

UC



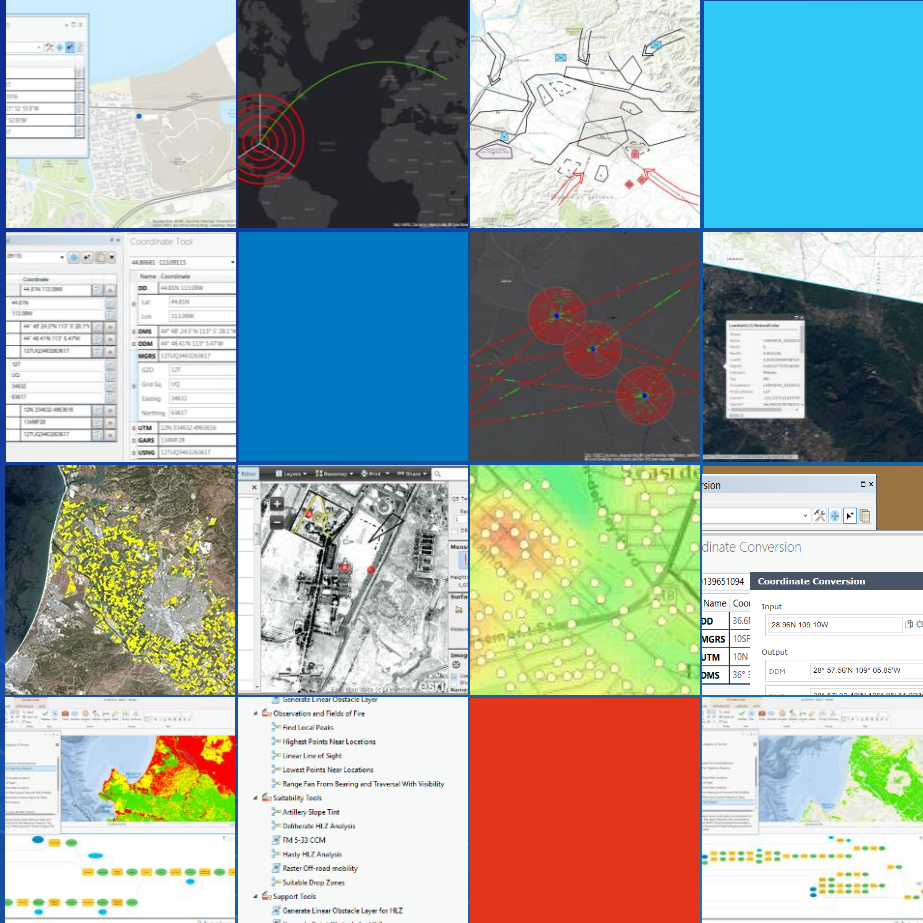
# Measuring Environmental Impact on Operations

Matt Funk

Eric Linz

# Defense Solutions

We support the Defense, Intelligence , and National Security industry



Fully documented and maintained

Fully supported

Open source

*Empowering our users with focused workflows that fit their needs*

# Overview of Defense Solutions

Flexible capability and deployment



Web



Mixed



Desktop



# Overview of Defense Solutions

Flexible capability and deployment



Web



Mixed



Desktop



# Understanding the environment is important to the success of the operation

- Where conditions are suitable to operate?
- Where can/can't we operate?
- What type of asset is most suitable?
- Where does the enemy have the advantage?
- Terrain and Weather Analysis are part of Intelligence Preparation of the Battlefield



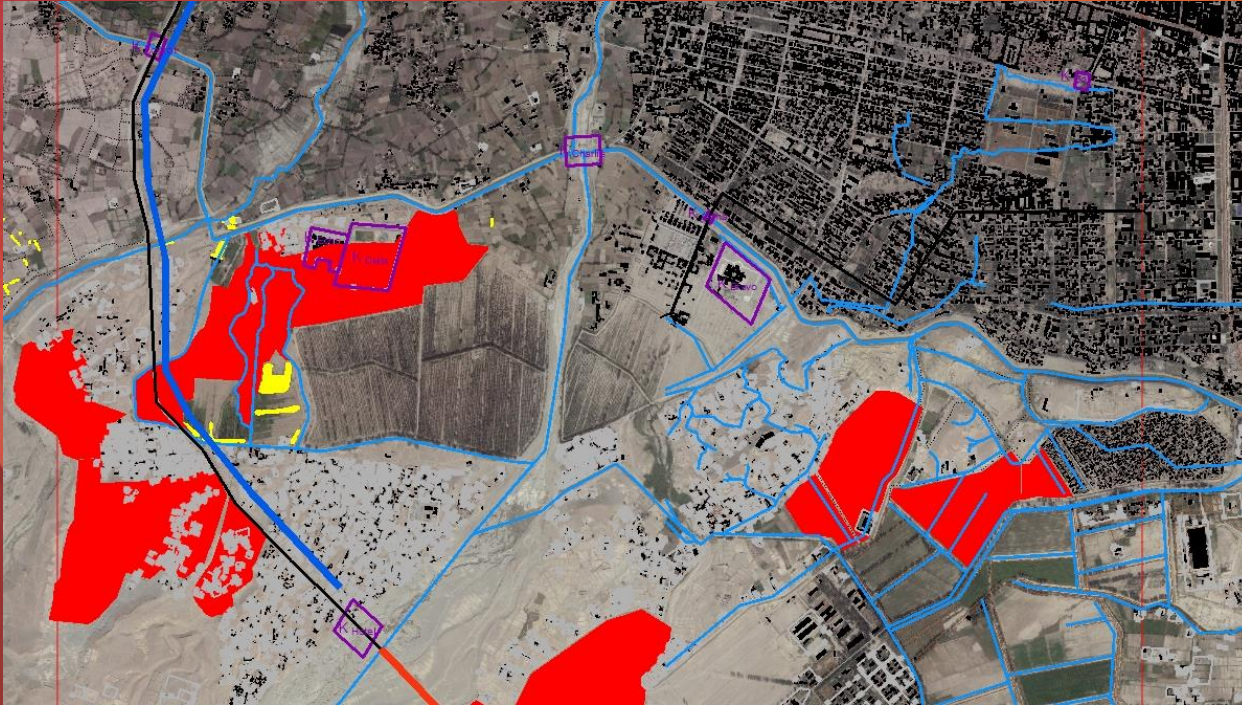
# Terrain's Effects on Operations



*Photo By: Cpl. Julio McGraw*

# Military Aspects of Terrain Process

- Data preparation
- Publish obstacles and lines of communication
- Create and publish suitability overlays
- Find and publish key terrain
- Create and publish Modified Combined Obstacle Overlay (MCOO)
  - Combining
    - Obstacles and lines of communication
    - Suitability overlays
    - Key terrain
  - Adding
    - Mobility corridors
    - Friendly/hostile avenues of approach



# Military Aspects of Terrain Demo

# Weather's Effect on Operations



# Military Aspects of Weather

[Home](#)[Get Started](#)[Workflows](#)[Resources](#)

## Overview

The Military Aspects of Weather (MAoW) template offers functionality with the ability to import weather and climate data and then to use this data to derive products and conversions. These products and conversions can then be used to calculate the potential operational impacts of the conditions on military operations.

Weather is a constantly changing phenomenon and as such there is the ability to download regular forecast updates and to have this automatically displayed on the user's screen.

This template illustrates how you can:

- Utilize scheduled tasks to download data using batch files.
- Import and analyze weather station data from the World Meteorological Organization

## Military Aspects of Weather

- Utilize scheduled tasks to download data using batch files.
- Identify the anticipated effects of forecast weather on potential operational activities.
- ArcGIS 10.1 – 10.4.x

<http://solutions.arcgis.com/defense/templates/maow/>

# Military Aspects of Weather

A map of Afghanistan with a purple and blue color scheme, representing climate data. The word 'Climate' is centered in a white box with a black border. The map shows geographical features like mountains and rivers, with some city names like 'Kabul' and 'Rawalpindi' visible.

## Climate

- Weather averages over long period of time.
- What are 'normal' conditions?

A map of Afghanistan with a green and orange color scheme, representing current weather data. The word 'Current' is centered in a white box with a black border. The map shows geographical features like mountains and rivers, with some city names like 'Kabul', 'Gardez', and 'Khost' visible.

## Current

- What are the conditions now?
- Weather variables at locations

A map of Afghanistan with a red and yellow color scheme, representing forecast weather data. The word 'Forecast' is centered in a white box with a black border. The map shows geographical features like mountains and rivers, with some city names like 'Kabul', 'Gardez', and 'Khost' visible.

## Forecast

- What will weather be like in the next few hours?
- Forecast weather variables and impacts

# Military Aspects of Weather

A map of Afghanistan with a purple and blue color scheme, representing climate data. The map is framed by a thick yellow border. The word "Climate" is centered in a white box with a black border.

**Climate**

A map of Afghanistan with a green and orange color scheme, representing current weather data. The map is framed by a thick yellow border. The word "Current" is centered in a white box with a black border.

**Current**

A map of Afghanistan with a red and orange color scheme, representing forecast weather data. The map is framed by a thick yellow border. The word "Forecast" is centered in a white box with a black border.

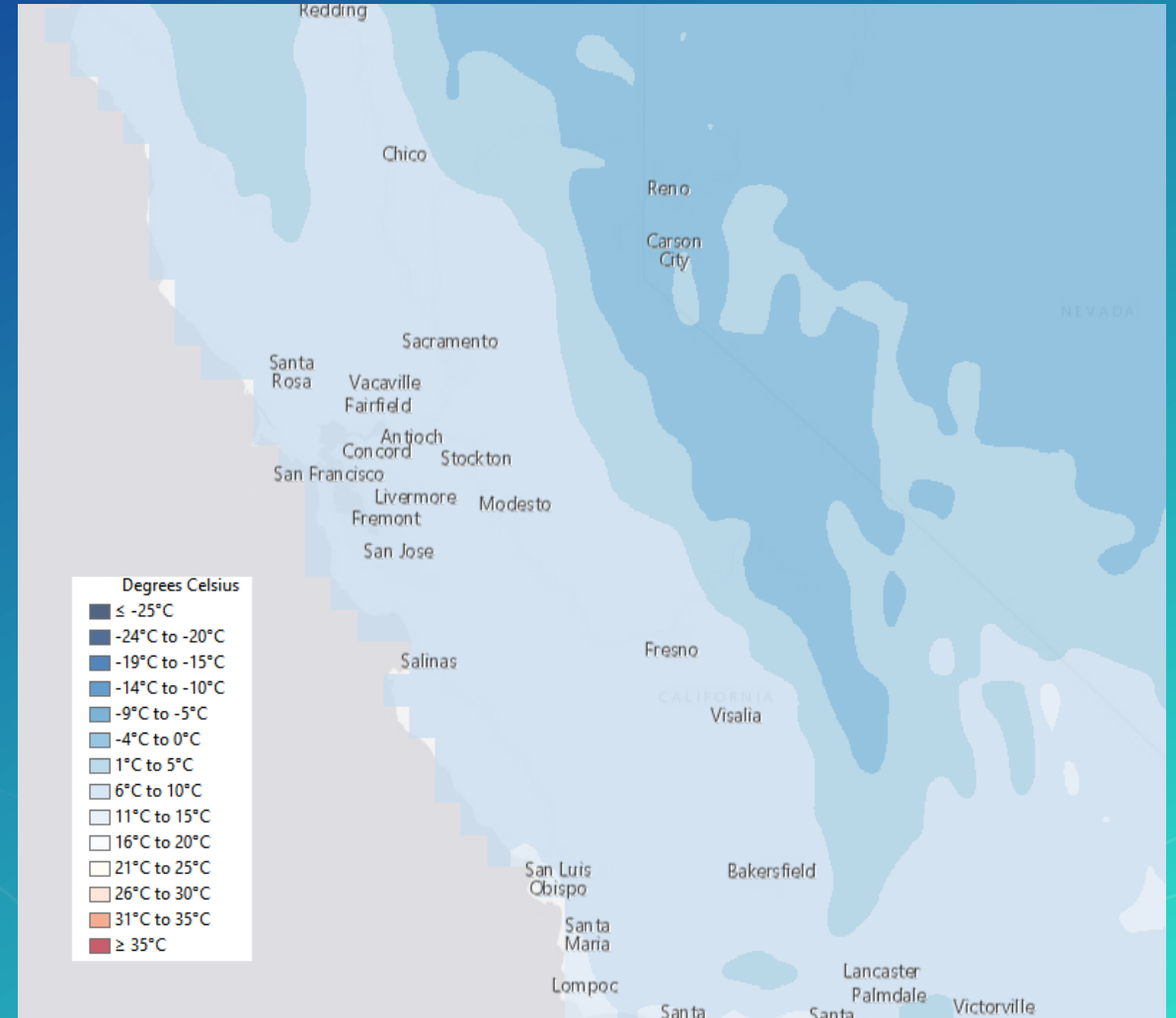
**Forecast**

# Expected Conditions with Climate

Long term planning

Expected conditions based on monthly averages

Global coverage



# Climatic Research Unit – 10 Minute Global

<http://www.cru.uea.ac.uk/>

## CRU CL 2.0

- Precipitation
- Wet days
- Mean temperature
- Mean diurnal temp range
- Relative humidity
- Sunshine
- Ground frost
- 10m windspeed

- <https://crudata.uea.ac.uk/cru/data/hrg/tmc/>

*Climatic Research Unit: Data*

## Ten Minute Climatology

File	Gzipped	Uncompressed	Description
<a href="#">readme.txt</a>	-	-	Documentation
<a href="#">grid_10min_problems.txt</a>	-	-	Problem log (none)
<a href="#">new_et_al_10minute_climate_CR.pdf</a>	-	3 MB	<i>Climate Research</i> paper describing dataset
<a href="#">grid_10min_pre.dat.gz</a>	28 MB	101 MB	Precipitation
<a href="#">grid_10min_rd0.dat.gz</a>	10 MB	56 MB	Wet-days
<a href="#">grid_10min_tmp.dat.gz</a>	11 MB	56 MB	Mean temperature
<a href="#">grid_10min_dtr.dat.gz</a>	9 MB	56 MB	Mean diurnal temperature range
<a href="#">grid_10min_reh.dat.gz</a>	12 MB	56 MB	Relative humidity
<a href="#">grid_10min_sunp.dat.gz</a>	12 MB	56 MB	Sunshine
<a href="#">grid_10min_frs.dat.gz</a>	7 MB	56 MB	Ground-frost
<a href="#">grid_10min_wnd.dat.gz</a>	6 MB	56 MB	10m windspeed
<a href="#">grid_10min_elv.dat.gz</a>	3 MB	15 MB	Elevation
<a href="#">tmc.iso.gz</a>	96 MB	509 MB	CD-ROM image of all files Use <i>Nero</i> , <i>Adaptec-CD</i> etc to cut to disc

*Last updated: July 2002, Mike Salmon*

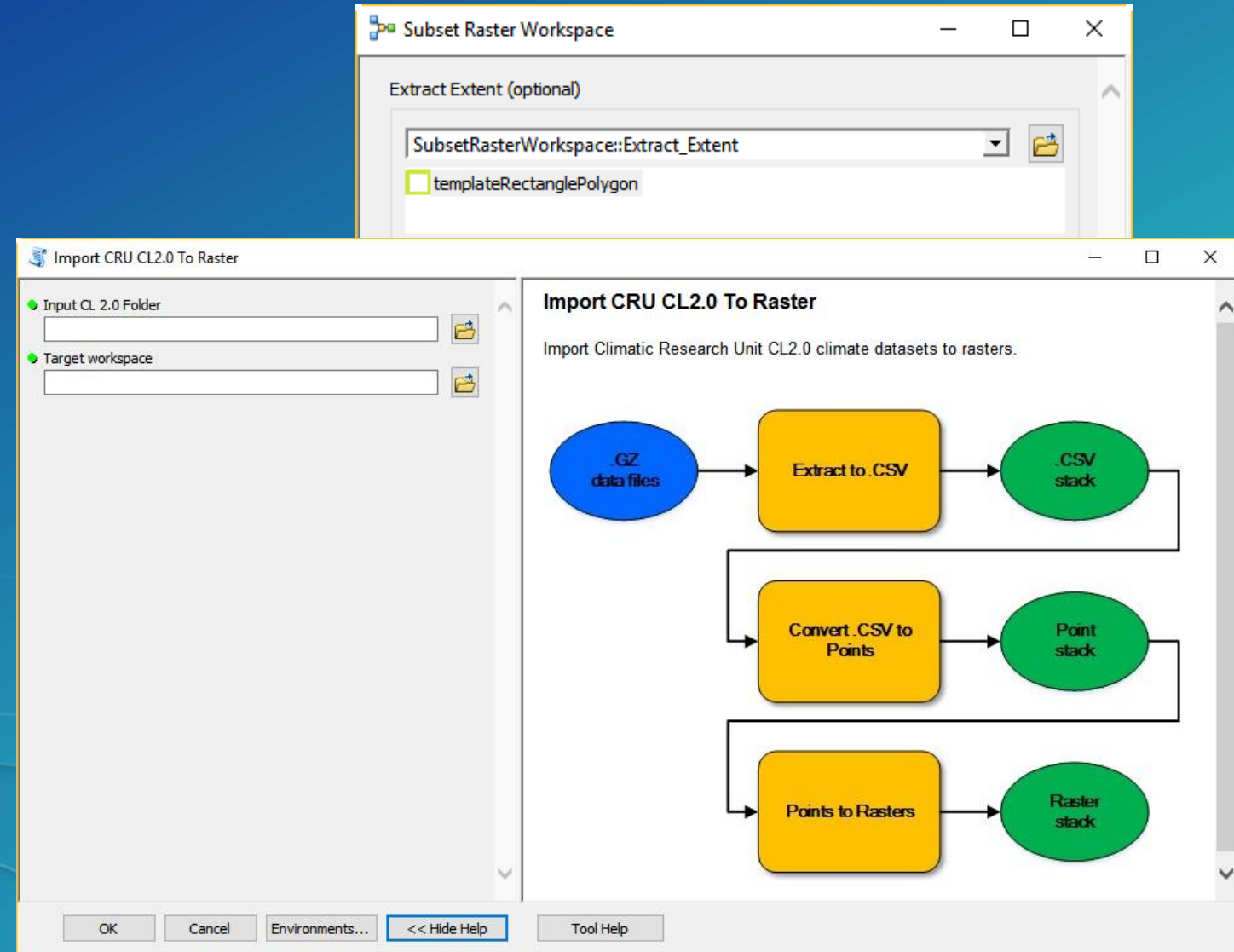
# Processing CRU data

- Download raw data

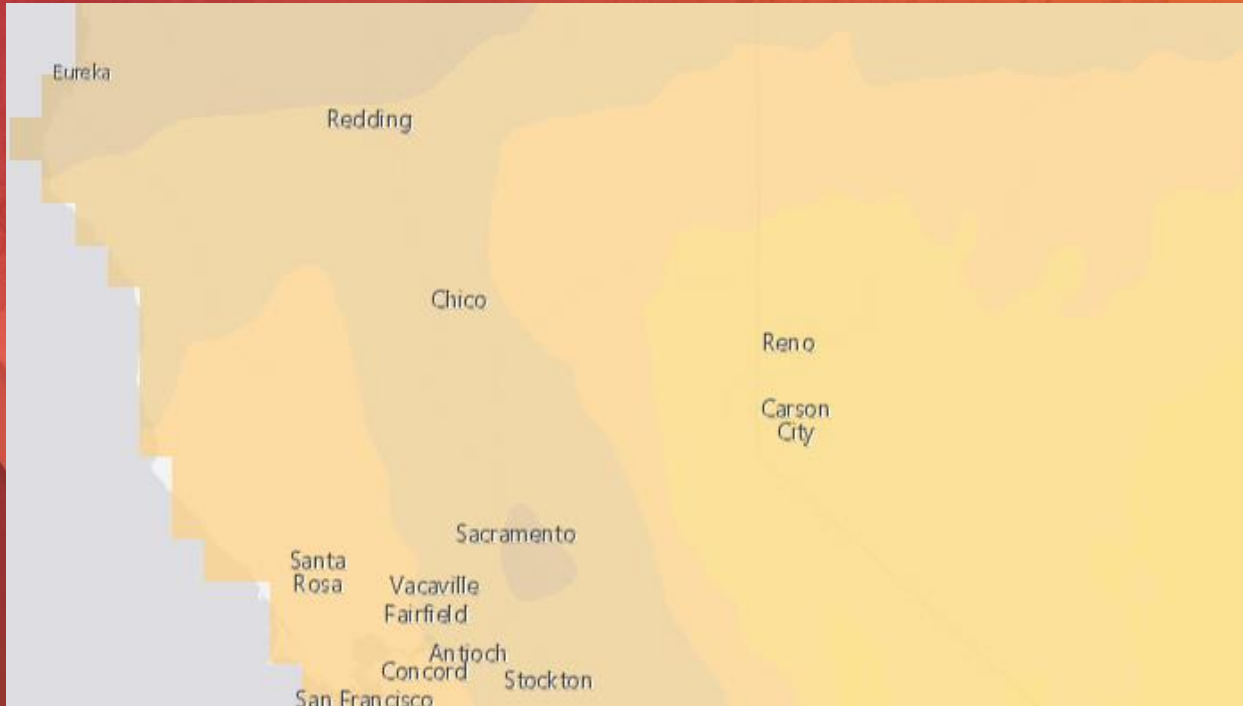
<https://crudata.uea.ac.uk/cru/data/hrg/tmc/>

- Import raw CRU data to raster datasets

- Optionally: Subset to smaller region



# Expected conditions with Climate



# Military Aspects of Weather



A map of Afghanistan with a color gradient from light blue in the north to light purple in the south, representing different climate zones. The word 'HINDU' is faintly visible in the upper right, and 'Kabul' is visible in the center-left.

**Climate**



A map of Afghanistan with several green dots indicating current weather stations or conditions. An orange dot is located in the north. The word 'HINDU' is faintly visible in the upper right, and 'Kabul' is visible in the center-left.

**Current**



A map of Afghanistan with a color gradient from light yellow in the north to light red in the south, representing forecast weather conditions. The word 'HINDU' is faintly visible in the upper right, and 'Kabul' is visible in the center-left.

**Forecast**

# Forecasted conditions and impacts

What conditions will be like in the next few hours?

- Temperature
- Cloud coverage
- Etc.

What will be their impact on operations?

- UAV operations
- Personnel
- Etc.



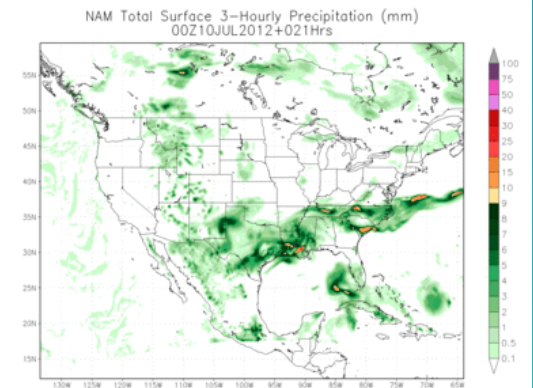
# Forecast data

- NOAA North American Mesoscale Forecast System (NAM)
- NAM Hourly Forecast product
  - 1 hour interval
  - Next 36 hours
- 141 weather variables
  - Only using 12
- OPeNDAP (Open-source Project for a Network Data Access Protocol)

<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-mesoscale-forecast-system-nam>

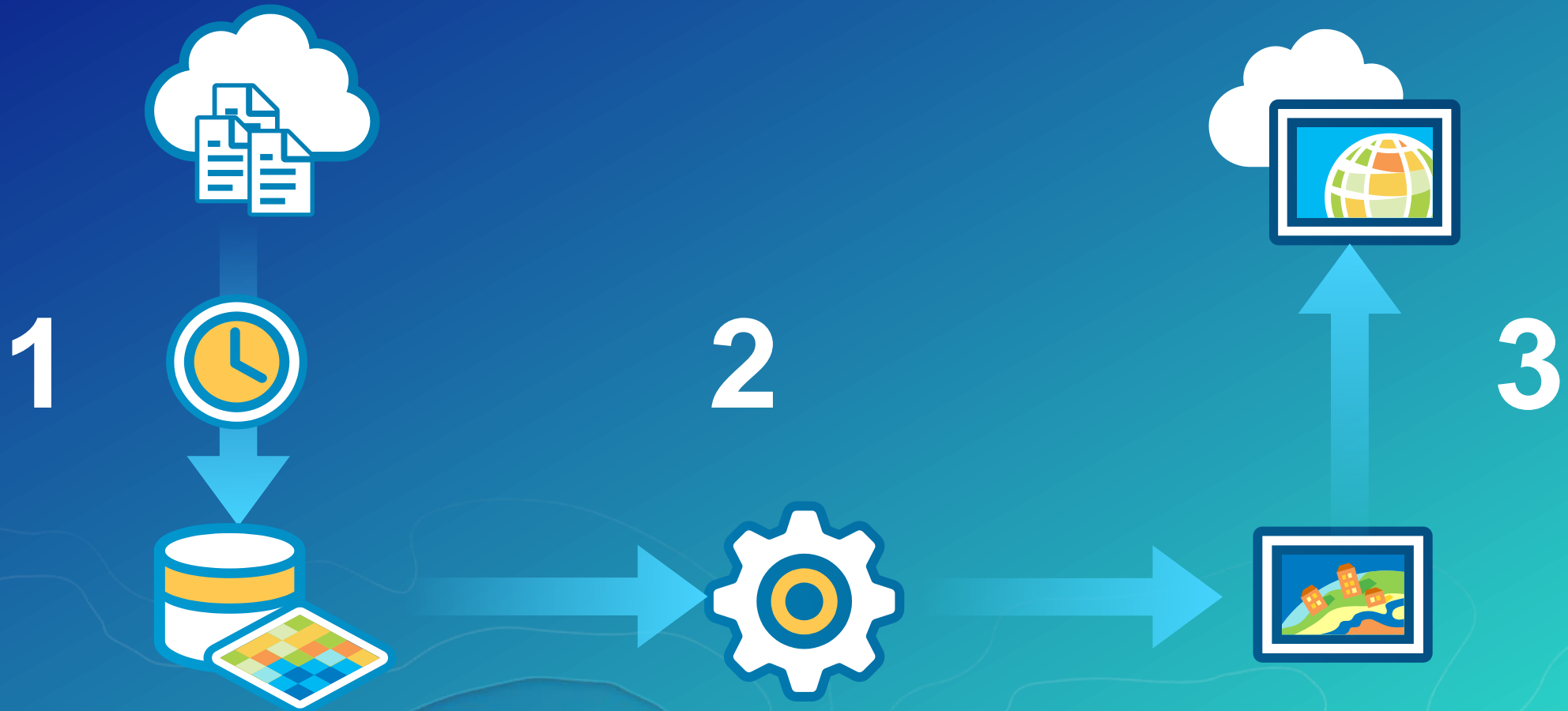
## North American Mesoscale Forecast System (NAM)

The North American Mesoscale Forecast System (NAM) is one of the major weather models run by the National Centers for Environmental Prediction (NCEP) for producing weather forecasts. Dozens of weather parameters are available from the NAM grids, from temperature and precipitation to lightning and turbulent kinetic energy. The NAM generates multiple grids (or domains) of weather forecasts over the North American continent at various horizontal resolutions. High-resolution forecasts are generated within the NAM using additional numerical weather models. These high-resolution forecast windows are generated over fixed regions and are occasionally run to follow significant weather events like hurricanes. The NAM home page is an excellent source of information for how the model is configured and run and an excellent source of forecast products.



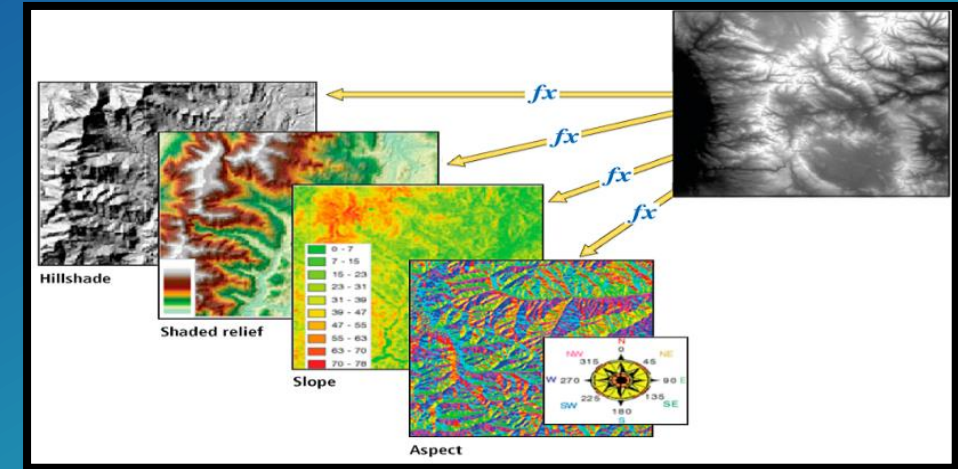
An animated image of NAM total surface 3-hourly precipitation, forecast from 03 UTC on July 10, 2012, to July 13, 2012, at 12 UTC. In the initial few frames, hurricane Emilia can be seen in the bottom left corner spinning off to the west. This image was produced with the Grid Analysis and Display System (GrADS) and ImageMagick.

# Forecast data process

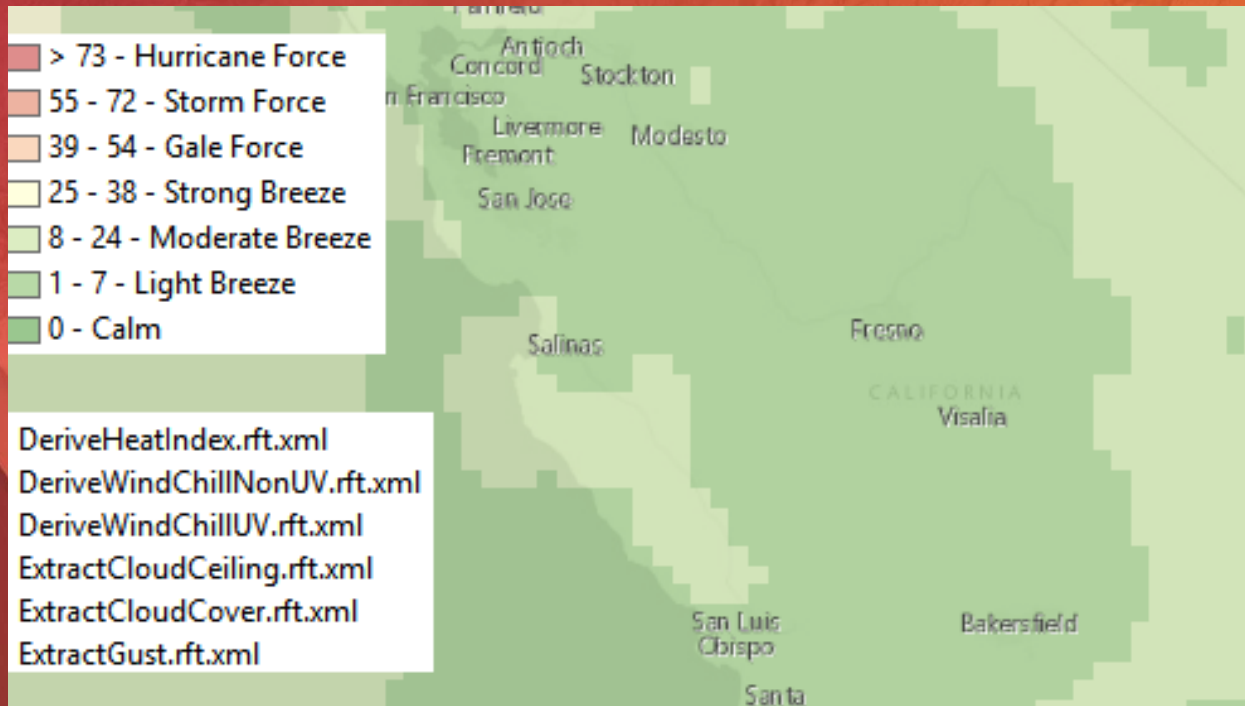


# Raster Function

- Geometric or Radiometric function applied pixel-by-pixel
- Hyper-efficient “on-the-fly” processing
- Chained together to create “processing chains”



# Forecasted weather and impacts



# Road Ahead – Fall/Winter 2017

## Terrain:

- Raster function based suitability
- Decouple from TDS schema
- Support for ArcGIS Pro

## Weather:

- More updated sources for climate data
- Support for ArcGIS Pro



# Questions?

... and answers

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[solutions.arcgis.com/#Defense](https://solutions.arcgis.com/#Defense)
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[geonet.esri.com/groups/defense-and-intelligence](https://geonet.esri.com/groups/defense-and-intelligence)
- Survey for our workshop:  
[Measuring Environmental Impact on Operations](#)

AT&T 8:18 AM 89%

< Defense Solutions: Measu... >

Defense & Intelligence (87)

FEEDBACK

The demo theater title was consistent with the demo theater

Low 1 2 3 4 5 High

The content of the demo theater was relevant to my work

Low 1 2 3 4 5 High

The presenter exhibited strong public speaking skills

Low 1 2 3 4 5 High

I would recommend this demo theater to a colleague?

Low 1 2 3 4 5 High

The presentation was organized and easy to understand

Low 1 2 3 4 5 High

The demo theater provided information or



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