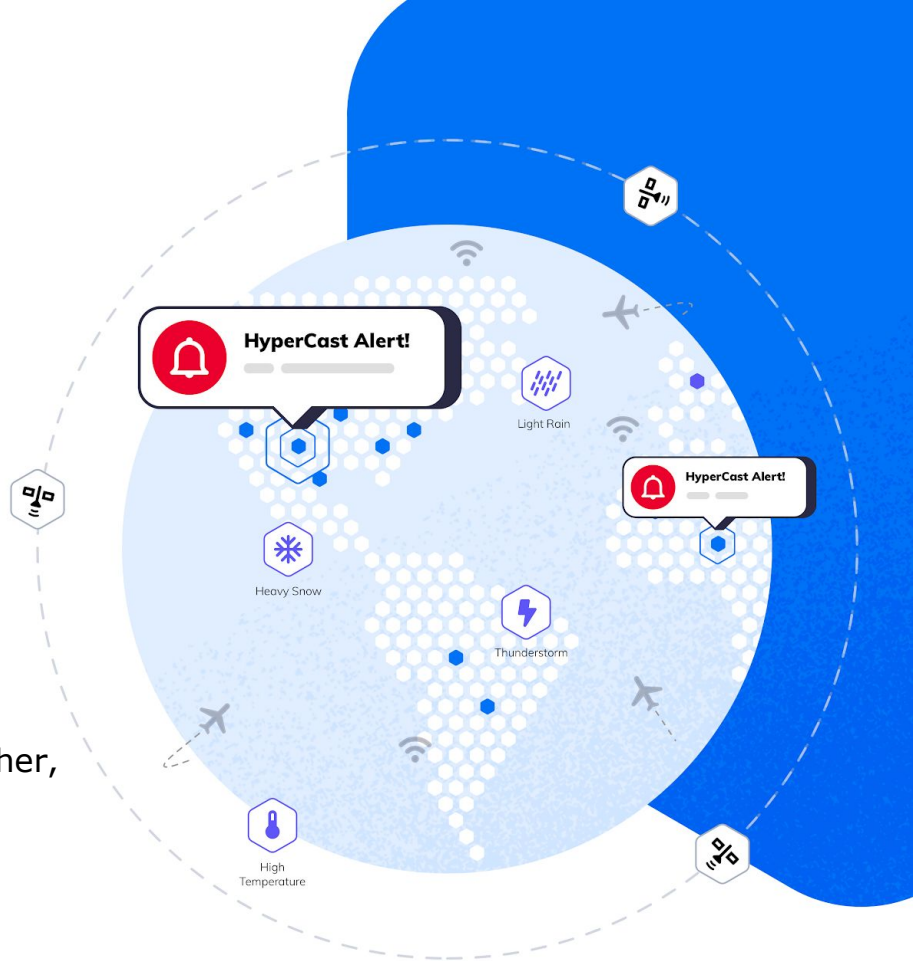


Challenges and Solutions of Numerical Weather Prediction on the Cloud

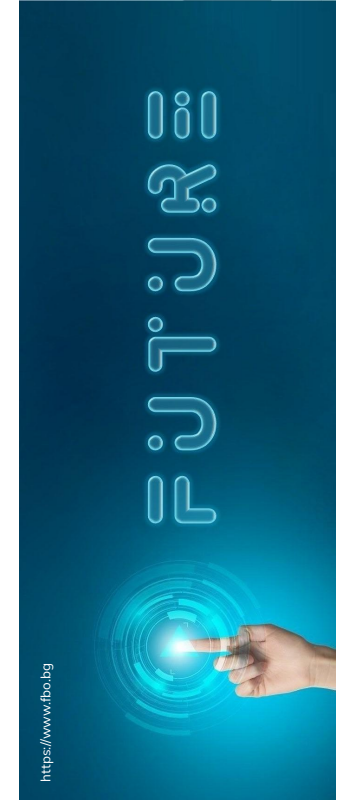
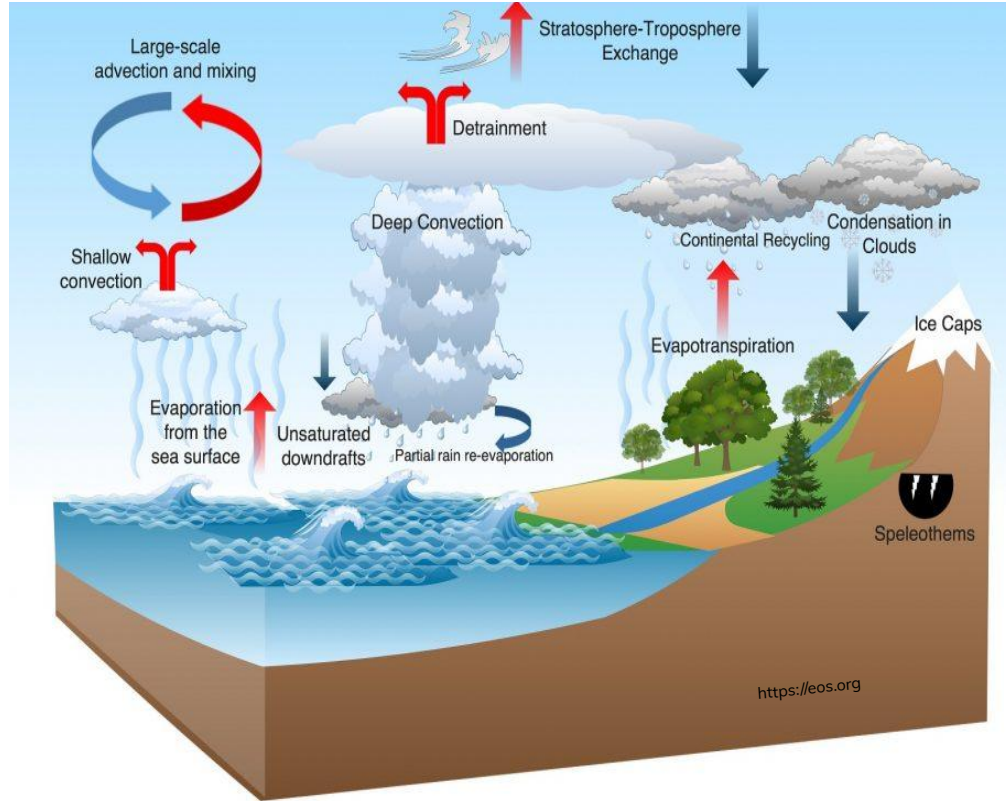
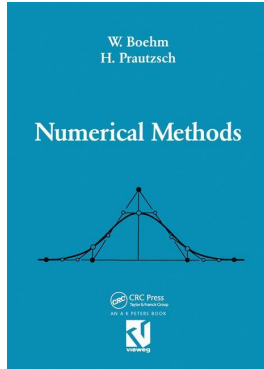
Iman Gohari, Ph.D.
NWP team, ClimaCell Inc.
AMS 100th Annual Meeting
6th Symposium on High Performance Computing for Weather,
Water, and Climate.
Boston, January 2020



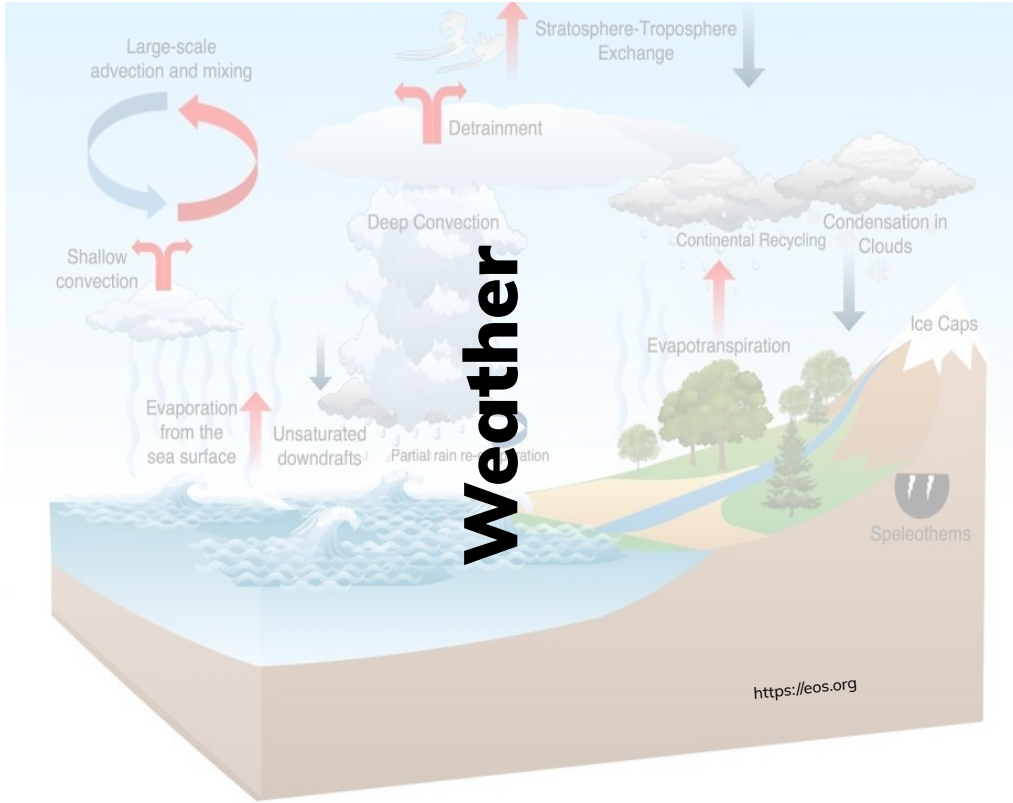
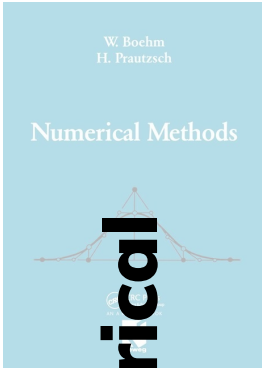
Agenda

- Numerical Weather Prediction: Basics
- ClimaCell Bespoke Atmospheric Model (CBAM)
- NWP on Cloud: Challenges
- NWP on Cloud: Solutions
- Conclusions

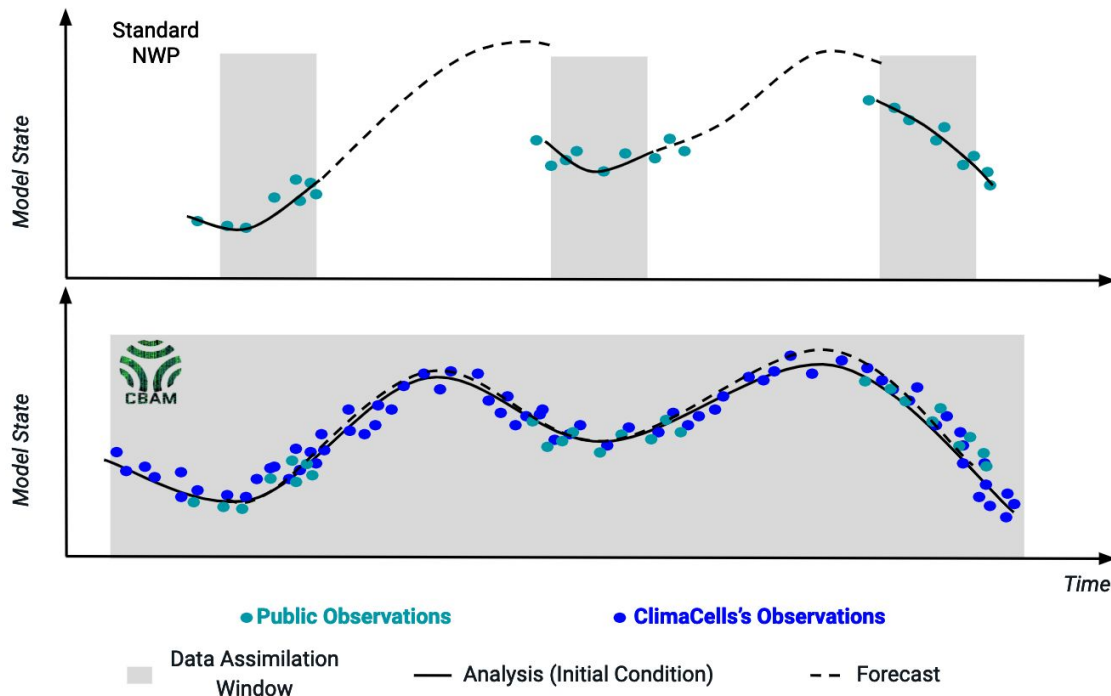
Numerical Weather Prediction: Basics



Numerical Weather Prediction: Basics



CBAM: Superior Forecast System



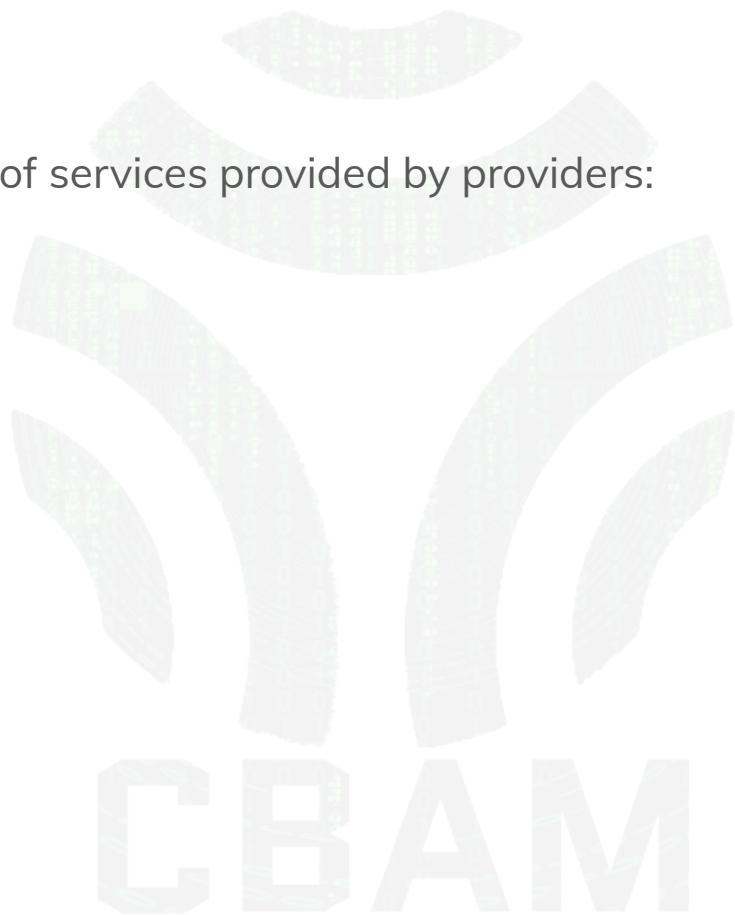
- ClimaCell Inc. has recently launched an automated, on-demand, scalable, cloud computing service for operational NWP modeling named ClimaCell Bespoke Atmospheric Model (CBAM).
- CBAM uses proprietary observations to fill the spatial and temporal gaps in publicly available weather observations
- Critical in data-sparse regions and rapid forecast cycles
- CBAM is a suite of atmospheric models that require extensive computational resources to operationally solve the laws of motion for accurate prediction of weather.
- CBAM includes a proprietary data assimilation system capable of traditional methods (e.g. 3DVar, etc) and assimilation of virtual sensors (e.g., Connected cars, Microwave link attenuation etc.)

NWP on Cloud: Challenges

- Variable latency among compute instances of unknown proximity:
 - Especially the interconnection speed
- Variability in hardware/software assigned to each virtual machine:
 - Especially in HPC applications which needs a scheduler software such as SLURM, TORQUE
- Occasional outages of different components:
 - Especially for highly competitive “compute-optimized” resources
- Unknown competition of multiple users operating VMs on the same hardware
- Data ingress/egress:
 - Especially for NWP application where data ingest/dessimnation is O(TB) per day
- Scalability:
 - Dynamic load balancing and recovery
- Security

NWP on Cloud: Solutions

- Choosing proper resources among the vast suite of services provided by providers:
 - Cloud-optimized vs general-purpose instances?
 - Network-optimized vs general-purpose instances?
 - Full-size or half-size instances?
 - High-speed vs regular filesystem?
- Designing a system that includes:
 - Fault-tolerance
 - Composite of fully-monitored microservices
 - (mostly) cloud-agnostic development



CBAM Use Cases: Results

Summary stat of **high** arithmetic intensity case

Cloud Provider	MPI Ranks	Average Compute Time [s]	Average I/O Time [s]	Variability* [%]
Option 1	108	1.280	9.587	4.12
Option 2	90	1.309	8.500	2.68

Summary stat of **extreme** arithmetic intensity case

Cloud Provider	MPI Ranks	Average Compute Time [s]	Average I/O Time [s]	Variability* [%]
Option 1	540	4.065	2.969	7.97
Option 2	435	11.517	1.890	11.40

Conclusions

- ClimaCell's ultimate goal is to have extremely competitive Service Level Agreement (SLA) for CBAM on Cloud services that encompasses:
 - Any customer expectation/need
 - Measurable/transparent standards
- To meet such goal ClimaCell's NWP team exercises best practices using:
 - **Clusters equipped with compute- and network- optimized instances**
 - **A software design based on fault-tolerance and microservices**
- Consequently, ClimaCell has achieved **>99.0% SLA*** for CBAM forecast worldwide, following the best practices summarized before.

Announcement



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January 7, 2020 • 3 min read

ClimaCell Announces Collaboration With Google Cloud on Weather Forecasting With 5X Jump in Resolution, Starting in India



ClimaCell, a weather technology company based in Boston, announced today a strategic collaboration with Google Cloud to deliver free access to high fidelity weather forecasting models in geographies that currently lack such services. The models' outputs will be made accessible through Google Cloud's public dataset program.

ClimaCell is committed to making critical data free and accessible, fostering innovation. Starting in India, ClimaCell's models will be available to the general public, including developers, scientists and business users alike.

The ClimaCell Bespoke Atmospheric Model ("CBAM") feeds from its proprietary "Weather-of-Things™" inputs, which add millions of new observations that have not been previously used for weather forecasting. From wireless signals to cars sensors, ClimaCell leverages the connected world to bridge the large sensing gap and to help improve forecasting anywhere in the world.



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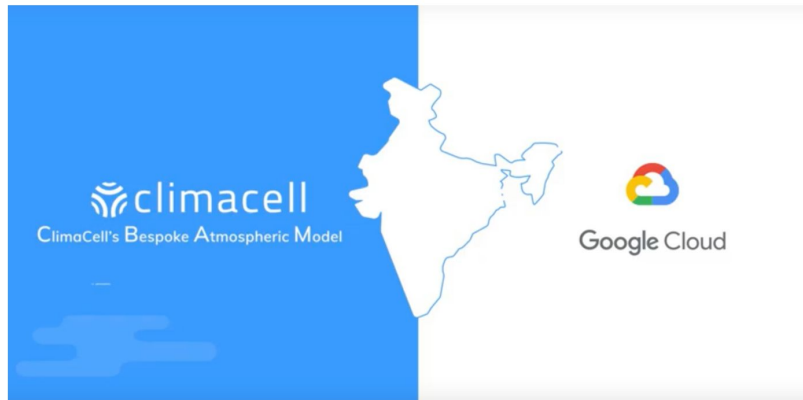
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Google and ClimaCell team up to launch a new high-resolution weather forecast for India

Frederic Lardinois @fredericl / 9:00 am MST • January 7, 2020

[Comment](#)



Weather technology company **ClimaCell**, which is taking a number of **innovative approaches** for gathering weather data and building forecasting models, today announced that it is partnering with Google Cloud to launch a new high-resolution forecasting model. The first model will focus on India, with other geographies following soon. ClimaCell and **Google** will make the forecast available for free through the Google Cloud Public Datasets program.

The model will provide forecasts for the next 48 hours and have a resolution of 2km and 15-minute timesteps. It will also serve as the foundation for other weather products from ClimaCell for predicting floods, air quality and more.



Thank You!