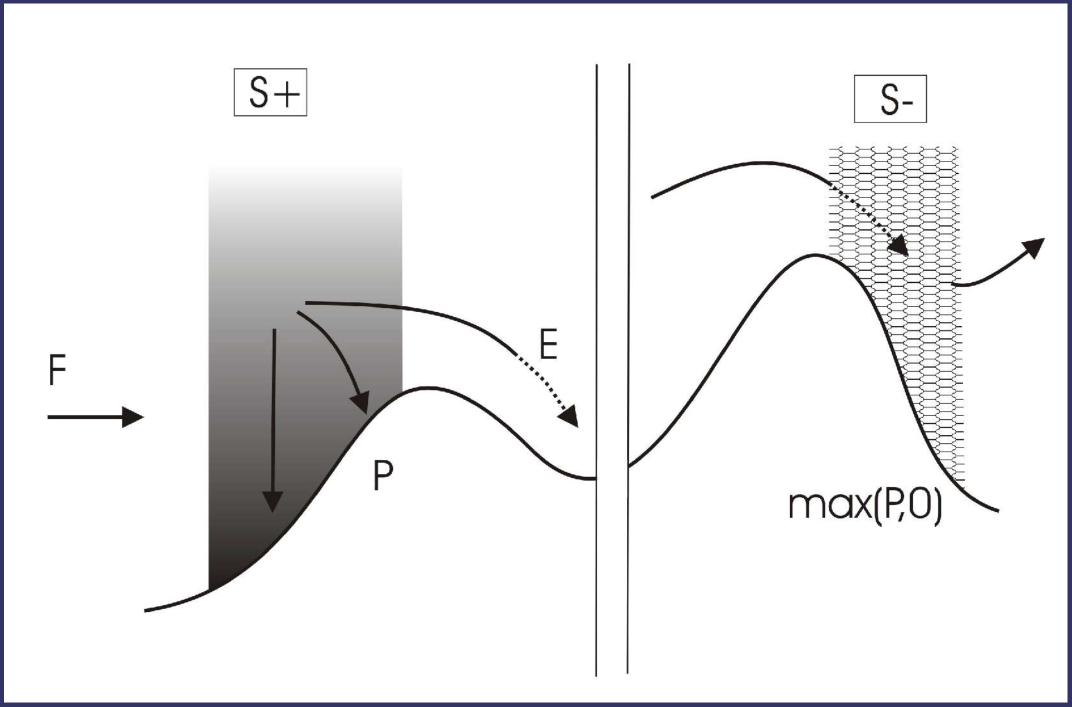
- Precipitation associated with
  - fronts
  - convection
  - orographic forcing

Orographic Precipitation

- Orographic precipitaiton is an order of magnitude bigger than frontal precipitation.
- Due to poor representation of micro-physics, numerical models does not forecast (or downscaled) OP-events well.

Orographic Precipitation

Moist air is forced over mountains

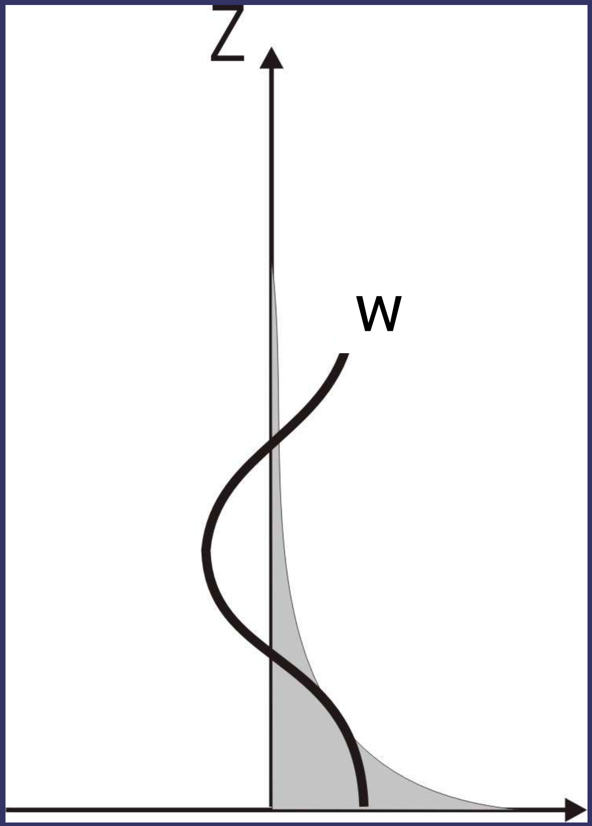


Principle – orographic precipitation

Given the terrein, we are left with two controlling factors:

1) Vertical motion ('Airflow dynamics')

2) Formation hydrometeors ('Micro-physics')



Linear model

(Smith & Barstad, 2004 JAS)

- Linear (airflow dynamics and micro-physics)
- Condensation rate (S) is vertically integrated
- Assumes near saturation
- Constant U (wind speed) and τ (cloud time delay)

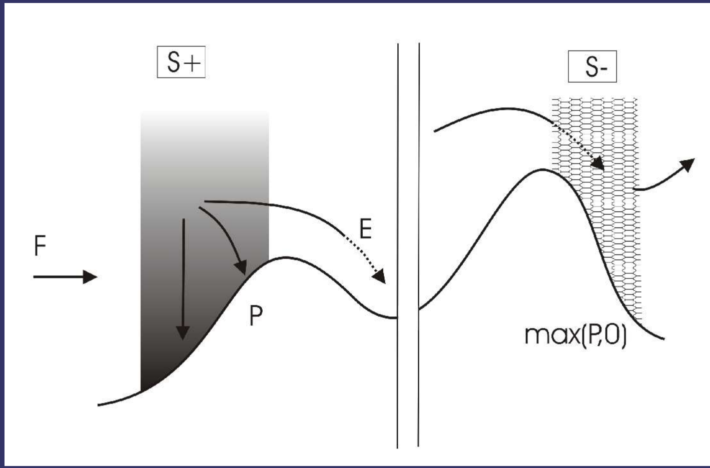
qcl=cloud water density
qf=hydro-meteor density
τ=micro-phys. time delay
C_w=lifting sensitivity factor

σ=Uk+Vl; intrisic freq.
m=vertical wave number
h=terrain
H_w=scale height of water vapor

$$\vec{U} \cdot \nabla q_{cl} = S(x,y) - q_{cl} / \tau_{cl}$$

$$\vec{U} \cdot \nabla q_{f} = q_{cl} / \tau_{cl} - q_{f} / \tau_{f}$$

P

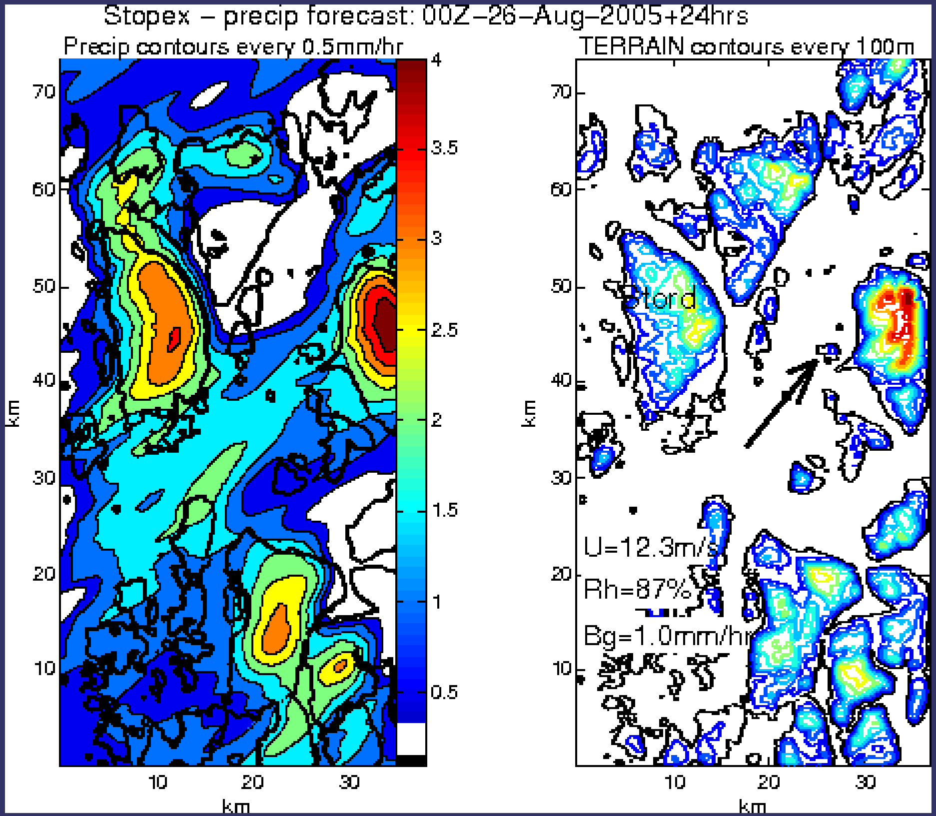


Precipitation in Fourier Space:

$$\hat{P}(k,l) = \frac{C_w i\sigma \hat{h}(k,l)}{[1 - imH_w][1 + i\sigma\tau_{cl}][1 + i\sigma\tau_f]}$$

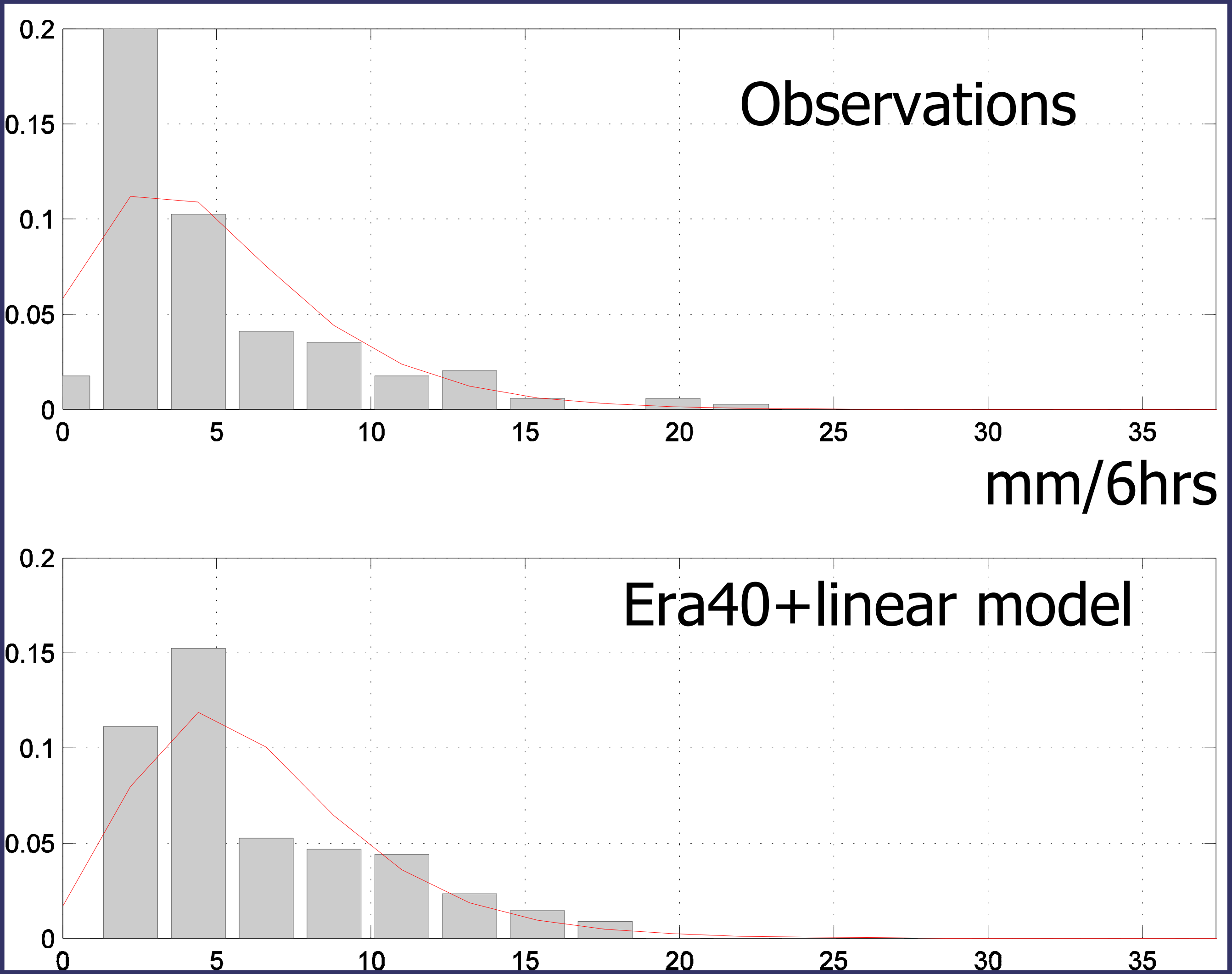
Linear method

- A simple method gives promissing results



http://www.gfi.uib.no/~idar/Stopex_forecast.html

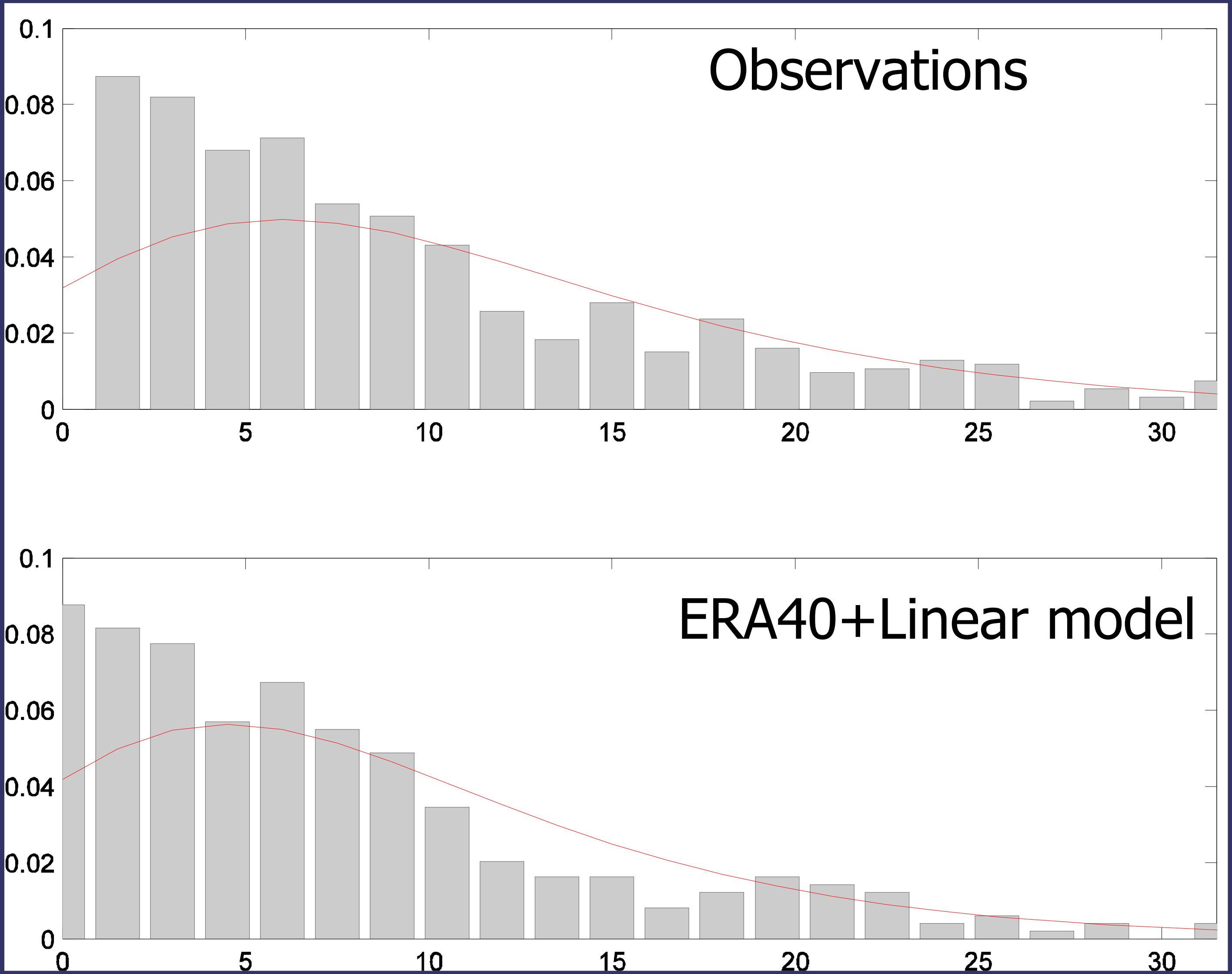
Downscaling –linear method



Særheim – Klepp

6hrs acc. precip.

Downscaling - daily



Stord
Acc. Precip.
mm/24hrs

Conclusions

Dynamical downscaling may help us part of the way

Q: Will this improve the accuracy of statistical downscaling?

STOPEX

- Observasjonar

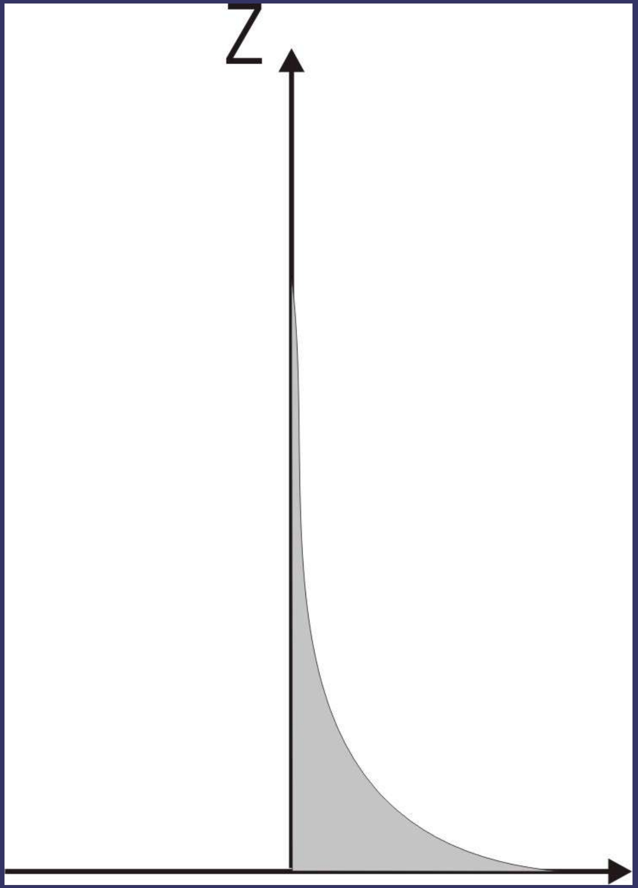
Transport av fukt

$$Influx = \rho\, q\, U H_w$$

ρ = tettheit til lufta
q = spesifik fukt
U = vind
H_w = skalahøgde for fukt i atmosfæren

C_w = lyftingskonstant

$$S(x) = C_w\, \rho\, q\, U\, dh/dx$$



Veldig avhengig av temperaturen ved bakken