Wind storm research at the HZG - long-term changes over the Pacific
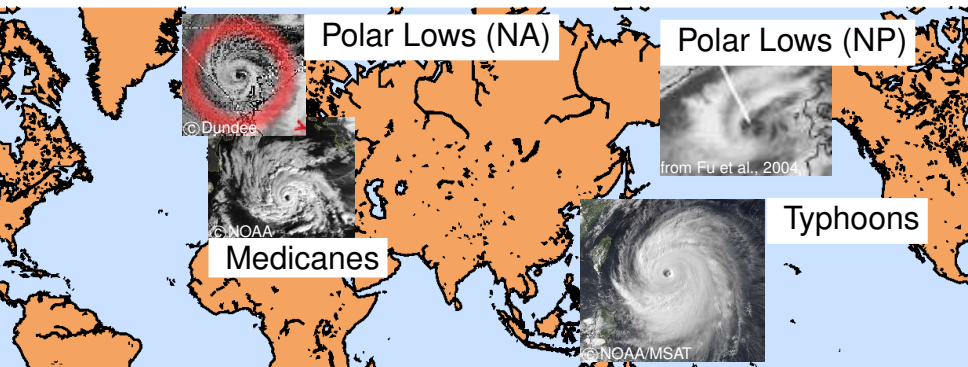
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Prof. Hans von Storch

with thanks to M.Barcikowska,L.Cavicchia,F.Chen

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Helmholtz-Zentrum
Geesthacht
Centre for Materials and Coastal Research

Recently investigated phenomena

Polar Lows (NA)

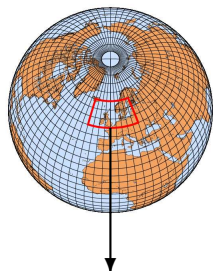Polar Lows (NP)

from Fu et al., 2004

Typhoons

Medicanes

How do the occurrence frequencies of these phenomena change over time?

Also at HZG: Extra-tropical Storms at centennial time scale: Lan Xia at 2.15pm

Research tools: numerical models

low-res global-domain

high-res RCM-domain

Simulation

- ▸ different atmosphere models
- ▸ dynamical downscaling decades of global data to RCM domain
- ▸ **spectral nudging**

Detection

- ▸ automated storm detection methods applied
- ▸ **scale separation** methods based

Simulation of Typhoon Songda

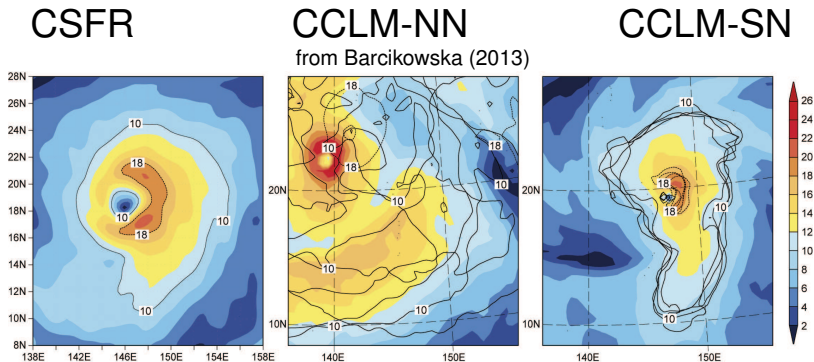
Figure 4.4 Horizontal surface wind speed fields [m s⁻¹] for TC Songda, on 1st September 2004, 00:00. From left: CFSR reanalysis, CCLM-NN, CCLM-SN. For CCLM the first simulation (simulation no 10 and 20) of each ensemble is shaded, the other simulation are shown as contour lines: 10 [m s⁻¹] as solid lines, 18 [m s⁻¹] as dotted lines.

Spectral nudging inhibits model variability
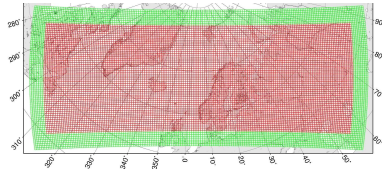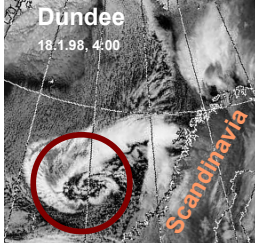
Detection of a Jan 1998 PL case

Zahn et al., 2008, Tellus

Berliner Weatherchart
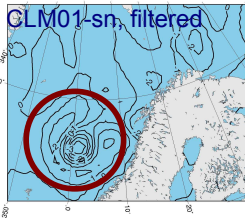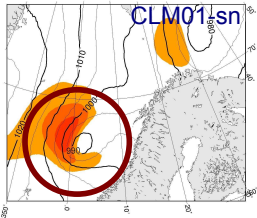
Dundee
18.1.98, 4:00

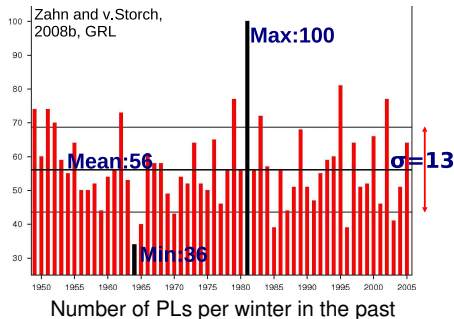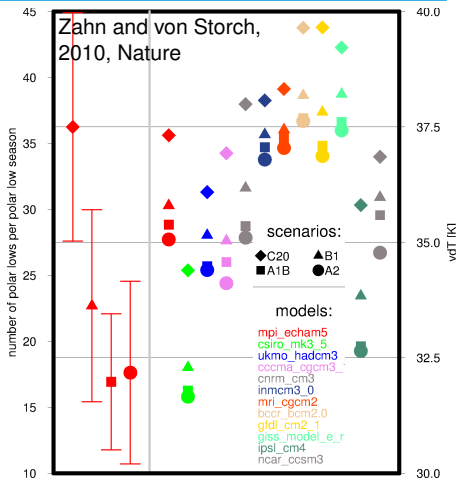Scandinavia

CLM01-sn

CLM01-sn, filtered
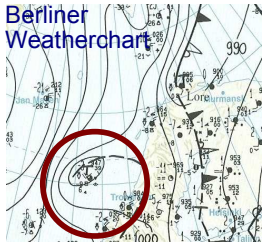
Simulation grid

- ▶ digital filter: 200 - 600km spatial scales are retained
- ▶ PL signal becomes more distinct
- ▶ used for detection
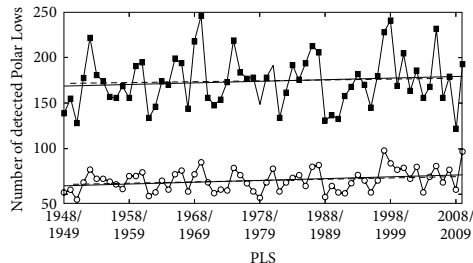
Past and future PL frequency

Number of PLs per winter in the past

- no change in past
- strong decrease under GHG warming
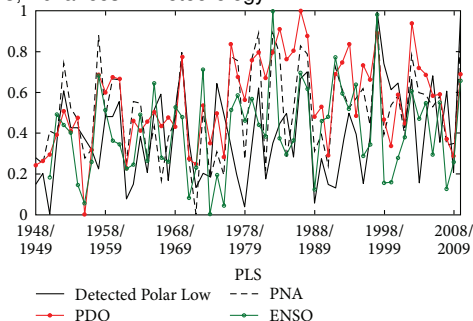- atmosphere projected to become more stable

Left: average PLs per IPCC scenario.
Right: Area and time-averaged ice free $SST - T_{500hPa}$ over northern North Atlantic.

Past PL frequency, North Pacific

from Chen and v.Storch, 2013, Advances in Meteorology
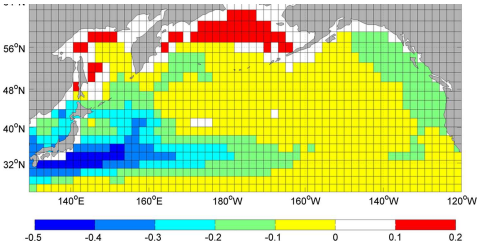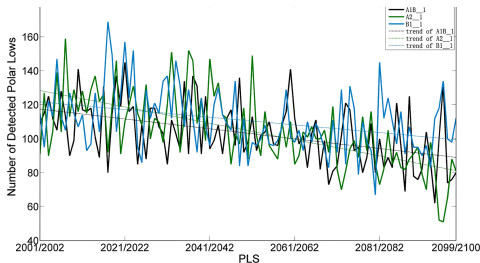
locations of genesis

- ▶ NCEP downscaled to 50km over North Pacific
- ▶ upward, but no significant change
- ▶ link to NP circulation indices:
  $C_{PNA} = 0.45$, $C_{PDO} = 0.39$, $C_{ENSO} = 0.22$

Future PL frequency, North Pacific
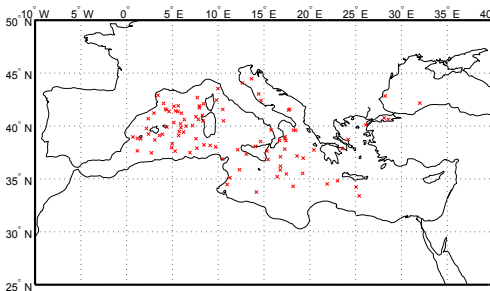
from Chen et al., 2014, Clim.Dyn.

locations of genesis

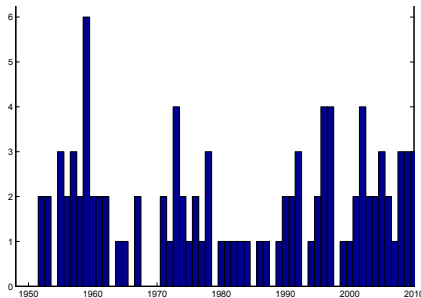A1B - C20 frequency change of $vdT > 39K$,
red/blue: less/more stable

▶ IPCC scenarios B1, A1B and A2
▶ downscaled to 50km over North Pacific
▶ significant decrease
▶ decrease linked to GHG increase
▶ linked to a more stable atmosphere

Medicanes, Mediterranean Sea

from Cavicchia et al., 2013, Clim.Dyn.
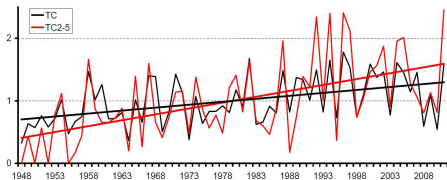

locations of medicane genesis

number of medicanes per season

- ▶ downscaled to 10km (double nesting)
- ▶ rare phenomenon
- ▶ negligible change

Past typhoon frequency

Barcikowska, in preparation
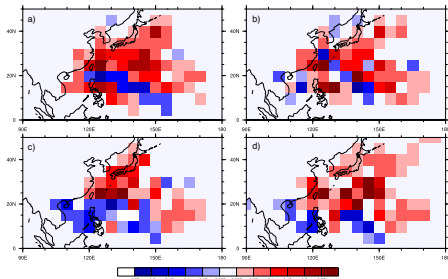

black/red: all/most intense typhoons in CLM

FIG. 3. Trends for yearly occurrences of intense TC estimated with a linear regression using a least squares fit derived for every 5° x 5° grid box; for the period 1978-2001, for a) CCLM-NCEP, b) CCLM-ERA, c) JMA, d) JTWC.

- ▶ NCEP downscaled to 50km with CLM
- ▶ slight overall increase
- ▶ stronger increase of most intense typhoons

- ▶ North: more activity
- ▶ South: less activity

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Future typhoon frequency
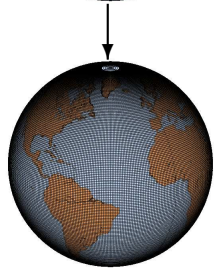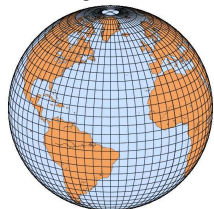

M. Barcikowska, pers. comm.

detected typhoons in transient A1B scenario
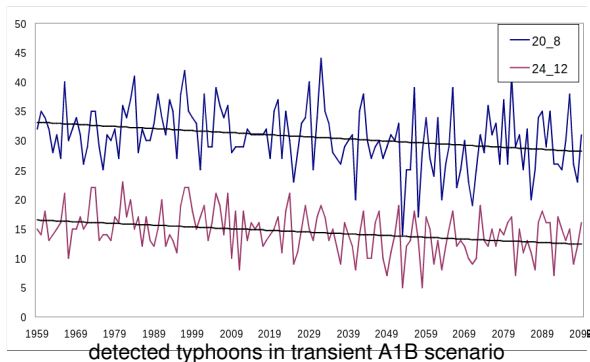
- ▸ IPCC A1B downscaled to 50km with CLM
- ▸ different detection configurations
- ▸ decrease with warming

Current activity: global downscaling

low-res global-domain

high-res global-domain

- ▸ apply a global ECHAM6
- ▸ dynamical downscaling to global domain (M. Schubert-Frisius)
- ▸ spectral nudging

- ▸ enables direct storm studies
- ▸ linkages between different ocean basins possible
- ▸ high potential driving further models down the chain

Summary

At HZG, different types of storms:

- were reconstructed using RCMs
- will be simulated using global downscaling

Storm activity changes:

- no significant past change of activity
- decreased activity in a warmed future
- decrease linked to more stable atmosphere

Thank you very much for your attention

ご清聴ありがとうございました

http://coast.hzg.de/staff/zahn/