Smart climatologies for preparation and planning of hazardous release

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Model based climatologies

✔ Provide 4-dimensional fields and maps.
✔ Fill in when observations are missing.
✔ Global climatologies, public or proprietary, available: NCAR/NCAP Reanalysis Project, ERA 40, JMA, MERA, etc.

➢ Too coarse resolution (0.5° to 2.5°, 6-hourly) for certain applications.
Dynamic downscaling

Global scale data mapped to local region while adding small scale variability

Courtesy Cliff Mass, Univ. Washington
Dynamic Downscaling with Regional Models

- Regional model “embedded” within a global model.
  - Global model constrains regional model.
  - Regional model defines small scale features.
  - Information only passed from global model to regional model.
Regional Climatographies by Dynamical Downscaling

- Global reanalysis
- Meteorol. observations
- WRF model

Year 1

Year 2

Year ...

Year N

Analysis
Variability
regimes
CFDDA - Continuous Data Assimilation

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Modified WRF/MM5:
\[ \frac{dx}{dt} = \ldots + W (x_{\text{obs}} - x_{\text{model}}) \]
where \( x = T, U, V, Q, P1, P2 \ldots \)
\( W \) is weight function
WRF 3.0.1.1, 3 domains: 30/10/3.3km, hourly output
66x66x39 grid points, first 5 levels: 2m, 6m, 10m, 18m, 36m
Physics: Lin et al., PBL: Yonsei University,
Kain Fritsh Cumulus parametrization (D1 & D2 only)
NOAH land surface, RRTM / Dudhia radiation,
Simple diffusion, KM 2D Smagorinsky
Surface stations coverage
Domain 3 (3.3km)

Reporting surface stations at 12z in October 1987-2006 (5% quantile)
Surface Verification Domain 3 at 00z and 12z October 1987-2006

X = obs. Y = model, left = Temperature, right = Humidity
sfc wind analysis fit to obs

Surface Verification Domain 3 at 00z and 12z October 1987-2006
X = obs. Y = model, left = U-wind, right = V-wind

u_wind between 850 & 1050 hPa
bias = 0.2, rms = 2.8, max = 52.0 m/s

v_wind between 850 & 1050 hPa
bias = -0.1, rms = 2.9, max = 32.9 m/s
SOMs classification

46%

1994/10/15 12z

32%

1995/10/01 12z

22%

2001/10/14 12z

SOM analysis of large scale (domain 1) 10-meter wind. Most representative day and frequency of occurrence for the first 3 patterns over 20 years*31 days*24 hourly = 14,880 WRF output files.
SOMs on Domain 3

10-meter wind fine scale (3.3km) wind analysis for the three most representative days of the SOMs large scale classification.
Summary

• Regional model based climatologies offer both spatial and temporal resolution at reasonable accuracy.

• High computing cost (6000 CPU*Hours) and storage (600 Gb).

• SOMs classification can extract statistically representative days without averaging fields.

➢ Next step: T&D climatologies and classification.
T&D climatologies

Global reanalysis
Meteorol. observations → WRF model → SCIPUFF

Year 1

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....

....

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