Spatio-Temporal Data: Applications

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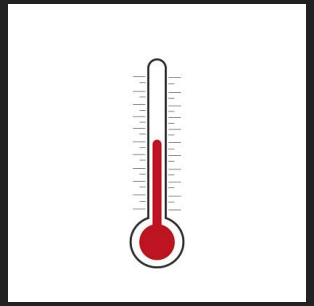
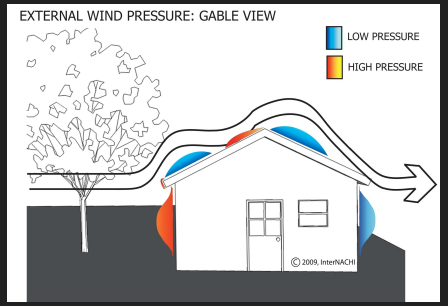
Outline

- Introduction
- Visual Interactive Dashboard (VIDa)
- Multi-Forcast Operations
- Curve Pattern Classification
- Evaluation
- Conclusion

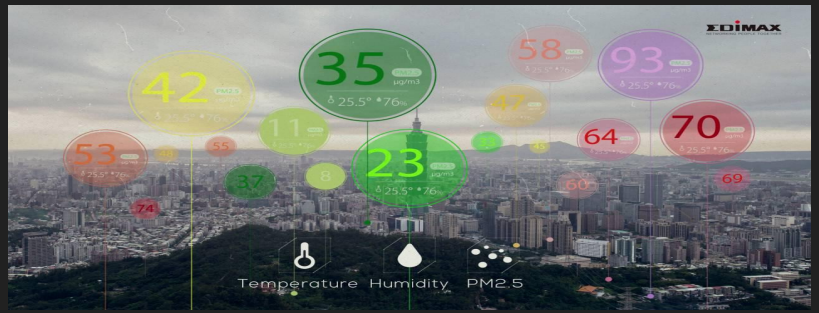
Introduction

- Atmosphere state is described by meteorological variables
  - temperature
  - pressure
  - moisture content
  - wind velocity
  - air quality
  - etc…



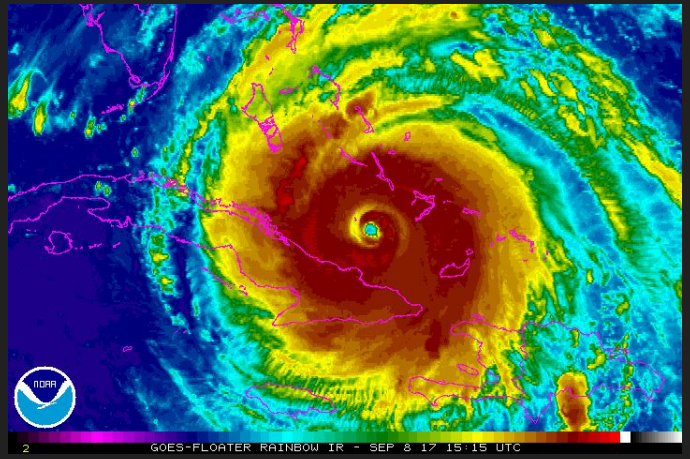


- Future predictions are made by Numerical Weather Prediction (NWP) models
  - contingent on having good representation of atmospheric state



Introduction

- Visualization tools facilitate data analysis of weather forecasts
  - provides insight for professional meteorologists/researchers
- Visual analysis can help identify
  - weather phenomena
  - atypical model behavior
  - model errors
- feedback given from meteorologists at Centro de Investigaciones del Mar y la Atmósfera in Buenos Aires, Argentina (CIMA)



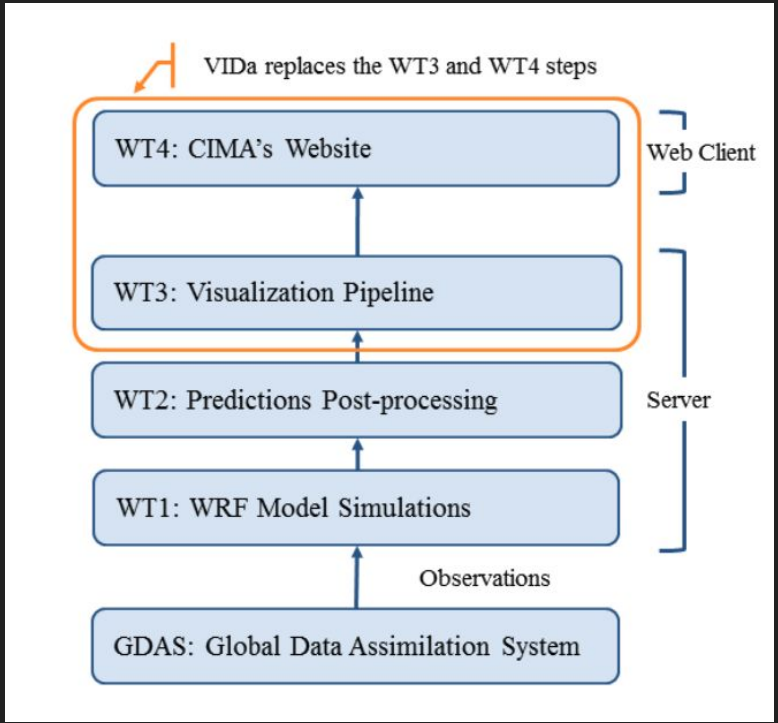
Introduction

- Visualization solution named “VIDa”
  - stands for Visual Interactive Dashboard
  - assists users in visual analysis of short-term weather forecasts
- Main Contributions
  - minimaps
    - variable-specific 2D geo-referenced projections
  - multi-forecast operations
    - i.e. addition/subtraction between 2D scalar-fields forecasts
  - curve-pattern selector tool
    - define pattern behaviors and classify output according to them
  - curve-pattern classification algorithm
    - arranges/analyzes forecasts which facilitates forecast verification
    - enables identification of temporal trends and atypical behaviors

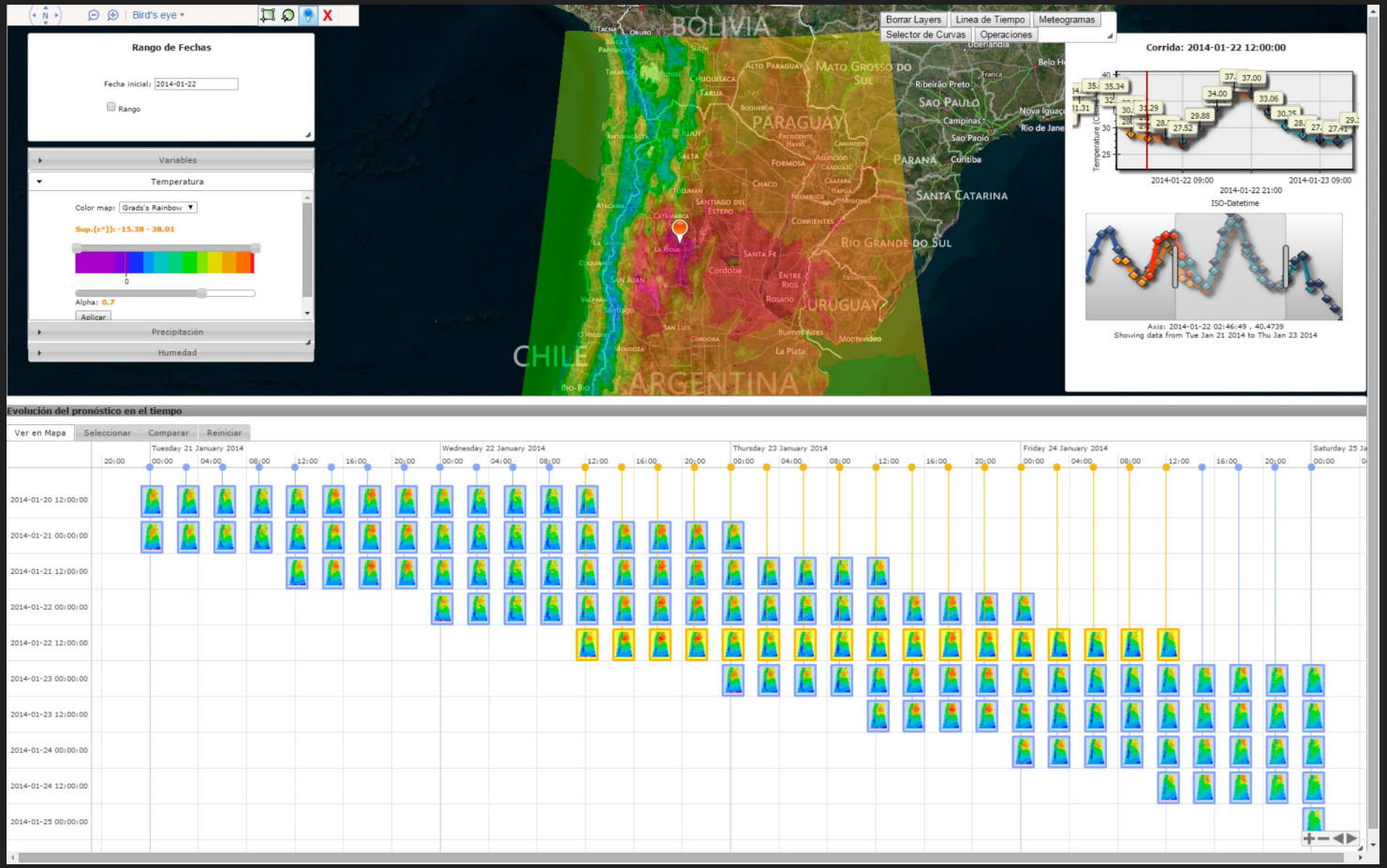
Previous Pipeline

1. Generation of numerical weather forecasts from observational data
2. Simulation outputs are post-processed
3. Specialists create new visualizations (2D plots)
4. Visualizations are exported as images

- Limitations
  - static interface
  - views cannot be linked/compared

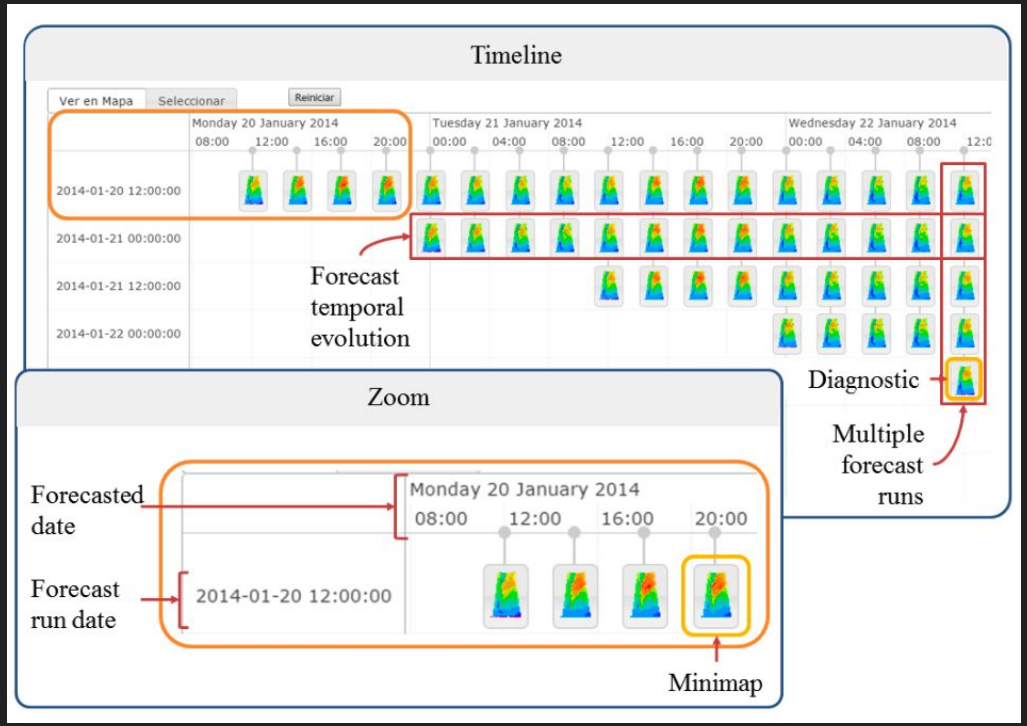


Visual Interactive Dashboard (VIDa)



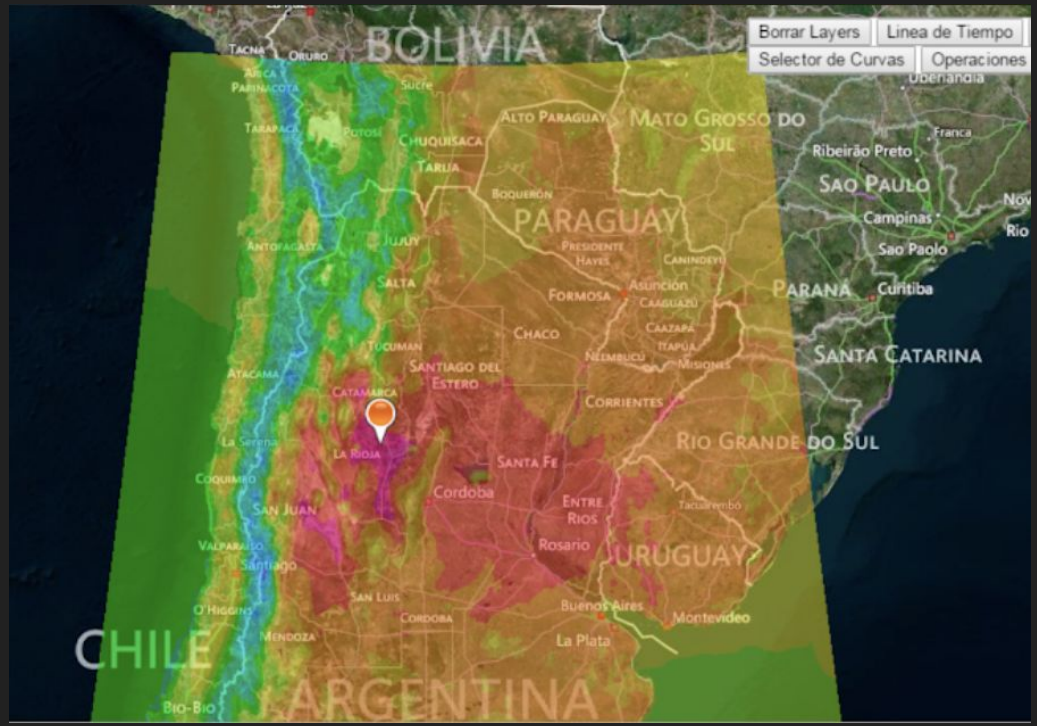
Minimap Timeline

- overview of complete 48-hour cycles of short-term weather-forecasts
- each minimap represents forecasted variable
- horizontal axis
  - temporal evolution of meteorlogical variable
- vertical axis
  - multiple forecasts given by date/time



Mapview

- Detailed 2D scalar-fields
- Forecasters can:
  - look at specific regions
  - apply spatial filters
  - analyze linked information
- Zoom ranges from 0-23x (depending on geographic locations)
  - 0x: world map fits in 512x512 pixels



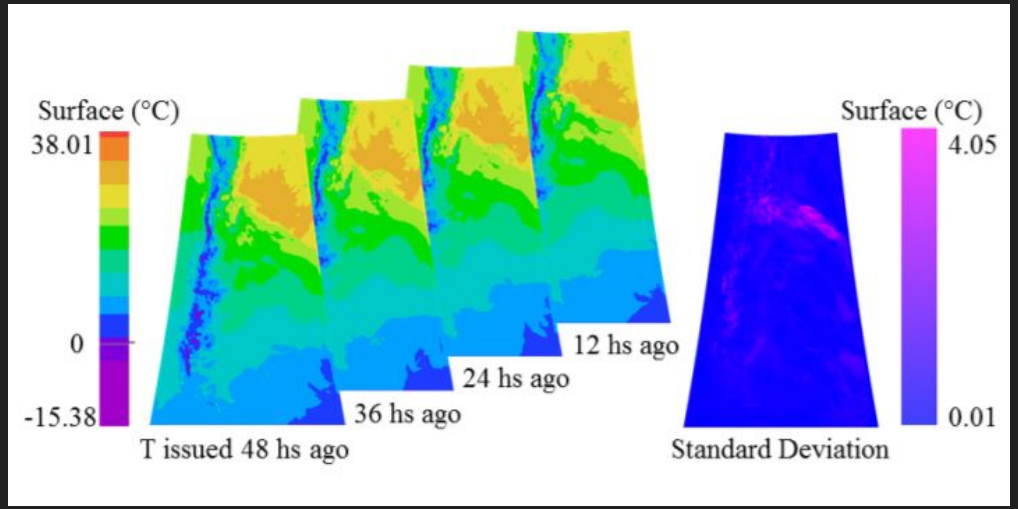
Multi-Forcast Operations

- Operations usually on Scalar fields (Temperature, pressure, precipitation)
- E.g. Select all cells with a delta of a certain threshold in a window of time.
- Typically described using Curve Patterns….
- Can perform on multiple scalar fields, (difference, unions, ect.)
- Data are large so operations run server-side rather than client-side.

-Carter S

Multi-Forcast Operations

- Often used for Forecast Verification (Uncertainty)
- Find any aberrant patterns and re-run them with small fixes.



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Curve Pattern Classification

"Curve Patterns" are usually some function of time

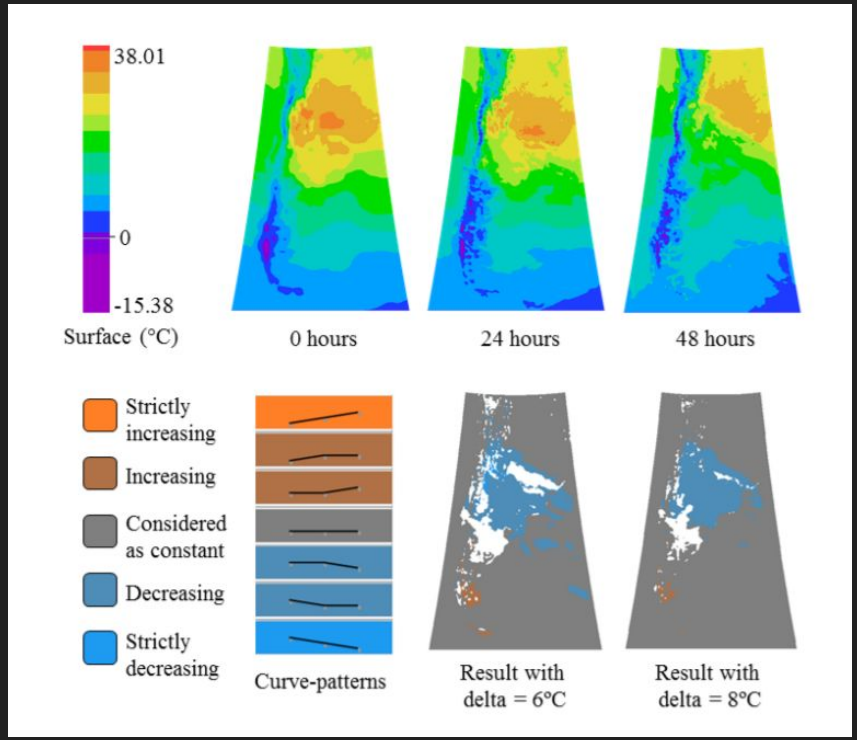
Selection uses visual drawing tool

Run per cell on server GPU

--pattern is converted to GPGPU code

Can specify what cells to check

E.g. only cells above sea level elevation



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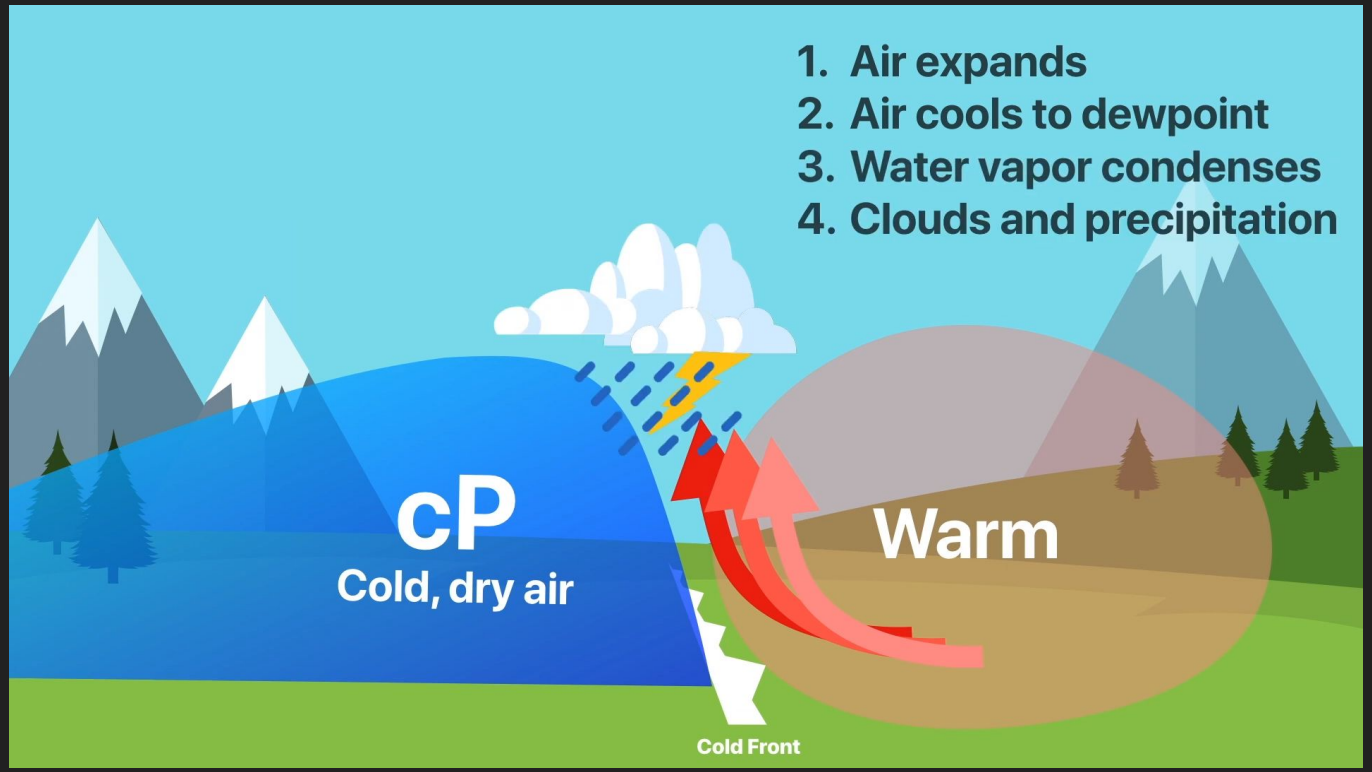
Evaluation

What is cold front?



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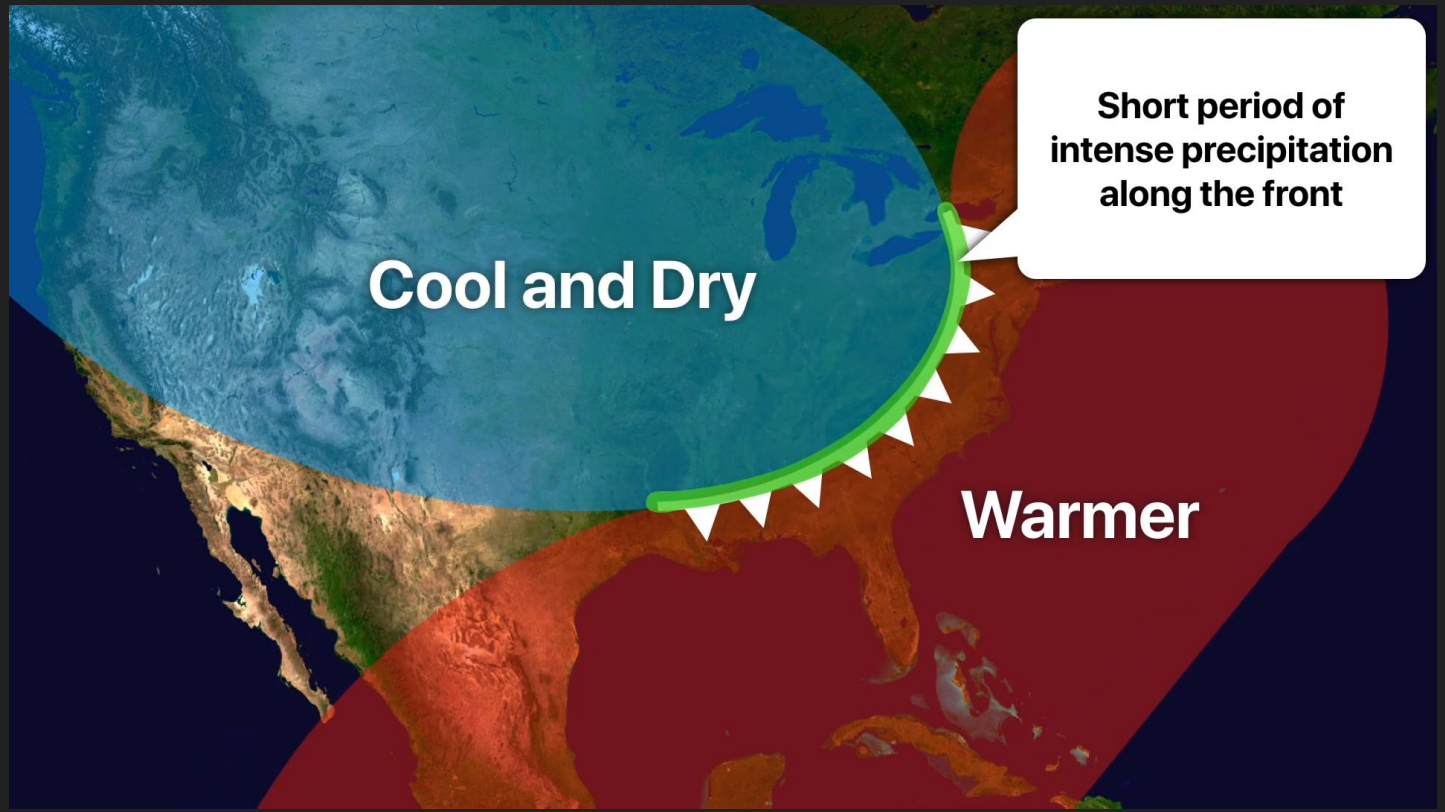
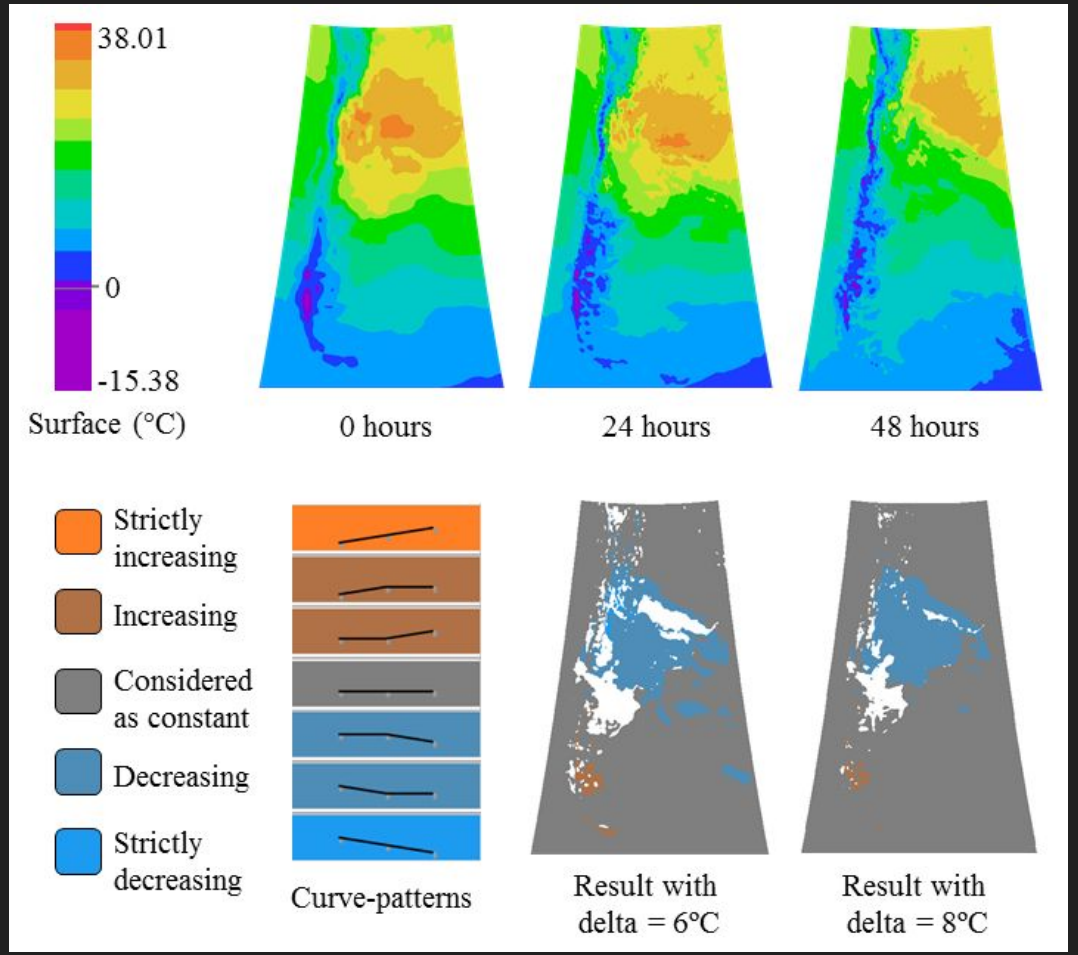


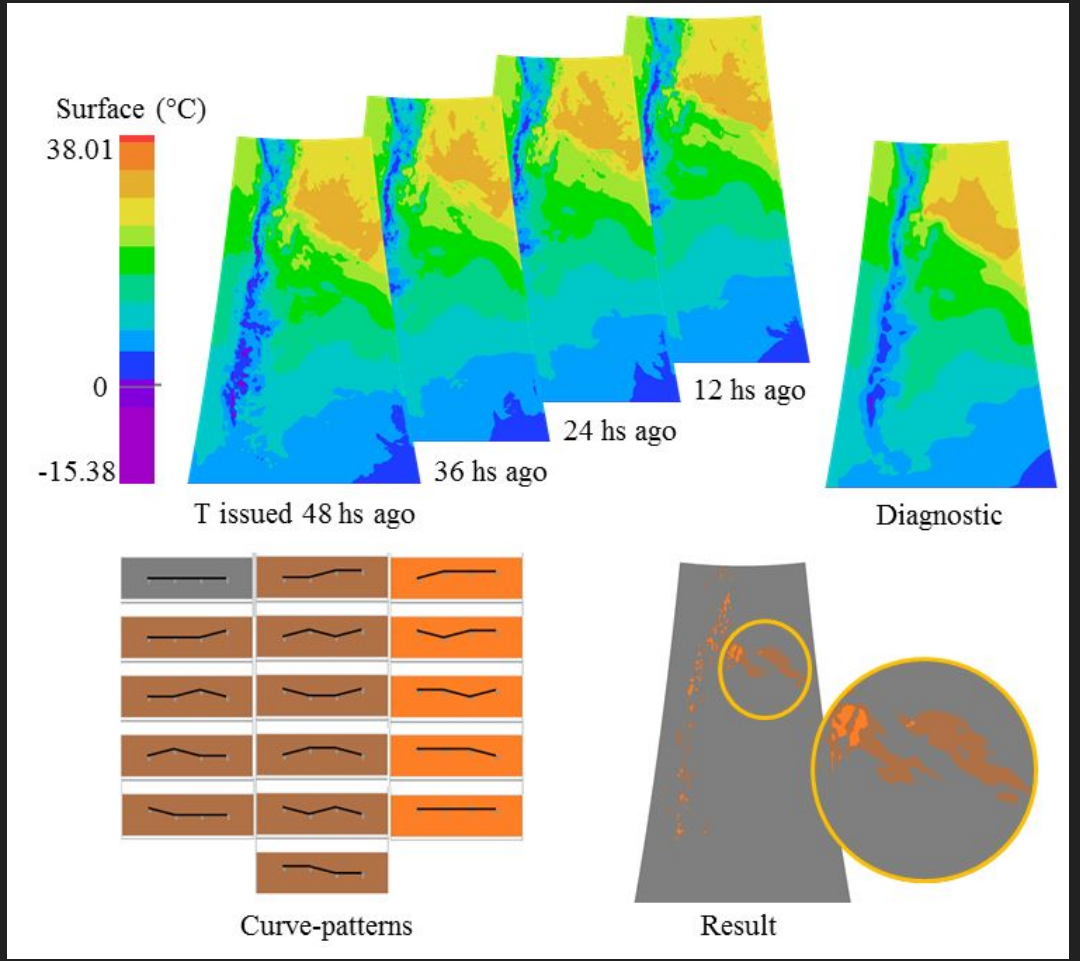
Analysis of Temporal Trends

This region corresponds to a cold-front event that was moving from south to north near the center of the domain and produces a significant temperature drop.

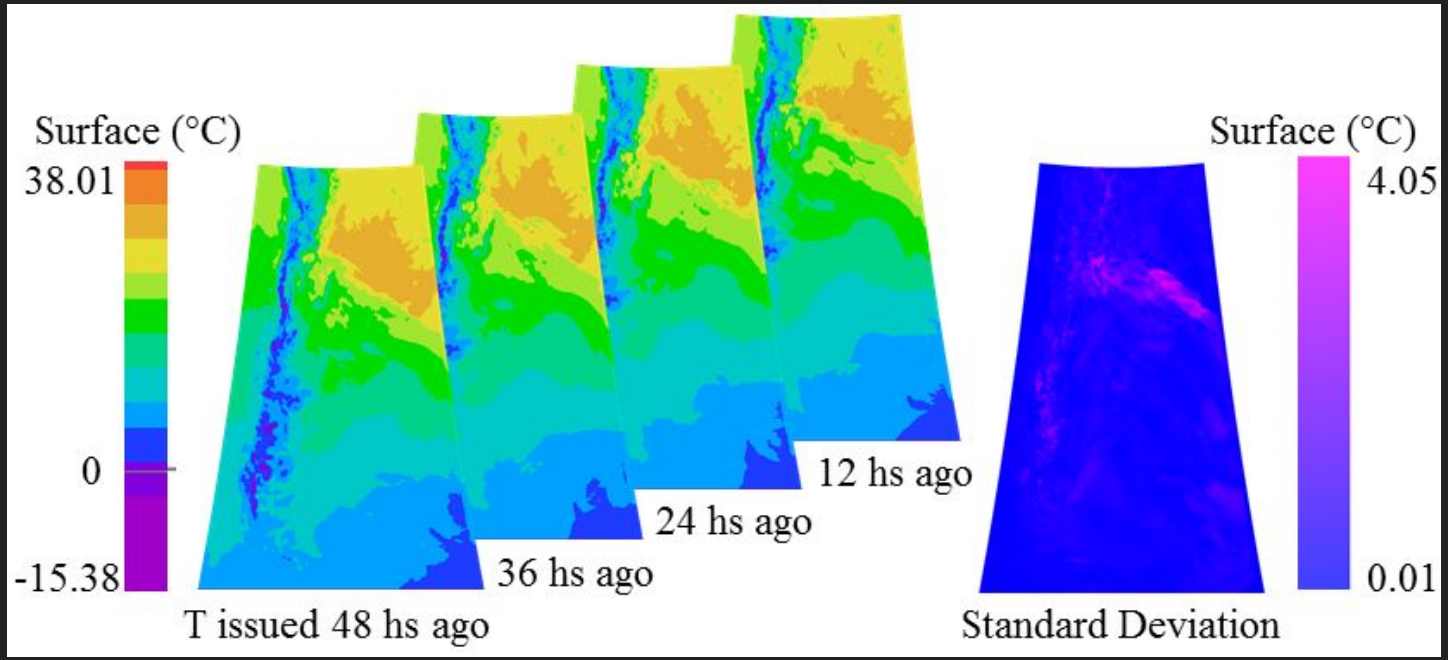


Forecast Verification

The performance is affected by the cold front introducing large errors in the forecasts.



Forecast Uncertainty Analysis



Conclusion

- Propose a solution to address weather forecast analysis.
- Providing a quick overview of short-term weather forecasts by means of a minimap timeline.
- Providing tool to apply different operations over two or more forecasts, in order to analyze forecast uncertainty.
- Introducing a curve-pattern selector tool and a classification technique for the analysis of multiple forecasts. By which temporal trends and forecast model errors can be identified and analyzed.

Any Questions?

Thank You.