7 Summary of the Webinar Presentation

Noel Cressie

10 January, 2025
Hosted by: Spatial Analysis and Simulation Lab/Community (SASL)
Title: **Mapping and Monitoring Carbon Dioxide from Space**

Introduction

Spatial Analysis and Simulation Lab (SASL) hosted its first webinar of the 2025 series, focusing on advancements in climate monitoring and carbon dioxide tracking using satellite-based technologies. Nabil Mohareb, Associate Professor and host of the session, welcomed the attendees and emphasized SASL's commitment to fostering interdisciplinary research and academic dialogue. The webinar aimed to explore cutting-edge topics related to spatial analysis, urban simulation, and environmental challenges.

Opening Remarks and Contextual Framework

Dr. Nabil introduced the session by highlighting SASL's mission to integrate smart urban planning and sustainability through spatial analysis, urban simulation, and environmental challenges. He outlined the lab's past achievements, including workshops, previous webinars, and research reports, and encouraged attendees to engage actively in the discussions.

Professor Noel Cressie is a Distinguished Professor at the University of Wollongong, Australia, and Director of the university's Centre for Environmental Informatics. He is a world-renowned expert in spatio-temporal statistics and satellite remote sensing. He has authored four books and over 350 peer-reviewed publications. His recent research focuses on tracking global atmospheric CO_2 and studying Antarctica's environmental future. He is a Fellow of the Australian Academy of Science, the Royal Society of New South Wales, and several other prestigious societies.

Presentation Insights

- **Carbon Cycle Dynamics:**
    - Professor Cressie detailed the global carbon cycle, explaining how carbon moves between terrestrial, atmospheric, and oceanic pools.
    - He emphasized the long-term carbon storage in terrestrial pools, such as fossil fuels, and the adverse impact of its rapid release into the atmosphere through human activities.
- **Overview of the OCO-2 Satellite:**

- OCO-2, launched in July 2014, orbits the Earth 14 times daily and provides high-precision data on atmospheric CO_2 concentrations.
- He explained the concept of Basic Areal Temporal Units (BATUs), representing a grid of 1-degree latitude by 1-degree longitude by one- month cells. This aggregation allows for meaningful spatial-temporal analysis.

- **Keeling Curve Analysis:**
  - The Keeling Curve was discussed, showing the rise of CO_2 levels from 1960 to the present. Cressie highlighted the periodic fluctuations due to seasonal photosynthesis and respiration cycles.
  - He pointed out that despite seasonal variations, the overall trend is a continuous increase in CO_2 levels at about 2 ppm per year, with current levels exceeding 420 ppm.
- **Spatio-Temporal Filtering:**
  - Cressie introduced spatio-temporal filtering techniques used to analyze satellite data. He demonstrated how filtering helps isolate the anthropogenic signal from natural atmospheric CO_2 variability.
- **Regional CO_2 Emission Patterns:**
  - Using filtered data, he presented regional maps showing CO_2 emissions and absorption across different latitudes.
  - He explained the zonal nature of CO_2 distribution in the atmosphere, noting that most variability occurs in the Northern Hemisphere due to industrial activity and land-mass distribution.
- **Impact of COVID-19:**
  - The presentation included a detailed analysis of the temporary reduction in CO_2 emissions during the COVID-19 pandemic. Cressie noted that while emissions decreased by more than 5%, the long-term trend resumed unaffected.
- **Challenges in Achieving Net Zero:**
  - He discussed the goal of achieving net zero emissions by 2050, emphasizing the need to halt the increase in CO_2 levels and actively reduce atmospheric CO_2.
  - He warned of potential tipping points, such as the saturation of oceanic carbon sinks, which could accelerate climate change if not mitigated.

Interactive Session (Q & A)

The interactive session featured several insightful questions from the audience:

- **Global Tipping Points and Prediction Models:**
  An inquiry about when Earth's ecosystems might reach a breaking point where they can no longer absorb CO_2 effectively. Cressie explained that while exact predictions are difficult, monitoring trends and employing predictive models could help signal when such a tipping point might occur. He emphasized the importance of international cooperation and technological innovation to prevent such scenarios.

- **Industrial and Economic Shifts:**
  Another point raised concerns about how industrial shifts between countries could impact global emissions, noting that if one country reduces emissions, others might increase theirs to gain economic advantage. Cressie acknowledged this challenge and highlighted the role of international agreements like the Conference of the Parties (COP) in ensuring that all countries contribute fairly to emission-reduction efforts.
- **Urban Planning Applications:**
  Regarding the applicability of satellite data in urban planning, Cressie discussed how instruments like OCO-3, mounted on the International Space Station, can provide targeted measurements of urban carbon footprints. He highlighted ongoing studies in Los Angeles and the potential for similar analyses in Cairo.
- **Aquatic Impact of CO_2 Absorption:**
  An inquiry was made about the effects of increased CO_2 absorption on marine life. Cressie explained the process of ocean acidification and its impact on marine ecosystems, on coral reefs. and particularly on plankton, which forms the base of the marine food web.
- **Real-Time Monitoring Tools:**
  A question was raised about real-time monitoring tools for construction projects. Cressie noted that while global-scale monitoring is possible through satellites, localized monitoring requires ground-based instruments and bottom-up estimation methods.

Key Takeaways

1. **Data Integration:**
   Combining satellite-based observations with bottom-up estimates based on inventories of carbon sources and sinks enhances the accuracy of carbon footprint assessments and provides actionable insights for policymakers.
2. **Urban and Regional Applications:**
   Spatial data from satellites can aid in designing sustainable cities by identifying emission hotspots, optimizing infrastructure, and monitoring progress toward decarbonization.
3. **Global Responsibility:**
   Coordinated international efforts are crucial for addressing climate change. While local actions matter, global cooperation is essential to achieve significant results.
4. **Research and Innovation:**
   There is a pressing need for continued research and innovation in carbon capture and storage, renewable energy, and sustainable urban design. Labs like SASL can play a pivotal role in these endeavors.

Conclusion

The webinar concluded with closing remarks thanking Professor Noel Cressie for his insightful presentation and valuable contributions. He reiterated the importance of collaborative research and the role of academic institutions in addressing global challenges.

SASL looks forward to hosting more such webinars and fostering collaborations to advance research in spatial analysis, smart urban planning, and environmental sustainability.

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