



# **CliGen (Climate Generator) Addressing the Deficiencies in the Generator and its Databases**

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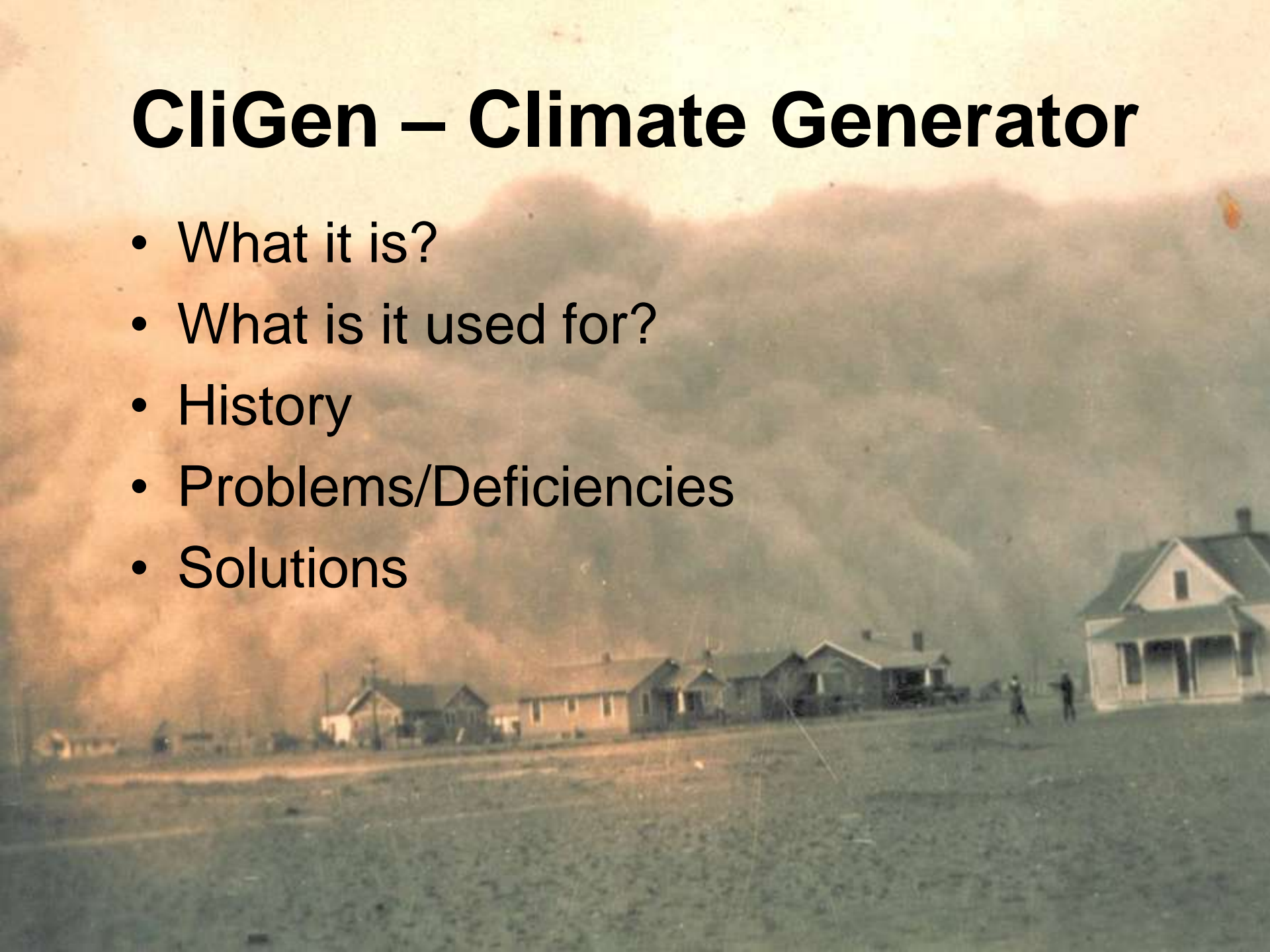
**Anchorage, AK**

**ISELE**

**September, 2011**

# CliGen – Climate Generator

- What it is?
- What is it used for?
- History
- Problems/Deficiencies
- Solutions



# CLIGEN – What it is

- Stochastic weather generator
  - mean + stdev \* standard normal
- Produces **daily** estimates
  - precipitation
    - quantity, duration, time-to-peak, peak intensity
  - temperature
    - maximum, minimum, dew point
  - solar radiation
  - wind
    - speed, direction

# CLIGEN – What it is

- Daily estimates are
  - **independent** of other variables except:
    - temperatures (Jan 2004)
    - occurrence of precipitation
  - for a **single** geographic point
  - based on **monthly** statistics of historical data
  - intended to match the **monthly** means and standard deviations of the historical data

# Sample Cligen Output

Station: ANDALUSIA AL

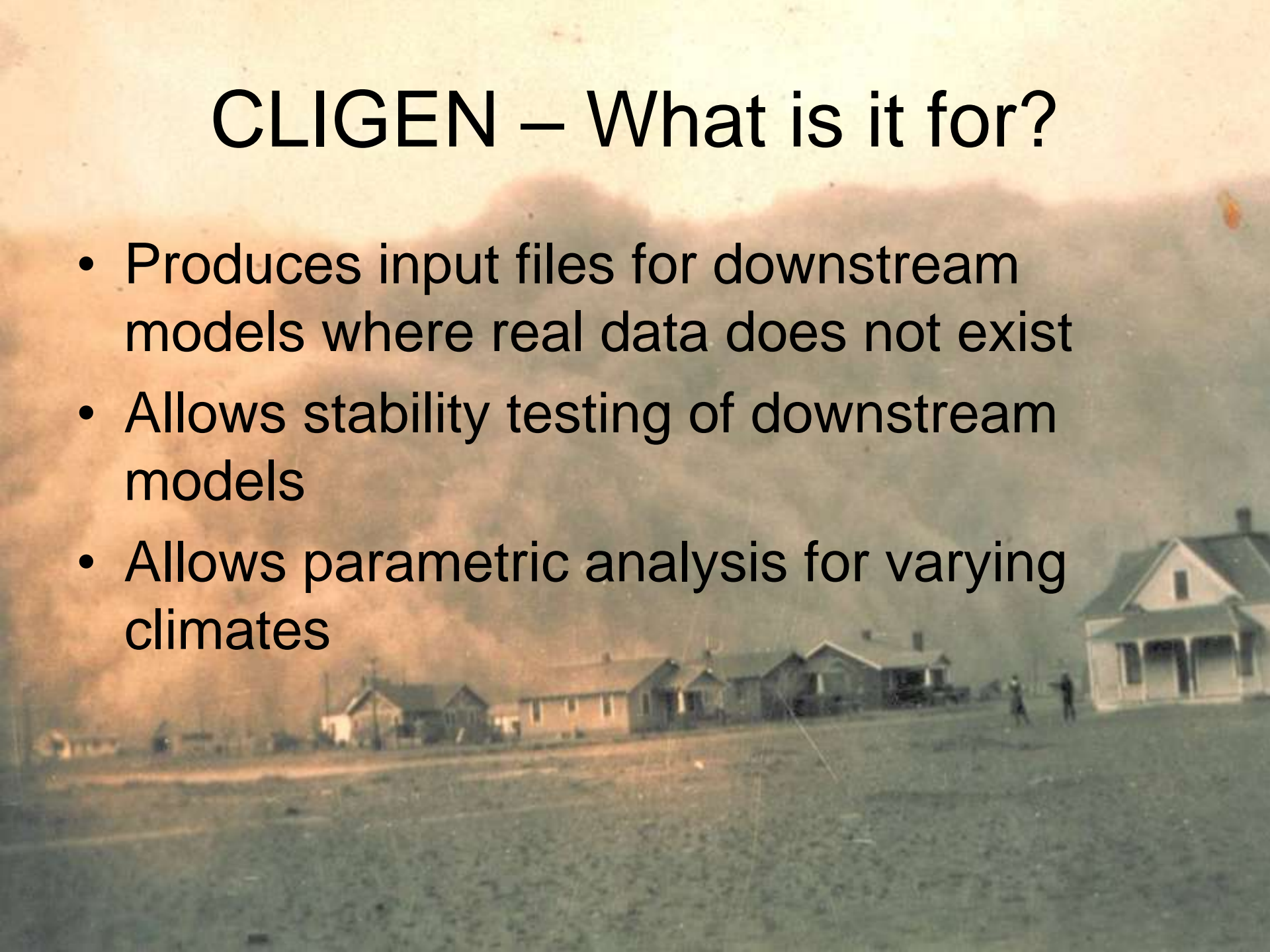
CLIGEN VER. 5.30001

Latitude Longitude Elevation (m) Obs. Years Beginning year Years  
31.32 -86.50 106 45 2000 50

da	mo	year	prcp (mm)	dur (h)	tp	ip	tmax (C)	tmin (C)	rad (l/d)	w-vl (m/s)	w-dir (Deg)	tdew (C)
1	1	2000	0.0	0.00	0.00	0.00	8.2	-3.7	191.	5.8	300.	-1.5
2	1	2000	35.0	6.33	0.13	19.74	10.3	-1.7	296.	2.8	103.	2.4
3	1	2000	0.0	0.00	0.00	0.00	23.9	12.2	238.	4.9	319.	11.9
4	1	2000	0.0	0.00	0.00	0.00	15.0	-0.8	181.	4.2	277.	6.8
5	1	2000	0.0	0.00	0.00	0.00	21.9	3.4	167.	6.1	289.	12.4
6	1	2000	0.0	0.00	0.00	0.00	10.5	-6.1	210.	2.7	41.	1.4
7	1	2000	0.0	0.00	0.00	0.00	20.9	5.6	302.	2.0	147.	12.1
8	1	2000	5.5	1.73	0.84	4.30	15.6	-0.1	288.	4.6	359.	3.9
9	1	2000	0.0	0.00	0.00	0.00	17.9	5.2	269.	3.0	335.	9.6
10	1	2000	0.0	0.00	0.00	0.00	17.9	5.9	323.	0.0	0.	6.4

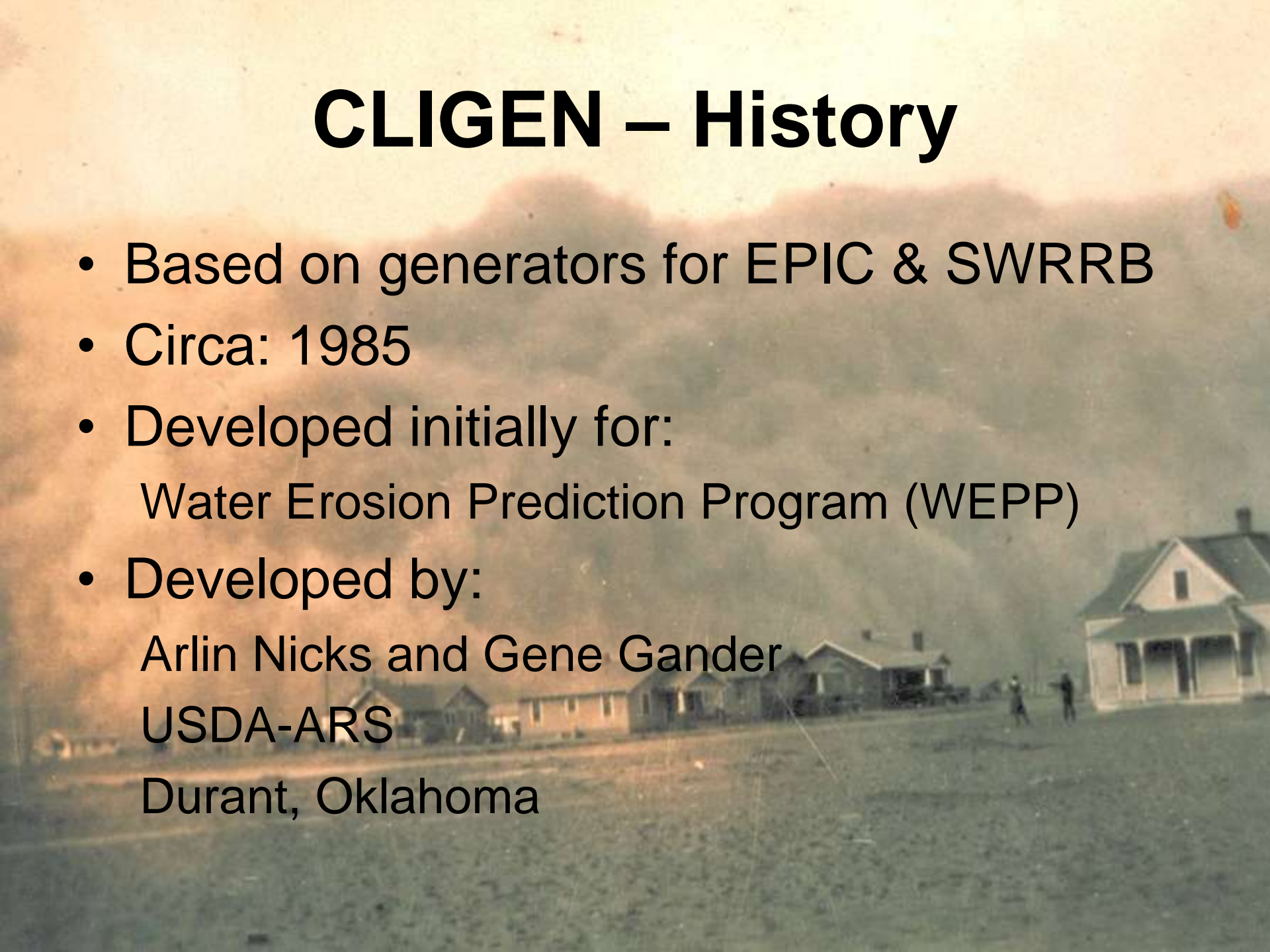
# CLIGEN – What is it for?

- Produces input files for downstream models where real data does not exist
- Allows stability testing of downstream models
- Allows parametric analysis for varying climates



# CLIGEN – History

- Based on generators for EPIC & SWRRRB
- Circa: 1985
- Developed initially for:  
Water Erosion Prediction Program (WEPP)
- Developed by:  
Arlin Nicks and Gene Gander  
USDA-ARS  
Durant, Oklahoma



# CLIGEN – History

- Last of Arlin Nick's changes (mid-1990's)
- David Hall and Dayna Scheele (USDA-FS)
  - addressed existing station data errors
  - expanded number of U.S stations (1999)
- Bofu Yu (Griffith Univ. in Australia)
  - addressed rainfall intensity issues (2000)
  - Version 5.x



# CLIGEN – History

- Charles Myer (USDA-ARS)
  - Addressed “quality control” of generated random numbers
  - Added range checking to some parameters
  - Added temperature correlation (2004)
    - max daily temp  $\geq$  min daily temp
    - min daily temp  $\geq$  dew pt temp
  - Added several interpolation options attempting to address seasonal variations within a month
    - none, linear, fourier, Yoder/Foster

# Current Raw Data Inputs

- Daily precipitation, max and min temps
  - 2590 stations (2718 with FS stations)
  - data (9-117 yrs with 1100 having >44 yrs)
- Solar radiation, ½ hr maximum precipitation
  - 142 stations (unknown origin of data)
- Time-to-peak distributions
  - 1548 stations (unknown origin of original data)
- Dewpoint temperatures
  - 273 stations (unknown origin of data)
- Wind
  - 852 stations (unknown origin of data)

# Updated Raw Data Inputs

## Problem

- Missing, unknown origin and/or dated input data

## Solution

- Update inputs with current data files available from NWS
  - TD3200 - 8000 active stations and/or TD3210 – 1380 Fed stations
    - Replaces original daily precipitation/temperature data files
  - TD3210 -1380 stations
    - solar radiation data source (derive from terrestrial SR minus cloudiness)
  - TD6406 - 954 stations (1 min interval data)
    - time-to-peak distributions (can be derived from data)
    - dewpoint temperature (daily values can be computed)
    - ½ hr max precipitation (can be derived from data)
- Cull stations/data based on defined quality controls
  - minimum number years of data, missing/invalid data removed, etc.
- Generate new replacement parameter data files

# Generator Issues

- Issues with interpolation methods
- K-S only tests normality of random numbers. Need randomness testing.
- For many stations:
  - Poor solar radiation data
  - Poor storm characteristics representation
- No correlation between most parameters

# Updated Interpolation

## Problems

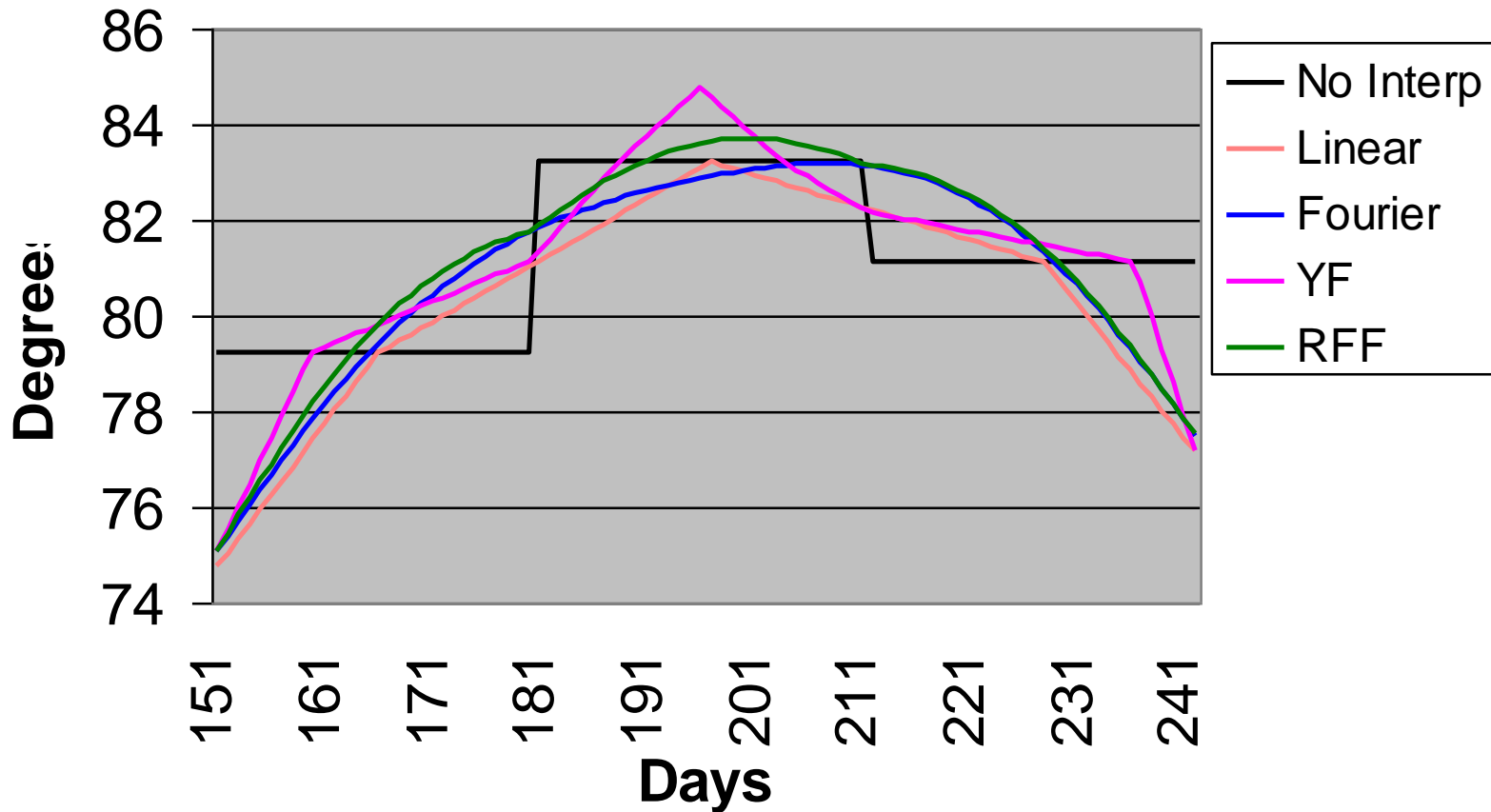
- Current interpolation procedures
  - Don't match monthly means – Linear & Fourier methods
  - Discontinuities within months – Linear & Yoder/Foster (YF)

## Solution

- New interpolation procedure – Rust/Fox Fourier (RFF)
  - Matches monthly mean values
  - Eliminates discontinuities within months
  - Does not interpolate monthly SD values
- Potential future improvement
  - Remove seasonal cycle from monthly SD

# Updated Interpolation

Max Temp Means - Springfield, CO  
June - August



# Stochastic Generation Update

## Problem

- Generated random number series not passing statistical means tests
- K-S tests for normality, but means testing more important

## Solution

- Guarantee zero mean for random deviates  $(-1,1)$ 
  - Generate half of random number deviates needed
  - Fold (negative) deviate series values
  - Mix “folded deviates” with original series

# Solar Radiation Update

## Problem

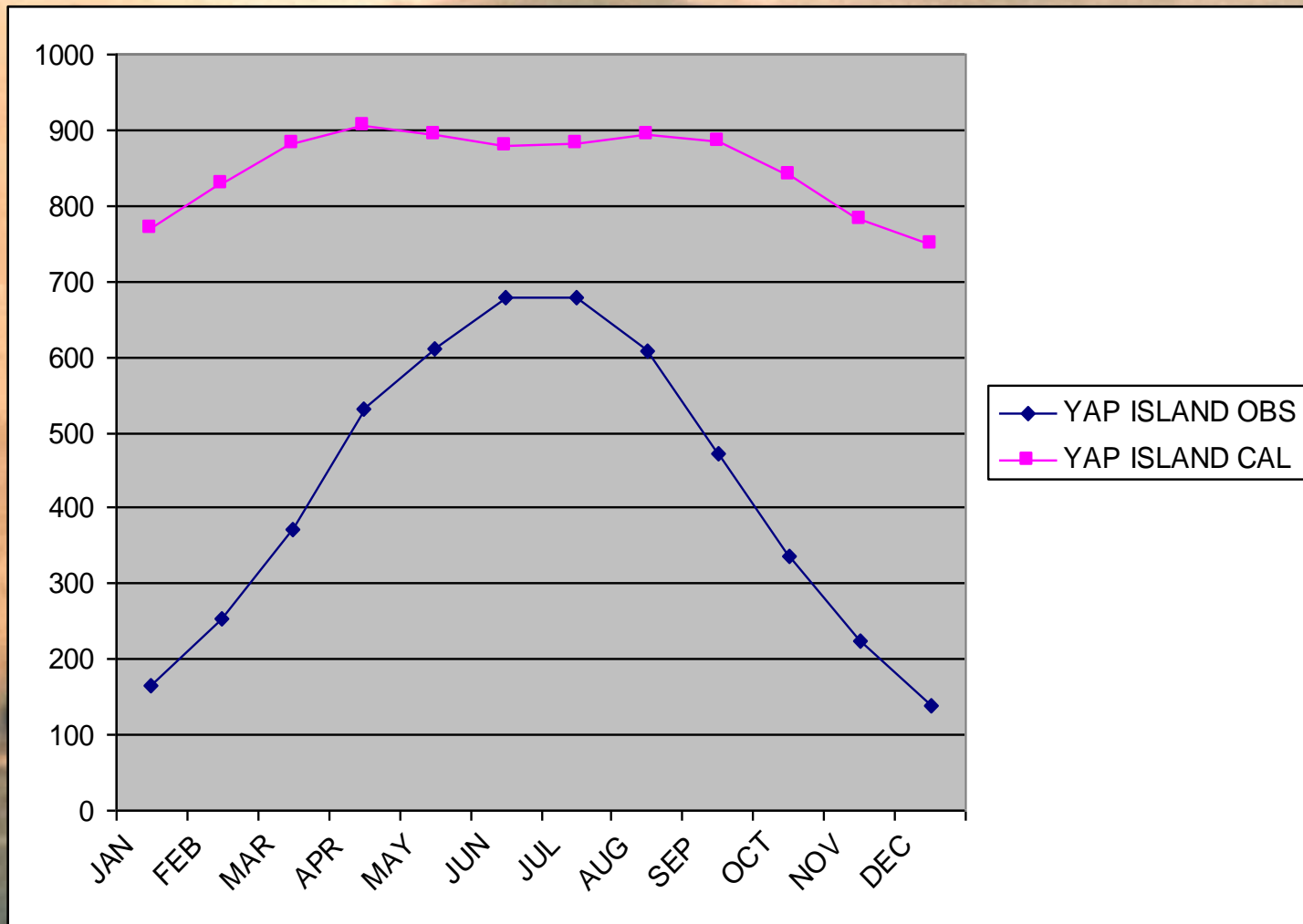
- Limited station data (143)
  - Causes interpolation issues
    - (Yap Island vs CA coastal locations)
    - Long daylight days (AK)

## Proposed Solutions

- Expand data set (TD3210 - 1380 stations)
- Determine “suitability” of station data for interpolation usage manually or within code



# Solar Radiation Update



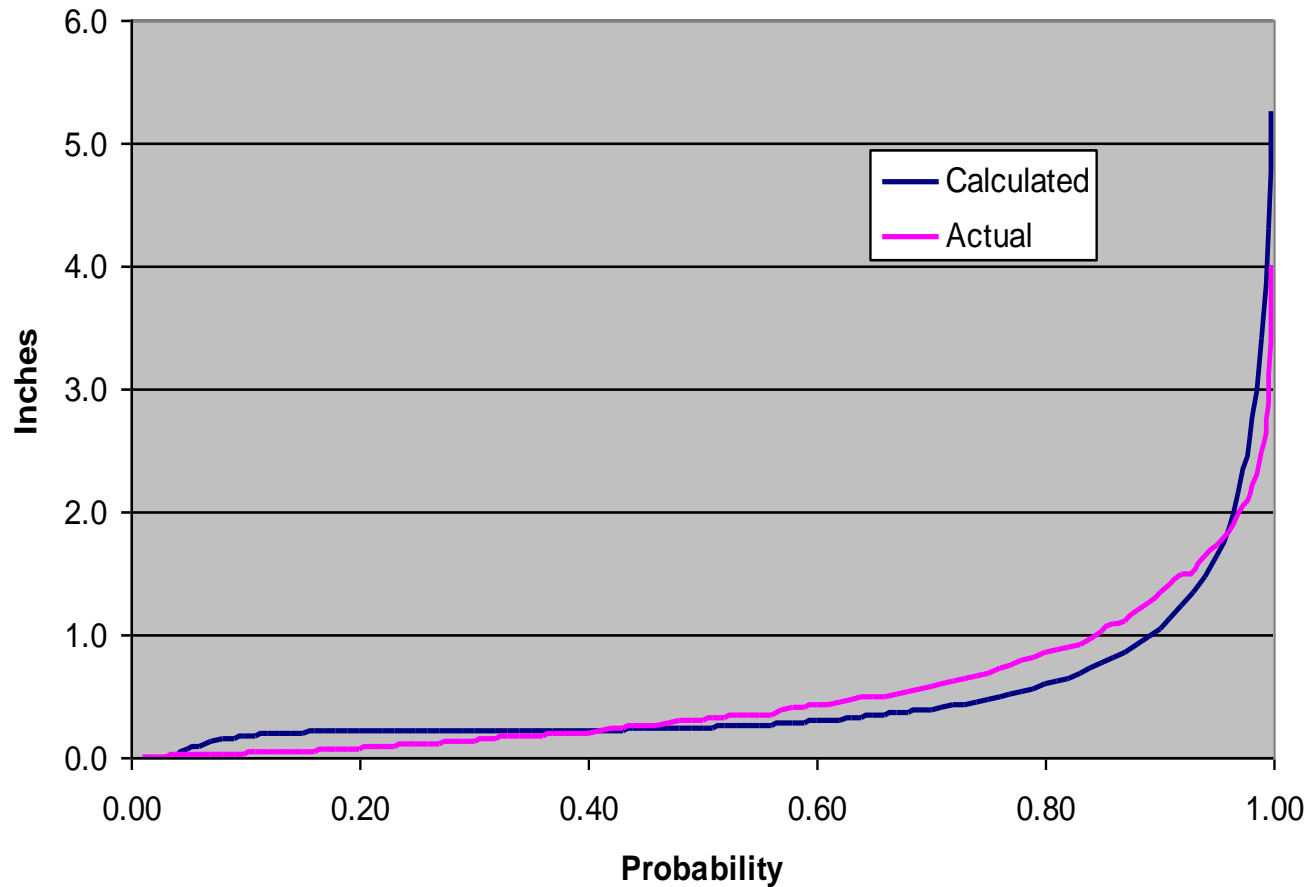
# Precipitation Update

## Problems

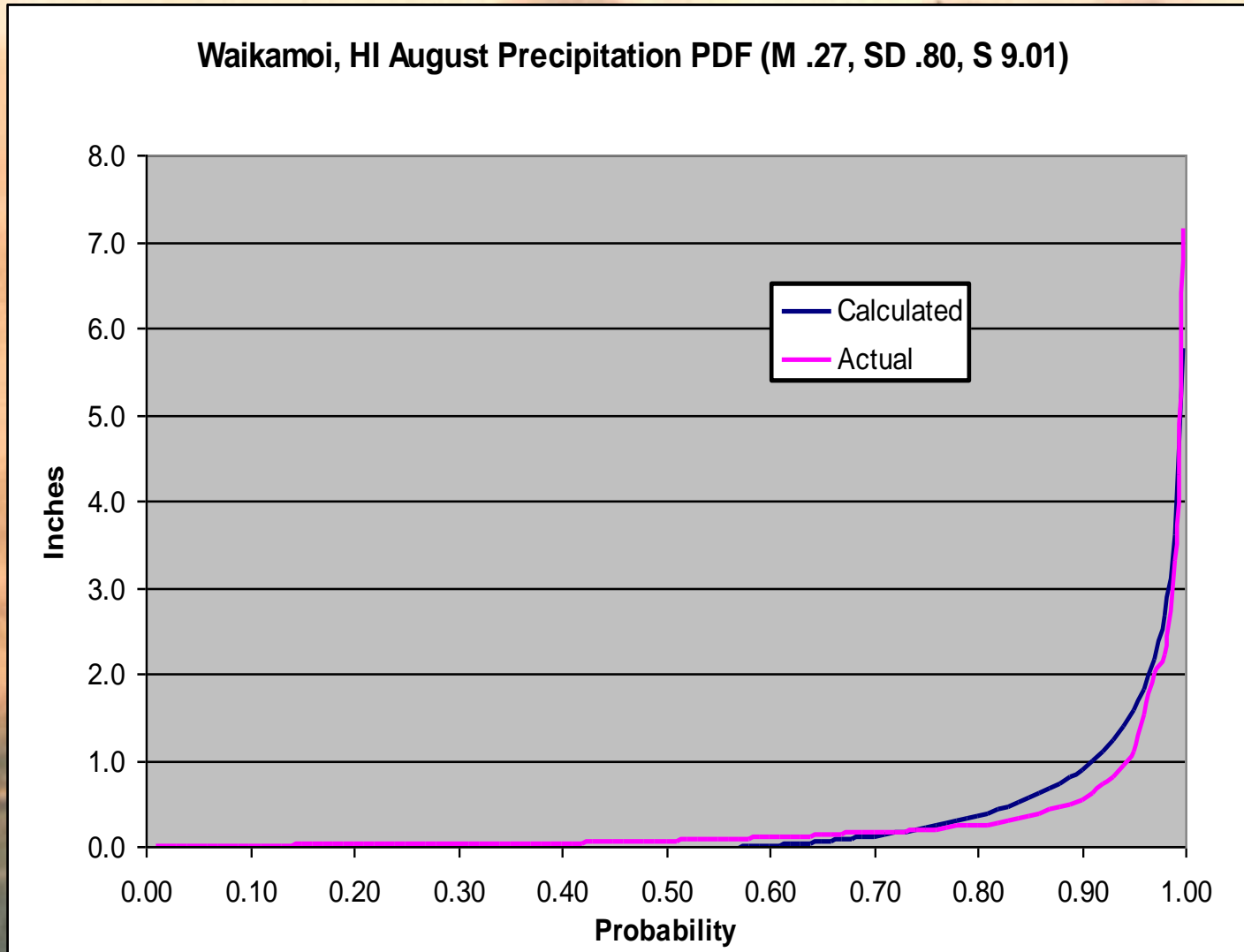
- Distribution of precipitation quantities doesn't match measured data for many locations
  - Impacts plant growth response and water erosion
- Description of a storm needs improvement
  - Directly impacts water erosion estimates
  - Simple “one size fits all” functional relationships between storm duration, intensity and quantity of precipitation
    - Multiple local peak storm intensities not simulated
    - Distribution of storm durations not well reflected

# Weibull Precipitation 1

Princeton, IN August Precipitation PDF (M .52, SD .69, S 5.87)



# Weibull Precipitation 2



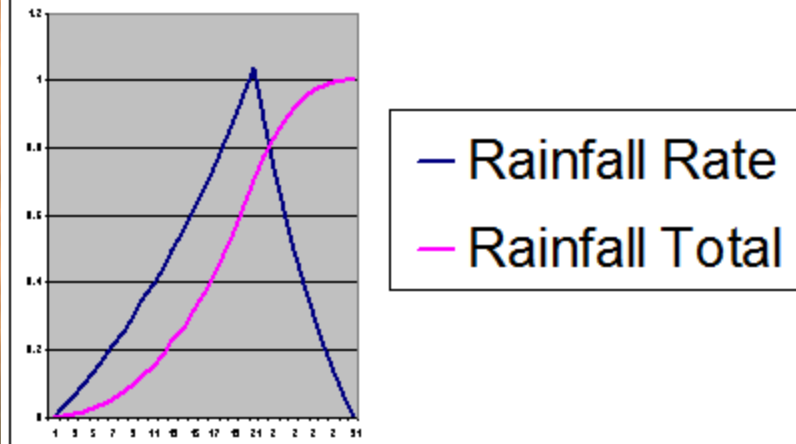
# Precipitation Update

## Proposed Solution

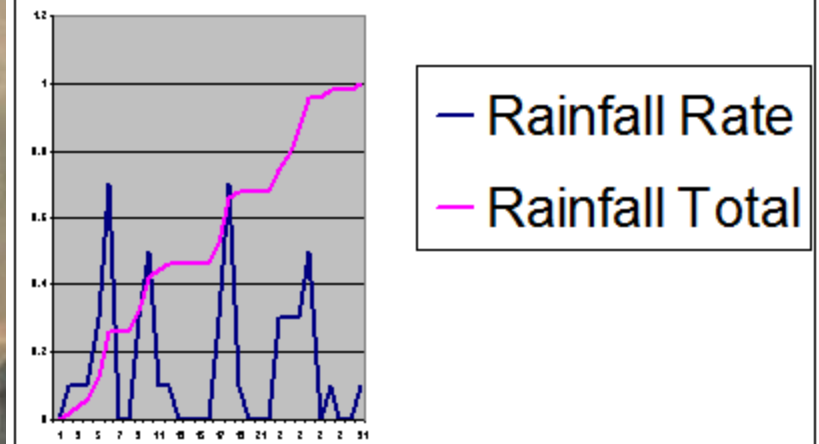
- Use ASOS one-minute data to create histograms for storm amount
- Create statistical storm descriptions of bands and breaks within individual storms
- Generate break-point descriptions of daily storms
- Remove time-to-peak, duration and intensity from output file

# Storm Description

## Gamma Function Storm



## Band Storm



# Correlation Update

## Problem

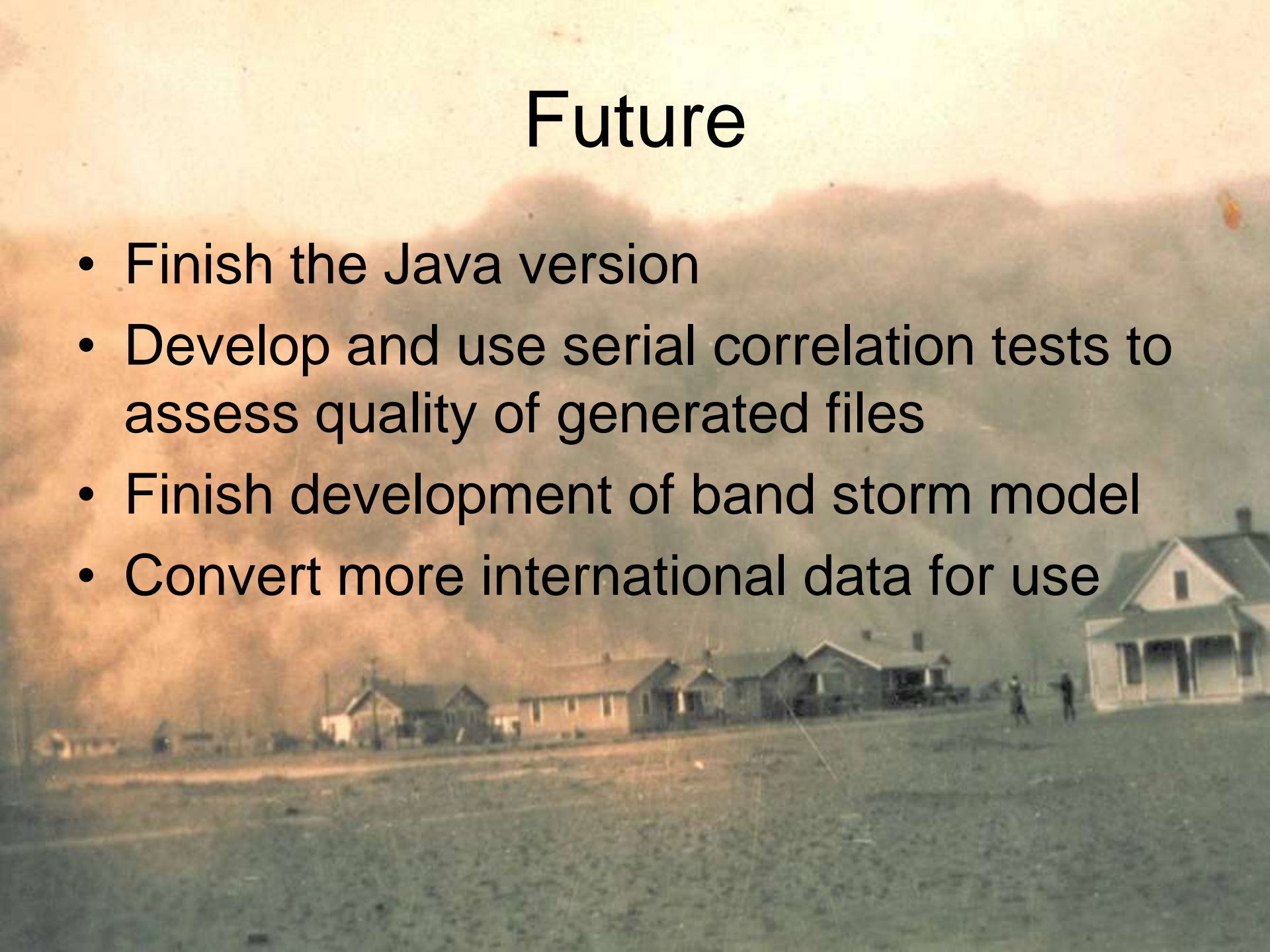
- Non-correlation among most parameters (except Tmax, Tmin and dewpoint)

## Possible (Partial) Solution

- Use GEM code for generating correlated params (Tmax, Tmin, precipitation quantity & dewpoint)
  - Solar radiation and wind correlation not completed
  - Precipitation time-to-peak, intensity and duration not even conceptualized within GEM project

# Future

- Finish the Java version
- Develop and use serial correlation tests to assess quality of generated files
- Finish development of band storm model
- Convert more international data for use





Comments/Questions?

